



ILD Cost estimate

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LDC First estimate done for LCWS06 march 2006,



Finalized end 2006/2007



Rescaled to ILD nov2008

➤ LDC-V5 :

- R tracker= 1.6 m,
- Hcal 40 layers,
- Yoke : Rout = 6m; Zout= 6.3m



➤ ILD :

- R tracker= 1.808 m,
- Hcal 48 layers,
- Yoke : Rout = 7.755m; Zout= 6.62m



Will have to be updated for DBD (2012)

GDE recommendations for ILC Cost estimate (ILCWBS(Note1))

- Based on WBS structure
- No tax included
- No escalation
- No contingency (risk assessed separately)
- M&S, lowest world-market value
- Manpower : External labor included in value
- Internal labor estimated in person hours (ManYear)

Currency exchange : 1M€ = 1.2M\$ =1.4 Oku¥

WBS structure



- Level of detail > 1% of total LDC (≈200K€)
- M&S, lowest world-market value

Colonne 1	Colonne 2	Colonne 3	Colonne 4	Colonne 5	Detector concept / detector items	Unit	Unit cost (\$)	Quantity	associated unit labor	labor cost	%of total
WBS Number					LDC						
1					inner detectors						
	1.1				Vertex detector						0,66
	1.2				Time projection Chamber						8,36
		1.2.1			Mechanics						
		1.2.2			Electronics						
	1.3				Supplementary tracking SIT/FTD/ETD						0,00
2					Calorimeters						
	2.1				Electromagnetic Calorimeter						33,59
		2.1.1			Barrel & endcaps						
			2.1.1.1		Mechanics						
			2.1.1.1.1		W (modules & slabs)	t	100 €/kg	116			4,48
			2.1.1.1.2		Carbone foil (modules & slabs)	m ²		97	8500		0,32
			2.1.1.1.3		Curing moulds (alveolar structure)						0,17
			2.1.1.1.4		Fixing system						
			2.1.1.1.5		Assembling and tests						0,14
			2.1.1.1.6		Logistics & transport						
			2.1.1.1.7		cooling ?						
			2.1.1.2		Detectors and sensors						
			2.1.1.2.1		Silicon wafers	m ²	2,5 €/cm ²	2130			20,55
			2.1.1.2.2		Testing						0,07
					Electronics :						
			2.1.1.2.3		* VFE : 0,1 €/ch, 85Mch	channel	0,1	85			3,28
			2.1.1.2.4		* FE : FPGA 20 to 40€ 8400 pieces	per PCB	33	11900			0,15
			2.1.1.2.5		* FE boards 8400 in 4 parts			11900			2,05
			2.1.1.2.6		* FE boards cabling and integration						0,00
			2.1.1.2.7		* Test bench						0,19
			2.1.1.2.8		Curing moulds						0,10
			2.1.1.2.9		Other materials (shielding, cooling)						
			2.1.1.2.10		Integration and tests						0,27
			2.1.1.2.11		Transport						0,09
			2.1.1.2.12		Calibration?						
			2.1.1.3		Power supplies						
			2.1.1.4		Integration and installation						
		2.1.2			DAQ						
	2.2			(analog)	Hadron Calorimeter						15,77
	2.3				Very Forward Calorimeters						1,71
3					Muon Detector						0,96
4					Magnet						24,70
	4.1				Coil						12,66
	4.2				Yoke and vacuum tank						9,11
	4.3				ancillaries						
5					Electronics/DAQ						
6					Offline computing						11,58
7					Infrastructure						
8					Integration/installation						

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%

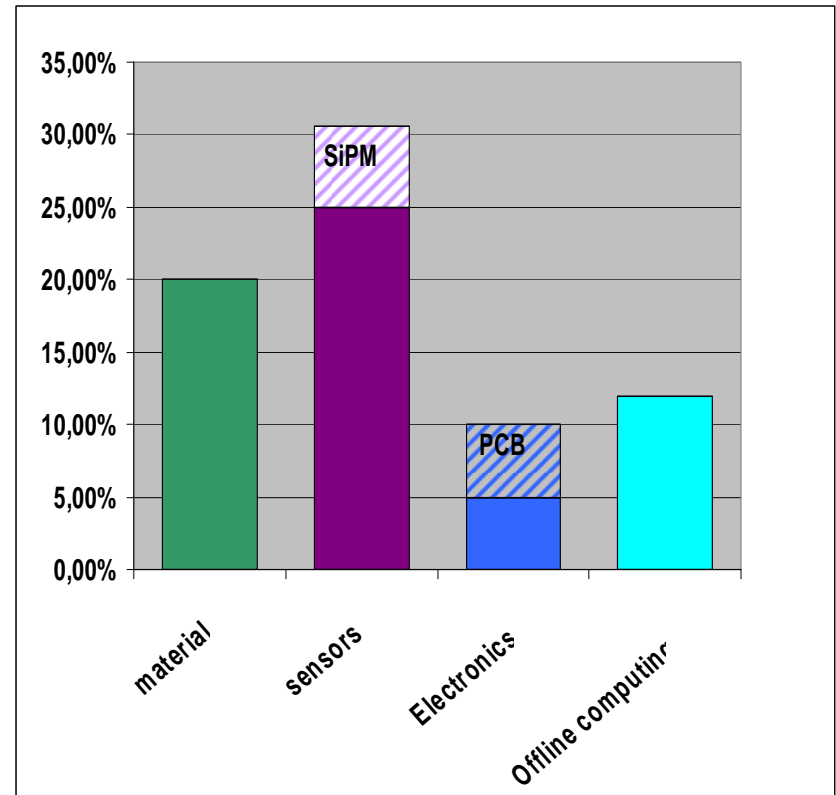
- Based on industrial offers for CMS , scaled to LDC
- Coil : SS304 12€/kg
Yoke: SS 3,6€/kg

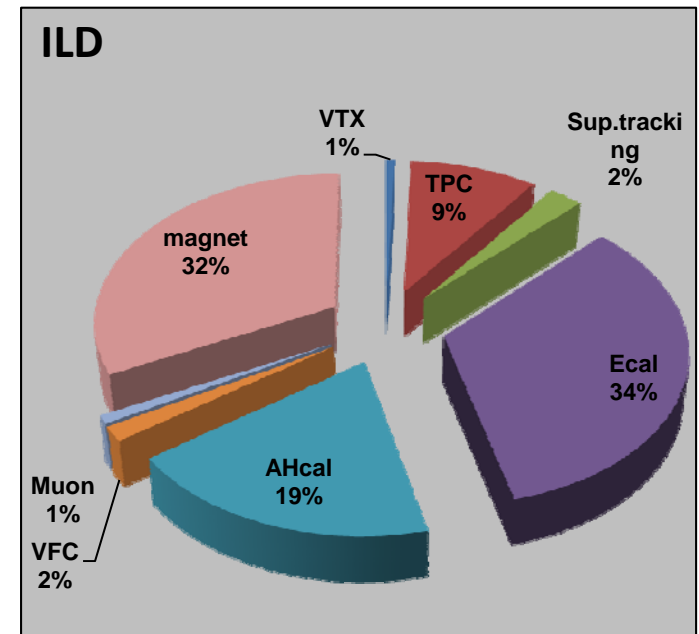
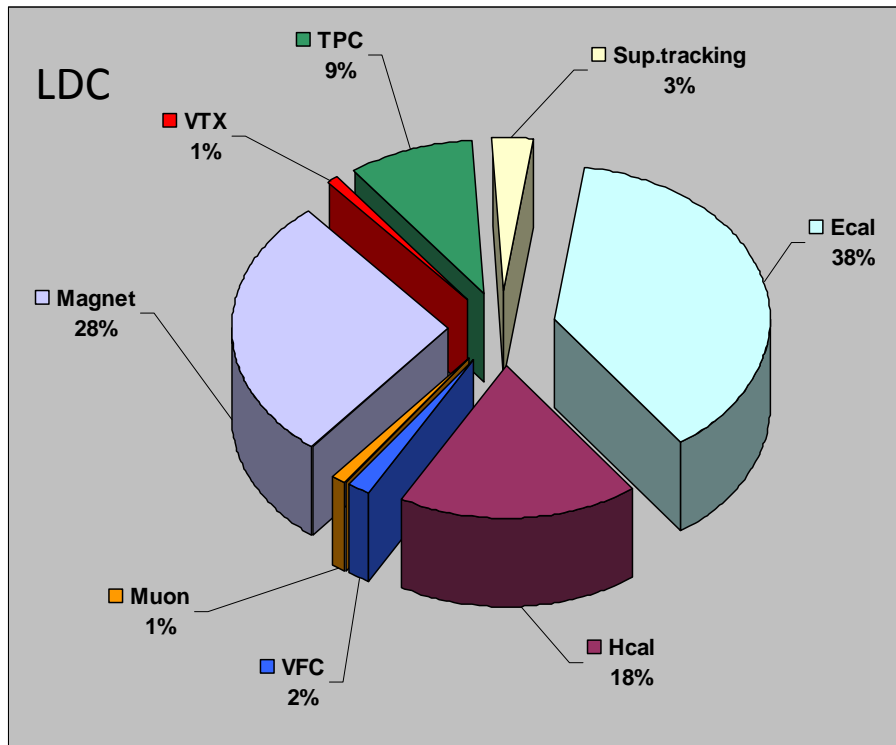
❖ Materials : 20% (W, Steel
AHcal & magnet)

❖ Sensors : 25% (μ strips,
Pixels & SiEcal)+5.6% for
SiPM.

❖ Electronics : 10 %, half of
which for PCB boards

❖ Offline computing : 12 %





Not included in graph

Off computing	≈ 10 %
transport	≈ 5%
Labor	1300 ManYear

Also missing : « Assembly on site » including, platforms, tooling, alignment, pillar, & most of the MDI components...etc....

Labor(MY)

On the basis of XFEL average salary for 2005 at DESY, including overheads to cover basic central services & administration 1 MY= 77k€.

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

1300MY= 100M€

XFEL: Standard cost uncertainty categories

Category	definition	lower/upper range
C1	good experience and present price for this component/sub-system are available, no cost scaling for large quantities has been applied	-10% / +10%
C2	experience and present price for similar components/sub-systems are available, no or only minor scaling to large quantities has been applied	-20% / +20%
C3	present price is available, significant (>25%) cost scaling to large quantities has been applied	-10% / +20%
C4	present price is available, price from industrial study is used which results in significant (>25%) cost reduction for production of large quantities	-10% / +20%
C5	present price not available, price from industrial study is used	-10% / +20%
C6	required technology pushes state-of-the art, significant R&D still required	-10% / +50%
P1	personnel requirements well known due to present experience or with similar systems in previous large scale projects	-10% / +10%
P2	personnel requirements less certain or relatively large fraction of R&D included in this WP	-20% / +20%

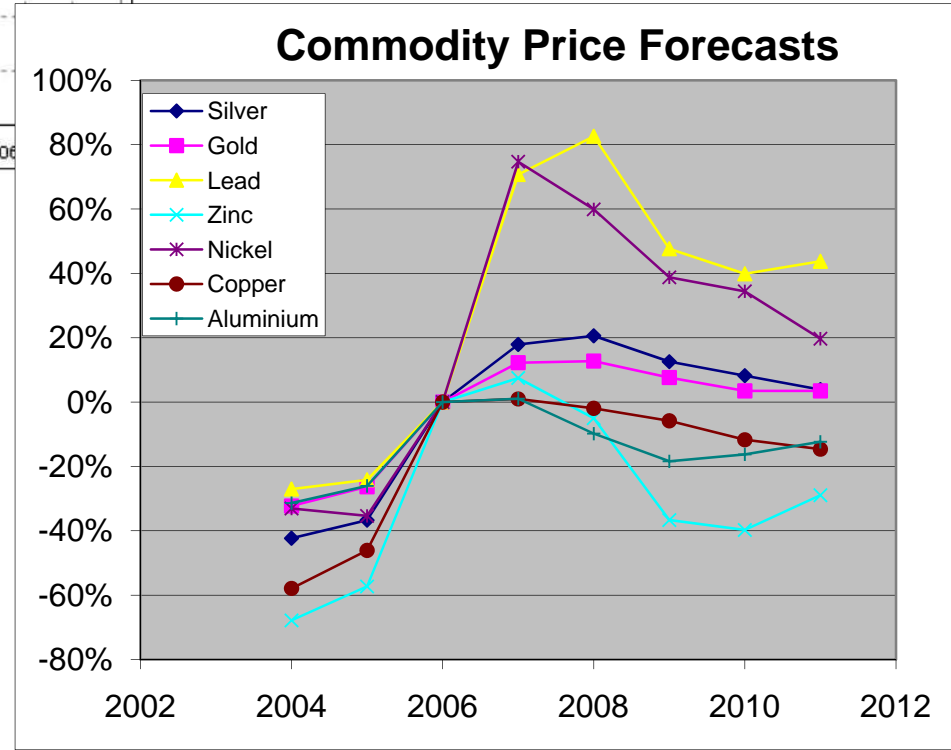
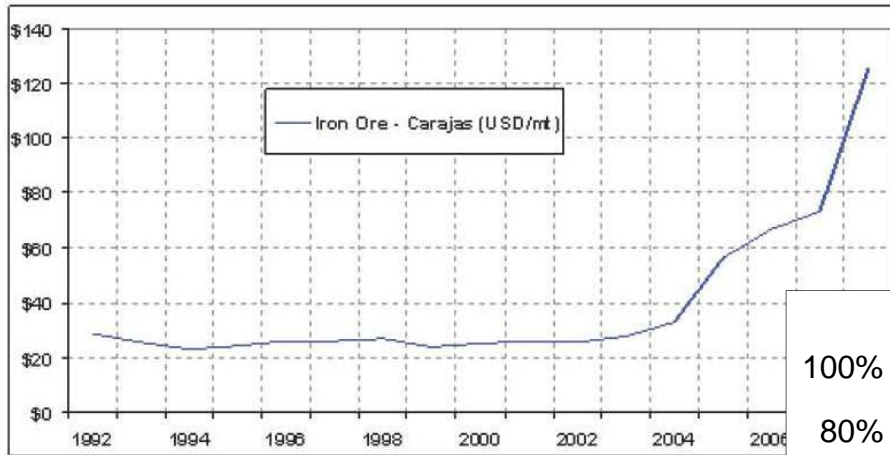
rules providing ranges according to the level of technological understanding

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%

Evolution of the price for the iron ore.

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008 (E)
Iron Ore Price (USD/mt)	25,01	26,06	25,45	27,7	32,76	56,18	66,85	73,2	125,17



LDC :

(not ILD)

M&S : 259 M€

Transport : 13M€

Labor(MY) : 100M€

372M€ -/+ 20% contingency

But :

*Prices are those of 2005-2006. Inflation of 3%/year 2006→2014 means 26% more

Is it still the right inflation rate

- Currency exchange , uncertainty ?

Currency exchange 2006 : 1M€ = 1.2M\$ = 1.4 Oku¥

Currency exchange 2010 : 1M€ = 1.34M\$ = 1.25Oku¥

- Evaluation of the materials cost not easy to anticipate in the 10 coming next years
- Missing items
- Uncertainty analysis should have been based on “multi-estimate” and analytical analysis of the probability distribution.

