ABSTRACT FOR ICNMTA 2014 TRAINING COURSE AND PRACTICAL SESSION

# The Sirad IEEM: a survey tool for the characterization of radiation tolerance of ICs

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The measure of the sensitivity of an electronic device to Single Event Effect (SEE) induced by ionizing radiation is essential for high reliability components, or systems built to operate in space, high altitude, defense, or in close proximity to nuclear reactors. To obtain direct positional information on the device response, complex microbeam facilities are typically employed. Ion electron emission microscopy technique provides an alternative approach.

An axial Ion Electron Emission Microscope (IEEM) is operational at the SIRAD irradiation facility at the 15 MV Tandem accelerator of the INFN Legnaro National Laboratories (Italy). In the IEEM, the Device Under Test (DUT) is located one millimeter behind a very thin (100 nm) self-standing Silicon Nitride ($Si_3N_4$) membrane with a Au deposition (40 nm). A broad (not focused) heavy ion beam is sent down the axis of the IEEM through the membrane onto the DUT to induce SEE. The membrane ensures a copious and uniform emission of secondary electrons and is thin enough not to significantly perturb the ion beam. The secondary electrons from the membrane are collected and focused by the IEEM, a system of electrostatic lenses, and imaged by a purposely developed high-rate and high-resolution position detector system. The SEE detected on the DUT are time-correlated with the IEEM reconstructed position of the ion impact responsible of the event; this information is used to disentangle regions of different sensitivity to SEE in the DUT.

The basic working principle of this tool will be explained and the different choices performed during its development up to the actual configuration will be reviewed. We will first describe tests performed irradiating a SDRAM memory system, purposely developed to evaluate the IEEM performance of this analysis tool. We will then show the results obtained probing three different devices: a MOSFET, in an Ion Beam Induced Charge Collection (IBICC) type experiment, a Shift Register fabricated in commercial silicon on insulator (SOI) technology and a NAND flash memory chip.

In the practical sessions we will see the IEEM in operation using a custom DUT composed of a PIN diode on top on which metal profiles are mounted, thick enough to completely stop the incoming ion beam ($^{79}Br$ 241 MeV). The regions shielded by the profiles appear as SEE-immune, contrasting with the high sensitivity exposed area of the device.