

# A 10Gb/s Serial Communication Transceiver in 0.13 $\mu$ m CMOS for a 2m Micro Twisted-Pair Cable

Eisse Mensink, Jan van Gorsel, Sander Heuvelmans, Mark Boerrigter

The authors are with Bruco Integrated Circuits B.V., Borne, The Netherlands. Work is done in cooperation with the National Institute for Subatomic Physics, NIKHEF, Amsterdam, The Netherlands.

## Background

Pixel chips for future applications produce a virtually infinite amount of data.

- Imaging needs more frames per second.
- High energy physics experiments will run at a higher luminosity, meaning more hits per second.

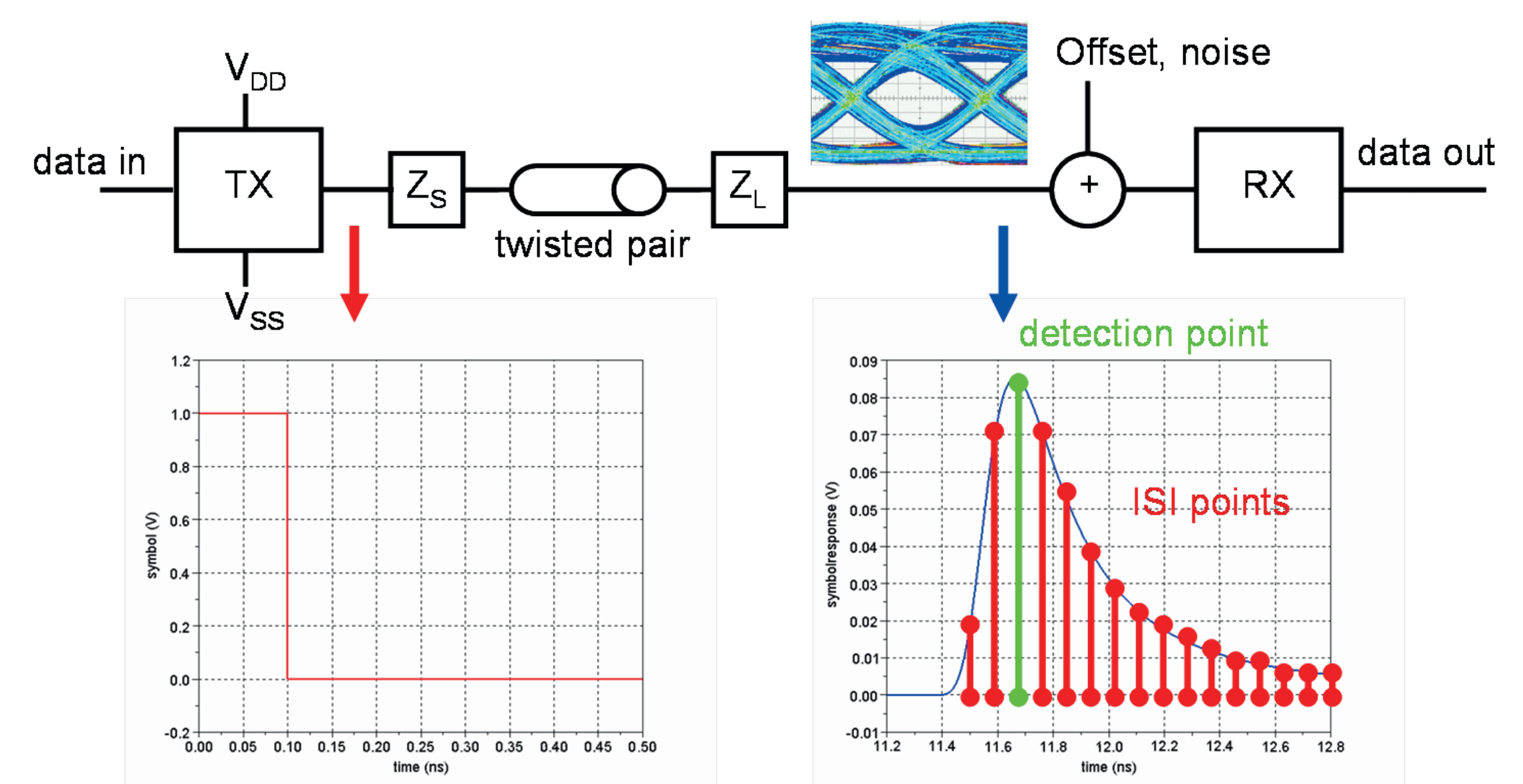
All this data has to be transported off the pixel chip.

For the upgrade of the LHCb experiment at CERN:

- Expected link speed is about 10Gb/s.
- Due to extreme radiation dose, 2m micro twisted-pair cables between the pixel modules and the optical modules.

## Cable & System Overview

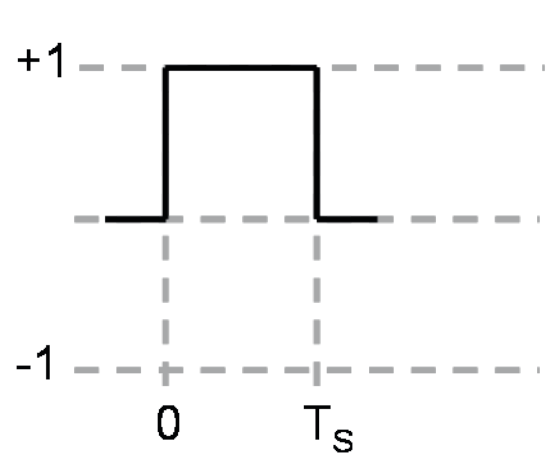
- 2m micro-twisted pair cable: 42dB loss @ 5GHz.
- System consists of transmitter, cable and receiver.
- Cable is terminated with  $Z_S$  and  $Z_L$ .
- Eye height at RX calculated with the help of symbol response



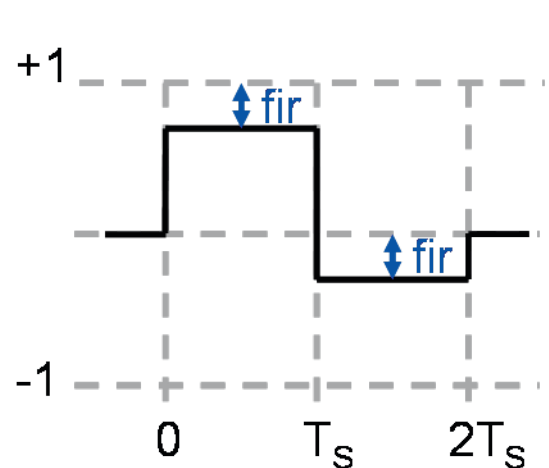
## No, FIR or PWM Equalization

Symbol shapes

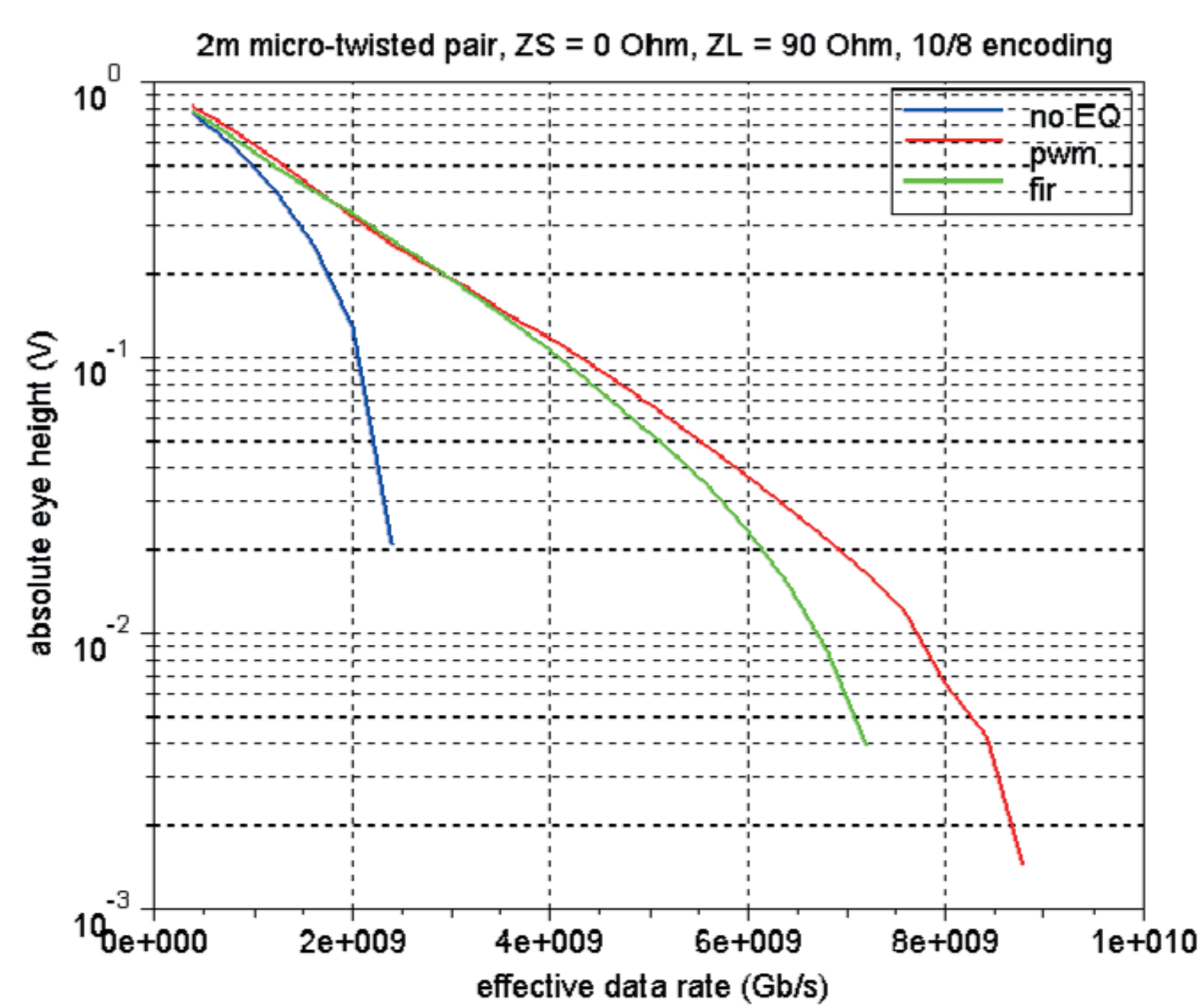
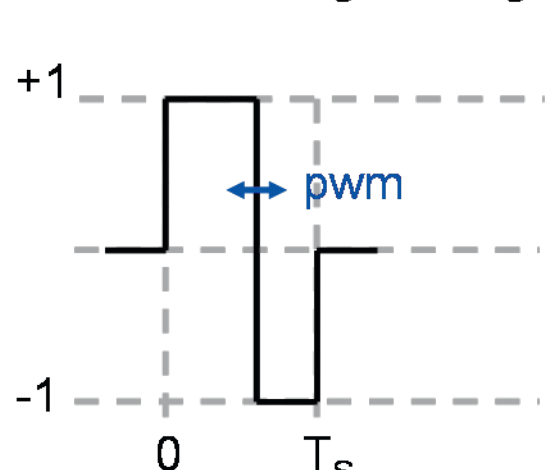
no EQ:



FIR:

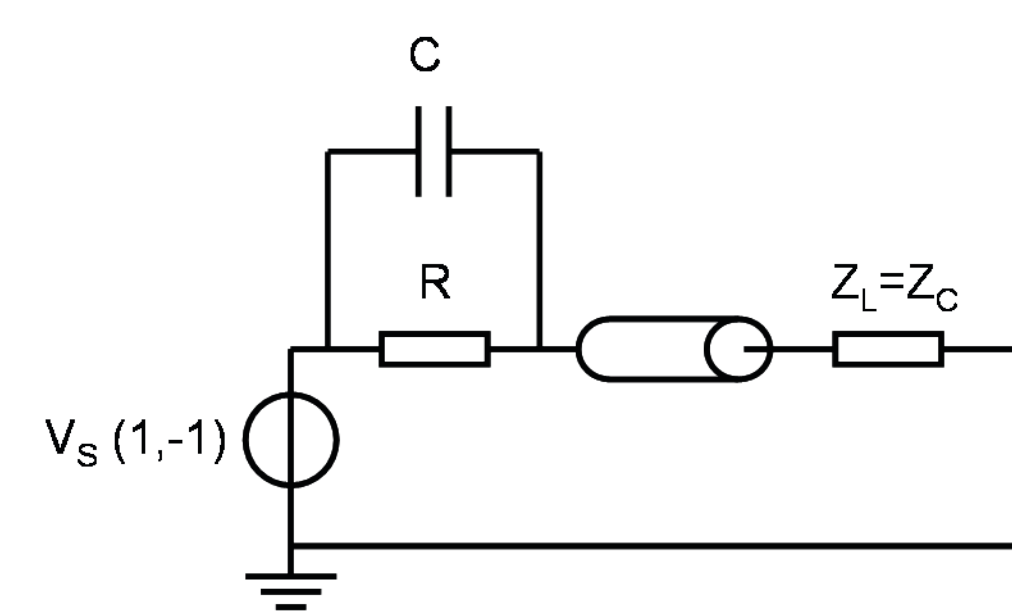


PWM:

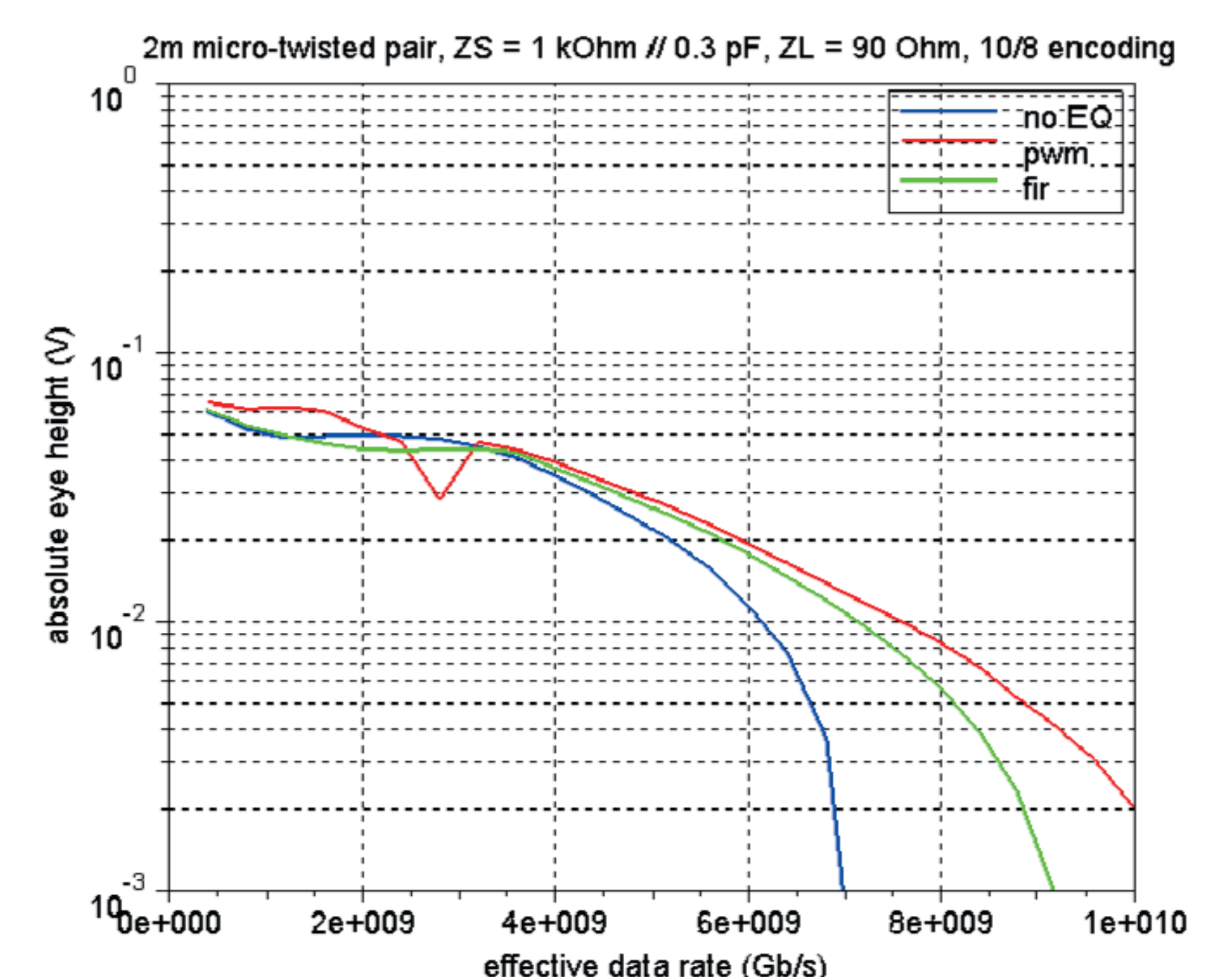


Highest data rate achievable with PWM EQ (pulse-width modulation equalization).

## RC Filter as Source Impedance

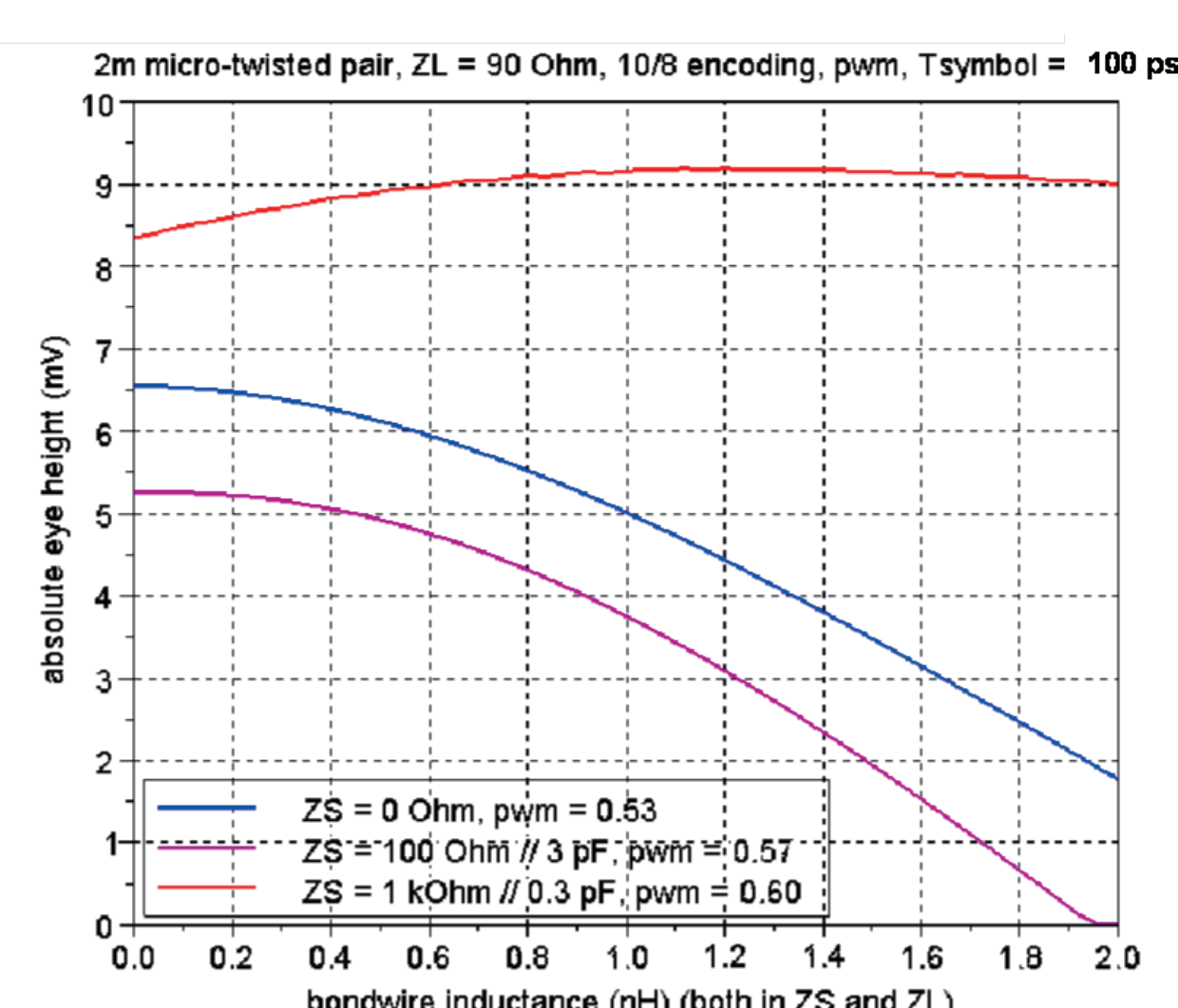
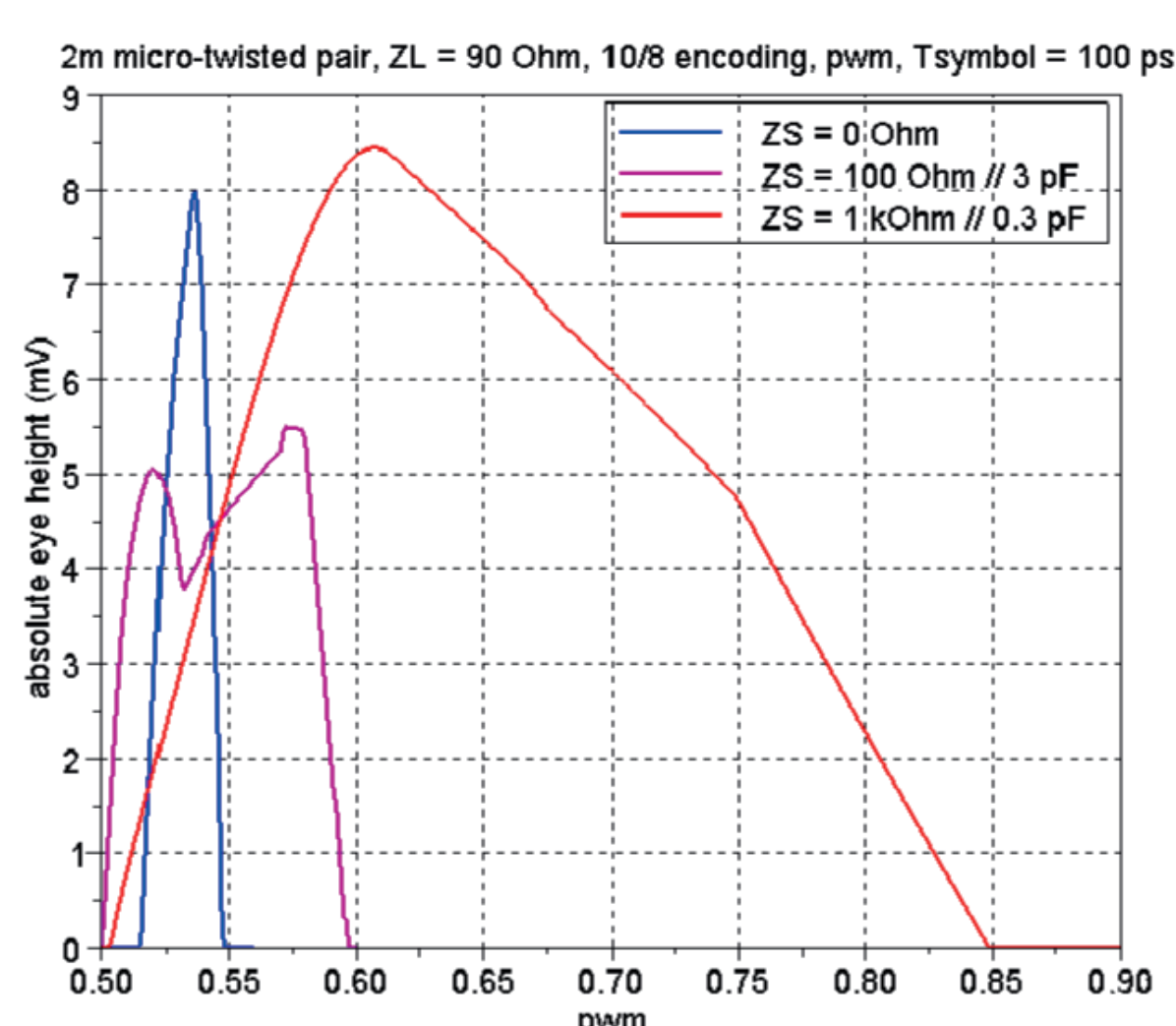


- Use RC filter as source impedance  $Z_S$ .
- $R = 1\text{k}\Omega$ .
- $C = 0.3\text{pF}$ .
- Eye height (little) larger at high data rates.



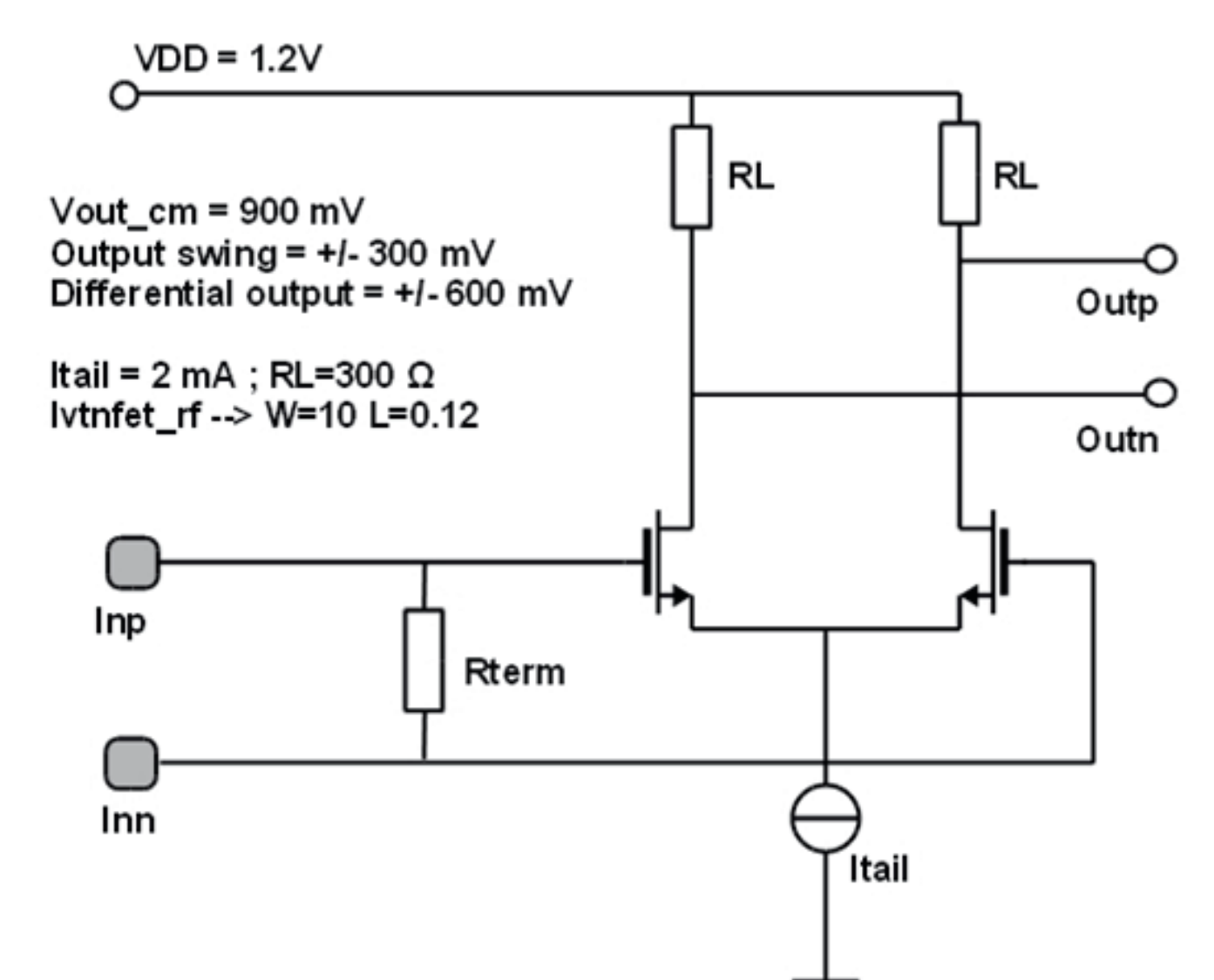
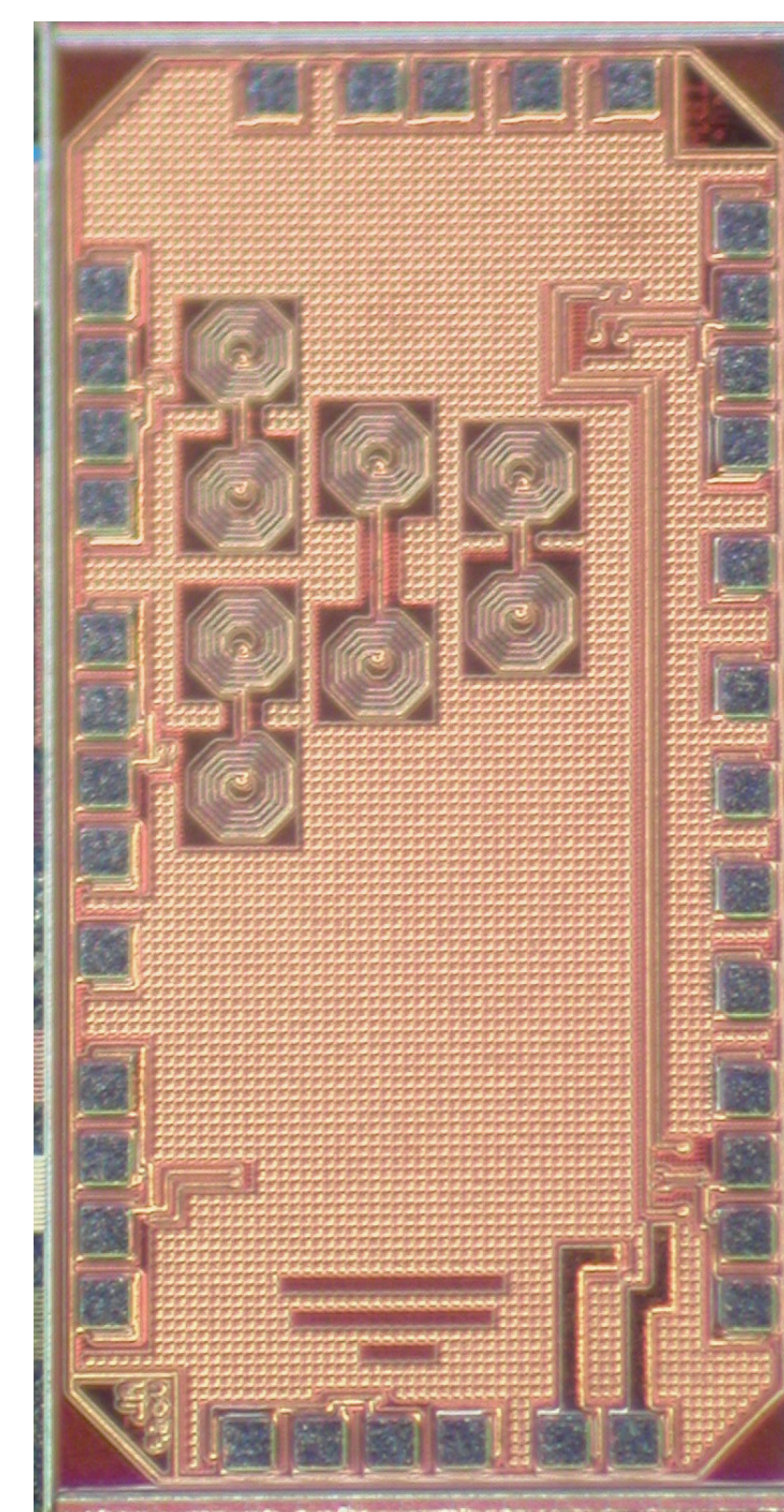
## Parameter Variation Tolerance

Main reason for using an RC filter as source impedance is the resulting robustness against parameter variations.



The solution with RC filter is both more robust against pwm variations and bondwire inductance.

## Chip & Basic CML Circuit



- Most circuits implemented with CML.
- TX: area = 0.35mm<sup>2</sup>, power = 60mW.
- RX: area = 0.10mm<sup>2</sup>, power = 16mW.

## Measurement Results (still in progress)

