A summary of the SiPM Cooling Workshop, 17 October 2013, CERN

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Agenda: https://indico.cern.ch/conferenceDisplay.py?confId=273434

The main goal of the Workshop was to discuss SiPM cooling issues with detector cooling experts, collect their opinions and inputs and try to converge on the preferred technology for the SiPM cooling. We also hoped that this meeting will give momentum to the pre-TDR work on the SiPM cooling and prompt new groups to join this project.

In summary, the goals were partially achieved: a) we have now a broader group of experts who are aware of our project, contributing with concrete suggestions and available for advice in future; b) though we failed to achieve a consensus on the preferred SiPM cooling technology, a few key points to decide upon were identified, and the decision logic was outlined; c) the NIKHEF group expressed willingness to include the SiPM cooling into its commitments for the Fiber Tracker project[3].

The following topics were elaborated or touched upon in presentations and discussions:

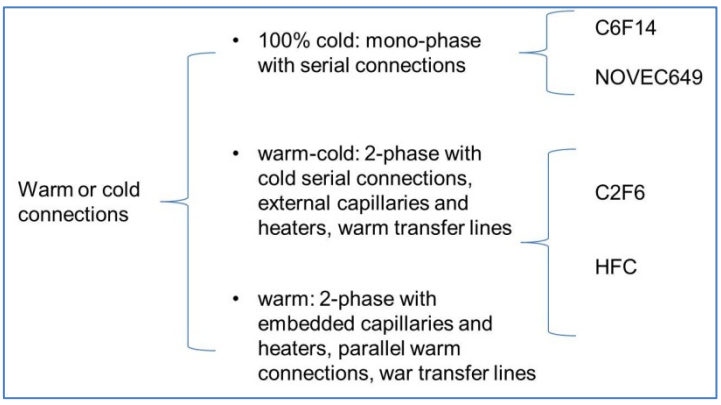
1. Fluorocarbons versus “green” or “greener” coolants and refrigerants (CO2, HFCs, air)
2. Evaporative or mono-phase (liquid) cooling?
3. Cooling logistics: manifolding, branching etc
4. Serial or parallel module connection?
5. Warm or cold cooling communications?
6. Dynamic or static flow control in liquid cooling; blends or pure refrigerants?
7. Compressors, pumps, “true” and hybrid thermo-syphon.
8. Whether or not should we care about eco-friendliness, GWP etc?
9. Should we pursue new ideas in cooling or resort to (copy?) existing proven solutions?
10. Are we interested in TE cooling?
11. System cost, whether or not the system must be cheap and simple.

[1] Speaker
[2] By Vidyo
[3] I am not sure that this decision was directly affected by the outcome of the Workshop, but Antonio and Bart actively contributed to it, by giving (B.V.) a joint presentation entitled “Outer tracker SiPM: A view on the thermal issues and cooling solutions”.

Outcomes of the discussion:

- The "*warm vs cold connections*" is the primary decision point for the technology choice.
- *CO2-based technologies are not appropriate*, as the lowest conceivable working temperature (-50°C) is too close to the CO2 snow-point (-56°C)
- The *48-branch manifolding scheme* is taken as the basis.
- A *well-tested cooling technology* is preferable to the one requiring R&D, at least for the baseline SiPM cooling option. The R&D efforts should be biased towards the optimal end-cap design (insulation, access to SiPMs etc).
- *Thermal design* should be the driving design factor for the mechanics. The Z-arrangement of the layers must be decided upon, ASAP.
- The *absence of strict limitations on material budget and radiation hardness* opens more opportunities for simple and robust solutions for SiPM cooling, avoiding the subtleties of inner detector cooling.
- Eco-friendliness should not be a primary driving factor for the design.
- *Serial module connection* within a single cooling branch offers significant advantages by reducing the length and volume of local connections. An urgent design work is needed to prove its viability. The solution should also provide a *reliable inter-module edge insulation*.
- To *discontinue chilled air option* as a candidate for principal SiPM cooling, because of unrealistic amount of dry compressed air required for vortex tubes. To *continue the research in TE* cooling with external cooler and copper heat spreaders.
- *Flexible vacuum insulation* (a la ATLAS IBL) – an interesting option for communication lines.
- To consider a) *monophase cooling with serial* module connections and b) pure C2F6- or R125-based *compression-evaporation cooling* (optionally, also with serial connections) as the two options for the TDR. The priorities of a) and b) should be decided upon ASAP, through further consultations with the experts and follow-up discussions within the FT community.

The decision matrix (the notion suggested by H.Postema and P.Petagna) can be as follows:



In simple terms, we should decide whether or not the end-cap zone has enough space for insulated module (inter-)connections. Then we choose an appropriate simple and "as COTS as possible" cooling technology (probably, sacrificing costs over robustness and performance) and focus the design efforts on the optimal module-end structure for this cooling method. Eco-friendliness is a desirable but not fundamental factor in this logic.