Contribution ID: **278** Type: **Poster presentation only**

Therapeutic Carbon-Ion effects on Monolithic Active Pixel Sensor with 130nm High-Resistivity Process

The Wuwei radiotherapy centre is the first carbon ion therapy facility in China .It can deliver 12C6+ beam with the energy up to ~410 MeV/A. The beam delivery system in the therapy facility ensures the beam energy deposition can cover the dedicated region in the body. It has been shown that Monolithic Active Pixel Sensors (MAPS) are very promising tools for direct online beam monitoring. Thus, a Monolithic Active Pixel Sensor (MAPS) with 25μm pitch is currently being designed in a novel 130nm High-Resistivity (>1kΩ·cm) CMOS process with the bulk depth of ~500μm.

Charge deposited by the carbon ions that pass through the MAPS is collected by the charge sensing node, which is formed by an n- well–p- substrate junction. The charge goes into the shaper and the amplifier insides each pixel and then read out by the in-chip scan circuitry. To improve the capability of charge collection, a reverse bias voltage is supplied to the p- substrate to increase the depletion region. Aiming for a comprehensive understanding of the carbon-ion induced process in the MAPS, a 3-dimensional TCAD model has been established. The thickness of the depletion layer, charge collection efficiency, charge collection time and characteristics of NMOS devices with different bias voltages and carbon-ion hitting locations have been deeply studied. This paper will discuss the simulation and analysis of the effects of the carbon ion on the MAPS.

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Session Classification: Poster session 2

Track Classification: Sensor Materials, Device Processing & Technologies