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ATLAS High Granularity Timing Detector: mechanics, services, integration and assemly

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The High-Granularity Timing Detector (HGTD), a novel detector based on Low Gain Avalanche Detector (LGAD) technology, being bult for ATLAS Phase 2 upgrade to help mitigate the effects of increased pileup at the HL-LHC by providing high-precision timing information, measuring charged-particle trajectories in time as well as space. In addition, it will provide an instantaneous measurement of the luminosity, reading this information at 40 MHz.
The HGTD consist of two end caps, which will be installed in the gaps between barrel and end cap calorimeters at approximately ± 3.5m from the interaction point, covering the pseudorapidity region between 2.4 and 4.0. With an average of 2.5 hits per track, the target time resolution per track for a minimum-ionising particle is 30 ps at the start of lifetime, increasing to 50 ps at the end of HL-LHC operation (total integrated luminosity of 4000 fb−1).
The HGTD includes 8032 front-end modules. Each module is constructed of two hybrids, each composed of Low Gain Avalanche Sensor (LGAD) of approximately 2×2cm2 in size, bump-bonded to ATLAS LGAD Timing Integrated Read-Out Chip (ALTIROC). The hybrids are held together by a short flexible PCB and connected to Peripheral Electronics Boards (PEB) by another flexible PCB. The LGAD sensor has 225 pixels of 1.3x1.3 mm2, which gives 3.61 million reading channels in total.
Each HGTD end cap comprises 4016 such modules installed on either side of four identical half-disc cooling supports, which make up two double-sided instrumented disks. The disks are rotated by 15° relative to each other to maximize the hit efficiency. The detector will operate at -35 Co using CO2 cooling, which requires encapsulation of the instrumented disks in a hermetic vessel, the vessel also includes a neutron moderator layer. To prevent condensation on the detector components, the interior volume of the vessel is flushed with dry nitrogen gas.
The HGTD envelope is limited by the space available in the gap region between the barrel and end cap calorimeters, making it very compact. The detector vessel has a radial extent of 110 mm to 1050 mm. The envelope in the beam direction (z) is 125 mm, including the front and rear covers and the internal moderator, resulting in only 75 mm in z for the detector components.
Such a tight envelope makes it very challenging the integration of the detector modules, on-detector electronics and connection of services. The construction of the detector requires construction of dedicated tools for assembling the instrumented half-disks and their integration into the vessel.

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