Si PAD sensor R&D for ALICE FoCal

19 March, 2017.

Motoi INABA

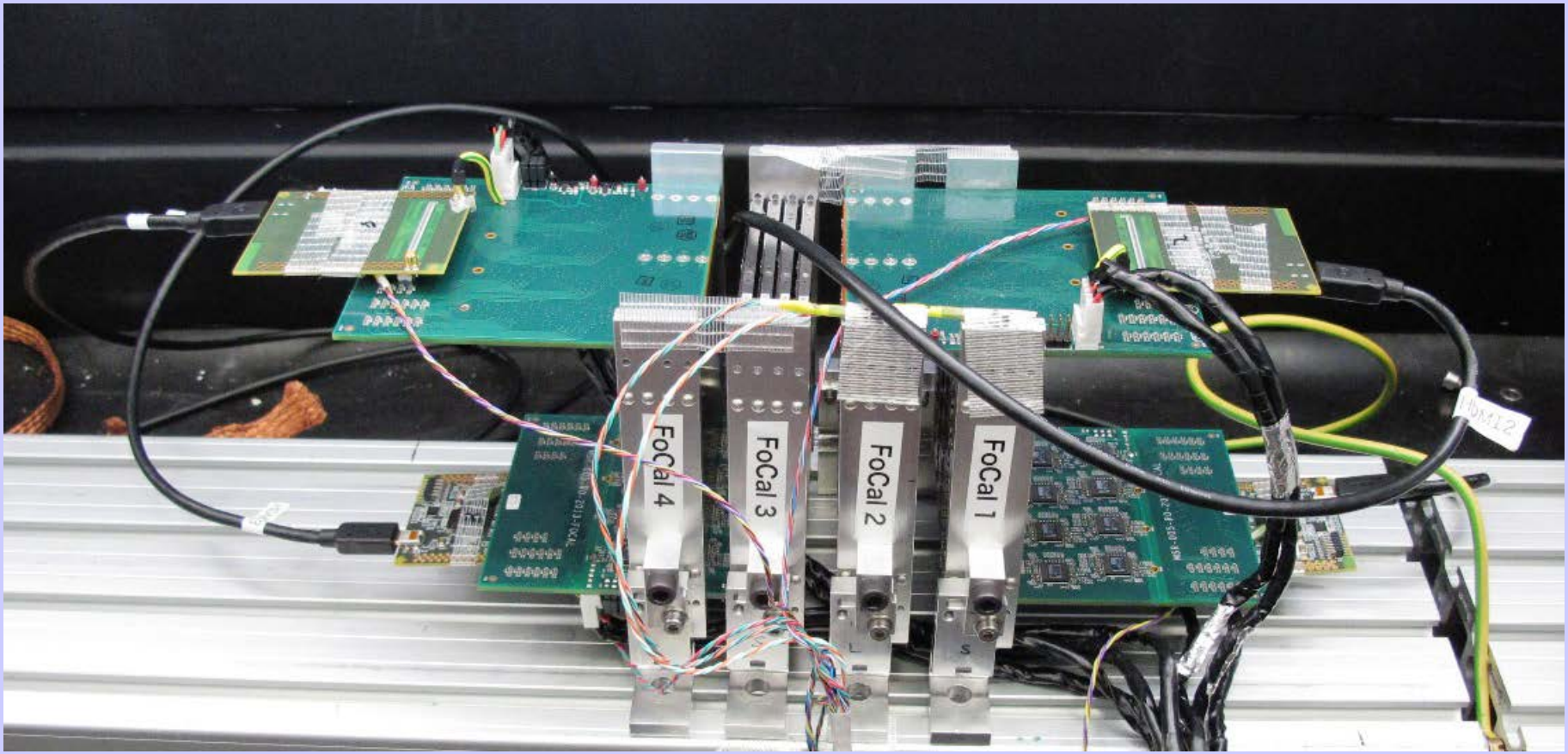
for ALICE FoCal collaboration

Tsukuba University of Technology, Faculty of Industrial Technology.

National University Corporation for the hearing impaired and visually impaired in Japan.

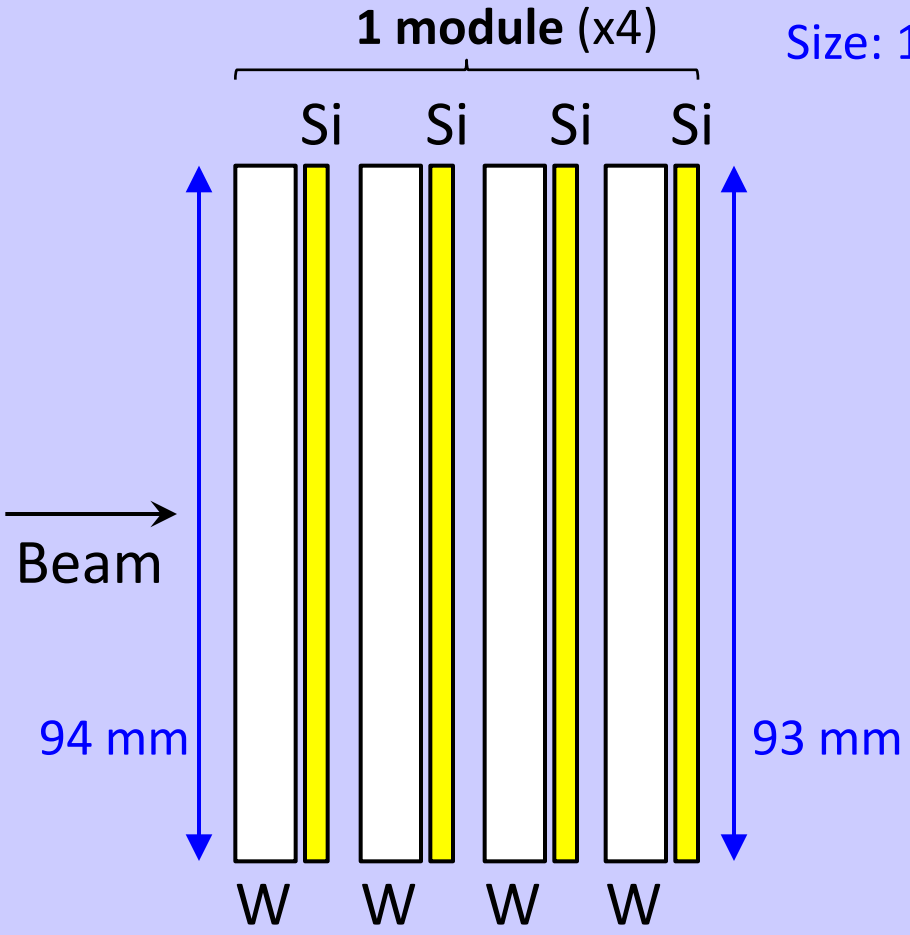
Background

For one of the ALICE detector upgrade plans, we carried out beam tests of the **FoCal-E PAD** detector prototype developed by ORNL at CERN PS / SPS complexes from 2014 to 2016. The next stage is development of the **original detector with a wider dynamic range.**

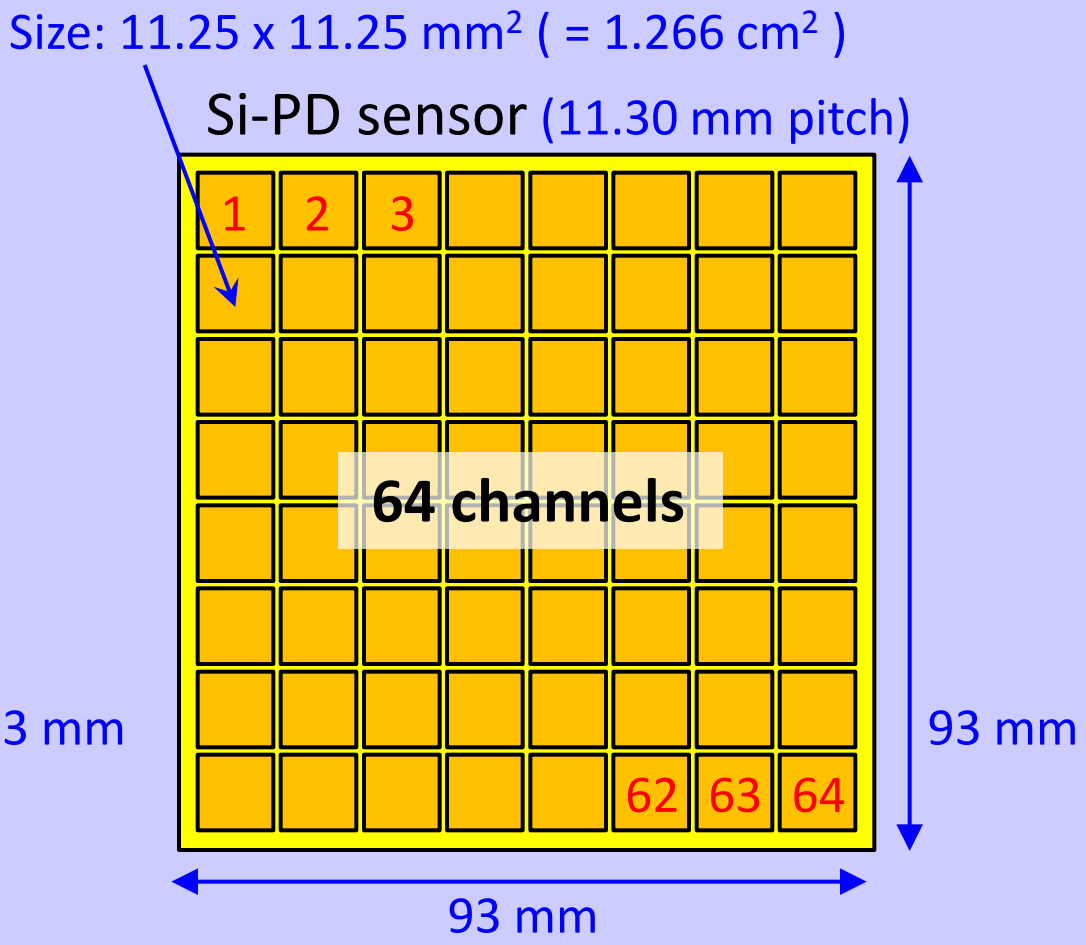


FoCal-E PAD detector prototype

FoCal-E PAD detector is the Si-W calorimeter that one module has 4 pairs of tungsten tiles (t = 3.5 mm) and Si-PD sensors (t = 0.5 mm).



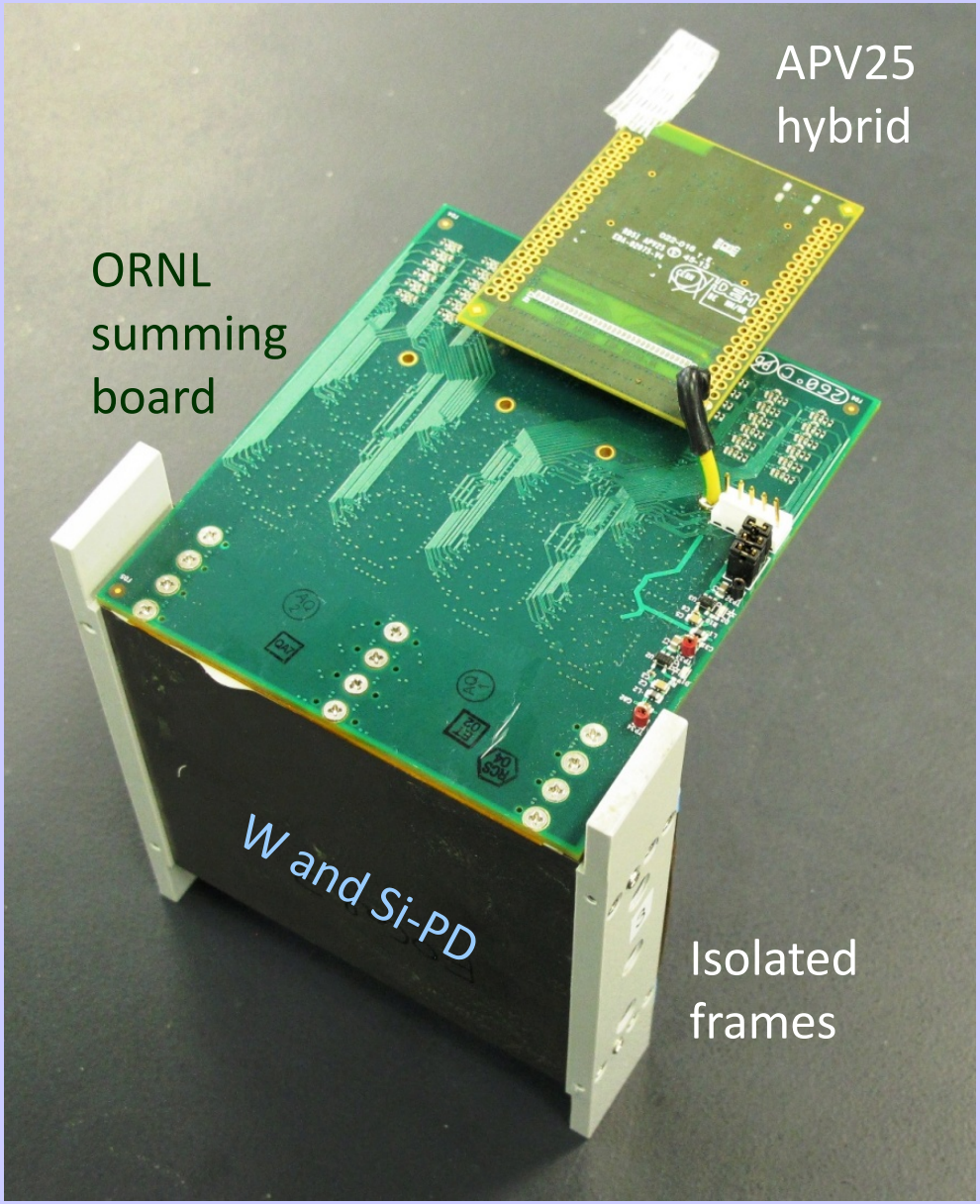
< Side view >

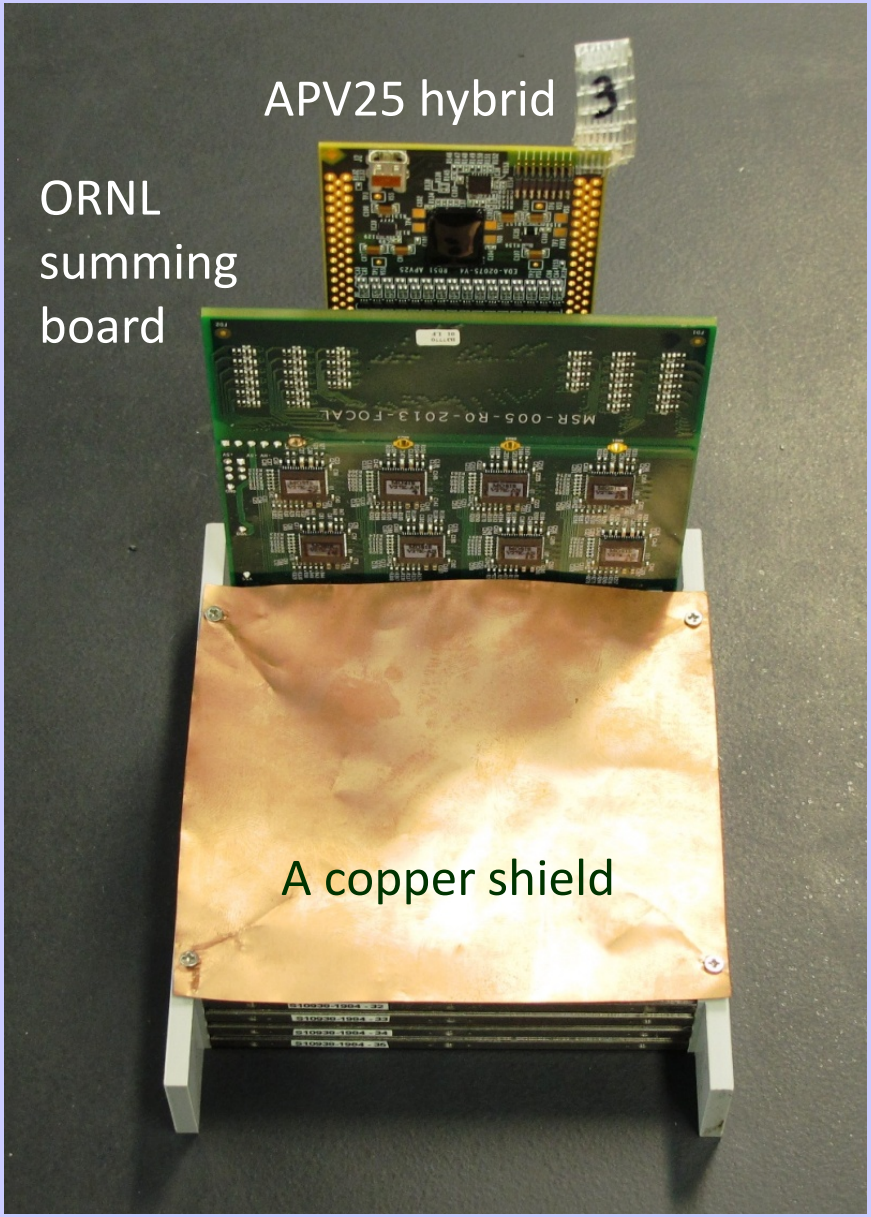


< Back view >

FoCal-E PAD detector prototype

by ORNL in 2012





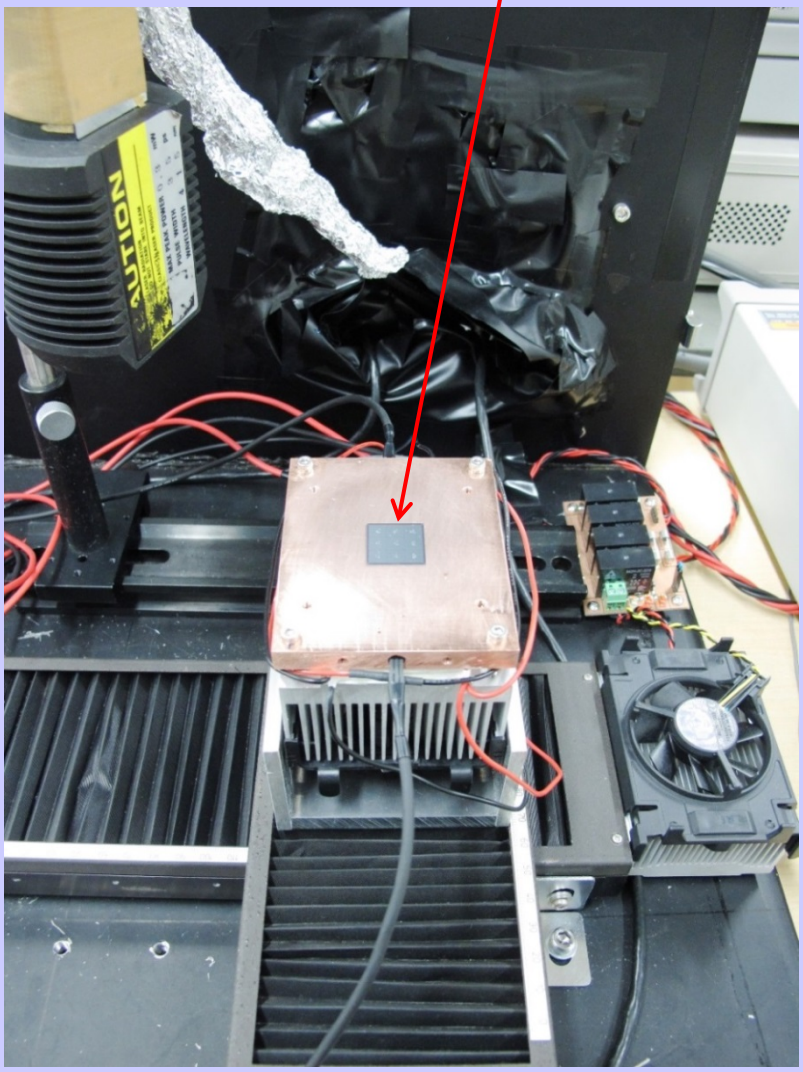
Test of Si-PD

We are interested in following tests on Si-PDs;

(1) V-I characteristics using the electrometer,
(2) V-C characteristics using the RLC meter,
(3) Dynamic characteristics using the Laser / LED pulsar,
(4) Light-incident-position dependence,
(5) Cable-length dependence,
(6) Estimation of heating and power consumption,
(7) Cross-talk check,
(8) Radiation durability, etc.

Test results of 3x3 Si-PDs from Kyushu Univ.

1st test bench for 3x3 Si-PD



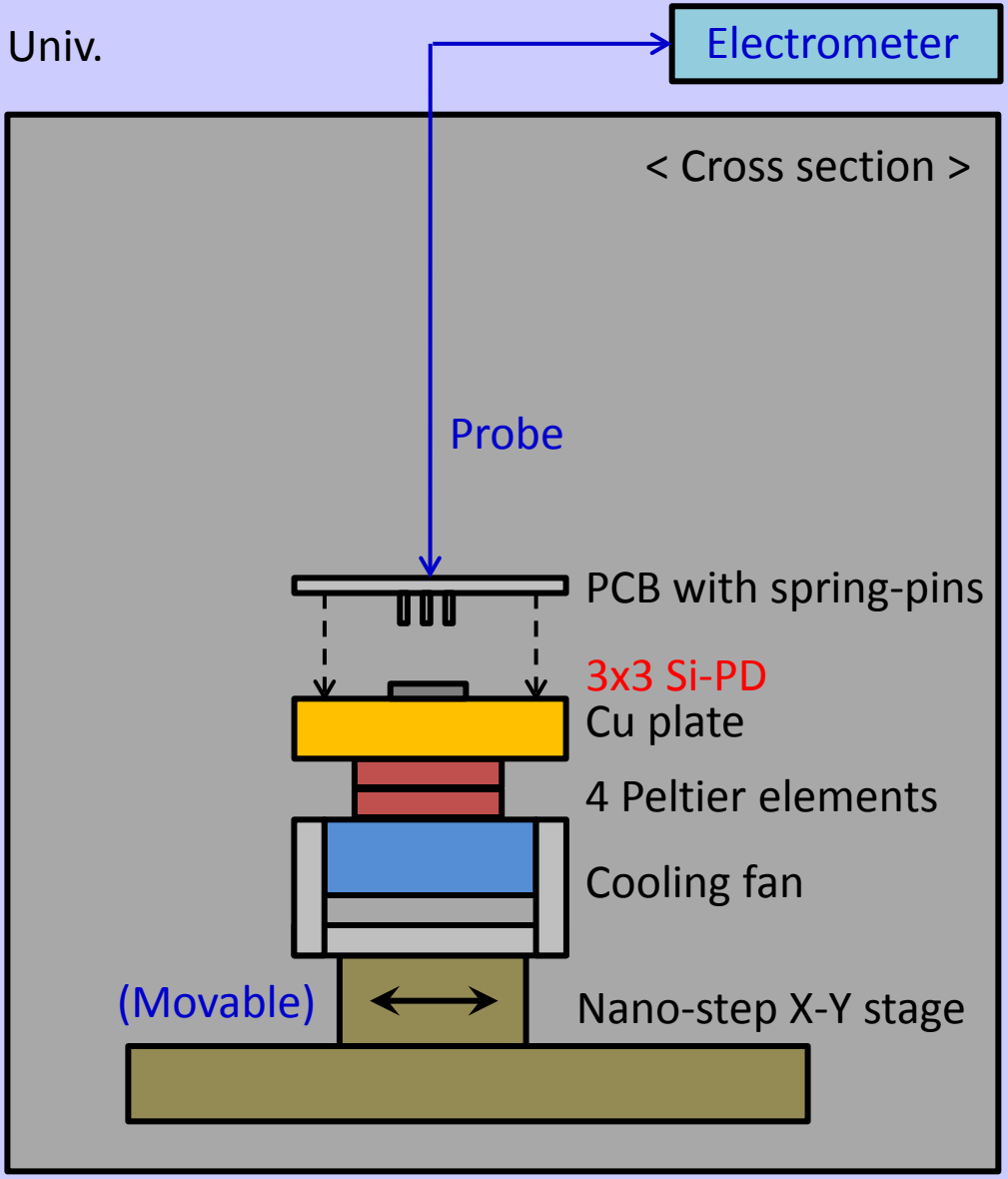
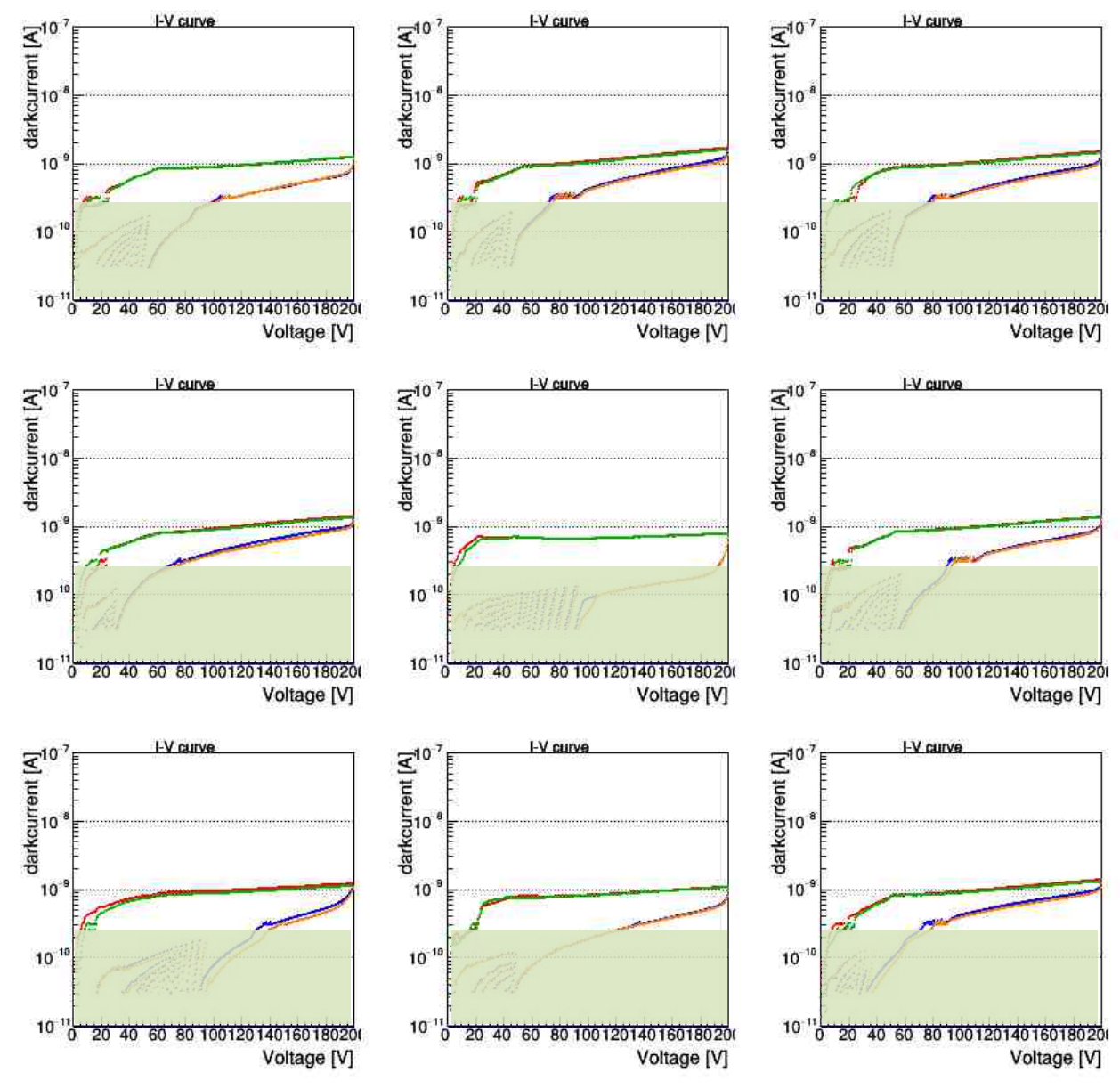


Fig.1 A cross section of the new test bench

V-I characteristics

10 ℃

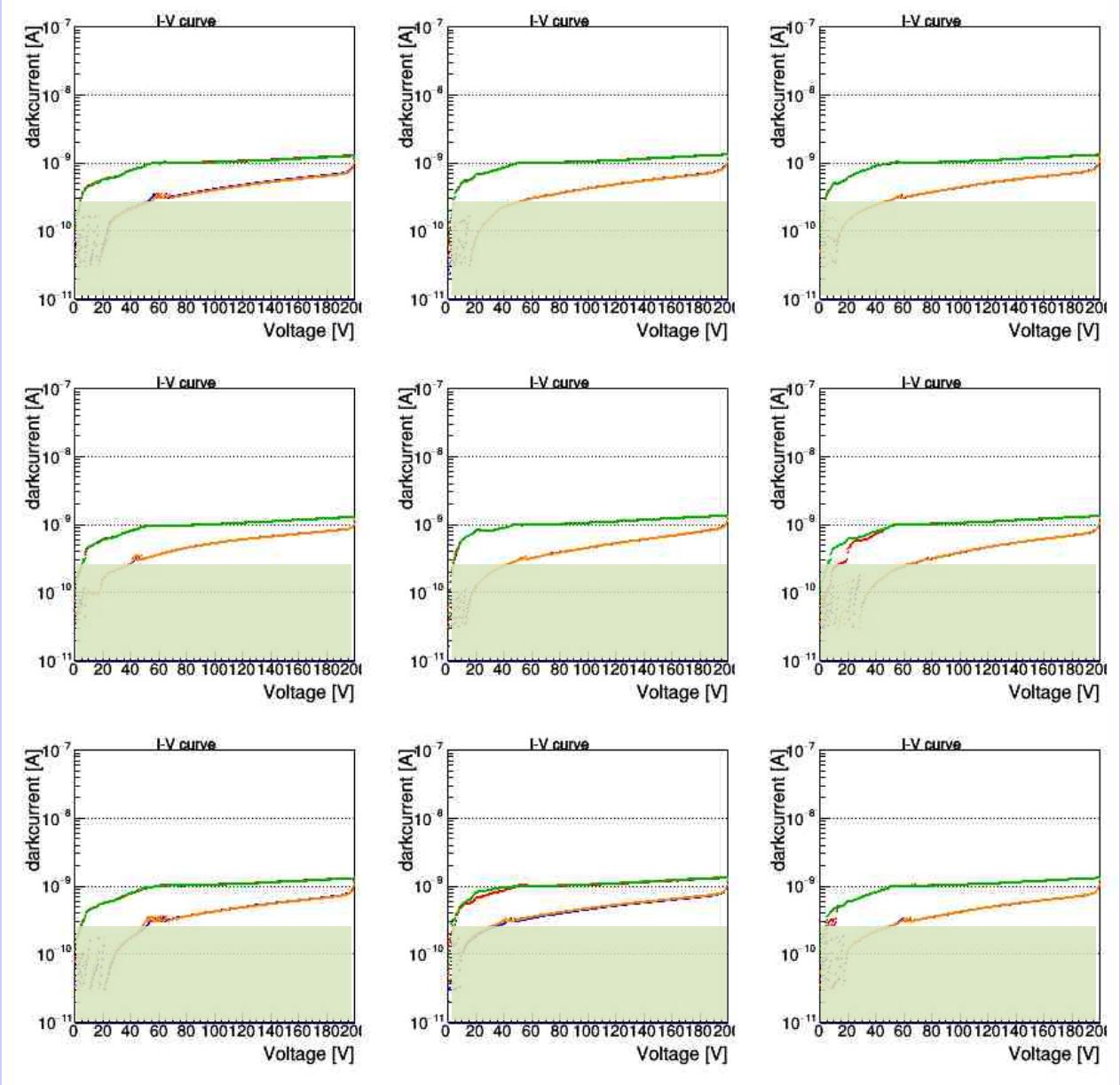


< 2[nA]

Tested by
K. Nishimatsu
UG4 student,
Univ. of Tsukuba

V-I characteristics

15 ℃



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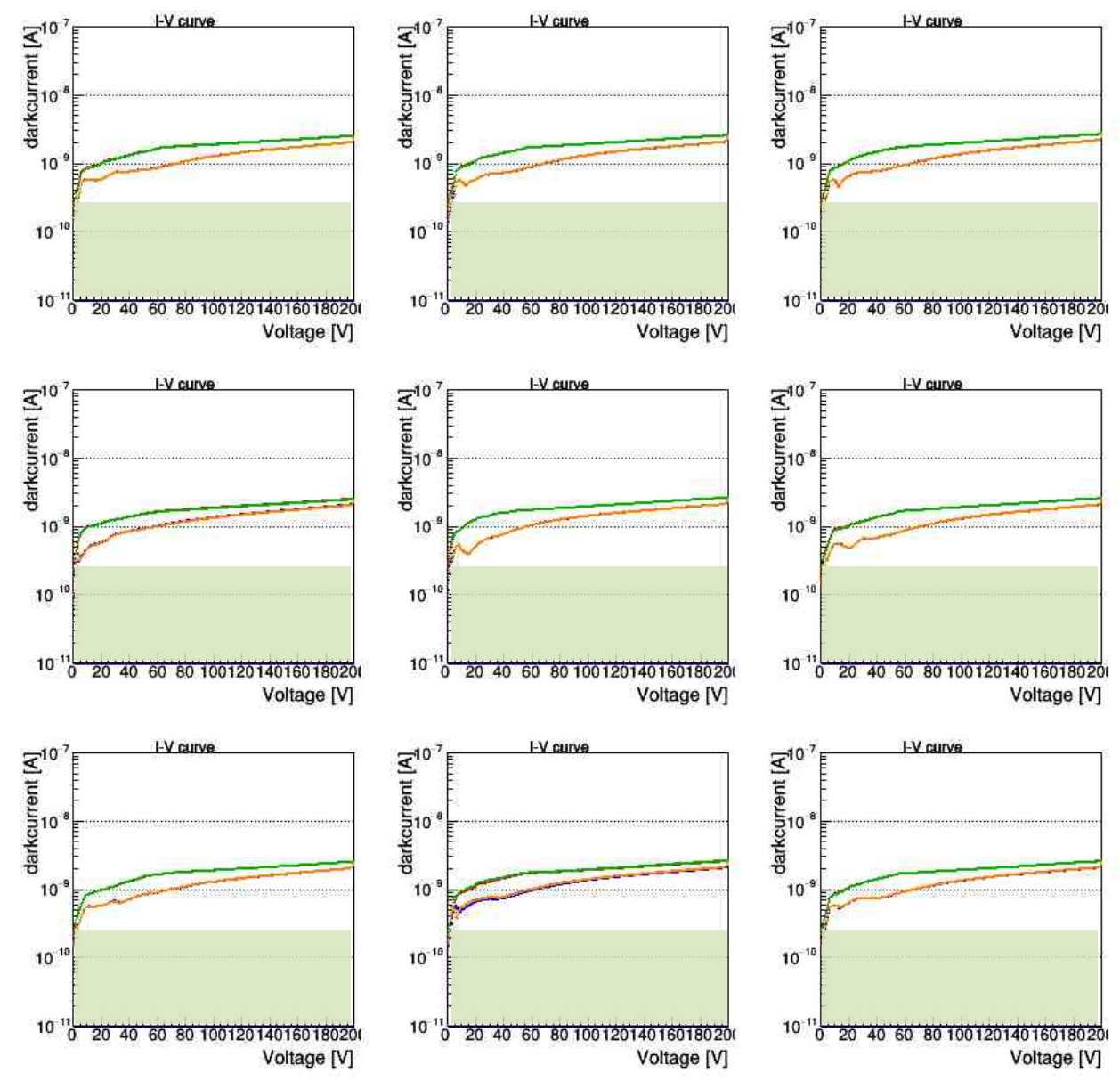
Tested by
K. Nishimatsu
UG4 student,
Univ. of Tsukuba

V-I characteristics

20 ℃



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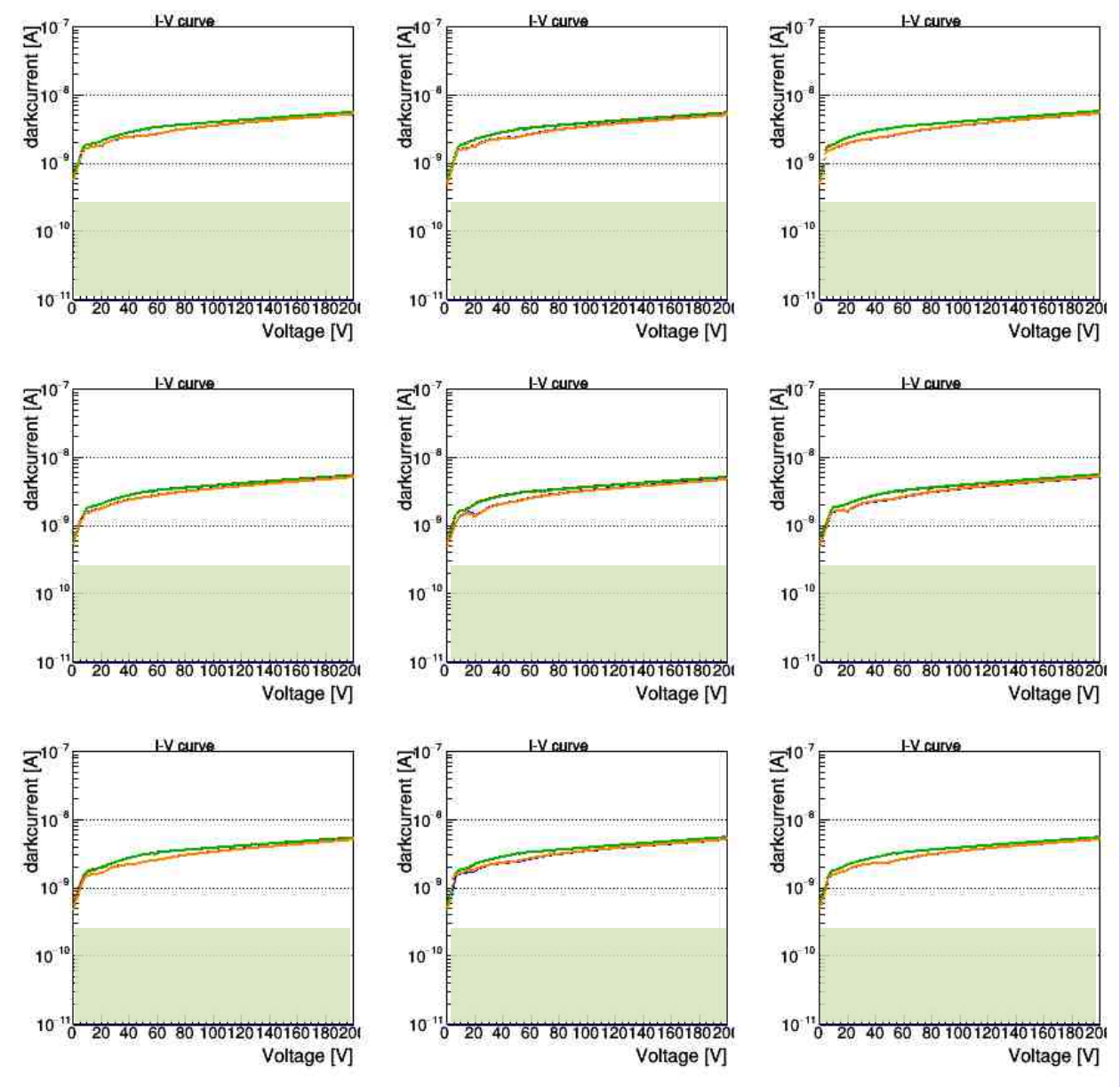
Tested by
K. Nishimatsu
UG4 student,
Univ. of Tsukuba

V-I characteristics

25 ℃



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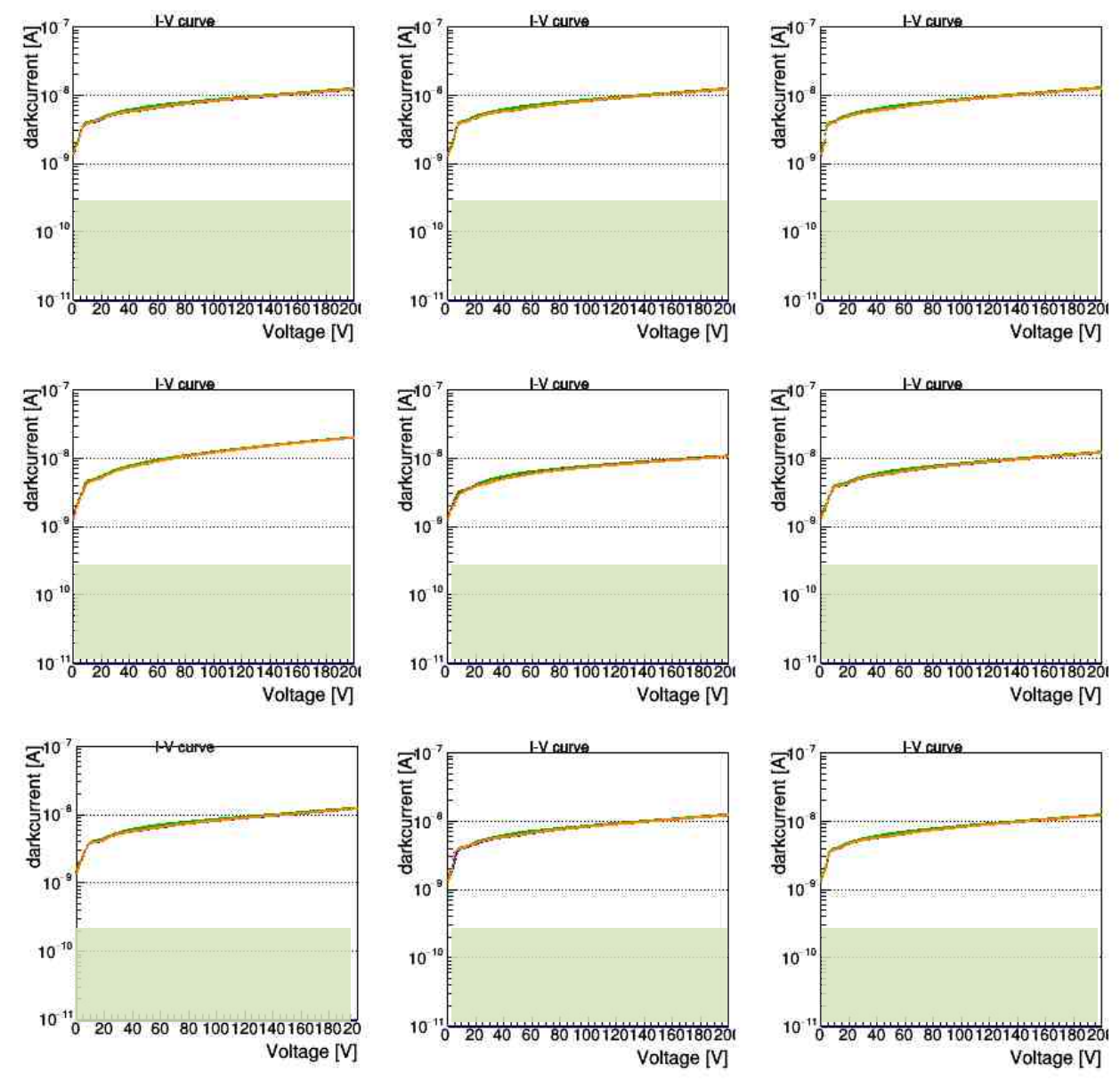
Tested by
K. Nishimatsu
UG4 student,
Univ. of Tsukuba

V-I characteristics

30 ℃



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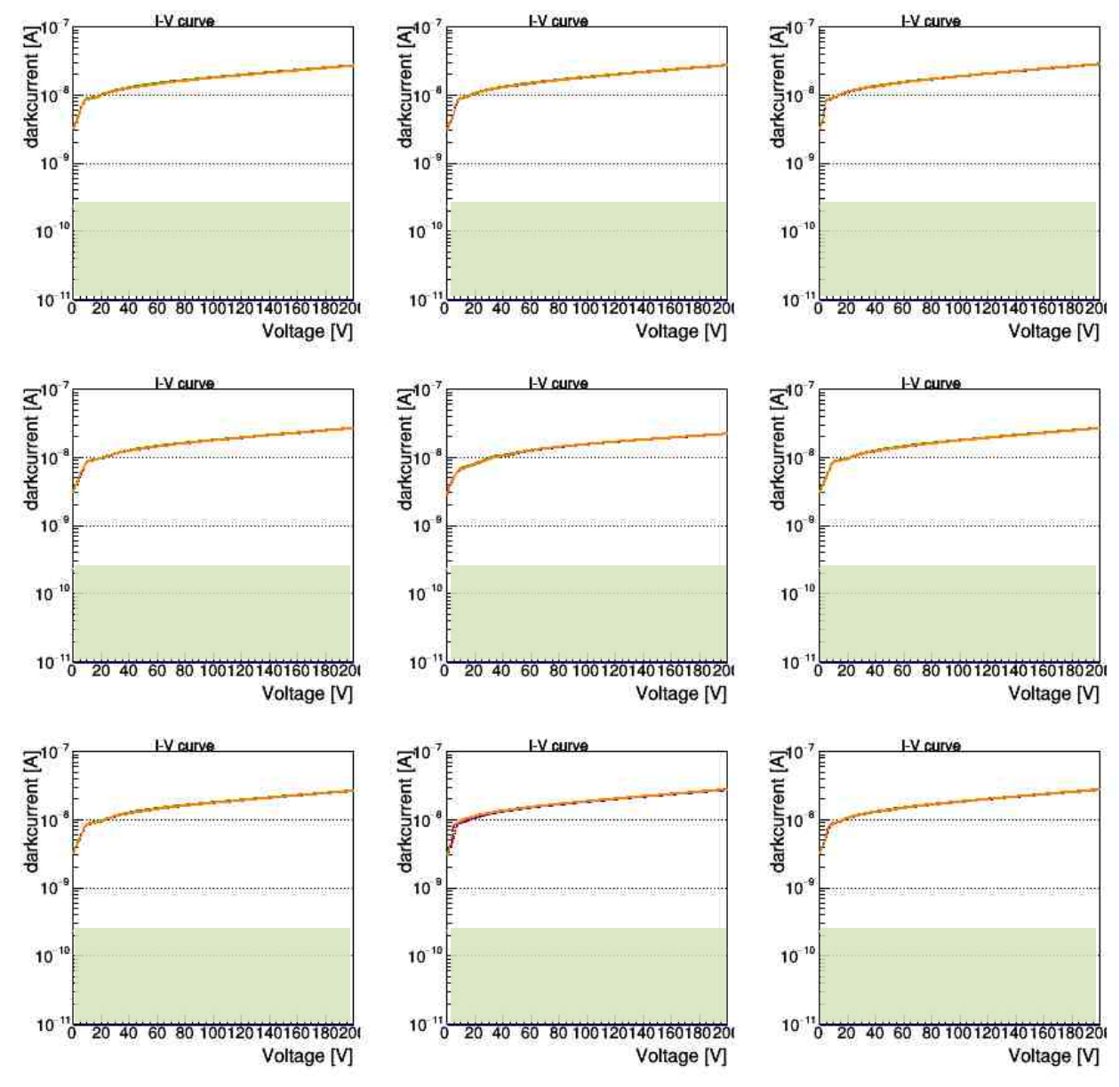
Tested by
K. Nishimatsu
UG4 student,
Univ. of Tsukuba

V-I characteristics

35 ℃



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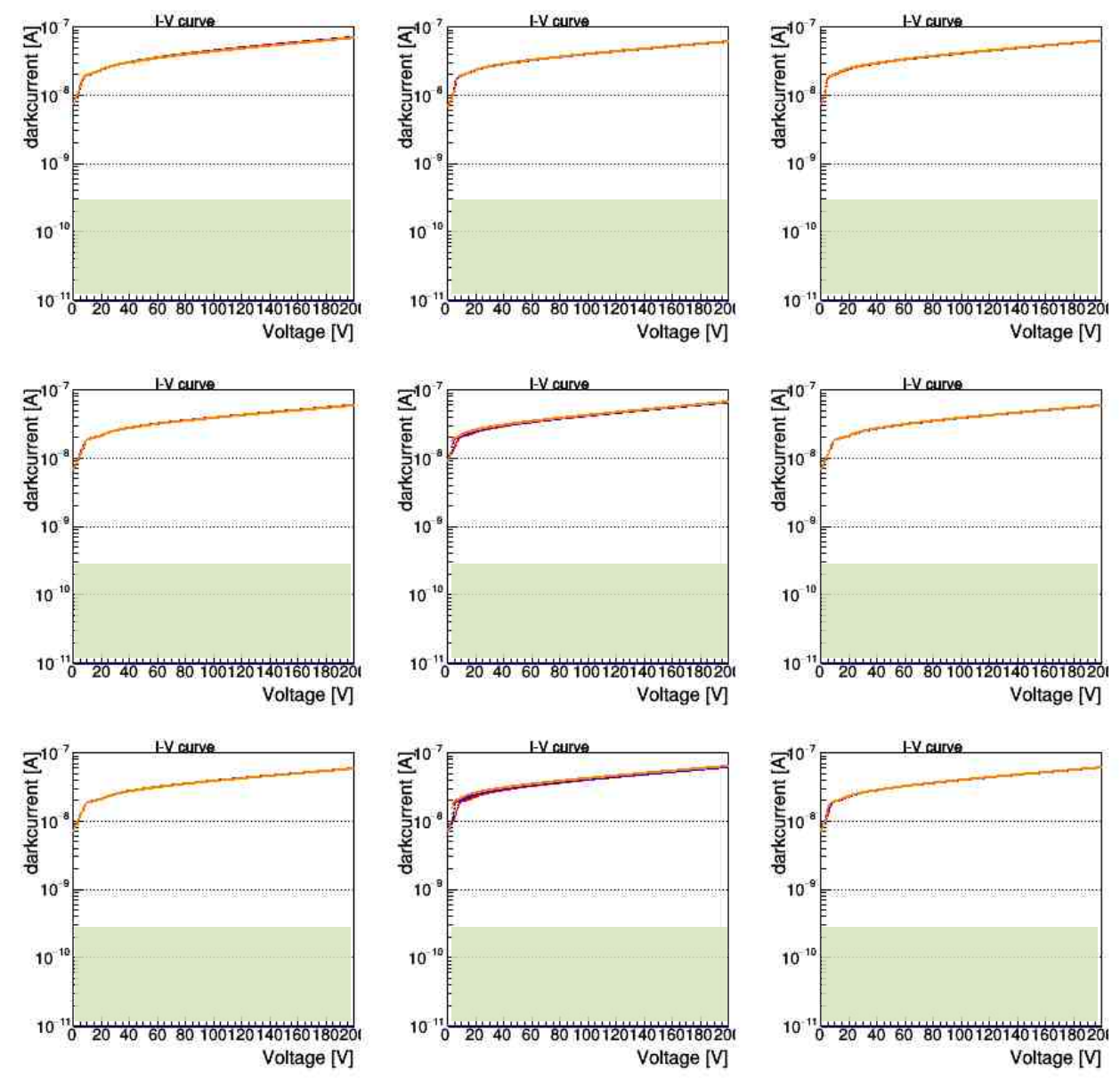
Tested by
K. Nishimatsu
UG4 student,
Univ. of Tsukuba

V-I characteristics

40 ℃



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Tested by
K. Nishimatsu
UG4 student,
Univ. of Tsukuba

2nd test bench for 8x8 Si-PD

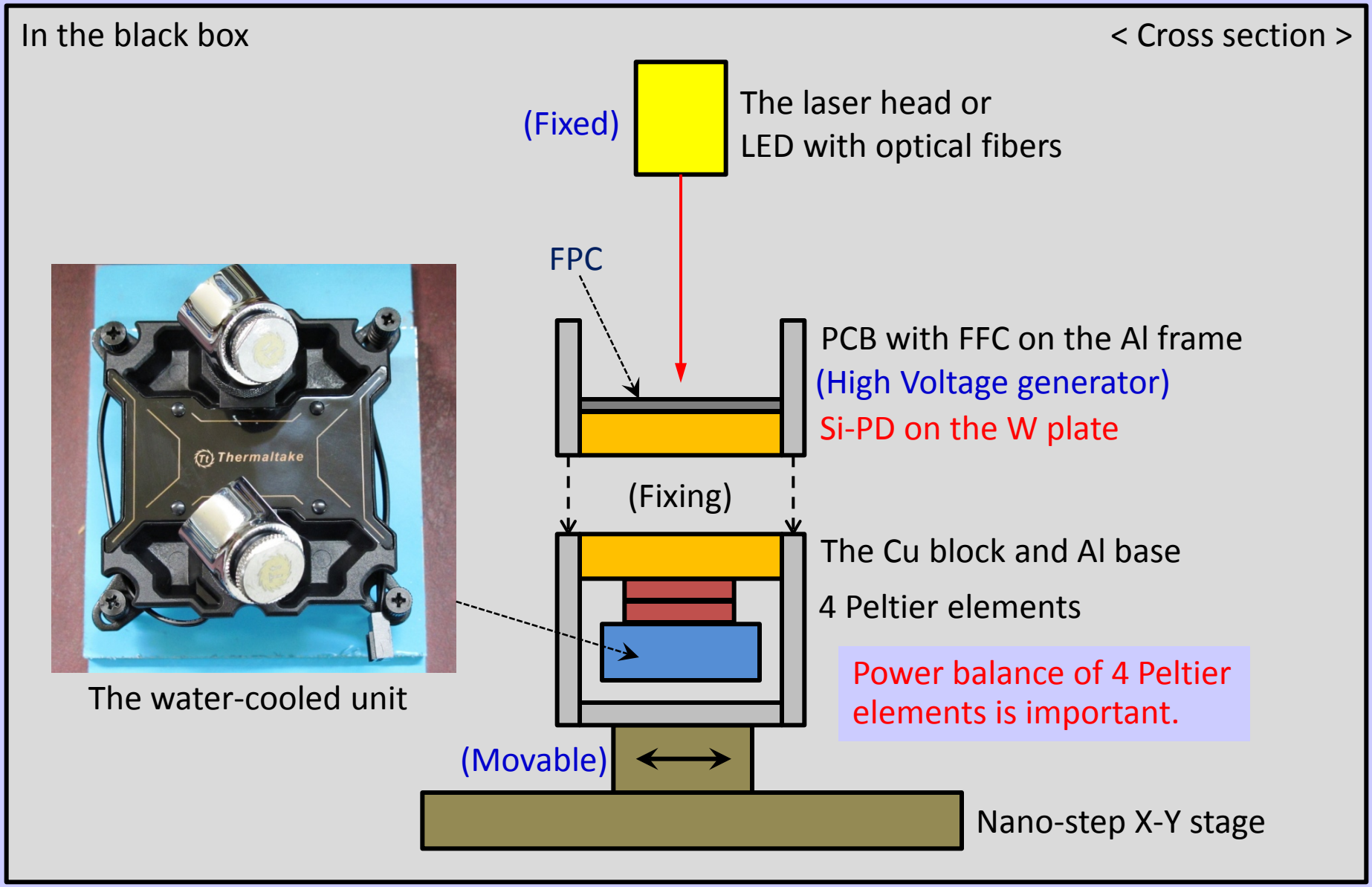


Fig.1 A cross section of the new test bench

Test plans for ALICE FoCal-E PAD

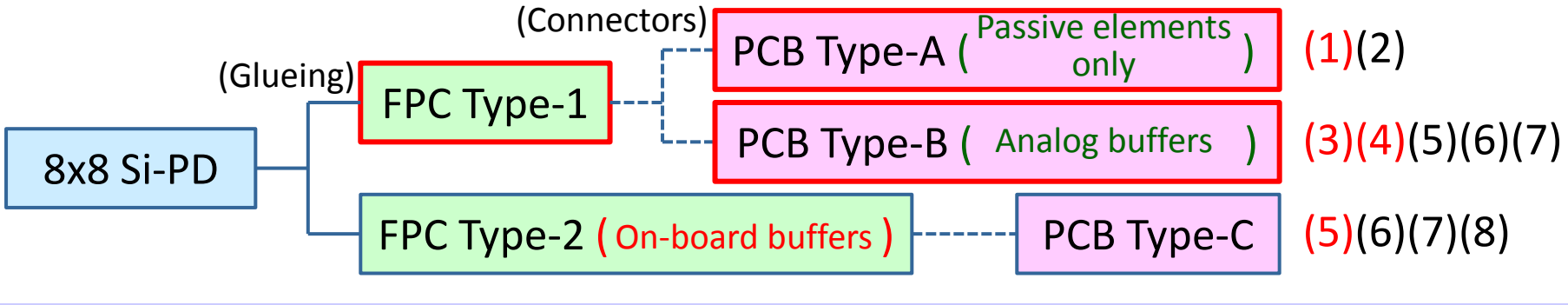
After the 2nd test bench for new Hamamatsu 8x8 Si-PDs is developed, we are going to test as follows;

(1) V-I characteristics using the electrometer,
(2) V-C characteristics using the RLC meter,
(3) Dynamic characteristics using the Laser / LED pulsar,
(4) Light-incident-position dependence,
(5) Cable-length dependence,
(6) Estimation of heating and power consumption,
(7) Cross-talk check,
(8) Radiation durability, etc.

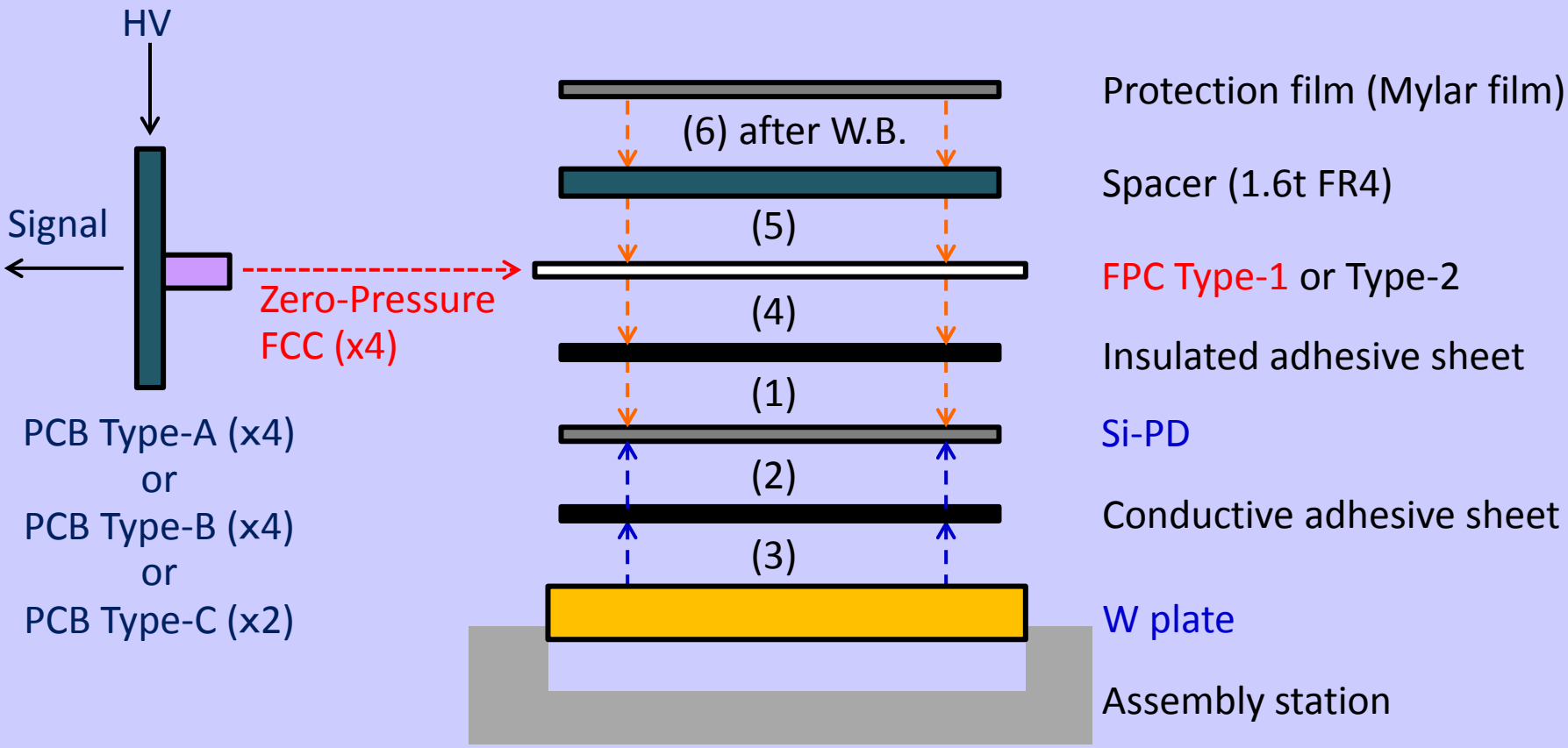
Important test points

- S/N
- Dynamic range
- Space

Mechanical design



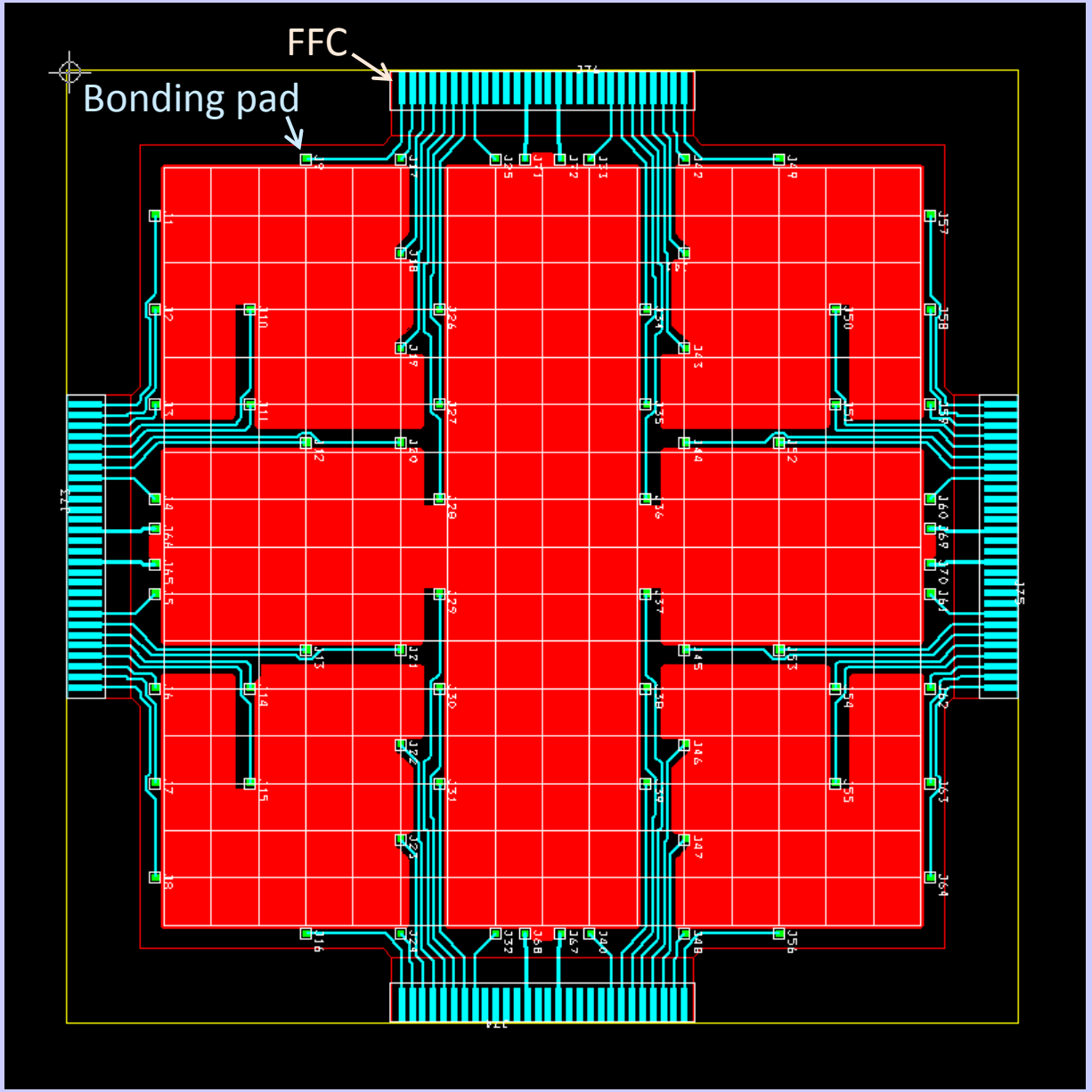
Assembly



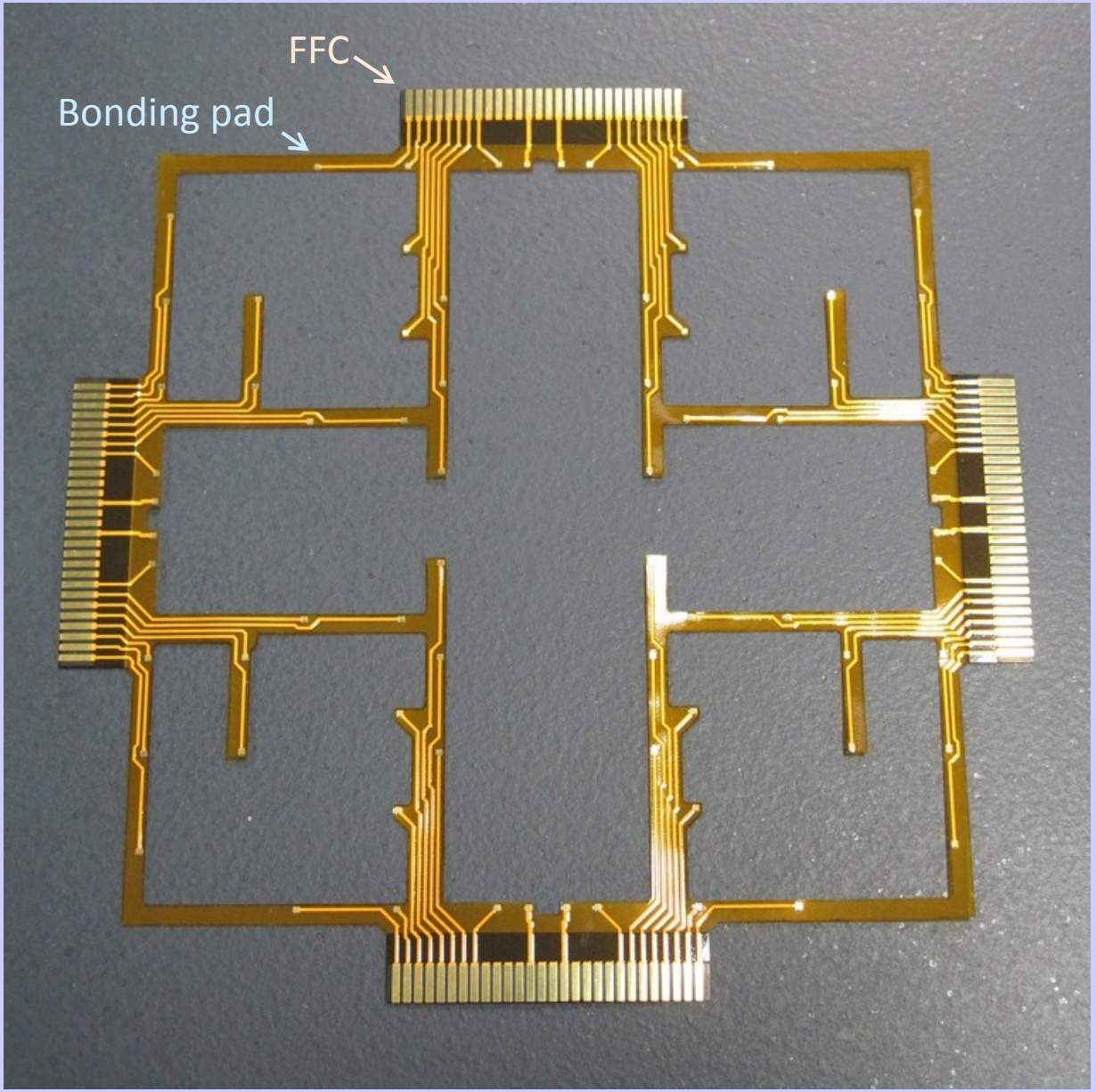
The PCB Type-A is designed for the static characteristics test using electrometer.

The PCB Type-B is designed for the dynamic characteristics test using the Laser light.

FPC design

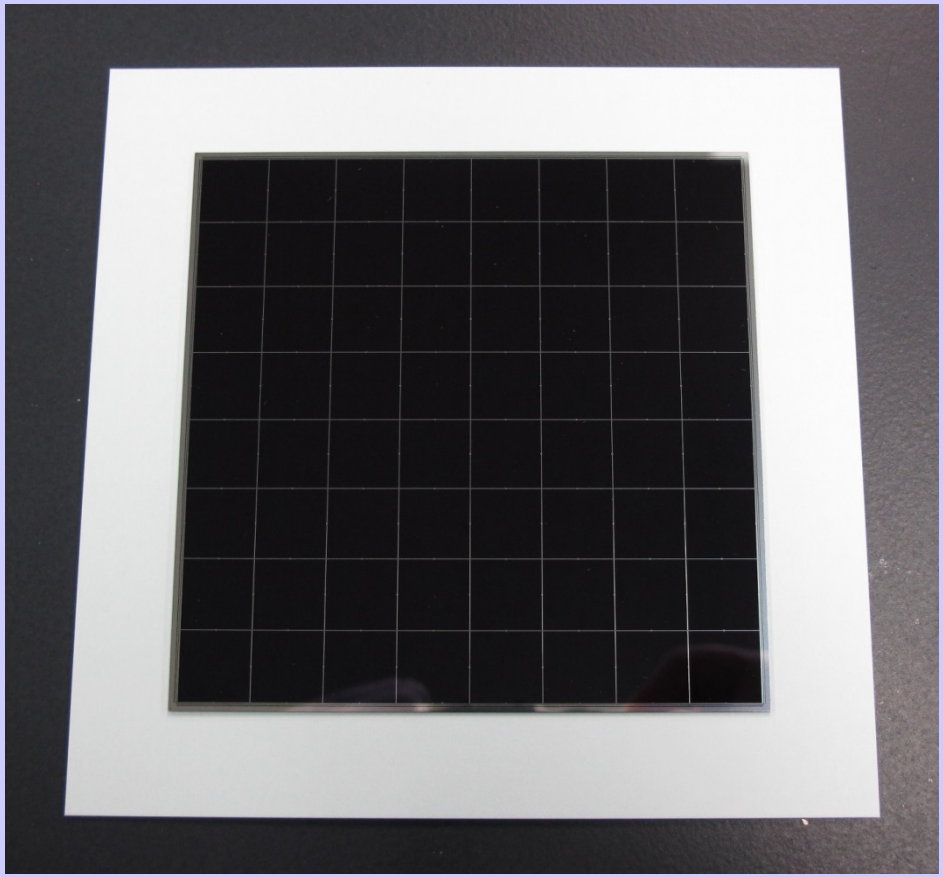


FPC design

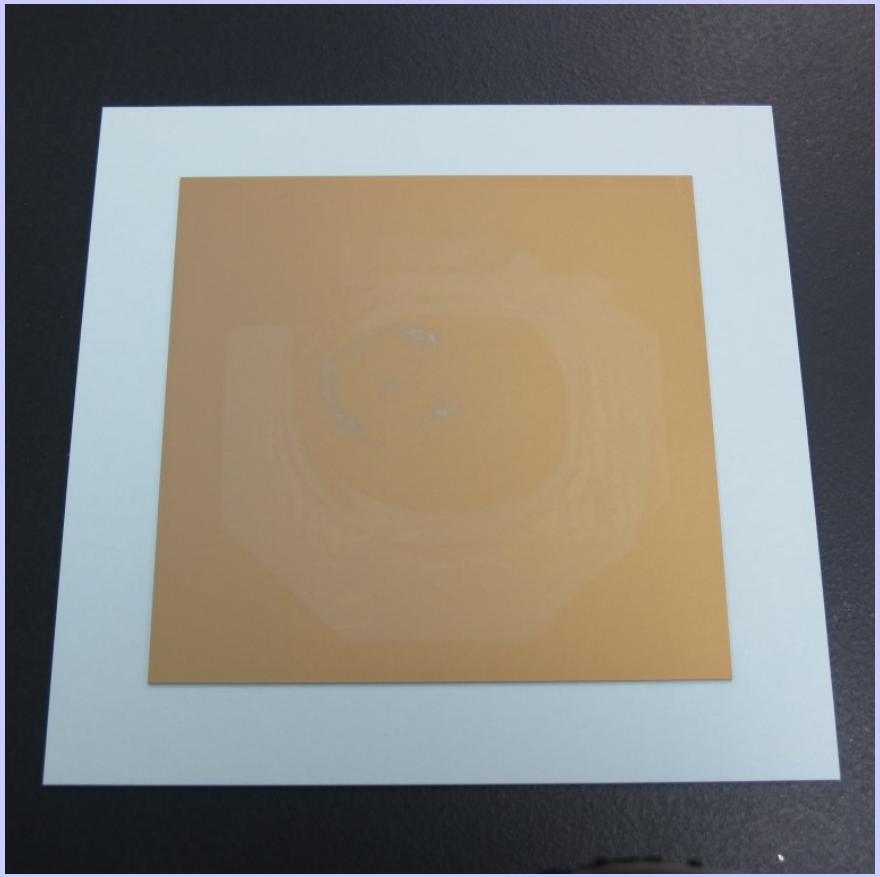


New Hamamatsu 8x8 Si-PDs

We got 10 Si-PDs at the end of January.



Top side



Bottom side

Insulated adhesive sheets

We imported three types of the double coated tape from 3M U.S.A..

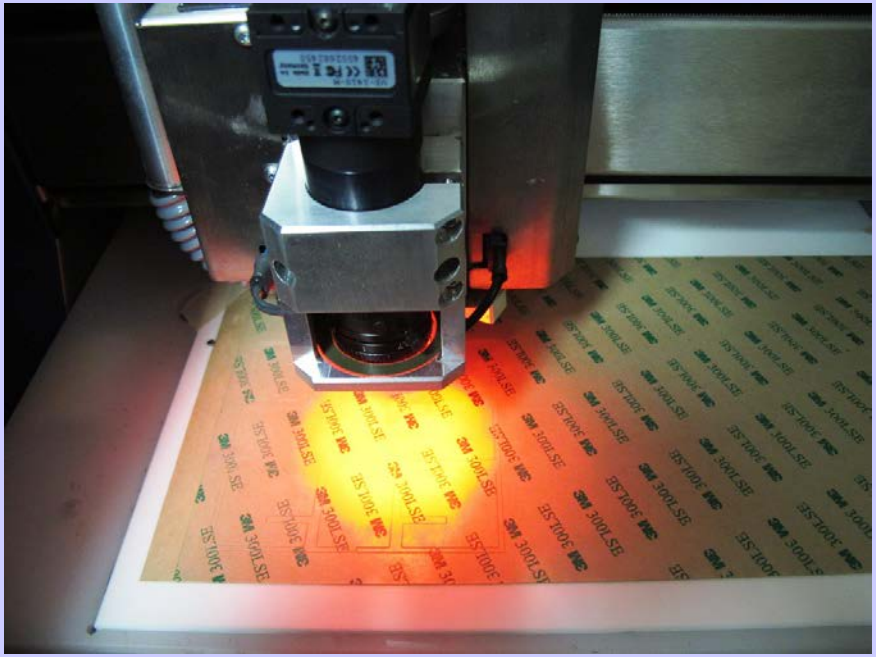
Product Number	Series	Carrier	Thickness	High Temp. Range	Dielectric Properties	Resistance	Unit Price
9495LE	300LSE	Clear Polyester	0.013mm	93℃	43kV/mm	¥890	¥915
9490LE	300LSE	Clear PET	0.013mm	93℃	40kV/mm	¥870	¥887
9495MP	200MP	Clear PET	0.013mm	121℃	54kV/mm	¥780	¥792

Conductive adhesive sheets

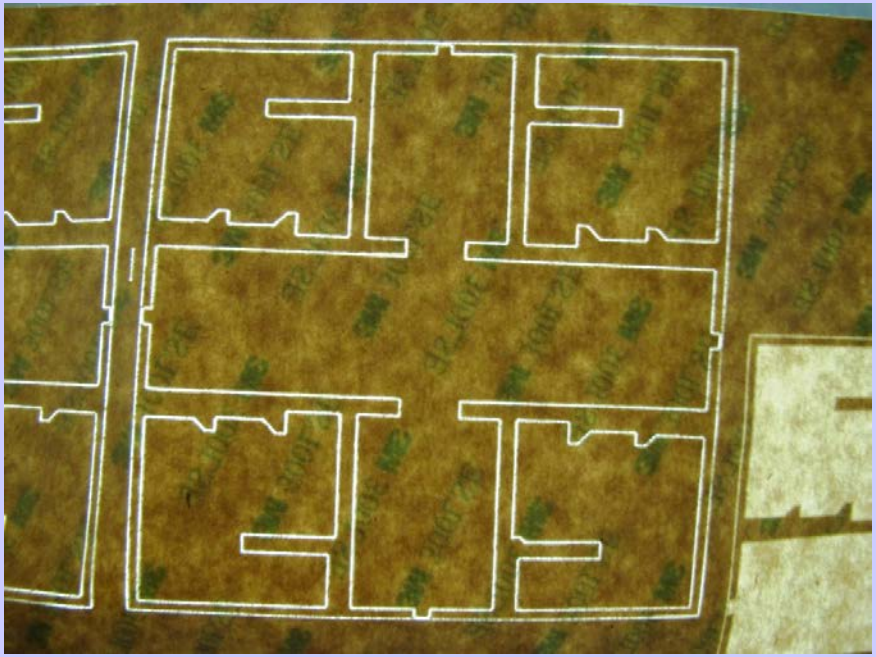
We also bought three types of the conductive tape as follows.

Product Number	Series	Carrier	Thickness	High Temp. Range	Adhesive force	Resistance	Unit Price
CN-4490	-	Cu/Ni plated	0.05mm	-	3.9 N/cm	0.050Ω／mm^2	¥1,540
X7001	-	Cu-planting	0.110mm	-	6.6 N/cm	0.015Ω／25mm^2	¥1,260
AL-25DC	-	Al-base	0.085mm	-	3.6 N/cm	0.035Ω／25mm^2	¥3,010

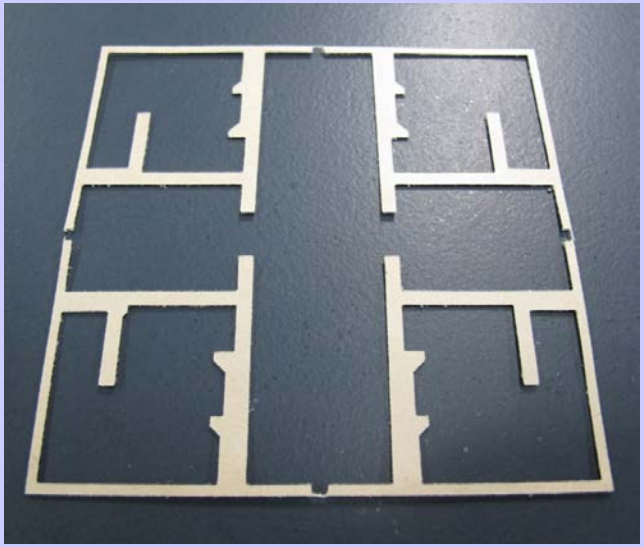
Cutting of adhesive sheets



Cutting using a machine

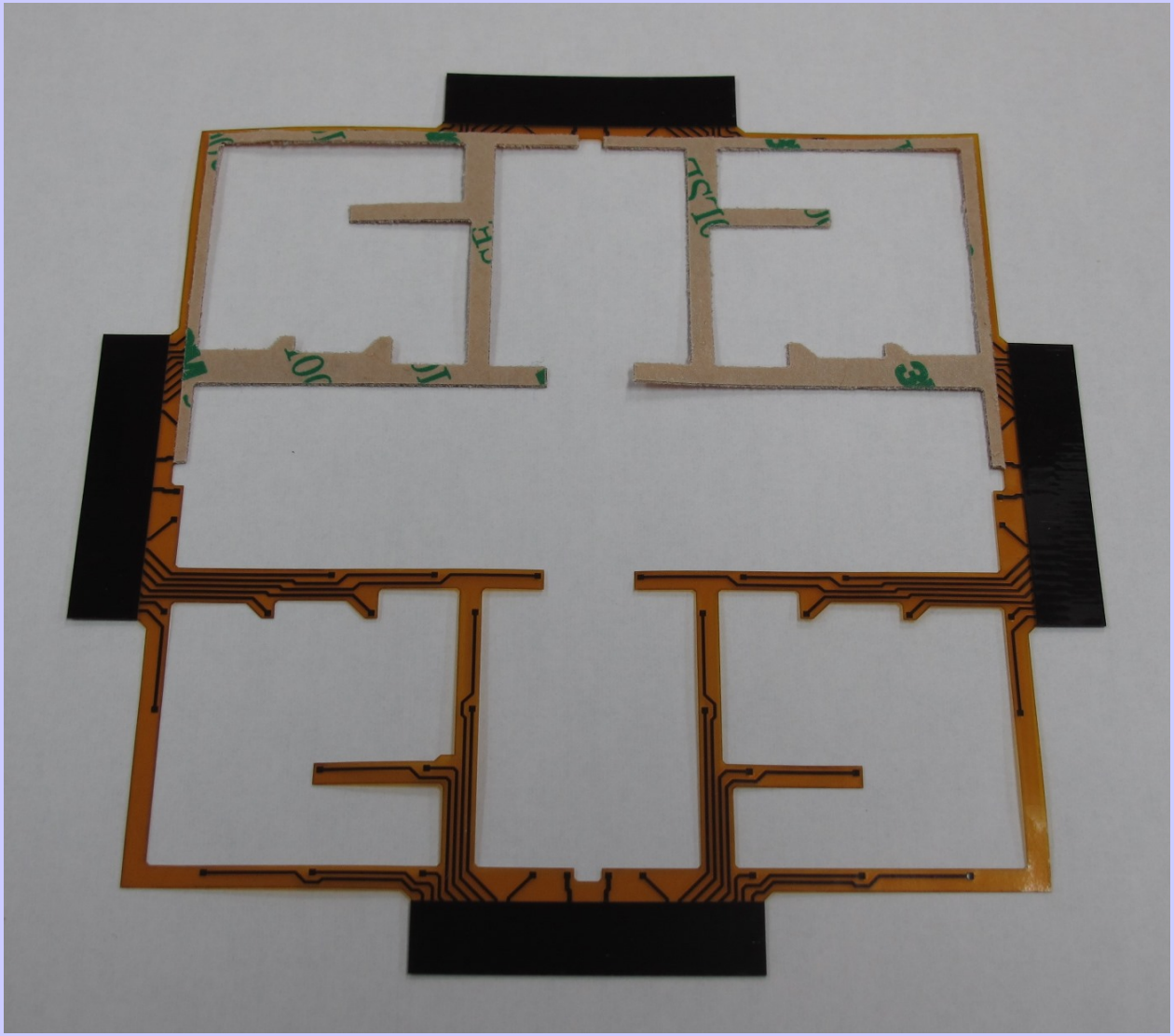


Just after cutting



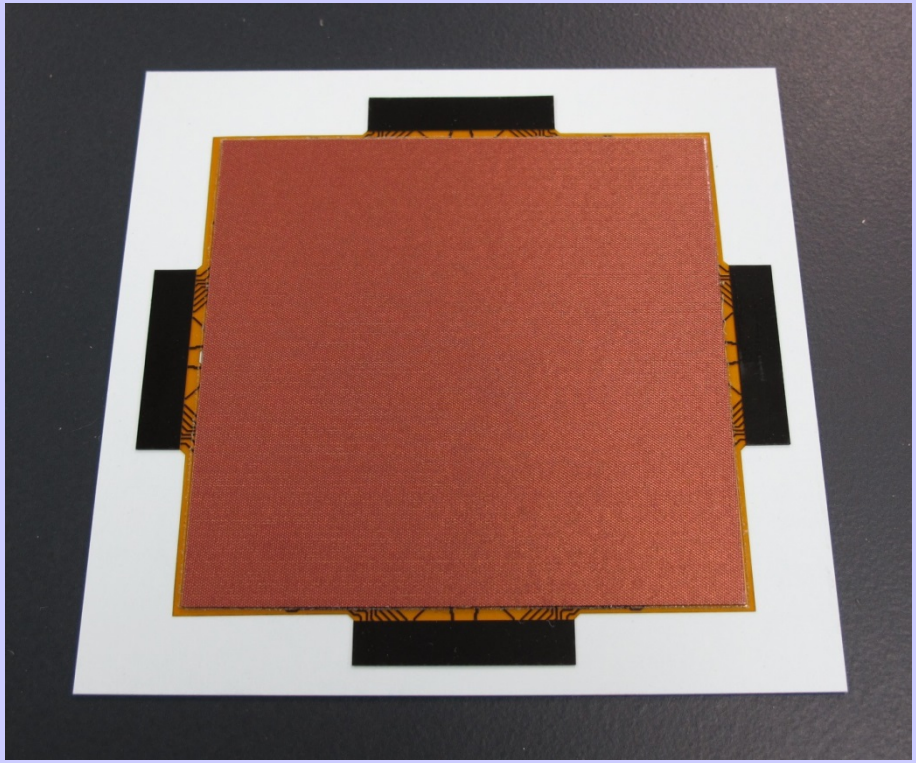
Ready for assembling

Assembly (1)

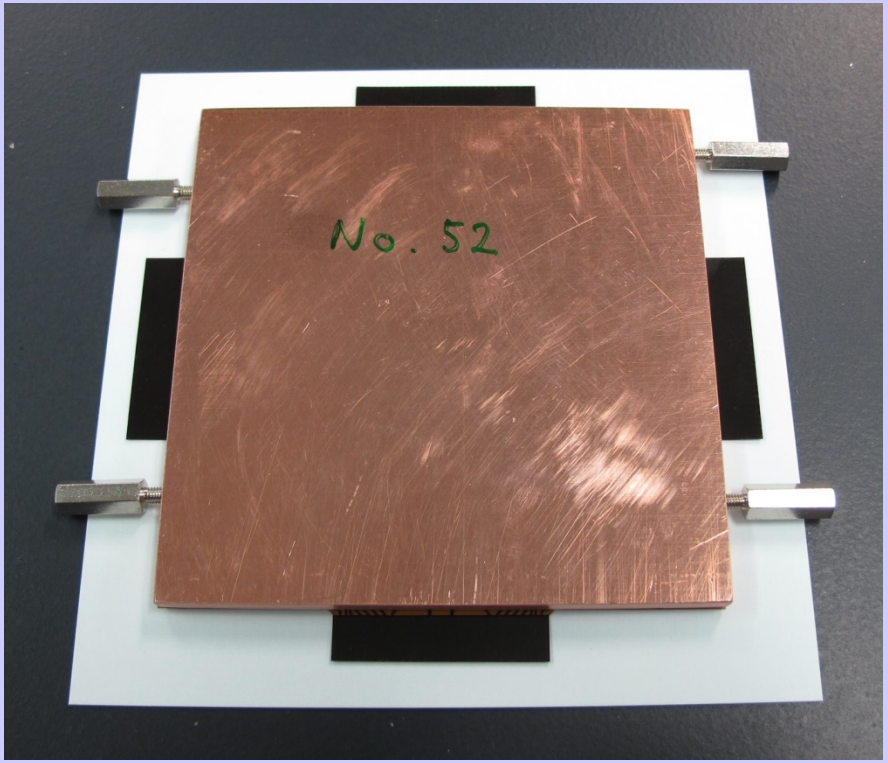


Insulated adhesive tapes on the bottom side of FPC

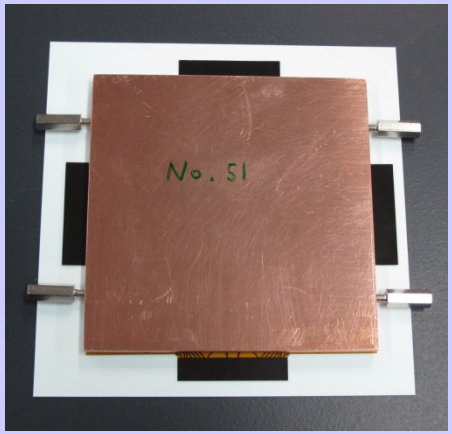
Assembly (2)



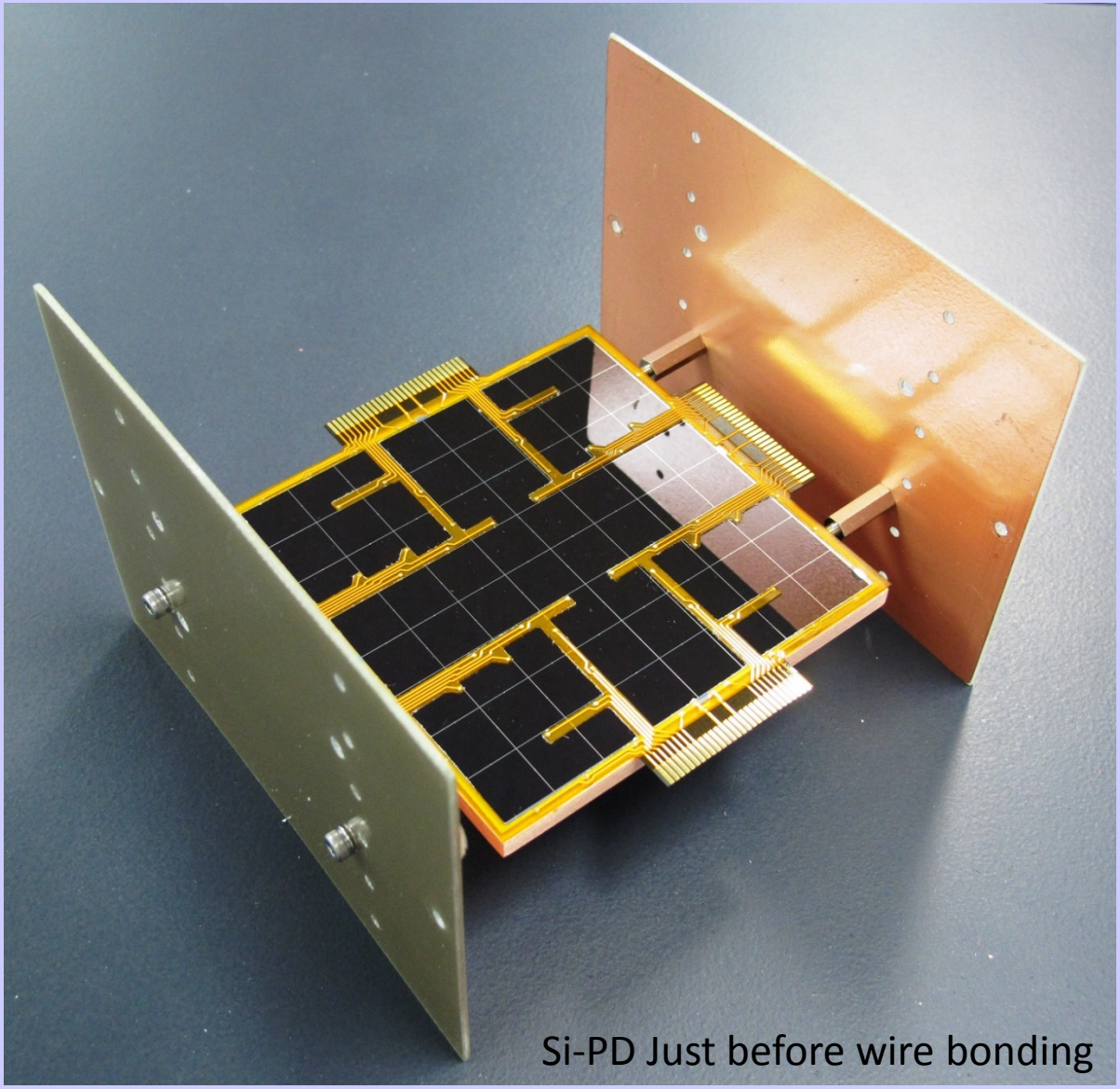
One side of a tape adheres to the bottom side of Si-PD



Another side of a tape adheres to the Cu plate

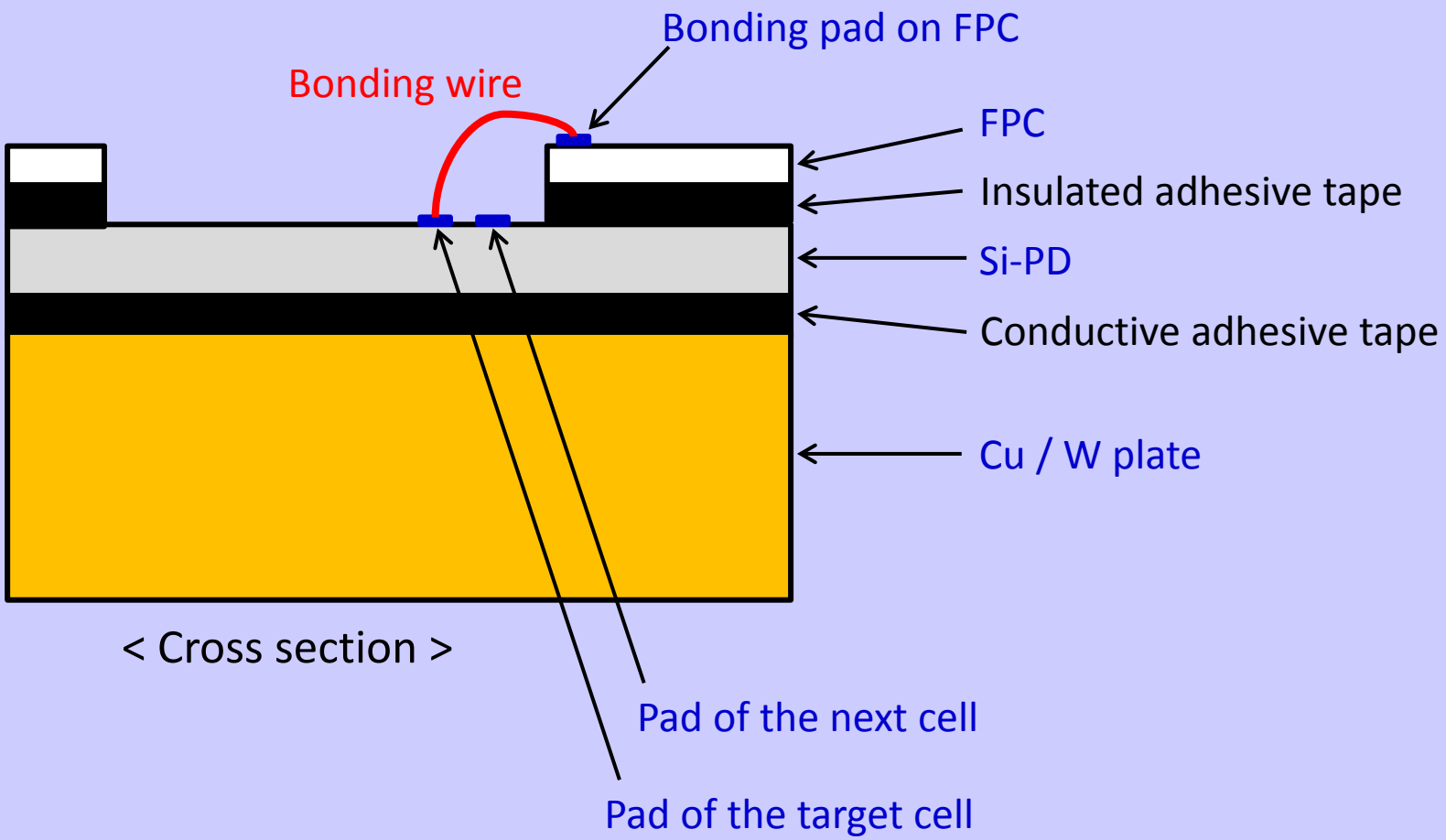


Shipping for wire bonding

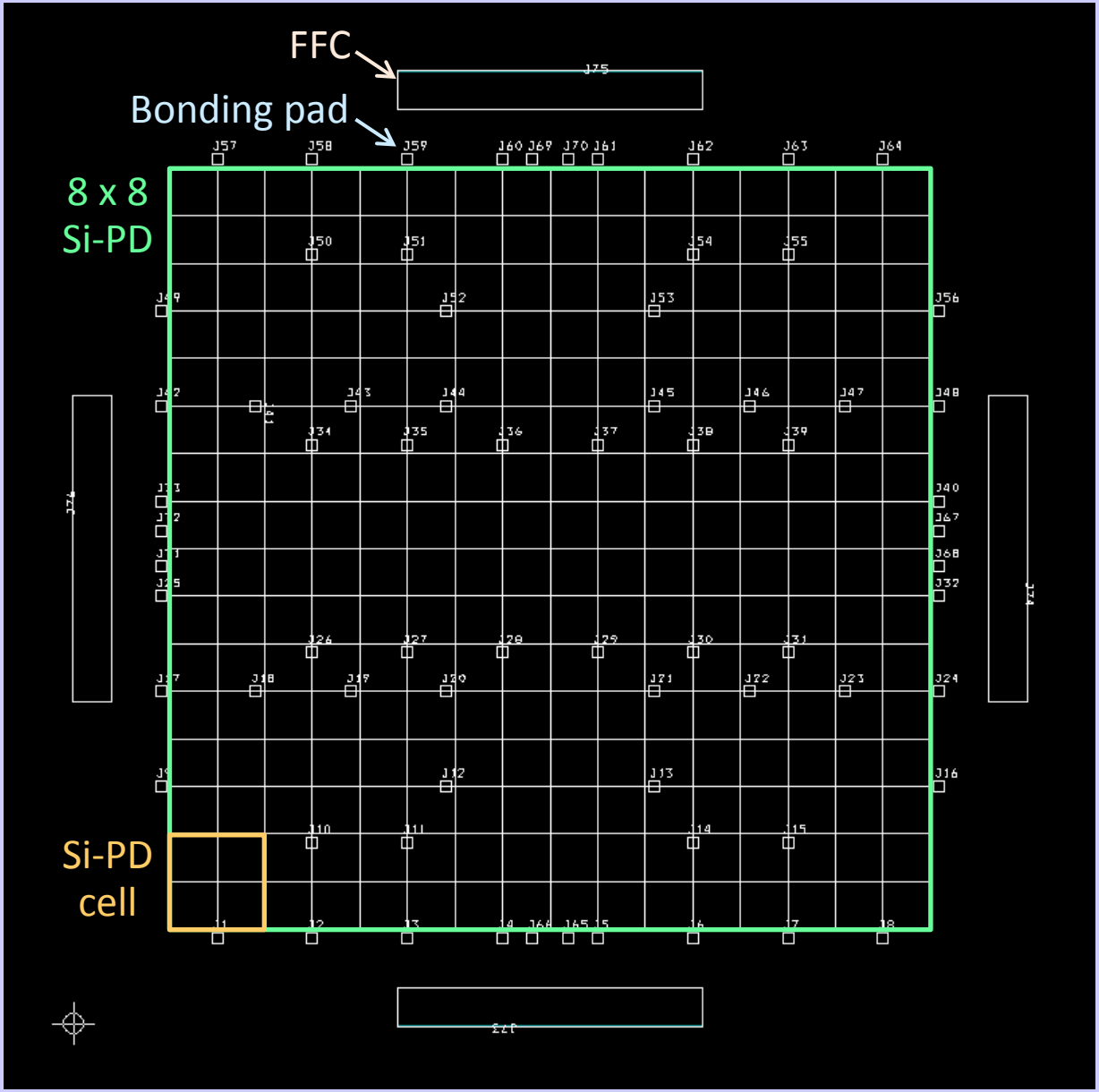


Si-PD Just before wire bonding

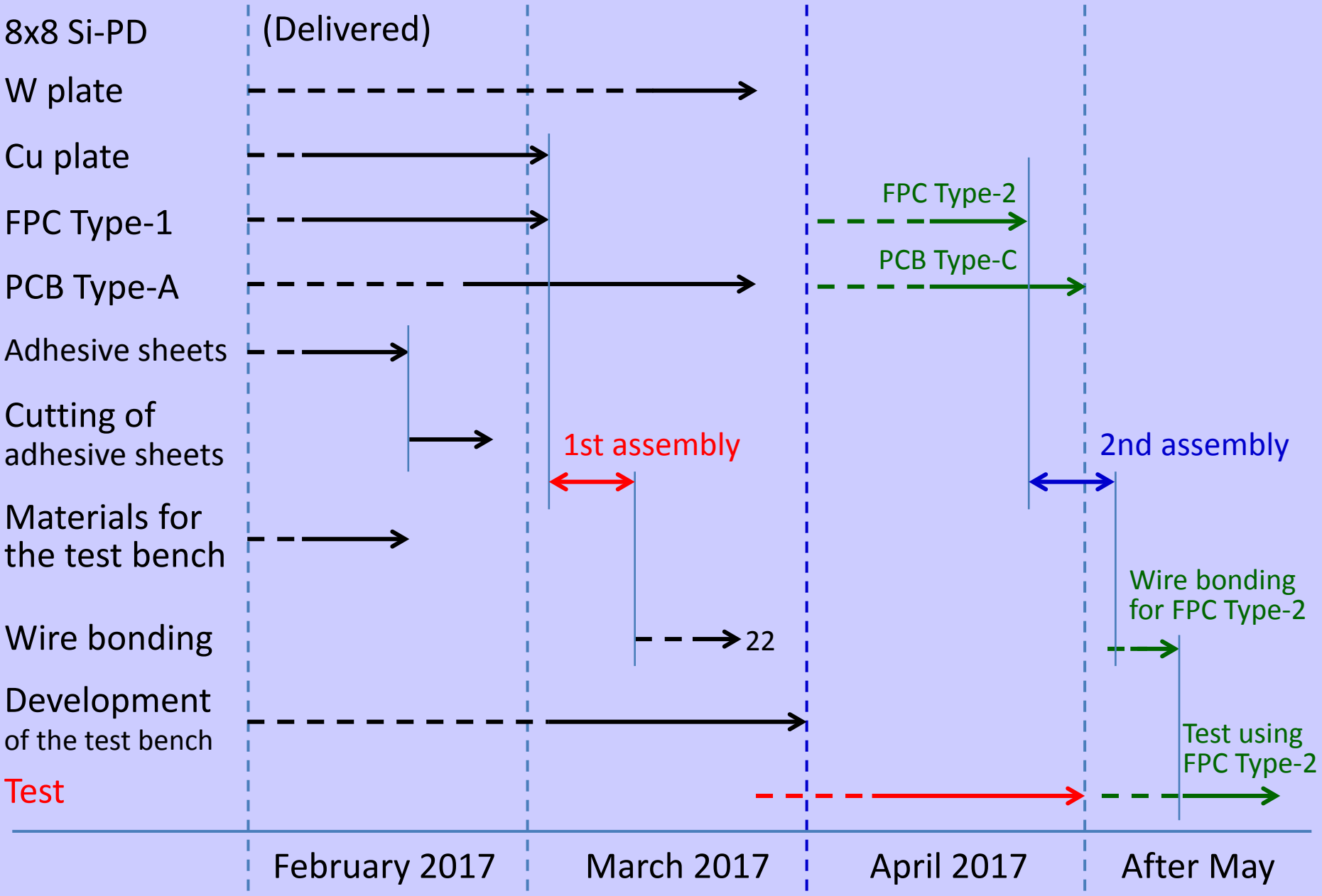
Wire bonding



Wire bonding: 72 points / module



Material lists and schedule



Thank you for your attention.