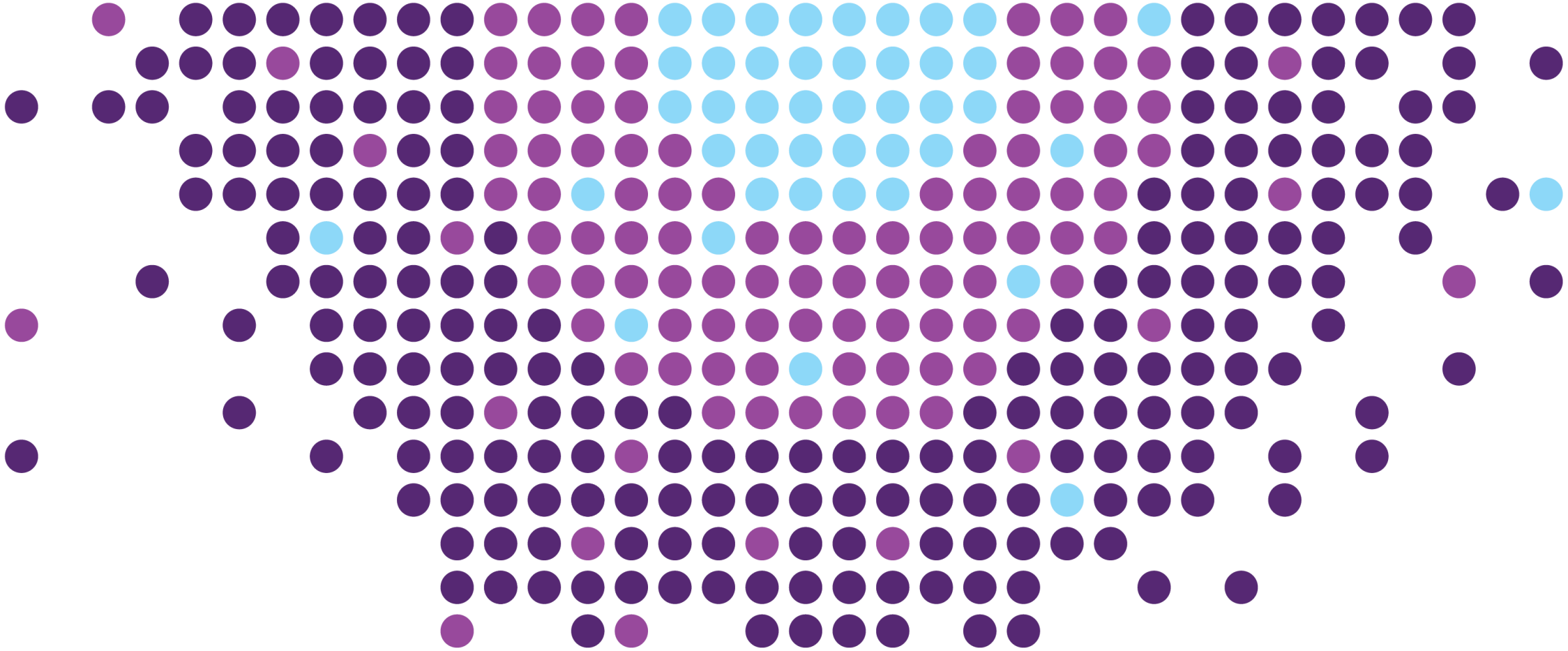


sck cen
Belgian Nuclear Research Centre

P. Romojaro, L. Fiorito, A. Stankovskiy and G. Van den Eynde - 27/01/2021

Nuclear Data for MYRRHA

NURA

With its **NURA** project, SCK CEN significantly increases its contribution to the fight against cancer. By pooling its knowledge and expertise in terms of radiopharmaceuticals, NURA contributes to the development of the next-generation radiopharmaceuticals. More specifically, NURA performs game-changing research into radiopharmaceuticals for treating different types of cancer in cooperation with clinical and industrial partners.

MYRRHA

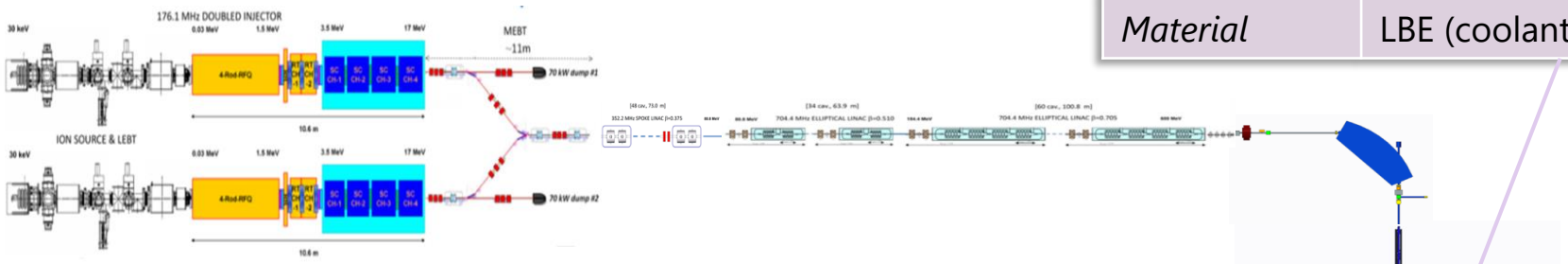
SCK CEN works actively on the design and construction of a new multi-purpose research plant: MYRRHA, which stands for *Multi-purpose HYbrid Research Reactor for High-tech Applications*. MYRRHA is a versatile research infrastructure but above all unique. It is the world's first research reactor driven by a particle accelerator.

RECUMO

With the public-public partnership RECUMO, SCK CEN and the *National Institute for Radio Elements* (IRE) reach out to one another. SCK CEN will decontaminate the current and future highly radioactive residues and thus reduce the stock. In this way, RECUMO contributes to the security of supply of medical radio-isotopes, which are indispensable in the fight against cancer.

MYRRHA

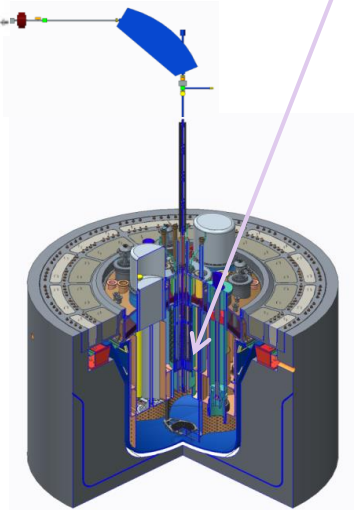
- MYRRHA – An Accelerator Driven System
  - Demonstrate the ADS concept at pre-industrial scale
    - Can operate in critical and sub-critical modes
  - Demonstrate transmutation
  - Fast neutron source



Target	
Main reaction	spallation
Output	$2 \cdot 10^{17}$ n/s
Material	LBE (coolant)

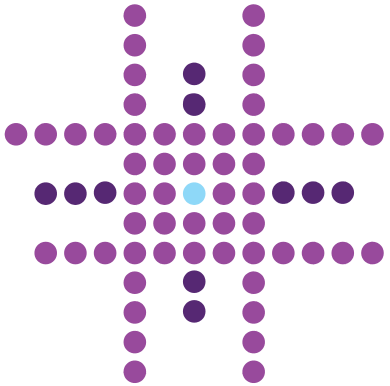
Accelerator	
Particles	protons
Beam energy	600 MeV
Beam current	2.4 to 4 mA

Reactor	
Power	65 to 100 MW_{th}
k_{eff}	0.95
Spectrum	fast
Coolant	LBE

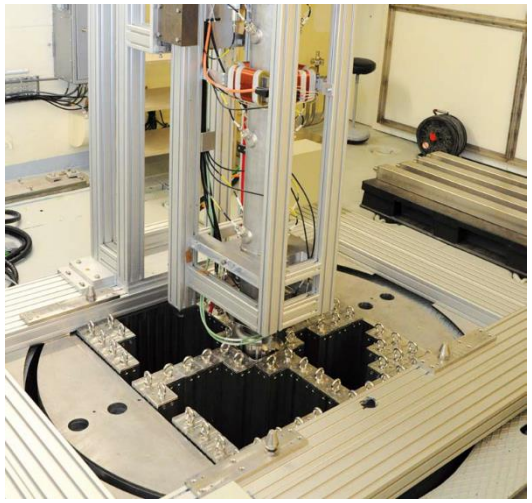


MYRRHA design

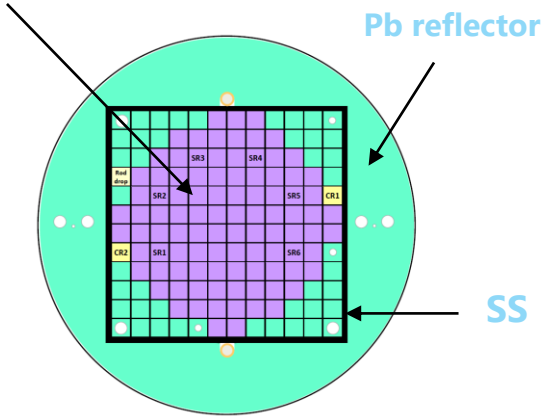
- Codes
  - Core
    - MCNP6.2
    - ALEPH2
  - Accelerator
    - MCNP6.2
    - ALEPH2
    - PHITS
- Nuclear data
  - JEFF-3.1.2, JEFF-3.2, JEFF-3.3 & JEFF-4T0
  - ENDF/B-VII.0, ENDF/B-VII.1 & ENDF/B-VIII.0
  - JENDL-4.0 & JENDL-5beta
  - TENDL-2014, TENDL-2015, TENDL-2017 & TENDL-2019

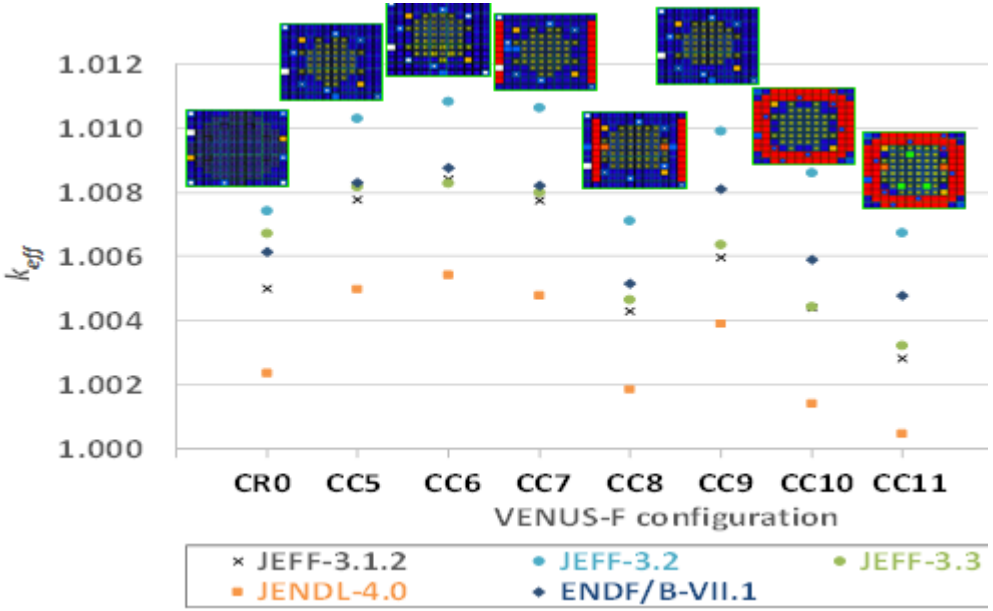


Nuclear Data Validation: VENUS-F



30% U metallic fuel + Pb "coolant"
(solid Pb, alternatively Bi)





Core	#FAs	FA composition	Reflector	In-Pile Section
CR0	97	9 U+16 Pb	Pb	-
CC5	41	13 U+8 Pb+4 Al_2O_3	Pb	-
CC6	41	13 U+8 Pb+4 Al_2O_3	Pb	-
CC7	41	13 U+8 Pb+4 Al_2O_3	Pb+C	-
CC8	47	13 U+8 Pb+4 Al_2O_3	Pb+C	thermal spectrum
CC9	41	13 U+8 Bi+4 Al_2O_3	Pb	-
CC10	41	13 U+Pb+8 Bi+4 Al_2O_3	Pb+C	-
CC10b	47	13 U+Pb+8 Bi+4 Al_2O_3	Pb+C	thermal spectrum
CC11	50	13 U+Pb+8 Bi+4 Al_2O_3	Pb+C	thermal and fast spectrum

Source: A. Kochetkov and P. Baeten

Besides criticality, we have:

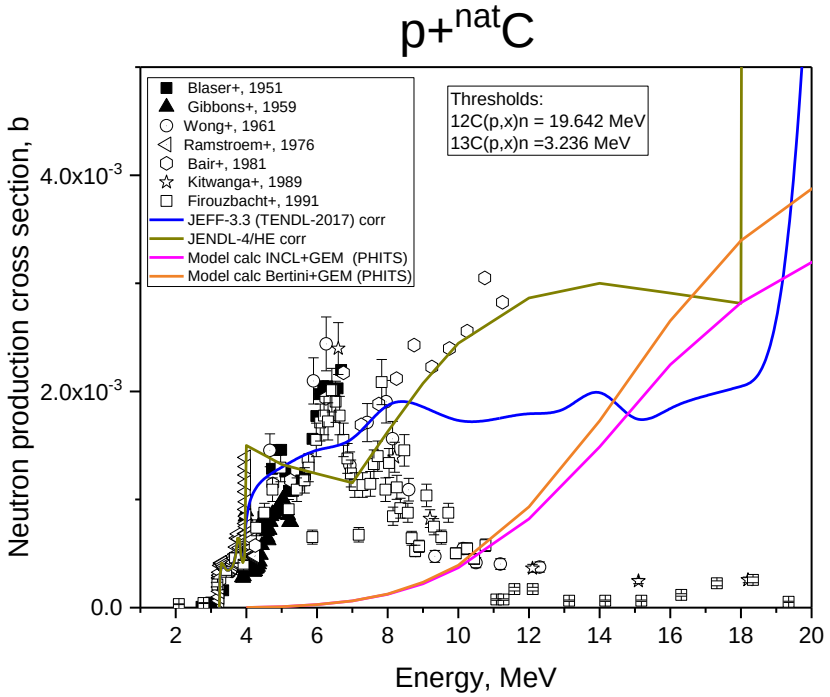
- Kinetic parameters
- CR curve
- Spectral indices
- Axial and radial traverses
- Pb-Bi void
- Fuel Doppler

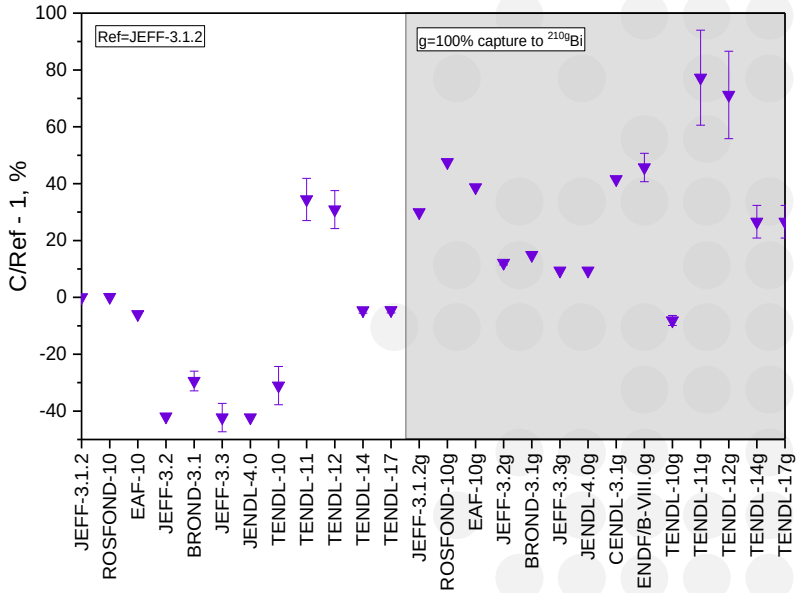
Extensive database for ND validation!

Nuclear Data Needs

Nuclear data needs in JEFF-3.3 for MYRRHA:

- Adoption of JENDL-4.0 evaluation for ^{204}Pb or re-evaluation in the RRR and URR
- New evaluation ^{57}Fe(n,inel.) including missing resonances
- Re-evaluation ^{10}B(n,inel.) uncertainty
- Covariance evaluation for ^{209}Bi(n,n) and ^{209}Bi(n,γ)
- Covariance evaluation for ν_T, ν_p, ν_d ^{240}Pu & ν_d ^{235,238}U and ^{239,242}Pu
- Reduction of uncertainty ^{240}Pu(n,f)
- Reduction of uncertainty ^{54,57}Fe(n,n)
- Reduction of uncertainty ^{208}Pb(n,n)
- Reduction of uncertainty ^{238}U(n,inel.)





Criticality

Shielding

Radioactive source term and waste management

Source: JEFFDOC-1994, JEFFDOC-1956 and P. Baeten

Benchmarks

- Criticality
  - VENUS-F - MYRRHA mockup
  - Different configurations for nuclear data validation
- Shielding
  - Double-differential neutron yields experiments
  - Neutron transmission experiments
- Nuclear data adjustment
  - Simple configuration
  - Highly sensitive to a single nuclide and reaction channel

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