DETECTOR FOR LUMINOSITY MEASUREMENT AT HIGH ENERGY PHYSICS EXPERIMENTS

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Luminosity measurement detector is a project of fast backward Cherenkov veto counter for both online and offline analysis applied for operation in p-p collisions, beam-gas and heavy ion modes. We performed Geant4 simulation of the quartz detector using events generated by Pythia8 in order to study various options to optimize luminosity measurement precision. Both empty event and hit counting approaches were considered. Several different geometries and configurations were proposed and simulated using GEANT4 framework. Detector structure optimization options were studied and a splitting approach was introduced providing an operation flexibility in a wide range of luminosity.

Main goal of this project is to develop a robust detector system that can provide accurate measurements of luminosity in radiation intensive environment. Increasing of luminosity and detection accuracy causes the need to review the triggers and the priority of different data streams. Thus, past luminosity control methods become obsolete and there is a need for the introduction of a new system for luminosity measurement and beam quality monitoring during the physics data taking.

A quartz Cherenkov detector was proposed for this purpose. It faces the following tasks:

- beam quality control for the high-luminosity hadron collider operation;
- luminosity measurement offline and real-time on a time scale of 10-100 ms;
- veto to determine luminosity for the heavy ion programme.

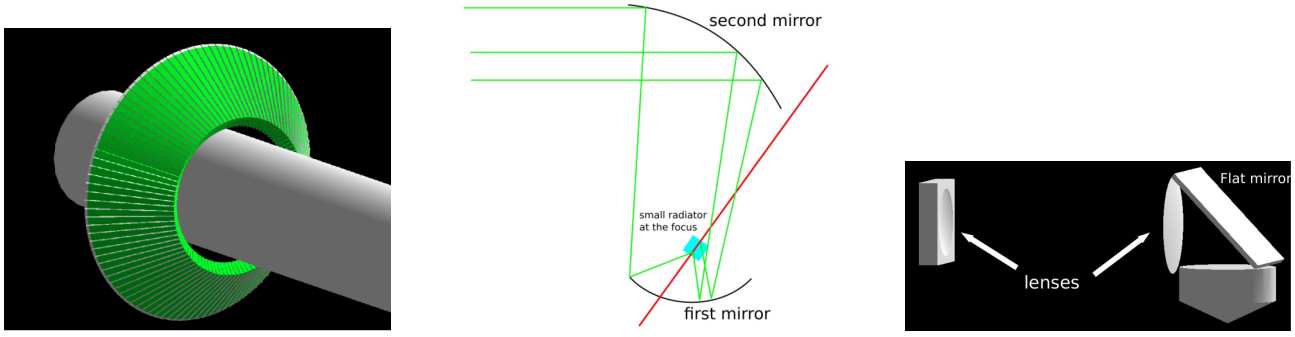

Fig. 1. Some of the geometries that were studied. Trapezoidal quartz bars tilted at an angle (left), two parbolic mirrors that deflect and focus ligh (center), quartz cone with mirror surface and focusing lenses (right)

In order to determine the optimal detector design, several geometries were simulated using Geant4 framework. Simplified material arrangement is included into the simulation to estimate the performance. This different methods were then tested at the DESY beamtest facility, using 5.6 GeV electron beam.

[1] Simulation of the Quartz Detector for Luminosity Measurement at LHCb upgrade, WDS'19 Proceedings of Contributed Papers - Physics, f9, pp. 189–192 (ISBN 978-80-7378-409-6)
[2] LHCb collaboration, The LHCb Detector at the LHC, JINST, 3, S08005, 2008.
[3] LHCb collaboration, Absolute luminosity measurements with the LHCb detector at the LHC, JINST, 7, P01010, 2012.
[4] Balagura, V., Analysis methods for luminosity data, CERN-LHCb-INT-2009-001, 2009.