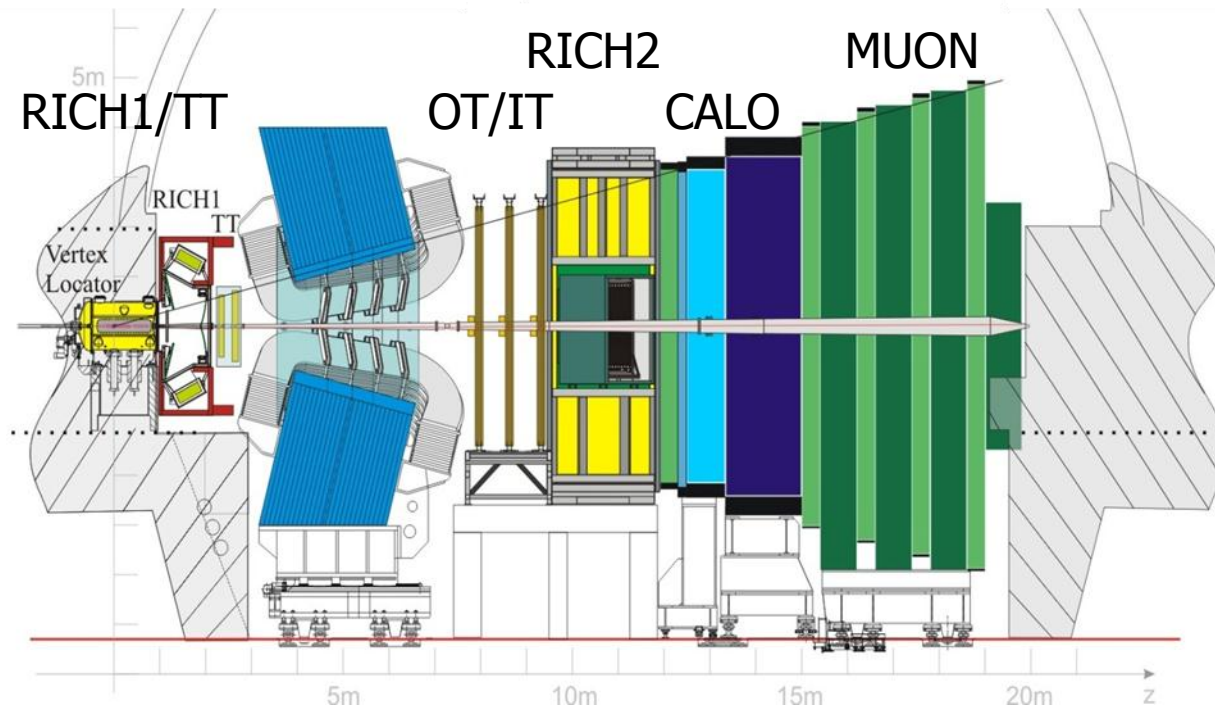


# Common Optical Link

Dirk Wiedner

16<sup>th</sup> February 2012

# LHCb overview



+TFC system

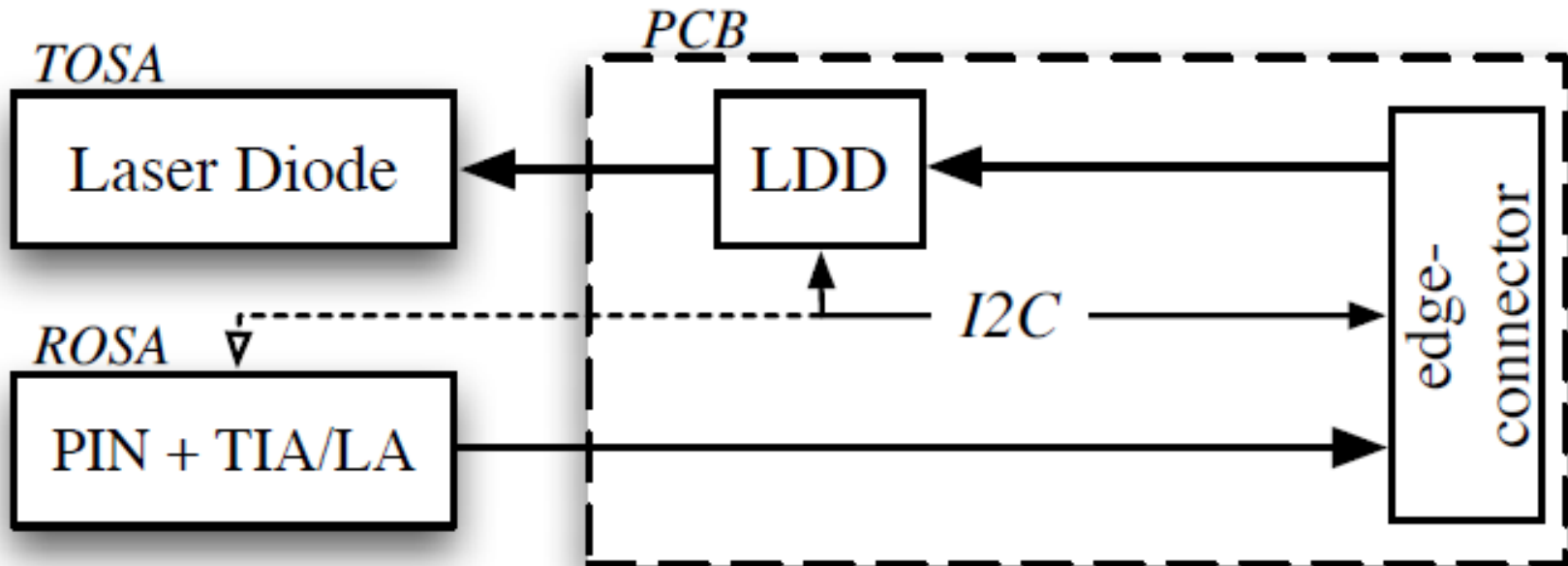
# Current LHCb optical links

- ▶ 1.1 MHz readout O(6000) links
  - +40 MHz L0 trigger readout O(2000) links
- ▶ GOL @ 1.6 Gb/s serializer + laser driver
- ▶ VCSEL
  - ULM photonics
  - SMA 850nm MM
- ▶ Or Agilent 12-way transmitter HFBR-772B
- ▶ Agilent 12-way receivers HFBR-782B
  - TLK2501 de-serializers
- ▶ MM-fiber 125/50  $\mu\text{m}$ 
  - FO-networks, DRAKA etc.
- ▶ TFC system SM fiber @ 160 Mb/s

# LHCb 40 MHz upgrade links

- ▶ 40 MHz for the entire detector
  - $O(12000)$  links
- ▶ GBT @ 3.2Gb/s t.b.d.
  - Data + TFC + ECS
  - FPGAs with fast link I/O in low rad regions
- ▶ **Versatile link**
  - Transceiver 850nm MM
  - **Dual transmitter 850nm MM**
  - Transceiver 1310 nm SM (anyone?)

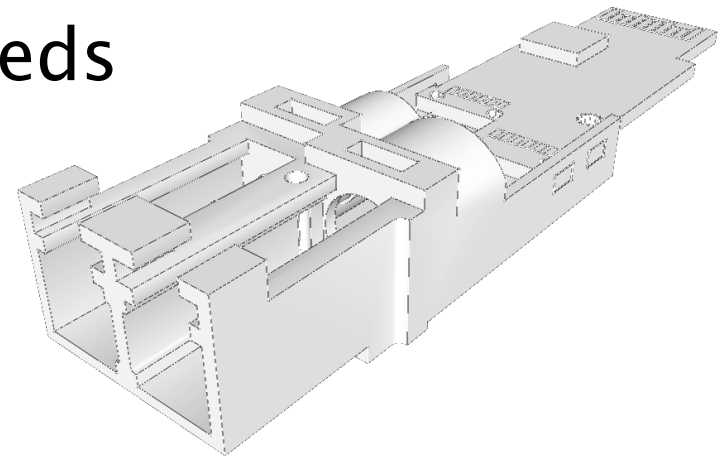
# Versatile link transceiver



- Transmitter Optical Sub-Assembly (TOSA)
- Laser Diode Driver (LDD)
- Limiting Amplifier (LA)
- TransImpedance Amplifier (TIA)
- PIN photodiode

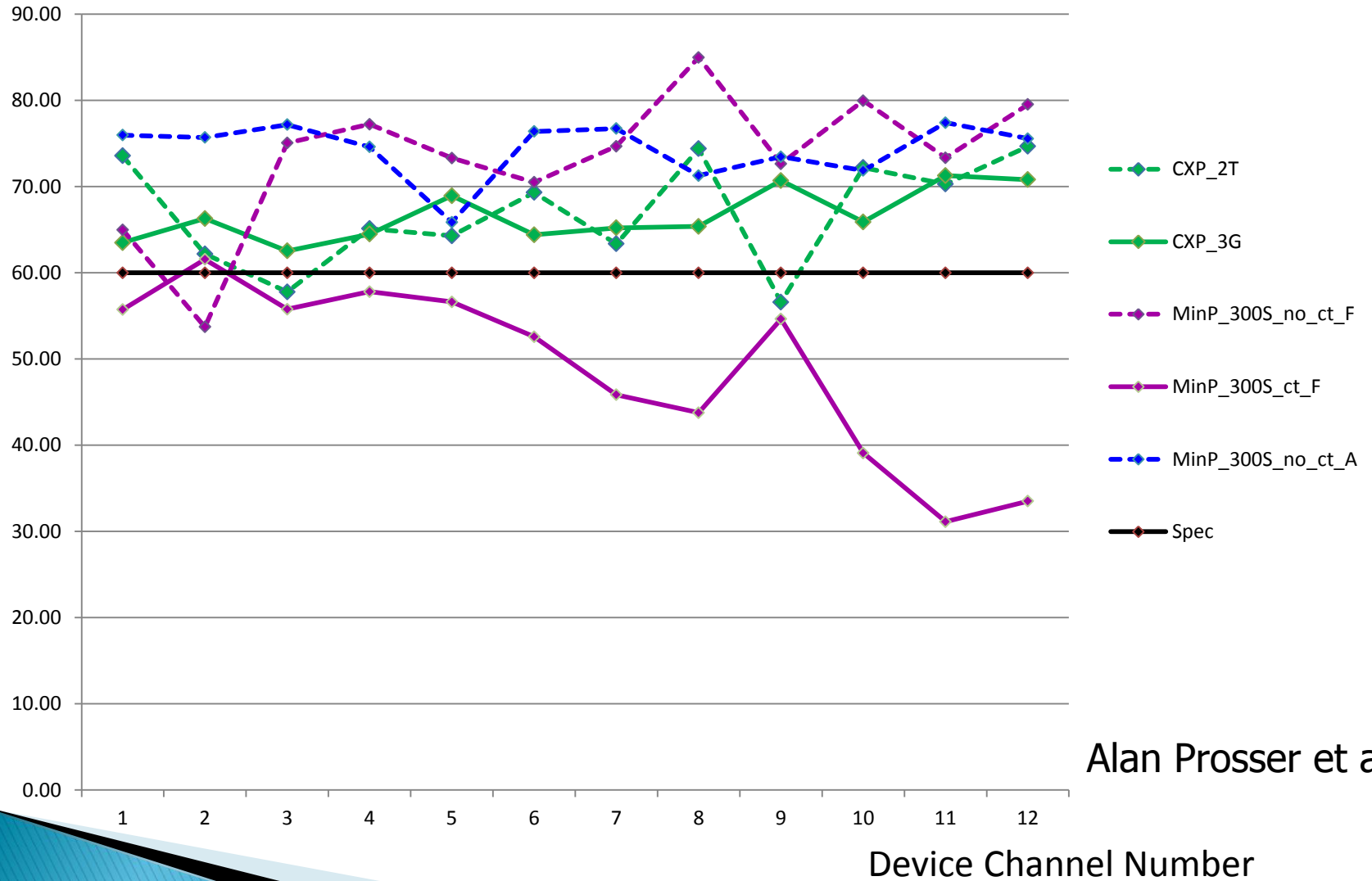
# Versatile link status

- ▶ Common R&D almost complete
  - VTRx and later VTTx
  - Optical tests
  - Mechanical tests
  - Irradiation of active and passive components
  - Environmental test
  - System tests (BER etc.)
- ▶ Some tests exceed LHCb needs
  - ...but might proof useful



# Optical tests

Eye Opening

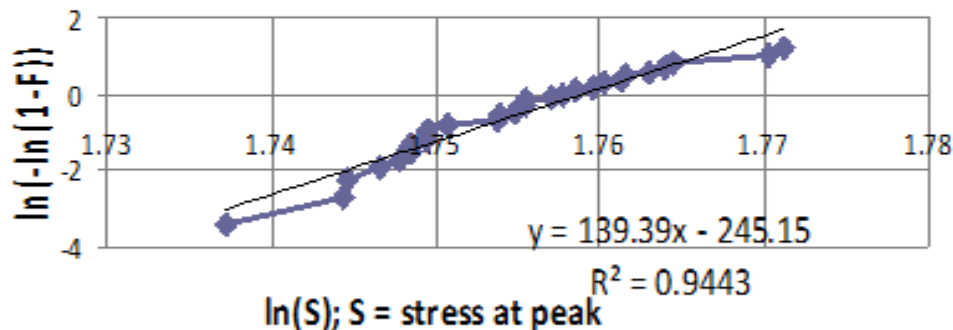


Alan Prosser et al.

# Mechanical fiber stress test

- ▶ Fiber from Corning and Draka
  - Irradiated
  - Pull test
- ▶ John Wilson et al.

smf28e; 500mm/min; irradiated (remove low outlier).





# Irradiation tests of commercial components

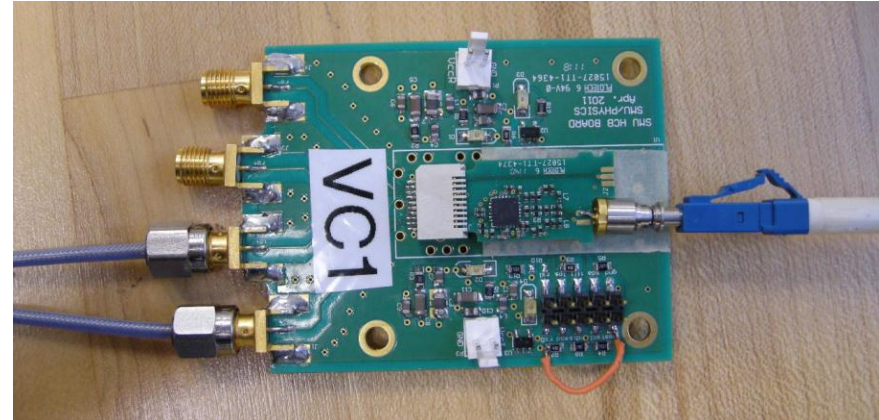
- ▶ TI laser driver
  - ONET1101L
  - 10 krad/h
  - Ok. At 900 krad
- ▶ 4-channel QSFP
  - AFBR-79Q4Z
  - 10 krad/h
  - Errors from 75 krad



Annie Xiang et al.

# Irradiation tests of commercial components

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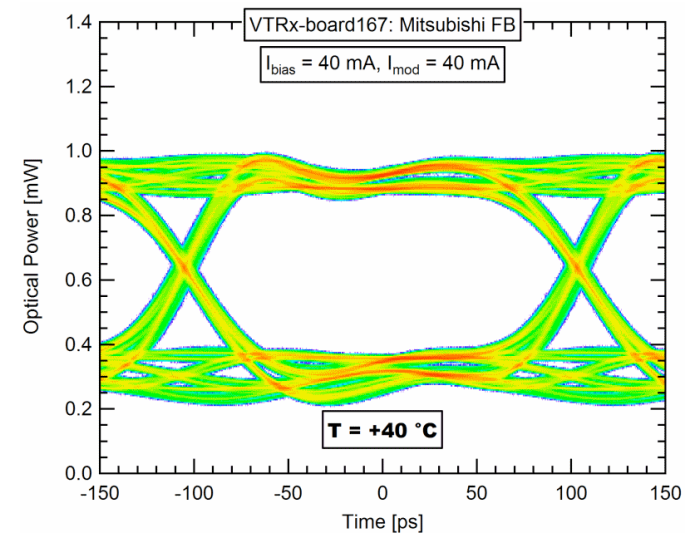
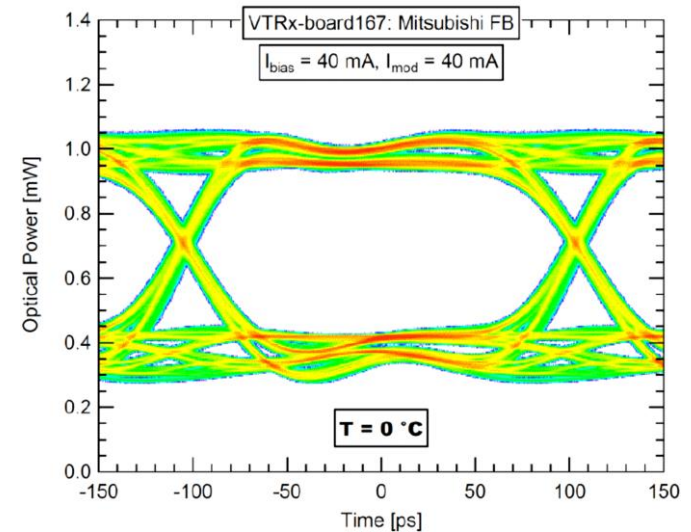


Annie Xiang et al.

# Environmental test

- ▶ VTRx jitter measurements
  - VTRx 131:
    - ONET1101L & FP TOSA
  - Rx side measurement
  - Temperature testing of VTRx – Eyes

Jan Troska



# R&D completion **March 2012**



## ● **VTRx**

- Investigate options
  - TOSA SM (VCSEL/EEL)
  - PIN MM-Tk (GaAs/InGaAs)
- **Gamma irradiation test**
- **Neutron irradiation test**
- **Environmental tests**
  - EMI/Crosstalk, B-field, Zthermal
- **Opto connector block**
  - Variants (printed, molded and machined)
  - Materials
  - Selection
- **VTRx flavours**
  - Flat connector block
  - VTTx
- **GB ASICs test and integration**
  - GBLD V4
  - GBTIA V2
  - GBTIARosa V2
- **VTRx FMC**
- **Documentation**

## ● **Passives**

- **Cable architectures options and specs**
- **Cable test procedures**
- **Tests**
  - Fibre pull tests
  - Cable irradiation tests
- **Documentation**
  - Connector test writeup
  - Microbend test writeup
  - Bandwidth



## ● **System**

- **Explore margins (stressed eyes, temperature, ...)**
- **Raise density at backend**
- **Demonstrate system based on VTTx**
- **Explore compatibility with higher level system ( ...)**
- **Documentation**

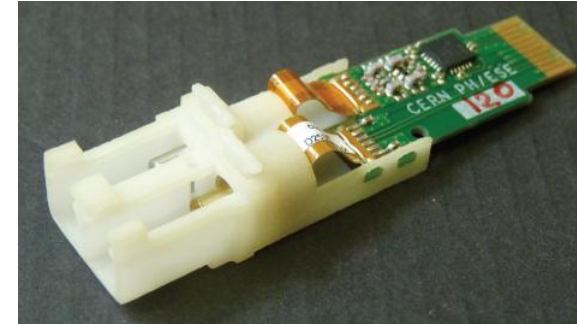


## ● **Back End**

- **Optical engines**
  - Survey
  - Characterization
  - FMCs
- **SM Tx**
  - High power
  - Arrays
- **MM Tx – QSFP**
- **Documentation**

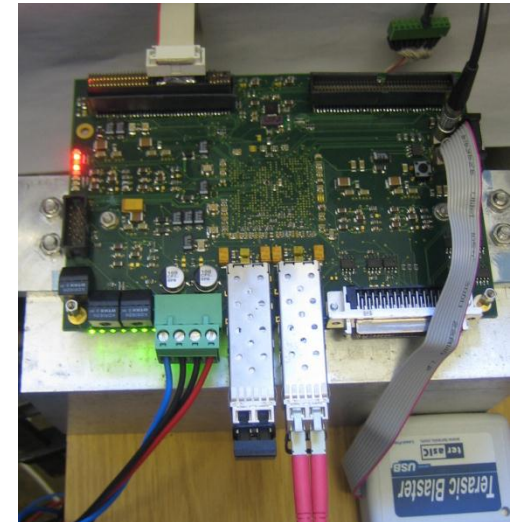
# Versatile link status

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  - Environmental test
  - System tests (BER etc.)
- ▶ Some tests exceed LHCb needs
  - ...but might prove useful
- ▶ **Next steps**
  - Tendering +user test systems
  - Custom R&D



# LHCb optical link activities

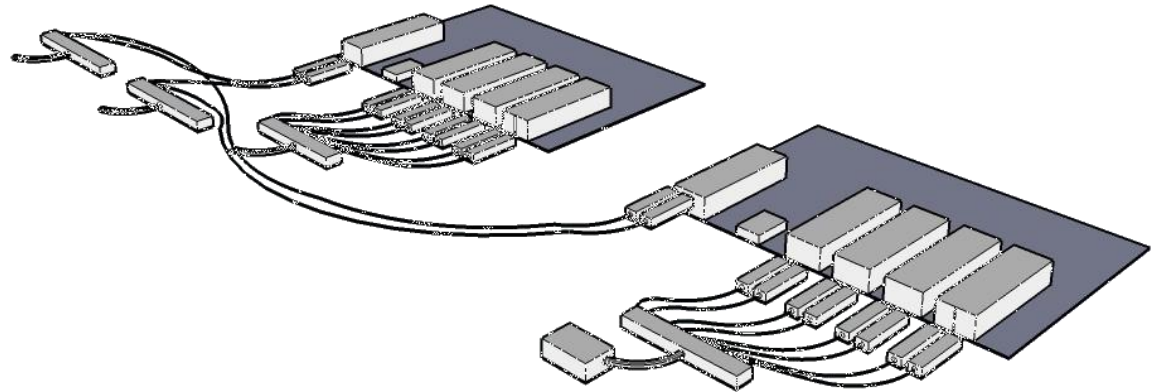
- ▶ Many Institutes started R&D
  - OT example:
    - Altera FPGA based front end at HD (Christian F.)
    - Readout board at Dortmund (Stefan S.)
    - Actel FPGA based front end at NIKHEF (Tom S.)
  - TELL40
    - Marseille
    - Lausanne
- ▶ **Important to proceed together**



# Tendering for LHCb

- ▶ TOSA MM: 11 000
- ▶ ROSA MM: 1 000
- ▶ VTTx MM: 5000 ?
- ▶ VTRx MM: 1 000
- ▶ 12Rx MM: 1 000 ?
- ▶ Fiber ??

- ▶ Specification
- ▶ Market survey
- ▶ Qualification



# Custom R&D

- ▶ Detector specific versatile link components and architecture
  - VTRx and/r VTTx PCB
  - Optoblock
  - Assembly vs. reference design
- ▶ Low power VTRx
- ▶ 10Gb/s opto engine
- ▶ Emergency technologies
  - Si photonics ...



# Summary

- ▶ LHCb 40 MHz upgrade
  - extra bandwidth
  - Higher radiation levels
- ▶ Versatile link project
  - 5 – 10 Gb/s optical link system
  - Common R&D achieved
  - Most tests concluded
- ▶ LHCb versatile link next step
  - System tests by users
  - Tendering
  - Specific implementations