Mechanical Structure for FST

20 July 2020 @ F2F meeting

Han-Sheng Li, Pu-Kai Wang, Yi Yang	Department of Physics, NCKU
Chung-De Chen, Pei-Chia Chung, Bing-Teng Hong, Tsai-Hsuan Hsieh, Jian-Yu Wang, Tian-Shiang Yang	Department of Mechanical Engineering, NCKU
Tang-Shiang Chang, Ming-Tang Dong, Yuan-Ruey Chuang, Yean Ho Liao	Aerospace Industrial Development Corporation

Presentations/Document

- Document:
  - Version 2: https://www.dropbox.com/s/cndffu9ybv8zkyu/Mechanical_Structure_for_FST_at_STAR_v2.pdf?dl=0

- F2F Meetings:
  - 2020-02-28: https://www.dropbox.com/s/xaszsze9q5es1g7/20200228_FST_Mechanical_YiYang.pdf?dl=0
  - 2019-08-08: https://www.dropbox.com/s/8a5o85qvgy8haof/20190808_FST_Mechanical_YiYang.pdf?dl=0
  - 2019-03-30: https://www.dropbox.com/s/43aiy53zandld9q/20190331_FST_status_YiYang.pdf?dl=0

The Forward Silicon Tracker

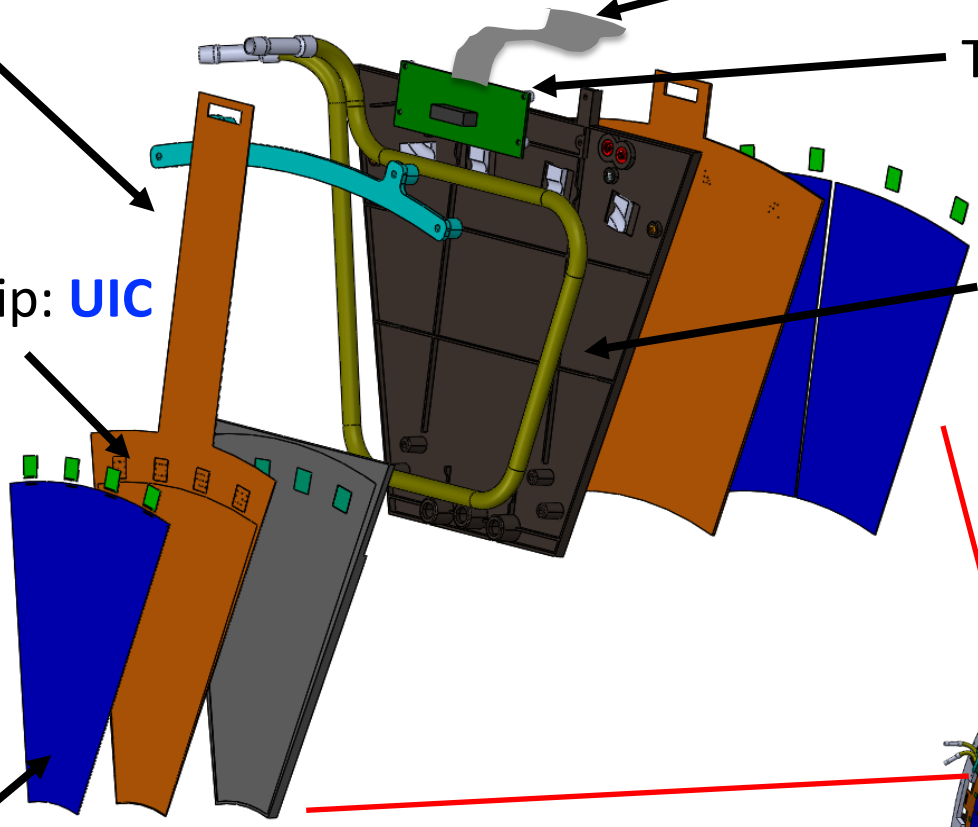
Flexible hybrid PCB: **SDU/IU**

Inner Signal Cable: **BNL**

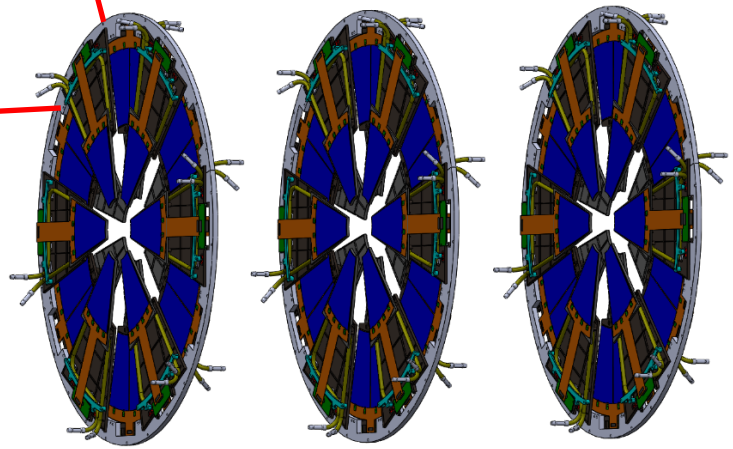
T-Board: **SDU/IU**

APV25 Chip: **UIC**

Mechanical Structure
(+ cooling pipe): **NCKU/AIDC**



Supporting Structure &
Integration: **BNL**



Silicon sensor: **UIC/SDU/NCKU**

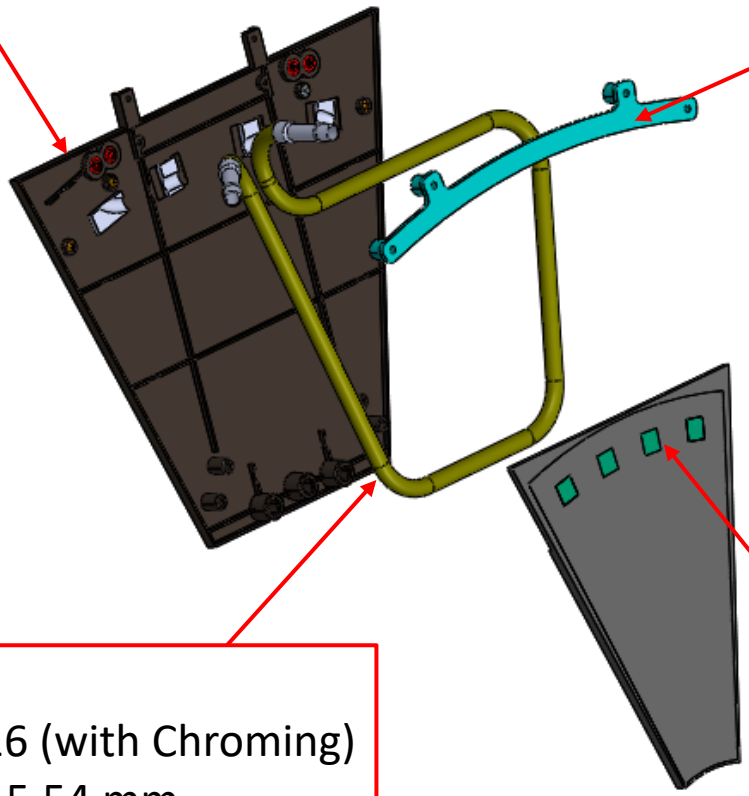
Cooling: **BNL/NCKU**

Simulation: **UIC/BNL/IISER/NCKU**

The Final Design

Main structure:
- ❑ Material: PEEK
- ❑ Thermal Conductivity: 0.24 W/m/K

Tube fixture:
- ❑ Material: PEEK

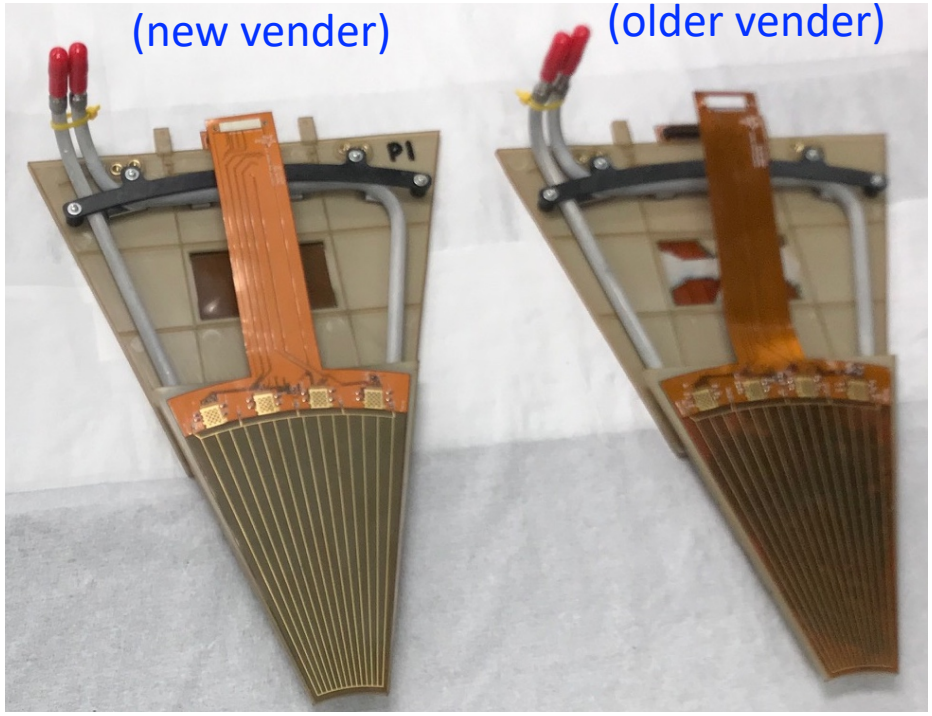


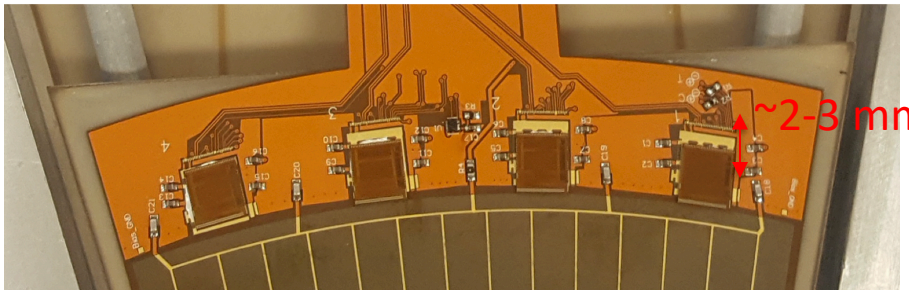
Tube:
- ❑ Material: Stainless 316 (with Chroming)
- ❑ Size: OD 6.35 mm, ID 5.54 mm
- ❑ Thermal Conductivity: 14 W/m/K

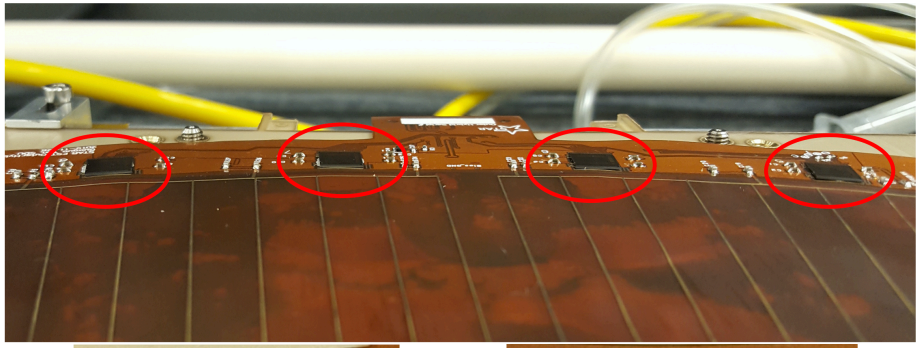
Heat sink:
- ❑ Material: Al 6061
- ❑ Size: ~8.2 x 8.0 x 3 mm^2

First Prototypes: FST-001, FST-002

- Two prototypes assembled by AIDC on Jan. 30 and Feb. 11, 2020
- Many issues found: flatness, bubbles, shifting…





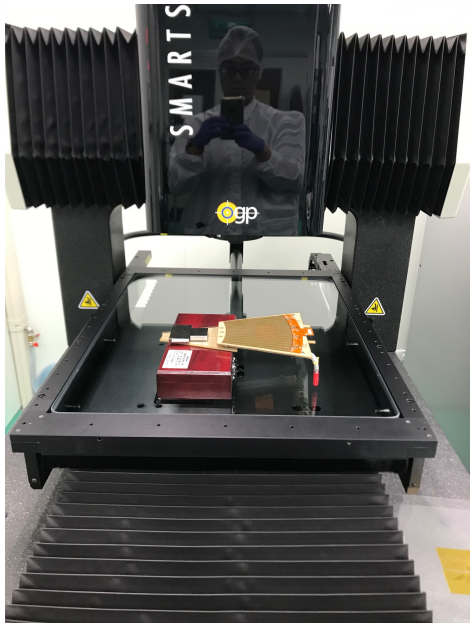


Flatness (RMS)	Thicker hybrid	Thinner hybrid
Inner	0.2942 (mm)	0.2663 (mm)
Outer	0.4654 (mm)	0.2585 (mm)

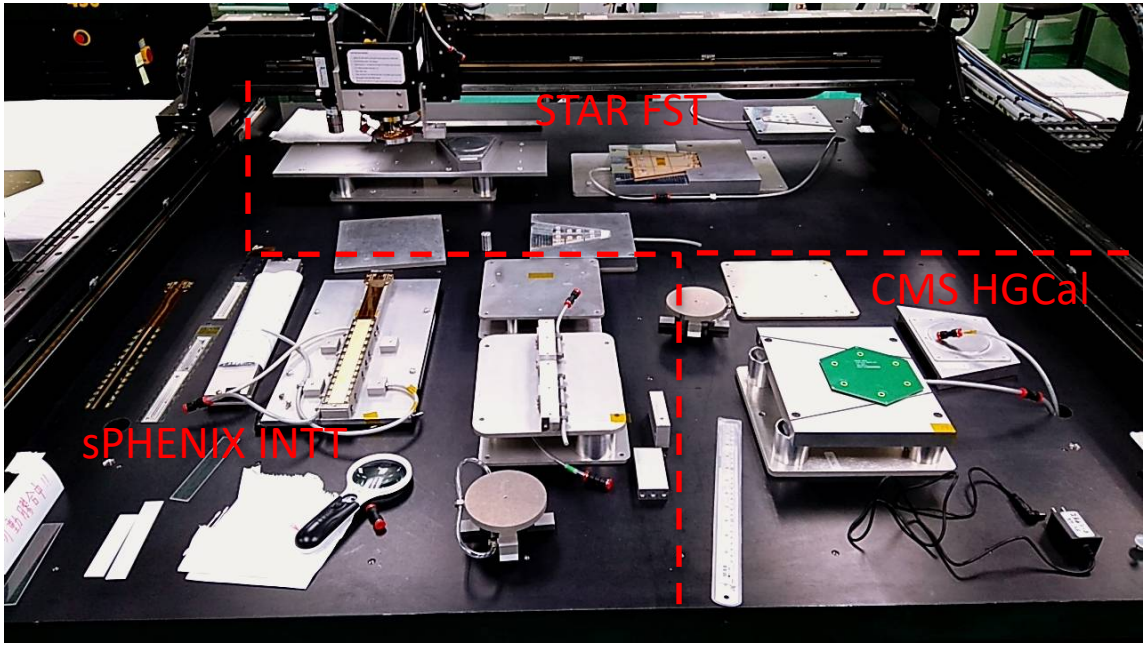
New Assembly Procedure

- To improve the precision of the assembly, we are using the robotic machine at TiDC (https://www.taiwan-tidc.org) to mount hybrid PCBs to inner and outer structures
  - ➔ More precise positioning
  - ➔ New fixtures and LabView codes are ready

Optical Gauging Products (OGP)

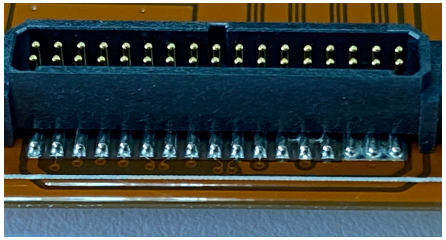


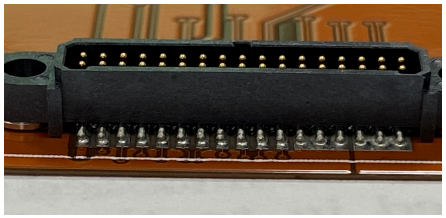
Assembly table and gantry

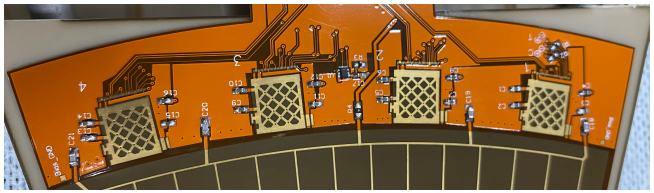


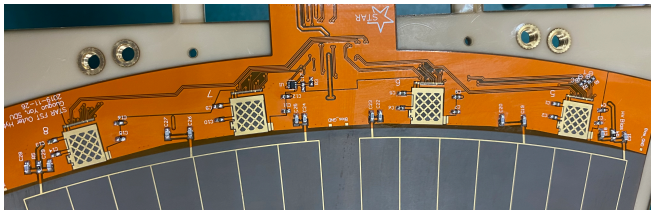
Connector & Components on Hybrid

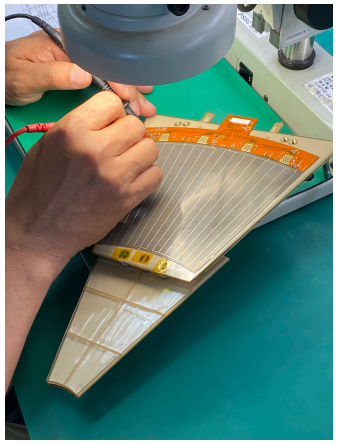
- FST-001 & FST-002: connector and components were mounted before assembly
- New procedure (FST-003, FST-004):
  1) Connector were mounted by outsourcing company
  2) Perform plugging-unplugging test
  3) Perform open connection test
     (Assembly hybrid + mechanical structure)
  4) Solder components manually
  5) Perform electrical test

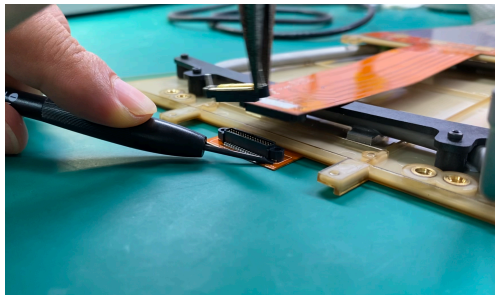


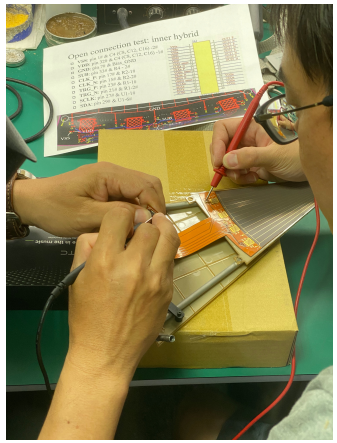






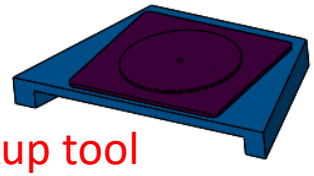






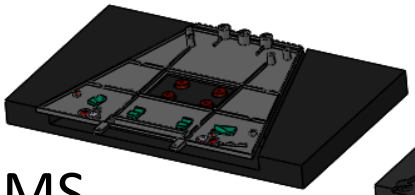
New Assembly Procedure: Outer

1) Place the pickup tool, outer MS + tray, outer Hybrid + tray on table

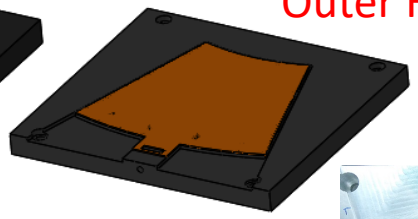


pickup tool

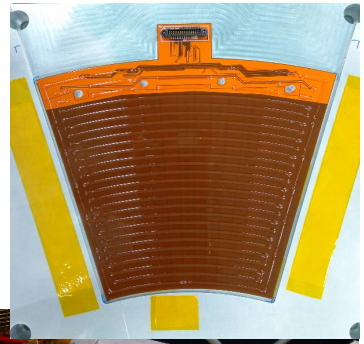
Outer MS + tray

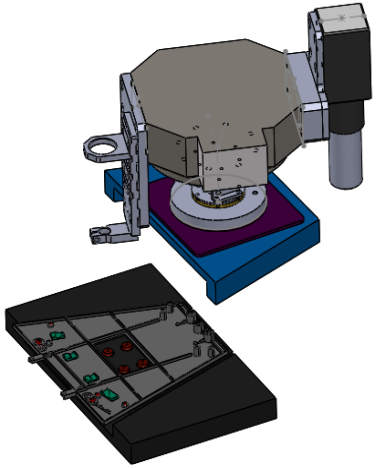


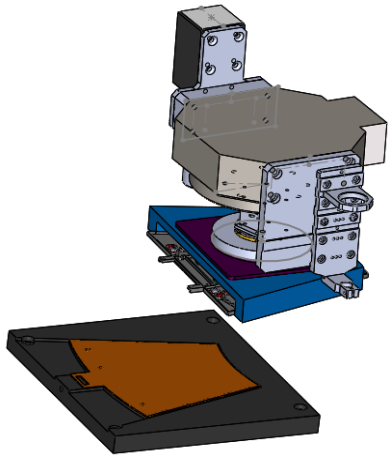
Outer Hybrid + tray

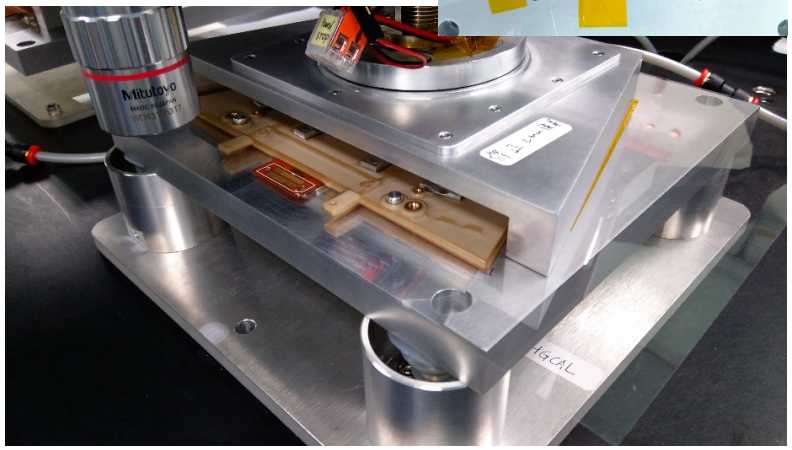


1) Place guide pin on outer MS
2) Apply glue on outer Hybrid
3) Use camera to locate the reference points
4) Glue







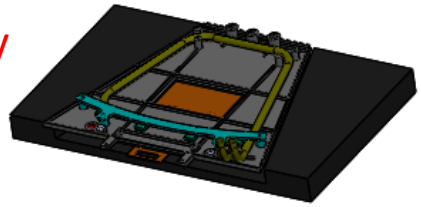


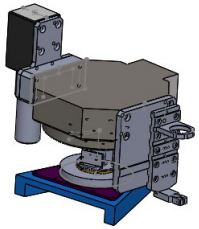
New Assembly Procedure: Inner

- Need to pre-fit and calculate the correct positions due to the shrinking of the MS (**will be fixed**)

1) Place the outer MS+Hybrid+Cooling tube (outer wedge) + tray and inner MS + tray on table

Outer wedge + tray



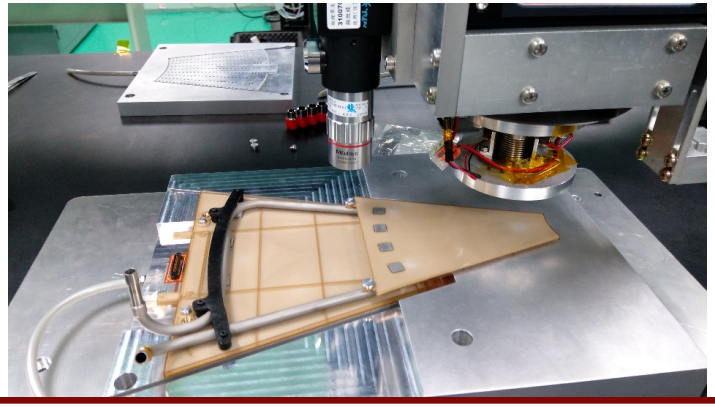


Inner MS + tray

2) Located the reference points

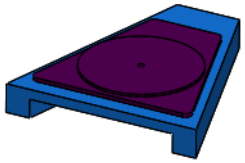
3) Use robotic arm to place the inner MS on the outer wedge

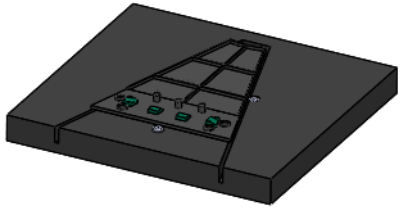
4) Record the positions and calculate the shifting

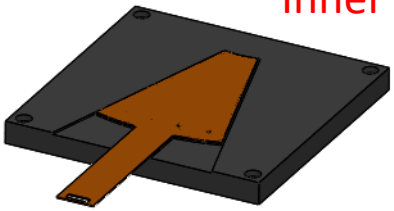


New Assembly Procedure: Inner

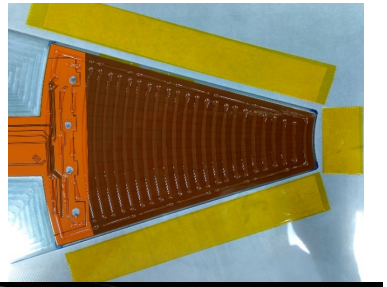
1) Place pickup tool, inner MS + tray, inner Hybrid + tray on table





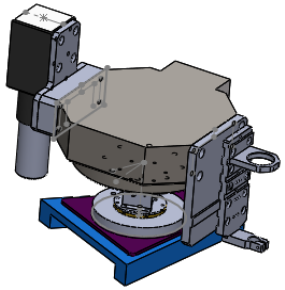


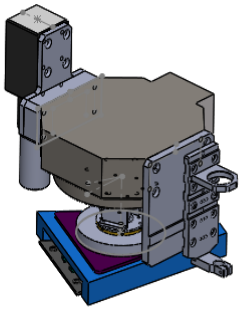
Inner Hybrid + tray

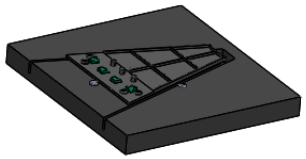


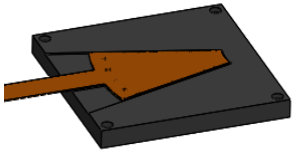
2) Use camera to locate the reference points

3) Pick up inner MS and glue it on the inner Hybrid



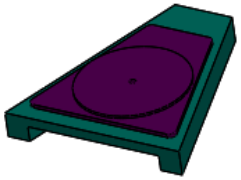
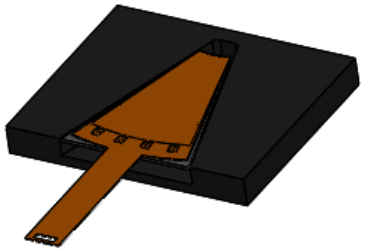
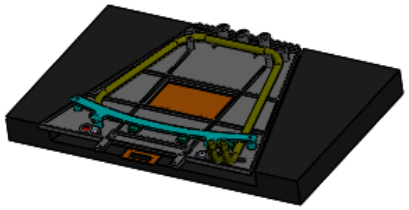




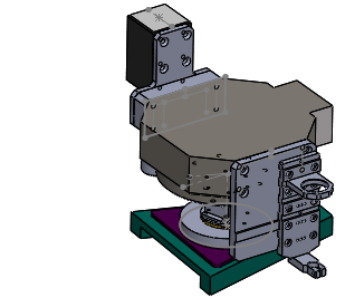
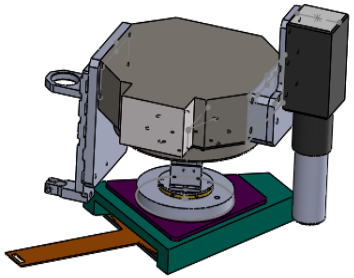
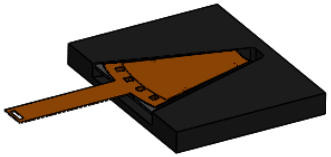
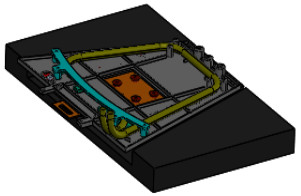


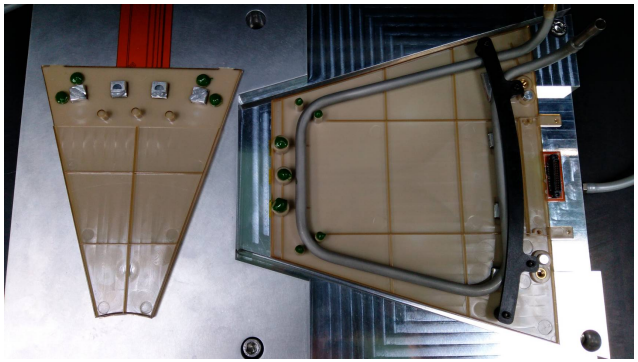
New Assembly Procedure: Outer+Inner

1) Place pickup tool, inner wedge + tray, outer wedge + tray on table

2) Use camera to locate reference points
3) Pick up inner wedge and glue



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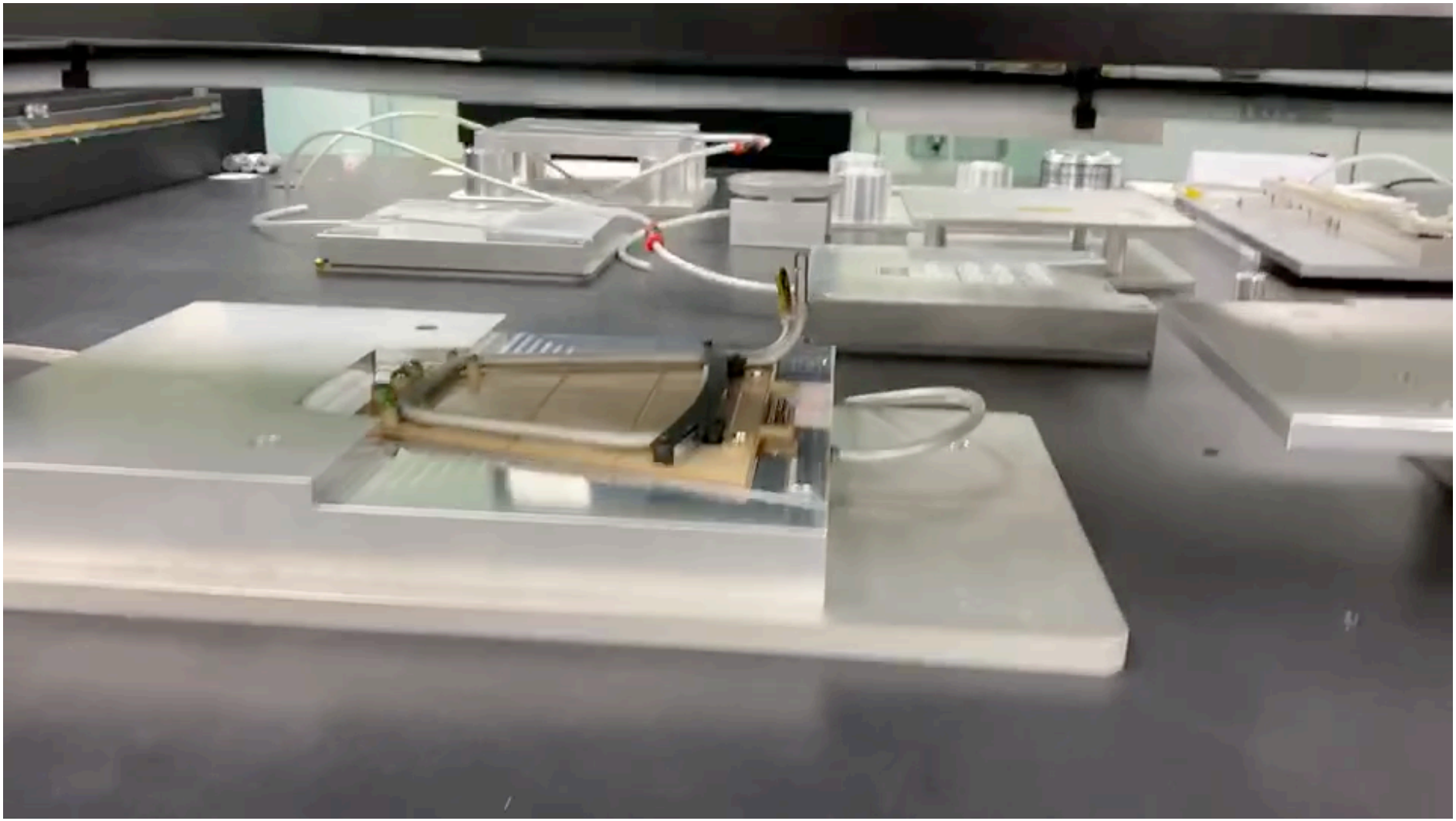
New Assembly Procedure: Video



Second Prototypes: FST-003, FST-004

Look good by eyes!

FST-003

FST-004

Second Prototypes: FST-003, FST-004

- "The inner chip placement was off .500 mm so I needed to reposition. The outer placement was off .200 mm”

  (slightly larger misalignment for FST-004)
- "They were inboard toward the sensor area . I needed to slide the chips back or outward. Michelle mention adhesion under some pads was not so good and created some issue but she got all in adjusting the powers.”

  (Only for FST-003)

➔ (1) Mainly due to the guide pin and this will be fixed after using the recommendation from Rahul’s team

➔ (2) Will improve the glue pattern

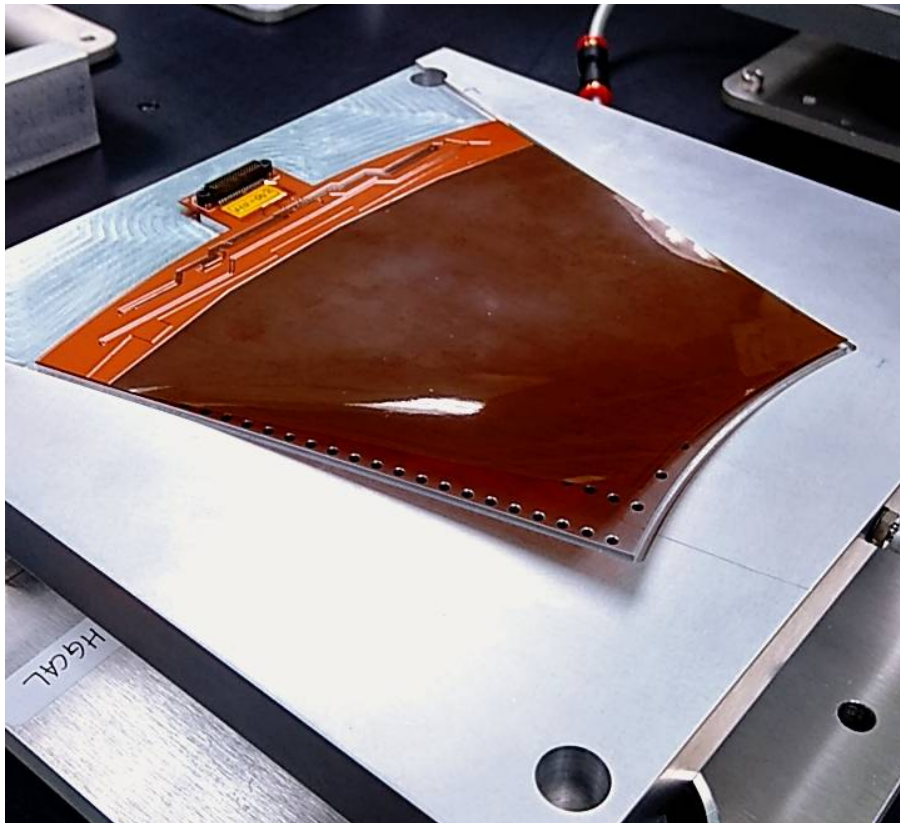
(See next slides)

Issue on Thicker Hybrid (new vender)

- The conducting lines are too thick: 48 μm vs. 24 μm
  - ➔ Difficult to be fixed on the vacuum tray
  - ➔ Need to use the thinner one for production

Thicker

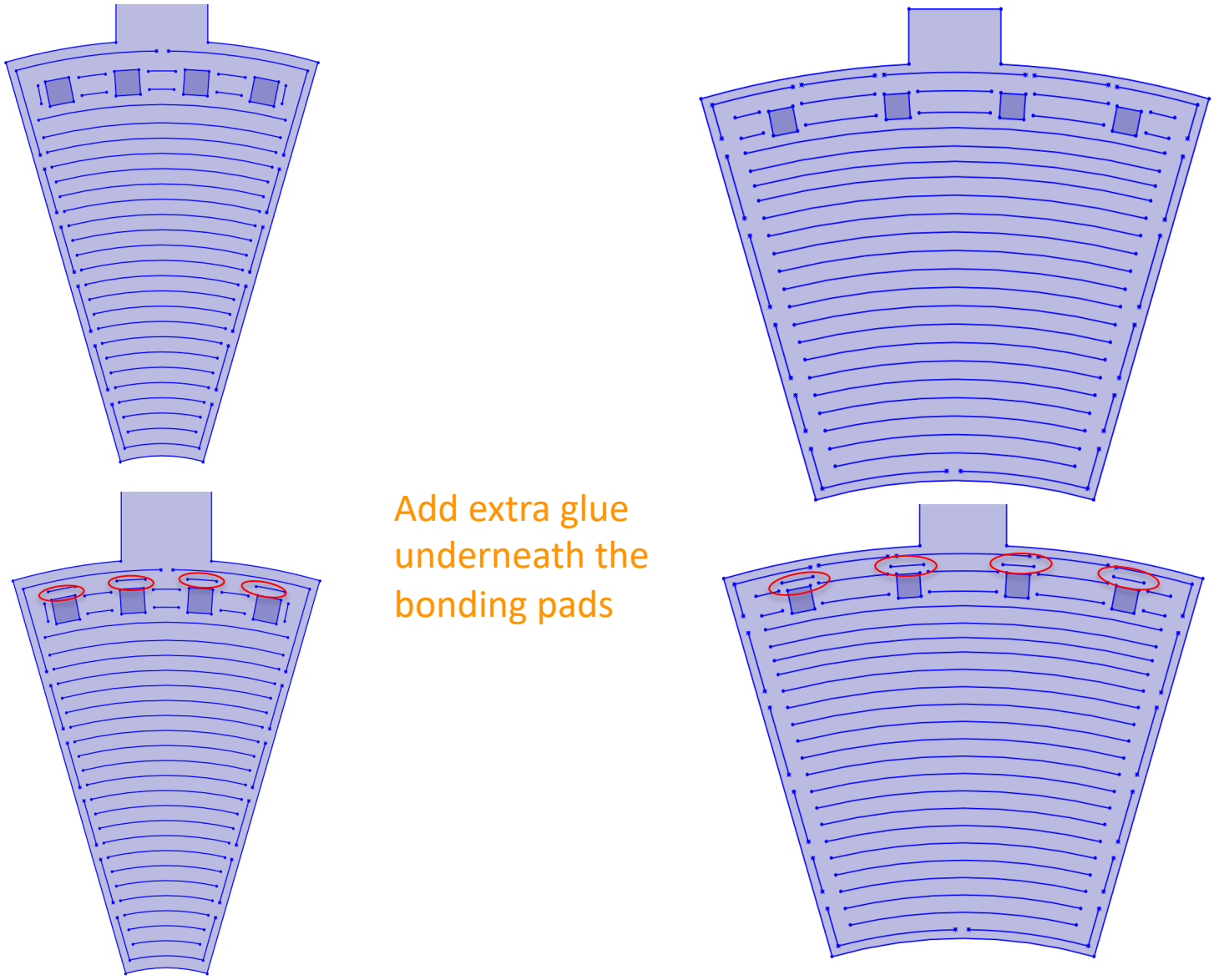
Thinner



Modified Gluing Pattern

Old

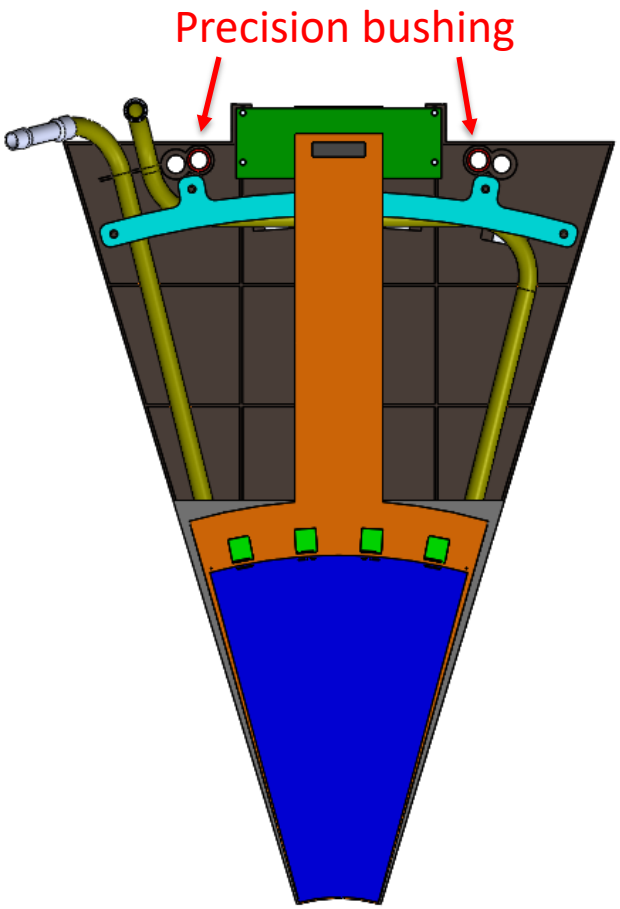
New

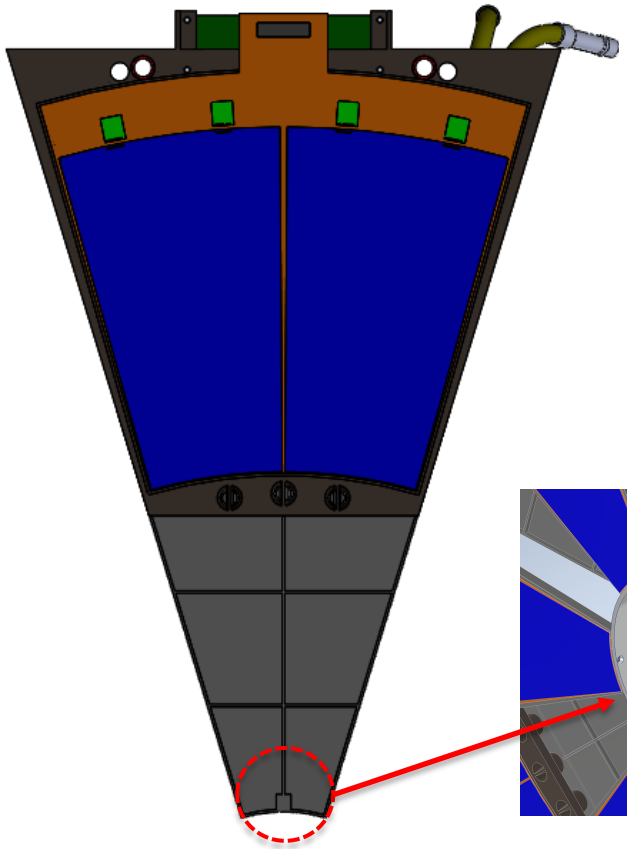


Add extra glue underneath the bonding pads

Modified Mechanical Structure

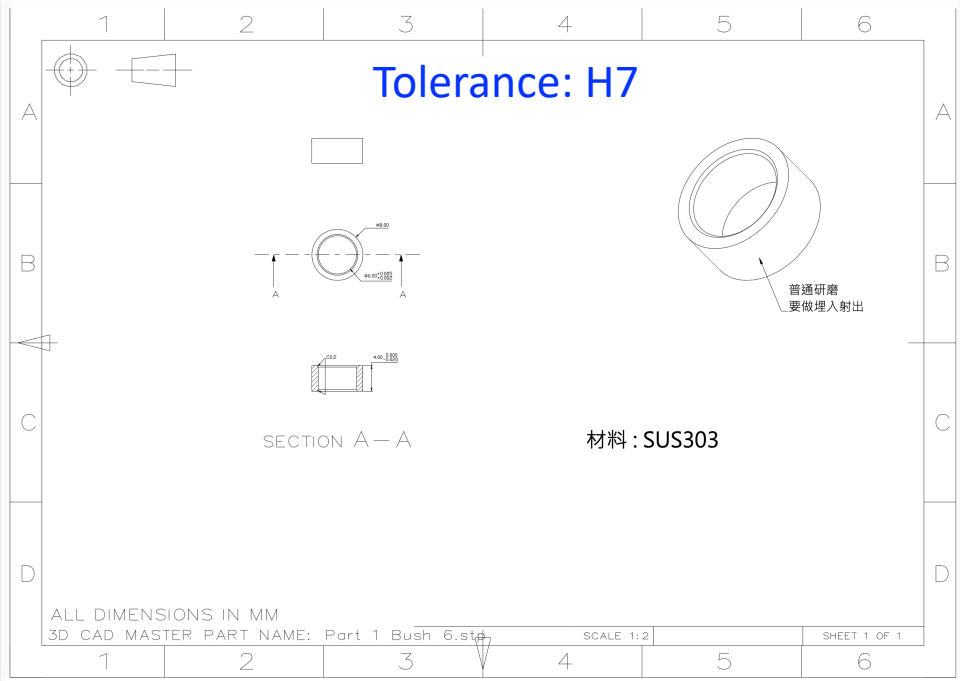
- Implemented the suggestions from Rahul's team
  - Precision bushings and pins (inner holes), larger through holes (outer holes)
  - Add inner supporting part (screw hole)

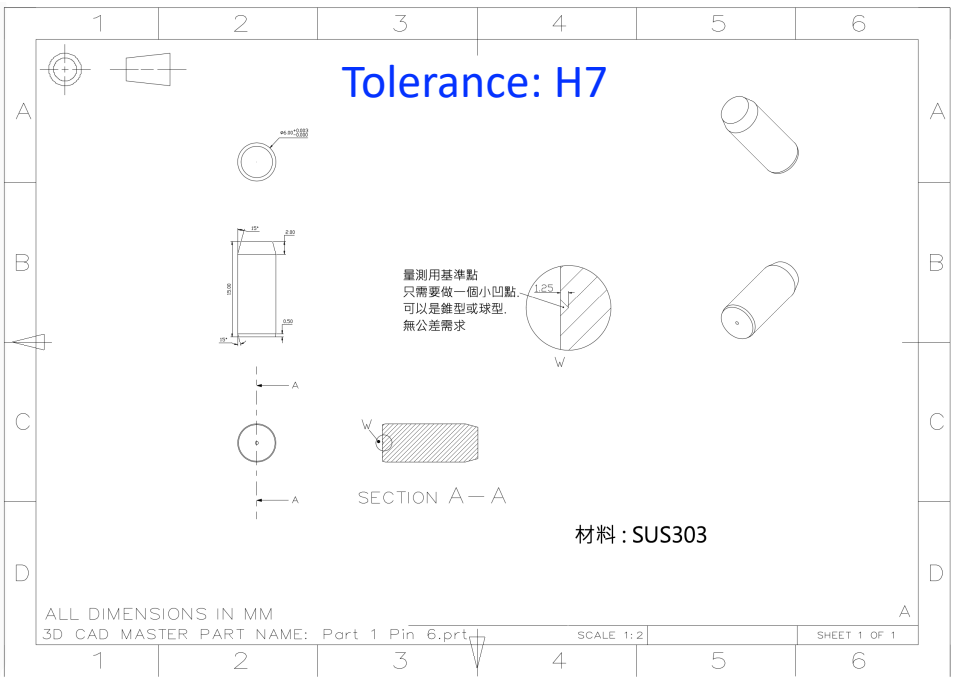




Bushing and Pin

- Precision bushings and pins will be customizely made in Taiwan
  - Bushing: MOQ: 500 pcs, ~15 USD/pc
  - Pin: MOQ: 500 pcs, ~4 USD/pc
  - Total: **~9,500 USD**



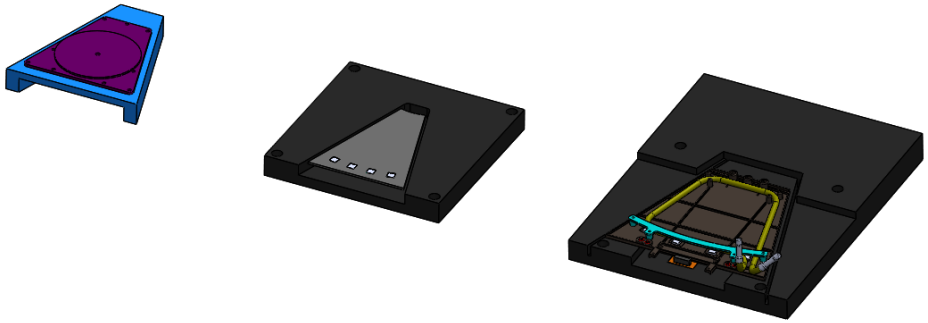


Modified Gluing Procedure for Inner Hybrid

* Manufacturing new fixtures now

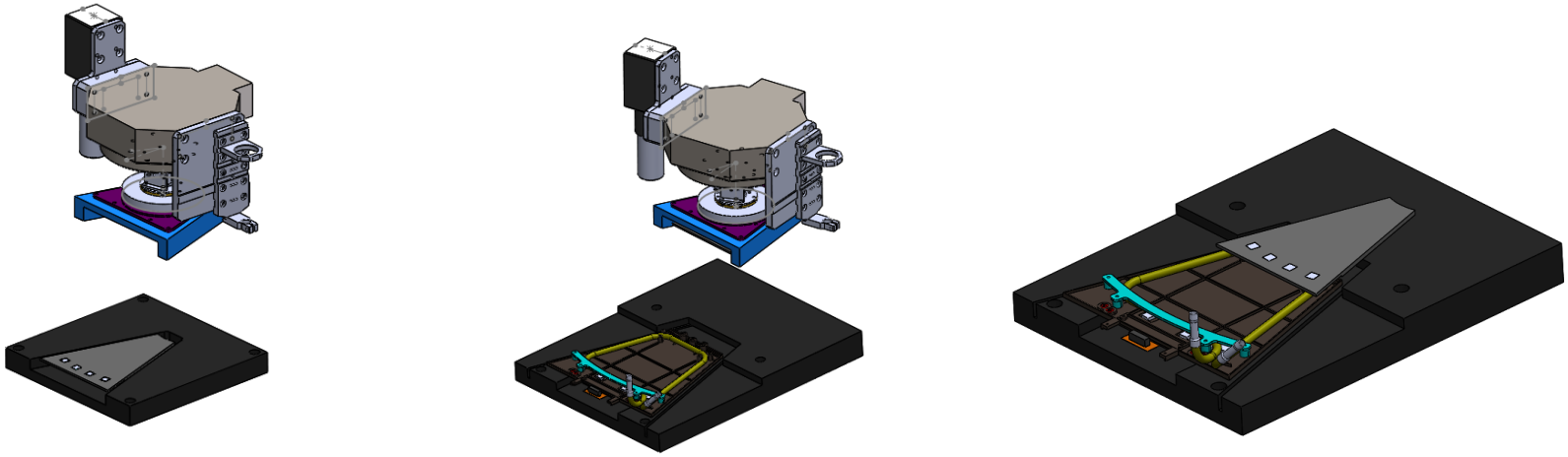
- Glue the inner MS first

1) Place pickup tool, inner MS + tray, outer wedge + tray on table



2) Use camera to locate reference points

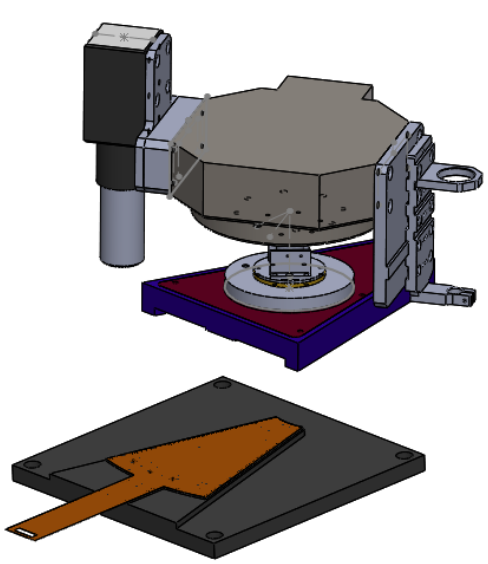
3) Pick up inner MS and glue it on the outer wedge

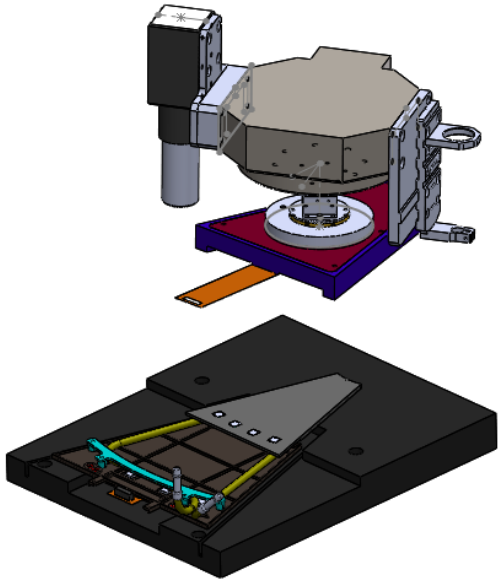


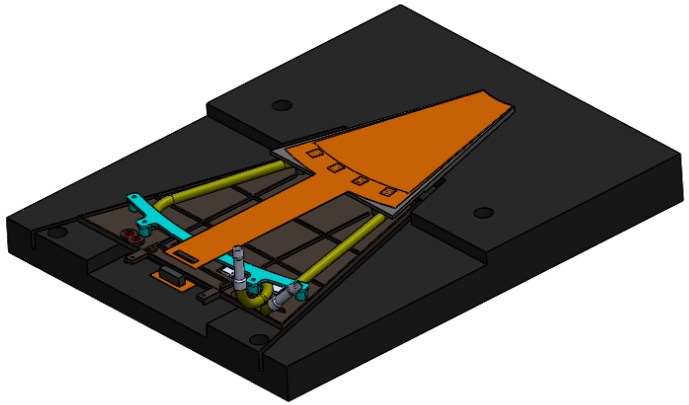
Modified Gluing Procedure for Inner Hybrid

- Follow the "same" procedure as the outer Hybrid

1) Place pickup tool, inner Hybrid + tray, outer wedge + inner MS + tray on table
2) Use camera to locate the reference points
3) Pick up inner Hybrid and glue it on the inner MS







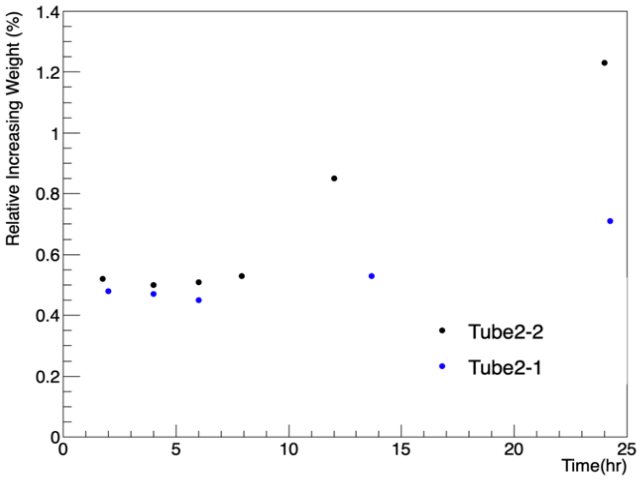
Soft Tube Compatibility Tests

- Use the Soxhlet extraction method (suggested by 3M)

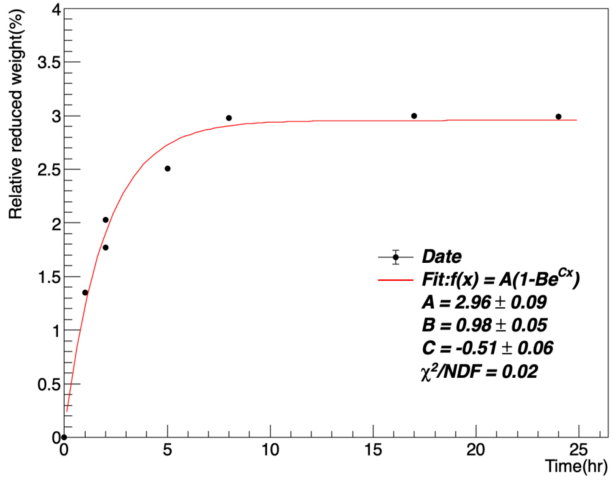
Recommended Flex Hoses for General Use

Tubing Name	Type	Extraction %	Weight gain %	Comments
Tygon™ C-544-A I.B.	Clear Braided Polyurethane	0.09	0.3	Excellent Compatibility. Good pressure resistance. Temperature Range –73 to 82C. www.tygon.com
Tygon 3370 I.B.	Clear Braided Silicone	1.47	4.8	Good Compatibility. Good Pressure resistance. Temperature Range –73 to 160C.
Flexfab™ 5521-050	Green braided silicone hose	2.08	NA	Good Compatibility. Good Pressure resistance. Temperature range –54 to 150C. http://www.flexfab.com
Nalgene™ 290 PUR	Clear Yellow. No Braid.	0.74	0.3	Excellent Compatibility. Little pressure resistance.

Tygon C-544-A I.B.

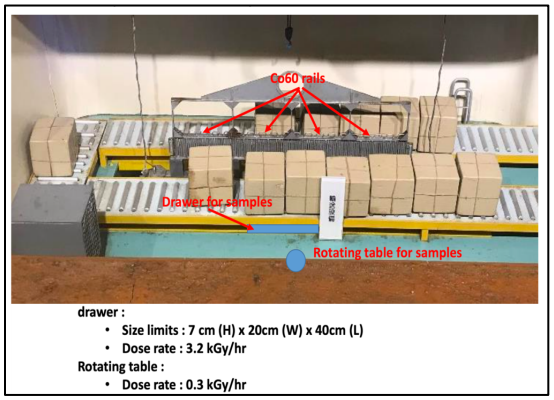


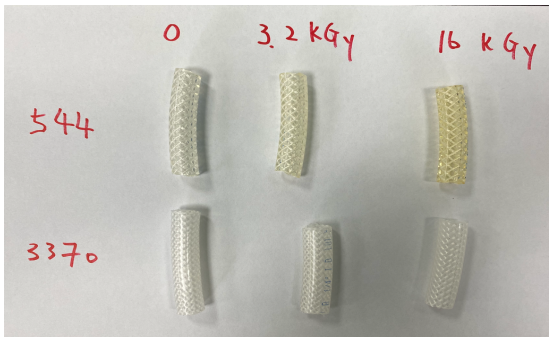
Tygon 3370 I.B.



Soft Tube Radiation Tests

- Use Co^{60} source at Institute of Nuclear Energy Research (INER)
- Cost: ~150 USD/test
- Two dosages:
  - 3.2 kGy (from proposal)
  - 16 kGy (5 times higher)





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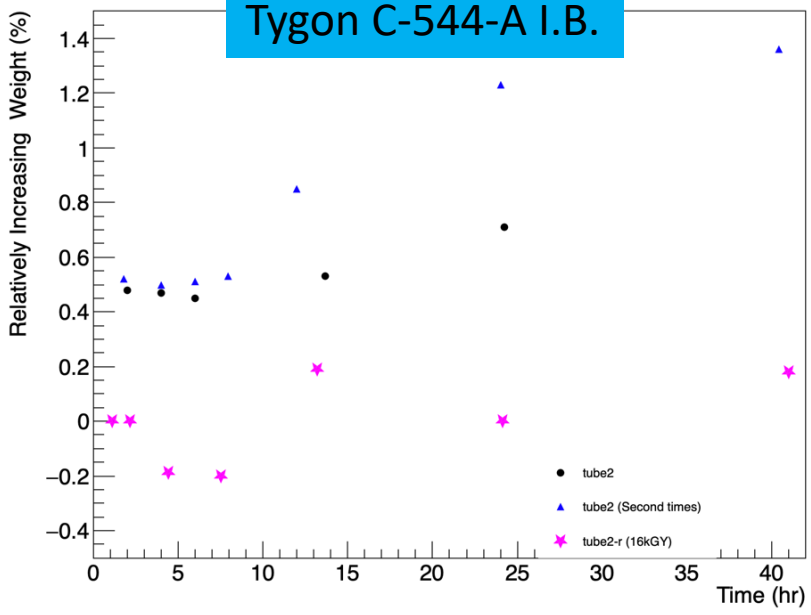
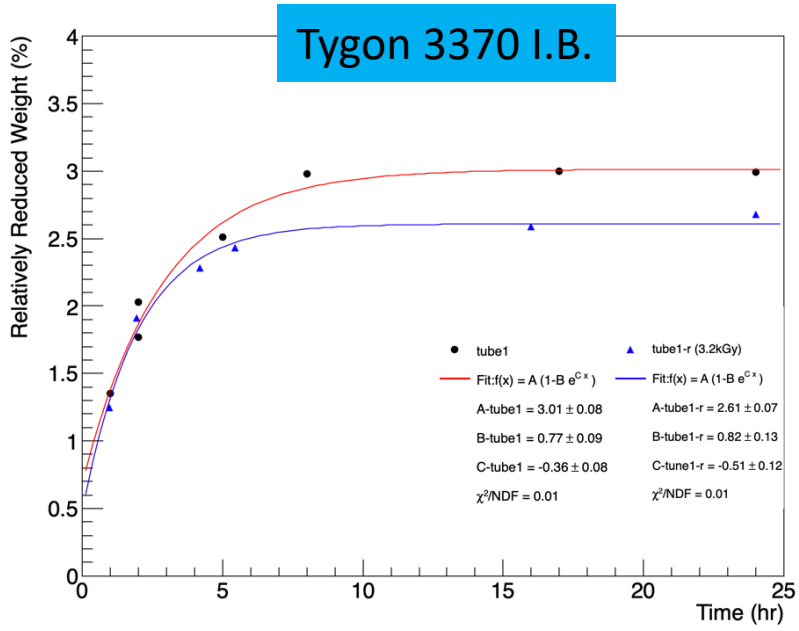


Tygon 3370 I.B.



Plan for the Measurements

- Plan to outsource (Taiwan CK Techno Co.,Ltd.) the measurements of flatness and parallelism
- Extremely expensive:
  - **Flatness** for single inner or outer MS (before assembly):
    - Price: **~200 USD/pc**
    - Method: optical
  - **Flatness** and **parallelism** for assembled module:
    - Price: **~400 USD/pc**
    - Method: mechanical (their know-how)

  ➔ Total of 60 sets: **48,000 USD** **Working on getting a better deal**

- Plan for the prototypes:
  - **Flatness** for single inner or outer MS (before assembly) at TiDC
  - **Flatness** and **parallelism** for assembled module (first 10) by CK Techno

Schedule for Production

- **Estimated production times:**
  - One week for preparation
  - One module per day
  - 70 working days for 60 modules
- **Current Schedule:**
  - Aug. 12, 2020: place orders
  - Sept. 14, 2020: preparation
  - Sept. 21, 2020: start production
  - Dec. 24, 2020: finish production
  - Dec. 31, 2020: ship to UIC

Backup