FPC bonding trial @ UoB

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EIC-UK WP1 (MAPS)
Face-to-face meeting at Brunel

Wed, 21st May 2025

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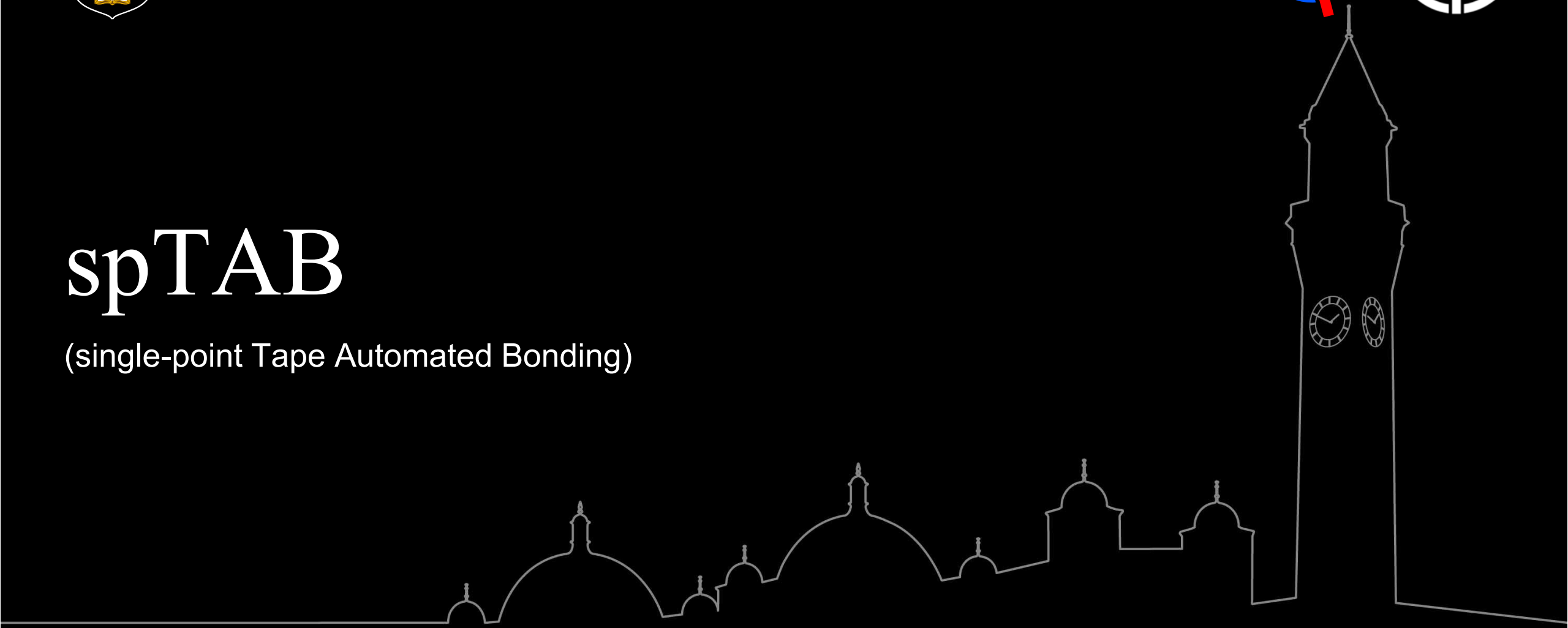
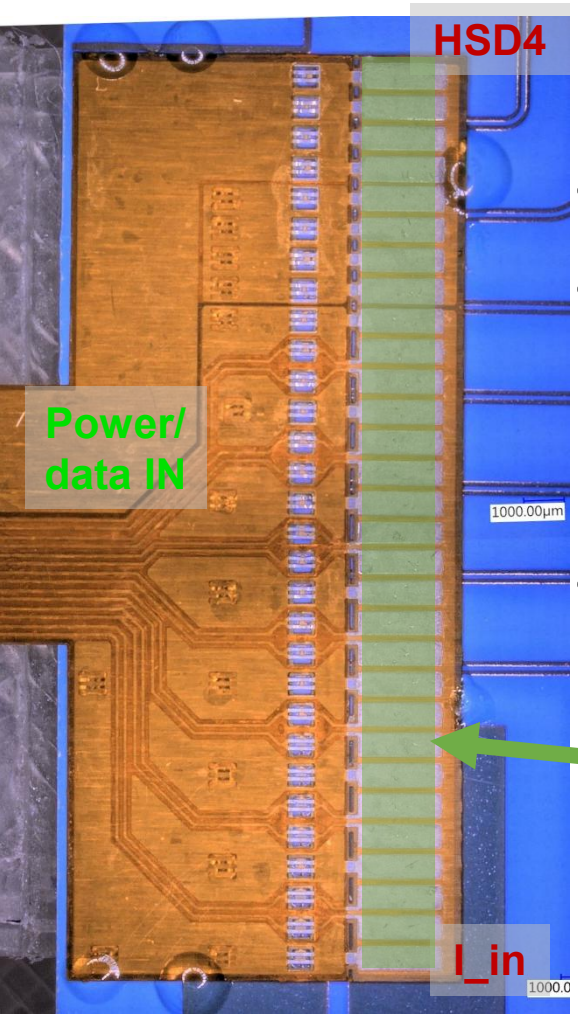
ePIC

spTAB

(single-point Tape Automated Bonding)



1st FPC to PCB mounting trial

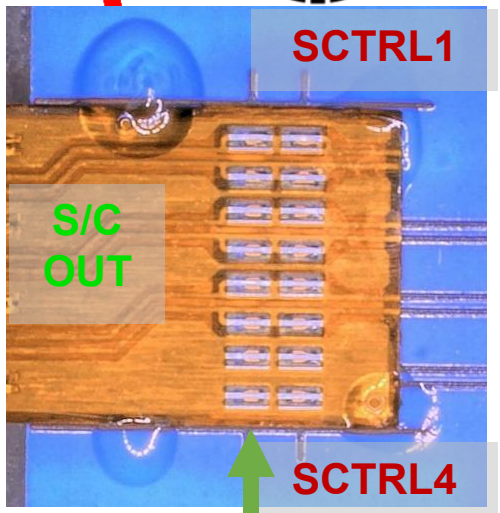


Following on from:

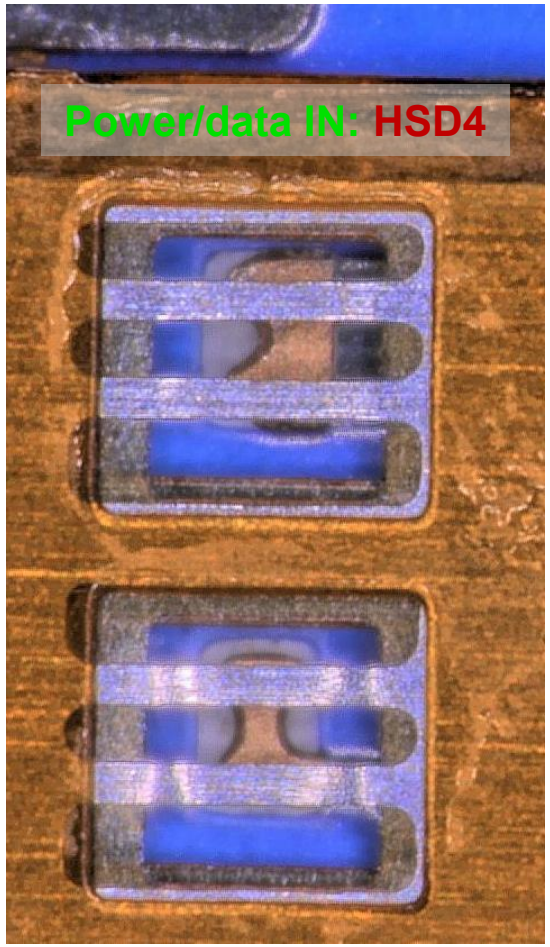
- Bond trials (here).
- Initial PCB mounting (here and here).

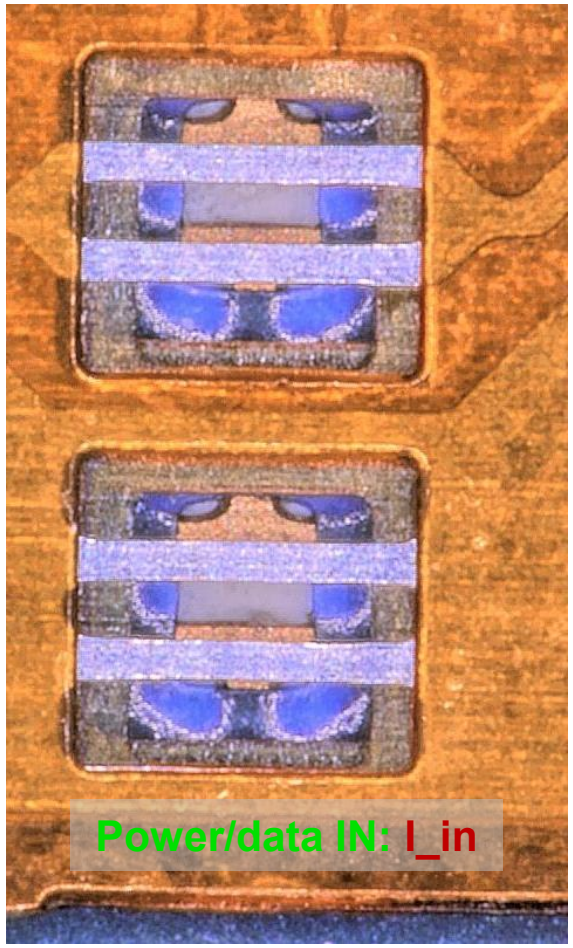
Reminder:

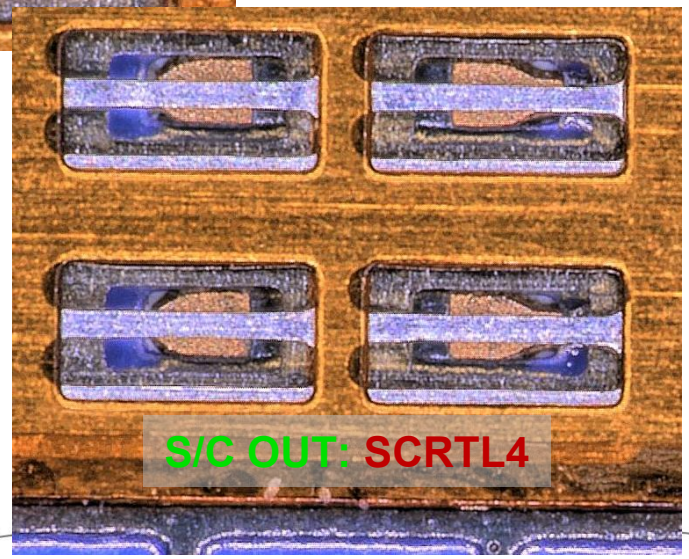
- Used a Kapton coated weight to hold FPC while applying glue.
  - Utilised the solder/probe pads on the Power/data IN side of the FPC – mounting was easy! However, this needs to be cut off.
  - Limited locations for the weight on the S/C OUT side of the FPC.



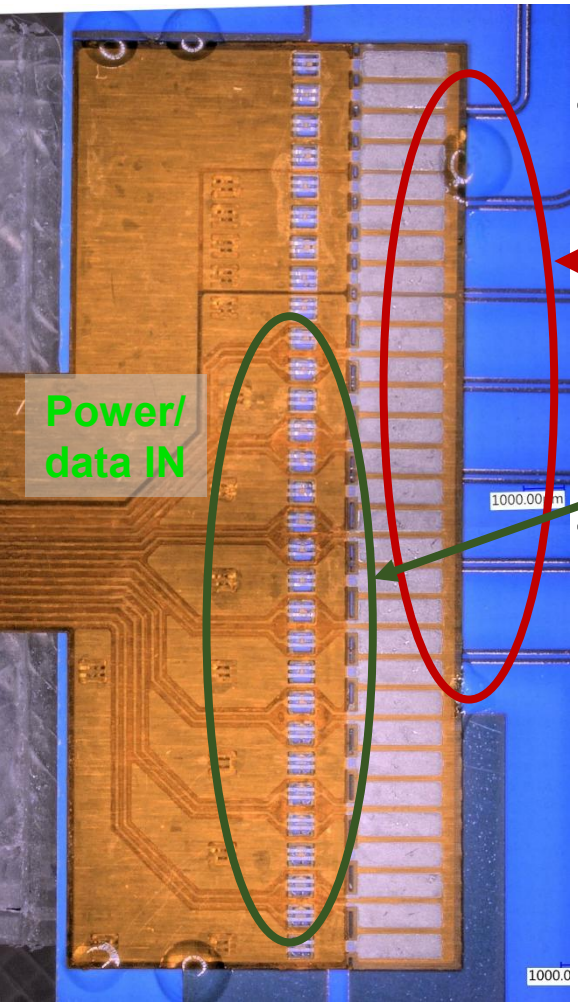
FPC to PCB alignment







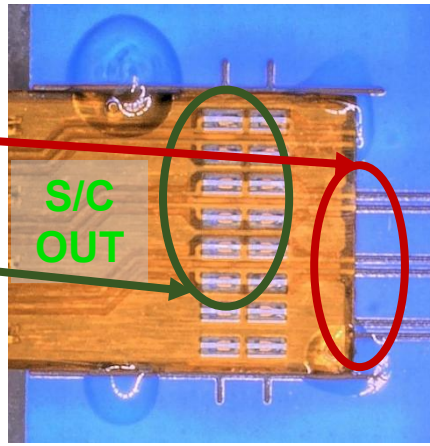
Initial error!



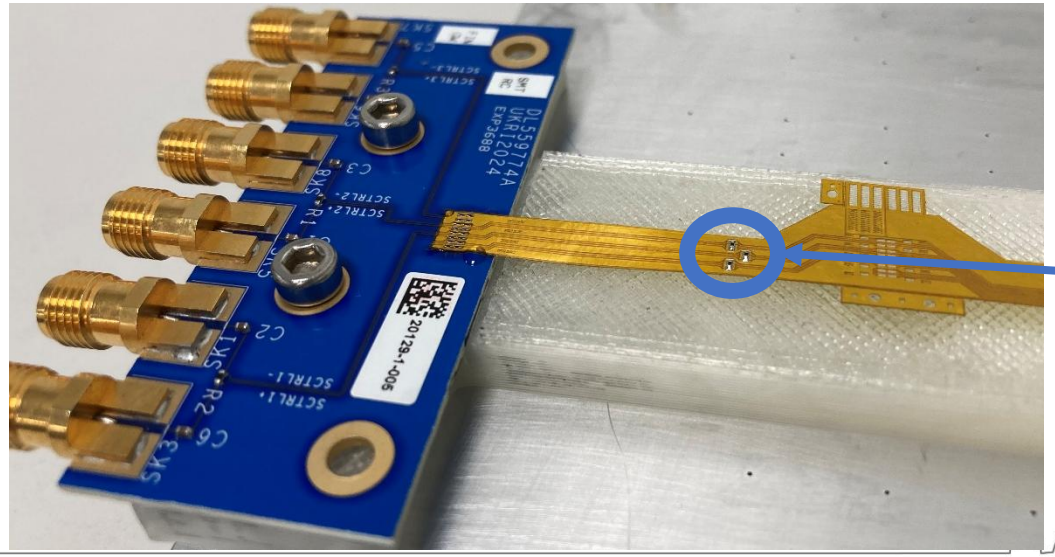
- The differential lines don't line up!

PCB differential lines

FPC differential lines

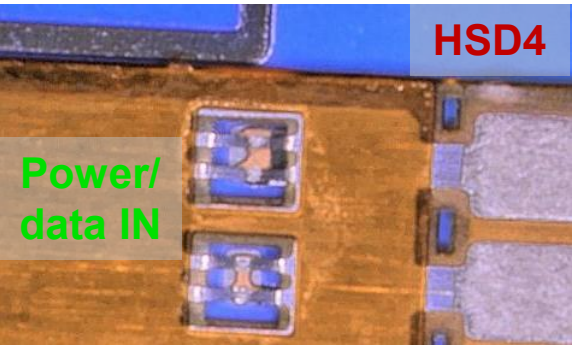


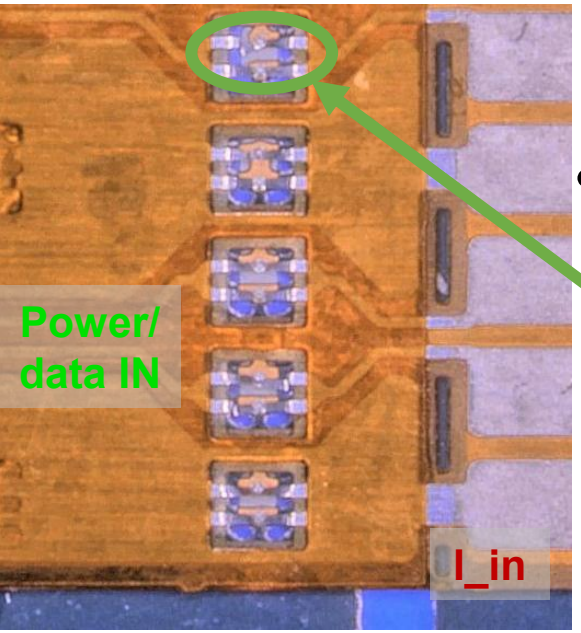
- We mounted the FPC up-side-down!



For full length data transmission testing, these resistors need to be removed!

FPC to PCB bonding



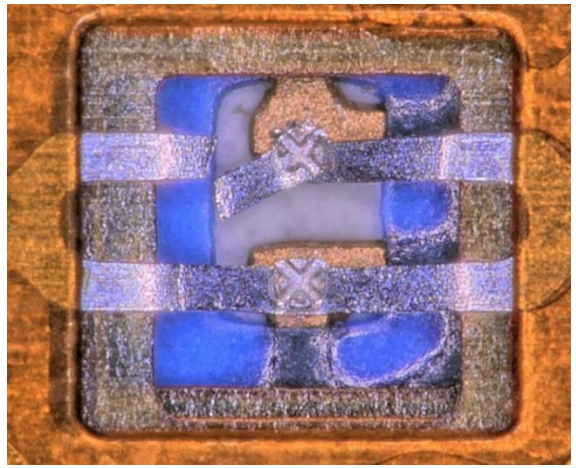


- Kept to the bond settings found to work well from testing.
- Vertical offset between FPC and PCB seemed much smaller than with the (unglued) test structure.
- Observing bonds being done appeared to go very smoothly.
  - A couple of foils had noticeable snapped at either end of FPC, seemed minimal.

Pushing the Al foil

- The FPC was mounted up-side-down, therefore aluminium foil was being stretched further than planned
  - Bonding top layer, instead of bottom, to the PCB!
- It was found that this appeared to be pushing the foils to their limits.
  - A lot of foil traces were damaged!
- Especially bad on the S/C OUT side.
- Since the bonding, we have been handling the structure to prepare mounts for shipping.

Base cross-section of M-FPC and B-FPCs



Visual inspection (post bonding)

Power/data IN

- 5 (out of 60) snapped foils.
- 76.6% of bonds appeared perfect (46/60).
- 9 foils showed irregular foil deformation (badly kinked).

S/C OUT

- 7 (out of 16) snapped foils.
- 37.5% of bonds appeared perfect (6/16).
- 3 foils showed irregular foil deformation (badly kinked).

Can be seen from original spreadsheet.

Image repository

Visual inspection (post handling)

Power/data IN

- 5 (out of 60) snapped foils.
- **75**% of bonds appeared perfect (45/60).
- 9 foils showed irregular foil deformation (badly kinked).
- **1** bond was poorly aligned, foil was twisted, limiting contact to PCB (previous image was not well focussed to see this).

S/C OUT

- **10** (out of 16) snapped foils.
- **18.75%** of bonds appeared perfect (3/16).
- 3 foils showed irregular foil deformation (badly kinked).

Can be seen from new spreadsheet (extra tabs to compare old and new data).
Image repository

New jig and PCB

- We have an additional jig from Oxford (thanks)!
  - This version is designed to be James-proof (FPC only fits in the correct orientation).
- We also have the updated PCBs from Andy (thanks)!
  - Now with the solder resist removed under the FPC to minimise the height different between the aluminium layers of the FPC and the pads of the PCB.

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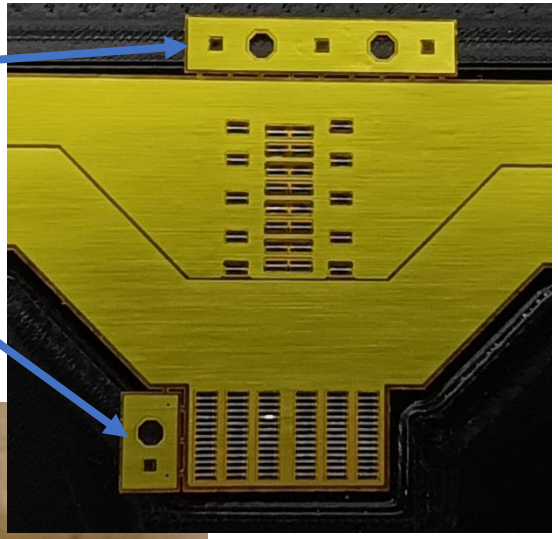
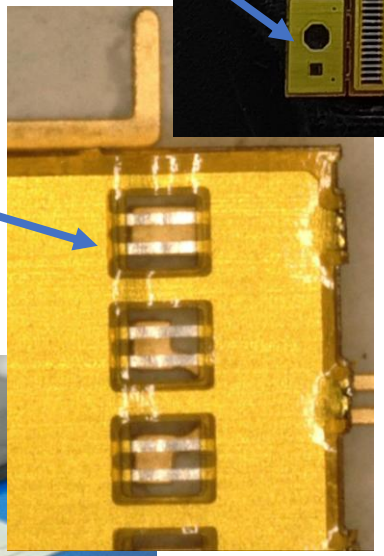
Main-FPC sample 2

- Upon inspection, this jig does not have the cut-outs for the B-FPC alignment tabs.
  - Can be solved by cutting off alignment.



- Initial visual inspection suggests good alignment between FPC foils and PCB bond pads can be achieved.



- Look at using a nylon stand-off as a weight to aid alignment.

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spTAB summary

- Handling of original M-FPC sample has revealed more damage to aluminium foil (only on the S/C OUT side).
- Is this linked to difficulty supporting and mounting this side of the M-FPC?
- New jig, PCBs and M-FPC received at Birmingham.
- Considerations for best method to hold FPC to PCB (during bonding) are under consideration. Examples below:
  - Bonding while FPC is held by a weight only (and holding with a bead of glue, around edges, after bonding).
  - Holding FPC with glue dots for bonding (and adding more glue afterwards).

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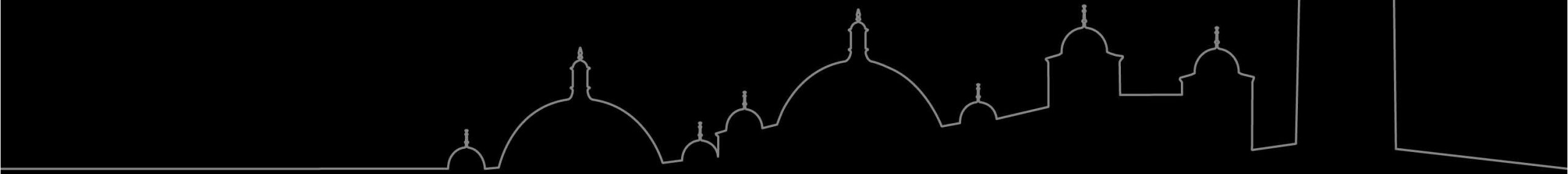
Wire bonding

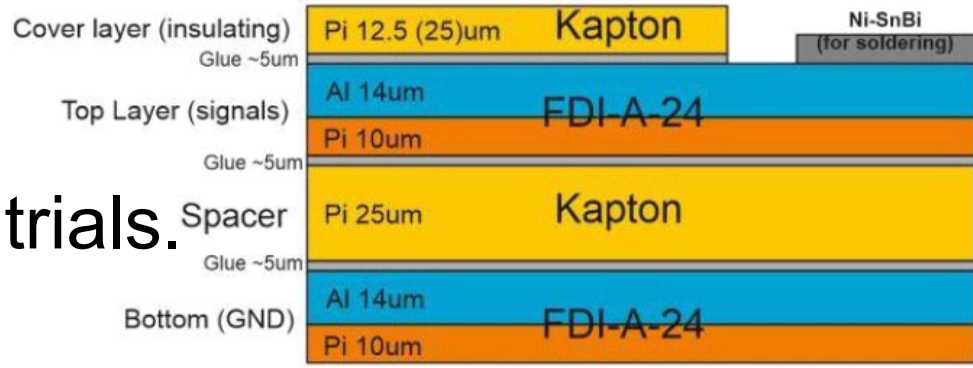


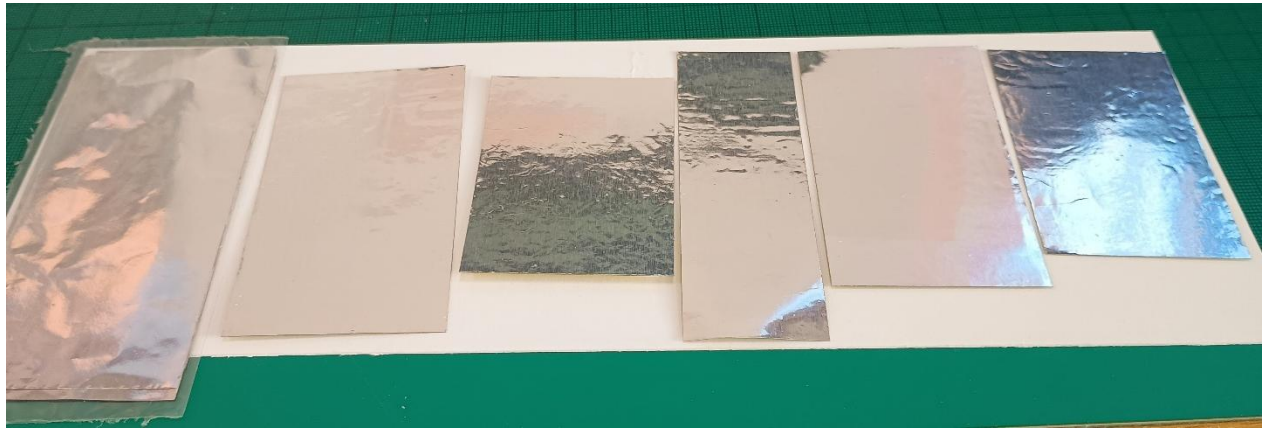
Wire bond samples

We received samples from LTU to trial wire wire bonding (and perform pull tests on).

Samples also share with Liverpool for these trials.

- Single Al foil layer: LTU-15-10
- Dual Al foil layers: LTU-15-10 + 25µmKapton + LTU-15-10





Initial findings from Liverpool were reported at the Electrical Interfaces Meetings.

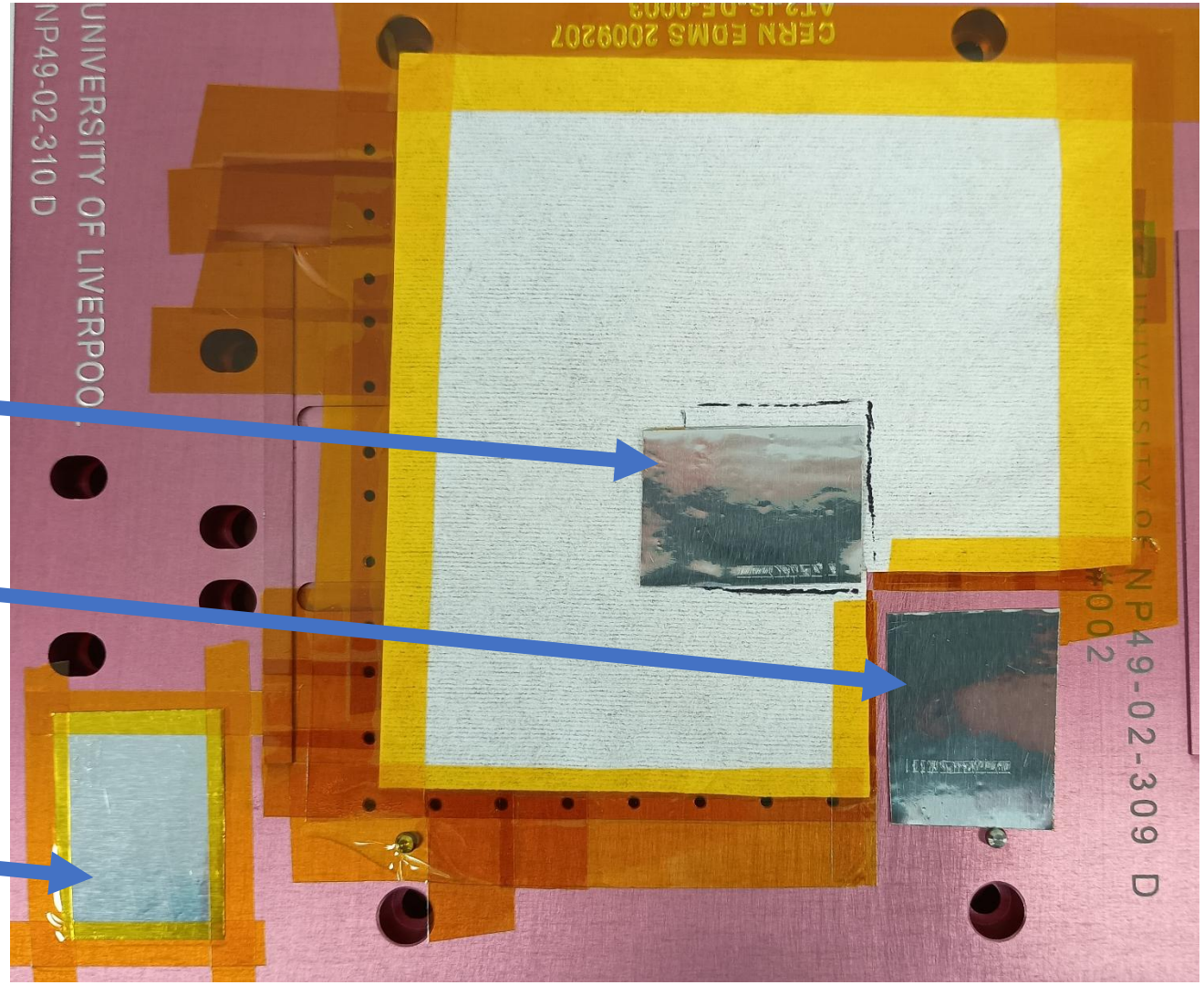
Mounting options

No samples have been cleaned for these tests

Focussed on Dual Al foil layers (LTU-15-10 + 25μmKapton + LTU-15-10) for 1st trials.

3 mounting options considered:

- Vacuumed with a diffuser.
- Vacuumed directly to jig (naked).
- Taped flat.



Material considerations

Liverpool showed that wire bonding onto this Al foils behaves very differently that to a standard PCB/silicon chip.

- Had to adjust bond parameters just to get wire to weld.
- Even then results were inconsistent.
- However, did show that good welds can occur.

PCBs (typically) have thin metallisation on thick (FR4) substrate.
ASICs (typically) have thin metallisation on silicon substrate.

- The metallisation can be similar to that on these foils (~15 µm Al).
- The substrate are very rigid* compared to these foils (<50 µm Kapton).

* For silicon >100 µm thick.

Soft substrates

Had to rethink the bond parameters due to these more flexible substrates. Many parameters are optimised for rigid substrates(with soft wire):

- Touchdown force (cN) – how much resistance the tool receives to known it has made contact.
- Overtravel (μm) – how far the tool is pushed into the substrate after making contact.
- Bond force (cN) – how much extra the tool pushes while welding.
- Deformation (%) – how much the wire should change before welding is complete.

How much is one compacting the substrate, rather than the wire?

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Wire bond trials

No samples have been cleaned for these tests

In general, minimal difference between the mounting variations.

"Taped", noticeably lifted during pull tests.

TF (cN)	Def (%)	BF (cN)	US (%)	S_OT (µm)	D_OT (µm)	LeaveAng (°)	Wire	Direction	Mounting	#/10	Mean (g)	SD (g)	# of S_b(1)	# of D_b(2)	# of Span(3)	# of S_p(4)	# of D_p(5)
18	35	20	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	24	50	25	90	CCC	w. grain	Taped	9	6.99	1.80	0	0	0	5	4
									Vac'd (naked)	3	4.94	0.80	0	0	0	3	0
									Vac'd (diff)	4	5.48	0.98	0	0	0	4	0
14	50	16	24	50	25	90	CCC	w. grain	Taped	8	4.74	1.18	0	0	0	8	0
									Vac'd (naked)	3	6.44	0.86	0	0	0	3	0
									Vac'd (diff)	9	6.00	1.91	0	0	0	9	0
14	50	16	24	25	25	90	CCC	w. grain	Taped	9	13.30	1.38	0	0	0	6	3
									Vac'd (naked)	9	14.37	1.68	0	0	0	6	3
									Vac'd (diff)	10	13.12	1.76	0	0	0	3	7
14	50	16	24	25	25	45	Heraeus	w. grain	Taped	8	11.21	1.75	1	2	3	0	2
									Vac'd (naked)	9	13.22	1.37	2	2	3	0	2
									Vac'd (diff)	4	9.61	0.32	0	0	0	4	0
14	50	16	24	25	25	90	Heraeus	w. grain	Taped	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	7	13.45	0.87	3	0	2	2	0
									Vac'd (diff)	8	11.44	2.18	4	1	1	2	0
14	50	16	24	25	25	45	CCC	w. grain	Taped	10	9.65	1.37	9	0	0	0	1
									Vac'd (naked)	10	11.93	0.72	8	0	0	1	1
									Vac'd (diff)	9	10.70	1.82	8	0	1	0	0
14	50	16	24	15	15	45	CCC	w. grain	Taped	10	10.73	2.18	2	1	1	0	6
									Vac'd (naked)	10	11.57	1.74	9	1	0	0	0
									Vac'd (diff)	10	10.02	2.41	10	0	0	0	0
14	50	16	24	13	13	45	CCC	w. grain	Taped	10							
									Vac'd (naked)	9	10.40	1.88	8	1	0	0	0
									Vac'd (diff)	10	9.95	2.27	6	0	0	4	0

Full spreadsheet can be seen here.

Run through of table information can be seen here.

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Reasons for the changes

If the tool pushes too hard, it risks piercing the foil or damaging the Kapton insulating the aluminium layers, therefore:

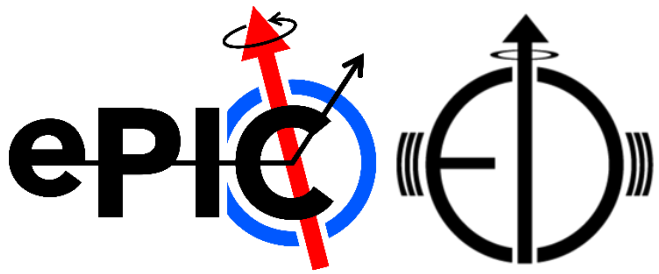
- Minimise touchdown force (TF).
- Minimise bond force (BF).
- Minimise overtravel (OT).

The foil (~15 μm) is thinner than the wire diameter (25 μm), it could melt at a similar point to (or before) the wire, so:

- Increase deformation (Def), to account for deformation of the foil (and not just the wire).

Wire bond summary

No samples have been cleaned for these tests



- Further studies on wire bonding to the aluminium foils from LTU have occurred.
- We are seeing some good indications and are determining parameters to focus on for optimising the welds.
- Parameters are not there yet but should be a good starting point.
  - Expecting that the support structure will also play a big part (bonding on a thick aluminium vacuum jig).
  - Noticed some difference with the bonds on the diffused vacuum sample. The clean room paper gave some cushioning and needed more overtravel (14 µm) than the others (13 µm) when very low.
- More to come from the studies @Liverpool by Jian.

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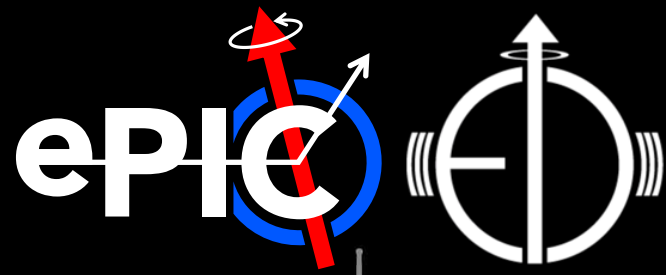
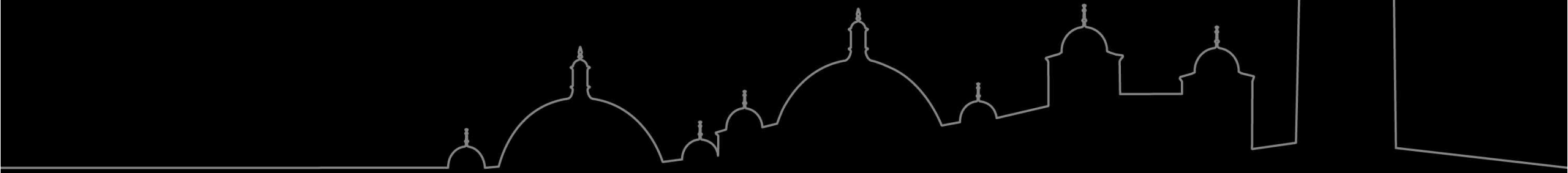


Thank you very much!

Any questions?



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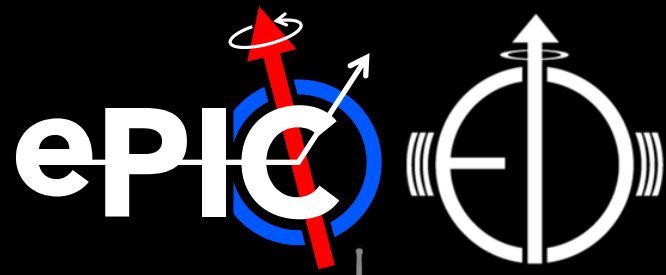
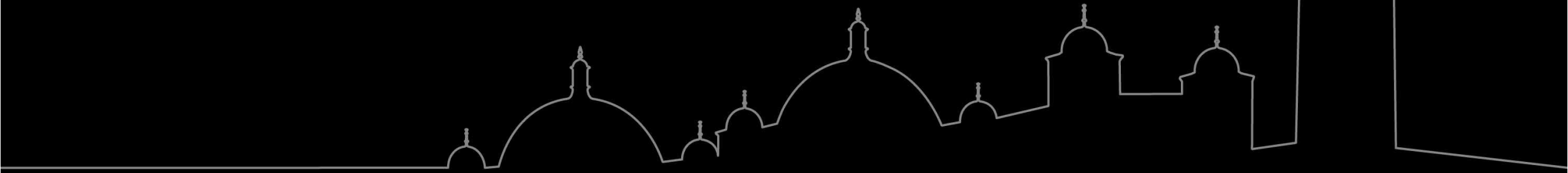
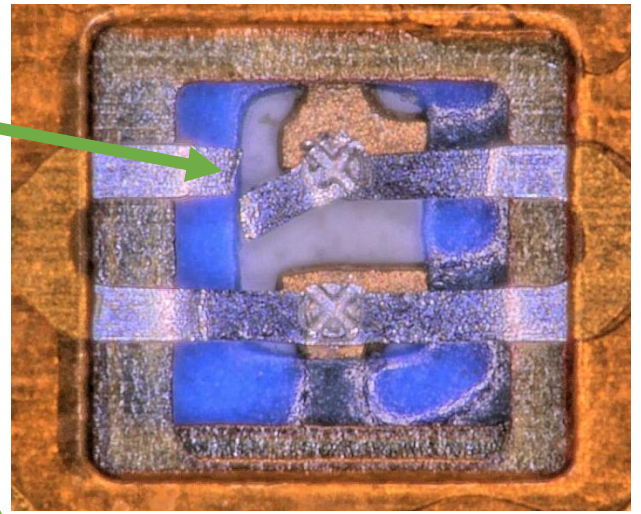


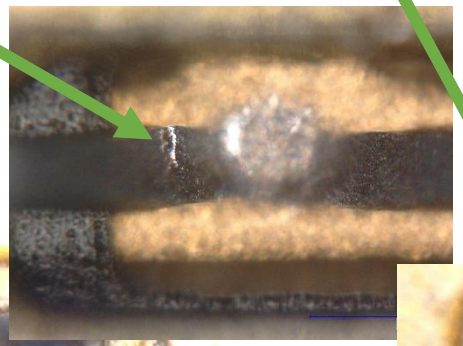
Additional (support) slides

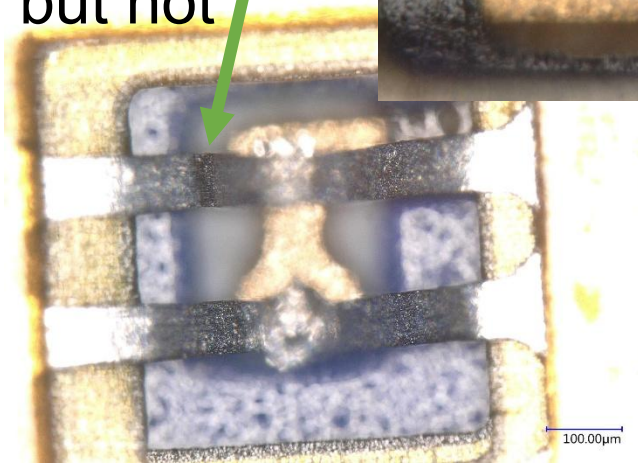


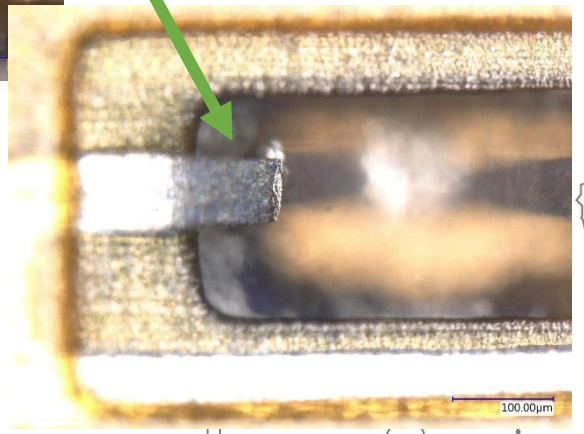
spTAB – visual inspection

- Most breaks appears at the edge of the PCB's solder mask (this layer is only 20 µm thick).
- Some irregular kinks in the foil are observed.
- More than 60% of the S/C OUT side show some damage.
  - May still have continuity, but not ideal for HS data Tx.
  - Due to trouble keeping FPC flat at this end?
  - Only ~25% on the Power/data IN side.

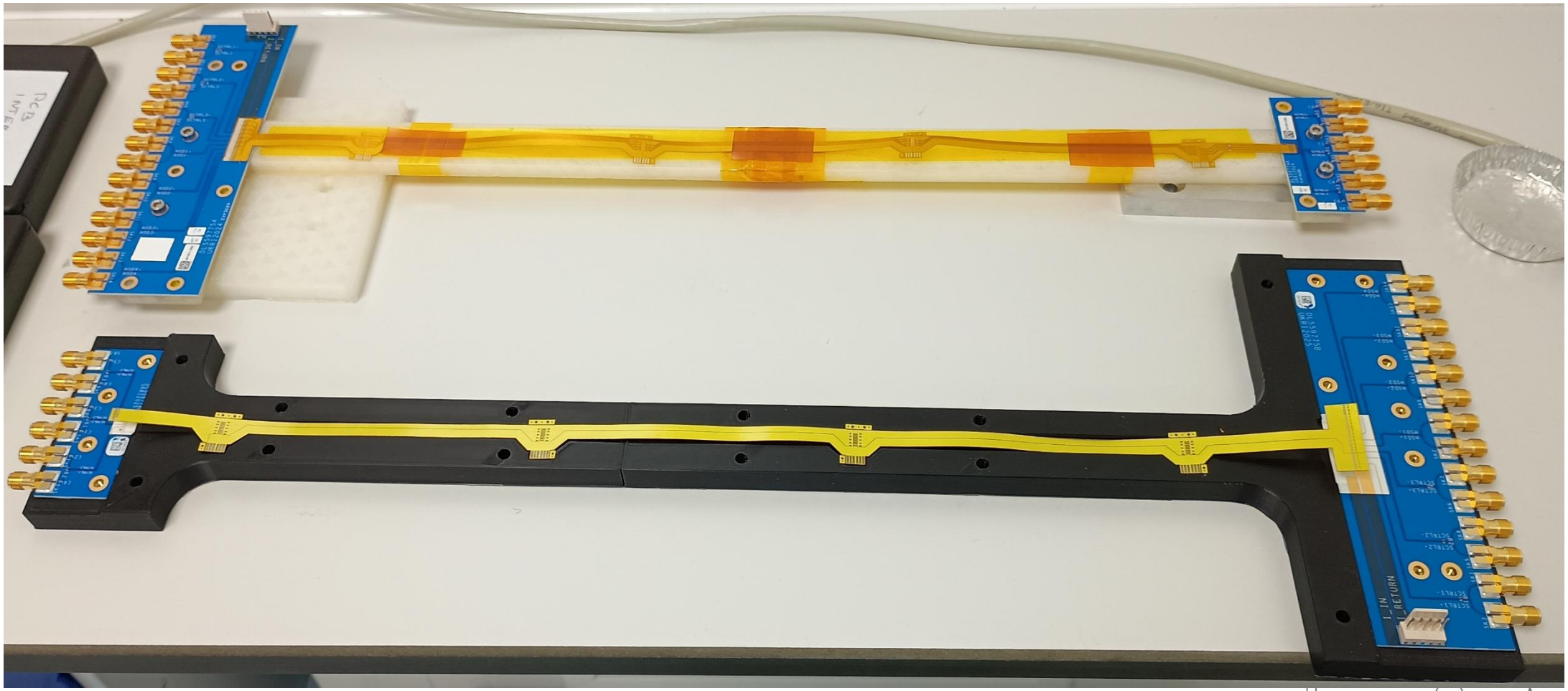








spTAB – M-FPC 2 on jig



Wire bond – spreadsheet definitions

TF = Touchdown Force (cN)
Def = Deformation (%)
BF = Bond Force (cN)
US = Ultrasonic Power (%)
S_OT = Source Overtravel (µm)
D_OT = Destination Overtravel (µm)
LeaveAng = Leave Angle (°), 90° = perpendicular to surface
Heraeus = Hersaeus AlSi-M, Aluminiun+1%Silicon wire (medium strength), 25 µm, >1% elongation, 15-17cN Breaking Load (installed to the Right-hand wire bonder in BILPA)
CCC = Custom Chip Connections CC-250, Aluminiun+1%Silicon wire (medium strength), 25 µm, 1-4% elongation, 15-18g Tear Strength (installed to the Left-hand wire bonder in BILPA)
w. grain = With the grain of the Al foil
a. grain = Against the grain of the Al foil
Taped = Foil taped down (all 4 sides) to chuck.
Vac'd (naked) = Foil vacuumed to chuck, nothing in between chuck and foil.
Vac'd (diff) = Foil vacuumed to chuck, with clean room paper as a diffuser between chuck and foil.
#/10 = # of pullable wires, out of a maximum of 10 wire attempts
# of S_b(1) = # of Source heel breaks (failure mode: "1")
# of D_b(2) = # of Destination heel breaks (failure mode: "2")
# of Span(3) = # of Span breaks, centre of wire snaps (failure mode: "3")
# of S_p(4) = # of Source peels (failure mode: "4")
# of D_p(5) = # of Destination peels (failure mode: "5")

Wire bond trials

The standard deviation is still higher than preferred.

TF (cN)	Def (%)	BF (cN)	US (%)	S_OT (µm)	D_OT (µm)	LeaveAng (°)	Wire	Direction	Mounting	#/10	Mean (g)	SD (g)	# of S_b(1)	# of D_b(2)	# of Span(3)	# of S_p(4)	# of D_p(5)
18	35	20	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	24	50	25	90	CCC	w. grain	Taped	9	6.99	1.80	0	0	0	5	4
									Vac'd (naked)	3	4.94	0.80	0	0	0	3	0
									Vac'd (diff)	4	5.48	0.98	0	0	0	4	0
14	50	16	24	50	25	90	CCC	w. grain	Taped	8	4.74	1.18	0	0	0	8	0
									Vac'd (naked)	3	6.44	0.86	0	0	0	3	0
									Vac'd (diff)	9	6.00	1.91	0	0	0	9	0
14	50	16	24	25	25	90	CCC	w. grain	Taped	9	13.30	1.38	0	0	0	6	3
									Vac'd (naked)	9	14.37	1.68	0	0	0	6	3
									Vac'd (diff)	10	13.12	1.76	0	0	0	3	7
14	50	16	24	25	25	45	Heraeus	w. grain	Taped	8	11.21	1.75	1	2	3	0	2
									Vac'd (naked)	9	13.22	1.37	2	2	3	0	2
									Vac'd (diff)	4	9.61	0.32	0	0	0	4	0
14	50	16	24	25	25	90	Heraeus	w. grain	Taped	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	7	13.45	0.87	3	0	2	2	0
									Vac'd (diff)	8	11.44	2.18	4	1	1	2	0
14	50	16	24	25	25	45	CCC	w. grain	Taped	10	9.65	1.37	9	0	0	0	1
									Vac'd (naked)	10	11.93	0.72	8	0	0	1	1
									Vac'd (diff)	9	10.70	1.82	8	0	1	0	0
14	50	16	24	15	15	45	CCC	w. grain	Taped	10	10.73	2.18	2	1	1	0	6
									Vac'd (naked)	10	11.57	1.74	9	1	0	0	0
									Vac'd (diff)	10	10.02	2.41	10	0	0	0	0
14	50	16	24	13	13	45	CCC	w. grain	Taped	10							
									Vac'd (naked)	9	10.40	1.88	8	1	0	0	0
									Vac'd (diff)	10	9.95	2.27	6	0	0	4	0

Full spreadsheet can be seen here.

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Wire bond trials

Seeing any wire span breaks is impressive.

TF (cN)	Def (%)	BF (cN)	US (%)	S_OT (µm)	D_OT (µm)	LeaveAng (°)	Wire	Direction	Mounting	#/10	Mean (g)	SD (g)	# of S_b(1)	# of D_b(2)	# of Span(3)	# of S_p(4)	# of D_p(5)
18	35	20	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	24	50	25	90	CCC	w. grain	Taped	9	6.99	1.80	0	0	0	5	4
									Vac'd (naked)	3	4.94	0.80	0	0	0	3	0
									Vac'd (diff)	4	5.48	0.98	0	0	0	4	0
14	50	16	24	50	25	90	CCC	w. grain	Taped	8	4.74	1.18	0	0	0	8	0
									Vac'd (naked)	3	6.44	0.86	0	0	0	3	0
									Vac'd (diff)	9	6.00	1.91	0	0	0	9	0
14	50	16	24	25	25	90	CCC	w. grain	Taped	9	13.30	1.38	0	0	0	6	3
									Vac'd (naked)	9	14.37	1.68	0	0	0	6	3
									Vac'd (diff)	10	13.12	1.76	0	0	0	3	7
14	50	16	24	25	25	45	Heraeus	w. grain	Taped	8	11.21	1.75	1	2	3	0	2
									Vac'd (naked)	9	13.22	1.37	2	2	3	0	2
									Vac'd (diff)	4	9.61	0.32	0	0	0	4	0
14	50	16	24	25	25	90	Heraeus	w. grain	Taped	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	7	13.45	0.87	3	0	2	2	0
									Vac'd (diff)	8	11.44	2.18	4	1	1	2	0
14	50	16	24	25	25	45	CCC	w. grain	Taped	10	9.65	1.37	9	0	0	0	1
									Vac'd (naked)	10	11.93	0.72	8	0	0	1	1
									Vac'd (diff)	9	10.70	1.82	8	0	1	0	0
14	50	16	24	15	15	45	CCC	w. grain	Taped	10	10.73	2.18	2	1	1	0	6
									Vac'd (naked)	10	11.57	1.74	9	1	0	0	0
									Vac'd (diff)	10	10.02	2.41	10	0	0	0	0
14	50	16	24	13	13	45	CCC	w. grain	Taped	10							
									Vac'd (naked)	9	10.40	1.88	8	1	0	0	0
									Vac'd (diff)	10	9.95	2.27	6	0	0	4	0

Full spreadsheet can be seen here.

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Wire bond trials

No samples have been cleaned for these tests

Initial settings (standard PCB) fail to get successful welds.

Lowering TF+BF, while increasing Def had little effect.

TF (cN)	Def (%)	BF (cN)	US (%)	S_OT (µm)	D_OT (µm)	LeaveAng (°)	Wire	Direction	Mounting	#/10	Mean (g)	SD (g)	# of S_b(1)	# of D_b(2)	# of Span(3)	# of S_p(4)	# of D_p(5)
18	35	20	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	24	50	25	90	CCC	w. grain	Taped	9	6.99	1.80	0	0	0	5	4
									Vac'd (naked)	3	4.94	0.80	0	0	0	3	0
									Vac'd (diff)	4	5.48	0.98	0	0	0	4	0
14	50	16	24	50	25	90	CCC	w. grain	Taped	8	4.74	1.18	0	0	0	8	0
									Vac'd (naked)	3	6.44	0.86	0	0	0	3	0
									Vac'd (diff)	9	6.00	1.91	0	0	0	9	0
14	50	16	24	25	25	90	CCC	w. grain	Taped	9	13.30	1.38	0	0	0	6	3
									Vac'd (naked)	9	14.37	1.68	0	0	0	6	3
									Vac'd (diff)	10	13.12	1.76	0	0	0	3	7
14	50	16	24	25	25	45	Heraeus	w. grain	Taped	8	11.21	1.75	1	2	3	0	2
									Vac'd (naked)	9	13.22	1.37	2	2	3	0	2
									Vac'd (diff)	4	9.61	0.32	0	0	0	4	0
14	50	16	24	25	25	90	Heraeus	w. grain	Taped	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	7	13.45	0.87	3	0	2	2	0
									Vac'd (diff)	8	11.44	2.18	4	1	1	2	0
14	50	16	24	25	25	45	CCC	w. grain	Taped	10	9.65	1.37	9	0	0	0	1
									Vac'd (naked)	10	11.93	0.72	8	0	0	1	1
									Vac'd (diff)	9	10.70	1.82	8	0	1	0	0
14	50	16	24	15	15	45	CCC	w. grain	Taped	10	10.73	2.18	2	1	1	0	6
									Vac'd (naked)	10	11.57	1.74	9	1	0	0	0
									Vac'd (diff)	10	10.02	2.41	10	0	0	0	0
14	50	16	24	13	13	45	CCC	w. grain	Taped	10							
									Vac'd (naked)	9	10.40	1.88	8	1	0	0	0
									Vac'd (diff)	10	9.95	2.27	6	0	0	4	0

Full spreadsheet can be seen here.

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Wire bond trials

No samples have been cleaned for these tests

Additionally increasing US stated to get somewhere.

TF (cN)	Def (%)	BF (cN)	US (%)	S_OT (µm)	D_OT (µm)	LeaveAng (°)	Wire	Direction	Mounting	#/10	Mean (g)	SD (g)	# of S_b(1)	# of D_b(2)	# of Span(3)	# of S_p(4)	# of D_p(5)
18	35	20	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	24	50	25	90	CCC	w. grain	Taped	9	6.99	1.80	0	0	0	5	4
									Vac'd (naked)	3	4.94	0.80	0	0	0	3	0
									Vac'd (diff)	4	5.48	0.98	0	0	0	4	0
14	50	16	24	50	25	90	CCC	w. grain	Taped	8	4.74	1.18	0	0	0	8	0
									Vac'd (naked)	3	6.44	0.86	0	0	0	3	0
									Vac'd (diff)	9	6.00	1.91	0	0	0	9	0
14	50	16	24	25	25	90	CCC	w. grain	Taped	9	13.30	1.38	0	0	0	6	3
									Vac'd (naked)	9	14.37	1.68	0	0	0	6	3
									Vac'd (diff)	10	13.12	1.76	0	0	0	3	7
14	50	16	24	25	25	45	Heraeus	w. grain	Taped	8	11.21	1.75	1	2	3	0	2
									Vac'd (naked)	9	13.22	1.37	2	2	3	0	2
									Vac'd (diff)	4	9.61	0.32	0	0	0	4	0
14	50	16	24	25	25	90	Heraeus	w. grain	Taped	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	7	13.45	0.87	3	0	2	2	0
									Vac'd (diff)	8	11.44	2.18	4	1	1	2	0
14	50	16	24	25	25	45	CCC	w. grain	Taped	10	9.65	1.37	9	0	0	0	1
									Vac'd (naked)	10	11.93	0.72	8	0	0	1	1
									Vac'd (diff)	9	10.70	1.82	8	0	1	0	0
14	50	16	24	15	15	45	CCC	w. grain	Taped	10	10.73	2.18	2	1	1	0	6
									Vac'd (naked)	10	11.57	1.74	9	1	0	0	0
									Vac'd (diff)	10	10.02	2.41	10	0	0	0	0
14	50	16	24	13	13	45	CCC	w. grain	Taped	10							
									Vac'd (naked)	9	10.40	1.88	8	1	0	0	0
									Vac'd (diff)	10	9.95	2.27	6	0	0	4	0

Full spreadsheet can be seen here.

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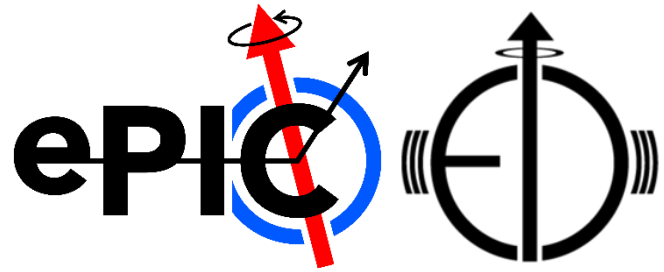
Wire bond trials

No samples have been cleaned for these tests



Bonds were done in small groups (of 10 wires).

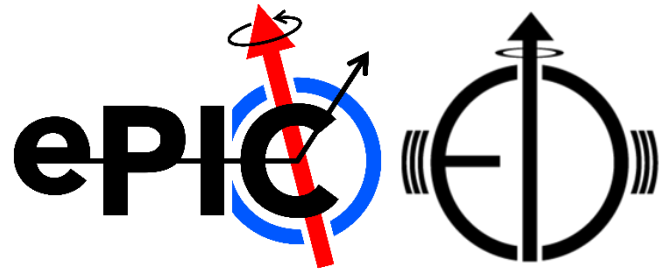
# of successful wires bonded was a good initial indicator.

TF (cN)	Def (%)	BF (cN)	US (%)	S_OT (µm)	D_OT (µm)	LeaveAng (°)	Wire	Direction	Mounting	#/10	Mean (g)	SD (g)	# of S_b(1)	# of D_b(2)	# of Span(3)	# of S_p(4)	# of D_p(5)
18	35	20	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	24	50	25	90	CCC	w. grain	Taped	9	6.99	1.80	0	0	0	5	4
									Vac'd (naked)	3	4.94	0.80	0	0	0	3	0
									Vac'd (diff)	4	5.48	0.98	0	0	0	4	0
14	50	16	24	50	25	90	CCC	w. grain	Taped	8	4.74	1.18	0	0	0	8	0
									Vac'd (naked)	3	6.44	0.86	0	0	0	3	0
									Vac'd (diff)	9	6.00	1.91	0	0	0	9	0
14	50	16	24	25	25	90	CCC	w. grain	Taped	9	13.30	1.38	0	0	0	6	3
									Vac'd (naked)	9	14.37	1.68	0	0	0	6	3
									Vac'd (diff)	10	13.12	1.76	0	0	0	3	7
14	50	16	24	25	25	45	Heraeus	w. grain	Taped	8	11.21	1.75	1	2	3	0	2
									Vac'd (naked)	9	13.22	1.37	2	2	3	0	2
									Vac'd (diff)	4	9.61	0.32	0	0	0	4	0
14	50	16	24	25	25	90	Heraeus	w. grain	Taped	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	7	13.45	0.87	3	0	2	2	0
									Vac'd (diff)	8	11.44	2.18	4	1	1	2	0
14	50	16	24	25	25	45	CCC	w. grain	Taped	10	9.65	1.37	9	0	0	0	1
									Vac'd (naked)	10	11.93	0.72	8	0	0	1	1
									Vac'd (diff)	9	10.70	1.82	8	0	1	0	0
14	50	16	24	15	15	45	CCC	w. grain	Taped	10	10.73	2.18	2	1	1	0	6
									Vac'd (naked)	10	11.57	1.74	9	1	0	0	0
									Vac'd (diff)	10	10.02	2.41	10	0	0	0	0
14	50	16	24	13	13	45	CCC	w. grain	Taped	10							
									Vac'd (naked)	9	10.40	1.88	8	1	0	0	0
									Vac'd (diff)	10	9.95	2.27	6	0	0	4	0

Full spreadsheet can be seen here.

Wire bond trials

No samples have been cleaned for these tests



Reducing the (source) overtravel had a large effect!

TF (cN)	Def (%)	BF (cN)	US (%)	S_OT (µm)	D_OT (µm)	LeaveAng (°)	Wire	Direction	Mounting	#/10	Mean (g)	SD (g)	# of S_b(1)	# of D_b(2)	# of Span(3)	# of S_p(4)	# of D_p(5)
18	35	20	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	24	50	25	90	CCC	w. grain	Taped	9	6.99	1.80	0	0	0	5	4
									Vac'd (naked)	3	4.94	0.80	0	0	0	3	0
									Vac'd (diff)	4	5.48	0.98	0	0	0	4	0
14	50	16	24	50	25	90	CCC	w. grain	Taped	8	4.74	1.18	0	0	0	8	0
									Vac'd (naked)	3	6.44	0.86	0	0	0	3	0
									Vac'd (diff)	9	6.00	1.91	0	0	0	9	0
14	50	16	24	25	25	90	CCC	w. grain	Taped	9	13.30	1.38	0	0	0	6	3
									Vac'd (naked)	9	14.37	1.68	0	0	0	6	3
									Vac'd (diff)	10	13.12	1.76	0	0	0	3	7
14	50	16	24	25	25	45	Heraeus	w. grain	Taped	8	11.21	1.75	1	2	3	0	2
									Vac'd (naked)	9	13.22	1.37	2	2	3	0	2
									Vac'd (diff)	4	9.61	0.32	0	0	0	4	0
14	50	16	24	25	25	90	Heraeus	w. grain	Taped	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	7	13.45	0.87	3	0	2	2	0
									Vac'd (diff)	8	11.44	2.18	4	1	1	2	0
14	50	16	24	25	25	45	CCC	w. grain	Taped	10	9.65	1.37	9	0	0	0	1
									Vac'd (naked)	10	11.93	0.72	8	0	0	1	1
									Vac'd (diff)	9	10.70	1.82	8	0	1	0	0
14	50	16	24	15	15	45	CCC	w. grain	Taped	10	10.73	2.18	2	1	1	0	6
									Vac'd (naked)	10	11.57	1.74	9	1	0	0	0
									Vac'd (diff)	10	10.02	2.41	10	0	0	0	0
14	50	16	24	13	13	45	CCC	w. grain	Taped	10							
									Vac'd (naked)	9	10.40	1.88	8	1	0	0	0
									Vac'd (diff)	10	9.95	2.27	6	0	0	4	0

Full spreadsheet can be seen here.

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Wire bond trials

No samples have been cleaned for these tests

Turning overtravel down as far as the bon machine would allow (without bond errors), seemed to the way to go.

TF (cN)	Def (%)	BF (cN)	US (%)	S_OT (µm)	D_OT (µm)	LeaveAng (°)	Wire	Direction	Mounting	#/10	Mean (g)	SD (g)	# of S_b(1)	# of D_b(2)	# of Span(3)	# of S_p(4)	# of D_p(5)
18	35	20	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	24	50	25	90	CCC	w. grain	Taped	9	6.99	1.80	0	0	0	5	4
									Vac'd (naked)	3	4.94	0.80	0	0	0	3	0
									Vac'd (diff)	4	5.48	0.98	0	0	0	4	0
14	50	16	24	50	25	90	CCC	w. grain	Taped	8	4.74	1.18	0	0	0	8	0
									Vac'd (naked)	3	6.44	0.86	0	0	0	3	0
									Vac'd (diff)	9	6.00	1.91	0	0	0	9	0
14	50	16	24	25	25	90	CCC	w. grain	Taped	9	13.30	1.38	0	0	0	6	3
									Vac'd (naked)	9	14.37	1.68	0	0	0	6	3
									Vac'd (diff)	10	13.12	1.76	0	0	0	3	7
14	50	16	24	25	25	45	Heraeus	w. grain	Taped	8	11.21	1.75	1	2	3	0	2
									Vac'd (naked)	9	13.22	1.37	2	2	3	0	2
									Vac'd (diff)	4	9.61	0.32	0	0	0	4	0
14	50	16	24	25	25	90	Heraeus	w. grain	Taped	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	7	13.45	0.87	3	0	2	2	0
									Vac'd (diff)	8	11.44	2.18	4	1	1	2	0
14	50	16	24	25	25	45	CCC	w. grain	Taped	10	9.65	1.37	9	0	0	0	1
									Vac'd (naked)	10	11.93	0.72	8	0	0	1	1
									Vac'd (diff)	9	10.70	1.82	8	0	1	0	0
14	50	16	24	15	15	45	CCC	w. grain	Taped	10	10.73	2.18	2	1	1	0	6
									Vac'd (naked)	10	11.57	1.74	9	1	0	0	0
									Vac'd (diff)	10	10.02	2.41	10	0	0	0	0
14	50	16	24	13	13	45	CCC	w. grain	Taped	10							
									Vac'd (naked)	9	10.40	1.88	8	1	0	0	0
									Vac'd (diff)	10	9.95	2.27	6	0	0	4	0

Full spreadsheet can be seen here.

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Wire bond trials

Some trials performed on a different bond machine, with different wire for comparison.

TF (cN)	Def (%)	BF (cN)	US (%)	S_OT (µm)	D_OT (µm)	LeaveAng (°)	Wire	Direction	Mounting	#/10	Mean (g)	SD (g)	# of S_b(1)	# of D_b(2)	# of Span(3)	# of S_p(4)	# of D_p(5)
18	35	20	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	20	50	25	90	CCC	w. grain	Taped	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (diff)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	50	18	24	50	25	90	CCC	w. grain	Taped	9	6.99	1.80	0	0	0	5	4
									Vac'd (naked)	3	4.94	0.80	0	0	0	3	0
									Vac'd (diff)	4	5.48	0.98	0	0	0	4	0
14	50	16	24	50	25	90	CCC	w. grain	Taped	8	4.74	1.18	0	0	0	8	0
									Vac'd (naked)	3	6.44	0.86	0	0	0	3	0
									Vac'd (diff)	9	6.00	1.91	0	0	0	9	0
14	50	16	24	25	25	90	CCC	w. grain	Taped	9	13.30	1.38	0	0	0	6	3
									Vac'd (naked)	9	14.37	1.68	0	0	0	6	3
									Vac'd (diff)	10	13.12	1.76	0	0	0	3	7
14	50	16	24	25	25	45	Heraeus	w. grain	Taped	8	11.21	1.75	1	2	3	0	2
									Vac'd (naked)	9	13.22	1.37	2	2	3	0	2
									Vac'd (diff)	4	9.61	0.32	0	0	0	4	0
14	50	16	24	25	25	90	Heraeus	w. grain	Taped	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
									Vac'd (naked)	7	13.45	0.87	3	0	2	2	0
									Vac'd (diff)	8	11.44	2.18	4	1	1	2	0
14	50	16	24	25	25	45	CCC	w. grain	Taped	10	9.65	1.37	9	0	0	0	1
									Vac'd (naked)	10	11.93	0.72	8	0	0	1	1
									Vac'd (diff)	9	10.70	1.82	8	0	1	0	0
14	50	16	24	15	15	45	CCC	w. grain	Taped	10	10.73	2.18	2	1	1	0	6
									Vac'd (naked)	10	11.57	1.74	9	1	0	0	0
									Vac'd (diff)	10	10.02	2.41	10	0	0	0	0
14	50	16	24	13	13	45	CCC	w. grain	Taped	10							
									Vac'd (naked)	9	10.40	1.88	8	1	0	0	0
									Vac'd (diff)	10	9.95	2.27	6	0	0	4	0

Full spreadsheet can be seen here.

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