

State of the art of the CEA R&D for Instrumentation and measurements in Experimental Nuclear Reactor

C. Destouches

► **To cite this version:**

C. Destouches. State of the art of the CEA R&D for Instrumentation and measurements in Experimental Nuclear Reactor. NSS-MIC 2016 - IEEE Nuclear Science Symposium and Medical Imaging Conference including Sessions on Nuclear Power Systems, Oct 2016, Strasbourg, France. cea-02439465

HAL Id: cea-02439465

<https://hal-cea.archives-ouvertes.fr/cea-02439465>

Submitted on 25 Mar 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

State of the art of the CEA R&D for Instrumentation and measurements in Experimental Nuclear Reactors

C. Destouches¹,

1 - CEA, DEN, DER, Dosimetry, Sensors, Instrumentation Laboratory, F-13108 Saint Paul Lez Durance, France

Reliable and accurate measurements (neutron, gamma flux, dimensions, temperatures, chemical properties) are key stakes in the field of the nuclear reactor science. In addition to the primary need of instrumentation for a safe nuclear reactor operating (command-control), specific instrumentation is developed for experimental studies of the properties of the reactor structure materials and of the nuclear fuel elements.

In-pile experimental sensors and measurement systems have to satisfy several severe criteria due to the harsh environment encountered: high gamma and neutron radiation flux levels (up to $1E14n/cm^2s$) and doses (up to $1E21 n/cm^2$, several GGy), high temperature (up to $700^{\circ}C$) and temperature gradients, but also strong operational criteria, such as miniaturization, high reliability (as no repairing is possible on irradiated sensors), long distance between sensors and electronics, etc. Finally, scientific requirements are also very high in terms of the measurement accuracy; as an illustration, neutron flux measurement accuracy has to be better than 10% (even 5%) to allow validation or improvement of calculation schemes.

After a summary of their goals and requirements (locations, ranges, uncertainties ...) a description of the main sensor developments performed by the CEA is given: Neutron Self-powered Detectors, Sub-Miniature Ionization/Fission chambers, Calorimeters, extensometers, Optical fiber based sensors (Bragg gratings, Pyrometry techniques, optical extensometer,...), solid state dosimeters, sensors for dimensional measurements (LVDT), ...

The calibration issues (prior, during and after irradiation) of these measurement systems are then discussed introducing associated modelling issues. Computational nuclear, thermos-hydraulic and mechanical codes as well as quality of the basic data (mainly nuclear data) are analyzed in order to highlight needs for improvements.

Finally, a conclusion on the state of the art of the measurement techniques in experimental reactor is drawn and the main future improvement axes are presented.