Progress on designing a dedicated electrical test board for the IZM structure

Universität Siegen, October 16th, 2025

The HEP Group and the Electronics Laboratory

We are interested in designing a PCB to host and electrically interface the **IZM structure** with **emphasis on characterizing the data transmission lines**.

• We need a **supporting PCB** with the necessary wire bond pads and some routing of traces, as well as appropriate connectors to interface the differential pair to the measuring equipment.

• Apart from the careful design of the high-speed traces, we must understand how to achieve impedance matching, in principle and in practice, for the wire bonds connecting the transmission lines of the structure to the traces and connectors on the PCB; another test board to study the matching.

• Use the simulation software Ansys (HFSS and SIwave tools) for modeling the structure and calculating the electrical properties of differential pairs.

Using our Tektronix differential TDR device (BW 20 GHz), the following measurements can be taken:

- **S-parameters**: input reflection coefficient (S11) and transmission coefficient (S12).
- **Impedance profile** of differential pair traces.

- From it, we can build an electrical model of the transmission line from the S-parameters for use in SPICE simulation.

- Predict the **maximum transmission rate** with the simulation.
- Verify this rate and **measure the bit error rate** as a function of the transmission rate.

On the IZM structure we have **six** Differential Transmission Lines in **M2 metal** layer with WB pads in M3 on left side:

a) open at the end: vias from M2 to M1 and Al with "buried pads" (not accessible); the lengths of pairs 1-4 are**:**

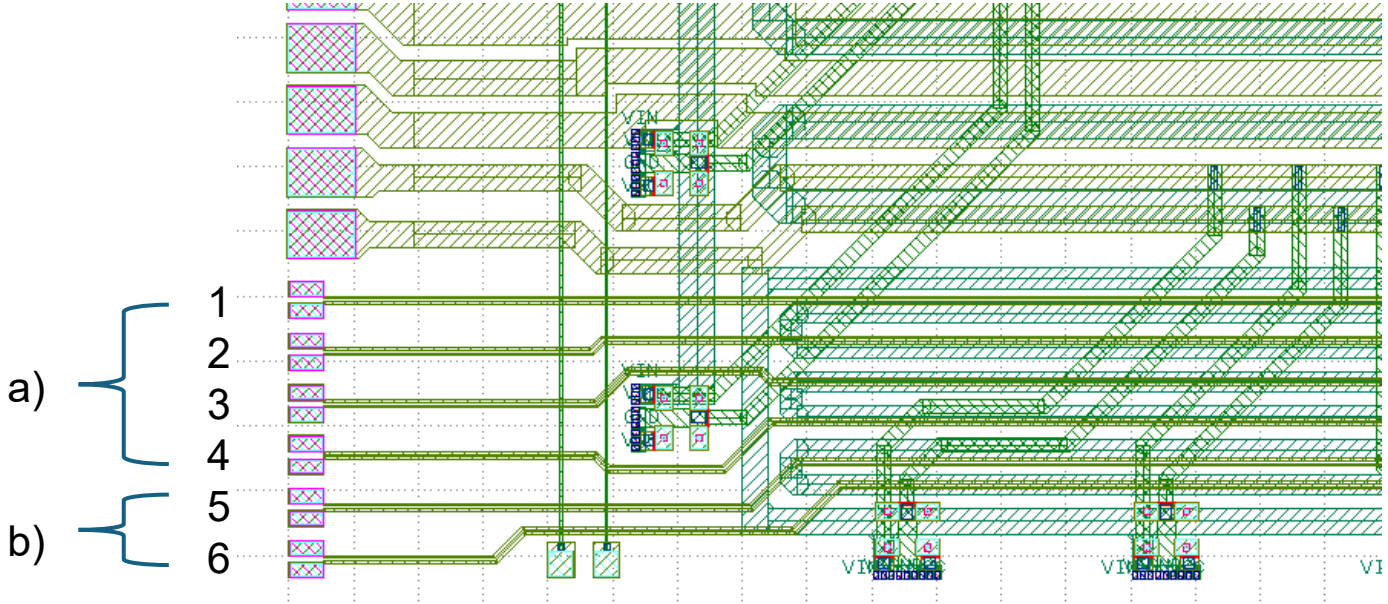
1 => ~12 cm
2 => ~ 9 cm
3 => ~ 6 cm
4 => ~ 3 cm

→ Possible measurements: reflection coefficient, and impedance profile.

b) full length pairs, ~12 cm, with four intermediate bridges in M1, at the end with WB pads in M3 (300 µm x 210 µm)

5 => ~12 cm
6 => ~12 cm

→ Possible measurements: reflection and transmission coefficients, and impedance profile.

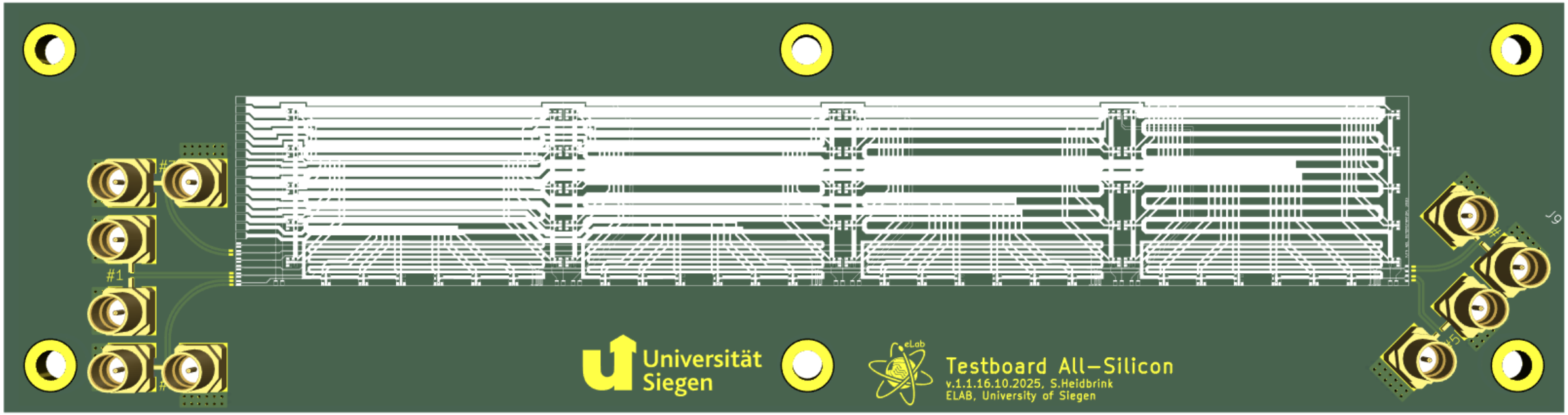


Thank you, Andreas and Marco, for preparing the IZM structures with front and back parts cut off !

We are awaiting the structures to arrive in Siegen for cross checking with our PCB designs.

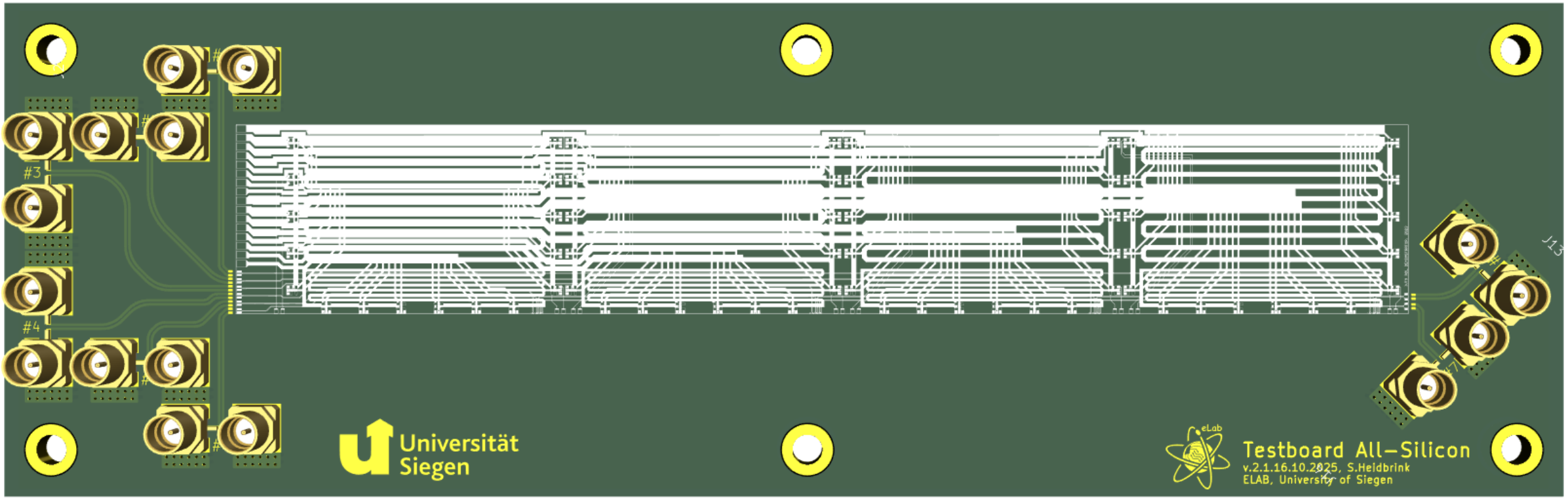
This is our preliminary PCB design for hosting the structure and interfacing with measuring devices:

A flavor “Short” optimized for short signal traces.
Four upper differential pairs share one pair of SMP connectors with optional wire bonding.

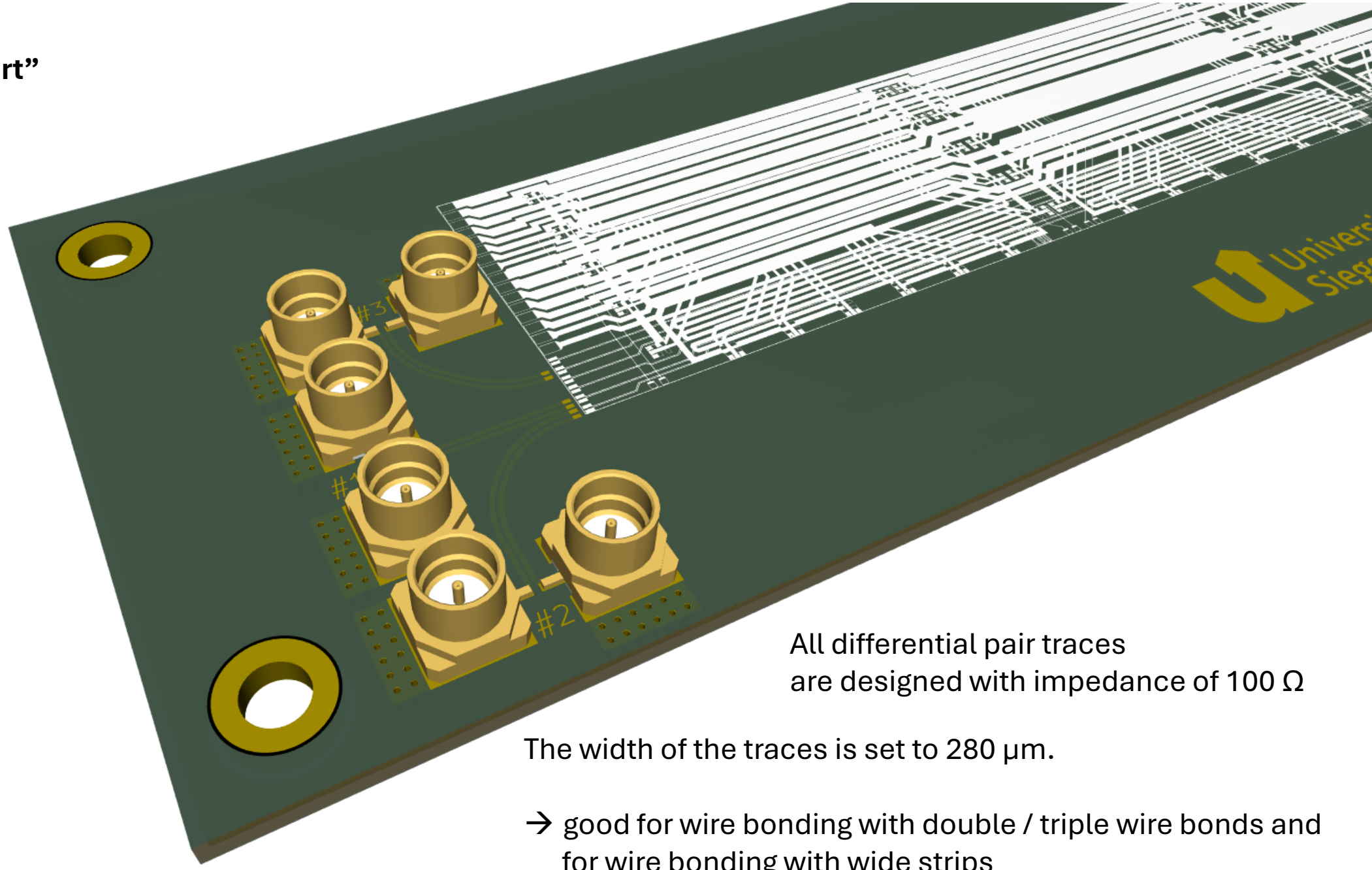


This is our preliminary PCB design for hosting the structure and interfacing with measuring devices:

A flavor “All” providing pairs of SMP connectors for all six differential pairs.



The flavor “Short”

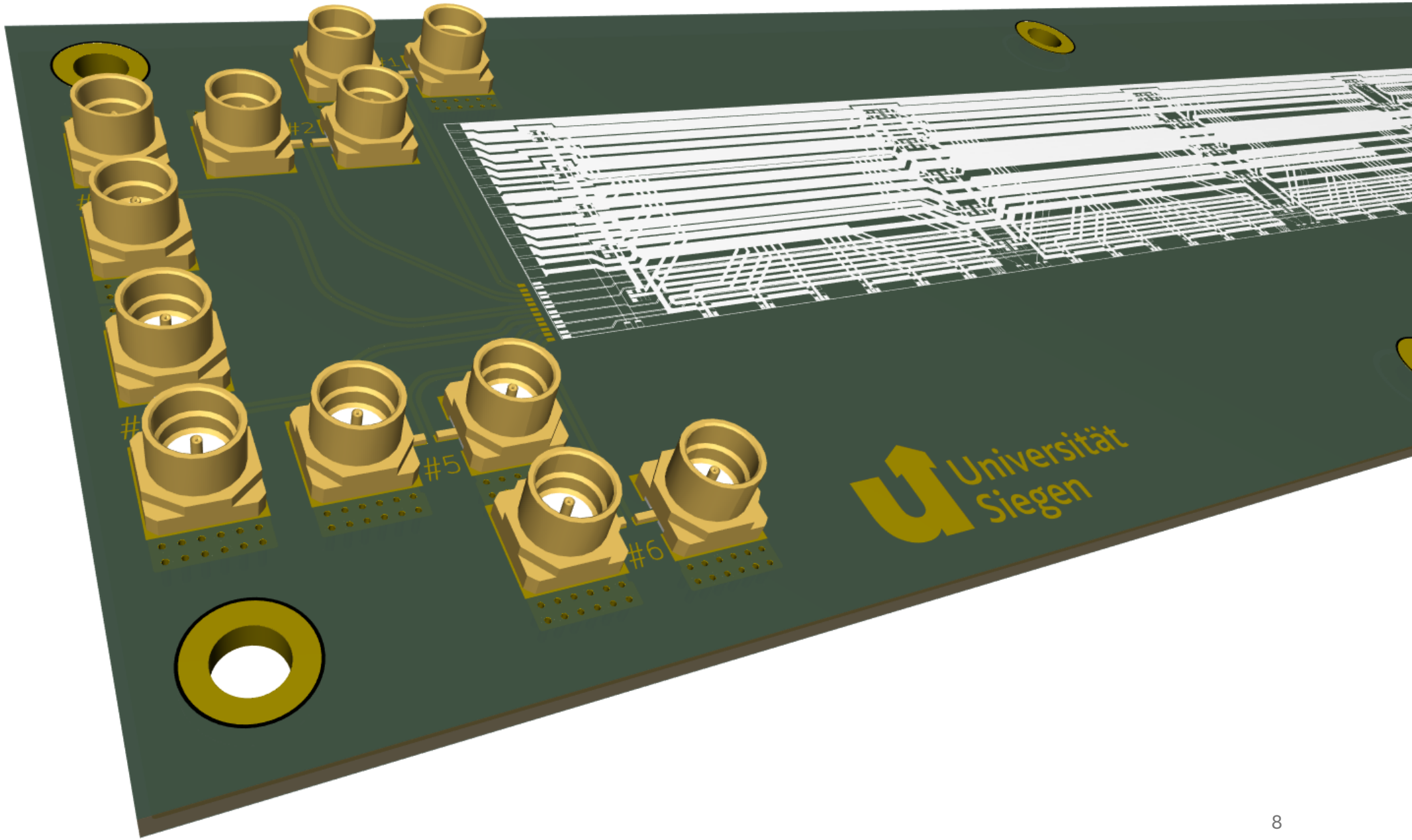


All differential pair traces
are designed with impedance of 100 Ω

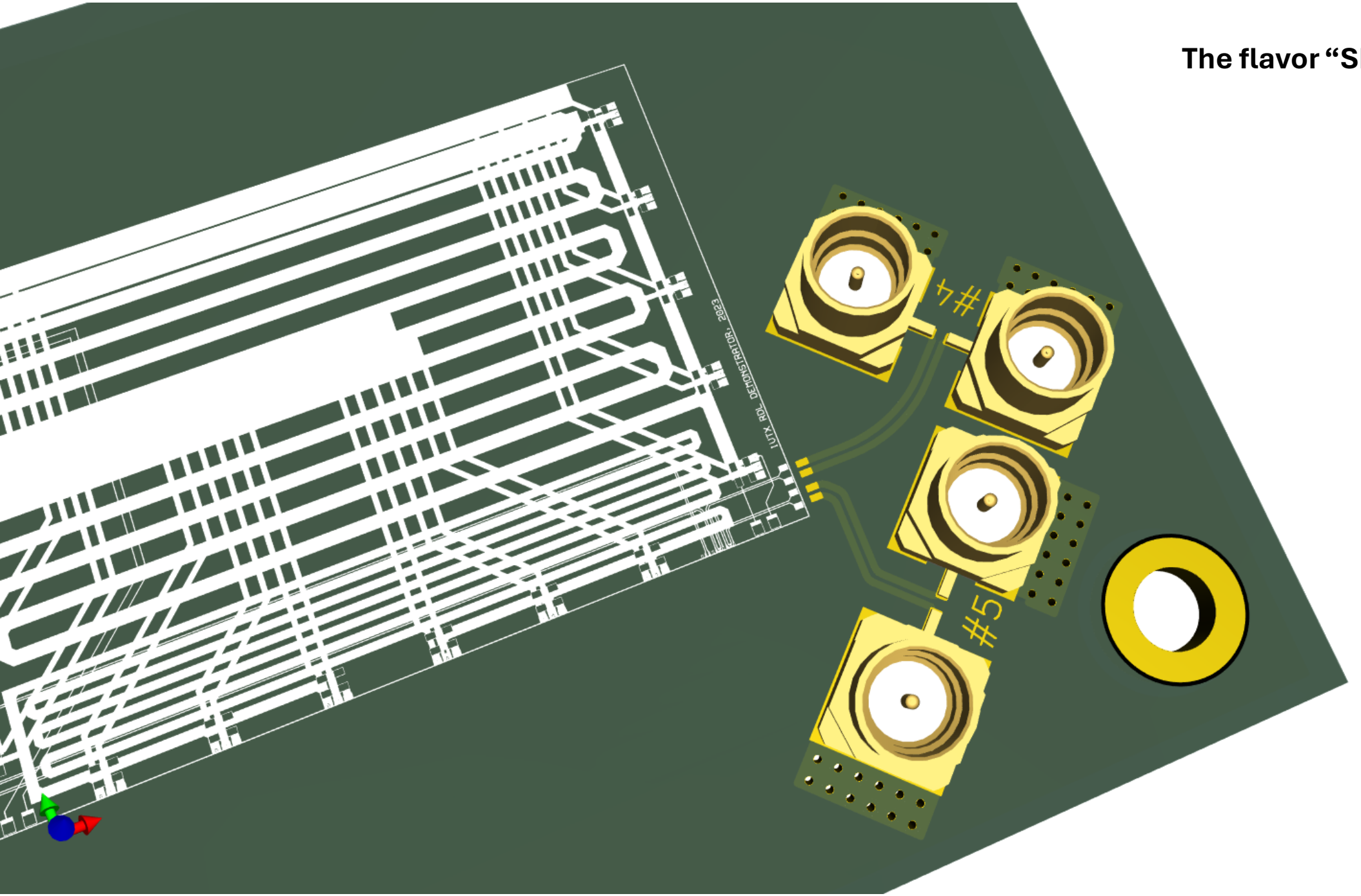
The width of the traces is set to 280 µm.

→ good for wire bonding with double / triple wire bonds and for wire bonding with wide strips

The flavor “All”



The flavor “Short” and “All”

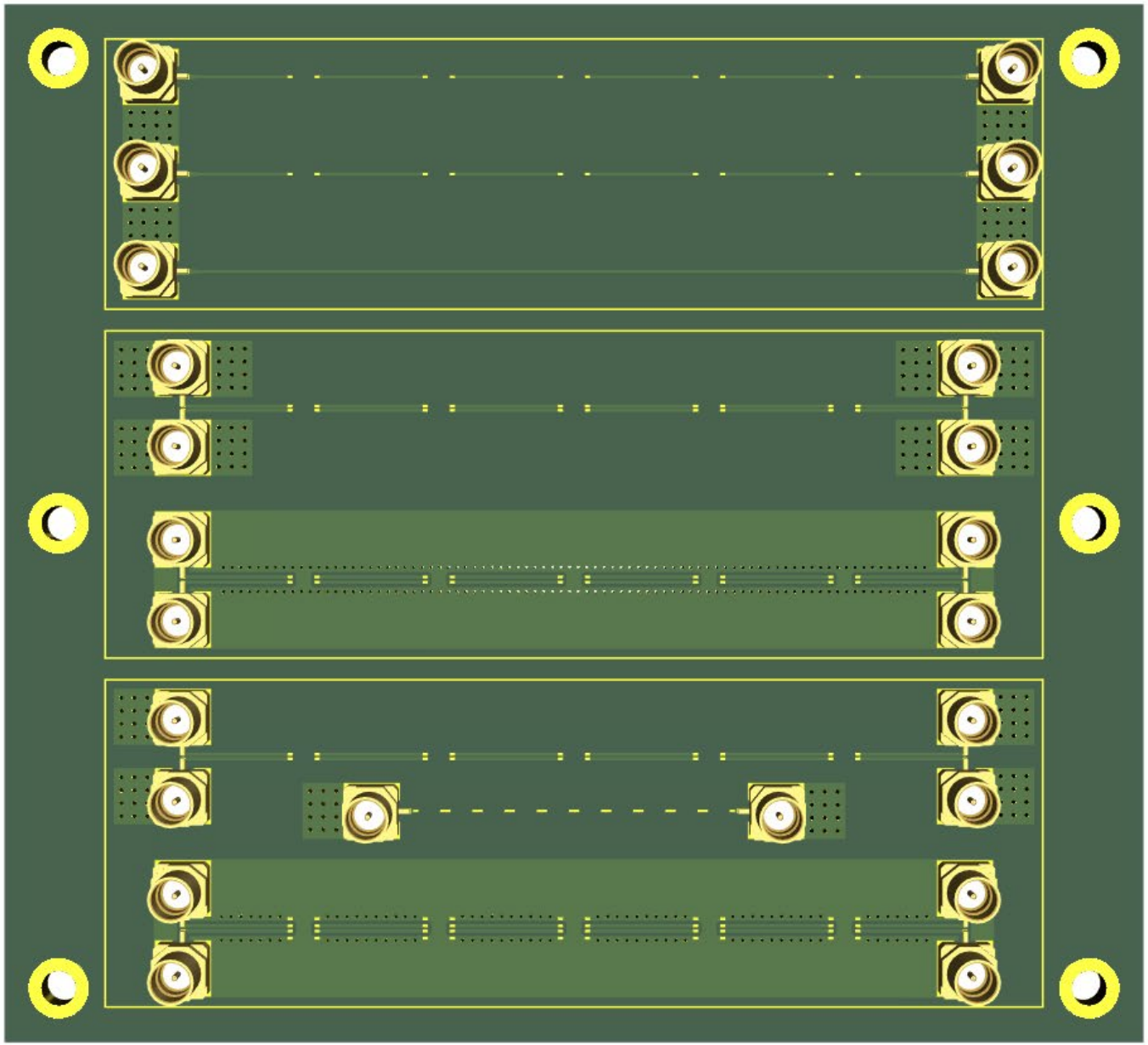


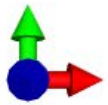
This is our preliminary PCB design for testing and studying the impedance matching of the wire bonds

The structures are suitable for single, double, triple **thin wire bonds** (25um)

and for **wide strip bonds.**

We plan to wire bond with wide strips with the help of outside companies.





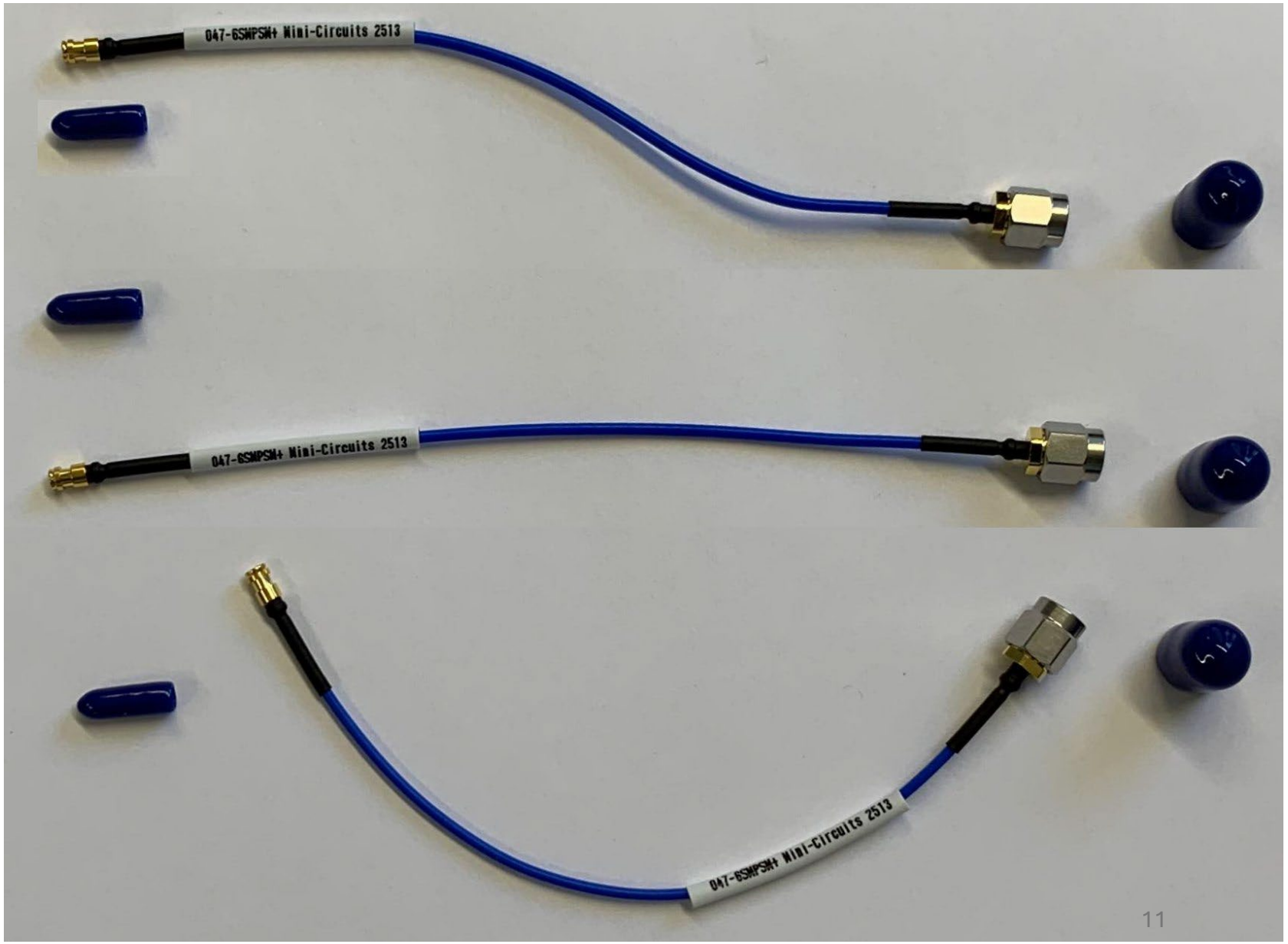
We will use a microwave small size connector of SMP type to allow for shorter traces on the PCB

We’ve got five

coaxial cables of 15 cm
SMA to **SMP** standard

bandwidth of 20 GHz

built by Mini-Circuits company

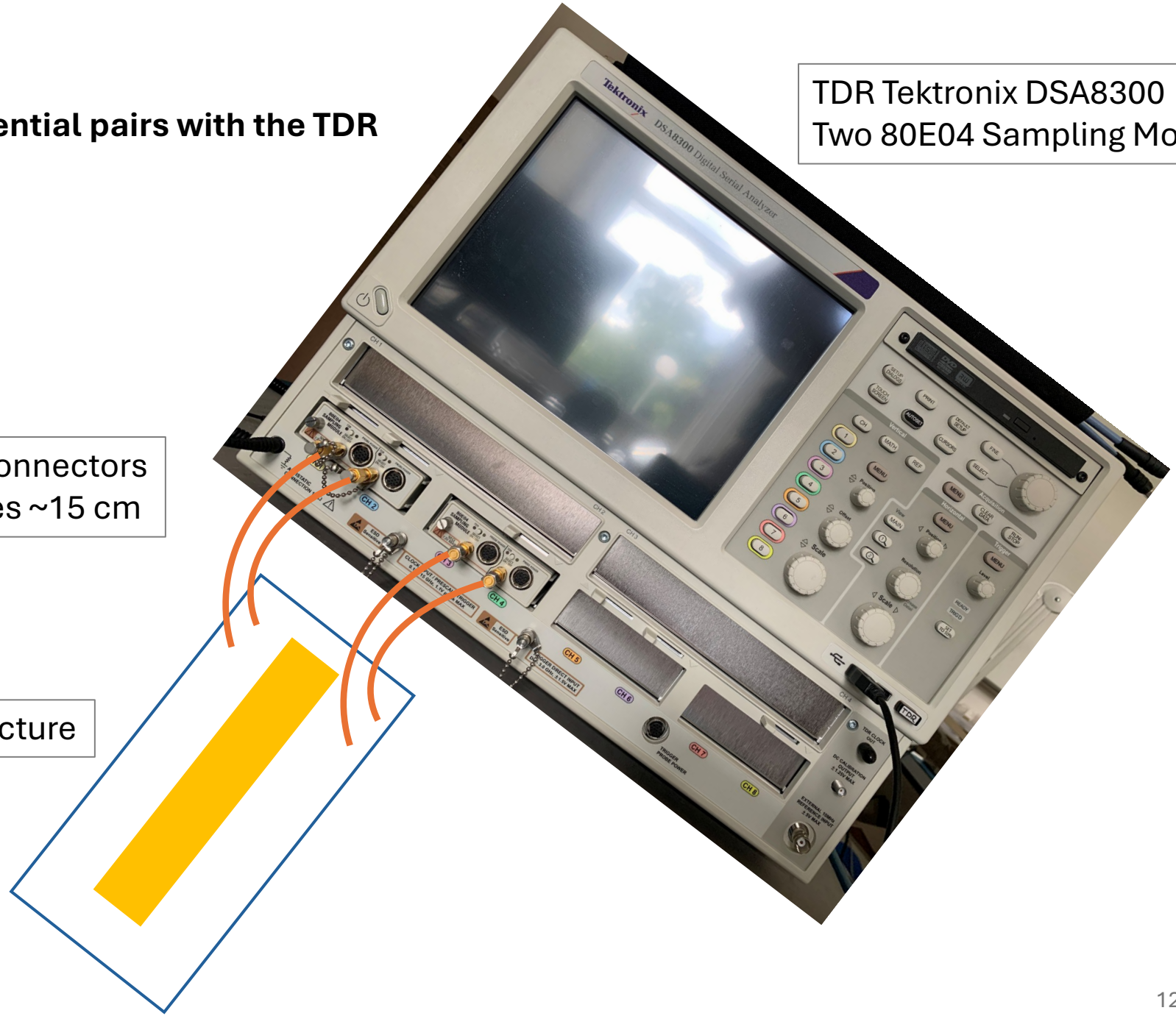


Example: Characterizing differential pairs with the TDR

TDR Tektronix DSA8300
Two 80E04 Sampling Modules

SMP micro connectors
coaxial cables ~15 cm

PCB with IZM structure



Outlook:

- Cross check the PCB designs with the measured geometry of the IZM structure

- Finalize the design of both PCBs

- Submit designs for production

- Study the impedance matching for wire bonds

- Attache one of the IZM structures to the PCB

- Perform first measurements

- Prepare to use the Ansys software for electrical simulations.