UK Atomic Energy Authority

UKAEA

Review of WPEC SG47 progress and objectives

- Ivo Kodeli

WPEC SG47 Webex Meeting, May 11, 2021

WPEC Subgroup 47 (SG47) on
Use of Shielding Integral Benchmark Archive and Database for ND Validation

Objective: promote & facilitate wider use of shielding benchmarks, provide feedback and recommendations for improvements from users on their needs & expectations

Main topics and improvements needed:

- **Priority list for future evaluations: in cooperation with EGPRS & TRGs restart activity on new benchmark evaluations** (practically on hold since > 10 years);
- **Quality evaluations:** assessment of measurement uncertainty, completeness of experimental information, quality standards for modern ND V&V
- **Computer code input data:**
  - **Provide additional inputs & feedback from users on model validation,**
  - **Variance reduction ww cards** to reduce CPU time (bringing it closer to critical benchmark),
  - **Extend the list of computer codes used for analysis,**
- **CAD geometry and material composition** description as detailed as reasonably possible; Code dependent vs. code specific approach.
- **Sensitivity profiles.**
- New benchmarks should be evaluated in benchmark databases ASAP, not only published in journals ! Example FNG benchmarks.

Focused CAD meeting

Presentation at the Apr. 20, 2021 meeting

- Ivo Kodeli, Introduction to CAD focused group meeting
- Adam Bird, Features for Importing CAD Geometries in MCBEND
- Alex Valantine, UKAEA experience with CAD as a reference geometry for SINBAD
- Steven Lilley, Discussion on CAD metadata
- Jonathan Shimwell, Demonstration on using Paramak for neutronics calculations

Main subjects

- CAD format could provide a safer (**less error prone**) **ADDITIONAL** description of the geometry, useful for describing increasingly more complex benchmark geometry of recent benchmarks.
- CAD allows „**automatic" model preparation** for different transport codes
- CAD (Computer-Assisted-Design) to CSG (Constructive solid geometry)
- STEP, FDS, STEP 242, SAT (ACIS kernel), libfive, OpenSCAD, McCAD
- Requirements for CAD formats:
  - *Open rather than commercial/proprietary software*
  - *User friendly*
  - *Likely to be supported in future*
- Prepared files to be available through GitLab:
  - *ASPIS Fe88: STEP + json material definition*
  - *FNG Copper: FDS – material, geometry, source & tally definition in a single file.*

CAD files prepared for GitLab repository

ASPIS – Iron88


```
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   "Si28": 0.000367465947155,
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  }
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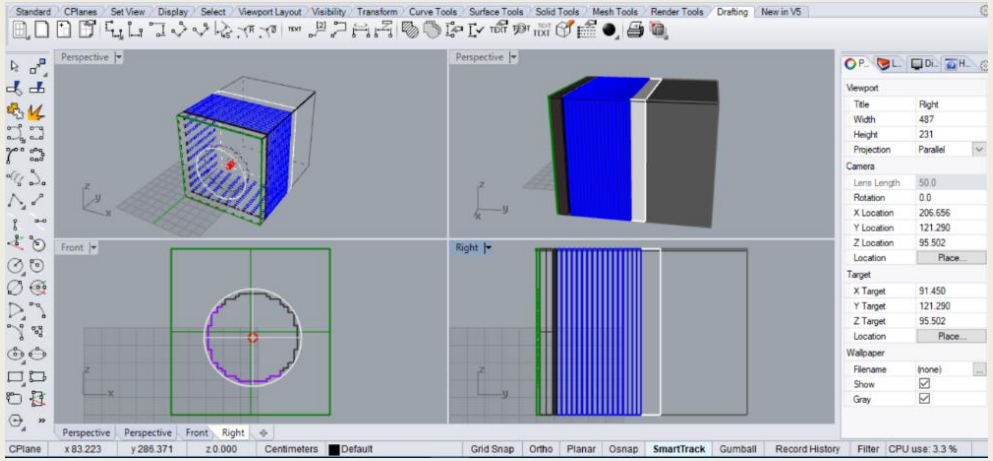
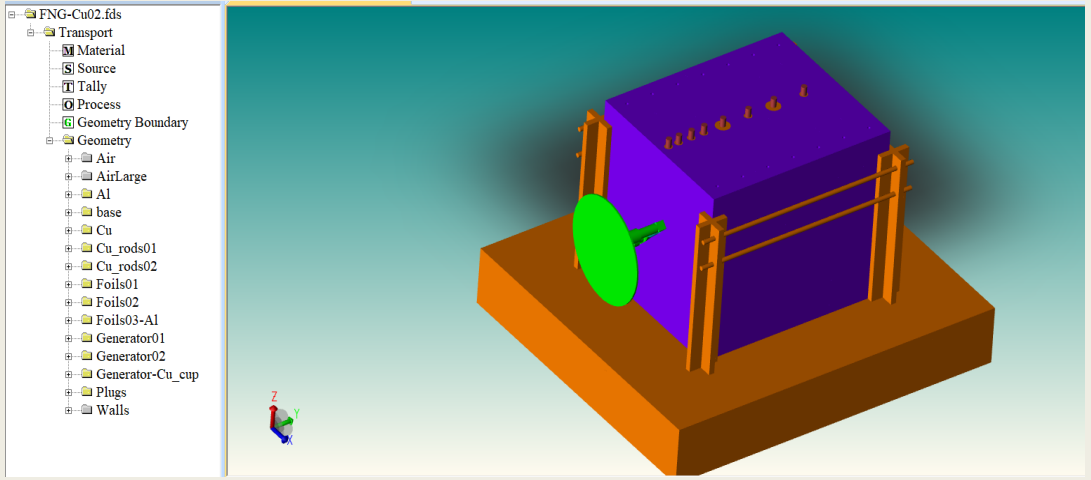


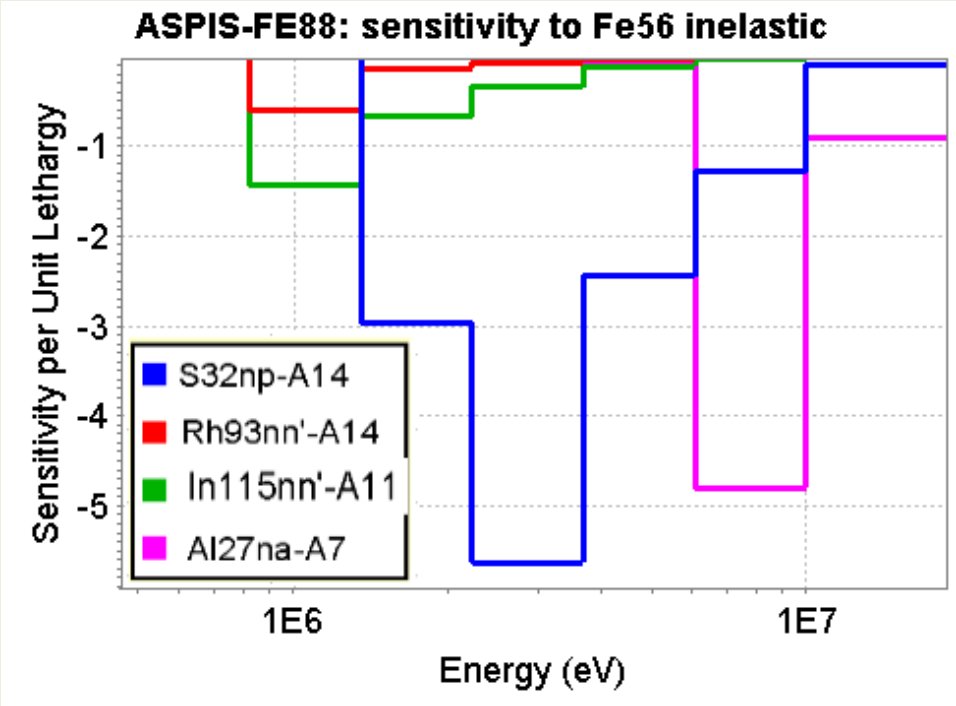
FNG Cu: FDS format

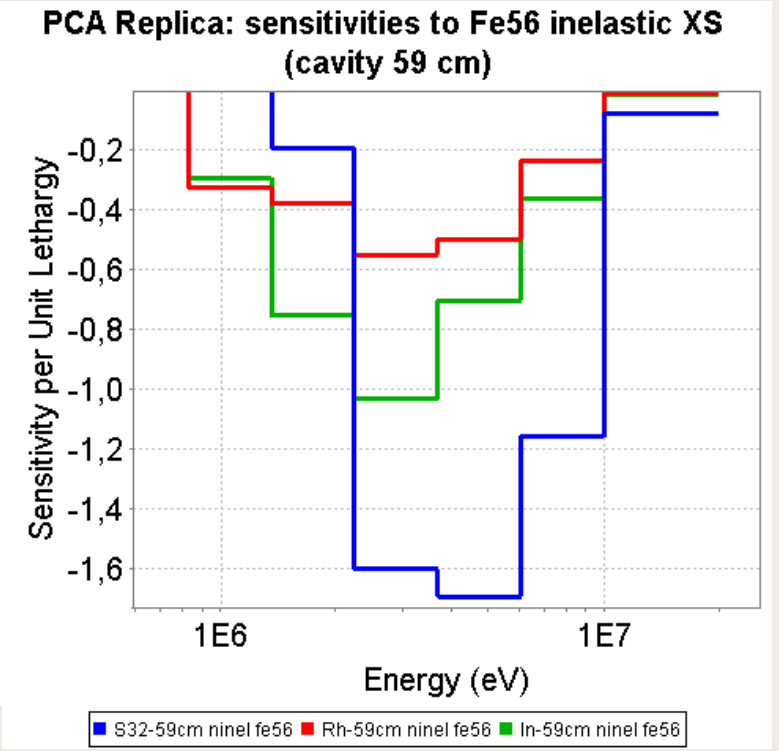


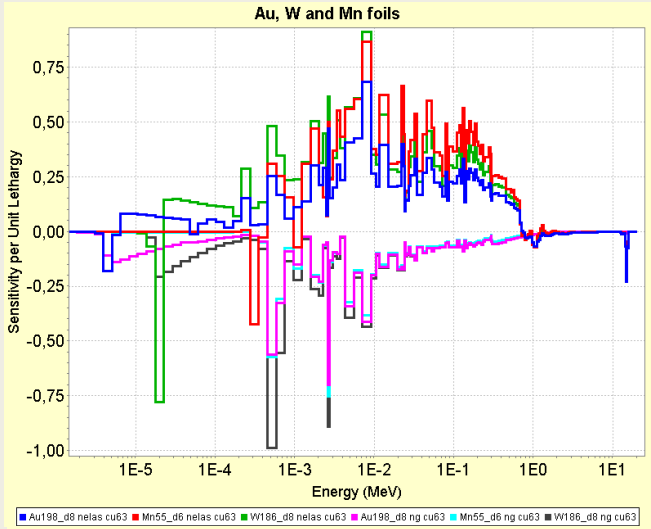
Sensitivity profiles

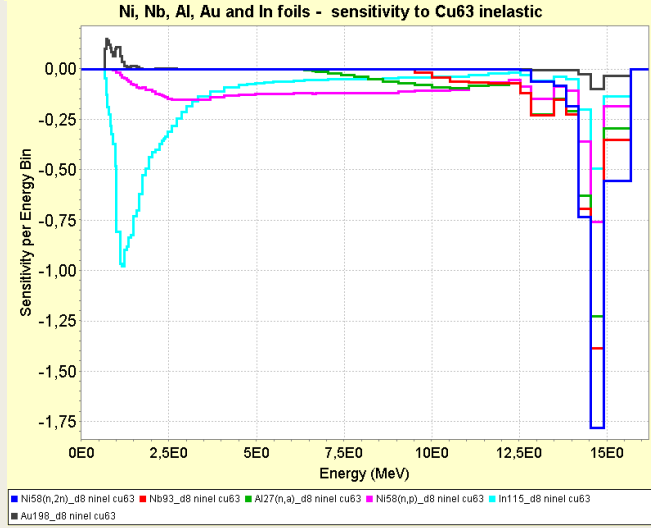
FNG-Cu

S/U performrd for several benchmark experiments: ASPIS Fe88, PCA Replica, FNG (Cu, W, HCPB, HCLL, …), VENUS-3, LLNL.
Format: SensitivitiesViewer (Nicola Soppera)

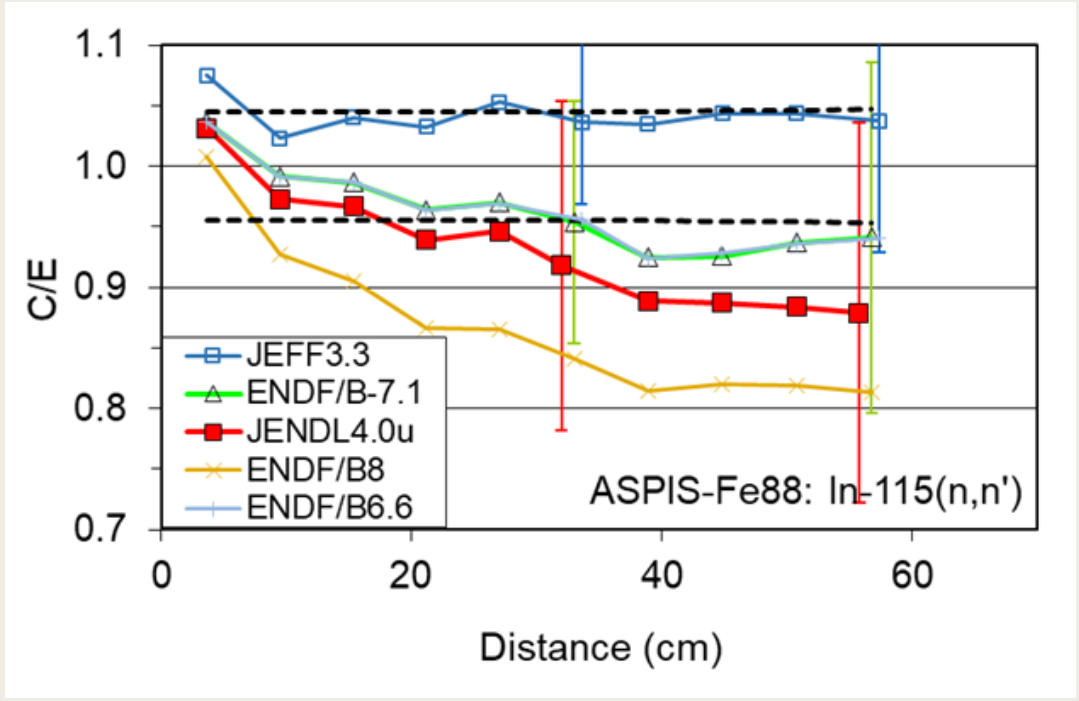


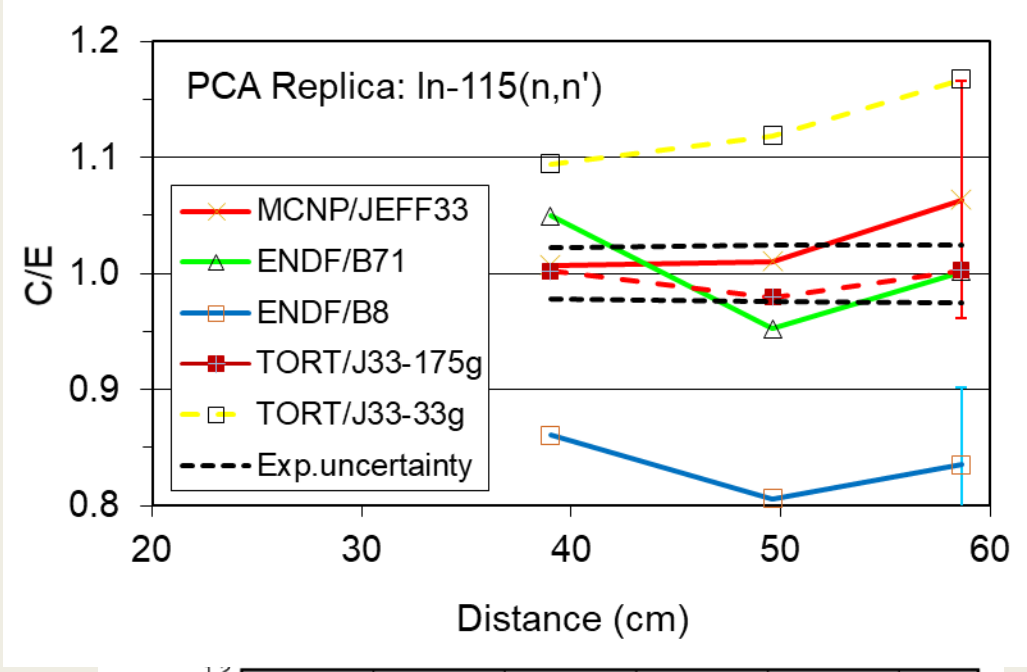


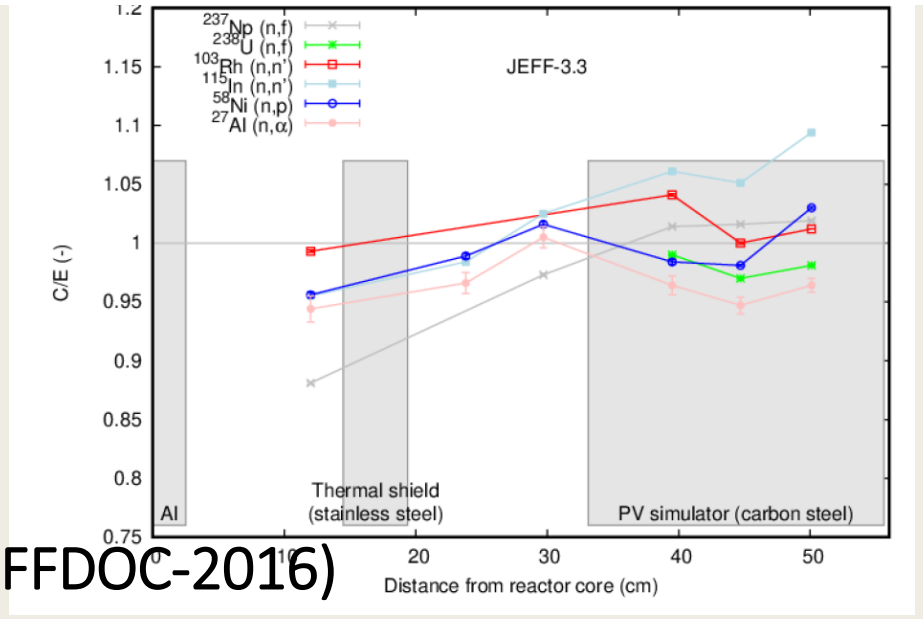




Consistency between ASPIS Fe88, PCA Replica and PCA ORNL benchmarks (In115)



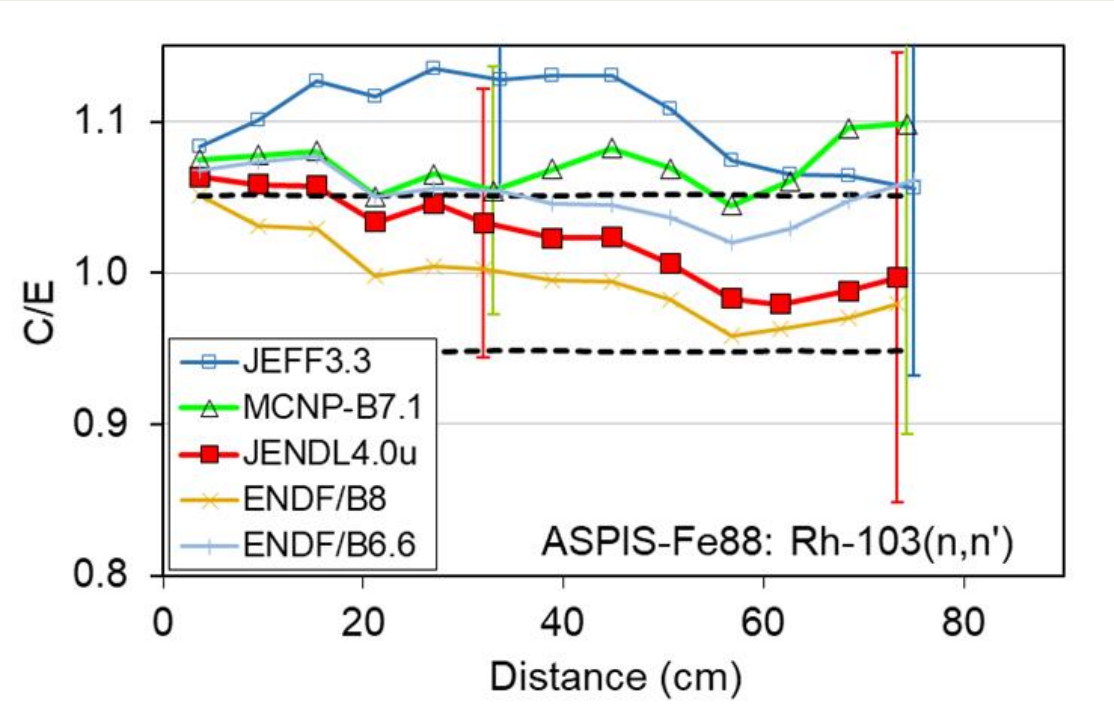


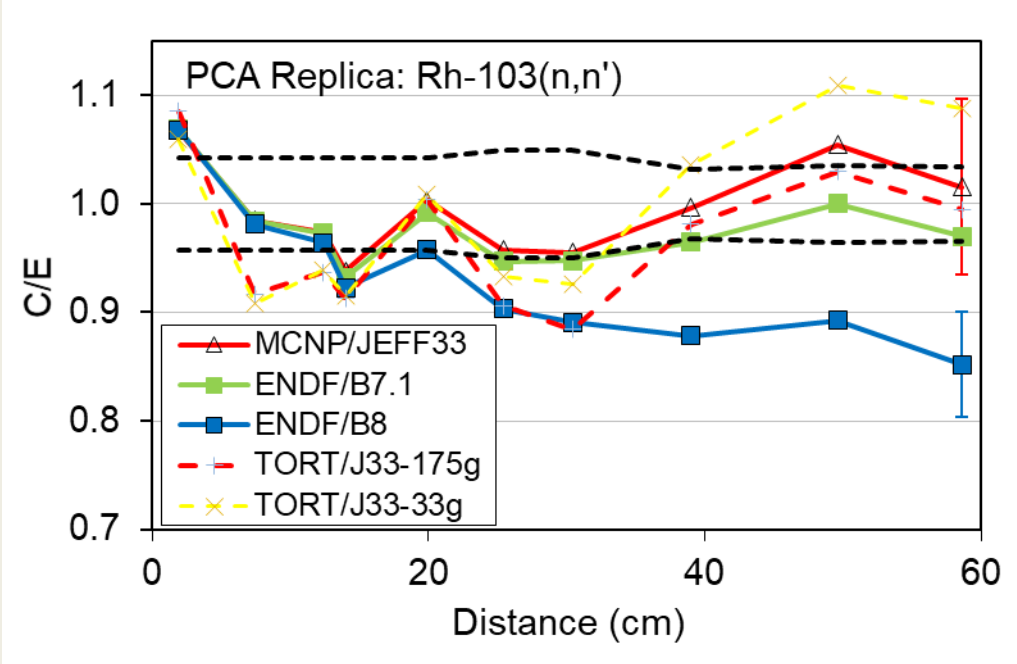


I. Remec: PCA ORNL using DORT/BUGLE-96:
C/E ~ 0.91 – 0.97

S. v.d.Marck (JEFFDOC-2016)

Consistency between ASPIS Fe88, PCA Replica and PCA ORNL benchmarks





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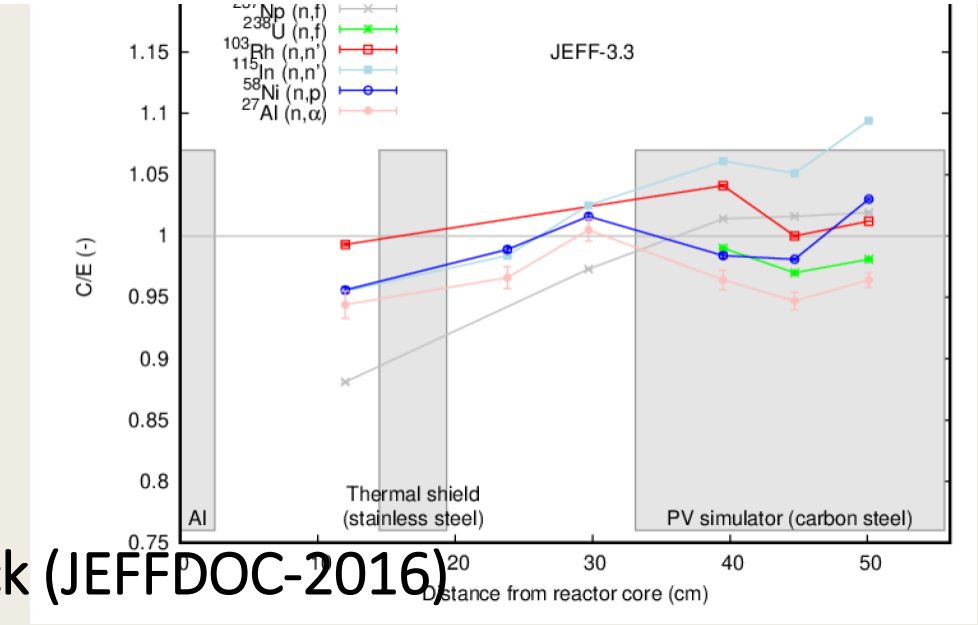
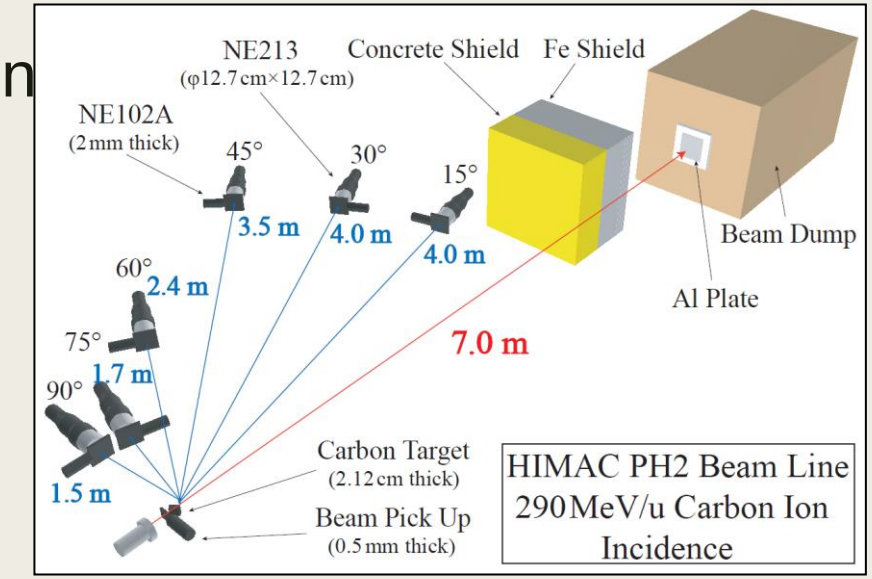


S. v.d.Marck (JEFFDOC-2016)

SINBAD News & Ongoing activities

- **Quality review** & MCNP inputs by A. Milocco (2015) added in updated SINBAD: Janus-1 & -8, Nesdip-2, Aspis water, Aspis n/g, Aspis graphite, Aspis Fe, PCA Replica. Updating of NESDIP-3, ASPIS-Fe88 is ongoing**;**
- **Quality review and new SINBAD evaluations:** SINBAD evaluation & independent review ongoing within **ICSBEP/IRPhE/SINBAD TRG meeting (Oct. 2021 and after):**
  - **Rez Fe spheres**
  - **FNG Copper**
  - **FNG-HCLL**
  - **HIMAC**
  - **TIARA**
  - **CIAE leakage spectra from Fe**
  - **OKTAVIAN Cr (evaluation to be performed by B. Kos using experience from QR by A. Milocco)**
  - **KFK 1977 Iron spheres (S. Simakov)**
- **Other pending updates, data received:**
  - **SuperMC/INEST Hefei:** Oktavian (Al, Fe, W, Si, Ni), FNS (C, O, V, W, Skyshine, Dugled Duct), FNG (SiC, SS, Bulk shield, Str., Dose rate, W), TUD (W, Fe, SiC, Bulk shield), IPPE (Th), Kant (Be), ISPRA Fe
  - **SERPENT: CCFE, KIT, JSI:** FNG benchmarks, **CEA Cadarache:** ASPIS-Fe88
  - **ASPIS Fe88:** MCNP, DORT/TORT inputs from **IJS, ENEA Bologna**

Production of secondary neutrons in the interaction of He, Ne, Si, Ar, Xe ions of energy 100-800 MeV/nucleon on fully stopping targets of C, Al, Cu and Pb

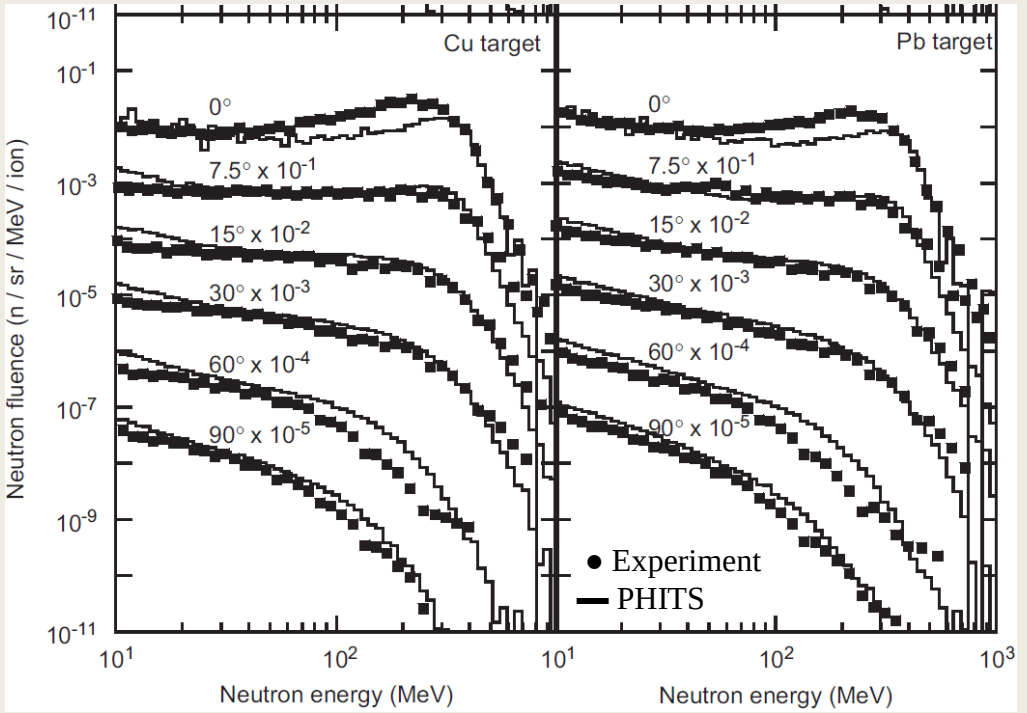


Geometry in the experiment

History and status of this evaluation:

- T. Kurosawa et al. originally reported the series of experimental data of secondary neutron production from thick targets in 1999-2001.
- Compiled in SINBAD as the NEA-1552/35 in early 2000.
- D. Satoh et al.(2007) re-evaluated Kurosawa's data using more reliable detection efficiencies calculated by a QMD-basis MC calculation.
- S. Tsuda et al. started to evaluate the full dataset and submitted to the shielding session in the ICSBEP Technical Review Group (TRG) meeting in 2018/2019.
- The report has been revised, and ready to submit to the ICSBEP TRG again in 2021.
- After the final approval, currently planed to be recorded both in the ICSBEP Handbook and in SINBAD.

Kindly provided by Shuichi Tsuda, JAEA

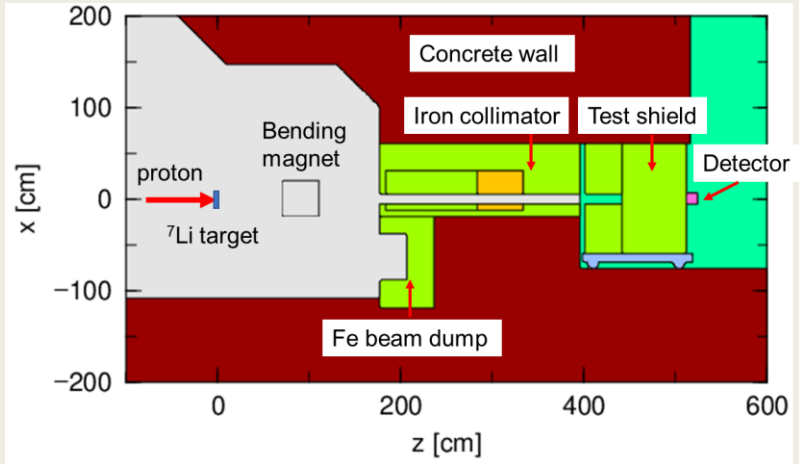


Examples of the secondary neutron production of 400MeV/u Carbon ion

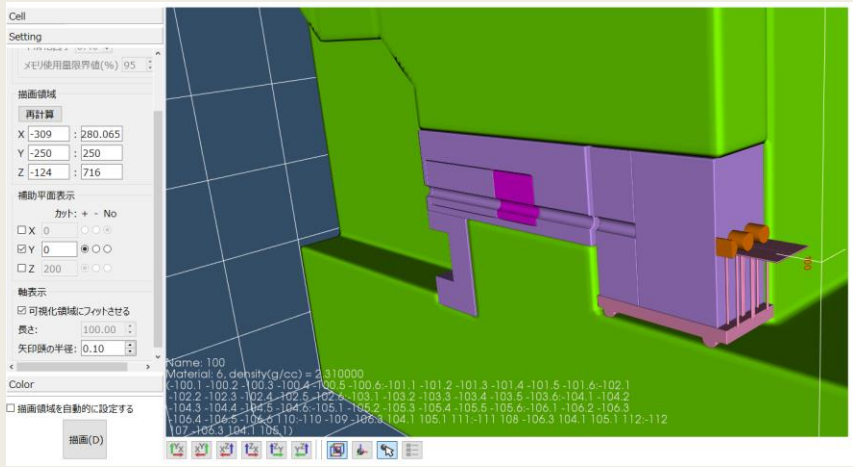
Re-evaluation for TIARA shielding experiments (NEA-1552/03) with the PHITS code

Yosuke Iwamoto 2021/05/10

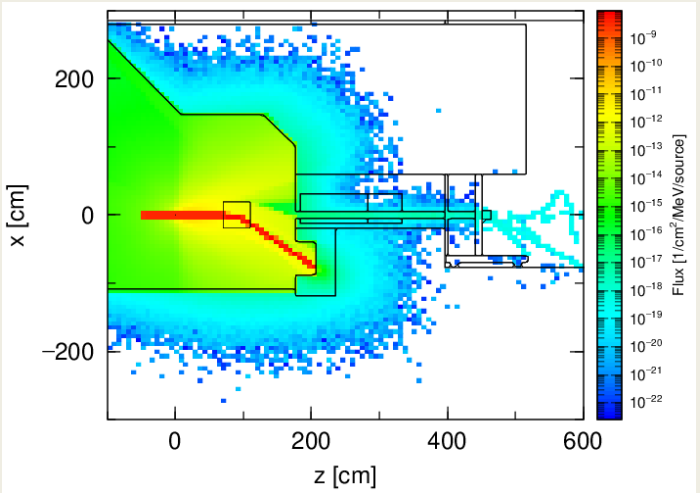
- Neutron energy spectra behind concrete and iron shields were measured for 43- and 68- MeV proton-^{7}Li neutrons at the TIARA facility.
- The particle and heavy-ion transport code system (PHITS) and the evaluated nuclear data library JENDL-4.0/HE will be used for the evaluation.



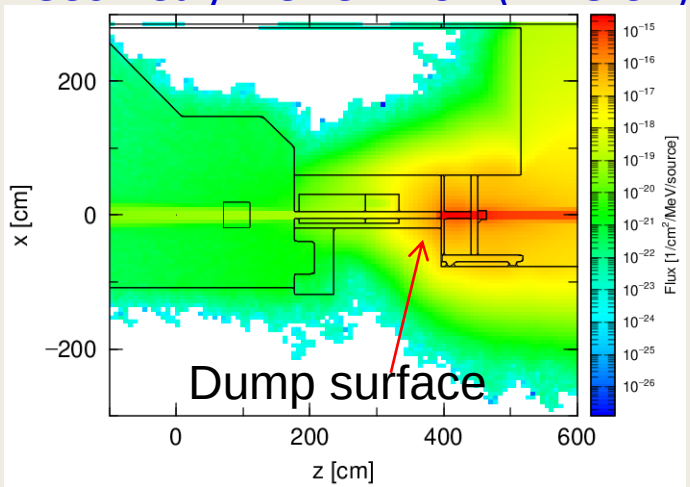
Calculation geometry with the [t-track] section



Calculation geometry with the PHITS Interactive Geometry Viewer in 3D (PHIG-3D)



Protons



Neutrons

Kindly provided by Yosuke Iwamoto, JAEA

- It will be submitted to OECD NEA TRG meetings for ICSBEP in 2022.

Focused meeting on new SINBAD evaluations

- Identify suitable benchmarks to be included in SINBAD
- Update and discuss priority list for new SINBAD evaluations
- Communicate with EGPRS, TRG, WPEC SGs
- Continue (re-start) quality review (initiated ~2008)

***	valid for nuclear data and code benchmarking
**	suitable for education & training
*	benchmarks of historical interest

SINBAD distribution policy & availability

- Clarification of the present NEA policy is needed: distribution can be done on benchmark case by case basis. For the convenience of the authors and users the rules should be transparent and clear.
- Opinions and recommendations from WPEC SG47 members and users on availability and sensitivity of SINBAD shielding benchmarks.

Conclusions

- SINBAD database currently contains compilations and evaluations for 102 shielding benchmarks. Few new data since 2009; Computer code inputs missing for some experiments
- SINBAD was successfully used in the scope of Fusion for Energy (**F4E), EUROfusion, CHANDA, SANDA, WPEC SG39, SG46, (CIELO), EFF-4** and **IAEA** activities and **demonstrated to be suitable for validation of modern nuclear data evaluations and codes, in combination with criticality, kinetics and other benchmarks**
- Ongoing activities, new acquisitions:
  - *New code inputs received (SuperMC, Serpent, Geant)*
  - *ASPIS, FNG, LLNL, and other benchmarks are studied within WPEC SG47*
  - ***Quality re-evaluated SINBAD benchmarks** ASPIS, JANUS, NESDIP (8 + 2 ongoing),*
  - *Several new SINBAD evaluations under review during ICSBEP/IRPhE/SINBAD meetings*
- **New features:** acceleration of M/C calculations (ADVANTG), **CAD geometry** (.stp format?), **sensitivity profiles** (formats of SensitivitiesPlot, N. Soppera?), computational model(s)
- NEA SINBAD online utility: name **Chimera** was proposed by Jim
- **Quality evaluations and classification:** done for ~50% of SINBAD benchmarks between 2008 and 2015. Needed for the remaining ~ 50 benchmarks; ongoing for TIARA, ASPIS Fe88
- **Evaluation of new shielding benchmarks** according to the priority list
- **Distribution policy** & availability need clarification
- Financing will be needed
- Coordination with other WPEC SG46 to promote good practice in use of benchmarks for ND V&V
- Formats issues seem to be less important for ND users than the content.

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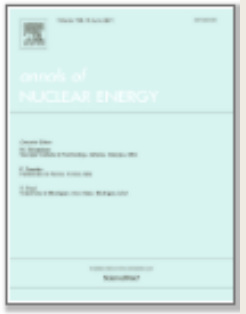

SINBAD – Radiation shielding benchmark experiments

Ivan A. Kodeli [a], Enrico Sartori [b]

https://authors.elsevier.com/sd/article/S0306454921001304

NEACRP discussions in 1980's on creation of shielding benchmark database - topics discussed

- **Code-dependent vs. code-independent strategy,**
- **Sensitivity analysis** should be carried out whenever practicable
- Some automatic analysis of results should be carried out within the data base itself
- The system should include relevant information both on measurement and calculation
- The system should contain every significant fact about both experiment and calculation.

Any relevant matters not covered in the experiential report and corrections which are necessary to the report would be included in general experimental commentary report,

- **External correlations** with other experiments through the use of common source or common counting system should be reported
- **Quality of information in measure reaction rates is likely to be much higher than that of measured spectra,** which depends on the quality of the processing of pulse-heights through unfolding algorithm. The derivation of a reliable dispersion matrix for spectra is difficult to achieve.

P. Miller, P. Nagel, M. Salvatores, E. Sartori, Shielding Experimental Benchmark Base at the Nuclear Energy Data Bank, Proc: 7th Int. Conf. on Rad. Shielding, Bournemouth, UK 1988
A.K. McCracken, E. Sartori, A Proposed Structure for a Shielding Experimental Benchmark Data Bank, NEACRP-A-1020, 19 Sept. 1989

SINBAD started ~1992 as a joint OECD/NEA DB and RSICC project

THANK YOU FOR YOUR ATTENTION