



KoALICE

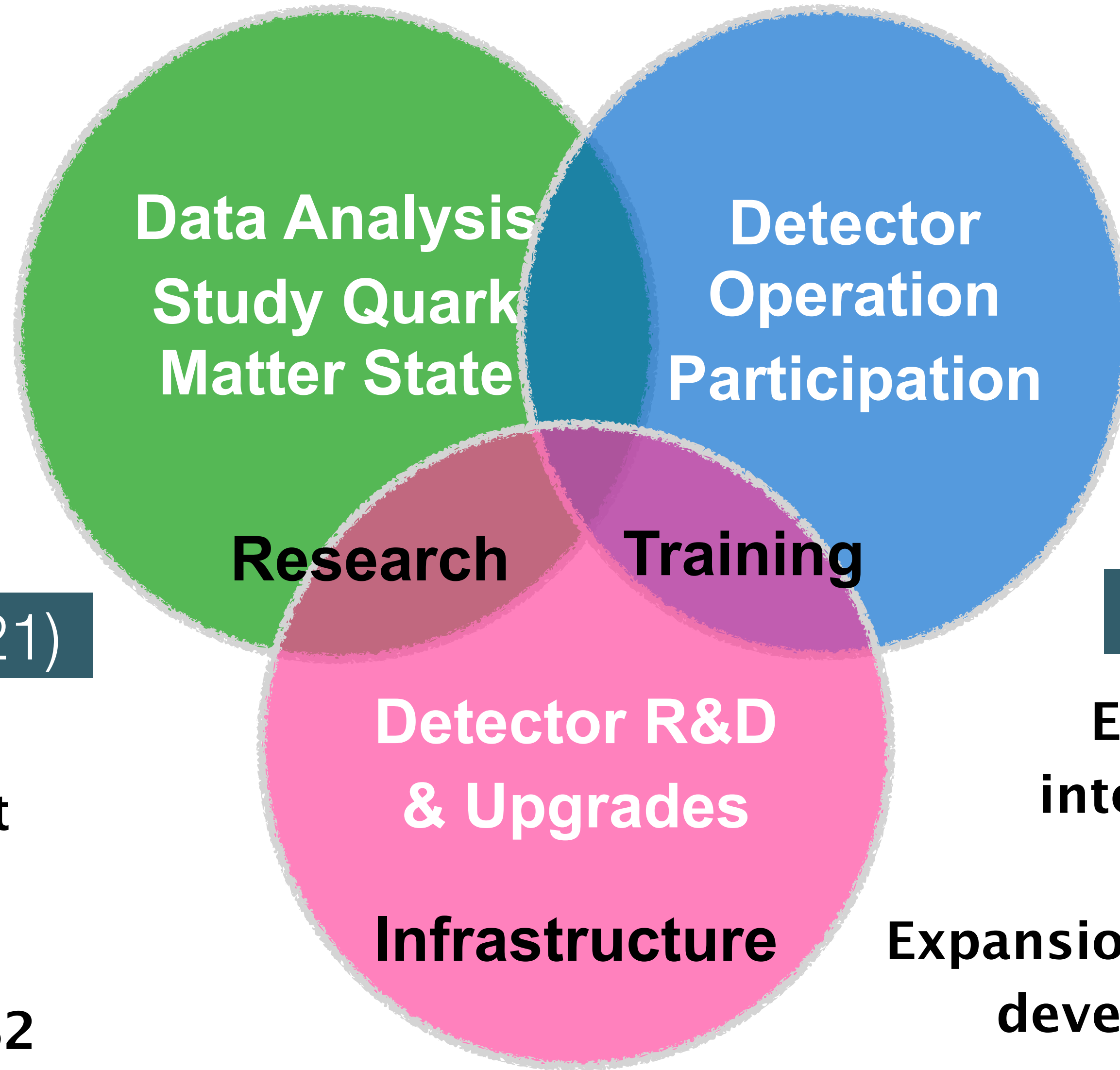
KoALICE 2024-4

CKC meeting

MinJung Kweon

Inha University

2024. 4. 22



Stage 5 (2019~2021)

International Acknowledgement & Successful Contribution for LS2

Stage 6 (2022-2024)

Expanding the area of international contribution & Expansion of semiconductor detector development area for LS3 &4





8 Universities + 1 Institute

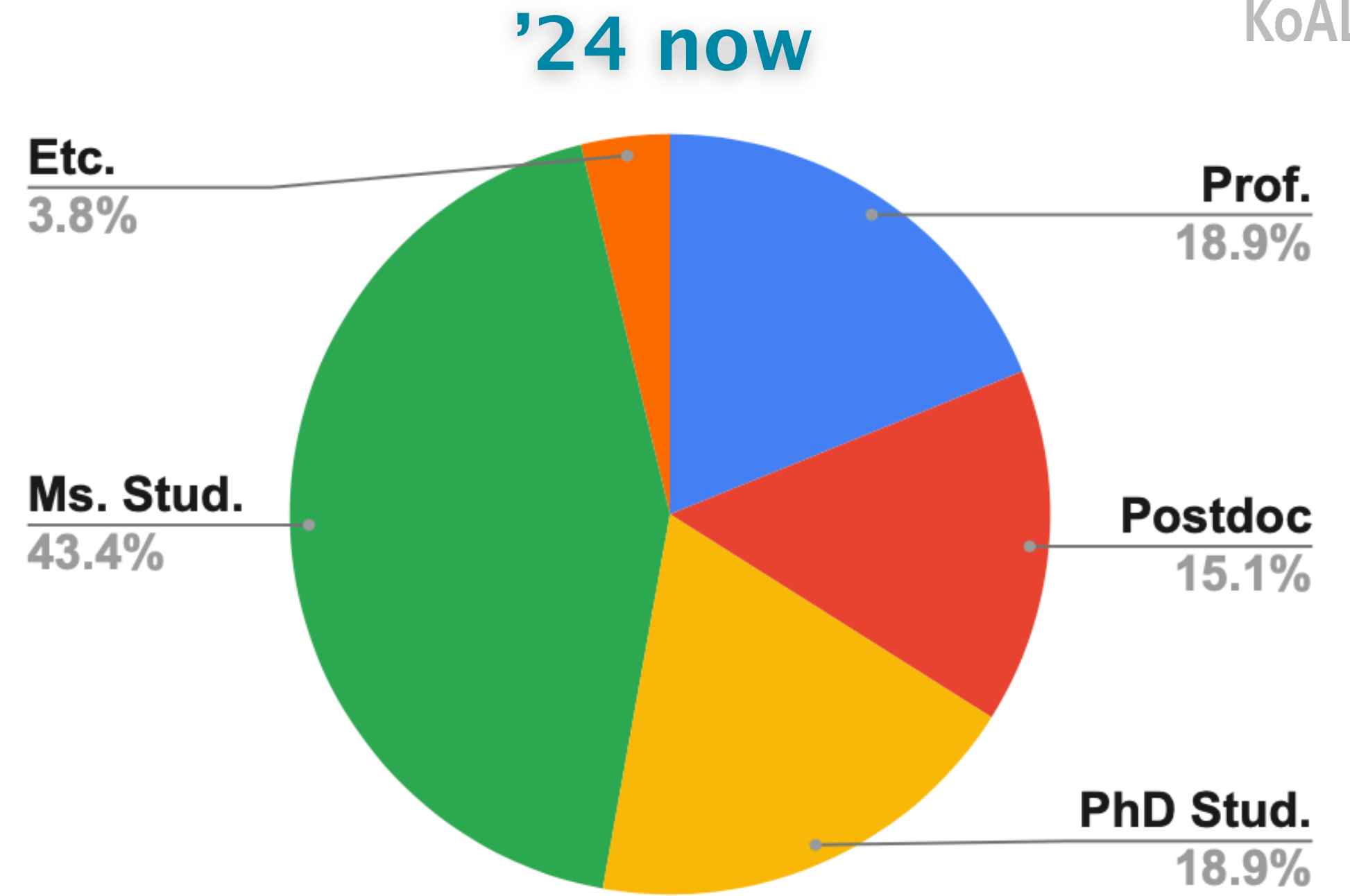
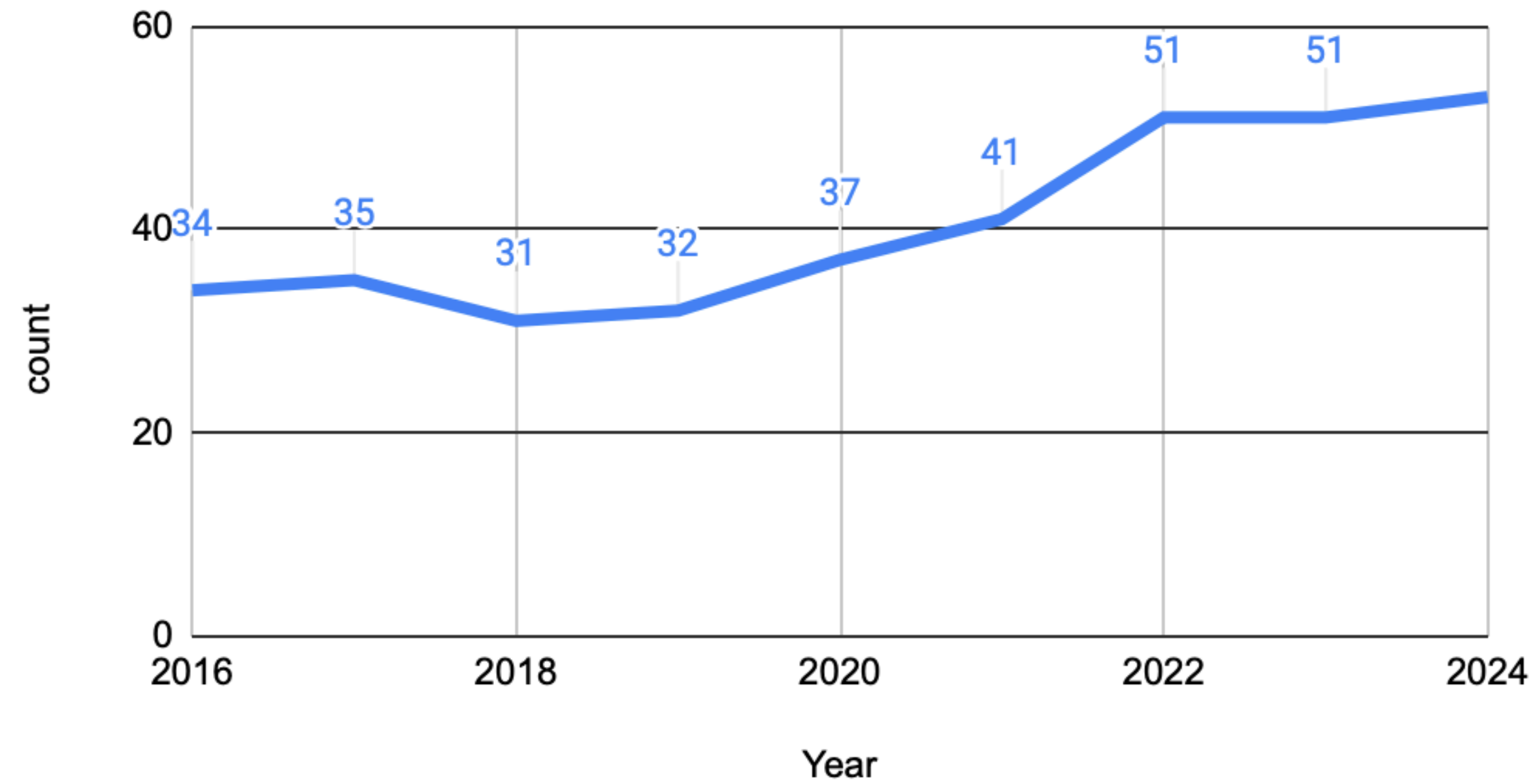
- Chungbuk NU
- Gangneung-Wonju NU
- Inha University
- Jeonbuk NU
- Yonsei University
- Pusan National University
- Sejong University
- Sungkyunkwan University
- KISTI (GSDC)

KoALICE in numbers (53+1)

- 18 PhD Physicists (18 M&O-A)
- 10 PhD Students
- 23 Master Students
 - 1 researcher (post-MS degree)
 - 1 Administrative Assistant
- +1 PhD Physicists from KISTI (1 M&O-A)



Participants



	Institute					Total
		Prof.	Pos doc	Grad. Stud.	Etc	
2019	6→7	7→8	7	16	1	32
2020	7	8	7	21	1	37
2021	7→8	8→9	7	24	1	41
2022	8	10	9	31	1	51
2023	8	10	10	30	1	51
2024	8	10	8	33	2	53

Main changes in members over the past year



● Changes

- **GH Hong (Yonsei)**: pos doc at Yonsei \Rightarrow Company related to semiconductor chip design, 2023.9.
- **JunLee Kim (JBNU)**: pos doc at JBNU \Rightarrow CERN fellow, 2024.4

● New posdoc

- **We are expecting 2–3 people join by this summer**

● 1 Ph.D and 3 Master degrees

- **JunLee Kim (JBNU)**: pos doc at JBNU University, 2023.9.
- **SW Choi (PNU)**: researcher at PNU, 2023.8.
- **SW Park (GWNNU)**: proceeds to Ph. D program at SKKU Graduate School of Physics, 2024.2.
- **YJ Kim (PNU)**: 2024.2.

Status of CERN visit over the past year



KoALICE

Stay	total	PhD	PhD Stud.	MS Stud.	Name
XLong (> 5 mo)	6	5	1		GH Hong(Chip design), Vit Kucera(HF O ² , HF data analysis), YW Baek(Muon run coordinator), Anton Alkin(O ² development), JS Kim(PhD), JY Cho(PhD stud., HF data analysis)
Long (2~5 mo)	2		2		YH Han(PhD stud., chip design), TY Park (PhD stud., electronics design)
Short (< 2 mo)	24	8	5	11	MJ Kweon, IK Yoo, BK Kim, SH Lim, YI Kwon, JH Yoon, A. Nassirpour, JY Kim, JH Ryu, JS Bae, HJ Lee, SJ Ji, SY Cho, SW Park, HW Kim, GL Woo, SW Choi, SH Yang, GY Kim, YH Hong, JS Yoon, HJ Lim, HG Jang, YJ Choi

◉ Long stay

- **YW Baek** : PhD, global polarization, multiplicity & MID upgrade, MUON subsystem run coordinator
- **GH Hong** : PhD, since '20.09 ~ '23.08, ITS3 Chip design
- **Vit Kucera** : PhD, since '22.03, Run3 O² framework development, Run3 HF data analysis, Supervising students
- **Anton Alkin**: PhD, since '23.01, O² framework development, data analysis
- **JS Kim**: PhD, TOF expert On-call & detector test
- **JY Cho**: PhD student, until '23.08, HF data analysis

◉ Stay 2~5 months

- **YH Han**: ITS3 chip design
- **TY Park**: ITS3 electronics design

◉ Short stay (<2 months)

- Run3 OFFLINE shift and Run3 & Run2 data analysis, ITS3 R&D

Scientific Achievements over the past year



A total of 9 physics papers with KoALICE members as main authors

Published in 2023

1. Production of pions, kaons, and protons as a function of the relative transverse activity classifier in pp collisions at $\sqrt{s}=13$ TeV, JOURNAL OF HIGH ENERGY PHYSICS, **Adrian Nassirpour**, 6 June 2023
2. Light (anti)nuclei production in Pb–Pb collisions at $\sqrt{s_{NN}}=5.02$ TeV, PHYSICAL REVIEW C, **Bong–hwi Lim**, 8 June 2023
3. Measurement of electrons from beauty–hadron decays in pp and Pb–Pb collisions at $\sqrt{s_{NN}}=5.02$ TeV, PHYSICAL REVIEW C, **Jonghan Park**, 15 September 2023
4. Pseudorapidity densities of charged particles with transverse momentum thresholds in pp collisions at $\sqrt{s} = 5.02$ and 13 TeV, PHYSICAL REVIEW D, **Jeongsu Bok, Beomkyu Kim**, 11 October 2023
5. Groomed substructure of D^0 –jets in pp at $\sqrt{s} = 13$ TeV, PHYSICAL REVIEW LETTERS, **Vit Kucera**, 7 November 2023

Published in 2024

1. Multiplicity and event–scale dependent flow and jet fragmentation in pp collisions at $\sqrt{s}=13$ TeV and in p–Pb collisions at $\sqrt{s_{NN}}=5.02$ TeV, JOURNAL OF HIGH ENERGY PHYSICS, **Junlee Kim, Beomkyu Kim**, 15 March 2024
2. Measurement of the fraction of jet longitudinal momentum carried by Λ_c^+ baryons in pp collisions, PHYSICAL REVIEW D, **Vit Kucera**, 5 April 2024

Accepted

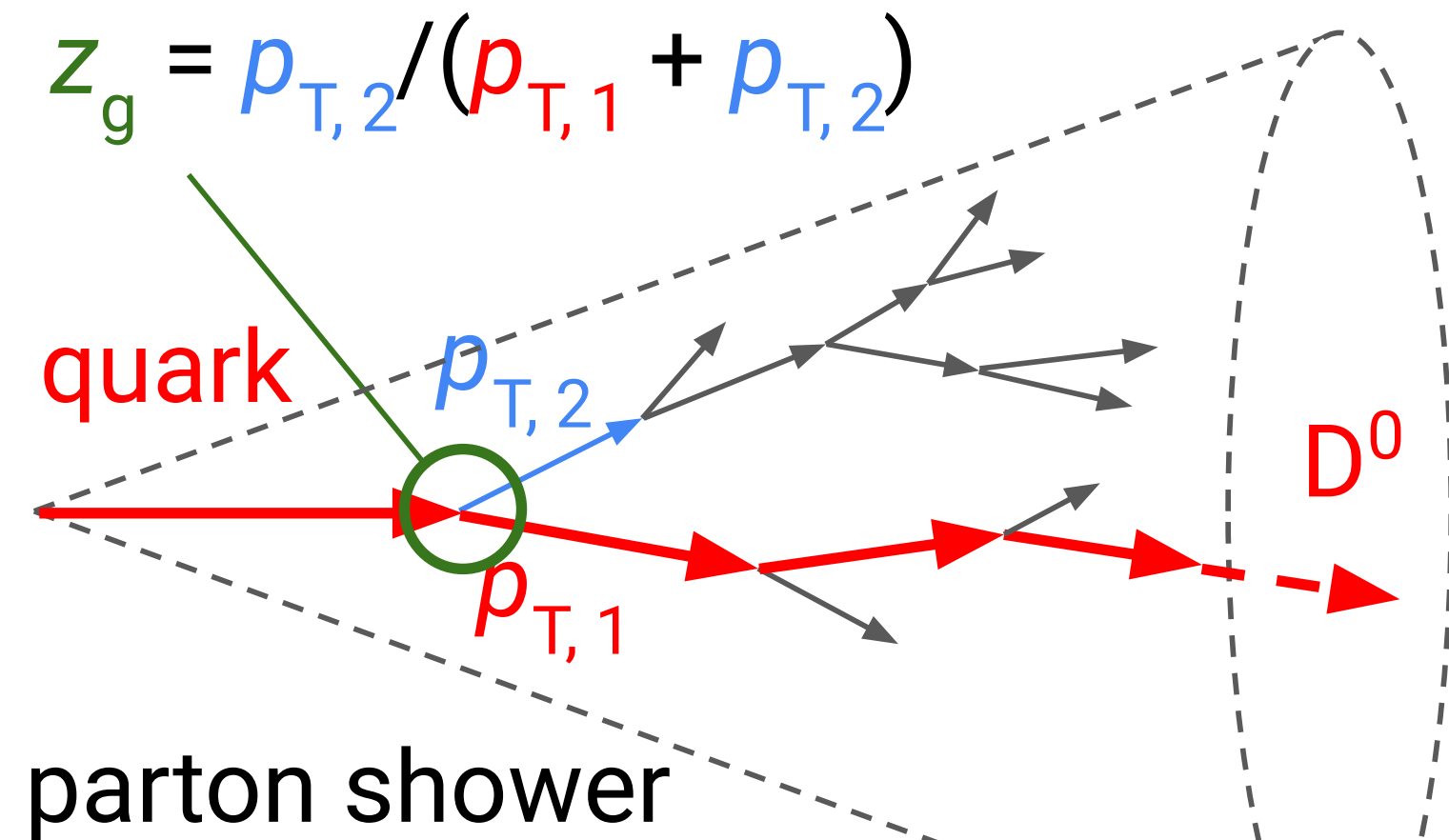
3. Observation of abnormal suppression of $f_0(980)$ production in p–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, PHYSICS LETTERS B, **Junlee Kim, Beomkyu Kim, Sanghoon Lim, Eun Joo Kim**, Accepted
4. Multiplicity and event–scale dependent flow and jet fragmentation in pp collisions at $= \sqrt{13}$ TeV and in p–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, **Adrian Nassirpour**, Accepted

Paper Highlight: D^0 -jets structure

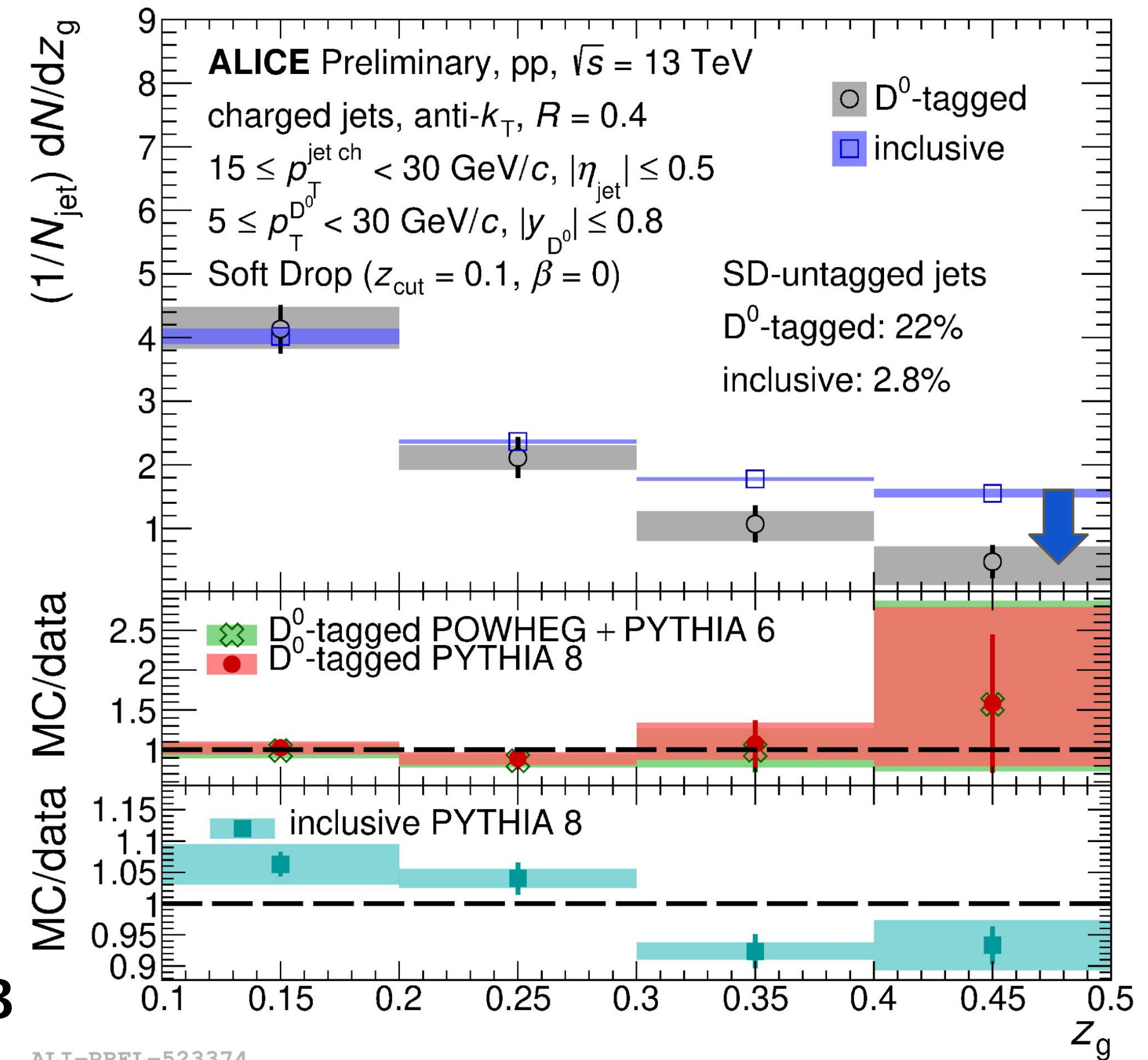
Groomed substructure of D^0 -jets in pp at $\sqrt{s} = 13$ TeV,

Fragmentation via heavy-flavor jets: Heavy flavor conserved in the parton shower and experimentally traceable

→ access to properties of gluon emissions



PHYSICAL REVIEW LETTERS, Vit Kucera, 7 November 2023

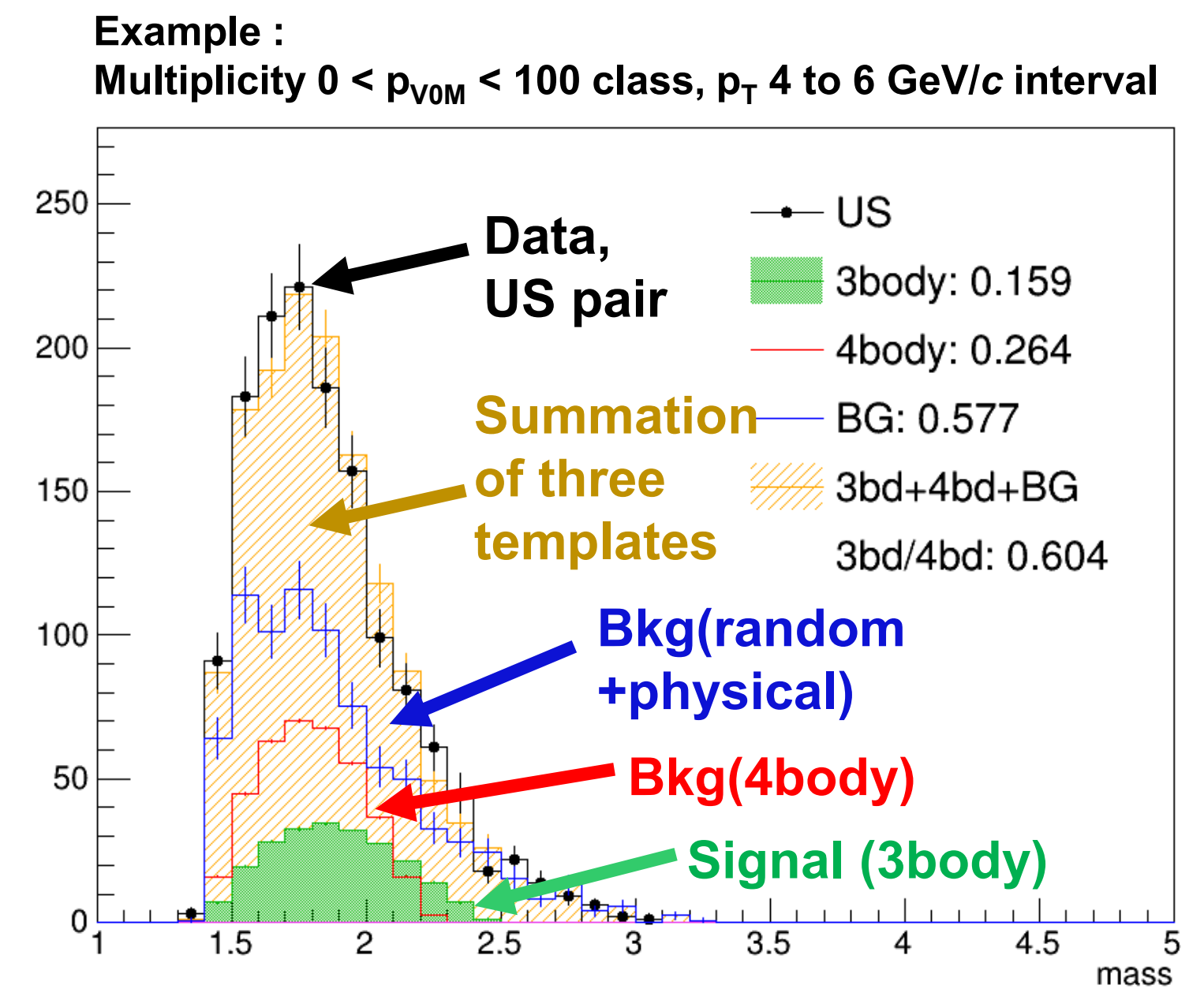
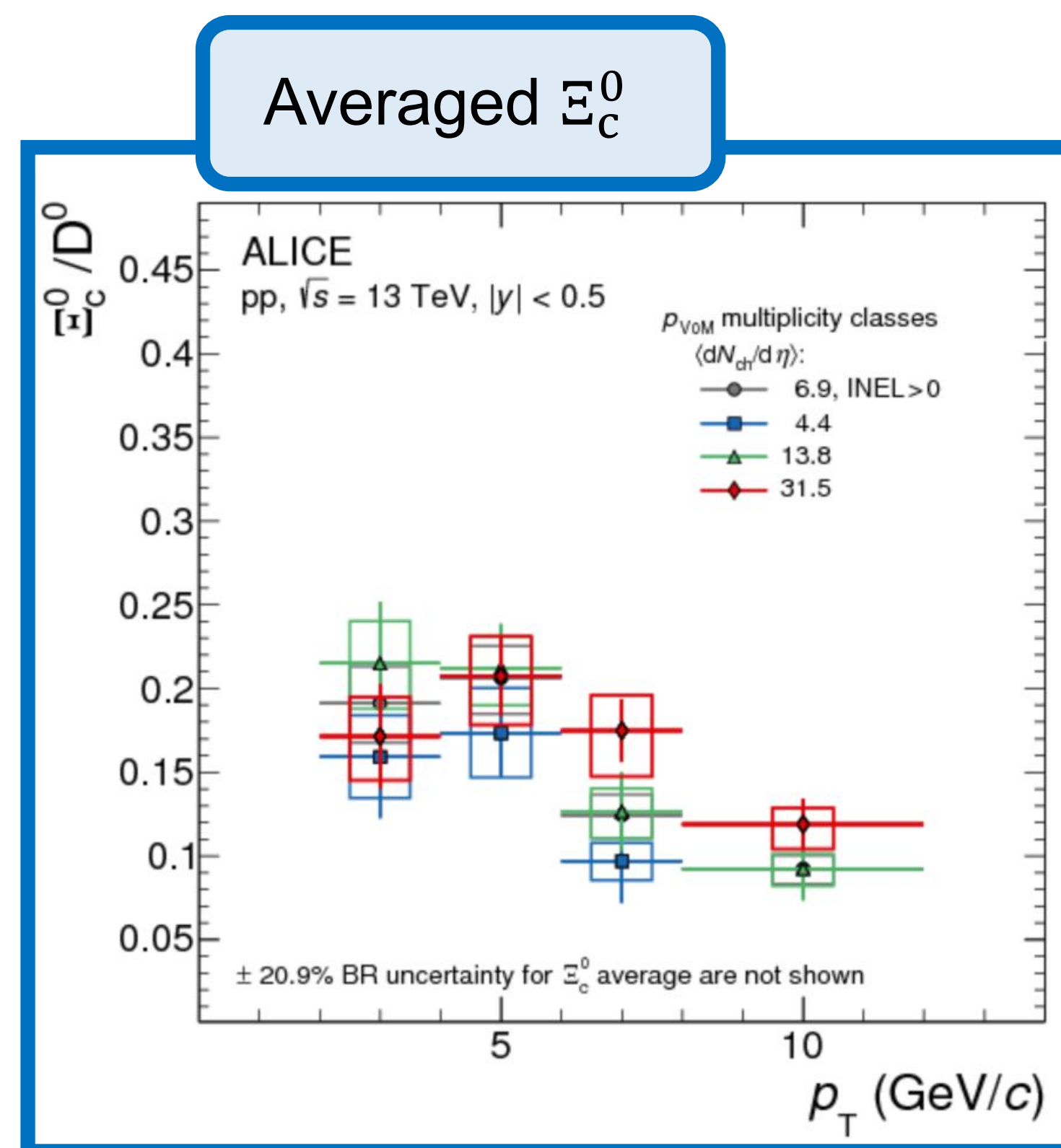
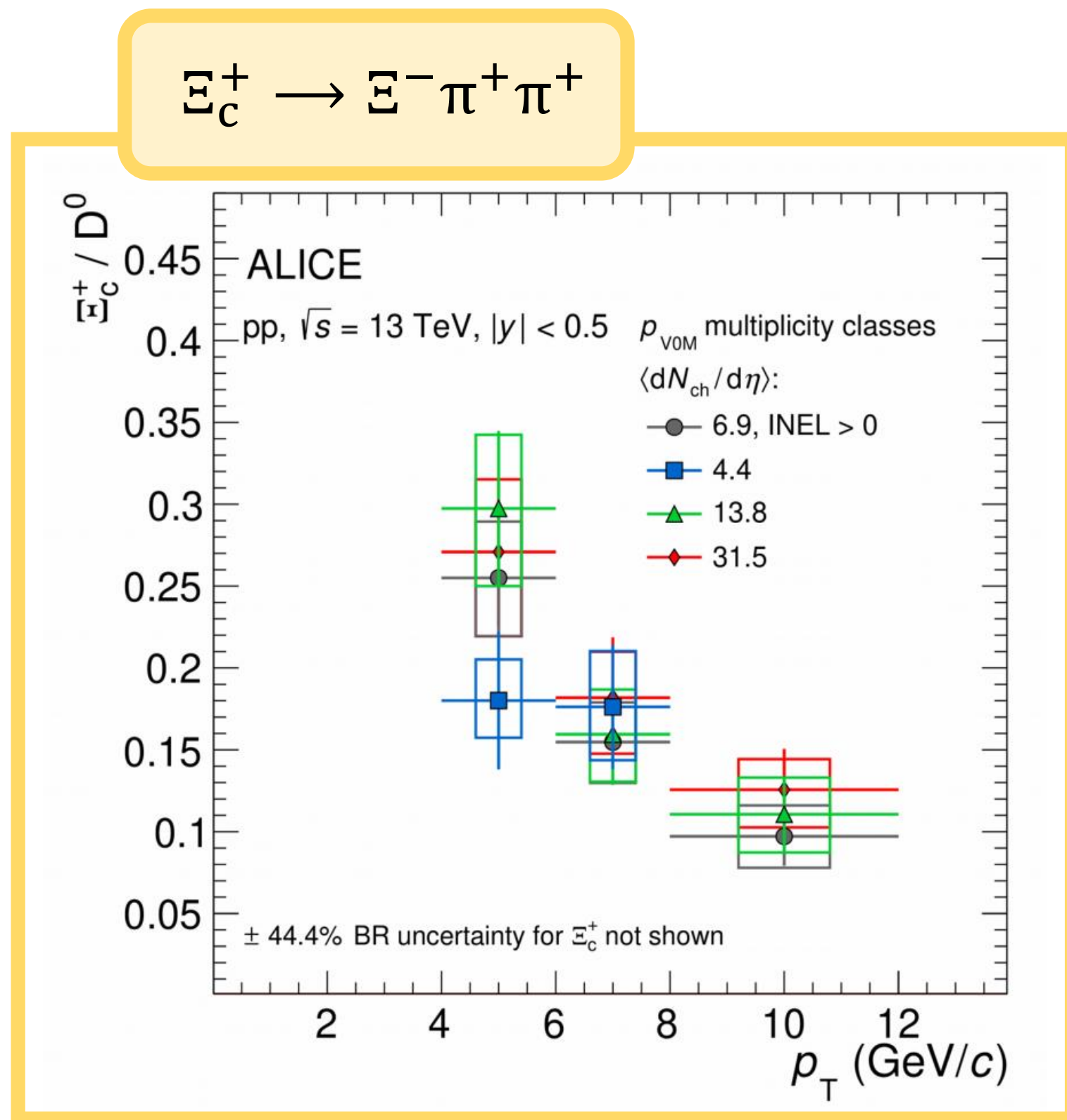


Data Analysis Highlight: Ξ_c^+ production in different multiplicity class



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Baryon enhancement at the LHC with respect to e^+e^- collisions is caused by **different hadronisation mechanisms** at play in the parton-rich environment produced in pp collisions



Branching fraction
 $= \text{BR}(\Xi_c^0 \rightarrow e^+ \Xi^- \nu_e) / \text{BR}(\Xi_c^0 \rightarrow \Xi^- \pi^+)$

Jaeyoon Cho + Chong Kim

MB + HMV0: 0.8261 ± 0.0945 (stat) + $0.0969 - 0.0842$ (syst)

First measurement of Ξ_c^+ production in different multiplicity class
 Paper proposal done at the last Physics Forum

◎ Paper Review & Analysis Review Committee

▸ Internal Paper Review Committee:

- The measurement of non-prompt D-meson elliptic flow in Pb-Pb collisions at 5.02 TeV (MJ Kweon)
- Measurement of the angle between jet axes in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV (Vit Kucera)
- Measurement of the angle between jet axes in pp collisions at $\sqrt{s} = 5.02$ TeV (Vit Kucera)
- Investigation of K^+K^- interactions via femtoscopy in Pb-Pb collisions at $\sqrt{s_{NN}}=2.76$ TeV at the LHC (JH Song)
- K^{*+} production in Pb-Pb collisions at 5.02 TeV (JH Song)
- Pseudorapidity dependence of long-range correlations in Pb-Pb and Xe-Xe collisions (BK Kim)
- Particle production as a function of charged-particle flatnecity in pp collisions at $\sqrt{s}=13$ TeV (Adrian Fereydon Nassirpour)

▸ Analysis Review Committees : BK Kim, IK Yoo, Vit Kucera (two analyses)

◎ Committee related to organization

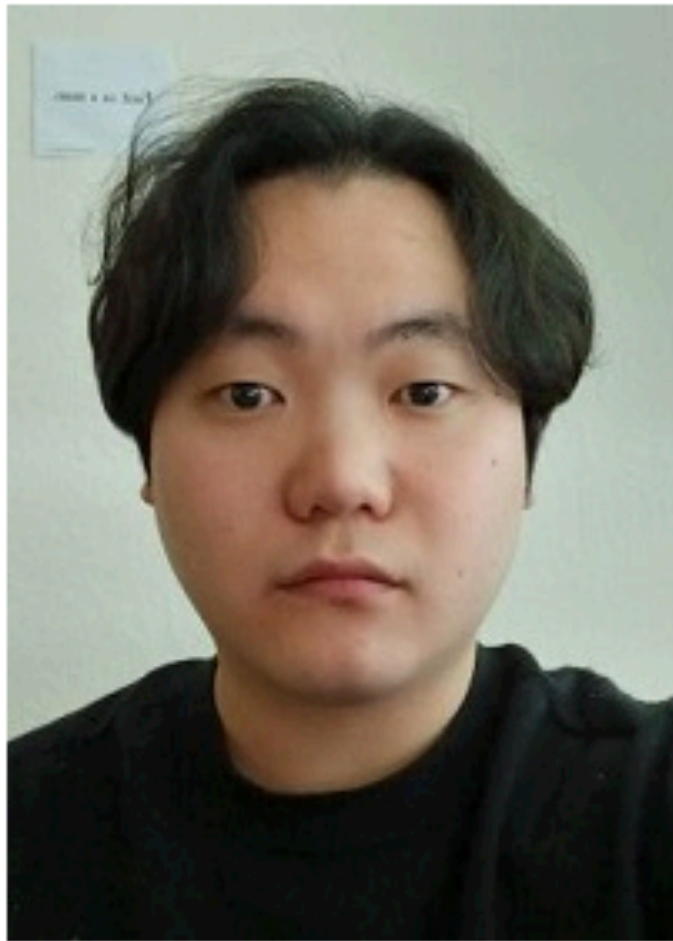
- ALICE junior Korean Ambassador : SJ Ji (since 2022)
- ALICE Conference Committee : MJ Kweon (since 2023)
- PAG-HF-JE Coordinator : Vit Kucera
- PAG-Resonance Coordinator : Adrian Fereydon Nassirpour
- MID subsystem run coordinator : YW Baek

◎ Awards

- Korean Physical Society Meeting outstanding presentation awards: JH Ryu, SJ Ji
- SNP School outstanding presentation awards: SJ Ji

◎ Outstanding awards

- Junlee Kim **awarded the Bosan nuclear physics prize** in 2024. This prize is an award given to a young researcher who have conducted outstanding research in the filed of nuclear physics in the Korean Physical Society. He continues his career in this field as a **CERN fellow** starting from this April.



김준이 박사

오고 있다.

전북대학교를 졸업한 김준이 박사(2011학번)가 한국물리학회가 수여하는 2024년 봄 한국물리학회상 '보산핵물리학상' 수상자로 선정됐다.

한국물리학회 보산핵물리학상은 국내외 저명 학술지에 우수한 논문을 발표했거나 우수한 학위논문을 집필하는 등 연구업적이 탁월해 향후 한국 핵물리학 발전에 기여할 것으로 기대되는 젊은 핵물리학자에게 수여하는 상이다.

김 박사는 스위스 제네바 유럽핵입자물리연구소(CERN)에 위치한 거대강입자 충돌기(LHC, Large Hadron Collider)의 ALICE 실험에서 상대론적 중이온 충돌 데이터 분석을 통해 하전입자의 흐름과 가벼운 공명입자 구조, 관련 모델 연구 등을 활발히 수행해 왔다.

특히 $f_0(980)$ 입자의 내부구조 이해를 위한 심도 있는 연구를 다각도로 수행해

김 박사는 짧은 연구 경력에도 불구하고 International Nuclear Physics Conference와 같은 저명한 국제 학술대회에서 우수한 연구성과를 발표했다.

이와 함께 김 박사는 그동안의 연구 성과를 인정받아 지난해 12월 유럽핵입자물리연구소에서 직접 선발하는 'CERN fellowship' 수상자로 선정됐고, 이달 1일부터는 유럽핵입자물리연구소에서 펠로우(Fellow)로서 핵물리학 연구를 이어나가고 있다.

Participating detector operation

Korea ALICE team (clustered) Due: 2.8 % of the total ALICE shifts

Details *Data taking 2023*

Total M&O	18	[including KISTI(1)]
Due credits	148.68	
Carryover	0	

overbooked

Booked/Due

100%

149 of 148.68

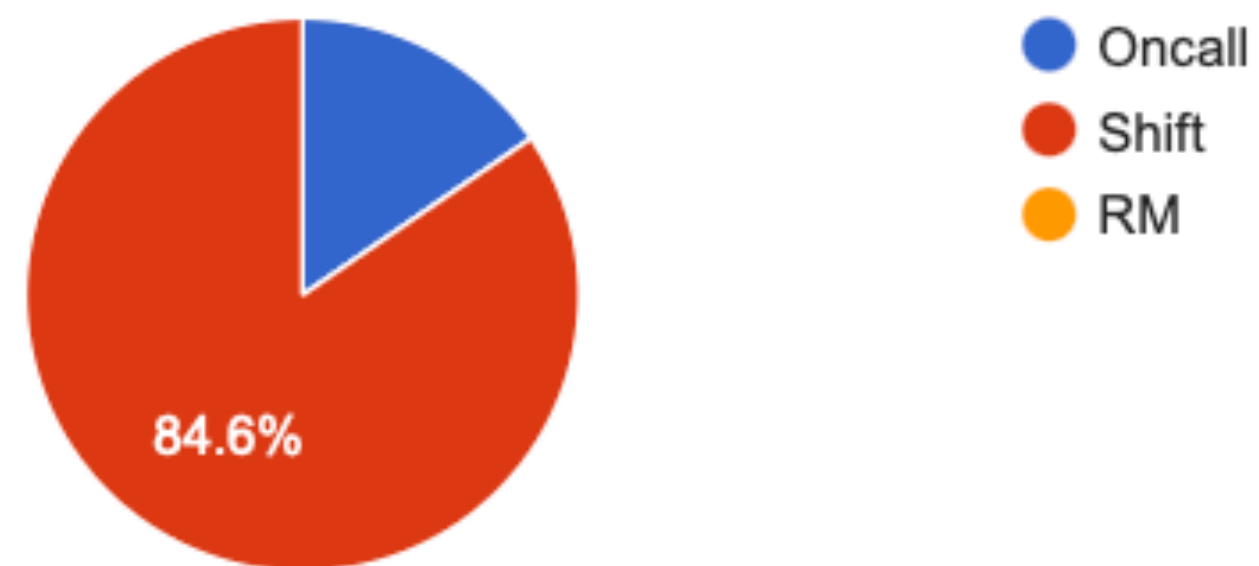
Done/Booked

100%

149 of 149

100% !

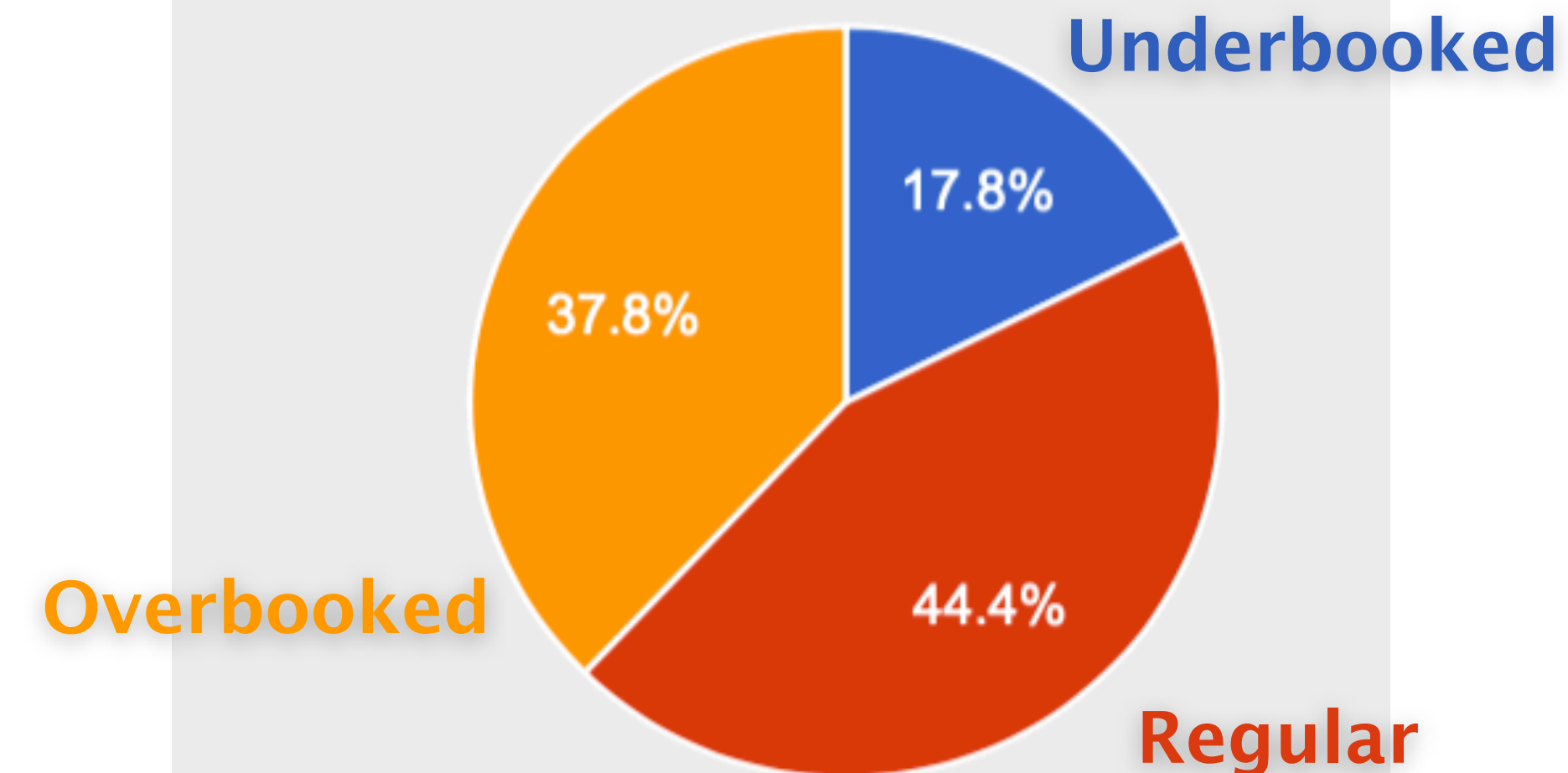
Shift Categories



ALICE total

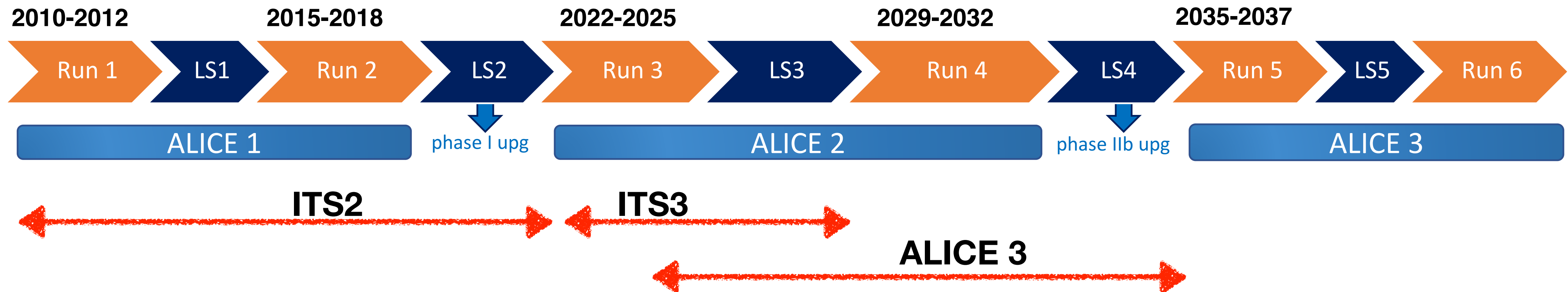
Total credits	5228.6
Total M&O	633
Lambda	8.26
Carryover	0

Institutions Status



Participation in silicon detector upgrade

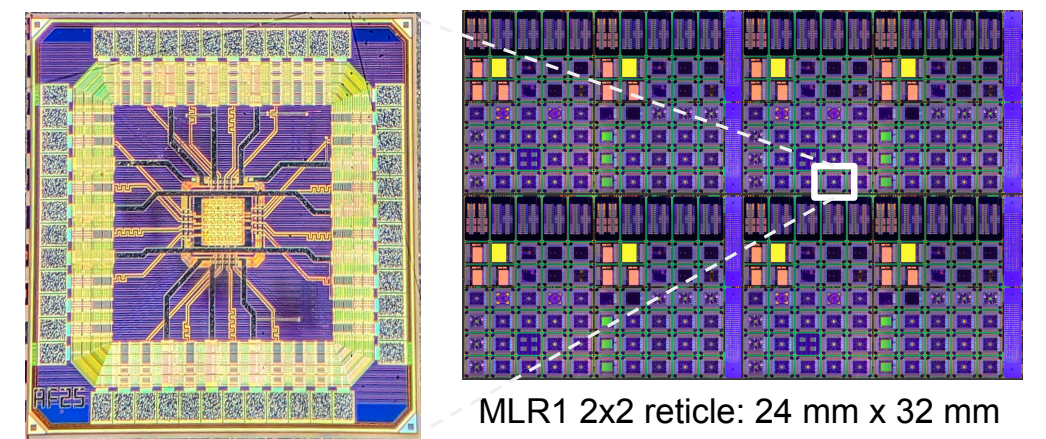
● KoALICE has been heavily involved in developing state-of-the-art silicon detector since 2013



● KoALICE contribution to ITS3

- Sensor design and fabrications (Yonsei)
- Sensor characterization (Inha, PNU)
 - KOMAC beam test, after-bent test (Inha, PNU)
 - Beam test data analysis (PNU)
- Studies on interconnect technology (Inha, **MEMSPACK**)
- Electronics board productions for test system (PNU, Inha, **NOTICE, MEMSPACK**)

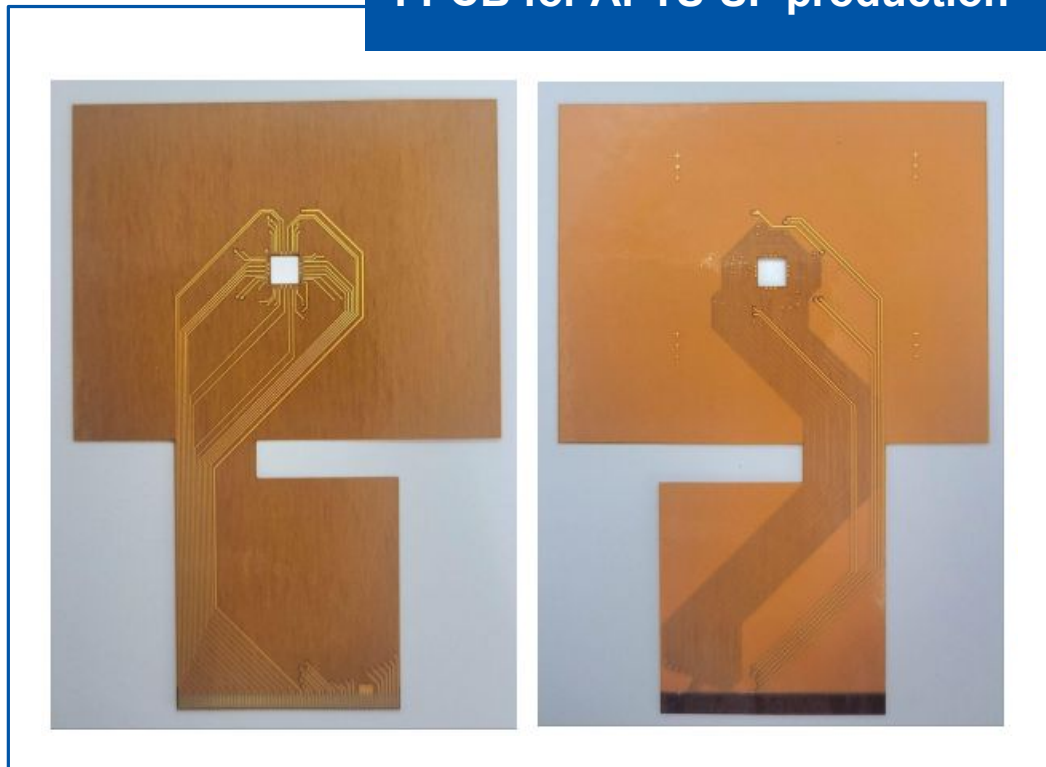
Develop bent ALPIDE chip test system & perform tests



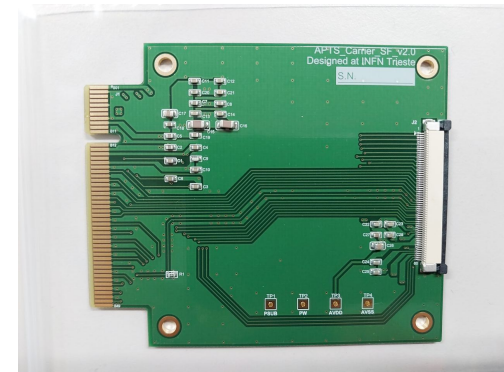
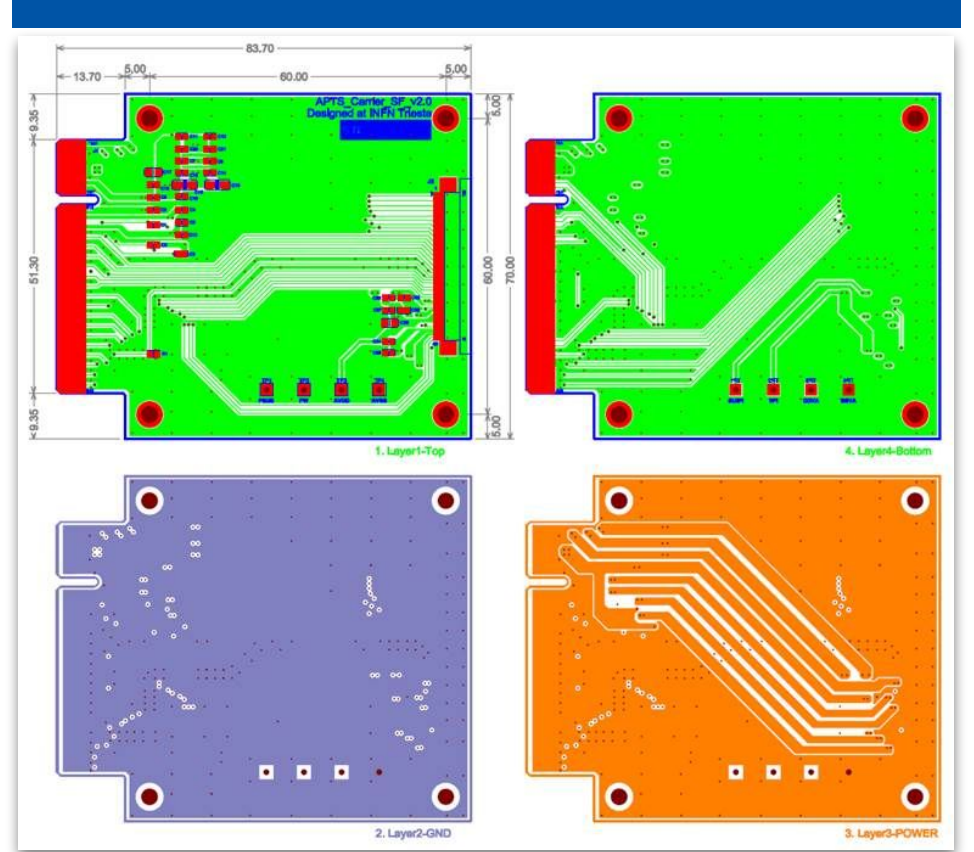
MLR1 2x2 reticle: 24 mm x 32 mm

APTS-SF sensor:
1.5 mm x 1.5 mm

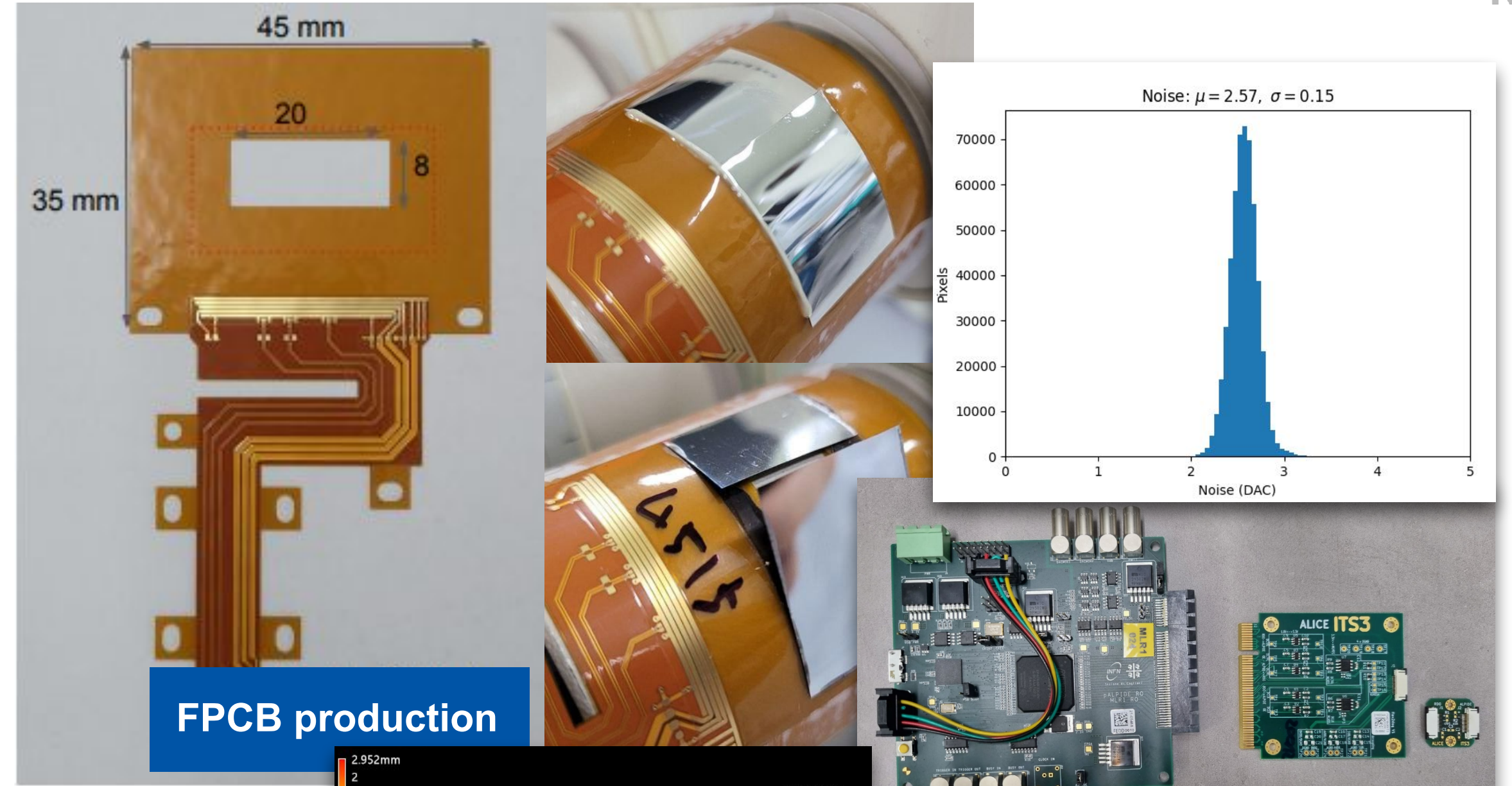
FPCB for APTS-SF production



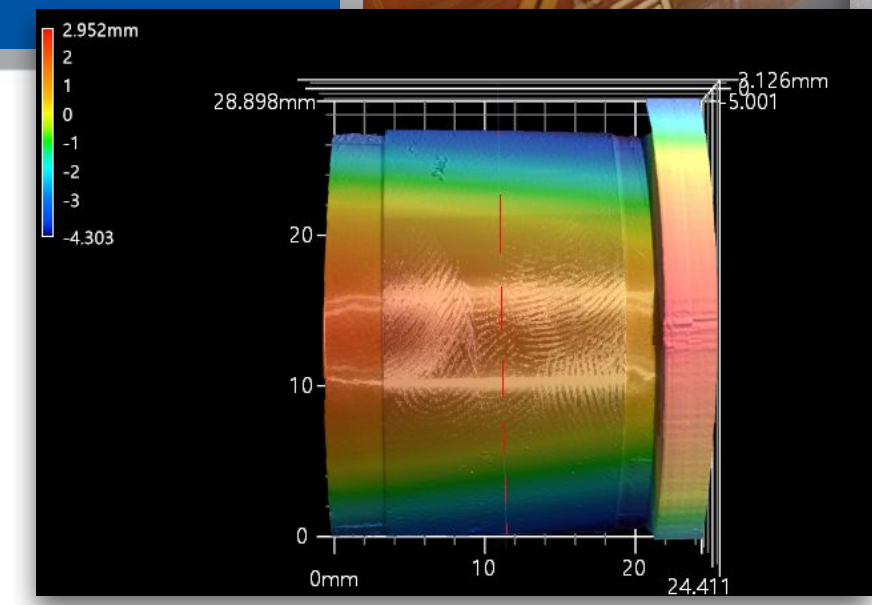
APTS-SF Carrier board design modification



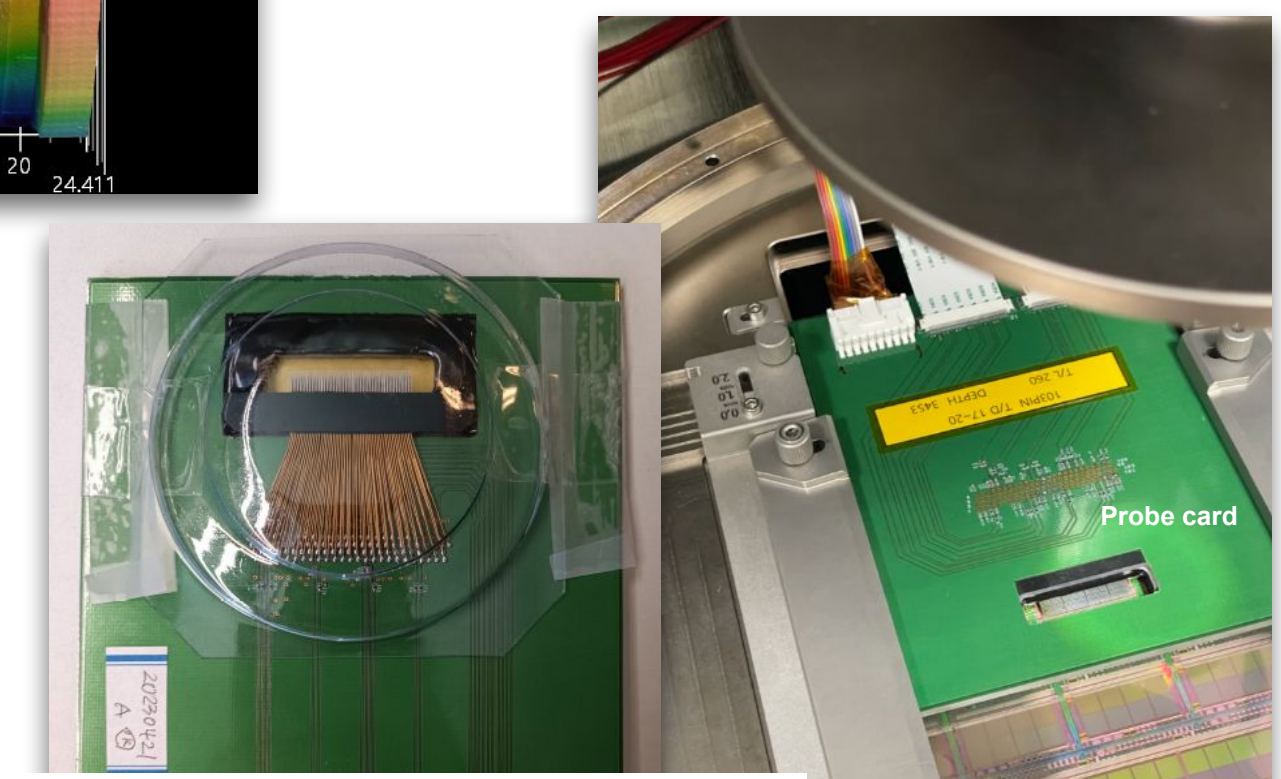
FPCB for APTS-SF design and production
APTS-SF Carrier board modification



FPCB production

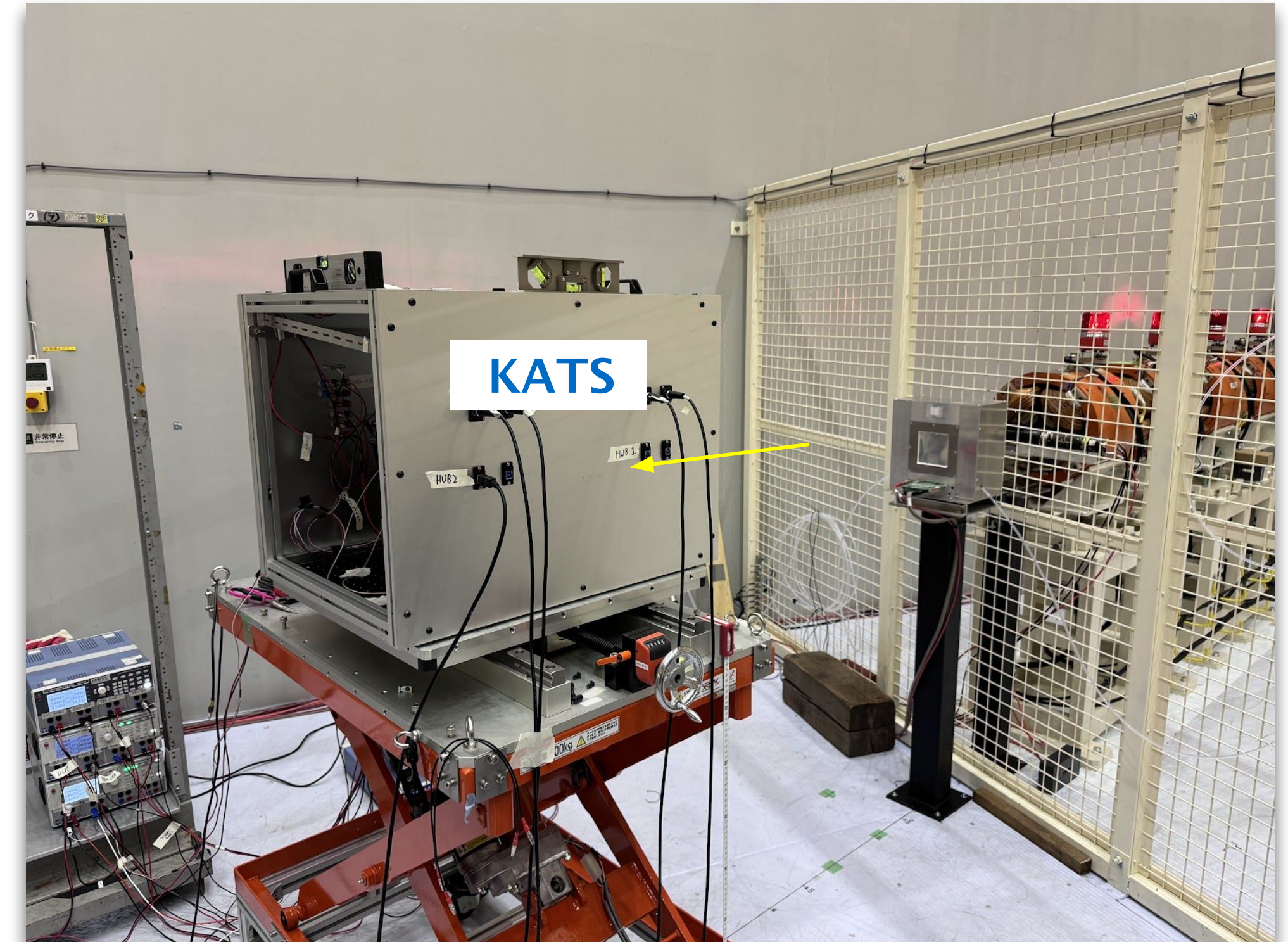
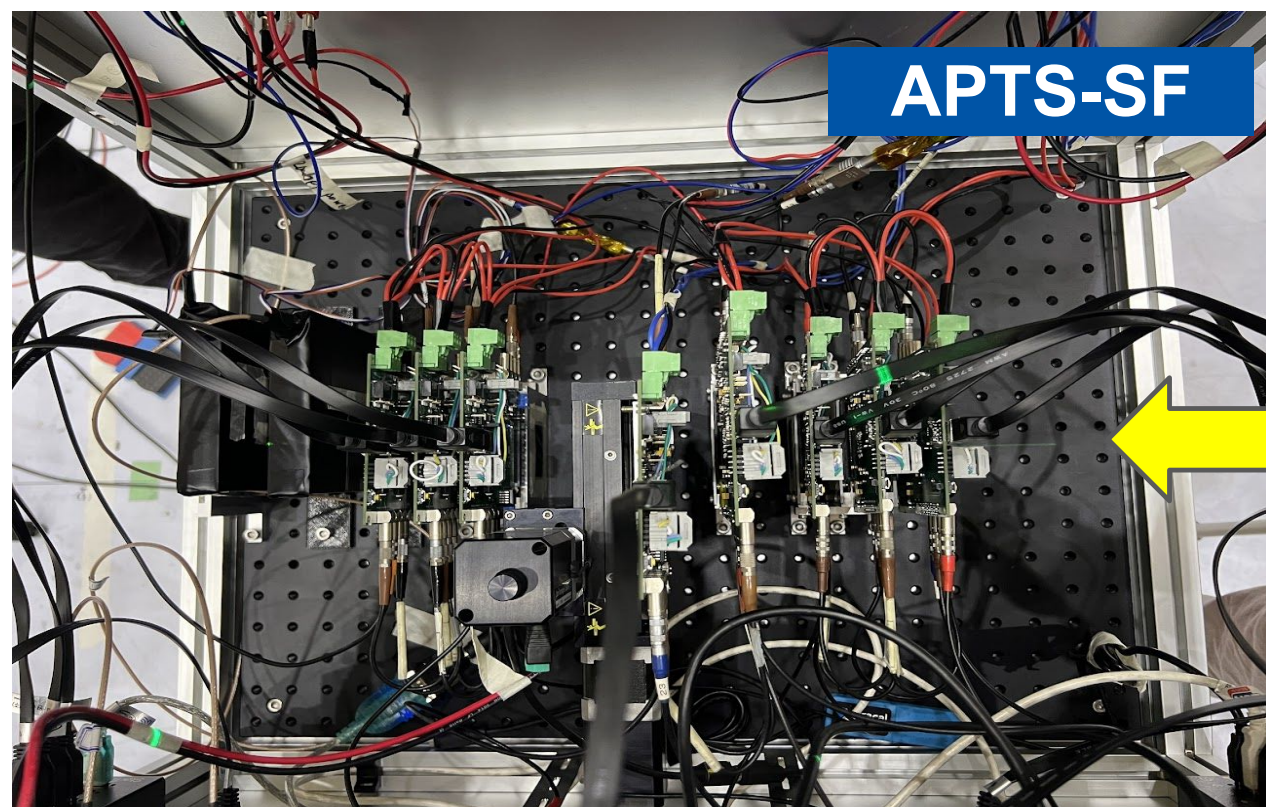
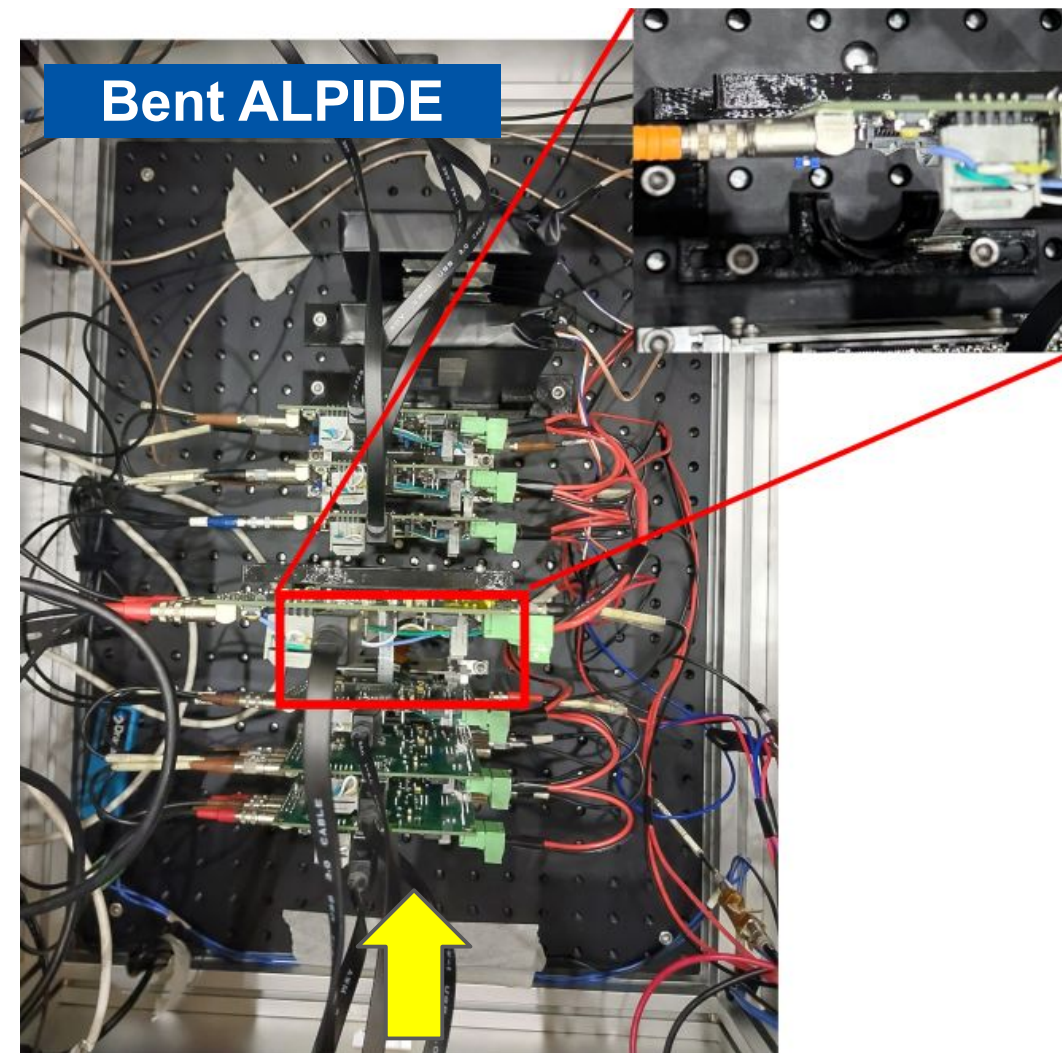
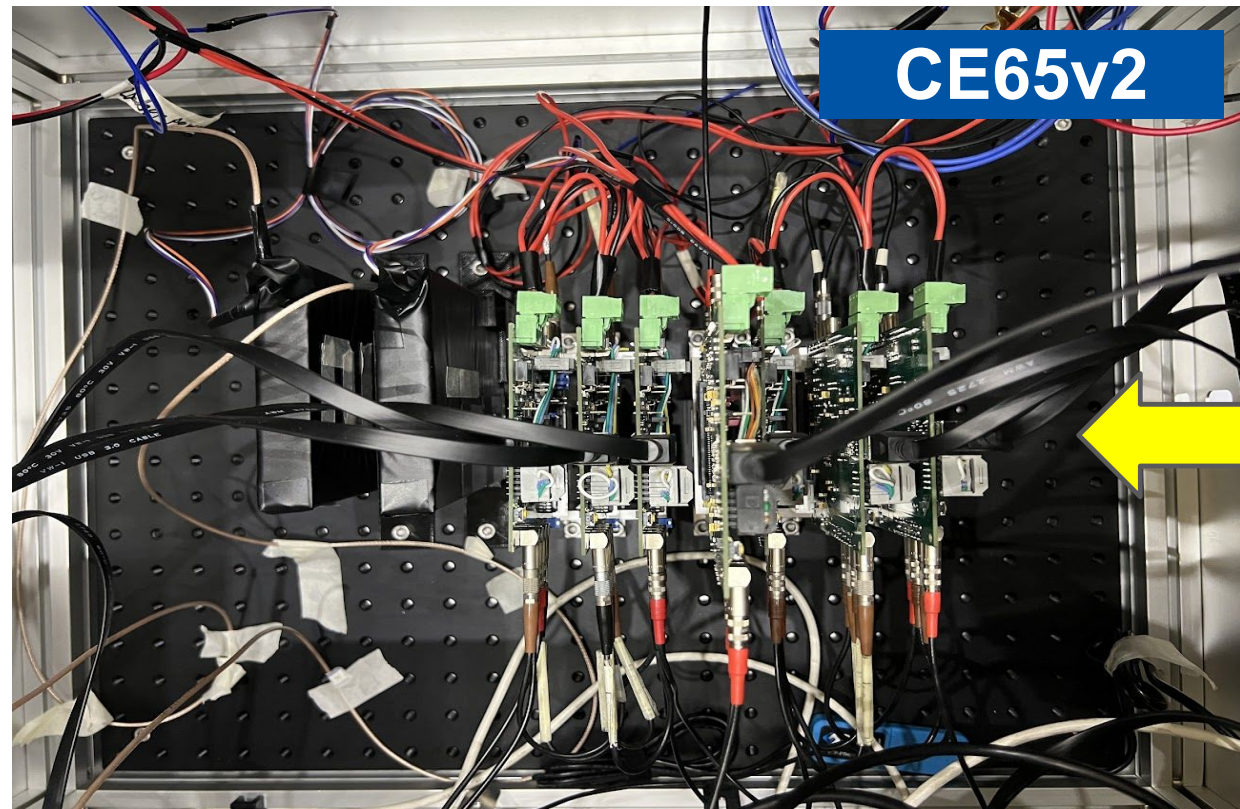


Bent ALPIDE Test system



Probecard production for MOSS

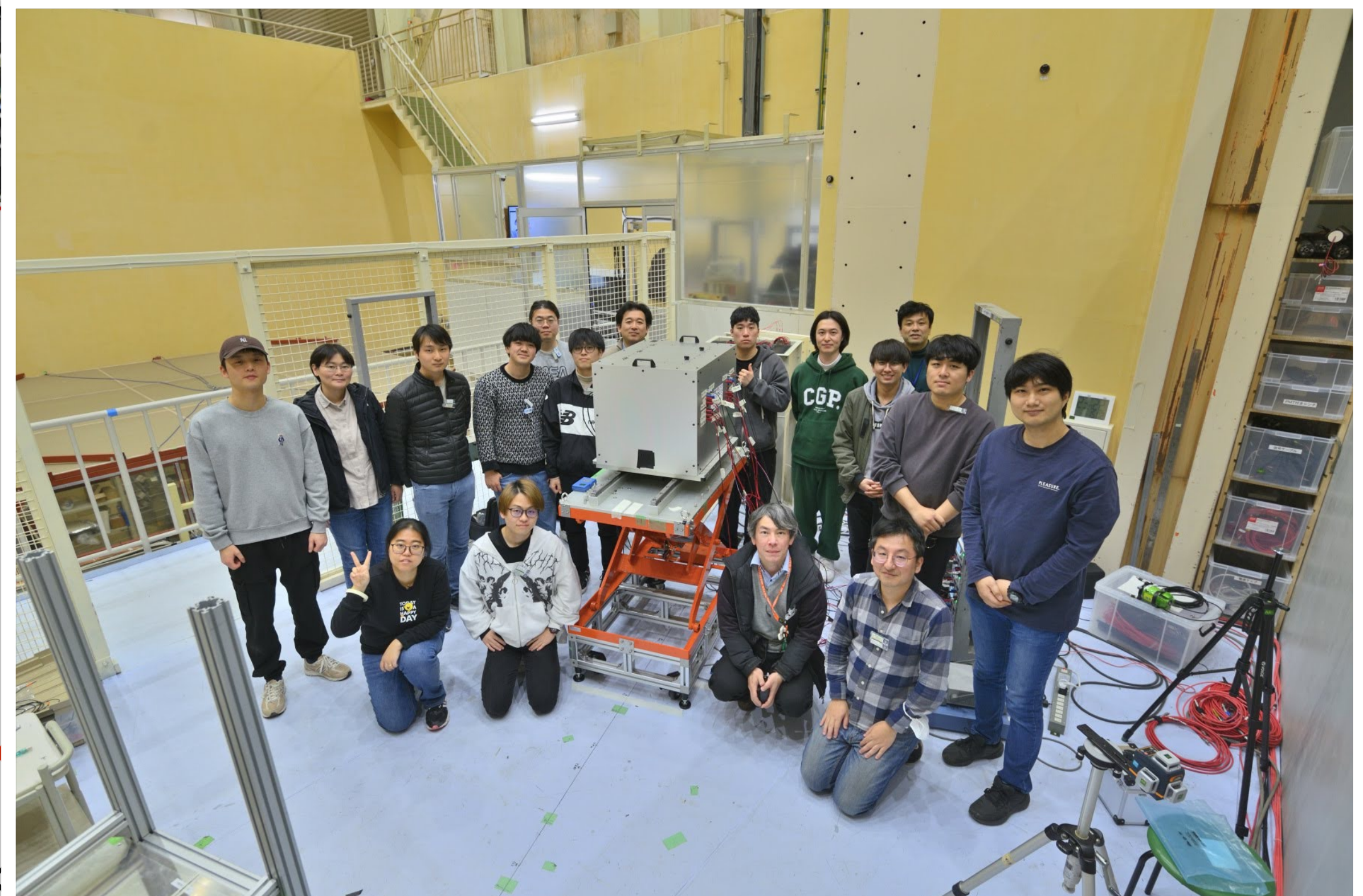
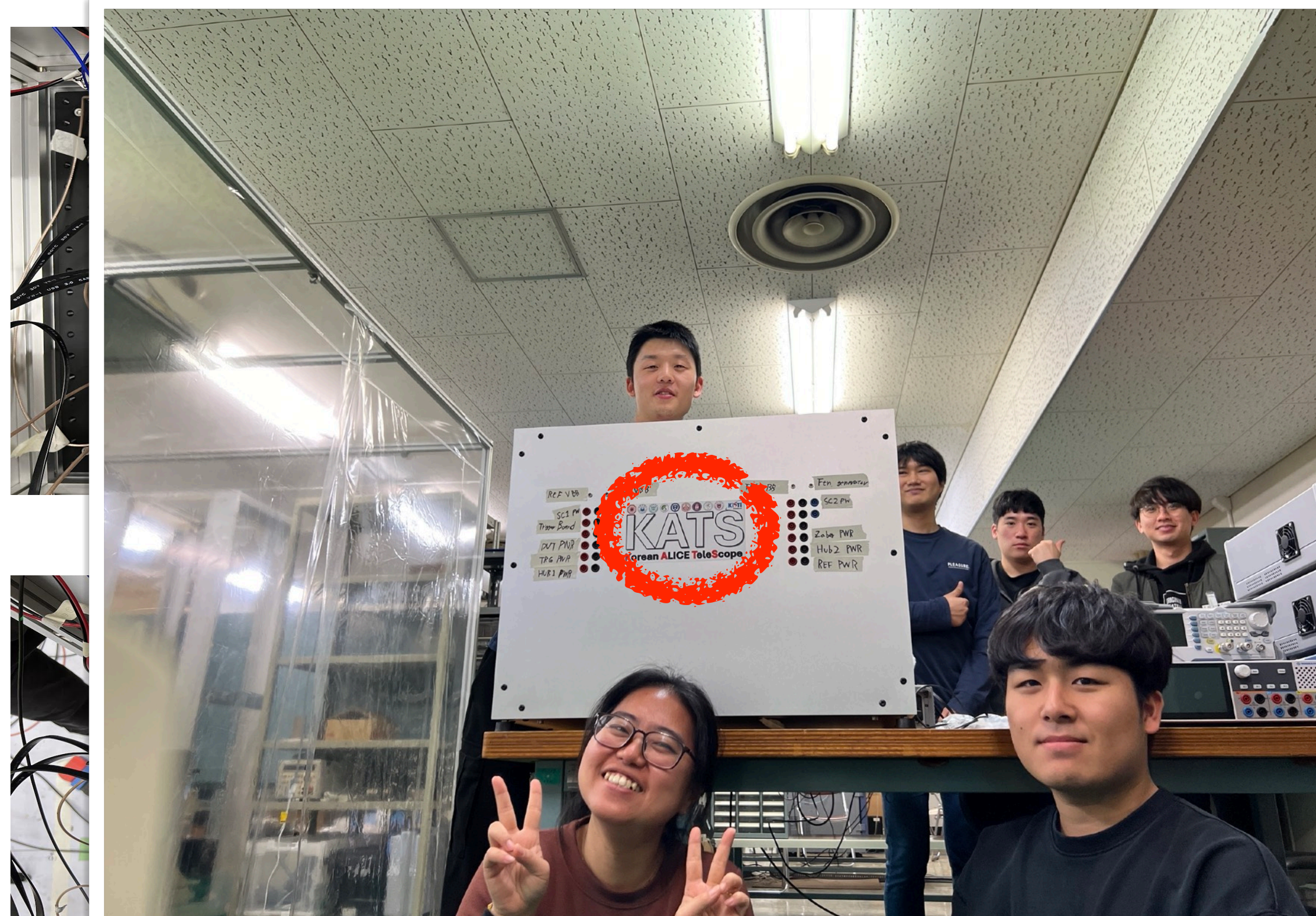
- ◎ Producing **Korean ALICE TeleScope (KATS)** production and its operation
 - Telescope: Detector system for tracking performance with multiple sensor layers
 - **The 1st ITS3 telescope production in ITS3 Asian institutions**



ITS3 beam test with Korean telescope at PF-AR beam line in KEK

- ▶ at March 11th – 18th
- ▶ Collaboration with Korean + Japanese colleagues (Total 17 participants from 5 Universities)
- ▶ Electron beam @ 3 – 5 GeV/c
- ▶ Various sensors have been studied (Bent ALPIDE, APTS-SF, CE65v2)

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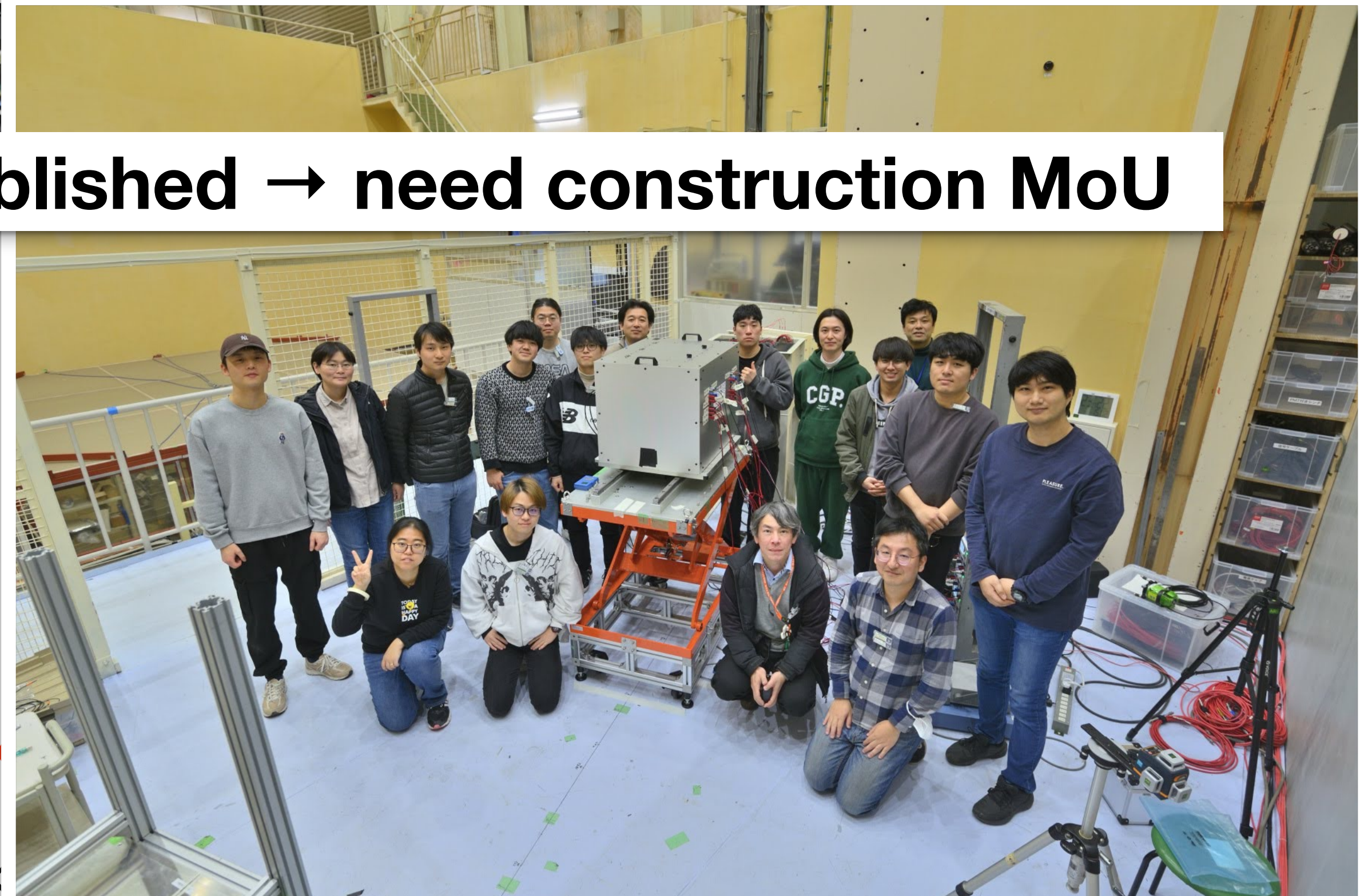
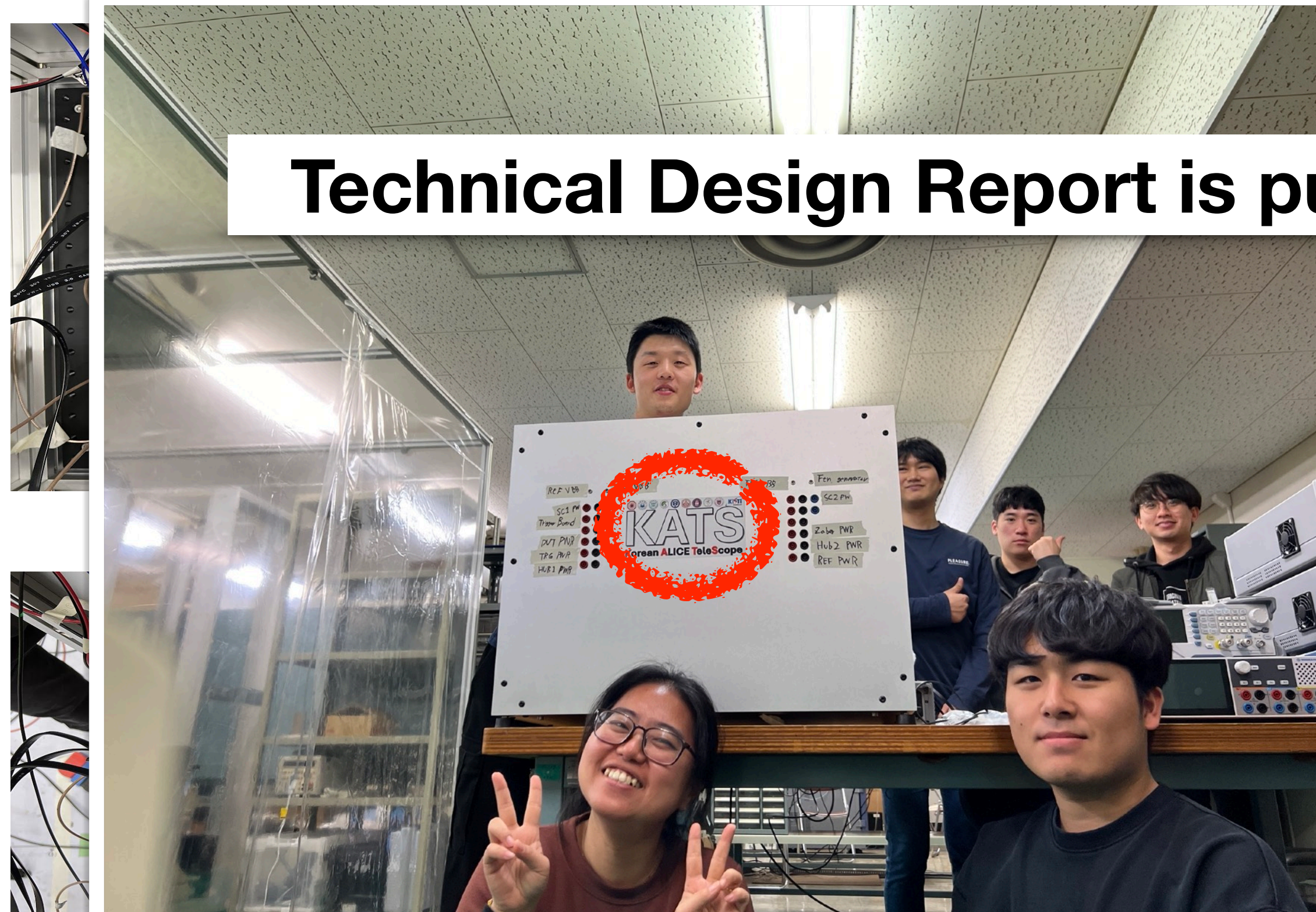


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Plan to produce KATS based on BabyMOSS chips & test bent BabyMOSS

- ◎ Producing **Korean ALICE TeleScope (KATS)** production and its operation
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Technical Design Report is published → need construction MoU

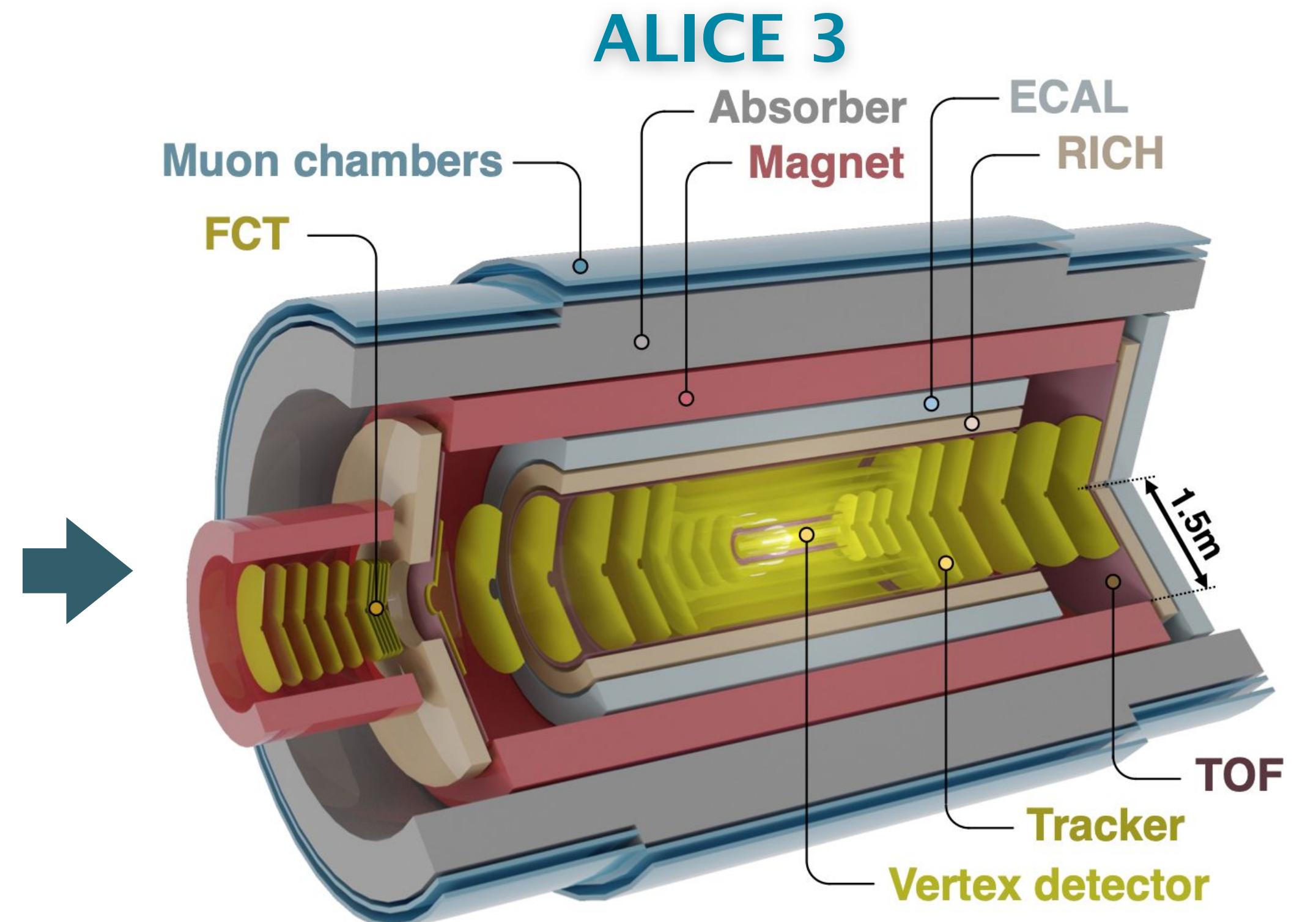
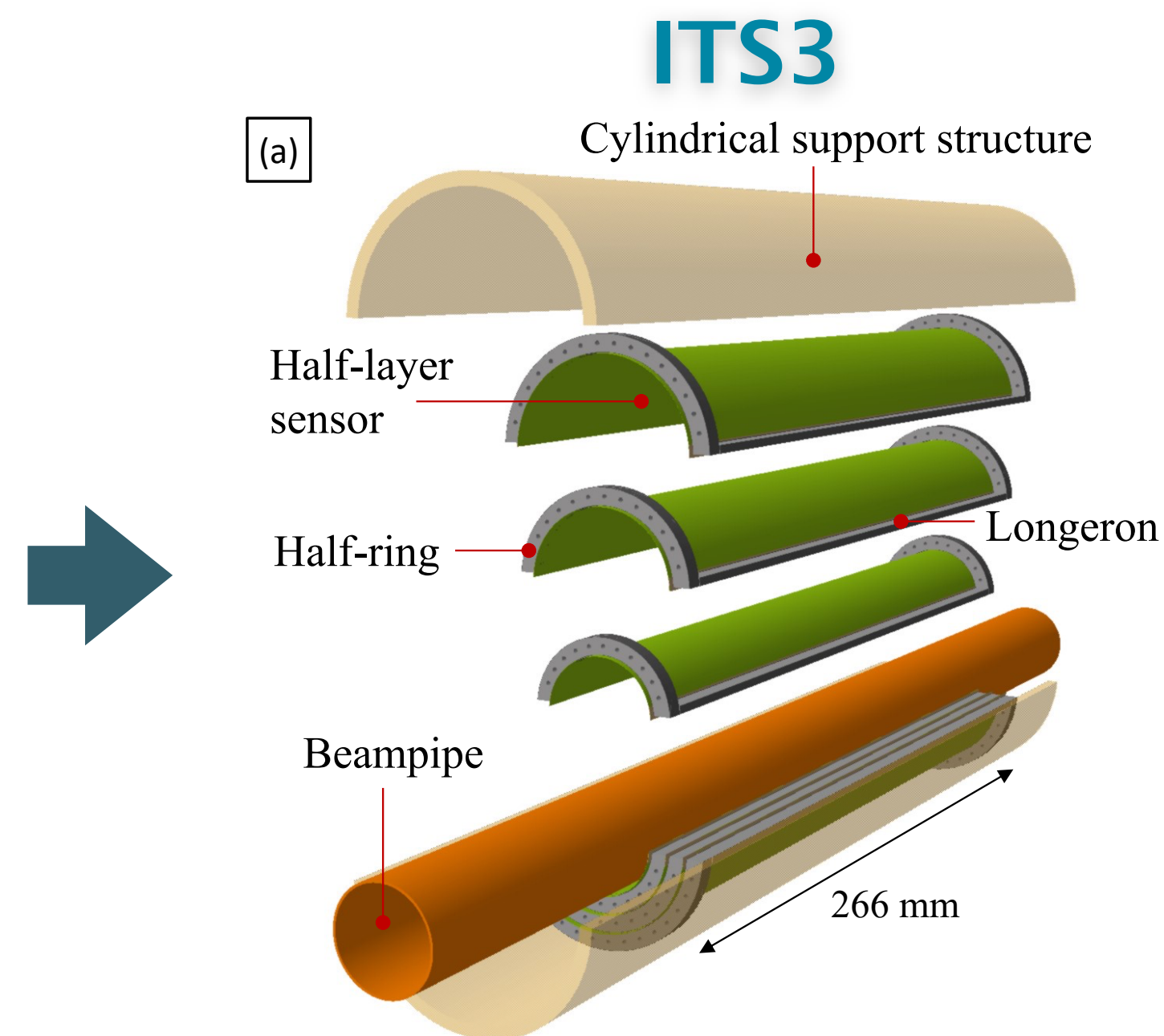
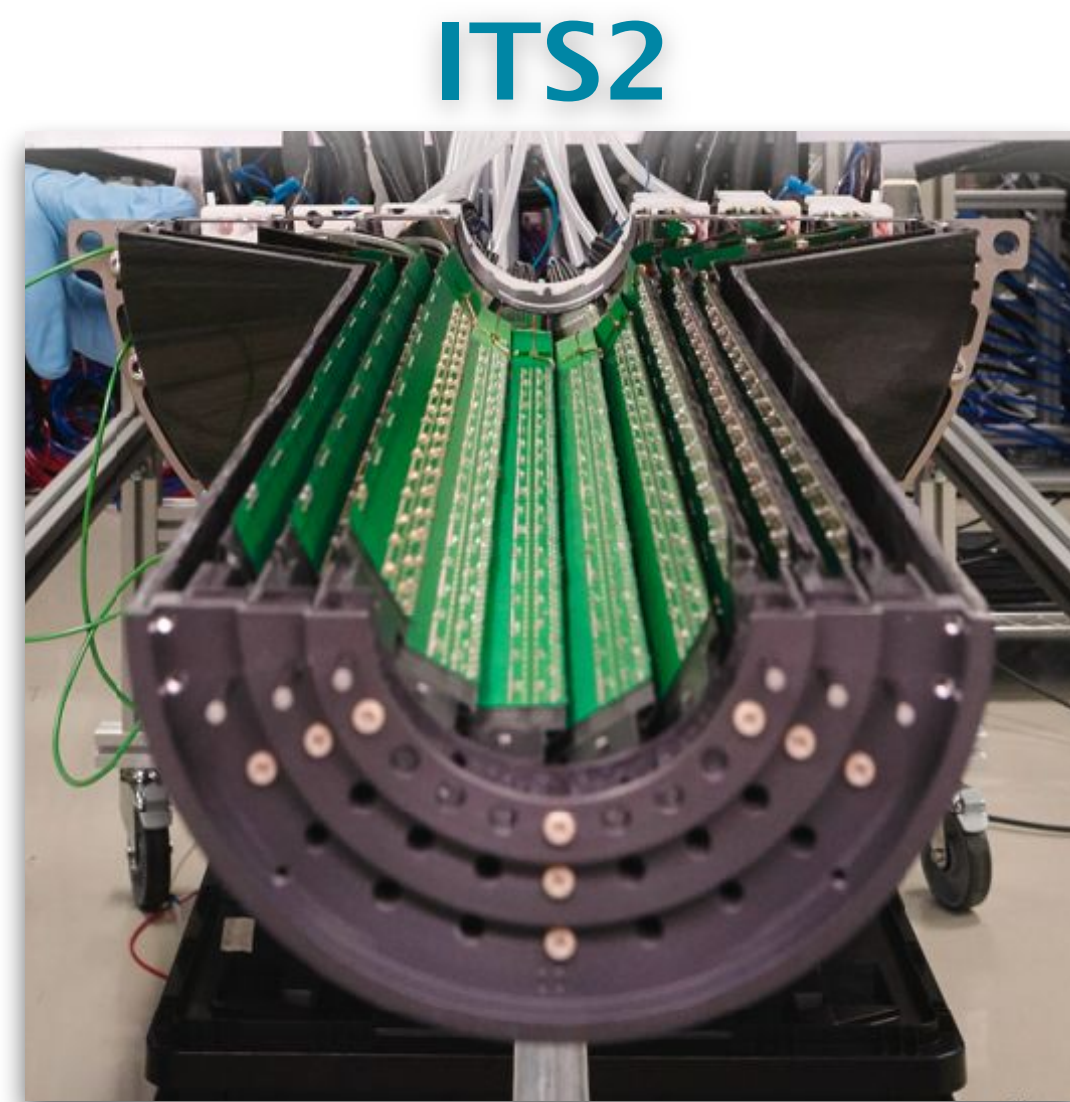


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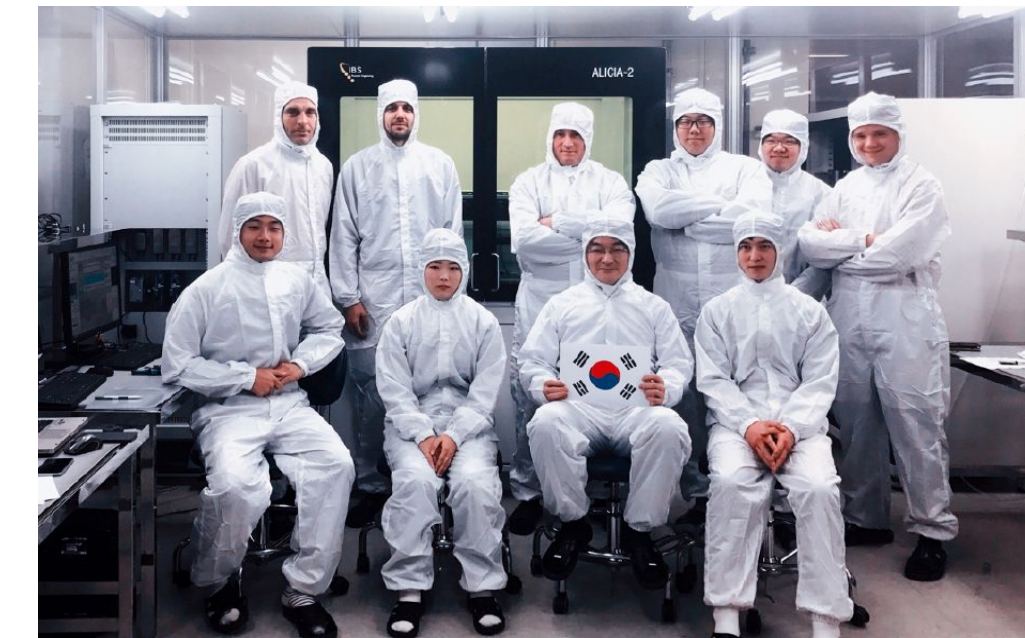
● KoALICE contribution to ALICE 3

- Opportunity to expand semiconductor detector development area: **ITS2** → **ITS3** → **ALICE 3**
- Explore and select ALICE 3 R&D topic in 2022
- Several KoALICE local meetings since May/2022 for intensive discussion on the direction of ALICE 3 R&D
- Meetings with NRF & Ministry in July/2022 (dedicated) and March/2023

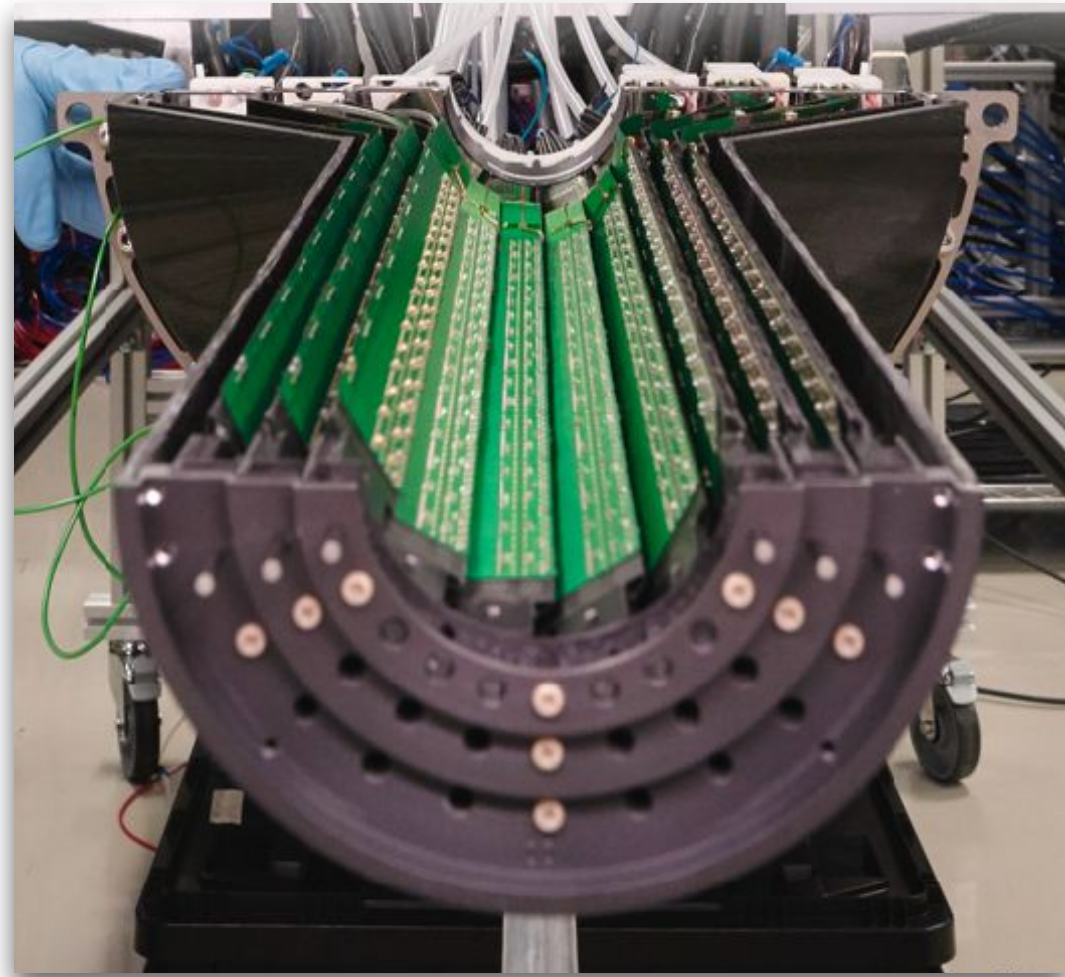


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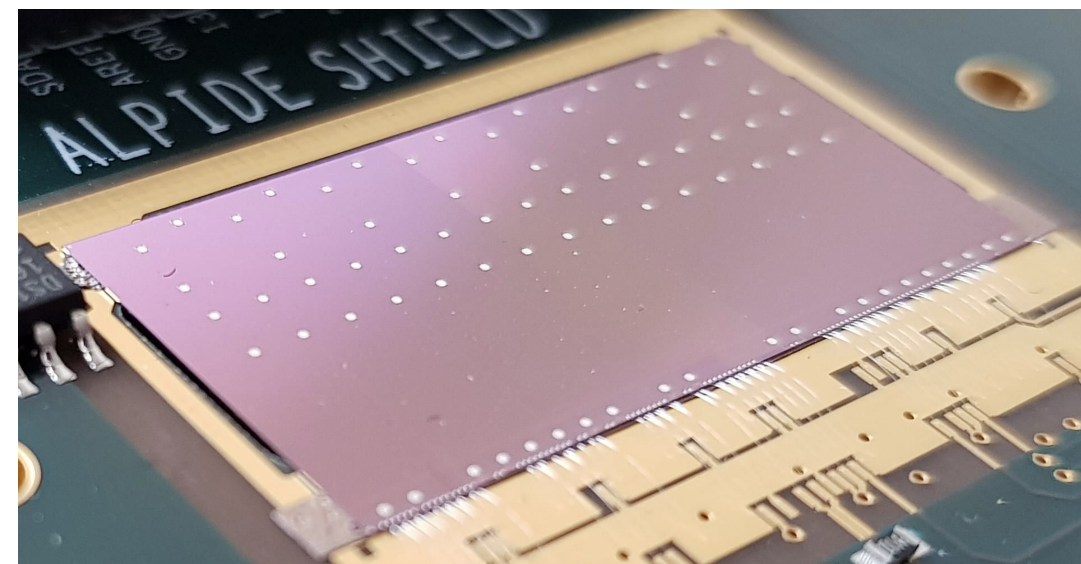
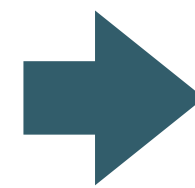


ITS2

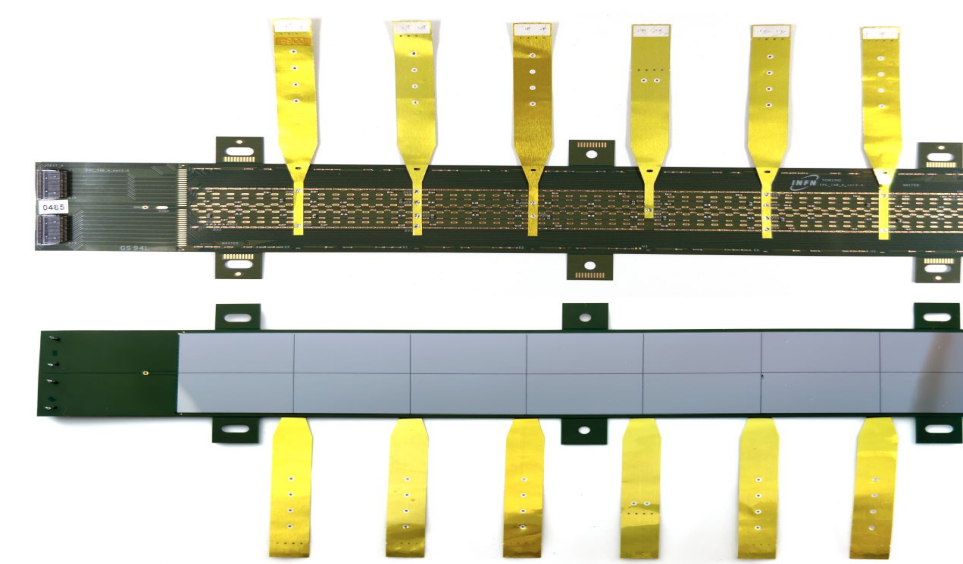


Korean ALICE team's activity

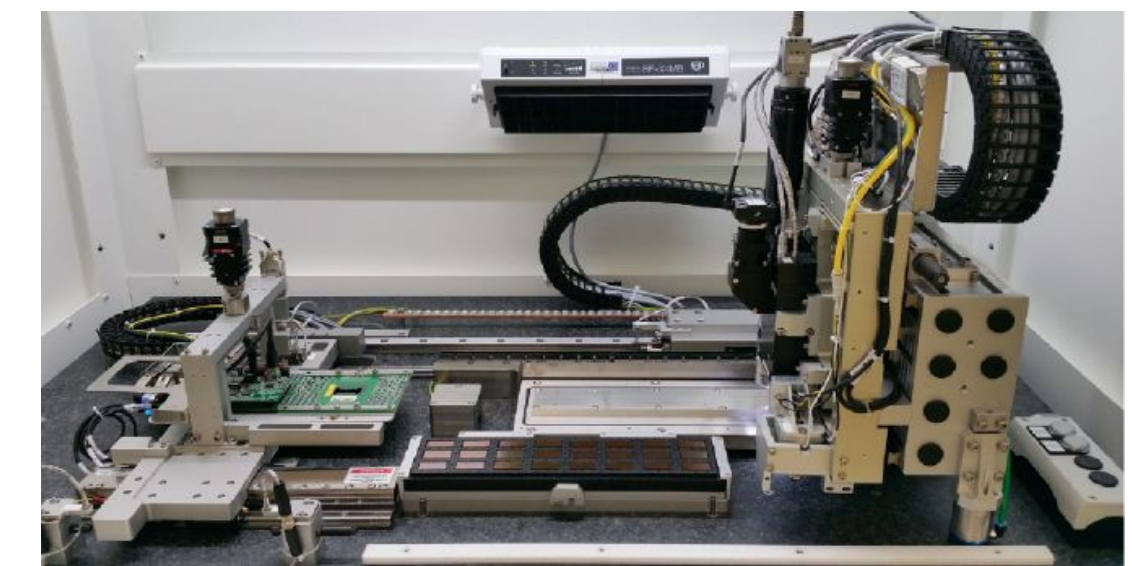
Industrialization of module assembly for ALICE 3 Outer Tracker based on the experience from ITS2 project



[ITS2 sensor ALPIDE]



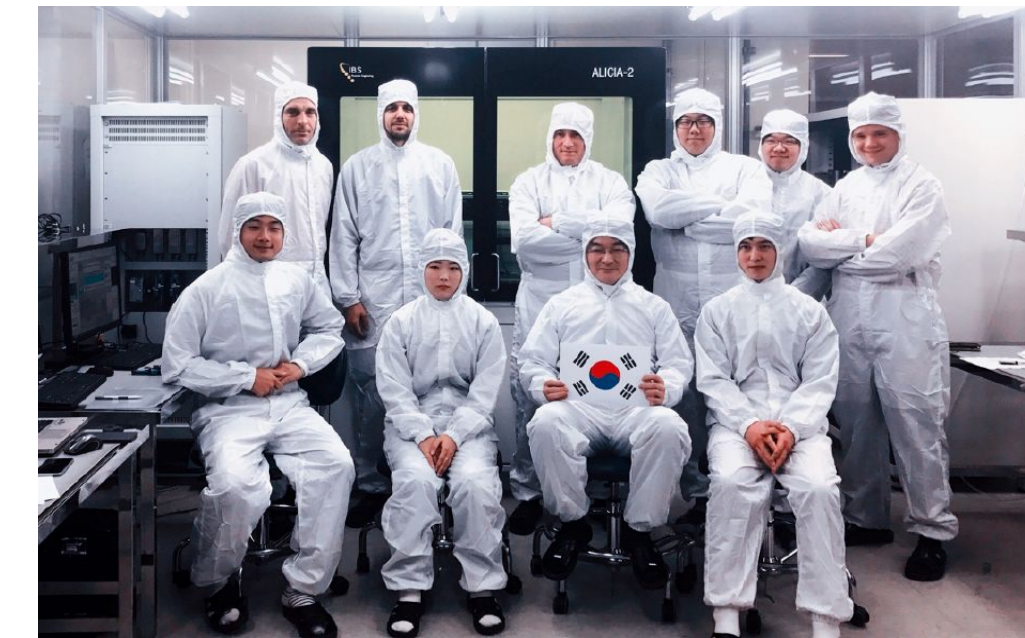
[ITS2 Hybrid Integrated Circuit (HIC) module]



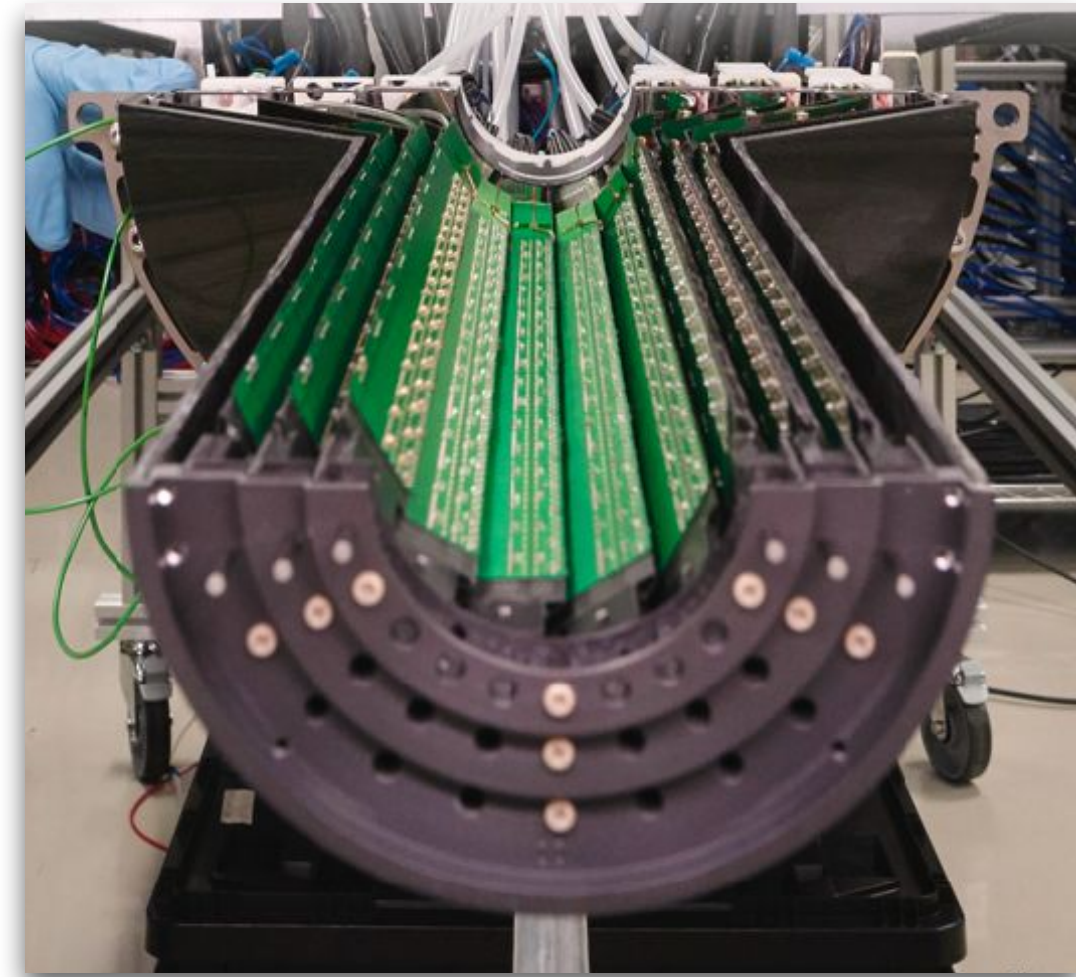
[ITS2 Assembly machine, ALICIA]

● KoALICE contribution to ALICE 3

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- **R&D on large scale industrial module assembly in collaboration with MEMSPACK in 2023**

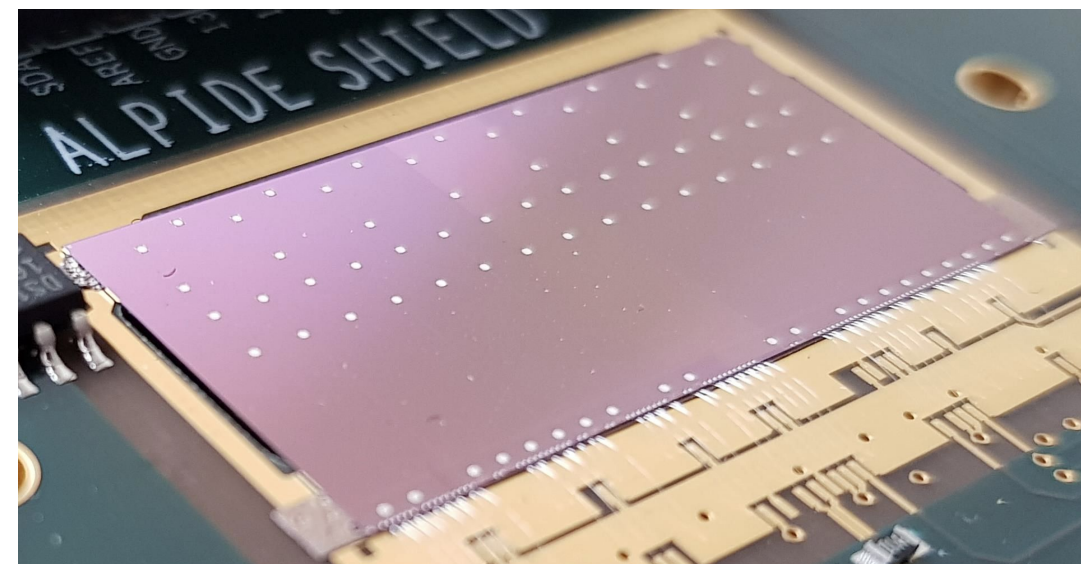
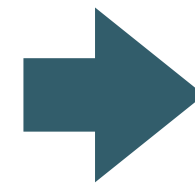


ITS2

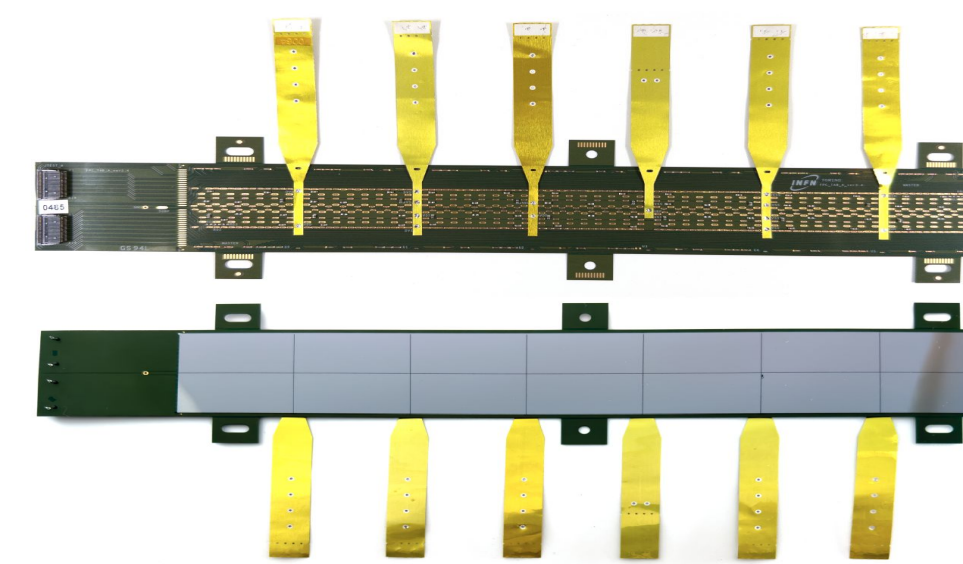


Korean ALICE team's activity

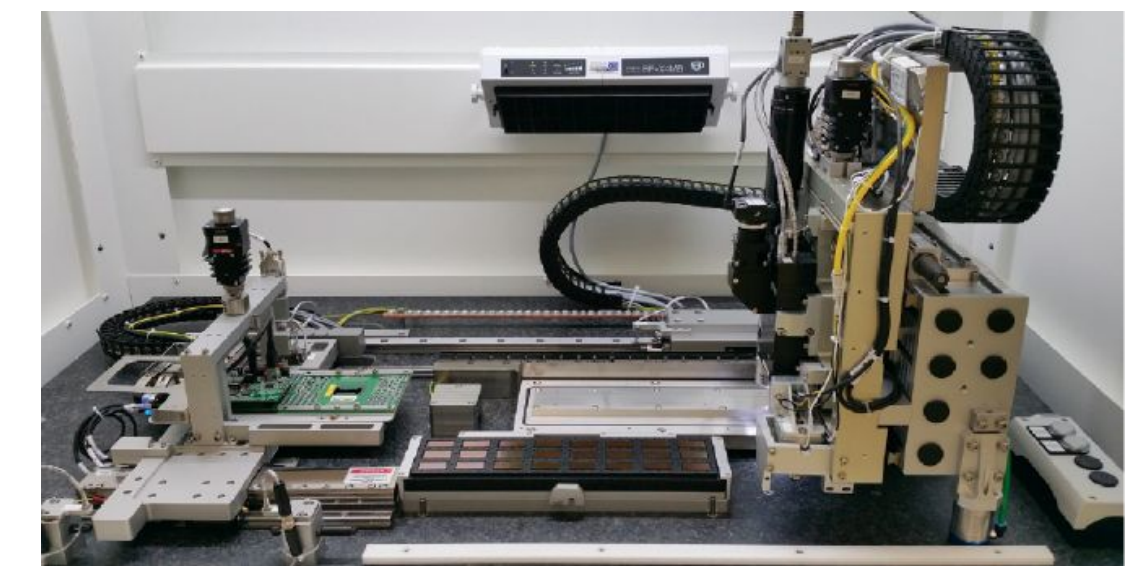
Industrialization of module assembly for ALICE 3 Outer Tracker based on the experience from ITS2 project



[ITS2 sensor ALPIDE]



[ITS2 Hybrid Integrated Circuit (HIC) module]



[ITS2 Assembly machine, ALICIA]

Korean group's activity for ALICE 3: Outer tracker

◎ R&D for the large scale industrial production

- Automatization and industrialization of chip test and module assembly
- Collaboration with MEMSPACK for ALICE 3 module assembly with a multi-purpose machine die bonder

Datacon 2200 evo+



MRSI 705



[General purpose die attach machines]



Integrated Dispenser

- Pressure/time (Musashi®), Auger, Jetter types available
- Epoxy stamping option
- Filled and unfilled epoxy, wide viscosity range
- Small footprint, low cost-of-ownership



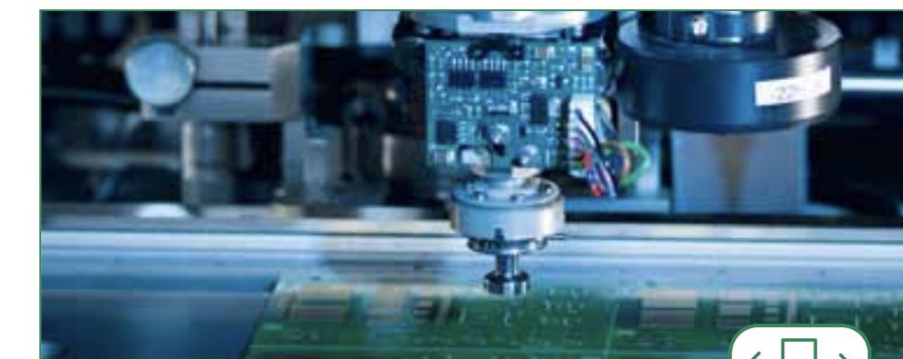
Vision Alignment

- New high-speed image processing unit
- Full alignment & Bad mark search
- Pre-defined fiducial geometry & customized teaching



Automatic Wafer and Tool Changer

- Fully Automatic cycle for Multi-Chip production
- Up to 7 Pick & Place tools (optionally 14), 5 eject tools
- Stamping tools and calibration tools possible



Pick & Place Head

- Die Attach, Flip Chip and Multi-Chip in one machine
- Die pick from: wafer, waffle pack, Gel-Pak®, feeder
- Die place to: substrate, boat, carrier, PCB, leadframe, wafer
- Hot and cold processes supported: epoxy, soldering, thermo-compression, eutectic

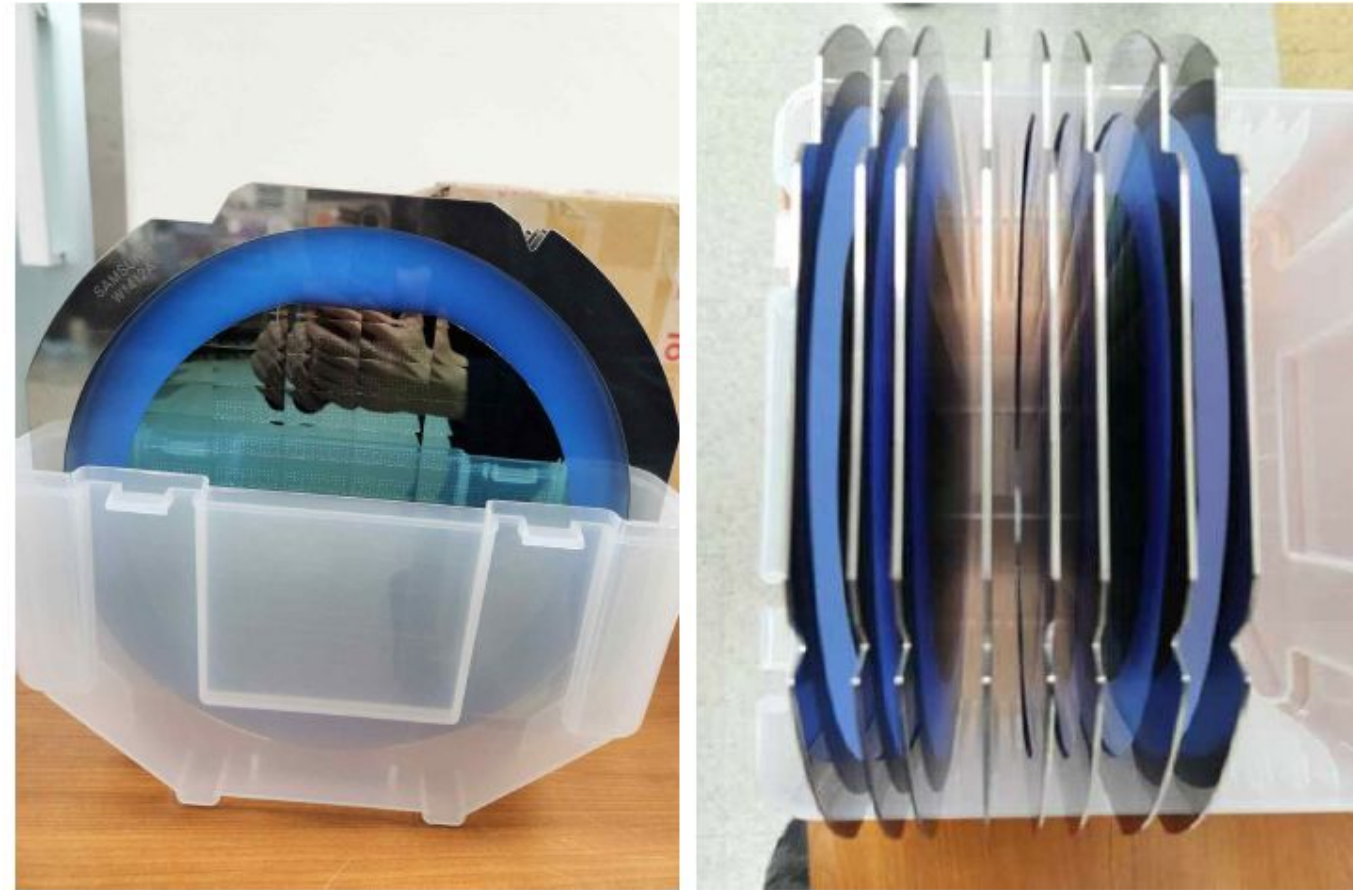


Korean group's interest for ALICE 3: Outer tracker

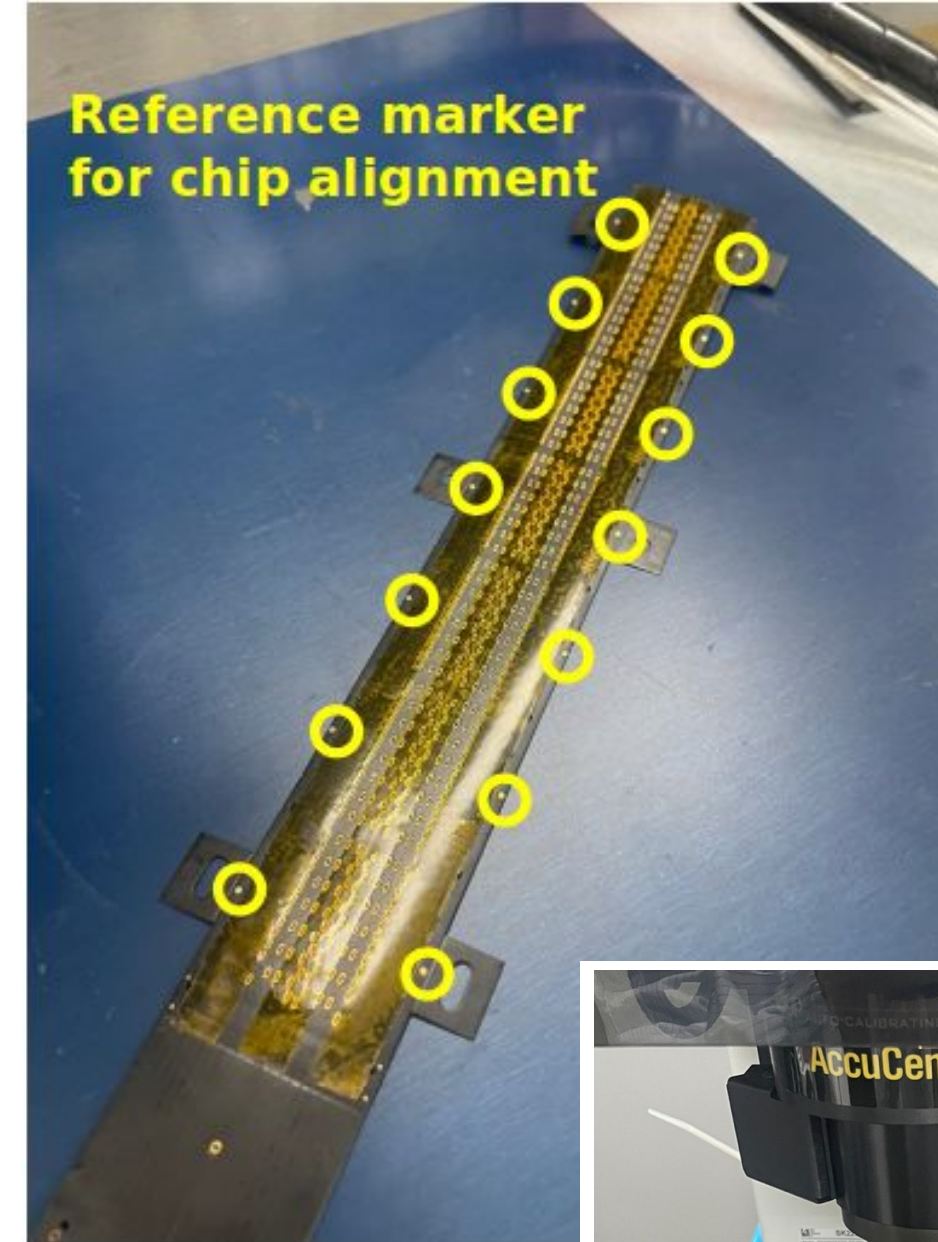
● Dummy module production

- Dummy HIC production for machine validation: Obtained a good precision of chip positioning from the pick-and place procedure

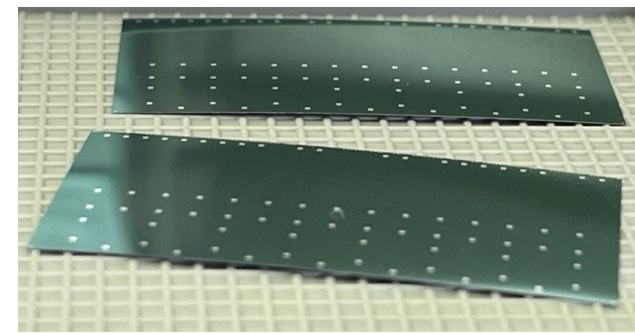
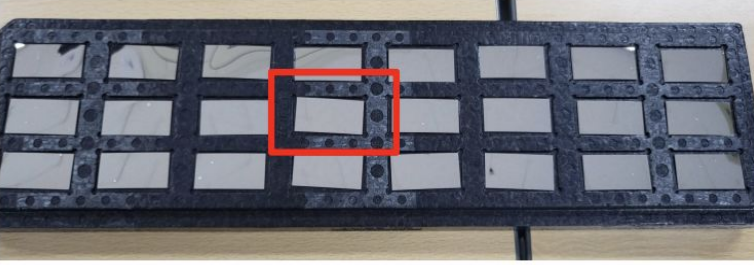
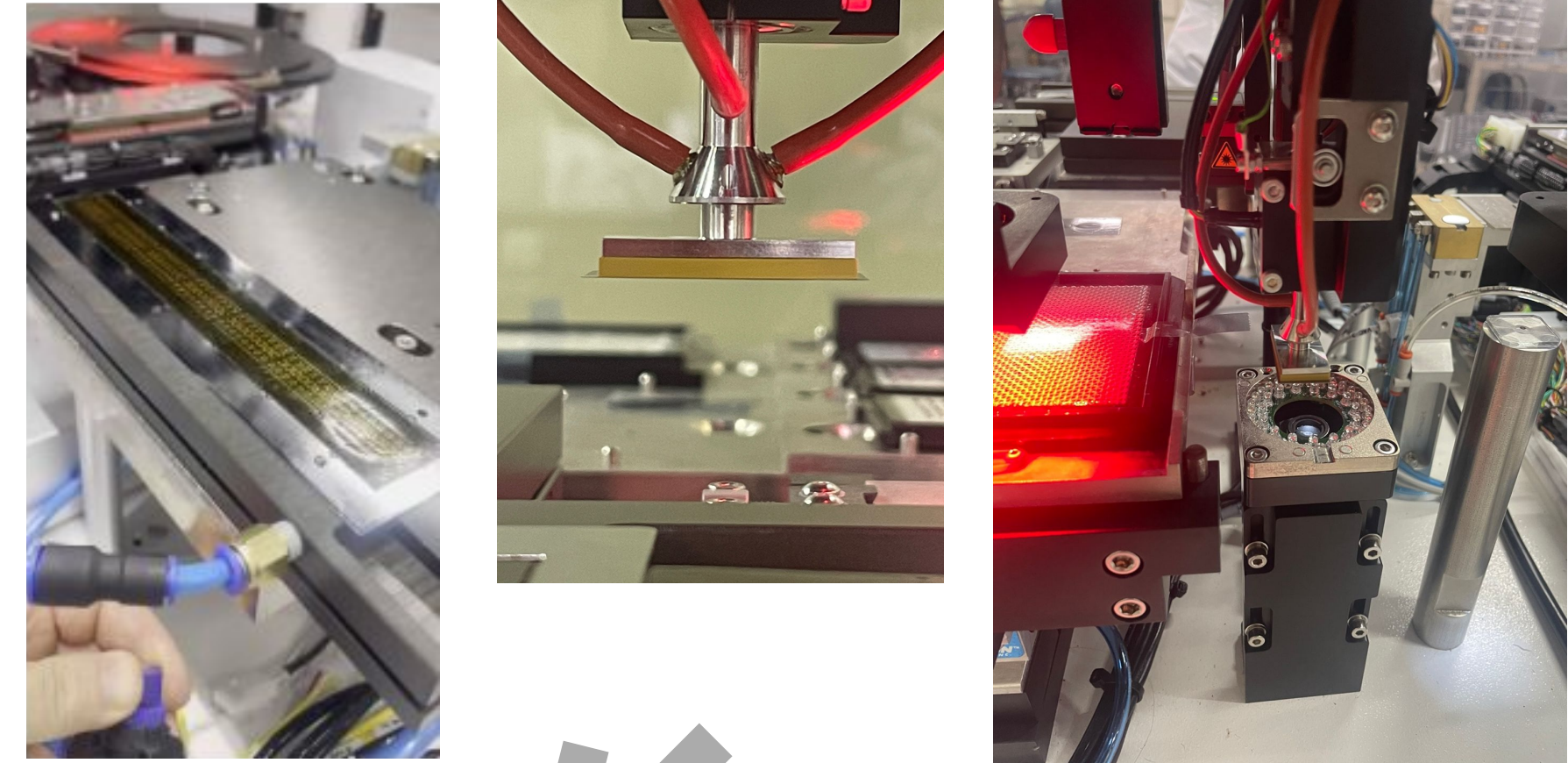
Dummy chips



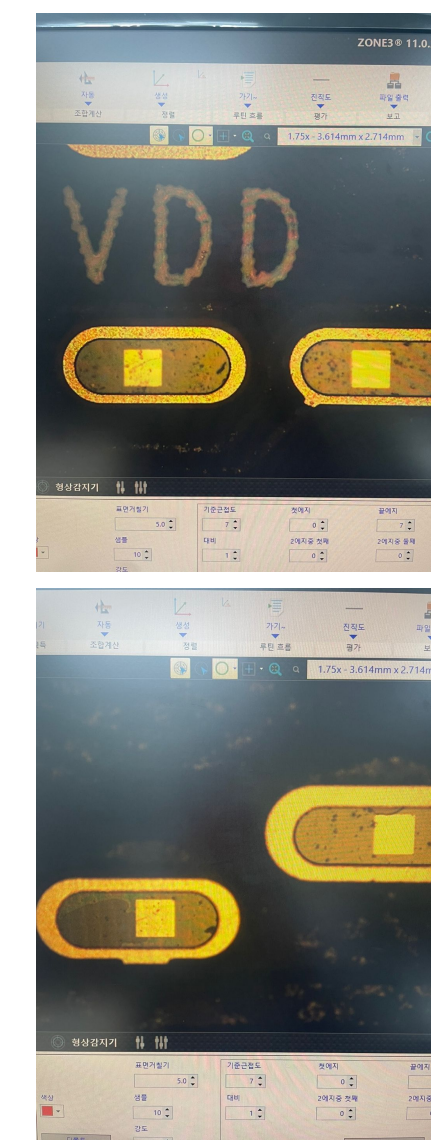
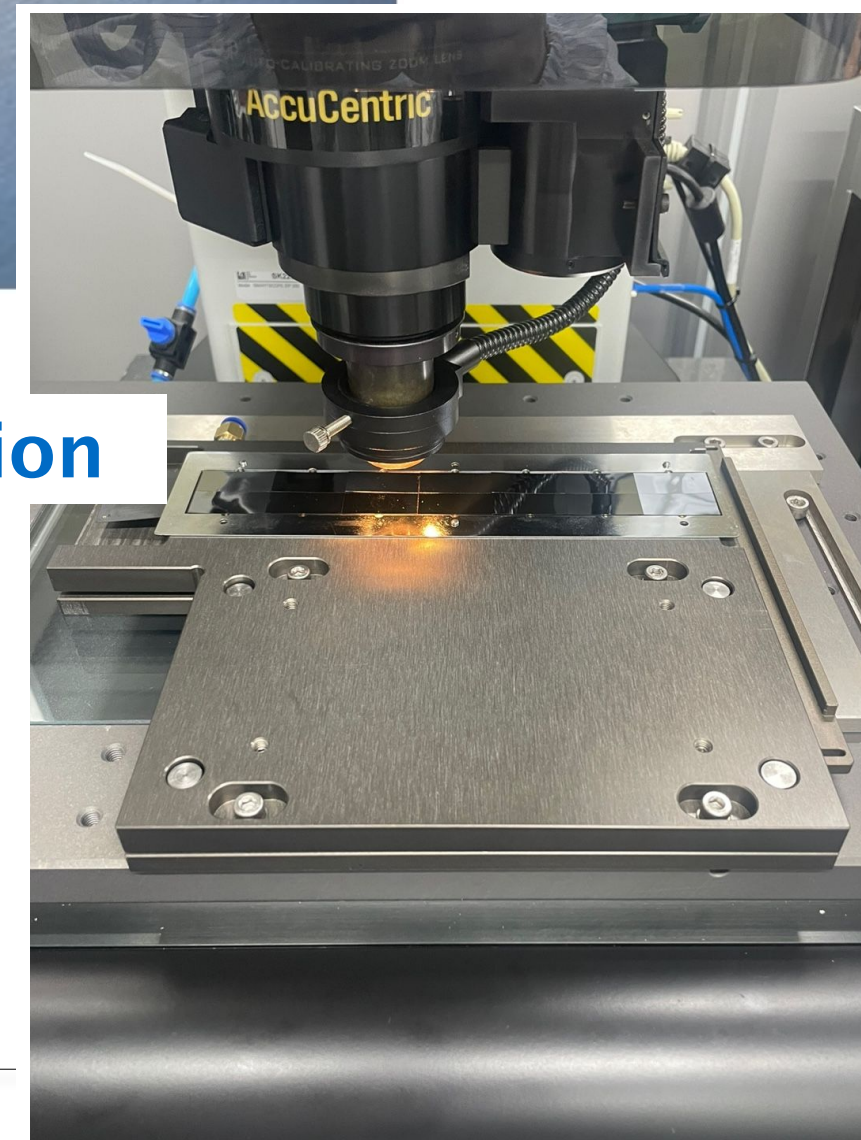
Dummy HIC



Preparation & patter scan



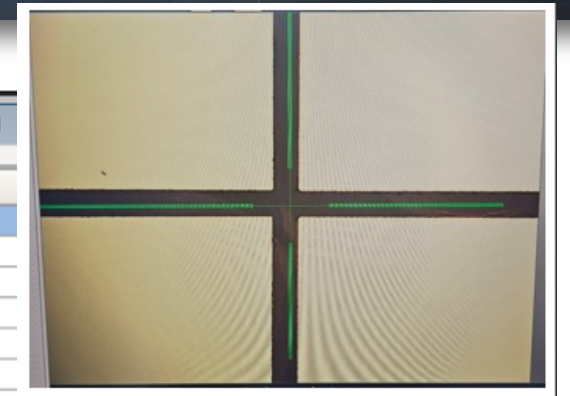
Module production



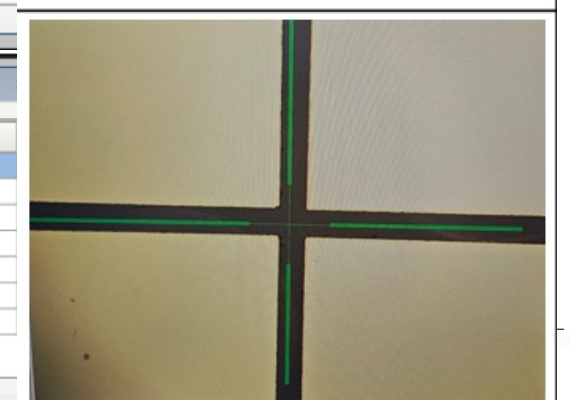
Chip positioning result



Measure#	PP-X	PP-Y	Distance
1	30.149999 mm	0 mm	30.149999 mm
2	30.15 mm	0 mm	30.15 mm
3	30.149999 mm	0 mm	30.149999 mm
4	30.15 mm	0 mm	30.15 mm
5	30.15 mm	0 mm	30.15 mm
6	30.149999 mm	0 mm	30.149999 mm



Measure#	PP-X	PP-Y	Distance
1	-0.000002 mm	15.15 mm	15.15 mm
2	-0.000002 mm	15.15 mm	15.15 mm
3	0 mm	15.149999 mm	15.149999 mm
4	0 mm	15.149999 mm	15.149999 mm
5	0 mm	15.15 mm	15.15 mm
6	0 mm	15.149999 mm	15.149999 mm
7	0 mm	15.15 mm	15.15 mm

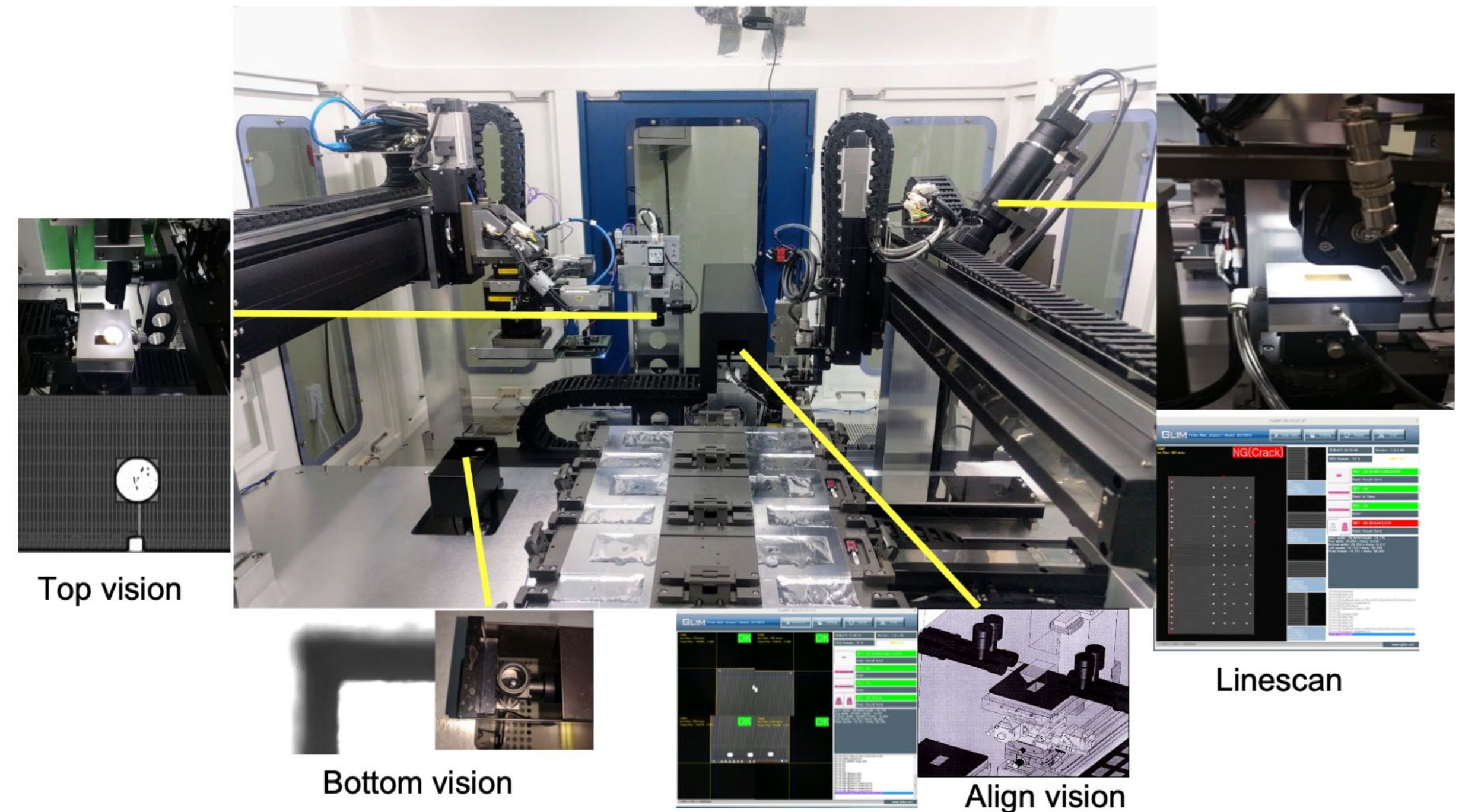
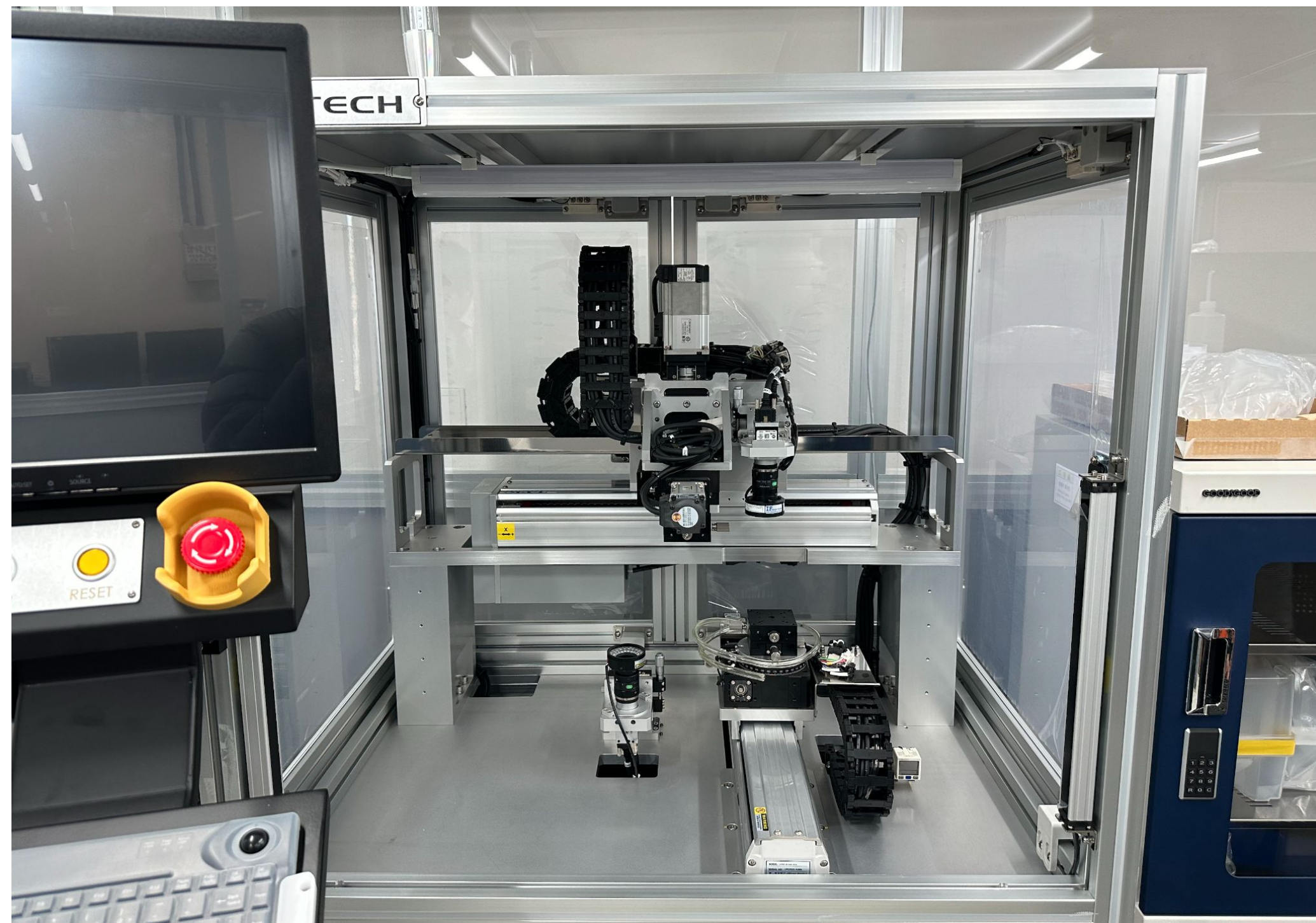


- Successfully produced five modules with a good position resolution
- Next step is using glues & wire bonding

Korean group's interest for ALICE 3: Outer tracker

- Investigating automatic mass chip test system for ALICE 3 OT
 - Preparation for the development of the chip test procedure has been initiated

Automatic chip test machine at Inha Univ.



COREA-YS-01, Yonsei Univ.

- Validate chip test procedure and compare test results from different machines

Korean group's interest for ALICE 3: Outer tracker



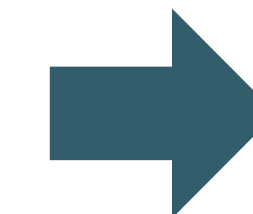
◎ Groups involved (+ average number of students assigned for the ALICE 3 project)

- **Inha University:** MinJung Kweon + 1.5 master students
- **Pusan National University:** Sanghoon Lim + 1 master students, In-Kwon Yoo + 1.5 master students
- **SungKyunkwan University:** Beomkyu Kim + 0.5 PhD student
- **Yonsei University:** Youngil Kwon + 0.5 PhD student
- **Sejong University:** Saehanseul Oh + 1 master student
- **Jeonbuk National University** (from the mass production): Eunjoo Kim
- Plan to hire postdoc dedicated to ITS3 + ALICE 3

✓ Collaborative since the Korea ALICE team shares the same budget

◎ R&D for the large scale industrial production

- **2023–25: selection of technologies, small-scale proof of concept prototypes**
- 2026–27: large-scale engineered prototypes → Technical Design Reports
- 2028–31: construction and testing
- 2032: contingency
- 2033–34: installation and commissioning



◎ KoALICE near-term planning

- **2023–25: Proof of the concept of assembly & mass chip test**
- **2026–27: Large-scale prototype production**

Korean group's interest for ALICE 3: Outer tracker



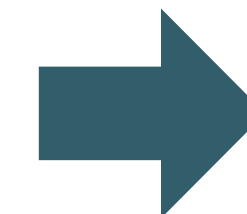
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◎ KoALICE near-term planning

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Need R&D MoU

Visit by the University of Turin delegation



◎ **University of Turin delegation visited KoALICE insitutues**

- Inha, PNU, SKKU, Yonsei and MEMSPACK
- Discuss future collaboration especially on R&D related to silicon sensors

Within KoALICE, there are also many local working group meeting ⇒ very collaborative effort!!!

April 2024

- 29 Apr KoALICE ITS3/ALICE3 meeting **NEW**
- 22 Apr KoALICE ITS3/ALICE3 meeting **NEW**
- 18 Apr KoALICE heavy flavor working group meeting
- 18 Apr koALICE JET working group meeting
- 15 Apr KoALICE ITS3/ALICE3 meeting **NEW**
- 10 Apr Discussion for the beam test at KEK
- 08 Apr KoALICE ITS3/ALICE3 meeting
- 04 Apr KoALICE heavy flavor working group meeting
- 04 Apr koALICE JET working group meeting
- 01 Apr KoALICE ITS3/ALICE3 meeting

March 2024

- 25 Mar KoALICE ITS3 meeting
- 21 Mar KoALICE heavy flavor working group meeting
- 21 Mar koALICE JET working group meeting
- 07 Mar KoALICE heavy flavor working group meeting
- 07 Mar koALICE JET working group meeting



Korean ALICE National Workshop

14–16 Jan 2024, Jeju Island

64 participants including KISTI !



KoALICE

Thank you

**Memorandum of Understanding
for Collaboration in the ALICE Experiment
Participation of National Research foundation of Korea (NRF)
in the ALICE ITS3 project**

Considering that:

The institutes supported by the National Research foundation of Korea (NRF) participating in the ALICE collaboration as full members are:

- Department of Physics, Pusan National University
- Department of Physics, Sejong University
- Yonsei University
- Inha University
- Jeonbuk National University
- Sungkyunkwan University
- Gangneung-Wonju National University
- Chungbuk National University (CBNU)

And that those institutes have participated in the development of the ALPIDE imaging sensor, which is installed in the current ALICE ITS2 detector.

The new Inner Tracking System (ITS3) is planned to be installed during the LHC Long Shutdown (LS3) to replace the innermost three layers of the ALICE Inner Tracking System.

The ITS3 system is meant to greatly reduce the material budget in the region close to the interaction point and improve the tracking precision and efficiency at low transverse momentum.

The combination of these two improvements will lead to a significant advancement in the measurement of low-momentum charmed hadrons and low-mass dielectrics in heavy-ion collisions at the LHC, which are among the main objectives of the ALICE physics program in the next decade.

This upgrade plan is consistent with KoALICE's physics research goals.

KoALICE shows their expression of interest in the ITS3 Upgrade.

The purpose of this MoU is to describe the work to be carried out for the R&D phase and the charges and responsibilities of KoALICE for the execution of this work.

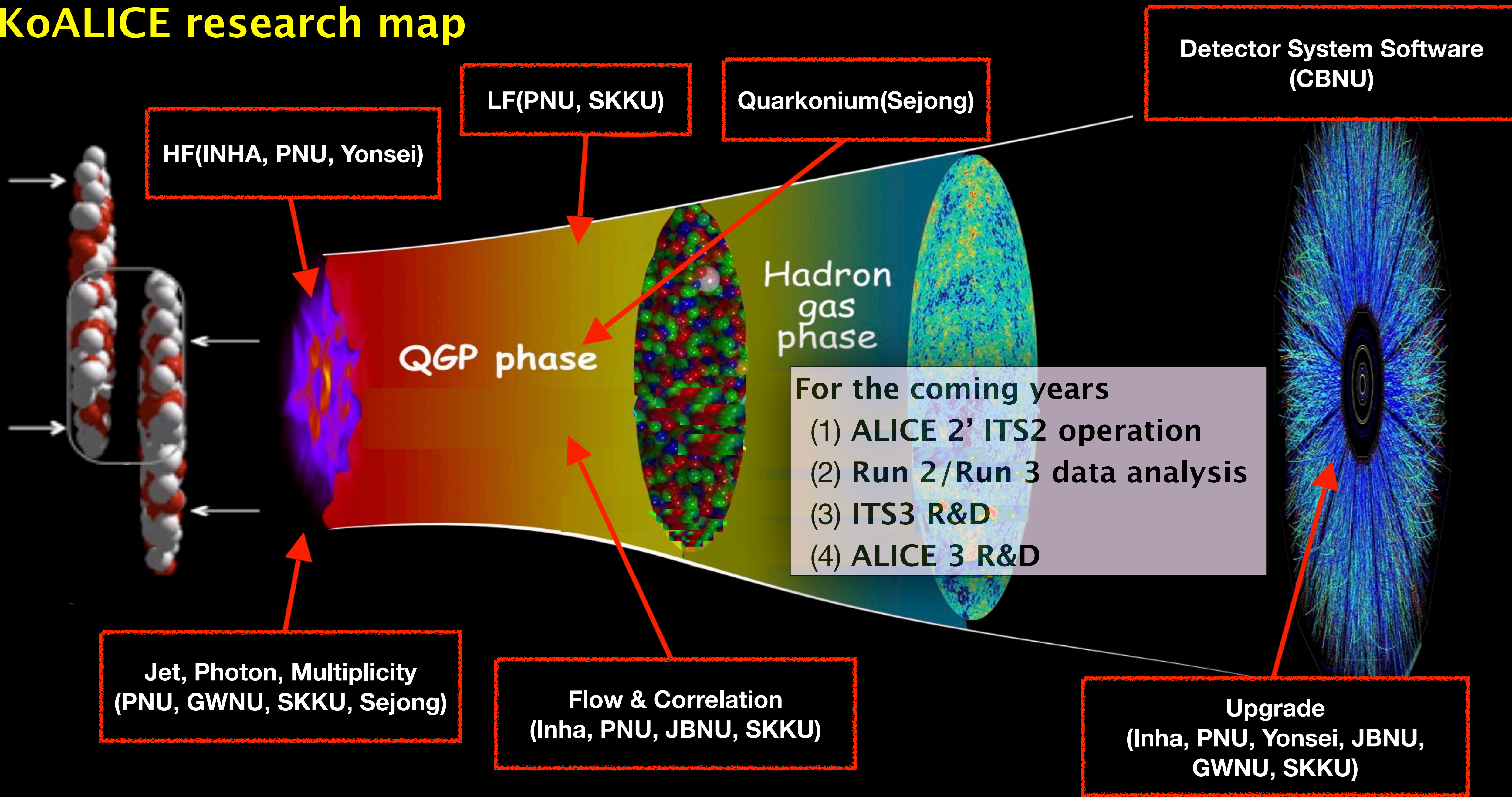
KoALICE shall participate in the ITS3 R&D and, in particular, shall provide the cost related to producing and testing of ALPIDE chips for the ITS3 detector.

Last November, ITS3 R&D MoU was signed

MoU Name	Memorandum of Understanding for Collaboration in the ALICE Experiment Participation of National Research foundation of Korea (NRF) in the ALICE ITS3 project
Contents	The total contribution from KoALICE shall be valued at 250,000 CHF as: <ul style="list-style-type: none"> - 96'000 CHF as in-kind contribution for scientist salary who designs ALPIDE chip for ITS3 - 30'000 CHF as in-kind contribution for ALPIDE chip production for MLR1/MLR2/ER1 - 6'000 CHF as in-kind contribution for ALPIDE carrier board construction - 11800 CHF as cash contribution for ALPIDE chip production of the engineering runs

	Period	Total	KoALICE contribution
R&D	'23 ~ '24	~3,030 kCHF	250 kCHF (~ 8.3 %)
Construction	'25 ~ '26 (or '27)	~2,500 kCHF	Planning

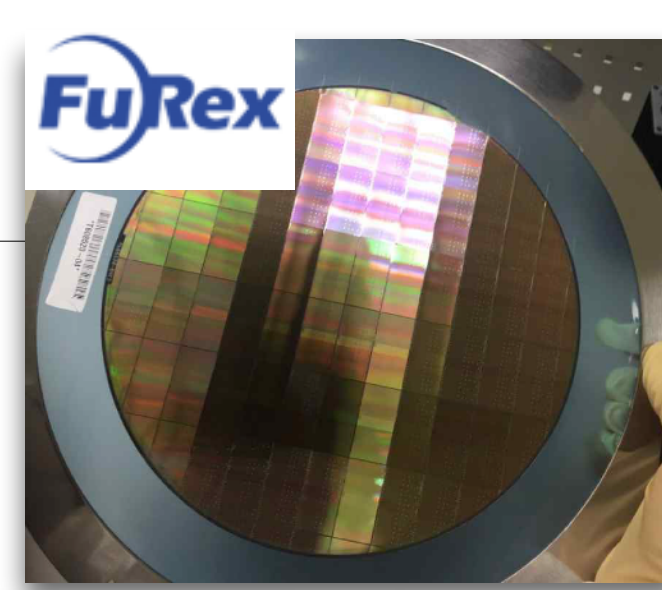
KoALICE research map



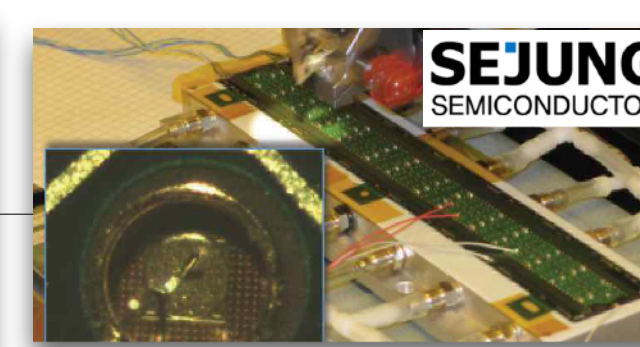
Run2/Run3 Data analysis	
General	Luminosity measurement [PNU/JBNU]
Light Flavour	f0 cross section and R_{AA} [JBNU] Hyperon Research [PNU] Pseudo rapidity density measurement [SKKU]
Heavy Flavour	Beauty Hadron Production [Inha] Charm and Multi-Charm Hadron Production [Inha/PNU] Cumulant Analysis for $b \rightarrow e$ [Yonsei] In-medium quarkonium property and quantum computing [Sejong] SHINCHON Simulation [PNU/JBNU/Inha]
Photon	Inclusive prompt photon production [Sejong]
Jet, Correlations	Particle correlations [JBNU/PNU] Jet fragmentation [SKKU/PNU] Di-jet measurement [SKKU] b-jet measurement [SKKU/PNU] Particle correlations in theory [Inha]
Software	Research on O ² system software and data process [CBNU]

* Local KoALICE HF, Jet meeting every weeks

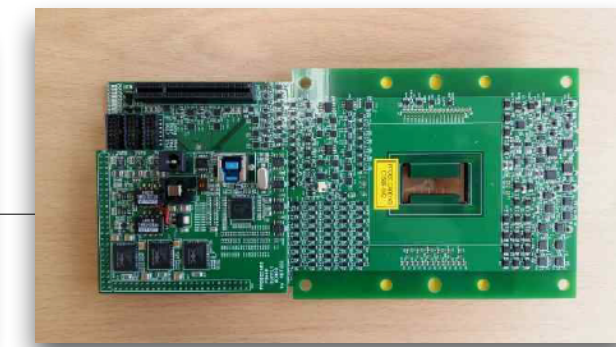
Reminder: ITS2 upgrade, our roles



Thinning & Dicing



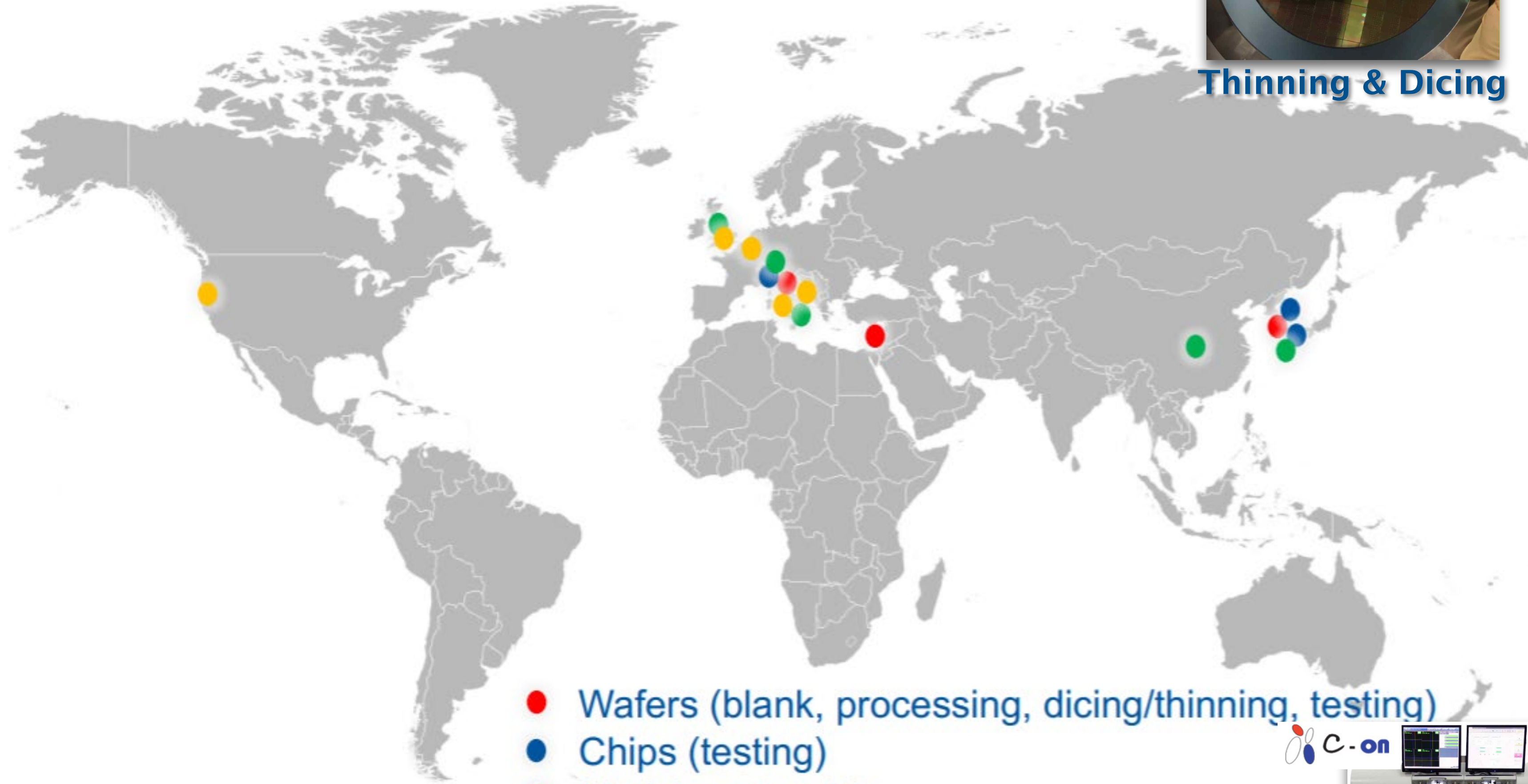
Wire Bonding



Probecard : NOTICE



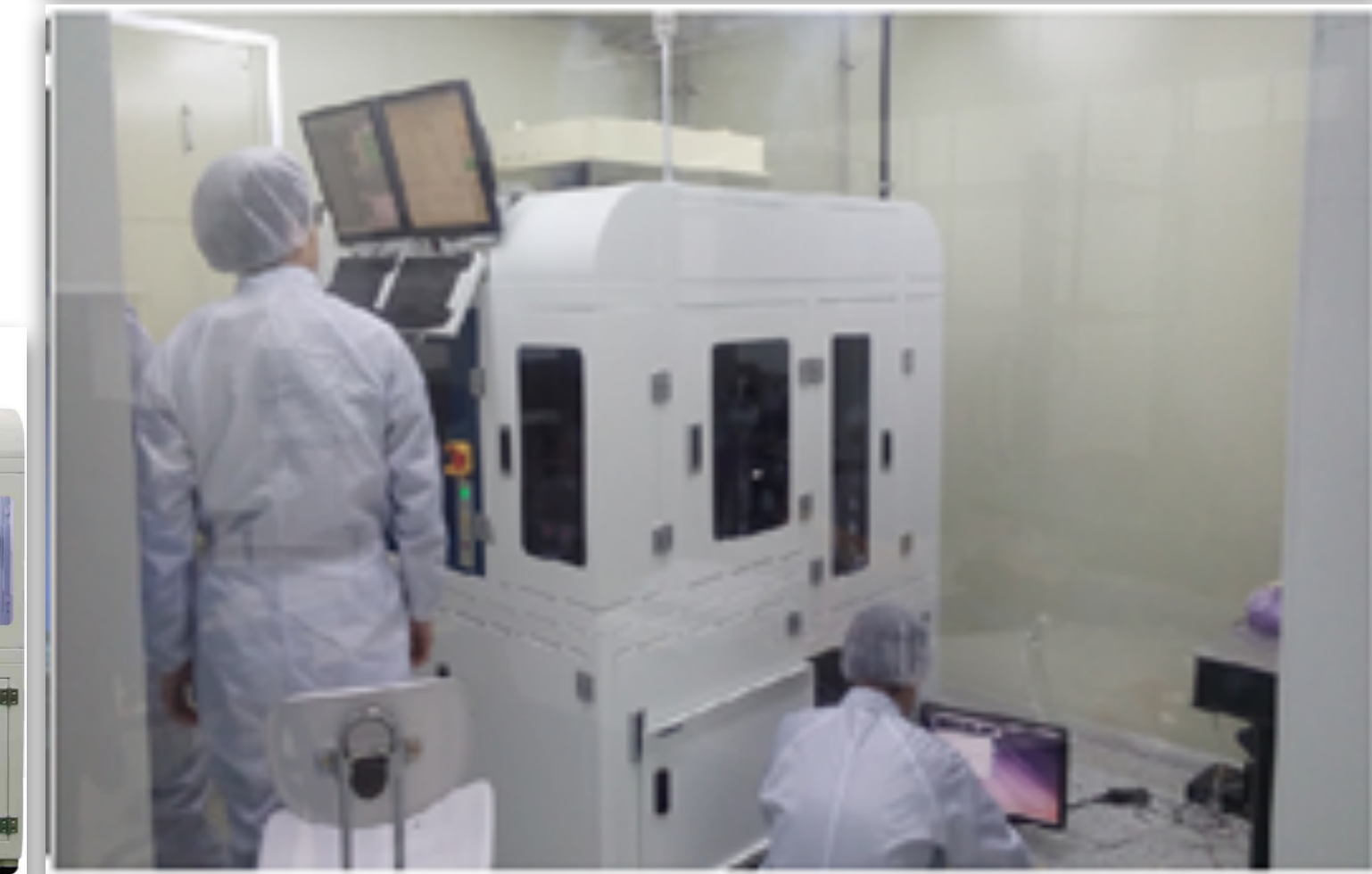
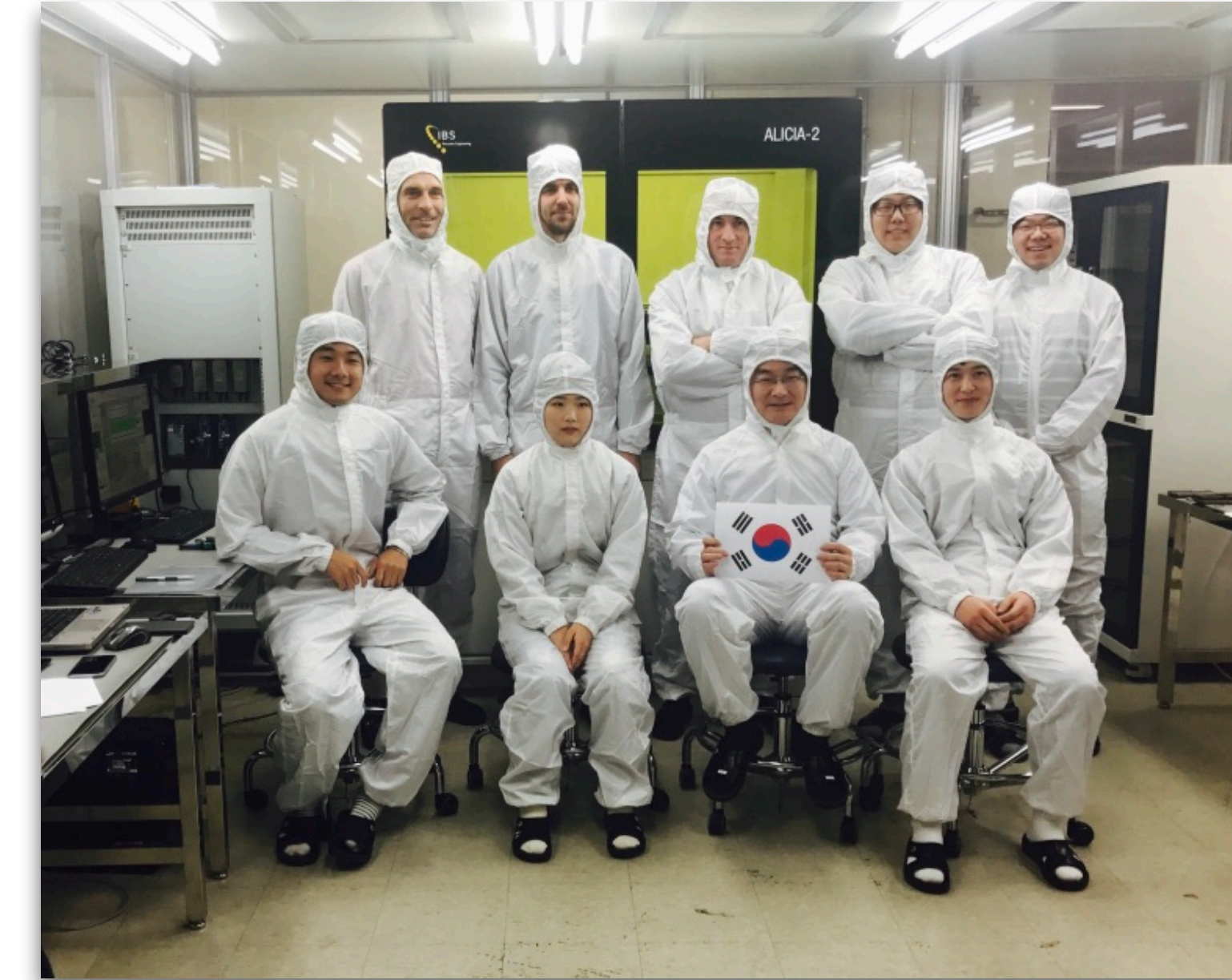
KoALICE



- Wafers (blank, processing, dicing/thinning, testing)
- Chips (testing)
- Module assembly
- Stave assembly



ATE machine

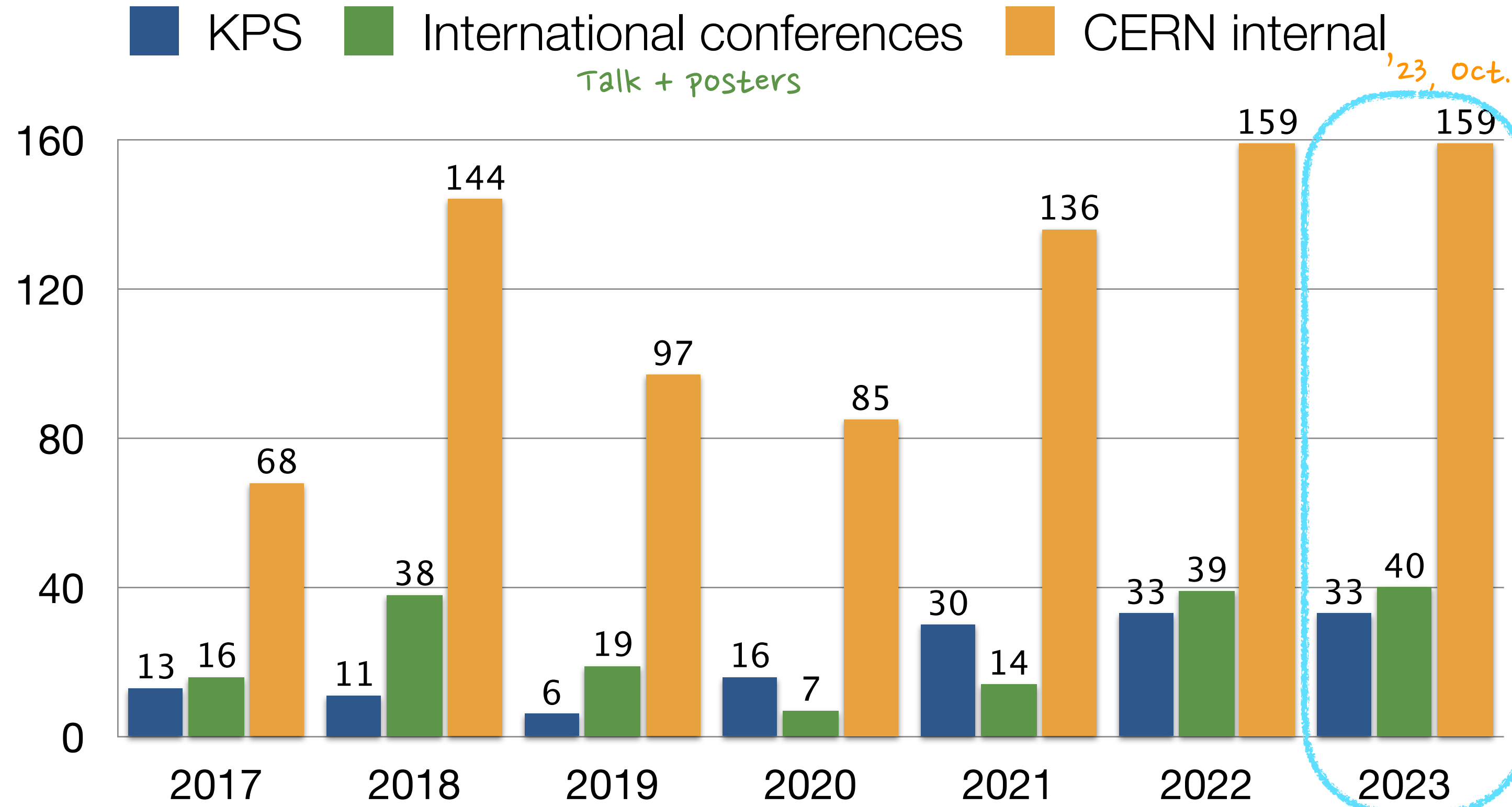


February 22, 2018

P.Riedler, CERN | PSI Seminar

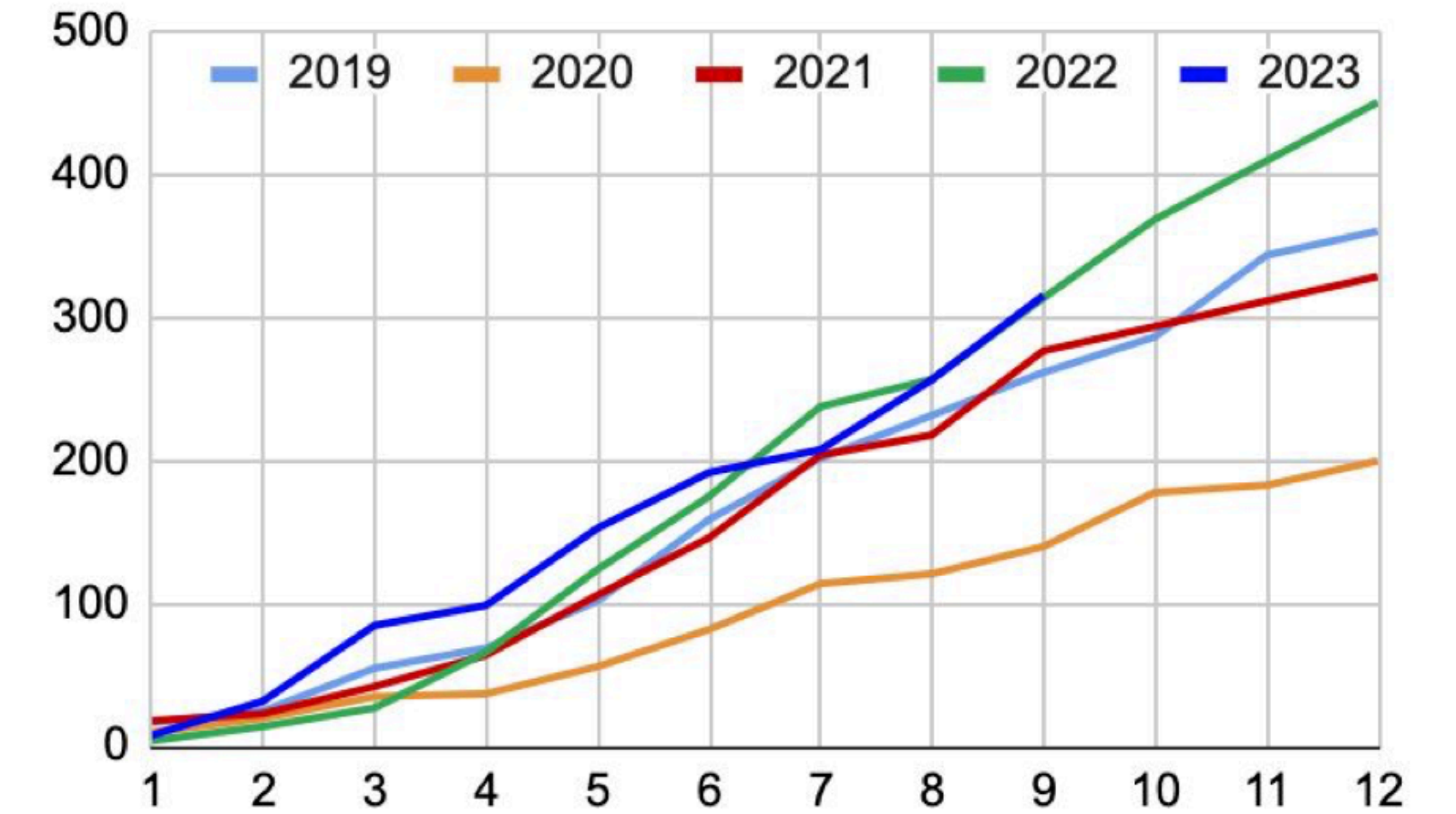
Scientific Outputs in Presentations (2023)

KoALICE



ALICE total

Talks



Posters

