

Design of HRPPD Signal Readout Chain

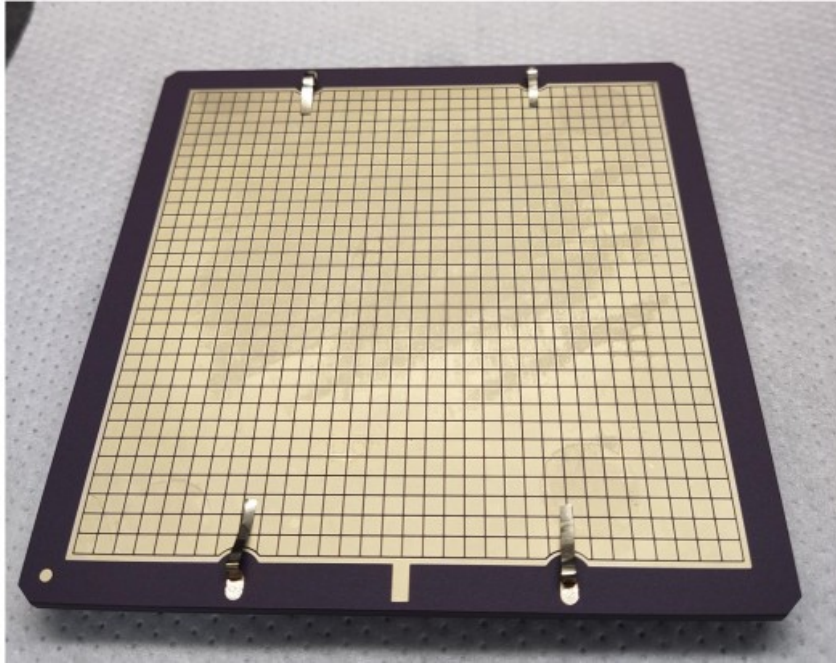
Slides for discussion on finalising the design

Dec. 2024

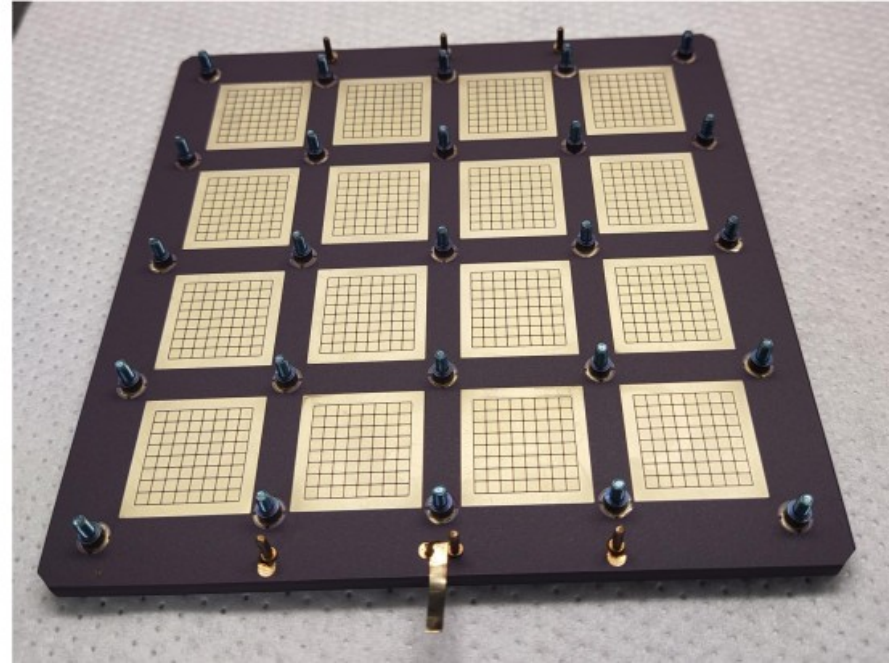
Jinky Agarwala

List of pieces brought to Trieste from the US
by Silvia (pictures are in slides 4 to 7)

- One passive interface
- Compression interposers
- Grounding caps

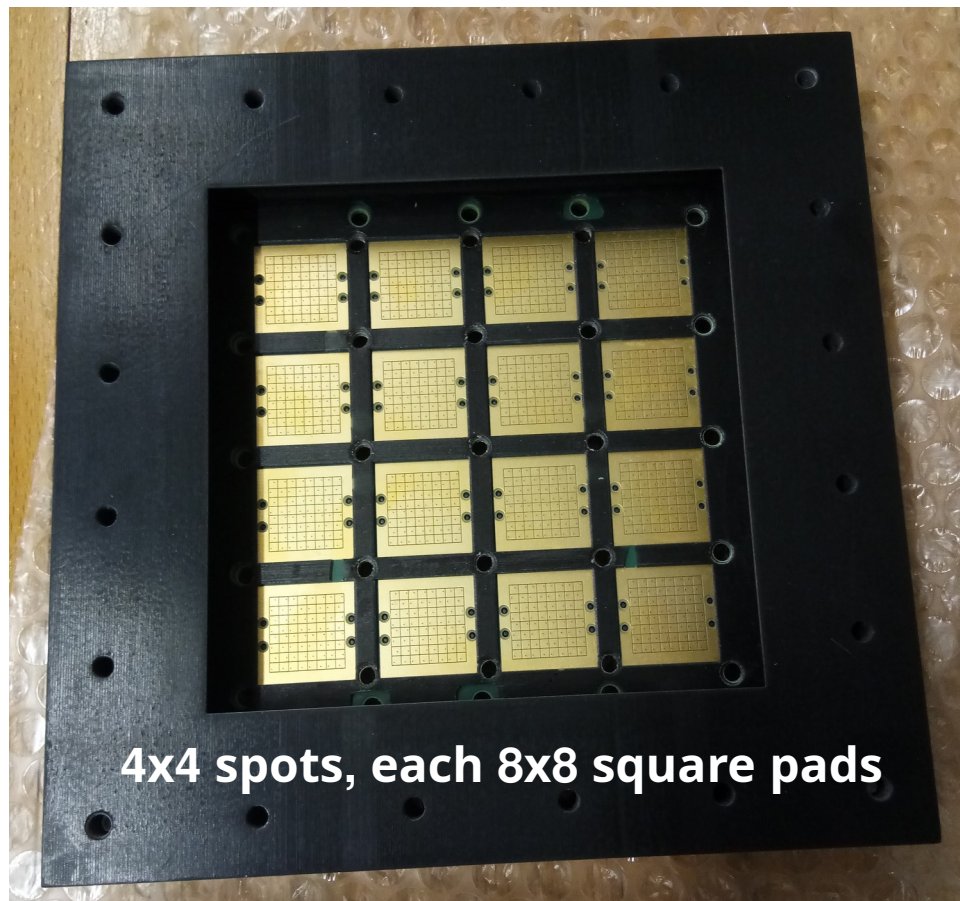


1024; 3 mm pixels



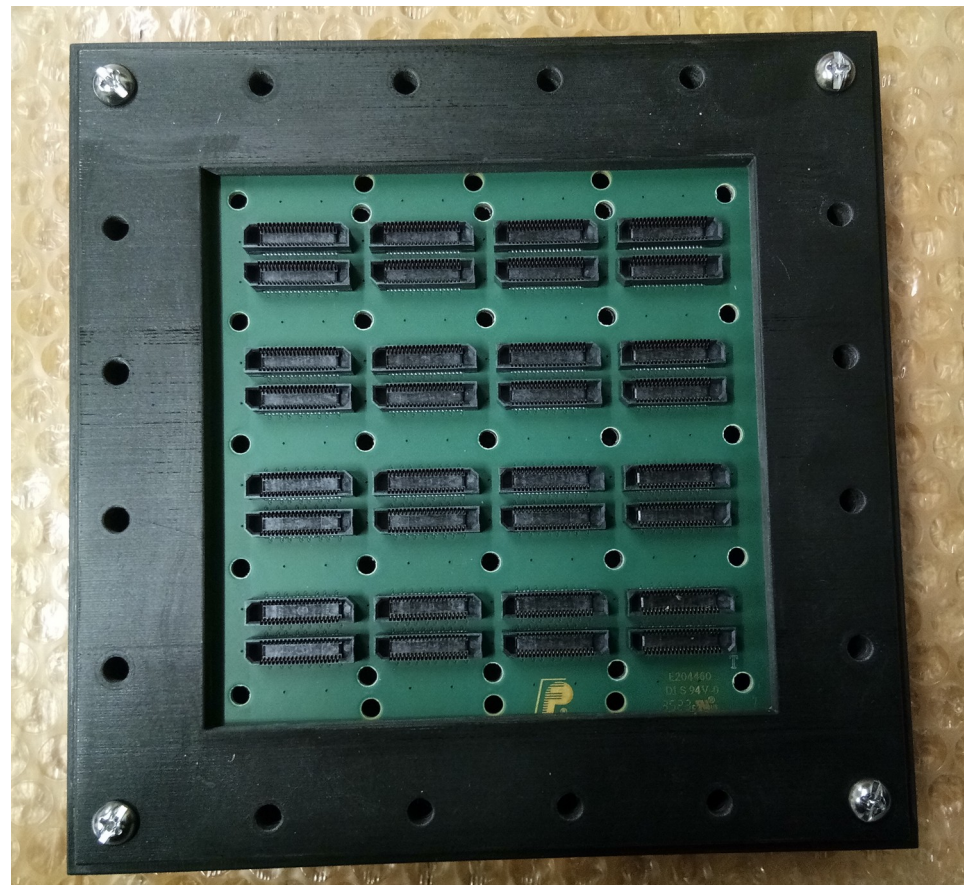
Anode plate vacuum side (left), air side (right)

Passive interface arrived in Trieste



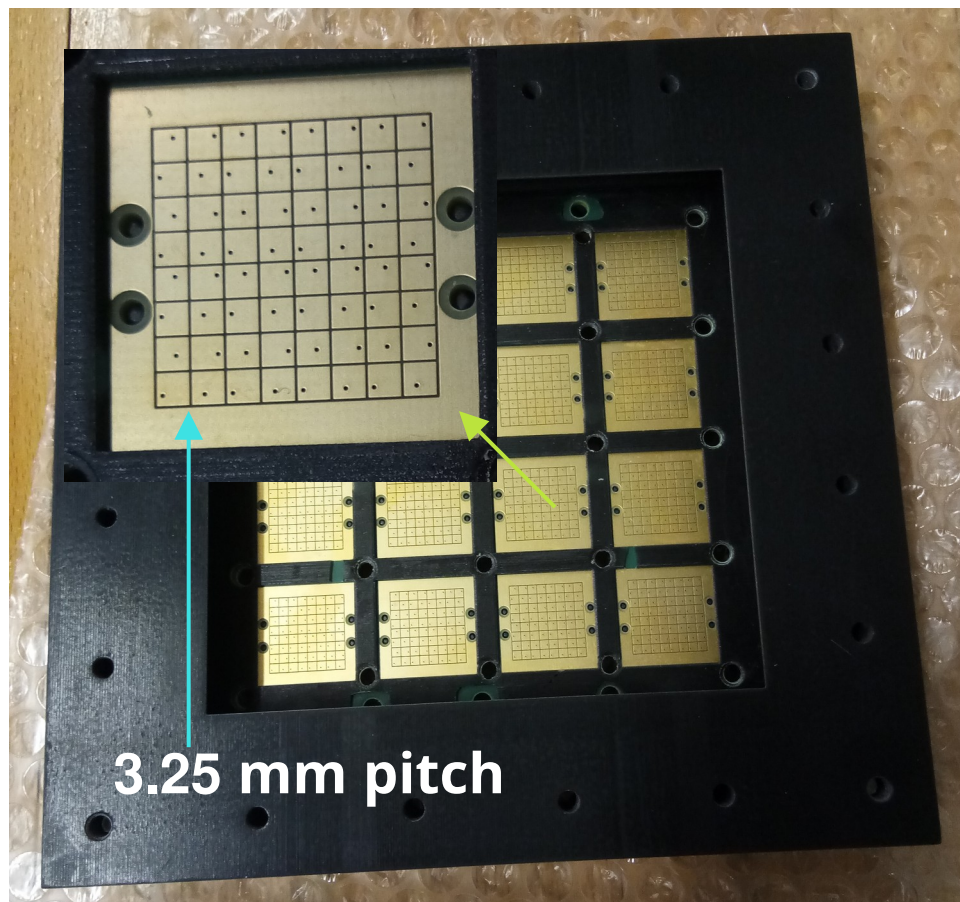
4x4 spots, each 8x8 square pads

Inner side
(matches HRPPD rear side)

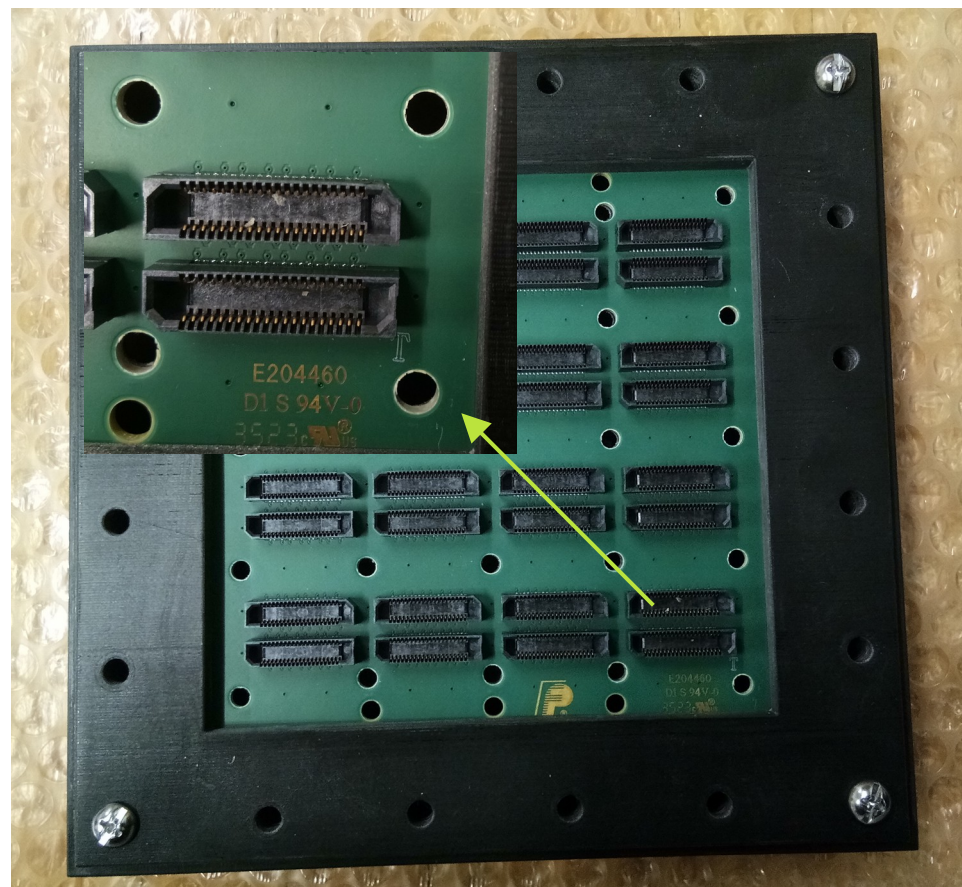


Outer side
32x Samtec ERF8 connectors/sockets 4

Passive interface arrived in Trieste

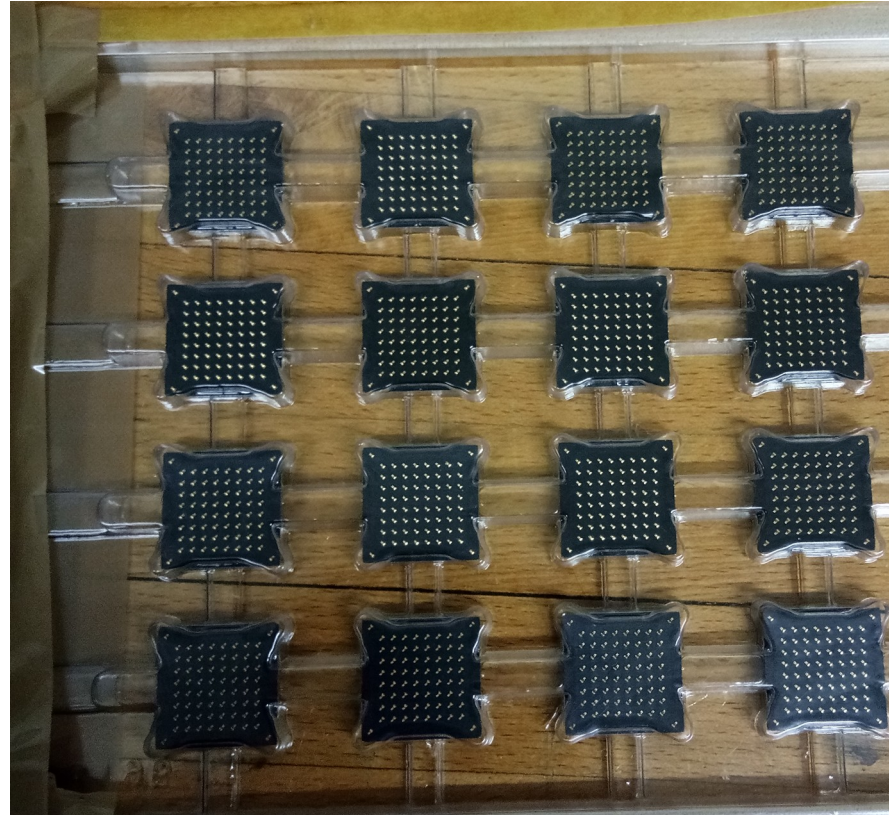


Inner side
(matches HRPPD rear side)

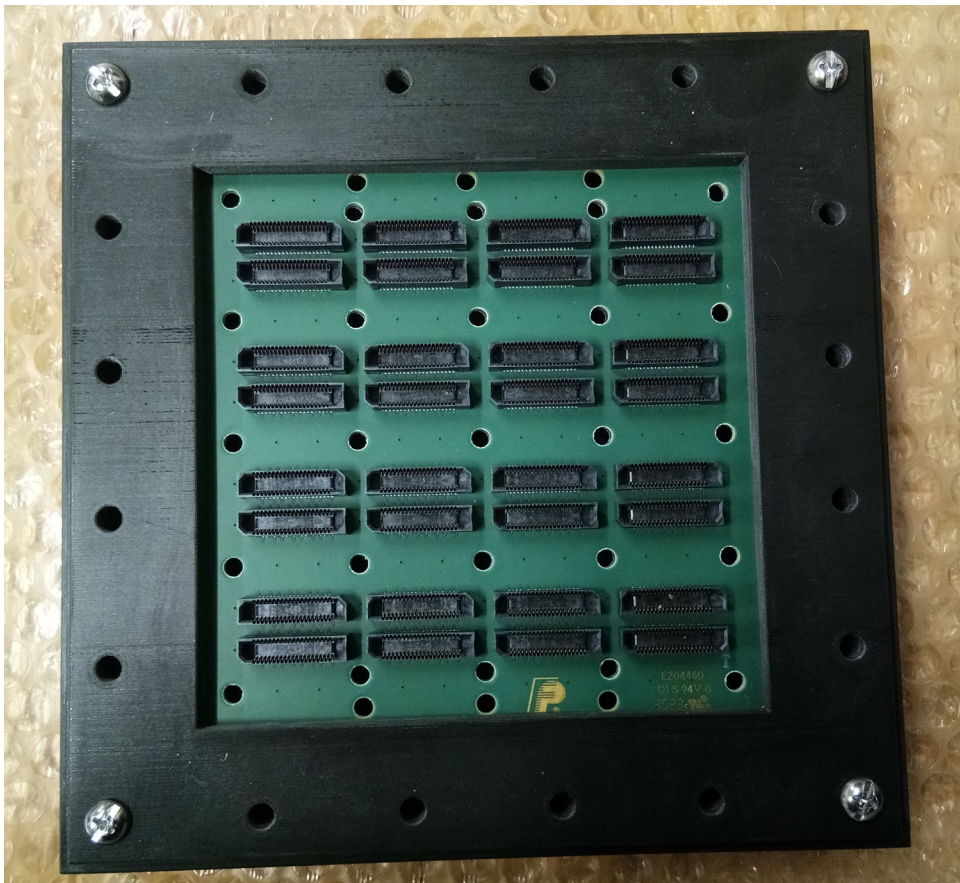


Outer side
32x Samtec ERF8 connectors/sockets

Compression interposers arrived in Trieste



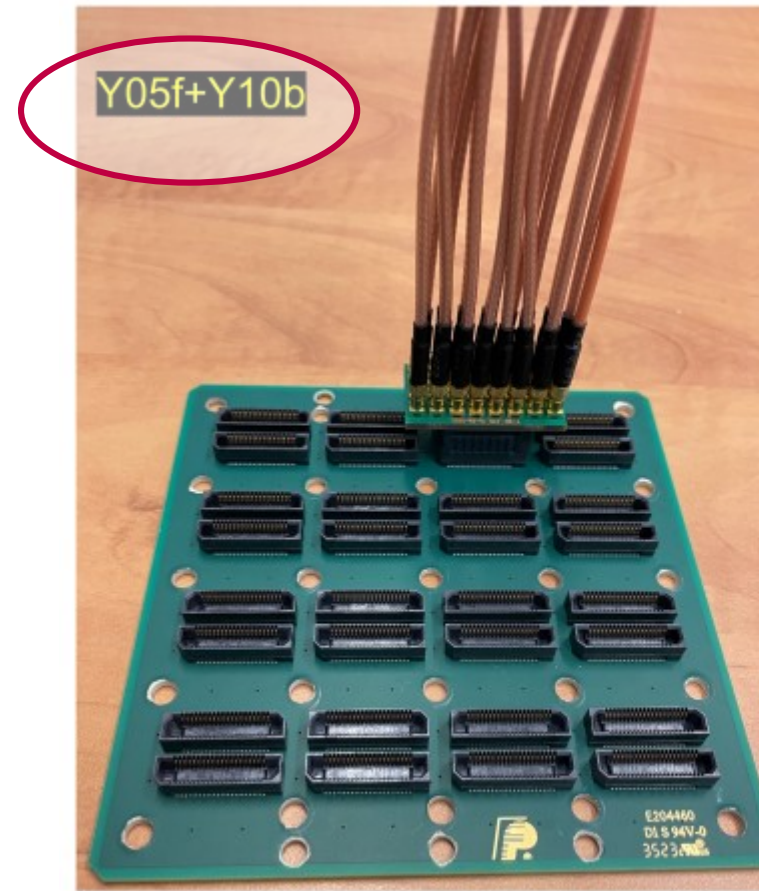
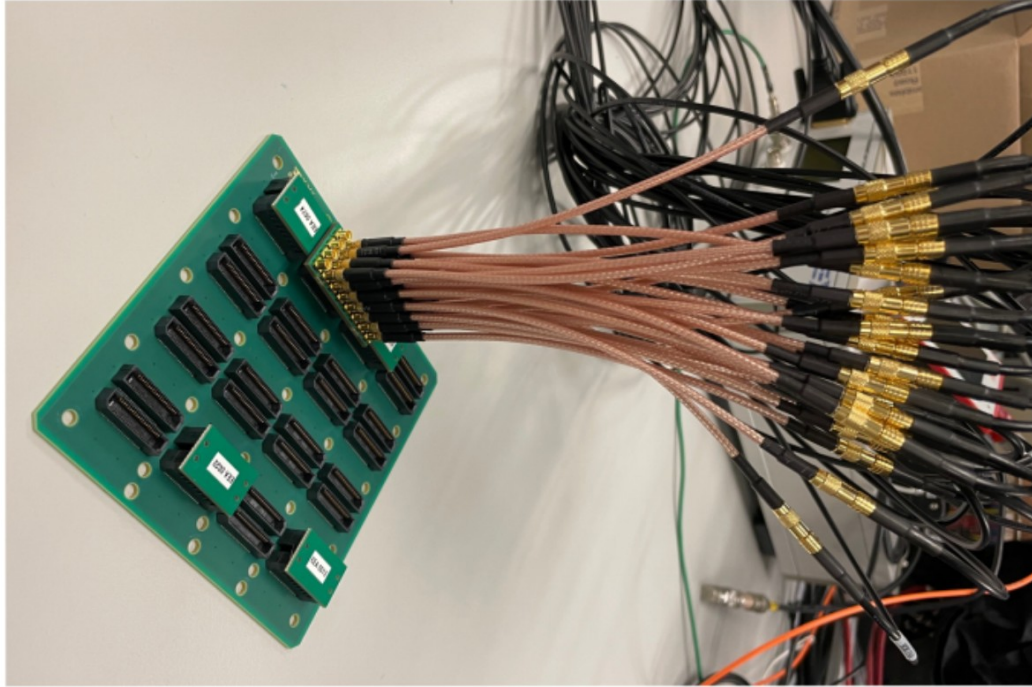
Direct connection between
HRPPD rear side and passive interface



Grounding caps

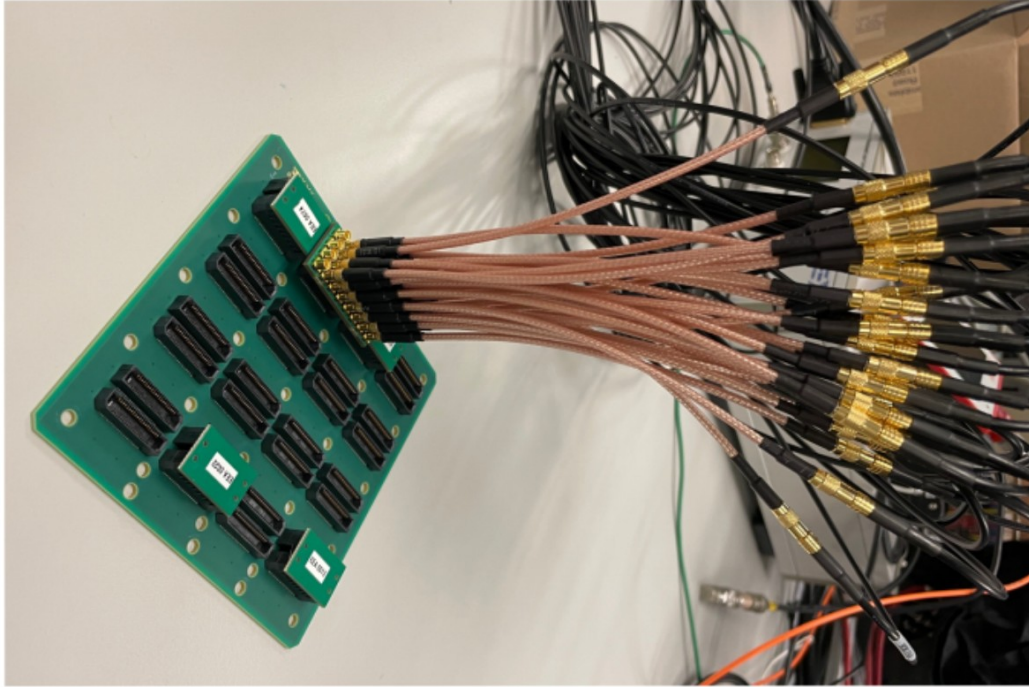
Adapter cards' design used @ BNL, JLab
(Pictures taken from presentations by Alexander Kiselev)

Adapter Card horizontal to the plane of interface

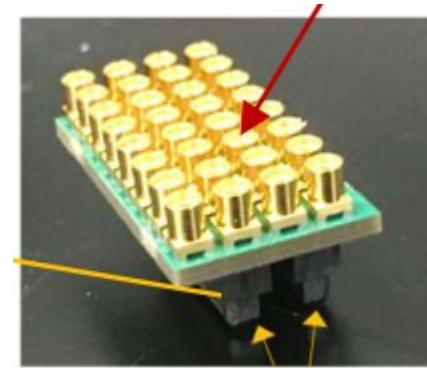


- For setups with a low electronics channel count
- Samtec to MMCX adapter - reads 4 x 8 channels
- MMCX to MCX pigtail cables, grounding caps

Adapter Card horizontal to the plane of interface

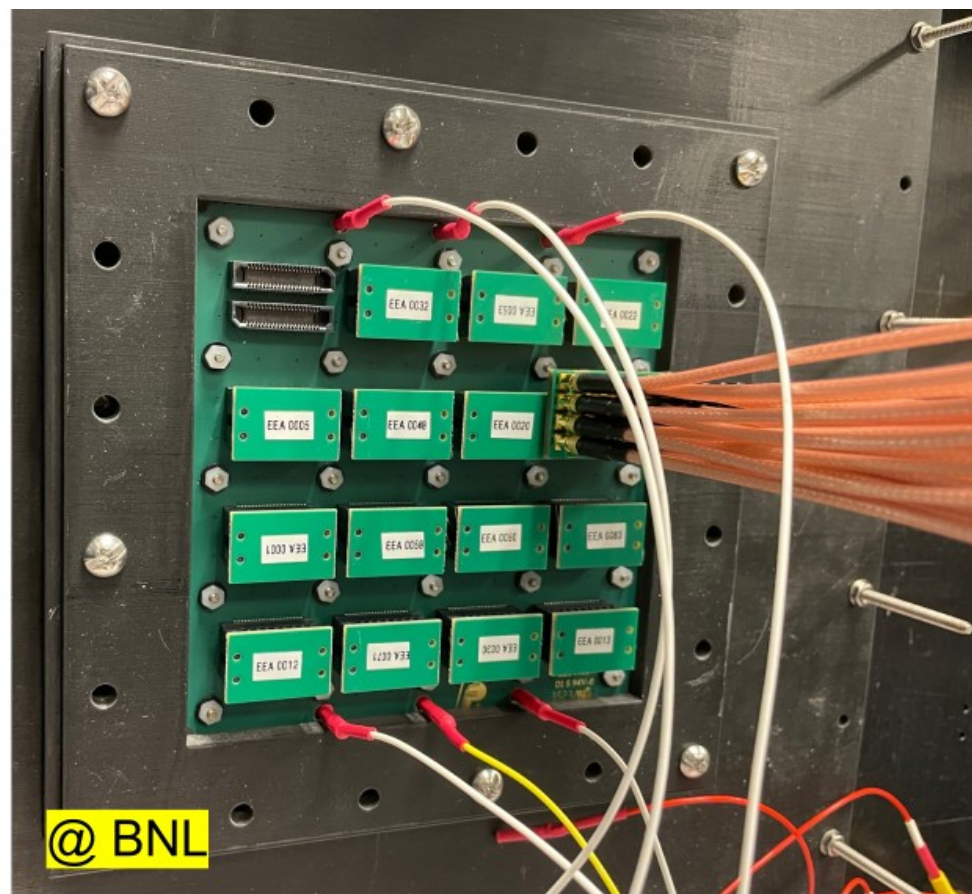


Electronics for selected pixels



Samtec mating connectors

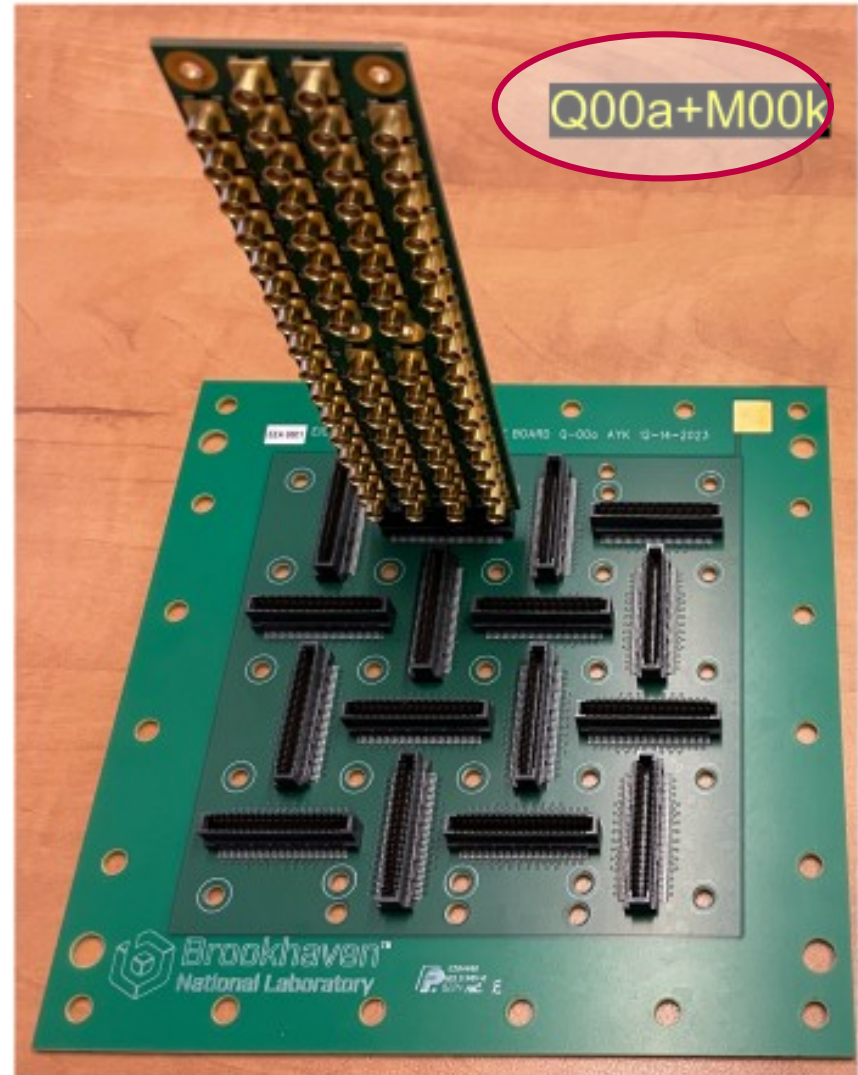
- For setups with a **low electronics channel count**
- **Samtec to MMCX** adapter - reads **4 x 8** channels
- **MMCX to MCX** pigtail cables, grounding caps



Horizontal adapter used @ available test stations

Adapter Card vertical to the plane of interface

- Samtec interface to 64 channel edge-to-MCX
- This Samtec interface is different than ours



For systematic $\frac{1}{4}$ active area scans

Notes from Alexander

I'm **not** using any preamps. HRPPD signal gets fed into V1742 or into a scope directly. Attached are the Y05f and Y08c **gerber files**. I'm using 32-channel MMCX adapters (essentially one at a time), which appeared to be a pretty suboptimal design.

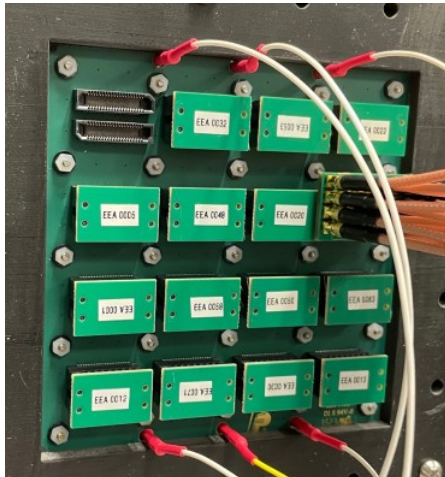
In your case, according to Silvia, you may want to design a single board like **Y08c**, where **few selected channels would be routed to a set of 2-pin headers**.

Summary of discussion on Dec. 6, 2024

Two measurement goals with the **HRPPD #25**

Ageing studies (major priority)

- Number of electronic channels:
 - High illumination: **4x4/3x3**
 - Reference for comparison: **How many?** 2? 4?
- Possibly **two independent studies** of ageing, one after another
- Position of the sensors:
 - HV cables can be obstacles for adapter cards. Pads can be selected from squares **B0, B3, C0, C3**



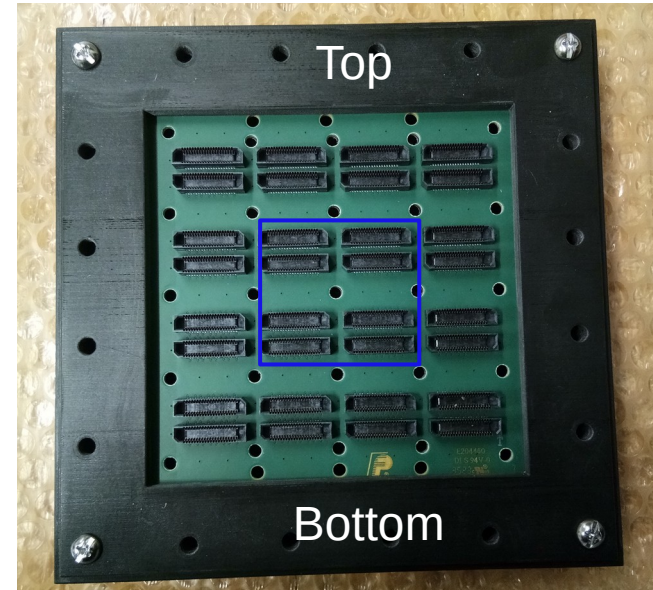
Top (PC)

D0	D1	D2	D3
C0	C1	C2	C3
B0	B1	B2	B3
A0	A1	A2	A3

Bottom (G)

Tests in Magnetic Fields

- Number of electronic channels:
 - **8x8**
- Position of the sensors:
 - one of the 4 central squares **B1, B2, C1, C2**



About electronics

- Pre-amplifiers will be included in the circuit.
- Direct coupled, so we need grounding via resistors ($\sim k\Omega$).
- Unused channels will be grounded.

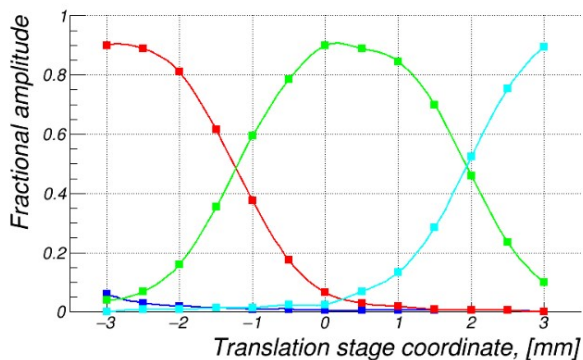
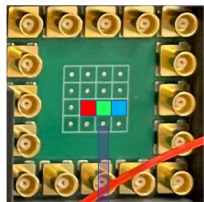
Samtec to MMCX to MCX	
With flat-cables (this adds flexibility concerning space-limit inside the dark-box)	(if available) with a 9° bend
Without flat-cables	Adapter cards have to be $> (5+2)$ mm in height to avoid clash with the grounding caps of neighbouring squares



To be discussed on Dec. 13, 2024

- Charge sharing (studied with HRPPD #6)
- Number of minimum channels for tests in magnetic fields
- New dark-box dimension

Charge sharing, from HRPPD #6



- Sum of all events, gives upper limit of Charge sharing
- 90% amplitude on the green pad where fibre core is pointing
- Considering 2D projection ~ 20% is shared to nearest pads, ~5% (from linear extrapolation) is shared to next-to-nearest pads.

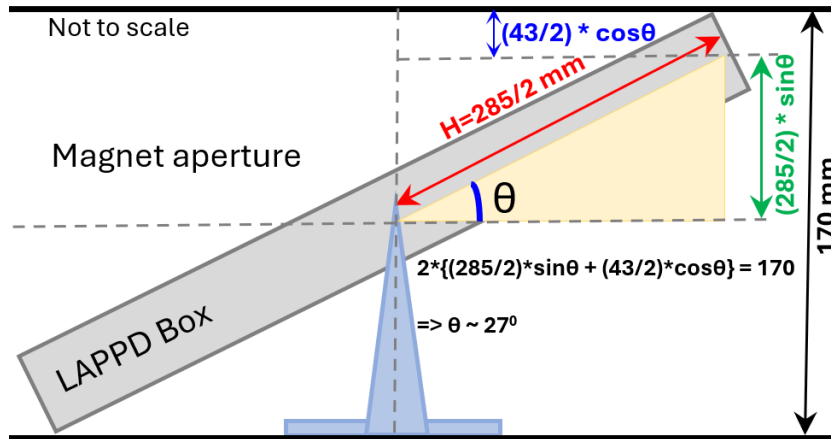
- For ageing tests, **3x3 sensors** are enough to contain **>95% of spot charge** coming from illumination
- For tests in magnetic fields, to reach 45°
 - 7x3 pads for theta-inclination are enough
 - 7x7 pads for phi-inclination are enough
 - Corner pads can be grounded, resulting $49 - (4 \times 6) = \mathbf{25 \text{ pads in total}}$

One digitizer board is enough as long as we need 32 channels or less. So, our software is almost ready! Minor modification needed - tuning TR levels, coincidence windows, etc.

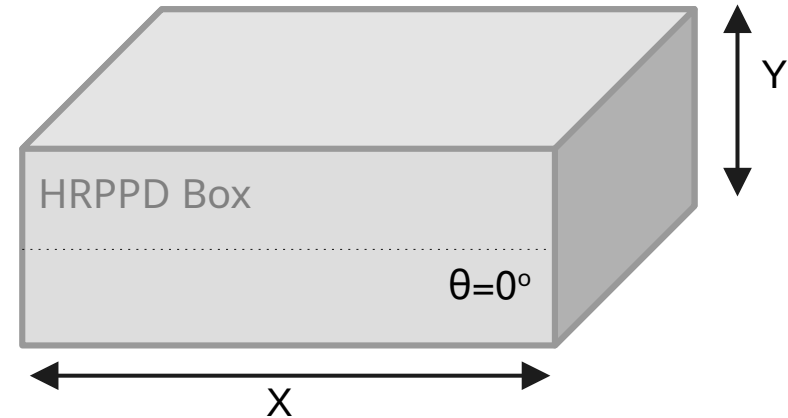
-	-	-		-	-	-
-	-				-	-
-						-
			X			
-						-
-	-				-	-
-	-	-		-	-	-

Dark-box for HRPPD

- Ageing studies inside the **old black-box** used for timing studies, apart from moving-arm-system, there will be optics that were not present for tests of LAPPDs
- For tests in magnetic fields **new dark-box** is needed



LAPPD @M113



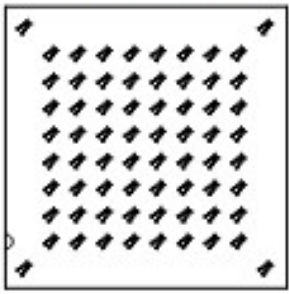
$$2 * \{(X/2) * \sin\theta + (Y/2) * \cos\theta\} = 170 \text{ mm}$$

- HRPPD dark-box will have higher Y value and shorter X value, compared to the LAPPD dark-box
- We want to reach to 45° inclination

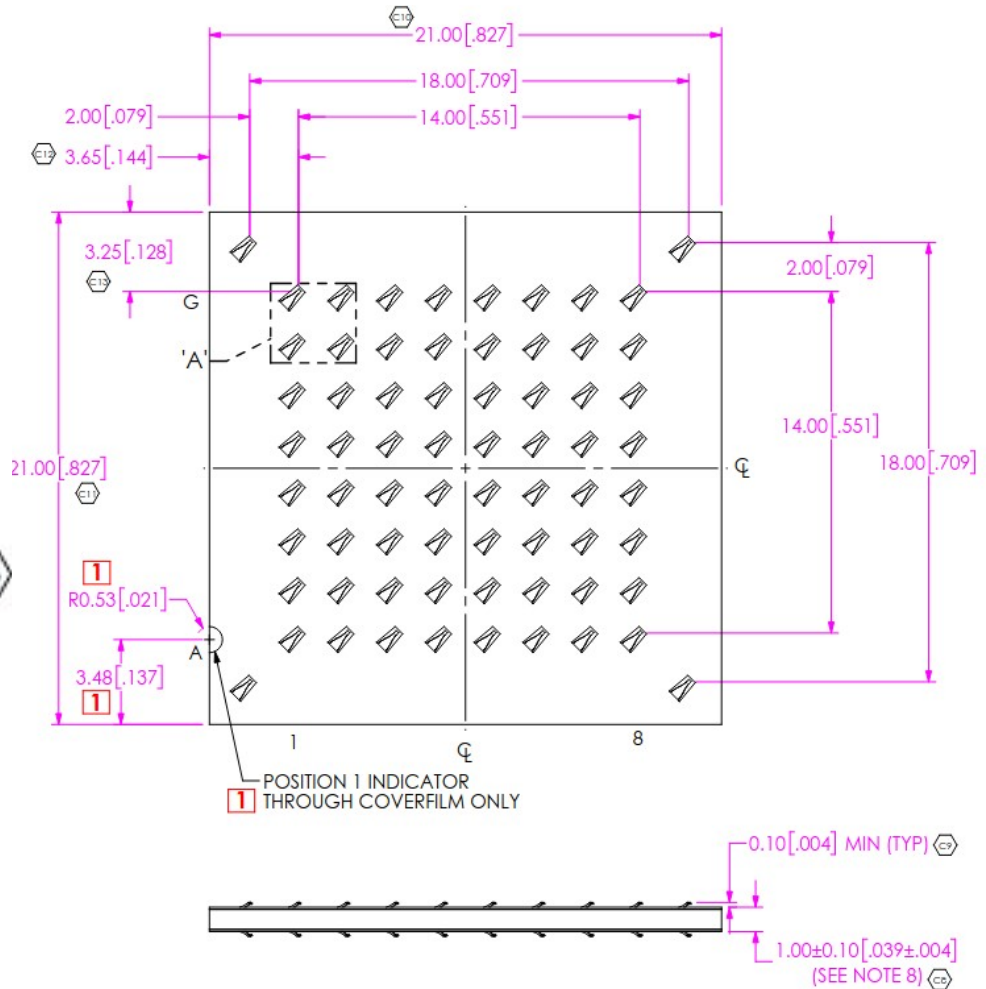
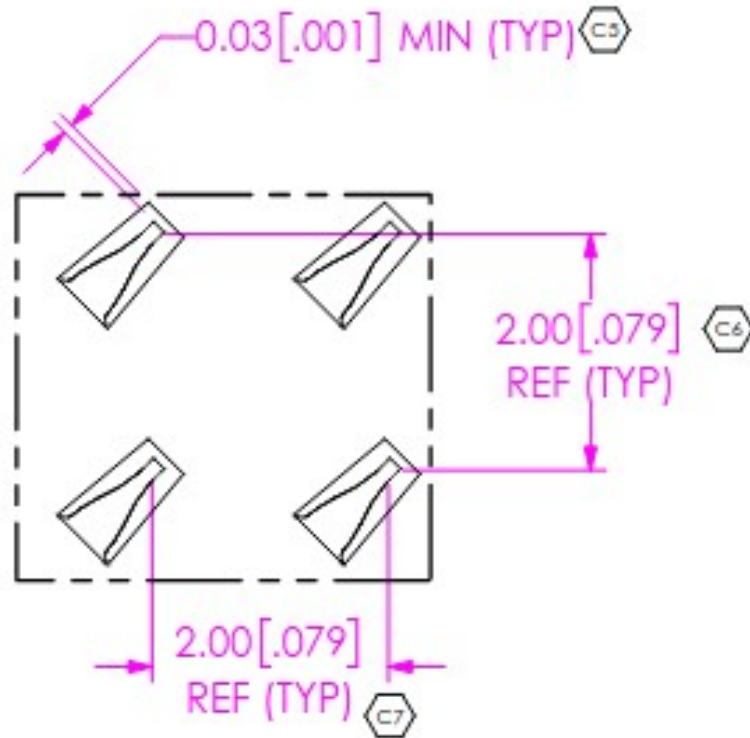
**Different electronic design
for the two dark boxes?**

Thank you!

Mechanical design of interposers

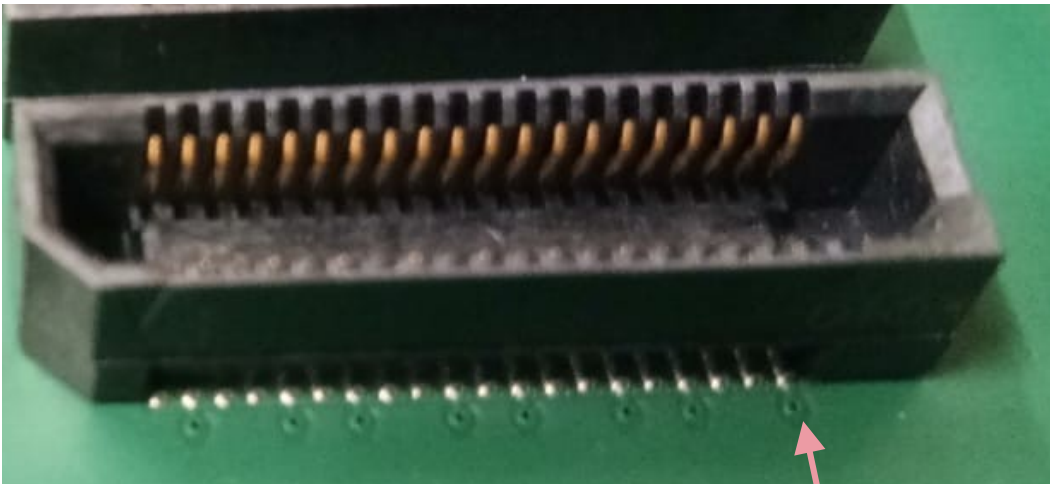


Designed and dimensioned in mm [inches]



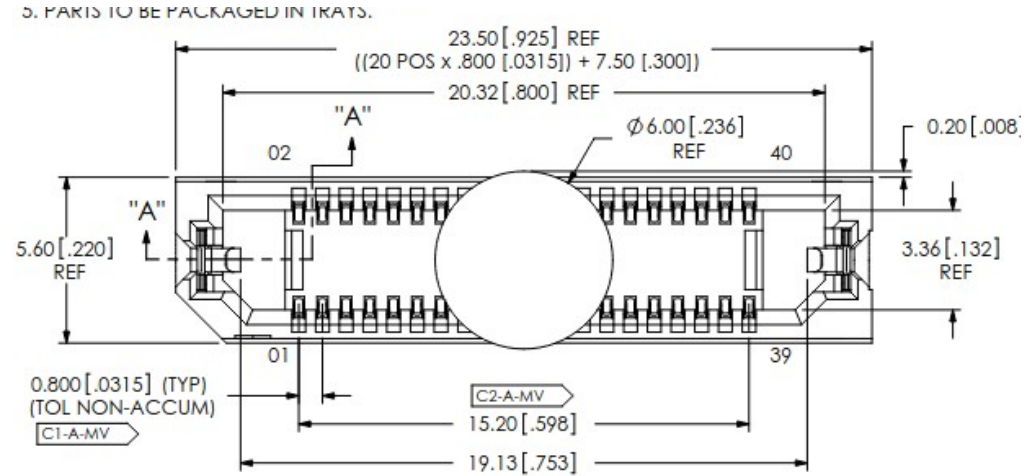


ERF8 sockets



Used for 32 pads

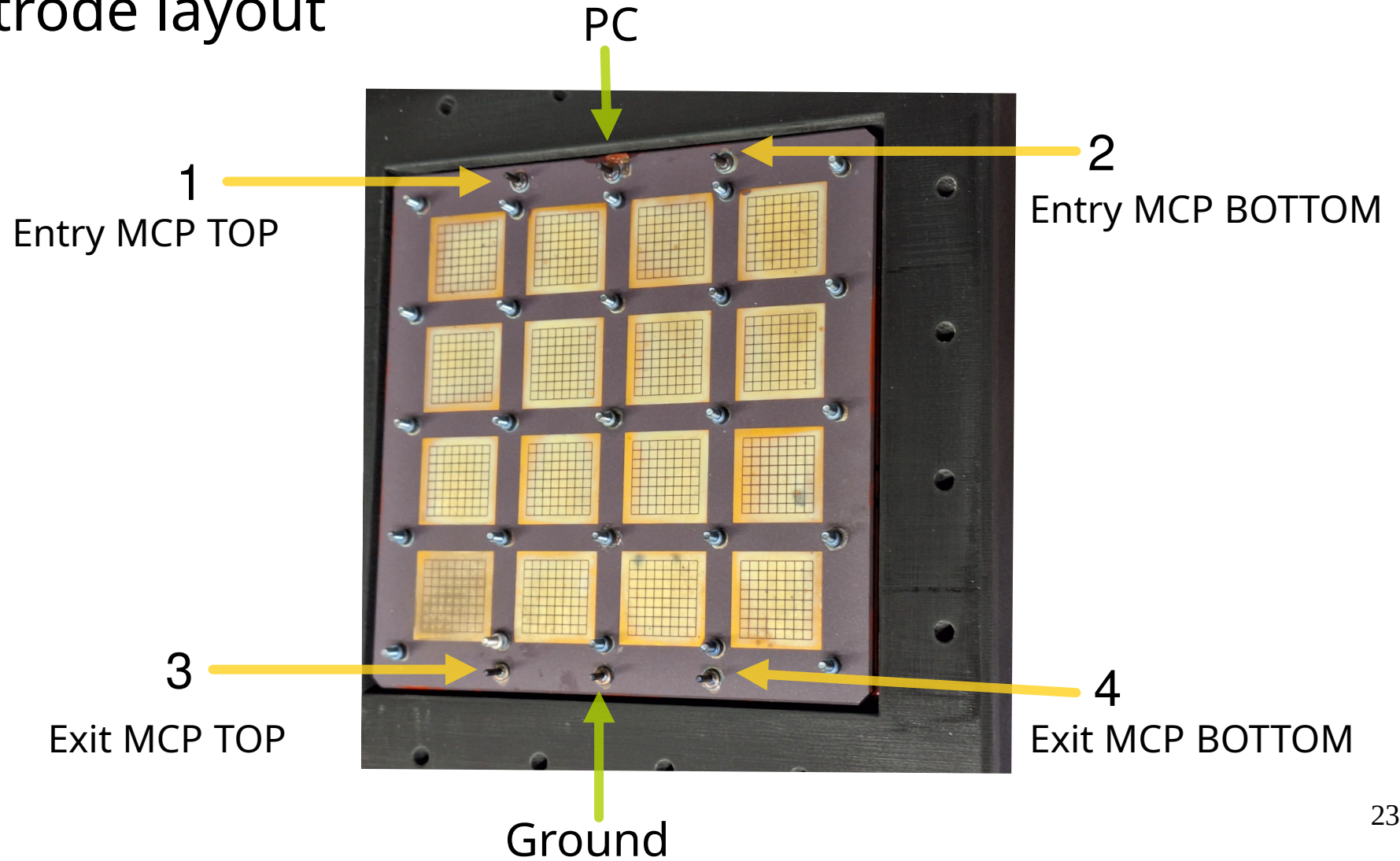
2 x 20 pins, 8 extras, 2 x 8 marked

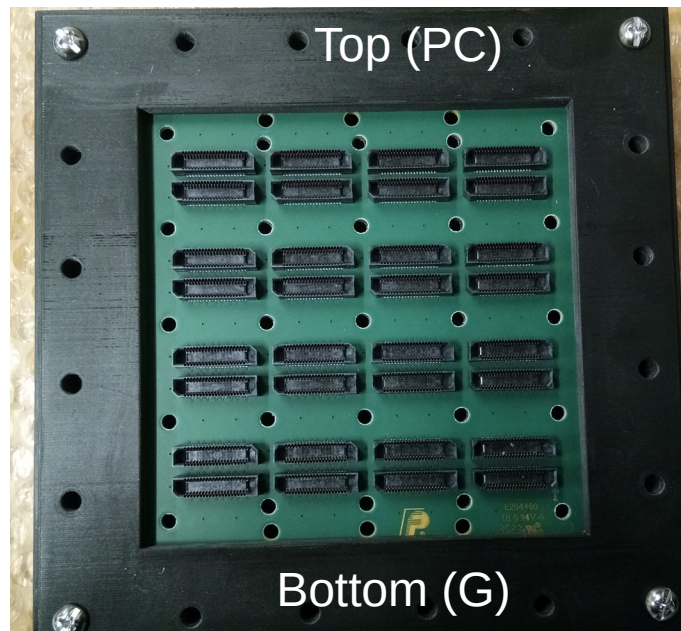


MAPPINGS

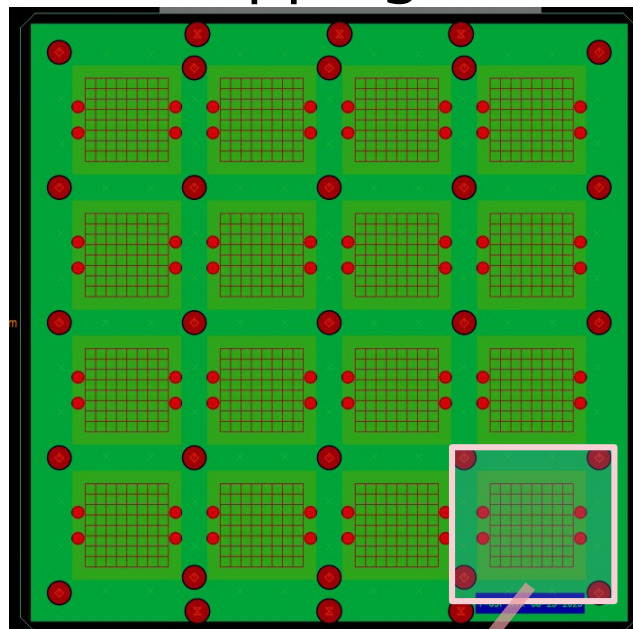
All mappings are done looking from the rear side of the HRPPD

Electrode layout





Mapping



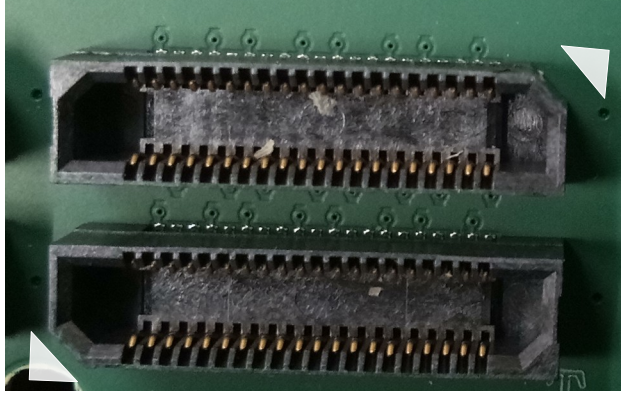
Our convention of naming 16 Groups

D	D0	D1	D2	D3
C	C0	C1	C2	C3
B	B0	B1	B2	B3
A	A0	A1	A2	A3
	0	1	2	3

Our convention of naming the pads from one Group (A3)

A3H0	A3H1	A3H2	A3H3	A3H4	A3H5	A3H6	A3H7
A3G0	A3G1	A3G2	A3G3	A3G4	A3G5	A3G6	A3G7
A3F0	A3F1	A3F2	A3F3	A3F4	A3F5	A3F6	A3F7
A3E0	A3E1	A3E2	A3E3	A3E4	A3E5	A3E6	A3E7
A3D0	A3D1	A3D2	A3D3	A3D4	A3D5	A3D6	A3D7
A3C0	A3C1	A3C2	A3C3	A3C4	A3C5	A3C6	A3C7
A3B0	A3B1	A3B2	A3B3	A3B4	A3B5	A3B6	A3B7
A3A0	A3A1	A3A2	A3A3	A3A4	A3A5	A3A6	A3A7

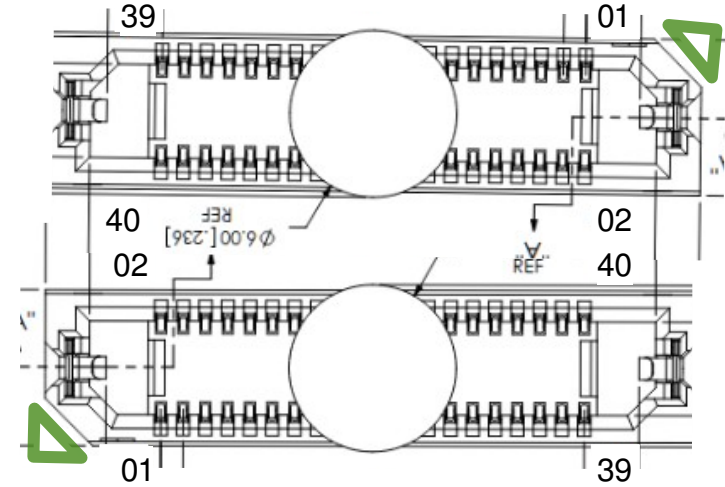
Mapping



t

b

Two ERF8 sockets connect to 64 pads of **one** Group



ERF8 Pin Numbers (for any group)

t39	t37	t35	t33	t31	t29	t27	t25	t23	t21	t19	t17	t15	t13	t11	t9	t7	t5	t3	t1
t40	t38	t36	t34	t32	t30	t28	t26	t24	t22	t20	t18	t16	t14	t12	t10	t8	t6	t4	t2

Top (t) pins read pads 32 to 63

b2	b4	b6	b8	b10	b12	b14	b16	b18	b20	b22	b24	b26	b28	b30	b32	b34	b36	b38	b40
b1	b3	b5	b7	b9	b11	b13	b15	b17	b19	b21	b23	b25	b27	b29	b31	b33	b35	b37	b39

Bottom (b) pins read pads 0 to 31

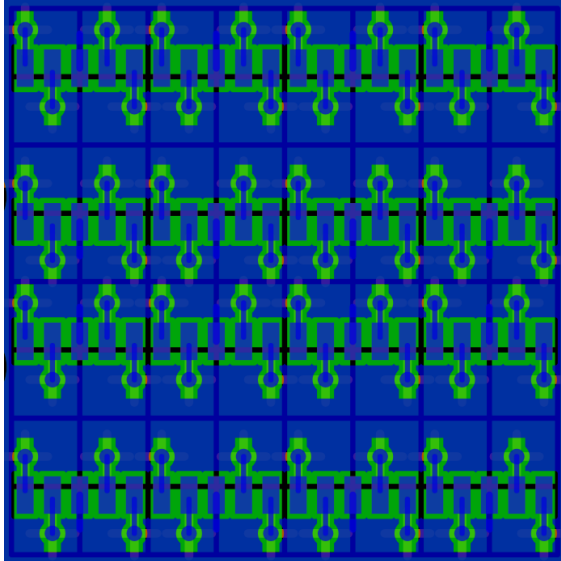
3rd and 8th columns from any side are grounded/not connected to Anode pads

Mapping

Readout Pads from A3

A3H0	A3H1	A3H2	A3H3	A3H4	A3H5	A3H6	A3H7
A3G0	A3G1	A3G2	A3G3	A3G4	A3G5	A3G6	A3G7
A3F0	A3F1	A3F2	A3F3	A3F4	A3F5	A3F6	A3F7
A3E0	A3E1	A3E2	A3E3	A3E4	A3E5	A3E6	A3E7
A3D0	A3D1	A3D2	A3D3	A3D4	A3D5	A3D6	A3D7
A3C0	A3C1	A3C2	A3C3	A3C4	A3C5	A3C6	A3C7
A3B0	A3B1	A3B2	A3B3	A3B4	A3B5	A3B6	A3B7
A3A0	A3A1	A3A2	A3A3	A3A4	A3A5	A3A6	A3A7

Gerber View-Y05f



ERF8 Pin Numbers (for any group)

t39	t37	t35	t33	t31	t29	t27	t25	t23	t21	t19	t17	t15	t13	t11	t9	t7	t5	t3	t1
t40	t38	t36	t34	t32	t30	t28	t26	t24	t22	t20	t18	t16	t14	t12	t10	t8	t6	t4	t2

b2	b4	b6	b8	b10	b12	b14	b16	b18	b20	b22	b24	b26	b28	b30	b32	b34	b36	b38	b40
b1	b3	b5	b7	b9	b11	b13	b15	b17	b19	b21	b23	b25	b27	b29	b31	b33	b35	b37	b39

Readout Pad Numbers (of Group A3) on ERF8 Pins

A3 H0	A3 G0		A3 H1	A3 G1	A3 H2	A3 G2		A3 H3	A3 G3	A3 H4	A3 G4		A3 H5	A3 G5	A3 H6	A3 G6		A3 H7	A3 G7
A3 F0	A3 E0		A3 F1	A3 E1	A3 F2	A3 E2		A3 F3	A3 E3	A3 F4	A3 E4		A3 F5	A3 E5	A3 F6	A3 E6		A3 F7	A3 E7

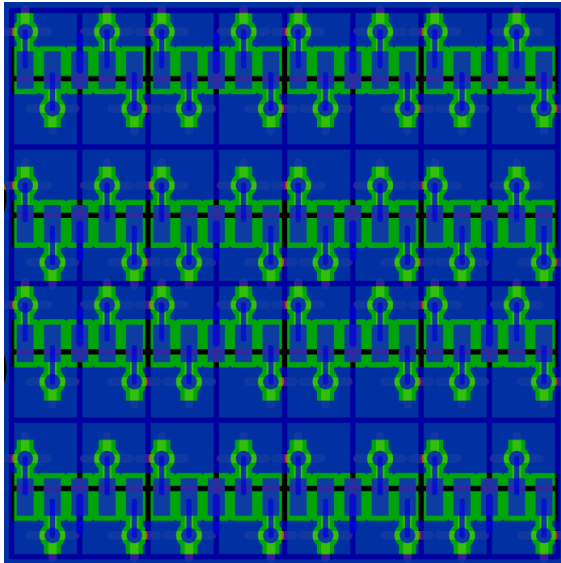
A3 D0	A3 C0		A3 D1	A3 C1	A3 D2	A3 C2		A3 D3	A3 C3	A3 D4	A3 C4		A3 D5	A3 C5	A3 D6	A3 C6		A3 D7	A3 C7
A3 B0	A3 A0		A3 B1	A3 A1	A3 B2	A3 A2		A3 B3	A3 A3	A3 B4	A3 A4		A3 B5	A3 A5	A3 B6	A3 A6		A3 B7	A3 A7

Mapping

Readout Pads from A3

A3H0	A3H1	A3H2	A3H3	A3H4	A3H5	A3H6	A3H7
A3G0	A3G1	A3G2	A3G3	A3G4	A3G5	A3G6	A3G7
A3F0	A3F1	A3F2	A3F3	A3F4	A3F5	A3F6	A3F7
A3E0	A3E1	A3E2	A3E3	A3E4	A3E5	A3E6	A3E7
A3D0	A3D1	A3D2	A3D3	A3D4	A3D5	A3D6	A3D7
A3C0	A3C1	A3C2	A3C3	A3C4	A3C5	A3C6	A3C7
A3B0	A3B1	A3B2	A3B3	A3B4	A3B5	A3B6	A3B7
A3A0	A3A1	A3A2	A3A3	A3A4	A3A5	A3A6	A3A7

Gerber View-Y05f



ERF8 Pin Numbers (for any group)

t39	t37	t35	t33	t31	t29	t27	t25	t23	t21	t19	t17	t15	t13	t11	t9	t7	t5	t3	t1
t40	t38	t36	t34	t32	t30	t28	t26	t24	t22	t20	t18	t16	t14	t12	t10	t8	t6	t4	t2

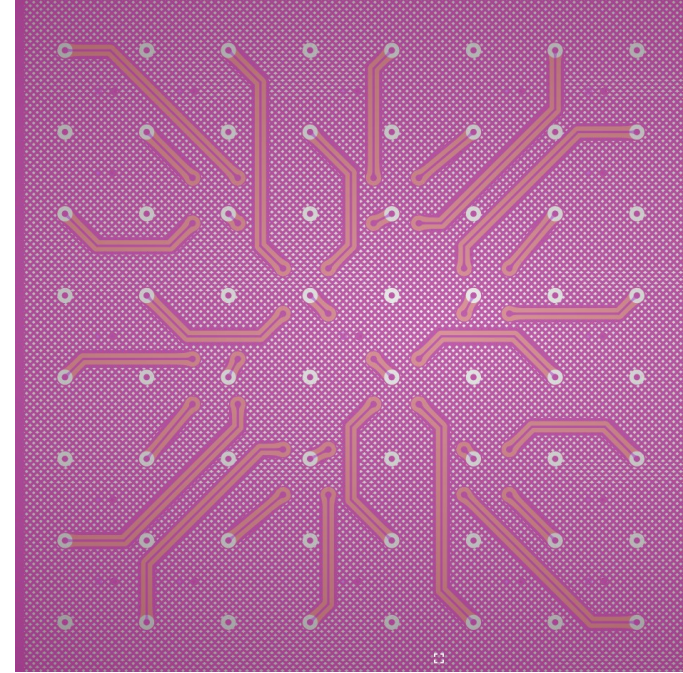
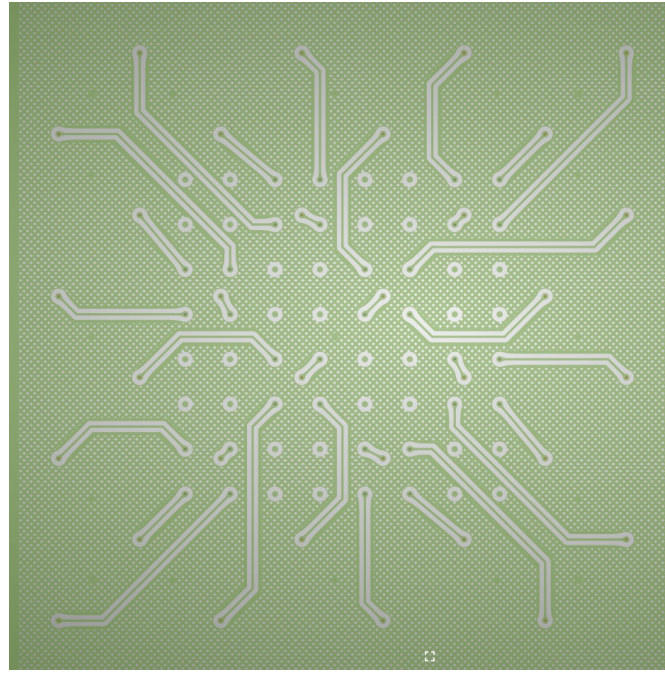
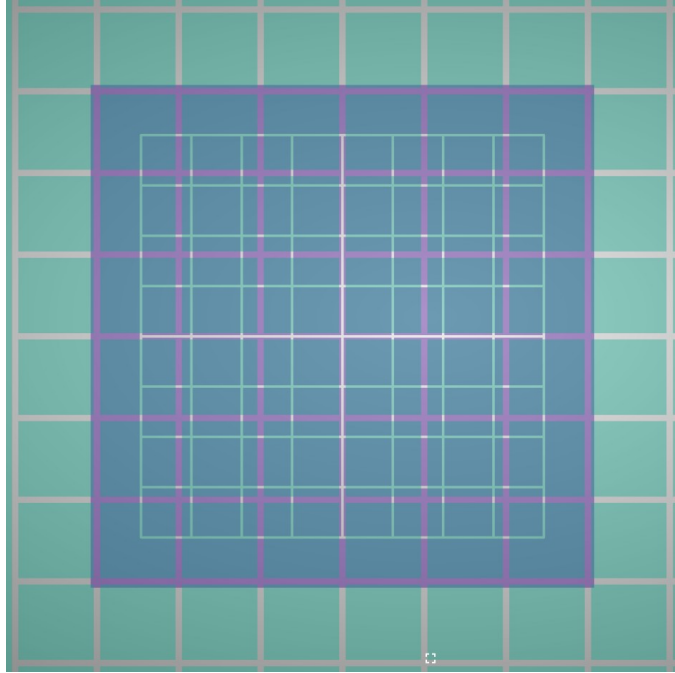
b2	b4	b6	b8	b10	b12	b14	b16	b18	b20	b22	b24	b26	b28	b30	b32	b34	b36	b38	b40
b1	b3	b5	b7	b9	b11	b13	b15	b17	b19	b21	b23	b25	b27	b29	b31	b33	b35	b37	b39

Pin Numbers on Readout Pads (from Group A3)

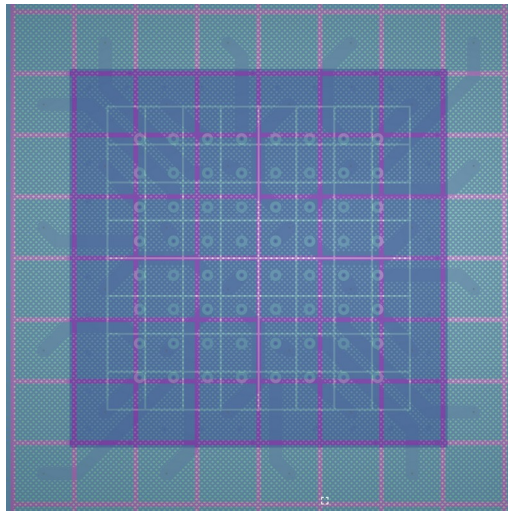
A3t39	A3t33	A3t29	A3t23	A3t19	A3t13	A3t9	A3t3
A3t37	A3t31	A3t27	A3t21	A3t17	A3t11	A3t7	A3t1
A3t40	A3t34	A3t30	A3t24	A3t20	A3t14	A3t10	A3t4
A3t38	A3t32	A3t28	A3t22	A3t18	A3t12	A3t8	A3t2
A3b2	A3b8	A3b12	A3b18	A3b22	A3b28	A3b32	A3b38
A3b4	A3b10	A3b14	A3b20	A3b24	A3b30	A3b34	A3b40
A3b1	A3b7	A3b11	A3b17	A3b21	A3b27	A3b31	A3b37
A3b3	A3b9	A3b13	A3b19	A3b23	A3b29	A3b33	A3b39

Complex routing of Anode pads

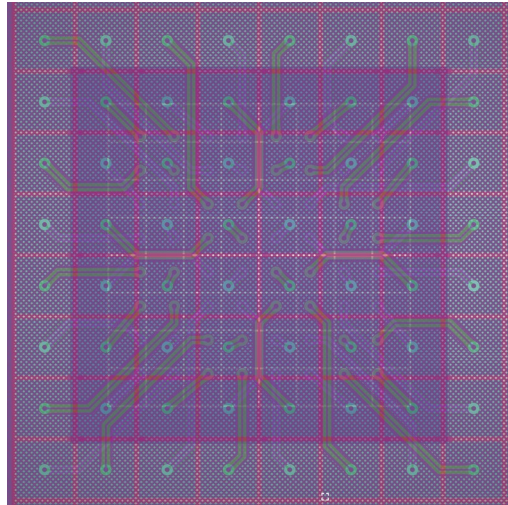
Gerber Y03h



Complex routing of Anode pads



Layer 1



Layer 2

56	57	58	59	60	61	62	63
48	49	50	51	52	53	54	55
40	41	42	43	44	45	46	47
32	33	34	35	36	37	38	39
24	25	26	27	28	29	30	31
16	17	18	19	20	21	22	23
8	9	10	11	12	13	14	15
0	1	2	3	4	5	6	7

Anode pad numbering (Vacuum side)

32 - 63

0 - 31

Mapping

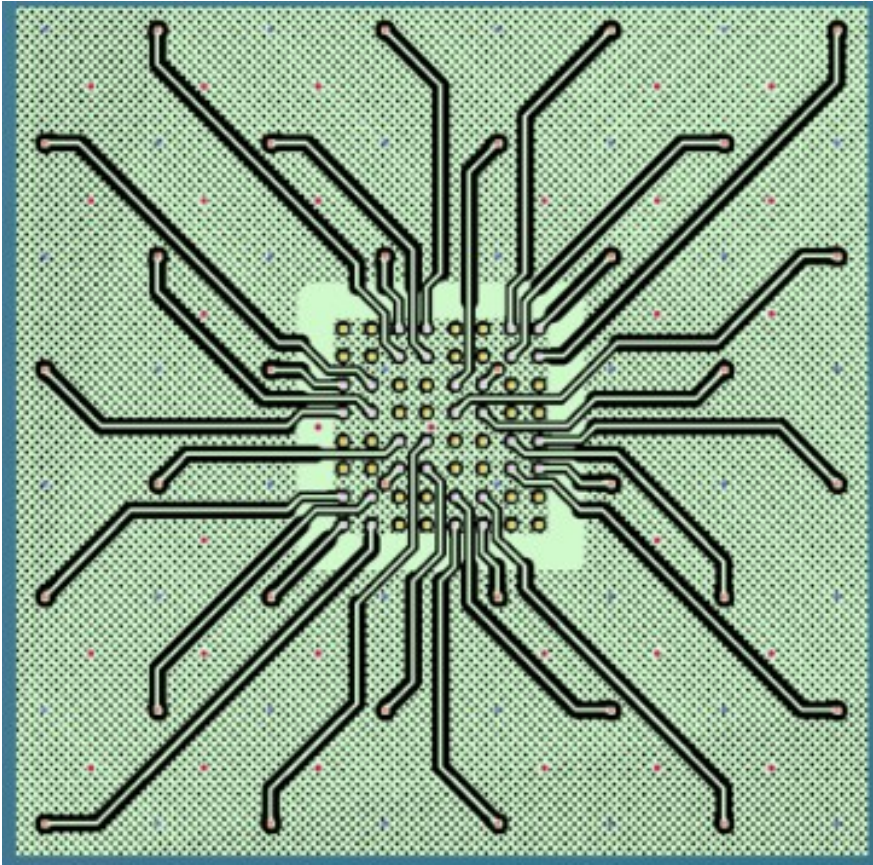
49	56	43	59	60	53	61	45
40	42	57	50	44	62	54	63
34	48	58	51	52	36	55	46
32	41	33	35	47	38	37	39
24	26	25	2	28	30	22	31
17	8	27	11	12	5	15	29
16	18	1	19	13	6	21	23
9	0	10	3	4	20	7	14

Layer1 / Layer2

of Anode pads written on RO pads

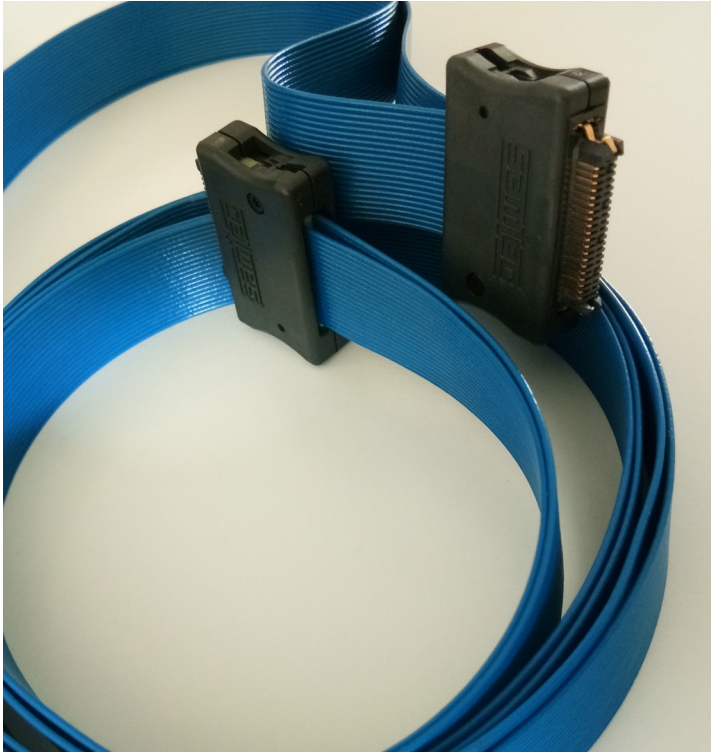
- Cells represent Air side pads
- Numbers represent vacuum side pads

Complex routing of Anode pads



This routing (taken from 2024 slides of Alexander) is somewhat different than Y03h

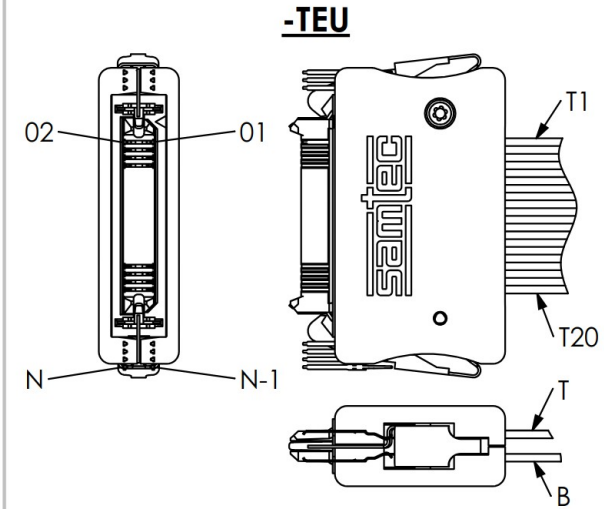
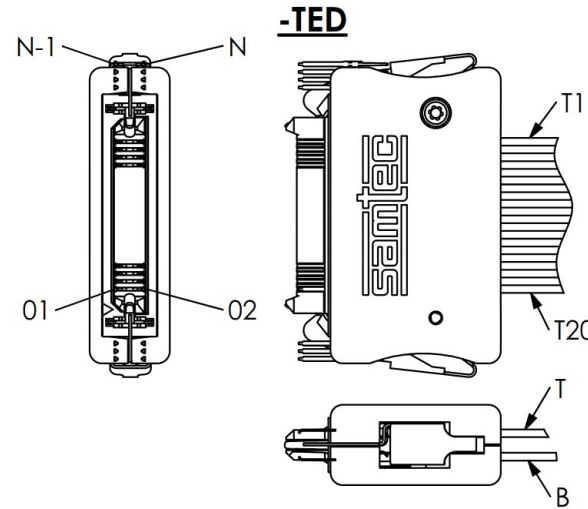
Purchased



40 cm long μ -Coaxial cables for reading signals

ERCD-020-40.00-TEU-TED-1-D

- Two of these cables + 100 SMA female connectors have been purchased at CERN.
- Idea is to cut-out the connector at one end of the μ -coax cables and connect them to SMA connectors that will be mounted on a bread-board.



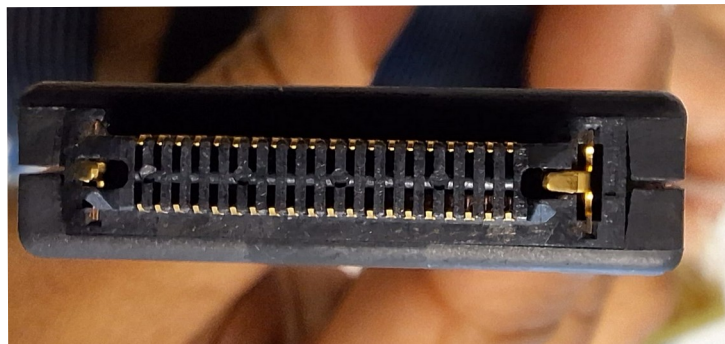
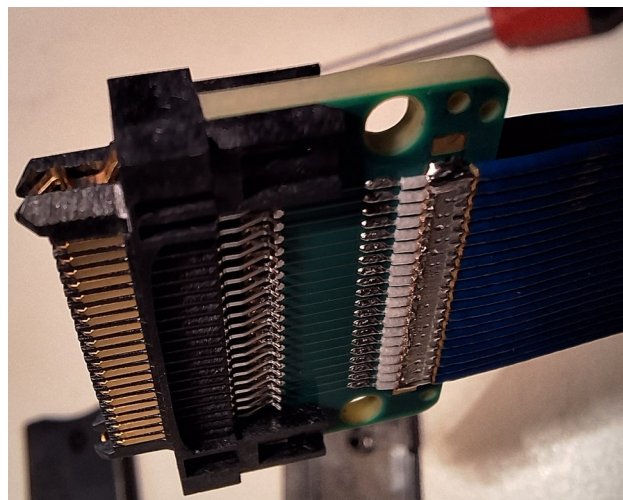
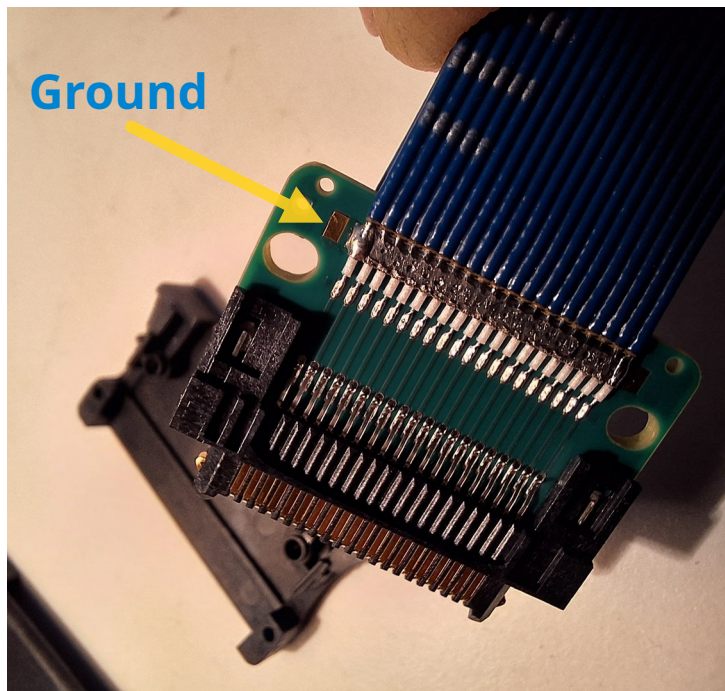
Purchased

Two Samtec flat μ -Coax cables
(20 pins/row) bought

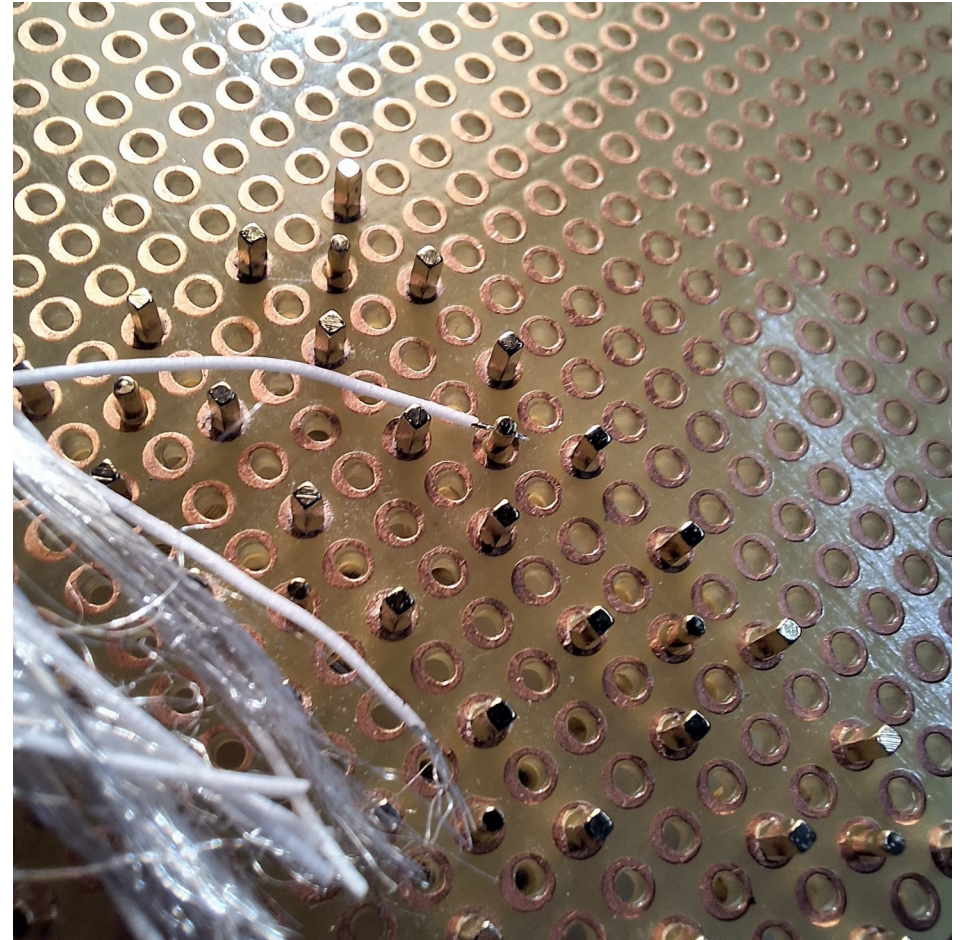
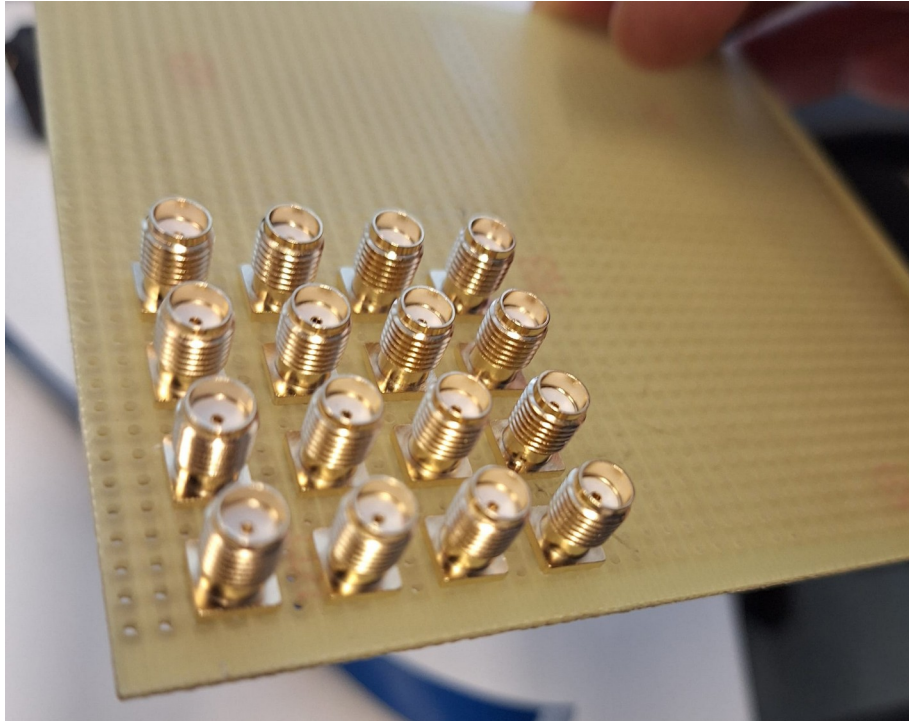
ERCD-020-40.00-TEU-TED-1-D

We will use these for preliminary
studies with the HRPPD #25





SMA connectors read the Micro coax

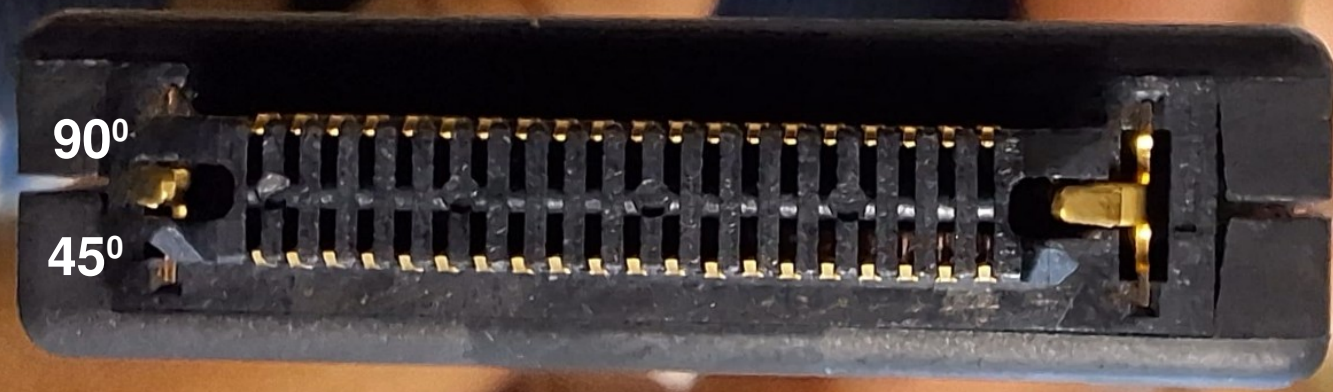




ERCD-020-40.00-TEU-TED-1-D

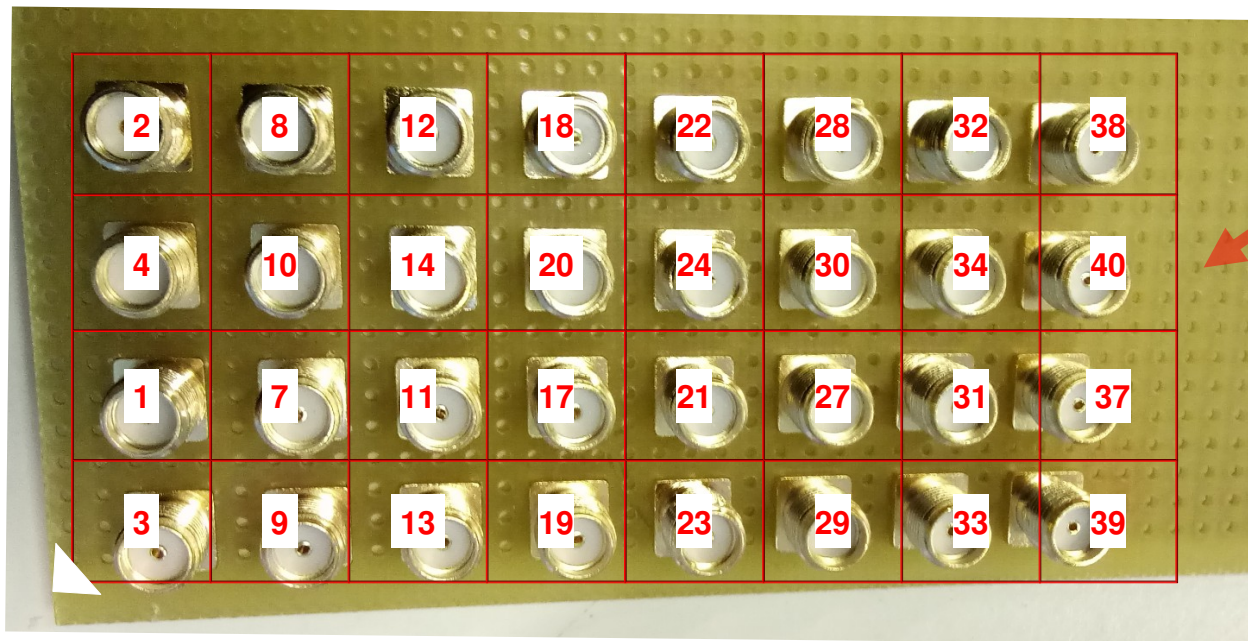
90°

45°

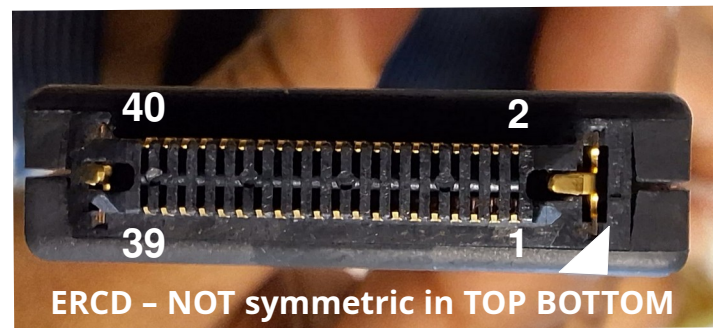
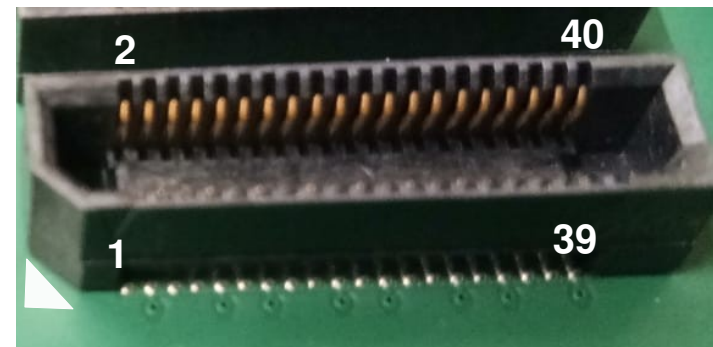


NOT symmetric in TOP and BOTTOM

Mapping of SMA connectors on Mauro's Bread Board



These numbers are the PIN # of ERCD connector attached at one end of the μ -Coax cables

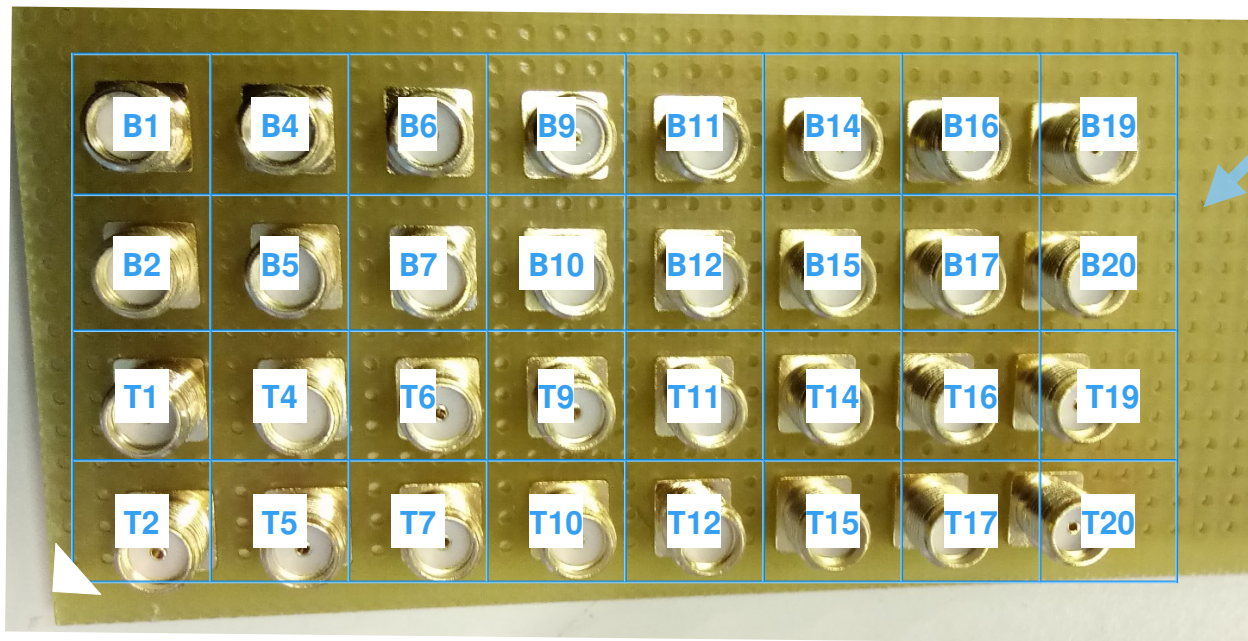


ERCD - NOT symmetric in TOP BOTTOM

b2	b4	b6	b8	b10	b12	b14	b16	b18	b20	b22	b24	b26	b28	b30	b32	b34	b36	b38	b40
b1	b3	b5	b7	b9	b11	b13	b15	b17	b19	b21	b23	b25	b27	b29	b31	b33	b35	b37	b39

P40	P38	P36	P34	P32	P30	P28	P26	P24	P22	P20	P18	P16	P14	P12	P10	P8	P6	P4	P2
P39	P37	P35	P33	P31	P29	P27	P25	P23	P21	P19	P17	P15	P13	P11	P9	P7	P5	P3	P1

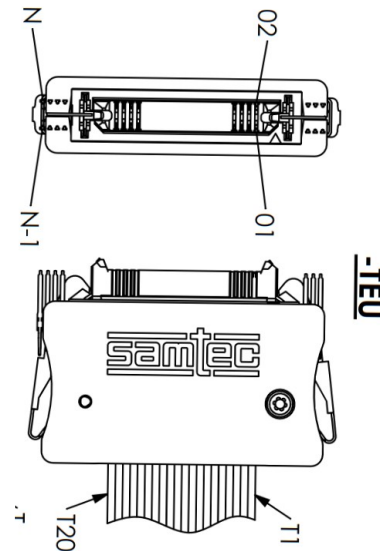
Mapping of SMA connectors on Mauro's Bread Board



Number of Top and Bottom μ -Coax Cables

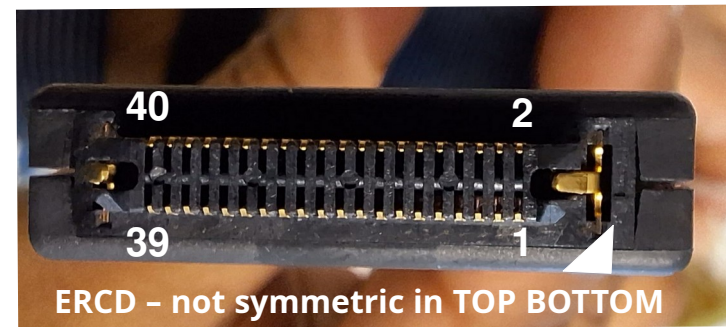
T - Top

B - Bottom



B20	B19	B18	B17	B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1
T20	T19	T18	T17	T16	T15	T14	T13	T12	T11	T10	T9	T8	T7	T6	T5	T4	T3	T2	T1

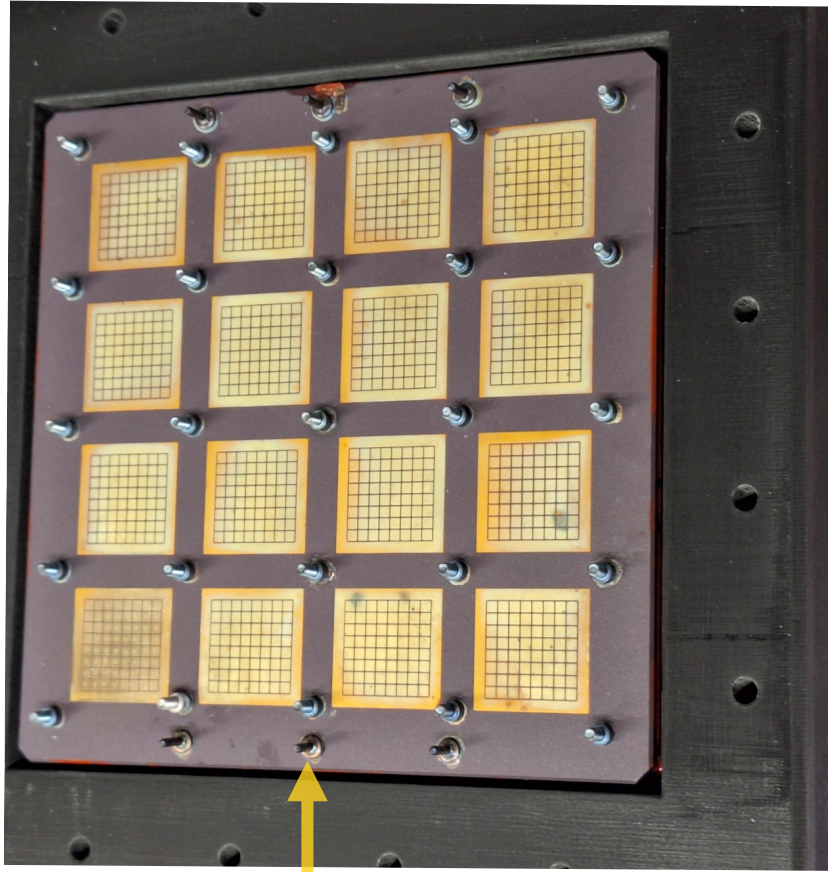
P40	P38	P36	P34	P32	P30	P28	P26	P24	P22	P20	P18	P16	P14	P12	P10	P8	P6	P4	P2
P39	P37	P35	P33	P31	P29	P27	P25	P23	P21	P19	P17	P15	P13	P11	P9	P7	P5	P3	P1



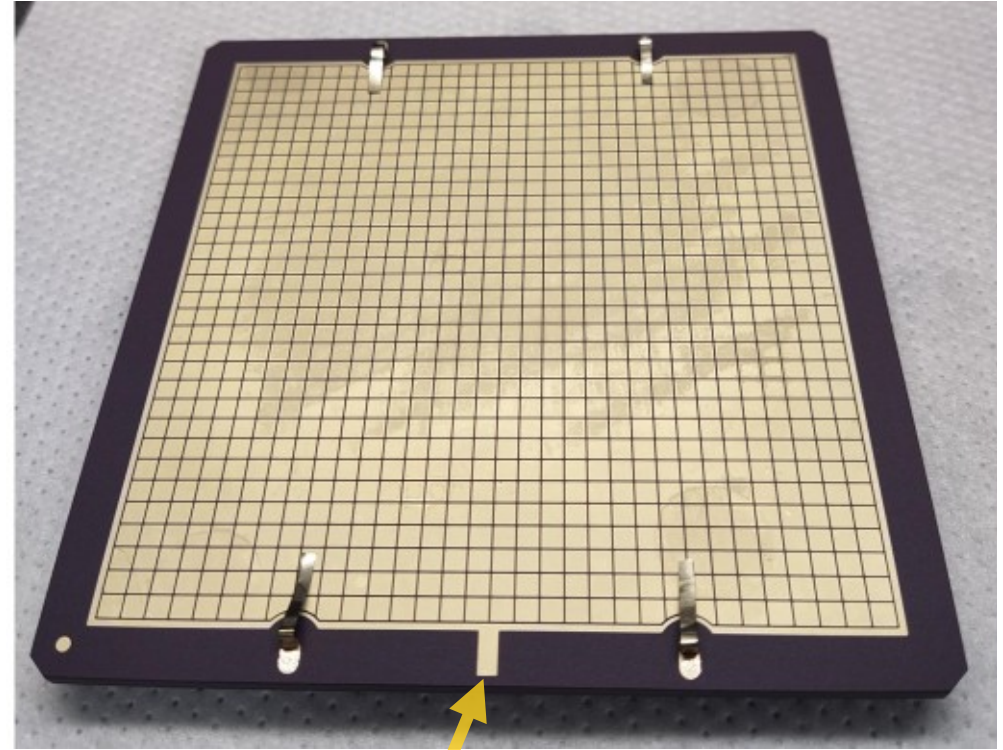
ERCD - not symmetric in TOP BOTTOM

A similar geometry between the SMA connectors and the RO pads from lower/upper half

Broken HV Pin

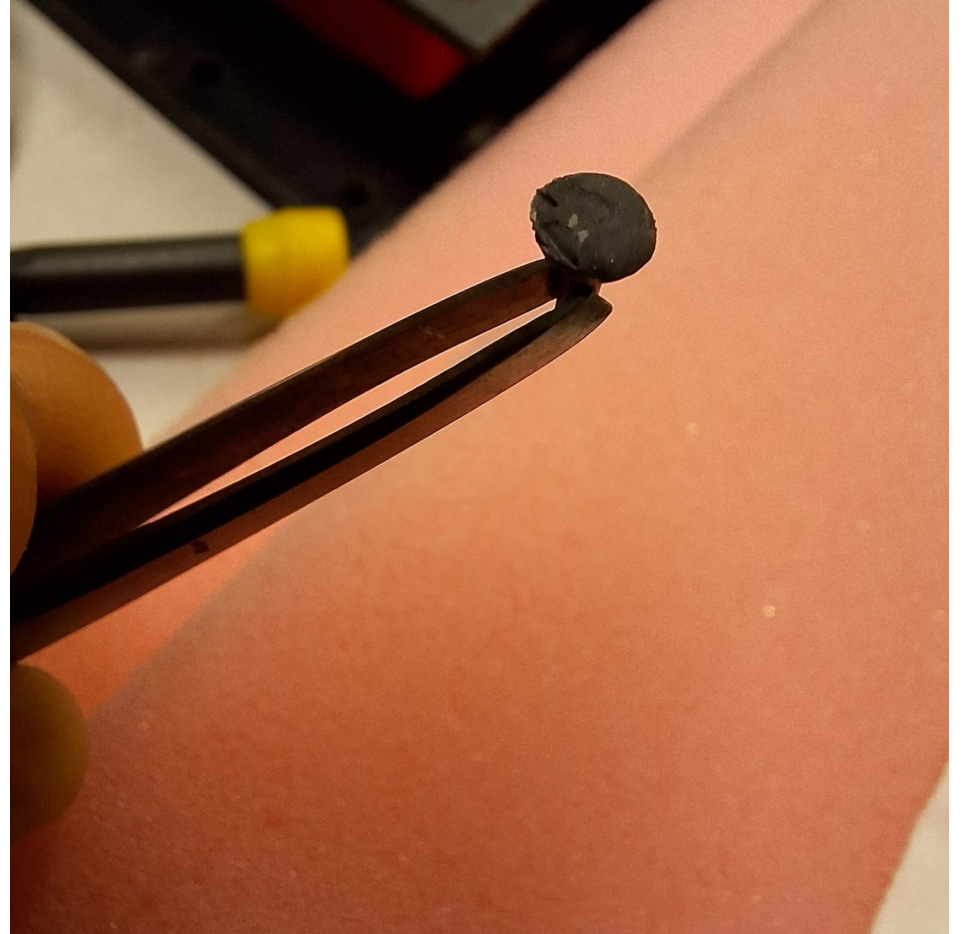


Broken Pin



Broken Pin is connected to the Guard Ring

Broken HV Pin



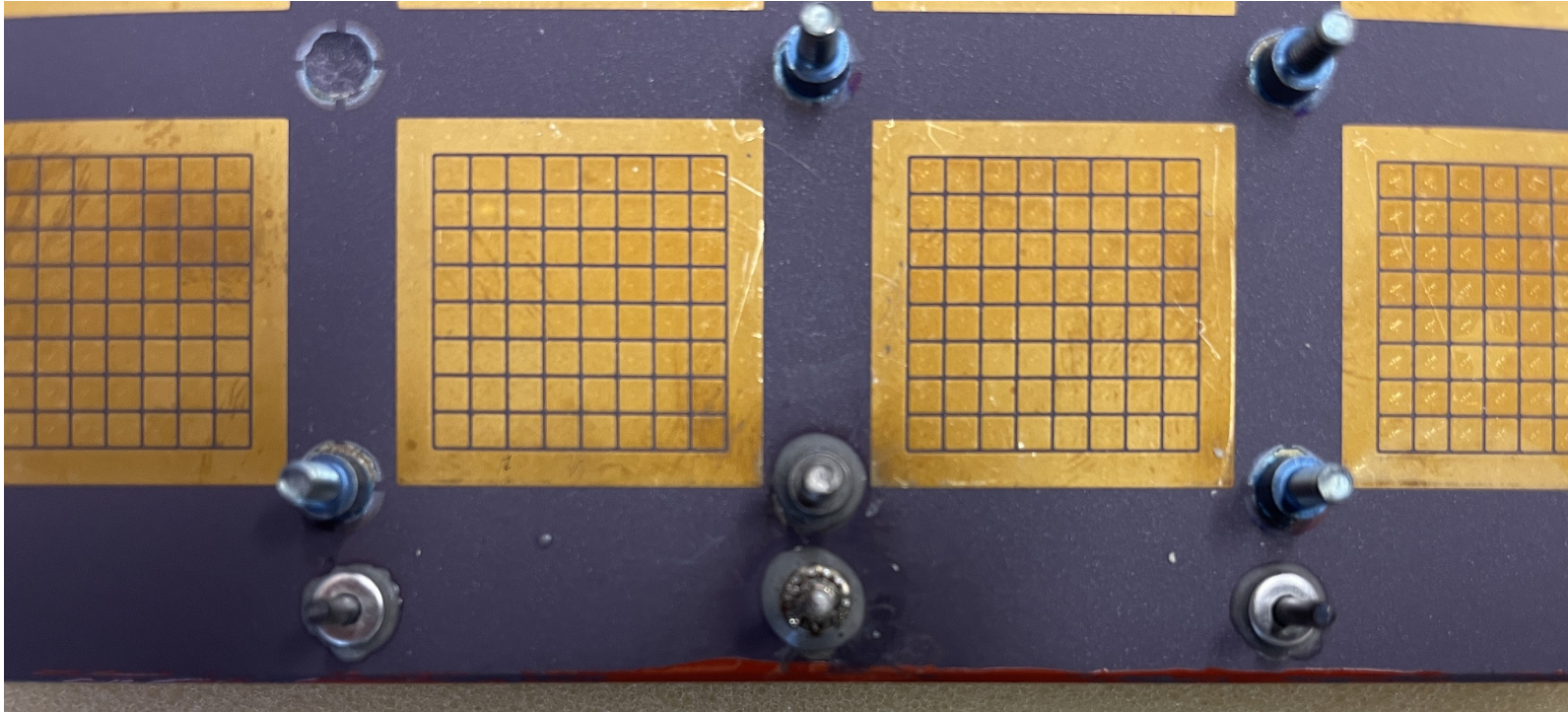
Broken HV Pin



This electrode has a connection with the Guard Rings of each 16 groups (8 x 8 pads).

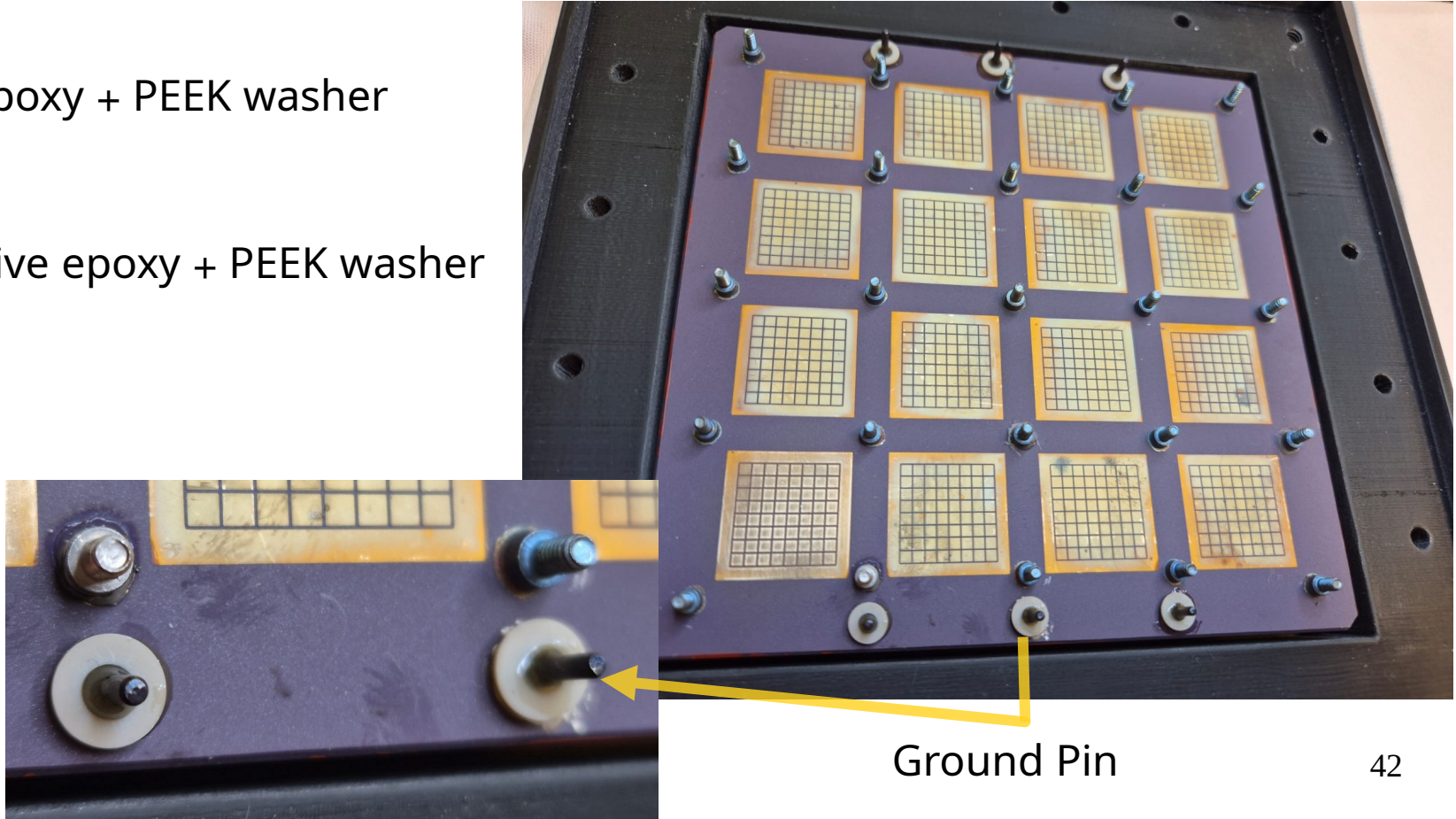
We can fix it (with conductive epoxy) or stay without the pin and provide grounding externally.

Picture from Alexander
Reinforced HV pin and broken screw

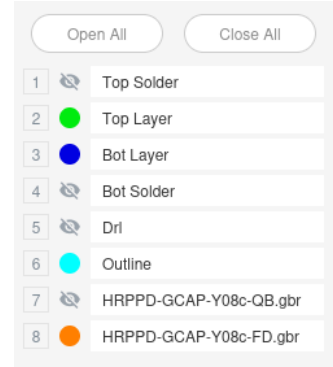
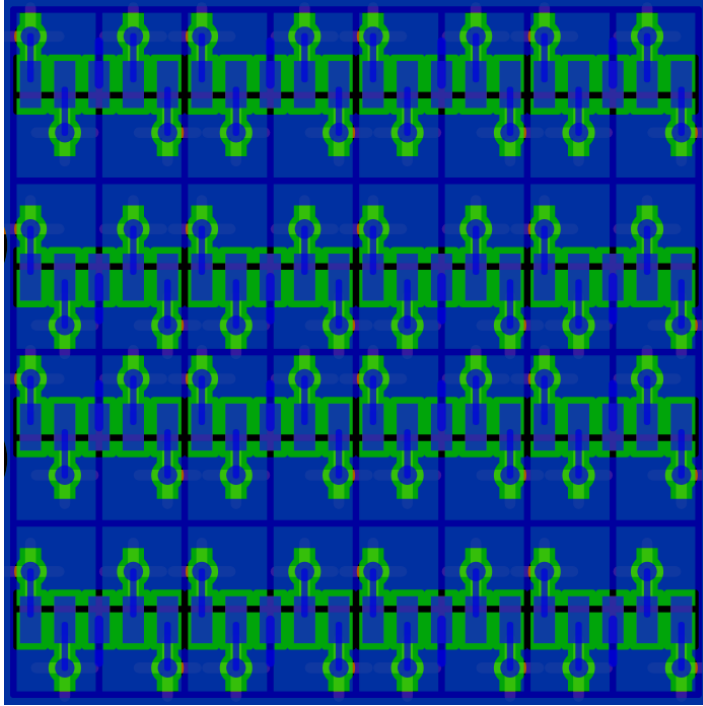


HV Pins reinforced

- Groun pin:
Conductive epoxy + PEEK washer
- Other 5 pins:
non-Conductive epoxy + PEEK washer

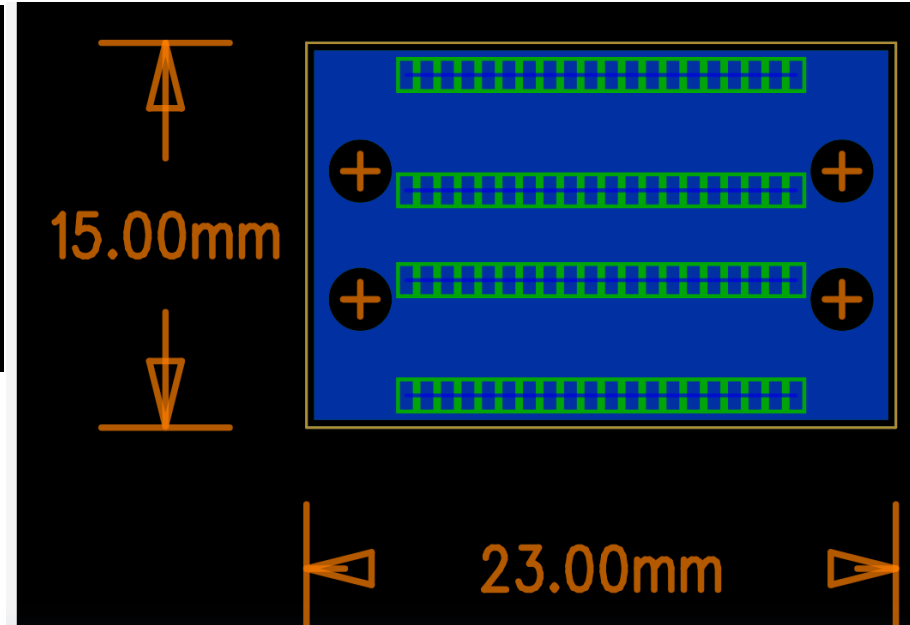


GERBER FILES



Y05f – HRPPD Backplane (Two **ERF8 Socket**).

Two sockets has 4 Rows.
Two sockets has 4 x 20 pins.
4 x 16 pins read 64 pads.
4 x 4 pins are Grounded.



Y08c – Backplane Grounding Cap (**ERM8 Terminal**).

Each Terminal has 4 Rows.
20 pins (single Row) are connected together.
ERM8 goes to ERF8 socket where 4 pins are Grounded.
Hence, eventually, all 4 x 20 pins in ERM8 are Grounded.

Y05f – HRPPD Backplane (Two **ERF8 Socket**).

Two sockets has 4 Rows.

Two sockets has 4 x 20 pins.

4 x 16 pins read 64 pads.

4 x 4 pins are Grounded.

