

Sci-W ECAL Status for CEPC

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On behalf of CEPC Calorimeter working group



Outline

- Motivation
- CEPC ECAL Status
 - Absorber optimization
 - Two layers prototype assembly and test
 - ECAL prototype
- Summary



PFA Calorimeter

➤ Challenges

➤ High granularity

➤ ECAL ~10 million channels

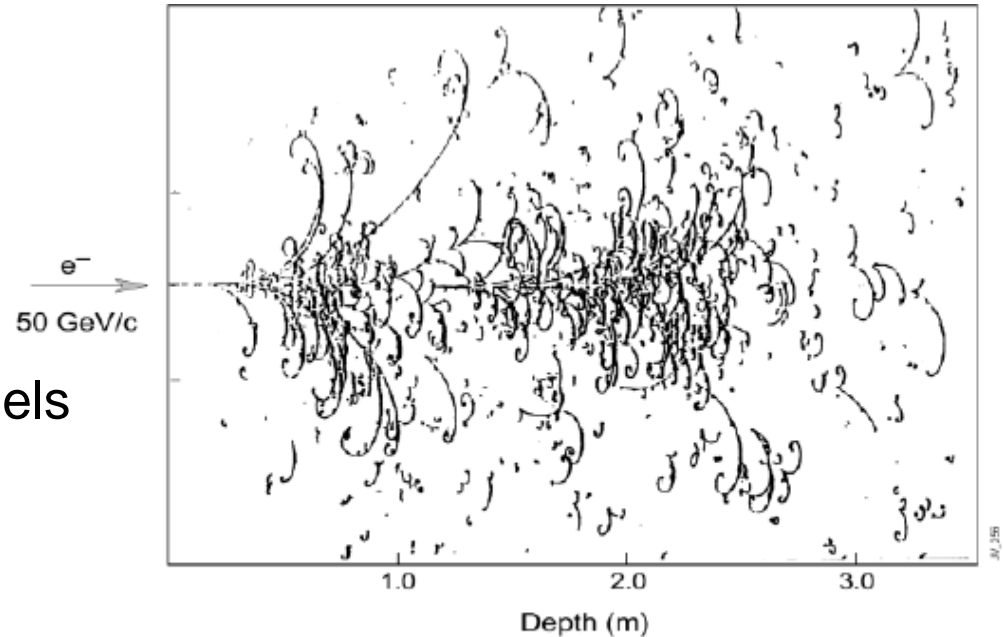
➤ Compact design

➤ High power

➤ ECAL about 100 kW

➤ EBU: 80 kW (without power pulsing)

➤ DIF: 20 kW

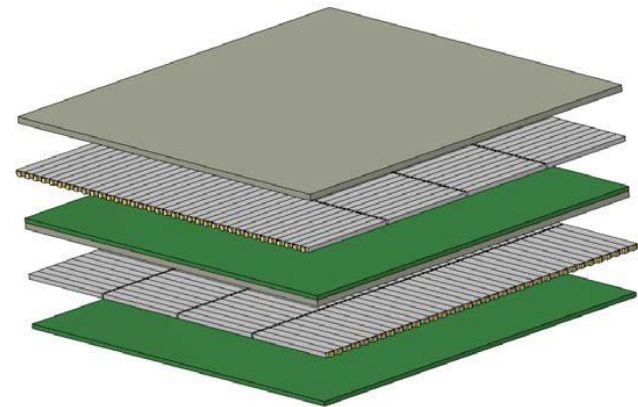
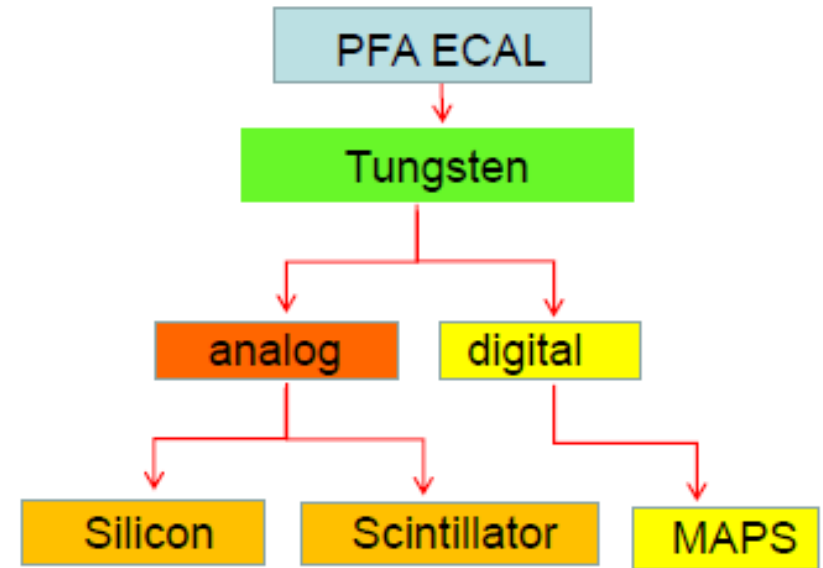


**Big European Bubble Chamber filled with Ne:H₂ = 70%:30%,
3T Field, L=3.5 m, X₀≈34 cm, 50 GeV incident electron**



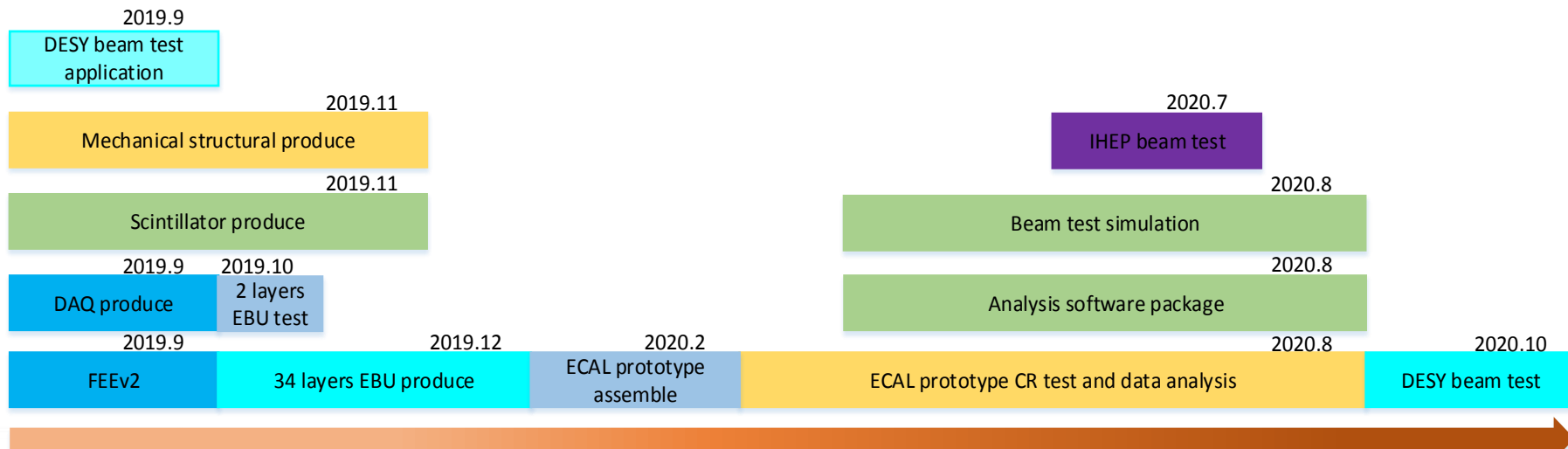
Sci-W PFA ECAL of CEPC

- **Sampling Calorimeter**
 - Sandwich structure
 - Absorber+SD+Electronics
- **Absorber**
 - Tungsten
- **Sensitive Detector**
 - Scintillator+SiPM
- **Electronics**
 - ASIC Chip



The schedule of ECAL

- According to the MOST funding task, a prototype should be assembled in the beginning of next year (2020.2)
- Then the cosmic ray test in laboratory and Beam test in IHEP and DESY respectively.



2019.8

2019/10/31

2020.10

5

Elements of ECAL



Scintillator (5mm*45mm*2mm)



SiPM (1mm * 1mm, 10k pixels)



- Dynamic range: $\sim 100\text{fC} \sim 200\text{pC}$
- channels: 36
- Dead time: 2ms
- Polar: positive
- power: 8mW/channel

General Status

- All of the elements and materials of the ECAL were arrival
 - Plastic scintillator, SiPM, SPIROC chips and others...
- Plastic scintillator strips production
 - About 1,000 plastic scintillator strips were produced now
 - 7, 000 strips will be produced in the end of Nov.
- 35 Electronics boards were produced last week. 32 layers will be welded in the end of Nov.
- The supporting mechanical design was discussed several times and one layer was prepared for trial assembly



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Absorber parameter

- In the previous design, the thickness of tungsten is 2.8 mm ($0.8 X_0$) each layer
- Considering the tungsten is very hard, not easy to punch
- Use the W-Cu alloy instead

$$\frac{1}{X_0} \equiv \sum_i \frac{w_i}{X_i}$$

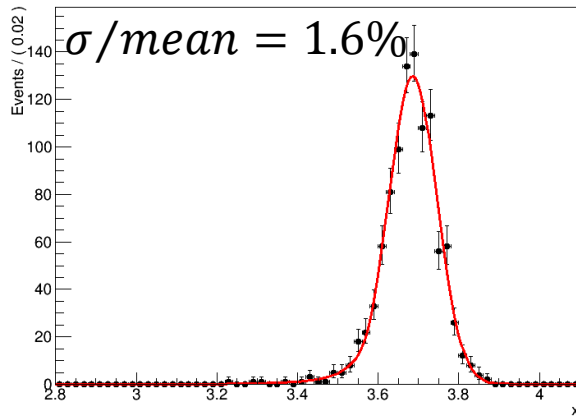
W:Cu	100:0	85:15	75:25
X_0 (mm)	3.5	4.4	5.1



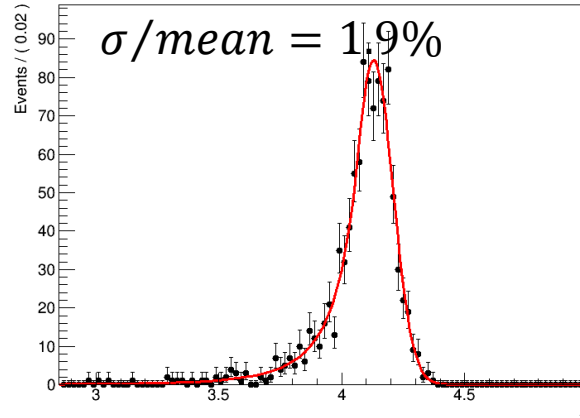
Absorber parameter

Energy resolution @ 100 GeV γ . 30 layers, each layer is 2.8 mm

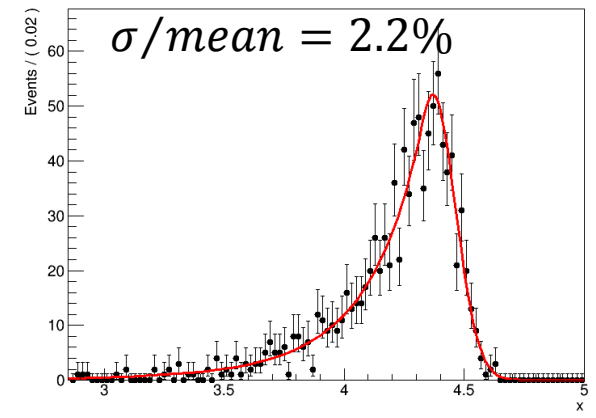
W:Cu 100:0



W:Cu 85:15

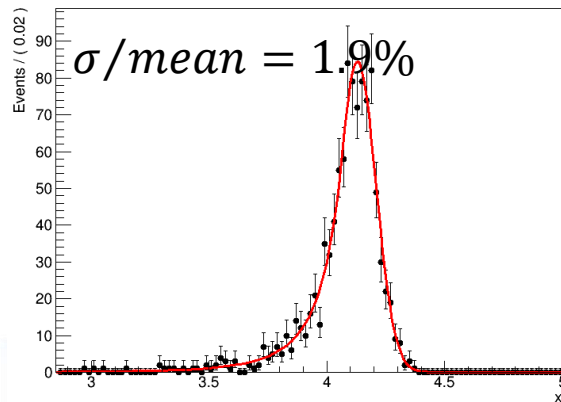


W:Cu 75:25

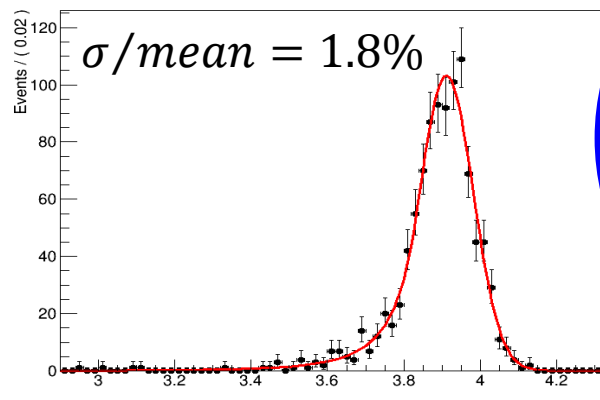


Energy resolution @ 100 GeV γ . 30 layers, W: Cu 85:15

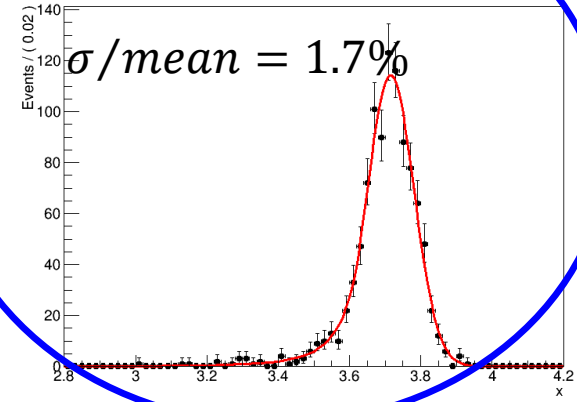
2.8 mm



3.0 mm



3.2 mm

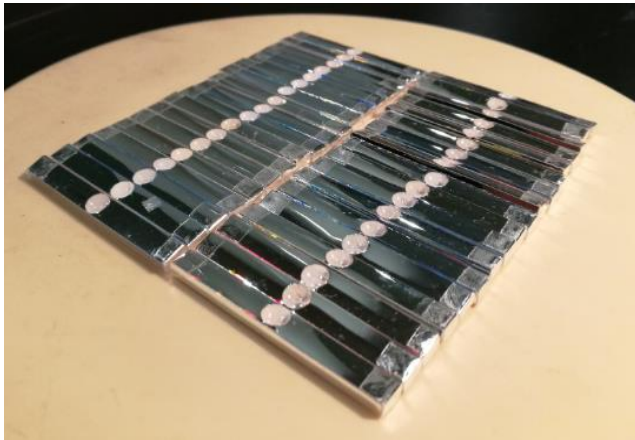
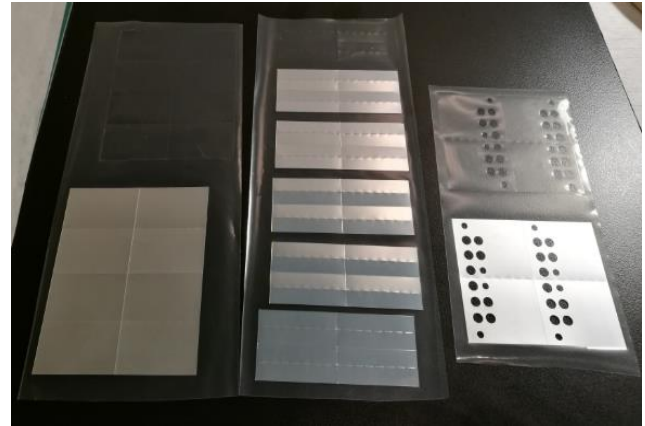
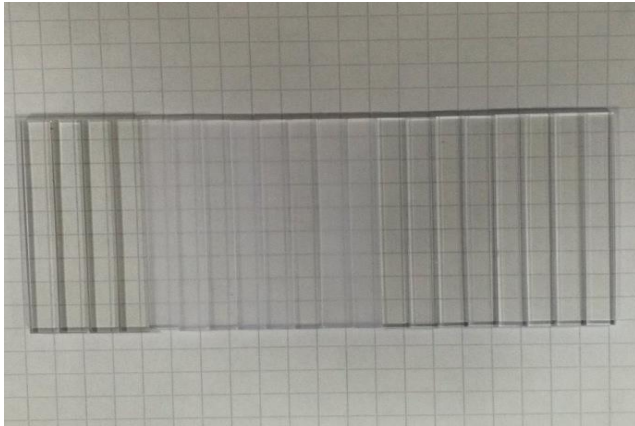
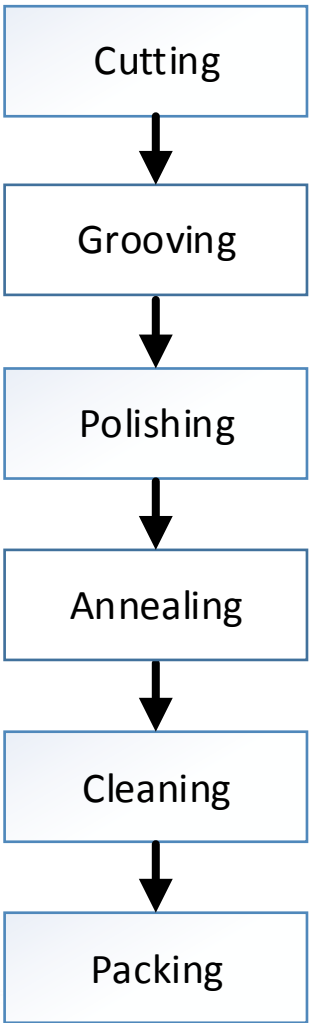


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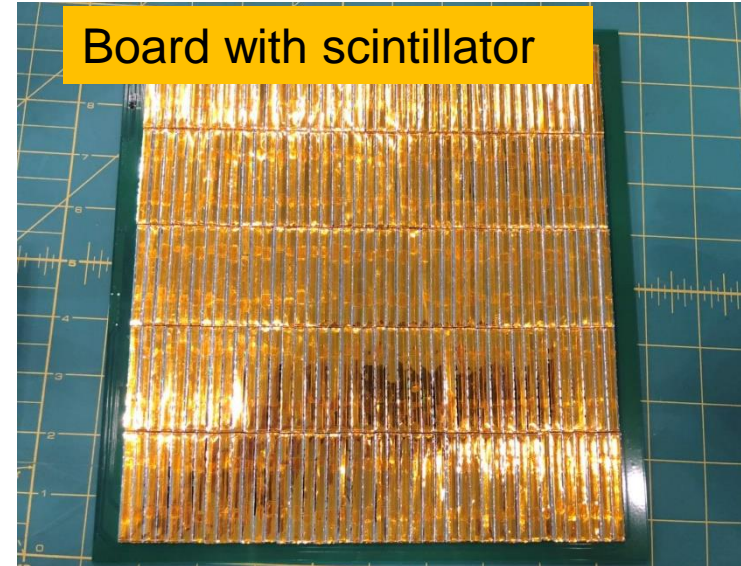


Prototype assembly



Prototype assembly

- EBU V2.1

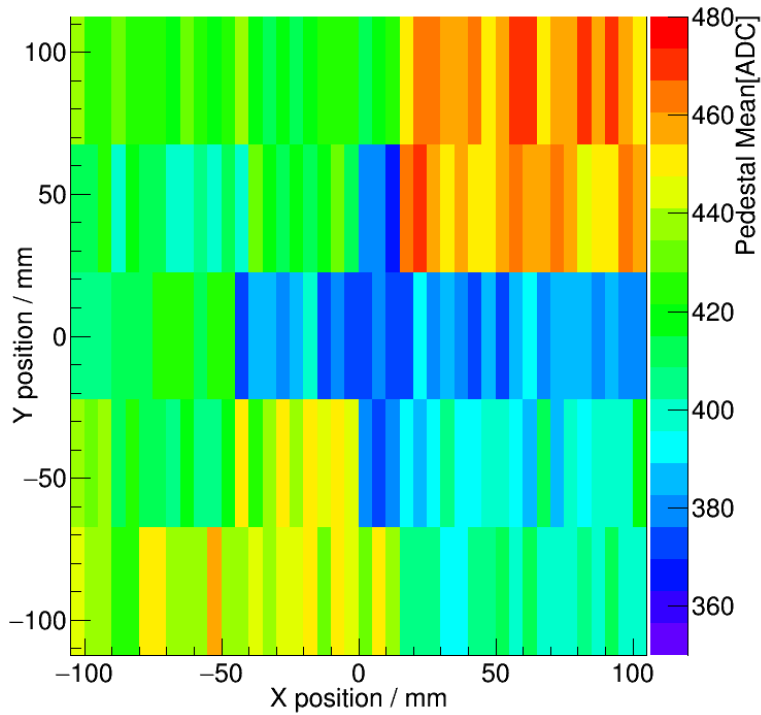


- Two layers were assembled with 2 different type SiPM.
 - S12571-010P, 10000 pixels, 10 um, PDE: 10%
 - S12571-015P, 4880 pixels, 15 um, PDE: 25%

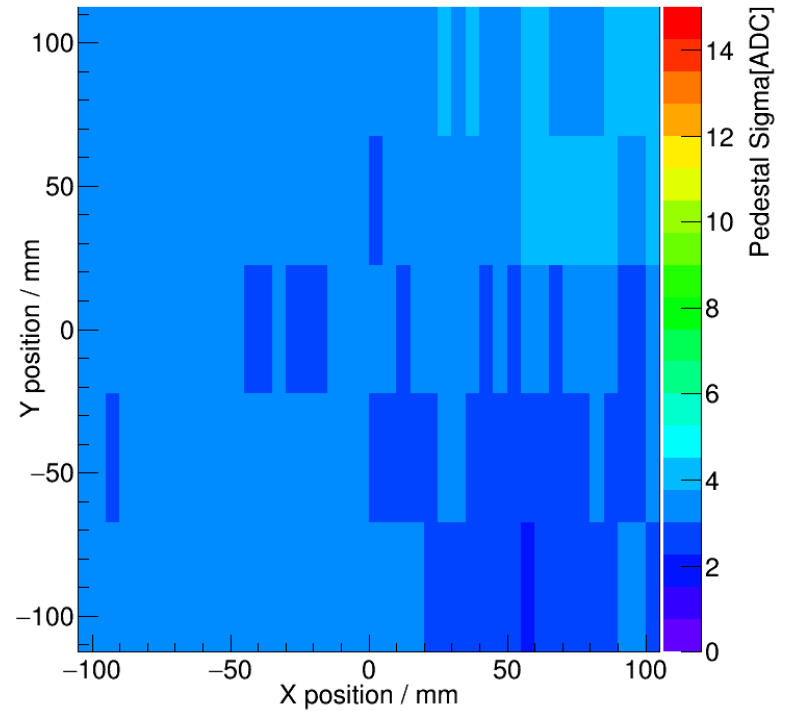


pedestal

Pedestal Position

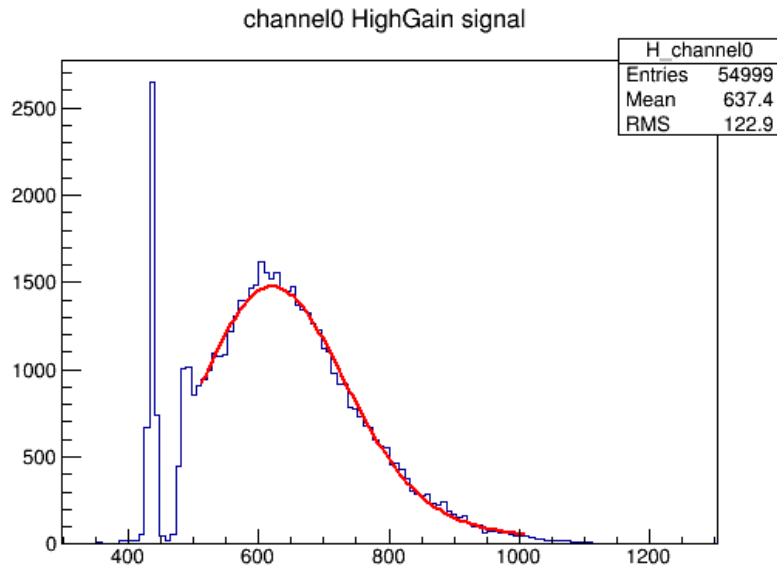
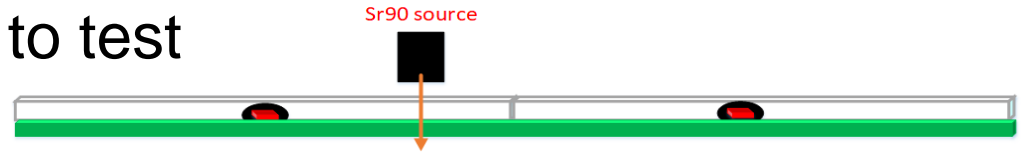


Pedestal width

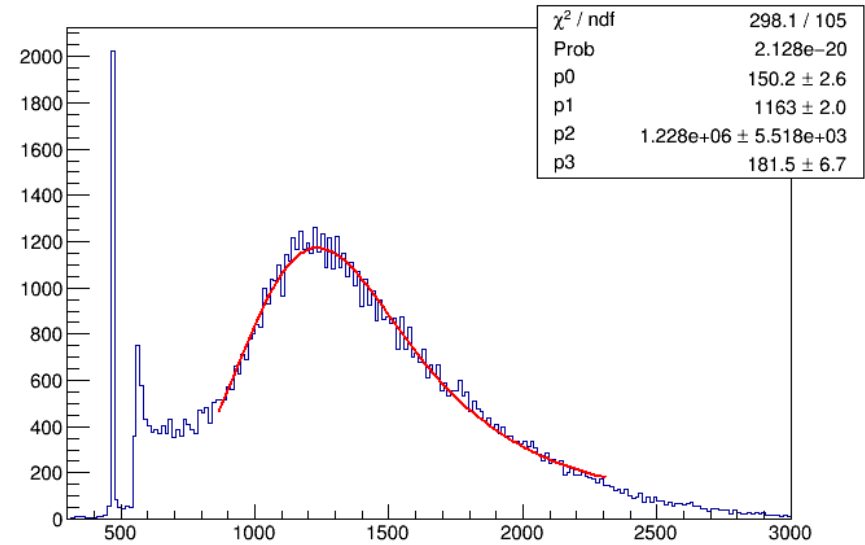


MIPs response

Use Sr-90 radiation source to test



10 um SiPM

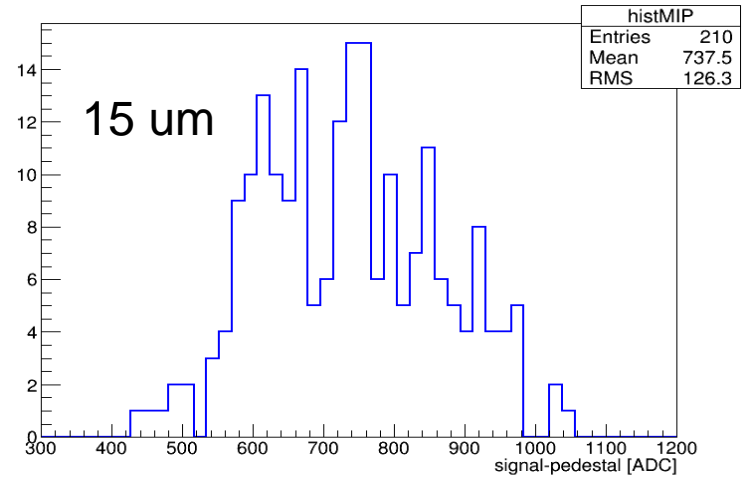
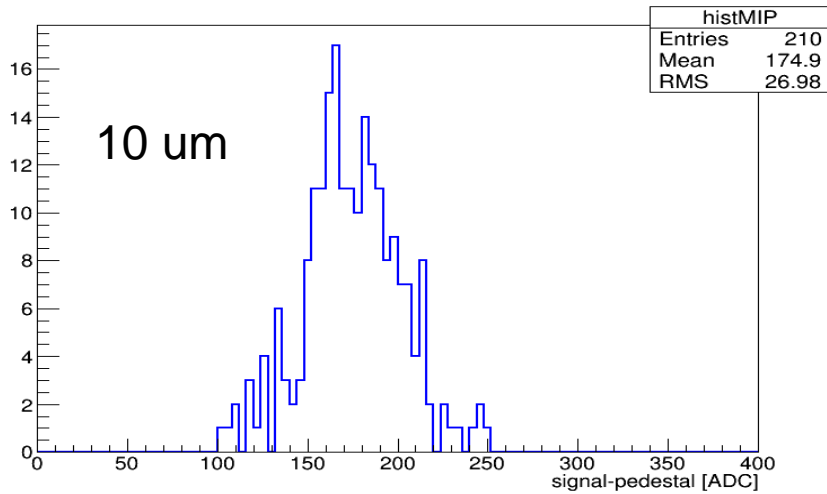


15 um SiPM

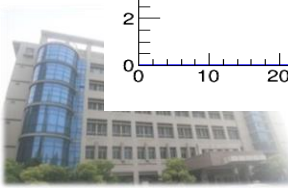
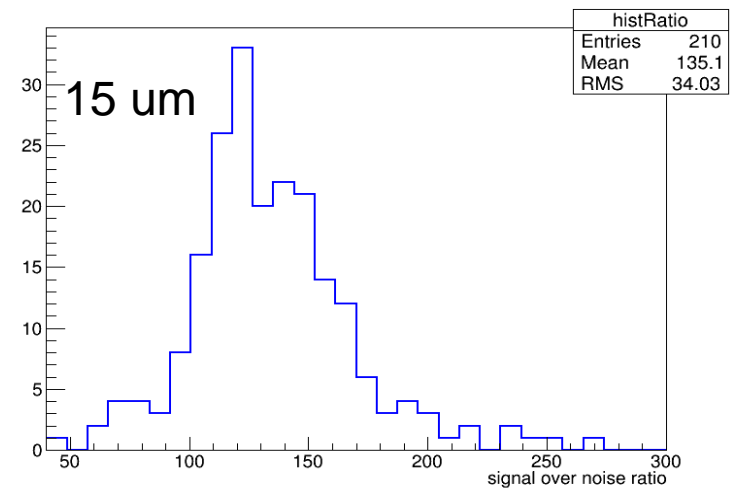
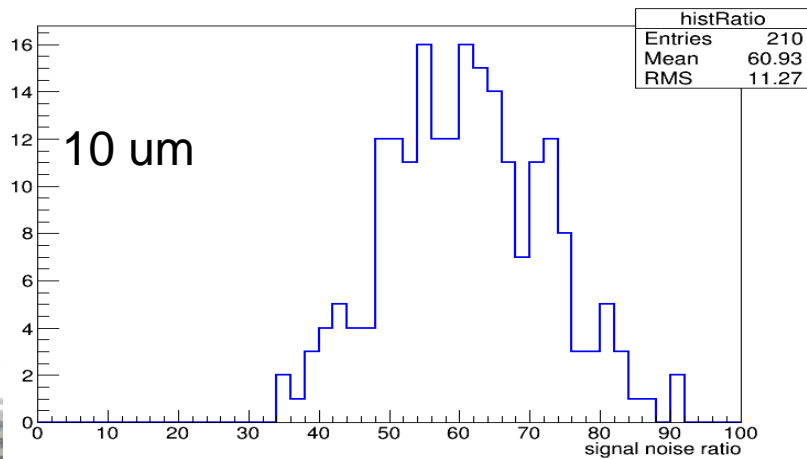


MIPs response

MIPs amplitude of each layer

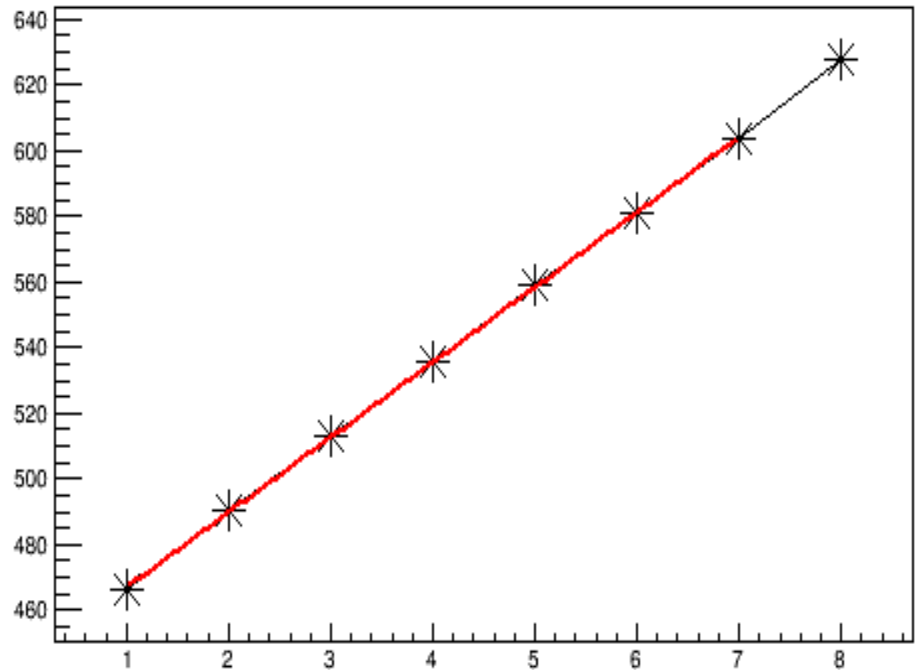
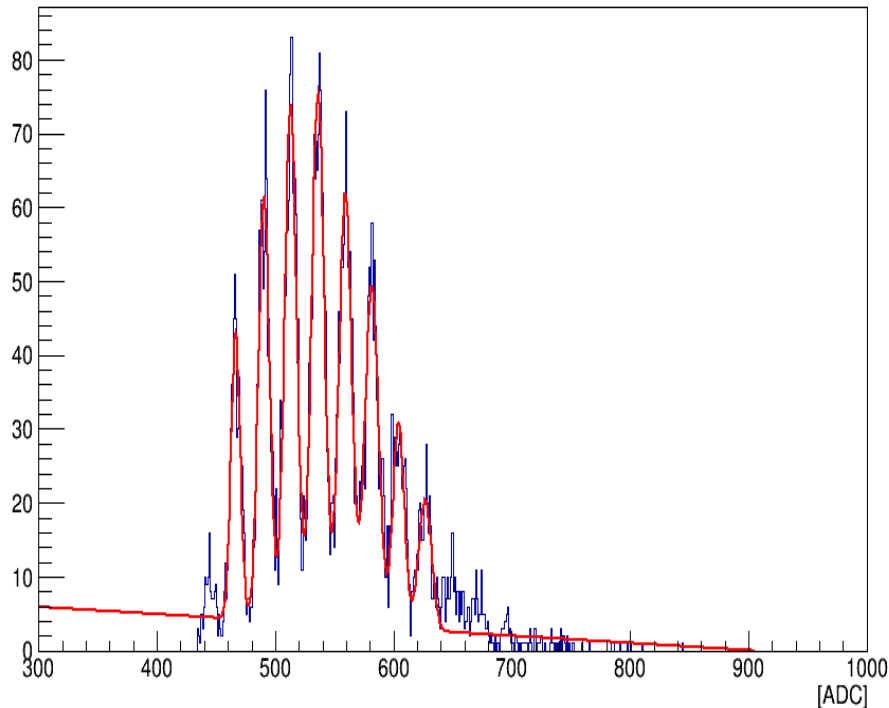


Signal Noise Ratio



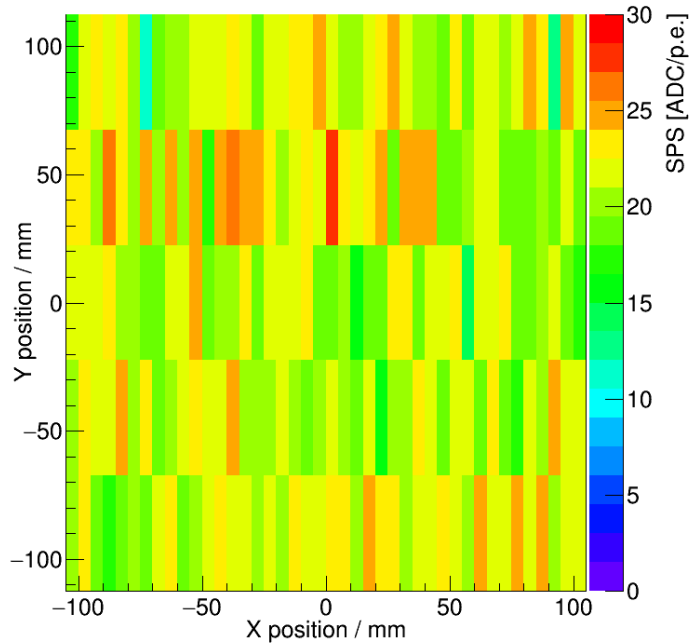
LED calibration

LED calibration system in electronics board could be used to calibrate the SPE of SiPM. If the gain of SiPM is good enough, the SPE could be seen clearly.

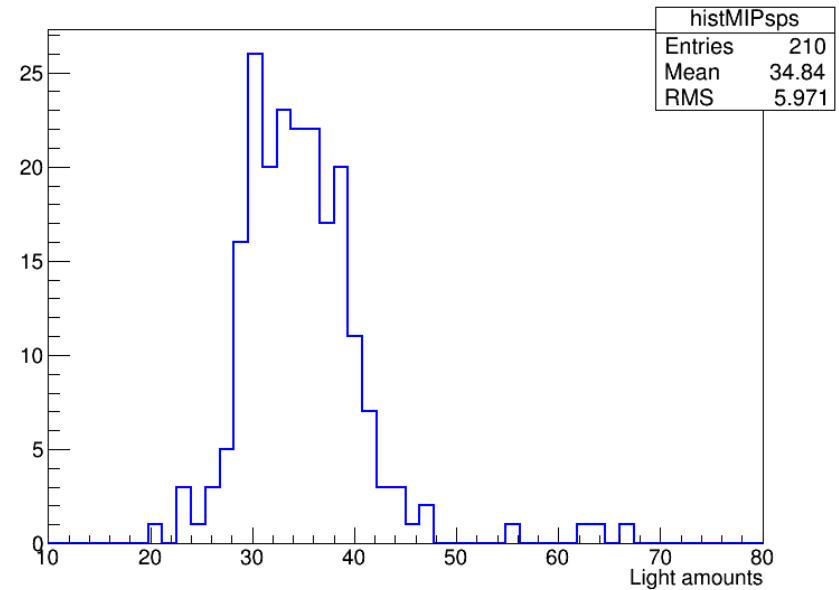


LED calibration

SPE amplitude of each channel
15 μm SiPM



Light yield of MIPs



The scintillator coupled with 15 μm SiPM, light yield is about 35 p.e. /MIP

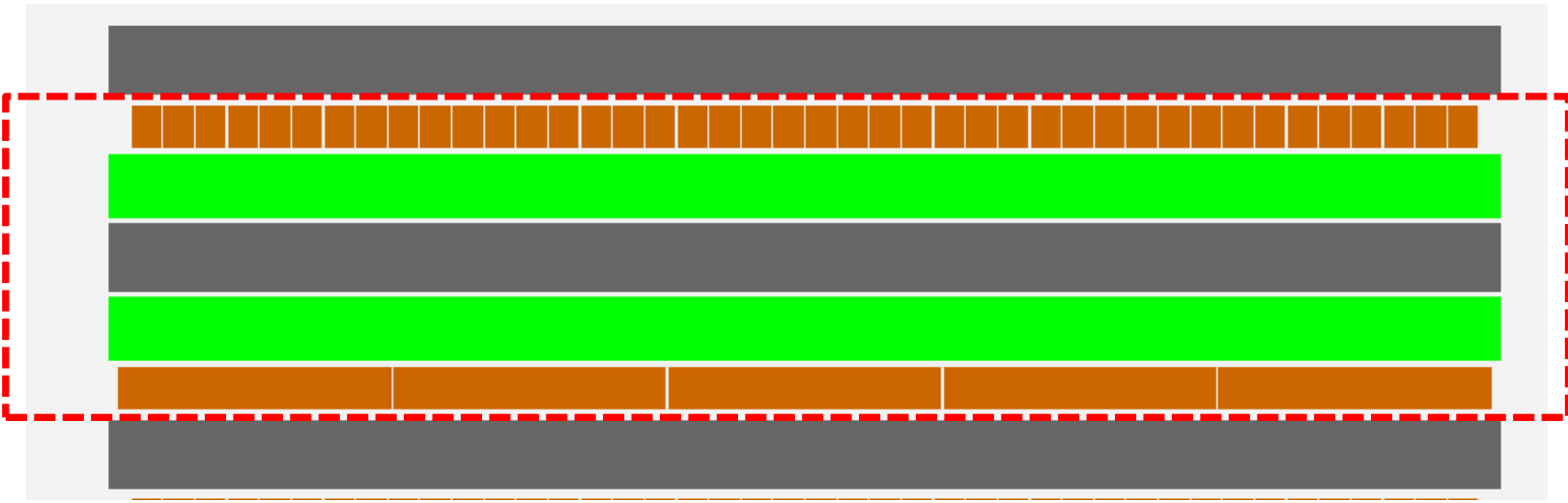





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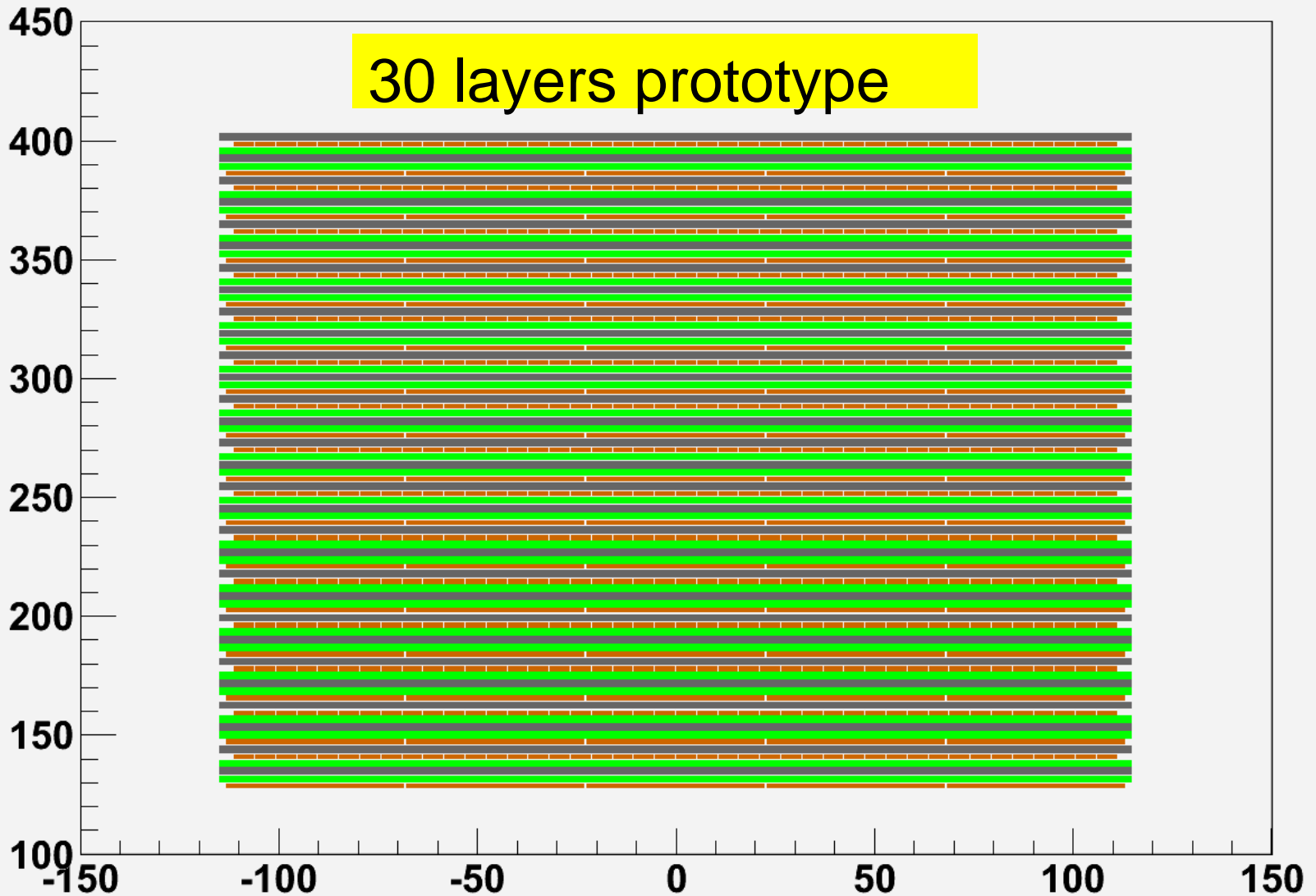
ECAL prototype



-  tungsten
-  scintillator
-  PCB



ECAL prototype



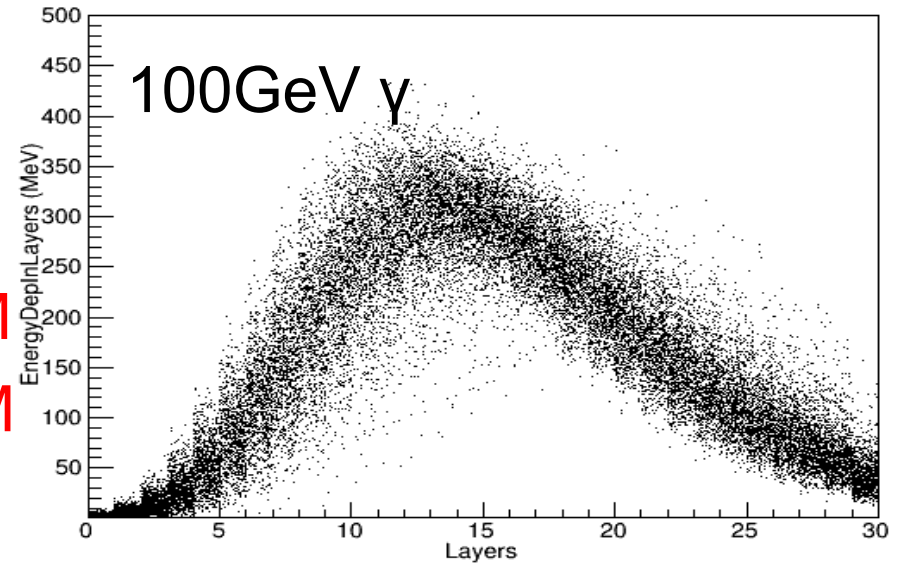
ECAL prototype

- 30 layers
 - 1-2 layers, 15 μm SiPM
 - 3-28 layers, 10 μm SiPM
 - 29-30 layer, 15 μm SiPM

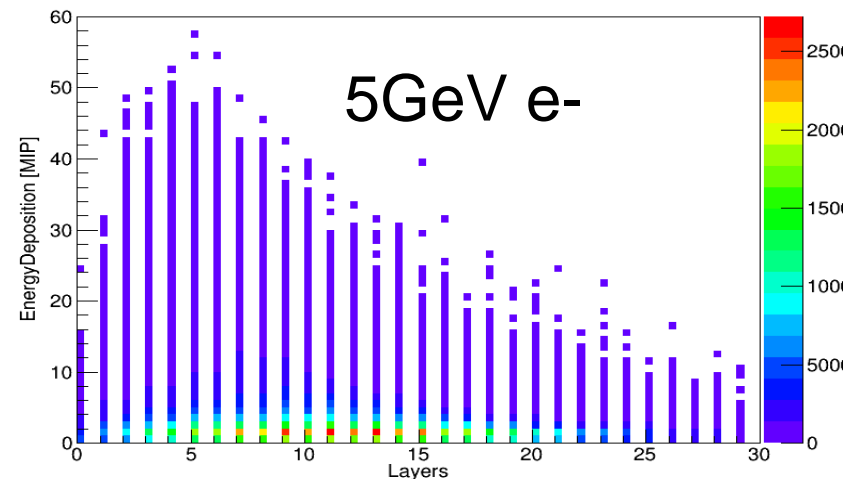
◆ 15 μm

- ◆ DCR \sim 100 kpc
- ◆ CT \sim 15%
- ◆ CT rate >10 pe \sim 0.06%
- ◆ LY \sim 30 pe/MIP
- ◆ Thr $>$ 10 pe or more

hh1



Shower profile in ECAL

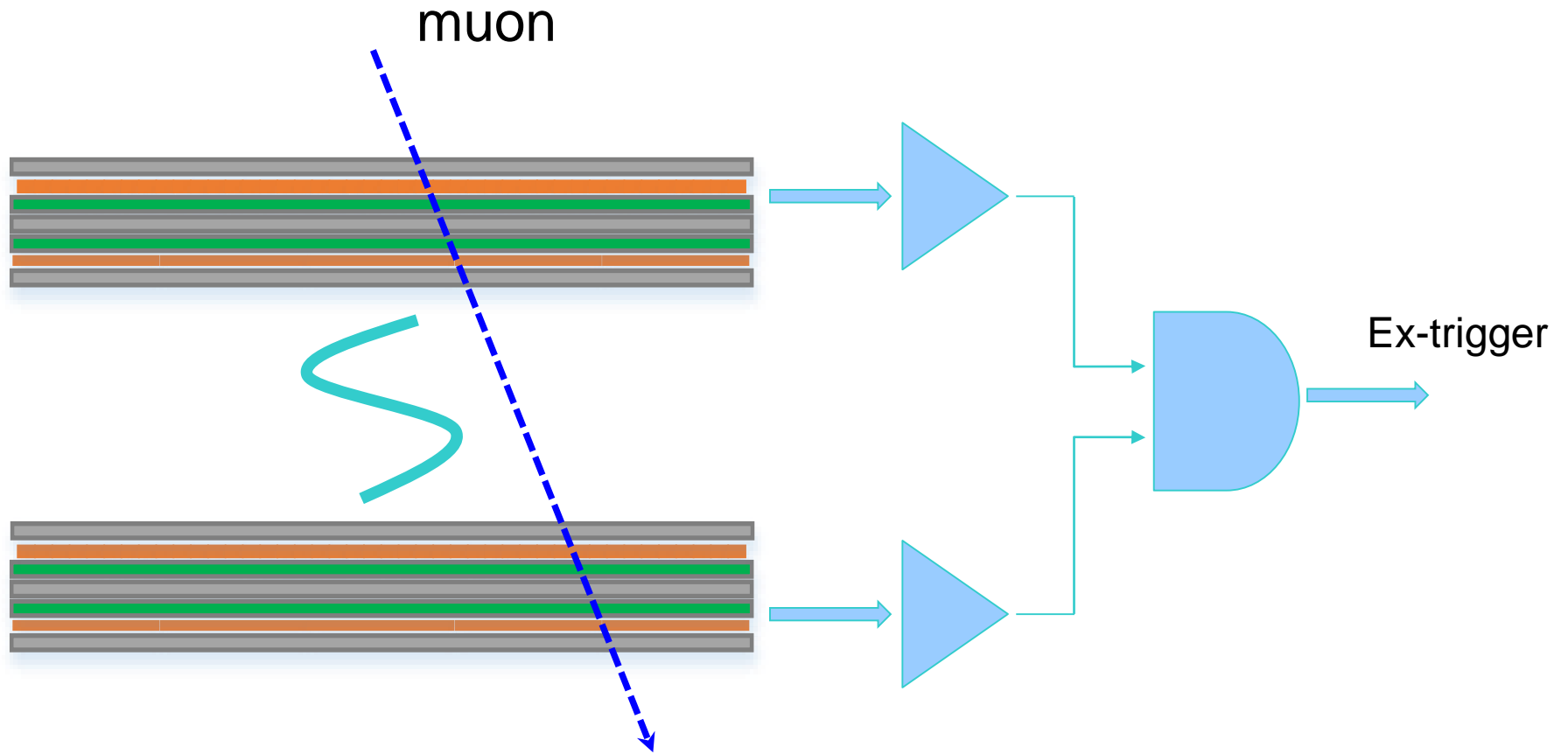


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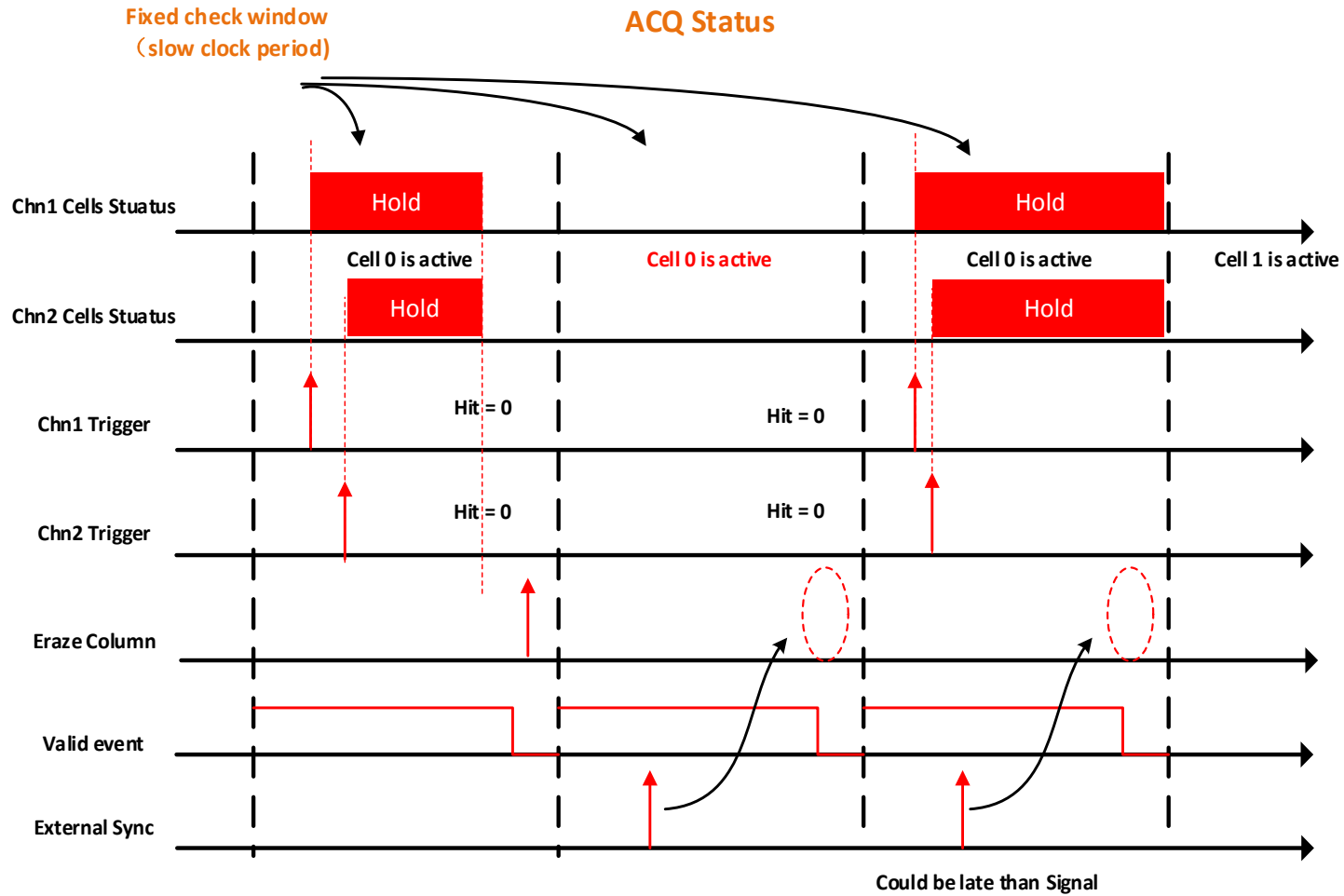
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ECAL test trigger



ECAL trigger



Validation Mode



Summary

- All the elements and materials are prepared
- Electronics boards are ready
- Two layers were assembled and tested. The operation are well.
- 30 layers will be started to assemble in Nov.

