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Micro-channel cooling for silicon detectors

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Abstract 1:
In this contribution a novel cooling concept for light-weight position-sensitive detectors is proposed. Our solution is based on a micro-channel cooling circuit that is integrated in the silicon sensor. Results are presented of a characterization of the cooling performance of several mechanical samples fabricated at HLL in Munich. A moderate flow of order 1 l/h of mono-phase cooling liquid is found to be sufficient to evacuate a power dissipation of several tens of Watts with a minimal temperature gradient between coolant and the sensor surface. The liquid flow has no significant impact on the mechanical stability of the sensor. A finite-element simulation can provide an adequate description of the cooling performance and is used to extrapolate the results to a more realistic environment

Abstract 2:
In many high-energy experiments, the silicon sensors will need to be kept at very low temperatures. The main goals of cooling are to keep the leakage current low, to avoid thermal run-away as well as uncontrolled annealing of defects due to radiation damage in the sensors. This project aims at testing a method to reduce material and space needed for the cooling system. Micro-channels etched into silicon are a very promising alternative to the current cooling strategy based on the use of bigger cooling pipes. DESY, in collaboration with IMB-CNM Barcelona, is investigating this method in a generic R&D project.

A prototype micro-channel layout has been designed, produced and tested in collaboration with CNM in Barcelona. The micro-channels are etched into silicon using DRIE etching and are further fabricated using anodic and eutectic bonding. The sample has been implemented into a setup containing a Hydrofluoroether monophase coolant. Two different versions of the device were tested, one with the full wafer and one with the silicon cut to the structure of the channels. Measurements were done using temperature sensors and an infrared camera and the experiment was carried out in air and in vacuum. At the same time the micro-channels were simulated regarding the flow and the thermal properties.

Summary

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