

LC-TOSA/ROSA-Based Optical Transmitter (MTx+) and Transceiver (MTRx+) for Detector Frontend Readout

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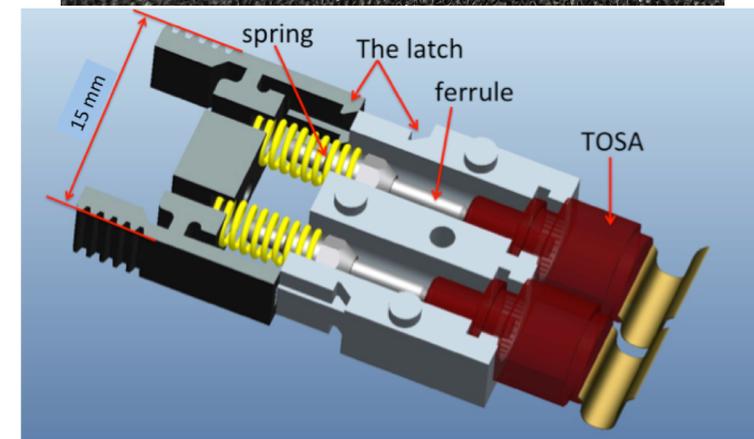
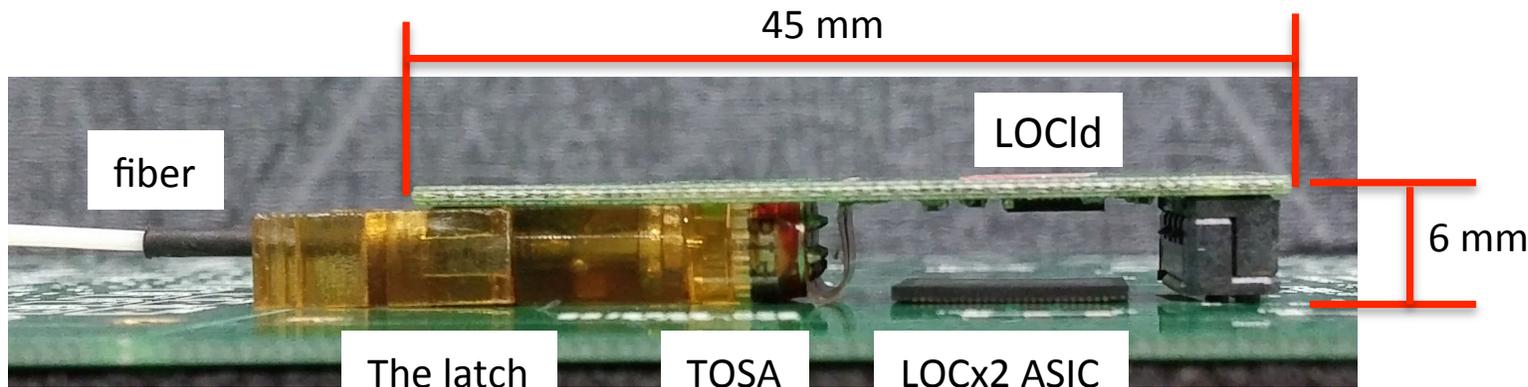
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Content

- Introduction and motivation of the work
- The designs the optical modules
- The measurement results
- Summary and next steps

Our past experience in optical modules

- Borrowing the idea of [SF-VTRx](#) from Csaba Soos (CERN, in the Versatile Link project), and with a custom coupler (called the Latch) for the TOSA and fiber, we developed the optical modules [MTx and MTRx](#) for ATLAS Liquid Argon Calorimeter's (LAr) trigger upgrade.



Our past experience in optical modules

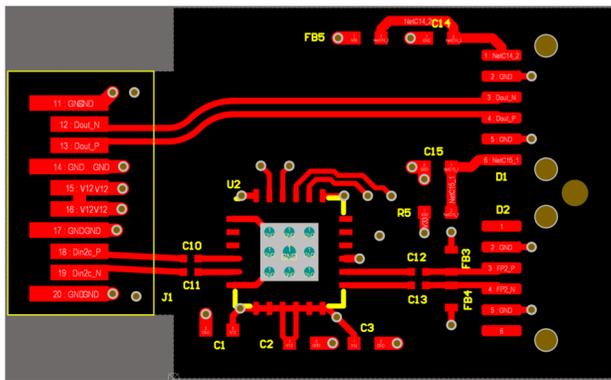
- MTx is a mid-board, dual-channel transmitter at 5.12 Gbps of each channel. MTRx is a transceiver with the receiver using the GBTIA loaded ROSA. Both modules share the same mechanical structure and are below 6 mm in height, a strict requirement from ATLAS/LAr front-end boards.
- About 3,000 of MTx and over 700 MTRx are being produced.

From 5.12 Gbps to 14 Gbps, ASIC and optical modules

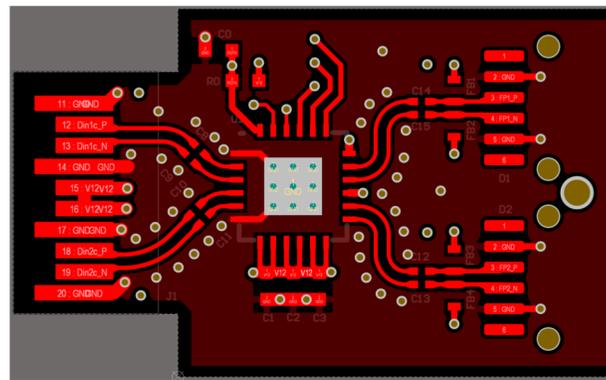
- ❑ After the production of [LOCI_d](#), the dual-channel VCSEL driver at 5.12 Gbps per channel, we developed LOCI_d65, a dual-channel VCSEL driver with pin-to-pin match to LOCI_d, using the 65-nm CMOS.
- ❑ LOCI_d65 operates up to 14 Gbps with input signal equalization, **at 116 mW for both channels, VCSEL included**. This work was reported at TWEPP2017 and later [published](#). The die of LOCI_d65 is only 1 mm x 1 mm.
- ❑ We like the idea of TOSA/ROSA based optical transmitter/transceiver with small form factor and below 6 mm. For most applications we also prefer fibers with LC connector over MT/MPO. So we set out to develop **MTx+ and MTRx+** with the following requirements:
 - Make the electrical connector as compatible with that of the SFP+ module as possible, and use its connector, avoiding the fragile board-stacking connector in MTx.
 - Use the off-the-shelf LC optical connector, without any customization (no matter how small that may be)
 - Bring the transmitting speed up to 10G per fiber (or 14G as we use LOCI_d65)
 - Make the module both board and front-panel mountable.

The designs in MTx+ and MTRx+

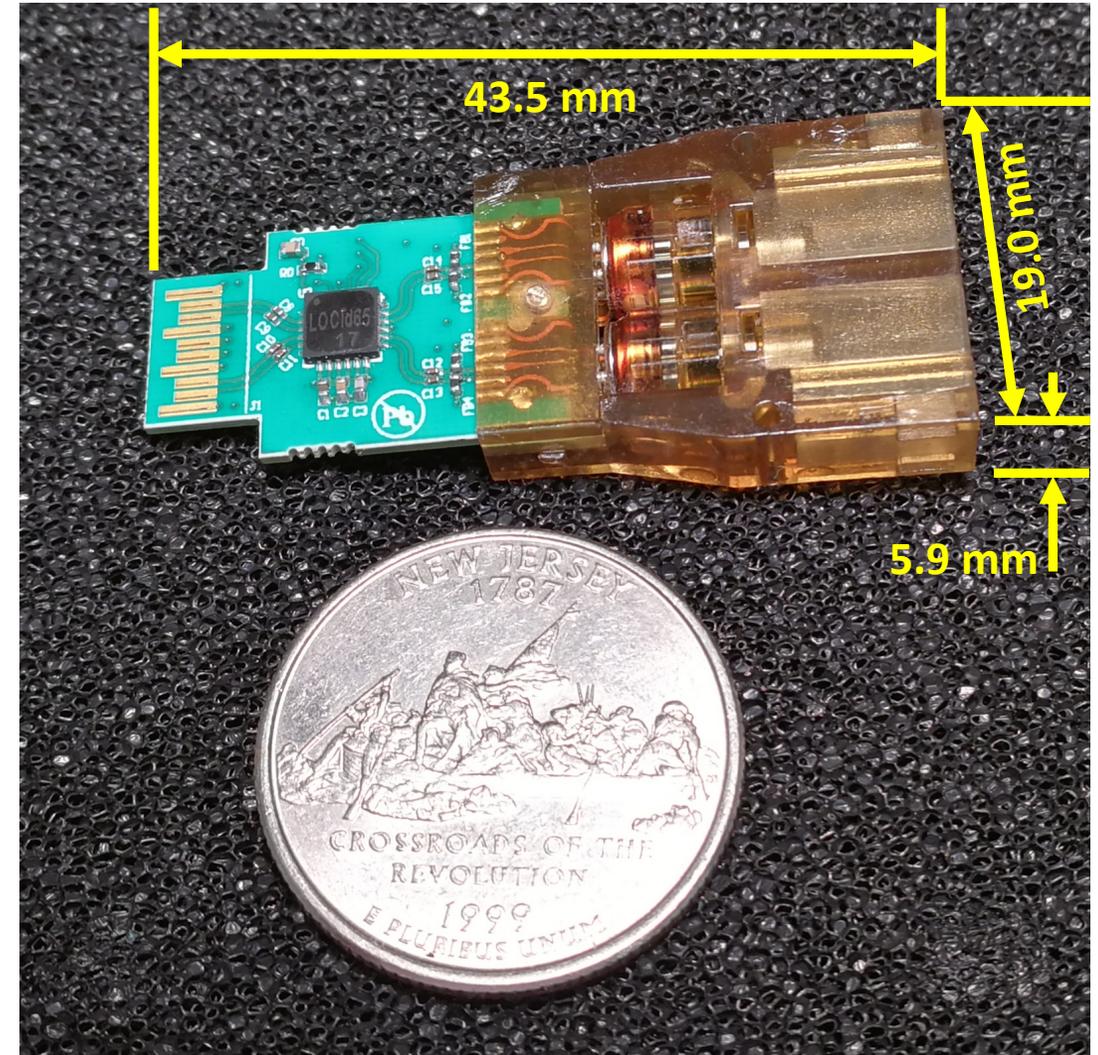
- ❑ Standard connectors (both electric and optical). The electric connector is close to the SFP+ definition
- ❑ Mid-board and front-panel mount
- ❑ Small formfactor, low mass
- ❑ Matches with SerDes, or two Serializers, example: IpGBT.



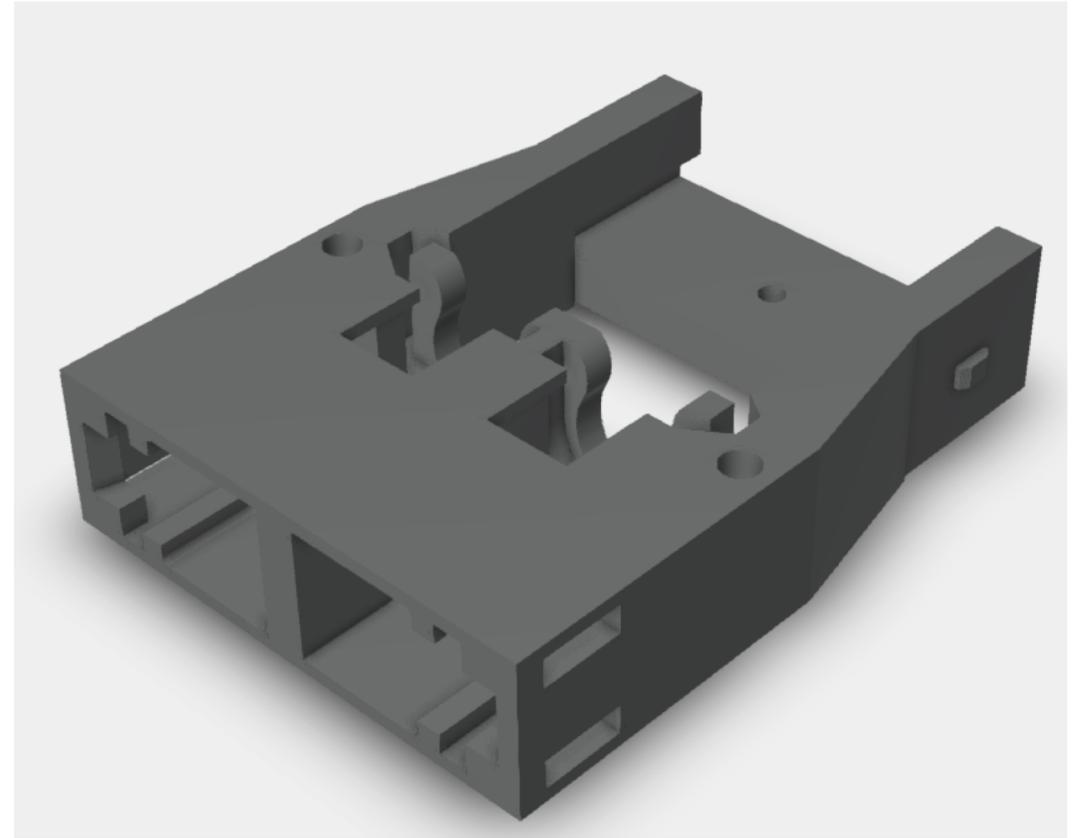
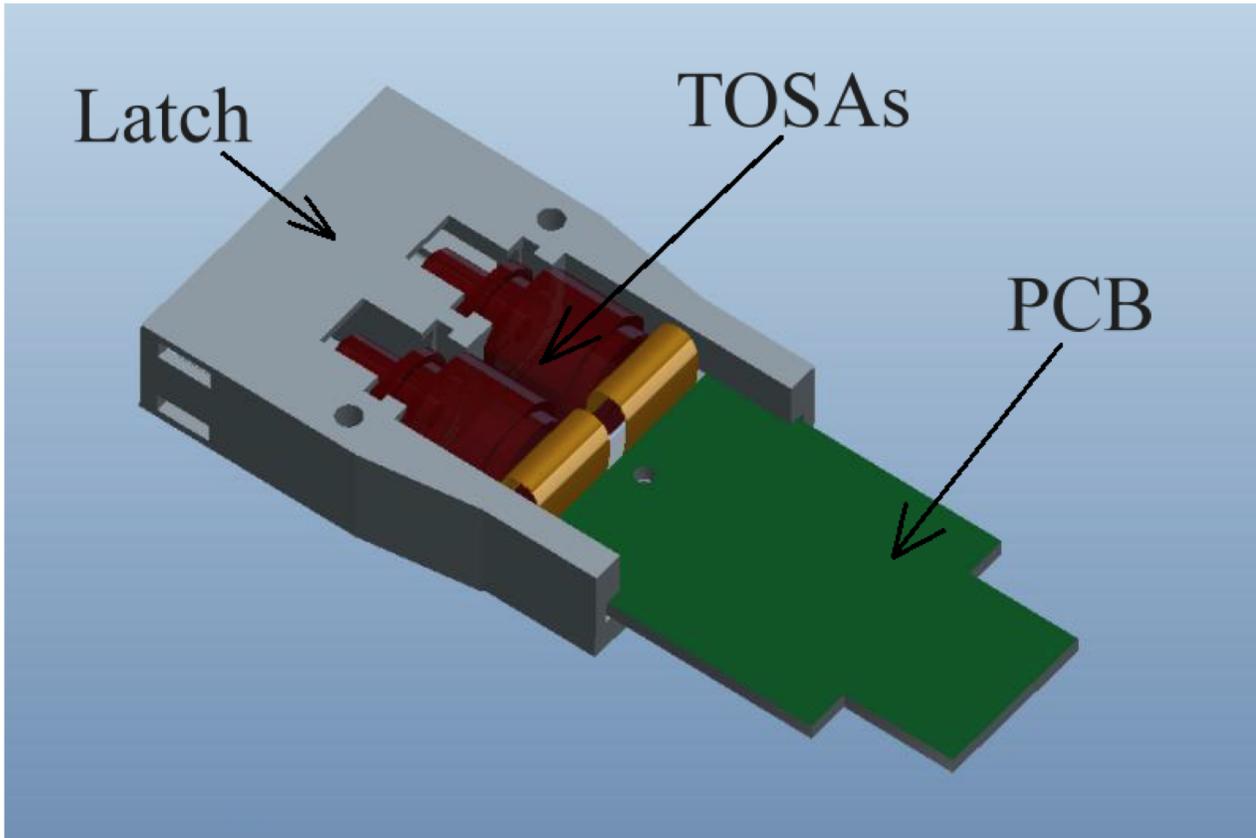
PCB of MTRx+



PCB of MTx+

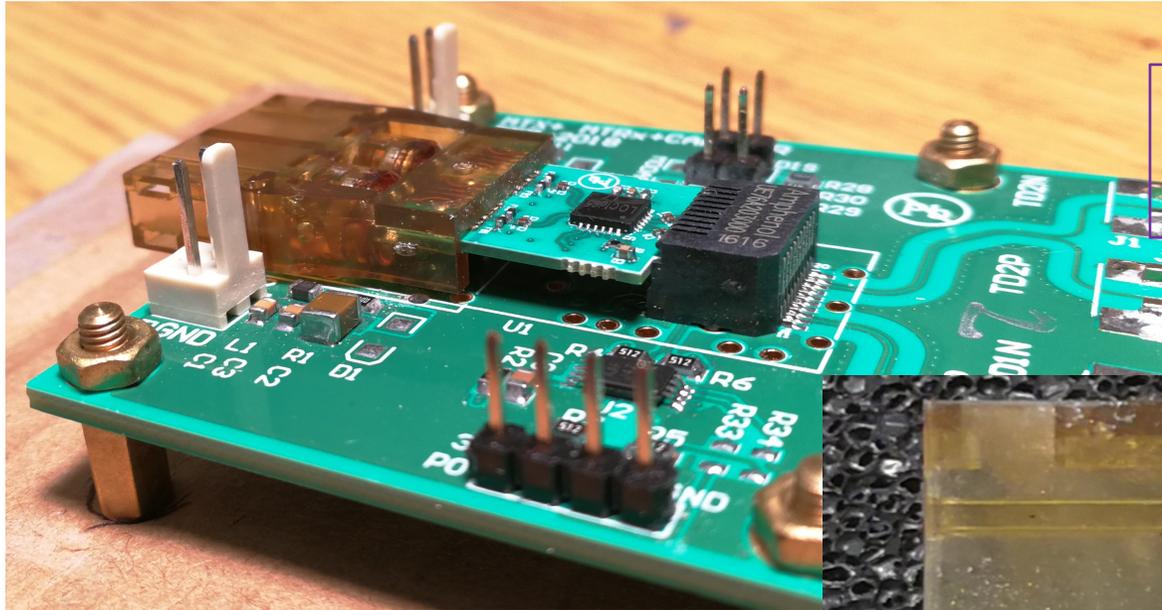


The new Latch

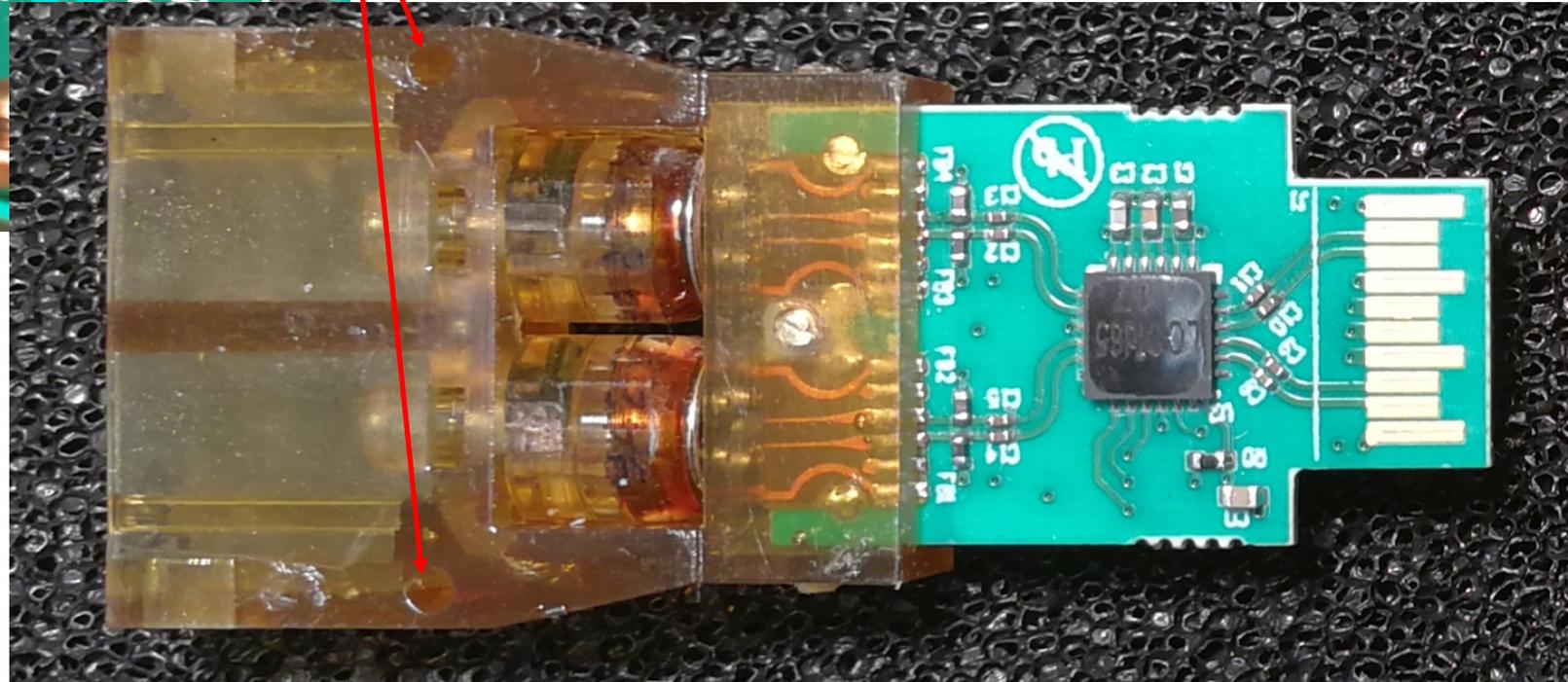


Evolved from the MTx Latch, the Latch for MTx+ is one piece that holds the TOSAs (or TOSA/ROSA) with fibers of [standard LC connectors](#).

When you board mount



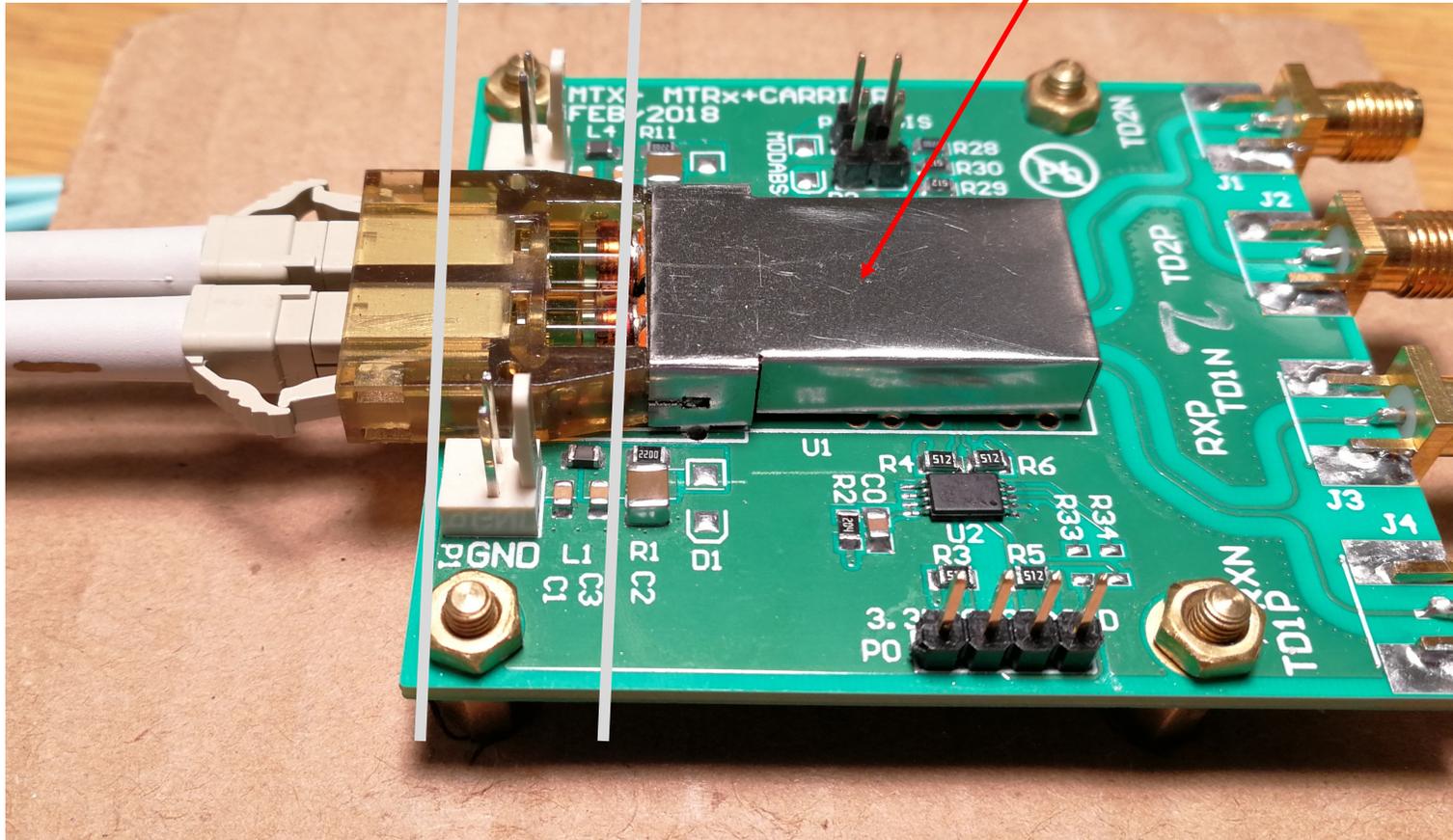
Two holes on the Latch to anchor MTx+ on the mother-board.



When you panel mount

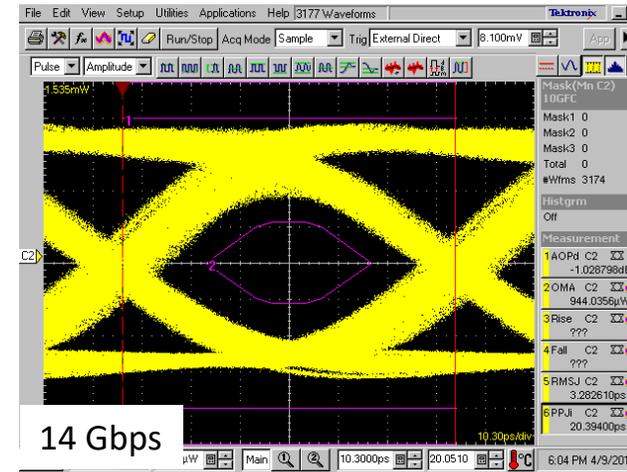
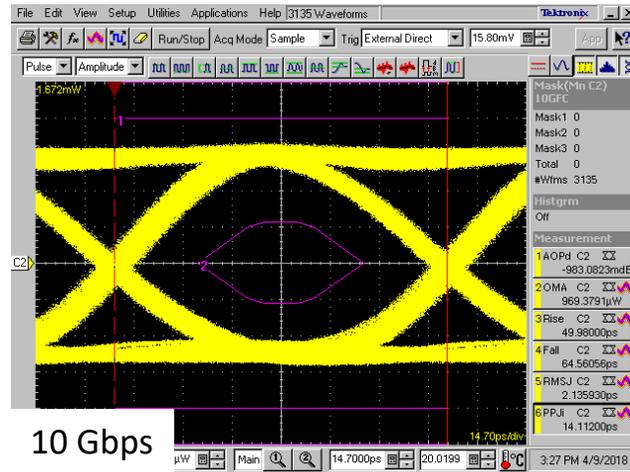
Front-panel position

MTx+ can be plugged into the metal shield, on the mother-board, like in the case of SFP+.

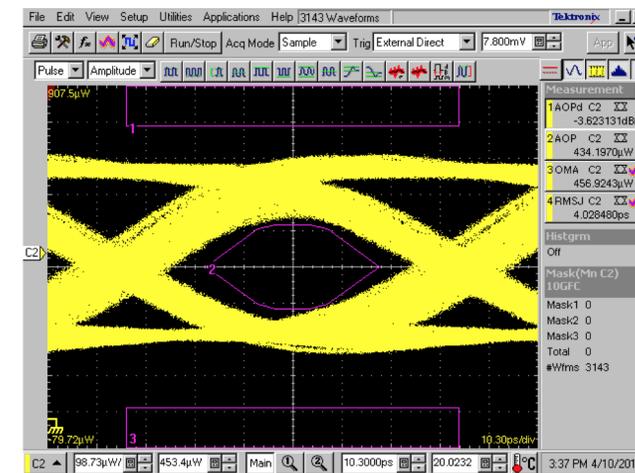
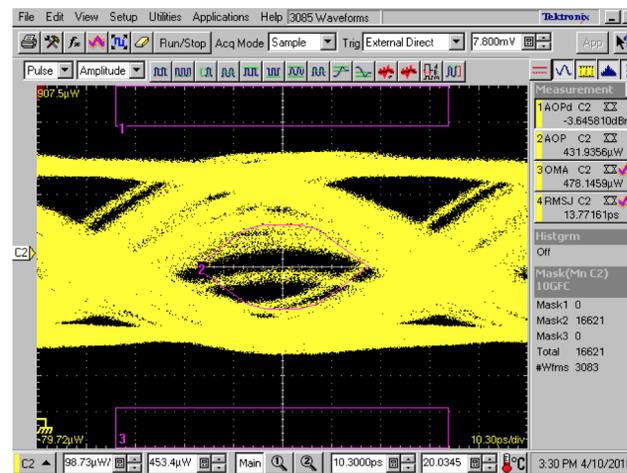


The measurement results from prototypes

- The eye diagrams eye diagram at 10 and 14 Gbps



- 14 Gbps eye diagram (through a 1 meter cable) recovered the input equalization.

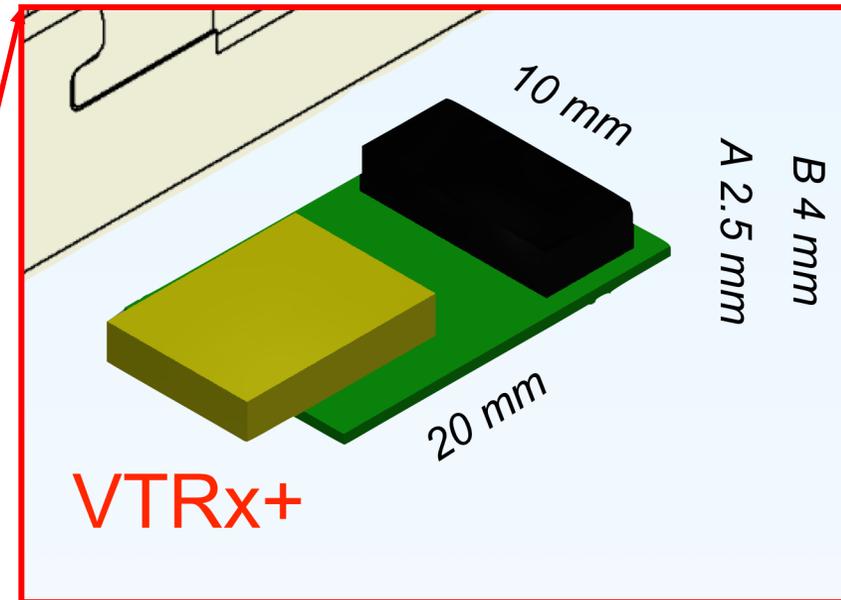
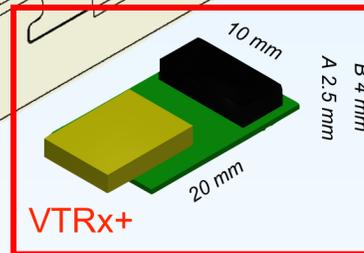
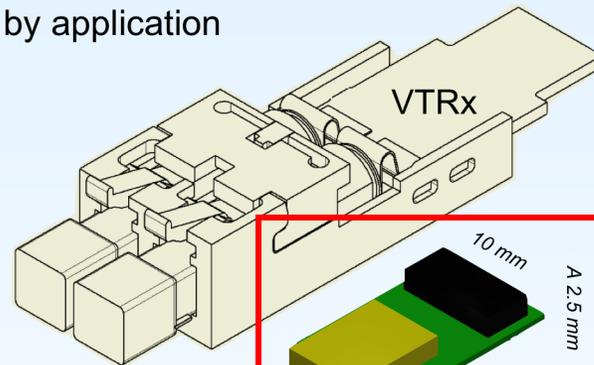


MTx+ and MTRx+ not to compete with VTRx+ They complement it.

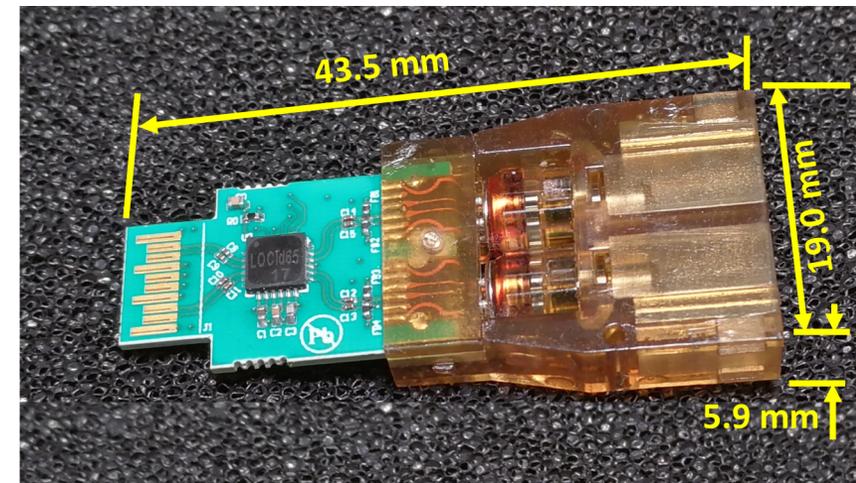
VL+ module



- Versatile
 - multi-channel, Rx/Tx count usage defined by application
- MM only
 - 850 nm VCSEL
 - InGaAs PIN (TBC)
- Miniaturized
 - Target dimensions 20 x 10 x 2.5/4 mm
- Pluggable
 - Either optical or electrical (or both) connector
- Data-rate matching IpGBT:
 - Tx: 5 and 10 Gb/s
 - Rx: 2.5 Gb/s
- Environment
 - Temperature: -35 to + 60 °C
 - Total Dose: 1 MGy qualification
 - Total Fluence: 1×10^{15} n/cm² and 1×10^{15} hadrons/cm²



Total Quantity
20000-50000 modules



Summary and next steps

- ❑ A new coupler to connect a TOSA(ROSA) to a fiber has been prototyped which enables the construction of MTx+ and MTRx+. With the LOClD65 VCSEL driver, the transmission speed goes up to 14 Gbps.
- ❑ MTx+ and MTRx+ do not complete with VTRx+. They complement it in working with IpGBT to form 10G optical links.
- ❑ More functional and irradiation tests on MTx+ will be carried out.
- ❑ Limited number of prototypes of MTx+ (later MTRx+) are available for serious developers.
- ❑ The Latch needs one more iteration to correct a few places. Then production of the Latch will start: once we have the mold, we might as well run a production of a few thousands of Latches. Once the Latch goes into production, the metal shield will also be produced.
- ❑ We need collaborator/partner to produce the driver ASIC LOClD65. So far we only have about 100 chips from the MPW run, and that verified the design.

Thank you!