Defect and Material Characterization

The proposed strategy of this research line is focussing on p-type silicon (B or Ga-doped, C co-doped), with the aim of revealing and characterizing the radiation induced defects, evaluate their impact on sensor properties and provide the input defect parameters. Detailed defect investigation could reveal mitigating solutions to acceptor removal in p-type sensors. The proposed research plan for the next 5 years is divided in 3 interlinked WPs:

WP1. Analysis of electrically active defects and of the radiation induced changes in the electrical characteristics of devices built on p-type silicon **-** annealing experiments at different temperatures, 80^0C and above 200^0C

WP2. Microstructural Investigations of extended and clustered defects by electron microscopy - silicon **-** annealing experiments at different temperatures, 80^0C and above 200^0C

WP3. Theory – modelling the detected defect generation, kinetics and impact on the electrical properties of the diodes and the role of intentional added impurities, with the aim of establishing the optimal impurity content for the envisaged applications

Approach:

1) STFZ silicon was the first choice – however, the STFZ wafers prove not to be homogeneous in terms of intrinsic defects even when diodes are processed on wafers from the same batch. It is not known yet if this is a real issue for irradiated sensors but definitely is a concern for defect studies when have to establish the role of intentional added impurities.

2) Epitaxial p-type silicon – could be a better choice with respect to homogeneity of the wafers and for understanding the defect generation process during irradiation - the investigation of this type of material started recently

General important aspects - a common RD50 project would help!

- the full cooperation between the groups involved in defect studies and those growing/processing the materials/diodes, especially when defect engineering attempts are made (e.g implantation with different atomic species in LGADs) . Details about the profile and magnitude of the concentration of the implanted species has to be known by those involved in defect investigations

- diodes processed within RD50 collaboration should be provided for defect analyses, including also not irradiated reference samples. Irradiation fluences should allow defect investigations with different techniques, including DLTS and TSC (standard and defect engineered p-type silicon, pads, LGADs and HVCMOS; different type of irradiations covering irradiation fluences from 10^{11} to 10^{17} cm^{-2}, equivalent 1 MeV neutrons; advanced defect analyses)