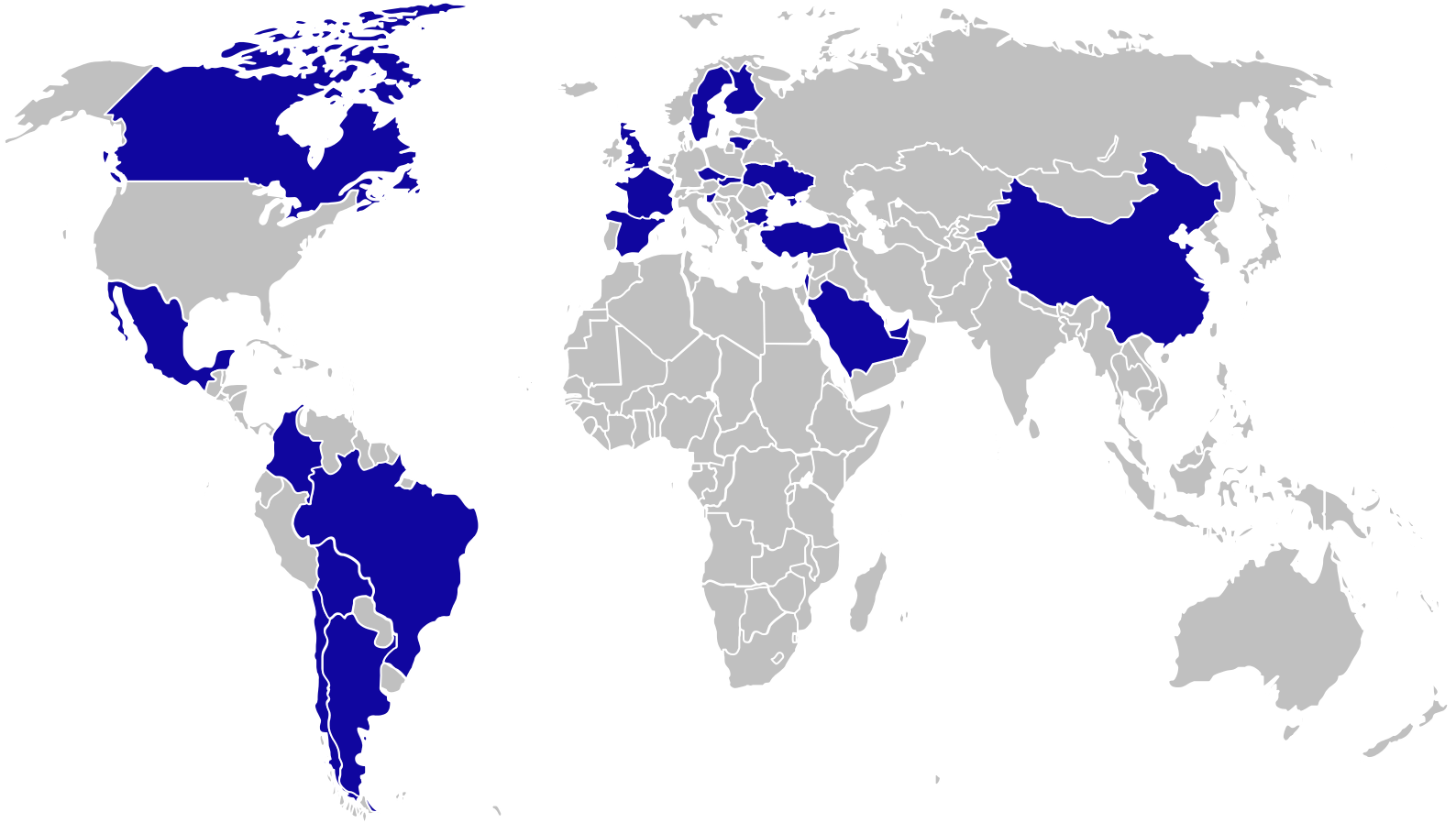
CEIDEN
PLATAFORMA TECNOLÓGICA DE ENERGÍA NUCLEAR DE FISIÓN

IDOM

IDOM Experiences with the Databases ICSBEP, SINBAD & SFCOMPO

IDOM Nuclear Services in the world



MORE THAN:

400
people
having participated
in nuclear projects

+400
projects

Over
40
years

26
countries

#8
in international nuclear
engineering design ranking

**ENR Global Sourcebook 2021*

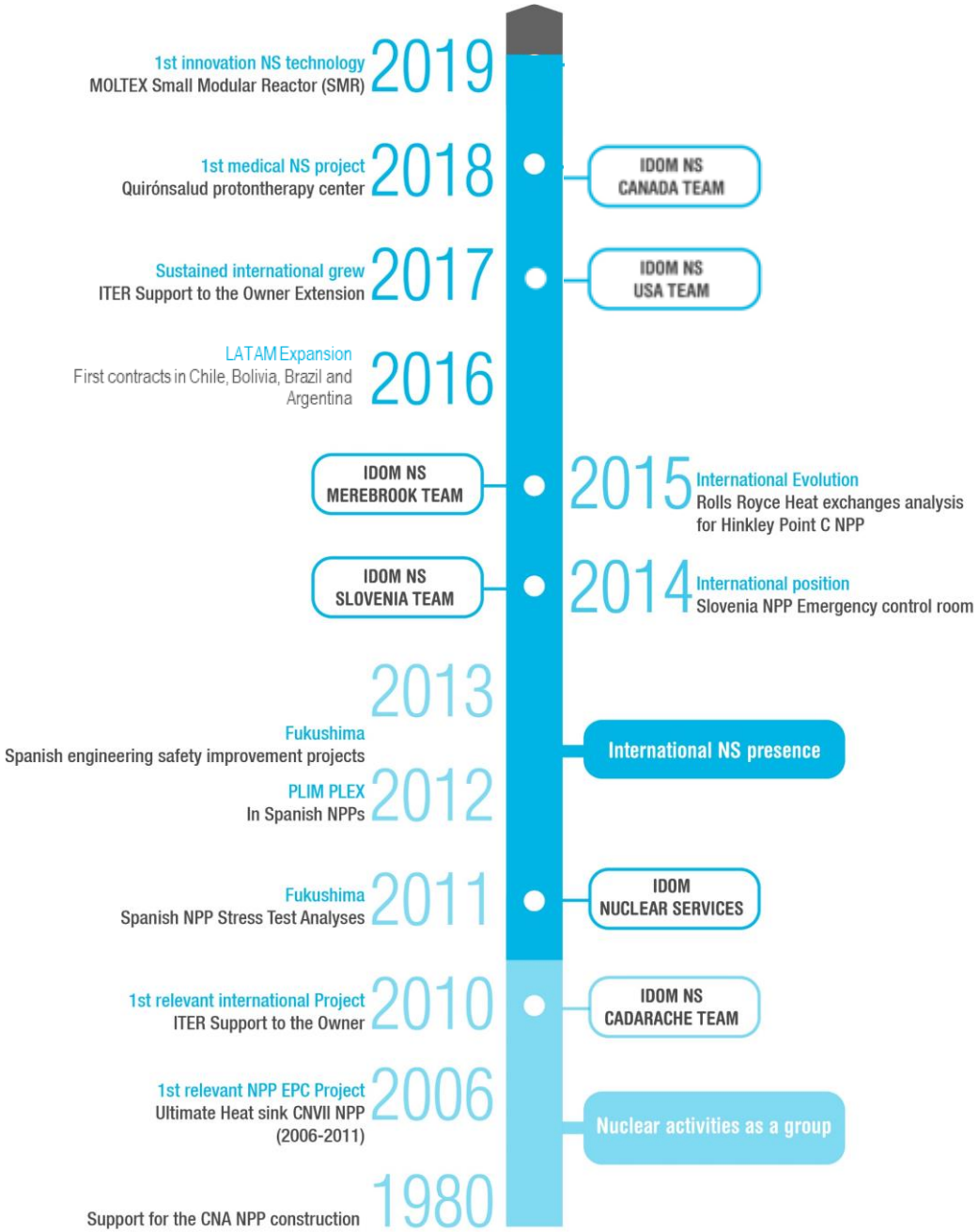
Spain, UK, Slovenia, Slovakia, Bulgaria, Ukraine, Lithuania, Finland, China, Mexico, Bolivia, Brazil, Argentina, Chile, Colombia, Belgium, Netherlands, Israel, Sweden, Emirates, Canada, France, Turkey, Czech Republic, Saudi Arabia, Croatia.

IDOM

IDOM Nuclear Services

Main Business Lines

- Nuclear Position
- New Build
- Operating Nuclear Power Plants (NPP)
- Back-end
- Nuclear Science - Fusion
- Small Modular Reactors (SMR) & Advanced Reactors (AR)
- Health Nuclear
- Defense



Main Stakeholders

IDOM has worked together with the main players in the international nuclear ecosystem

Governments, Public Organizations & Agencies

Nuclear Owners, Operators & WMOs

Nuclear Supply Chain & Vendors

IDOM Experiences with the Databases ICSBEP, IRPHEP, SINBAD y SFCOMPO

- Training & learning
- Support to CODE validation: modeling and analysis of the FNG-ITER Benchmark of SINBAD database

Replicate benchmark experiment in simulations

- Study effects of technological uncertainties on the validation of CODE: Modelling and analysis of samples from ARIANE program (SFCOMPO)

Source of Information

Training & Learning

Replicate benchmark experiment simulations

HEU-MET-FAST-002

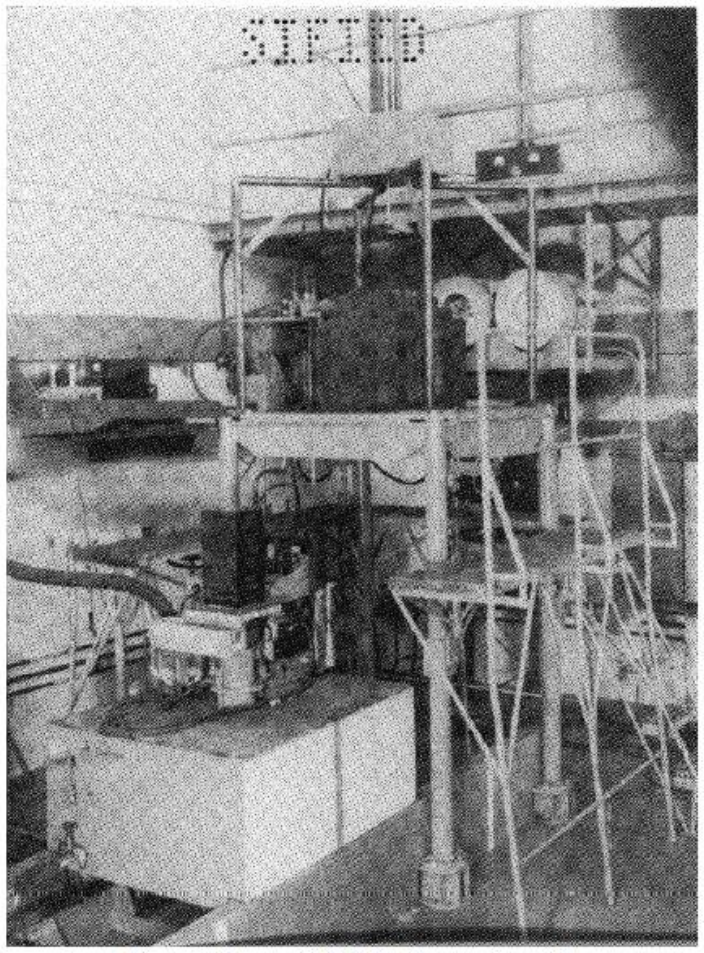


Figure 1. Topsy with Tuballoy Tamper Assembly.

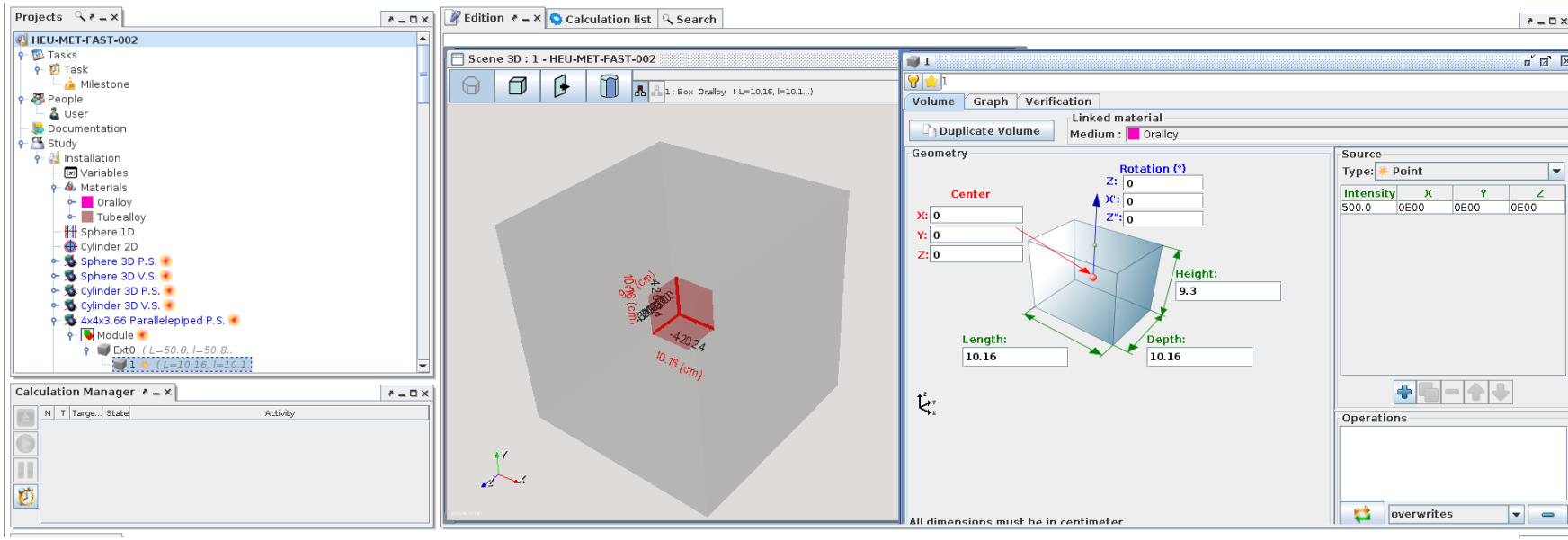
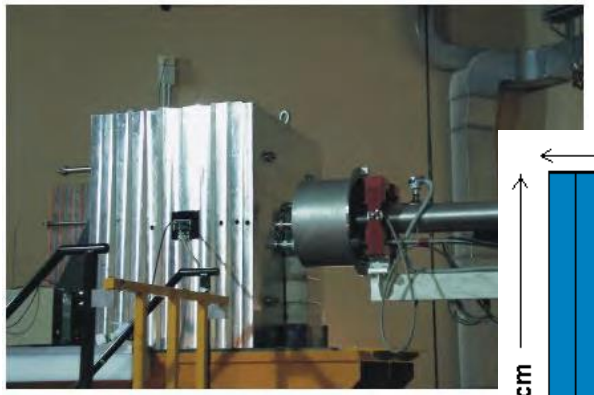
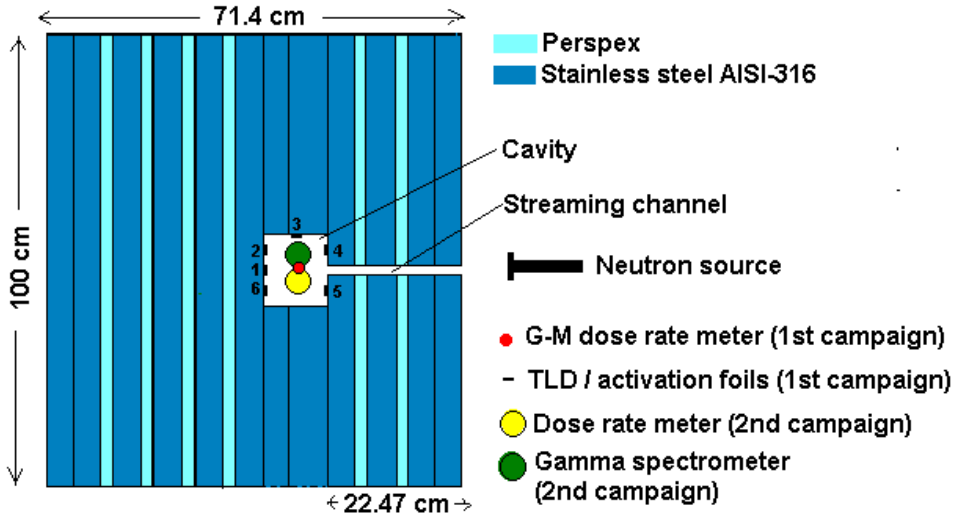


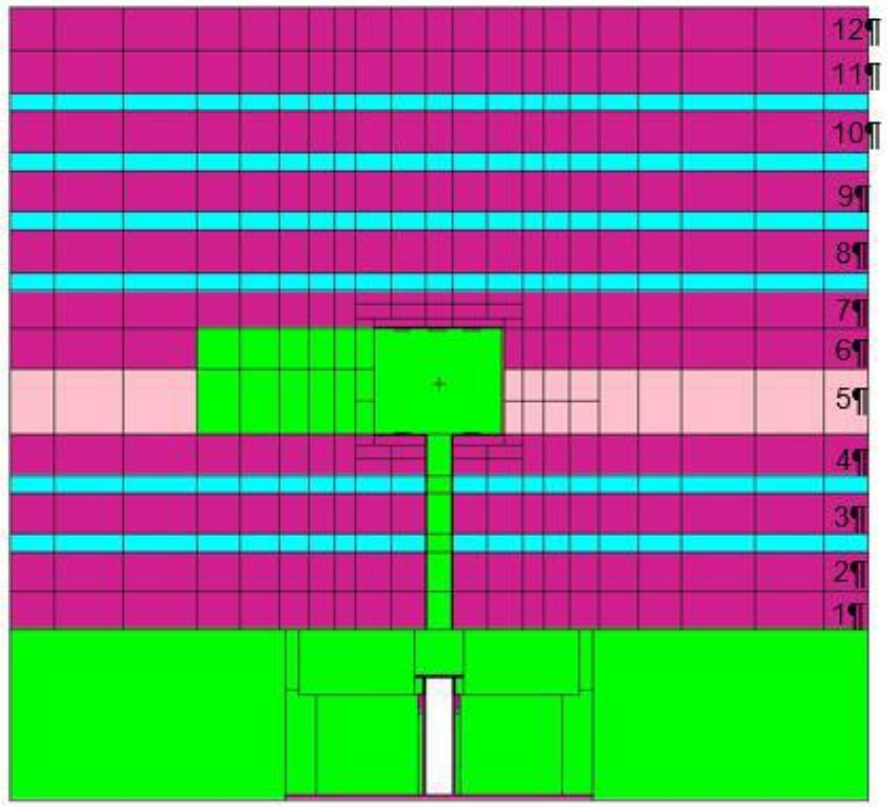
Table 7.a. Sample Calculations Results (United States).

Representation	KENO (16-group Hansen-Roach)	KENO (27-group SCALE ENDF/B-IV)	MCNP (Continuous Energy ENDF/B-V)	TWODANT (27-group SCALE ENDF/B-IV)
Sphere	0.9945 ± 0.0008	1.0075 ± 0.0009	1.0024 ± 0.0011	1.0083
Cylinder	0.9973 ± 0.0007	1.0082 ± 0.0009	1.0030 ± 0.0010	1.0079
4 x 4 x 3.66 Inch Parallelepiped	0.9938 ± 0.0007	1.0050 ± 0.0008	1.0020 ± 0.0010	NA
5 x 5 x 2.53 Inch Parallelepiped	0.9922 ± 0.0007	1.0045 ± 0.0009	1.0041 ± 0.0010	NA
3 x 3 x 7.56 Inch Parallelepiped	0.9933 ± 0.0007	1.0094 ± 0.0009	1.0039 ± 0.0010	NA
3 x 3.5 x 6 Inch Parallelepiped	0.9952 ± 0.0007	1.0035 ± 0.0010	1.0028 ± 0.0011	NA

Support to CODE validation: modeling and analysis of the FNG-ITER Benchmark of SINBAD database







Replicate benchmark experiment in simulations

Support to CODE validation: modeling and analysis of the FNG-ITER Benchmark of SINBAD database

References provided with the Benchmark:

- Benchmark specifications in html format
- MCNP Inputs
- Final Report

Replicate benchmark experiment in simulations

SINBAD ABSTRACT NEA-1553/55

FNG-ITER DOSE RATE EXPERIMENT

```
message: ip

   DOSERATE EXPERIMENT
c     Neutron transport - IRRADIATION MODEL
c      cup di rame
     1 3 -8.94       6   (1:7) -2   -8
c     gap di acqua cilindrico
     2 2 -1.0        6    8     -2   -9
```

EXPERIMENTAL VALIDATION OF SHUT-DOWN DOSE RATES

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Support to CODE validation: modeling and analysis of the FNG-ITER Benchmark of SINBAD database

Materials

- Small discrepancies in the compositions given
- Discrepancies in the impurities considered
- Composition of Nickel activation foils not defined

Replicate benchmark experiment in simulations

Element	wt% cor
	Referenc
B	0.003
C	0.04
Si	0.45
P	0.02
S	0.00
V	0.16
Cr	16.8
Mn	1.14
Fe	68.3
Co	0.14
Ni	10.7
Cu	0.09
Mo	2.12
Sn	0.00
Pb	0.00
Total	99.99

Table A1-9: Comparison of chemical c except the fifth one betwee

Table A1-10: Cor

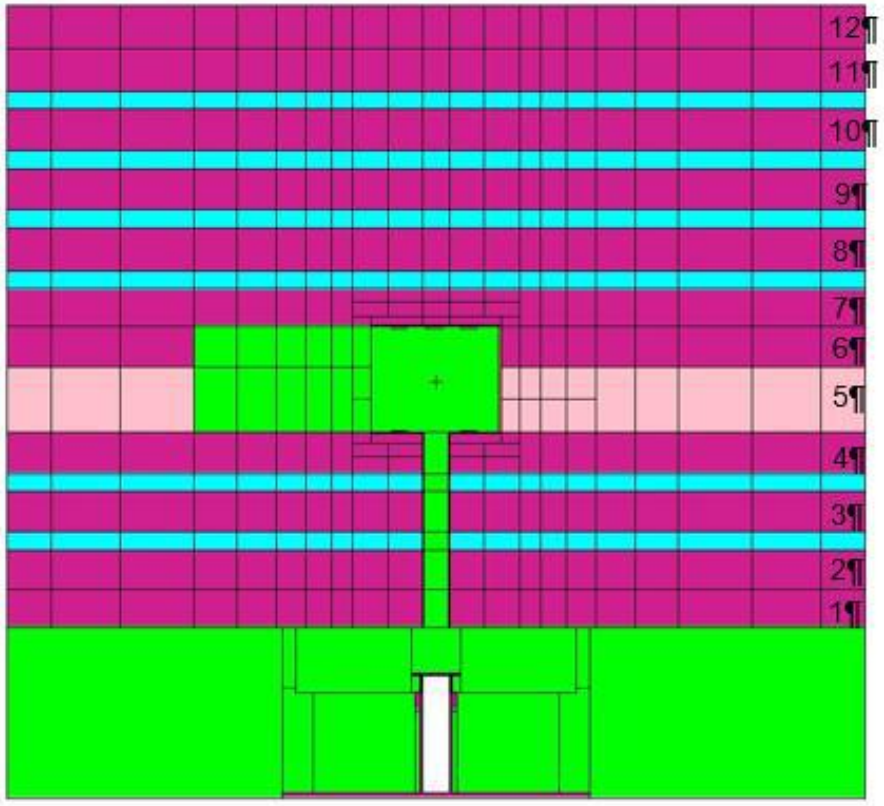
Element	wt% content Reference [2]	wt% content MCNP input files [2]	wt% content
B	0.005	0.005	0.005
C	0.03	0.03	0.03
Al	-	-	<0.03
Si	0.69	0.69	0.69
P	0.021	0.021	0.021
S	0.006	0.006	<0.01
V	0.12	0.04	0.12
Cr	17.8	17.81	17.8
Mn	1.64	1.64	1.64
Fe	66.223	66.23	66.22
Co	0.07	0.07	0.07
Ni	11.3	11.3	11.3
Cu	0.09	0.09	0.09
As	-	-	<0.01
Zr	-	-	<0.03
Nb	-	0.011	<0.01
Mo	2	2	2
Sn	0.004	0.004	<0.01
Ti	-	-	<0.01
Pb	0.001	0.001	<0.01
Total	100	99.948	

Table A1-11: Comparison of chemical composition of stainless steel AISI-3126 used for the fifth layer, m10 between reference [2], MCNP input files and reference [8].

Support to CODE validation: modeling and analysis of the FNG-ITER Benchmark of SINBAD database

Geometry

- Position and thickness of Layer 5



Material	Thickness [cm]	Location on the y-axis [cm]
-First part (100 cm x 100 cm cross-section):		
SS316	4.35	5.6 ... 9.95
SS316	4.65	9.95 ... 14.6
Perspex	2.06	14.6 ... 16.66
SS316	4.65	16.66 ... 21.31
Perspex	2.06	21.31 ... 23.37
SS316	4.60	23.37 ... 27.97
SS316	7.70	27.97 ... 35.67 fifth layer
SS316	4.90	35.67 ... 40.57
SS316	4.17	40.57 ... 44.74
Perspex	2.06	44.74 ... 46.8
SS316	4.95	46.8 ... 51.75
Perspex	2.06	51.75 ... 53.81
SS316	4.80	53.81 ... 58.61
Perspex	2.06	58.61 ... 60.67
SS316	4.80	60.67 ... 65.47
Perspex	2.06	65.47 ... 67.53
SS316	4.90	67.53 ... 72.43
SS316	5.00	72.43 ... 77.43

```
   90   py  25.3
c ---------------------------------
c     piano per definire una parete interna scatola
   91   py      28.17
c  ------------------------------------
c  piani limite del blocco perspex - ss
```

This discrepancy may come from the fact that when the 2-mm thick bottom and lateral walls, and the additional coating surrounding cavity center had been added, the position of layer number 5 has not been adjusted to this new configuration.

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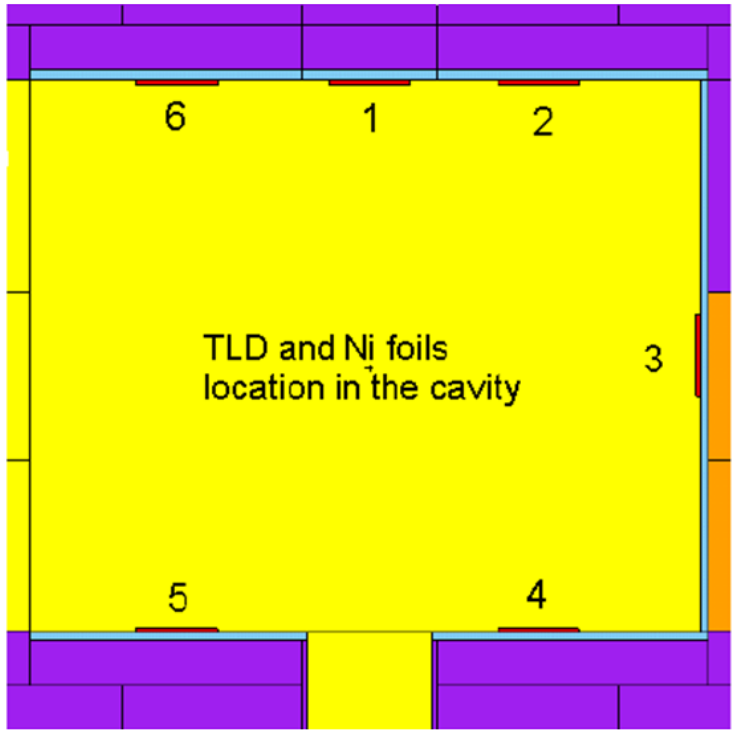
Support to CODE validation: modeling and analysis of the FNG-ITER Benchmark of SINBAD database

Geometry

- Nickel Activation foils:
  - Small discrepancies on foil 3 thickness
- TLD detectors
  - Discrepancies on TLD 3 radius

Replicate benchmark experiment in simulations



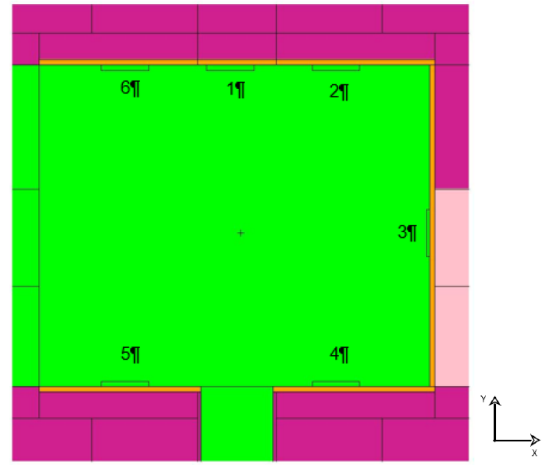


Figure 5-6: Central cavity and Ni activation foils on cavity walls (XY view).

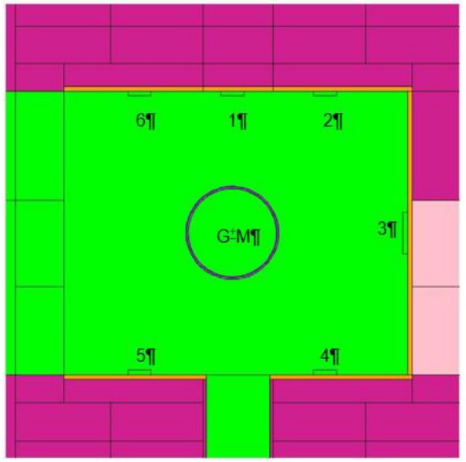
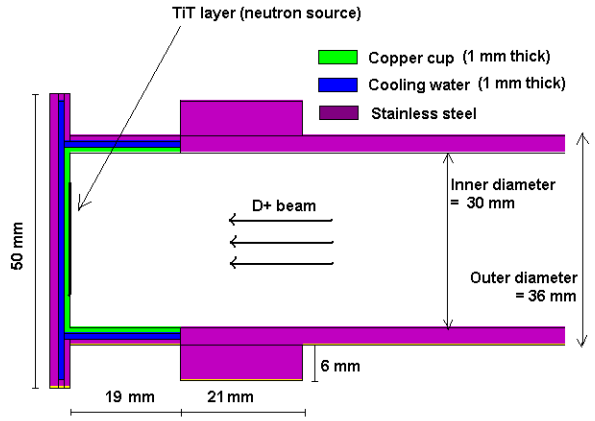


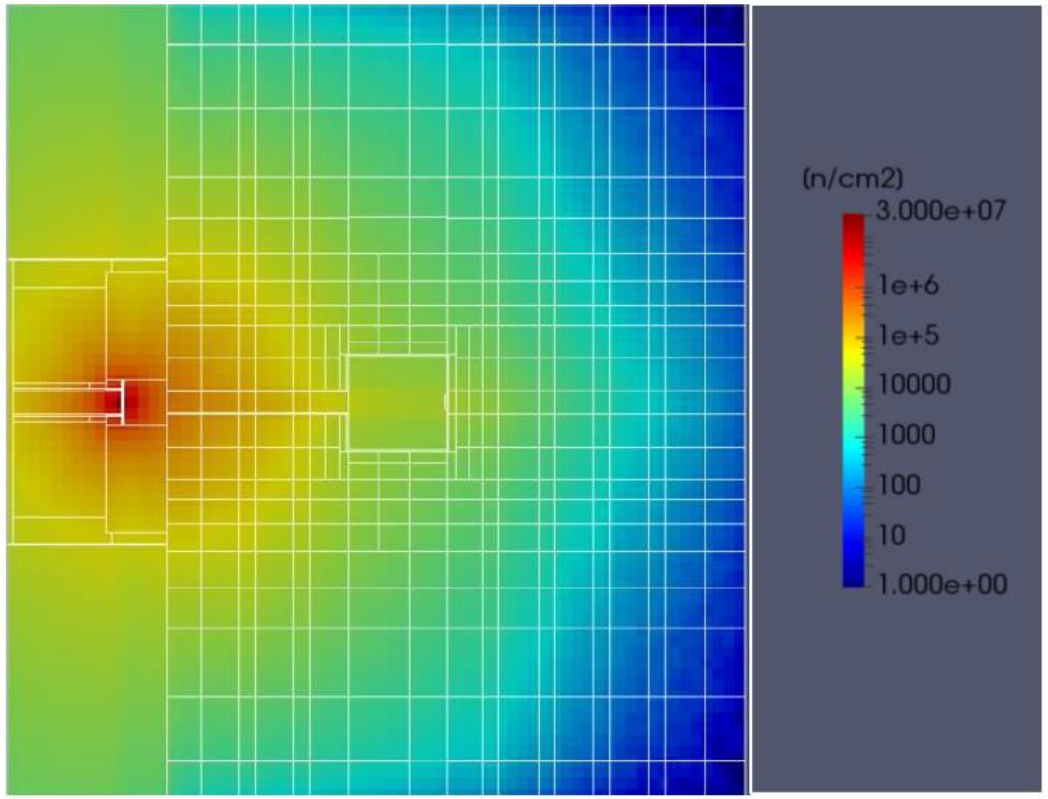
Figure 5-8: G-M detector in cavity center and TLD detectors located all around cavity walls.

Support to CODE validation: modeling and analysis of the FNG-ITER Benchmark of SINBAD database

Source

- Routines *source.f* in MCNP5/X format not compatible with MCNP 6.2





Replicate benchmark experiment in simulations

Support to CODE validation: modeling and analysis of the FNG-ITER Benchmark of SINBAD database

Materials

- Small discrepancies in the compositions given
- Discrepancies in the impurities considered
- **Composition of Nickel activation foils not defined**

Geometry

- Position and thickness of Layer 5
- Nickel Activation foils:
  - Small discrepancies on foil 3 thickness
- TLD detectors
  - Discrepancies on TLD 3 radius

Source

- **Routines *source.f* in MCNP5/X format not compatible with MCNP 6.2**

Obtaining results in agreement with the benchmark is difficult mainly due to the source definition

Study effects of technological uncertainties on the validation of CODE: Modelling and analysis of samples from ARIANE program (SFCOMPO)

Sample ARIANE-GU3

- All necessary data obtained from *SFCOMPO* and/or *ARIANE program final report*
- Typical uncertainties and manufacturing tolerances obtained from *SFCOMPO Evaluation Guide*
- XS libraries:
  - JEFF-3.1
  - JEFF-3.2
  - ENDF/B-VII.0
  - ENDF/B-VII.1

Source of Information

Parameter	Uncertainty/tolerance
Fuel pellet diameter	± 20 µm
Fuel pellet density	± 1 %
Enrichment (^{235}U wt%)	± 0.05 %
Core power	± 2 %
Water moderator density	± 0.005 g/cm^3
Boron content in water	± 10 ppm
Water moderator temperature	± 2° C
Fuel temperature	± 100° C

Table 6-1: Values of typical uncertainties extracted from [3]

Type	PWR	
Name	Gösgen	
Country	Switzerland	
Total number of assemblies	177	
Thermal power	3002	MW
Electric power	1020	MW
Fuel type	UO_2	
235U/U	4.1	%
Pu/U+Pu	-	%
Gd2O3/oxide	-	%
Active fuel length	355.0	cm
Fuel density	10.4	g/cm^3
Estimated sample burn up	52.5	MWd/kg$_{HM}$
Lattice type	15 x 15	
Assembly pitch	21.56	cm
Pin pitch	1.43	cm
Fuel pins	205	
Guide tubes	20	
Instrumentation tubes	0	
Guide tube material	Zr-4	
Guide tube outer radio	0.69	cm
Guide tube inner radio	0.62	cm
Cladding material	Zr-4	
Cladding outer radio	0.5375	cm
Cladding inner radius	0.465	cm
Pellet radius	0.4555	cm
Central gap	-	

Table 5-2: Overview of the characteristics of the ARIANE.GU3 sample.

Cycle	Core periphery	Neighbor assembly type	Start date	End date
16	No	-	June 29, 1994	June 10, 1995
17	No	-	July 05, 1995	June 08, 1996
18	No	-	June 30, 1996	June 07, 1997

Table 5-3: Operational cycles for the ARIANE.GU3 sample

Study effects of technological uncertainties on the validation of CODE: Modelling and analysis of samples from ARIANE program (SFCOMPO)

Sample ARIANE-GU3

- All necessary data obtained from *SFCOMPO* and/or *ARIANE program final report*
- Typical uncertainties and manufacturing tolerances obtained from *SFCOMPO Evaluation Guide*
- XS libraries:
  - JEFF-3.1
  - JEFF-3.2
  - ENDF/B-VII.0
  - ENDF/B-VII.1

Source of Information

Parameter	pcm difference		Inside 3σ
	minimum	maximum	
Fuel pellet diameter	0	150	yes
Fuel pellet density	0	150	yes
Enrichment	200	400	no
Power	0	600	no
Water density	0	200	no
Boron content	0	200	no
Water moderator temperature	0	100	yes
Fuel temperature	0	400	no

Table 8-1: Results of ARIANE GU3 sample

Final Remarks

Benchmark databases are a good tool,

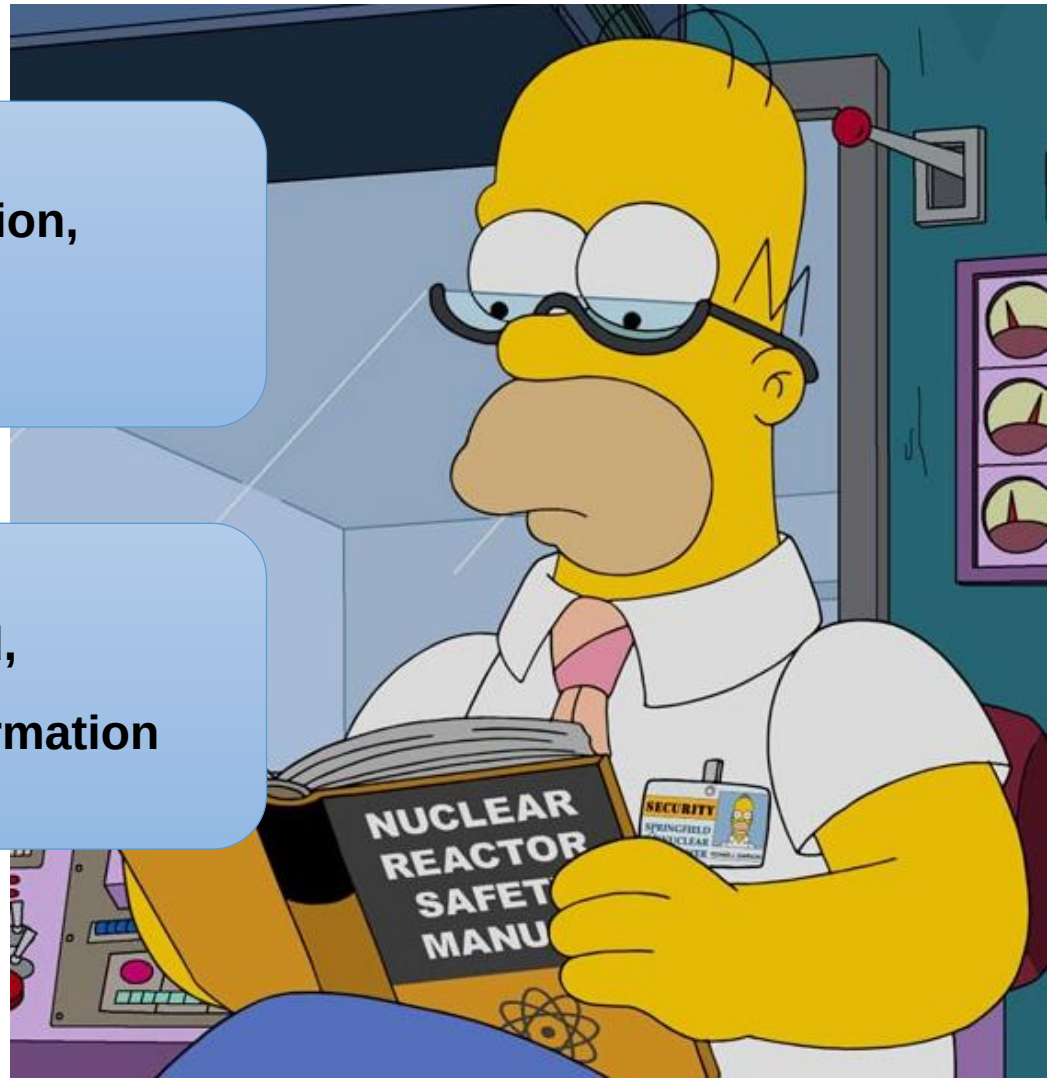
not only for replicating the benchmark for code validation,

also are a good source of exercises

and information in general

While ICSBEP & SFCOMPO are very well structured,

SINBAD database seems to have more contradicting information



Muchas Gracias