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Needs for a Comprehensive European Plan to Acquire and Curate Nuclear Data

Summary Report of the IAEA Consultants' Meeting
IAEA Headquarters, Vienna, Austria
25 – 27 April 2023

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ABSTRACT

A Consultant's Meeting was held at the IAEA to discuss the needs for a comprehensive European plan to acquire and curate nuclear data. Participants representing nuclear data groups, the nuclear physics community (NuPECC), and the existing funding agency (EURATOM), reviewed the status of nuclear data curation in Europe, including coordination, funding, and capacity building. A summary of the discussions as well as the list of recommendations and actions are included in this report.

August 2023

Contents

1. Introduction

Nuclear data are essential for energy and non-energy applications such as nuclear power (fission), research reactors, nuclear fusion, nuclear medicine, non-destructive testing, environmental monitoring, and cultural heritage. They are also important for nuclear physics researchers enabling them to enhance their knowledge and plan future activities that may lead to new discoveries.

The impact of credible and reliable nuclear data extends beyond the scientific community. Nuclear data libraries essentially bridge the gap between science, technology, and society. By effectively disseminating the outcomes of fundamental nuclear physics research to a wide range of users, these data libraries connect scientific knowledge with practical applications, benefitting various sectors of society.

The collection/compilation, evaluation and dissemination of nuclear data are laborious tasks that rely heavily on contributions from experts in both the basic and applied science research communities. Efforts carried out at national and international levels benefit from the coordination provided by international organisations such as the International Atomic Energy Agency (IAEA) in Vienna and the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (NEA-OECD) in Paris. The development and maintenance of nuclear data libraries, and dissemination of nuclear data to various user communities constitute major goals of the international networks associated with these agencies: the Nuclear Reaction Data Centres Network (NRDC/IAEA), the Nuclear Structure and Decay Data evaluators (NSDD/IAEA), and the Nuclear Energy Agency (NEA/OECD).

Support from national funding agencies for activities related to the compilation, evaluation and dissemination of nuclear structure and decay data has decreased significantly in Europe during the last two decades. On the other hand, experimental research activities have increased through the implementation of EU funding schemes, leading to a rapid growth in the production of new experimental data. A key issue for both basic and applied nuclear science is to ensure that the new data produced by on-going advances in nuclear science and technology are incorporated promptly into the available databases. One of the challenges in achieving this, is developing, and maintaining a high level of expertise in nuclear data evaluation to satisfy the data needs of a continuously developing user community.

The Nuclear Physics Expert Collaboration Committee (NuPECC), an expert committee under the auspices of the European Science Foundation, has an important role in coordinating and shaping the basic nuclear physics research landscape in Europe. On the occasion of the preparation of the new Long Range Plan 2024 for Nuclear Physics, NuPECC has engaged with the Nuclear Data Section to promote a concerted and comprehensive approach in support of nuclear data activities in Europe that would be sustainable and, at the same time, allow to maintain the locally produced nuclear data expertise and skills.

To this end, the Nuclear Data Section held a Consultants' Meeting at the IAEA Headquarters in Vienna, from 25 to 27 April 2023, to discuss the needs for a Comprehensive European Plan to acquire and curate nuclear data. Participants from EU countries representing the nuclear physics research and nuclear data community attended: E. Körner (Germany), NuPECC Secretary; A. Böltzig (Germany) for ChETEC-INFRA; M. Lewitowicz (France), NuPECC Chair; S. Leray (FRANCE) for CEA; E. Widmann (Austria), NuPECC Deputy Chair; R. Garbil (EU) for EURATOM, and IAEA staff S. Charisopoulos (Physics), D. Ridikas (Physics), A. Koning (Nuclear Data), and P. Dimitriou (Nuclear Data). A. Koning, Head of the Nuclear Data Section welcomed participants to the IAEA and P. Dimitriou, the Project Officer, set out

the goals of the meeting in the introduction. M. Lewitowicz was elected Chair and E. Körner Rapporteur of the meeting, respectively.

On Tuesday, Keith Jankowski, Nuclear Data Program Manager, from the US Department of Energy, Office of Science, joined the meeting remotely to give a guest presentation on the US Nuclear Data Program and other inter-Agency activities aimed at enhancing the nuclear data evaluation effort in the US.

On Wednesday afternoon, meeting participants were given a tour of the Nuclear Science and Instrumentation Laboratory in Seibersdorf by the Head of the Laboratory, K. Kanaki.

The summary report is organised as follows: summaries of the presentations are given in Section 2, while a summary of the discussions, recommendations and actions is given in Section 3. Conclusions are summarized in Section 4. The meeting agenda and participants' list are available in Annexes 1 and 2, respectively. The presentations can be found on the meeting website: https://conferences.iaea.org/event/347/

2. Summaries of presentations

2.1. Curated Nuclear Data at the Nuclear Data Section, P. Dimitriou (IAEA)

Accurate quantification of fundamental nuclear parameters, including nuclear structure and decay data, reaction cross section data, fission decay parameters, and other properties that characterize the interaction of ions with matter, is crucial for a wide range of applications, both in the energy and non-energy sectors. These applications encompass areas such as power-related technologies, reprocessing and waste management, non-proliferation efforts, nuclear medicine, environmental monitoring, materials analysis, and preservation of cultural heritage.

The Nuclear Data Section (NDS) of the International Atomic Energy Agency plays a vital role in satisfying the need for reliable and precise information. The Section is responsible for collecting, evaluating, and recommending specific nuclear data serving energy and non-energy purposes alike. In addition to its role in data assessment, the Section also maintains numerous databases and associated search infrastructure to facilitate access to these valuable resources.

In fulfilling its role as provider of reliable nuclear data, associated information and online databases, the IAEA NDS relies on the following tools:

- International coordination of networks,
- International coordination of research projects,
- Organisation of international meetings of experts,
- Capacity building through international workshops.

NDS coordinates three international networks of experts: the Nuclear Structure and Decay Data evaluators network (NSDD), the Nuclear Reaction Data Centers network (NRDC), and the International Nuclear Data Evaluation Network (INDEN).

- NRDC: a network of Data Centers tasked with the compilation of experimental nuclear reaction data into the Exchange Format database (EXFOR) [1]. The network was created in 1975 as a merger of the four reaction data centers existing at the time (Nuclear Data Section/IAEA, National Neutron Cross Section Center/BNL, ENEA Neutron Data Compilation Center/Saclay, Nuclear Data Information Center/Obninsk). At present, NRDC comprises 13 Data Centers from all over the world (China (CIAE), Hungary, India, Japan (2), Korea, Russia (3), Ukraine, USA/BNL, IAEA, NEA Data Bank). EXFOR is hosted at NDS. (https://www-nds.iaea.org/nrdc/)

- NSDD: a network responsible for the evaluation of nuclear structure and decay data that populate the Evaluated Nuclear Structure Data File [2]. The network was established in 1974 and currently comprises 18 Data Centers including NDS, 7 Data Centers from the US (ANL, BNL, LBNL, MSU, ORNL, TAMU, TUNL) and centers from Australia, Canada, China (2), Bulgaria, Hungary, India, Japan, Romania, and Russia. The ENSDF database is hosted at NNDC/BNL. The evaluation process is managed by NNDC/BNL while the network is coordinated by NDS. (https://www-nds.iaea.org/nsdd/)
- INDEN: a network that was created relatively recently and serves as a platform for the exchange of know-how, expertise, and evaluated methodologies and best practices in the evaluation of nuclear reaction data [3]. Evaluated data files produced within the INDEN network are disseminated on the IAEA website. The network comprises three separate working groups focused on the evaluation of nuclear reaction data for light-elements, for structural materials, and for actinides. (https://www-nds.iaea.org/INDEN/). Evaluated nuclear reaction data are generally included in the ENDF libraries produced in the US (ENDF/B), in Europe (JEFF), Japan (JENDL), China (CENDL), Russia (BRON and ROSFOND).

The databases and libraries listed above (EXFOR, ENSDF, and ENDF libraries) are curated databases and libraries, in so far as they are comprehensive and complete, continuously maintained up to date and developed to capture the progress and developments in nuclear measurements and evaluation methodologies. They rely strongly on both well-established infrastructures and dissemination tools which are also continuously maintained and improved. While those activities in connection with infrastructures, dissemination and coordination are mainly the responsibility of the coordinating data centers (NNDC/BNL, IAEA, NEA), the compilation and evaluation of the nuclear data that are the source of the databases/libraries are the jobs of nuclear scientists from the basic and applied research communities who form the international networks and collaborations.

The past few decades have seen a sharp decline in the number of trained contributing nuclear data evaluators, as well as in the contributions of existing nuclear data evaluators worldwide. Focusing on nuclear structure and decay data evaluation and the NSDD network, the following observations are made:

- There is a shortfall in ENSDF evaluators due to the lack of funding in Europe, India, Japan, Russia, and Australia.
- The overall evaluation effort outside the US has dropped to about 5% in the past 5 years except for Canada which contributes up to 15% alone (however, this effort is funded by the US DoE).
- While the number of evaluators in the US has remained stable overall, the actual evaluation effort in the US has dropped by approximately 30%.
- The total evaluation effort is estimated to be the equivalent of 6.8 full-time evaluators, leaving a clear gap considering the 12 full-time equivalent that is needed to maintain the 10-year updating cycle.
- The retirement of experienced senior evaluators is not compensated by timely recruitment of new evaluators.

The main consequences of the above facts are that (i) ENSDF is falling short of capturing all the new measurements in a timely manner and (ii) there is a gradual loss of nuclear data evaluation expertise particularly in Europe, Japan, and Russia. The fact that new measurements are not incorporated in the database in a timely manner means that the experimental effort that is funded and supported by national and EU agencies, are not having a direct impact in applications and hence on society at large.

For the last twenty years, the IAEA has been working to promote awareness of this dire situation and involve the nuclear physics research and nuclear data community in these efforts [4,5,6,7]. However, this bottom-up approach that is based on reaching out to the community of experts and researchers,

has not been that effective. In Europe, the root of the problem is the lack of a centralised European Nuclear Data Agency or a European Nuclear Data Program like the US Nuclear Data program organisation. The only channels available for obtaining funding for nuclear data are competitive EURATOM-funded fixed-term projects. The current situation clearly shows that this type of funding is not adequate to create a sustainable and robust nuclear data evaluation effort.

The key questions that the European basic and applied research community should answer, especially now that the NuPECC Long Range Plan 2024 is in preparation, are:

- What are the data needs of the European nuclear physics community?
- Are the European nuclear physics measurements being promptly incorporated into the databases to have an impact in applications and societal benefits?
- What is the European nuclear physics community going to do to:
  - Address the gaps in the databases?
  - Incorporate new measurements in the databases in a timely manner?
  - Ensure that nuclear physics measurements ARE USED in applications?

The role of the IAEA in addressing the above outstanding issues is to provide support through international coordination (networks, meetings, town hall meetings), training (ICTP workshops, IAEA workshops), outreach activities to promote nuclear data evaluation, evaluation tools and dissemination, and partial financial support (seed grants) to establish mentorship schemes on nuclear data evaluation.

References:

[1] N. Otuka, et al., Nucl. Data Sheets **120** (2014) 272.
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[5] D. Balabanski and A.L. Nichols, Reference Data Libraries for Nuclear Applications – ENSDF, Summary Report of the Technical Meeting, 10-11 November 2008, IAEA, Vienna, Report INDC(NDS)-0543.
[6] A. Negret, D. Balabanski, P. Dimitriou, et al., EPJ Web of Conferences **146** (2017) 02042.
[7] https://nupecc.org/pub/lrp17/lrp2017.pdf

2.2. Nuclear Data in the NuPECC Long Range Plan 2024 for European Nuclear Physics, M. Lewitowicz (GANIL)

The Nuclear Physics European Collaboration Committee (NuPECC) [1], hosted by the European Science Foundation, today represents a large nuclear physics community from 22 countries, 3 ESFRI (European Strategy Forum for Research Infrastructures) nuclear physics infrastructures and ECT* (European Centre for Theoretical Studies in Nuclear Physics and Related Areas), as well as from 4 associated members and 9 observers.

The importance of nuclear data for fundamental research and numerous applications is recognized in all recent NuPECC reports. For example, in the NuPECC 2022 report on “Nuclear Physics in Everyday Life” (>100 pages, on-line and printed version available at https://nupecc.org/pub/np_life_print.pdf) it is stated that: “The profound understanding of nuclear structure and behaviour, plus all the data collected on nuclear reactions, which are achieved through major nuclear physics experimental programmes, also underpin progress in developing advanced forms of nuclear energy.”

NuPECC, as one of its major activities, regularly organises a consultation of the community, leading to the definition and publication of a Long Range Plan (LRP) for European nuclear physics. To this aim, NuPECC has in the past produced five LRPs: in November 1991, December 1997, April 2004, December 2010, and November 2017 [2]. The LRP identifies opportunities and priorities for nuclear science in Europe and provides national funding agencies, ESFRI and the European Commission with a framework for coordinated advances in nuclear science in Europe. It serves also as a reference document for the strategic plans for nuclear physics in the European countries.

In the LRP 2017, among identified "key issues" for the nuclear physics community one can find:

"…

- Accurate nuclear data and predictive modelling of nuclear processes;
- Ensure that the new measurements performed in the European facilities are incorporated promptly into the available databases and are therefore used in both reaction modelling and evaluations that are important for energy and non-energy applications."

The specific recommendations of the LRP2017 with respect to the nuclear data are the following:

"…

- Considering the large effort required on the evaluation process, it is important that a continuous support be ensured to the evaluation community, at present rather weak, with fresh new forces needed all over Europe. In this respect, the training of a new generation of young researchers is becoming mandatory.
- The European research funding programs bring together the majority of European neutron sources. The projects ERINDA, CHANDA, ANDES, etc., help to prepare the methodologies, facilities, detectors, interpretation, and tools to produce and use nuclear data with very high quality. Such intensive cooperation is the main reason of significant improvement of the experimental (EXFOR) and evaluated (ENDF) databases and the TALYS code during last years. It will be important to use the Horizon 2020 program in the same way."

NuPECC published in February 2022 an assessment of the implementation of the LRP 2017 [1] which summarises achievements in nuclear science and techniques resulting from the LRP recommendations. In this report, the progress in the collection and evaluation of nuclear data between 2017 and 2022 is summarized as follows:

"…

- Collaborative efforts to improve data relevant for nuclear energy have been developed. The involvement of international institutions such as the IAEA and the Nuclear Energy Agency of OCDE has been very important to set up a Joint Evaluated nuclear data Library for Fusion and Fission (JEFF).
- The Horizon 2020 program has supported several projects: SANDA, which is focused on the safety of European nuclear installations, and ARIEL, which provides transnational access to a variety of neutron facilities across Europe.
- The JEFF collaboration was central in assessing and addressing nuclear data needs for the MYRRHA project. A collaboration agreement between SCK CEN and the Joint Research Centre (JRC) of the European Commission focused on the neutron-induced cross section for lead and bismuth.
- Neutrons for Science (NFS) at SPIRAL2 began experiments in 2021."

In May 2022, NuPECC took the decision to launch the process of creating a new Long Range Plan for Nuclear Physics in Europe with the aim of publishing the document in 2024 [3]. With the intention of strengthening the bottom-up approach that has always played an important role in its LRPs, NuPECC has opened a call for contributions to the next LRP describing the view of collaborations, experiments, or communities on the key topics for the next 10 years to be included in the upcoming LRP. All 153 received and validated community contributions are now posted at a dedicated NuPECC Web page [4].

Nuclear Data are explicitly mentioned in 18 contributions to LRP2024 and one of them entitled "Nuclear Data for Science and Technologies" [5] deals with the most important topics and needs in this domain:

- Scientific context
  - needs for data at the few % level precision, role of EURATOM projects and OECD/NEA and IAEA
- Nuclear data for nuclear technology
  - new reactor designs, safety, waste management
- Nuclear data applications for fundamental research
  - resonant structure at low neutron energy, nuclear astrophysics
- Important cross cutting applications with radiation therapy
  - secondary reactions with neutrons and ions
- Maintenance of competencies in the nuclear data field
  - importance of infrastructures and well-trained scientists

The above-mentioned contributions to the LRP2024 are being analysed by ten LRP2024 Thematical Working Groups (TWGs). A draft of the LRP recommendations elaborated by the LRP Steering Committee in collaboration with the TWG Conveners is expected to be available for consultation with the whole community at the end of 2023. The final version of the NuPECC LRP2024 will be published in 2024.

In summary, Nuclear Data for fundamental research and applications has been one of the major topics in the past and remains so in the current NuPECC LRP2024. NuPECC is ready to play the role of facilitator and to trigger new concrete initiatives related to Nuclear Data. The implementation of the recommendations related to Nuclear Data will require considerably greater efforts than today's, in terms of resources and organisation to be provided by national, European, and international funding organisations.

References:

[1] https://nupecc.org
[2] https://nupecc.org/pub/lrp17/lrp2017.pdf
[3] https://nupecc.org/?display=lrp2024/main
[4] https://nupecc.org/?display=lrp2024/call_for_input
[5] https://indico.ph.tum.de/event/7050/contributions/6292/

2.3. Nuclear Data at the CEA, S. Leray (CEA-Saclay)

The CEA, with all its divisions involved, has a significant, high expertise work force, probably unique in Europe (and in the world), spanning the whole chain of Nuclear Data (ND) production, from differential measurements and theory to validation and evaluation.

Nuclear Data at DES (Energy Division)

The nuclear data activities at DES are mainly conducted at the IRESNE Institute in Cadarache and focus on nuclear data for fission reactor applications, including fuel cycle inventories. They are driven by the CEA R&D programs on the optimization of French GEN-2 and GEN-3 PWRs and the related fuel cycle (e.g., extension of reactor lifetime, EPRs starting, waste minimization) and studies of new concepts, such as SMRs and GEN-4 reactors, of interest for France. The current ND files show good performance for existing reactors and fuel cycle. However, such a good agreement sometimes results from error compensations. As ND uncertainties tend to dominate in state-of-the-art reactor simulations, a general goal is to get more precise and unbiased evaluated data with, as far as possible, associated covariance data. These activities are conducted in strong connection with the DES simulation program that aims at developing and validating more and more precise and reliable neutron transport and inventory codes (APOLLO3, TRIPOLI4, DARWIN…).

CEA/DES is involved in:

- Differential measurements, mostly through national or international collaborations, often with CEA/DRF and CNRS, at JRC Geel, CERN n-TOF, GANIL/NFS, ILL. The measured data are neutron-induced reaction cross sections, nature-multiplicity-energy distribution of emitted particles, fission yields, energy released, with the corresponding uncertainties.
- Integral measurements, using data from French power reactor operation and from former DES critical facilities. Since the shutdown of these facilities in 2018, DES had to turn to international collaborations to acquire new validation data (NEA ZPR Task Force).
- Model and code developments (CONRAD, FIFRELIN), integrating the latest theoretical advances, to avoid fits to postulated laws, for better internal consistency.
- Evaluations, with a particular expertise in the resonance energy range, which are a major contribution to JEFF, in collaborations with CEA/DAM, CNRS/IN2P3, NEA, and IAEA.
- Validation with analyses of experiments involving reactor physicists: C/E, sensitivity/impact studies, uncertainty assessment.

Nuclear Data at DRF (Fundamental Research Division)

In the Nuclear Physics Department (DPhN), the LEARN laboratory (around 9 permanent staff plus postdocs and PhD students) is devoted to studies and applications of nuclear reactions. It benefits from strong links with the LENA laboratory of DPhN, studying nuclear structure and reactions through experiments at GANIL, GSI, RIKEN, or Isolde, and developing microscopic calculations of nuclear structure with different techniques (ab-initio approach, mean field...).

The experimental activities are focused on three domains:

- Neutron capture and fission cross section measurements on actinides: with thermal neutrons at ILL for almost all minor actinides and, since 2000, in the resonance region at n_TOF.
- Fission yields and fragments properties measurements: yields at ILL with the Lohengrin spectrometer and the gamma-prompts with the FIPPS spectrometer; since 2022, fission yields of actinides correlated to neutron multiplicities at NFS with the Falstaff spectrometer.
- Decay of fission products: measurements of fission antineutrino energy spectra (Double-Chooz, Nucifer, Stereo and Nucleus).

In addition, the laboratory has an important activity on modeling and code developments:

- modeling of fission electron and antineutrino energy spectra
- INCL code developments for high-energy nucleon-induced reactions

Nuclear Data at DAM (Military Applications Division)

The Service de Physique Nucléaire (SPN) at CEA/DAM has a longstanding involvement in the field of Nuclear Data, combining experiments, theory, and evaluations. SPN carries out studies of the static (mass, density, energies) and dynamic properties of nuclei and of nuclear reactions, with a particular expertise on fission, photo-nuclear reactions, and isomers.

Experimental activities, which involve the conception and construction of innovative detectors, are conducted either at CEA/DIF facilities or at French or foreign research infrastructures, often in collaboration with CEA/DRF or CNRS/IN2P3. Examples of recent experiments are:

- strength function and level density measurements with the SFYNCS device at CEA-DIF;
- ^{239}Pu(n2n) measurement at CEA-DIF with the NENUPHAR tandem;
- $\bar{\upsilon}$ and χ measurements on actinides at Los Alamos in the framework of a DAM/NNSA collaboration;
- measurements of fission yields and several observables in correlation using inverse kinematics at GSI (SOFIA collaboration) and GANIL (VAMOS).

SPN has an important activity on theory and evaluation. It is a renowned laboratory for theoretical nuclear physics, which enables it to develop models and codes for evaluation purposes that are increasingly based on microscopic physics, such as QRPA calculations (based on the Gogny effective force). The aim is, thanks also to the comparison with increasingly comprehensive experimental data providing constraints on theoretical models, to progress towards parameters common to all systems and to try to resolve possible compensation effects in current evaluations. A substantial effort is also devoted to uncertainty estimation and reduction, using Bayesian approaches, and production of covariance matrices.

Nuclear Data at DRT (Technological Research Division)

Having been involved in their evaluation for the last 50 years, The LNHB has unique expertise on nuclear decay data and is responsible for the decay data sub-library in JEFF. LNHB coordinates the Decay Data Evaluation Project (DDEP), an international collaboration initiated in 1993 by CEA LNHB (France) and PTB (Germany) and joined by a few evaluators from other countries in the world. Right from the beginning, strong links have been established with the ENSDF evaluators through the NSDD network, coordinated by the IAEA. Activities include database management, dissemination, evaluations, and the review process. This library, which contains about 230 evaluated nuclei, is mainly dedicated to the metrology community, and published by the International Bureau of Weights and Measures (BIPM).

Since 2016, the collaboration has been faced with a strong decrease of manpower due to retirements, decrease in international contribution, and funding difficulties. The current effort has become sub-critical and is currently limited to about 1 FTE, essentially supported through the French metrology programme.

The LNHB is highly involved in the measurement of decay data, for metrology, medicine, and nuclear reactor purposes, including high-precise techniques such as γ-ray spectrometry for absolute emission intensity measurements and low temperature detectors to determine x-ray emission intensities and beta/electron capture decay spectra. Half-life measurements are also being undertaken.

Unique expertise has also been developed in the theory of beta decays and electron captures, leading to the development of the BetaShape code which was recently adopted for evaluating decay data by both DDEP and ENSDF communities.

2.4. US Nuclear Data Program and Nuclear Data InterAgency Working Group, K. Jankowski (DoE, Office of Science, Nuclear Physics)

The presentation focused on the US Nuclear Data Program (USNDP), US based working groups on nuclear data, updates on the annual Workshop on Applied Nuclear Data Activities (WANDA), and potential upcoming initiatives.

The USNDP, led by the Department of Energy, Office of Science (DOE/SC), Nuclear Physics (NP), has the mission to provide current, accurate, and authoritative data for scientists working in pure and applied areas of nuclear science and engineering. This is done through data compilation, evaluation, dissemination, and archiving in databases. Data gaps are also addressed through targeted experiments and theoretical models. The USNDP infrastructure is a priority for NP and work is being done to invest in its people and databases.

Two working groups exist, both from the US federal agencies and national labs/universities, with the purpose of coordination and collaboration intended to lead to a more efficient use of resources. The Nuclear Data Working Group (NDWG) has been organizing annual workshops since 2014 to discuss nuclear data needs, overlaps, and to prioritize. This has led to coordinated federal agency funding opportunities, with $50M having been invested by DOE offices since 2015.

Outreach continues to find areas that need nuclear data. The most recent example is a coordinated meeting between the nuclear data and fusion energy communities, particularly industry. These on-going discussions will lead to identification and prioritization of nuclear data needs for fusion energy, as well as any overlaps with other application areas. The Nuclear Science Advisory Committee (NSAC) also completed a report describing ways to enhance the nuclear data program. Finally, international coordination is important because nuclear data plays a critical role in all areas of nuclear science and engineering.

2.5. Nuclear Data Activities at EURATOM in the last two decades, R. Garbil (EURATOM)

The European Atomic Energy Community (Euratom) Research and Training framework programmes are benefitting from a consistent success in pursuing excellence in research and facilitating Pan-European collaborative efforts across a broad range of nuclear science and technologies, nuclear fission, and radiation protection. To fulfil Euratom R&D programmes' key objectives of maintaining high levels of nuclear knowledge and building a more dynamic and competitive European industry, the promotion of Pan-European mobility of researchers is implemented by co-financing transnational access to research infrastructures and joint research activities, including the JRC, through Research and Innovation, Coordination and Support Actions, European Joint Programme, and partnership funding schemes. The establishment of European technology platforms is capitalised by the research community. Mapping of research infrastructures and E&T capabilities allows a closer cooperation within the European Union and beyond, benefitting from multilateral international agreements and from closer cooperation between Euratom, OECD/NEA, IAEA, and international fora. Euratom success stories in facilitating Pan-European E&T collaborative efforts through Research and Training framework programmes show the benefits of research efforts in key fields, of building an effective 'critical mass' and implementing European MSc curricula, of promoting the creation of 'Centre of Excellence' with an increased support for 'Open access to key research infrastructures', exploitation of research results, management of knowledge, dissemination and sharing of learning outcomes.

Successful EU/Euratom projects selected on a competitive basis and promoted through the scientific community (detailed information on all projects is available both on their website and on CORDIS) covered highly relevant E&T needs for research organisations, industry, and associated end users.

Nuclear data and associated tools are also critical elements of the nuclear energy industry and research, playing an essential role in the simulation of nuclear systems, safety and performance calculations and interpretation of the reactor instrumentation. Nuclear data improvement requires the combination of much different expertise distributed over many small- and medium-sized institutions across Europe. The Euratom programmes have facilitated the setup of Pan-European collaborations getting together the required expertise inside the latest projects CHANDA, SANDA, ERINDA, ARIEL and the JRC action EUFRAT. The holistic and inclusive approach of these projects has enabled the coordination of European nuclear data research capabilities to improve the facilities, detectors, models and evaluation, validation, and simulation tools. This all-encompassing approach highlights the success stories and provides a summary of the achievements and their impact on the EU nuclear safety and industry, together with an outlook for the future.

The next EURATOM Fission WP2023-25 will provide further opportunities and continuity for research and innovation in this area alongside priorities mostly related to advanced and innovative technology such as Small and Modular Reactors SMRs, Advanced Modular Reactors AMRs and innovative Generation-IV systems GIF. In addition, both basic and applied sciences reliable curated nuclear data provided through the EURATOM reactors and accelerators' research Community also serves scientific fields such as astrophysics, material science, and even radiation therapy.

There is strong international coordination through Euratom or agencies such as the IAEA, the OECD Nuclear Energy Agency, the US Nuclear Data Program, but gaps exist in the international plans for the coordination and oversight of these databases, and available resources are insufficient.

There are today strong needs for a Comprehensive European plan to acquire and curate nuclear data for the wider scientific community. High-level recommendations from this consultancy meeting should create the proper conditions - through in-kind and dedicated funding schemes – so that the most relevant actors involved in the field of nuclear data, at both European and international level, can achieve the following:

a) ensure that new measurements performed in the European Facilities are incorporated promptly into the available databases and are therefore used in both reaction modelling and evaluations that are important for energy and non-energy applications – a challenge for both basic and applied nuclear physics communities.
b) support activities in compilation, evaluation and dissemination of nuclear structure and decay data in Europe, and
c) maintain a high level of expertise in nuclear data evaluation to meet the requirements of a continuously developing European research and applied sciences landscape through targeted training and mentorship schemes.

Background information: The latest EU collaborative platforms (fora or initiatives) strategic documents, roadmaps or review reports are valuable contributions *inter alia* from the Sustainable Nuclear Energy Technology Platform (SNETP)[1] – composed of the three major pillars, Generation II & III Alliance (NUGENIA), the European Sustainable Nuclear Industrial Initiative (ESNII) and Nuclear Cogeneration Industrial Initiative (NC2I) – the Implementing Geological Disposal Technology Platform (IGD-TP)[2] and the Multidisciplinary European Low-Dose Initiative (MELODI)[3] and other European fora such as the European Nuclear Energy Forum (ENEF)[4], the European Nuclear Safety Regulators Group (ENSREG)[5], the European Technical Safety Organisations Network (ETSON)[6], the Nuclear Europe Industrial Association (ex- European Atomic Forum (FORATOM))[7], the European Energy Research Alliance Joint Programme on Nuclear Materials (EERA JPNM)[8], the Generation IV International Forum (GIF)[9], the Heads of the European Radiological Protection Competent Authorities (HERCA)[10], the International Commission on Radiological Protection (ICRP)[11], the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)[12], together with dedicated international working groups and review reports of the Nuclear Energy Agency (OECD/NEA)[13] and the International Atomic Energy Agency (IAEA)[14] at international level. Work Programme and calls for proposals are published on the EU 'Funding and tender opportunities' portal[15]. Public project results are published on the European Commission R&D Information System (CORDIS)[16].

1 https://snetp.eu/
2 https://igdtp.eu/
3 https://melodi-online.eu/
4 https://energy.ec.europa.eu/topics/nuclear-energy/nuclear-safety/european-nuclear-energy-forum-enef_en
5 https://www.ensreg.eu/
6 https://www.etson.eu/
7 https://www.nuclearеurope.eu/
8 http://www.eera-jpnm.eu/
9 https://www.gen-4.org/gif/
10 https://www.herca.org/
11 https://www.icrp.org/
12 https://www.unscear.org/
13 https://www.oecd-nea.org/
14 https://www.iaea.org/
15 https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/programmes/horizon
16 https://cordis.europa.eu/

2.6. Report on the SANDA project, E. Gonzalez (in absentia)

(http://www.sanda-nd.eu/)

The project started on 01/09/2019 with a duration of four years initially but was granted an extension of one year. It comprises 35 Partner institutes from 18 EU countries (Au, Be, Bu, Cz, Fi, Fr, Ge, Gr, Hu, It, Ne, Pol, Por, Ro, Sln, Sp, Sw, UK) and Switzerland and has integrated a large fraction of the European Nuclear Data community. To ensure efficient use of funds, time, and human resources, the project was built on a close collaboration with ARIEL and use of other mobility tools, it exploited results and tools from previous EURATOM projects such as ANDES, CHANDA, and benefited from the collaboration with the international organizations (IAEA, NEA/OECD, JEFF) and adoption of their recommendations for priority topics and isotopes.

The main objectives of the project are (i) to address the important data needs with present tools to the extent that it is possible (measurements, samples, evaluations, validation), (ii) improve the tools for addressing important and not yet reachable data needs as soon and as efficiently as possible (detectors, facilities, samples Labs, sensitivities, evaluation tools, new benchmarks, data needs), (iii) focus mostly on experimental data and on providing new results and new tools, and (iv) cover all aspects of the nuclear data cycle.

SANDA Status

Despite the limitations due to COVID-19, the project is making good progress in all the proposed activities and is providing many results in the following areas:

1. Detector development

New detectors for fission include the production of a first prototype of the Micromegas XY-strip detector, the experimental validation of a new Gaseous Proton Recoil Telescope, the improvement of FALSTAFF which is now ready for the experiment at NFS, the design and testing of the new neutron detector BRIKEN, the design and testing of other neutron detectors (Stilbene, SCONE) and the testing of the new facility for measurements of half-lives at CEA/DRT/LNE-LNHB. We have new electronics and testing for HPGe at n_TOF, the construction, testing and use in actual measurements of the sTED and i-TED detectors for n_TOF (EAR1 and EAR2), and detectors for non-energy applications (DDX data for the n--induced emission of lchp) are also being tested at n_TOF.

Target preparation activities include the production and delivery of a first set of 12 samples to SANDA experiments, and the design and simulations for the development of an isotope separator (IS) have been completed and the preparation of the site for the IS at PSI are in progress.

Preparation and approval of beam requests are ongoing at: n_TOF, GELINA, NFS, ILL, IGISOL, RIKEN, GSI/FAIR, WPE, HIT.

2. Measurements

A wealth of new nuclear data measurements have been performed at n_TOF, GELINA, NFS, LR-0, ILL, IGISOL, RIKEN, GSI/FAIR, Hospitals on neutron-induced fission, (n,alpha) and (n, lchp) reactions, (n,γ), inelastic scattering, TAGS measurement of isomers, β-delayed neutrons, absolute fission yields, long-lived and short-lived beta+ emitters by means of different reaction paths (a detailed list is provided in the presentation).

3. Nuclear Data Pipeline

Regarding evaluations and evaluation tools, new versions of TALYS and EMPIRE have been prepared, tested, and distributed. New evaluations of cross sections including for the actinides U-235, U-238 and Pu-239, structural materials Al-27, Ti-48, Ti-50, Ni-58, Ni-60, Ni-61, Ni-64, Cr-50, Cr-52, Cr-53 and Cr-54 and fission fragments Os-186, 187 and 188, and La-139 are in progress. Significant progress has also

been made in the nuclear structure and decay evaluation of I-131 and La-140, Sn-117, and the A=101, A=103 and A=107 mass chains.

Sensitivity calculations, benchmarks, and formatted libraries have also made progress contributing to an improved JEFF-3.3. AMPX-formatted libraries of the most recent JEFF libraries have been provided. ESFR, MYRRHA and ALFRED advanced reactor systems sensitivity/impact studies have been completed. The identification of the most relevant experimental benchmarks for validation with existing databases has been completed and many validations of C/E with identification of trends have been performed comparing simulations with existing benchmarks specialized in different technologies and applications.

Preparation of new integral experiments at GELINA/MINERVE, LR-0 & TAPIRO has advanced. The first experiments at GELINA using MINERVE samples covers samples of Ag-107, Ag-109 and Tc-99. The ongoing program at GELINA will provide data for samples of Sm, Nd, Cs, Mo, Ru, Eu, Gd, Rh. The experiments at LR-0 have provided a new benchmark for the delayed neutron fraction and prompt neutron lifetime. The first calibrations of reactor instrumentation at TAPIRO have been performed.

SANDA future perspectives

Despite the difficulties and delays due to the COVID pandemic, significant progress has been made and results achieved in all the activities and work packages with the following output:

- Significant number of publications (20) in peer-reviewed journals, communications to conferences and workshops and training of PhD (27) and Master (16) students;
- Additional results and achievements are expected until the end of the project, mainly on differential and integral measurements, sensitivity studies and evaluations, and the corresponding publications and data for inclusion in EXFOR, ENDF and ENSDF data libraries.

Successor of SANDA

Finally, the successor of SANDA is the new project HORIZON-EURATOM-2023-NRT-01-06: Improved nuclear data for the safety of energy and non-energy applications of ionising radiation.

The scope of the new call includes:

- experimental measurements of the reactions of interest and estimation of their uncertainties and (cross-) correlations;
- the evaluation of available experimental data and the creation of evaluated nuclear data libraries (including uncertainties and covariance matrices);
- the validation of these (updated) evaluated nuclear data libraries by means of available differential and integral experimental data;
- the dissemination of these (updated) evaluated nuclear data libraries according to the standards of ‘reproducible science’ – including all the information needed to reconstruct the evaluation process.

2.7. Nuclear Data and Nuclear Astrophysics - ChETEC-INFRA, A. Boeltzig (HZDR)

Nuclear astrophysics research crucially relies on nuclear data in its quest to study the processes governing the chemical evolution of the universe. Evaluated databases of nuclear properties are a cornerstone for experiments to study the relevant nuclear reactions, and as input parameters for astrophysical models.

Of particular interest for astrophysics are stellar reaction rates, which are derived from the nuclear reaction cross sections. A set of temperature-dependent rates is required for the reactions at play, to obtain a model of a given stellar scenario.

Community efforts aim to provide compilations of reaction rates which reflect the current state of the art for use in modeling. Data evaluation and extrapolation is a crucial task, as data for such reactions often come at substantial experimental efforts or are not practically accessible to laboratory experiments at the energies of interest. Apart from the scarcity of data, inconsistencies between multiple data sets often require review and evaluation to arrive at a suggested reaction rate.

Publications of results of nuclear experiments with an astrophysical motivation often include the calculation of a reaction rate to demonstrate the impact of the new data. However, concerted efforts to compile reaction rates were brought up by the nuclear astrophysics community, to provide consistently evaluated sets of reactions rates based on state-of-the-art nuclear data for astrophysics.

Reaction rate compilations for nuclear astrophysics differ in scope of included reactions, degree of evaluation and breadth of community involvement. Widely used compilations include NACRE [1,2,3], the compilation on Solar Fusion Cross Sections [4,5,6], STARLIB [7], and JINA Reaclib [8,9]. The KaDONIS [10,11] database focused on Maxwellian-averaged cross sections for neutron-induced reactions, and motivated the further development of ASTRAL [12,13]. A recently launched online database ChANUREPS [14] aims at collecting reaction rate data from individual publications, to allow for swift application of new rates in models.

The challenge for any of these compilations or databases are long-term sustainability (secured availability in the case of related online services) and timeliness (incorporating newly available data). For compilations with periodic review cycles, efforts to keep these compilations updated have been, for example, organized in the form of workshops calling for community participation.

As is typical for long-term projects, funding for these established compilations often comes from changing sources. Networking projects, such as the NSF-funded JINA-CEE [15] (USA) creation of ReacLib, or EU-funded ChETEC-INFRA [16] supporting ASTRAL, ChANUREPS and Solar Fusion III have provided valuable support for these nuclear astrophysics-related database projects. Given the fixed-term nature of such funding projects, however, continuity remains a challenge to be addressed, in order to ensure that data from experimental efforts in nuclear physics can be taken up by the astrophysical community in a timely manner.

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3. Discussion

Status

The successful outcome of basic nuclear research and development of nuclear energy and non-energy applications including nuclear astrophysics relies strongly on accurate measurements and collection of nuclear data in certified databases.

Nuclear data for energy and non-energy applications typically include information related to nuclear reactions, radioactive decay, and nuclear properties such as masses, radii, and moments. Information on the interaction of neutrons, charged particles and photons with atomic nuclei for use in transport calculations is also crucial.

Reliable, up-to-date, and quality-assured nuclear reaction and decay data are required for reactor design, fuel cycle analysis and reactor operation. New needs are emerging in relation with, for instance, the extension of reactor lifetime, waste minimization, studies of new concepts, such as SMRs, GEN-4 reactors and new compact fusion devices. Decay data such as half-lives, decay modes and branching ratios are also important for radiation shielding, waste management, non-proliferation, as well as monitoring and radiological assessment of nuclear accidents or incidents. Transport calculations in nuclear engineering and materials sciences rely heavily on complete libraries of nuclear cross sections, angular distributions, and emission spectra, as well as parameters characterizing the decay radiation.

Credible nuclear data are also important for a wide range of non-energy applications. In nuclear medicine, radioisotopes are used to diagnose and treat diseases. Radiotherapy and particle therapy techniques rely on information on the type, energy, and direction of the emitted radiation. In nuclear forensics, gamma radiation detection is employed for monitoring systems and border control. Nuclear space exploration uses gamma-ray and neutron spectroscopy to study the composition of planetary surfaces or cosmic sources. Nuclear propulsion is being studied as an alternative fuel for long-duration space missions such as crewed missions to Mars or outer planets. Non-destructive nuclear methods used in the field of cultural heritage to study, preserve and authenticate artifacts and artworks rely on knowledge of the signature gamma lines emitted by the various elements.

The availability of reliable, up-to-date, and well-structured databases and data libraries, with user-friendly visualization and retrieval tools, is indispensable for the nuclear specialists in the various applications fields who implement the data directly in their studies, and for the nuclear physics researchers who need the data to improve their knowledge from existing studies and plan future activities that may lead to new discoveries.

The collection, evaluation and dissemination of nuclear data is a complex task that relies on contributions from expert scientists in basic and applied science communities. Efforts carried out at a national and international level benefit from the coordination provided by international organisations such as the International Atomic Energy Agency (IAEA) in Vienna and the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (NEA-OECD) in Paris. The development and maintenance of nuclear data libraries, and dissemination of nuclear data to various user communities is the main goal of the international networks associated with these agencies, such as the Nuclear Structure and Decay Data evaluators (NSDD/IAEA), the International Nuclear Data Evaluation Network (INDEN/IAEA), and the Nuclear Reaction Data Centres Network (NRDC/IAEA). Nuclear reaction data libraries are maintained by national or regional efforts. The Joint Evaluated

Fission and Fusion (JEFF) library which primarily involves European contributions, is coordinated by the NEA Data Bank. The nuclear structure and decay data file (ENSDF) on the other hand, is hosted at the National Nuclear Data Center/BNL in the United States and is based on international contributions that are coordinated by the NSDD/IAEA network.

Regarding nuclear data evaluation efforts, at present, the European contribution to JEFF is significant, both in terms of coordination and technical expertise. However, the situation is different for ENSDF. Over the past 20 years, the European contribution to ENSDF has declined and become limited. One of the primary reasons for this decline is inadequate funding. Both JEFF and ENSDF evaluation efforts in Europe have suffered from a shortfall in evaluators and a loss of expertise due to the lack of financial support. This situation is likely to worsen in the future, as funding continues to be inadequate, and the existing experts retire without sufficient replacement. In Europe, there is significant investment in the development of facilities for basic nuclear research, including both large-scale ESFRI (European Strategy Forum on Research Infrastructures) facilities and smaller scale facilities. These facilities are focused on new measurements and are often complemented by support for infrastructures and networking, as well as for theoretical and computational developments (see https://nupecc.org/pub/lrp17/lrp2017.pdf)

The investment in nuclear research facilities in Europe is provided for and funded directly by European member states, as well as indirectly through EU (European Union) projects. The EU has several programmes that support nuclear science and innovation, such as the Euratom Framework Programme, which provides funding for nuclear-energy related research projects across Europe. The EU also supports nuclear research through its Horizon Europe programme, in particular the Research Infrastructure work programme, which is focused on enhancing excellence and innovation in research infrastructures across a wide range of scientific disciplines, including nuclear physics (e.g., ENSAR, ENSAR2 and EURO-LABS projects) and nuclear astrophysics (ChETEC-INFRA).

The EURATOM Framework has also supported nuclear data activities in Europe through a series of funded projects such as CHANDA, SANDA, ARIEL, and ERINDA, thus enabling the integration of the nuclear data community at European level. Today, more than 35 infrastructures and organizations are working together in cooperation with international organizations (IAEA, NEA). EURATOM support has led to achievements in R&D, new measurements for applications, data evaluation and validation, developments in theory, and updates of data libraries, such as JEFF, EXFOR, and to a lesser extent ENSDF. However, these projects provide support in the short term and the available funding falls short of what is required to sustain a European effort in nuclear data that is equivalent to the region's rate of production of experimental data.

The European Joint Research Centre (JRC) is a central source of reliable nuclear data for the EU through the operation of experimental facilities dedicated to targeted measurements for applications. It also supports the JEFF collaboration through coordination and contributions to the JEFF library.

The advent of new accelerator and detector technologies in conjunction with enhanced computing power has led to the rapid growth of experimental data and paved the way for novel approaches to handling and exploiting bulk data using AI/ML techniques. While participants acknowledge the high standards and competence of the existing compilation and evaluation networks, they also recognise that the short and long-term needs of the expanding and diverse community of nuclear data users in basic research and applications cannot be met satisfactorily by the existing evaluation effort. The contributions of national and regional programmes to the worldwide nuclear data evaluation effort must increase. In Europe, this enhanced effort should be commensurate to the region's technical expertise and usage of these databases.

To quantify the required extension of the European effort, one should consider that for maintaining the nuclear structure and decay data file (ENSDF) up to date within a 10-year cycle, the total number of full-time evaluators needed is 12 (according to available estimates) whereas currently there are

only 6 available worldwide and Europe's contribution amounts to less than one full-time evaluator. The JEFF collaboration on the other hand, involves several groups from OECD member states, including experimental, theory, data evaluation, and data validation experts all involved in the various stages of the nuclear data pipeline. The collaboration comprises about 30 nuclear reaction data evaluators though only a few are full-time evaluators. In radioactive decay data, the number of evaluators is much smaller, and again the responsibility of maintaining the decay data sub-library is not a full-time activity. These figures demonstrate that the existing effort to compile and evaluate nuclear data in Europe is not equivalent to the region's rate of production of experimental data and usage of nuclear data. The situation calls for drastic action that will lead to the establishment of an enhanced and sustainable nuclear data programme in Europe.

The extension of the existing compilation and evaluation efforts in Europe require better cooperation within Europe and pooling of resources with the needed scientific and technical expertise, in addition to adequate funding. In this respect, the US Nuclear Data Program could serve as an example of how such a nuclear data programme could be established and organised, with alternative funding schemes and opportunities including a platform for the exchange of information between stakeholders and the nuclear data user community.

Concluding remark

The broadened short and long-term nuclear data needs in both basic and applied sciences require a comprehensive European plan to produce and curate nuclear data, involving all contributing and benefitting scientific parties/communities in Europe.

Recommendations

The European nuclear physics community should:

- establish priorities for nuclear data measurements and evaluations for applications that will be addressed by a comprehensive European nuclear data programme - the priorities should be based on existing priority lists maintained by the different stakeholders.
- recognise the importance of curated nuclear data also for fields beyond nuclear physics and its applications, e.g., research in astrophysics and particle physics, and strive to maintain the related databases based on FAIR (findable, accessible, interoperable, reusable) principles.
- strive to establish a sustainable source of funding of measurements and data evaluation, including well-defined career paths in nuclear data that will involve national funding agencies and the European Commission (EC) (EURATOM and all other relevant EU work programmes).
- maintain access to key experimental infrastructures that enable specific measurement methodologies including target preparation and supply to produce nuclear data relevant for applications.
- Reinforce cooperation with international organisations (IAEA, NEA), which should provide support in the form of coordination, training, dissemination, and outreach needed to attract and train the next generation of evaluators.

Actions

- Organize meetings at international and European level to bring together stakeholders including national funding agencies, EC (incl. EURATOM) representatives, nuclear technology industrial partners, representatives of the nuclear physics research community (NuPECC), the nuclear physics research infrastructures (EURO-LABS and ChETEC-INFRA), and the nuclear data community (JRC, EURATOM-funded project coordinators) as well as international organizations (IAEA, NEA).

- Consider organizing a side event at the IAEA General Conference 2023 to highlight the importance of nuclear data programmes for basic sciences, nuclear energy development and other applications worldwide.
- Reach out to JRC to explore opportunities to establish a sustainable nuclear structure and decay data evaluation effort in addition to the existing nuclear reaction data evaluation effort.
- Reach out to national funding agencies and EU large-scale facilities to investigate ways of strongly enhancing the support of curation of nuclear data in addition to the production of nuclear data.
- Ensure adequate funding is allocated to nuclear structure and decay data evaluation in the next proposal submitted to the open call HORIZON-EURATOM-2023-NRT-01-06: Improved nuclear data for the safety of energy and non-energy applications of ionising radiation.
- Organise workshops, summer schools, and webinars to raise awareness of the importance of nuclear data and to enhance capacity building in nuclear data evaluation methods, validation, and dissemination.

4. Summary

In summary, the meeting organized by the IAEA Nuclear Data Section served as a crucial platform for discussing the pressing issue of a Comprehensive European Plan for acquiring and curating nuclear data. Participants examined the current state of experimental nuclear physics activities, both large and small-scale facilities, infrastructures, and available funding schemes for nuclear research and nuclear data activities in Europe. It became evident that the lack of long-term planning and funding for nuclear data activities in Europe over the past few decades has resulted in a shortage of nuclear data experts, particularly evaluators, and a gradual loss of expertise. Participants agreed on the urgent necessity for a unified and coordinated effort. This effort must involve the active engagement of the nuclear physics and nuclear data communities, as well as the relevant stakeholders, to establish a sustainable and comprehensive European nuclear data program. The primary objective of this program would be to address the nuclear data requirements of the European user communities effectively.

A series of recommendations and specific actions were put forth during the meeting that serve to guide the collaborative and coordinated efforts to that end. The commitment and active involvement of all stakeholders will be vital in successfully implementing the recommendations and actions proposed during the meeting.

ANNEX 1

Consultancy Meeting on the Needs for a Comprehensive European Plan to Acquire and Curate Nuclear Data

25 to 27 April 2023
IAEA, Vienna, Austria

ADOPTED AGENDA

Tuesday, 25 April

09:00 - 09:10	**Opening of the meeting**, A. Koning / NDS Section Head
	Welcome and Introduction, P. Dimitriou / Scientific Secretary
	Election of Chair and Rapporteur(s), Adoption of Agenda
09:10 - 11:10	**Presentations I (45'+15')**
	- Curated nuclear data at the Nuclear Data Section (P. Dimitriou) - Nuclear Data in the NuPECC Long Range Plan 2024 for European Nuclear Physics (M. Lewitowicz)
11:10 – 11:30	*Coffee break*
11:30 – 12:30	**Presentations I (45'+15')**
	- Nuclear Data at CEA (S. Leray)
12:30 – 14:00	*Lunch break*
14:00 – 16:00	**Presentations II (45'+15')**
	- Nuclear Data Activities in EURATOM (R. Garbil) - US Nuclear Data Program (K. Jankowski, guest speaker)
16:00	*Coffee break*
16:30 – 17:30	**Presentations II cont' (45'+15')**
16:30	- Nuclear Data and Nuclear Astrophysics - ChETEC-INFRA (A. Boeltzig)

Wednesday, 26 April

09:00 – 11:00	**Roundtable discussion**
	- SANDA project – slides by Enrique Gonzales (in absentia)
11:00 – 11:30	*Coffee break*
11:30 – 13:00	**Roundtable discussion cont'**
13:00 - 14:00	*Lunch break*
14:00 – 18:00	**Seibersdorf Lab Tour**
19:00 – 21:00	***Dinner at a Restaurant***

Thursday, 27 April

09:00 – 12:50	**Roundtable discussion cont' - Drafting of recommendations**
12:50 – 13:00	**Closing of the meeting**

ANNEX 2

Consultancy Meeting on the Needs for a Comprehensive European Plan to Acquire and Curate Nuclear Data

25 to 27 April 2023
IAEA, Vienna, Austria

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