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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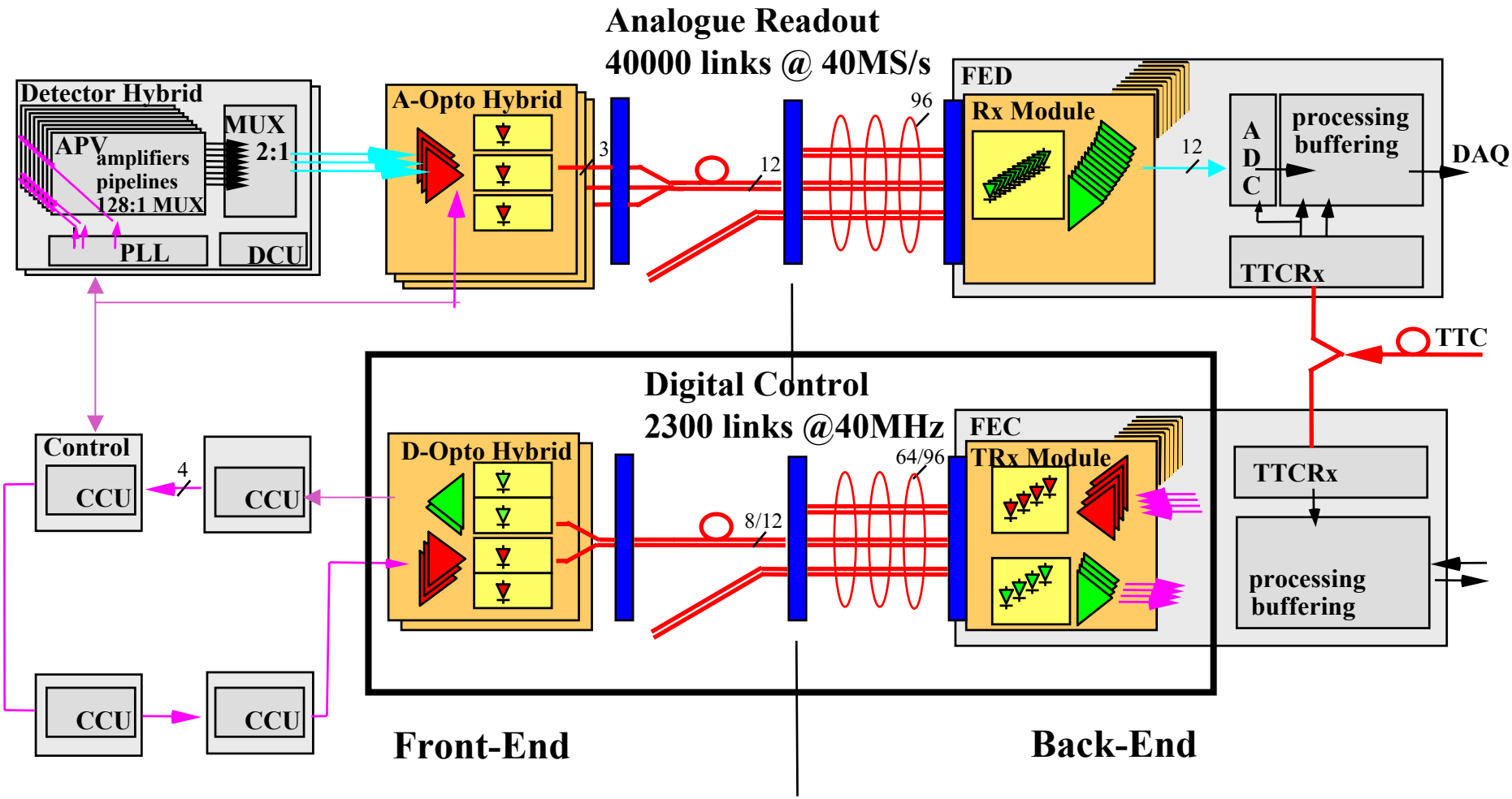
Tracker Optical Links

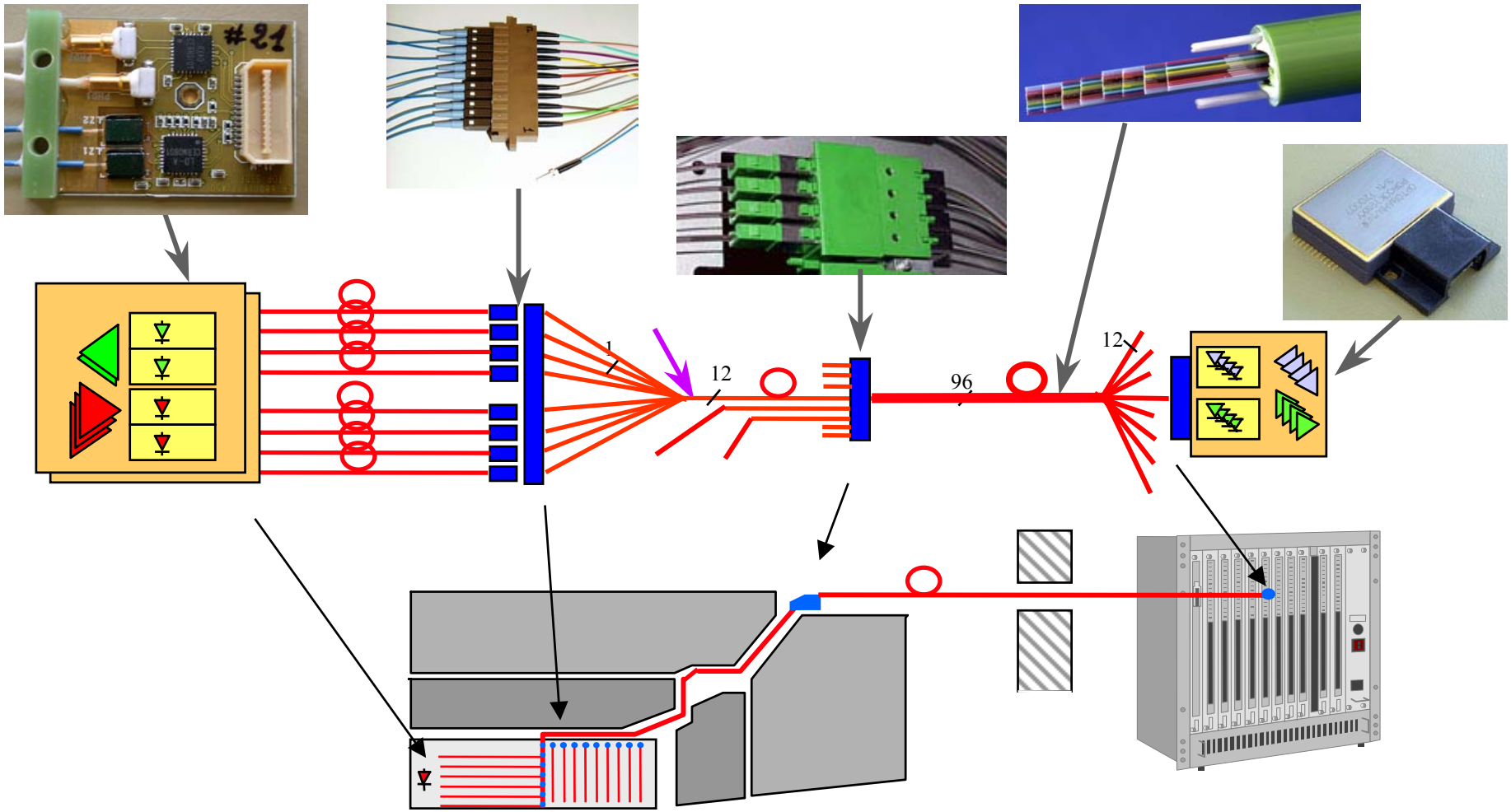


Tracker Requirements

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 ~ -10°C
  - B = 4T
  - 150kGy & 3×10^{14} π/cm^2 radiation dose
  - 10 years min. lifetime

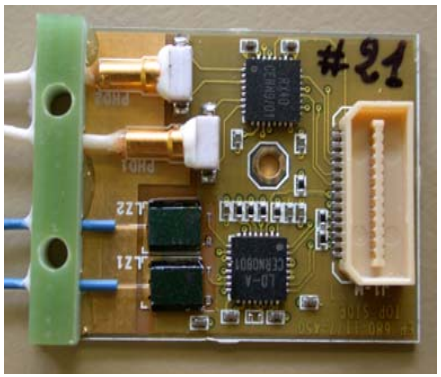
System implementation



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

Prototype Testing

- DOH (3/5 Parts)



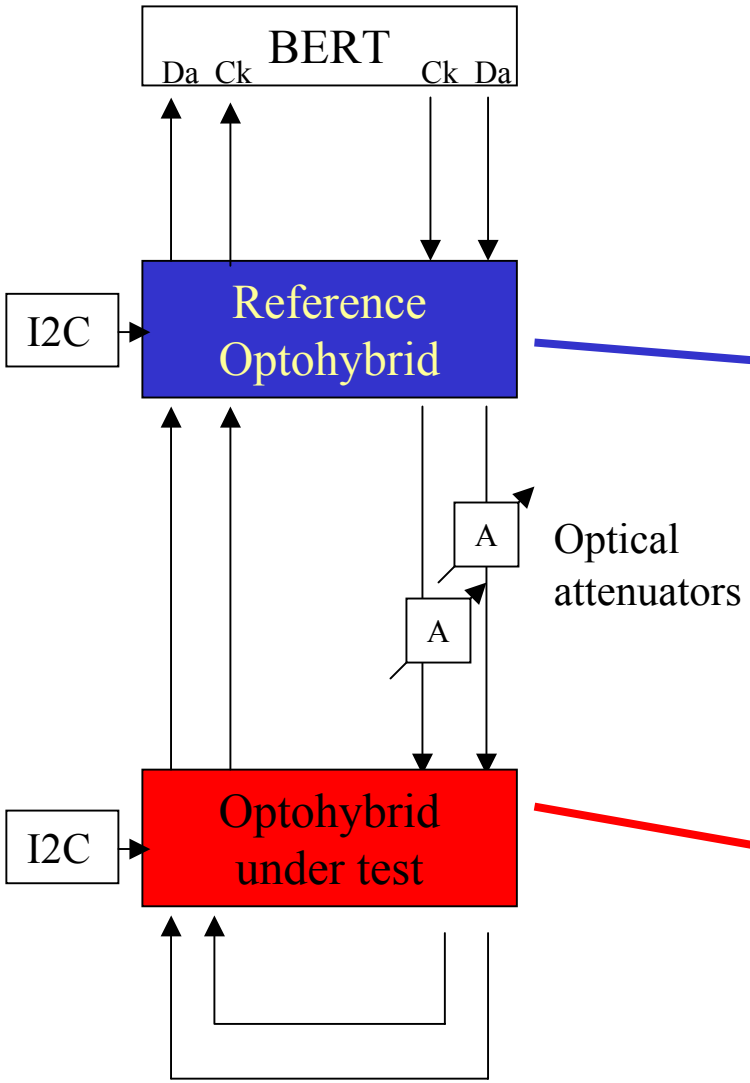
ASIC made at CERN
Dimensions:
Footprint: 35x25mm
Height : 5mm

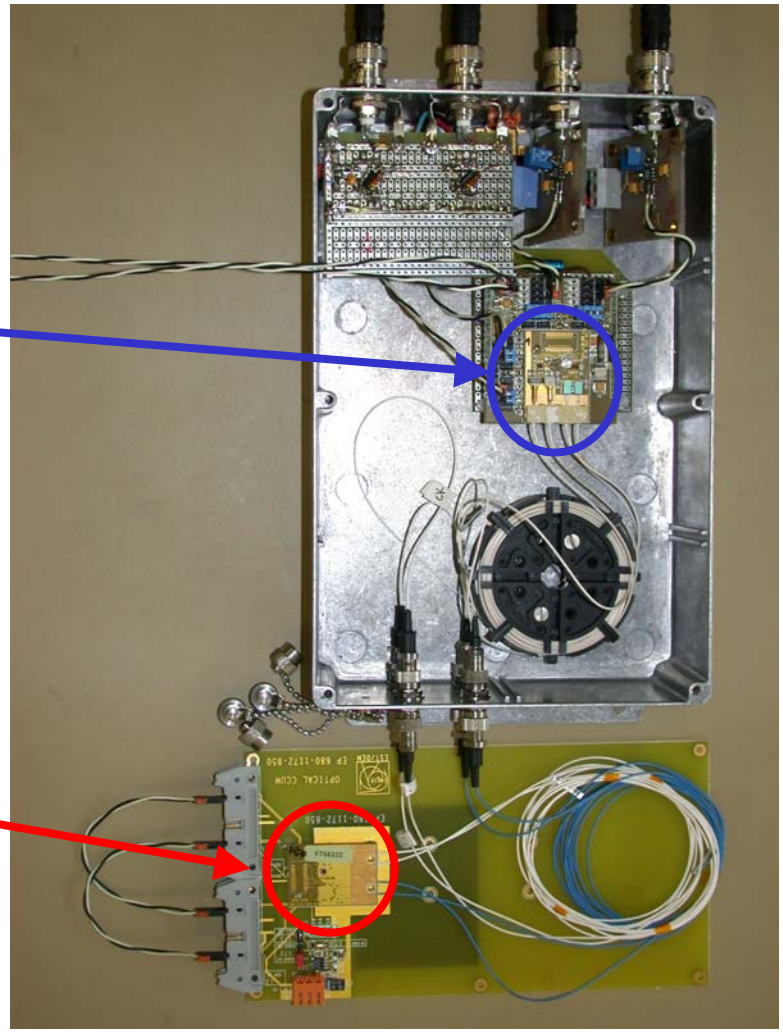
- TRx (5/10 Parts)

Commercial 4 way
2.5 Gbit/s Transceiver
from NGK Optobahn

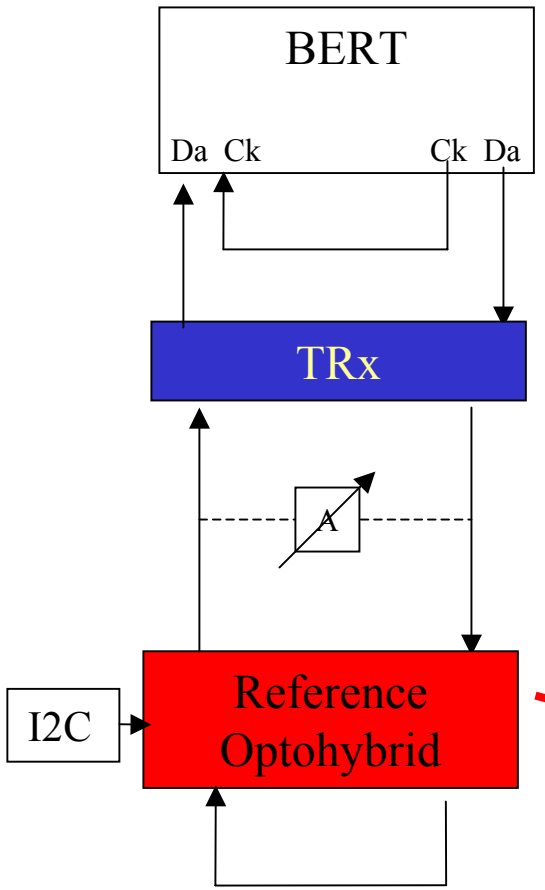
Measurements	Digital optohybrid	NGK Transceiver
Optical Power	X	X
Sensitivity	X	X
Saturation	X	X
Reset	X	
Minimum Data Rate		X

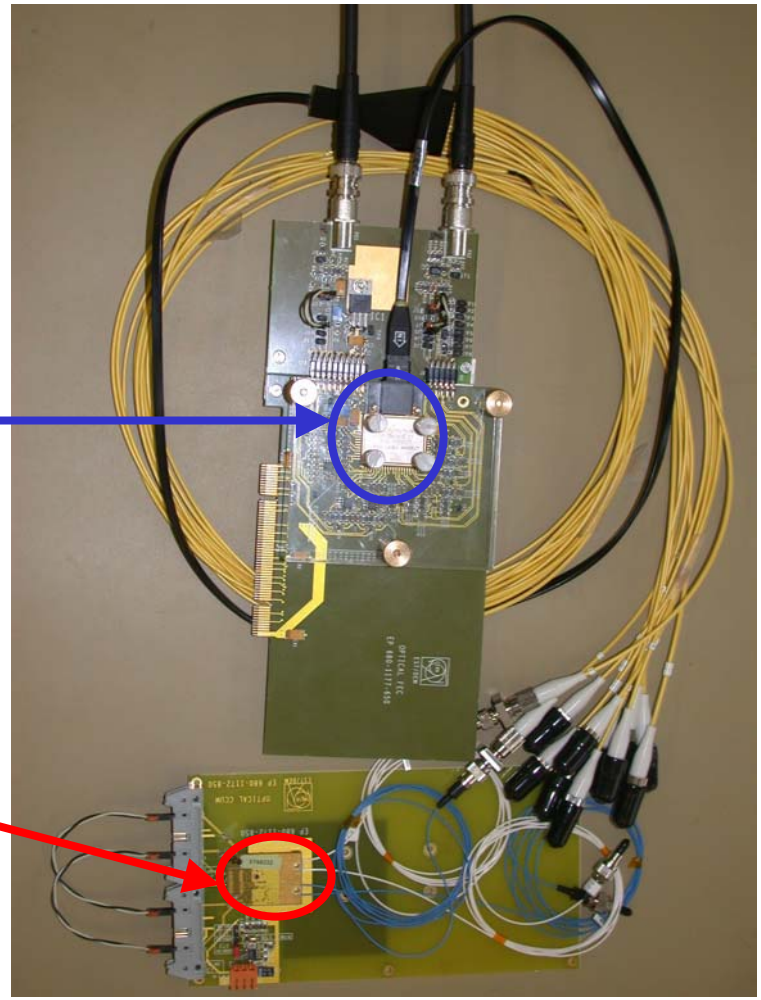
Measurement setup DOH



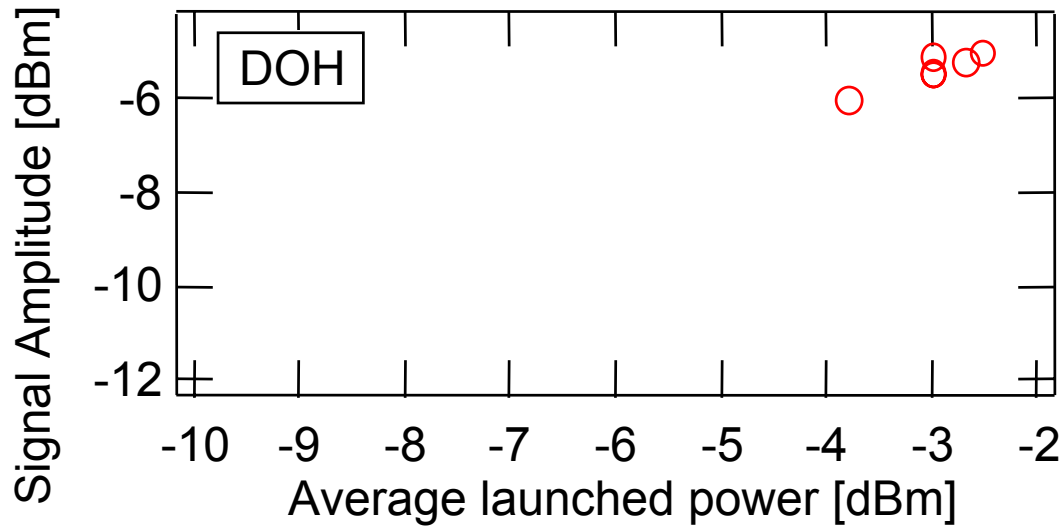


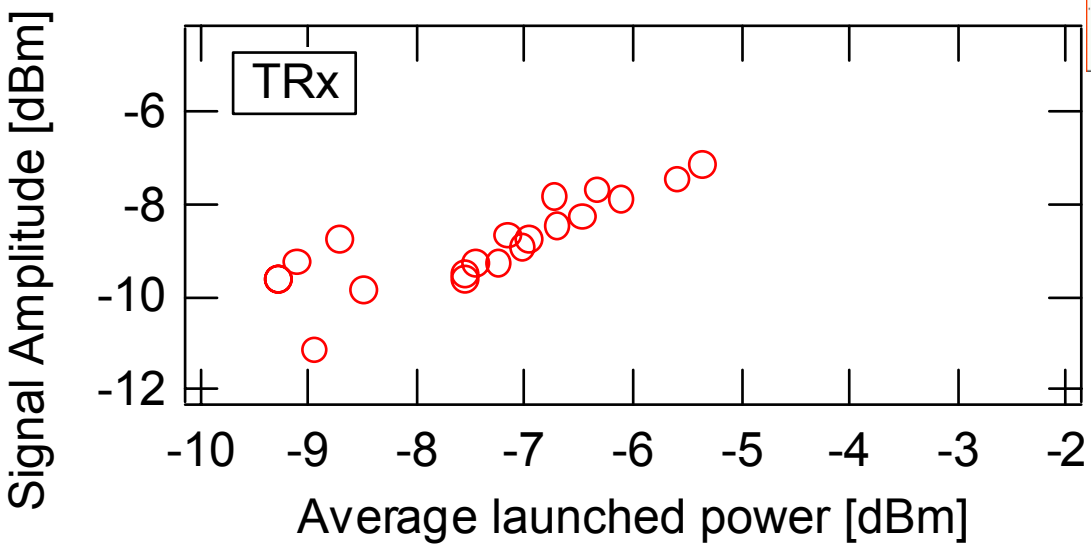
TRx test setup



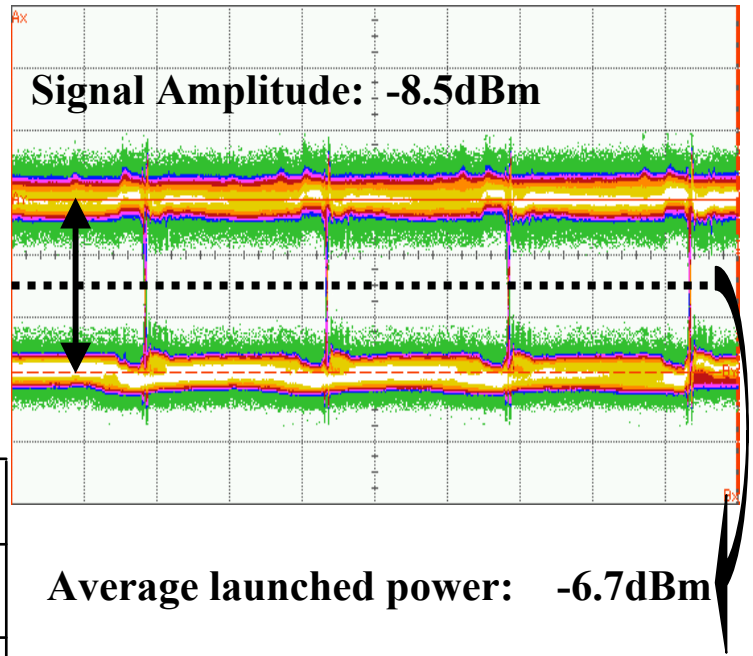


Tx Characteristics



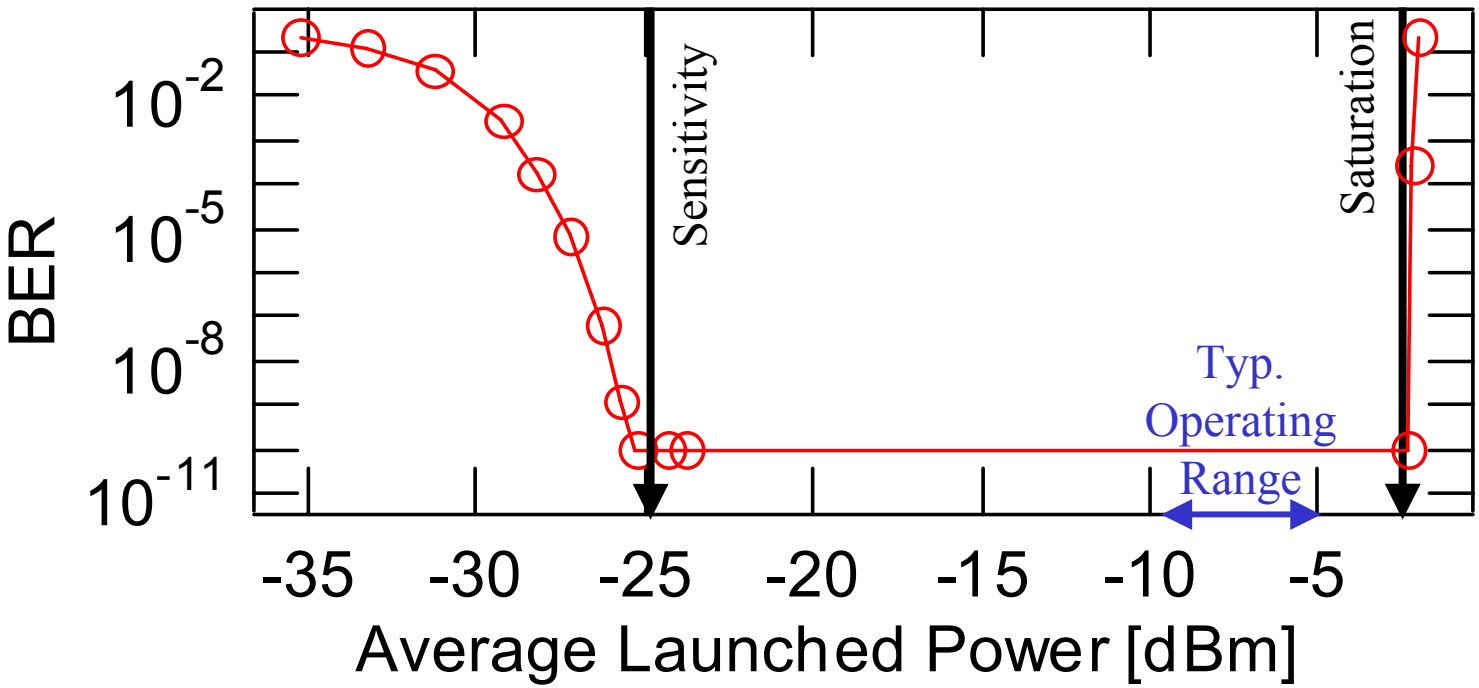


Typical eye-pattern from TRx

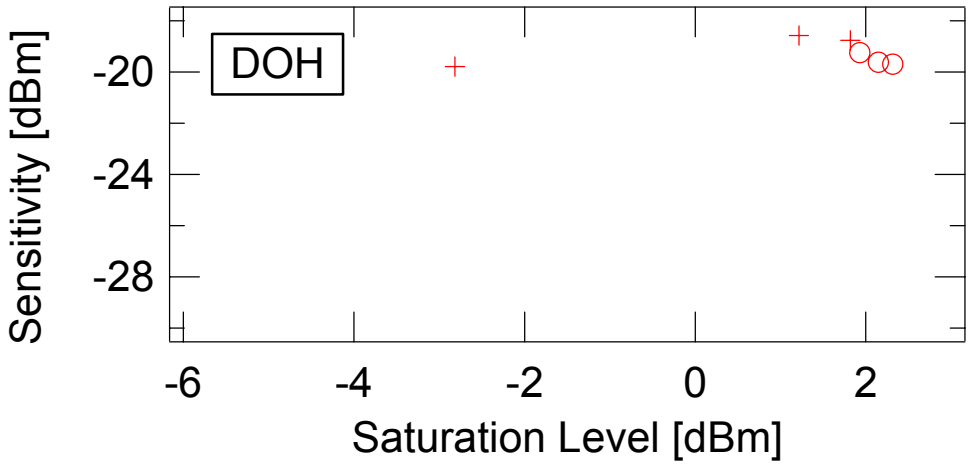


Rx Sensitivity & Saturation

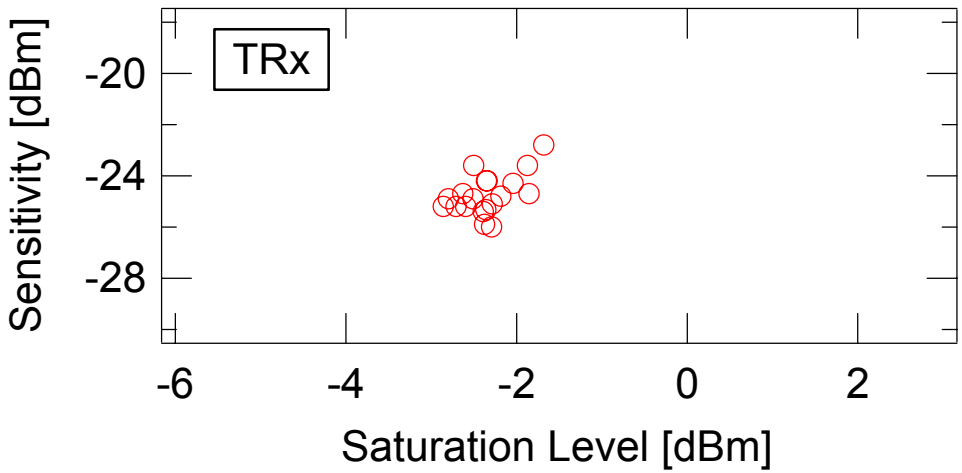
Example of bit-error-rate versus average launched power



Rx characteristics



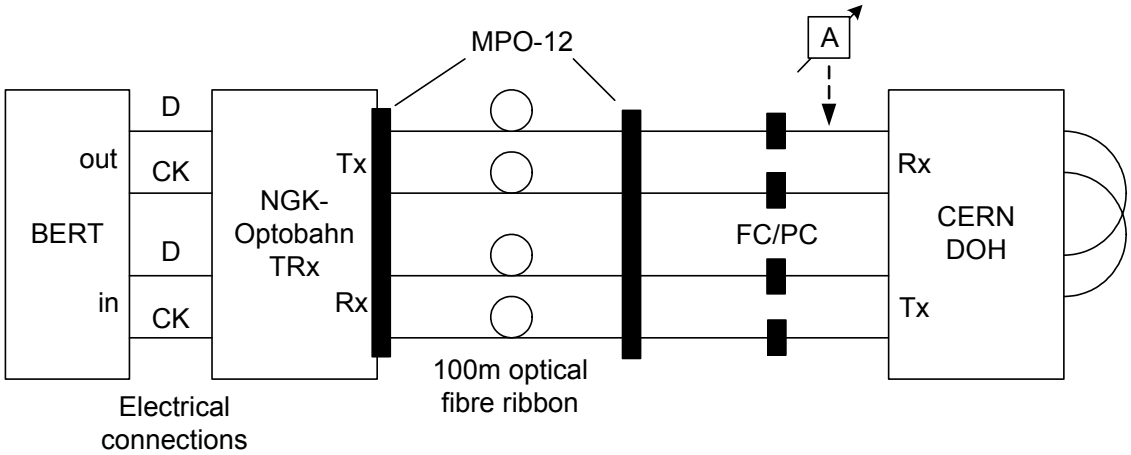
- **DOH**
  - **RX40 Specs**
  - **Sensitivity ~ -20 dBm**
  - **Saturation ~ -3dBm**



- **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	- Clock: ~9.5dB
- Data: ~17.5dB	- 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