R&D Reports

ATLAS Phase-1 and Phase-2 Work with NJU and Data Transmission ASIC Development at IHEP for Future Detectors

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Dec. 12, 2014 at IHEP

OUTLINEs

1. ATLAS Phase-1 Upgrade work and R&D for Phase-2 with NJU.
2. Data Transmission ASIC Development at IHEP.
3. Outlook to LHC Upgrades and R&D for CEPC Detectors.

ATLAS Phase-1 Work with NJU

SMU (graduate student Zhao Xiangdong) and NJU (Qi Ming) work together to develop the custom latch for the world's smallest TOSA based optical transmitter – MTx.

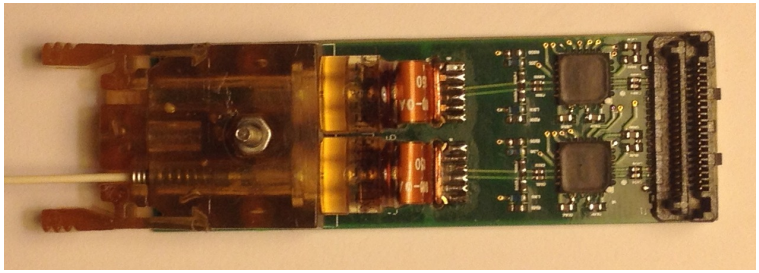
Why TOSA based? VCSELs operating in air have reliability issues, as learned mostly in LHC experiments; while this problem is being solved in industry (Finisar, ULM and TrueLight all claim to produce VCSEL arrays that can operate in air), Phase-1 Upgrades (LS2 2017 – 2018) of LHC experiments still use TOSA based optical transmitter to be conservative.

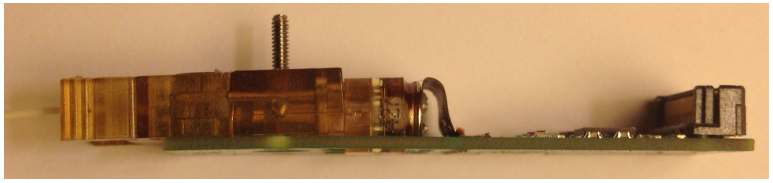
SMU leads the development of optical transmitters for detector front-end readout systems.

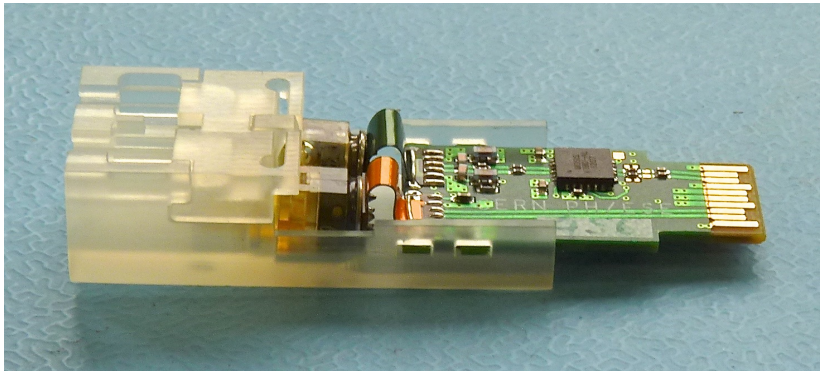
ATLAS Phase-1 Work with NJU

Three issues in this development: the speed, the size and radiation tolerance for particle detector front-end environments.

MTx beats VTTx (the product of CERN's Versatile Link Common Project) in speed and size.

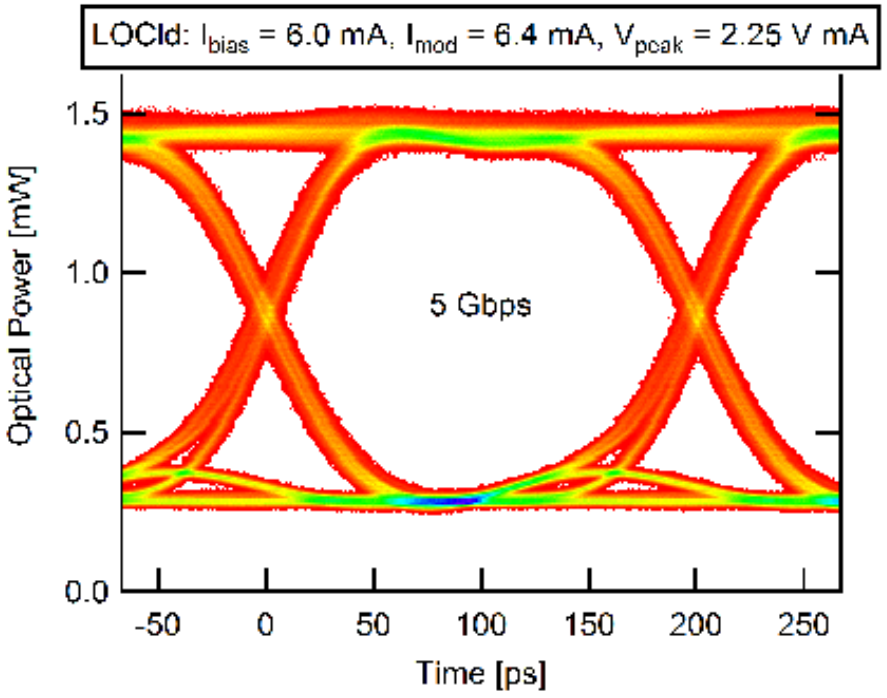


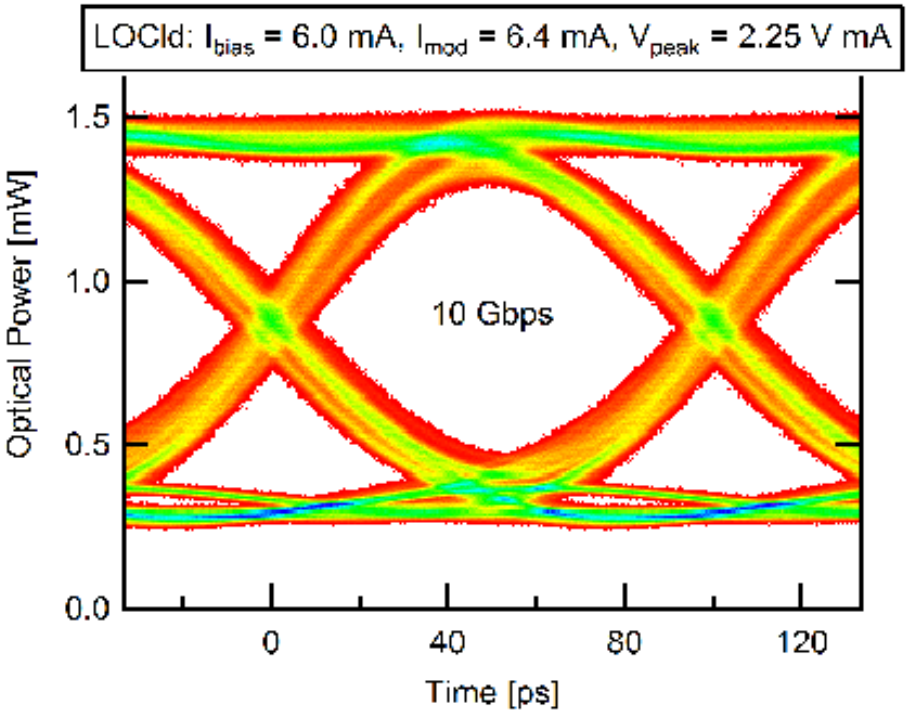




ATLAS Phase-1 Work with NJU

MTx measurement results





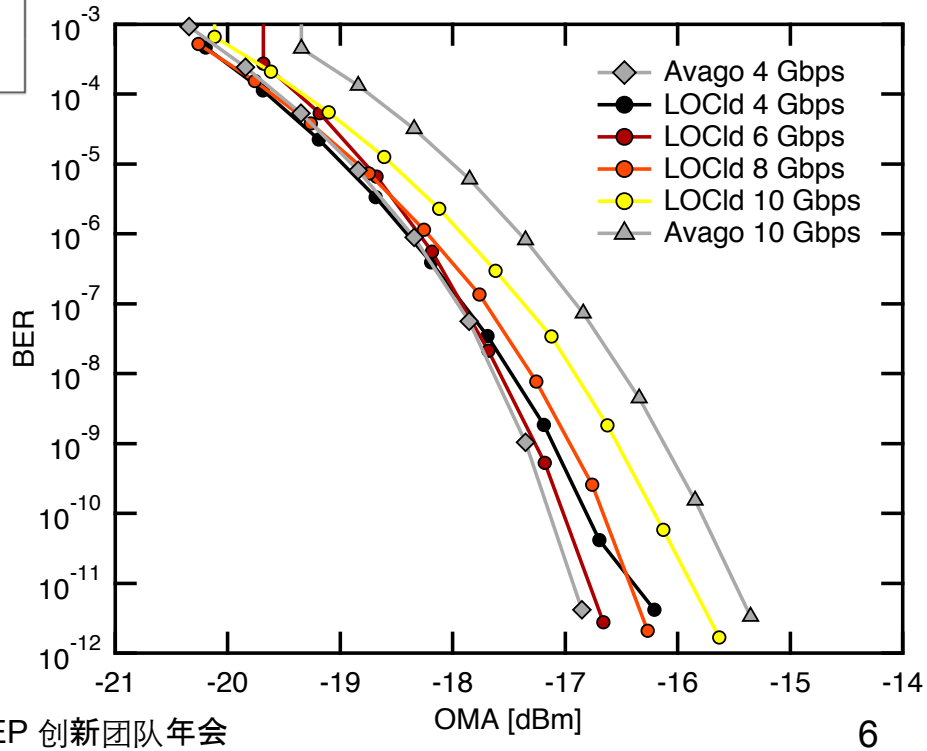
ATLAS Phase-1 Work with NJU

Table 1: Eye Parameters using data rates of 5, 8, and 10 Gbps.

	5 Gbps	8 Gbps	10 Gbps	Unit
OMA	1.13	1.11	1.05	mW
EH	88	85	71	%OMA
ER	6.9	6.6	5.9	dB
t_r	50	40	39	ps
t_f	52	52	48	ps
T_j	28	29	29	ps
DU_j+DD_j	15	15	15	ps

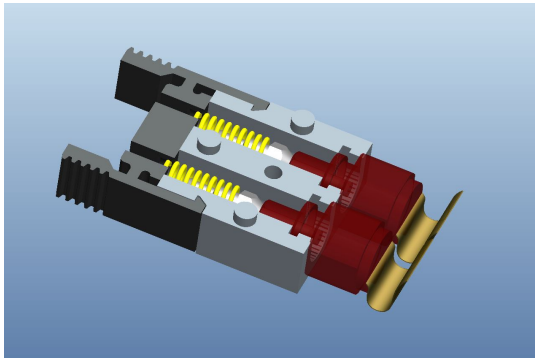
The module performs better than the Avago 10 Gbps reference.

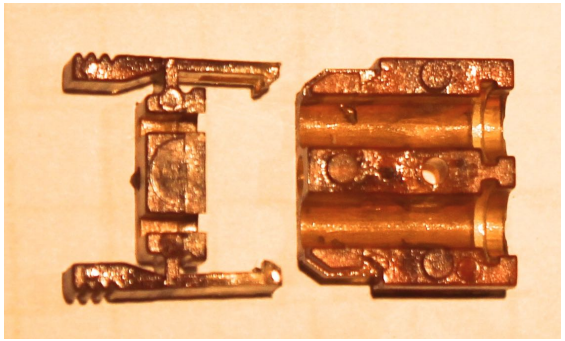
Figure 5: BER results using MTx transmitter



ATLAS Phase-1 Work with NJU

One of the key development in MTx is the custom latch which is now a success from the collaboration between SMU and NJU





This latch, which is being injection molded by a company in China (through NJU) enables MTx to be the worlds smallest TOSA based optical transmitter.

MTx is crucial to ATLAS LAr Trigger upgrade. MTx will also be used in nSW (according to Vinnie, MTx will need to be sent to USTC for the final board level assembly). It is also a candidate for silicon detector stave readout.

ATLAS Phase-2 Work with NJU

Diamond detector has been studied in HEP for quite some time and is used in LHC experiments.

Polycrystal diamond detector was proposed for ATLAS FCal upgrade (2023) but it was found not radiation resistant enough to be placed at such forward range for the HL-LHC luminosity.

NJU (Qi Ming, and with SMU) proposed an R&D on single crystal diamond for calorimeters at ultra high radiation environment. A workshop was held August 2014 to kick-off this project. In this R&D, NJU will work with other institutions in China to develop the sensor. SMU will help with irradiation tests, and later promotion in LAr as a candidate to be considered for FCal upgrade, should the tests results be positive. The first sensor will be available in early 2015 and the tests will soon follow once we learn how to metalize the surface.

If successful, this will be a unique technology contribution from China.

Data Transimission ASIC Development

With the LOC ASIC family SMU has become the leader in ASIC development for HEP detector front-end data readout via optical links.

Several students from USTC, IHEP (Liu Gang) and CCNU have worked at SMU in the design and tests of these ASICs.

After returning to IHEP, Liu Gang has designed a full serializer ASIC (0.18 um CMOS) under the supervision of Gong Datao (SMU) and Jiang Xiaoshan (IHEP), supported by a fund of which they both are co-PIs. This design was reviewed in November and will be prototyped in about a week. If tested successful, this will pave the road of serial data readout for other ASICs for detector front-end, including pixel detectors.

Worth mentioning though is that Li Xiaoting, a student from CCNU, just returned to CCNU from SMU, and got her PhD this Monday. She will lead the development of similar ASICs at CCNU. I encourage collaboration between IHEP and CCNU on detector data readout.

OUTLOOK

R&Ds in electronics support new detector developments.

ASICs (pre-amplifier, shaper, ADC, high speed serial data transmission) and FPGA based back-end data receiving and processing are to be among the emphases for LHC upgrade and detector developments for CEPC.

2014 is just the beginning of the Innovation Team. I look forward to work with my colleagues to bring more advanced R&Ds up in China for future HEP experiments.