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An ultra-light helium cooled pixel detector for the Mu3e experiment

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The Mu3e experiment searches for the lepton flavour violating decay $\mu^+ \to e^+e^-e^+$ with an ultimate aimed sensitivity of 1 event in 10^{16} decays.
To achieve this goal, the experiment must minimize the material budget per tracking layer to $X/X_0 \approx 0.1\%$ and use gaseous helium as coolant.
The pixel detector uses High-Voltage Monolithic Active Pixel Sensors (HV-MAPS) which are thinned down to 50 μ m.
Both helium cooling and HV-MAPS are a novelty for particle detectors.
In this talk, I present my work on successfully cooling a pixel tracker using gaseous helium.
The thermal studies focus on the two inner tracking layers, the Mu3e vertex detector, and the first operation of a functional thin pixel detector cooled with gaseous helium.
The approach, which circulates gaseous helium under ambient pressure conditions with gas temperature around 0℃ using a miniature turbo compressor with a mass flow of 2 g/s allows the vertex detector to operate below 70℃ at heat densities of up to 400 mW/cm^2.
Finally, performance data of the final HV-MAPS used by Mu3e, the MuPix11, is presented.
These results demonstrate the feasibility of using HV-MAPS combined with gaseous helium as coolant for an ultra-thin pixel detector exploring new frontiers in lepton flavor.

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