CORTEX

Core monitoring techniques and experimental validation and demonstration

Results and lessons learned

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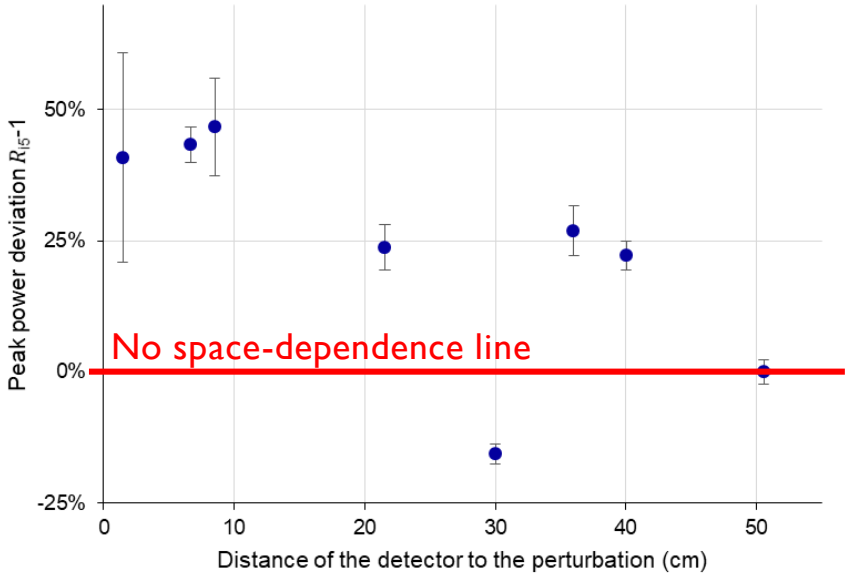
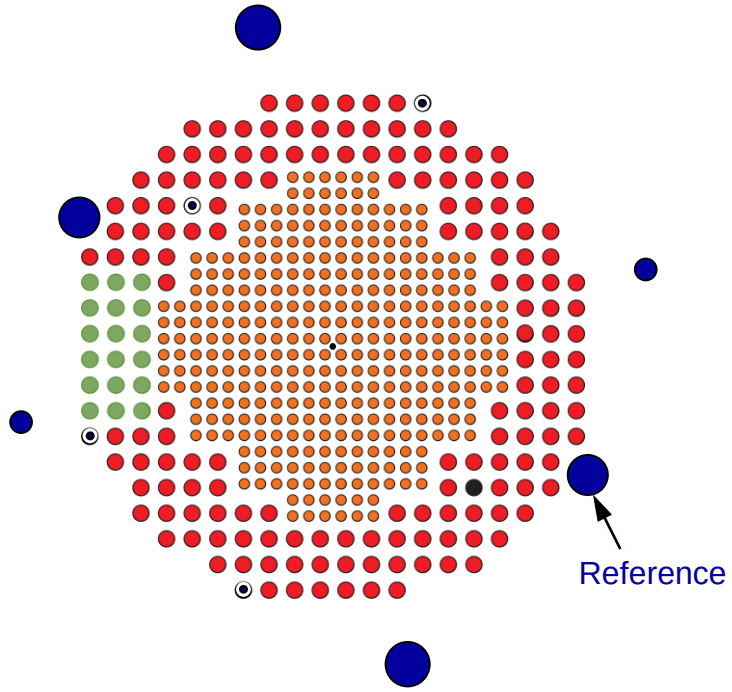
- Early results of 1st campaign
- Preliminary results of 2nd campaign
- Lessons learned

Early results of 1st campaign

A spatial dependence was observed!



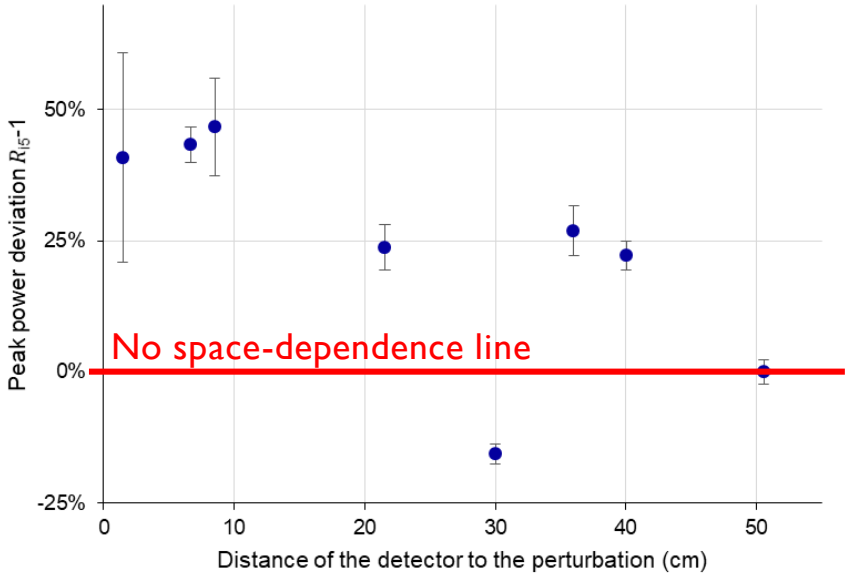
Results in relative noise powers,
as a function of distance to the perturbation
(18 rods at ±1.5 mm and 0.1 Hz)

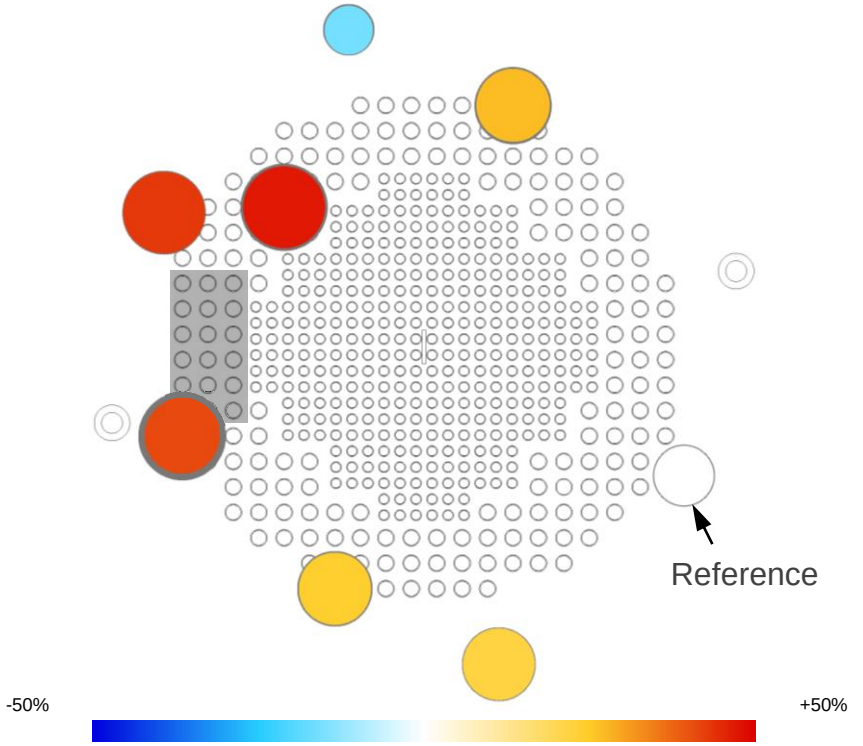


Configuration of the first experimental campaign,
with perturbation in green and detectors in blue

Early results of 1st campaign

A spatial dependence was observed![1]





Results in relative noise powers, as a function of distance to the perturbation (left), and on a cross section of CROCUS (disks) (18 rods at ±1.5 mm and 0.1 Hz)

[1] V. Lamirand et al., "Analysis of the first COLIBRI fuel rods oscillation campaign in the CROCUS reactor for the European project CORTEX," EPJ Web Conf., vol. 247, p. 21010, Feb. 2021.

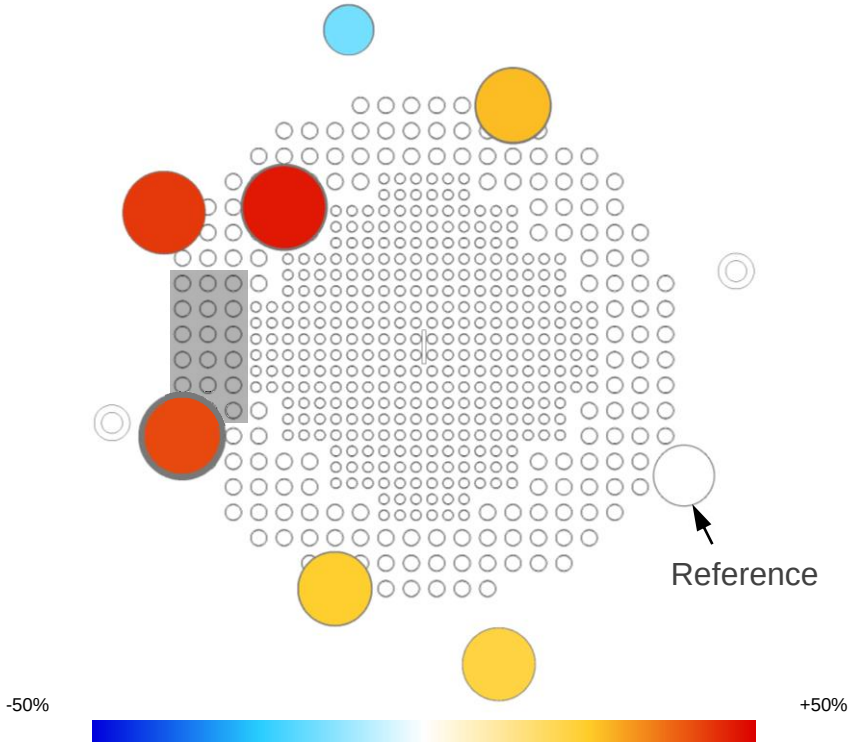
Early results of 1st campaign

A spatial dependence was observed![1]

- Noise level not following the flux map
- Accessible within the uncertainties

… with limitations & inconsistencies:

- Outliers & repeatability issues
- Resolution uncertainty not considered
- Correlations not taken into account



Results in relative noise powers on a cross section of CROCUS (disks) (18 rods at ±1.5 mm and 0.1 Hz)

[1] V. Lamirand et al., "Analysis of the first COLIBRI fuel rods oscillation campaign in the CROCUS reactor for the European project CORTEX," EPJ Web Conf., vol. 247, p. 21010, Feb. 2021.

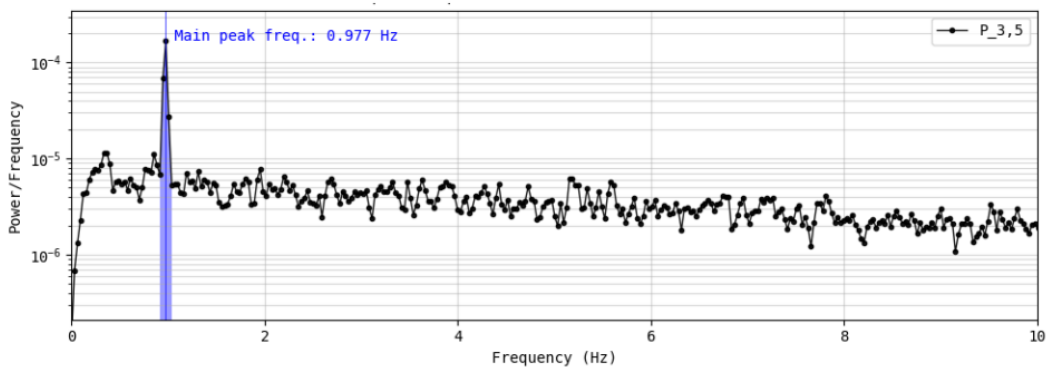
Improved Ist campaign analysis methodology

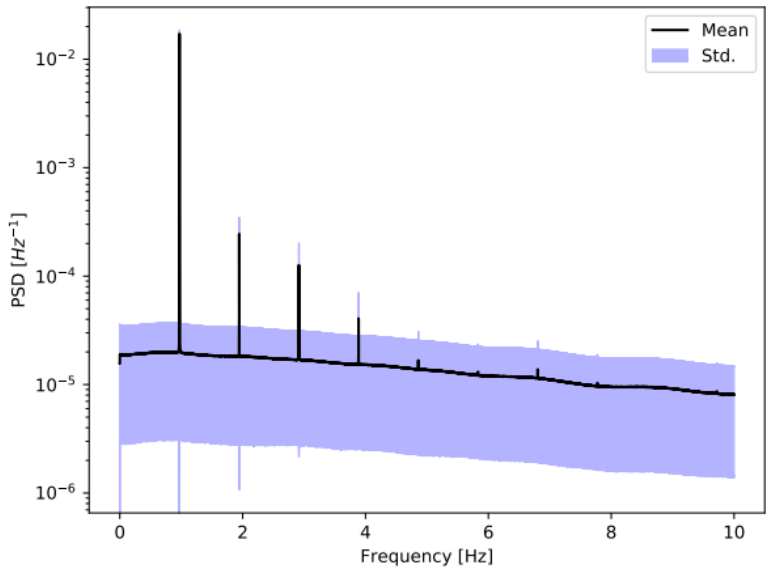
Bootstraping instead of usual (naive) PSD estimate

- PSD base frequency results consistent with old evaluations.
- Phase angles resolved (also base freq.)!
- Increased prominence at higher harmonic frequencies.

… some issues were also identified:

- Repeatibility issues
- Frequency variations in COLIBRI: longer measurements required!
- Uncertainty calculated from multiple ratio evaluations (not ropagated from ground up)





Old (top) and new (left) power spectral density evaluation between detectors 3 & 5

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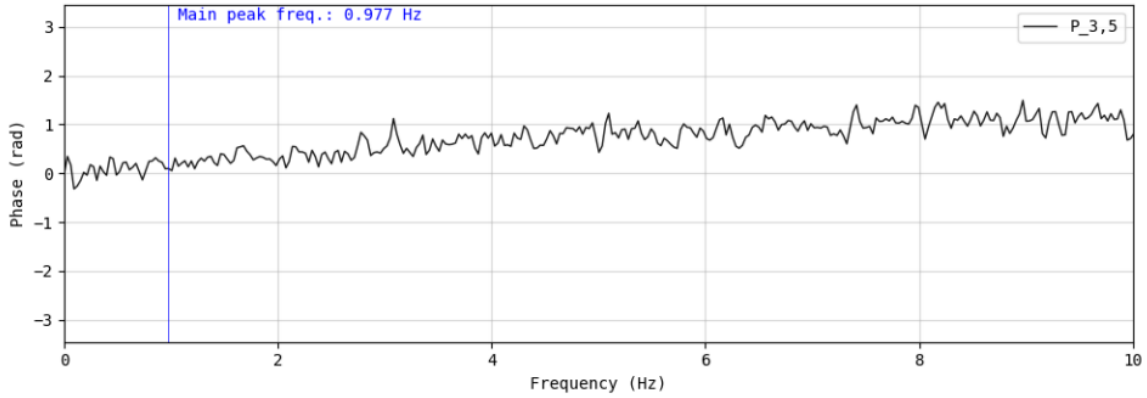
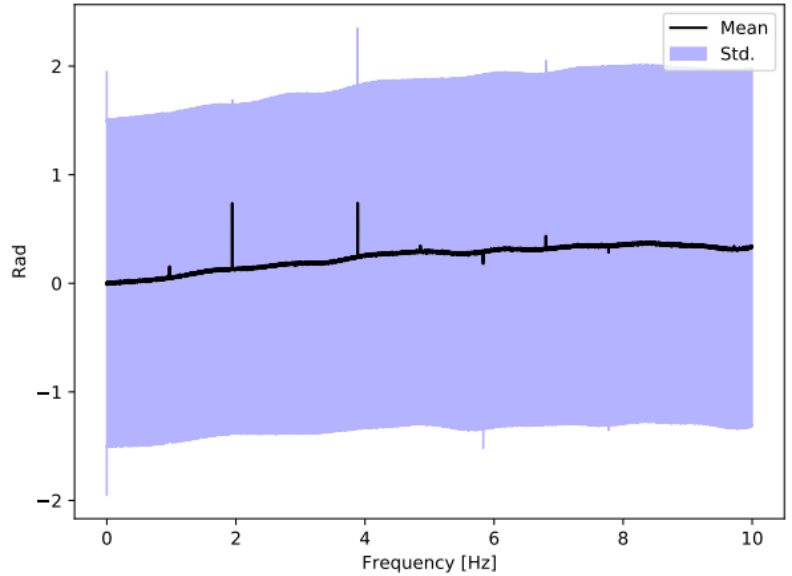




Old (top) and new (left) pahse angle evaluation between detectors 3 & 5

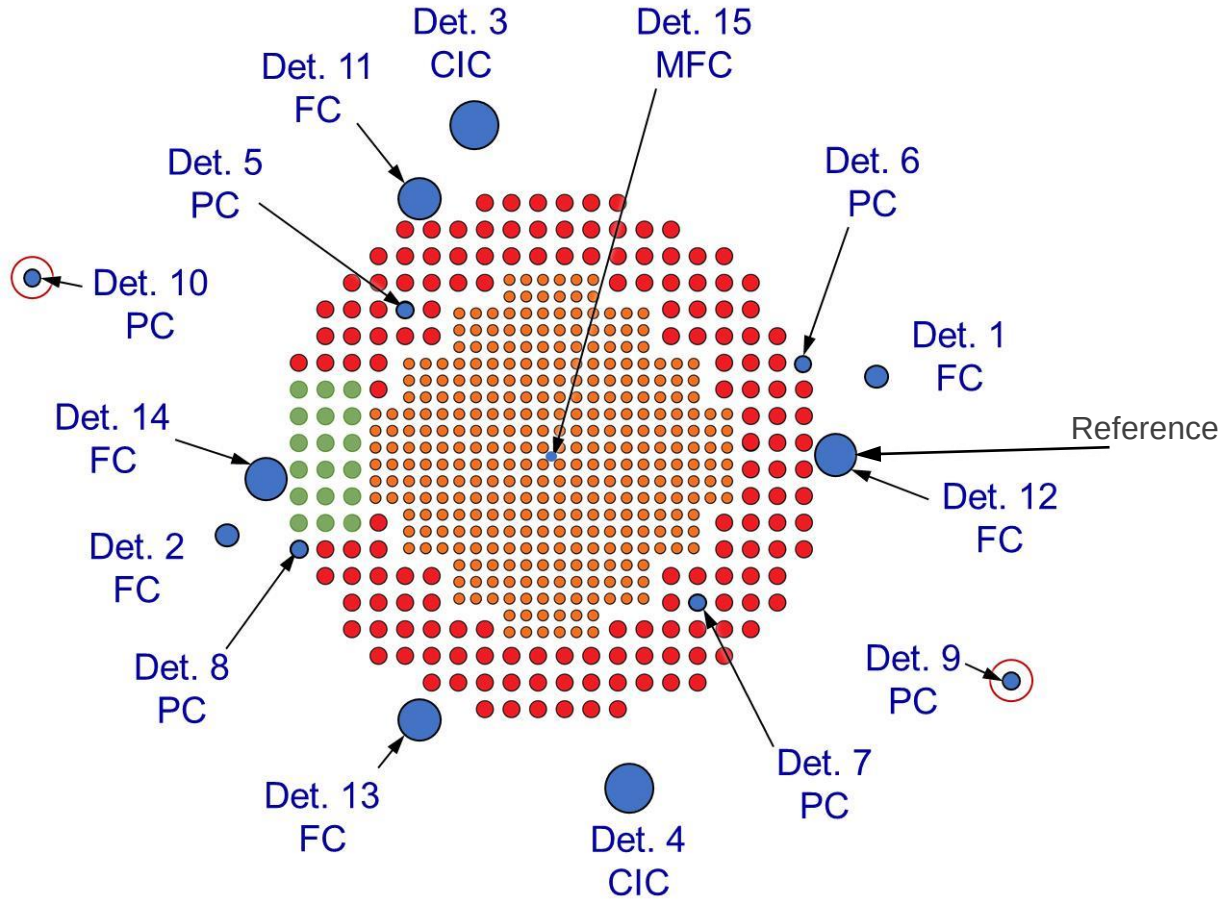
Preliminary results of 2nd campaign

Improvements:

- More detectors + strategic locations (e.g. behind oscillator)
- Longer measurements (~few 1000 s)
- Repeatibility
- Inclusion of correlations & covariances
- Uncertainty propagation

...shortcomings

- Repeatibility more focused
- Propagated and uncertainty differs from std. of final values.



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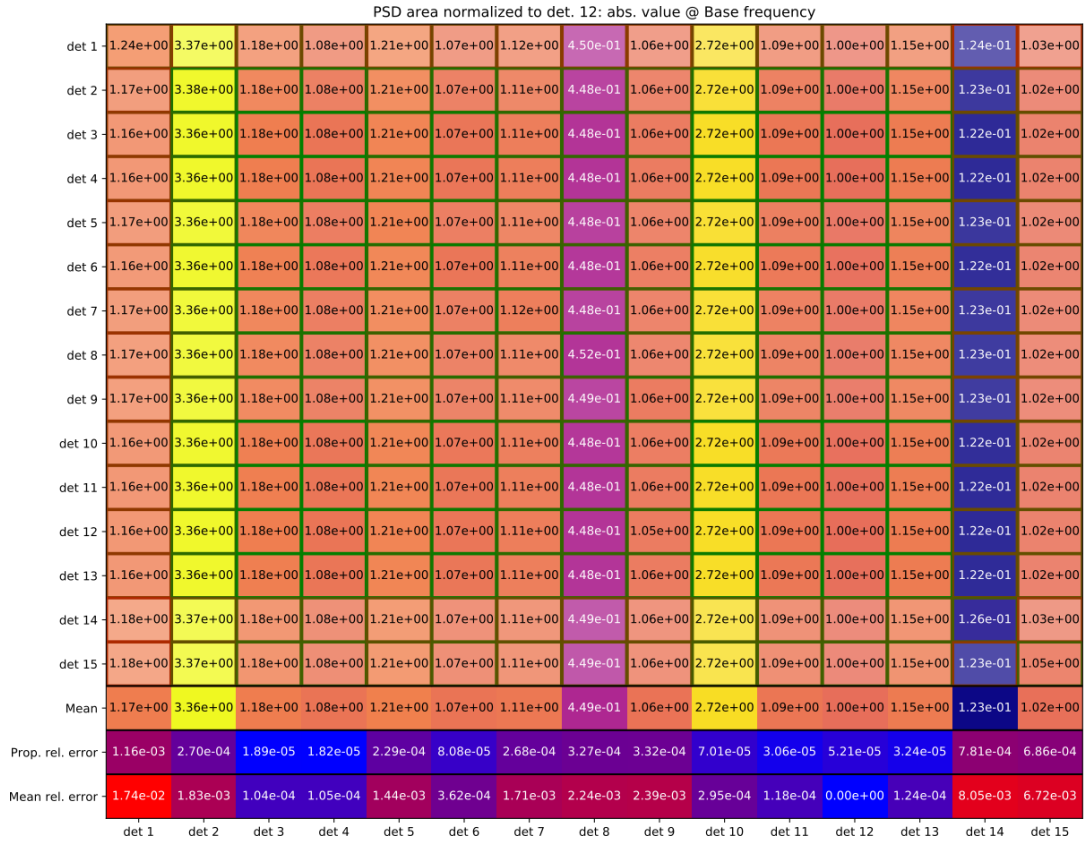
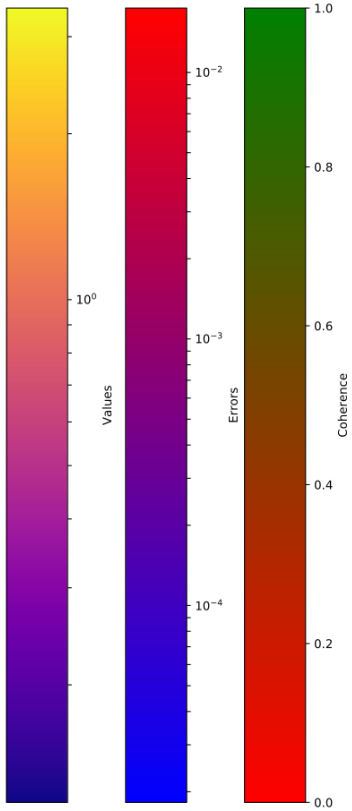
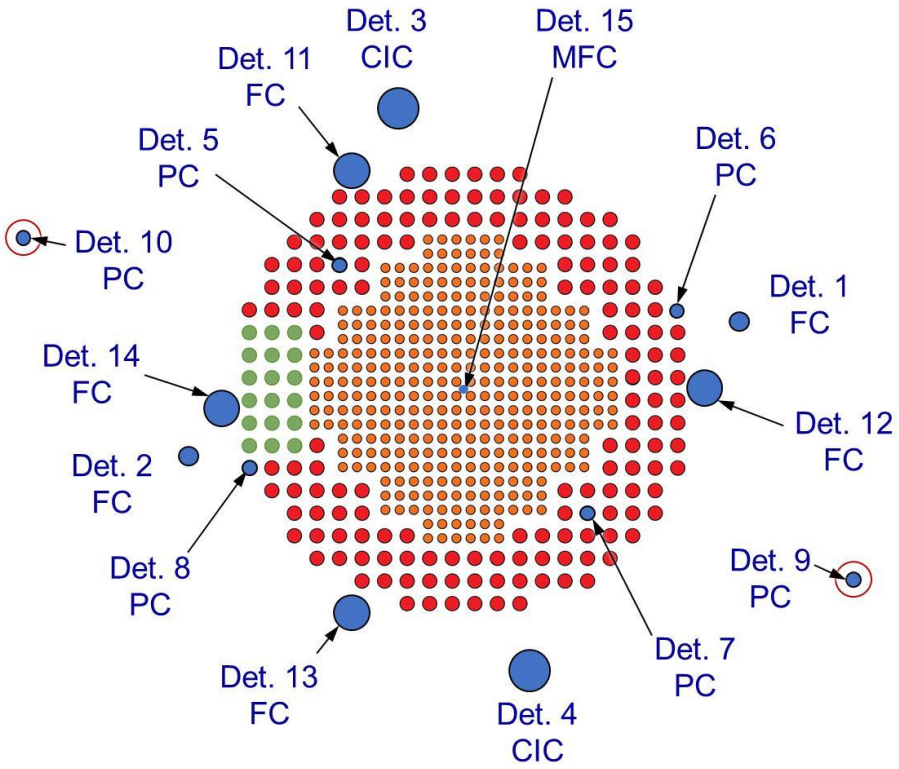
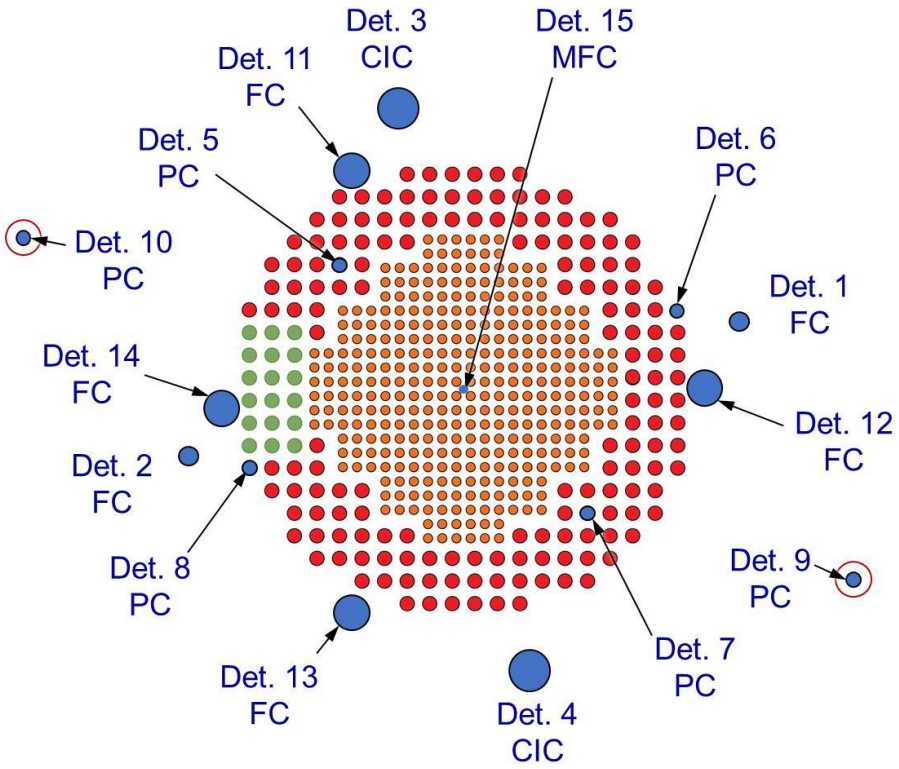






Spectral power (PS) ratio for measurement at 0.97 Hz and oscillation amplitude of 1.5 mm.

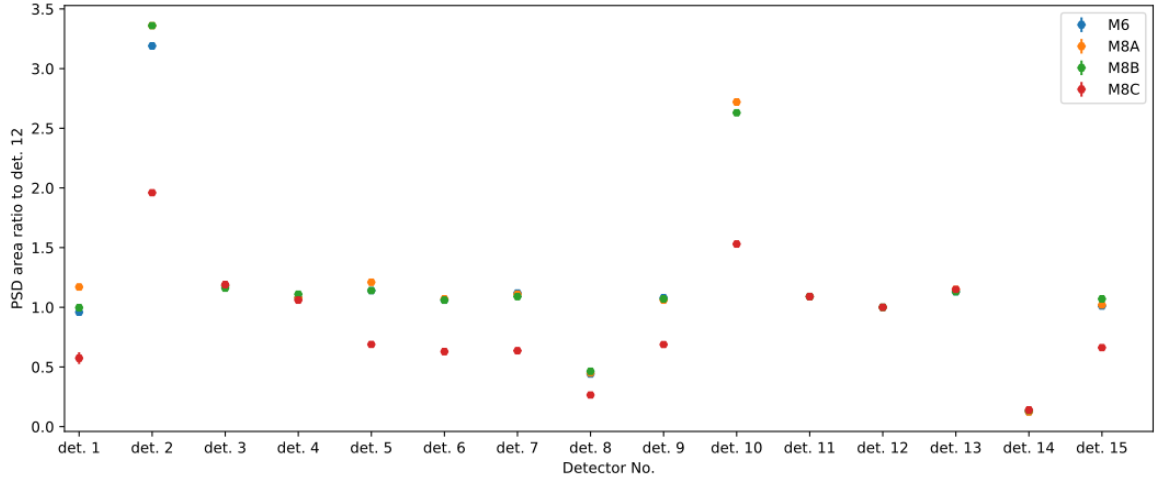
Preliminary results of 2nd campaign

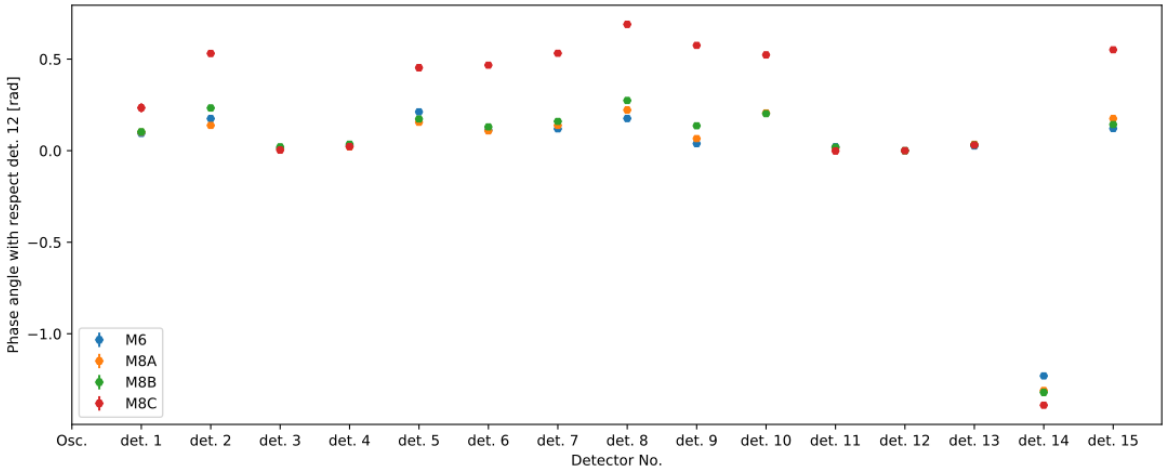


Phase angle difference for measurement at 0.97 Hz and oscillation amplitude of 1.5 mm.

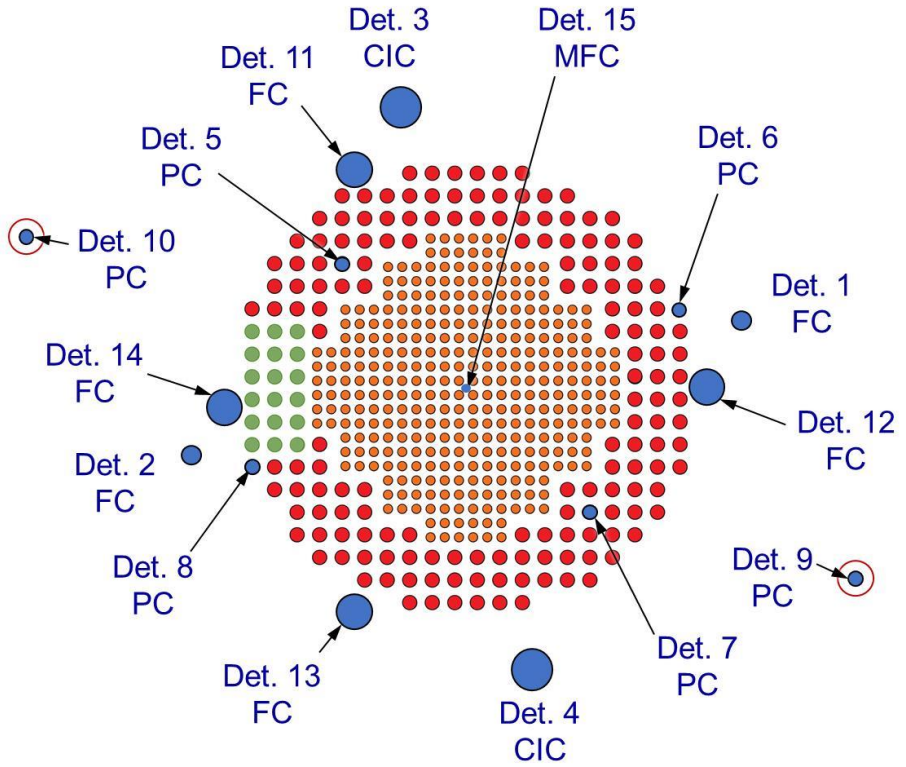
Preliminary results of 2nd campaign

Consistency: PS ratio





Consistency: Phase angle difference



Something clearly occured during measurement M8C!

3rd campaign

Improvements:

- 18 detectors in total
- More repeatibility
- Neutron current detector
- 2x synchronized oscillators (COLIBRI + POLLEN)
- Taking into account all correlations + all uncertainties we know of

...shortcomings

- Analysis in progress

Lessons learned

- Less data points, but better ones
- If you cannot know, repeat (and vice versa)
  - Importance of repeatability, especially for COLIBRI: imperfect oscillation
  - Importance of maximal data: collection of position signal for full propagation
- Data analysis of noise experiments is quickly tough (and expensive)
- Research reactors can contribute to noise code validation, but high spatial resolution is needed
- Spatial dependence of noise seem to be at hand!

Thank you!