BELLE II PXD WORKSHOP

PXD9 PROBE CARD MASS TESTING

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9. Summary

▸ DEPFET modules fully assembled are attached to a kapton cable.

▸ Pre-testing of the modules before the attachment avoids having to remove the kapton in the case that the module doesn't behave as expected, simplifying the rework procedure.

▸ A needle card is required for this purpose.
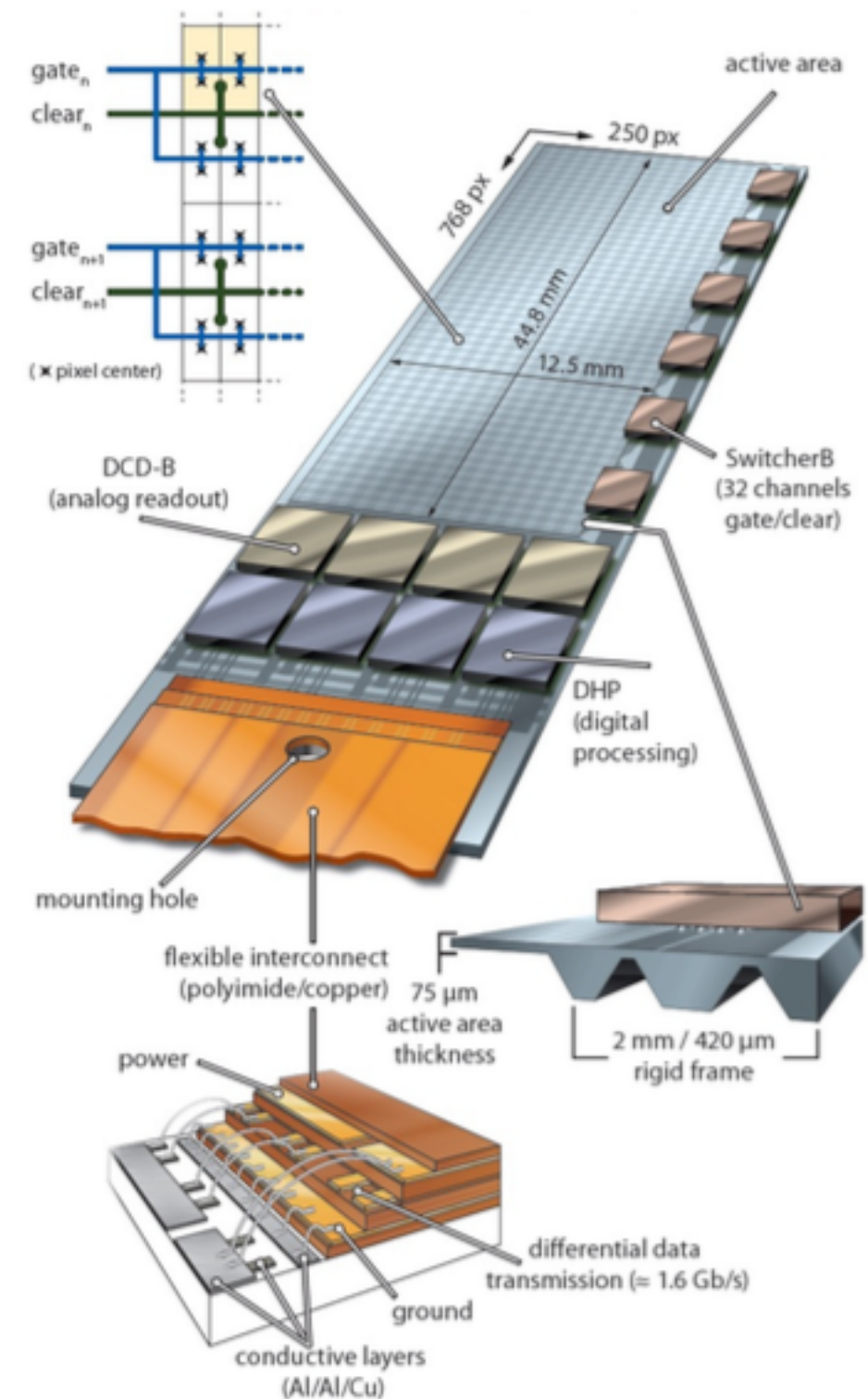
▸ The probe card directly interfaces the PXD9 modules to:

- ▸ RJ45 cable for the slow control signals.

- ▸ Glenair cable for power delivery.

- ▸ Infiniband cable for HSL data transmission.

▸ In ideal contact, the module can be fully operated (at the lowest frequency and half rate) through the probe card.
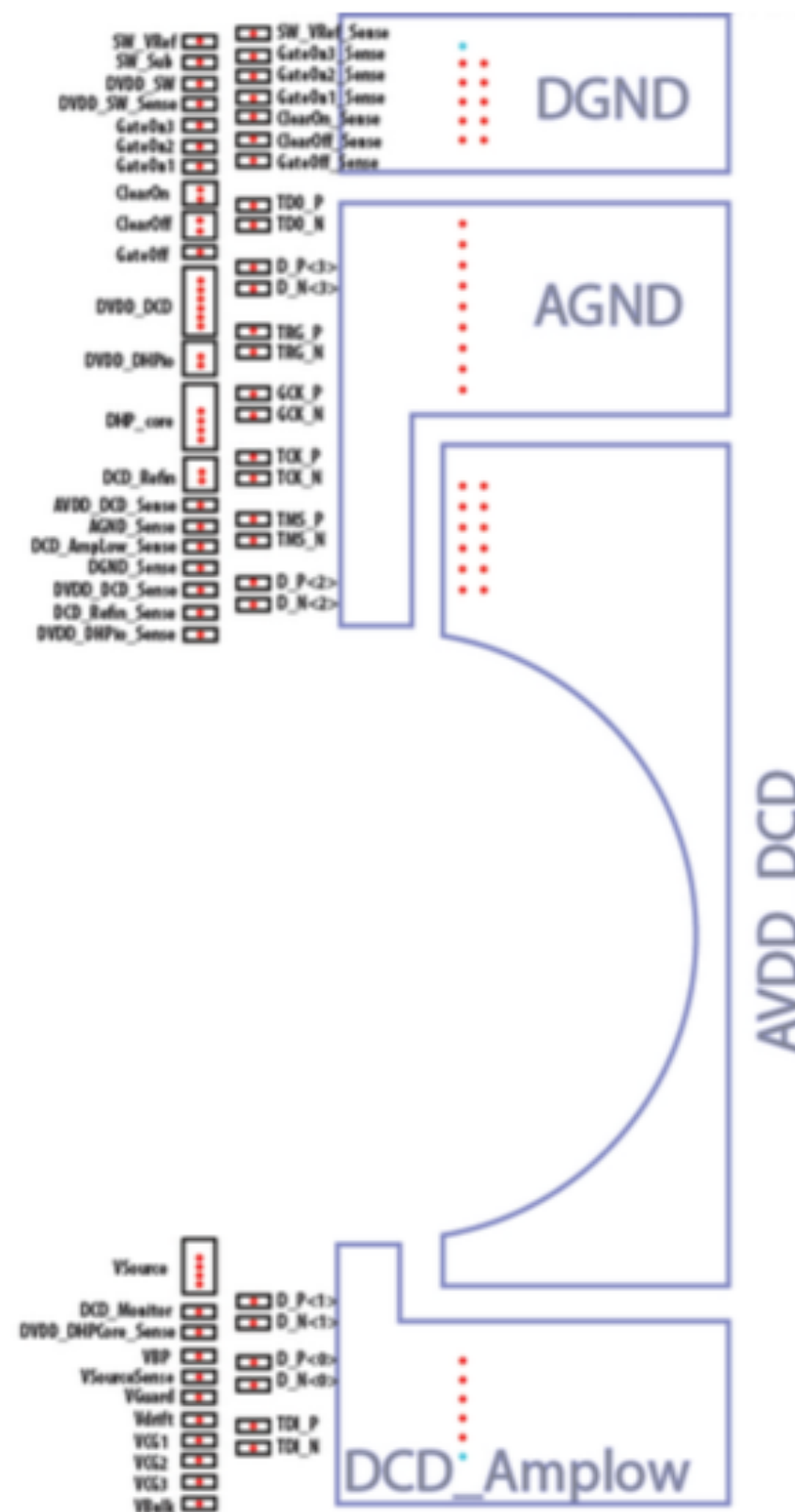
- ▸ 2 different probe card designs for the 2 different layouts of PXD9: design A for IF/OB and B for IB/OF

- ▸ Pad distribution for PXD9:

  - ▸ 59 small aluminium pads, 4 big copper pads.

  - ▸ 8 pads for high speed differential lines.

- ▸ Design considerations:

  - ▸ 114 needles (multiple needles for the big pads) are required.

  - ▸ PCB size is limited by connectors for power supply and infiniband.

  - ▸ Design priority: rather simple and passive PCB, minimizing the path length of the high speed signals.

- ▸ Many thanks to Daniel Esperante for the desing of the probe card.

Needles - Vision hole

JTAG

Power Connector

Sensor hole

High Speed Ifiniband
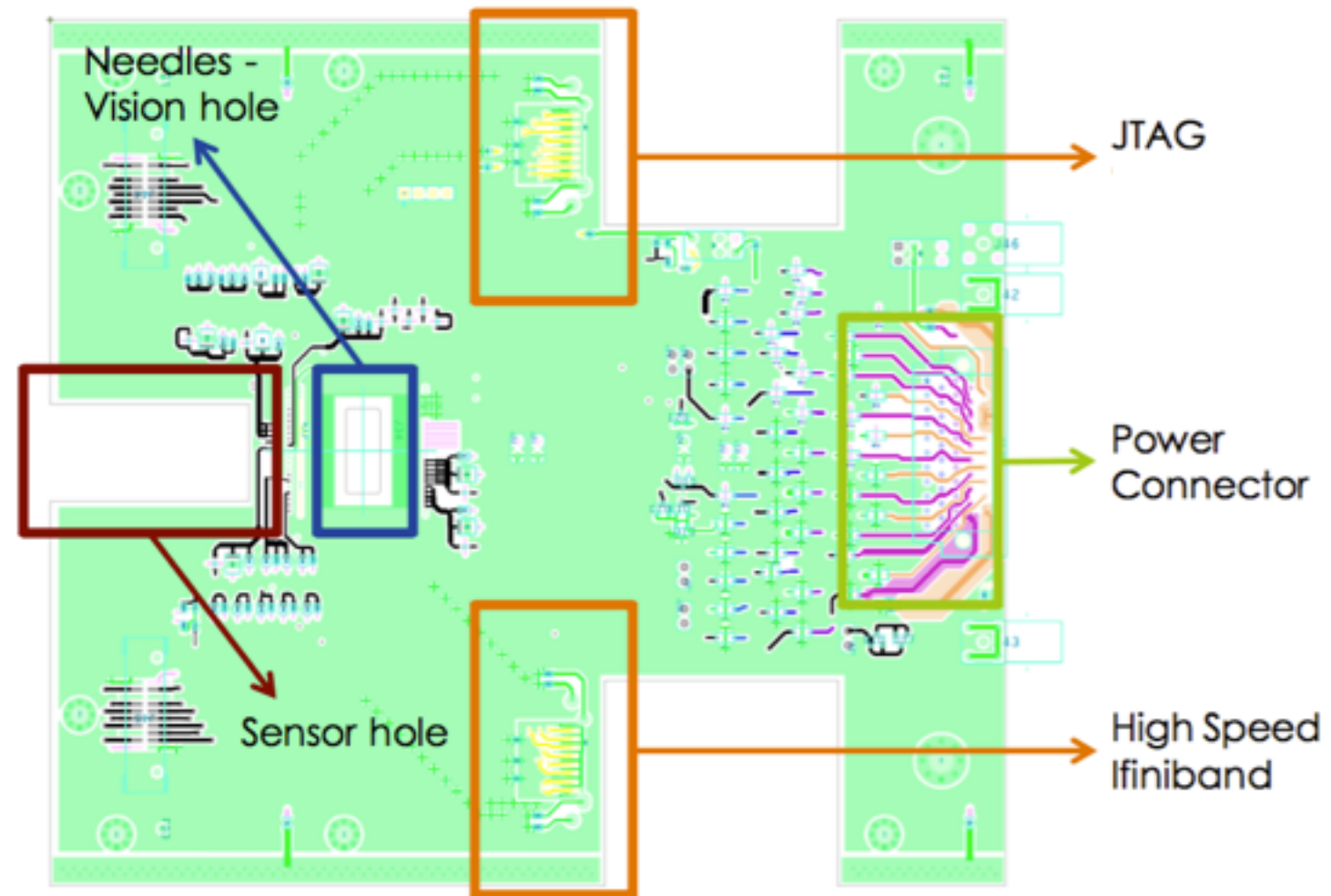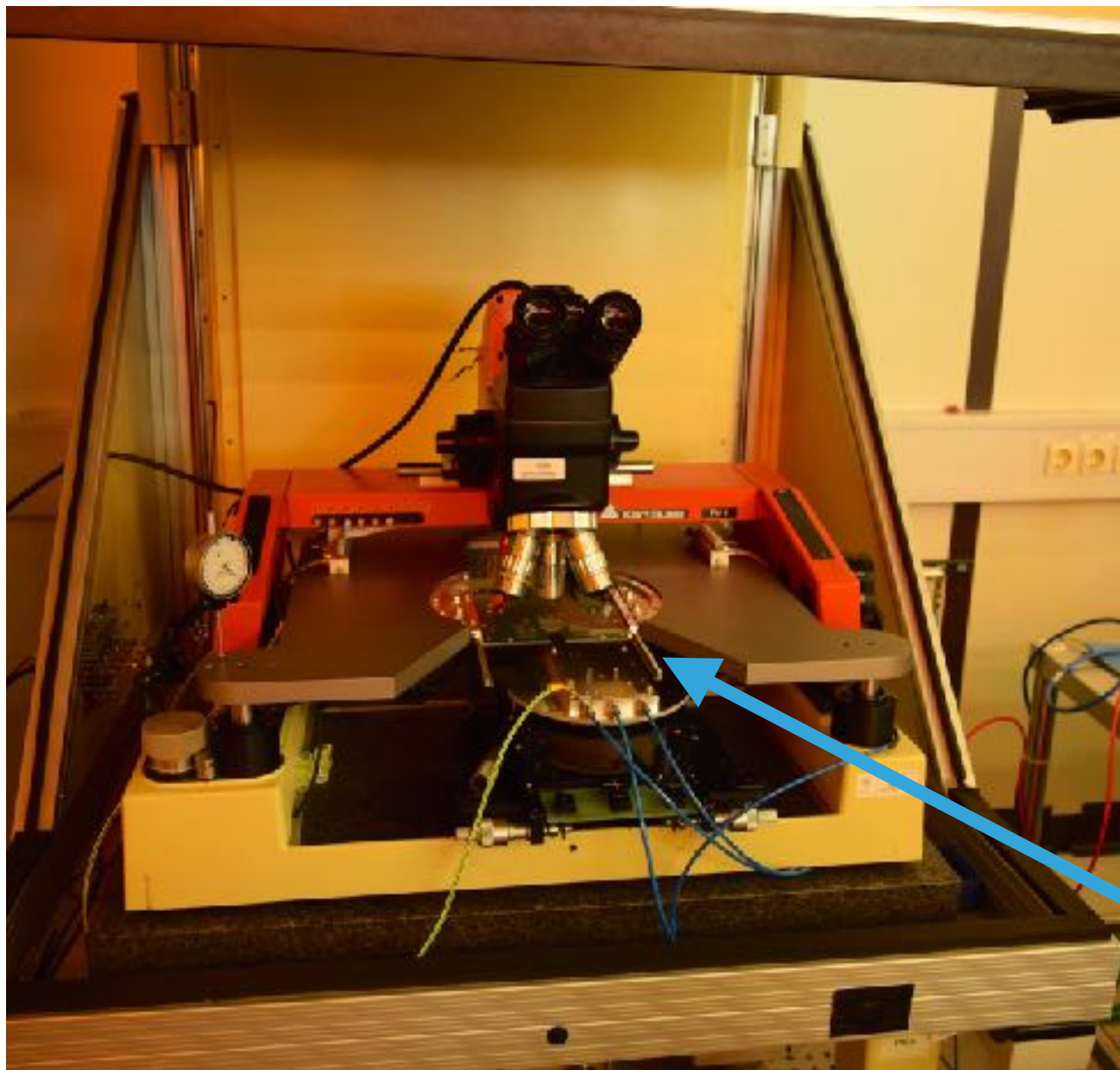
- ▸ Modules are placed with their base jig on the cooling jig and secured with screws and vacuum under the probe card.

- ▸ Through the optical microscope we can align the needles with the module and calibrate at what point the touchdown is performed.

INFINIBAND

NEEDLES

GLENAIR

RJ45

- ▸ With the help of the micrometer on the left, we apply the desired overtravel (~60 microns).
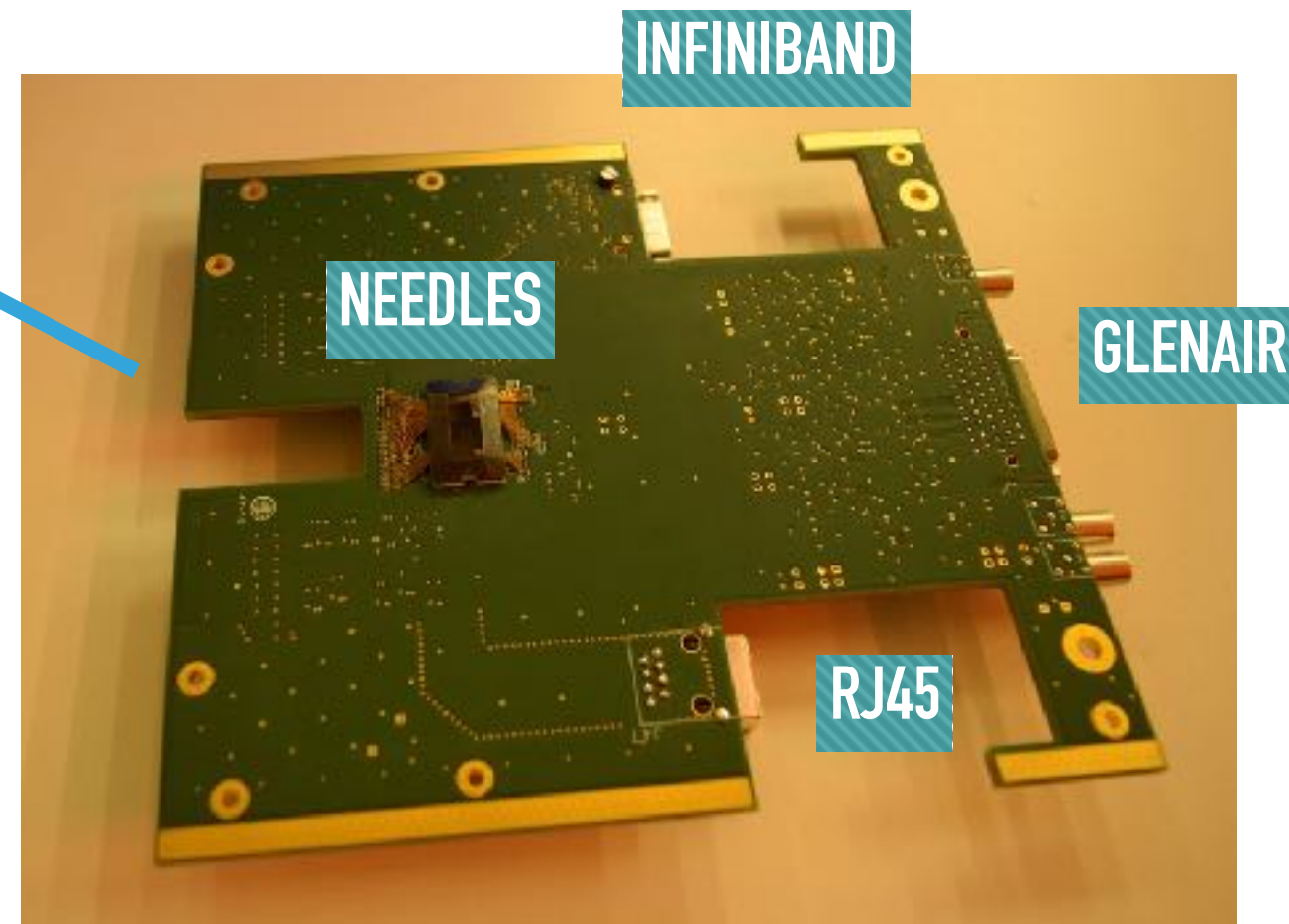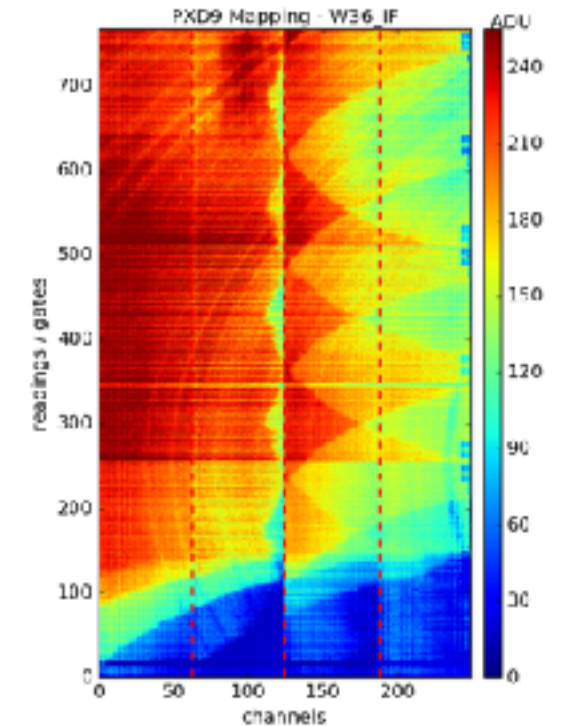
‣ 2 probe card A (IF/OB compatible)

‣ 2 probe card B (IB/OF compatible)

‣ 1 Power breakout board (LMU_BB-04)

‣ 1 LMU power supply (LMUPS-05)

‣ 1 DHH carrier card (DHHCCv0.03)

‣ 1 DHE (DHE S/N: 0081)

‣ 1 JTAG breakout board

‣ 1 XJLink2 controller

‣ 1 DAQ PC

‣ 1 Archiver PC (only PS archived)

‣ Cables and services
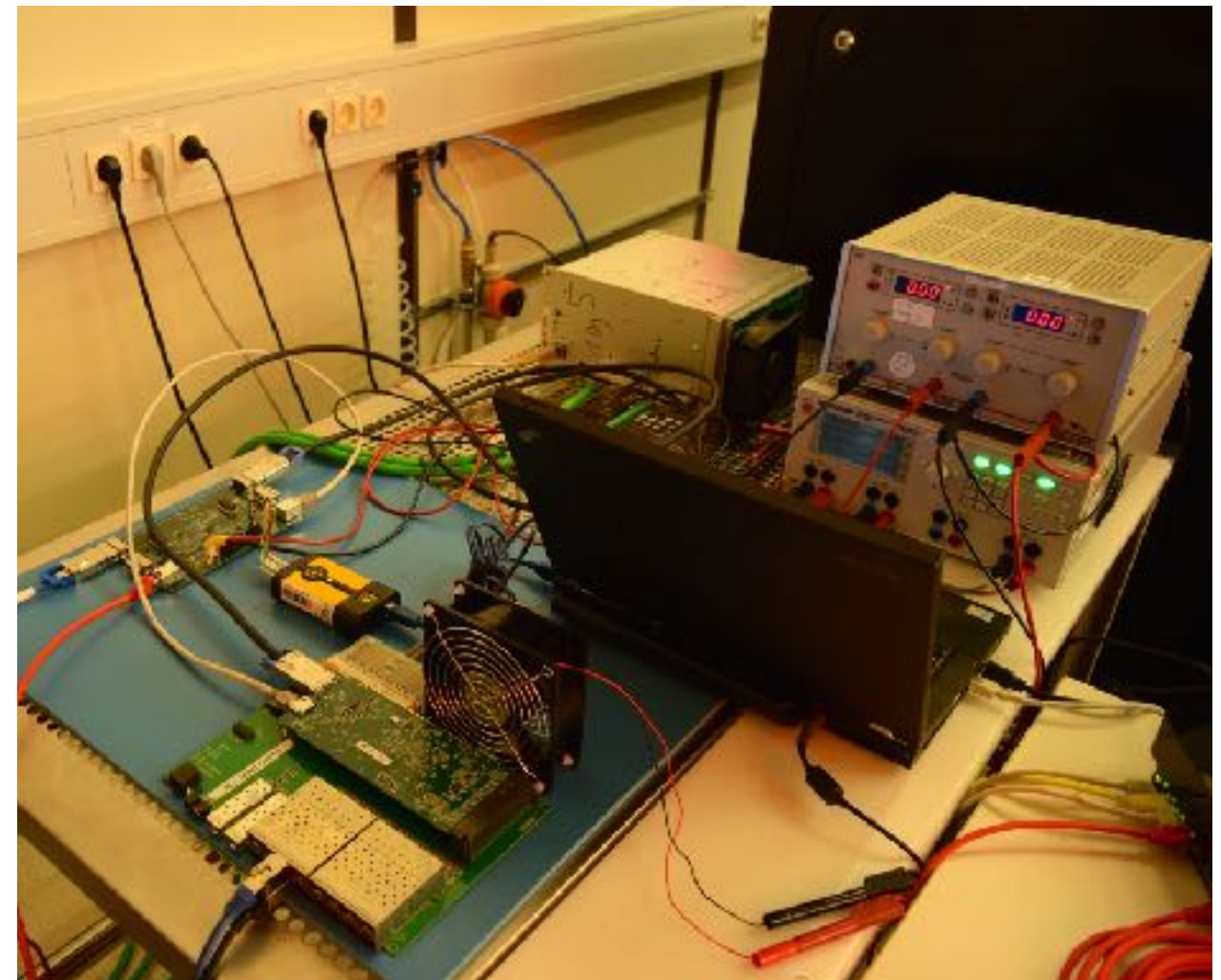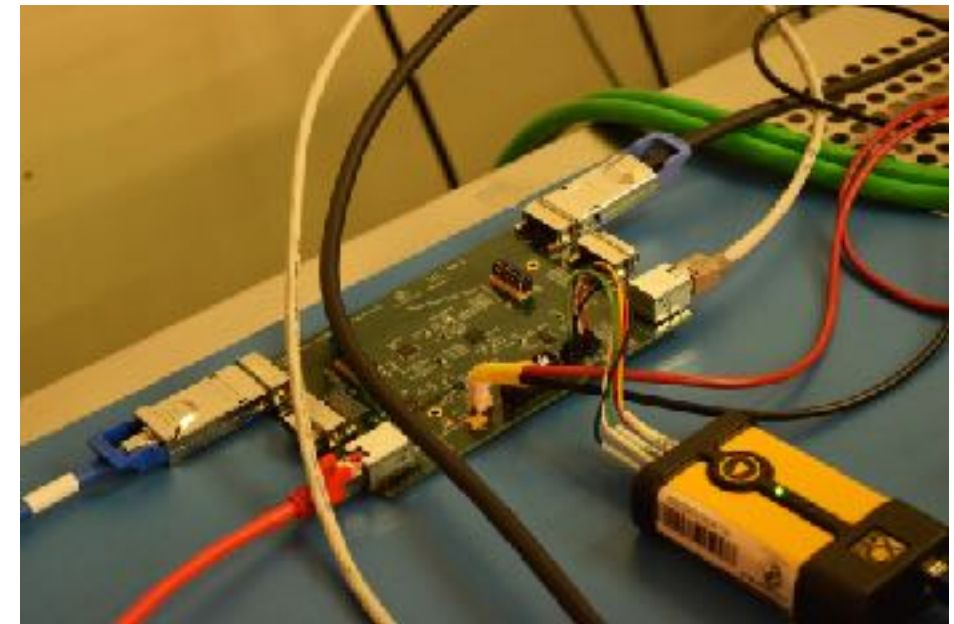
1. Visual inspection.

2. Check of voltages & currents for DHP, SW and DCD-digital.

3. Chip configuration: JTAG write & read. Retrieving the IDCODEs, uploading and reading SW sequence, …

4. Boundary scan.

5. Getting the HSL connections.

6. Retrieve the testpattern from the DCDB.

7. Enable DCD-analog and check voltage & currents.

8. Enable and check of DEPFET voltages & currents.

9. Read DEPFET pedestals.
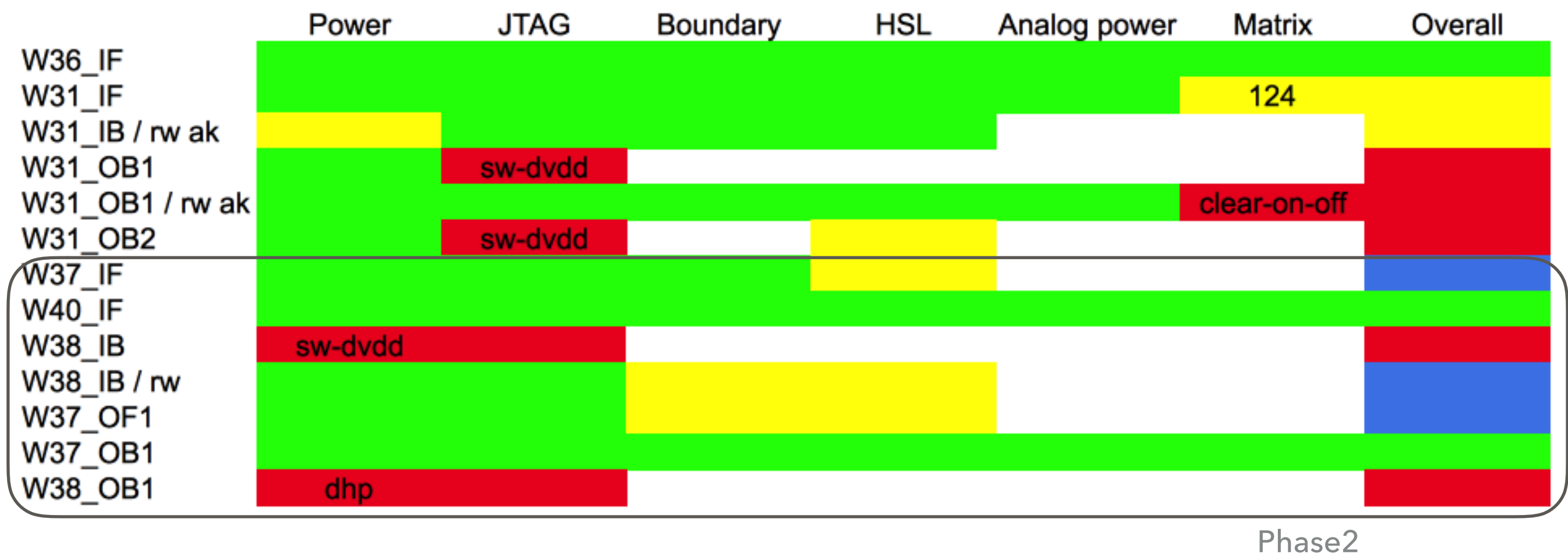
10. Illuminate the matrix with a laser source.

▸ One complete report of each of modules with all the details available at http://elog.mpp.mpg.de/DEPFET/

  ▸ A copy of the entry is available also at https://elog.belle2.org/elog/PXD-Mass-Testing/

▸ A check list section into each one of the modules listed at the HephyDB: http://hephy.at/hephydb/hephydb/

	Power	JTAG	Boundary	HSL	Analog power	Matrix	Overall
W36_IF							
W31_IF						124	
W31_IB / rw ak							
W31_OB1		sw-dvdd					
W31_OB1 / rw ak						clear-on-off	
W31_OB2		sw-dvdd					
W37_IF							
W40_IF							
W38_IB	sw-dvdd						
W38_IB / rw							
W37_OF1							
W37_OB1							
W38_OB1	dhp						

Phase2

TEST RESULTS COLOR CODE:

PERFECT | **PASSED** | **MINOR ERRORS / POSSIBLE TOUCHDOWN PROBLEMS** | **SHOW STOPPER**

YIELD (AFTER REWORKS):
IF: 4/4 | IB: 2/2 | OF: 1/1 | OB: 1/4 | TOTAL: 8/11 (72%)

	Power	JTAG	Boundary	HSL	Analog power	Matrix	Overall
W02_IF							
W03_IF							
W05_IF							
W08_IF							
W32_IF							
W41_IF							
W42_IF							
W43_IF							
W44_IF							
W45_IF							
W46_IF							
W47_IF				34		34	

TEST RESULTS COLOR CODE:

PERFECT | PASSED | MINOR ERRORS / POSSIBLE TOUCHDOWN PROBLEMS | SHOW STOPPER

YIELD:
IF: 12/12 (100%)

	Power	JTAG	Boundary	HSL	Analog power	Matrix	Overall
W01_IB				123			
W02_IB							
W03_IB				12			
W09_IB				234			
W32_IB						24	
W41_IB							
W42_IB				123		123	
W43_IB				1			
W44_IB							
W45_IB							
W46_IB							
W47_IB				123			

TEST RESULTS COLOR CODE:

PERFECT | **PASSED** | **MINOR ERRORS / POSSIBLE TOUCHDOWN PROBLEMS** | **SHOW STOPPER**

YIELD:
IB: 12/12 (100%)

	Power	JTAG	Boundary	HSL	Analog power	Matrix	Overall
W08_OF2				13		13	
W09_OF1				13		13	
W09_OF2							
W11_OF1							
W11_OF2				13	dcd-avdd		
W12_OF1				12		12	
W32_OF1				123		12	
W32_OF2				12			
W33_OF1						124	
W33_OF2						123	
W41_OF1				123		123	
W43_OF1	sw-dvdd						
W44_OF1	sw-dvdd						
W44_OF2	sw-dvdd						
W45_OF1						124	
W45_OF2	dhp						
W46_OF1				12			
W46_OF2				12			

TEST RESULTS COLOR CODE:

PERFECT | PASSED | MINOR ERRORS / POSSIBLE TOUCHDOWN PROBLEMS | SHOW STOPPER

YIELD:
OF: 11/16 (69%)

	Power	JTAG	Boundary	HSL	Analog power	Matrix	Overall
W03_OB1							
W05_OB1							
W06_OB1							
W08_OB1							
W08_OB2							
W09_OB1	sw-dvdd						
W09_OB2							
W12_OB1							
W12_OB2							
W32_OB2							
W33_OB1							
W42_OB1							
W42_OB2							
W44_OB1							
W44_OB2							
W45_OB2							
W46_OB1							
W46_OB2							

TEST RESULTS COLOR CODE:

PERFECT | PASSED | MINOR ERRORS / POSSIBLE TOUCHDOWN PROBLEMS | SHOW STOPPER

YIELD:
OB: 15/16 (94%)

RESULTS: OVERVIEW

▸ The yield (modules without show stoppers, and including reworks) of all the probe card tests performed to the date is accounted in the following table:

	IF	IB	OF	OB
Preprod.	2/2	1/1	0	0/2
Phase2	2/2	1/1	1/1	1/2
Phase3	12/12	12/12	11/16	15/16
Total	16/16 (100%)	14/14 (100%)	12/17 (71%)	16/20 (80%)

▸ A total of 67 modules were tested, with 9 of them showing errors which were catalogued as show stoppers. Out of this 9 errors: 6 are switcher related, 2 dhp related, 1 dcd related and 1 DEPFET matrix related.

▸ Modules like W38_IB (the one with the rotated switcher) could be debugged with the probe card and repaired before kapton attachment.

‣ In some of the modules the needles are able to make a really good contact, and a really stable connection is achieved (W31_OB1 ran without losing any HSL for almost an hour). Whereas in others getting the HSL was really difficult (ie. W37_IF).

‣ In most of the cases, testing an IF/OB module with the probe card A was straightforward, meanwhile IB/OF modules used to take more of an effort.

‣ For an optimal contact, planarity between the probe card and the module is crucial. In this sense, the jig used to house the module can really affect the measurement.

   ‣ Instead of using a unique jig for each of the modules (as it was intended), we found jigs that worked fairly for each type of modules and kept using those for all the measurements.

▸ To improve the contact between the needles and the pads, we perform consecutive touchdowns in the same spot in order to scratch a bit the surface on the pad and allow for better contact.

▸ Regularly cleaning and polishing the needles of the probe card also helped with their perfomance.

▸ Occasionally, when the performance was really deteriorated and cleaning didn't help, they were shipped to the manufacturer (PTSL) for a refurbishment.

SUMMARY

▸ Two probe card designs to test the PXD9 modules have been produced and are in operation.

▸ A testing protocol for the mass production was developed and tested with real modules.

▸ Ideally we can fully operate all the modules before kapton attachment.

 ▸ Unfortunately, not all the touchdowns are optimal, and sometimes we can't operate the module fully.

▸ In total we were able to test 67 modules, spotting show stopper errors in 9 of them. And allowing for the refurbishment of one of the modules.

THANKS FOR YOUR ATTENTION

BACKUP

▸ 2 probe card A (IF/OB compatible)

▸ 2 probe card B (IB/OF compatible)

▸ 1 Power breakout board (LMU_BB-04)

▸ 1 LMU power supply (LMUPS-05)

▸ 1 DHH carrier card (DHHCCv0.03)

▸ 1 DHE (DHE S/N: 0081)

▸ 1 JTAG breakout board

▸ 1 XJLink2 controller

▸ 2 Bench power supplies
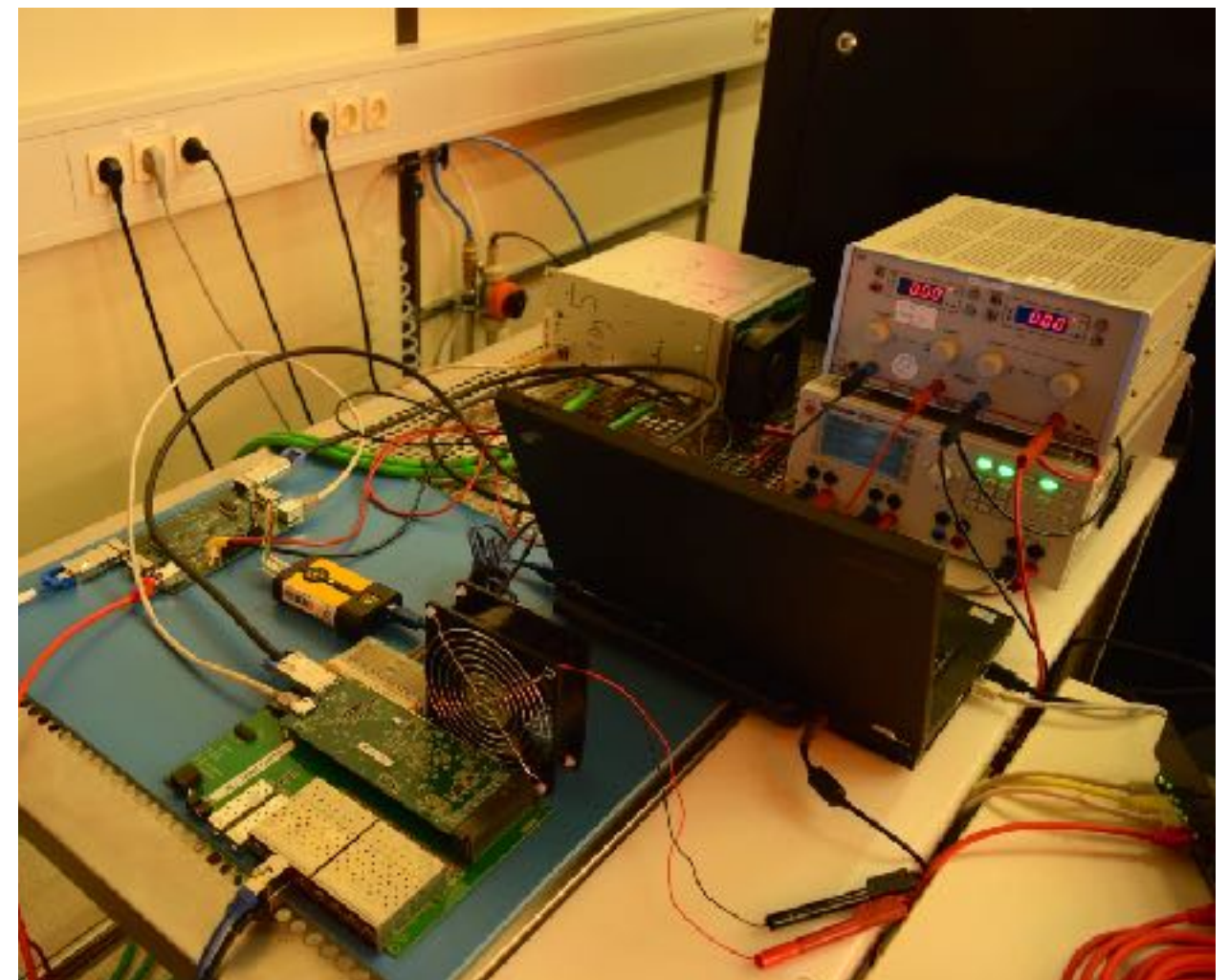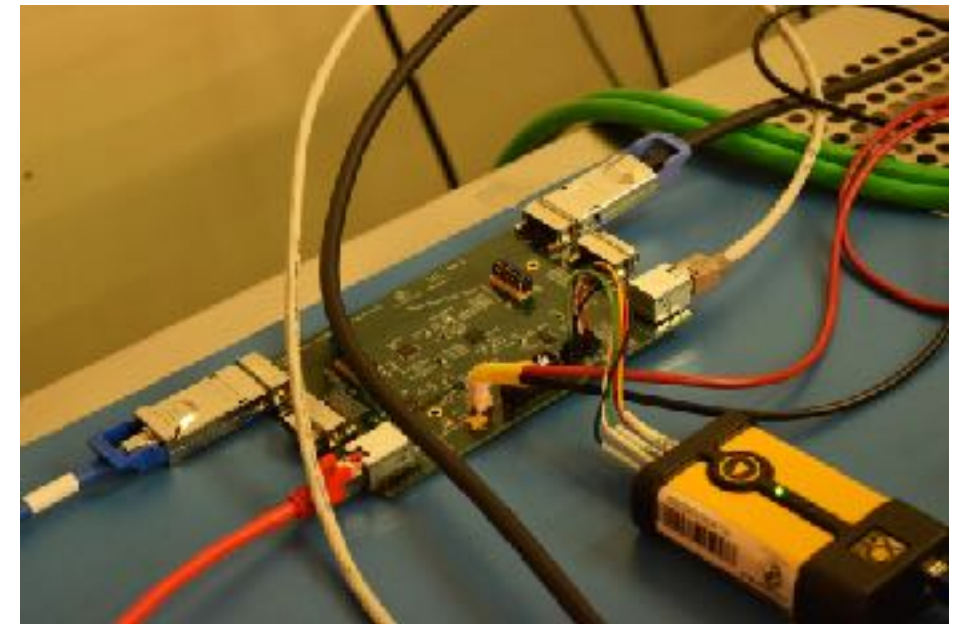
‣ 2 Infiniband cables, 2 green power cables, a glenair cable, RJ45 cables and banana cables

‣ 2 SFP adaptors

‣ 2 Fans to cool the DHE and the LMU PS

‣ 1 Cooling block (water cooled) with a vacuum pipe

‣ 2 Network switchers

‣ pxdtest6 SL7 pc: using the latest software release available at mid november 2016 (for stability/feature reasons), steering the modules with ini files (no DB)

‣ pxdtest5 SL7 pc: up-to-date software release, compatible with the DB

‣ edet2 SL7 pc: set up as archiver