NFRP 2018 - SANDA

SUPPLYING ACCURATE NUCLEAR DATA FOR ENERGY AND NON-ENERGY APPLICATIONS

2019-2023

WORKPACKAGE 1 –

Developments of new innovative detector devices

Maëlle Kerveno, CNRS/IPHC, Strasbourg (France)

Kick-off meeting, Brussels, 9-10 September 2019

OUTLINE

WP description

WP structure and partners

WP commitments, milestones and deliverables

WP efforts

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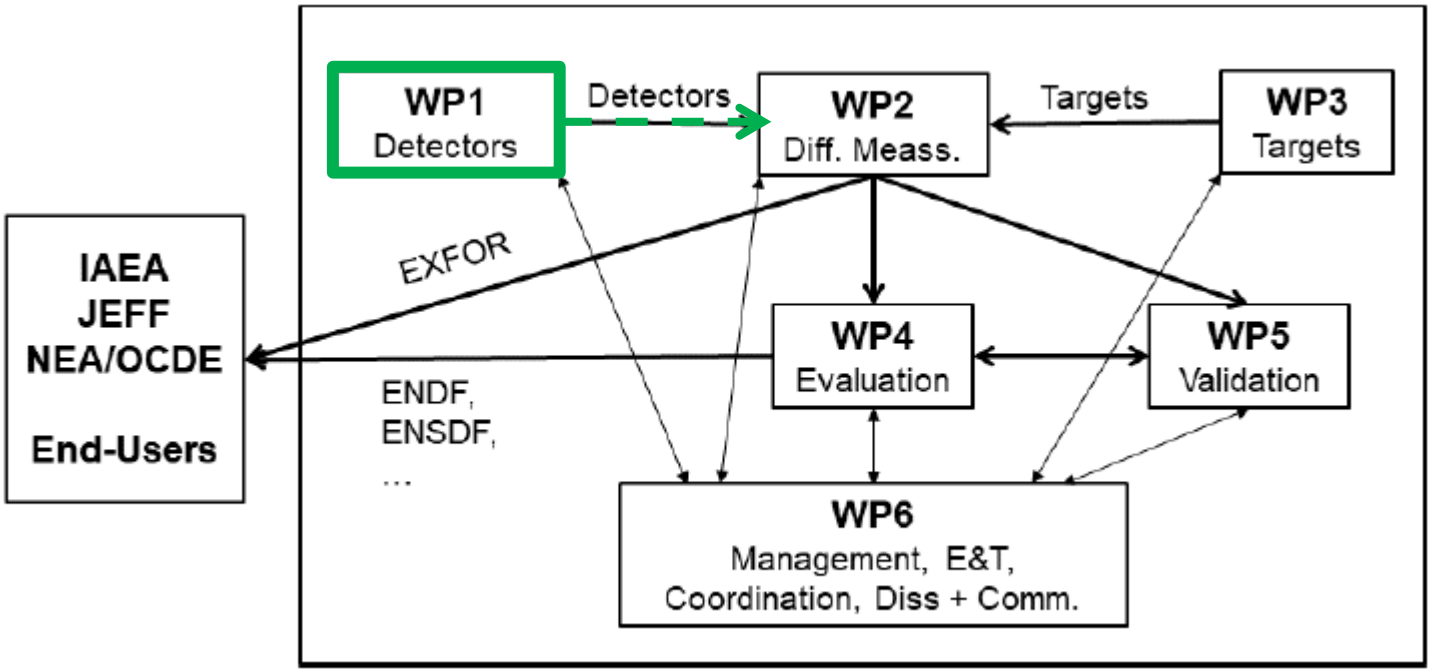
WP efforts

WP 1 in SANDA : Developments of new innovative detector devices

Support the **development of new measurement devices** which allow **high precision measurements for Energy and N.E. applications**

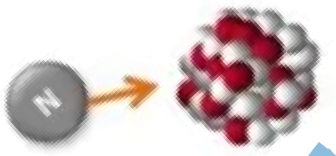
-> for an immediate use in the frame of WP2 (~1/3 of tasks)
-> for more long term experiments which need more R&D



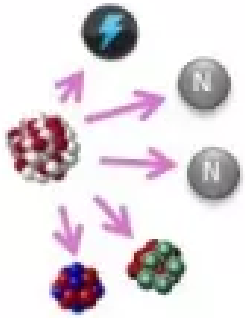
WP 1 Physics case

Better experimental knowledge of neutron induced reactions

Especially on actinides (Energy appl.) or for Non-Energy applications



Fission

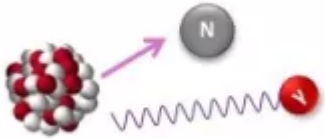


Fission cross section
Fission products
and their decay

Capture

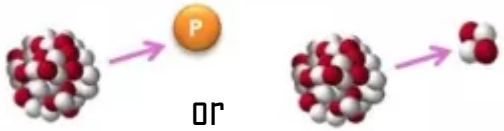
(n,γ) cross section

Neutron emission



Neutron spectrum
(n,xn) reaction XS

Lcp production

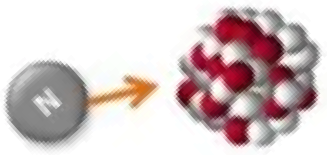


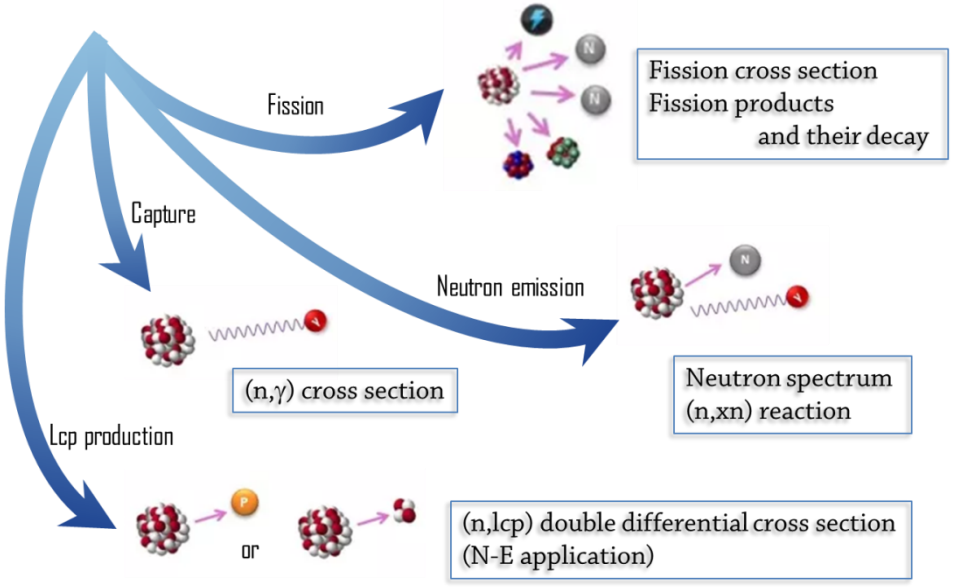
or

(n,lcp) double differential cross section
(N-E applications)

WP 1 Physics case

Better experimental knowledge of neutron induced reactions
Especially on actinides (Energy appl.) or for Non-Energy applications





Experimental challenges

For new evaluations

-> new measurements with reduced uncertainties (even on already studied isotopes)

-> new experiments more discriminating and binding for theoretical models

Actinide samples

-> low mass samples : very efficient detector devices needed

-> high resolution for particle discrimination

New facilities

-> n_TOF EAR2, SPIRAL2/NFS

Instrumental work is needed!

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OUTLINE

WP description

WP structure and partners

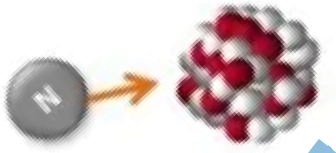
WP commitments, milestones and deliverables

WP efforts

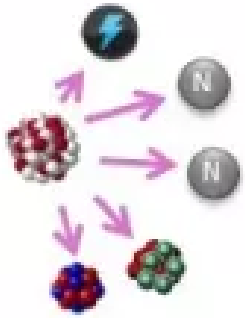
SANDA

WP structure and partners

WP 1 Structure



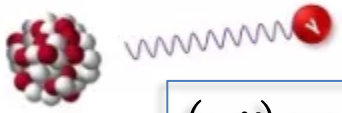
Fission



Fission cross section
Fission products
and their decay

TASK 1

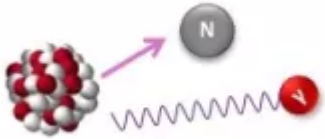
Capture



(n,γ) cross section

TASK 3

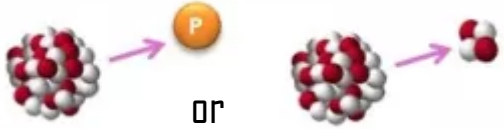
Neutron emission



Neutron spectrum
(n,xn) react. XS

TASK 2

Lcp production



(n,lcp) double differential cross section
(N-E application)

TASK 4

SANDA

WP structure and partners

WP 1 Structure and tasks

TASK 1

Innovative devices from fission cross section to Fission products decay

Leader : CEA/DRF/IRFU – Frank Gunsing

SUBTASK 1.1.1 new devices for fission cross section measurements

- development of a **micromegas Time Projection Chamber**
  Partner : **CEA/DRF/IRFU** ; project leader : F. Gunsing; collab. TUW, JRC-Geel
- development of a **new Gaseous Proton Recoil Telescope**
  Partner : **CNRS/CENBG** ; project leader : L. Mathieu; collab. CEA/DEN, CEA/DRF/IRFU, JRC-Geel

SUBTASK 1.1.2 new devices for fission products studies

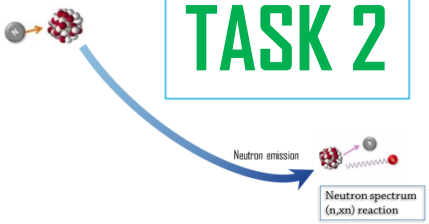
- development of a **new large gas cell** with electric field guidance **for IGISOL**
  Partner : **JYU** ; project leader : H. Penttilä; collab. UU
- coupling of **FALSTAFF with FIPPS @ ILL**
  Partner : **CEA/DRF/IRFU** ; project leader : D. Doré; collab. GANIL, ILL
- build a **new version of BELEN**
  Partner : **UPC** ; project leader : F. Calvino; collab. IFIC
- **new measurement facility** dedicated to the **measurement of half-lives**
  Partner : **CEA/LNE-LNHB** ; project leader : M. Kellet; collab. CNRS/SUBATECH, IFIC

Measurements planned in WP2

SANDA

WP structure and partners

WP 1 Structure and tasks



TASK 2 Innovative devices for neutron emission studies

Leader : CERN – Massimo Barbagallo

SUBTASK 1.2.1 Build of a compact fast neutron spectrometer

Partner : **CEA/DEN/CAD** ; project leader : R. Jacqmin; collab. -

SUBTASK 1.2.2 Development of Germanium detectors for (n,xn) measurements at n-TOF

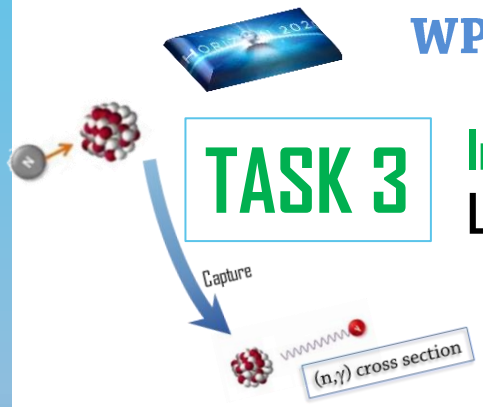
Partner : **CERN** ; project leader : M. Barbagallo; collab. UMANCH., NTUA, UOI., IFIN-HH

SUBTASK 1.2.3 Development of the SCONE detector

Partner : **CEA/DAM** ; project leader : G. Belier; collab. -

WP structure and partners

WP 1 Structure and tasks



TASK 3

Innovative devices for capture cross section measurement on actinides

Leader : CIEMAT – Emilio Mendoza

- Development of **CLYC detector for (n,γ) XS** measurements **@EAR2 n_TOF**
  Partner : **CIEMAT** ; project leader : E. Mendoza; collab. USE
- Extend the **i-TED technique** for measurement on **actinides @EAR2 n_TOF**
  Partner : **UPC** ; project leader : F. Calvino; collab. - IFIC

SANDA

WP structure and partners

WP 1 Structure and tasks

TASK 4

Detectors for non-energy application

Leader : PTB – Ralf Nolte

- **Doub. Diff. XS (n,lcp)** measurements @ **n_TOF from 20 to 200 MeV**
  Partner : **HZDR** ; project leader : A. Junghans; collab. PTB
- **Doub. Diff. XS (n,lcp)** measurements @ **n_TOF from 20 to 200 MeV**
  Partner : **PTB** ; project leader : R. Nolte; collab. HZDR

Measurement planned in WP2

WP structure and partners

Summary

WP 1

- **8 partners** (CEA, CERN, CIEMAT, CNRS, HZDR, JYU, PTB , UPC)
- **80.8 pm, 476 k€**
- **4 tasks**

TASK 1 2 subtasks, 4 partners (CEA, JYU, CNRS, UPC)

TASK 2 3 subtasks, 2 partners (CEA, CERN)

TASK 3 0 subtask, 2 partners (CIEMAT, UPC)

TASK 4 0 subtask, 2 partners (PTB, HZDR)

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WP commitments, milestones and deliverables

Deliverable 1.1 (CNRS)

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

M48

¤ Development of a micromegas Time Projection Chamber for cross section measurements

Taken advantage of the expertise of CEA/IRFU on the development and use of the MicroMegas detector technology for **precise (n,f) XS measurements**

COMMITMENTS :

Use of micromegas as "Transparent" XY beam detector exploiting strip timing (**TPC** mode) to measure **angular distributions** of (n,f) and (n,lcp) **cross sections**

Program :

- Detailed simulations of detector geometry, particle's interactions and trajectories
- Simulation of a physics case
- Preliminary detector design including field degrader
- Contribution for report subtask 1.1.1

CEA ms.6 M24

SANDA

WP commitments, milestones and deliverables

Deliverable 1.1 (CNRS)

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

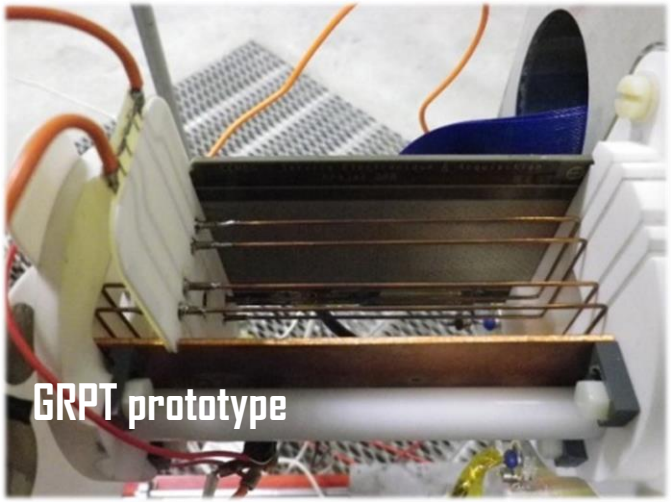
M48

¤ Development of a new Gaseous Proton Recoil Telescope (GRPT)

Taken advantage of the work already performed in CHANDA in view of the measurement of the quasi-absolute fission **cross section measurement of ^{242}Pu(n,f) relative to H(n,p) scattering** between 200 keV and 2 MeV

COMMITMENTS :

Completion of the GRPT (in view of measurement with 5% accuracy below 1 MeV)



Program :

- End of the construction of the GRPT 2021
- Commissioning 2021-2022
- Ready for measurement 2022-2023

CNRS ms.5 M24

SANDA

WP commitments, milestones and deliverables

Deliverable 1.2 (JYU)

"Report on the design of the large gas cell for IGISOL"

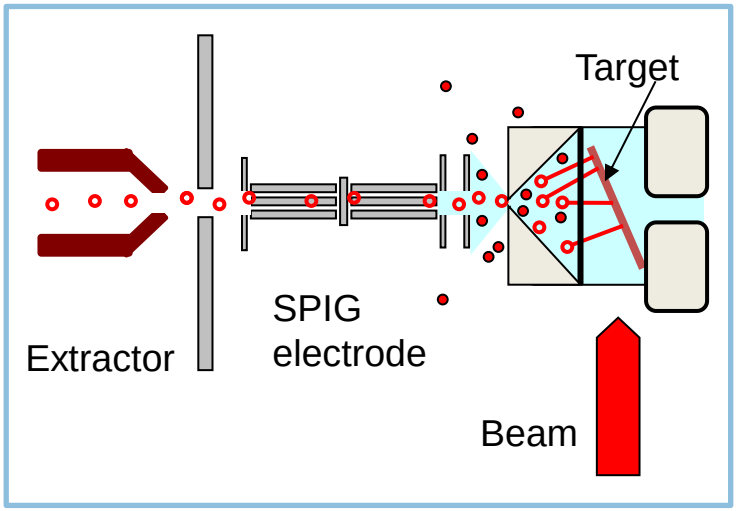
M24

¤ development of a new large gas cell with electric field guidance for IGISOL

Taken advantage of the work already performed in CHANDA for the development of a proton to neutron converter at IGISOL for **neutron fission induced studies**

COMMITMENTS :

Study of a new stopping gas cell with better ions stopping efficiency and faster transport. (expected overall improvement of efficiency of the order of 100)



Program :

- Study, comparison of all the possible technical solutions for gas filled stopping cells with electric field guidance.
- Simulations of the performances (fission product stopping, ion survival) and optimization of cell dimensions, electrode structure and voltage in the IGISOL environment.
- Technical drawing of the new gas cell

JYU ms.2 M18

WP commitments, milestones and deliverables

Deliverable 1.3 (CEA)

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

M24

¤ coupling of FALSTAFF with FIPPS @ ILL

Taken advantage of the work already performed in CHANDA for the building of the **new device FALSTAFF for actinide fission fragments studies**

COMMITMENTS :

Prepare a new setup by coupling FALSTAFF and FIPPS @ ILL to provide new nuclear data for fission modeling improvements (fission and deexcitation models, prompt γ-ray spectra with FF A & M, FF angular momentum)

Program :

- Simulations of the coupling of FALSTAFF (fragment kinetic energy and fragment mass after evaporation) and FIPPS (γ-ray cascades from FF)
- Evaluation of performances in view of the measurement at ILL

WP2

CEA ms.1 M12

WP commitments, milestones and deliverables

Deliverable 1.3 (CEA)

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

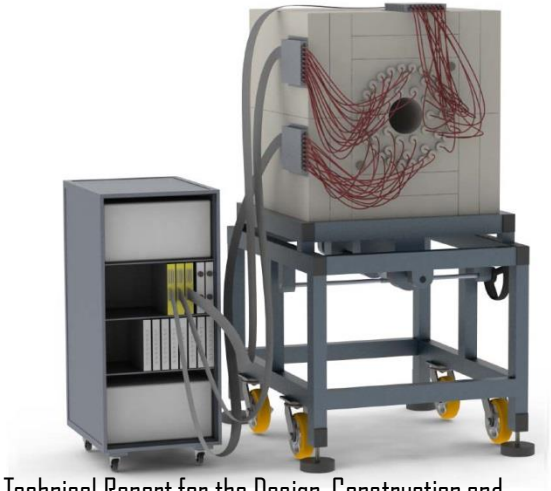
M24

- build a new version of BELEN

Taken advantage of the development performed in CHANDA of the **versatile neutron detector BELEN** dedicated to beta delayed neutron studies

COMMITMENTS :

Optimize the BELEN detector to obtain a device with very high efficiency capability for Pn and low resolution energy spectra measurements



From Technical Report for the Design, Construction and Commissioning of the Beta-Delayed Neutron Detector – BELEN

Program :

- MCNP or GEANT4 simulations of the BELEN matrix responses
- Production of new unfolding codes for Bonner Spheres systems
- Design an optimized geometry for effective rings
- Evaluation of performances in view of the measurement at IGISOL

WP2

UPC ms.7 M12

WP commitments, milestones and deliverables

Deliverable 1.3 (CEA)

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

M24

¤ new measurement facility dedicated to the measurement of half-lives

Taken advantage of the expertise of the CEA/LNE-LNHB group in **decay data evaluation and metrology activities**

COMMITMENTS :

Prepare and commission a new measurement facility dedicated to the measurement of half-lives for a range of radionuclides.

Program :

- Developing an automated sample changer for use with an ionization chamber
- Creating the necessary command modules in the LabView environment
- Commissioning of the device in view of measurement in

WP2

CEA ms.3 M18

SANDA

WP commitments, milestones and deliverables

Deliverable 1.4 (CEA)

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

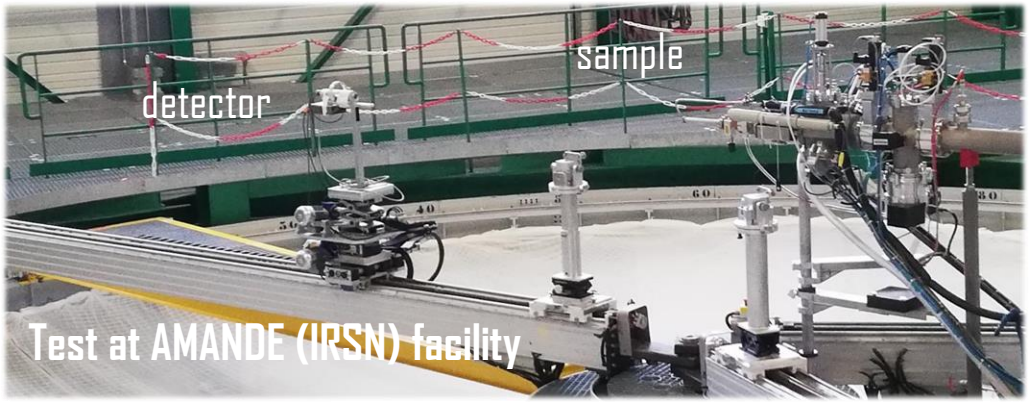
M36

¤ development of a compact broad-band fast neutron spectrometer

Provide a **neutron spectrometer** useable in **many applications**

COMMITMENTS :

Construction of a compact broad-band fast neutron (10 keV – 10 MeV) spectrometer based on a solid organic scintillator (stilbene detector) with its associated electronics



From Augusto Di Chicco, proceedings of ANIMMA 2019 conference

Program :

- Improvement of the PSD procedure
- Study of the anisotropy at very low neutron energy (< 100 keV)
- Calculation of the response matrix
- Tests and commissioning at neutron facility (AMANDE, PTB, ...)

CEA ms.4 M24

SANDA

WP commitments, milestones and deliverables

Deliverable 1.5 (CEA)

M48

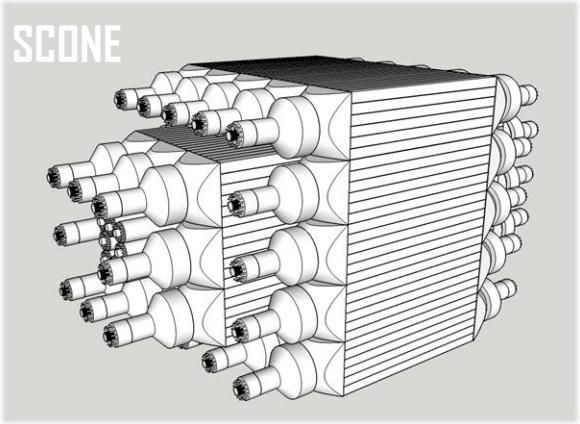
"Report on the performance of the SCONE setup at NFS"

- development of the SCONE setup for (n,xn) reaction studies at NFS

Taken advantage of the expertise of CEA/DAM for **(n,xn) reactions** experimental studies with a new high efficiency detector

COMMITMENTS :

Development of a **new neutron counter based on plastic scintillator** bars wrapped with Gd loaded material (SCONE) for measurements at **NFS facility**



Program :

- Final assembly of SCONE (~900 EJ200 plastic scintillator bars)
- Installation at NFS
- Commissioning of the setup

CEA ms.9 M24

WP commitments, milestones and deliverables

Deliverable 1.6 (CERN)

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

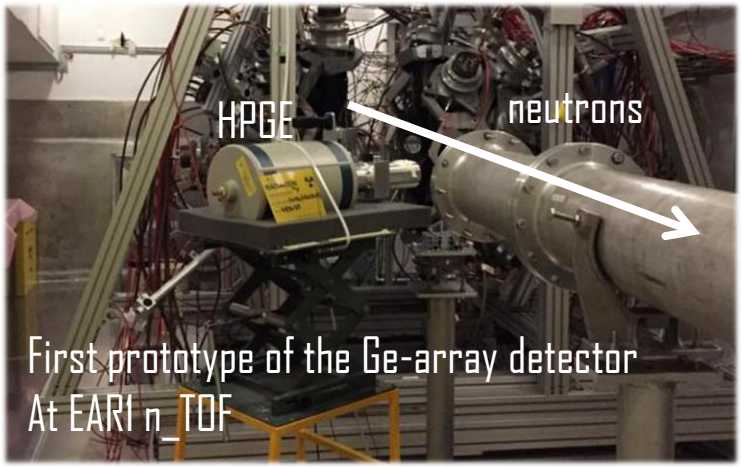
M48

¤ development of Germanium detectors for (n,xn) measurements at n-TOF

Taken advantage of **the high flux of the CERN/n_TOF** facility to study fast neutron reactions

COMMITMENTS :

Development of a new 4 HPGE setup with newly developed electronics to overcome the huge γ-flash preceding the neutron beam



Program :

- Efficiency and energy resolution characterization of standards and prototype detector (with "isolated" preamp) by GEANT 4 simulations
- Develop and benchmark the PSA code
- Determination of the better choice for the Ge crystal (GEANT 4, FLUKA simulations) and RC or TRP preamps
- Tests of the setup at CERN/n_TOF

CERN ms.8 M24

SANDA

WP commitments, milestones and deliverables

Deliverable 1.7 (CIEMAT)

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

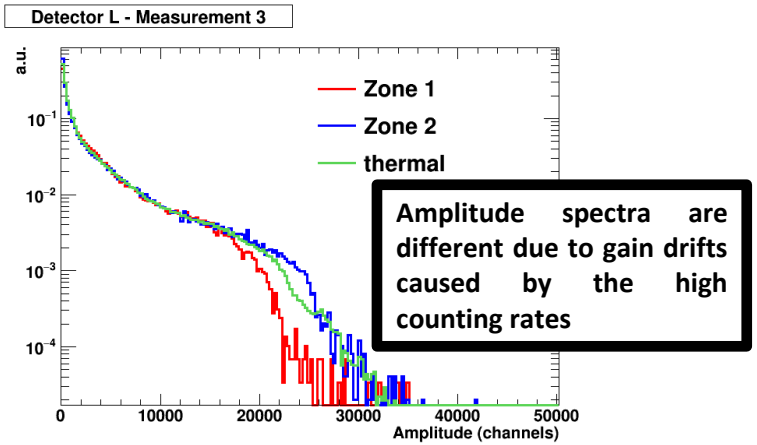
M48

¤ development of s-TED detector for (n,γ) XS measurements @ EAR2 n_TOF

Taken advantage of the CIEMAT **experience with scintillators (organic and inorganic)** acquired in the CHANDA project for (n,γ) measurement at n_TOF EAR2

COMMITMENTS :

Design and test a total energy detector prototype based on segmented CLYC inorganic scintillator adapted to the very demanding characteristics (high counting rates) of the n_TOF EAR2 experimental area and for meas. with actinide samples



Program :

- Characterization of a CLYC prototype detector (source meas. vs MC simulations)
- Test experiment at CIEMAT & CNA (tof) in Seville for neutron detection efficiency determination
- Optimization of the design (crystal size, PMT…)
- Test measurements at CERN on Au sample

CIEMAT ms.10 M36

SANDA

WP commitments, milestones and deliverables

Deliverable 1.7 (CIEMAT)

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

M48

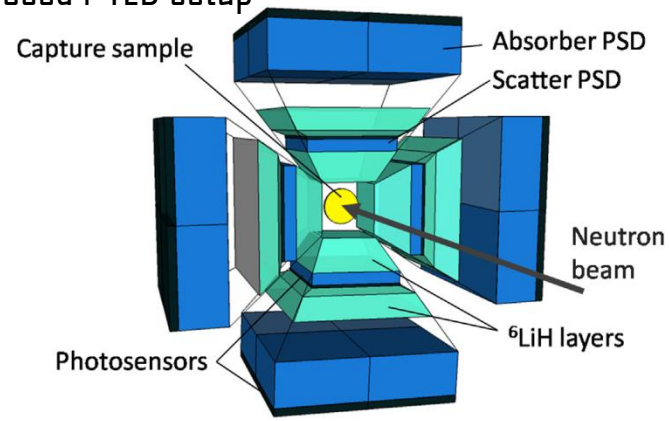
- extend the i-TED technique for measurement on actinides @ EAR2 n_TOF

Taken advantage of the work performed on **i-TED technique for (n,γ) cross section meas.** in astrophysics field

COMMITMENTS :

Developed an i-TED (imaging total energy detector) for radiative capture measurement with highly radioactive sample at EAR2 n_TOF

proposed i-TED setup



From C. domingo-Prado, NIMA825 (2016) 78

Program :

- Preparation and commissioning of i-TED at EAR2 n_TOF
- Experimental benchmark at EAR2 n_TOF
- Recommendation on actinides of the NEA HPRL that can be studied with i-TED

CIEMAT ms.10 M36

WP commitments, milestones and deliverables

Deliverable 1.8 (PTB)

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

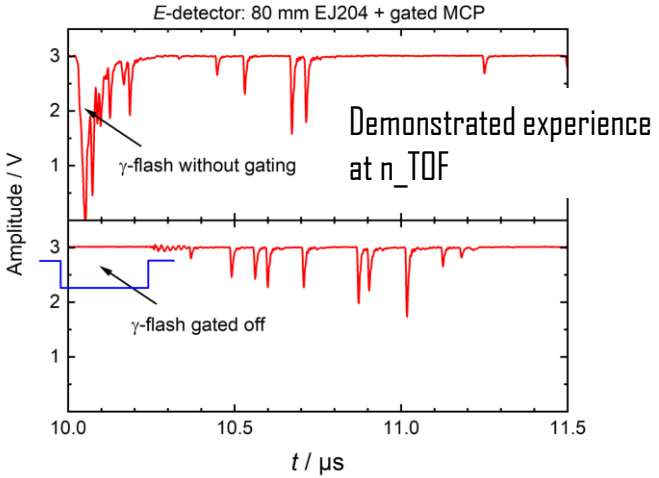
M24

¤ Double Diff. XS (n,lcp) measurement @ EAR1 n_TOF from 20 to 200 MeV

Taken advantage of the demonstration that the **neutron-induced emission of light charged particles** can be done **up to 200 MeV at EAR1 n_TOF** (^{235}U(n,f)/^{1}H(n,n) exp.)

COMMITMENTS :

Development of a scattering chamber and detector telescopes for H and He ions detection useable at EAR1 n_TOF (good resol., low thresholds, high max. neut. Energy)



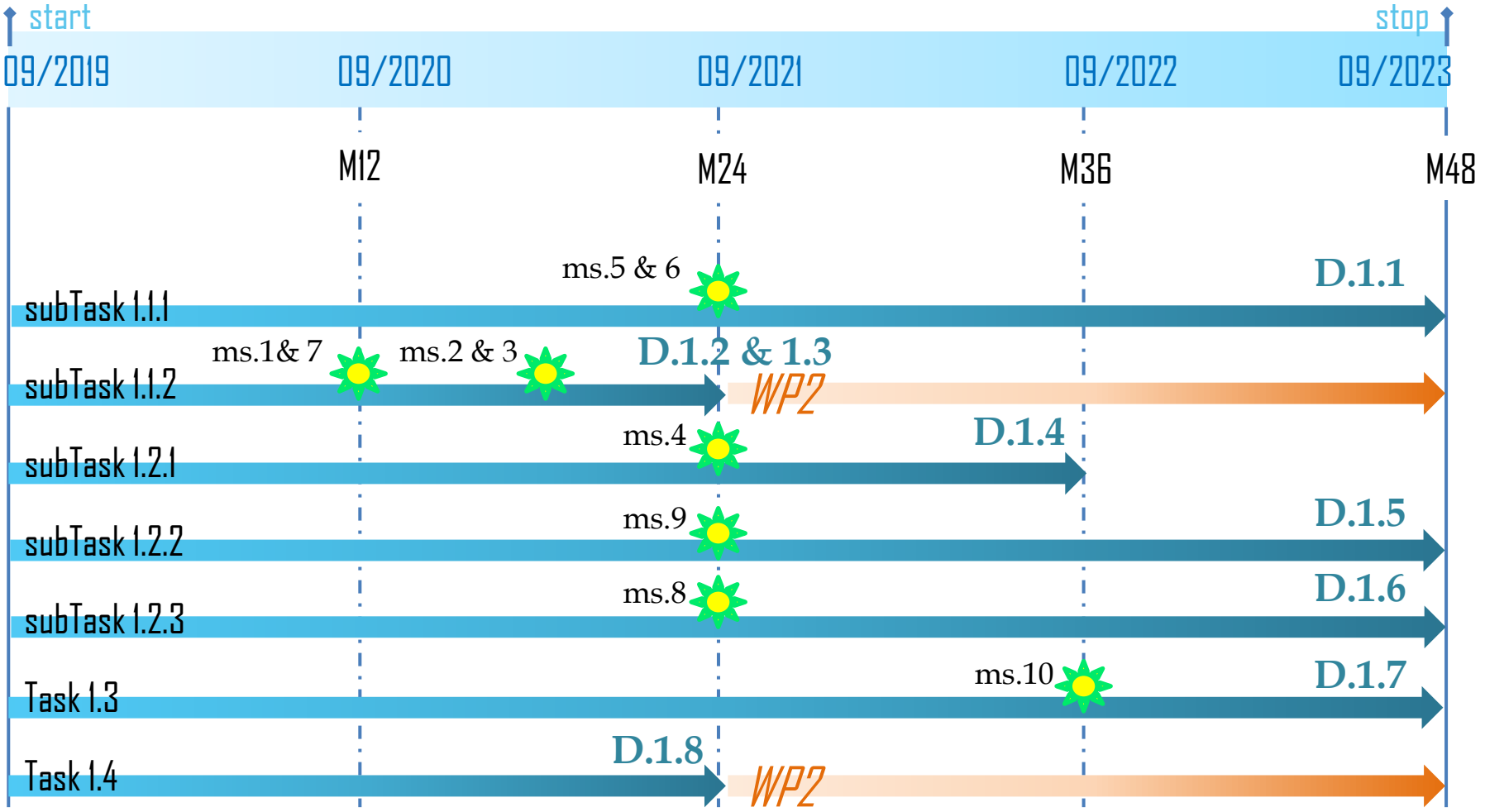
Program :

- ΔE & E detectors and PreAmps developments
- Design and construction of a compact vacuum chamber
- Test measurements with prototype det. and electronics (beam facilities HZDR and PTB), final test at a spallation source

WP2

WP commitments, milestones and deliverables

Summary : SANDA-WP1 gantt chart



OUTLINE

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SANDA

Partners

partners	budget	pm
CEA	195 000 €	36.1
CNRS	32 000 €	4.5
CERN	55 000 €	1.2
CIEMAT	60 000 €	13.3
UPC	35 000 €	6.5
JYU	50 000 €	9
PTB	23 000 €	5.7
HZDR	26 000 €	4.5
TOTAL	**476 000 €**	**80,8**

Deliverables

D.1.1	D.1.2	D.1.3	D.1.4	D.1.5	D.1.6	D.1.7	D.1.8
14.6 pm	9 pm	16.1 m	5 pm	1.2 pm	9 pm	15.8 pm	10.2 pm

WP1 Work document

Workpackage 1 : Developments of new innovative detector devices
WP leader: CNRS/IPHC Maëlle Kerveno

Task 1.1: innovative devices from fission cross section to Fission products decay

task leader : CEA/DRF/IRFU Frank Gunsing

n°	subtask	Partners	Lead and financed institut	collaboration	project leader	Subject	deliverables	deliverable date & responsible	Milestones	Milestones date & responsible	EC allocated budget	WP 2 mens. allocated budget
1	1.1.1	CEA	CEA/DRF/IRFU	TUW, JRC-Geel,...	F. Gunsing	development of a micromegas Time projection Chamber	D.1.1 "Report on the study and construction of new devices for precise fission cross section measurements"	M48 CNRS	M.1.5 Completion of simulations for a MicroMegas-based time projection chamber at CEA/DRF/IRFU, CEA, M24	M24 CNRS/CENBG	50 000 €	
2		CNRS	CENBG	CEA/IDEN, LPSC	L.Mathieu	development of a new gaseous proton recoil detector			M.1.6 Completion of GRPD - gaz recoil proton detector at CNRS/CENBG, CNRS, M24	M24 CEA/DRF/IRFU,	32 000 €	
3	1.1.2	JYU	JYU	U.U.	H. Penttilä	development of a new large gas cell with electric field guidance for IGISOL	D.1.2 "Report on the design of the large gas cell for IGISOL"	M24 JYU	M.1.2 Completion of simulations for new gas cell with electric field guidance at IGISOL, JYU, M18	M18 JYU	50 000 €	
4		CEA	CEA/DRF/IRFU	GANIL, ILL...	D. Doré	coupling of FALSTAFF with FIPPS @ ILL	D.1.3 "Report on the performances of new devices for precise study of fission products and their decay in view of measurements"	M24 CEA	M.1.1 Completion of the simulation for the coupling of FALSTAFF and FIPPS at ILL,	M12 CEA/DRF/IRFU	50 000 €	15 000 €
5		UPC	UPC	IFIC	F. Calviño	build a new version of BELEN optimised for maximum total efficiency and spectrometric response			M.1.7 Completion of the design of the new version of the BELEN detector at UPC,	UPC M24	20 000 €	10 000 €
6		CEA	CEA/LNE-LNHB	SUBATECH, IFIC	M. Kellet	new measurement facility dedicated to the measurement of half-lives			M.1.3 Completion of a new measurement facility by CEA/LNE-LNHB,	M18 CEA/LNE-LNHB	36 000 €	10 000 €

Task 1.2: innovative devices for neutron emission studies

task leader : CERN Massimo Barbagallo

n°	subtask	Partners	Lead and financed institut	collaboration	project leader	Subject	deliverables	deliverable date & responsible	Milestones	Milestones date & responsible	EC allocated budget	WP 2 mens. allocated budget
6	1.2.1	CEA	CEA/IDEN/CAD		R. Jacqmin	build of a compact fast neutron spectrometer based on a single organic crystal,	D.1.4 "Report on the commissioning of a compact broad-band fast neutron spectrometer"	M36 CEA	M.1.4 Completion of the design of the fast neutron spectrometer at CEA/IDEN	M24 CEA	40 000 €	
7	1.2.2	CERN	CERN	Univ. Manch., NTUA, Univ. Ion., IFIN-HH	M. Barbagallo	development of Germanium detectors for (n,xn) measurements at n-TOF	D.1.6 "Report on the performance of the HPGe equipped with newly developed electronics"	M48 CERN	M.1.8 Completion of the commissioning of the HPGe equipped with newly developed electronics at CERN	M24 CERN	55 000 €	
8	1.2.3	CEA	CEA/DAM		G.Belier	development of the SCONE detector	D.1.5 "Report on the performance of the SCONE setup at NFS"	M48 CEA	M.1.9 Completion of the installation of the SCONE setup at NFS	M24 CEA	40 000 €	

Task 1.3: innovative devices for capture cross section measurement on actinides

task leader : CIEMAT Emilio Mendoza

n°	subtask	Partners	Lead and financed institut	collaboration	project leader	Subject	deliverables	deliverable date & responsible	Milestones	Milestones date & responsible	EC allocated budget	WP 2 mens. allocated budget
9	-	CIEMAT	CIEMAT	Univ. Sevilla	E. Mendoza	development of CLYC detector for (n,g) XS measurements @EAR2 n_TOF	D.1.7 "Report on the development and performances of the new detectors for capture cross section measurements at n-TOF"	M48 CIEMAT	M.1.10 Completion of the new detectors for capture measurements at n-TOF, CIEMAT, M36	M36 CIEMAT	60 000 €	
10		UPC	UPC		F. Calviño	extend the γ-TED technique for measurement on actinides @EAR2 n_TOF					15 000 €	

Task 1.4: detectors for non-energy application

task leader : PTB Ralf Nolte

n°	subtask	Partners	Lead and financed institut	collaboration	project leader	Subject	deliverables	deliverable date & responsible	Milestones	Milestones date & responsible	EC allocated budget	WP 2 mens. allocated budget
12	-	HZDR	HZDR	PTB	A. Junghans	DDX (n,cp) mess @ n-tof from 20 to 200 MeV	D.1.8 "Report on the development and performances of the new detectors for non-energy applications";	M24 PTB	-	-	26 000 €	0 €
13		PTB	PTB	HZDR	R. Nolte	DDX (n,cp) mess @ n-tof from 20 to 200 MeV					23 000 €	30 000 €

Hoping

¤ a fruitful collaboration,

¤ Efficient cooperation for reporting,

AND

¤ Nice and significant results !!!

Thank you for your attention…