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IRSN
INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

IRSN WORK IN SUPPORT TO NCSP: FY2024

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MEMBRE DE
ETSON

Content

Highlights on FY2024 work

IER 296 TEX-MOX : Final design optimization and cooling system testing

⟶ *see dedicated talks by V. JAISWAL and N. THOMPSON on Wednesday*

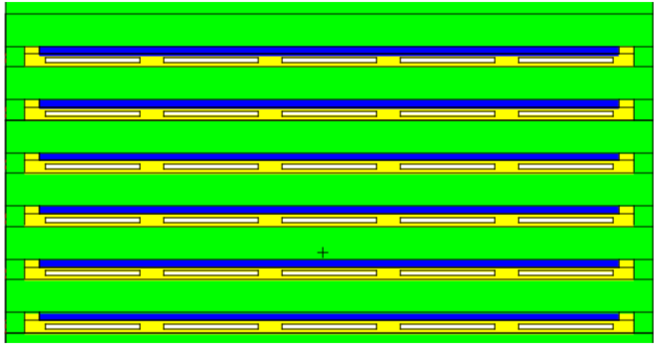
- IER 296
  - Fuel : ZPPR plates
    - PUMN (Pu/Pu+U weight ratio of 28.8%, ^{240}Pu content of 11.6%)
    - PUMH (Pu/Pu+U weight ratio of 34.9%, ^{240}Pu content of 26.4%)
  - Moderator: Polyethylene

➞ **Dedicated cooling system to address issue due to decay heat: up to 500W of PUMN and PUMH plates**

- CED2 report officially published by IRSN February 15th 2024, thanks to LLNL and LANL reviews.
  - Configurations optimized to match with French industrial application cases provided by French utility ORANO

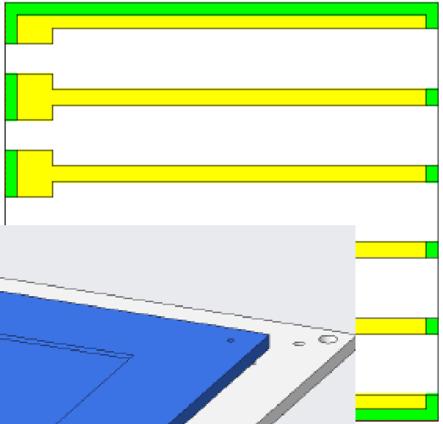
3 configurations :
- THERM configuration : C_k around 0.8 - 0.9
- INTER1 &2 configurations : C_k around 0.7 - 0.9

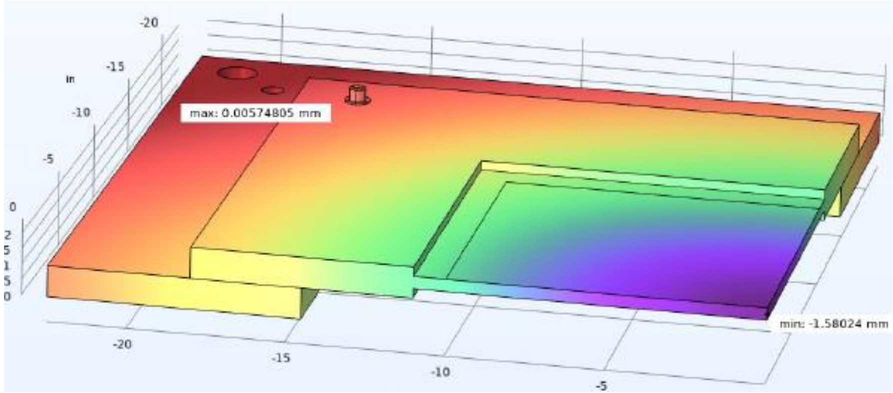
TEX-MOX - IER 296 : FY2024 last neutronics computations

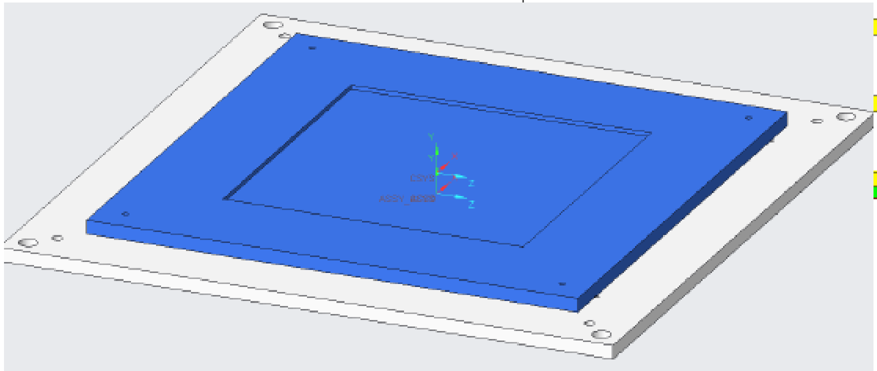


- Impact of grooving channels (thickened up to 10 mm since CED2)
  - Into Aluminum plates ➔ -1000 pcm
- Update of new PLANET's top plate
  - Assessment of its deflection ➔ -600 pcm
- Influence of cooling system hoses compositions and geometry

Polyethylene
Aluminium
Fuel plates

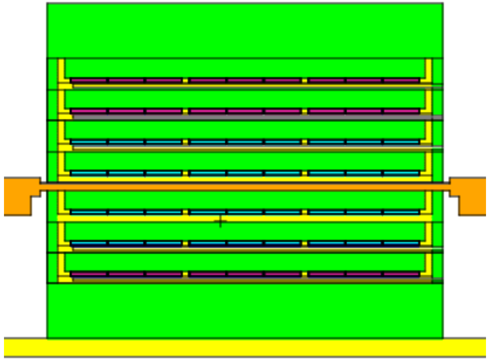






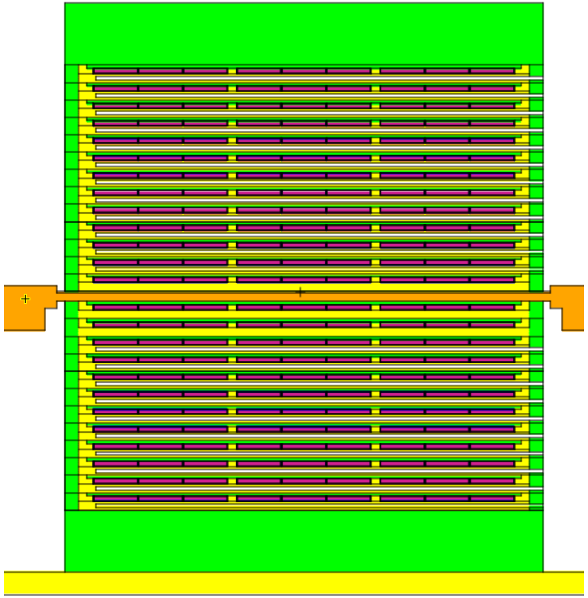
TEX-MOX - IER 296 – Final configurations updated after CED2

THERM



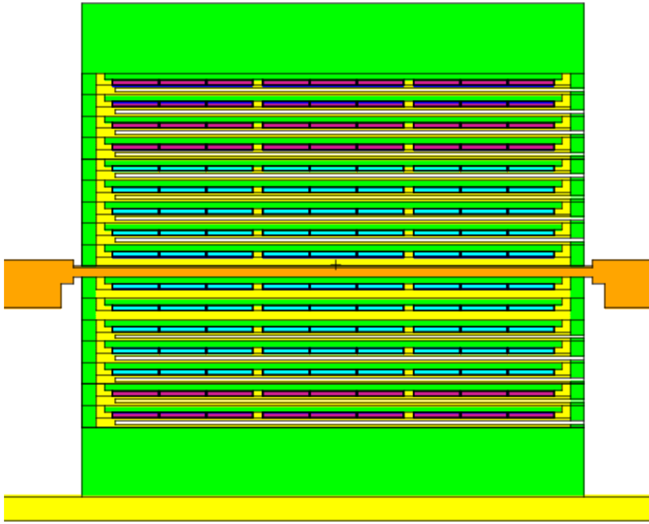
7 layers

INTER1



25 layers

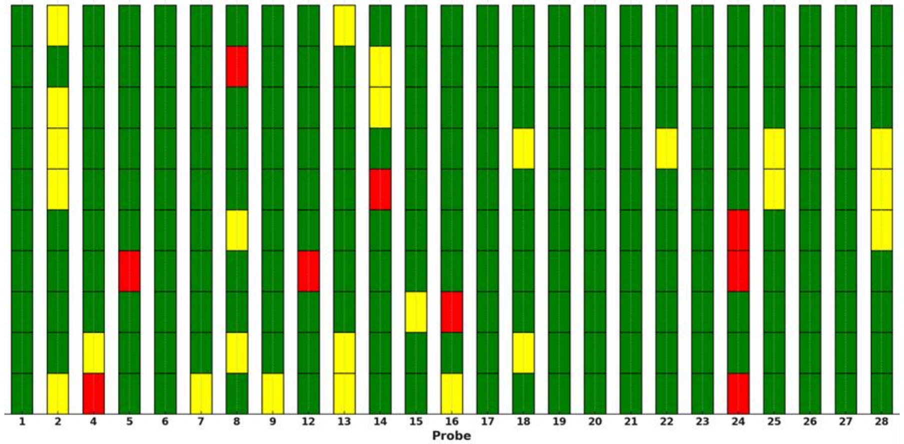
INTER2

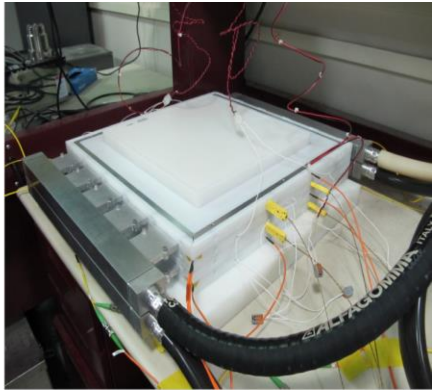


16 layers

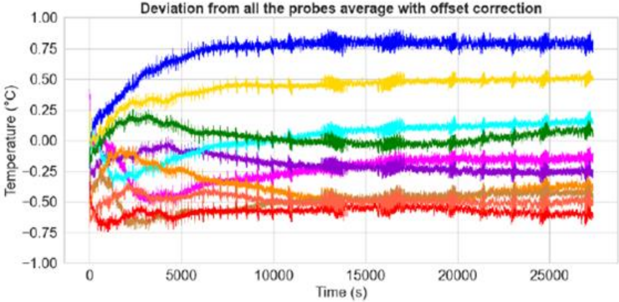
Polyethylene
Aluminum
PUMN
PUMH
Aluminum: PLANET top plate

MIHL (IRSN/LANL): Fabricate and test cooling design for the TEX/MOX experiment.





- **Majority of Measurements are Green** : Indicating sensors are functioning well, with measurements within ±1°C of the global average.
- **Moderate Deviation Yellow** : Deviation between ±1°C and ±1.5°C from the global average.
- **Significant Deviation Red** : Deviation greater than ±1.5°C.



The cooling system works great !

In all the tested scenarios, the temperature remains under 40°C with the fans off, and under 28°C with fans on

Participation to blind dosimetry intercomparison exercise [IER-602]

- **Location:** TRIGA Reactor, held at the Armed Forces Radiobiology Research Institute (AFRRI), Bethesda, MD
  - Aug. 23: measurements to characterize AFRRI's TRIGA
  - **June 24-28, 2024**: International dosimetry exercise

- **Objectives:**
  - Test the performance of nuclear accident dosimeters (NADs) against the requirements of ANSI/HPS-N13.3-2013 (R2019) standards, to evaluate the speed of results delivery (first results available in less than 3 hours)

- **Equipment deployed by IRSN:**
  - **Neutron spectrometers:** SNAC 2 (activation foils)
  - **Dosimeters:** RPL gamma dosimeter, neutron alanine dosimeter, activation belt, Silicon Diode Sensors
  - **Additional Tools:** beta counter, NaI spectrometer, silicon diode reader.

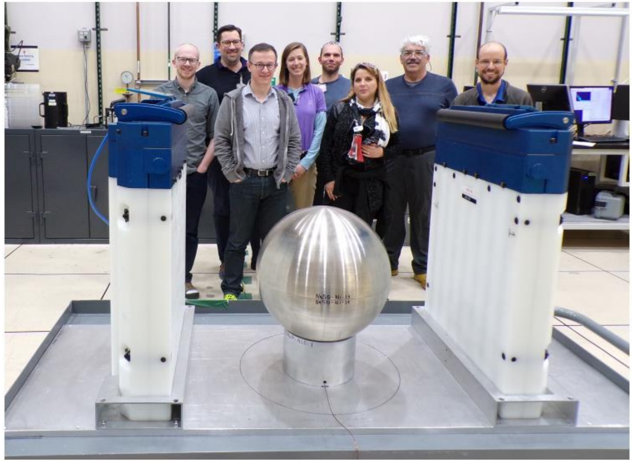
- **Activities:**
  - Placed dosimeters on BOMAB phantoms and aluminum plates for neutron irradiation.
  - Participated in "blind" experiments to evaluate dosimeter performance in both controlled and limited-information scenarios.
  - Collected and analyzed data for dosimetry response, including orientation corrections.

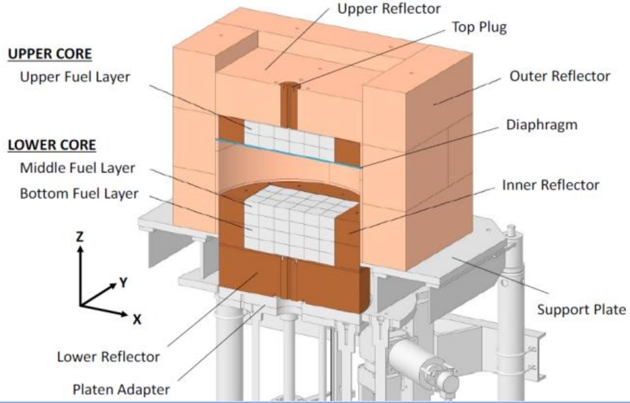
Benchmark reviews for ICSBEP

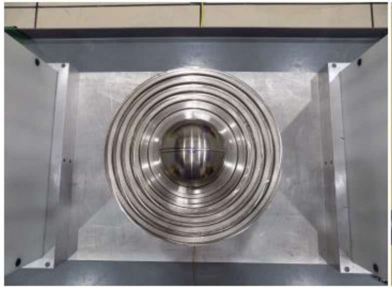
- FUND-NCERC-NP-HE3-MULT-001: Neptunium Subcritical Observations (NeSO): Nickel-Reflected Neptunium-Metal-Sphere Subcritical Measurements by Jean-Baptiste CLAVEL

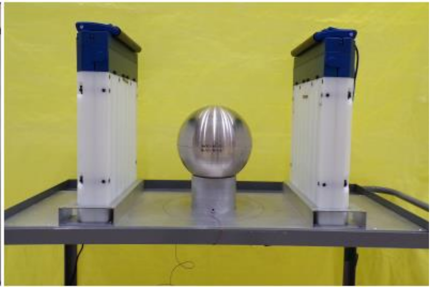
- PU-MET-FAST-050: The Jupiter Experiments: High-240 Plutonium Metalplates Separated By Lead And Reflected By Copper, review by Mariya Brovchenko via NCSP CED team

- Contribution to ICSBEP TRG commitee

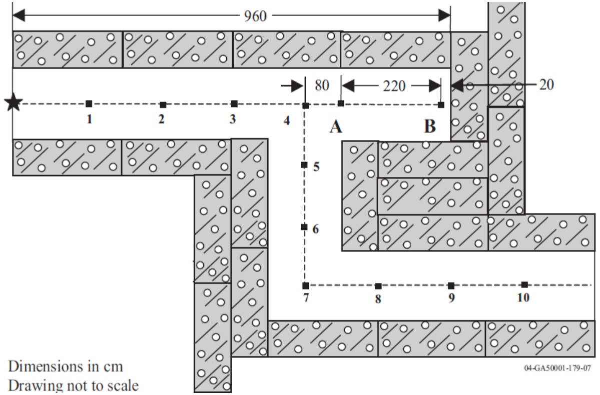








Analytical Methods & Nuclear Data



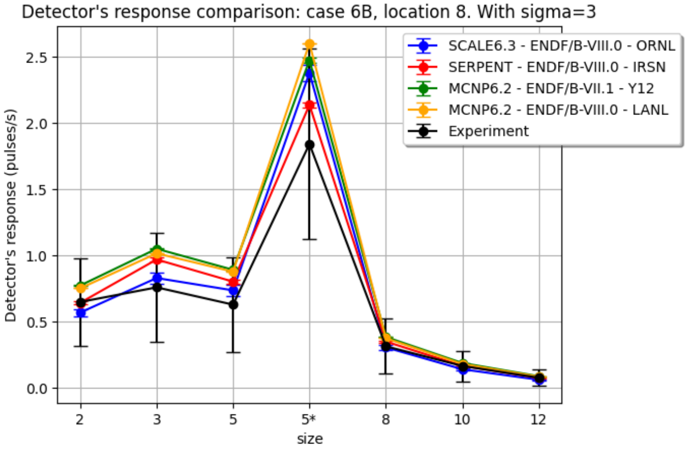
- **Slide Rule** → *see dedicated talk by A. BARDELAY this afternoon*

- **Benchmark intercomparison**
  - k_{eff} : completion of the action in 2023
  - β_{eff} : completion of the action in 2024

➔ 2 Reports reviewed by participants, published.

- **Shielding benchmark** → *see dedicated talk by V. JAISWAL this afternoon*

  - ALARM-CF-AIR-LAB-001 from ICSBEP :
    NEUTRON FIELDS IN THREE-SECTION
    CONCRETE LABYRINTH
    FROM CF-252 SOURCE
  - Participants : ORNL, LANL, LLNL, Y-12 and IRSN
  - Calculations done in 2024
  - 1st draft version of report expected Q2-2025



Information Preservation & Dissemination

LFE Database

- participation to LFE database meetings with ORNL, LLNL and NNL
- Comments and testing of the database
- Identification of relevant French events for NCS to be shared

LFE Seminar November 6th between IRSN and French utilities and applicants

- French utilities : Orano: La Hague, Melox, NPS, Tricastin, CEA Saclay, Valduc, Cadarache, Andra and Framatome
- Invited talk of D. Hill on the international LFE database
- French operators shared an interest in this LFE database and highlighted its importance for the knowledge preservation
- This database will help experts to identify events from similar facilities

✓ **First event submitted by Orano Melox (MOX fuel fabrication) !**

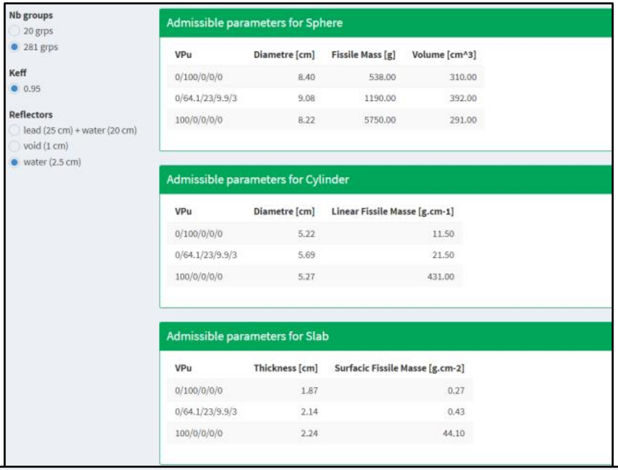
FY 2025 challenges

Main FY2025 challenges

- **IER 296 TEX-MOX**
  - Experiments scheduled in FY2025
- **Fukushima Fuel Removal and Monitoring**
  - Simulation on current states of reactors
  - Evaluation of neutron noise technics in representative configurations
  - Validation/testing of IRSN neutron detector system on CROCUS reactor (Switzerland)
- **IER 484 : Dosimetry on AFFRI reactor**
  - Review of CED4A
  - IRSN available to contribute to a new exercise organization
- **CED 0 : Explore possible needs for experiments with LANL ARIES rods (MOX)**
- **IRSN-AM13/ORNL-AM10/LLNL-AM5/LANL-AM5/Y12-AM1 : Benchmark intercomparison study**
  - After shielding, intercomparison on Nuclear Data processing to be launched for FY2025
- **Slide rule**
  - Phase 6 (Pu sensitivity + shielded calculations)
  - Ongoing development of the web application

LICORNE: Free and user-friendly access to extensive criticality standards data base

https://licorne.irsn.fr/


Nb groups
20 grps
281 grps
Keff
0.95
Reflectors
lead (25 cm) + water (20 cm)
void (1 cm)
water (2.5 cm)

Admissible parameters for Sphere

VPu	Diametre [cm]	Fissile Mass [g]	Volume [cm^3]
0/100/0/0/0	8.40	538.00	310.00
0/64.1/23/9.9/3	9.08	1190.00	392.00
100/0/0/0/0	8.22	5750.00	291.00

Admissible parameters for Cylinder

VPu	Diametre [cm]	Linear Fissile Masse [g.cm-1]
0/100/0/0/0	5.22	11.50
0/64.1/23/9.9/3	5.69	21.50
100/0/0/0/0	5.27	431.00

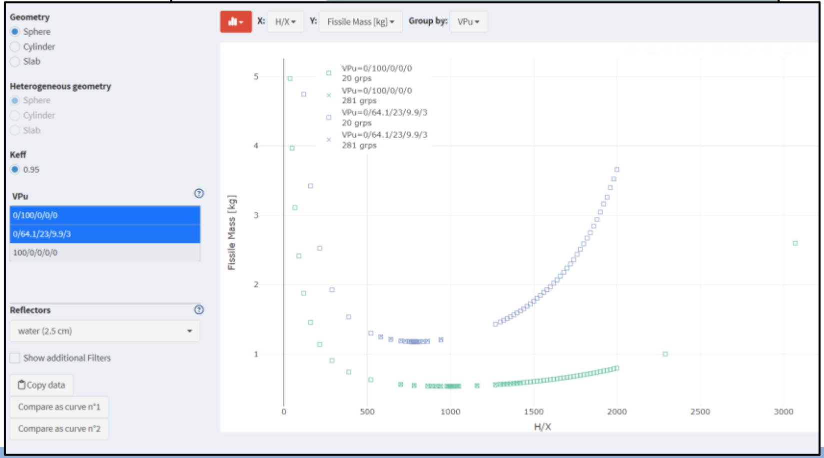
Admissible parameters for Slab

VPu	Thickness [cm]	Surfacic Fissile Masse [g.cm-2]
0/100/0/0/0	1.87	0.27
0/64.1/23/9.9/3	2.14	0.43
100/0/0/0/0	2.24	44.10

- Standard Data Base calculated with the CRISTAL French package
  - Criticality standard values for 1D geometries
    - Sphere, cylinder, slab
  - Multiple parameters
    - Fissile material, enrichment (including HALEU), poison, reflector nature and thickness, etc.
  - Data Base contains more that 2 millions of results
  - Data Base can be easily extended (new reference values, new parameters, etc.)

- Multiples outputs values (critical and permissible values)
  - Masses, volume, diameter, thickness, etc.
  - Several k_{eff} criteria : 1, 0.98, 0.97, 0.95

- CSV export



CONCLUSION

- **Integral Experiments**
  - **TEX-MOX** : Cooling device and temperature monitoring system are operational, procurements on tracks for a challenging TEX MOX experiment in FY2025 !
  - **Dosimetry** : AFFRI TRIGA reactor appears to be a nice frame to upgrade the ambitions of exercises. Towards a full exercise with organ doses estimation ?

- **Launching of Fukushima fuel removal monitoring project with LANL**

- **Analytical Methods**
  - **Slide Rule : all previous calculations are documented, new features waited for 2025 :**
    - Phase 6 (Pu sensitivity + shielded calculations)
    - Ongoing development of the web application
  - **Benchmarks Intercomparisons**
    - Efficient task to enhance reliability of benchmarks used for validation
    - Report on shielding benchmark in FY2025
    - New exercise on ND processing to be started

Thank you !