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Advanced cooling techniques

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Effective thermal management of modern silicon detectors for HEP experiments is a challenging task. Although technological progresses on electronic chips allow for remarkable lowering of their specific power consumption at every new generation, the increasing request for performance and the very large number of sensing modules, concentrated in a confined volume in convoluted geometries, determine a detector power dissipation per unit volume comparable to the one of the most demanding high power electronics applications. This, added to a hostile radiation environment and to the well-known requirements of material budget minimization (very specific to our field), pushes the thermal design towards the adoption of advanced technologies.

This is in particular true for pixel detectors, where only a careful weighting of all the design requirements may lead to the optimal choice of the cooling technology, both at system level and for local thermal management solutions. There is unfortunately no universal "magical recipe", providing the designers with the best-adapted thermal management solution for every pixel detector. A lot is indeed left to the appreciation of the correct balance between requirements that are often conflicting. Some of these requirements can be easily translated into well-defined numerical values, like the minimal radiation length for the target physics performance, or the power density to be evacuated from the detector volume. Other ones however, like design and manufacturing complexity, reliability, damage tolerance, or maintainability are much less adapted to an objective quantification.

The talk will review some of the most recent trends in vertex detector cooling, with a special focus placed onto the numerous upgrade programmes ongoing in the HEP community. The most impacting advantages and disadvantages of the different classes of solutions adopted or under study will be discussed, with the intention to provide a critical view of the options available.

Author: PETAGNA, Paolo (CERN)

Presenter: PETAGNA, Paolo (CERN)

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