Costing and optimisation

the impact of times

the time as a leitmotiv

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Again !

same subject, same guy !

Note to the reader : the font used for these slides is « Deja vu » (« already seen » in french)

In the ancient times there was a costing group

The revenant

Any global costing activity ceased after DBD.
3 years ago
there is no more a costing group
but some clear consciousness of cost survives
and costing may (should) ressuscitate one day.

Recalling first the way costing went

The method, borrowed from ILC accelerator (following itself ITER)
is probably as (in)valid as it was
but I do not see a better one.

It consists in breaking the flow of fabrication into well identified items
where the procurements can be defined and costed
and the work handled by ILD groups estimated in manpower, duration, tooling.
The description of this is called a Work Breakdown System.

Remember that our costing is not complete, some parts of the detector processing have not been taken into account for the BDB, as written in the DBD
some have been updated.

At some point everything should be revisited (when ?)
We have to go back to the tedious WBS elaboration in a precise way as we do currently for the assembly constraints.

But, this when some of the « optimised » parameters will be known !

But the real material prices will be known only at the time of buying

by the way, may be we should invest NOW in tungsten ?

and we ignore our ressources for construction.

We just judge on what we think is defendable in front of the funding agencies, probably about the LHC experiments prices (true ones, not TDR's ones)

Start of the Ecal WBS

	Steps/Needs	Quantitie	Unit	Tools	Place	Unit cost/time	Cost in k€	M.Y
2.	**Electromagnetic calorimeter**						**155662,67**	**115,8**
2.1	**Barrel**	**1**					**106283,14**	**77,1**
2.1.1	**Module structure construction**	**40**					**12853,54**	**51,1**
2.1.1.1	**Material procurements and operations**						**11813,04**	**5**
	Tungsten plates (thickness tolerance +- 40 µm) Thickness : 1.05 – 2.1 – 4.2 mm	87	ton		Industry Several	120	10440	
	Dimensional inspection of W plates	24000	plates	3D measurement	HOME/Industry			5 ?
	Carbon fibres prepreg 1K for H structure	6000	m²		Industry	0,09	540	
	Carbon fibres prepreg 3K for alveolar	13000	m²		Industry	0,05	650	
	Thin carbon plate (2mm) with 12K fibres	40	plates		Industry	1	40	
	Thick carbon plate (15mm) with 12K fibres	40	plates		Industry	2	80	
	Rails fabrication (male + female parts)	80	rails		Industry	0,5	40	
	Metal inserts	960	inserts		Industry	0,024	23,04	
2.1.1.2	**Monolayer alveolar structure**	**600**					**600**	**15**
	Tools procurements						**330**	**0**
	Hextool moulds	6	moulds		Industry	50	300	
	Steel ground cores	18	cores		Industry	1	18	
	Storage boxes	40	boxes	Specific boxes	Industry	0,300	12	
	Operations						**270**	**15**
	Dimensional inspections (cores & moulds)	all		3D measurement	Industry			
	Wrapping operations	600	wrapping	Clean room	Industry	2 days		12
	Curing process	600	cures	autoclave	Industry	0,4	240	
	Cutting process (15 trapezoidal shape)	600	layers	Diamond machining	Industry	0,05	30	
	Transport & storage	40	boxes		Industry			
	Quality inspection of cores & moulds for re	all		3D measurement	HOME/Industry			
	Production follow-up							3
2.1.1.3	**Module alveolar structure**	**40**					***100,5***	**20,1**
	Tools procurement						**100,5**	**0**
	Assembling mould	2	moulds		Industry	30	60	
	Aluminium cores	150	cores		Industry	0,2	30	
	module handling tool	1	tool		HOME		1	
	Transport & storage boxes	40	boxes	transport boxes	Industry	0,1	4	
	Lift table (2T)	1	lift		Industry	5,50	5,5	
	Operations						***0***	***20,1***
	Dimensional inspections (cores & moulds)	all		3D measurement	Home			0,1

Cost in the DBD

Chapter		LoI	DBD MILCU	Means
Magnet Yoke		58,61	94,95	94,95
Muon system		7,2	6,68	6,68
Magnet coil		40,79	25,45	25,45
Magnet ancillaries		9,43	10,36	10,36
Hcal				48,21
	AHCal	41,39	51,26	
	sDhcal		45,16	
Ecal				116,705
	SiW-Ecal	95,97	159,53	
	Sci-Ecal		73,88	
Si tracking				
	inner		2,3	2,3
	outer		20,92	20,92
Vertex		2,49		3,38
	CMOS		3,2	
	FPCCD		4,01	
	DEPFET		2,93	
TPC		29,39	35,82	35,82
Forward calorimeters		4,54	5,7	5,7
Beam tube		1,37	0,51	0,51
Integration		1,46	1,54	1,54
Global DAQ		1,03	1,11	1,11
Transport		11,14	11,95	11,95

FIGURE 1.3-12. Summary table.

$\Rightarrow$ 150

The cost drivers are the magnet (coil+yoke) and the calorimeters.

For the coil it is a matter of size and field or globally stored energy,
for the yoke the size matters
and the thickness driven by the stray field and the returned flux

The parameters ILD can play on by itself are size and nominal field

For calorimeters (except for new features) the main cost drivers are
the size which plays with a square, and the layer numbers

secondary factors are the pixel sizes (electronics).

We can wonder if a factor 2 reduction in cost can still be called optimisation

The intrication of costing and optimisation

The cost is a major driver for optimisation,

But it is difficult to cost precisely not knowing where you will end up !

This is very true if technological changes are considered

Remark 1 : We are completely driven by technology, ex high granularity, SiPM .

Remark 2 : If we have enough time in front of us we should prefer
to bet on technology evolution, not on end-of-the-road means.
We should also discuss safety in that context

On the contrary
it may not be true when the point is to modify some dimensions
which do not induce fabrication process changes
or if the impact of these changes is marginal compared
to the cost impact of the dimensionnal changes.

Some impressive values for cost and the associated question of ILD realisability
have been the driving force for an « optimisation » of the detector,
what a nice and pudic word !

The impact of time on cost

alles fließt

Few remarks nevertheless

How does the cost evolve with passing years ?
- may lower with technological evolution, with optimisation
- may jump up or down for material prices
- happy that inflation died away
- what about your actual salaries after 20 years of work on LC?

The ignorance of the time left does not help optimising
the optimisation process
are 10 years a realistic assessment ?

The ongoing sub-detector R&D may enable a better understanding of cost today
Caveat : in some places the R&D is going at a rather slow pace
on some subjects it is not moving at all.

But the fact that some LHC experiments develop upgrades that may serve as prototypes for ILD may provide some new insight into the real cost and on the ratio of TDR cost over real one.
will they have any time for optimising ?

CMS HGCAL is currently quoted at 54 MchF
a bit more than half in the silicon (price quoted by the vendor)
for the rest a lot of interference with our estimate.

Optimising

Exploring what have been the approaches for optimisation

Little hardware R&D optimisation has been, to my knowledge,
reported as such to ILD. This should be discussed here
and not only in the R&D collaborations.

Hardware optimisation has to freeze out at some point, the start
soft optimisation may be pursued till the end of the experiment,
but is often the trigger for hard optimisation !!! Phases ?

Many different optimisation studies through simulation have been done
see Jenny's talk

As said many times, we use simulation and reconstruction
- the simulation has to be faithful at the right level, this is going on
- the reconstruction should not hide the hardware performances
  - under its own features or misperformances

Optimisation as finalisation or tuning

Clearly the development of different technological solutions
and the choice of the final ones is a big chunk of optimisation
but first of development

and has been up to now postponed (for quite good reasons)

But when do we switch from development to optimisation ?

Most of the work, if I am right, has played with
a certain number of parametres
varied in certain domains
and some of their correlations considered.
what I would easily call finalisation.

Do these studies cover properly the fields ?
examples of criteria : jet resolution, lepton identification in jets,
photon resolution, reconstruction, tau reconstruction, hadron PID ..
Have all the good criteria been used to test each of the parameters
like cell sizes, number of layers, dimensions ?

Optimisation as a compromise

Can we find a compromise between performances
and safety or cost, what we look for,
without compromising them too much ?

Optimisation and the time scale

We did not converge very fast
on possible new models to be explored thoroughly.

aren't we then, sometimes, going in circles ?
I have seen studies done when results exist since years
but done in a better integrated way.

at what speed are we really progressing ?

Do we have the time and the will, and the guts,
to open new directions looking for a farther optimum ?

On the other side
are there some parameters which can be rather readily defined to
help reduce the dimensionality of optimisation?

Should we play safe and stay with what is well in hands ?
probaly at some point but when should we take that point of view?

Can we be educated by the LHC examples ?

It would deserve a good study

and I would just ask few questions :

do you consider than one of the two big experiments dominates
by its detector performances and then its physics results ?
is there a « then » ?
Does really any specific design influence the physics results ?
Does the crystal calorimeter do better on Higgs into gammas ?
What is really the impact of the toroids ?
Is it obvious that all the best B physics is done by LHCB ?

On the other side they have been inspired by our work for their upgrades
Is'nt any idea developped for their purpose we could pursue ?

We have been wandering with ILD optimisation and time

Should the measurement of time enter in the calorimeter landscape ?
It is already quite present in the TPC but to compensate the loss
of a spatial dimension.

Already, I believe, all the chips we use embed a TDC,
the AHCAL wanted to see the time dependence for the neutrons
the SiW ECAL does not use its TDC but it is present.

CMS hopes to reduce the pile up by measuring the time of the showers.

Can we dream of doing something interesting ?
probably requiring unusual electronics capabilities.

Do we have time ? do we have manpower ?

Do we have time for time ?

The first point would be to inquire about the capabilities

From what I learned from educated and knowledgeable people
from a purely electronic point of view tens of ps are at hand
dream of 10ps or 3mm !

But does your sensor have the capability, signal large enough,
reduced jitter ?
Except for very astute devices, that probably means also a small size,
say a transverse size matched to the time, then to the longitudinal size

matched does not mean equal ?

Going 5d but up to what point do we need energy ?

For me, who knows essentially Arbor* for a reconstruction tool,
having the time to drive the pattern instead of the distance
to the interaction point is a must and I would expect impressive
results. But do we have the time ?

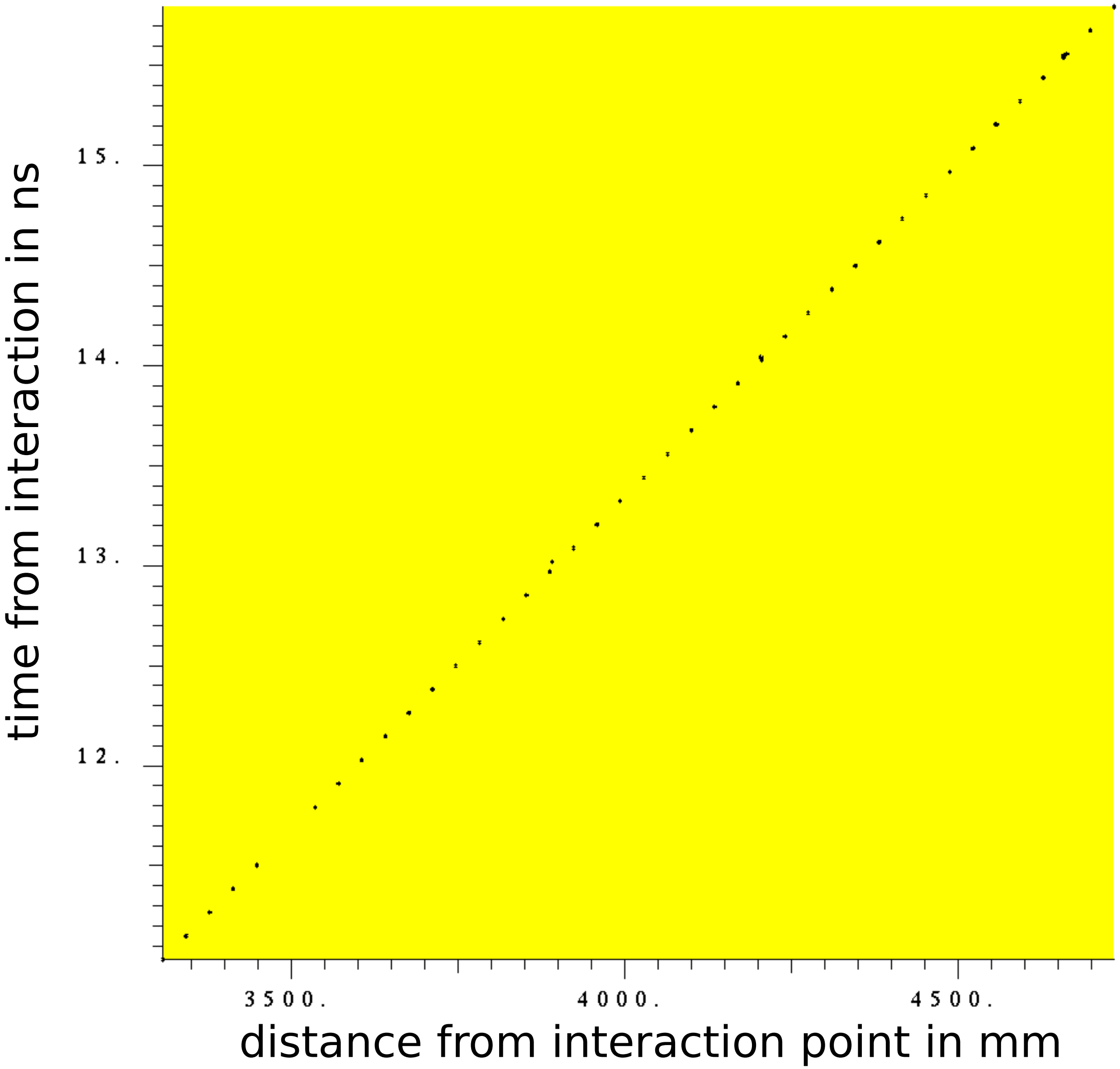
* To know more about it, look at presentations by M. Ruan on Arbor, see Bo Li's talk

To illustrate, here is a time versus distance plot for a high energy muon

Something rather trivial !

Irony,

We can even measure
the speed of muons in iron !



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