UNIVERSITY OF CAMBRIDGE

Update on Investigations at Cambridge

- Recap
- Lines of Enquiry
- Bits and Boards
- Where we are

Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect - Recap

UNIVERSITY OF CAMBRIDGE

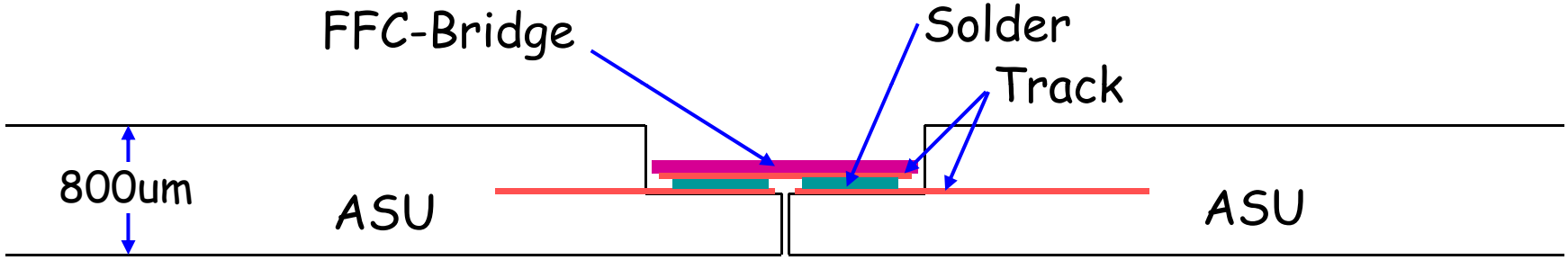
We have been looking at using "Bridges" to jumper multiple connections between adjacent ASUs

The Bridge would be soldered onto pads on the ASU (or DIF) PCB

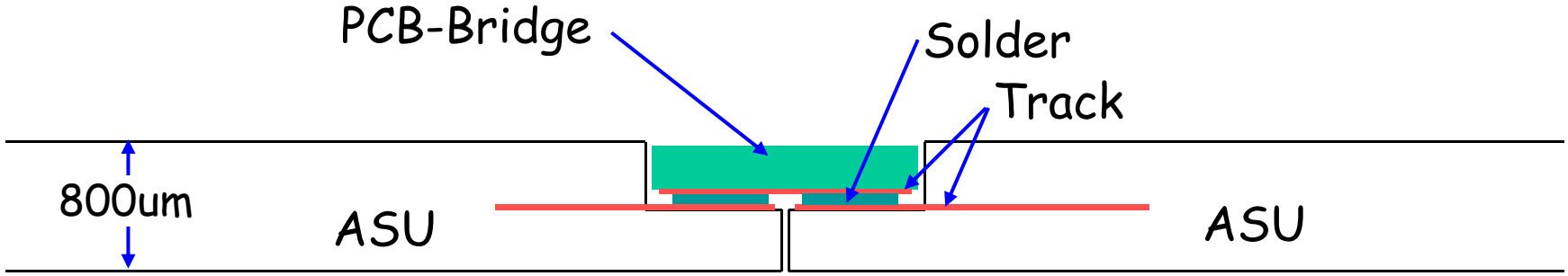
Each Bridge would provide >=30 connections
Up to 4 Bridges fit in the width of an ASU
… 1 per path would be an ideal solution ☺☺

UNIVERSITY OF CAMBRIDGE

Short FFC (Flat,Flexible-Cable) Bridges make connections on a 1mm pitch – OK for at least 120 connections



Alternatively the Bridges can be thin PCBs, also with 1mm pitch connections. This gives a mechanical as well as electrical joint



ECAL SLAB Interconnect - Recap

UNIVERSITY OF CAMBRIDGE

- Provides copious connections (4 x 30 across ASU)
  - plenty for Power Planes
  - would allow 4 or more rows of connections
- Solder joints well proven electrically
- Signal transmission likely to be less compromised
- Rework possible

- Using an FFC-Bridge would make the mechanical joint independent: this might appeal to the mechanical designers

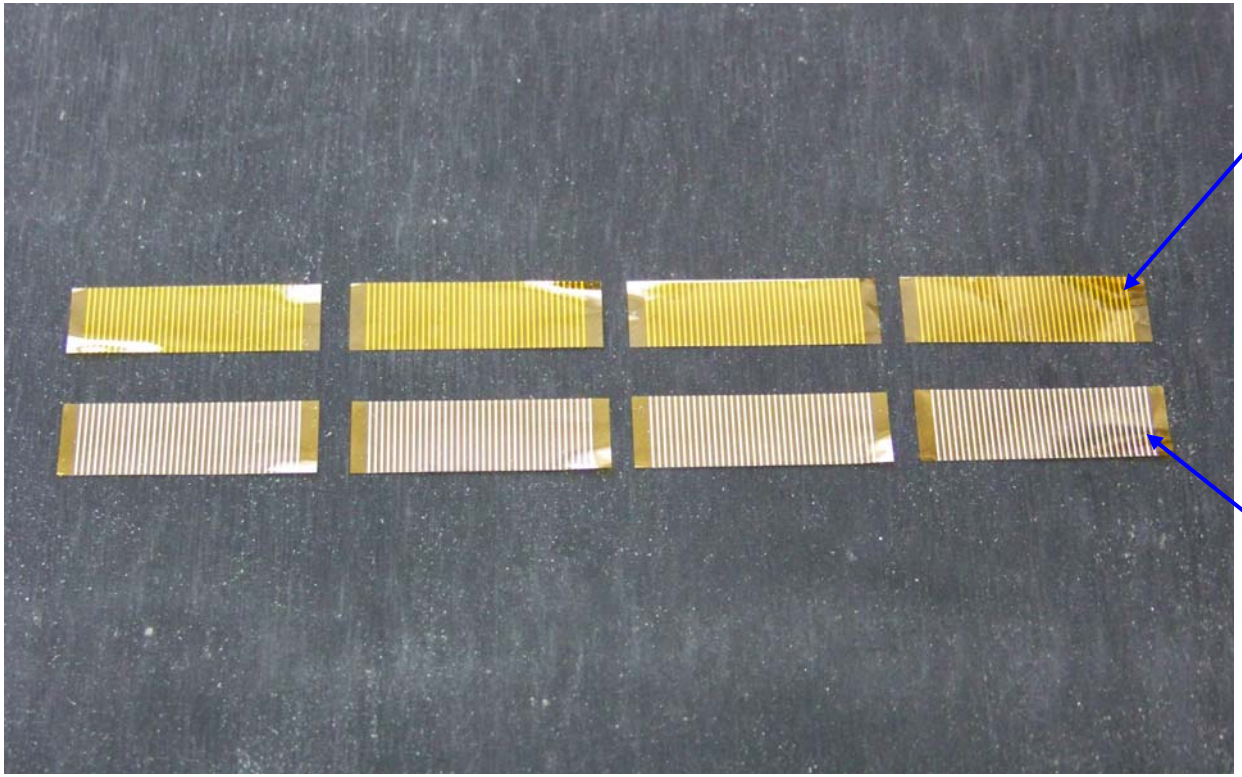
- Using a PCB-Bridge combines mechanical and electrical joint

UNIVERSITY OF CAMBRIDGE

- How to solder the joints
  - IR using linear Quartz-Halogen lamp
  - Laser Soldering
- Signal Integrity
  - Signal delivery along LVDS lines
  - Crosstalk
- Effect on Detector Glue Connections
  - Does soldering cause joint deterioration?
  - If not, what about rework?

ECAL SLAB Interconnect - Bits

UNIVERSITY OF CAMBRIDGE



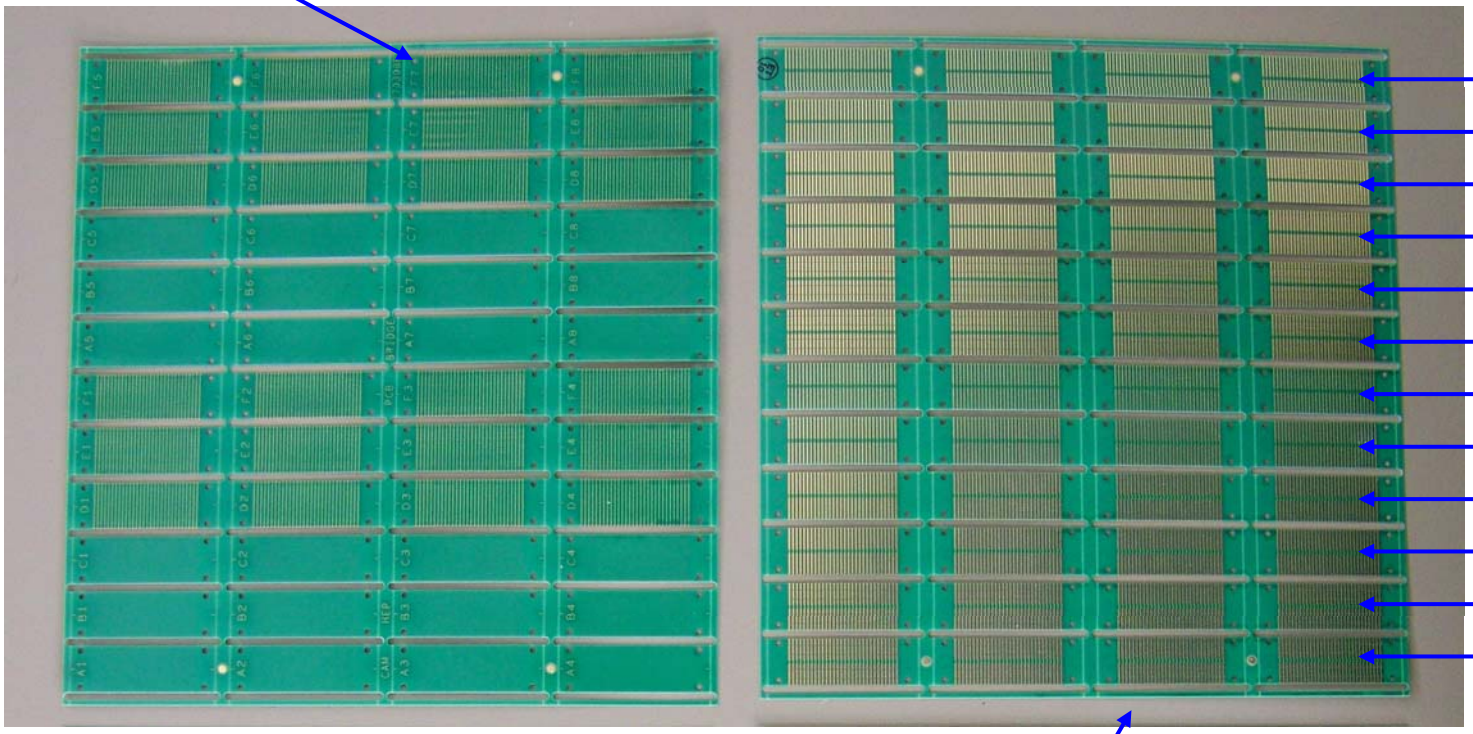
FFC-Bridges: we have 250 cut, 250 on roll

We now cut them in half: only ~6 mm long

ECAL SLAB Interconnect - Bits

UNIVERSITY OF CAMBRIDGE

Top View



0.4 mm FR4, Au Plated

Under View

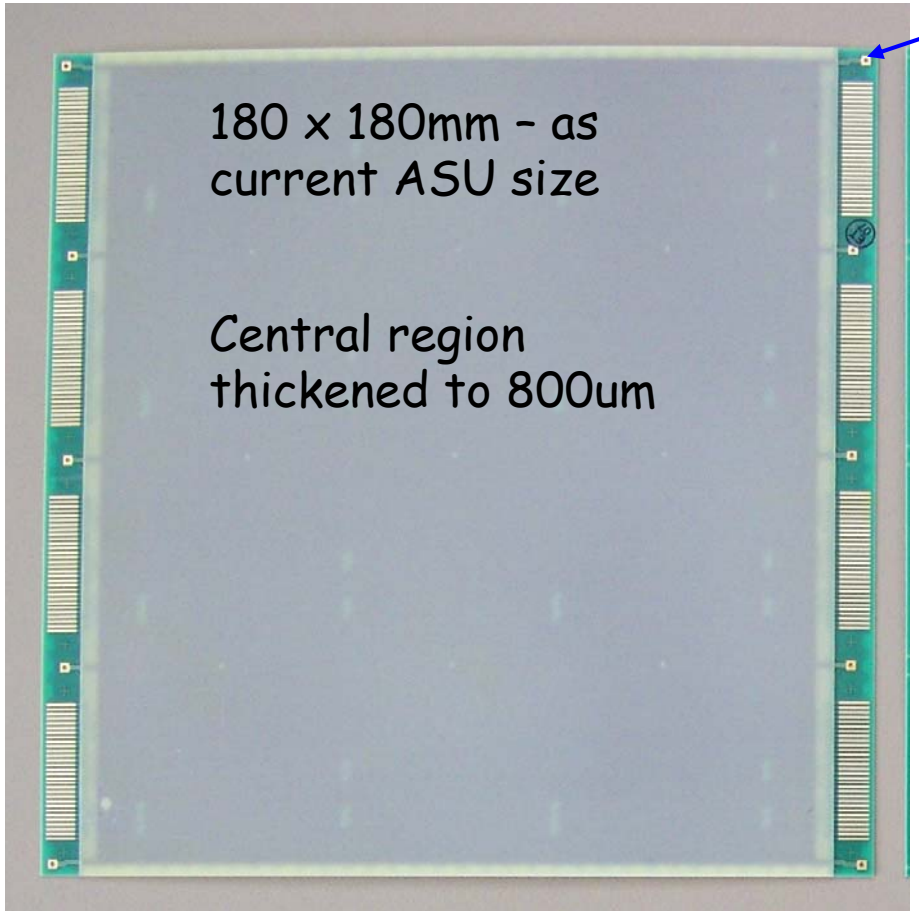
PCB-Bridges: have 15 Panels of 8 lots of 6 variants

We cut these in half too: only ~6 mm long

ECAL SLAB Interconnect - PCBs

UNIVERSITY OF CAMBRIDGE

Top View



Interconnect region 400um

4 identical rows of differential tracks connecting 36 way

interconnect pads on left and right

Can be sliced into 4 sections, so provides for many trials

Differential tracks have a range of spacings & other charcteristics to test signal propagation and cross-talk

ASU-Test_2 PCB: we have 15

ECAL SLAB Interconnect - PCBs

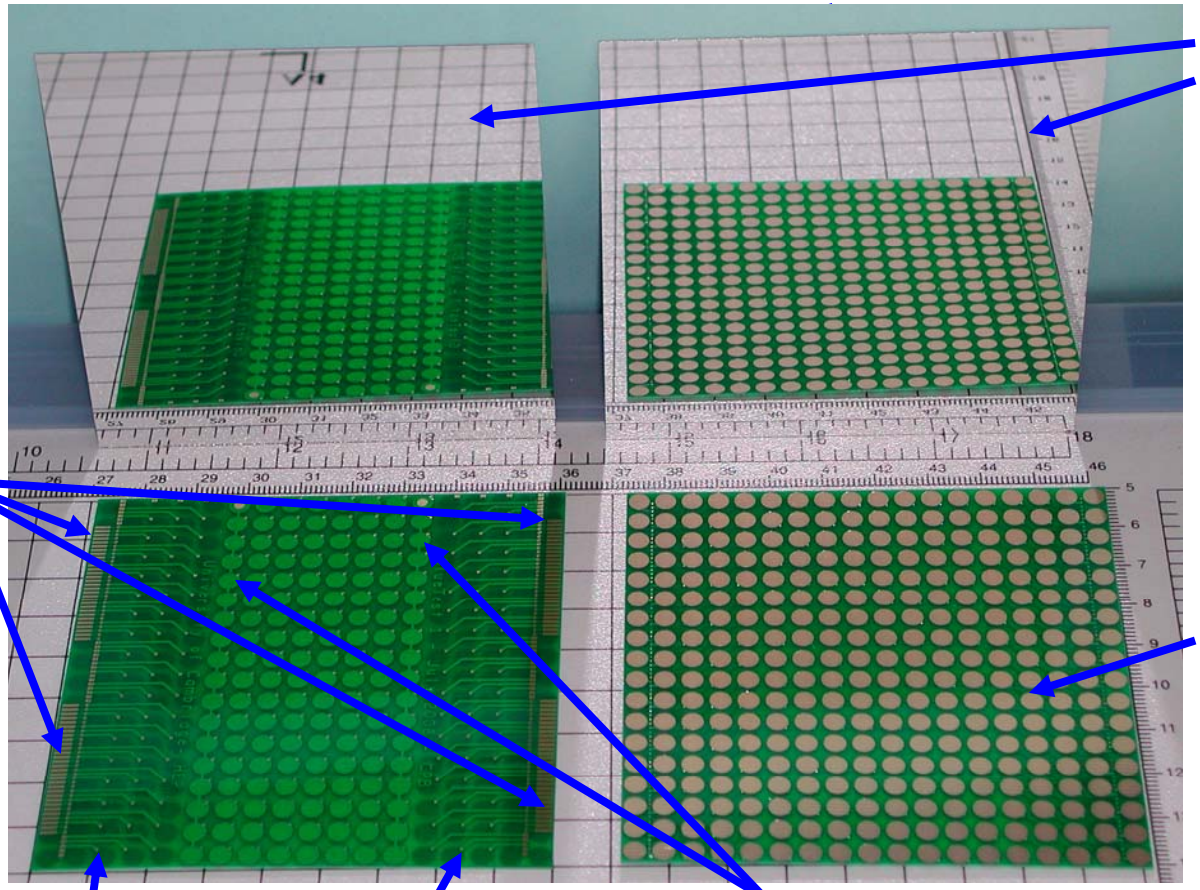
UNIVERSITY OF CAMBRIDGE

Top View

Under View

Aluminised 300um Glass plates: we have 9 (plus more un-coated)

30-way Interconnect Footprints (4 per PCB)



Pads on 5mm pitch

5 rows joined to fingers/pads

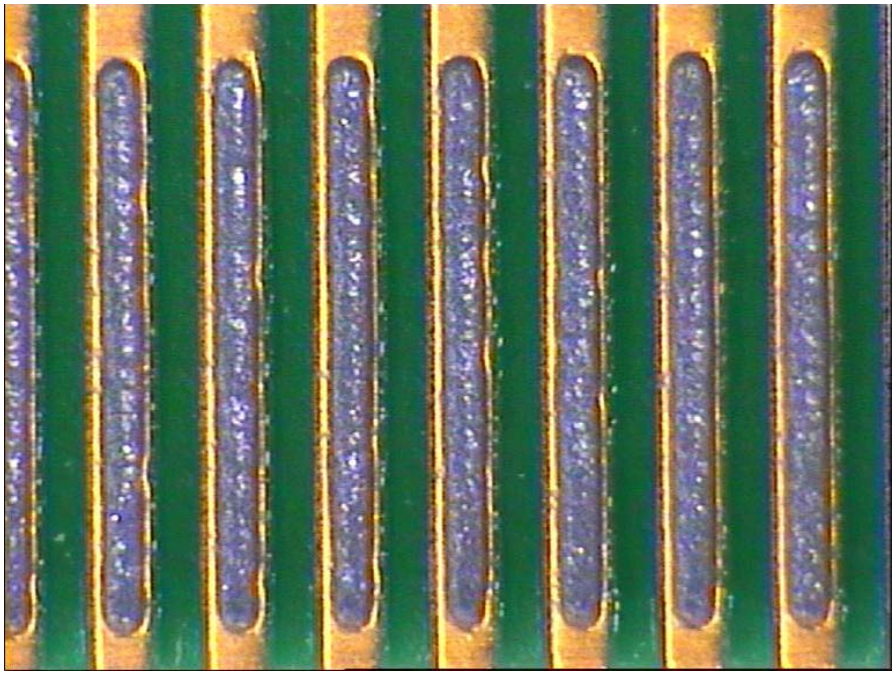
These 2 rows "commoned"

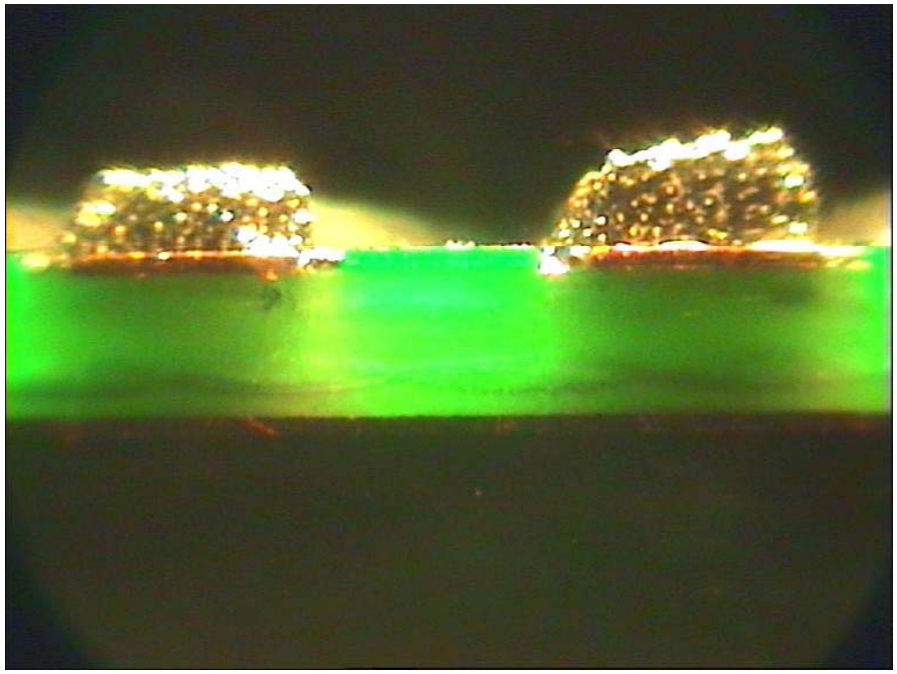
GlueTest PCB: we have 28

Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Soldering

UNIVERSITY OF CAMBRIDGE



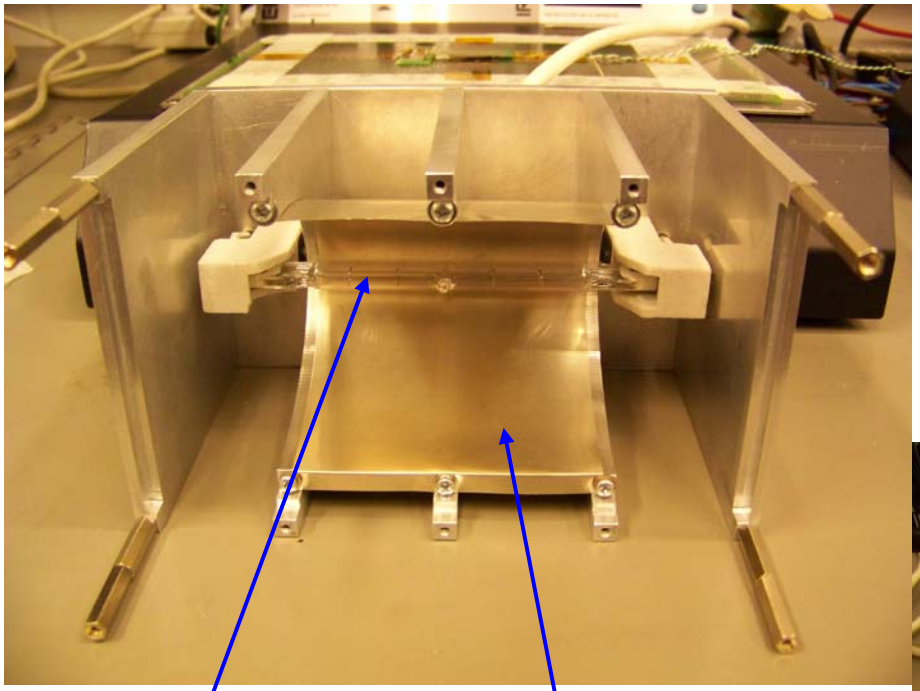


PCB-Bridges: solder pasting

Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Soldering

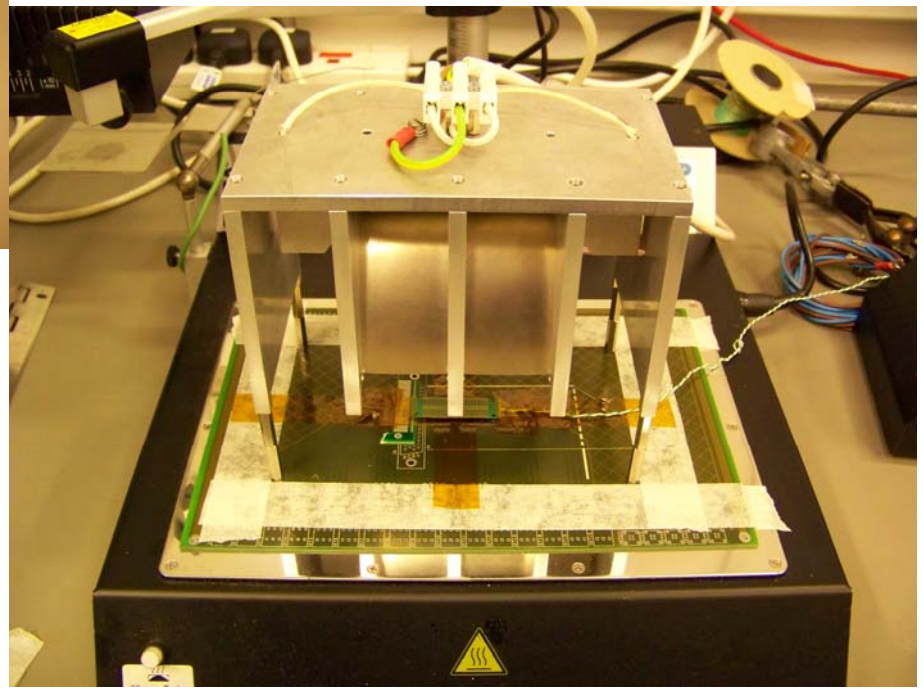
UNIVERSITY OF CAMBRIDGE



Linear Halogen Lamp

Elliptical Reflector

Re-flowing a PCB-Bridge



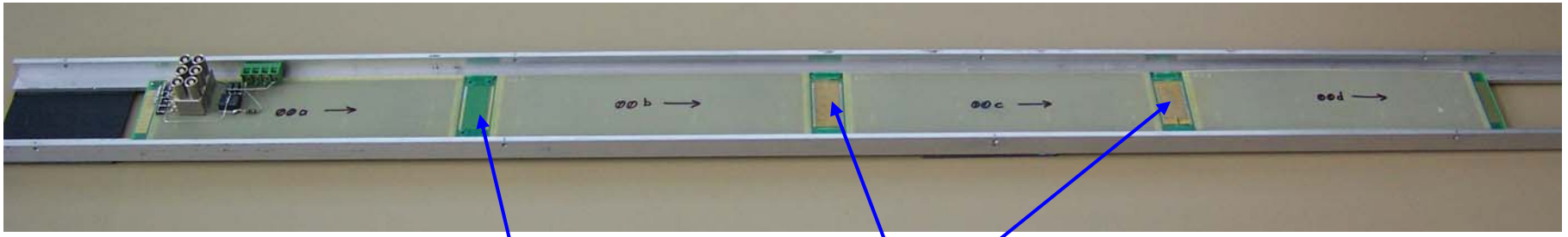
Imaging Halogen IR Source

Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Soldering

UNIVERSITY OF CAMBRIDGE

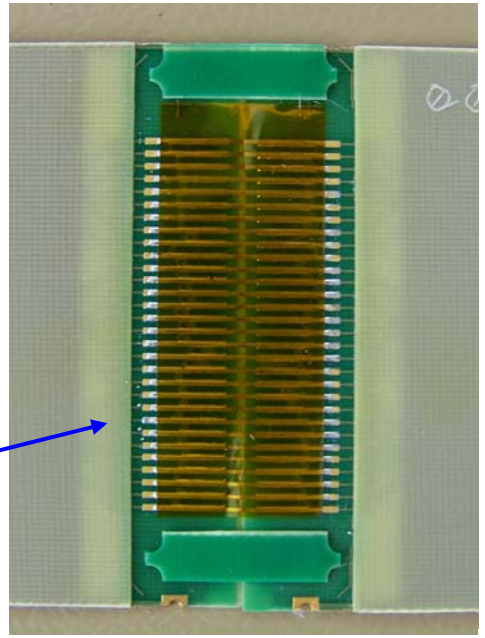
4 Section ASU-Test Assembly



PCB-Bridge joint

FFC-Bridge joints

View of FFC-Bridge joint



ASU-Test_2: 4 Section Assembly

Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Soldering

UNIVERSITY OF CAMBRIDGE

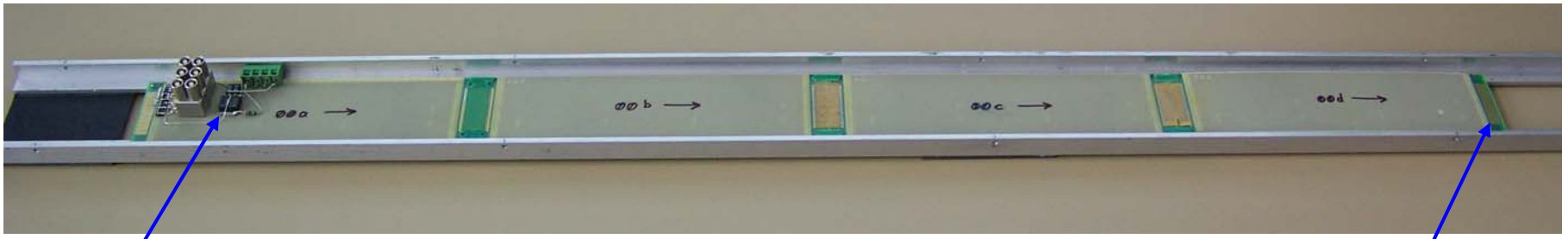
ASU-Test_2: 10 Section Assembly in Progress

Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Crosstalk

UNIVERSITY OF CAMBRIDGE

Using the 4 Section ASU-Test_2 Assembly



LVDS Drive Circuit:
Back Term'n = 100R

Track Series Res ~ 8R

End Term'n = 82R

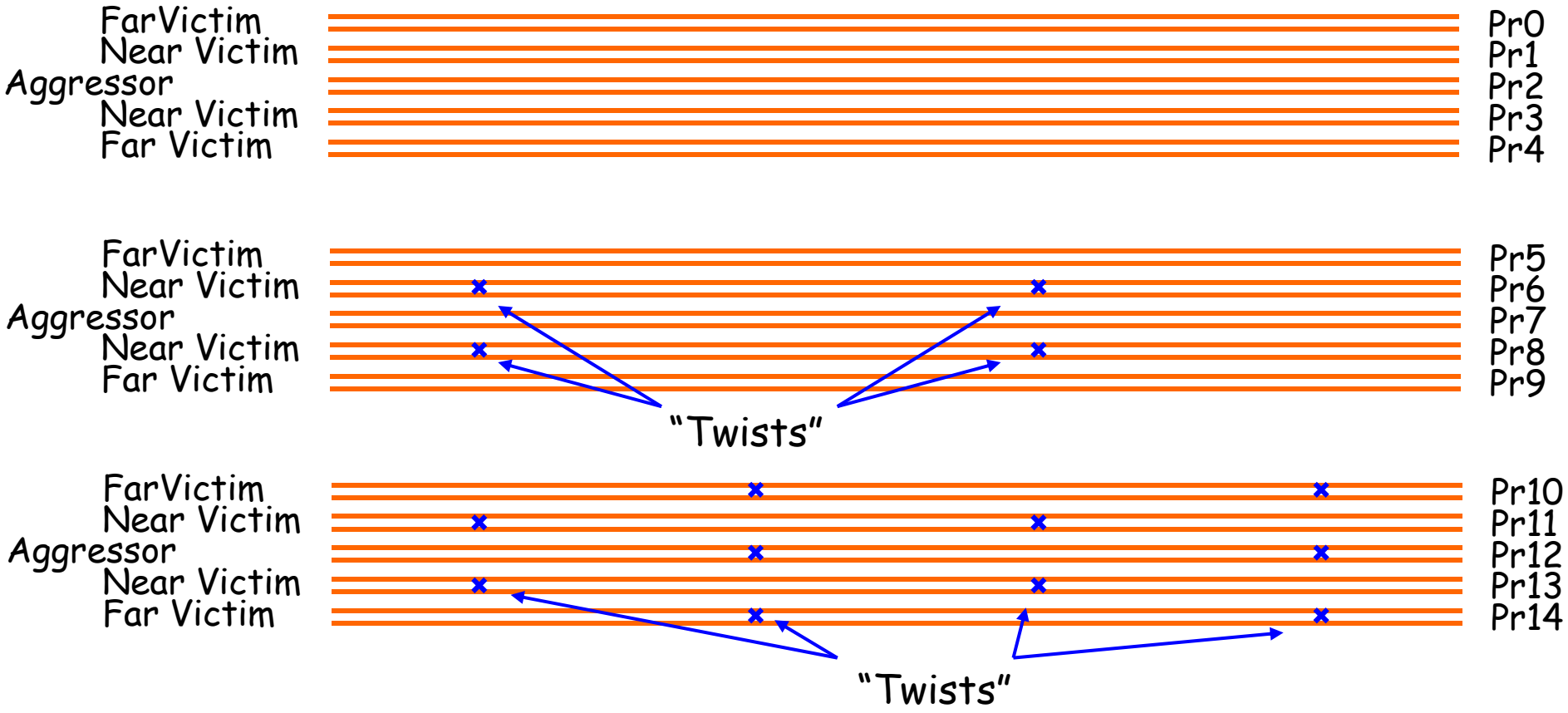
Length = 4x180mm = 720mm

Crosstalk Setup

Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Crosstalk

UNIVERSITY OF CAMBRIDGE



ASU-Test_2: Traces

Maurice Goodrick & Bart Hommels , University of Cambridge

UNIVERSITY OF CAMBRIDGE

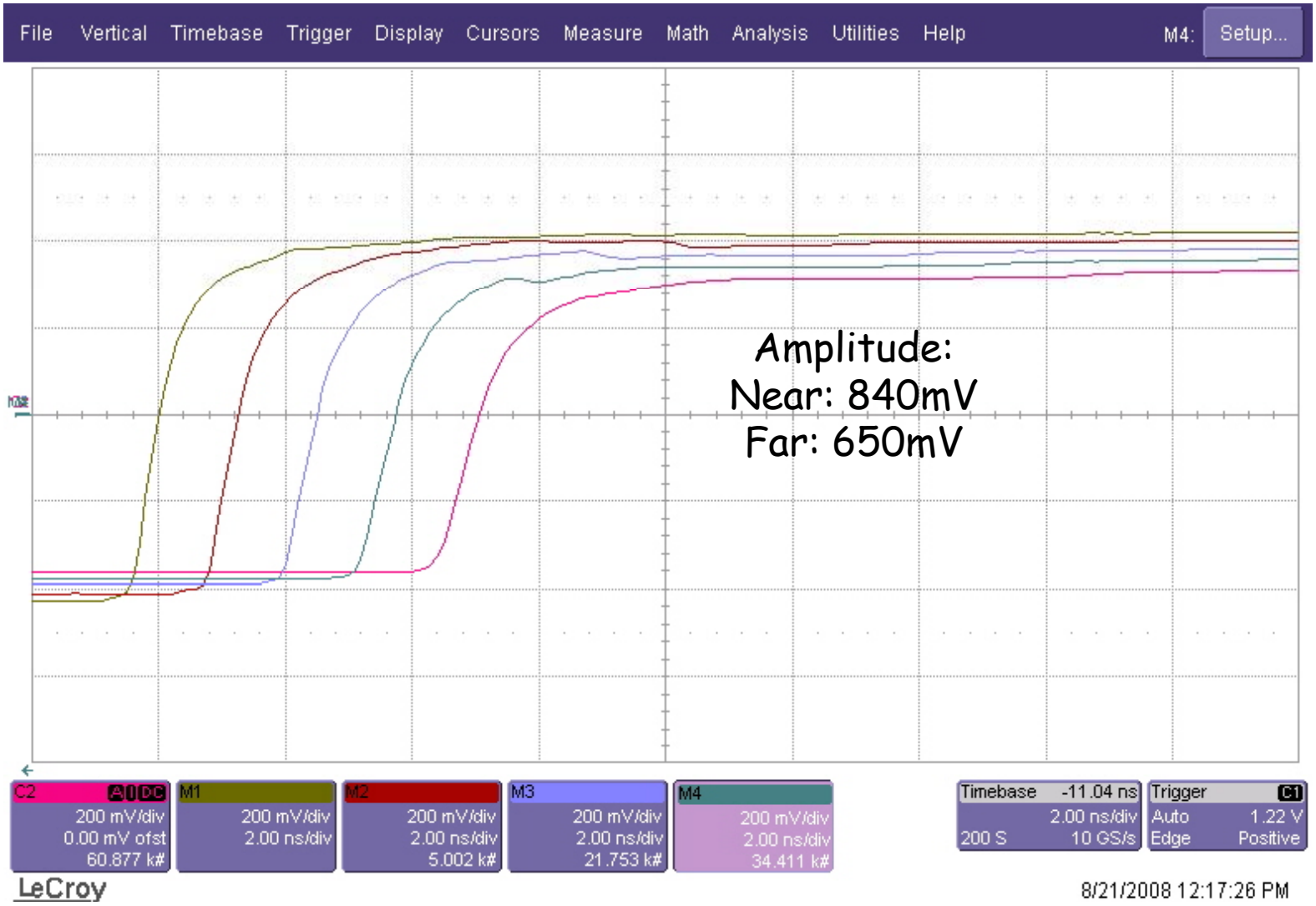
Group	Pair Separation/ (Track & Gap)
A	1
B	1.5
C	2
D	3

ASU-Test_2: Traces

Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Crosstalk

UNIVERSITY OF CAMBRIDGE

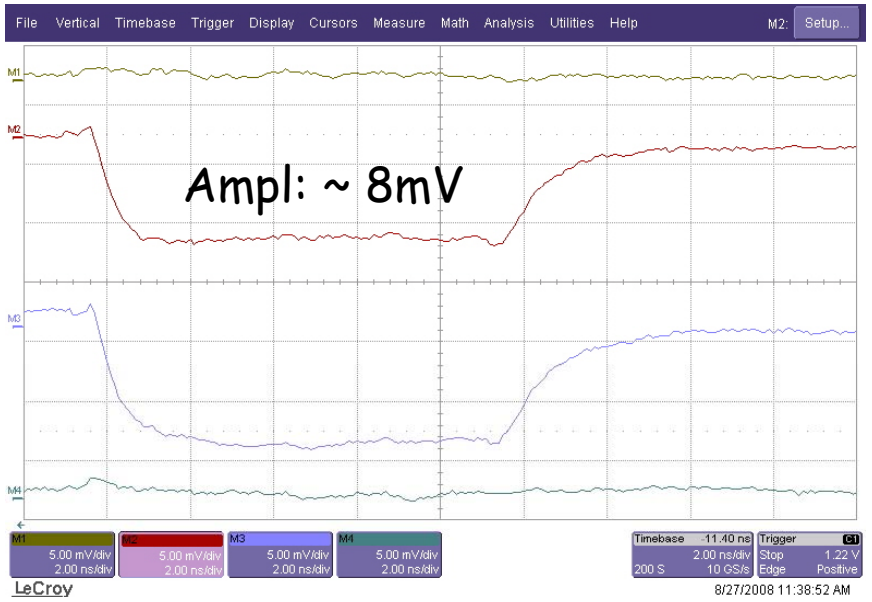


ASU-Test_2: Aggressor Signal Propagation (Pr2, Group A)

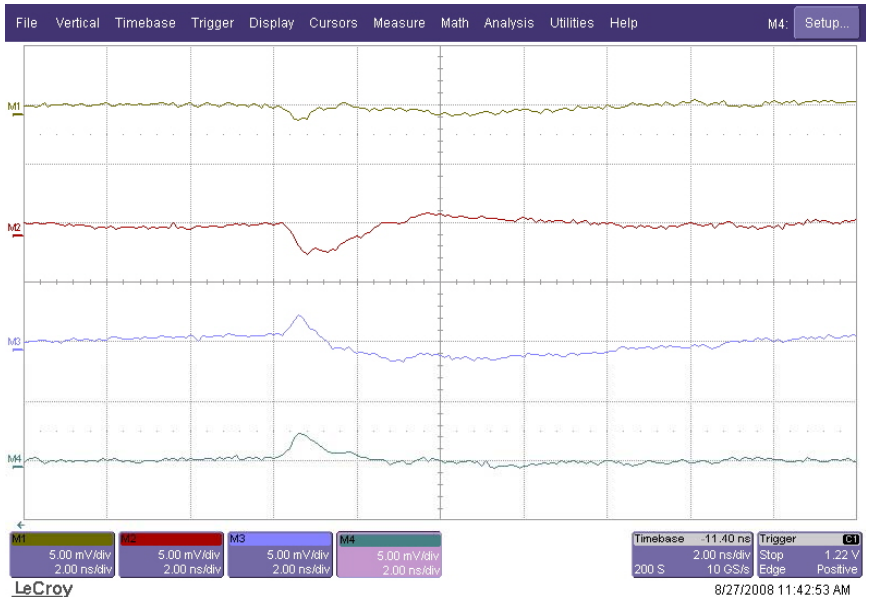
Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Crosstalk

UNIVERSITY OF CAMBRIDGE



Driver End



Far End

ASU-Test_2: Victim Crosstalk (Prs 0,1,3,4, Group A)

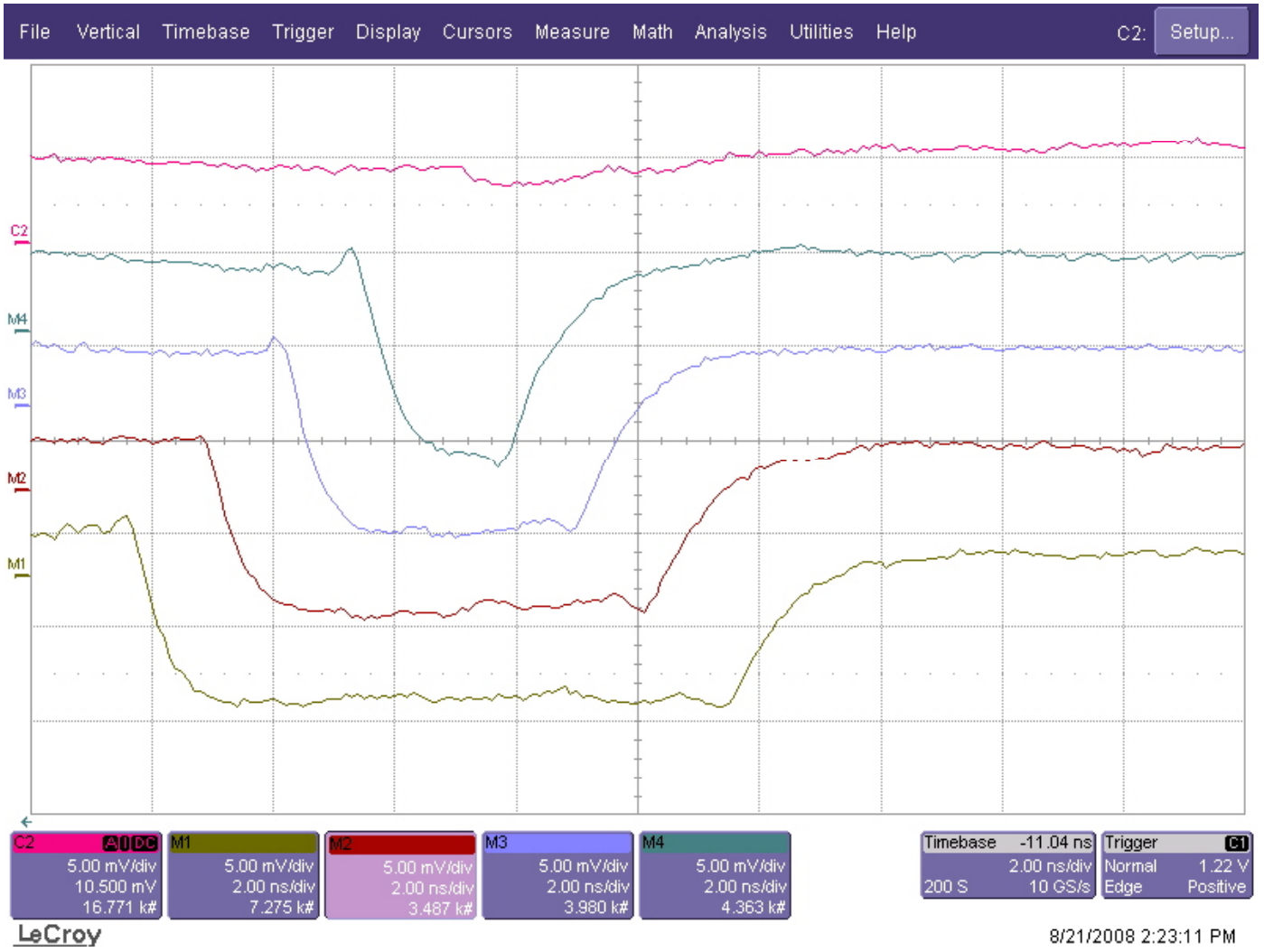
Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Crosstalk

UNIVERSITY OF CAMBRIDGE

Far End

Near End

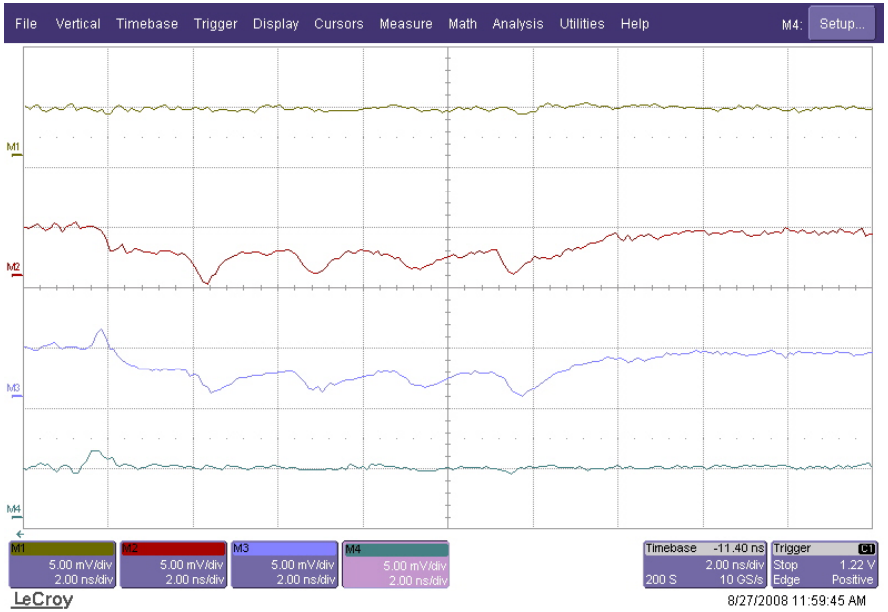


ASU-Test_2: Victim Crosstalk Along Slab (Pr 1, Group A)

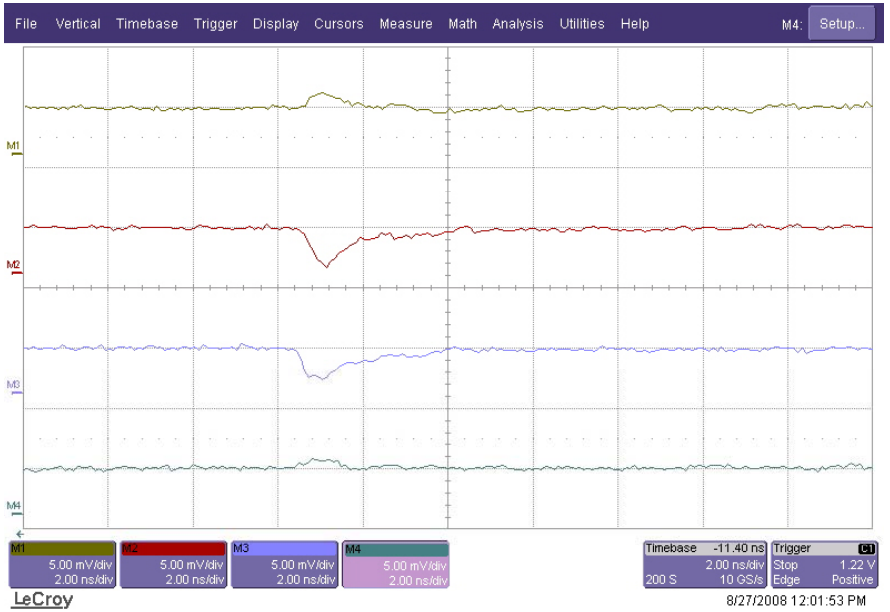
Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Crosstalk

UNIVERSITY OF CAMBRIDGE



Driver End



Far End

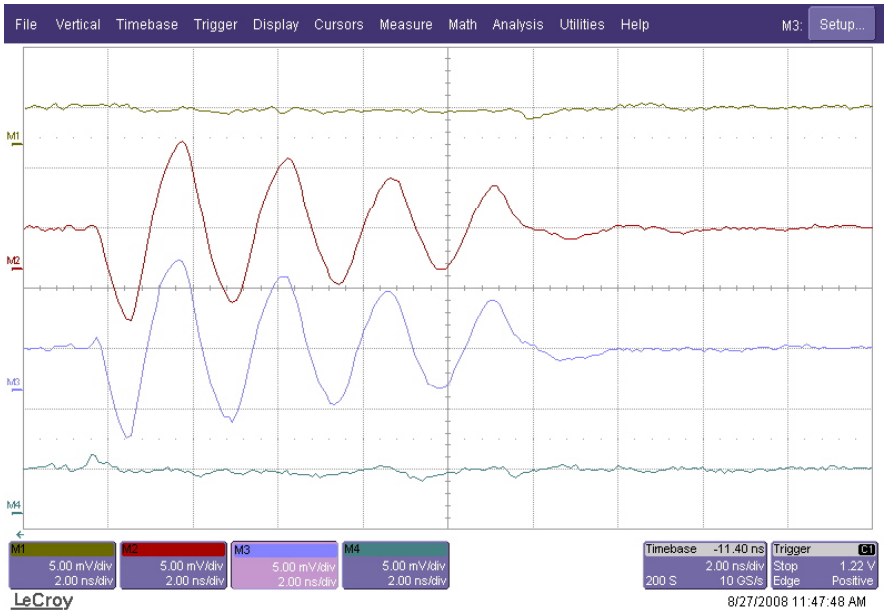
Greater Pair Separation => Far Less Crosstalk

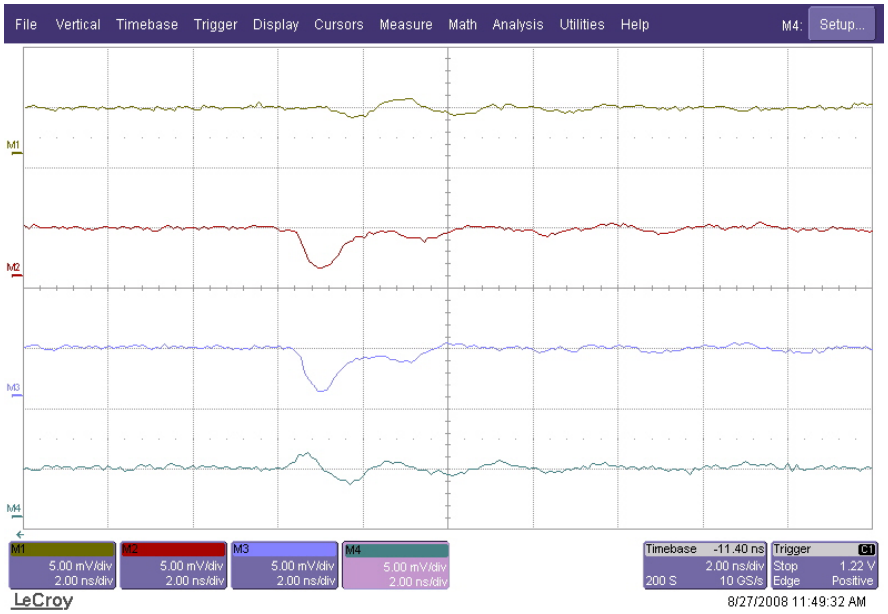
ASU-Test_2: Victim Crosstalk (Prs 0,1,3,4, Group C)

Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Crosstalk

UNIVERSITY OF CAMBRIDGE





Driver End

Far End

"With Twists"

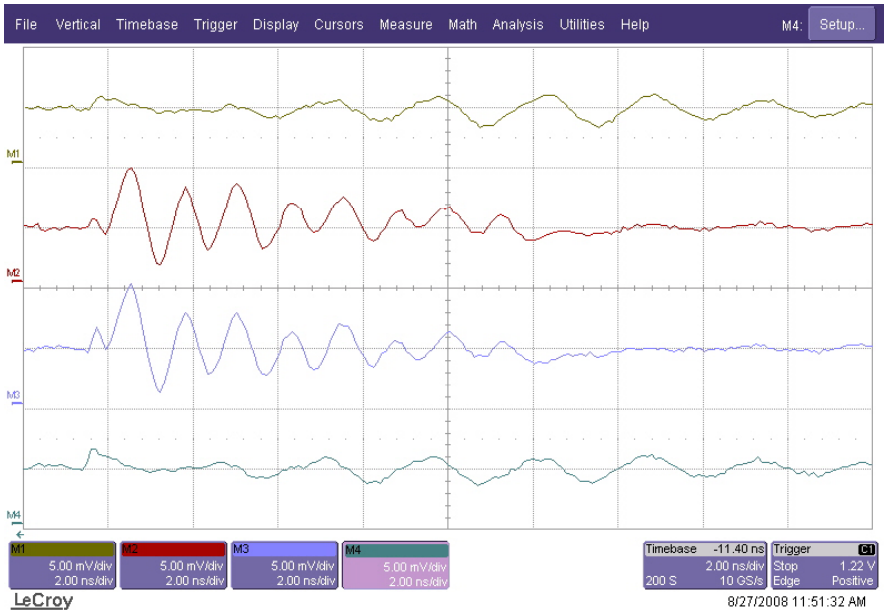
Crosstalk alternates sign

ASU-Test_2: Victim Crosstalk (Prs 5,6,8,9, Group A)

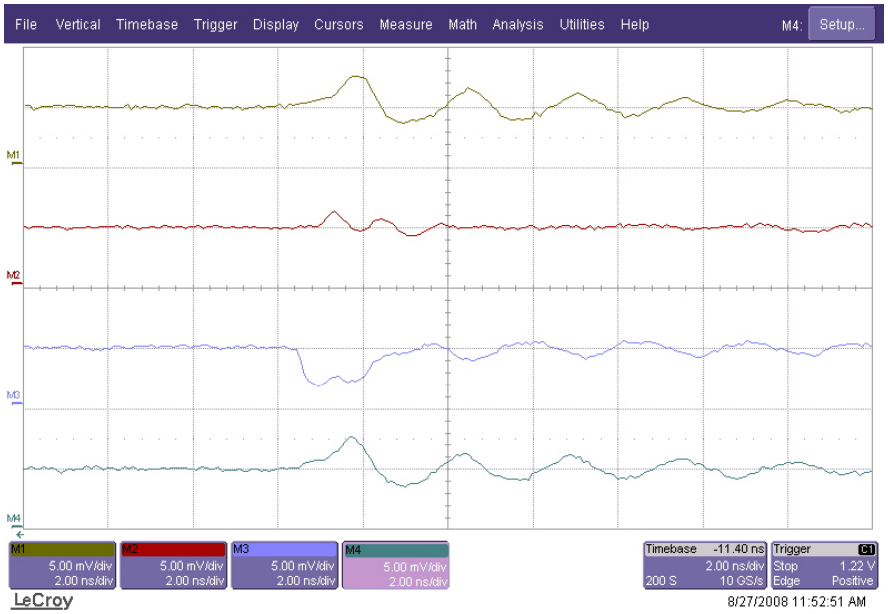
Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Crosstalk

UNIVERSITY OF CAMBRIDGE



Driver End



Far End

"With Extra Twists"

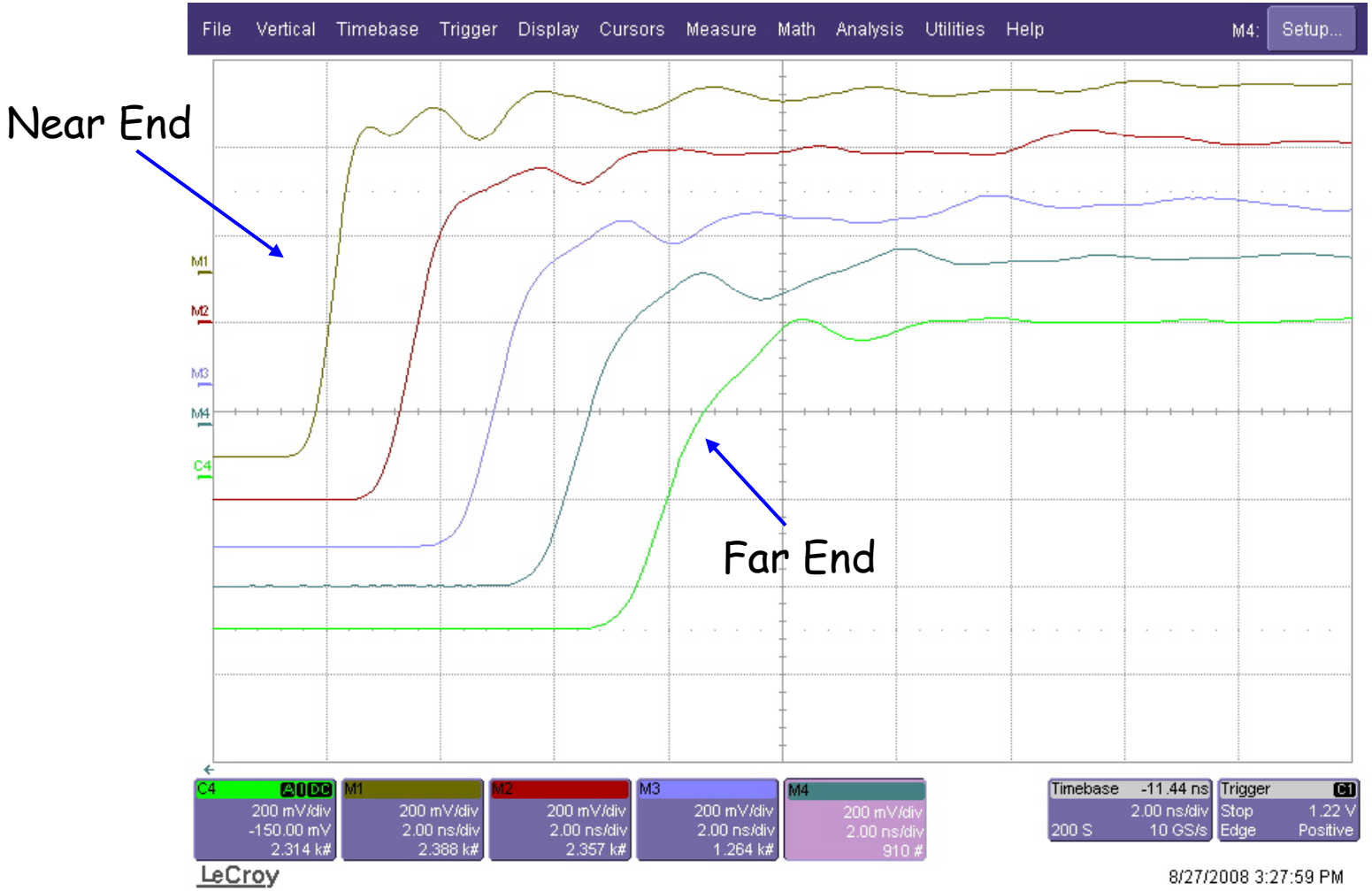
Crosstalk alternates sign twice as fast

ASU-Test_2: Victim Crosstalk (Prs 10,11,13,14, Group A)

Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Crosstalk

UNIVERSITY OF CAMBRIDGE



ASU-Test_2: Propagation with Added 10pFs at ASU Joints (Pr 2, Group C)

Maurice Goodrick & Bart Hommels , University of Cambridge

UNIVERSITY OF CAMBRIDGE

Conclusions: for the 750mm Assembly

- Signal degradation and crosstalk look relatively small, even with closely spaced pairs (~10mV)
- Pair separation of 2 x Track & Gap reduces crosstalk dramatically (confirming folk lore)
- "Twisting" pairs doesn't really help
- Periodic capacitive loads do have a perceptible effect (~100mV) – this will have to be watched

ECAL SLAB Interconnect – GlueTest

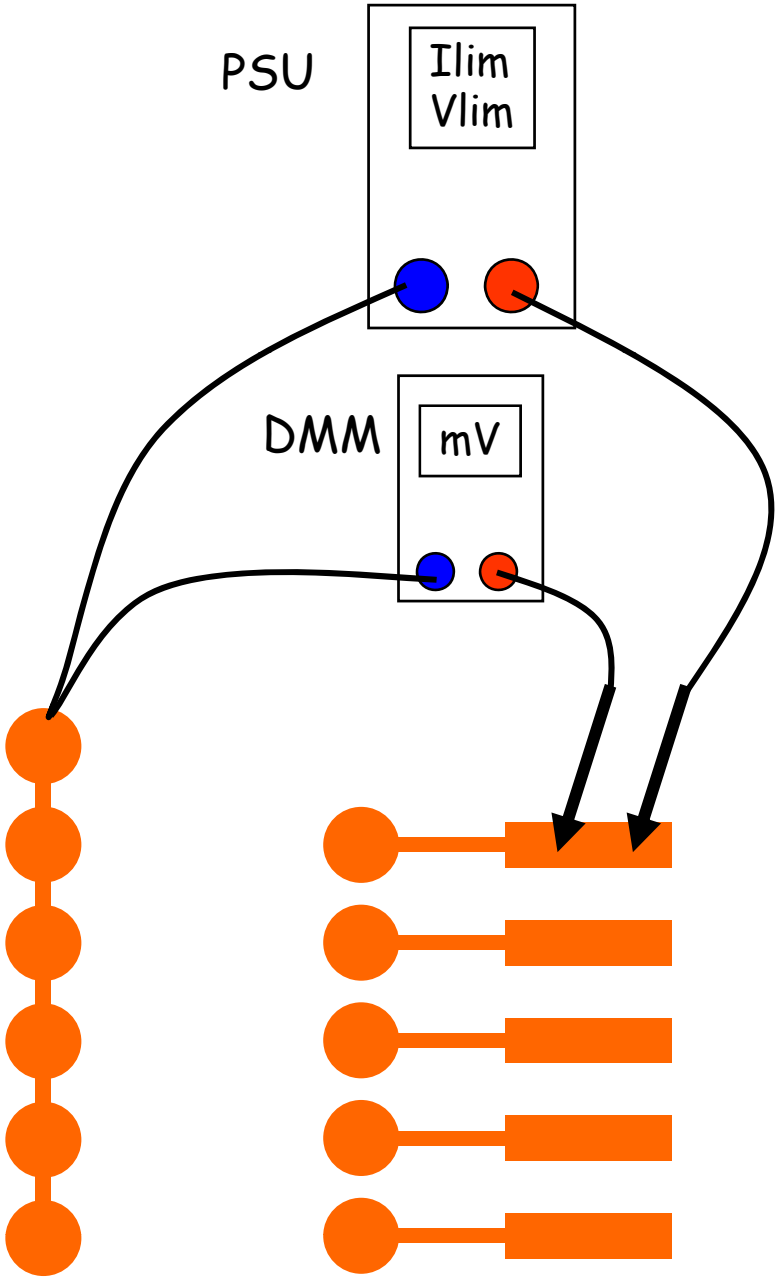
UNIVERSITY OF CAMBRIDGE

- Marc Anduze provided a number of 300um 90x90 glass plates (plus some of 500um)
- We had 9 of them aluminised
- Manchester glued 2 of these to Gluetest PCBs
- We have made initial resistance measurements
- Plan is to subject these to the IR soldering process, and to re-check the resistances

- We find that glue joints are not simple!
- Ray Thompson of Manchester has written a very useful note on this
- We will use both leaded (183 deg) and Sn-Bi solder (150 deg)
- If these temperatures are a problem, it might push us to Laser Soldering

ECAL SLAB Interconnect – GlueTest Initial

UNIVERSITY OF CAMBRIDGE



GlueTest - PCB #1

Connector #1						
I Lim(mA)	50	50	50	50	50	100
V Lim (V)	1	2	3	4	1	1
Finger						
0	9.2	9.2	9.2	9.2	9.1	18
1	9	9	9	9	9	18
2	9.6	9.6	9.6	9.6	9.6	19
3	9.1	9	9	9.1	9	18
4	1000	2000	3000	22	21	43
5	1000	114	66	18	17	35
6	1000	2000	3000	20	20	40
7	1000	2000	3000	23	23	46
8	1000	2000	3000	28	27	56
9	1000	160	18	19	19	38
10	1000	87	18	18	18	37
11	1000	2000	22	24	24	49
12	470	31	15	15	14	30
13	180	31	17	17	16	33
14	1000	2000	33	29	29	58
15	1000	2000	3000	22	22	44
16	1000	31	16	16	16	32
17	1000	2000	3000	18	19	38
18	120	27	28	16	16	33
19	1000	38	18	18	18	36
20	1000	2000	3000	18	18	36
21	1000	2000	3000	20	20	41
22	1000	2000	3000	18	17	35
23	1000	2000	15	15	15	30
24	1000	2000	19	19	19	39
25	215	124	49	40	39	78
26	1000	2000	23	16	16	33
27	1000	2000	34	24	24	49
28	1000	2000	20	21	21	42
29	12	12	12	12	12	24

Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Laser Soldering

UNIVERSITY OF CAMBRIDGE

James Gilbert
University of Hull
Hull, UK

Maurice Goodrick & Bart Hommels , University of Cambridge

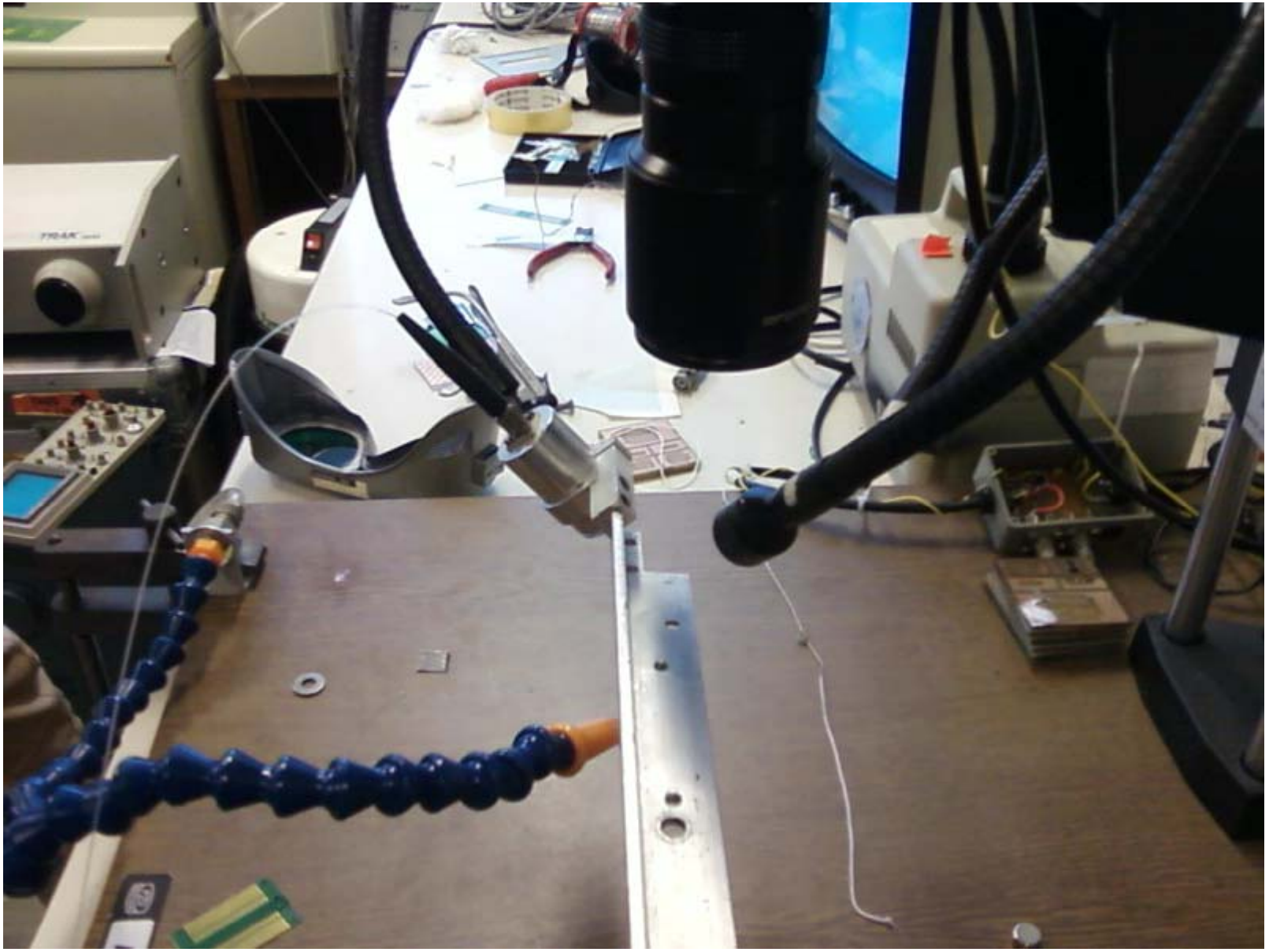
ECAL SLAB Interconnect – Laser Soldering

UNIVERSITY OF CAMBRIDGE

Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Laser Soldering

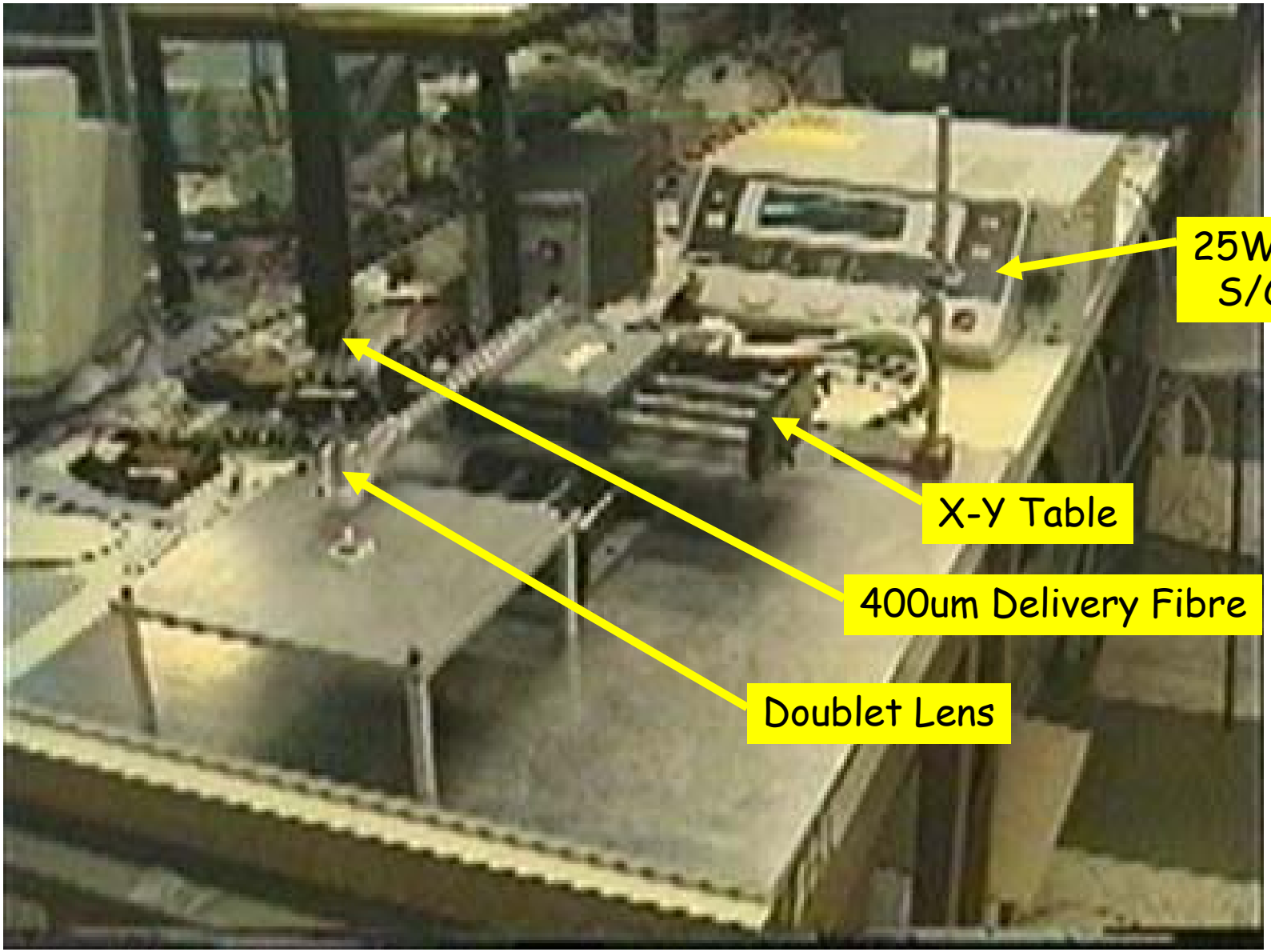
UNIVERSITY OF CAMBRIDGE



Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Laser Soldering

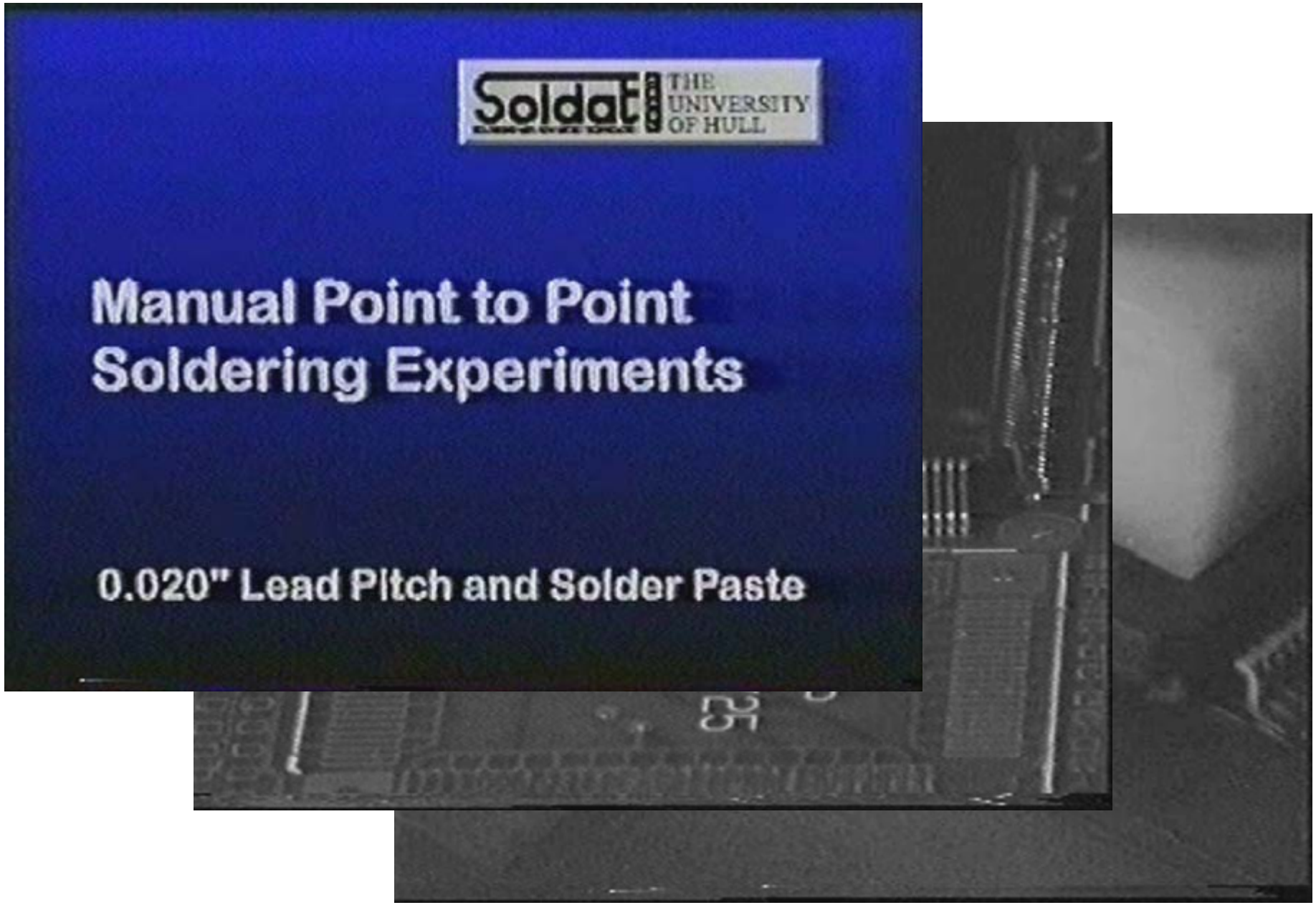
UNIVERSITY OF CAMBRIDGE



Maurice Goodrick & Bart Hommels , University of Cambridge

ECAL SLAB Interconnect – Laser Soldering

UNIVERSITY OF CAMBRIDGE



Maurice Goodrick & Bart Hommels , University of Cambridge

UNIVERSITY OF CAMBRIDGE

Laser Soldering: Conclusions

- Promises low damage
- ~ 600 Euro/W: might need 10 – 25 W, so > 6000 Euro for laser
- Possibly going to be a bit slow
- Hull willing to do initial trials F.O.C.