

“Nuclear Data Needs, UQ, and Assimilation at WPEC 2005-2017: results and the way forward

M.Salvatores

Joint Session "Perspectives and future of WPEC"
NEA, Wednesday 17, 2017

SG39 will complete its activity by early 2018. A new subgroup (SG46) has been proposed. However, SG39 has not been the starting point...

Starting point (~2005):

- Data needs assessment: at the time of fashionable ADS, there was a multiplication of data requirements without much justification nor user implication
- In order to understand, rationalize and streamline potential needs, it was required to define target accuracies and to verify both data uncertainties /covariance data and sensitivity tools availability for a meaningful SUA. Users (if possible industry) to be consulted.

The first step (SG26; 2005-2008):

- Wide participation; « provocative » uncertainty data (expert judgement) initially used.
- **Did trigger wide effort to assess systematically uncertainty data.**
- A first list of **priorities for GEN-IV reactors** was established and implemented in the HPRL
- New covariance data bases were actively developed, **new requirements for their completeness.**
- **How to meet data needs** (revisited): microscopic experiments, evaluations, data assimilation/adjustments. Use of integral experiments strongly suggested



Nuclear Science
NEA/WPEC-26
www.oecd-nea.org



International Evaluation
Co-operation

Volume 26

Uncertainty and Target Accuracy
Assessment for Innovative Systems
Using Recent Covariance Data
Evaluations

Next step (Subgroup 33; 2009-2013):

- Do we understand data assimilation methods?
A compilation of methods was delivered
- How **reliable covariance** data are?
- A **comprehensive benchmark exercise** to understand if adjustments converge, starting from different x-section data bases and using different covariance data (wide participation). **Results at ND2013**



Next step (Subgroup 39; 2013 to present) :

- How reliable adjustment trends are? Role of stress tests
- Are there methods to make the approach more robust?
How to avoid compensations. Some examples in first deliverable (Yokoyama, Palmiotti, Ivanov, Pelloni).
- **New approaches to integral data selection applied to adjustment (example presented at ND2016).**
- **First feedback to new evaluations (CIELO). A summary of the main results by Pino and Kenji later**

Next step (new Subgroup **SG46**):

- **Optimize choice of integral experiments. A priority: avoid compensations!!**
- **Define new agreed protocol to supply reliable and unambiguous feedback to evaluators**
- **Quantify impact on target reactor designs**
- **Prioritize new experiments, both differential and integral, fostering international collaborations**

Methods and Issues for the Combined Use of Integral Experiments and Covariance Data: Results of a NEA International Collaborative Study

M. Salvatores,^{1,2,*} G. Palmiotti,² G. Aliberti,³ P. Archier,¹ C. De Saint Jean,¹
E. Dupont,⁴ M. Herman,⁵ M. Ishikawa,⁶ T. Ivanova,⁷ E. Ivanov,⁷ S.-J. Kim,⁸ I. Kodeli,⁹
G. Manturov,¹⁰ R. McKnight,³ S. Pelloni,¹¹ C. Perfetti,¹² A. Plompen,¹³ B.T. Rearden,¹²
D. Rochman,¹⁴ K. Sugino,⁶ A. Trkov,⁹ W. Wang,¹⁵ H. Wu,¹⁵ and W.-S. Yang^{3,16}

¹CEA, Nuclear Energy Division, Cadarache, Saint-Paul-les-Durance, France

²Idaho National Laboratory (INL), Idaho Falls, ID, USA

³Argonne National Laboratory (ANL), Argonne, IL, USA

⁴OECD, Nuclear Energy Agency (NEA), Issy-les-Moulineaux, France

⁵Brookhaven National Laboratory (BNL), Upton, NY, USA

⁶Japan Atomic Energy Agency (JAEA), Tokai-mura, Ibaraki, Japan

⁷Institut de Radioprotection et de Surete Nucleaire (IRSN), Fontenay-aux-Roses, France

⁸Korea Atomic Energy Research Institute (KAERI), Daejeon, South Korea

⁹Jozef Stefan Institute (JSI), Ljubljana, Slovenia

¹⁰Institute of Physics and Power Engineering (IPPE), Obninsk, Russia

¹¹Paul Scherrer Institut (PSI), Villigen, Switzerland

¹²Oak Ridge National Laboratory (ORNL), Oak Ridge, TN, USA

¹³Institute for Reference Materials and Measurements (IRMM), Geel, Belgium

¹⁴Nuclear Research and Consultancy Group (NRG), Petten, The Netherlands

¹⁵China Institute of Atomic Energy (CIAE), China Nuclear Data Center, Beijing, China

¹⁶Purdue University, West Lafayette, IN, USA

(Dated: August 8, 2013)

The Working Party on International Nuclear Data Evaluation Cooperation (WPEC) of the OECD NEA Nuclear Science Committee established in 2009 a Subgroup (called "Subgroup 33") on "Methods and issues for the combined use of integral experiments and covariance data." The first stage has been devoted to producing the description of different adjustment methodologies and assessing their merits. A detailed document related to this first stage has been issued. Nine leading organizations (often with a long and recognized expertise in the field) have contributed: ANL, CEA, INL, IPPE, JAEA, JSI, NRG, IRSN and ORNL. In the second stage a practical benchmark exercise was defined in order to test the reliability of the nuclear data adjustment methodology. Comparison of the results obtained by the participants and major lessons learned in the exercise are discussed in the present paper that summarizes individual contributions which often include several original developments not reported separately.

**Attenuation in pure iron
(ASPIS experiment). $S(n,p)$**

**Fission
Source**



Effect of Fe-56 inelastic (CIELO vs ENDF/B-7)

		ENDF/B-7	CIELO
A7	C/E	0.98	1.22
A12	C/E	0.94	1.33
A14	C/E	0.92	1.36

SG46: “Efficient and Effective Use of Integral Experiments for Nuclear Data Validation”

Definition of the project and of proposed activities

It is proposed a new WPEC subgroup that should have a mandate on formalizing and applying a methodology for:

- **Selecting appropriate experiments** and in particular those that provide separate effects information on the basis of the findings of Subgroup 39.
- **Analyzing C/E by isotope, reaction, and energy range in order to point out compensation effects** (based on low uncertainty, sensitivity coefficients, and c^2). Possibly, all energy range from thermal to fast, should be examined.
- **Computing sensitivity coefficients of selected experiments and integral parameters according to the guidelines worked-out in the previous Subgroups 33 and 39.** This part of the work should account for and complete the work performed at the Databank by Ian Hill available through the DICE code.
- **Performing new generalized adjustments to **provide unambiguous feedbacks**.** Some approaches has been proposed (Yokoyama, Palmiotti, Pelloni and Ivanov) but not yet finalized or widely used. Other approaches could be proposed and compared. **The use of reaction cross correlations and of covariance data for angular distributions, secondary energy distribution from inelastic scattering should be done as far as these data will be made available** in the different nuclear data projects.

Moreover the new SG46 should give guidelines on:

- How to define a general protocol for the use of sensitivity coefficients and covariances in order to provide an improved traceability for safety and design purposes.
- How to systematically quantify **impact on a list of selected target power reactors** (thermal, epithermal, and fast spectrum reactors). This list of reactors should be defined as far as possible with the help of industry representatives (TerraPower could be a good example)
- How to provide updated target accuracies for nuclear data uncertainty reduction by combining inverse approach and integral experiments (some efforts in this direction have started at ORNL). This last goal should have a significant impact in **prioritizing new experiments**, both differential and integral and to foster international collaborations for that purpose.

The new subgroup should work in in **close contact with the new WPEC Subgroups 44**, working on new Covariance Data, **and 45 VaNDaL** that is supposed to create a database of the selected benchmarks along with the respective decks for calculations.

In future:

- It is very probably the right time to verify **new needs** and **iterate with users/customers**. Too many « Needs » documents have been produced with very little input from credible users: **a serious discussion with them is a priority.**
 - **New target accuracies? Safety requirements?**
 - **A specific project do do that? Which framework?**
- Better **interaction with evaluators** to be established on key issues e.g.:
 - use of integral experiments in evaluations;
 - reliability of covariance data (Subgroup 44).
- A unified file? Several files? Share of work? Further evaluation collaborations? What is the NEA policy perspective? CIELO has been the limit?
- **Experiments perspective**: new « smart » integral experiments to be supported in the frame of wide international collaborations (case of MA and related NEA Expert Group). This is a very high priority.