CORTEX

CORe monitoring Techniques and EXperimental validation and demonstration

OBJECTIVES

The CORTEX project aims at developing core monitoring techniques that allow detecting, characterizing 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 be also demonstrated on actual plant events. The project will thus contribute to improved safety and operation of current nuclear power plants and future reactors.

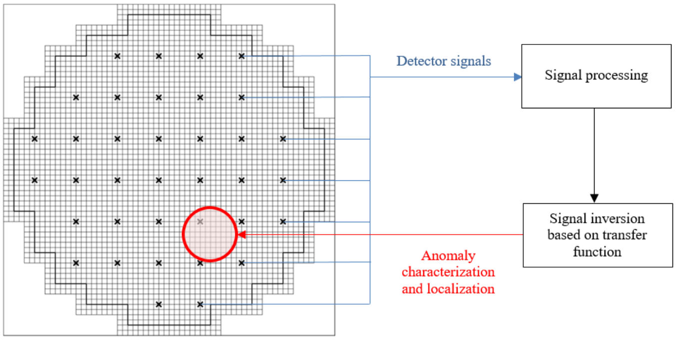

Fig. 1. Concept of CORTEX. The left-hand picture represents the radial layout of a boiling water reactor, with fuel assemblies as squares and neutron detector strings as crosses.

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. Then the origin and characteristics of the anomalies can 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 Fig.1.
In addition to 2 Work Packages (WPs) on knowledge dissemination and project management, the project includes 4 technical WPs:

- In WP1 modelling capabilities for reactor noise analysis will be developed
- In WP2 the modelling tools will be validated against neutron noise experiments to be performed at the CROCUS and AKR-2 research reactors
- In WP3 advanced signal processing and machine learning methodologies will be developed for the analysis of plant data
- In WP 4 the developed modelling tools and signal processing techniques will be applied to plant data and actual core diagnostics tasks will be undertaken

MAIN DELIVERABLES OR RESULTS

- Modelling capabilities based on both low-order and advanced neutron transport methods, for the estimation of 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 Sept 2017 – 31 Aug 2021
4 years

PARTNERS

Chalmers / CEA / EPFL / GRS / ICCS-NTUA / ISTec / KKG / Kyoto-U / LGI / Lincoln / MTA EK / PEL / PSI / TUD / TUM / UJV / UPM / UPV / Nagoya-U / AMS / CNAT / IRSN / Ringhals / Tractebel

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