TPC costing

Through a fabrication process description and the subsequent Work Breakdown System (WBS)

Nota bene: All what follows is just a sketch which has to be elaborated by knowledgeable people.

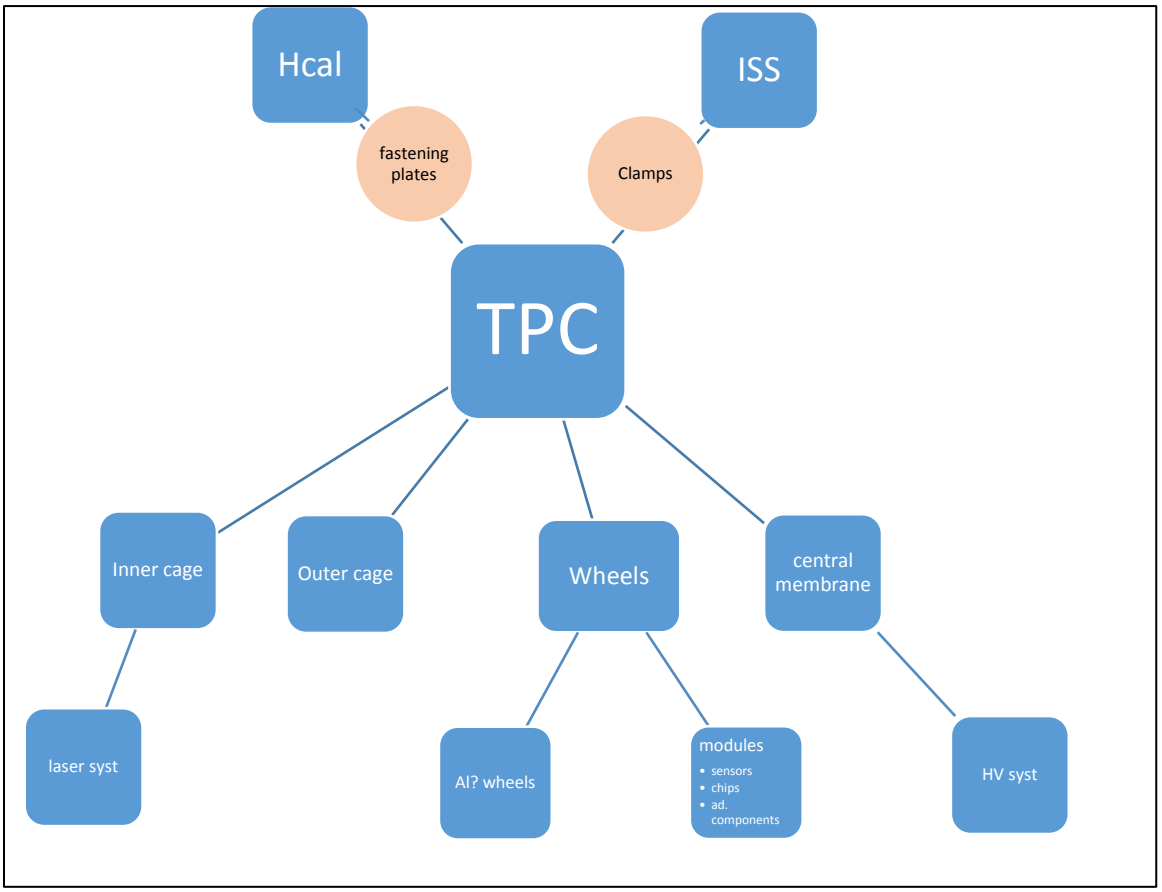
1.2				Time projection Chamber (corrected by R.Settles)	
	1.2.1			Mechanics	
		1.2.1.1		inner fieldcage	
		1.2.1.1		outer fieldcage	
		1.2.1.3		central membrane	
		1.2.1.4		endcap sectors and mechanics	
		1.2.1.5		laser system	
		1.2.1.6		gas & cooling system	
		1.2.1.7		TPC assemble & test	
		1.2.1.8		transport fixtures/shipping	
		1.2.1.9		TPC management	
		1.2.1.10		Prototypes & engineering Models	
	1.2.2			Electronics	
		1.2.2.1		Prototypes & engineering Models	
		1.2.2.2		Frontend electronics	
		1.2.2.3		Data transfer	
		1.2.2.4		Readout board/assembly	
		1.2.2.5		FEE power and power switching	
		1.2.2.6		Mounting, cooling, interlocks	
		1.2.2.7		Slow controls	
		1.2.2.8		Engineering Workstations	
		1.2.2.9		Final debug & test / shipping	
		1.2.2.10		System design Documentation	
		1.2.2.11		TPC FEE Project Management	

Above is shown the WBS developed for the DBD. It contains most if not all the items but in a static way which does not exhibit the way the fabrication is done not giving much clues for estimating the manpower involved even though it may be perfectly correct from the point of view of the cost, not reproduced here. It is valuable to identify what are the procurements, what are the operations to be performed in the fabrication, in the testing and in the assembly phase, what are the tools needed for these operations, what is the manpower and time to perform them.

An important issue is to define properly the names of the different items.

TPC description

A volume of gas[1] limited by an inner cylinder (inner field cage[2]), an outer cylinder (outer field cage) and two end plates (called also “wheels” some places). In the middle of the cylinder stays a membrane under high voltage (~50kV), a specific cable brings the HV. A laser system for calibration is associated to the cages. The end plates are like bicycle wheels where detecting modules are fastened. These modules are …, their number, their differences. The components of a module are the sensors, the FEE made of ASIC’s and additional components. The data acquisition and data concentrators are … The modules are powered, read out and cooled. The following schema shows dependences.



TPC fabrication process.

Some items can be prepared independently before to be assembled. The first levels of assembly are performed on the production centres, then the ensembles are shipped to Kitakami assembly hall where the final TPC assembly is done before insertion in the detector. At each step the adequate tests are performed, in particular reception tests are done after transportation. This scheme is not unique and probably not well established yet. Nevertheless some reasonable assumptions should be made in such a way that a full process can be described in order to be costed.

[1] Inlet and outlet size, pressure control, flux control, temperature control.
[2] What it is made out, its assembly

Independent procurement items:

- Two identical Al (?) wheels received from manufacturer. Reception test: they are surveyed. They have targets to be surveyed after installation.
- The inner and outer field cages. Is the resistor chain provided by the manufacturer? Can they be bought from manufacturer, can we have already a price estimate? Should the prototype be extrapolated? Then how works the extrapolation with diameter, length, thickness? Can we use the prices of other experiments? Or should the fabrication be detailed to estimate the price with procurements and assembly manpower? Is the testing done by the manufacturer? Do we need reception tests?
- The central membrane and its frame. Test?
- The laser system and its optical components. Control and check.

Are these items just put in cases and shipped to Kitakami for further assembly? Cases have to be built. The transportation and the cases have to be costed, as well as reception tests on site.

- The module sensors (how many?). Is there any testing to be done before equipping them?
- The ASIC's. Test and burn-in.
- Additional components

The modules, detectors plus their electronics, are probably assembled on their fabrication site and tested. Equipment to test these modules has to be built then costed. What is the test made of? How long does it take? How many people are needed? Once tested modules are arranged in cases to be shipped, cost of the cases and shipping. They are probably tested again when received in Kitakami before to be inserted in the wheels, second test set-up.

What is the tooling for installing the modules on the wheels? Cost, time of installation, manpower?

- Data acquisition, read-out, concentrators, optical drivers (where?), per module?
- Low voltage equipment, DC-DC convertors?
- Patch panels or hubs?
- Supports for the patch panels

Miscellaneous questions;

Order of assembly in Kitakami:

Are the wheels equipped with modules before to be assembled with the cages?

Are the cages one piece or do we have half-cylinders connected to the central membrane?

If not, how is the central membrane installed?

Is the TPC in when the central yoke ring is lowered in the cavern?

When are the optical components for the laser system installed?

Laser system, installation and propagation of the light from where.

Do we need to have a possibility to enter physically in the TPC already installed?

How and when are the wheels assembled with the cages? What is the needed tooling?

When are the end plates cabled up to the patch panels? After the wheels assemblage or after assembling the complete TPC.

Tooling for the insertion in the calorimeter, surface or cavern?

Testing after assembly, gas system, low and high voltages, acquisition. Without field.

Interfaces:

- Fastening the TPC to the HCal. What are the pieces, the assembling process, the tooling to manipulate the TPC and hold it during the fastening. Damping?
- Fastening the ISS to the TPC, pieces, tooling
- Thermal insulation from ECal and ISS?
- Bringing the HV in
- Bringing the low voltage in. Cooling the cables?
- Bringing the control
- Drawing the data out
- Where to interface it? Patch panels, data concentrators?
- Cooling, bringing in and out CO2 pipes