

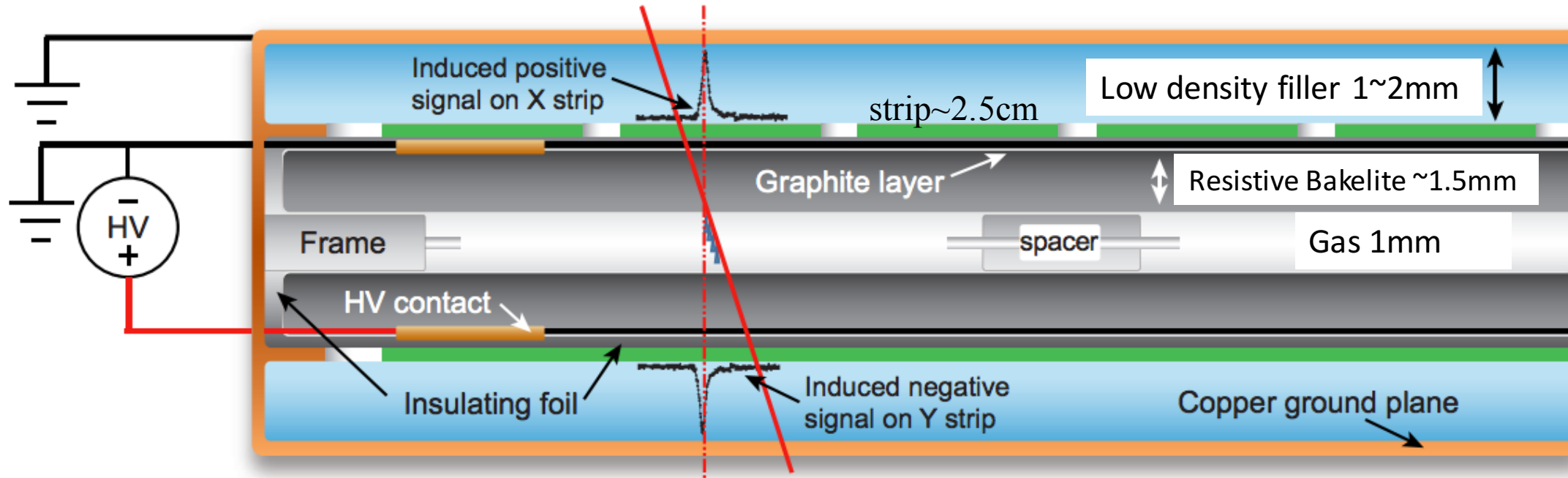
Introduction of RPC

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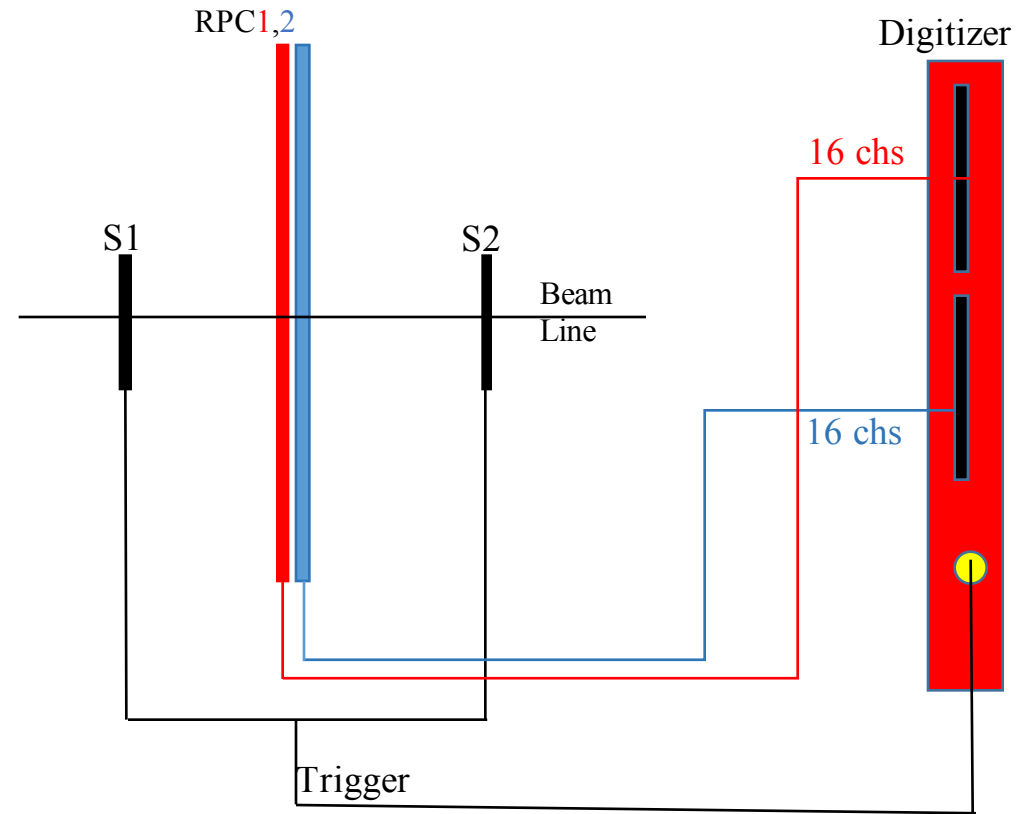
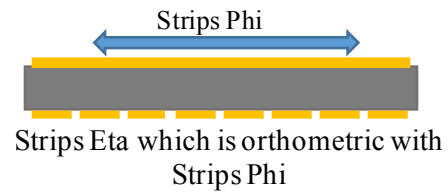
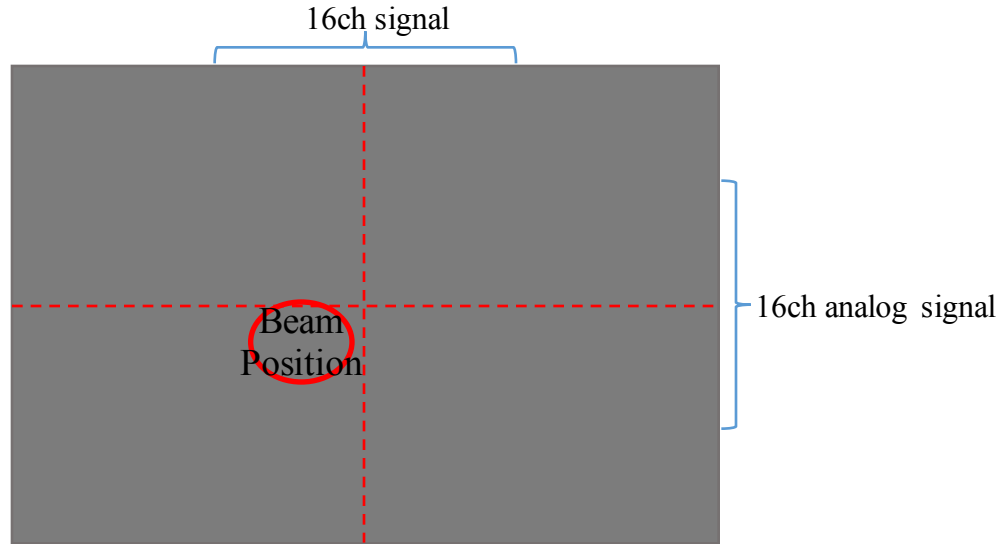
RPC structure



➤ Design requirement of new RPC:

- Time resolution: 0.4 ns
- Spatial resolution: ~ 1 cm

Detector and Test System



Beam Test in Gif++

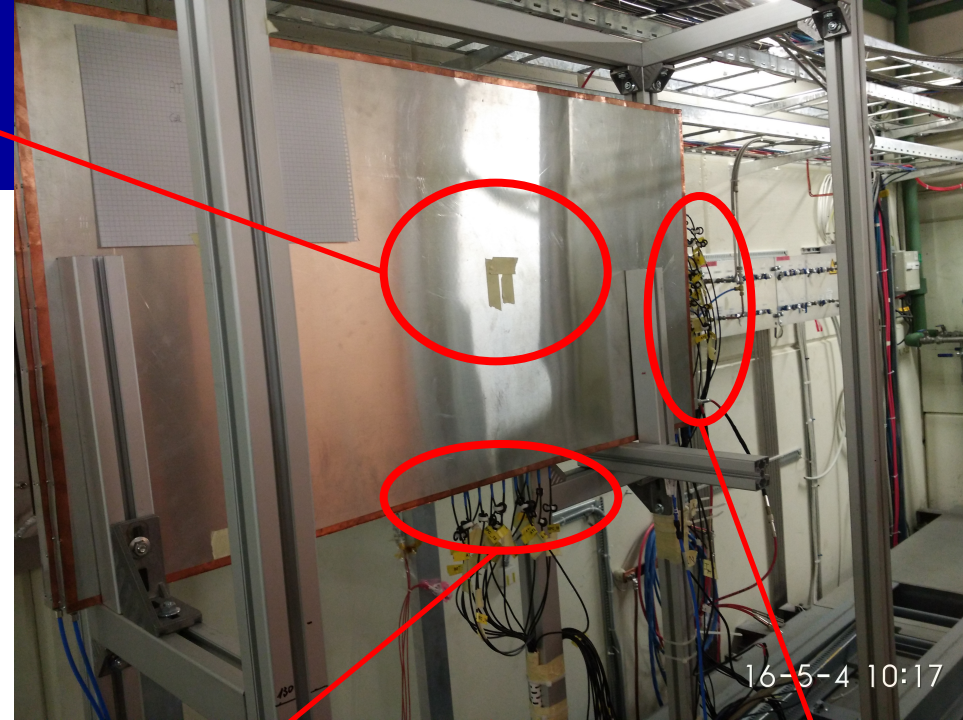
➤ Beam&Source

- Data taken with muon beam and gamma intensity up to 20 kHz per cm^2 estimated counting rate
- Beam: Circle with diameter $\sim 10\text{cm}$
- Beam rate: $\sim 10\text{k/spill}$ (1 spill is about 3s)
- Chamber distance 4.72m
- Source full intensity: $13.9\text{ TBq }^{137}\text{Cs}$
- Absorption factor: $X=3.3, 10, 22, 46, 100$ (intensity attenuated by $1/X$)

➤ Electronic system

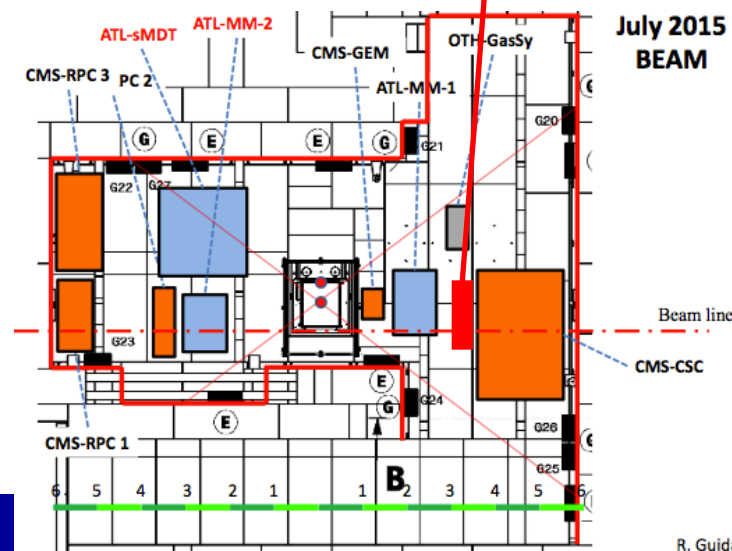
- Readout strips, amplifier inside the chamber box
- Chamber A and B
- 8 most-central readout channels along both X and Y
- Waveform is 1024 points and 0.4ns resolution

Beam
position

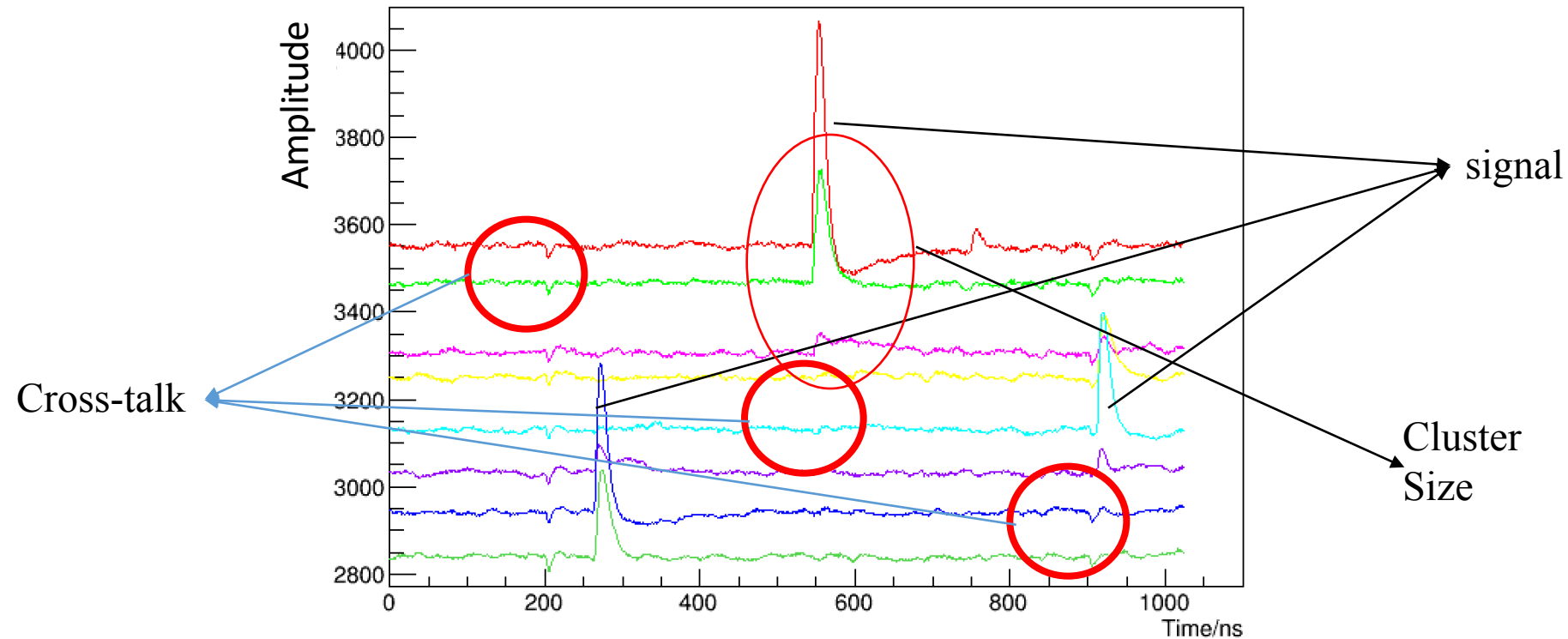


8ch * 2chambers(X)

8ch * 2chambers(Y)



Waveform of a random trigger



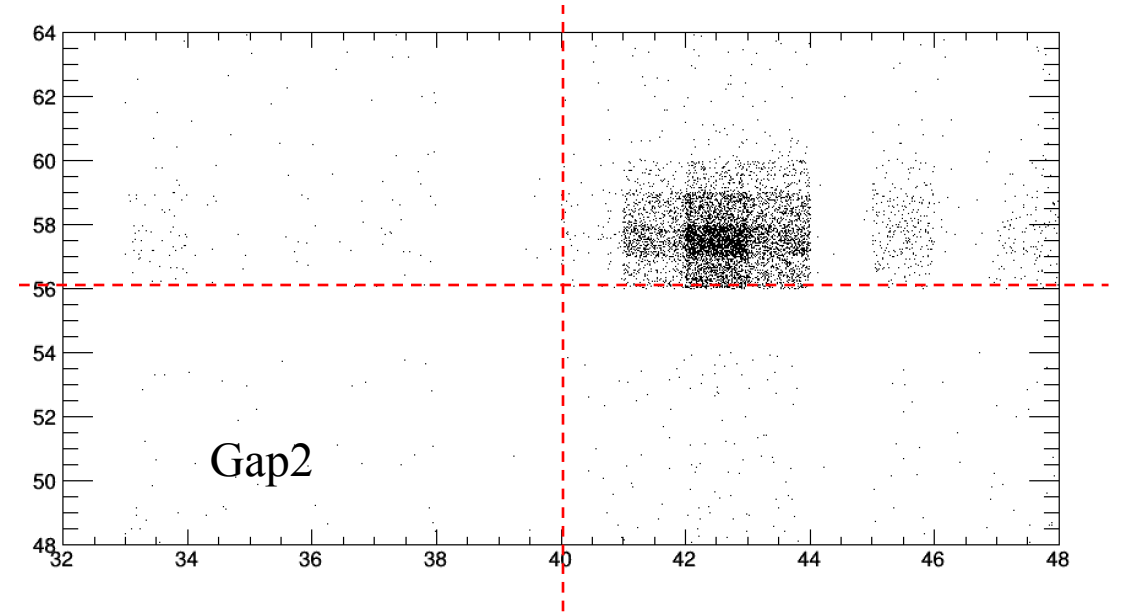
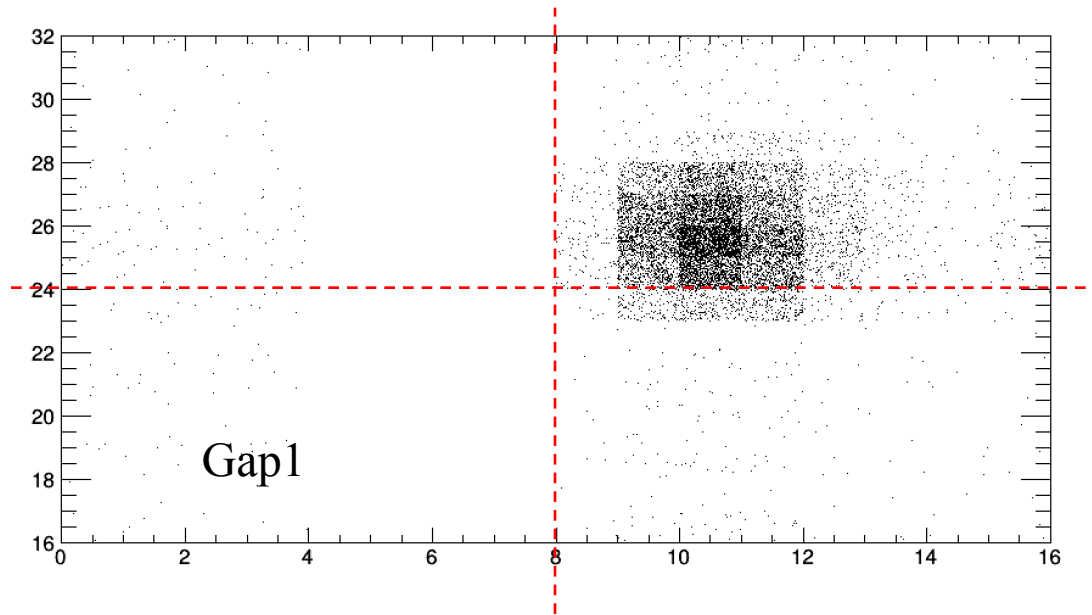
➤ Photon signal:

- Random time in waveform
- Small amplitude
- Hit in single chamber

➤ Muon signal:

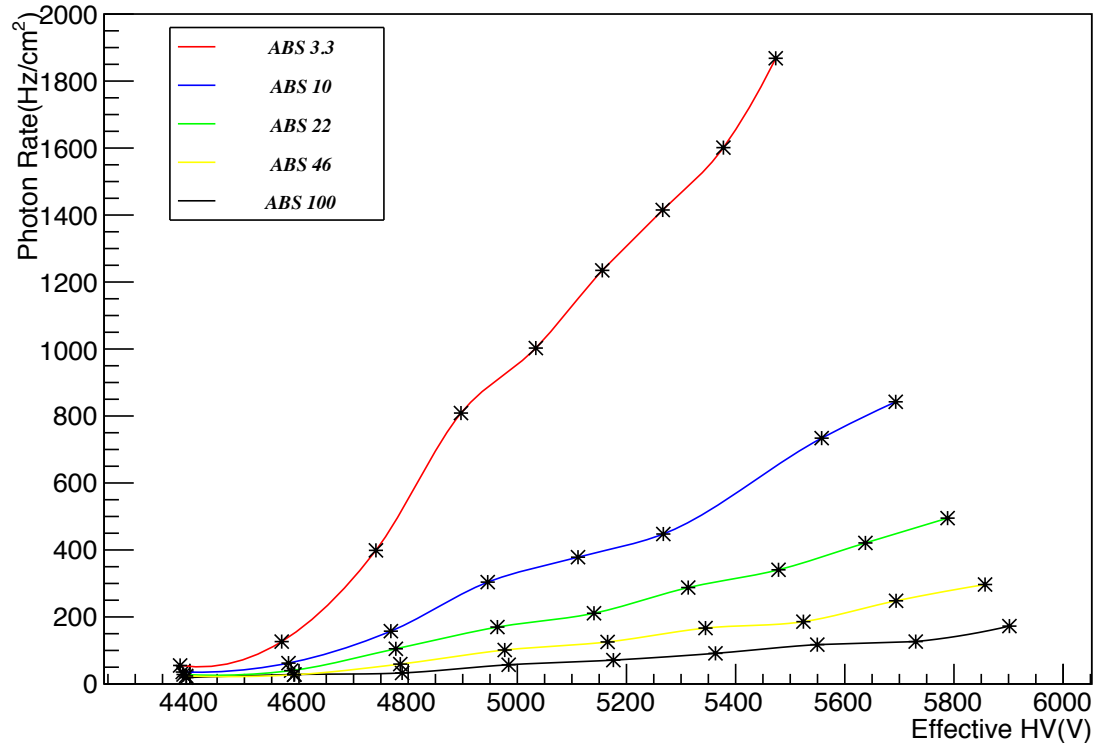
- 200ns before coincidence trigger
- Large amplitude
- Hit in double chamber
- Rate: $\sim 40\text{Hz/cm}^2$ (Only 1 signal in 400ns time window)

Position of Beam



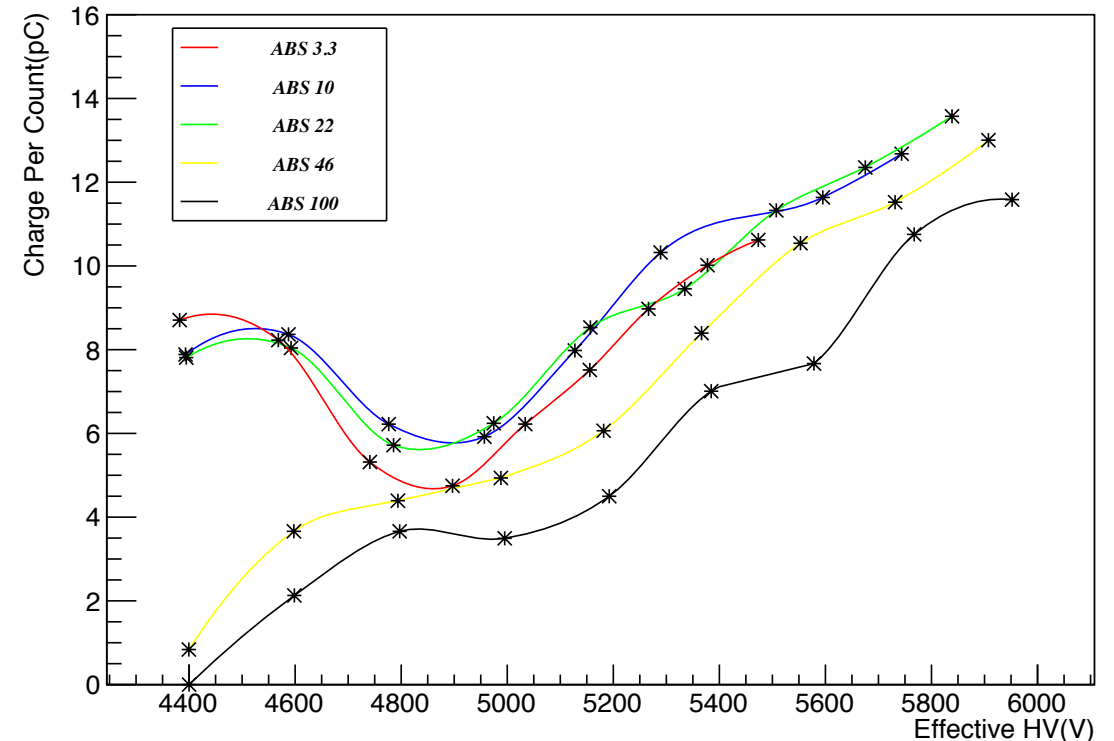
Photon rate and Charge per event

Graph



Photon rate

Graph



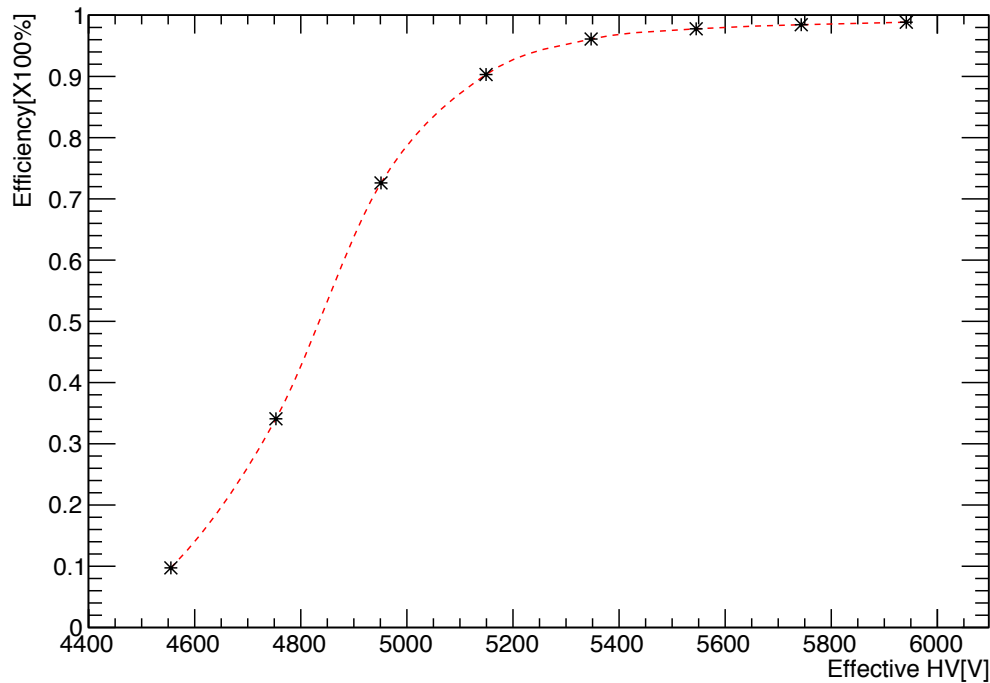
Charge per event

- applied HV is HV applied to chamber. Effective HV is the voltage applied to gas.
$$\text{EffectiveHV} = \text{AppliedHV} - \text{Current} * \text{ResistanceOfBakelite}$$
- Signal of photon are always very small, electronic system is so sensitive to detect the small signals.

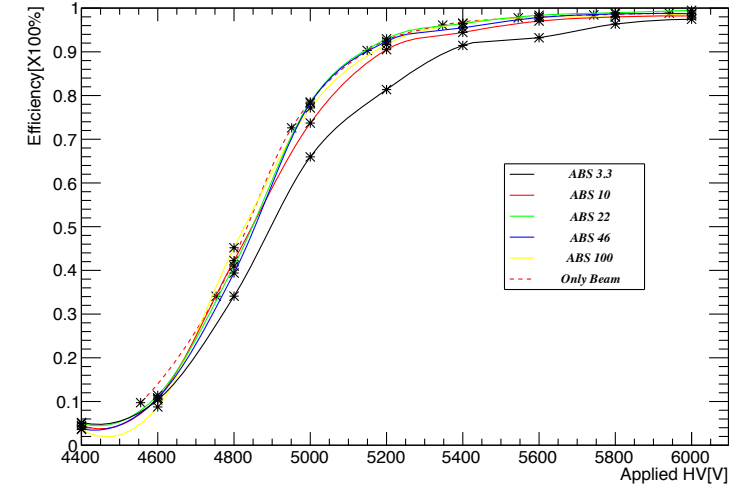
Efficiency

1. Choose a tight muon signal in monitor chamber
2. Check the efficiency in test chamber --- “tag and probe”

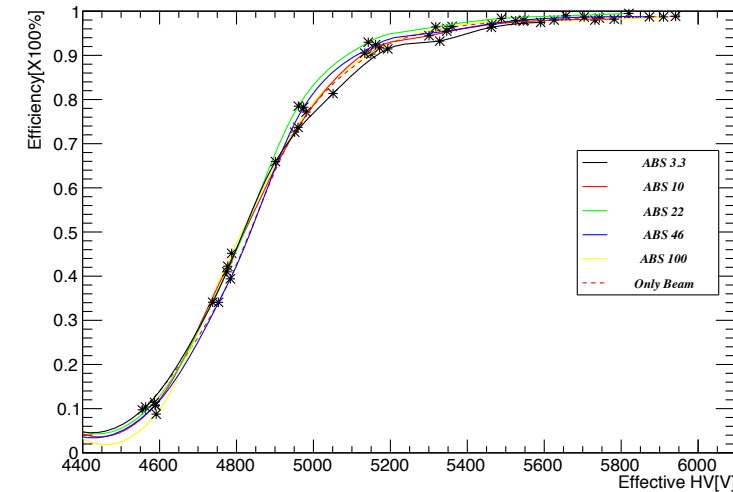
Efficiency without source



*ABS factor 22(the green line) is similar with the real situation of LHC(600 Hz/cm² in BI region)

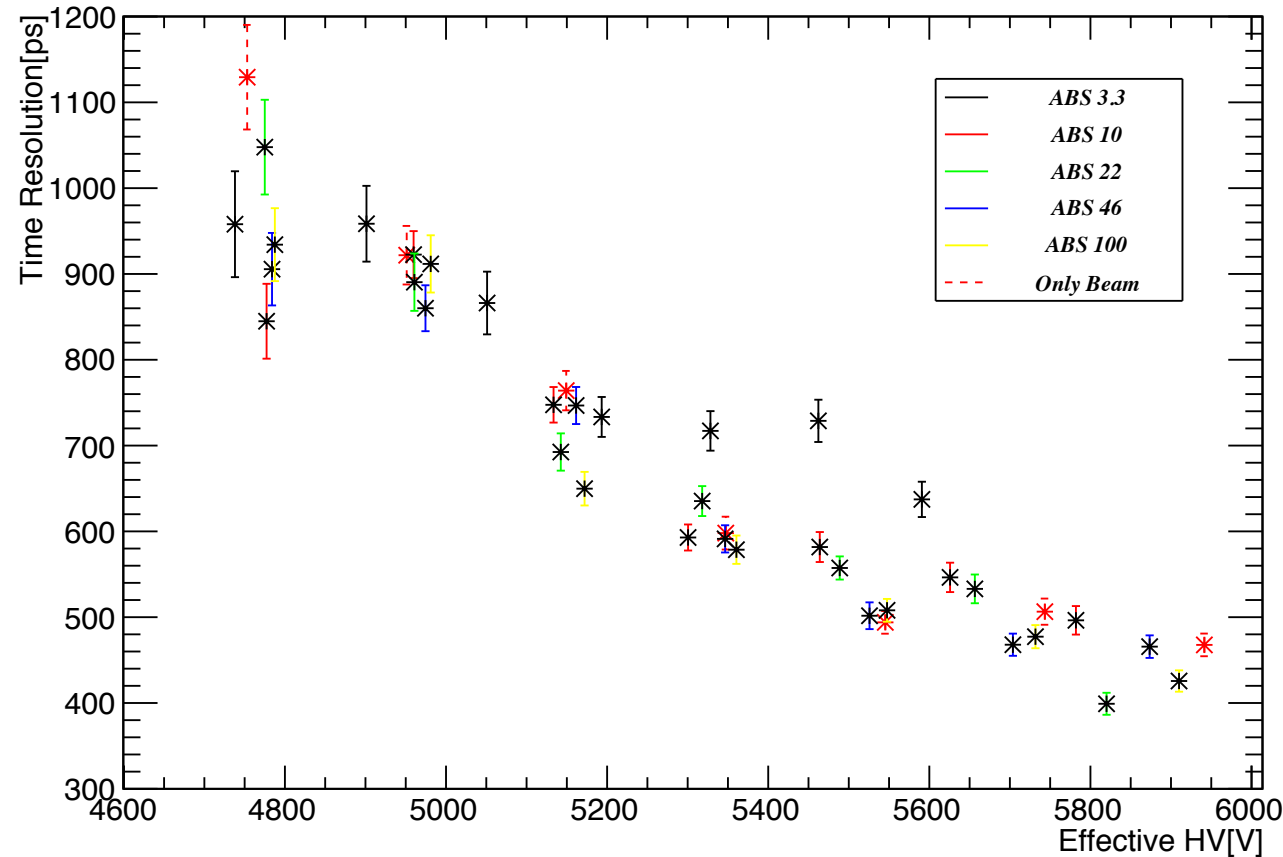


Efficiency with source(applied HV)



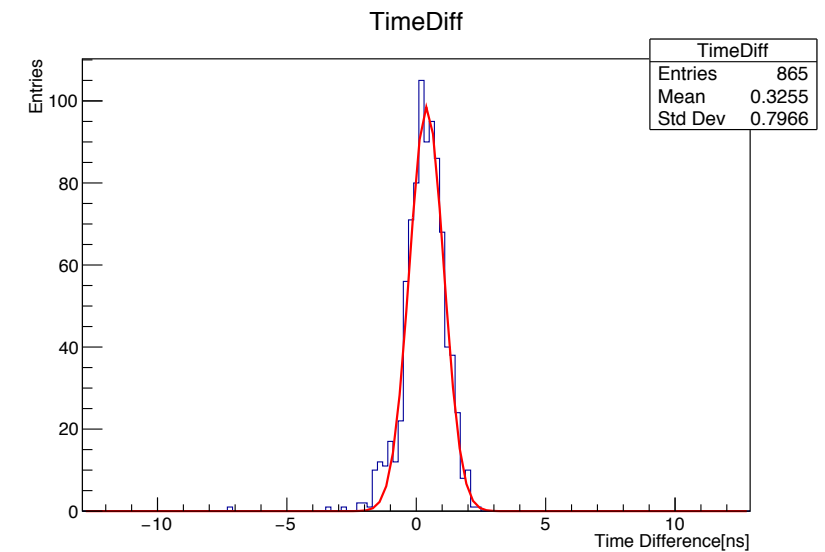
Efficiency with source(effective HV)

Time resolution



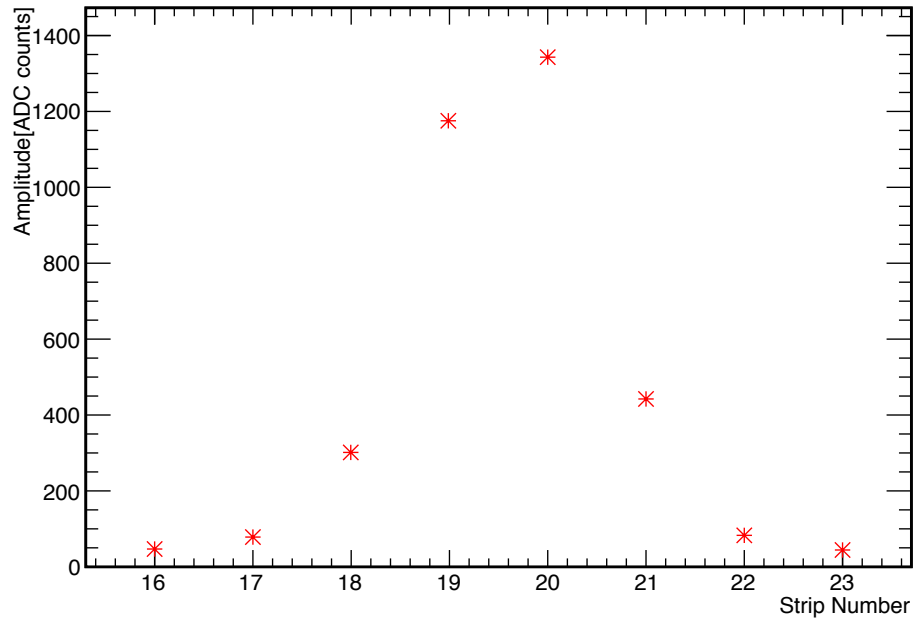
Time resolution in different HV and ABS

- Resolution is much better in high HV region
- The reason is drift speed in gas volumn
- Time resolution is almost $\sim 400\text{ps}$
- In some of the strips, the resolution is better

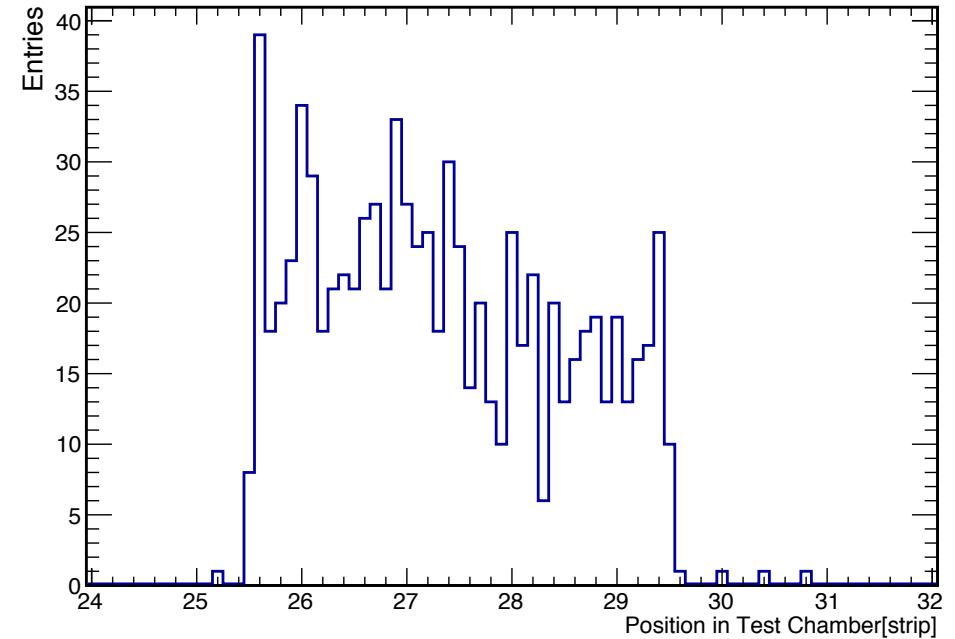


1. Time difference between signals in 2 chambers
2. Fit the distribution to get the resolution

Space resolution calculation



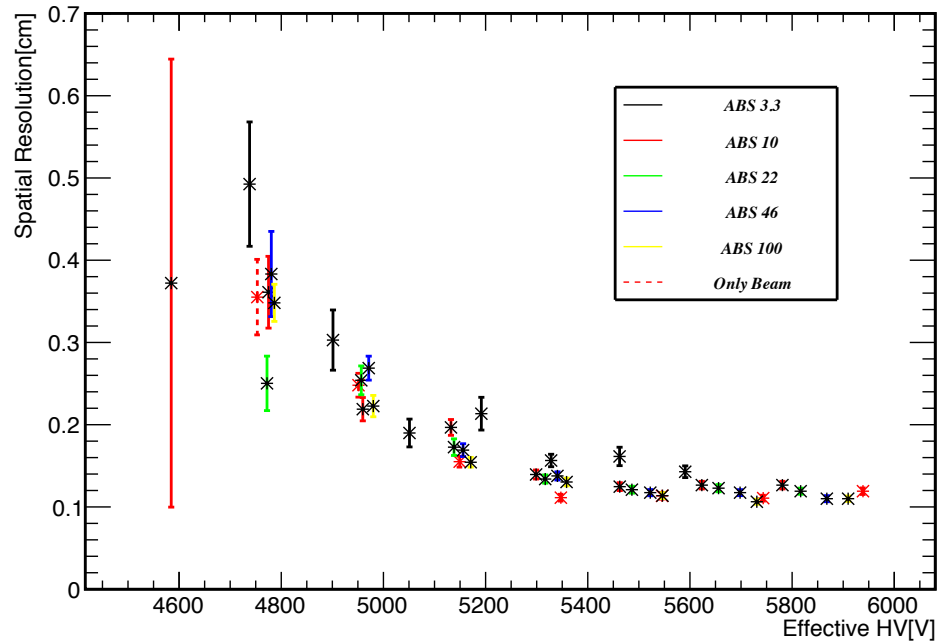
amplitude vs strip



Position difference between signals in 2 chambers

1. Fit the first plot to get the center of hit — $f(x)=a*(fabs(x-b))^c+d$
2. Fill the histogram and get the distribution in the second plot
3. Fit the distribution with gaussian function and get the resolution

Space resolution



- Center of hit is calculate by fit the time pass threshold vs strip
- Resolution of ABS 3.3 is worse then others. Photon signal contaminate the threshold calculation
- Space resolution is almost ~ 1 mm

Space resolution in different HV and ABS

Cross-Talk Study in Doublet Chamber

➤ Operation of RPC:

- 2 Singlet in 2 boxes --> 1 doublet in 1 box

➤ Advantages:

- Save space
- Coincidence trigger by itself
- Combined measurement

➤ Aim: Study the interference between the 2 chambers after installing them in 1 box

➤ Method:

- Keep 1 chamber HV on, the other chamber HV off. Calculate the efficiency of the off chamber.

➤ Result:

- For muon:
- Only 1 random coincidence in 10k signals
- For gamma:
- Only 1 random coincidence in 20k signals
- A very good result.

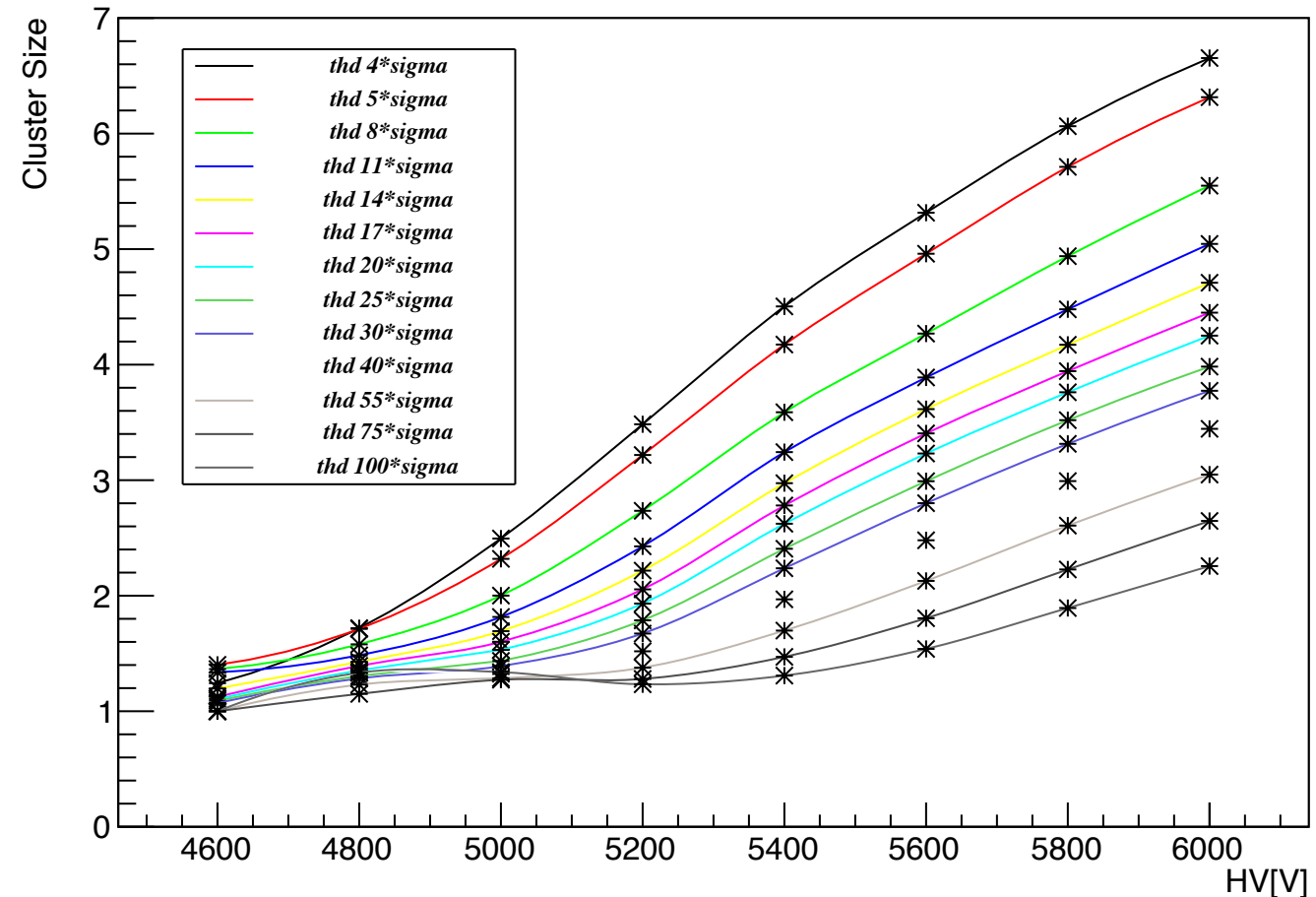
Cluster Size VS HV

- The cluster size is larger than we expected.
- The normal value we expected is about 1.5 or no more than 2.
- Try to reduce the cluster size.

Some possible solution:

- Raising threshold maybe a solution, but it will be harmful to the efficiency.
- Install some isolation between different strips in readout panel

Graph



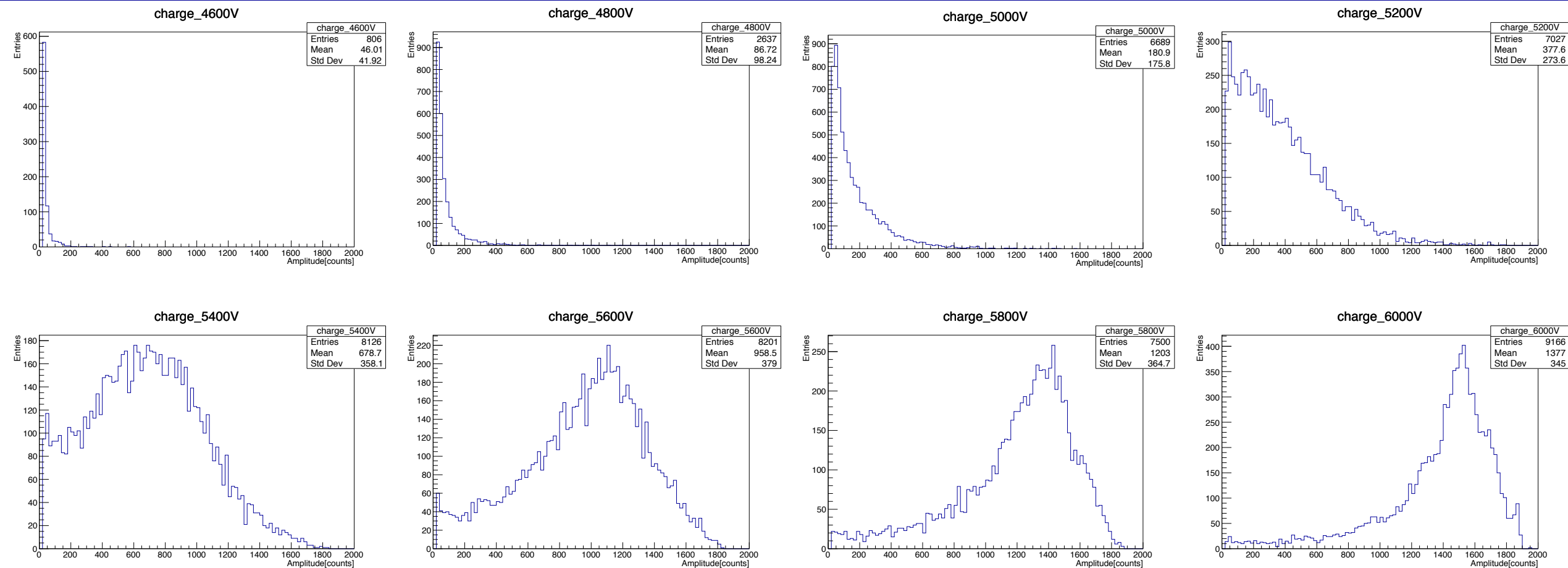
Summary

➤ New type of RPC satisfied the requirement of BIS7/8

- The new RPC show a high efficiency in high radition situation
- Time resolution $\sim 400\text{ps}$
- Space resolution(preliminary result) $\sim 2\text{mm}$

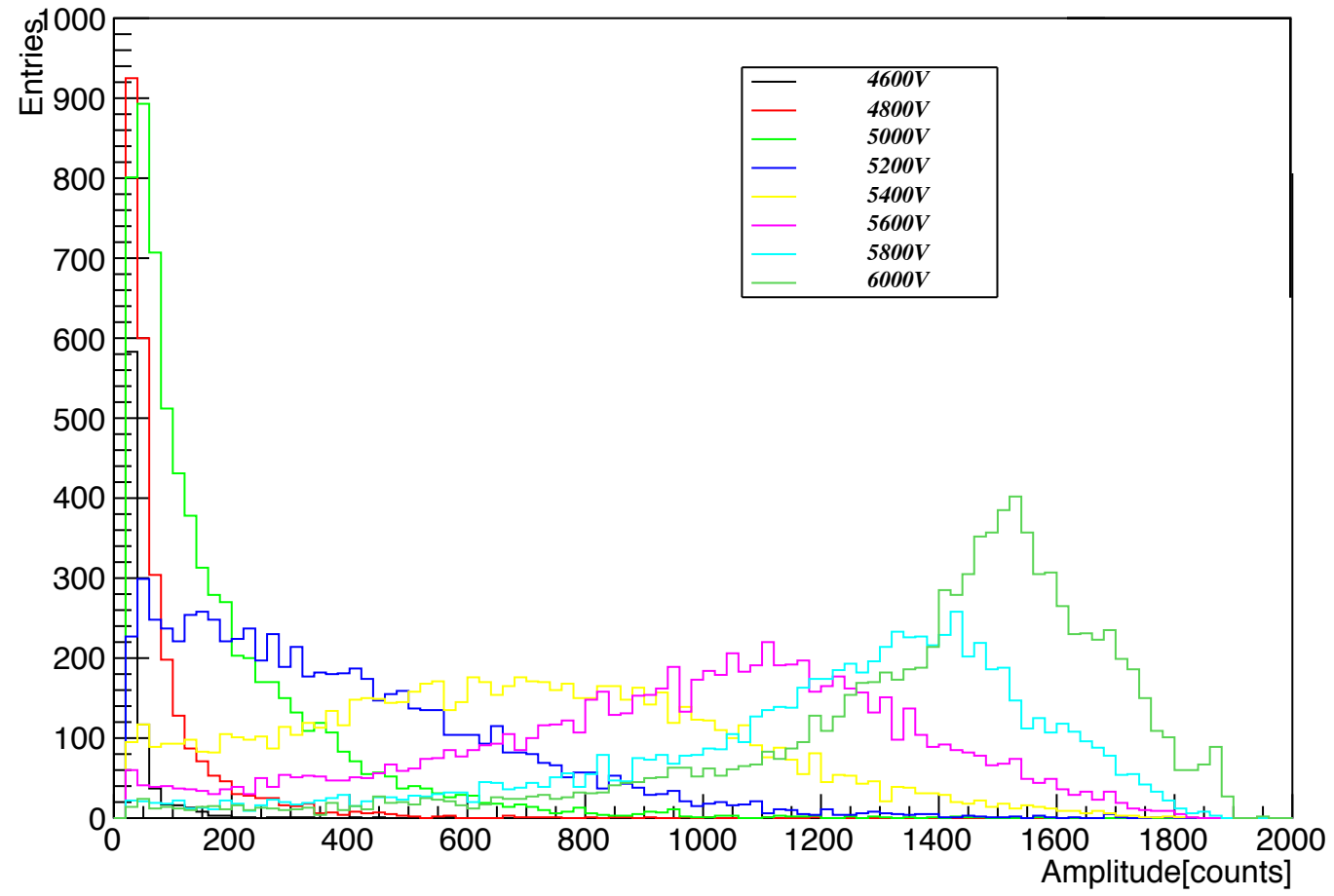
Backup

Charge distribution for muons in different HV



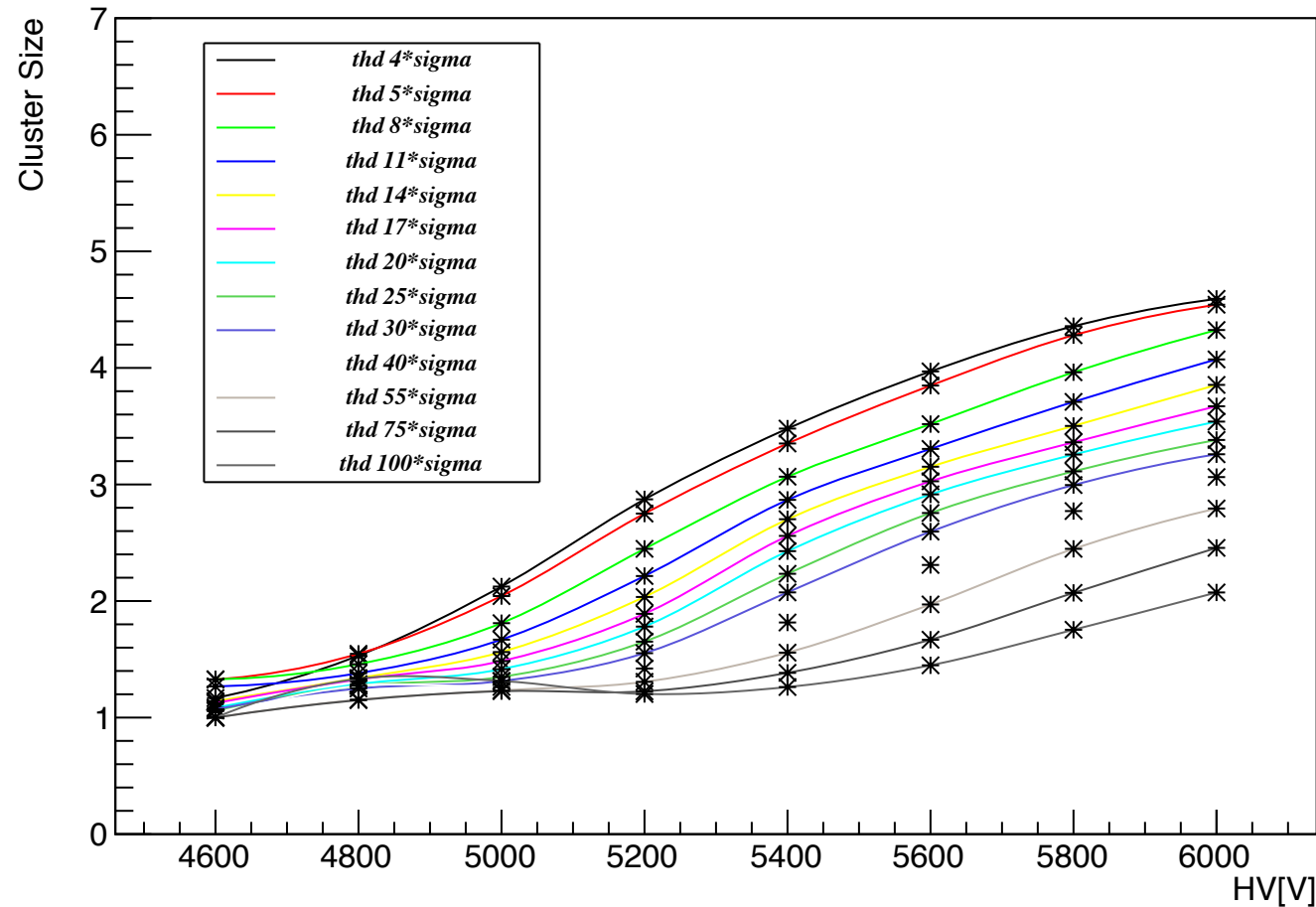
Amplitude is proportional to the charge.

Charge distribution

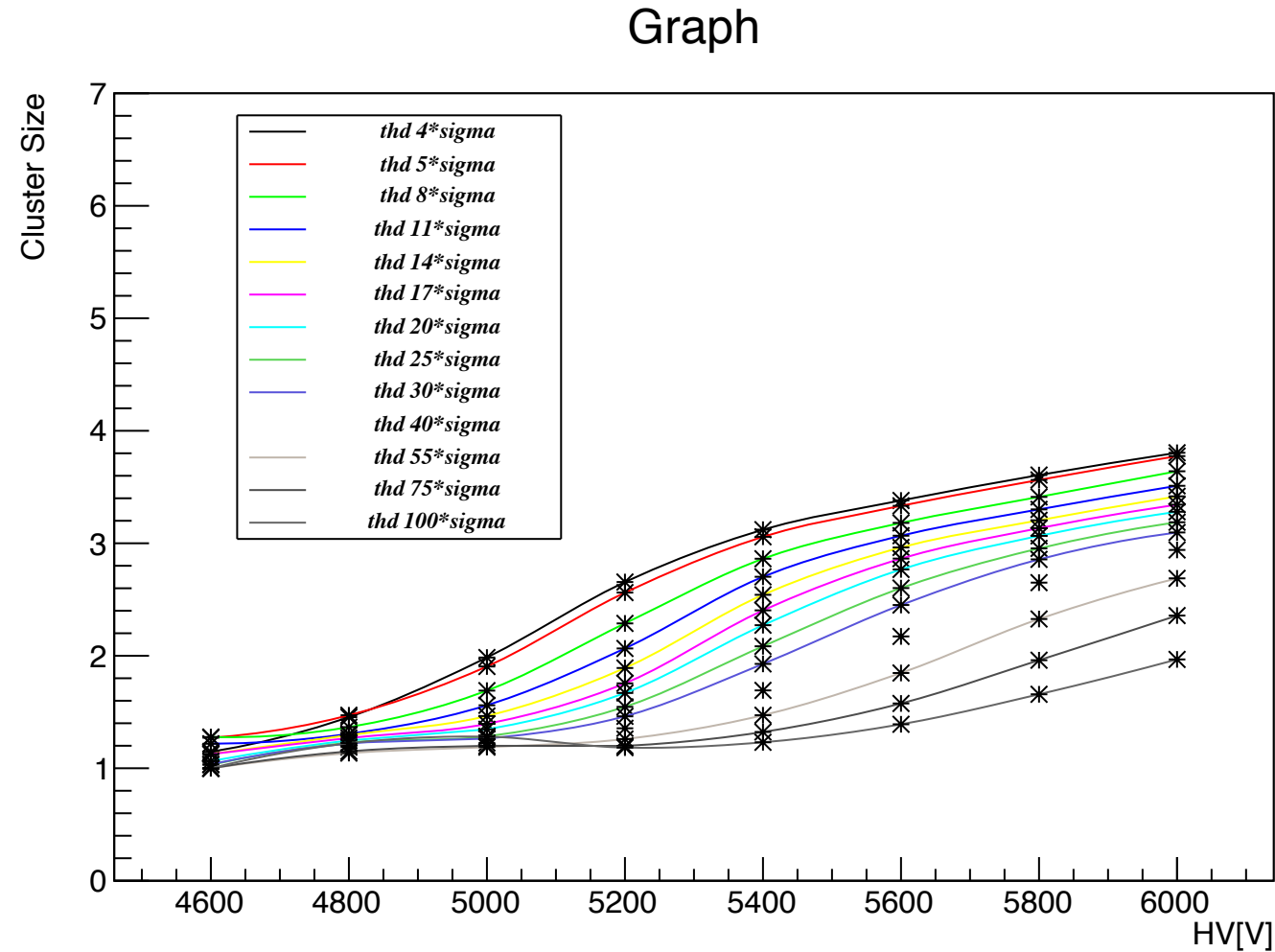


Cluster Size VS HV(4ns time cut is applied)

Graph

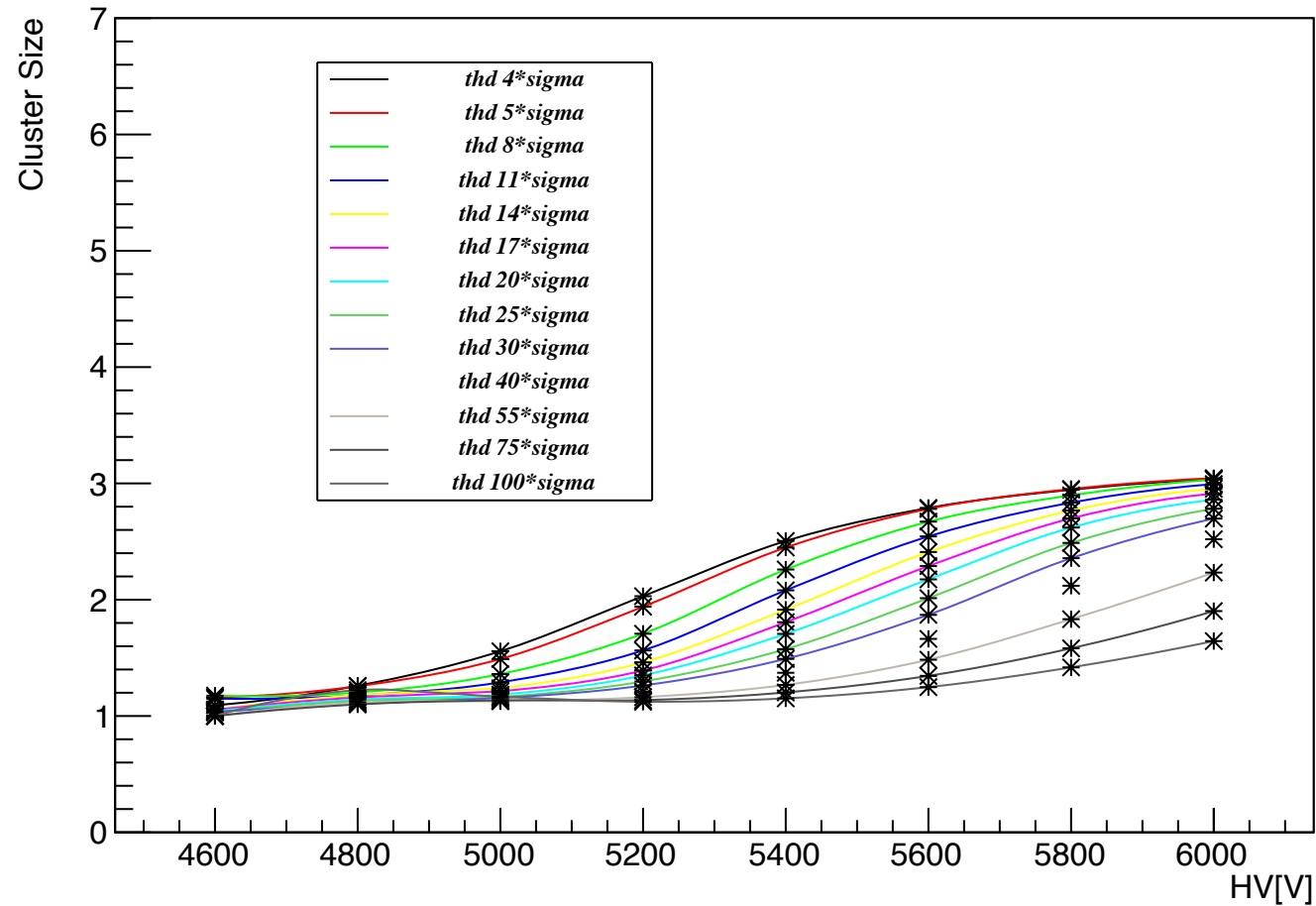


Cluster Size VS HV(3ns time cut is applied)



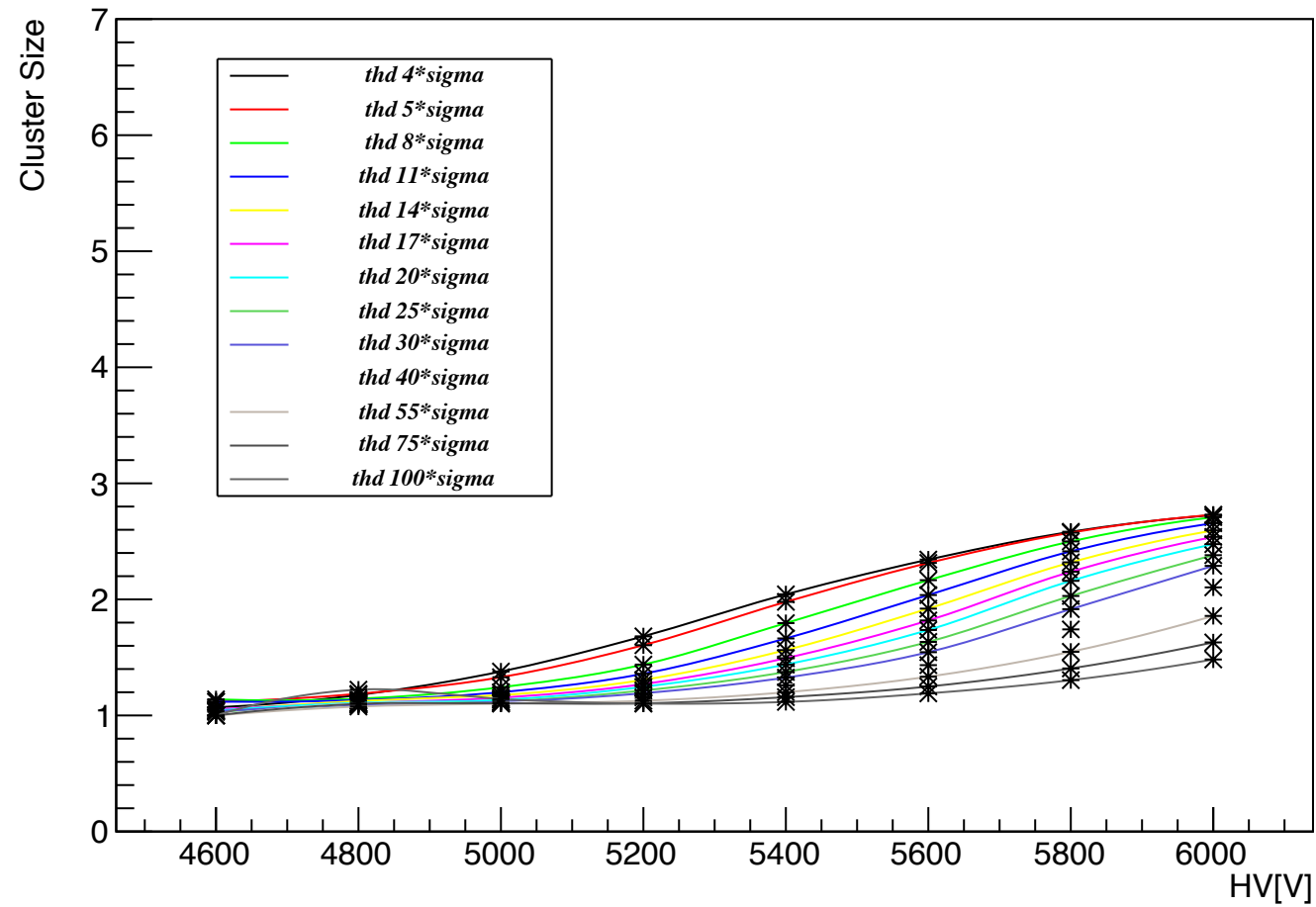
Cluster Size VS HV(2ns time cut is applied)

Graph



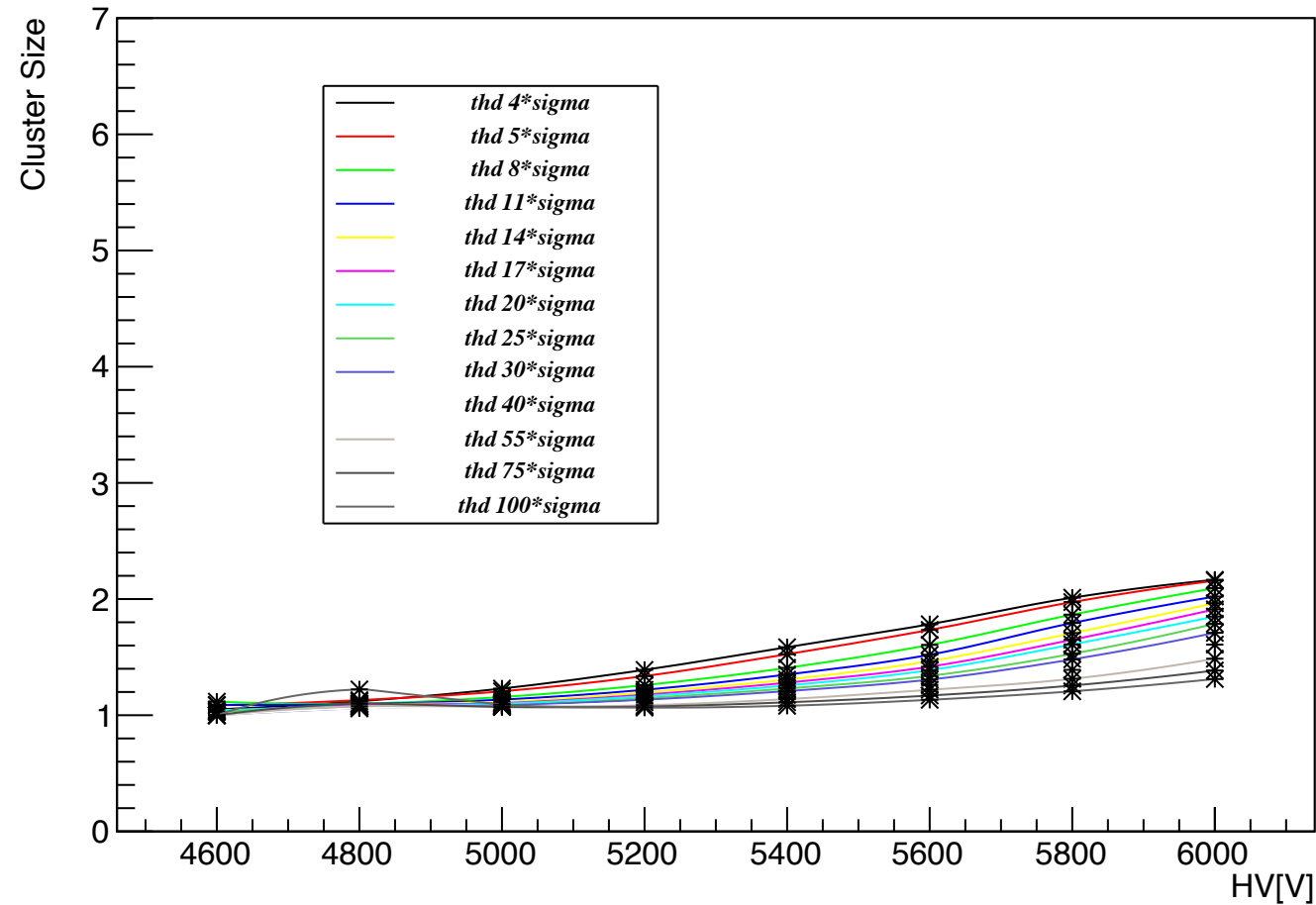
Cluster Size VS HV(1.5ns time cut is applied)

Graph

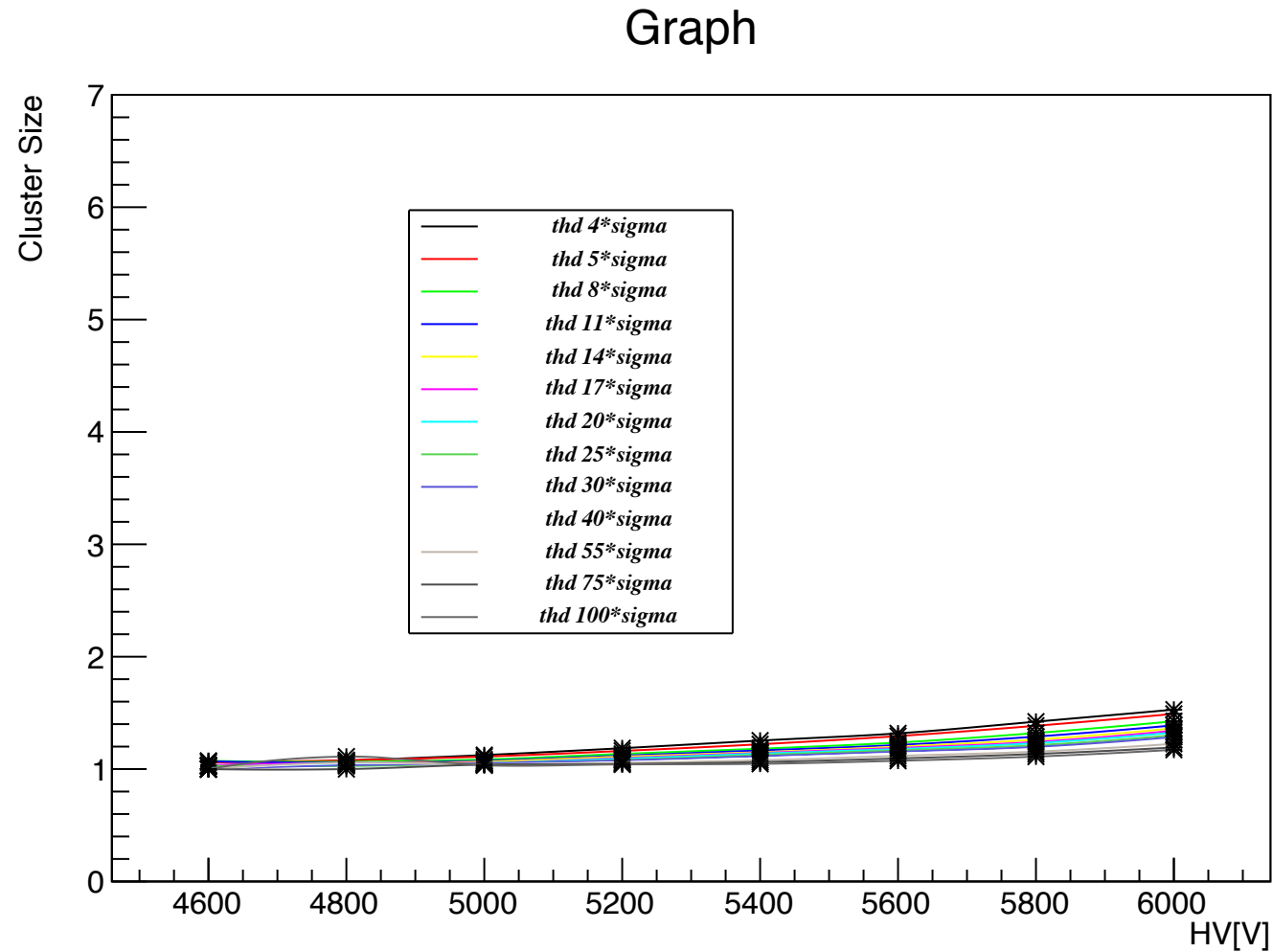


Cluster Size VS HV(1ns time cut is applied)

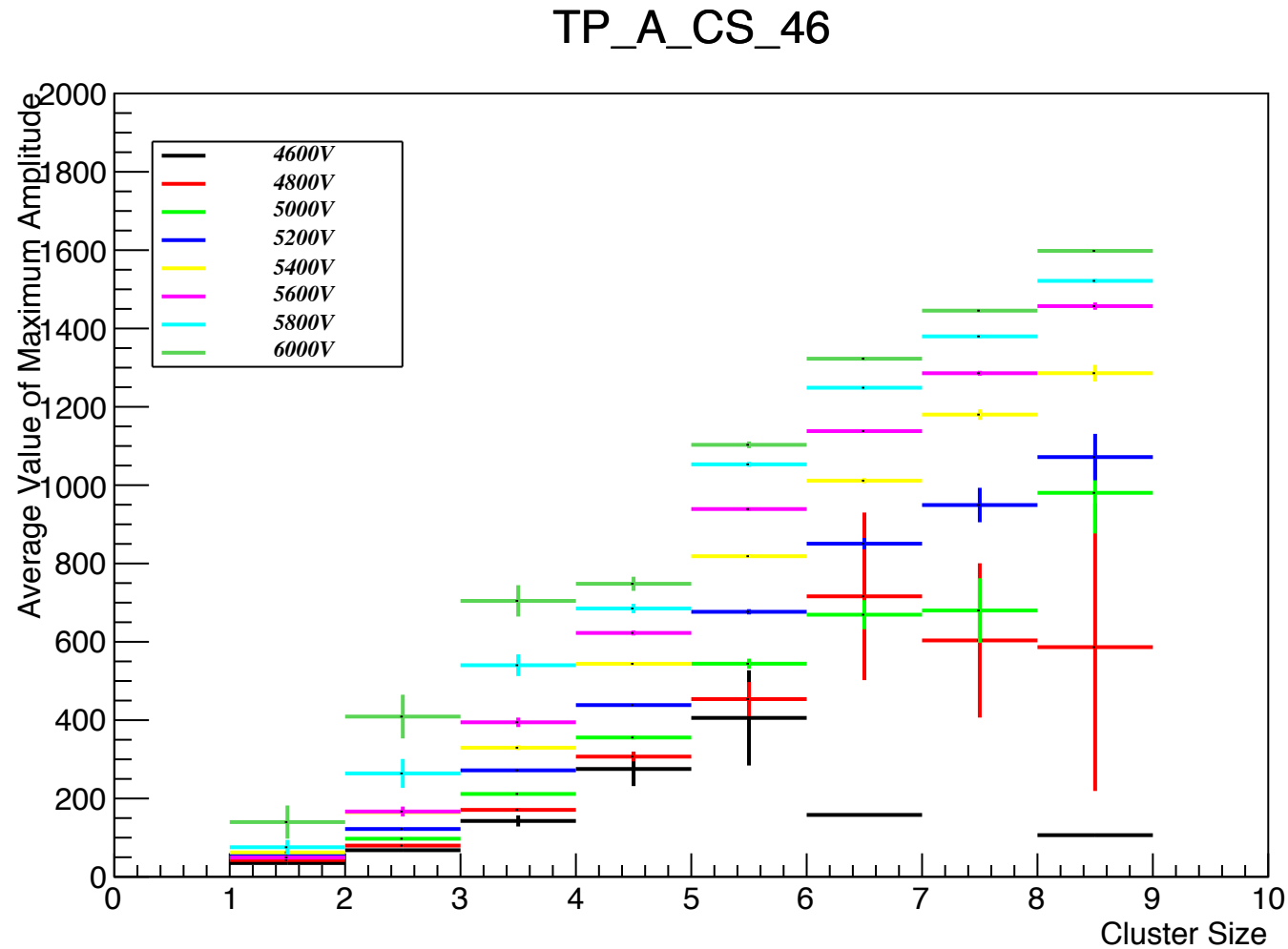
Graph



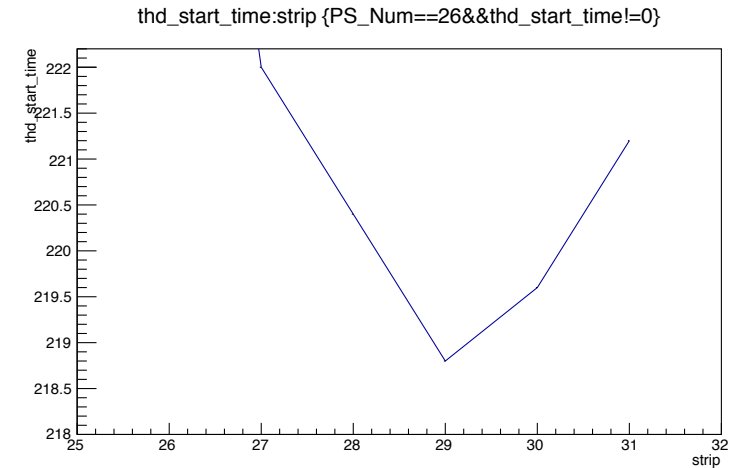
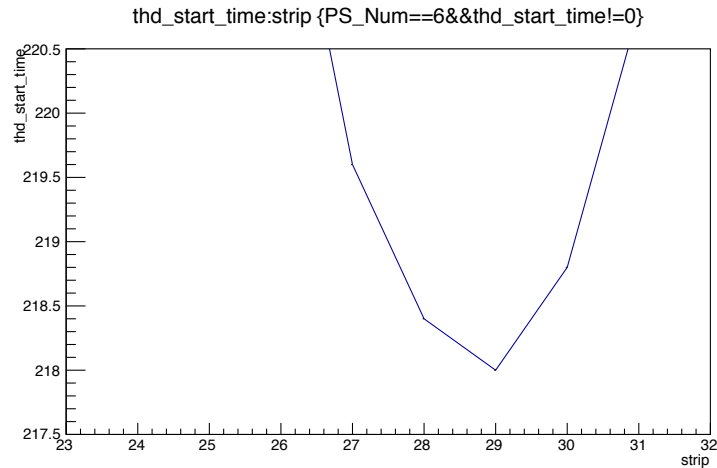
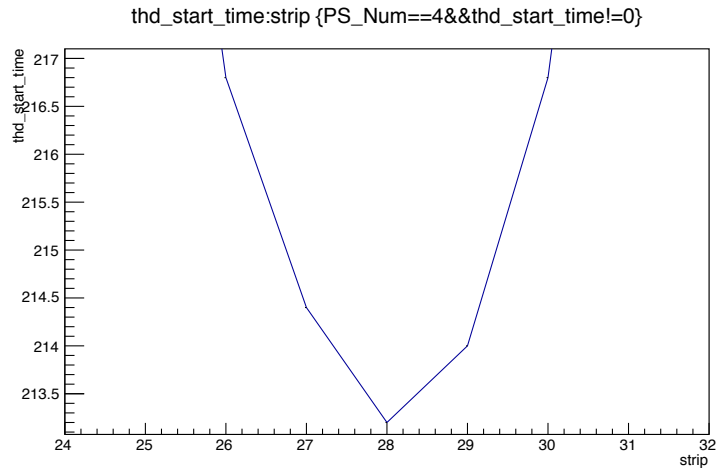
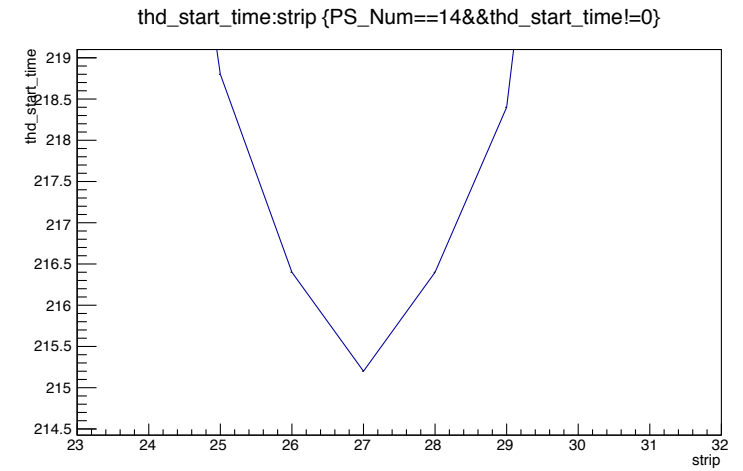
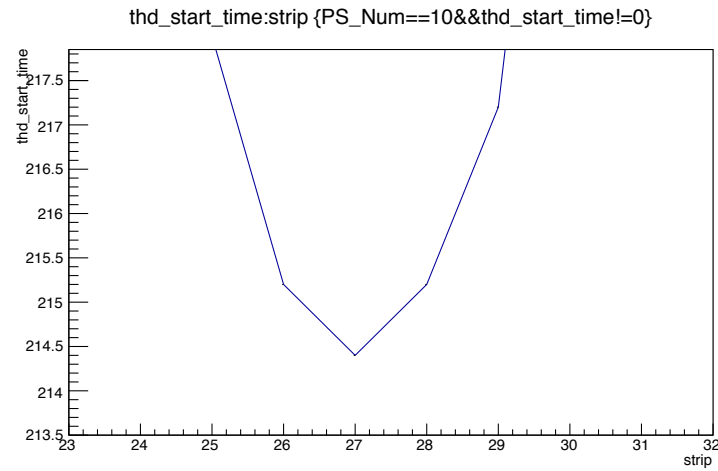
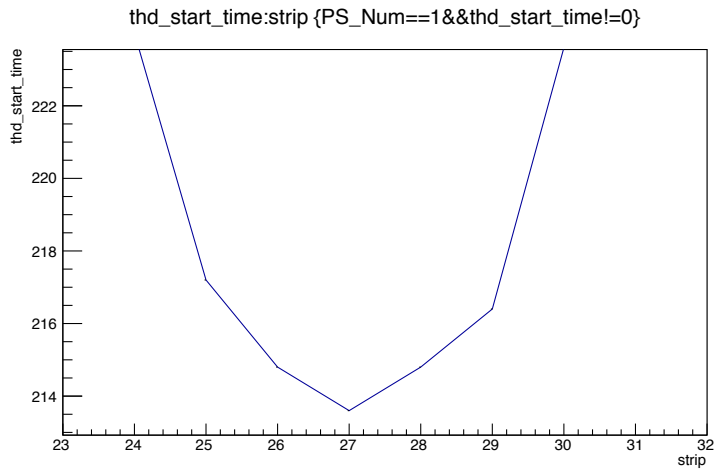
Cluster Size VS HV(0.7ns time cut is applied)



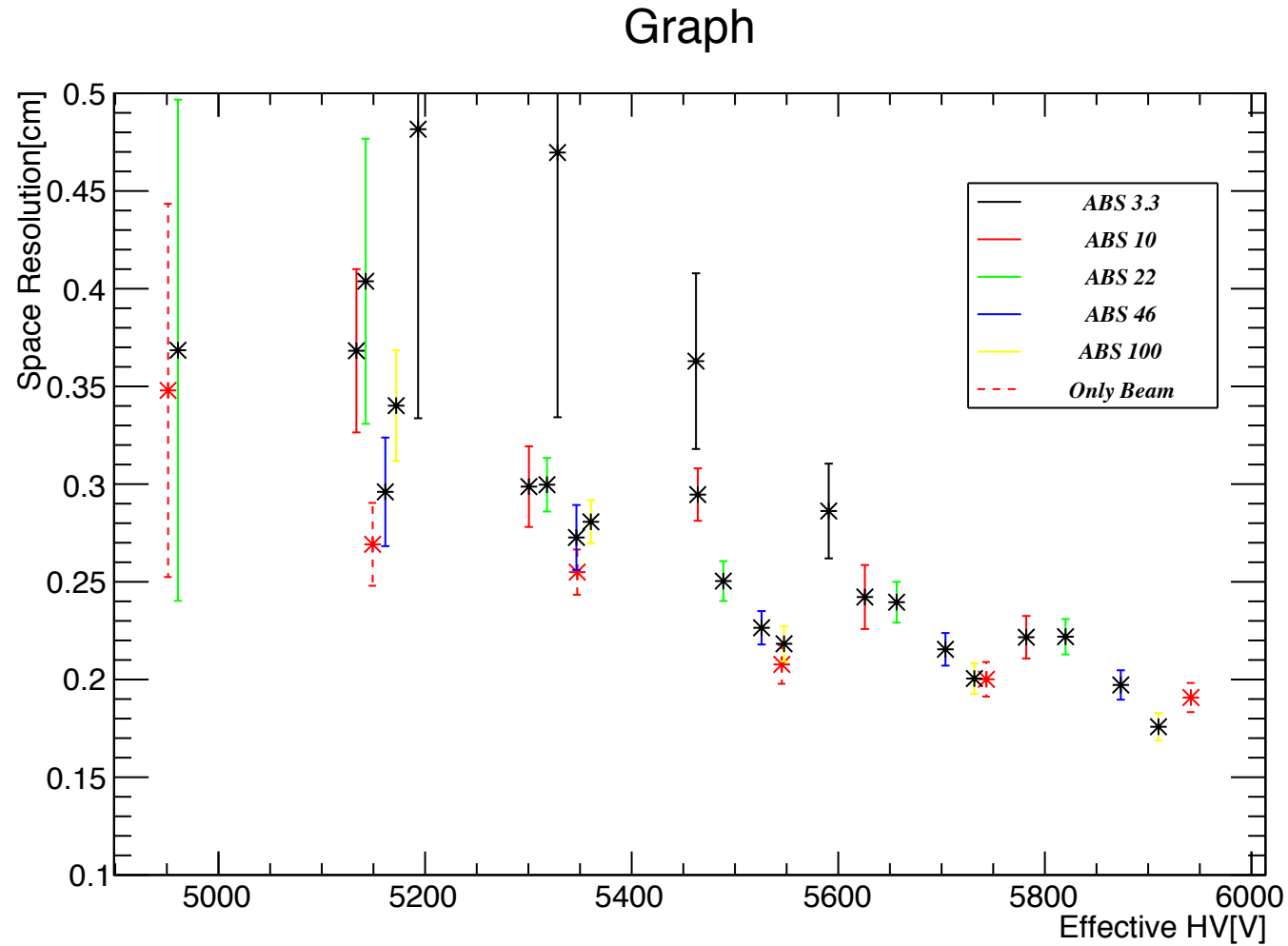
Max_amplitude VS Cluster Size(no time cut is applied)



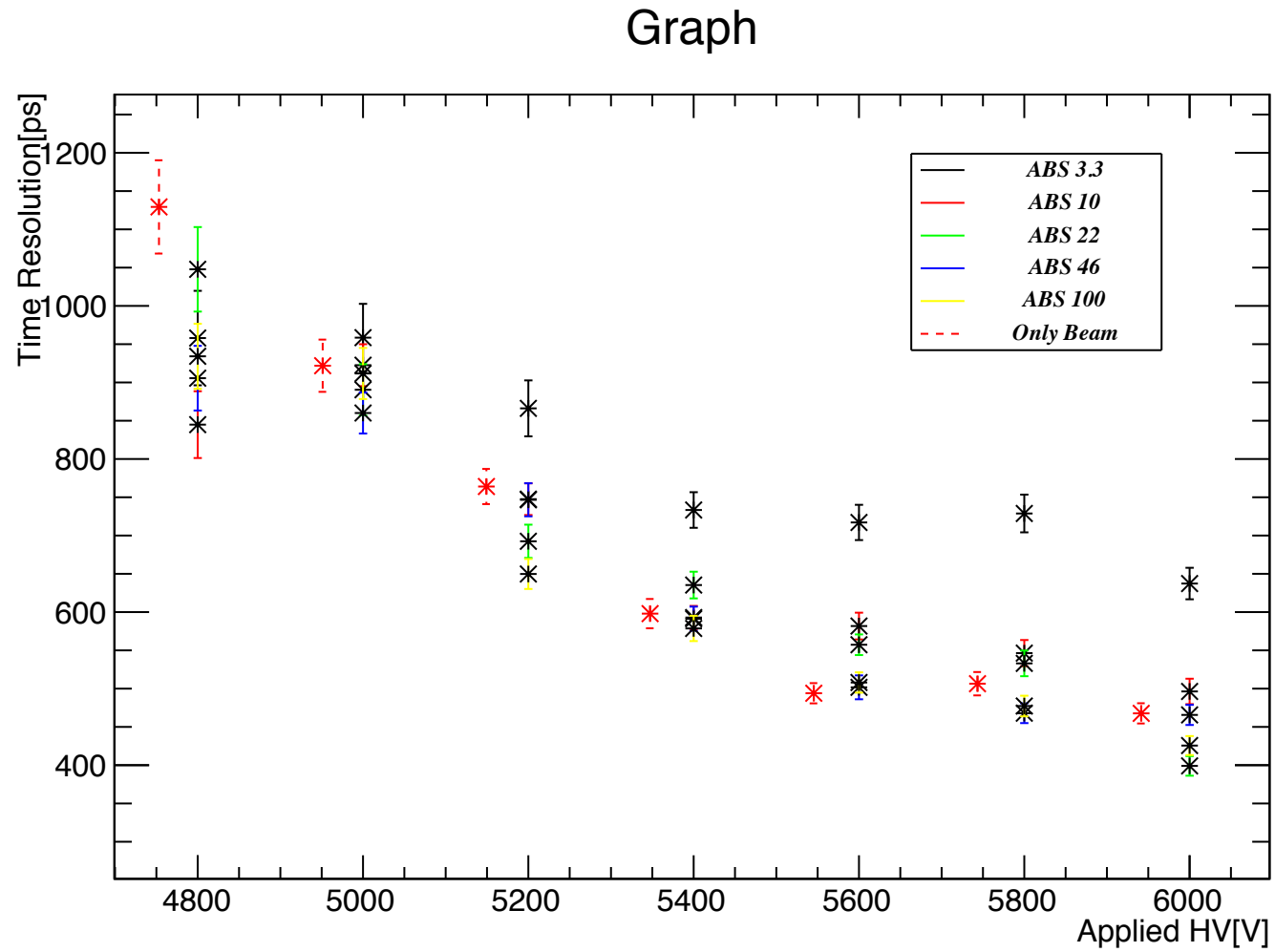
Threshold time in 6000V($4 \times \sigma$)



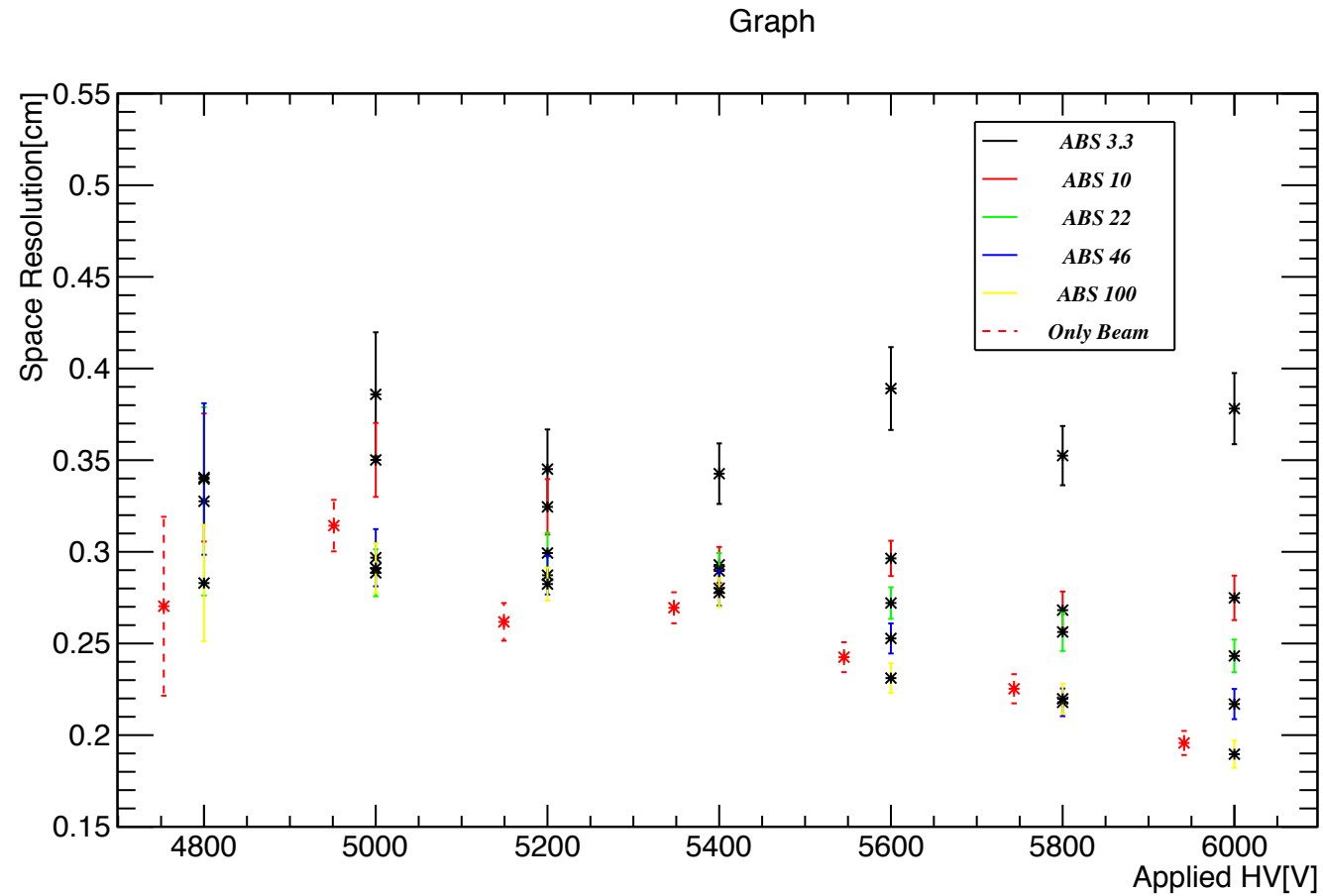
Space resolution of cluster size 5



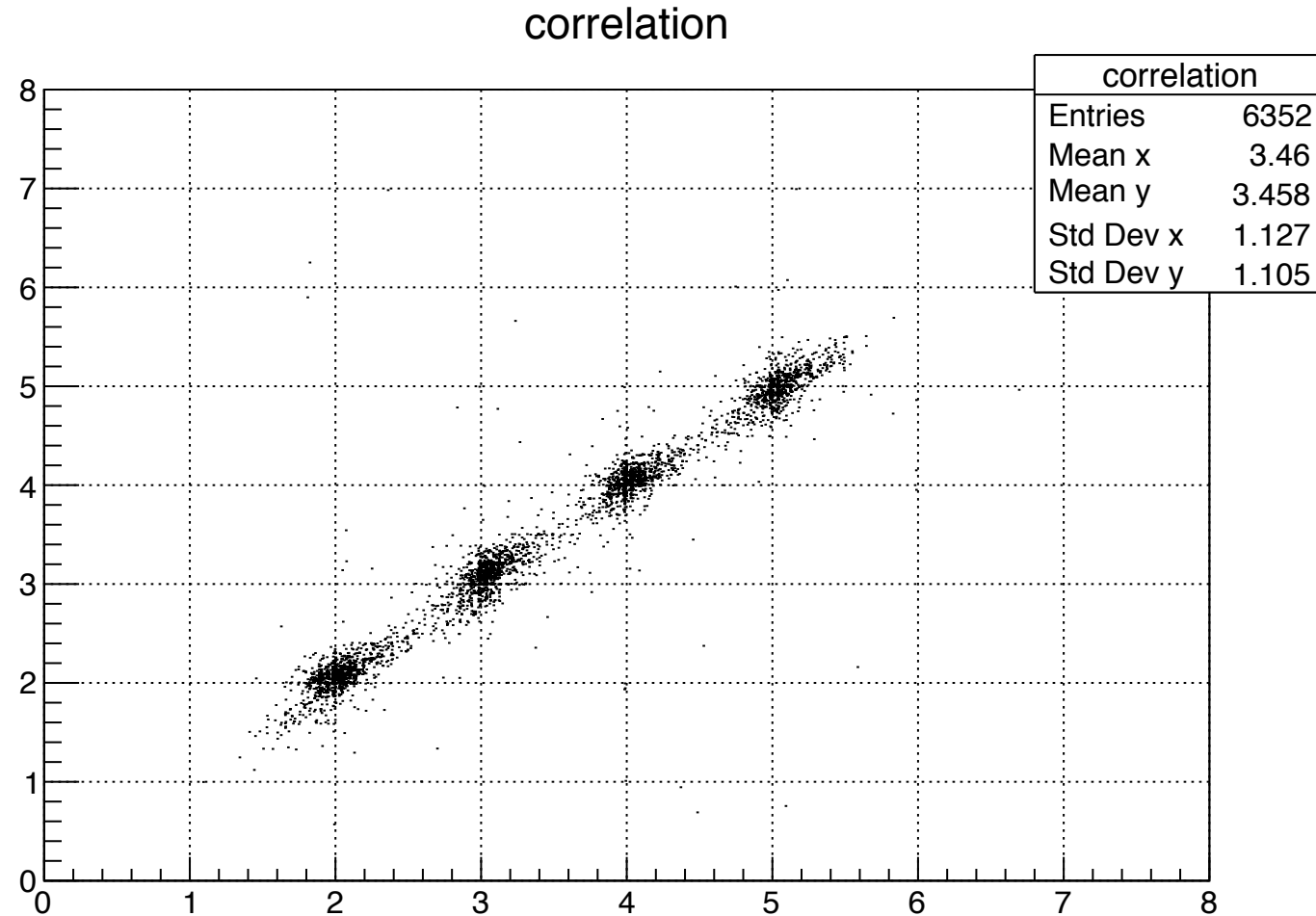
Time resolution(Applied HV)



Space resolution(Applied HV)



Correlation between positon of 2 chamber



position_A-positionB

