10. Annual MT Meeting



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A Beam Monitor for Ion Beam Therapy Based on HV-CMOS Pixel Sensors

Radiotherapy is an important method in treatment of tumors. The most commonly used radiotherapy is X-ray and gamma radiation. More recently, irradiation with heavy ionized particles –such as protons and carbon ions –have been introduced clinically. The source of these particles is a particle accelerator. In contrast to X-ray and gamma radiation, ions and protons depose energy close to the end of their path, in a small tissue volume (Bragg-peak). By adjusting the beam direction and particle energy, it can be achieved that the largest portion of energy is delivered to the tumor and the healthy tissue in front and behind is less affected.

The present beam monitors are made of gas-filled ionization and multi-wire projection chambers (MWPC) that provide dose, position, and spot size information. We are developing a replacement detector system based on HV-CMOS technology. This technology promises to not only match the current beam monitoring system, but also significantly improve some key parameters: better spatial resolution, smaller integration time, 2-dimensional depiction of the beam spot and operational in a wider beam parameter range. However, the biggest advantage of a solid-state detector over MWPCs is the magnetic field tolerance. A simultaneous operation of magnetic resonance imaging and ion-irradiation allows for aiming at moving tumors deep inside the human body while sparing sensitive organs, like lung, colon or heart.

HV-CMOS is the right choice of technology, since standard monolithic active pixel sensors (MAPS) are not radiation tolerant enough to survive months or even years of continuous in-beam operation, while hybrid detectors exceed the material budget and are inhomogeneous affecting the beam (bumps).

We have designed and produced a series of test chips. The latest version, HitPix3, was used to build a 5x5 chip detector matrix. Its has been successfully tested in the beam of Heidelberg Ion Therapy Center and will remain there for further studies.

Speed talk:

I am unwilling/unable to present a speed talk

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