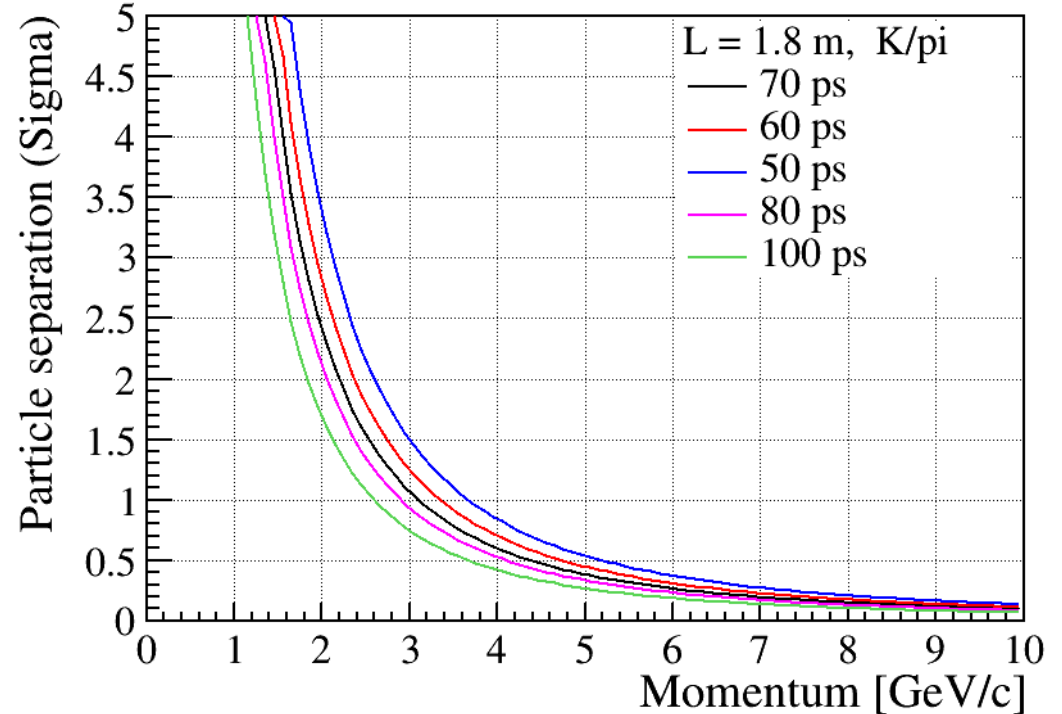
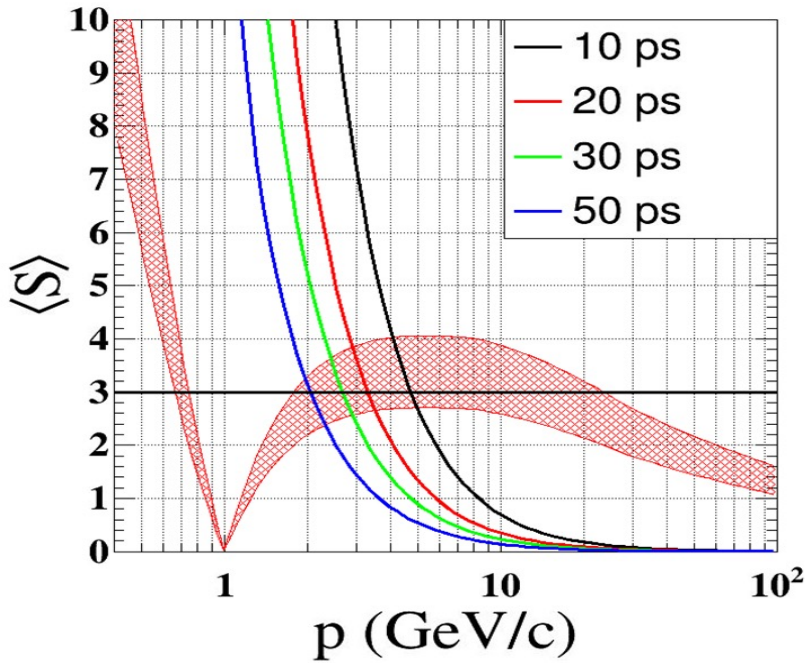


---

# LGAD based time of flight and outer tracker

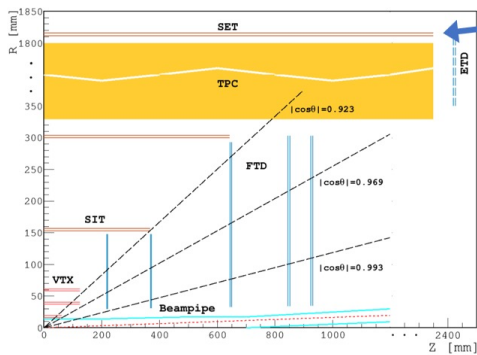
# Physics requirement

- 3 sigma K/pi separation below 2GeV
  - 50 ps precision is the target

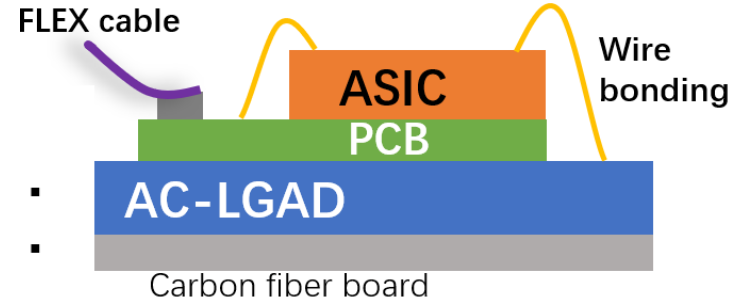
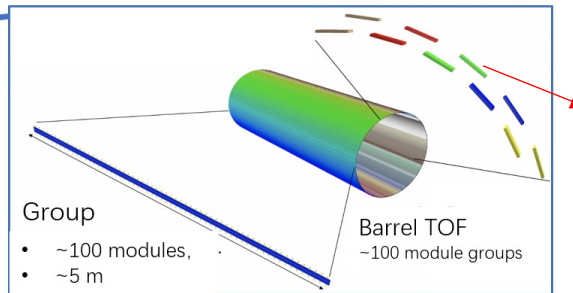


# CEPC 4D outer tracker

Baseline detector concept in CDR



LGAD timing detector in Barrel region



- 
- 



## CEPC 4D outer tracker concept design:

- Should be part of SET (silicon wrapper layer outside TPC or drift chamber)
- Serve as Timing detector and part of the tracker
- Barrel :  $50 \text{ m}^2$  , Endcap  $20 \text{ m}^2$  ,  $\sim 10^6$  channels
- Strip AC-LGAD ( each strip:  $4 \text{ or } 10 \text{ cm} \times 0.05 \text{ cm}$  )
  - Timing resolution:  $30\text{-}50 \text{ ps}$
  - Position resolution:  $\sim 10 \mu\text{m}$  @ R-phi direction
  - $\sim 1 \text{ mm}$  @ z direction

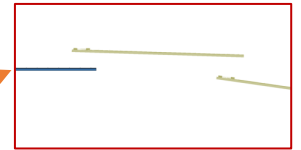
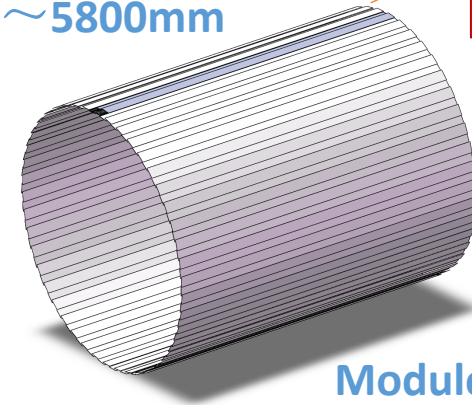
### Strip AC-LGAD + ASIC :

- TOT->amplitude->charge sharing->position
- TOA+TOT->timing (time-amplitude correction)

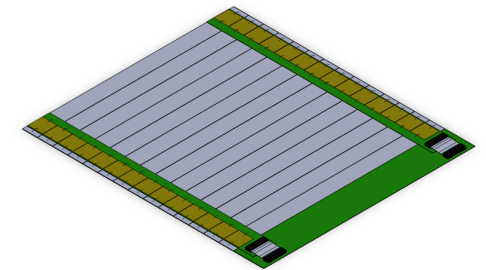
# Arrangement of the ToF with strip LGAD

- One layer:  
90 ladders, 45 ladders each side,  
42 modules/ladder, 28 ASIC/module
- Total modules needed:  
 $45 * 2 * 42 = 3780$  modules

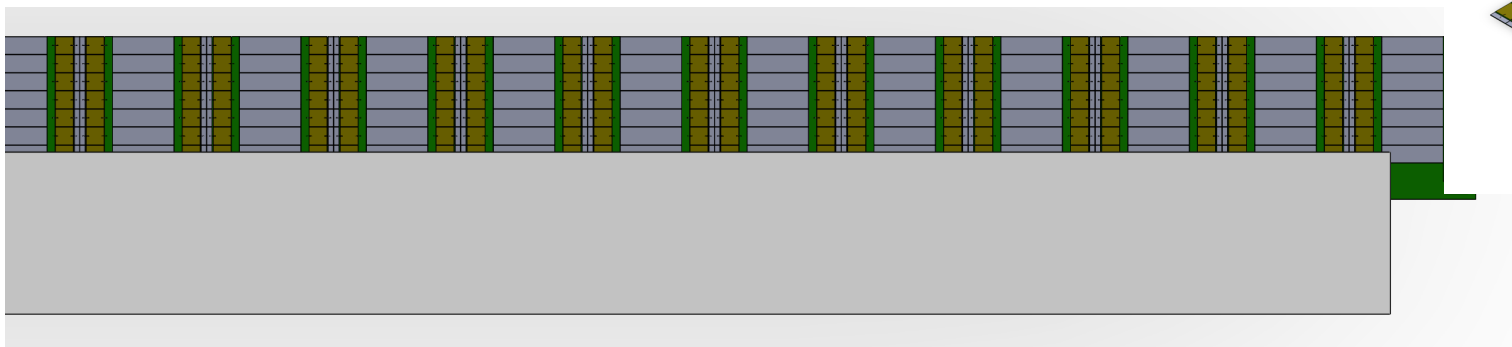
One layer ToF  
R= 1800 mm  
H~5800mm



Module  
140mm x 160mm



Ladder



	ATLAS HGTD	CEPC TOF barrel
Area (m <sup>2</sup> )	6.4	~ 70
Granularity	1.3 mm × 1.3mm	70mm × 0.1mm (10平方厘米, 每个芯片128道)
Capacitance	4pF	~10 pF
Charge	>4fC	>15fC
Channel number	~ $3.6 \times 10^6$	~ $1 \times 10^7$ (10644480)
Module assembly	Bump bonding	Wire bonding at strip
MIP Time resolution	30-50 ps	~50 ps
Spatial resolution	~ 300 $\mu\text{m}$	~ 10 $\mu\text{m}$
Number of Module	8032	3780 (14cm*14cm)
Number of channels per module	255	2816 (22 芯片, 128道)
Data size	16 bit (9 TOT, 7 TOA) 2.5ns → 量程 25ns bunch	16 bit (9 TOT, 7 TOA) + channel(7bit, 128) +bunch ID(8bit) + chip ID (4-5 bit) ~40-48 bits
Data rate		5Hz/ cm <sup>2</sup>

# Endcap design

- ITK strip endcap

## LGAD endcap design

- Help to reduce the material budget
- The size of the petal is decided by the silicon wafer size

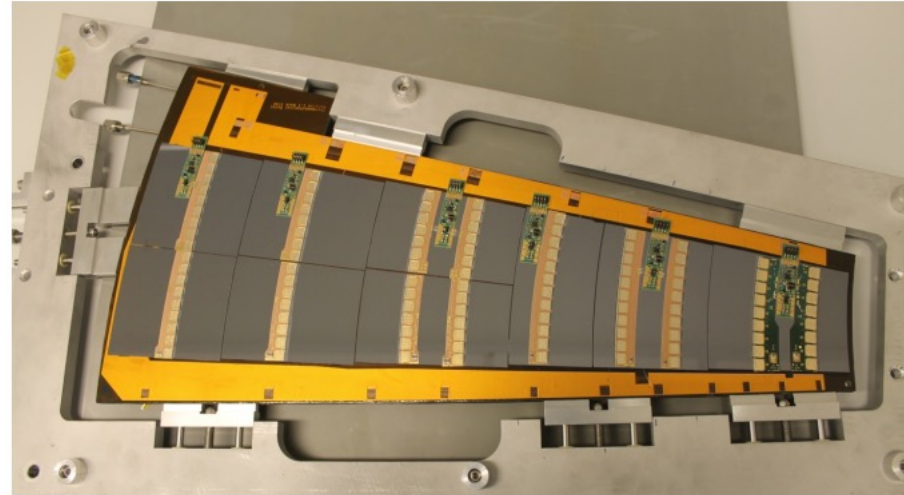
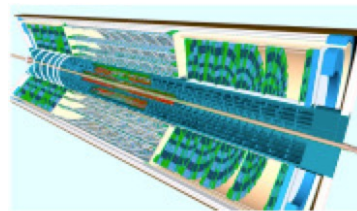
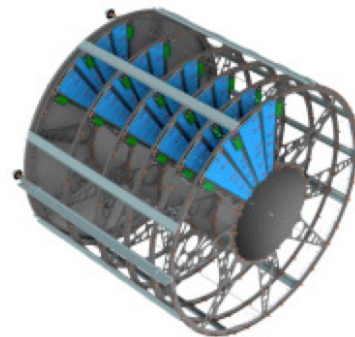


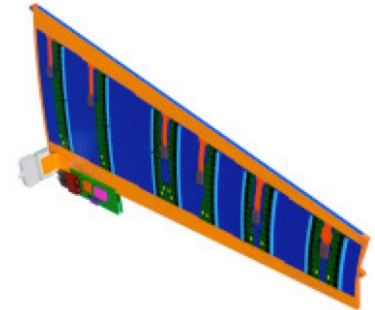
Figure 9.18: Photo of the thermo-mechanical petal prototype.



(a)



(b)



(c)

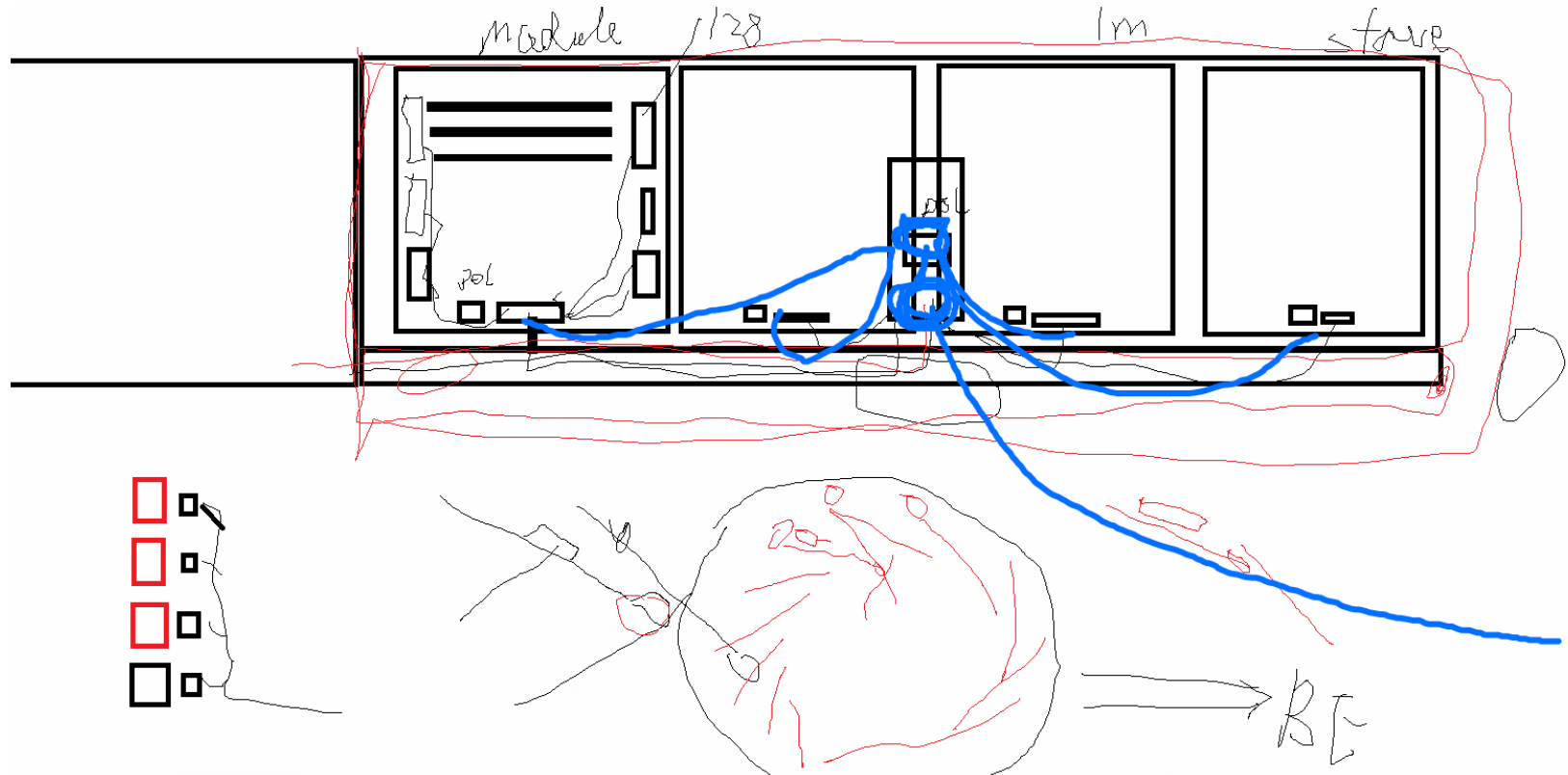
# Backup

---

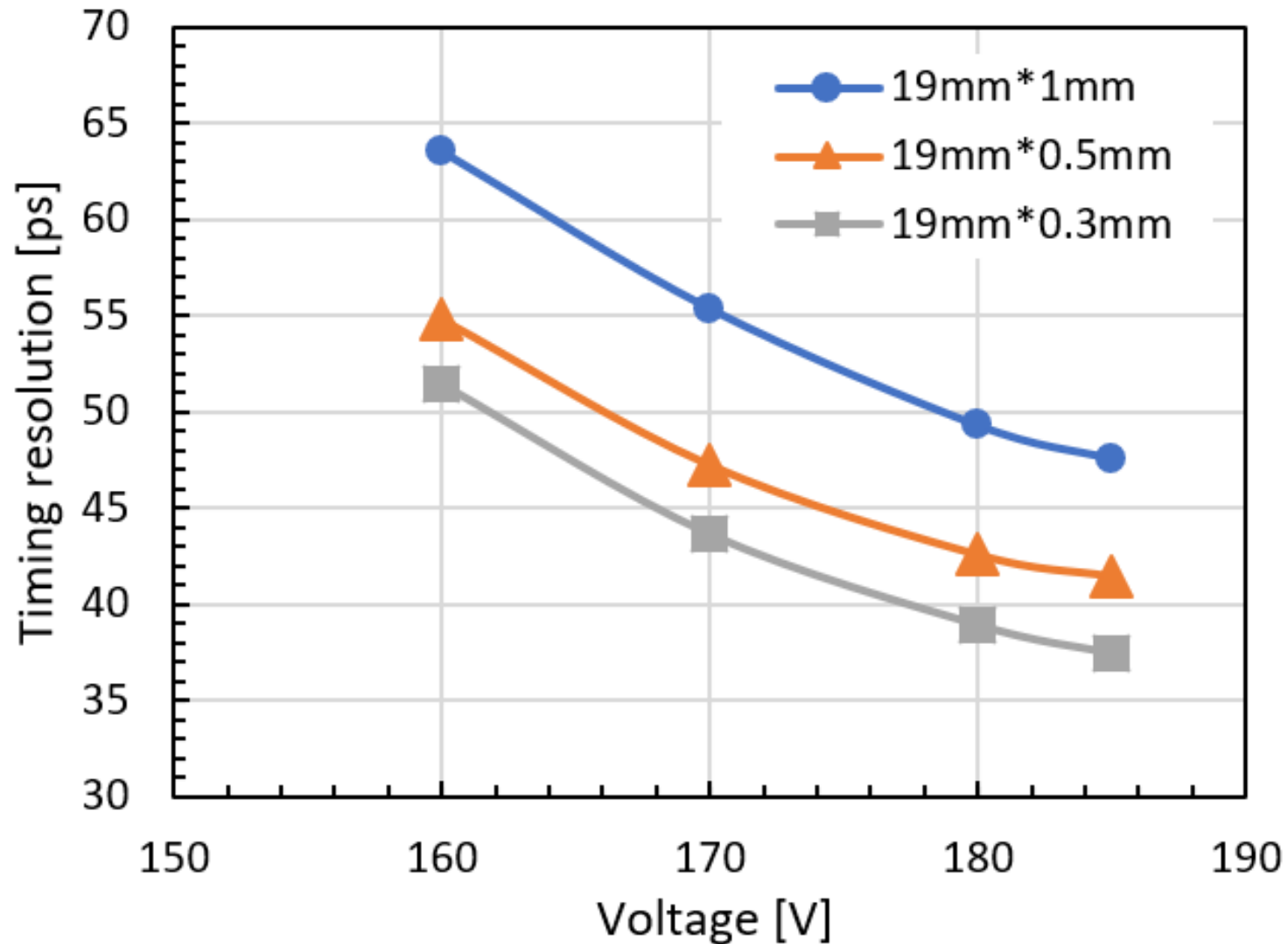




# 确定了电子学框架

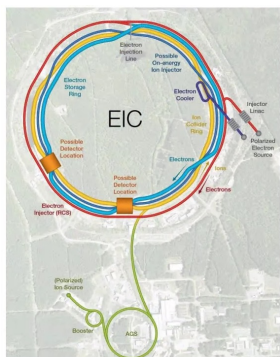


# Timing resolution (different dimension of strip )

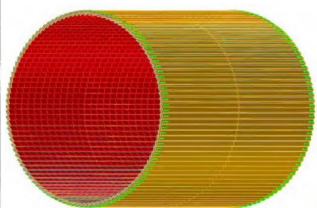


# Application of AC-LGAD

## Electron-Ion Collider (EIC): Timing-tracker

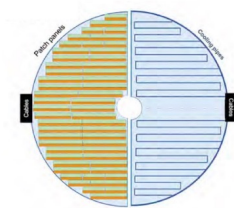


Barrel AC-LGAD detector



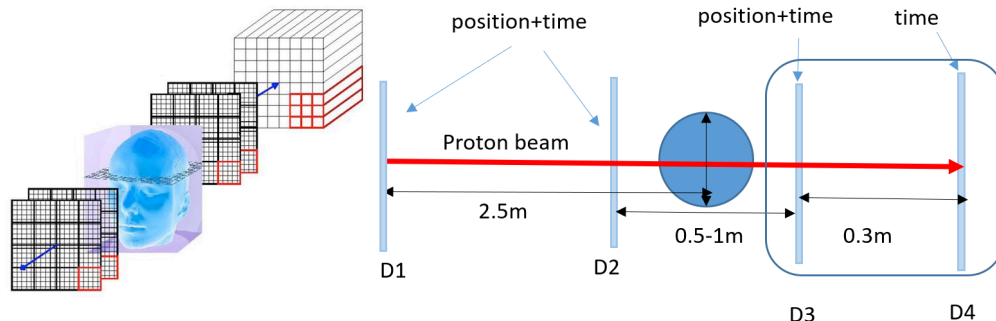
10.9 m<sup>2</sup>

Hadron endcap AC-LGAD detector



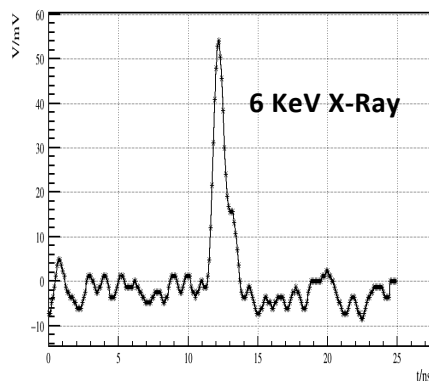
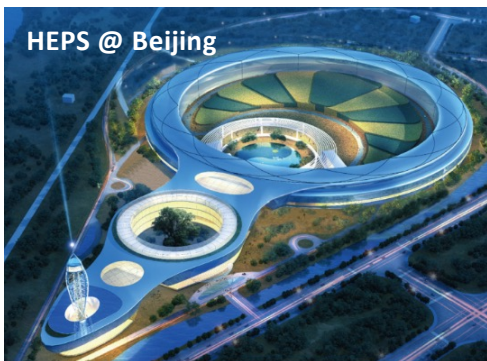
2.22 m<sup>2</sup>

## Nuclear Medicine Instruments: Such as proton therapy and proton CT



## X-ray detectors @ advanced light sources

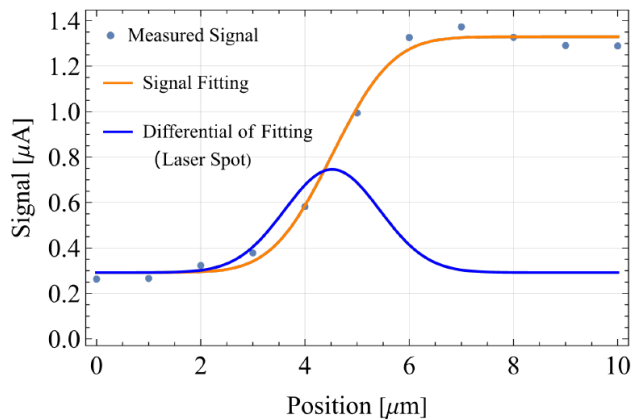
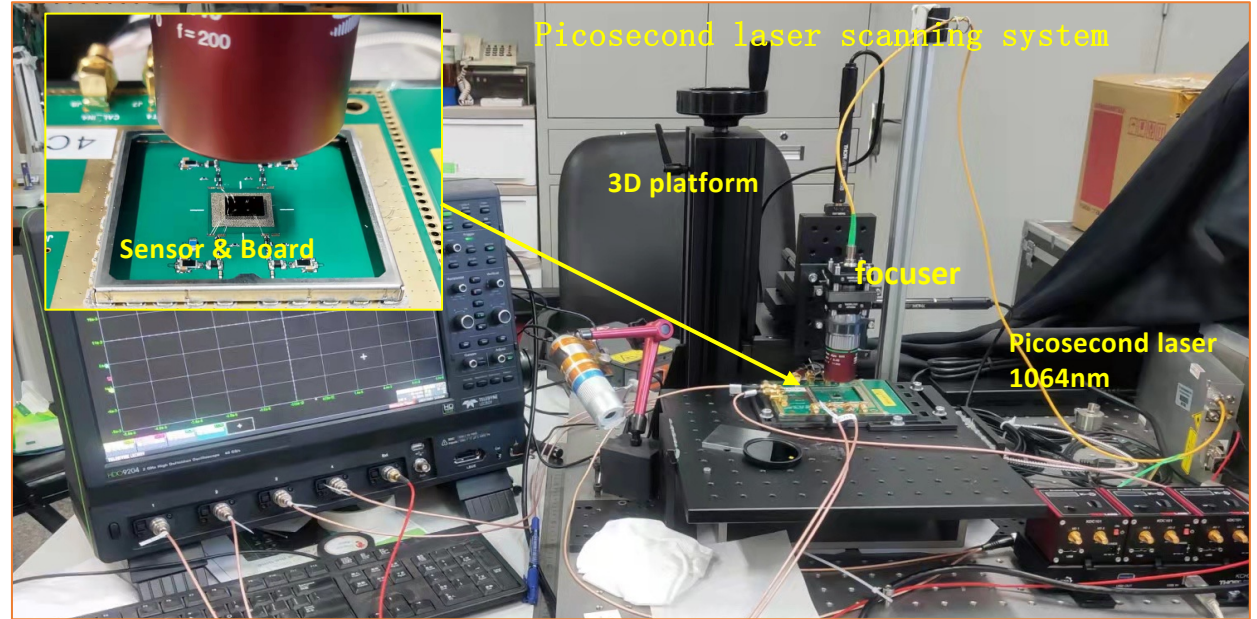
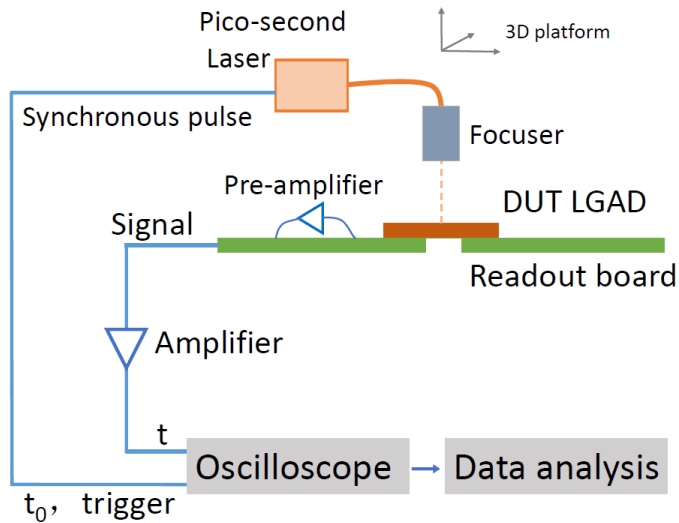
HEPS @ Beijing



## other applications

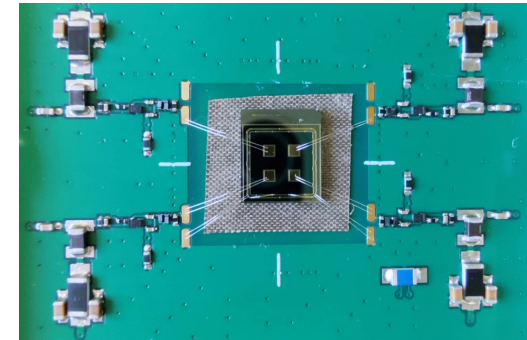
- Beam Telescope for Beam Test Platform
- LiDAR: Positioning and Navigation
- Track and time detectors in other particle physics and nuclear physics experiments
- ...

## 4.1 AC-LGAD sensor test : Picosecond laser test



### Picosecond laser scanning system

- Displacement accuracy  $1 \mu\text{m}$
- Automated scanning
- Picosecond laser 1064nm
- Spot size  $2 \sim 5 \mu\text{m}$

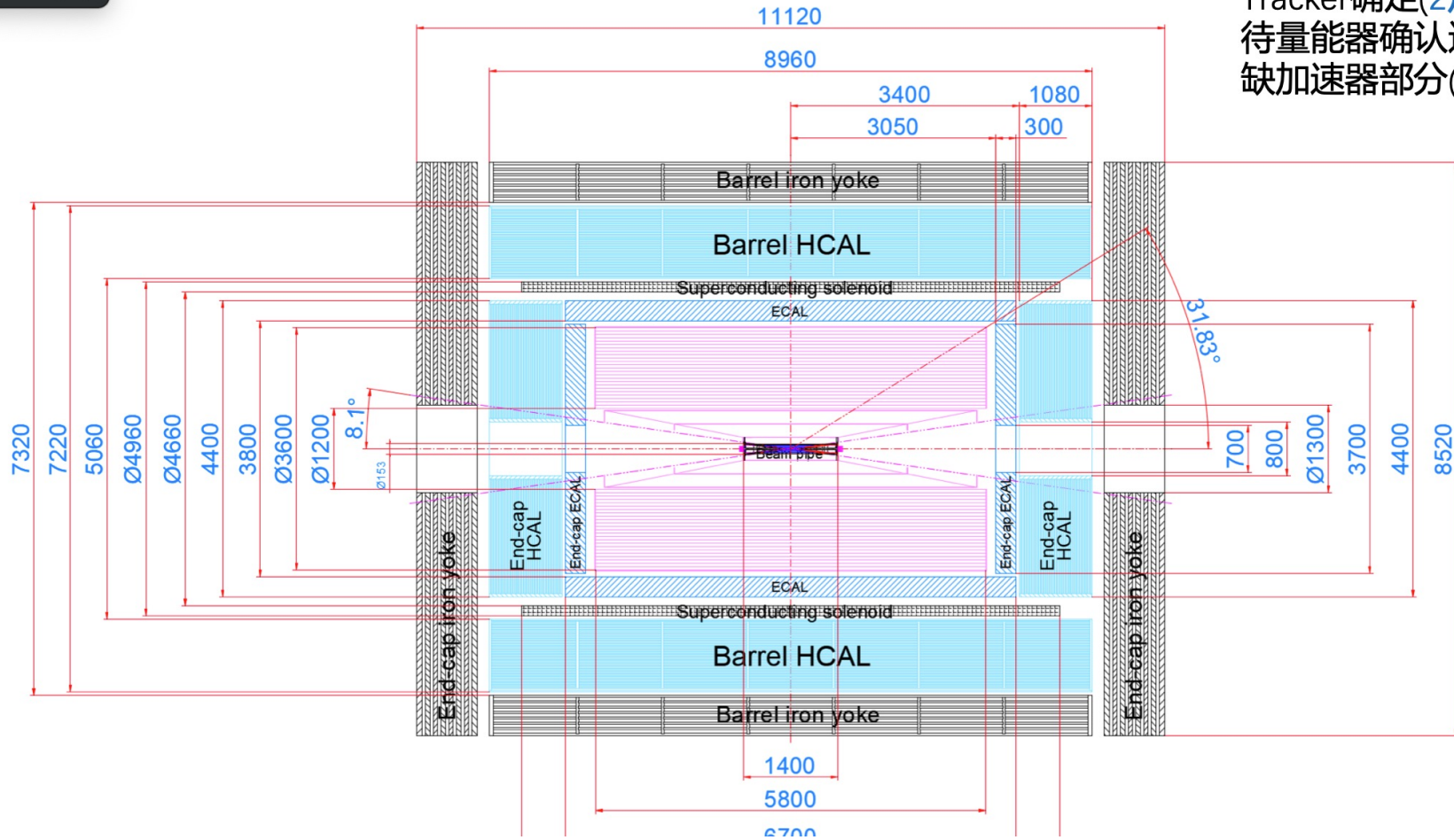


李一鸣; 王

# 进展: (标注完整)

说明:

Tracker确定(2月23日)  
待量能器确认边界(3月1日)  
缺加速器部分(2月29日)



缺