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Error-free 10.7 Gb/s digital transmission over 2 km optical link using an ultra-low-voltage electro-optic modulator

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We demonstrate the feasibility of 10.7 Gb/s error-free (BER < 1e-12) optical transmission on distances up to 2 km using a recently developed ultra-low-voltage commercial electro-optic modulator (EOM) that is driven by 0.6 Vpp and with an optical input power of 1 mW. Thus, the modulator could be driven directly from the detectors'board signals without the need of any further amplification reducing significantly the power dissipation and the material budget.

Summary

In the high luminosity stage of the Large Hadron Collider, the so called SLHC, the bandwidth needed for data extraction from the detectors will grow significantly due to the huge particle content of events which will be generated at high repetition rates. Increase in bandwidth of the optical link is thus a key factor to allow fast data processing and to reduce latency times between events'detections. Actually, the trend is focusing on increasing the data rate of the optical link to around 5 Gb/s looking in perspective at a transfer rate of 10 Gb/s. The increase in the transmission bit rate not only would permit a higher speed data transfer, but could also significantly reduce the number of optical links per detector leading to volume and cost reduction.
To this extent, electro-optic modulators (EOM), in particular lithium niobate Mach-Zehnder modulators (LNM), are widely employed in the telecom industry and represent a standard de facto for 10 to 40 Gb/s transmissions. Besides being capable of high frequency modulation, LNM are also proven to be: very radiation hard, immune to high static magnetic field and operating at low temperatures (down to -20°C). All these features are close to the strict requirements of the SLHC and for this reason LNM can be attractive in the implementation of the next generation optical-links. Moreover, the possibility to use external CW laser as optical sources, presents many advantages since it lowers the power dissipation inside the detector and the risk for the laser integrity due to absence of transient instabilities caused by high radiation level, and it allows for higher bit rates (≈ 40 Gb/s).
In the context of the SLHC optical link, the typical driving voltage (3-4 V) of LNMs at high bit rate may create a serious issue requiring the use of amplifiers, and a general increase in the dissipated power. A recently developed ultra-low-voltage LNM, employed for transmission over the typical short distances (transmitter-to-receiver length < 1 km) covered by an optolink in High Energy Physics experiments, can represent a solution to this problem.
Indeed, in this work we demonstrate that error-free transmission (BER < 1e-12) at a bit rate of 10.7 Gb/s and for a 2 km optical-link is achievable by modulating a ultra-low-voltage LNM with 0.6 Vpp and having 1 mW of optical input power at a wavelength of 1550 nm. This result shows that it could be feasible for the LNM to be modulated directly with the detectors'board signals which can reach up to 1 V without the need for any further amplification, thus strongly reducing the components number and the power requirement for each optical link.

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