ILD Optimization

Where are we going?

Ties Behnke, DESY

Scope

ILD re-optimization started at the ILD Cracow meeting 2013

Motivation:

- Performance optimization
- Cost reduction
- Robustness and versatility

Belgrade 2014: Concrete Steps

TPC: organise an internal review/ discussion to make the arguments for the TPC, then prepare a concise writeup on that.

Si tracking: review the choices of the overall system, including SET, and decide a new baseline.

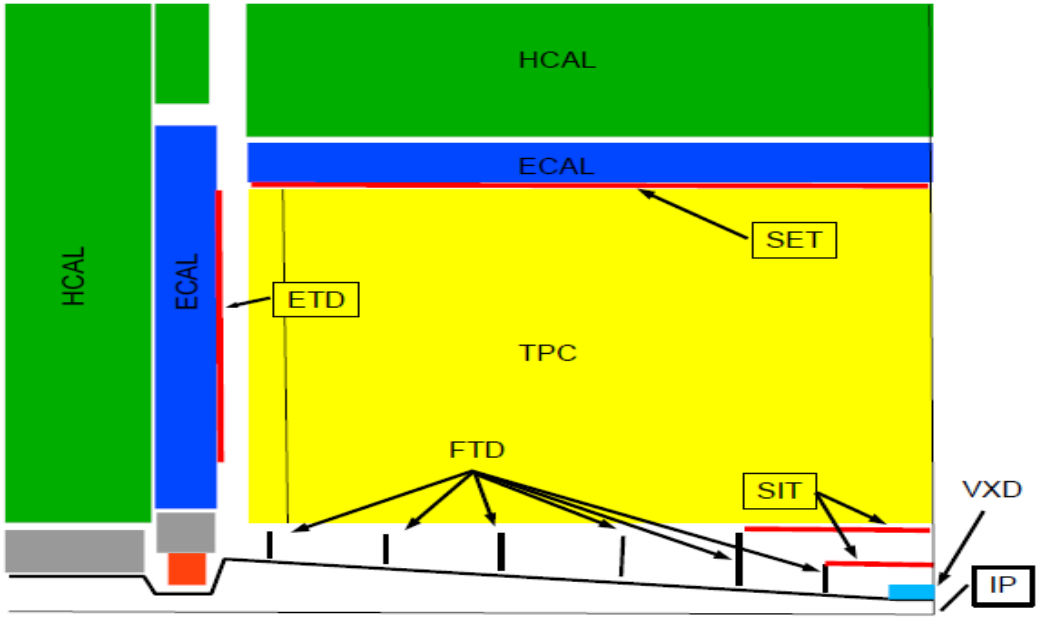
Calorimeter: intense discussion is ongoing, need to discuss how to converge to a decision

Forward: tighly coupled to L* issue (see next slide)

Yoke: depends critically on the overall integration discussions on things like stray field etc.

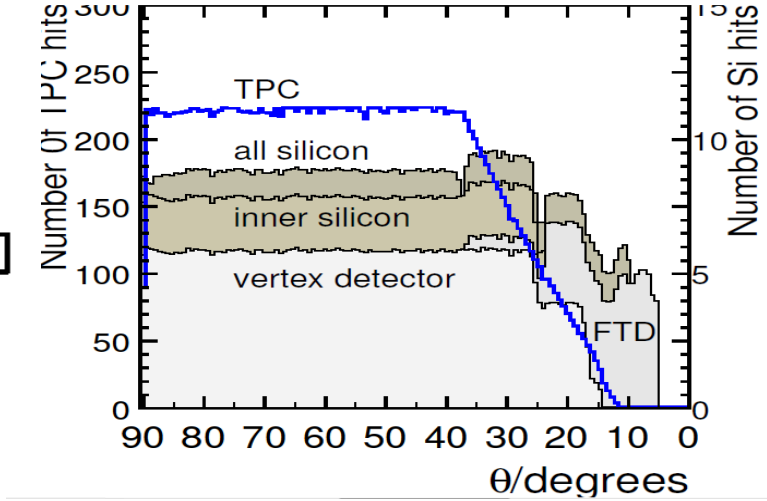
Summer 2015: Time to take stock, where do we stand?

ILD Tracking System



Ambitious hybrid system

- TPC for robustness and efficiency
- Silicon for ultimate resolution and vertexing



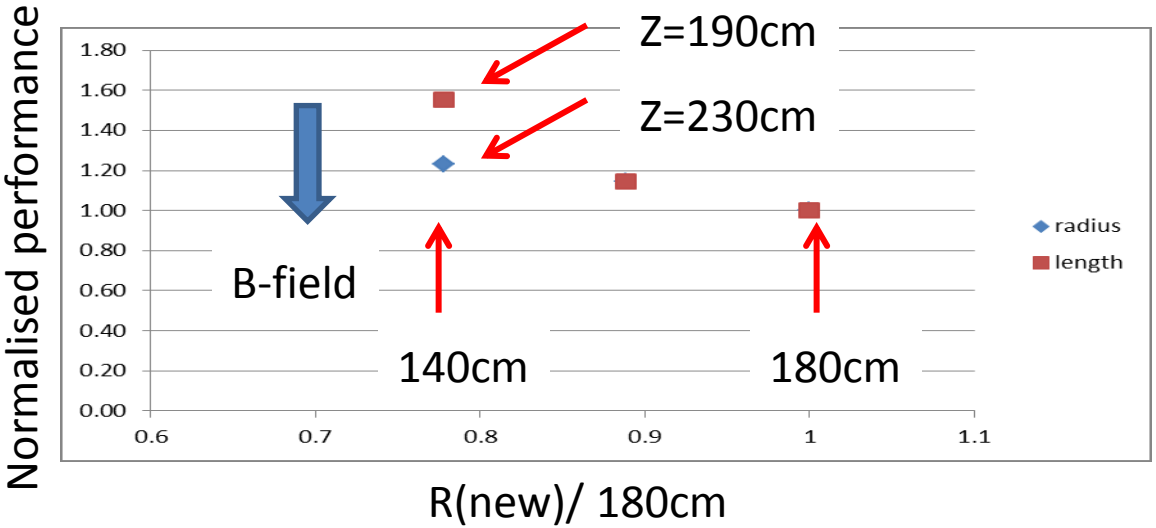
Hermetic, coverage down to very small forward angles.

Tracking

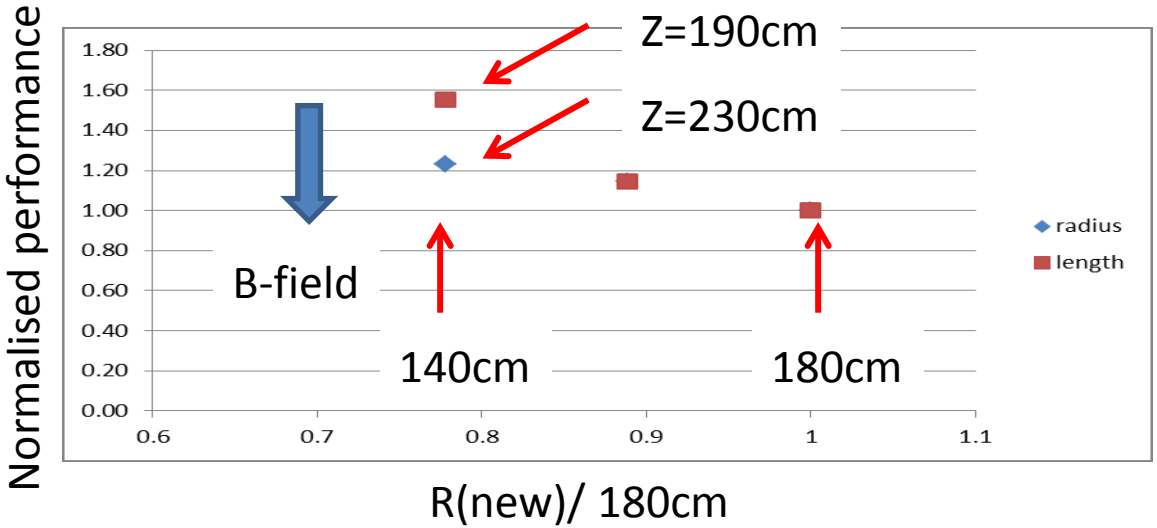
Questions for tracking:

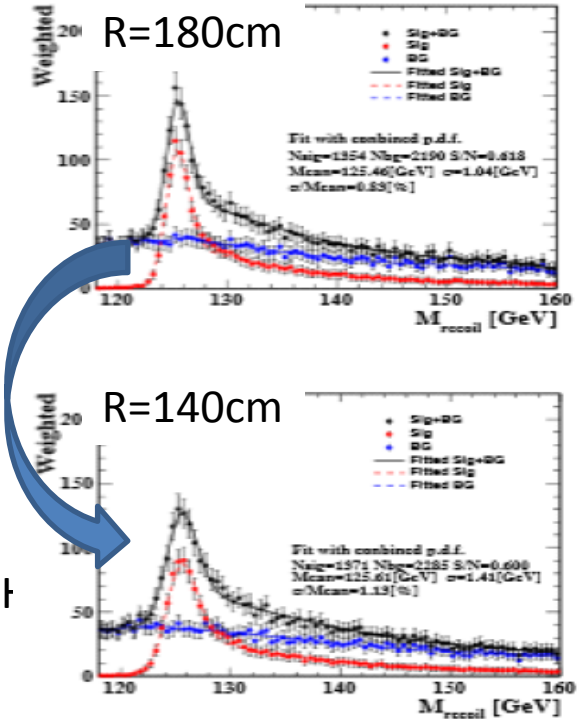
- Radius and length of TPC
- Role of internal and external Silicon
- Advantages of a TPC
- Role of dE/ dx

Derived from study by M.Berggren



Tracking Performance





30% degradation in MH

Performance indicator a la Mikael

Tracking

2. √s=250 GeV, L=250fb^-1 ⇨ If we change R: 1.8 m ⇒ 1.4 m

⇨ σ_resolution degrades	~	10 %.
⇨ σzh precision degrades	<	5 %.
⇨ Mh precision degrades	~	12 %.

※ (R: 1.8 m ⇒ 1.6 m) Mh precision degrades

~26% more data to recover nominal precision.

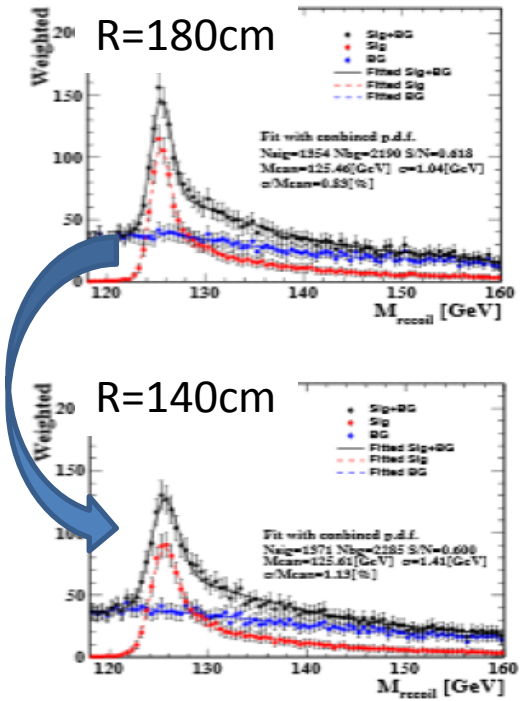
3. √s=350 GeV, L=350fb^-1 ⇨ If we change R: 1.8 m ⇒ 1.4 m

⇨ σ_resolution degrades	~	25 %.
⇨ σzh precision degrades	>	5 %.
⇨ Mh precision degrades	~	30 %.

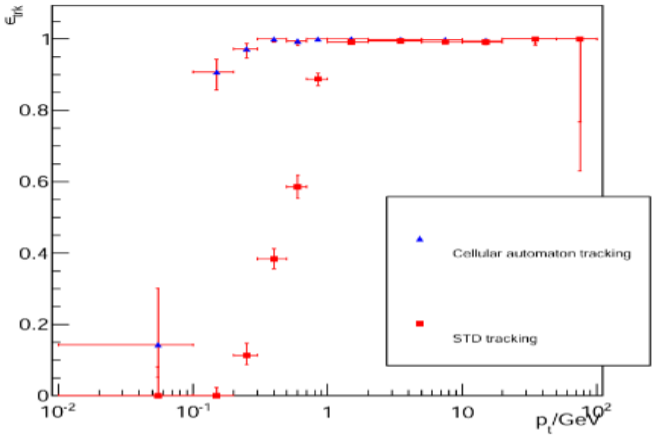
※ (R: 1.8 m ⇒ 1.6 m) Mh precision degrades ~ 10 %.

~69% more data to recover nominal precision.

We clearly see that reduced precision comes at a price.



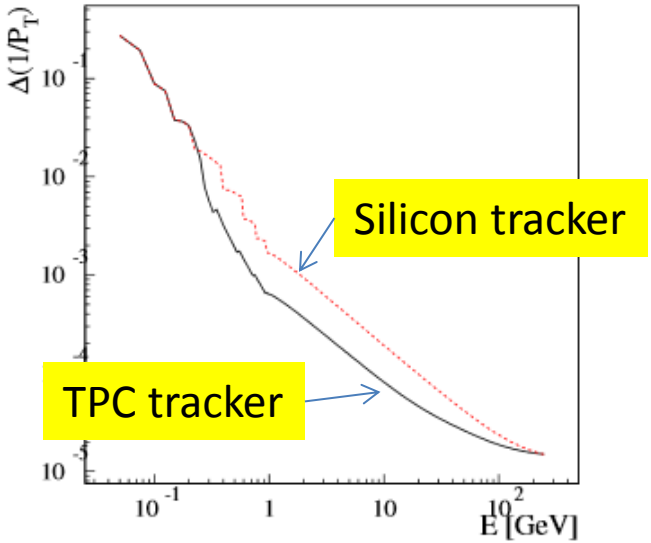
Low Momentum Performance



From Y.Voutsinas (Vertex-14)

VTX: First (and very convincing) demonstration that the double layer design in ILD actually makes sense and helps.

TPC has distinct advantage at low momenta because of lower material compared to Silicon tracking.

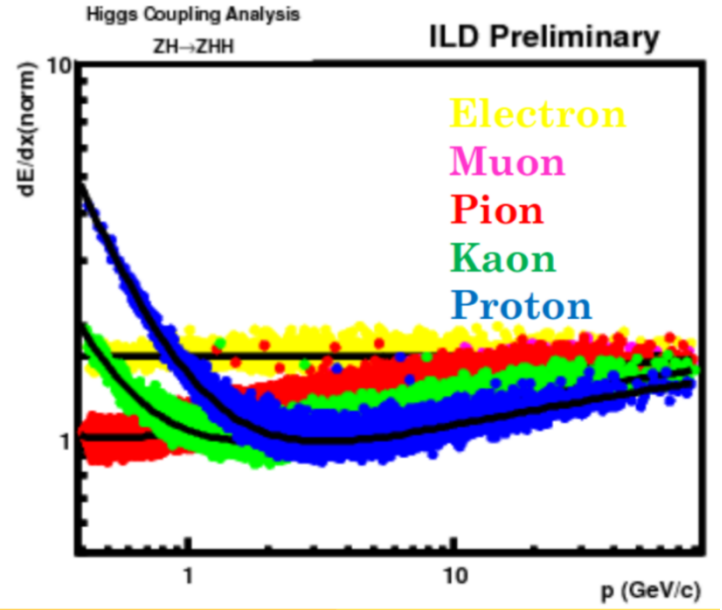


First Results on dE/dx

Background rejection efficiency:

Single lepton ID	Cut based	Old likelihood	New likelihood
Signal(%)	98.1	98.1	97.8
ttbar – all hadronic(%)	7.9	3.1	2.3

- Improvement of all hadronic event rejection: ~30%
- Note: lepton energy threshold is loosened on likelihood_new
  - From E(lep)>15GeV → E(lep)>10GeV



Many other analyses are ongoing and are trying to link detector performance to physics gains:

Extremely nice to see
(Remember: this was the main punch line when we started the ILD re-optimzation)
(See talk on dE/dx later today)

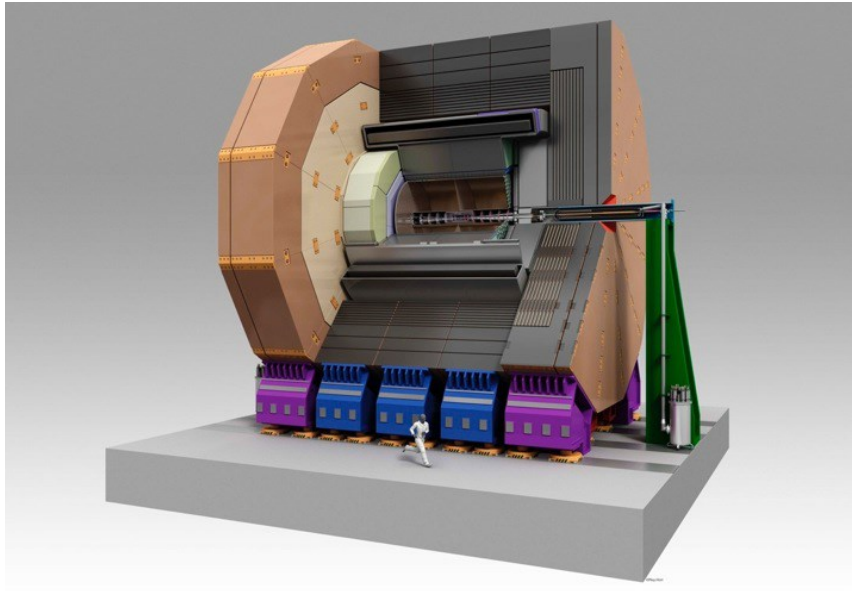
Tracking Summary

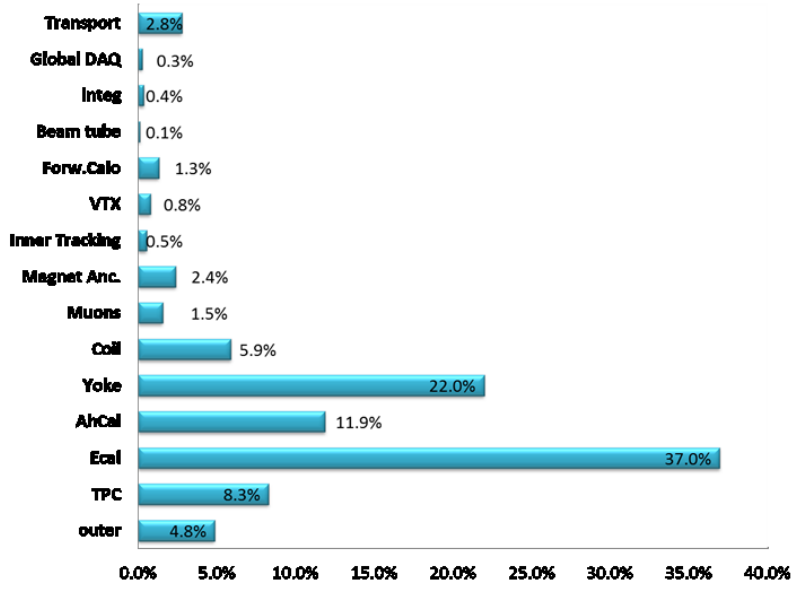
Start to see the performance as a function of the tracking system parameters

- Complete study on the scaling of the system
    - Size can be compensated by B-field to some extend
    - External Silicon is very important to ultimate tracking performance
- Low momentum performance starts to be understood
- Role of dE/dx is being studied
- Forward tracking? Needs more detailed simulation and studies

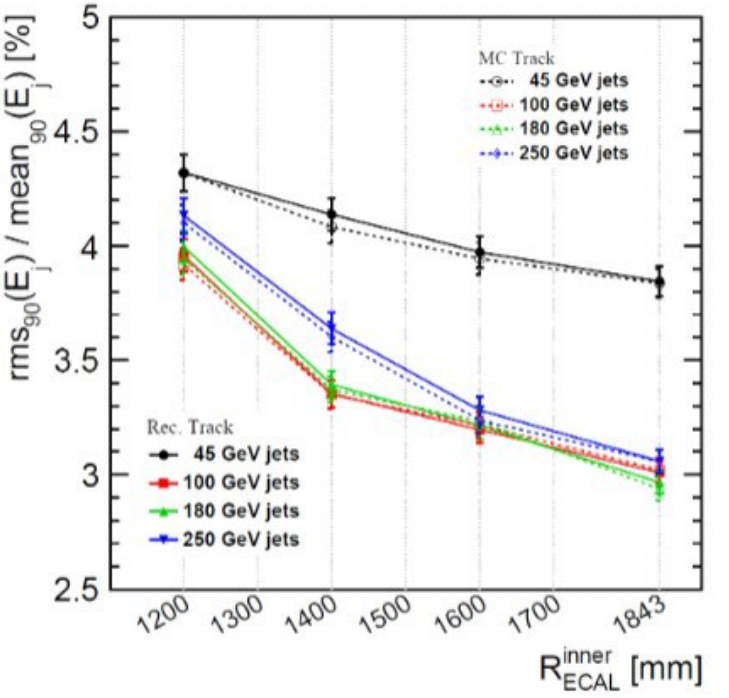
Overall Optimization

Look critically at most ILD parameters and details, considering cost impact.





Calorimeter Optimization

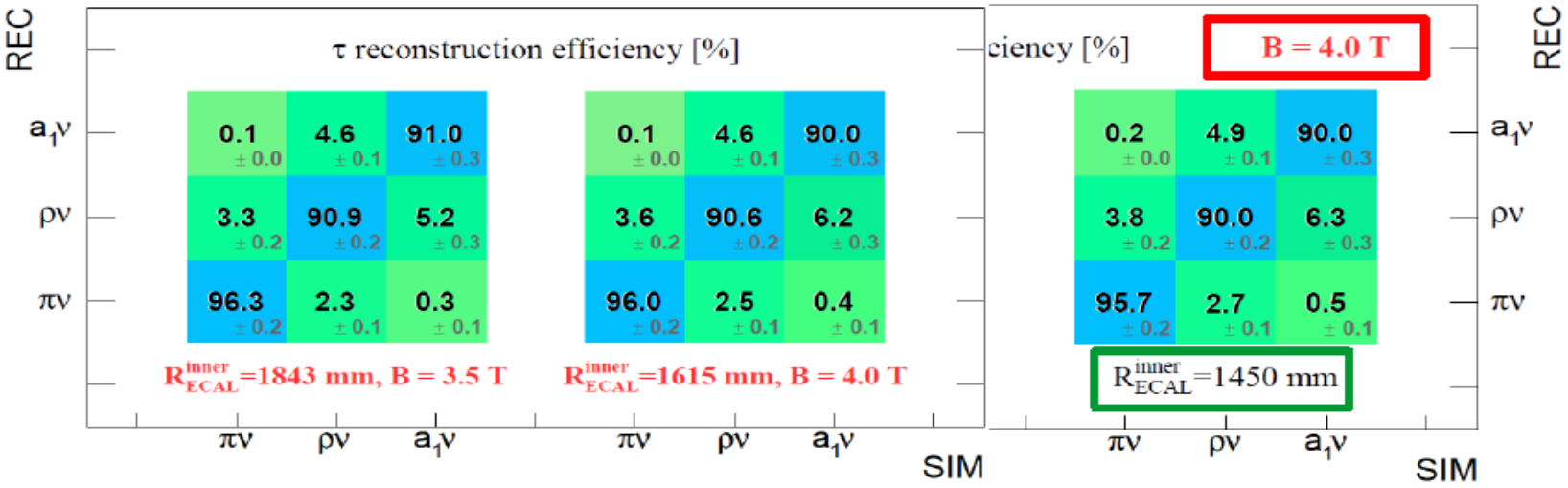


A lot of work has happened
to optimize the calorimeter.

Detailed studies by different groups (LLR, Cambridge, DESY, Kyushu, etc.)
on performance of smaller ILD etc.

We are moving towards matching
detector performance with physics.

Calorimeter Performance

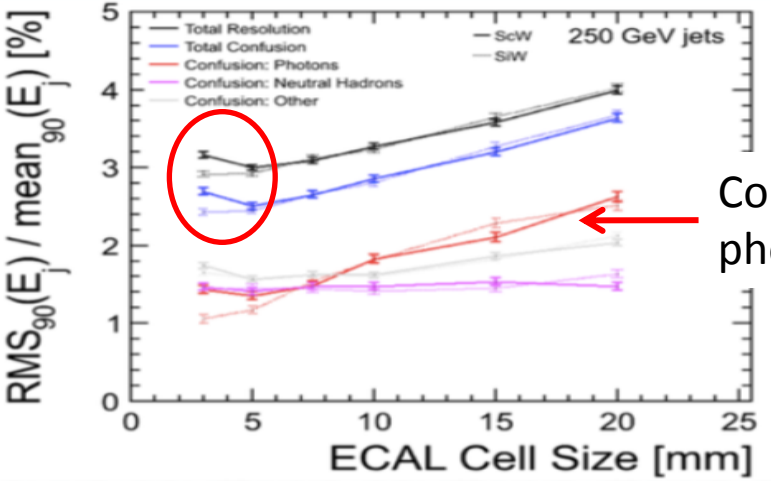


Tau reconstruction: sensitive measure for the performance of the system.

Smaller detector can perform well if magnetic field is increased.

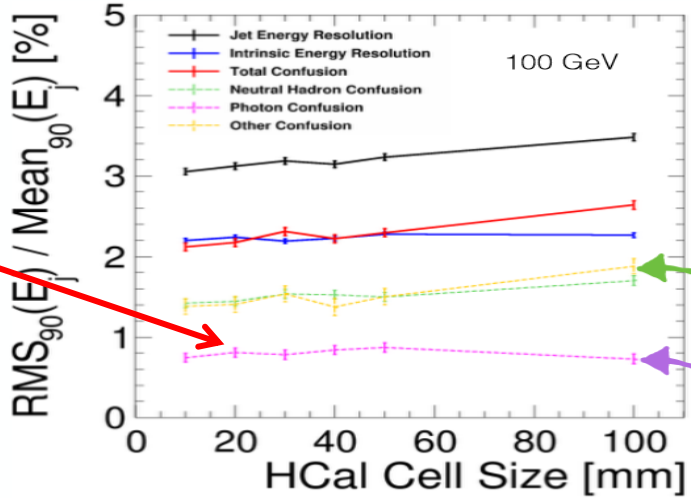
Calorimeter in view of PFLOW

ECAL



Confusion photons

HCAL



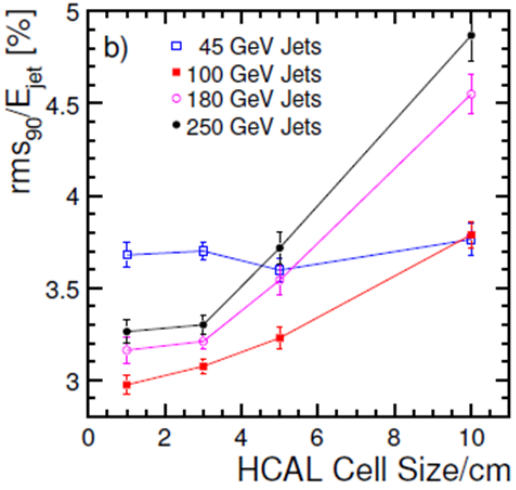
performance vs ECAL cell size

performance vs. cell size

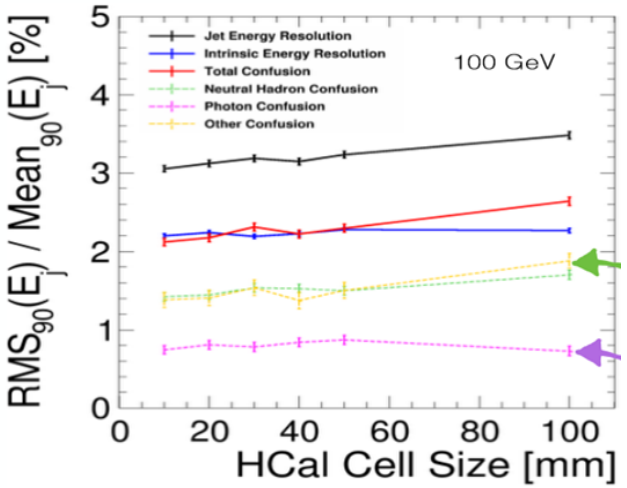
+ Extremely nice to see the detailed studies and the high level of understanding
- We rely heavily on one piece of software for crucial studies

Particle Flow: Algorithms

The new Pandora shows different performance

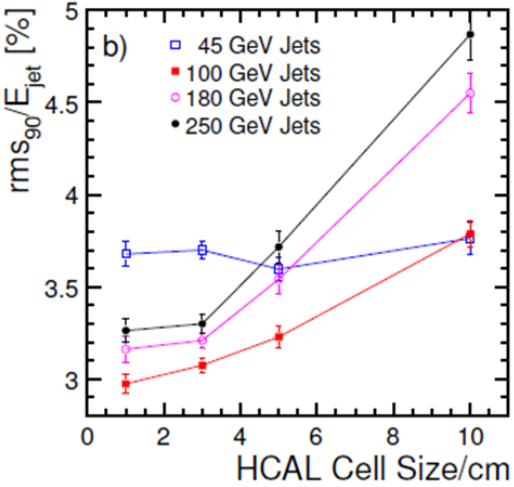


Significant changes from “old” to “new” Pandora



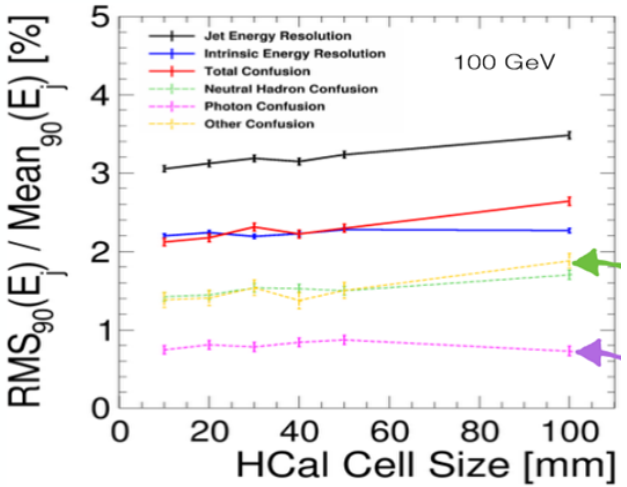
Particle Flow

The new Pandora shows different performance



Significant changes from “old” to “new” Pandora

This illustrates how sensitive our conclusions are to the software.



Pandora

Intense effort under way to understand the details of the performance of Pandora.

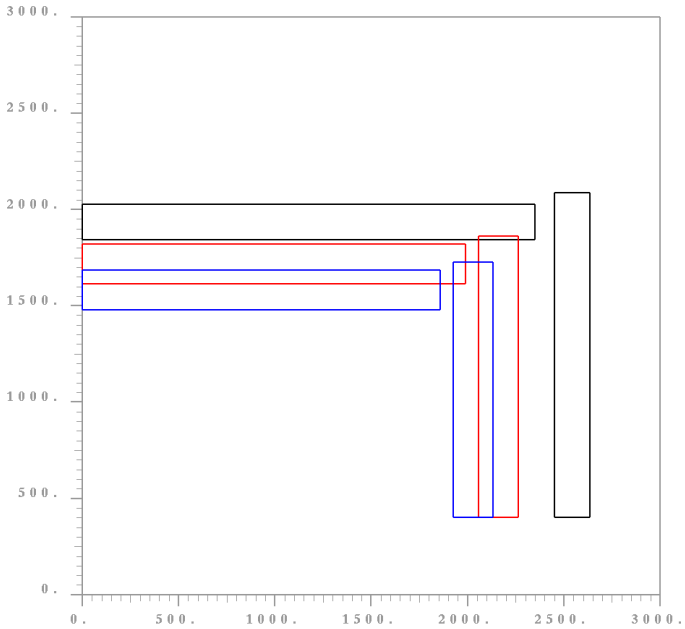
- Dependence on energy cutoff
- Other cuts? “Compensation”? Calibration?
- This shows that we are very sensitive and that our conclusions are not solid.

Where to go from here

Agreement:

We need to define and study several models.

H. Videau: propose two new baselines.



But: we are not yet there, we still cannot really compare different models in an un-biased way.

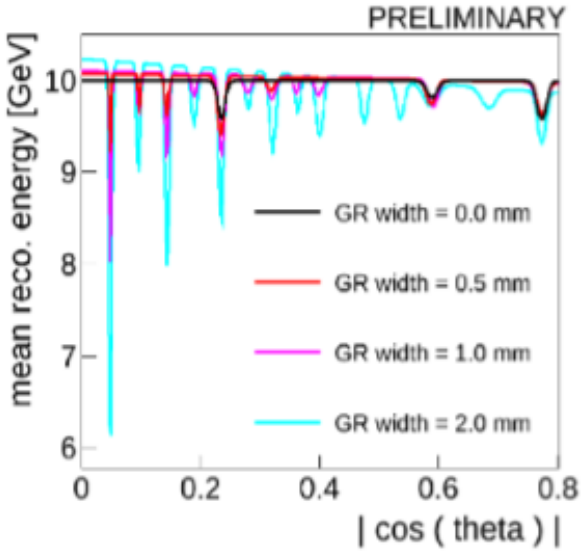
We do not understand our tools well enough to really draw conclusions.

The Way forward

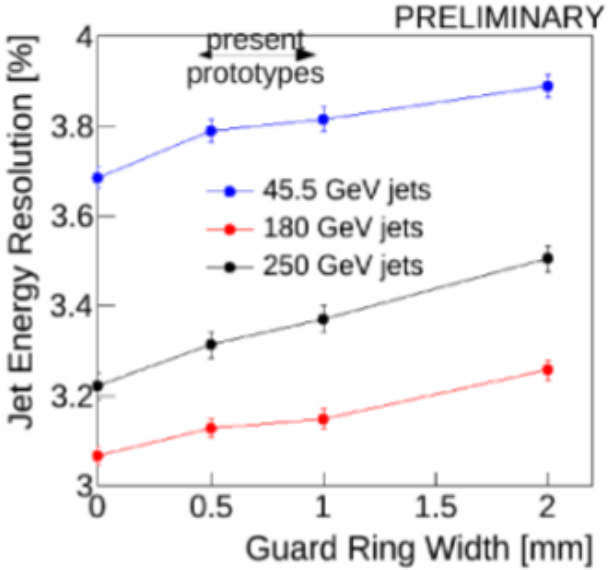
- Tracking performance:
  - Resolutions: ok
  - Particle ID: need further work
  - Technologies: far from ready
- Particle flow:
  - Algorithms are not well enough understood
  - Cross checks are missing
  - Though there is enormous progress
- Simulation:
  - Detailed models need to be evaluated and implemented
  - Impact of calibration/ non-perfect detectors to be implemented
- Mechanics:
  - We should try to converge on one mechanical model
  - This particularly applies to Calo.

Simulation: why does it matter

Detailed simulation models are crucial to understand precision physics

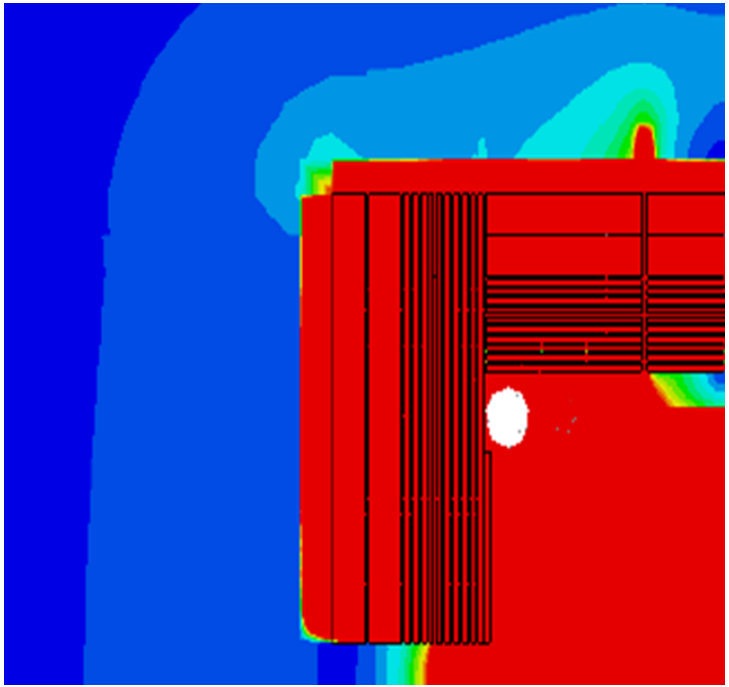


Reconstructed energy from ECAL vs. cos(theta):
dips are from dead areas and guard rings in the Si sensors



Impact of the Jet energy resolution from different guard ring designs.

The outer detector



- Detailed modelling of the outer detector
- Optimization of steel and field
- Optimization of interface between cavern and detector

This work is proceeding smoothly.
Large impact on overall costing,
Little impact on physics performance.

Belgrade 2014: Concrete Steps

TPC: organise an internal revie PC, then prepare a concise writeu

We start to see the story, the different parts are taking shape

Si tracking: review the choices and decide a new baseline.

More work is needed, in particular in the forward direction, and at the interface VTX – SIT- FTD

Calorimeter: intense discussion is ongoing, need to discuss how to converge to a decision

Definition of new models has to wait for detailed understanding of performance issues.

Forward: tighly coupled to L* issue (see next slide)

Yoke: depends critically on the tray field etc.

Lots of progress on the integration and MDI aspects.

Summer 2015: Time to take stock, where do we stand?

Outlook

Simulation/ Reconstruction: see talks by Frank.

- We realise that we depend strongly on our tools
- Some conclusions from the past might be misleading.
- A real optimization can only be done once we have understood our tools:

Contrary to what we thought until recently we are not yet ready to define new detector models.
We should push hard to reach this point.