Interface Control Document Template

XXXXXXXXX (Sub detector name)

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Summary	
Annexes	

Document Change Record

Edition	Revision	Date	Modified pages	Observations
0	0			
	2	21/8/16	18-21	Cooling system added, minor corrections elsewhere
	3	22/8/16	all	Minor corrections here and there
	4	27/9/16	many	Large changes in the mechanics
1	0	27/11/16	many	Separation between external and internal parts

Distribution	*See Distribution list at the end of this document*

Template V1.0

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1. INTRODUCTION

1.1. Scope of the document

The purpose of this version of the document is first to assemble all elements that may be relevant for the Silicon-tungsten electromagnetic calorimeter (SiECal). The document doesn't claim however neither exactness nor completeness at this stage.

All mistakes are mine!!!!!

Note: Unless otherwise against, this document does not address software interfaces.

1.2. Applicable Documents (AD)

Applicable Documents (AD)			
AD	**Title**	**Reference**	**Version**
DBD	ILD DBD	arxiv: 1306.6329	v1

1.3. Reference Documents (RD)

Reference Documents (RD)			
RD	**Title**	**Reference**	**Version**
	Lots of material by Cornat, Grondin, Clerc, Roig, Krueger/Suehara, Giraud, Boudry, Gastaldi, Magniette, Anduze, Videau …		

1.4. Details of change to the previous design

Indicate (if necessary) the changes compared to the previous version of design. This section may become obsolete but since the reference of the document is the DBD and there are unavoidable changes since then we would like to record them here

- Alveolar structure: 3 rail system in DBD, 2 rail system here;

- SiECal thickness increased to 223 mm from 185 mm with respect to DBD due to more realistic layer structure.
- In front of the first sensitive layer there was a layer of 2mm CF. It is now replaced by a 2.1mm tungsten plate.

1.5. List of abbreviations

List of Abbreviations			
MSE	Mechanical System Equipment	**SiEH1_sn**	SiECal hub Type 1 in stave n
EL	Electrical System Equipment	**SiEH1_qn**	SiECal hub Type 1 in quadrant n
CB	Cabling	**SiEH2_sn_m**	SiECal hub Type 2 in stave n and column m
PW	Power	**SiEH1_qn_m**	SiECal hub Type 2 in quadrant n and column m
CF	Carbon fibre	**DIF**	Detector Interface Card
LV	Low voltage		
HV	High Voltage		

1.6. Nomenclature

Nomenclature			
Module	Module	**Overlap**	Distance in z between barrel and end cap
Stave	Set of 5 modules covering an octant of the barrel	**Overshoot**	Amount by which the end cap outer radius exceeds the barrel outer radius.
Slab	Tungsten slab sandwiched between two detecting structures, to be slit in the stave.	**Alveoli layers**	
Alveolus	Hole in the module structure to contain a slab	**Alveoli columns**	

2. GENERAL DESCRIPTION OF SUBSYSTEM

3. GENERAL INTERFACE DESCRIPTION

1.

2.

4. MECHANICAL INTERFACE

1.7. Coordinate system

- Frame of reference axes

1.8. Mechanical concept

- General description of detector elements
- Surface treatments and status
- Interfaces to other detectors
  - attachment points: position, center distances, diameters, tolerances
  - mounting specifications (torque, washers, brake type, heat seals, etc..)
  - connectors (type, identification, position),
  - With drawings
- location of the marking labels

1.9. Critical dimensions

- Dimensions and tolerances
- position of the center of gravity (with tolerances)

1.10. Weights

Estimated weights with margin and tolerancing

1.11. Positioning and alignment constrains

For every subsystem:

- Positioning constrains: position of q subsystem from another
- Alignment constrains: absolute/or relative alignment precision for a system from another AND requested precision for the verification of this alignment.

5. ELECTRICAL INTERFACE

The guiding line for the SiEcal is to have as few connections to the outside world as possible. A set cables will arrive at *external* hubs that are for example located at the front face of a barrel stave as shown in Figure 1.

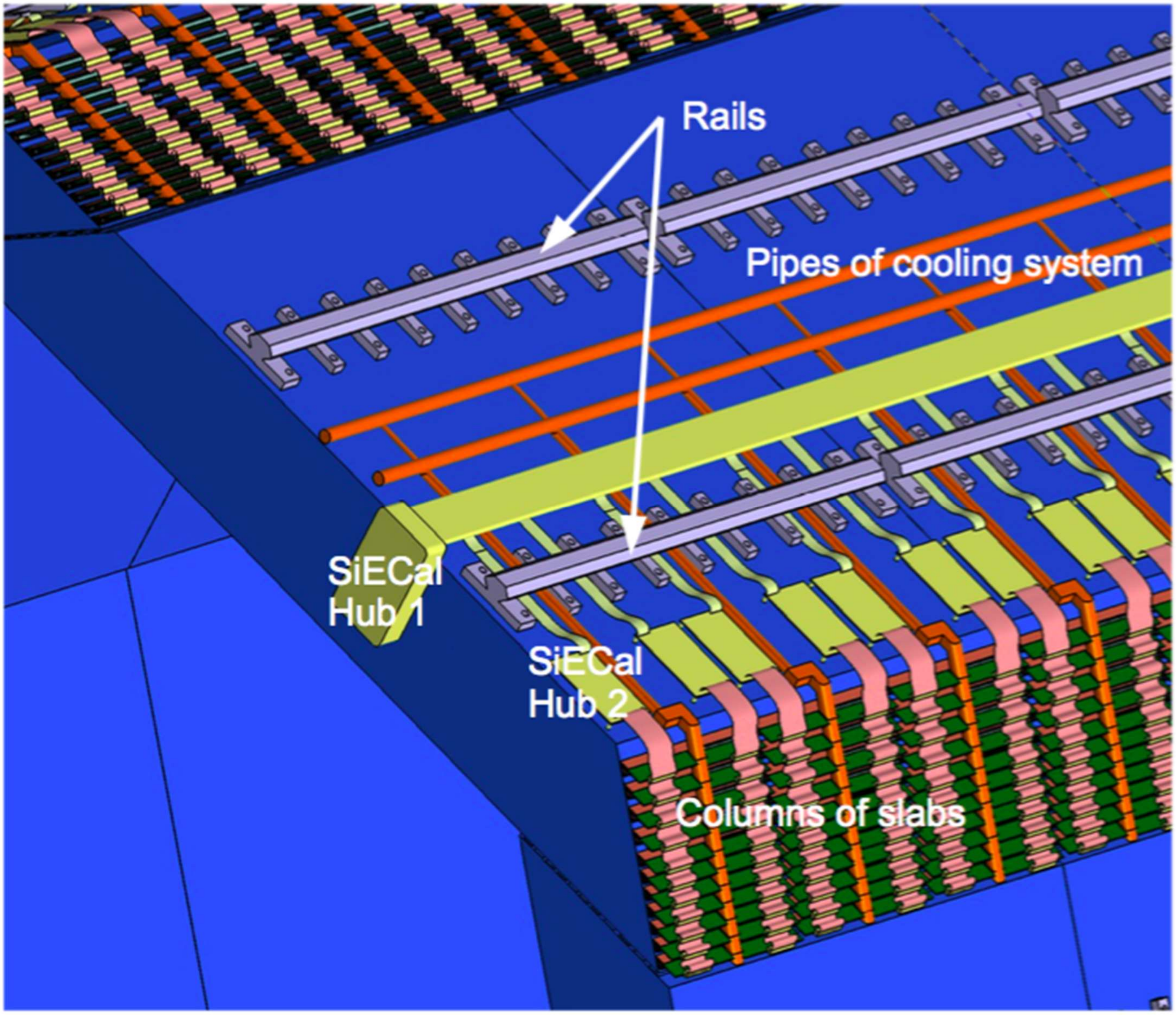

Figure 1: Schematic view onto SiECal Barrel Module indicating services such as the hubs for power distribution as well as data concentration and distribution of readout commands. Note that the size of the hub may still vary (In particulr Hub1 is most presumably too small). Shown are also parts of the cooling system that is descrived below.

The following conventions will be used for the identification of the external hubs:

- SiEH1_sn: Here “H1” means that it is an external hub (Concentration Level 1), “s” labels a hub in front of a stave and “n” identifies the stave. In the endcaps the “s” may be replaced by a “q”

1.12. Block diagram

The Figure 2 shows a primitive block diagram for one column of SiEcal slabs.

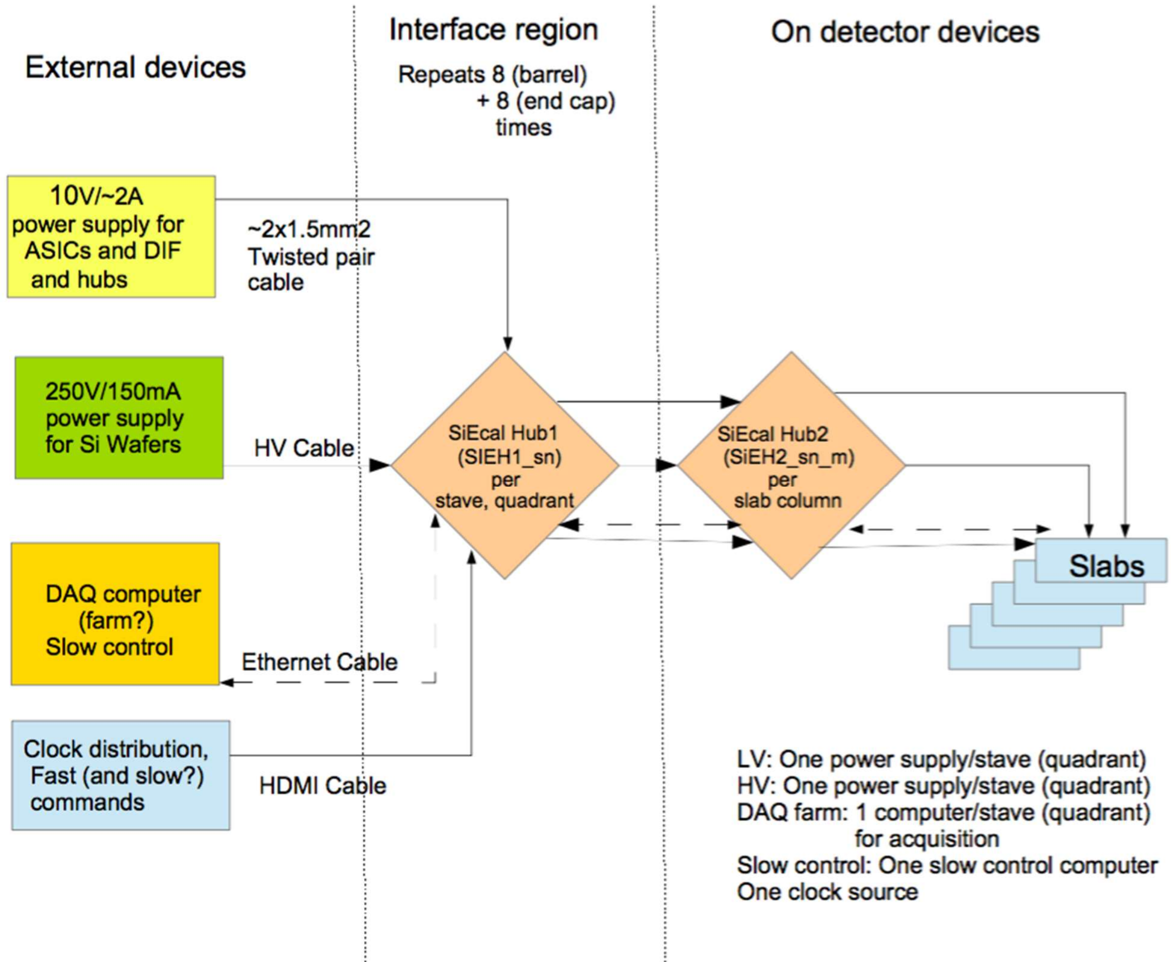

Figure 2 : Schematic view of power distribution and distribution and concentration of other relevant signals and data for one column of slabs.

The cables that arrive or leave from the Hub of type 1 have the following purpose:

- Low voltage power supply for the readout electronics and the powering of the active hubs
  - In going cables
  - 10 V/few A power supply (Voltage drop may not be correctly taken into account)
  - Twisted pair within one insulated cable
  - There is no regulation foreseen in Hub1, this happens in Hub2
- High voltage power supply for the biasing of the silicon wafers
  - Standard “red” HV cables (150 V/few mA, in going)
- Ethernet cables for data transmission and detector control
  - Out going and in going
  - Behind the 1st hubs is a computing network with the 2nd hubs as network devices with MAC Address, IP Addresses etc. Naturally the 1st hubs themselves are part of the same network.

- Layers will be switched off by remote control, in principle the layers should be part of a GPIB bus system of which the master GPIB card is integrated into the 2nd hub. Each GPIB master card receives commands via Ethernet.
- Standard HDMI cable (Type A) for clock distribution fast and slow commands

This means that 4 types of cables arrive at or leave from a given hub. What concerns the barrel altogether 32 cables will be fed through the overlap between barrel and endcap. On both sides the endcaps will be served by 16 cables each (I DO NOT REMEMBER ANYMORE WHERE TO PUT THE HUBS IN THE ENDCAPS).
As seen in Figure 1 further hubs are located inside the space between SiEcal and Hcal. Power and clock are fanned out to these hubs and further to the slabs. These should create no interference with other detectors. For details see SiECAL TDD

In the following the interfaces are described:

- Power (the type of power [regulated, unregulated, heating-, number of lines for each type):
  At the Hub1 the power arrives directly from supplies sitting in the electronics trailer,
  Low voltage (~10V, few A) for the operation of the readout system
  High voltage (150, few mA) for the bias voltage of the wafers
  power regulation is realized in the hub on top of each column so slabs (See SiECal TDD).
- Remote control: control type (relays, digital ...), the number of each type of control:
  Layers will be switched off by remote control, in principle the layers should be part of a GPIB bus system of which the master GPIB card is integrated into the 2nd hub. Each GPIB master card receives commands via Ethernet.
- Insulation:
  The twisted pair cable will arrive within one insulated cable, further there are standard HV cables and standard Ethernet and HDMI cables.
- Other interfaces: clock, other instruments, ...
  Further interfaces are the clock distribution and transmission of fast commands (both within one micro-HDMI cable), Slow control and a standard Ethernet cable for data transmission to the SiECal DAQ computer.

For convenience the original instructions are lited below:
It should indicate all electrical interfaces, including redundancies:

- power: the type of power (regulated, unregulated, heating), number of lines for each type;
- remote control: control type (relays, digital ...), the number of each type of control
- insulation;

Other interfaces: clock, other instruments, ...

1.13. Connection diagram

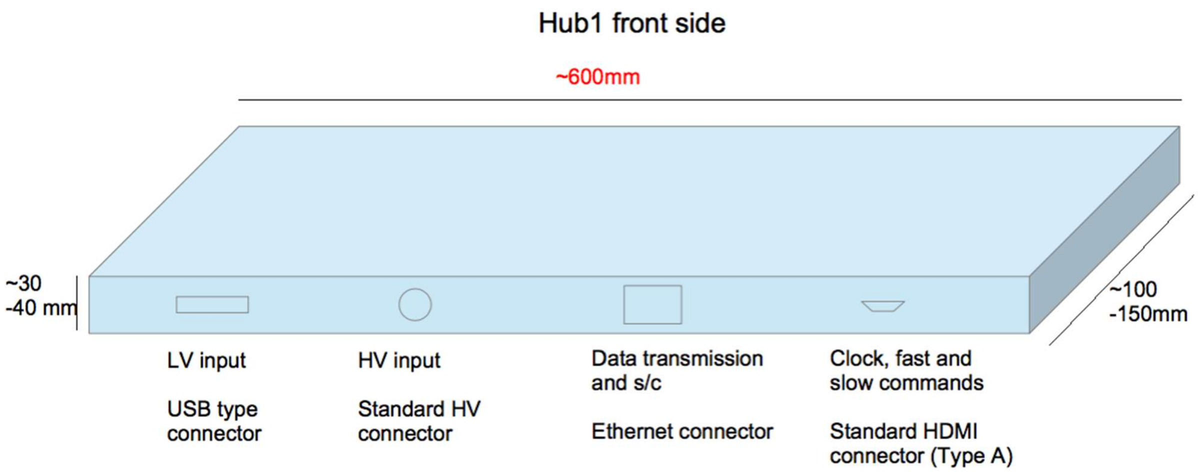

Figure 3: Schematic front view of SiECal Hub of Type1 with dimensions. Shown are also the four connections for supplying power, data transmission and clock transmission.

Figure 3 shows a schematic view on the front face of the SiECal Hub of Type 1.
The type of cables is already given above in 6.1. The connectors will be specified in the following.

For convenience the original instructions are listed below:
This is a general wiring diagram showing the names of cables, connectors, equipment, ...

1.14. List of Connectors

- USB type Connector
- Standard HV Connector
- Standard Ethernet Connector
- Standard HDMI Connector

For convenience the original instructions are listed below:
This is a general wiring diagram showing the names of cables, connectors, equipment, ...
For each connector on should indicate:

- The location (eg equipment A);
- the name of the connector;
- type (manufacturer's name + complete reference);
- the general function (eg power ...)
- coded pins, keying;
- the precise limits of the respective supplies;
- the principle of shield connections and grounding policy.

1.15. Cabling and connecting sheets

For every connector and every pin it will be specified:

- the signal type (analog, digital, power, RF, ...),
- the waveform (period, duty cycle, maximum value, minimum value)
- a graphical representation for complex signals (ramp, modulation ...),
- the category (transmitter or receiver)
- the reference of the pining of the connector,
- the electrical diagram of the interfaced circuit.

Later, too lazy now. The most complicated one is the HDMI connector.

1.16. Electrical grounding scheme

A diagram will indicate how are connected or isolated mechanical grounds, shieldings ...
The maximum contact resistance will be defined.

Not competent to answer (Well, this applies also to the other points but even more here).
I assume that grounding of the power supplies will already happen in the trailer. Not sure whether it Is realistic to draw e.g. copper braids throughout the detector.

1.17. Power Consumption

(For the following it will be assumed that the Detector Interface (DIF(Cards that are part of an SiEcal layer will be power pulsed as the rest. In this case they will not add significantly to the power budget. Note that this is currently not the case and e.g. the cooling system is based on a steady DIF power consumption between 0.3 and 3 W. Already the lower limit will lead to a permanent current of 643 A in the SiECal system. This should be avoided!)

The principle of power pulsing implies that the bias currents at the ASICs (and also of the DIF cards?) are enabled with a duty cycle of 1%.

The total average electrical power consumption is about 1.6 kW. The barrel is expected to consume between 1.2kW and the end caps about 0.4 kW.

The peak power consumption is therefore about 100 times higher.

The peak current in a detector layer is of the order of 10 A (around 7080 layers exist in total). However, the external connections and power supplied are not affected since the power pulsing will be realized via large capacitances (typically super capacitances of 400 mF with 16 mΩ ESR). In the current scheme the capacitances will be located on top of each column of slabs.

Note finally that bias voltage to the silicon wafers does not add significantly to the power budget (O(10 W)).

1.18. Other electrical interfaces

For the moment we use this section to describe what is inside the electronic trailer.

- SiECal power supplies
- 16 LV power supplies (type Lambda devices)
- 16 HV power supplies (type CAEN)
- Computer Farm (typically 16 DELL Poweredge),
- Connected to central storage of Central DAQ system for event building?
- Alternative direct SiECal data immediately to central DAQ system

For convenience the original instructions are listed below:
This section defines all other electrical interfaces (clock s, other instruments ...).

6. FLUID INTERFACE

For every fluid it will be indicated:

- the type of fluid,
- the reference of the mechanical interface to which it relates,
- the pressure,
- the flow,
- the purity constraints of the fluid.

1.19. Gas system Interface

The SiEcal is cooled with water. See therefore next subsection

1.20. Liquid system Interface

The information here and in Sec. 8 are extracted from a detailed study of the cooling system that is available under [xxx].
The SiECal will be cooled by a water-cooling system. A cooling station is located outside *about 30 m off the beam axis of the ILD Detector* (need to indicate the beam axis in Fig. 23) and the cooling water will be brought to and away from the barrel staves and end cap quadrants. From there it is further distributed to the individual modules and the slabs hosted in the alveoli. Figure 4 shows the general concept of the cooling system.
Further information on the architecture are given in Figure 5. In a simplified way the system features a hierarchical structure represented by the cooling Lines A-F: The barrel and end cap circuits already indicated in Fig. 23 are split further into a distribution ring and then further in lines serving the staves, the individual modules and slabs. Each of these lines has a different diameter as given in Figure 6.
Remark R.P.: We may want to introduce more consistency between drawings such as in Fig. 4 and Fig. 5. Figure 4 doesn't seem to include the distribution ring and cooling pipes enter only from the bottom (due to the sub atmospheric pressure?) while in Fig. 5 the Line D enters from the top.

=> TO DO: Where will the distribution ring be mounted, at the outside of the yoke the hadronic calorimeter or elsewhere? This ring seems to be critical to me. Further need to define precisely where in particular the lines A-D are to be routed. I suppose also that there is more than one Line D.

Where are joints between the different circuits (critical spots for leaks even if the system is largely self-protected)!!!

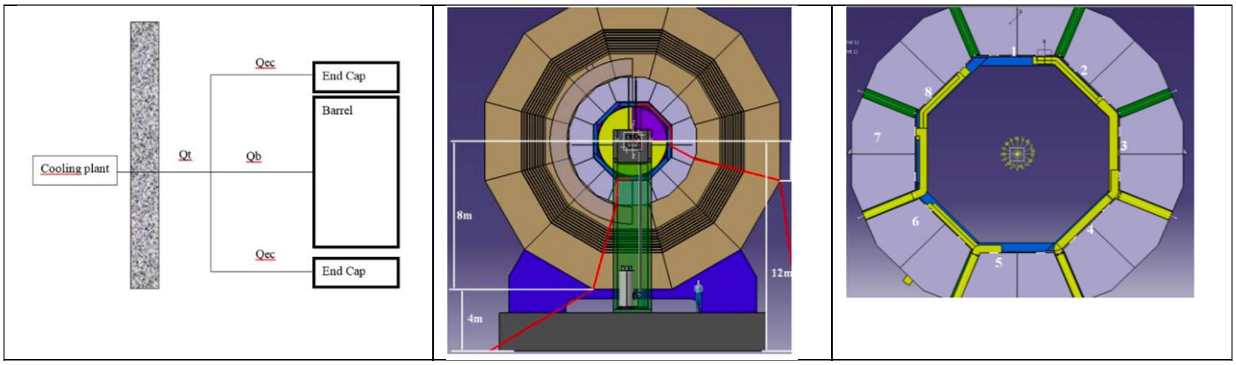

Figure 4 :(Left) Schematic view on the cooling for the barrel and the two end caps of the SiECal. Flow Qt=Qec+Qec+Qb. (Middle) some cooling pipes from/to with detector with general dimensions (REMARK: The red lines don't look well routed!). (Right) four cooling lines that arrive from the bottom due sub atmospheric pressure in the cooling circuit.

The cooling pipes are made from copper.

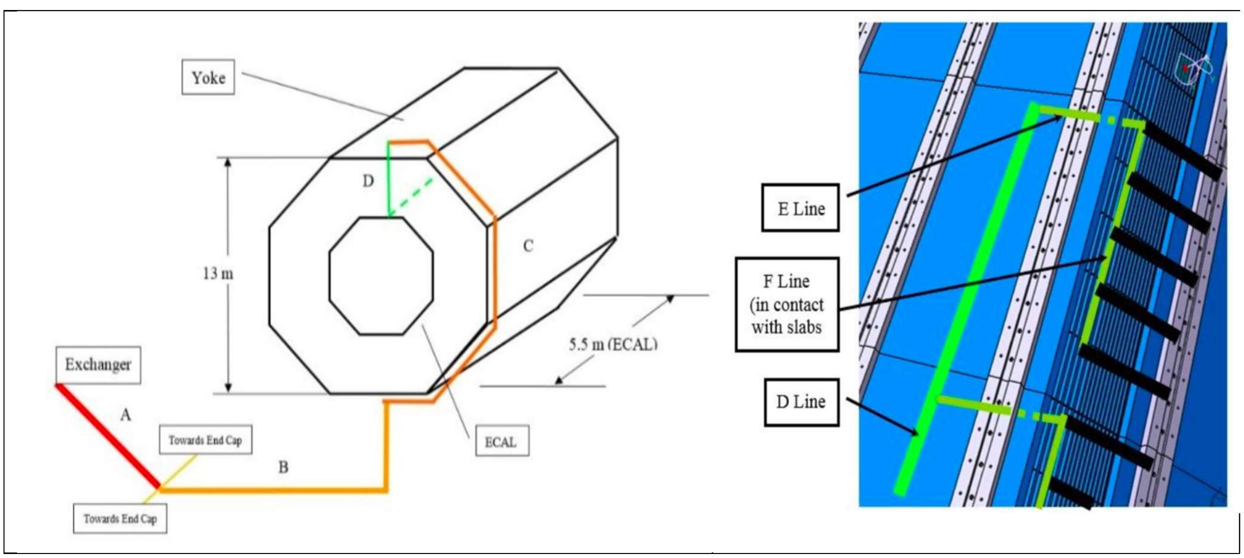

Figure 5: Schematics view on SiECaL cooling networxk. (Left) General view defining the cooling Lines A-D. (Right) Local view on barrel region defining the Lines E and F leaving from Line D. (REMARK : A corresponding drawing is missing for the end caps).

3.

Line	Length	Internal Diameter (mm)	Function
A	50	40	cooling plant / distribution Barrel & end-c
B	30	30	distribution Barrel & end-cap / line for 5 modules
C	25	20	distribution ring
D	10	12	distribution for 5 modules
E	1,5	8	distribution for 5 columns
F	0,3	4	cooling pipe for 1 column

Figure 6: Length of individual pipes of cooling network and the purpose of the pipes. (REMARK : To be replaced by a written table).

For every fluid please indicate

- Type of fluid

Regular water

- Reference of the mechanical interface to which it relates

Don't know what to answer. Maybe cooling of SiECal detector elements in barrel and end caps.

- Pressure

The system will be *leakless*. Water circulates therefore at *subatmospheric* pressure in the cooling pipes assuring an automatic "sealing" of a water leak by regular air penetrating into the circuit in case of a leak.

- Flow

Line A: 0.53 m/s, turbulent flow with Reynolds number (Re) 21231
Line B: 0.63 m/s, turbulent flow with Re 18783
Line C: 0.70 m/s, turbulent flow with Re 14088
Line D: 0.49 m/s, turbulent flow with Re 5868
Line E: 0.22 m/s, laminar flow with Re 1760
Line F: 0.18 m/s, laminar flow with Re 702

- (Added by RP) Temperature of the fluid

Water temperature input: 18°C
Water temperature output: 23°C (maximal).
It is expected that during the cooling process the water will be heated up by 1.63°C

- Purity constraints of the fluid.

No information found but I don't think that there are particular constraints

4.

7. THERMAL INTERFACE

For the subsystems:

- Thermal dissipation: in and out of operation

The SiECal will evacuate all its produced heat by means of the cooling system. The only sources of heat dissipation are the cooling pipes in which water with a temperature of around 20°C will be flowing. Out of operation there is no heat dissipation at all.

- Limit temperatures: during standby mode, for switching power, in operation

Don't know what to answer.

8. INTERFACES FOR DETECTOR TESTING

5.

These are the specific interfaces related to the test equipment:

- MSE interfaces: mechanical assembly test ... ;
- ESE interfaces: electrical interfaces with the test and verification systems;
- OSE interfaces: reference cubes, or targets for the surveys ...

Honestly no idea at the moment.

TO DO LIST

Actions	Who ?	When ?

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