

TPC Costing

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COSTING

History : 2008, 2012 DBD (based on ALEPH). The DBD costing is just a rescaling of the 2008 number for inflation.

2018-2019 : update for the IDR, coordinated by Henri Videau

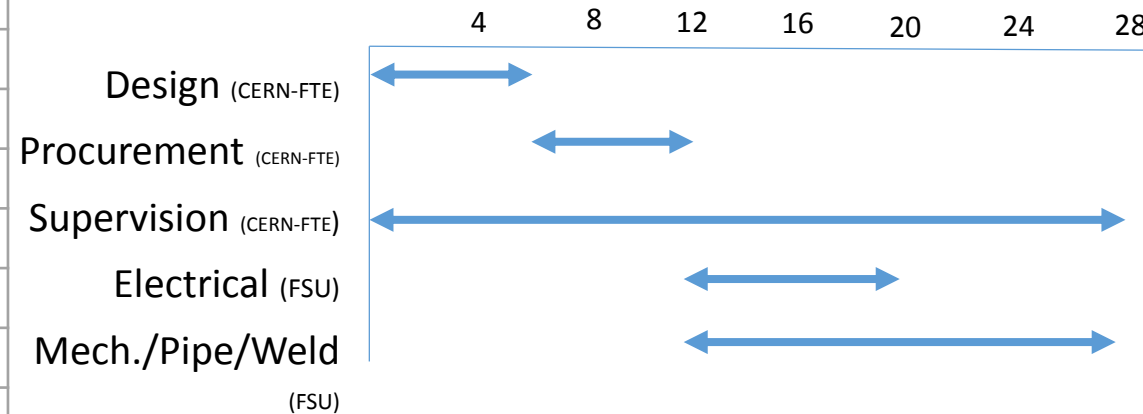
- Clear rules (count home labour, do not include R&D, include transportation, tests, assembly,...)
- New WBS. The WBS must represent in some detail the various steps necessary to build, test and assemble the TPC
- At LCWS19 in Sendai, 2 costings for MM (22 M) and GEM (30M). Separate techno-independent (field cage, cooling, gas...) and techno-dependent parts (modules)
- Currency unit : € (equivalent to ILCU in 2019) (escalation and \$/€ rate compensate)

GENERAL PHILOSOPHY

- Whenever possible, use real numbers from real experiments or prototypes.
- When we do not have updated numbers, take the DBD ones

Hardware cost and technical resources needed: a first order evaluation, including time line

Module	Hardware ¹ (kCHF)	Construction work ² (week)
Control rack	10	8
Mixer	24	3
Distribution	36	4
Pump	36	2
Exhaust	18	1
Analysis	26	2
Purifier	42	4
Software	20	
Tot	212 kCHF	24 weeks (FSU)



¹ assuming price of components used for the construction of the LHC gas systems

² assuming 100% availability of all people involved, team fully competent/trained and assuming CERN standard implementation for the LHC gas systems

Software Controls: PLC, server, software licenses (WinCCOA and Oracle db) – CERN standard implementation.

Gas costs: Ar-CF4-iC4H10 95/3/2%

assuming 310 nl/h fresh gas flow

Gas	Volume [m3]	Cost [ChF] as of 7/2019	Cost/m3 [ChF/m3]	Cost * fraction [ChF/m3 mix]	Consump. Per day [m3]	Reach [days]
Ar 50	127.0	555	4.37	4.15	7.070	18
CF4 45	9.9	1379	139.30	4.18	0.223	44
iC4H10	9.6	686	71.50	1.43	0.149	64

9.76
ChF/m3

7.44
m3/day

72.62
ChF/day

~26 kChF /year

2008 cost

WBS from 2008 clearly needed to be detailed and updated

Colonne1	Colonne2	Colonne3	Colonne4	Colonne5	Detector concept / detector items
WBS Number					ILD
	1.2				Time projection
		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		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		fixtures/shipping
			1.2.1.9		TPC management
			1.2.1.10		engineering Models
		1.2.2			Electronics
			1.2.2.1		engineering Models
			1.2.2.2		Frontend electronics
			1.2.2.3		Data transfer
			1.2.2.4		board/assymbly
			1.2.2.5		switching
			1.2.2.6		interlocks
			1.2.2.7		Slow controls
			1.2.2.8		Workstations
			1.2.2.9		shipping
			1.2.2.10		Documentation
			1.2.2.11		Management

New WBS (1/2)

					2019 cost (Micromegas option)				person.year cost	80 000,00		
Colonne1	Colonne2	Colonne3	Colonne4	Colonne5	Detector concept / detector items	Unit	Unit cost (€)	Quantity	total m&s	Home/Industry	labor (FTE.year)	total labor cost
WBS Number					ILD							
	1.2				Time projection Chamber				16 400 020			4 988 000
		1.2.1			Field cages				1 930 000			0
			1.2.1.1		inner fieldcage		860000	1	300 000			
			1.2.1.2		outer fieldcage		4300000	1	820 000			
			1.2.1.3		central membrane		300000	1	300 000			
			1.2.1.4		hanging and damping				200 000			
			1.2.1.5		HV test bef. Assembly				10 000			
			1.2.1.6		shipping				300 000			
			1.2.2		Endplates			2	540 000			64000
			1.2.2.1		base material (Al)		10000	2	20 000			
			1.2.2.2		machining		40000	2	80 000			
			1.2.2.3		Fixtures		10000	2	20 000			
			1.2.2.4		Module jigs		500	120	60 000			
			1.2.2.5		shipping				300 000			
			1.2.2.6		assembly				60 000		0,8	64000
			1.2.3		Modules (20 spares)			140	2 042 800			520000
			1.2.3.1		back-frames	frame	1000	140	140 000			
			1.2.3.2		PCBs	PCB	2000	140	280 000			
			1.2.3.3		mesh and DLC	detector	4000	140	560 000			
			1.2.3.4		connectors	connector	45	13440	604 800			
			1.2.3.5		storage boxes	box	200	140	28 000			
			1.2.3.6		shipping		70000		70 000			
			1.2.3.7		Mounting and test				360 000		6,5	520000

New WBS (2/2)

	1.2.4		Ancillaries				2 307 680		400000
		1.2.4.1	CO2 compressor	compressor	65000	14	910 000	2	160000
		1.2.4.2	CO2 comp. Shipping	compressor	7000	14	98 000		
		1.2.4.3	Gas mixer				400 000	1,3	104000
		1.2.4.4	Gas analyser				100 000	0,5	40000
		1.2.4.5	laser system				540 000		
		1.2.4.6	HV power supplies	supply	6000	12	72 000	0,3	24000
		1.2.4.7	HV racks	rack	5000	2	10 000	0,5	40000
		1.2.4.8	LV power supplies	8-channel supply	7900	16	126 400	0,3	24000
		1.2.4.8	VHV power supply		50000	1	50 000	0,1	8000
		1.2.4.9	Packing and shipping		80	16	1 280		0
	1.2.5		Cables and pipes				49 540		724000
		1.2.5.1	HV cable (60m) x120	60m HV cable	130	120	15 600	2	160000
		1.2.5.2	LV cable	cable	25	120	3 000	2	160000
		1.2.5.3	fibre optics	fibre	120	120	14 400	2	160000
		1.2.5.4	CO2 hoses	m	70	50	3 500	0,5	40000
		1.2.5.5	steel pipes for CO2	m	17	240	4 080	2	160000
		1.2.5.6	VHV cable 60 kV	cable			800	0,05	4000
		1.2.5.7	steel pipes for gas	m	17	480	8 160	0,5	40000
	1.2.6		Electronics				9 470 000		
		1.2.6.1	Front End cards	card	3000	2880	8 640 000		
		1.2.6.2	Module cards	card	4000	140	560 000		
		1.2.6.3	Backend	backend	5000	14	70 000		
		1.2.6.4	Slow Control				200 000		
	1.2.7		Assembly on site				0		2 160 000,00
		1.2.7.1	Mounting in surface					2	160000
		1.2.7.2	test in surface					8	640000
		1.2.7.3	installation in racks					9	720000
		1.2.7.4	final test					8	640000
	1.2.8		Management				60 000		1 120 000,00
		1.2.8.1	follow-up					14	1120000
		1.2.8.2	documentation				60 000		

- Micromegas module cost based on an estimate for T2K upgrade, multiplied by 2 for better mechanical requirements
- Ancillaries : supplies, pipes and cables taken from market price. Compressors for CO₂ cooling taken from real unit cost of TRACI
- Gas system from a CERN estimate for T2K upgrade.
- Field cage and GEM modules updated by Ties at Sendai (31/10/2019)
- To do : check and update these numbers. (Stripped kapton made by Rui de Oliveira : 80 k€)
- Continuously improve the WBS as the implementation plan gets more precise.