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LHCb ECAL upgrade II

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The aim of the Phase-2 Upgrade of LHCb is to collect up to 300 fb^{-1} of data in a few years, operating at a luminosity of $(1..2) \cdot 10^{34} cm^{-2} s^{-1}$. Because of the significant increase in particle densities and radiation doses, the present LHCb Electromagnetic Calorimeter (ECAL) will require a major revision. The increased instantaneous and integrated luminosity will result in very high particle density and radiation doses in the areas close to the beam pipe. In these conditions, ECAL has to provide high-quality energy and position measurement for electromagnetic showers, as well as separation of two closely lying showers. Another requirement for the whole ECAL, which is aimed to reduce combinatorial background at high luminosity operation, is the ability to measure the time of arrival of the photon or electron with an accuracy of few tens of picosecond. The intrinsic time resolution of the ECAL modules is expected to be sufficient to meet this requirement, although the use of an additional timing layer is not excluded. The expected particle flow and radiation doses strongly depend on the distance from the beam pipe and determine the technology and granularity of the upgraded ECAL modules. The upgraded ECAL will be subdivided accordingly into several zones. The central part, with the highest expected doses, will be a sampling spaghetti calorimeter (SPACAL) based on radiation-hard crystal scintillators and a Tungsten absorber. The peripheral areas will be instrumented with modified Shashlik type modules, similar to the modules of the present ECAL, with modifications aiming to achieve the best time resolution for this technology. The intermediate part will be a spaghetti calorimeter with polystyrene-based scintillating fibres and a moulded lead absorber. The main advantages of using lead-polystyrene spaghetti type are the possibility to modify granularity with minimal intervention and fibres replacement to increase radiation hardness. An extensive R&D campaign is ongoing to optimize the Upgrade 2 ECAL structure. It includes: - studies of scintillating materials, in terms of scintillation kinetics and radiation hardness; - simulation studies to find the optimal detector layout, longitudinal segmentation and granularity; - beam test studies of the performance of various ECAL module prototypes, both for central (SPACAL) and peripheral areas. for the moment, a time resolution for 5 GeV electrons achieved for W-Crystal and Lead-Polystyrene Spacal prototypes is about 20 ps, and better than 40 ps for Shashlik type modules. In this talk, we will present the results of time resolution measurements for all these technologies, as well as predictions from detailed Monte-Carlo simulation.

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