

LDC costing status

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Cost based on

WBS structure

- Level of detail > 1% of total LDC ($\approx 200\text{K€}$)
- M&S, lowest world-market value
- No contingency
- No escalation (2005-2006)

We should have for each subsystems a WBS dictionary including :

- Basic parameters
- Basis of estimate
- Risk analysis
- uncertainties

Then estimation of

- Manpower
- Contingency

M&S

VTX	1 700 000,00 €
TPC	21 661 500,00 €
Supp.tracking	6 900 000,00 €
Ecal	87 035 070,00 €
AnalogHcal	40 849 900,00 €
VFC	4 440 200,00 €
Muon	2 500 000,00 €
Magnet	64 000 000,00 €

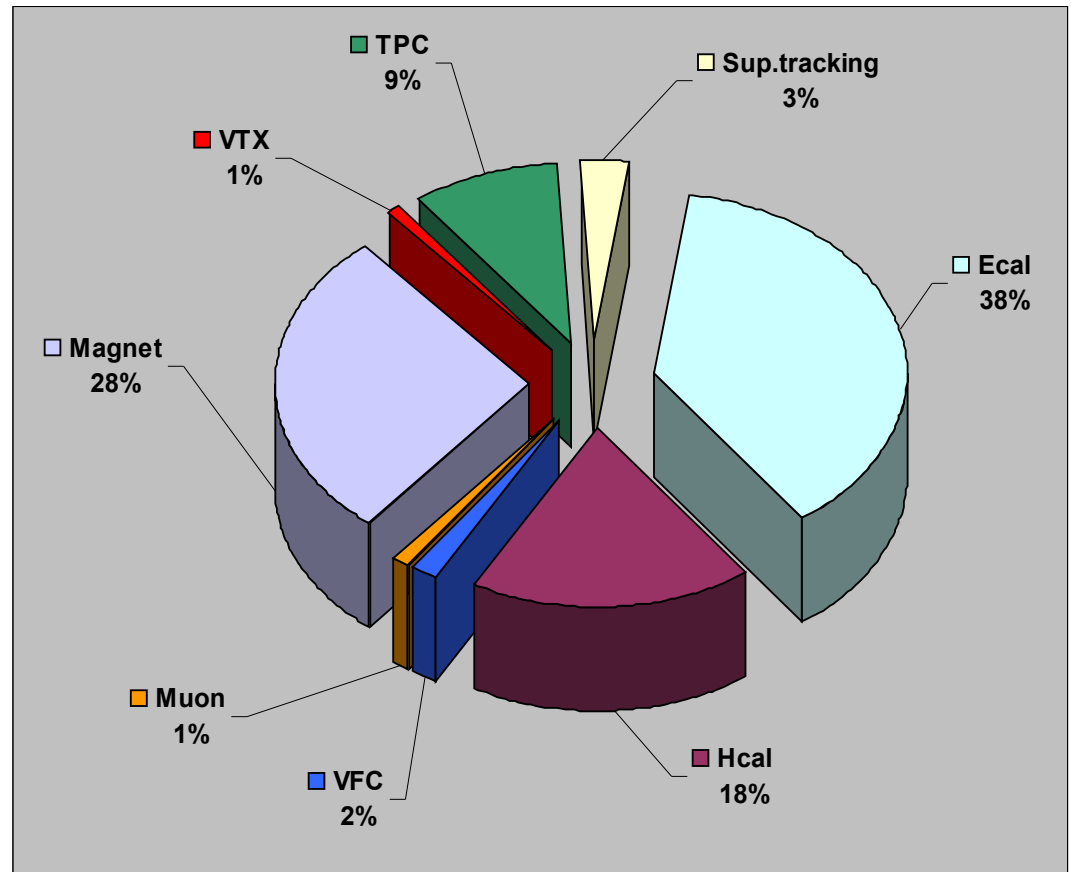
Not included :

Electronics/DAQ

Infrastructure

Integration/installation

Offline computing



Case of Dhcal : ≈ 35 M€ \Rightarrow M&S \searrow 2%

WBS Number	LDC	M&S	subdetector		
1	inner detectors			30 261 500,00 €	11,68%
1.1	Vertex detector		1 700 000,00 €		0,66%
1.2	Time projection Chamber		21 661 500,00 €		8,36%
	1.2.1 Mechanics	9 860 000,00 €			3,81%
	1.2.2 Electronics	11 801 500,00 €			4,56%
1.3	Supplementary tracking		6 900 000,00 €		2,66%
2	Calorimeters			132 325 170,00 €	51,07%
2.1	Electromagnetic		87 035 070,00 €		33,59%
	2.1.1 Barrel & endcaps				
	2.1.1.1 Mechanics	13 445 000,00 €			5,19%
	2.1.1.2 Detectors and sensors	69 320 070,00 €			26,76%
	2.1.1.3 Power supplies	1 770 000,00 €			
	2.1.1 Integration and installation	2 300 000,00 €			
	2.1.3 DAQ	200 000,00 €			
2.2	(analog) Hadron Calorimeter		40 849 900,00 €		15,77%
	2.2.1 Barrel, endcap and rings				
	2.2.1.1 Mechanics	12 950 000,00 €			5,00%
	2.2.1.2 Detectors & sensors	14 746 900,00 €			5,69%
	2.2.1.3 Electronics	6 286 000,00 €			2,43%
	2.2.1.4 HV/LV power supply and				
	2.2.1.5 Calibration systems	4 167 000,00 €			1,61%
	2.2.1.6 Cabling and cooling				
	2.2.1.7 Assembly and installation	2 500 000,00 €			
	2.2.2 DAQ	200 000,00 €			
2.3	Very Forward		4 440 200,00 €		1,71%
3	Muon Detector		2 500 000,00 €	2 500 000,00 €	0,96%
4	Magnet			64 000 000,00 €	24,70%
4.1	Coil		32 800 000,00 €		12,66%
4.2	Yoke and vacuum tank		23 600 000,00 €		9,11%
4.3	ancillaries		7 600 000,00 €		2,93%
5	Electronics/DAQ				
6	Offline computing		30 000 000,00 €		
7	Infrastructure				
8	Integration/installation				

← TPC FE : 6.4 M€

← μstrips : 4M€

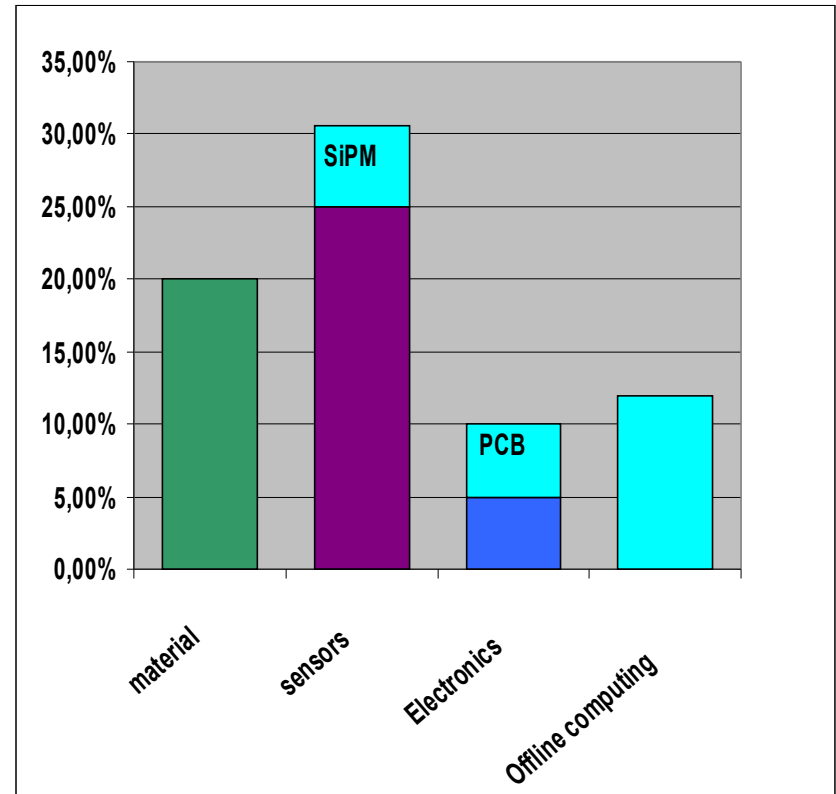
← W: 11.6M€
Si: 53.25 M€

← Steel: 13M€
SiPM: 14.5 M€

← Magnet : 64 M€

← Off.Computing
30 M€

- ❖ Materials : 20% (W, Steel AHcal & magnet)
- ❖ Sensors : 25% (μ strips, Pixels & SiEcal)+5.6% for SiPM.
- ❖ Electronics : 10 %, half of which for PCB boards
- ❖ Offline computing : 12 %



Main costs

A majority of estimates comes from older detectors or from prototypes prices scaled for higher quantities

But for the driver costs : industrial quotations (materials, magnet) or valuations from producers (Si sensors)



- **Raw Material** : 10% for Ecal and Hcal absorbers
 - Tungsten : 100€/kg (from industrial quotations for 40t)
 - Stainless Steel : AHCAL 15€/kg (from ATLAS)
- **Sensors/ detector** : 30%
 - Si supp tracking : Single side 3€/cm²
 - Silicon sensors Ecal : 2,5€/cm²
 - SiPM : 2,5€ (estimation from producer)
- **Magnet** : 25%
 - Based on industrial offers for CMS , scaled to LDC
 - Coil : SS304 12€/kg
 - Yoke: SS 3,6€/kg

Uncertainties (according to Xfel cost uncertainty categories)

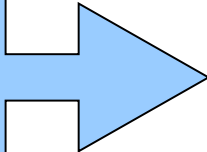
item	description	value	Risk category	lower	upper
TPC	timepix+postproces	6 400 000,00 €	C6 (-10/+50%)	640 000,00 €	3 200 000,00 €
Ecal	Si wafers	52 250 000,00 €	C6 (-10/+50%)	5 225 000,00 €	26 125 000,00 €
	VFE	8 500 000,00 €	C6 (-10/+50%)	850 000,00 €	4 250 000,00 €
	PCB	5 300 000,00 €	C5 (-10/+20%)	530 000,00 €	1 060 000,00 €
Ahcal	SiPM	14 500 000,00 €	C6 (-10/+50%)	1 450 000,00 €	7 250 000,00 €
	PCB	4 354 000,00 €	C5 (-10/+20%)	435 400,00 €	870 800,00 €
offline		30 000 000,00 €	C6 (-10/+50%)	3 000 000,00 €	15 000 000,00 €
Raw material	W	11 600 000,00 €	Market : +/-30%		
	Stainless steel Ahc	12 700 000,00 €	Market : +/-30%		
	Magnet conductor	900 000,00 €	Market : +/-30%		
	Yoke & vacuum tan	23 600 000,00 €	Market : +/-30%		
total for material		48 800 000,00 €		14 640 000,00 €	14 640 000,00 €
other M&S		88 900 000,00 €	C6 (-10/+50%)	8 890 000,00 €	44 450 000,00 €
Total M&S		root mean square sum		18 258 351,46 €	56 394 987,52 €
				7,05%	21,77%
		direct sum		35 660 400,00 €	116 845 800,00 €
				13,77%	45,11%

Unknown in WBS:
 DAQ/infrastructure/integration



- M&S  259 M€
- Transport : ($\approx 5\%$ total amount)  13M€
- Labor(MY) Average cost including overheads (2005) : 77K€

VTX	100
Sup.Tracking	200
TPC	100
Ecal	300
Hcal	300
Magnet	200
Muons	100

 1300MY= 100M€
Uncertainty 20%?

$\Sigma = 372 \text{ M€}$

Conclusion (1)

- 1st number



372M€ +/- 20%
contingency

But

- ✓ Few details on some inner detectors
- ✓ informations still missing on
 - DAQ
 - Infrastructure
 - Integration (mainly manpower)
 - Logistic
 - MDI
- ✓ R&D needed to refine the costing

CMS :
360M€ (2006)
Ecal : 82 M€

Conclusion (2) : next steps

- ❖ Complete missing items
- ❖ Take into account for each subdetectors the different technological versions.
Especially on driver costs :
 - Ecal : Maps...
 - Hcal : RPC & micromegas...
- ❖ Estimate their possible impact on the scaling of magnet.