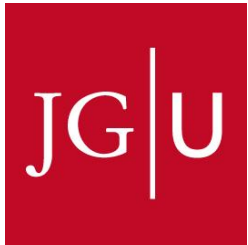


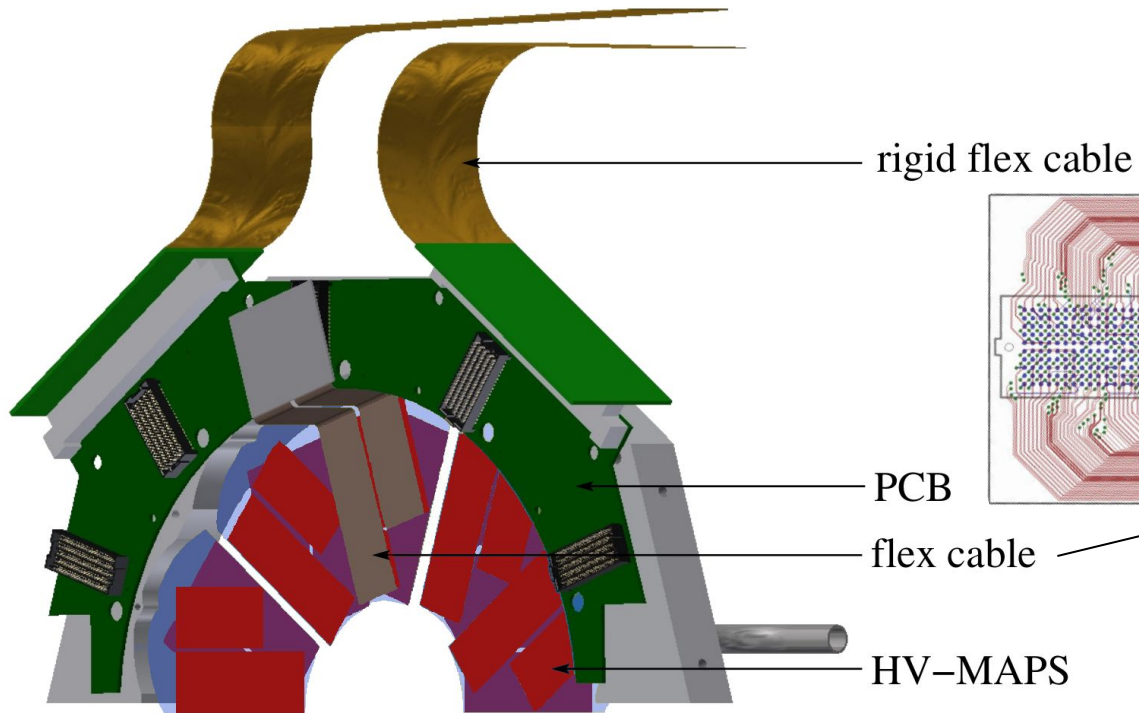
Development of a test bench for the Aluflex cables in the PANDA Luminosity detector at FAIR

Jannik Petersen

PANDA Collaboration Meeting, 11/05/2019



Signal Routing



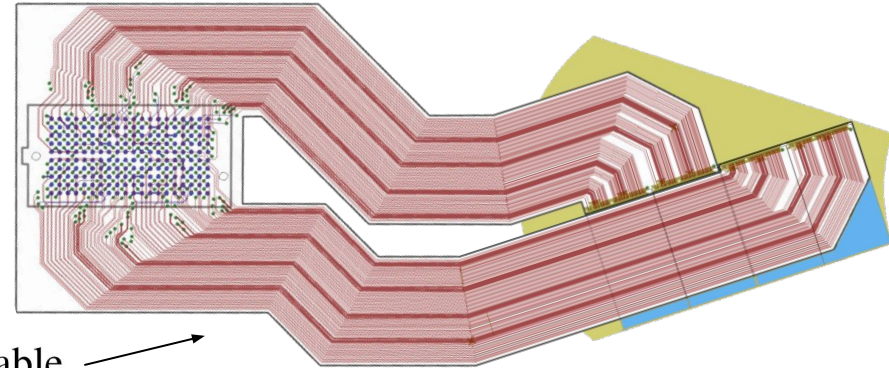
Radiation length for the prototype module:

Aluminum traces:

Copper traces:

Average $X/X_0 = 0.3 \%$

Average $X/X_0 = 0.4 \%$

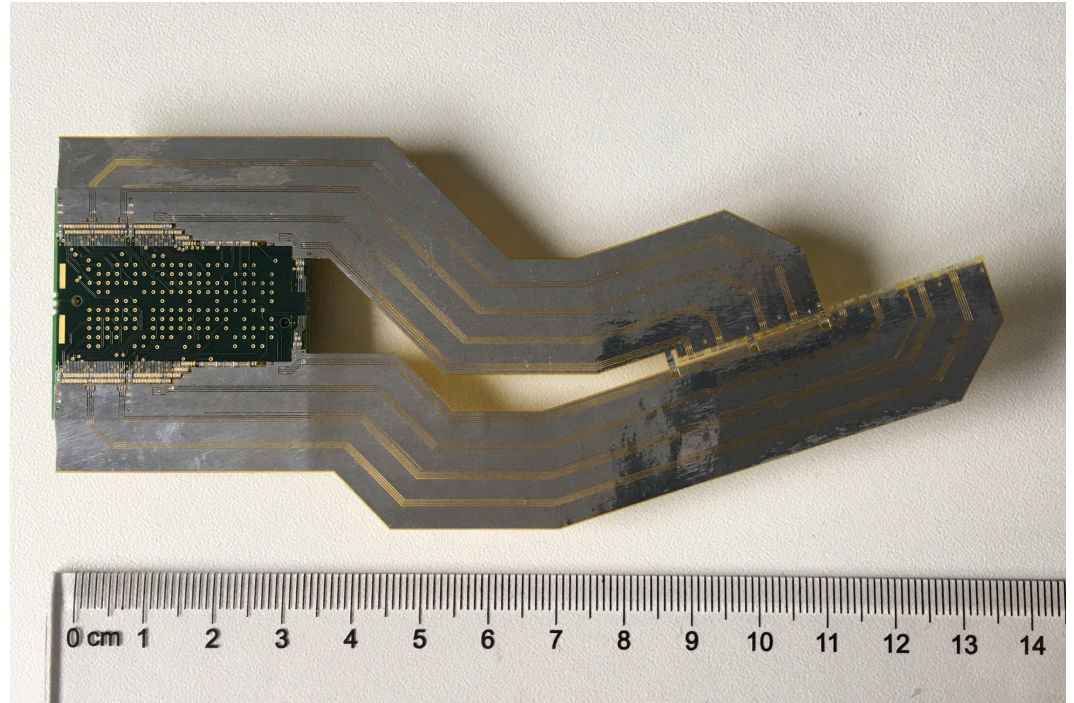


The Aluflex Cable

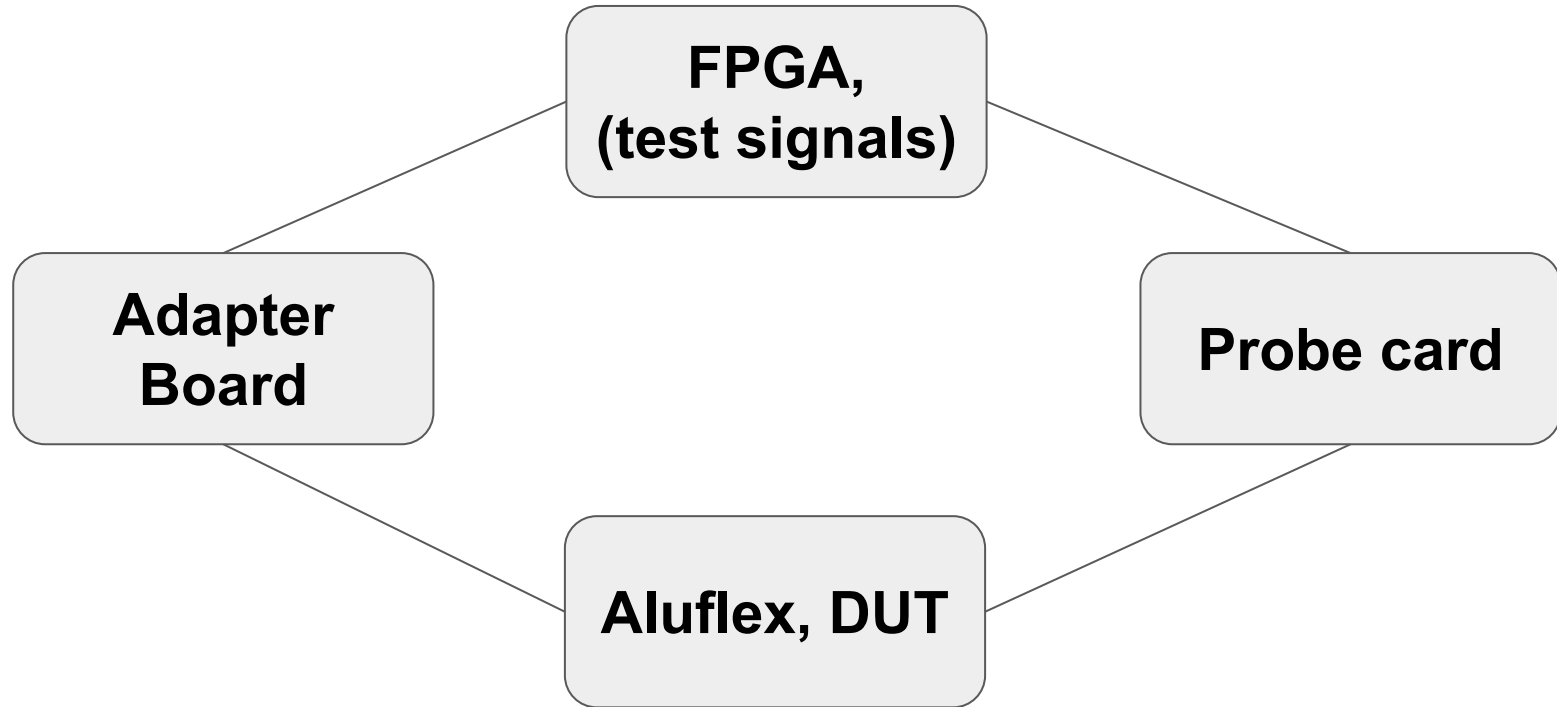
- 4 MuPix8 sensors
- 50 pins per sensor
- Pad size = $80\mu\text{m}$
- min. pad distance = $70\mu\text{m}$

→ precise test bench!

- LVDS pairs for data transfer
- HV, LV for power supply
- Single line traces for control



Test Bench Schematic



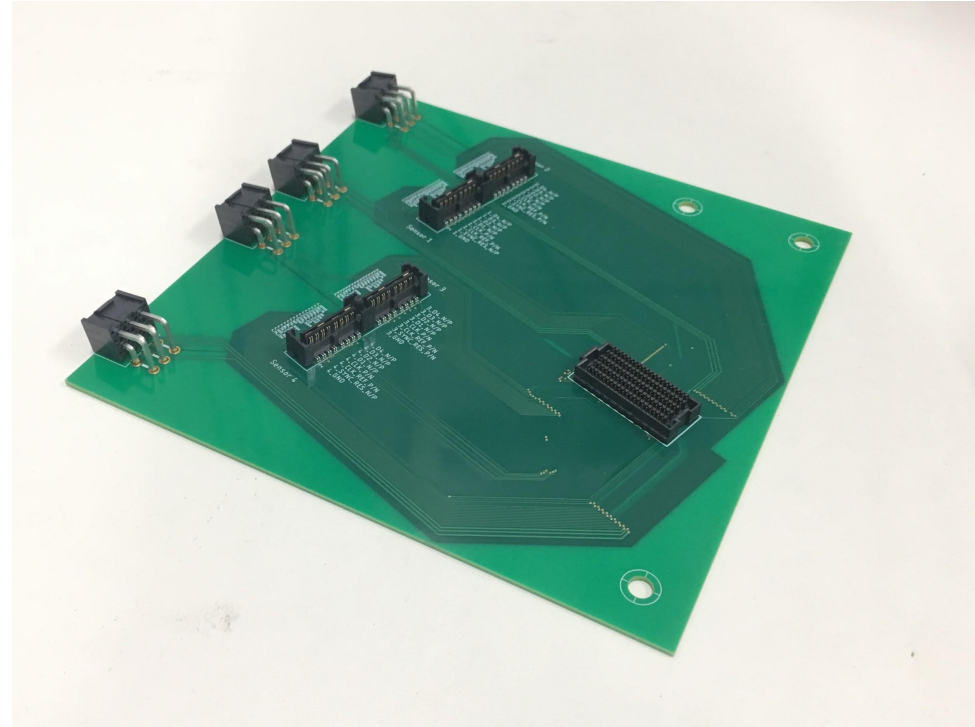
Adapter PCB

Board:

- Impedance matched traces
- Aluflex angle adjusted
- Screwed onto the clamping table

Connectors:

- 4 Samtec IPBT connector
- 2 Samtec QFS-DP connector
- 1 Samtec SEAF connector

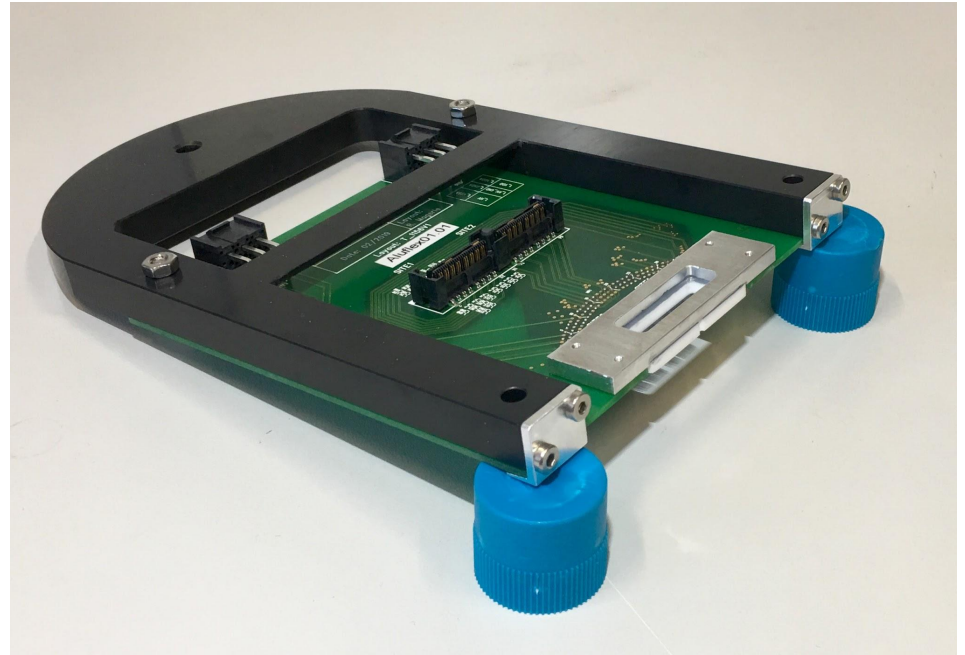


The Probe Card

- 100 tungsten probes
→ two “sensors” at same time
- Probe depth 2mm
- Mounted on vertical stage via holder

Connectors:

- 2 Samtec IPBT connector
- 1 Samtec QFS-DP connector



Positioning Elements

Precise connection can be achieved with **micrometer stages**

- XY Positioning Stage
- 360° Rotary Stage
- Vertical Translational Stage

Positioning elements will be **screwed on metal plane**

To ensure successful connection to the cable a **USB microscope** will be used

Problem: How to fix the cable onto the positioning stage?



Source: www.edmundoptics.com

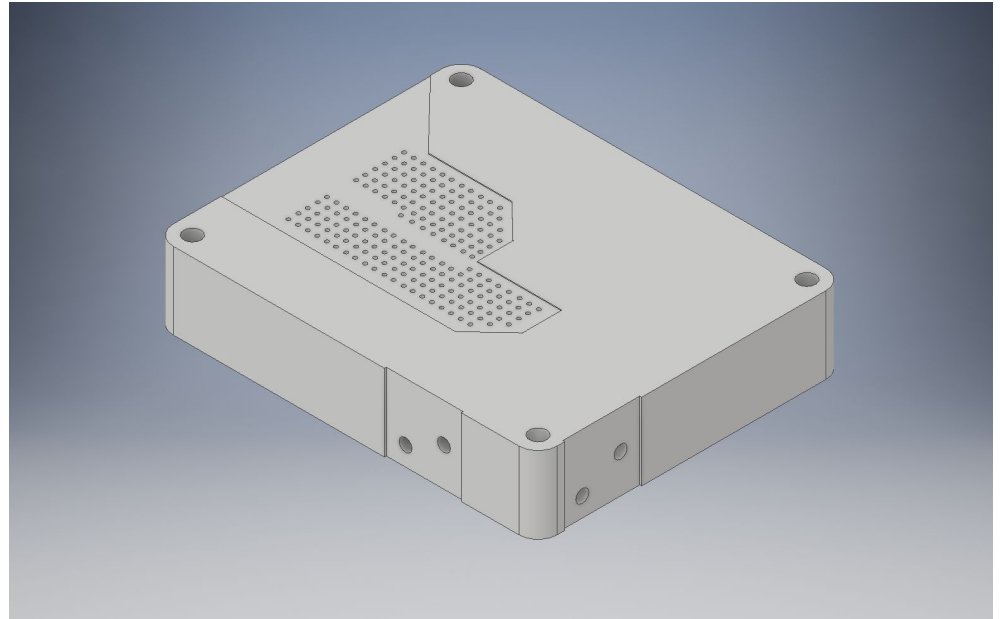


Source: <http://www.veho-us.com>

Vacuum Clamping Table

Custom-made vacuum clamping table made by 3D-printer at HIM

- Carefully fixes the cable
- Easy on-/off-fixation
- Uses rotary vane pump from Lumi box

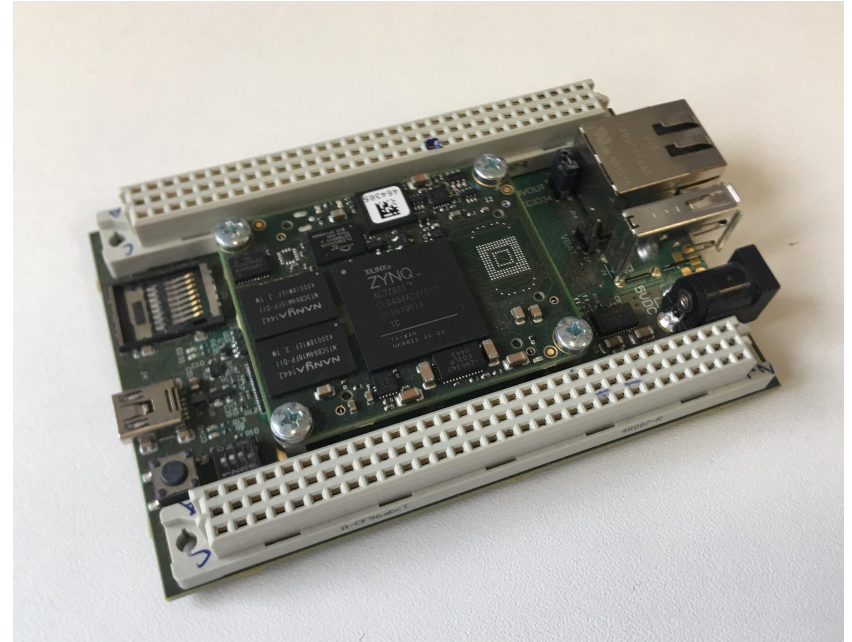
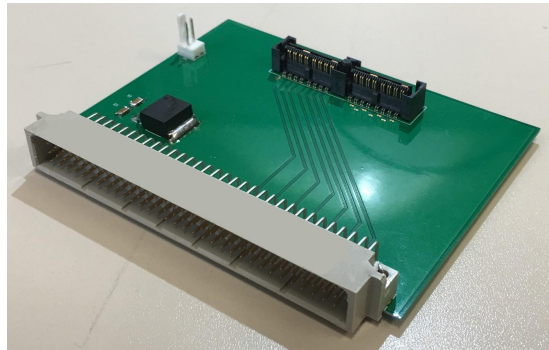


FPGA - Field Programmable Gate Array

Used to produce LVDS signals

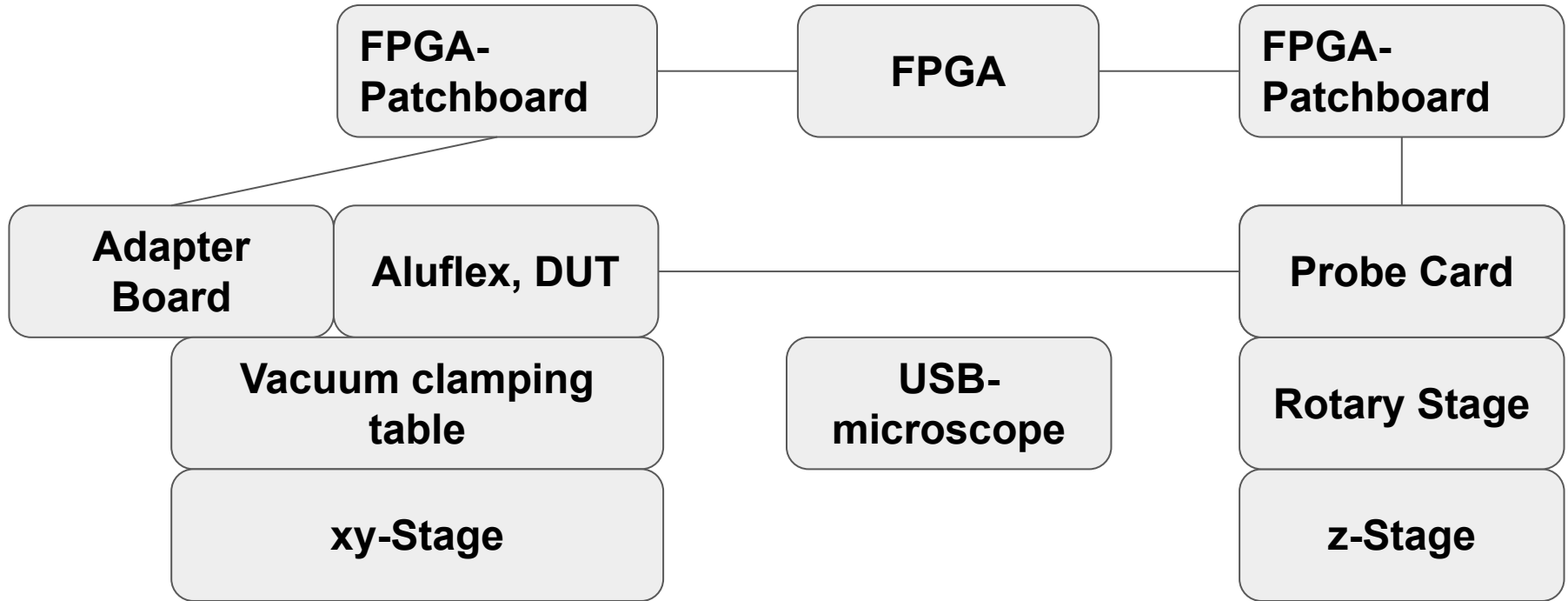
- Bandwidth: 800 MHz
- Transmission rate: up to 950 Mbit/s

Requires additional adapter board



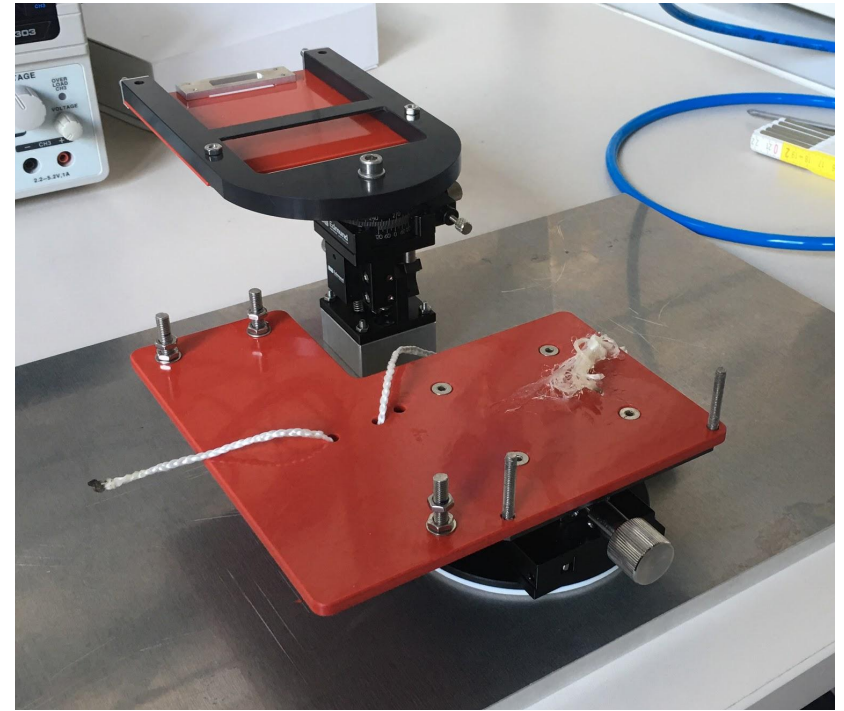
TE0720 Carrier Board with a XILINX ZYNQ XC7Z020

Detailed Test Bench Schematic



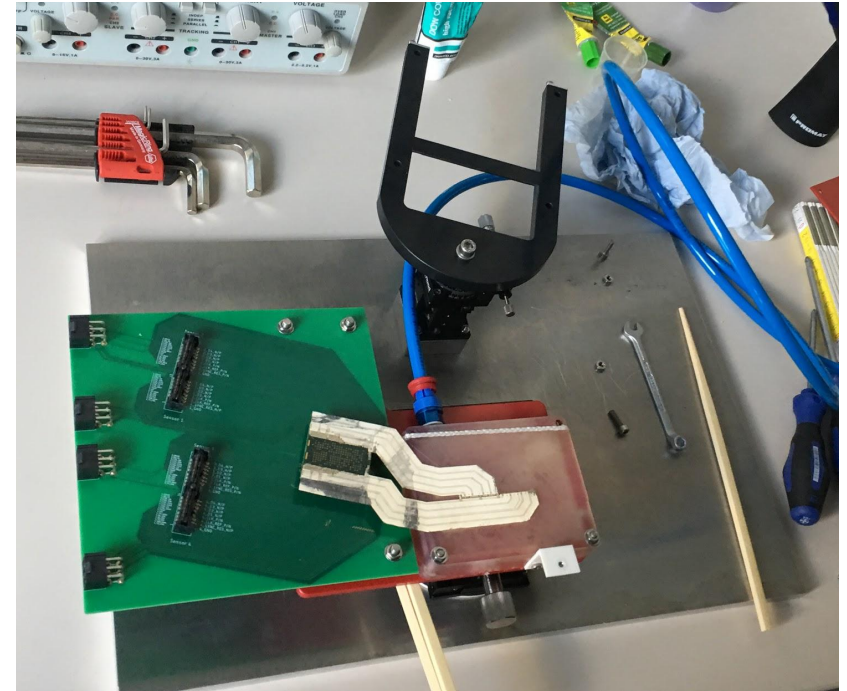
Test Bench Setup 1/4

- Aluminium ground plate
- Positioning stages
- Adapter plate (red L-shaped plate)
- Probe card holder (black U-shaped) + dummy



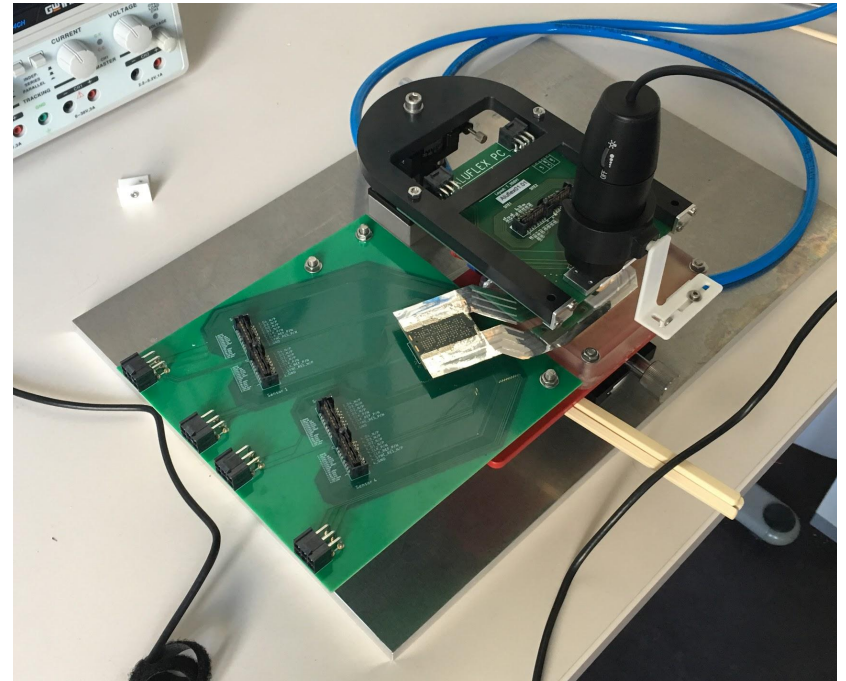
Test Bench Setup 2/4

- Vacuum clamping table
- Adapter PCB
- Aluflex cable



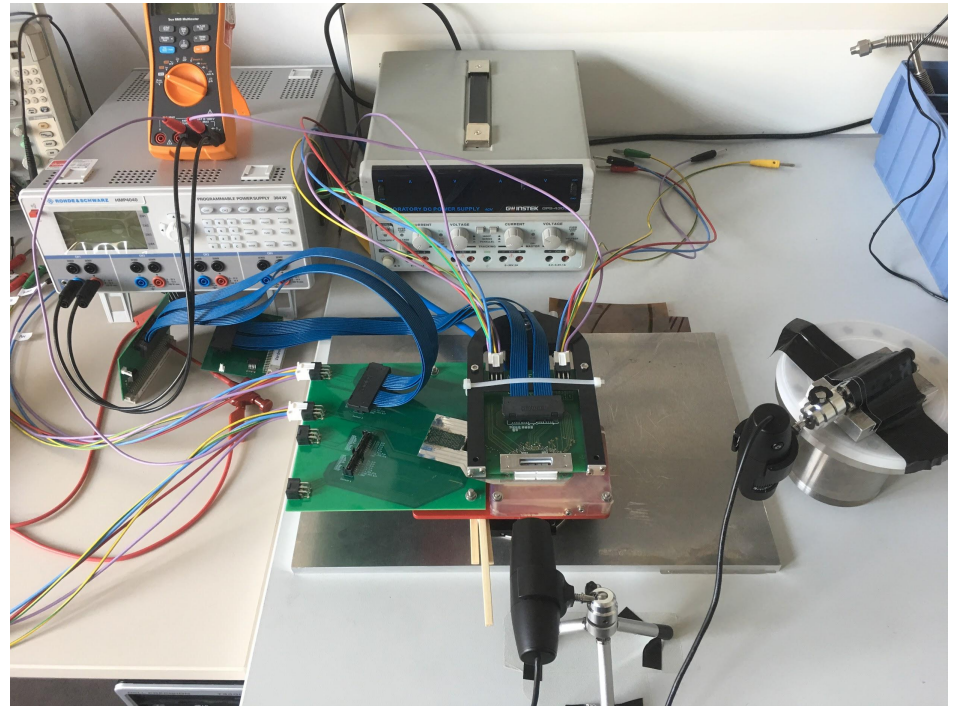
Test Bench Setup 3/4

- Probe card
- USB microscope



Test Bench Setup 4/4

- Rearranged USB microscopes
- 6QDP cables
- Power and HV cables
- FPGA Adapter board

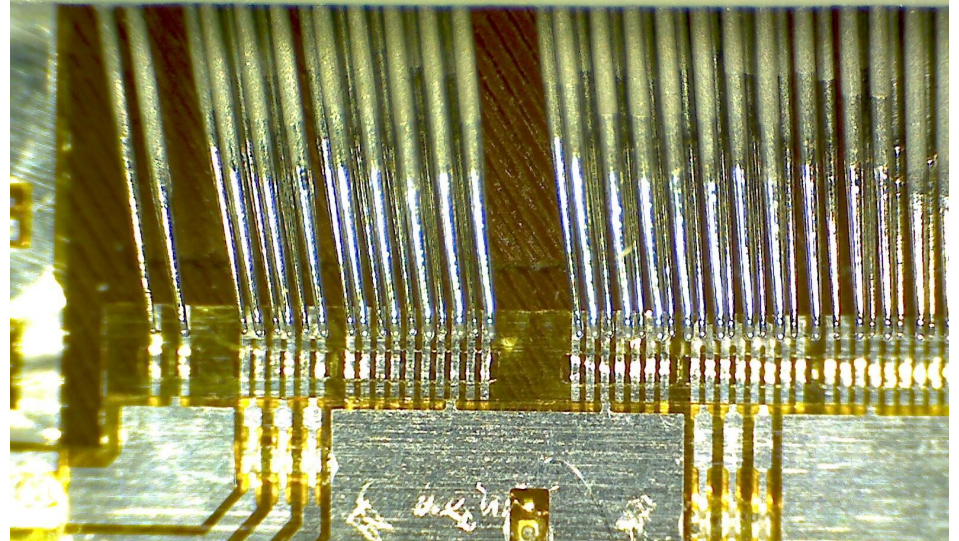


Testing the Aluflex cable

Requirement:

Good electrical contact between probe tips and bond pads!

- LV-Test
- HV-Test
- Data-Line-Test



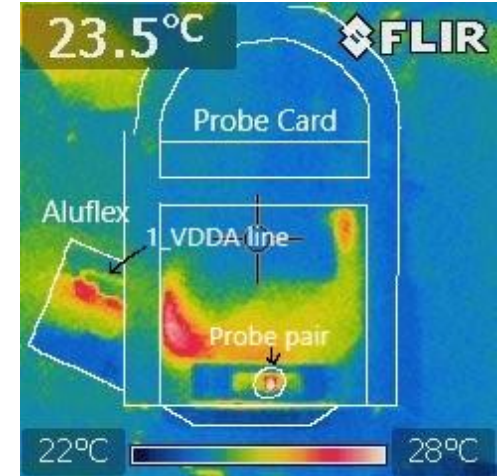
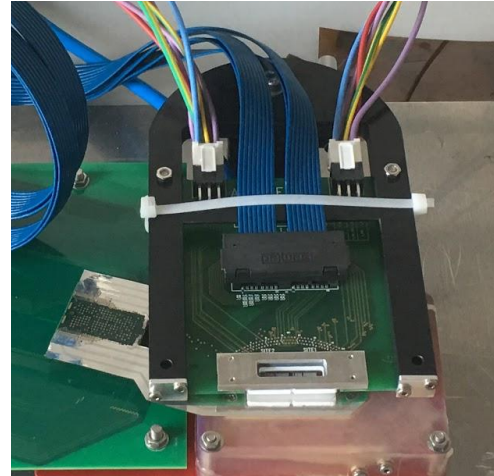
Contacting process in perspective of the USB microscope

LV-Test

Goal:

Determination of the power drop in a single line under stress conditions

- LV-lines must withstand at least 0.4A (corresponding to the power consumption of a single MuPix8 and its supply voltage of 1.8 V)



Infrared camera makes loaded line and needles visible

LV-Test Results

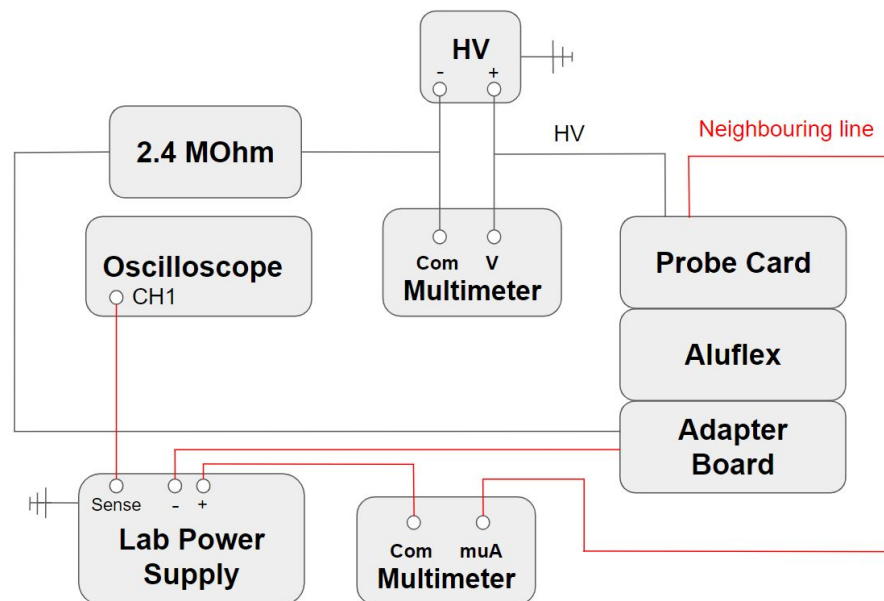
Current [mA]	Voltage [V]	Power [mW]
100 ± 0.2	0.119 ± 0.001	11.9 ± 0.1
400 ± 0.1	0.454 ± 0.001	181.6 ± 0.1
800 ± 0.1	0.928 ± 0.001	742.4 ± 0.1
900 ± 0.1	1.046 ± 0.005	946.9 ± 5
1000 ± 0.1	1.165 ± 0.003	1160 ± 10
1100 ± 0.1	1.292 ± 0.004	1430 ± 10
1200 ± 0.1	1.424 ± 0.001	1710 ± 10

Results for line 1_VDDA with a measured resistance of $(1.02 \pm 0.02\Omega)$

Goal:

Are the lines next to the HV line influenced by the applied HV?

- MuPix8 sensors are operated at a maximum HV of 100V



HV-Test Results

Applied HV [V]	Line	Voltage [mV]	Current [μ A]
18.5	4_HV_GND	65	0.00
	4_VDDA	100	0.00
	4_VSSA	80	0.00
61.0	4_HV_GND	175	0.00
	4_VDDA	400	0.00
	4_VSSA	400	0.00
101.3	4_HV_GND	1000	0.00
	4_VDDA	1050	0.00
	4_VSSA	800	0.00

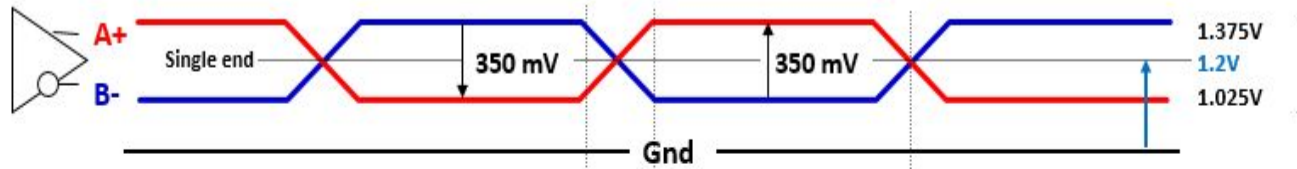
HV applied on line 4_HV with voltages measured in the neighboring lines

Data-Line-Test

Goal:

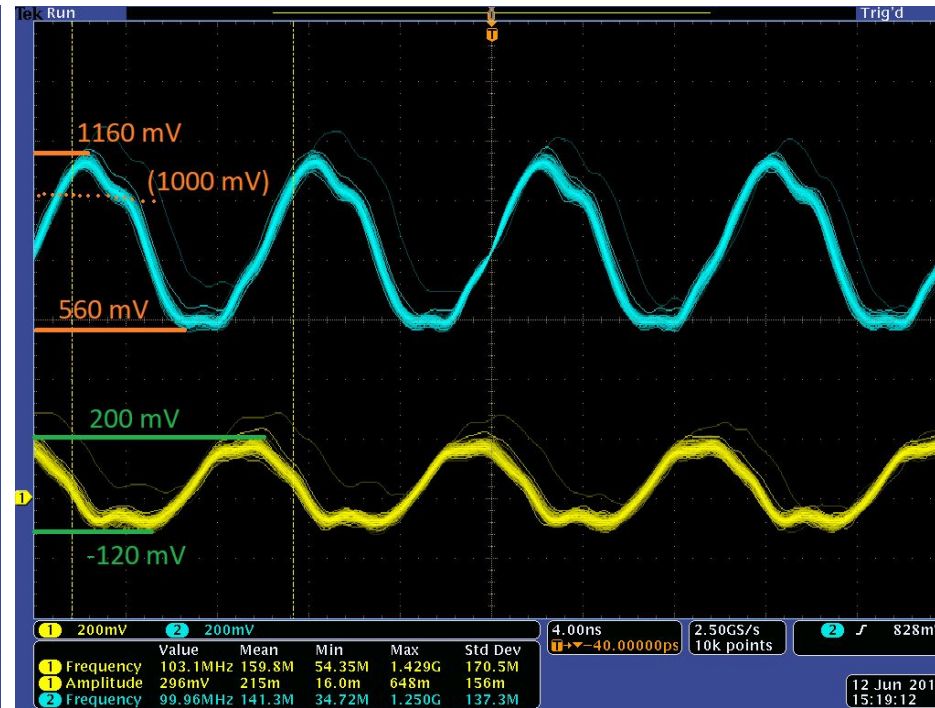
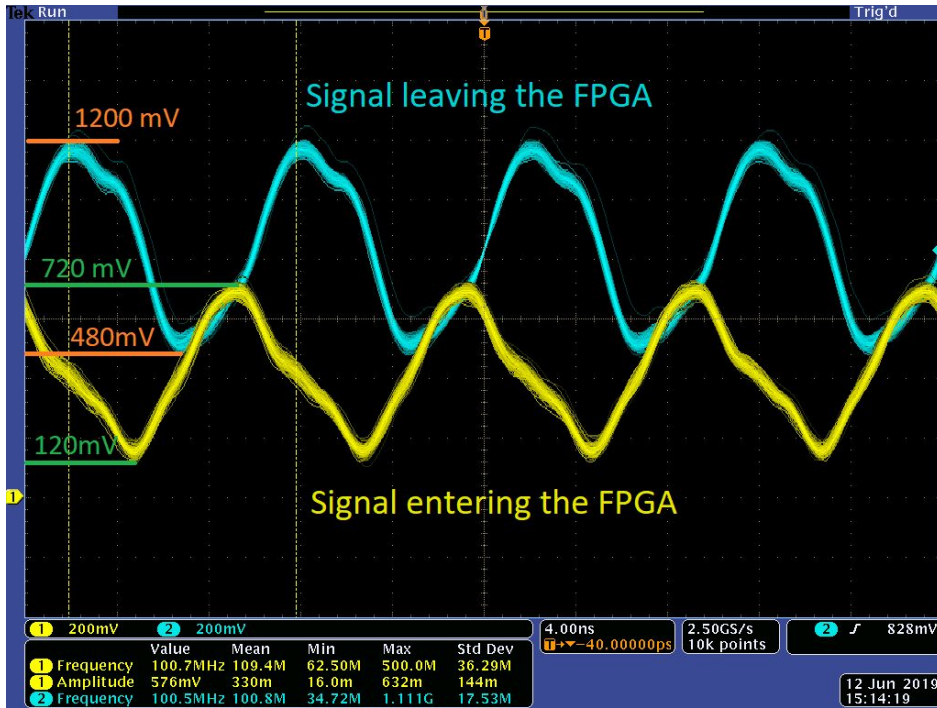
What is the influence of the data lines on the signal quality?

- Signal should not be deteriorated

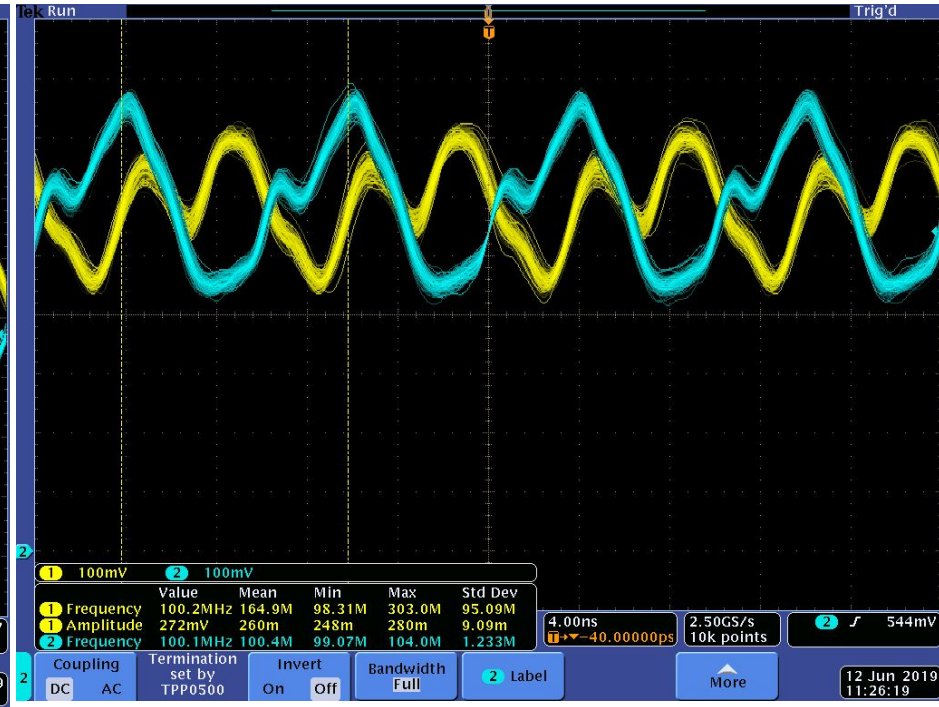
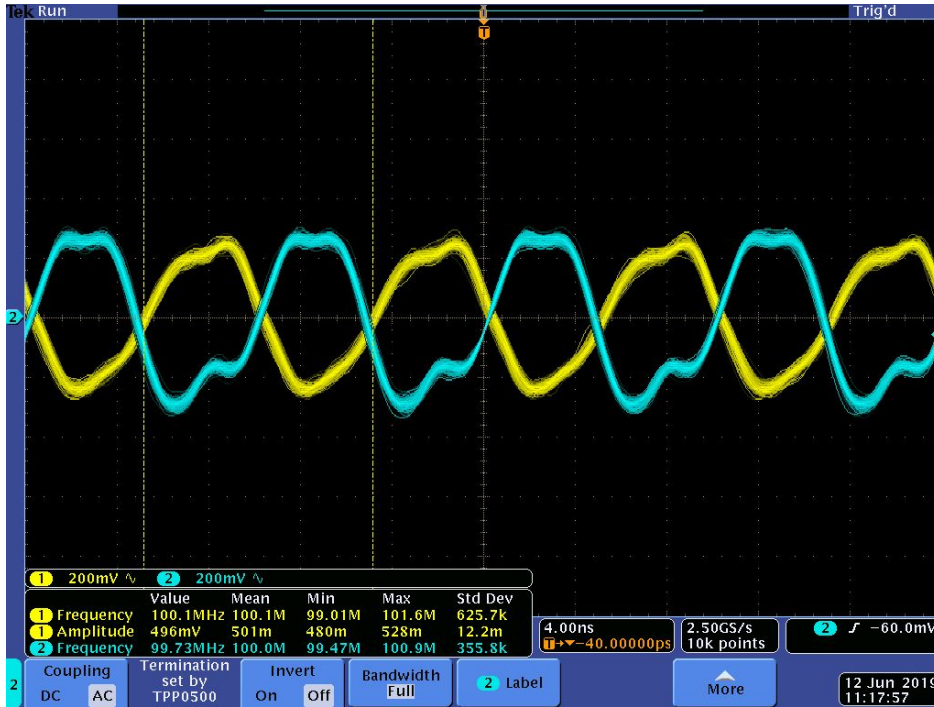


Exemplary differential signal

Data-Line-Test Results (Single Line)



Data-Line-Test Results (Pair of Lines)



Conclusion

- Test bench works, **but** positioning wasn't as precise as hoped for
- LV- and HV-test were successful
- Data-Line-Test have to be repeated in order to get significant results

Next steps:

1. Improve test bench in matters of positioning
2. Test remaining 4 Aluflex cables
3. ...
4. (Setup LMD prototype)