Radiation Hardness Evaluation of SiGe Technologies for the Front-End Electronics of the ATLAS Upgrade

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Abstract
The microelectronic technology currently being used for the Front-End chip in the Inner Detector modules of the ATLAS experiment has been submitted to an intensive radiation assurance program, and it is known to be sufficiently radiation-hard for the radiation levels expected during the LHC life-span. Nevertheless, these studies have also revealed that this technology would not be valid for its application in the ATLAS Upgrade, given the ten-fold increase expected in radiation levels for the Super-LHC. In the search for new technologies that can be used for detector readout in the future upgraded modules, two possibilities have emerged: Deep Sub-Micron CMOS (DSM) and SiGe BiCMOS technologies. SiGe technologies are showing very good power/speed performances at relatively low consumptions in modern applications like mobile phones, wireless systems, or communications, that could give them some advantage as candidates for the ATLAS Upgrade Front-End chip. However, the radiation hardness of these technologies up to the high radiation levels expected in the Super-LHC experiments, is still to be verified.

In this framework, we have studied several SiGe HBT technologies from IHP (Innovation for High Performance Microelectronics, Germany) in order to compare among them and with other manufacturers in the search for the best technological option. We have performed gamma and neutron irradiations to study separately ionization and displacement effects. We will present the effects from these irradiations on different bipolar transistors from these technologies, and the consequences in the suitability of these technologies for their use in the ATLAS Upgrade.