Expression of Interest for participating in the H2020 Innovation Pilot on detector technologies at accelerators

Title: *Development and study of microchannels cooling substrates with advanced channel connectivity*

Participants (max. 6): *list the participating institutes, laboratories and industrial partners*

Name of the legal entity	Type (university, institute, laboratory, company)	Country
LPNHE Paris (CNRS)	Laboratory	FR
FBK-CMM	Company	IT
CERN	Laboratory	CH
LAPP Annecy (CNRS)	Laboratory	FR

Contacts: *One name + e-mail per participant*

Participating institute / company	Main contact person	E-mail
LPNHE Paris (CNRS)	M. Bomben	marco.bomben@cern.ch
FBK-CMM	M.Boscardin	boscardi@fbk.eu
CERN	A.Mapelli	alessandro.mapelli@cern.ch
LAPP Annecy (CNRS)	J. Leveque	leveque@lapp.in2p3.fr

Description: *(max. 1 page)*

Micro-channel cooling presents significant advantages with respect to more traditional cooling systems in light-structure position-sensitive detectors for collider experiments. The reduced material and the more uniform distribution over the surface of the tracking module allow significantly better cooling performance and a reduced thermal figure of merit (TFM) for the detector. For this reason, many High Energy Physics experiments are adopting this solution for the cooling systems of their inner trackers.

The present EoI proposes microchannel-based novel solutions for the cooling of thin silicon detectors for the inner layers of collider experiments. The project will profit of the significant experience accumulated by the proponent groups in the prototyping of existing microchannel devices. Both standard-liquid and dual-phase (carbon dioxide) coolant solutions will be studied. The innovation with respect to existing results will be centred on two main axes: 1) the more methodical study of the thermo-dynamical conditions along the channel length, in particular in the case of dual-phase systems, and the comparison with models; this will include features never investigated methodically till now, such as the surface roughness and the channel aspect ratio, which have a critical effect on the fluid condition; 2) the problematics of interconnectivity between the different micro-channel elements, which still represent one of the most challenging aspects of the system. Prototype microchannel substrates will be produced by the LPNHE Paris and the CERN groups in collaboration with FBK Trento, which already provided similar productions in the past. For the first axis, involving the thermo-dynamical studies, specific devices will be produced, allowing the observation of the fluid inside the channels thanks to high-resolution high-speed cameras. The EP-DT detector cooling laboratory at CERN will allow to characterise the produced devices while the experience of the LAPP group in simulation and modelling will allow to interpret the collected data. For the second axis, involving the interconnectivity, a powerful element will be the integration of 3D printing techniques with new materials, which will allow to simplify the design of some of the parts, and to study the integration of the connections in the interior part of cooling elements. Another EoI in this call [P.Petagna et al] is proposing the use of 3D printing techniques with new materials used for micro-channel cooling systems, which would result in an excellent synergy between the two EoIs. Some of the produced substrates will be coupled to existing tracker modules in such a way to compare the thermal performance of a well-known standard cooling system with the microchannel distributed elements.

Deliverables (max. 3): list the expected deliverable(s) of the proposed activities

- Deliverable 1: Prototyping, data extraction and comparison with models
- Deliverable 2: Construction of large-scale cooling systems to proof the reliability of the specific interconnections solutions and their integration in the tracking stave.
- Deliverable 3: Measurement of the thermal performance of the system in application to existing modules.

Budget estimate

- *Man-power (total number of person-months which are needed to achieve the objectives)*
- *Full cost including personnel and other direct costs (typically 1/3 EC contribution, 2/3 matching resources)*
- *DO NOT include overheads, which will be added to the EC contribution at the proposal preparation phase*

Total number of PMs	EC contribution (in kEUR) (a)	Matching funds (in kEUR) (b)	Full costs (in kEUR) (a) + (b)
72	150KE	300KE	450KE