

Calorimeter R&D in Korea for FCC-ee and EIC projects

Hwidong Yoo (Yonsei Univ.)

**LESA test beam workshop,
September 5, 2025**

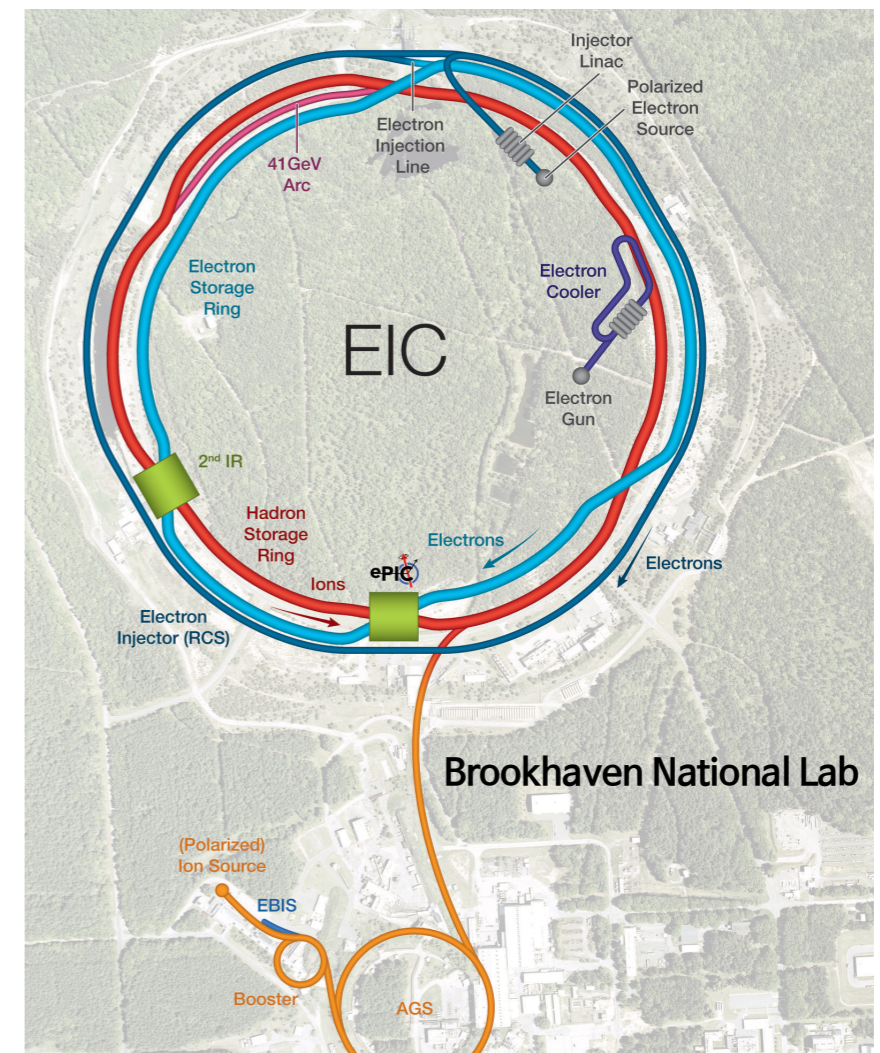
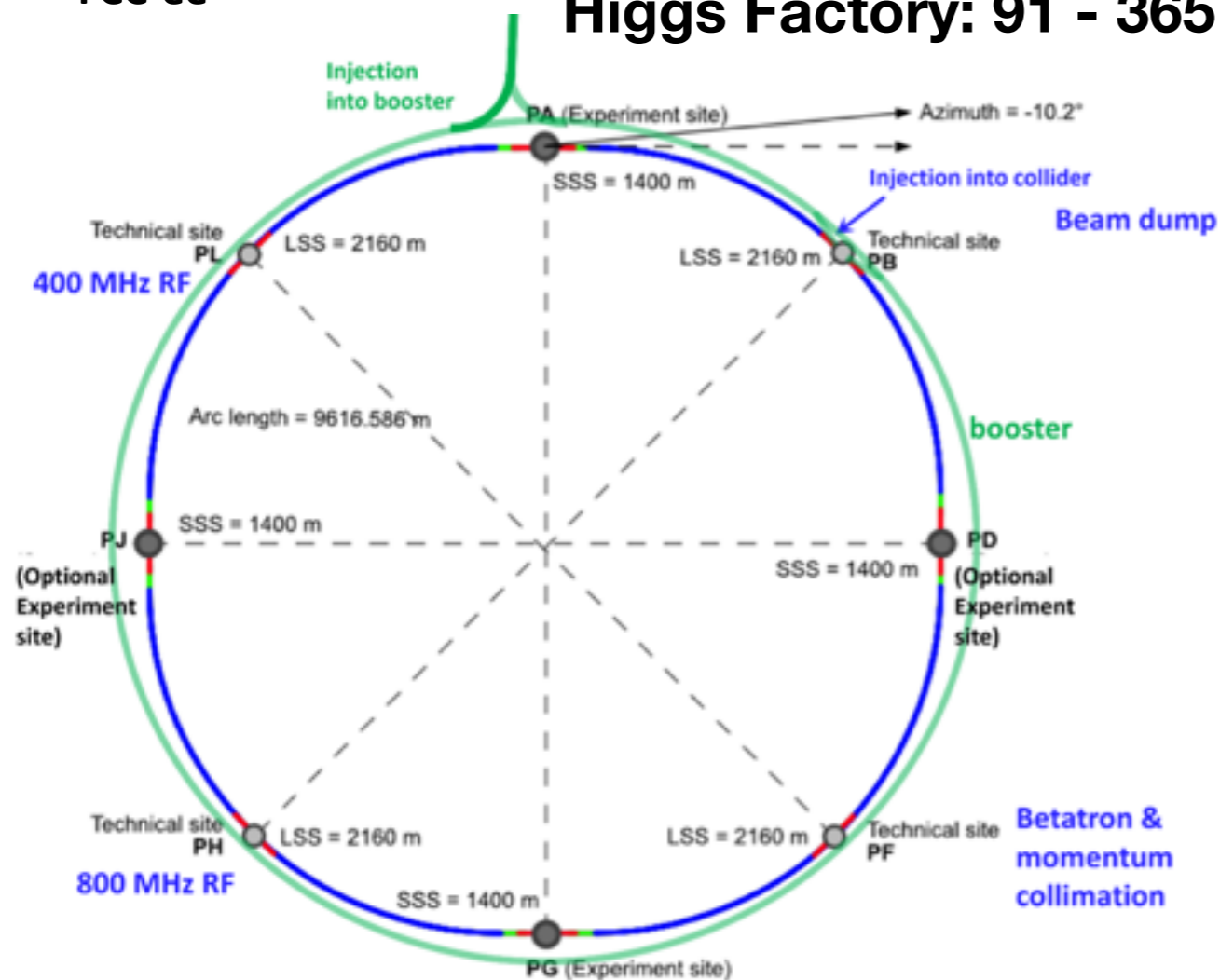


Introduction

- Calorimeter R&D projects in Korea: optical fiber-based calorimeter
 - FCC-ee (+CEPC) IDEA detector: Dual-Readout Calorimeter
 - EIC ePIC detector: Barrel Imaging Calorimeter

FCC-ee

Higgs Factory: 91 - 365 GeV



41 GeV, 100 to 275 GeV

p/A beam →

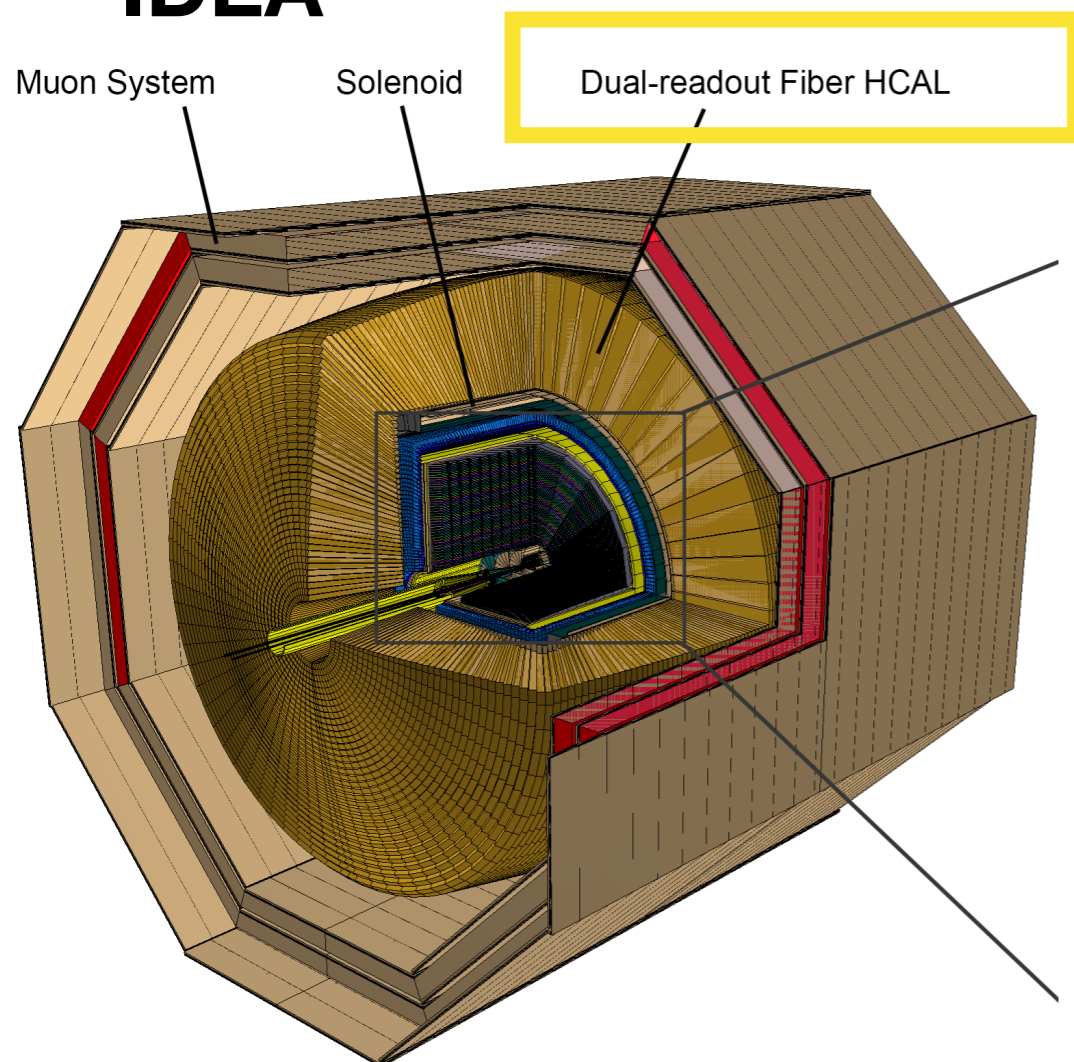
← e beam

5 GeV to 18 GeV

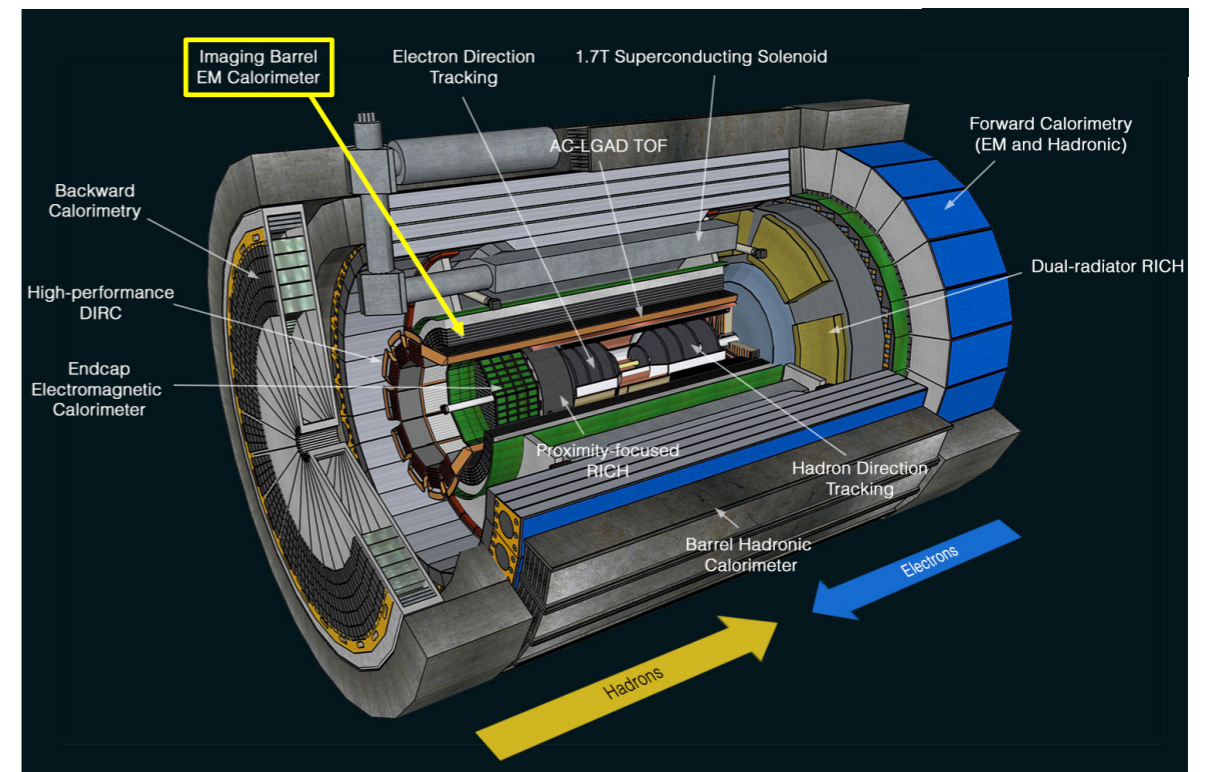
Introduction

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IDEA



ePIC



Dual-Readout Calorimeter (DRC)

- FCC-ee (+CEPC) IDEA detector: Dual-Readout Calorimeter

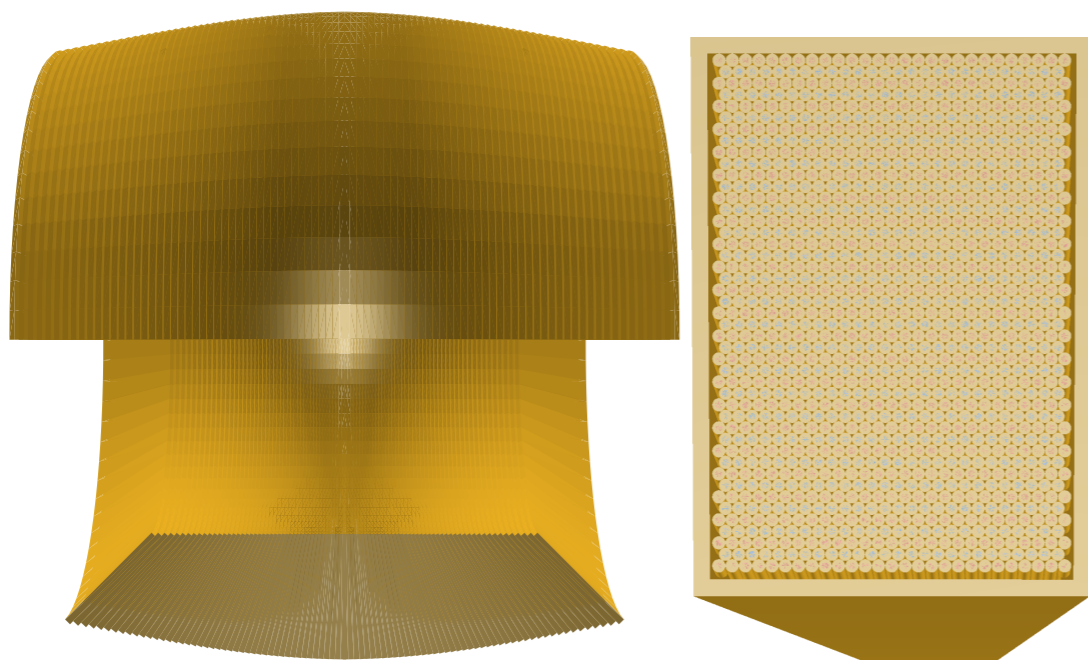
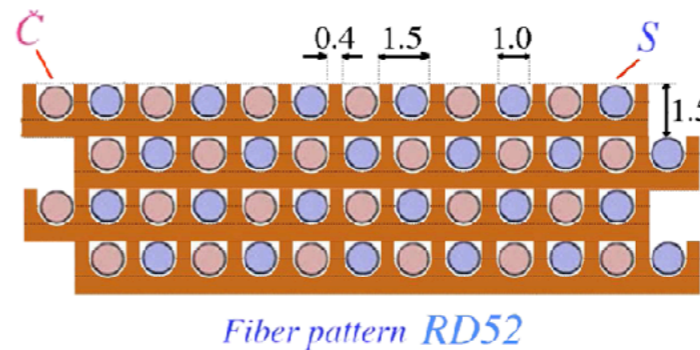
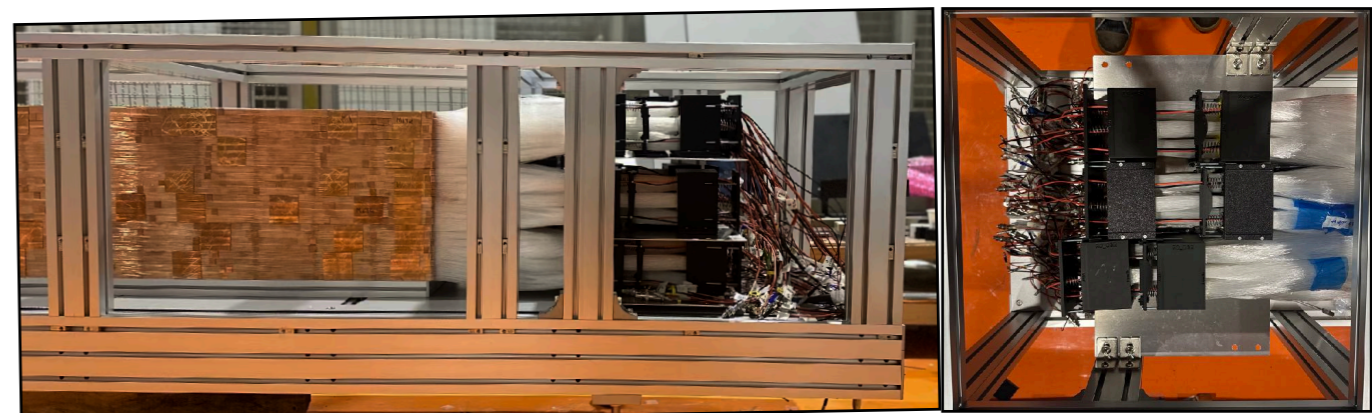
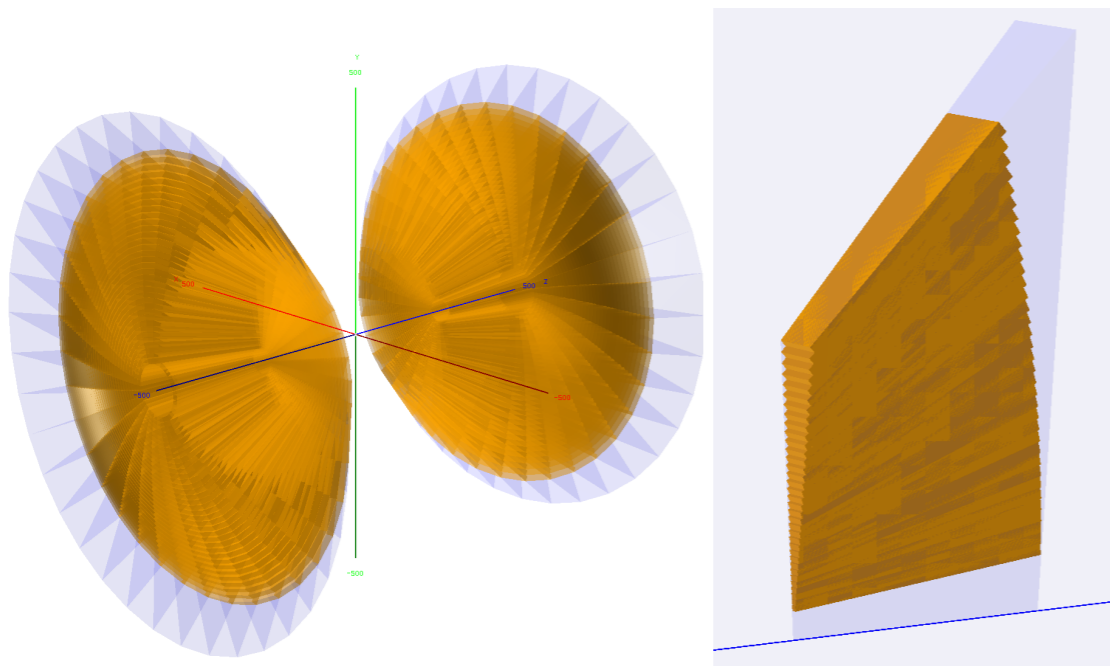


Figure 29: Barrel region of the dual-readout calorimeter, with a few towers highlighted for visualization purposes (left). Backside of one tower with the assembly of tubes and the support structure around them, forming one tower (right).

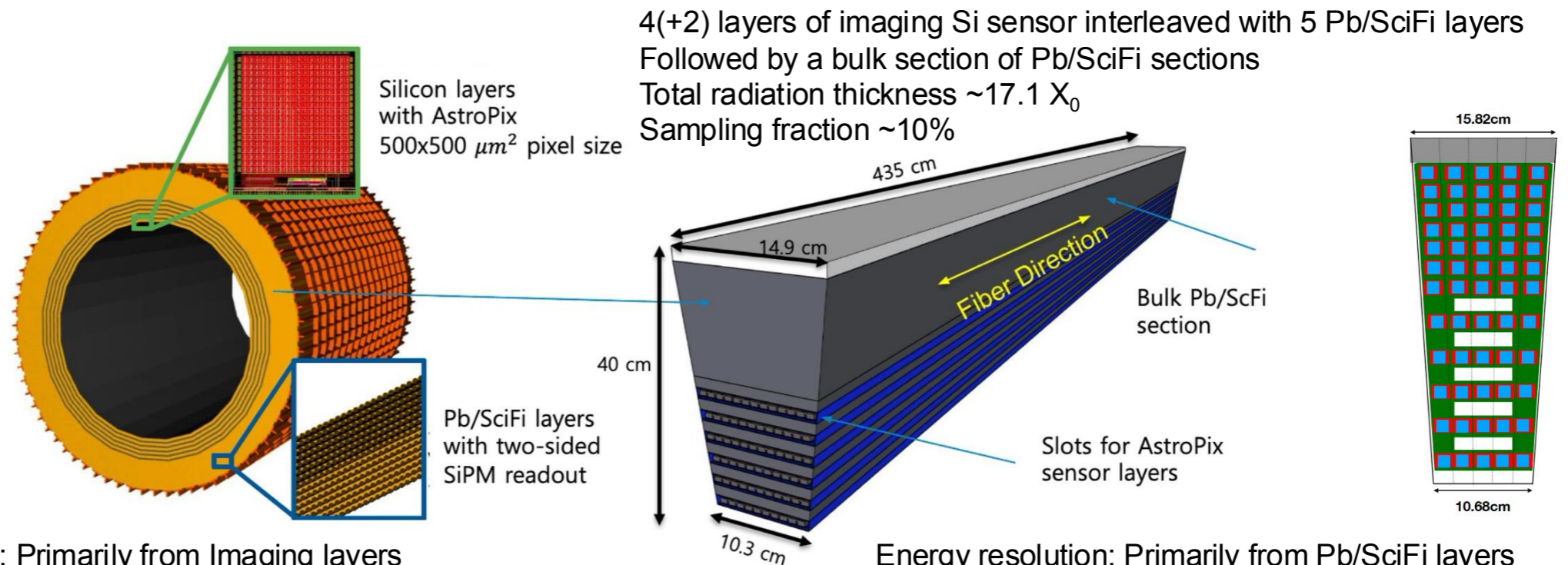


S: Kurary SCSF-78
C: Mitsubishi SK-40



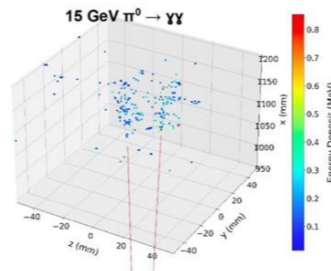
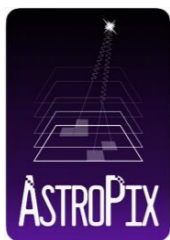
Barrel Imaging Calorimeter (BIC)

- Korea-EIC group will construct 50% of BIC detector (>\$14M)
- We are very interested in LESA TB facility for the BIC tests!



Position resolution: Primarily from Imaging layers (+2-side Pb/SciFi readout and radial segmentation)

Energy resolution: Primarily from Pb/SciFi layers (+ Imaging pixels energy information)



AstroPix tracking layers to capture 3D image of shower development
 NASA AMIGO-X mission

GlueX Pb/SciFi sampling calorimeter

Test-beam Exp. (2022 - 2025)

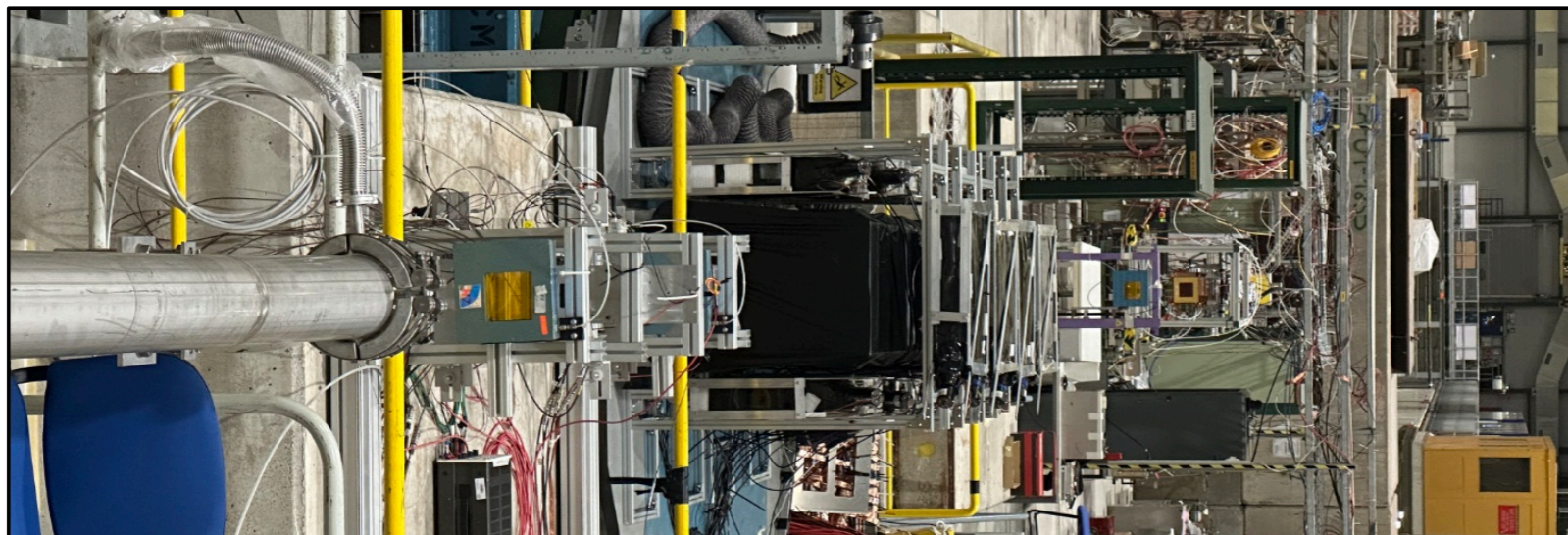
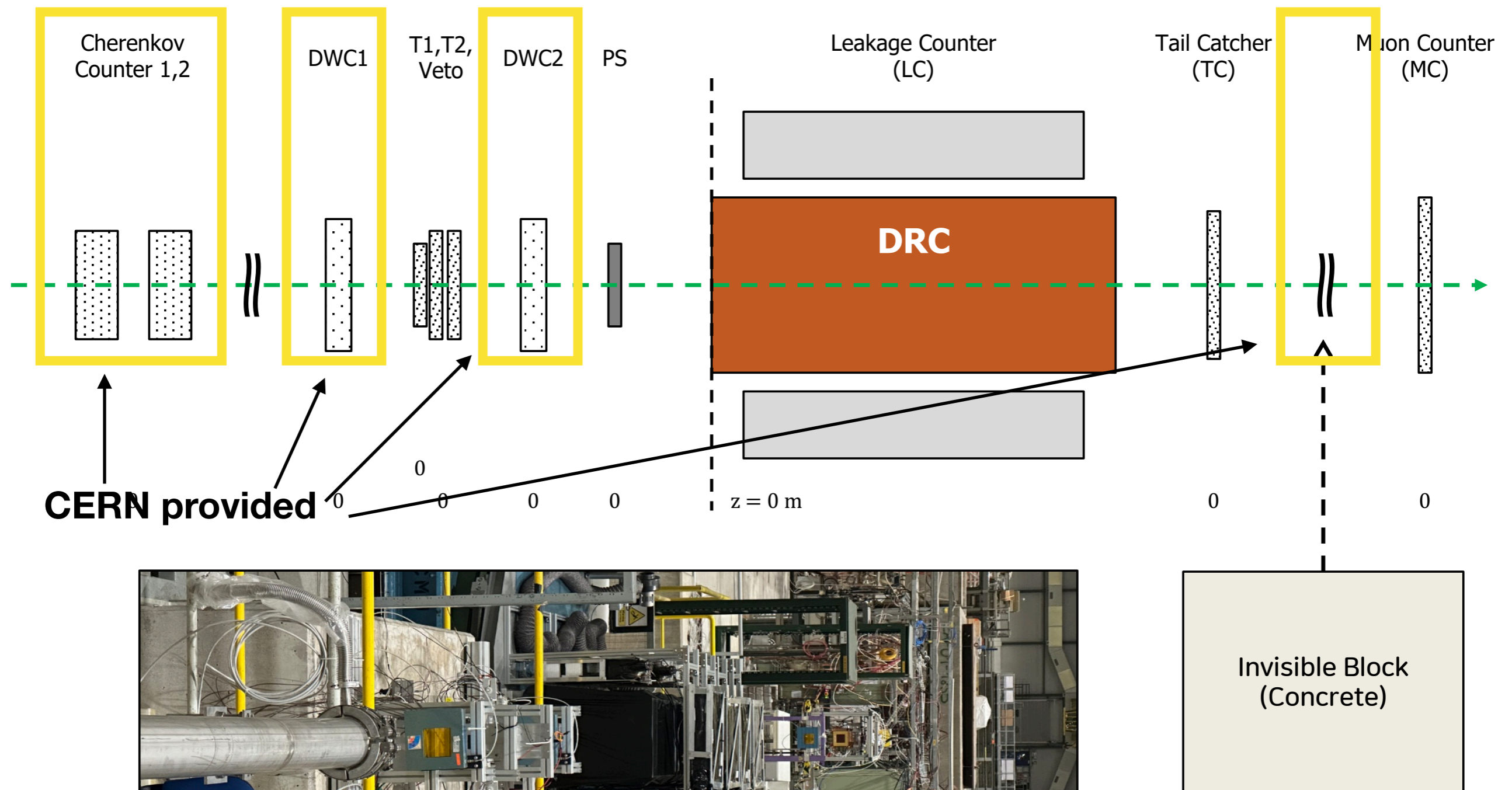
	Date	Duration (week)	Facility	e Energy (GeV)	Detector Type	Module Size (cm ³)	Weight (kg)
CERN	08/17 /2022	1	SPS	10 - 120	DRC	10x20x250	300
	07/05 /2023	1	PS	0.5 - 5	DRC	10x10x50	30
	08/07 /2024	1	PS	0.5 - 3	BIC	15x9x32	15
	08/07 /2024	3	SPS	10 - 120	DRC	30x30x250	1500
	07/23 /2025	1	PS	0.5 - 5	BIC	32x15x24	30
	08/06 /2025	1	SPS	10 - 120	DRC	30x30x250	1500
KEK	03/19 /2025	1	PF-AR	0.5 - 5	BIC	32x12x24	30
	06/12 /2025	1	PF-AR	0.5 - 5	BIC	32x15x24	30
	Dec. /2025 (?)	1	PF-AR	0.5 - 5	DRC	15x15x50	70

Team-Korea for Future Collider

- 9 Institutes, 11 faculties, more than 30 researchers and graduate students: most of members are young generation!

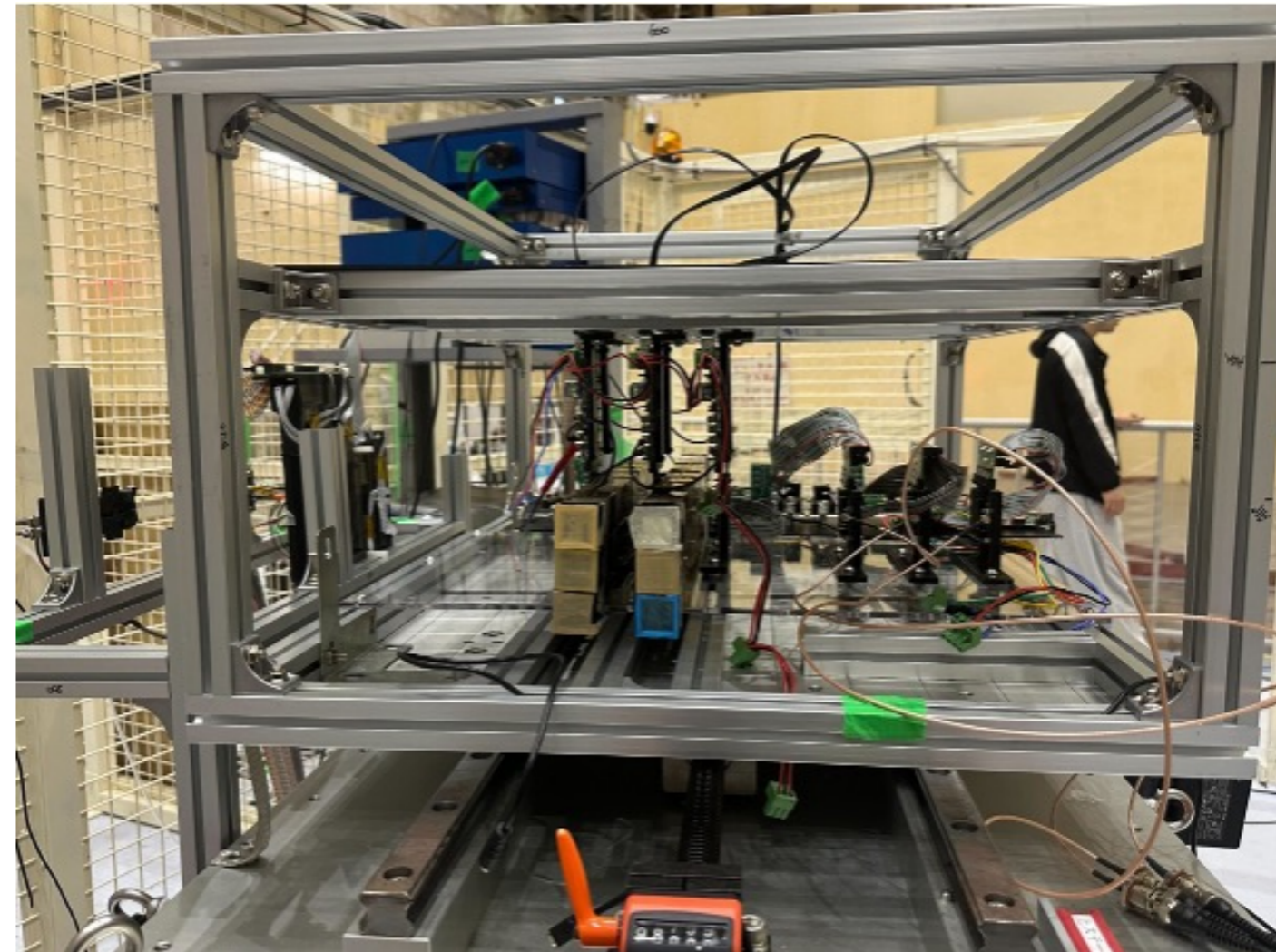
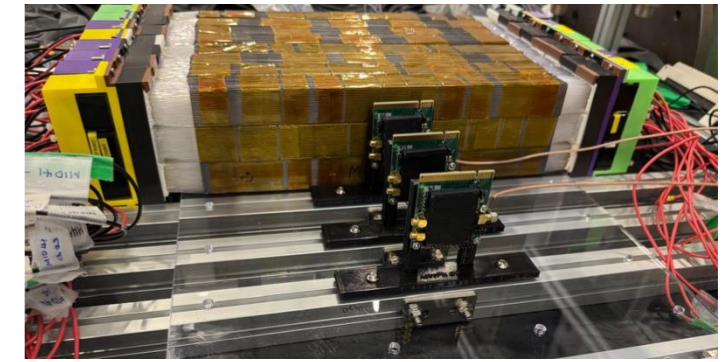
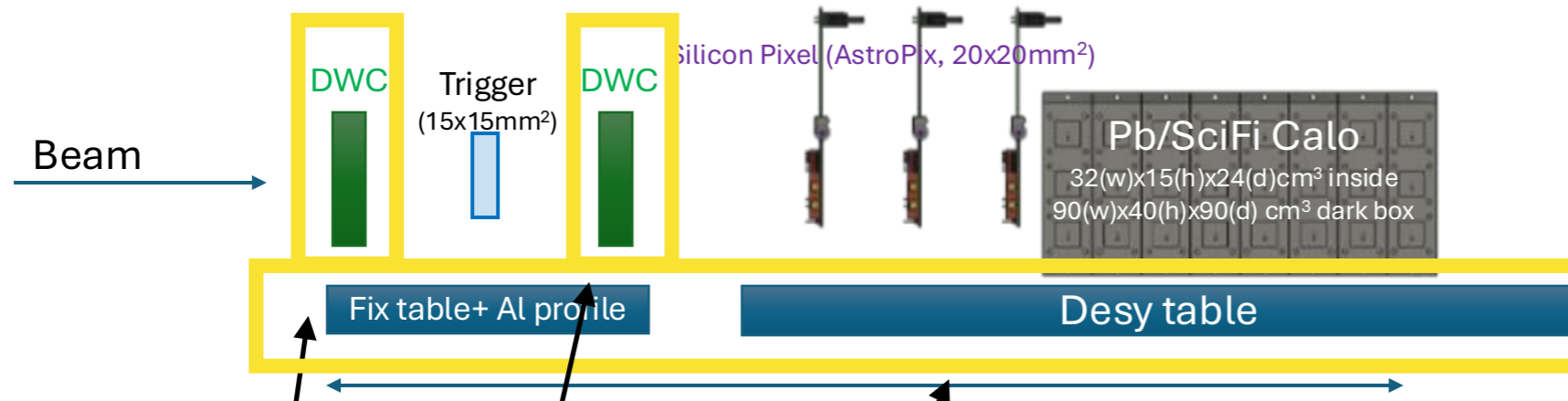


Typical DRC Test-Beam Setup



North Area (SPS H8)

Typical BIC Test-Beam Setup



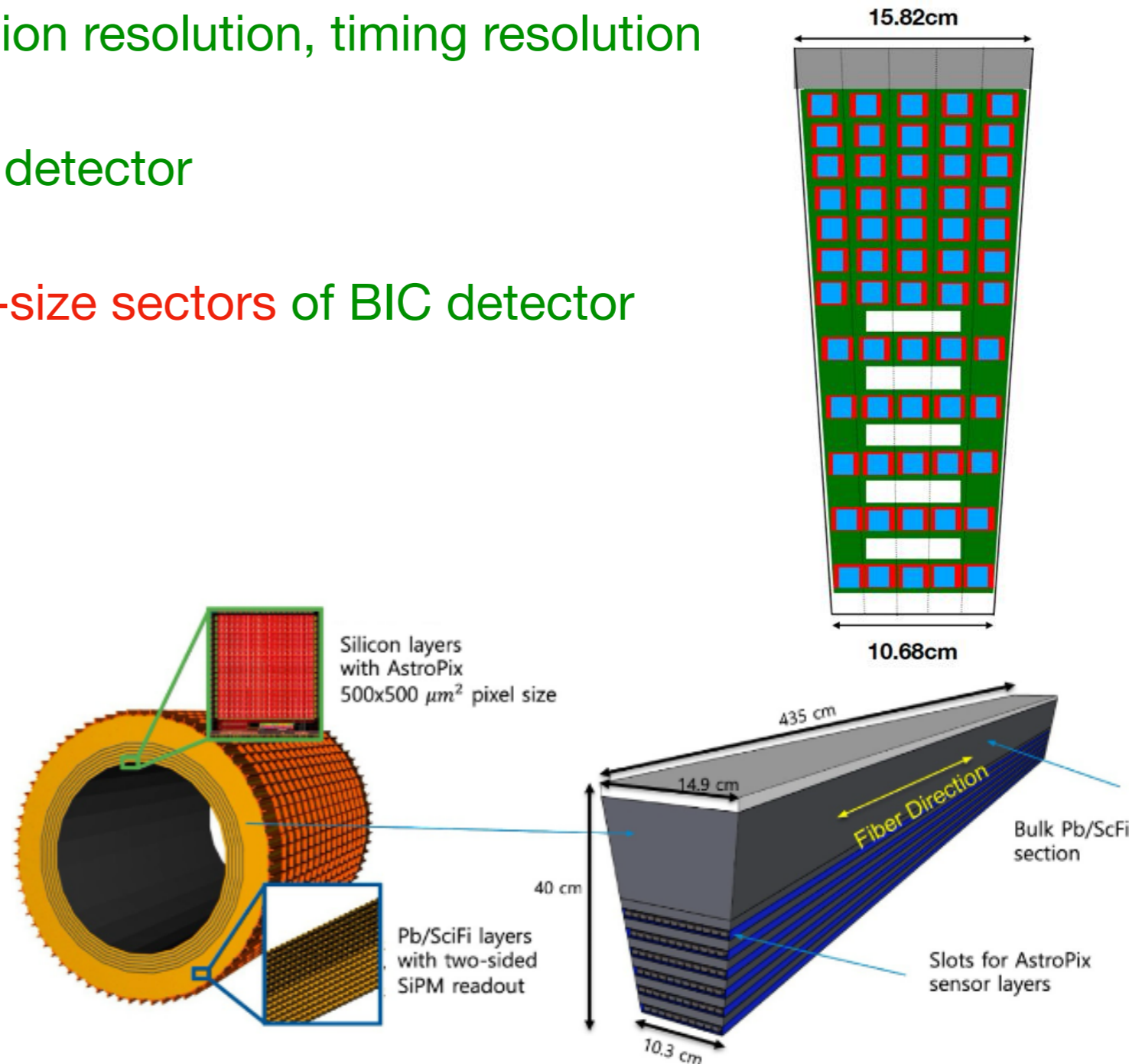
CERN provided

Expected Test-beam Programs at LESA

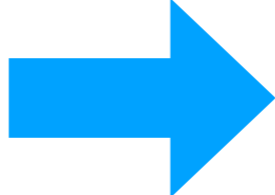
- Typical performance study on prototype:
 - Energy scan/resolution, position resolution, timing resolution
 - Small-size prototype of DRC detector
 - Small-size prototype and **full-size sectors** of BIC detector

- Needs

- High intensity
- Variety of beam energy sets
- Narrow beam size
- Minimize electricity noise

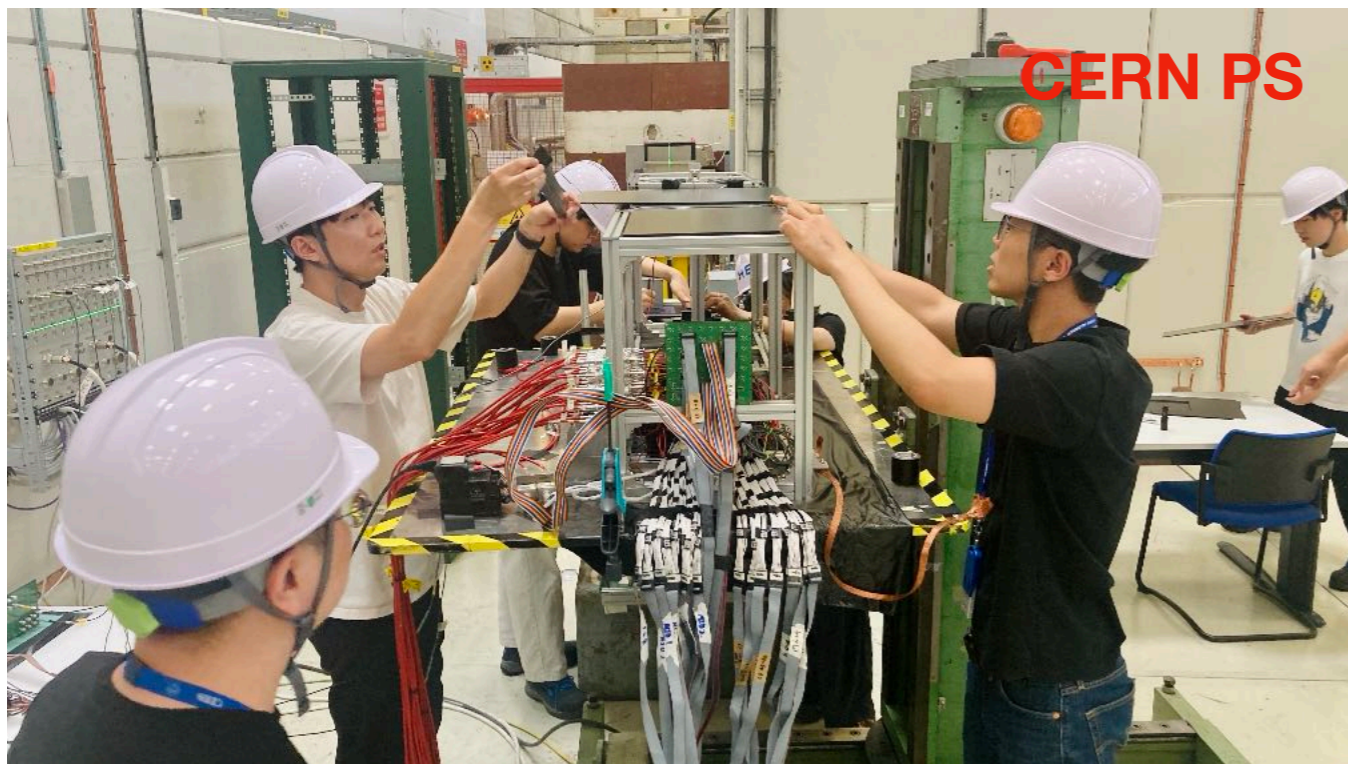
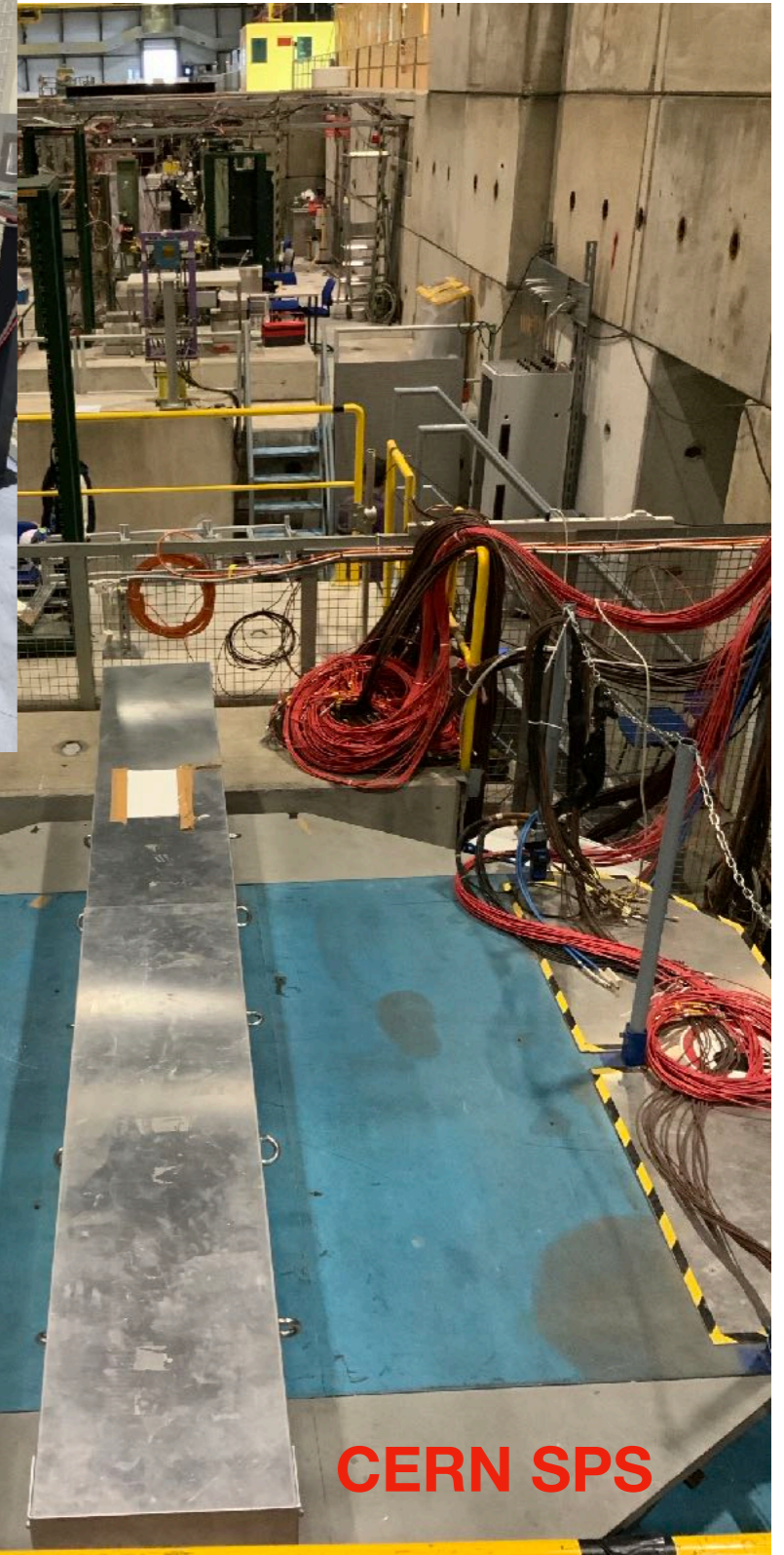
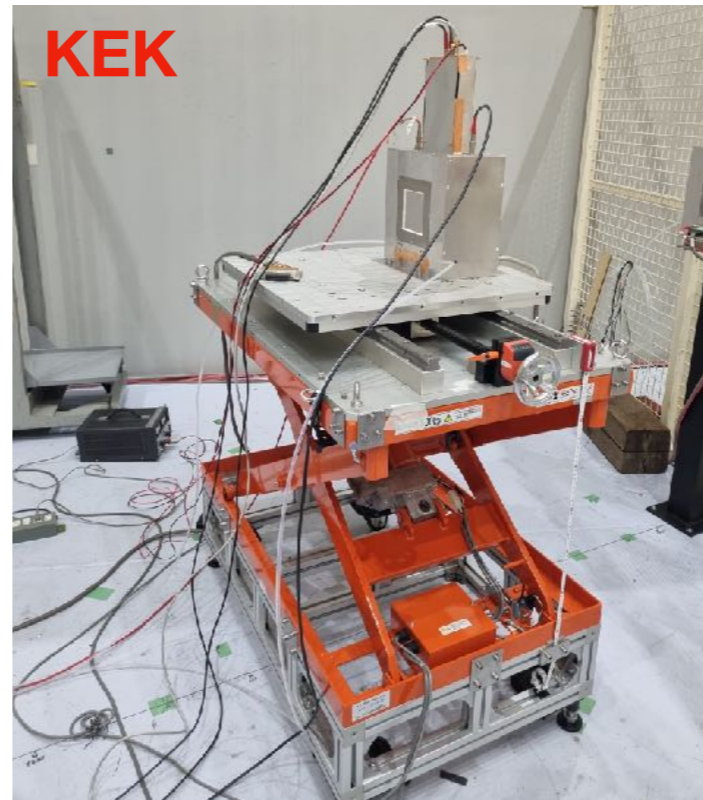


Desired Beam Parameters

- In general, we are very happy to have a similar beam conditions as KEK PF-AR
 - Beam energy: 0.5 - 8 GeV
 - Very welcome to expand the beam range (both minimum and maximum)
 - Very welcome for various beam types if possible (pion, hadron, muon beams like CERN)
 - Beam energy spread: 1~2 %
 - Beam rate: ~350 Hz at 3 GeV (KEK)
 - Beam intensity: single bunch 50 mA (KEK)
- 
- We satisfy the rate and intensity**

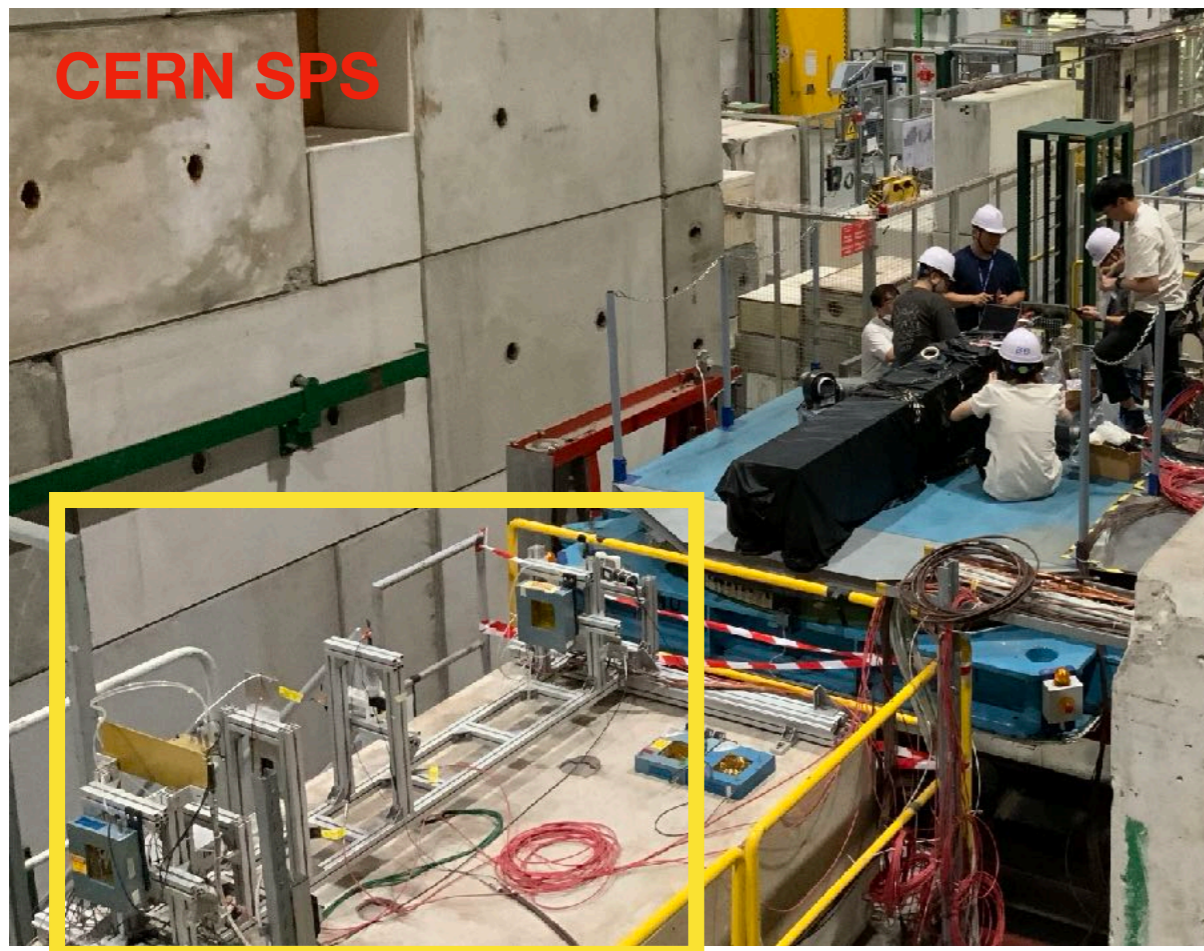
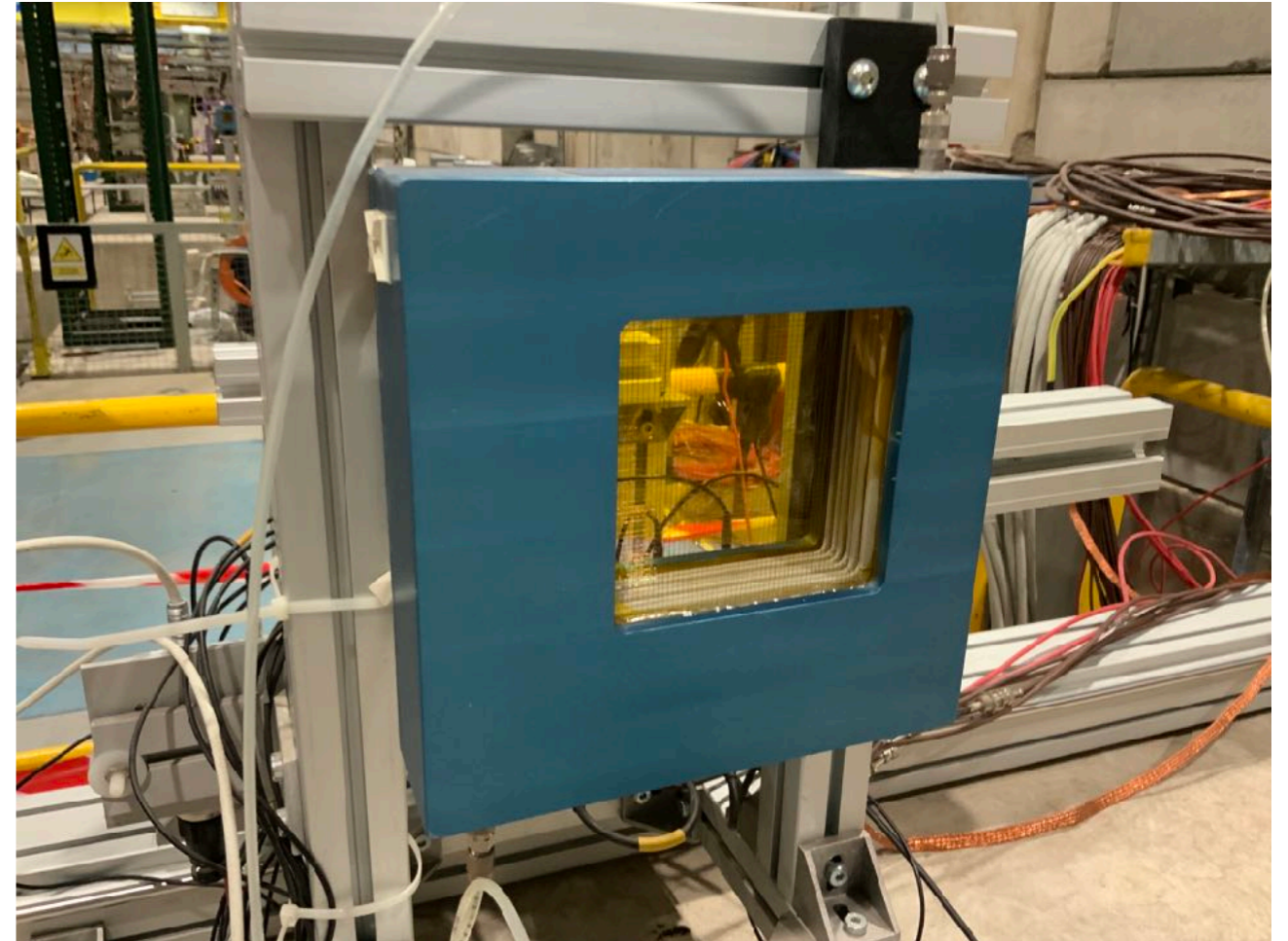
Instruments from LESA We Need

- Moving table
- Beam position detector
- Particle Identification
- Electronics equipments



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Instruments from LESA We Need

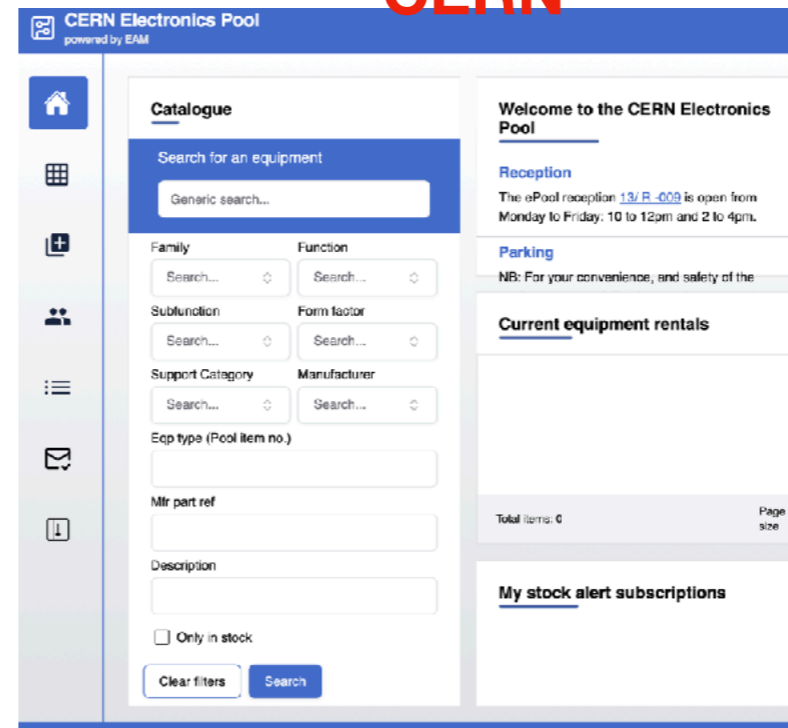
- Moving table
- Beam position detector
- ~~Particle Identification~~
 - ~~In case we have different type of particles~~
- Electronics equipments



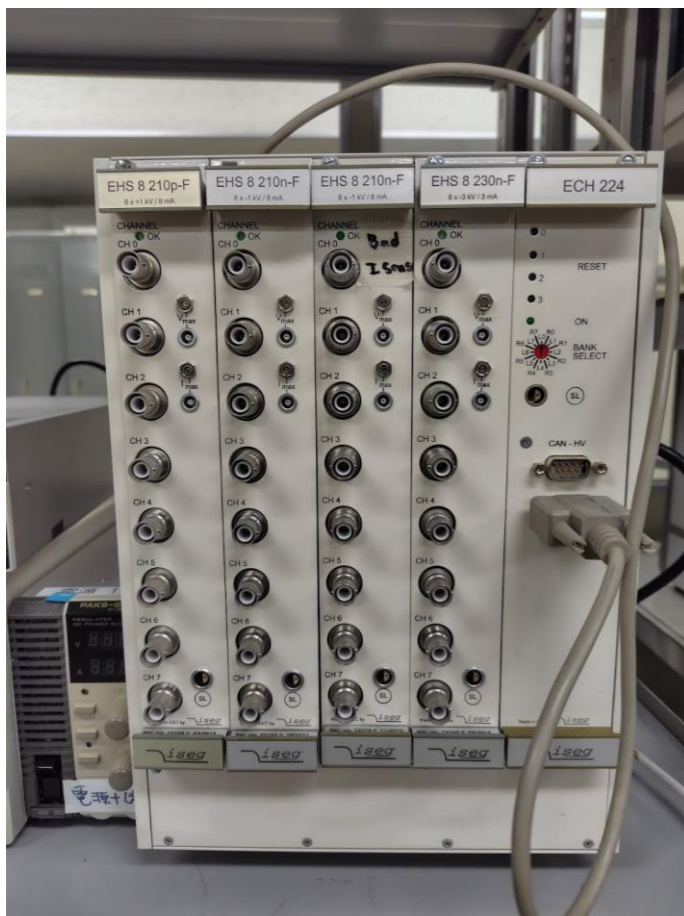
Instrument from LESA We Need

- Moving table
- Beam position detector
- Particle Identification
- **Electronics equipments**

CERN

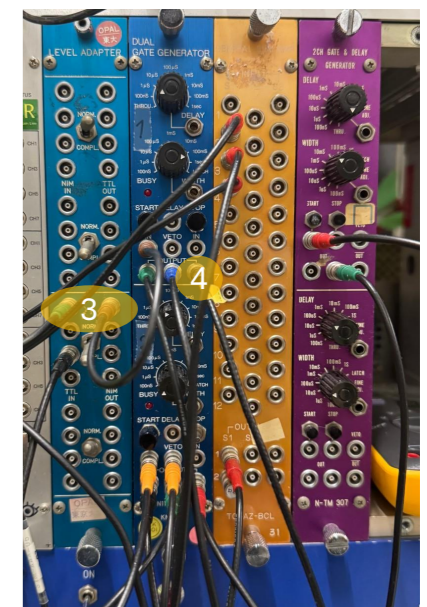


Trigger setup



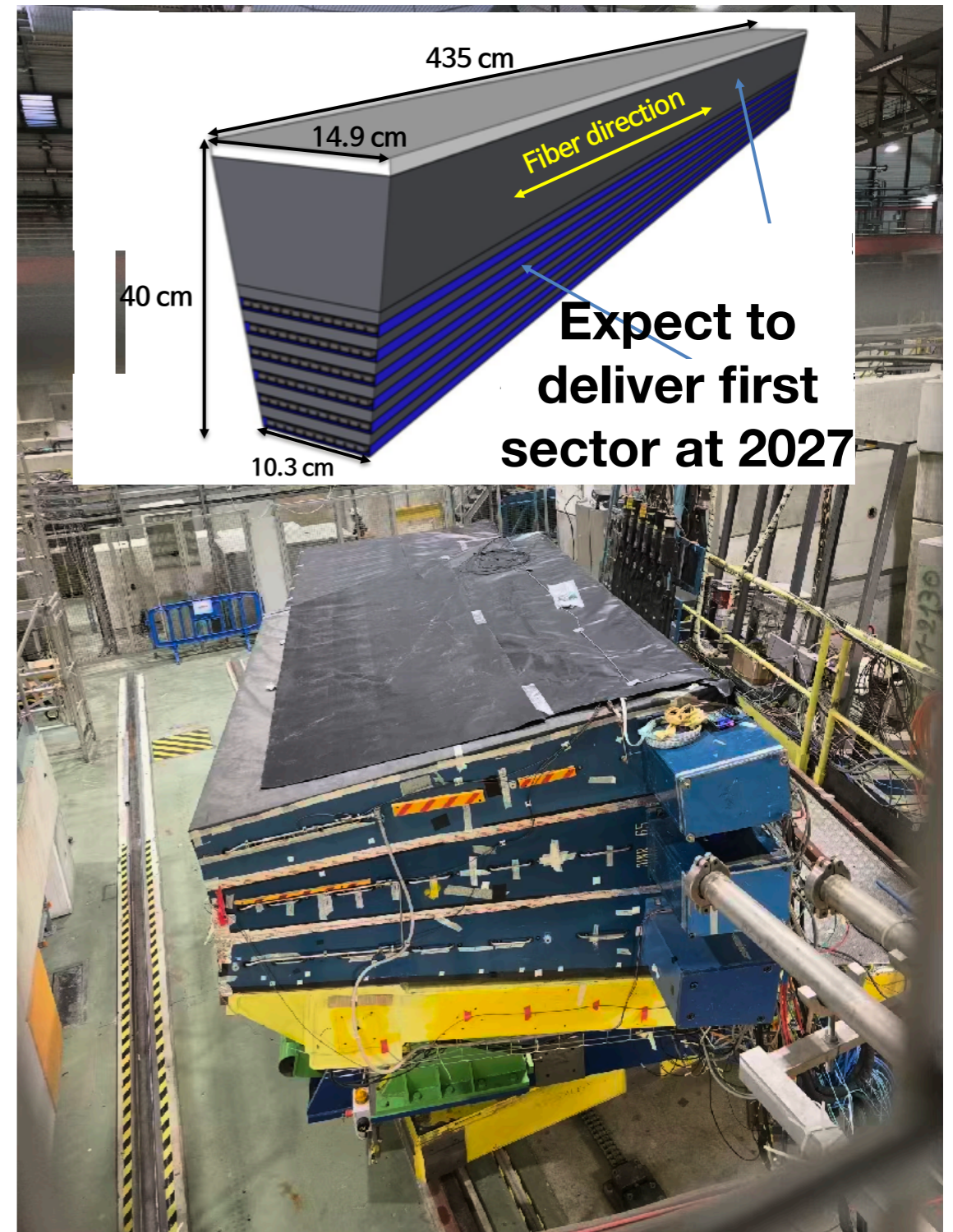
Injection Veto

KEK



Special Request

- Once we construct full-size module (BIC single sector), we need to test the performance of the sector!
- Large experimental area
- Very large supporting table



Summary

- We need a beam-test facility in US, particularly for successful construction of EIC project!

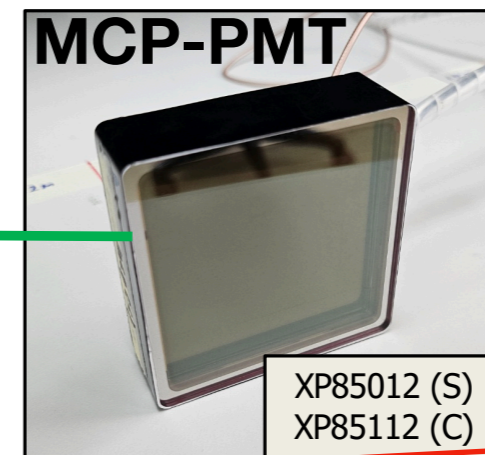
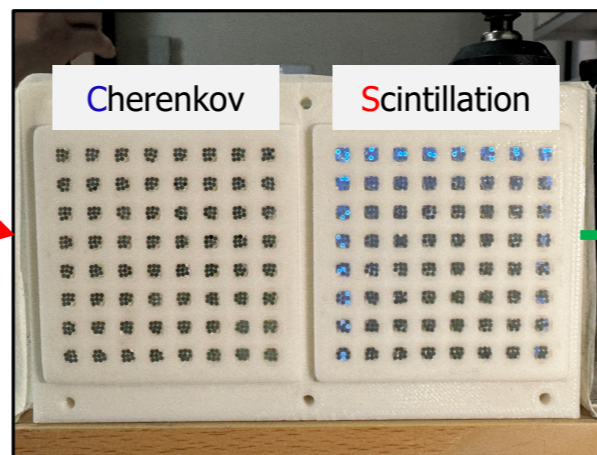
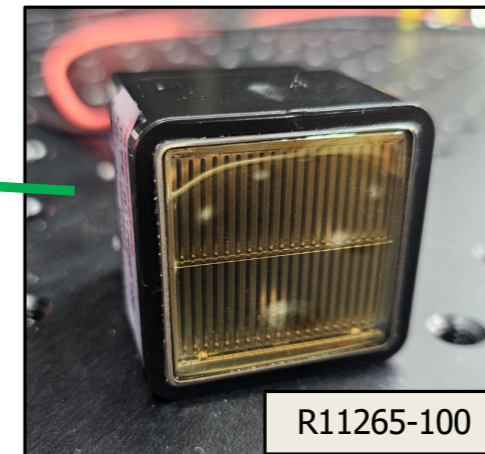
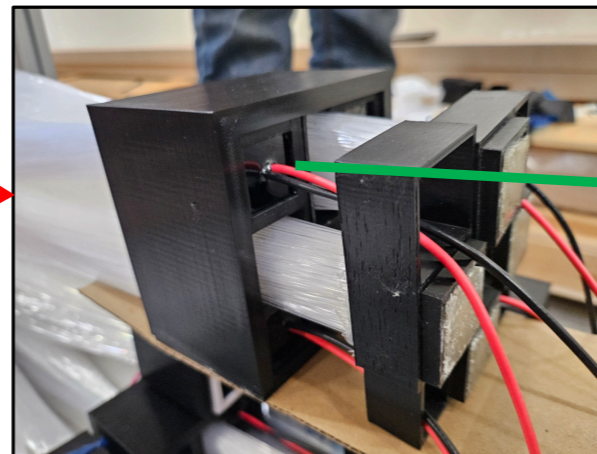
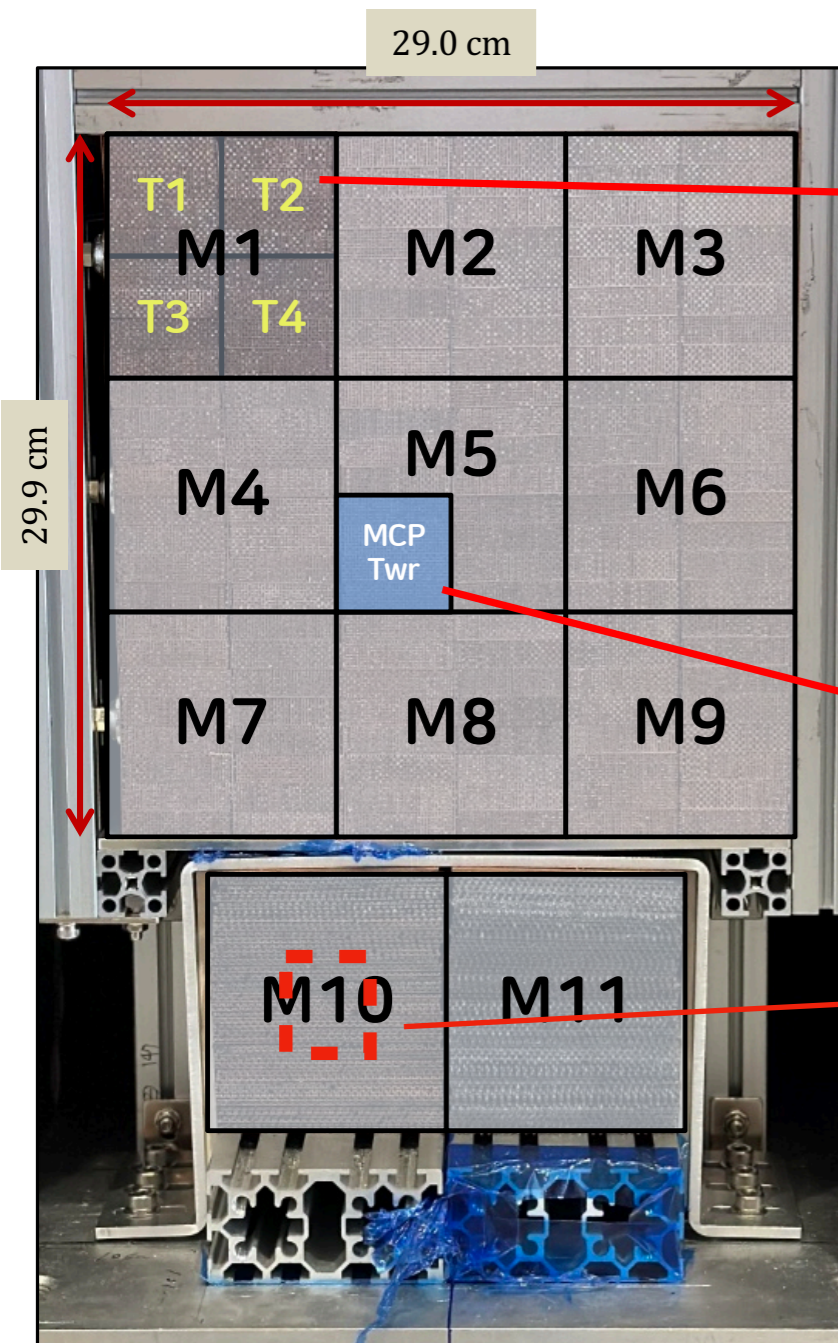
- Our BIC collaboration:

USA	Argonne National Laboratory	NASA Goddard Space Flight Center	Oklahoma State University	University of Connecticut	University of California Santa Cruz			
								
	<hr/>							
	Canada	University of Manitoba	University of Regina	Mount Allison University	NSERC	Canada Fund for Innovation		
								
Korea	Kyungpook National University	Yonsei University	University of Seoul	Pusan National University	Korea University	Sungkyunkwan University	Hanyang University	Gangneung-Wonju National University
								
Germany	Karlsruhe Institute of Technology	University of Giessen	<div style="background-color: #0056b3; color: white; padding: 20px; text-align: center;"> <h2>ePIC BIC Detector Subsystem Collaboration</h2> </div>					
								

Back Up

Electronics R&D

- High granularity solutions: MCP-PMT (128 ch) vs SiPM (400 ch)



MCP-PMT (talk [12.07](#))

S-ch: 200
C-ch: 200
on the center of M10

- The DRC module is divided to 'tower' unit, each tower is bundled to single readout channel. (Square type PMT, Hamamatsu R11265-100)
- On M5-T3, **MCP-PMT** is attached, which provides high granularity, dividing single tower into 64 channels. (XP85012, XP85112)

DAQ R&D

- Customized DAQ system is designed: 20 DAQ boards and 1 TCB board (to control multi DAQ boards)
 - DAQ board is based on DRS4 chip for fast timing resolution (32 channel / board)
- Very powerful performance during test-beam experiments
- Upgrade plan is under discussion for faster timing resolution

200-400 ps with MCP-PMTs

DRS4 chip

