Contribution ID: **46** Type: **poster**

3D Doping Concentration Imaging of Silicon Sensors Using Backside Pulsing

Mapping the distribution of dopants in three dimensions provides a deeper understanding of the characteristics of silicon sensors, such as depletion voltage, electric field distribution, and charge collection properties. A uniform distribution across a large sensor area and depth is essential for high manufacturing yield and device reliability. However, conventional measurement techniques face significant limitations when applied to high-resistivity silicon sensors commonly used in high-energy physics and photon science. Methods such as secondary ion mass spectrometry provide high-resolution measurements but are insensitive to doping concentrations below 1×10ˆ12 cmˆ(-3), while capacitance-voltage profiling and spreading resistance profiling offer only coarse granularity. There is a need for a reliable, high-granularity method capable of characterizing doping concentration in 3D.

To address this, we have developed a novel 3D doping concentration imaging method for silicon sensors, leveraging the backside pulsing technique [1]. The tested sensors, with 75 µm and 25 µm pixel pitches, were bump-bonded to the charge-integrating readout chips JUNGFRAU [2] and MÖNCH [3], respectively. Careful calibrations were first performed using X-ray fluorescence and the backside pulsing method, with the sensors biased above full depletion. The 3D doping concentrations were then extracted for individual pixels by applying backside pulsing at different bias voltages and numerically solving the 1D Poisson's equation for electrostatics.

We will present 3D doping concentration distributions from sensors with up to 4×8 cmˆ2 with 75 µm pixels and up to 1×1 cmˆ2 sensors with 25 µm pixels. Furthermore, we will discuss the observed inhomogeneity in integrated doping concentration, both laterally across the sensor plane and vertically through the sensor depth. Finally, the potential impact of observed doping non-uniformity on the detector's operation and performance will be outlined.

[1] D. Mezza, et al 2016 JINST 11 C11019

[2] A. Mozzanica, et al 2018 Synchrotron Radiation News 31(6) 16-20

[3] M. Ramilli, et al 2017 JINST 12 C01071

Workshop topics

Sensor materials, device processing & technologies

Authors: MOZZANICA, Aldo; MAZZOLENI, Alice (Paul Scherrer Institute (PSI)); BERGAMASCHI, Anna; SCHMITT, Bernd; LOPEZ CUENCA, Carlos; RUDER, Christian (Paul Scherrer Institute (PSI)); Dr MEZZA, Davide (Paul Scherrer Institut); THATTIL, Dhanya (Paul Scherrer Institute (PSI)); GREIFFENBERG, Dominic; FRÖJDH, Erik (Paul Scherrer Institut); ZHANG, Jiaguo (Paul Scherrer Institut); MULVEY, Jonathan (Paul Scherrer Institute (PSI)); Dr HEYMES, Julian (Paul Scherrer Institut); FERJAOUI, Khalil Daniel; PATON, Kirsty (Paul Scherrer Institut); MOUSTAKAS, Konstantinos; CARULLA ARESTE, Maria del Mar; BRÜCKNER, Martin; MÜLLER, Martin (PSI); SIEBERER, Patrick (Paul Scherrer Institut PSI); DINAPOLI, Roberto (Paul Scherrer Institut); SILLETTA, Saverio (PSI); HASANAJ, Shqipe (Paul Scherrer Institute (PSI)); LI, Shuqi; EBNER, Simon (Paul Scherrer Institute (PSI)); KING, Thomas (Paul Scherrer Institute (PSI)); KEDYCH, Vadym (Paul Scherrer Institute (PSI)); Dr HINGER, Viktoria (Paul Scherrer Institut); GAUTAM, Viveka (Paul Scherrer Institute (PSI)); Dr XIE, Xiangyu (Paul Scherrer Institut)

Presenter: Dr XIE, Xiangyu (Paul Scherrer Institut)