



Contribution ID: 174

Type: Oral Presentations

## Long term aging studies of the new PMTs for the HL-LHC ATLAS hadronic calorimeter upgrade

Wednesday, 6 September 2023 12:00 (20 minutes)

**Abstract.** TileCal, the central hadronic calorimeter of the ATLAS experiment at the Large Hadron Collider (LHC), is readout by about 10,000 photomultipliers (PMTs). Earlier studies of performance showed a degradation in PMT response as a function of the integrated anode charge. At the end of the High-Luminosity LHC (HL-LHC) program, the expected integrated charge for PMTs reading out the most exposed cells is 600 C. A model of the evolution of the PMT response as a function of the integrated charge, based on the measurement response during the Run 2, was built. The projected loss at the end of the HL-LHC is 25% for 8% of the total TileCal PMTs. These PMTs will be replaced with a newer version, in order to keep the global detector performance at an optimal level. A local test setup is being used in the Pisa laboratory to study the long term response of the new PMT model considered for replacement in the TileCal readout of most exposed calorimeter cells. Furthermore, the performance of the new is compared to the old PMT model, the current version used to readout TileCal cells. For the first time this new PMT model has been tested after integrating more than 800 C of anode charge. Preliminary results obtained from data collected in the Pisa laboratory over a period exceeding one year are shown in this presentation. We started a study aimed to understand the response degradation of the PMTs in order to disentangle the effect of loss of quantum efficiency and change in gain.

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**Session Classification:** D4