

Video space

Overview of the PETALE program in CROCUS

Vincent Lamirand

*Program manager of experimental
research, LRS@EPFL*

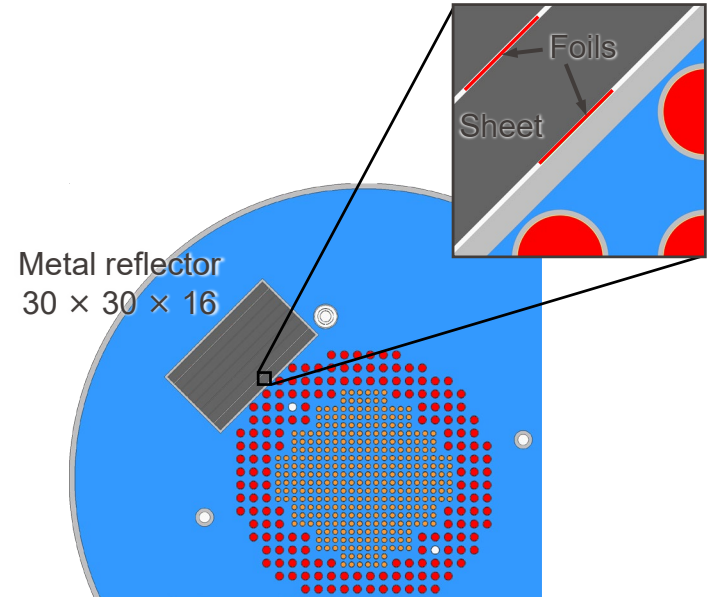
NEA WPEC SG47 – 11.05.2021, online

Objectives of PETALE

Program in CROCUS* on **elemental-type** reflector experiments, for new constraints in the MeV-range on **stainless steel nuclear data**

- Separate study of s. steel, Fe, Ni and Cr
 - Reactivity worth of reflectors
 - Transmission using activation dosimetry

Collaboration between CEA & EPFL

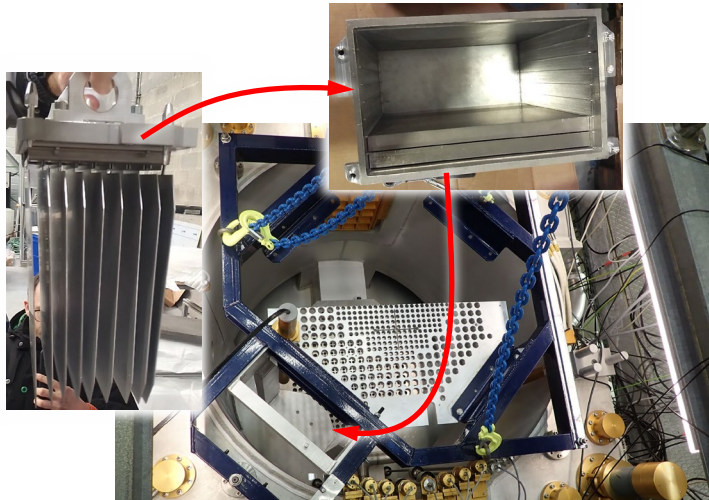


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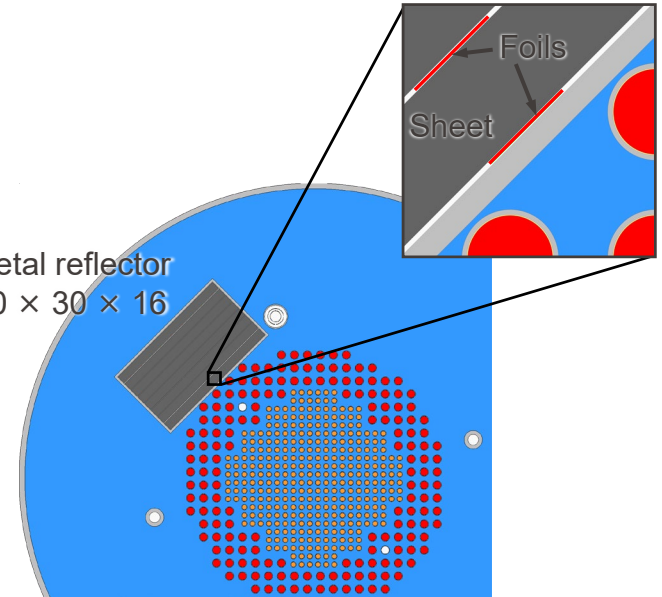
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Metal reflector
30 × 30 × 16

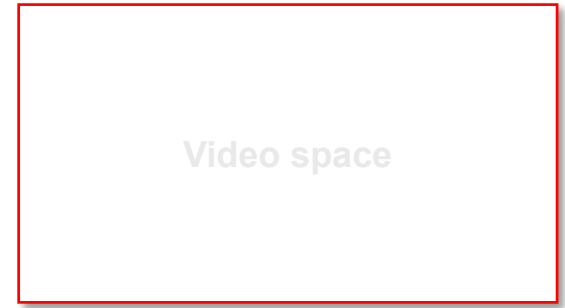
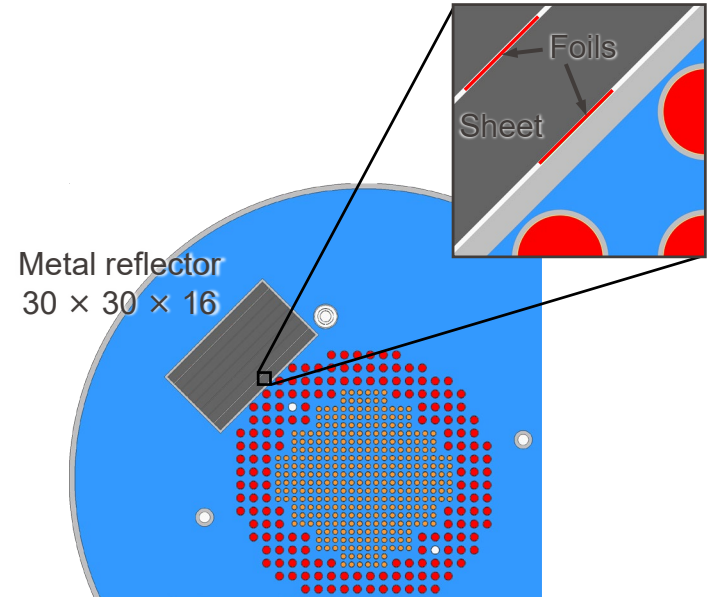


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- Boundary conditions in CROCUS
 - Limited neutron flux: $1.0 \times 10^9 \text{ cm}^{-2} \cdot \text{s}^{-1}$ at periphery
 - Limitations on core activation: teaching and visits



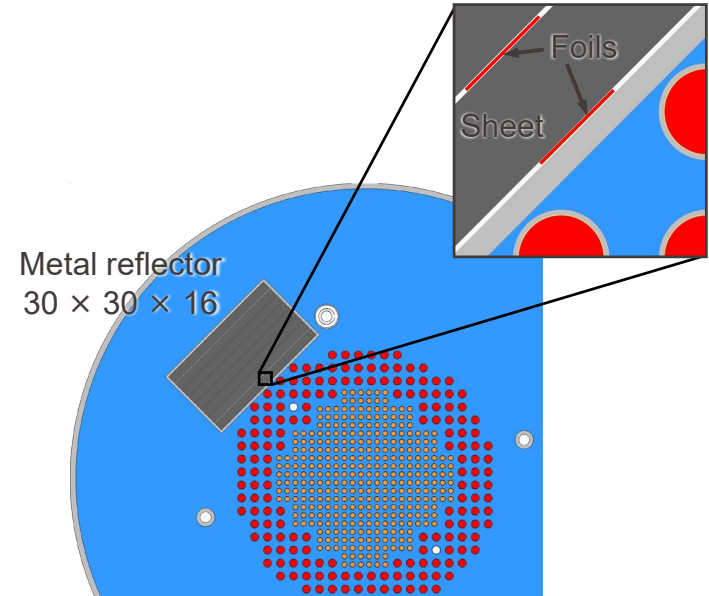
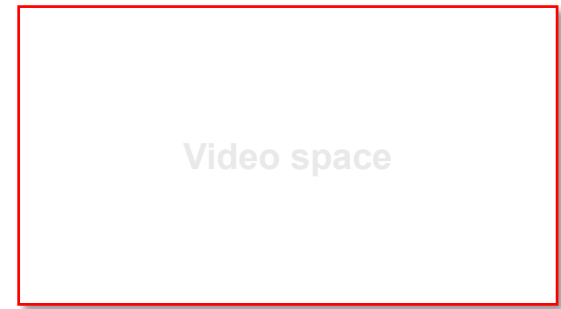
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➔ Extensive design studies

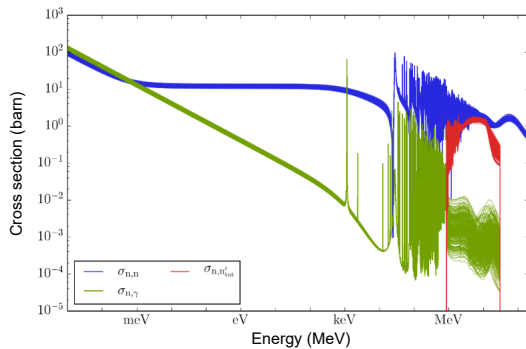
- Minimize exp. biases: e.g. no inter-sheet water
- Reduce technological uncertainties: metrology
- Define ad-hoc response functions for optimal feedback on nuclear data: **optimized dosimetry***



Optimization by unc. propagation

Relating cross sections uncertainty distribution with measured reaction rates* to **optimize the feedback** on the nuclear data of interest

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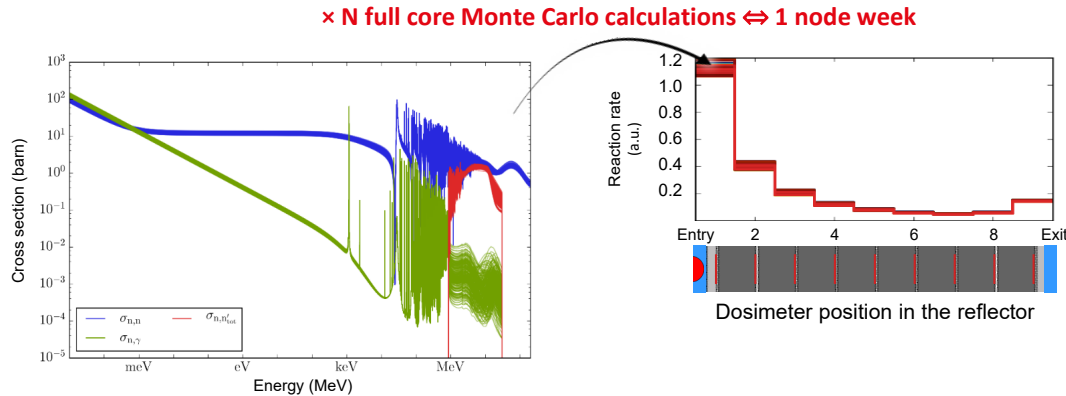
⁵⁶Fe cross sections dispersion in TENDL 2017

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- Nuclear data uncertainty propagation by **Total Monte Carlo** (TMC) approach
- **Correlated Sampling** used to estimate the flux/reaction rate associated to different ACE files

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⁵⁶Fe cross sections dispersion in TENDL 2017

Reaction rate distributions with $\ln(n,\gamma)$ in the iron metal reflector (128 ACE files)

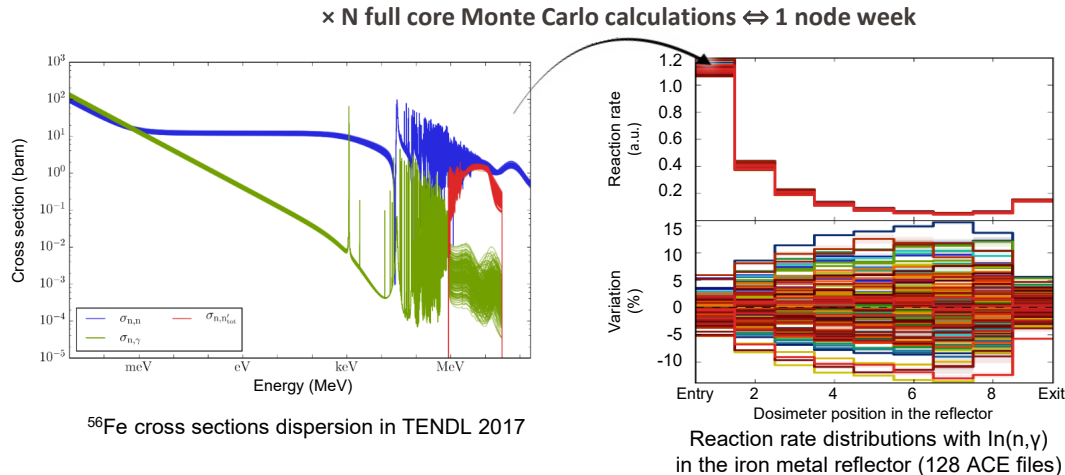
* A. Laureau et al., "Uncertainty propagation for the design study of the PETALE experimental programme in the CROCUS reactor," *EPJ Nucl. Sci. Technol.*, vol. 6, p. 9, 2020.

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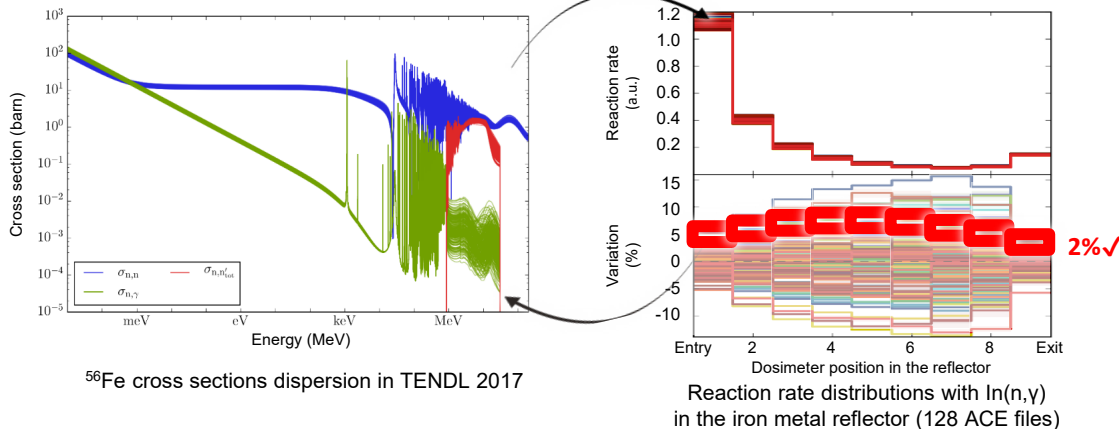
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× N full core Monte Carlo calculations ↔ 1 node week

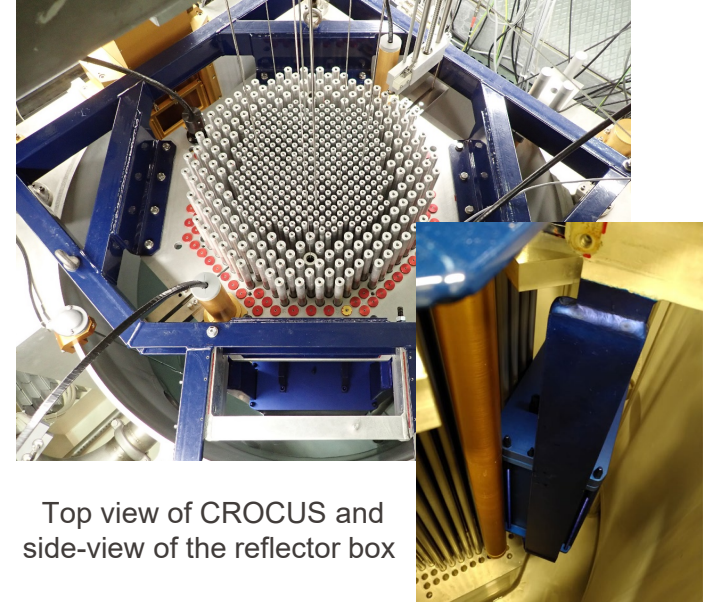
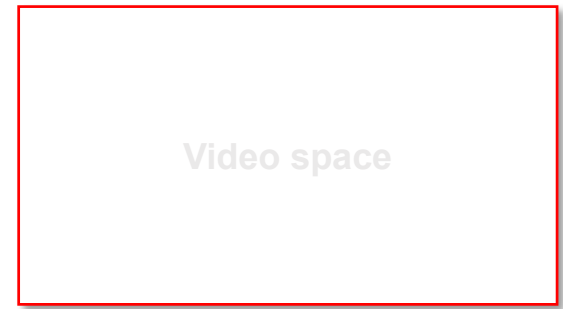


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Conducted experiments

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 - Complementary experiments: calibrations, etc.



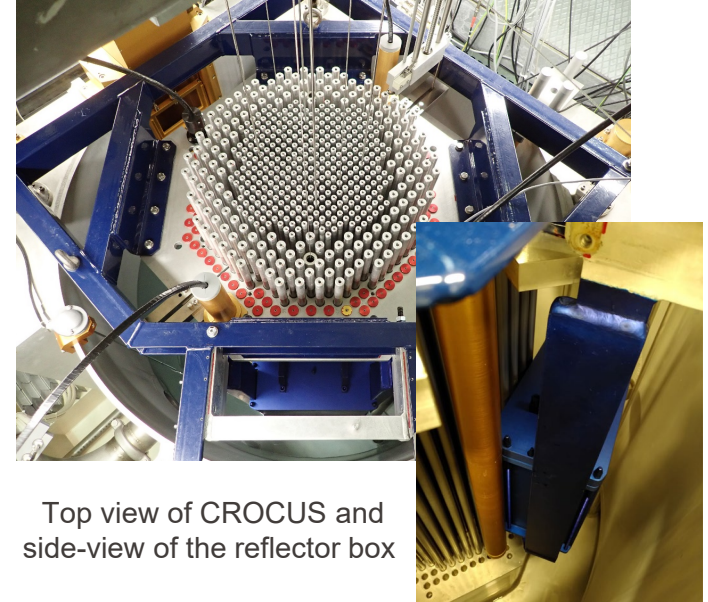
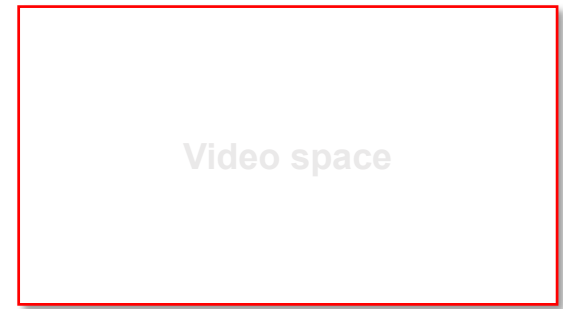
Top view of CROCUS and side-view of the reflector box

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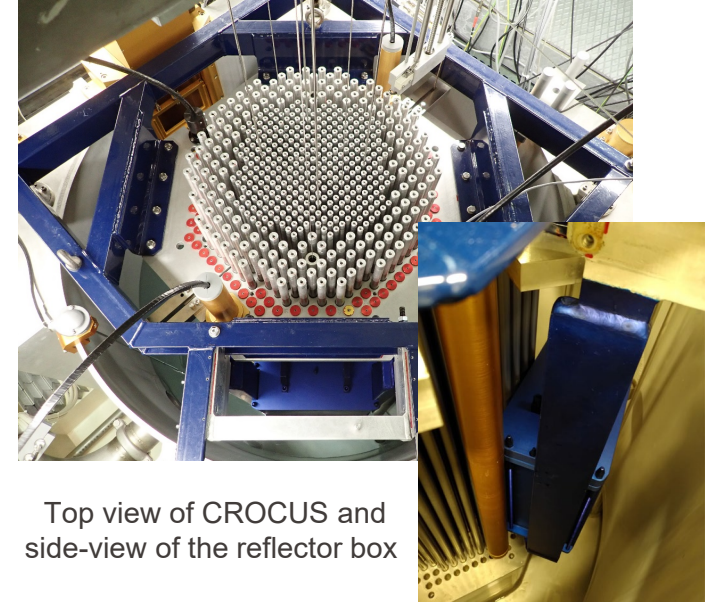
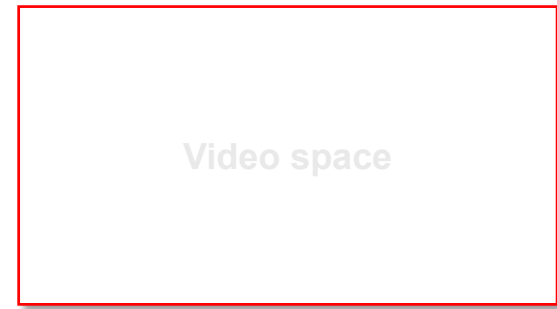


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5 transmission experiments per reflector material
using 7 different reactions: $^{115}\text{In}(n,\gamma)$, $^{197}\text{Au}(n,\gamma)$, $^{115}\text{In}(n,n')$, $^{58}\text{Ni}(n,p)$, $^{54}\text{Fe}(n,p)$, $^{56}\text{Fe}(n,p)$, $^{27}\text{Al}(n,\alpha)$
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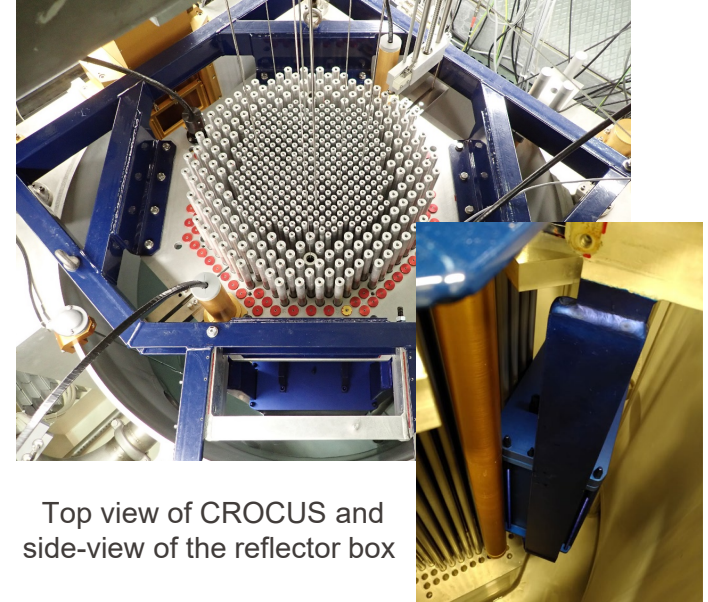
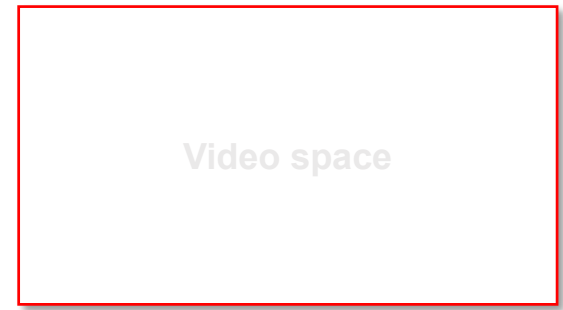
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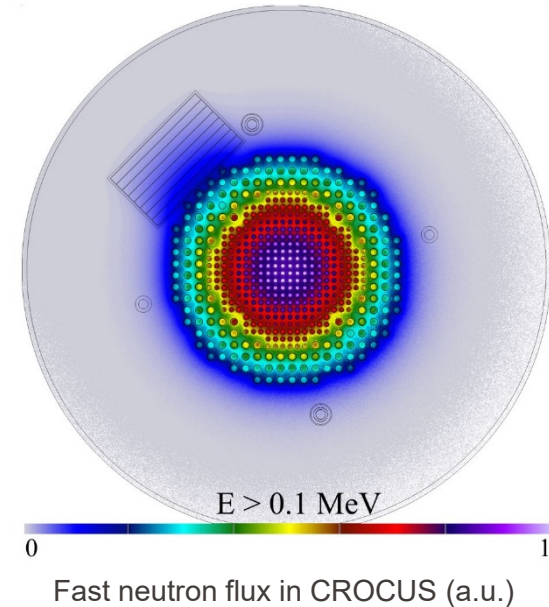
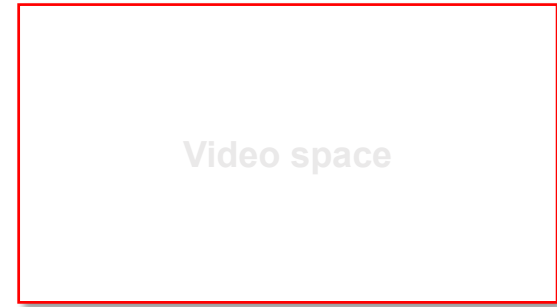
Conducted from Sep. to Dec. 2020



Top view of CROCUS and side-view of the reflector box

On-going analysis

- Experimental
 - Sample measurements: mainly finished, last long half-life Fe dosimeters on-going
 - First results under discussion within CEA-EPFL
- Modelling
 - On-going, as the experiments were conducted: Serpent2 @EPFL, TRIPOLI-4 @CEA
 - Uncertainty propagation

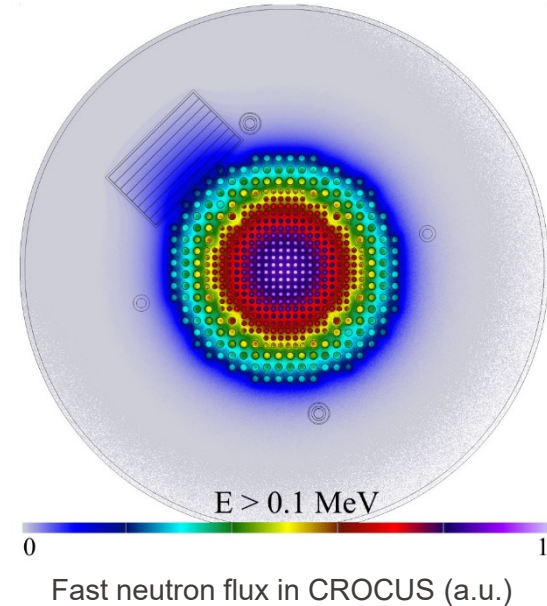
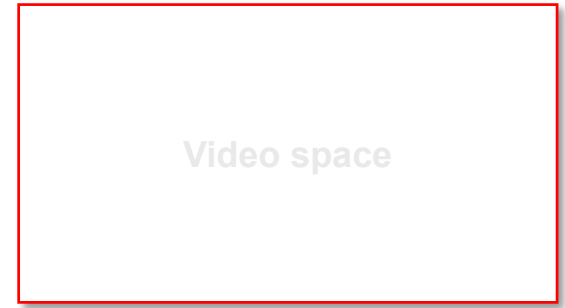


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Future works

- Sensitivity to new cross sections in EUROfusion
- Proposal for new experiments in preparation
- Data assimilation @EPFL: Bayesian MC



EPFL

cea



Thank you!

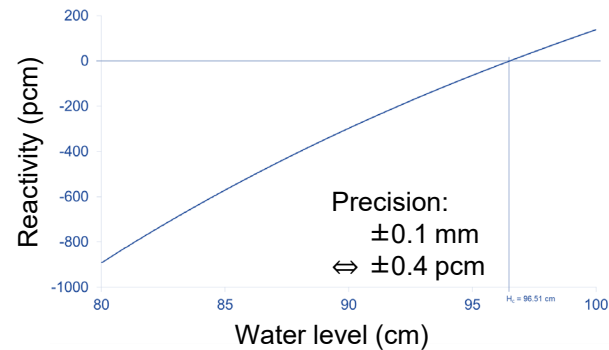
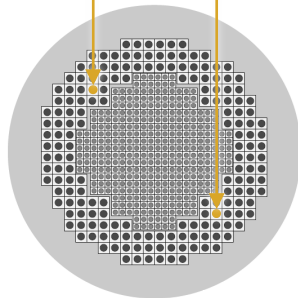
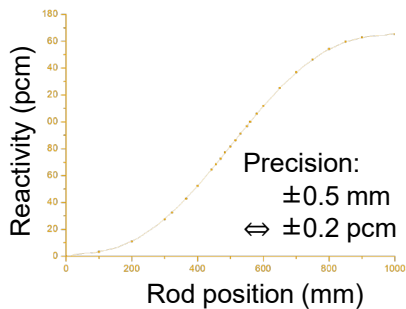
Vincent
Lamirand

Reactor type

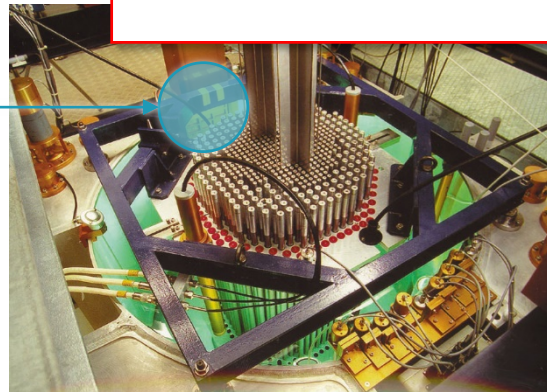
- LWR with partially submerged core
- Room T (controlled) and atmospheric P
- Forced water flow ($160 \text{ l}\cdot\text{min}^{-1}$)

Operation

- 100 W (zero-power reactor)
- i.e. maximum $2.5 \times 10^9 \text{ cm}^{-2}\cdot\text{s}^{-1}$
- Control: B_4C rods and spillway



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Core

- $\varnothing 60 \text{ cm}/100 \text{ cm}$, 2-zone
- Inner: 336 UO_2 1.806 wt% 1.837 cm
- Outer: 176 U_{met} 0.947 wt% 2.917 cm

