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HORIZON 2020

PROJECT PRESENTATION (PP)

Supplying Accurate Nuclear Data for energy and non-energy Applications

SANDA

H2020 Grant Agreement number: 847552

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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 assessment of safety and performance 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 for the use of radioactive materials in non-energy applications, and for the interpretation of measurements in these facilities and systems. 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%. 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. Despite several decades of nuclear data research these levels of precisions have still not been reached for all the isotopes and reactions required and their determination raise important challenges. The quality and completeness of the nuclear databases is continuously improving thanks to large collaborative projects and indeed the tools developed in previous projects like ANDES and CHANDA, plus those being developed within SANDA, will bring at reach the target precision for some important isotopes/reactions. In addition, the R&D of SANDA will contribute to prepare the path (new detectors, facilities and methods) for future experiments addressing the remaining nuclear data needs in the years to come.

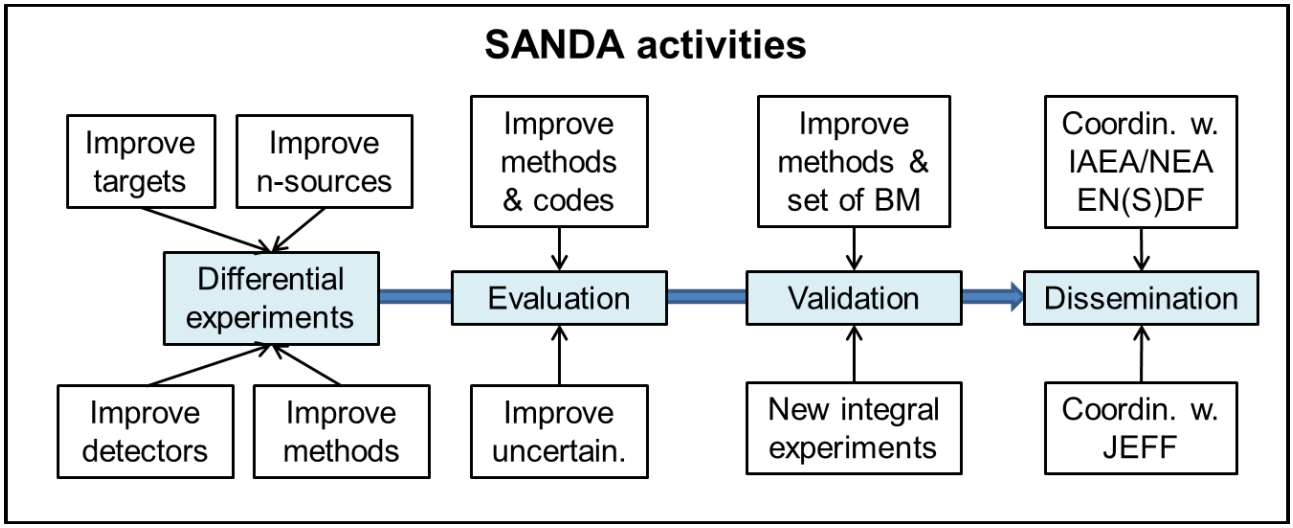
The SANDA project puts together most of the European nuclear data community, infrastructures and resources to prepare the methodologies, detectors, facilities, interpretation and tools to produce accurate and reliable nuclear data tools including data, codes and methodologies that can be used to simulate, analyse, optimize, exploit and evaluate the safety of nuclear energy and non-energy applications. The project 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. In addition, the project is preparing experimental infrastructures, detectors, measurement capabilities and methodologies to enable the European nuclear data community to provide the data to meet other high priority needs within the shortest possible delay.

SANDA includes 35 partners from 18 countries from EU plus Switzerland and the most relevant facilities to measure nuclear data. The participants of SANDA are strongly involved in previous EURATOM projects producing nuclear data, in present projects like ARIEL coordinating access to nuclear data facilities and in international organizations dedicated to the compilation, validation and distribution of nuclear data (NEA/OECD and IAEA). Indeed, the project has been prepared and it is being implemented in close contact with OECD/NEA, the IAEA Nuclear Data Section and the organizations contributing to the JEFF project. SANDA also collaborates closely with ARIEL.

SANDA benefits from and complements the developments of CHANDA and previous EURATOM projects, to perform its measurements at new or recently upgraded facilities (like NFS@GANIL and N_TOF Area_2@CERN, …) providing neutron fluxes orders of magnitude higher than those previously available, and using newly developed detectors and methods and optimized targets. SANDA also is developing and applying new evaluation and validation tools and associated integral experiments with special attention to the production and use of uncertainties and correlation matrices for experimental and evaluated data. The project covers the whole energy region for the needs of thermal and fast neutron reactors and non-energy applications, including the high energy data (up to few GeV) needed for the subcritical ADS and medical applications.

Special attention is taken to use the research developed in SANDA for the education and training of young scientists and engineers that will learn by doing their PhD in the project and by specific schools co-organized by SANDA. Also, very special care will be applied to the early and efficient

dissemination of the project results to the EU community of nuclear data users, making sure that results and data produced are openly available. The project also plans to contact the Nuclear Data R&D actors, funding agencies and associated stakeholders to prepare instruments that can provide a sustainable framework for the required nuclear data R&D at Horizon Europe and beyond.



To achieve all these objectives, SANDA, is making a significant effort on the developments of new innovative detector devices. This includes innovative devices for the fission reaction like the GRPD (gas recoil proton detector) or a MicroMegas-based time projection chamber, and the coupling of the FALSTAFF spectrometer with the FIPPS gamma spectrometer at ILL, or new gas cell at IGISOL, new version of BELEN and upgrades on half-life and nuclear decay data measurement facilities. There will be also developments for neutron detection like a new compact broad band fast neutron spectrometer or a new SCONE setup based on plastic scintillator bars wrapped with a Gd loaded material. Additional developments will be dedicated into gamma detectors like a new HPGe prototype with adapted electronics for fast operation, detectors based on the CLYC inorganic scintillator acting as calorimeter or as total energy detector, and the i-TED a total energy detector with imaging capability. Particular attention is also being devoted to detectors for non-energy application, extending the techniques at n_TOF EAR1, to measure DDX data for the neutron-induced emission of light charged particles from carbon, nitrogen and oxygen.

The preparation of experiments is also being enhanced by improvements in the target preparation for present and future experimental campaigns. These improvements are being suported by the intensification of the "producer – user – interaction" and by fostering the network of target makers. In addition, there is provision of the production of a number of targets by PSI and JRC for measurements included within SANDA, and the development of an isotope separator that would become a key element opening the path to future measurements that are not realistic today because of the present target manufacturing limitations.

With these tools, SANDA proposes an ambitious set of nuclear data measurements including:

- 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; ^{239}Pu(n,f) cross section measurement with the STEFF spectrometer.
- Neutron induced charged particle production cross sections: ^{16}O(n,α) reaction up to 20 MeV; ^{nat}C(n,lchp) reaction at NFS; new (n,chp) cross section data with an array of hyper pure germanium detectors; prompt fission neutron spectra above 10 MeV (^{235}U(n,f)) .

- Neutron 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.
- Neutron capture measurements of stable isotopes: ^{92,94,95}Mo(n,γ) at GELINA and n_TOF
- 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.
- Decay data measurements including data for fission products from major and minor actinides with DTAS detector; new beta delayed neutron measurements with the BELEN detector; measurement of half-live and g-ray emission probabilities of ^{106}Ru, ^{153}Sm, ^{166}Ho, ^{186}Re, ^{212}Pb, ^{225}Ac and ^{223}Ra.
- Fission yields measurements in (n,f) reactions: ^{235}U at ILL by coupling the first arm of FALSTAFF to the new FIPPS g-ray spectrometer; studies with the LOHENGRIN spectrometer at ILL; new method based on the PI-ICR for fission product yield studies at JYFL and ffission yield studies in inverse kinematics with a test of (p,2p) surrogate reactions.
- New measurements for non-energy applications: spectrum averaged cross sections for dosimetry (^{117}Sn(n,inl)^{117m}Sn and ^{60}Ni(n,p)); Measurement of double-differential charged-particle emission cross sections at n_TOF in the range from 20 MeV to 200 MeV relevant for hadron therapy; measurement of beta+ emitters (like the high priorities of IAEA ^{11}C, ^{13}N, ^{15}O, ^{30}P or the ^{10}C, ^{12}N, ^{38m}K and ^{29}P).

The experimental activities are complemented in SANDA by actions for nuclear data evaluation of different types like the continuous development of TALYS and new tools for nuclear reaction evaluation that could conduct to new evaluations (with covariance information) for (n,xng) 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). Developments are also applied to the evaluation of fission yields (using the measurements of kinetic energy dependency of yields, isomeric ratios or isotopic distributions) and to the evaluation of nuclear structure and decay data, performing ENSDF evaluations to improve the next version of the JEFF Radioactive Decay Data Library and the Evaluated Nuclear Structure Data File. Additional efforts are being applied to improve processing and sensitivity calculations for specific applications (different than criticality). High-energy models are also covered, paying particular attention to develop and comprehensive uncertainties model for this energy domain.

The production of new data is completed with several actions oriented to the validation of the measured and evaluated nuclear data files. This includes in one side impact studies and sensitivity analyses like the impact of (JEFF) nuclear data uncertainties and systematic errors on reactor engineering design and safety parameters for fast reactors and for the JHR, as well as assessment of (JEFF) nuclear data needs. On the other hand a number of validation studies will be performed using existing experiments and databases (like IRPhE, SIMBAD,…) assessing correlations in integral experiments and obtaining C/E validation and trends. Additionally, new integral experiments are being prepared and/or performed at GELINA, MINERVE, LR-0 and TAPIRO to improve the validation capabilities within SANDA and for future projects.

With all these elements, the project is expected to contribute, directly and indirectly, to the enhancement of the safety and competitiveness of the European nuclear industry by significantly improving the accuracy of nuclear data, this will also 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.

Project information

Website address: http://www.sanda-nd.eu/ (in construction)
Preliminary website: http://win.ciemat.es/sanda/

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