

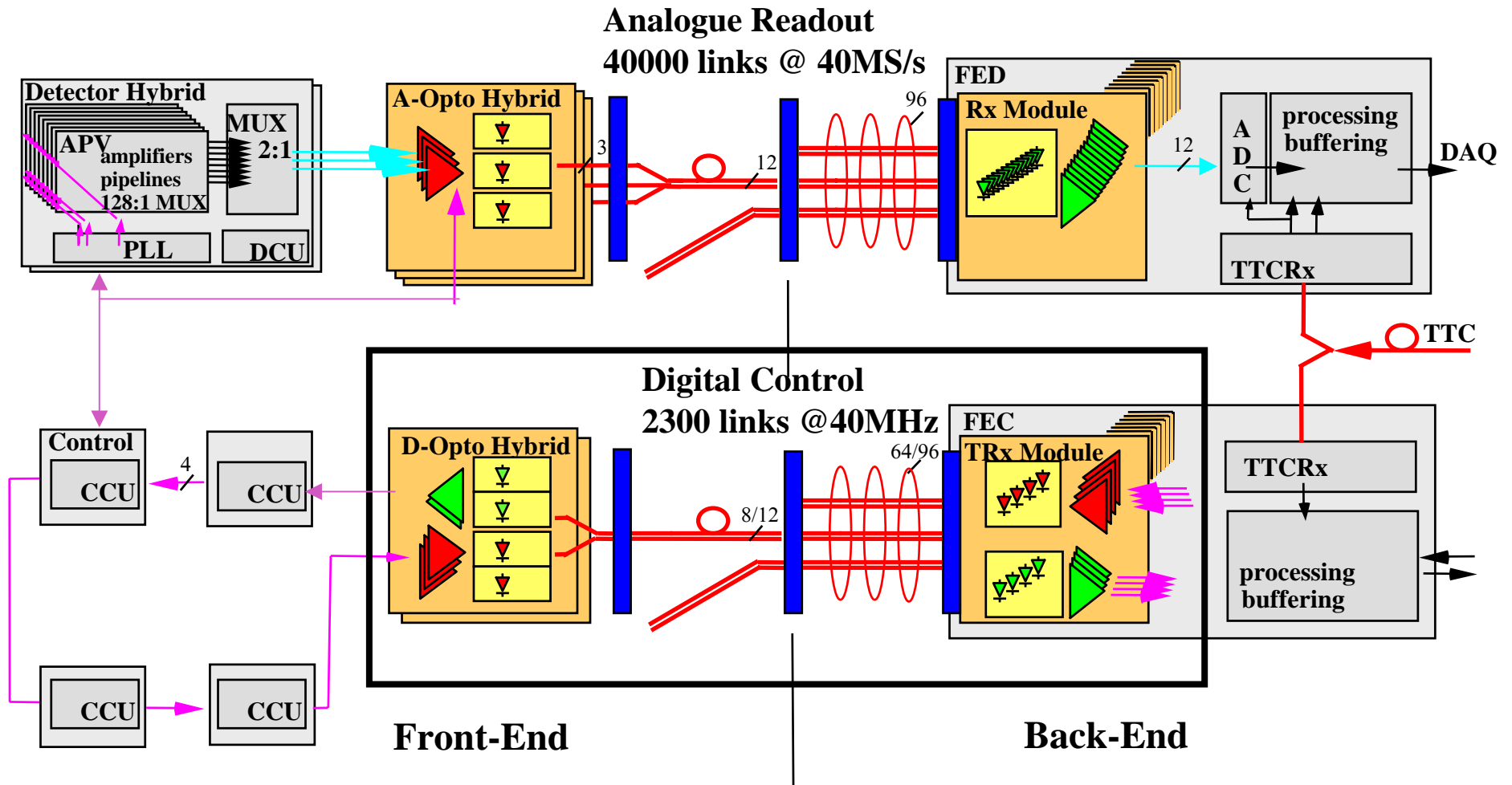
80Mbit/s Digital Optical Links for Control, Timing and Trigger of the CMS Tracker

Part I. System Overview
Part II. Prototype Testing

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Tracker Optical Links





Tracker Requirements

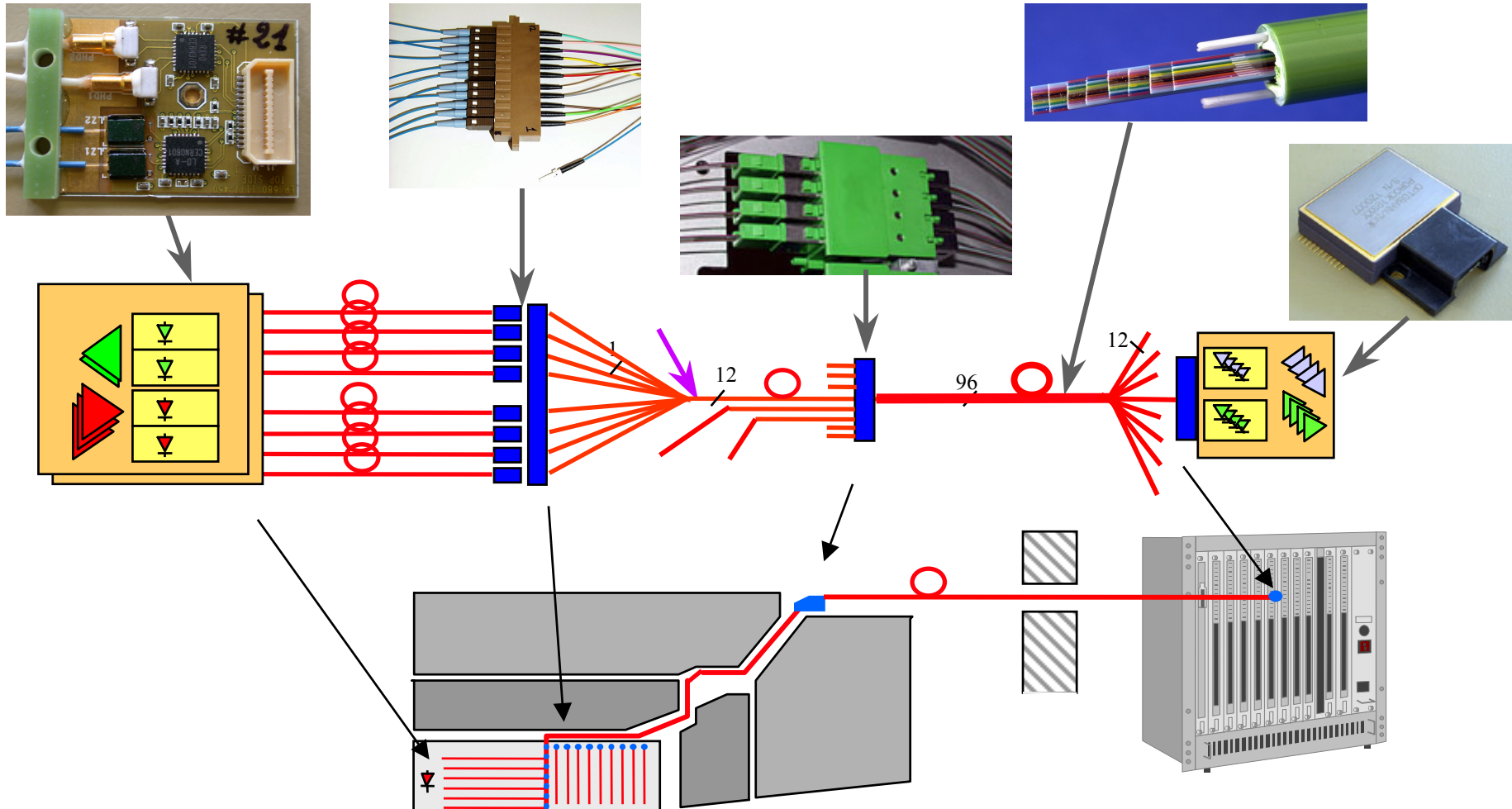
Item	Min	Typ	Max	Notes
Wavelength (nm)		1310 nm		To share analogue readout link components
Speed (Mbit/s)	2		80	
Bit-error-rate		10^{-12}	10^{-9}	
Jitter (ns)			0.5	rms
Skew (ns)			2	Fibres to or from same optohybrid

•Tracker environment

- $T \sim -10^{\circ}\text{C}$
- $B = 4\text{T}$
- 150kGy & $3 \times 10^{14} \pi/\text{cm}^2$ radiation dose
- 10 years min. lifetime



System implementation



Final p-i-n diodes and back-end Transceiver still to be procured



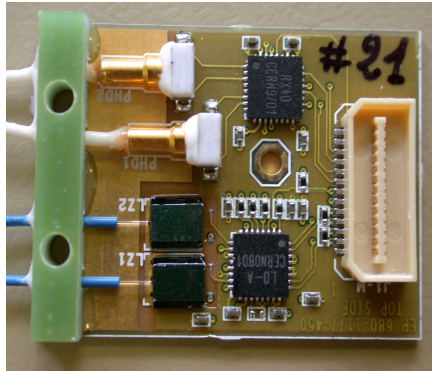
Part Two

Prototype testing



Prototype Testing

- DOH (3/5 Parts)



ASIC made at CERN
Dimensions:
Footprint: 35x25mm
Height : 5mm

- TRx (5/10 Parts)

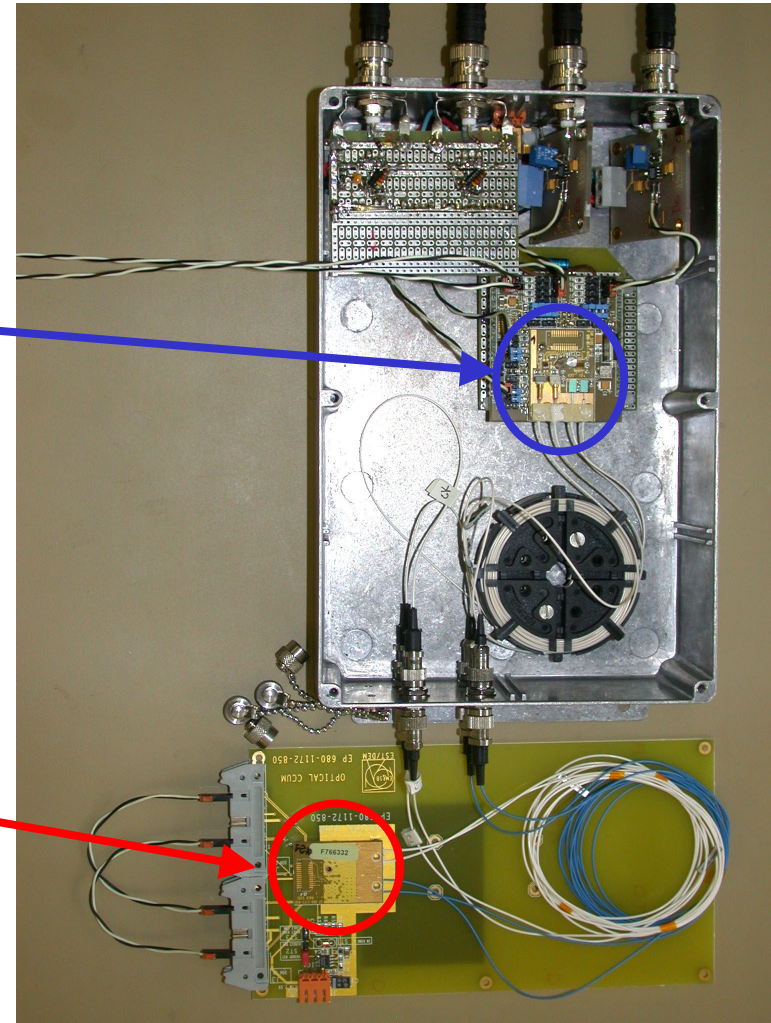
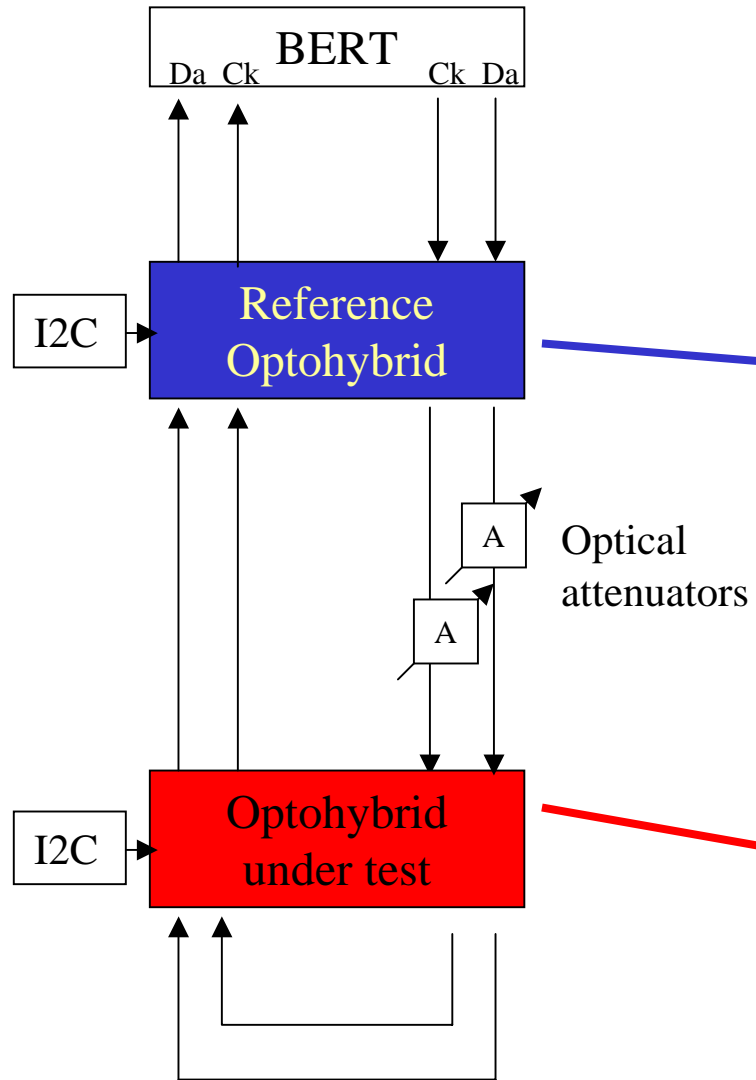


Commercial 4 way
2.5 Gbit/s Transceiver
from NGK Optobahn

Measurements	Digital optohybrid	NGK Transceiver
Optical Power	X	X
Sensitivity	X	X
Saturation	X	X
Reset	X	
Minimum Data Rate		X

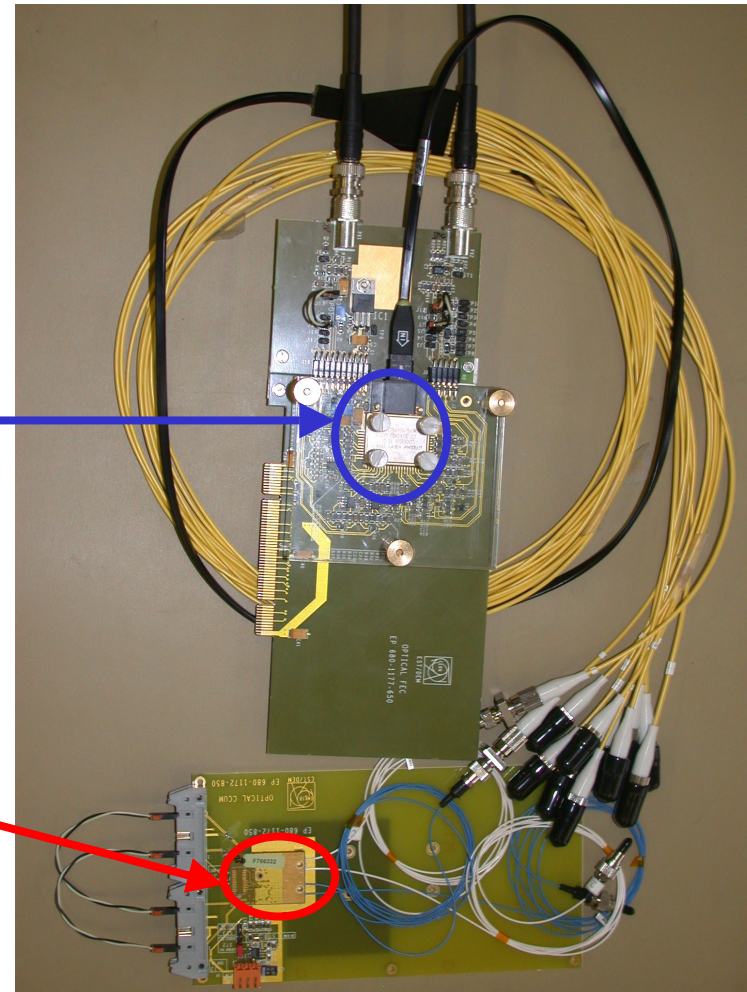
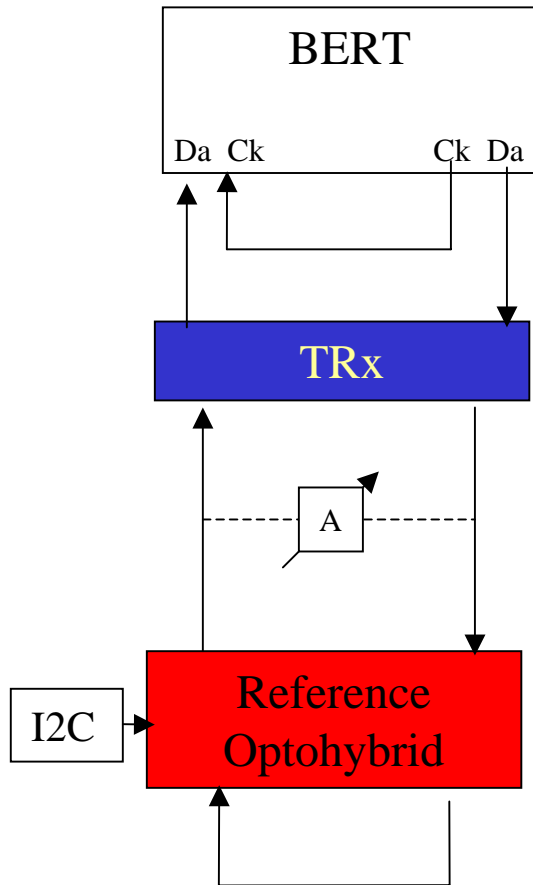


Measurement setup DOH



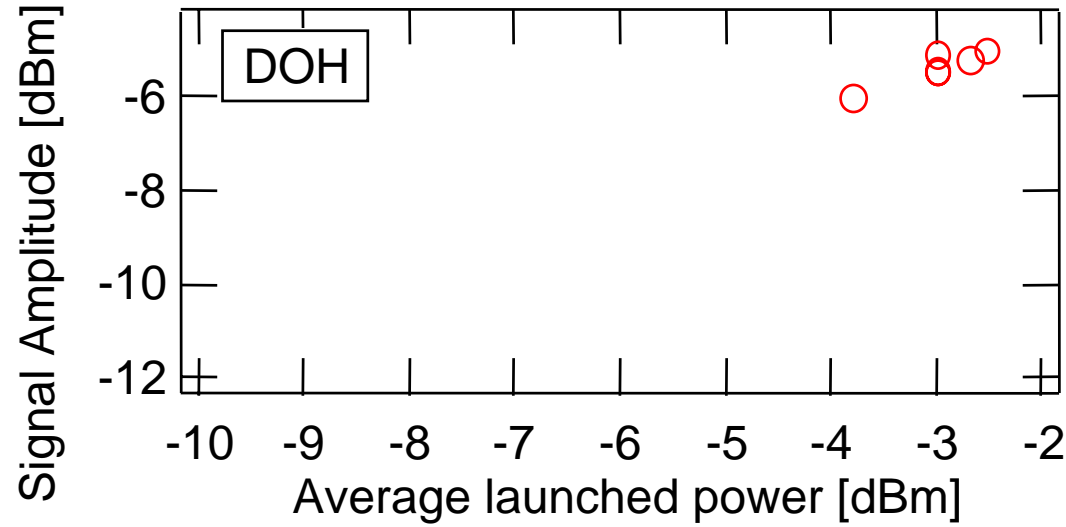


TRx test setup

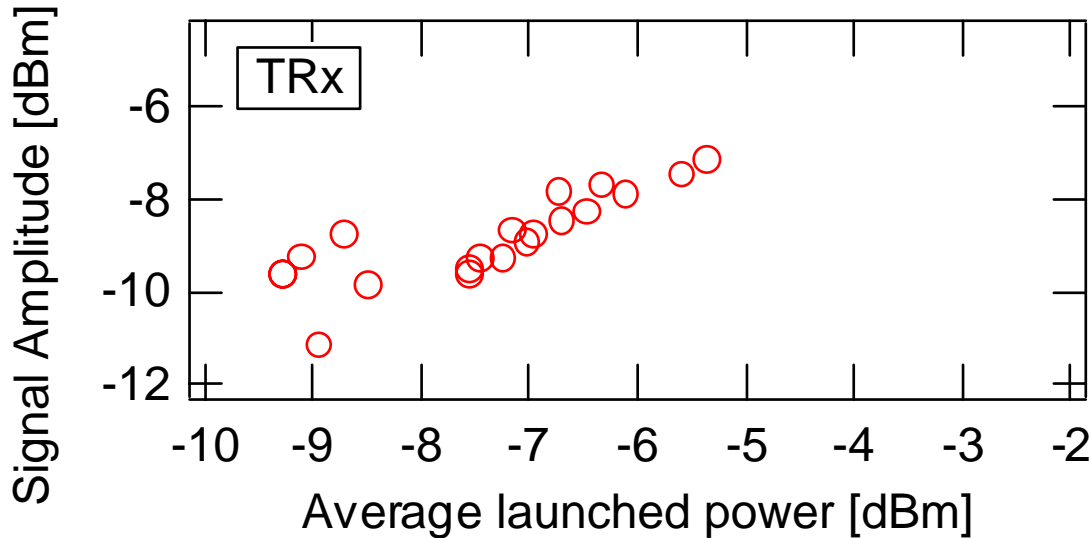
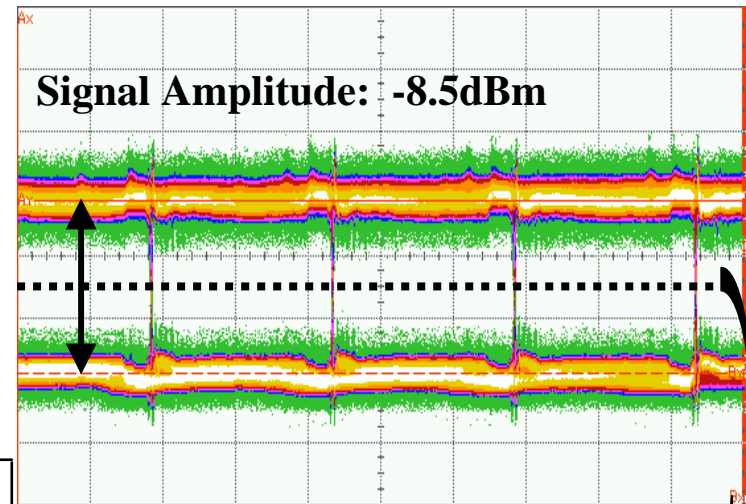




Tx Characteristics



Typical eye-pattern from TRx

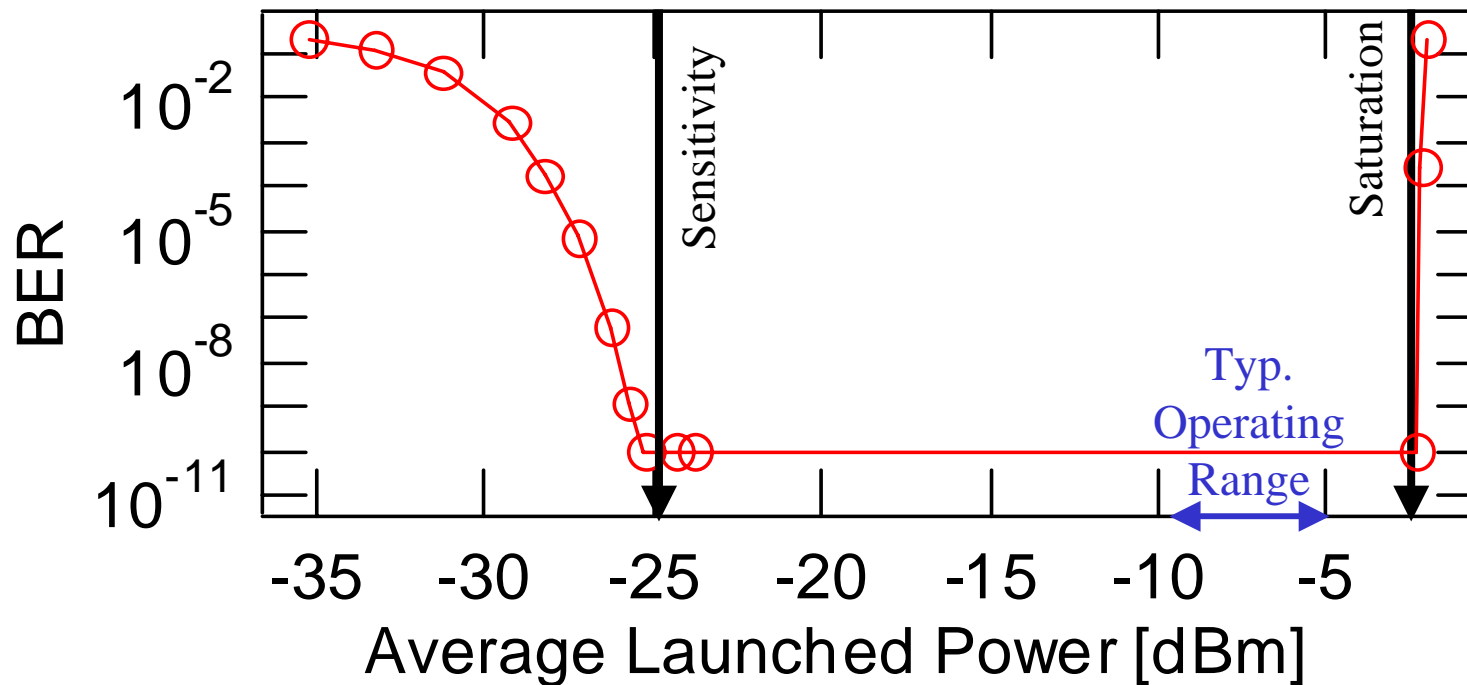


Average launched power: -6.7dBm



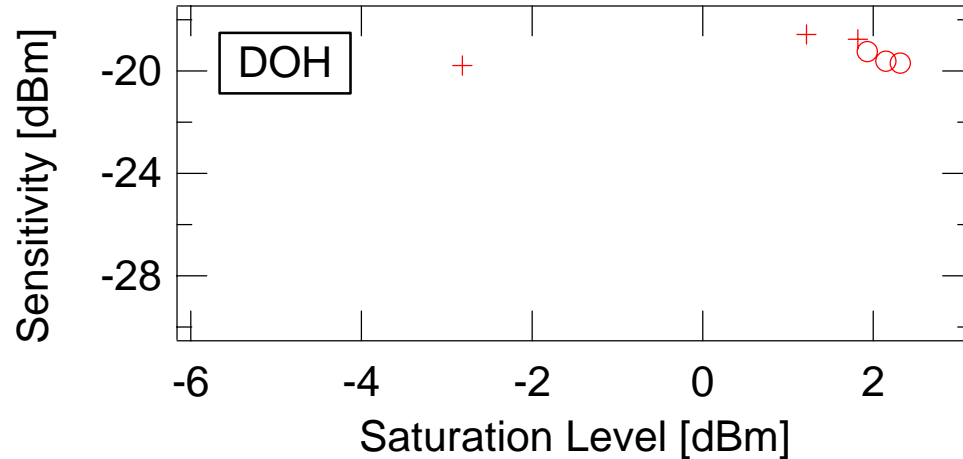
Rx Sensitivity & Saturation

Example of bit-error-rate versus average launched power



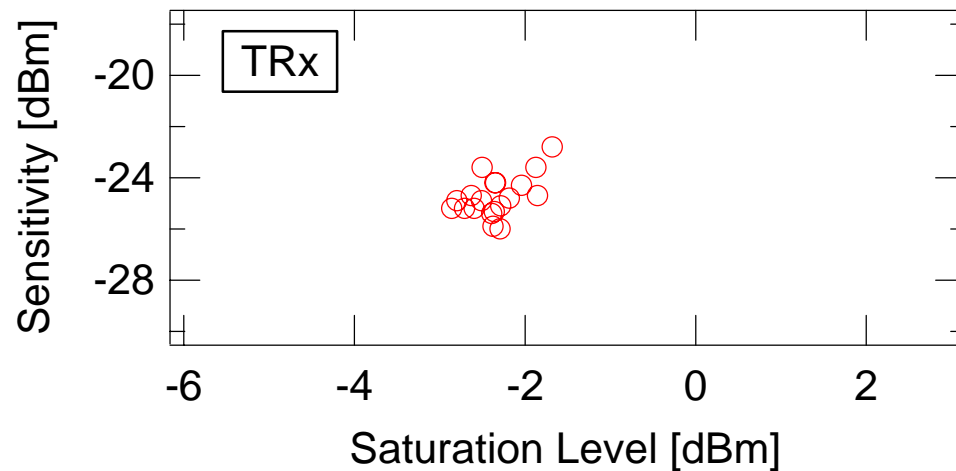


Rx characteristics



•DOH

- RX40 Specs
- Sensitivity ~ -20 dBm
- Saturation ~ -3dBm



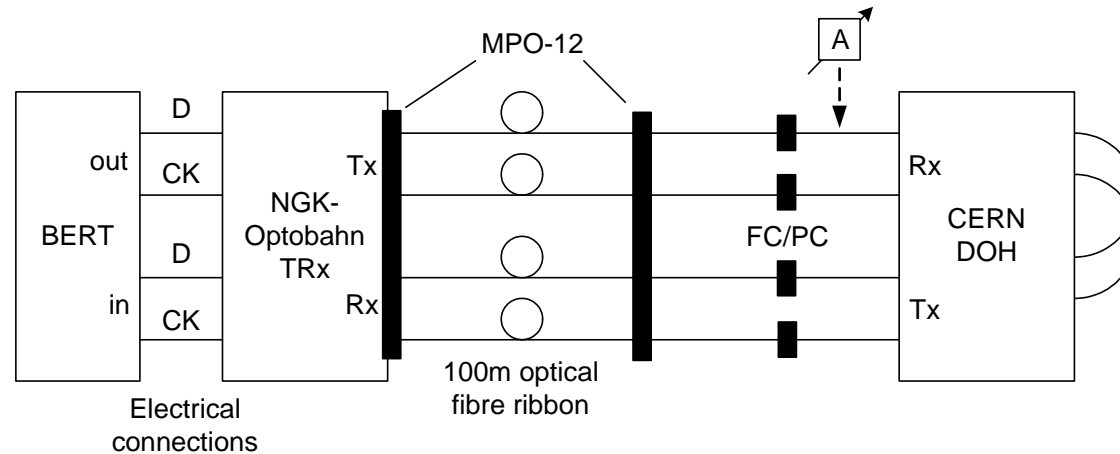
•TRx spec :

- Sensitivity ~ -18 dBm
- Saturation ~ -5 dBm



Full link

- Full link made with DOH, TRX, 100m cable + 3 'patch-panels'



- Optical power margins measured in each channel
 - optical attenuation increased to point where errors occur or link fails
 - From DOH to TRx
 - From TRx to DOH
 - Clock: ~17.5dB
 - Data: ~17.5dB
 - Clock: ~9.5dB
 - Data: ~10dB
- Two Links tested with attenuation for 15 hours without any errors → $BER < 3 * 10^{-13}$



Summary

- 80Mbit/s digital links developed at CERN for CMS Tracker control
 - will also be used by ECAL, Preshower and Pixels
- Philosophy has been to (re)use analogue link components
- Extensive testing of the prototype DOH and NGK-TRx
 - Devices work well and compatible with intended link system
 - Testing procedures in place for production
- Full prototype link with DOH, TRX and realistic cabling tested
 - operates with a large safety margin
 - BER < 10^{-12}
- The remaining specs and interfaces to be frozen end of 2002, procurement of devices to start in 2003



- More information on the Digital Optical Links:

<http://cern.ch/cms-opto>