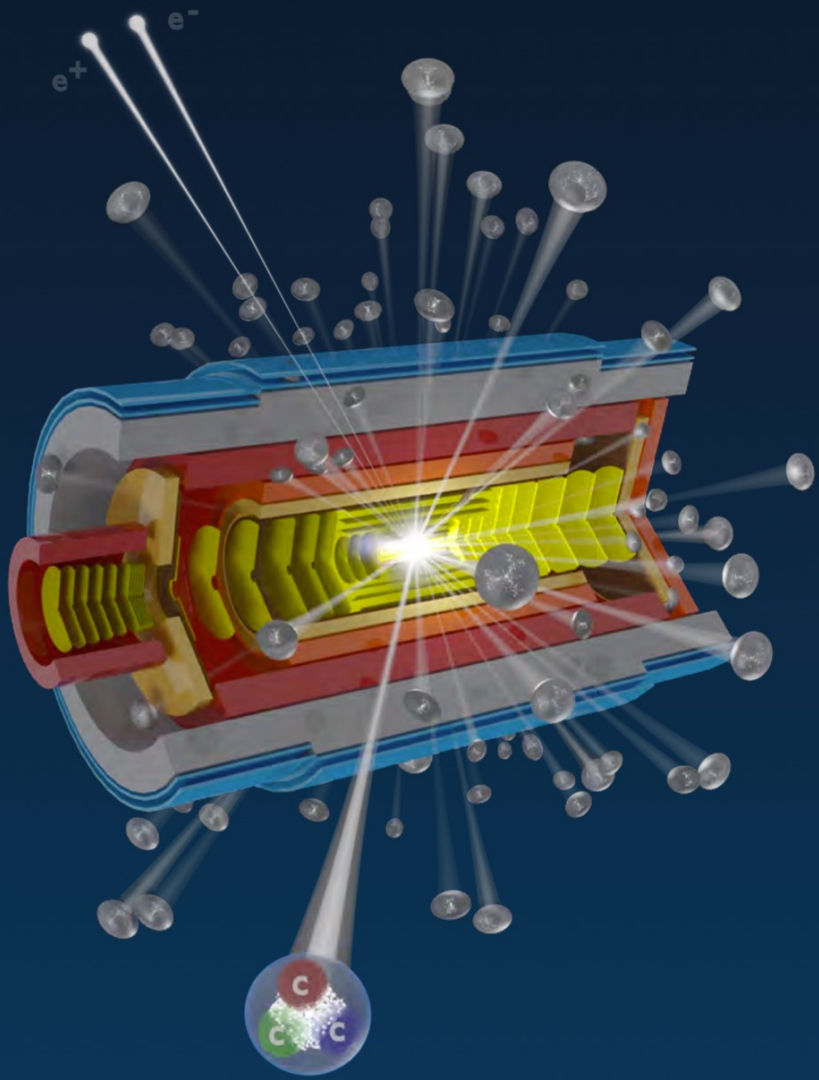


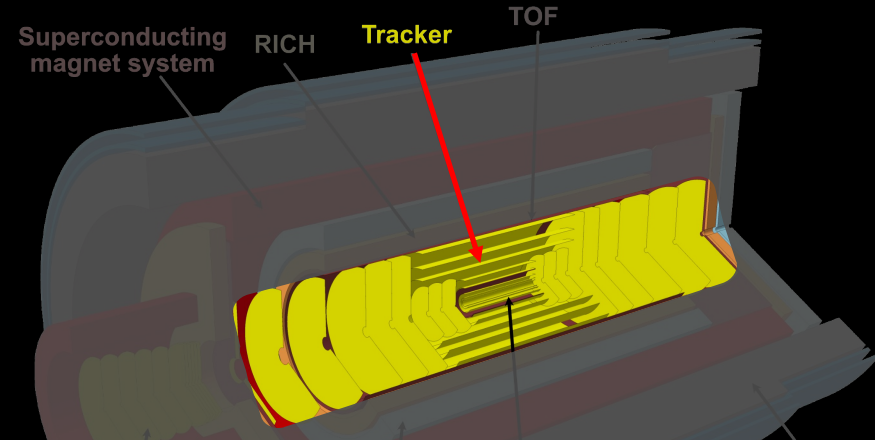
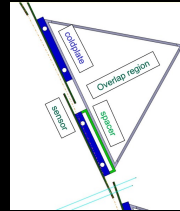
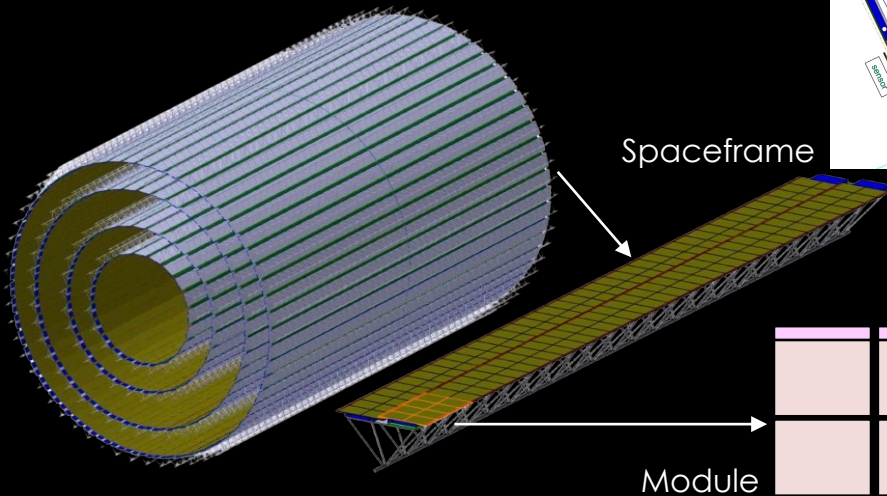


Module assembly in Korea

Sanghoon Lim

ALICE 3: Outer Tracker

- 8 layers and 9 disks based on MAPS
 - Total of $\sim 60 \text{ m}^2$ of silicon ($\sim 33 \text{ m}^2$ for barrel OT)
 - Compact design ($R < 80 \text{ cm}$, $|z| < 4 \text{ m}$)
- Pixel pitch of $\sim 50 \mu\text{m}$ for $\sim 10 \mu\text{m}$ intrinsic resolution
- 1% X_0 per layer
- Low power: $\sim 20 \text{ mW/cm}^2$



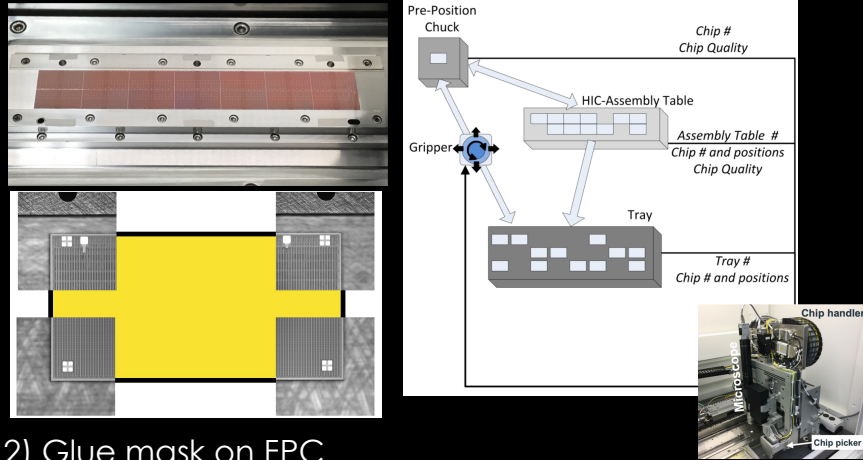
Layer	Det.	Material thickness (% X_0)	Intrinsic resolution (μm)	Barrel layers		Forward disks	
				Full length (Δz) (cm)	Radius (r) (cm)	Position ($ z $) (cm)	$R_{\text{in}} - R_{\text{out}}$ (cm)
6	IT/OT	1	10	1×124	20	150	5–68
7	OT	1	10	1×129	30	180	5–68
8	OT	1	10	2×129	45	220	5–68
9	OT	1	10	2×129	60	260	5–68
10	OT	1	10	2×129	80	300	5–68
11	OT	1	10			350	5–68

Sensor: $3.2 \times 2.5 \text{ cm}^2$

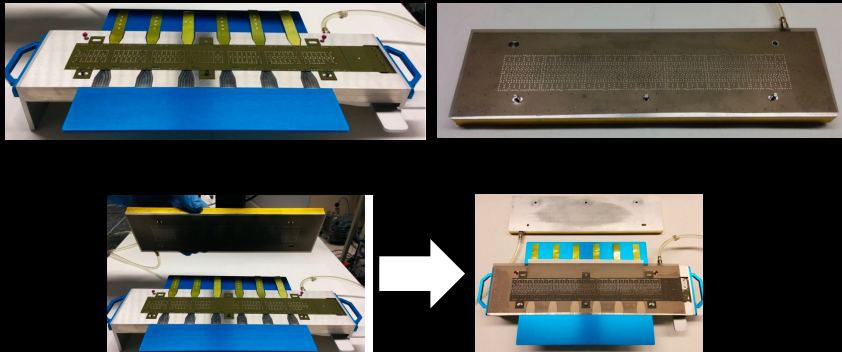
Path to the module after sensor fabrication (ITS2)

Module assembly procedure for ITS2 OB
2600 modules for ~2 years in 5 sites

1) Chips positioned on the HIC table



2) Glue mask on FPC

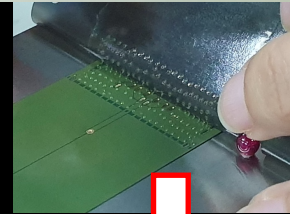
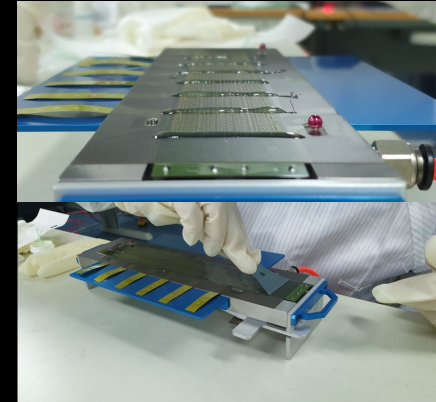


ALICE 3 OT:

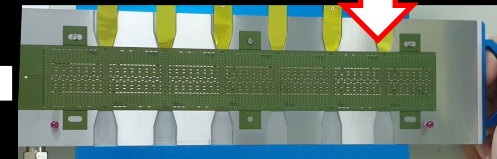
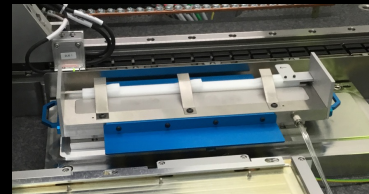
5620 for barrel and 2688 for disks

~10000 modules considering yield and spares

3) Gluing and curing



~5 hours curing time



Module assembly for ALICE 3 OT

- **Automatization and industrialization of module assembly**
 - Collaboration with MEMSPACK using a multi-purpose machine die bonder



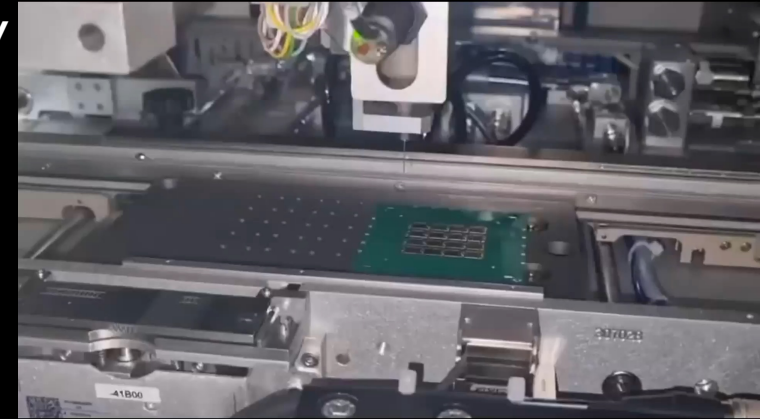
Datacon 2200 evo+



Visit from Japan



Visit from Germany



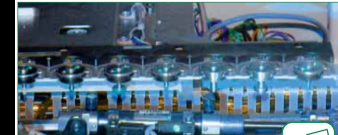
Integrated Dispenser

- 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



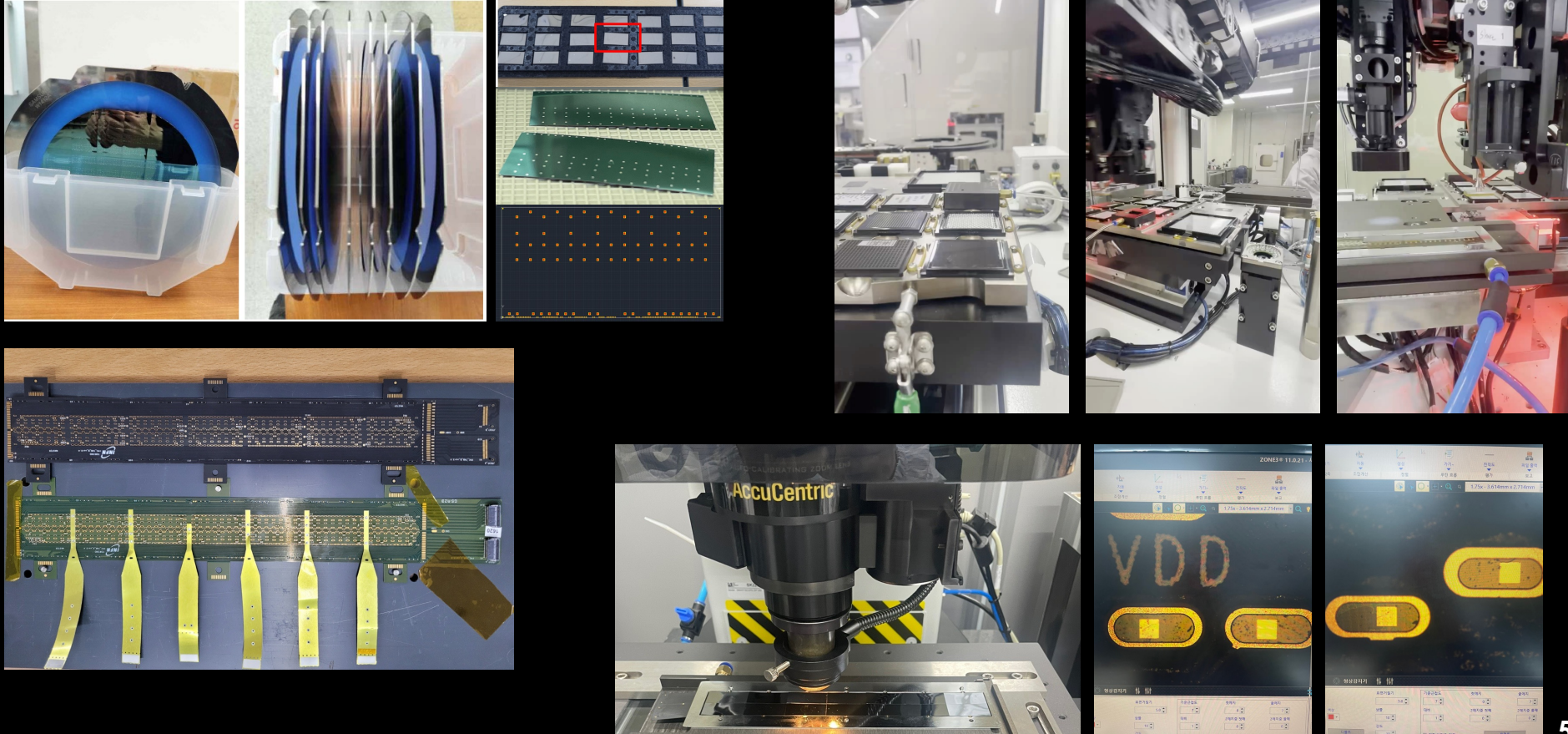
Pick & Place Head

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



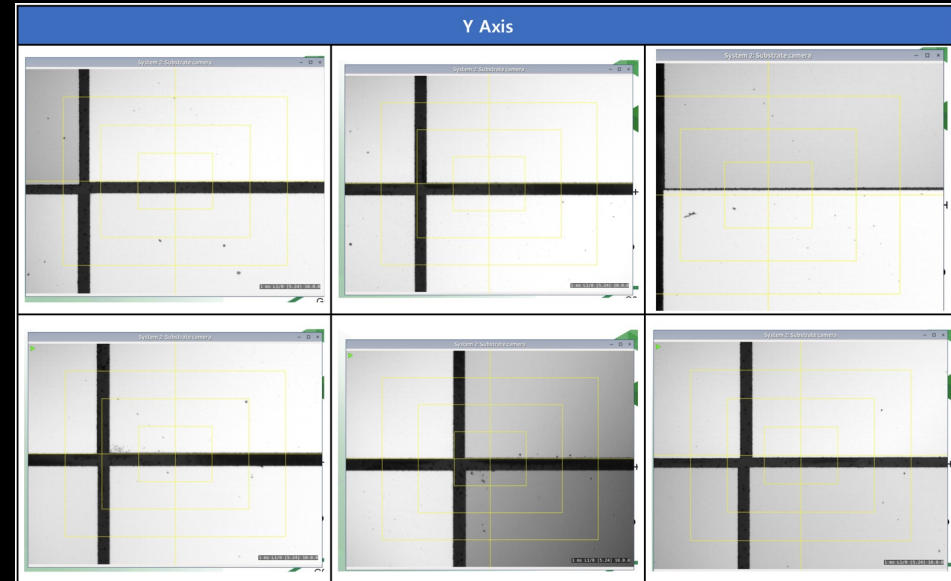
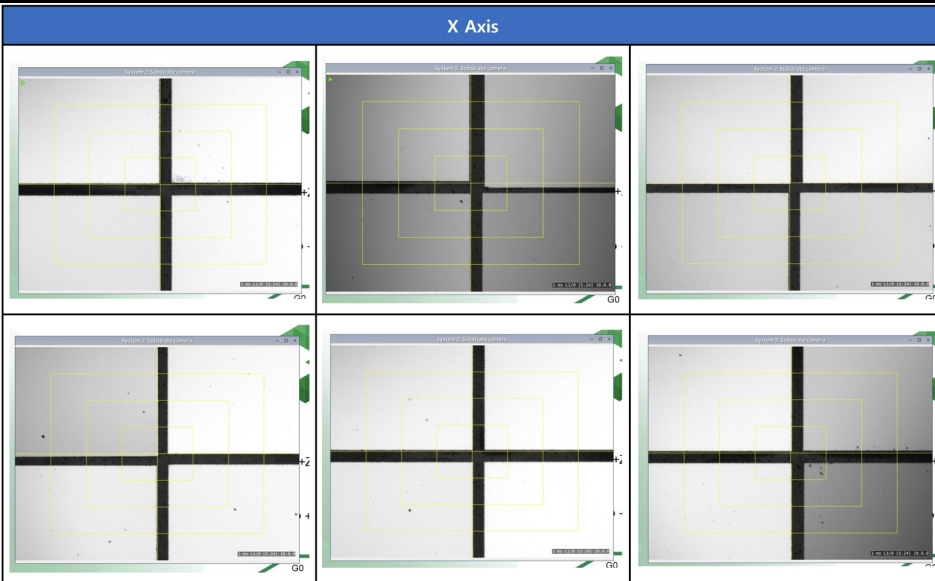
Dummy module assembly (2023 Dec.)

- Dummy HIC production (ITS2 OB design) for machine validation (using double-sided tape):



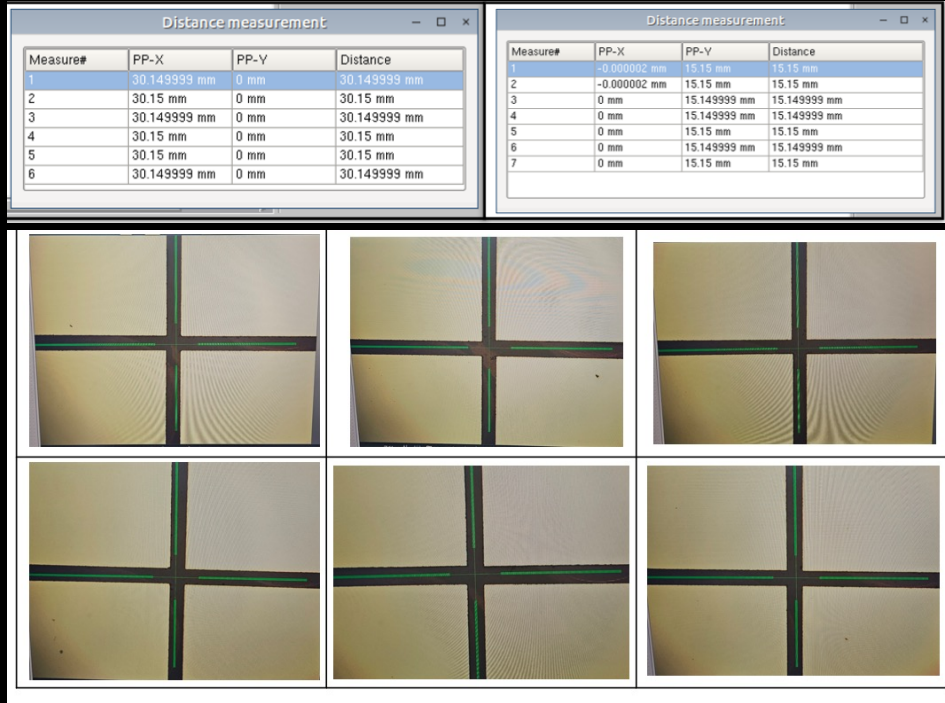
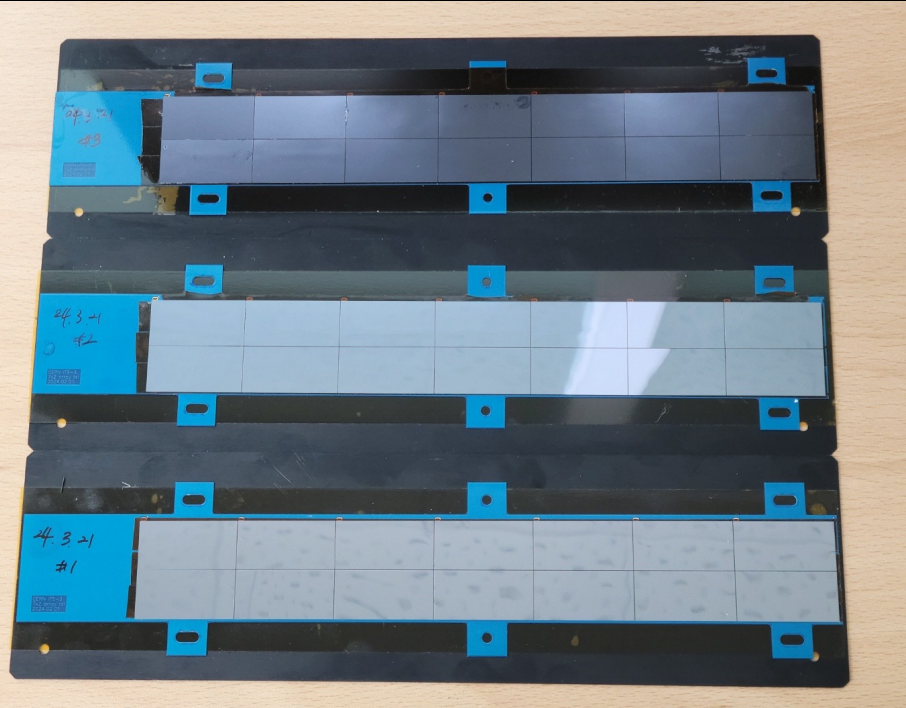
Dummy module assembly (2023 Dec.)

- Chips are aligned with respect to the marker on the FPC
Chip-to-chip alignment may vary due to the precision of FPC production
- Difficult to achieve stable results of position precision due to the warpage of dummy FPC
 - Different brightness is because of the tilt of chips



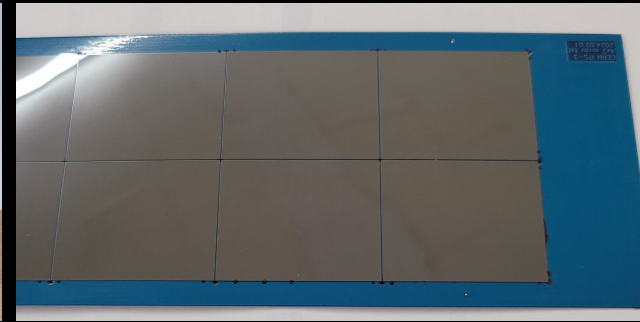
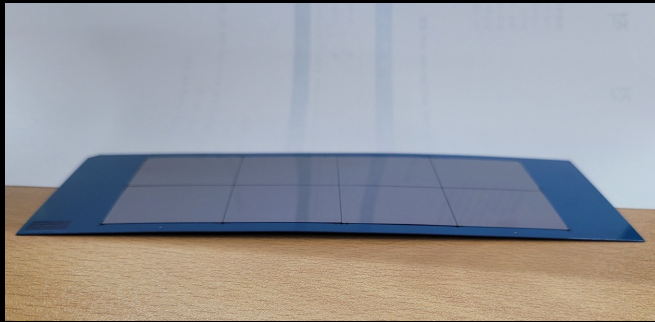
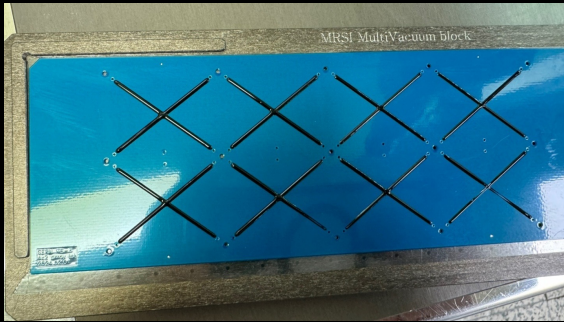
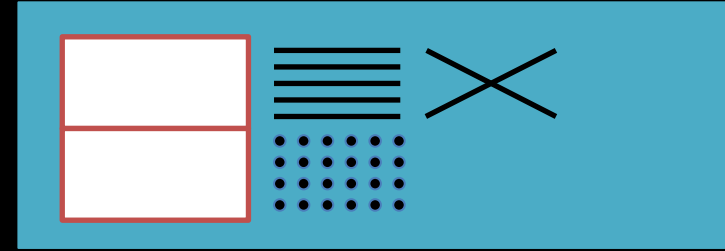
Dummy module assembly (2024 March)

- Machine validation using dummy chips and dummy boards
 - Both for ITS2 OB HIC design and ALICE 3 OT design
 - Thicker chip (50-100 μm) and board (0.3 mm) to validate the repeatability of position precision
 - Successfully produced five modules with good position precision (using double-sided tape)



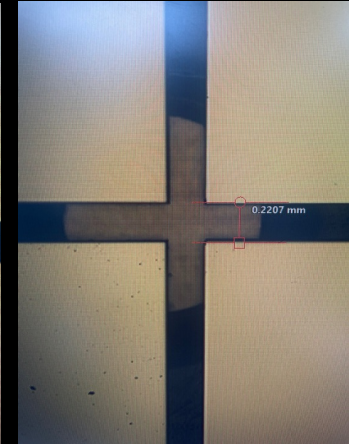
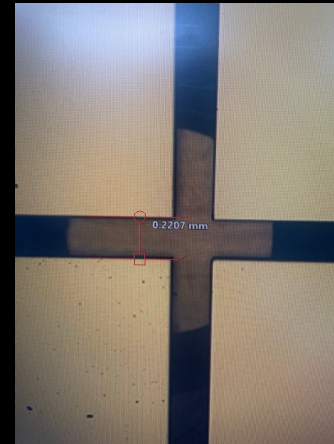
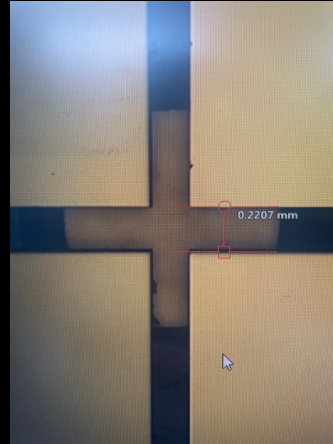
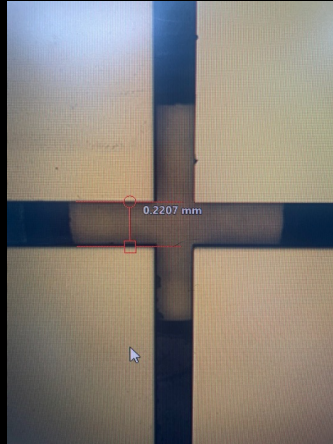
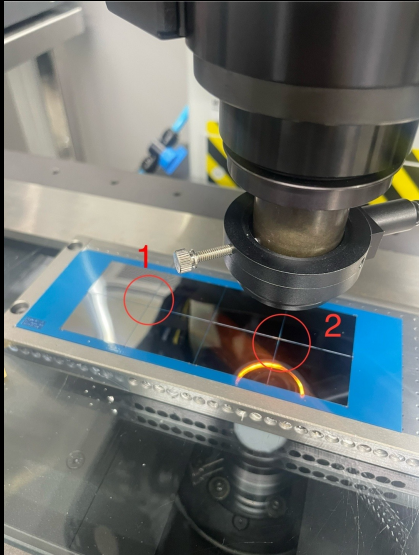
Dummy module assembly (2024 June)

- Die bond with heat cure epoxy (1125)
 - Epoxy generally used by MEMSPACK
 - Heat cure condition: 100 °C, 30 minutes (outside from the die bonder machine)
 - Dispense epoxy on the PCB (a few lines) and place chips
 - 0.3 mm thick chip (will reduce gradually)
 - Various dispensing patterns to minimize the position variation



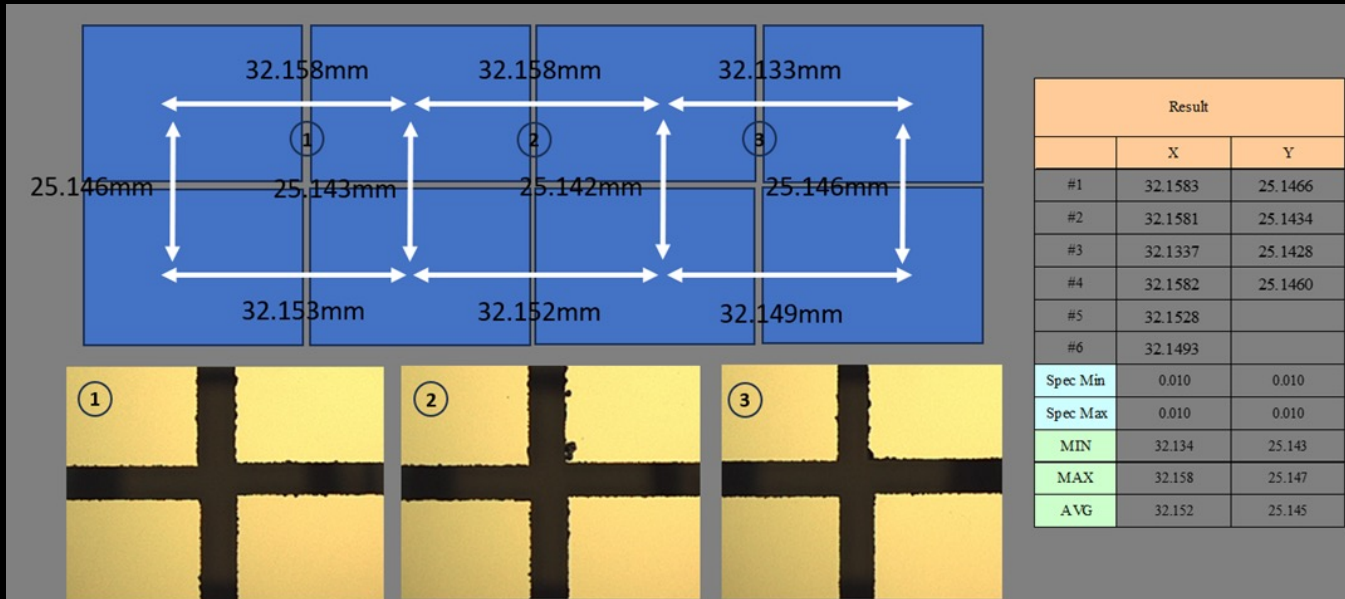
Dummy module assembly (2024 June)

- Die bond with heat cure epoxy (1125)
 - Epoxy generally used by MEMSPACK
 - Heat cure condition: 100 °C, 30 minutes (outside from the die bonder machine)
 - Dispense epoxy on the PCB (a few lines) and place chips
 - 0.3 mm thick chip (will reduce gradually)
 - Various dispensing patterns to minimize the position variation



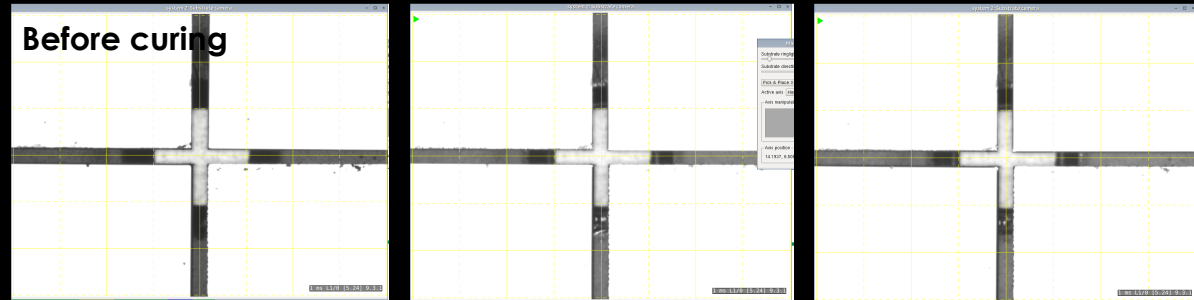
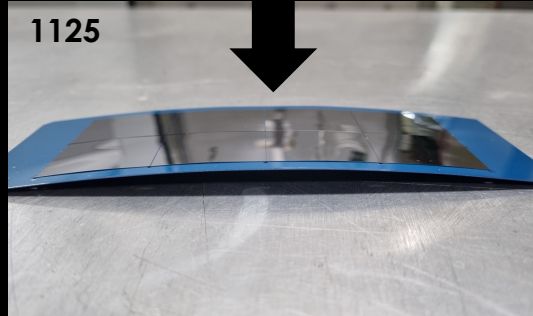
Dummy module assembly (2024 October)

- Die bond with heat cure epoxy (1125)
 - Epoxy generally used by MEMSPACK
 - Heat cure condition: 100 °C, 30 minutes (outside from the die bonder machine)
 - Dispense epoxy on the PCB (a few lines) and place chips
 - 0.3 mm thick chip (will reduce gradually)
 - Confirmed a good position precision



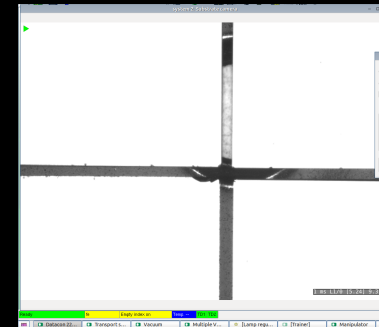
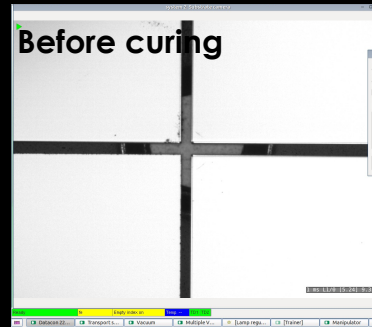
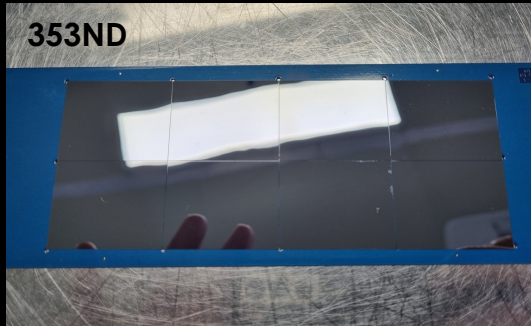
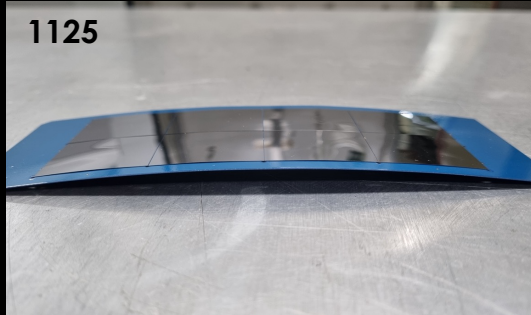
Dummy module assembly (2025 Feb.)

- Die bond with heat cure epoxy (1125)
 - Epoxy generally used by MEMSPACK
 - Heat cure condition: 100 °C, 30 minutes (outside from the die bonder machine)
 - Dispense epoxy on the PCB (a few lines) and place chips
 - 0.3 mm thick chip (will reduce gradually)
 - Confirmed a good position precision. However, bending is observed after curing



Dummy module assembly (2025 Feb.)

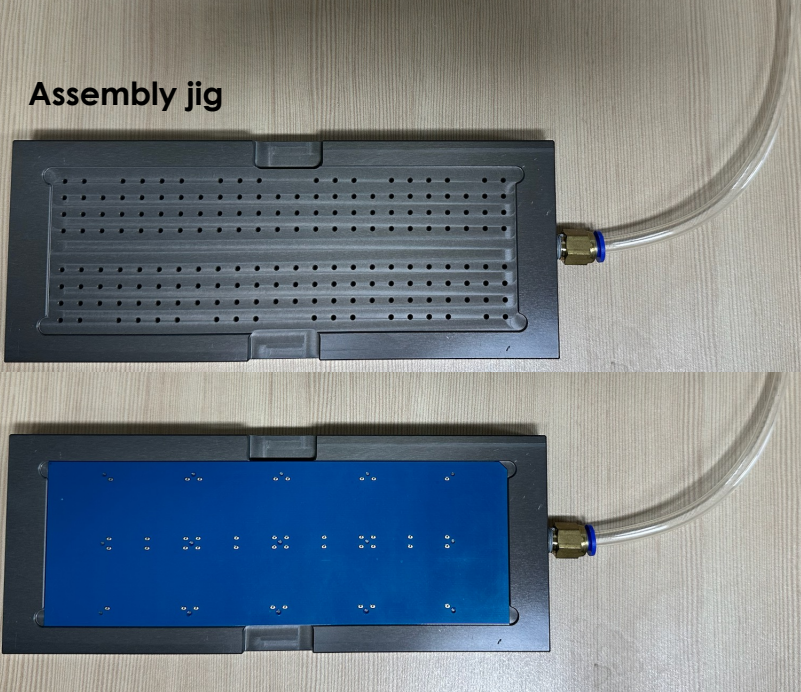
- Die bond with room temperature cure epoxy
 - Two-component epoxy (353ND), easier to handle than Araldite 2011
 - 100 μm thick chip
 - Confirmed a good position precision after curing



Concept of mass production procedure

- Uses several assembly jigs to run the assembly station continuously
 - FPCB is held with a vacuum during curing
 - Plan to build the system and verify the procedure
 - Expected production rate: 20-30 modules (chips+FPCB) per day

Assembly jig



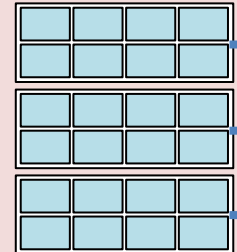
Assembly station
(die bonder machine)



Jig station

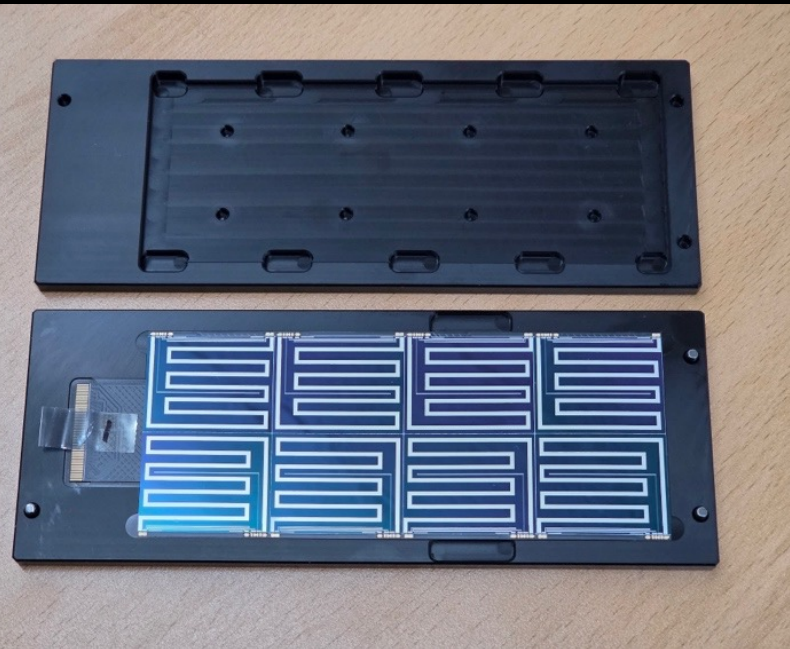
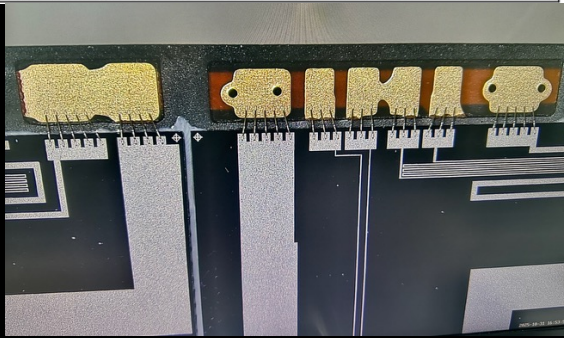
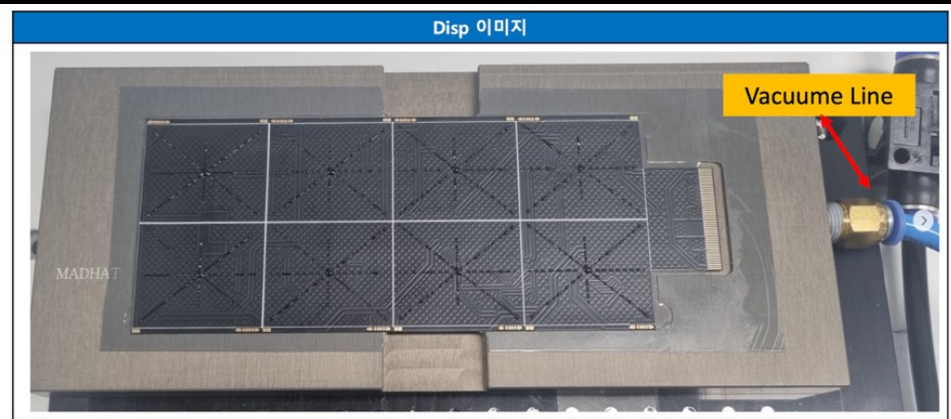


Curing station



Vacuum
line

- MADHAT (heat generating sensor) module assembly for the mechanical and cooling study of the stave
 - Plan to produce an ~300 modules which can validate the continuous production model
 - Successful setup at MEMSPACK:
Flexible PCB, 100 μm sensor thickness, 353ND epoxy



Customized module assembly machine (C-ON tech)

- Initial design for the customized machine
 - Chip handling system will provide an accurate position precision
 - Plan to start discussion for the design of a prototype machine for BIC

