NEA Tools to Support SG46 Work

+ WPRS Feedback

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WPEC SG46
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Tools Available

DICE,IDAT,JANIS,NDaST

See kick-off SG46 meeting for more details.

Summary of recent applications of the tools

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

Industrial engineering: is a branch of engineering which deals with the optimization of complex processes, systems, or organizations. **Industrial engineers** work to eliminate waste of time, money, materials, person-hours, machine time, energy and other resources that do not generate value. According to the Institute of Industrial and Systems Engineers, they create engineering processes and systems that improve quality and productivity.[1]

Sensitivity Profiles Available [DICE + IDAT]

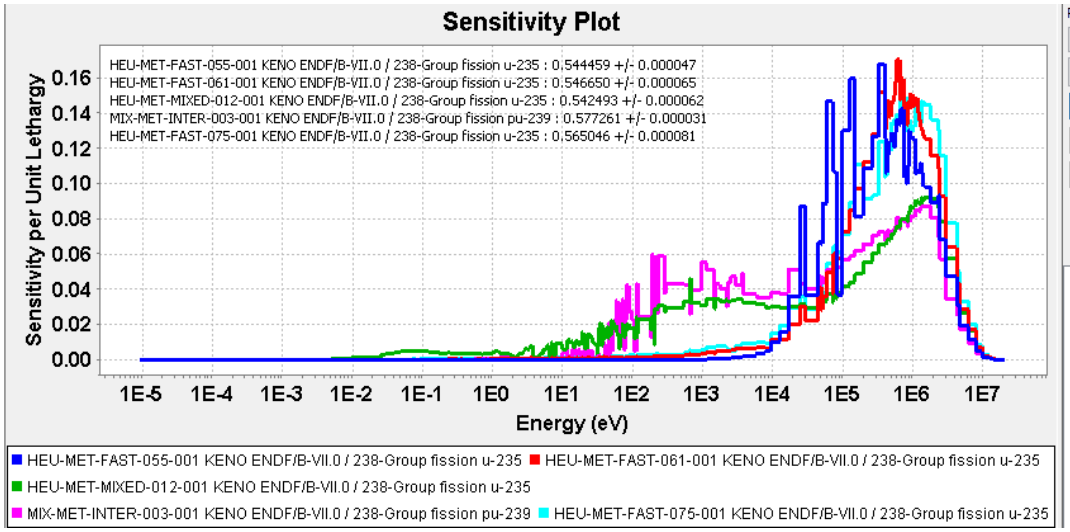
Handbook Edition	Number of Unique Cases	Sources
2012	727	TSUNAMI1D+TSUNAMI3D [VALID]+MMK-KENO
2013	3575	Previous +Non VALID cases SCALE6.0 from Balance Inputs
2014	4011	Previous + MCNP6 + SCALE6.2BClutch
2015	4065	Previous + New Cases
2016	~4200	Previous + New Cases + P1 Sensitivities [~400 cases]
2017	~4200	Previous+P1 Sensitivities [~700 cases]
2017	~600	IDAT Sensitivities [Waiting input +Code GPT]

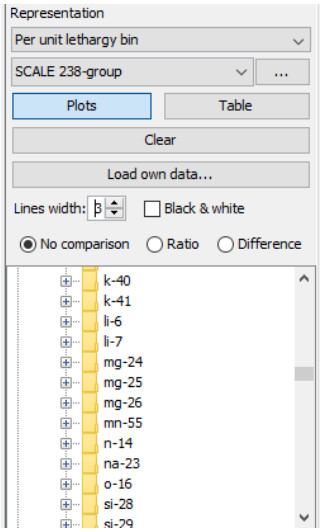
- Distributed with the Handbooks and browsable online.
- Sensitivity dot product to characterise similarity.

Covariance Data Available [JANIS]

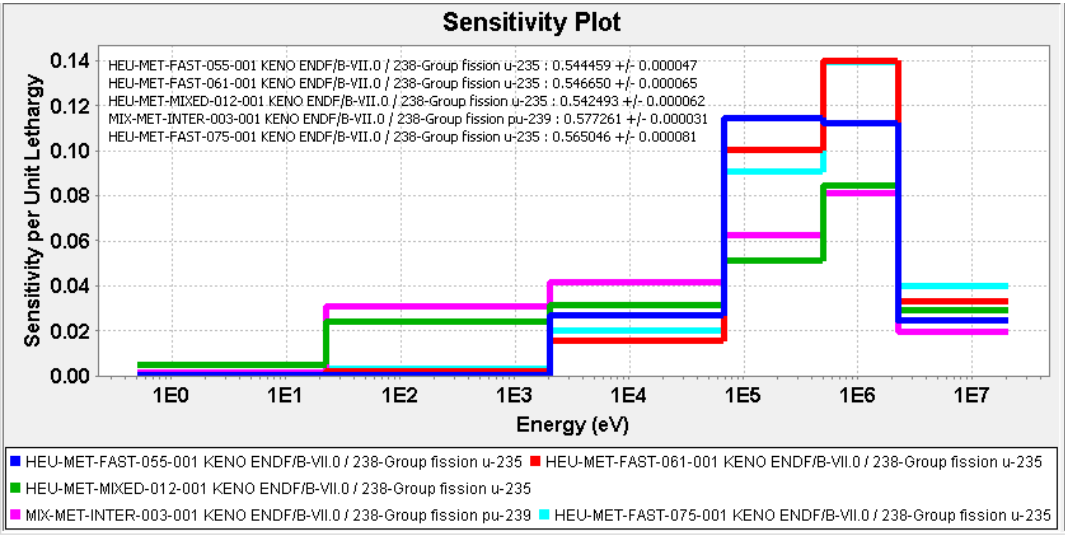
- All major libraries have BOXER files with MF32/MF33 processed. (~30 libraries with covariances, ~40 libraries)
- Users can add MF31. In the future these will be available
- No MF34. Will come in the future.

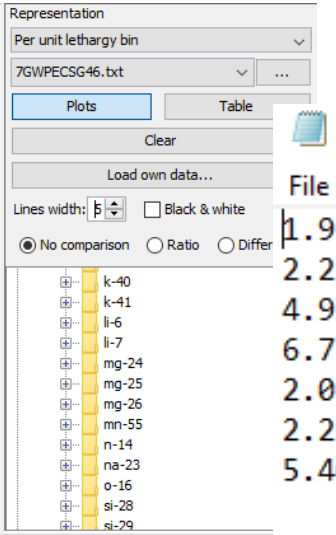
DICE+IDAT With Proposed 7 Group Structure

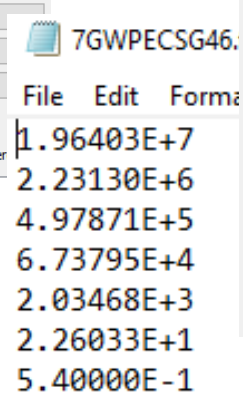


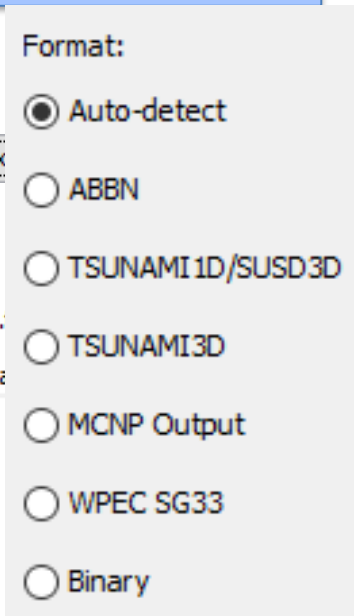


Quasi-Random ZPPR Fission Sensitivity Profiles









Action

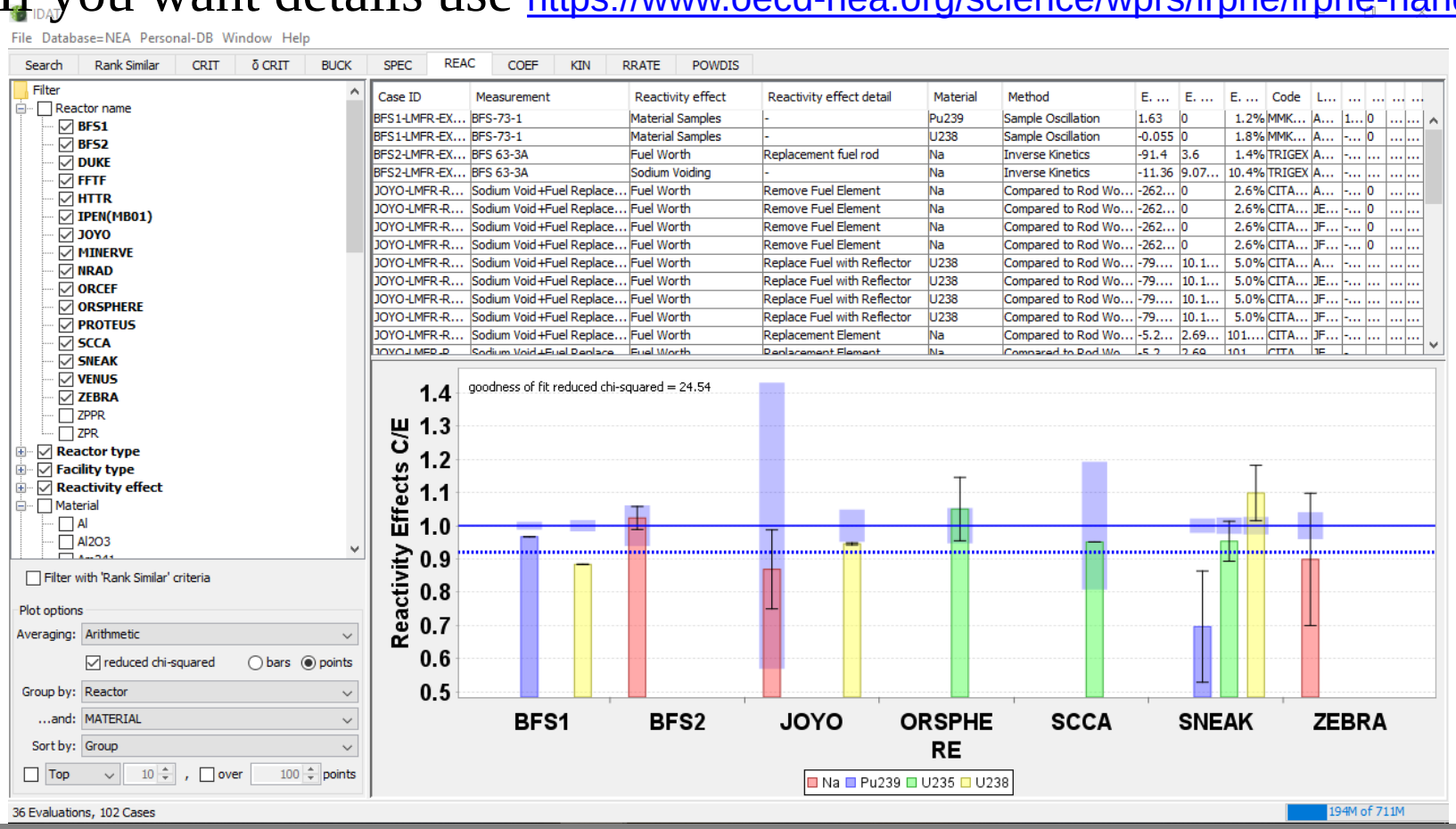
"I also expect a contribution coming from the NEA archives as described by Ian Hill and possibly NEA helping to perform the sensitivity coefficient calculation for some specific system."

Survey of Reactivity Worth Measurements

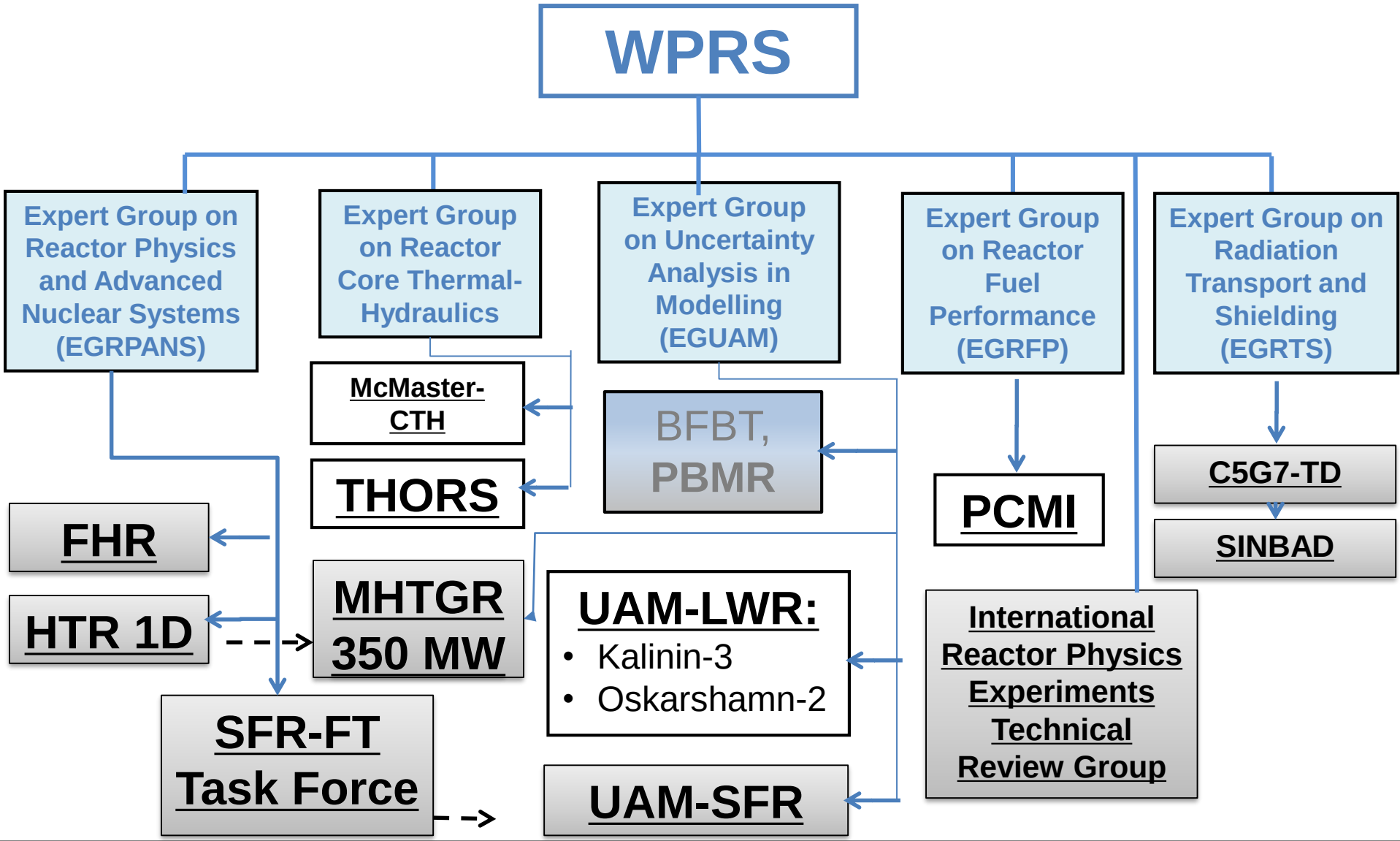
There are 634 measurements of reactivity worth's of materials in IRPhE

There are 2210 measurements of spectral indices in IRPhE

If you want details use https://www.oecd-nea.org/science/wprs/irphe/irphe-handbook/

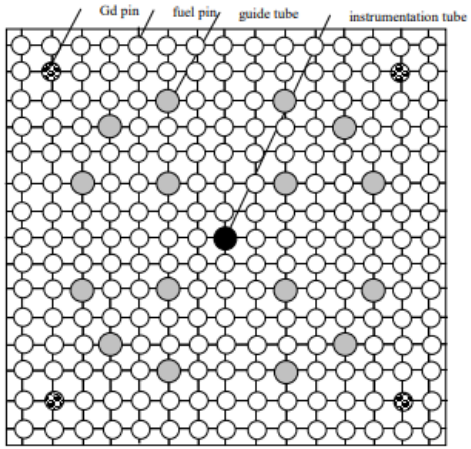


Recent Benchmarks under WPRS

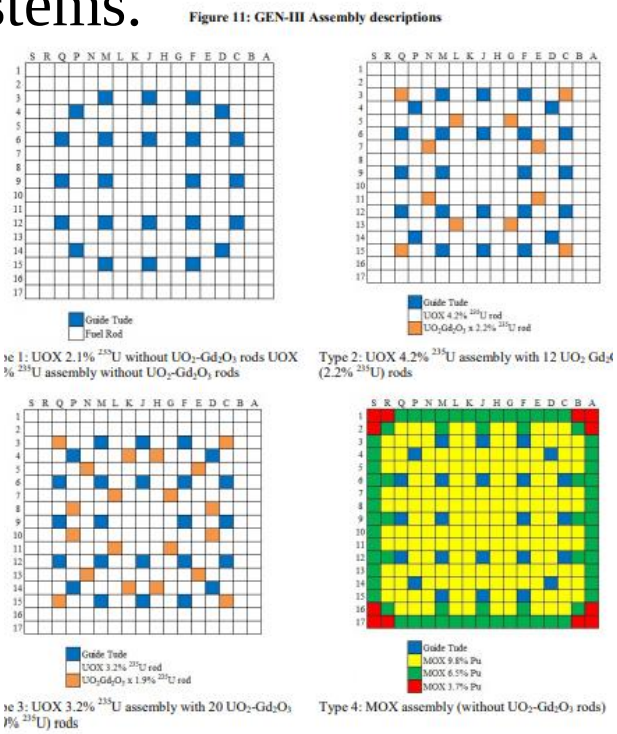


LWR-UAM Phase I (Ex 2)

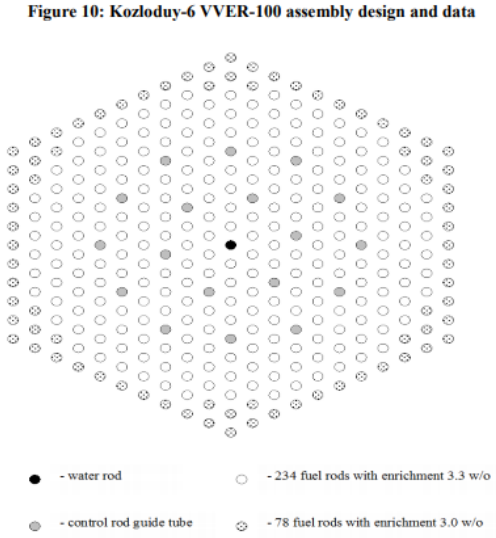
Propagate uncertainties from nuclear data and manufacturing uncertainties to LWR systems.



Ex I-2: TMI



Ex I-2: GEN-III



Ex I-2: Kozloduy-6

Stressed that target uncertainty will encapsulate ALL uncertainties

No specific target accuracies were provided. (they were requested)

SFR-UAM Task Force (report 2016)

Nuclear Science
NEA/NSC/R(2015)9
February 2016
www.oecd-nea.org

Benchmark for Neutronic Analysis of Sodium-cooled Fast Reactor Cores with Various Fuel Types and Core Sizes

Figure 2.1. Radial core layout of 3600 MWth carbide core

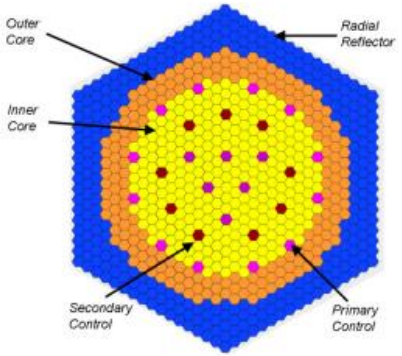


Figure 2.7. Radial core layout of 1000 MWth metallic-fuel core

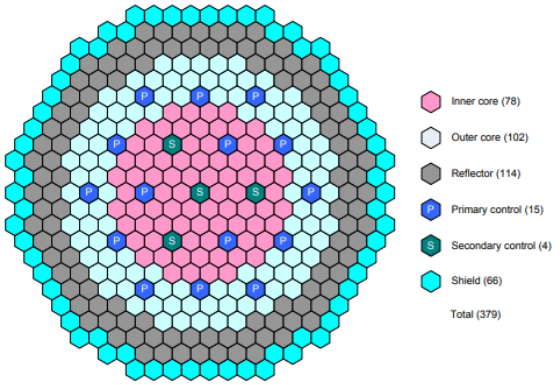


Figure 2.3. Radial core layout of 3600 MWth oxide core

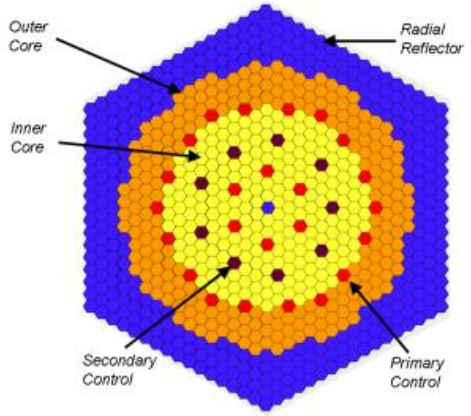
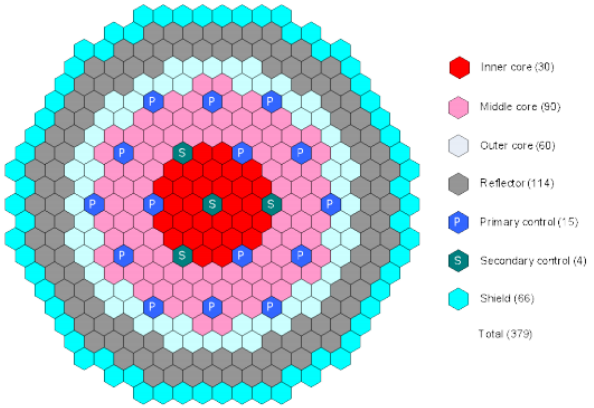


Figure 2.12. Radial core layout of 1000 MWth oxide-fuel core



SFR-UAM

Propagation of uncertainty from pincell to reactor, check consistency.
Uncertainties not just from nuclear data.

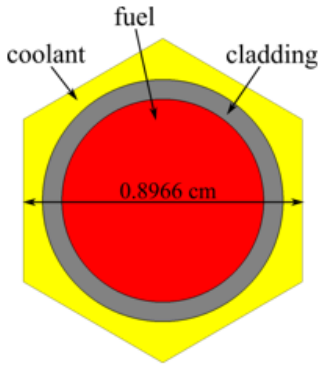


Figure 1: MET1000 pin cell model.

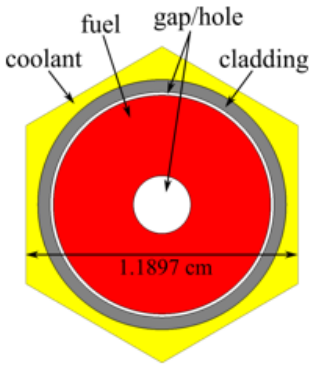


Figure 2: MOX3600 pin cell model.

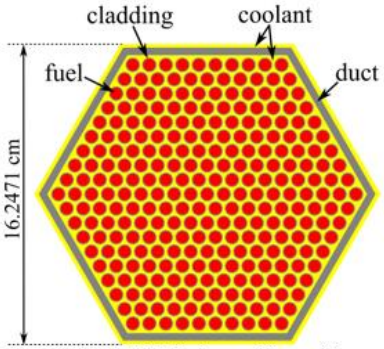


Figure 3: MET1000 fuel assembly model.

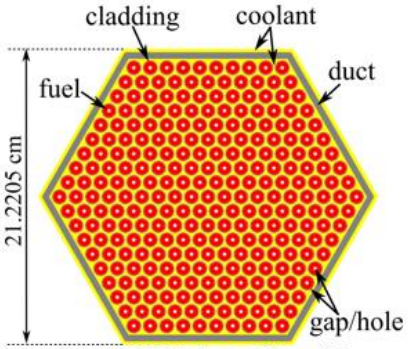


Figure 4: MOX3600 fuel assembly model.

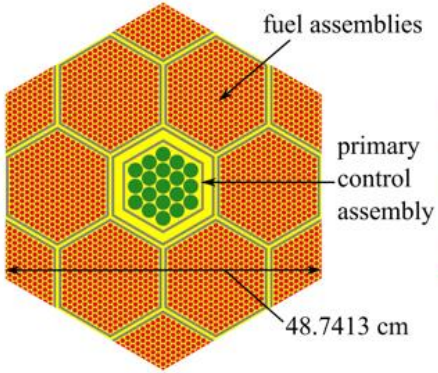


Figure 7: Option B: MET1000 super-cell model – detailed fuel assemblies surrounding a primary control rod assembly.

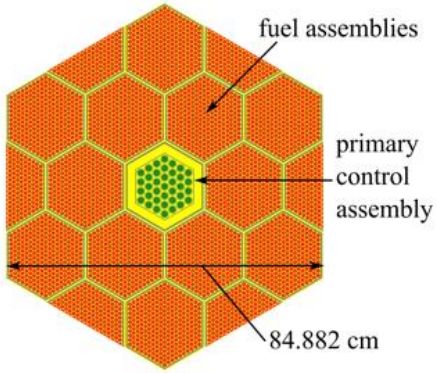


Figure 8: Option B: MOX3600 super-cell model – detailed fuel assemblies surrounding a primary control rod assembly.

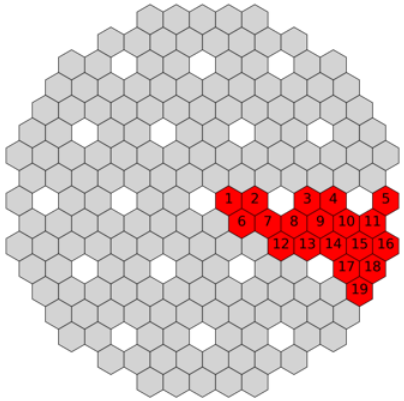


Figure 9: Fuel assembly map of the MET1000 core. Requested axially integrated assembly powers indicated in red.

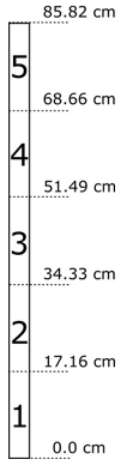


Figure 10: Axial zones of the active fuel assembly region for the determination of the axial power distribution in fuel assembly 6 of the MET1000 core.

Archive Benchmarks of Note

Reviewed NEACRP-L and NEACRP-A documents:

- REACTOR SHIELDING BENCHPWX NO. 2 for a PWR (1975)
- Fast Reactor Shielding Benchmark (1975)

- EGIEMAM-I (II)
- HTGR Depletion benchmark
- Kinetic parameters at CROCUS (IRPhE)
- HTR with Reactor Grade Plutonium (R-Z model available)
- PMBR benchmark
- + Many LWR and HWR lattice benchmarks

Nuclear Data Sensitivity Tool (NDaST) Flowchart

Benchmarks (Sensitivities) → Nuclear Data (% Change or Covariance) → Integral Results

Select / load benchmarks

Sensitivities (S) & C/E data

DICE

IDAT

Personal

Numerical Benchmarks

Database of over 4000 Sensitivity Data Files

User Input Perturbation (P)

isotope/reaction/energy cross section

AND /OR

JANIS 4

Covariance data via JANIS (C)

Built in processed data for major libraries

Load personal (coverx)

M energy groups (fixed)

S*P

Δk_{eff} for selected cases

C/E output plot grouped by criteria

S*C*S^T

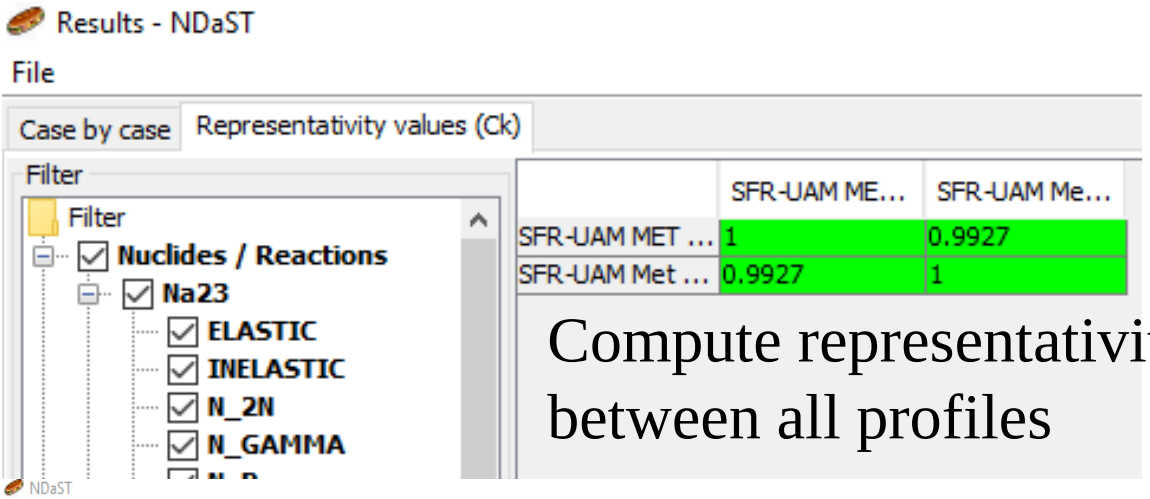
$U_{C(XS)}$ for selected cases

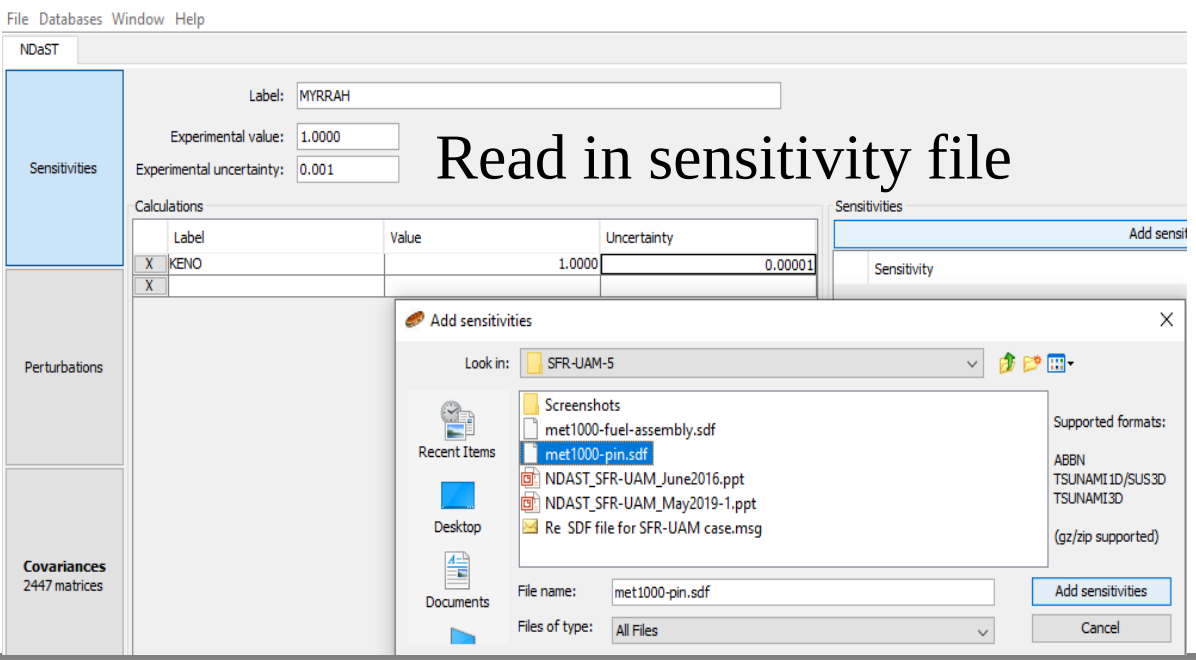
Additional uncertainty on output plot grouped by criteria

Matrix plot showing individual contribution to $U_{C(XS)}$ by isotope-reaction

JANIS MF33: ENDF/B-VII.1 = 2138 files, JEFF-3.2 = 5688 files JENDL-4.0 = 2155 files TENDL-2013 = 77811 files, SCALE6.2

NDaST Applications





Isotope	Reaction	Library	Uncertainty (pcm)
U-238	Inelastic	TENDL2015	N/A
U-238	Inelastic	TENDL2017	566
U-238	Inelastic	JEFF3.3	806
U-238	Inelastic	ENDF/B-VII.1	1331
U-238	Inelastic	ENDF/B-VIII.0	566
U-238	Inelastic	JENDL-4.0	870
U-238	Inelastic	FENDL-3.1b	1328

NDaST

- NDaST was used extensively during CIELO to provide feedback to the project. [Chadwick, Trkov]
- Often it gave results that were confirmed months later by extensive direct substitution.
- Other times it failed. I've presented numerous times why… most GLS methods will have similar issues.
- P1/mubar
- PNFS (Ein)…….PNFS NJOY issues
- Inelastic energy/angle changes

Final notes, and some random controversial statements

- Many tools available, many formats. NEA a good place recombobulate.
- Many benchmarks exist. Most aren't used. Many of the 'best' ones aren't even used.
- I like PIA. Translate upwards to funding people.
- Numerous benchmarks are so downstream that they aren't even thought about. How can adjustments be proposed without all downstream applications considered?
- When giving R/Z models considered computing similarity metric to detailed models.
- Adjustments might not even have access to some of the levers that evaluators are using.
- SG33 did excellent work on integral experimental correlations (Ishikawa). Continuing to examine their impact on adjustments would help calibrate the amount of effort in this area.

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