# Conception of an active dosemeter based on silicon CMOS sensors to measure secondary neutrons in the radio/hadron therapy context

DIRECTOR : DANIEL HUSSON
IPHC GROUPE RAMSES, 23, RUE DU LOESS, 67037 STRASBOURG
TEL : 03 88 10 64 87 ; E-MAIL : DANIEL.HUSSON@IPHC.CNRS.FR

The aim of this thesis is to develop a dosimetric system for real-time measurement of neutrons, one of the main secondary radiation in radio/hadron-therapy. During these treatments, neutrons are produced by nuclear reactions with the accelerator system, being emitted isotropically in the treatment room. Patients are therefore exposed to an unwanted neutron field, with the risk of irradiation for other organs, far away from the tumor.

Our group has already developed [1] a prototype of sensor based on the technology of integrated CMOS circuits (system-on-chip), inspired by those which are widely used for article physics. The AlphaRad chip performs a real-time mesurement of neutrons in the full range of energies (meV up to several MeV) with a good sensitivity (starting at the microSv equivalent neutron). The chip offers a powerful neutron/gamma discrimination [3], which is a unique feature. Fast, simple to handle and low power consuming [2], it is an ideal tool for the purpose of neutron counting inside treatment rooms.

The present prototype is currently under test with charged secondaries emitted by fast and thermal neutrons (protons and alpha). The most recently performed measurements at the AIFIRA micro-beam (CENBG Bordeaux) helped to define the main features of the future sensor which will be used in clinical conditions. The electronic designers are already at work, and the final chip should be available by the end of 2015.

During his thesis work, the student will characterize the chip in laboratory, before complete qualification in the real framework of treatment rooms. Experimental measurements shall be combined to simulations. We aim to establish the efficiency for fast as well as thermal neutrons, and the limits of sensitivity have to be measured with high accuracy. The student will be part of the RaMsEs team, which has already a good expertise in dosimetric systems, integrated electronics and the use of standard Monte-Carlo tools (GEANT IV, MCNPX).

**Absolute requirement for this funding: to be elected to this IDEX funding, the candidate must have a foreign diploma**.

**[1]** Y.Zhang, D.Husson et al, *IEEE Tr.Nuc.Sc* 59,4 (2012) 1465 ; **[2]** Y.Zhang, D.Husson et al, *Microelectronics Journal* 43,11 (2012) 730 ; **[3]** M.Vanstalle, D.Husson et al., *Nuc.Instr.Meth. A* 662,1 (2012) 45 ; **[4]** M.Kachel, D.Husson et al., *Rad.Prot.Dosim.* (nov.2013)