Tracking and Imaging Detectors – in Heaven and on Earth

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ABSTRACT

Since many years the Max-Planck-Institut für extraterrestrische Physik and the MPI for Physics develop imaging and tracking systems from the near infrared to Gamma rays and for minimum ionizing particles. The detectors are developed in our own silicon foundry, the MPI semiconductor laboratory. The detector systems are all based on ultra high resistivity silicon with integrated electronics. The main underlying device concepts are silicon drift detectors, pnCCDs and active pixel sensors based on the DePFET principle. The detector systems are flying on SOHO (CELIAS) as ion detectors, on the Mars rovers Spirit and Opportunity as X-ray fluorescence detectors as well as on ROSETTA. High speed spectroscopic pnCCDs are flying as a wide field X-ray imager on XMM-Newton. On ground they are e.g. foreseen as wave front sensors for adaptive optics systems (LBT) and focal plane detectors for the new generation of X-ray Free Electron Lasers (FLASH, LCLS and XFEL). The major future missions which will have one of the above detector system aboard are: eROSITA (2012), BepiColombo (2014) and IXO (2020). In particle physics silicon strip detectors have been developed e.g. for the ATLAS experiment. Future experiments include the vertex detector for Super Belle at KEK in Japan.

In this talk special emphasis will be given to the underlying functional device principles to derive and understand the physical limitations of the measurement precision. The focus will be on parameters like: position resolution, energy and time resolution, quantum efficiency and radiation hardness in harsh environments. The expansion towards longer wavelengths beyond the band-gap limited 1.15 µm in silicon towards 40 µm will be briefly described. The extension towards hard X-rays and Gamma rays up to 1 MeV will be described in detail by coupling $LaBr_3$ or CsI(Tl) scintillators to light sensitive silicon drift detectors.