

Detector module: update

20250626

M.Borri et al



Science and
Technology
Facilities Council

Outline

- Pre-TDR activity, detector module: emerging requirements.
- Low-readiness development increment: tooling update.
- Overview of future development increments.

Emerging requirements

Overview

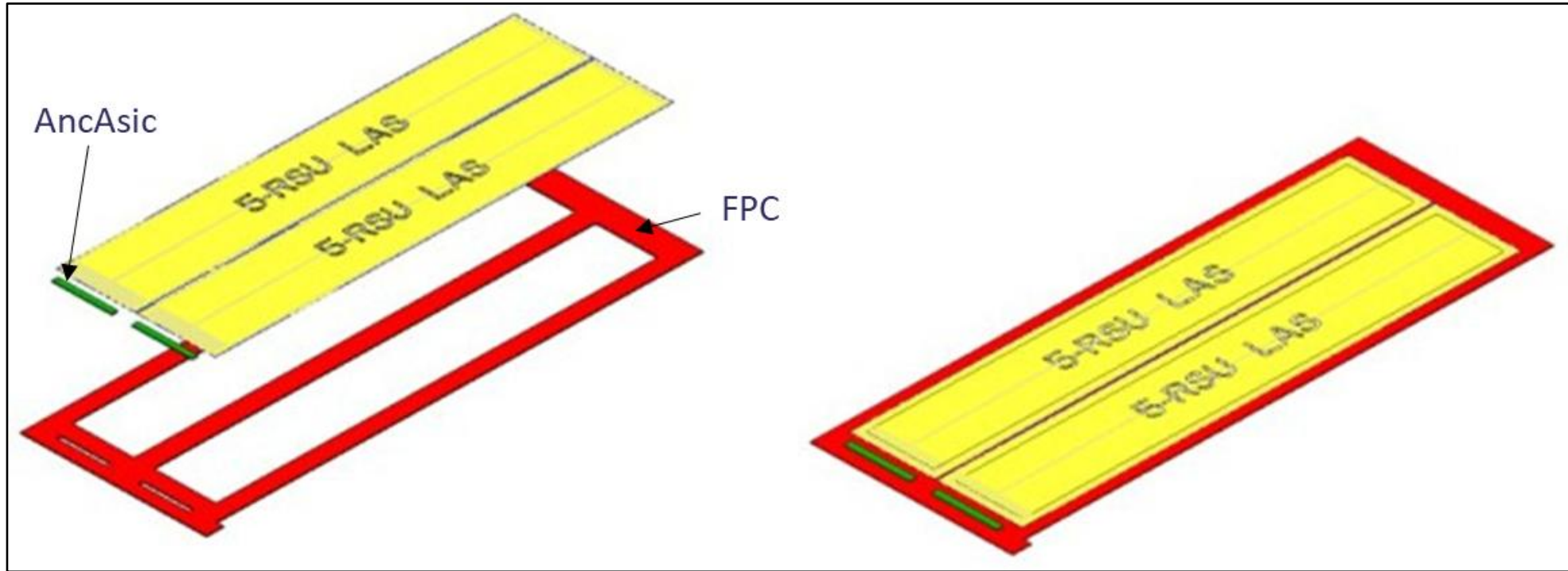
Draft of chapter which was presented to EPIC-SVT-WP1:
<https://indico.bnl.gov/event/27905/contributions/106638/attachments/61422/105511/20250407-moduleChapter4PubMBorri-rep-2021a10.pdf>

- Ad-hoc meeting, monthly: Bham, Brun, Liv, DL;
- Pre-TDR is an opportunity to progress the definition of the detector module;
- Table of contents:
 - Overview;
 - OB module concept:
 - Options inc. baseline;
 - Tooling and assembly;
 - Characterisation and production testing (QC);

1.1	Characterization and production testing (QC)	...
1.1.1	Overview	...
1.1.2	Module characterization	...
	Mechanical characterization	Interplay w EPIC-SVT-WP4
	Electrical characterization	Interplay w EPIC-SVT-WP2
	Radiation characterization	Interplay w EPIC-SVT-WP2
1.1.3	Module production testing	...
	Process and equipment standardisation	...
	Pre-assembly requirements	...
	Post-assembly requirements	...
	Post-assembly test-sequence (electrical tests)	...

3 types of
characterisation

Module baseline



Module description:

- 2 LAS
- 2 AncAsic
- 1 FPC
- Glue Si dies to FPC
- Wire bonding Si dies to FPC

Module characterisation

Mechanical characterisation:

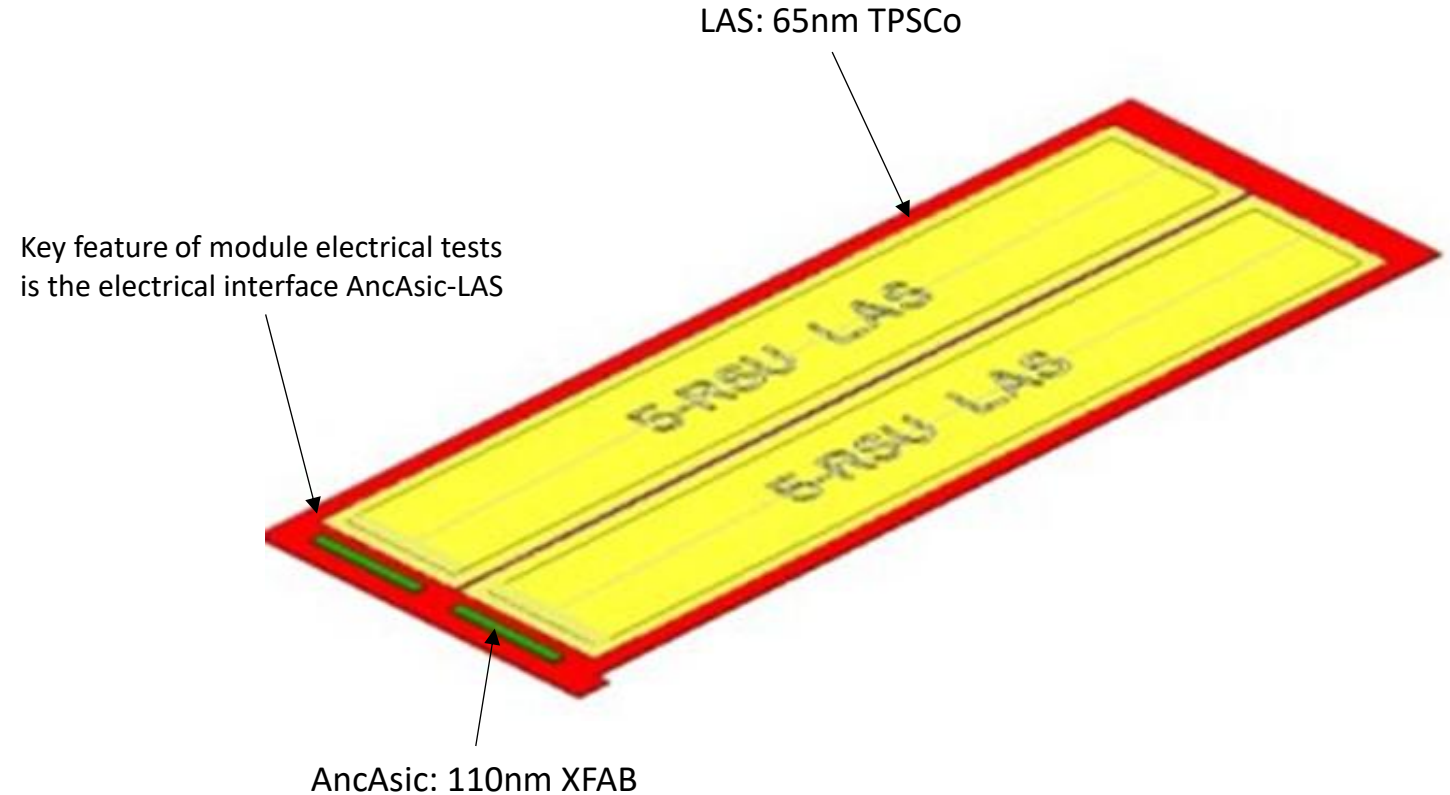
- Metrology measurements;
- Peel testing;
- Thermal cycling;
- Shear and/or pull testing on microelectronics interconnects;
- Air leak tightness; (WP4?)

Electrical characterisation:

- Powering tests;
- Digital communication tests;
- In-pixel circuitry tests;

Radiation characterisation:

- Radioactive sealed sources;
- In-beam;
- Irradiations (TID and NIEL);



Module production testing

Process and equipment standardisation:

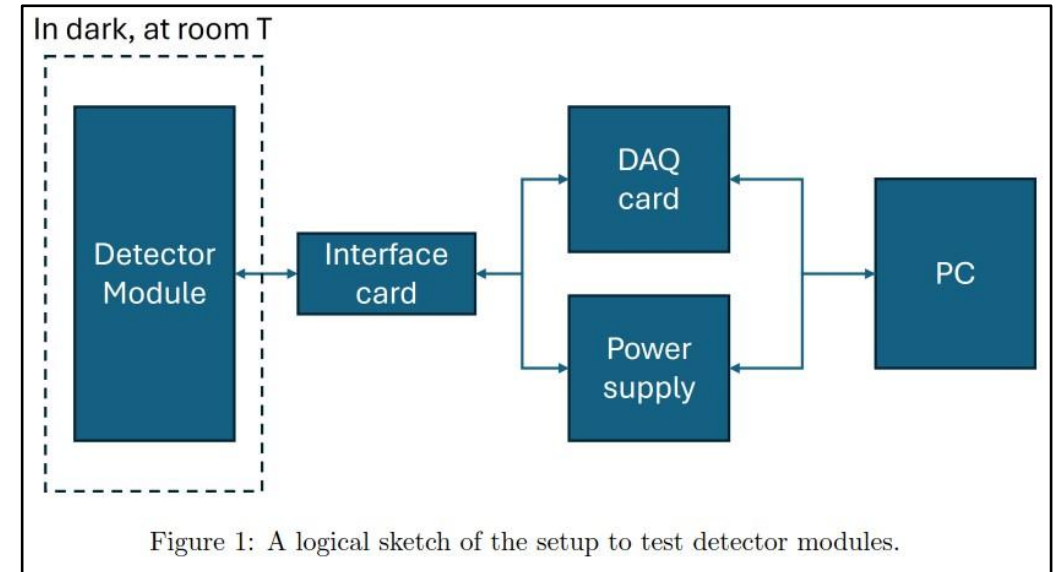
- distributed production involving multiple sites;
- documented processes;
- traceability of components, adoption of serial numbering, ad-hoc database;
- Requirements on cleanliness;
- standardisation of the storage

Pre-assembly requirements:

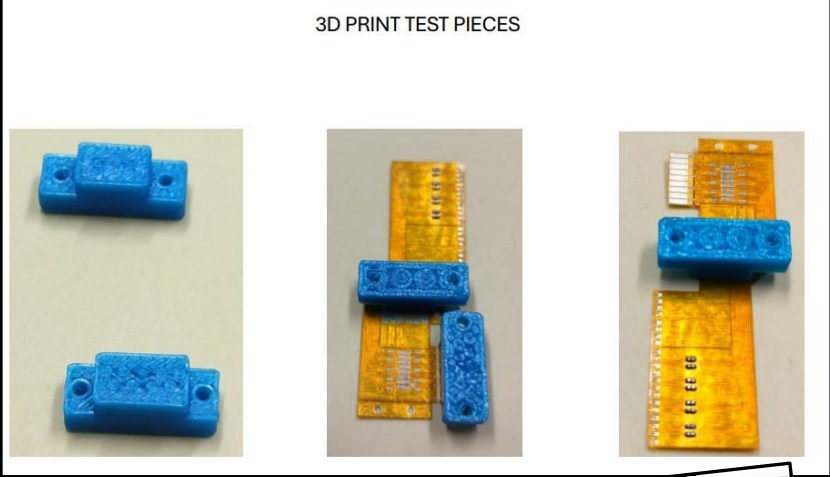
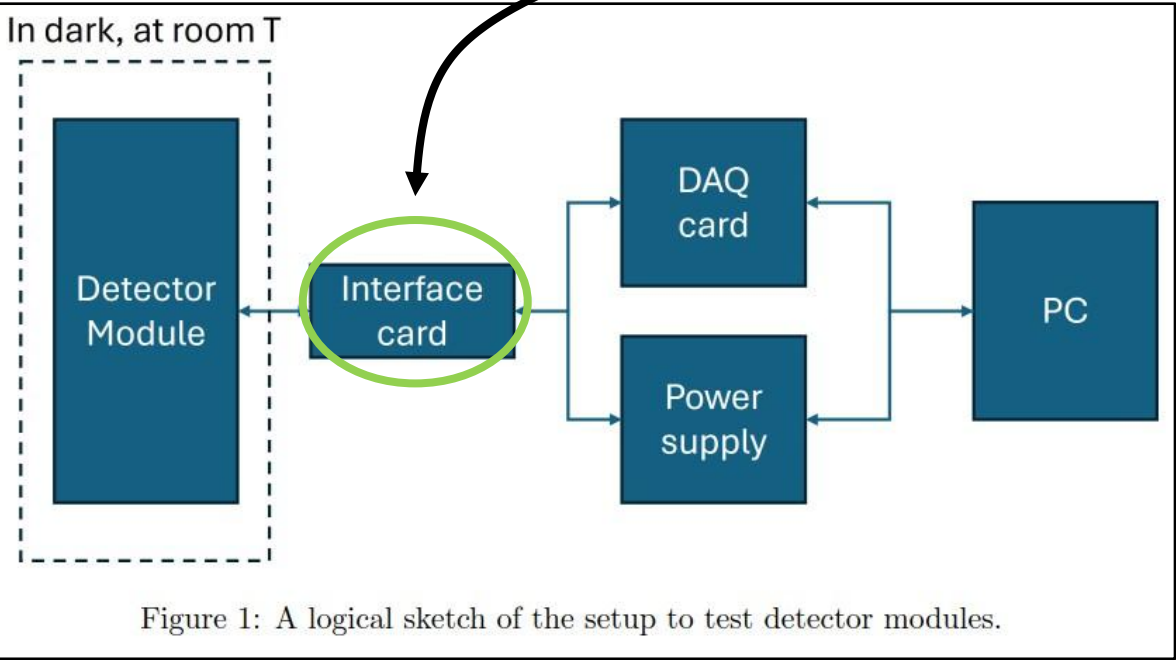
- AncAsic and the LAS will be probe tested after dicing by using wafer probe testers;
- Flexible Printed Circuits will be probe tested to check for short circuit and open circuit defects;

Post-assembly test-sequence (electrical tests):

- automated test system w scripted scans;
- room temperature and in a dark environment;
- quality grading: quality factors and fiducial cuts;

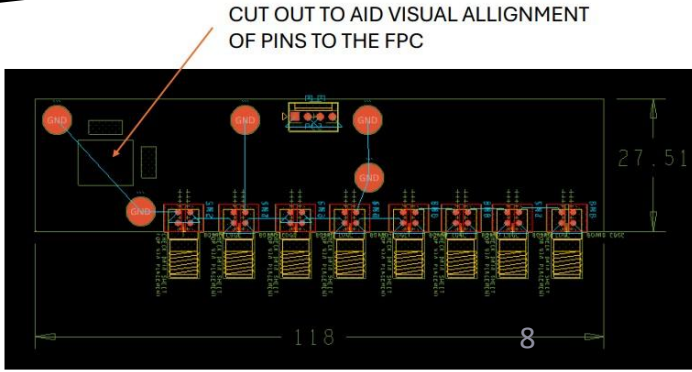
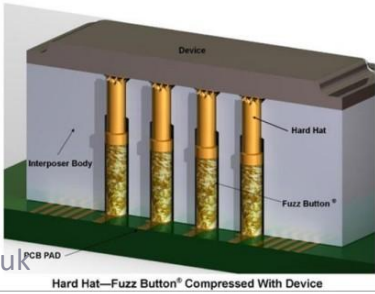
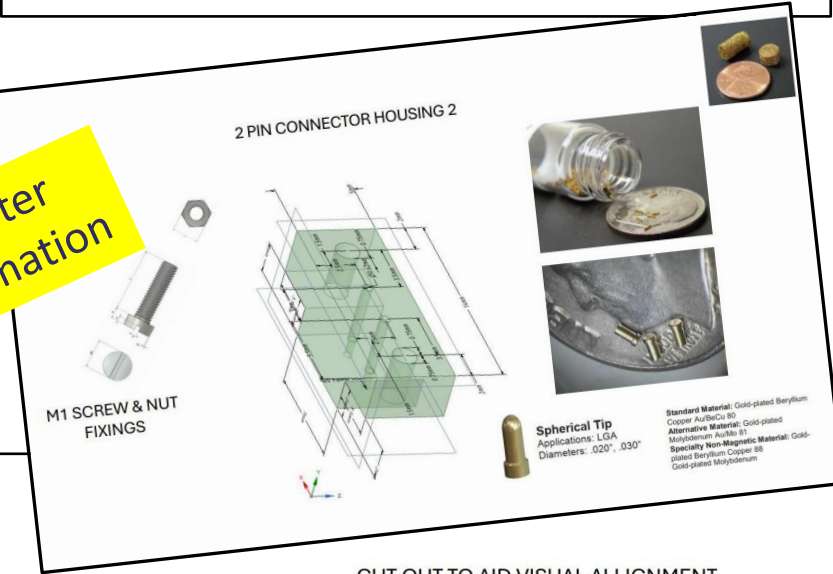


Module production testing – module test rig



B-FPC
Probe testing
(A.Hill)

To be resumed after
UKRI funds confirmation



Module production testing

Post-assembly test-sequence (electrical tests):

- Ancillary Asic (AncAsic)
 - Powering tests
 - Impedance measurements
 - Power consumption measurements
 - Digital communication tests
 - Configuration and register read-back measurements
 - Loopback measurements of the communication interface with LAS
- Large Area Sensor (LAS):
 - Powering tests:
 - Impedance test
 - Power consumption measurements
 - Epitaxial-layer IV measurements
 - Digital communication tests
 - Configuration and register read-back

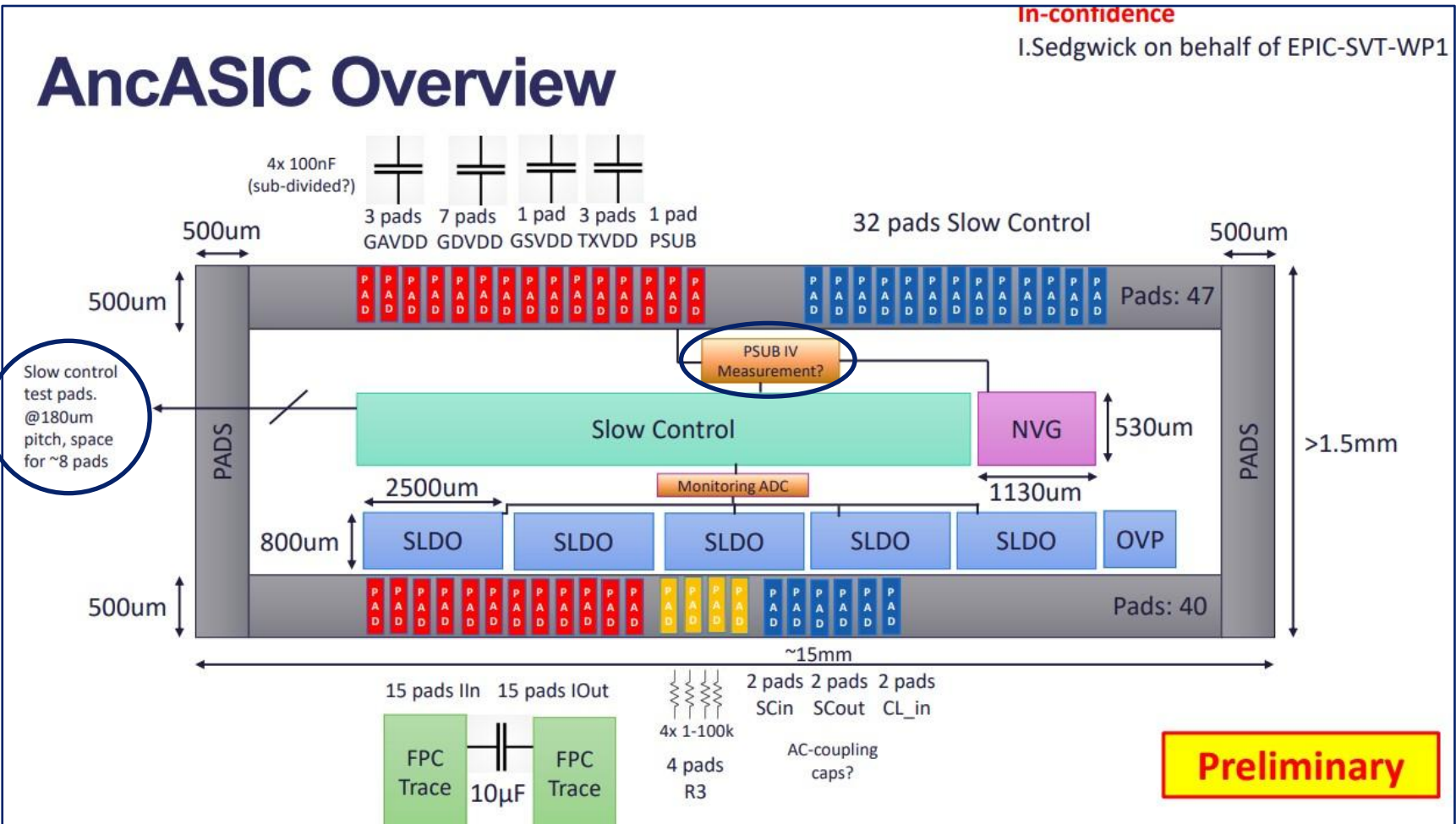
- In-pixel tests
 - Digital scan
 - Digital white frame
 - Analogue scan
 - Threshold scan
 - Threshold tuning
- Noise occupancy measurement
- Additional tests for debugging:
 - GCLK monitoring
 - GRST monitoring
 - SYNC monitoring

Test sequence based on experience w ALPIDE,
MOSS pixel circuitry and interpolation of existing
info on MOSAIX

[M.Buckland, J.Glover, J.Liu and M.Borri]

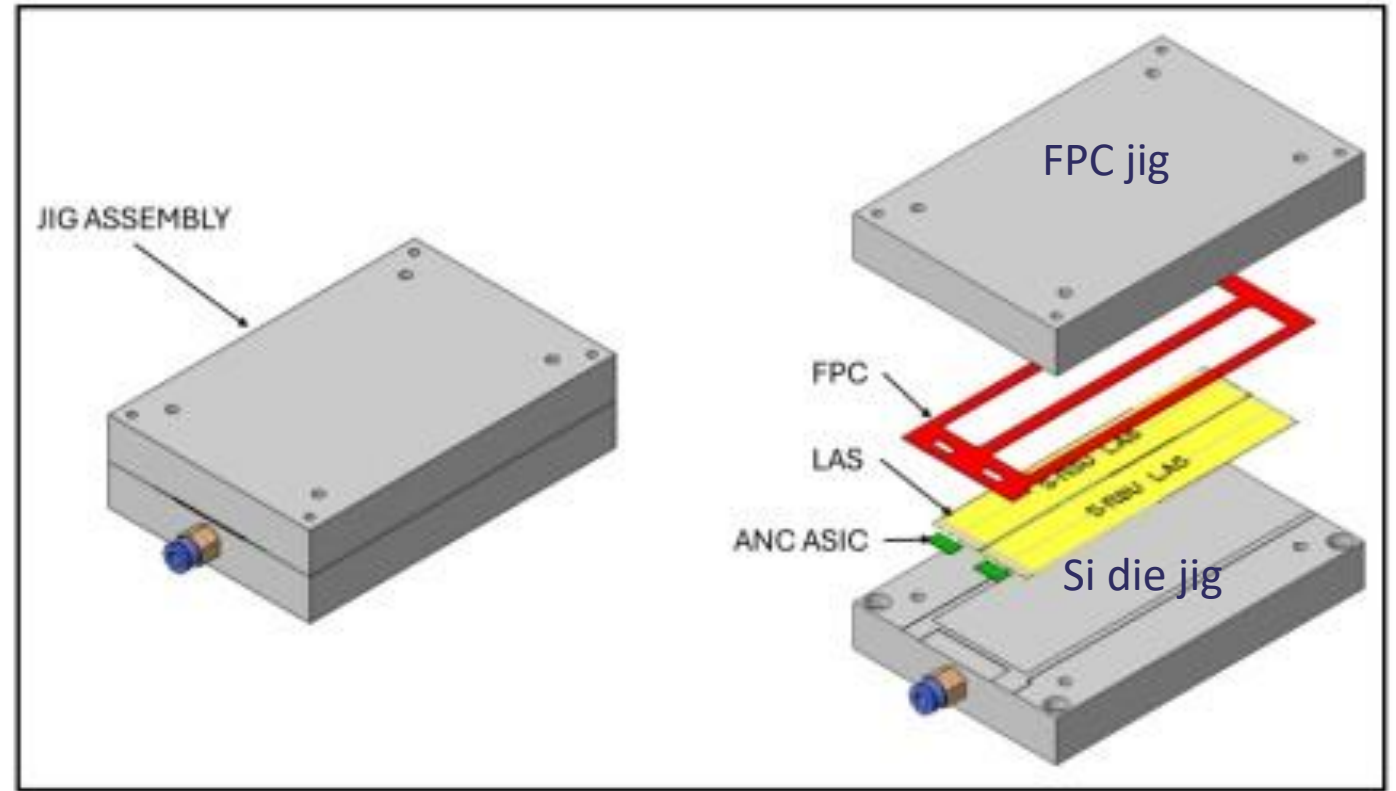
Module production testing – AncAsic design

Discussion on how to implement diagnostics in AncAsic: under evaluation.



Low-readiness prototyping: tooling

Module tooling



Two jigs ready for Sept-Oct:

DL to complete design -> Jul;

Lpool to manufacture -> Aug, Sept; [J.Liu to confirm with T.Jones]

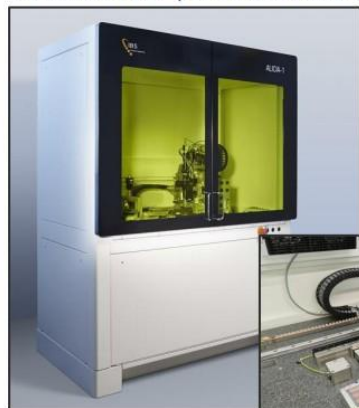
Bham deploy for assembly -> Oct onwards;

Module assembly

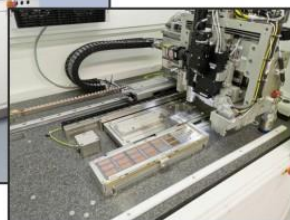
Are we using the right approach to assemble modules?

automated

ALICE ITS2 – 10m² (ALPIDE 100um and 50um)



DL (ALICE, R3B)+ RAL (LHCb)



- Currently re-used for R3B-TRT: 0.2m² (ALPIDE 50um)
- Plan to be reused for LHCb Upgrade II tracker: ???m² (ChipName?? 50um??)
- Plan to use a similar approach for ALICE 3: 100 m² (TBC 100um or 50um)

marcello.borri@stfc.ac.uk



Mu3e – 0.4 m² (MuPix 50um) Oxford

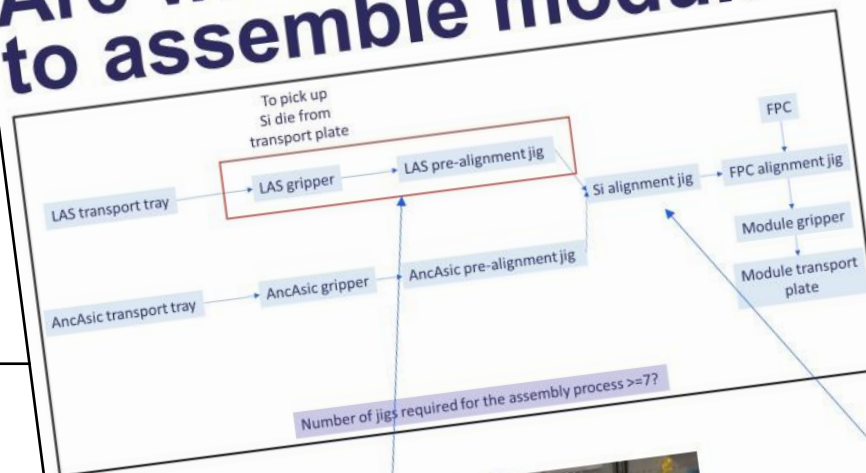


Are we using the right approach to assemble modules?

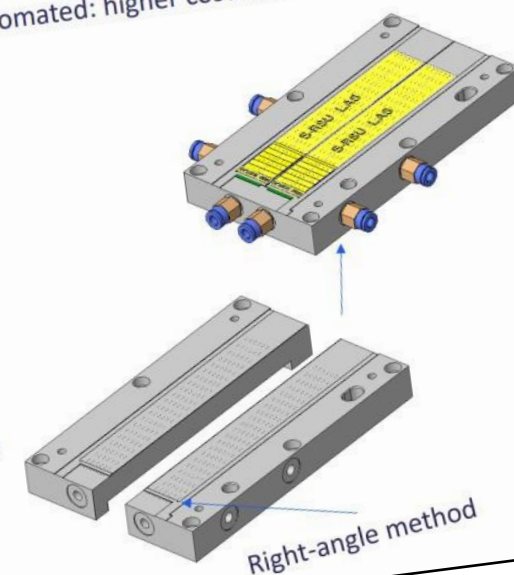
manual

EPIC-SVT 8 m² (LAS 50um)

Manual: lower cost? simpler to implement?
Automated: higher cost? Higher reliability/yield?



marcello.borri@stfc.ac.uk



Right-angle method

marcello.borri@stfc.ac.uk



Future development increments & conclusion

Future and conclusion

- Pre-TDR effort is contributing to the definition of the detector module;
- Low-readiness development increment will use mechanical parts;
- Assembly to start in Autumn 2025;

