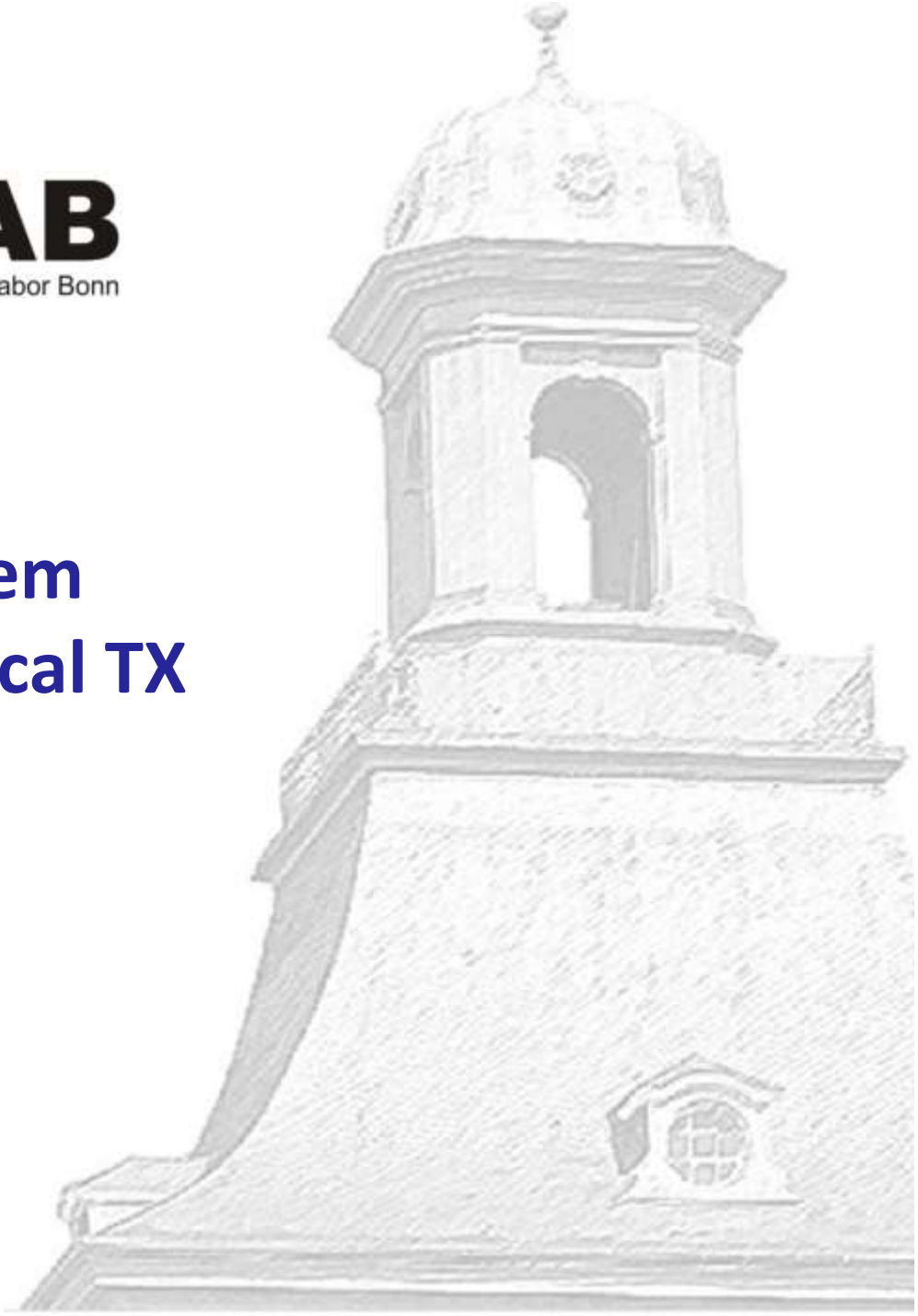
universitätbonn

SI LAB
Silizium Labor Bonn



Transmission line system
From PXD module to optical TX

Leonard Germic
University of Bonn

lgermic@uni-bonn.de

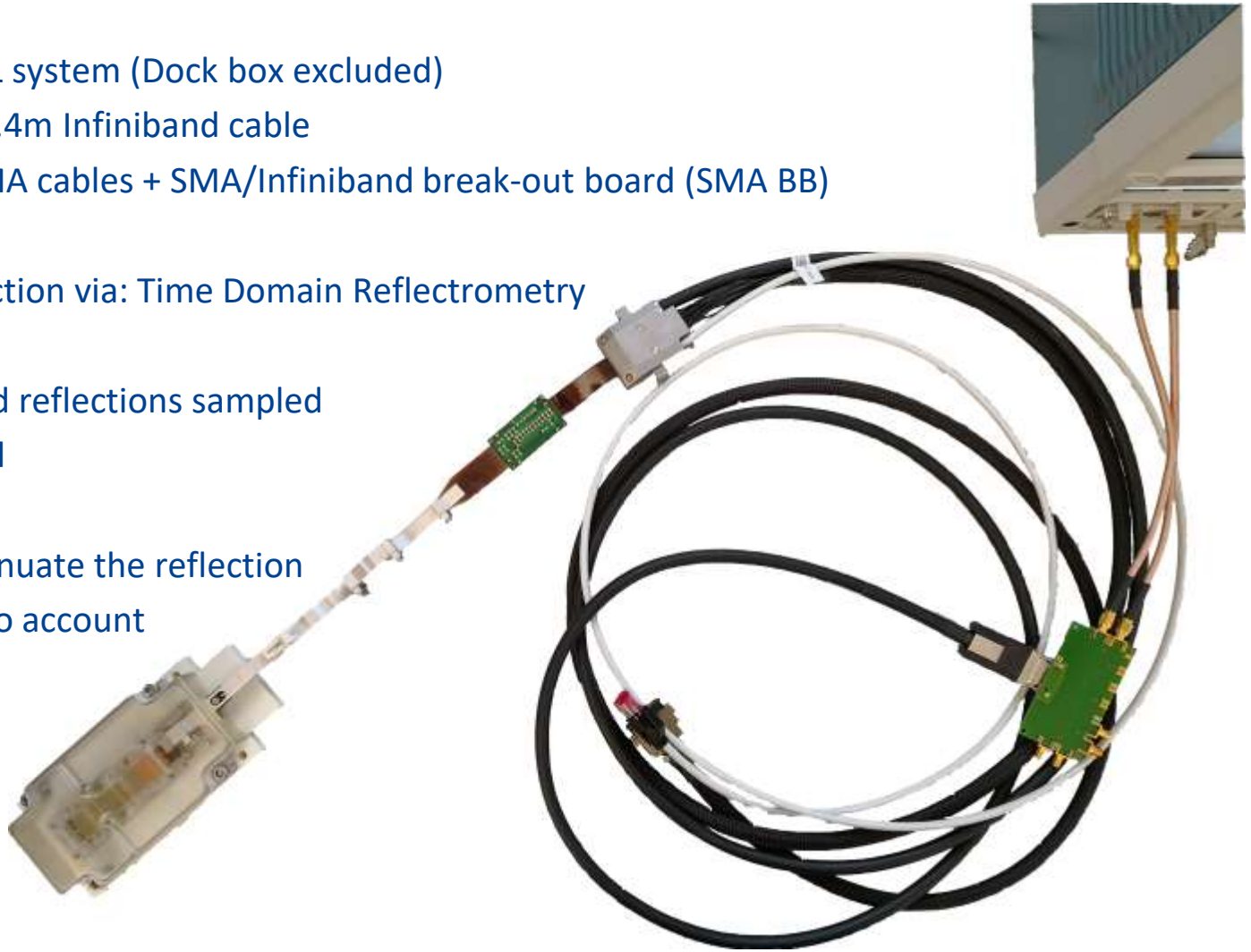
Scattering Parameters: Reflection coefficient

- Bare module with final TML system (Dock box excluded)
  - EOS, Kapton, PP and 2.4m Infiniband cable
- Fixture: high-bandwidth SMA cables + SMA/Infiniband break-out board (SMA BB)

- Impedance mismatch detection via: Time Domain Reflectrometry

- Incident step is injected and reflections sampled
  at the same terminal

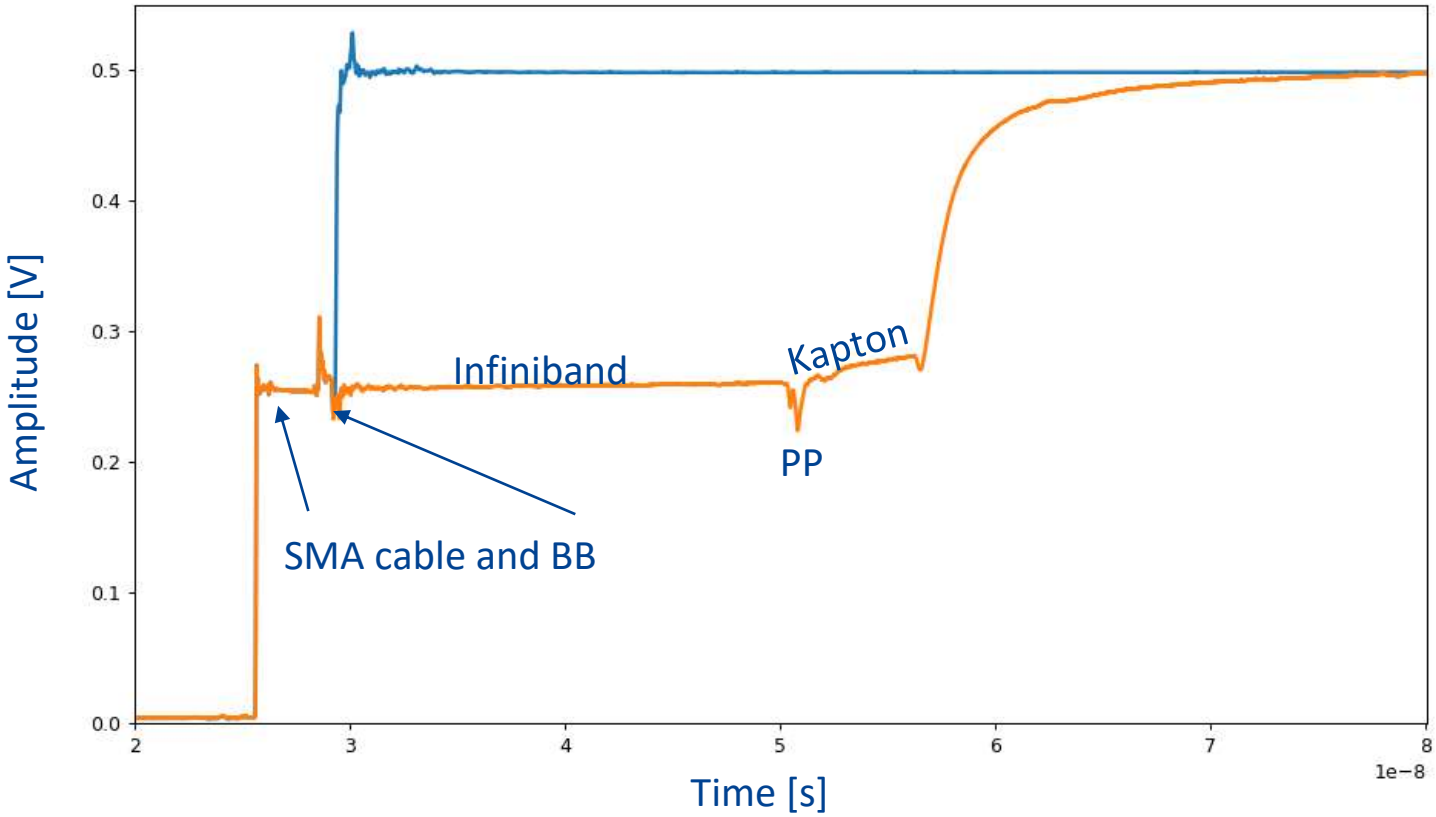
- Low-bandwidth cables attenuate the reflection
  have to be taken into account



Scattering Parameters: Reflection coefficient

- Reference waveform without TML system: SMA cable and SMA BB only (blue)
- Waveform with reflections of TML system (orange)

- $R = \frac{V_{reflected}}{v_{incident}} = \frac{Z_L(x) - Z_0}{Z_L(x) + Z_0}, Z_L\ impedance\ at\ point\ x, Z_0\ characteristic\ impedance$



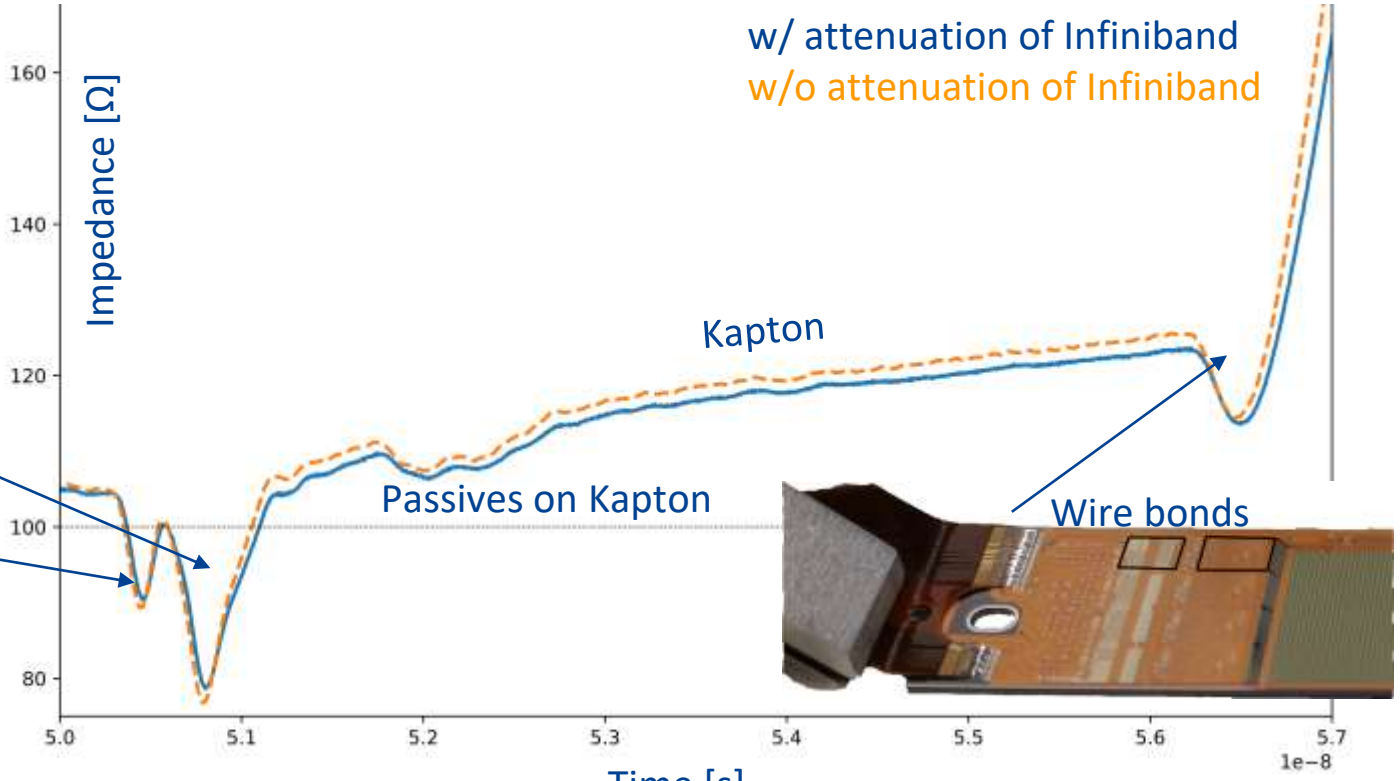
Scattering Parameters: Reflection coefficient

- $R = \frac{V_{reflected}}{v_{incident}} = \frac{Z_L(x)-Z_0}{Z_L(x)+Z_0}$, Z_L impedance @ x, Z_0 characteristic impedance $Z_0 = \sqrt{\frac{L}{C}}$
- Maximal reflection: $v_{reflected} = 0.16 \times v_{incident}$
- **Tolerable: no serious distortion of the clock or data line**

PP

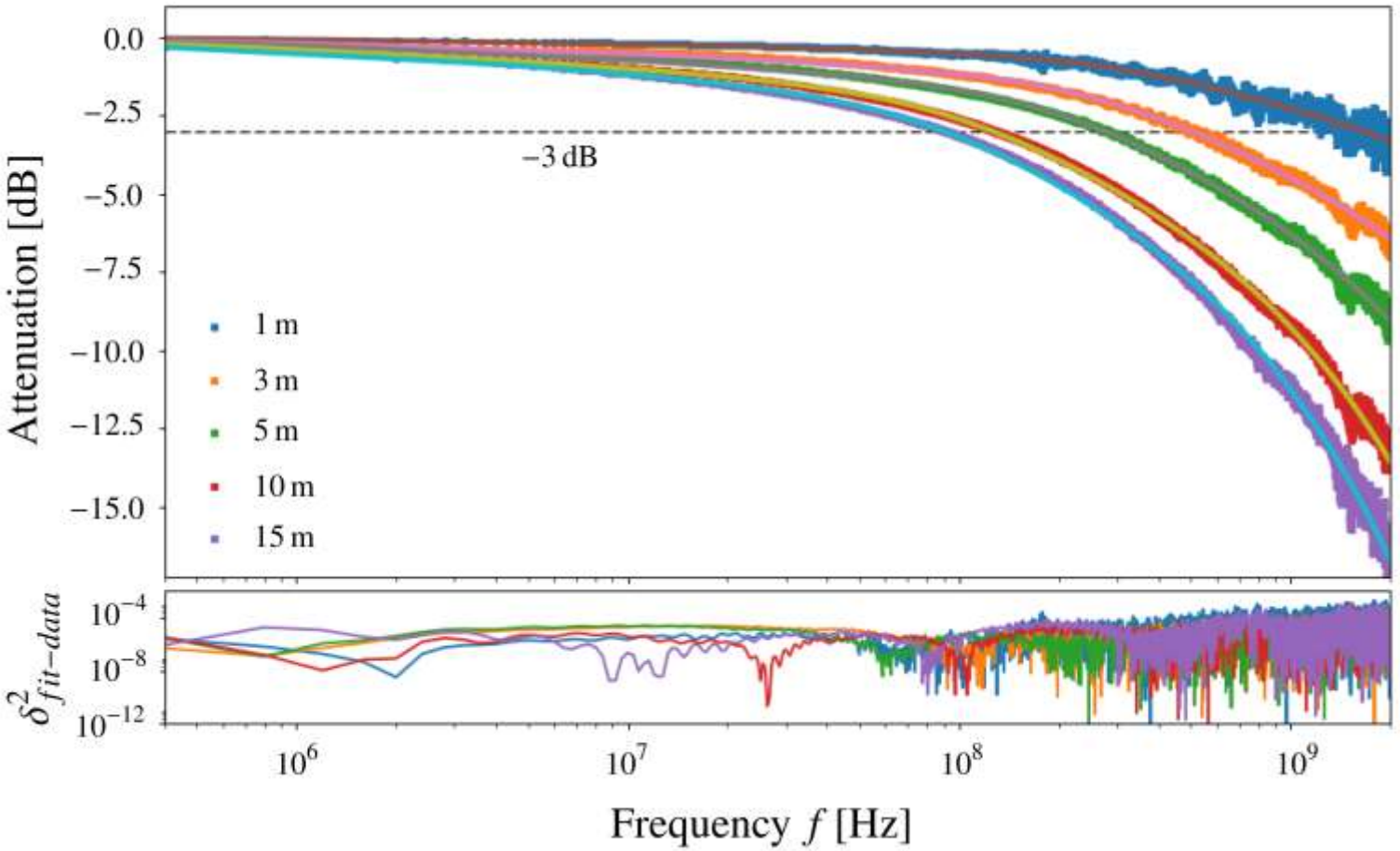
Soldering

Samtec



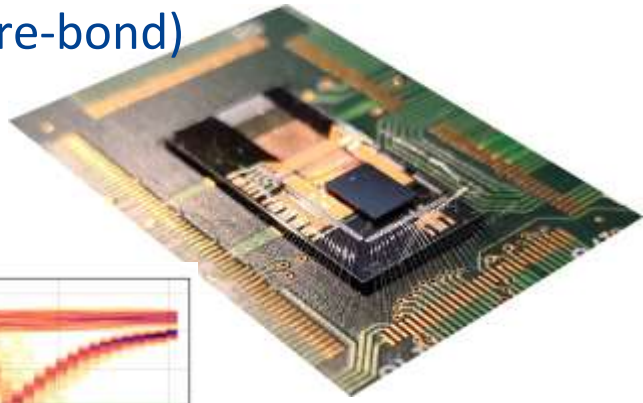
Scattering Parameters: Transmission coefficient

- Measured frequency behaviour of Infiniband cables
- Bandwidth extraction and data for transmission simulation (analytic model fit)

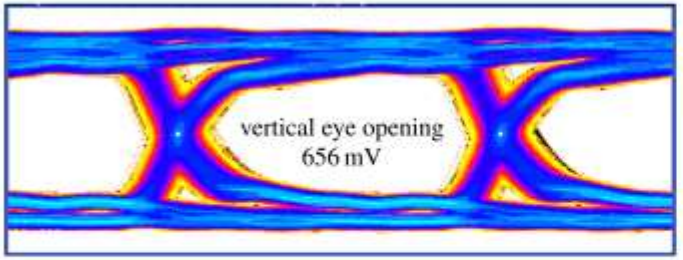


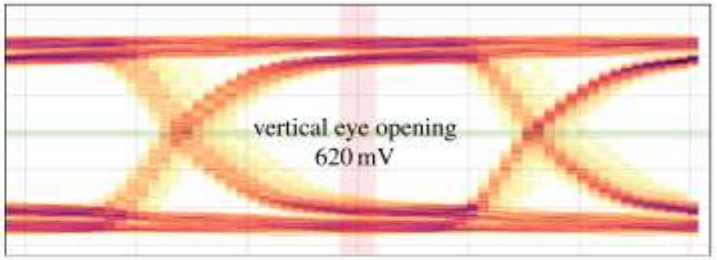
Simulation versus Measurements

- DHPT1.2b waveform sampled on test board (5mm after wire-bond)
- Example for 1m, 10m and 15m Infiniband cable
- Deviation approx. 10%

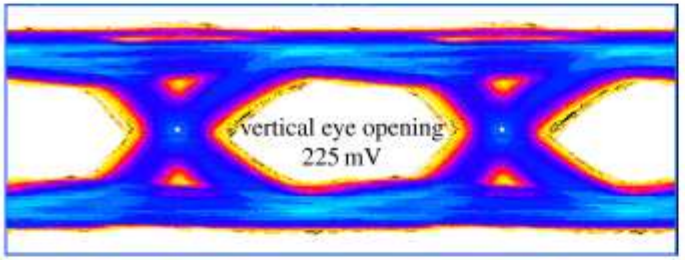


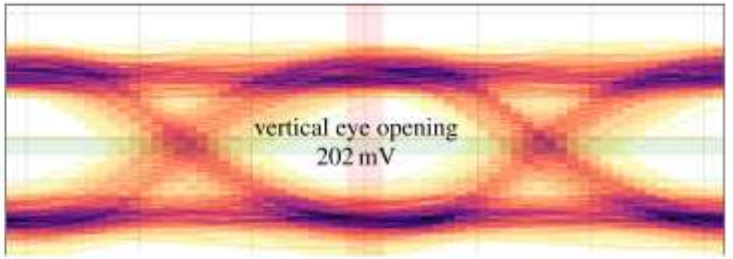
1m



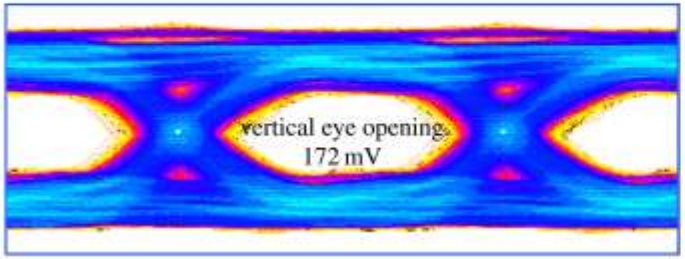


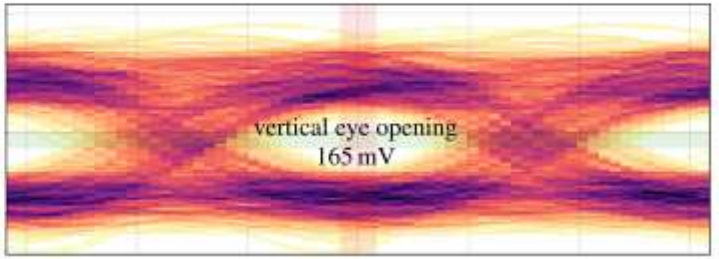
10m





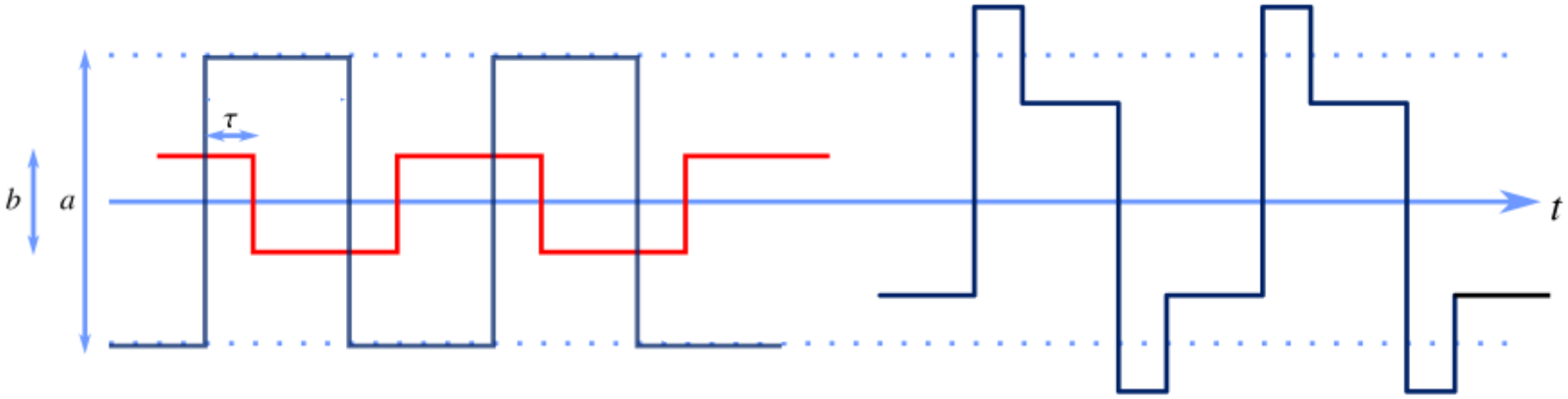
15m





CML driver: short intro

- CML driver of DHP has three adjustable parameters a, b and τ
- a and b are steered currents that are added and subtracted according to τ



- Limitation of the CML driver
  - If a approaches the maximum value no current can be added (out of the dynamic range)
    → No enhancement of the high frequency part of the signal, only attenuation of the low frequency part
  - If spectrum shaping of signal is important (low band-width TML) do not use max a!

CML parameter sweep

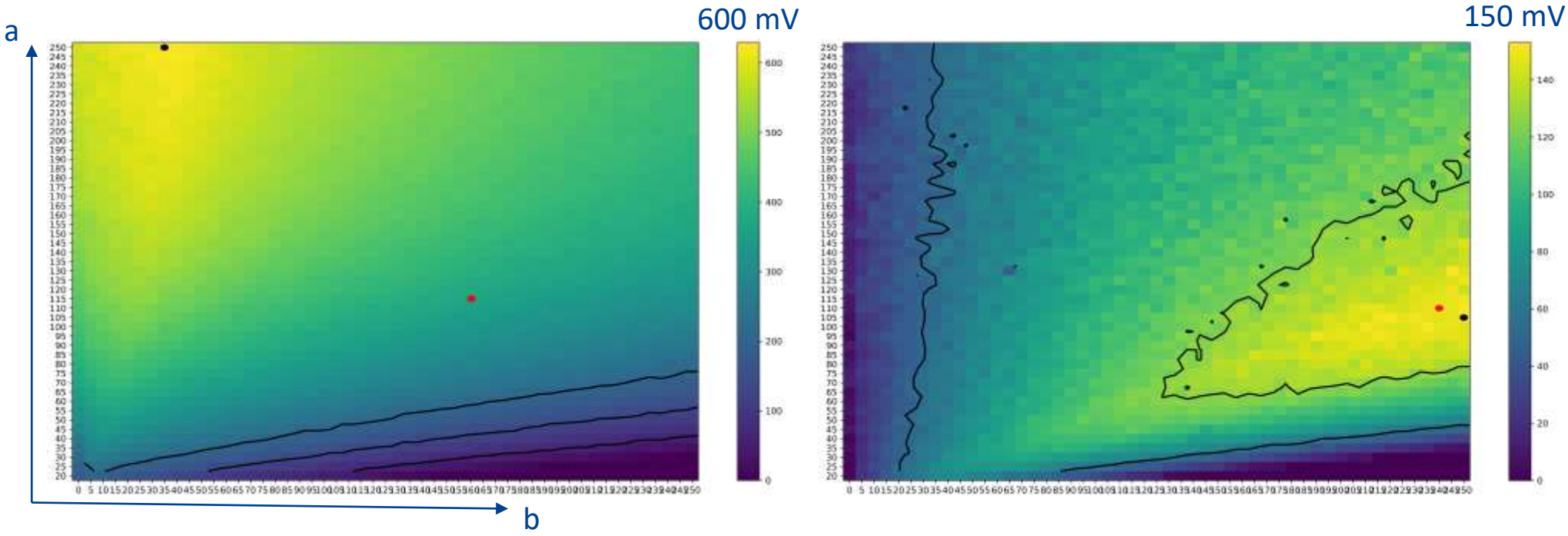
- CML parameter sweep for fixed τ=bit width
- Vertical eye opening simulation

1m Infiniband cable

BWD=1230MHz

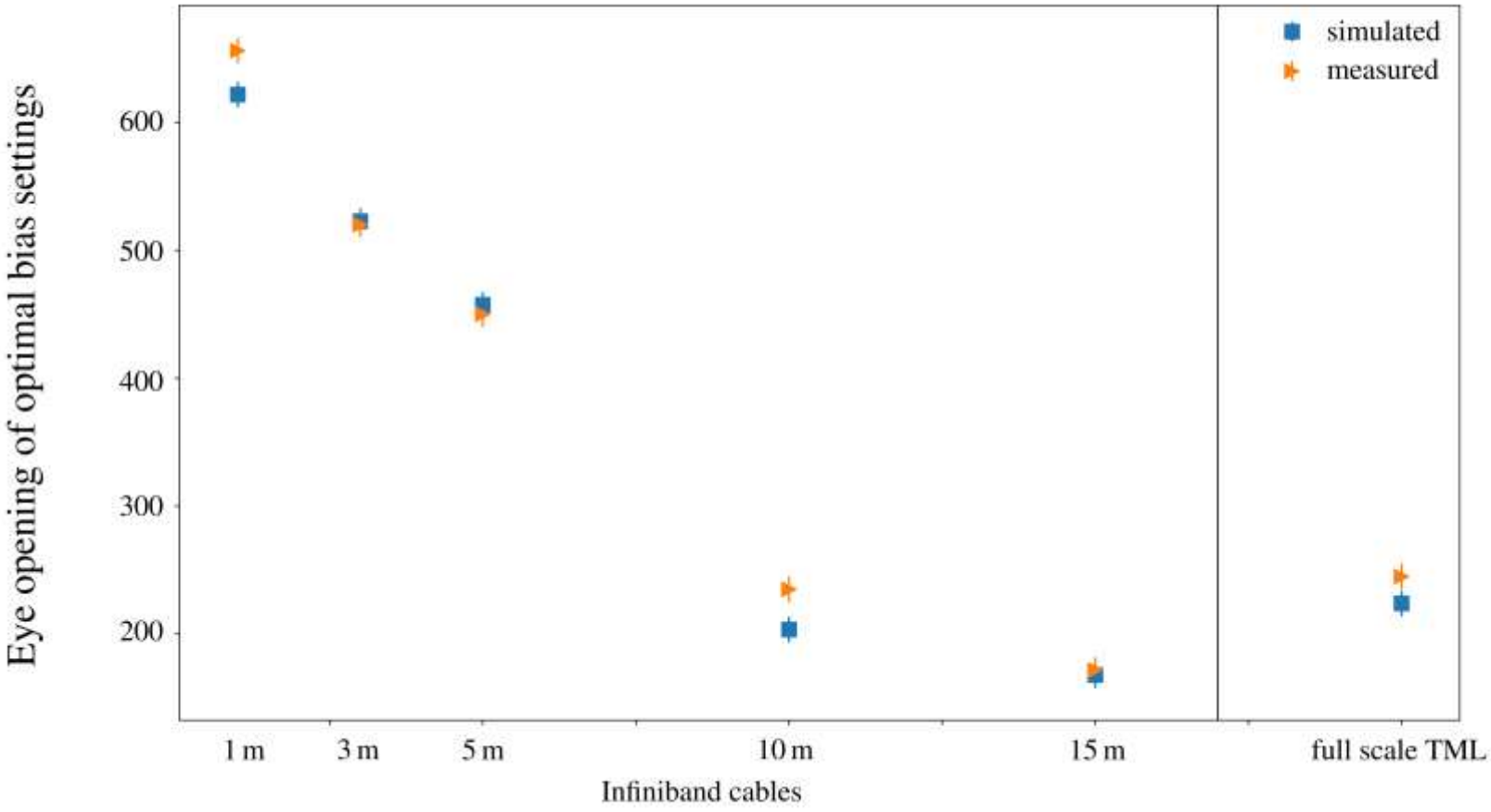
15m Infiniband cable

BWD=92MHz



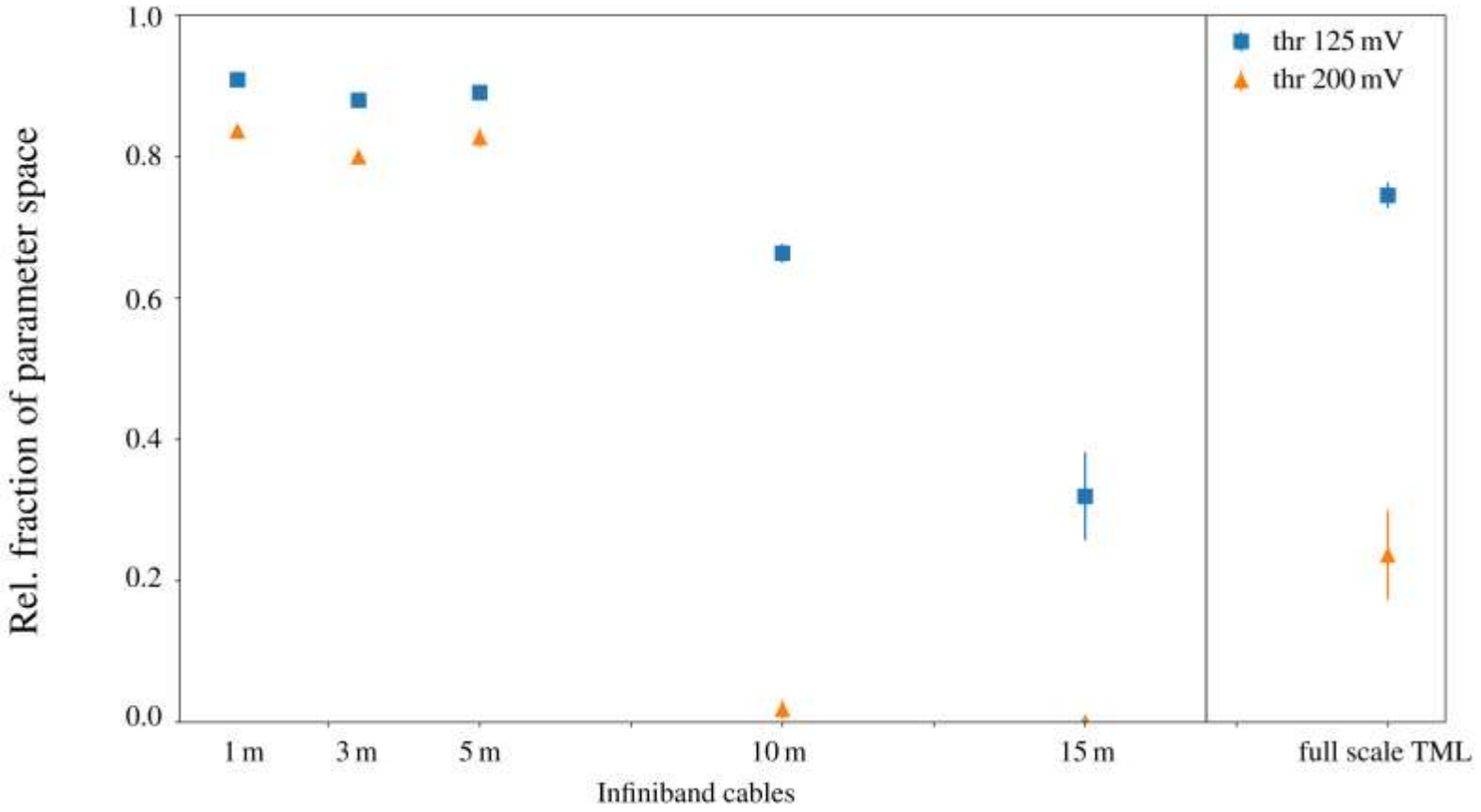
Simulation versus Measurements

- Vertical eye opening for optimal point (max opening)



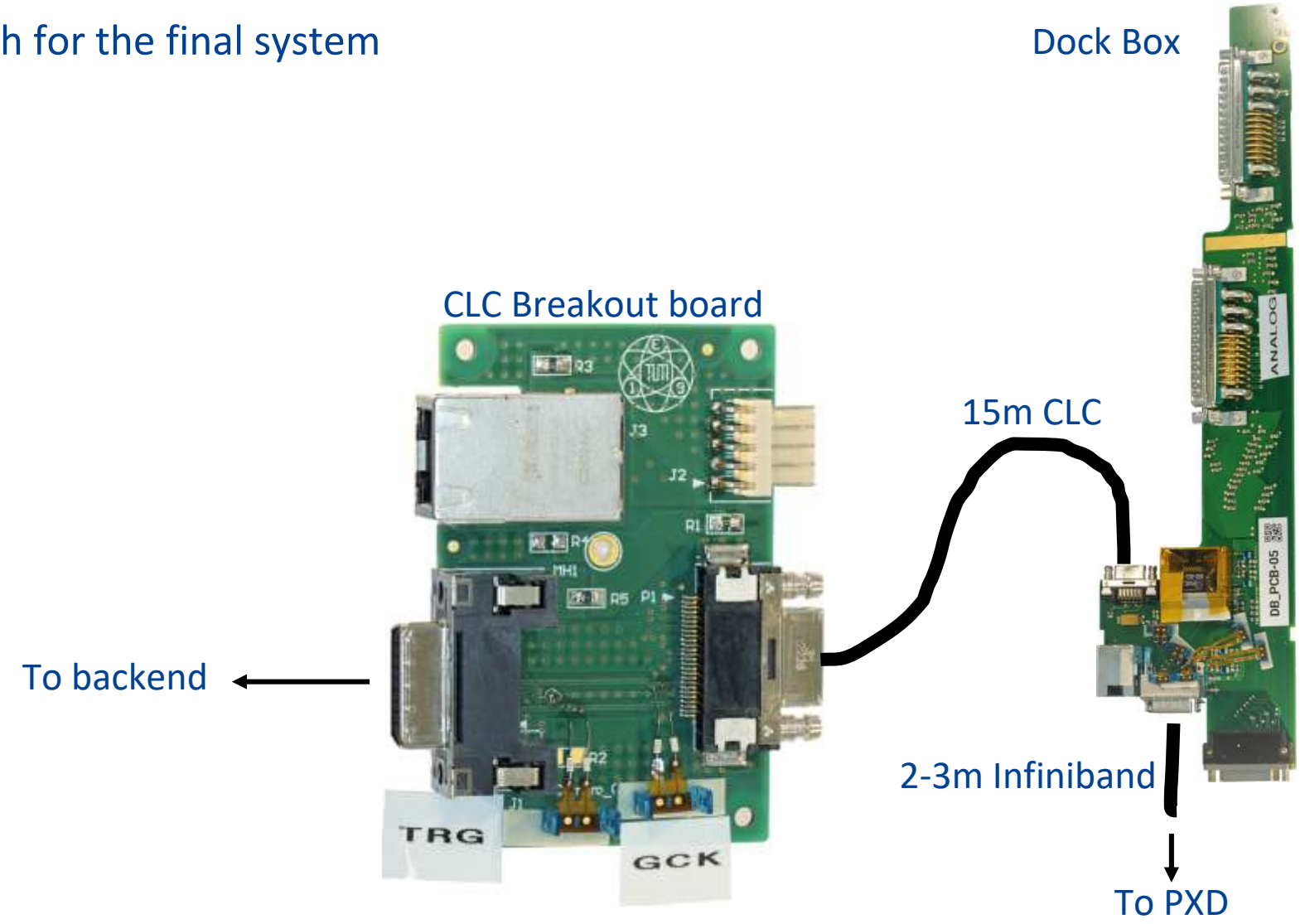
Simulation versus Measurements

- Simulated relative parameter space for eye>125mV and eye>200mV



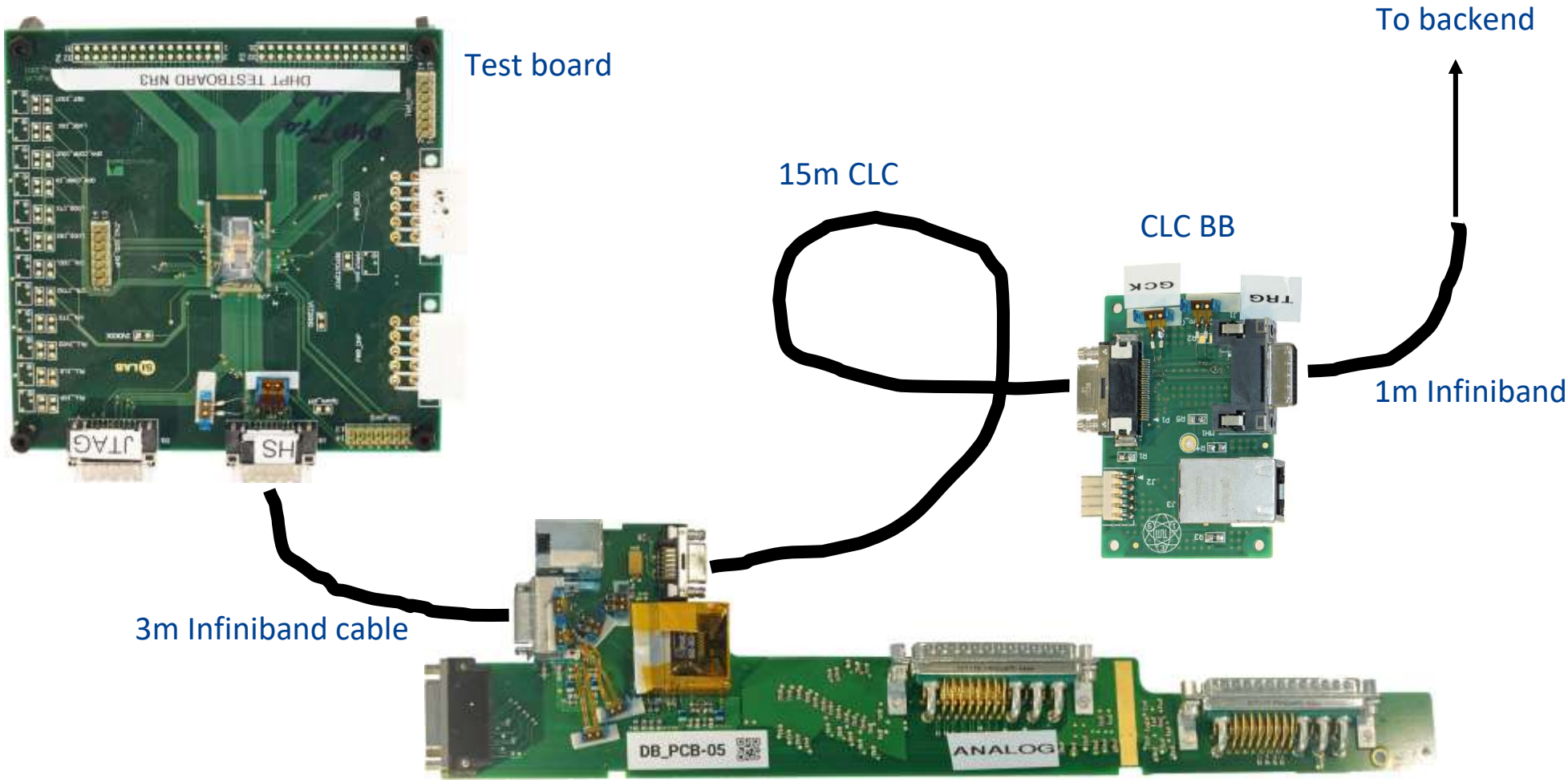
GCK slew rate

- GCK path for the final system



GCK slew rate

- GCK path for reference measurements



GCK slew rate

- GCK path for Infiniband

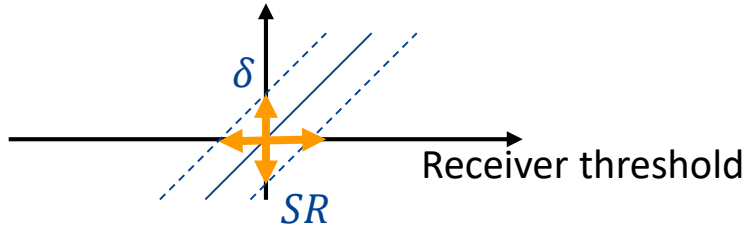
Test board

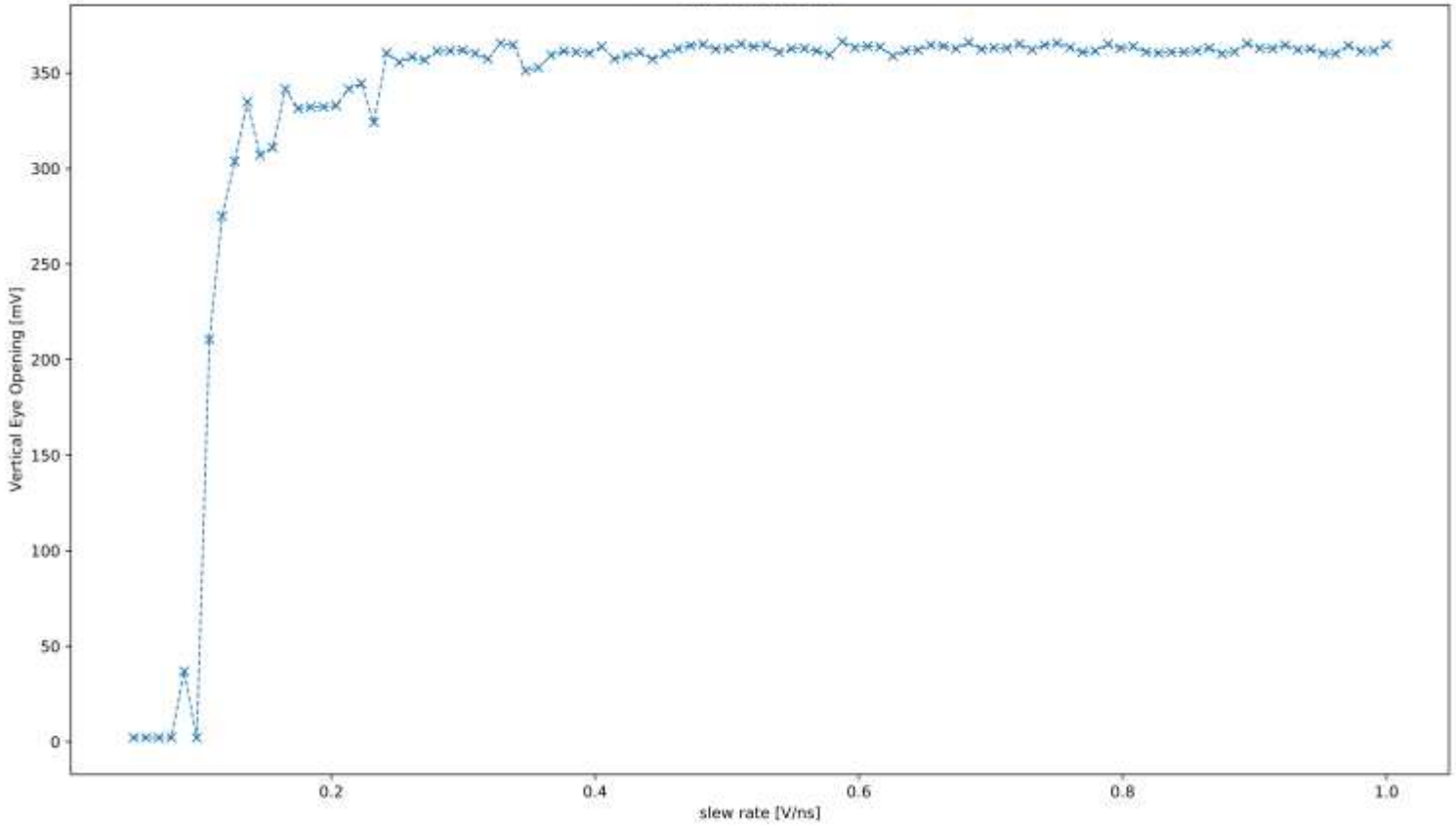
To backend

1m, 3m, 5m, 10m and 15m Infiniband cable

GCK slew rate impact on Eye: Example

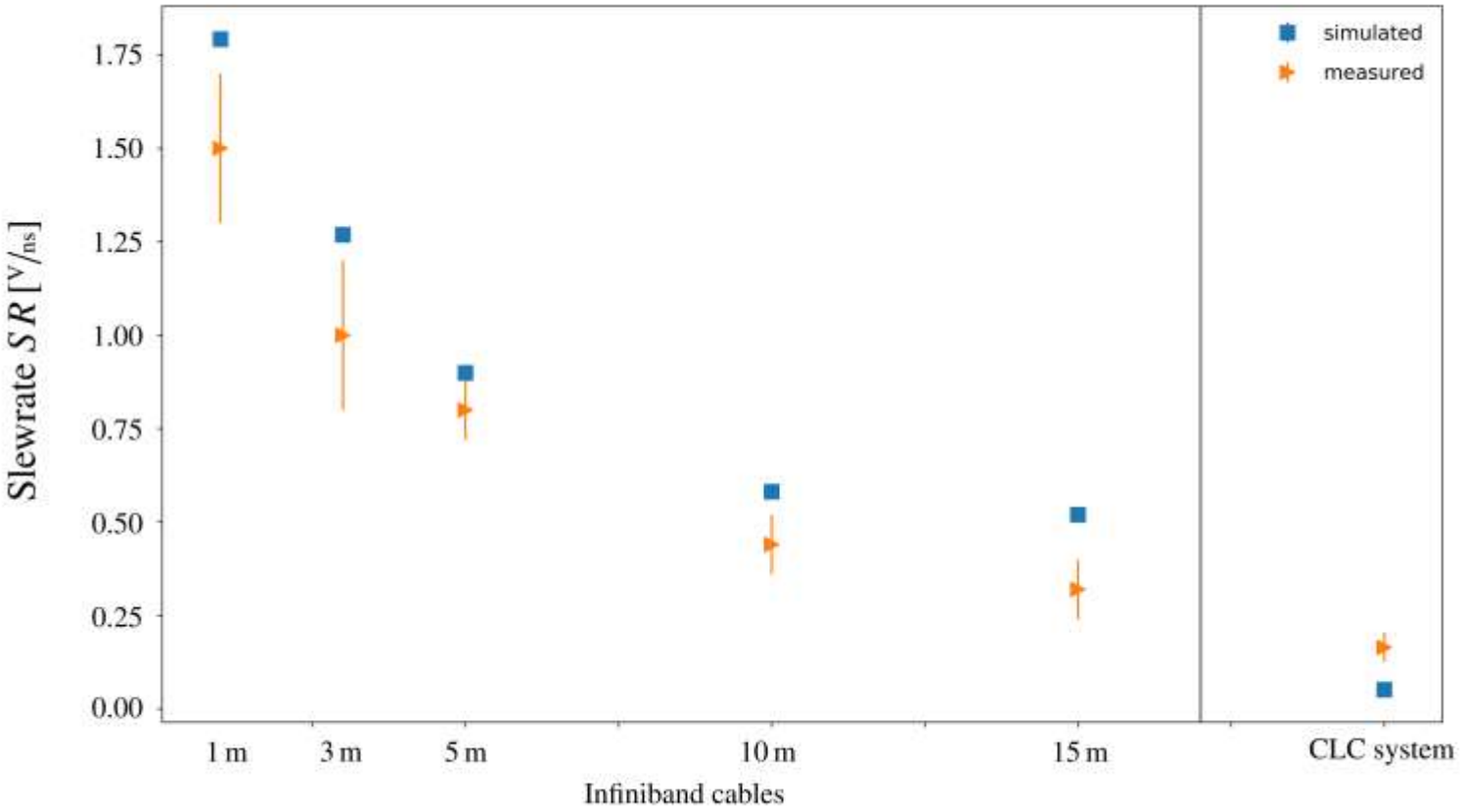
- Input: simulated LFSR 7bit pattern (PRBP)
- Jitter: $J = \frac{\delta}{SR}$, δ noise on GCK





GCK slew rate measurement vs simulation

- Slew rates of GCK at DHP Testboard for different TML systems

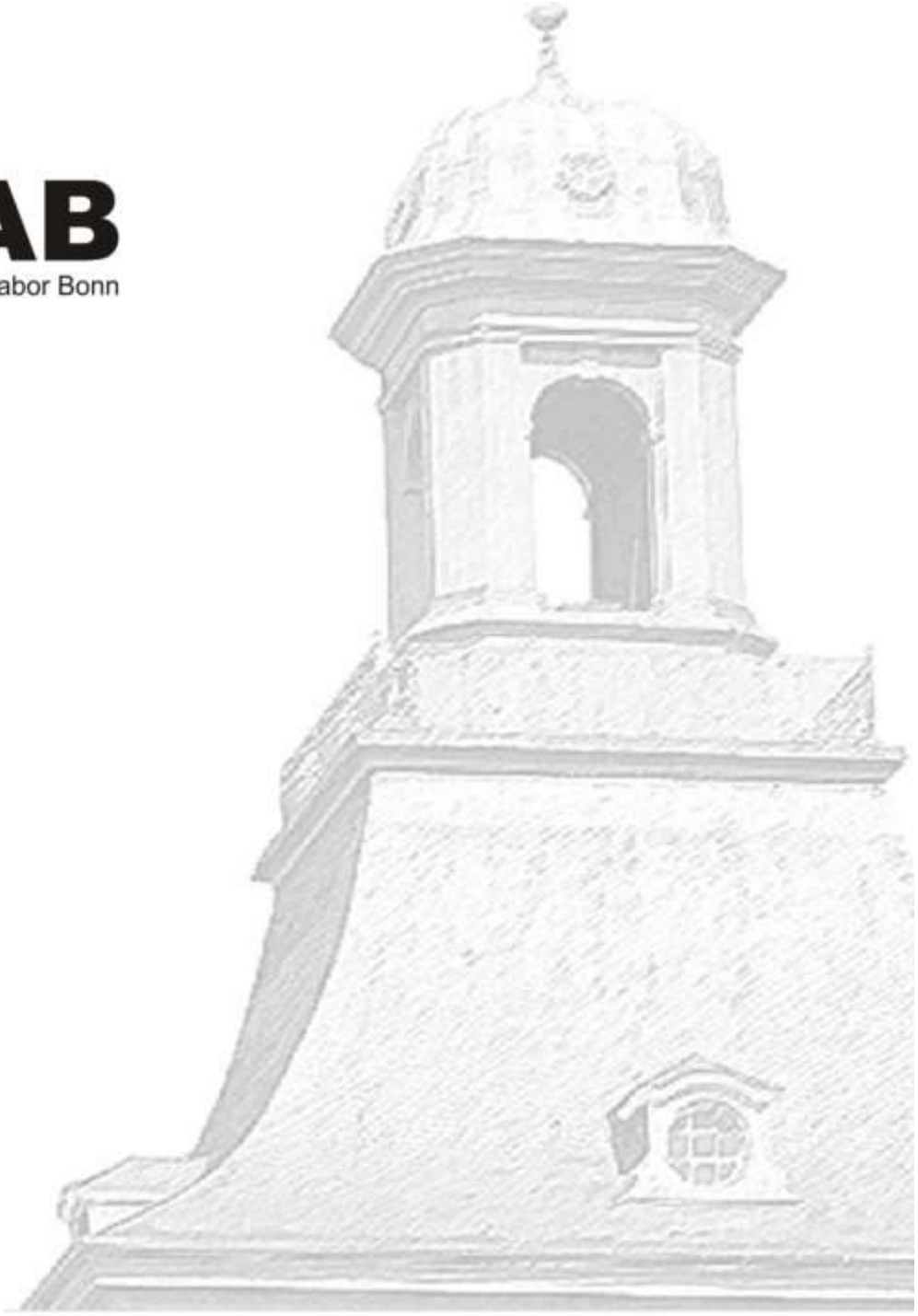


Conclusion

- Extracted scattering parameters yields simulation compatible with measurements
- Eye opening and slew rates confirmed
- CML driver parameter scan simulated and region of best eye opening detected
  - Best parameter set provided
- Final TML system of PXD (Module to Dock Box) characterised

universitätbonn

SI LAB
Silizium Labor Bonn



Thank you

yourname@uni-bonn.de