2.5 Gb/s Simple Optical Wireless Communication System for Particle Detectors in High Energy Physics

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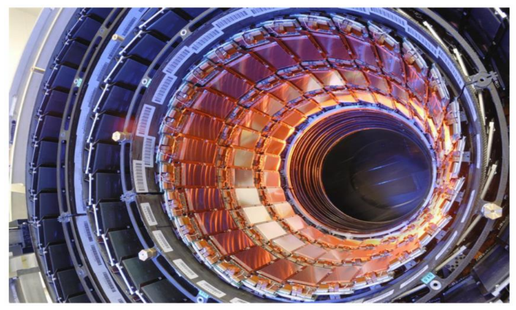
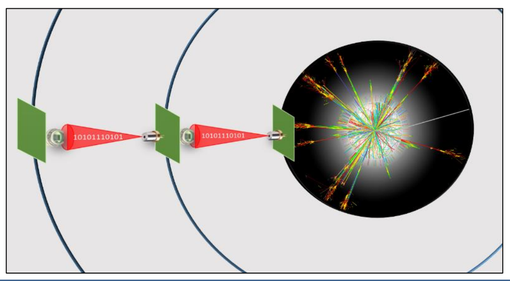
Abstract: **We successfully demonstrated simple and low cost 2.5 Gb/s optical wireless transmission at 10 cm distance, aiming to be employed in high-energy physics using off-the-shelf VCSEL and PIN photodiode with proper ball lens. The measured tolerance to misalignment is around ±1mm at Bit Error Rate of 10^{-12}**

Introduction

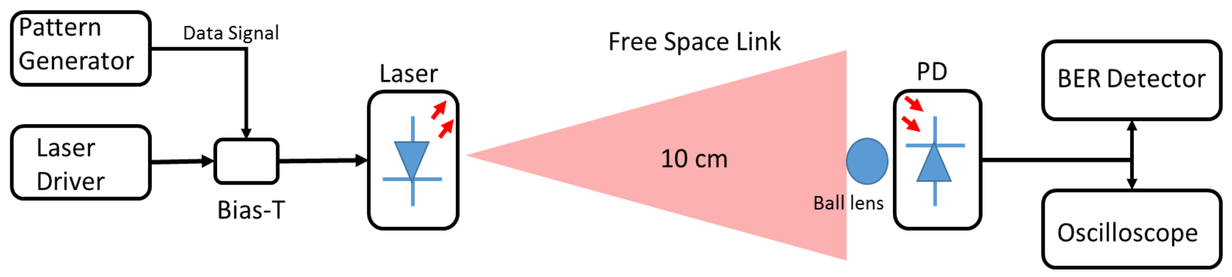
- Particle physics experiments generate large amounts of data, whose transmission requires complex networks of optical fibers. Future upgrades will require more bandwidth with limited space constraints.
- High-speed **Optical Wireless Communication (OWC)** can be a viable solution to reduce the complexity and thus also minimizing the material budget.
- We designed an OWC system for particle detectors, having as a reference application the inner tracker of the Compact Muon Solenoid (CMS).
- The proposed OWC solution will introduce the radial connectivity between silicon detector modules.
- We report the design of the **2.5 Gb/s OWC link** and detailed tolerance to misalignment study,

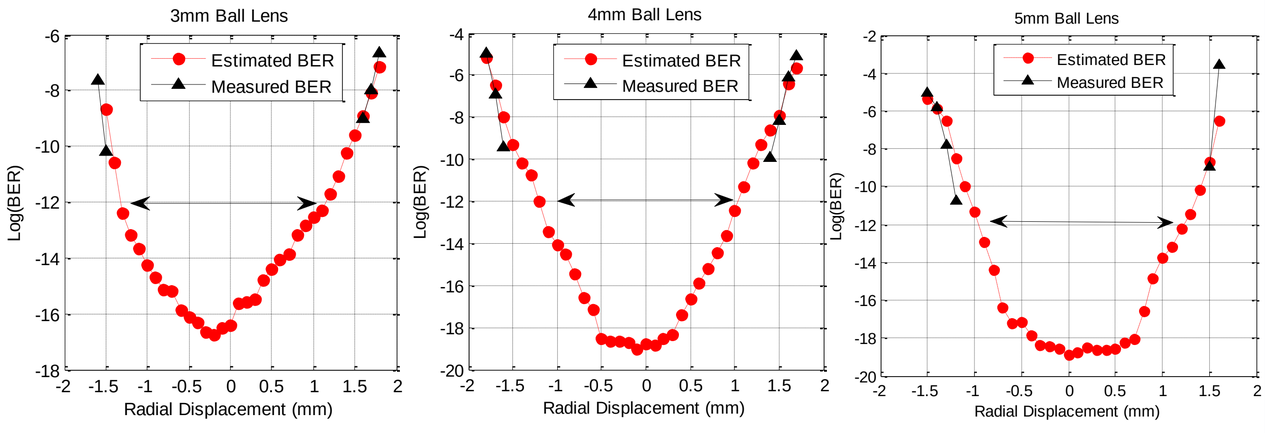




OWC system optimization

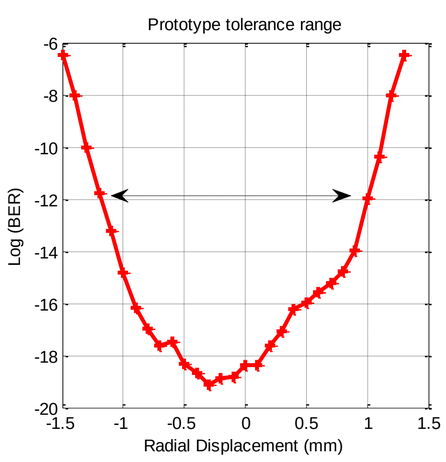
- 2.5 Gb/s OWC setup is realized based on off-the-shelf VCSEL (1550nm) and PIN photodiode with TIA at 10cm of distance.
- For obtaining higher tolerance range for **passively aligned** OWC setup, the system was optimized by using 3mm, 4mm and 5mm diameter ball lenses at the receiver.
- Misalignment tolerance range of ±1mm was observed for all ball lenses at BER of 10^{-12}.
- Optical components (VCSEL, InGaAs PIN and Quartz/Fused silica glass types lenses) are selected because of their radiation tolerance [1][2].

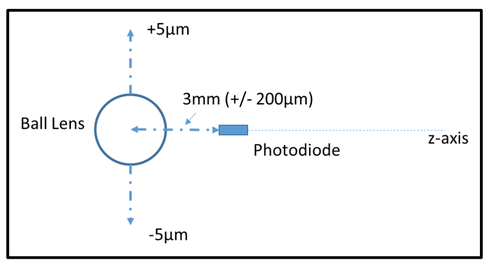


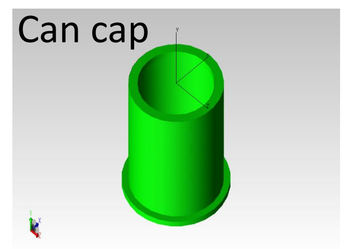


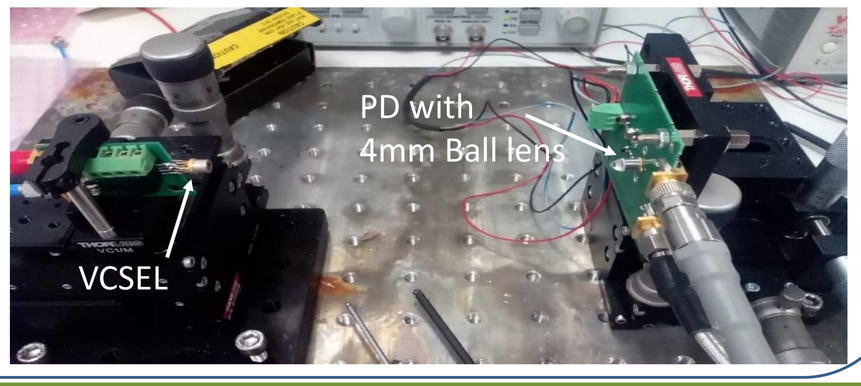
OWC System prototype

- Based on the 2.5 Gb/s system optimization results, 4mm diameter ball lens was chosen for final photodiode prototype preparation.
- 4mm ball lens holder was designed, to keep active area of the photodiode precisely at focal length of the ball lens with tolerance of ±200µm
- Using prototype, **tolerance values of ±1.1mm** was observed at BER of 10^{-12} for 2.5 Gb/s OWC system, which was similar to results obtained in system optimization experiment.









Conclusion

- We **experimentally** demonstrated **2.5 Gb/s Optical Wireless Communication** connectivity using **VCSEL** and **PIN photodiode** at **10 cm of distance** for particle detectors in HEP. We studied in detail optimization of receiver using 4mm focusing ball lens and **obtained tolerance to misalignment range of ±1mm** at BER of 10^{-12}. Finally we also reported the successful implementation of prototype**.**

Acknowledgment

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Reference

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