The Versatile Link
System-level Component Tests

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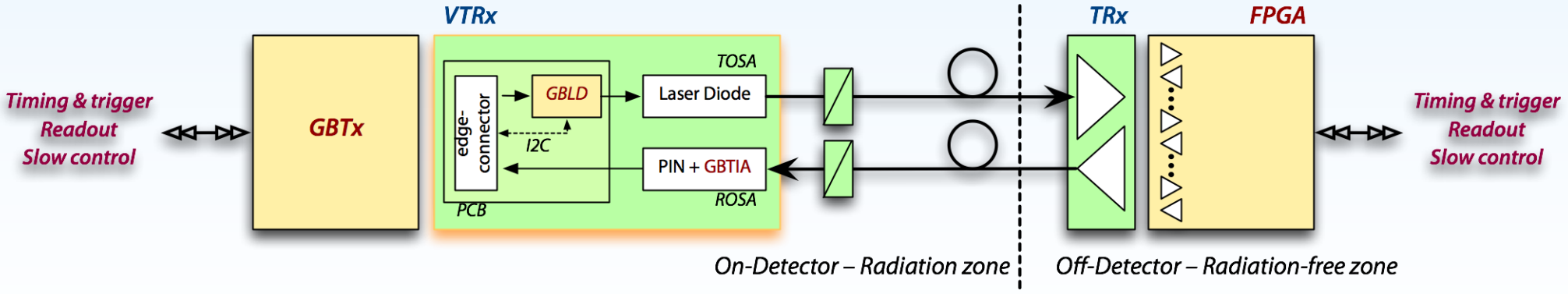
Outline

- Introduction
- Versatile Link architectures
- System-level testing
- Optical link budget
- Typical applications
- Summary

Versatile Link project

- Optical layer linking front-end to back-end up to 150 m distant.
- Bi-directional @ 5 Gbps
- Two Point-to-point solutions
  - 850 nm Multimode
  - 1310 nm Single-mode
- Front-end pluggable module
- Rad-hard front-end

- Joint Project Proposal submitted to ATLAS & CMS upgrade steering groups in 2007 and endorsed in 2008
- Project Kick-off: April 2008
  - Phase I: Proof of Concept (18mo)
  - Phase II: Feasibility Study (18mo)
  - (Consolidation)
  - Phase III: Pre-production readiness (18mo)
  - Production: Phase I Upgrade: ATLAS, CMS, LHCb (calorimeter-grade components)



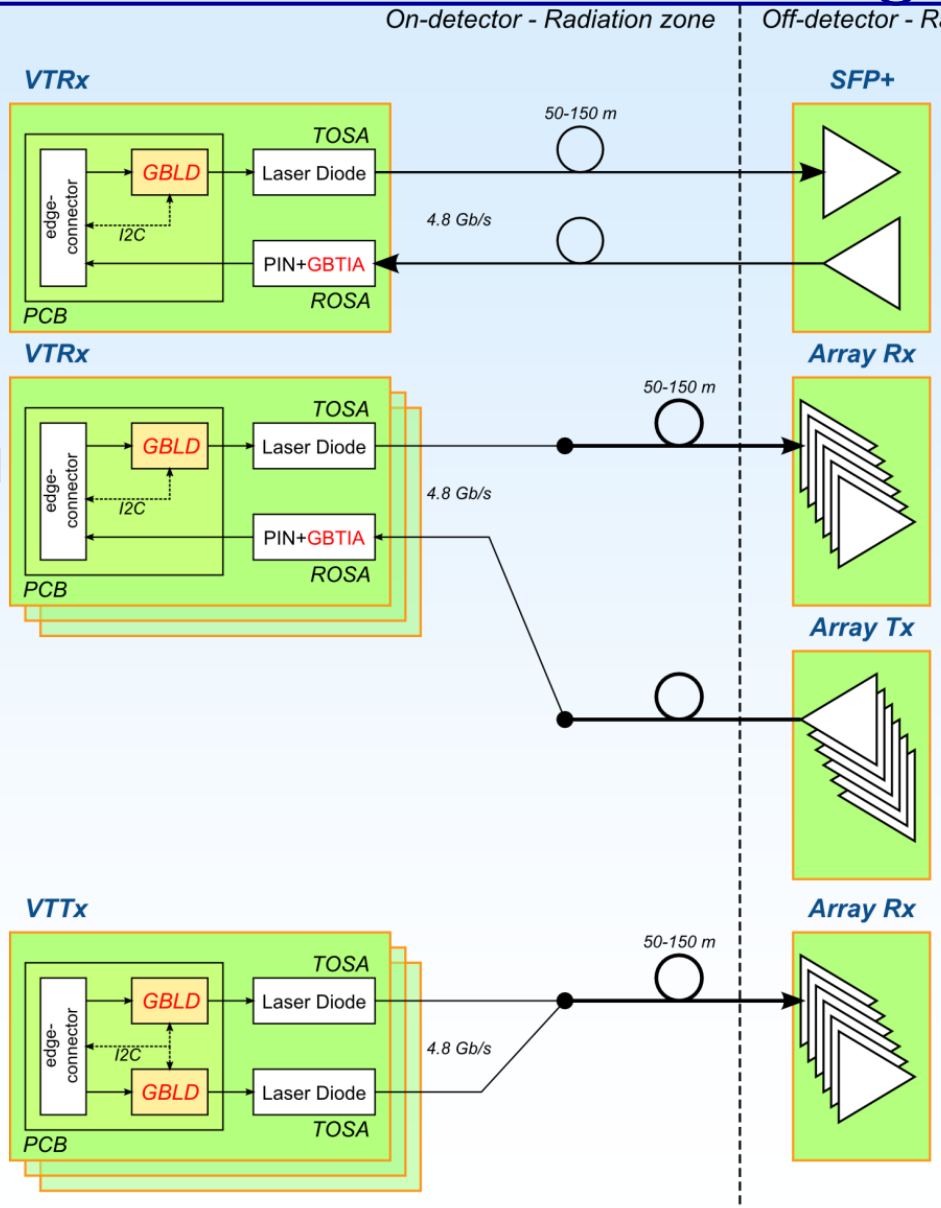
Jan Troska et al. "Versatile Transceiver and Transmitter Production Status" (poster session)

Supported architectures

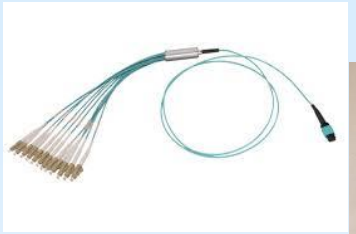
- Single-channel readout, or control links
- Single-mode and multi-mode variants exist

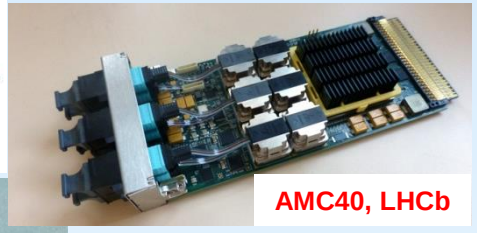
- Multi-channel receiver and transmitter arrays increase density at the back-end
- Typically multi-mode, however, some single-mode solutions exist too

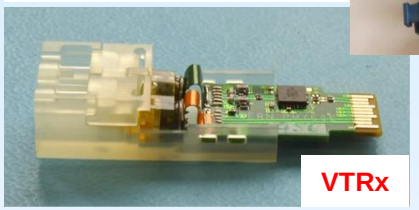
- Asymmetric bandwidth needs (up>>down)
- Typically complemented by single-channel control links
- Multi-mode solution

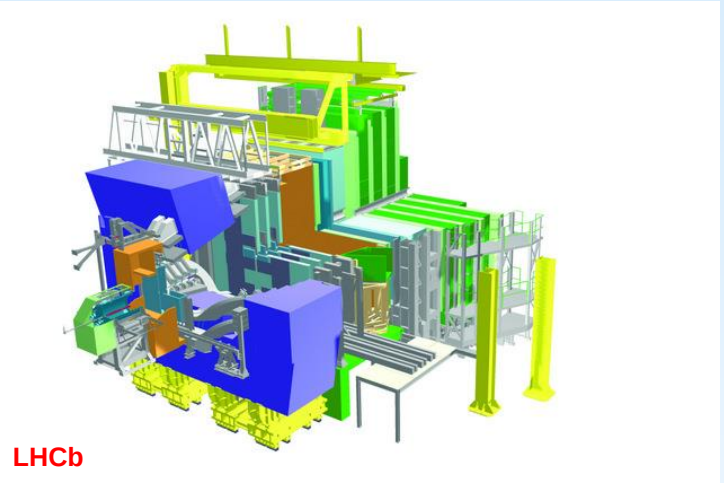


System-level testing









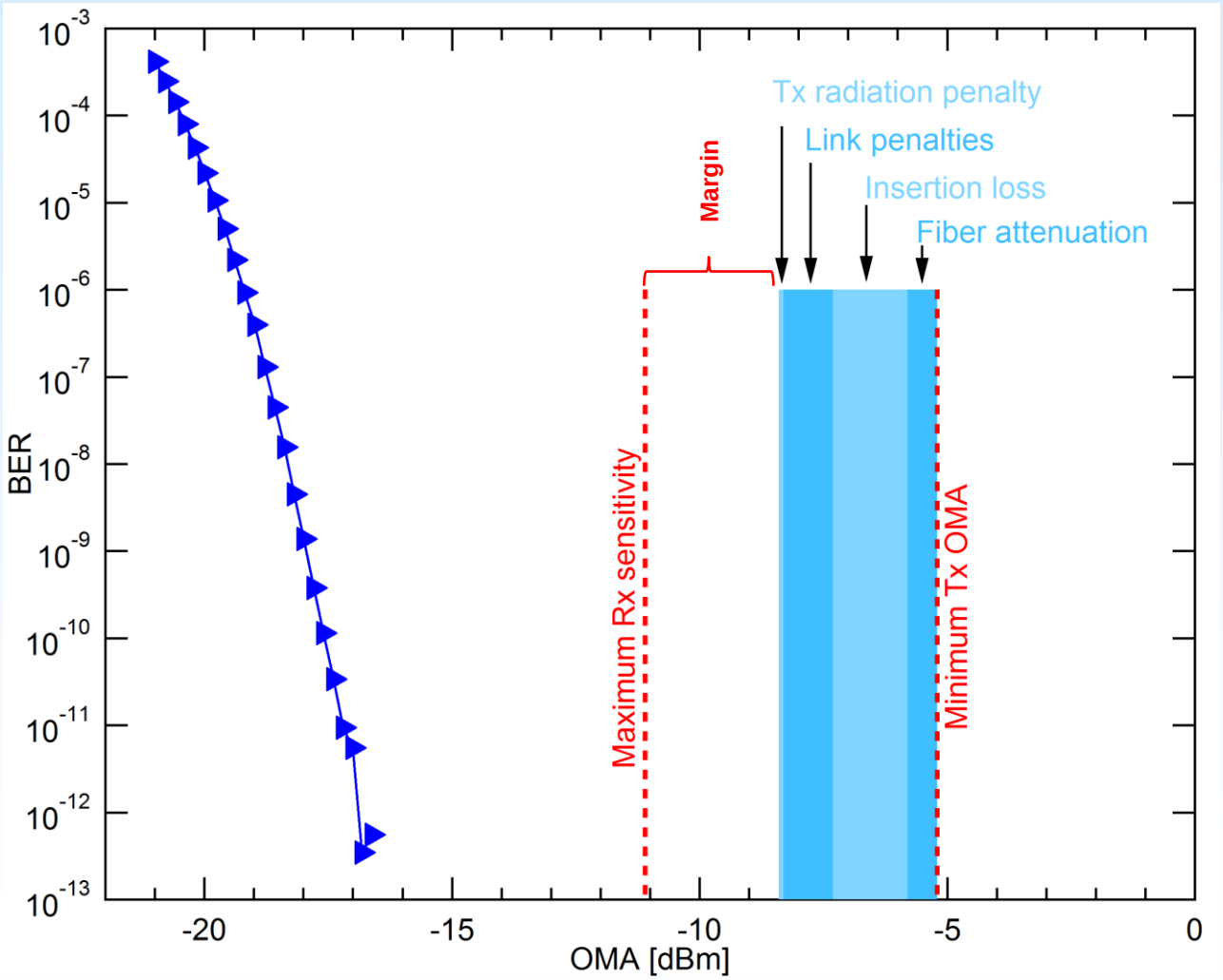
- Component testing
  - Verify compliance w.r.t. their specifications
  - Carried out extensively during component selection and protyping
- System-level testing
  - Verify compatibility of the components in the system
  - Allows to measure system performance vs. component parameters (e.g. fibre type/length)

Rainer Schwemmer et al. "Evaluation of 400m, 5Gbit Versatile Link lengths over OM3 and OM4 fibres for the LHCb upgrade" (poster session)

Optical link budget

- Allows you to calculate the margin in your system
- Accounts for the statistical spread of the component specifications
- Includes losses and various penalties
  - Fibre attenuation
  - Insertion loss (connectors, splices)
  - Radiation damage (front-end, passive and active components)
  - Link penalty
- Considers raw link performance
  - Encoding and/or equalization can also contribute to the link margin
- Target is to keep **3dB** margin (conservative)
  - Ageing and unforeseen effects
  - Don’t forget high-reliability requirements we have in our systems

Optical link budget

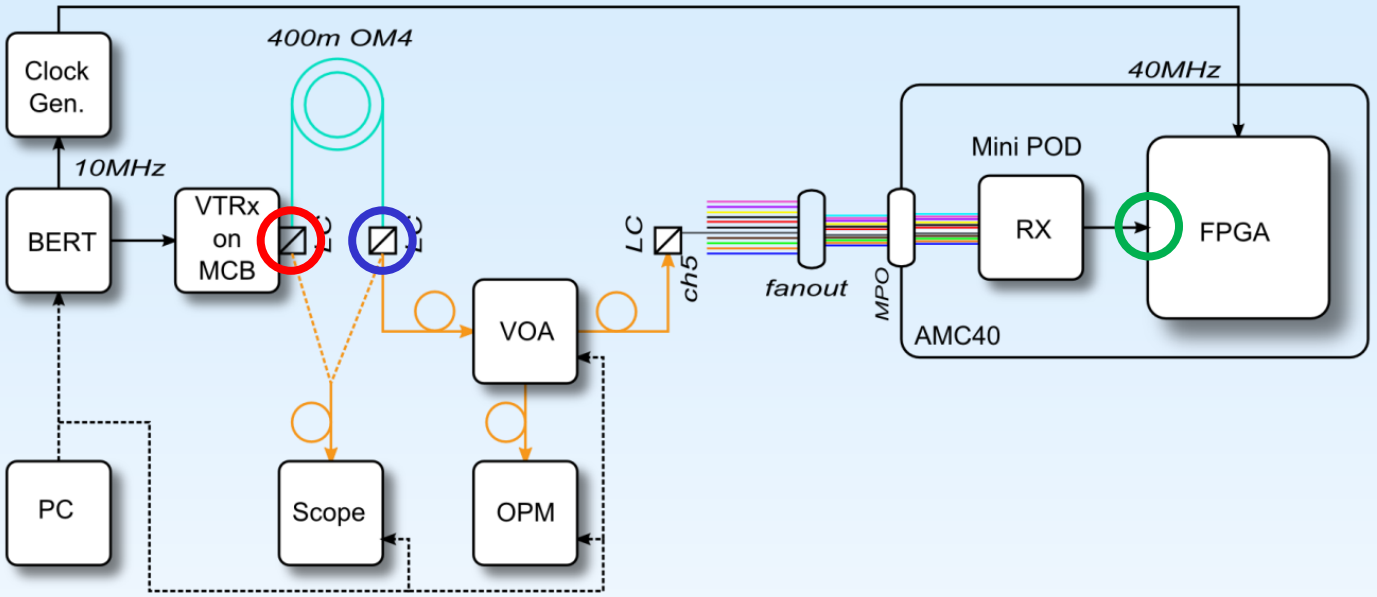


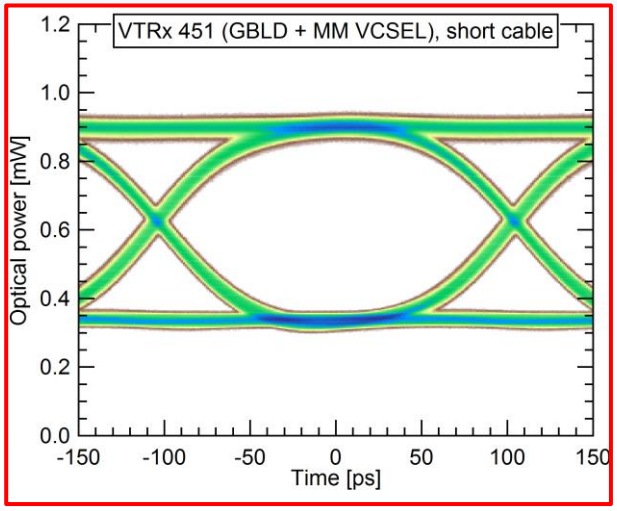
Link specifications and margins

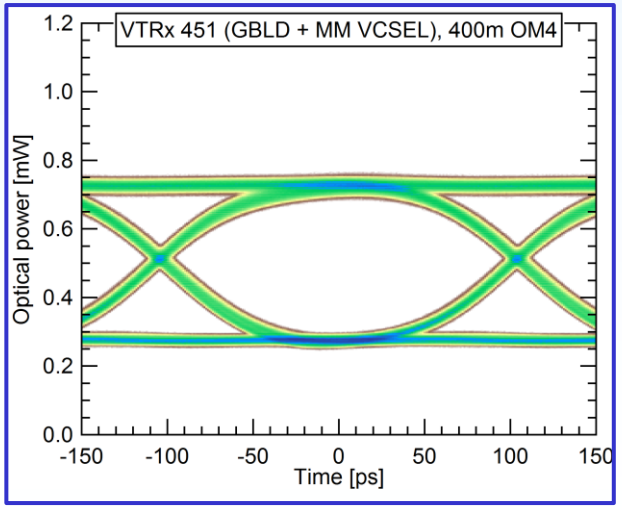
Versatile Link

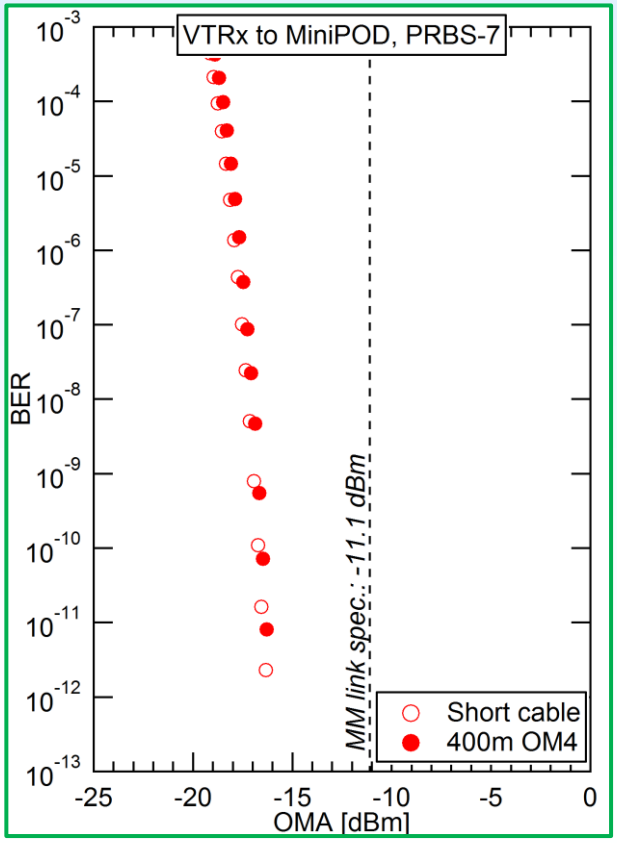
	MM_VTx_Rx	MM_Tx_VRx	SM_VTx_Rx	SM_Tx_VRx
Min. Tx OMA	-5.2 dBm	-3.2 dBm	-5.2 dBm	-5.2 dBm
Max Rx sensitivity	-11.1 dBm	-13.1 dBm	-12.6 dBm	-15.4 dBm
Power budget	5.9 dB	9.9 dB	7.4 dB	10.2 dB
Fiber attenuation	0.6 dB	0.6 dB	0.1 dB	0.1 dB
Insertion loss	1.5 dB	1.5 dB	2.0 dB	2.0 dB
Link penalties	1.0 dB	1.0 dB	1.5 dB	1.5 dB
VTx rad. penalty	0 dB	-	0 dB	-
VRx rad. penalty	-	2.5 dB	-	2.5 dB
Fiber rad. penalty	0.1 dB	0.1 dB	0 dB	0 dB
Margin[1]	2.7 dB	4.2 dB	3.8 dB	4.1 dB

Multi-mode application: uplink



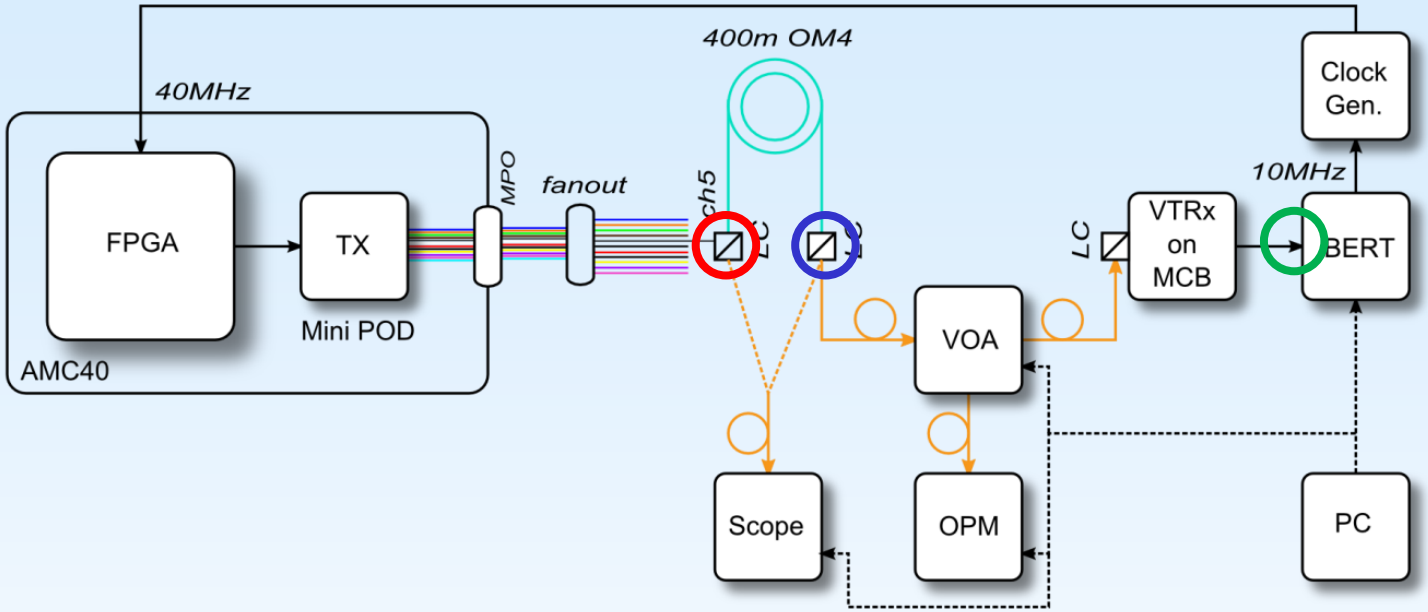


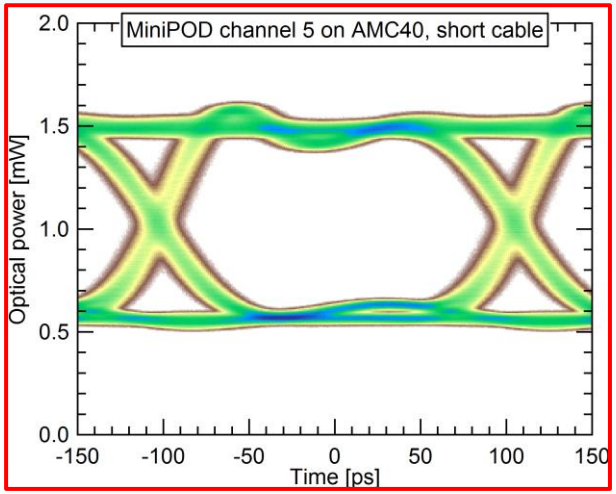


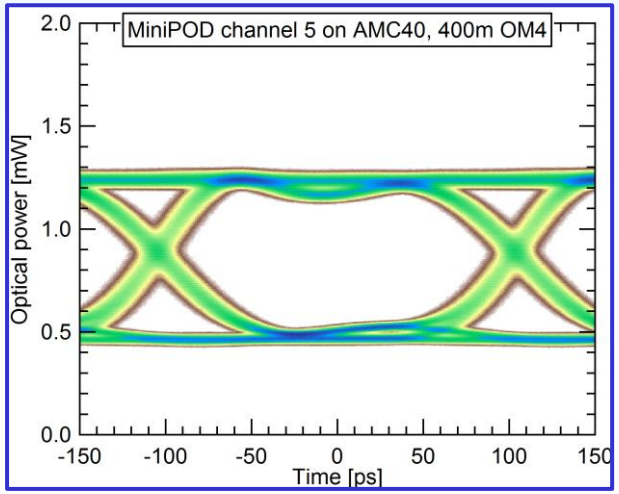


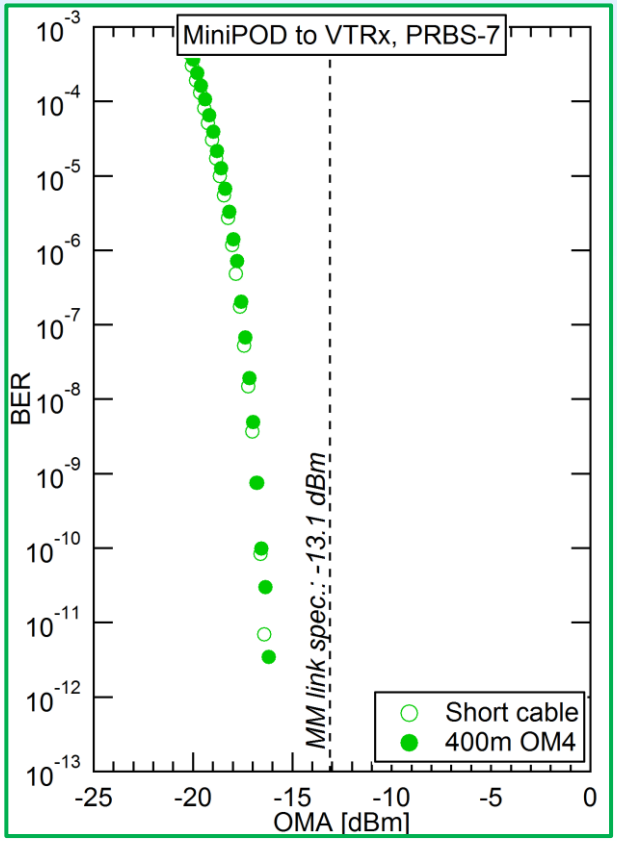
Multi-mode application: lab setup

Multi-mode application: downlink

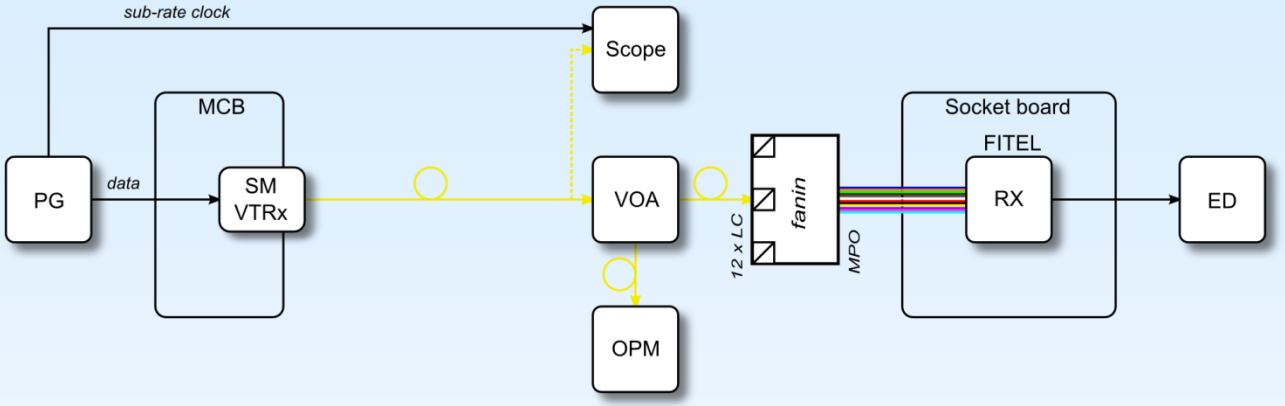


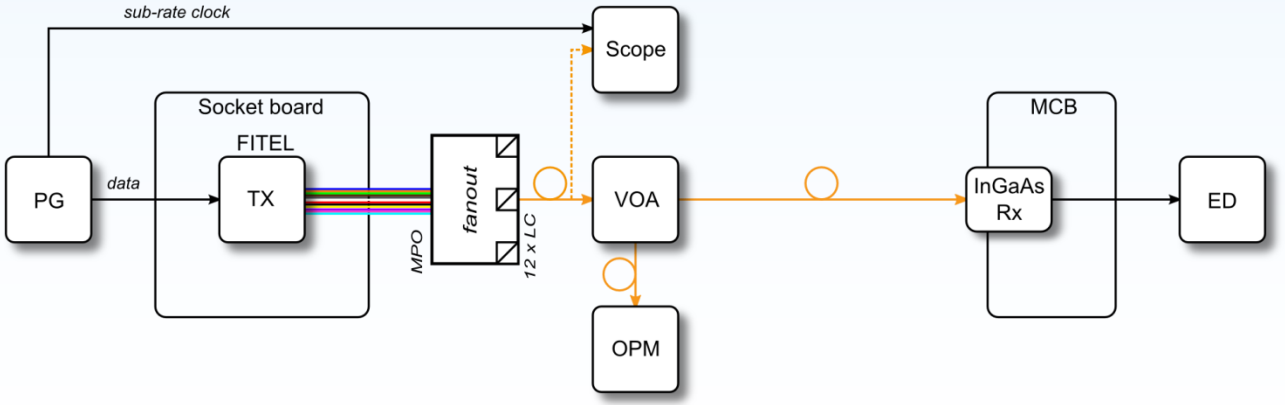


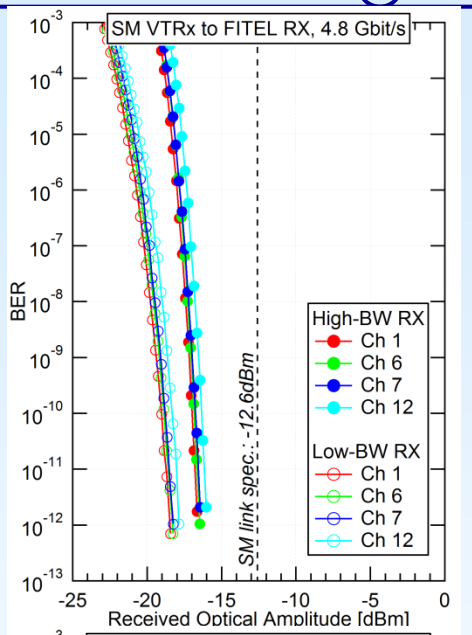


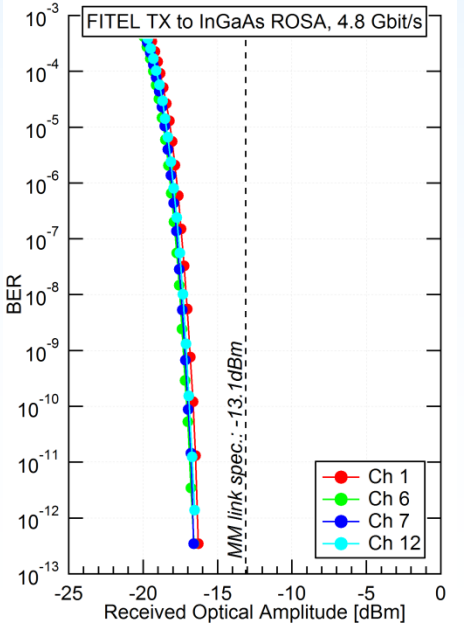


Hybrid application: SM uplink/MM downlink

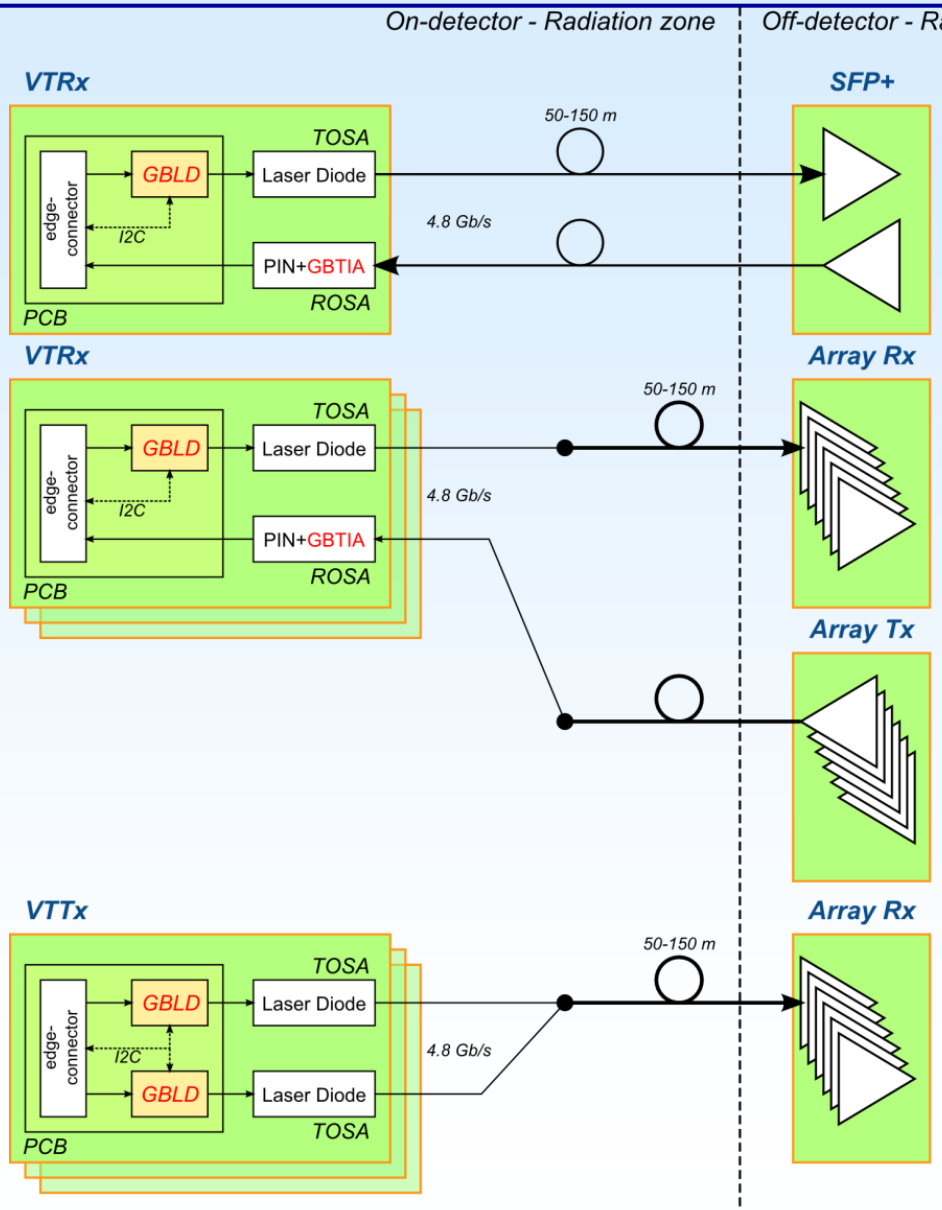


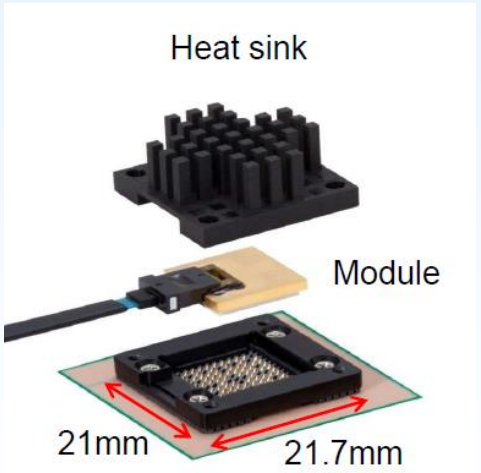






Applications summary





Summary

- Versatile Link components are available for interested users to carry out similar tests
  - Single-, and multi-mode VTRx and multi-mode VTTx
  - We are happy to assist you
- Different link architectures are supported
  - VTRx to SFP+
  - VTRx/VTTx to Array Tx/Rx/TRx
  - VTRx to QSFP+ (to be investigated)
- Compatible back-end components have been identified and are recommended for interested users
- System-level testing allows users to optimize their system and to evaluate the performance