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Thermal Runaway Studies for the CMS TFPX Phase-II Upgrade

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The CMS Phase-2 upgrade is intended to handle the increased data output and fluence expected in the high-luminosity operation of the LHC and requires developing and installing a redesigned silicon tracker. Silicon sensors close to the beam pipe will receive heavy radiation doses, leading to increased dark current and bias voltages that in turn generate increased heat load and put the detectors at risk of catastrophic thermal runaway. Prevention of runaway, by providing robust thermal pathways for heat removal, is a key design requirement for the CMS Inner Tracker. Here we present preliminary data on the thermal properties of the proposed mechanical structure and materials of the tracker forward pixel detector (TFPX), with a specific focus on characterizing the thermal pathways and evaluating the margin of safety against runaway. Thermal runaway is simulated as it would occur in the tracker by mimicking the behavior of a heavily radiation-damaged silicon sensor with a dummy sensor module affixed to a cooled carbon fiber and foam plaquette. This setup maps out the stable operating range for the final tracker and provides a basis for evaluating and selecting materials and assembly methods.

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