

Ladder Assembly Procedure



Belle II – New Collaborators Meeting

25th April 2013

C. Irmeler (HEPHY), Y. Onuki (IPMU)

Introduction

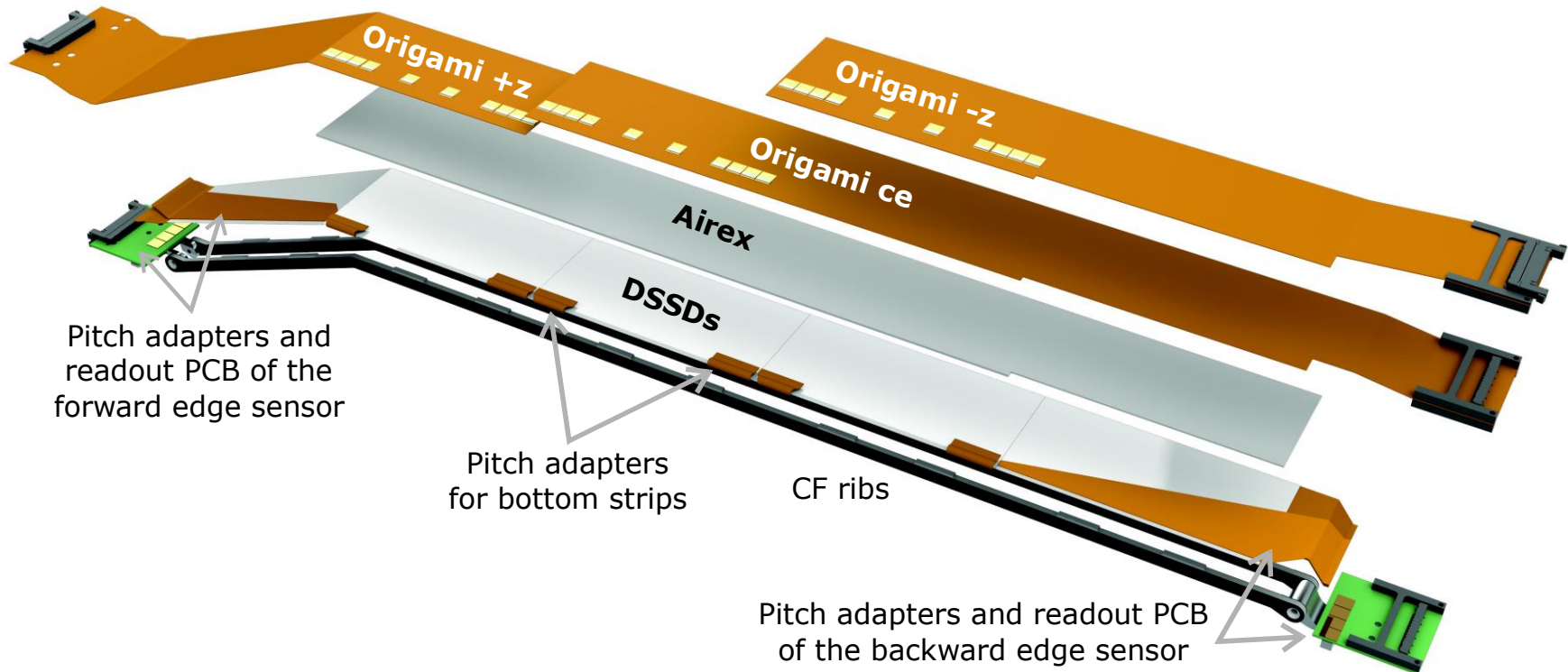
- Overview of the assembly procedure for a Layer 6 ladder.
- Drawings and slides without HEPHY header are taken from Y. Onuki's talk, presented at the 14th B2GM in March 2013
- Procedure recently tested @ IPMU
- Pictures from test assembly and new ideas added
- Modification of some jigs and steps is in progress

Ladder Assembly – Organization

- Sharing of production:
 - L₃: Melbourne – 7 + spares (2 sensors each)
 - L₄: Tata (at IPMU) – 10 + spares (3 sensors each)
 - L₅: HEPHY Vienna – 12 + spares (4 sensors each)
 - L₆: Tokyo (IPMU) – 16 + spares (5 sensors each)
- Contract between Tata and IPMU is being prepared
- Interest of Italian groups (ex-SuperB) to join ladder assembly

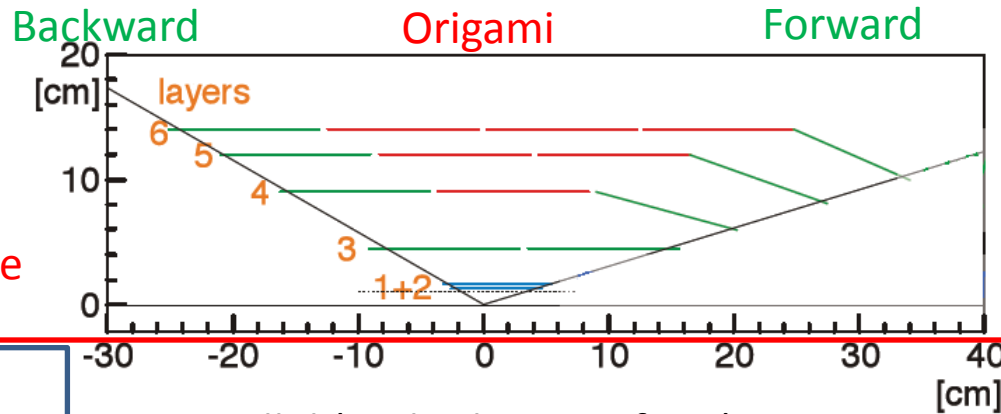


Ladder 6 with Origami Readout



- Challenging procedure, several jigs needed for assembly
- Master drawings & jigs prepared by Y. Onuki

SVD ladder assembly flow



Common Procedure

Origami PA
gluing

← parallel (multiple sets of jigs)

Place DSSDs (rectangle, trapezoidal) onto assembly bench and align them

Backward
assembly

Forward assembly

← parallel
(independent
each other)

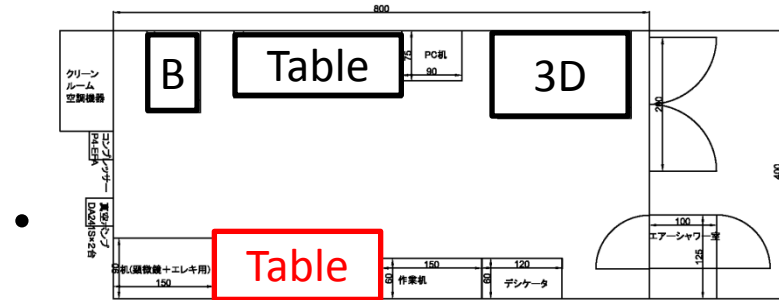
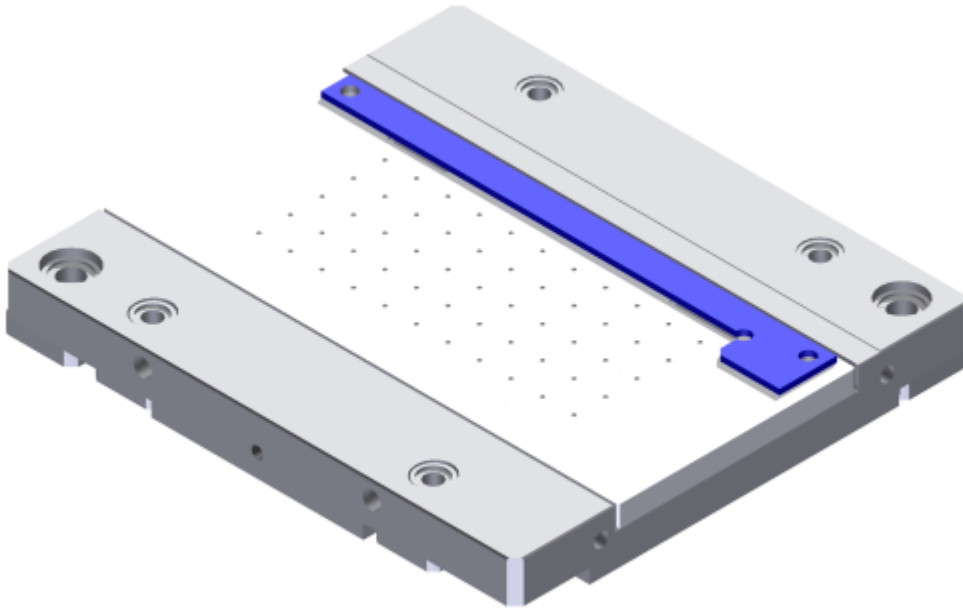
Origami assembly

Glue forward and backward
sensors onto ribs

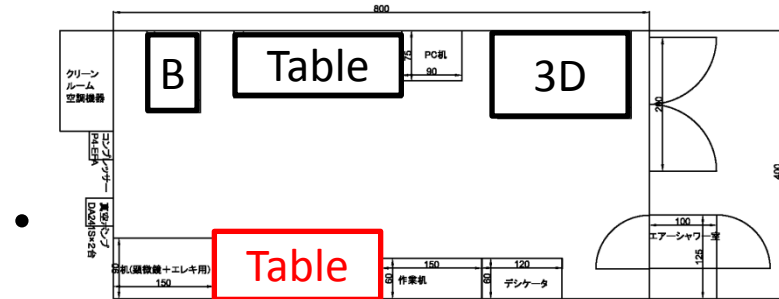
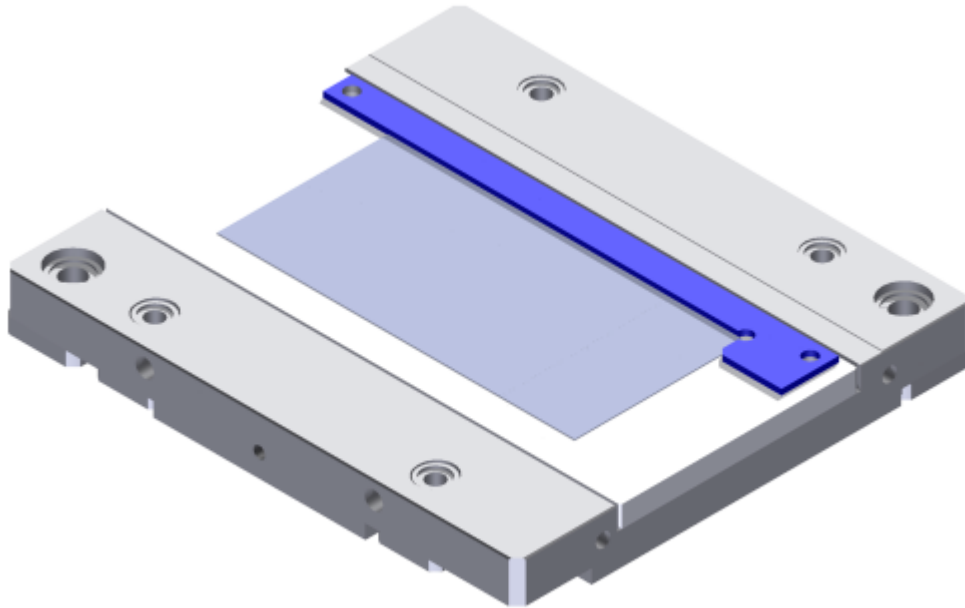
time

Attach Origami sensors to ribs

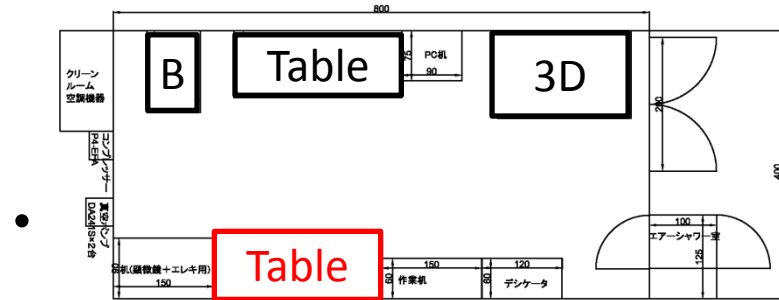
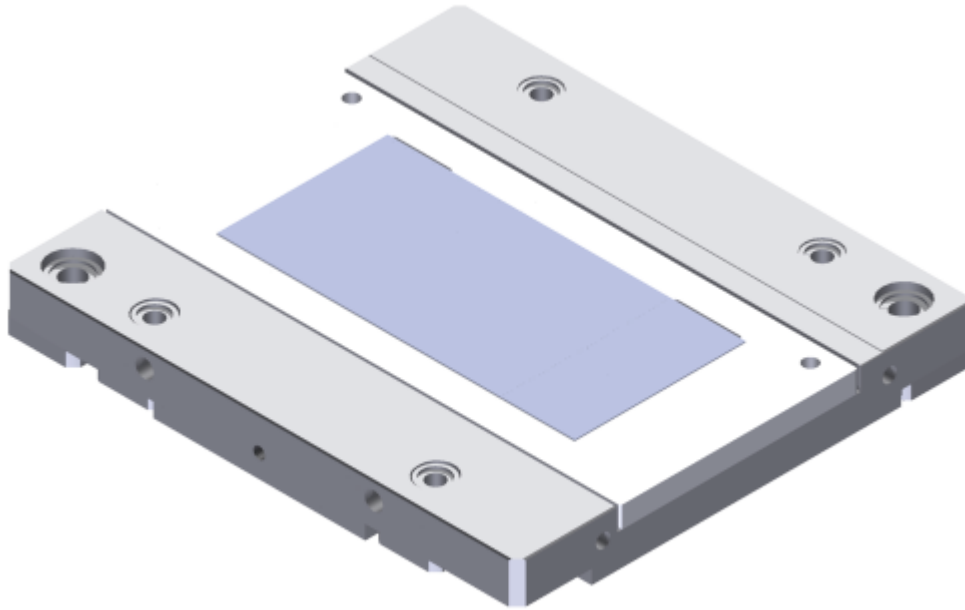
Common Proc.01: Placing DSSD stopper



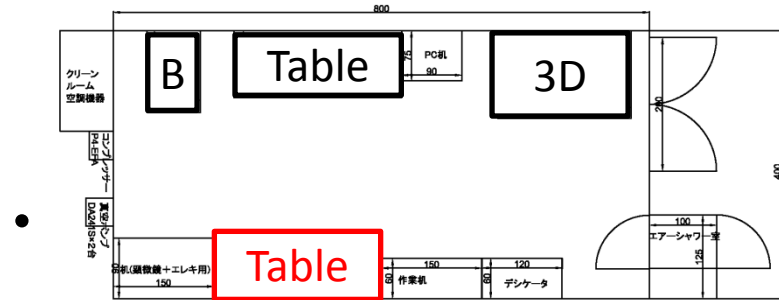
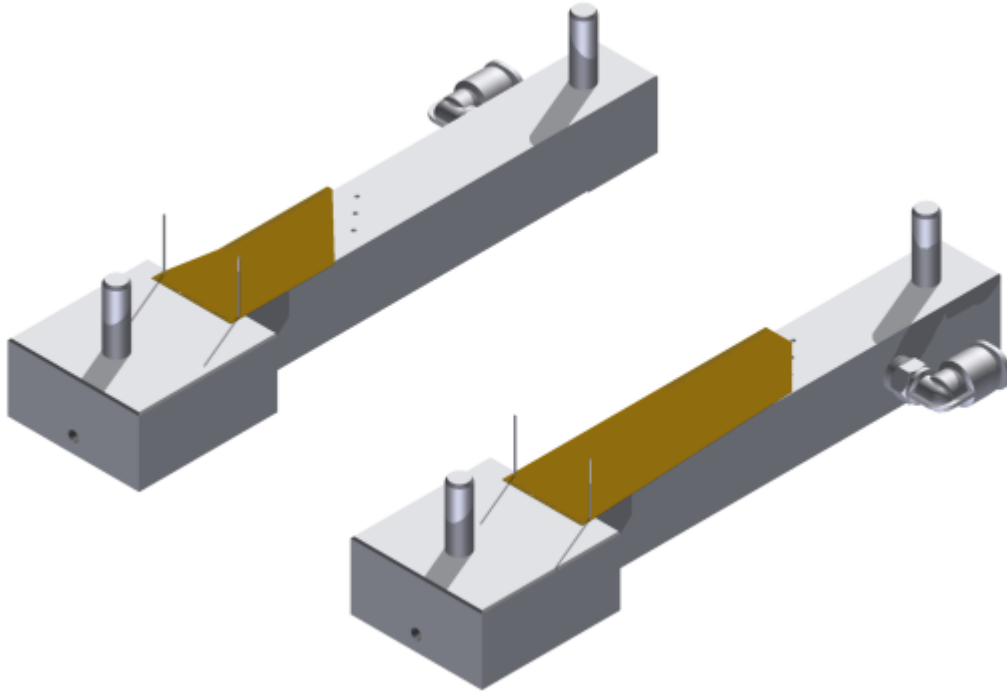
Common Proc.02: Placing DSSD



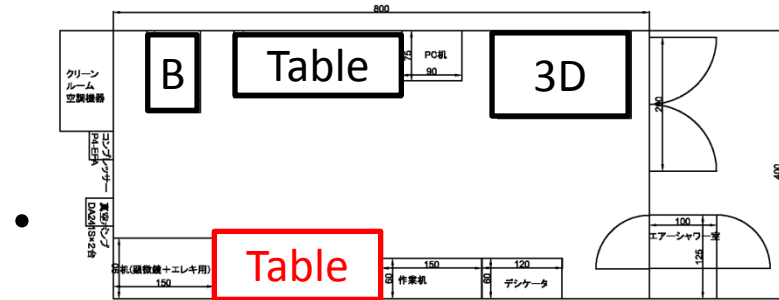
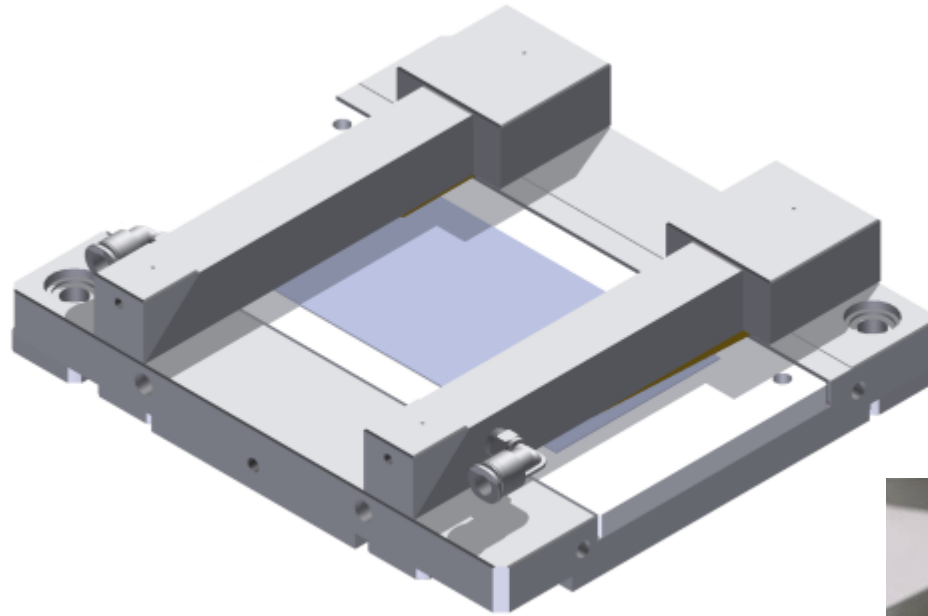
Common Proc.03: Removing DSSD stopper



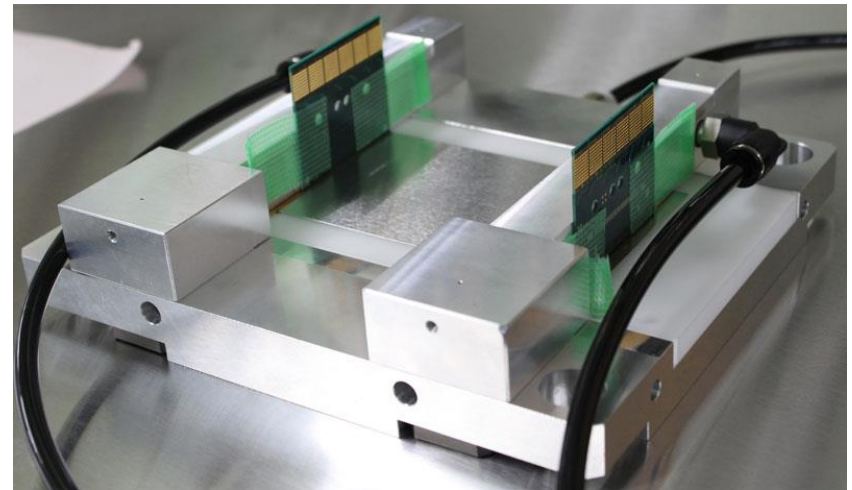
Common Proc.04: Aligning PA1 and PA2. Dispensing glue.



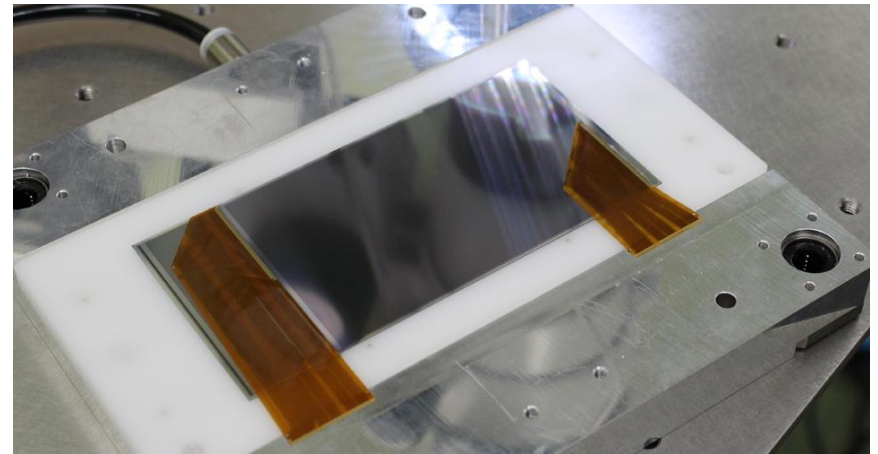
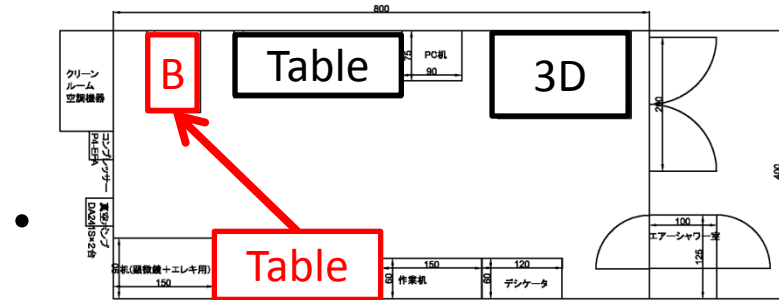
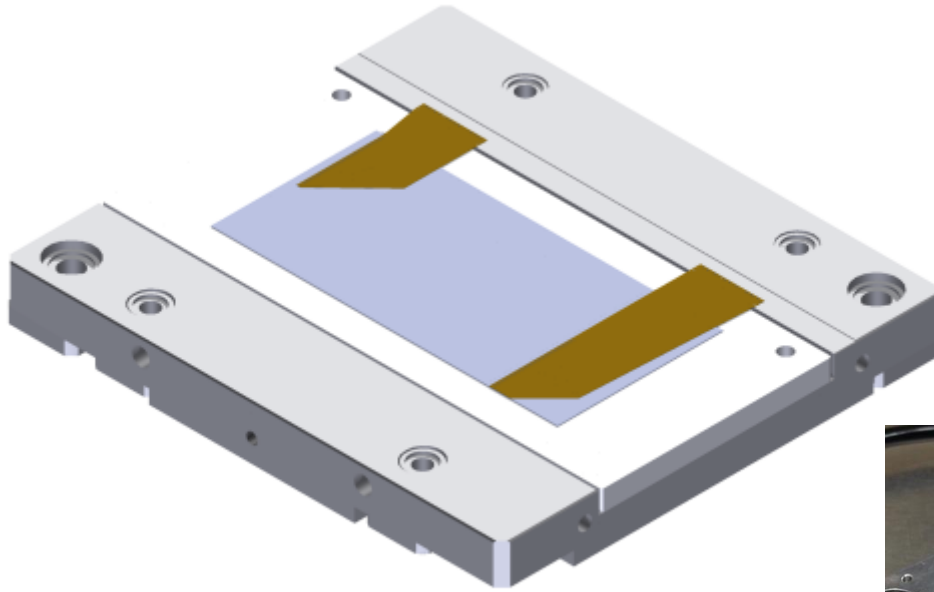
Common Proc.05: Gluing PA1 and PA2



PA jigs will be modified!



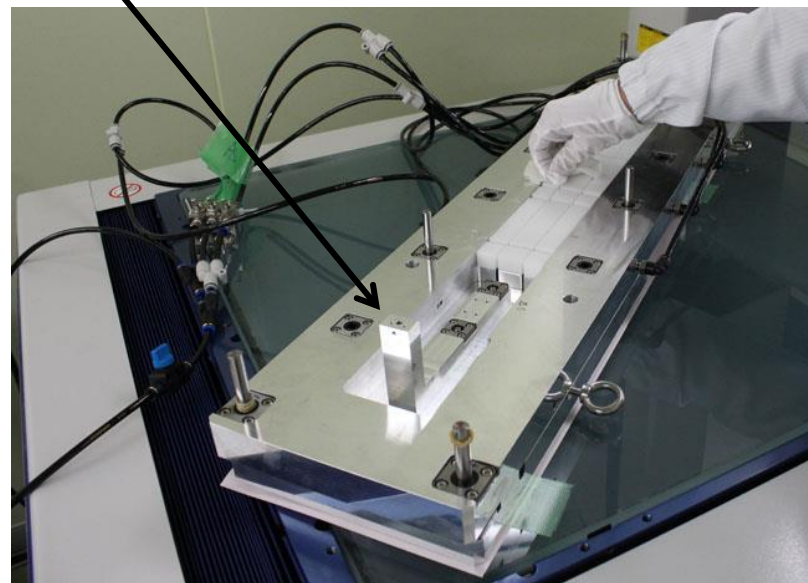
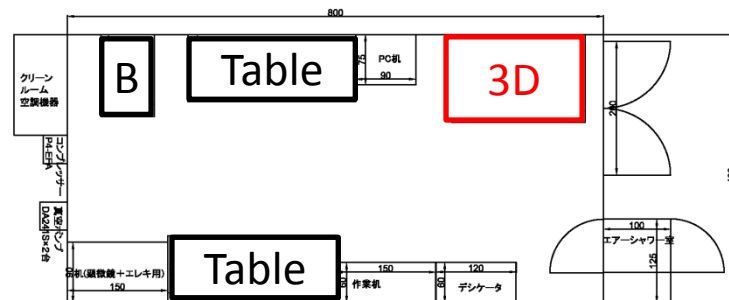
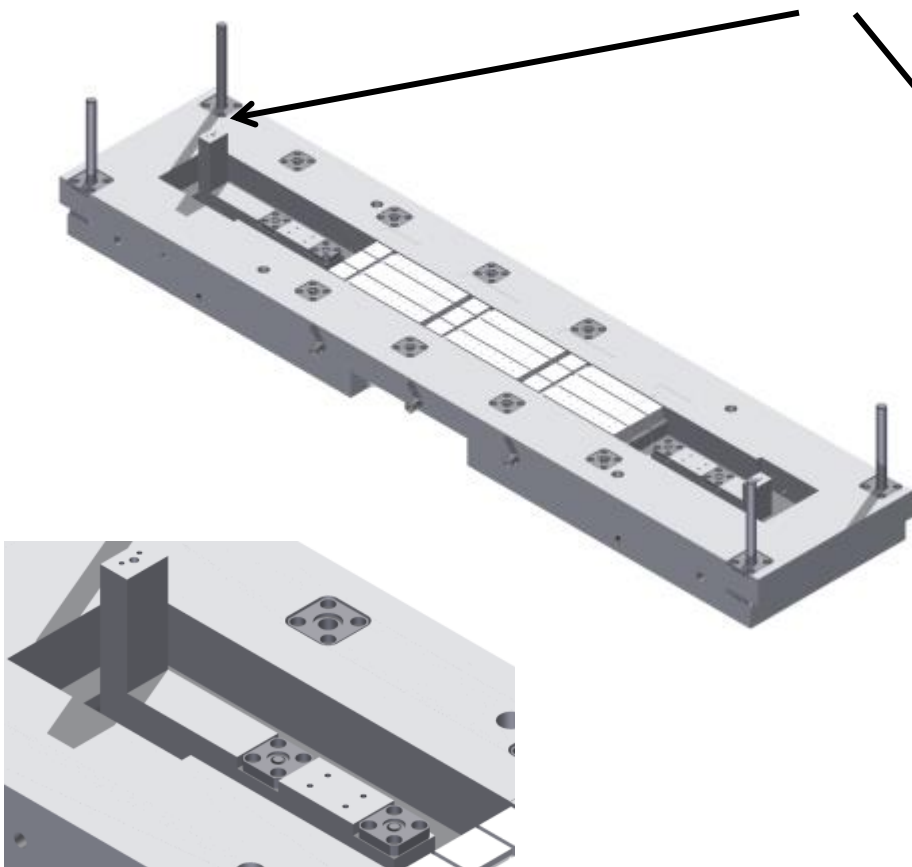
Common Proc.06: Wire bonding after removing PA1 and PA2-jig



Mechanical QA: Visual inspection of bonding wires.

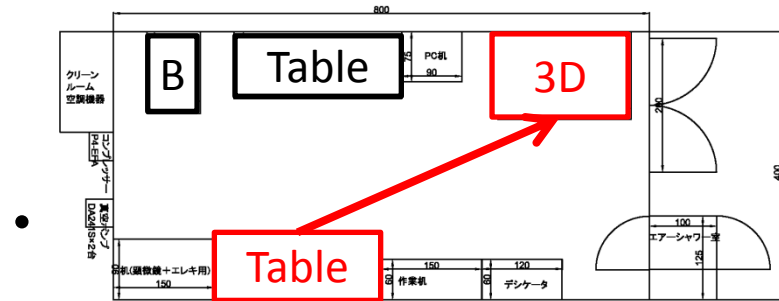
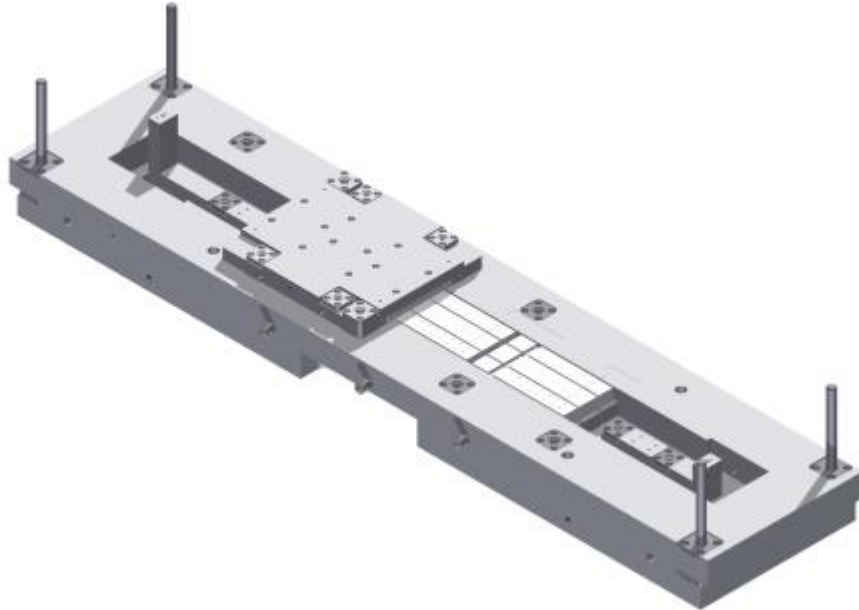
Common Proc.07: Assembly bench w/ FW&BW mount bracket

BW ladder mount = Origin

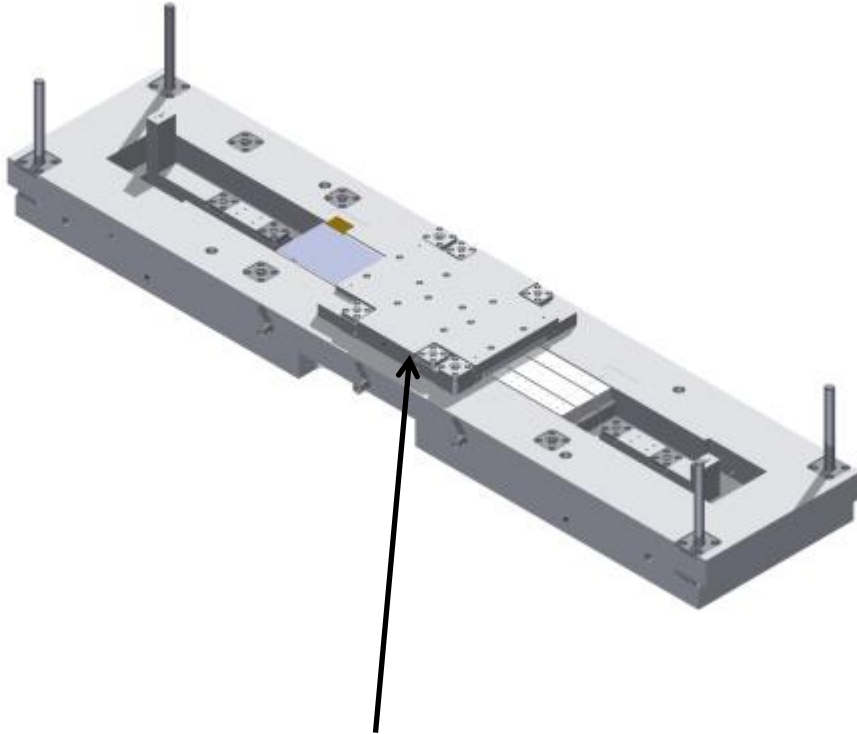


Calibrate coordinate system according to ladder mount position

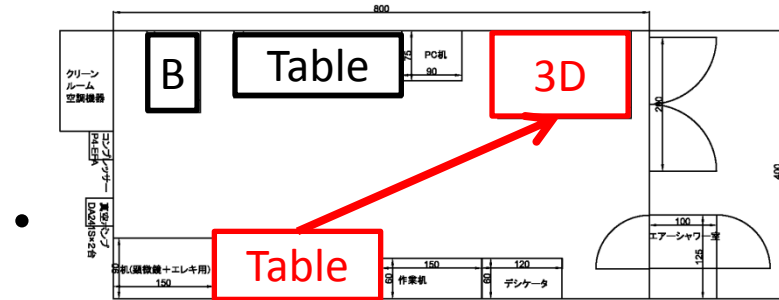
Common Proc.08: Placing DSSD(-z)



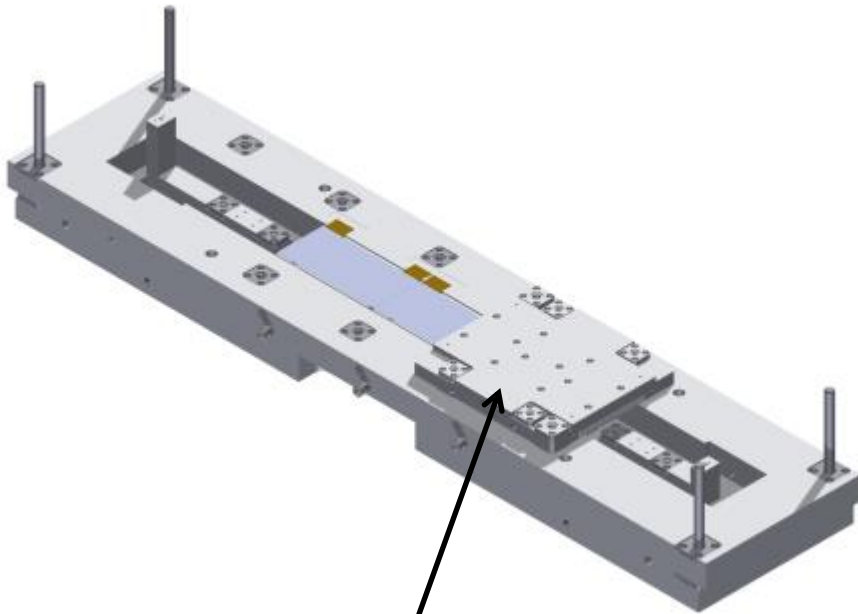
Common Proc.09: Placing DSSD(CE)



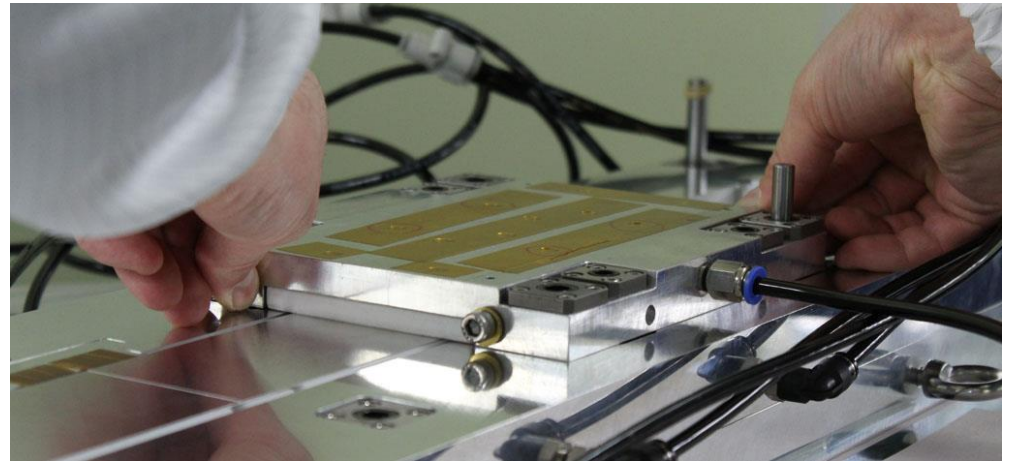
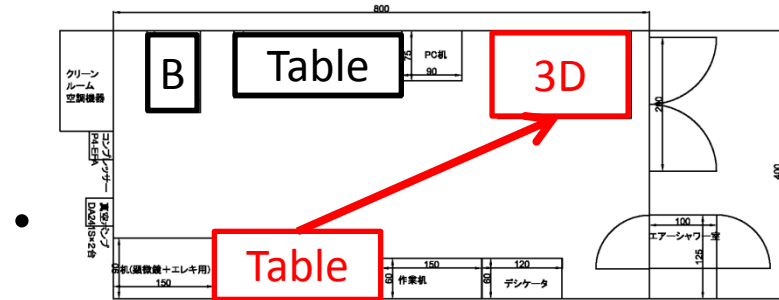
Repeating Common Proc.01-6



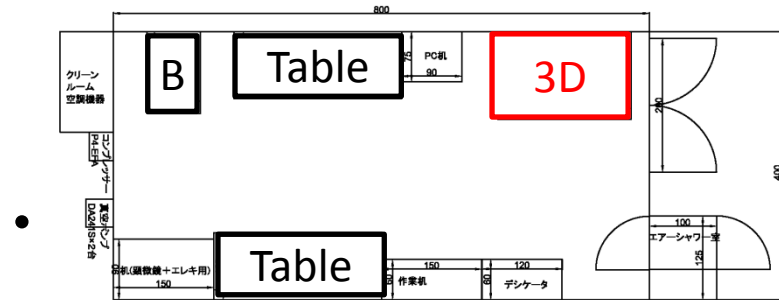
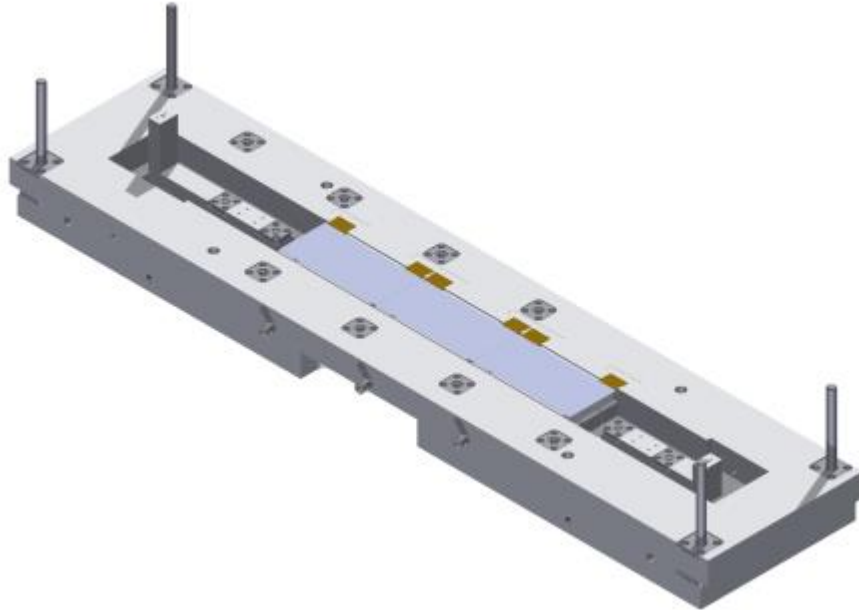
Common Proc.10: Placing DSSD(+z)



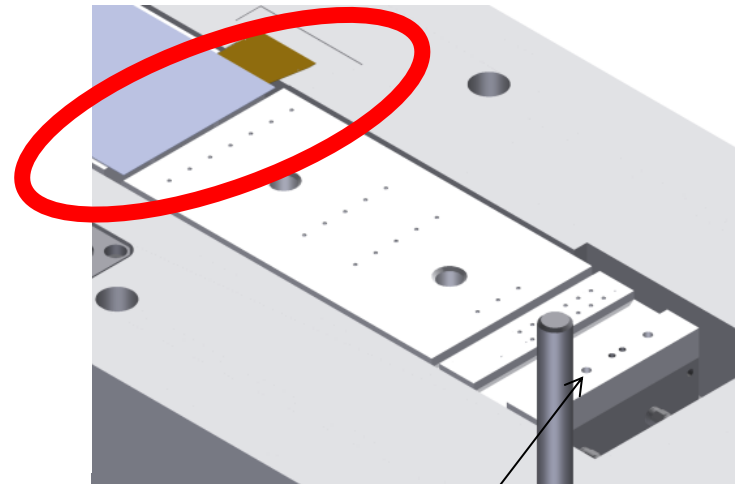
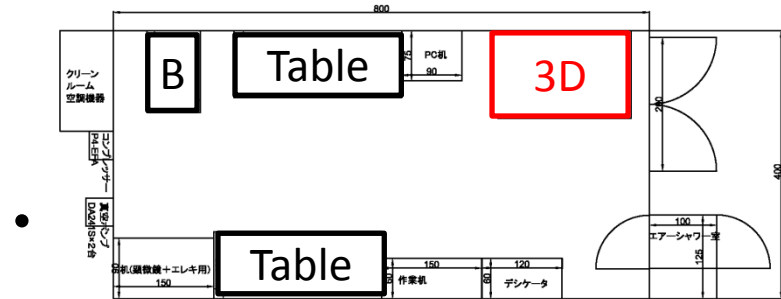
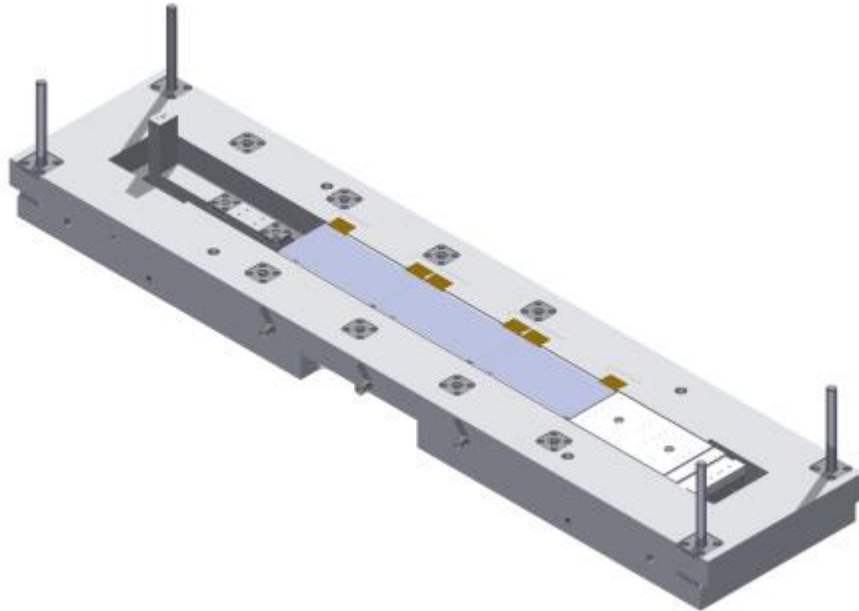
Repeating Common Proc.01-6



Common Proc.11: Removing Alignment-jig



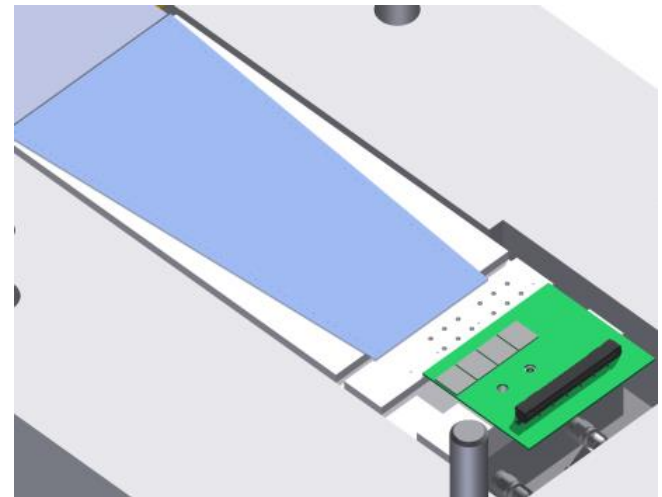
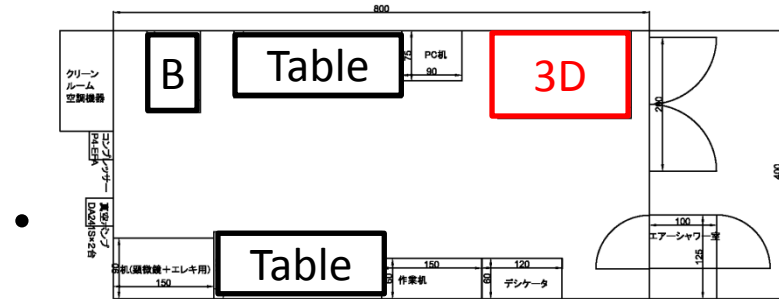
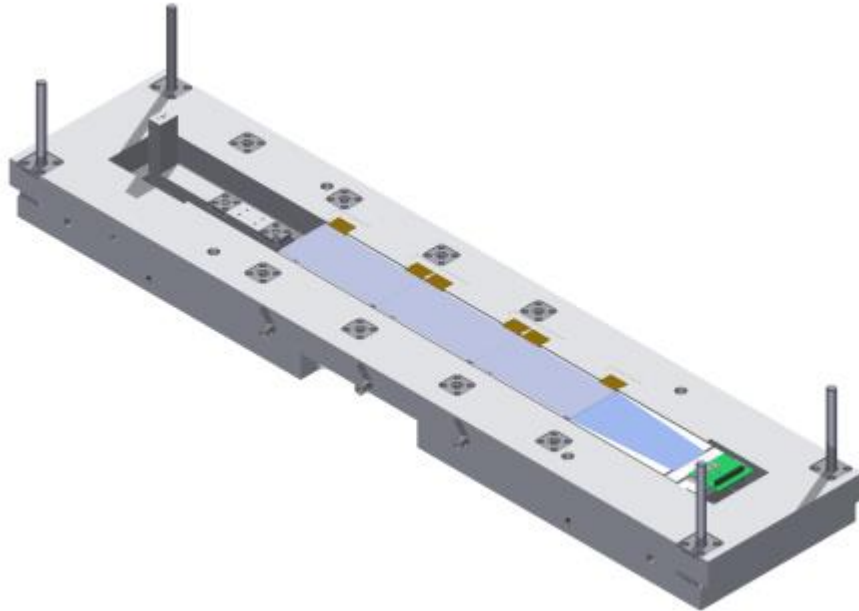
Common Proc.12: Replacing FW part.



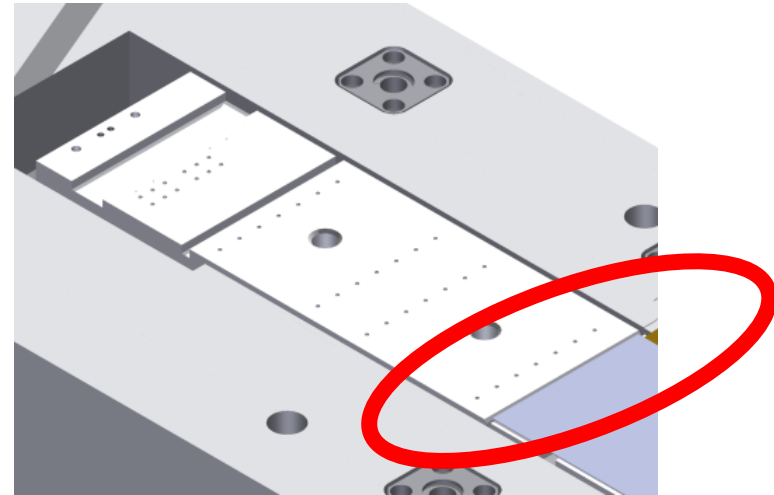
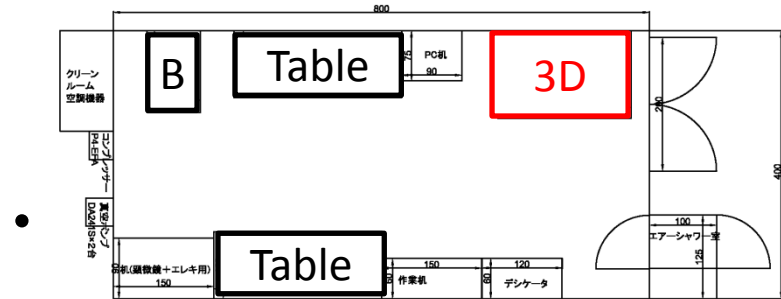
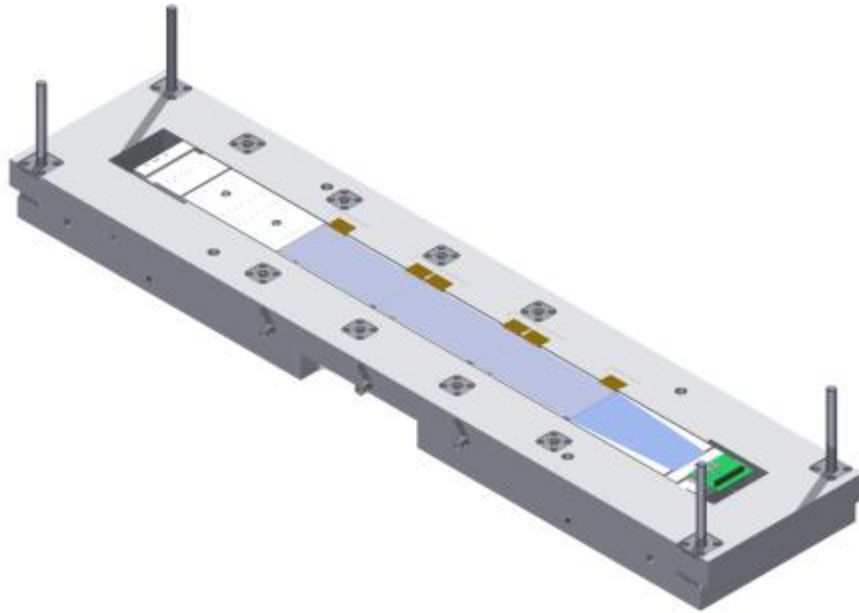
**FW jig very close to sensor → damage of edge possible
Should be done before Common Proc. 08!**

In this procedure, only replacing FW part.
The other jigs never move.

Common Proc.13: Placing FW DSSD and FW hybrid board

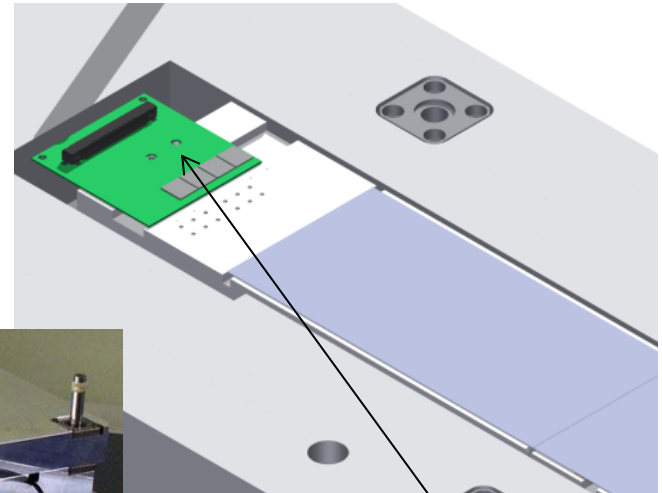
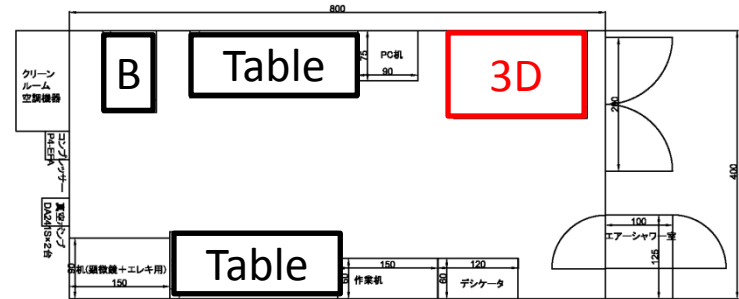
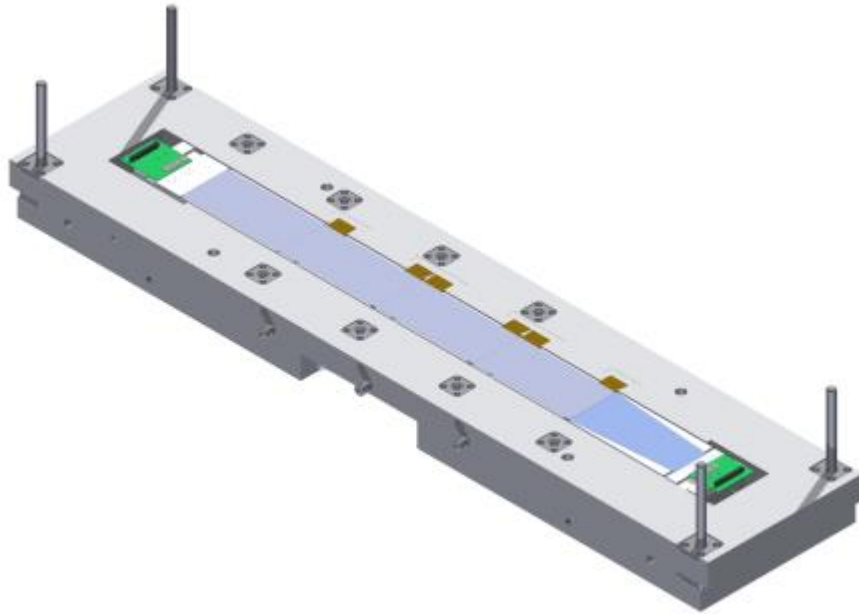


Common Proc.14: Replacing BW part

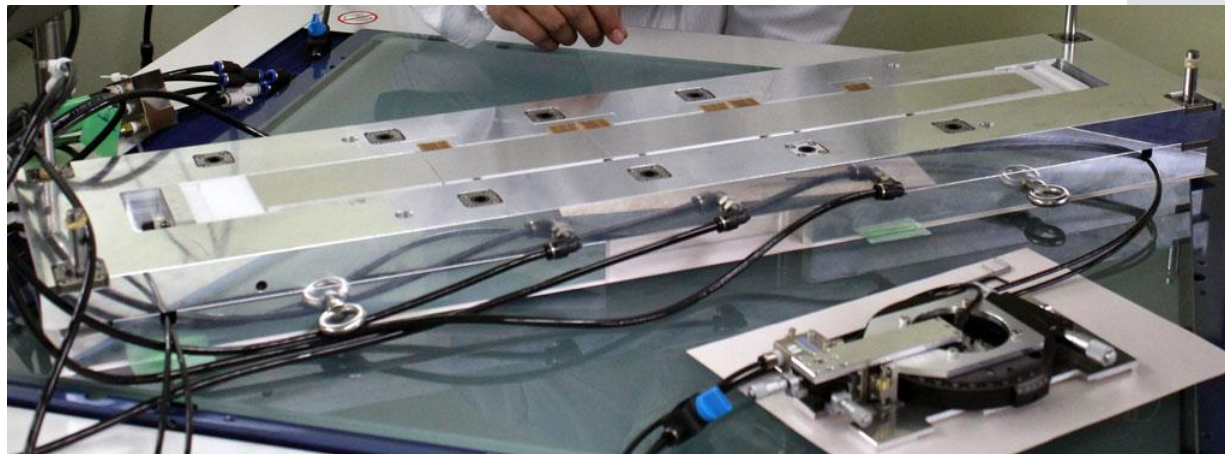


**BW jig very close to sensor → damage of edge possible
Should be done before Common Proc. 08!**

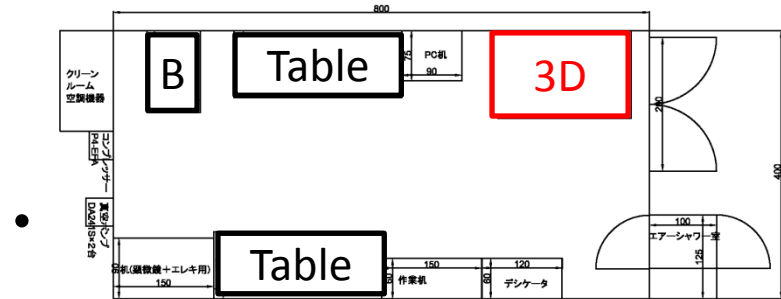
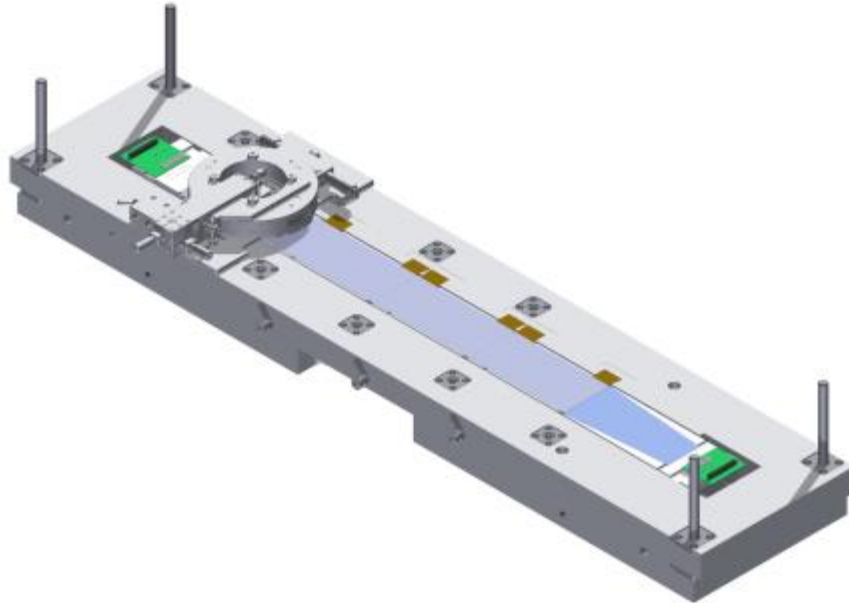
Common Proc.15: Placing BW DSSD and BW hybrid board



Screw hole to fix the hybrid board

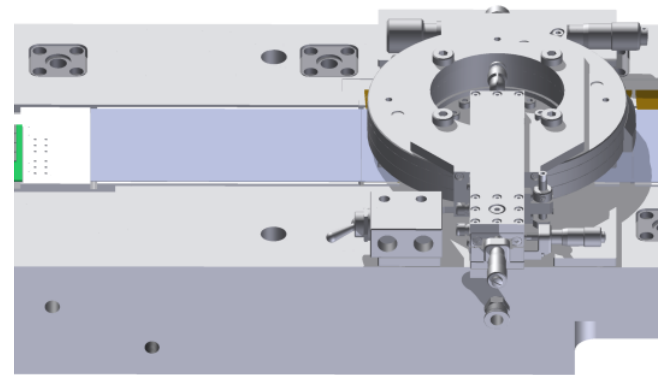
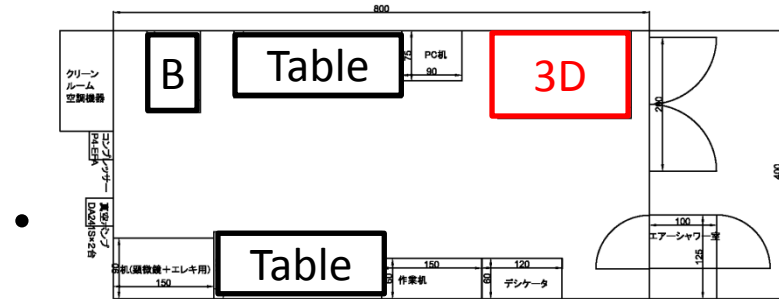
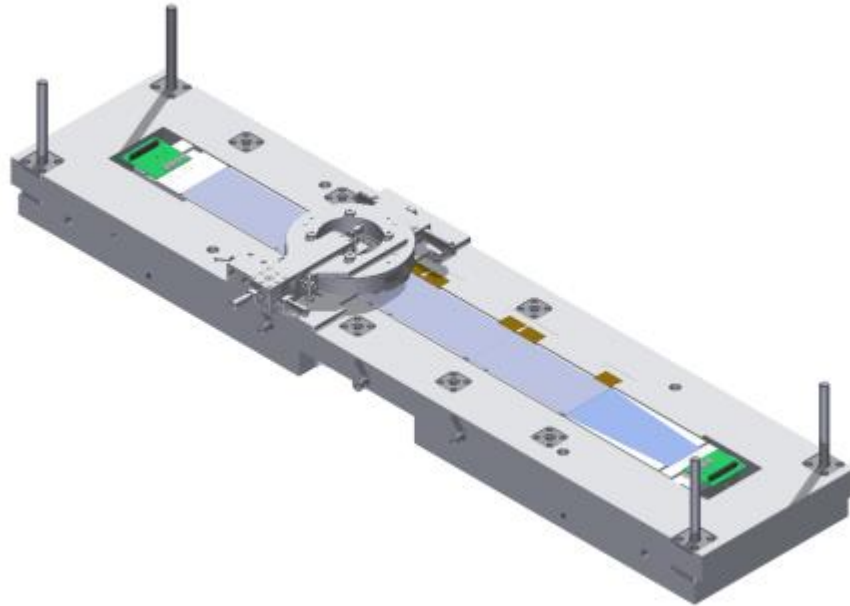


Common Proc.16: Placing XYZ θ -stage. Aligning DSSD(BW).



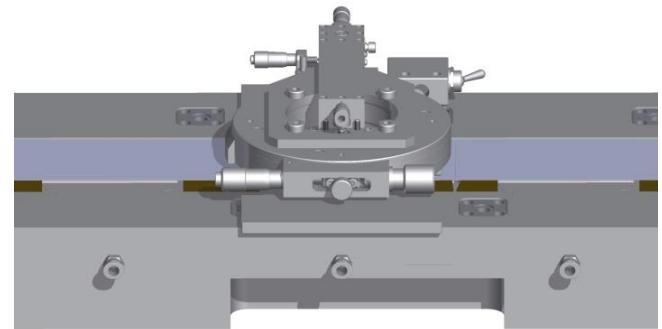
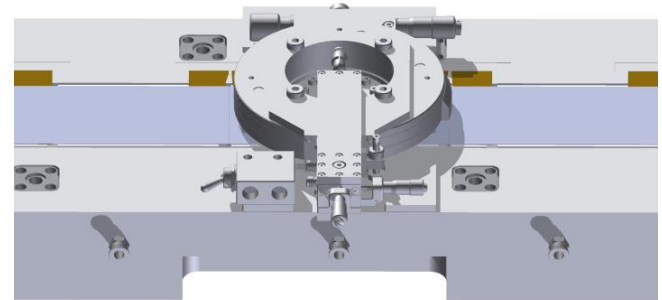
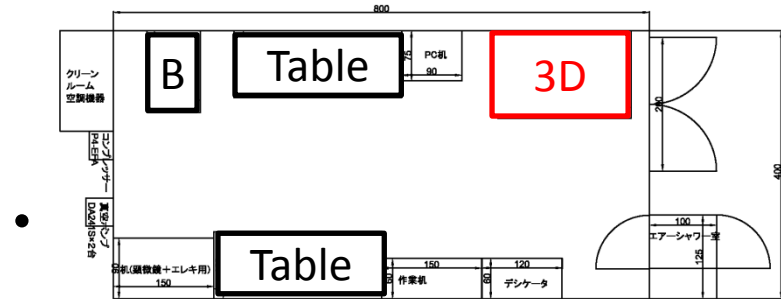
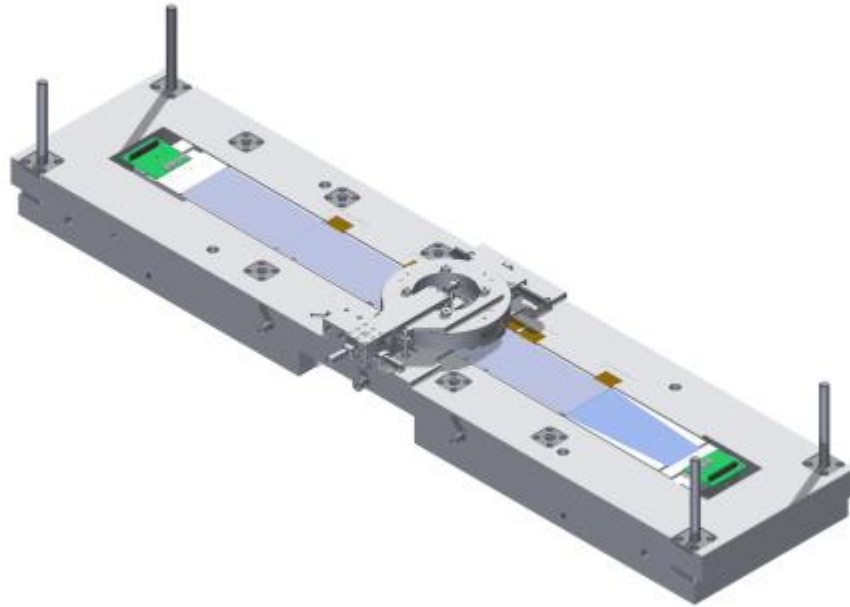
The detail of this procedure can be seen in the slide of Shimizu at Wetzlar

Common Proc.17:Placing XYZ θ -stage. Aligning DSSD(-z).



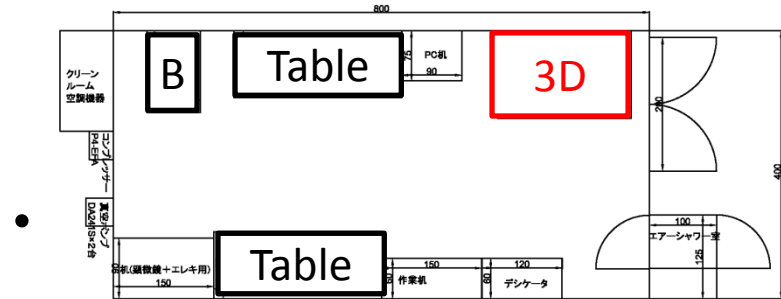
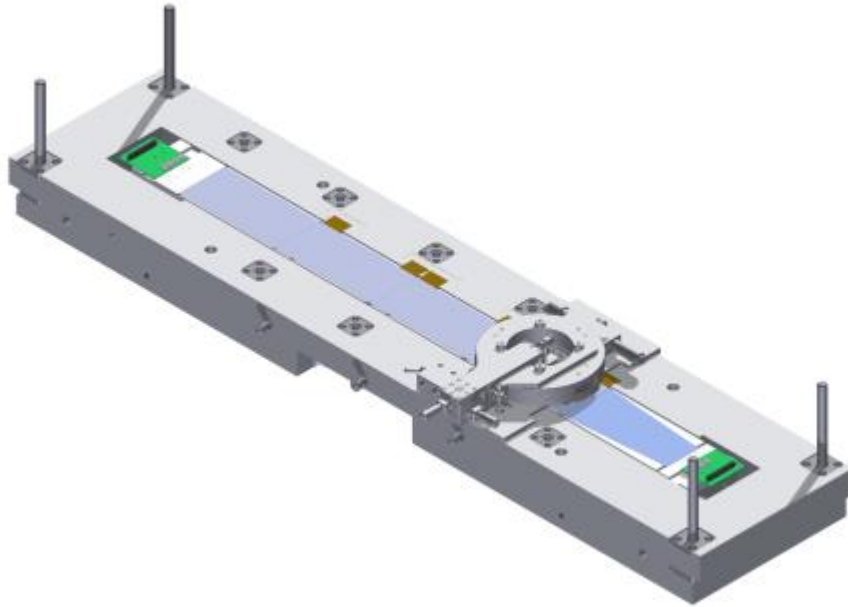
The detail of this procedure can be seen in the slide of Shimizu at Wetzlar

Common Proc.18:Placing XYZ θ -stage. Aligning DSSD(CE).



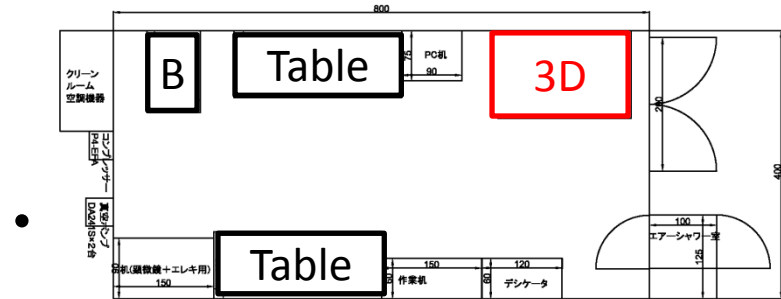
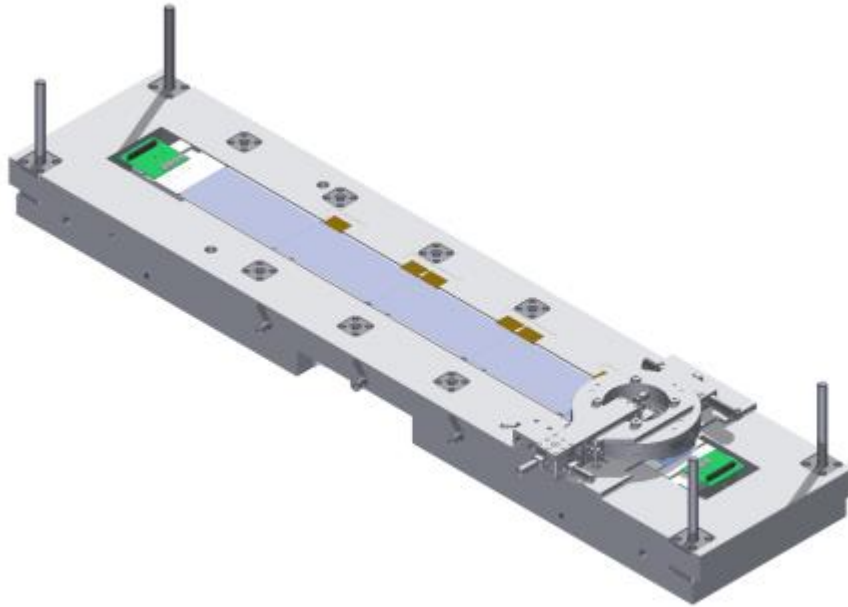
The detail of this procedure can be seen in the slide of Shimizu at Wetzlar

Common Proc.19:Placing XYZ θ -stage. Aligning DSSD(+z).



The detail of this procedure can be seen in the slide of Shimizu at Wetzlar

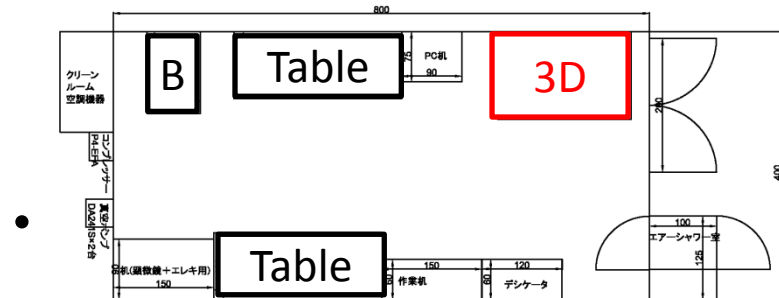
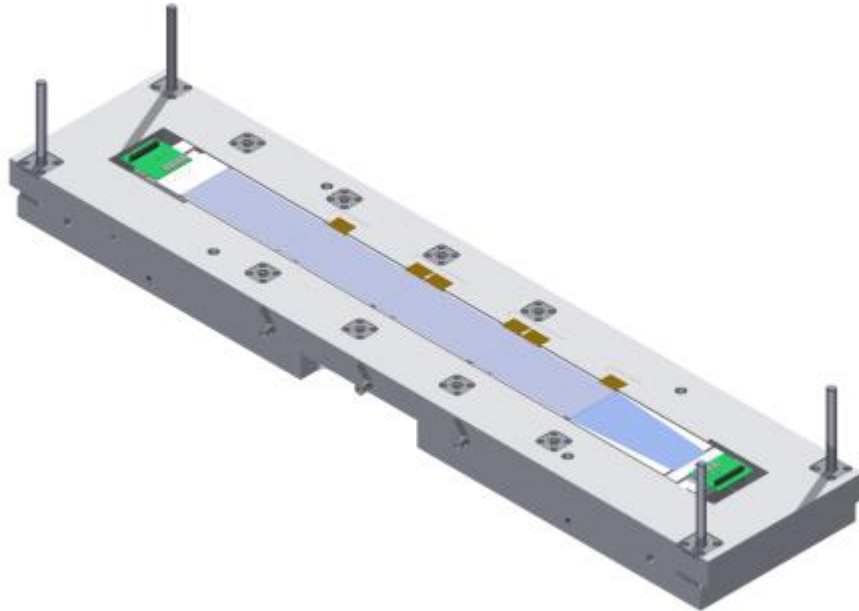
Common Proc.20:Placing XYZ θ -stage. Aligning DSSD(FW).



The detail of this procedure can be seen in the slide of Shimizu at Wetzlar

<http://indico.mppmu.mpg.de/indico/materialDisplay.py?contribId=37&sessionId=5&materialId=slides&confId=2114>

Common Proc.21: Removing XYZ θ -stage



Mechanical QA:

Inspection of alignment of DSSDs w/ the coordinate measuring machine.

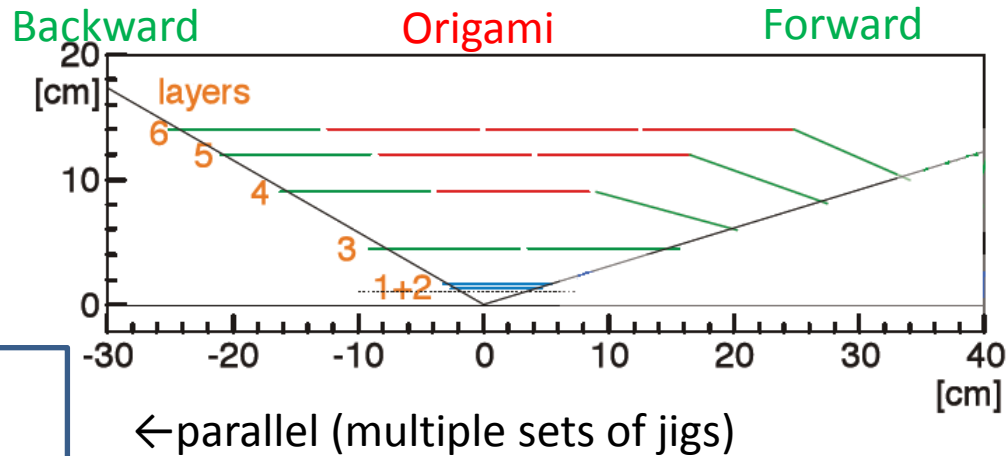
The detail of the procedure can be seen in the slide of Shimizu at Wetzlar

<http://indico.mppmu.mpg.de/indico/materialDisplay.py?contribId=37&sessionId=5&materialId=slides&confId=2114>

Independent BW and FW part assembly

- **Baseline procedure**
 - Full ladder is assembled at one site
 - Sensors can be aligned before hybrids are attached.
- **Independent assembly of BW, FW and Origami parts**
 - Origami assembly unchanged
 - Pre-assembled FW and BW modules has to be attached
 - **Can we alignment complete BW and FW modules?**
 - $xy\theta$ -stage needs to be modified in order to align sensor + hybrid at once
- The following assembly procedures of BW and FW modules have to be modified, too

SVD ladder assembly flow



Origami PA
gluing

Place DSSDs (rectangle, trapezoidal) onto assembly bench and align them

Backward
assembly

Forward assembly

← parallel
(independent
each other)

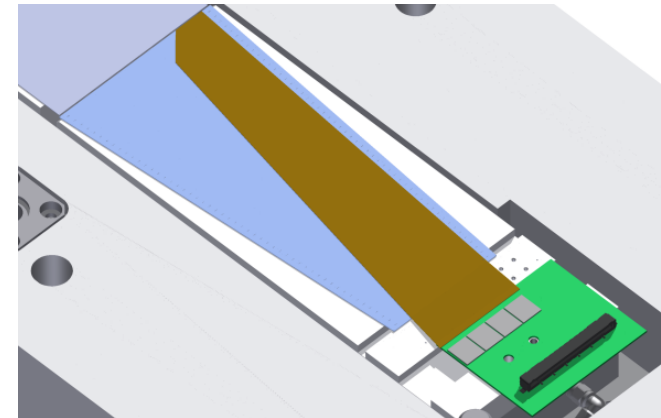
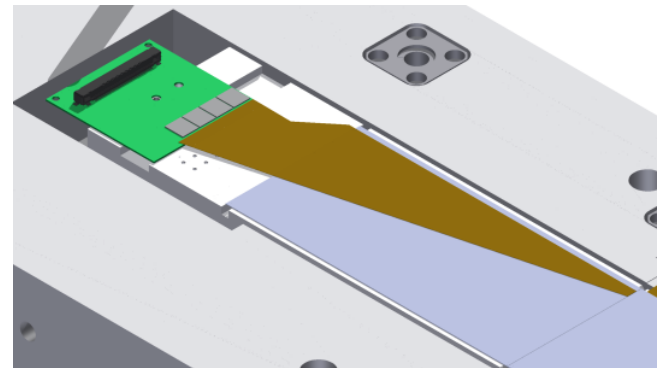
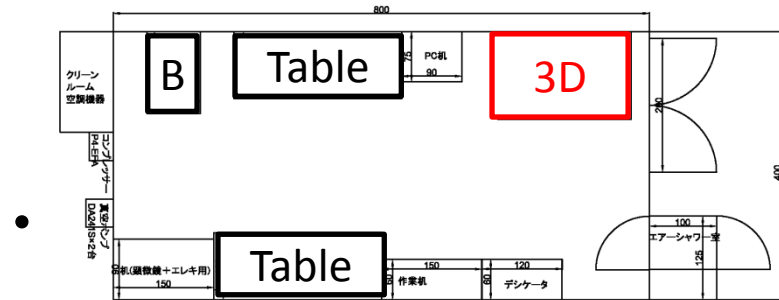
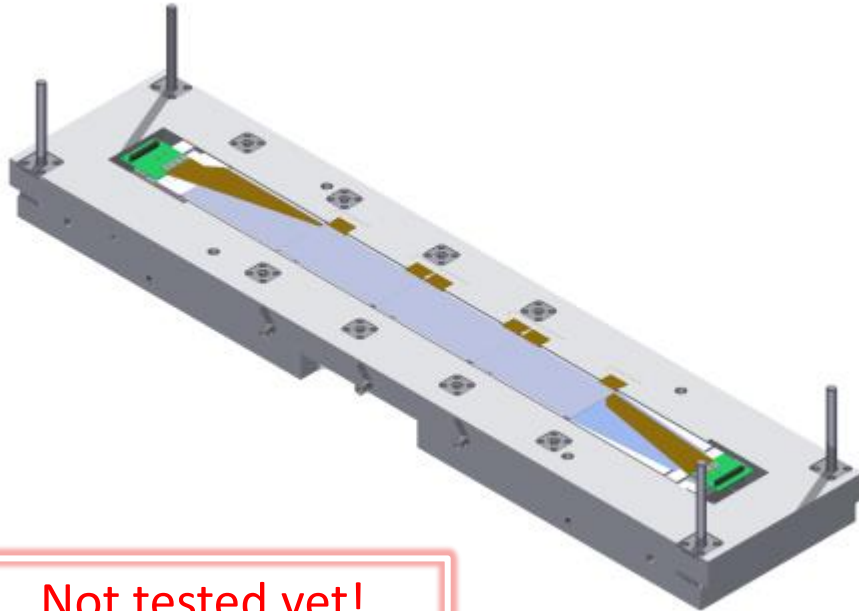
Origami assembly

Glue forward and backward
sensors onto ribs

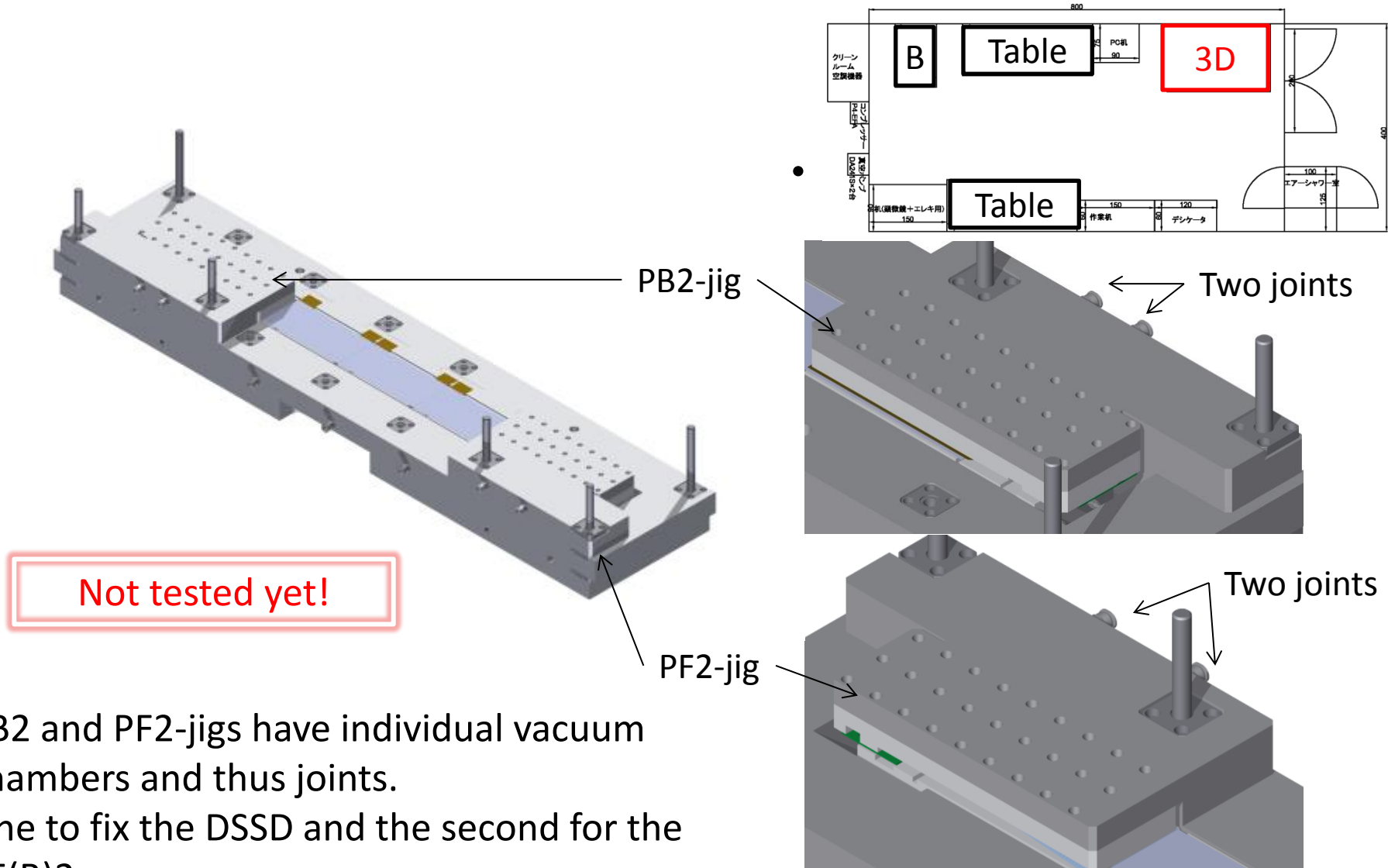
Attach Origami sensors to ribs

time

FW&BWProc.01: Aligning PF2 and PB2

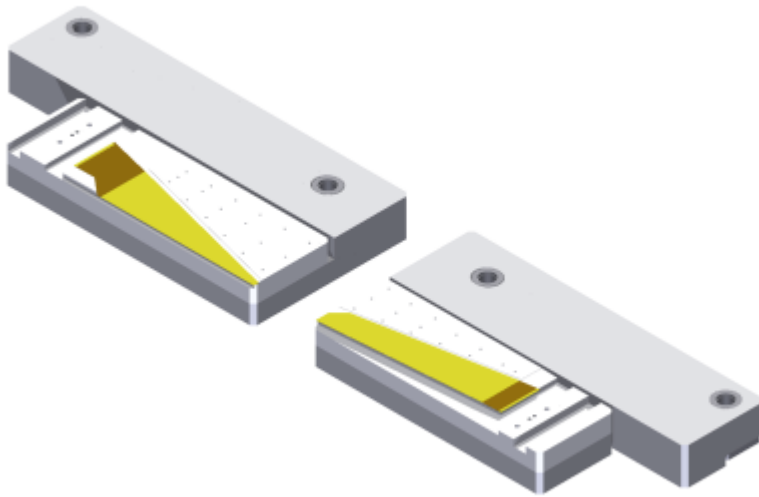


FW&BWProc.02 : Placing PF2-jig and PB2-jig. Vacuum chucking.

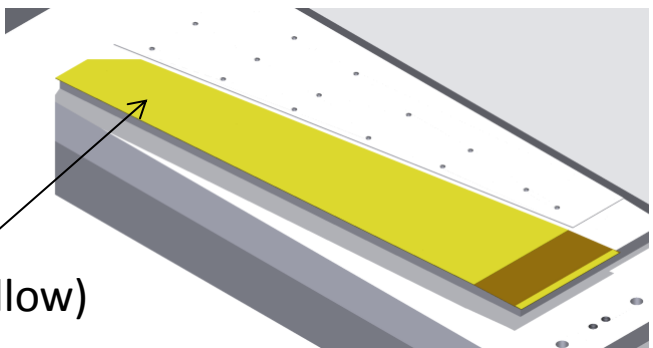
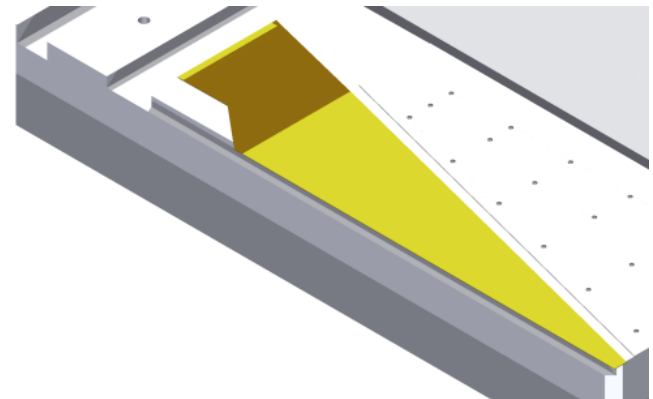
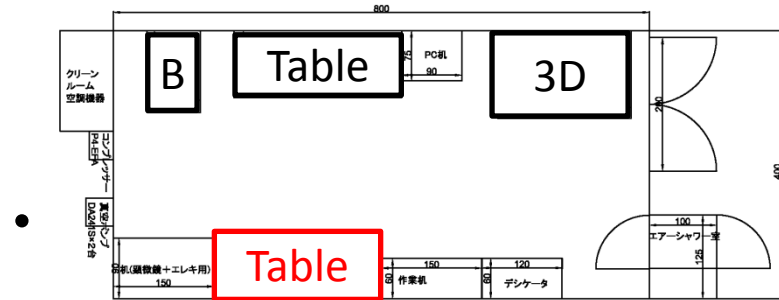


PB2 and PF2-jigs have individual vacuum chambers and thus joints. One to fix the DSSD and the second for the PF(B)2.

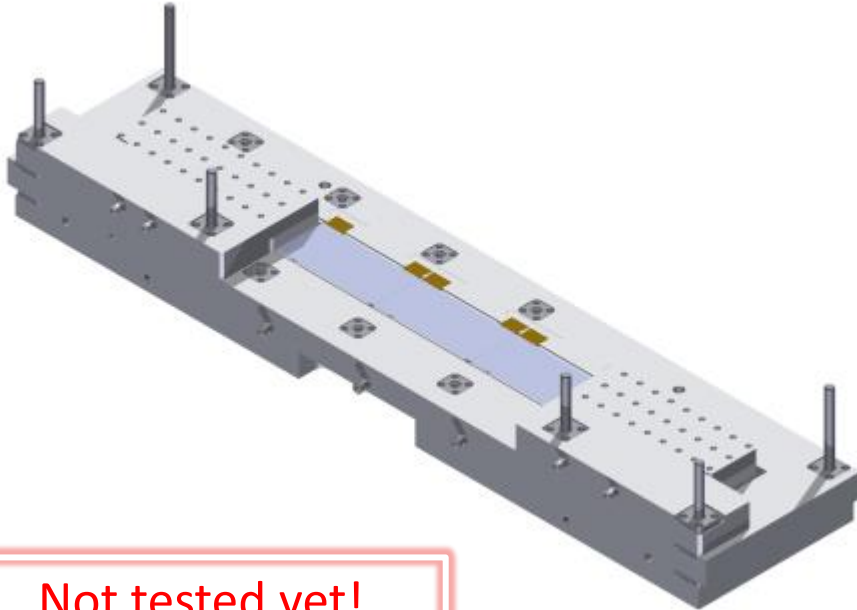
FW&BWProc.03 : Picking up the jigs. Dispensing glue.



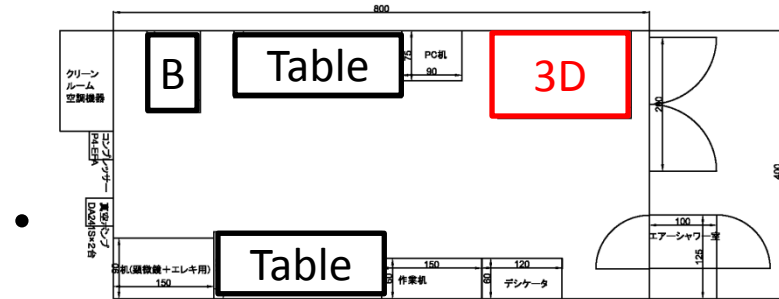
Not tested yet!



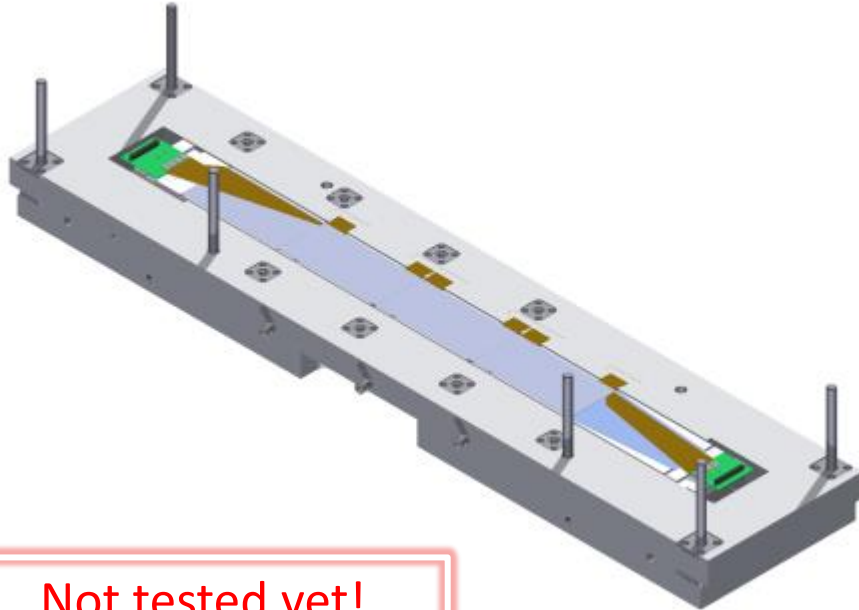
FW&BWProc.04 : Placing again and gluing PF2 and PB2



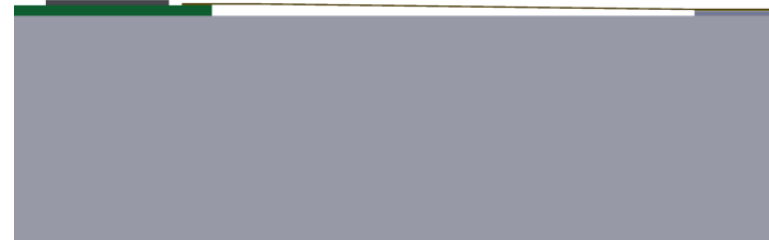
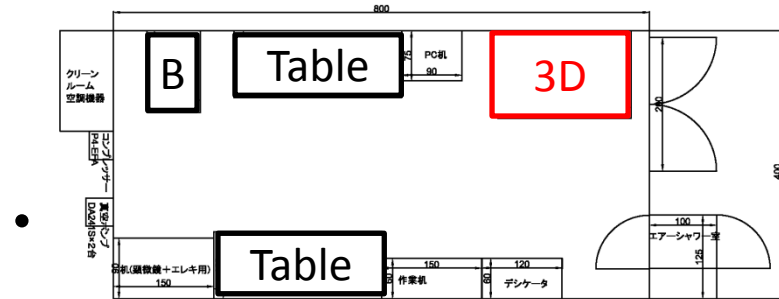
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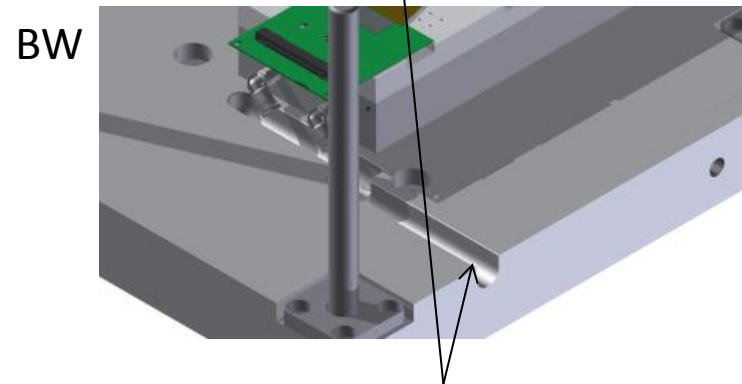
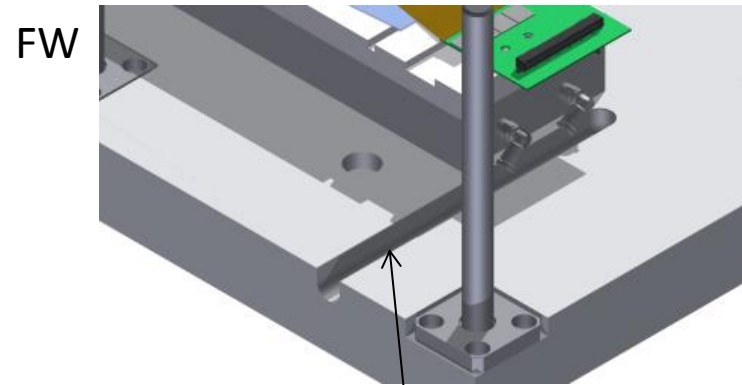
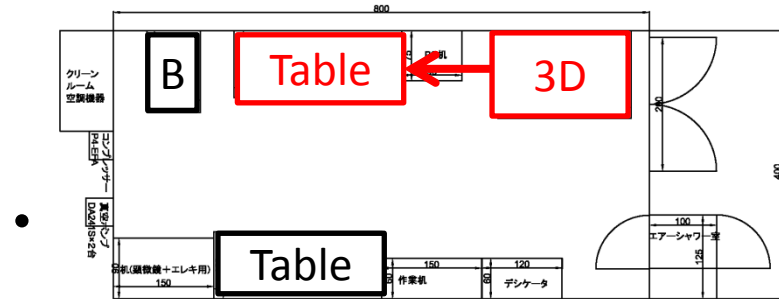
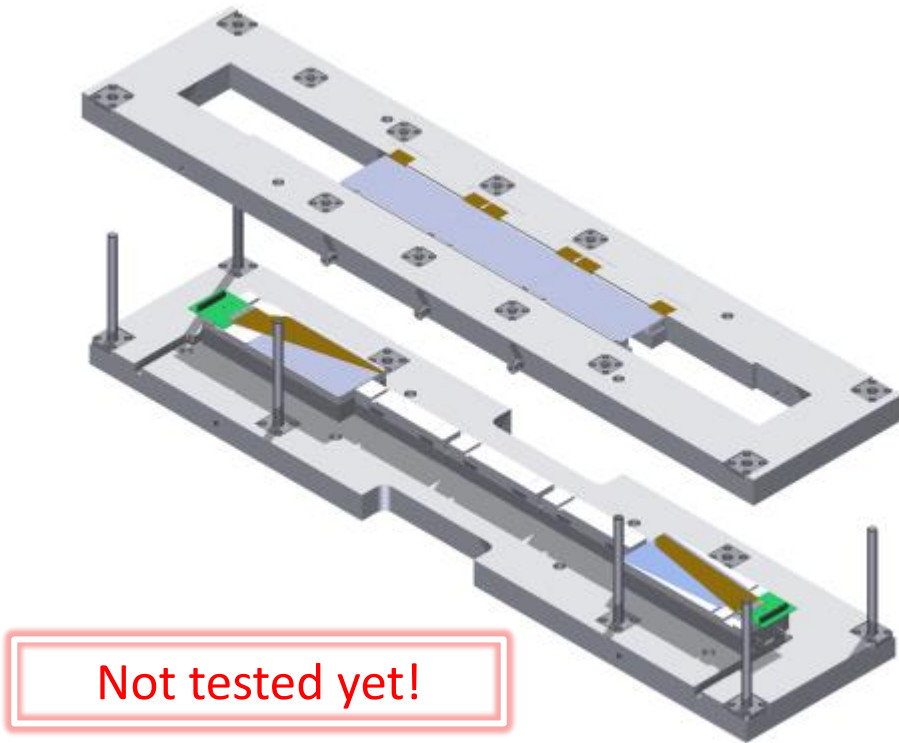
FW&BWProc.05 : Removing PB2-jig and PF2-jig



Not tested yet!

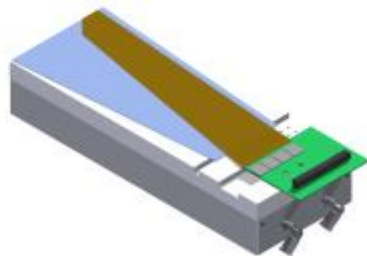
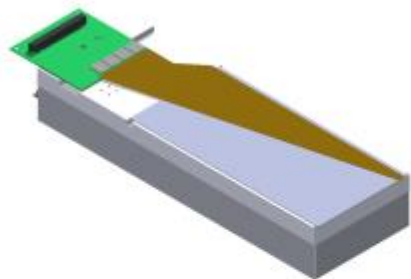


FW&BWProc.06 : Lifting up the assembly-bench

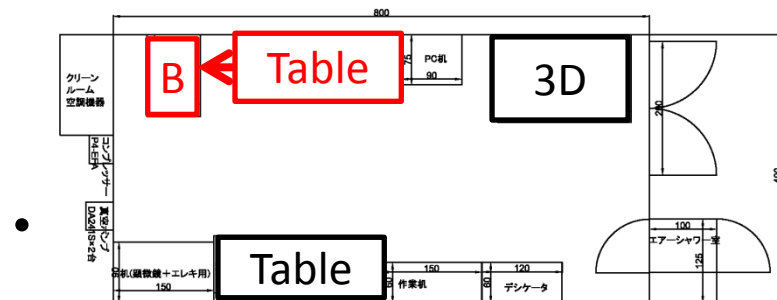


There are grooves for vacuum tubes at the FW and BW

FW&BWProc.07 : Wire bonding after picked up the F(B)W parts.



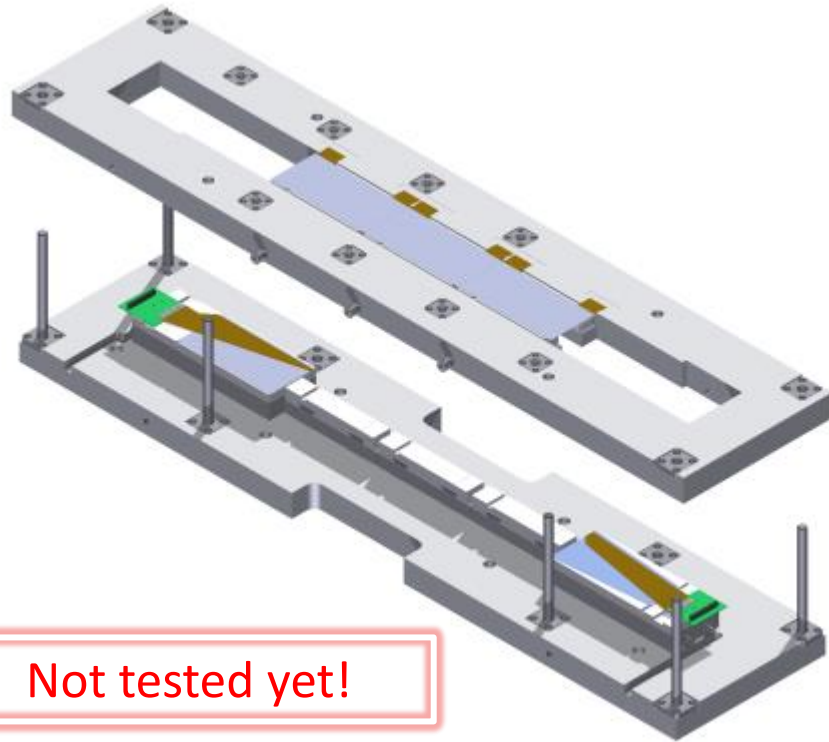
Not tested yet!



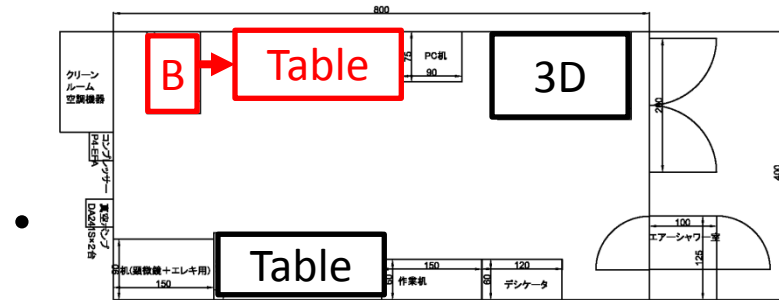
After the screwing the hybrid board,
We can plug the connector.

Mechanical QA: Visual inspection of bonding wires
Electrical QA: Readout test with APVDAQ

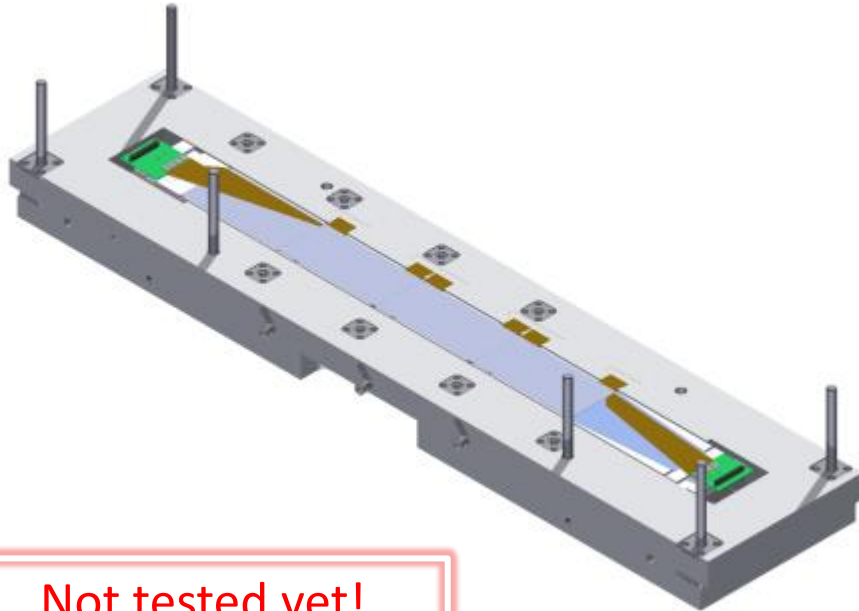
FW&BWProc.08 : Lifting up the assembly-bench



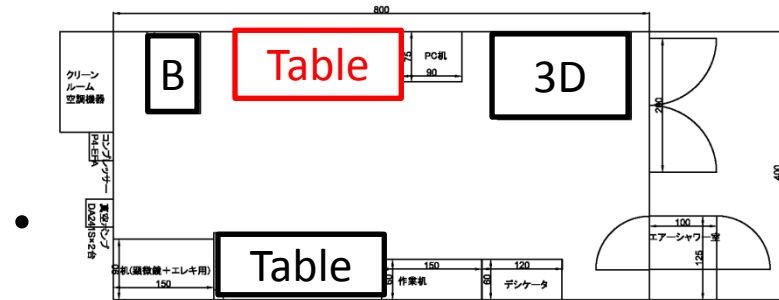
Not tested yet!



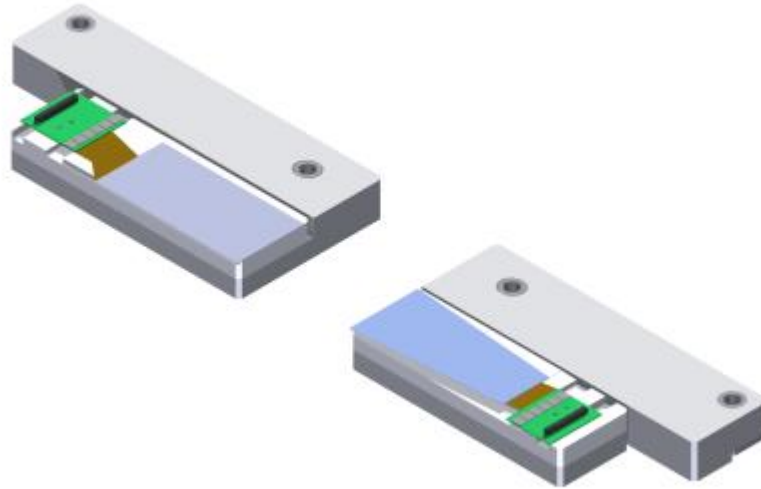
FW&BWProc.09 : Returning the FW and BW part.



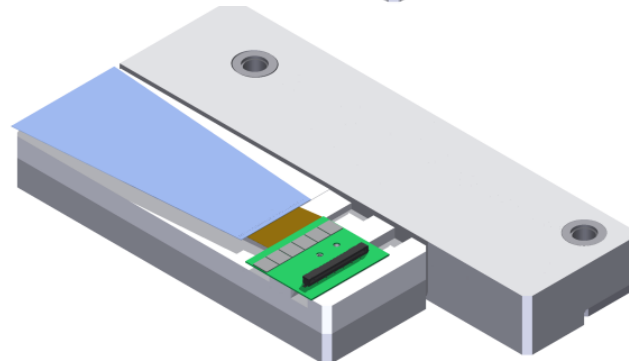
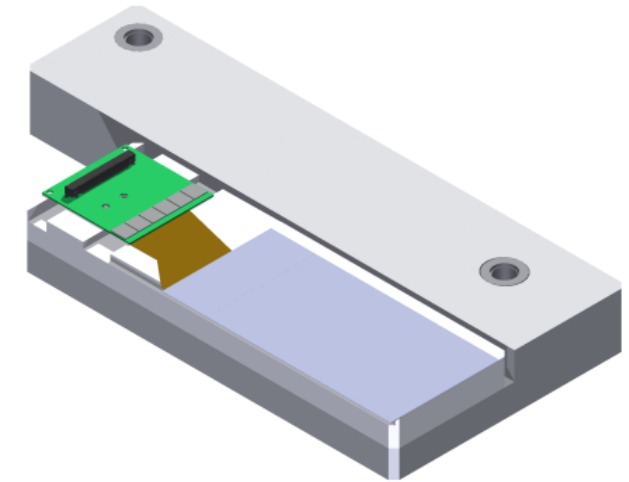
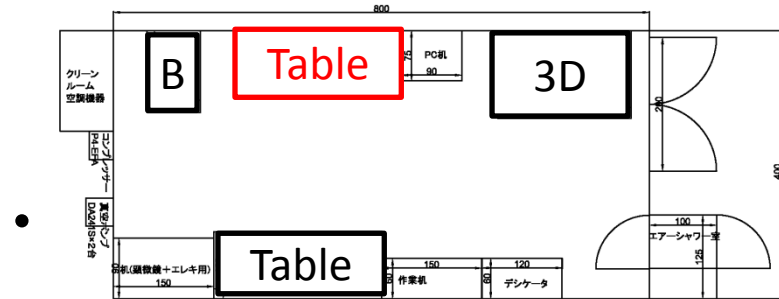
Not tested yet!



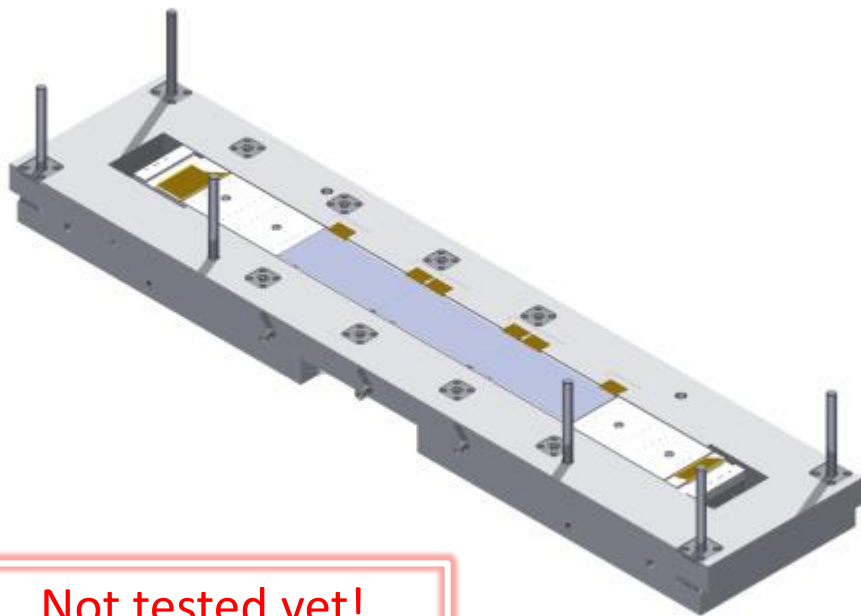
FW&BWProc.11: Picking up the BW and FW parts.



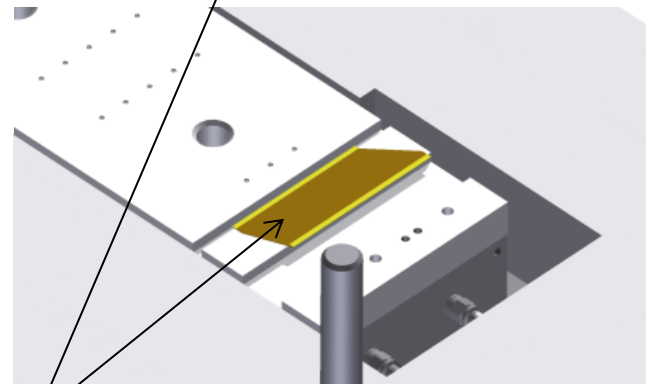
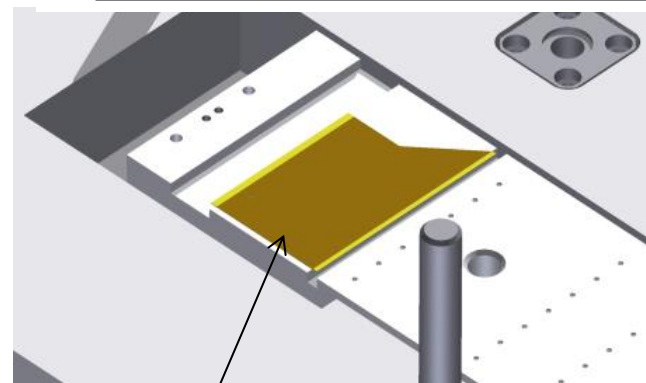
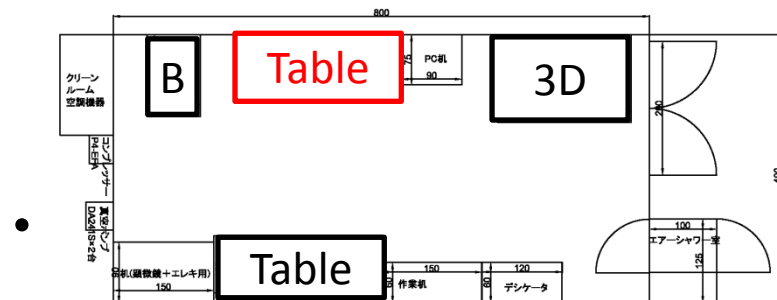
Not tested yet!



FW&BWProc.12: Placing PF1 and PB1. Dispensing glue on them.

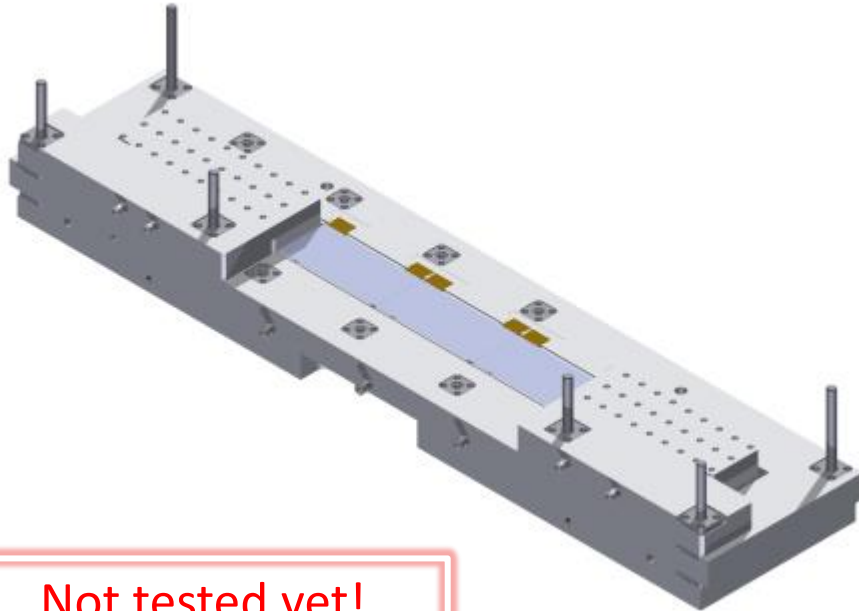


Not tested yet!

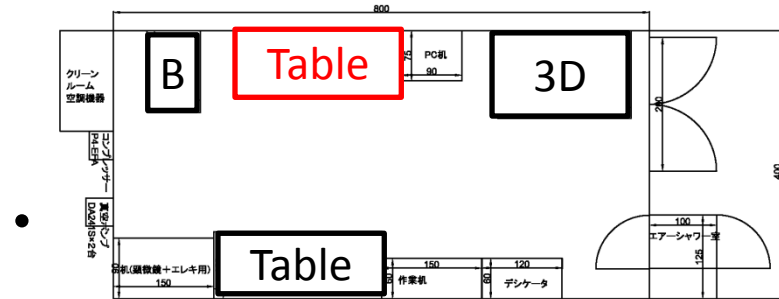


There are alignment holes on the surface

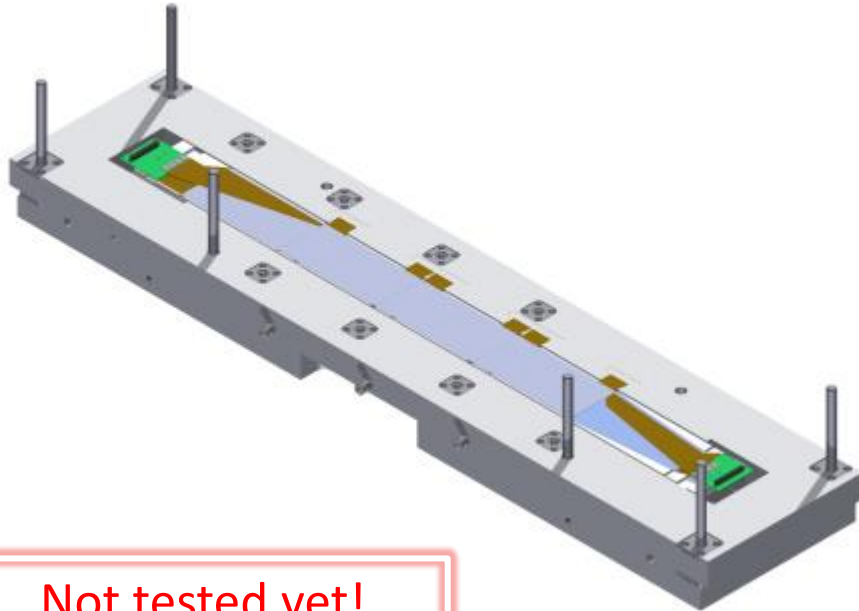
FW&BWProc.13 : Gluing PF1 and PB1.



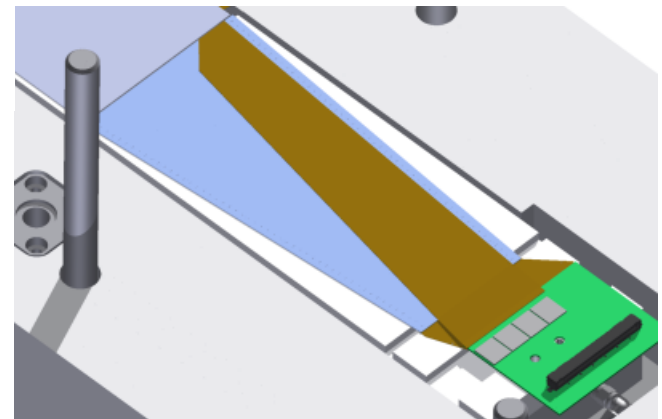
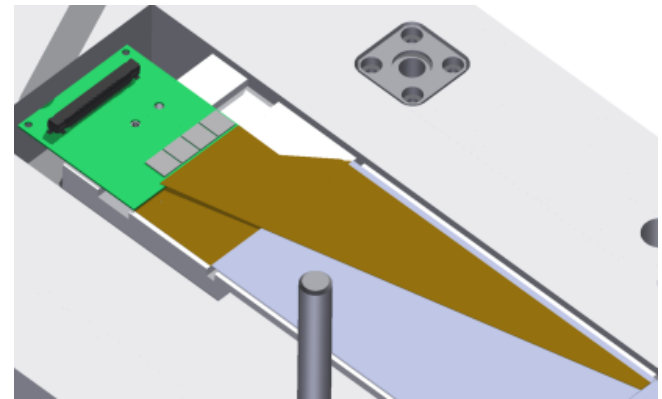
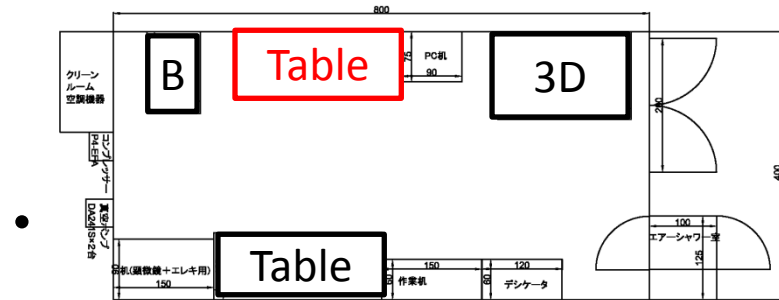
Not tested yet!



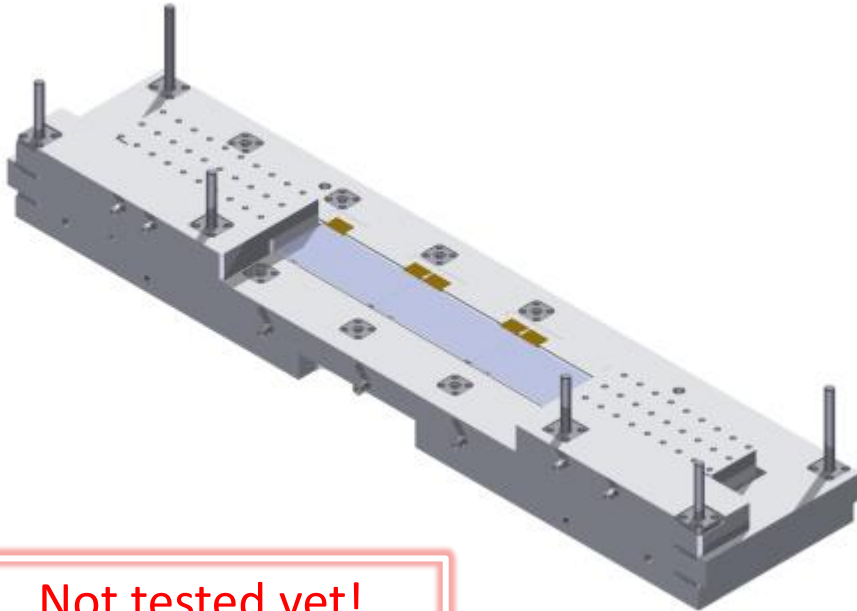
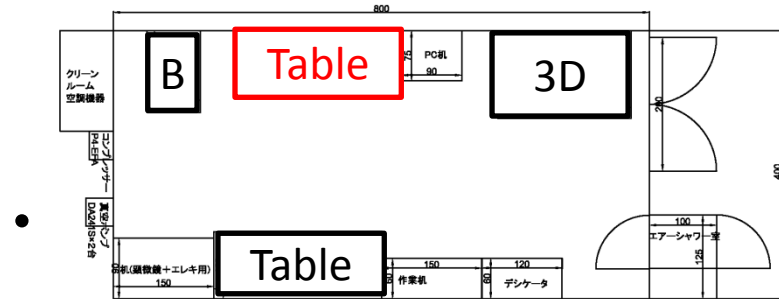
FW&BWProc.14: Removing the jigs



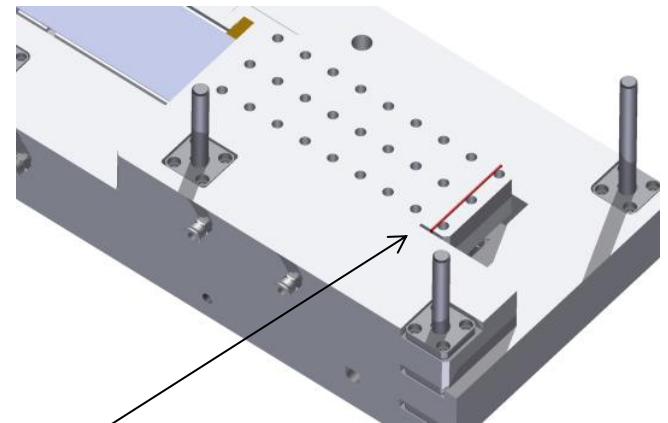
Not tested yet!



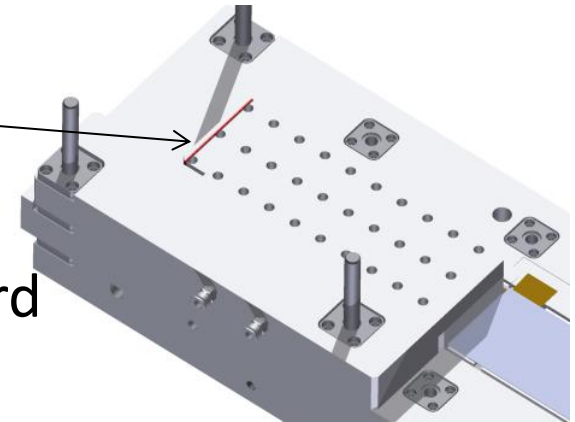
FW&BWProc.15 : Placing PF2-jig and PB2-jig again.



Not tested yet!

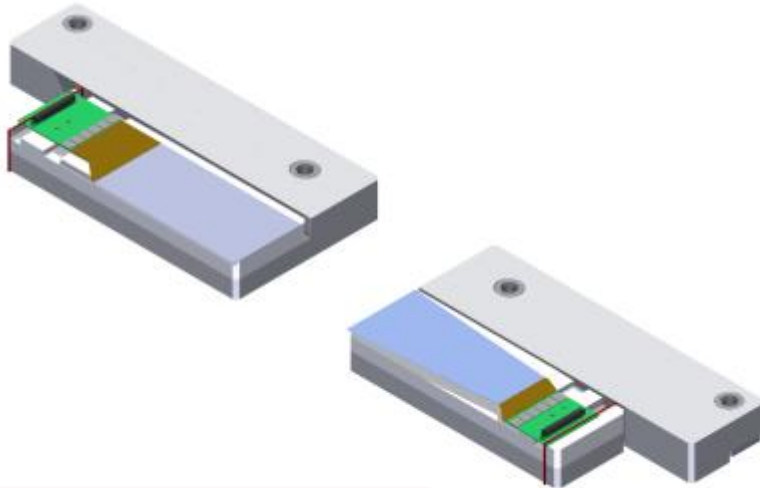
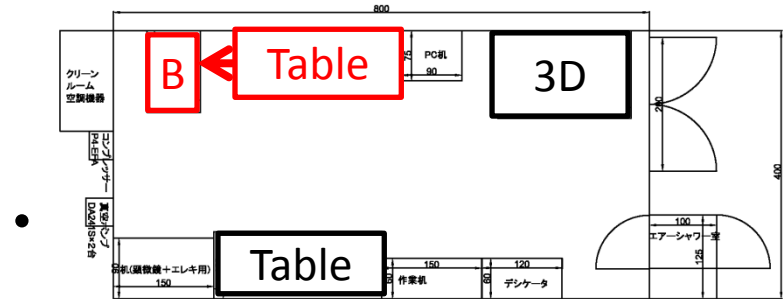


Rubber

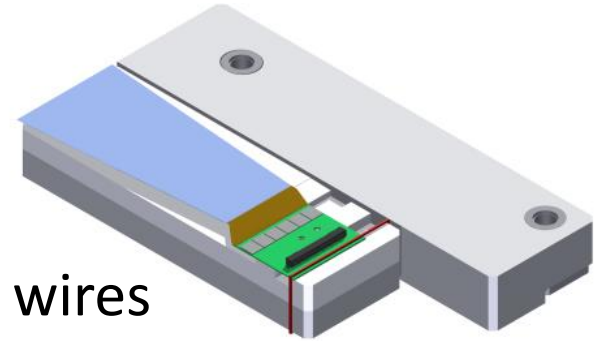
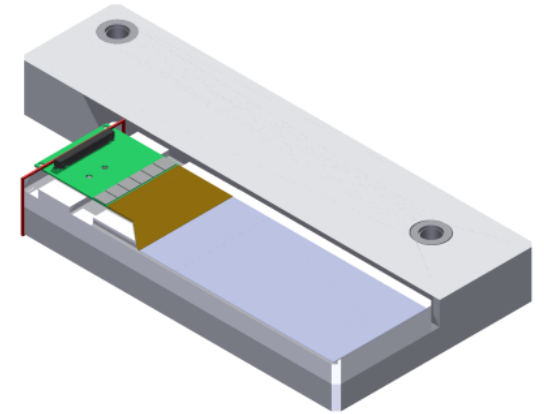


The after, clipping rubbers for each hybridboard to fix the hybridboard to the PF(B)2-jigs.

FW&BWProc.16: Picking up the parts. Wire-bonding.

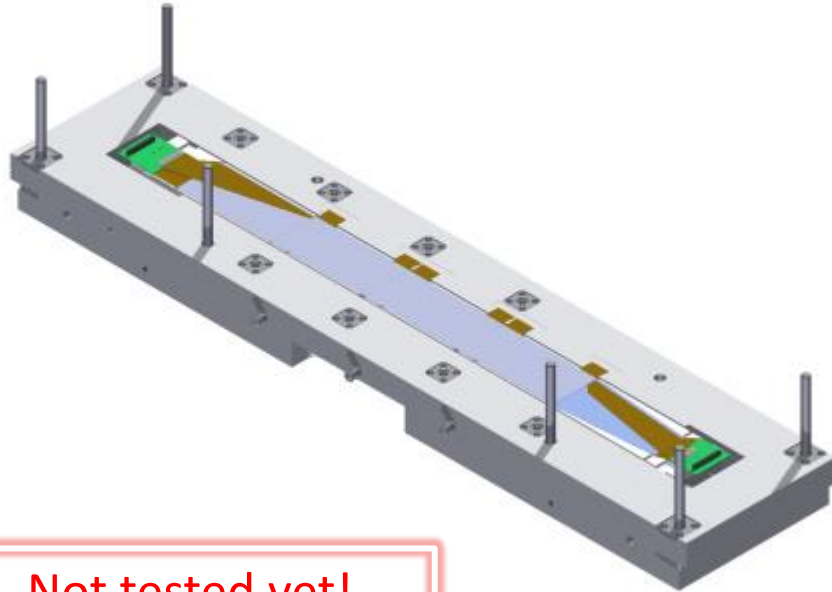


Not tested yet!

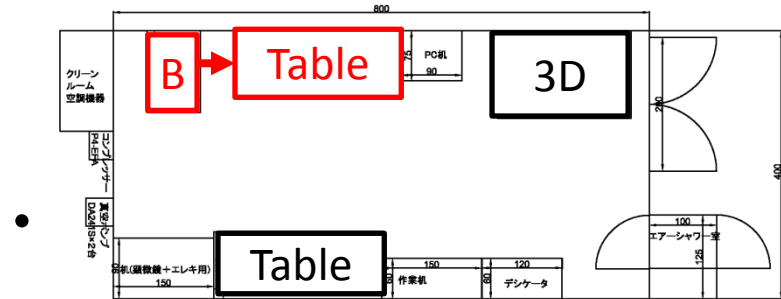


Mechanical QA: Visual inspection of bonding wires
Electrical QA: Readout test with APVDAQ

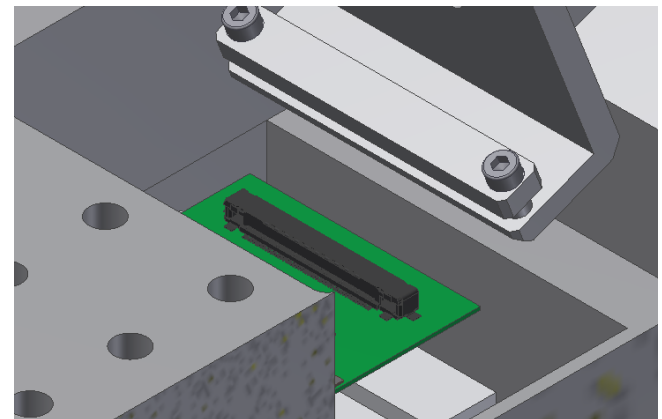
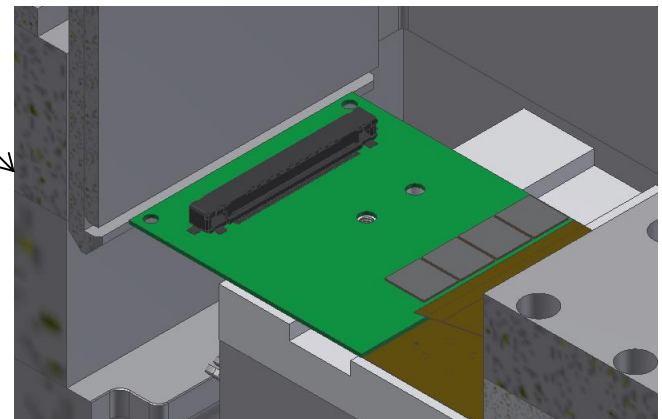
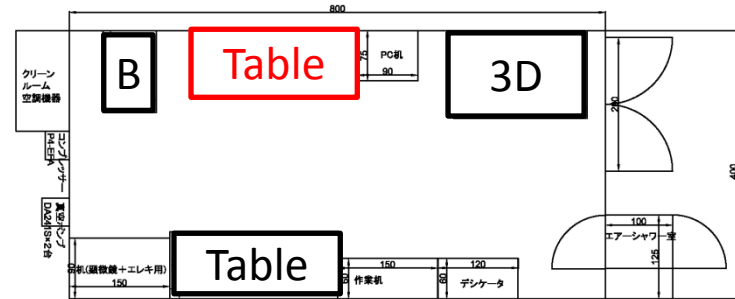
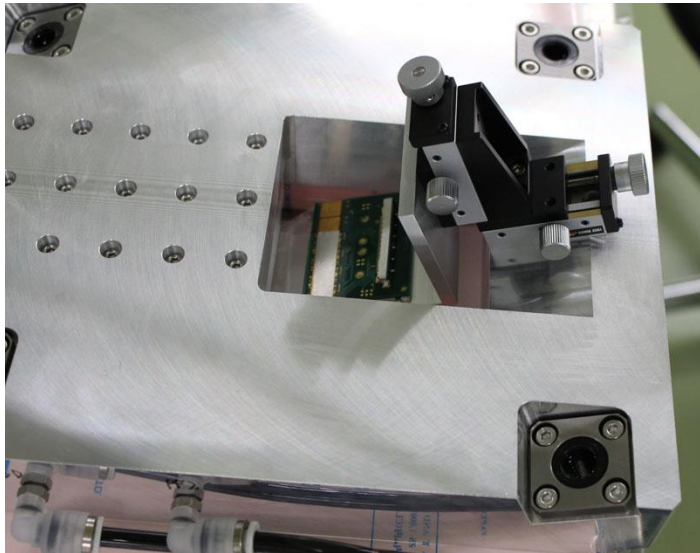
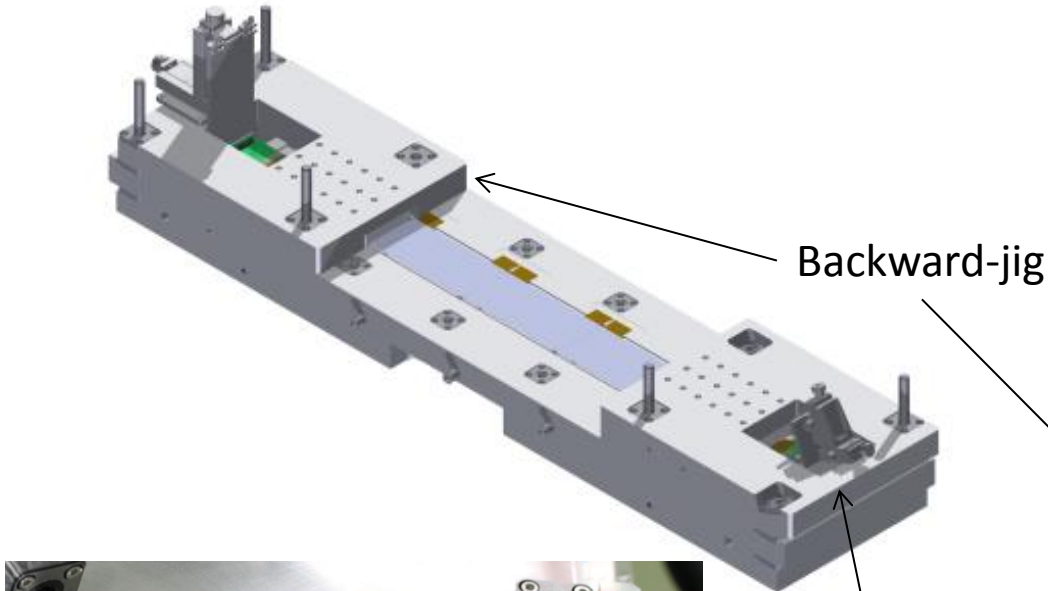
FW&BWProc.17: Returning the PF2,PB2-jigs



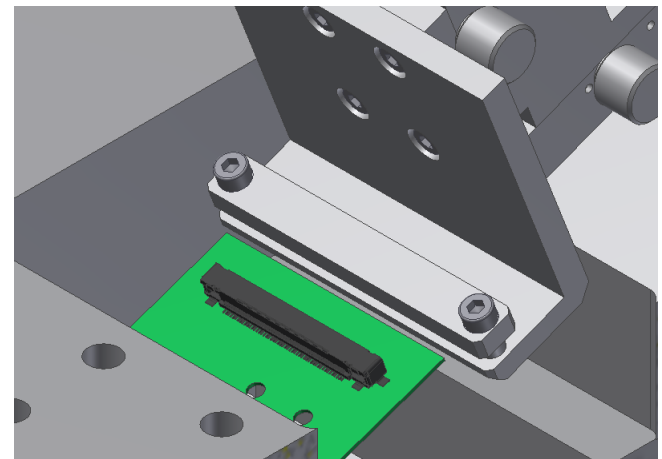
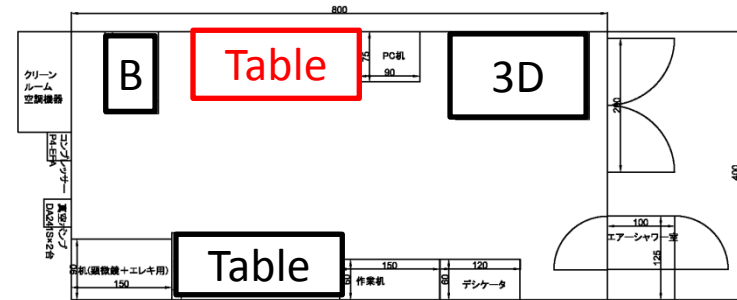
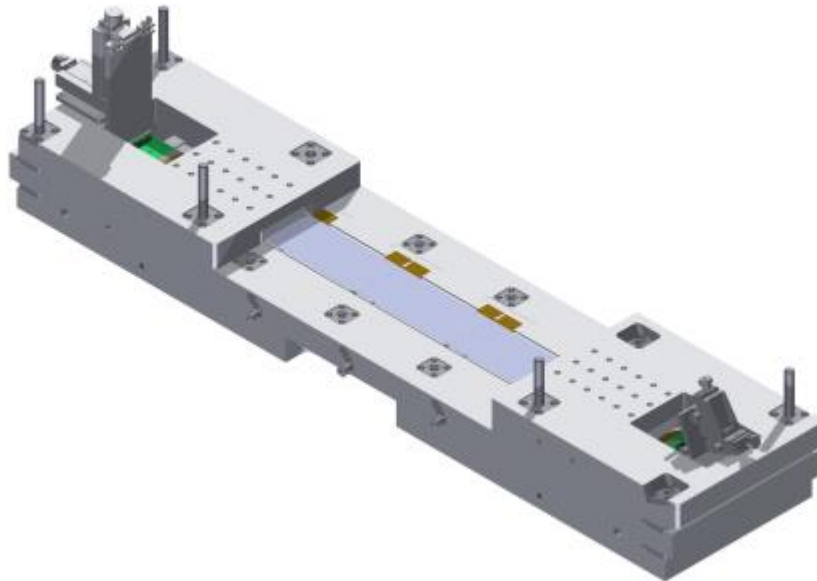
Not tested yet!



FW&BWProc.18: Placing Slant-jig and Backward-jig.

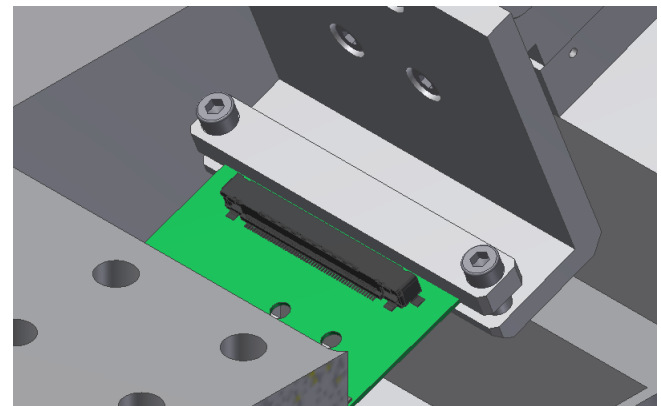
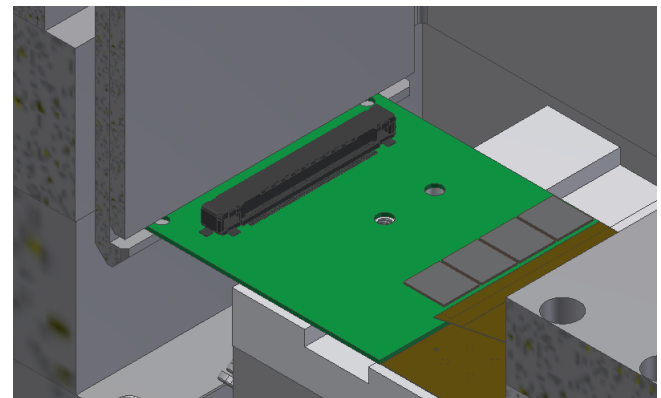
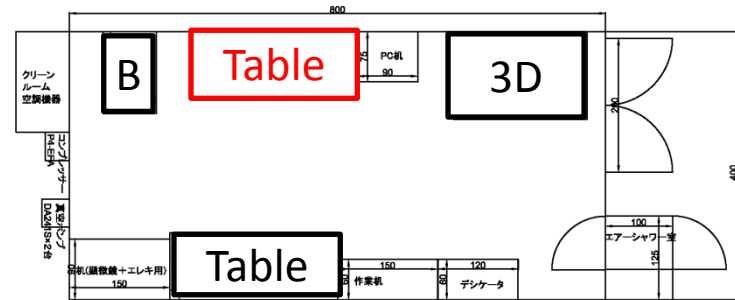
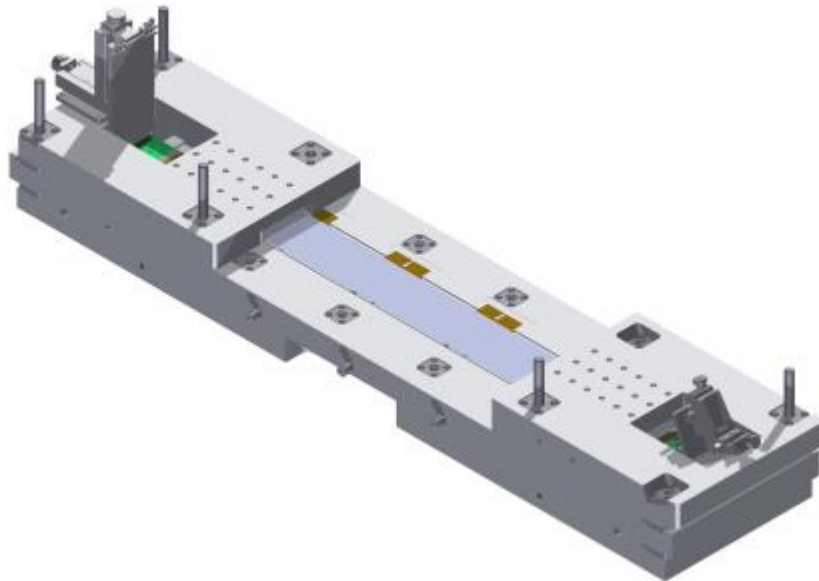


FW&BWProc.19 : Picking up the slant hybrid board.



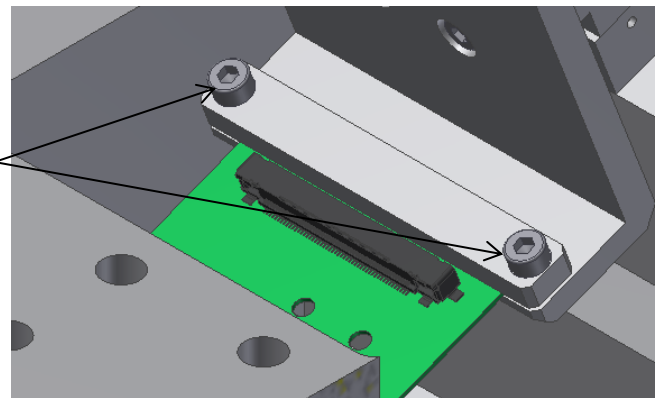
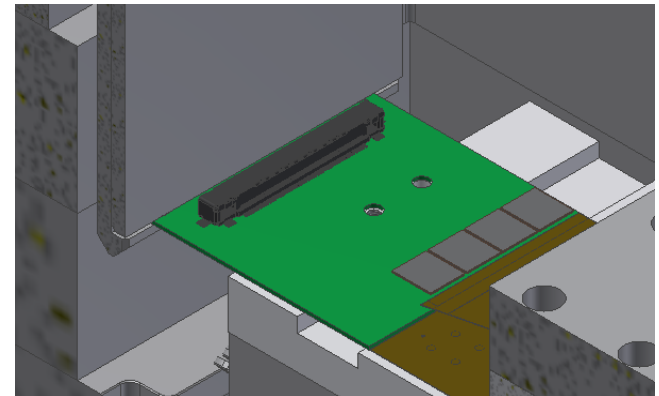
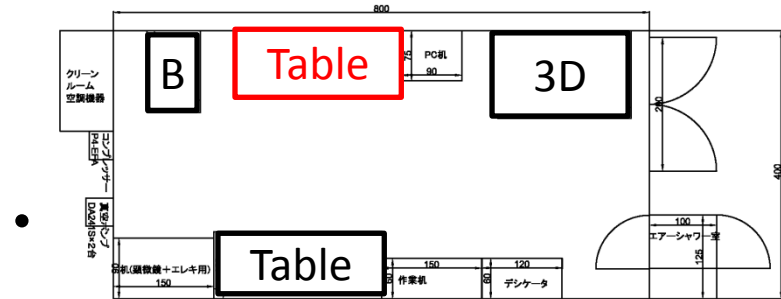
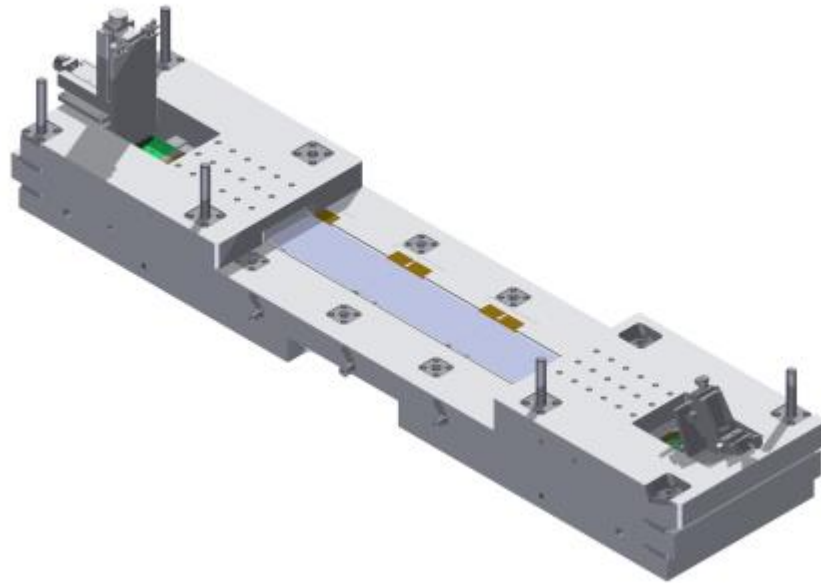
Picking up hybrid board with thin wire.

FW&BWProc.20: Moving the X-stages



Moving the X-stage to the edge of hybrid board

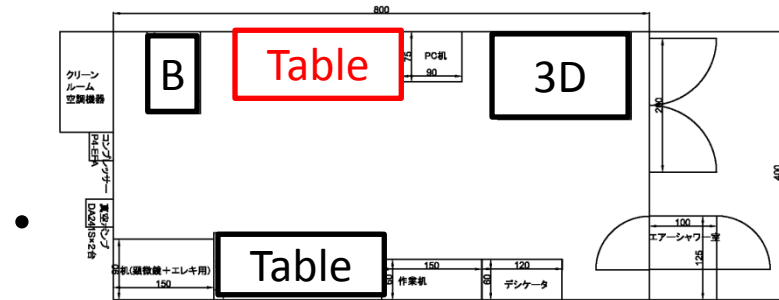
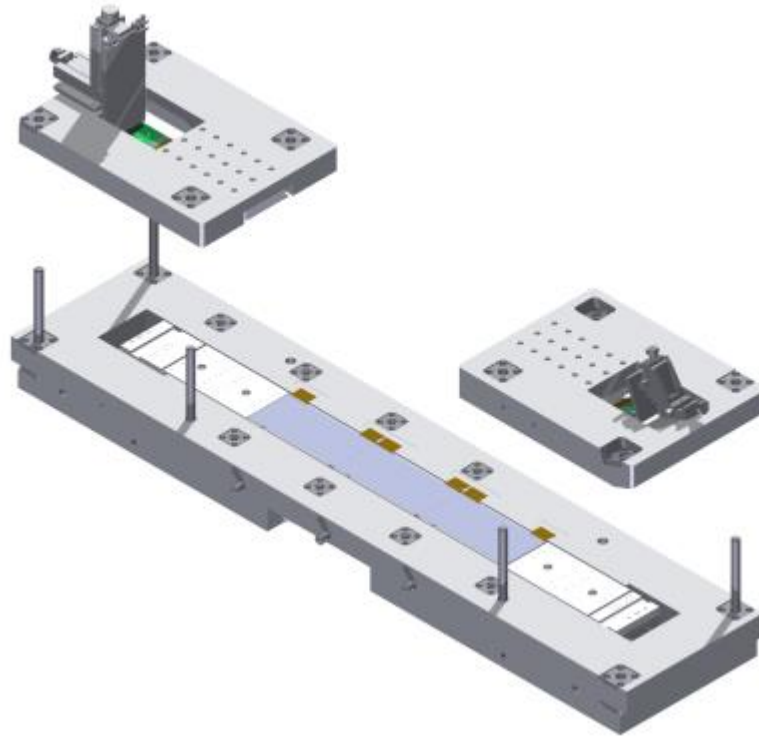
FW&BWProc.21: Clamping the edge of hybridboard



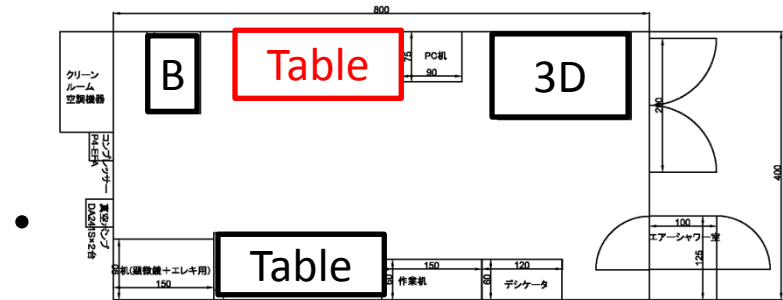
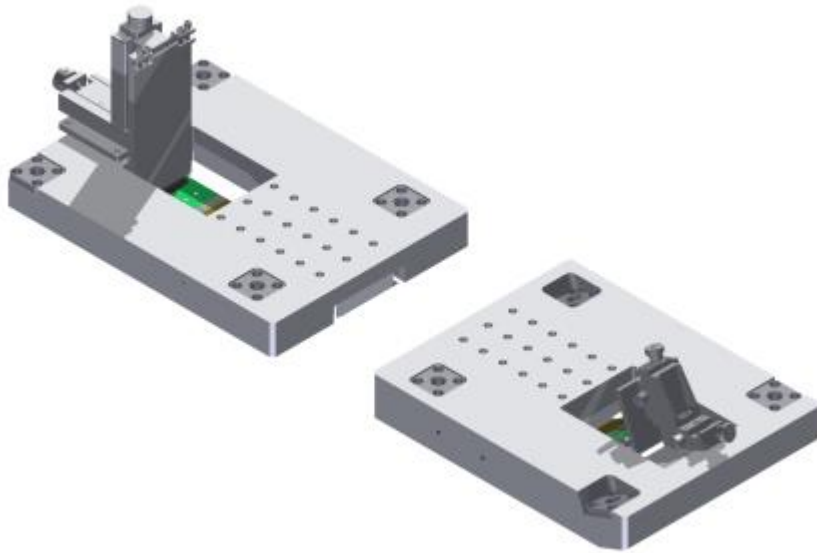
Clamping screw

Clamping the edge of hybrid board with screw

FW&BWProc.22 : Picking up the Slant-jig and Backward-jig.

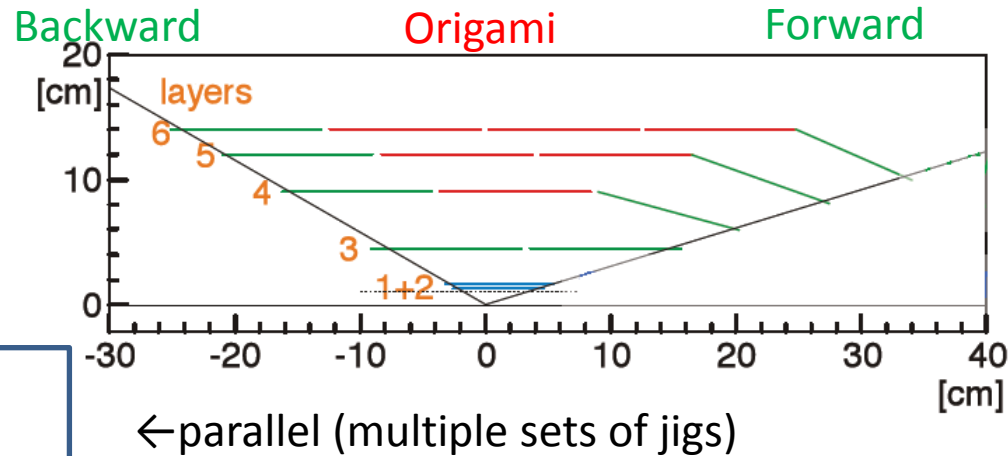


FW&BWProc.23 :



Place jigs at a secure location 😊

SVD ladder assembly flow



Origami PA
gluing

Place DSSDs (rectangle, trapezoidal) onto assembly bench and align them

Backward
assembly

Forward assembly

← parallel
(independent
each other)

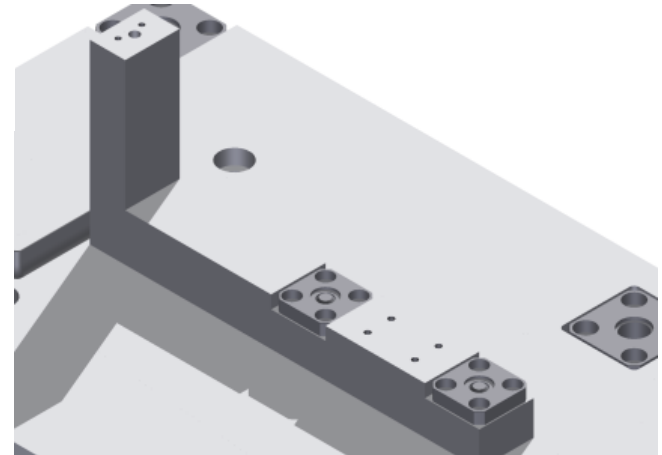
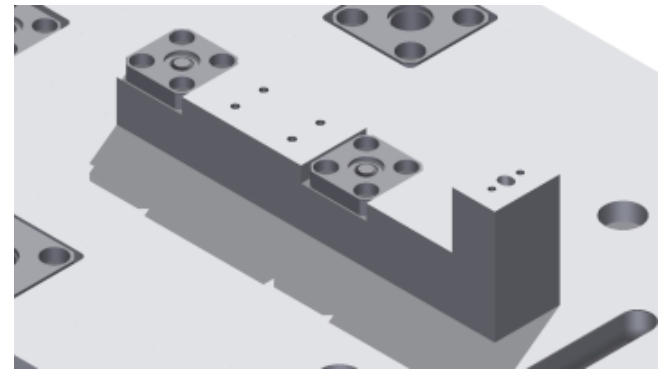
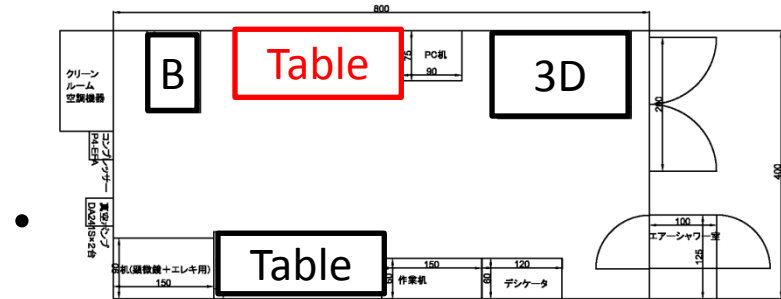
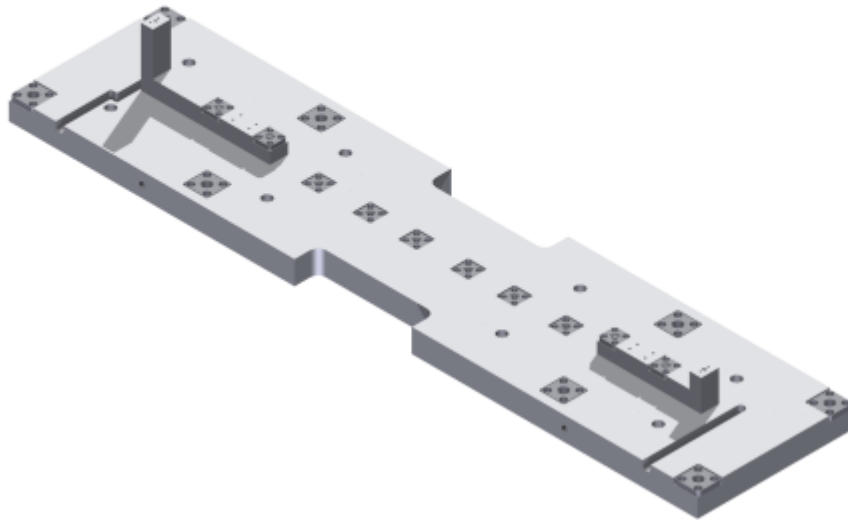
Origami assembly

Glue forward and backward
sensors onto ribs

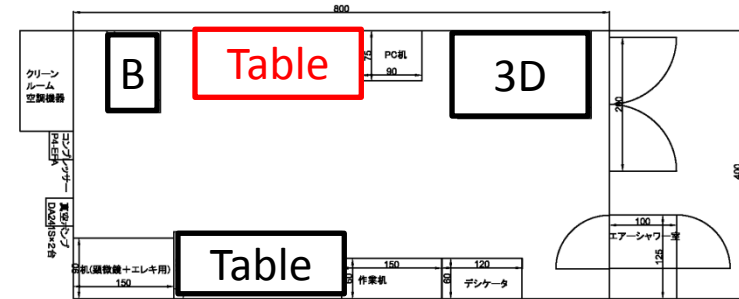
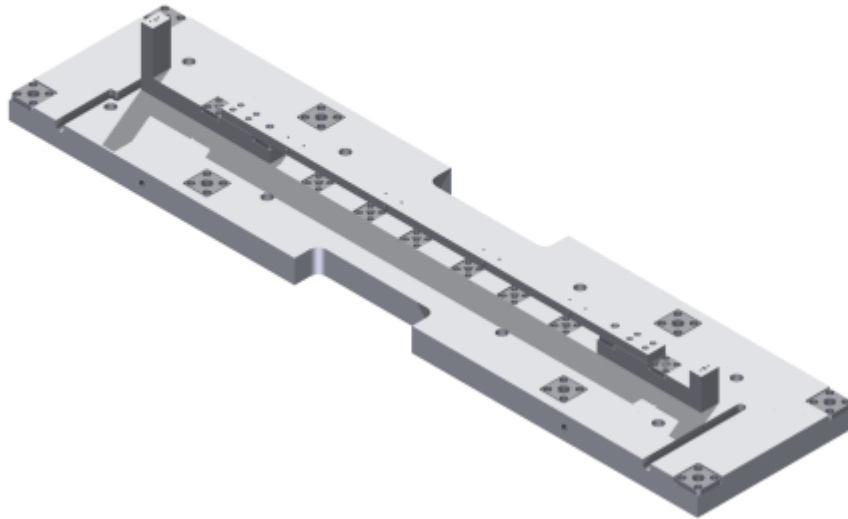
time

Attach Origami sensors to ribs

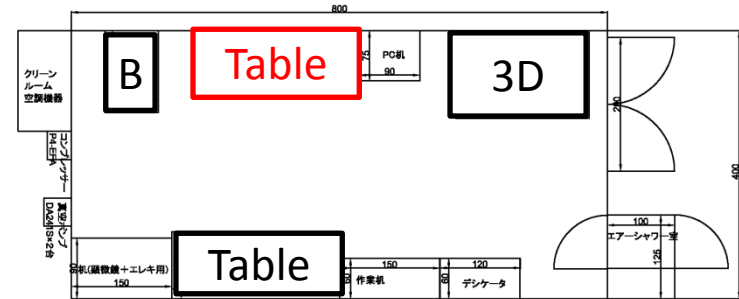
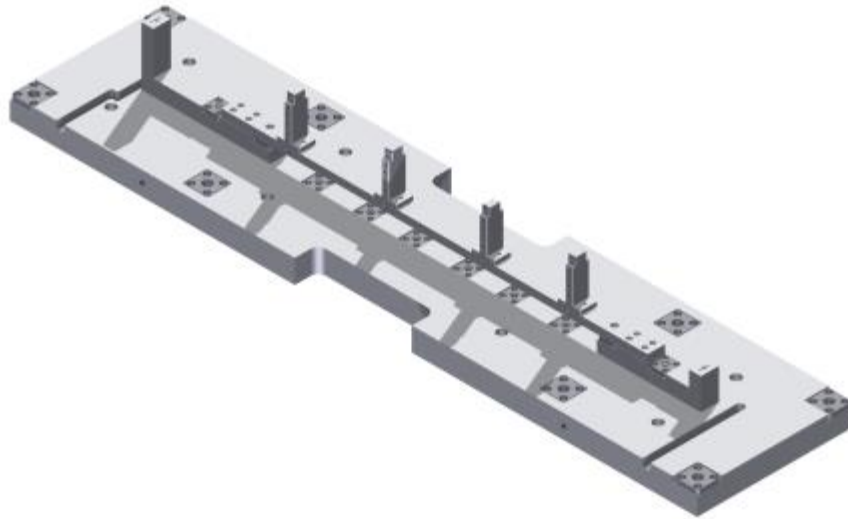
Gluing ribs Proc.01: Placing the FW and BW parts



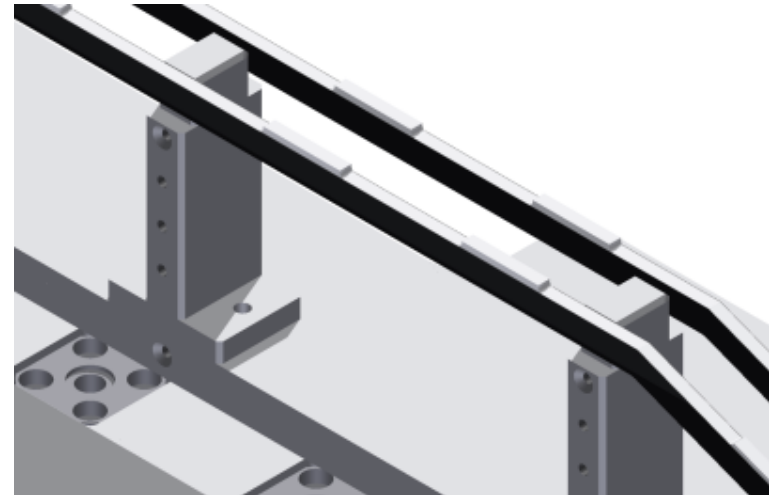
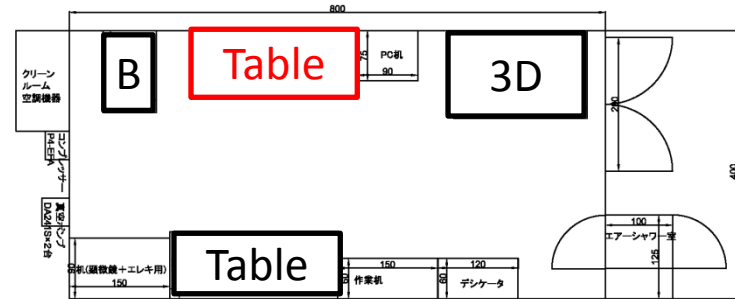
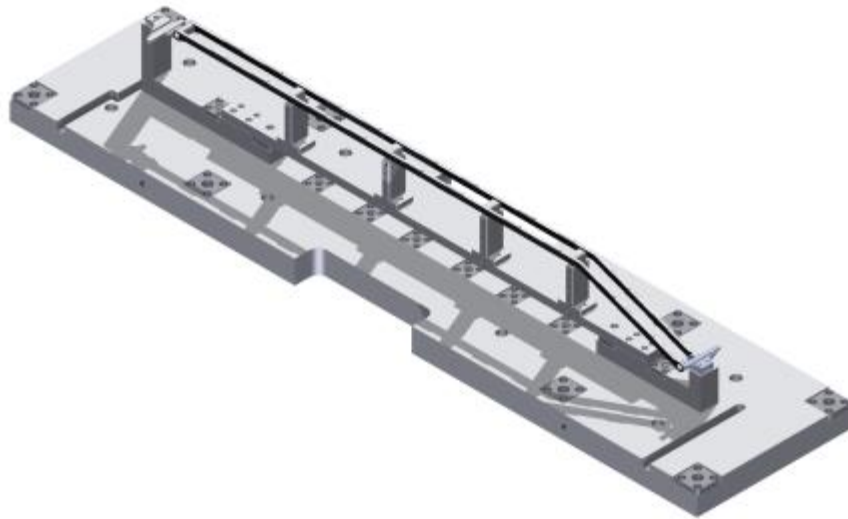
Gluing ribs Proc.02: Placing the bridge and screwing



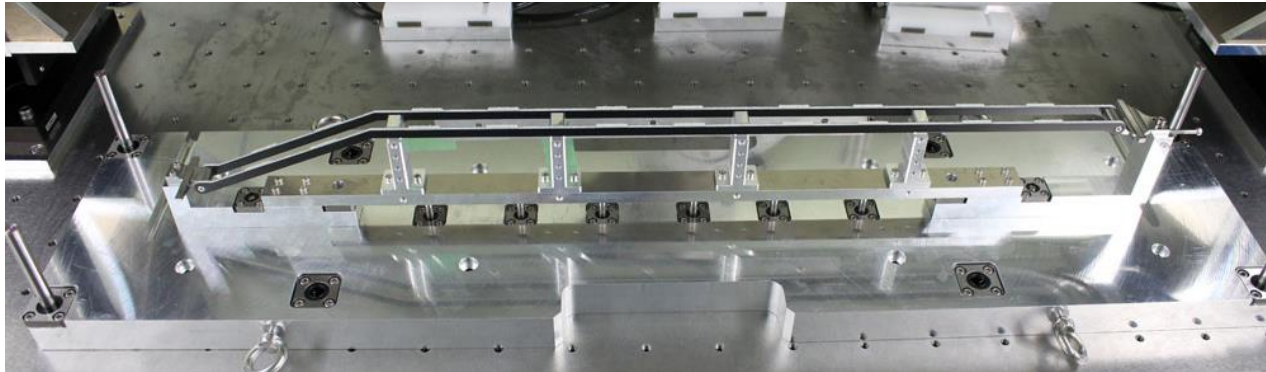
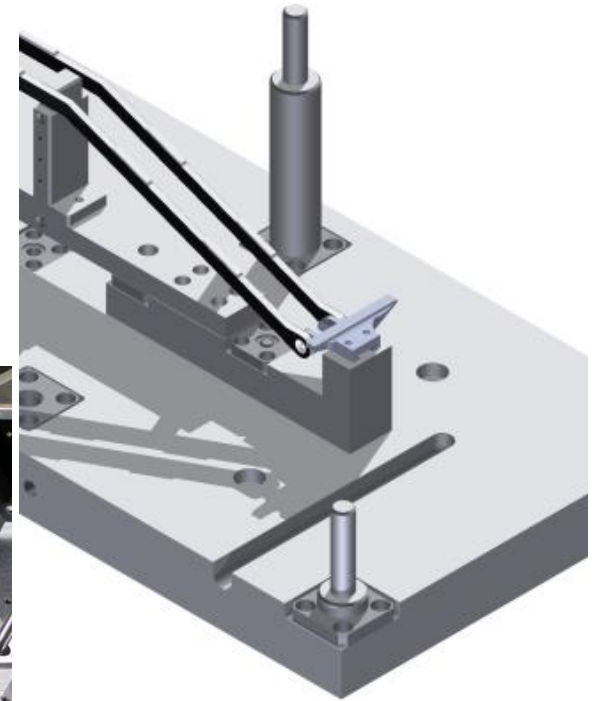
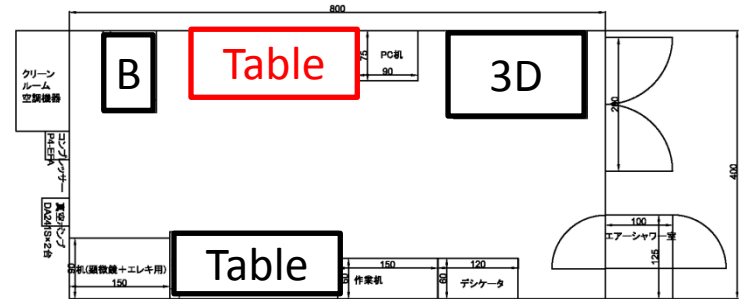
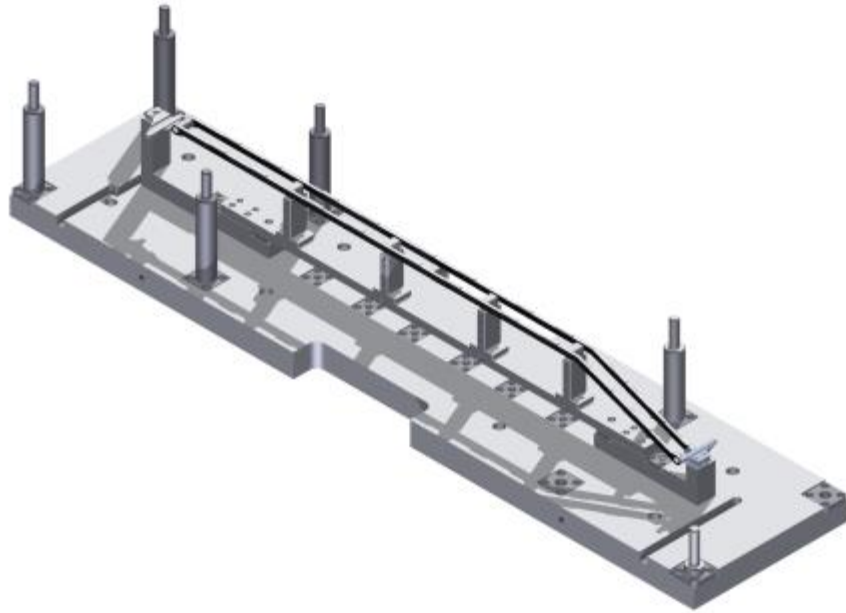
Gluing ribs Proc.03: Placing the supports



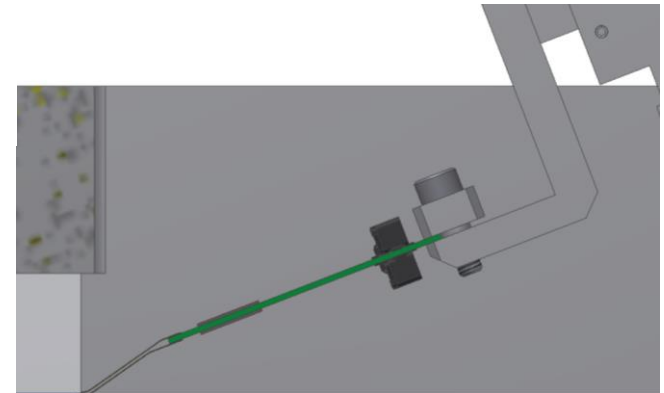
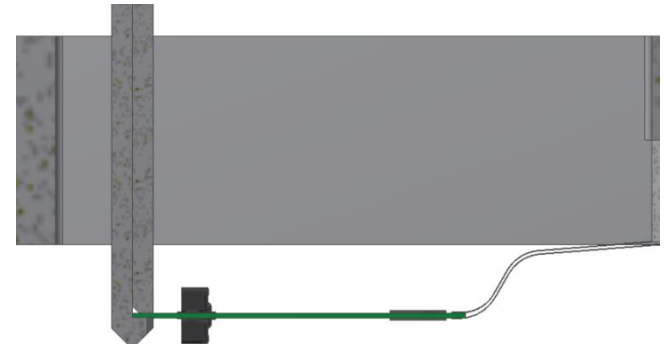
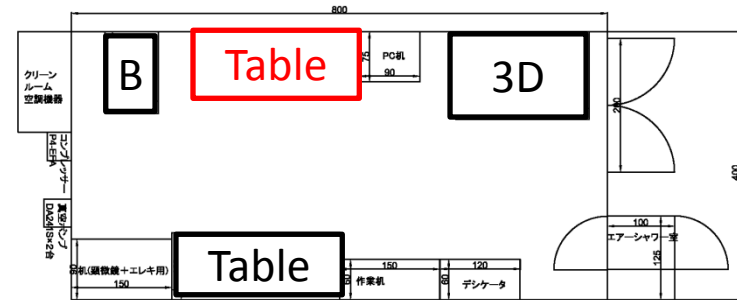
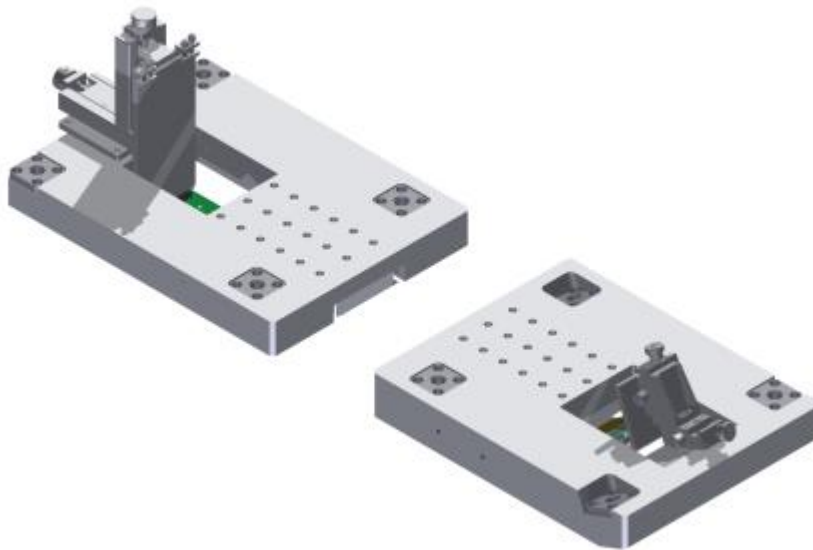
Gluing ribs Proc.04: Placing the ribs



Gluing ribs Proc.05: Placing the stopper pins

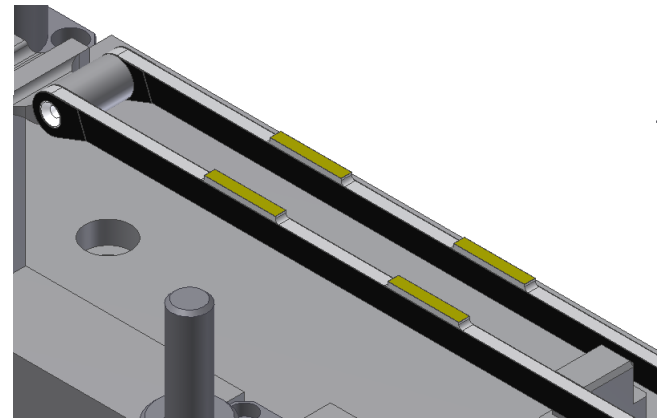
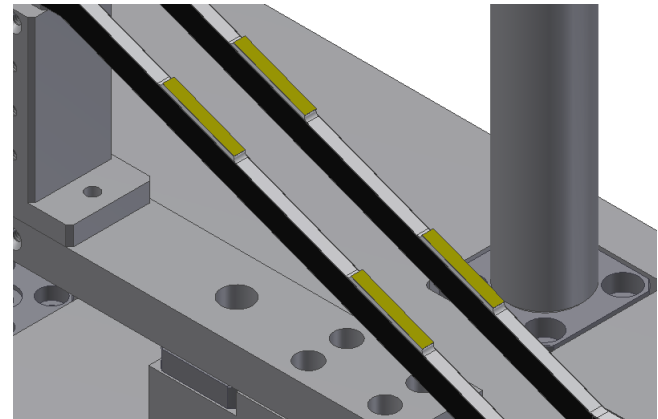
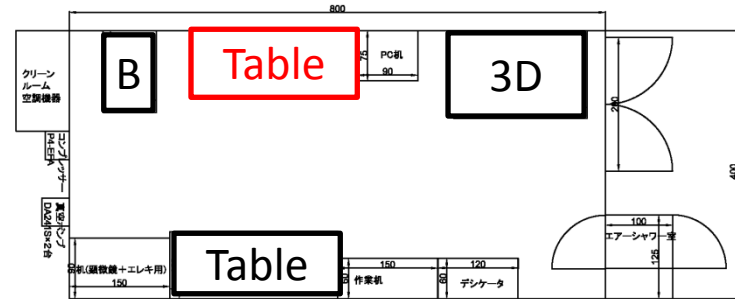
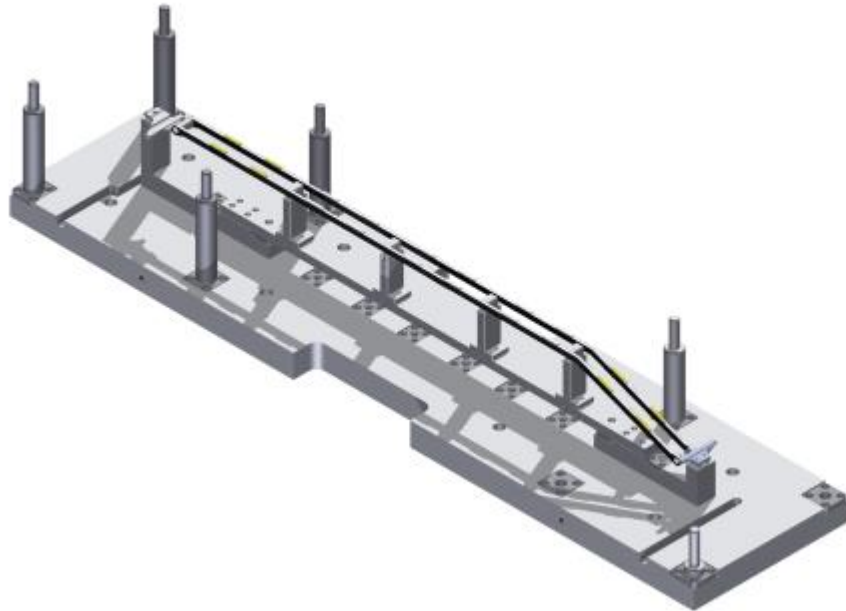


Gluing ribs Proc.06: Moving the boards to the position.

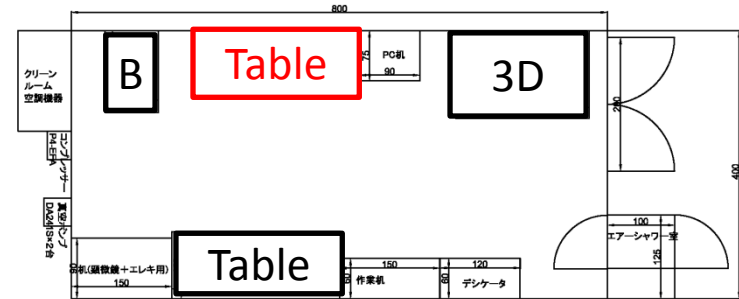
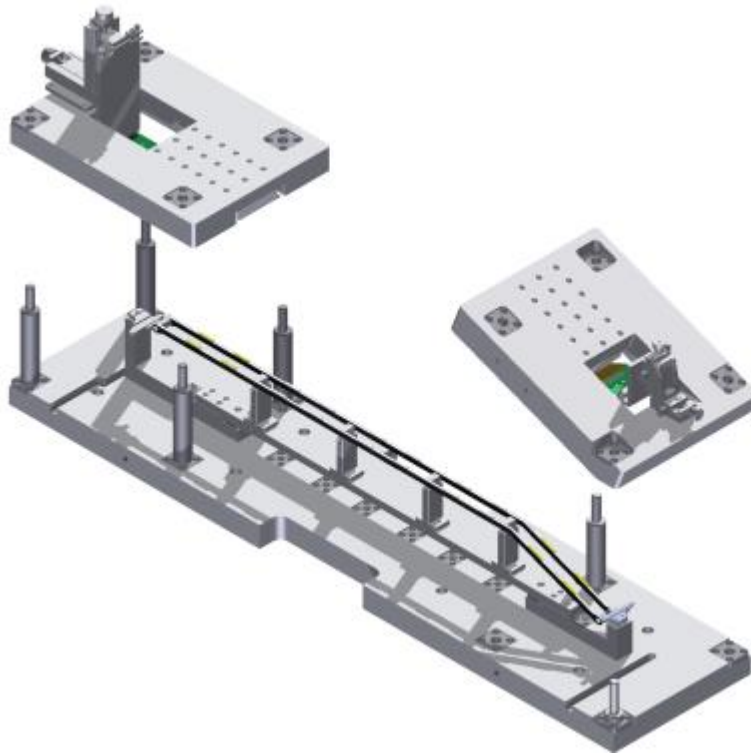


Moving the hybrid boards to the proper positions.

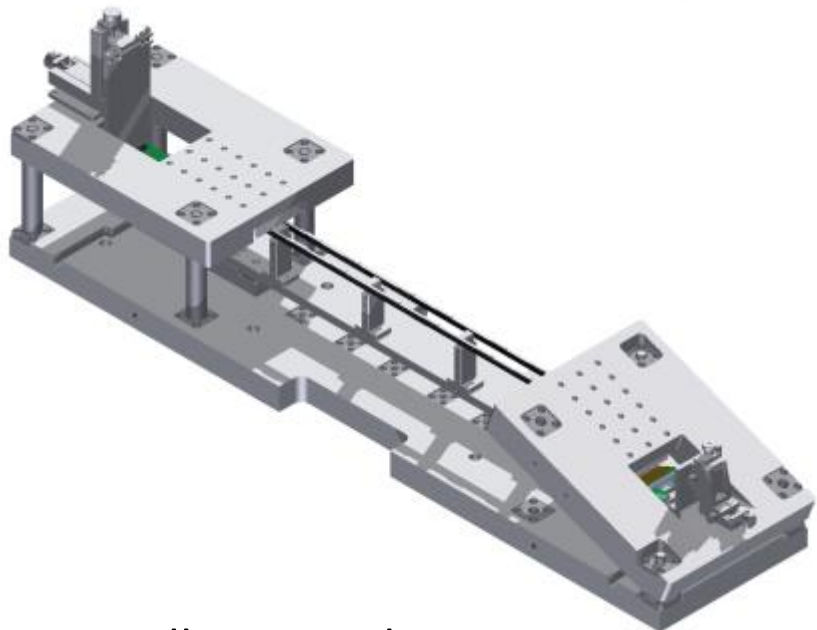
Gluing ribs Proc.07: Dispensing glue on the ribs



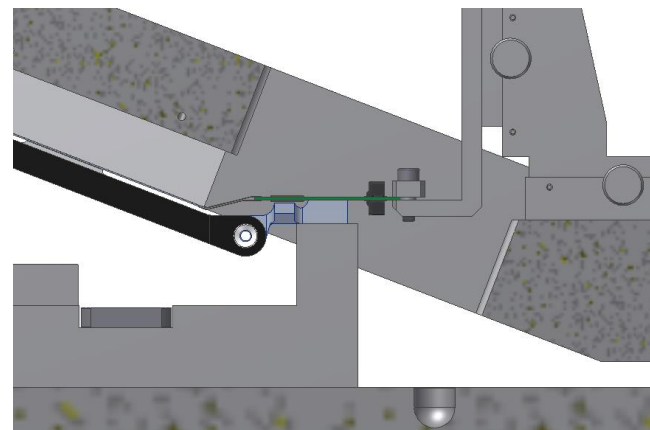
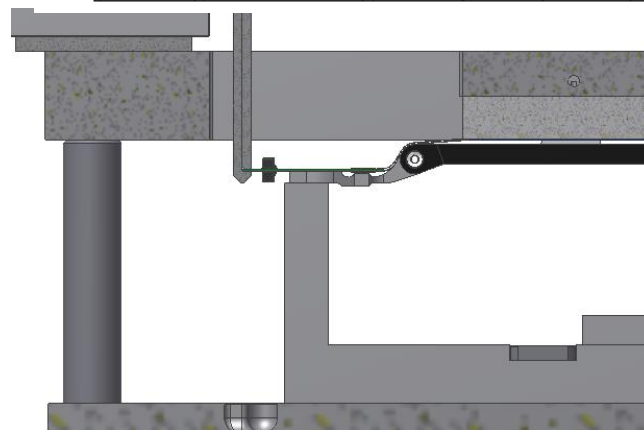
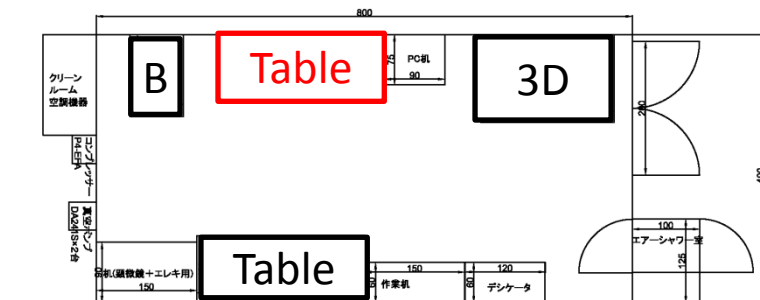
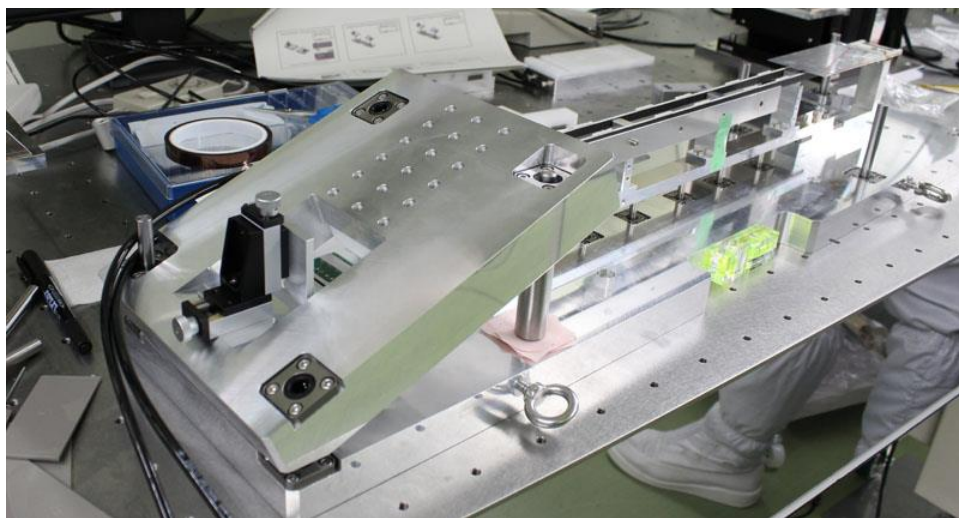
Gluing ribs Proc.08 : Placing the Slant-jig and Backward-jig



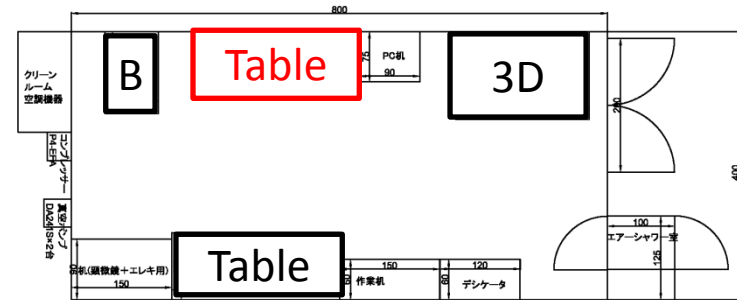
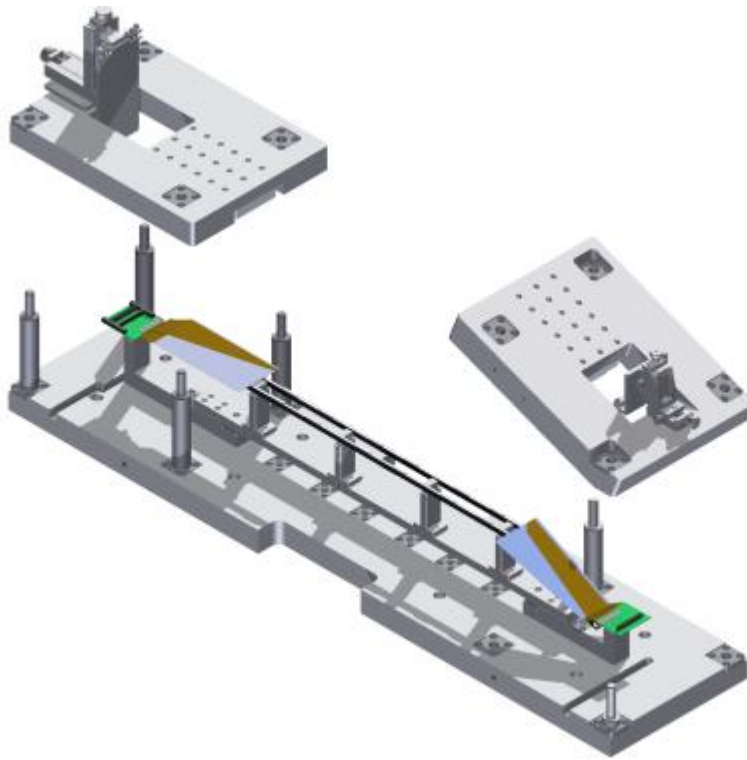
Gluing ribs Proc.09: Gluing and connecting the board on the MB.



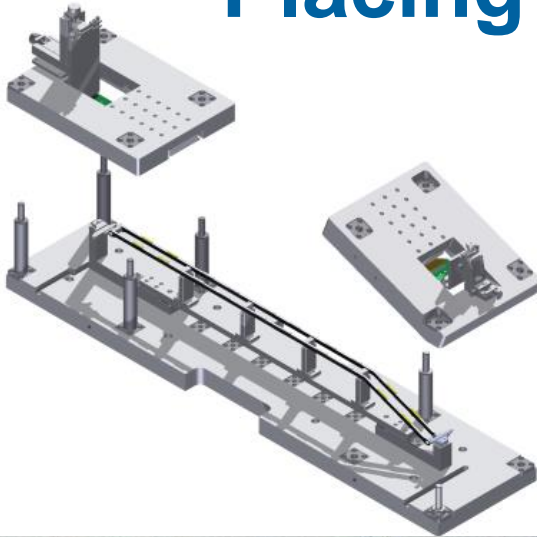
The jigs will stop at the proper Z position.



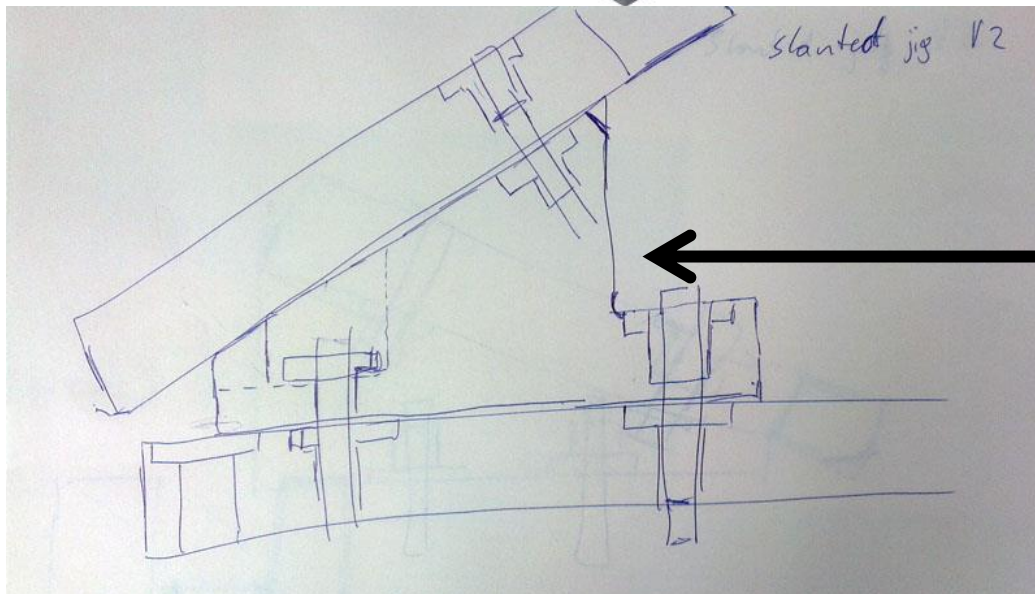
Gluing ribs Proc.10: Picking up the Slant-jig and Backward-jig



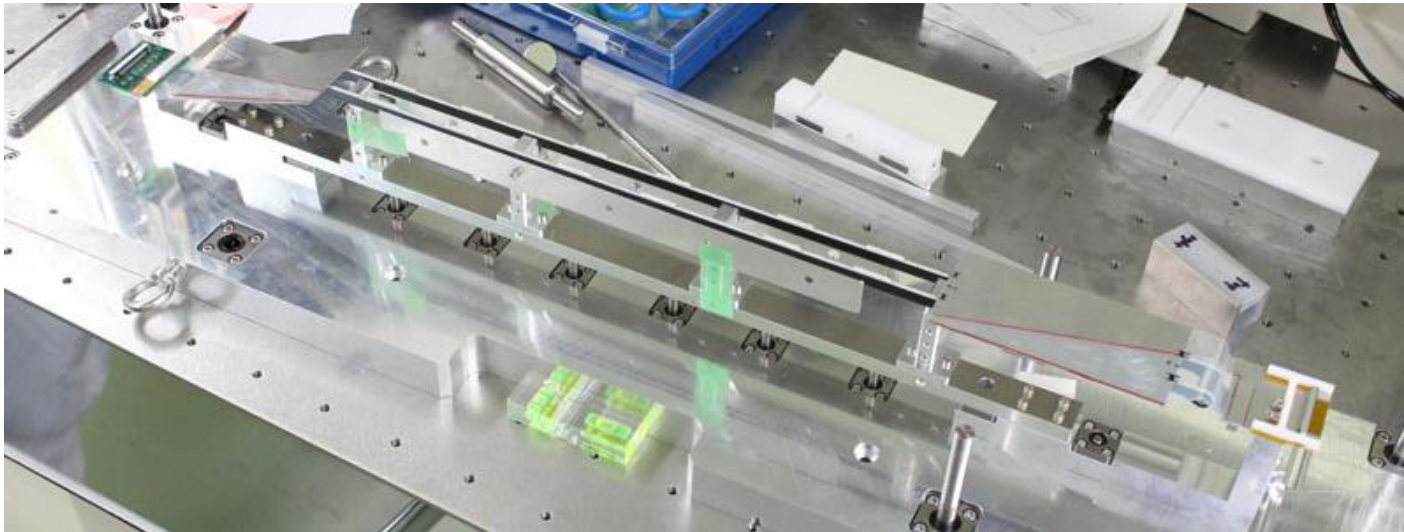
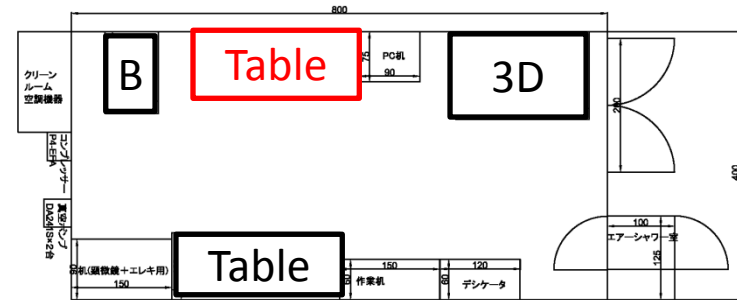
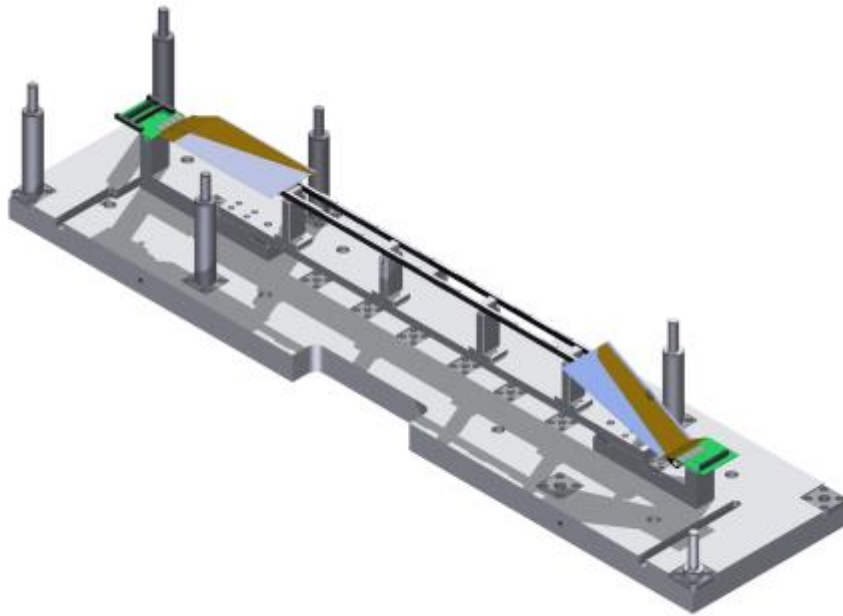
Placing Slant and BW parts



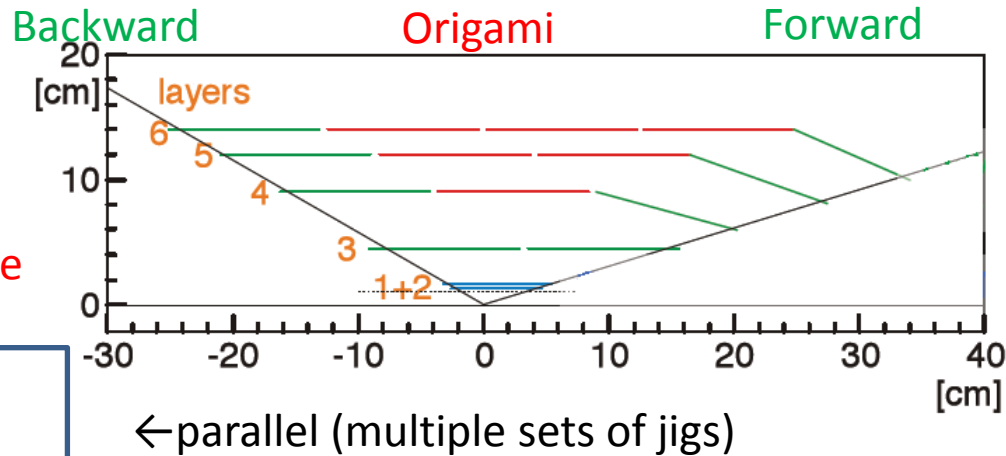
- Precision of pins poor
- Original Idea:
 - Angle of slanted sensor is defined by slant jig, 2 pins and linear bushings
 - Not precise enough
 - Fragile setup
- Possible solution:
 - Use two wedge shaped jigs to determine angle
 - Allows to use high precision pins
 - Needs to be verified



Gluing ribs Proc.11:



SVD ladder assembly flow



Common Procedure

Origami PA
gluing

Place DSSDs (rectangle, trapezoidal) onto assembly bench and align them

Backward
assembly

Forward assembly

← parallel
(independent
each other)

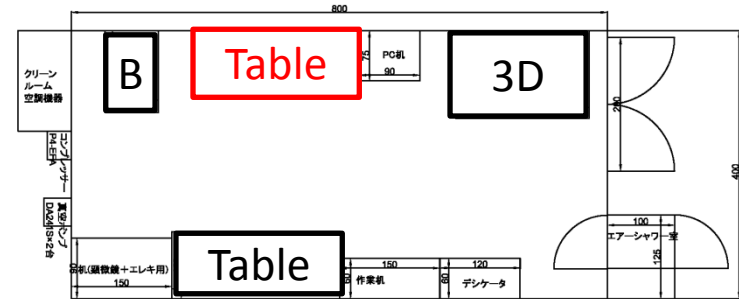
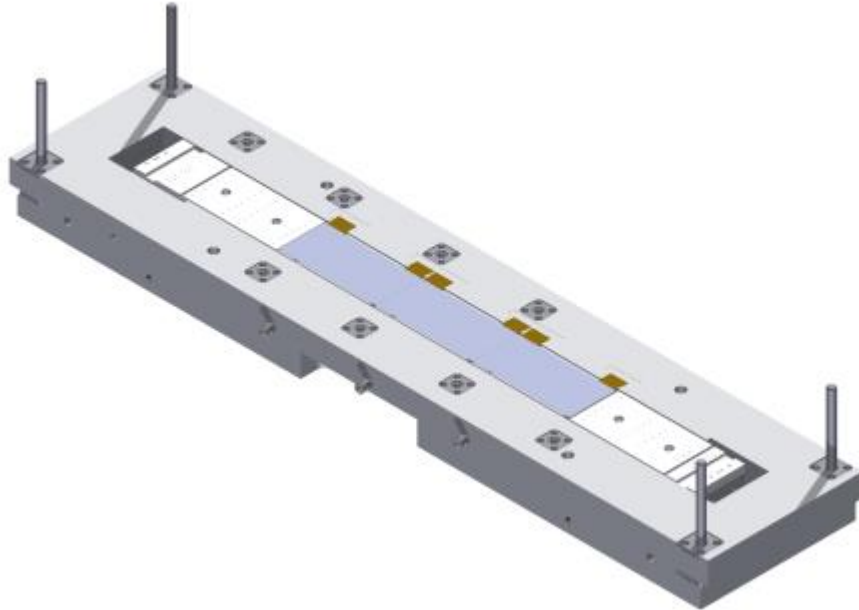
Origami assembly

Glue forward and backward
sensors onto ribs

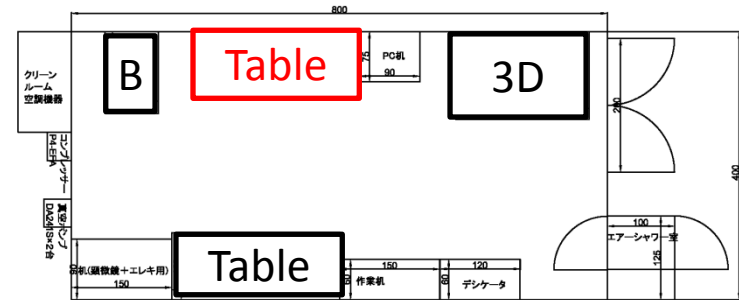
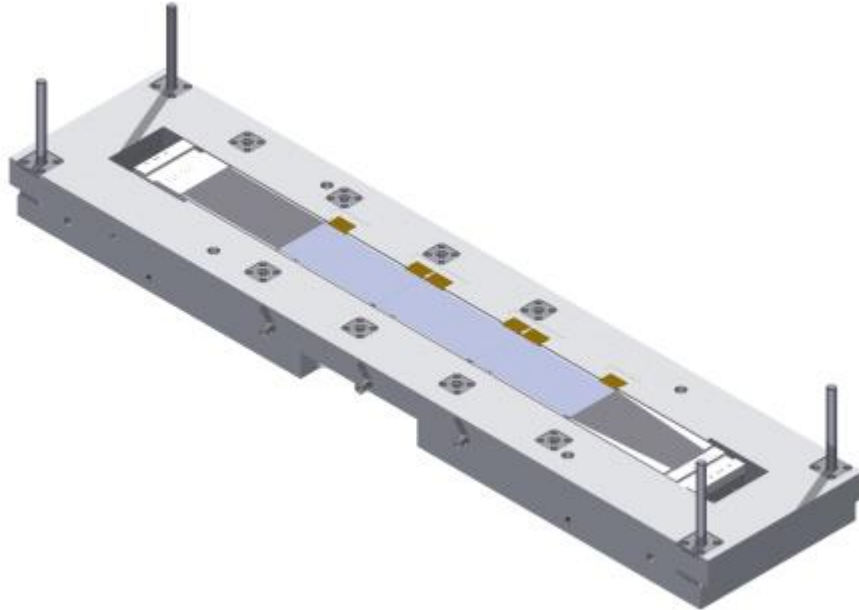
time

Attach Origami sensors to ribs

OrigamiProc.01: Preparing the Assembly-bench

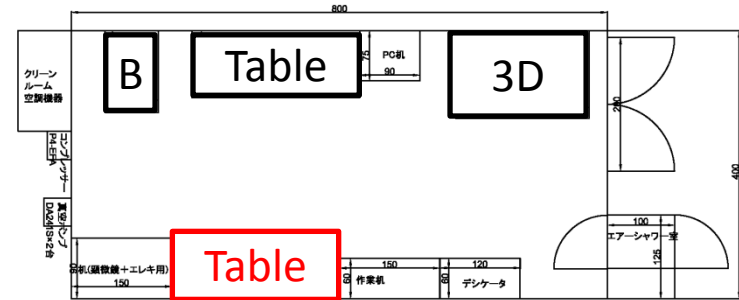
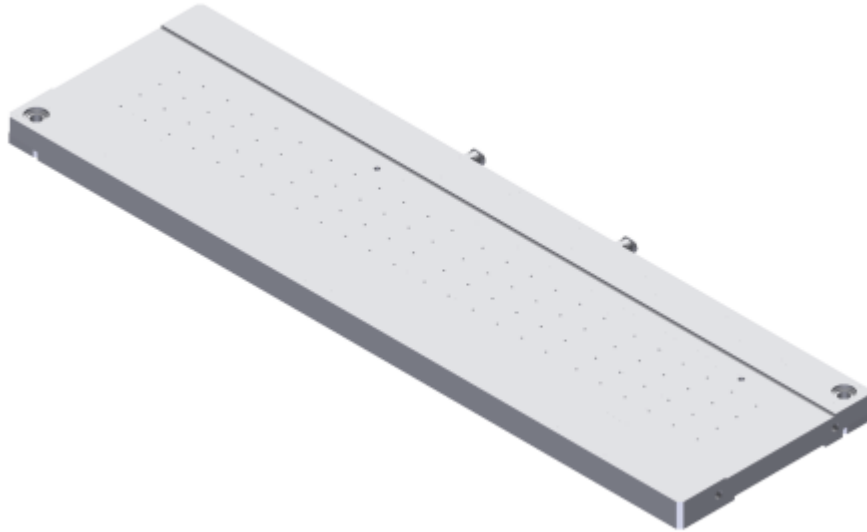


OrigamiProc.02 : Placing the dummy FW and BW DSSD

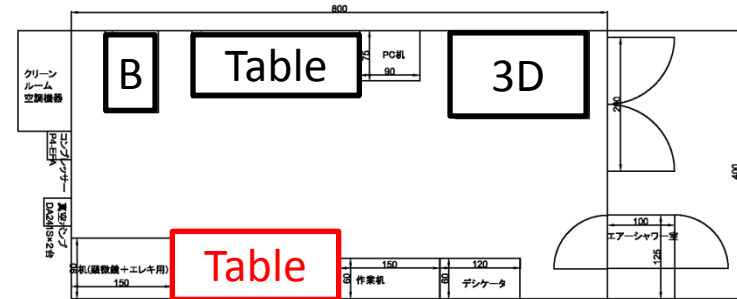
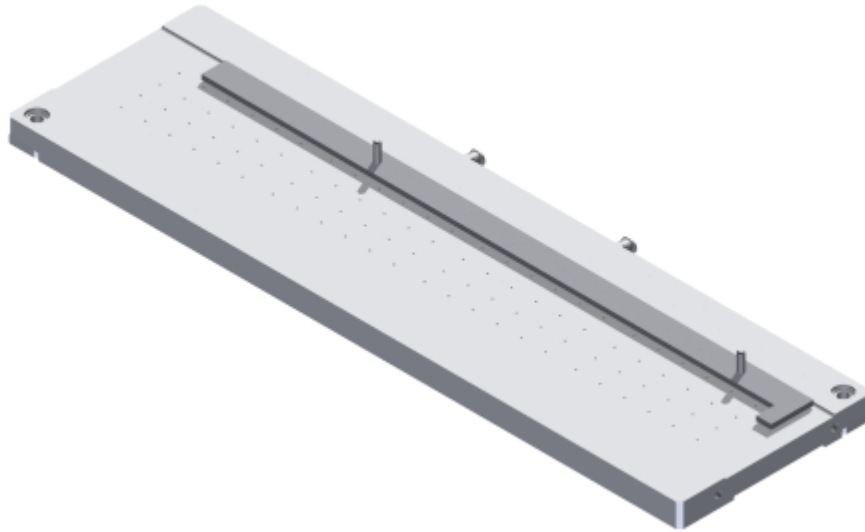


Dummy DSSDs are just used for making flat Z surface.

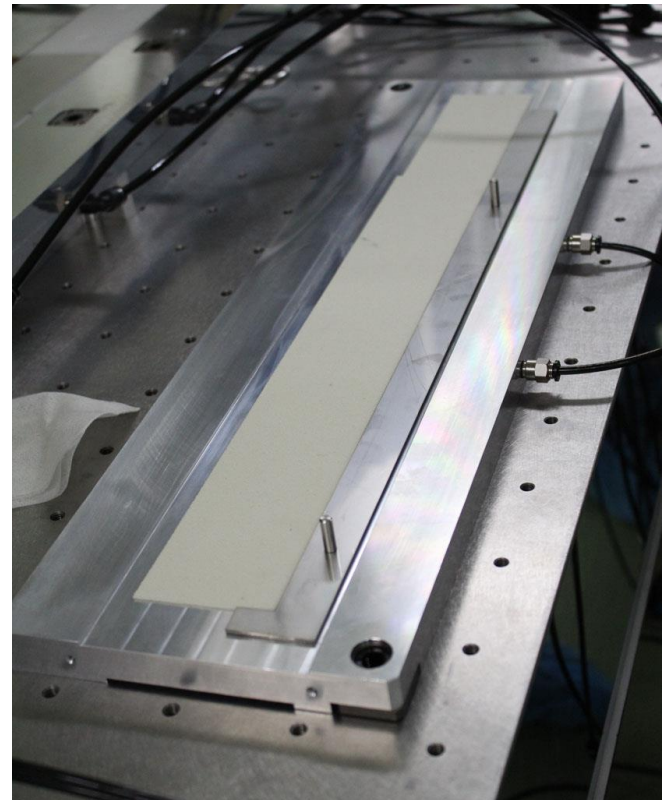
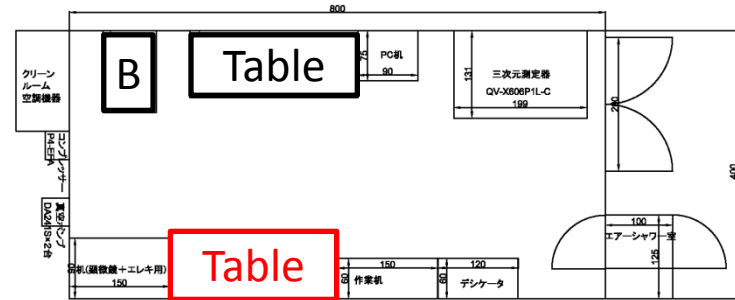
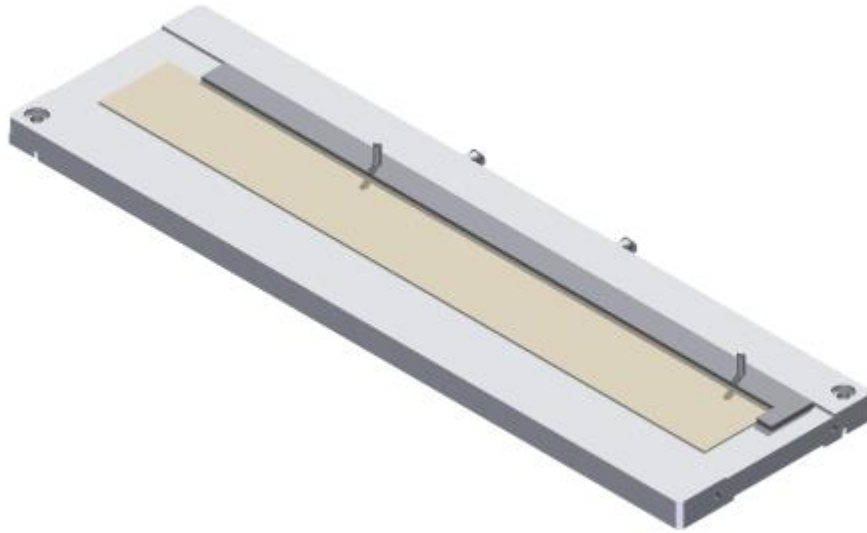
OrigamiProc.03 : Preparing the AIREX-jig



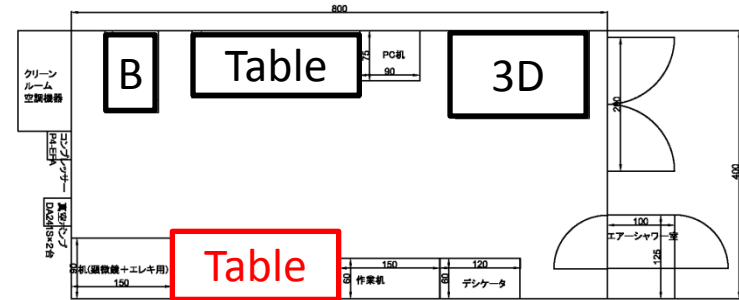
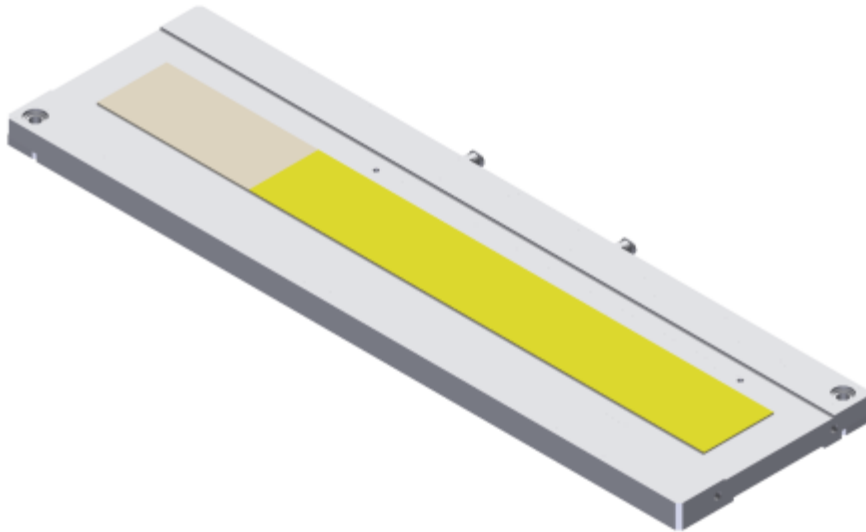
OrigamiProc.04: Placing the AIREX stopper



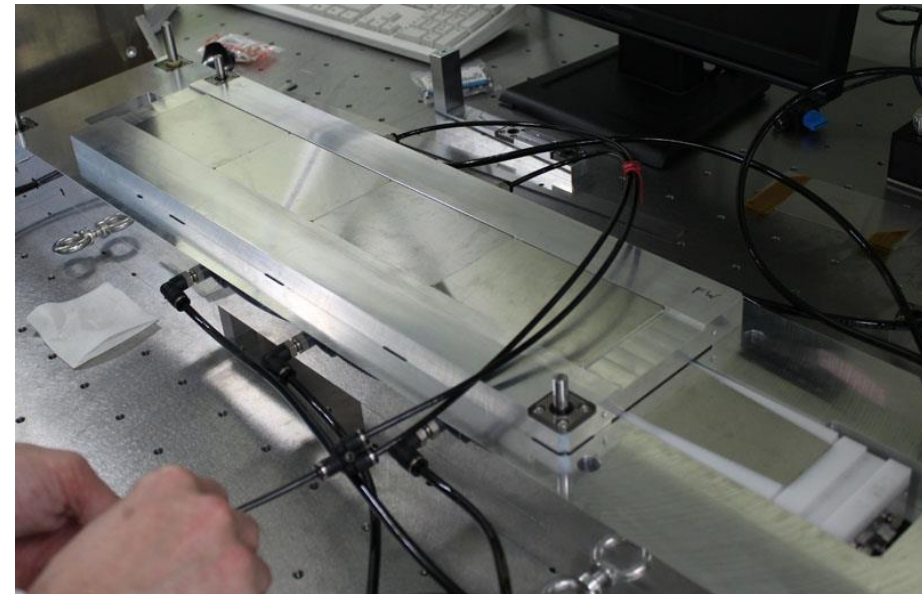
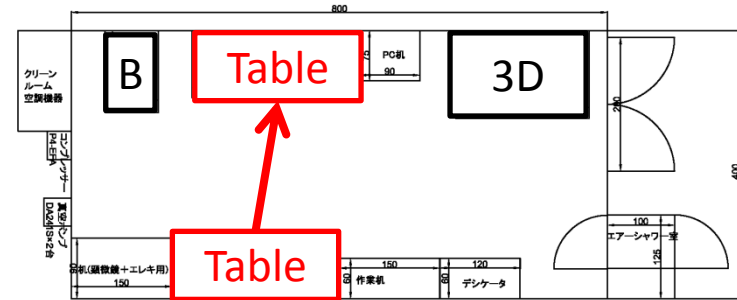
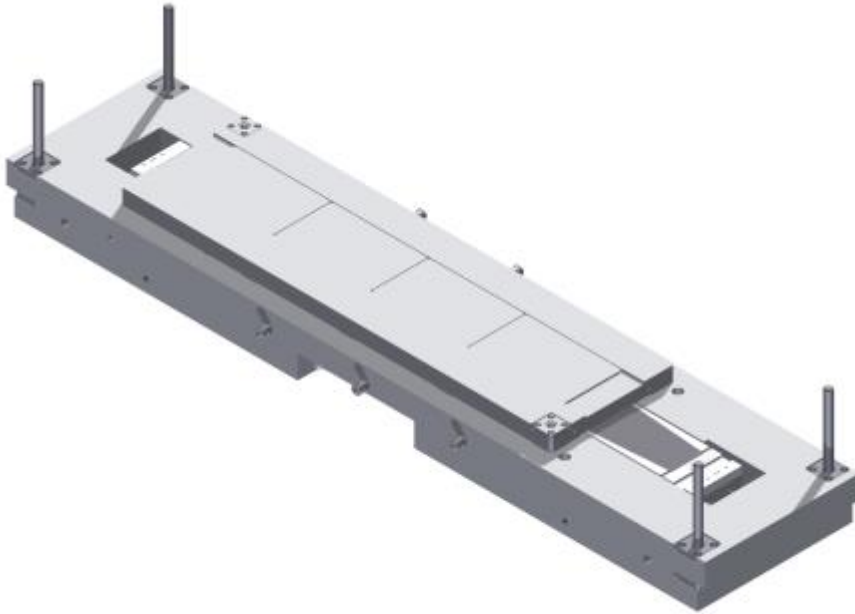
OrigamiProc.05 : Placing the AIREX



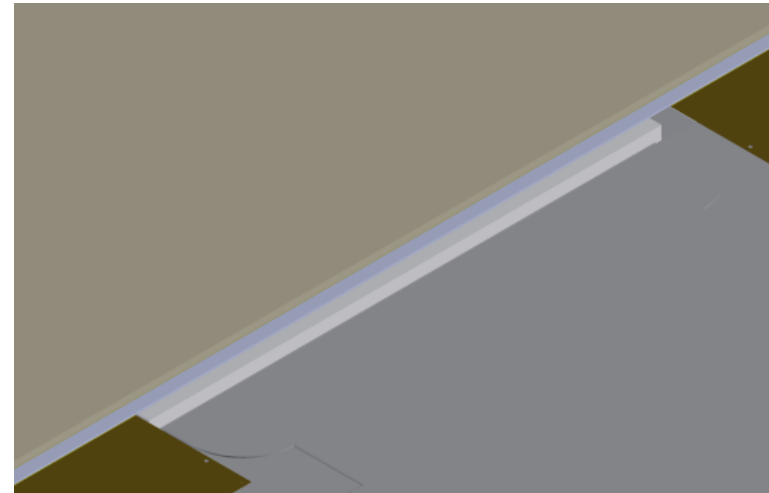
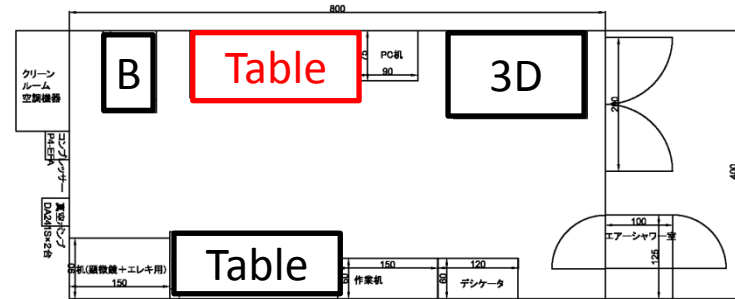
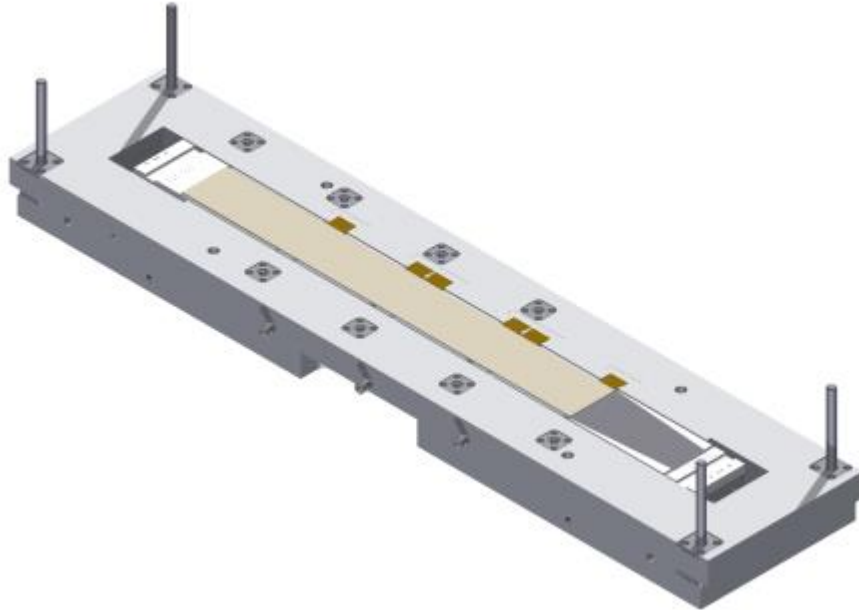
OrigamiProc.06: Removing AIREX stopper. Dispensing glue



OrigamiProc.07: Gluing AIREX

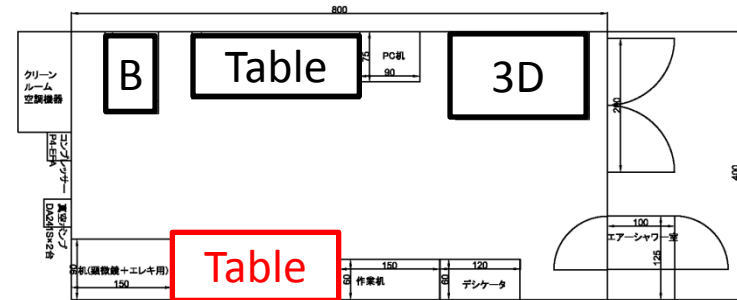
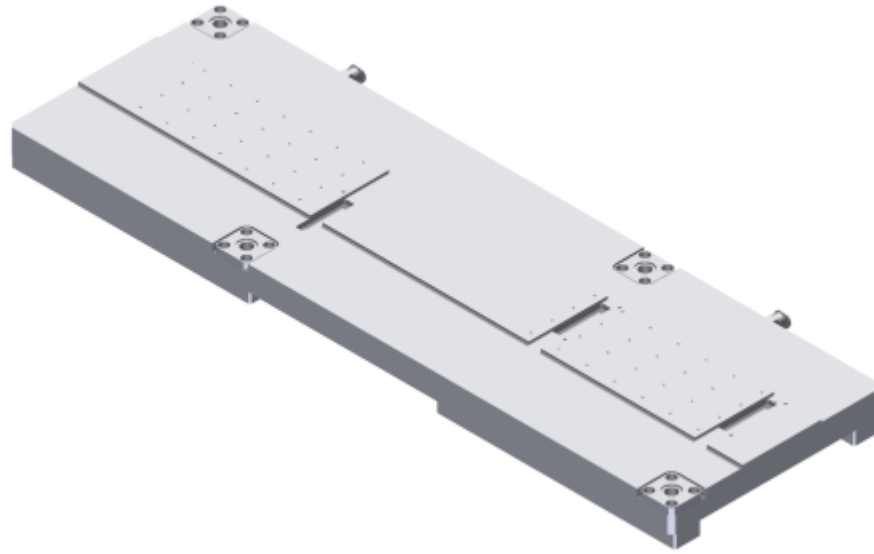


OrigamiProc.08: Removing AIREX-jig

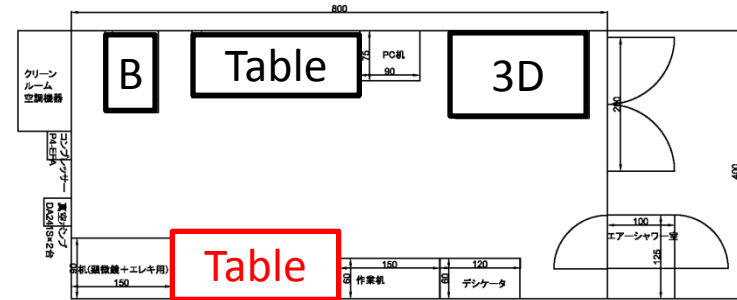
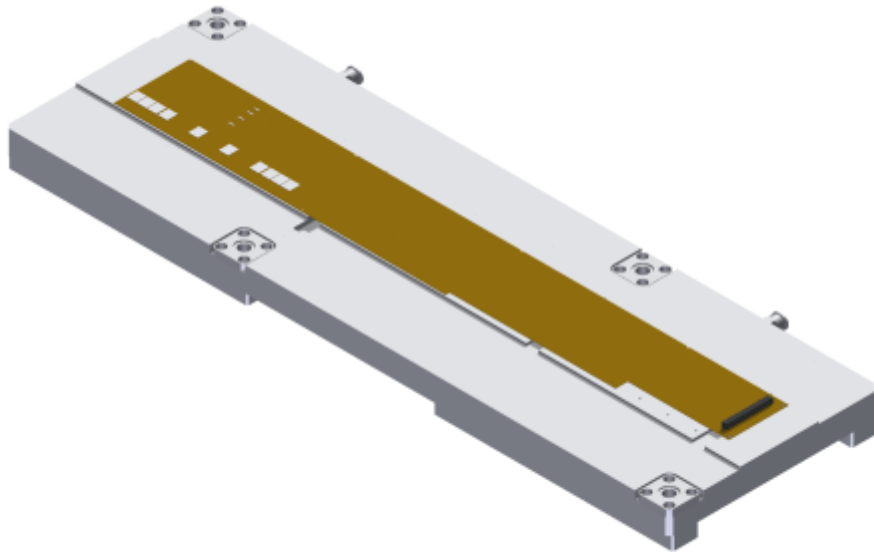


Dummy BW-DSSD is not glued with the AIREX

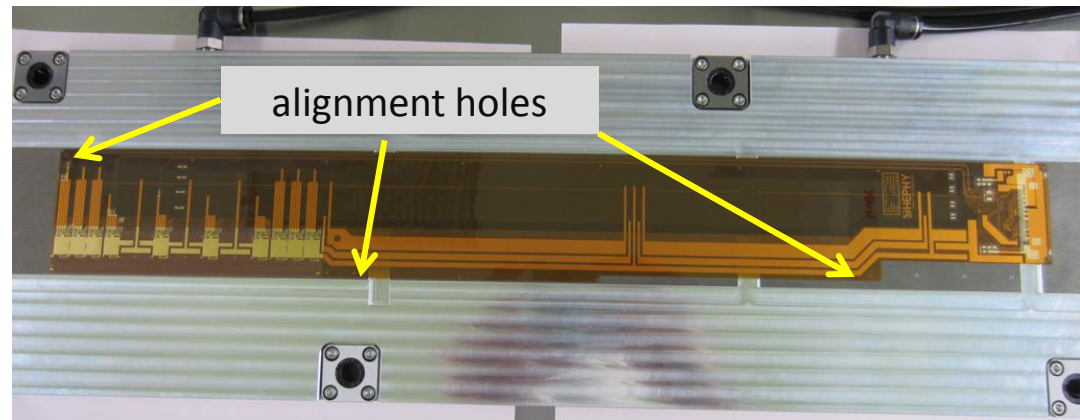
OrigamiProc.09: Preparing the Origami-alignment-jig



OrigamiProc.10: Placing Origami(CE). Wire-binding APV25



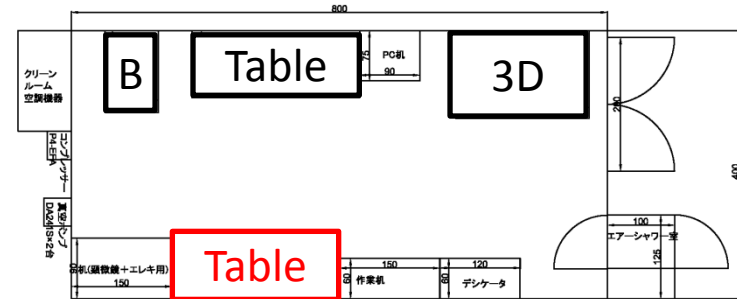
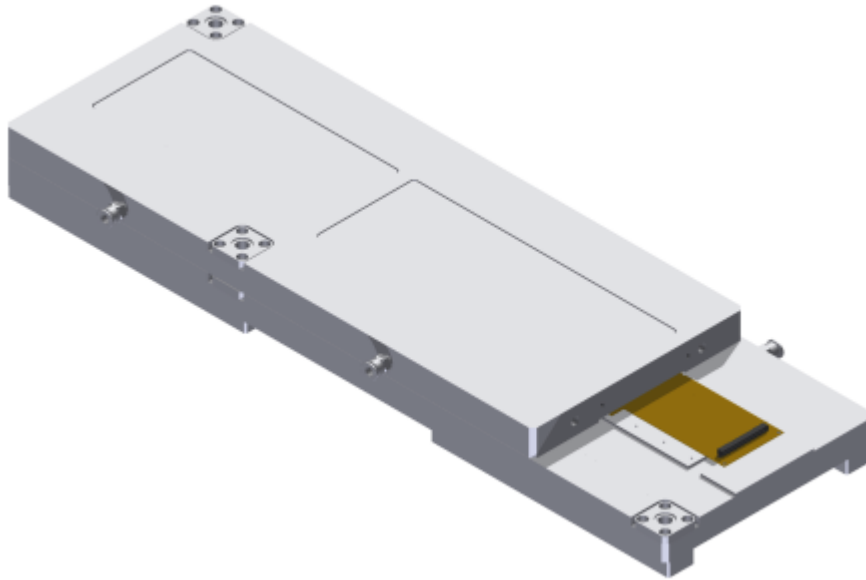
Origami(CE) can be aligned by alignment holes



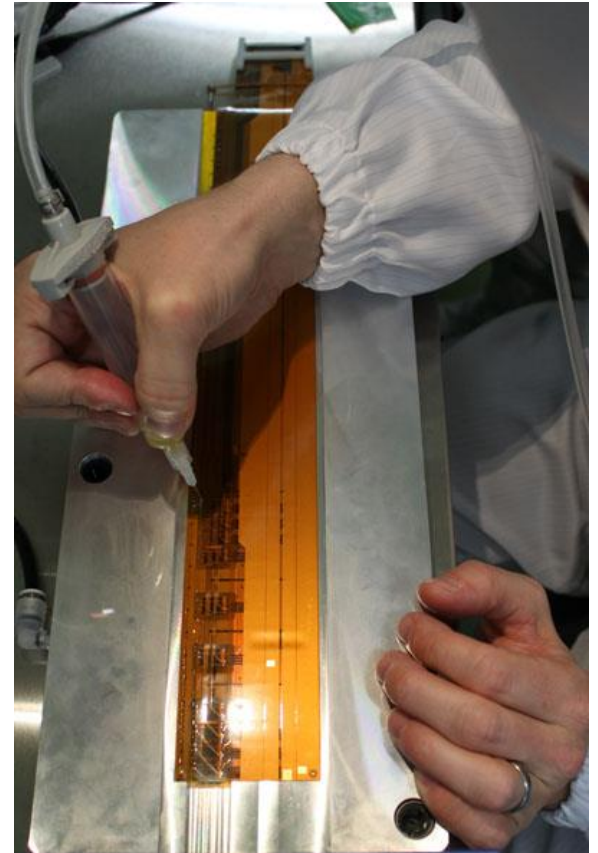
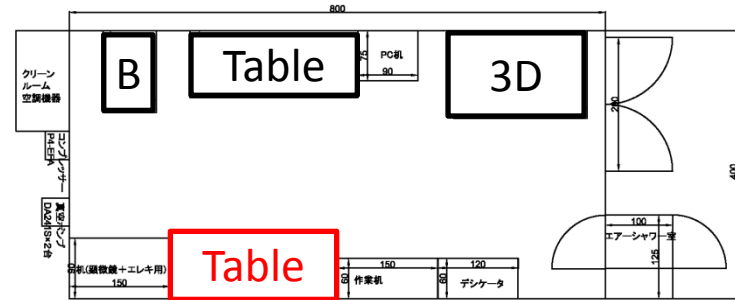
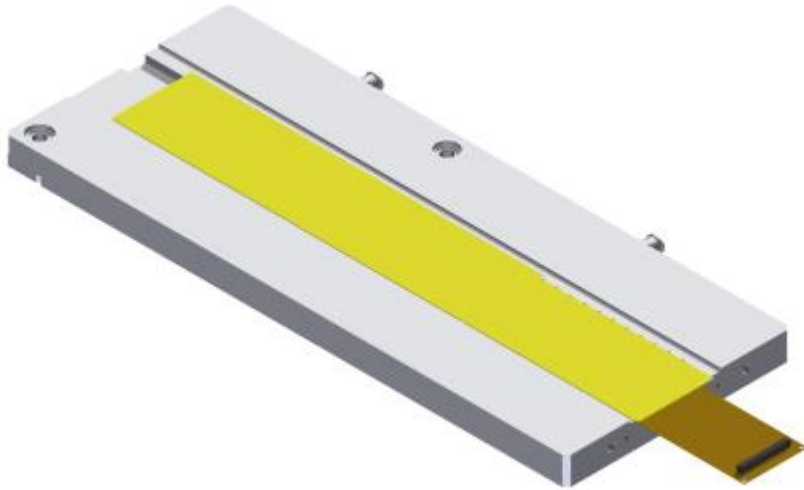
Mechanical QA: Visual inspection of bonding wires

Electrical QA: Readout test with APVDAQ

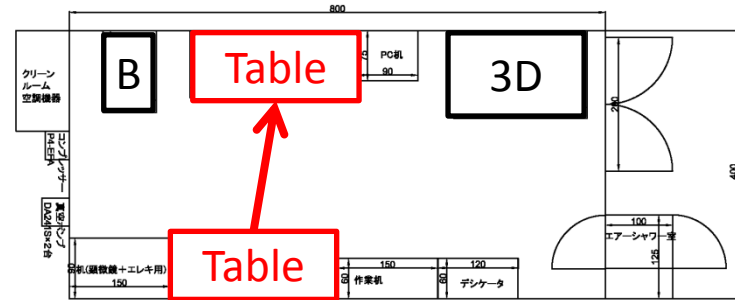
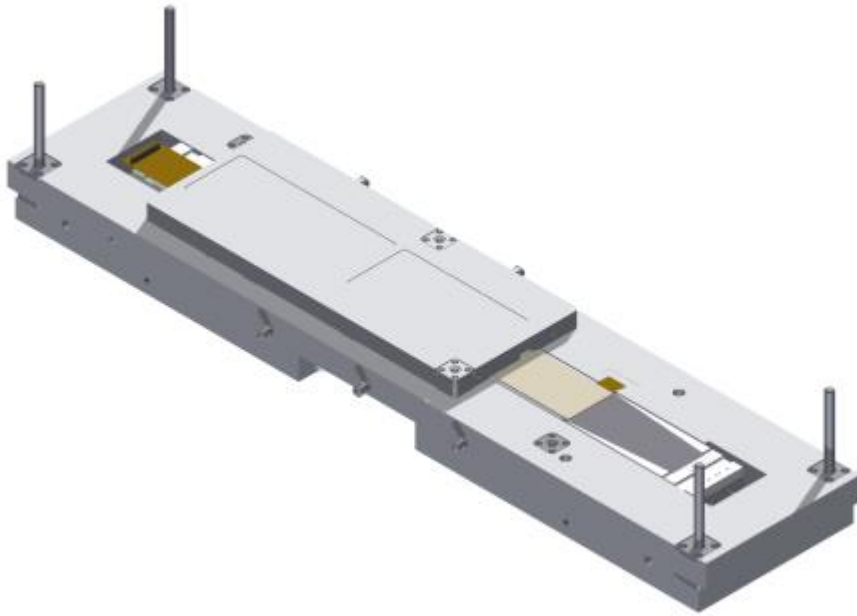
OrigamiProc.11: Placing Origami(CE)-jig.



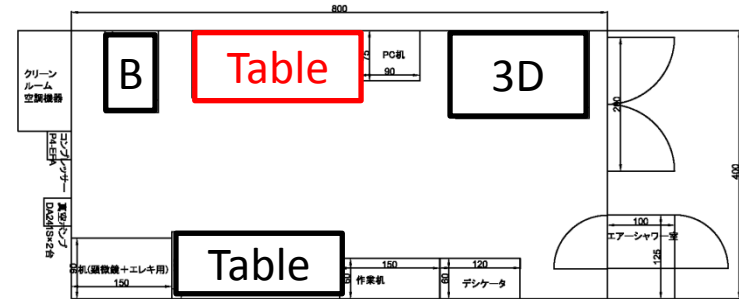
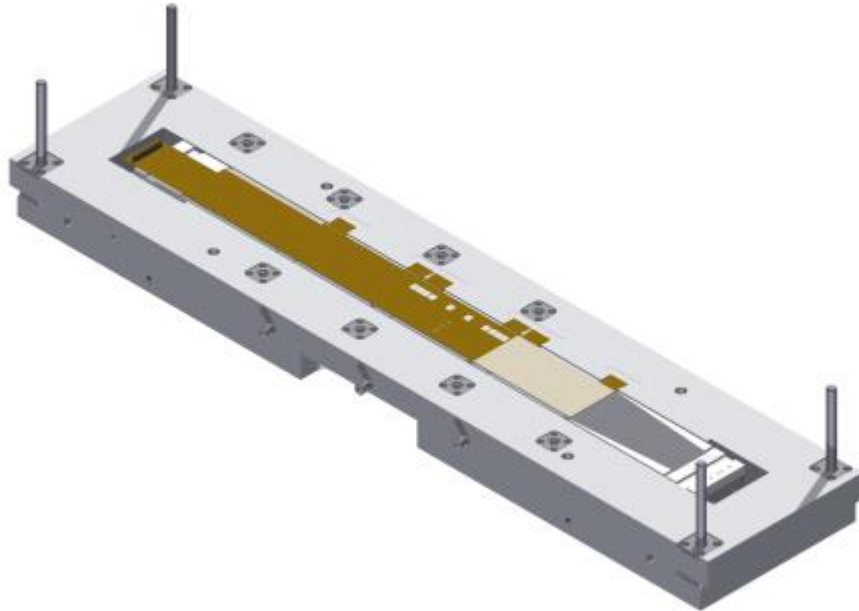
OrigamiProc.12: Dispensing glue.



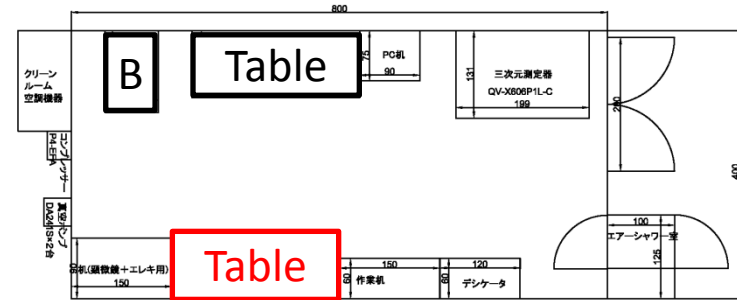
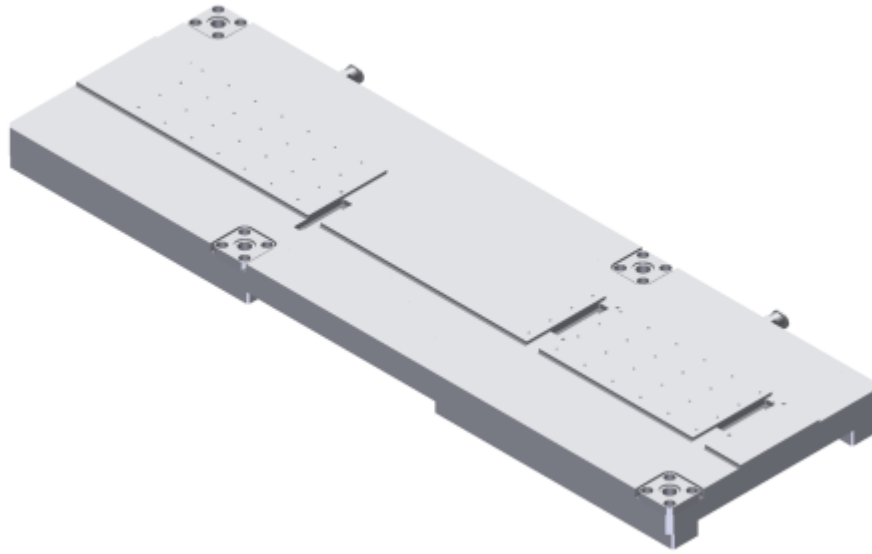
OrigamiProc.13 : Gluing Origami(CE)



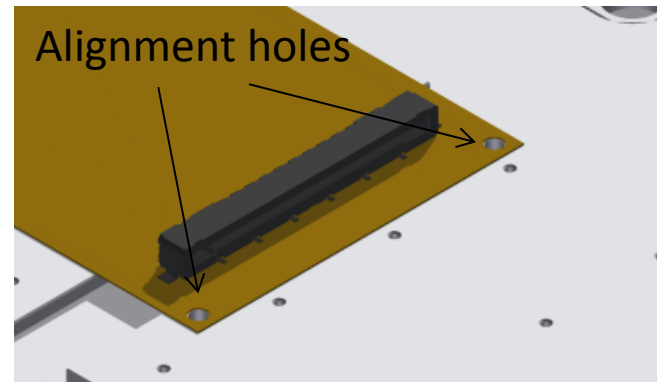
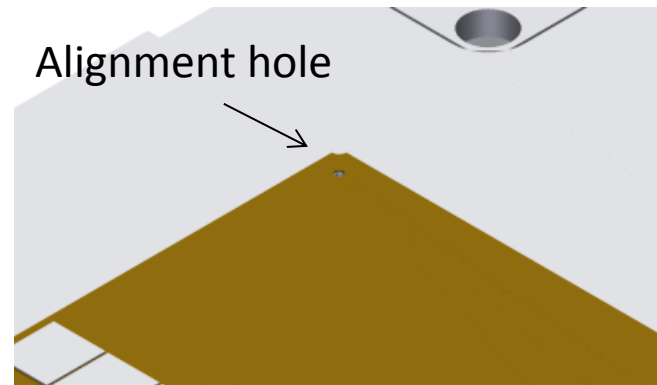
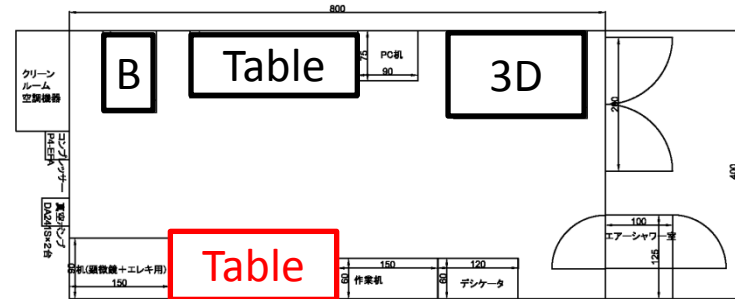
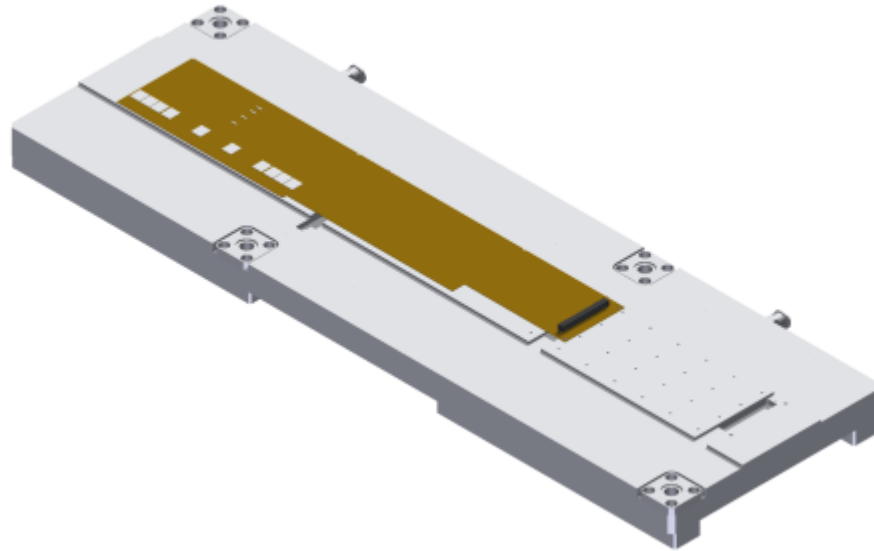
OrigamiProc.14: Removing Origami(CE)-jig



OrigamiProc.15: Preparing the Origami-alignment-jig



OrigamiProc.16 : Placing Origami(-z). Wire-binding APV25

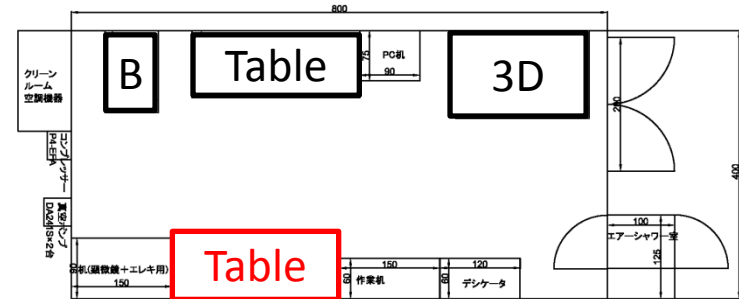
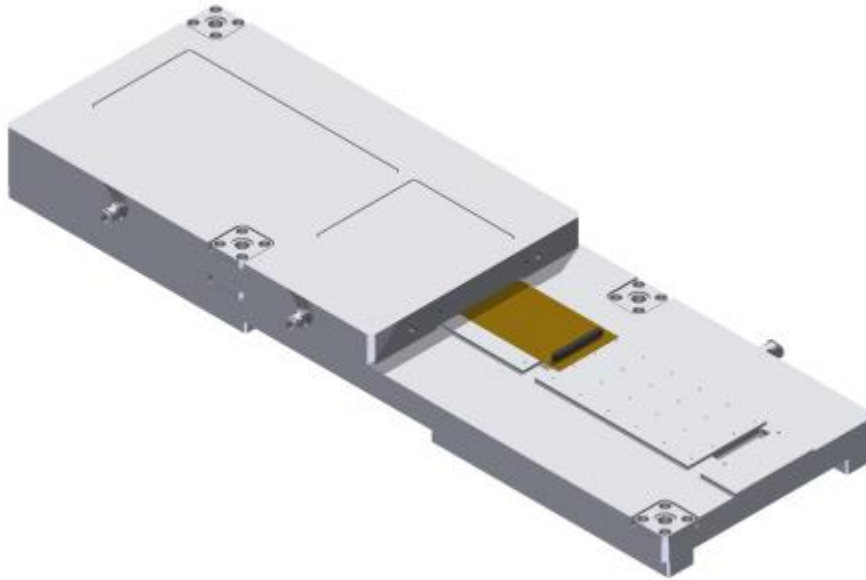


Origami(-z) can be aligned with the alignment holes

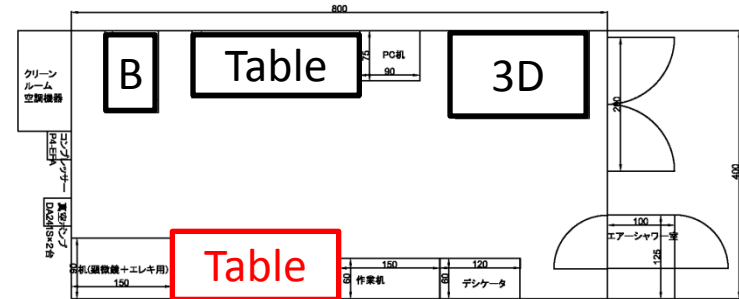
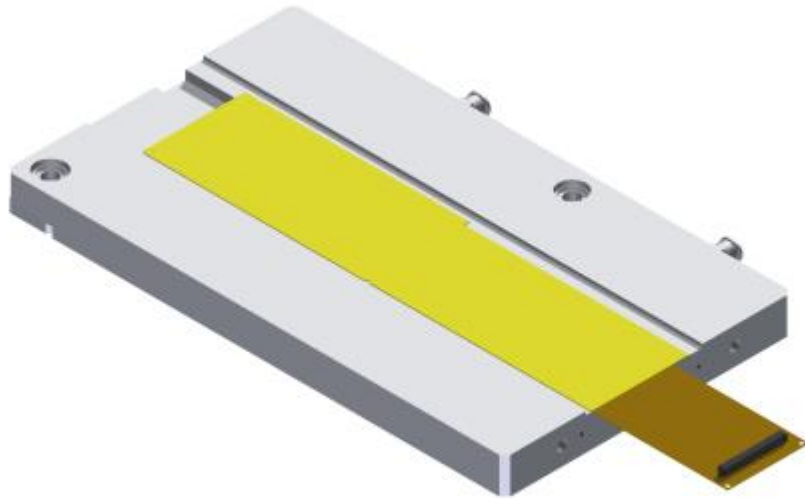
Mechanical QA: Visual inspection of bonding wires

Electrical QA: Readout test with APVDAQ

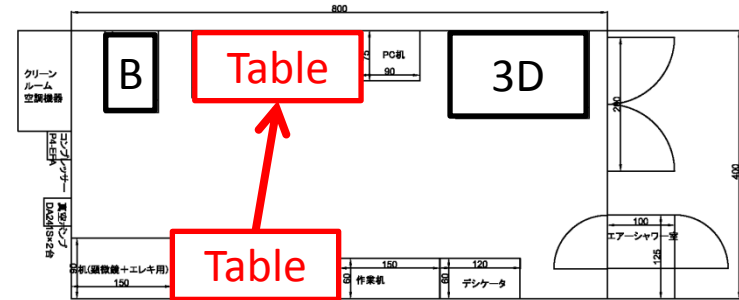
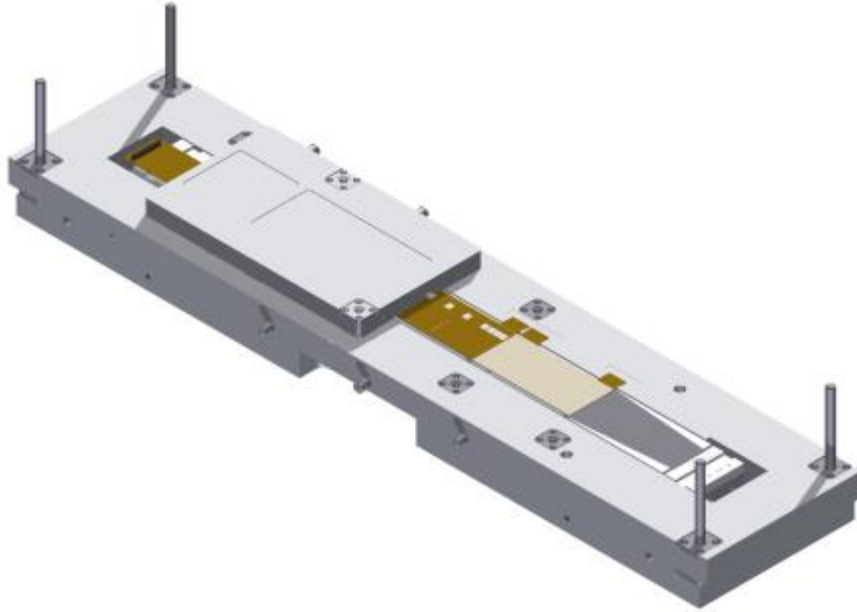
OrigamiProc.17: Placing Origami(-z)-jig



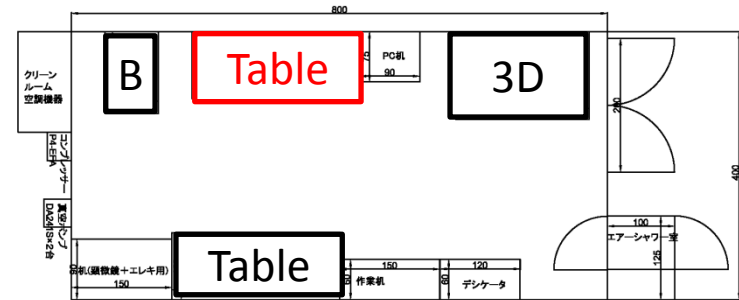
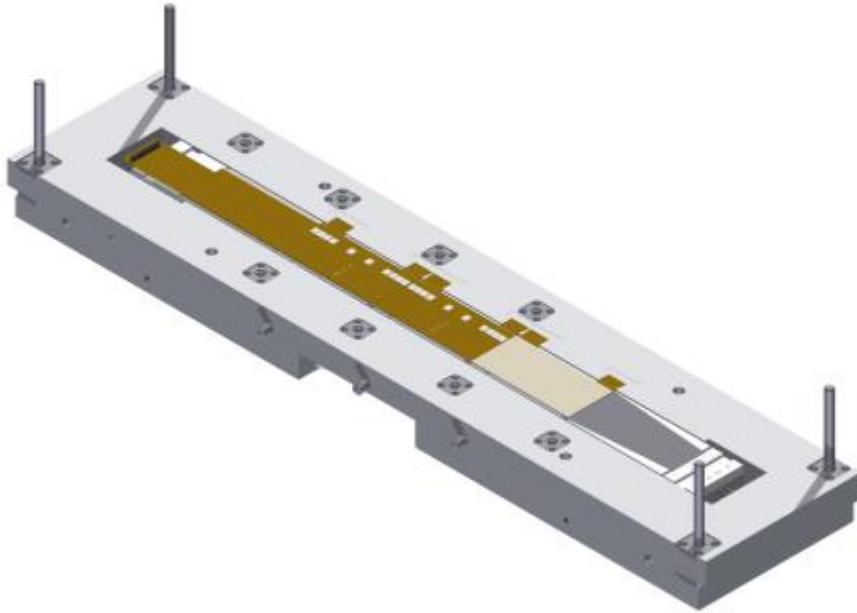
OrigamiProc.18: Dispensing glue



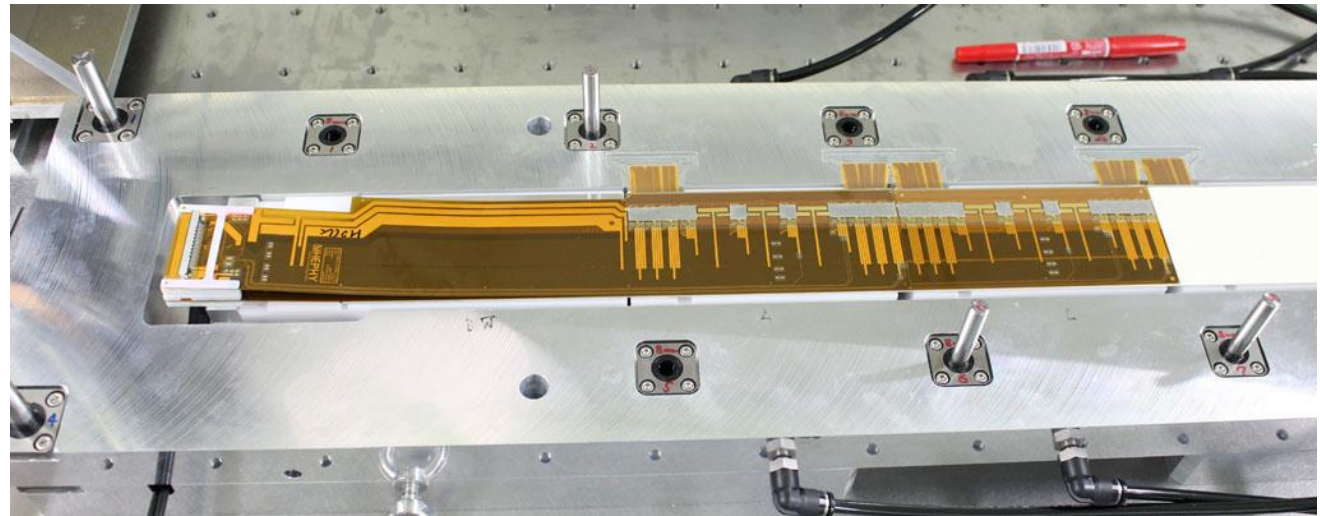
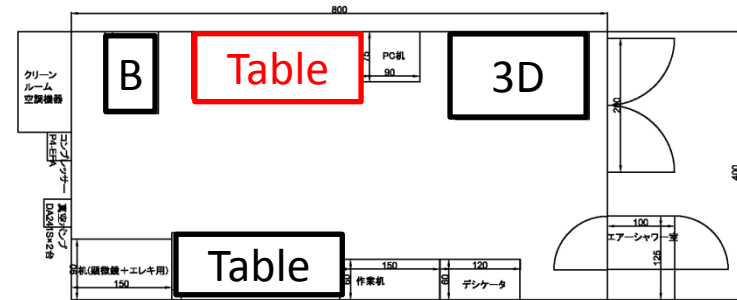
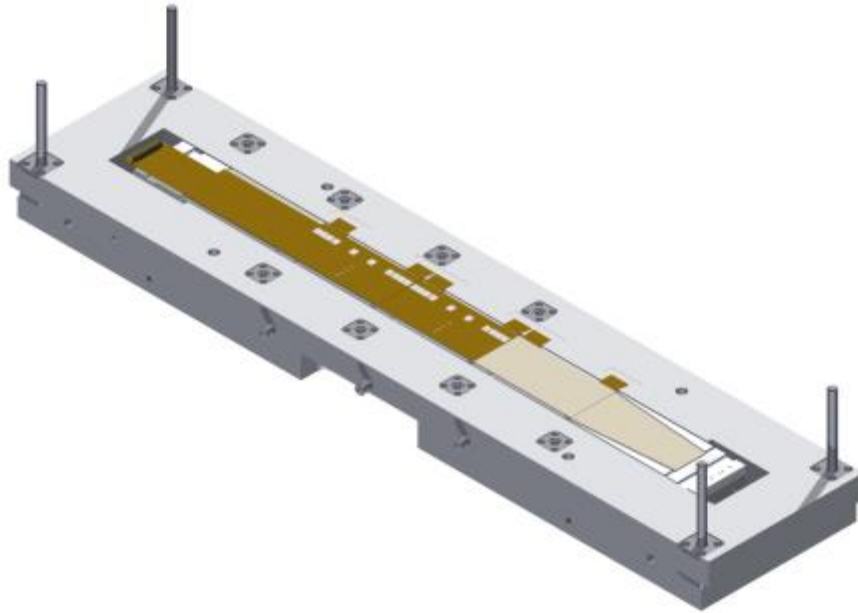
OrigamiProc.19: Gluing Origami(-z)



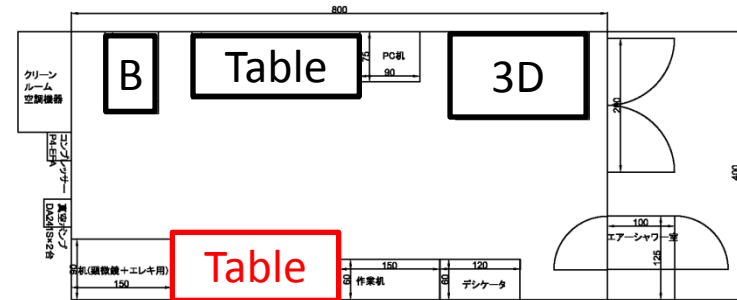
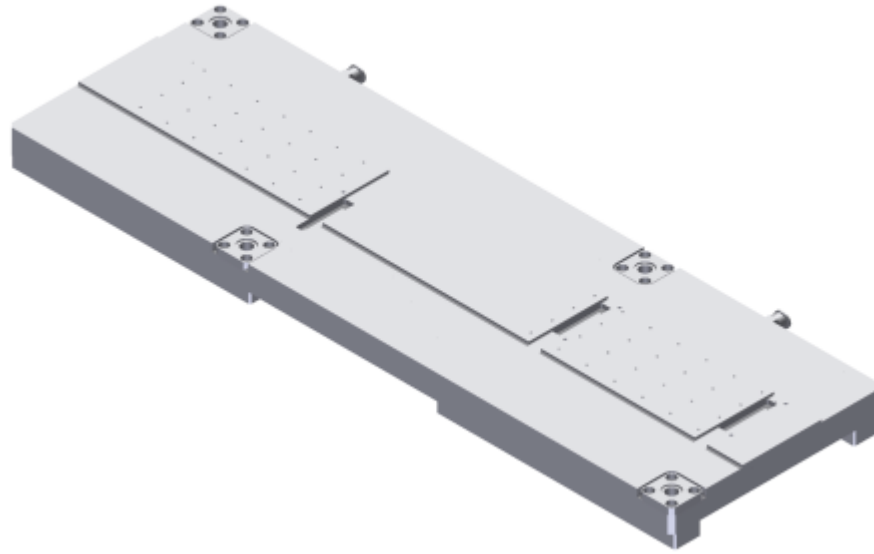
OrigamiProc.20: Gluing Origami(-z)



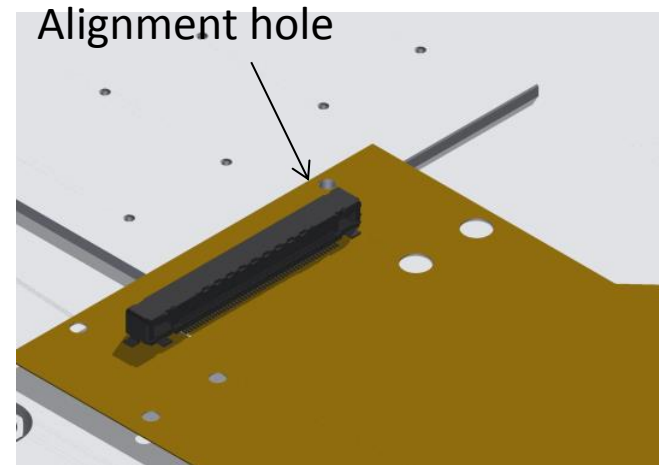
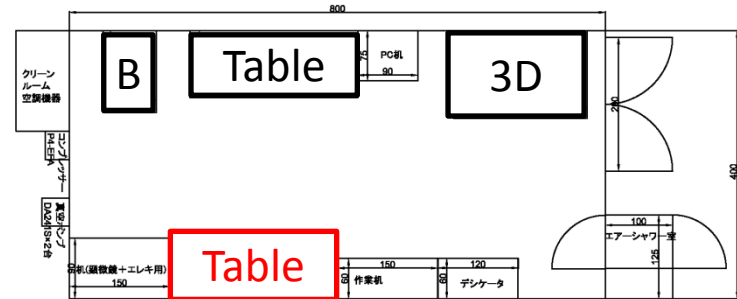
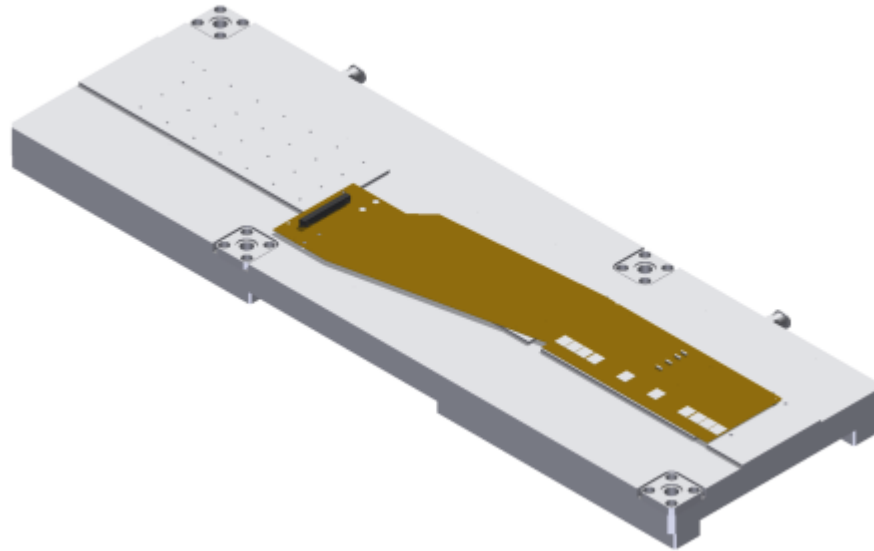
OrigamiProc.21: Placing Airex(+z)



OrigamiProc.22: Preparing the Origami-alignment-jig



OrigamiProc.23 : Placing Origami(+z). Wire-binding APV25

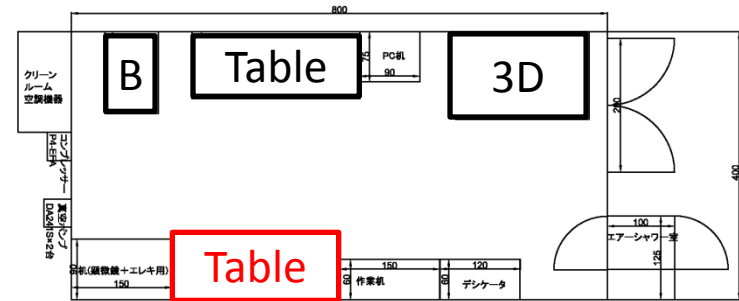
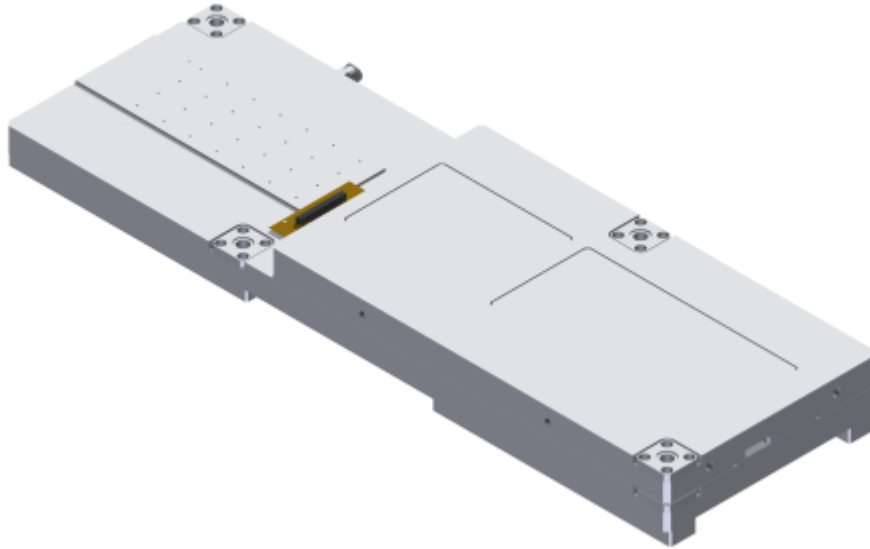


Origami(+z) can be aligned with the alignment holes

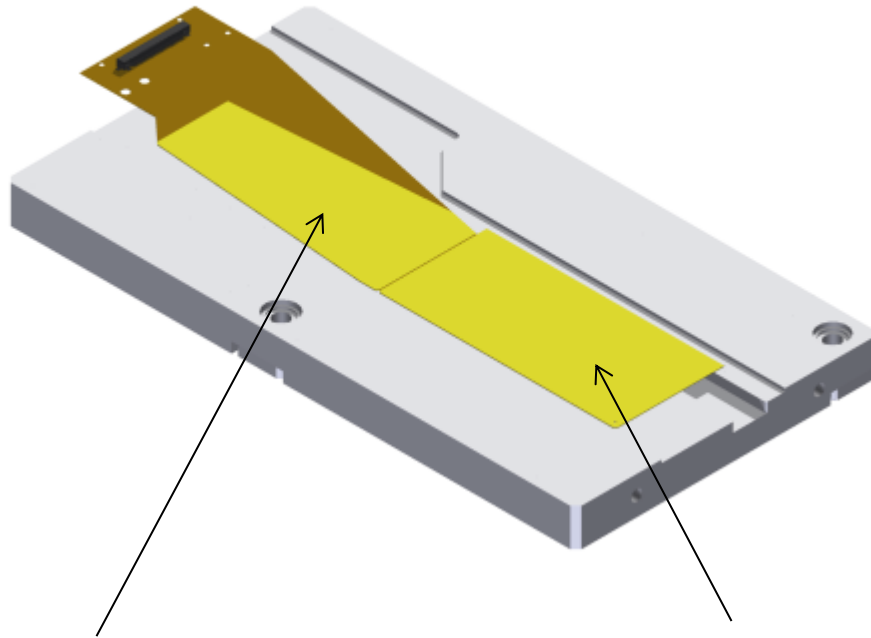
Mechanical QA: Visual inspection of bonding wires

Electrical QA: Readout test with APVDAQ

OrigamiProc.24 : Placing Origami(+z)-jig

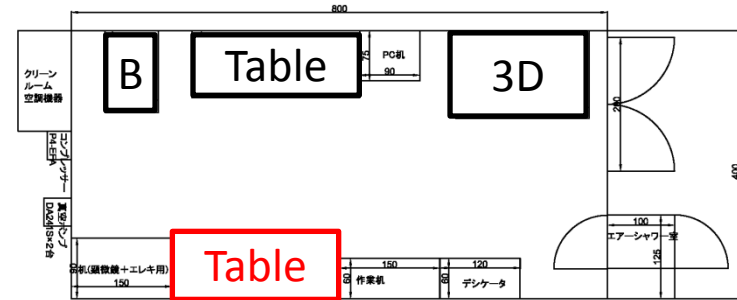


OrigamiProc.25 : Dispensing glue

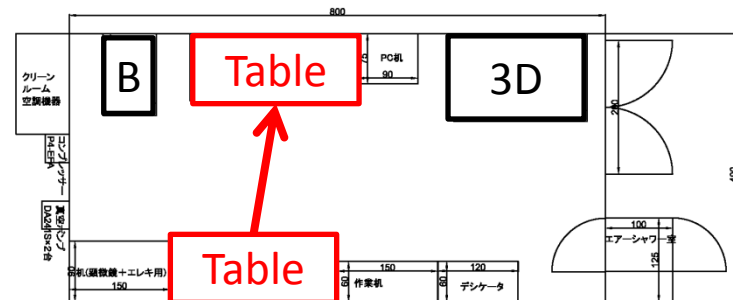
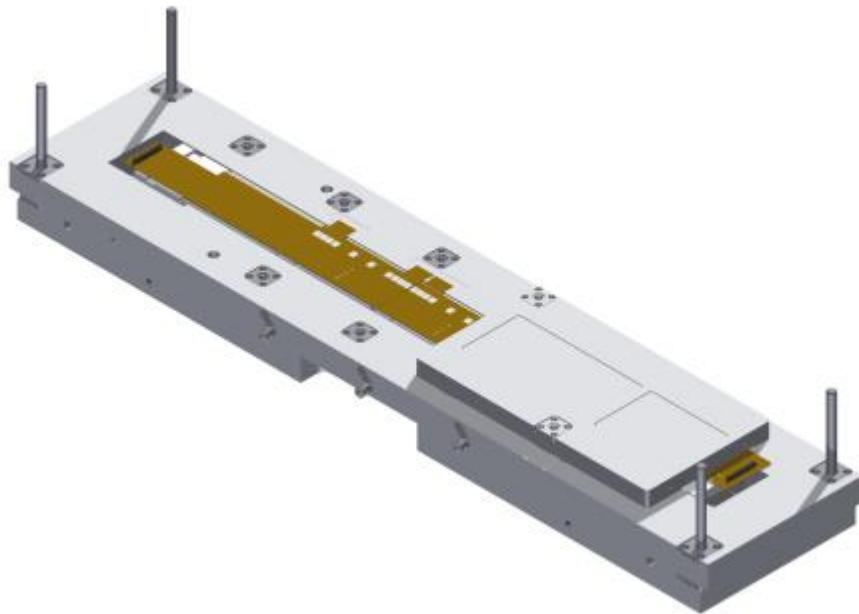


For slant AIREX

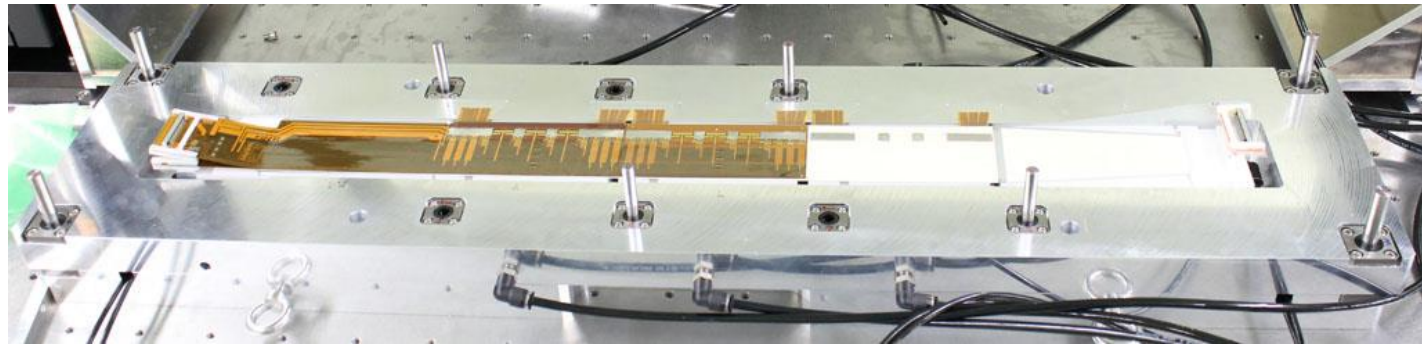
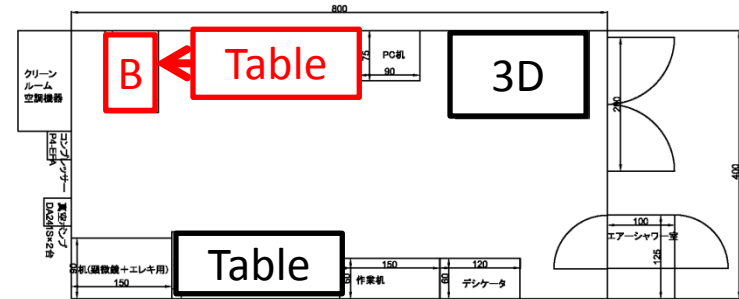
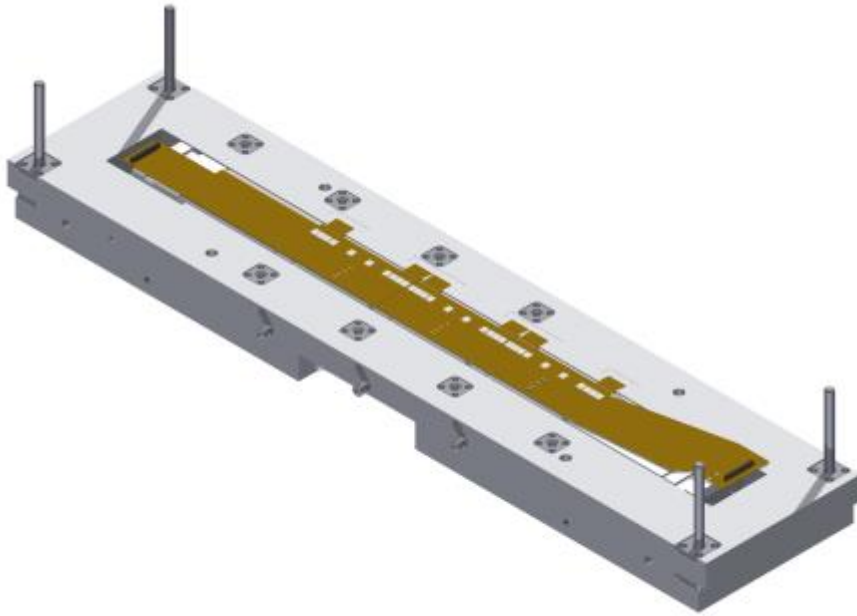
For Origami(+z) AIREX



OrigamiProc.26 : Gluing Origami(+z)



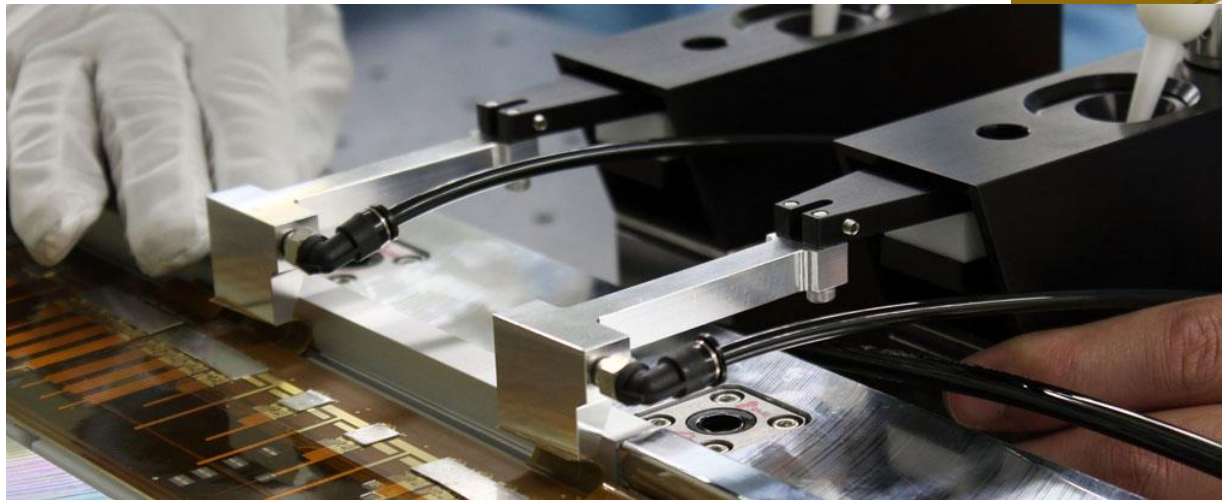
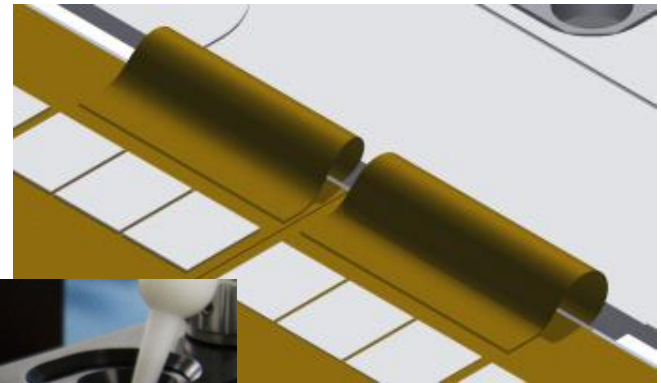
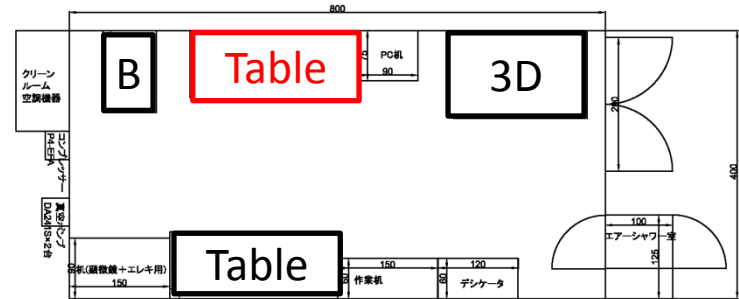
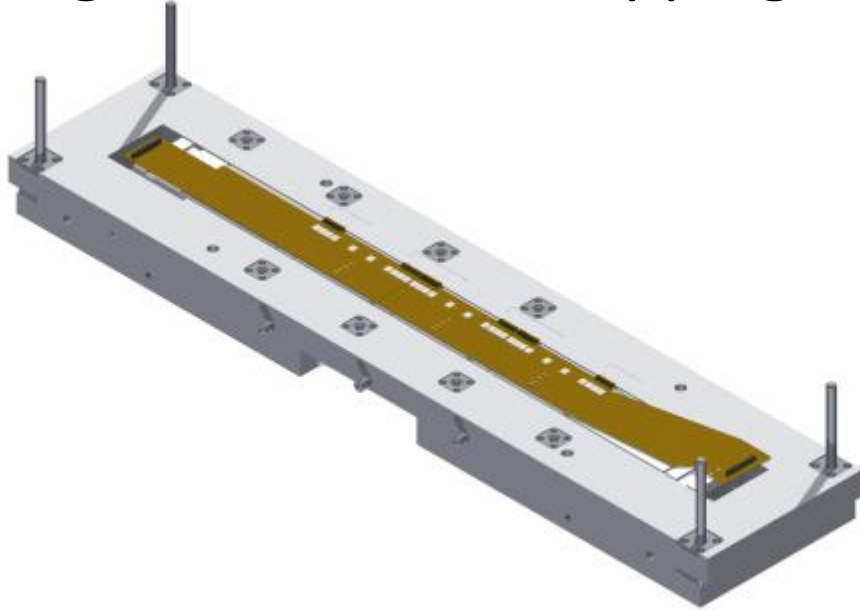
OrigamiProc.27 : Removing Origami(+z)-jig.DSSD wire-bond



Mechanical QA: Visual inspection of bonding wires

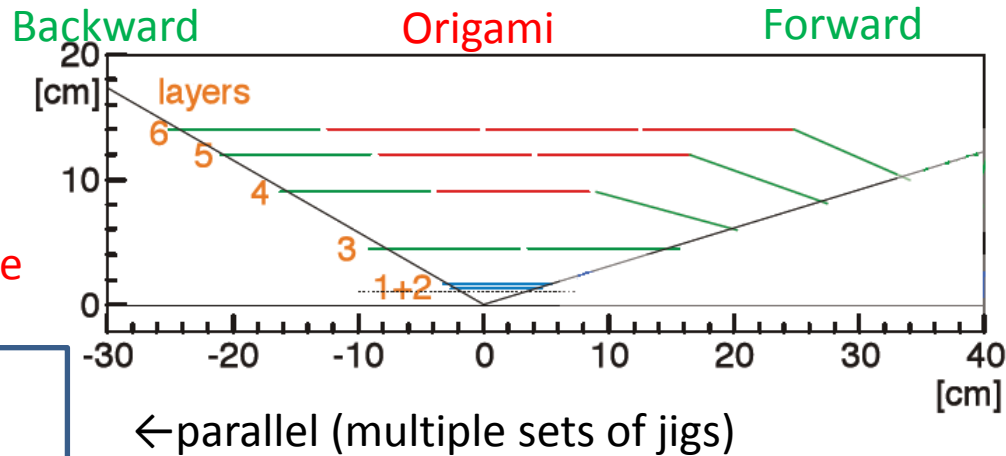
Electrical QA: Readout test with APVDAQ

OrigamiProc.28: Wrapping PAs



Wrapping and gluing as usual way.

SVD ladder assembly flow



Common Procedure

Origami PA
gluing

Place DSSDs (rectangle, trapezoidal) onto assembly bench and align them

Backward
assembly

Forward assembly

← parallel
(independent
each other)

Origami assembly

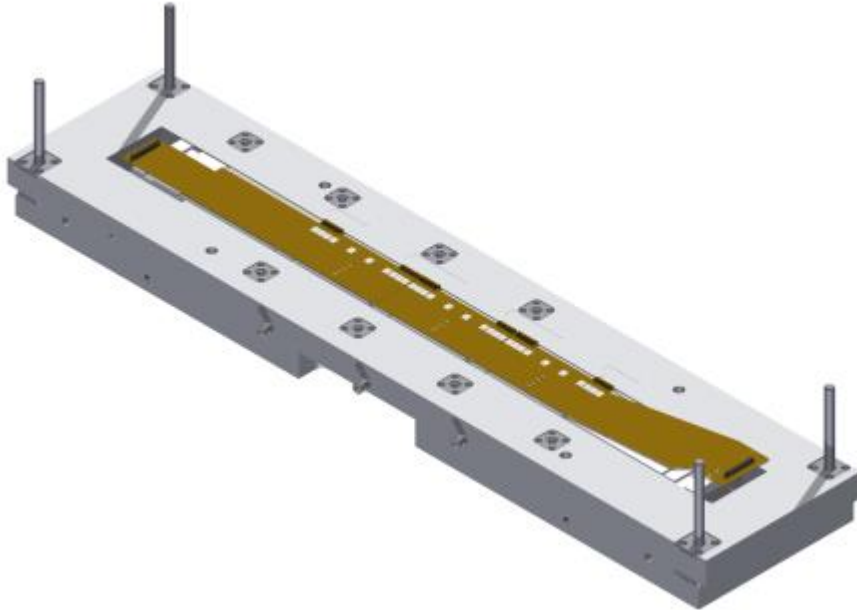
Glue forward and backward
sensors onto ribs

time

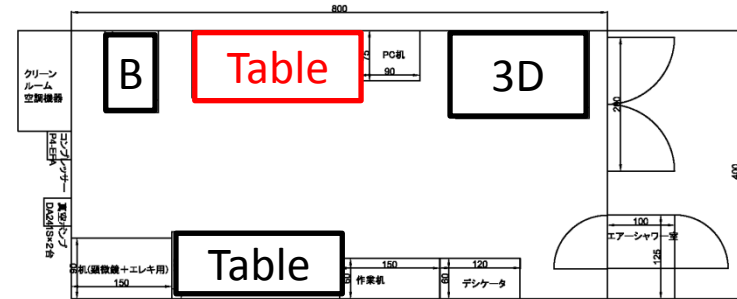
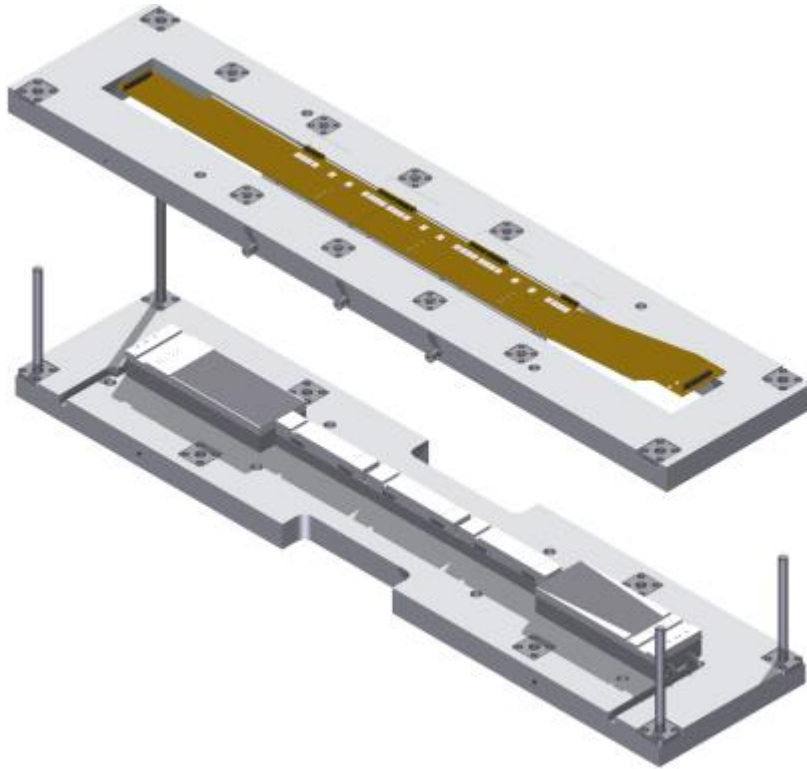
Final procedure

Attach Origami sensors to ribs

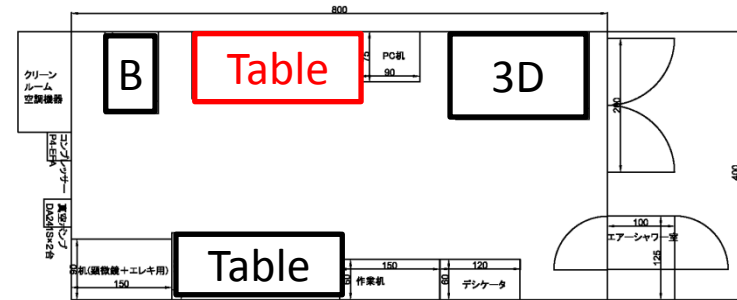
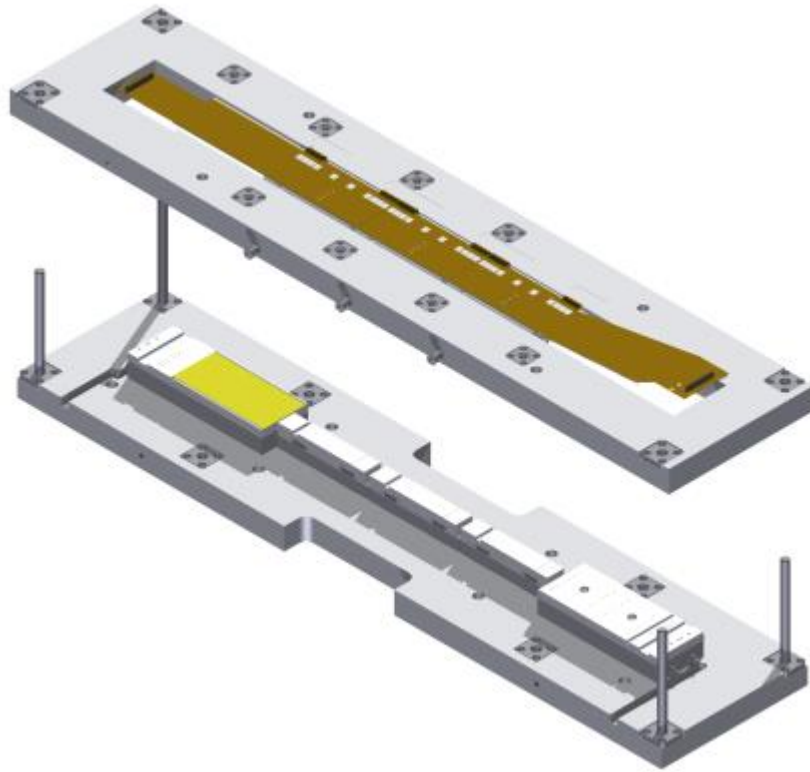
Final Proc.01 : Preparing the Origami part



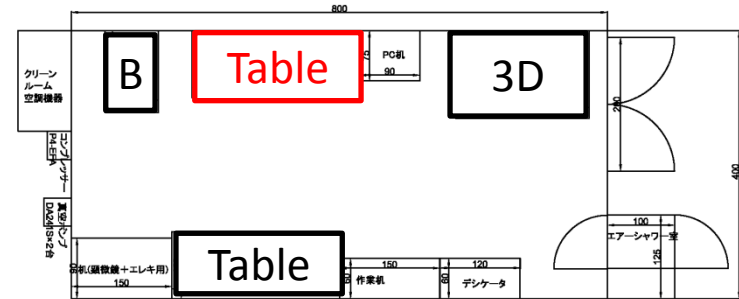
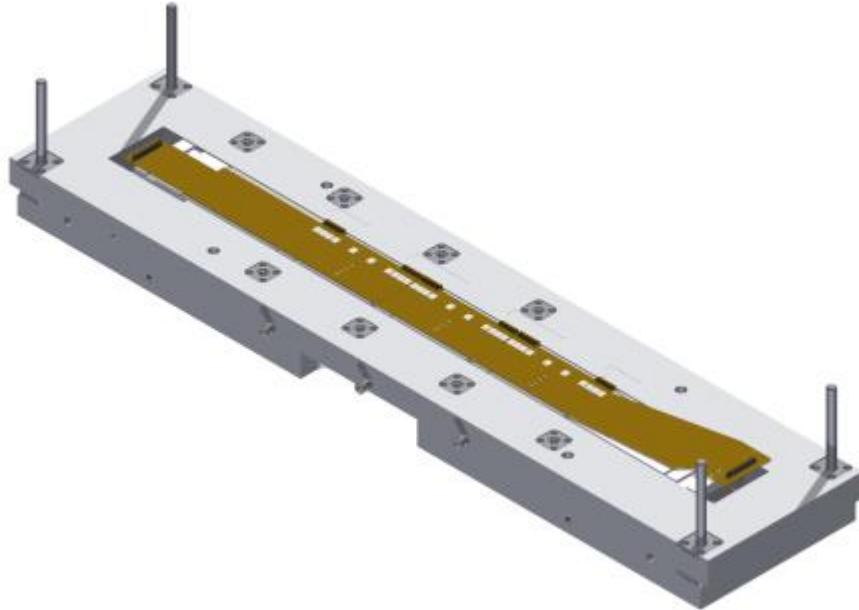
Final Proc.02 : Lifting up the assembly-bench



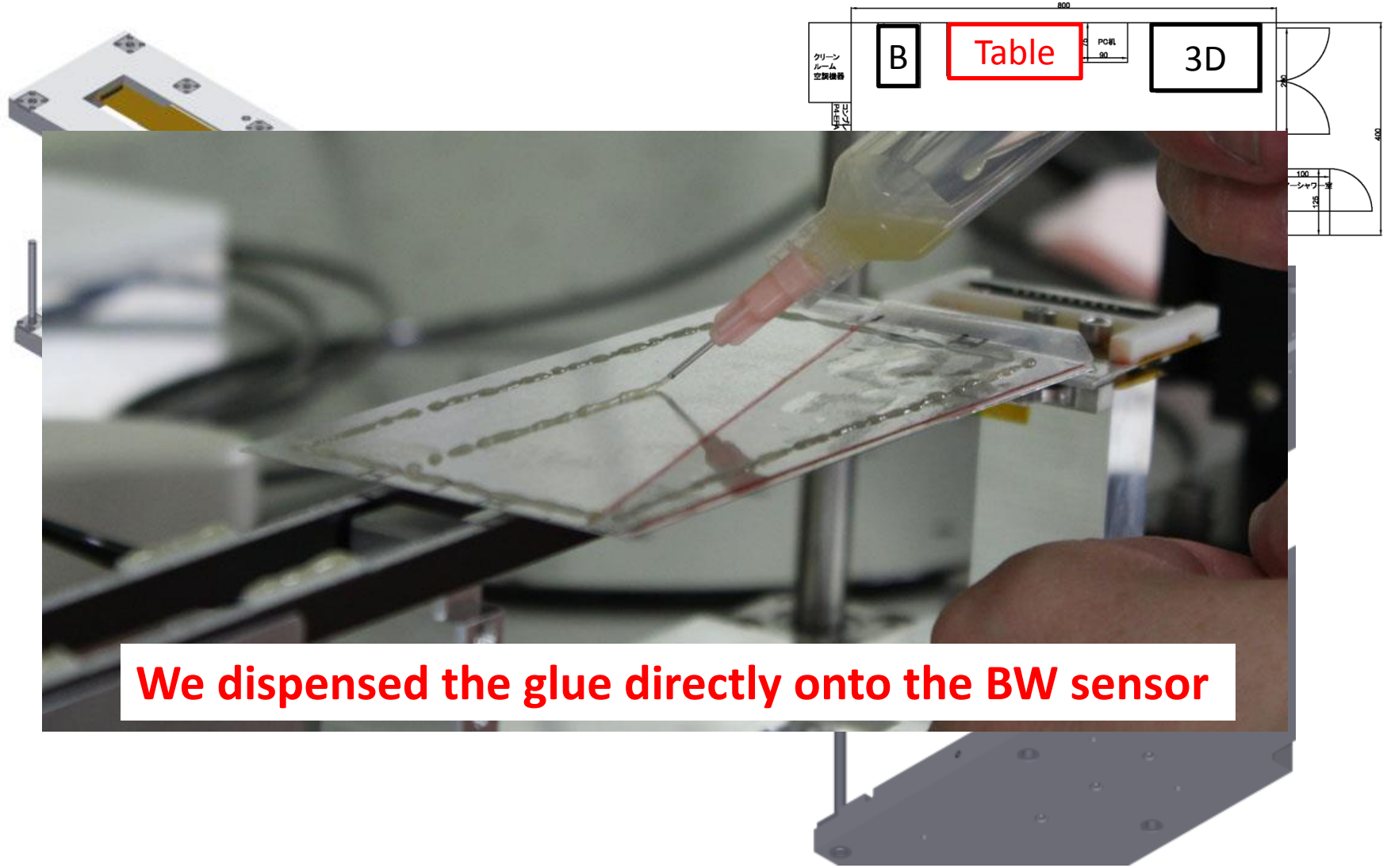
Final Proc.03 : Dispensing the glue on the BW dummy DSSD



Final Proc.04: Placing down the assembly-bench

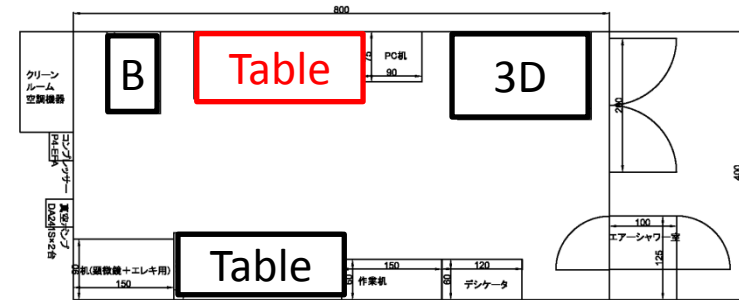
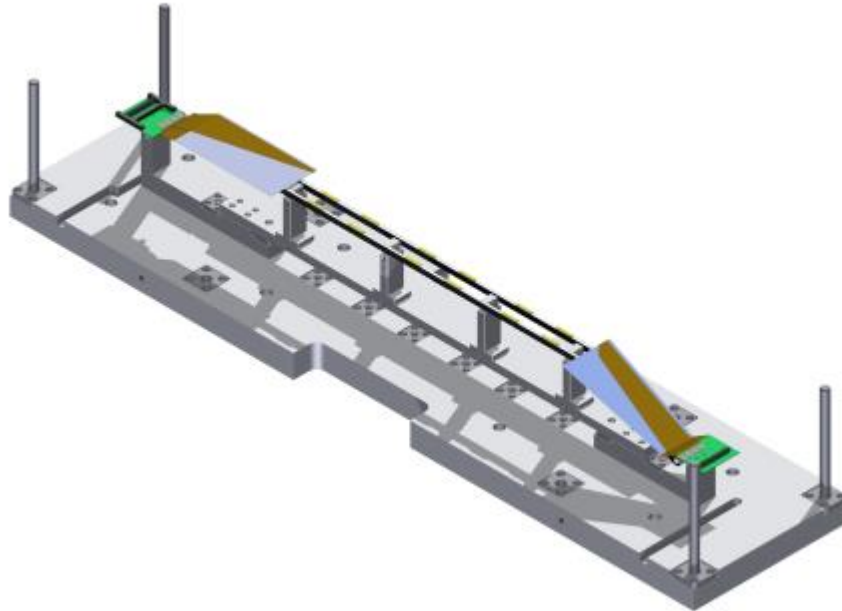


Final Proc.05 : Lifting up again. Glues are stamped on BW.

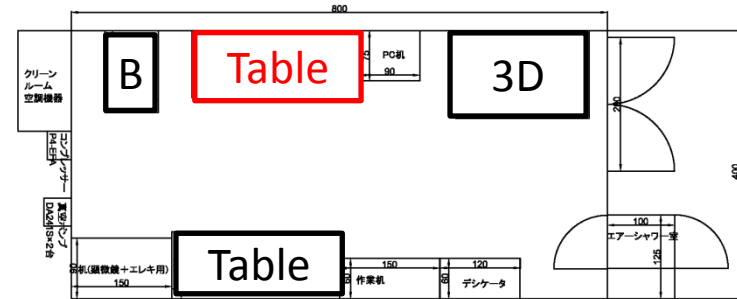
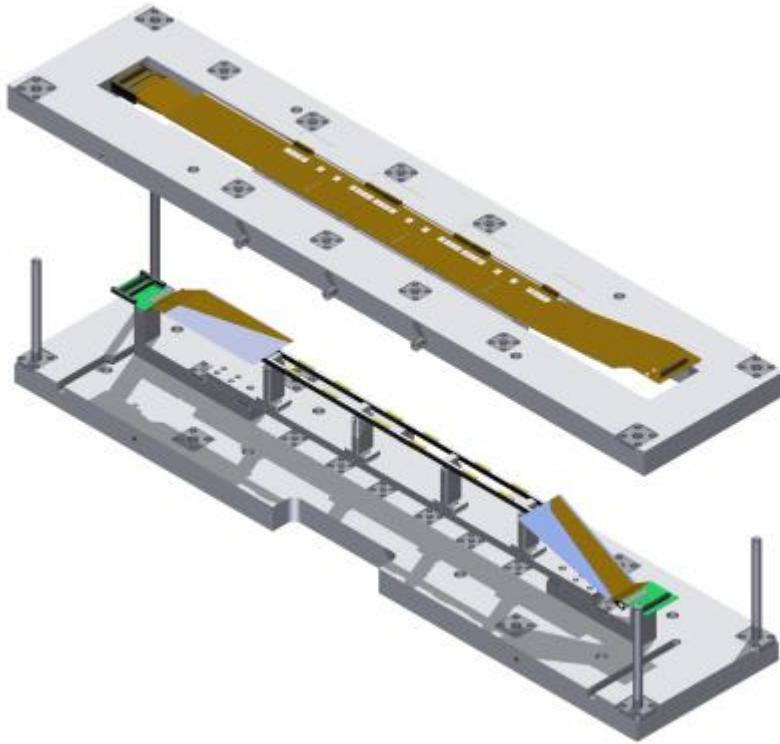


We dispensed the glue directly onto the BW sensor

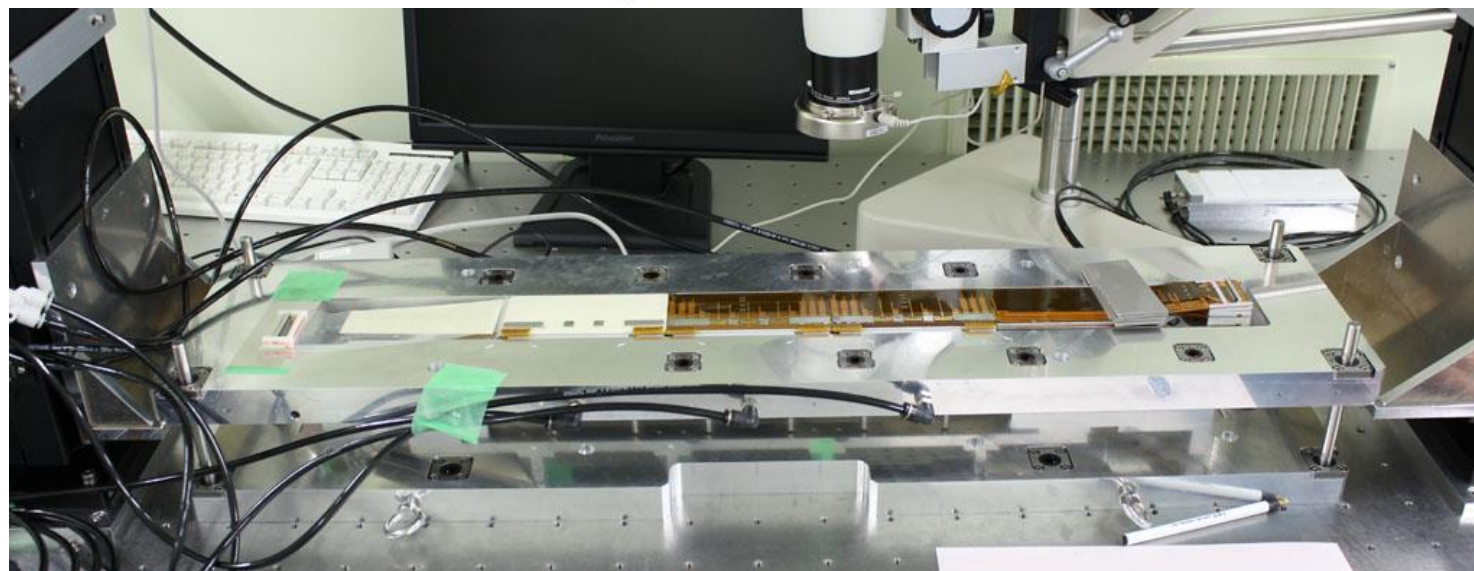
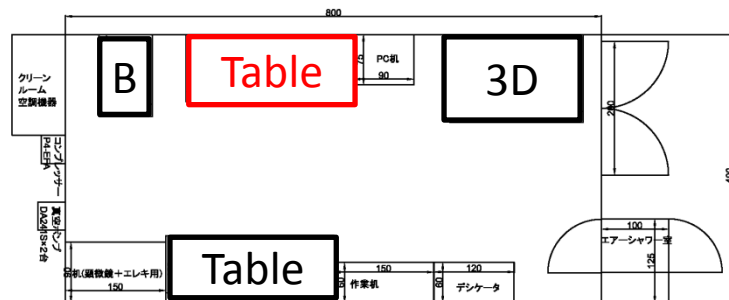
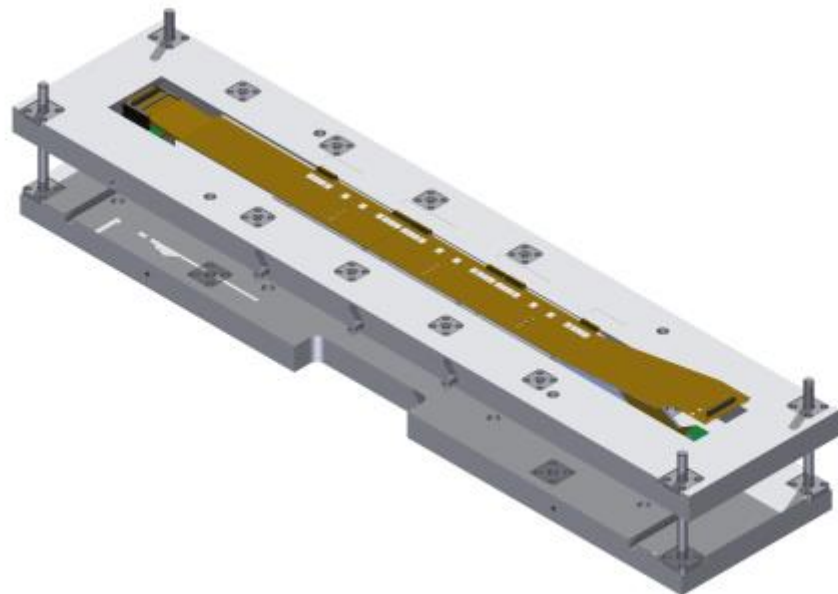
Final Proc.06: Replacing the Ribs+FW+BW parts. Dispensing glue.



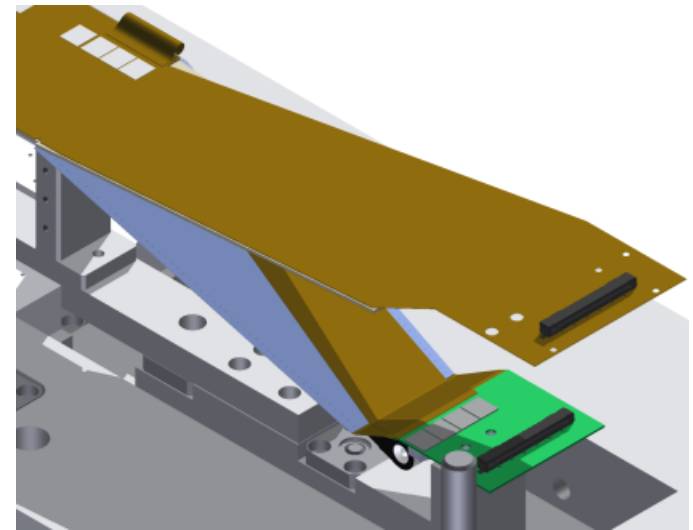
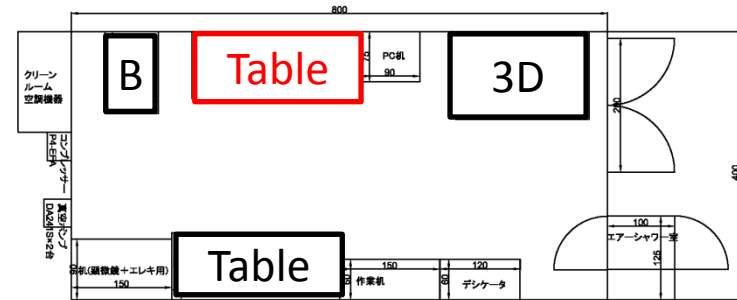
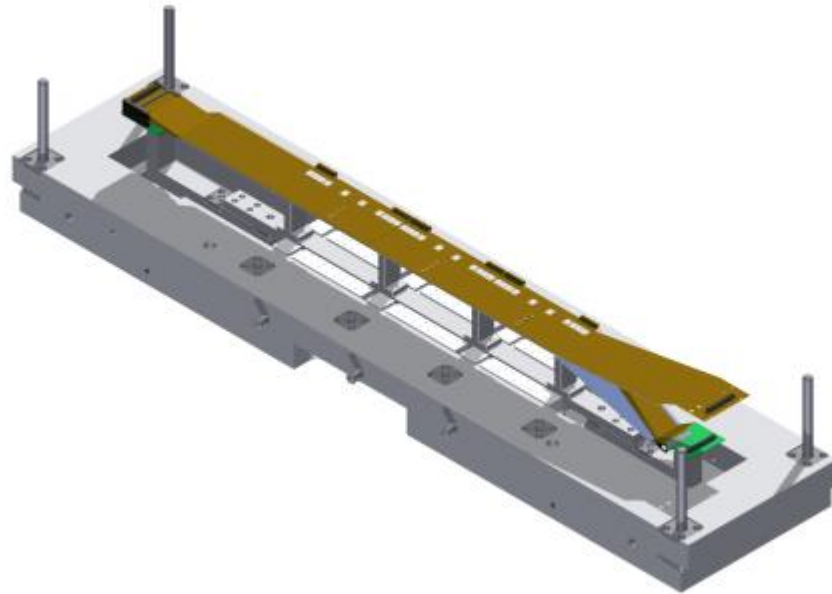
Final Proc.07 : Placing the Assembly-bench



Final Proc.08: Gluing the Origami and Ribs.

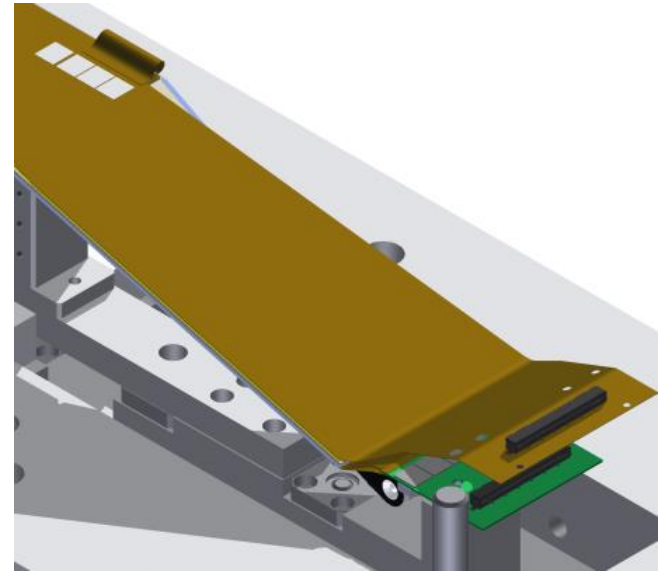
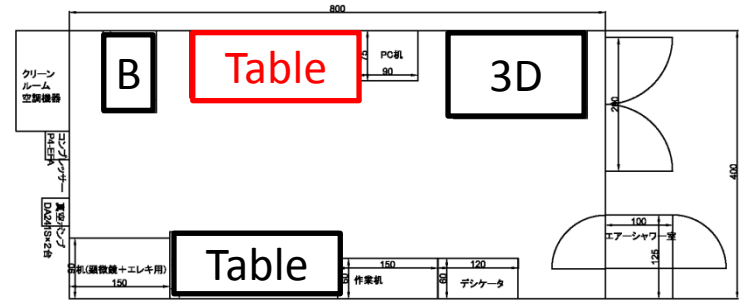
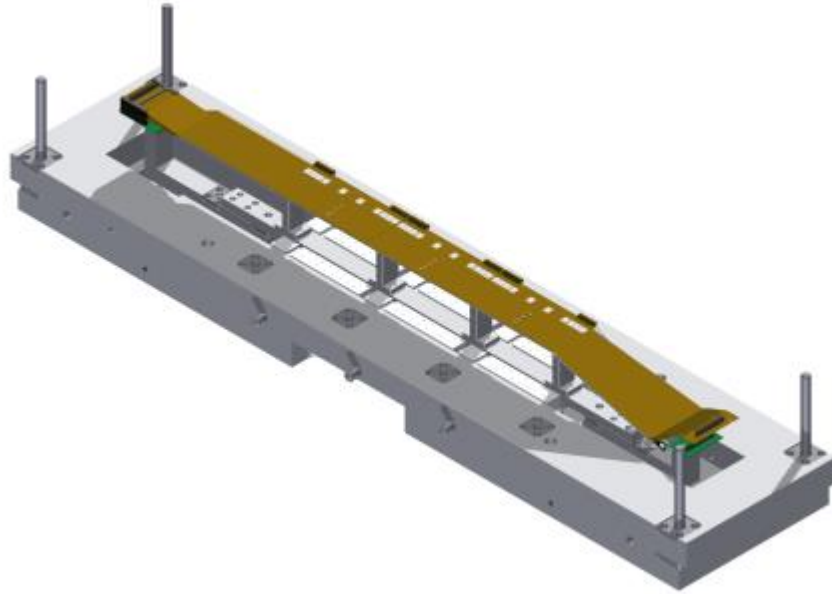


Final Proc.09 : Placing down the bench. Dispensing glue.

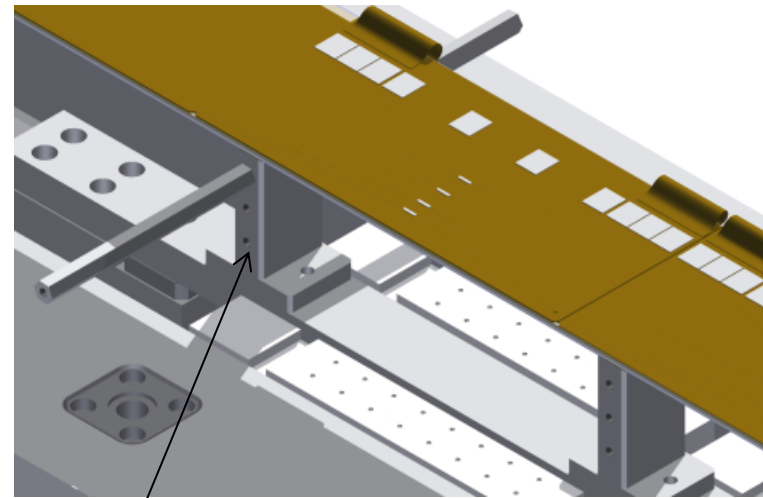
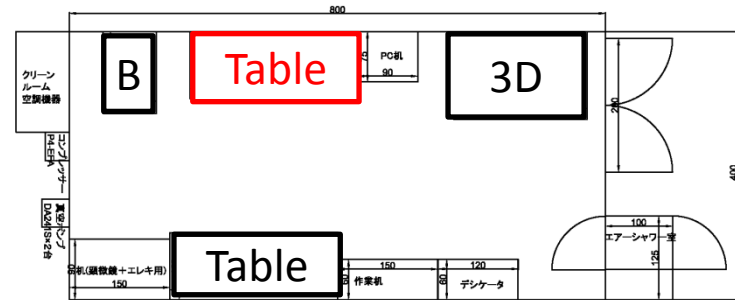
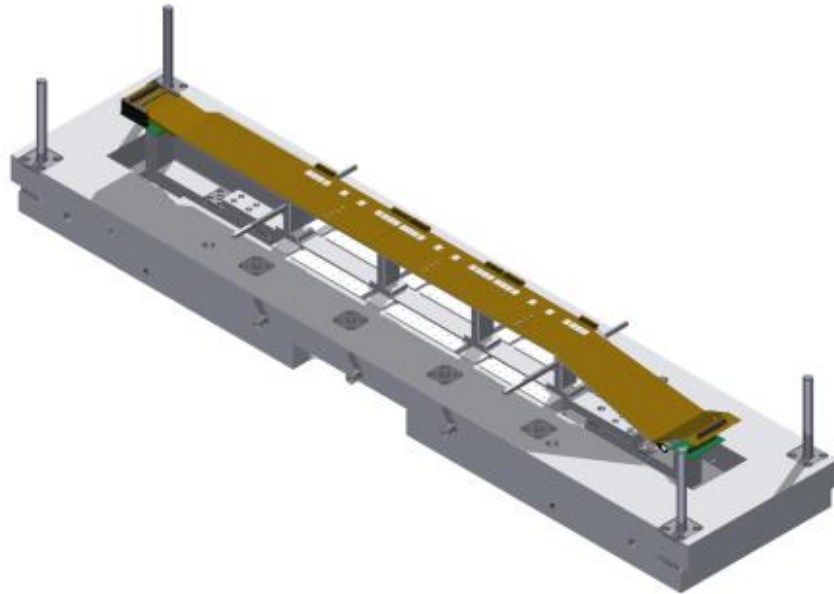


Dispensing glue some spots on the backside of Origami(+z)

Final Proc.10: Gluing the Origami(+z)



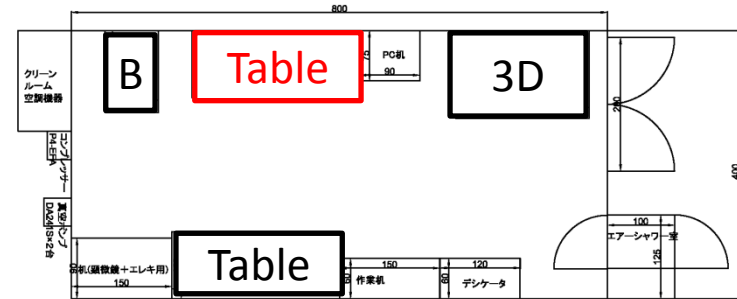
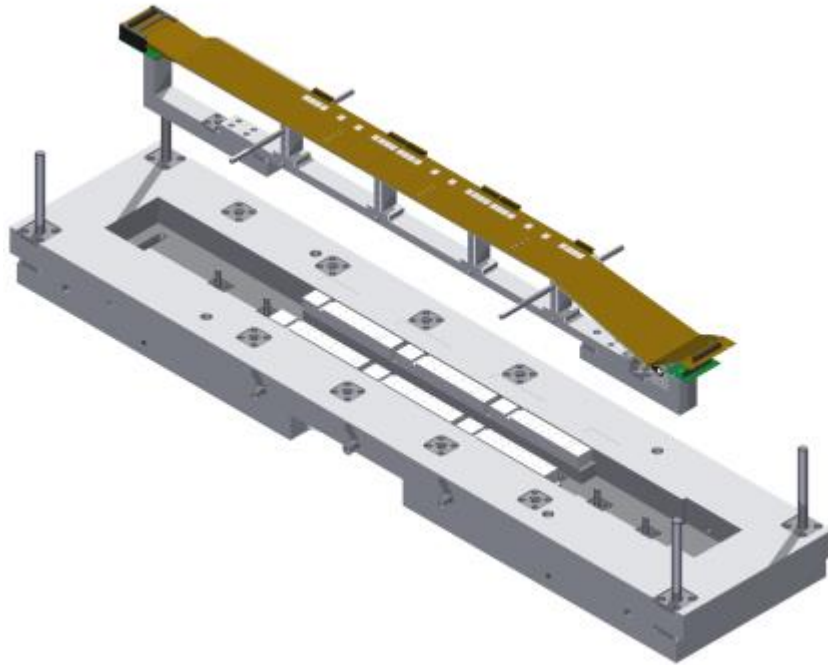
Final Proc.11: Attaching the rods at the rib support.



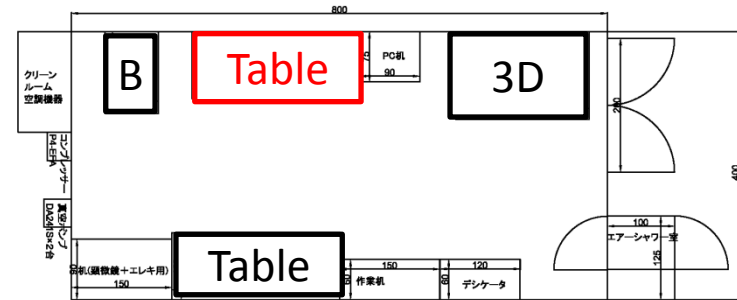
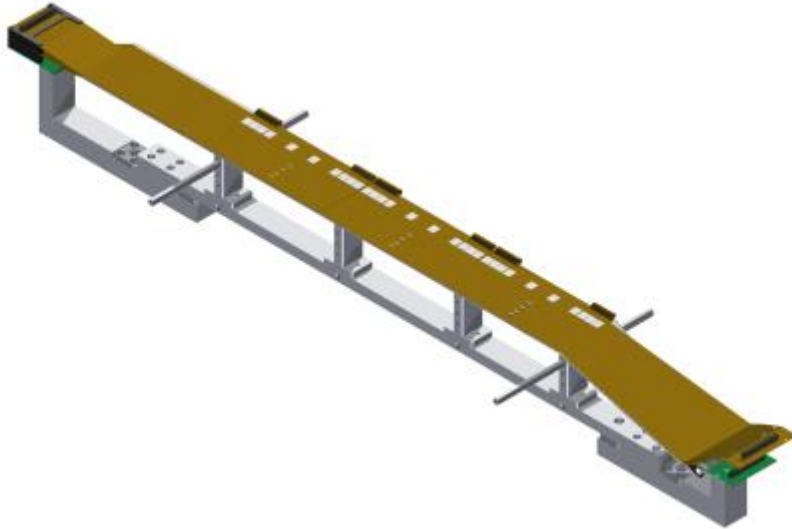
M3 screw holes

The rods act like a bumper and handles.

Final Proc.12: Pulling up the support with rods.



Final Proc.13 : Finish.



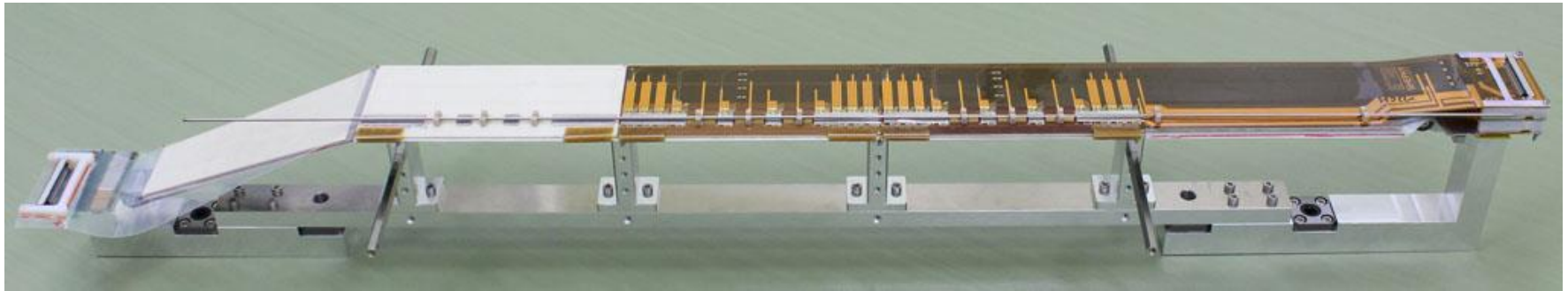
Mechanical QA:

- Inspection of alignment of DSSDs w/ the coordinate machine.
- Thermal cycle test(not all, sampling)

Electrical QA:

- Readout test with APVDAQ
- Source test

The Final Layer 6 Dummy Ladder



- The ladder is still mounted on the rib jig
- Cooling pipe already attached

Thank you

