Detectors at SNOWMASS

Snowmass had a dual purpose (maybe tripple?)

- be a detector and physics ILC workshop
- serve as the second ILC machine workshop
- provide enough barbecue etc time to bring both communities together

history:

started as regional physics and detector workshop (ALCPG)
then got re-invented as SNOWMASS
then got extended to include the machine
then became international detector / physics workshop

FOCUS: clearly on the machine and the definition of a new baseline

Detector and Physics

concentration on detector concepts plus usual physics WG

will review only concepts / detectors, not physics

schedule:

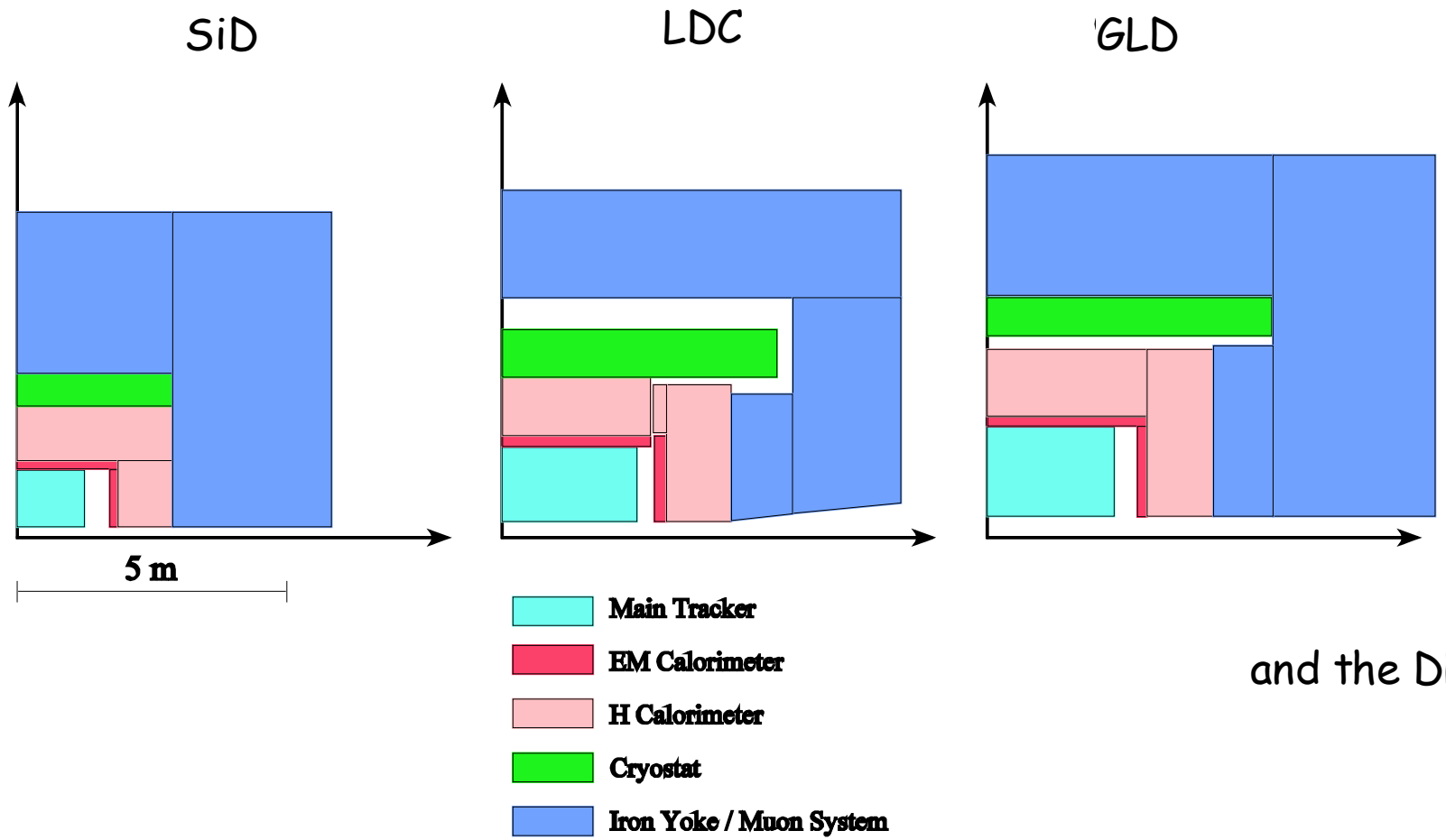
three parallel streams for

SiD --- LDC --- GLD

advantage:
a fair bit of time for the concepts and for serious work on the concepts

disadvantage:
„balkanisation" of the community, little interaction between concepts, duplication of many talks and efforts.

Current Concepts: a reminder



and the DREAM

"small" "large" "huge"

...but actually the differences are not that big...

The concepts: a reminder

LDC / SiD : TPC + ~ size + ~ field

LDC / GLD : Si_W calorimeter + ~ size + ~ field

but for recent evolution

LDC „lives" between SiD and GLD

with significant overlap tp both concepts.

a new „concept" at snowmass: based on DREAM calorimeter

Concepts at SNOWMASS

Different concepts used Snowmass differently:

SiD: try to build the group, bring together nearly all interested people, do a real „baseline design effort"

very closed group operation, minimal overlap or exchange with the other groups

LDC, GLD: more like a conventional workshop,
also driven by much smaller number of people attending.
community was far from complete

significant and very frutiful exchanges between LDC and GLD, in particular in the area of particle flow.

Goals of snowmass

Since the creation of LDC
and the nomination of the contacts

- LDC scetch document: summarise the current state, list open questions
- document is available on http://www.ilcldc.org
- idea for snowmass:
  - Try to complete the list of questions,
  - try to work our priorities
  - provide a roadmap towards answering the questions

Discussions at snowmass

Discussion centered around the following sub-topics:

- particle flow (a lot of it together with GLD, some exchange with SiD)
- vertex detector design (in close cooperation with the VTX detector group)
- tracking design: magnetic field, role of additional tracking
- very forward region design

for LDC: working groups were defined at snowmass which looked into the questions and tries to come up with first ideas / answers/ discussions

Particle Flow

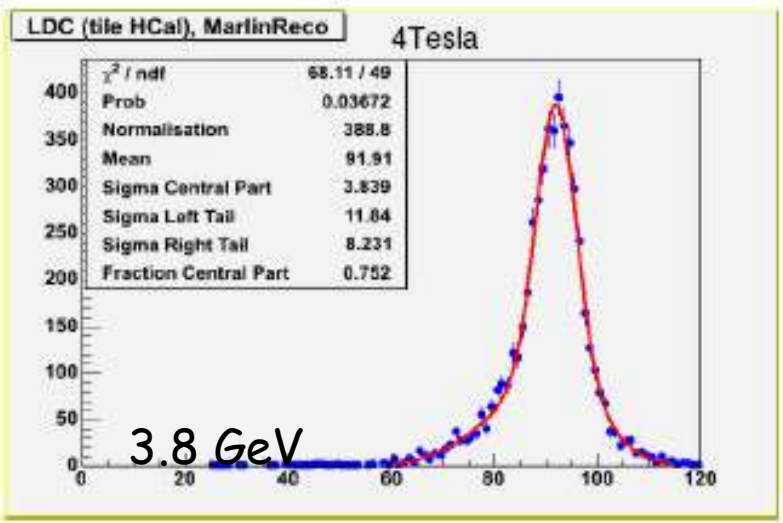
The A-List (in some order of priority)

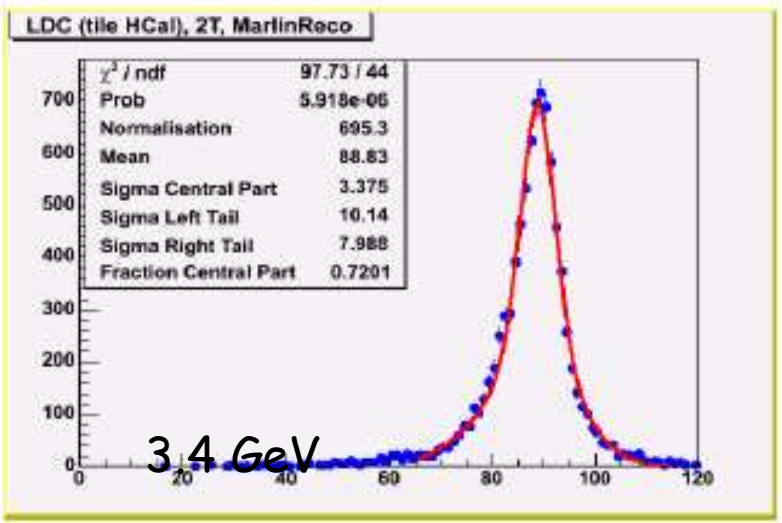
1) B-field : is BR^2 the correct performance measure (probably not)
2) ECAL radius
3) TPC length
4) Tracking efficiency
5) How much HCAL – how many interactions lengths 4, 5, 6…
6) Longitudinal segmentation – pattern recognition vs sampling frequency for calorimetric performance
7) Transverse segmentation
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

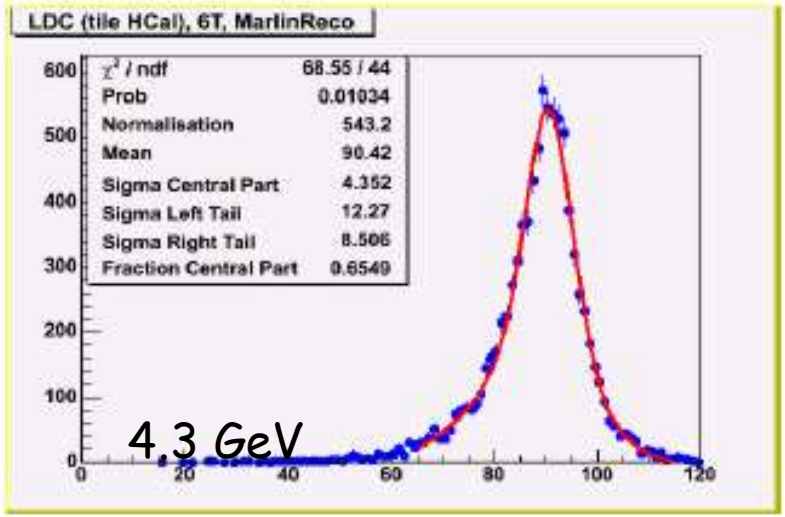
The B-List

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

B-field dependence



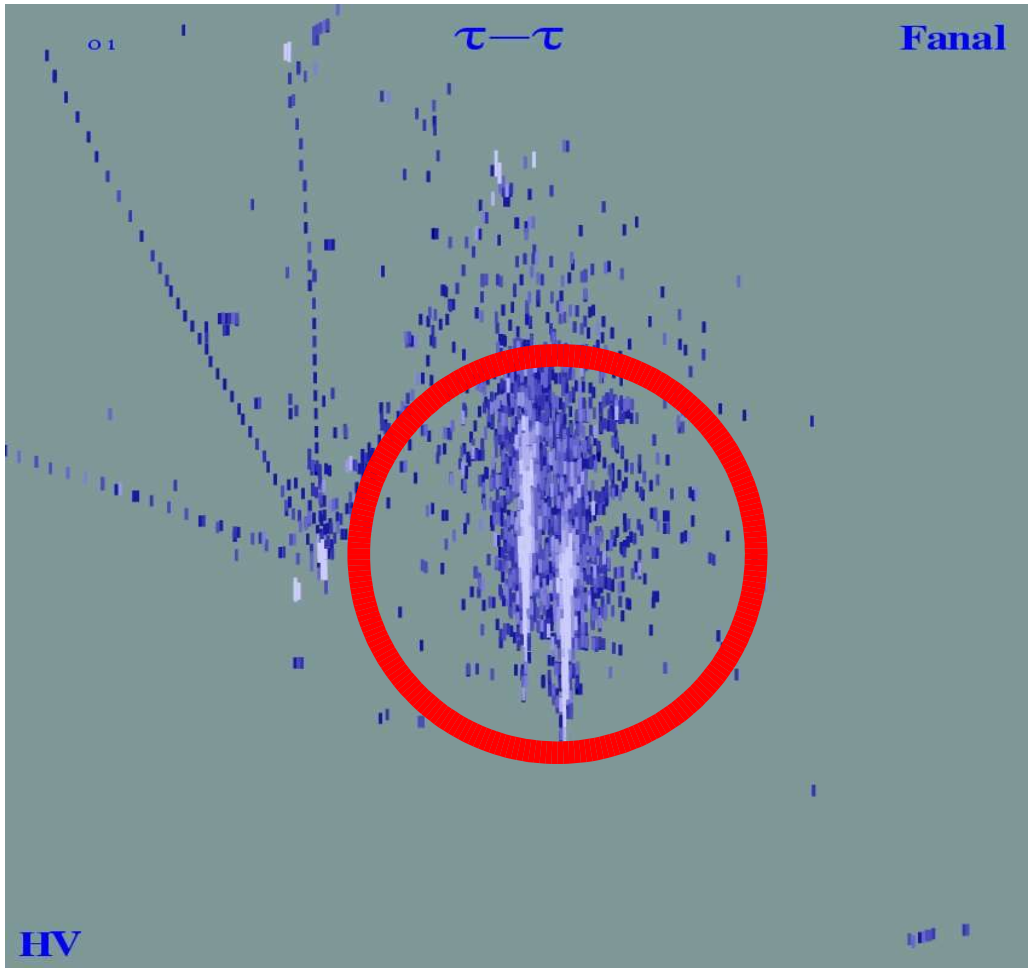




performance seems to deterioate with higher B-fields:
not yet understood, studies are under way

Alexei, Dennis, Predrag, DESY ILC group

Granularity ECAL



simulation done with 1x1 mm2 granularity

typical ECAL granularity:

at the moment 1x1 cm2

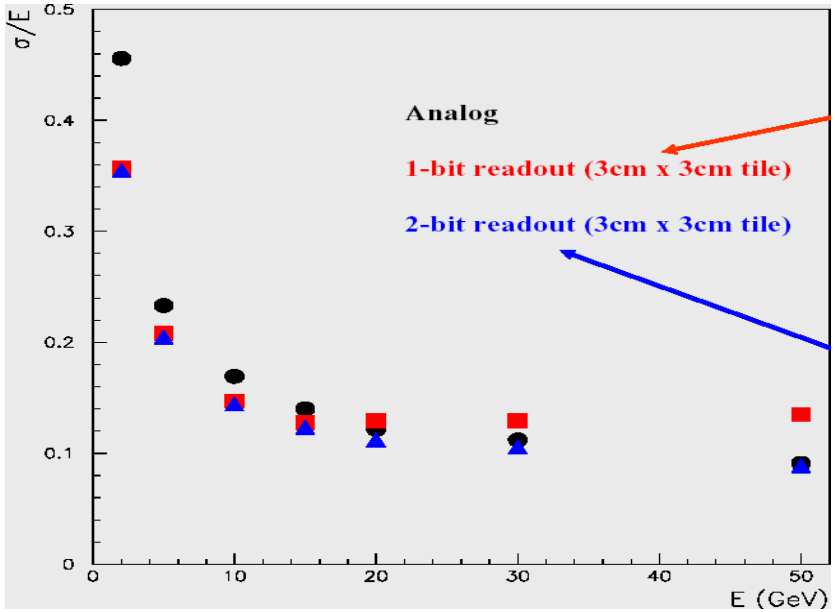
Does it make sense to improve the granularity:

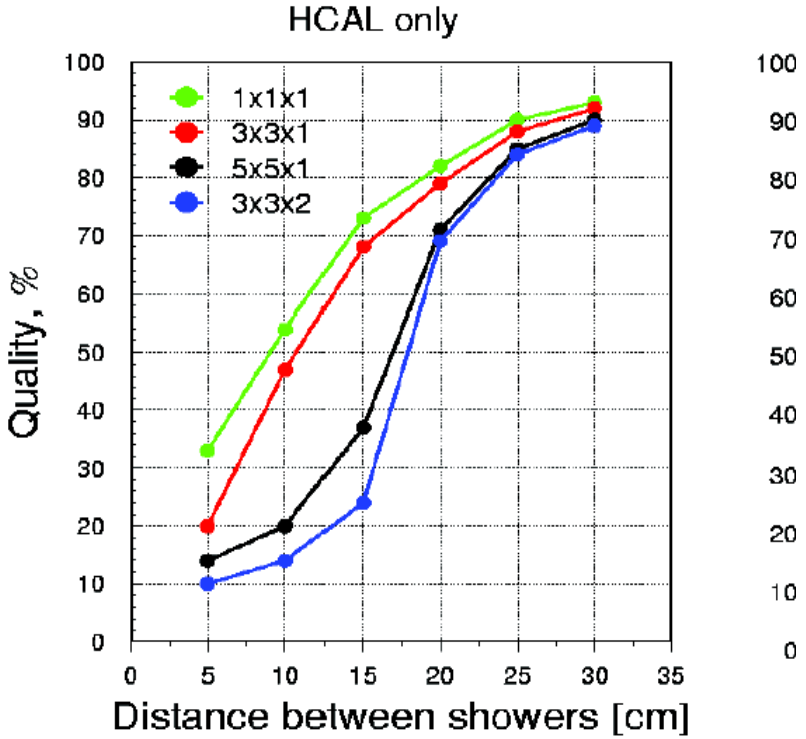
needs serious simulation study

Granularity: HCAL

HCAL
Felix Sefkow

- Scintillators: trade granularity against amplitude resolution





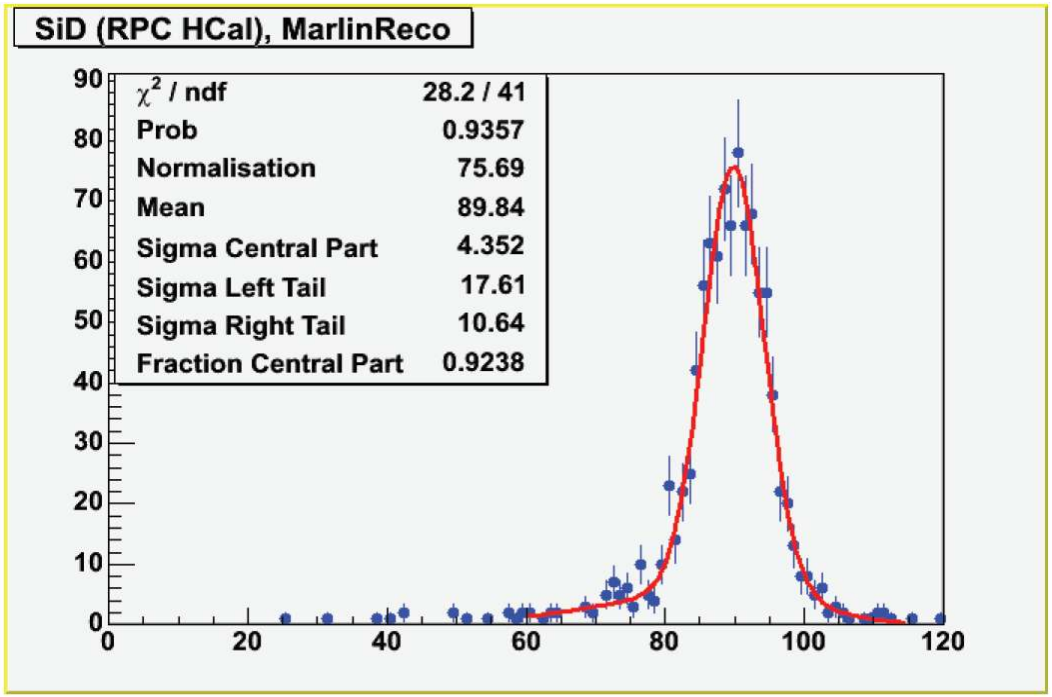
- 3cm tile size optimized for shower separation – and semi-digital readout

Other Questions: PFLOW

in general tools to study PFLOW are becoming available

opens the door for many more detailed questions to be studies

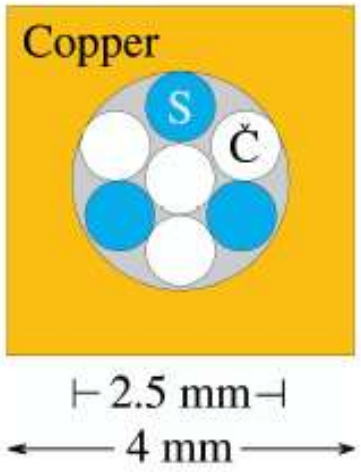
example: role of neutral long lived particles, 2 photon separation, ...



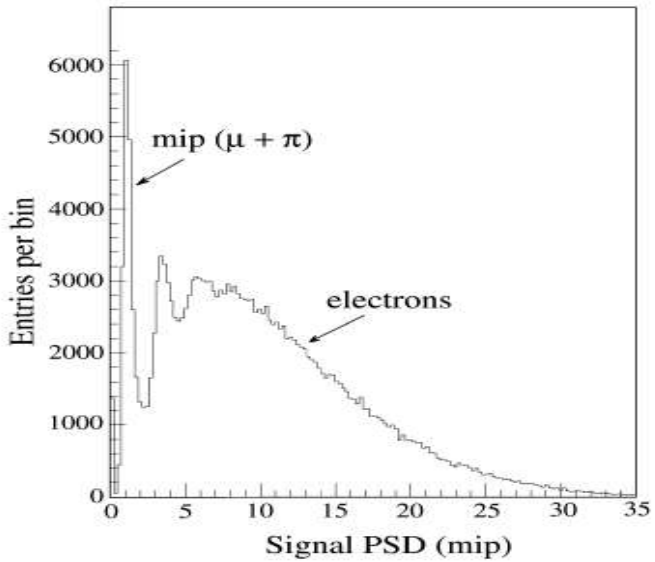
example: Z0 reconstrution, full PFLOW implementation MARLIN package (LDC) applied to the SiD detector

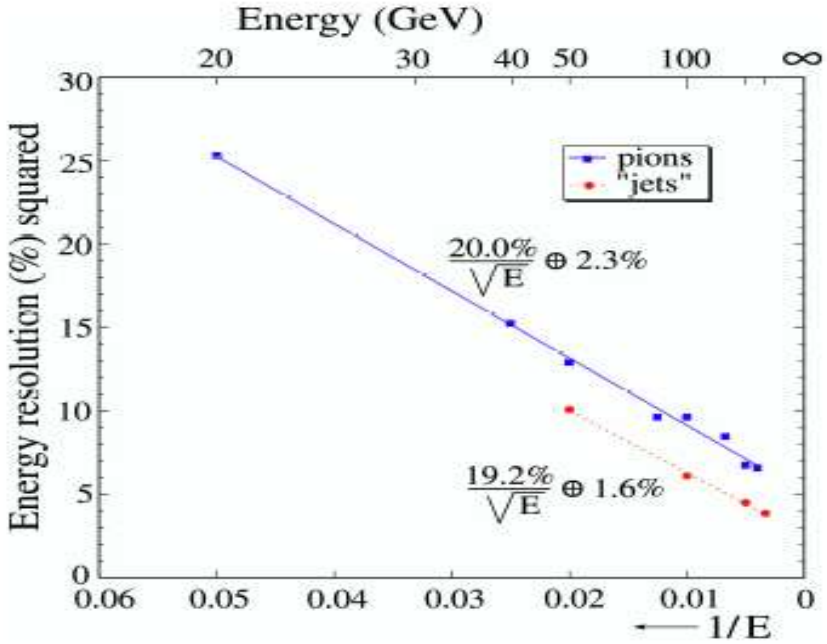
The DREAM concept

idea: very different approach to calorimetry



fiber calorimeter,
different fibers measure different particles
Cerenkov for EM
scintillation for total energy





Vertex Detector

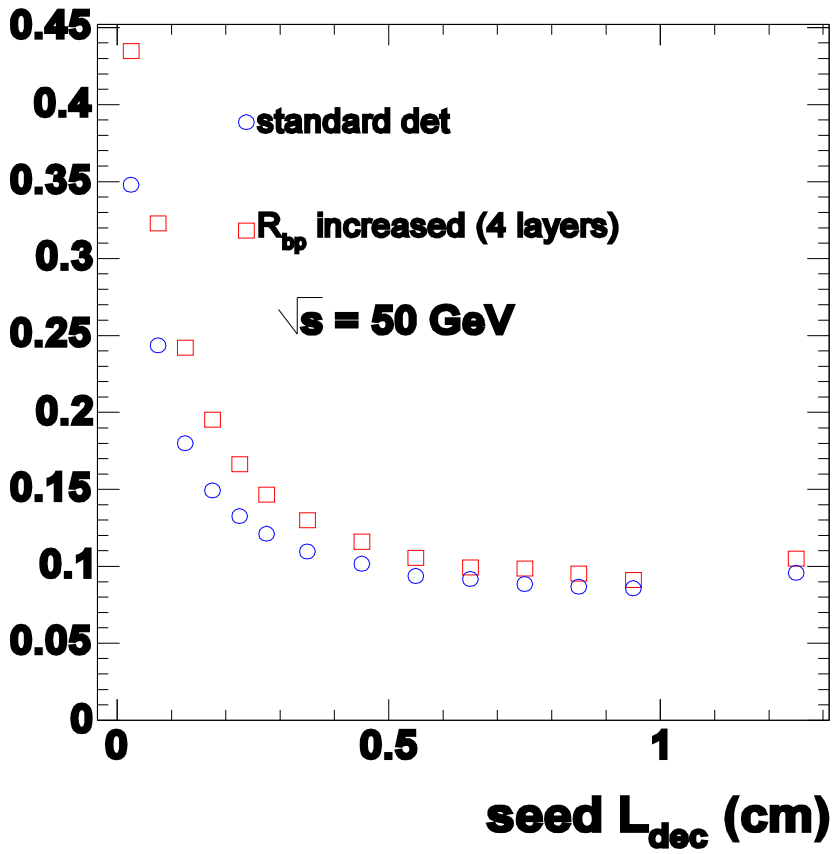
Amazing range of technologies are being discussed

Nice: first studies were presented to try and better justify the radius and number of layers of the VTX with channels other than H->cc

example:
try to estimate luminosity factor

make VXT worse:
need more luminosity

Reaction: Vertex charge determination in B events



Additional Tracking

Additional tracking devices under consideration for non-SI concepts:

intermediate SI tracker (SIT for LDC)

forward SI tracking disks (FTD for LDC)

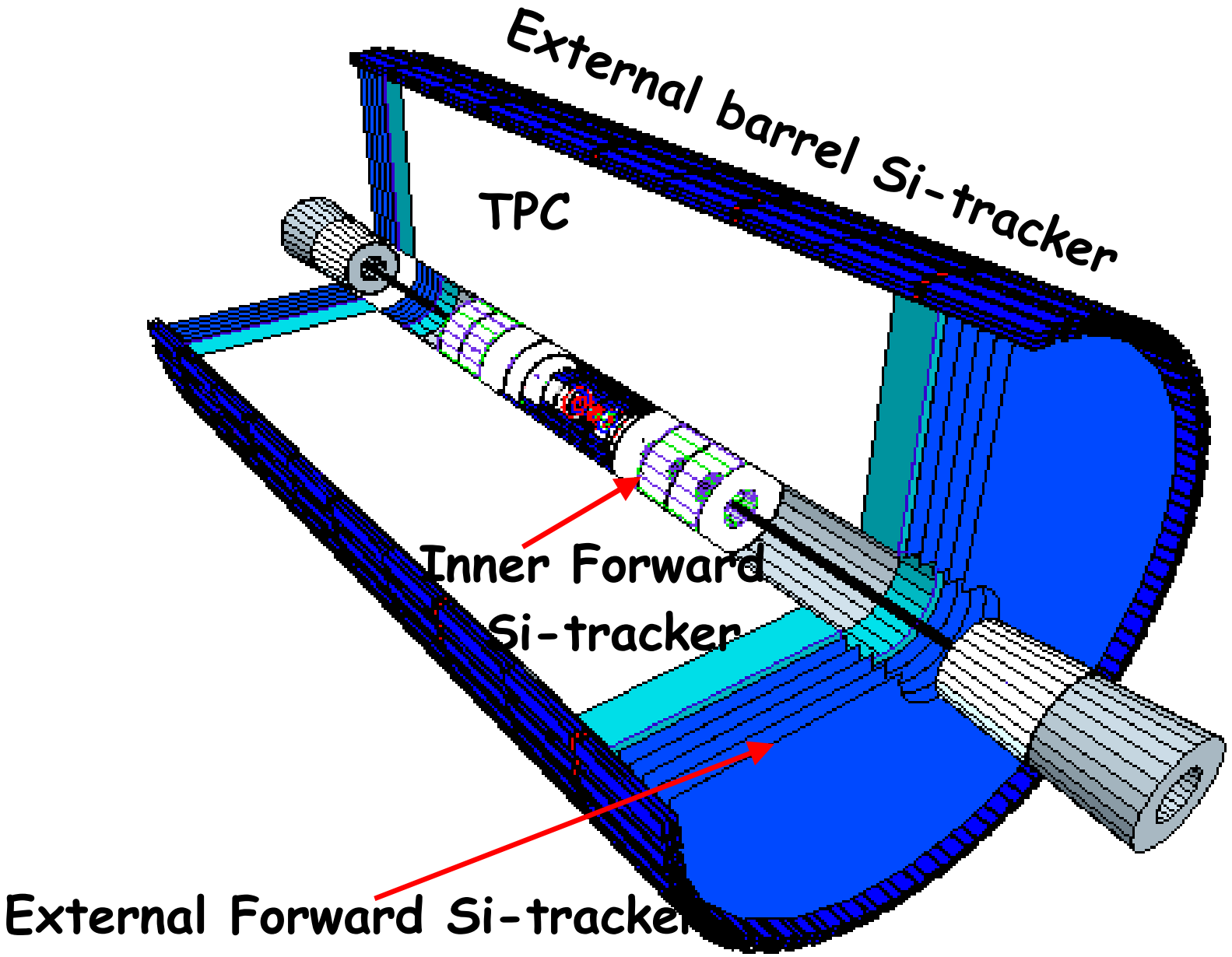
forward chambers behind TPC endplate (FCH for LDC)

Outside SI tracking in front of ECAL (SET for LDC)

Questions:

have to justify these (expensive) detectors
study clear physics cases for each of them

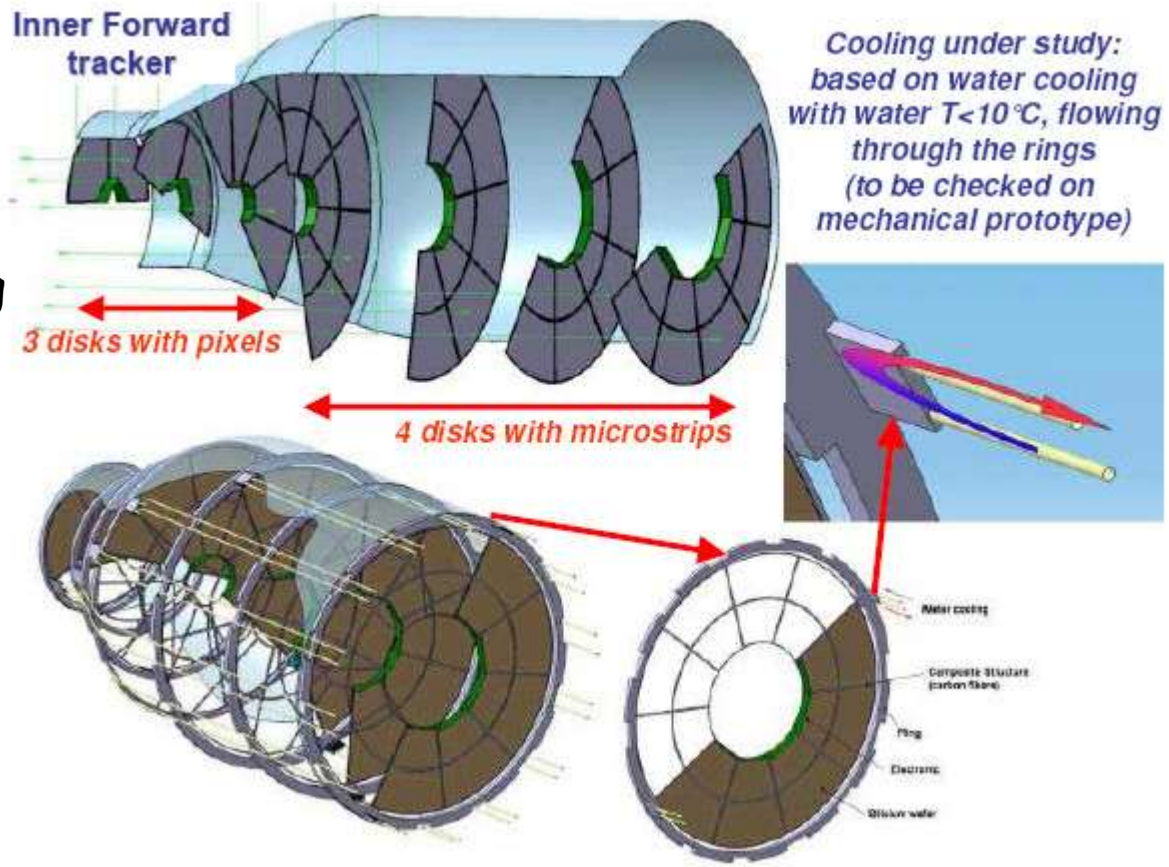
Additional Tracking



Inner Silicon

Important question: Materials, supports

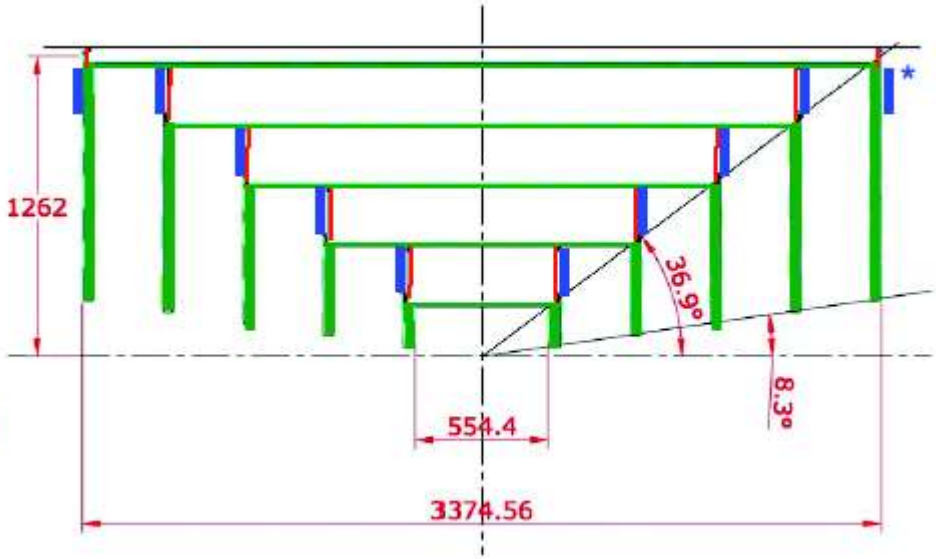
start to see
serious enginieering
efforts

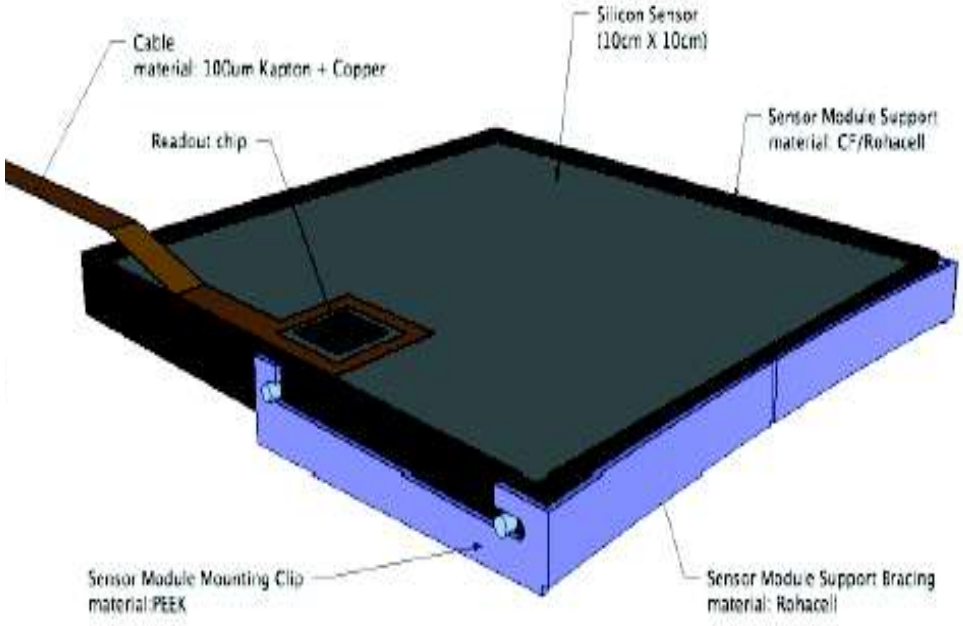


design by Paris:
rejected, people think that we need common support for SIT, FTD and both sides

SiD mechanical ideas

- Closed CF/Rohacell cylinders
- Nested support via annular rings
- Power/readout motherboard mounted on support rings





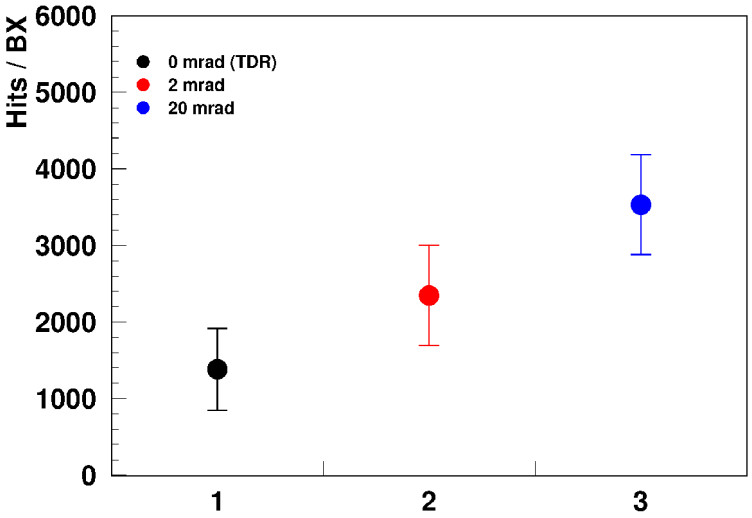
- Cylinders tiled with 10x10cm sensors with readout chip
- Single sided (ϕ) in barrel
- R, ϕ in disks
- Modules mainly silicon with minimal support (0.8% X_0)
- Overlap in phi and z

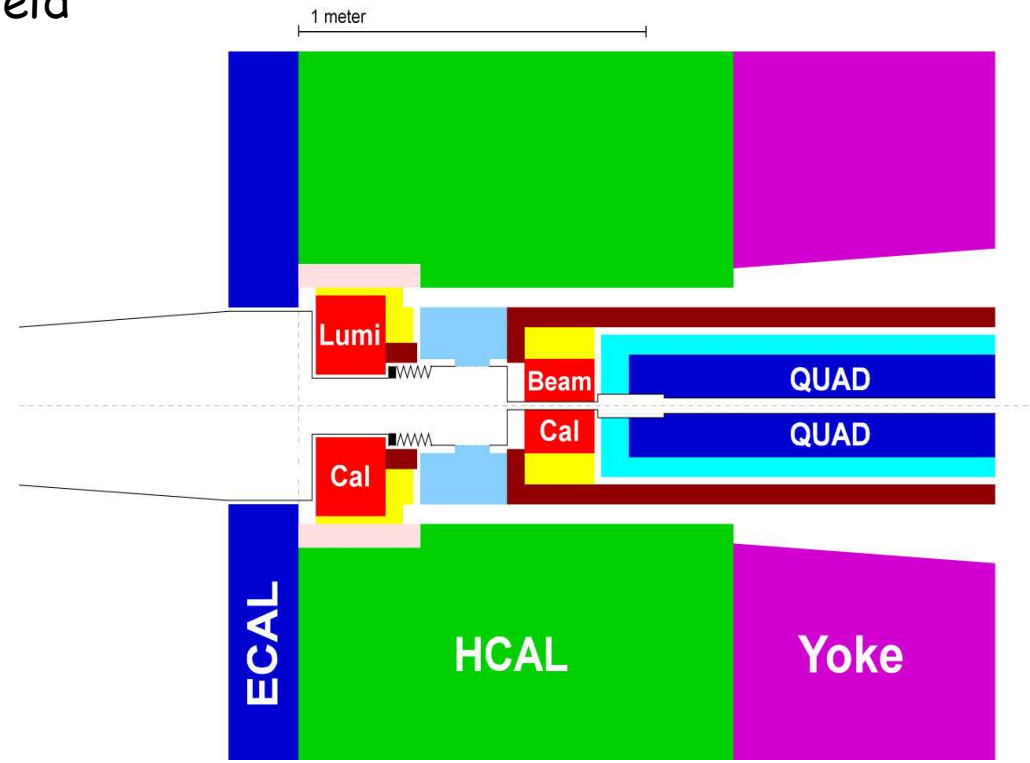
Forward Direction

Questions:

- 20 mrad crossing angle
- B-field: serpentine field, DID field
- backgrounds, optimization

LDC baseline design for small crossing angle (most elaborate design at the moment)





background rates for different configurations

Magnetic Field

Questions asked and discussed:

With which precision do we need to know the B-field?

WITHOUT a superimposed magnetic field (DID):

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} .

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

discussed possibility to use z=0 tracks to do this

Situation is much more complicated WITH DID

Conclusion: knowledge of field to 3.5×10^{-5} is needed, THEN correct tracks
region of very good uniformity somewhere is very useful (z=0)

Conclusion on concepts

three concepts are being developed, progress was made for all of them

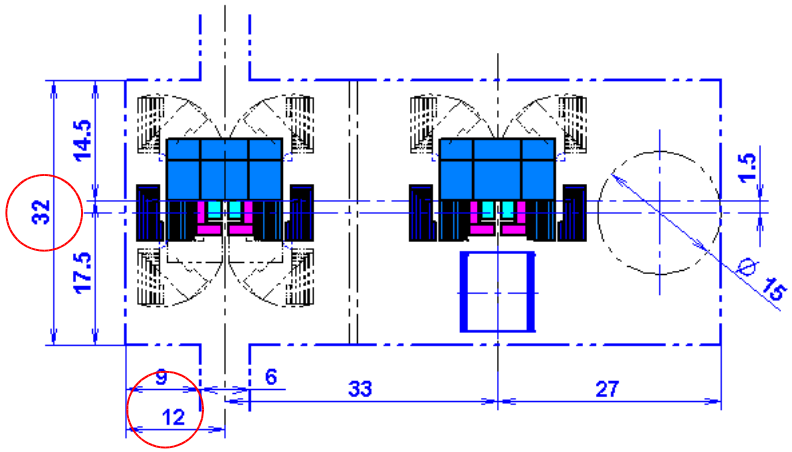
important: many tools are becoming available, which do allow more studies and serious studies

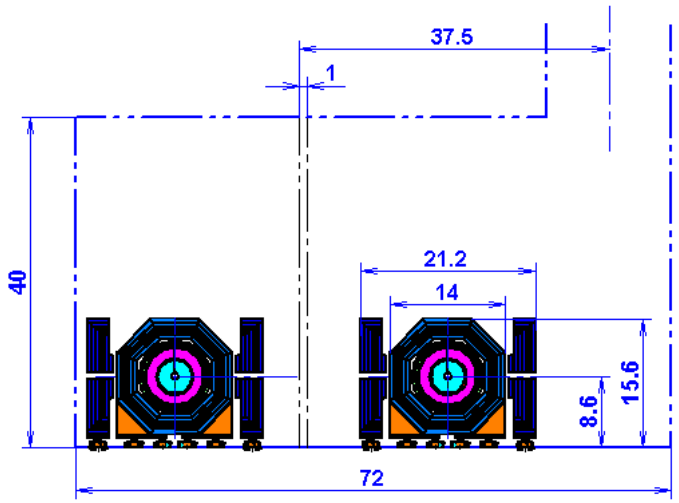
good at snowmass: lots of discussions within the concepts, close contact to the machine people

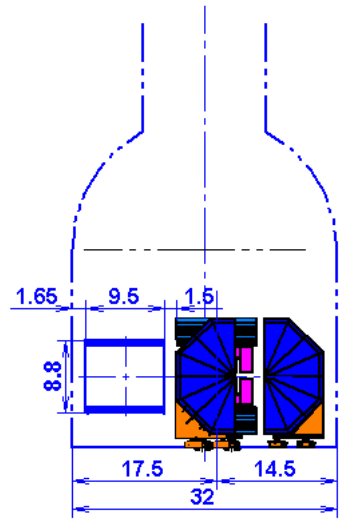
bad at snowmass: concepts were treated too much as collaborations, too little interchange and interaction between concepts: lots of duplication of effort

The experimental hall

At Snowmass







proposal by the GLD group, after discussions at snowmass
(2 interaction regions)

Interaction Regions

discussion: 1 versus 2 interaction regions

- common agreement that two experiments are very desirable
  - cross check
  - competition
  - different optimization choices of the detectors
- two beam deliveries are very expensive (cost detector = cost BDS)
  - proposal (Barish): consider push-pull geometry with only one BDS
  - met with very large scepticism by the community
  - baseline at the moment is two BDS and two IP

my personal view: the discussion is not fininshed, we need to fight for two detectors and two BDS!

Crossing Angle

lots of discussions on crossing angles (see also machine snowmass review)

strawmans design: 2mrad versus 20mrad

at snowmass: people realised disadvantage of large crossing angle (backgrounds)

move now to try to minimise the crossing angle
angles discussed: 0 – 2 - „10" mrad??? discussion is still open

One important input (not discussed extensivly):
do we want to maintain the photon collider option?
If yes, who is the community for this?
Is there a large enough community to justify this?

means >20mrad probably

Detector R&D

organisation of detector R&D:

at the moment very much regional (Europe DESY PRC + regional funding agencies)
US DOE/NSF reviews
Asia: KEK? others?

Need for a more central R&D review? Who? In which context?

WWS has charged detector R&D panel with collecting information on R&D

charge now has been extended to also move towards a prioritization of R&D

Things are very much in flow, not clear, where they are heading!

Conclusion

Significant discussions have happened at snowmass on detector concepts

Unfortunatly developments there are somewhat disjoint between concepts

Still
significant progress has been made particularly in the area of particle flow
(thanks to a strong DESY contribution)

important: lists of open questions have been assembled and prioritized
(there is even some agreement between concepts on this)

The Vienna ECFA meeting will be the next important point to see where we are.