Progress Report

RIKEN/RBRC
Itaru Nakagawa

Taiwan Shipping

- 200um sensors (Type-A x 6 + Type-B x 6) are to be picked up on March 5th.
- Silicon sensors to BNL
- HDI's to BNL

Silicon Sensors

- 150 sets are delivered to RIKEN by the end of May.
- Datasheet CD is handed to Kai-Yu. He will upload data to the database.
- 129 sets + 2 bad sensor sets are shipped to NCU for testing
- 20 sets + 2 bad sensor sets are shipped to BNL
- 1 set is already in assembly process in REPIC.co as a 2nd test module for Nara test bench. To be delivered by the end of July.
- Another 150 sets is in preparation for the procurement in JFY2019.

Silicon Sensors

- Silicon sensors are to be exported to BNL
  - 50 sets from 1st batch + 25 sets from 2nd batch (Untested)
  - To be pick up on Nov.25th
- 56 sets silicon sensors are to be shipped to Taiwan
  - 29 sets from 1st batch are already in Taiwan.
  - 51 sets + 5 sets spares = 56 sets from 2nd batch for 40 ladders assembly in Taiwan
  - 18 sets (20% of total 90 sets from 2nd batch) are to be QA tested.

Silicon Shipping

- 2019/7 20 sets to BNL (1st batch)
- 2020/11 75 sets to BNL (50 from batch1 + 25 from batch-2)
- 2019/7 129 sets (1st batch) to NCU
- 2020/4 29 sets (1st batch) to NCU
- 2020/12 56 sets (2nd batch) to NCU

HDI Export to BNL

ID	Production	Delivery	Shipping Destination
1 ~ 59	Batch-1	2020/4/23	Taiwan 19 in June BNL 40 in June
60 ~ 180	Batch-1	2020/7/31	60 ~ 79 Taiwan in Nov. 80 ~ 84 Hayashi REPIC co. in Dec. 100,101,110,111,148~180 BNL in Dec.
181 ~ 270	Batch-2	2020/10/29	181 ~ 244 BNL in Dec. 245 ~ 246 Taiwan in Nov.

- 100 HDI's are to be shipped to BNL on Dec.16th
  - 36 HDI's from Batch-1
  - 64 HDI's from Batch-2

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3. 1008 ROC board test preparation
4. Source Test Fixture
5. Interception Board Update

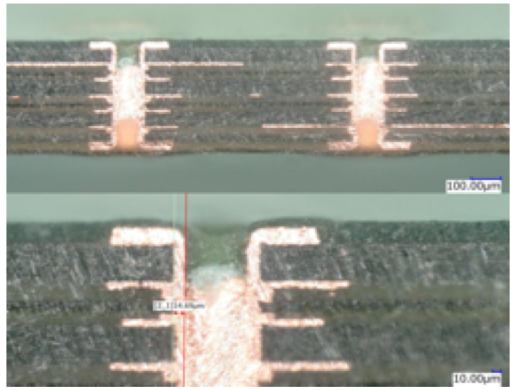
Module-70 Open Issue

Thru Hole Investigation Plan

Yield Sample HDI

Module-70

Destructive Microscope → After Reflow Destructive Microscope → Non-Destructive X-ray → Module-70 Destructive Microscope



- No issue found

- Same batch sample w/ Module-70
- Waiting for Yamashita co.'s report

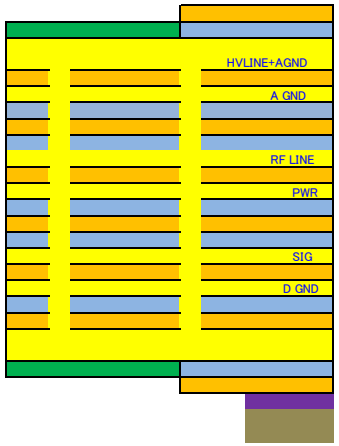
- Trying to Schedule in the middle of April
- Expensive ($300) and can be done only 1 or 2 at the maximum.
- **X-ray resolution is not sufficient to observe open lines.**

- Same thru hole with X-ray.
- Module-70 will be destroyed
- No more calibration at least one wedge side

We are here

Thruhole Cross Section Observation

	Regist	20 μm
	Copper plated	15 μm
L1	Electrolytic copper foil	9 μm
	Base Polyimide	50 μm
L2	Electrolytic copper foil	9 μm
	Glue	25 μm
	Base Polyimide	12.5 μm
	Glue	15 μm
L3	Electrolytic copper foil	9 μm
	Base Polyimide	50 μm
L4	Electrolytic copper foil	9 μm
	Glue	25 μm
	Base Polyimide	12.5 μm
	Glue	15 μm
L5	Electrolytic copper foil	9 μm
	Base Polyimide	50 μm
L6	Electrolytic copper foil	9 μm
	Glue	25 μm
	Base Polyimide	25 μm
L7	Electrolytic copper foil	9 μm
	Copper plated	15 μm
	Regist	20 μm
		μm
		438 μm
	TOTAL厚	438 μm



	Coverlay Polyide	12.5 μm
	Coverlay Glue	25 μm
	Copper plated	15 μm
L1	Electrolytic copper foil	9 μm
	Base Polyimide	50 μm
L2	Electrolytic copper foil	9 μm
	Glue	25 μm
	Base Polyimide	12.5 μm
	Glue	15 μm
L3	Electrolytic copper foil	9 μm
	Base Polyimide	50 μm
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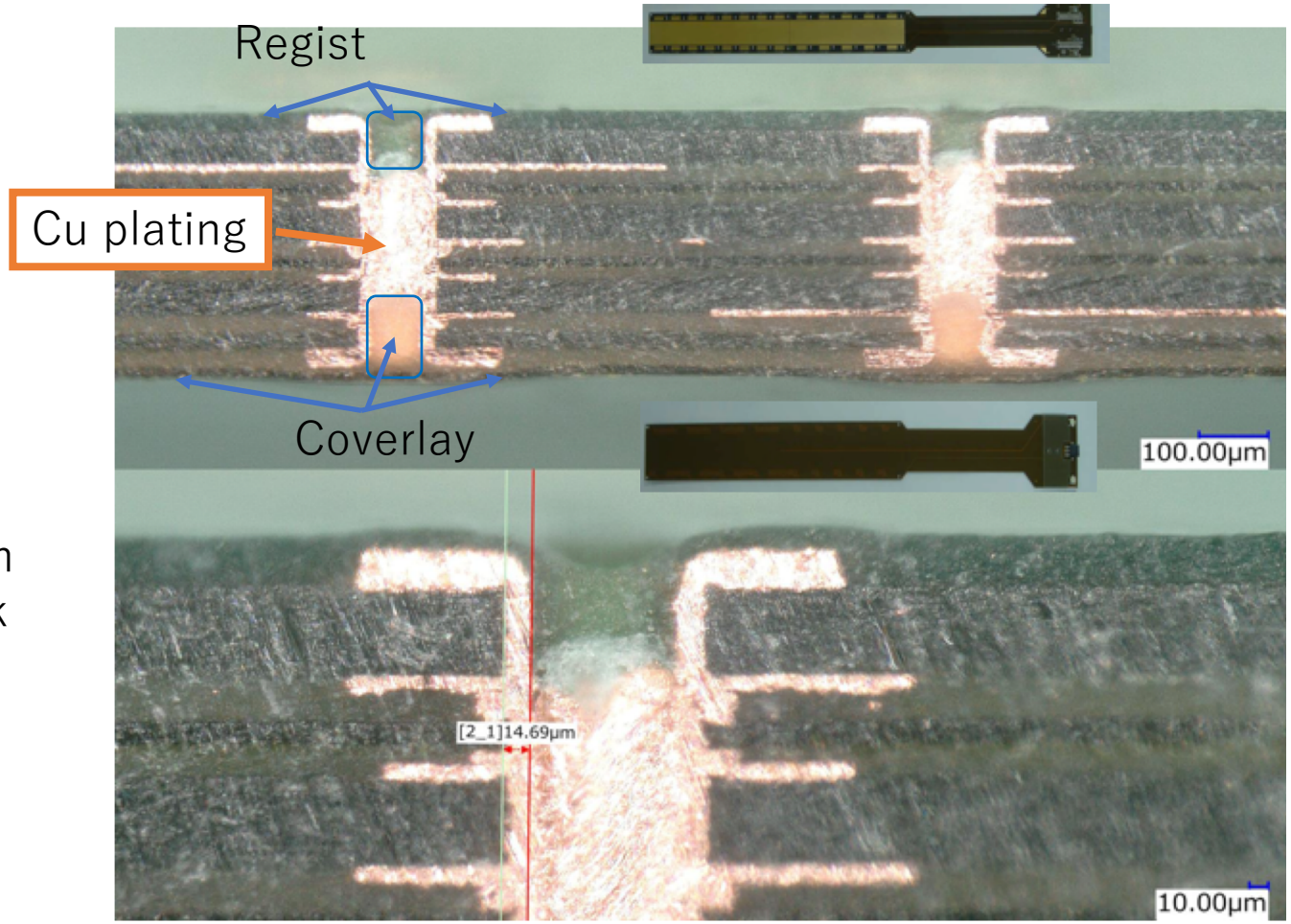
	Base Polyimide	50 μm
L6	Electrolytic copper foil	9 μm
	Glue	25 μm
	Base Polyimide	25 μm
L7	Electrolytic copper foil	9 μm
	Copper plated	15 μm
	Coverlay Glue	25 μm
	Coverlay Polyimide	12.5 μm
	Glue for support plate	40 μm
	Support Plate FR-4 1.0t	1000 μm
	TOTAL厚	473 μm



Batch-1A production (HDI#1 - #59)

Yamashita co. took one of the yield HDI from Batch-1A production (HDI#1 - #59) and took a microscopeshots of thruhole.

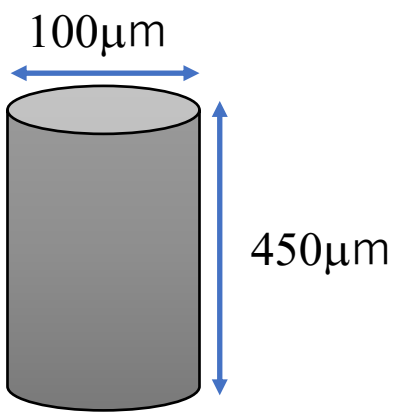
The cross section of thruhole looks very healthy and no indication of poor quality thruholes.

Next Step: perform reflow process and then observe the thru hole again.

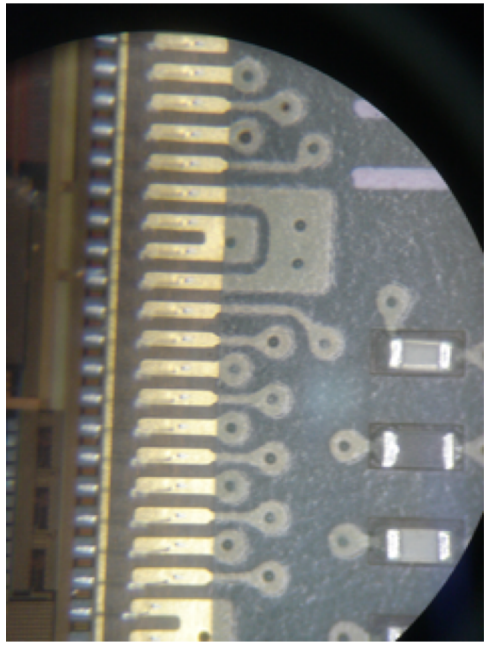
Other non-destructive Measurement?

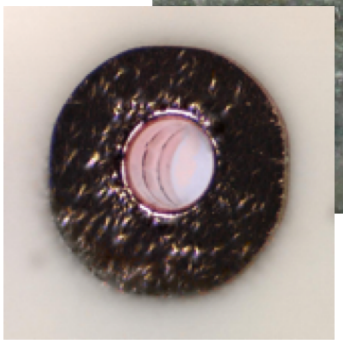
Q. Can we scrape off Regist/coverlay so that we can still look into the thruhole with a microscope?

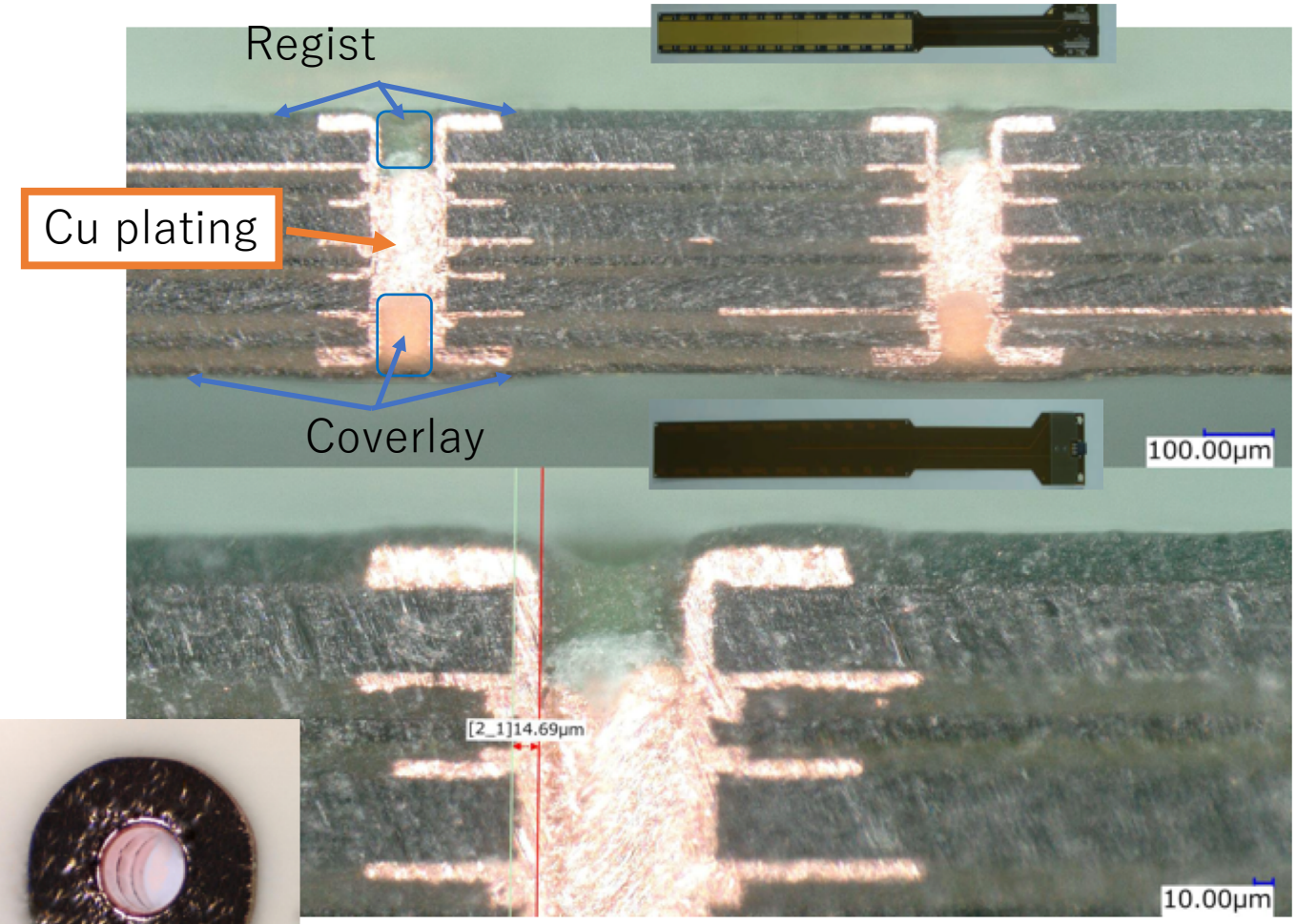
A. We can scrape them off only at the surface, but they penetrate into the thruhole as the cross section shows. Thus we still cannot see inside the thruhole.



HDI Thru Hole





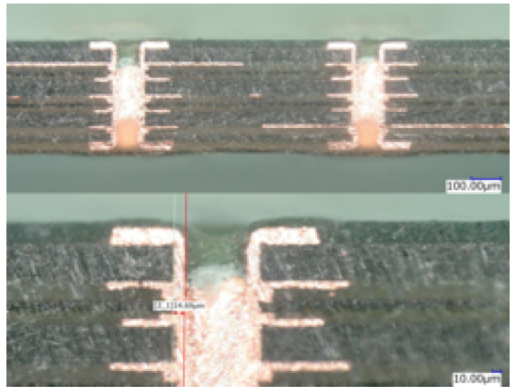


Thru Hole Investigation Plan

Yield Sample HDI

Module-70

Destructive Microscope → After Reflow Destructive Microscope → Non-Destructive X-ray → Module-70 Destructive Microscope



- No issue found

- Same batch sample w/ Module-70
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- Trying to Schedule in the middle of April
- Expensive ($300) and can be done only 1 or 2 at the maximum.
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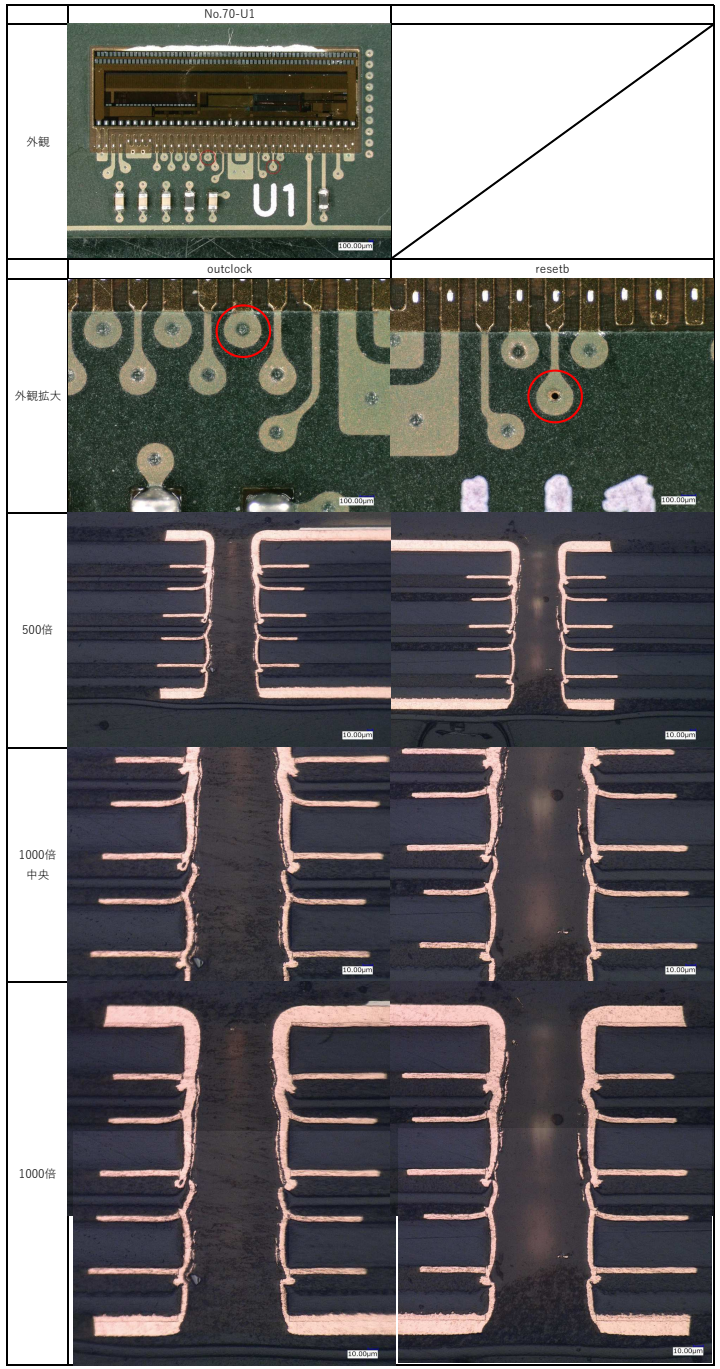
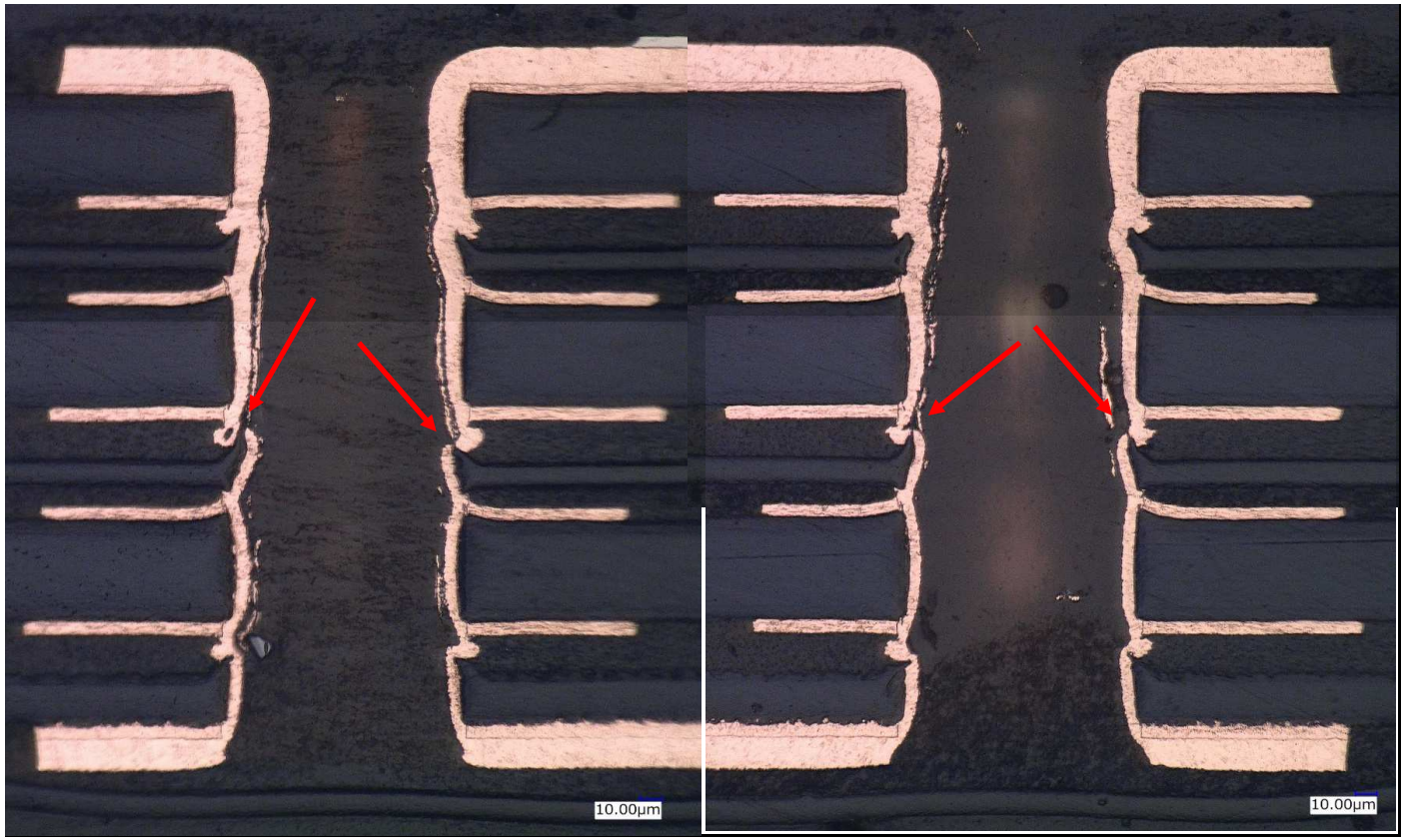


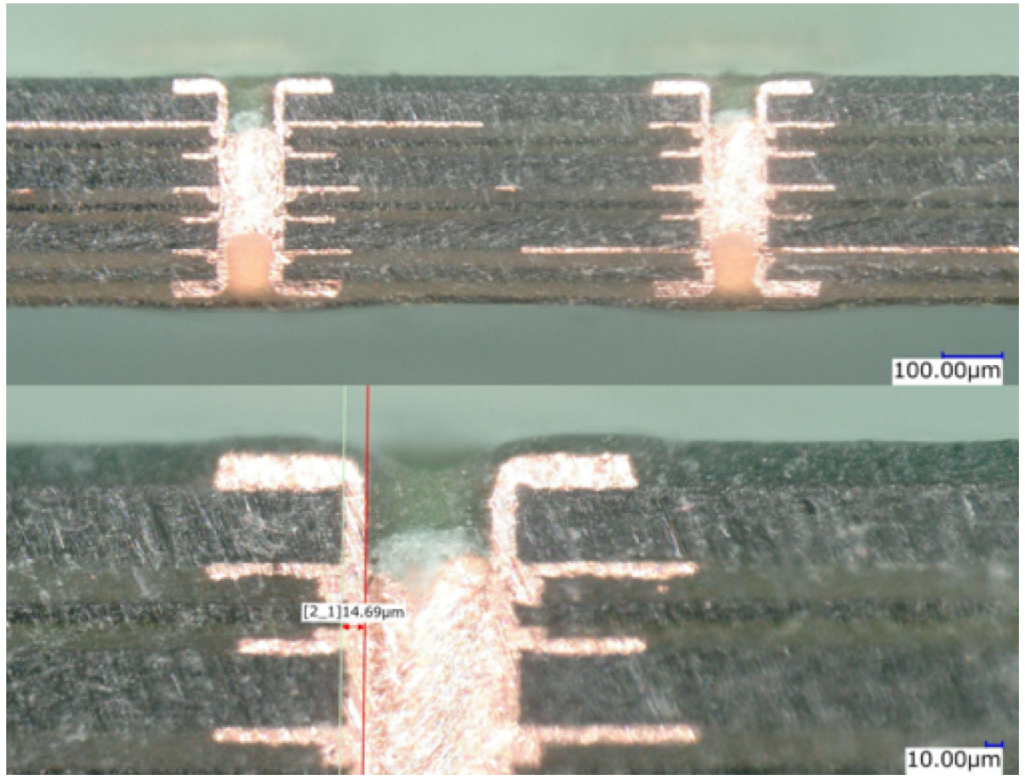
Microscope Measurement

- We observed obvious cracks in these thru holes. These are smoking guns of open lines in the Module-70.
- We will investigate other thruholes to get some more hints which helps to speculate the cause.



Thurhole Comparison

Good Example



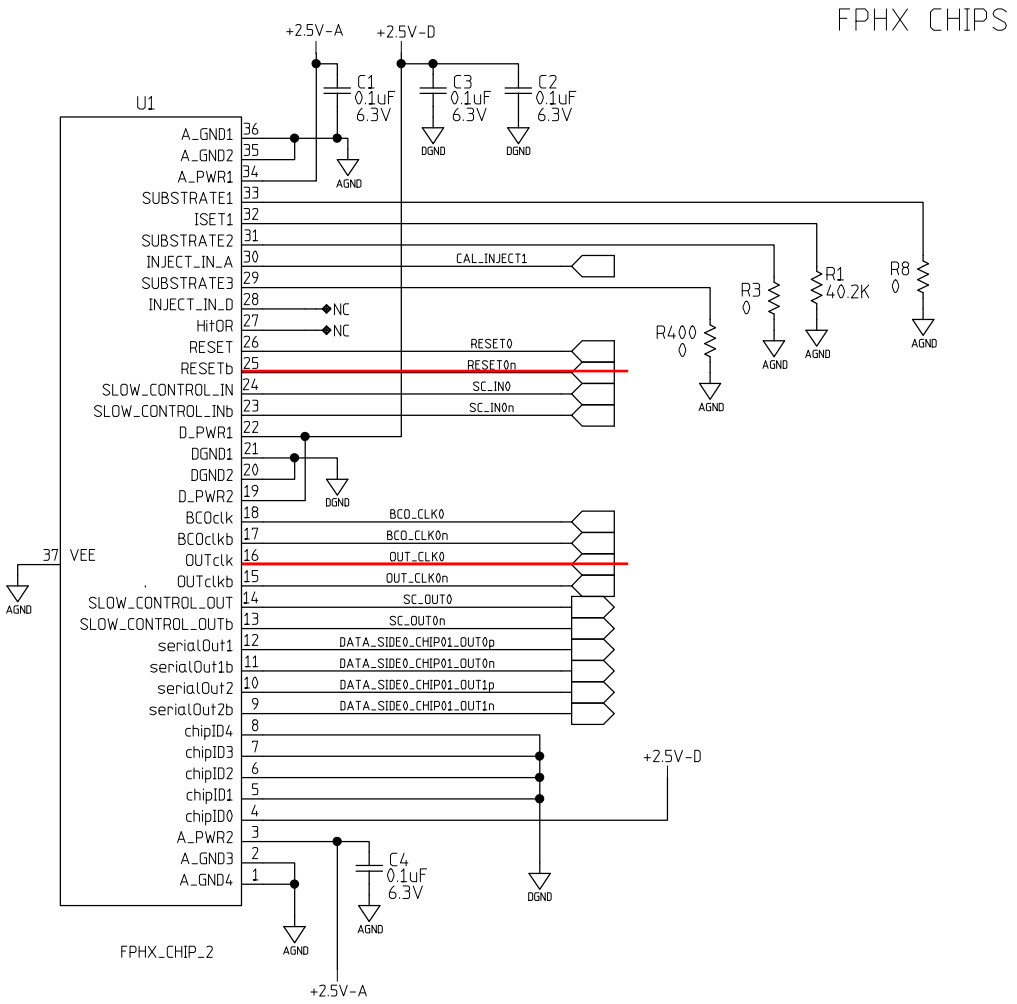
Batch-1A production (HDI#1 - #59)

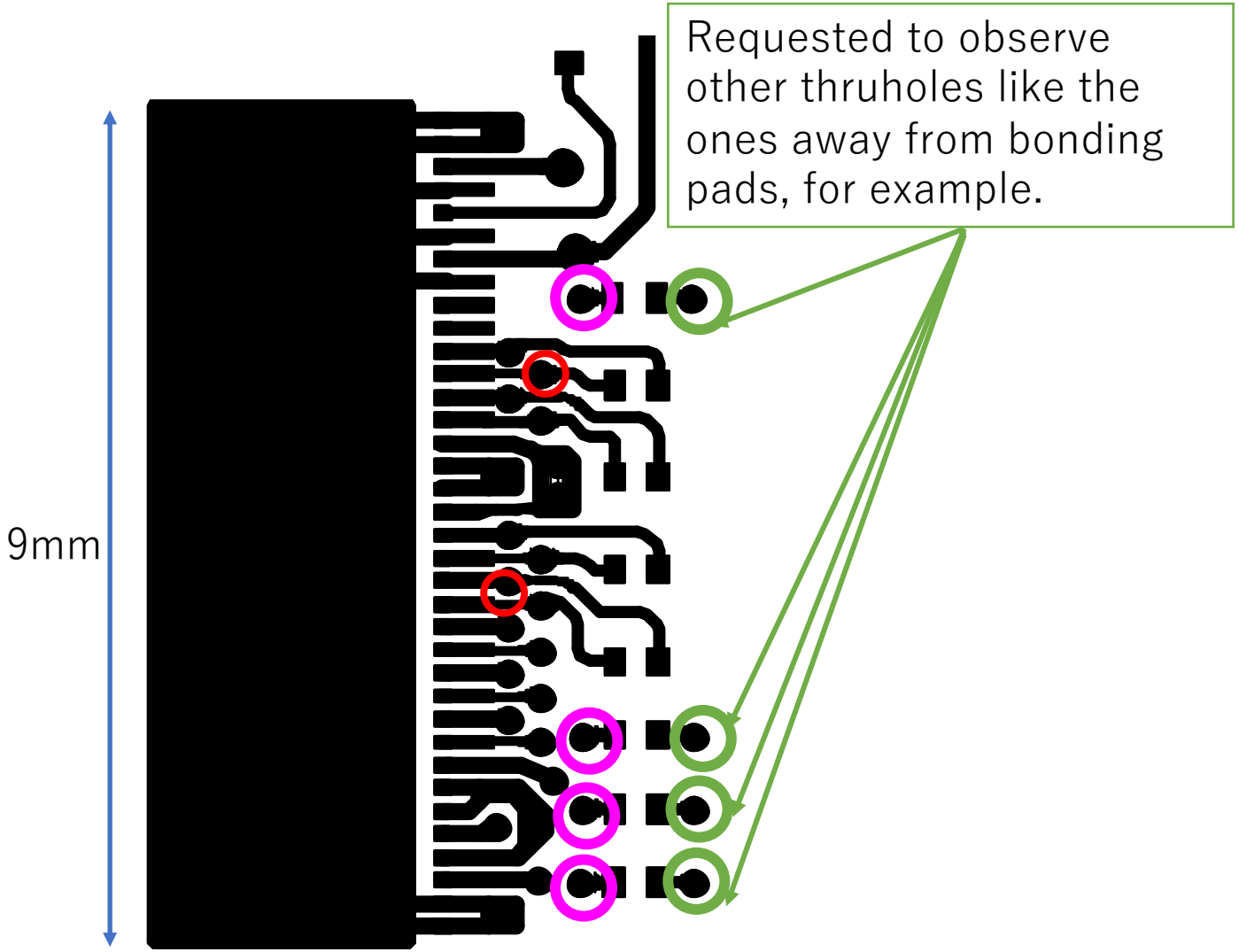
Thicker

Module-70 (Batch-1B HDI#70)

Thinner

Proposed plan





U1 chip may not possible though because this area was destructed

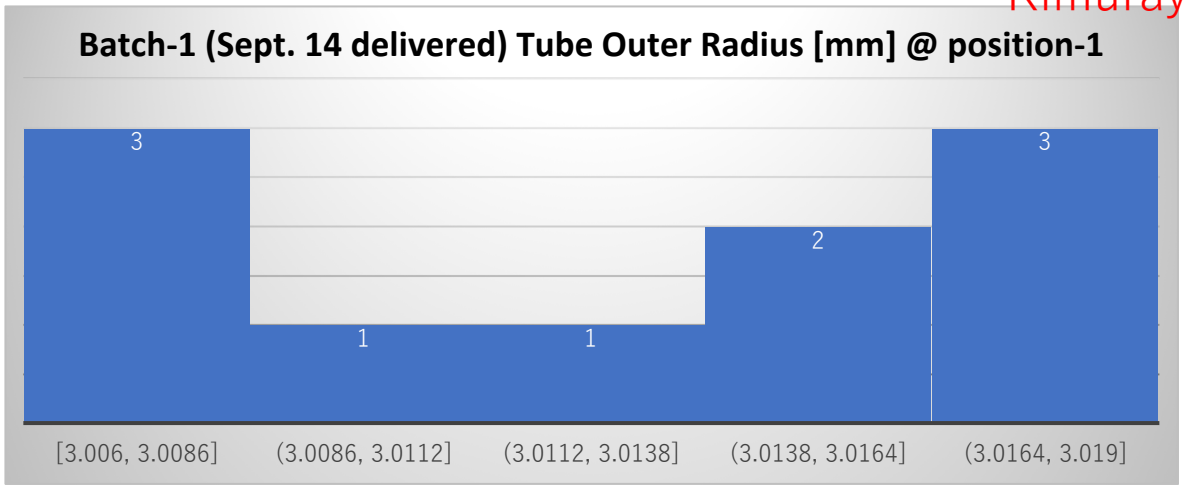
Conclusion and Plan

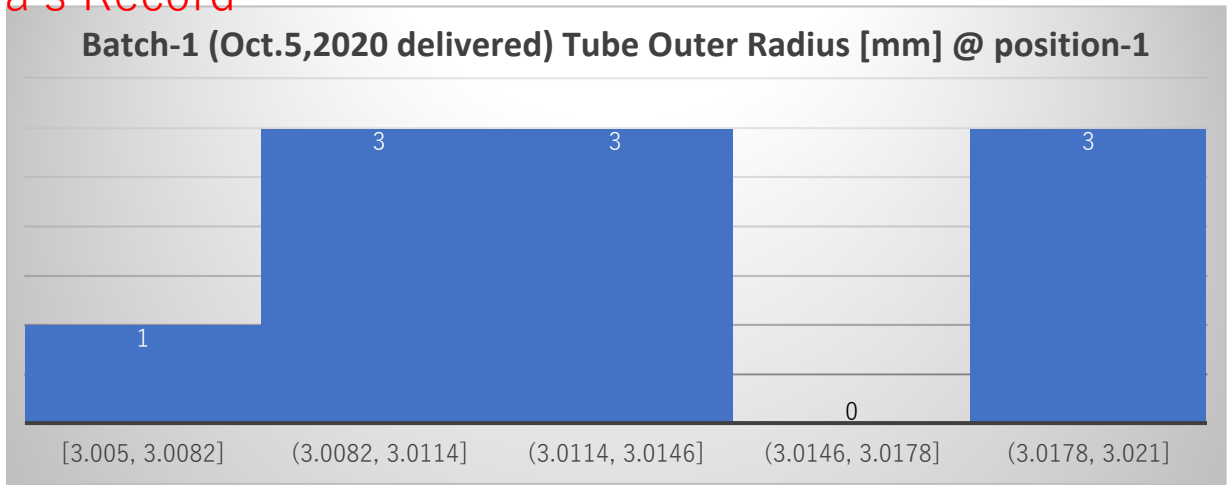
- We observed broken copper plating in both thruholes we observed to be open.
- The copper plating thickness seem to be not constant. The thickness is normal around the top layer, but it gets thinner than it designed to be.
- This relatively poor copper plating **may be** the reason why it easily be broken by tiny difference in the wirebonding conditions.
- We'll inspect into other thruholes to obtain more hints.

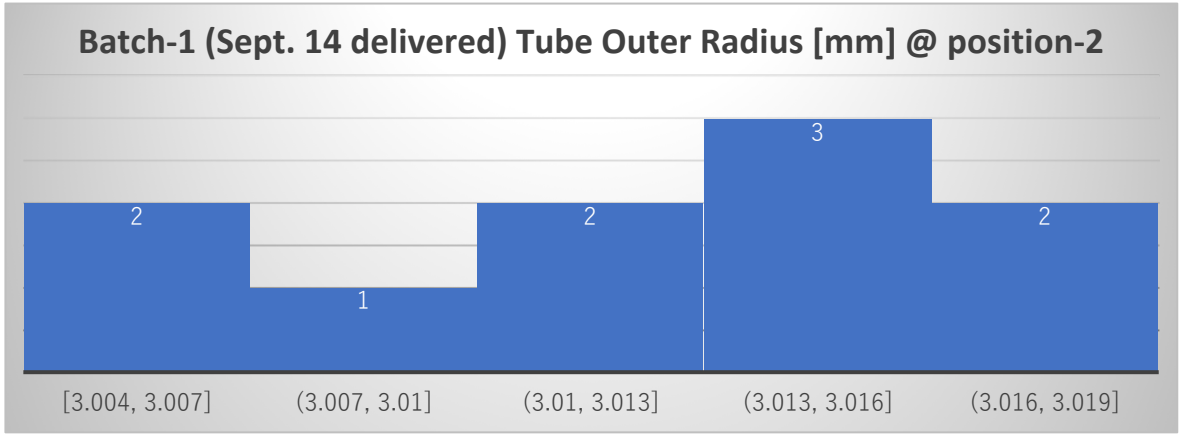
Stave Leak Issue

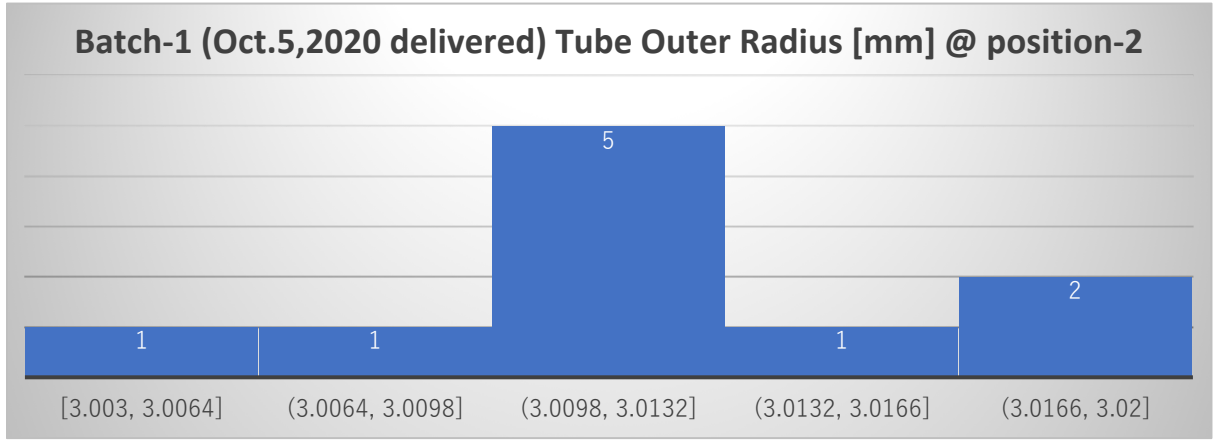
Batch-1 Carbon Tube Outer Radius

Kimuraya's Record



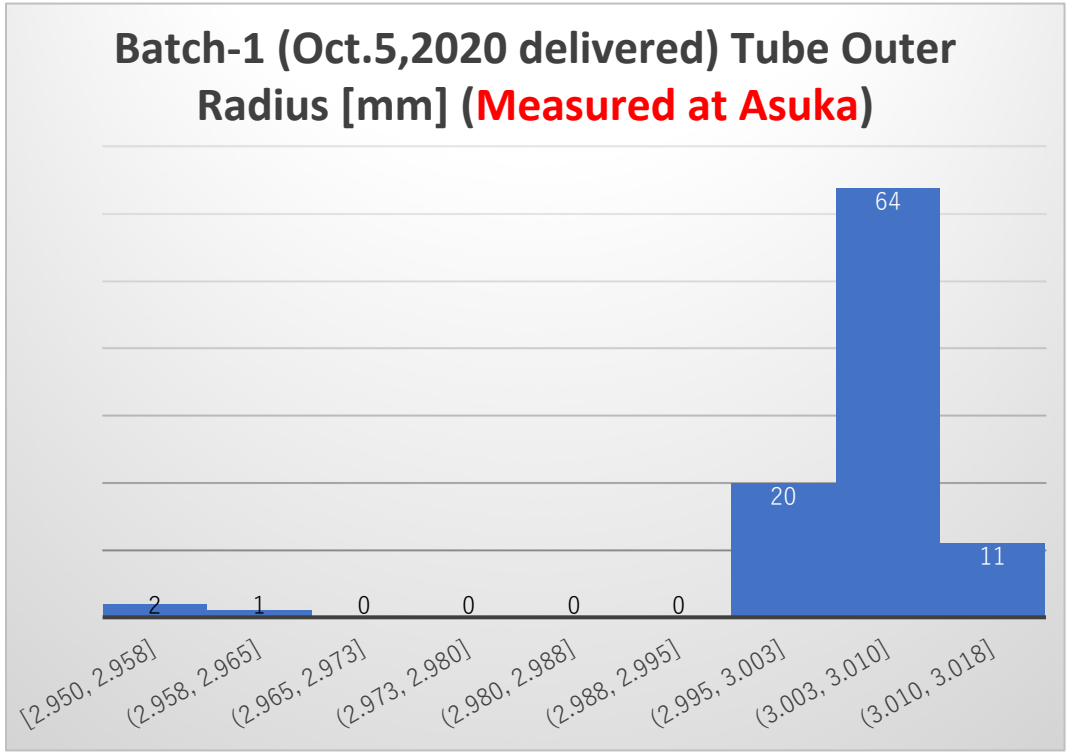






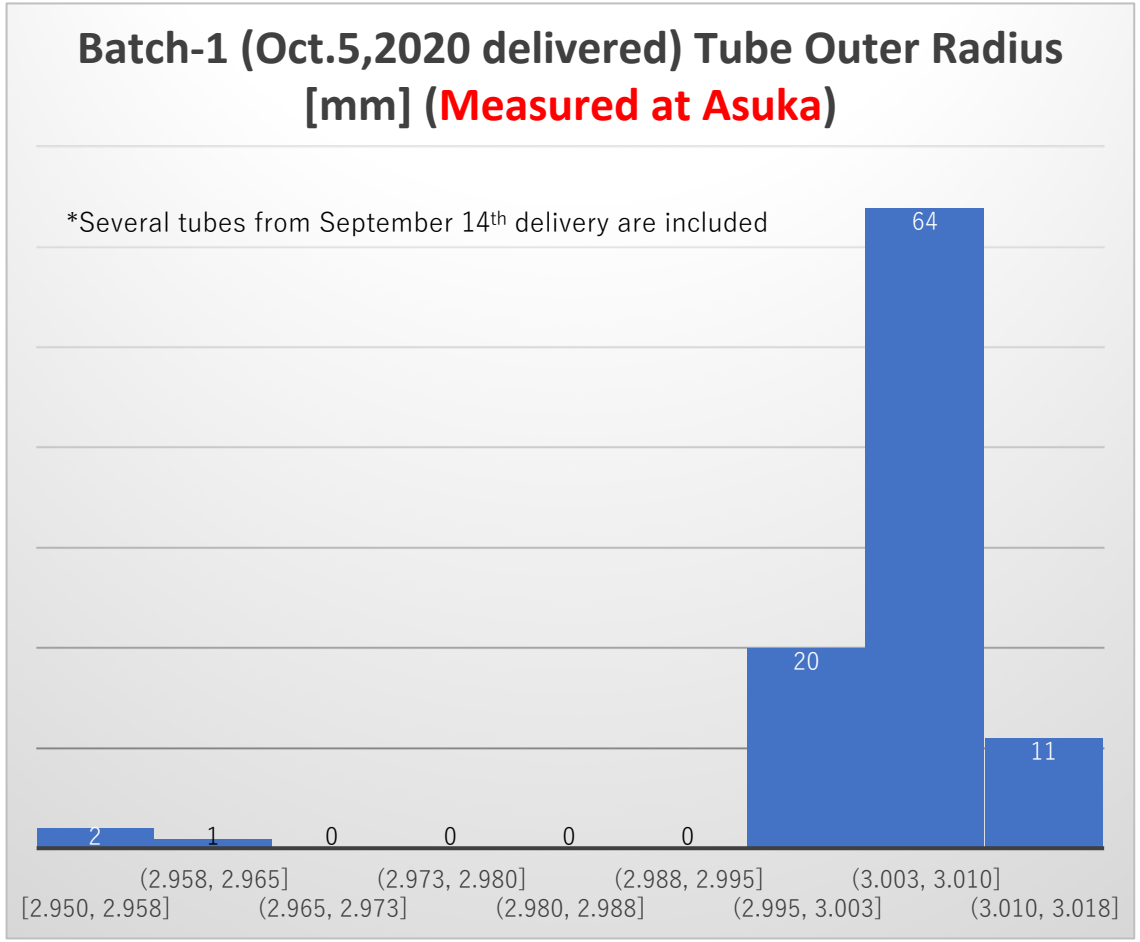
- Unfortunately only data for 10 tubes remain. Other 90 tube's data were deleted for both Sept.14 and Oct.5 deliveries.
- The outer diameter of tubes were **biased towards positive tolerance** (3.0±0.127mm), unfortunately.

Batch-1 (Oct.5,2020 delivered) Tube Outer Radius

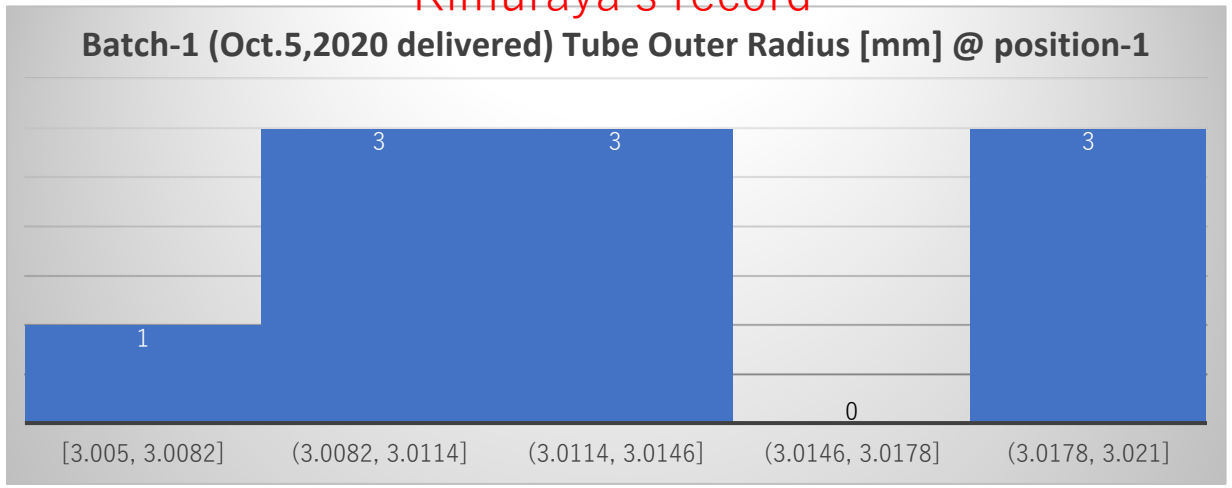


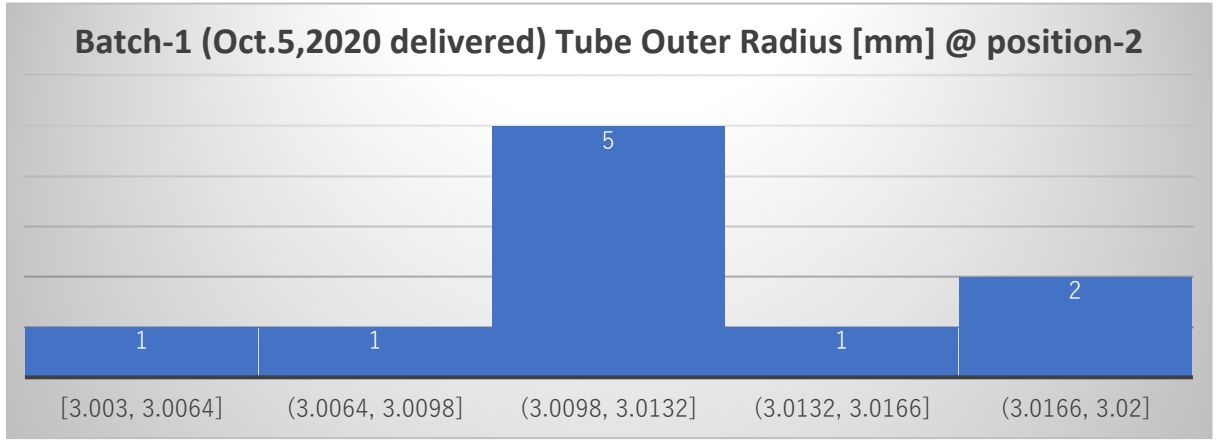
- Asuka measured the outer diameter by themselves.
- These these tubes are kept track of tube & stave ID number and the outer diameter of the tubes.

Batch-1 Carbon Tube Outer Radius



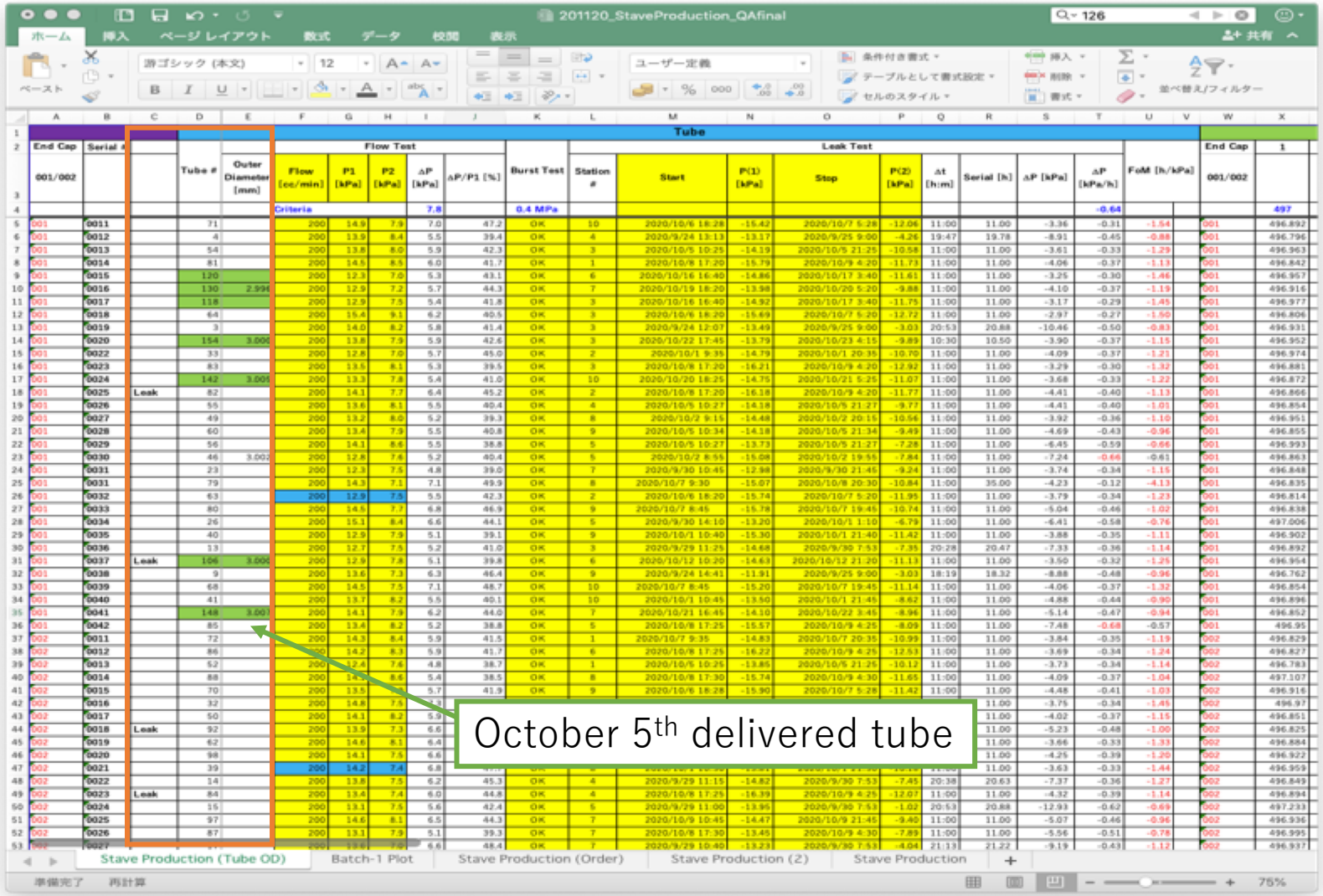
Kimuraya's record





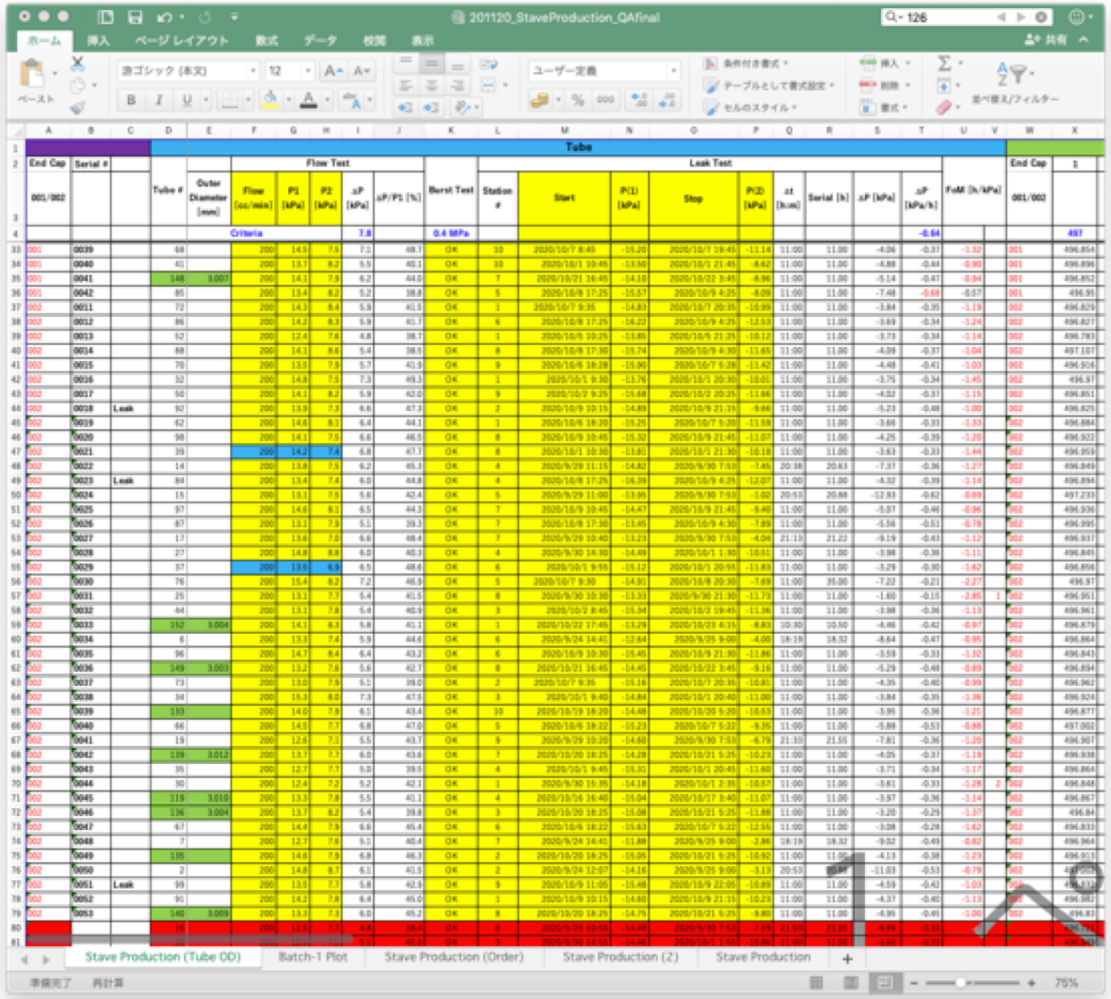
- Kimuraya's record remains only 10 tubes out of 100 tubes.
- Asuka's outer diameter in house measurements are recorded for ~90 tubes out of 100 tubes.

Batch-1 Stave with known outer diameter of carbon tubes



- 15 tubes out of 100 batch-1 (October 5th) delivered tubes were implemented to 75 batch-1 staves.
- These tubes are relatively smaller diameter tubes.
- 11 tubes out of 15 tubes are kept track of the outer diameter and stave ID.
- Using this information, I tried to correlate between leaking tube found in BNL and the outer diameter.
- There found 1 leaking tube found for the outer diameter of 3.000.

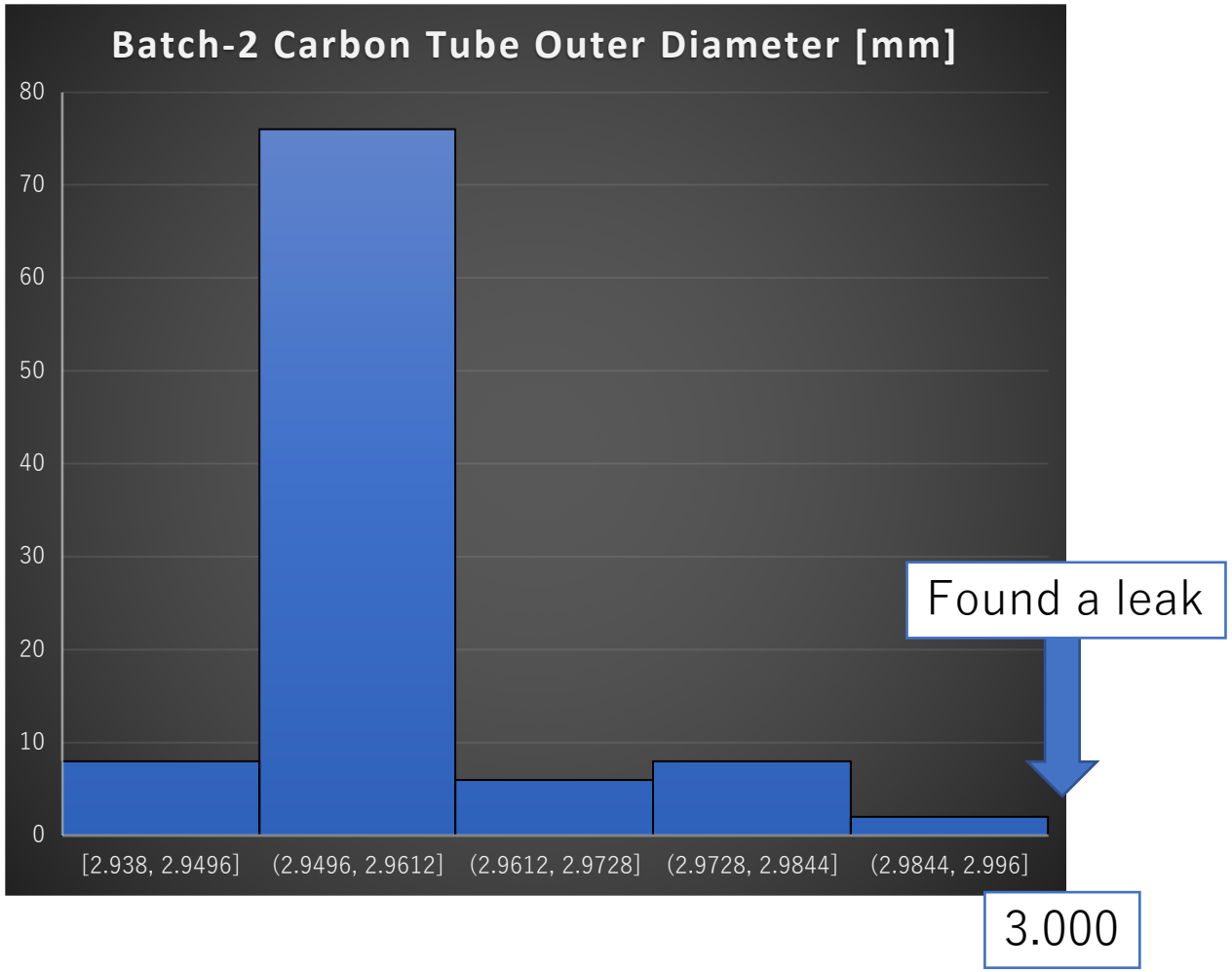
Batch-1 Stave with known outer diameter of carbon tubes



- Others are not (yet) found leak.

Concerns

- Batch-2 tube diameters are all less than 2.996.
- We found a leak for the 3.000 tube.
- Is the 2.996 tube safe enough?
- Further investigation may be needed.



ROC Regulator

ROC-9

- Repair of DF18 connectors for column-A,C are completed.
- Analogue/Digital Regulators are replaced.

	Column-A	Column-C
Digital	3.3V	3.0V
Analogue	3.0V	2.8V

- To be shipped to NWU.
- We resume operating voltage optimization study with the bus-extender configuration in NWU and finalize the regulator output voltage.

1008 ROC Testing in RIKEN

1008 ROC Test in RIKEN

- As we discussed in January 5th, 2021 INTT meeting, we start preparation for 1008 ROC test in RIKEN together with regulator replacements for the FPHX powers.
- While Milan is in BNL, I would like to ask Milan to disassemble ROCs from the FVTX big wheel and send them to RIKEN.
- Some other modules are also need to be shipped to RIKEN. See following list.

1008 ROC Status

- List of ROCs already disassembled from the big wheel

			2020/3/6
INTT ROC ID	9	10	11
FVTX ROC ID	SW	SW	27
Location on Sept. 28, 2020	Taiwan	Taiwan	
Location on Oct. 20, 2020	NWU		BNL? NWU?

To be shipped from BNL to RIKEN:
24 ROCs - 3 ROCs = 21 ROCs

Test bench setup hardware list

INTT Standalone Hardware List

Items	Make	Quantity	Status	Action	Action on NCU
PC					
PCIe-6536B Board	NI				
SHC68-C68-D4 Cable	NI				
653x Cable Adaptor	NI				
ROC		21	To be shipped from BNL		
Optical Driver for Data (mounted in ROC)		N/A	To be shipped from BNL		
FEM		2	To be shipped from BNL		
FEM-IB		1	To be shipped from BNL		
VME Crate		1	Available in RIKEN		
Optical Data Fiber		2	Available in RIKEN		
Optical LC-LC fiber (SC, BCLK, START)		4	To be shipped from BNL		
Slow Control USB A to B cable			To be purchased in RIKEN		
FPGA Download Cable	Actel				
FPGA Download Cable	Xilinx				
Beam Clock Board			To be shipped from BNL		
Beam Clock Board Power cable			To be made in RIKEN		
FVTX ladder + Bus Extender			To be shipped from BNL or NWU		
INTT module			N/A		
Conversion Cable			N/A		
Flat twist pair BLCK cable			To be made in RIKEN		
LV cable for ROC			To be made in RIKEN		
FPHX Chip Power Cable			To be made in RIKEN		
Silicon Bias Cable			N/A		

Test bench Setup from Scratch

https://docs.google.com/spreadsheets/d/1G3sE67uU5dOf9w7EyjSG7qJ508biLG9rJeUtQugx4Uc/edit#gid=1162282211

Source Test Fixture Cost Breakdown

Source Test Fixture Quote

Break Down	Cost [US$]
Material Cost	$2,000
Design	$3,000
Machining (Fixture + Control Box)	$4,000
Assembly+ Testing + Tuning	$1,500
Misc (profit, tax, etc…)	$3,000
Total	**$13,500**
Total without Design Cost	**$10,500**

Source Test Fixture Quote

Break Down	Lobar [Hour]	Cost [US$]
Material Cost	N/A	$2,000
Circuit/System Design	32	$2,500
Print Circuit Board Design	8	$500
Machining (Fixture + Control Box)	64	$4,000
Assembly+ Testing + Tuning	24	$1,500
Misc (profit, tax, etc…)		$3,000
Total		**$13,500**
Total without Design Cost		**$10,500**

Control Box Material Cost Breakdowns

Make : Oriental Motor

製品/品名	単価（税別）	数量	合計金額（税別）	出荷日※（土日祝含まず）	削除
	Unit price (JPY)	Quantity			
EASシリーズ ▸ EAS4X-E060-ARMKD	84,830円	1	84,830円	5日	削除
オプション ▸ CC010VA2FB2	3,400円	1	3,400円	5日	削除
オプション ▸ CC02FLT	3,820円	1	3,820円	5日	削除
オプション ▸ CC05IF-USB	8,500円	1	8,500円	5日	削除
オプション ▸ OPX-2A	12,750円	1	12,750円	5日	削除
オプション ▸ PAES-S-4X	9,180円	2	18,360円	5日	削除

※ 出荷日について・・・15時までにご注文いただいた場合の目安です。
（土日祝は含みません）

合計金額 （税別） **131,660円**

再計算

Total ~$1.3k

Fabrication Plan

- 1st one delivery is expected in the middle of April
- 2nd one is to be fabricated without waiting for the 1st one using the budget for JFY2021.

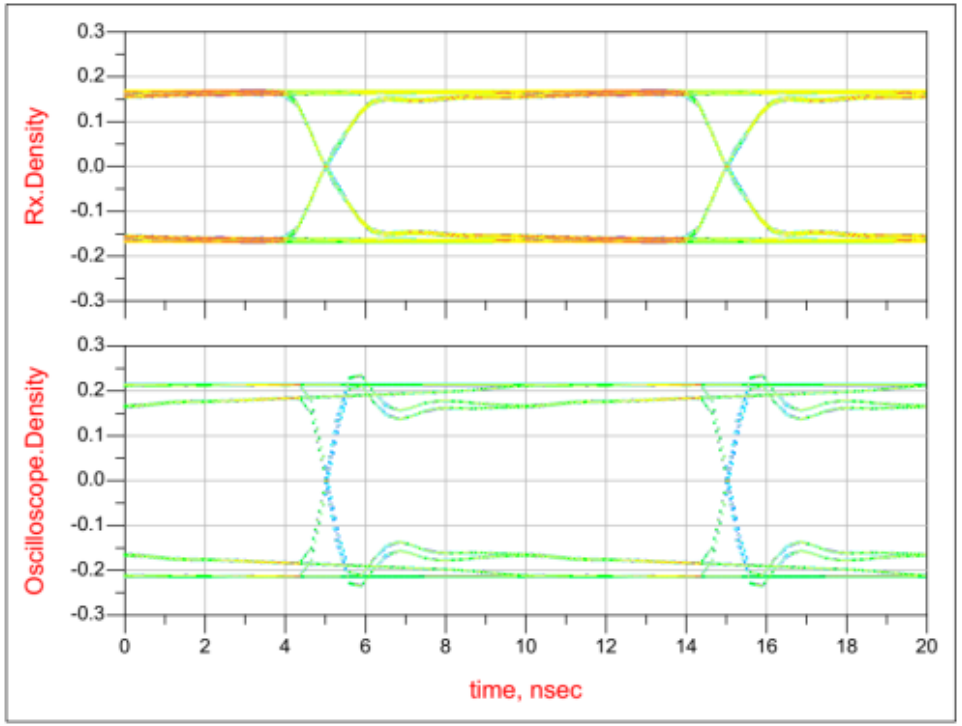
Interception Board Update

Simulation Parameters

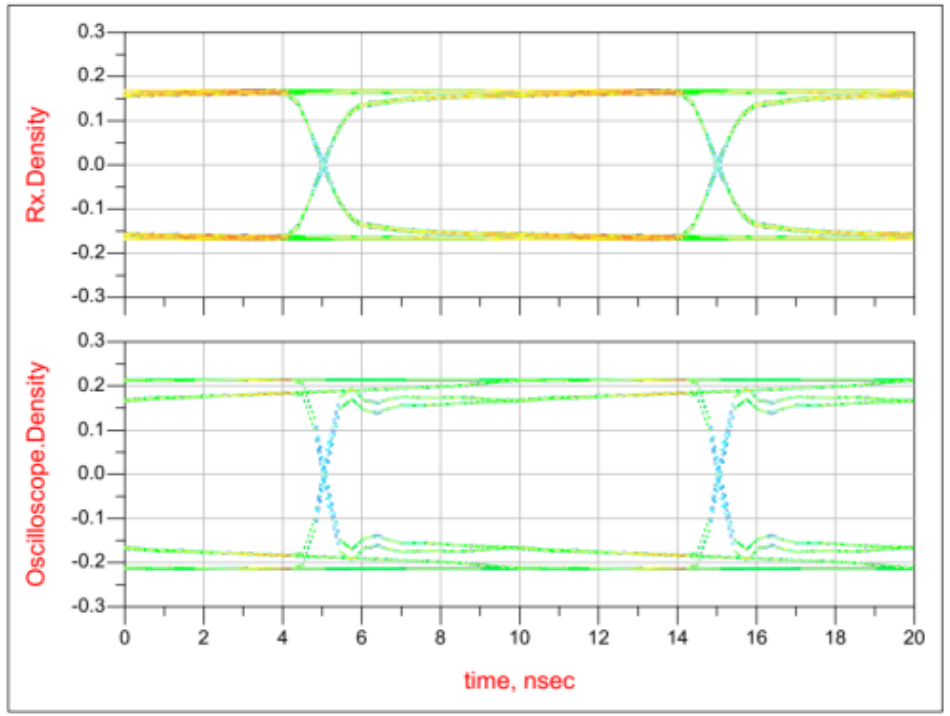
		Simulation-I	Design	Simulation-II	Fabrication
Line	Length [mm]	100	59	60	60
	Width [μm]	80	110 -> 80	80	80
	Pitch [μm]	80	100 -> 80	80	80
	Damping Resistance [Ω]	91	-	-	-
	Resonance Frequency [MHz]	500	600		
Dielectric	Material	RO4350B	FR4	RO4350B	FR4
	Thickness[μm]	760	500/3?	760	800
	Relative Permittivity	3.66	3.9 – 4.3?	3.66	3.9 ~ 4.3
	Tangent	0.0037	0.004	0.0037	0.004

材質：FR-4 板厚：0.5mm程度（4層全て足した厚み）
スルーホール径：0.15mm ライン/スペース：
110μm/100μm

Updated Simulation



Simulation-I (L=10cm)



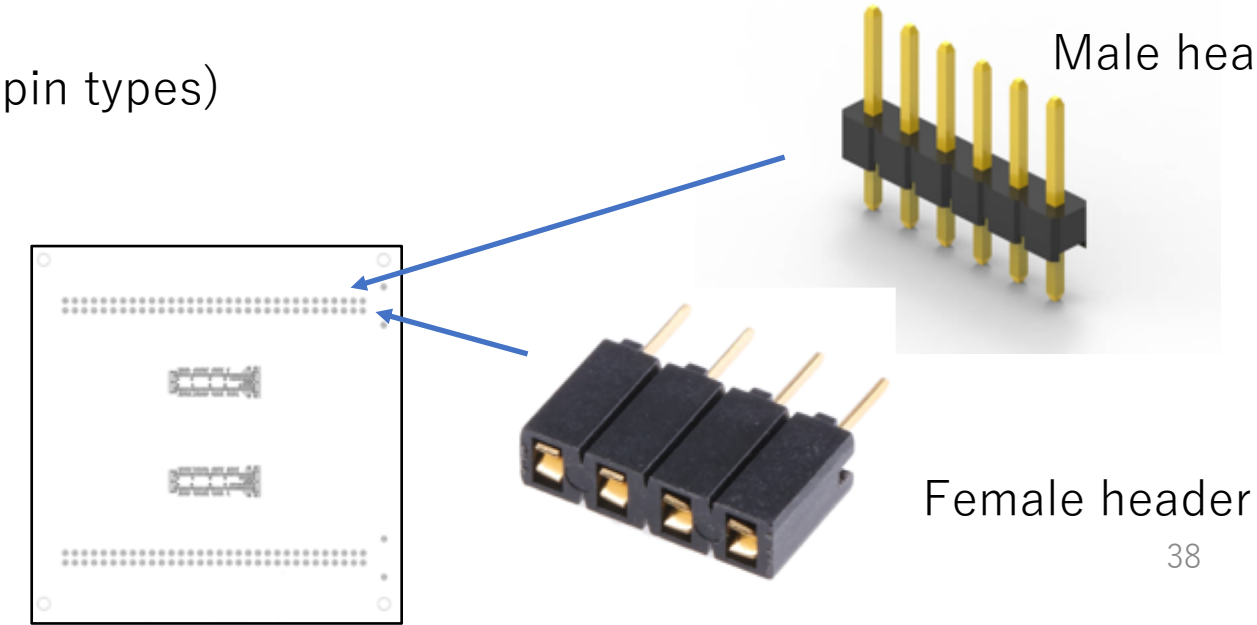
Simulation-II (L=0.60cm)

The signal distortion is better than the original simulation.

Load Map

We are here now

Concept → Simulation → Layout Design → Simulation → Fabrication

2~4 weeks | 1~2 weeks | 5~6 weeks

Total Quantity 6 (3 male + 3 female header pin types)
Expected Delivery : middle of April