



# Latest results of a monolithic active pixel sensor prototype for the CEPC vertex detector

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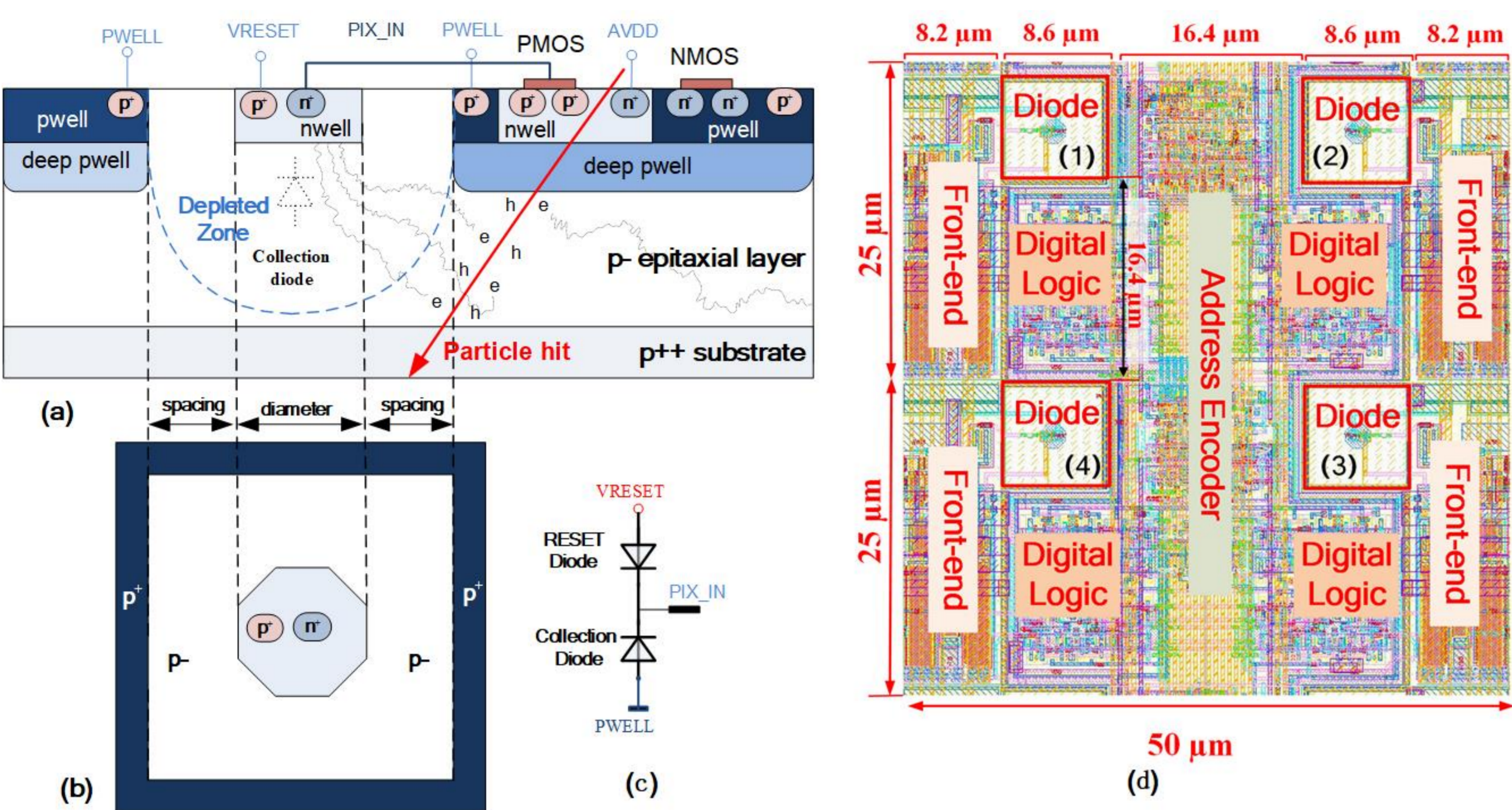
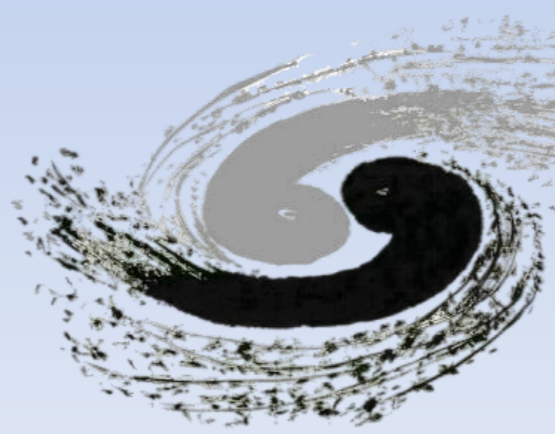


Fig. 1 Cross section(a), top view(b), RESET schematic(c) and four adjacent pixels (d) of TaichuPix2.

## Spatial resolution verification with infrared laser beam

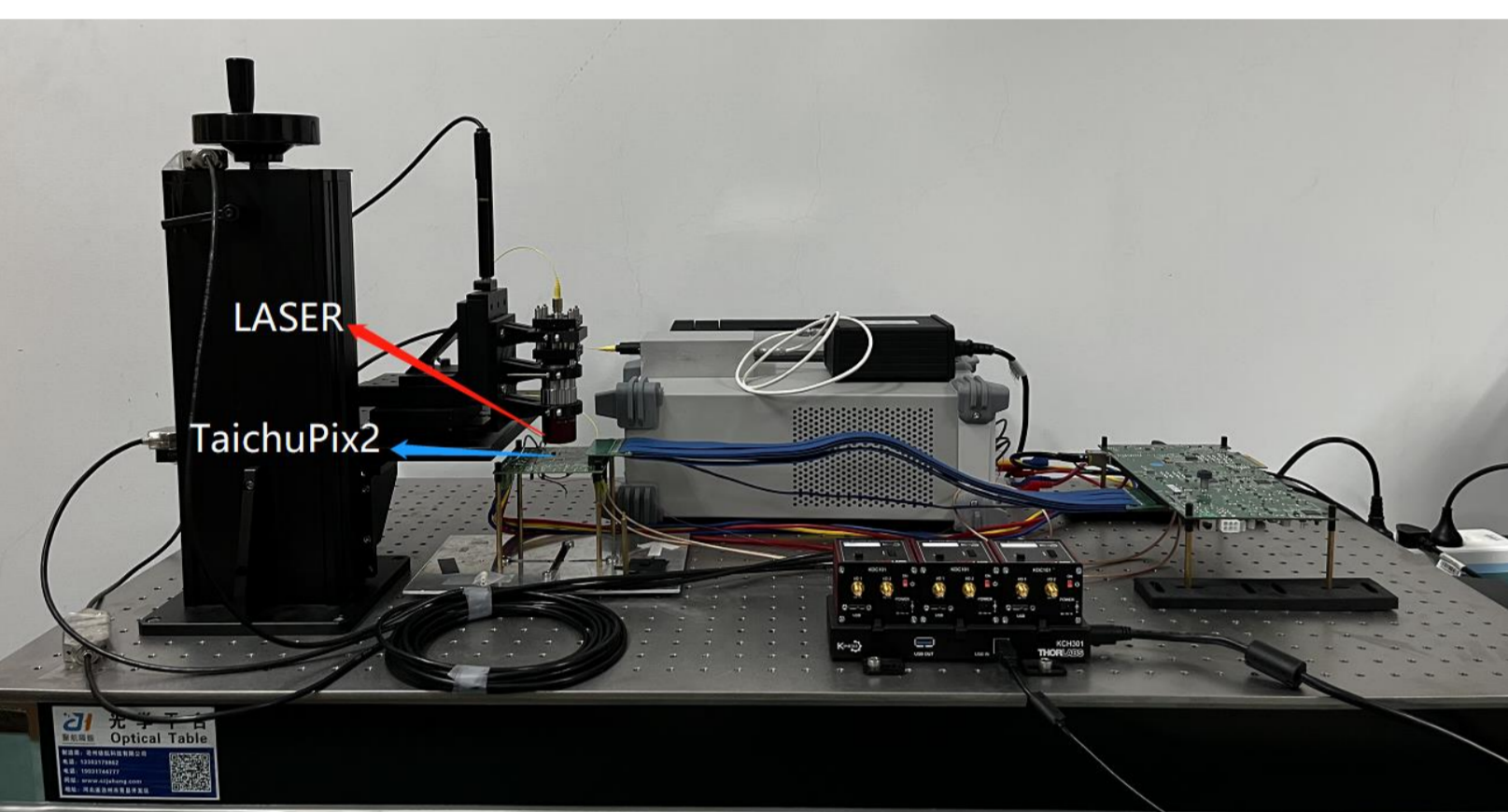


Fig. 7 3-D translation stage with laser diode

### Set up:

- 1064 nm laser diode, efficient spot size of  $1\sim 4\ \mu\text{m}$
- 3-D translation stage with movement of  $1\ \mu\text{m}$
- Scans with  $200\ \mu\text{m}$  random lines on the chip

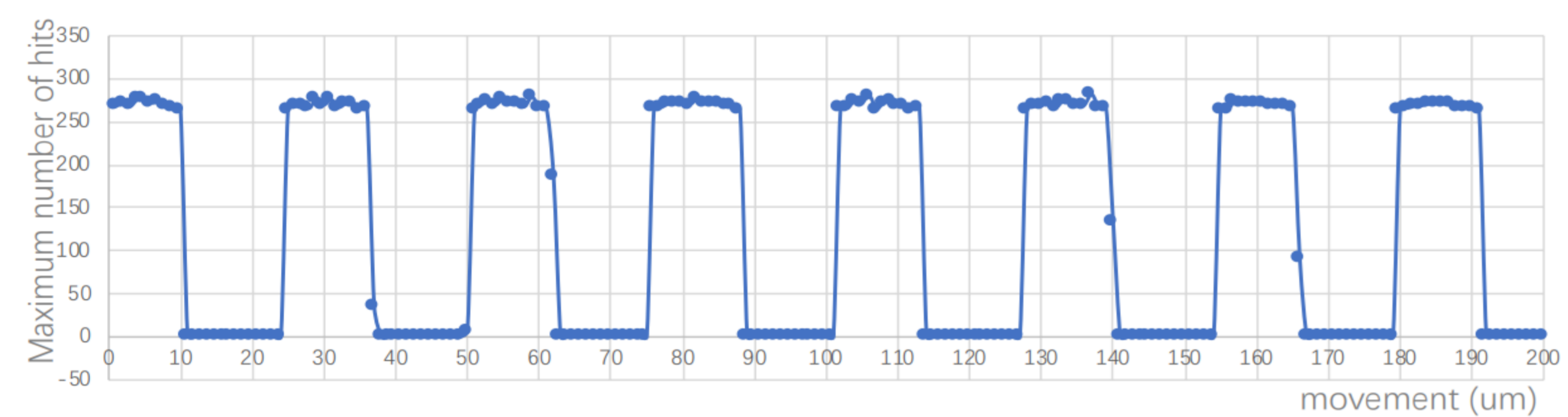


Fig. 8 Observed signal hits corresponding to the laser movement

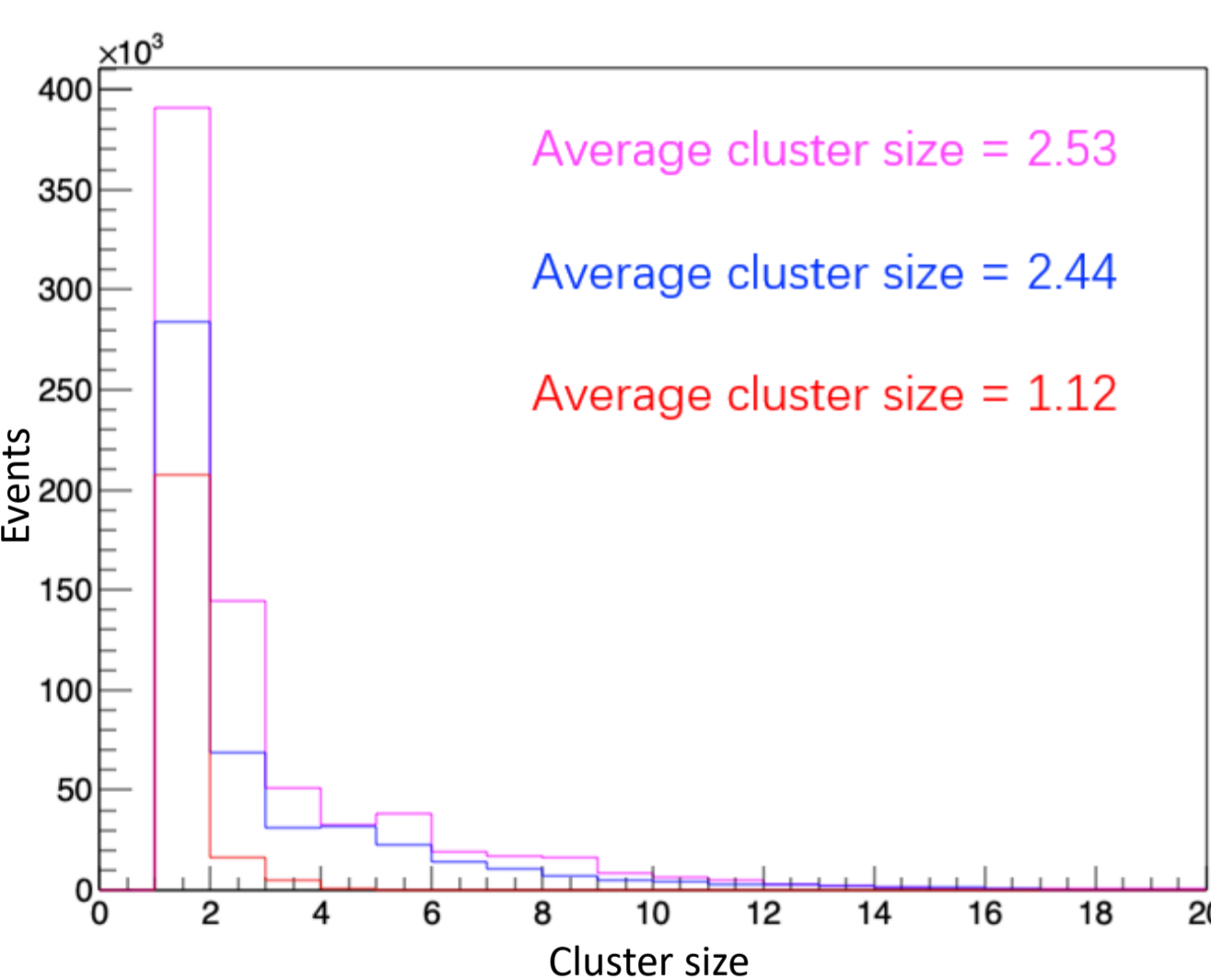


Fig. 9 Cluster size with different laser intensity

- Expected X,Y computed by a linear fit of the observed ones
- Resolution defined as the  $\sigma$  of Gaussian fit to the residual X,Y
- Measured resolutions are  $6.13 \pm 0.2$  for X and  $5.98 \pm 0.19$  for Y

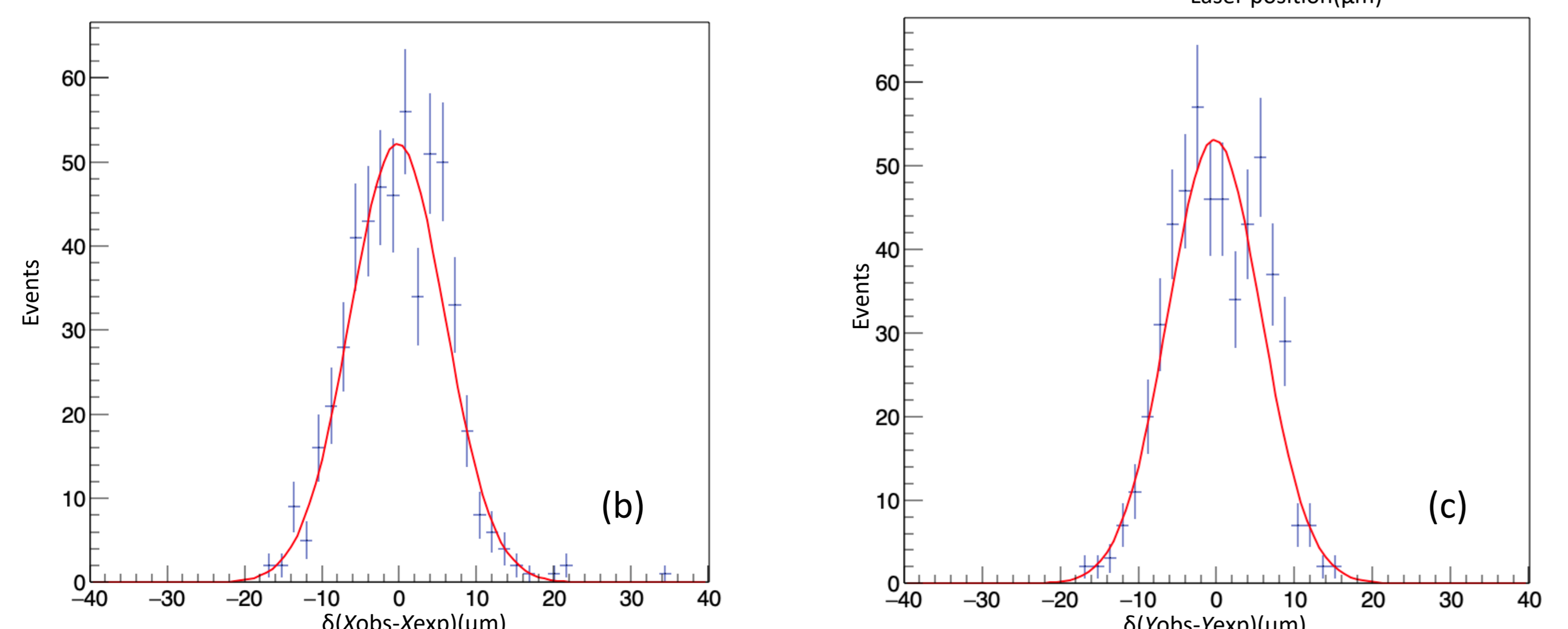


Fig. 10 Observed and expected X w.r.t the stage movement(a). Residual X (b) and Residual Y (c) with Gaussian fit applied.

A Monolithic Active Pixel Sensor (MAPS) prototype, called TaichuPix, based on a data-driven structure and a column drain readout architecture, has been designed for the Circular Electron Positron Collider (CEPC) vertex detector.

- High resolution, low material, fast readout and low power
- Latest results of radioactive source test on TaichuPix
- First verification of the spatial resolution with an infrared laser beam

## Fully functional characterization with a radioactive source



Fig. 2 A Setup of the beta source (including a DC power supply, KC705 FPGA Kit, wire bonding board, etc.)

### Set up:

- Chip size:  $5 \times 5\text{mm}^2$
- Pixel size:  $25 \times 25\ \mu\text{m}^2$
- TaichuPix2 chip includes a matrix of  $192 \times 64$
- Beta source: Strontium-90,  $54\text{MBq} (\pm 15\%)$ ; disk source;  $5 \times 10^6\ \text{nps} (\pm 50\%)$

Long one-bit register chain implemented for masking noisy pixels

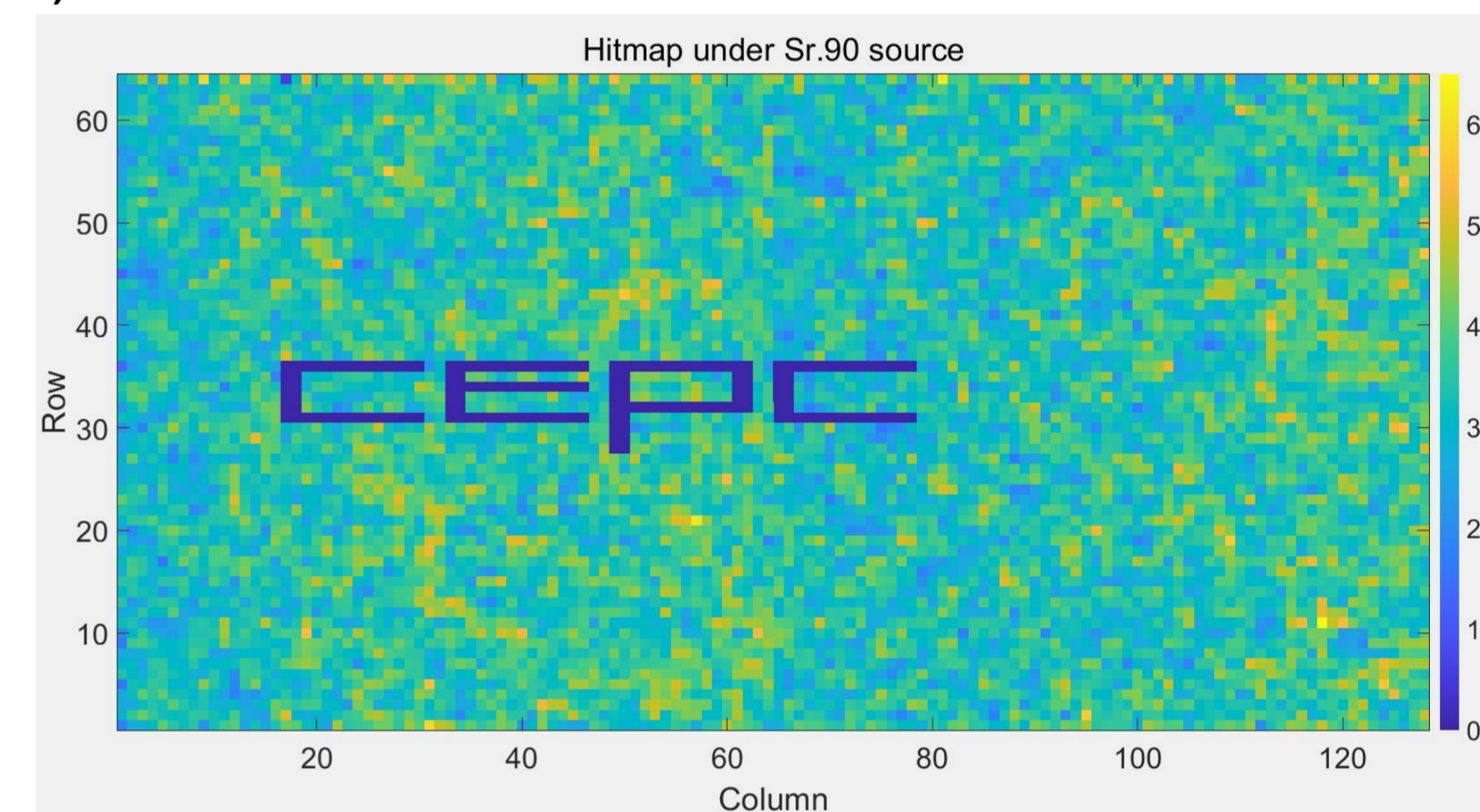


Fig. 3 A hit map with a shielding "CEPC" region

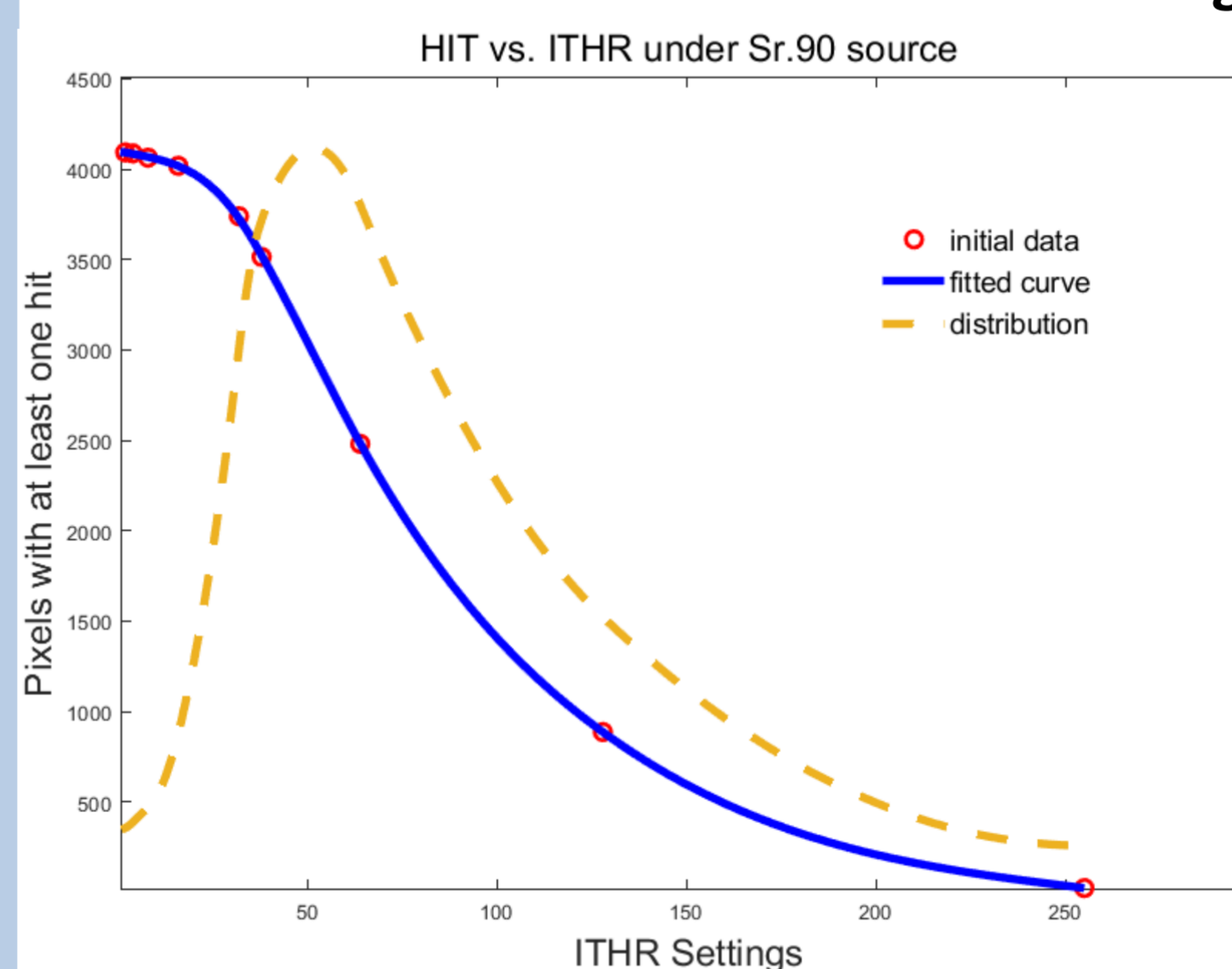


Fig. 4 A fit curve of hits to different ITHR values

- ITHR is an 8-bit register, the larger value of ITHR leads to a higher threshold.
- A Landau distribution was obtained after differentiating the fit curve.
- To several pixels, the output of the pre-amplifier can be measured, and the peaking time of waveforms is less than  $500\ \text{ns}$ .
- The timewalk distribution shows a value of  $60\ \text{ns} \sim 80\ \text{ns}$ .

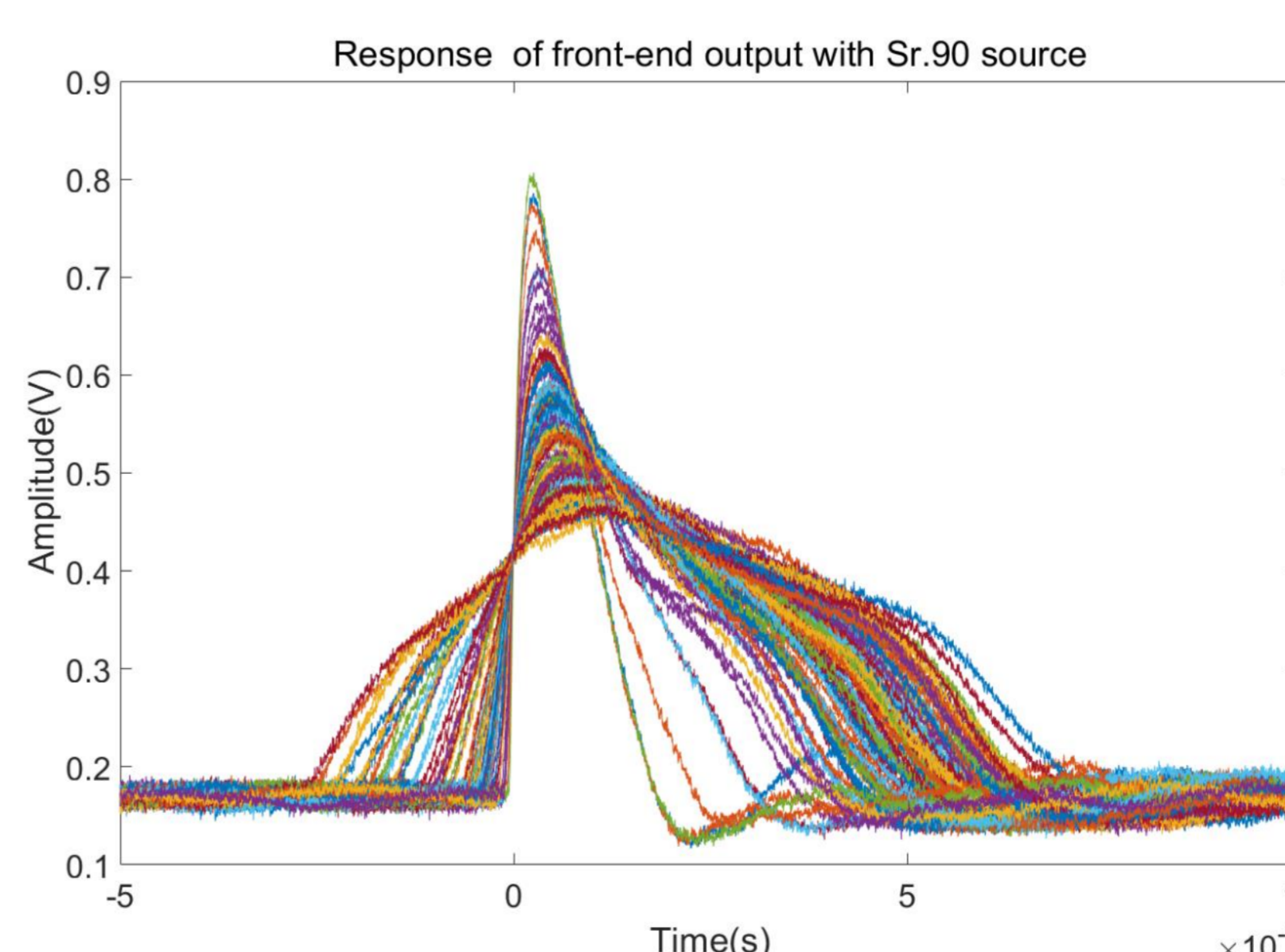


Fig. 5 Response of a pixel to electrons from a  $^{90}\text{Sr}$  source, measured by an oscilloscope.

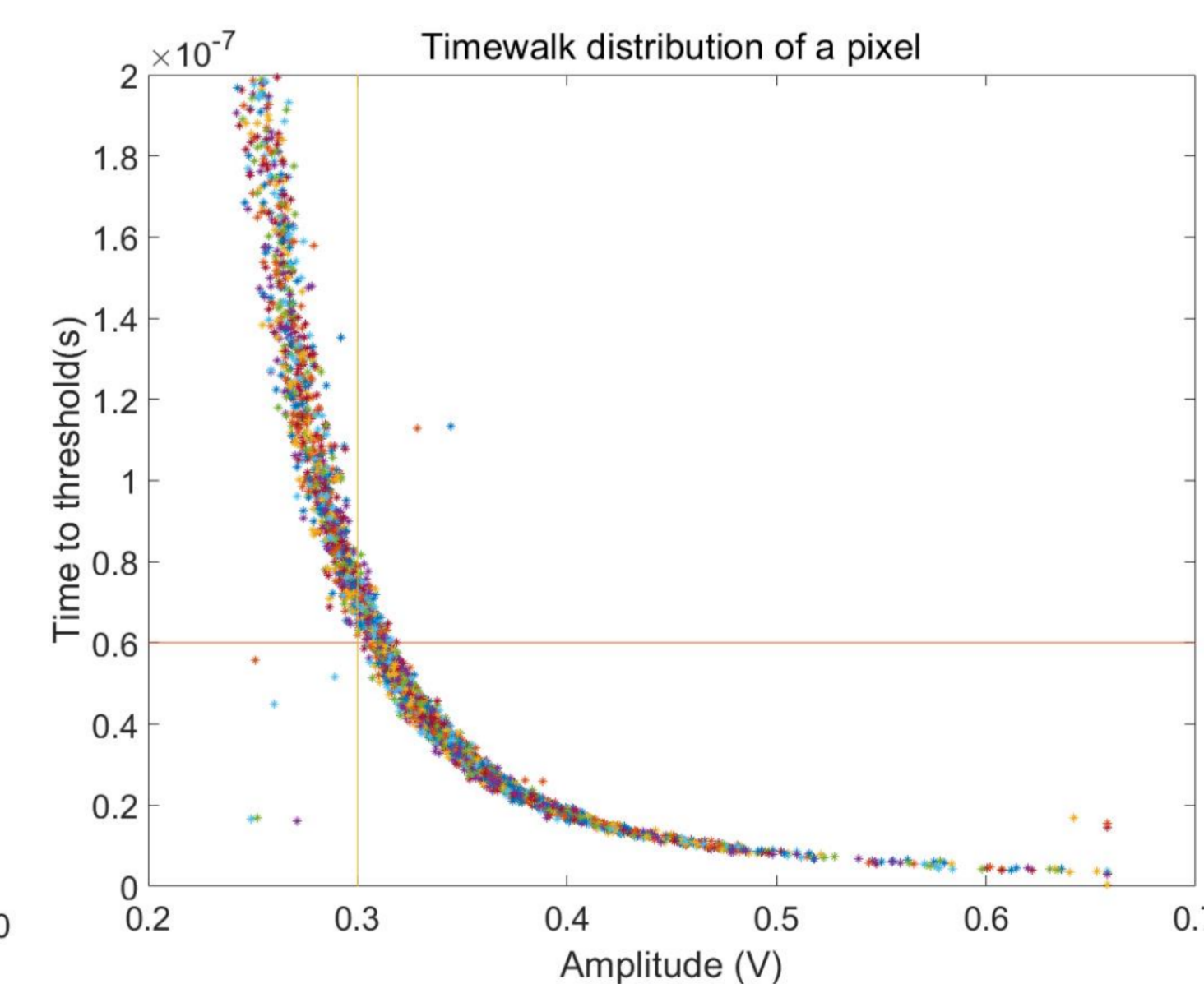


Fig. 6 Timewalk obtained from  $^{90}\text{Sr}$

## Summary and Outlook

This poster presents the latest charge collection performance of TaichuPix2 by using a radioactive source. A 3-D translation stage with an infrared laser system was used to verify the spatial resolution, which indicates a spatial resolution of approximately  $6\ \mu\text{m}$ . A further optimized prototype, TaichuPix3, is ready for the test. More results will be obtained with these setups soon.