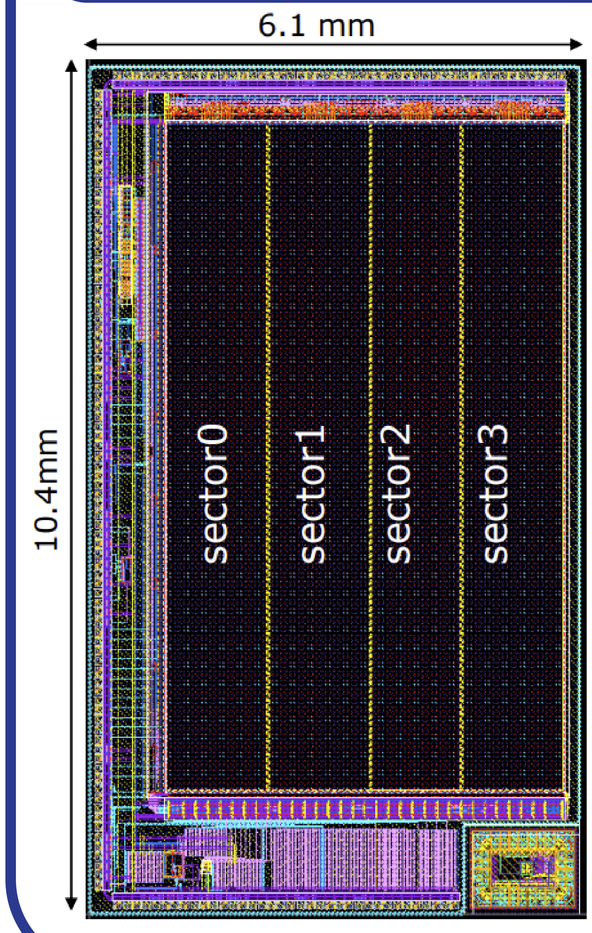
JadePix-3 Beam Telescope

The Developments and Recent Measurements

Abstract: JadePix-3 is a full-featured, large-size detector chip designed on the TowerJazz CIS 180nm process. The toroidal positron collider (CEPC) has extremely high technical requirements for vertex detector performance, and JadePix-3 focuses on spatial resolution, power consumption, and other parameters that have an important impact on CEPC vertex detector performance. The beam telescope is a high-precision particle track detection system and an important test tool for testing and developing high-performance detectors. JadePix-3 has reached the top level regarding power consumption and position resolution. A new beam telescope system has been designed based on JadePix-3. The poster will introduce the related contents and show the performance test results of the JadePix-3 beam telescope based on cosmic rays and radioactive sources.

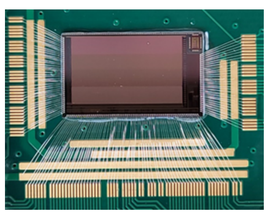
The Sensor



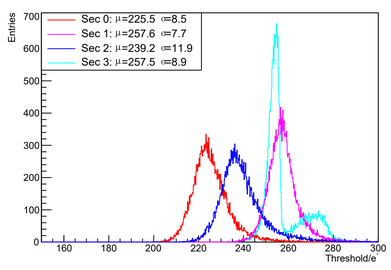
Key parameters:

- Pixel array: 512 rows 192 columns
- Minimal pixel size: 16 x 23.11 um
- Rolling shutter readout: 512 rows x 192ns/row = 98.3 us/frame
- 4 parallel sectors, scalable in z direction

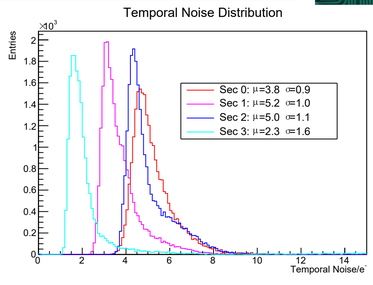
Sector	Diode	Analog	Digital	Pixel layout
0	2 + 2 um	FE_V0	DGT_V0	$16 \times 26\ \mu m^2$
1	2 + 2 um	FE_V0	DGT_V1	$16 \times 26\ \mu m^2$
2	2 + 2 um	FE_V0	DGT_V2	$16 \times 23.11\ \mu m^2$
3	2 + 2 um	FE_V1	DGT_V0	$16 \times 26\ \mu m^2$



Threshold Distribution

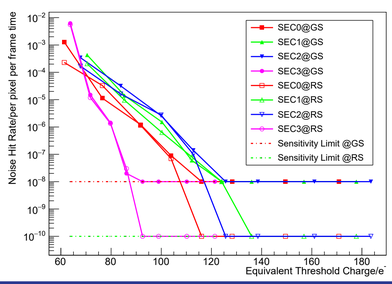


Temporal Noise Distribution

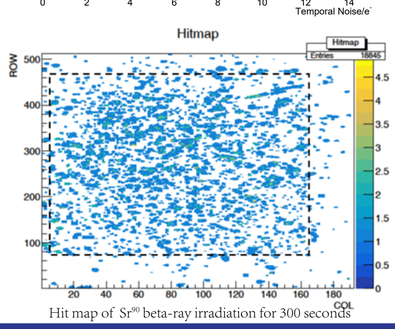


The threshold, Temporal Noise, and Noise hit rate have been tested and verified via electronic pulse test, i.e. s-curve scan based on global shutter, or long-time rolling shutter scan.

Noise Hit Rate

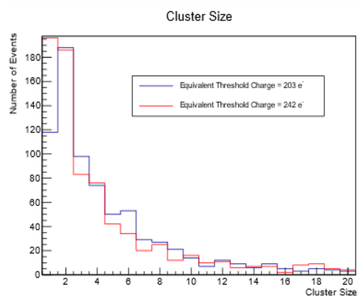


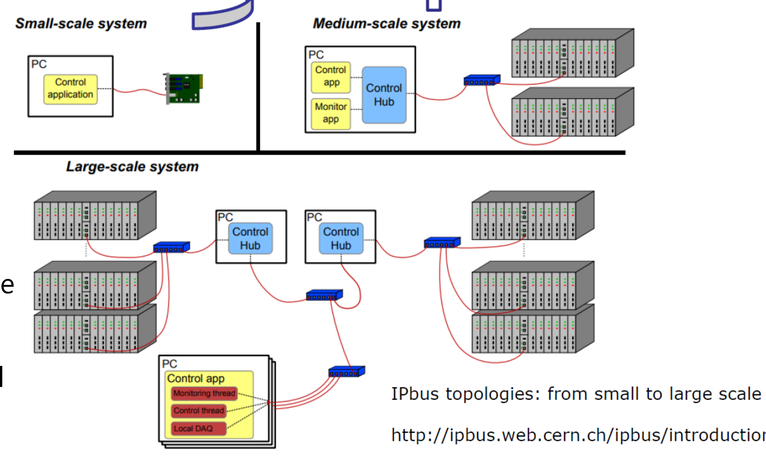
Hitmap



Hit map of Sr^{90} beta-ray irradiation for 300 seconds

Cluster Size

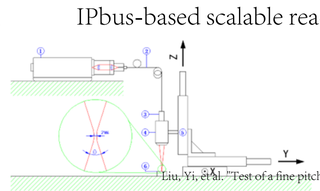




IPbus topologies: from small to large scale

http://ipbus.web.cern.ch/ipbus/introduction/

IPbus-based scalable readout system

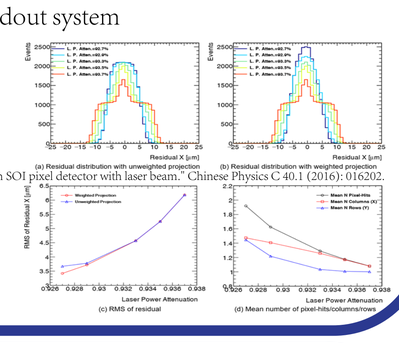


Liu, Yi, et al. "Test of a fine pitch SOI pixel detector with laser beam." Chinese Physics C 40.1 (2016): 016202.

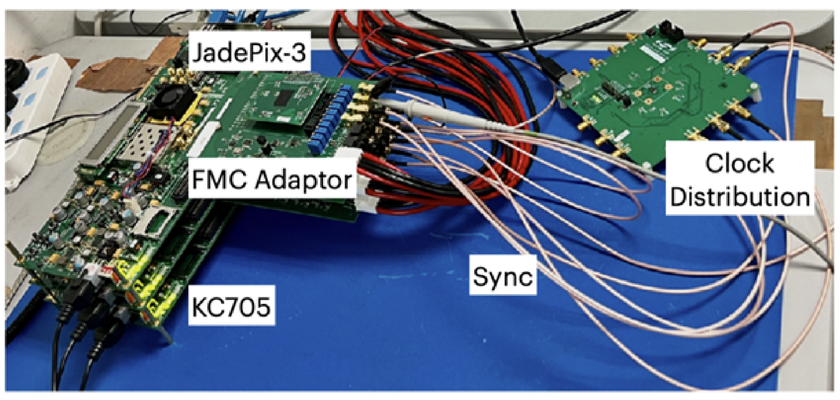
Laser test setup for spatial resolution verifying.

X: 6.2 to 3.4 μm

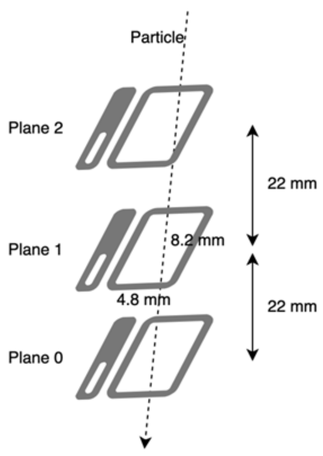
Y: 2.7 to 4.4 μm



The telescope



Prototype of Jadepix-3 beam telescope with 3 planes.

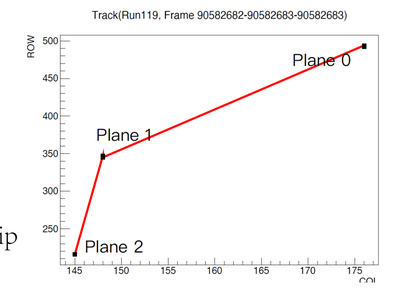


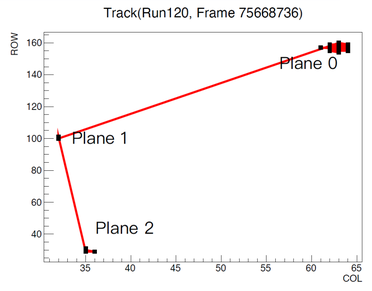
Tracks hit 3 planes displayed

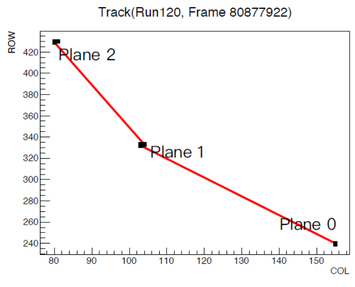
- 2.5 hours / run

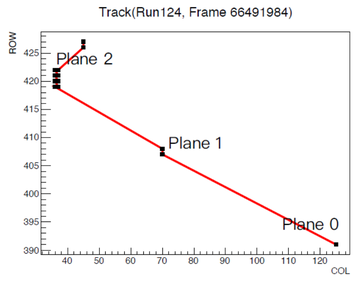
Sources of position offset

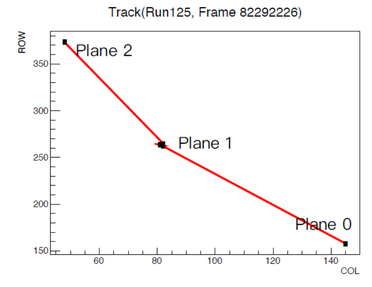
- Gluing of chips manually
- Different pitch on sector 2
- Thick protective cover on the chip

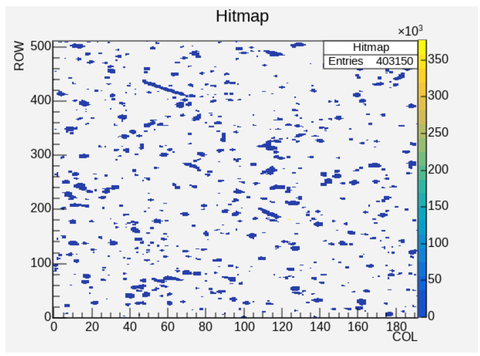










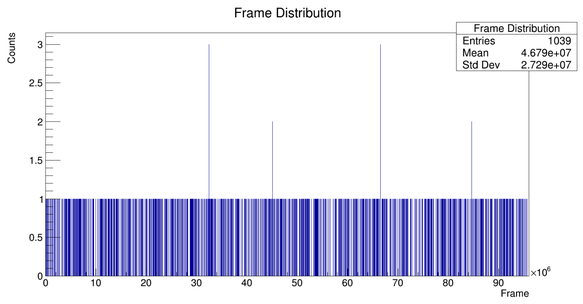


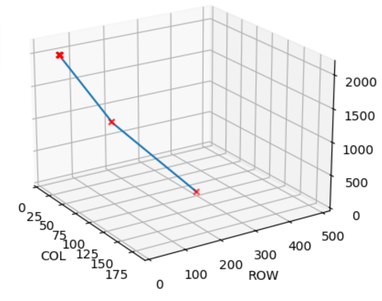
Hitmap of a typical run(run 153, plane 0)

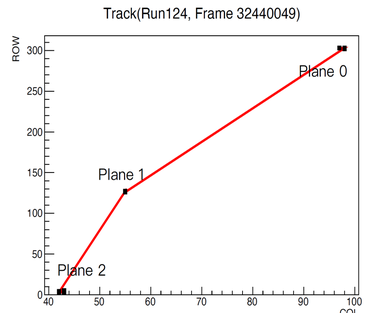
96 M frames scan in 160 minutes for a typical run

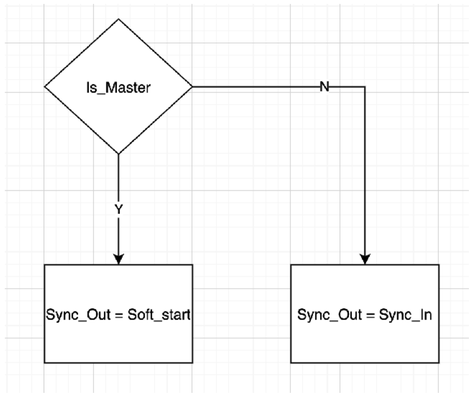
- 1063 frames recorded with single plane hit
- 2 frames recorded with 2 planes hit
- 2 frames recorded with 3 planes hit

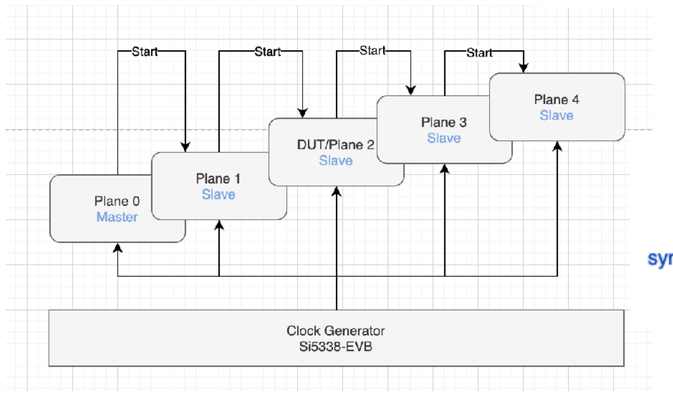
Hit rate 5.7/cm²/min



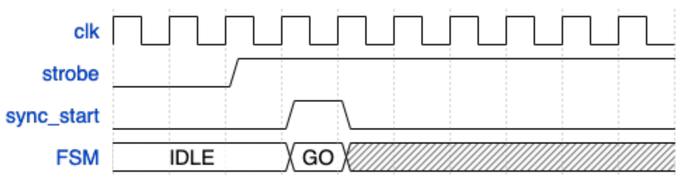


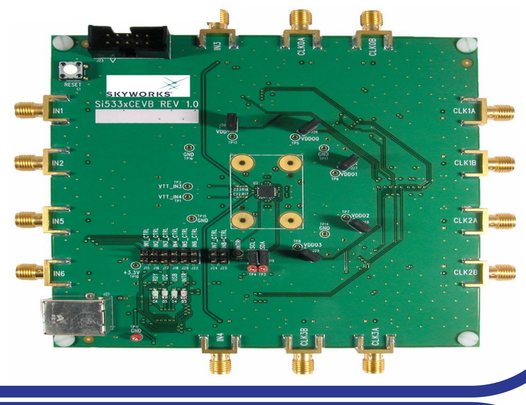






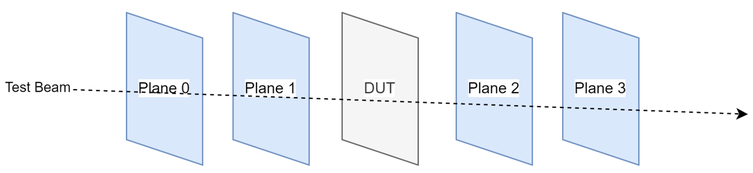
- Daisychain sync signal
- Sync clock via clock distribution board





The future

1. To complete the integration of 5 detector planes
2. Trigger information： Plastic scintillator + SiPM
3. Corryvreckan software for track reconstruction and analysis
4. Beam test @ Dec.2022 @ Desy



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