



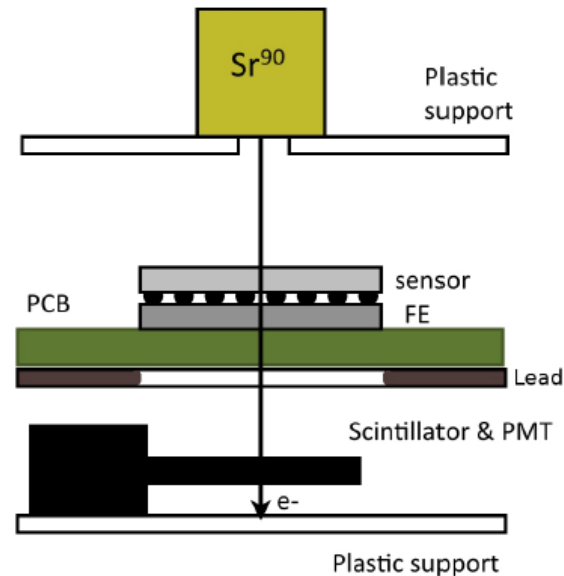
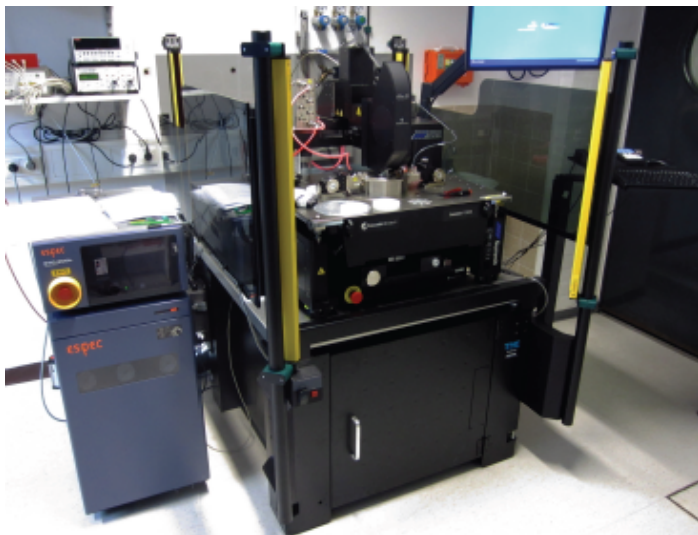
Deliverable 7.7

Final Pixel Module Characterization

A. Macchiolo, MPP

Available instrumentation and expertise at MPP

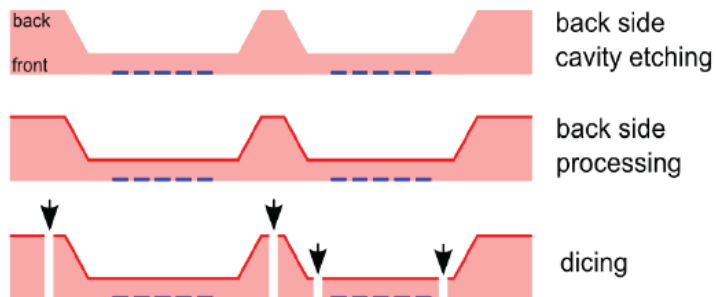
- ❑ Pixel sensor design with TCAD tools
- ❑ Semiautomatic probe-station (high-voltage and cold chuck) for automatized measurements of bare sensors at wafer level and after dicing
- ❑ Set-up for characterization of ATLAS pixel modules before and after irradiation (USBPix and RCE read-out systems) in two climate chambers
- ❑ Extensive experience with beam test set-up and analysis with AIDA telescopes



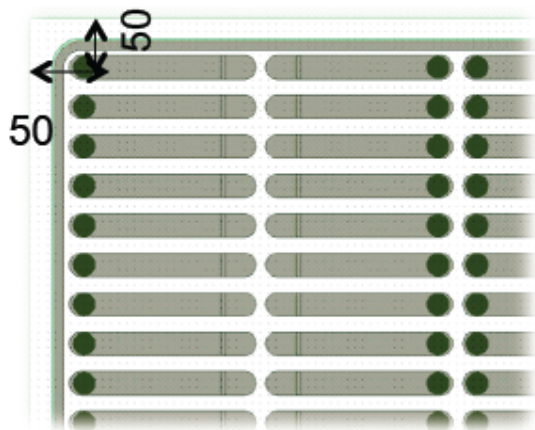
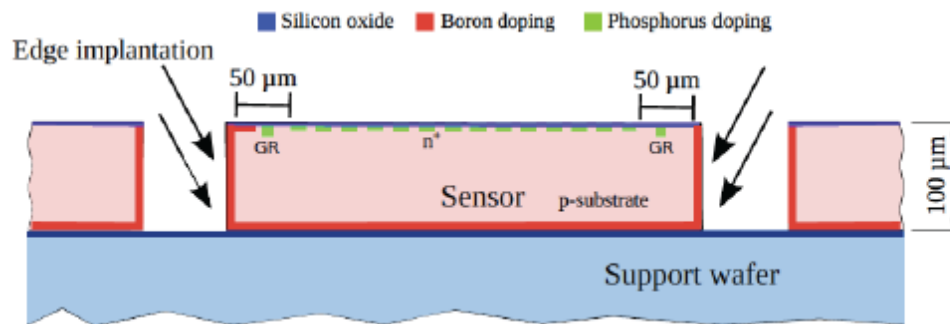
Present activities on hybrid pixel modules at MPP (I)

- ❑ Investigation of different technologies for producing thin n-in-p sensors with active or slim edges, in collaboration with ADVACAM (Finland) and CIS (Germany)
- ❑ Interested in the development of new interconnection techniques (SLID and TSV, see WP₄)

Anisotropic wet etching without handle-wafer at CIS

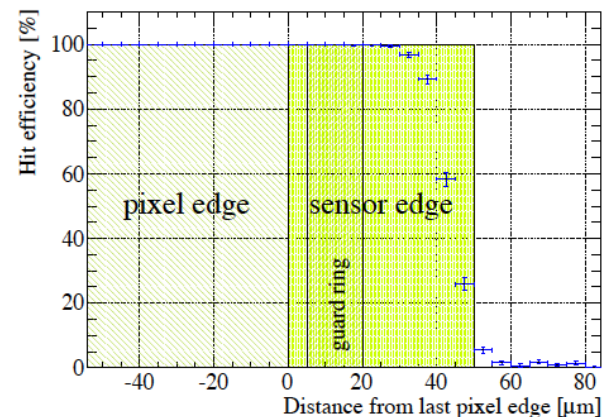


SOI technology with active edges at ADVACAM



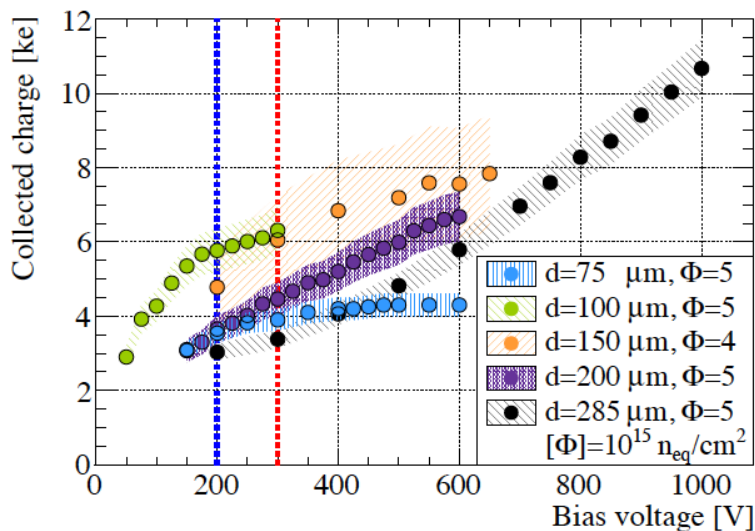
*FE-I4 sensor with active edge
New ADVACAM production*

Hit efficiency for active edge sensor

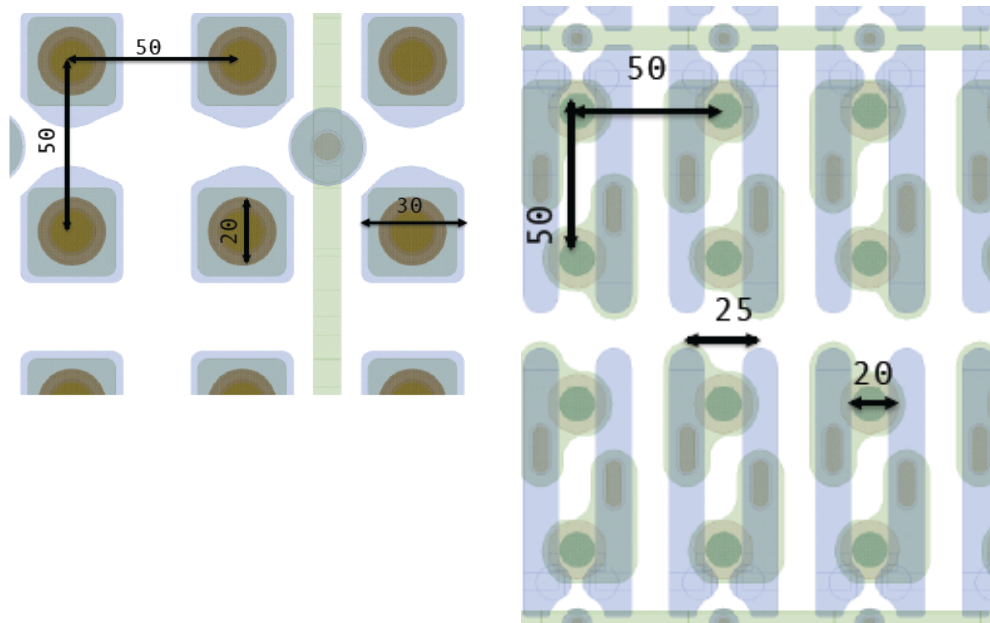


- ❑ Development of thin n-in-p planar pixel sensors with slim and active edges
- ❑ Work in collaboration with CIS (Erfurt) and ADVACAM (Finland)
 - ❑ Characterization of charge collection efficiency with radioactive sources in the lab and test beam measurements for determining hit efficiency after irradiation
 - ❑ Results used in the optimization of the planar pixel sensor design for next generation of chips with finer pitch: edge design + pixel cell → partial fulfillment of Deliverable 7.6 (Initial pixel characterization)

Comparison of CCE for different pixel sensor thicknesses

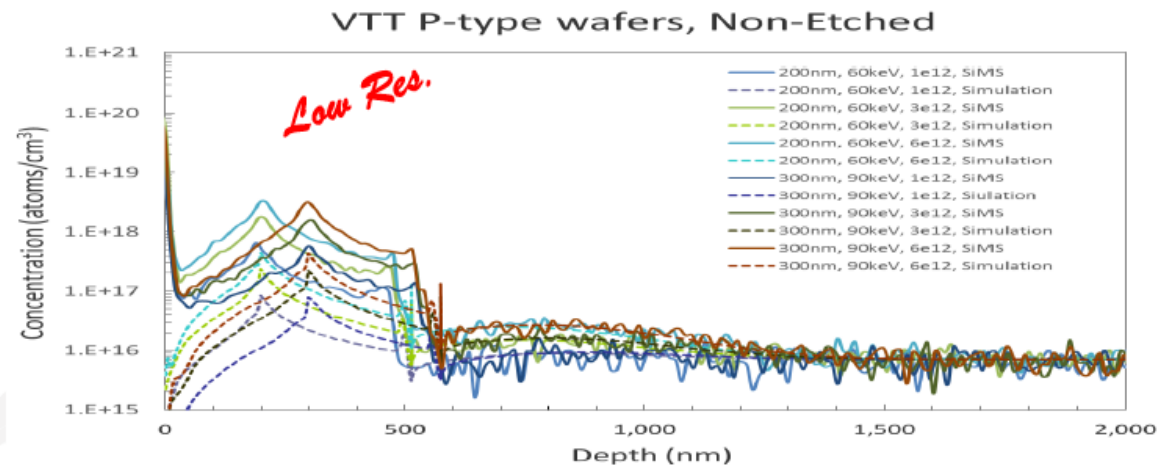


New pixel designs for RD53 chips, with new PT structure



Collaborating institutes in WP7 - LAL

- ❑ Participation in the development of active edge pixel sensors with ADVACAM
- ❑ Involved in developments of new interconnection methods for hybrid pixel modules, collaboration with LETI on implementation of TSV on the read-out chips (WP4).
- ❑ TCAD simulation for the optimization of pixel cell and edge design
- ❑ SIMS and Scanning resistance Methods to extract process parameters as input to simulations



D7.7 Final pixel characterization (I)

- ❑ The aim is to compare performances of 3D and planar hybrid pixel modules of different types, as a function of the fluence, up to the highest level foreseen for the pixel systems at HL-LHC.
 - Modules from WP7 MPW runs should be available in 2018, assembled with RD53 prototypes chip

- ❑ Deadline: March 2019

- ❑ Means of verification: Report

- ❑ Institutes involved: CERN, MPG-MPP, INFN-FI, INFN-MI, UNIMAN

D7.7 Final pixel characterization (II)

- ❑ Coordination at various levels can help to optimize resources:
 - ❑ **Hybridization:**
 - ❑ Work in collaboration with WP4 (Micro-electronics and interconnections), for exploring innovative interconnection techniques.
 - ❑ Investigate the possibility of interconnecting the sensors to the chips after irradiation (cold bump-bonding), to avoid problems with the limited radiation hardness of present chips and their excessive activation.
 - ❑ **Passivation against sparks:** share experience and possible common runs of deposition of BCB and Parylene
 - ❑ **Read-out systems for the pixel modules:** at least the prototype chip from RD53 will be the same one for CMS and ATLAS
 - ❑ Share resources and knowledge for module testing
 - ❑ Develop common tuning and measurement procedures to facilitate the comparison between the different technologies.

D7.7 Final pixel characterization (III)

Irradiations:

- Coordinate irradiations at the AIDA-2020 facilities (CERN PS, KIT, Ljubljana) of pixel modules from the MPW runs and channel common requirements to the irradiation centers

Test beams:

- Study of the hit efficiency up to a fluence of $\sim 10^{16} n_{eq}$ in the full range of possible η incidence for sensors with 50×50 and $25 \times 100 \mu m^2$ pitches
- If groups are interested we could ask in 2017 and 2018 for specific test-beam time at CERN SPS for testing prototype devices and modules of the WP7 MPW runs.