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Cooling the CMS Phase II Inner Tracker, Challenges and Solutions

The High Luminosity LHC will reach an instantaneous luminosity of $5 \times 10^{34}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$ with 140 to 200 pp collisions per bunch crossing and collect a total of 3 ab^{-1} of 14 TeV data. To cope with these challenging data taking conditions, the CMS Inner Tracker will be rebuilt for Phase II Upgrades. To limit particle occupancy to the per mille level, and improve tracking and vertexing performance, we will increase the granularity of the sensors. This will result in power dissipation of approximately 50 kW. For sensors to survive the radiation close to the beam pipe, we will need to maintain them around -20 C. Thus, cooling the detector will be of paramount importance. We present a scheme for cooling built into the structural support of the Pixel Detector. The cooling system is studied and optimized through finite element analysis simulations. The simulations are informed by experimental measurements of the thermal transport properties of bulk and interface materials performed in novel, custom-made apparatuses.

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