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Development of an ALPIDE telescope and its test results at PF-AR in KEK

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10th Asian Triangle Heavy-Ion Conference



For the KoALICE-ITS3 team





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ITS3 upgrade



Introduction

	Pixel structure	Detector design	Material budget
ITS2	<p>Standard</p>		
ITS3	<p>Modified-with-gap</p>		

MAPS(Monolithic Active Pixel Sensors)

- Truly cylindrical
 - ▶ Bent Si Detector
- 65 nm Technology
 - ▶ Stitching
- Low power consumption
 - ▶ <20 mW/cm²
 - ▶ Air cooling
- Less material budget
- Closer to interaction point
 - ▶ 23 mm → 19 mm



Various chip R&D activities are ongoing -Bending, stitching, cooling, etc

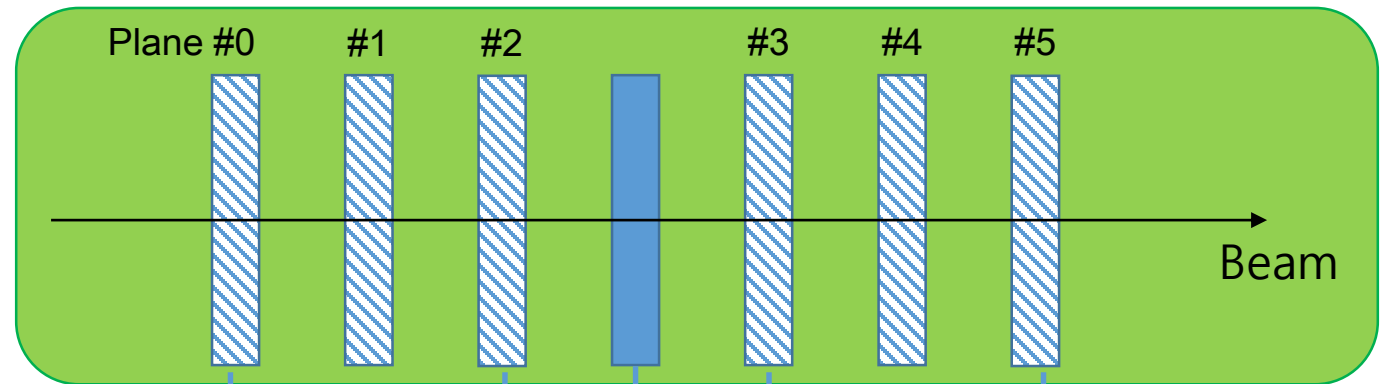
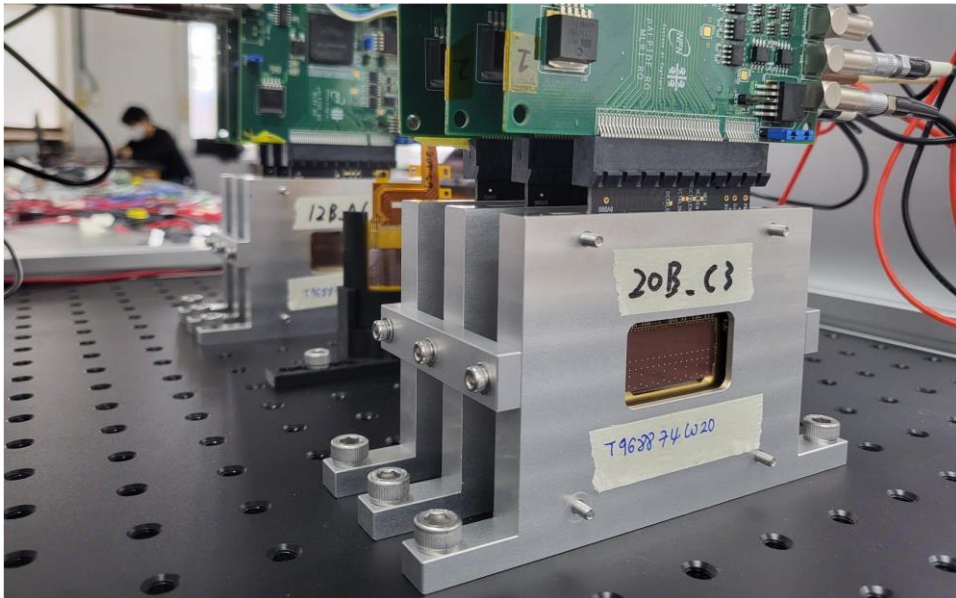


Motivation

■ Chip R&D

- In Lab measurements
 - ▶ Tuning of operational parameters
 - Pulse and noise measurements
 - Measurement with a source

- In Test beam
 - ▶ Detection efficiency/Fake Hit Rate vs. threshold for digital chips
 - Particle tracks reconstructed by telescope
 - Association of clusters in DUT with tracks



Reference arms

- Consists of well-known detectors (ALPIDEs)
- Track reconstruct



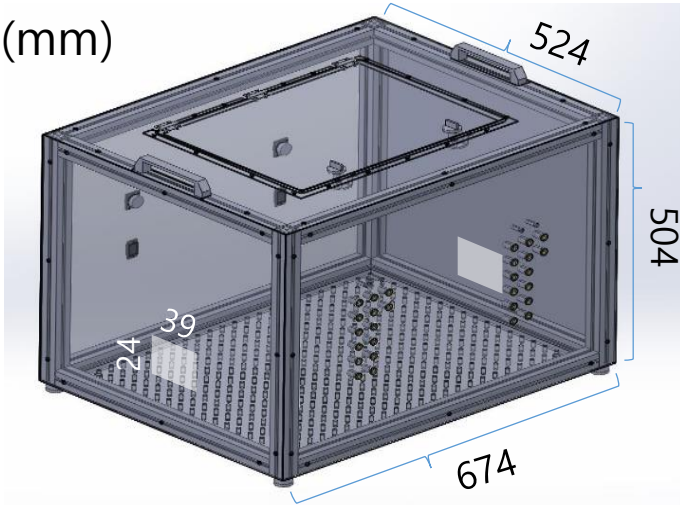
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Korean ALICE Telescope (KATS)



■ Al Box Dimension

(mm)



■ Full Feed through connect



→ BNC to BNC : scintillator signal out

→ USB-B to USB-A : communication with computer

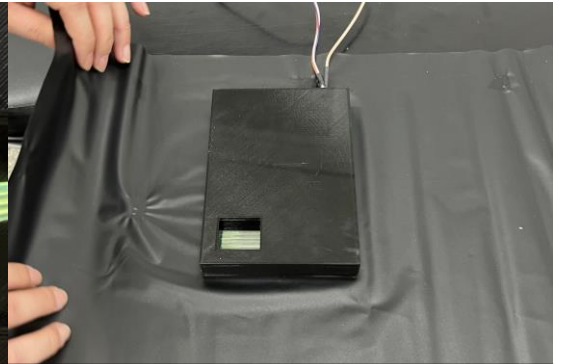
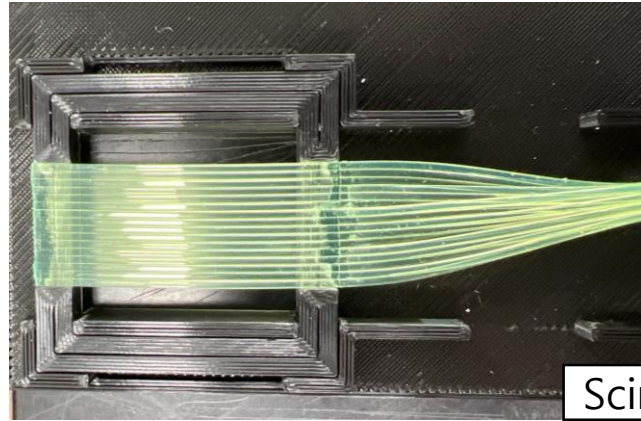
→ LEMO to LEMO : apply back bias voltage to boards

→ Banana to flat : supply power for devices

■ Adjustable Inner modules



Moving stage



Scintillator module for trigger

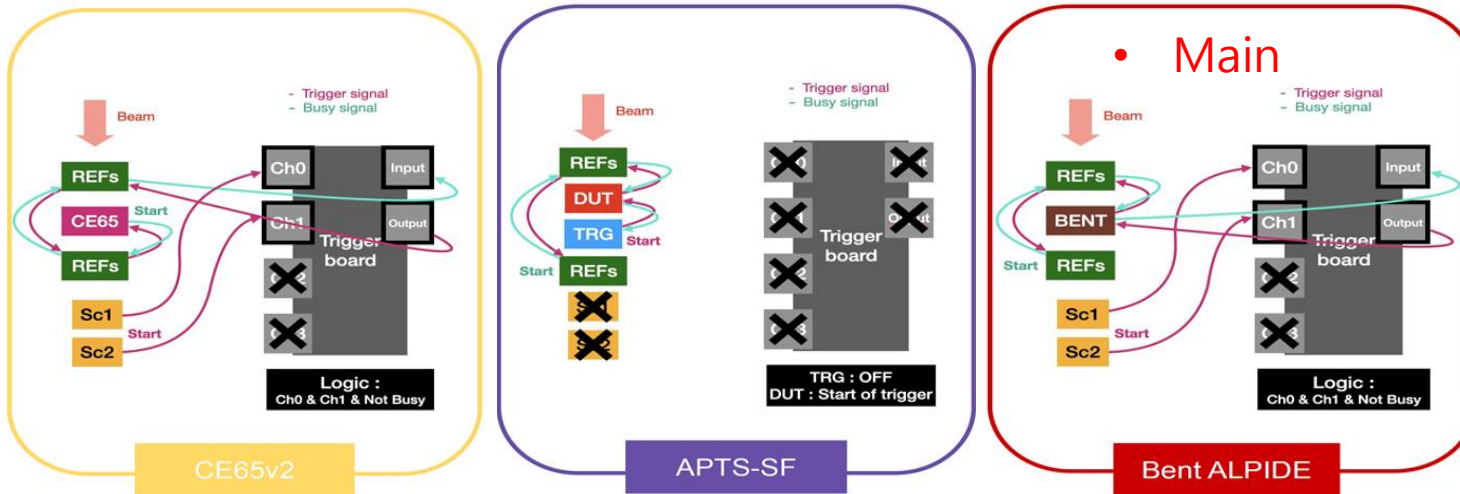


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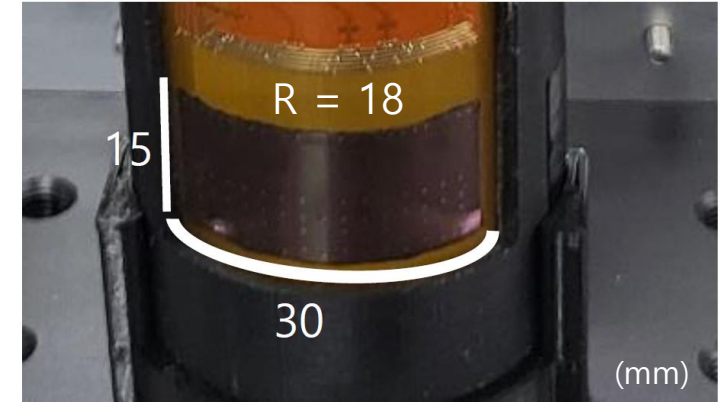
KATS operation setup



Trigger chain

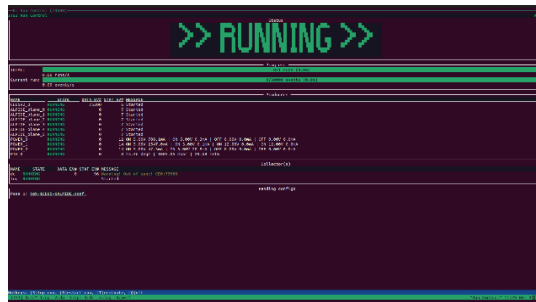


Bent ALPIDE



DAQ and analysis framework

- Generic multi-platform data acquisition framework
- Multiple data collector
- Online monitoring GUI



EUDAQ2

- Data reconstruction framework
- Flexible, fast and lightweight
- Modular concept



Corryvreckan



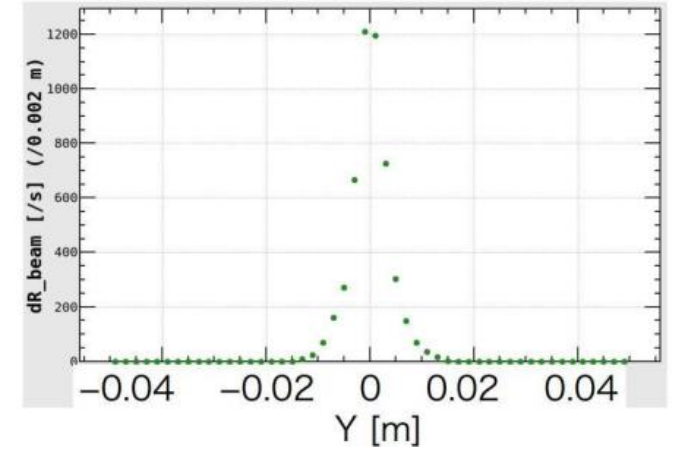
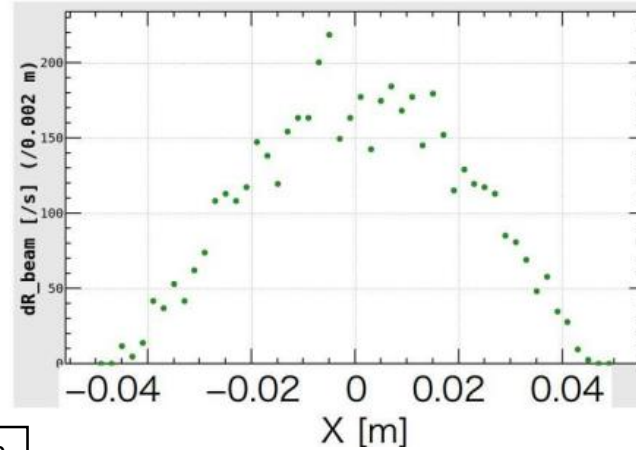
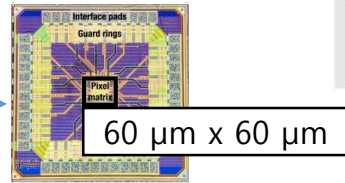
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KATS operation test in KEK



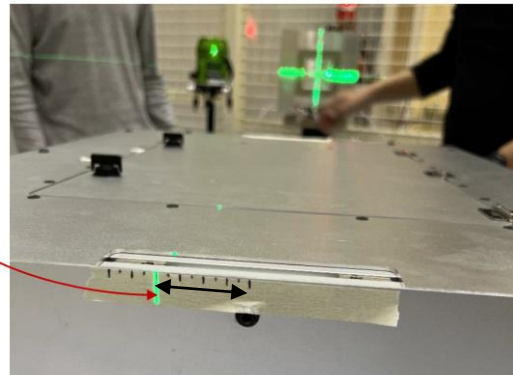
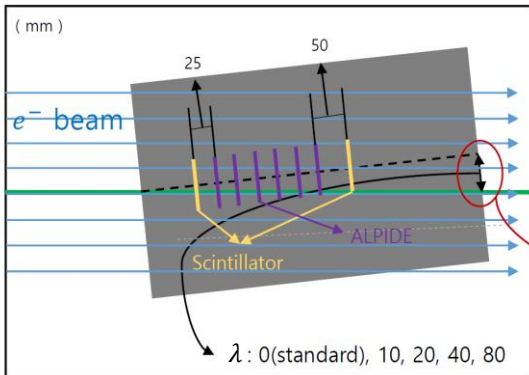
■ Beam at PF-AR in KEK

- Particle : electron
- Momentum : 0.5 – 5 GeV/c
- Size : roughly 8 x 2 cm² (x – y size of beam)
- Beam rate
 - ▶ Official: 156 Hz/cm² @ 3 GeV/ c
 - ▶ Measured with scintillator module
 - 130 Hz/cm² @ 3GeV/ c
 - 62 Hz/cm² @ 5GeV/ c
 - ▶ Too low for APTS-SF chip

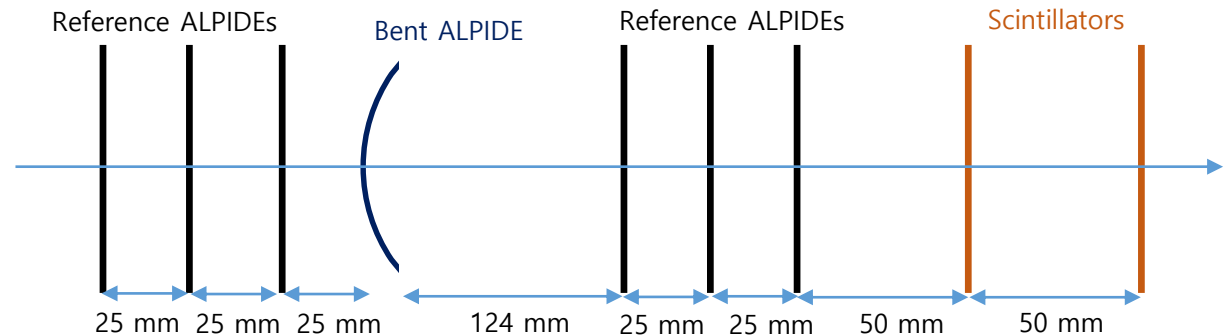


■ Experimental target : Understanding the functionality of KATS

- Incident angle scan



- DUT test setup





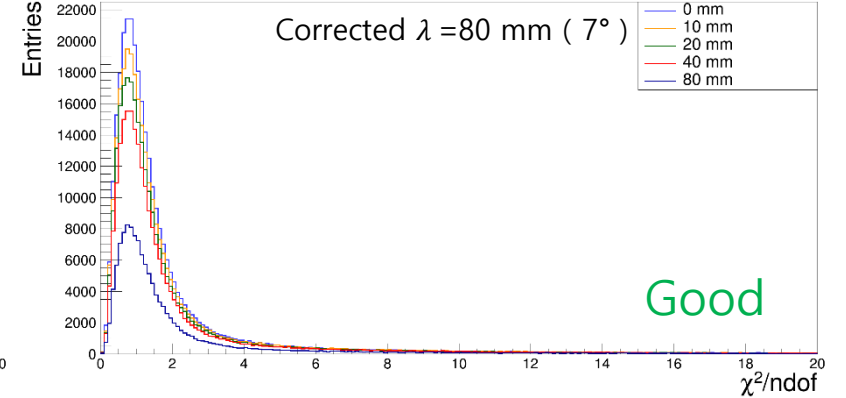
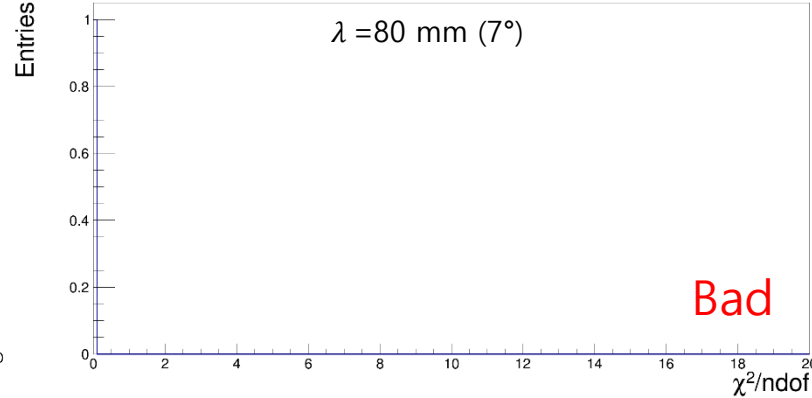
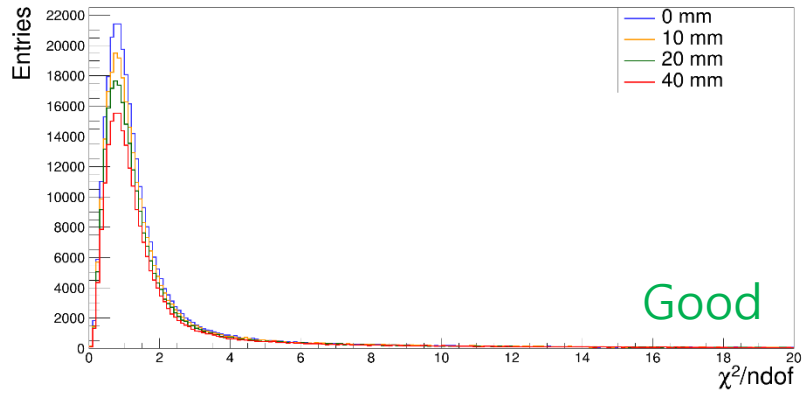
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KATS operation test in KEK

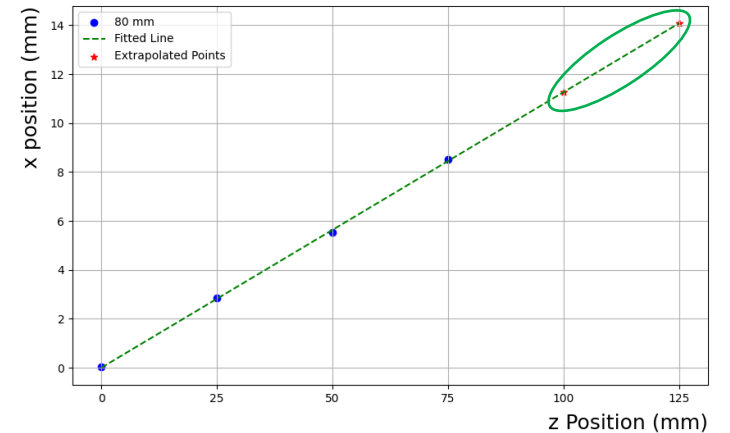
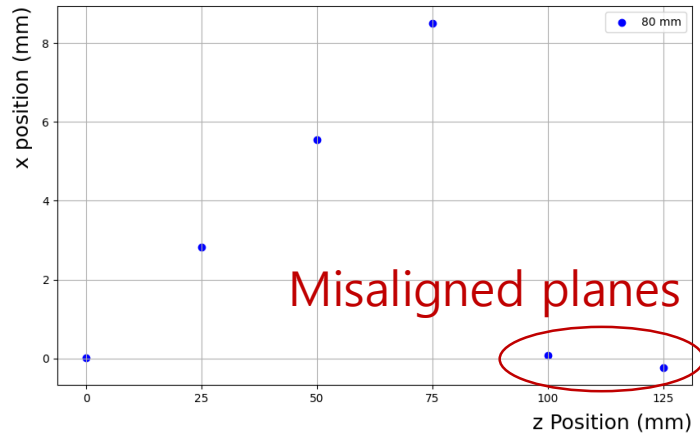
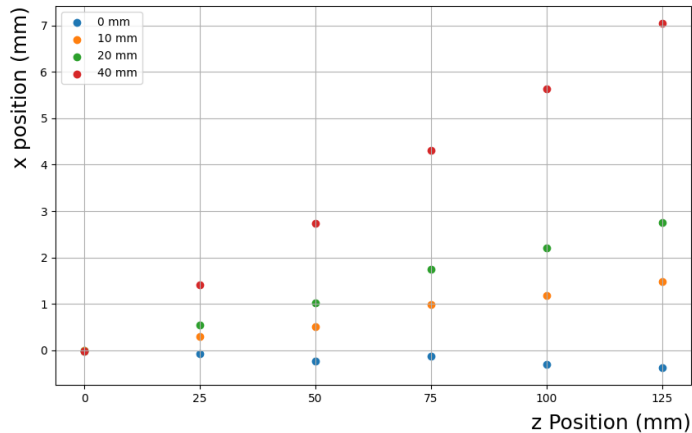


Result – Incident angle scan

- Tracking performance



ALPIDE position after alignment



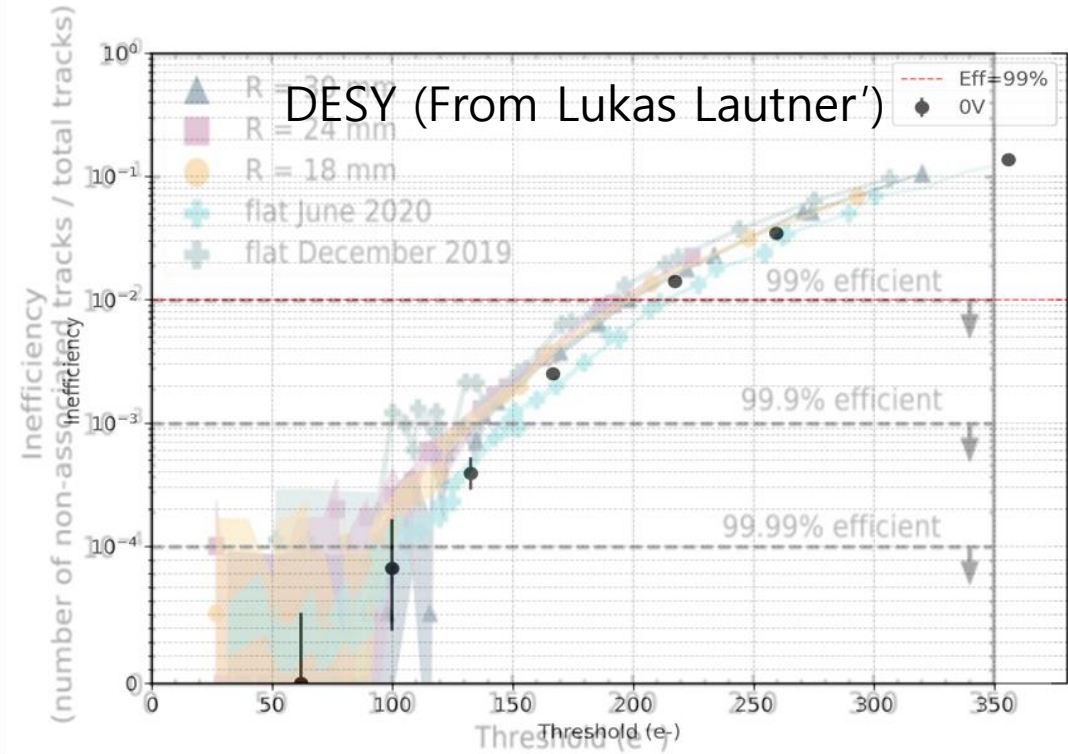
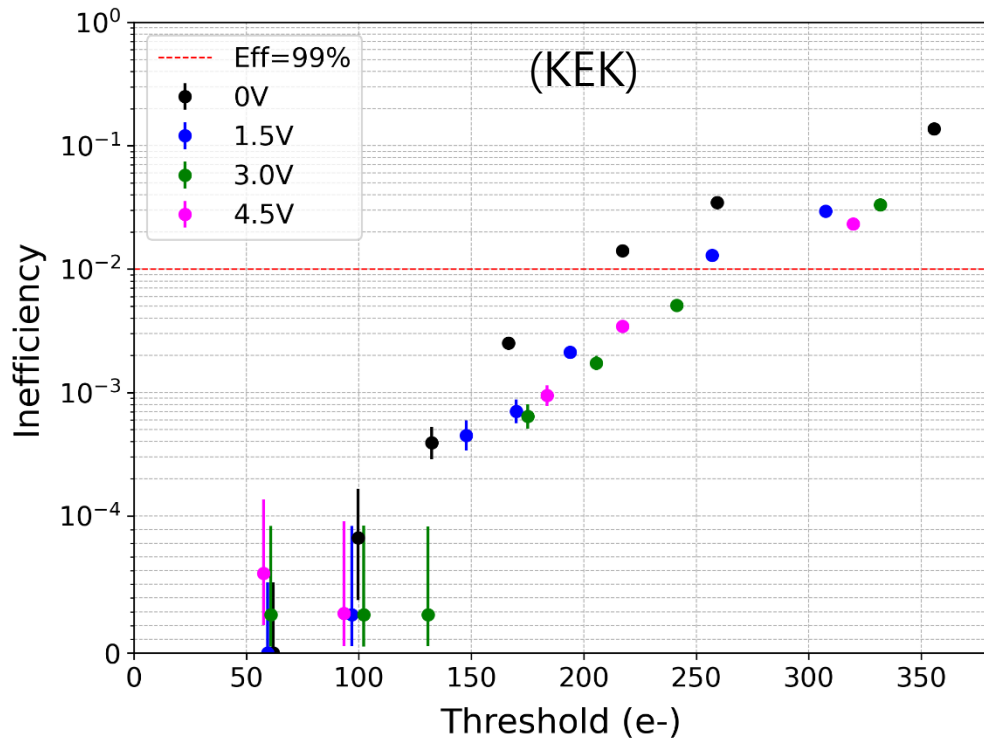


KATS operation test in KEK



Result – Bent ALPIDE test

- Inefficiency vs Threshold



- ▶ Inefficiency = number of non-associated tracks / total tracks
- ▶ Consistent result with DESY experiment at 0V, R = 18 mm

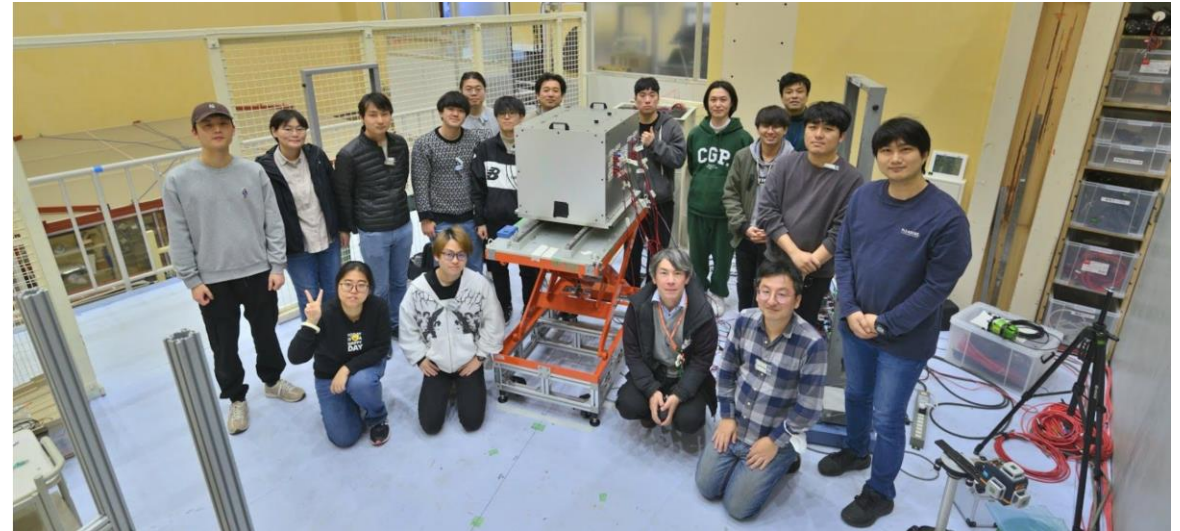


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Summary & Outlook



- The ITS3 upgrade pioneers wafer-scale, bent silicon detector
- KATS was developed for various test beam setups
- Alignment module performs effectively within the practical range of misalignment of detectors
- Confirmed KATS can reconstruct particle tracks well enough
- Bent ALPIDE test results are comparable to those from the DESY experiment
- Planning to upgrade with a different type of the reference detector
- Planning to beam test with other R&D chips



Thank you