LDC activities summary

Henri Videau

for
the LDC members

contacts: M. Battaglia, T. Behnke, B. Hsiung,
D. Karlen, Y. Sugimoto, H. Videau

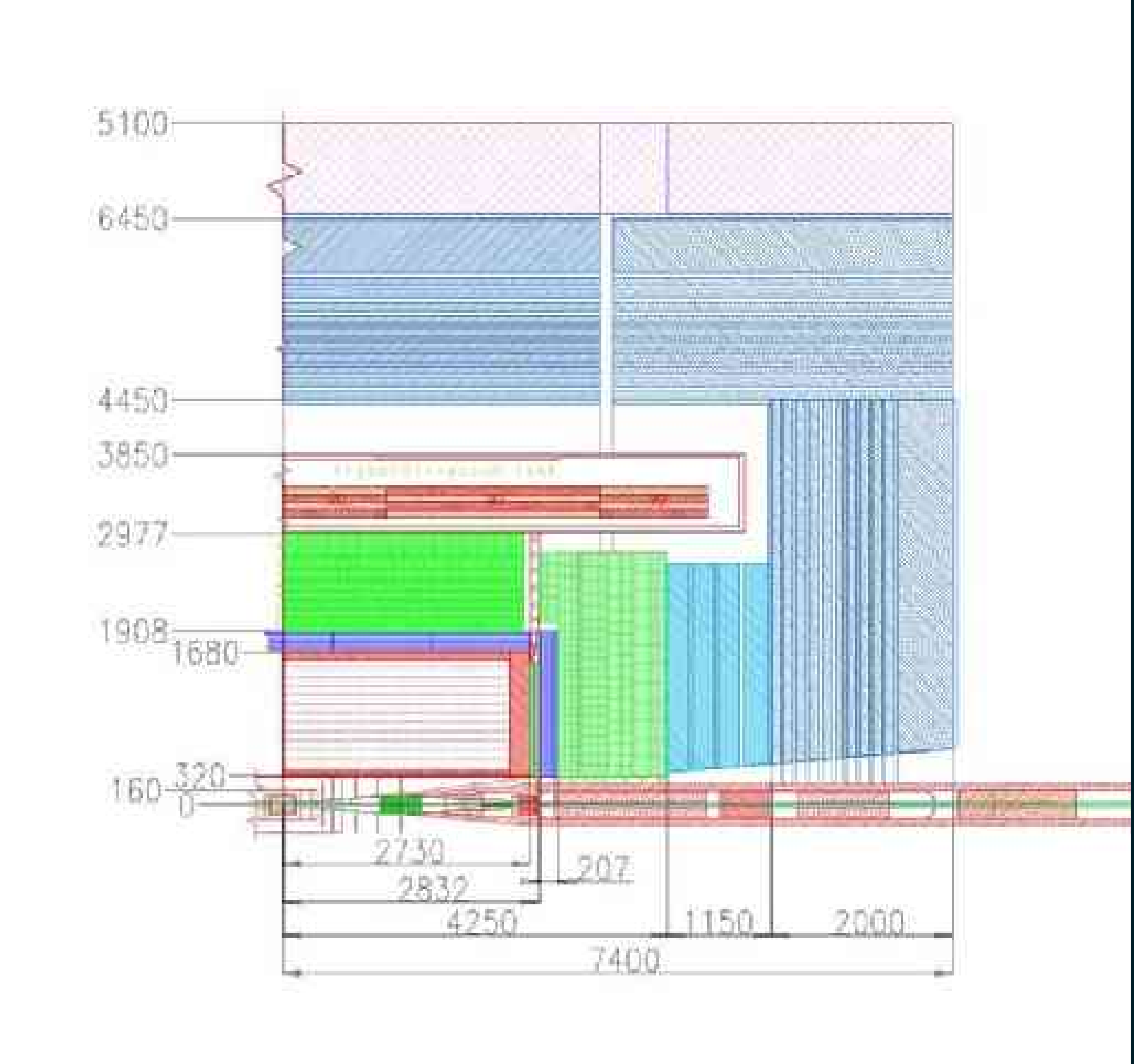
a summary and some personal and partial
and partial views

A reminder on LDC

A concept of detector for ILC
deriving from the TESLA detector
and from the US large detector

identified by
a rather large TPC as central tracker
a high granularity Si-W el.mgn. calorimeter

The Tesla model



SiD LDC GLD

How does LDC stay between SiD and GLD
with quite some overlap

LDC / SiD : TPC + ~ size + ~ field

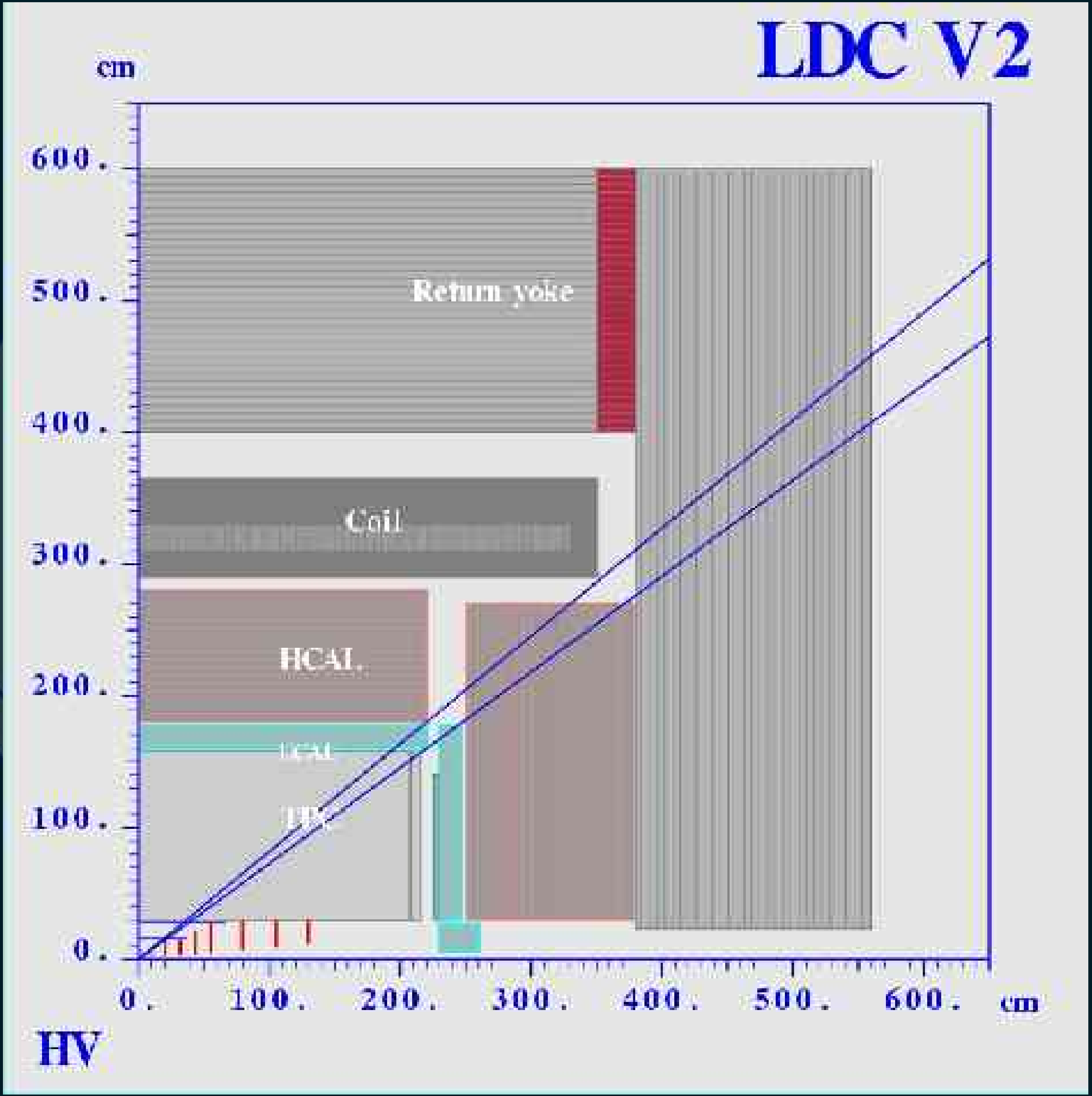
LDC / GLD : Si_W calorimeter + ~ size + ~ field
but for recent evolution

Since the creation of LDC
and the nomination of the contacts

a document has been developed to make the design evolve from the TESLA TDR to a more elaborate concept.
This LDC sketch document can be found on ILCLDC.org
It recalls the baseline and provides a large number of questions to define the evolution toward a new baseline.
The idea for Snowmass was to try to

- complete this list of questions,
- order them by priority
- provide a roadmap to their answer
  - and to a new baseline   getting few results
    - have a software ready to get them

We can try this configuration implemented in Mokka in a scalable form under the name of LDC_1

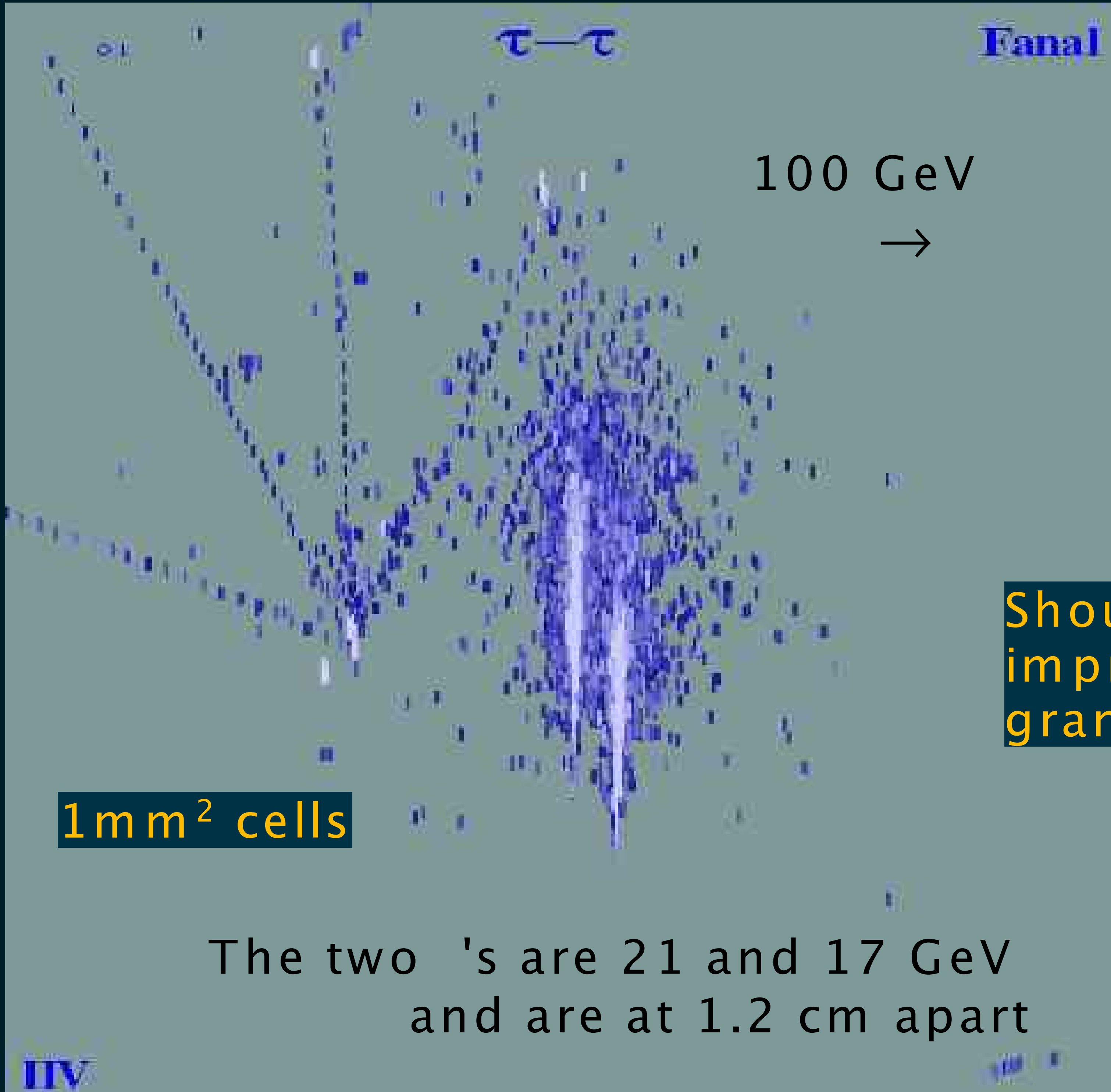


To reach that goal few working groups were formed and I will report on their conclusions.

They focus on particle flow
and tracking performances and concern:

the forward detectors and the interference with MDI
the PFA and its impact on the detector design
the question of the magnetic field quality
the silicon tracking elements

Aside that, some developments offer new perspectives



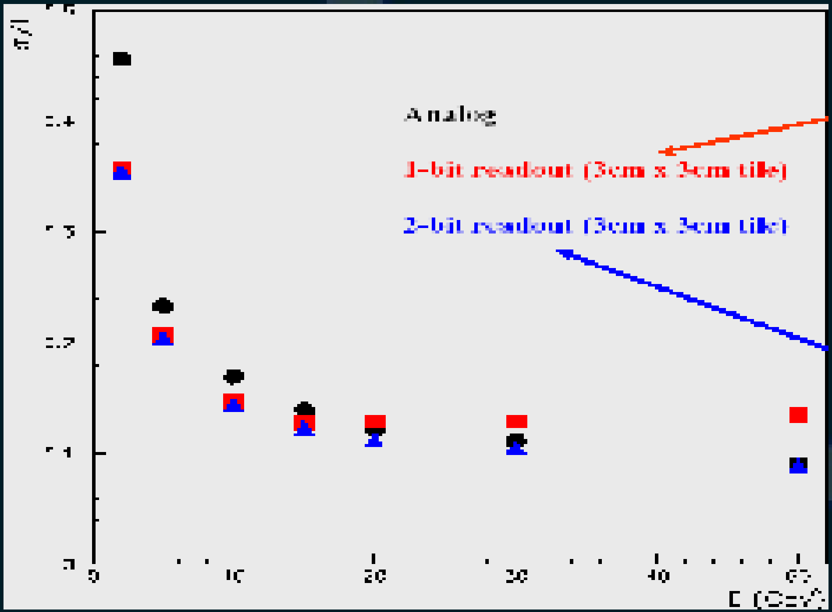
Should we improve the granularity?

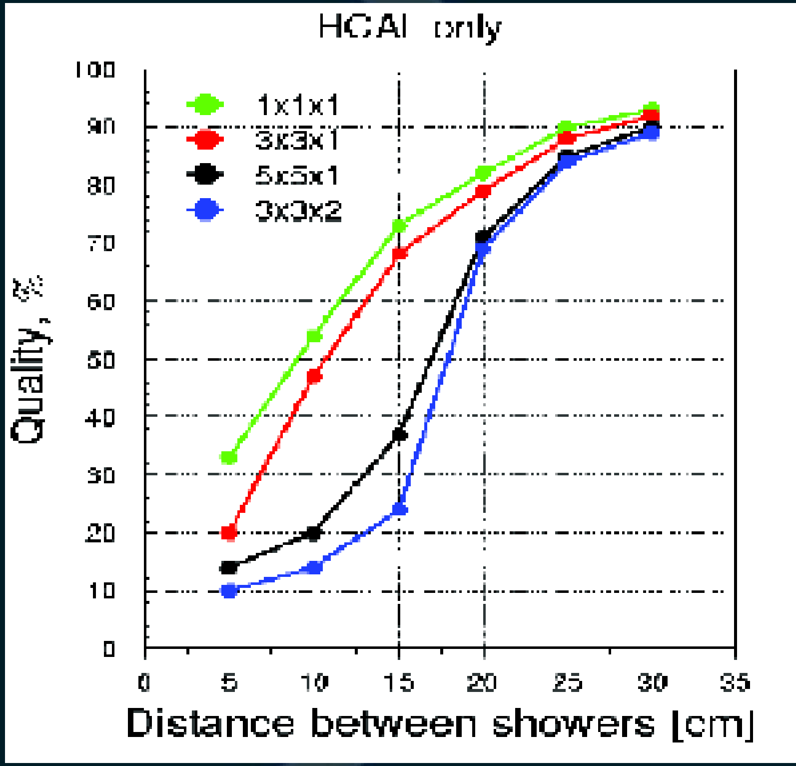
The two 's are 21 and 17 GeV
and are at 1.2 cm apart

HCAL
Felix Sefkow

Granularity

- Scintillators: trade granularity against amplitude resolution





- 3cm tile size optimized for shower separation – and semi-digital readout

List of questions set during the first week

Priority Items
----

1. B-field : is BR^2 the correct performance measure ?
2. ECAL radius
3. z ECAL endcap
4. Calorimeter total number of interaction lengths inside coil (ECAL + HCAL) : do we need 4, 5, 6.. lambda_I ?
5. Longitudinal Segmentation. How much does the longitudinal segmentation improve the ability to identify the particles in the jets in pattern recognition terms,
   rather than just being an issue about sampling frequency for calorimetric energy resolution.
6. Transverse Segmentation.
7. Compactness / Gap-size.
8. HCAL Absorber choice: Stainless Steel, W, U, Pb etc.
9. Circular vs Octagonal TPC and circular vs polygonal ECAL: how important are the gaps beteen TPC and ECAL
10. HCAL outside coil

Additional items perceived to be possibly of secondary importance

---

1. For events with missing energy, the forward part of the detector may be very important for correct reconstruction. This should be addressed by looking at jet energy resolution vs polar angle. Detailed studies though depend quite a bit on the actual accelerator design, and may not be that easy to pursue in a general manner.
2. Detection thresholds for tracks, clusters.
3. Momentum resolution. What would happen if we back off substantially in momentum resolution specs since these were not designed around particle flow but from the recoil mass to the di-lepton in Zh events? Method: degrade single-point resolution within the same B, R**2 geometry.
4. How important is lepton id to the detection of semi-leptonic heavy flavor decays (b, c) with neutrinos for jet energy resolution issues?
5. Particle ID. How much do we care about correct mass assignment to charged particles, particularly protons in terms of PFA?
6. Are backgrounds from gamma-gamma and the machine important to the PFA and are there detector design methods to mitigate these effects?
7. How important is 2-photon separation to particle flow, particularly after applying pi0 mass constrained fits?
8. Is a tail-catcher important for spotting late interacting K0L and neutrons?
9. Could the DREAM approach work in the forward endcaps where the tracking performace is starting to degrade?

Going to the studies done during Snowmass

Forward detection
Particle Flow Analysis
Magnetic field
Ancillary Si tracking

IP Instrumentation

Measurement of the Luminosity (precise and fast)

Wolfgang Lohmann,
DESY

August 2005

Snowmass Workshop

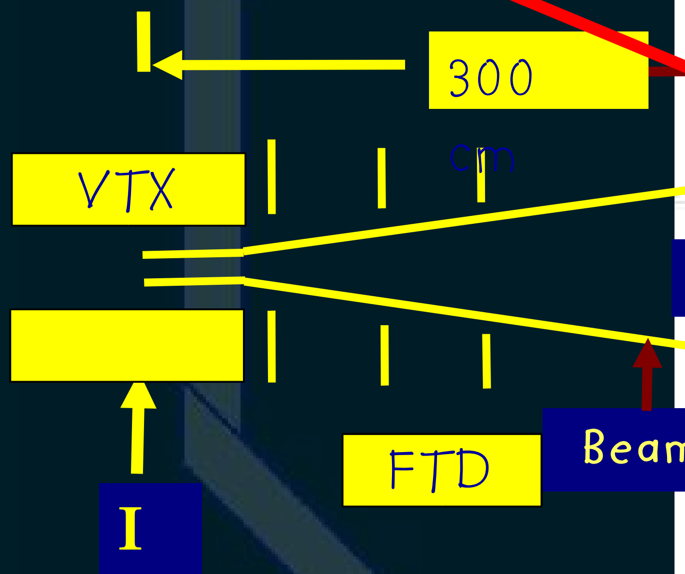
Precise Luminosity Measurement

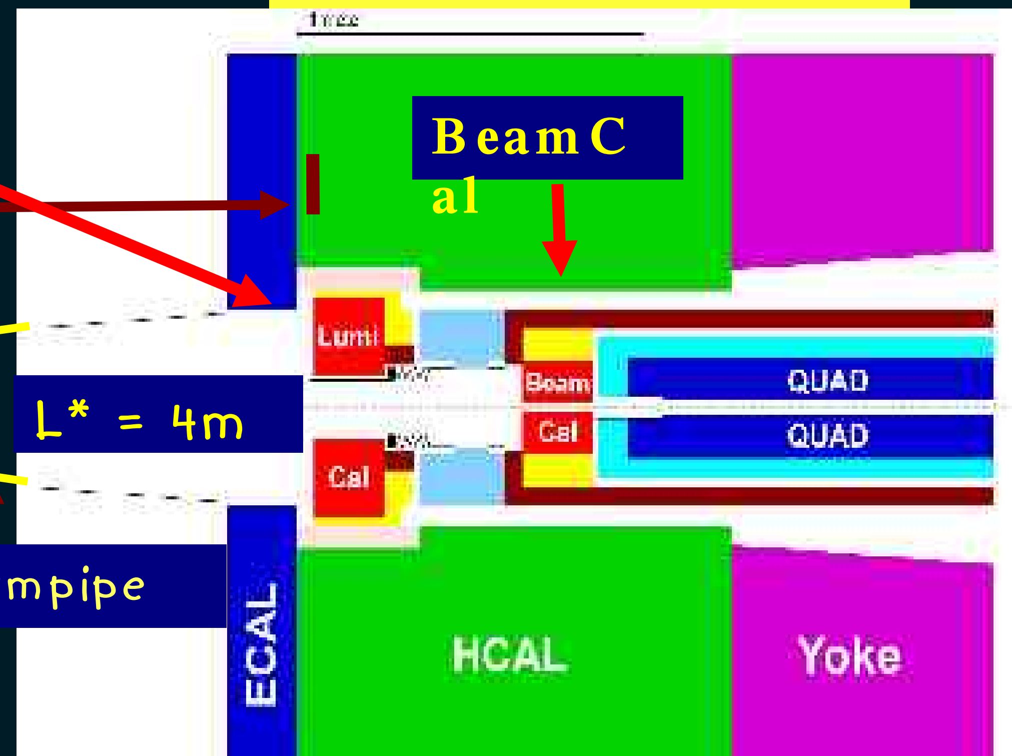
Gauge process: Bhabha Scattering

$e^+e^- \qquad e^+e^-$

Device: LumiCal

$26 < \theta < 82$ mrad





$$L = \frac{N_{LumCal} \qquad N_{bgr}}{_{Bhabha}}$$

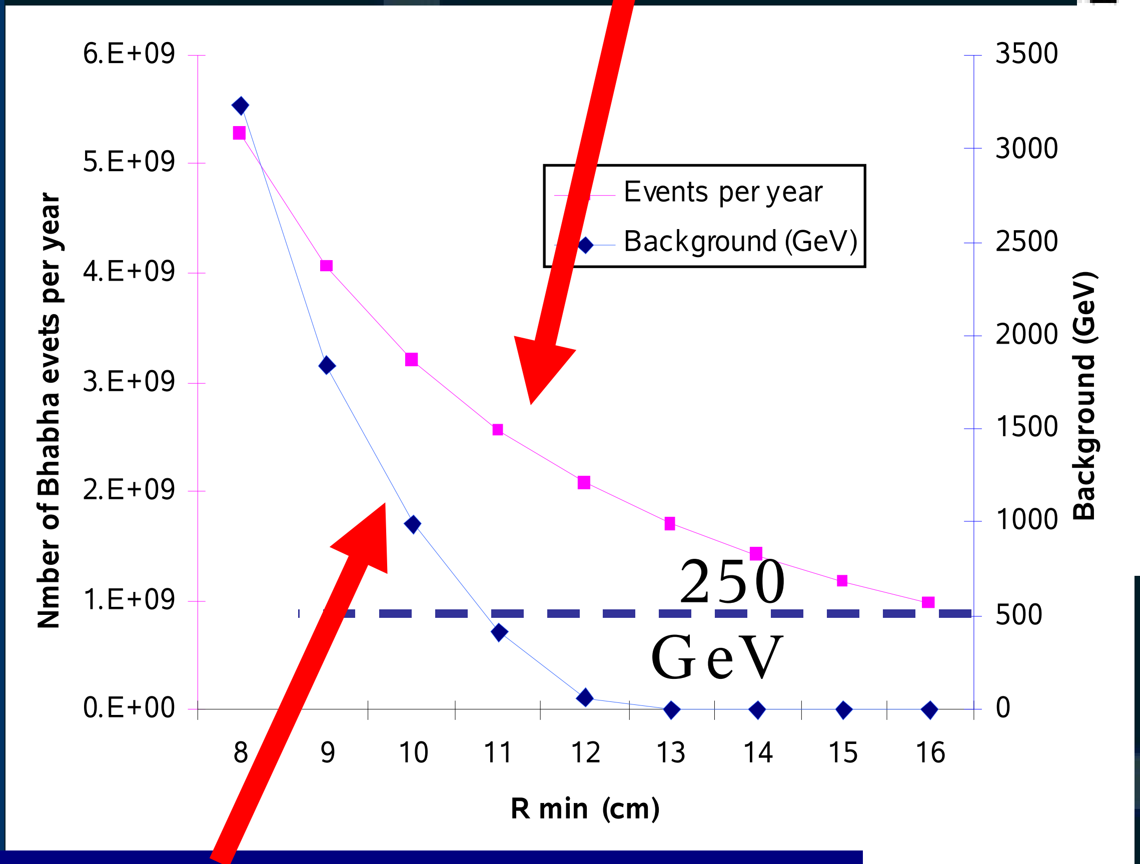
Accuracy (from Physics)
O(<10⁻³)

$(OPAL: \quad L/L = 3 \quad 10^{-4}(stat) \quad 5.4 \quad 10^{-4}(theo))$

$(ALEPH: \quad L/L = 6 \quad 10^{-4}(stat) \quad 6.1 \quad 10^{-4}(theo))$

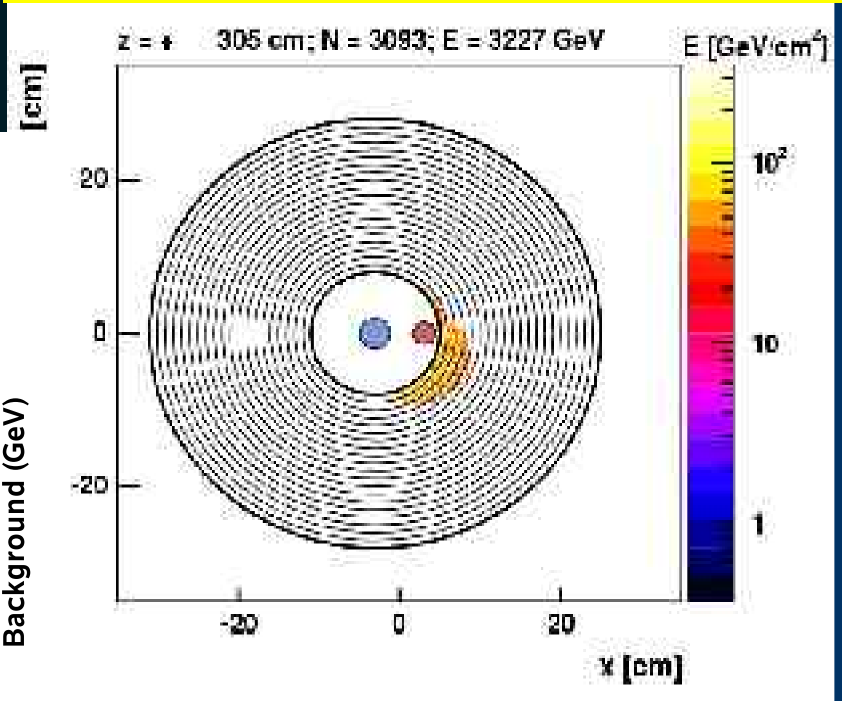
mrad crossing angle 20

Number of Bhabha events as a function of the inner Radius of LumiCal



Background from beamstrahlung

Beamstrahlung pair background using serpentine field



A design for 20 mrad crossing angle will be done (needs time)

The 20 mrad problem

The beamstrahlung background destroys the phi symmetry, essential for measuring accurately the luminosity.
It can be restored by making the LCAL inner radius larger but to keep the backsplash from the BCAL away it is needed
either to set the LCAL in front of the ECAL
or to push the L* to 4.5

Beam diagnostics and beam parameters determination using LCAL and BCAL and photocal

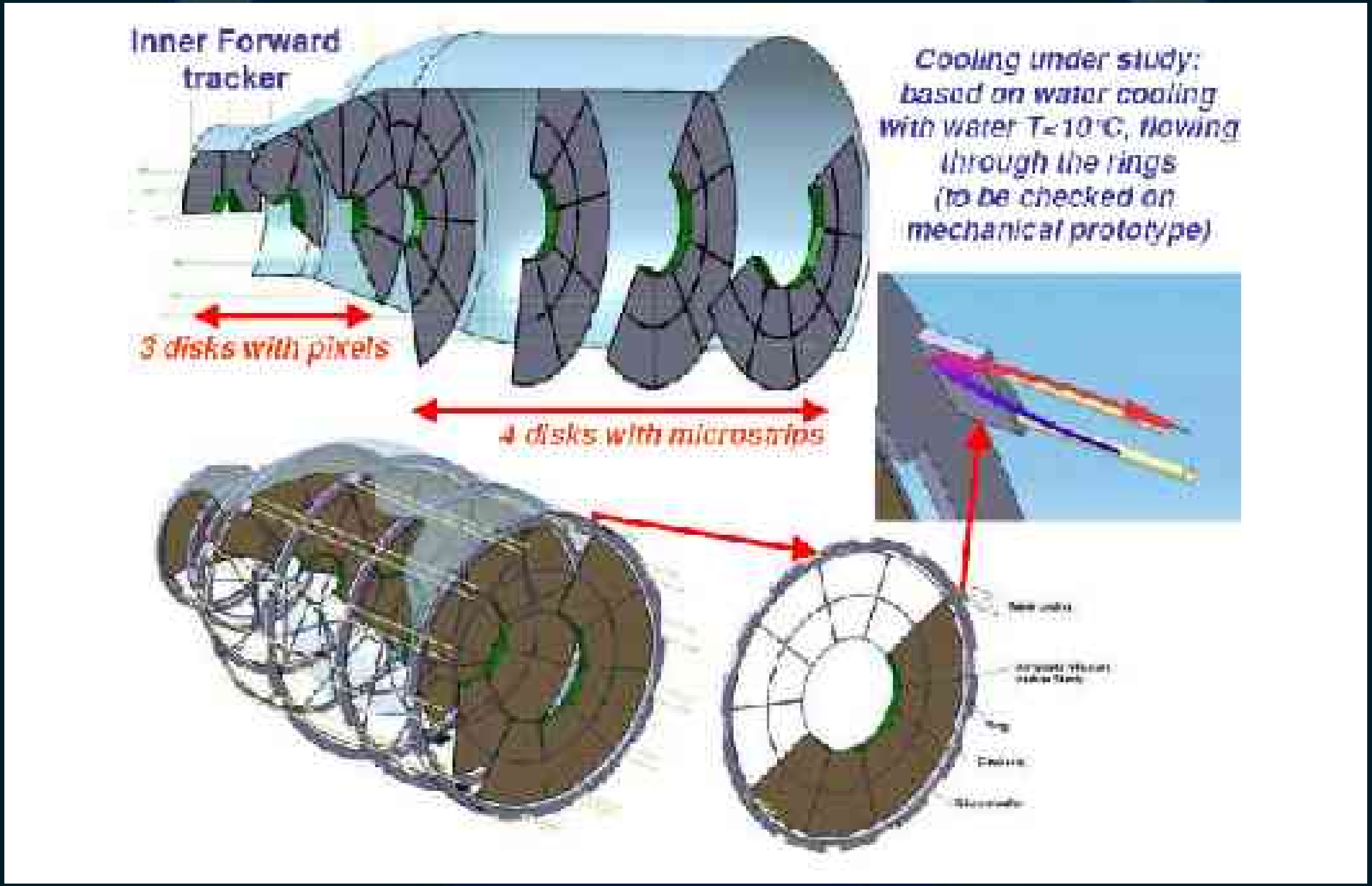
For a small crossing angle a pretty advanced design of the very forward region is worked out

For 20 mrad crossing angle many studies have to be redone

I hope we will be able to present a layout for the 20 mrad crossing angle case in a few months

Klaus Mönig

The forward tracker needs a common structure



PFA Progress and Priorities

Mark Thomson

(for Steve Magill, Felix Sefkow, Mark Thomson and Graham Wilson)

We are now in the position to start to learn how to optimise the detector for PFA

Prioritised PFA list

(from discussions + LDC, GLD, SiD joint meeting)

The A-List (in some order of priority)

1) B-field : is BR^2 the correct performance measure (probably not)
2) ECAL radius
3) TPC length
4) Tracking efficiency
5) How much HCAL – how many interactions lengths 4, 5, 6…
6) Longitudinal segmentation – pattern recognition vs sampling frequency for calorimetric performance
7) Transverse segmentation
8) Compactness/gap size
9) HCAL absorber : Steel vs. W, Pb, U…
10) Circular vs. Octagonal TPC (are the gaps important)
11) HCAL outside coil – probably makes no sense but worth demonstrating this (or otherwise)
12) TPC endplate thickness and distance to ECAL
13) Material in VTX – how does this impact PFA

The B-List

1) Impact of dead material
2) Impact (positive and negative) of particle ID - (e.g. DIRC)
3) How important are conversions, V^0s and kinks
4) Ability to reconstruct primary vertex in z

Goals for Vienna:

★ B-field dependence:
- ✦ Requires realistic forward tracking (HIGH PRIORITY) – **Who ?**

★ Radial and length dependence:
- ✦ Ideally with > 1 algorithm

★ Complete study of "perfect particle flow"

★ Try to better understand confusion term
- ✦ Breakdown into matrix of charged-photon-neutral hadron

★ Study HCAL granularity vs depth
- ✦ already started (AR)
- ✦ how many interaction lengths really needed ?

★ ECAL granularity
- ✦ how much ultra-high granularity really helps ?
- ✦ granularity vs depth

Effect of the field on PFA

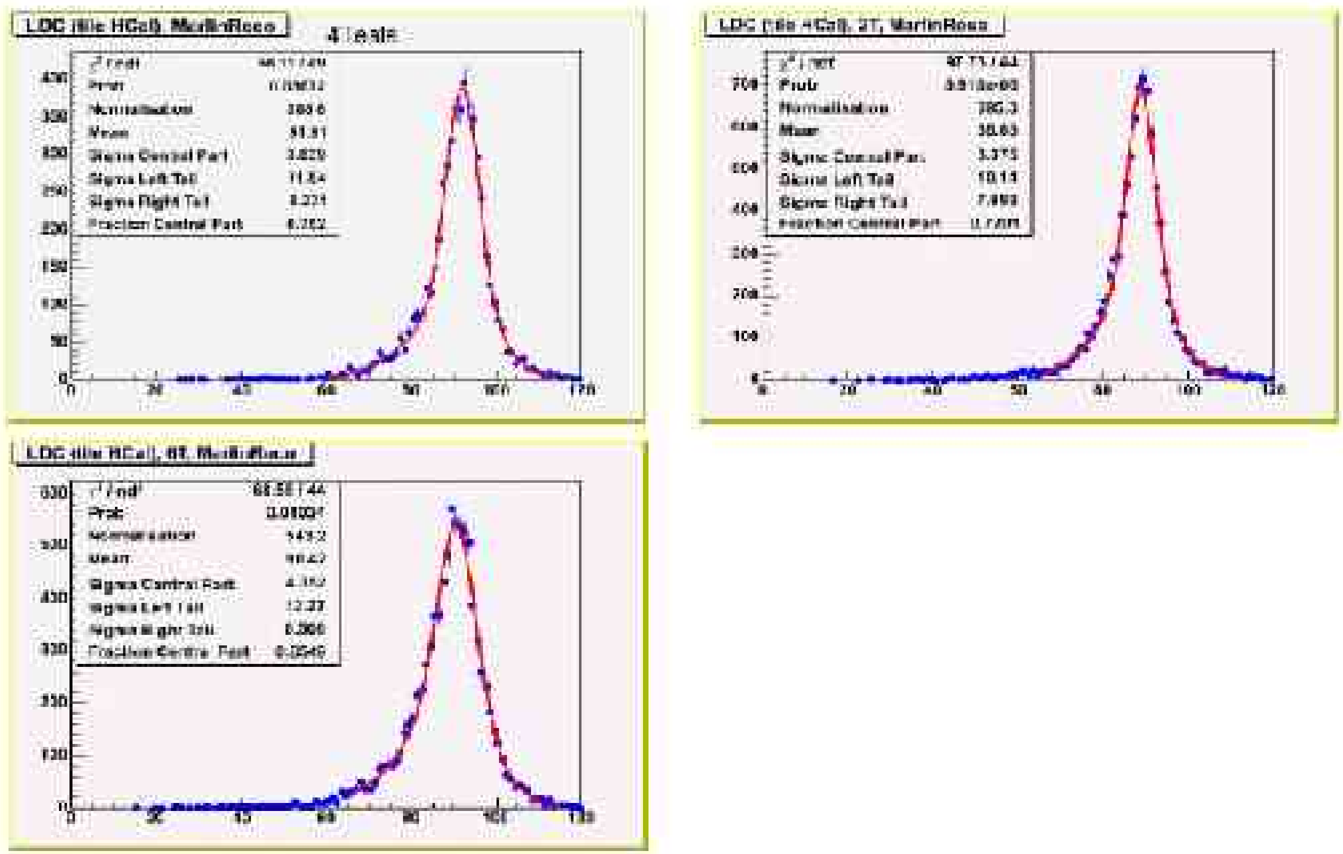
Alexei Raspereza

Simulation

- Z^0 => u, d, s jets @ Z pole : 10000 events
- LDC detector with tile HCAL (3x3 cm tile size) with 2 and 6 T fields
- Simulation is done with Mokka (D12scint model) on GRID
- Reconstruction with MarlinReco, TPC tracking and Clustering only + PFA
- Simulation and Reconstruction done on GRID

Elaborated software tools worked during the worshop

Preliminary Studies



It looks like the PFA performance at the Z degrades with the field. Needs cross-examination.

LDC question TR_7: Magnetic Field

Daniel Peterson
Cornell University

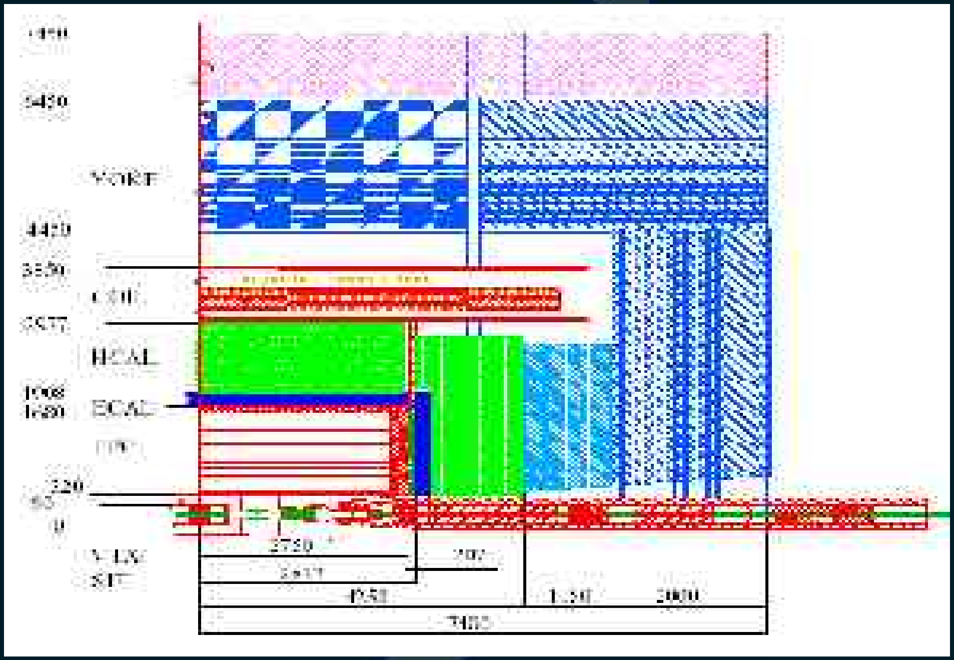
What quality of the field do we need in the TPC, SIT, and other detectors?

How can we measure and monitor the field distortions at the required level of accuracy?

Can the large distortions in the large crossing angle be accounted for?

Can control samples be used to improve the knowledge of the field map?

Does it make sense to eliminate the plug, at the cost of a shorter magnet and thus a less homogeneous field?



Of course, this is all preliminary.

How can we measure and monitor the field distortions at the required level of accuracy?

Mapping the magnetic field to an accuracy of $\delta B/B < 1 \times 10^{-5}$ is a difficult measuremen

The Aleph field map was internally self consistent to 40×10^{-5}.

The map measurements are fit to conform with Maxwell's equations.
Differences of the corrected map, with respect to a model of the magnet, are within 40×10^{-5} .

However, the "consistency" is not a direct measure of the accuracy.

The observed Aleph momentum resolution imples that the field map has an accuracy of $\sigma_0 = 70\mu m$.
Thus, a magnetic field uncertainty achieved was

$$\delta B/B = 70mm/30mm \times (1.5 \times 10^{-5}) = 3.5 \times 10^{-5}$$

We must measure the field map to the best possible accuracy, probably 3.5×10^{-5}.
We will require an independent measurement of the field distortions to achieve the required accuracy, 1×10^{-5} .

Controlling the distortions by measuring tracks using laser

Specific to TPC
Disentangling the effect of the field
on the trajectories,
on the drift of the electrons

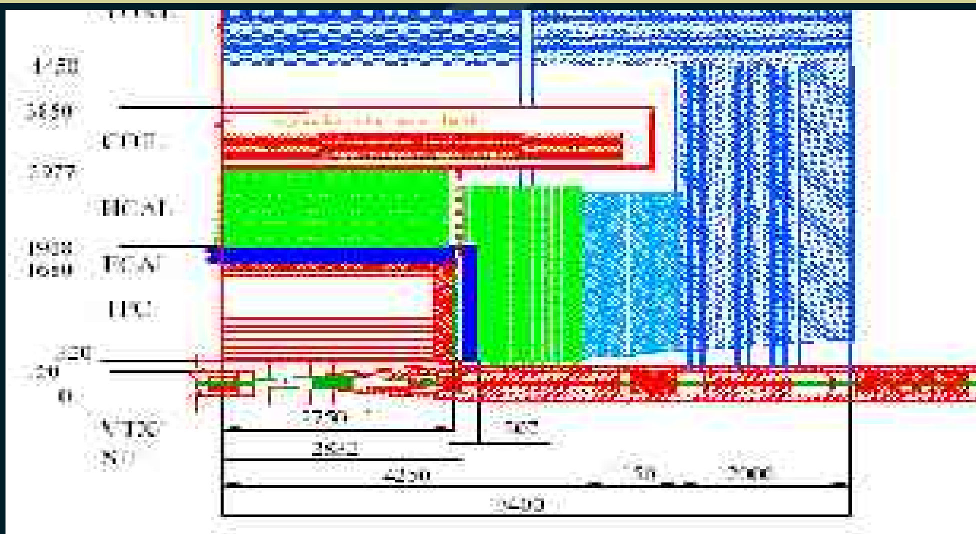
At LDC, we can also use the tracks to measure magnetic field correction in the drift trajectory if the track trajectory is in a region of high-uniformity magnetic field.
(It may be necessary to use only track trajectories near z=0.)

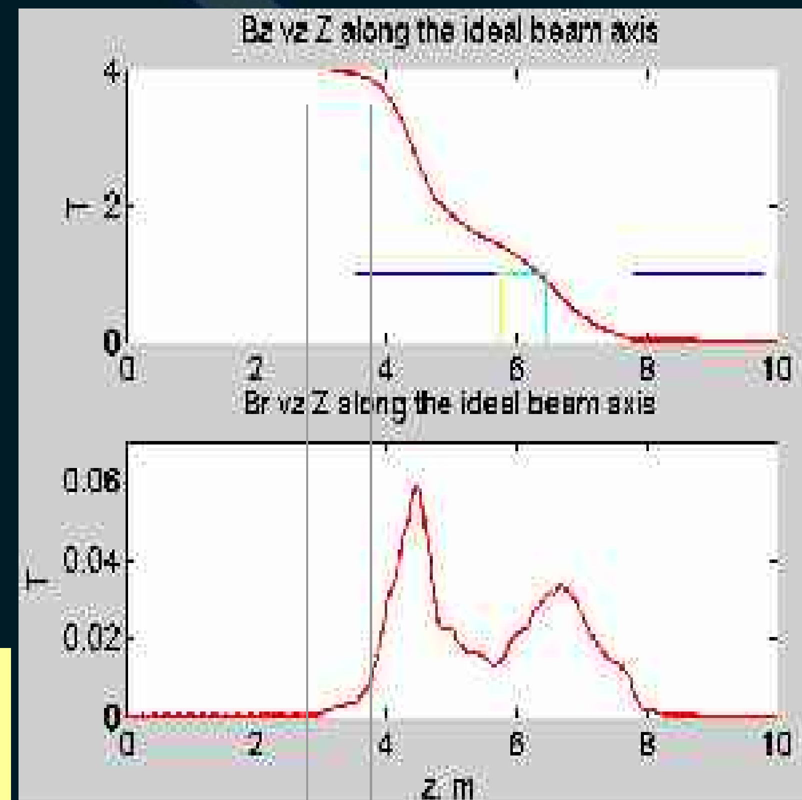
The two-track fits can also be used to align the VTX and SIT.

DID!   not trivial at all

Does it make sense to eliminate the plug,

at the cost of a shorter magnet and thus a less homogeneous field?





This changes B_z by only 5%, at the maximum Z.
The B_r component of < ¼ %.
It is all azimuthal independent.

Does it violate the uniformity of $< 10^{-4}$ close to z=0 , as will be needed for the control sample tracks?

Extent of TPC: 2.7m

Field at 3.8m, length of TPC plus a distance equal to the length of the plug

Conclusions

Field quality, or uniformity, of 1×10^{-5} can not be achieved.

Systematic uncertainties must be limited to this precision
avoid introducing systematic error into the VTX and SIT alignment.

All track trajectories and drift trajectories must be corrected by mapping or a transport fit.

The magnetic field should be measured to an accuracy of 1×10^{-5}
with all compensation magnets and iron in place.

One can not rely on finite element analysis for the measurement of the solenoid field.

To provide an independent measure of the drift trajectory distortion,
Locate the readout sub-panels to 12 μm. Use lasers to measure the distortion of the drift trajectory.

Hypothetically, the resolution of a two-trackfit, without the VTX or SIT, is $\delta(1/p_t) = 4 \times 10^{-5}$/GeV,
and is competitive with single track system resolution.

Two-track fits can be used for consistency checks of the drift trajectory distortion.
and for aligning the VRX and SIT.

The magnetic field of the “DID” must be understood at the level of 5×10^{-4} (of itself) .
However, the “DID” contributes significant non-homogeneity near z=0.

Removing the plug appears to be a smaller perturbation that the “DID”.
But a field uniformity of 10^{-4} is required near z=0 to for the control sample measurements.

Provided the uniformity is adequate in a meter at the center of the TPC, the coil can be shortened, the plug suppressed.
A slight reduction of the length of the TPC enables then to have a natural length for the ECAL barrel (related to the optimisation of the silicon)

But DID!

and the electrostatic effects!

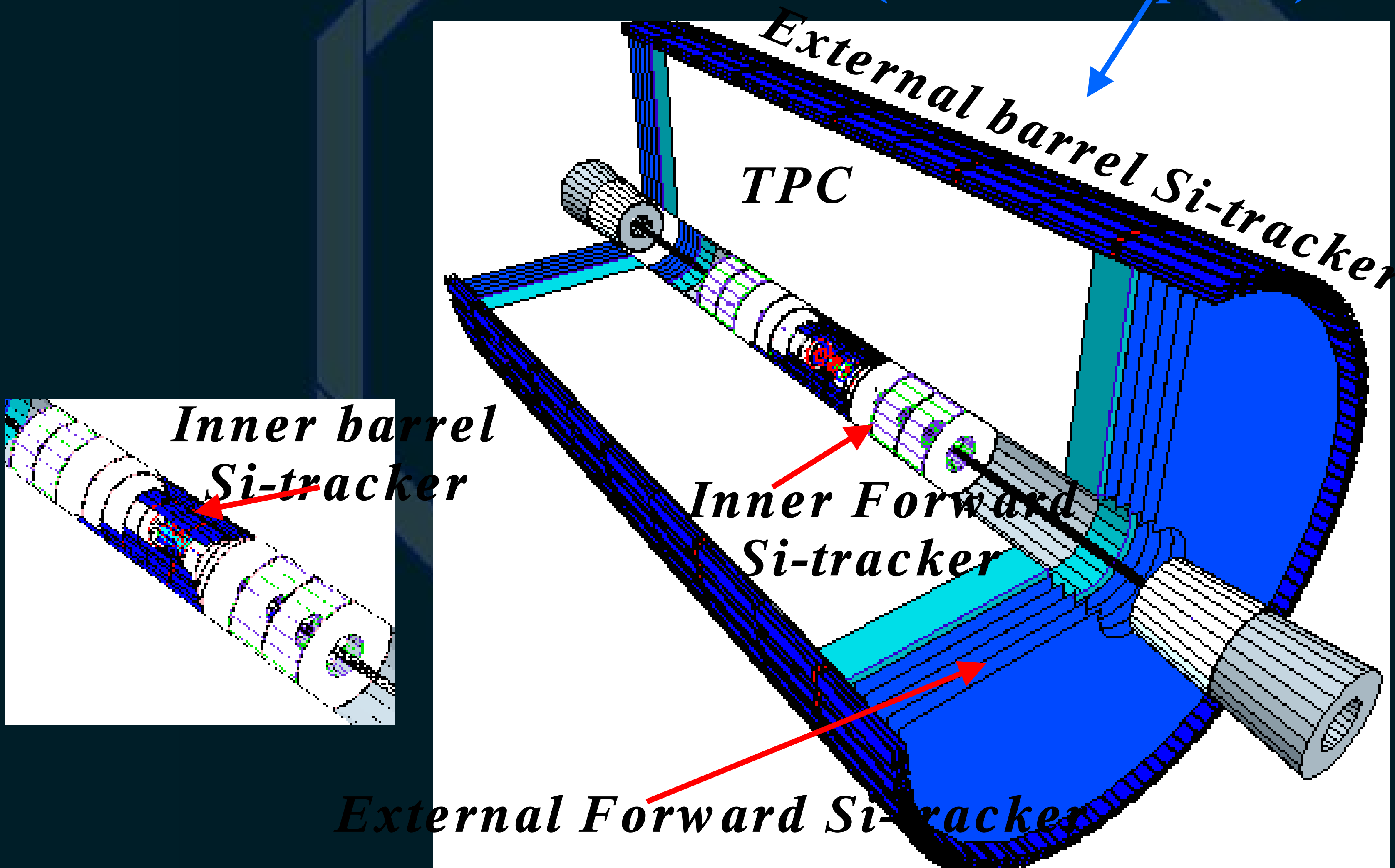
The Si trackers in the LDC concept

Rick Van Kooten, Valeri Saveliev, Aurore Savoy-Navarro, Lee Sawyer

- Scope of the group charge
- Reminder of the Si tracking components in a LDC concept
- Common issues to all the Si tracker components
- Specific issues by component
- Prospects

Studies have been developed on the four elements of detection in silicon under consideration: SIT, FTD, FCH, SET

The 4 Si-components = the Si-Envelope are included in the MOKKA framework (DB description)



Vdet, inner tracker and forward tracker would have a common mechanical structure to assure the alignment precision

All the services to be handled in a common way between the inner parts and the Vdet.

Inner tracker: increase to 3 layers?
Forward disks: make the firsts with pixels
Forward chamber: number of layers?
SET: see next

The Silicon outer tracker in the central region

This component ensures the connection between the central tracking and the calorimetry in the barrel. It improves the momentum resolution and possibly other performances (see below).

Specific issues for this component:

- Number of layers? Strip length? *(revisit the SGV study & pursue GEANT based simulation)*
- How much better than a dedicated first layer in the em calorimeter? *(idem as previous point)*
- Issues on material budget: *optimisation with respect to the field cage especially when going away from the 90° region?*
- Occupancies:
  V. Saveliev' occupancies G4 studies *will be pursued.*
- Cluster matching capability, PFA impact? *(SGV & GEANT-based simulations studies)*
- Any need for preshower capability (pi0 separation?): *already studied with SGV, will be further addressed with detailed simulation.*
- Impact on Physics
- Integration issues wrt to TPC (reduction in the TPC radius) *(SGV & GEANT-based simulations studies)*
- Integration issues with the ECAL (space allocation, mounting) *(SGV & GEANT-based simulations studies)*

A. Savoy-Navarro, LPNHE-Paris

Conclusions

The software tools to optimise the detector are now at hand

A new baseline detector should be defined with smooth possible variations. ~Vienna?

A parametrisation of the performances against a reasonable set of parameters should be provided. ~Bangalore

An estimate of the cost of the detector and its scaling with the parameters shall exist. (scaling for the cost driving items). end 2006?