



# CORTEX

Core monitoring techniques and  
experimental validation and demonstration

## Simulations of COLIBRI experiments at CROCUS

### A summary

**CORTEX workshop, 23-24 March 2021**

**Chalmers, CEA, KU, UPV, TUM, EPFL**



This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 754316.

# Neutron noise solvers

- **Monte Carlo transport**

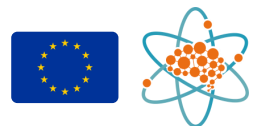
- TRIPOLI-4
- MC-Kyoto

- **Deterministic transport**

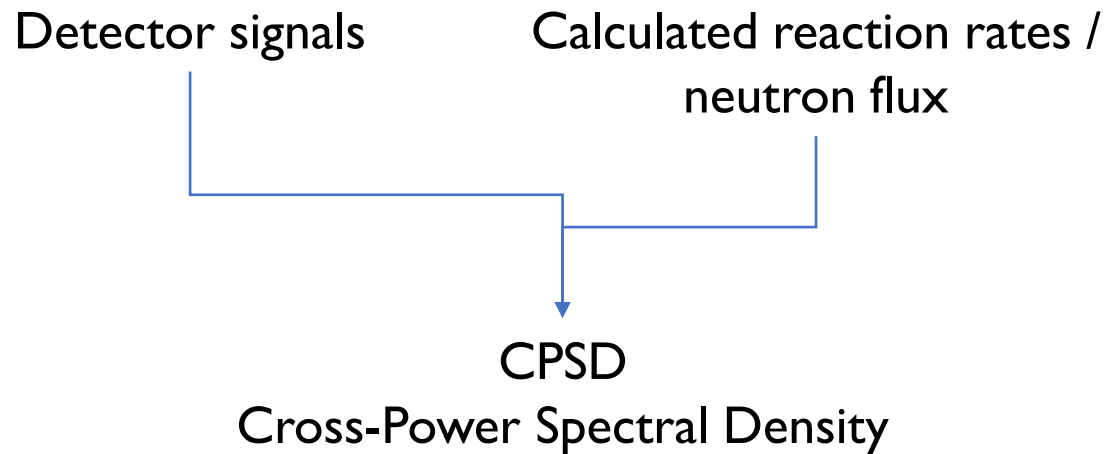
- APOLLO3
- NOISE-SN

- **Diffusion**

- FEMFFUSION
- PARCS
- CORE SIM+

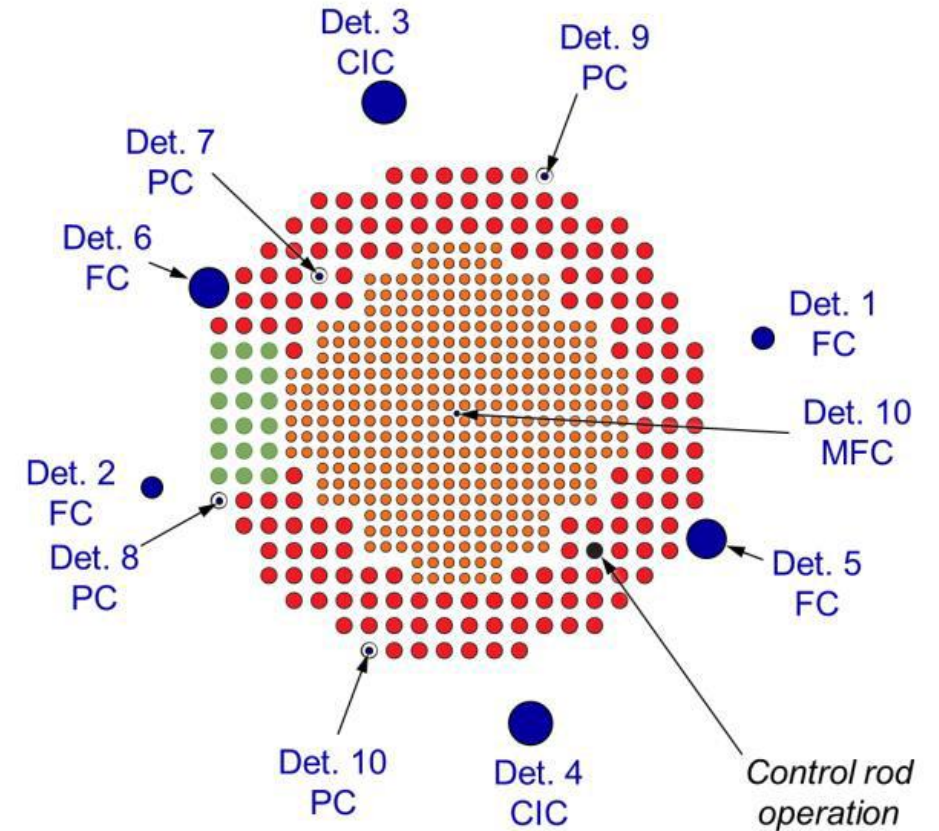


# Comparison with experiments from the first COLIBRI campaign at CROCUS - EPFL



Detector pairs X-5

Normalization using CPSD 6-5

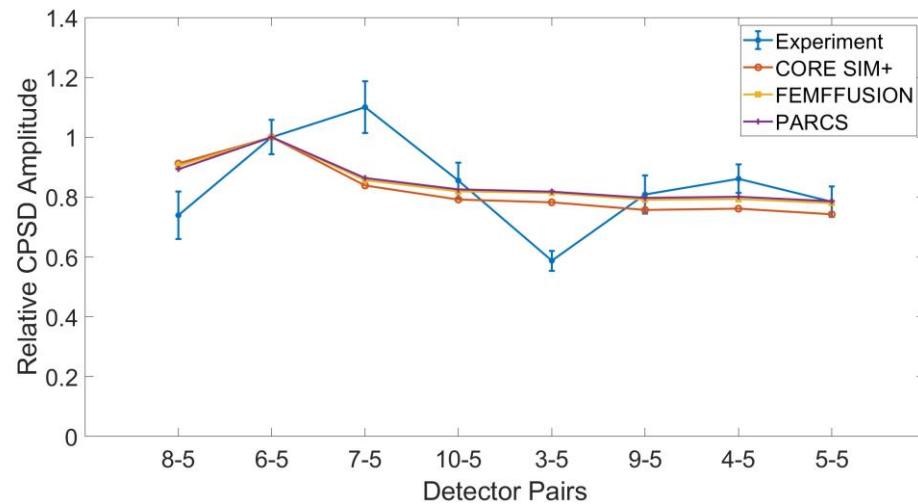


# Diffusion-based solvers

## Experiment I2

Rod displacement = +/- 2.0 mm

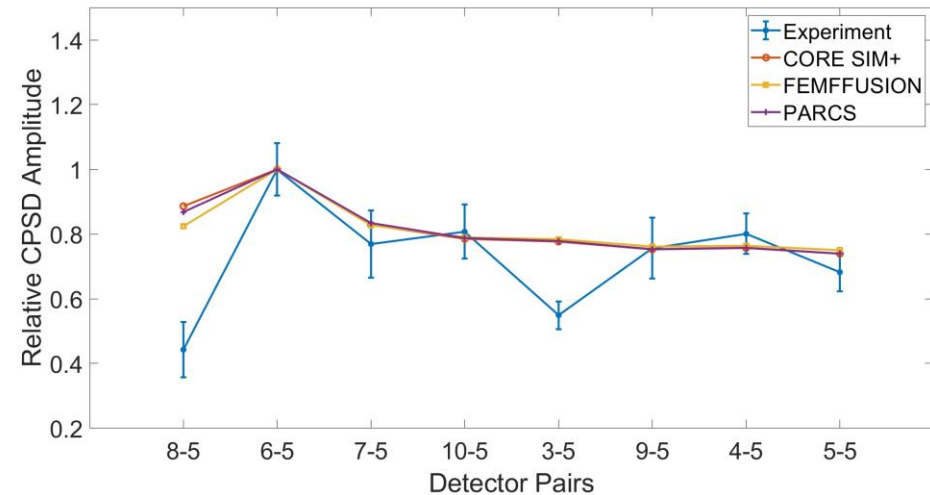
Frequency = 0.1 Hz



## Experiment I3

Rod displacement = +/- 2.0 mm

Frequency = 1.0 Hz

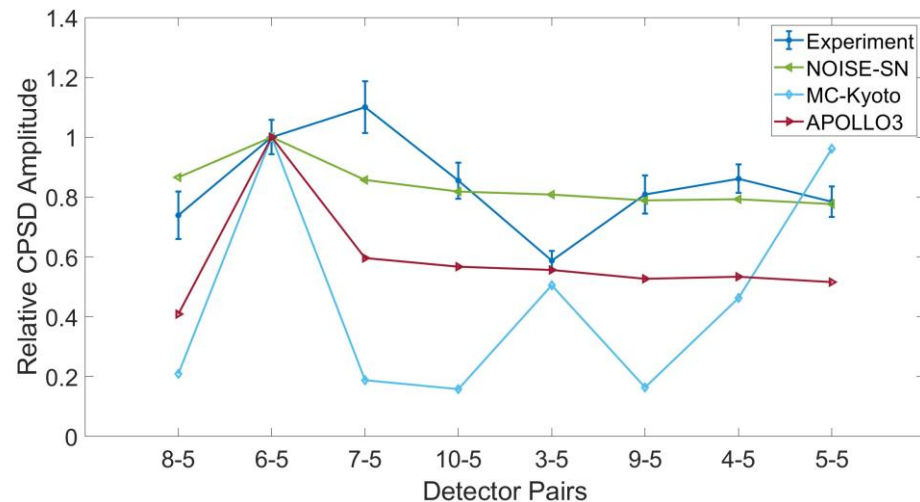


# Transport-based solvers

## Experiment I2

Rod displacement = +/- 2.0 mm

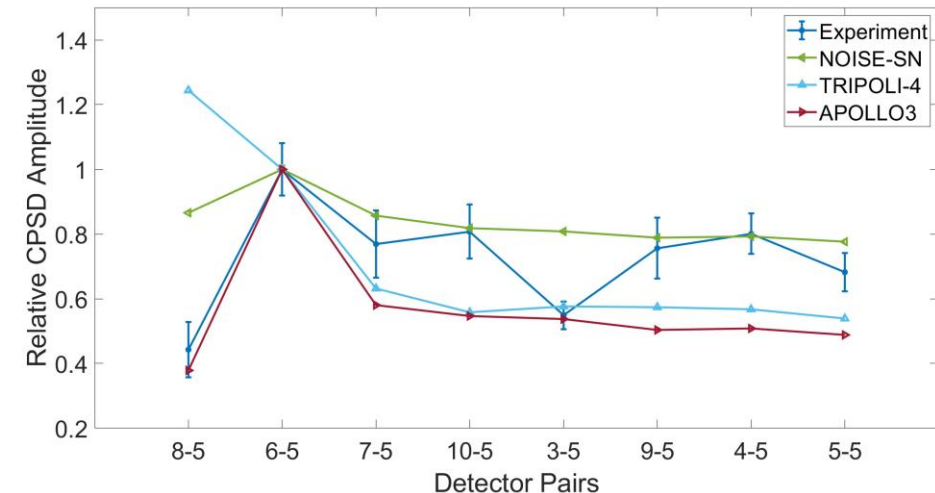
Frequency = 0.1 Hz



## Experiment I3

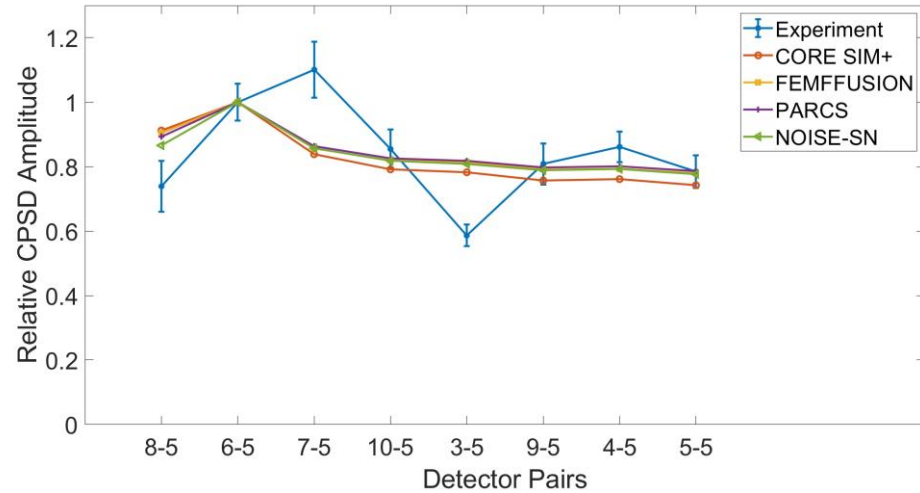
Rod displacement = +/- 2.0 mm

Frequency = 1.0 Hz

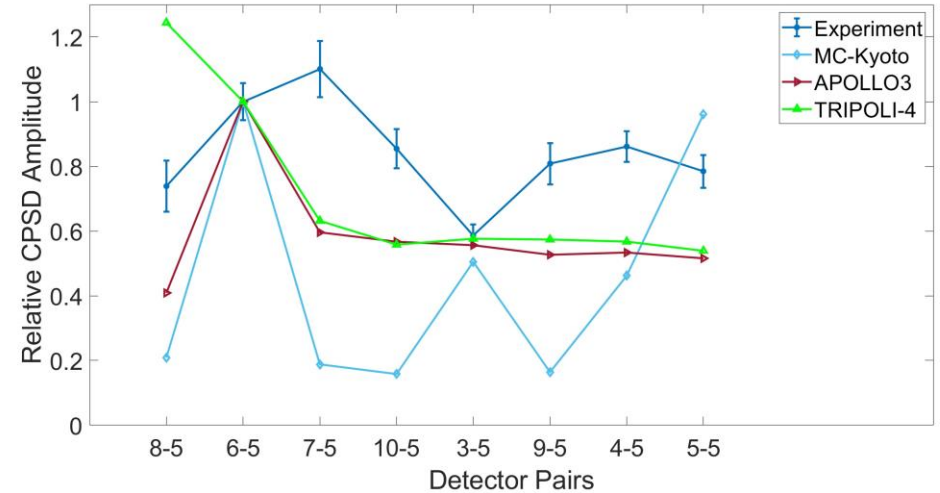


# Experiment 12

## Simplified model



## Detailed model

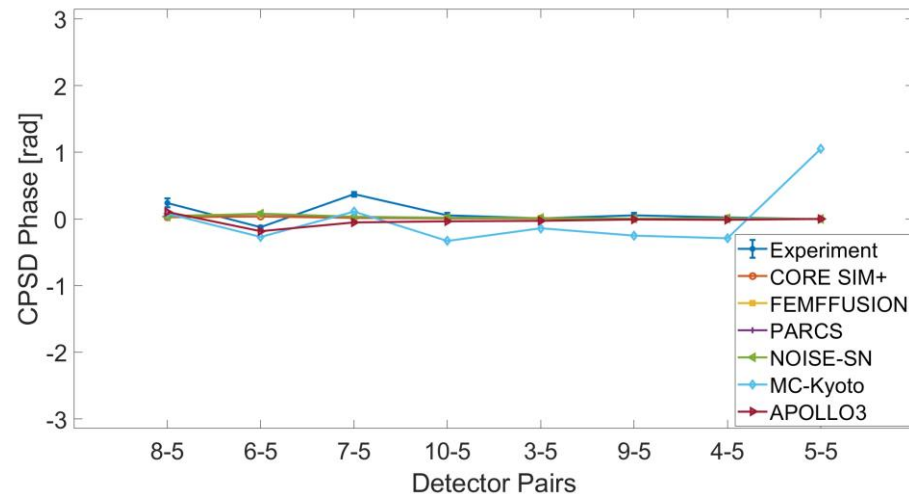


# Phase of the neutron noise

## Experiment I2

Rod displacement = +/- 2.0 mm

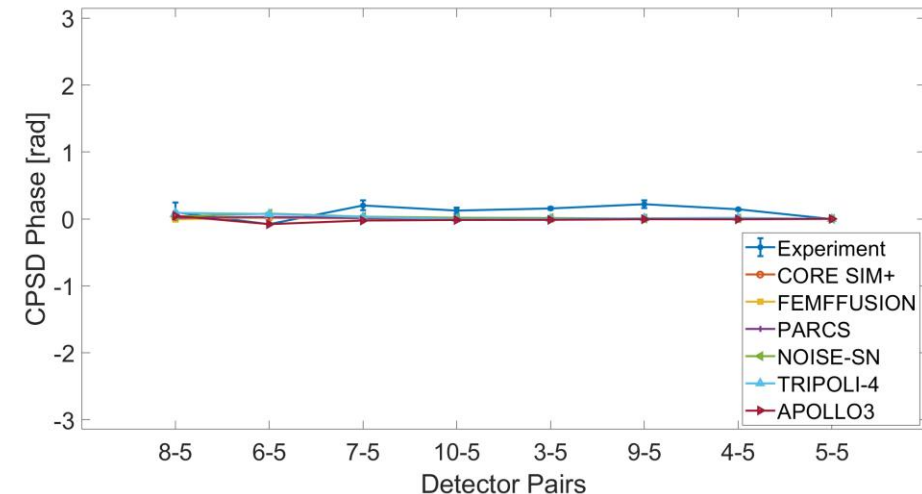
Frequency = 0.1 Hz



## Experiment I3

Rod displacement = +/- 2.0 mm

Frequency = 1.0 Hz

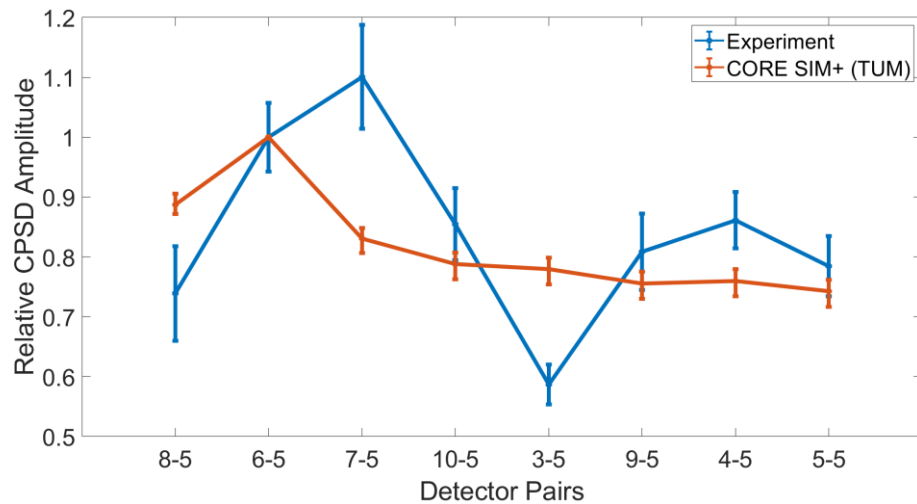


# CORE SIM+ and Uncertainty

## Experiment I2

Rod displacement = +/- 2.0 mm

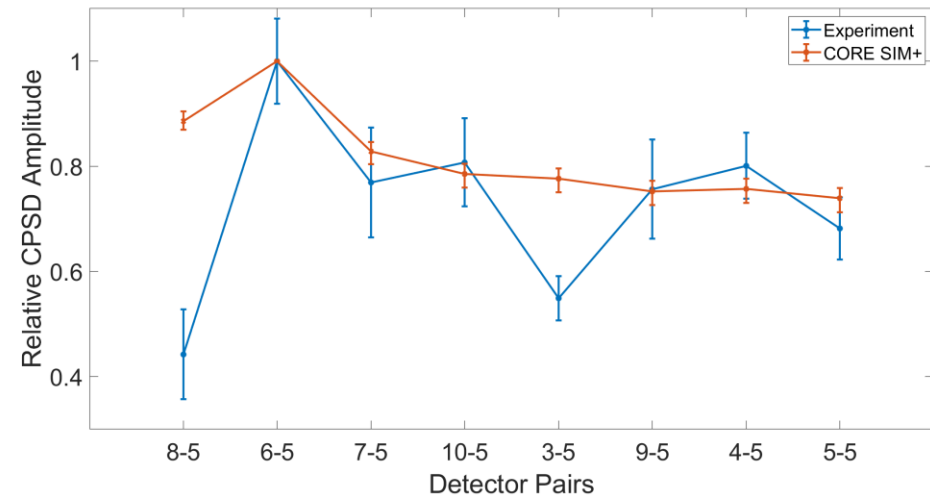
Frequency = 0.1 Hz



## Experiment I3

Rod displacement = +/- 2.0 mm

Frequency = 1.0 Hz



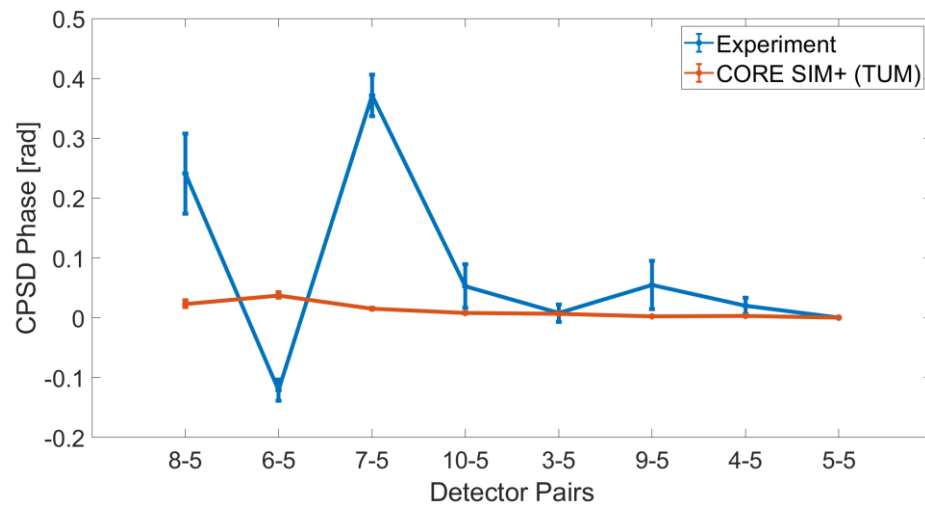


# CORE SIM+ and Uncertainty

## Experiment I2

Rod displacement = +/- 2.0 mm

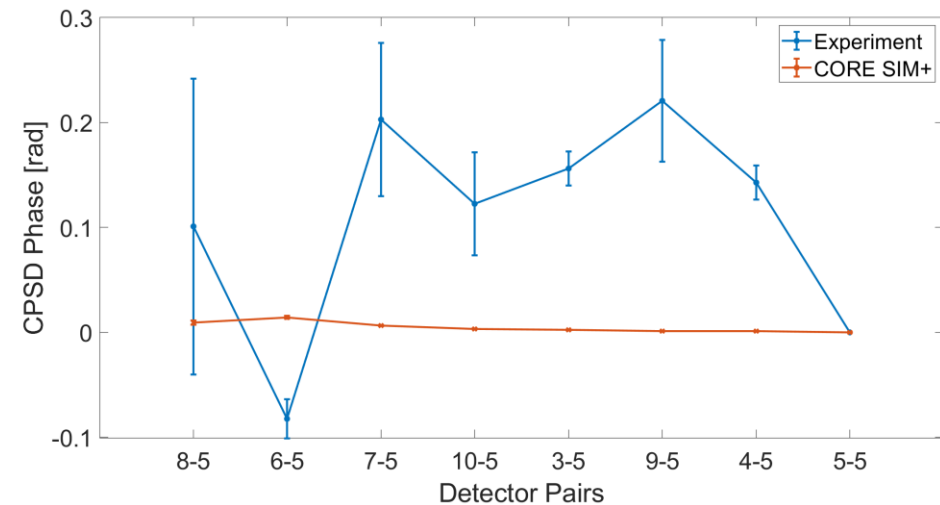
Frequency = 0.1 Hz



## Experiment I3

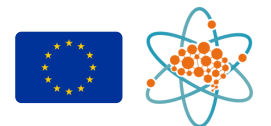
Rod displacement = +/- 2.0 mm

Frequency = 1.0 Hz



# Summary and outlook

- Analysis of 1<sup>st</sup> COLIBRI campaign at CROCUS
  - Experimental trends are reproduced with simulations
  - Differences between the simplified / diffusion model and the detailed / transport model
  - Quantification of uncertainties associated with CORE SIM+ simulations
- Simulations were used to support the design of new experiments
- Second and third experimental neutron noise campaigns at CROCUS



# Thank you

