Updates from the SoLID-GEM Chinese Collaboration

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SoLID Collaboration Meeting
January 8, 2021
JLab

SoLID-GEM Chinese Collaboration

China Institute of Atomic Energy (CIAE)

Lanzhou University

Institute of Modern Physics, CAS (IMP)

Tsinghua University

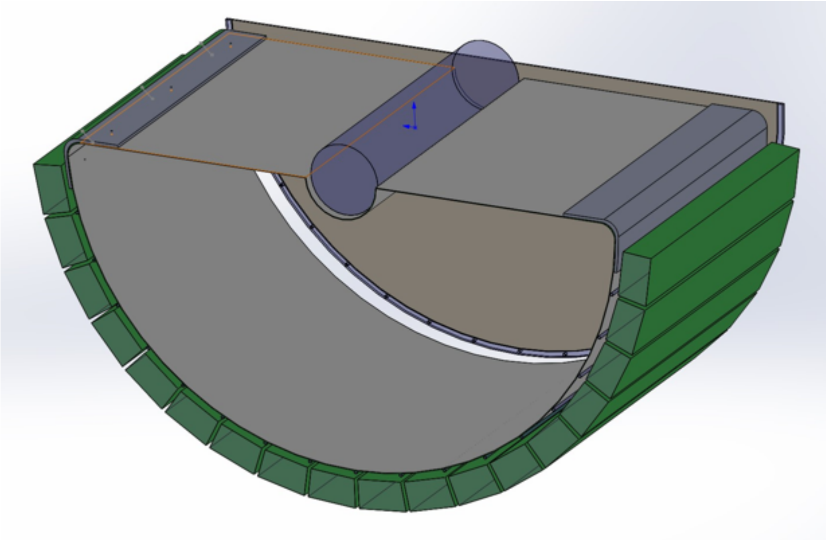
University of Science and Technology of China (USTC)

LZU

Lanzhou University

- Development of a TPC with GEM readout
  - The development of the GEM readout had been completed and was reported at the last collaboration meeting.
  - Development of the TPC is now ongoing

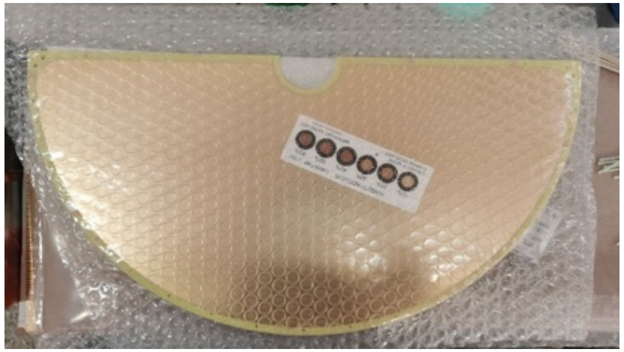
Design and Fabrication

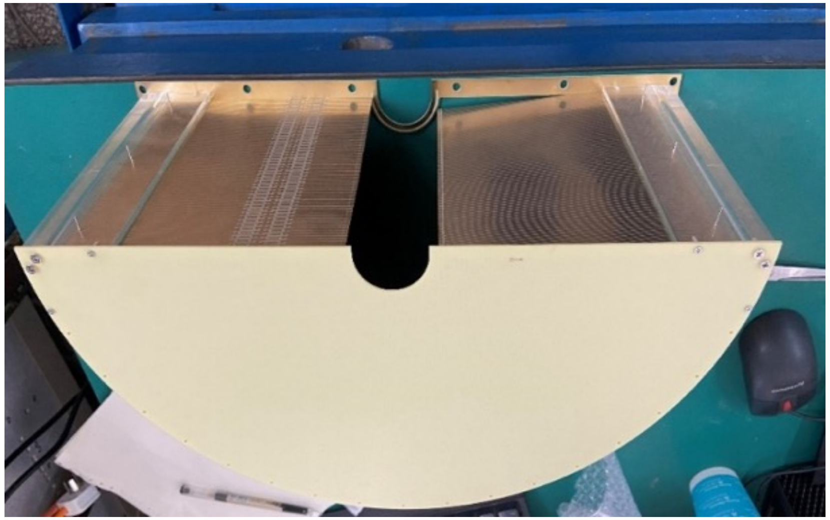


Simulation of electric field uniformity

参考线	偏差最大值/‰	偏差最小值/‰
A	15.7	0.07
B	2.19	0.067
C	5.09	0.17

The TPC prototype in the making

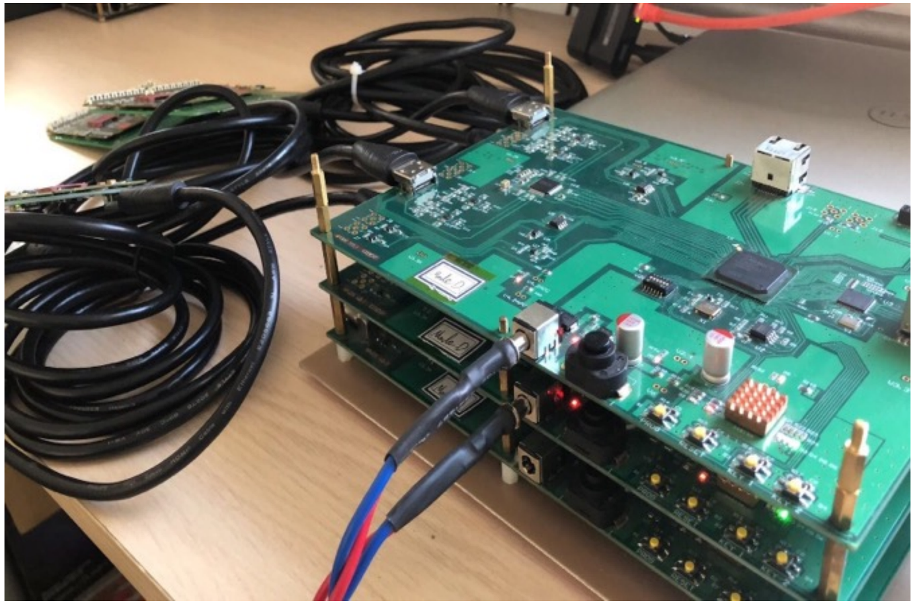




APV25 Electronic and DAQ System Developed by CIAE

The APV25 Electronic and DAQ System uses *APV25* electronics front-end card, *APVDS* electronic digital system and newly developed data acquisition software *GeoAPV.* Both APVDS and GeoAPV are developed by CIAE.

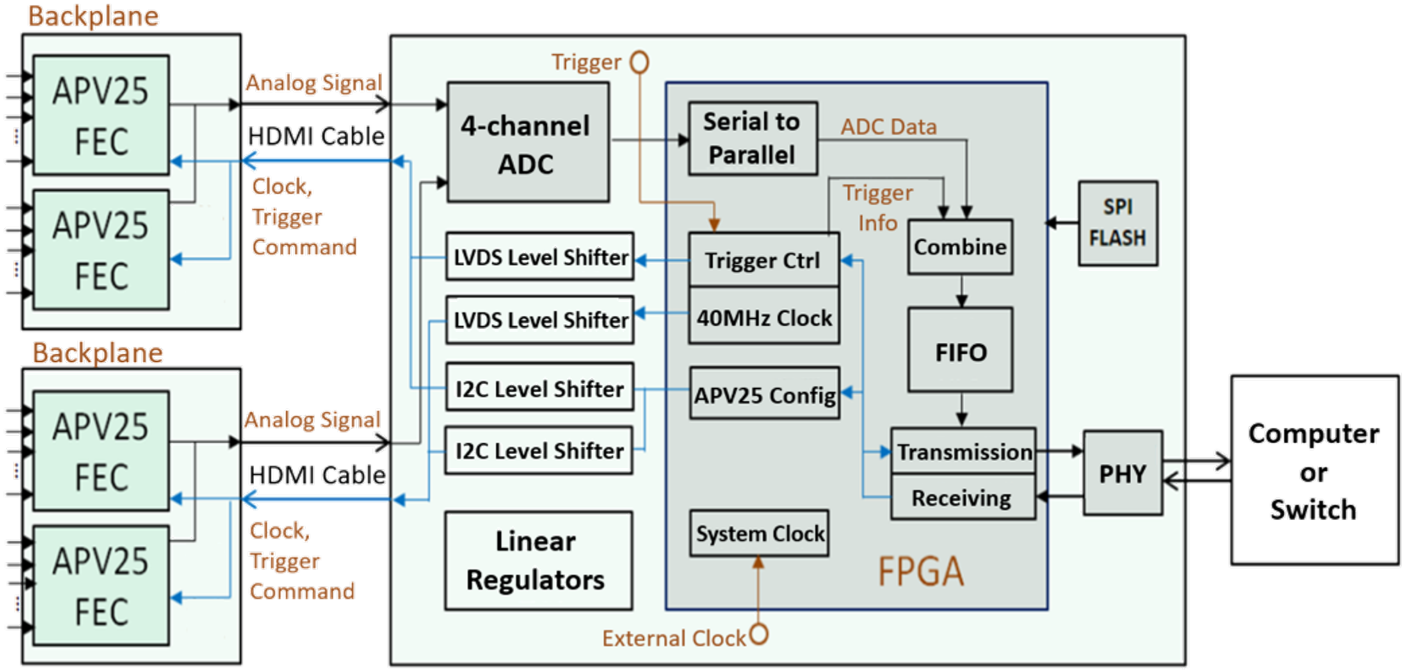
Testing in the configuration of 1,024 channels, internal trigger mode while monitoring the sampling waveform,
the transmission rate can stably maintain 715 Mbps



GeoAPV
CHINA INSTITUTE OF ATOMIC ENERGY

Development of APVDS Electronic Digital System

- **ADC** (ADS5242) +**FPGA** (Spartan 6)
- In 128-channel configuration, the system trigger rate can reach 285 kHz - the upper limit of APV25

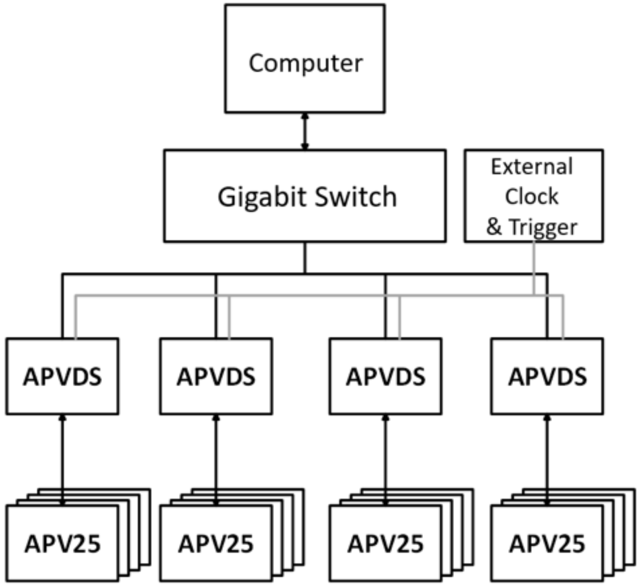


Hardware Integration

Each APVDS digitalization board is capable of processing 512 channels' input.

The whole system uses multiple APVDS board to expand the capacity of the system.

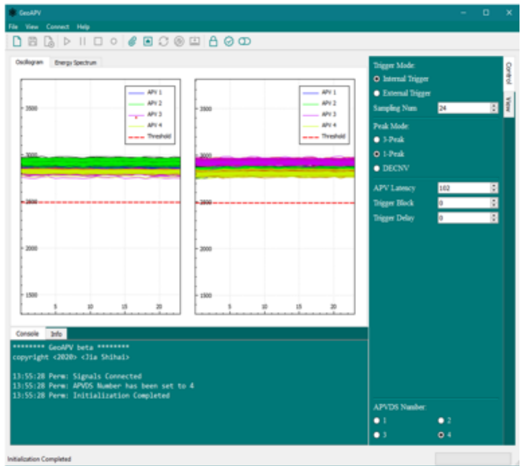
(4 APVDS boards designed; 2 APVDS boards tested)



Every APVDS has an independent IP address and shares a common external clock signal from APVTTS board.

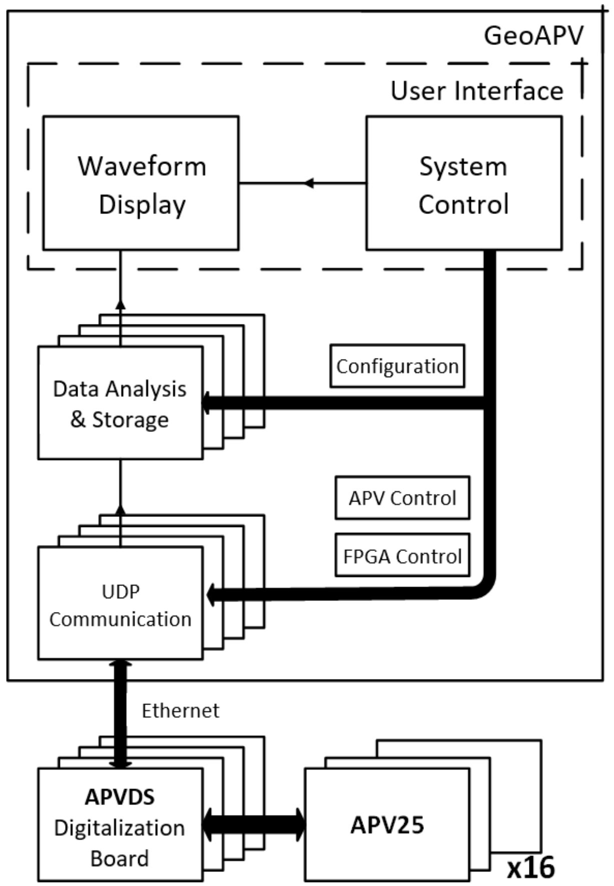
Data Acquisition Software

GeoAPV is developed for APV25 front-end card and APVDS board



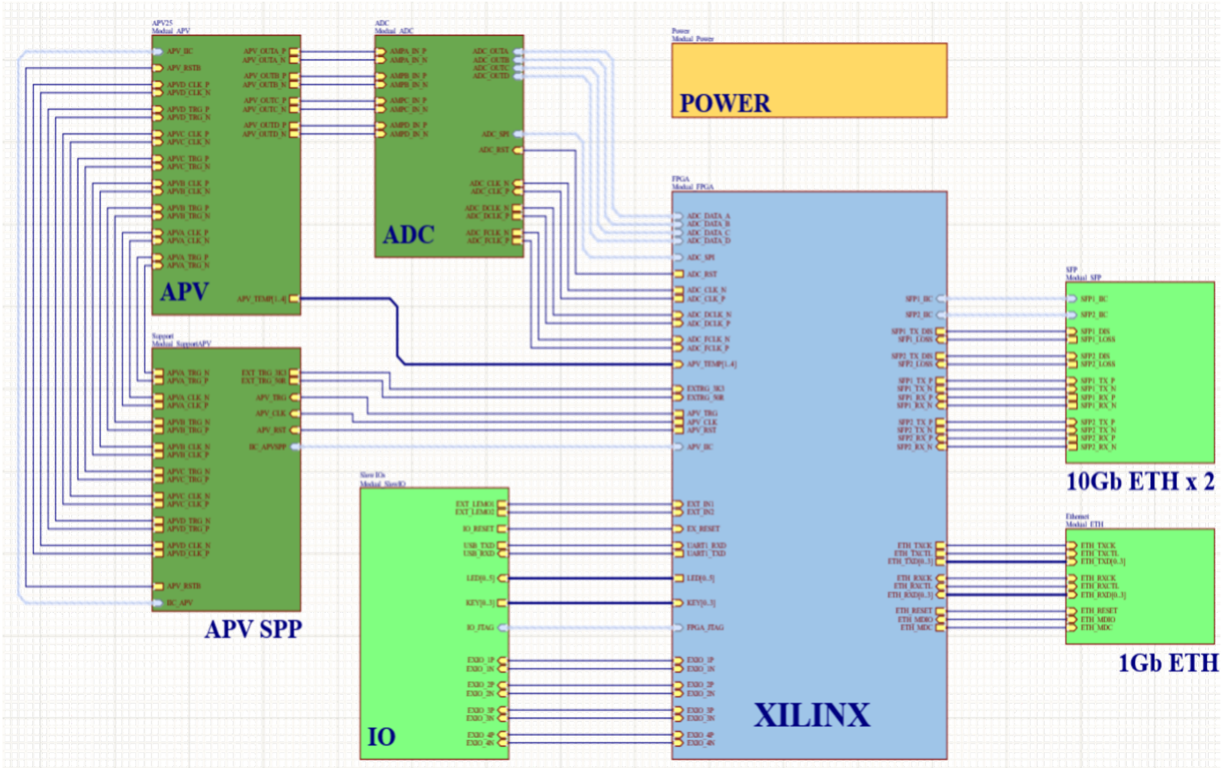
Mainly improved in usability, scalability, and modularity.

It performs intuitive operations, monitors input waveform in real time, and will integrate more functions in the future

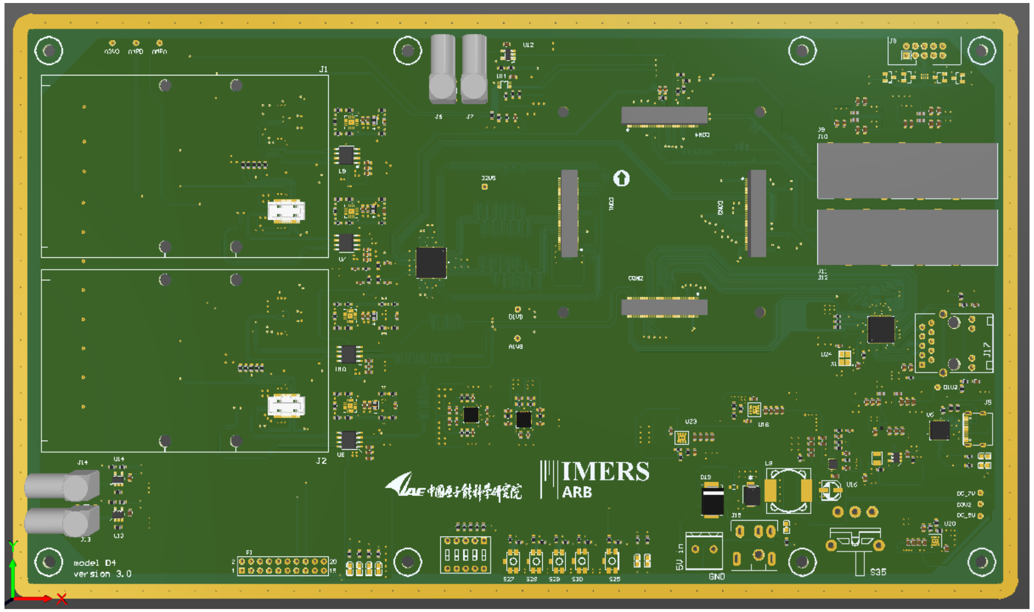


New Design of APVDS Board

- Single 1 Gbps Ethernet gets updated to Dual 10 Gbps Ethernet Ports
- Artix-7 FPGA Chip Provides 188% More Logic Cells
- ADC Analog Bandwidth Improved from 300 MHz to 540 MHz



APVDS v3.0



- 8-layered FR-4 PCB
- Quad Onboard APV25 Connecters
- UART, 1 Gbps Ethernet and 20-pin Extension Port

Version 3.0 focuses on improving the ethernet speed rate, system stability, and versatility. With the help of our new PCB design and choosing state-of-the-art components, we finished the design of the system which is capable of processing up to 4,096 channels of detector signal.

The whole new APVDS is being manufactured, and the first prototype will be tested by the end of 2020.

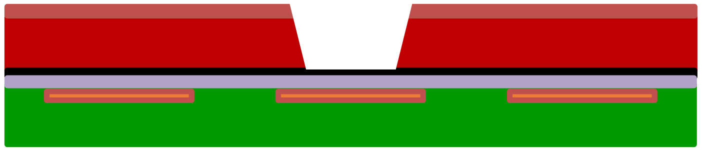
USTC

中国科学技术大学
University of Science and Technology of China

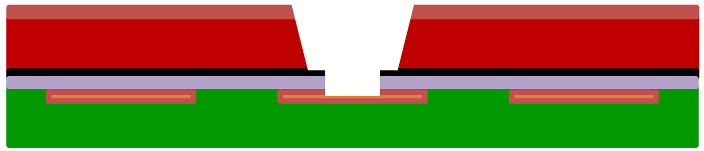
- Cosmic-ray test of high-rate uRWELL detectors

A novel idea to realize high-rate μRWELL

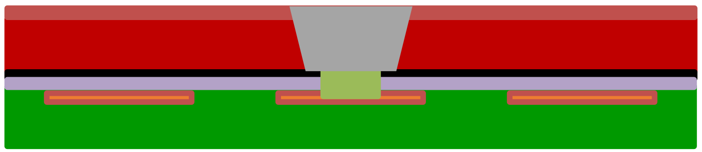
PEDF: Pattern , etch , drill & fill



Step1: Copper & APICAL etching to make a big hole with DLC on bottom.



Step2: Drill a small hole and expose the copper of the readout pad to the air.



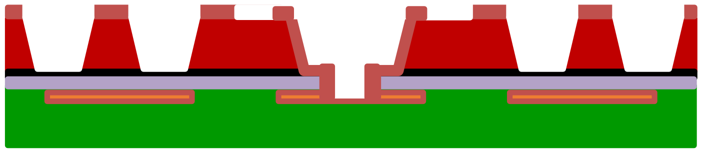
Step3: Connect the DLC to readout pad with silver glue.

Step4: Make μRWELL structure and remove the copper around silver glue.

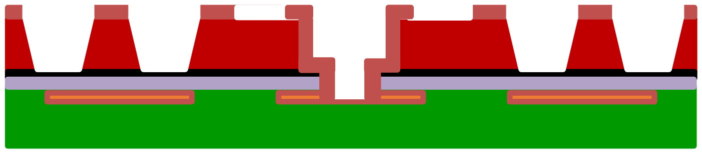
Advantages:

1. No copper-coated DLC needed, so better resistivity control
2. No alignment issue even for large area
3. Larger contact area between DLC and silver glue resulting in better contact between the two.

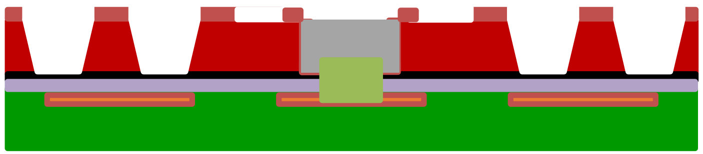
Derivatives: PEDP,DEF,DEP µRWELL



PEDP: Pattern , etch , drill & plate



DEP: Drill , etch & plate



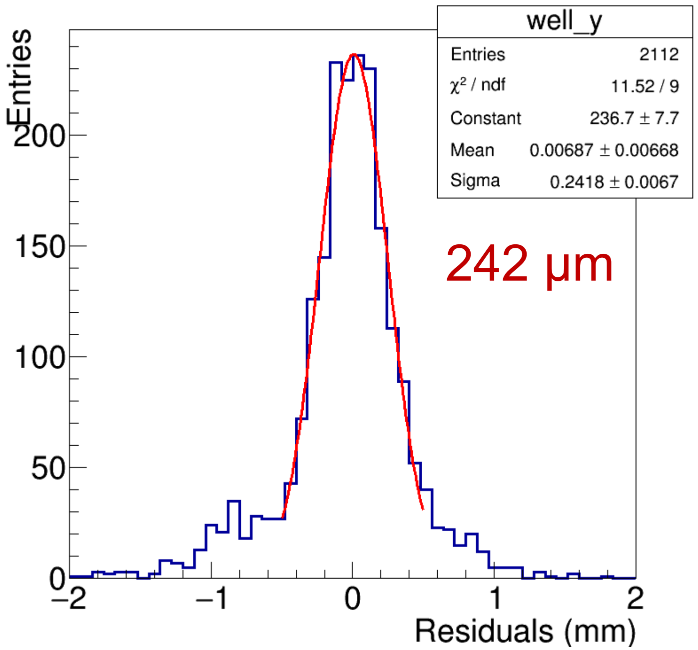
DEF: Drill , Etch & fill

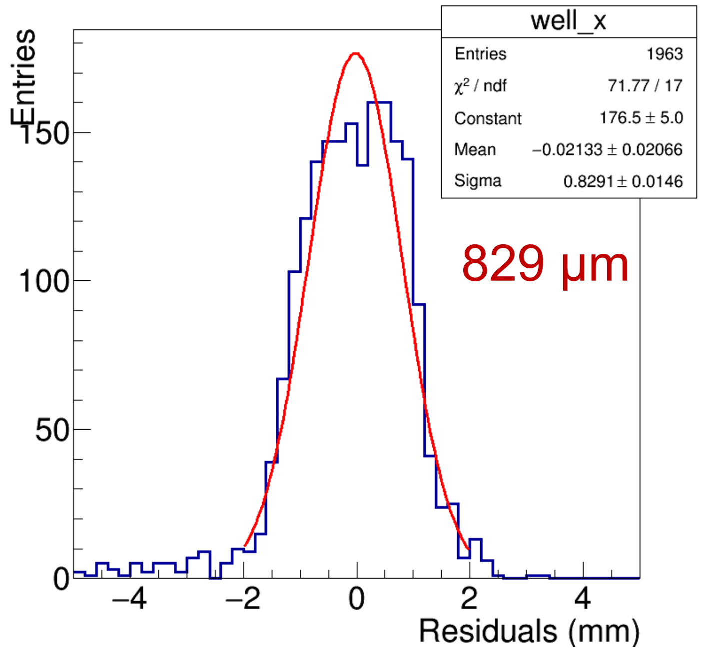
Small-size uRWELL PCB prototypes for the four high-rate options (PEDF , DEF , PDEP , DEP) have been produced at CERN and sent to USTC.

Thanks to Rui De Oliveira and CERN PCB workshop for technical support.

Position resolution

- A cosmic-ray telescope was set up using three GEM detectors with APV25 readout.
- The position resolution of the uRWELL prototype was measured with cosmic rays





Incident angle < 5.7 degree

Position resolution: 240 μm (1mm pitch) and 830 μm (3mm pitch)

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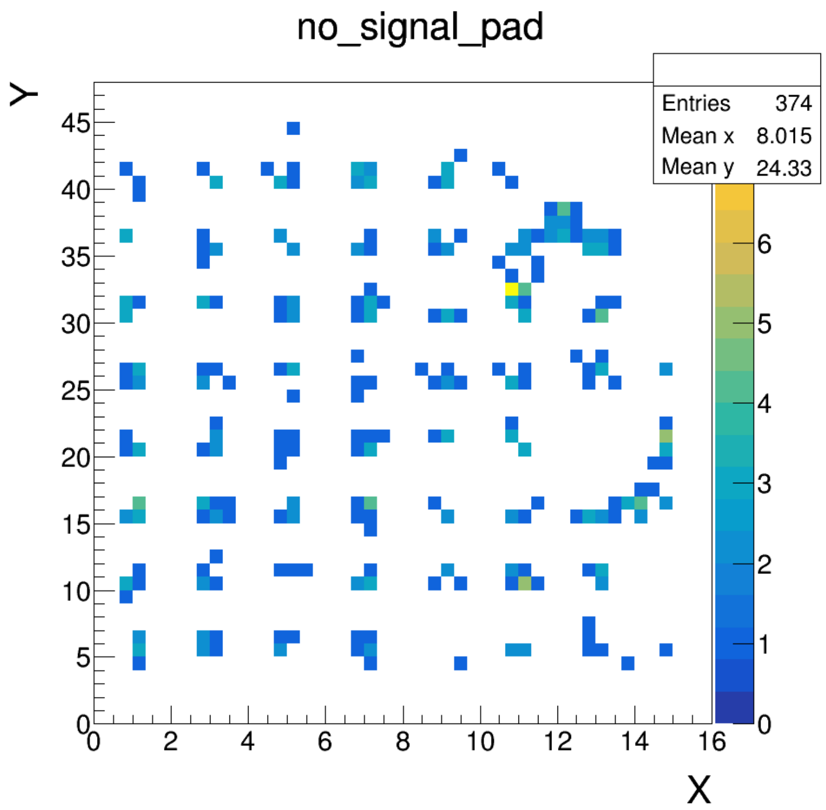
Detection efficiency

Detection efficiency: 95.2% (7858/8251)



Much of the inefficiency comes from the grounding holes (> 2%)