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ATLAS High Granularity Timing Detector (HGTD) for the High Luminosity LHC

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The High Luminosity LHC (HL-LHC) will allow its experiments to perform high precision measurements in the Standard Model, explore new regions of the phase space and search for signals of new physics through very rare processes. Colliding proton beams at $\sqrt{s}$ = 14TeV, the HL-LHC will reach an instantaneous luminosity of 7.5×10^{34}/cm²s. With 200 simultaneous collisions per bunch crossing, the noisy environment dominated by QCD jet production will make the tracking-vertex association and particle identification a very demanding task and many of the current detectors, trigger and data acquisition systems will not be able to retain their performance in this environment. Moreover, this high luminosity will give rise to a significant increase in the radiation dose, with the high rapidity regions being the most affected. To cope with these challenges, the experiments will have to resort to new systems using state-of-the-art particle detectors in order to withstand years of radiation dose delivered by the HL-LHC. The ATLAS experiment will deploy a new semiconductor based system, the High Granularity Timing Detector (HGTD), a 2m disk to be installed between the ATLAS barrel and the endcap ($2.4 < |\eta| < 4.0$) that will provide timing information in order to aid track-vertex association and pileup mitigation.

HGTD will use the forefront technology in silicon timing sensors, the Low Gain Avalanche Detector (LGAD). Having an intrinsic gain of only a few tens, these silicon-based sensors can provide picosecond timing resolution while withstanding radiation doses that can reach up to $2.5 \times 10^{15} n_{eq}$/cm² and 2 MGy[Si].
LGAD based detectors can be built with millimetric segmentation and very thin, resulting in a low material budget. As part of the ATLAS Phase-II program, the University of São Paulo group already participates in the R\&D of LGAD sensors for HGTD and its Demonstrator at CERN, and will soon start the sensor prototypes qualification.

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