The Test of APV25 Readout System for GEM Detector at CIAE

Siyu Jian(蹇司玉)

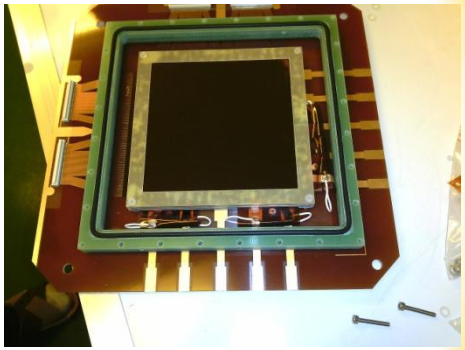
China Institute of Atomic Energy
(中国原子能科学研究院)

outline

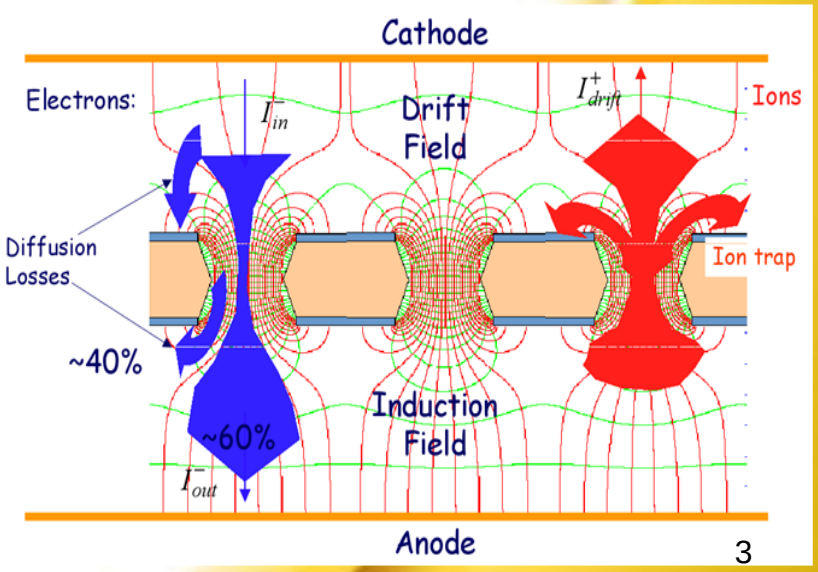
- Brief introduction about GEM and APV readout system.
- Our work in calculating spatial resolution and energy resolution.
- X ray imaging
- summary and plan

Brief introduction about GEM

- **A type of gaseous ionization detector.**
- **used in nuclear and particle physics and radiation detection.**
- **invented in 1997 by Fabio Sauli.**



- **high rate capability;**
- **good localization accuracy;**
- **robustness of operation.**



Brief introduction about GEM and APV readout system

■Reading out method

- ●Parallel strips;
- ●CCD;
- ●Pads array;
- ●CMOS
- ●….

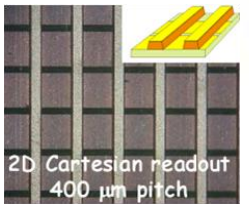
■**Parallel strips:**

simple
cheap
less channels

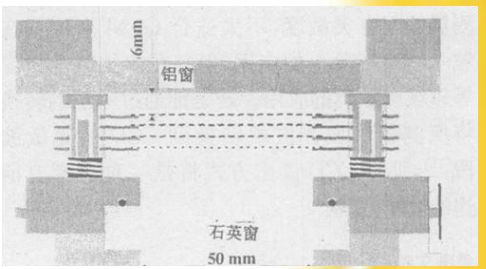
■Still need large quantities of readout channels

100mm/400um=256 channels (each dimension)

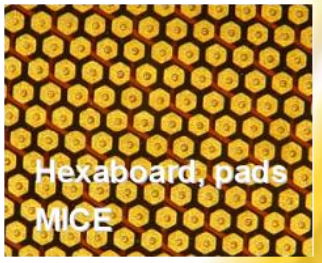
- Parallel strips



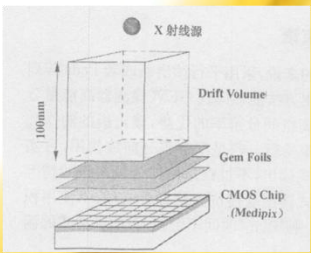
- CCD



- Pads array

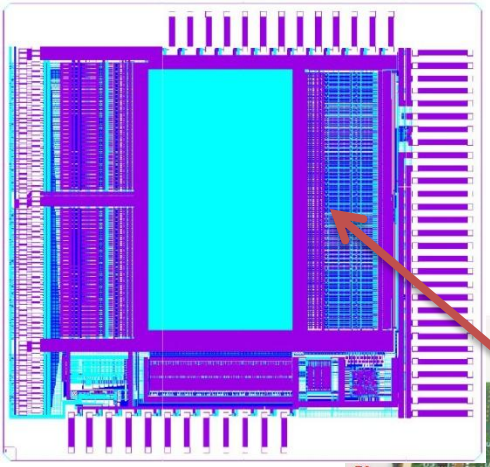


- CMOS

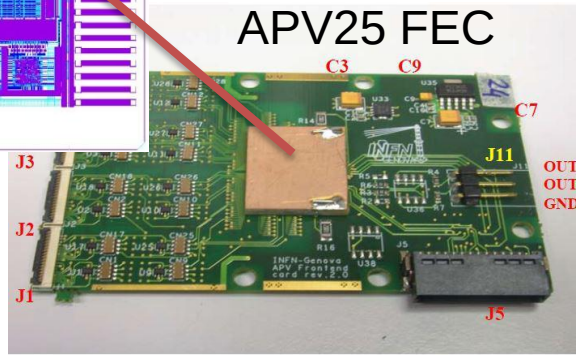


Brief introduction about GEM and APV readout system

APV25 CHIP

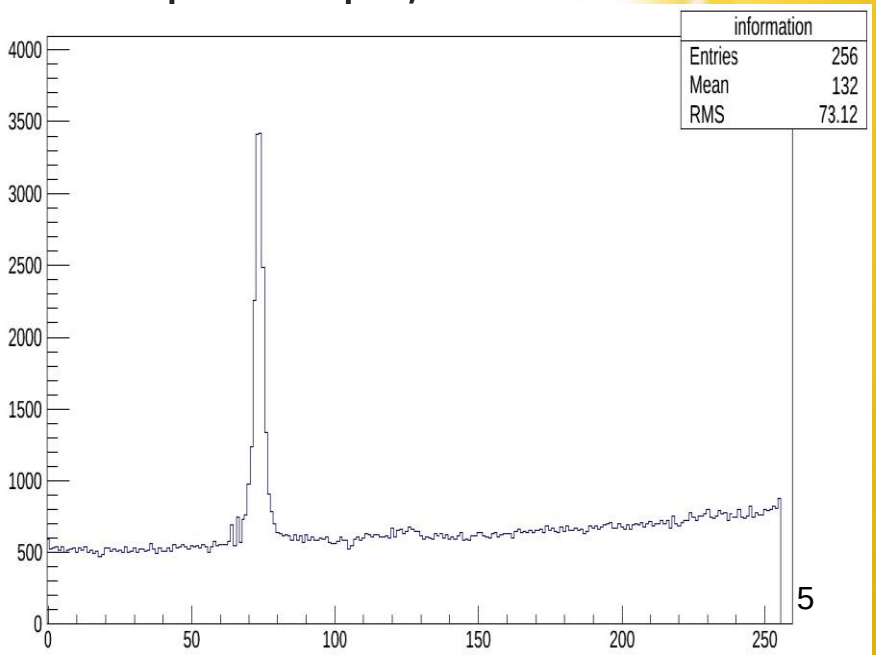


APV25 FEC



- ✓ **128 channel per chip;**
- ✓ **Analog readout better performance;**
- ✓ **Long latency**

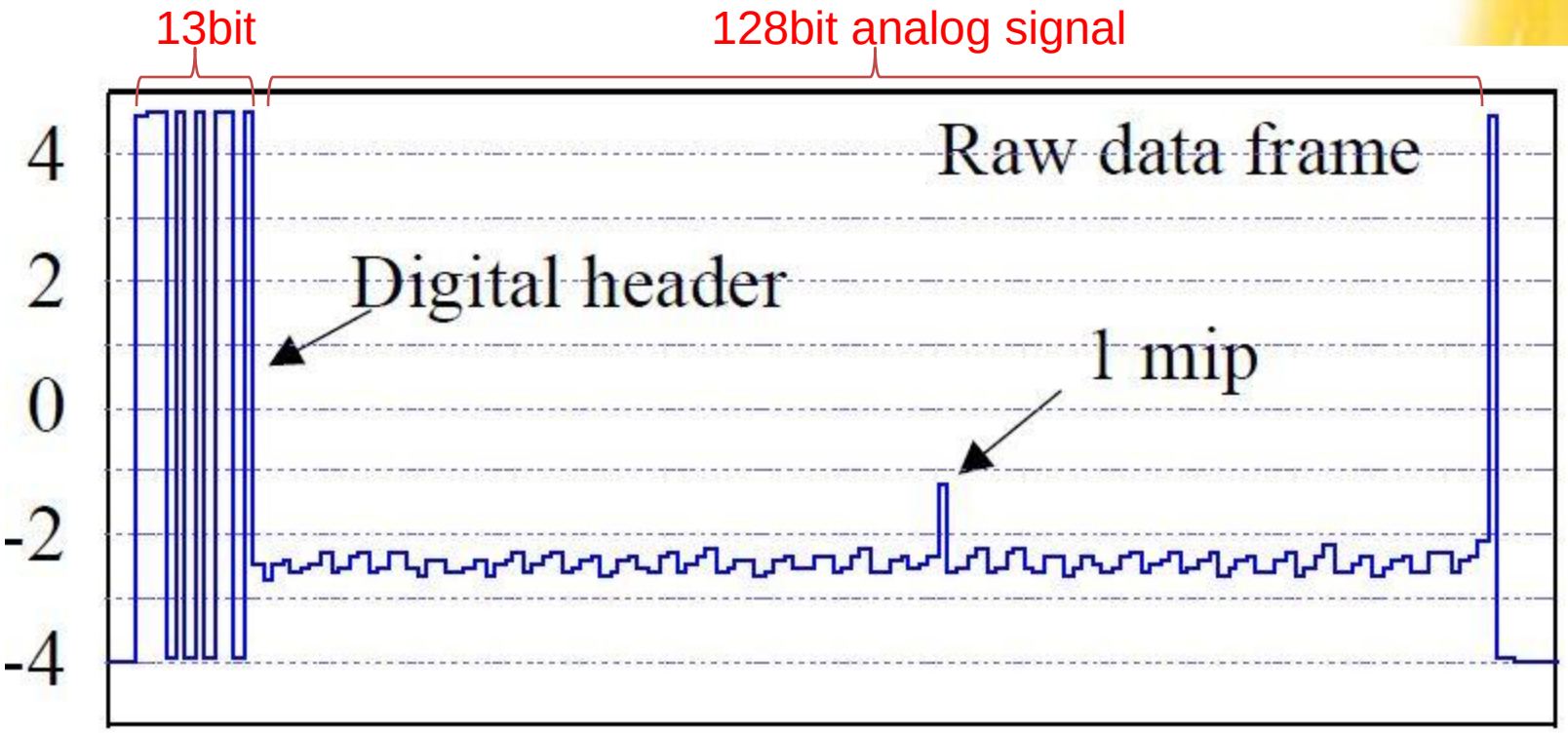
  160 pipeline locations allow for a trigger latency of up to 4 μs;



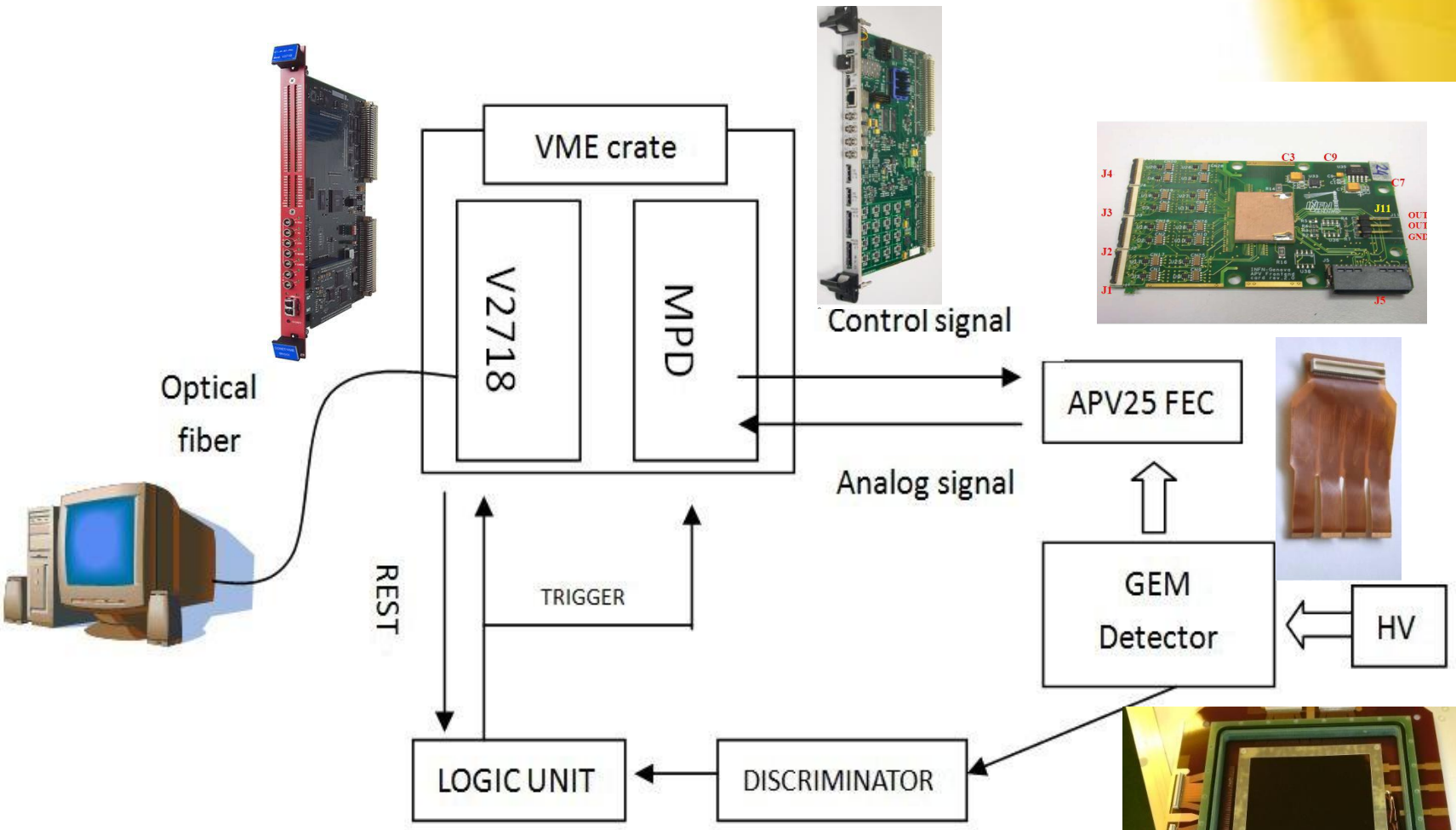
✓**Working at 40MHz frequency.**

Reduce the possibility of Event cascade

- Not appropriate for high rate application
  - Maximum event rate of APV is not very high.
    one frame : 128+12+1=141;
    maximum sample rate
    40MHz/141≈277KHz



The structure of APV readout system

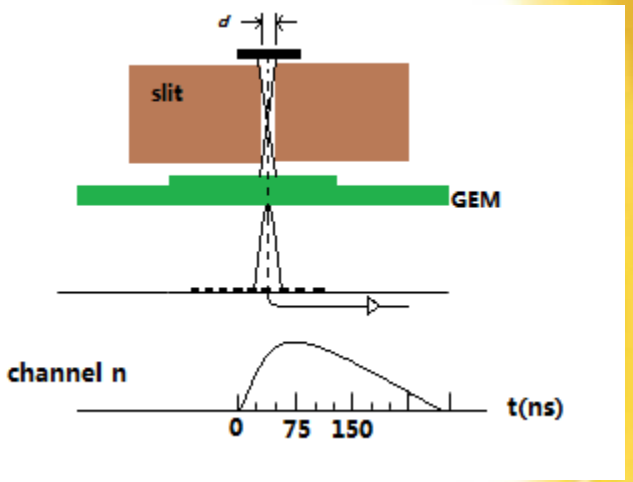


Spatial resolution and energy resolution.

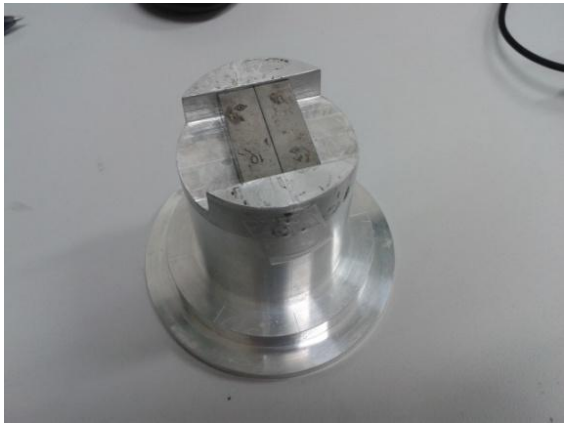
$$\sigma_{tot}^2 = \sigma_{GEM}^2 + c_1\sigma_{geometry}^2$$

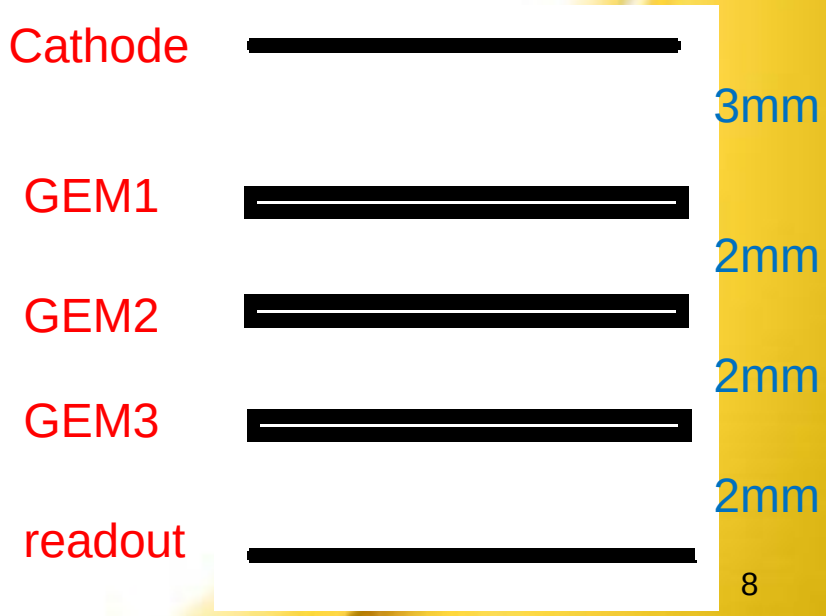
When: $\sigma_{geometry} \ll \sigma_{GEM}$

$$\sigma_{tot}^2 \cong \sigma_{GEM}^2$$



- Slit(um): 20;
- Ar: CO_2=70% : 30%;





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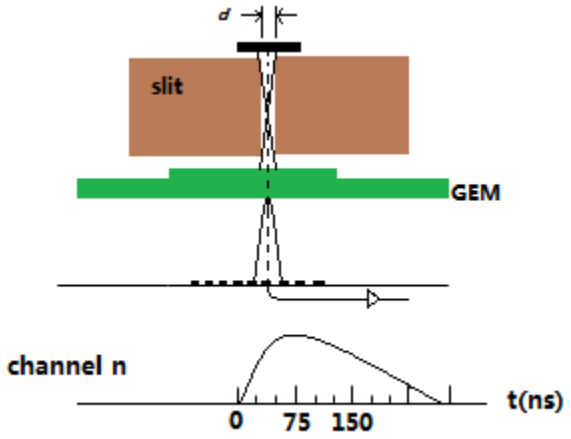
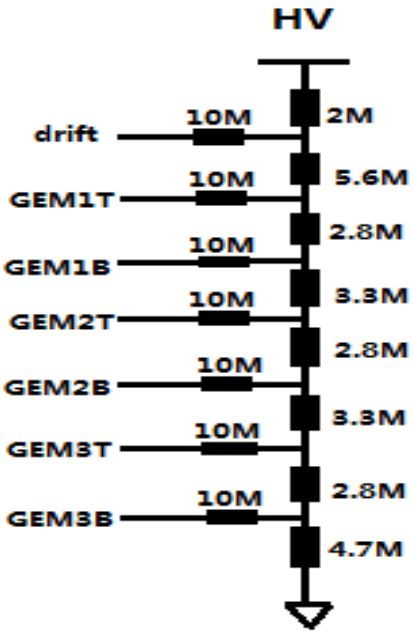


- Slit(um): 20;
- Ar: CO_2=70% : 30%;
- HV: 3600V;



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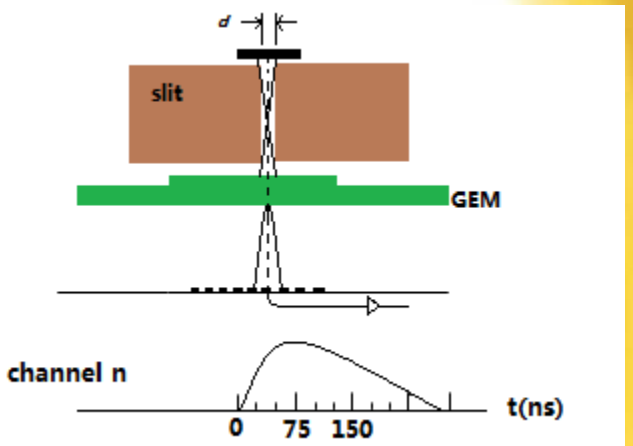
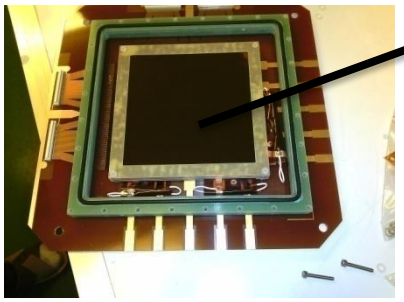
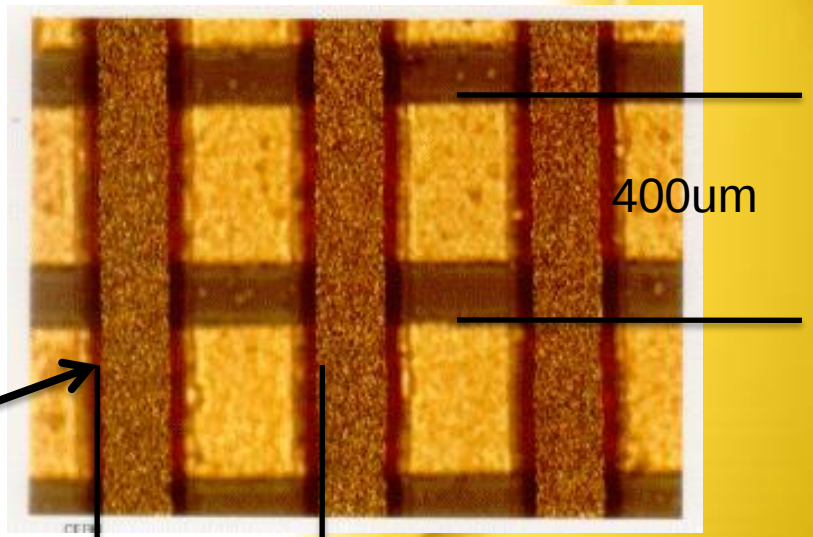


- Slit(um): 20;
- Ar: CO_2=70% : 30%;
- HV: 3600V;
- The distance between strips: 400um;





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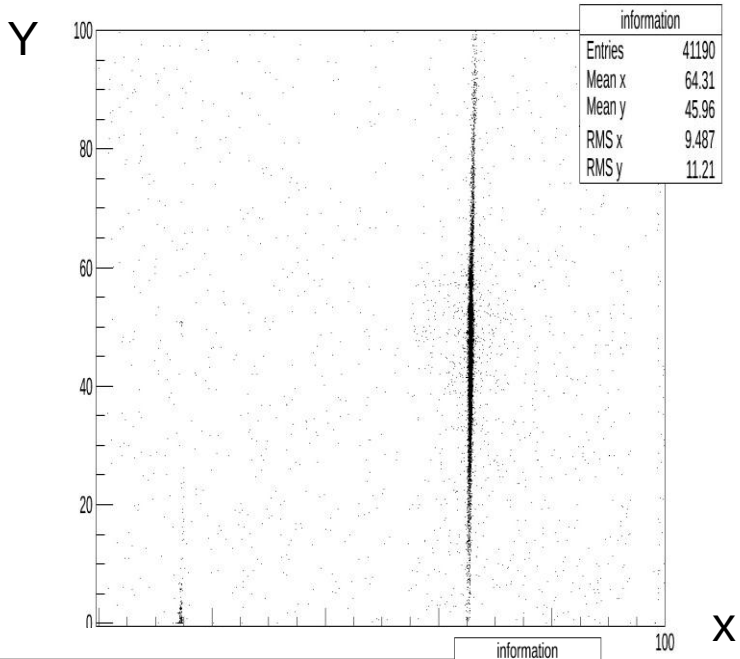
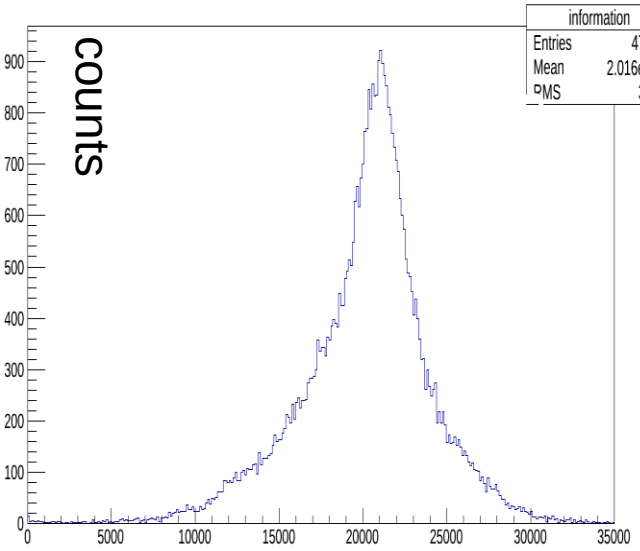
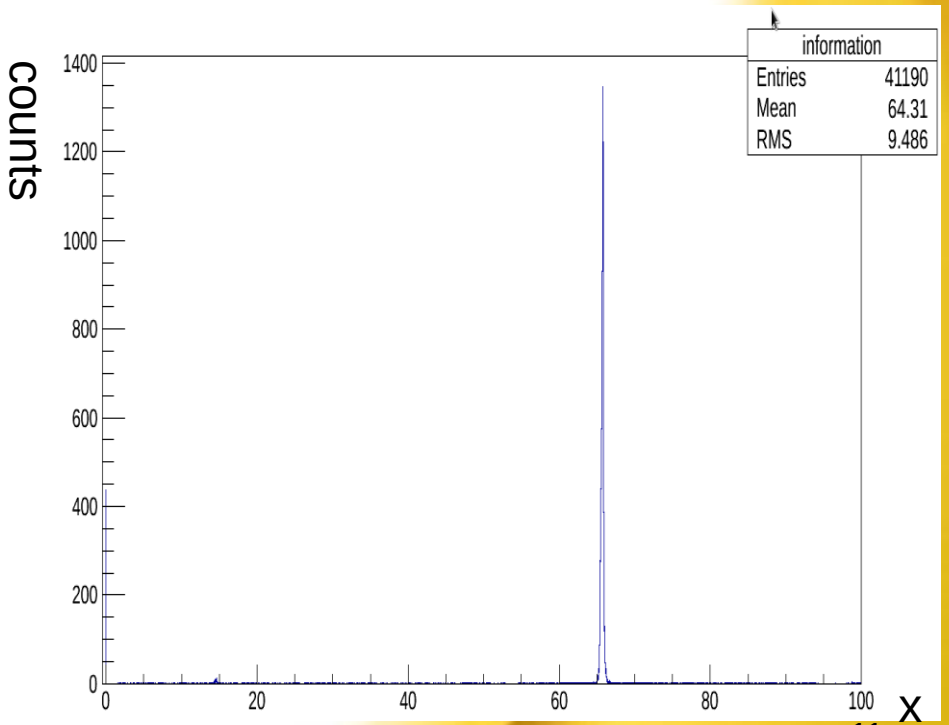


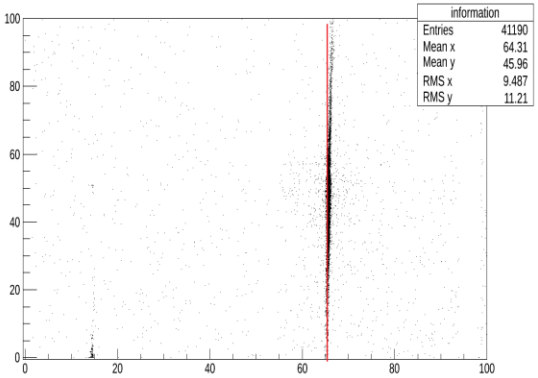


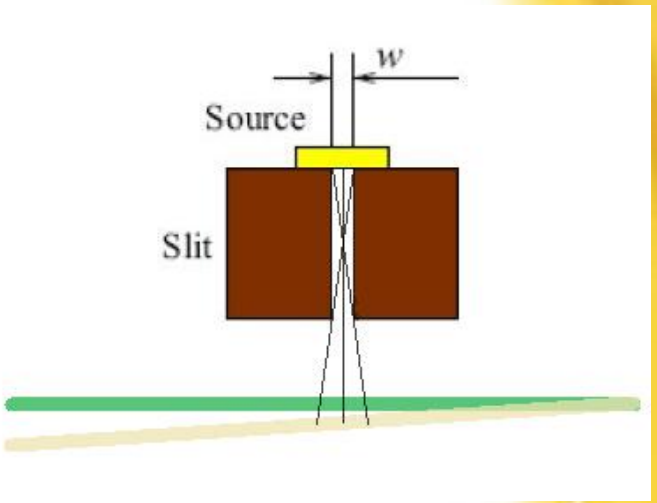
- Spatial resolution≈76um(sigma)



Spatial resolution and energy resolution.

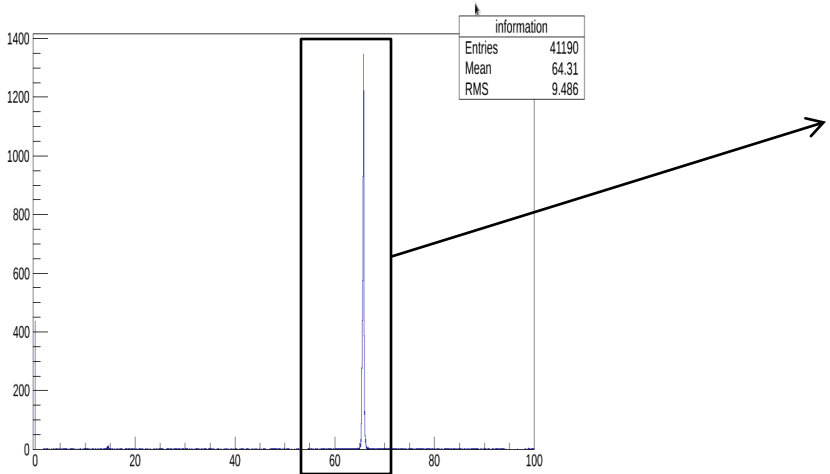
- Slit did not parallel to the readout strip strictly;

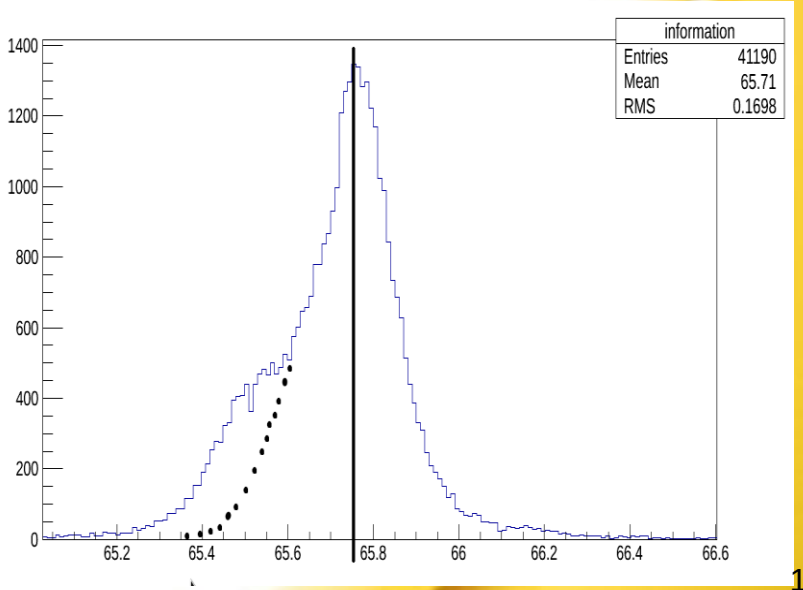




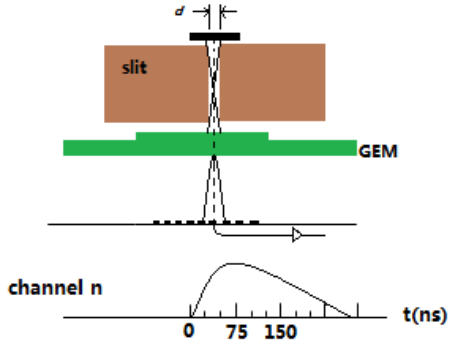
- Detector did not vertical to the beam strictly

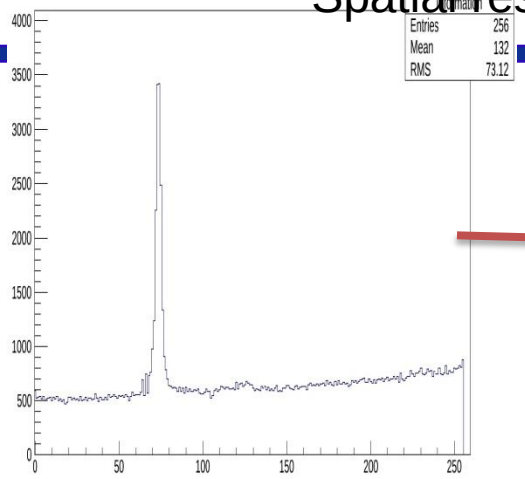
  The detector is little incline to the left side

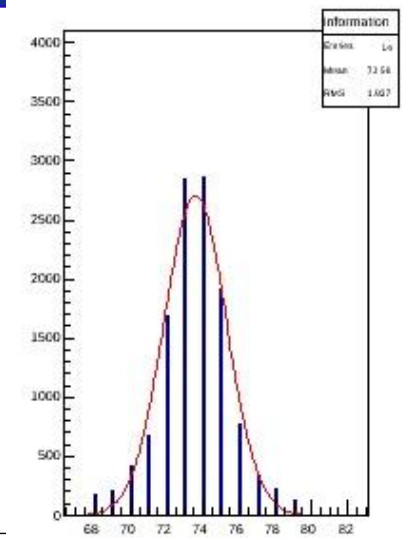




Spatial resolution and energy resolution.



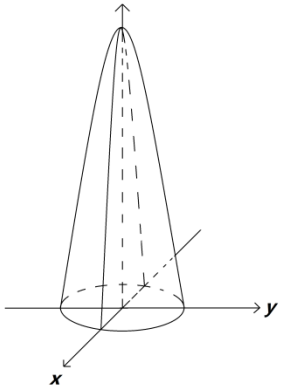


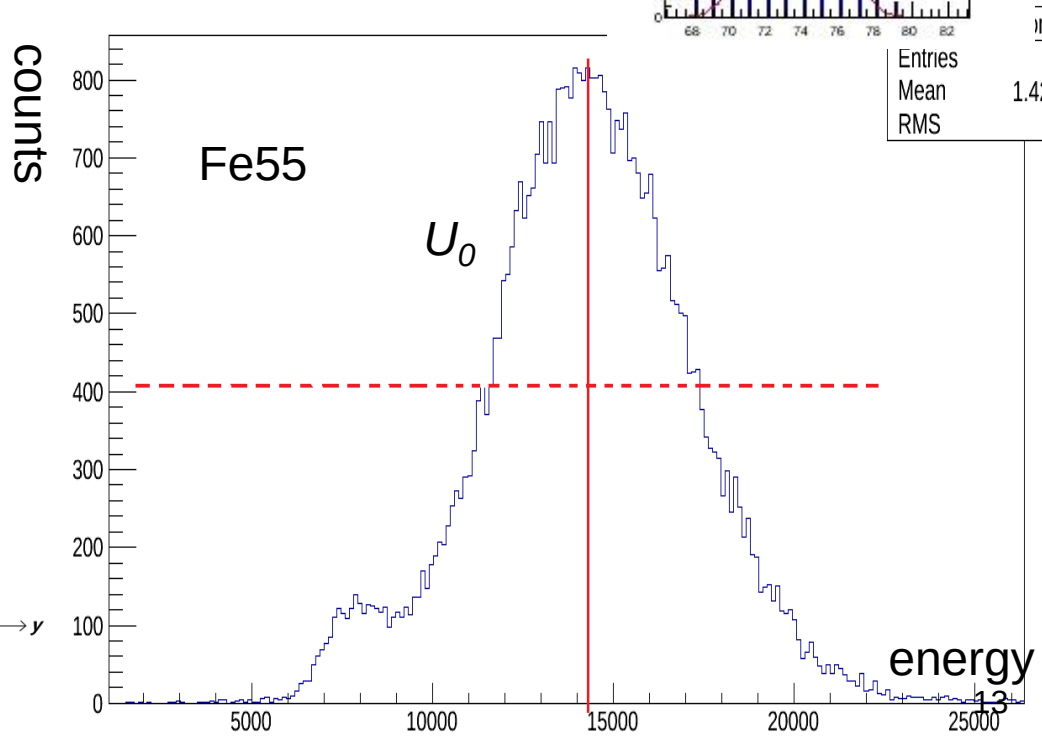


- cut the baseline from the raw signal
- integral of the x axis and y axis
- add the result of x axis and y axis

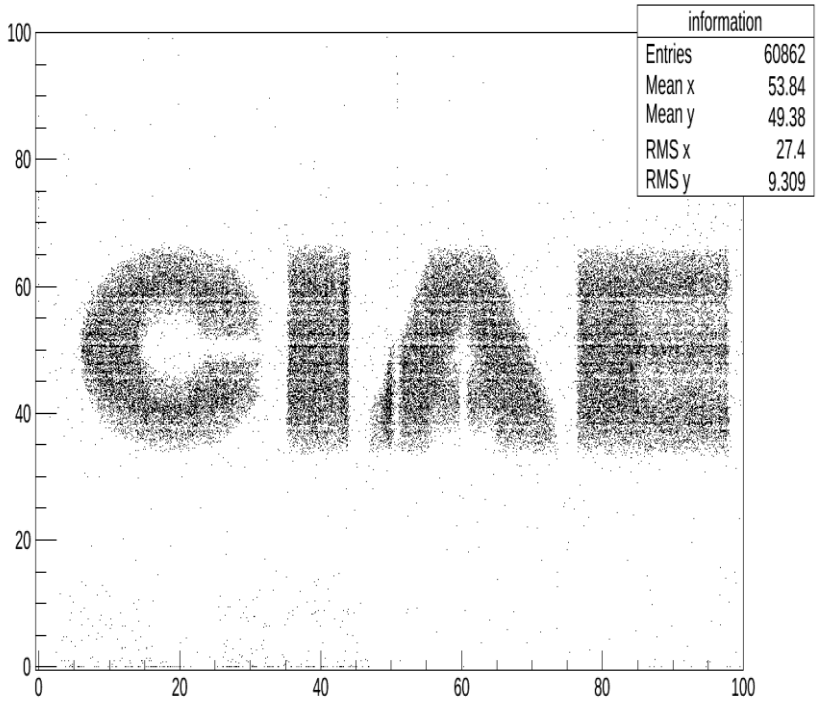
$$\varepsilon = \frac{\Delta U_{1/2}}{U_0} = \frac{\Delta E}{E}$$

$$\varepsilon = 30.1\%$$

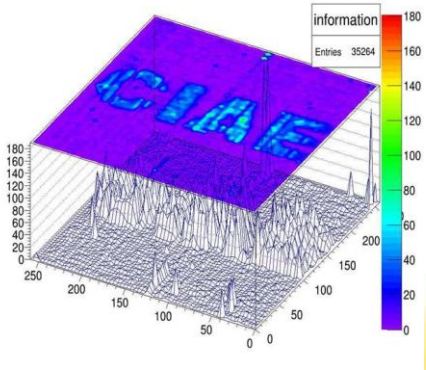


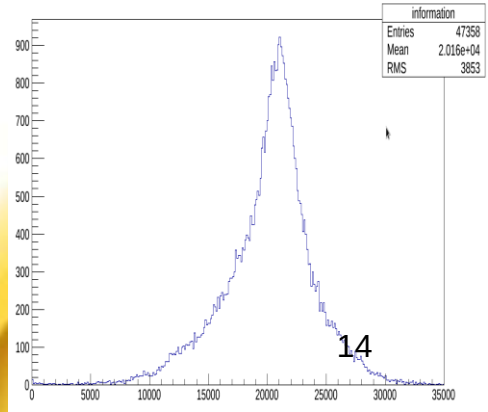


CIAE imaging @ about 1k sample rate



- X ray Energy: 10KeV;
- 256 channels for each dimension(512 channel in total);
- 4 APV FECs were used (2 for each dimension)





CIAE imaging @ about 1k sample rate

- Sample rate

  The maximum sample rate is several KHz. The sample rate is very low.

  APV: 277KHz*141(1 frame)*12bit(12bit ADC)=60MB/s

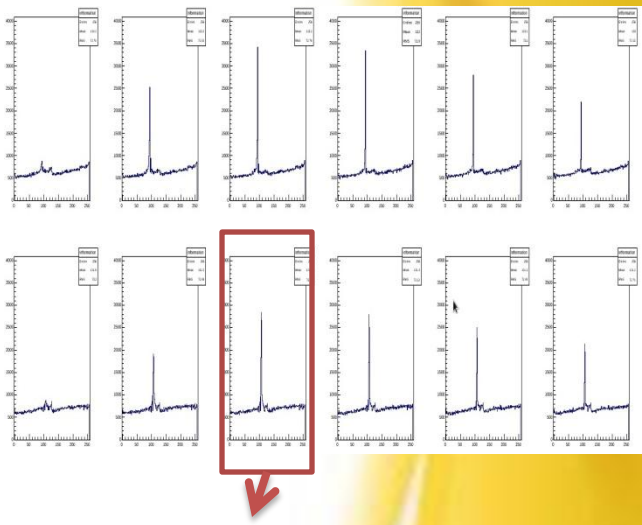
  V2718: 70MB/s (v2718 manual)

  VME crate:

  80Mb/s(VME64) 80Mb/(8*128)=78KHz

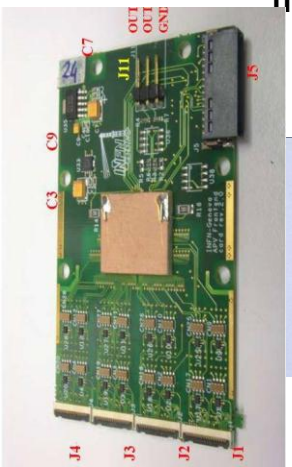
  ✓ improve Firmware;

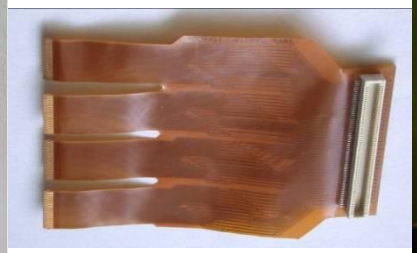
  ✓Data compression;

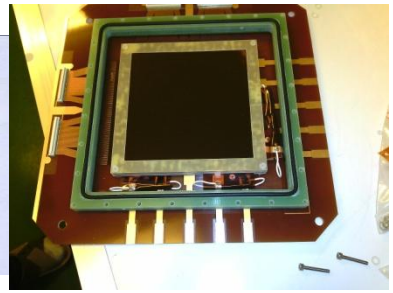


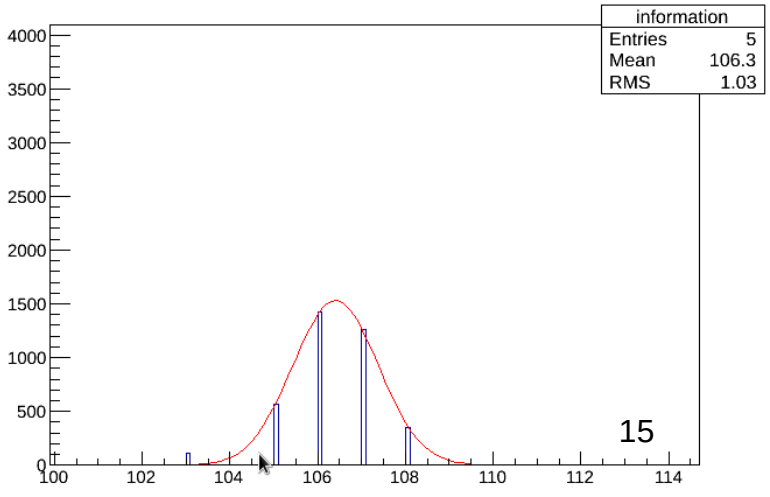
- The connection between APV and detector is not very reliable.

  More reliable connector should be introduced in.









Summary and Plan

- The connection between GEM and APV is very poor.
- The sample rate is not very high.
  - ✓ VME crate and V2718 VME controller is not suitable for high rate application

When event rate is 200KHz
200KHz X 12bit(ADC) X 128=37.5MB/s
37.5MB/s X 16 =225MB/s

- Increase the sample rate;
- Test our system in BSRF (Beijing Synchrotron Radiation Facility);
- Neutron imaging;
- Cosmic ray imaging;
- …….

Thank you for your attention !