



Cracow
2013

ILD meeting at Cracow

Introduction and Charge

Ties Behnke, DESY
for the ILD JSB

ILD@Krakow

Many thanks to Leszek and his team for offering to host the ILD meeting!

Krakow is an important member of ILD and of the FCAL R&D collaboration since many years.

- ILD restructuring
- ILD optimization for the next steps

ILD @ Kracow

Today:

General introduction, critical review of the ILD design

Summary of the worldwide ILC situation

End of afternoon: summary of R&D status

Tomorrow:

Day is dedicated to optimization of ILD:

- Look at all aspects:
 - Physics
 - Subdetectors and layout
 - Overall integration and MDI

Last Day:

- Lessons learned
- Development of future plans
- Confrontation with reality: what can we actually do

ILD: where are we?



2013: delivery of the ILD DBD as part of the ILC TDR

- Fairly sophisticated system design, no complete engineering design
- First “complete” estimate of the cost

2013: site decision in Japan, but no overall decision yet on the project

2013: positive statements around the world supporting an ILC in Japan,

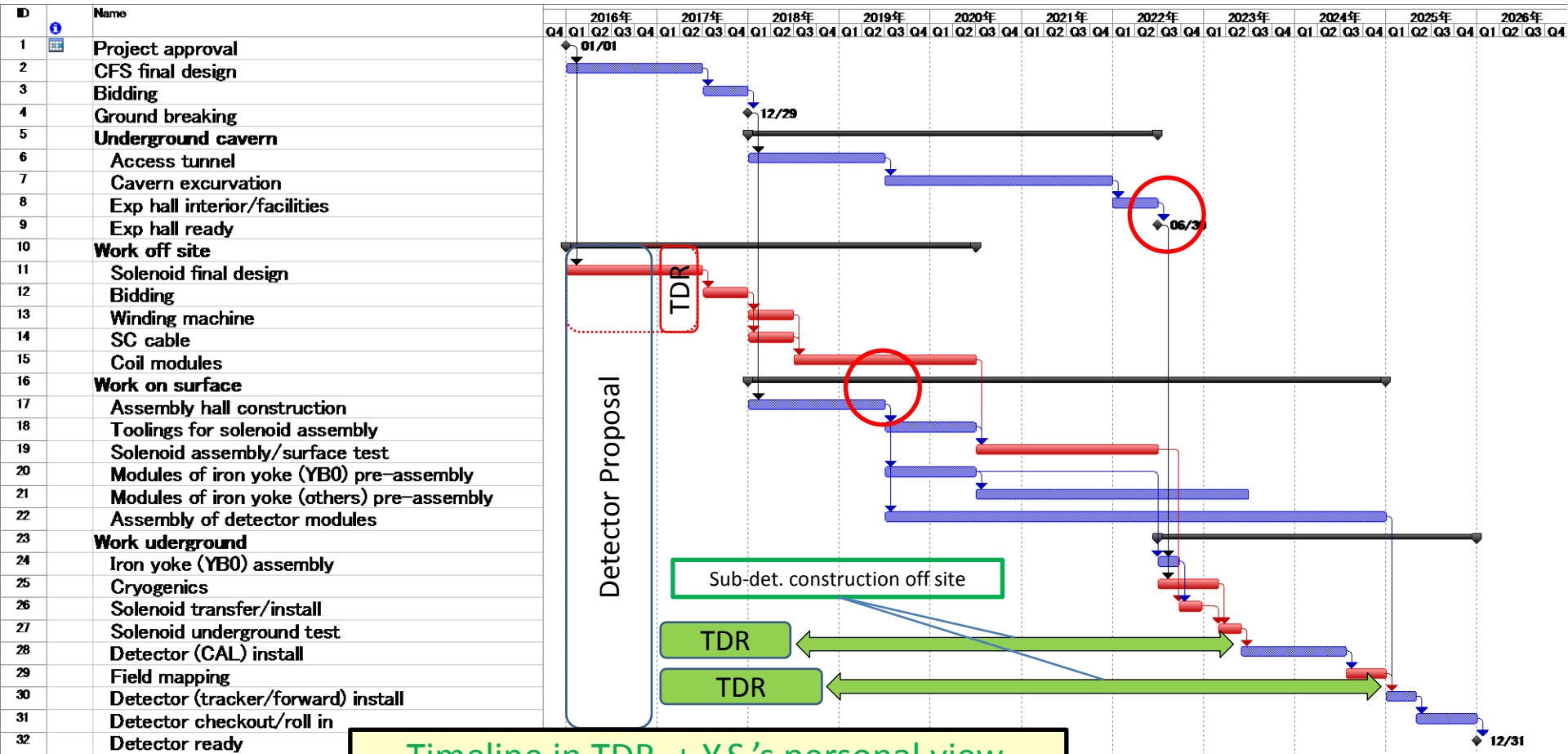
- European strategy process
- Snowmass process in the US

We are in a transition period between pre-project (concept) phase and project (collaboration) phase

For the near future R&D will remain our main goal, but we need to prepare to shift gears rapidly once the project is approved.

A possible scenario

- We cannot predict the project approval date, but we should draw a clear timeline after the project approval



Timeline in TDR + Y.S.'s personal view, from ECFA meeting 2013

Window of Opportunity

Situation in Japan: see talk by Satoru/ Hitoshi later today.

Window of opportunity NOW

We might have some limited time to

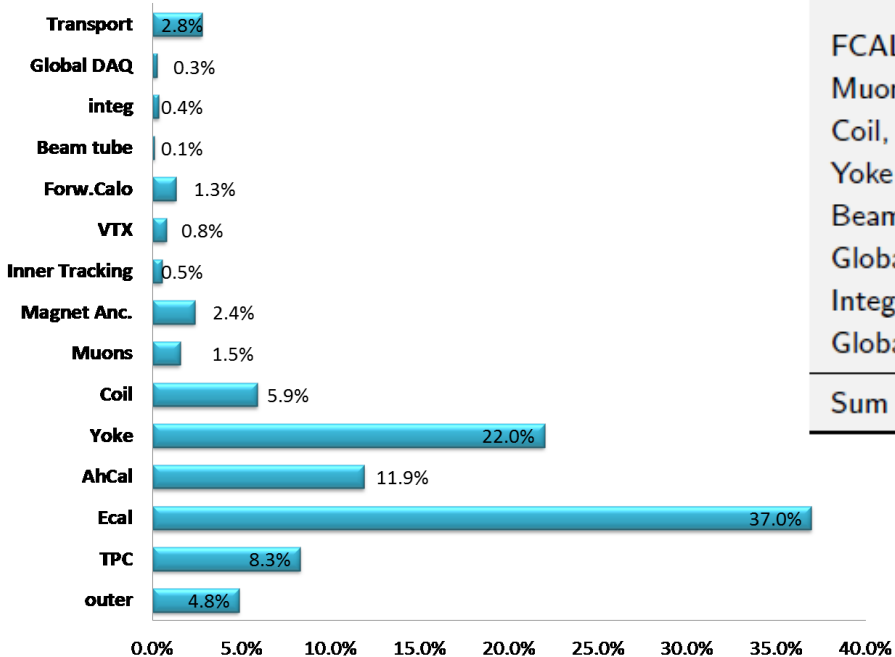
- Look carefully into our fundamental design choices
- Take costs more fully into account than we have done so far
- Question Choices and prejudices
- Do fundamental studies on – in particular – the impact on physics

Once ILC is a real project we might not have this chance again!

Lets use it wisely!

ILD Costs

Costing exercise as part of DBD
Needs significant more work
and checking, but main
messages are clear.



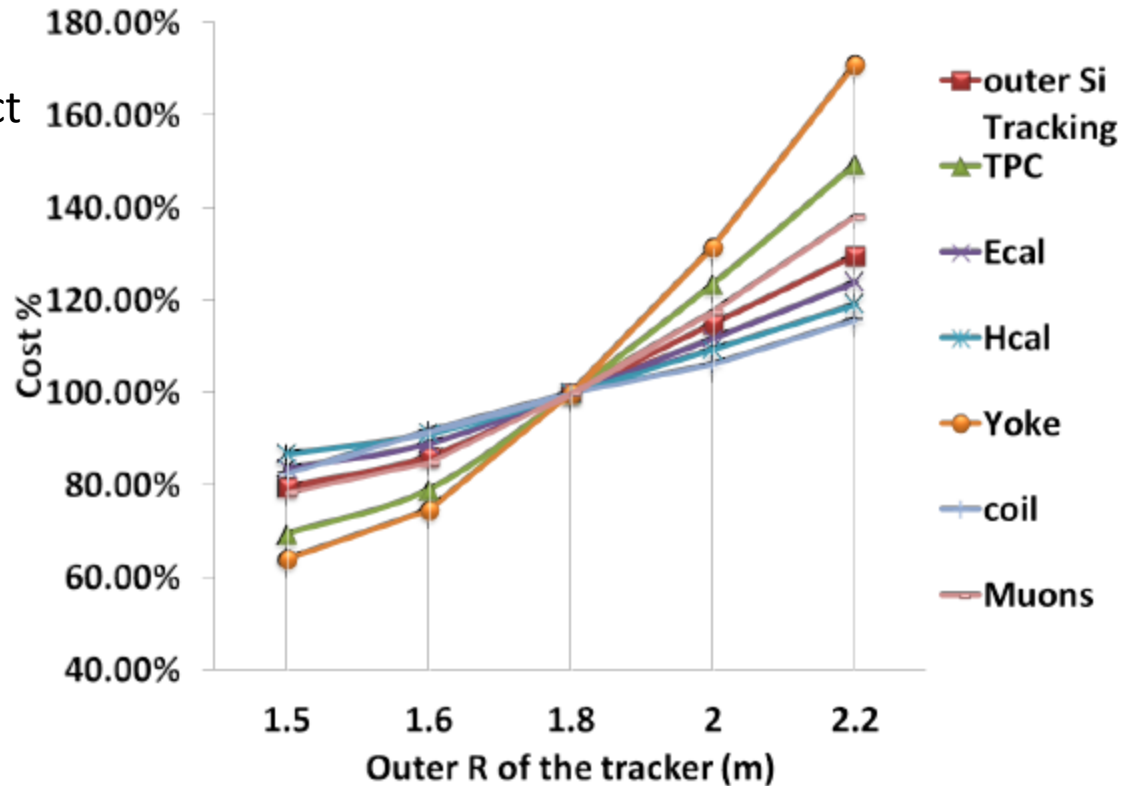
System	Option	Cost [MILCU]	Mean Cost [MILCU]
Vertex			3.4
Silicon tracking	inner	2.3	2.3
Silicon tracking	outer	21.0	21.0
TPC		35.9	35.9
ECAL			116.9
	SiECAL	157.7	
	ScECAL	74.0	
HCAL			44.9
	AHCAL	44.9	
	SDHCAL	44.8	
FCAL		8.1	8.1
Muon		6.5	6.5
Coil, incl anciliaries		38.0	38.0
Yoke		95.0	95.0
Beamtube		0.5	0.5
Global DAQ		1.1	1.1
Integration		1.5	1.5
Global Transportation		12.0	12.0
Sum ILD			391.8

Huge effort by LLR group
for the DBD

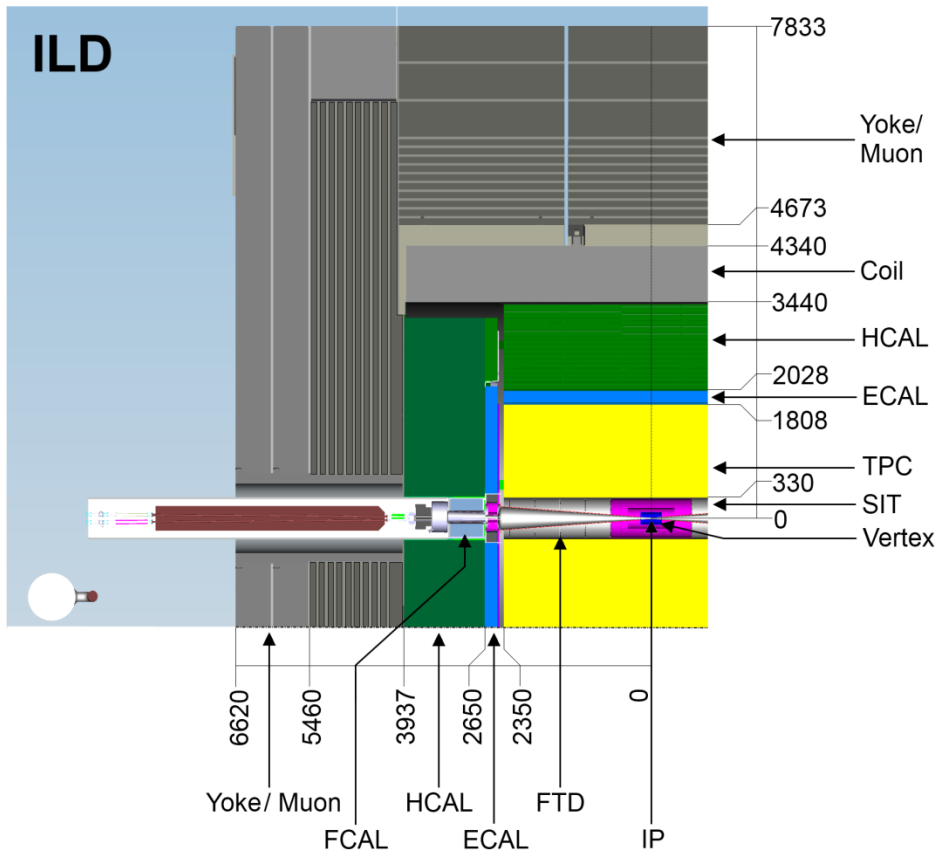
ILD cost scaling

Cost scaling law with different systems radius

- Potentially large impact on the cost
- Careful optimization of cost –performance benefit is needed



The current ILD concept



Started as a combination of GLD and LDC in 2007

(LCWS 2007 at DESY
LDC/ GLD meeting in Cambridge 2007)

Some detailed optimization work done, but main parameter choices were “ad hoc” (politics) as much as physics driven

The inner system

Do we understand our performance requirements?

- VTX detector
- Silicon tracking?

Readout speed might be an important variable to control background and complexity:

Are the ambitious enough in ILD in this respect?

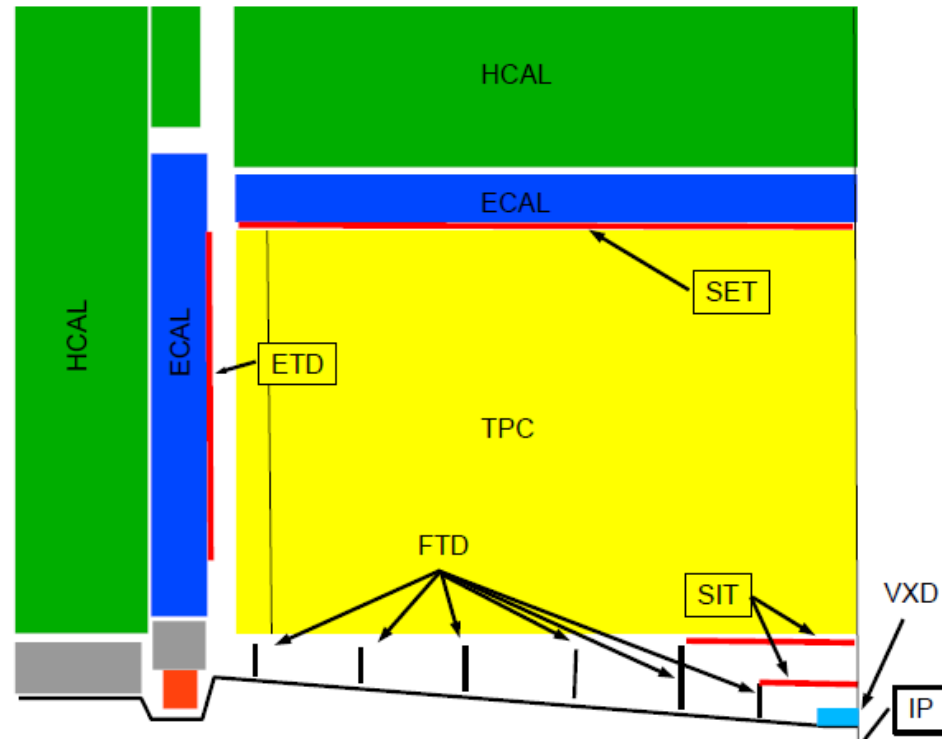
Do we understand / do we have a proper design of the beamtube etc?

We propose a big Silicon system for ILD:
are we sure of its parameters?

What about the outer Silicon system?
How much of this is baseline?

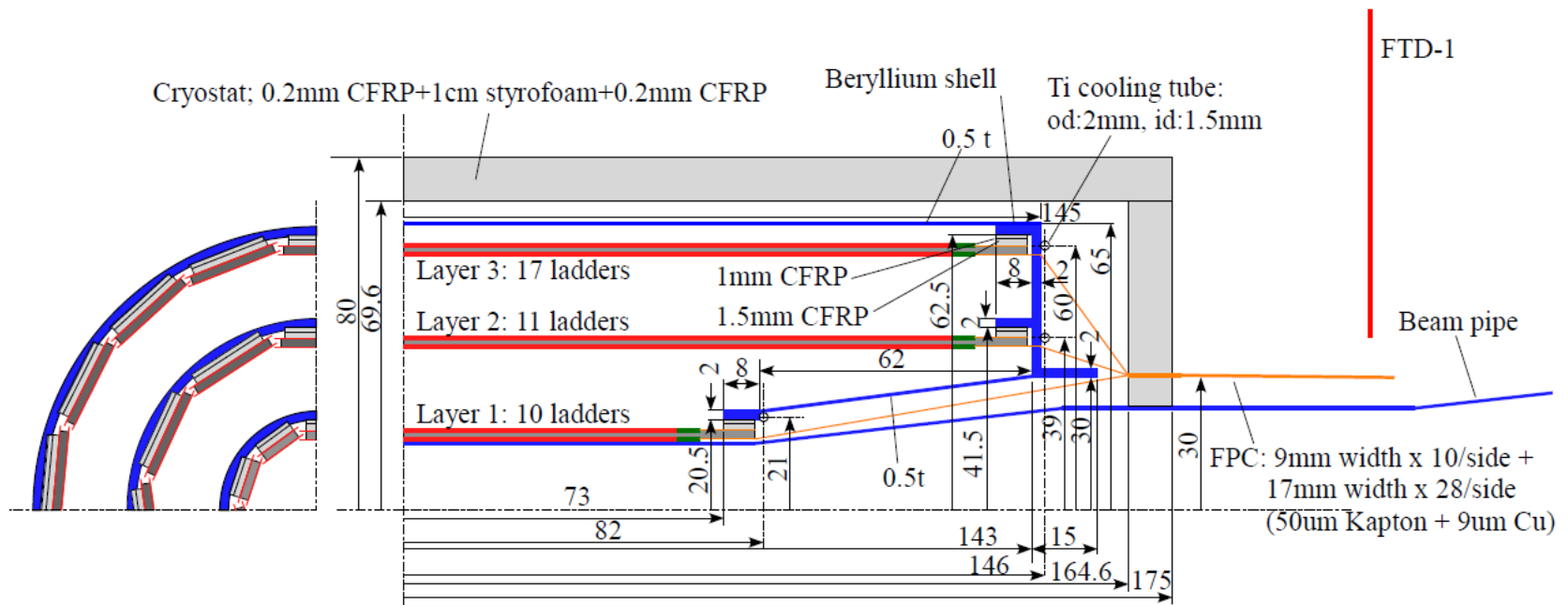
Design of the VTX detector

- Role and merit of double layer
- Alternative geometries?



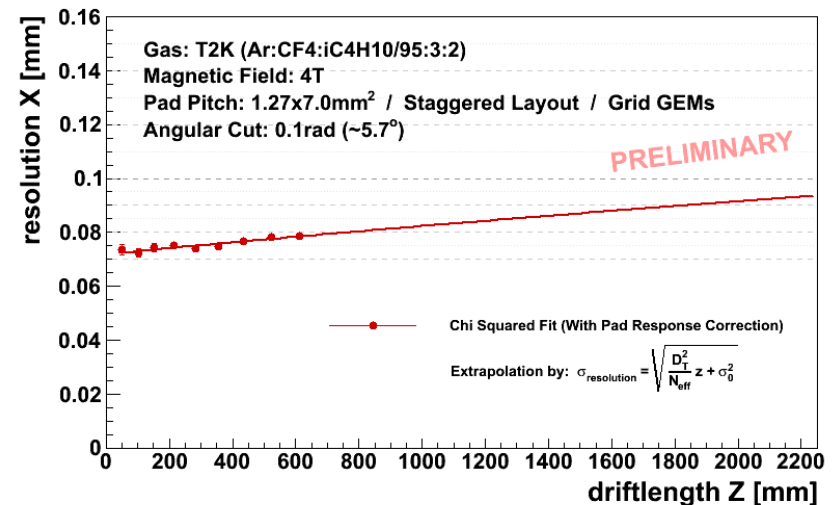
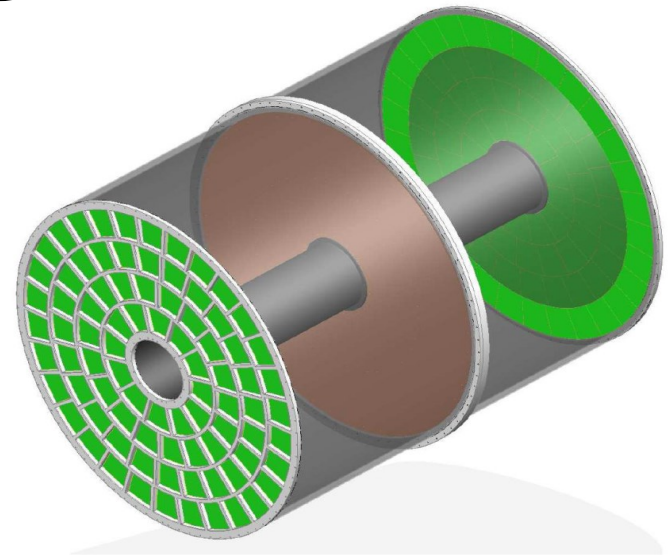
Vertex detector

- Excellent impact parameter resolution better than $(5 \oplus 10/p \sin^{3/2} \Theta)$ μm is required for efficient flavor tagging
- 3 layers of double ladders (ca 1 mm apart) (6 pixel layers)
 - Effect on pair-background rejection is expected, but not demonstrated yet
- Barrel only: $|\cos\Theta| < 0.97$ for inner layer and $|\cos\Theta| < 0.9$ for outer layer
- Point resolution $< 3\mu\text{m}$ for innermost layer
- Material budget: $0.3\%X_0/\text{ladder}=0.15\%X_0/\text{layer}$
- Sensor options: CMOS, FPCCD, DEPFET, others?



TPC: ILD

- Time Projection Chamber: The central tracker of ILD
- Tracks can be measured with many (~200/track) 3-dimensional r-f-z space points
- $s_{rf} < 100\mu\text{m}$ is expected for all drift distances
- dE/dx information for particle identification
- Two main options for gas amplification: GEM or Micromegas
- Readout pad size $\sim 1 \times 6\text{mm}^2 \rightarrow 10^6$ pads/side
- Pixel readout R&D as a future alternative
- Material budget: $5\%X_0$ in barrel region and $< 25\%X_0$ in endplate region
- Cooling by 2-phase CO2
- Momentum resolution: $2 \cdot 10^{-5}$



Tracking System

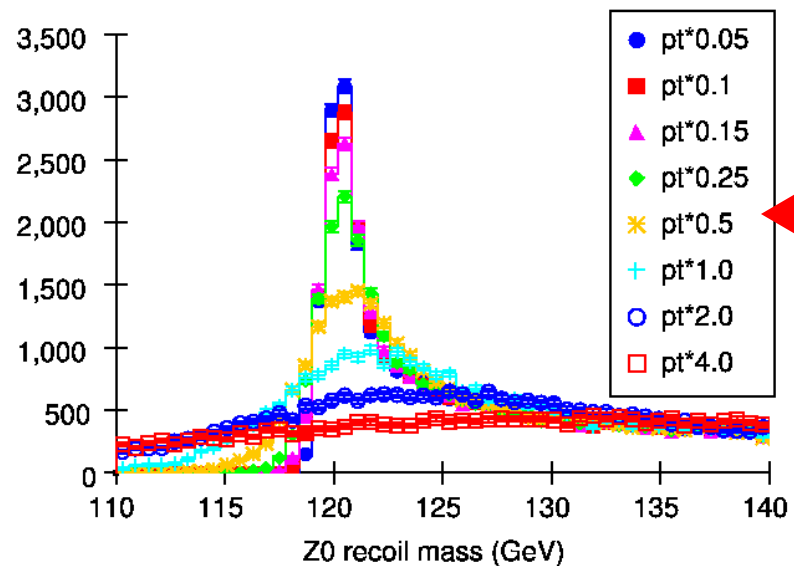
Momentum resolution:

- Current parameter is strongly driven by Higgs Mass measurement:
are these arguments still valid?
- If we can relax the requirements: what is the impact on TPC/ Silicon?
 - Complex interplay of TPC, inner and outer Silicon

Overall system optimization:

- Aspect ratio
- Outer radius
- Role of Silicon
- Role of material e.g. in the TPC system
- Forward tracking

ILC500-LDMAR01-Z(ee)H, Espread=0.0011



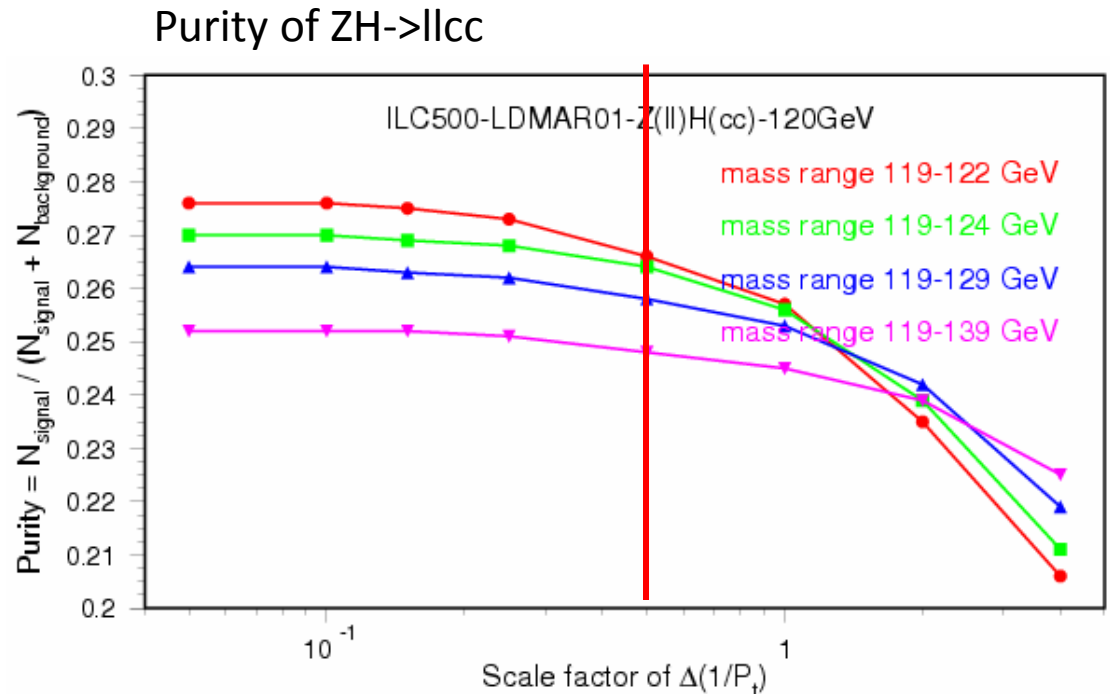
Tracking System

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Material

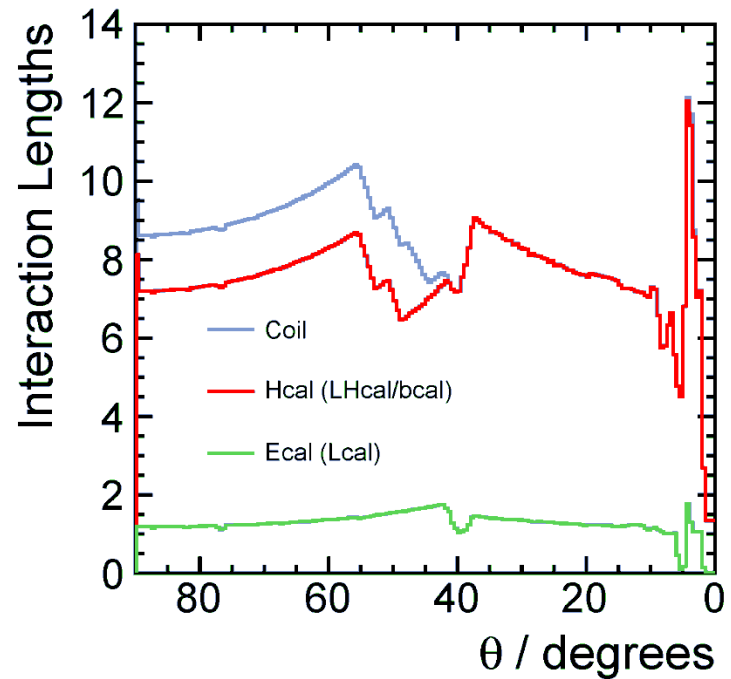
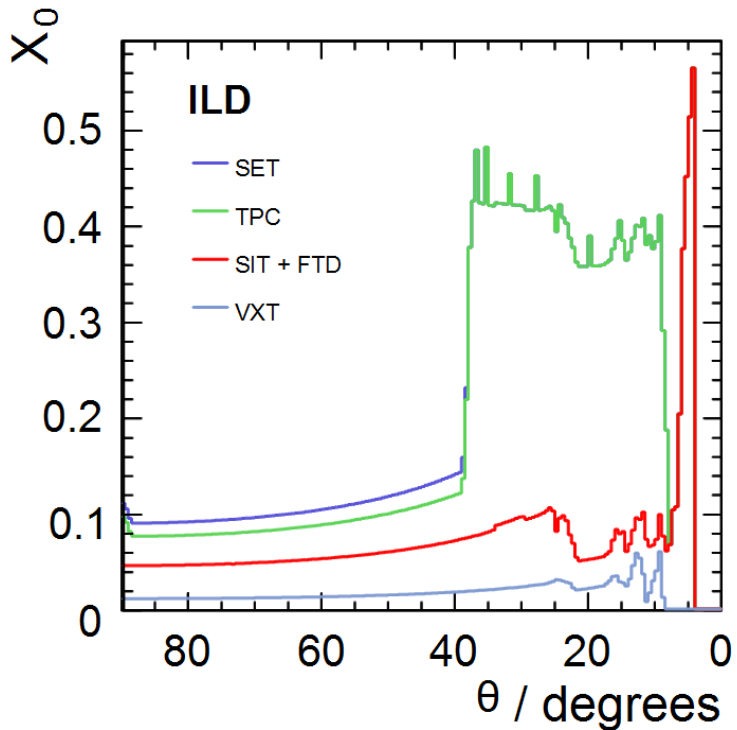
And never forget:

Material issues

- Silicon tracker
- TPC tracker

System thickness

- ECAL/ HCAL thickness
- choice of material?



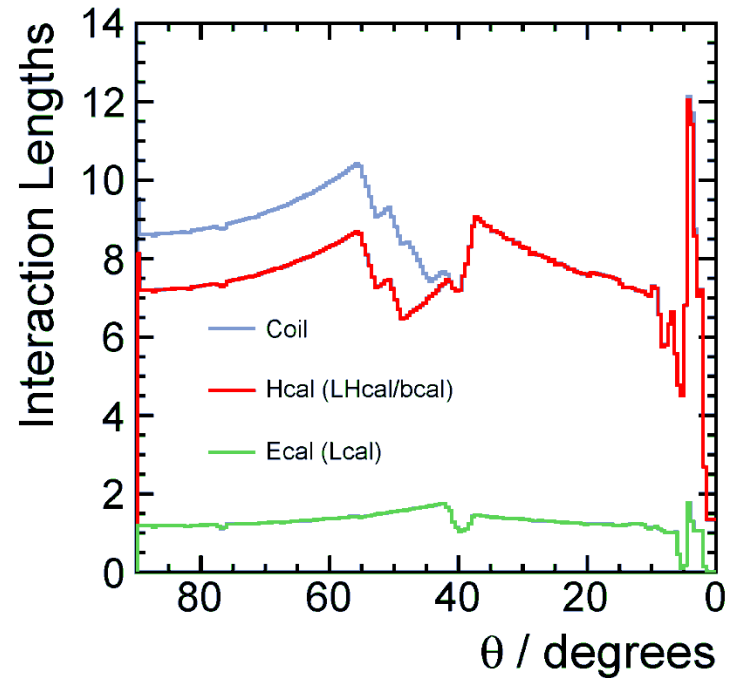
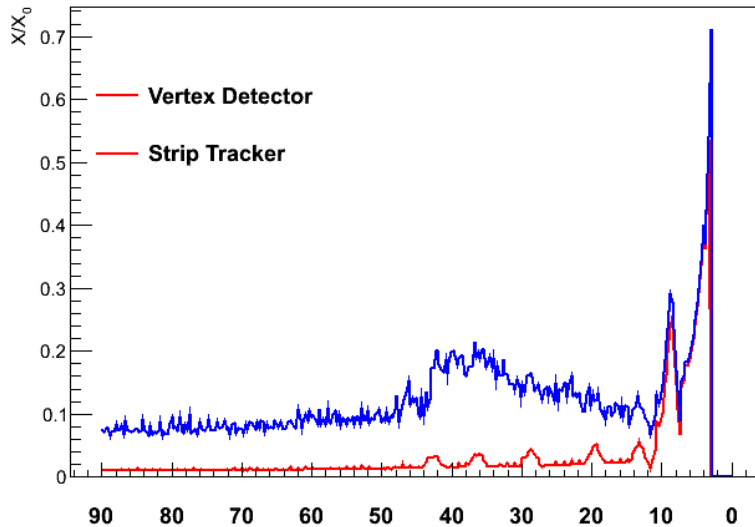
Material

And never forget:
Material issues

- SiD material: this might be aggressive, but we are not better...

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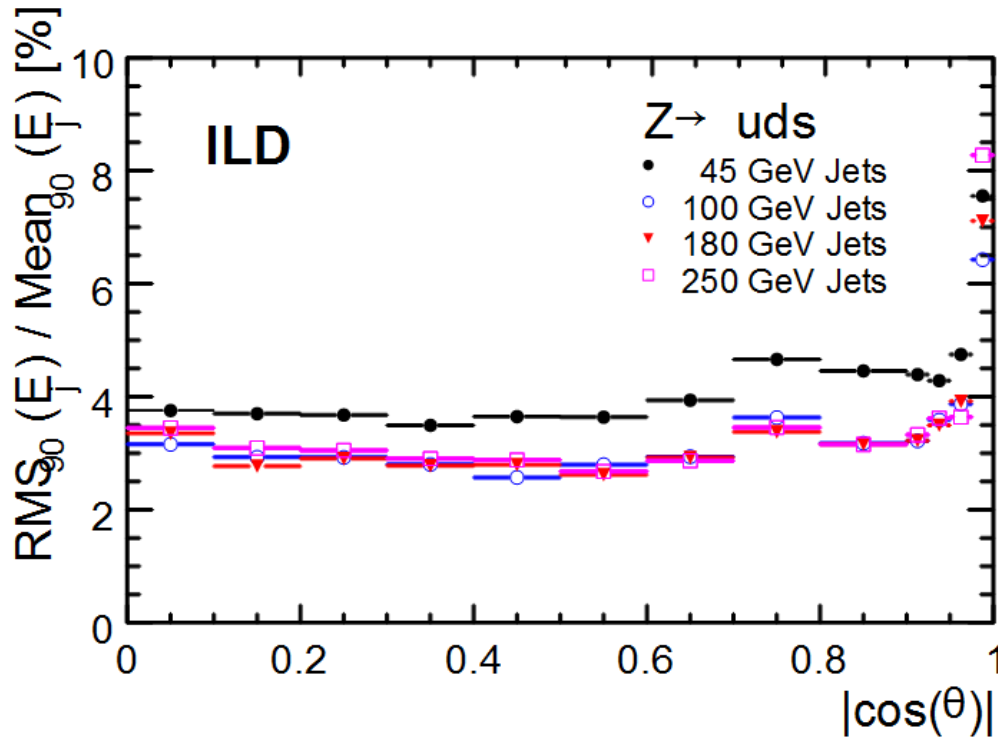
Questions: a possible list

- What is the right outer diameter for the VTX?
- Are we confident about performance in the forward direction
- What is the minimum momentum we need to reconstruct
- Does the data size have an impact on design of the VTX?

- Where do we need highest momentum resolution
 - Higgs mass, invisible higgs, branching ratios?
- How important are systematic effects to the final performance
- Do we understand possible biases in the momentum estimation
- Do we understand the relative roles of TPC and Silicon?

- What is the impact of material on the physics performance
 - Barrel
 - Endcap

Pflow as a driving force



Pflow has been at the core of the definition of ILD

- Size
- Calorimeter performance
- Tracking performance

Pflow: Impact

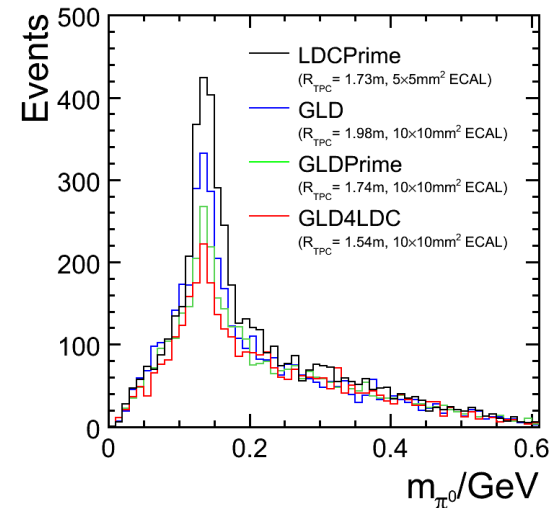
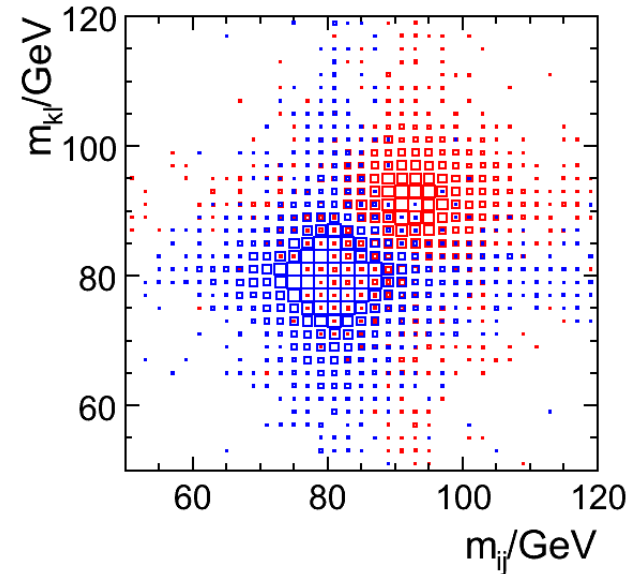
W/Z separation:

Key ingredient to define the requirement on particle flow performance

Impact on actual physics studies:
typically less clear than thought:

Most studies show little to no sensitivity to the exact performance

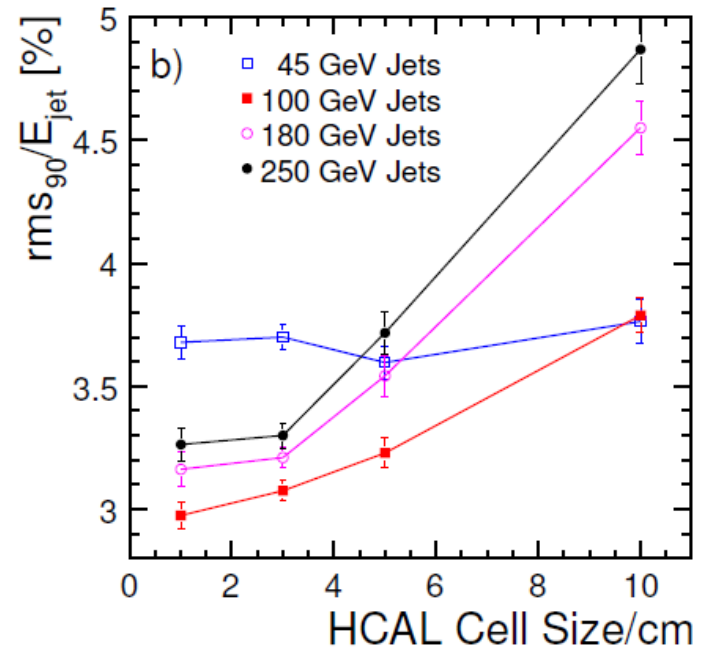
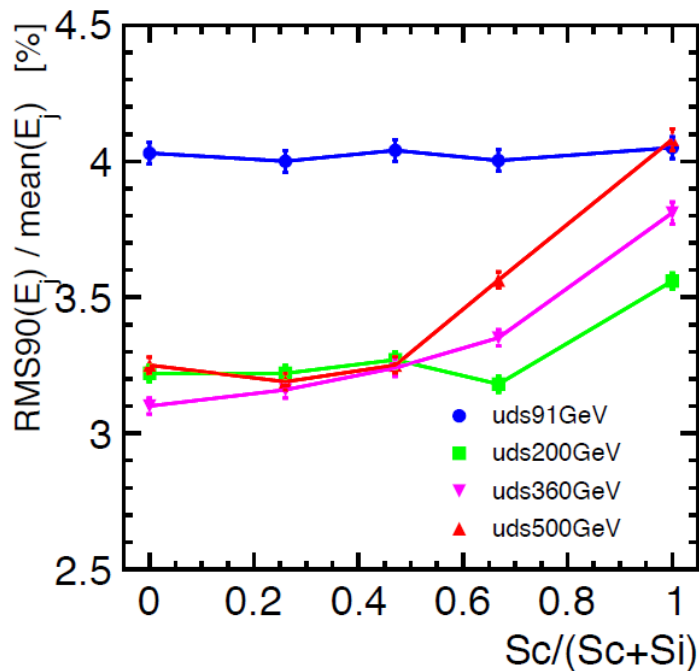
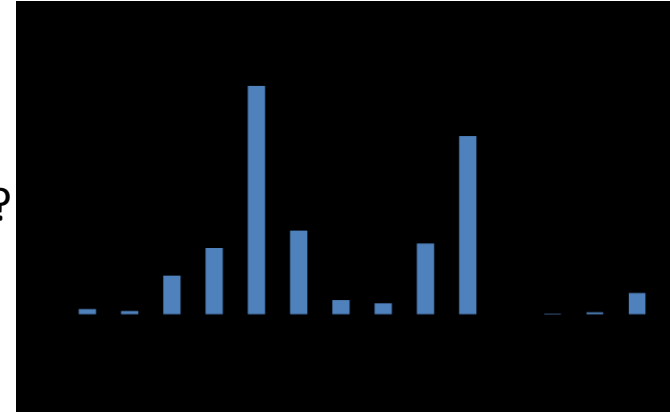
But: how poorly do we do with a significantly deteriorated particle flow performance?



Imaging Calorimeter

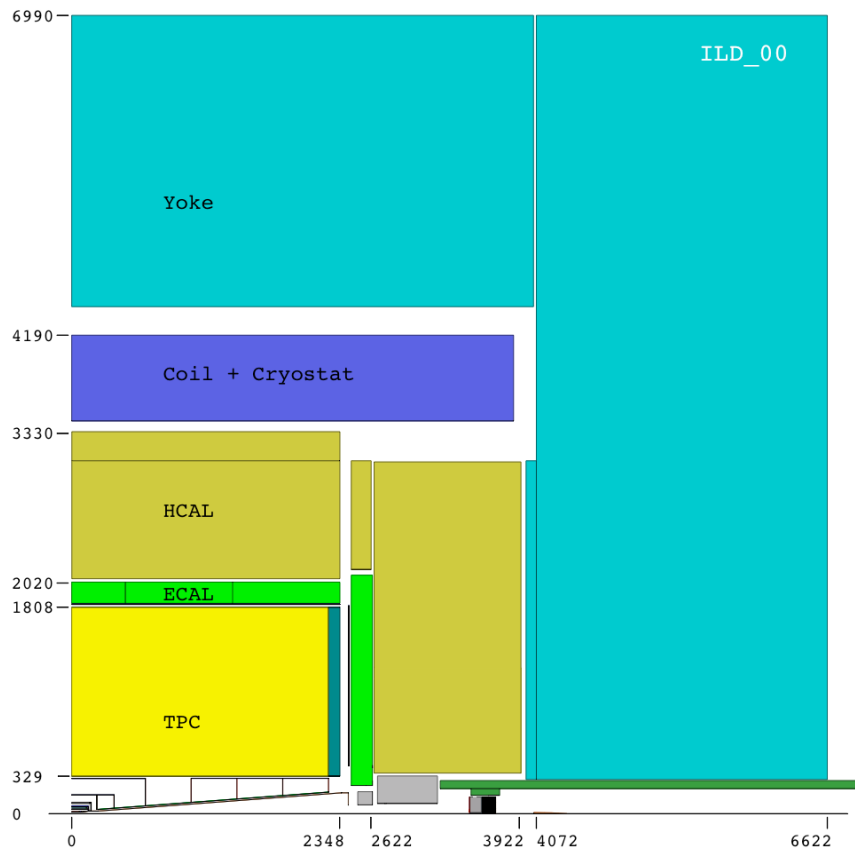
Calorimetry is clearly a main part of ILD

- Can we make our calorimeter cheaper?
- Can we make the step from ECAL to HCAL less severe?
- Can we find an intelligent way to stage the system?
- Si for the ECAL is a very attractive, but also very expensive option



Overall Detector size

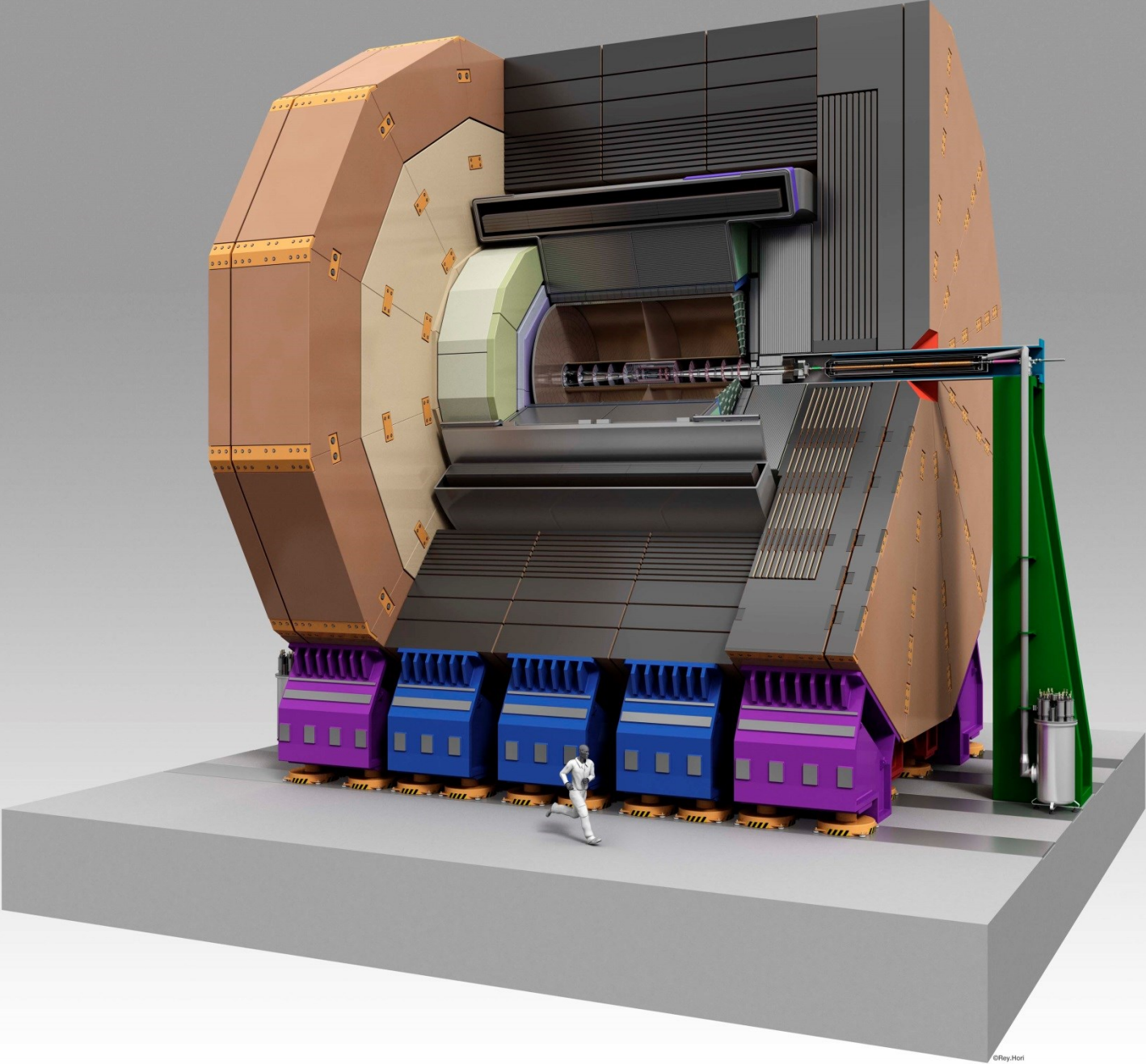
Other constraints:



Outer radius of Yoke:

Defined from push-pull condition on field < 50 mG

- Is this the correct requirement
- Changing this will have a huge impact on size (and cost)



ILD Organisation

The Plan:

At the ECFA meeting May 2013:

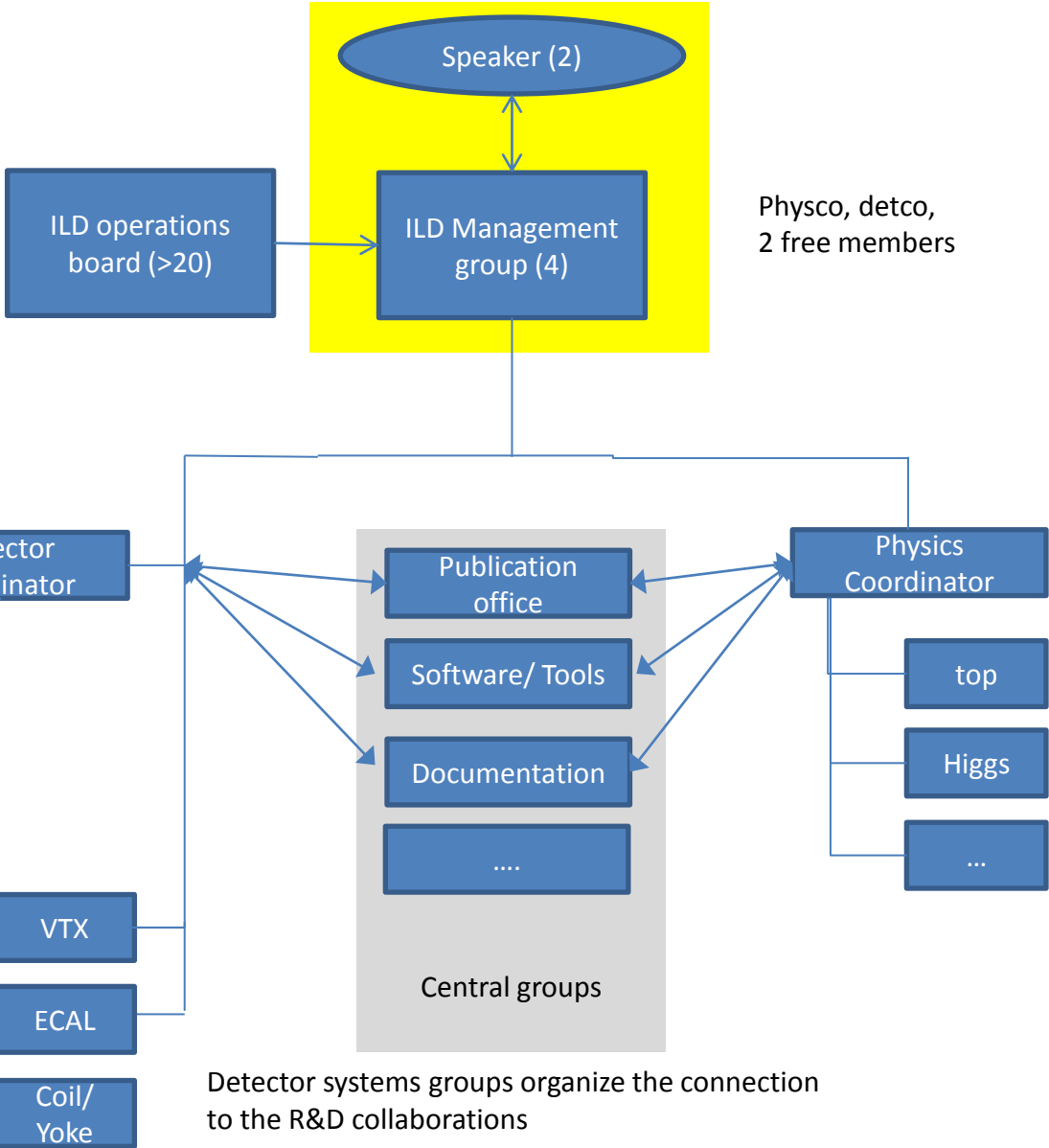
Proposed and discussed new structure for ILD

Thursday this week: Discussion about the structure, try to reach consensus on the main points.

LCWS 2013: initiate the new ILD structure formally.

- Document describing the new structure is on the indico WEB site under the Thursday meeting
- Comments are welcome.

Institute Assembly



This week:

Discuss in more details the different systems and possible optimization options.

Try to map out a program of work to develop/ answer the key questions

- Which are the right questions to ask
- How can we answer them

Define a program of work to get the physics into scope: what are the sensitive points to study? Try to have a new and fresh look at the performance requirements

Understand what is technically feasible.