

IRSN WORK IN SUPPORT TO NCSP: FY2023

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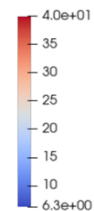
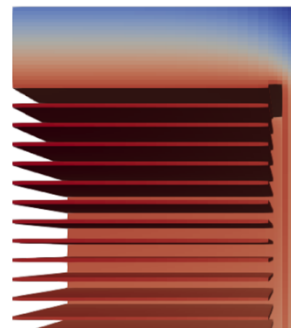
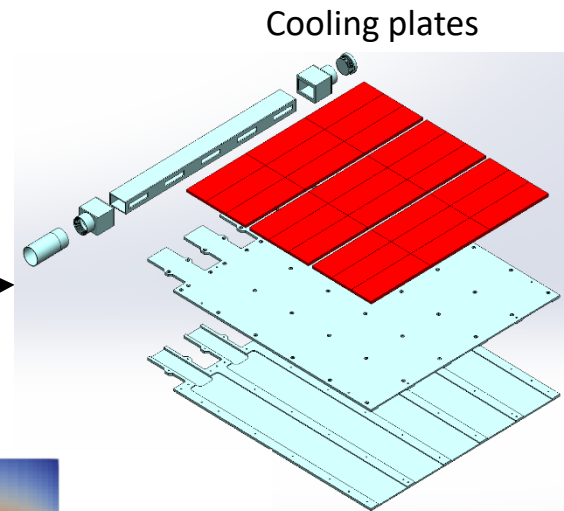
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Highlights on FY2023 work

Integral Experiment in 2023 : TEX-MOX detailed design, CED2 report

- CED1 officially published in 2022.
 - Fuel : ZPPR plates PUMN (Pu/Pu+U weight ratio of 28.8%, ^{240}Pu content of 11.6%) et PUMH (Pu/Pu+U weight ratio of 34.9%, ^{240}Pu content of 26.4%)
 - Moderator: Polyethylene
 - *Thermal issue to warrant safe behavior of CH_2 and accuracy of experiments due to decay heat: up to 500W*
- Collaborative work between LANL and IRSN on thermal behaviour and cooling system
 - It has been shown that an active cooling system is efficient to warrant temperature below 40°C (313K) during the experiment
 - If the fan is off, passive cooling is sufficient to maintain CH_2 temperature below 60°C (333K)



Temperature increase (to room temp.) in CH_2 with passive cooling

TEX-MOX - IER 96

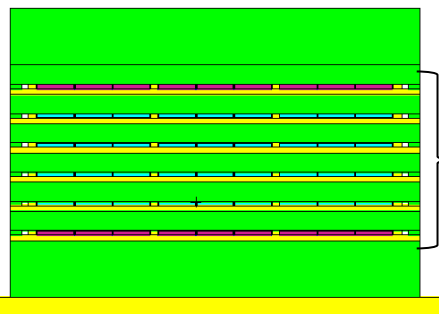
- IRSN worked on designs able to match with industrial configurations (application cases) from Orano (operator of main French fuel cycle facilities)
- Orano provided 9 applications cases corresponding to different steps of the fuel cycle
 - MOX and/or PuO₂ powder
 - Moderation by water, water+CH₂, water+ additives, fire extinguishing powder
 - Reflection by water, concrete, water+Zr
 - Different energy ranges (some are in thermal energy range, some are in fast energy range)
- Matching our three configurations and their relevant application cases:
 - by assessing C_k (objective is to be as close to 1 as possible, the more cases match each other, a threshold of 0.8 is generally considered as good)

For THERM configuration : C_k around 0.8 - 0.9

For INTER1 &2 configuration : C_k around 0.7 - 0.9

TEX-MOX - IER 96 – Final configurations

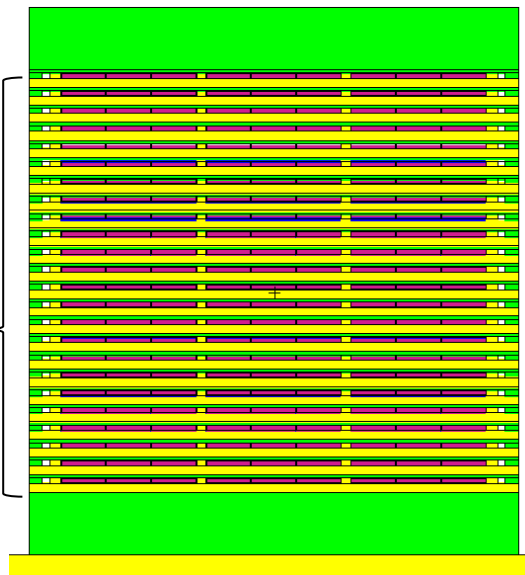
THERM



6 layers

323 kg

INTER1



24 layers

866 kg

INTER2



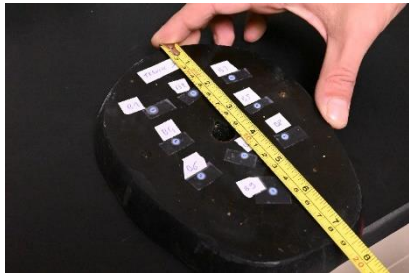
14 layers

508 kg

-  Polyethylene
-  Aluminium
-  PUMN
-  PUMH

IRSN contribution to AFRRI's TRIGA reactor characterization

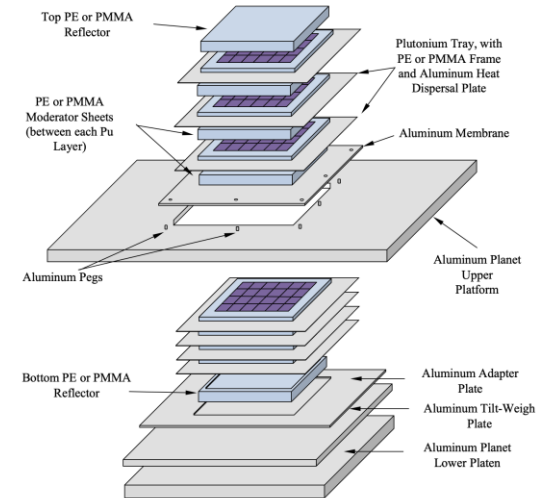
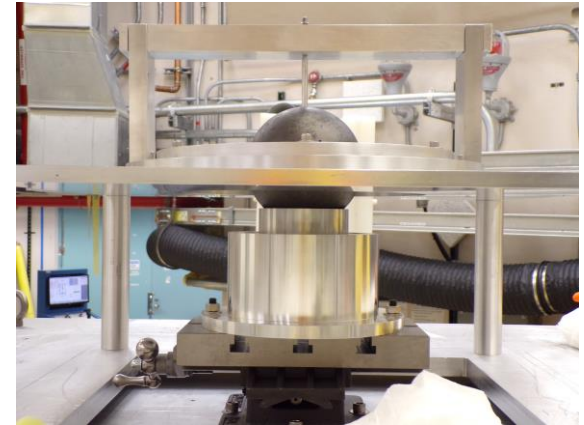
- Feb. 2023: meeting at AFRRI (experimental design) and preliminary measurements (F. Trompier)
- Aug. 2023: measurements campaign (F. Trompier and Y. Ristic)
- Dosimetry techniques: silicon diode, activation foils, RPL gamma dosimeter, neutron alanine dosimeter, activation neutron spectrometer, activation belt

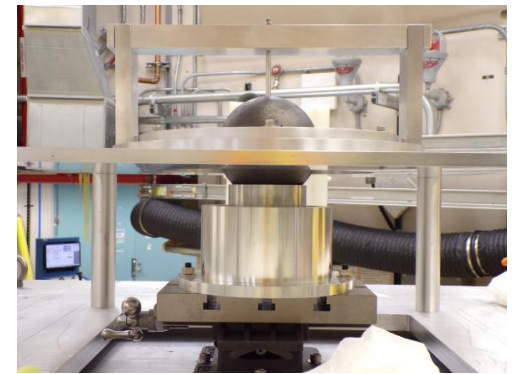


Benchmark reviews for ICSBEP

3 external reviews

- HEU-MET-FAST-104: MUSIC (Measurements of Uranium Subcritical and Critical) (LANL)
- PU-MET-THERM-004: TEX-Pu Experiments for Thermal Scattering Law Validation of Polyethylene and Polymethylmethacrylate (LLNL)
- LEU-COMP-THERM-111 : Molybdenum Sleeve Experiments in Fully-reflected Water-Moderated Triangular-Pitched (SANDIA), last work with our dear late colleague Gary





- 2 cases : critical configurations
- External review with MORET code and 3 nuclear data libraries
 - » Consistent results

Case		Simplified model with MORET 5D (Continuous Energy)			Simplified Model with MCNP 6.2	Benchmark
		ENDF/B-VIII.0	JEFF 3.2	JEFF 3.3	ENDF/B-VIII.0	
1	k_{eff}	1.00017 ± 0.00003	1.00141 ± 0.00003	1.00152 ± 0.00003	1.00104 ± 0.00001	$1,00146 - 0,00121 / + 0,00122$
	C-E	-129	-5	6	-51	-
2	k_{eff}	1.00007 ± 0.00003	1.00133 ± 0.00003	1.00143 ± 0.00003	1.00092 ± 0.00001	$1,00164 - 0,00102 / + 0,00103$
	C-E (pcm)	-157	-31	-21	- 65	-

Analytical Methods & Nuclear Data

- **Slide rule** : Update of 2019 IRSN report including all the computations performed by IRSN, ORNL and LLNL.
=> See dedicated talk on behalf of Johann HERTH
 - Draft reviewed by participants
 - To be published in Q2 2024
- **Benchmark intercomparison** (phase 2)
 - K_{eff}
 - Completion of the action in 2023
 - Report reviewed by participants, published.
 - β_{eff}
 - Computations completed => See Romain Vuiart's talk
 - Report to be written in FY2024
- **LFE Database**
 - participation to LFE database meetings with ORNL, LLNL and NNL
 - IRSN plans to organize a seminar with French operators (Orano, CEA and Framatome) in 2024 to discuss lessons learned from NCS events and to identify the relevant events for the LFE database

FY 2024 challenges

Main FY2024 challenges

IER 296 TEX-MOX CED3a :

- Milestone of the NCSP FY 2022 “Make it happened” list
- Objective is to perform the experiments in FY2025

IER 484 : Dosimetry on AFFRI reactor

- International exercise (24th-28th June 2024)

IED 0 : Explore possible needs for experiments with LANL ARIES rods (MOX)

IRSN-AM13/ORNL-AM10/LLNL-AM5/LANL-AM5/Y12-AM1 : Benchmark intercomparison study

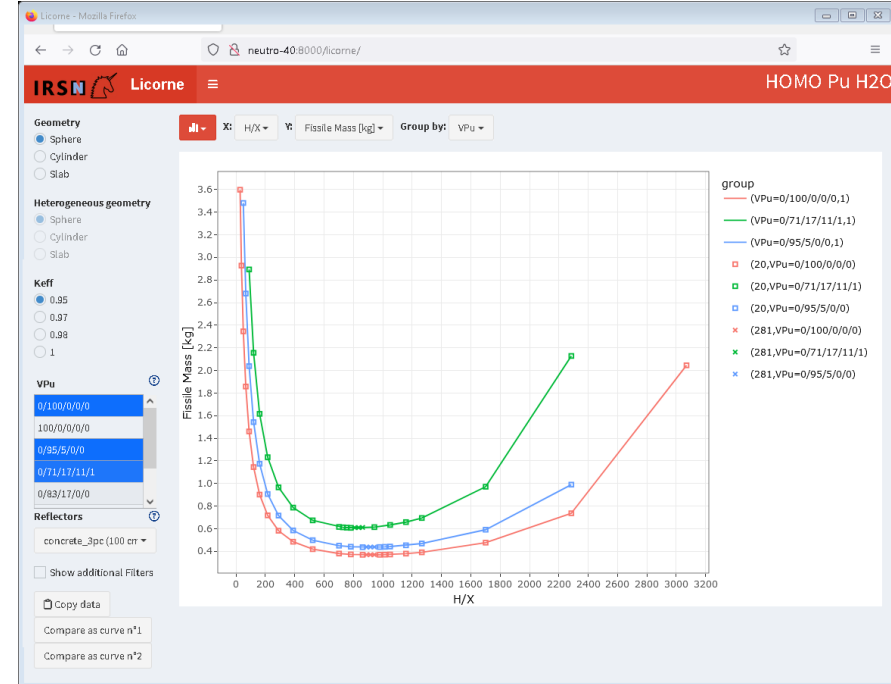
- After β_{eff} intercomparison on shielding benchmarks launched for FY2024



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



- Web application that will be freely available online on the internet
- Standard Data Base produced with the CRISTAL French package
 - Criticality reference values for 1D geometries
 - Sphere, cylinder, slab
 - Multiple parameters
 - Fissile type, enrichment, poison, reflector type and thickness, etc.
 - Data Base contains more that 2 millions of calculations
 - Data Base can be easily extended (new reference values, new parameters, etc.)
- Multiples outputs values
 - Masses, size, volume, surface, concentration, thickness, etc.
 - Several k_{eff} criteria : 1, 0.98, 0.97, 0.95



CONCLUSION

Integral Experiments

- **TEX-MOX** : still lots of work to do but we are on track for a challenging TEX MOX experiment in FY2025 !
Many thanks to LLNL and LANL colleagues involved in this aventure.
- **Dosimetry** : AFFRI TRIGA reactor appears to be a nice frame to upgrade the ambitions of exercises.
Towards a full exercise with organ doses estimation ?
- **New perspectives on MOX with ARIES rods (CED0 in 2024)**

Analytical Methods

- **Slide Rule**
 - Important step completed with multiple doses computations, final report to be published soon
 - Complex calculations, first results was very different among participants
 - » Useful work to conclude on reference values.
- **Benchmarks Intercomparisons**
 - Scope of computation intercomparisons widens, new people in charge : Jeremy and Romain
 - Efficient task to enhance reliability of benchmarks used for validation

Thank you !