UNIVERSITÄT BONN

SI LAB
Silizium Labor Bonn

First test structure measurements

All-Silicon Meeting

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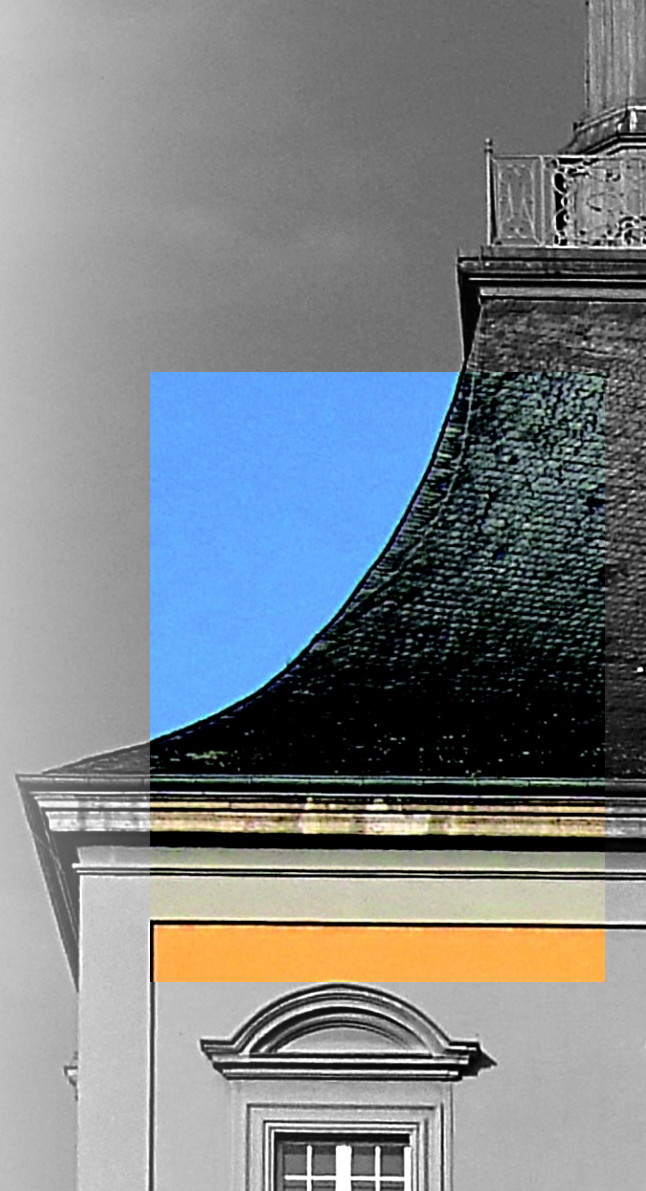
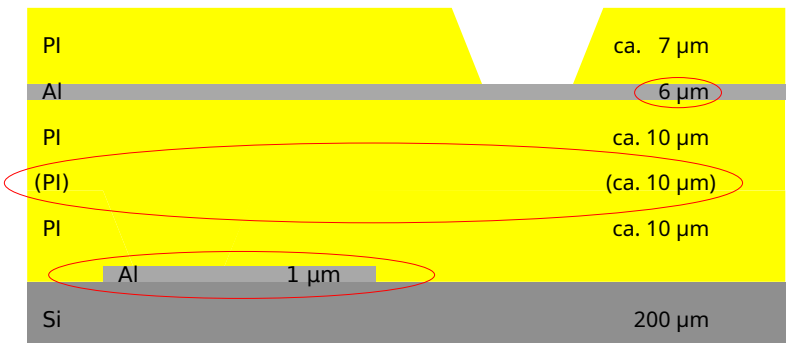


Bachelor Project

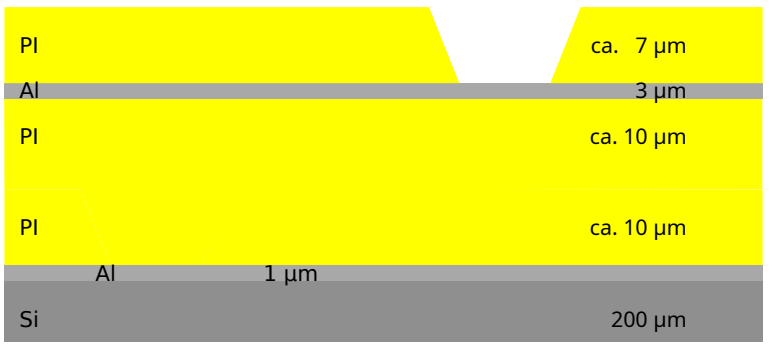
- Initial plan was to have test structures designed and simulated by bachelor student, then produced by us and measured.
  - Test sturctures had 20um/30um polyimide tickness with only structures on one metal layer (+GND plane, stackup on next pages)
  - Problems with design and production lead to only 3 usable traces (single ended, no differential!) on 30 tested differential lines.
  - GND was not connected (over etched, pad completely gone)
  - Test PCB hat footprint error and needed quite some modification
- Finally no usable measurements were possible
  - Design was modified and new structures produces as fast as possible

Stackup

- Original stackup (1125):
- Impledace simulation match to 100 Ohm, 80 Ohm



- New stackup (1225):
- No simulation to data, no thickness measurements on real module, yet
- Not many samples investigated



New design (1225)

- Same trace layout as before
  - Solid, shared GND pad, so that a few wirebonds would be sufficient (good choice!)
  - No vias (only cut outs for connections)
  - Large wire bond pads
  - 3 different designs with 10 differential pairs each (one initially for 20um, one for 30um, one for cross talk)
- Same (suboptimal) PBC: with modifications it seems to work well enough
  - Connect GND from vias to GND plane (solder mask opend with laser)
  - Open soldermask for GND connections at bullseye footprint (opend with laser)
  - Drill screw holes larger for bullseye screws

Production steps

- Sputtering of 1um Al (1125/1225)
- Photo resist + etch of Al (1125)
- HD 4100 processing (no hard bake) (1125/1225)
- Hard bake (1125)
- HD4100 processing (1125*/1225)
- Hard bake (1125/1225)
- Sputtering of 6 um (1125) / 3um (1225)
- Photo resist + etch (1125/1225)
- HD4100 processing (1125/1225)
- Hard bake (1125/1225)

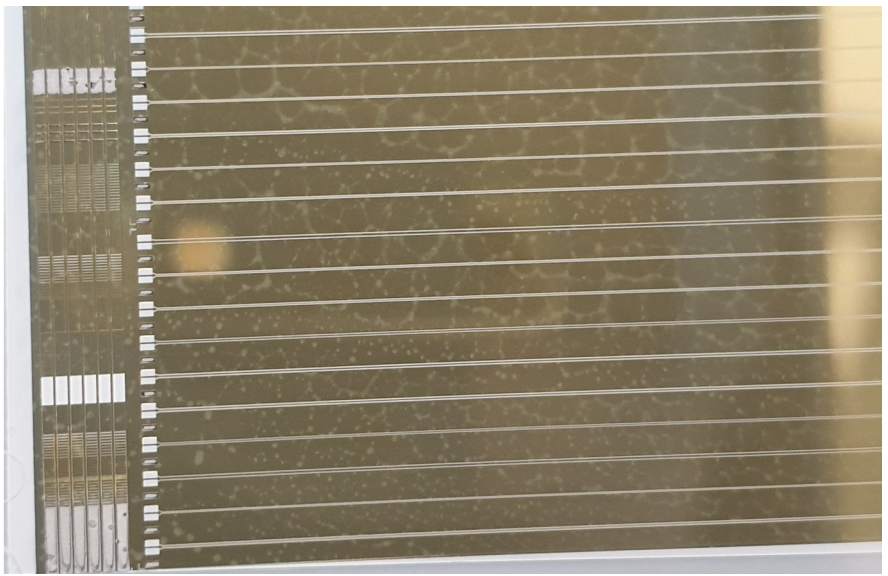
For 1125 two 525um 10cm wafers were processed of which one broke during PEB
For 1225 four 200um wafers were processed of which one broke on the MLA

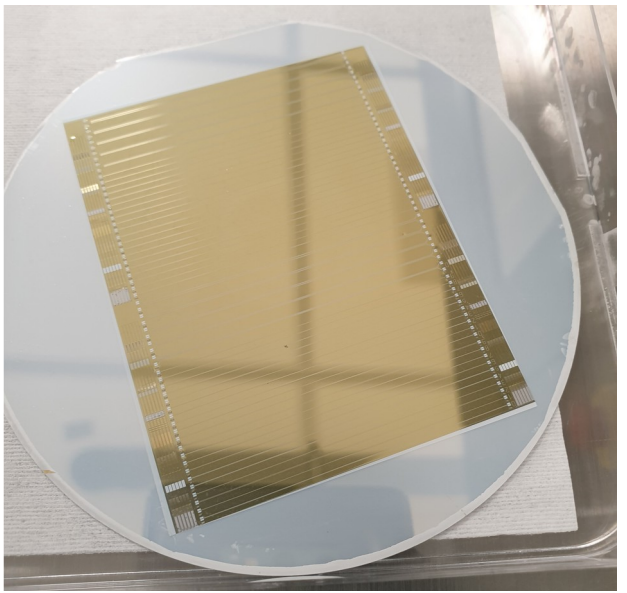
*for 1125 this step was repeated twice but MLA broke during one exposure, so 10 um thickness missing

Preliminary results

Disclamer: Only 1 day for measurements, only one test structure, no selection, no simulation

- Several of the structures seem to work!
- TDR and eye diagrams show somewhat expected behaviour
- Comparison to simulations possible after measurements of real thickesses of structures





Preliminary results

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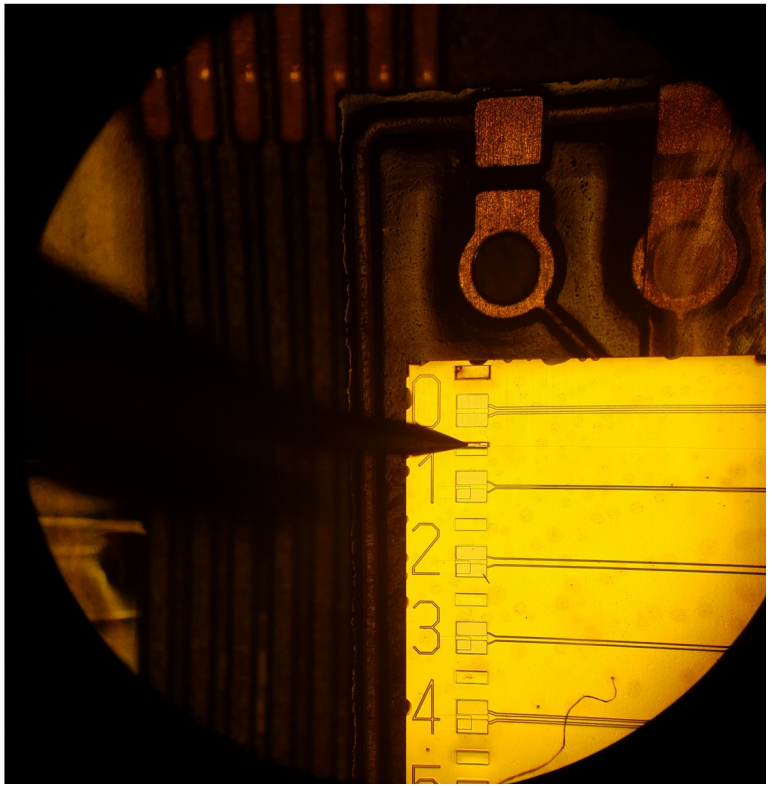

- Verified contact and resistance of traces with needle prober
- Found good contact to GND on most modules
- Measured resistances and verified on bonded strucutres:

W01b T1 TS1

TS1		TS5	
a)	16.35 Ohm	a)	14.28 Ohm
b)	16.49 Ohm	b)	14.44 Ohm
a-b)	open	a-b)	open
TS2		TS9	
a)	31.1 Ohm	a)	20.57 Ohm
b)	31.44 Ohm	b)	-- Ohm
b-a)	20.33 Ohm	a-b)	open
a-b)	40.93 Ohm		
TS4		TS10	
a)	14.21 Ohm	a)	21.42 Ohm
b)	14.34 Ohm	b)	22.03 Ohm
a-b)	open	a-b)	open

Preliminary results

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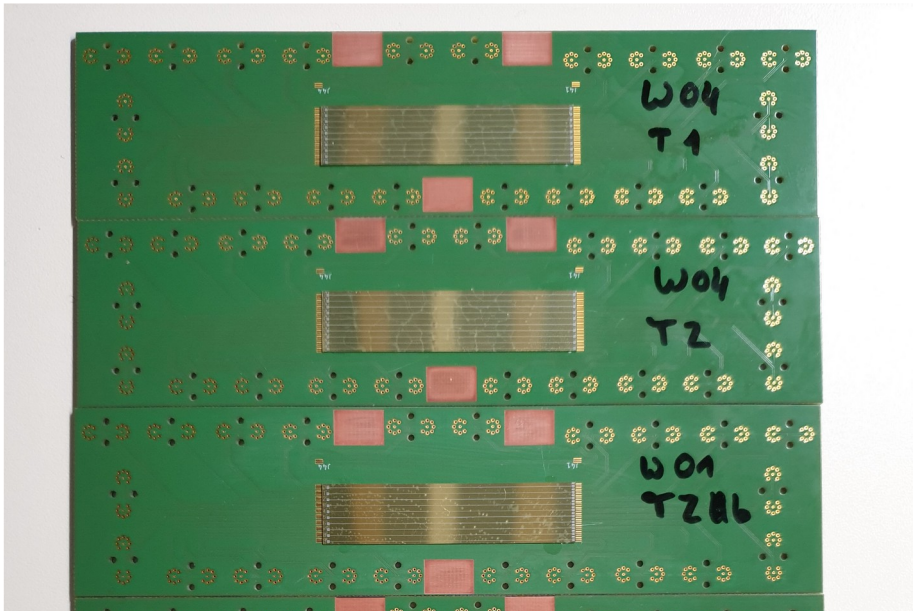

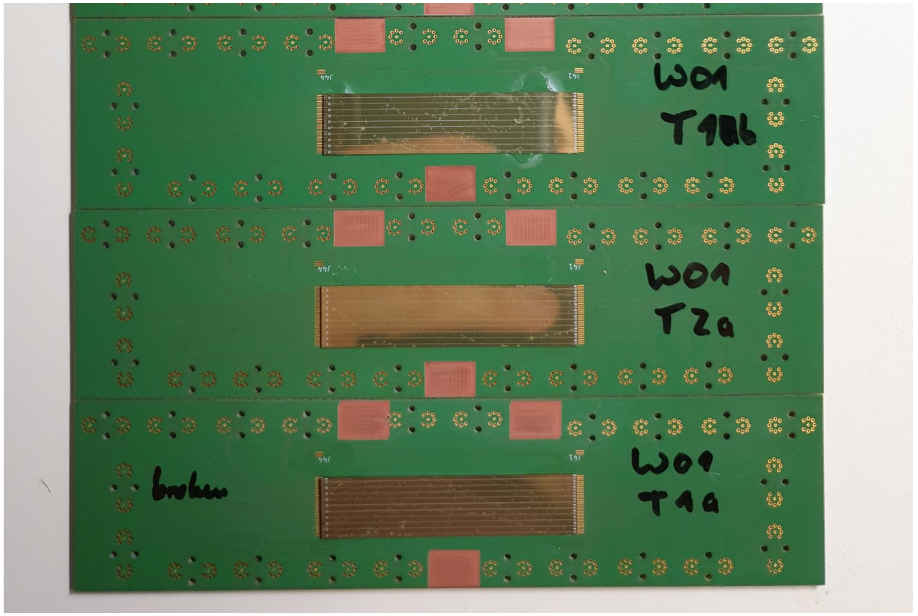

One module broke during glueing

Preliminary results

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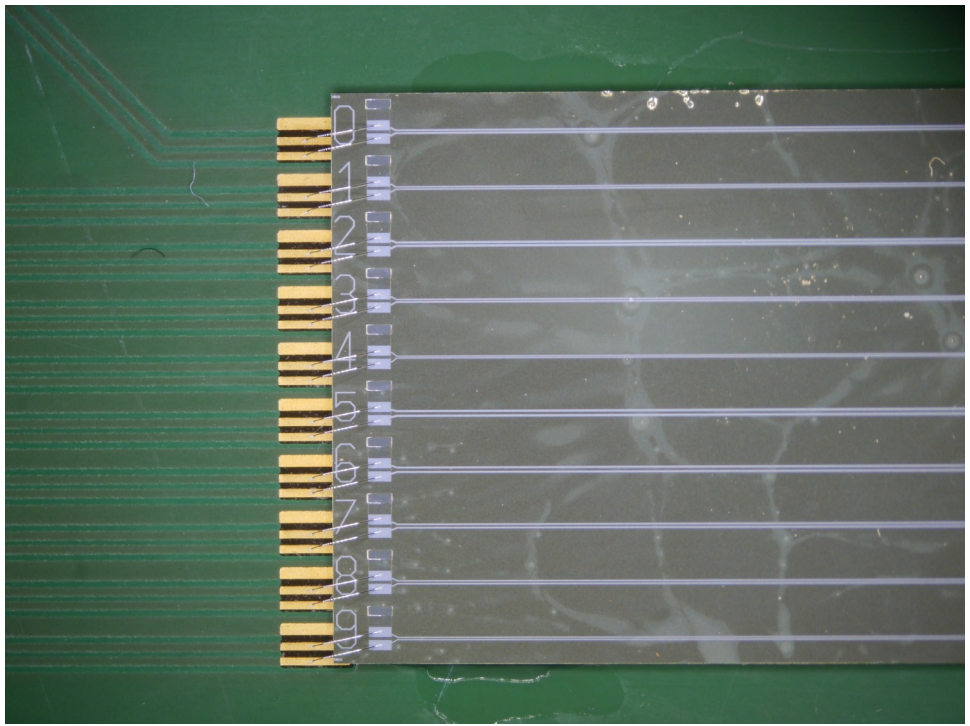
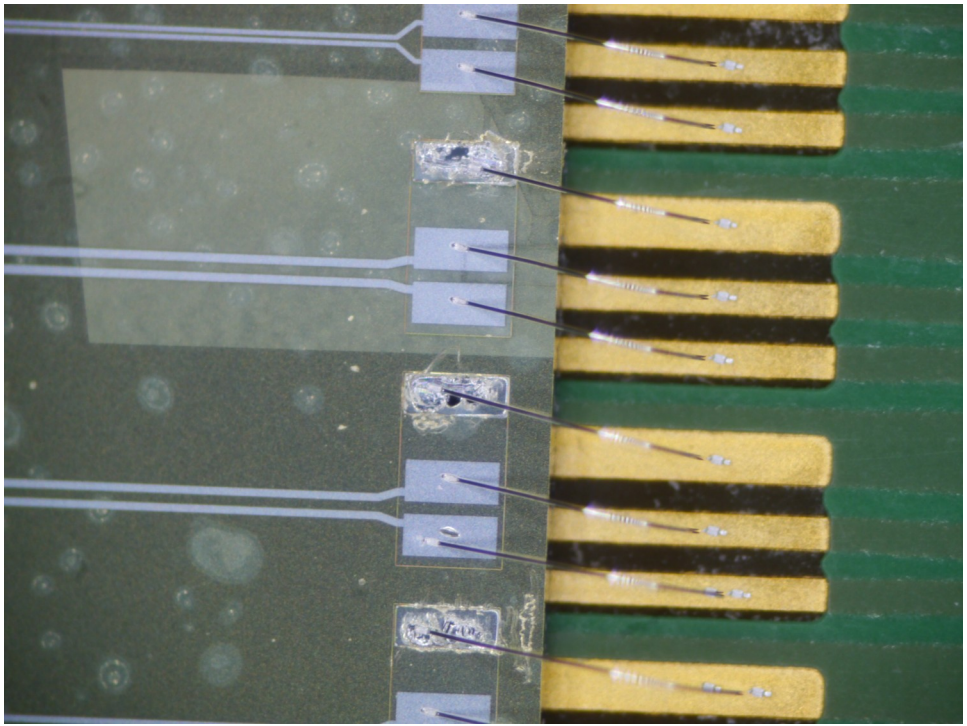
After needle measurements test structures were bonded to PCBs

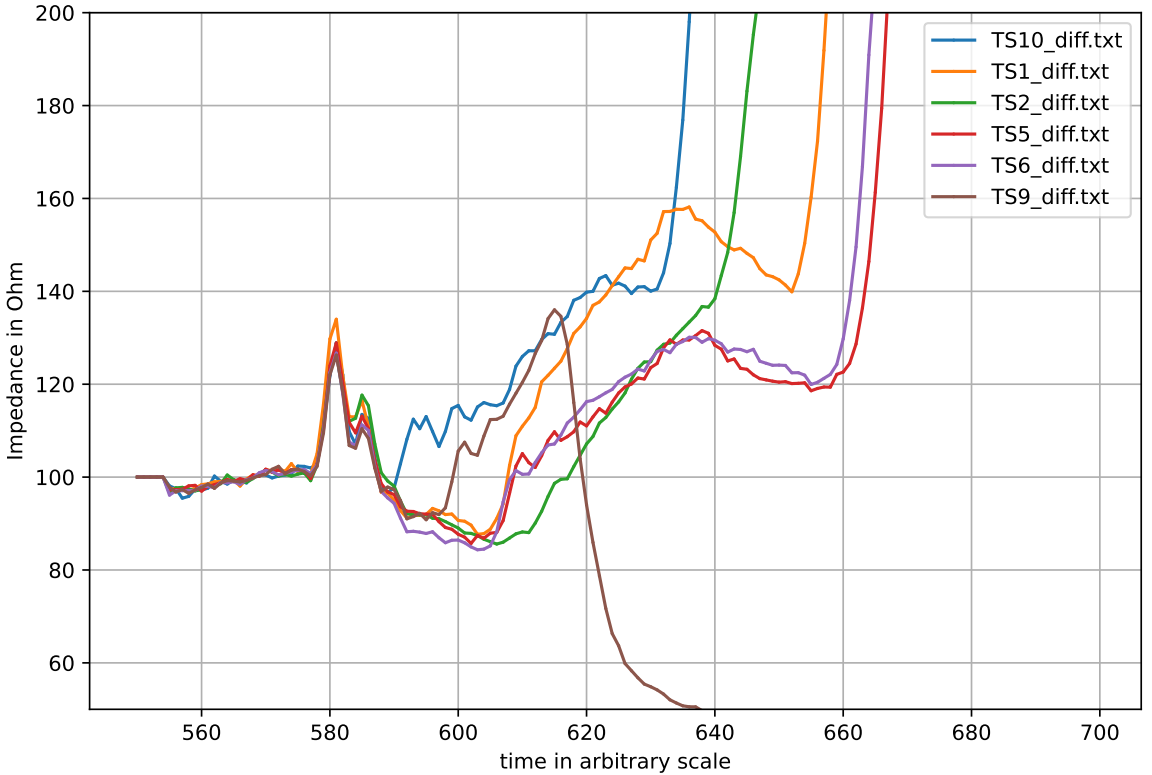




Preliminary results

Disclamer: Only 1 day for measurements, only one test structure, no selection, no simulation

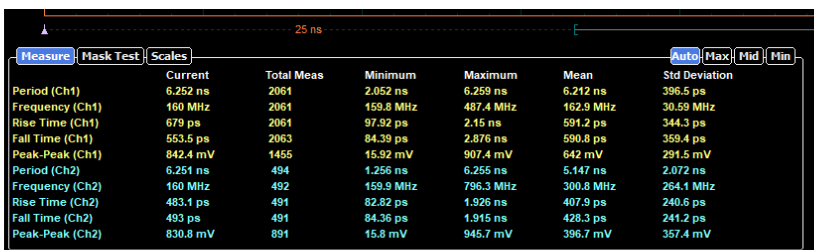
- TDR shows no impedance matching (also on PCB)
- But 5cm structure is resolvable and impedance is in expected and acceptable range
- One differential pair shows short



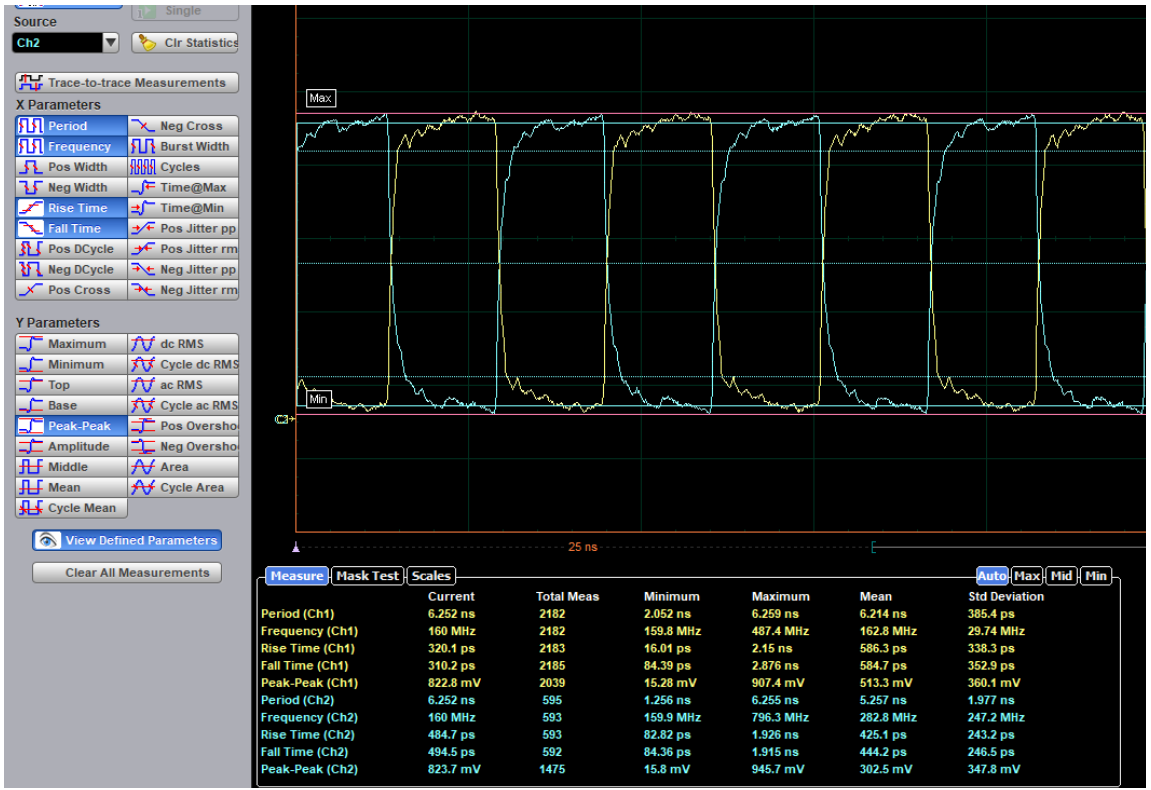
Preliminary results

Disclamer: Only 1 day for measurements, only one test structure, no selection, no simulation

- Rise and fall times were measured with signal generator and square signal
- Rise/Fall time in range of 300 ps to 600 ps



	Current	Total Meas	Minimum	Maximum	Mean	Std Deviation
Period (Ch1)	6.252 ns	2061	2.052 ns	6.259 ns	6.212 ns	396.5 ps
Frequency (Ch1)	160 MHz	2061	159.8 MHz	487.4 MHz	162.9 MHz	30.59 MHz
Rise Time (Ch1)	679 ps	2061	97.92 ps	2.15 ns	591.2 ps	344.3 ps
Fall Time (Ch1)	553.5 ps	2063	84.39 ps	2.876 ns	590.8 ps	359.4 ps
Peak-Peak (Ch1)	842.4 mV	1455	15.92 mV	907.4 mV	642 mV	291.5 mV
Period (Ch2)	6.251 ns	494	1.256 ns	6.255 ns	5.147 ns	2.072 ns
Frequency (Ch2)	160 MHz	492	159.9 MHz	796.3 MHz	300.8 MHz	264.1 MHz
Rise Time (Ch2)	483.1 ps	491	82.82 ps	1.926 ns	407.9 ps	240.6 ps
Fall Time (Ch2)	493 ps	491	84.36 ps	1.915 ns	428.3 ps	241.2 ps
Peak-Peak (Ch2)	830.8 mV	891	15.8 mV	945.7 mV	396.7 mV	357.4 mV

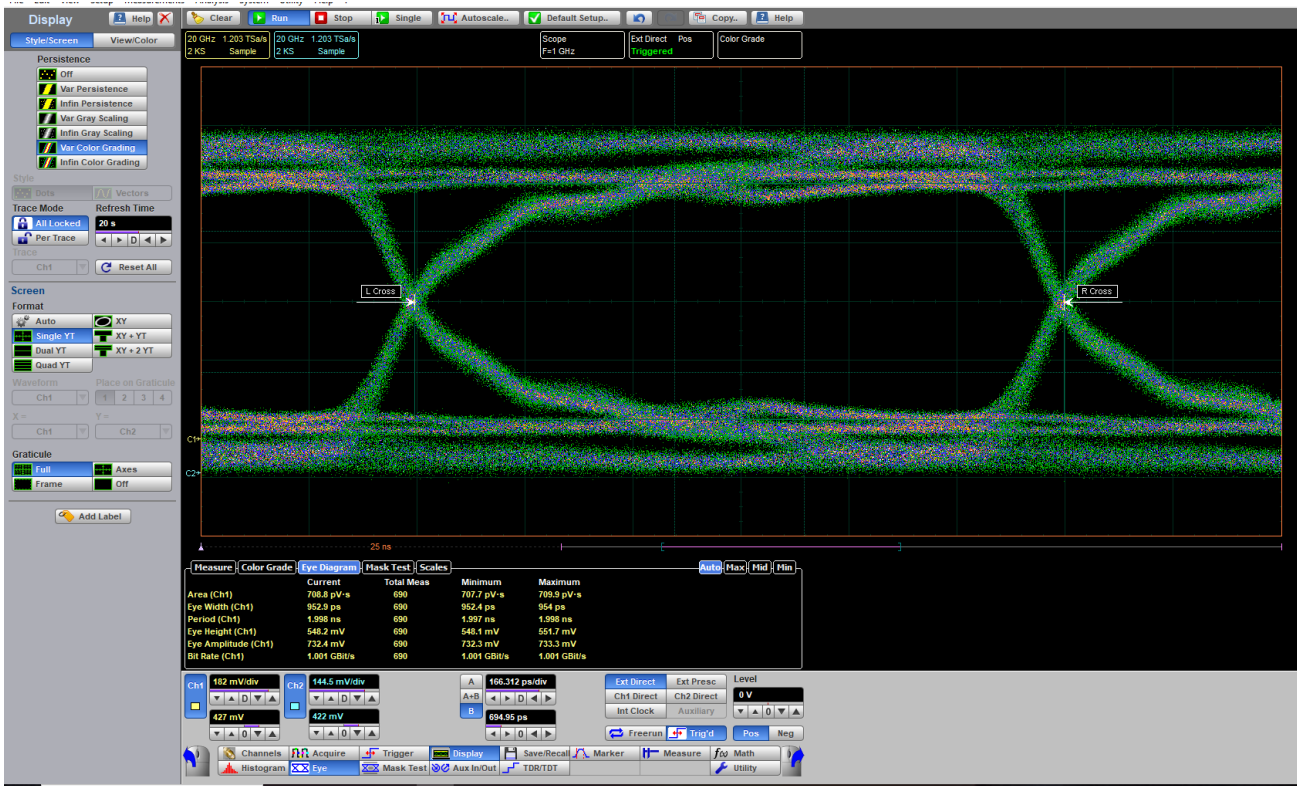


	Current	Total Meas	Minimum	Maximum	Mean	Std Deviation
Period (Ch1)	6.252 ns	2182	2.052 ns	6.259 ns	6.214 ns	385.4 ps
Frequency (Ch1)	160 MHz	2182	159.8 MHz	487.4 MHz	162.8 MHz	29.74 MHz
Rise Time (Ch1)	320.1 ps	2183	16.01 ps	2.15 ns	586.3 ps	338.3 ps
Fall Time (Ch1)	310.2 ps	2185	84.39 ps	2.876 ns	584.7 ps	352.9 ps
Peak-Peak (Ch1)	822.8 mV	2039	15.28 mV	907.4 mV	513.3 mV	360.1 mV
Period (Ch2)	6.252 ns	595	1.256 ns	6.255 ns	5.257 ns	1.977 ns
Frequency (Ch2)	160 MHz	593	159.9 MHz	796.3 MHz	282.8 MHz	247.2 MHz
Rise Time (Ch2)	484.7 ps	593	82.82 ps	1.926 ns	425.1 ps	243.2 ps
Fall Time (Ch2)	494.5 ps	592	84.36 ps	1.915 ns	444.2 ps	246.5 ps
Peak-Peak (Ch2)	823.7 mV	1475	15.8 mV	945.7 mV	302.5 mV	347.8 mV

Preliminary results

Disclamer: Only 1 day for measurements, only one test structure, no selection, no simulation

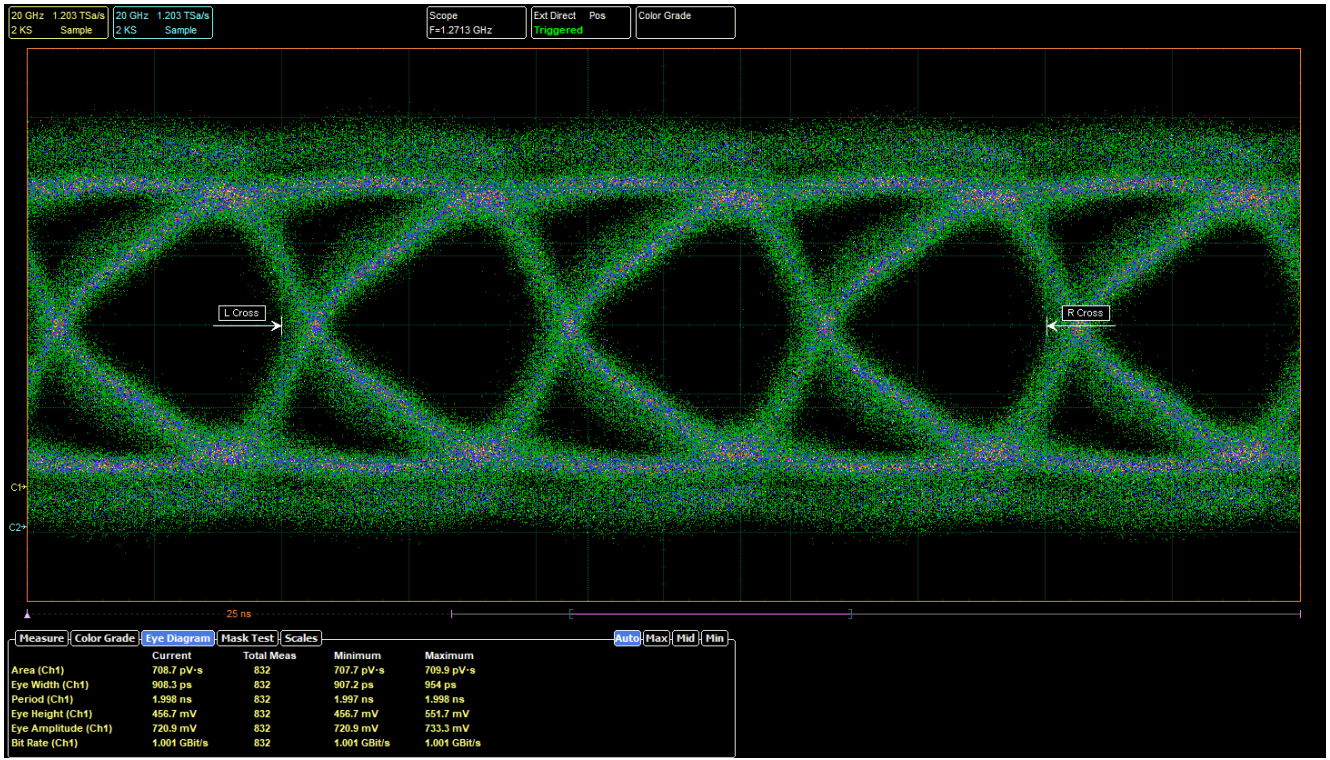
- On one test trace eye diagrams were recorded
  - With 1GHz!!!
- That looks pretty good!
  - But is also pretty expected considering the trace lenght is only 5 cm



Preliminary results

Disclamer: Only 1 day for measurements, only one test structure, no selection, no simulation

- On one test trace eye diagrams were recorded
  - With 3GHz!!!
- That looks still pretty good!



Conclusion

- Production of first test structures was not successful
- Second production run with modified stack up worked really well!
- Test structures work
  - TDR shows first results (need verification with simulation!!!)
  - Eyediagrams look very promising (need verification with simulation)
  - Resistances were measured with multimeter (need verification with calculation)
- Next steps:
  - Increase thickness of Al
  - Manufacture vias
  - Produce longer test structures (up to 14 cm)
  - Refine processing
  - Test new photo resists
  - Optimize test structures