**SRI 2024** 

## SRI2 24

Contribution ID: 535

Type: Contributed talk

## HEPS-BPIX4 : Process in 6M Hybrid Pixel Detector Design and Engineering Prototype for HEPS

Thursday 29 August 2024 12:15 (15 minutes)

Abstract: HEPS-BPIX4 is a new engineering generation hybrid pixel detector prototype with 6M pixels with 140um×140um following the previous one with a pixel size of 150um×150um and frame rate up to 1.2kHz at 20-bit dynamic range. The 6M pixel detector is design for the Biological macromolecule experiment station of HEPS(BA beamline), which will be operational by 2025. The BPIX chip, fabricated in a radiation tolerant design with a standard 0.13um CMOS process, was used to construct multichip modules with a active size of 82.2X36.8mm2 comprising 256X576pixels.

The BPIX4 readout chip was improved in terms of pixel size, electronic noise, number of threshold compared with the previous ones. The comparator threshold of each pixel is adjusted with a global threshold voltage (VCMP) and can be individually trimmed with a 5 bit digital-to-analog converter (5 bit DAC). There are two comparators and two counters in each pixel and a digital pulse from the comparator increments the each 16bit counter, leading to completely digital storage of the number of detected X-rays in each pixel.

The silicon sensors used for the modules were designed at IHEP and fabricated by inhouse fab. Each pixel consists of a pn-junction realized by a highly doped p-electrode implanted into a high-resistivity n-bulk. The sensors with a thickness of 450um are fully depleted at about 60 V and normally biased with 100 V.

A detector module consists of a single, fully depleted monolithic silicon sensor bump-bonded to an array of 2X6 ROCs. A model of the hybrid architecture is shown in Fig.1. Each sensor pixel is electrically connected to its corresponding ROC pixel with an Sn-Cu bump ball of 25to 35 m diameter. Wire-bonds are used to connect the pads on the side of the ROC to further readout electronics.

One module together with a detector control board (DCB), a data acquisition computer and a power supply forms a standalone detector system with 1.2KHz readout frame rate. A multi-module setup of 6M engineering prototype can be realized by mounting modules on a high-precision mechanical frame. The 6 M is an array of 5×8 modules comprising 5898240 pixels on an active area of 411 mm 294 mm achieving 200 Hz maximum frame rate. It is used at the macromolecular crystallography beamline BA at the HEPS.

All presented calibrations and characterizations were carried out at the BSRF using monochromatic X-rays since better results were achieved with X-rays than with the internal calibration signal of the readout chip. Either the direct synchrotron beam in combination with absorbing filters or an elastic scatter for homogeneous detector illumination were used.

## I plan to submit also conference proceedings

Yes

**Primary authors:** Mr ZHANG, Jie (Institute of High Energy Physics); LI, Zhenjie (Institute of High Energy Physics); Mr WEI, Wei (Institute of High Energy Physics)

**Co-authors:** Mr LI, Hangxu (Institute of High Energy Physics); Mr DONG, Mingyi; Mr LIU, Peng (Institute of High Energy Physics); Ms MA, Si (Institute of High Energy Physics); Ms JI, Xiaolu (Institute of High Energy Physics); Mr ZHANG, Yan (Insti

Physics); Ms LIU, Yaoguang (Institute of High Energy Physics); Mr CHEN, Yuanbai (Institute of High Energy Physics); Ms LI, Zhe (Institute of High Energy Physics)

**Presenter:** LI, Zhenjie (Institute of High Energy Physics)

Session Classification: Mikrosymposium 4/1: New Detector Developments

Track Classification: 4. New detector developments