NEA Nuclear Data Activities

Michael FLEMING

Head of the Data Bank (Acting)

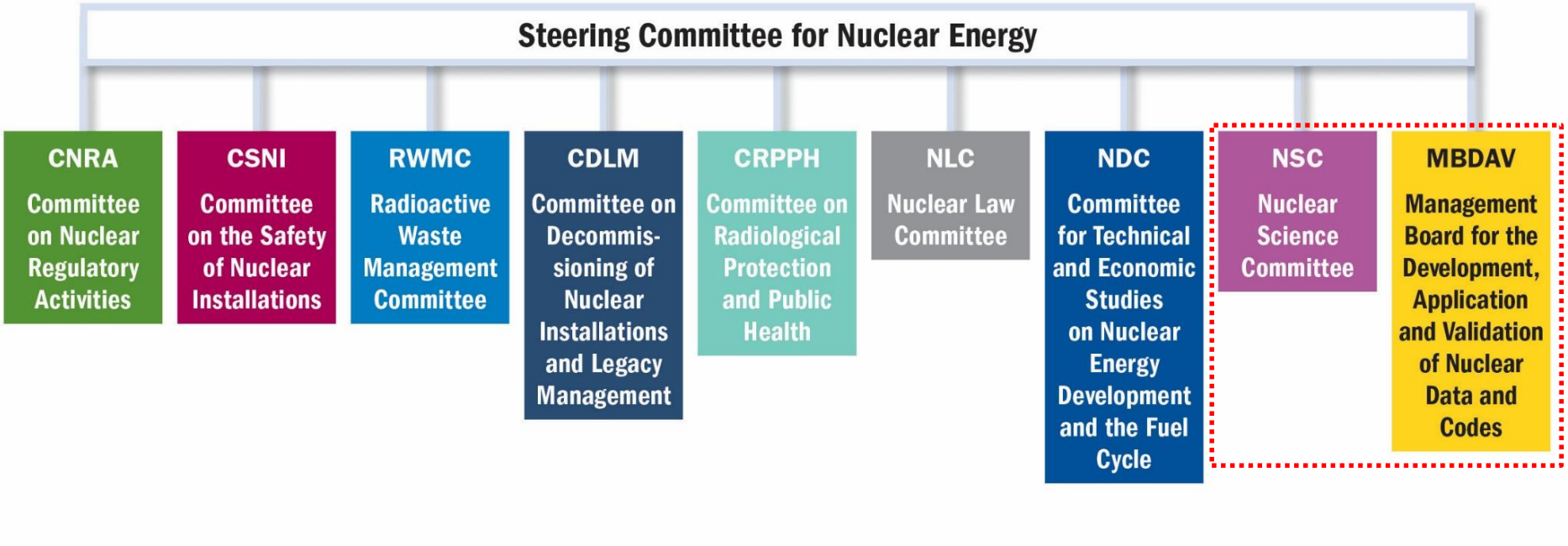
33rd Meeting of the International Nuclear Data Committee (INDC)
29 March - 1 April 2021

The NEA: 34 Countries Seeking Excellence in Nuclear Safety, Technology, and Policy

- 34 member countries + strategic partners (e.g. China and India)
- 8 standing committees and more than 70 working parties and expert groups
- The NEA Data Bank - providing nuclear data, code, and validation services
- Global relationships with industry and universities.

NEA countries operate about 90% of the world's installed nuclear capacity

NEA Structure



JEFF (DB), EXFOR (DB) and WPEC (NSC)

IAEA Collaboration

- NEA and IAEA have long and deep history of collaboration and co-ordination to maximise impact on international nuclear data activities
- IAEA Nuclear Data Section engagement has been a key ingredient to the success of the NEA nuclear data programme of work
- NEA and IAEA organisational instruments (e.g. CRPs, SGs) are complementary and offer options for the community in launching collaborations
- IAEA Staff on Loan within Data Bank provides distribution services to non-OECD IAEA members

JEFF Nuclear Data Library Project

- Long-standing project with original JEF-1 release in 1986, outputs are in use across the world for nuclear energy, science, technology and other applications
- Development and testing of a general-purpose nuclear data library, including neutron and other incident particle data, decay data and fission yields
- Multiple sub-groups operating on long-term or ad hoc basis to address aspects of the JEFF development process
- 2 ‘Nuclear Data Weeks’ per year in April/November – now hosted online – next meeting is **26-30 April 2021**

Chair of JEFF

Dr Arjan PLOMPEN

JRC-Geel, EC

JEFF Nuclear Data Library Project

- Latest release JEFF-3.3 publication in EPJ/A 2020

  A. Plompen et al., The Joint Evaluated Fission and Fusion Nuclear Data Library, JEFF-3.3

  https://doi.org/10.1140/epja/s10050-020-00141-9

- Over 70 co-authors from 30 organisations including the IAEA Nuclear Data Section

- Leverages IAEA project outputs including the Neutron Standards and contributions from IAEA to other projects including CIELO

GitLab at the NEA

- In 2018 the NEA implemented a GitLab system with core functionality that has been used for projects such as EXFOR compilation and the GNDS specifications

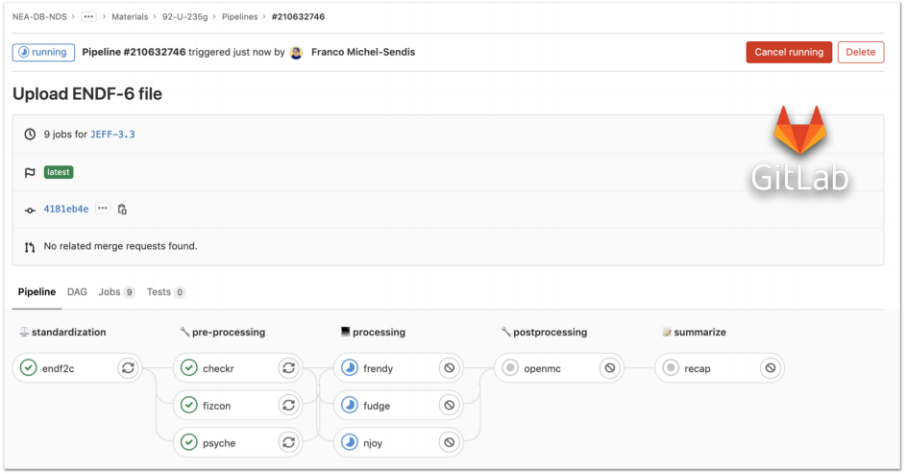
- The implementation of an upgraded service has been in planning since 2019, providing more computational resource in runners, full docker container registries, ‘gitlab-pages’ and other features

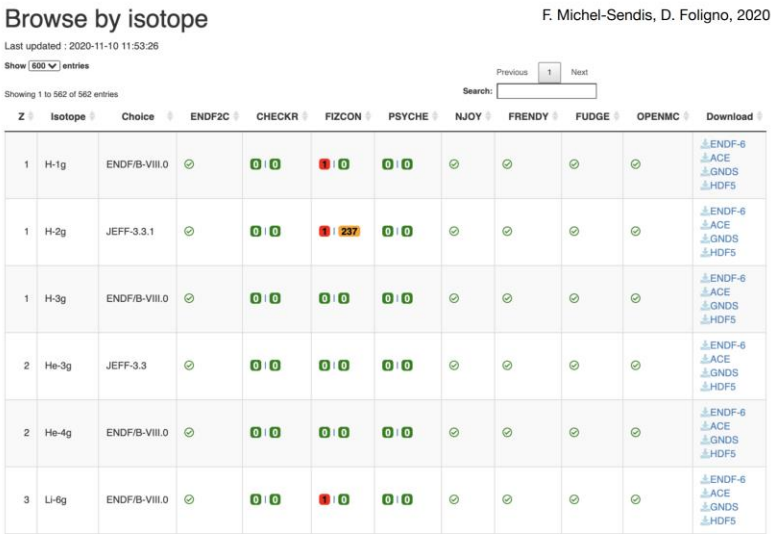
- Since Feb/March 2021 NEA is now rolling out a new GitLab instance with more sophisticated architecture to accommodate these functionalities – **expected migration in Q2 2021**

- **This will be a key platform for current and future cross-DB and cross-NEA work**

GitLab for JEFF

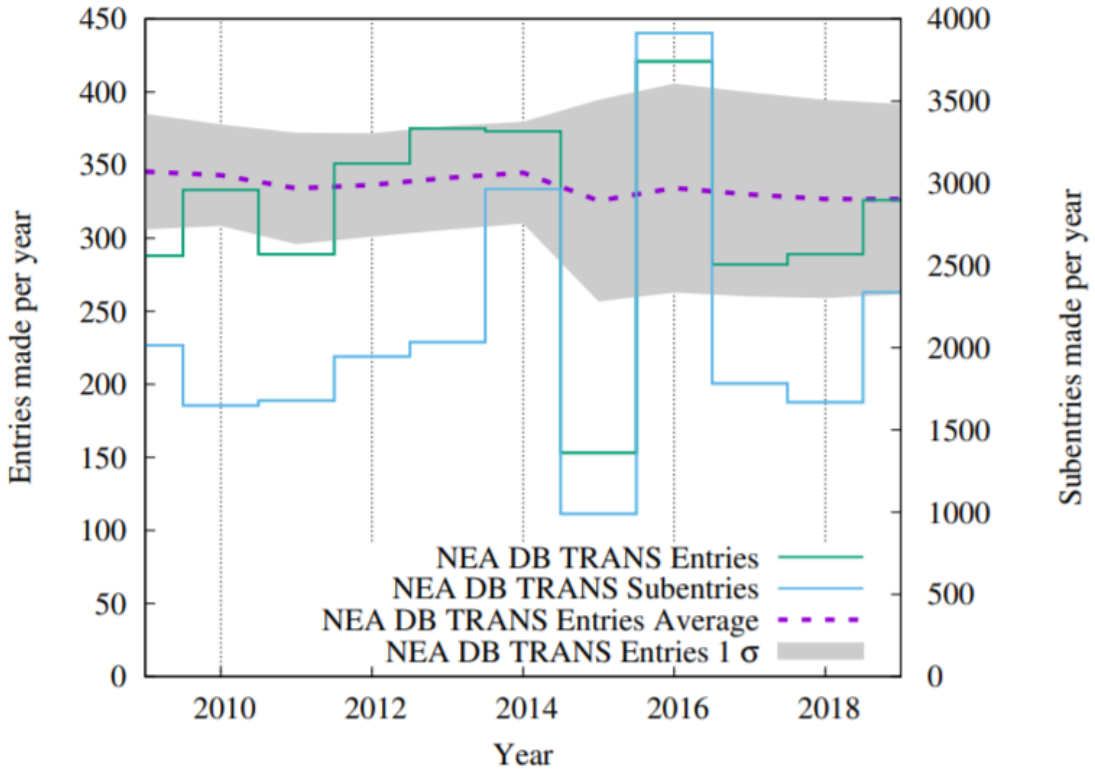
- This system offers a powerful collaboration tool with built-in, automated processes including processing, testing and benchmarking
- Replaces/integrates previous scripts and processes such as NDEC
- PoC developed using cloud-based solutions and will be migrated (with first NEA instance) in 2021





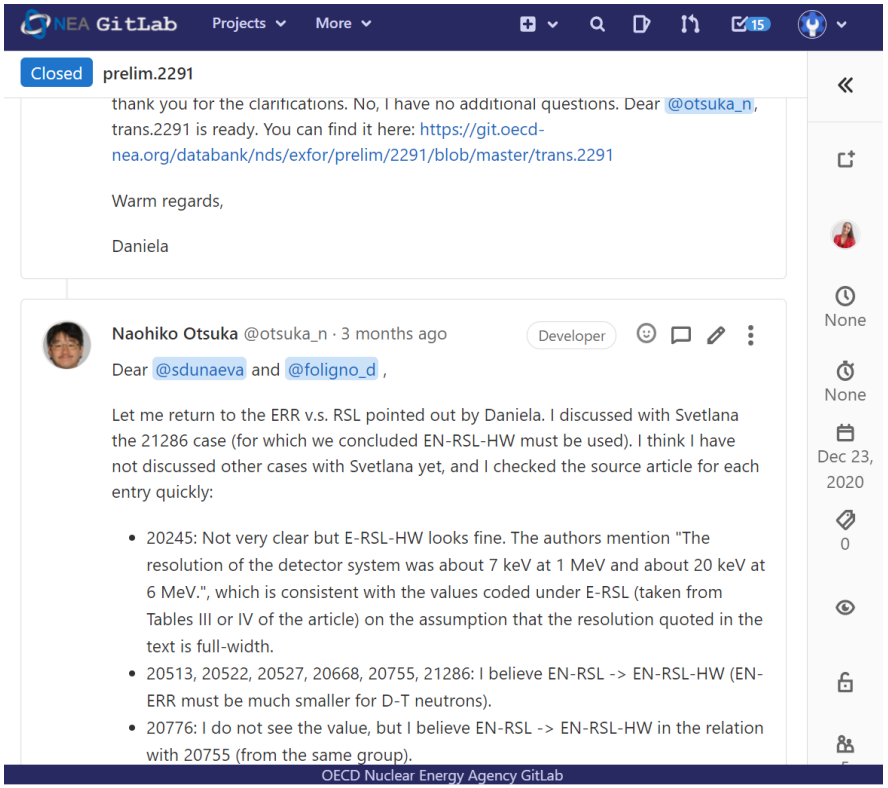
EXFOR compilation

- As the areas 2 and O compiler centre, the NEA Data Bank continues to play a central role in the EXFOR project within the NRDC
- Approximately 300 new or revised entries per year
- **Strong collaboration with IAEA through NRDC**
- Ongoing work with SG50 to develop proposals for enhancements to meet needs of user community



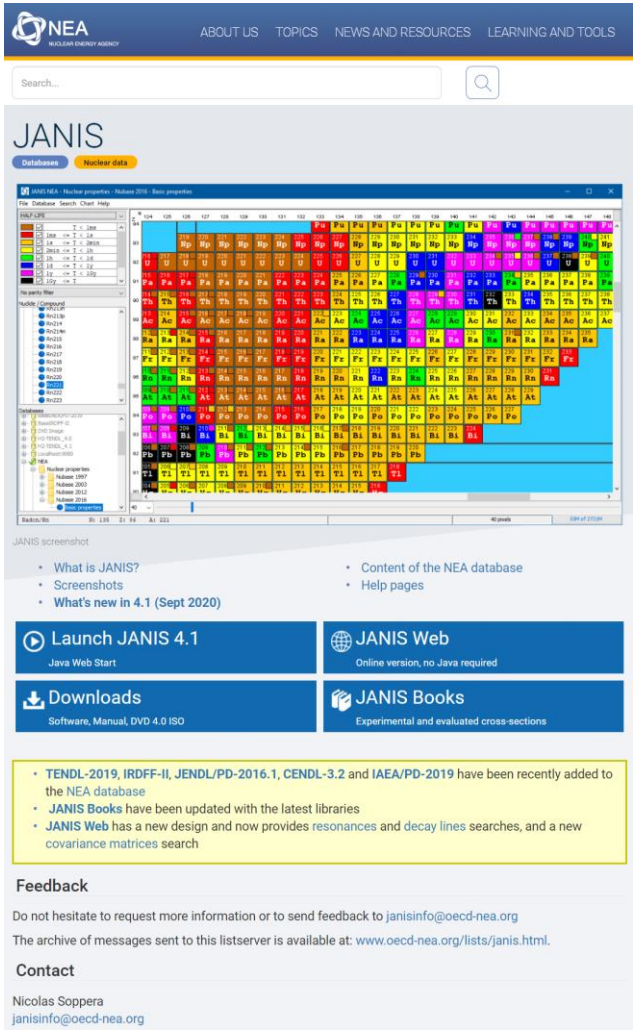
GitLab for EXFOR

- NEA EXFOR compilation work migrated to GitLab in 2018
- Processes are now increasingly captured within the system including preservation of entry development and QA
- Automatic communication to all NRDC and several computer processes remain manual



JANIS new release

- **JANIS version 4.1 was released in September 2020 (first release since 4.0 in 2013)**
- Includes updates to webstart version, books, application, libraries, supported data, much more
- Wide range of features are documented in the ‘What’s new in 4.1’ page
- Existing CLIs for JANIS and other related tools (e.g. DICE, NDaST) for script/automated tasks – although documentation is limited
- DICE API planned for 2021



WPEC admin

- 50 subgroups have been created over 31 years with 8 active (2 closed in 2020)
- 2 Expert Groups have been established to address long-term high-priority needs and an international standard data format
- 32nd WPEC meeting and subgroups was held 11-15 May 2020 (via WebEx) with a **record 130 participants** in 10 sessions
- 9-16 November 2020 meetings held with **114 participants** and 7 December SG47 with **41**
- **33rd WPEC to be held 10-14 May 2021**
- **Tentative first hybrid meeting 6-10 December 2021 (conditions permitting)**

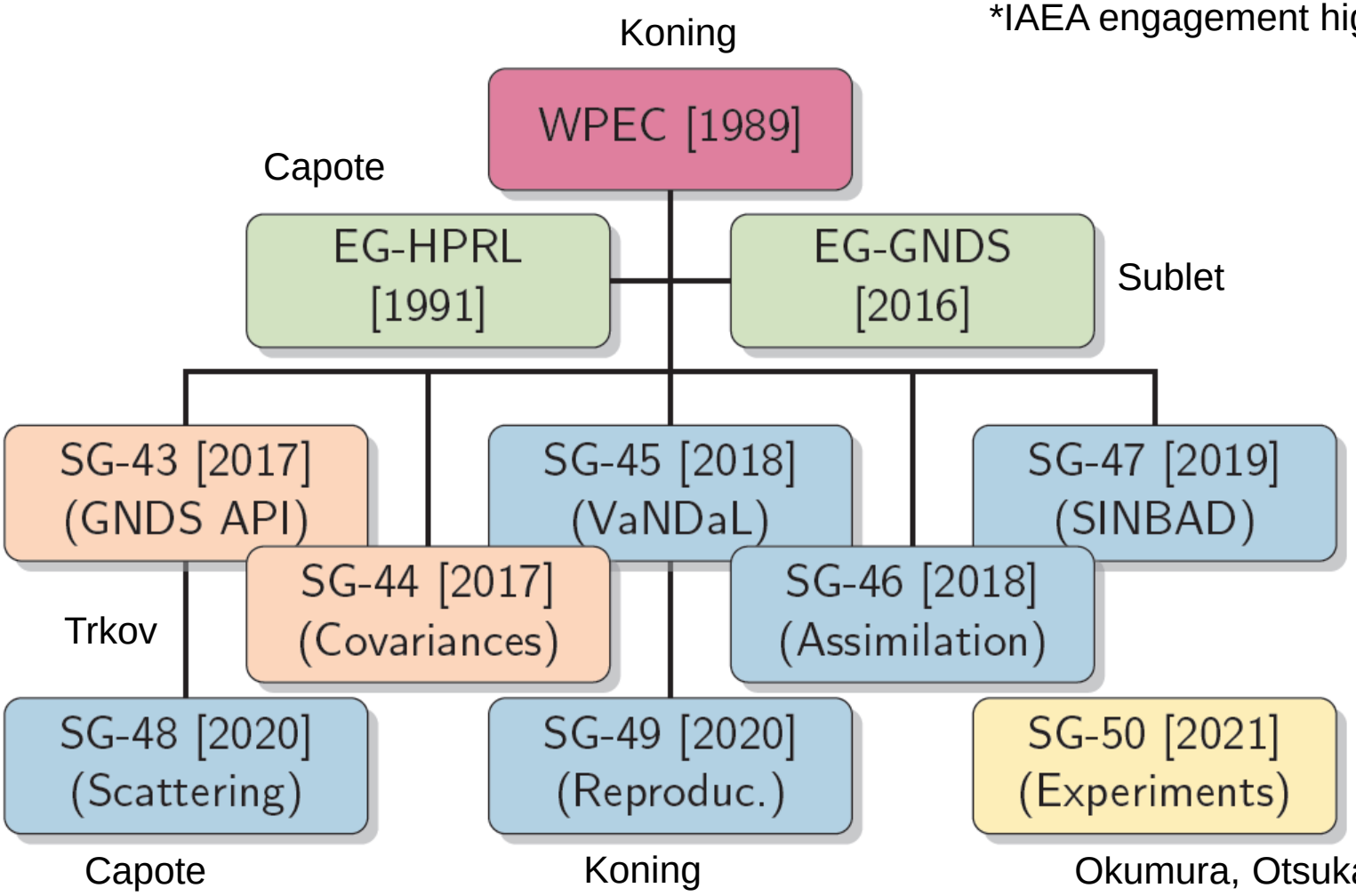
Chair of WPEC 2019-2021

Dr Osamu IWAMOTO

Head of the Japanese Nuclear Data Center, JAEA

WPEC (NSC) overview

*IAEA engagement highlighted



EG on High Priority Request List

Objective: To maintain a point of reference for nuclear data priorities, including a rigorous process to review and add new entries

- The High-Priority Request List (HPRL) is an online database of experimental and/or evaluation needs
  - Requires a detailed justification with quantification of impact including sensitivity/uncertainty calculations with modern nuclear data libraries
  - Continuously updated/reviewed with progress and new requests
- HPRL provides reviewed data that funding decision-takers need to determine what research to support
  - SG41 and SG40/CIELO were direct responses to needs expressed through the HPRL
- A new HPRL system (in JCMS) is in development with the new NEA website and will be made public in 2021
  - **<u>Active NEA development period ongoing Q1/Q2 2021</u>**

EG-HPRL Chair

Dr Emmeric DUPONT

CEA, France

EG on Generalised Nuclear Data Structure

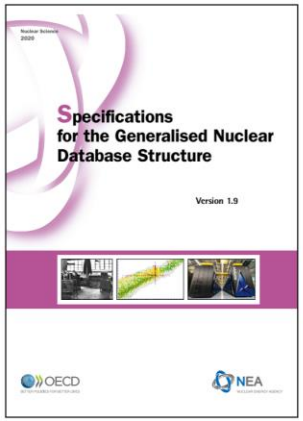
Objective: To create and maintain a modern international standard for the storage of nuclear data 'GNDS'

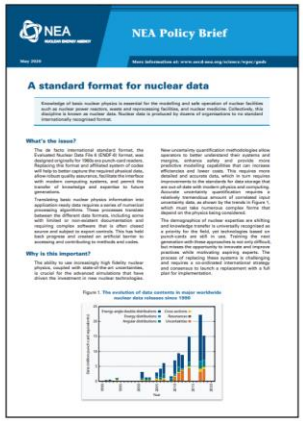
- Nuclear data has been stored in the ENDF-6 format
  - Fixed column-width from the age of punch cards
  - Officially maintained by US CSEWG
  - Many Byzantine features due to long legacy with challenges for extensibility
- Subgroup 38 was created to agree the requirements for an international replacement format (which was successful) and start the specifications
- EG-GNDS formed as an official body to finalise the first specifications and create a process for continual updates – *first publication 2020*

EG-GNDS Chair

Dr David BROWN

BNL, USA





GNDS version 1.9 (first publication) May 2020

ISBN 978-92-6490-197-1

342 page detailed technical specifications

With a policy brief for high-level/general audience

Subgroup 45: VaNDaL

Objective: To collect, review and QA inputs for nuclear data validation with integral experiments (primarily ICSBEP)

- ICSBEP contains thousands of experiments, but simulation inputs (if they exist) are not designed for ND V&V
- Nuclear data community makes *extensive* use of these experiments, duplicating effort and introducing errors with modelling
- Thousands of inputs have been shared in SG45 (using NEA GitLab) and are used in cross-comparison, complemented by
  - Data stored in the NEA DICE databases
  - Other output / sensitivity / verification data generated by participants
- A new meta-format for model specification has been drafted, which can be used for serialisation into code-specific (e.g. MCNP) inputs
- With report on QA methods and other tools for inter-comparison, will be documented in SG summary report

SG45 Co-ordinator

Dr Wim HAECK

LANL, US

Monitor

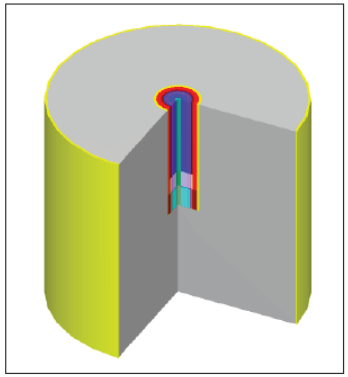
Dr Andrej TRKOV

JSI, Slovenia

Subgroup 46: TAR/Assimilation

Objective: Update Target Accuracy Requirements (TARs) for nuclear systems and develop methods for integral ND feedback

- Launched & led by Prof. Massimo SALVATORES, who sadly passed away 27 March 2020, with Dr. Giuseppe PALMIOTTI (INL, US)
- Feedback from applications/reactor community provides the focus for future work – the workflow is:
  - Accuracy requirements + S/UQ identifies priority needs (e.g. SG46)
  - Experimentalists review what can be achieved and add to HPRL
  - Experiments are run and taken into account for next library
- Several models have been included (LWR, SFR, LFR, ADS, etc.) with S/UQ calculations in progress – <u>but more can be considered!</u>
- Only simplified models are required to probe the nuclear physics needs



MYRRHA – k_{eff} ISC (%/%)		
Quantity		JEFF-3.3
^{239}Pu	ν	$0.696 \pm 2.9 \cdot 10^{-6}$
^{239}Pu	(n,f)	$0.482 \pm 2.9 \cdot 10^{-6}$
^{238}U	(n,γ)	$-0.112 \pm 3.7 \cdot 10^{-7}$
^{241}Pu	ν	$0.091 \pm 4.5 \cdot 10^{-7}$
^{240}Pu	ν	$0.081 \pm 4.5 \cdot 10^{-7}$
^{238}U	ν	$0.070 \pm 6.1 \cdot 10^{-7}$
^{241}Pu	(n,f)	$0.064 \pm 4.6 \cdot 10^{-7}$
^{240}Pu	(n,f)	$0.055 \pm 4.6 \cdot 10^{-7}$
^{239}Pu	(n,γ)	$-0.053 \pm 3.1 \cdot 10^{-7}$
^{209}Bi	(n,n)	$0.052 \pm 1.1 \cdot 10^{-5}$

SG46 Co-ordinators

Professor Óscar CABELLOS
Mathieu HURSIN

UPM, Spain and PSI, Switzerland

Monitors

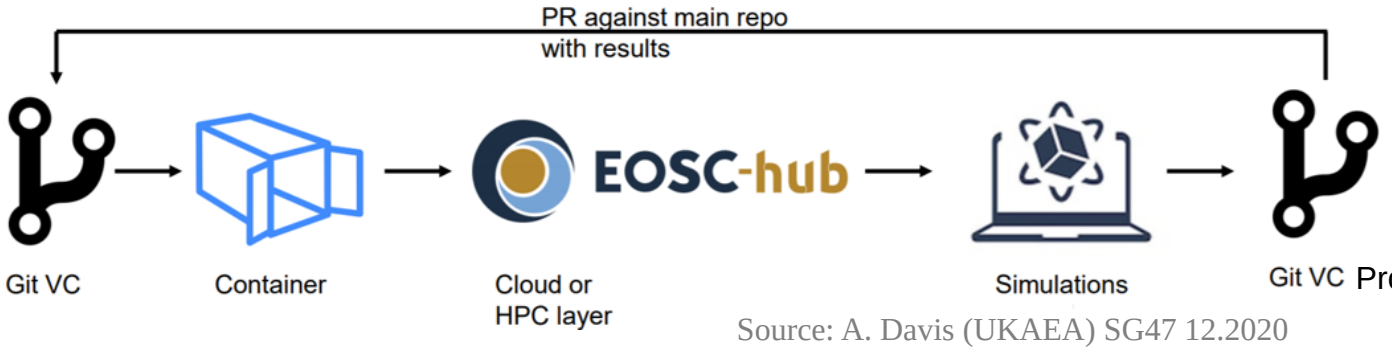
Dr Ajran PLOMPEN and
Dr Andrej TRKOV

JRC-Geel and JSI, Slovenia

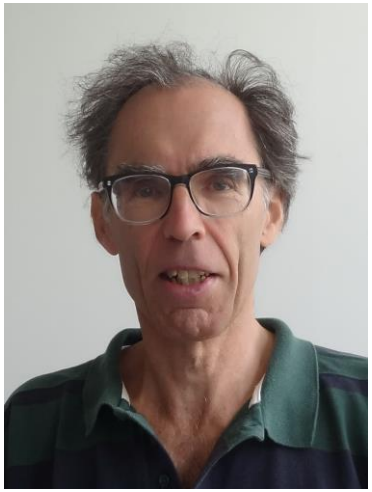
Subgroup 47: SINBAD for Validation

Objective: Identify and develop shared resources for SINBAD benchmarks to aid in nuclear data validation and evaluation

- Many SINBAD experiments are (or could be) used for nuclear data testing/validation and integral feedback
  - Models are often limited in terms of overall description
  - Supplementary information is valuable for ND (MC weight window meshes for VR, CAD geometries, more detailed source terms/code mods, etc.)
  - Many SINBAD entries are complex and additional model information greatly improves the potential value for ND users and others



Source: A. Davis (UKAEA) SG47 12.2020



SG47 Co-ordinator

Dr Ivan-Alexander KODELI

UKAEA, UK / JSI, Slovenia

Monitors

Professor Óscar CABELLOS and Dr Luiz LEAL

UPM, Spain and IRSN, France

- ***Enhanced co-operation with WPRS/EGPRS and new TF***

Subgroup 48: Thermal Scattering

Objective: To advance the state-of-the-art in thermal scattering evaluated data, processing and validation

- Following success of SG42, which re-invigorated the field, many new advances are possible:
  - FOAK uncertainties – only possible with the new GNDS formats
  - Remove approximations applied in legacy formats and processing
  - Collaborate on modern, open-source processing for new TSL data
- SG42 and 2018 libraries demonstrated value and more communities are engaging:
  - Spallation source facilities (unique needs) SNS, ESS, ILL, ISIS, CNS
  - Better links with NRDC/EXFOR to improve stored experimental differential data
  - Collaborate on TSL validation methods - involve new types of integral measurements
- Kick-off on 13 May 2020 with 47 participants

SG48 Co-ordinator

Dr Gilles NOGUÈRE

CEA, France

Monitor

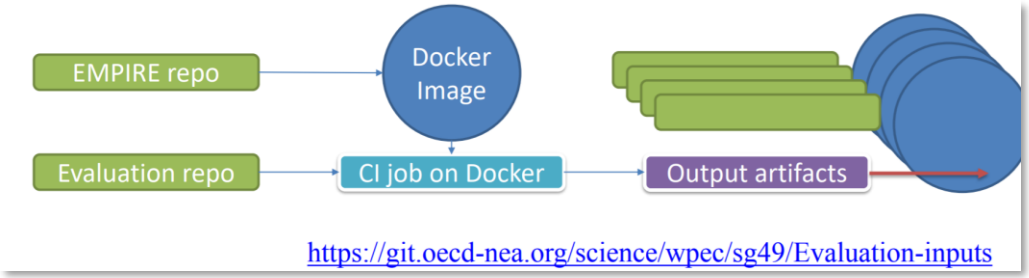
Professor Ayman HAWARI

NCSU, US

Subgroup 49: Reproducibility

Objective: Enable reproducibility in evaluation by documenting the processes and developing tools to store knowledge

- Most evaluation work is practically impossible to reproduce
  - Counter to basic principles of scientific work
  - Looming challenge due to demographics of workforce
  - Technology will not solve the problem – but can help
- Establishing guidance for information required in the evaluation process (differs by component – e.g. energy range, isotope)
- Building a version-controlled system that takes the models, codes, scripts, data(bases) to ensure reproducibility
  - These will be used by library projects and coupled with automated testing systems – *ENDF and JEFF have launched GitLab projects*



SG49 Co-ordinators

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LANL, US / PSI, Switzerland

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Dr D. BROWN,
Dr O. IWAMOTO,
Prof. A. KONING

BNL, JAEA, IAEA

Subgroup 50: Experimental Database

Objective: To develop derived databases from EXFOR that incorporate unofficial corrections and evaluator judgement

- EXFOR has been a uniquely successful database that contains differential experimental data **as published**
  - (Often) not all uncertainties are available (particularly legacy data)
  - Corrections are made by evaluators (who aren't the experimentalists)
  - Some data types are needed in evaluation but not part of EXFOR
  - Ultimately, evaluators weight many data including judgement – which is subjective and certainly not unique
- These (*ex post facto* data) are outside the scope of EXFOR but fundamental to nuclear data evaluation – and often unrecorded
- Plan: three 'layers' that translate into a new format (1), add 'objective' data (2) and allow 'subjective' evaluator input (3)
- Multiple meetings held 2020/21 covering metadata, requirements (similar to IAEA ToF CM), NRDC co-ordination and 6 April 20201 for codes and databases

SG50 Co-ordinators

Dr Amanda LEWIS
Dr Denise NEUDECKER

NNL and LANL, US

Monitor

Professor Arjan KONING

IAEA

Thank you for your attention