Horizon 2020

SUPPLYING ACCURATE NUCLEAR DATA FOR ENERGY AND NON-ENERGY APPLICATIONS

SANDA

Kick-off meeting

E.M. Gonzalez-Romero (CIEMAT)

on behalf of the SANDA Euratom project

H2020 Grant Agreement number: 847552

CIEMAT, Atomki, CEA, CERN, CNRS, CSIC, CVREZ, ENEA, HZDR, IFIN-HH, IRSN, IST-ID, JRC, JSI, JYU, KIT, NPI, NPL, NRG, NTUA, PSI, PTB, SCK-CEN, Sofia, TUW, UB, ULODZ, UMAINZ, UMANCH, UOI, UPC, UPM, USC, USE, UU.

SANDA Basic data

H2020 Grant Agreement number: 847552

A project for the EURATOM WP2018 for NFRP-2018-4

Project Start date: 01/09/2019

Duration: 48 months

Requested contributions: 3.5 MEuros

35 Partners: *CIEMAT*, Atomki, CEA, CERN, CNRS, CSIC, CVREZ, ENEA, HZDR, IFIN-HH, IRSN, IST-ID, JRC, JSI, JYU, KIT, NPI, NPL, NRG, NTUA, PSI, PTB, SCK-CEN, Sofia, TUW, UB, ULODZ, UMAINZ, UMANCH, UOI, UPC, UPM, USC, USE, UU.

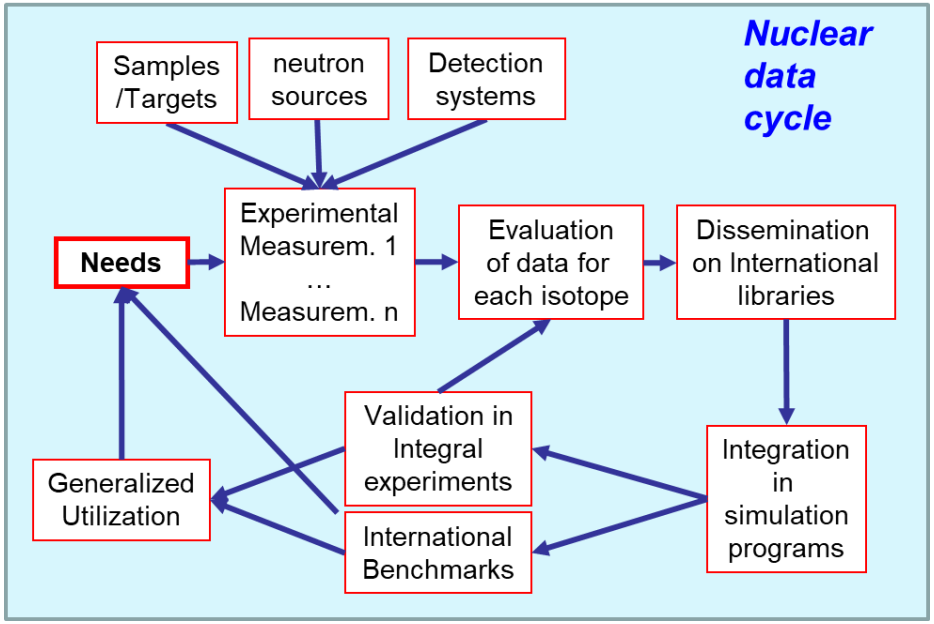
from 18 EU-countries (Au, Be, Bu, Cz, Fi, Fr, Ge, Gr, Hu, It, Ne, Pol, Por, Ro, Sln, Sp, Sw, UK) + Switzerland

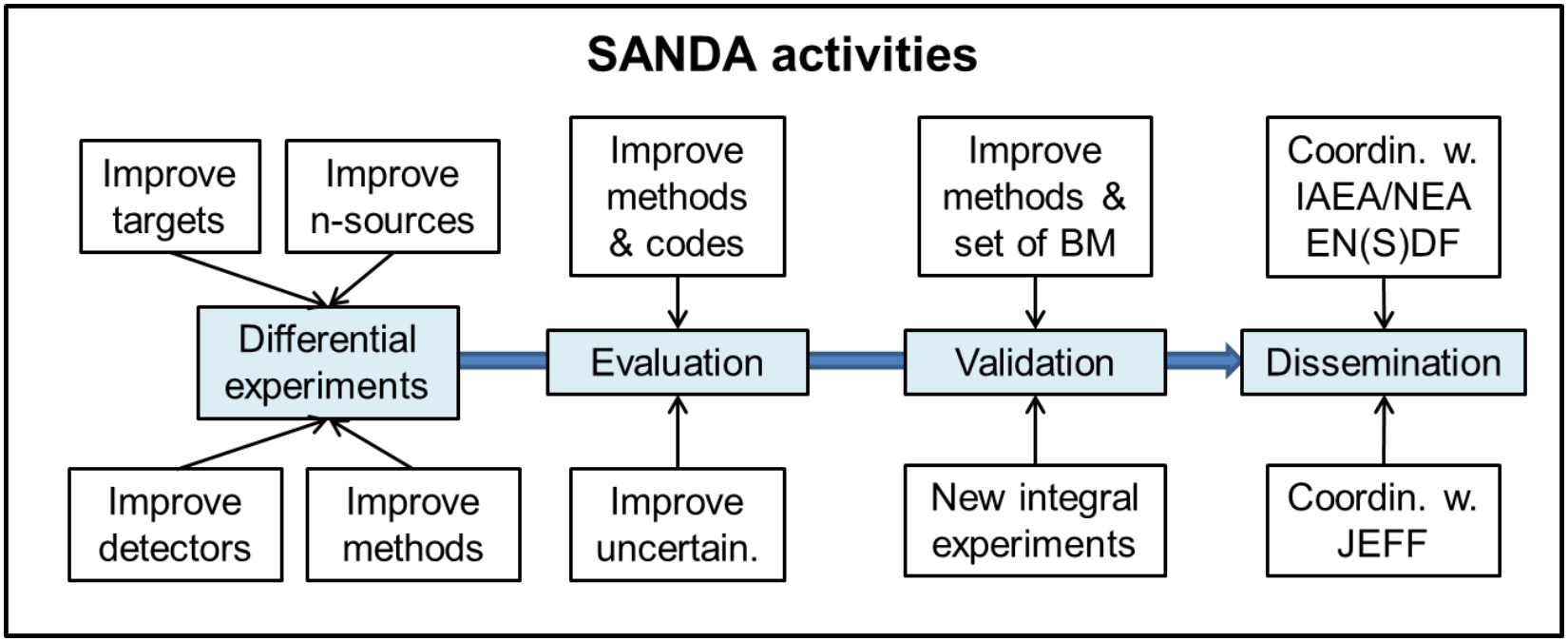
Coordinator: CIEMAT

SANDA Objectives

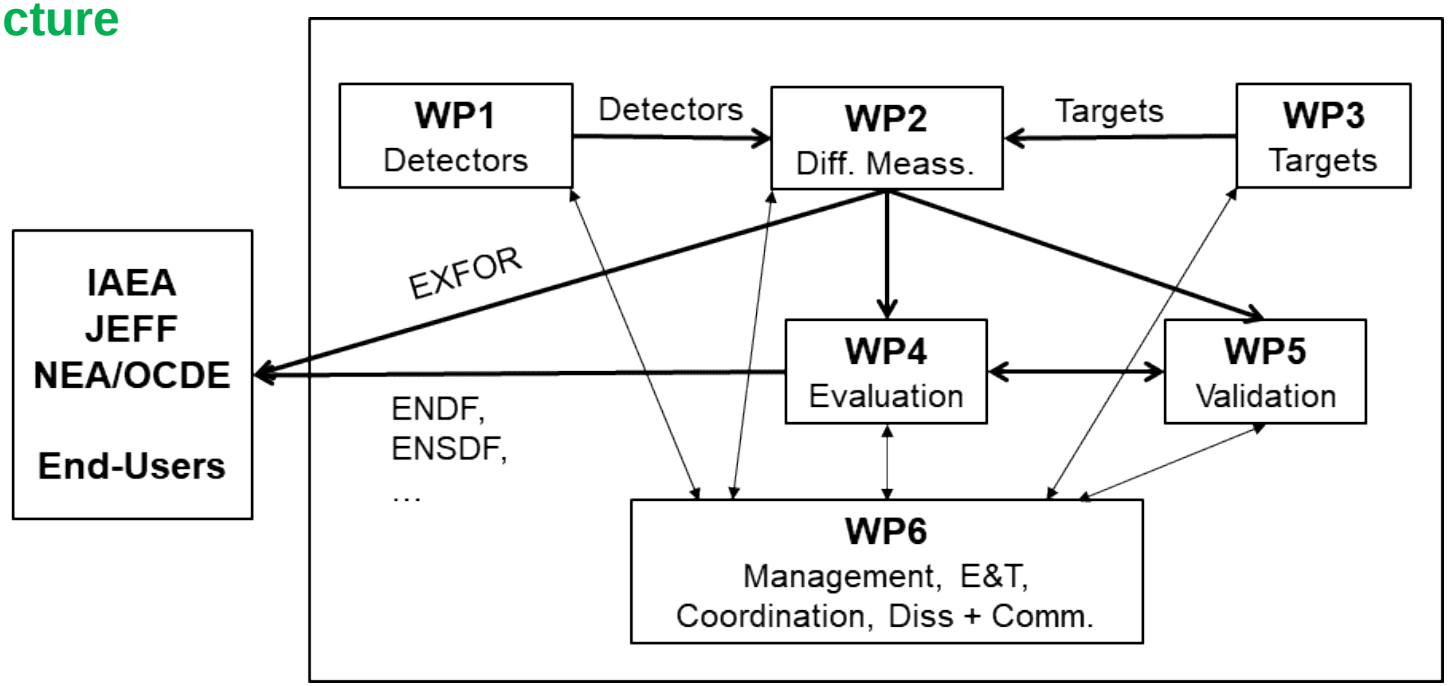
- The proposal will address aspects of nuclear data research to produce accurate and reliable tools including data, codes and methodologies that can be used to simulate, analyse, optimize, exploit and evaluate the safety of nuclear energy and non-energy applications.
- The proposal is built taking into 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.
- The project will strongly collaborate with the ARIEL proposal for access to Nuclear Data related facilities also approved by EURATOM WP 2018 NFRP7.

SANDA objectives





SANDA structure



WP #	Work Package Title	Lead P	PM
1	Developments of new innovative detector devices	CNRS	80.8
2	New nuclear data measurements for energy and non-energy applications	CIEMAT	213
3	Target Preparation for Improvement of Nuclear Data Measurements	PSI	66.2
4	Nuclear data evaluation and uncertainties	PSI	173.2
5	Nuclear data validation and integral experiments	CEA	69.2
6	Management, ND research coordination at EU level and Education and Training	CIEMAT	27.4

SANDA WP1: Developments of new innovative detector devices

Task 1.1: Innovative devices from fission cross section to fission products decay studies

Subtask 1.1.1: fission cross section

GRPD - gas recoil proton detector and a MicroMegas-based time projection chamber.

Subtask 1.1.2: fission yields and decay data studies

Coupling the FALSTAFF spectrometer with the FIPPS gamma spectrometer at ILL.
A new gas cell with electric field guidance at IGISOL.
A new version of the BELEN detector (based on the Bonner sphere principle).
Upgrades on half-life and nuclear decay data measurement facilities to allow half-life measurements for radionuclides important to the nuclear medicine and nuclear industry.

Task 1.2: Innovative devices for neutron emission studies

Subtask 1.2.1 fast neutron spectrometer

A new compact broad band fast neutron spectrometer will be developed to characterize neutron flux.

Subtask 1.2.2 neutron detectors

SCONE setup based on plastic scintillator bars wrapped with a Gd loaded material to measure (n,xn).

Subtask 1.2.3 gamma detectors

A new HPGe prototype 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: 2 for n_TOF EAR2

One based on the CLYC inorganic scintillator acting as γ-ray calorimeter or as total energy detector.
The second is based on total energy detectors with gamma-ray imaging capability (i-TED).

Task 1.4: detectors for non-energy application

Extending 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.

SANDA WP2: New nuclear data measurements for energy and non-energy applications 1/2

Task 2.1: Neutron induced fission and charged particle production cross sections

Task 2.1.1: Neutron induced fission cross sections

- Energy dependence of the nubar for the ^{235}U(n,f) cross section at JRC-Geel.
- Surrogate reaction excitation functions and cross sections for the ^{239}Pu(n,f), ^{241}Pu(n,γ) and ^{241}Pu(n,f) .
- New measurements of ^{230}Th(n,f) and ^{241}Am(n,f) cross section at the CERN n_TOF EAR2
- ^{239}Pu(n,f) cross section measurement with the STEFF spectrometer

Task 2.1.2: Neutron induced charged particle production cross sections

- ^{16}O(n,α) reaction in the energy range from the threshold up to 20 MeV
- ^{nat}C(n,lchp) reaction at NFS for improving cross section standards.
- New (n,chp) cross section data with a powerful array of hyper pure germanium detectors.
- Prompt fission neutron spectra above 10 MeV (^{235}U(n,f)) .

Task 2.2: Neutron capture cross sections

Subtask 2.2.1. Capture measurements of fissile isotopes

- Combined measurement of the ^{239}Pu(n,γ) and ^{239}Pu(n,f) cross sections at GELINA and n_TOF.

Subtask 2.2.2. Capture measurement of stable isotopes

- ^{92,94,95}Mo(n,γ) cross sections at GELINA and n_TOF .

Task 2.3: Neutron elastic and inelastic scattering and neutron multiplication cross sections:

- Neutron inelastic cross section measurements on ^{239}Pu, ^{233}U, ^{14}N and ^{35,37}Cl.
- Branching ratio for ^{209}Bi, ^{208}Pb(n,tot) and ^{238}U(n,inel) cross sections at GELINA.

SANDA WP2: New nuclear data measurements for energy and non-energy applications 2/2

Task 2.4: Decay data measurements

Subtask 2.4.1. Beta decay measurements with TAGs

High precision decay data for fission products from major and minor actinides with DTAS detector.

Subtask 2.4.2. Beta delayed neutron measurements

New measurements with the BELEN detector.

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

Measurement of half-lives for : ^{106}Ru, ^{153}Sm, ^{166}Ho, ^{186}Re, ^{212}Pb, ^{225}Ac and ^{223}Ra

Accuracy measurements of high priority isotopes defined in the framework of NFRP-2018-6 for SNF.

Task 2.5: Fission yields measurements

Subtask 2.5.1. Fission yield studies in (n,f) reactions

^{235}U at ILL by coupling the first arm of FALSTAFF to the new FIPPS γ-ray spectrometer.

Fission yield studies with the LOHENGRIN spectrometer at ILL.

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

Subtask 2.5.2. Fission yield studies in inverse kinematics

Test of (p,2p) as surrogate reactions for fission experiments (fission of ^{237}Pa).

Task 2.6: New measurements for non-energy applications:

Subtask 2.6.1. Spectrum averaged cross sections for dosimetry

Activity induced in foils by neutrons from a ^{252}Cf source via the ^{117}Sn(n,inl)^{117m}Sn and ^{60}Ni(n,p) .

Subtask 2.6.2. Measurement of cross sections relevant for hadron therapy

Measurement of double-differential charged-particle emission cross sections at n_TOF in the range from 20 MeV to 200 MeV.

Subtask 2.6.3. Measurement of beta+ emitters

High priorities of IAEA: ^{11}C, ^{13}N, ^{15}O, ^{30}P produced by protons <250 MeV (also ^{10}C, ^{12}N, ^{38m}K and ^{29}P).

SANDA WP3: Target Preparation for Improvement of Nuclear Data Measurements

Task 3.1: Intensification of the "producer – user – interaction"

A series of regular meetings of target makers with the users to better communicate the requirements from both sides. Support bilateral meetings and organize user workshops.

Task 3.2: Fostering the network of target makers

Sharing knowledge, equipment and resources as a key issue for efficient work in this high-cost and man-power intensive activity. Especially for producing radioactive targets, there are only a few laboratories in Europe, which are able and allowed to handle such material.

Task 3.3: Target production

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.

Task 3.4: Development of an isotope separator

Definition and development of the design of an isotope separator meeting the requirements for the special application as target production facility and the preparation of the site for the installation.
The final aim is to install at PSI a dedicated modern high efficiency, high transmission, high throughput mass separator designed for these special applications.

SANDA WP4: Nuclear data evaluation and uncertainties

Task 4.1: Nuclear reaction code developments and evaluations

Task 4.1.1: TALYS development

Test influence of theoretical parameters and improve prompt fission neutron and gamma observables.

Task 4.1.2: Nuclear reaction evaluation

Improve evaluation methodologies for nuclear data and the associated uncertainties, by making use of Bayesian inference and "model defect" methods. Provide *all evaluations with covariance* information.
New evaluations: new (n,xnγ) for the main actinides, Cr, actinides (U235, U238, Pu239, and Am241), important fission products (Sm, Nd, Cs, Mo, Ru, Eu, Gd, Rh) and the Pu isotopic chain (Pu238-Pu244)

Task 4.2: Fission yields and nuclear structure and decay data evaluations

Task 4.2.1: Evaluation of Fission yields

Deeply test some model assumptions used in the fission yield evaluations using the measurements of kinetic energy dependency of yields, isomeric ratios or isotopic distributions.

Task 4.2.2: Evaluation of nuclear structure and decay data

Perform ENSDF (Evaluated Nuclear Structure Data File) evaluations: theoretical calculations, evaluations, modern evaluation tools and nuclear data library production, 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

Best processing parameters for processing CE libraries with the AMPX system + checking, processing and verification of evaluated nuclear data files. Sensitivity calculations for fission yields.

Task 4.4: Applications

Selection/classification of benchmarks for nuclear data sensitivities and validation of nuclear data.

Task 4.5: High-energy model uncertainties

Investigate if the present methodology, using the Bayesian framework developed at CHANDA, can be generalized to the whole set of parameters of INCL and extended to ABLA.

SANDA WP5: Nuclear data validation and integral experiments 1/2

Task 5.1: Impact studies, sensitivity analyses, and assessment of needs for various applications

Subtask 5.1.1: Impact studies and sensitivity analyses

Impact of (JEFF) nuclear data uncertainties and systematic errors on reactor engineering design and safety parameters will be evaluated in a quantitative manner for innovative nuclear systems (and fuel cycles): sodium-cooled fast reactors such as ASTRID or ESFR, lead-cooled fast reactors such as MYRRHA and ALFRED, and the JHR.

+ Nuclear data sensitivity/impact on Criticality-safety and Decommissioning and waste disposal.

Subtask 5.1.2: Assessment of (JEFF) nuclear data need

Update of the OECD/WPEC/SG26 report and Recommendations will be made as to which nuclear data are in need of improvement and what “performance” gains can be expected as a consequence.

Task 5.2: Validation studies (using existing experiments)

Subtask 5.2.1: Assessing correlations in integral experiments

Assessments of “missing correlations in integral experiments” problem plus Simulations will be made to estimate the correlations.

Subtask 5.2.2: C/E validation and trends

C/E validations and sensitivity/uncertainty analysis on reactor physics experiments (IRPhE), shielding benchmarks (SIMBAD), criticality benchmarks and pile oscillation experiments (MINERVE/CERES). The results derived from these studies will be combined to validate nuclear data and analyze possible biases.

Gaps in the validation will be identified and discussed

SANDA WP5: Nuclear data validation and integral experiments 2/2

Task 5.3: New integral experiments

Subtask 5.3.1: Experiments at GELINA and MINERVE

Neutron transmission measurements at the JRC GELINA facility using the same samples used in the MINERVE/CERES measurements.
Samples are UO_2 matrix with a small admixture of a fission product: Sm, Nd, Cs, Mo, Ru, Eu, Gd, Rh
Combined analysis of MINERVE/GELINA to improve the fission product cross section in the resonances

Subtask 5.3.2: Experiments at LR-0

- Full characterization of a critical ^{235}U-fuelled configuration for an IRPhEP-quality type benchmark;
- Direct and indirect measurements of the ^{235}U prompt fission neutron spectrum;
- Measurements of spectrum-averaged cross sections in well-characterized neutron spectra (graphite)

Subtask 5.3.3: Experiments at TAPIRO

Measure minor actinide spectrum-averaged fission and capture cross sections.

SANDA WP6: Management, ND research coordination at EU level and Education and Training

Task 6.1: Management

Task 6.2: Sustainable framework for the coordination of the European nuclear data research

Task 6.3: Coordination of Education and training activities

Task 6.4: Coordination of Dissemination and Communication activities