

# Interface Control Document

## TPC

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<b>Summary</b>	The TPC interfaces to SiECAL, SIT and VDET are described. After a light description of the TPC, this document provides detailed information on the matters which concerns interactions or possible conflicts with other subdetectors: space occupation, power flow, matter budget, vibrations, support. Many of the issues are not decided yet. This document also lists several solutions and options to be studied.
<b>Annexes</b>	

### Document Change Record

Edition	Revision	Date	Modified pages	Observations
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<b>1</b>	<b>0</b>	<b>2017/10/04</b>		

**Distribution**

*See Distribution list at the end of this document*

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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 TPC. The document doesn't claim however neither exactness nor completeness at this stage. Unless explicitly mentioned, this document does not address software interfaces

**Very preliminary**

### 1.2. Applicable Documents (AD)

Applicable Documents (AD)			
AD	Title	Reference	Version
DBD	ILD DBD	arxiv: 1306.6329	v1
XML 2017	Change in size and small option		
ICD	ILD Conventions and Rules		

### 1.3. Reference Documents (RD)

Reference Documents (RD)			
RD	Title	Reference	Version
TDD	TPC Technical Document (to be written)		

### 1.4. Details of change to the previous design

*Indicate (if necessary) the changes compared with 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*

- In order to study performance vs cost effects, a small ILD model has been established. One of the changes on this model is the change of the TPC outer radius from 1808 mm to 1460 mm.
- Due to the increase of the SiEcal thickness from 185 mm to 223 mm, the TPC barrel (ie outer radius) was decreased to 1426.8 mm in order to compensate for that effect.
- One additional change concerns the material budget of the wall. Even though in the DBD it is mentioned that the field cage material for the inner and outer wall are respectively 1% and 3%, in the DD4HEP model it was initially 0.9% for both walls. This has

now been altered and the material budget for the inner and outer field cage walls are 0.9% and 2.7% respectively.

### 1.5. List of abbreviations

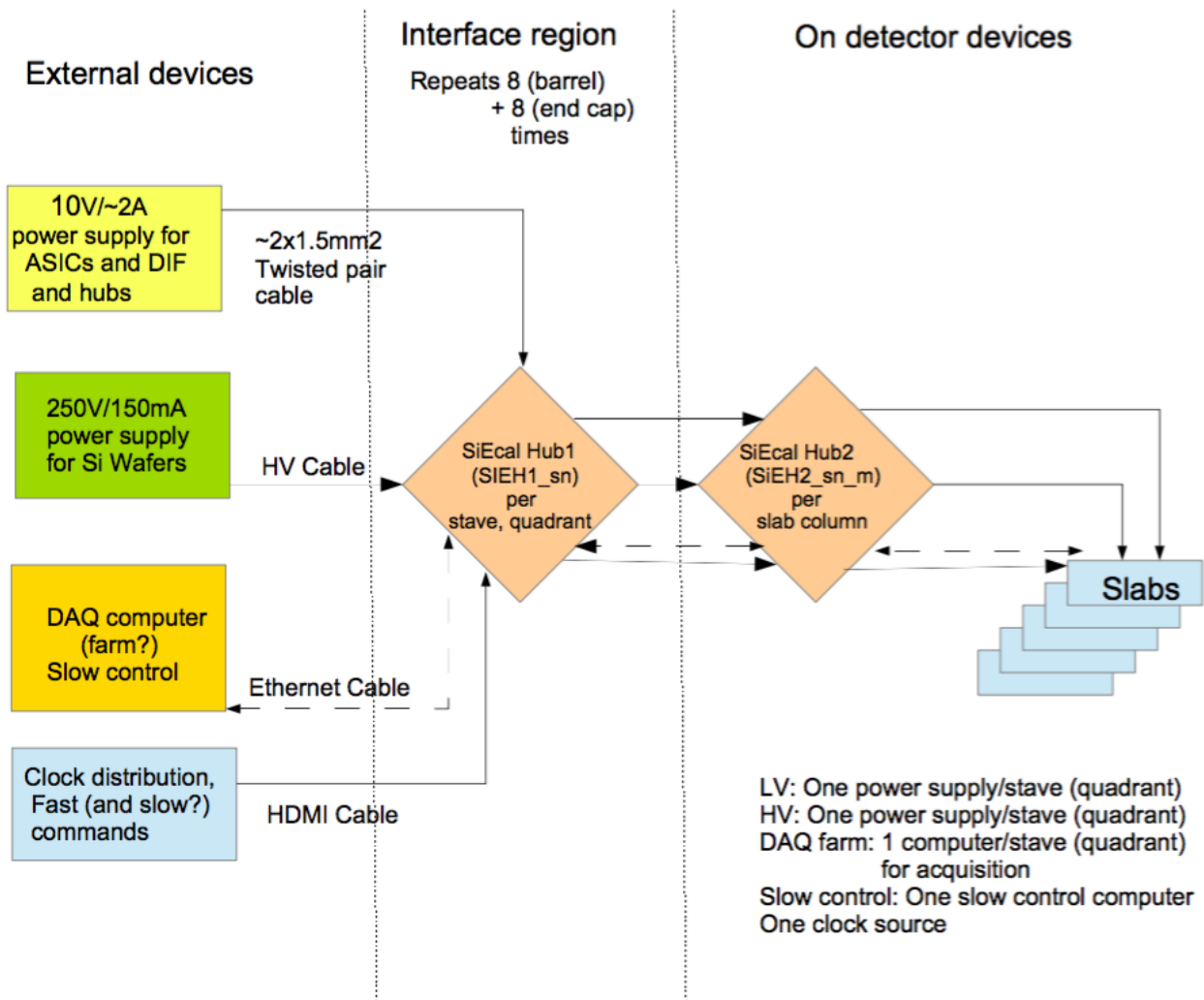
List of Abbreviations			
<b>ISS</b>	Internal Support Structure	<b>VHV</b>	Very High Voltage (Cathode polarization)
<b>FC</b>	Field Cage		
<b>LV</b>	Low voltage		
<b>HV</b>	High voltage for detectors		

### 1.6. Nomenclature

Nomenclature			
<b>Module</b>	Module with its electronics	<b>Field Cage</b>	Gas-tight double cylinder equipped with a voltage degrader to insure a uniform electric field (figure)
<b>Web</b>	The support of the endcap detector modules	<b>Patch panel</b>	Panel to receive cables/fibres from the detectors and to the concentrators, and from the HV and LV supplies to the detectors
<b>Membrane</b>	Thin metallized film stretched in the middle of the field cage to serve as a cathode for the drift electric field	<b>Endplate</b>	Readout device closing the gaseous chamber at both ends, composed of modules supported by a web
<b>Ribbon</b>	Carbon Fibre part mechanically connecting the TPC to its support (coil or HCAL)		

### 1.7. Block diagram

Figure 1 shows a primitive block diagram for one column of SiEcal slabs (to be adapted to TPC)



**Figure 1 : 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 patch panels have the following purpose:

- Low voltage power supply for the readout electronics and the powering of the active hubs
  - In going cables and their feedback sense
  - 5 V/few A power supply
  - Optical fiber for the signal
- High voltage power supply for the gating device
- High voltage power supply for the gaseous amplification
  - Standard “red” HV cables (fw 100 V, few nA, in going), or a thinner version.
- Optical fibers for data transmission and detector control
  - Out-going and in-going
- Clock distribution

In the following the interfaces are described:

- Power (the type of power [regulated, unregulated, heating-, number of lines for each type]):  
At the patch panel the power arrives directly from supplies sitting in the electronics trailer, Low voltage (~5V, few A) for the operation of the readout system. The power should be adequately tuned to avoid useless dissipation in the regulators.  
High voltage (few 100V, few nA) for the gaseous amplification device (technology dependent)
- 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 card is integrated. Each master card receives commands via Ethernet. (to be corrected by a specialist)
- Insulation:  
Standard HV cables.
- Photoelectric laser source:  
Enlights the cathode with UVs to produce photoelectrons to study and monitor distortions
- Calibration laser:  
Provides a UV beam for alignment purposes
- Gas analysis
- P and T monitoring

For convenience the original instructions are listed 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, ...

## 1.8. Connection diagram

For convenience the original instructions are listed below:

This is a general wiring diagram showing the names of cables, connectors, equipment, ...

## 1.9. 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.

### **1.10. 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 pinning of the connector,
- the electrical diagram of the interfaced circuit.

### **1.11. Electrical grounding scheme**

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

### **1.12. 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 module cards enabled with a duty cycle of 1%.

The total power consumption with the present electronic designs (assuming  $1.5 \cdot 10^6$  channels per endplate) is 6 kW per endplate (about 4 mW per channel). This can be reduced by a factor of 50 to 100 if the duty cycle of 0.5% can allow switching off the electronics between bunch crossings. The decision to do so also involves assessment of the need to be able to take cosmic data, for alignments purposes, and consideration of possible mechanical effects of power switching within an intense magnetic field. The power dissipated by the electronics could be reduced by a factor of two by limiting the voltage supply. The amplification system consumption is negligible.

### **1.13. Other electrical interfaces**

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



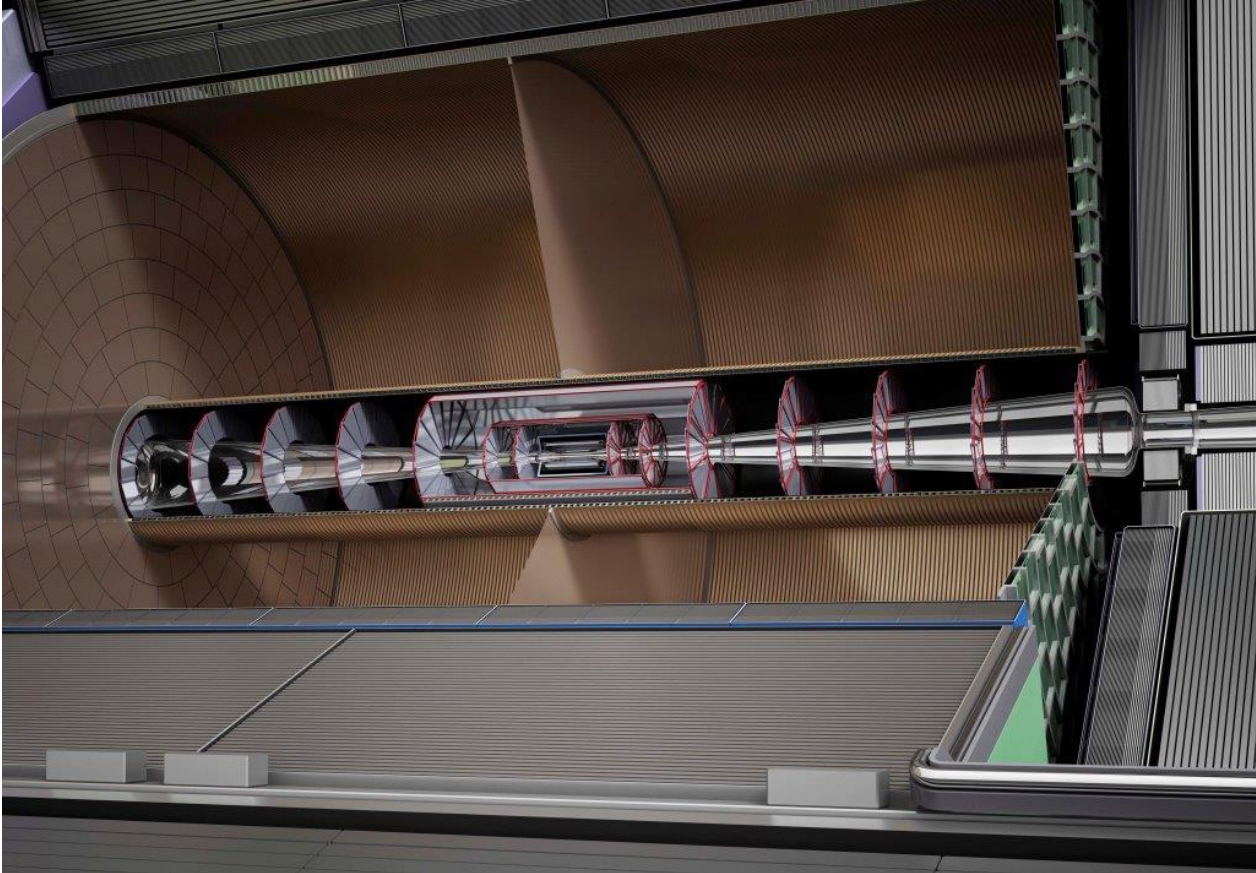
- HV power supplies
- 16 LV power supplies (type Lambda devices)
  
- Computer Farm (typically 16 DELL Poweredge),
- Connected to central storage of Central DAQ system for event building?
- Alternative direct SiECal data immediately to central DAQ system

For convenience the original instructions are listed below:

This section defines all other electrical interfaces (clock s, other instruments ...).

## 2. GENERAL DESCRIPTION OF SUBSYSTEM

The TPC is a gas-tight vessel at atmospheric pressure closed by 2 endplates carrying the detector modules. A Technical Design Document will describe it in more detail.



Several options are retained during the R&D and costing periods. The baseline radius, and a reduced radius (so-called ‘small’ option). The segmentation of the baseline option can be in 4 or 8 “wheels” depending on how large can be the modules, and 3 to 6 wheels for the small option. For the time being, the baseline is with 8 wheels, as this corresponds to module sizes comparable to those tested so far during the R&D phase. Several technologies are under study : Micromegas with a resistive anode, GEM and digital pixels.

## 3. GENERAL INTERFACE DESCRIPTION

The following items are considered:

Dimensions

Mechanical interface: support of the TPC and support of the ISS by the TPC.

Matter obstruction for the calorimeter (thickness of the FC)

Services (cooling, LV and HV supplies, signal)

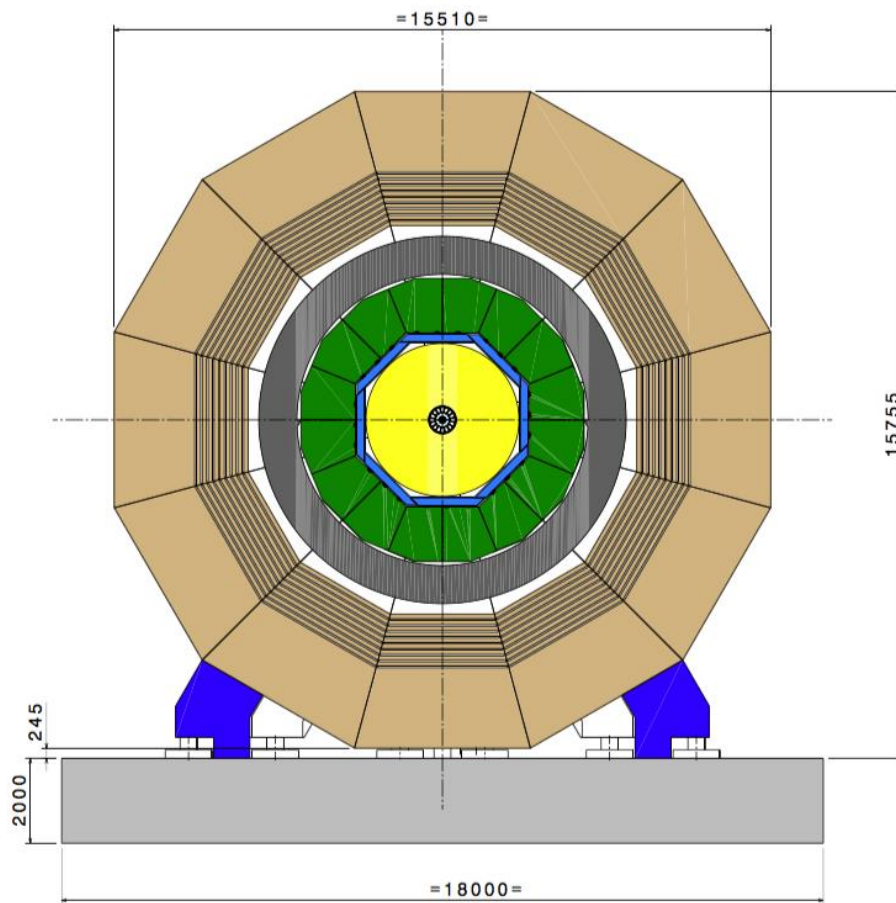
Very High Voltage for the field cage.

Gas for the TPC.

## 4. MECHANICAL INTERFACE

The TPC is fastened to the HCAL structure or to the coil cryostat. Itself supports Inner Silicon Subdetectors and the vertex detector. (Fig. III-5.8 of DBD – Vol.4 of the ILC TDR 2013)

The TPC is supported by 2x3 ribbons...



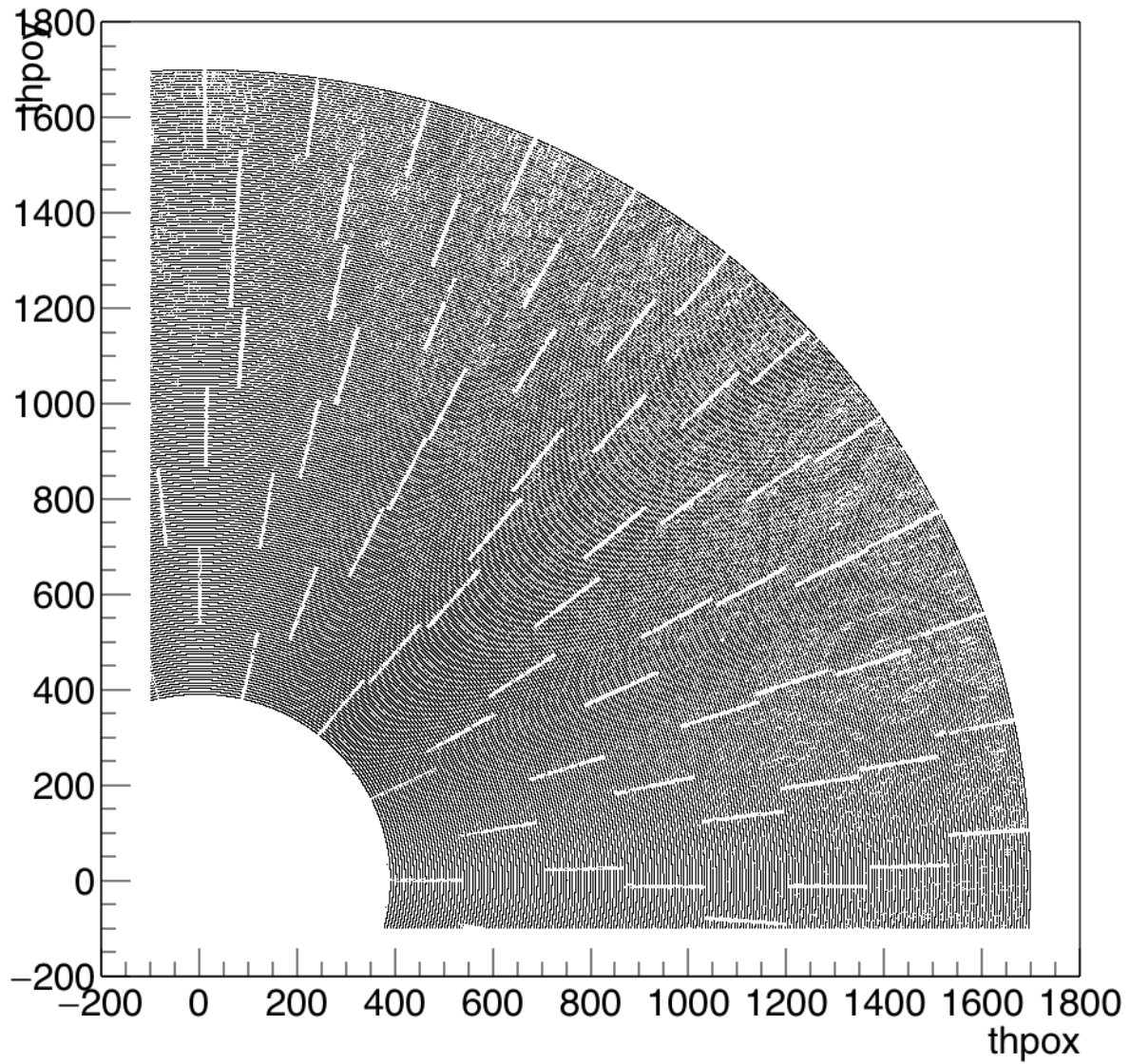
Section A-A

So far there is no official design of the SET. It could be fasten to the TPC or to the ECAL.

## 5. ELECTRICAL INTERFACE

The guiding line for the TPC is to have as few connections to the outside world as possible. There will be one or a few HV and LV cables per module, and optical fibres for the signal and the electronics settings. To ease the separation of the detector from the supplies and concentrators, there will be patch panels on each side (A and B).

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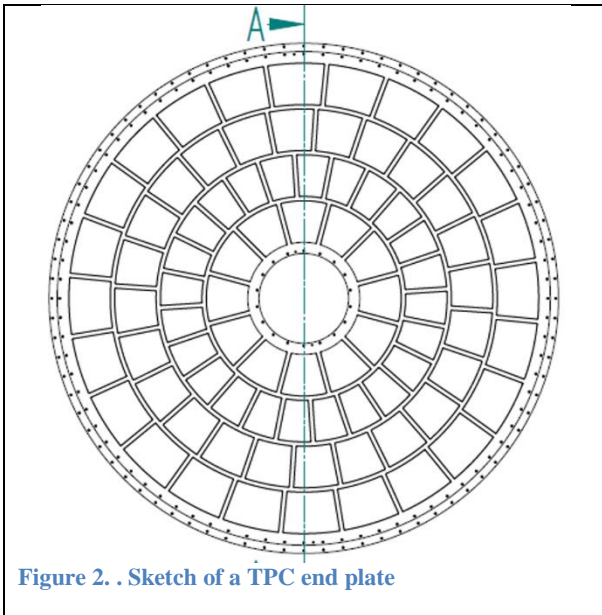


Figure 2. . Sketch of a TPC end plate

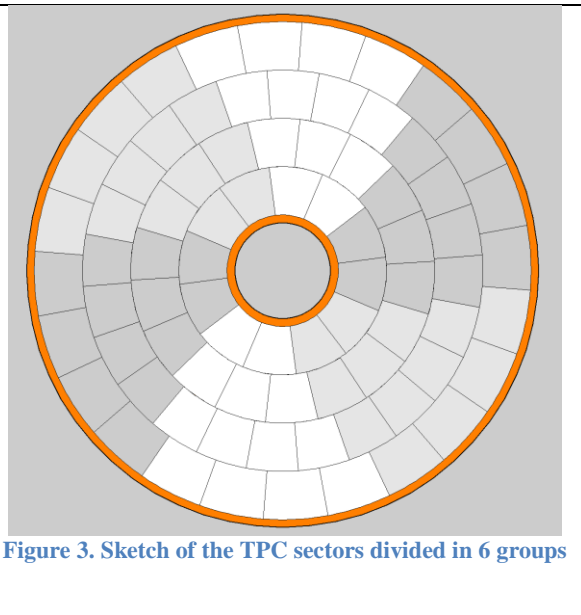


Figure 3. Sketch of the TPC sectors divided in 6 groups

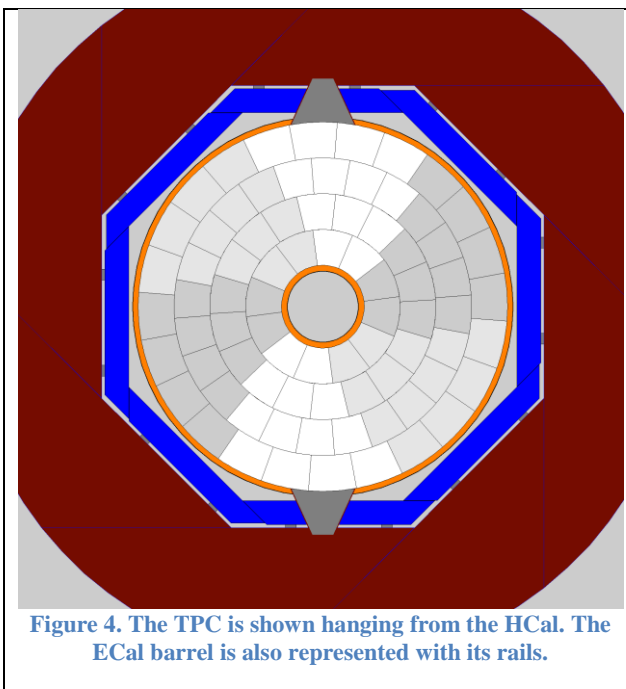


Figure 4. The TPC is shown hanging from the HCal. The ECal barrel is also represented with its rails.

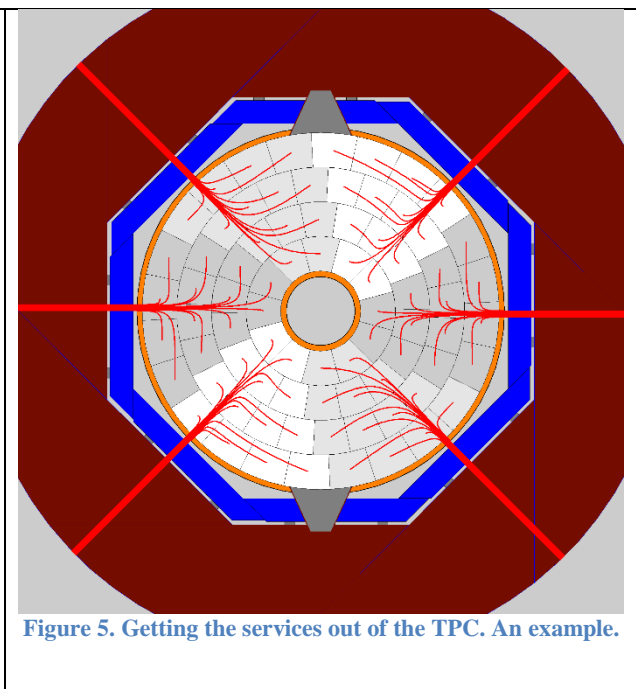


Figure 5. Getting the services out of the TPC. An example.

## 6. FLUID INTERFACE

If the 2PCO2 cooling solution is retained, the cooling fluid will be circulated in 1mm diameter pipes in the modules (or the PCB will be equipped with microchannels), under a pressure of 50 to 100 bars.

- the flow,
- the purity constraints of the fluid.

### 1.14. Gas system Interface

The detector gas mixture will be brought and expelled by 2 cm diameter pipes.

### 1.15. 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 TPC will be cooled by a diphasic CO<sub>2</sub> system. A compressor is located outside *about 30 m off the beam axis of the ILD Detector* and the cooling fluid will be brought to and away from each endplate. From there it is further distributed to the individual modules by manifolds. Possibly several modules (maybe four?) can be served in series.

**Error! Reference source not found.** shows the general concept of the cooling system.

## 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

60 °C.

## 8. INTERFACES FOR DETECTOR TESTING

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 ...



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