Institut
Sciences de la Fusion et de l'Instrumentation en Environnements Nucléaires
Aix*Marseille Université

- **JOB TITLE :** PhD position - Advanced solid state detectors for 2 to 20 MeV neutron energy ranges detection and monitoring in fusion and fission environments

- **RESEARCH FIELD(S) :** Radiation detection and measurement, Rays interaction with matter, Instrumentation, semiconductors**,** Nuclear physics (fission and fusion), Signal treatment and analysis.

- **JOB LOCATION :** 50% at the IM2NP (Institut Matériaux Microélectronique Nanosciences de Provence, Campus de Saint Jérôme - Case 142 - Avenue Escadrille Normandie Niemen - F-13397 MARSEILLE Cedex 20), 50 % at the CEA (Commissariat à L'Énergie Atomique et aux Energies Alternatives, Cadarache, 13115 Saint-Paul-lez-Durance)

- **JOB DESCRIPTION :** Aix-Marseille University's 3 years PhD contract

- **Abstract**

The fusion reactions involving deuterium and tritium mainly produce neutrons of 2.45MeV and 14MeV. However other transient phenomena linked to plasma (disruption, ELM[1], ...) or to plasma heating systems (neutral injection) can produce higher energy neutrons. A large background of scattered neutrons is also present. Thus, the neutron spectrum extends from low energies to several tens of MeV with flux levels covering several orders of magnitude.

If, on the one hand, neutrons transport energy to ultimately produce electricity, they are also essential for the fusion fuel cycle: through TBM[2]s tool located on the internal wall, they will be used to produce Tritium. Hence, an accurate knowledge of these neutron fluxes and associated spectrums is crucial for the experiments that are expected on ITER machine through real-time monitoring systems embedded in TBMs. Actually, the tokamak vessel is a harsh environment (very high temperature, ultrahigh vacuum, high magnetic and electric fields, thermomechanical constraints, high radiation levels), which requires specific and dedicated monitoring/measurement systems. If the choice of concepts has been preliminary identified (solid sensors, photoconductive or other carbon semiconductors for example), R&D and qualification needs remain essential before integration into a TBM.

Consequently, the thesis research program proposed here will be dedicated to designing, studying, testing and qualifying miniaturized neutron solid-state detectors based on ad-hoc semiconductor materials such as silicon-carbide (SiC) or/and diamond CVDs for neutron detection and monitoring in a representative nuclear fusion environment.

Neutron detector prototypes that will be developed and tested during this thesis work in WEST Tokamak machine under nuclear fusion conditions particularly neutron fusion spectrum. They will be then proposed to be tested in JHR reactor under a higher neutron flux and strong radiation conditions following a specific and dedicated representativeness approach (<u>from fission spectrum to fusion spectrum</u>).

These thesis works will be carried out across the strong partnership between CEA (IRFM, IRESNE)[1] and Aix-Marseille University through the LIMMEX[2] joint Lab. The AMU and CEA involved teams have a scientific expertise, recognized nationally and internationally, which is conducive to the launch of new works to meet the challenges across two major scientific instruments: the Jules Horowitz Reactor in fission and the WEST

Tokamak in fusion. Indeed, the measurement of neutron flux by high-performance hardened detectors, more and more miniaturized, is essential for these two facilities.

1. Edge-Localized Modes
2. Institut de recherche sur la fusion magnétique (IRFM), Institut de recherche sur les systèmes nucléaires pour la production d'énergie bas carbone (IRESNE)
3. Laboratoire d'Instrumentation et de Mesure en Milieux Extrêmes

- **QUALIFICATIONS/SKILLS/EDUCATION & RESERACH REQUIREMENTS/DUTIES :** Master degree in Physics, Engineering, Instrumentation, Electronics, Nuclear Engineering, Material Sciences and Engineering, ……

- **APPLICATION DEADLINE** (If applicable) : July 1st 2021

- **REQUESTED DOCUMENTS OF APPLICATION :**
  - Grades from last completed degree
  - Cover letter & Curriculum Vitae
  - Letter of recommendation if applicable
  - The internship report at the end of the study possibly

- **CONTACT TO APPLY (EMAIL OR WEBSITE**) :
  Please send any information request at the two following addresses :
  isfin-direction@univ-amu.fr, abdallah.lyoussi@cea.fr