Considerations regarding a dedicated electrical test board for the IZM structure

Universität Siegen, August 21, 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.

Thank you for providing two IZM structures, the test board and the design files.

We analyzed the design of the IZM structure using the K-Layout program. In particular, we looked at the differential data pairs and began to consider how we could characterize them using measurements.

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.

The simulation software Ansys, which is used for scientific and engineering purposes, is available at Siegen University. There are four groups using it, and we can share the annual costs with them.

What measurements can we take of the structure mounted on the PCB?
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.
- 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.

We performed a calculation of the impedance of the transmission lines using impedance calculators, and found that we need to ask you for some additional information:

- What is the dielectric constant of the dielectric material in the structure?

The typical range for polyimide is 2.8–3.5, and with the addition of fluorine it can be as low as 1.8.

- Is the polyimide layer deposited on the metal layer structure flat on its top, or does it reflect the metal structure beneath?

- What are the thicknesses of the copper layer (4 μm) and the polyimide layers (7 μm)?

- Do we know the cross-sectional shape of the traces?

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**:**

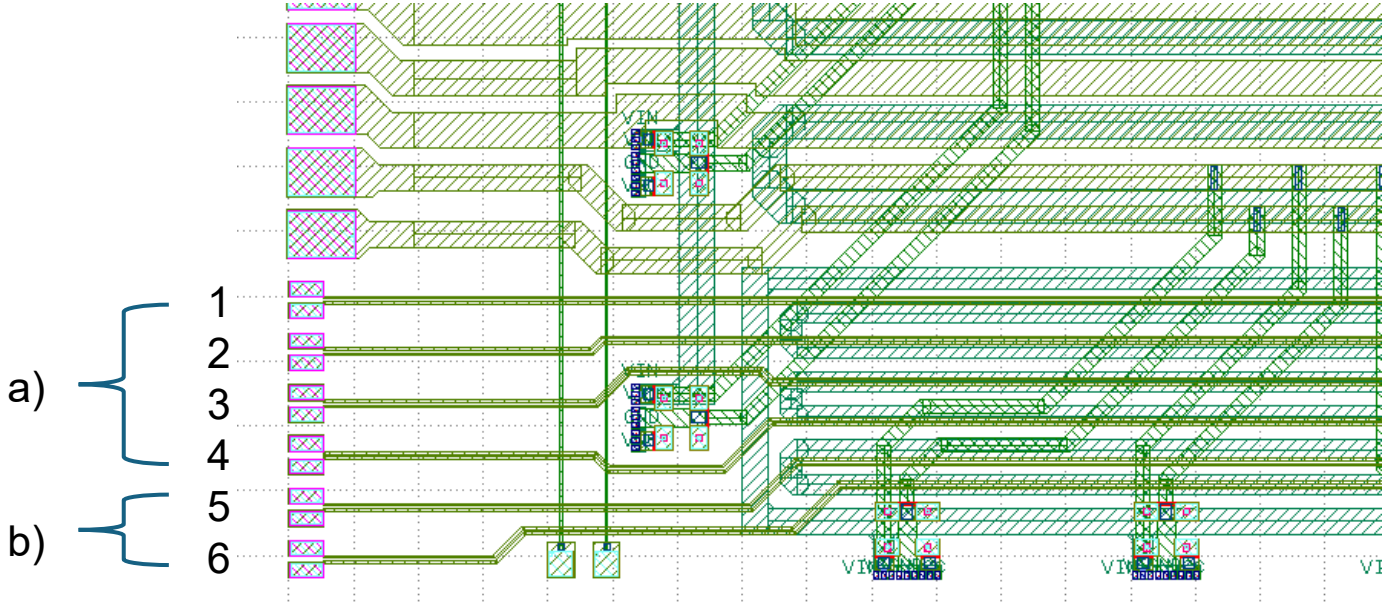
1 => ~12 cm
2 => ~ 9 cm
3 => ~ 6 cm
4 => ~ 3 cm

⇒ 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

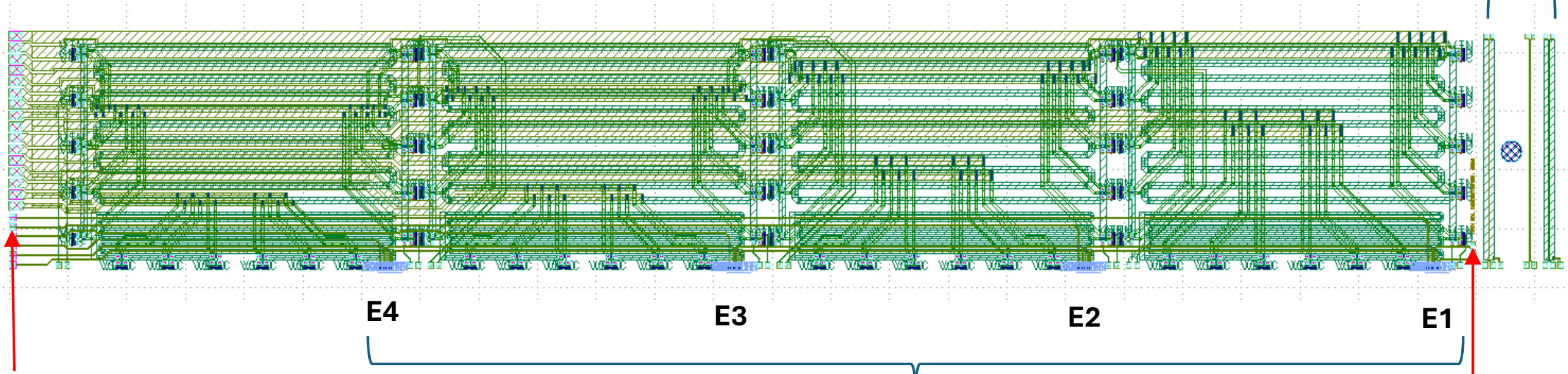
=> Possible measurements: reflection and transmission coefficients, and impedance profile.



E1 to E6 labels mark endings of the six differential transmission line pairs

"Coupon" with three differential pairs & WB pads on both ends

IZM structure: ~13.3 cm x ~1.9 cm

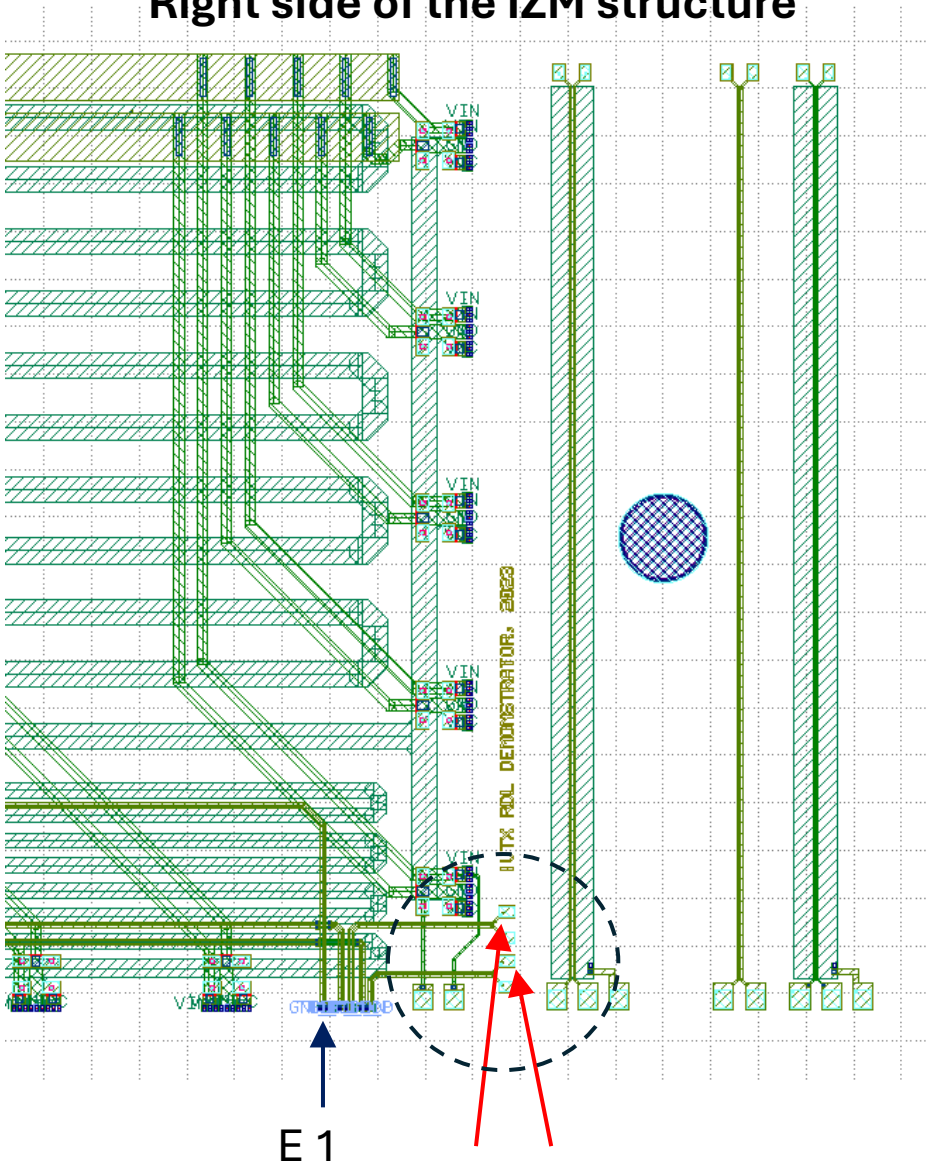


WB pads on the left for six diff. pairs

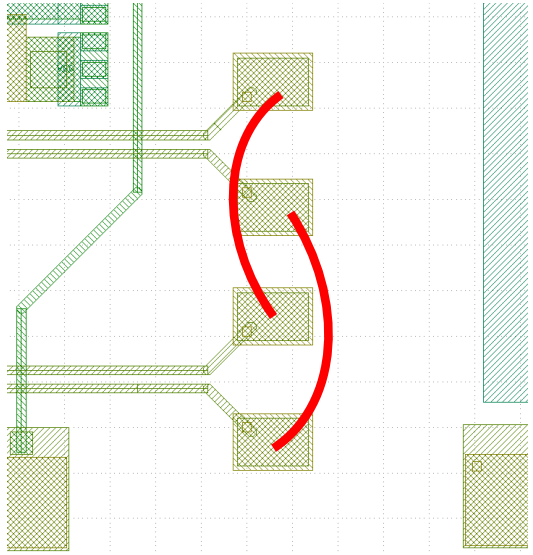
buried pads; no WB pads

E5, E 6 with WB pads

Right side of the IZM structure



Option 1

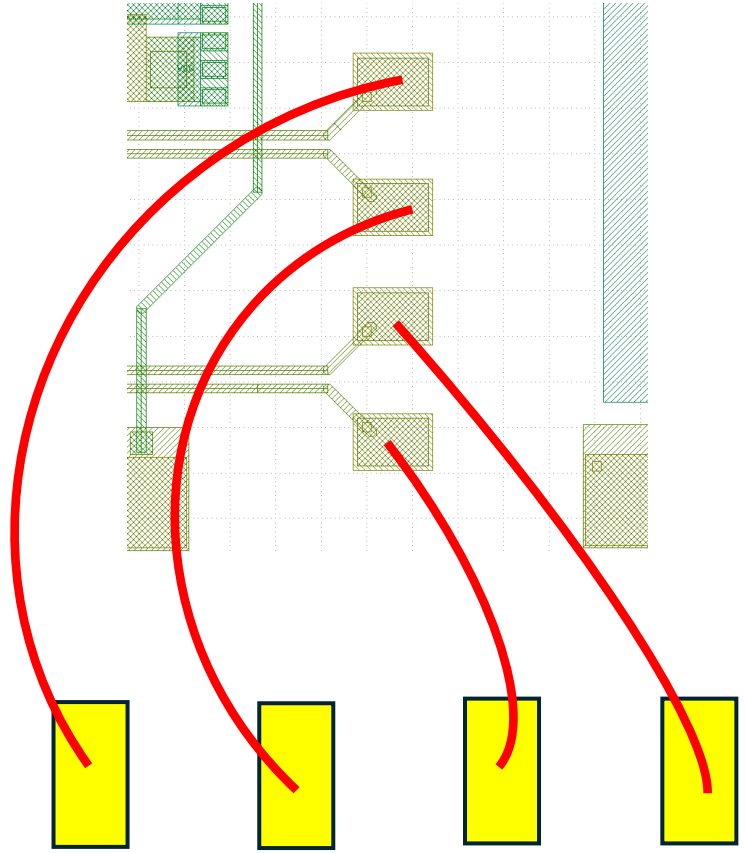


E5, E6 are wire bonded together

pads: 300 µm x 210 µm
WBs length ~ 1 mm

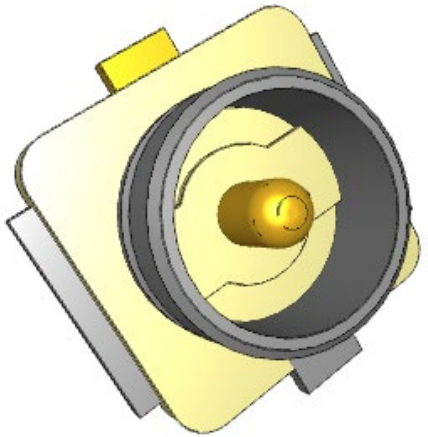
"***loop back***", total length 2x 12 cm, input and output pads on the left side of the structure, SMA connectors

Option 2



E5, E6 wire bonded to PCB with SMA or Hirose micro connectors, WBs ~ several mm

We consider to use Hirose micro connectors to allow for shorter traces on the PCB



Hirose Micro Coaxial Connectors

up to 6 GHz

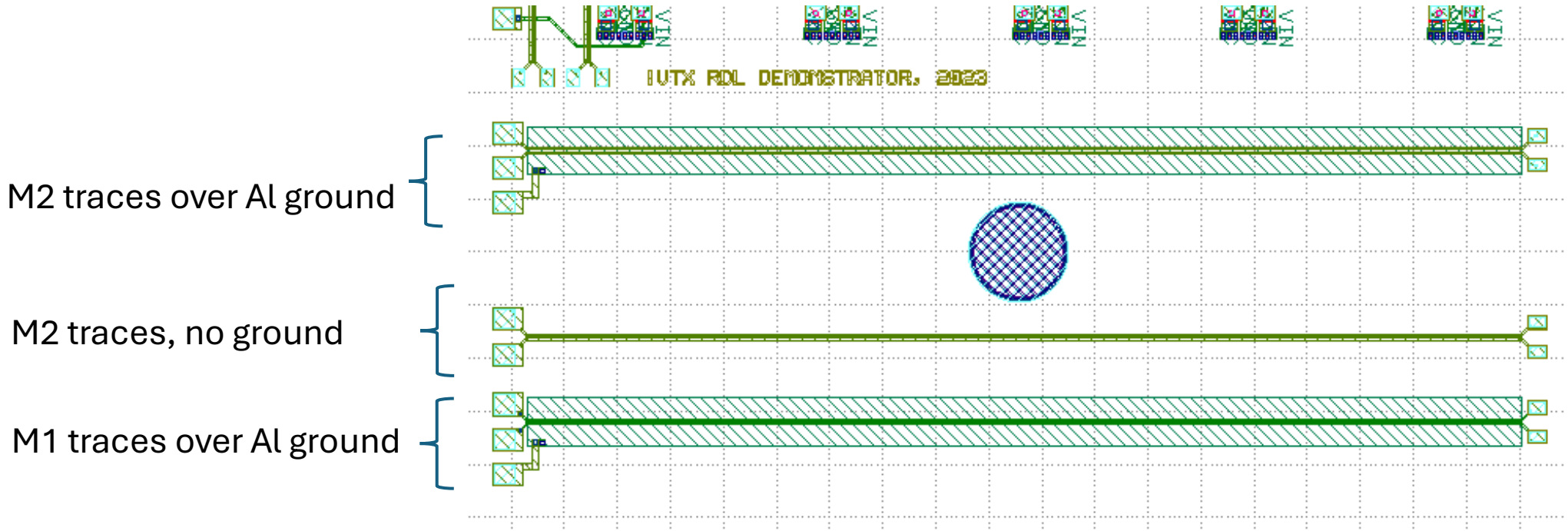
SMD size: ~ 3 mm x 3 mm

Flexible cables

Adapter cables Hirose to SMA available

Three differential pair on the right side of the IZM structure

“Short” length ~1.9 cm, WB pads on both ends: on the left 400 µm x 400 µm , on the right 300 µm x 210 µm



Wire bonding to pads on PCB with SMA or Hirose micro connectors.

A full characterization is possible.

Example: Measuring the coupon

TDR Tektronix DSA8300
Two 80E04 Sampling Modules

Hiroso micro connectors
coaxial cables ~10 cm

PCB with IZM structure

Our next steps:

Optimize the placement of the micro connectors on the PCB to allow for a short (~10 cm) signal cable connection to the TDR.

Design bonding pads for the PCB and bonding wires to achieve the best impedance matching.

Design a dedicated test PCB for evaluating wire bond connections.