Contribution ID: **43** Type: **not specified**

Interlocking modular microfluidic cooling substrate for future HEP experiments

Friday 2 June 2023 12:10 (20 minutes)

For future experiments, the coverage of larger surfaces with silicon trackers faces challenges related to the large number of sensors to be positioned, cooled and interconnected. A modular cooling substrate design must be adopted to access industrialised series production. Replacement of faulty sensors during their integration represents an additional design requirement. In present detectors, the sensing modules are in thermal contact with the cooling line through a thermal interface material that allows for sensor replacement. This solution has a negative effect on thermal performance and sensor resolution.

In this talk, a different approach is presented. A microfluidic cooling substrate is permanently glued at the back of the sensor, providing an integrated module that can be thoroughly tested, electrically and thermally, before the final detector integration. This solution minimises the material in front of the sensor by reducing the number of thermal interfaces. On the flip side, the challenge becomes the design of a re-workable and reliable hydraulic interconnection between the modules.

The design of the interlocking Modular microfluidic Cooling Substrate is based on embedded mini/microchannels produced by either silicon femtosecond laser engraving or polymer and ceramic additive manufacturing. The research presented here looked deeper into 3D-printed ceramic substrates as new attractive material and technology for high energy physics applications.

The proposed interconnection of the microfluidic module relies on mechanical and hydraulic interlocking fixations. The mechanical interface is based on a LEGO-like concept, while an in-plane hydraulic connection across microfluidic modules provides the sealing through a micro O-ring. Design alternatives to the baseline interconnection were also explored. Production processes and materials play a key role with respect to achievable tolerances which affect the interconnection. The ability to guarantee correct modules dis/mounting, positioning capability, and sealing was investigated for polymer and ceramic samples. In addition, fundamental aspects of ceramic microfluidic substrates, such as substrate flatness, gluing interface with the sensors and their hydraulic and thermal performances, were investigated. Finally, a real detector layout was taken as a reference to evaluate the implementation of the newly developed modular microfluidic solutions.

Author: ANGELETTI, Massimo (CERN)

Presenter: ANGELETTI, Massimo (CERN)

Session Classification: Plenary