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Challenges in the optimization of the HGCAL Optical Fibre Plant

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The Compact Muon Solenoid (CMS) detector at the CERN Large Hadron Collider (LHC) is undergoing an extensive Phase II upgrade program to prepare for the challenging conditions of the High-Luminosity LHC (HL-LHC). As part of this program, a novel endcap calorimeter that uses almost 6M Silicon and Scintillator sensors is foreseen. These sensors will sample the electromagnetic and hadronic particle showers using 47 longitudinal layers with fine lateral granularity and providing 5D measurements of energy, position and timing. An hierarchy of electronics cards and transmission links shall be used to readout and ship the enormous amount of data to the trigger and data acquisition systems. An opto-electrical conversion is used to convert the signals to fast optical fibers with a max. 10.24 Gb/s throughput.

The exact mapping of fibres, connectors and shuffles needed to be used is subject to different constraints: mechanical spacing for splicing, connectors and routing; packing efficiency, minimizing the so-called dark-fibers throughput balancing of the inputs to the FPGAs in the data acquisition system. Some of these constraints impact significantly the performance and the budget of the system. Thus an optimisation of the optical fibre plant has the potential to: 1) reduce the final cost of the system by reducing the number of dark fibres and the need for additional shuffling in the backend electronics and 2) increase the longevity of the detector by reducing the number of breaks, and therefore losses, in the fibre paths.

In this presentation we exemplify this optimization procedure as a use case. Custom-made algorithms have been employed so far without resorting to a formal definition of a loss function quantifying the different constraints. The challenges faced towards constructing such a loss function are also discussed.

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