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Performance Analysis of the LHC BSRL and Possible Improvements

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The Beam Synchrotron Radiation Longitudinal density monitor (BSRL) at the LHC leverages time-correlated single-photon counting to provide high-dynamic-range measurements of the relative charges in each RF bucket with a time resolution of 50 ps. These measurements are needed for the operation of the LHC as well as for the luminosity calibration required by the LHC Experiments.
In this work we identify sources of error for each the BSRL components. These components are the optics (mirrors, filters and optical fibres), the detector (a hybrid photomultiplier - HPM), the electronics (a Time to Digital Converter - TDC) and some data analysis used for the final results.
Knowledge of the errors of the BSRL is crucially important as any errors are passed directly into the luminosity calibration of the LHC experiments.
We quantify the errors introduced by each of these parts and for external systems, like the LHC timing. For the largest contributors to the overall error, we propose mitigation strategies that can be deployed in the short term.

Footnotes

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