SNETP Sustainable Nuclear Energy Technology Platform

# CORTEX

# CORe monitoring Techniques and Experimental validation and demonstration

## OBJECTIVES

The CORTEX project aims at developing core monitoring techniques that allow detecting, characterising and backtracking anomalies in nuclear reactors before they can have any adverse effects on plant safety and availability. The applicability and usefulness of these techniques will also be demonstrated on actual plant events.
The project will thus contribute to improved safety and operation of current nuclear power plants and future reactors.

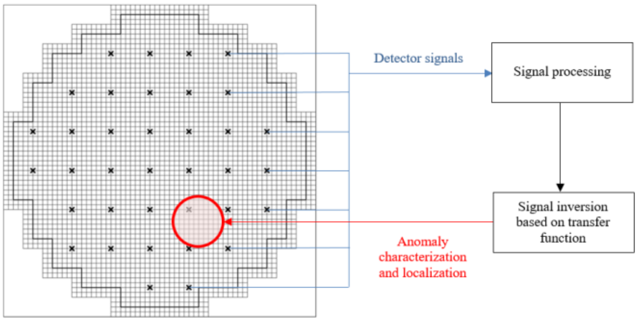


*Fig. 1. Concept of CORTEX. The image on the left represents the radial layout of a boiling water reactor, with fuel assemblies as squares and neutron detector strings as crosses.*

## DESCRIPTION OF WORK

The work relies on the use of the fluctuations existing in any process parameter that is measured to monitor the reactor state, primarily in the neutron flux (i.e., the so-called neutron noise). These fluctuations always occur, even in steady state conditions, and they can be processed with signal analysis techniques in order to identify possible anomalous patterns. The origin and characteristics of the anomalies can then be recovered from the detector signals via an inversion procedure. Such a procedure is based on the reactor transfer function that describes the relationship between any system perturbation and the induced fluctuations. The concept is illustrated in Figure 1.
In addition to two Work Packages (WPs) on knowledge dissemination and project management, the project includes 4 technical WPs:

- **WP1:** modelling capabilities for reactor noise analysis will be developed.
- **WP2:** the modelling tools will be validated against neutron noise experiments to be performed at the CROCUS and AKR-2 research reactors.
- **WP3:** advanced signal processing and machine learning methodologies will be developed for the analysis of plant data.
- **WP4:** the developed modelling tools and signal processing techniques will be applied to plant data and actual core diagnostics tasks will be undertaken.

## MAIN RESULTS / HIGHLIGHTS

- Modelling capabilities based on both low-order and advanced neutron transport methods to estimate the reactor transfer function
- Fluid-Structure Interaction models for a realistic description of possible core perturbations
- A methodology for uncertainty and sensitivity analysis in reactor noise simulations
- Neutron noise experiments for code validation
- New detectors for neutron flux and neutron current measurements
- Advanced signal processing techniques for extracting relevant fluctuations from the measured signals
- Machine-learning methodologies for inverting the reactor transfer function and recovering the anomalies
- Demonstration of the overall methodology applied to real plant data
- Better understanding of abnormal fluctuations in nuclear reactors and their origin
- Classification of abnormal fluctuations according to their safety impact
- Recommendations about in-core and ex-core instrumentations

## DURATION

1 September 2017 – 31 August 2021
4 years

## CONTACTS


**Technical Project Leader:**
Christophe Demazière (Chalmers)
Email: demaz@chalmers.se

Paolo Vinai (Chalmers)
Email: vinai@chalmers.se


## PARTNERS

Chalmers University of Technology (Sweden); CEA and LGI Consulting (France); MTA EK (Hungary); EPFL, KKG, PSI (Switzerland) GRS, ISTec, TIS, PEL, TU Dresden and TU Munich (Germany); Institute of Communication & Computer Systems - National Technical University of Athens (Greece) ; UJV (Czech Republic) ; University of Lincoln (UK) ; UPM and UPV (Spain)


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