EUROPEAN COMMISSION
Directorate-General for Research and Innovation

RTD.C – Clean Planet
C.4 – Euratom Research

AMENDMENT Reference No AMD-847552-61

Grant Agreement number: 847552 — Supplying Accurate Nuclear Data for energy and non-energy Applications (SANDA)

The parties agree to amend the Grant Agreement as follows ('**Amendment**'):

1. Change of Annex 1 (description of the action)

Annex 1 is changed and replaced by the Annex 1 attached to this Amendment.

2. Change of the action's duration

The duration of the action in **Article 3** is changed to 60 months.

3. Change of the reporting periods

The reporting periods are changed.

This implies the **following changes** to the Grant Agreement:

- The reporting periods in **Article 20.2** are replaced by:

  - RP1: from month 1 to month 18
  - RP2: from month 19 to month 36
  - RP3: from month 37 to month 60

All other provisions of the Grant Agreement and its Annexes remain unchanged.

This Amendment **enters into force** on the day of the last signature.

This Amendment **takes effect** on the date on which the amendment enters into force, except where a different date has been agreed by the parties (for one or more changes).

Please inform the other members of the consortium of the Amendment.

SIGNATURES

For the coordinator

Yolanda Benito with ECAS id nlopcaye signed in the Participant Portal on 11/08/2023 at 17:49:25 (transaction id SigId-9899-1tyyPxX PkUKUALru68nb7KuozngVt7lPGGug3XpzikKlO0X9lhMgahWHZf3OV SwrZJy7c5maxo1zfwtnHvLFwnW-rS0vSrmBGYCB6RrHHY290e-qtGlO mvCjmY9DRZu2bIBe7qofJzThM8KydBpzn6uuTGzgKS1p7e8a3hbZq WZWS34mDEEnXRP0l4tyiAY2viwdym). Timestamp by third party at 2023.08.11 17:49:43 CEST

For the Commission

Signed by Yves DEJAEGERE with ECAS id dejaeyv as an authorised representative on 24-08-2023 11:35:53 (transaction id SigId-26023-AlEKSlPrVuFqxzS7L3JloxKxlsTh6BMLZaUrOCTerUbzGF6HPkfXSza7S dzSXzUEyBMO6nHjQR3vyqUt90KRJgH-rS0vSrmBGYCazaoYLaDdfU-5S9gJiLcQdjXk15AIfLmByIaYn0Fsi4RHLsWKsRQ5m6zu6vjzGbgOPcl dAdiSzudSxEL3597pQ1vV9XzHJ6zSRA)
2023.08.24 11:35:57 CEST

Enclosures:

Annex 1

EUROPEAN COMMISSION
Directorate-General for Research and Innovation

RTD.C – Clean Planet
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ANNEX 1 (part A)

Research and Innovation action

NUMBER — 847552 — SANDA

Table of Contents

1.1. The project summary

Project Number [1]	847552	Project Acronym [2]	SANDA

One form per project

General information	
Project title [3]	Supplying Accurate Nuclear Data for energy and non-energy Applications
Starting date [4]	01/09/2019
Duration in months [5]	60
Call (part) identifier [6]	NFRP-2018
Topic	NFRP-2018-4 Improved nuclear data for energy and non-energy modelling applications.
Fixed EC Keywords	Nuclear physics, Nuclear related engineering, Very large data bases
Free keywords	Nuclear Data - Experiments – Evaluation – Uncertainties- Cross section and nuclear structure libraries for Safety, Simulation, Performance, Medical and other applications

Abstract [7]

Supplying Accurate Nuclear Data for energy and non-energy Applications.
The project will include experimental measurements of new or improved quality data, evaluation, validation and dissemination of the data to produce libraries that can be used by safety authorities, research institutions, the nuclear energy industry, health organizations, other non-energy applications and the EU society at large. The project will also include in smaller fraction support to detector development, facility setups and samples fabrication to prepare important measurements and validations that are not possible in the time framework of the present proposal but that will be required in near future for the safe and efficient use of nuclear technologies.
The selection of topics, isotopes, reactions, measurements, experiments and evaluation has been made taking into account the relevance, expected impact and priorities of the resulting data according to the NEA/OECD and IAEA high priority lists and committees as well as the experience of the participants and of previous EU proposals with large participation of the partners for the present proposal (CHANDA, ANDES,…). The impact has been evaluated from the perspective of a safe, efficient and competitive use of nuclear technologies.
In comparison with previous projects, the present proposal proposes to concentrate more efforts on delivering actual results than in the preparation for the future, by enhancing the support to evaluations, validations and actual measurements. Also special attention has been paid to make sure that the topics included cover the non-energy application requiring nuclear data as well as it will cover the needs of the nuclear energy sector.
Respecting those principles, the proposal has also tried to be as inclusive to the different EU research groups and countries as possible maintaining the manageability of the project, its efficiency and the maximum quality and relevance of the action and involved partners.

1.2. List of Beneficiaries

Project Number [1]	847552	Project Acronym [2]	SANDA

List of Beneficiaries

No	Name	Short name	Country	Project entry date[8]	Project exit date
1	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	CIEMAT	Spain		
2	ATOMMAGKUTATO INTEZET	ATOMKI	Hungary		
3	COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES	CEA	France		
4	ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE	CERN	Switzerland		
5	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	CNRS	France		
6	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	CSIC	Spain		
7	CENTRUM VYZKUMU REZ SRO	CVREZ	Czechia		
8	AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE	ENEA	Italy		
9	HELMHOLTZ-ZENTRUM DRESDEN-ROSSENDORF EV	HZDR	Germany		
10	INSTITUTUL NATIONAL DE CERCETARE-DEZVOLTARE PENTRU FIZICA SI INGINERIE NUCLEARA-HORIA HULUBEI	IFIN-HH	Romania		
11	INSTITUT DE RADIOPROTECTION ET DE SURETE NUCLEAIRE	IRSN	France		
12	IST-ID ASSOCIACAO DO INSTITUTO SUPERIOR TECNICO PARA A INVESTIGACAO E O DESENVOLVIMENTO	IST-ID	Portugal		
13	JRC -JOINT RESEARCH CENTRE-EUROPEAN COMMISSION	JRC	Belgium		
14	INSTITUT JOZEF STEFAN	JSI	Slovenia		
15	JYVASKYLAN YLIOPISTO	JYU	Finland		
16	KARLSRUHER INSTITUT FUER TECHNOLOGIE	KIT	Germany		
17	USTAV JADERNE FYZIKY AV CR	NPI	Czechia		
18	NPL MANAGEMENT LIMITED	NPL	United Kingdom		

1.2. List of Beneficiaries

No	Name	Short name	Country	Project entry date[8]	Project exit date
19	NUCLEAR RESEARCH AND CONSULTANCY GROUP	NRG	Netherlands		
20	ETHNICON METSOVION POLYTECHNION	NTUA	Greece		
21	PAUL SCHERRER INSTITUT	PSI	Switzerland		
22	PHYSIKALISCH-TECHNISCHE BUNDESANSTALT	PTB	Germany		
23	STUDIECENTRUM VOOR KERNENERGIE / CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE	SCK-CEN	Belgium		
24	SOFIA UNIVERSITY ST KLIMENT OHRIDSKI	Sofia	Bulgaria		
25	TECHNISCHE UNIVERSITAET WIEN	TUW	Austria		
26	UNIVERSITATEA DIN BUCURESTI	UB	Romania		
27	UNIWERSYTET LODZKI	ULODZ	Poland		
28	JOHANNES GUTENBERG-UNIVERSITAT MAINZ	UMAINZ	Germany		
29	THE UNIVERSITY OF MANCHESTER	UMANCH	United Kingdom		
30	PANEPISTIMIO IOANNINON	UOI	Greece		
31	UNIVERSITAT POLITECNICA DE CATALUNYA	UPC	Spain		
32	UNIVERSIDAD POLITECNICA DE MADRID	UPM	Spain		
33	UNIVERSIDAD DE SANTIAGO DE COMPOSTELA	USC	Spain		
34	UNIVERSIDAD DE SEVILLA	USE	Spain		
35	UPPSALA UNIVERSITET	UU	Sweden		

1.3. Workplan Tables - Detailed implementation

1.3.1. WT1 List of work packages

WP Number[9]	WP Title	Lead beneficiary[10]	Person-months[11]	Start month[12]	End month[13]
WP1	Developments of new innovative detector devices	5 - CNRS	80.80	1	60
WP2	New nuclear data measurements for energy and non-energy applications	1 - CIEMAT	213.00	1	60
WP3	Target Preparation for Improvement of Nuclear Data Measurements	21 - PSI	66.20	1	60
WP4	Nuclear data evaluation and uncertainties	21 - PSI	173.20	1	60
WP5	Nuclear data validation and integral experiments	3 - CEA	69.20	1	60
WP6	Management, ND research coordination at EU level and Education and Training	1 - CIEMAT	27.40	1	60
		Total	629.80		

1.3.2. WT2 list of deliverables

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D1.1	Report on the study and construction of new devices for precise fission cross section measurements	WP1	5 - CNRS	Report	Public	54
D1.2	Report on the design of the large gas cell for IGISOL	WP1	15 - JYU	Report	Public	50
D1.3	Report on the performances of new devices for precise study of fission products and their decay in view of measurements	WP1	3 - CEA	Report	Public	24
D1.4	Report on the commissioning of a compact broad-band fast neutron spectrometer	WP1	3 - CEA	Report	Public	50
D1.5	Report on the performance of the SCONE setup at NFS	WP1	3 - CEA	Report	Public	48
D1.6	Report on the performance of the HPGe equipped with newly developed electronics	WP1	4 - CERN	Report	Public	48
D1.7	Report on the development and performances of the new detectors for capture cross section measurements at n-TOF	WP1	1 - CIEMAT	Report	Public	48
D1.8	Report on the development and performances of the new detectors for non-energy applications	WP1	22 - PTB	Report	Public	24
D2.1	Report on the (n,f) cross section measurements	WP2	29 - UMANCH	Report	Public	48
D2.2	Report on the (n,chp) cross section measurements	WP2	5 - CNRS	Report	Public	54
D2.3	Report on the 239Pu(n,g),	WP2	8 - ENEA	Report	Public	56

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
	92,94,95Mo(n,g) cross measurements at n_TOF and GELINA					
D2.4	Report on the 239Pu, 233U, 14N and 35,37Cl inelastic cross section measurements at GELINA	WP2	10 - IFIN-HH	Report	Public	59
D2.5	Report on the measurements of the branching ratio for 209Bi, 208Pb(n,tot) and 238U(n,inel) cross sections at GELINA.	WP2	13 - JRC	Report	Public	56
D2.6	Report of the decay data measurements performed with DTAS and BELEN	WP2	6 - CSIC	Report	Public	48
D2.7	Report on the development of a new technique for obtaining low resolution information on the beta delayed neutron energies with BELEN-like detectors.	WP2	31 - UPC	Report	Public	30
D2.8	Report on the method based on the PI-ICR technique for general fission product yield studies at JYFL	WP2	15 - JYU	Report	Public	51
D2.9	Spectrum averaged cross sections for dosimetry	WP2	18 - NPL	Report	Public	56
D2.10	Report on the measurement of double-differential charged-particle emission cross sections at the CERN n_TOF facility in the neutron energy range from 20 MeV to 200 MeV	WP2	22 - PTB	Report	Public	56
D2.11	Report on the production cross sections of beta+ emitters used for range verification in proton therapy.	WP2	34 - USE	Report	Public	30

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D2.12	Report on the fission yield studies with the LOHENGRIN spectrometer at ILL	WP2	5 - CNRS	Report	Public	48
D2.13	Report on fission yield studies with FALSTAFF at NFS	WP2	3 - CEA	Report	Public	52
D2.14	Report on fission yield studies in inverse kinematics at FAIR	WP2	33 - USC	Report	Public	34
D2.15	Report on the of half-live and gamma-ray emission probabilities of beta emitters measurement	WP2	3 - CEA	Report	Public	48
D3.1	Report on the meetings performed in the frame of ("Producer - user - interaction")	WP3	21 - PSI	Report	Public	36
D3.2	Report on the meetings performed in the frame of "Network of target producers"	WP3	13 - JRC	Report	Public	58
D3.3	Report on produced targets	WP3	13 - JRC	Report	Public	30
D3.4	Documentation of the design of a mass separation tool for target preparation	WP3	28 - UMAINZ	Report	Public	48
D3.5	Documentation of the site specification for installation of a mass separator in the Hotlab of PSI	WP3	21 - PSI	Report	Public	59
D4.1	Report on code development, methods	WP4	21 - PSI	Report	Public	40
D4.2	Report on new nuclear reaction data evaluation	WP4	3 - CEA	Report	Public	48
D4.3	Report on the evaluation for fission yields	WP4	3 - CEA	Report	Public	48
D4.4	Report on the evaluation for nuclear structure and decay data	WP4	10 - IFIN-HH	Report	Public	48
D4.5	Report on the processing and sensitivity analysis	WP4	32 - UPM	Report	Public	36

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D4.6	Report on the applications: recommendation	WP4	1 - CIEMAT	Report	Public	36
D4.7	Report on the possibility to generalize the high-energy model uncertainties methodology	WP4	3 - CEA	Report	Public	48
D5.1	Report on sensitivity analysis methods	WP5	1 - CIEMAT	Report	Public	24
D5.2	Report on ESFR, MYRRHA, and ALFRED sensitivity and impact studies	WP5	23 - SCK-CEN	Report	Public	24
D5.3	Report on JHR sensitivity and impact study	WP5	3 - CEA	Report	Public	52
D5.4	Report on HLW sensitivity and impact study	WP5	16 - KIT	Report	Public	24
D5.5	Report on assessment of nuclear data needs	WP5	3 - CEA	Report	Public	50
D5.6	Report on correlations between integral experiments	WP5	1 - CIEMAT	Report	Public	50
D5.7	Report on reactor and shielding C/E validation and nuclear data trends	WP5	32 - UPM	Report	Public	49
D5.8	Report on critical benchmark C/E validation and nuclear data trends	WP5	19 - NRG	Report	Public	49
D5.9	Report on C/E validation and nuclear data trends	WP5	32 - UPM	Report	Public	48
D5.10	Report on experiments at JRC Geel using MINERVE samples	WP5	3 - CEA	Report	Public	51
D5.11	Report on integral experiments at LR-0	WP5	7 - CVREZ	Report	Public	51
D5.12	Report on integral experiments at TAPIRO	WP5	8 - ENEA	Report	Public	58
D5.13	Report on new integral experiments and needs	WP5	3 - CEA	Report	Public	60

Deliverable Number[14]	**Deliverable Title**	**WP number**[9]	**Lead beneficiary**	**Type**[15]	**Dissemination level**[16]	**Due Date (in months)**[17]
D6.1	Web for the project	WP6	1 - CIEMAT	Websites, patents filing, etc.	Public	9
D6.2	Report on a sustainable framework for the coordination of the European nuclear data research	WP6	3 - CEA	Report	Public	54
D6.3	Report on school on nuclear data research methods and tools and E&T activities	WP6	13 - JRC	Report	Public	54
D6.4	Project presentation	WP6	1 - CIEMAT	Report	Public	3
D6.5	Project "Communication and Dissemination Action Plan"	WP6	1 - CIEMAT	Report	Public	6
D6.6	Project "Data Management Plan"	WP6	1 - CIEMAT	ORDP: Open Research Data Pilot	Public	6

1.3.3. WT3 Work package descriptions

Work package number [9]	WP1	**Lead beneficiary** [10]	5 - CNRS
Work package title	Developments of new innovative detector devices		
Start month	1	**End month**	60

Objectives

Detector development is a key and basic activity to address the issues in nuclear data improvement for either nuclear energy or non-energy applications. In particular, devices which allow high precision measurements for main actinides present in advanced reactor fuels and/or for new isotopes present in closed cycles are still required. In the previous EC project CHANDA, the design and construction of several new devices for the measurement of reaction cross sections or fission yields or decay data was performed. They will be commissioned and used in the coming years and especially during the present project that concentrates on measurements and nuclear data production. Nevertheless, there are still some needs for further development of new detectors in relation with the needs expressed by the energy and non-energy application communities. In this work package, support is thus primary given to detector developments leading to immediate measurements (sometimes directly related to actions supported in WP2) but also to the development of new innovative detectors which will be able to tackle the remaining challenges in nuclear data measurements.

Description of work and role of partners

WP1 - Developments of new innovative detector devices [Months: 1-60]
CNRS, CIEMAT, CEA, CERN, HZDR, JYU, PTB, UPC
Description of the work
Task 1.1: Innovative devices from fission cross section to fission products decay studies
Task coordinator: CEA/DRF/IRFU, partners: CEA/DAM, CNRS/CENBG, CEA/LNE-LNHB, JYU, UPC
Subtask 1.1.1: fission cross section
The target accuracy requirements for the integral parameters characterizing new fast reactor systems imply to reduce by a factor of 2 to 4 the uncertainty on actinide fission cross section measurements. This goal can be reached by the development of new detector devices which allow the use of the very precise standard H(n,p) cross section for the determination of induced neutron flux. Further, innovative fission detectors like time projection chamber have also to be developed to obtain better and more accurate nuclear data on fission observables. For accurate fission cross section measurements on actinides, two new setups, GRPD - gas recoil proton detector and a MicroMegas-based time projection chamber, will be then developed by respectively the CNRS/CENBG and the CEA/DRF/IRFU.
Subtask 1.1.2: fission yields and decay data studies
Fission yield studies for modelling and more accurate data for evaluation are of importance and requested for spent fuel heat prediction. In this task, CEA/DRF/IRFU will couple the FALSTAFF spectrometer (developed in the CHANDA project) with the FIPPS gamma spectrometer at ILL. This new setup will allow the production of new accurate nuclear data on 235U and thus the improvement of the fission process modelling. This measurement is also supported in the WP 2.
The JYU will improve the quality of the neutron induced fission product collection at IGISOL by the design of a new gas cell with electric field guidance. This new device will allow better efficiency which is expected to be of the order of 100 compared to what exist today. This improvement will benefit greatly for the fission products studies.
Finally, for fission product decay data, UPC will build a new version of the BELEN detector (based on the Bonner sphere principle) optimized for maximum total efficiency and spectrometric response and will measure beta-delayed-neutron spectra and Pn for selected fission product. This measurement is also supported in the WP 2.
Within the decay data evaluation community a lack of suitable half-life and nuclear decay data measurement facilities has been highlighted and in order to answer this shortfall, the LNE-LNHB intends to contribute in this field. The measurement work at LNE-LNHB is undertaken with highly calibrated detectors, at a metrological level of precision, for all types of radiation. A new measurement facility composed of a dedicated ionisation chamber and an automated sample changer will be constructed by the CEA/LNE-LNHB and will allow half-life measurements for a number of radionuclides important to the nuclear medicine community, as well as the nuclear industry. With such a detector system and sample changer, half-lives with uncertainties of 0.1% are attainable.
Task 1.2: Innovative devices for neutron emission studies
Task coordinator: CERN, partners: CEA/DEN, CEA/DAM

The accurate knowledge of the neutron population and its energy distribution is necessary to properly estimate reactor core key parameters like Keff or radial power distribution. New neutron or secondary particles detector with high performances can be developed to make progress in the knowledge of neutron emission.
Subtask 1.2.1 fast neutron spectrometer
A new compact broad band fast neutron spectrometer will be developed by the CEA/DEN with the aim of being used in various environments like nuclear reactor or near neutron beam facilities to characterize neutron flux.
Subtask 1.2.2 neutron detectors
For measurements at spiral2/NFS, a new innovative setup based on plastic scintillator bars wrapped with a Gd loaded material is under development by the CEA/DAM. This device will perform (n,xn) cross section measurements for very radioactive actinides like 239Pu for which new precise data are requested.
Subtask 1.2.3 gamma detectors
The prompt-gamma ray spectroscopy is a powerful indirect method to study (n,xn) reaction. Up to now, despite the very good characteristics of the CERN/n_TOF neutron beam for the study of these reactions, the method couldn't be developed there due the presence of a very intense -flash. Some instrumental developments are thus required to adapt Germanium detectors to the intense background. A new HPGe prototype, developed by CERN, with adapted electronics will thus be designed and tested at CERN/n_TOF.
Task 1.3: innovative devices for capture cross section measurement on actinides
Task coordinator: CIEMAT, partners: UPC
The new 20-m long n_TOF EAR-2 neutron beam line built with the support of the CHANDA project, is ~300 times more intense (30 times more fluence and 10 times shorter flight path) than the 200-m long flight path of n_TOF EAR-1. Such a high neutron flux allows measurements with very low sample masses (1 mg or even lower) but has the drawback of having 10 – 100 times larger neutron background compared to EAR-1. For this reason, it is critical to have detectors capable of standing high reaction rates and better background rejection capabilities. Two new detectors will thus be developed for capture cross section measurements on actinides.
The first prototype, developed by CIEMAT, is based on a Cs2LiYCl6:Ce (CLYC) inorganic scintillator and will allow measurement as gamma-ray calorimeter but also as total energy detector for cross sections determination.
The second line of detector development, undertaken by UPC, concerns a new technique based on novel total energy detectors with high energy resolution and gamma-ray imaging capability (i-TED). These two new devices will allow measurements on actinides for which only low mass sample are available.
Task 1.4: detectors for non-energy application
Task coordinator: PTB, partners: HZDR
Double differential cross section (DDX) data on the neutron-induced emission of light charged particles are required for assessing the risk of secondary tumours in particle radiation therapy. The n_TOF facility can be used to provide experimental DDX data with continuous neutron energy coverage. Such data would significantly improve the scarce data base for neutron energies close to and above 100 MeV and allow the improvement of the intranuclear cascade model for the relevant low-mass nuclei and composite ejectiles. This action, led by HZDR and PTB, thus aims to extend the techniques developed so far at n_TOF EAR1, to a measure DDX data for the neutron-induced emission of light charged particles from carbon, nitrogen and oxygen. The measurement itself is also supported in WP2.

Participation per Partner

Partner number and short name	WP1 effort
1 - CIEMAT	13.30
3 - CEA	36.10
4 - CERN	1.20
5 - CNRS	3.00
UBx	1.50
9 - HZDR	4.50
15 - JYU	9.00
22 - PTB	5.70
31 - UPC	6.50

Partner number and short name	WP1 effort
Total	80.80

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D1.1	Report on the study and construction of new devices for precise fission cross section measurements	5 - CNRS	Report	Public	54
D1.2	Report on the design of the large gas cell for IGISOL	15 - JYU	Report	Public	50
D1.3	Report on the performances of new devices for precise study of fission products and their decay in view of measurements	3 - CEA	Report	Public	24
D1.4	Report on the commissioning of a compact broad-band fast neutron spectrometer	3 - CEA	Report	Public	50
D1.5	Report on the performance of the SCONE setup at NFS	3 - CEA	Report	Public	48
D1.6	Report on the performance of the HPGe equipped with newly developed electronics	4 - CERN	Report	Public	48
D1.7	Report on the development and performances of the new detectors for capture cross section measurements at n-TOF	1 - CIEMAT	Report	Public	48
D1.8	Report on the development and performances of the new detectors for non-energy applications	22 - PTB	Report	Public	24

Description of deliverables

Deliverables:
D.1.1 "Report on the study and construction of new devices for precise fission cross section measurements"; CNRS; M54
D.1.2 "Report on the design of the large gas cell for IGISOL", JYU; M50

D.1.3 “Report on the performances of new devices for precise study of fission products and their decay in view of measurements”; CEA; M24
D.1.4 “Report on the commissioning of a compact broad-band fast neutron spectrometer”; CEA; M50
D.1.5 “Report on the performance of the SCONE setup at NFS”, CEA; M48
D.1.6 “Report on the performance of the HPGe equipped with newly developed electronics”, CERN; M48
D.1.7 “Report on the development and performances of the new detectors for capture cross section measurements at n-TOF”; CIEMAT; M48
D.1.8 “Report on the development and performances of the new detectors for non-energy applications”; PTB; M24

D1.1 : Report on the study and construction of new devices for precise fission cross section measurements [54]

Report on the study and construction of new devices for precise fission cross section measurements

D1.2 : Report on the design of the large gas cell for IGISOL [50]

Report on the design of the large gas cell for IGISOL

D1.3 : Report on the performances of new devices for precise study of fission products and their decay in view of measurements [24]

Report on the performances of new devices for precise study of fission products and their decay in view of measurements

D1.4 : Report on the commissioning of a compact broad-band fast neutron spectrometer [50]

Report on the commissioning of a compact broad-band fast neutron spectrometer

D1.5 : Report on the performance of the SCONE setup at NFS [48]

Report on the performance of the SCONE setup at NFS

D1.6 : Report on the performance of the HPGe equipped with newly developed electronics [48]

Report on the performance of the HPGe equipped with newly developed electronics

D1.7 : Report on the development and performances of the new detectors for capture cross section measurements at n-TOF [48]

Report on the development and performances of the new detectors for capture cross section measurements at n-TOF

D1.8 : Report on the development and performances of the new detectors for non-energy applications [24]

Report on the development and performances of the new detectors for non-energy applications

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS1	Completion of the simulation for the coupling of FALSTAFF and FIPPS at ILL	3 - CEA	12	Completion of the simulation for the coupling of FALSTAFF and FIPPS at ILL
MS2	Completion of simulations for new gas cell with electric field guidance at IGISOL	15 - JYU	18	Completion of simulations for new gas cell with electric field guidance at IGISOL
MS3	Completion of a new measurement facility by CEA/ LNE-LNHB	3 - CEA	18	Completion of a new measurement facility by CEA/ LNE-LNHB
MS4	Completion of the design of the fast neutron spectrometer at CEA/DEN	3 - CEA	24	Completion of the design of the fast neutron spectrometer at CEA/DEN
MS5	Completion of GRPD - gaz recoil proton detector at CNRS/CENBG	5 - CNRS	24	Completion of GRPD - gaz recoil proton detector at CNRS/CENBG

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS6	Completion of simulations for a MicroMegas-based time projection chamber at CEA/ DRF/IRFU	3 - CEA	24	Completion of simulations for a MicroMegas-based time projection chamber at CEA/ DRF/IRFU
MS7	Completion of the design of the new version of the BELEN detector at UPC	31 - UPC	24	Completion of the design of the new version of the BELEN detector at UPC
MS8	Completion of the commissioning of the HPGe equipped with newly developed electronics at CERN	4 - CERN	24	Completion of the commissioning of the HPGe equipped with newly developed electronics at CERN
MS9	Completion of the installation of the SCONE setup at NFS	3 - CEA	24	Completion of the installation of the SCONE setup at NFS
MS10	Completion of the new detectors for capture measurements at n-TOF	9 - HZDR	36	Completion of the new detectors for capture measurements at n-TOF

Work package number [9]	WP2	Lead beneficiary [10]	1 - CIEMAT
Work package title	New nuclear data measurements for energy and non-energy applications		
Start month	1	End month	60

Objectives

As demonstrated by international (OECD-NEA, IAEA), EC (CHANDA, ANDES, ERINDA, EUFRAT), regional (JEFF, ENDF/B, JENDL) and national nuclear data projects (GEDEPEON, NEEDS, TRAKULA) the nuclear data measurement requirements (High Priority Request List for nuclear data of the OECD-NEA) are very challenging. It was concluded that in many cases, despite significant improvements achieved in the above-mentioned projects, substantially improved experimental methods, setups and facilities were required to bridge the gap between measurement need and experimental result.
In this work package new measurements will be carried out to significantly improve the accuracy of nuclear data needed in energy and non-energy modelling applications, mainly in the field of fission, radiation protection, safety, sustainability and enhancement of nuclear technologies. Thus, at the end of the project a number of new high precision nuclear data sets will be available for the major actinides present in advanced reactor fuels, to reduce uncertainties in new isotopes in closed cycles with waste minimization, to better assess the uncertainties and correlations in their evaluation. The measurements to be carried out will use extensively the instrumentation (detectors, data acquisition systems), methodologies, new techniques and new facilities (n_TOF EAR2 and NFS) developed during the project and at the CHANDA project.
The tasks of this work package are accurate measurements of: neutron-induced fission and charge particle production cross sections, neutron capture cross sections total, neutron elastic and inelastic scattering and neutron multiplication cross sections, decay data (fission product β-delayed γ-rays and neutrons), fission yields, medical and other non-energy applications.

Description of work and role of partners

WP2 - New nuclear data measurements for energy and non-energy applications [Months: 1-60]
CIEMAT, CEA, CNRS, CSIC, CVREZ, ENEA, IFIN-HH, IRSN, IST-ID, JRC, JYU, NPI, NPL, NTUA, PTB, SCK-CEN, ULODZ, UMANCH, UOI, UPC, USC, USE, UU
Task 2.1: Neutron induced fission and charged particle production cross sections
Task coordinator: UMANCH, partners: CNRS/CENBG, CNRS/LPCC, CVREZ, NPI-CAS, NTUA, UOI, UU

Task 2.1.1: Neutron induced fission cross sections
UU will perform a high accuracy measurement of the energy dependence of the nubar for the 235U(n,f) cross section at JRC-Geel. The accuracy in the nubar is crucial for determining the uncertainty in the criticality of a nuclear reactor. The measurement will be carried out with the MONET setup and a technique developed within CHANDA, which allow for the suppression of systematic effects present in previous data.
CNRS/CENBG will apply the surrogate reaction analysis technique for providing new excitation functions and cross sections for the 239Pu(n,f), 241Pu(n,g) and 241Pu(n,f) reactions.
Three (n,f) cross section measurements will be carried out at the CERN n_TOF EAR2 built and equipped with support of the CHANDA project. The NTUA will perform a new measurement of the poorly know 230Th(n,f) cross section. The measurement is linked to the design of new reactors exploiting the Th fuel cycle. The UOI will carry out a new measurement on the 241Am(n,f) cross section. High quality data are needed for determining the destruction rate of 241Am in thermal and fast reactors and the associated high-level waste inventories.
The UMANCH will perform a new measurement of the high priority 239Pu(n,f) cross section. The measurement will be carried out with the STEFF spectrometer and

Task 2.1.2: Neutron induced charged particle production cross sections
CNRS/LPCC will perform a new measurement on the 16O(n,a) reaction in the energy range from the threshold up to 20 MeV. Such a reaction is responsible for 25% of the production of He in current reactors and the available data show discrepancies of 30%. The need of new cross section data for this reaction is listed in the OECD-NEA high priority request list. The measurement will improve significantly the accuracy reached in previous measurements.
UU will perform a new measurement on the natC(n,lchp) reaction at NFS facility supported by CHANDA and provide high quality data for improving cross section standards. Such standards are very important for the normalization of other cross sections in the high neutron energy range (i.e. above a few MeV).

NPI CAS will provide new (n,chp) cross section data with a powerful array of hyper pure germanium detectors constructed recently.
CVREZ will obtain information on the prompt fission neutron spectra above 10 MeV by performing activation measurement with well-known threshold reactions at a nuclear reactor. Such an information is highly requested since data for the 235U(n,f) prompt fission spectra above 10 MeV are almost non existing.

Task 2.2: Neutron capture cross sections
Task coordinator: ENEA, partners: CIEMAT, JRC, ULODZ, IRSN

Subtask 2.2.1. Capture measurements of fissile isotopes.
CIEMAT, ULODZ and JRC will perform various cross section measurements at GELINA and n_TOF on the high priority reactions 239Pu(n,g) and 239Pu(n,f). The methodology developed within CHANDA for the absolute measurement of the 235U alfa ratio will be applied to the 239Pu case. A new ionization chamber built by ULODZ will be tested in a 239Pu(n,f) measurement at JRC, which also deliver the 239Pu samples. The combined measurement of the 239Pu(n,g) and 239Pu(n,f) cross sections will be carried out at CERN with the use of the Total Absorption Calorimeter.

Subtask 2.2.2. Capture measurement of stable isotopes.
ENEA will measure the 92,94,95Mo(n,g) cross sections at GELINA and at the n_TOF facility with the high performance total energy detectors developed during the CHANDA project. The impact of the new evaluated nuclear data and their uncertainties will be verified in criticality safety and reactor applications at IRSN as end-user. The data will be part of an evaluation done in WP4 by IRSN.

Task 2.3: Neutron elastic and inelastic scattering and neutron multiplication cross sections
Task coordinator: IFIN-HH, partners: CNRS/IPHC, JRC

Precise knowledge of the neutron inelastic scattering and (n,2n) reaction cross sections is required due to their impact on the criticality coefficient of the fission reactors. IFIN-HH, CNRS/IPCH and JRC will perform neutron inelastic cross section measurements on several isotopes of interest for development of nuclear facilities: 239Pu, 233U, 14N and 35,37Cl. The 239Pu cross section measurements are of high priority for the development of the fast reactors which enable an indirect burning of 238U through 239Pu. Cross section data for 233U are known poorly and needed because it is the main isotope of relevance to the Th/U fuel cycle. 14N represents 99.63% in natural nitrogen and is part of uranium nitride (UN, U2N3 and UN2) which is considered as potential fuel for Generation IV Reactors. Last, but not least, neutron-induced reactions on 35,37Cl is very important for the development of the Fast Spectrum-Molted Salt Reactors based on chloride salts. The GRAPhEME and the GAINS germanium arrays upgraded within the CHANDA project will be used at the neutron source GELINA of JRC-Geel for producing high quality data. The new data acquisition system based on 14 bit/500 MSamples/s digitisers developed within CHANDA will be also used.

JRC will perform high accuracy measurements of the branching ratio for 209Bi, 208Pb(n,tot) and 238U(n,inel) cross sections at GELINA in response to specific requests based on the output of sensitivity studies of keff CHANDA.

Task 2.4: Decay data measurements
Task coordinator: CSIC, partners: CEA/LNHB, CNRS/Subatech, CSIC, JRC, SCK, UPC

Subtask 2.4.1. Beta decay measurements with TAGs.
CSIC and CNRS/Subatech provide high precision decay data for fission products from major and minor actinides present in working and future advanced reactor fuels. It will contribute to a better determination of the decay heat in reactors and consequently will contribute to the overall safety of the nuclear industry. The data obtained will also be of relevance for the calculation of neutrino spectra, necessary both for inspection technologies under development and for fundamental science. A proven combination of the total absorption gamma spectroscopy technique (TAGS) and high-resolution radioactive beam purification schemes techniques improved during the CHANDA project will be applied. The DTAS detector and the GASIFIC data acquisition system, also supported by CHANDA, will be used in the measurements.

Subtask 2.4.2. Beta delayed neutron measurements.
UPC and CSIC will perform new measurements with the BELEN detector and the GASIFIC data acquisition, both supported by CHANDA, and develop a new technique for extracting low resolution energy spectra with long counters following the Bonner sphere principle. Such a methodology will allow extracting information on the beta delayed neutron energies even of very short-lived fission fragments.

Subtask 2.4.3. Measurement of half-live and gamma-ray emission probabilities of beta emitters.

CEA/LNHB will undertake decay data measurements using the existing and calibrated gamma spectroscopy facility at LNE-LNHB. The current facility is to be used for the measurement of half-lives for a range of radionuclides prioritary for reactor safety and medical applications: 106Ru, 153Sm, 166Ho, 186Re6, 212Pb, 225Ac and 223Ra .

Accurate nuclear data are also important for a proper estimation of the main source terms of interest for the final repository for SNF (decay, heat, neutron and gamma-ray emission rate, fissile material content, volatile nuclides). Priorities are currently being defined in the framework of NFRP-2018-6. JRC and SCK will carry out high accuracy measurements of the high priority isotopes.

Task 2.5: Fission yields measurements
Task coordinator: UU, partners: CEA/IRFU, CNRS/LPSC, UJY, USC

Subtask 2.5.1. Fission yield studies in (n,f) reactions.
CEA/IRFU will perform an innovative experiment on 235U at NFS by coupling FALSTAFF to the VAMOS detector, replacing the original proposal of coupling FALSTAFF and FIPPS at ILL that was found not feasible during the SANDA project. A part of the FALSTAFF spectrometer was built and tested within the CHANDA project. The goal is to evaluate the performance of FALSTAFF (work for WP1) and at the same time provide new nuclear data and to improve the modelization of the fission process thanks to the association of those new detection systems on a high neutron flux beamline. This data will be equivalent to the original proposal and will give access to direct comparisons with fission and deexcitation models, prompt gamma ray spectra with a good identification of the atomic number and mass of the fragments and information on the angular momentum of the fission fragments.

CNRS/LPSC will develop new program with the LOHENGRIN spectrometer at the Laue Langevin Institute (ILL) allowing to test deeply the assumption of the models used in the fission yield evaluations. The program will be the measurements of kinetic energy dependency of yields, isomeric ratios or isotopic distributions. The Gas Filled Magnetic spectrometer developed within CHANDA will be used in the measurements coupled to the LOHENGRIN spectrometer for purification of the extracted beam.
Recently, a new ion manipulation method, Phase-Imaging Ion-Cyclotron-Resonance (PI-ICR), has been developed for Penning traps. It allows faster and more accurate measurement
of atomic masses, as compared to the more traditional techniques. The achieved high mass resolving power allows to resolve isomers separated only by a few tens of keV's.
JYU has begun to apply a pioneering technique called Phas-Imagin Ion-Cyclotron-Resonance (PI-ICRS) for determining isomeric yield ratios (IYR) in fission. In a CHANDA-supported experiment isomeric ratios of neutron rich indium and cadmium isotopes in proton-induced fission were measured. JYU will develop a method based on the PI-ICR technique for general fission product yield studies. The UU will perform fission yields measurements as a follow up of the developments achieved with CHANDA. Independent fission yields in neutron induced fission will be performed using the IGISOL/JYFLTRAP facilities at JYU.

Subtask 2.5.2. Fission yield studies in inverse kinematics.
USC will perform an experiment to demonstrate the use of (p,2p) as surrogate reactions for fission experiments and identify key nuclei accessible by the new FAIR facility for fission experiments induced by (p,2p) reactions. The experiment will allow investigating the fission of 237Pa, determining the resolution achieved in excitation energy of the fissioning compound nucleus and the possibility to determine fission barriers. The data are relevant for fission models concerning the damping of shell effects with excitation energy and their impact in the potential energy surface and level densities.

Task 2.6: New measurements for non-energy applications
Task coordinator: USE, partners: IST, NPL, PTB

The recent reviews from IAEA (INDC(NDS)-0591 and INDC(NDS)-0596) indicate that of the most important nuclear data needs are for the production of medical radioisotopes. Among the medical radionuclides of interest, the most relevant are currently gamma and positron emitters for both diagnostic and therapeutic applications. Several charged-particle and neutron production routes exist for the production of medical radioisotopes but sometimes no data or only one data set is available. New measurements of the excitation functions and thick-target yield measurement for validation of the recommended data are needed.

Subtask 2.6.1. Spectrum averaged cross sections for dosimetry.
NPL will perform spectrum-averaged benchmark measurements of the activity induced in foils by neutrons from a 252Cf source via the 117Sn(n,inl)117mSn and 60Ni(n,p) reactions. Such measurements have been prioritized by the IAEA in order to mitigate known shortcomings in the data in the reactor dosimetry file IRD.

Subtask 2.6.2. Measurement of cross sections relevant for hadron therapy.
PTB and IST will collaborate in the research of secondary high neutron production in particle radiation therapy of cancer. Secondary neutrons with energies up to about 200 are produced by beam interaction in the treatment head and in the target volume. The risk of secondary tumours induced by these neutrons is important, in particular for young patients. The measurement of double-differential charged-particle emission cross sections will be carried out at the CENR n_TOF facility in the neutron energy range from 20 MeV to 200 MeV. Part of the necessary equipment will be developed by HZDR within WP1.

Subtask 2.6.3. Measurement of beta+ emitters.
USE will perform measurements of production cross sections of beta+ emitters used for range verification in proton therapy. The list of isotopes covers the high priorities of IAEA: 11C, 13N, 15O, 30P produced by protons with energies up to 250 MeV. The gamma-ray detection set-up will consist of a medical PET scanner, or equivalent, and successful preliminary tests have been carried out already at CNA. Other recently proposed isotopes for range verification, with shorter half-lives such as 10C, 12N, 38mK and 29P will be considered along the project.

Participation per Partner

Partner number and short name	**WP2 effort**
1 - CIEMAT	14.30
3 - CEA	7.10
5 - CNRS	11.50
G-INP	3.50
Univ Nantes	2.50
UNICAEN	2.00
IMT Atlantique	1.50
6 - CSIC	14.40
7 - CVREZ	11.70
8 - ENEA	15.00
10 - IFIN-HH	11.20
11 - IRSN	1.50
12 - IST-ID	4.00
13 - JRC	17.20
15 - JYU	5.00
17 - NPI	17.30
18 - NPL	2.30
20 - NTUA	6.00
22 - PTB	4.00
23 - SCK-CEN	2.20
27 - ULODZ	12.00
29 - UMANCH	10.00
30 - UOI	6.00
31 - UPC	1.80
33 - USC	10.00

Partner number and short name	WP2 effort
34 - USE	10.00
35 - UU	9.00
Total	213.00

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D2.1	Report on the (n,f) cross section measurements	29 - UMANCH	Report	Public	48
D2.2	Report on the (n,chp) cross section measurements	5 - CNRS	Report	Public	54
D2.3	Report on the 239Pu(n,g), 92,94,95Mo(n,g) cross measurements at n_TOF and GELINA	8 - ENEA	Report	Public	56
D2.4	Report on the 239Pu, 233U, 14N and 35,37Cl inelastic cross section measurements at GELINA	10 - IFIN-HH	Report	Public	59
D2.5	Report on the measurements of the branching ratio for 209Bi, 208Pb(n,tot) and 238U(n,inel) cross sections at GELINA.	13 - JRC	Report	Public	56
D2.6	Report of the decay data measurements performed with DTAS and BELEN	6 - CSIC	Report	Public	48
D2.7	Report on the development of a new technique for obtaining low resolution information on the beta delayed neutron energies with BELEN-like detectors.	31 - UPC	Report	Public	30
D2.8	Report on the method based on the PI-ICR technique for general fission product yield studies at JYFL	15 - JYU	Report	Public	51
D2.9	Spectrum averaged cross sections for dosimetry	18 - NPL	Report	Public	56

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D2.10	Report on the measurement of double-differential charged-particle emission cross sections at the CERN n_TOF facility in the neutron energy range from 20 MeV to 200 MeV	22 - PTB	Report	Public	56
D2.11	Report on the production cross sections of beta+ emitters used for range verification in proton therapy.	34 - USE	Report	Public	30
D2.12	Report on the fission yield studies with the LOHENGRIN spectrometer at ILL	5 - CNRS	Report	Public	48
D2.13	Report on fission yield studies with FALSTAFF at NFS	3 - CEA	Report	Public	52
D2.14	Report on fission yield studies in inverse kinematics at FAIR	33 - USC	Report	Public	34
D2.15	Report on the of half-live and gamma-ray emission probabilities of beta emitters measurement	3 - CEA	Report	Public	48

Description of deliverables

D.2.1 Report on the (n,f) cross section measurements (UMANCH) M48
D.2.2 Report on the (n,chp) cross section measurements (CNRS) M54
D.2.3 Report on the 239Pu(n,g), 92,94,95Mo(n,g) cross measurements at n_TOF and GELINA (ENEA) M56
D.2.4 Report on the 239Pu, 233U, 14N and 35,37Cl inelastic cross section measurements at GELINA (IFIN-HH) M59
D.2.5 Report on the measurements of the branching ratio for 209Bi, 208Pb(n,tot) and 238U(n,inel) cross sections at GELINA. (JRC) M56
D.2.6 Report of the decay data measurements performed with DTAS and BELEN (CSIC) M48
D.2.7 Report on the development of a new technique for obtaining low resolution information on the beta delayed neutron energies with BELEN-like detectors. (UPC) M30
D.2.8 Report on the method based on the PI-ICR technique for general fission product yield studies at JYFL. (JYU) M51
D.2.9 Spectrum averaged cross sections for dosimetry (NPL) M56
D.2.10 Report on the measurement of double-differential charged-particle emission cross sections at the CERN n_TOF facility in the neutron energy range from 20 MeV to 200 MeV. (PTB) M56
D.2.11 Report on the production cross sections of beta+ emitters used for range verification in proton therapy. (USE) M30
D.2.12 Report on the fission yield studies with the LOHENGRIN spectrometer at ILL (CNRS) M48.
D.2.13 Report on fission yield studies with FALSTAFF at NFS (CEA) M52

D.2.14 Report on fission yield studies in inverse kinematics at FAIR (USC) M34
D.2.15 Report on the of half-live and gamma-ray emission probabilities of beta emitters measurement (CEA) M48

D2.1 : Report on the (n,f) cross section measurements [48]

Report on the (n,f) cross section measurements

D2.2 : Report on the (n,chp) cross section measurements [54]

Report on the (n,chp) cross section measurements

D2.3 : Report on the 239Pu(n,g), 92,94,95Mo(n,g) cross measurements at n_TOF and GELINA [56]

Report on the 239Pu(n,g), 92,94,95Mo(n,g) cross measurements at n_TOF and GELINA

D2.4 : Report on the 239Pu, 233U, 14N and 35,37Cl inelastic cross section measurements at GELINA [59]

Report on the 239Pu, 233U, 14N and 35,37Cl inelastic cross section measurements at GELINA

D2.5 : Report on the measurements of the branching ratio for 209Bi, 208Pb(n,tot) and 238U(n,inel) cross sections at GELINA. [56]

Report on the measurements of the branching ratio for 209Bi, 208Pb(n,tot) and 238U(n,inel) cross sections at GELINA.

D2.6 : Report of the decay data measurements performed with DTAS and BELEN [48]

Report of the decay data measurements performed with DTAS and BELEN

D2.7 : Report on the development of a new technique for obtaining low resolution information on the beta delayed neutron energies with BELEN-like detectors. [30]

Report on the development of a new technique for obtaining low resolution information on the beta delayed neutron energies with BELEN-like detectors.

D2.8 : Report on the method based on the PI-ICR technique for general fission product yield studies at JYFL [51]

Report on the method based on the PI-ICR technique for general fission product yield studies at JYFL

D2.9 : Spectrum averaged cross sections for dosimetry [56]

Spectrum averaged cross sections for dosimetry

D2.10 : Report on the measurement of double-differential charged-particle emission cross sections at the CERN n_TOF facility in the neutron energy range from 20 MeV to 200 MeV [56]

Report on the measurement of double-differential charged-particle emission cross sections at the CERN n_TOF facility in the neutron energy range from 20 MeV to 200 MeV

D2.11 : Report on the production cross sections of beta+ emitters used for range verification in proton therapy. [30]

Report on the production cross sections of beta+ emitters used for range verification in proton therapy.

D2.12 : Report on the fission yield studies with the LOHENGRIN spectrometer at ILL [48]

Report on the fission yield studies with the LOHENGRIN spectrometer at ILL

D2.13 : Report on fission yield studies with FALSTAFF at NFS [52]

Report on fission yield studies with FALSTAFF at NFS

D2.14 : Report on fission yield studies in inverse kinematics at FAIR [34]

Report on fission yield studies in inverse kinematics at FAIR

D2.15 : Report on the of half-live and gamma-ray emission probabilities of beta emitters measurement [48]

Report on the of half-live and gamma-ray emission probabilities of beta emitters measurement

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS1	Completion of the simulation for the coupling of FALSTAFF and FIPPS at ILL	3 - CEA	12	Completion of the simulation for the coupling of FALSTAFF and FIPPS at ILL
MS3	Completion of a new measurement facility by CEA/ LNE-LNHB	3 - CEA	18	Completion of a new measurement facility by CEA/ LNE-LNHB
MS5	Completion of GRPD - gaz recoil proton detector at CNRS/CENBG	5 - CNRS	24	Completion of GRPD - gaz recoil proton detector at CNRS/CENBG
MS9	Completion of the installation of the SCONE setup at NFS	3 - CEA	24	Completion of the installation of the SCONE setup at NFS
MS11	Activation measurements for the extraction of prompt fission neutron spectra above 10 MeV	7 - CVREZ	24	Activation measurements for the extraction of prompt fission neutron spectra above 10 MeV
MS12	Measurement of the energy dependence of the nubar with the MONET setup	13 - JRC	24	Measurement of the energy dependence of the nubar with the MONET setup
MS13	Completion of the measurements with FALSTAFF at ILL	3 - CEA	36	Completion of the measurements with FALSTAFF at ILL
MS14	Completion of the measurement on the (p,2p) fission induced reactions at FAIR	33 - USC	30	Completion of the measurement on the (p,2p) fission induced reactions at FAIR
MS15	Measurement of the 230Th(n,f) cross section at n_TOF	20 - NTUA	36	Measurement of the 230Th(n,f) cross section at n_TOF
MS16	Measurement of the 241Am(n,f) cross section at n_TOF	30 - UOI	36	Measurement of the 241Am(n,f) cross section at n_TOF
MS17	Measurement of the 239Pu(n,f) cross section at n_TOF	29 - UMANCH	36	Measurement of the 239Pu(n,f) cross section at n_TOF
MS18	Measurement of the 16O(n,alpha) cross section at NFS, GENESIS and AMANDE	5 - CNRS	36	Measurement of the 16O(n,alpha) cross section at NFS, GENESIS and AMANDE
MS19	Measurement of the natC(n,lchp) at NFS	35 - UU	50	Measurement of the natC(n,lchp) at NFS
MS20	Completion of the (n,chp) cross section measurements at NPI CAS with germanium detectors	17 - NPI	36	Completion of the (n,chp) cross section measurements at NPI CAS with germanium detectors

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS21	Measurement of the 239Pu(n,g) at n_TOF	1 - CIEMAT	36	Measurement of the 239Pu(n,g) at n_TOF
MS22	Measurement of the Mo isotopes at GELINA and n_TOF	8 - ENEA	34	Measurement of the Mo isotopes at GELINA and n_TOF
MS23	Completion of the 239Pu, 233U, 14N and 35,37Cl inelastic and (n,2n) cross section measurements at GELINA	10 - IFIN-HH	57	Completion of the 239Pu, 233U, 14N and 35,37Cl inelastic and (n,2n) cross section measurements at GELINA
MS24	Completion of the branching ratio for 209Bi, 208Pb(n,tot) and 238U(n,inel) cross section measurements at GELINA	13 - JRC	49	Completion of the branching ratio for 209Bi, 208Pb(n,tot) and 238U(n,inel) cross section measurements at GELINA
MS25	Completion of the measurements with TAGS and BELEN	6 - CSIC	49	Completion of the measurements with TAGS and BELEN
MS26	Completion of the measurements at the CEA-LNHB	3 - CEA	52	Completion of the measurements at the CEA-LNHB
MS29	Decision on targets to be manufactured	13 - JRC	18	Decision on targets to be manufactured

Work package number [9]	WP3	Lead beneficiary [10]	21 - PSI
Work package title	Target Preparation for Improvement of Nuclear Data Measurements		
Start month	1	**End month**	60

Objectives

The demand for high-quality targets, specially designed for the envisaged experiment and targets manufactured for nuclear reaction studies in a broad variety of application fields is constantly increasing, with the production of radioactive samples comprising particular challenges due to the special requirements arising from the emitted radiation. Only a handful of laboratories in Europe are capable and equipped to meet these special requirements. Resource sharing, knowledge transfer as well as tight interaction with the end-users in order to fabricate tailored samples are a MUST for a more efficient and qualitatively improved delivery of urgently needed targets. Moreover, intensive R&D work has to be triggered for new innovative solutions of target preparation and characterization. In particular, we aim to develop a dedicated mass separator device in order to provide the community with isotopically pure targets for special applications.

Description of work and role of partners

WP3 - Target Preparation for Improvement of Nuclear Data Measurements [Months: 1-60]
PSI, JRC, UMAINZ
Task 3.1: Intensification of the "producer – user – interaction"
Task coordinator: PSI, partners: JRC

The, as exact as possible, knowledge on the specific conditions of an envisaged experiments is crucial for the manufacturing and characterization of "tailored targets". For instance, very often, experimenters only rely on information from commercial suppliers concerning impurities in samples or materials for irradiation. Later on, in their real experiment, they observe that unexpected impurities cause side effects which make their initially wanted signal invisible. Moreover, using radioactive isotopes as target material, users should be aware about the problems caused by the emitted radiation from the target itself, in particular the impacts on detectors and additionally induced background. In many cases, these boundary conditions caused by the specific requirements of the envisaged experiment have to be considered already for the way, how the isotope is produced, separated and purified. Later one, the selection of the target preparation method, the kind of backing and the final characterization of the isotope content are crucial parameters to pave the way for a successful experiment. We intend to trigger a series of regular meetings of target makers with the users to better communicate the requirements from both sides, including both partners of SANDA but also other research groups that might be interested and might contribute to the discussions in the network. We intend to support bilateral meetings and organize user workshops (annual or every second year) after identifying interested users.

Task 3.2: Fostering the network of target makers
Task coordinator: JRC, partners: PSI

Sharing knowledge, equipment and resources is a key issue for efficient work in high-cost and man-power intensive fields. Especially for producing radioactive targets, there are only a few laboratories in Europe, which are able and allowed to handle such material. Production of radioactive isotopes and handling of radioactive material is, due to the measures to be taken for radiation protection, extremely time consuming and cost-intensive. In addition, storage and transport of radioactive material get more complicated due to the more strict regulations within the European Union. Networking of target makers will, therefore, be mandatory to become more efficient. First synergies identified in the frame of the CHANDA project will be maintained and extended; more synergies between target producers will be identified and new partners will be included into the network if possible, including both partners of SANDA but also other research groups that might contribute to the discussions in the network. Moreover, we want to establish a joint database of TP (target preparation) facilities and suppliers of enriched isotopes. The web platform of the International Nuclear Targets Development Society (INTDS) will be used for distributing information and offers. This society and its internet platform gives additional opportunities to establish also contacts with groups outside Europe, for instance with target makers from USA (Oakridge and Argonne) or South Africa (iTembaLabs), to exchange knowledge, learn from their experience and broaden the possibilities for young researchers (students, postdocs) to go abroad for improving or complete their knowledge and skills. Regular exchange on progresses at meetings and workshops is foreseen.

Task 3.3: Target production
Task coordinator: JRC, partners: PSI

A limited number of targets can be produced according to requests from collaboration members. Both PSI and JRC will be responsible for the manufacturing of the final target. The target manufacturer will be in close contact concerning the special requirements of the envisaged experiment using the possibilities of user-producer interaction provided in the frame of task 3.1. Resources will be allocated according to the effort. Target requests can be submitted to the TP task leader. Both requests related to energy (minor actinides, 233U, 239Pu or fission products like 79Se) and non-energy applications (for instance 179Ta) will be considered. Each target request will be evaluated on the basis of the relevance of the target and the possibilities of the TP facilities.
During the first 12 months of the project, target request from collaborators will be collected and evaluated. As an essential milestone, the decision on which targets can be manufactured will be made after this time span.

Task 3.4: Development of an isotope separator
Task coordinator: PSI, partners: UMAINZ

Demands to improve the nuclear data basis are observed in numerous fields of nuclear applications. In particular, in the field of nuclear energy, high precision data with low uncertainties for minor actinides and fission products are urgently needed. Key players in the corresponding fields name 238/236U, 245Cm, 239/240/242Pu as relevant for minor actinides, Cs, Mo and other element isotopes as examples for fission products. This list is of course not complete. In some cases, these isotopes are also of interest in other nuclear data domains like nuclear astrophysics. A prominent example is the neutron capture cross section of 135Cs which is important both for the determination of the amount of radioactive cesium in burnt fuel elements of fast reactors, and it contributes to a quantitative interpretation of the isotopic Ba abundances in terms of the temperature during stellar He burning, as well as of the presence of radioactive isotopes in the Early Solar System.
A considerable number of these reactions is not possible to study, because the target isotope cannot be produced in pure form. A dedicated modern high efficiency, high transmission, high throughput mass separator designed for these special applications would improve the situation considerably, and, in a certain number of cases, would allow measurements with these isotopes for the first time. An additional advantage is the possibility to directly implant the separated isotope into the wanted backing in the wanted dimensions.
A considerable number of urgently wanted isotopes are available at PSI, where currently 30 l of spent nuclear fuel solutions containing up to 100mg of Pu isotopes, 10 mg of 135Cs or 1 mg 245Cm, each per liter, are stored.
Since the available starting material is normally limited, the machine has to be designed meeting the special requirements, delivering e.g. high ion current, highest ionization efficiency and transmission as well as offering the possibility for recovery of the remaining sample material after implantation. Our final aim is to install such a facility at PSI and make separated material available for the nuclear data community in Europe in a proportional way to the investment from EC. The site is best suited due to the central position in Europe and the existing infrastructure including laboratory space with the necessary permission for working with highly-radioactive samples including actinides. The goal of the present effort is the definition and development of the design meeting the requirements for the special application as target production facility and the preparation of the site for the installation.
PSI is responsible for the site specification in the PSI hotlab, UMAINZ will develop the design, additional support for consulting on specific scientific and engineering topics will be subcontracted by PSI.

Participation per Partner

Partner number and short name	WP3 effort
13 - JRC	15.20
21 - PSI	27.00
28 - UMAINZ	24.00
Total	66.20

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D3.1	Report on the meetings performed in the frame of ("Producer - user - interaction")	21 - PSI	Report	Public	36
D3.2	Report on the meetings performed in the frame of "Network of target producers"	13 - JRC	Report	Public	58
D3.3	Report on produced targets	13 - JRC	Report	Public	30
D3.4	Documentation of the design of a mass separation tool for target preparation	28 - UMAINZ	Report	Public	48
D3.5	Documentation of the site specification for installation of a mass separator in the Hotlab of PSI	21 - PSI	Report	Public	59

Description of deliverables

D.3.1 Report on the meetings performed in the frame of (“Producer – user – interaction”) (PSI): M36
D.3.2 Report on the meetings performed in the frame of “Network of target producers” (JRC): M58
D.3.3 Report on produced targets (JRC): M30
D.3.4 Documentation of the design of a mass separation tool for target preparation (UMAINZ): M48
D.3.5 Documentation of the site specification for installation of a mass separator in the Hotlab of PSI (PSI): M59

D3.1 : Report on the meetings performed in the frame of ("Producer - user - interaction") [36]

Report on the meetings performed in the frame of (“Producer – user – interaction”)

D3.2 : Report on the meetings performed in the frame of "Network of target producers" [58]

Report on the meetings performed in the frame of “Network of target producers”

D3.3 : Report on produced targets [30]

Report on produced targets

D3.4 : Documentation of the design of a mass separation tool for target preparation [48]

Documentation of the design of a mass separation tool for target preparation

D3.5 : Documentation of the site specification for installation of a mass separator in the Hotlab of PSI [59]

Documentation of the site specification for installation of a mass separator in the Hotlab of PSI

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS27	Scheduling regular user-producer meetings	21 - PSI	6	Scheduling regular user-producer meetings

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS28	Scheduling regular target maker meetings	13 - JRC	6	Scheduling regular target maker meetings
MS29	Decision on targets to be manufactured	13 - JRC	18	Decision on targets to be manufactured

Work package number [9]	WP4	Lead beneficiary [10]	21 - PSI
Work package title	Nuclear data evaluation and uncertainties		
Start month	1	End month	60

Objectives

Nuclear data evaluation is the necessary step to ensure that the experimental information is passed on simulation tools for a variety of applications. Many international evaluation libraries exist from different national and international organizations, all of them being regularly updated, demonstrating the importance of such process. The CHANDA project had recognized this essential work by dedicating part of its efforts in supporting the update of the OECD/JEFF library. In this work, it is proposed to continue the work started in the CHANDA project, making use of the experimental and theoretical achievements obtained during these 4 years, as well as combining them with and experimental observations from WP1, WP2 and new model developments developed in this WP.

In this work package, it is proposed (1) to continue the development of open-source evaluation tools by improving the phenomenological and microscopic models (TALYS and EMPIRE for reaction nuclear data; and specific codes for decay and structure data, as well as fission yields), (2) to perform evaluation work for important isotopes (actinides and fission products, to be proposed to different international libraries), (3) to provide processed data ready to be used by simulation codes for validation purposes, (4) to provide sensitivity vectors for feedback analysis, and (5) to recommend a set of preferred systems (or benchmarks) for the validation of the new evaluations (see WP5).

The tasks of this work package are dedicated to support the above goals, using previous developments combined with new theoretical and experimental insights obtained during the progress of this project. The outcomes such as evaluation tools, input files, evaluation files or sensitivity vectors will be available to all interested institutions, for possible inclusion in various libraries and databases. A few international projects and groups apart from the participants are potentially interested in these results: the IAEA Nuclear Data Section for nuclear data coordinated research projects, the OECD/NEA data bank with the projects under the Working Party on International Nuclear Data Evaluation Co-operation and the JEFF library, the US Cross Section Evaluation Working Group for the ENDF/B library.

Description of work and role of partners

WP4 - Nuclear data evaluation and uncertainties [Months: 1-60]
PSI, CIEMAT, ATOMKI, CEA, CNRS, IFIN-HH, JSI, Sofia, TUW, UB, UPM, USC, UU
Task 4.1: Nuclear reaction code developments and evaluations
Task coordinator: PSI, partners: CEA/DAM/DIF, CEA/DEN, PSI, CNRS/IPHC, TUW, UB, UU

Task 4.1.1: TALYS development
The development of TALYS for better modelling and its associated model parameter database will be performed in contact and coordination with the TALYS collaboration. Examples of important observables are the spectra and multiplicities of gamma and neutron. They are essential for nuclear applications such as criticality but also for shielding. In this context, efforts on statistical decay of fission fragments using TALYS were initiated during the ANDES project, and continued during the CHANDA project. For this new project, the goal is to make use of the previously developed codes and TALYS interfaces to test the influence of different theoretical prescriptions for the initial conditions for the decay (fragment mass, charge, excitation energy end spin distributions) on prompt fission neutron and gamma observables. Inputs from the GEF model, from the "scission point model" SPY, and from microscopic dynamical fission calculations will be tested and compared along with more phenomenological prescriptions.

Task 4.1.2: Nuclear reaction evaluation
Prior the production of nuclear reaction evaluations (in the form of ENDF files), different methods will be studied and compared. CEA/DAM, PSI and CEA/DEN will work together to improve evaluation methodologies for nuclear data and the associated uncertainties, by making use of Bayesian inference method with differential as well as carefully selected integral constraints. These groups have a large experience in ENDF file productions.
These applied methods can be complemented by "model defect" methods, as presented by TUW. TUW is well known for its developments of Bayesian evaluation techniques and associated uncertainties accounting also for model deficiencies. But despite recent progress there are still important problems not solved, especially for light nuclei and the resonance regime. Such developments will be based on the most recent version of the nuclear model code TALYS and the hybrid

R-matrix code GECCCOS thus consistently extending the evaluation regime beyond statistical model calculations. The Uppsala University (UU) has also recently invested large efforts in studying the possibility of using model defect methods in evaluations. In this context, UU will combine its resources with the previous partners. To continue to develop the so-called TENDL methodology, by including new functionality to treat model defects and inconsistent experimental data. This will allow incorporating reliable and quantitative methods for the use of calibration data and hence produce justified co-variances for the evaluated nuclear data.
These studies will define the tools used by the different partners to produce (or support) the evaluation work: new (n,xng) for the main actinides (CNRS/IPHC and CEA/DEN), Cr evaluations (UU), major and minor actinides (such as U235, U238, Pu239, and Am241: CEA/DEN, CEA/DAM/DIF, CNRS), some important fission products (Sm, Nd, Cs, Mo, Ru, Eu, Gd, Rh: CEA/DEN, PSI) and the Pu isotopic chain (Pu238 to Pu244: UB and IAEA). As a standard practice, all evaluations will be provided with covariance information, processed and used in task 4.3.

Task 4.2: Fission yields and nuclear structure and decay data evaluations
Task coordinator: IFIN-HH, partners: IFIN-HH, CEA/LNHB, CNRS/LPSC, Sofia, Atomki, CNRS/Subatech

Task 4.2.1: Evaluation of Fission yields
The analysis and evaluation of fission yields is also of prime importance for many applications (e.g. correct estimation of the content of spent nuclear fuel). The CEA/DEN, CNRS/LPSC have a large experience in measuring, analysing and evaluating thermal neutron-induced fission yields. In the framework of a collaboration between the Physical Studies Laboratory (LEPh) of the CEA (France), the Subatomic and Corpuscular Physics lab (LPSC of CNRS) of Grenoble (France) and others, a program of actinide fission yield measurements of interest for the current and innovative nuclear reactors has been initiated for several years. In this task, the proposed work will allow to deeply test some model assumptions used in the fission yield evaluations. The program will be based on the measurements of kinetic energy dependency of yields, isomeric ratios or isotopic distributions. It is defined in three parts: two experimental, and the last one dealing with the improvement of the modelling of the fission products used in the evaluations (e.g. modelling of the fission products from the FIFRELIN Monte Carlo code).

Task 4.2.2: Evaluation of nuclear structure and decay data
Together with the fission yields, evaluations of nuclear structure and decay data can have an important impact on specific applications, such as decay heat calculations. Additionally, it is important that the (cumulative) fission yields are evaluated together with decay data. In this context, a few experienced groups will join efforts to perform ENSDF (Evaluated Nuclear Structure Data File) evaluations. ENSDF constitutes the main source of nuclear structure information used in RIPL (The Reference Input Parameter Library), the major library used by TALYS and EMPIRE. It should be noted that some of these groups also have experimental and simulation programs which are combined with the evaluation efforts. For instance, new TAGS data will be analysed to develop the calculation of the experimental uncertainties associated to these experiments, in order to be able to provide nuclear databases with covariance matrices for beta decay data. These covariance matrices are mandatory for the propagation of decay data uncertainties on the decay heat, antineutrino spectra and beta-delayed neutron emission fractions of reactors (CNRS/Subatech). Evaluation activity will be performed by CEA/LNHB, ATOMKI, Sofia and IFIN-HH: theoretical calculations, evaluations, modern evaluation tools (and training) and nuclear data library production (e.g. evaluated decay scheme), to improve the next version of the JEFF Radioactive Decay Data Library and the Evaluated Nuclear Structure Data File.

Task 4.3: Processing and sensitivity
Task coordinator: UPM, partners: CIEMAT, UPM, CNRS/Subatech

The processing step is strongly linked to the evaluation process and allows basic evaluations (in the ENDF-6 format) to be used by a variety of simulation codes. In the CHANDA project (Task 9.4), quality-assured processing routes for PREPRO and NJOY nuclear data processing codes were established; however, the AMPX code system was neglected because AMPX was not freely distributed with SCALE at that time. As a continuation of the work done in CHANDA and in consonance with efforts done by OECD-NEA, CIEMAT proposes to define and validate a processing route for AMPX and GEANT4 in order to process state-of-the-art nuclear data. Best processing parameters will be identified and input decks for processing CE libraries with the AMPX system will be generated. Additionally, state-of-the-art nuclear data libraries (e.g., JEFF-3.3, ENDF/B-VIII.0 and JENDL-4.0u2) will be processed and validated using the same criticality validation suite used by MCNP. Additionally, UPM will perform the checking, processing and verification of evaluated nuclear data files: (1) review of the processing tools, (2) processing and verification of evaluated nuclear data files and covariances, and (3) verification of covariance nuclear data in criticality, shielding and spent nuclear fuel assay data. The second part of this task will concern the sensitivity calculations and uncertainty propagation based on the processed files. Such sensitivity will be performed for fission yields (CNRS/Subatech).

Task 4.4: Applications
Task coordinator: CIEMAT, partners: UPM, CIEMAT, JSI

To complete this work package and provide a suitable link with the Work Package on validation (WP5), recommendations for preferred benchmark for thermal and high energy (up to 20 MeV) will be proposed. Whereas nuclear data validation has been in the recent years mostly restricted to critical benchmarks, this effort will also focus on other types of measurements, such as shielding benchmarks and kinetics. The code such as SUS3D (JSI) will be used for shielding calculations, with improved S/U analysis of the impact of the uncertainties in the secondary angular and energy distributions. For criticality and kinetic parameters, a review of different suites of inputs used in ICSBEP will be performed (CIEMAT and UPM), with selection/classification of benchmarks for different levels of nuclear data sensitivities for benchmarking and validation of nuclear data. For shielding, and spent nuclear fuel, a review of the SINBAD and SFCOMPO databases will be performed (JSI).

Task 4.5: High-energy model uncertainties
Task coordinator: CEA/DRF, partners: CEA/DRF, USC

Finally, the higher energy part (above 20 MeV) and especially the propagation of uncertainties from the high-energy models (and parameters) will be studied (CEA/DRF, USC). Codes used for the simulation of Accelerator-Driven Systems (ADS) and for number of other applications, such as for instance radiation protection or hadron therapy, are usually Monte Carlo transport codes, in which the probability of the occurring high energy nuclear reactions and characteristics of the reaction products are provided by nuclear physics models and not through nuclear data bases as at lower energies. This implies that specific methods have to be developed to assess the uncertainties due the parameters and approximations used in these nuclear models.
During the last Nuclear Data projects, an important effort has been devoted to the development, improvement and validation of the high energy nuclear models, in particular the INCL-ABLA combination of models that are now widely used for high energy applications. In CHANDA, for the first time, a study has been conducted to investigate a possible methodology for quantifying the uncertainties linked to high energy models and propagating them in Monte Carlo transport codes. A Bayesian framework has been proposed and tested on INCL for a few varying parameters. In this project, it is proposed to investigate if the methodology can be generalized to the whole set of parameters of INCL and extended to ABLA.

Participation per Partner

Partner number and short name	WP4 effort
1 - CIEMAT	16.60
2 - ATOMKI	8.60
3 - CEA	43.20
5 - CNRS	5.00
G-INP	2.50
Univ Nantes	2.00
IMT Atlantique	2.00
10 - IFIN-HH	5.00
14 - JSI	7.20
21 - PSI	6.00
24 - Sofia	5.30
25 - TUW	5.00
26 - UB	35.00
32 - UPM	11.80
33 - USC	5.00

Partner number and short name	WP4 effort
35 - UU	13.00
Total	173.20

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D4.1	Report on code development, methods	21 - PSI	Report	Public	40
D4.2	Report on new nuclear reaction data evaluation	3 - CEA	Report	Public	48
D4.3	Report on the evaluation for fission yields	3 - CEA	Report	Public	48
D4.4	Report on the evaluation for nuclear structure and decay data	10 - IFIN-HH	Report	Public	48
D4.5	Report on the processing and sensitivity analysis	32 - UPM	Report	Public	36
D4.6	Report on the applications: recommendation	1 - CIEMAT	Report	Public	36
D4.7	Report on the possibility to generalize the high-energy model uncertainties methodology	3 - CEA	Report	Public	48

Description of deliverables

D.4.1 “Report on code development, methods” (PSI): M40
D.4.2 “Report on new nuclear reaction data evaluation” (CEA): M48
D.4.3 “Report on the evaluation for fission yields” (CEA): M48
D.4.4 “Report on the evaluation for nuclear structure and decay data” (IFIN-HH): M48
D.4.5 “Report on the processing and sensitivity analysis” (UPM); M36
D.4.6 “Report on the applications: recommendation” (CIEMAT): M36
D.4.7 “Report on the possibility to generalize the high-energy model uncertainties methodology” (CEA): M48

D4.1 : Report on code development, methods [40]

Report on code development, methods

D4.2 : Report on new nuclear reaction data evaluation [48]

Report on new nuclear reaction data evaluation

D4.3 : Report on the evaluation for fission yields [48]

Report on the evaluation for fission yields

D4.4 : Report on the evaluation for nuclear structure and decay data [48]

Report on the evaluation for nuclear structure and decay data

D4.5 : Report on the processing and sensitivity analysis [36]

Report on the processing and sensitivity analysis

D4.6 : Report on the applications: recommendation [36]
Report on the applications: recommendation

D4.7 : Report on the possibility to generalize the high-energy model uncertainties methodology [48]
Report on the possibility to generalize the high-energy model uncertainties methodology

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS30	availability of TALYS modules	3 - CEA	32	availability of TALYS modules
MS31	availability of new EMPIRE modules/models	26 - UB	32	availability of new EMPIRE modules/models
MS32	availability of evaluated files for important actinide isotopes	3 - CEA	32	availability of evaluated files for important actinide isotopes
MS33	availability of evaluated files for important fission products	3 - CEA	36	availability of evaluated files for important fission products

Work package number [9]	WP5	Lead beneficiary [10]	3 - CEA
Work package title	Nuclear data validation and integral experiments		
Start month	1	**End month**	60

Objectives

Nuclear data validation is considered here as a subset of the broader Verification, Validation and Uncertainty Quantification (VVUQ) process in Modelling and Simulation. In this VVUQ general process, validation is defined as the assessment of a computational model accuracy by comparison with experimental data assumed to represent reality faithfully. In nuclear engineering, it is generally further implied that this model fidelity assessment relates to a specific application domain (i.e., the intended use).

For complex engineering systems such as reactors, the VVUQ process formally requires a constructive approach with a validation hierarchy, validation metrics and criteria, a validation domain, etc. Different system tiers have to be considered, from low-level subtiers to the full-scale system. Corresponding models and representative experiments have to be identified, from simple single-physics "benchmarks" to full-scale multi-physics experiments. In such a framework, nuclear data are just one set of model parameters among others that influence the global simulation outputs. Requirements are initially expressed only in terms of high-level systems responses. In principle, sensitivity and uncertainty analyses have to be performed for the different system tiers while accounting for the different sources of errors.

As JEFF evaluated nuclear data are used in many applications, and as sensitivities of system responses to nuclear data can vary considerably depending on specific design choices, it would be impractical to attempt a "general" catch-all validation approach. Instead, it is necessary to proceed by parts, beginning with the most sensitive data. As a common goal for this project, we set out to validate a few selected nuclear data for some applications. In order to have reasonably realistic plant models and target performance criteria to use, we chose reactor systems for which a significant amount of (pre-)design work had already been done, while trying to have some system diversity.

As single-physics benchmarks (sensitive only to a few nuclides and reactions) are more and more commonly integrated in the evaluation process itself (see WP4), together with differential experiments, they have to be excluded from the validation experiments, not to be used twice.

Error and uncertainties in nuclear data (important actinides, fission products and structural materials) are known to have a major impact on some high-level nuclear system parameters. When high-fidelity models are used, these errors and uncertainties can be the dominant component in the aggregate performance. The careful assessment of these errors and uncertainties via the validation process is therefore essential. This is not a straightforward task, however, as there are well-known difficulties and many potential pitfalls. One of which being hidden error compensations, which typically occur when the validation relies only on very global experiments.

As nuclear data evaluations produced in WP4 will come with covariances, it will be possible to incorporate this information directly in the computational analysis, as should be done. Then, the process calls for ensemble computing, and finally assessment of uncertainty in the outputs by statistical inference. As this represents a large effort, the partnership will be harnessed to leverage additional resources. No data adjustment or assimilation will be attempted.

In the end, we should be able to quantify the impact of (WP4) nuclear data errors and uncertainties on the selected system outputs, and to suggest relevant additional validation experiments if the target performance is not met.

This work package is subdivided into three tasks, each of them containing some subtasks :

- Task 5.1: Sensitivity analyses, impact studies, uncertainty estimates, and expected gains. The objective is to relate improvements in (JEFF-3.3) nuclear data to performance gains in the operation, design, licensing of innovative reactors or concepts, such as ASTRID, MYRRHA, JHR, and possibly also ALLEGRO, ALFRED/LEADER, MSFR (thorium fuel cycle). The scope covers not only the reactors, but also criticality-safety, nuclide inventories in subassemblies or waste streams.
- Task 5.2: Validation studies for the above applications, by performing detailed analyses of available relevant benchmarks and integral experiments (not already used in the evaluation process), and inferring trends in nuclear data. The objective is the validation of the files produced under WP4, as well as the identification of gaps in the validation domain.
- Task 5.3: New validation experiments and needs for new integral data. The objective is to find some means of obtaining the required validation data, in a general context of dwindling experimental reactor capabilities. The work includes innovative experiments in existing facilities, for the purpose of filling the gaps.

Description of work and role of partners

WP5 - Nuclear data validation and integral experiments [Months: 1-60]
CEA, CIEMAT, CNRS, CVREZ, ENEA, IRSN, JSI, KIT, NRG, SCK-CEN, UPM
Task 5.1: Impact studies, sensitivity analyses, and assessment of needs for various applications
Task coordinator: CIEMAT, partners: CEA, CNRS/LPSC, SCK-CEN, JSI, KIT, UPM, IRSN

Subtask 5.1.1: Impact studies and sensitivity analyses
Under this task, the impact of (JEFF) nuclear data uncertainties and systematic errors on reactor engineering design and safety parameters will be evaluated in a quantitative manner. The focus is on innovative nuclear systems (and fuel cycles): sodium-cooled fast reactors such as ASTRID or ESFR, lead-cooled fast reactors such as MYRRHA or ALFRED, the JHR water-cooled MTR under construction in France. Other reactors which have also undergone at least some preliminary engineering design work will be included, if the project can leverage external resources: advanced light-water cooled reactors, ALLEGRO gas-cooled fast reactor, thorium-233U fuelled molten salt reactor (SAMOFAR project).
We aim for a diversity of systems, as it is well-known that the impact of nuclear data largely depends on the specific design choices, even within a given “family” of systems. It is therefore essential to consider different systems and to perform systematic sensitivity studies to appreciate relative differences. Yet, we fully realize that our selection is only partially representative of the vast spectrum of nuclear plants and facilities.
Reactor parameters of interest are typically core power distribution, critical mass, control rod worth, Doppler coefficient, coolant void reactivity, burnup swing, decay heat, etc. Reactor operating conditions corresponding to the most conservative state will be selected, depending on the parameter; for instance, depleted core conditions for sodium void estimation. The focus will be on steady-state operation, but reactor transient conditions with feedback will also be considered, if readily-available calculation models can be found.
Additionally, the impact of nuclear data on neutron propagation into reflectors and shields will be addressed, as this has important implications for predicting quantities such as local heating, pressure vessel damage or radiation dose rate.
Nuclear data needs for plant decommissioning and waste storage will also be assessed, to a smaller extent.
In general, the work will rely on already-developed computational models of the reactor, component or system. Advantage will be taken of models developed under past EC-funded projects, or as part of separate engineering design studies, for which target uncertainties and design/safety margins should be available.
The particular methods used for performing the sensitivity and impact studies are left with the contributing organizations, which all have a proven record in this respect. Each of them will be free to choose their preferred (well-tested) method and code. Classical (forward) sensitivity calculation capabilities have become routine in many deterministic and Monte Carlo code packages (cf. DICE & NDaST), including fuel depletion studies. Generalized sensitivity and perturbation capabilities are less commonly used, but this is not expected to be a serious hindrance for the present purpose. Nonetheless, some consideration will be given to advanced methodologies and to errors which arise from various approximations.
The JEFF-3.3 evaluated file will be used throughout as a reference, including covariance data (when available). When new evaluations will become available from WP4, they will be substituted and tested. Discrepancies with JEFF-3.3 may be used (with due care) to estimate systematic errors and assess their impact.
Methods of sensitivity analysis: CIEMAT, LSPC, UPM and CEA/DEN will compare their methods of sensitivity studies CNRS/LPSC will use generalized sensitivities computed by the Monte Carlo method. Recent developments make it possible to calculate sensitivities of almost any output to various nuclear data. The availability of such reference solutions opens up the possibility of investigating the impact of classical approximations, such as the use of group-wise cross sections and macro-group sensitivity coefficients, the neglect of some nuclear data correlations, the neglect of uncertainties in secondary distributions, etc.
UPM will use the SCALE system for reactor physics calculations and S/U analysis. They will compare sensitivities computed with Monte Carlo calculations in both multi-group and continuous-energy modes, assessing biases and pointing out the configurations/energy ranges for which an accurate resonance self-shielding still remains a challenge, which is of interest for calculation schemes based on deterministic codes.
CIEMAT will investigate a hybrid method coupling Monte Carlo simulations with the Equivalent Generalized Perturbation Theory, in order to account for the impact of nuclide inventory errors on end-of-life reactor parameters. This hybrid method, which has already been tested in CHANDA, will be used to quantify other classical approximations. CEA/DEN will contribute to these comparisons with their own sensitivity calculation method and results.
SFR: CEA/DEN and UPM will perform sensitivity and impact studies for a PuO2-UO2-fuelled ASTRID-type sodium-cooled fast reactor Advantage will be taken of the CP-ESFR reactor model developed under ESFR-SMART. If possible, a SUPERPHENIX model, also used in ESFR-SMART, will be included for comparison purposes. A convenient starting point will be the work performed in WP2.1 of ESFR-SMART, which considered the impact of nuclear data.
JHR: CEA/DEN will perform a similar study for the U3Si2/UMo-fuelled light-water cooled JHR MTR reactor. A detailed JHR model is available in Camprini’s PhD thesis, for instance.

MYRRHA: SCK-CEN, CIEMAT and UPM will perform sensitivity studies for MYRRHA, the lead-cooled PuO2-UO2-fuelled lead-bismuth-cooled developed by SCK-CEN. The reactor model used in the CHANNDA project will be used as a starting point. A more detailed model may be necessary, however.
ALFRED: UPM will perform sensitivity, uncertainty analysis and quantitative evaluation of nuclear data improvements on safety-related parameters of the PuO2-UO2-fuelled lead-cooled fast reactor ALFRED demonstrator. This work will build upon the results of the FP7 LEADER and FP7 ESNII+ projects, which include a calculation model.
Criticality-safety: IRSN will also contribute to this task by performing nuclear data sensitivity/impact studies for criticality-safety applications.

Decommissioning and waste disposal: KIT will investigate nuclear data needs which arise in connection with nuclear plant decommissioning and waste disposal operations. Indeed, with the aging of the nuclear fleets, several states prepare for the shutdown and decommissioning of nuclear power plants and facilities, and for the final disposal of HLW and LLW/MLW. These topics involve the radiological characterization of various materials, mostly by simulations using inventory codes. In general, the nuclei involved are different from those that are important for nuclear reactor operation and fuel cycle and sometimes simulations have to rely on evaluated files derived from basic physics models with little or no validation. The study will consider actinide inventory, fission products, isomeric state production cross sections, 14C production, tritium production, etc. Taking into account the different types of observables, the potential isotopes involved, and the large uncertainties introduced by the host rock and the Deep Geological Repository (DGR) geometry choice, the operation conditions, the predisposal management and the fuel history, that introduce huge variability on the sensitivity coefficients the proposal is to perform scoping calculations that allow to estimate the "Contribution to nuclear data needs for HLW disposal" rather than on the precise numerical sensitivity coefficients and with special attention to the scenarios defined by KIT (coordinating the studies).

Subtask 5.1.2: Assessment of (JEFF) nuclear data needs
At the conclusion of Subtask 5.1.1, the findings will be compiled and cross-analyzed in a synthesis document, which will be published. This document may be viewed as an update of the well-known OECD/WPEC/SG26 report, based on more recent data and on better-substantiated reactor models.
We will discuss the importance of the a priori covariance data used, and the implications of the results. Recommendations will be made as to which nuclear data are in need of improvement and what "performance" gains can be expected as a consequence.
These results will be communicated to the OECD/NEA for consideration by the JEFF community (JEFF-4 perspective) and for inclusion in the HPRL.

Task 5.2: Validation studies (using existing experiments)
Task coordinator: UPM, partners: CEA/DEN, CIEMAT, JSI, KIT, NRG, IRSN

The various actions in this Task 5.2 will make systematic use of the JEFF-3.3 evaluated files, with their associated covariances. As new evaluations will progressively become available from WP4, they will be substituted and the validation calculation will be repeated.

Subtask 5.2.1: Assessing correlations in integral experiments
While a considerable effort has been given to nuclear data covariances in recent years, much less attention has been paid to correlations in integral experiments used in validation, adjustment, and assimilation studies. In point of fact, correlation coefficient data for criticality cases are available for only 93 integral experiments of the DICE database associated with the ICSBEP Handbook.
Although this project will not attempt to produce adjusted nuclear data libraries nor to assimilate validation information, CIEMAT, JSI, CEA/DEN, and UPM will share their best experts' opinions on the "missing correlations in integral experiments" problem, with the goal of assessing its impact on nuclear data validation studies. Simulations will be made to estimate the correlations between the experimental uncertainties of integral experiments and quantify their impact on some reactor concept.

Subtask 5.2.2: C/E validation and trends
UPM and CEA/DEN will use a carefully-selected set of reactor physics experiments (from reactor benchmarks or models in IRPhE or other sources such as reactor startup experiments, etc.) for performing nuclear data validation. JEFF-3.3-based C/E results will be analyzed for possible biases and reactor performance. The same set of experiments will be analyzed again with new (WP4) evaluations when they become available, and trends will be inferred.
JSI: will perform cross section sensitivity/uncertainty analysis of selected shielding benchmarks (from the SINBAD database in particular), known to be more sensitive to scattering reactions than criticality experiments. New WP4 evaluations will be compared with JEFF-3.3, and the reasons for the differences will be investigated.

NRG will perform Monte Carlo calculations and C/E calculations of criticality benchmarks. The benchmarks will be grouped according to sensitivity profiles, to facilitate the C/E analysis. NRG is uniquely positioned to perform this task because of its large collection of benchmarks already integrated in a database.

IRSN will perform a similar study for a subset of their large suite of criticality-safety benchmarks.
CIEMAT will use a Monte Carlo procedure recently developed in the CHANDA project to validate fission product nuclear data against MINERVE/CERES pile oscillation experiments available in IRPhE.
The results derived from these studies will be combined in such a way that the same experimental information is not included twice. Gaps in the validation will be identified and discussed.

Task 5.3: New integral experiments
Task coordinator: CEA/DEN, partners: CVREZ, ENEA

Subtask 5.3.1: Experiments at GELINA and CEA/DEN
The proposed experiments will consist in performing neutron transmission measurements at the JRC Geel GELINA facility using the same samples as those used in the CEA Cadarache MINERVE reactor as part of the past CERES Burnup Credit programme. Preliminary studies show that such experiments should be feasible. Each sample is made of a UO2 matrix with a small admixture of a fission product: Sm, Nd, Cs, Mo, Ru, Eu, Gd, or Rh. The expected outcome will be a set of transmission data for each sample. These data will be first used to determine the amount of contaminants in the samples by Neutron Resonance Transmission Analysis (NRTA). The knowledge of the relative amount of such contaminants will help improve the analysis of the past MINERVE measurements. In a second step, a combined analysis of the MINERVE spectrum-averaged data and the GELINA microscopic energy-dependent data will help improve the fission product cross section data in the resonance region.

Subtask 5.3.2: Experiments at LR-0, CVREZ and CEA/DEN
The flexible zero-power LR-0 critical facility at Rez and its well-defined neutron spectrum will be used to create benchmark-quality nuclear data validation conditions:
- Full characterization of a critical 235U-fuelled configuration (criticality, power distribution and spatial distribution of flux and reaction rates) for an IRPhEP-quality type benchmark;
- Direct and indirect measurements of the 235U prompt fission neutron spectrum, especially the high-energy tail. The direct method uses neutron spectrometry techniques while the indirect method uses low uncertainty flux monitors. Some of the neutron detectors developed under WP1 could also be tested on that occasion;
- Measurements of spectrum-averaged cross sections in well-characterized neutron spectra (from fast to thermal), obtained by spectrum shaping arrangements using high-purity graphite moderation.

Subtask 5.3.3: Experiments at TAPIRO, ENEA and CEA/DEN
The TAPIRO fast neutron source reactor at the ENEA Casaccia centre near Rome will be used to measure minor actinide spectrum-averaged cross sections. The program, called AOSTA, will consist of minor actinide irradiations and fission cross section measurements. Reference major actinides will be also measured in the same spectral conditions. Delayed gamma peak spectrometry will be used to infer capture cross sections, while dedicated miniature fission chambers containing pure deposits of actinides will be used to measure fission cross sections. As for Subtask 5.3.2, the AOSTA program could provide the opportunity to test some of the neutron detectors developed in WP1.
Although only the leading organizations are named across each subtask, it is expected that other project partners will be interested and will volunteer contributions to the above experimental programs in due course.
At the outcome of this Task 5.3, valuable new validation data are expected and will be made available broadly. The subsequent use of this experimental information for nuclear data validation will provide some indication of the remaining gaps to improve evaluated files and meet target performance. Recommendations will be made as to the best course of action to bridge this gap, knowing that there is only a very small number of zero-power experimental reactors still in operation worldwide.
Should difficulties arise with one of the above subtasks, resources could be redirected to experiments in another facility. In particular, innovative (semi-)integral transmission-type experiments could be considered at one of the JRC Geel facilities, in the GELINA target hall or at the MONET tandem Van-de-Graaff. Such experiments would consist in studying transmitted beams of MeV-energy neutrons thru a stack of plates made of pure material (238U, Fe, Na, MgO…). The stack thickness would be optimize for maximizing the activation detectors sensitivity to neutron inelastic scattering in the stacked material. Preliminary simulations suggest that such an experiment would be feasible.
Under Task 5.3, there is a risk that one of the three facilities will not be available for the intended experiments. Such a risk is considered to be rather low. Should it happen, the resources could be redirected to expand on the experiments in one of the other two facilities.

Participation per Partner	
Partner number and short name	**WP5 effort**
1 - CIEMAT	15.20
3 - CEA	8.70
5 - CNRS	0.00
G-INP	3.00
7 - CVREZ	16.30
8 - ENEA	3.00
11 - IRSN	1.90
14 - JSI	6.00
16 - KIT	3.00
19 - NRG	3.90
23 - SCK-CEN	1.10
32 - UPM	7.10
Total	69.20

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D5.1	Report on sensitivity analysis methods	1 - CIEMAT	Report	Public	24
D5.2	Report on ESFR, MYRRHA, and ALFRED sensitivity and impact studies	23 - SCK-CEN	Report	Public	24
D5.3	Report on JHR sensitivity and impact study	3 - CEA	Report	Public	52
D5.4	Report on HLW sensitivity and impact study	16 - KIT	Report	Public	24
D5.5	Report on assessment of nuclear data needs	3 - CEA	Report	Public	50
D5.6	Report on correlations between integral experiments	1 - CIEMAT	Report	Public	50
D5.7	Report on reactor and shielding C/E validation and nuclear data trends	32 - UPM	Report	Public	49
D5.8	Report on critical benchmark C/E	19 - NRG	Report	Public	49

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
	validation and nuclear data trends				
D5.9	Report on C/E validation and nuclear data trends	32 - UPM	Report	Public	48
D5.10	Report on experiments at JRC Geel using MINERVE samples	3 - CEA	Report	Public	51
D5.11	Report on integral experiments at LR-0	7 - CVREZ	Report	Public	51
D5.12	Report on integral experiments at TAPIRO	8 - ENEA	Report	Public	58
D5.13	Report on new integral experiments and needs	3 - CEA	Report	Public	60

Description of deliverables

D.5.1 Report on sensitivity analysis methods; CIEMAT, LPSC, UPM, CEA; M24
D.5.2 Report on ESFR, MYRRHA, and ALFRED sensitivity and impact studies; SCK, CEA, UPM; M24
D.5.3 Report on JHR sensitivity and impact study; CEA; M52
D.5.4 Report on HLW sensitivity and impact study; KIT; M24
D.5.5 Report on assessment of nuclear data needs; CEA, CIEMAT, UPM, SCK, KIT; M50
D.5.6 Report on correlations between integral experiments; CIEMAT, JSI, CEA, UPM; M50
D.5.7 Report on reactor and shielding C/E validation and nuclear data trends; UPM, JSI, CEA; M49
D.5.8 Report on critical benchmark C/E validation and nuclear data trends; NRG, IRSN; M49
D.5.9 Report on C/E validation and nuclear data trends; UPM, CEA, JSI, NRG, IRSN; M48
D.5.10 Report on experiments at JRC Geel using MINERVE samples; CEA; M51
D.5.11 Report on integral experiments at LR-0; CVREZ, CEA; M51
D.5.12 Report on integral experiments at TAPIRO; ENEA, CEA; M58
D.5.13 Report on new integral experiments and needs; CEA, JRC, CVREZ, ENEA; M60

D5.1 : Report on sensitivity analysis methods [24]

Report on sensitivity analysis methods

D5.2 : Report on ESFR, MYRRHA, and ALFRED sensitivity and impact studies [24]

Report on ESFR, MYRRHA, and ALFRED sensitivity and impact studies

D5.3 : Report on JHR sensitivity and impact study [52]

Report on JHR sensitivity and impact study

D5.4 : Report on HLW sensitivity and impact study [24]

Report on HLW sensitivity and impact study

D5.5 : Report on assessment of nuclear data needs [50]

Report on assessment of nuclear data needs

D5.6 : Report on correlations between integral experiments [50]

Report on correlations between integral experiments

D5.7 : Report on reactor and shielding C/E validation and nuclear data trends [49]

Report on reactor and shielding C/E validation and nuclear data trends

D5.8 : Report on critical benchmark C/E validation and nuclear data trends [49]

Report on critical benchmark C/E validation and nuclear data trends

D5.9 : Report on C/E validation and nuclear data trends [48]

Report on C/E validation and nuclear data trends

D5.10 : Report on experiments at JRC Geel using MINERVE samples [51]

Report on experiments at JRC Geel using MINERVE samples

D5.11 : Report on integral experiments at LR-0 [51]

Report on integral experiments at LR-0

D5.12 : Report on integral experiments at TAPIRO [58]

Report on integral experiments at TAPIRO

D5.13 : Report on new integral experiments and needs [60]

Report on new integral experiments and needs

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS34	Report on assessment of nuclear data needs	3 - CEA	50	Report on assessment of nuclear data needs

Work package number [9]	WP6	**Lead beneficiary** [10]	1 - CIEMAT
Work package title	Management, ND research coordination at EU level and Education and Training		
Start month	1	**End month**	60

Objectives

This work package has four complementary objectives of coordination.
-This WP will be dedicated to the general management of the project, the follow-up and validation of quality and timing of deliverables and milestones. It will also provide the tools for management, information exchange and external visibility including a dedicated web,
- the second objective will be the preparation of a framework for the coordination of the European nuclear data research in a sustainable structure well beyond the duration of the project, and, as far as possible, covering all the domains of applications of nuclear data,
-the third objective will be the coordination of the education and training activities, covering both the promotion and follow-up of training in the other tasks and work-packages of the project, and the organization of dedicated open training courses during the duration of the project, and
- the fourth objective will be the coordination and follow-up of the dissemination and communication activities all over the project.

Description of work and role of partners

WP6 - Management, ND research coordination at EU level and Education and Training [Months: 1-60]
CIEMAT, CEA, CNRS, JRC
Task 6.1: Management; CIEMAT, JRC
This task will handle the management of the consortium, including the administrative and financial operations, the notification of the consortium agreement preparation, the draft version for the rules of operation of the different management bodies and the reporting to the EU. One specific objective will be the coordination of the three periodic reports and the final report of the project. To facilitate the dissemination of the project progress and results and the exchange of information within the project a Web site will be prepared and open by the project. All consolidated information will be fully open, but a restricted access area will be reserved for materials under discussion within the project participants. The project will also prepare a detailed 'Communication Action Plan'.

Task 6.2: Sustainable framework for the coordination of the European nuclear data research; CIEMAT, CEA CNRS and JRC
This task will include:
- the identification of potential partners and contact points at the different Member States, MS.
- the follow-up and identification of tools for joint programing for FP9: EJP or similar
- the identification of potential program for the ND community in a 5 to 10 years horizon covering all the domains of applications of nuclear data
- the preparation of documentation and visits to Member States (MS) representatives with influence on the EURATOM programs, European technological platforms and other bodies of influence on the EURATOM programs, to explain the ND community, its needs of a long-standing framework for coordination, and the possible instruments to stablish that framework
- the preparation of one meeting of the ND community with interested Member States (MS) representatives, European technological platforms and other relevant stakeholders
- maintaining and clarifying the link to the JEFF project
- the identification of ways and frameworks to maintain our community effort and to reinforce links between experimentalists, theoreticians and evaluators around a common ambition

Task 6.3: Coordination of Education and training activities, JRC, CIEMAT
This task will promote that the research activities within the project result in PhD and Master theses and to favour the training of young scientist with working visits to the facilities associated to the project. A special event of the task will be the organization of one training course specialized in Nuclear Data for increased Safety of the nuclear and radiological EU installations. It will be open to the participants in other EU projects related to the field. This school will be organized as special edition of known schools on nuclear R&D. Initial contacts had been made with the organizers of the series

of the Nuclear Resonance Analysis schools. No fee will be requested and financial support will be allocated to provide travel support to a fraction of the students. Cooperation with ENEN will be set-up.

Task 6.4: Coordination of Dissemination and Communication activities, CIEMAT
This task will prepare a Communication and Dissemination Action Plan to be implemented by all the tasks and partners. The dissemination plan will make sure that the results are readily available for end-users, as soon as possible and well beyond the project duration in the standard formats (EXFOR, ENDF, ENSDF,…) and as much as possible using open repositories operated by international organizations like IAEA or NEA/OECD.
The communication plan will make sure that the general information of the project, its progress and main results reach to the potential end-users in the EU, both for classic end-users and for new potential end users.
Scientific Journals, international scientific and technical conferences, PhD and master theses and courses, sectorial conferences, national nuclear and radioprotection societies, and technological platforms will be included in both dissemination and communication actions.

In addition, a Data Management Plant, DMP, will be prepared to comply with the principles of the Open Research Data Pilot, ORDP. The DMP will explain that the digital research data generated in the action associated to a number of deliverables whose main results are data will be deposited in a research data repository (EXFOR of IAEA, and others of IAEA or NEA/OECD) and the measures that will be taken to make possible for third parties to access, mine, exploit, reproduce and disseminate, free of charge for any user: (i) the data, including associated metadata, needed to validate the results presented in scientific publications, as soon as possible; (ii) other data, including associated metadata, as specified and within the deadlines laid down in the 'data management plan', DMP. The selected repositories will be available long after the completion of the project by agreements with international organizations IAEA or NEA/OECD. Together with these organizations the consortium will provide information about tools and instruments at the disposal of the beneficiaries and necessary for validating the results.

In addition a web page will be prepared for the project both for the internal communication within the project and as an open window for external researchers and general public that wants to get updated on the activities and publications from the project. Although working versions of deliverables, publications and other materials might be password protected during the project execution all technical final results (compatible with regulations) will be openly available from the project web pages. The project web will be maintained at least 5 years after the project finalization.

Participation per Partner

Partner number and short name	WP6 effort
1 - CIEMAT	23.30
3 - CEA	1.80
5 - CNRS	2.00
13 - JRC	0.30
Total	27.40

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D6.1	Web for the project	1 - CIEMAT	Websites, patents filing, etc.	Public	9
D6.2	Report on a sustainable framework for the coordination of the	3 - CEA	Report	Public	54

List of deliverables

Deliverable Number[14]	**Deliverable Title**	**Lead beneficiary**	**Type**[15]	**Dissemination level**[16]	**Due Date (in months)**[17]
	European nuclear data research				
D6.3	Report on school on nuclear data research methods and tools and E&T activities	13 - JRC	Report	Public	54
D6.4	Project presentation	1 - CIEMAT	Report	Public	3
D6.5	Project "Communication and Dissemination Action Plan"	1 - CIEMAT	Report	Public	6
D6.6	Project "Data Management Plan"	1 - CIEMAT	ORDP: Open Research Data Pilot	Public	6

Description of deliverables

D.6.1 Web for the project: CIEMAT, M9
D.6.2: Report on a sustainable framework for the coordination of the European nuclear data research: CEA, M54
D.6.3 Report on school on nuclear data research methods and tools and E&T activities: JRC, M54
D.6.4: Project presentation: CIEMAT, M3
D.6.5: Project "Communication and Dissemination Action Plan": CIEMAT, M6
D.6.6: Project "Data Management Plan": CIEMAT, M6

D6.1 : Web for the project [9]

Web for the project

D6.2 : Report on a sustainable framework for the coordination of the European nuclear data research [54]

Report on a sustainable framework for the coordination of the European nuclear data research

D6.3 : Report on school on nuclear data research methods and tools and E&T activities [54]

Report on school on nuclear data research methods and tools and E&T activities

D6.4 : Project presentation [3]

Project presentation

D6.5 : Project "Communication and Dissemination Action Plan" [6]

Project "Communication and Dissemination Action Plan"

D6.6 : Project "Data Management Plan" [6]

The DMP will explain that the digital research data generated in the action associated to a number of deliverables whose main results are data will be deposited in a research data repository (EXFOR of IAEA, and others of IAEA or NEA/OECD) and the measures that will be taken to make possible for third parties to access, mine, exploit, reproduce and disseminate, free of charge for any user: (i) the data, including associated metadata, needed to validate the results presented in scientific publications, as soon as possible; (ii) other data, including associated metadata, as specified and within the deadlines laid down in the 'data management plan', DMP. The selected repositories will be available long after the completion of the project by agreements with international organizations IAEA or NEA/OECD. Together with these organizations the consortium will provide information about tools and instruments at the disposal of the beneficiaries and necessary for validating the results.

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification

1.3.4. WT4 List of milestones

Milestone number[18]	Milestone title	WP number[9]	Lead beneficiary	Due Date (in months)[17]	Means of verification
MS1	Completion of the simulation for the coupling of FALSTAFF and FIPPS at ILL	WP1, WP2	3 - CEA	12	Completion of the simulation for the coupling of FALSTAFF and FIPPS at ILL
MS2	Completion of simulations for new gas cell with electric field guidance at IGISOL	WP1	15 - JYU	18	Completion of simulations for new gas cell with electric field guidance at IGISOL
MS3	Completion of a new measurement facility by CEA/LNE-LNHB	WP1, WP2	3 - CEA	18	Completion of a new measurement facility by CEA/LNE-LNHB
MS4	Completion of the design of the fast neutron spectrometer at CEA/DEN	WP1	3 - CEA	24	Completion of the design of the fast neutron spectrometer at CEA/DEN
MS5	Completion of GRPD - gaz recoil proton detector at CNRS/CENBG	WP1, WP2	5 - CNRS	24	Completion of GRPD - gaz recoil proton detector at CNRS/CENBG
MS6	Completion of simulations for a MicroMegas-based time projection chamber at CEA/DRF/IRFU	WP1	3 - CEA	24	Completion of simulations for a MicroMegas-based time projection chamber at CEA/DRF/IRFU
MS7	Completion of the design of the new version of the BELEN detector at UPC	WP1	31 - UPC	24	Completion of the design of the new version of the BELEN detector at UPC
MS8	Completion of the commissioning of the HPGe equipped with newly developed electronics at CERN	WP1	4 - CERN	24	Completion of the commissioning of the HPGe equipped with newly developed electronics at CERN
MS9	Completion of the installation of the SCONE setup at NFS	WP1, WP2	3 - CEA	24	Completion of the installation of the SCONE setup at NFS
MS10	Completion of the new detectors for capture measurements at n-TOF	WP1	9 - HZDR	36	Completion of the new detectors for capture measurements at n-TOF
MS11	Activation measurements for the extraction of prompt fission neutron spectra above 10 MeV	WP2	7 - CVREZ	24	Activation measurements for the extraction of prompt fission neutron spectra above 10 MeV

Milestone number[18]	Milestone title	WP number[9]	Lead beneficiary	Due Date (in months)[17]	Means of verification
MS12	Measurement of the energy dependence of the nubar with the MONET setup	WP2	13 - JRC	24	Measurement of the energy dependence of the nubar with the MONET setup
MS13	Completion of the measurements with FALSTAFF at ILL	WP2	3 - CEA	36	Completion of the measurements with FALSTAFF at ILL
MS14	Completion of the measurement on the (p,2p) fission induced reactions at FAIR	WP2	33 - USC	30	Completion of the measurement on the (p,2p) fission induced reactions at FAIR
MS15	Measurement of the 230Th(n,f) cross section at n_TOF	WP2	20 - NTUA	36	Measurement of the 230Th(n,f) cross section at n_TOF
MS16	Measurement of the 241Am(n,f) cross section at n_TOF	WP2	30 - UOI	36	Measurement of the 241Am(n,f) cross section at n_TOF
MS17	Measurement of the 239Pu(n,f) cross section at n_TOF	WP2	29 - UMANCH	36	Measurement of the 239Pu(n,f) cross section at n_TOF
MS18	Measurement of the 16O(n,alpha) cross section at NFS, GENESIS and AMANDE	WP2	5 - CNRS	36	Measurement of the 16O(n,alpha) cross section at NFS, GENESIS and AMANDE
MS19	Measurement of the natC(n,lchp) at NFS	WP2	35 - UU	50	Measurement of the natC(n,lchp) at NFS
MS20	Completion of the (n,chp) cross section measurements at NPI CAS with germanium detectors	WP2	17 - NPI	36	Completion of the (n,chp) cross section measurements at NPI CAS with germanium detectors
MS21	Measurement of the 239Pu(n,g) at n_TOF	WP2	1 - CIEMAT	36	Measurement of the 239Pu(n,g) at n_TOF
MS22	Measurement of the Mo isotopes at GELINA and n_TOF	WP2	8 - ENEA	34	Measurement of the Mo isotopes at GELINA and n_TOF
MS23	Completion of the 239Pu, 233U, 14N and 35,37Cl inelastic and (n,2n) cross section measurements at GELINA	WP2	10 - IFIN-HH	57	Completion of the 239Pu, 233U, 14N and 35,37Cl inelastic and (n,2n) cross section measurements at GELINA
MS24	Completion of the branching ratio for 209Bi, 208Pb(n,tot) and 238U(n,inel) cross	WP2	13 - JRC	49	Completion of the branching ratio for 209Bi, 208Pb(n,tot) and 238U(n,inel) cross

Milestone number[18]	Milestone title	WP number[9]	Lead beneficiary	Due Date (in months)[17]	Means of verification
	section measurements at GELINA				section measurements at GELINA
MS25	Completion of the measurements with TAGS and BELEN	WP2	6 - CSIC	49	Completion of the measurements with TAGS and BELEN
MS26	Completion of the measurements at the CEA-LNHB	WP2	3 - CEA	52	Completion of the measurements at the CEA-LNHB
MS27	Scheduling regular user-producer meetings	WP3	21 - PSI	6	Scheduling regular user-producer meetings
MS28	Scheduling regular target maker meetings	WP3	13 - JRC	6	Scheduling regular target maker meetings
MS29	Decision on targets to be manufactured	WP2, WP3	13 - JRC	18	Decision on targets to be manufactured
MS30	availability of TALYS modules	WP4	3 - CEA	32	availability of TALYS modules
MS31	availability of new EMPIRE modules/ models	WP4	26 - UB	32	availability of new EMPIRE modules/models
MS32	availability of evaluated files for important actinide isotopes	WP4	3 - CEA	32	availability of evaluated files for important actinide isotopes
MS33	availability of evaluated files for important fission products	WP4	3 - CEA	36	availability of evaluated files for important fission products
MS34	Report on assessment of nuclear data needs	WP5	3 - CEA	50	Report on assessment of nuclear data needs

1.3.5. WT5 Critical Implementation risks and mitigation actions

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
1	The start of the NFS facility has not yet been approved by the French nuclear regulatory body because of a long licensing process for the SPIRAL2 components needed for the NFS operation. There is a risk that NFS will not start its operation during the execution period of the project.	WP1, WP2	If NFS start of operations is delayed, the activities of the experimental program foreseen at NFS, related to D.1.5 and D.2.2, will be relocated to different facilities. The activities related to D.1.5 at NFS are mainly related to the commissioning of a neutron detector and can be done in several other laboratories of the members of the consortium. The measurement related to D.2.2 are already distributed between several experimental facilities (NFS, GENESIS, AMANDE and NPI CAS) and if NFS is not available we will try to make the proposed measurement in another one of those facilities. In addition, a narrow collaboration is being discussed with the ARIEL EURATOM-H2020 project, to open additional opportunities to organize experimental campaigns in the Nuclear DATA facilities open by ARIEL, that can contribute to the education and training of new nuclear professionals and students and at the same time contribute to make relevant measurements aligned with the priorities of SANDA.
2	CERN will shut down its accelerator complex during 2019 and 2020 for increasing the luminosity of LHC and n_TOF will build a new spallation target during that period. The new target will have to be commissioned and characterised before running the cross-section measurements. The delay in the upgrade of the CERN accelerators will propagate in the realisation of the measurements, part of D.2.1, and of D.2.3.	WP2	CERN holds very high-level standards keeping the schedules, and taking into account that all CERN experiments depend on this system it is very unlikely a long delay. Should it happen, some of the measurements could be moved to JRC facilities or other facilities. In addition, a narrow collaboration is being discussed with the ARIEL EURATOM-H2020 project, to open additional opportunities to organize experimental campaigns in the Nuclear DATA facilities open by ARIEL, that can contribute to the education and training of new nuclear professionals and students and at the same time contribute to make relevant measurements aligned with the priorities of SANDA. In the very unlikely case that the original experiments cannot be performed in any of the available facilities, an equivalent measurement will be proposed to redirect these resources.
3	Under Task 5.3 for New Integral Experiments, there is a risk that one of the three facilities will not be available for the intended experiments or it could experience long delays. Such a risk is considered to be very low.	WP5	The risk of not being to operate the integral experiments is low but should it happen, the resources foreseen for the integral measurements in the defaulting facility would be redirected to expand on the experiments in one of the other two facilities.
4	The ability and capacity to provide targets foreseen in WP3 to facilitate needs of	WP3	The user-producer network proposed in WP3 is there to ensure that an appropriate compromise is found between need and feasibility of a target, in

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
	SANDA and EU Member States in nuclear data experiments are resource limited and may be limited by the regulatory framework at the producer and at the user institute. For radioactive and nuclear targets users need to ensure that the regulatory requirements are met at the institute hosting the target(s) and that the post-project regulatory requirements (waste management, return shipments) are met. So, it is possible to experience delays in target production due to late specification of needs, missing confirmation of permissions for working with radioactive samples or transport permissions issues.		terms of availability of base-material, equipment for processing material, technical parameters of the target, means of characterisation and in terms of prioritization of the available staff and technical and financial resources. The WP3 in fact exists to deal with the risk that a nuclear data measurement project needs an appropriate target. So, these risks specific to WP3 can be considered 'business as usual' for WP3, and experience at the participating laboratories has shown that significant and adequate solutions tend to be found for most requests of interest, after adequate discussion.
5	Some of the new data expected for the new evaluation might not be available in time for the evaluations to be completed during the duration of the project.	WP4	Depending on the evaluation affected and the missing data, we could propose to still complete the proposed evaluation, in the case that the rest of new available data and new theoretical and mathematical framework - including nuclear physics models - provide sufficient improvements respect to the existing data, or we might propose to evaluate a different but similar isotope where the new available data will provide significant improvements versus the present evaluated libraries.

1.3.6. WT6 Summary of project effort in person-months

	WP1	WP2	WP3	WP4	WP5	WP6	Total Person/Months per Participant
1 - CIEMAT	13.30	14.30	0	16.60	15.20	23.30	82.70
2 - ATOMKI	0	0	0	8.60	0	0	8.60
3 - CEA	36.10	7.10	0	43.20	8.70	1.80	96.90
4 - CERN	1.20	0	0	0	0	0	1.20
5 - CNRS	3	11.50	0	5	0	2	21.50
· G-INP	0	3.50	0	2.50	3	0	9
· IMT Atlantique	0	1.50	0	2	0	0	3.50
· Univ Nantes	0	2.50	0	2	0	0	4.50
· UNICAEN	0	2	0	0	0	0	2
· UBx	1.50	0	0	0	0	0	1.50
6 - CSIC	0	14.40	0	0	0	0	14.40
7 - CVREZ	0	11.70	0	0	16.30	0	28
8 - ENEA	0	15	0	0	3	0	18
9 - HZDR	4.50	0	0	0	0	0	4.50
10 - IFIN-HH	0	11.20	0	5	0	0	16.20
11 - IRSN	0	1.50	0	0	1.90	0	3.40
12 - IST-ID	0	4	0	0	0	0	4
13 - JRC	0	17.20	15.20	0	0	0.30	32.70
14 - JSI	0	0	0	7.20	6	0	13.20
15 - JYU	9	5	0	0	0	0	14
16 - KIT	0	0	0	0	3	0	3
17 - NPI	0	17.30	0	0	0	0	17.30
18 - NPL	0	2.30	0	0	0	0	2.30

	WP1	WP2	WP3	WP4	WP5	WP6	Total Person/Months per Participant
19 - NRG	0	0	0	0	3.90	0	3.90
20 - NTUA	0	6	0	0	0	0	6
21 - PSI	0	0	27	6	0	0	33
22 - PTB	5.70	4	0	0	0	0	9.70
23 - SCK-CEN	0	2.20	0	0	1.10	0	3.30
24 - Sofia	0	0	0	5.30	0	0	5.30
25 - TUW	0	0	0	5	0	0	5
26 - UB	0	0	0	35	0	0	35
27 - ULODZ	0	12	0	0	0	0	12
28 - UMAINZ	0	0	24	0	0	0	24
29 - UMANCH	0	10	0	0	0	0	10
30 - UOI	0	6	0	0	0	0	6
31 - UPC	6.50	1.80	0	0	0	0	8.30
32 - UPM	0	0	0	11.80	7.10	0	18.90
33 - USC	0	10	0	5	0	0	15
34 - USE	0	10	0	0	0	0	10
35 - UU	0	9	0	13	0	0	22
Total Person/Months	80.80	213	66.20	173.20	69.20	27.40	629.80

1.3.7. WT7 Tentative schedule of project reviews

No project reviews indicated

1. Project number

The project number has been assigned by the Commission as the unique identifier for your project. It cannot be changed. The project number **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

2. Project acronym

Use the project acronym as given in the submitted proposal. It can generally not be changed. The same acronym **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

3. Project title

Use the title (preferably no longer than 200 characters) as indicated in the submitted proposal. Minor corrections are possible if agreed during the preparation of the grant agreement.

4. Starting date

Unless a specific (fixed) starting date is duly justified and agreed upon during the preparation of the Grant Agreement, the project will start on the first day of the month following the entry into force of the Grant Agreement (NB : entry into force = signature by the Euratom). Please note that if a fixed starting date is used, you will be required to provide a written justification.

5. Duration

Insert the duration of the project in full months.

6. Call (part) identifier

The Call (part) identifier is the reference number given in the call or part of the call you were addressing, as indicated in the publication of the call in the Official Journal of the European Union. You have to use the identifier given by the Commission in the letter inviting to prepare the grant agreement.

7. Abstract

8. Project Entry Month

The month at which the participant joined the consortium, month 1 marking the start date of the project, and all other start dates being relative to this start date.

9. Work Package number

Work package number: WP1, WP2, WP3, ..., WPn

10. Lead beneficiary

This must be one of the beneficiaries in the grant (not a third party) - Number of the beneficiary leading the work in this work package

11. Person-months per work package

The total number of person-months allocated to each work package.

12. Start month

Relative start date for the work in the specific work packages, month 1 marking the start date of the project, and all other start dates being relative to this start date.

13. End month

Relative end date, month 1 marking the start date of the project, and all end dates being relative to this start date.

14. Deliverable number

Deliverable numbers: D1 - Dn

15. Type

Please indicate the type of the deliverable using one of the following codes:

R	Document, report
DEM	Demonstrator, pilot, prototype
DEC	Websites, patent fillings, videos, etc.
OTHER	
ETHICS	Ethics requirement
ORDP	Open Research Data Pilot
DATA	data sets, microdata, etc.

16. Dissemination level

Please indicate the dissemination level using one of the following codes:

PU	Public
CO	Confidential, only for members of the consortium (including the Commission Services)
EU-RES	Classified Information: RESTREINT UE (Commission Decision 2005/444/EC)
EU-CON	Classified Information: CONFIDENTIEL UE (Commission Decision 2005/444/EC)
EU-SEC	Classified Information: SECRET UE (Commission Decision 2005/444/EC)

17. Delivery date for Deliverable

Month in which the deliverables will be available, month 1 marking the start date of the project, and all delivery dates being relative to this start date.

18. Milestone number

Milestone number:MS1, MS2, ..., MSn

19. Review number

Review number: RV1, RV2, ..., RVn

20. Installation Number

Number progressively the installations of a same infrastructure. An installation is a part of an infrastructure that could be used independently from the rest.

21. Installation country

Code of the country where the installation is located or IO if the access provider (the beneficiary or linked third party) is an international organization, an ERIC or a similar legal entity.

22. Type of access

TA-uc	if trans-national access with access costs declared on the basis of unit cost,
TA-ac	if trans-national access with access costs declared as actual costs, and
TA-cb	if trans-national access with access costs declared as a combination of actual costs and costs on the basis of unit cost,
VA-uc	if virtual access with access costs declared on the basis of unit cost,
VA-ac	if virtual access with access costs declared as actual costs, and
VA-cb	if virtual access with access costs declared as a combination of actual costs and costs on the basis of unit cost.

23. Access costs

Cost of the access provided under the project. For virtual access fill only the second column. For trans-national access fill one of the two columns or both according to the way access costs are declared. Trans-national access costs on the basis of unit cost will result from the unit cost by the quantity of access to be provided.

History of changes

	HISTORY OF CHANGES
11-August-2023	**Detailed information on the CNRS and Linked Third Parties efforts per workpackage**
	Annex 1 Part A
	- Change of the aggregated description of the efforts to WPs from CNRS and its 5 Linked Third Parties into a separated indication of the efforts from each of the 6 institutions to each workpackage. This affects the WPs descriptions and the WT6 project effort table.
19-July-2023	**Change of project duration including the update of the Gantt chart following the first amendment**
	Annex 1 Part A
	- Change of the project duration and the WPs duration from 48 to 60 months. - Consequent update of the third periodic review that will cover from month 37 to month 60. - Changes on the "Due Date" for deliverables: D1.1, D1.2, D1.4, D2.2, D2.3, D2.4, D2.5, D2.6, D2.8, D2.9, D2.10, D2.12, D2.13, D2.15, D3.2, D3.5, D4.3, D4.4, D5.3, D5.5, D5.6, D5.7, D5.8, D5.10, D5.11, D5.12, D5.13, D6.2, D6.3 and milestones: M19, M23, M24, M25, M26, M34. - Change on the name for deliverable D2.13 and the description of task 2.5.1 in WP2 and change of the description of the last paragraph of task 5.1.1 of WP5.
	Annex 1 Part B
	- Update of the Gantt chart taking into account the proposed durations of the workpackages and the due times for the deliverables and milestones of the first amendment.
10-May-2019	**Implementation of Project Officer request of April 30th and May 10th 2019.**
	Annex 1 Part A
	- Remove from WP6 deliverables D6.1, D6.2, D6.3, D6.4 (periodic and final reports) - Change type of deliverables ORDP <-> R on deliverables of WP2 and WP6
	Annex 1 Part B
	- Remove the indication of ILL as potential subcontractor from the PSI description, section 4.1.21 page 73.
12-April-2019	**Implementation of Legal Officer message of April 2nd 2019.**
	- Removed all references to ILL in Part A of Annex 1: Workpackage WP3, tasks 3.3.
24-March-2019	**Implementation of Legal Officer requests Ref. Ares(2019)1520427 - 06/03/2019 and message of March 14th 2019.**
	Annex 1 Part A
	- CEA sectors are described with a consisting nomenclature across the Annex 1 part A and B. Changes in Workpackage WP4, task 4.2.1 and task 4.5 - Removed all references to collaborators in Workpackage WP3, tasks 3.1 and 3.2 - Change on the description of the relation with the TALYS collaboration and removal of nominal reference of non-beneficiaries in Workpackage WP4 task 4.1.1 - Removed all references to ILL as selected subcontractor in Part A of Annex 1. The choice of subcontractor is left open. Workpackage WP3, tasks 3.1, 3.2 and 3.4 and Workpackage WP4 task 4.2.1.
	Annex 1 Part B
	- Removed most references to ILL as selected subcontractor in Part B of Annex 1. The choice of subcontractor is left open at section 3.3 page 23, section 3.3 i) page 24 and section 4.2 page 94. However ILL is mention as potential subcontractor at 4.1.21 page 73 - Cost of the certificate of financial statement are included for CIEMAT, CEA and PSI at table 3.4b pages 26 and 27 - Additional details of travel costs are included at table 3.4b pages 26 and 27 - Information on resources dedicated to Education and Training actions included at

	section 3.4 page 28
1-March-2019	**Change from the proposal format to DoA format and adding some information requested/suggested on the Evaluation and Ethics summary reports**
	Annex 1 Part A
	- Several deliverables had been reclassified as of type Open Research Data Pilot, ORDP: D2.1 to D2.6, D2.10 and D2.15 - An additional deliverable has been included in WP6 to describe the Data Management Plan, DMP, following the principles of the Open Research Data Pilot - Include additional critical risks and risk-mitigation measures in particular for WP3 and WP4
	Annex 1 Part B
	- Removed cover page and list of participants - Added history of changes and table of contents at page 1 - Added at the bottom of each page the proposal number, the acronym and the page number - Removed tables 3.1a, 3.1b and 3.1c from section 3.1 - Removed tables 3.2a and 3.2b from section 3.2 - Removed table 3.4a from section 3.4 - Added sections 4 and 5 from the proposal to this file starting on page 29 - Some additional details are indicated in section 2.2 to describe the contribution of SANDA for the ORDP at page 14 - Additional elements are included in the section 2.2 to address the Evaluation Summary Report comment of detail dissemination aspects for particular end users such as medical physicists at page 17 - Also, in section 2.2 new elements for the management of potential innovations (e.g. new instrumentation) had been included at page 15 - An explanation of how SANDA addresses the Ethics issues, Protection of the environment indicated in the Ethics Summary Report, is included in section 5.1 at page 95 - Several small typos had been corrected

Table of Contents

1. Excellence

1.1 Objectives

The proposal will address aspects of nuclear data research to produce accurate and reliable tools including data, codes and methodologies that can be used to simulate, analyse, optimize, exploit and evaluate the safety of nuclear energy and non-energy applications. The proposal is built taking into account the High Priority Nuclear Data needs list from OECD/NEA and IAEA to provide the final users with immediately usable data and tools for the cases where this is feasible during the project duration. Also the proposal aims to prepare experimental infrastructures, detectors, measurement capabilities and methodologies to enable the European nuclear data community to be able to provide the data to meet other high priority needs within the shortest possible delay. The proposal has been prepared in close contact with OECD/NEA, the IAEA Nuclear Data Section and the various organizations contributing to the JEFF project. It is planned to maintain a close collaboration with these institutions in order to favour synergies, optimize the use of resources, and maximize the dissemination of the results, tools and know-how developed within the project. In fact, we consider our proposal as a significant contribution towards a very ambitious challenge for the present generation of scientists: the construction of a unified, evaluated nuclear database and infrastructure that can be used in all fields, from basic research to applications.

1.2 Relation to the work programme

The proposal is related to NFRP-2018-4: “Improved nuclear data for energy and non-energy modelling applications”. In order to address the specific challenge the project will include experimental measurements of new or improved quality data, evaluation, validation and dissemination of the data to produce libraries, computer codes and IT tools and methodologies that can be used by safety authorities, research institutions, the nuclear energy industry, health organizations, other non-energy applications and the EU society at large. The proposal has taken into account the High Priority Nuclear Data needs list from OECD/NEA and IAEA and covers the most important needs originating from the fields of fission energy generation, radiation protection, safety assessment, waste management including geological disposal and sustainability of the nuclear fuel cycle. The proposal has been prepared in close contact with OECD/NEA, the IAEA Nuclear Data Section and the JEFF project and it is organized to maintain a close collaboration with these institutions to optimize the dissemination and long-term support of results, tools and know-how developed within the project.

The scope of the project covers all the aspects of the nuclear data cycle, from new detectors and improved infrastructures, to actual measurements, specific evaluation and integration into nuclear data libraries, models to be used in the evaluation, validation with benchmarks of pre-existing and new integral experiments, models to be used at high energies, and integration within the international organizations (OECD/NEA and IAEA) tools for data and computer codes dissemination and archiving. To be able to cover such a wide range of aspects of the nuclear data field a wide collaboration with 35 institutions from all over Europe has been put together on a concerted effort where each institution contributes on the fields where they have demonstrated experience and capacity.

The proposal will address different types of isotopes including actinides important both for present reactors but also for advanced reactors, their nuclear fuels and fuel cycle facilities, in particular different type of nuclear assemblies with fast neutron spectra propose in closed nuclear cycles with significant contributions to waste minimization. It will also cover structural materials, fission fragments and lighter isotopes for non-energy applications. In most cases the proposed actions in the project are oriented towards the reduction of the uncertainties of the calculations involving these isotopes but also towards a better assessment of these uncertainties and the correlations associated to the new data to be produced.

A large fraction of the resources, well over 5%, will be directly contributing to the Education and Training activities. The main mechanism will be to support the work of PhD Students, Master Students and postdoctoral researchers within the actions of the project. In the recently completed project, CHANDA, of a similar consortium for nuclear data research this action resulted in over 50 PhD and Master Theses. For the present proposal we estimate that this number will also exceed 20. The experience of other earlier similar nuclear data projects, like ANDES, shows that many of these students will develop a career as scientists and engineers in research on nuclear data and in nuclear technologies at large. This main action will be complemented with direct actions by organizing dedicated schools to train on specific tools and know-how associated to the nuclear data research.

1.3 Concept and approatch

(a) Concept

Nuclear data and associated tools are a critical element of the nuclear energy industry and research, playing an essential role in the simulation of nuclear systems or devices for nuclear energy and non-energy applications, for the calculation of safety and performance parameters of existing and future reactors and other nuclear facilities, for the innovation of the design of those nuclear facilities and the innovation on radioactive devices and use of radioactive materials in non-energy applications, and for the interpretation of measurements in these facilities and systems.

Nuclear data final users are most often nuclear engineers and scientists working for nuclear safety authorities, radioactive waste management institutions, operators of nuclear and radioactive facilities, engineering companies developing innovative nuclear devices and applications, hospital health physics and nuclear medicine units, institutes involved in nuclear technologies research, basic research, environmental nuclear applications and other non-energy nuclear applications.

The nuclear data themselves and the associated tools included in the present proposal will contribute to research in a wide range of Technology Readiness Levels, TRLs, covering from TRL 1 in the basic measurements of isotopes of potential contribution to new designs and the contributions to basic research for nuclear physics or astrophysics, to TRL8 as in the support of the operation of industrial complete systems like the optimization of the operation and fuel loading of the nuclear reactors on operation. The proposal will also cover contributions at intermediate level like new detector systems for the TRLs 2, 3 and 4, the validation on integral experiments for intermediate TRL5, or their use for the design of prototypes of new facilities for waste management and improved safety of the nuclear energy and their use in the design and optimization of new nuclear health diagnose and treatment devices with TRL 6 and 7.

No matter how sophisticated the tool is, no simulation, calculation or interpretation of measurements can be better than the limit imposed by the nuclear data they use. Several parameters, particularly safety parameters of reactors and other nuclear facilities, need to be known with a precision well below 0.1% resulting in nuclear data precisions better than a few percent, sometimes better than 2%, and this is a serious challenge. In other cases the precision needed can range from 5 to 20% but the isotope or material to be measured is highly radioactive or very scarce raising a different but also important challenge. To address these challenges the proposal will use the recent developments from the previous projects ANDES, ERINDA and CHANDA where many of the current proposal´s partners had participated. The proposal includes actions to improve the samples of materials needed for measurements, and the detectors, neutron sources and methodologies to be used for experimental determination and validation of nuclear data. An additional challenge is to perform an evaluation of the experimental measurements that provides the highest accuracy possible, being compatible with nuclear theory, without bias and with a consistent evaluation of the uncertainties. The most recent models and tools will be improved and applied within the project to this evaluation effort that will receive a significant fraction of the effort of the proposal.

In order to have nuclear data available to applications several steps are needed in what is known as the nuclear data cycle, see figure below. The nuclear data are typically deduced from differential measurements (a more or less direct measurement of the reaction of interest separated from other effects). This requires preparation of a high purity sample of the isotope to measure, often radioactive and scarce, as well as the availability of sophisticated detection systems and controllable sources of neutron and other radiations (often based on particle accelerators). Then the data are analyzed and the results are provided to international databases (like EXFOR, in particular at the OECD/NEA and IAEA). Putting together several measurements and using nuclear theories, the data are further analyzed, assimilated into evaluated files having a standard format, and finally assembled into what is known as "evaluated nuclear data libraries". These libraries are available from the same international organizations, through the contributions and direct concerted efforts provided by countries and research organizations, and using methods and tools developed by projects like the previous CHANDA. These evaluated data are then validated by comparing their predictions to integral experiments (complex systems, typically experimental reactors, where many effects are important but which are able to closely reproduce conditions and parameters of direct applications to the operation and safety of the industrial nuclear systems). From the differences between predictions and integral experiments, we can deduce corrections to the basic nuclear data and develop better evaluated libraries. This validation process can also reveal the possible need for additional differential measurements or evaluations, repeating the process until the required accuracy is achieved.

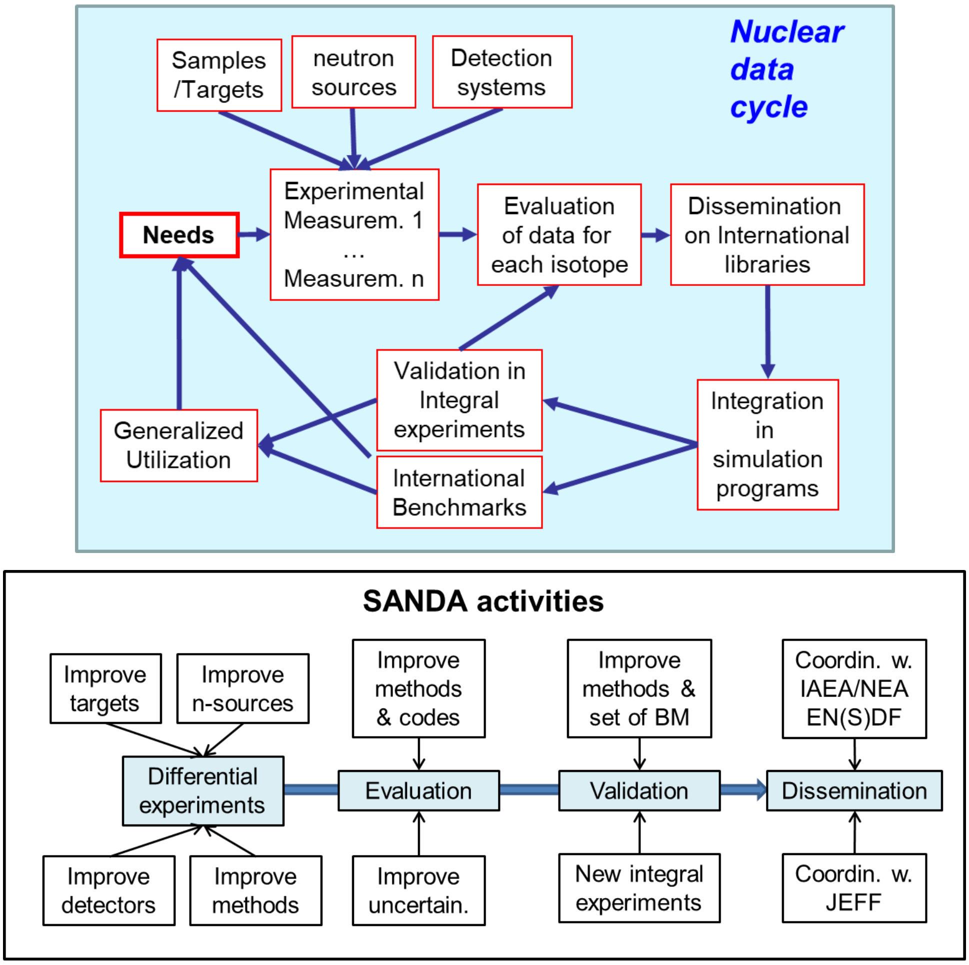

Figure: Nuclear data cycle and objectives of SANDA

Producing high quality data requires a combination of many different know-hows (target production, detectors, neutron sources, analysis, evaluation, nuclear theory, nuclear reactors, simulation codes, …) and a substantial time from the moment a specific need is pointed out to the moment when the evaluated and validated data can be distributed to final users. The whole process can take several years. In most cases, developing and characterizing a new neutron source takes more than 5 years and a new detector system can take from several months to few years. To schedule, perform, analyze and make public a differential experiment takes one to several years. Then, updating a particular evaluation to integrate new measurements can take again several months depending on the isotope (actinides are more complex due to their nuclear structure and the number of possible nuclear reactions). Finally, the time to validate the new evaluated data depends very much on the availability of previous benchmarks or integral experiments well suited for the isotope and reaction of interest. If the experiments are available the validation can be made within a few months, however if a new integral experiment is needed, it may take several years to license the new configuration of the experimental reactor, prepare the measurements and analyze the results.

In addition, it is important to realize that the necessary expert know-how is widely distributed within many research teams, particularly in Europe, and that most of these teams specialize only on one or few components of the nuclear data cycle. There are groups specialized on theory and evaluation, other on validation, some research organizations are specialized on differential experiments and others on integral experiments.

Therefore, in order to build an efficient system to provide the nuclear data that the EU society requires, its nuclear industry, the health system and other applications of nuclear technologies, it is important to prepare a very well structured wide and well synchronized collaboration between the key EU expert institutions. The collaboration needs to have close connections with the international organizations and the final users to clearly identify the nuclear data needs, priorities and schedules. Then it has to organize the actions from each partner (measurements, detector developments, evaluations or validations) with much anticipation and make sure that these actions are actually doable.

This proposal builds on previous experience and previous projects of the participants, particularly ANDES and CHANDA, that have prepared detector designs, new neutron sources, new evaluation methodologies and new validation concepts. The proposal is a comprehensive collaboration of 35 EU institutions having the know-how, experience and tools for nuclear data research in the EU. An efficient work plan is proposed to contribute to the production of high quality nuclear data to respond to priority needs, particularly those included in the OECD/NEA and IAEA priority lists.

A large fraction of the work will concentrate on delivering the final project results to the end-users. This implies capitalizing on experiments for which detectors and neutron sources had been prepared in CHANDA or other projects. It also means a much larger evaluation efforts than in previous nuclear data projects, and significant efforts on validation, including experiments on experimental reactors already available and known, as well as the corresponding dissemination.

In addition, the proposal intends to contribute to the development of instruments like new detectors, new laboratories for target preparation, including the design of an isotopic separator, commissioning of new neutron sources and new devices for integral experiments and new IT codes. These developments are important to make possible in the near term, but not necessary within the project duration, the measurement and preparation of well-identified nuclear data that cannot be made with the presently available tools.

The new proposal will use the results from CHANDA that validated new detector concepts, commissioned new neutron source (n_TOF-EAR2@CERN), developed new experimental methods to improve the accuracy of differential measurements, developed new evaluation methods and tools, provided improvements on the integral experiments methods and on the use of high energy models. We note that the CHANDA scientific activities resulted in over 125 peer reviewed publications and 50 PhD and Master theses.

The proposal will collaborate with the three largest international entities in the field of nuclear data that have significant European participation: JEFF (Joint Evaluated Fission and Fusion Nuclear data library), OECD/NEA data activities including the High Priority Request List (HPRL) and the IAEA International Nuclear Data Committee (INDC) and the Nuclear Data Section (NDS). The nuclear data evaluations will be prepared in a collaborative effort with JEFF to make sure that the results from this proposal are well aligned with the multiyear JEFF-4 file roadmap, integrated and disseminated. The results of the proposal will also be made available to other nuclear data libraries. The collaboration with OECD/NEA is evident from the conception of the proposal, as members of the proposal consortium are the coordinator and main participants in JEFF, their inputs have been used to define the deliverables and, as in previous projects, we intend to organize some of the general meetings of the proposal jointly with the OECD/NEA Nuclear data weeks, the JEFF meetings or the HPRL review meetings. Similarly the collaboration with the IAEA INDC and NDS has started already during the proposal preparation phase as one of the IAEA staff members (R.C.) participated in the discussion of the proposal technical choices and selection of deliverables to be proposed, the continuation of the collaboration is guaranteed by the participation of several partners, including the coordinator of the proposal, as members of the INDC.

Similarly to the relation between ANDES and ERINDA in the early EURATOM FP7, if the proposal is accepted, the new project will collaborate with other initiatives on nuclear data supported by EURATOM in particular with any project supporting the access to facilities responding to the NFRP-2018-7 (Availability and use of research infrastructures for education, training and competence building). The present proposal is based on the assumption of the availability of the required infrastructures and the resources within the proposed collaboration to perform the experiments included in the proposal. Nevertheless, it has also a lot of potential capacity to offer collaboration on training and competence building to initiatives responding to NFRP-2018-7 in areas covering nuclear data and in this way enhancing the expected results from both proposals.

(b) Approach

The proposal will combine actions at all the different elements of the nuclear data cycle to achieve the maximum possible impact on the nuclear data availability and improvement for the highest priority needs of the EU, both for nuclear energy and for non-energy applications.

The proposed actions, tasks and deliverables have been defined by taking into account the available tools, detectors, materials and know-how at the beginning of the project, the available resources, and the time required to complete the work and provide the final products to the end-users.

The actions will start in parallel on all the work-packages, WP, (detector development, target development, measurements, evaluation and validation) to produce the necessary tools and validation results in due time.

The priority has been given to delivering data and tools readily useable by the end-users at the conclusion of the project, and over 70% of the effort is directed to this type of actions. This translates, depending on the present status of the particular nuclear data for one isotope or reaction, into different schemes.

In a most favorable case, when there are recent or sufficient experimental measurements, the effort will concentrate on updating the evaluation methodology and tool and then applying it to the isotope of interest. This will be followed by making the result available to international organizations like IAEA or OECD/NEA as evaluated nuclear data files. In parallel new validation methods and selection of integral experiments will be prepared, and when a new evaluated file becomes available, these tools will be used for its validation.

In many cases, however, new differential measurements are needed. In this situation there will be actions within the detector´s work-package to develop specific detectors or adapt the existing experimental setups to perform the new measurements. If needed, the samples for the measurements will be prepared in parallel. Most measurements can be performed within the laboratories of the project partners and, thanks to investments made in previous EURATOM projects, only limited additional effort on new detector development will be needed. Then the actual measurement campaign will take place and the results will be analyzed. These experimental results will be provided to the international EXFOR database with the associated reports (deliverables). In some cases, the new data will be enough to improve the evaluation of the isotope in question and then they will follow the scheme indicated in the previous paragraph. However, for some of the more complex cases, it will not be possible to complete the full evaluation and validation within the time frame of the project. In such cases, the EXFOR files will be the main project output. However, because of their relevance and high value, we have the assurance that they will be used by the scientific community to continue the evaluation and validation in the framework of separate collaborative projects (JEFF notably). This process, which relies on voluntary contributions within internationally organized frameworks, is however significantly slower and is likely to receive lower priority than when the evaluation and validation is performed within a funded collaborative project, for example, within the EURATOM framework.

In addition, there is a fraction of the resources that are earmarked for improving the capacities of the European nuclear data community in terms of new detectors, new facilities for target preparation, experimental setups, validation experiments and new methodologies and tools to prepare future measurements, evaluation and validations of very important data not feasible with the present tools. All work-packages include in different amount this type of actions: the detectors WP will include some developments of detectors that have been defined for specific types of experiments but need long development times, the measurement WP will use current methods to validate difficult measurements where there is no other alternative, the evaluation WP will improve several models and tools used for better uncertainty and correlations assessment and the validation WP will prepare the basis for future integral experiments and new analysis tools to be used in the evaluation and validation processes.

In this respect the proposal includes a particular effort for designing an isotope separator. For many measurements a challenge comes from the difficulty to prepare a good quality sample of the isotope of interest without contaminations from other isotopes. This is always a difficult task requiring expensive and complex mass separator devices, but it becomes even more challenging when the isotopes involved are radioactive. Developing this capacity is therefore paramount with respect to several important nuclear data needs. This requires that the hosting laboratory is licensed to work with radioactive materials, has a stock of them or possibilities to get access to these materials and the interest to provide this type of service. At present there is no such facility in Europe and only limited possibilities in laboratories in Russia or USA, which causes a serious handicap and limitation to European laboratories. In the preparation of the proposal one of the partners was identified with the required characteristics and will for hosting a mass separator for radioactive isotopes, taking the responsibility of finding the resources to build it if the facility can be designed and shown to be feasible on the basis of the shared effort. So, the targets proposal includes a task for a feasibility and pre-design study of such a facility.

In addition to these technical actions, the proposal will include coordination actions to organize the collaboration between the different laboratories able to produce targets and also between these laboratories and the users. During the CHANDA project, this has proven to be a key element for an efficient response to the experimental needs for targets.

There will also be coordination efforts to make sure that there is a coherent organization and support of the partners and other European nuclear data research groups, projects and financing programs to guarantee that the data, tools and methods produced will effectively serve the end-users, and will become part of a sustainable vehicle for nuclear data research within the EU.

Finally, there will also be some coordination action to make sure that the proposal is used as an efficient education and training tool.

1.4 Ambition

The proposal is designed to help making significant progress beyond the state of the art in various ways:

- First, it will provide new evaluated files/libraries for a number of key isotopes in a form ready to be applied by the end-users, including actinides. In particular, it will include some key isotopes for present and advanced nuclear reactors and nuclear waste management, like Plutonium isotopes, structural materials like Chromium, and several fission fragments, but also new evaluations of nuclear structure of isotopes of relevance for nuclear waste management. Plutonium isotopes produce a large fraction of the nuclear fissions and power at the end of the fuel irradiation, the fission fragments contribute to the decay heat at short and long term and the structural materials contribute to the reactivity balance and to the production of radioactive wastes of intermediate half-life. So, the new data will allow a more precise assessment of the safety and performance of the nuclear reactors under operation, help reduce excessive margins in new designs of advanced reactors, and allow a more precise description of waste management streams and options. This includes the characterization of the composition and characteristics of the spent nuclear fuel to be stored in the deep underground final disposal but also options for closed fuel cycles with advanced waste minimization elements.
- Second, it will provide differential measurements of several isotopes to improve the data to be evaluated (actinides like Pu, Am and Th isotopes), but it will also provide other important missing data that can be directly used by experts involved in evaluation and validation work as part of international efforts (IAEA, NEA and JEFF). These measurements will include cross section of potential components of new fuels designed to be more tolerant to accident conditions, decay properties of isotopes important to understand the radioactivity (neutrons, alpha, beta and gamma radiations) and heat source of spent nuclear fuel, which are of importance to the design of waste disposal facilities. The measurements will also provide new data needed for non-energy applications in particular for two aspects of health applications of nuclear technology: the secondary doses in medical therapeutic irradiations and the efficiency and innovation on production of standard and new isotopes for medical nuclear diagnostics and therapy.
- Third, the proposal will develop new tools to be used within the proposal and beyond in various aspects of the preparation of nuclear data. In particular, it will lead to new versions of nuclear modeling codes for evaluation of nuclear data such as TALYS, high energy models, and the methodologies to fully include uncertainties and correlations in the nuclear data evaluation systems. These improvements will open the possibility of best-estimate predictive calculations with realistic uncertainties on the final outputs, more broadly applicable to safety assessments and innovative design of new reactors and components, instead of using conservative calculation schemes. Progress

on the high energy models and the assessment of their uncertainties included in the proposal is also a key element for ADS-based waste transmutation and minimization options.

- Forth, better networking target-producing laboratories and their users, each having very different backgrounds and understandings for the target characteristics, will allow having more efficient definition of the target specifications and a better identification of the best technique and best laboratory for the production of each particular target. In addition, the feasibility study of an isotope mass separator will be a major contribution towards a real break-through facility, possibly opening the doors to measurements and experiments, which have not been considered despite their relevance because of the impossibility of having the appropriated material targets. It would also allow to improve the accuracy of some measurements that at present have to be made using targets which are far from pure because of a large contamination due to other isotopes than the one to be measured.
- Considering all these lines of improvements together, the proposal will be a significant step forward towards improved simulations of neutron and radiation transport and towards a more faithful modelling of the basic processes taking place in many different applications. This should translate into gains in applications such as plant safety assessment, reactor core and shielding designs, waste processing and storage facilities, and health applications, among others.
- The ambition is that the project also contributes to several non-energy applications with particular attention to health applications.
- Finally, as this joint initiative addresses important R&D challenges, it should yield valuable lessons which will help the nuclear data research community in formulating robust science-based policy recommendations to decision makers.

2. Impact

2.1 Expected impacts

The project is expected to contribute, directly or indirectly, to the enhancement of the safety and competitiveness of the European nuclear industry by significantly improving the accuracy of nuclear data. Benefits should result in particular from better data for actinides like the Plutonium isotopes and some fission products, which are among the main components of the irradiated nuclear fuel inside the present reactors and in nuclear wastes. These isotopes have been proposed as components, sometimes with high fractions, in several advanced reactors and fuel cycles allowing waste minimization. Better nuclear data improve the accuracy of the predictions derived from simulation codes and analysis tools used by the regulatory bodies for safety assessment and by the industry to implement preventive safety actions. In addition, by producing reliable nuclear data uncertainties and correlations for many important isotopes, the project will contribute to the replacement of legacy calculation procedures by best-estimate evaluations with appropriate uncertainties, which should lead to less conservatism in safety assessments, operation and design of nuclear facilities. Indeed, these best-estimate-type calculations allow to reduce the unnecessary safety and design margins, resulting in more competitive operation of the present nuclear installations without sacrificing safety standards, and in more competitive designs of new reactors, nuclear facilities or their components.

This enhancement of safety and competitiveness applies not only to reactor operation and construction but also to the waste management, storage, reprocessing or disposal, and also in some sense to the decommissioning of nuclear facilities.

The project will also contribute to make nuclear energy more efficient and durable by improving the data and tools needed for the design and demonstration of advanced reactors (fast critical or subcritical) proposed for more sustainable nuclear fuel cycles. These advanced reactors may reduce the use of natural resources (Uranium) in large factors (60-100) by recycling the actinides in the fuel. The concentration of Pu in these reactors is usually increased as compared with present reactors by factors larger than 10. There are also proposals to improve the use of natural resources by complementing or replacing the U-Pu cycle by the Th-U cycle. The project will have an impact there too, by improving the accuracy and uncertainties of the nuclear data for those isotopes.

The project will also contribute to the improvement of the cost effectiveness of nuclear energy in two senses. As already indicated, the data will allow to reduce safety and operation margins and this will result in savings in refueling, in the implementation of safety upgrades and in nuclear waste management, including transport, storage and final disposal. On the other hand, the availability of high quality nuclear data with reliable uncertainties can boost confidence in the simulations and engineering calculations allowing a simplification of the process of nuclear development and innovation. Because of safety considerations, in the traditional development of new components, fuels or designs for nuclear reactors or facilities, there is a significant effort going to different levels of prototyping and demonstration campaigns that are costly, lengthy and not without risks. With reliable nuclear data and simulations, the number of prototypes and demonstration steps can be reduced, thereby reducing delays and costs.

The project will also contribute to improve the efficiency and cost effectiveness of non-energy applications. Although several non-energy fields are addressed in the proposal, the clearest example comes from the health applications where the project can help to find more cost effective ways to produce and use radioactive isotopes needed for medical diagnostics and therapy. A better evaluation of neutron interactions with the light isotopes present in the patient tissues will allow a more efficient planning of therapeutic irradiations, which will in turn help improve the health of patients after the irradiation by optimizing the secondary doses resulting from the irradiation.

Furthermore, as a consequence of the project contribution to extend the use of best-estimate calculations with reliable uncertainty assessment instead of scoping or conservative calculations, the project will reinforce the responsibility of the research community in formulating robust science-based policy recommendations to decision makers. By approaching Member State representatives at different national and CE committees and bodies, as proposed within the project, a case will be made for a sustainable coordination of nuclear data research. It will also be a good opportunity to inform decision-makers on the progress made and the value of the science-based recommendations as a basis for sound policy decisions.

The project will strengthen the competitiveness of the European nuclear data community by focusing its resources on common goals aligned with the needs identified by the Member States and the EURATOM project, and taken on board the JEFF-4 roadmap. This synergy effect will be further enhanced by a specific action (under the coordination WP) towards outlining a proposal for sustainable nuclear data research in Europe beyond the duration of the project.

On the other hand, the development of new detectors, better experimental methods, better coordination of the target preparation, possibly new facilities such as an isotope separator, should create new opportunities and enhance the competitiveness of the European nuclear research institutions.

The results from the proposal will also contribute to the basic understanding of nature as it will contribute with data useful for basic physics research and nuclear astrophysics and cosmology.

Finally, the project will contribute to the training of a significant number of professionals who can be expected to join the nuclear energy industry and research community. In the recent similar project CHANDA over 50 PhD and Master theses had been prepared on the basis of the project data.

On the basis of all the above arguments, we claim that the project results will be of high value for EU Member States, independently of their choices with respect to the use of nuclear technology for electricity generation and independently of the future policy and choice of cycle for the nuclear reactors operation.

The project is not expected to face particular barriers from regulators who are clearly in favor of high quality data, allowing well-defined standards. There is no particular concern regarding public acceptance either.

The main difficulty and obstacle to achieve the maximum impact from the result of the project is probably the long time and effort needed to complete a nuclear data cycle, i.e., the process leading from the preparation of the experiments to the availability of the final evaluated files to the end user. In this sense, there is a risk that the results of some of the more complex measurements and some of the detector developments do not reach their full impact within the time frame of the project, but they will do so later provided there is continued support for the associated research lines from Member States or EURATOM.

To handle these risks, first we have maximized the efforts towards activities that can reach the end-users within the project duration (more than 70%); second, we have included within the project an initiative to prepare a framework for a lasting European R&D cooperation on nuclear data that would guaranty that the available resources and financing through the EU are available to complete the longer term actions, and third we have involved IAEA, OECD/NEA and members of the JEFF community in the project.

In this way, we think that the project can reach its full impact rather shortly if the proposed sustainable coordination framework can be developed. If not, the full impact will be reached later, within the framework of international organizations.

Regarding the isotope separator whose construction is most needed but will depend on funding sources external to the project, PSI has proposed to act as host laboratory and express their interest to build and operate such a facility. PSI has the necessary experience and licensing conditions to handle radioactive materials and is used to provide similar services through Europe. PSI is also committed, should the feasibility study conclude favorably, to take action to secure the necessary funding to construct and operate the isotope separator, see the letter from PSI below. Yet, the feasibility study will be done without prior assumption on construction siting, so as to cover the risk that for unknown reasons PSI could not host finally the isotope separator.

Finally, one additional risk is related to the use of the NFS neutron source at GANIL for some experiments. The facility uses the SPIRAL II accelerator that is presently pending its operating license from the ASN, the nuclear regulatory authority in France. NFS is expected to get a license shortly, before the project starts. However, in the unlikely event that NFS were not to be available during the project, the experiments would have to be performed at another neutron source, with the drawback of a lower beam intensity and longer irradiation time.

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To: to whom it may concern
cc: Dr. D. Schumann,

Villigen PSI, 19. September 2018

Memorandum

Letter of support
To whom it may concern

Dear Madam/Sir,
I'm writing here to express our full support for the feasibility study for a future RMS facility at PSI as envisaged by the SANDA project. With support from Paul Scherrer Insitute the Laboratory of Radiochemistry will try to find the resources for the construction of the Isotope Separator if the feasibility study is positive. The facility is of fundamental interest for the future of Radiochemistry at Paul Scherrer institute and for future joint Euratom activities. The nuclear data community will get rights of use of the facility proportional to the investment from EC and based on collaboration agreements.
The focus of the entire project follows one of our laboratories main research lines and has therefore our full support and utmost priority.
With my best regards,

(Robert Eichler)

2.2 Measures to maximise impact

a) Dissemination and exploitation[1] of results

The project will include different mechanisms to exploit and disseminate its results.

The main scientific and technical results for the exploitation of the project are of 6 types:

1) Raw and analyzed data from differential measurements in EXFOR standard format
2) Evaluated data files, either as cross sections, fission yields, or decay data in ENDF6 standard format, or nuclear structure data in ENSDF standard format
3) Models and computer codes for the different activities of the nuclear data cycle, including the implementation of the high energy models
4) Methodologies for differential and integral experiments and for evaluation processes
5) Results and description of integral experiments, ideally in IRPhE-style format
6) New designs for detector and experimental setups and possibly the actual detectors or experimental setups themselves.

All the deliverables and results of the types 1, 2, 4, 5 and 6 will be made fully public and free, and will be transferred to international open databases, open web pages or will be accessible from the project web space. The models and computer codes, in many cases, would also be openly available, but in some cases access restrictions may be imposed on the sources of the codes by the developing teams. Even distribution of the compiled codes might be limited by training and maintenance constraints.

The targeted communities for the dissemination actions are of different types:

a) nuclear scientists and engineers performing simulations of nuclear reactors or other fuel cycles facilities and activities. This includes applications for evaluation of safety of reactor and other nuclear facilities, validation of processes, reloading and other normal operations in nuclear facilities, dismantling and decommissioning of present reactors, spent fuel storage, waste management and disposal, design of new reactors, etc.
b) nuclear or health scientists performing simulations of nuclear treatments or diagnostic for medical applications. This includes applications for principal and secondary doses from irradiation treatment, optimization of the irradiation sequence for treatments, interpretation of nuclear diagnose devices, design and optimization of nuclear medicine devices and procedures, etc.
c) nuclear physicists developing radiation detectors, nuclear facilities and various methods to measure, evaluate, or validate basic nuclear data
d) nuclear scientists and engineers performing simulations to optimize isotope production for medical therapy or diagnosis
e) nuclear scientists in environmental or other industries designing or analyzing results from radiative tools
f) students and people in training period
g) research organizations, public organizations, technological platforms and industry using nuclear technologies
h) international organizations like NEA and IAEA, responsible for the storage and dissemination of nuclear data

[1] See participant portal FAQ on how to address **dissemination and exploitation** in Horizon 2020

Different vehicles will be used to communicate and disseminate the different results of the project to the different communities mentioned above. The main deliverables of the project will be highly specialized data which will be used mainly by expert scientists and engineers for research, industrial, medical and academic purposes. For this reason our dissemination and communication action will take the form of files on international databases, technical papers and reports published in scientific journals, PhD theses or possibly other self-contained recording forms that would ease their utilization and preservation. Still, several other communication paths will be used to attract attention of wider communities to try to reach all the segments of the society that might be interested in of the project activities and results.

In the following paragraphs we describe some of the instruments that will be used by the project to communicate its activities, progress and to disseminate results.

Dissemination of experimental data and evaluated files/libraries via international organizations

For the nuclear data produced by the project, either experimental or evaluated, the main dissemination path is the well-established international libraries and international nuclear data centers coordinated by IAEA, https://www-nds.iaea.org/, and by the NEA Data bank, https://www.oecd-nea.org/databank/. These organizations maintain on their own resources an infrastructure that receives, tests, archives, stores and distribute both experimental nuclear data in the EXFOR format and evaluated nuclear data libraries in the standard formats of ENDF and ENSDF. This mechanism assures that the project output data will be available broadly and well beyond the end of the project.

The project will communicate all experimental data to the EXFOR nuclear database of the IAEA. The Experimental Nuclear Reaction Data (EXFOR) is an open database maintained and operated by IAEA, https://www-nds.iaea.org/exfor/exfor.htm. It is also a standard format to describe the experimental information which is necessary to analyze the “raw” nuclear data measurements. The transmission of data to EXFOR is the responsibility of each data producer, but the project will stress to its partners the need for early communication to this database and will help liaise with IAEA if special support is needed. Providing the data to EXFOR is the most efficient dissemination method that the project can use to warranty early availability of its experimental data to the evaluators and users.

For most evaluated data (cross sections, decay data, fission yields,...) the project will liaise with the JEFF project (NEA/OECD) to make sure that the results (transmitted in the form of ENDF-formatted evaluated files) received priority consideration for inclusion in the JEFF-4 library. There will then be available from the NEA data Bank and from the IAEA ENDF area https://www-nds.iaea.org/exfor/endf.htm. These are the standard locations any interested user will search for to get the latest versions of the evaluated libraries.

Finally, for the evaluated nuclear structure data the project will update ENSDF files and update them to the IAEA data repository and distribution http://www.nndc.bnl.gov/ensdf/.

All data from IAEA nuclear data databases (EXFOR, ENDF, ENSDF,…) are openly available.

By these mechanisms the project will comply with the with the principles of the Open Research Data Pilot, ORDP. The digital research data generated in the action associated to a number of deliverables whose main results are data will be deposited in the previously escribed research data repository open for third parties to access, mine, exploit, reproduce and disseminate, free of charge for any user, including associated metadata, and the tools and instruments necessary for accessing and validating the results.

Dissemination of computer codes for the different activities of the nuclear data cycle and to implement the high energy models

The nuclear data analysis, evaluation and particle transport codes used in the project (such as TALYS, EMPIRE, AMPX, CONRAD, FIFRELIN, MCNP, SCALE, NDaST, GEANT4, etc.) are developed and maintained continuously by various groups and organizations. Most of them are already broadly available and used. To every possible extent, the project will facilitate the inclusion of new models, algorithms and methods in future versions of these codes for improved capabilities. So, for the dissemination of new methods and models via these codes, the responsibility will lie with the development teams. Most of the codes have corresponding web pages that provide detailed information of the capacities, details for use and updates. In addition, some of the codes are also archived in and can be retrieved from the NEA Data bank.

In general, the codes are openly available, but in some cases some access restrictions may apply, imposed by the code owners and parent organizations because training and maintenance constraints.

Scientific journal articles

For the methodologies and detector developments, where there is no pre-organized dissemination structure the main dissemination pathway will be a combination of peer review scientific journal articles, communications to conferences, PhD and Master theses and the project web pages.

Peer-reviewed articles published in scientific journals will be the main mechanism for dissemination and communication of results to the scientific community interested in the project results. These articles are also an efficient way to provide to all the end-users additional details on the quality, scope, range of validity, precision and reliability of the results of the project. The articles will cover reports on:

- methods newly developed,
- description of progress on detector designs and experimental setups,
- improvements of neutron facilities used for measurements,
- validation of nuclear data using integral experiments or pre-existing international benchmarks,
- improvements and uncertainties of high energy models.

Although in principle all the results and development of the project will be ultimately public, in the case that some of the innovations need to be protected (new instrumentation, detector, experimental setup, target fabrication methods,…), the time and scope of publications and public reports will be carefully managed together with the team making the development to allow efficient protection and industrial exploitation of those innovations.

In addition, these scientific journals will also be used to complement the information provided to the international data bases for the data and codes disseminated by international databases, such as:

- results of the differential nuclear data measurements, with detailed information on setup, sources or errors, calibration, background noise, signal corrections, etc,
- evaluated nuclear data files, with details on the methods and approximations used in the data selection, normalization and reduction process,
- computer simulation tools used for modelling nuclear physics phenomena, detectors, experiments, and simultaneously accounting for uncertainties and errors,
- examples of applications of all the above.

The papers will consider journals such as: EUROPEAN PHYSICAL JOURNAL, NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION A-ACCELERATORS SPECTROMETERS DETECTORS AND ASSOCIATED EQUIPMENT, PHYSICAL REVIEW C, PHYSICAL REVIEW LETTERS, etc.

The members of the collaboration of the proposal have demonstrated in the past an excellent efficiency at stimulating the production of many high-quality journal articles. For example, the previous project CHANDA produced more than 125 articles in 54 months.

All the articles published will be by definition open-access, but some publishers sometimes request a fee to provide access to the full text of the article. If such a limitation is deemed unacceptable, the project will either make available a copy of the manuscript to open-access archives, like the CERN archives, for actions and measurements developed in that facility, or establish a link to similar information using the project web space.

PhD and Master theses

For the scientific and research community, and in particular for the students and academic communities that are a significant part of the nuclear data end-users a complementary method to the scientific journal articles is the preparation of PhD and Master theses. They will cover the same topics but can provide significantly more details on the methodologies used, the range of application and the interpretation of the results.

The members of the collaboration of the proposal have also demonstrated in the past a high efficiency in supporting PhD and Master theses. For example, more than 50 theses were associated to the previous project CHANDA. These theses are of open access in most universities.

Sustainable framework for nuclear data research at Europe

The previous methods are the main dissemination paths, that will be complemented by tools described below both for dissemination and communication of the project results, its progress and to make it know to new end-users.

From the point of view of the exploitation of results, the storage and dissemination of data via reference databases operated by international organizations guarantees long-term availability and excellent visibility. The collaboration of the project members with those organizations also implies support from these international organizations to the exploitation of the project outputs, for mutual benefits.

In addition, the project includes an action to outline and propose a sustainable framework for nuclear data research in Europe beyond the duration of the project. This will be done by seeking support for joint programing at the level of the Member States, including also EURATOM. The main incentive would be to guarantee the continuation of the long-term basic research lines of the project within Europe and an enhancement of the exploitation and impact of the project results.

Communications to specific conferences

Communications at specialized conferences in the fields of nuclear data, nuclear instrumentation, nuclear simulations and nuclear data for other applications will be used to inform about the progress made on the same topics as those indicated on the section of the Scientific Journal Articles.

These communications will help prepare the integration of the project results in a broader framework. In addition, they will also serve to collect early feedback on the methods, solutions and tools developed as part of the project. These conferences will also contribute to the dissemination of the project results.

International nuclear data conferences will be “natural” targets of the project, especially the ND2019, to present planned activities, and ND2022, to present results. These are the next two editions of the Nuclear Data conference. ND2019 will be organized in China and will take place at an early stage of the project, so the main focus of the project participants will be on the ND2022 conference.

Communications to wider conferences

Communications to wider conferences will include conferences and workshops on general nuclear science and nuclear applications, general discussions on experimental techniques and organization of international experiments and collaborations. This will include global energy conferences like the European Nuclear Conference (ENC) series, the GLOBAL conference series, IAEA and NEA generic conferences, events organized by EC like FISA or EuradWaste, but also workshops and meetings of national nuclear societies and national radioprotection societies with wider participation of non-energy end-users of the project results.

The main purpose is to make professionals and a broad public aware of the project activities and results, explaining how the results can be beneficial to many applications, including nuclear safety, efficiency of energy generation systems, accuracy of nuclear medicine protocols, etc. These meetings also contribute to dissemination of the results to new end-users.

We are also interested in the feedbacks collected at these events for improving the methods used by the project and identifying new nuclear data needs beyond those already considered within the project.

Communications of activities, plans, progress, methods to international organizations NEA and IAEA

The project members are already deeply involved in international expert groups and organizations responsible for collecting, testing and disseminating nuclear data worldwide within both the OECD/NEA and the IAEA agencies. The project will continually inform these organizations on the activities, plans, progress, methods and results being produced. In the case of the OECD/NEA, the communication will include different working groups, but special attention will be given to the JEFF working groups and to the WPEC high priority nuclear data list. In the case of IAEA special attention will be given to the International Nuclear Data Committee, INDC, the Nuclear Data Section and the EXFOR data base.

To facilitate the communication with the JEFF groups, and to make sure that the project activities remained fully aligned with the JEFF-4 work plan, some of the project general meetings will be organized in conjunction with the JEFF periodic meetings and events.

Regular communication with the above international organizations will facilitate the integration of the project priorities into the international priority lists. It will also shorten the time required to make the data produced by the project adopted in official evaluated nuclear libraries and by the final users.

Participation in generic events with partners of the technological platforms SNETP and NUGENIA

The meetings organized by or with large participation of the European Nuclear Technological Platforms, SNETP and NUGENIA, are a special forum with many opportunities to make professionals and researchers aware of the project activities and results. Special attention will be devoted to explain how the results can be beneficial for the applications of the professionals and researchers.

Dissemination to health and medical physicists:

The project will contact reference networks of health and medical physicists, like EURADOS, and the European Federation of Organizations for Medical Physics, EFOMP, to jointly identify nuclear data of relevance for the applications of these research and applied community and also to make sure that these experts are aware of the progress on nuclear data provided by SANDA. For these contacts SANDA will benefit from the participation of health physicists and members of those associations in several teams of the participants in the project.

WEBSite of the project

A set of web pages will be setup both for the internal communication within the project and as an open window for external researchers and a wider public interested in the activities and publications of the project.

Although working versions of deliverables, publications and other materials might be password protected, all final technical results (compatible with applicable regulations) will be made openly available on the project web pages. The project web will be maintained for at least 5 years after the project end.

Dissemination to students:

The project will prepare specific actions to facilitate that the research performed within the project contributes to the education and training of students. The most important action will be to involve students as participants in the research performed within the project in activities that contribute to their PhD and Master theses. In addition, the project will organize specific E&T courses on topics related to the project research.

b) Communication activities[2,3]

Several of the tools already described in the above dissemination section will also be used for the broader communication and promotion of the project. In particular:

- communications to specific conferences,
- communications to wider conferences,
- communications of activities, plans, progress, methods to international organizations NEA and IAEA,
- participation in generic events with partners of the technological platforms SNETP and NUGENIA,
- the WEBSite of the project,
- and also in a certain sense, the PhD and master theses and the Scientific journal articles.

[2] See participant portal FAQ on how to address **communication activities** in Horizon 2020

[3] For further guidance on communicating EU research and innovation for project participants, please refer to the H2020 Online Manual on the Participant Portal.

3. Implementation

3.1 Work plan

The proposal will combine actions on all the different stages of the nuclear data cycle required to produce and validate the nuclear data needed to improve the safety and performance of nuclear energy reactors and fuel cycle facilities, and more generally, the competitivity of the European industry both in nuclear energy and in non-energy applications.

In preparing the project detailed actions and work plan we have taken into account the long delays between detector design, measurement, evaluation, validation and dissemination. We also took into considerations the data needs for which there are already enough new data and model developments to warrant new evaluations, and the cases where new detectors, models, and measurements for which it would not be possible to complete the evaluation or validation process within the project time frame. So, the project is organized in work-packages, WP, corresponding to the different types of activities making up the nuclear data cycle. This division of the work has the advantage that the participants on each WP can share models, tools, experience and the same infrastructures, which should make the collaborative activities more efficient.

A key aspect of the project organization is efficient communication and timely transfer of information across WPs, as some tasks in a given WP are conditioned by the results coming from another WP. The coordinator with the help of the executing committee will be responsible for this inter-WP coordination. Some of the milestones of the project will help to the coordination and synchronization of the different WP inputs/outputs so as to deliver the final results.

The project will include five technical work-packages plus one WP dedicated to management and coordination tasks:

The WP1 “Developments of new innovative detector devices” will be devoted to detector development and improvements of experimental setups. It will cover the design and construction of new devices for the measurement of fission, capture, (n,xn) and double differential cross sections. An important part of the WP will be dedicated to detector developments leading to immediate measurements (sometimes directly related to actions in WP2) but it will also include the development of more innovative detectors which will be necessary to tackle some of the difficult challenges in nuclear data measurements beyond the project duration.

The WP2 “New nuclear data measurements for energy and non-energy applications” will include new measurements to significantly improve the accuracy of nuclear data needed in energy and non-energy modelling applications, mainly in the field of fission, radiation protection, safety, sustainability and enhancement of nuclear technologies. Some of the experiments in this WP will use detectors prepared in WP1 and targets prepared in WP3. Some of the measurement results will then be used to improve the evaluation of the corresponding nuclear data. However, the project will end before some of the measurements performed in the later phase of the project can be evaluated and tested. These data will be published in peer review journals and stored in the EXFOR open international database for use in future evaluations conducted in new projects or as part of the international efforts within JEFF, NEA or IAEA.

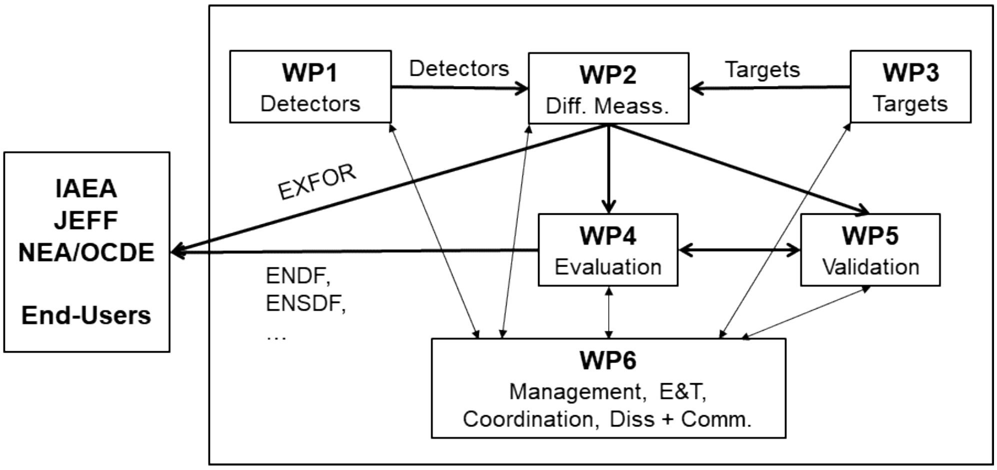
The WP3 “Target Preparation for Improvement of Nuclear Data Measurements” will include actions to facilitate the interaction between target producing laboratories and the various teams using them to make measurements. WP3 will also coordinate the target producers’ activities to optimize the target designs and the use of European resources for their fabrication. In addition, the WP3 activities will include the fabrication of some targets needed in the experiments of WP2. Moreover, the WP will address a long-standing problem, namely the lack of a facility for producing the high-purity materials needed for some radioactive targets, by making the first critical step towards the construction of an isotope separator in Europe. The project will prepare a feasibility study that if successful will be used by PSI for the construction of a facility able to fabricate isotopically enriched radioactive materials needed for some nuclear data measurements.

The WP4 “Nuclear data evaluation and uncertainties” will complete the development of open-source evaluation tools by improving the phenomenological and microscopic models (like TALYS, EMPIRE and INCL/ABLA for reaction nuclear data; and in specific codes for decay and structure data, as well as for fission yields). Then it will perform actual evaluations of important isotopes (actinides and fission products, to be proposed for inclusion in different libraries) and will provide processed data ready to be used by simulation codes for validation purposes (in particular to WP5) including covariance information. Some of the necessary data for the evaluation will be provided by the WP2. In addition, the WP will provide sensitivity analyses for simple systems (or benchmarks) used as part of the evaluation process itself, that will also be made available to the IAEA. For high-energy reaction modeling of interest for ADS simulation and radiation protection and medical applications, WP4 will focus on developing methods for model uncertainties assessment.

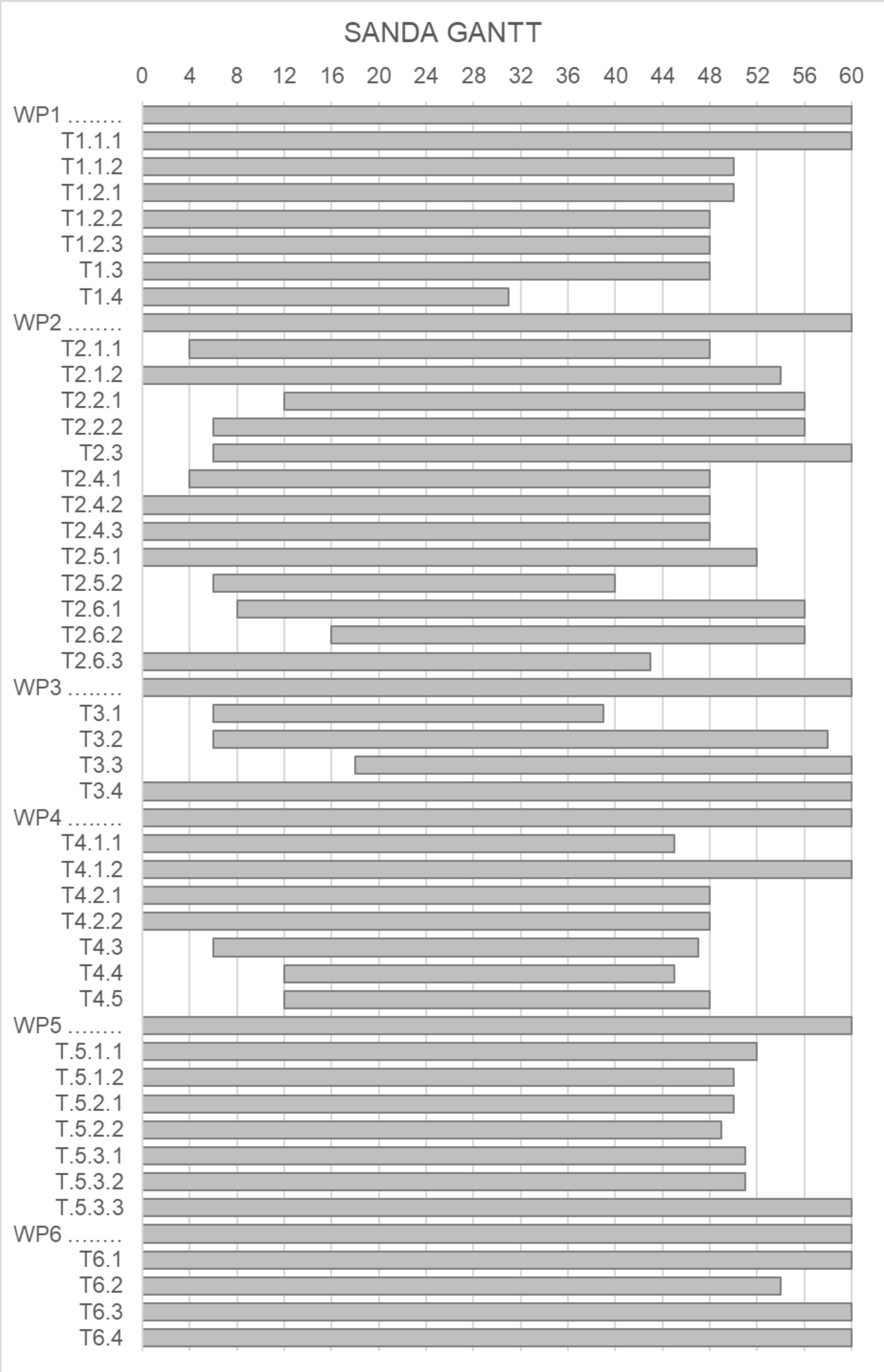
The WP5 “Validation and integral experiments” addresses the validation step using integral experiments and benchmarks, in connection with the end-user needs and applications. This will include the use of existing integral experiments (possibly with a new analysis), including criticality and shielding experiments. The WP will also include performing new data validation experiments in existing experimental facilities, in particular on actinides and structural materials. In addition, the WP will include sensitivity analyses and impact studies, for both generic and specific systems, and will derive quantitative statements as to the performance of the WP4 nuclear data files for such systems.

Finally, the WP6 “Management, ND research coordination at EU level and Education and Training” will include the project management and inter-WP coordination, a group reflection on a future framework for European nuclear data research in a sustainable structure well beyond the duration of the project, the coordination of the education and training activities and the coordination and follow-up of the dissemination and communication activities performed directly by the different WPs.

The interdependencies between the various WPs are sketched in the following Pert chart.



The various tasks of the project will proceed in parallel in all the work-packages starting for different isotopes, reactions and data from a different status of the required elements. For some isotopes, the evaluation tasks in WP4 can start immediately however in some cases they will have to wait from new data from WP2 of from new integral experiments of WP5. In the same manner, the validation tasks in WP5 will have to wait for new experimental results, or be updated when new evaluated files are supplied by WP4. Similarly, some of the experiments in WP2 can start immediately, whereas other experiments will have to wait for some detector development or for target fabrication. Working in parallel and on different isotopes and reaction channels will favor inter-WP communication, help anticipate possible difficulties, and thus lower the risks of getting into a deadlock. A more detailed description of the timing of the different work packages and their components can be found in the following Gantt chart.


SANDA GANTT
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WP1 ....
T1.1.1
T1.1.2
T1.2.1
T1.2.2
T1.2.3
T1.3
T1.4
WP2 ....
T2.1.1
T2.1.2
T2.2.1
T2.2.2
T2.3
T2.4.1
T2.4.2
T2.4.3
T2.5.1
T2.5.2
T2.6.1
T2.6.2
T2.6.3
WP3 ....
T3.1
T3.2
T3.3
T3.4
WP4 ....
T4.1.1
T4.1.2
T4.2.1
T4.2.2
T4.3
T4.4
T4.5
WP5 ....
T.5.1.1
T.5.1.2
T.5.2.1
T.5.2.2
T.5.3.1
T.5.3.2
T.5.3.3
WP6 ....
T6.1
T6.2
T6.3
T6.4

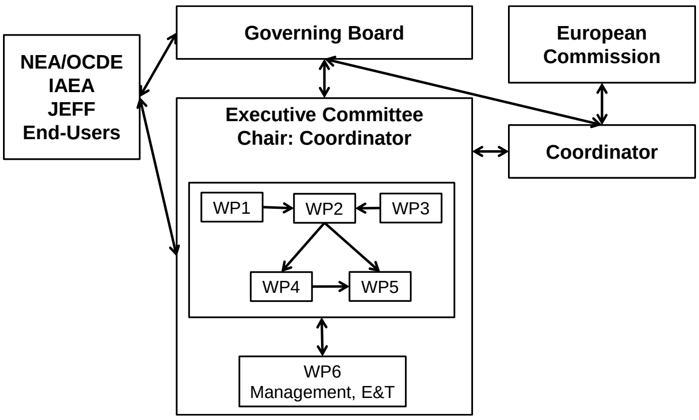
3.2 Management structure and procedures

The organization structure of the proposal Consortium comprises the following main bodies, see figure:

- Governing Board is the uppermost decision-making and arbitration body of the Consortium. Each partner has one voting representative to the Governing Board. The Chairperson will be elected during the Kick-off Meeting which will take place at the latest one month after the start of the project. The coordinator will not stand for election of the chair person.
- Executive Committee, as the supervisory body for the project execution will have the responsibilities for implementing the general policy and strategic orientations decided on by the Governing Board, for establishing the Project Deliverables for the Commission, and for preparing progress reports of the Project for the Commission and the Governing Board. The Executive committee will guarantee the integration of the activities and the coordination of the technical activities. It is composed of the Work Package leaders plus the project Coordinator, who chairs this committee. It may invite international experts to its meetings as appropriate, in particular from IAEA, JEFF and NEA depending on the topics on the agenda.
- The Coordinator manages the project, chairs the Executive Committee, and reports to the Governing Board. He also liaises with the European Commission.
- Training: The Executive committee will directly follow the progress and quality of the training activities organized by WP6.

Organizational Levels: The management structure of the project has two levels: the Governing Board and the Executive Committee. This structure focuses responsibilities and channels information. For each of the two levels, the taking of decisions, the dissemination of results, and the exchange of information is clearly identified and controlled by people and bodies. This structure concentrates responsibilities for day-to-day management in the Executive Committee, which is accountable to the Governing Board. In the Governing Board all partners have their voice and vote to influence in the strategic and financial decisions and to provide detailed guidance for the Executive Committee.

Critical situations: The management structure in organizational levels allows the Executive Committee to detect unexpected developments and critical situations, which might occur during the lifetime of the Project and which might endanger to planned course of activities, so early that the Coordinator and the Responsible Committees are able to react flexibly and to take the appropriate actions.



Governing Board

The Governing Board is the ultimate decision-making body of the Consortium. It decides on matters relating to:

- the preparation and final approval of the management reports related to financial statements and technical advancement of the project prior to the submission to the EC,
- all budget-related matters,
- the acceptance of new partners as well as the exclusion of partners,
- the restructuring of the work-packages, should that be necessary,

- proposals to the partners for the alteration of the Consortium Agreement,
- proposals to the partners for the premature completion / termination of the project.

The Governing Board meets on a regular schedule this being at least every 12 months. In due time before each meeting, it is anticipated that an Executive Committee meeting will be held, in order to review all technical issues shortly before the Board meets. If needed and upon request from the Executive Committee, the Governing Board may call for an extraordinary meeting.

The Governing Board may decide to invite international experts to its meetings in particular representatives from IAEA, JEFF and NEA.

General meetings

In addition to the Governing Board meetings, the project Coordinator will organize with the same frequency and normally at contiguous dates general meetings of the project. In these meetings there will be a progress report of each work-package with technical and administrative progress at the task level and informing of the achievement of the milestones, status of deliverables, and possible difficulties.

In addition, individual participants in the project will be invited to attend and present their contribution and the technical results they have achieved. Furthermore, international experts from IAEA, JEFF and NEA will be invited to these project general meetings.

Executive Committee

The Executive Committee is the supervisory body for the technical execution of the project. The responsibilities of the Executive Committee include:

- Ensure the scientific monitoring and progress review of the project, the training activities,
- Approval of the WP work schedules and co-ordination of the work programmes within and between the technical work packages,
- Preparation, where necessary, of revisions to the detailed work programmes,
- Preparation of multi-purpose use of projects instruments, such as workshops, topical meetings, etc.
- Address problems and/or issues arising from the WPs, identify issues that need to be referred to the Governing Board,
- Identification of technical developments which are related to patents and the development of design, component, or process issues,
- Schedule meetings supporting the effective conduct of the work programme,
- Contribution to management reports,
- Contribution to activity and financial reports
- Inform the Governing Board concerning contractors presenting financial or technical difficulties within a work-package,
- Should the need arise, propose new scientific orientations to the Governing Board and implement the agreed-upon orientations,
- Information across the project of any other difficulty arising in connection with the conduct of the work-packages,
- Follow up of any publication/communication on work done within the project.

The Executive Committee meets on a regular schedule, being at least every six months. It may invite international experts to its meetings in particular from IAEA, JEFF and NEA as a function of the topics to discuss.

Immediately before these Executive Committee meetings it is anticipated that the work packages may hold technical meetings.

Project Coordinator

The project Coordinator assisted by the Executive Committee is responsible for the overall (technical and financial) management of the project. Moreover, the Coordinator will:

- Act as the project contact with the EC,
- Act as the intermediary between all the project participants and the EC, since all information related to the project will be transmitted to the EC through the project Coordinator,
- Establish the contracts with the project partners,

- Receive all payments made by the EC and administer the EC contribution,
- Process the invoicing, and exercising the payment to all project partners,
- Inform the EC of the distribution of payments to the partners,
- Establish provisions for support of the Governing Board and the Executive Committee, and respective meetings,
- Establish and update the project Web site, the contractors' address lists, etc.,
- Organize registration and central deposit of all documents prepared under the project,
- Prepare and submit the contractually required periodic activity and financial reports; supplementary reports as necessary,
- Prepare the Consortium Agreement which regulates the internal organization and management of the consortium,
- Handle all other administrative and financial matters related to the project contract,
- If the need arises: prepare and publish calls for tenders in case of competitive calls for new contractors, pre-evaluation of the proposals and negotiation of contracts,
- Act as a focal point for all kinds of project external and internal requests.

Milestones

The milestones are described within each work-package and are summarized in the table 3.2a.

3.3 Consortium as a whole

One of the main assets of the proposal is the consortium of partner organizations involved in the proposal. Indeed, this consortium includes most of the EU institutions with significant experience and capacity to develop the EU capabilities in all the steps of the nuclear data cycle: detection systems, analysis tools, evaluation tools, models of intermediate and high energy reactions, integral experiments, simulation tools ... and the scientists and professionals capable of developing and using all these tools. This consortium was built based on the experience of the ANDES and the CHANDA projects, including also the capabilities and laboratories required to perform differential measurements, integral experiments and for target preparation (this last one from the network organized within the CHANDA project). In fact, 29 from the 35 partners of the proposal were already members of CHANDA. So, the consortium is used to work together and has already demonstrated the complementarity of the partners and the efficiency to achieve the proposed objectives as well as a significant added value for joining the efforts and producing a large number of high-quality results, publications and trained scientists.

The consortium includes research teams with considerable expertise in detector developments like CEA (Micromegas, FALSTAF, neutron detectors, LNHB …), CERN (n_TOF, gamma fast detectors …), CIEMAT (for neutron detectors and photon detectors from capture reactions,…), CNRS (GRPD and photon detectors,…), HZDR (large facility and detectors for DDX), JYU (IGISOL), UPC (BELEN), and PTB (laboratory of standards and detectors for DDX).

To perform the proposed experiments covering many different reactions, the consortium includes more than 20 partners with specific know-how and capacities. There are partners that operate the experimental facilities (neutron sources or isotope sources and complex experimental setups) needed for the measurements proposed like JRC (Geel), CNRS (Surrogate experiments facilities), CERN (n_TOF), JYU (IGISOL/JYFLTRAP), NPI (CAS), and teams like CEA or USC that will perform experiments in the ILL and FAIR, respectively. In addition, the consortium includes teams with large experience in the analysis of the proposed measurements like CIEMAT (capture measurements on actinides), CNRS (surrogate reactions), CSIC (TAS and decay data), CEA (on many channels), UU and NPI (on n,lxhp), IFIN-HH, NTUA and JRC (on inelastic and n,2n), USE, IST and PTB (on reactions for non-energy applications), ENEA (on capture for non-actinides), and others like UPC, ULODZ, USC, NPL for their experience on specific detectors that need to be developed or adapted for the experiments.

For the target activities all the main target producers in Europe, JRC, PSI and UMAINZ, are included in the consortium, and in addition a combined effort of PSI, UMAINZ and one subcontractor of PSI is proposed for the feasibility study of the isotope separator, intended to be ultimately built at PSI.

The consortium has also included many key partners in the WP on evaluation, covering the different areas of expertise needed. It will include teams with experience on basic developments and new tools like TUW, CEA, PSI and JSI; experts on reaction cross section evaluations like CEA, CNRS, UU, PSI and UB; experts on fission yield and neutron structure evaluation like IFIN-HH, Sofia, Atomki, CEA and CNRS; experts on processing and applications like UPM, JSI and CIEMAT; and experts on high energy models like USC and CEA.

Also, several partners have been included in the consortium for their expertise on validation, integral experiments and nuclear data needs. The experience for the validation studies is provided by the teams of CEA, CIEMAT, JSI, NRG, UPM and IRSN. For the integral experiments the consortium includes the owners and operators of the facilities hosting the experiments CEA (MINERVE…), CVREZ (LR-0) and ENEA (TAPIRO…). In addition, SCK-CEN, JSI, KIT, UPM, CEA and CIEMAT, that have been very active in recent years in sensitivity studies and associated evaluations of nuclear data needs, will contribute to these activities again for WP5.

Furthermore, the proposal includes several large research organizations (CEA, CERN, CIEMAT, CNRS, ENEA, JRC ...) acting, *de facto,* as funding agencies, and institutions (CEA, SCK-CEN, ENEA ...) responsible for important new systems proposed to be built in the next years like MYRRHA, ASTRID or ALFRED. In addition, several institutions (CEA, CIEMAT, ENEA, JRC, NRG, NTUA, PSI and USC) have important multidisciplinary activities that allow them to establish bridges between safety-oriented nuclear data research and other applications, in many cases relating to health, security and environmental protection. Adding several institutions from other countries finally brings together a very comprehensive and relevant consortium to develop the activities proposed in the proposal, representing the different interests, programs and organizations involved in nuclear data research for nuclear safety in the EU. Based on this consortium, the project will undoubtedly have the best assets to propose a sustainable framework for long-term nuclear data research in the EU.

i) Sub-contracting:

PSI will subcontract some activities related to the design of the isotope separator. Some research groups had been tentatively contacted as candidate for that subcontracting because of their scientific and engineering experience in this type of systems.

ii) **Third parties:**

Part of the work of CNRS will be performed by the following linked third parties:

- Grenoble INP

LPSC, Unité Mixte de recherche or Joint Research Unit (UMR/JRU 5821) is set up by Centre National de la Recherche Scientifique (CNRS), Université Grenoble Alpes (UGA) and Institut National Polytechnique de Grenoble (Grenoble INP). Since Pr. Grégoire Kessedjian (WP2 & 4) and Pr Adrien Bidaud (WP5), Grenoble INP employees, will be active in the project, CNRS requests the inclusion of Grenoble INP as Linked Third Party in line with the Article 14 of the Grant Agreement.

- Université de Bordeaux

Université de Bordeaux will also participate in the project as third party contractually linked with CNRS through the joint research unit n°5797, also called "CENBG". This involvement is due to the fact that Mr Mourad Aiche is employed by Université de Bordeaux as a university professor, and will be involved in WP1. Moreover, a contract has been signed between Université de Bordeaux & CNRS regarding the JRU5797 ("Quinquennal contract" of a five-year period) stating the resources (human, financial, infrastructures...) allocated by each institution to the laboratory for research purposes."

- Université Caen Normandie

The laboratory LPC is a joint research unit (JRU6534) between CNRS, UNICAEN and ENSICAEN. As François-René Lecolley is lecturer at the University of Caen and will work on WP2, UNICAEN will be linked to the main beneficiary CNRS.

- IMT Atlantique

UMR6457 SUBATECH is a joint research unit of CNRS, Université de Nantes and IMT Atlantique. Amanda Porta (WP2) and Lydie Giot (WP4) are employed by IMT Atlantique.

- Université de Nantes

UMR6457 SUBATECH is a joint research unit of CNRS, Université de Nantes and IMT Atlantique. Muriel Fallot, involved in WP2 an WP4, is employed by Université de Nantes.

3.4 Resources to be committed

Table 3.4b: 'Other direct cost' items (travel, equipment, other goods and services, large research infrastructure)

Please complete the table below for each participant if the sum of the costs for' travel', 'equipment', and 'goods and services' exceeds 15% of the personnel costs for that participant (according to the budget table in section 3 of the proposal administrative forms).

1 CIEMAT	Cost (€)	Justification
Travel	18000	10000 to participate in project meetings, 10 person*trips at 1000 euros each, and 8000 to participate in detector tests (WP1) and differential measurements (WP2), 4 person*travel at 2000 euros each.
Equipment		
Other goods and services	8000	5000 for consumables for detector tests (WP1) and differential measurements (WP2) and 3000 for certificate of financial statement
Total	26000	

4 CERN	Cost (€)	Justification
Travel	3000	For participating in meetings, 4 person*trips at 750 euros each.
Equipment	32000	Special solid-state detector able to operate at short times after γ flash
Other goods and services	15000	5000 for consumables for detector tests and 10000 for a design study of the detector and electronics able to operate at short times after γ flash
Total	50000	

5 CNRS	Cost (€)	Justification
Travel	36400	Travelling costs for key members listed in section 4 to make experiment, and to assist project meetings, 40 person*trips at 810 euros each and 4 person*trips at 1000 euros each
Equipment		
Other goods and services	7000	Consumables for the construction of a new detector and actinides sample purchase
Total	43400	

7 CVREZ	Cost (€)	Justification
Travel	5000	For participating in meetings and experiments, 5 person*trips at 1000 euros each
Equipment		
Other goods and services	13000	Consumables related to experiments and utilization of LR-0 experimental reactor
Total	18000	

13 JRC	Cost (€)	Justification
Travel	29000	4000 for travels to meetings, 4 person*trips at 1000 euros each, of the project plus 25000 to support for the travel of participants in the meetings for the targets producer-user interaction in WP3, 25 person*trips at 1000 euros each.
Equipment		
Other goods and services	27000	2000 for the organization of a workshop and 25000 for the support to the E&T course
Total	56000	

18 NPL	Cost (€)	Justification
Travel		
Equipment		
Other goods and services	15636	Purchase of foils for activation by neutrons, foils will have to be chemically pure and possibly isotopically enriched.
Total	15636	

21 PSI	Cost (€)	Justification
Travel	22500	Support for the travel of participants in the meetings for the targets producer coordination in WP3, 20 person*trips at 1000 euros each plus 5 person*trips at 500 euros each.
Equipment		
Other goods and services	2500	For certificate of financial statement
Total	25000	

27 ULODZ	Cost (€)	Justification
Travel	6389	For attendance at collaboration meetings, 4 person*trips at 750 euros each, and for travel to experiments, 2 person*trips at 1694.5 euros each.
Equipment		
Other goods and services		
Total	6389	

29 UMANCH	Cost (€)	Justification
Travel	10000	4000 for attendance at data-analysis collaboration meetings,4 person*trips at 1000 euros each, and 6000 for travel to experiments, 3 person*trips at 2000 euros each.
Equipment		
Other goods and services		
Total	10000	

30 UOI	Cost (€)	Justification
Travel	3750	2000€ for participating in meetings (analysis meetings, collaboration meetings, conferences), 4 person*trips at 500 euros each, and 1750 € for travel expenses for performing experiments, 2 person*trips at 875 euros each in average.
Equipment		
Other goods and services		
Total	3750	

In addition, CEA foresees a cost of 1500 Euros for certificate of financial statement and other direct costs that will not exceed 15% of their personnel costs.

Please complete the table below for all participants that would like to declare costs of large research infrastructure under Article 6.2 of the General Model Agreement[4], irrespective of the percentage of personnel costs. Please indicate (in the justification) if the beneficiary's methodology for declaring the costs for large research infrastructure has already been positively assessed by the Commission.

Participant Number/Short Name	Cost (€)	Justification
Large research infrastructure		

As an additional clarification of the resources we provide the intended distribution of the costs between CNRS and its associated linked third parties:

	PM	personnel costs	other direct costs
CNRS	21.5	138,764 €	43,400 €
Grenoble INP	9	58,500 €	- €
Université de Bordeaux	1.5	9,750 €	- €
Université de Nantes	4.5	29,250 €	- €
IMT Atlantique	3.5	22,750 €	- €
Université de Caen Normandie	2	13,000 €	- €
TOTAL CNRS	21.5	138,764 €	43,400 €
TOTAL third parties	20.5	133,250 €	- €
TOTAL	42	272,014 €	43,400 €

In addition to the personnel and other direct costs described in the tables the consortium will provide free of charge for the project the access to the facilities required for the differential measurements and the integral experiments as well as the access to the laboratories required to develop and test the detector developments. This includes the experimental reactors MINERVE, LR-0, and TAPIRO, and the experimental neutron infrastructures of n_TOF, JRC-Geel, IGISOL.

As indicated in section 1.2, a large fraction of the resources, well over 5%, will be directly contributing to the Education and Training activities. The main mechanism will be to financially support the work of PhD Students, Master Students and postdoctoral researchers within the actions of the work packages 1 to 5 of the project. In the recently completed project CHANDA, of a similar consortium for nuclear data research this action resulted in over 50 PhD and Master Theses. For the present proposal we estimate that this number will also exceed 20 PhD and Master Theses. In addition, as indicated in the table 3.4b, JRC foresees to dedicate 25000 Euros for the support to the E&T course indicated in task 6.3 of the work package 6.

4 Large research infrastructure means research infrastructure of a total value of at least EUR 20 million, for a beneficiary. More information and further guidance on the direct costing for the large research infrastructure is available in the H2020 Online Manual on the Participant Portal.

4. Members of the consortium

4.1. Participants

1. CIEMAT

The CIEMAT, an Organism of the Ministry of Economy and Competitiveness, is a Public Research Agency for excellence in energy and environment, as well as in many vanguard technologies and in various areas of fundamental research.
The group involved in the project is the Nuclear Innovation Unit of the Nuclear Division, belonging to the Energy Department. The group works in nuclear data research since its formation in 1997, participating in the EU projects NTOF-ND-ADS of FP5 and the CANDIDE network of FP6 and coordinating the NUDATRA Domain of IP-EUROTRANS and the ANDES project. It has also participated in the nuclear data experiments n_TOF at CERN, at the JRC and the preparation of experiments at FAIR. The nuclear data activity is part of a wider research program on nuclear advanced nuclear cycles including the nuclear waste transmutation and advanced reactors for sustainable nuclear energy. The group has contributed to FEAT and TARC FP4 projects at CERN, the MUSE4, PDS-XADS y ADOPT of FP5; in EUROTRANS, PATEROS, RED-IMPACT, JHR-CA, MTR-I3 and SNF-TP of FP6; ANDES (as coordinator), CP-ESFR, CDT, MAXSIMA and FAIRFUELS of FP7 as well as several ISTC projects. The Nuclear innovation group also participates in the NEA Working Party on scientific issues of Advanced Fuel Cycles, WPFC previously WPPT, and in several expert groups of IAEA. Finally CIEMAT is founder member of the Sustainable Nuclear Energy Technological Platform, SNETP, with representation on the Governing Board and on the Executive committee.
CIEMAT will contribute with the experience in nuclear data measurements at n_TOF where it is responsible for the actinides capture measurements. CIEMAT is responsible of an innovative experimental technique for measuring capture cross sections of fissile materials and of an experiment performed on 235U.
CIEMAT participates in several international research projects and expert groups on advanced fuel cycles and their influence in the nuclear waste management. CIEMAT has developed the EVOLCODE2 system designed to simulate any type of advanced fuel cycle and which is able to propagate the uncertainties in the simulations, taking into account any form of covariance matrices. CIEMAT has developed the experimental experience in fast critical and subcritical systems within the experimental facilities MASURCA, YALINA and the VENUS-F reactor, developing methodologies for reactivity monitoring and specific measurement technologies.

Finally, its participation in RED-IMPACT, PATEROS, CANDIDE, WPFC, SNETP, NUGENIA, ANDES and CHANDA provided this team with the know-how and experience to identify the relevance and potential impact of the progress in nuclear data for the reactor systems, its fuel cycle and the final disposal.

In this project CIEMAT will act as coordinator, coordinate WP2 and WP6 and participate in WP1, WP4, and WP5.

Prof. Dr. E. Gonzalez-Romero (M), head of the Nuclear Fission Division, coordinator of CHANDA and ANDES EURATOM projects, chairman of the n_TOF collaboration Board, former chairman of the SNETP Executive Committee and present member of the SNETP Board, member of the WPFC/NEA, member of the INDC of the IAEA. He acts as coordinator of the SANDA proposal.

Dr. D. Cano-Ott (M), head of the Nuclear Innovation Unit an international expert in neutron cross section measurements, decay data, neutron detectors and gamma-ray detectors. He is spokesperson of the MONSTER collaboration. He is author of co-author of more than 200 international publications and has participated in most of the FP5, FP6 and FP7 nuclear data projects and coordinated WP8 of CHANDA. He is a regular consultant of international agencies like IAEA and OECD/NEA, referee of Q1 journals in the field and member of various expert groups.

Dr. D. Villamarin (M), responsible of the experimental activities in the experimental reactors, MASURCA and YALINA, and coordinating the participation of CIEMAT in the MYRTE and FREYA projects and responsible of the activities on integral experiments in ANDES and CHANDA.

Dr. F. Alvarez (M), author of the EVOLCODE2 system, expert in the evaluation of nuclear data needs and fuel cycle calculations, and participant in various European projects such as IP-EUROTRANS, ANDES, CHANDA, CDT-FASTEF, CP-ESFR, ARCAS, ESFR-SMART.

Dr. E. Mendoza (M), researcher. He has participated in CHANDA, ANDES, ENSAR and ENSAR-2 FP7 projects. He is responsible of the data analysis of the ^{235}U measurements at n_TOF. Dr. V. Bécares (M), researcher. He is participating in the ANDES and FREYA projects and is heavily involved in the experimental programme carried out at the VENUS-F reactor.

Publications

- J.Allison et al., Nucl. Instr. Meth. A 835 (2016) 186-225
- E. Mendoza et al, Phys. Rev. C 97, 5 (2018) 054616
- J. Lerendegui et al., Phys. Rev. C 97, 2 (2018) 024605
- M.B. Chadwick et al., Nuclear Data Sheets 148 (2018) 189
- R. Capote et al., Nucl. Data Sheets 148 (2018) 254

Significant infrastructures

Laboratorio de patrones neutrónicos: It is a metrologic facility with a very intense ^{252}Cf neutron source which will allow to perform tests of equipment and electronics before carrying out the experiments.

Laboratorio de datos nucleares: The Nuclear Data Laboratory at CIEMAT is a facility which has the state of art equipment for detector assembly and characterisation: a glove box for assembling and filling neutron detectors in a nitrogen or argon atmosphere, an X/Y robot embedded in a dark chamber which allows scanning detectors and photomultipliers (PMTs) with a submilimetric precision, a large variety of neutron and gamma sources, a high performance neutron time of flight spectrometer and a high performance digital data acquisition system based on 14 bits digitisers (developed by CIEMAT).

The EULER supercomputer, a constellation cluster with 1920 cores with nearly 4 TB of RAM memory, interconnected by Infiniband and fully devoted to the execution of jobs. A parallelised version of MCNPX is available, thus being able to perform the very time consuming simulations involved in the modelling of a spallation target and shielding problems.

No third parties involved.

2. ATOMKI

The Institute for Nuclear Research (MTA Atomki) is one of the member institutes in the research network of the Hungarian Academy of Sciences. The primary activity of the Institute is devoted to both experimental and theoretical research in nuclear physics and related fields. Today, our activity focuses on both fundamental and applied research, covering a broad range of modern physics: atomic and subatomic physics, materials science, and several other areas employing the techniques of physics research, such as the environmental and biomedical sciences. This multidisciplinarity has been gradually built on the basis of particle accelerators and the associated analytical facilities.
Atomki is actively involved in producing high-quality new nuclear reaction and nuclear structure data, as well as in the critical evaluation of such data published worldwide. Atomki is one of the evaluation centres of the International Network of Nuclear Structure and Decay Data (NSDD). Since 2012, the team in Atomki has been responsible for the evaluation of the isotopes belonging to the A = 101 – 105 mass chains.

The library of Atomki subscribes for all the major journals publishing nuclear structure data. We have the necessary computers and codes for the evaluation work. Besides these, as an NSDD evaluation centre, we can rely on the expertise and help of NSDD.

Dr János Timár is member of the Hungaria Academy of Sciences and Scientific Adviser of the Institute for Nuclear Research (Atomki). He is author or co-author of more than 130 publications, which received more than 1600 independent citations. He's a world-recognised expert in experimental nuclear physics in the field of gamma-ray spectrometry with multidetector systems and heavy-ion induced fusion-evaporation reactions.

<u>Publications</u>

- Negret A, Balabanski D, Dimitriou P, Elekes Z, Mertzimekis TJ, Pascu S, Timár J, Nuclear structure and decay data evaluation in Europe, EPJ WEB OF CONFERENCES 146: Paper 02042. (2017)
- Elekes Z, Timár J, Nuclear Data Sheets for A = 128, NUCLEAR DATA SHEETS 129: pp. 191-436. (2015)
- Timár J, Elekes Z, Singh B, Nuclear Data Sheets for A = 129, NUCLEAR DATA SHEETS 121: pp. 143-394. (2014)
- Elekes Z, Timár J, Singh B, Nuclear Data Sheets for A=50, NUCLEAR DATA SHEETS 112:(1) pp. 1-131. (2011)
- Abriola D, Bostan M, Ertürk S, Fadil M, Galan M, Juutinen S, Kibédi T, Kondev F, Luca A, Negret A, Nica N, Pfeiffer B, Balraj S, Sonzogni A, Timár J, Tuli J, Venkova T, Zuber K, Nuclear Data Sheets for A = 84, NUCLEAR DATA SHEETS 110:(11) pp. 2815-2944. (2009)

No third parties involved.

3. CEA

CEA, the French Atomic and Alternative Energy Commission is a public government-funded research organization established in 1945. Through its nine established centres spread throughout France, the CEA is a key player in research, development and innovation in four main areas: Defence and security, low carbon energies (nuclear and renewable energies), technological research for industry, fundamental research in the physical sciences and life sciences. CEA is a prominent player in the European Research Area, with an internationally acknowledged level of expertise in its core competencies. CEA is engaged in numerous cross-disciplinary and collaborative projects with leading academic and industrial partners worldwide.

The CEA is organized in four research and development sectors: nuclear energy (DEN), technological research (DRT), fundamental research (DRF) and defence (DAM). The nuclear energy programmes are devoted to the support for nuclear power stations in operation, design of systems for the future, studies for waste management and dismantling of obsolete installations. CEA has recognised and long scientific and technological experience in the field of nuclear safety and nuclear data. The synergy between its different components allows CEA to cover all the aspects of nuclear data: fundamental measurements, theory, integral measurements, evaluation, simulation code development and validation.

CEA DRF conducts fundamental research in the fields of energy, climate, fundamental laws of the Universe, condensed matter and nanoscience. The IRFU (Institut de Recherches sur les lois Fondamentales de l'Univers) is responsible for experimental and theoretical research in nuclear and particle physics, astrophysics, and instrumentation (see also: http://www.irfu.cea.fr). The nuclear physics department (DPhN) plays a leading role in developing instrumentation and carrying out research at several European facilities. It conducts a program of basic research on nuclear reactions involving neutrons, photons and protons over a wide energy range. DPhN groups have also recognised experience in the modelling of nuclear reactions, validation and benchmarking of reaction models for applications to nuclear energy, transmutation of nuclear waste, non-proliferation, non-destructive characterization of waste packages, nuclear medicine, etc... The following key experts will be involved in SANDA:

- S. Leray: Directeur de Recherche CEA, has expertise in high-energy nuclear reactions and was WP leader in FP7 ANDES and CHANDA. She will be involved in WP4 and WP6.
- J.C. David: physicist specialist of model validation and high-energy transport codes will coordinate T4.5.
- Frank Gunsing, Eric Berthoumieux and Emmeric Dupont, are nuclear physicists working on neutron-induced reaction measurements at neutron time-of-flight facilities, nuclear data, and detector development. They have been involved in related FP5, FP6 and FP7 European programs and will be involved in WP1.
- D. Doré: Experimental nuclear physicist working on fission yield and delayed neutron measurements. Leader of the FALSTAFF collaboration, will be involved in WP1 and 2.

Publications:

- D. Doré et al., Nuclear Data Sheets Vol. 119 (2014) 346-348
- L. Thulliez, et al., EPJ Web of Conf. 146 04028 (2017)
- J.C. David, et al., Eur. Phys. J. A 49, 29 (2013)
- A. Boudard, et al, Phys. Rev. C 87 014606 (2013)
- D. Mancusi, et al., Phys. Rev. C 91, 034602 (2015)
- F. Belloni et al., Mod. Phys. Lett. A 28 SI (2013) 13
- M. Diakaki et al., , Nucl. Instr. Meth. A 903 (2018) 46
- F. Gunsing et al., , Eur. Phys. J. Plus 131 (2016) 371

CEA DEN (Nuclear Energy Division). Within the CEA, the Nuclear Energy Division (DEN) provides the public authorities and the industry with the expertise and innovation needed to develop improved nuclear power generation systems. CEA/DEN is responsible for research and innovation programmes in two key areas: supporting the French nuclear industry, and developing future nuclear systems. As part of a large multidisciplinary simulation programme, DEN research units are actively working on basic physics data, models, and validation experiments for improved simulation tools. In the area of nuclear energy, the research is primarily being conducted by teams of the DEN. Within DEN, the Innovation and Nuclear Support

Division (DISN) is the Program Division in charge of the strategy, development and follow-up of basic research, simulation tools and associated experimental facilities which are necessary as a support for present and future nuclear power plants. One of them is the Simulation Program of DEN which aims at improving the legacy codes (such as APOLLO, CRONOS, ERANOS, TRIPOLI, CATHARE, FLICA…) and developing a new generation of codes. This program includes the development of predictive physical models, advanced numerical techniques, new software architectures, experimental validation of the calculations and basis data improvement Nuclear data evaluation (especially in the resonance range) and validation activities at CEA Cadarache are an essential subset of this programme. They are performed by a group of nuclear physicists in the Reactor Department (DER), in close connection with experimentalists, neutronics code developers and users, as well as reactor and fuel cycle physicists. The validation activities make use of an extensive database of measurements, many of them performed in the CEA critical facilities (EOLE, MINERVE, MASURCA) or derived from power reactors and other facilities. The group is well known for its many years of contributions to the JEFF-3 files and to past EC projects on nuclear data (CANDIDE, EUROTRANS, ERINDA, ANDES, CHANDA). In the neutronic field of this Simulation Program, an important amount of work has been done, and is on-going, to provide improved Nuclear Data to the JEFF community and to develop a new evaluation code CONRAD. In parallel several dedicated integral experiments have been performed in the EOLE, MINERVE and MASURCA facilities to assess the neutronic behaviours of different types of reactor cores.
The following key DEN experts will be involved in SANDA:

- C. De Saint Jean, head of the physics section, who is in charge of the CONRAD nuclear data modelling and evaluation code, also in covariance evaluation, in WP4 and WP6,
- G. Noguere, nuclear data evaluation specialist, in WP4,
- O. Bouland, fission reaction and evaluation specialist, in WP4,
- P. Tamagno, nuclear reaction modelling (CONRAD code), in WP4,
- O. Serot, fission reaction and fission yield specialist, in WP4,
- A. Chebboubi, fission yield specialist, in WP4
- O. Litaize, fission modelling specialist (FIFRELIN code), in WP4,
- P. Leconte, experimental reactor physicist and validation specialist (in charge of the physical design and interpretation of integral experiments in EOLE & MINERVE reactors), will be in WP1 and WP5,
- B. Geslot, experimental reactor physicist, in WP1 and WP5,
- A. Gruel, experimental reactor physicist, in WP5,
- G. Truchet, reactor physicist, in WP5,
- P. Blaise, experimental reactor physicist, in WP5,
- D. Bernard, reactor physicist and validation specialist, (Expert in Nuclear Data as well as in the interpretation of integral experiments, former WP3 leader in ANDES) will be involved in WP5,

Publications:

- D. Bernard, *et al.* NSE **179** 3, 302 (2015).
- P. Tamagno, *et al.*, EPJA **51**, 12 (2015).
- G. Noguère, *et al*. Phys Rev C **92**, 1 (2015).
- O. Litaize, *et al*., NDS **118**, 216 (2014).
- O. Bouland, *et al.*, NDS **118**, 211 (2014).
- C. De Saint Jean, *et al.* NDS **148**, 383 (2018).
- P. Leconte, *et al.* JNST **52**/42 (2015).
- R. Jacqmin, *et al.*, NIMPR A **280**, 210 (2017).
- G. Truchet, *et al.*, ANE 85 17 (2015).
- O. Serot, *et al.*, NDS **123**, 225 (2015).
- A. Chebboubi, *et al.*, EPJ **146** (2017).
- B. Geslot, *et al.*, ANE **108**, 268 (2017).
- A. Guel, *et al.*, EPJ NST **3**, 11 (2017).
- P. Blaise, *et al.*, ANE **110**, 290 (2017).

The CEA DAM (Direction des Applications Militaires or Division of Military Applications) is primarily involved in defence applications like the French Simulation program. The development of the Simulation

program relies on extensive modelling of physical processes as well as systematic experimental validation of each of the individual models with laboratory experiments. That effort encompasses the fields of nuclear physics and nuclear data which are relevant to the SANDA project, as it was for the HINDAS, EUROTRANS/NUDATRA, CANDIDE, EFNUDAT, ERINDA, ANDES, and CHANDA projects. CEA DAM also provides evaluated nuclear data files to the JEFF project jointly with CEA DEN and collaborates with NRG, PSI and IAEA on the development of the TALYS nuclear reaction code. The section of CEA DAM involved in SANDA is the Service de Physique Nucléaire of the CEA DIF (DAM Ile-de-France) [Nuclear Physics News Vol.18, No 4, 2008, p. 5,]. The following key experts will be involved in SANDA:
- E. Bauge (Head of Laboratory) specialized in the modelling of direct nuclear reactions and nuclear data covariances.
- S. Hilaire, specialist of the microscopic modelling of nuclear reactions, more specifically of level densities, gamma strength functions and fission modelling. One of the authors of the TALYS code.
- G. Belier, experimentalist specialized in neutron induced reactions on actinides.
- J. Taieb, experimentalist leader of the SOFIA experiment on fission fragment yields at GSI

Publications:

- E. Bauge, *et al.* Eur. Phys. J. A **48** 113 (2012).
- D. Rochman, *et al*. EPJ Nucl. Sci. Tech. **4**, 7 (2018).
- J.F. Lemaitre,*et al.* Phys. Rev. C **98**, 024623 (2018).
- M. Martini**,** *et al.,* Phys. Rev. C **94**, 014304 (2016).
- P. Romain, Nucl. Data Sheets **131**, 227 (2016).
- S. Goreily, *et al.*, Phys. Rev. Lett**. 111** 242502 (2013).
- X. Ledoux, *et al.*, Nucl. Inst. And Meth. **A 844**, 24 (2017).
- E. Pellereau, *et al.*,Phys. Rev. C **95** 054603 (2017).
- A. Ebran, *et al*, Nucl. Inst. And Meth. A **728**, 40 (2013).

The CEA DRT (Technological Research Direction) tackles the major societal and industrial issues of the 21st century by developing and disseminating technologies, for all industrial sectors and all types of companies, which contribute to the development of digital technology in society, improving public health or respecting the planet. The DM2I (Department of Metrology, Instrumentation and Information), is one of the five departments within the DRT and forms part of the Carnot Institute LIST, specialized in the development of measurement chains, from sensor to information processing, and intelligent decision support systems in the three major areas of energy, health and safety. The LNHB laboratory, within DM2I, has a major role in the field of metrology: it is the national metrology laboratory for ionizing radiation, in association with the LNE. The LNHB has measurement capabilities which include measurements of radioactivity, neutron source emission rate and dosimetry of charged photons and particles and is made up of the following three entities: the Radioactivity Metrology Laboratory (LMA) in charge of primary metrology for the measurement of activity and the transfer of references to accredited calibration laboratories, having a technical platform which includes the means of preparing primary and secondary sources and measurements adapted to the diversity of physical forms of radionuclides, their half-life and their decay scheme; the Fundamental Data Unit (CDF), in charge of the evaluation and the publication, through the Bureau International des Poids et Mesures (BIPM), of nuclear and atomic data for the metrology community associated with the decay of radionuclides (half-lives, energies and emission intensities of the different radiations emitted, decay schemes…) and the Dosimetry Metrology Laboratory (LMD) in charge of primary metrology for the dose and transfer of references to accredited calibration laboratories, having a technical platform which includes radiation sources adapted to different problems, as well as equipment and dosimetric techniques adapted to the transfer of references in these fields. The activities dedicated to the field of radiotherapy are located on the DOSEO platform. The following key experts will be involved in SANDA:

- M.A. Kellett (Head of Laboratory): specialized in the field of nuclear decay data evaluation and nuclear data library production. Has produced the JEFF radioactive decay data library for the past 15 years. Coordinator of the “Decay Data Evaluation Project” collaboration and the EMPIR project “MetroBeta”.
- X. Mougeot: specialized in the field of beta spectra measurements, theoretical studies of beta spectral shapes and author of the BetaShape code.
- M.-C. Lépy: Directeur de Recherche CEA, expert in X- and γ-ray spectroscopy.

- V. Chisté: specialized in the field of measurement of radionuclides with ionization chambers and nuclear decay data evaluation.
- V. Lourenço: specialized in radiochemical separation techniques and radioactive source production.

Publications

- M.A. Kellett, O. Bersillon, EPJ Web of Conferences 146 (2017) 02009.
- M.A. Kellett, A.L. Nichols, IAEA Report STI/PUB/1618 (2013).
- M.A. Kellett, Appl. Radiat. Isot. 70 (2012) 1919.
- X. Mougeot, Phys. Rev. C 91 (2015) 055504.
- X. Mougeot, C. Bisch, Phys. Rev. A 90 (2014) 012501.
- M.-C. Lépy, et al., Appl. Radiat. Isot. 134 (2018) 131.

No third parties involved.

4. CERN

CERN operates the largest complex of particle accelerators. The 60-year history of CERN is marked with impressive achievements in the construction and operation of powerful linear and circular accelerators. In 2008, CERN brought into operation the Large Hadron Collider (LHC) installed in a tunnel of almost 27 km circumference. Experiments at other accelerators and facilities than LHC are pillars of laboratory's activities, as well new technology development, i.e. R&D of new detection systems. In this context, the n_TOF facility at CERN, an intense source of neutrons, generated by the spallation mechanism induced by 20 GeV/c protons from the PS accelerators onto a solid lead target, provides two different beam lines, EAR-1 and EAR-2, for performing (n,f), (n,gamma), (n, charged particles) and (n,xn) neutron induced reaction cross-sections. The facility was built with the support of the NTOF-ND-ADS project of the European Commission and the second neutron beam line n_TOF EAR-2 was built and equipped with the support of the CHANDA EC project.

Dr. Enrico Chiaveri (M) research physicist, Spokesperson of n_TOF Collaboration. Project leader of EAR2 (Experimental Area 2), member of ERINDA and coordinator of the CHANDA project WP7. He is author of co-author of more than 200 refereed publications.

Dr. Massimo Barbagallo (M) is currently a CERN Research Fellow at n_TOF, where he is in charge of managing the two experimental areas and beam lines and he provides supports to non-local members of the Collaboration performing experiments at n_TOF. As former Post-Doc for INFN, his activities have been including R&D of detection systems used to carry on frontier cross-section measurements on highly radioactive isotope, both of interest for Nuclear Technologies and Nuclear Astrophysics. He is author of more than 50 publications on referred journals.

Publications

- E. Mendoza et al., Measurement and analysis of the ^{241}Am neutron the n_TOF facility at CERN, Phys. Rev. C 97, 054616 (2018).
- T. Wright et al., Measurement of the ^{238}U(n,γ) cross section up to 80 keV with the To-tal Absorption Calorimeter at the CERN n_TOF facility, Phys. Rev. C 96, 064601 (2017).
- M. Sabate-Gilarte et al., High accuracy determination of the neutron flux in the new ex-perimental area n_TOF-EAR2 at CERN, Eur. Phys. J. A. (2017) 53: 210
- C. Weiss et al., The new vertical beam line at the CERN n_TOF facility design and out-look on the performance, Nucl. Instrum. Methods Phys. Res. A 799 (2015) 90-98.
- U. Abbondanno et al., n_TOF Performance Report, CERN/INTC-O-011, INTC-2002-037, 2002

Previous projects or activities

CERN has participated in the most relevant EC projects in the field of nuclear data for nuclear technologies like CHANDA (FP7), ANDES (FP7) and NTOF-ND-ADS (FP5)

Significant infrastructures

The neutron time-of-flight (n_TOF) facility at CERN is an intense source of neutrons from thermal energies up to 1 GeV, generated by the spallation mechanism of 20 GeV/c protons (with a time resolution of 6 ns RMS) from the PS accelerators onto a solid lead target. The unique features of the n_TOF facility (very high instantaneous neutron flux in the two experimental areas, low duty cycle, high resolution and low background) allow the measurement of cross-section of neutron induced reactions. In addition, the availability of the state-of-the art CERN laboratories for detectors development provide the perfect playground to accomplish the task proposed.

The detection system to be developed within this proposal for performing (n,xn) measurements is currently undergoing test beam at the n_TOF facility and a dedicated more performant electronic is under study in parallel. Following this phase, the final construction of the detector will follow.

No third parties involved.

5. CNRS

The Centre National de la Recherche Scientifique (National Centre for Scientific Research) is a government-funded research organisation, under the administrative authority of French Ministry of Research. As the largest fundamental research organisation in Europe, CNRS carries out research in all fields of knowledge through ten Institutes, three of which are national, what is the case of the National Institute of Nuclear and Particle Physics (IN2P3). Its own laboratories as well as those it maintains jointly with universities, other research organisations, or industry are located throughout France, but also overseas with international joint laboratories located in several countries.

Measured by the amount of human and material resources it commits to scientific research or by the great range of disciplines in which its scientists carry on their work, the CNRS is clearly the hub of research activity in France. It is also an important breeding ground for scientific and technological innovation, and has been one of the most active participants to previous and current European Framework Programmes. Over the past years, the CNRS has acquired an outstanding experience in coordinating FP Projects.

The CNRS National Institute of Nuclear and Particle Physics (IN2P3) seeks to promote and bring together research activities in nuclear physics, high-energy physics and their applications. The Institute coordinates programs in this field on behalf of CNRS and universities, in partnership with the French Atomic Energy and Alternative Energies Commission (CEA). Particularly, CNRS/IN2P3 with its partners is involved in EURATOM programs since decades, covering various domains of research, from the management and disposal of nuclear waste, nuclear safety, environmental protection and nuclear innovation. Basic nuclear physics research pursued in CNRS/IN2P3 laboratories has lead the research teams to propose innovative techniques to develop state-of-the-art nuclear data research in the framework of several EURATOM European projects (HINDAS, EUROTRANS/NUDATRA, ANDES, CHANDA). The new SANDA project will take advantage of all the skills developed in CNRS/IN2P3 in the field of nuclear data both for the experimental side of the nuclear data projects with activities of detector developments and measurements and more recently, for the evaluation side. This particularity allows integrated actions from measurements to evaluation performed by R&D team with the aim to better fulfil evaluated nuclear data requirements. These more “integrated” actions will be a real benefit for improvement of nuclear data production and its communication to industrials, and will contribute to a real share experience between all the actors of the nuclear data community at the European level.

Dr Maëlle Kerveno (F) is a Nuclear Physics Physicist of the « Institut Pluridisciplinaire Hubert Curien » (Nuclear data for reactors group, CNRS/IN2P3, Université de Strasbourg). She completed her Ph. D. thesis in 2000 at University of Nantes. Since she joined CNRS in 2002, she developed skills in experimental nuclear physics and became a specialist in nuclear data for innovative nuclear power plants and nuclear waste incineration systems. She is scientific coordinator of the NFS project at IPHC. She is the co-leader of the national integrated project NACRE in the frame of the NEEDS challenge and responsible of the master project OPALE in IN2P3. She was also the CNRS national scientific responsible of the European CHANDA project. She will conduct projects on cross section evaluation in WP 4 and will participate to measurements project in WP2 in SANDA. She will act as national scientific responsible for CNRS in SANDA but also as WP1 leader and as local scientific responsible of SANDA at IPHC. She will also participate to WP 6 in SANDA for management and to prepare nuclear data coordination at European level.
Dr Grégoire Kessedjian (M) is a Nuclear Physics Physicist of the « Laboratoire de Physique Subatomique et de Cosmologie » (reactor physics group, CNRS/IN2P3, Université Grenoble Alpes, Grenoble INP). He defends his Ph. D. thesis in 2008 at University of Bordeaux. Since he joined Grenoble INP in 2009 as associate professor position, he developed skills in experimental nuclear physics and became a specialist in nuclear data and evaluations dedicated to nuclear fuel cycle studies. He is scientific coordinator of projects on fission studies at LPSC and co-proposer of fission yields experiment program at ILL. He is responsible of the nuclear master degree "IEN" in Grenoble INP. He is member of the LPSC scientific council and the French national university council (CNU). He will conduct projects on fission yields measurements and evaluation in WP 2 and 4 in SANDA. He will be the local scientific responsible of SANDA at LPSC.

Dr Ludovic MATHIEU (M) is a Nuclear Physic physicist at the «Centre d'Etudes Nucléaires de Bordeaux Gradignan, CENBG». He joined the CNRS in 2009 as an experimental physicist, after completing his PhD in 2005 on molten salt reactor simulations. His experience in numerical simulations was found to be very useful for experimental research, in order to design experiments or analyze data. He developed skills in accurate measurements of neutron-induced cross sections, and is now developing a new type of proton recoil detector. He is the local contact at the CENBG of the NEA for 10 years, as well as the local scientific responsible of the CHANDA European project. He will conduct project on fission cross section measurements in WP 1 and 2 in SANDA.

Dr Mourad Aiche (M) is a physicist of the "Centre d'études nucléaires de Bordeaux-Gradignan" (CNRS-IN2P3, University of Bordeaux), graduated from Université Louis Pasteur at Strasbourg before he completed his Ph. D thesis in 1991 at CRN Strasbourg. He joined in 1993 the " High-Spin, high-deformation" group in Bordeaux, France, where his main activities were the design and the data analysis of experiments dedicated to the super deformed nuclei in the A=150 region .In 2000, he joined as a founding member the "aval du cyle et énergies nouvelles" in Bordeaux. He has expertise in nuclear fission, reaction mechanisms as well as neutron and γ detection techniques related to nuclear data for nuclear energy studies. During this time, he was the CNRS scientific coordinator of the ERINDA European project from 2011 up to 2013. He will participate to project on fission cross section measurements in WP 1 in SANDA.

Dr Beatriz Jurado (F) is CNRS researcher at the «Centre d'Etudes Nucléaires de Bordeaux Gradignan, CENBG», which she joined in 2004. She completed her Ph. D. thesis in 2002 at the GSI in Darmstadt, Germany. She is expert in indirect measurements of neutron cross sections with surrogate reactions and in nuclear fission, experiments and modelling. She leads the research on surrogate reactions of the CENBG collaboration, which is one of the worldwide leaders on the topic. She has been the spokesperson of many experiments on surrogate reactions carried out at the IPN Orsay and the University of Oslo, and has supervised the work numerous master students, PhD students and post-docs on the study of surrogate reactions. She will conduct project on fission cross section measurements by surrogate method in WP 2 in SANDA. She will be the local scientific responsible of SANDA at CENBG.

Dr. Adrien Bidaud (M) is a Nuclear Reactor Physicist of the Laboratoire de Physique Subatomique et Cosmologie (CNRS/IN2P3, Université Grenoble Alpes, Institut Polytechnique de Grenoble). He is associated professor in Grenoble Institute of Technology since 2006. His PhD (University of Paris-Orsay, 2006) was about nuclear data sensitivity and uncertainty analysis. Since then, he developed activities in the field of nuclear energy prospective scenarios by setting up interdisciplinary project associating nuclear reactor physicists, geologists experts in uranium and energy economists. He kept on contributing to the field of Nuclear Data sensitivity and uncertainty analysis and participated to various OECD/NEA expert groups. As co-chair for CNRS of the Nuclear Systems and Scenarios of the NEEDS challenge, he coordinates research activities funded by CNRS, CEA, IRSN, Framatome, Orano and EDF in the fields of nuclear data, integral experiments, instrumentation, innovative reactor concept design and simulation tools, as well as scenarios studies. He will conduct project on nuclear data sensitivity in WP 5 in SANDA.

Dr. Philippe Dessagne (M) is a Nuclear Physics Physicist of the « Institut Pluridisciplinaire Hubert Curien » (Nuclear data for reactors group, CNRS/IN2P3, Université de Strasbourg). He completed his Ph. D. thesis in 1982 at University of Paris Sud. Since he joined CNRS in 1983, he developed skills in experimental nuclear physics (nuclear structure, beta decay) and became a specialist in nuclear data for innovative nuclear power plants and nuclear waste incineration systems. He is coordinator of DNR team at IPHC. He is the french coordinator of the Collaboration Agreement with Romania. He is also a member of the collaboration board of the SPIRAL2-NFS project and he was responsible of the WP8.3 for the FP7-CHANDA European project. He will conduct project on neutron inelastic cross section measurement in WP 2 in SANDA.

Dr. Greg Henning (M) is a Nuclear Physics Physicist at the « Institut Pluridisciplinaire Hubert Curien » (Nuclear data for reactors group, CNRS/IN2P3, Université de Strasbourg). He completed his Ph. D. thesis in 2012 at the University Paris Sud (Orsay) and joined the CNRS in 2015. His researches focus on nuclear physics and nuclear reactions, specifically for reaction of interest in nuclear reactors. He teaches "nuclear physics for nuclear reactor" to master students and is the leader of EEDIN collaboration in the national integrated project NACRE in the frame of the NEEDS challenge. He will participate to projects on neutron inelastic cross section measurement and evaluation in WP 2 and 4 in SANDA.

Dr François-René Lecolley (M) is a Nuclear Physics Physicist of the « Laboratoire de Physique Corpusculaire de Caen » (ENSICAEN, CNRS/IN2P3, Université Caen Normandie). He completed his Ph. D. thesis in 1996 at University of Caen. Since he joined University of Caen in 1998 as an assistant professor, he developed skills in experimental nuclear physics and became a specialist in nuclear data for nuclear power plants. He is scientific coordinator of the SCALP project at CNRS/IN2P3. He will conduct project on (n,alpha) cross section measurement in WP 2 in SANDA. He will be the local scientific responsible of SANDA at LPCC.

Dr Gregory Lehaut (M) is a Nuclear Physics Physicist of the "Laboratoire de Physique Corpusculaire de Caen" (Fondamental Interaction and neutrino properties group, and “Aval du cycle électro-nucléaire” group, CNRS/IN2P3, Université de Normandie/ENSICaen). He completed his Ph. D. thesis in 2009 at Caen University. Since he joined the CNRS/IN2P3 in 2011, he developed skills in experimental nuclear and particle physics, particularly in detection system and data analysis. He is involved in several experiments: SCALP (cross section measurement for nuclear reactor), SoLid (search for short baseline neutrino oscillation). He will participate to project on (n,alpha) cross section measurement in WP 2 in SANDA.

Dr Muriel Fallot (F) is Assistant Professor in the Department of Physics and of the SUBATECH laboratory at the University of Nantes, France. She received her Ph.D. in nuclear physics from the Pierre and Marie Curie University of Paris in 2002. As a nuclear and reactor physicist, she has spent her career chasing reactor antineutrinos at the Double Chooz, Nucifer and SoLid experiments (as the coordinator of the Reactor and Spectrum Working Groups), bringing her nuclear and reactor physics expertize. She has contributed to predictions of reactor antineutrino spectra with the development of reactor and spectrum models, and the acquisition of new nuclear data with the Total Absorption Gamma-ray Spectroscopy technique. She coordinates the third Work Package of the NEEDS/NACRE nuclear data project. She is head of the Nuclear Structure and Energy group of the Subatech laboratory and coordinates the Master 2 “Nuclear Dismantling and Modelling” of the University of Nantes. She will conduct projects on decay data measurements and evaluation in WP 2 and 4 in SANDA

Dr Magali Estienne (F) is a Nuclear Physics Physicist of the Subatech laboratory (CNRS/in2p3, Univ. of Nantes, IMTA). She received her Ph.D. in 2005 in nuclear physics from the University of Nantes. As a nuclear physicist she has spent her career studying the physics of the quark gluon plasma at Brookhaven within the STAR experiment and then at CERN within the ALICE experiment. She has been head of the High-Pt group of Subatech for 3 years and directed the EMCal and DCal detector projects for 8 years at Subatech. Since nearly two years, she has joined the Nuclear Structure and Energy group of Subatech to bring her expertize to the research projects of the group. She has contributed to reactor antineutrino spectrum predictions with nuclear data since 2012 and has become an expert in this field. She also participates to the experimental activities of the team (TAGS experiments and E-Shape project). She will participate in projects on decay data measurements and evaluation in WP 2 and 4 in SANDA

Lydie Giot (F) is an assistant professor in nuclear reactor science and engineering at the engineering school IMTA and SUBATECH Laboratory since 2007. She completed her Ph. D. thesis in 2003 at University of Caen in experimental nuclear physics. She was the head of the nuclear reactor engineering program at IMTA from 2009 to 2017. Her research work is mainly focussed on reactor simulations and associated depletion calculations using Monte Carlo codes. She participated in modeling several types of reactors such as N4-PWR, research reactors (CEA-OSIRIS, SCK-CEN-BR2) within the Double Chooz, Nucifer and SoLid experiments. Since 2014, she develops decay heat calculations using the summation method mainly on PWR/BWR reactors on the U/Pu cycle especially with the Monte Carlo code SERPENT aiming also to the impact of different data libraries (JEFF and ENDF) and of new decay data measurements performed with the Total Absorption Spectroscopy Method. She will participate in projects on decay data evaluation in WP 4 in SANDA

Dr Amanda Porta (F) is a Nuclear Physics Physicist of the Subatech laboratory (group SEN, CNRS/IN2P3, Université de Nantes, IMT Atlantique). She discussed her Ph. D. thesis in 2005 at University of Turin (Italy) in neutrino physics. She had the opportunity to change from neutrino to nuclear physics in 2009 when she arrived in the Nantes’s group as an assistant professor at the IMT Atlantique (engineer school), since then she developed skills in experimental nuclear physics, in particular in beta decay measurements for nuclear power plant safety. She has been the SEN group responsible in interim for 3 months at the end of 2015, she represented the SEN group in the in2p3's nuclear data community in the same period. She is responsible of the organisation of the classes on reactor's physics and operation in the SNEAM (Sustainable Nuclear Engineering - Applications and Management) international master at the IMT Atlantique. She will participate in projects on decay data measurements in WP 2 in SANDA

M Sylvain David (M) is researcher at CNRS in IPN Orsay. Since 1999 he is working on reactor physics, more specifically on innovative systems and fuel cycles and associated scenarios. He supervised around 6 PhD in reactors physics, neutronics or scenario studies. Since 2014, he is deputy director at CNRS/IN2P3 in charge of interdisciplinary, in particular nuclear physics for energy application (nuclear data, reactor physics, energy scenarios …). He will participate in the WP 6 in SANDA to prepare nuclear data coordination at European level.

Publications

- A collision history-based approach to sensitivity/perturbation calculations in the continuous energy Monte Carlo code SERPENT, M. Aufiero 1 A. Bidaud 1 M. Hursin J. Leppänen G. Palmiotti S. Pelloni P. Rubiolo 1, Annals of Nuclear Energy, Elsevier Masson, 2015, 85, pp.245-258.
- Investigation of the ^{238}U(d,p) surrogate reaction via the simultaneous measurement of γ-decay and fission probabilities, Q. Ducasse, B. Jurado,et al., Phys. Rev. C 94 (2016) 024614
- From gamma emissions to (n,xn) cross sections of interest: the role of GAINS and GRAPhEME in nuclear reaction modeling, M. Kerveno, A. Bacquias, C. Borcea, Ph. Dessagne, G. Henning, L.C. Mihailescu, A. Negret, M. Nyman, A. Olacel, A. J. M. Plompen, C. Rouki, G. Rudolf, and J.C. Thiry, European Physical Journal A 51, 167 (2015)
- Total Absorption Spectroscopy Study of ^{92}Rb Decay: A Major Contributor to Reactor Antineutrino Flux , A.-A. Zakari-Issoufou et al., Phys. Rev. Lett. 115, 102503 (2015)
- Development of a gaseous recoil-proton detector for neutron flux measurements between 0.2 and 2 MeV neutron energy, P. Marini, L. Mathieu, M. Aiche, T. Cheron, P. Hellmuth, J.L. Pedroza, S. Czajkowski, B. Jurado and I. Tsekhanovich, EPJ Web of Conferences 146, 03015
- Fission fragment yield distribution in the heavy-mass region from the 239Pu (nth,f) reaction, Y.K. Gupta, D.C. Biswas, O. Serot, D. Bernard, O. Litaize et al., Phys.Rev.C, 2017, 96 (1), pp.014608

Previous projects or activities

IN2P3/CNRS is involved for twenty years in European nuclear data projects. Successively IN2P3 teams have participated to the FP5-EURATOM ADOPT/HINDAS, FP6-EURATOM EUROTRANS/NUDATRA, FP7-EURATOM/ANDES and CHANDA. It was also the coordinator of the FP6-EURATOM/NUWASTE/EFNUDAT project. The IN2P3 teams have thus developed large skills in the nuclear data fields for energy applications and became major actors in this thematic.

Significant infrastructures

IN2P3/CNRS offers three nuclear facilities through its technology platforms (AIFIRA@CENBG, ALTO@IPNO and GENESIS@LPSC) where a large variety of nuclear data measurements are possible. These platforms are included in the submitted H2010-NFRP2018 CSA project ARIEL. The AIFIRA platform offers high intensity (up to 50 µAe) beams of light ions (H+,D+, He+) with excellent beam brightness and energy stability. These characteristics make AIFIRA a very valuable tool for neutron-induced reaction measurements. The ALTO facility of the IPN Orsay consists of a 15 MV tandem capable of accelerating heavy ion beams from protons to iodine. The LICORNE convertor at ALTO platform produces intense, kinematically focused, quasi-monoenergetic beams of neutrons over an energy range of 0.5 to 4 MeV, ideal for energy applications. The GENESIS platform is provided by the GENEPI 2 electrostatic accelerator and can deliver 220 keV deuterons, analyzed by a magnet and guided onto a deutered or tritiated target. Subsequent D(d,n)3He or T(d,n)4He reactions produce fast neutrons of 3.1 MeV or 15.2 MeV respectively (at 0° for 220 keV incident neutrons) which are suitable for measurements relative to energy applications.

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
Does the participant envisage that part of its work is performed by linked third parties[5]	Y

If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party

- Grenoble INP

LPSC, Unité Mixte de recherche or Joint Research Unit (UMR/JRU 5821) is set up by Centre National de la Recherche Scientifique (CNRS), Université Grenoble Alpes (UGA) and Institut National Polytechnique de Grenoble (Grenoble INP). Since Pr. Grégoire Kessedjian (WP2 & 4) and Pr Adrien Bidaud (WP5), Grenoble INP employees, will be active in the project, CNRS requests the inclusion of Grenoble INP as Linked Third Party in line with the Article 14 of the Grant Agreement.

- Université de Bordeaux

Université de Bordeaux will also participate in the project as third party contractually linked with CNRS through the joint research unit n°5797, also called "CENBG". This involvement is due to the fact that Mr Mourad Aiche is employed by Université de Bordeaux as a university professor, and will be involved in SANDA (WP1). Moreover, a contract has been signed between Université de Bordeaux & CNRS regarding the JRU5797 ("Quinquennal contract" of a five-year period) stating the resources (human, financial, infrastructures...) allocated by each institution to the laboratory for research purposes."

- Université Caen Normandie

The laboratory LPC is a joint research unit (JRU6534) between CNRS, UNICAEN and ENSICAEN. As François-René Lecolley is lecturer at the University of Caen and will work on WP2, UNICAEN will be linked to the main beneficiary CNRS.

- IMT Atlantique

UMR6457 SUBATECH is a joint research unit of CNRS, Université de Nantes and IMT Atlantique. Amanda Porta (WP2) and Lydie Giot (WP4) are employed by IMT Atlantique.

- Université de Nantes

UMR6457 SUBATECH is a joint research unit of CNRS, Université de Nantes and IMT Atlantique. Muriel Fallot, involved in WP2 an WP4, is employed by Université de Nantes.

Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
Does the participant envisage that part of the work is performed by International Partners[6] (Article 14a of the General Model Grant Agreement)?	N

[5] A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the Model Grant Agreement).

[6] ‘International Partner’ is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

6. CSIC

The CSIC (Spanish National Research Council) is Spain's largest public research institution, and ranks third among Europe's largest research organization. The CSIC is attached to the Spanish Ministry of Science, Innovation and Universities through the State Secretariat for Research, Development and Innovation, and plays a key role in scientific and technological policy in Spain and worldwide. CSIC has 10.940 employees, including 3.764 researchers. CSIC has 120 Institutes spread across the country and covering different areas of Science and Technology. 67 of them are fully-owned institutes and 53 are Joint Research Units in partnership with other Spanish universities or research institutions. CSIC has also a delegation in Brussels.

CSIC supports research and training across a wide range of knowledge, from the most basic or fundamental aspects of science to the most complex technological developments; from human and social sciences to food science and technology, including biology, biomedicine, physics, chemistry and materials, natural resources and agricultural sciences. As the third largest research organization in Europe, CSIC carries out research in all fields of knowledge.

CSIC produces 20% of the national scientific output (more than 12.000 ISI paper in 2014). CSIC remains the leading patent filer among research bodies in Spain with more than 180 patent requests published in 2014.

In addition, CSIC has a broad experience in conducting R&D projects funded by national and international public agencies and industry. CSIC is a major player in the development of the European research area and therefore a significant contributor to the European integration process. Within the 7th Framework Programme CSIC has signed 726 actions (including 70 coordinated by CSIC). As to the number of projects, CSIC is listed the 1st organisation in Spain and the 4th in Europe within the research organizations, with a total FP7 contribution of over 264 million euros (E-CORDA).

As to the funding obtained by CSIC within each programme, the distribution is People 20%, Cooperation 47%, Capacities 8% and Ideas 25%. Taking into account the research areas, the most relevant ones in terms of funding have been Physical Science and Technology and Biology and Biomedicine.

In H2020 (2014-2018) CSIC has obtained 446 projects with a total EU financial contribution of 181 million euros. As E-CORDA points out CSIC is listed the 1st organisation in Spain and the 3rd participant within the research organization by number of projects. CSIC is a major player in the ERC programme with a total of 87 projects signed as Host Institution in all areas of knowledge. CSIC is also an active member in Knowledge and Innovation Communities (KIC), such as Raw Materials and Food of the European Institute for Innovation and Technology (EIT). The Instituto de Fisica Corpuscular (IFIC) is one of the largest Institutes at CSIC dedicated to basic and applied research in subatomic physics.

Dr. Alejandro Algora is a staff researcher at the Instituto de Fisica Corpuscular (CSIC-Univ. of Valencia), Spain. He completed his PhD at the MTA ATOMKI, Debrecen, Hungary, 1996. He is an experienced researcher in experimental physics, and has lead many experiments in large facilities around the World (LNL-Legnaro, ISOLDE-CERN, GSI, Univ. of Jyväskylä, RIKEN). In recent years he has contributed to a revitalization of total absorption measurements of beta decays related to the prediction of the decay heat and the antineutrino spectrum. He has acted as member and he is presently member of several international and collaboration committees (RISING(GSI), PRESPEC(GSI), ISOLDE Collaboration Committee (ISOLDE-CERN), IDS(ISOLDE), JEFF, etc.). He is one of the leaders (spokespersons) of new measurements related to the prediction of the decay heat and the antineutrino spectrum of relevance for the WP2 and acted as expert in beta decay in several meetings at the IAEA and NEA (years: 2005, 2006, 2009, 2014, 2015, 2017, 2018).

Dr. Jose L. Tain is leading since more than 25 years the experimental nuclear physics group working on several applications of advanced experimental techniques to the improvement of reactor technology. With more than 160 publications he has contributed decisively to the improvement of techniques for the measurement of neutron capture cross sections at neutron time of flight facilities with improved accuracy. Particularly relevant for this proposal are his experimental studies of decay data for fission products. He has developed new analysis methodologies for beta decay total absorption gamma ray spectroscopy, which have a direct impact on the improvement of reactor decay heat summation calculations. He has also developed a new neutron counter for accurate measurements of beta delayed neutron emission probabilities, for improved calculations of the reactor delayed neutron fraction. He is a consultant of IAEA, NEA and JEFF for these matters.

Publications

- Algora, et al., Decay Heat in Pu-239: Solving the gamma Discrepancy in the 4-3000-s Cooling Period. PHYSICAL REVIEW LETTERS. 105, 202501 (2010) (published November 2010) This article was selected for a Viewpoint article, and received the editor mark of wide interest
- Algora and J. L. Tain, Decay heat and nuclear data.
- Book Chapter, in Nuclear Reactors, Editor Amir Mesquita, IntechOpen, DOI: 10.5772/34622 (published February 2012)
- Available from: https://www.intechopen.com/books/nuclear-reactors/decay-heat-and-nuclear-data
- Fallot, M. et al., New Antineutrino Energy Spectra Predictions from the Summation of Beta Decay Branches of the Fission Products. PHYSICAL REVIEW LETTERS. 109, 202504 (2012) (published November 2012)
- Zakari-Issoufou, A. -A. et al., Total Absorption Spectroscopy Study of Rb-92 Decay: A Major Contributor to Reactor Antineutrino Spectrum Shape. PHYSICAL REVIEW LETTERS. 115, 102503 (2015) (published September 2015)
- Tain, J. L. et al., Enhanced gamma-Ray Emission from Neutron Unbound States Populated in beta Decay. PHYSICAL REVIEW LETTERS. 115, 062502 (2015)— (Published August 2015)

No third parties involved.

7. CVREZ

Research organization Centrum Výzkumu Řež s.r.o. (CVREZ), UJV Group Member, was established in 2002 as a daughter company of ÚJV Řež a.s. Its principal mission is to perform applied R&D in energy (mainly nuclear) and neutron physics as well as act as Czech Technical Safety Organization (TSO).
Two research reactors and a set of experimental equipment (probes and loops) form the backbone of the research infrastructure of the company. This makes CVREZ able to participate in sophisticated research projects and participate in the development of new technologies for GEN IV and the fusion reactor. CVREZ participates in Jules Horowitz Reactor Project (hot laboratories development and supply), and has new research infrastructure SUSEN, which it was built by large ERDF project "Sustainable Energy" (SUSEN) with the budget of nearly 95 MEUR.
CVREZ was involved in 14 FP7 projects and 18 projects in H2020. CVREZ represents the Czech Republic in the Executive Committee of EERA, European Energy Research Alliance and in the ETSON association. CVREZ is a member of SNETP and NUGENIA.

In this project the CVREZ will be participating in a work package WP2 experiments and WP5 validation focused on the experimental work, evaluation of the experimental data for validation and following validation of selected cross sections. The LR-0 reactor together with attached detector infrastructures (2x HPGe, Organic scintillation detector (n/g) and hydrogen proportional counter (neutrons 0.1 – 1.3 MeV will be employed.

Ing. Michal Košťál PhD (male) master degree (2006), PhD (2012) at Czech Technical University in Prague; Faculty of Nuclear Science and Physical Engineering, department of Nuclear Reactors. 2007 – Present – Research centre Rez, Czech Republic; Physicist at LR-0 reactor, focused on neutron and gamma spectrometry. Scientific advisor of reactor dosimetry group. Supervisor of student's diploma thesis and other activities, reviewer in ANE, NIM-A, FED, JRNC. From 2014 Associate Editor, Journal of Nuclear Engineering and Radiation Science, ASME; from 2016 – 2017 Guest Editor, Fusion Engineering and Design, Elsevier.

Ing. Martin Schulc Ph.D. (male) master degree (2010), PhD (2016) at Czech Technical University in Prague; Faculty of Nuclear Science and Physical Engineering, Department of Physics. 2014 – Present – Research centre Rez, Czech Republic; Physicist at LR-0 reactor, focused on neutron and gamma spectrometry. Supervisor of students' bachelor thesis and other activities, reviewer and guest editor in Journal of Nuclear Engineering and Radiation Science.

Publications

- Validation of zirconium isotopes (n,g) and (n,2n) cross sections in a comprehensive LR-0 reactor operative parameters set; M. Košťál, M. Schulc, V. Rypar et al; Appl. Rad. and Isot., Vol. 128, 2017, pp. 92-100
- Neutron deep penetration through reactor pressure vessel and biological concrete shield of VVER-1000 Mock-Up in LR-0 reactor; M. Košťál, F. Cvachovec, B. Jánský et al; Ann. of Nucl. En., Vol. 94, 2016, pp. 672-683
- On similarity of various reactor spectra and 235U prompt fission neutron spectrum; M. Košťál, Z. Matěj, E. Losa et al; Appl. Rad. and Isot., Vol. 135, 2018, pp. 83-91
- Measurement of neutron spectra in a silicon filtered neutron beam using stilbene detectors at the LVR-15 research reactor; M. Košťál, J. Šoltés, L. Viererbl et al; Appl. Rad. and Isot., Volume 128, 2017, pp. 41-48
- Measurement of various monitors reaction rate in a special core at LR-0 reactor, M. Košťál, M. Schulc, J. Šimon et al; Ann. of Nucl. En., Vol. 112, 2018, pp.759-768
- The Influence of Changes in Iron Cross Section in the Thermal Region between CENDL-3.1 and ENDF/B-VII.0, Kostal, M., Milcak, J., Rypar, V., et al, Nuclear Data Sheets, Vol. 118, (2014), pp 561-563

CVREZ has participated in the projects:

- Reactor Dosimetry, CEZ, Validation of calculational models for Dukovany NPP 2017
- Nuclear data validation, EDF, Measurement of neutron fluxes in various iron arrangements for validation of EDF calculational tools, 2016
- Heavy reflector benchmark, EDF, Benchmarking of neutron and gamma fluxes in PWR geometry, (2016-2017)
- VVER-1000 benchmarking, CV Rez, Benchmarking of selected reactor physics parameters under IRPhEP (2013 – 2018)
- CRP, IAEA – NDS, measurement of 89Y(n,2n) cross section (2016-2017)

CVREZ has relevant infrastructures for the project such as:

- LR-0 reactor, pool type zero power reactor with flexible operational parameters
- Silicon filtered neutron spectra. It is neutron field in LVR-15 reactor (Its neutron MW reactor) which is formed in radial channel by use of 1m thick Si filter. This kind of field ideal for energy calibration of neutron spectrometric detectors
- HPGe in vertical position, well characterized detector suitable for measurements of gamma activities of irradiated foils and samples
- HPGe in horizontal position, well characterized detector suitable for measurement of gamma activities of fission products in fuel pins
- FD-11 neutron spectrometric detector, can be used with various crystals (Stilbene, NE-213; p-terfenyl) for measurement of fast neutron flux

No third parties involved.

8. ENEA

The ENEA main research themes are: energy efficiency; renewable energy; nuclear energy; climate and environment; safety and health; new technologies; and electric system research. In 2009, pursuant to Law n. 99 July 23 2009, the new ENEA was set up inheriting expertise, skills and capability of previous research bodies (CNRN-National Committee for Nuclear Research, CNEN-National Committee for Nuclear Energy, and former ENEA-National Committee for Research and Development of Nuclear and Alternative Energy). At national level ENEA coordinates a project funded by the Ministry of Economic Development (MISE) devoted to maintain the present expertise and increase it, where applicable, in the fields of safety, security and sustainability of nuclear installations. At European level, ENEA has an agreement with the IRSN, a bilateral collaboration on several aspects of severe accidents, nuclear fission safety, nuclear data, code validation and application. In the domain of various EURATOM Framework Programs, ENEA has been involved in several projects within the field of nuclear safety, such as SARNET 1 and 2 (Severe Accident Research Network of Excellence), NURESAFE (Nuclear Reactor Safety Simulation Platform), IVMR (In Vessel Melt Retention Severe Accident Strategy for existing and future NPPs), CESAM (Code European for Severe Accident Management), FASTNET (Fast nuclear emergency tools), CHANDA (Solving Challenges in Nuclear Data for the Safety of European Nuclear Facilities). ENEA is also member of CSARP (Cooperative Severe Accident Research Program), MCAP (MELCOR Code Assessment Program) and CAMP (Code Applications and Maintenance Program) with the USNRC.
ENEA is the Italian representative at the Committee on the Safety of Nuclear Installations (CSNI) and at the Nuclear Science Committee (NSC) of OECD/NEA, and participates in a number of working and expert groups, such as the Working Group on Analysis and Management of Accidents (WGAMA), the Working Group on Risk Assessment (WGRISK), the Senior Expert Group on Safety Research Opportunities Post-Fukushima (SAREF), the Joint CNRA/CSNI Ad-Hoc Group on the Safety of Advanced Reactor (GSAR), the Working Group on Fuel Safety (WGFS), the Working Group on Advanced Fuel Cycle Scenarios (AFCS), the Working Party on International Nuclear Data Evaluation Co-operation (WPEC), the Working Party on Nuclear Criticality Safety (WPNCS), the Expert Group on Improvement of Integral Experiments Data for Minor Actinide Management (EGIEMAM-II), amongst others.
ENEA is a member of the CERN n_TOF Collaboration since its establishment, in the year 1999.

Alberto Mengoni (male, born 1957) is a senior researcher at ENEA, the Italian National Agency for New Technologies, Energy and Sustainable Economic Development. From 2009 to 2017, he served as Science and Technology Attaché at the Embassy of Italy in Tokyo, for the Italian Ministry of Foreign Affairs and International Cooperation. He has been, previously, appointed as Head of the Nuclear Data Services Unit at the International Atomic Energy Agency (IAEA) in Vienna, a position held from 2005 to 2009. From 2001 to 2005 he coordinated, for CERN - the European Center for Nuclear Research in Geneva - the "Nuclear Data for Accelerator Driven Systems", an FP5 project initiated by Carlo Rubbia. His fields of research have been nuclear structure and reactions for applications to basic science and technology. Dr. Mengoni has performed a significant fraction of his research activity in nuclear physics at Japanese research institutions (the Japan Atomic Energy Agency, RIKEN and the University of Tokyo), after starting his career as researcher at ENEA Bologna, in Italy.
Mario Carta (male, born 1954) has a master degree in Physics (1979) from the University of Rome "La Sapienza". ENEA researcher starting from June 1983, from 1979 to 1990 is involved in fast reactor physics. From 1986 to 1990 (being detached at CEA-CEN Cadarache – France from 1986 to 1988), is member of the international SPX-1 start-up analysis group. From1991 to 1995 is involved in the analysis of severe accident consequences in thermal reactors. From 1996 to 2013 is involved in the analysis of Accelerator Driven Systems neutronics, with different coordination roles at national and international level. Since 2013 is Head of the ENEA Research Nuclear Reactors Laboratory. TPC member for several international conferences, is author/co-author of more than 180 publications among reviews, conferences, and technical reports.

Donato Maurizio Castelluccio (male, born 1973) holds a M.Sc. in Physics, the Specialization Diploma in Medical Physics (IV year) and the III degree Qualified Expert (QE) Certification. Since 2015 he is member of the Italian Delegation at the Comprehensive Nuclear Test Ban Treaty Organization (CTBTO) based in Vienna, and member of the Italian National Data Center (NDC) for the same Organization as Radionuclide Expert. Since 2010 he is serving the Laboratory for Design and Technical Support for Nuclear Safety and Sustainability (FSN-SICNUC-PSSN) of the Italian National Institute for New Technologies, Energy and

Sustainable Economic Development - ENEA in Bologna. Currently he is also involved in neutronic analyses for safety assessment and for design margins definition and optimization of the European Demonstrator Lead-cooled Fast Reactor (ALFRED). He is INFN Associate for the n_TOF experiment and since November 2017 a PhD candidate at the University "Tor Vergata" in Rome. During his professional career he has gained experience in many national and international laboratories in the field of experimental physics.

Publications

- Measurement and resonance analysis of the $^{33}S(n,\alpha)30Si$ cross section at the CERN n_TOF facility in the energy region from 10 to 300 keV, J. Praena et al. (The n_TOF Collaboration) Phys. Rev. C 97, 064603 (2018), DOI: 10.1103/PhysRevC.97.064603
- Neutron capture cross section measurement of ^{238}U at the CERN n_TOF facility in the energy region from 1 eV to 700 keV, F. Mingrone et al. (The n_TOF Collaboration), Phys. Rev. C 95, 034604 (2017). DOI: 10.1103/PhysRevC.95.034604
- $^{62}Ni(n,\gamma)$ and $^{63}Ni(n,\gamma)$ cross sections measured at the n_TOF facility at CERN
- C. Lederer et al. (n_TOF Collaboration), Phys. Rev. C 89, 025810 (2014), DOI: 10.1103/PhysRevC.89.025810
- New Measurement of the ^{25}Mg (n,γ) Reaction Cross Section, C. Massimi et al. (The n_TOF Collaboration), Nuclear Data Sheets 119, 110-112 (2014), DOI: 10.1016/j.nds.2014.08.031
- M. Carta et al., "Research Reactors for the development of materials and fuels for innovative nuclear energy systems", IAEA NUCLEAR ENERGY SERIES NO. NP-T-5.8, International Atomic Energy Agency, Vienna, September 2017.

ENEA has participated in previous relevant projects like:

- CHANDA - Solving Challenges in Nuclear Data for the Safety of European Nuclear Facilities
- EU-FP7 Euratom-Fission Project. http://www.chanda-nd.eu/
- CESAM - Code for European Severe Accident Management
- EU-FP7 Euratom-Fission Project
- EVITA (European Validation of the Integral Code ASTEC)
- EU-FP5 Euratom-Fission Project

No third parties involved.

9. HZDR

Helmholtz-Zentrum Dresden - Rossendorf e. V. (HZDR) founded in 1992 is a registered, non-profit institution supported by the German Federal Government and the Free State of Saxony. HZDR pursues interdisciplinary research in the fields matter, health and energy. It has 1100 employees including 500 scientists in eight research institutes. The largest research facility at HZDR is the international user facility ELBE, a 40 MeV superconducting electron accelerator delivering a beam intensity of up to 1 mA in continuous wave mode. ELBE is a world-wide unique instrument providing a compact, accelerator-driven photon and particle source. The variety of secondary radiation being offered extends from high-energy gamma rays, to infrared and THz radiation, to neutron, positron and electron beams. ELBE is operated as user facility, providing more than 50% of the beamtime to external user groups.

HZDR is involved in double-differential cross section section data of high energy neutrons impinging on light nuclei (nitrogen, oxygen, carbon), which are relevant for the absorbed dose outside of the target volume in radiation therapy. HZDR will contribute to the development of the experimental setup for the measurement of DDX data for the neutron-induced emission of light charged particles from C,N,O, i.e. a scattering chamber and telescopes suitable for the measurement of hydrogen and helium ions with low cutoff energies (Task 1.4) . After the restart of CERN n_TOF the experimental activities should begin by measuring data for a small number of angles. This set of angles can already provide valuable benchmarks for testing nuclear models, in particular the INCL model in the low energy range. This would also be a valuable input for the work package focusing on high-energy modelling.

HZDR operates facilities that are very well suited for the proposed tasks: The photo-neutron source nELBE is the first one at a superconducting electron accelerator. The excellent pulse structure of ELBE allow to perform neutron time of flight measurements with high resolution and a short flight path. The nELBE neutron source has a source strength of 5*1011 n/s with a fast neutron spectrum from ca. 100 keV to 8 MeV. HZDR operates a laboratory for the development of particle detectors e.g. gaseous drift chambers, ionization chambers, resistive plate chambers and the corresponding analogue and digital read-out electronics.

Dr. Arnd R. Junghans (male), has experience in nuclear physics experiments with electron accelerators, low energy van de Graaffs and relativistic heavy ion synchrotrons ,measuring cross sections of particle and neutron induced reactions. He is the leader of the HZDR “nuclear data” group.

Dr. Roland Beyer (male) has experience in neutron time-of-flight measurements including development of detectors and experiment electronics. He is the beam line scientist for the nuclear physics beam lines at the ELBE user facility.

Dr. Ronald Schwengner (male) has more than 25 years of experience in nuclear-structure experiments at more than 10 heavy-ion and electron accelerators in Europe using gamma and particle spectroscopy.

<u>Publications</u>

- “The γ-ray angular distribution in fast neutron inelastic scattering from iron” Beyer, R., Dietz, M., Bemmerer, D. et al. Eur. Phys. J. A (2018) 54: 58. https://doi.org/10.1140/epja/i2018-12492-7
- “Fast-neutron-induced fission of 242Pu at nELBE” Toni Kögler, Roland Beyer, Mirco Dietz, Arnd R. Junghans, Christian Lorenz, Stefan E. Müller, Tobias P. Reinhardt, Konrad Schmidt, Ronald Schwengner, Marcell P. Takacs and Andreas Wagner, EPJ Web Conf., 146 (2017) 11023 https://doi.org/10.1051/epjconf/201714611023
- “Breaking of axial symmetry in excited heavy nuclei as identified in giant dipole resonance data” Grosse, E., Junghans, A.R. & Massarczyk, R. Eur. Phys. J. A (2017) 53: 225. https://doi.org/10.1140/epja/i2017-12415-2
- “Nuclear deformation and neutron excess as competing effects for dipole strength in the pygmy region” Massarczyk, R., Schwengner, R., Dönau, F., Frauendorf, S., Anders, M., Bemmerer, D., Beyer, R., Bhatia, C., Birgersson, E., Butterling, M., Elekes, Z., Ferrari, A., Gooden, M.E., Hannaske, R., Junghans, A.R., Kempe, M., Kelley, J.H., Kögler, T., Matic, A., Menzel, M.L., Müller, S., Reinhardt, T.P., Röder, M., Rusev, G., Schilling, K.D., Schmidt, K., Schramm, G.,

Tonchev, A.P., Tornow, W., Wagner, A. (2014) Physical Review Letters, 112 (7), art. no. 072501, https://link.aps.org/doi/10.1103/PhysRevLett.112.072501

HZDR has participated in previous projects like

- HZDR has been involved in a large number of large EU projects, as partner as well as in the role of the coordinator. The most important ones with respect to the present proposal are listed below.
- ERINDA (GA No. 269499) European Research Infrastructures for Nuclear Data Applications
- CHANDA (GA No. 605203) solving CHAllenges in Nuclear DAta
- CALIPSOplus (GA No. 730872) Convenient Access to Light Sources Open to Innovation, Science and to the World
- SPIRIT (GA No. 227012) Support of Public and Industrial Research using Ion Beam Technology
- Start-up KIC Raw Materials (SUGA 2015 EIT RM) Start-up activities in order to set up the EIT Raw Materials Knowledge and Innovation Community - EIT RM

No third parties involved.

10. IFIN-HH

IFIN-HH is one of the most important R&D organizations in Romania, contributing with almost 10% to the national scientific output. The institute is mainly dedicated to research and development in nuclear physics and nuclear engineering, and in related areas including astrophysics and particle physics, field theory, mathematical and computational physics, atomic physics and life and environmental physics. The institute operates four accelerators: a 9-MV TANDEM accelerator, an 1-MV TANDETRON accelerator dedicated to AMS measurements, a 3-MV TANDETRON accelerator dedicated to IBA measurements and a cyclotron capable of producing intense beams at 13 MeV/amu. These are mainly used for nuclear structure and atomic physics studies but also for applied research. Other facilities of the institute are the Radioactive Waste Treatment Plant (STDR), the IRASM centre for R&D and gamma industrial irradiation services.

In the field of nuclear data, IFIN-HH has significant know-how in the field of nuclear reactions including experimental and theoretical study of neutron-induced cross sections. IFIN-HH also hosts a Data Centre of the Nuclear Structure and Decay Data (NSDD) Network, the collaboration producing and maintaining the Evaluated Nuclear Structure Data File (ENSDF) under the coordination of IAEA.

Dr. Alexandru NEGRET is the leader of the experimental nuclear reactions group involved in neutron cross section measurements. During the last decade the group enlarged and produced extensive highly precise nuclear data sets. A. Negret is also the responsible of the NSDD Data Centre operating in IFIN-HH.

Dr. Adina OLACEL is a female scientist at the end of her postdoc, currently having a permanent position in IFIN-HH. She did her PhD and postdoc within the nuclear reactions group and is specialized in experimental neutron cross section measurements, data processing and simulations.

Dr. Marian BOROMIZA concluded his PhD in 2018 with a thesis dedicated to neutron cross section measurements and to the comparison between the charged particle and the neutron induced reactions. He also holds a good know-how in the field of data analysis while showing great interest to the theoretical investigation of nuclear reactions.

Dr. Catalin BORCEA is a senior scientist, with extensive experimental and theoretical know-how in the field of nuclear reactions, precise nuclear data and also nuclear structure.

Dr. Sorin PASCU is a nuclear structure experimentalist involved in data evaluation. He is member of the NSDD Data Centre form IFIN-HH and will be involved in nuclear structure evaluation for the current project.

Publications

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- Negret, M. Sin, C. Borcea, R. Capote, Ph. Dessagne, M. Kerveno, N. Nankov, A. Olacel, A. J. M. Plompen, and C. Rouki, Cross-section measurements for the ^{57}Fe(n,nγ)^{57}Fe and ^{57}Fe(n,2nγ)^{56}Fe reactions, Phys. Rev. C96, 024620 (2017).
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Previous projects or activities

IFIN-HH is involved in numerous international collaborations in the field of nuclear physics. It is the main contributor to the Romanian participation to FAIR, ISOLDE, n_TOF and SPIRAL2. The list of European projects where IFIN-HH was recently involved includes CHANDA (FP7), ANDES (FP7), ERINDA (FP7), HadronPhysics (FP6) and EURONS (FP6).

No third parties involved.

11. IRSN

IRSN is a French public body with industrial and commercial activities that was set up in 2001. The Institute is placed under the joint authority of the Ministries of Defence, the Environment, Industry, Research, and Health. It is the nation's public service expert in nuclear and radiation risks, and its activities cover all the related scientific and technical issues.

IRSN interacts with all parties concerned by these risks (public authorities, local authorities, companies, research organizations, stakeholders' associations, etc.) to contribute to public policy issues relating to nuclear safety, human and environmental protection against ionizing radiation, and the protection of nuclear materials, facilities, and transport against the risk of malicious acts.

Within the nuclear safety division of IRSN, the Neutronics and Criticality Safety Department performs, amongst other, R&D activities that aim to support safety studies in the frame of criticality and reactor physics. In particular, its activities cover development, verification and validation of reactor physics and criticality safety simulation codes, but also nuclear data evaluation and validation.

Thus, the Monte Carlo transport code MORET is being developed and validated since the 70's and is continuously improved. During the last 3 years, last features of the MORET code were mainly focused on sensitivities/uncertainties studies in order to allow bias and uncertainties estimation and feedback to nuclear data. The experimental validation database of the continuous energy calculation route of the MORET 5 code consist of more than 2000 benchmarks mainly taken from ICSBEP and IRPHE handbooks and French proprietary experimental programs and covers a wide range of media, isotopes and neutron spectrum. The validation database will be used for the workpackage 5 for criticality configurations.

Besides, the Neutronics and Criticality Safety Department has worked on data evaluations for criticality safety and reactor applications. In addition to the data evaluation, IRSN also provides data uncertainties that are used in criticality safety assessments (Calculation bias estimation). Few examples are the 235U, 16O and titanium as shown in the references. These evaluations have been proposed to inclusion in the last JEFF evaluation files. The ^{235}U resonance evaluations in JEFF are that derived at IRSN. The huge validation database of the MORET 5 code is of course used to validate the proposed nuclear data evaluations prior sending them to the JEFF project. As members of the JEFF project, IRSN also contributes to the validation of the new release of the JEFF evaluation files.

This long-lasting experience in the nuclear data evaluation and validation and in criticality safety ensures that the actions foreseen in the SANDA project will be suited to the needs of criticality safety practitioners.

Dr. Luiz Leal (M) is currently deputy head of neutronics laboratory in the Neutronics and Criticality Safety Department at IRSN. He was previously Distinguished R&D Staff in the Nuclear Data and Criticality Safety Group at Oak Ridge National Laboratory (USA). For the past 30 years, he has been performing research activities on nuclear data evaluation for reactor and criticality safety applications. His work consists of data evaluation in the resolved and unresolved resonance regions for actinides, fission products, structural materials, etc. Many JEFF and ENDF evaluation are derived from his work. Recent work includes data evaluation for low-energy neutron interaction with molecules for determination of double differential cross sections. He received many awards, among them the Eugene P. Wigner Reactor Physicist Award in 2016 and the Technical Excellence Award in the Criticality Safety Division of the American Nuclear Society in 2010. He will carry out the nuclear data and covariances evaluation for molybdenum using the new measurements performed in WP1 by ENEA.

Dr. Isabelle Duhamel (F) is currently scientific advisor in the Neutronics and Criticality Safety Department at IRSN, where she is in charge of the IRSN PRINCESS project (PRoject for IRSN Neutron physics and Criticality Experimental data Supporting Safety). She was previously the head of Criticality Research and Neutronics Development Laboratory at IRSN, which was in charge of criticality calculation packages development, verification and validation and of integral critical experiments design for criticality safety. She has more than 20 years of experience in criticality and was mainly involved in nuclear data and code validation, Sensitivity/uncertainties analyses and in critical experiments design. She has been participating in several OECD expert groups (JEFF, UACSA, SG 45 of WPEC) and is currently the coordinator of the SG5 of the WPNCS (Working Party on Nuclear Criticality Safety) that deals on experimental needs. She is an active member of ICSBEP (International Criticality Safety Benchmark project). She will be in charge of the nuclear data validation in the WP5 for criticality issues.

Publications

- Luiz Leal, Adimir Dos Santos, Evgeny Ivanov and Tatiana Ivanova, "Impact of 235U Resonance Parameter Evaluation in the Reactivity Prediction,' Nuc. Sci. Eng., Volume 187, 2017.
- Luiz Leal, Evgeny Ivanov, Gilles Noguere, Arjan Plompen and Stefan Kopecky, "Resonance Parameter and Covariance Evaluation for 16O up to 6 MeV," EPJ Nuclear Sci. Technol. 2, 43 (2016).
- Luiz Leal, Sophie Pignet, Nicolas Leclaire, Isabelle Duhamel (IRSN), and Gary Harms (SNL), "Differential and Integral Data Evaluation for Titanium: An Application to Criticality Safety," Transactions of the American Nuclear Society, Vol. 117, Washington, D.C., October 29–November 2, 2017
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- Tatiana Ivanova (IRSN), Isabelle Duhamel (IRSN), Stéphane Evo (IRSN) – "Impact of Nuclear Data on Multiplication Factor and Reactor Physics Parameters Calculation for Experiments Simulating Damp MOX Powders" - Proc. of the International Conference on Nuclear Data for Science and Technology, ND2007, 22-27 April, 2007, Nice, France, http://nd2007.edpsciences.org/
- Duhamel, E. Létang, "The PRINCESS Project: An IRSN Project For Experimental Data Acquisition In The Frame Of Criticality Safety And Reactor Physics", ANS Winter Meeting, November 2016, Las Vegas, NV, USA

No third parties involved.

12. IST-ID

IST-ID, the Association of Instituto Superior Técnico for R&D (http://www.ist-id.pt) is a private not-for-profit institution for which Instituto Superior Técnico (IST) is one of the founding associates. IST is part of the Universidade de Lisboa, and it is the largest and most reputed school of engineering, Science and Technology (S&T) in Portugal. Its mission is to provide top quality higher education in the areas of Engineering, S&T and Architecture, as well as developing RD&I activities that meet the highest international standards.
IST-ID is the host institution of Centro de Ciências e Tecnologias Nucleares (C2TN) where part of the proposed R&D activity will be carried out. Under agreements between IST and IST-ID, IST makes available the majority of facilities, infrastructures and services, where IST-ID R&D activities are carried out. Researchers from the Radiological Protection and Safety Group (GPSR) of C2TN will be involved in the project. They are members of the EU Research Platforms MELODI, EURADOS, Alliance, NERIS, IGD-TP and EURAMET.

Dr. Pedro Vaz (M). Coordinator Researcher of IST with Habilitation. President of Centro de Ciências e Tecnologias Nucleares (C2TN) and Coordinator of the Radiological Protection and Safety Group (GPSR) of C2TN. Ph.D in Physics. Co-author of more than 300 peer-reviewed articles. Has participated in several EU EURATOM funded research projects as well as in CERN experiments related to the measurements of the cross-sections for neutron-induced reactions. Portuguese delegate and representative to several international Committees and Groups under the EU, IAEA, OECD/NEA and EU platforms.

Dr. Isabel F. Gonçalves (F). Senior Researcher of IST. Member of C2TN and GPSR.
PhD in Physics. Has participated in several EU EURATOM funded research projects as well as in CERN experiments related to the measurements of the cross-sections for neutron-induced reactions. Sound experience in neutronics and in Nuclear Engineering and Technology and Reactor Physics related topics.

Publications

- S. Di Maria et al. Area and Prompt Decay Constant Techniques for Reactivity Assessment in Deep Subcritical Configuration: A Case Study within the Framework of the FREYA Project. OECD Proceedings of the Thirteenth Information Exchange Meeting on Actinide and Fission Product Partitioning and Transmutation, Seoul, Republic of Korea, 23-26 September 2014, pp. 262-268.
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- S Barros et al. Comparison of Unfolding Codes for Neutron Spectrometry with Bonner Spheres. Proceedings of the Neutron and Ion Dosimetry Symposium (NEUDOS-12), France, 3-7 June 2013. Radiation Protection Dosimetry (2014), Vol. 161, No. 1–4, pp. 46–52. doi:10.1093/rpd/nct353
- Y Romanets et al. Evaluation of the Radiation Field and Shielding Assessment of the Experimental Area of HIE-ISOLDE. Proceedings of the Neutron and Ion Dosimetry Symposium (NEUDOS-12), France, 3-7 June 2013. Radiation Protection Dosimetry (2014), Vol. 161, No. 1–4, pp. 347–351. doi:10.1093/rpd/ncu031
- S Di Maria et al. Neutronic assessment and criticality analysis of the in-vessel fuel storage facilities in the CDT project. Proceedings of the 15th International Conference on Emerging Nuclear Energy Systems (ICENES-15). Transactions of Fusion Science and Technology, 61(1T), 2012, pp. 298-301. ISSN 1536-1055

IST-ID has participated in several projects like:

- CDT ("Central Design Team"), 7th Framework Programme EURATOM
- ANDES ("Accurate Nuclear Data for nuclear Energy Sustainability"), 7th Framework Programme EURATOM
- FREYA ("Fast Reactor Experiments for hYbrid Applications"), 7th Framework Programme EURATOM

- MARISA ("MYRRHA Research Infrastructure Support Action"), 7th Framework Programme EURATOM
- MYRTE ("MYRRHA Research and Transmutation Endeavour"), Horizon 2020 EURATOM

No third parties involved.

13. JRC

The Joint Research Centre (JRC) is the European Commission's science and knowledge service. Its mission is to support EU policies with independent evidence throughout the whole policy cycle. Its work has a direct impact on the lives of citizens by contributing with its research outcomes to a healthy and safe environment, secure energy supplies, sustainable mobility and consumer health and safety. The JRC hosts specialist laboratories and unique research facilities and is home to thousands of scientists working to support EU policy. The JRC has ten Directorates and is located across five EU Member States (Belgium, Germany, Italy, the Netherlands and Spain).

The Directorate involved in this project is Directorate G - Nuclear Safety and Security. This directorate is responsible for the JRC's nuclear work programme, funded by the EURATOM Research and Training Programme. It contributes to the scientific foundation for the protection of the European citizen against risks associated with the handling and storage of highly radioactive material, and scientific and technical support for the conception, development, implementation and monitoring of community policies related to nuclear energy. Research and policy support activities of Directorate G contribute to achieving effective safety and safeguards systems for the nuclear fuel cycle, enhancing nuclear security and contributing to the goal of low carbon energy production.

The research programmes are carried out at the JRC sites in Germany (Karlsruhe), Belgium (Geel), The Netherlands (Petten) and Italy (Ispra) and consist of research, knowledge management and training activities on nuclear safety, security and safeguards. They are performed in collaboration and/or in support to the EU Member States and relevant international organizations. Today the Directorate G is one of the leading nuclear research establishments for nuclear science and technology and a unique provider of nuclear data measurements.

Dr. Alf Göök is a nuclear physicist working for the ANDANTE work packages FISSION and STANDARDS, with a focus on prompt neutron correlation measurements with fission fragments. His expertise lies in the design and development of high-resolution ionization chambers for charged particle measurements as well as in the detailed characterization of liquid scintillator based neutron detectors. He is an expert in using the GEANT-4 and MCNP software packages.

Dr. Ir. Jan Heyse is work package leader for activities on neutron cross section measurements and on education and training (E&T) at JRC.G.2. His main activities include the organization and follow up of neutron induced reaction measurements, the development of new set-ups for novel nuclear applications and giving support to external users. He coordinates E&T activities within the JRC.G.2 unit.

Dr. Markus Nyman (M) is responsible for conducting elastic and inelastic neutron scattering measurements at the GELINA facility. He also provides support for external users. He has 15 years of professional experience, mostly in neutron scattering experiments and in-beam gamma-ray spectroscopy. He has also been involved in medical radioisotope production, teaching, as well as radiation detector and cyclotron repair and maintenance work.

Dr. Carlos Paradela (M) is a nuclear physicist with 15 years of experience in fission and neutron-induced reactions and more than 100 publications in peer-reviewed journals. He is involved in the measurement and analysis of capture and total cross sections at GELINA facility and non-destructive isotopic composition determination by using neutron resonance transmission analysis (NRTA). He also provides support and training to external users of the facility.

Dr. ir. Arjan Plompen (M) is acting head of the JRC.G.2 unit. He coordinated the activities of Domain C of the CHANDA project and work packages for the ANDES, EUROTRANS, EFNUDAT and CANDIDE EC projects. He is the chairman of the coordination group of the JEFF project. and chairman of WPEC in 2018 and 2019 (both OECD-NEA). He was member for JRC of the INDC (2004-2016, IAEA) and was scientific responsible for coordinating the programs on inelastic scattering and activation cross sections at JRC.

Dr. Peter Schillebeeckx (M) is project leader of the nuclear data activities of the JRC.G.2. His scientific interests include capture and total cross section measurements and the use of neutron resonance analysis for non-intrusive elemental composition determinations. He and his team have actively explored the limits of accuracy in resonance range and have ample experience in resonance range nuclear data evaluation.

Dr. Stephan Oberstedt (M) is a nuclear physicist with 25 years of experience and 200 publications in peer-reviewed journals. He leads the ANDANTE work packages FISSION and STANDARDS. He is responsible for the measurements of nuclear fission cross-section data, fission-fragment yields, and prompt fission neutron and gamma-ray characteristics. He is the JRC representative for neutron metrology at the BIPM CCRI(III) as well as member of the collaboration on neutron metrology between NPL, IRSN, PTB and JRC.

M.Sc. Goedele Sibbens (F) is responsible for the Target Preparation group at JRC.G.2, which has dedicated laboratories for the production and characterization of actinide and stable targets for nuclear measurements. Recent achievements include the production and characterization of U-233, U-235, U-238, Pu-239, Pu-240, Pu-242, Am-241 thin deposits and Li-6, Li-7, B-10 and tristearin thin layers for nuclear measurements of the EC projects ANDES, ERINDA, EUFRAT, METROFISSION and CHANDA. She participates in WP3 for production and characterization of nuclear targets and the coordination thereof.

Publications

- Nyman et al., "Measurement of the 477.6-keV γ-ray production cross section following inelastic neutron scattering by ^{7}Li ", Phys. Rev. C 93 (2016) 024610
- Kim et al., "Neutron capture cross section measurements for ^{238}U in the resonance region at GELINA", Eur. Phys. J. A 52 (2016) 170
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Significant infrastructures

The main contribution will be provided by the JRC.G.2 Unit - Standards for Nuclear Safety, Security and Safeguards (SN3S). The JRC.G.2 Unit hosts two key European laboratories for neutron-induced nuclear reaction measurements and an important facility for the production and characterization of nuclear and radioactive targets. These laboratories are operated and supported as a direct action of the EURATOM program. The GELINA facility is a white pulsed neutron source time-of-flight facility for neutrons with energies from 1 meV to 20 MeV. It combines an excellent time resolution of less than 2 ns with flight paths ranging from 10 to 400 m an unsurpassed neutron energy resolution is obtained. The MONNET facility is a 3.5MV Tandem Generator. At this facility quasi mono-energetic beams of neutrons are produced in the energy range from 10 keV to 24 MeV using binary reactions of protons and deuterons with lithium, deuterium or tritium targets. JRC Geel has dedicated equipment and expertise in the domain of measurements of neutron-induced reactions that cover the total, fission, capture and inelastic scattering processes of interest to this proposal.

Previous projects or activities

The JRC.G.2 Unit is an active participant to European projects with a nuclear data component (ANDES, ERINDA, EUFRAT, CANDIDE, NUDAME, EFNUDAT, EUROTRANS, CHANDA) and has ample experience with coordination of projects, work packages and tasks in these projects. JRC Geel actively collaborates in nuclear data projects operated by the OECD Nuclear Energy Agency and the IAEA Nuclear Data Section and has bilateral collaboration agreements with institutes in Europe, DOE, JAEA and AECL.

No third parties involved.

14. JSI

The Jožef Stefan Institute is the leading Slovenian scientific research institute, covering a broad spectrum of basic and applied research in the fields of natural sciences and technology. The staff of more than 960 specializes in research in physics, chemistry and biochemistry, electronics and information science, nuclear technology, energy utilization and environmental science. The subjects concern production and control technologies, communication and computer technologies, knowledge technologies, biotechnologies, new materials, environmental technologies, nanotechnologies, and nuclear engineering.
The mission of the Jožef Stefan Institute is the accumulation - and dissemination - of knowledge at the frontiers of natural science and technology to the benefit of society at large through the pursuit of education, learning, research, and development of high technology at the highest international levels of excellence.
The main part of the institute is located in Ljubljana. The institute operates a TRIGA research reactor, which is located about three kilometres outside the town. The main research areas of the Reactor Physics Department are theoretical, experimental and applied reactor physics, plasma physics, nuclear fragmentation, neutron dosimetry, neutron radiography, the physics of semiconducting devices and oncology. The department provides services to the Krško Nuclear Power Plant such as nuclear core design verification, physics start-up tests, etc. The staff of the Department has expertise in neutron transport calculations using deterministic and Monte Carlo methods, benchmarking, nuclear data evaluation and processing for applications, sensitivity and uncertainty calculations, applied to criticality as well as shielding problems and fusion (JET, ITER) applications.

JSI has long term expertise in nuclear data (ND) evaluation, processing, use and validation for various nuclear applications and will participate in ND validation and benchmarking, cross section sensitivity/uncertainty (S/U) analysis and ND covariance matrix evaluation and validation.

Prof. Dr. Ivan Aleksander Kodeli is a senior research associate at the Jožef Stefan Institute, Reactor Physics Department, Ljubljana, and visiting professor at the University of Maribor, Slovenia (since 2009). He obtained the Ph.D. degree and University habilitation (HDR) at the University Paris XI, France. He started his professional career at the JSI. He worked later as IAEA representative at the OECD/NEA Data bank (for two and seven years), and at CEA Saclay for seven years.
Scientific expertise: Neutron/gamma transport calculations using deterministic and Monte Carlo methods, nuclear data sensitivity and uncertainty calculations (fission, fusion reactors, ADS, some medical and industrial applications), nuclear data evaluation, processing and benchmarking, benchmark experiment preparation and analysis (fusion shielding, criticality), cross section covariance matrices. He was responsible for the SINBAD project at NEA DB.

Bor Kos is PhD student working at JSI on the Monte Carlo acceleration, using ADVANTG code, cross section sensitivity and uncertainty code development and use, benchmark analysis and nuclear data validation.

Aljaž Čufer is post-doc working on advanced Monte Carlo calculations for fusion applications linked to JET, ITER and DEMO.

Igor Lengar is researcher at JSI specialised in neutronics analysis for fusion applications.

Publications

- Kodeli, L. Plevnik, Nuclear data adjustment exercise combining information from shielding, critical and kinetics benchmark experiments ASPIS-Iron 88, Popsy and SNEAK-7A/7B, Progress in Nuclear Energy 106 (2018) 215 - 230
- Kodeli, Beta-Effective Sensitivity and Uncertainty Analysis of MYRRHA Reactor for Possible Use in Nuclear Data Validation and Improvement, Annals of Nuclear Energy 113 (2018) 425 - 435.
- Kodeli, S. Slavic, SUSD3D Computer Code as Part of the XSUN-2017 Windows Interface Environment for Deterministic Radiation Transport and Cross Section Sensitivity-Uncertainty Analysis, Science and Technology of Nuclear Installations Volume 2017, Article ID 1264736, (2017) 16 pages https://doi.org/10.1155/2017/1264736

- Kodeli, K. Kondo, R.L. Perel, U. Fischer, Cross-Section Sensitivity and Uncertainty Analysis of the FNG Copper Benchmark Experiment, Fusion Engineering and Design, 109-111 (2016) 1222-1226.
- Kodeli, A. Milocco, P. Ortego, E. Sartori, 20 Years of SINBAD (Shielding Integral Benchmark Archive and Database), Progress in Nuclear Science and Technology, Volume 4 (2014) pp. 308-311.
- Kodeli, Sensitivity and Uncertainty in the Effective Delayed Neutron Fraction (beta-eff), Nuclear Instruments and Methods in Physics Research A 715(2013)70-78

JSI participated in a large number of EU projects, such as:

- CHANDA (Solving CHAllenges in Nuclear DAta for the Safety of European Nuclear Facilities);
- ANDES (Accurate Nuclear Data for nuclear Energy Sustainability) project of EC (FP7-Fission-2009, SP5-EURATOM);
- EU fusion programme (ITER) within EFDA, Fusion for Energy (F4E), EUROFUSION (EC fusion benchmark activities performed at the ENEA Frascati FNG facility with the pre- and post-analysis, etc.);
- Joint European Torus (JET) project (NEXP Streaming Benchmark Experiment);
- Our research groups have been taking part in OECD/NEA working group activities (WPEC, EGRTS, UAM, SINBAD, IRPhE, ICSBEP) and in many IAEA CR, TC, training and consultation projects. JSI co-ordinates WPEC WG47 on "Use of Shielding Integral Benchmark Archive and Database for Nuclear Data Validation" (2018-2021)

Significant infrastructures

The institute operates a TRIGA research reactor and the stuff has long term experience in reactor measurements (reactivity, kinetics, neutron & gamma flux using activation foils and spectrometers). JSI has developed a complete cross section sensitivity and uncertainty computational tool and has competences in the nuclear data evaluation & use, and in the evaluation & use of the critical, physics and shielding benchmarks for the SINBAD, IRPhE and ICSBEP databases.

No third parties involved.

15. JYU

The University of Jyväskylä (JYU) with its about 15 000 students and 2500 employees ranks among the five largest universities in Finland. The Accelerator Laboratory (JYFL_ACCLAB) is operated as a part of the Department of Physics (JYFL), the second largest department of the University (800 students, 150 employees). The Department of Physics has mechanical and electrical workshops that in addition to the accelerator laboratory serve also the rest of Department of Physics and faculty-based Nanoscience Center. The Accelerator Laboratory is acknowledged as a national expertise center of accelerators and ionizing radiation.
JYFL-ACCLAB runs two cyclotrons, the K = 130 MeV heavy ion cyclotron and a high intensity K = 30 MeV proton/deuteron cyclotron MCC30/15. The high intensity cyclotron is located next to the Ion Guide Isotope Separator On-Line (IGISOL) facility. The mass separator facility can be served by both cyclotrons.
IGISOL employs a chemically insensitive ion guide technique, capable of forming ions of any element, including the refractory ones. The IGISOL research group, consisting of about 15 researchers, graduate and undergraduate students, concentrates mainly on studies on exotic nuclei far from stability, their ground state properties and decay spectroscopy.
Particle induced fission is used to produce neutron rich isotopes for atomic mass measurements and decay studies; in addition, the fission process itself has been the subject of research. An integral part of the facility is a high mass resolving power Penning trap, called JYFLTRAP, primarily intended for beam purification and atomic mass measurements, that can in addition be used to unambiguously identify the fission products by their mass. This allows determining the isotopic fission yield distributions for all elements. A recent development has been employing the PI-ICR (position imaging ion cyclotron resonance) technique to enhance the mass resolving capabilities for precision mass measurements. The use of the PI-ICR method allows in many cases the identification of the isomeric states on the basis of their mass. The development work to apply the technique to the measurement of isomeric ratios is in progress. In addition, a MR-TOF (multireflection time of flight) device has been build and expected to be installed and commissioned by 2020. The mass resolving of the MR-TOF device is sufficient to be applied in the fission yield measurements. The detailed studies for this adaptation will be started as soon as MR-TOF device will be installed.
In addition, a neutron converter target which makes it possible to induce fission with a simulated fast fission neutron field has been designed and build within the EU funded project CHANDA. Neutrons are typically used to study neutron induced fission reactions, while proton induced fission provides higher yields for neutron rich isotope production for research.

The IGISOL facility is an internationally acknowledged user laboratory, providing annually more than 1000 hours beam time for external users' experiments, selected by an independent Program Advisory Committee on the basis of the scientific quality of submitted proposals. The proposed activities JYU will participate in this program aim to improve the quality of the IGISOL facility to even better to support experiments of external users. In particular, these improvements will increase the capabilities to provide isotopically – even isomerically in some cases – purified radioactive short-lived isotopes for research, as well as determine fission yield distributions. These improvements are essential to provide even more accurate nuclear data in the near future.

The gas cell technique is originally developed in JYU. JYU Accelerator Laboratory has long experience in determining fission yield distributions. The novel technique employing the Penning trap, also developed in JYU, allows fast determination of the isotopic yield distributions. The Penning trap also allows production of ultra-pure radioactive sources of rare neutron rich nuclei for research.

Dr. Heikki Penttilä (M), Docent, University researcher. Ph.D. 1992 University of Jyväskylä. 30 years of experience on mass spectrometry, nuclear spectroscopy and fission research. Post-doctoral appointee in Argonne National Laboratory 1992-94, Senior Assistant University of Jyväskylä 1994-99 (Department of Environmental Sciences) and 1999-2002 (Department of Physics), Fellow of Finnish Academy 2002-2007, Head of Research University of Jyväskylä 2007-2009, University researcher 2009-.

Prof. Ari Jokinen (M), Professor, Ph.D. 1994 University of Jyväskylä. 25 years of experience on nuclear spectroscopy and ion beam manipulation. CERN Fellow 1994-1996, Senior researcher, University of

Jyväskylä 1996-1999, Fellow of Finnish Academy 1999-2004, Senior researcher University of Jyväskylä 2004-2006, Lecturer 2006-2011, Professor 1.8.2011-.

Prof. Iain D. Moore (M), Professor. Ph.D. in Nuclear Structure Physics, 2001, University of Manchester, UK. Expert in laser-based techniques for nuclear physics, ion beam production and manipulation and mass spectrometry of exotic nuclei. Postdoctoral Research Scholar, Argonne National Laboratory 2001-03, Researcher, University of Jyväskylä 2004-06, Senior Researcher, University of Jyväskylä 2006-2012, University Lecturer, University of Jyväskylä 2012-2016, Professor 2016 -.

Dr. Anu Kankainen (F), Fellow of Finnish Academy, PhD 2006 University of Jyväskylä in 2006. Expert in nuclear astrophysics, atomic mass measurements and decay spectroscopy. PI of "MAIDEN" project (ERC Consolidator Grant) 2018-23. Postdoctoral Researcher, University of Jyväskylä 2006-12, University of Edinburgh 2013-14. Fellow of Finnish Academy 2014-

Dr. Tommi Eronen (M), Fellow of Finnish Academy, Ph.D. 2008 University of Jyväskylä. Expert in ion trapping and manipulation techniques and atomic mass measurements of short-lived nuclei, more than 10 years of experience in the field. Currently PI of a research program devoted to beta decay Q-value measurements of transitions that potentially have an ultralow Q-value. Postdoctoral researcher University of Jyväskylä 2009-2011, Alexander von Humboldt Fellow and postdoc at Max Planck Institute for nuclear physics 2011-2014, Senior researcher University of Jyväskylä 2014-2015, Assistant Research Scientist at Texas A&M University 2015-2016, Fellow of Finnish Academy 2016-(2021).

Dr. Sami Rinta-Antila (M), Laboratory engineer. PhD 2006 University of Jyväskylä. 15 years of nuclear spectroscopy experience. Research Associate in University of Liverpool 2007-2009. University of Jyväskylä post-doctoral researcher 2009-2018, Laboratory Engineer 2018.

Publications

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- Mattera, et al., Production of Sn and Sb isotopes in high-energy neutron-induced fission of natU. European Physical Journal A, 54 (3), 33 (2018). doi:10.1140/epja/i2018-12462-1
- Algora, A., et al., Total absorption studies of high priority decays for reactor applications: 86Br and 91Rb. In ND 2016: International Conference on Nuclear Data for Science and Technology (pp. 10001). EDP Sciences (2017). doi:10.1051/epjconf/201714610001

No third parties involved.

16. KIT

The Karlsruhe Institute of Technology is one of the biggest sciences and engineering research institutions in Europe and funded jointly by the Federal Republic of Germany and the State of Baden-Wuerttemberg. KIT was established on 01/10/2009 from a merger of Universität Karlsruhe (founded in 1825), one of Germany's leading research universities, and Forschungszentrum Karlsruhe GmbH (founded in 1956), one of the largest national research centres in the Helmholtz Association. Higher education, research, and innovation are the three pillars of KIT's activities. Its research and development program is embedded in the superordinate program structure of the Hermann von Helmholtz Association of National Research Centres.

Ron Dagan (M) is Associate Professor at KIT: Karlsruhe Institute of Technology. He received his habilitation degree in Reactor Physics at the year 2009 at IKE Stuttgart. He has been working in the last decades on diverse projects concerning Reactor and nuclear data applications. He participated in the European projects on solutions for nuclear reactors' waste in form of transmutation and incineration. In the last years he has been working on storage optimisation for dedicated disposal. The work concerns the validation of the accurate nuclide vectors to be disposed based on validation of experimental results using updated nuclear data and appropriate nuclear models.

<u>Publications</u>

- Michel Herm, Ron Dagan, Ernesto González-Robles, Nikolaus Müller, Volker Metz
- „Comparison of calculated and measured radionuclide inventory of a Zircaloy-4 cladding tube plenum section", MRS Advances (Material Research society), DOI:10.1557/adv.2018.274, 2018.
- Dagan R., Becker M., Ivanov A." Introduction of a Resonant Up-Scattering Treatment for Multi-group Cross Section Generation", International Conference on Mathematics, Computational Methods & Reactor Physics, (M&C 2017).
- R. Dagan, M. Herm, V. Metz, Maarten Becker, "Determination of minor actinides in irradiated fuel rod components" "Annual Meeting of Nuclear Technologies", Berlin May 2017
- R. Dagan, P. Schillebeeckx, B. Becker, S. Kopecky, F. Gunsing, C. Lampoudis, Y. Danon, "Impact of the Energy Dependent DDXS on Determination of Resonance Parameters", Nuclear Data Sheets 118 (2014) 179–182.

No third parties involved.

17. NPI

The Nuclear Physics Institute of the Czech Academy of Sciences (NPI of the CAS) (http://www.ujf.cas.cz/) is a public research organization with the primary goal to independently conduct research in the scientific disciplines of nuclear physics and related scientific disciplines, and the use of the nuclear physics methods and procedures in interdisciplinary fields of science and research, especially in biology, environmental science, medicine, radio pharmacy, and material sciences. Moreover, NPI contributes to the utilization of research results, training of students, and provides access to large research infrastructures. NPI of the CAS had 314 employees in 2017.

The activities of NPI are gathered around four pillars: theoretical research, multidisciplinary oriented research, operation of large research infrastructures and research facilities and education and training of students. International cooperation is inherent to all of these activities.

On its cyclotrons, NPI conducts a long-term research program with intermediate energy neutrons. The neutrons in the energy range 15-35 MeV are produced using the accelerated proton or deuteron beams on Lithium and Beryllium converters. The protons/deuterons are accelerated using the isochronous U120M and TR24 cyclotrons in the energy range 20-35 MeV, 10muA (U120M) and 18-24 MeV, 150 muA (TR24). The neutron converters are adapted for the maximum intensity of the neutron flux (distance, current). Depending on the choice of the neutron converter, the neutron beams with different spectra can be produced.

Neutron beams with quasi-monoenergetic spectra from the thin Li converter are used mainly for the measurement of the neutron induced cross-sections (reactions (n,xn), (n,charged particle), (n,gamma)). The available detection techniques vary from the neutron activation analysis to direct detection of charged particles using telescopes and HPGe detectors on the collimated neutron beam. The maximum intensity of the neutron field is 109 n/cm^2/s in the monoenergetic peak. Continuous spectra neutron beams from the reaction of protons or deuterons on the thick Be converter are used for the testing of radiation hardness of materials for fusion reactors (DPA measurements), electronics radiation hardness (SEE), development of neutron monitors, irradiation of subcritical assemblies, delayed neutrons measurement, etc. The maximum intensity of the neutron field is 1011 n/cm2/s integrated over the whole spectrum energy range.

A new neutron converter based on the p+Be reaction is under construction (in operation by the end of 2018). The continuous neutron spectrum with the maximum energy of 24 MeV and 1012 n/cm2/s make this neutron generator one of the most powerful neutron sources worldwide in this energy range, and an ideal tool for applications where high neutron integrals are necessary.

Spectral fluxes are determined by the MCNPX simulation, continuous experimental verification is performed using the proton-recoil-telescope method, Time-Of-Flight measurements and the dosimetry foil technique.

Mgr. Mitja Majerle (M), PhD. (H – index 7), is a senior researcher with scientific experience in cross-section extraction procedures for reactions with neutrons (NPI), measurements of neutron spectra from p+Li and p+Be neutron generators at NPI, thermal calculations of the static and rotating targets for SPIRAL2/NFS (NPI), adapting the Rigorous Two Step method (R2S) to calculate residual dose rates based on the superimposed mesh tally (KIT), modelling neutron fluxes for KIT design of the spallation target ESS, Modelling neutron fluxes from the reactions d+Be and d+C for SPIRAL2/NFS neutron facility (KIT), usage of Monte Carlo simulation codes MCNP(X), FLUKA in gamma-spectrometry and spallation experiments (JINR Dubna, TSL Uppsala), measurement of neutron fluxes using neutron activation analysis (JINR Dubna), measurement of the tissue equivalent dose rates with linear accelerator used for cancer treatment (UKC Ljubljana). Mitja Majerle graduated at the Faculty of Mathematics and Physics, Ljubljana, with diploma work Calibration of the Linear Accelerator Philips SL-75/5 for the Needs of the Three-dimensional Planning in the Radiotherapy. He has a PhD. from the Faculty of Nuclear Sciences and Physical Engineering, Prague, with thesis Monte Carlo methods in spallation experiments.

Ing. Jan Novák (M), PhD. (H – index 6) is a senior researcher with scientific experience in measurement and evaluation of differential cross sections in the reactions of charged particles in solid and gas targets using semiconductor detectors, experimental data processing and the development of codes for processing and analysis, analysis of reaction mechanisms at stripping, angular distribution calculations, measurement of spectra of neutron beams using proton recoil telescope, development of the code for neutron spectrum determination, handling scintillation detectors, pulse shape discrimination, measurement of neutron spectra of accelerator driven generators using time of flight method, development of software for detector digital signal Managing, development of software for determining the neutron spectrum from TOF data, scintillation detector efficiency calculation, digitization of multidimensional coincidence measurement. Jan Novák graduated from the Faculty of Nuclear Sciences and Physical Engineering in Prague with a Diploma work: Tunable Microwave Generators in the 1 GHz, and got his PhD. at the Nuclear Physics Institute of the CAS, with the thesis: Study of the ^{31}Si Nuclear Structure in the ^{30}Si(d,p)^{31}Si Reaction.

Mgr. Martin Ansorge (M) is a PhD. student with skills in fast neutron detection and energy calibration of NE-213 probe using TOF technique, sensitivity and uncertainty analysis of TOF technique, energy spectra unfolding with codes GRAVEL and MAXED from UMG package, supported by Monte Carlo code SCINFUL for simulating response matrix of detector, Monte Carlo simulations with MCNPX and Geant4 frameworks and neutron cross-section measurements. In 2017 he graduated from the Czech Technical University with a Master thesis on Neutron field energy spectrum measurement of accelerator driven generators by the Time of Flight Technique. He is working on his PhD. thesis on Development of methodology for studying of reactions (neutron, charged particle) at neutron energies up to 35 MeV.

Publications

- Majerle, M., Ansorge, M., Bém, P., Novák, J., Šimečková, E., Štefánik, M. Radiation Protection Dosimetry 180, 386–390, 2018; DOI: 10.1093/rpd/ncy031
- Majerle, M., Ansorge, M., Bém, P., Cihak, M., Novák, J., Šimečková, E., Štefánik, M., et. al. 5TH INTERNATIONAL CONFERENCE NUCLEAR ENERGY FOR NEW EUROPE, (NENE 2016)
- Au, Bi, Co and Nb cross-section measured by quasimonoenergetic neutrons from p+7Li reaction intheenergy range of 18–36MeV, Majerle, M.; Bem. P.; Novak, J.; Simeckova, E.; Stefanik, M. NUCLEAR PHYSICS A, vol. 953, pp. 139-157, DOI: http://dx.doi.org/10.1016/j.nuclphysa.2016.04.036, 2016, IF 2.202
- Neutronics experiments, radiation detectors and nuclear techniques development in the EU in support of the TBM design for ITER, Angelone, M.; Fischer, U.; Flammini, D.; Flammini, D.; Jodlowski, P.; Klix, A.; Kodeli, I.; Kuc, T.; Leichtle, D.; Lilley, S.; Majerle, M.; Novak, J.; Ostachowicz, B.; Packer, L. W.; Pillon, M.; Pohorecki, W.; Radulovic, V.; Simeckova, E.; Stefanik, M.; Villari, R., FUSION ENGINEERING AND DESIGN, vol. 96-97, pp. 2-7, DOI: 10.1016/j.fusengdes.2015.06.114, 2015, IF 1.152
- Analysis of the Dosimetry Cross Sections Measurements up to 35 MeV with a Li-7(p, xn) Quasi-monoenergetic Neutron Source, Simakov, S. P.; Fischer, U.; Bem, Pavel; Burjan, V.; Goetz, M.; Honusek, M.; Kroha, V.; Novak, J.; Simeckova, E.; Forrest, R. A.,JOURNAL OF THE KOREAN PHYSICAL SOCIETY, vol. 59, iss. 2, pp. 1856-1859, DOI: 10.3938/jkps.59.1856, 2011, Times Cited: 4, IF 0.476 (2010)

No third parties involved.

18. NPL

The National Physical Laboratory (NPL) is the UK's National Measurement Institute, and is a world-leading centre of excellence in developing and applying the most accurate measurement standards, science and technology available. It employs over 500 scientists, covering a wide range of disciplines in experimental and theoretical sciences.

The NPL Nuclear Metrology Group (NMG) operates a neutron facility where well-characterised neutron fields are produced in a large low-scatter experimental area. We have several radionuclide neutron sources, the output of which has been measured to high precision in the NPL manganese sulphate bath. These include a high output (>10^7 s^{-1}) ^{252}Cf source. A pneumatic transfer system is available to introduce and remove this source from the experimental area remotely.
Monoenergetic and thermal neutron fields are produced via a 3.5 MV Van de Graaff accelerator.
The NMG also maintains a suite of gamma spectrometers calibrated with standard solutions.
These facilities are described on the NPL web site (www.npl.co.uk) and are listed in various international databases (NEA, BIPM, NuPECC). They are used for calibrating instruments, research into improving measurement standards, and for measuring nuclear data.
NMG staff also have substantial experience in the Monte Carlo modelling of neutron and gamma behaviour, which can be used to calculate correction factors for geometric and scattering effects.

The NPL NMG will make integral (spectrum-averaged) benchmark measurements of the activity induced in metal foils by neutrons from our high output ^{252}Cf source. There is a need for such measurements because of known shortcomings in, for example, the data in the reactor dosimetry file IRDFF (see IAEA reports INDC(NDS)-0616 and INDC(NDS)-0639, and the High Priority Request List under Special Purpose Quantities). Of the reactions listed in the latter, 50-Sn-117 (n,inl) Sn-117m and 28-Ni-60 (n,p) appear the most promising in terms of combining urgency with practicality.
Foils will be exposed to 252Cf neutrons in the low-scatter area of the neutron facility, and the induced activity will be quantified by gamma spectrometry in calibrated high-resolution spectrometers.
It is envisaged that the NPL NMG will carry out this work without the involvement of subcontractors, third parties or international partners.

Dr. N.P. Hawkes (M) is a Principal Research Scientist working on neutron metrology research and on neutron measurement services. He is the secretary of the UK Nuclear Science Forum, which coordinates nuclear data work in the UK, and has decades of experience in experimental neutron physics. He worked on neutron diagnostics at the JET fusion experiment, and on research for the civil nuclear power programme at the Atomic Energy Research Establishment, Harwell.

Dr. P. Salvador-Castiñeira (F) is a Higher Research Scientist specialising in thermal neutron measurement services and in measurements of neutron-induced and spontaneous fission. She has published several papers in the latter field, including in Phys. Rev. C. She has worked at the Institute for Reference Materials and Measurements (JRC-EC, Belgium) and studied at the Technical University of Catalonia (Spain) and at Uppsala University, Sweden.

Dr. A. Boso (M) is a Higher Research Scientist working on novel neutron spectrometers and on neutron dosimetry around therapy accelerators. Prior to joining NPL he studied experimental nuclear structure physics at Università degli Studi di Padova, and has co-authored publications in Phys. Rev. Lett. And Phys. Rec. C.

Andrew Pearce (M) is a Senior Research Scientist holding an MSc (Dist) in Radiometrics (Instrumentation and Modelling) and a BSc (Hons) in Computational Physics. He has 20 years' experience in providing measurement standards of radioactivity by high resolution gamma spectrometry and coincidence counting, and 14 years' experience in measuring and evaluating nuclear decay data for international collaborative projects such as the DDEP. He is responsible for the technical oversight of the NPL high resolution gamma spectrometry service. From 2003 - 2005 he took part in the development of a mathematical model to improve the Système International de Référence for gamma-emitting radioactivity, in collaboration with BIPM.

Sean Collins (M) is a Research Scientist with 10 years' experience of providing calibrations of surface emission rate for wide area reference standards, and 6 years' experience of providing measurement standards of radioactivity by high resolution gamma spectrometry. He holds a Higher National Diploma in Clinical Science.

Publications

- P. Salvador-Castiñeira, F.-J. Hambsch, A. Göök, M. Vidali, N.P. Hawkes, N.J. Roberts, G.C. Taylor and D.J. Thomas, Absolute and relative cross section measurements of ^{237}Np(n,f) and ^{238}U(n,f) at NPL, Web of Conferences, 10.1051/epjconf/201714604050.
- C. Michotte, A. K. Pearce, M. G. Cox and J. -J. Gostely, An approach based on the SIR measurement model for determining the ionisation chamber efficiency curves, and a study of 65Zn and 201Tl photon emission intensities, Appl. Radiat. Isot. 64 (10-11) (2005)1147.
- N.P. Hawkes, A. Bennett, S.S. Cheema, N.A. Horwood, L.N. Jones, P. Kolkowski, N.J. Roberts, G.C. Taylor and D.J. Thomas, Progress in providing neutron standards at the UK National Physical Laboratory, Nucl. Instrum. Methods in Phys. Res. A 580 (2007) 183 – 185.
- N.P. Hawkes, A. Bennett, S.S. Cheema, N.A. Horwood, P. Kolkowski, N.J. Roberts, G.C. Taylor and D.J. Thomas, Progress in Neutron Metrology and Dosimetry at the National Physical Laboratory, London, UK, Proceedings of the 13th International Congress of the International Radiation Protection Association (IRPA13), Glasgow, 14-18 May 2012, poster P02.258, www.irpa.net/page.asp?id=54638.

No third parties involved.

19. NRG

NRG is an internationally operating nuclear service provider. The mission of NRG is to respond to the social need for high quality nuclear research and innovation, safe and reliable nuclear isotope production and services to organisations working with nuclear technology. As such, the company produces isotopes, conducts nuclear technological research, is a consultant on the safety and reliability of nuclear installations and provides services related to radiation protection. Research is performed for governments aimed at developing knowledge about nuclear technology. NRG is a world market leader in the production of medical isotopes. NRG operates the 45 MW High Flux Reactor (HFR) owned by the European Union. The company has around 500 world-class employees with high quality know-how and works for and with partners in healthcare, the energy market, industry, government and science. The company has offices and nuclear facilities located in the Netherlands, in Petten and Arnhem. A complete nuclear infrastructure is available. NRG operates as well as maintains several facilities, not only the HFR but also hot cell laboratories for non-destructive and destructive testing and characterization of irradiated fuel. The hot cell laboratories deploy a series of advanced techniques for characterization and testing of irradiated materials like gamma spectrometry, tomography, transmission electron microscope (TEM), LV-SEM ceramography, profilometry and gas puncturing. NRG has a large experience in numerical modelling and computational engineering in the nuclear field. To this purpose, a large computing cluster is available. Finally, NRG is actively participating to the European nuclear R&D, through memberships and participation in SNE-TP, NUGENIA, ESNII, and NC2I.

NRG will perform benchmark calculations as validation of the nuclear data. The benchmarks will be adapted to be able to generate sensitivity profiles, to provide as much information as possible to benefit nuclear data development. NRG is uniquely positioned to perform this task because of its large collection of benchmark cases.

Dr. Steven van der Marck (M) holds a PhD in theoretical physics. In 2000 he joined NRG, where he has worked in reactor physics and isotope production ever since. He is an expert in the use of Monte Carlo applications in these fields, as well as on the influence of nuclear data libraries on the outcome of simulations. As part of his work, Steven has compiled a large set of benchmark cases to test the quality of nuclear data libraries. In this collection there are more than 2500 criticality safety benchmark cases, more than 60 shielding benchmark cases, and more than 30 delayed neutron benchmark cases. Steven has used these benchmarks to document the quality of the nuclear data libraries ENDF/B (VII.0, VII.1, and VIII.0), JEFF (3.0, 3.1, and 3.3), JENDL (3.3, 4.0), and TENDL (2012, 2017). Steven is a member of the TENDL team, which produces the most extensive nuclear data library in the world. He is (co-) author of 50 peer reviewed articles and more than 30 conference contributions.

Bernard Erasmus (M) is a neutronics specialist with a Master's degree in nuclear reactor physics, who has been working in the field of neutronics since 2009. Previously he formed part of the reactor physics team at the South African Nuclear Energy Corporation (Necsa), and since 2016 he has been part of the reactor physics team at NRG in the Netherlands. During the past two years, Bernard has contributed to the application, testing and verification of nuclear data, with specific focus on uncertainty propagation using various methods such as Total Monte Carlo, covariance sampling methods as well as the sensitivities method. This has led to contributions in the CHANDA project and to the JEFF-3.3 nuclear data library.

Publications

- D.A. Brown et al., Nuclear Data sheets 148 (2018) 1–142, ENDF/B-VIII.0: The 8th Major Release of the Nuclear Reaction Data Library with CIELO-project Cross Sections, New Standards and Thermal Scattering Data
- B. Erasmus, JEF/DOC 1857 November 2017, Benchmarking Results of Uncertainty Propagation Methods on a set of integral experiments
- D. Rochman, A.J. Koning, J.Ch. Sublet, M. Fleming, E. Bauge, S. Hilaire, P. Romain, B. Morillon, H. Duarte, S. Goriely, S.C. van der Marck, H. Sjöstrand, S. Pomp, N. Dzysiuk, O. Cabellos, H. Ferroukhi, and A. Vassiliev, Proc. ND-2016 (11–16 September 2016, Bruges, Belgium), The TENDL library: hope, reality and future

- D. Rochman, W. Zwermann, S.C. van der Marck, A.J. Koning, H. Sjöstrand, P. Helgesson, B. Krzykacz-Hausmann, Nuclear Science and Engineering 177 (2014) 337–349, Efficient use of Monte Carlo: uncertainty propagation
- S.C. van der Marck, Nuclear Data Sheets 113 (2012), 2935–3006, Benchmarking ENDF/B-VII.1, JENDL-4.0 and JEFF-3.1.1 with MCNP6

NRG has participated in projects like:

- The European project CHANDA (http://www.chanda-nd.eu/)
- The TENDL project (https://tendl.web.psi.ch/tendl_2017/tendl2017.html)
- The JEFF project (https://www.oecd-nea.org/dbdata/jeff)

No third parties involved.

20. NTUA

The National Technical University (NTUA) is the oldest and most prestigious technological educational institution of Greece, and has unceasingly contributed to the country's scientific and technical development since its foundation in 1836, as well as in the enrichment and implementation of global education and knowledge.
The Nuclear Physics group of National Technical University of Athens (NTUA) involved in the CHANDA project, consists of two staff members, Prof. R. Vlastou-Zanni and Assoc. Prof. M. Kokkoris, as well as one post-doc and five PhD students. The group has experience in charged-particle and gamma ray spectroscopy, nuclear reactions, neutron induced reactions, detector physics, simulations and theoretical calculations, in collaboration with many Greek and European Nuclear Physics Institutes. The main research activity of the group is currently focused on neutron-induced reactions within the frame of the n_TOF collaboration at CERN and at NCSR "Demokritos" in Athens.

Prof. Rosa Vlastou has been with the National Technical University of Athens since 1980, where she is currently a Professor in the Department of Physics and Director of the Nuclear Physics Laboratory. She has been a visiting scientist in many European Laboratories and Universities and has participated in several European projects (ESSA-30, EUROGAM, EUROBALL, CHANDA) and currently at CERN (n-TOF). Her research activities are focused on Nuclear Structure, Nuclear Reactions and Applications of Nuclear Techniques in Materials Analysis and Environmental studies. She has supervised 12 PhD theses (and 3 more are in progress) and many MSc and Diploma theses. She has been a member of the Organizing Committees of 8 International and 4 Hellenic Nuclear Physics Conferences. Her record includes over 170 publications in scientific journals and over 250 papers in conference proceedings, more than 2000 citations and h factor 24. She was President of the Hellenic Nuclear Physics Society (2012-2016), Vice President (2002-2004) and Secretary (2004-2006, 2010-2012).

Publications

- ^{197}Au(n,2n) reaction cross section in the 15-21 MeV energy range. A.Kalamara, R.Vlastou, M.Kokkoris, N.G.Nicolis, N.Patronis, M.Serris, V.Michalopoulou, A.Stamatopoulos, A.Lagoyannis and S.Harissopoulos. Phys.Rev.C97(2018)034615.
- Measurement of the ^{234}U(n, f) cross-section with quasimonoenergetic beams in the keV and MeV range using a Micromegas detector assembly. A. Stamatopoulos, A. Kanellakopoulos, A. Kalamara, M. Diakaki, A. Tsinganis, M. Kokkoris,V. Michalopoulou, M. Axiotis, A. Lagoyiannis, and R. Vlastou. Eur. Phys. J. A (2018) 54: 7
- Neutron induced fission cross section of ^{237}Np in the keV-MeV range at the CERN n_TOF facility. M. Diakaki, D. Karadimos, R. Vlastou, M. Kokkoris, P. Demetriou, E. Skordis, A. Tsinganis, and the n_TOF collaboration. Phys.Rev. C93 (2016) 034614.
- Neutron-induced fission cross section of ^{234}U measured at the CERN n_TOF facility. D.Karadimos, R.Vlastou, M.Diakaki,…., C. Papadopoulos,…A.Tsinganis,… and the n_TOF collaboration. Phys.Rev.C89 (2014)044606
- Measurement of the ^{242}Pu(n,f) cross section at the CERN n TOF facility. A.Tsinganis, …, R.Vlastou… and the n_TOF collaboration. Nucl.Data Sheets 119 (2014)58

NTUA has participated previously in the projects:

- Spokesperson of the research project "Measurement of the ^{230}Th(n,f) reaction cross-section at EAR-1 and EAR-2 of the n_TOF facility" (2017-)
- Spokesperson of the research project "Measurement of the ^{240}Pu(n,f) reaction cross-section at EAR-2 of the n_TOF facility" (2015-)
- Spokesperson of the research project "Isomeric cross section of the 191Ir(n,2n) reaction at the NCSR "Demokritos" (2014-2018)
- Spokesperson of the research project "Cross section measurements of the 197Au(n,2n) reaction at the NCSR "Demokritos" (2014-2017)
- Participation in the CHANDA project (2013-2018).

Significant infrastructures

The Nuclear Physics Laboratory at the National Technical University of Athens employs a large number of detection and computation systems. Among those, the laboratory possesses HPGe detectors with the proper shielding, Si and Micromegas detectors, NaI and liquid scintillators, a variety of NIM modules, an XRF spectrometer, a low background alpha-spectrometer as well as computers for data analysis (e.g. ROOT), theoretical calculations (e.g. TALYS and EMPIRE) and Monte Carlo simulations (e.g. MCNP, GEANT4 and FLUKA). A close collaboration has been established with the Tandem 5.5 MV HV TN-11 Accelerator Laboratory at NCSR "Demokritos" and CERN in the framework of the n_TOF collaboration.

No third parties involved.

21. PSI

PSI is a multi-disciplinary research centre for natural sciences and technology. In national and international collaborations with universities, other research institutes and industry, we are active in solid state physics, materials sciences, elementary particle physics, life sciences, nuclear and non-nuclear energy research, and energy-related ecology.
Being a world-leading scientific institute, PSI is well-equipped with all nuclear physics and chemistry related instrumentations. As the most essential point, PSI operates the most powerful proton accelerator in Europe and, in addition the spallation neutron source SINQ, a facility, which is unique world-wide. From several material research programs performed with this facility, PSI owns now a repository of activated samples, which can serve as benchmarks for nuclear data on the one side, and might be used as a source for the preparation of exotic radioactive targets on the other side. Two Laboratories, both located in the department of Nuclear Energy and Safety (NES), are involved in the project.

Within the NES department, the Laboratory for Reactor Physics and Thermal-Hydraulics (LRT) is the principal research unit and national center of excellence in Switzerland in the domain of simulations of System behaviour of Nuclear Power Plants. Nuclear data are a key element of such simulations and the LRT is investing substantial efforts in the measurements, calculations, evaluations and use of nuclear data. The combination of theoretical approaches for cross section calculations with the applied aspect linked to the simulations of real Power Plants is making the LRT a unique place with a broad overview from fundamental physics to applied simulations. With the production of the TENDL library and the important support to the JEFF community, the LRT is an important and unique partner for nuclear data development and validation.

The working group Isotope and Target Chemistry under the leadership of Dr. Dorothea Schumann (f), Laboratory of Radiochemistry (LRC), is experienced in the radiochemical separation and determination of radionuclides in accelerator waste as well as the manufacturing of radioactive targets. The group contributed to the HINDAS project (High and Intermediate energy Nuclear Data for Accelerator driven Systems) with several determinations of excitation functions of long-lived radio nuclides produced by proton irradiation of natural lead, to ANDES with the determination of the radionuclide inventory of the MEGAPIE target and was/is involved in other international EC-funded projects (EURISOL, EUROTRANS, GETMAT, SEARCH). In the frame of CHANDA, the group was essentially contributing to the establishment of a network for target maker activities.

Dr. Dorothea Schuman is a researcher with a large expertise in the fields of radioanalytical studies of accelerator waste (beam dumps, concrete samples etc.) for licensing of nuclear waste disposal, nuclear data for transmutation of nuclear waste and the development of target preparation techniques.

Dr. Dimitri Rochman is a researcher with a large expertise in the fields of nuclear data evaluation for nuclear technologies, nuclear data uncertainty analysis and propagation, development of theoretical nuclear reaction codes (TALYS) and creator of various of the TENDL releases.

Publications

- How inelastic scattering stimulates nonlinear reactor core parameter behaviour, D. Rochman, A. Vasiliev, H. Ferroukhi, A. Dokhane and A. Koning, Annals of Nuclear Energy 112 (2018) 236.
- Correlation nu-sigma-chi in the fast neutron range via integral information, D. Rochman, E. Bauge, A. Vasiliev and H. Ferroukhi, Eur. Jour. of Physics N 3 (2017) 14.
- Nuclear Data Uncertainties for Typical LWR Fuel Assemblies and a Simple Reactor Core, D. Rochman et al. Nucl. Data Sheets 139 (2017) 1.
- A Bayesian Monte Carlo method for fission yield covariance information, D. Rochman, O. Leray, A. Vasiliev, H. Ferroukhi, A.J. Koning, M. Fleming and J.C. Sublet, Annals of Nuclear Energy 95 (2016) 125.
- Re-evaluation of the thermal neutron capture cross sections of 147Nd, D. Rochman, O. Leray, G. Perret, A. Vasiliev, H. Ferroukhi and A.J. Koning, Annals of nucl. Ene. 94 (2016) 612.

The Laboratory for Reactor Physics and Thermal-Hydraulics (LRT) is the principal research unit and national centre of excellence in Switzerland in the domain of simulations of System behaviour of Nuclear Power Plants. Nuclear data are a key element of such simulations and the LRT is investing substantial efforts in the measurements, calculations, evaluations and use of nuclear data. The combination of theoretical approaches for cross section calculations with the applied aspect linked to the simulations of real Power Plants is making the LRT a unique place with a broad overview from fundamental physics to applied simulations. With the production of the TENDL library and the important support to the JEFF community, the LRT is an important and unique partner for nuclear data development and validation. The colleague in charge, Dr. Dimitri Rochman (m) has a long-lasting expertise in the development of the TENDL library and related issues and was already involved in other related projects: CHANDA, JEFF, TENDL, CIELO and EUROfusion.

Subcontracting

PSI will subcontract some activities related to the design of the isotope separator. Some research groups had been tentatively contacted as candidate for that subcontracting because of their scientific and engineering experience in this type of systems.

No third parties involved.

22. PTB

The Physikalisch-Technische Bundesanstalt (PTB) is the German national institute for science and technology and the highest technical authority for metrology and certain sectors of safety engineering. It operates under the auspices of the Federal Minister of Economics and has 2000 employees.
Within division 6 'Ionizing Radiation', the department 6.4 'Neutron Radiation' operates two particle accelerators for producing charged particle, neutron and high-energy photon fields. One of the main tasks is the production of neutron reference fields (ISO) for the characterization and calibration of radiation detectors. Measurements of cross sections for neutron-induced reaction are carried out at the PTB accelerator facility and at external facilities.

Ralf Nolte is head of the working group 6.42 'Neutron Metrology' within department 6.4 'Neutron Radiation'. He holds a PhD degree in physics and more 25 years of experience in neutron metrology and nuclear data measurements. His scientific expertise is documented in about 100 publications in peer-reviewed journals. He was a member of the n_TOF collaboration at CERN until 2018.

Elisa Pirovano is staff member in working group 6.42. She has holds a PhD degree in physics and has four years of professional experience in nuclear data measurements. Her scientific expertise is documented in about seven publications in peer-reviewed journals. She is a member of the n_TOF collaboration at CERN.

Publications

- D. Schmidt, 'Determination of neutron scattering cross sections with high accuracy at PTB in the energy region 8 to 14 MeV', Nucl. Sci Eng. 160 (2008) 349 - 362
- W. Mannhart, D. Schmidt: Measurement of neutron activation cross sections in the energy range from 8 MeV to 15 MeV', PTB-Bericht PTB-N-53, Physikalisch-Technische Bundesanstalt Braunschweig January 2007, ISSN 0936-0492
- R. Nolte, M.S. Allie, F.D. Brooks, A. Buffler, V. Dangendorf, J.P. Meulders, H. Schuhmacher, F.D. Smit, M. Weierganz, Cross Sections for Neutron induced fission of 235U, 238U, 209Bi and natPb in the energy range from 33 MeV to 200 MeV measured relative to n p scattering, Nucl. Sci. Eng. 156 (2007) 197 210
- E. Pirovano, R. Beyer, A.R. Junghans, N. Nankov, R. Nolte, M. Nyman, and A.J.M. Plompen, 'Backward-forward reaction asymmetry of neutron elastic scattering on deuterium', Phys. Rev. C 95 (2017), 024601
- E. Pirovano, R. Beyer, M. Dietz, A.R. Junghans, S.E. Müller, R. S.E. Müller, R. Nolte, M. Nyman, A.J.M. Plompen, M. Röder, T. Szücs, and M.P. Takacs, Cross section and neutron angular distribution measurements of neutron scattering on natural iron, submitted for publication in Phys. Rev. C.

Previous projects or activities

The PTB has offered transnational access (TA) to PIAF in the EU-funded EFNUDAT, ERINDA and CHANDA projects and contributed to the joint research actions (JRA) of EFNUDAT. On the national level, PTB participated in the TRAKULA project supported by the Federal Ministry for Education and Research (BMBF).

Significant infrastructures

The PTB ion accelerator facility (PIAF) consists of two low-energy ion accelerators and ancillary equipment. The TCC CV-28 variable-energy isochronous cyclotron provides beams of protons ($E < 19$ MeV, $I < 80$ μA), deuterons ($E < 13.5$ MeV, $I < 80$ μA) and alpha particles ($E < 28$ MeV, $I < 20$ μA). Complementary, the same ion beams are available with energies up to 4 MeV (protons, deuterons) or 6 MeV (alpha particles) in the low energy region and with similar currents from a HVEE Tandetron accelerator. Experiments with almost mono-energetic neutrons in the energy range from 20 keV to 20 MeV are performed in the center of a very large experimental hall in open geometry. All ion beams are available in DC or ns-pulsed mode experiments with adjustable repetition rate for time-of-flight (TOF). A multi-detector TOF spectrometer is connected to the main beam line of the cyclotron. This instrument offers unique opportunities for the measurement of angular differential elastic and inelastic neutron scattering cross sections as well as neutron emission cross sections by detection of the scattered neutrons.

No third parties involved.

23. SCK-CEN

The Belgian Nuclear Research Centre, SCK-CEN, is a foundation of public utility. With laboratories in Mol and a registered office in Brussels, it is one of the largest research centres in Belgium. About 700 people work on the development of peaceful applications of ionising radiation. Our statutory mission prioritizes important societal issues: the safety of nuclear installations, solutions for radioactive waste disposal, radiation protection, sustainable development and education. In order to perform its research programme, to provide services to industry, the medical sector, government and third parties, and for training purposes, SCK•CEN operates several nuclear facilities.

Dr. Alexey Stankovskiy, male: Obtained his PhD. in nuclear physics in 1998 working at the Obninsk Institute of Nuclear Power Engineering, Russia. In 2002, he obtained a Doctoral degree in Nuclear Engineering at Tokyo Institute of Technology, Japan. From 2008, he became a member of SCK-CEN as a research scientist. His research is focused on the neutronics design of MYRRHA, including management and support of nuclear data, and the development of the ALEPH2 burn-up code.

Prof. Dr. Ir. Gert Van den Eynde, male: Head of the Expert Group Reactor Nuclear System Physics. He holds a Master degree in Engineering in Computer Science, a Master degree in Nuclear Engineering and a PhD. in Nuclear Engineering. He is involved in the MYRRHA project since 1999 and was task leader in the FP6 IP-EUROTRANS for the XT-ADS core design. His main fields of research are computational methods for neutron transport and reactor core modelling and analysis.

Publications

- Stankovskiy, H. Iwamoto, Y. Çelik and G. Van den Eynde, High-energy nuclear data uncertainties propagated to MYRRHA safety parameters, Annals of Nuclear Energy 120 (2018) 207-218
- H. Iwamoto, A.Stankovskiy, L.Fiorito and G. Van den Eynde, Monte Carlo uncertainty quantification of the effective delayed neutron fraction, Journal of Nuclear Science and Technology, Vol. 55 (5) (2018) 539 – 547
- M. Griseri, L. Fiorito, A. Stankovskiy, G. Van den Eynde, Nuclear data uncertainty propagation on a sodium fast reactor, Nuclear Engineering and Design 324 (2017) 122-130
- L.Fiorito, G. Žerovnik, A.Stankovskiy, G. Van den Eynde, P.-E. Labeau, Nuclear data uncertainty propagation to integral responses using SANDY, Annals of Nuclear Energy 101 (2017) 359-366
- Y. Çelik, A.Stankovskiy, J. Engelen, G. Van den Eynde, B. Şarer, S. Şahin, Radiation source terms of MYRRHA reactor components and equipment, International Journal of Hydrogen Energy, Vol. 41, Issue 17, 11 May 2016, pages 7213-7220

Previous projects or activities

Since 1998 SCK-CEN is collaborating with European laboratories and research centres in the development of MYRRHA. MYRRHA is a heavy liquid metal cooled nuclear system designed to operate as Accelerator Driven sub-critical System (ADS) or as a critical fast reactor. It consists of a proton accelerator proton coupled to a liquid Pb-Bi spallation target in a Pb-Bi cooled and sub-critical fast core. MYRRHA is a basis for the European experimental ADS. It will provide protons and neutrons for many R&D applications, including transmutation studies.

No third parties involved.

24. SOFIA

University of Sofia "St. Kl. Ohridski" is the oldest university in Bulgaria. It was founded in 1888 and ever since it has been the leading university in the country. The University is heading consistently the Bulgarian Universities Ranking in most of the fields taught here, including Physics. Undergraduate and Graduate Physics courses are thought at the Faculty of Physics which is a separate division since 1963, succeeding the Faculty of Physics and Mathematics which was established earlier in 1902. The Faculty consists of 12 Departments, one research centre, and a number of teaching and research laboratories. The Faculty's library is subscribed for the major Nuclear Physics journals, needed for the work to be carried out within the present project.

The Department of Nuclear Engineering, where the activities related to the present project will be performed, is responsible for training and education of students for the needs of the Bulgarian nuclear industry. Since 2017, the Department became a member of the Nuclear Structure and Decay Data (NSDD) network, coordinated and managed by the IAEA's Nuclear Data section and the Brookhaven National Laboratory's National Nuclear Data Centre. As part of NSDD network, our main responsibility is to collect and asses experimental nuclear data, and to compile the best values for inclusion in the Evaluated Nuclear Structure Data File (ENSDF).

Dr. Stefan Lalkovski will be the primary responsible for the ENSDF Nuclear Data evaluation activities that will be carried out at the University of Sofia within WP4 of the present project. He is an expert in nuclear physics, nuclear structure and nuclear data evaluation.

Publications

- Lalkovski, S., D., Stefanova, E.A., Kisyov, S., Korichi, A., Bazzacco, D., Bergström, M., Görgen, A., Herskind, B., Hübel, H., Jansen, A., Khoo, T.L., Kutsarova, T., Lopez-Martens, A., minkova, A., Podolyák, Z., Schönwasser, G., Yordanov, O., Structure of the neutron mid-shell nuclei ^{111,113}Ag, (2017) Physical Review C - Nuclear Physics, 96 (6), art. no. 044328
- Lalkovski, S., Ivanova, D., Stefanova, E.A., Korichi, A., Petkov, P., Kownacki, J., Kutsarova, T., Minkova, A., Bazzacco, D., Bergström, M., Görgen, A., Herskind, B., Hübel, H., Jansen, A., Kisyov, S., Khoo, T.L., Kondev, F.G., Lopez-Martens, A., Podolyák, Z., Schönwasser, G., Yordanov, O. Coexisting structures in 105Ru (2014) Physical Review C - Nuclear Physics, 89 (6), art. no. 064312
- Lalkovski, S., Bruce, A.M., Denis Bacelar, A.M., Górska, M., Pietri, S., Podolyák, Z., Bednarczyk, P., Caceres, L., Casarejos, E., Cullen, I.J., Doornenbal, P., Farrelly, G.F., Garnsworthy, A.B., Geissel, H., Gelletly, W., Gerl, J., Grębosz, J., Hinke, C., Ilie, G., Ivanova, D., Jaworski, G., Kisyov, S., Kojouharov, I., Kurz, N., Minkov, N., Myalski, S., Palacz, M., Petkov, P., Prokopowicz, W., Regan, P.H., Schaffner, H., Steer, S., Tashenov, S., Walker, P.M., Wollersheim, H.J. Sub-microsecond isomer in $_{45}^{117}Rh_{72}$ and the role of triaxiality in its electromagnetic decay rate (2013) Physical Review C - Nuclear Physics, 88 (2), art. no. 024302, .
- Lalkovski, S., Bruce, A.M., Jungclaus, A., Górska, M., Pfützner, M., Cáceres, L., Naqvi, F., Pietri, S., Podolyák, Zs., Simpson, G.S., Andgren, K., Bednarczyk, P., Beck, T., Benlliure, J., Benzoni, G., Casarejos, E., Cederwall, B., Crespi, F.C.L., Cuenca-García, J.J., Cullen, I.J., Denis Bacelar, A.M., Detistov, P., Doornenbal, P., Farrelly, G.F., Garnsworthy, A.B., Geissel, H., Gelletly, W., Gerl, J., Grebosz, J., Hadinia, B., Hellström, M., Hinke, C., Hoischen, R., Ilie, G., Jaworski, G., Jolie, J., Khaplanov, A., Kisyov, S., Kmiecik, M., Kojouharov, I., Kumar, R., Kurz, N., Maj, A., Mandal, S., Modamio, V., Montes, F., Myalski, S., Palacz, M., Prokopowicz, W., Reiter, P., Regan, P.H., Rudolph, D., Schaffner, H., Sohler, D., Steer, S.J., Tashenov, S., Walker, J., Walker, P.M., Weick, H., Werner-Malento, E., Wieland, O., Wollersheim, H.J., Zhekova, M.
- Core-coupled states and split proton-neutron quasiparticle multiplets in $^{122\text{-}126}$Ag, (2013) Physical Review C - Nuclear Physics, 87 (3), art. no. 034308.
- Lalkovski, S., Isacker, P.V. IBM-1 calculations towards the neutron-rich nucleus ^{106}Zr, (2009) Physical Review C - Nuclear Physics, 79 (4), art. no. 044307.

<u>The SOFIA institution has participated in the previous related activities</u>:

- Lalkovski, S., Kondev, F.G., Nuclear Data Sheets for A=112 (2015) Nuclear Data Sheets, 124, pp. 157-412.
- Kondev, F.G., Lalkovski, S. Nuclear Data Sheets for A = 207 (2011) Nuclear Data Sheets, 112 (3), pp. 707-853.
- Kondev, F.G., Lalkovski, S. Nuclear Data Sheets for A = 200 (2007) Nuclear Data Sheets, 108 (7), pp. 1471-1582.

The work will be carried out in office 220, situated on the second floor of, building A of the Faculty of Physics at the University of Sofia "St. Kl. Ohridski", blvd "James Bourchier" 5. The working place is equipped with contemporary office equipment, including computers and printers. As staff at the University, SL has access to the Faculty and University libraries. The University is subscribed for the main nuclear physics journals, which is the main resource needed for the data evaluations to be carried out in the present project. Last, but not least, University of Sofia has a status of Nuclear Data Center and SL is member of the Nuclear Structure Decay Data network.

No third parties involved.

25. TUW

The TU Wien is the largest university in Austria for engineering sciences. It is a public university with about 28.000 students, funded by the Austrian Federal Government. It is organized in 8 faculties: Architecture, Civil Engineering, Technical Chemistry, Electrical Engineering and Information Technologies, Informatics, Mechanical Engineering, Mathematics, Physics. The TU Wien is involved in many international and national research projects focussed on different topics related to the expertise of each faculty. The TU Wien has experience in co-ordinating EC-projects.
The Atominstitut (Institute of Atomic and Subatomic Physics) is part of the Faculty of Physics of the TU Wien. Currently 25 university positions for scientific personnel, 29 for non-scientific personnel and about 50 doctoral and diploma students are working at the Atominstitut. The research and training possibilities are grouped around a 250 kW TRIGA research reactor and include x-ray and accelerator installations, quantum optic equipment and highly specialised chemistry and physics laboratories. The institute is participating in a doctorial college programme and has a permanently occupied foreign post at the Institute Laue-Langevin (ILL) in Grenoble. The broad spectrum of research fields represented at the Atominstitut provides a fertile environment for productive scientific collaboration. A strong 'bottom-up' structure has guaranteed a development towards innovative areas of research. In particular there is internationally recognised expertise in the field of Nuclear Physics both in theory and experiment. The research groups at the Atominstitut are well integrated in the international research. Especially, they have successfully participated in several EC and EURATOM contracts, in some of them serving as coordinator. Apart from participation in European and national projects members of the Atominstitut are actively involved in various activities of international organisations, e.g. in the International Nuclear Data Centres (NEA/OECD and IAEA).

Univ. Prof. Dr. Helmut Leeb (1952), Dean of Academic Affairs of the Faculty of Physics of the TU Wien and member of the Atominstitut (Institute of Atomic and Subatomic Physics), TU Wien; specialised in Theoretical Nuclear Physics. The scientific activities are focussed on scattering and reaction theory and its application to nuclear and neutron physics; more than 200 scientific articles on nuclear and neutron physics in international journals. More than 250 talks at universities, research institutes and conferences. Austrian delegate in the Nuclear Science Committee and the MBDAV of NEA/OECD. Leader of several research projects supported by Austrian funding agencies and participant in several EC-projects, in particular coordinator of the Network PANSI3 within EURONS, participant in 3 EFDA projects, 2 F4E grants, 2 EUROfusion grants and the EURATOM projects CHANDA, ANDES, IP_EUROTRANS and NTOF-ND-ADS. Based on his expertise in the development of uncertainty determinations in nuclear data, the role in the SANDA project will be in WP4.

Publications

- A modified general least square method for large scale nuclear data evaluation. G. Schnabel, H. Leeb, Nucl. Instr. Meth. A 841, 87 (2017).
- Differential Cross Sections and the Impact of Model Defects in Nuclear Data Evaluation. G. Schnabel, H. Leeb in Proc. of the 4th Int. Workshop on Nuclear Data Evaluation for Reactor Applications (WONDER 2015), EPJ Web of Conferences 111, 09001 (2016).
- Bayesian evaluation including covariance matrices of neutron-induced reaction cross sections of ^{181}Ta. H. Leeb, G. Schnabel, Th. Srdinko, V. Wildpaner, Nucl. Data Sheets 123, 153 (2015)
- Adequate treatment of correlated experimental data in nuclear data evaluations avoiding Peelle's pertinent puzzle. D. Neudecker, R. Frühwirth, T. Kawano, H. Leeb, Nucl. Data Sheets 118, 364 (2014).
- Impact of model defect and experimental uncertainties on evaluated output. D. Neudecker, R. Capote Noy, H. Leeb, Nucl. Inst. Meth. A 723, 163 (2013).

No third parties involved.

26. UB

The University of Bucharest (UB) is one of the leading institutions of higher education in Romania, and enjoys a considerable national and international prestige. Its various schools are well known for their activities in all important scientific and academic domains. There are over 50 institutes, departments and research centres functioning within UB, most of which work in collaboration with similar centres in other countries. The Faculty of Physics was founded in 1967 as an independent branch of the Faculty of Mathematics and Physics of the University of Bucharest, one century and a half old center of traditions in basic and technical science, teaching and research. The Department of Atomic and Nuclear Physics gives Master and PhD degree in: atomic and molecular interactions, astrophysics, nuclear interactions, elementary particles, and applied nuclear physics. The teaching staff is recognised internationally for their research activities, and collaborations with prestigious institutions in the field (NEA DB Paris, IAEA Vienna, JRC-Geel, PTB Braunschweig, LNHB Saclay, BNL, CERN, GSI, etc.). Within SANDA project, UB will provide theoretical support for obtaining accurate data relevant for the reactor safety.

Mihaela Sin is associate professor at the Department of Atomic and Nuclear Physics, Faculty of Physics since 1989, specialized in nuclear models and data evaluation. Along the years she gave courses and seminars on Nuclear Physics, Nuclear Reaction Models and Fission, Nuclear Data Evaluation, Applications of Nuclear Technologies for undergraduate and master students, being involved also in post-graduate programs of training in Nuclear Radiation and Isotope Applications. Together with her students and co-workers she was involved in several national research contracts, but most of her research activities in the nuclear data field have been carried on in collaboration with the Nuclear Data Section of IAEA and the National Nuclear Data Center, Brookhaven National Laboratory (USA). In the last years she has been participating directly or through support activities in five IAEA Coordinated Research Projects. As member of the developers" team of the nuclear reaction code EMPIRE is co-author of evaluations adopted by ENDF/B-VII, RIPL-3 and other specialized nuclear data libraries. Presently she is also involved in the FP7 project Accurate Nuclear Data for Nuclear Energy Sustainability contributing to new and accurate evaluations of neutron reaction data for U-238 and Am-241.

No third parties involved.

27. ULODZ

The University of Lodz (ULODZ) was established in 1945 and has long been one of the biggest and most popular universities in Poland. The 12 faculties, and a branch unit of the University provide programmes in 90 fields of study and 160 specializations. In addition, the University offers several doctoral programmes, more than 50 postgraduate study programmes (including an MBA programme), as well as studies in English and French. More than 32 000 students attend the University of Lodz.

The ULODZ nuclear physics group is member of n_TOF Collaboration, CERN from 2003 and has a huge expertise in the measurement of (n,f) and (n,chp) cross sections. The ULODZ has also a long standing expertise in the development of charged particle detectors and will develop a new ionisation chamber for fission measurements for the measurement of (n,g) cross sections of fissile isotopes.

Prof Hab Dr Jozef Andrzejewski is head of the Nuclear Physics and Radiological Protection Department of the University of Lodz. He is an active member of the n_TOF collaboration and has a large experience in experimental nuclear physics. He has participated in a large variety of experiments in Russia, Finland, German, Poland and at CERN and is an expert in neutron cross section measurements and ionisation chambers.

Publications

- P. Žugec,J. Andrzejewski, J. Perkowski:Measurement of the 12C(n, p)12B cross section at n_TOF at CERN by in-beam activation analysis, Physical Review C 90, 021601(R) (2014)
- C. Lederer, J. Andrzejewski, J. Perkowski,:Neutron capture reactions on Fe and Ni isotopes for the astrophysical s-process, Nuclear Data Sheets 120 (2014) 201-204
- C. Weiss, J.Andrzejewski, J. Perkowski: A new CVD diamond mosaic-detector for (n, α) cross-section measurements at the n_TOF experiment at CERN, Nucl. Instr. Meth. Phys. Research A 732 (2013) 190–194
- F. Gunsing, J. Andrzejewski,: Measurement of resolved resonances of ^{232}Th(n,gamma) at the n_TOF facility at CERN, Phys. Rev. C85 (2012) 064601
- L. Damone , J. Andrzejewski, J. Perkowski: 7Be(n;p)7Li Reaction and the Cosmological Lithium Problem:Measurement of the Cross Section in a Wide Energy Range at n_TOF at CERN, Physical Review Letters 121, 042701 (2018)

ULODZ has participated in the following related projects:

- Polish Ministry of Science and Higher Education under grant 295/N-CERN/2008/0,
- Narodowe Centrum Nauki (NCN) - Poland, under two the grants: Precise measurements of neutron cross-sections at n_TOF facility, CERN, UMO-2012/04/M/ST2/00700 and UMO-2016/22/M/ST2/00183.

No third parties involved.

28. UMAINZ

JGU is one of the leading research universities in Germany. With more than 150 institutes and clinics, a School of Music and an Academy of Arts, it represents the academic hub of Rhineland-Palatinate. Its main core research areas are particle and hadron physics, the materials sciences and translational medicine. In the natural sciences, JGU is at the top of the ranks in Germany for acquired third-party funding per professor (DFG Förderranking). In Physics, JGU regularly achieves outstanding positions in international research rankings, and the research network "Precision Physics, Fundamental Interactions and Structure of Matter (PRISMA)" was recognized as a national Cluster of Excellence in 2012 which is in the process of renewal for the next 4 years.
The LARISSA research group under the leadership of Prof. Klaus Wendt is well recognized for a variety of relevant contributions in quantum optics, laser physics and laser based studies on exotic nuclei. These concern on-line applications at ISOLDE/CERN and other major research facilities worldwide, radioisotope separation and enrichment for fundamental investigations, e.g. on the neutrino mass, and finally atomic physics studies and ultra-trace analysis on actinides and other radiotoxic nuclides. Research at LARISSA is supported by several externally funded projects, including national funds from the DPG, BMBF and the EC-funded projects ENSAR and MEDICIS-PROMED. Klaus Wendt is also a PI in the German Cluster of Excellence PRISMA.

Prof. Klaus Wendt is a world recognised expert in laser spectroscopy and mass spectrometry. He is Group leader of the Working Group LARISSA – LAser Resonance Ionization for Spectroscopy and Selective Applications and in 2007 has been appointment extraordinary professor (permanent) at JGU Mainz, institute for Physics.

Publications

- On the Hyperfine Structure and Isotope Shift of Radium, K. Wendt, S.A. Ahmad, W. Klempt, R. Neugart, E.W. Otten, H.H. Stroke, Z. Phys. D 4, 227-241 (1987)
- Rapid Trace Analysis of ^{89,90}Sr in Environmental Samples by Collinear Laser Resonance Ionization Mass Spectrometry, K. Wendt, G. K. Bhowmick, G. Herrmann, J. V. Kratz, J. Lantzsch, P. Müller, W. Nörtershäuser, E.-W. Otten, R. Schwalbach, U.-A. Seibert, N. Trautmann, and A. Waldek, Radiochim. Acta 79, 183-190 (1997)
- Resonance ionization spectroscopy of thorium isotopes - towards a laser spectroscopic identification of the low-lying 7.6 eV isomer of ^{229}Th,S. Raeder, V. Sonnenschein, T. Gottwald, I.D. Moore, M. Reponen, S. Rothe, N. Trautmann, K. Wendt, J. Phys. B 44, 16, 165005 (2011)
- Measurement of the first ionization potential of astatine by laser ionization spectroscopy, S. Rothe, A. N. Andreyev, S. Antalic, A. E. Barzakh, A. Borschevsky, L. Capponi, T. E. Cocolios, H. De Witte, J. Elseviers, D. V. Fedorov, V. N. Fedosseev, D. Fink, L. Ghys, M. Huyse, Yu. Kudryavtsev, D. Radulov, M. M. Rajabali, E. Rapisarda, P. Van den Bergh, P. Van Duppen, E. Eliav, S. Fritzsche, N. Imai, U. Kaldor, U. Köster, J. Lane, J. Lassen, V. Liberati, K. M. Lynch, B. A. Marsh, K. Nishio, Y. Wakabayashi, D. Pauwels, V. Pershina, L. Popescu, T. J. Procter, S. Raeder, R. E. Rossel, K. Sandhu, M. D. Seliverstov, A. M. Sjödin, M. Venhart, K. D. A. Wendt, Nature Communication 4, 1835- (2013)
- The electron capture in ^{163}Ho experiment – ECHo, L. Gastaldo, K. Blaum, K. Chrysalidis, T. Day Goodacre, A. Domula, M. Door, H. Dorrer, Ch.E. Düllmann, K. Eberhardt, S. Eliseev, C. Enss, A. Faessler, P. Filianin, A. Fleischmann, D. Fonnesu, L. Gamer , R. Haas, C. Hassel, D. Hengstler, J. Jochum, K. Johnston, U. Kebschull, S. Kempf, T. Kieck, U. Köster, S. Lahiri, M. Maiti, F. Mantegazzini, B. Marsh, P. Neroutsos, Yu.N. Novikov, P.C.O. Ranitzsch, S. Rothe, A. Rischka , A. Saenz, O. Sander, F. Schneider, S. Scholl, R.X. Schüssler, Ch. Schweiger, F. Simkovic, T. Stora , Z. Szücs, A. Türler, M. Veinhard, M. Weber, M. Wegner, K. Wendt, and K. Zuber, Eur. Phys. J. Special Topics 226, 1623–1694 (2017)

No third parties involved.

29. UMANCH

Nuclear physics at the University of Manchester (UMANCH) covers experiment and theory, with 9 academics (4 Prof, 2 Reader, 2 Senior Lecturer, 1 Lecturer), 1 EPSRC Energy Fellow, 5 PDRAs and at present 17 PhD students. We also host a Nuclear Fellow, who works on industrial liaison and outreach. Our current core support includes a technician who runs a large research laboratory and a mechanical workshop technician. We also host a cross-community design engineer. Our research interests are focused on fundamental aspects of nuclear physics ranging from hadrons to exotic nuclear systems. Part of our strategy is to harness this fundamental core capability to also address applied nuclear physics and nuclear skills training, working with the UoM Dalton Nuclear Institute. Nuclear physics at UoM is part of a rich research portfolio in one of the largest UK physics departments. We have strong links to UoM multi-disciplinary institutes (Dalton Nuclear Institute, Photon Science Institute, Wolfson Molecular Imaging Centre) and to the Cockcroft Institute for Accelerator Science and the Christie National Health Service Foundation Trust. UoM is one of seven educational organisations in the UK that work together as the Nuclear Technology Education Consortium (NTEC), to support the UK nuclear energy programme. NTEC provides Master's level courses for young professionals with relevant work experience and students with a science or engineering background, who are aiming to enter the nuclear industry. As well as the MSc option, industry participants can also take individual courses for continuing professional development, which gives UoM a strong connection with many industrial partners.

The measurements as envisaged in the previous EU grant (CHANDA) request for fission dynamics and nuclear data measurements at n_TOF have been performed. Specifically, during the period of the grant STEFF has been relocated from the research reactor at ILL to n_TOF as supported by CHANDA and two ^{235}U(n,f) measurements were performed. Recently, approval has been given by the INTC to run a ^{239}Pu(n,f) experiment late in 2018. Two PhD students will have attachments to n_TOF during this period. This grant will be used to support analysis of the gamma-yield from ^{239}Pu(n,f) data and future measurements with STEFF. These future experiments would involve measurements of fission yields for Pu and Cm isotopes at EAR2 at n_TOF as part of the long-term plan. Manchester will continue to develop a novel high-solid-angle double-gridded Bragg detector (DGBD) for use at n_TOF with a view of performing yield measurements at EAR2 with small samples.

Dr. Gavin Smith (M) is a researcher and expert in Pure and applied Nuclear Physics specializing in the gamma-ray spectroscopy of fission fragments and the development of detection systems for nuclear measurements. This includes the development of techniques and apparatus for g-factor and lifetime measurements in fission fragments. PI for the development of the STEFF spectrometer which has been used at the ILL and n_TOF, CERN for the measurement of fission-fragment distributions. He is also expert in the generation of spin of fission fragments. PI for the UK Nuclear Data Network (from April 2016), which brings together industrial and academic parties with an interest in nuclear data measurements. Co-I on Nuclear Physics consolidated grant. He is author or co-author of 120 publications in referred Nuclear Physics journals (see publication list). Proven track record of PhD supervision. Experience in numerical methods for digital pulse processing. Experienced programmer in C/C++. External examiner for PhD students from universities of Surrey, York, Paisley and Liverpool.

Dr. Tobias Wright (M) is an EPSRC post-doctoral research fellow in the applied nuclear physics group at the University of Manchester. His is an expert in nuclear data measurements, specifically towards UK requirements and has led proposals which have been awarded beam time at n_TOF, CERN and ILL, Grenoble. He has co-supervised one PhD student to completion and am currently co-supervising three further PhD students and is author or co-author of 47 refereed publications.

<u>Publications</u>

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<u>The UMANCH has participated in the previous related activities</u>:

- Development of new apparatus and techniques for use in nuclear fission experiments. Design, building and commissioning of the binary SpecTrometer for study of Exotic Fission Fragments (STEFF) (CHANDA WP-8).
- STEFF experimental programs at ILL and the CERN n_TOF facility.
- Lead institution in STFC Grand Challenge Nuclear Data Network UKNDN.
- Member of the UK Nuclear Science Forum (UKNSF): participants from research institutes and industry with common interests in UK nuclear data needs and UKNDN funds the chairperson's expenses allowing the UKNSF to continue.
- Delivery of training programs in nuclear applications: Neutron Resonance Analysis schools (2014 and 2017) in collaboration with JRC-Geel (CHANDA WP-13), training for MEDICIS fellows (Marie Curie network on radioisotope beams for medicine). NTEC module in Radiation and Radiological Protection for industry. GEANT4 training for research and industry.
- Neutron reaction cross section measurements: ^{238}U(n, gamma) at n_TOF, ^{13}C(n, gamma) at ILL/AMS analysis at VIENNA (UK specific waste application), ^{235}U(n,f) measurements with STEFF at n_TOF and ILL.
- Strong involvement at ISOLDE, CERN on the production of isotopically pure radioactive beams using laser resonance ionization.

No third parties involved.

30. UOI

The University of Ioannina (UoI) consists of 15 departments belonging in seven schools of different scientific disciplines. It is one of the largest Universities of Greece where more than 25 thousand students are enrolled in different levels of studies. The academic staff of UoI consists of about 500 Professors who are in charge of conducting high-level research along with their teaching duties. In the proposed research project the Nuclear Physics Laboratory is involved. The Nuclear Physics Laboratory (NPLAB) of the Department of Physics consists of three Professors (N. Patronis, X. Aslanoglou and N.G. Nicolis), two senior researchers (C. Papachristodoulou& K. Stamoulis) and two PhD students (supervisor N. Patronis). The research activity of Assist. Prof. N. Patronis group is focused on the experimental study of nuclear reactions with emphasis to the neutron induced reactions. In this respect there is experience on data analysis techniques as well as on theoretical modeling of nuclear reactions. Additionally, there is experience on the development of experimental setups, on neutron beam characterization studies, as well as on radiation transportation codes and Monte-Carlo simulation techniques.

Dr. N. Patronis (M). Since 2009, Assistant Professor N. Patronis is one of the faculty members of the NPL of the Physics Department of the University of Ioannina. Within this period, he taught more than eight undergraduate and postgraduate courses. At the moment he is the advisor of two PhD students and has supervised more than 15 bachelor thesis projects, as well as three MSs students. The research activity of N. Patronis is focused on nuclear reaction studies with neutron beams, radioactive ion beams, as well as studies of special interest for nuclear physics applications. The outcome of this research activity resulted in more than 115 publications in peer reviewed journals and more than 2000 citations (h-factor=26).

Publications

- N. Patronis, P.A. Assimakopoulos, D. Karamanis, S. Dababneh, M. Heil, F. Käppeler, R. Plag, P. E. Koehler, A. Mengoni and R. Gallino: Neutron capture studies on unstable 135Cs for nucleosynthesis and transmutation, Physical Review C 69 (2004) 025803.
- N. Patronis, C.T. Papadopoulos, S. Galanopoulos, M. Kokkoris, G. Perdikakis, R. Vlastou, A. Lagoyannis and S. Harissopoulos: Activation cross section and isomeric cross section ratio for the (n,2n) reaction on 191Ir, Physical Review C 75 (2007) 034607.
- N. Andreyev, J. Elseviers, M. Huyse, P. Van Duppen, S. Antalic, A. Barzakh, N. Bree, T. E. Cocolios, V. F. Comas, J. Diriken, D. Fedorov, V. Fedosseev, S. Franchoo, J. A. Heredia, O. Ivanov, U. Koster, B. A. Marsh, K. Nishio, R. D. Page, N. Patronis, M. Seliverstov, I. Tsekhanovich, P. Van den Bergh, J. Van De Walle, M. Venhart, S. Vermote, M. Veselsky, C. Wagemans, T. Ichikawa, A. Iwamoto, P. Moller, and A. J. Sierk: New Type of Asymmetric Fission in Proton-Rich Nuclei, Physical Review Letters 105 (2010) 252502.
- The n_TOF collaboration: Nuclear data activities at the n TOF facility at CERN, Eur. Phys. J. Plus, 131, 371 (2016)
- E. Georgali, Z. Eleme, N. Patronis, X. Aslanoglou, M. Axiotis, M. Diakaki, V. Foteinou, S. Harissopulos, A. Kalamara, M. Kokkoris, A. Lagoyannis, N. Nicolis, G. Provatas, A. Stamatopoulos, S. Stoulos, A. Tsinganis, E. Vagena, R. Vlastou, and S. M. Vogiatzi: 162Er(n,2n)161Er from reaction threshold up to 19 MeV, Phys. Rev. C 98, 14622, (2018)

The infrastructure available at NPLAB are:

- Specialized software installed in Linux machines for data analysis purposes (e.g. ROOT)
- Computer codes for nuclear reaction modeling (TALYS, ECIS, FRESCO, etc)
- Specialized software for detector simulation toolkits (e.g. Geant4, MCNP)
- Two low background HPGe detectors for γ-ray detection.
- More than ten Silicon surface barrier detectors and two PIPS detectors for charged particle detection
- Vacuum chamber equipped with oil-free pumping system (will be available on September 2018)
- Two MCA and DAQ systems for data-taking and data recording
- Event-by-event CAMAC DAQ system

No third parties involved.

31. UPC

Universitat Politècnica de Catalunya · BarcelonaTech* (UPC), is a public institution dedicated to higher education and research, specialised in the fields of architecture, engineering and technology. It is one of the biggest universities in Spain, with over 33.000 students, 30 departments and 216 research groups (academic year 2016-2017).

It is the UPC's mission to create knowledge, innovate, develop technology and make this technology available to society. With this mission in mind, it works to drive innovation and become the preferred technology partner of companies and institutions.

Under the current Horizon 2020 programme (2014-2020), to date the UPC has been granted 147 projects, coordinating 41 (8 of them are funded by the European Research Council). The UPC also has 28 projects (coordinating 4) funded by other European programmes. All of these projects have a total EU financial contribution of EUR 56 million. According to the H2020 country profile and featured projects for Spain, published in February 2018, by the European Commission (EC), the UPC is the top university and third institution in Spain in terms of number of projects and income from the EC for H2020 funded projects.

Since 2013 the UPC has endorsed the European Commission's 'European Charter and Code for Researchers', which seeks to ensure that researchers will continue their professional development, and enjoy research freedom and fulfilment from contractual and legal obligations. Moreover, in the context of the Human Resources Strategy for Researchers (HRS4R) which supports the Charter, the UPC has obtained (July 2017) an official acknowledgment for HR Excellence in Research and has been granted by the European Commission the certified Logo of the program: "HR Excellence in research".
The UPC staff has at their disposal the communication and dissemination services offered by its Media Office whose most outstanding services are the dissemination of the scientific activity and the development of communication campaigns.

The Experimental Nuclear Physics group (ENP) will be responsible of this research project. It is part of the Advanced Nuclear Technologies (ANT). ANT is a "Recognized Research Group" by the Regional Government under reference, 2017 SGR 1179. ENP works on nuclear data measurement of interest for nuclear technology and astrophysics. Experimental activities are all carried out at the world's leading laboratories (CERN, RIKEN, GSI, …) in the framework of international collaborations. The group focuses in three main topics, namely: cross section measurements of neutron induced nuclear reaction, delayed neutron emission measurements, and design of neutron detectors.
UPC is active member of the n_TOF, in charge of CERN's n_TOF, NUSTAR, a large collaboration aiming at exploiting the future FAIR international facility, and BRIKEN (UPC, IFIC, CIEMAT, Oak Ridge National Laboratory, JINRL-Russia y RIKEN-Japan), which was created in 2012 to build and exploit the world's largest neutron delayed detector at the Japanese RIKEN laboratory.

Along the last years, the ENP group has been experiencing a notable expansion in terms of requests to participate in new proposals to measure nuclear data.

Prof Francisco Calviño is head of the ENP group and author and co-author of more than 160 refereed publications. He is professor at the faculty of nuclear engineering since 1987 and a researcher in the fields of neutron cross sections and decay data. He has supervised over 11 PhD thesis and is member of various international collaborations such as n_TOF, NUSTAR, DESPEC and BRIKEN.

Publications

- Conceptual design of a hybrid neutron-gamma detector for study of ß-delayed neutrons at the RIB facility of RIKEN Tarifeño, A.; et al. Journal of instrumentation Vol. 12, num. 4, p. P04006-1-P04006-21. DOI: 10.1088/1748-0221/12/04/P04006
- First Measurement of Several β-Delayed Neutron Emitting Isotopes beyond N=126. Caballero-Folch, R.; et al. (65/11) Physical Review Letters Vol. 117, num. 1, p. 012501-1-012501-6. DOI: 10.1103/PhysRevLett.117.012501

- High-accuracy determination of the U-238/U-235 fission cross section ratio up to approximate to 1 GeV at n_TOF at CERN. Paradela, C; et al. (165/32) Phys Rev C Vol. 91, p. 024602-1-024602-11. DOI: 10.1103/PhysRevC.91.024602.
- Neutron Capture Cross Section of Unstable Ni-63: Implications for Stellar Nucleosynthesis. Lederer, C; et al. (105/16) Physical review letters Vol. 110, p. 22501-1-22501-5. DOI: 10.1103/PhysRevLett.110.022501.
- Neutron physics of the Re/Os clock. I. Measurement of the (n, gamma) cross sections of Os-186,Os-187,Os-188 at the CERN n_TOF facility. Mosconi, et al. (128/21) Physical review C Vol. 82, num. 1, p. 01580201-01580210. DOI: 10.1103/PhysRevC.82.015802. 2010-07-15.

<u>The UPC has participated in the previous related activities</u>:

- Cross section measurement at CERN's nTOF. UPC was leading the radiative capture cross section measurements of $^{203, 204, \text{ and } 205}$Tl.
- Delayed neutron emission measurements. Experiment S410 (GSI) has been completely finished using BELEN (BEta deLayEd Neutron detector)-30. $^{208-211}$Hg, $^{211-215}$Tl, $^{214-217}$Pb, $^{217-220}$Po, and $^{223-226}$At were measured. Half-lifes and neutron emission probabilities were determined for some of them.
- Low mass region of the light fission. Accurate determination of beta-delayed neutron emission probabilities has been performed. We used BELEN-48 at the IGISOL-JYFL mass separator in combination with a Penning trap. New results of neutron emission probabilities for ^{91}Br, ^{86}As, ^{85}As, and ^{85}Ge nuclei have been obtained. UPC is also performing measurements at RIKEN-Japan. BELEN is used as a part of a much larger neutron detector.
- Neutron detector development. In the last years UPC has developed three versions of BELEN, each of them with increased number of He-3 counters, to be used in different experiments at GSI and JFYL. During the last 5 years UPC has lead the design and construction of the BRIKEN neutron counter, made of 166 He-3 tubes.

No third parties involved.

32. UPM

The Universidad Politécnica de Madrid (UPM) is the largest Spanish technological university specialized in all engineering fields and architecture. With two recognitions as Campus of International Excellence, its outstanding research activity together with its highly-qualified professionals trainings, make UPM a really competitive university at international level. More than 2.400 researchers carry out their activity at the UPM, grouped in more than 200 Research Groups, 20 Research Centers or Institutes and 55 Laboratories, all of them committed to transform the knowledge generated into innovation advances applied to the productive sector, contributing to solve the challenges of the European citizens.
The intense collaboration with governmental bodies and industry guarantees that research at UPM offers real solutions to real-world problems. The dynamism of R&D&I activity at the UPM, together with the transfer of knowledge to society, are among its lines of strategy.
These two commitments place UPM among the Spanish universities with the greatest research activity, both at national and international level, counting on a International Projects Office that helps and support researchers in the international research arena. UPM highly innovation driven commitment is showed by the application for around 40 patents/year thanks to its Technology Transfer Office and by the generation around 20 spinoff/year (70% survival rate) trained and mentored by the UPM Center for Innovation Support. Moreover, UPM is highly committed to communication and outreach with and specific unit devoted to it.
The UPM research group on Nuclear Data & Reactor Physics has more than 20 years of research and academic experience in the reactor physics and nuclear data activities. They have participated in European projects such as "Accurate Nuclear Data for Nuclear Energy Sustainability" and CHANDA "Solving Challenges in Nuclear Data for the Safety of European Nuclear Facilities". UPM is also participating in many OECD/ NEA activities such as NSC/WPEC, DB/JEFF and WPRS/UAM.

UPM will participate in WP4 "Nuclear data evaluation and uncertainties", coordinating Task 4.3, participate in Task 4.4, coordinate Deliverable D.4.3 and in WP5 "Validation", participating in Tasks 5.1 and 5.2.

Oscar Cabellos (M) M.Sc. in Power Engineering and PhD in Nuclear Engineering. Associate Professor at the Energy Engineering Department. His background includes cross-sections uncertainty developments and analysis and nuclear data evaluation. Over 40 papers in international scientific journals with reviewers, and more than 60 papers/presentations in proceedings of international conferences. More than 15 years of research and academic experience in the reactor physics and nuclear data. Nuclear Data Scientist (October 2014-October 2017) at the OECD/ NEA Data Bank, mainly involved in WPEC, EXFOR, JANIS and JEFF activities at the NEA. Currently chairman on Processing and Verification, Benchmarking and Validation working group within the JEFF project and UPM leader of several EU projects.

Nuria Garcia-Herranz (F) M.Sc. in Power Engineering and PhD in Nuclear Engineering. Associate Professor at the Energy Engineering Department. She has more than 15 years of academic and research experience in Reactor Physics. Her scientific work is mainly focused on neutronics calculations for criticality safety and reactor core applications (including light water reactors and Gen-IV fast reactors) as well as the development of methods for sensitivity and uncertainty analysis accompanying those simulations. She has been UPM leader of several EU projects and is member of the Expert Group on Uncertainty Analysis in Modeling of NEA. Over the past years, she has advised and graduated 4 PhD students and 25 MSc students.

Publications

- M.B.Chadwick, R.Capote, A.Trkov, M.W.Herman,D.A.Brown, G.M.Hale, A.C.Kahler, P.Talou, A.J.Plompen, P.Schillebeeckx, M.T.Pigni, L.Leal, Y.Danon, A.D.Carlson,P.Romain, B.Morillon, E.Bauge, F.-.Hambsch, S.Kopecky, G.Giorginis, T.Kawano, J.Lestone, D.Neudecker, M.Rising, M.Paris, G.P.A.Nobre, R.Arcilla, O.Cabellos, I.Hill, E.Dupont, A.J.Koning, D.CanoOtt, E.Mendoza, J.Balibrea, C.Paradela, I.Durán, J.Qian, Z.Ge, T.Liu, L.Hanlin, X.Ruan, W.Haichen, M.Sin, G.Noguere, D.Bernard, R.Jacqmin, O.Bouland, C.DeSaintJean, V.G.Pronyaev, A.V.Ignatyuk, K.Yokoyama, M.Ishikawa, T.Fukahori, N.Iwamoto,O.Iwamoto, S.Kunieda, C.R.Lubitz, M.Salvatores, G.Palmiotti, I.Kodeli, B.Kiedrowski, D.Roubtsov, I.Thompson, S.Quaglioni, H.I.Kim, Y.O.Lee, U.Fischer, S.Simakov, M.Dunn, K.Guber, J.I.Márquez-Damián, F.Cantargi, I.Sirakov, N.Otuka, A.Daskalakis, B.J.McDermott, S.C.van der Marck, "CIELO Collaboration Summary

Results: International Evaluations of Neutron Reactions on Uranium, Plutonium, Iron, Oxygen and Hydrogen”. Nuclear Data Sheets, Volume 148, 189-213. (2018)

- Cabellos, O., Alvarez-Velarde, F., Angelone, M., Diez, C.J., Dyrda, J., Fiorito, L., Fischer, U., Fleming, M., Haeck, W., Hill, I., Ichou, R., Kim, D.H., Klix, A., Kodeli, I., Leconte, P., Michel-Sendis, F., Nunnenmann, E., Pecchia, M., Peneliau, Y., Plompen, A., Rochman, D., Romojaro, P., Stankovskiy, A., Sublet, J.C., Tamagno, P., Marck, S.V.D, “Benchmarking and validation activities within JEFF project”. EPJ Web of Conferences, 146, art. no. 06004. (2017)
- O. Cabellos. “Processing and Validation of JEFF-3.1.2 Cross-section Library into Various Formats: ACE, PENDF, GENDF, MATXSR and BOXER”. Nuclear Data Sheets, Volume 118, 456-458 (2014)
- N. García-Herranz, O. Cabellos, F. Álvarez-Velarde, J. Sanz, J. Juan. “Nuclear data requirements for the ADS conceptual design EFIT: Uncertainty and sensitivity study”. Annals of Nuclear Energy, Volume 37, Issue 11, November 2010, Pages 1570-1579
- P. Romojaro, F. Álvarez-Velarde, I. Kodeli, A. Stankovskiy, C.J. Díez, O.Cabellos, N.García-Herranz, J. Heyse, P.Schillebeeckx, G.Van den Eynde, G.Žerovnik. “Nuclear data sensitivity and uncertainty analysis of effective neutron multiplication factor in various MYRRHA core configurations”. Annals of Nuclear Energy, Volume 101, March 2017, Pages 330-338

<u>UPM has participated in the projects:</u>

- EUROTRANS: “European Research Programme for the Transmutation of High Level Nuclear Waste in an Accelerator Driven System”, FP6.
- ANDES “Accurate Nuclear Data for nuclear Energy Sustainability, FP7-Fission-2009”
- CHANDA "Solving Challenges in Nuclear Data for the Safety of European Nuclear Facilities"
- ESNII+ “Preparing ESNII for HORIZON 2020"
- ESFR-SMART "European Sodium Fast Reactor Safety Measures Assessment and Research Tools"

<u>Significant infrastructures</u>

The group contributing to this project operates the DIN-cluster (320 AMD cores) located at the Energy Technology Engineering (Nuclear Engineering) Department to support the computational analysis in the areas of nuclear data and reactor physics and has also access to Magerit supercomputer at UPM which is providing computer support to national and international research projects.

No third parties involved.

33. USC

The university of Santiago de Compostela is a high education institution offering 63 offcial degrees and developping reserach activities in all areas of knowledge. In particular, the Nuclear and Particle Physics department has a long experience in basic research using the most outstanding European infrastructures in the field like CERN, GSI or GANIL. Scientists from USC have competences in the experimental and theoretical investigations on nuclear physics. In particular they have been highly involved in experiments at GSI and CERN n-TOF dealing with fission and neutron-induced reactions.

The experience gained by USC researchers in experiments related to nuclear data measurements and development of simulation reaction codes clearly justifies its participation in WP2 and WP4.

Dr. José Benlliure, full professor at the University of Santiago de Compostela, obtained his Ph.D. at the University of Valencia in 1995 with work on nuclear multi-fragmentation done at GANIL (France) from 1991 till 1995. Postdoctoral positions at LPC-Caen (France) (1995) and GSI (Germany) (1996-1998). In 1998 he obtained and associated lectureship at the University of Santiago de Compostela, in 2002 a full lectureship and in 2011 was appointed as full professor in the same university. His main scientific activity deals with the investigation of nuclear reactions in particular fission, spallation and fragmentation. He is co-author of more than 215 publications has presented numerous invited talks in international conferences and has supervised eleven PhDs. He has been member the GANIL Scientific Council and the FAIR Council.

Publications

- J.L. Rodriguez-Sanchez, J. Benlliure et al., "Presaddle and postsaddle dissipative effects in fission using complete kinematics measurements"
- Phys. Rev. C 94 (2016) 061601
- J.L. Rodriguez-Sanchez, J. Benlliure et al., "Light charged particles emitted in fission reactions induced by protons on Pb-208"
- Phys. Rev. C 94 (2016) 034605
- J.L. Rodríguez-Sánchez, J. Benlliure et al., "Constraining the level density using fission of lead projectiles"
- Phys. Rev. C 92 (2015) 044612
- J.L. Rodríguez-Sánchez, J. Benlliure et al., "Complete characterization of the fission fragments produced in reactions induced by Pb-208 projectiles on proton at 500A MeV"
- Phys. Rev. C 91 (2015) 064616
- J.L. Rodríguez-Sánchez, J. Benlliure et al., "Proton-induced fission cross sections on Pb208 at high kinetic energies"
- Phys. Rev. C 90 (2014) 064606

The USC has participated in the projects:

- CHANDA, Solving Challenges in Nuclear Data
- CE, FP7 – 605203
- ANDES, Accurate Nuclear Data for nuclear Energy Sustainability
- CE, FP7 - 249671
- EUROTRANS, EUROpean Research Programme for TRANSmutation of High Level Nuclear Waste in an Accelerator Driven System
- CE, FI6W-CT-2004-516520

- HINDAS, High and Intermediate Energy Nuclear Data for Accelerator-Driven Systems
- CE, FIS5-1999-00150

No third parties involved.

34. USE

The University of Seville has a history of more than 500 years and nowadays is a leading institution in both academy and research, hosting more than 70.000 students. Within the Faculty of Physics, the research team working in the Dpt. of Atomic, Molecular and Nuclear Physics has a long tradition on research on nuclear physics including both theoretical (optical model calculations) and experimental (mainly on neutron capture and neutron production) aspects of nuclear reactions. The experiments take place at both international (n_TOF, ILL, LiLiT, BRR, etc.) and the local HiSPANoS neutron source. Recently the type of nuclear data measurements has been extended to proton induced reaction of interest in medical physics, in particular in proton therapy.

In addition, the University of Seville runs the facilities of the National Accelerator Centre (CNA). The CNA is a Spanish joint institution which, since its creation in 1998, has the mission of carrying out research in particle accelerators and its multiple applications. The CNA is recognized as a Spanish Singular Scientific and Technological Facility, and it is a user's-oriented laboratory, open to the Spanish and the international scientific community belonging to universities, public research institutions, public and private companies, hospitals or other institutions that require the use of the facilities. CNA is a pioneering center in Spain in the field of applications of particle accelerators for research. It has three particle accelerators: a 3 MV van de Graaff tandem accelerator, a cyclotron that supplies 18 MeV protons and 9 MeV deuterons, and a 1 MV Cockcroft-Walton tandem accelerator (called Tandetron) which is indeed a mass spectrometer. The tandem is linked to a neutron production target of either Lithium or Deuterium that is the core of the HiSPANoS neutron beam.

The responsible for carrying out the work within this EU project is Dr. Carlos Guerrero, a "Ramon y Cajal" researcher at the University of Sevilla. Prior to his arrival to Sevilla via an EC Marie Curie CIG project in 2014, he carried out a PhD at CIEMAT (Spain) on neutron capture measurements of minor actinides, and then moved to CERN (Switzerland) for 7 years during which he was a CERN Fellow (3 years) and a the Run and Analysis Coordinator (5 years) of the CERN n_TOF facility. As of today he is coordinating the HiSPANoS Collaboration in Spain, carrying out neutron beam experiments at n_TOF, BRR, LiLiT and HiSPANoS, and has launched a research line on measuring nuclear reactions of interest for medical physics, in particular for range verification in proton therapy.

<u>Publications</u>

- J. Lerendegui-Marco et al., "Radiative neutron capture on 242Pu in the resonance region at the CERN n_TOF-EAR1 facility", Phys. Rev. C 97, 024605 (2018)
- C. Guerrero et al., "Prospects for direct neutron capture measurements on s-process branching point isotopes", Eur. Phys. J. A 53:87 (2017)
- M. Barbagallo et al., "7Be(n,alpha) reaction and the Cosmological Lithium Problem: Measurement of the cross section in a wide energy range at n_TOF at CERN", Phys. Rev. Lett. 117, 152701 (2016)
- C. Guerrero et al., "Performance of the neutron time-of-flight facility n_TOF at CERN", Eur. Phys. J. A 49:27 (2013)
- C. Guerrero et al., "Measurement and resonance analysis of the 237Np neutron capture cross section", Phys. Rev. C 85 044616 (2012)

No third parties involved.

35. UU

Uppsala University is the oldest university in the Nordic countries and was founded in 1477. Today it is a large institution with 41 000 students and 6 500 employees. The university conducts education and research within 9 faculties: theology, law, arts, languages, social sciences, educational sciences, medicine, pharmacy, science and technology. Uppsala University – a member of the COIMBRA group (http://www.coimbra-group.eu/) – has been the highest-ranking comprehensive research university in Sweden – and among the top 20 in Europe – for five consecutive years. Some 5,000 scientific publications are produced each year of which about 50 % are articles in international scientific journals.

Uppsala University has a significant presence on the international academic arena, with much collaboration in both education and research. More than 1,000 international universities, primarily in Europe, U.S., and Asia, are involved in more than 3,000 research partnerships with UU. The Faculty of Sciences and Technology alone has about 1600 employees and 10500 students, and has an annual turnover of about 220M€. The nuclear reactions group is part of the Division of Applied Nuclear Physics of the Department of Physics and Astronomy and has a long standing experience in measuring data on neutron induced reactions at several facilities. It has also build up an expertise in nuclear data evaluation and uncertainty quantification. The group has previously participated in FP5 (HINDAS) and FP6 (EFNUDAT, CANDIDE and EUROTRANS), and FP7 (CHANDA). The group has, together with the division of applied nuclear physics, ongoing collaboration with Swedish industry and authority and has a strong activity in contract education, e.g., radiation protection and reactor physics, with external partners.

Stephan Pomp (born 1968, male) is professor in applied nuclear physics. He is head of the applied nuclear physics programme at the Department of Physics and Astronomy and leader of the nuclear reactions research group (currently 13 members). His main research interest are neutron-induced reactions, in particular the fission process and light-ion production. His current experimental research activities are linked to IGISOL (Jyväskylä, Finland), JRC Geel (Belgium) and NFS@GANIL (Caen, France). Stephan Pomp was main or co-supervisor for 12 PhD theses. He has 48 physics publications in refereed international journals and more than 140 contributions to refereed international conferences. He is member of the Programme Advisory Committees for leading conferences in the field of applied nuclear physics and is also member of the board of the Nuclear Physics Division of EPS, and UU representative in the European Radiation Dosimetry Group (EURADOS).

Henrik Sjöstrand (born 1978, male) is Associate Professor at Applied Nuclear Physics and docent since 2015. He is the project leader of the evaluation and nuclear data (ND) uncertainty quantification (UQ) effort at Uppsala University since 2012. He has been the supervisor for four Ph.D. students, two post-docs and a large number of master students. He has 77 peer-reviewed original articles in international journals, and he has a Scopus H-index of 16. In his work, he has addressed ND issues, e.g., today's and the next generation of fission reactors; nuclear fusion; material issues; and dosimetry. He works with EUROfusion consortium in several projects related to ND as well as collaborates directly with the Swedish nuclear industry. He has contributed to JEFF3.3 (Ni59), participated in the IAEA DPA-CRP and is currently a member of WPEC Subgroup 44 (uncertainty quantification) and 46 (Use of Integral Experiments).

Ali Al-Adili (born 1984, male) is a researcher in applied nuclear physics. He obtained his Ph.D. at the Joint Research Centre in Geel, Belgium. His main research interest is nuclear fission. He is the main responsible for the fission neutron investigations carried out at the division and is also involved in experimental activities at the IGISOL facility (Finland) and at LICORNE facility (France). Ali has been a co-supervisor of one Ph.D. student and a few master students. He is the author and co-author of more than 50 articles and proceedings. Ali has received of two awards; the ENEN Ph.D. prize for top three European nuclear technology theses, and the Ångström Premium (given by Uppsala University). For his Ph.D. he received the JRC fellowship grant (3 years research at JRC). For the neutron investigations, he obtained three CHANDA visiting-scientist grants (total of 21 man weeks) and three accepted EUFRAT experimental proposals. He was recently granted the JSPS+STINT grant for a short-term fellowship at RIKEN laboratory in Japan.

Andreas Solders (born 76, male, phd) is a researcher in applied nuclear physics. Andreas main research interest is nuclear fission, in particular the study of fission yields and neutron multiplicity. As the principal investigator he has a leading role in the collaboration between UU and JYU to measure independent isotopic and isomeric fission yields at IGISOL. Andreas Solders has been the main or co-supervisor of three PhD students. He has 12 original publications in refereed international journals and 24 refereed conference contributions (h-index 11).

Alexander Prokofiev (born 1963, male) is a researcher, Ph.D., and docent in applied nuclear physics. His current experimental research activities are linked to the NFS facility at GANIL (Caen, France). His main research interests are (1) neutron-induced nuclear reactions such as fission and light-ion production, in particular in the context of future energy applications, (2) development of facilities and detectors for neutron research, (3) neutron-induced radiation effects in materials and systems. He is a project leader in development of a new neutron facility, NESSA. He has been co-supervisor for two PhD students as well as main supervisor for several diploma and exchange students. He has 57 publications in refereed international journals and more than 80 contributions to refereed international conferences (Scopus H-index 19).

Publications

- Al-Adili et al., ”Fragment-mass, kinetic energy, and angular distributions for 234U(n,f) at incident neutron energies from En = 0.2 MeV to 5.0 MeV”, Phys. Rev. C 93, 034603 (2016)
- V. Rakopoulos et al, ”First isomeric yield ratio measurements by direct ion counting and implications for the angular momentum of the primary fission fragments”, Phys. Rev. C 98, 024612 (2018)
- Tarrío, D., Prokofiev, A.V., Gustavsson, C., Jansson, K., Andersson-Sundén, E., Al-Adili, A., Pomp, S., “Characterization of the Medley setup for measurements of neutron-induced fission cross sections at the GANIL-NFS facility”, EPJ Web of Conferences 146, 03026 (2017)
- Helgesson P., Sjöstrand H., Rochman D.; "Uncertainty driven nuclear data evaluation including thermal (n,alpha): applied to Ni-59"; Nuclear Data Sheets 145, 1-24 (2017)
- P Helgesson, H Sjöstrand, “Treating model defects by fitting smoothly varying model parameters: Energy dependence in nuclear data evaluation”, Annals of Nuclear Energy 120, 35-47 (2018)

Previous projects or activities

The UU group has participated previously in the FP5 (HINDAS) and FP6 (EFNUDAT, CANDIDE and EUROTRANS), and FP7 (CHANDA) projects.

No third parties involved.

4.2. Third parties involved in the project (including use of third party resources)

Please complete, for each participant, the following table (or simply state "No third parties involved", if applicable):

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Y
If yes, please describe and justify the tasks to be subcontracted Only PSI will subcontract part of the research for the design of the isotope separator. The details can be found in the description of partner 21 PSI.	
Does the participant envisage that part of its work is performed by linked third parties[7]	Y
If yes, please describe the third party, the link of the participant to the third party, and describe and justify the foreseen tasks to be performed by the third party Only CNRS will have linked third parties to perform part of its work. The details can be found in the description of partner 5 CNRS.	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
If yes, please describe the third party and their contributions	
Does the participant envisage that part of the work is performed by International Partners[8] (Article 14a of the General Model Grant Agreement)?	N
If yes, please describe the International Partner(s) and their contributions	

[7] A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the Model Grant Agreement).

[8] 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

5. Ethics and Security

5.1 Ethics

The consortium ensures that the ethical issues identified in the SANDA ethics evaluation are conveniently addressed.

For the Environment protection question:

As indicated in the proposal and in the workpackages description some of the measurements and research activities proposed in the workpackages: WP1 “Developments of new innovative detector devices”, WP2 “New nuclear data measurements for energy and non-energy applications” and WP5 “Nuclear data validation and integral experiments” involve the use of small quantities of radioactive isotopes and sources of radiation (photons, neutrons and charged particles).

The concerned activities and all preparatory operations with those radioactive materials and sources of radiation will be performed at specific facilities, radioactive installations, that have been designed for minimizing down to below the regulatory limits the impact of the experiments to workers, general public and environment.

The facility designs, operation conditions and operation protocols have been validated and the facilities have been authorized to operate with radioactive materials up to well identified limits and to perform a well-defined type of operations, by the corresponding national nuclear regulatory bodies. The proposed experiments are in all cases included in the inventories and scope of operations authorized for the concerned facilities.

Furthermore, all the actions in these facilities are supervised by specially trained and authorized persons, normally from the staff of the radioactive installation and/or staff of the internal radiation protection offices of the respective participants. Radioactive installations and radiation protection offices are controlled by the national nuclear regulatory bodies and must ensure that the experiments are carried out according to national law which ultimately stems from IAEA guidelines.

For the project protection of personal data:
Participants will be informed on the purpose of the personal data requested. Personal Data processing will follow the provisions of the Law 677/2001 on the protection of natural persons with regard to the processing of personal data and the free movement of such data and of EU Regulation 2016/679 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation).

5.2 Security[9]

Please indicate if your project will involve:

- activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO

[9] See article 37 of the Model Grant Agreement. . For more information on the classification of Information, please refer to the Horizon 2020 guidance: https://ec.europa.eu/research/participants/data/ref/h2020/other/hi/secur/h2020-hi-guide-classif_en.pdf.