Optimising LDC for Particle Flow

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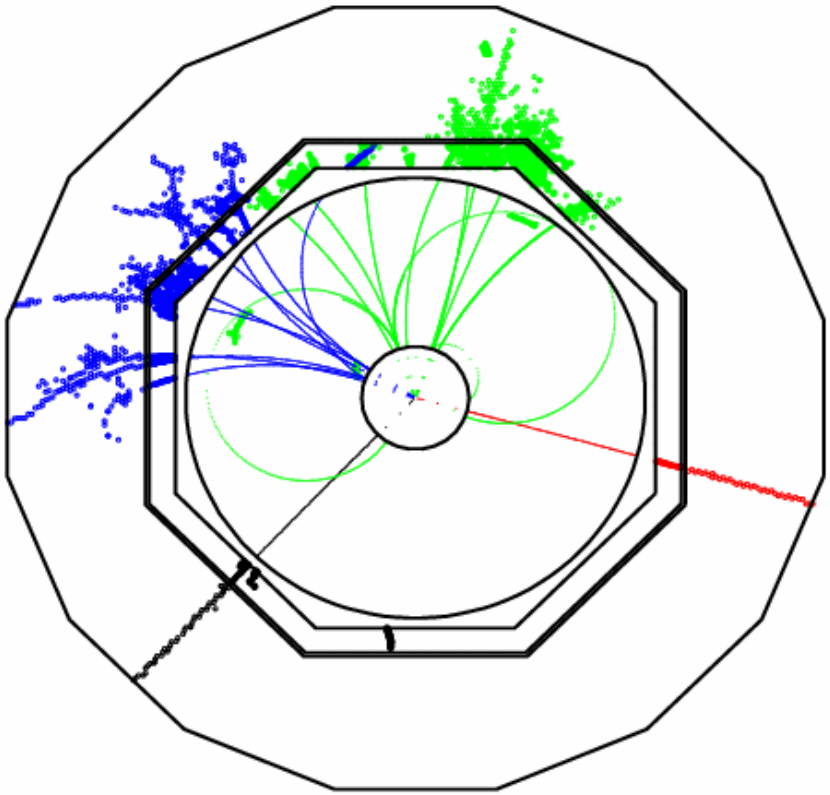


Purpose of This Talk:

- Show (again) recent studies
- LDC in the light of the above
- Other potential design issues

Why ?

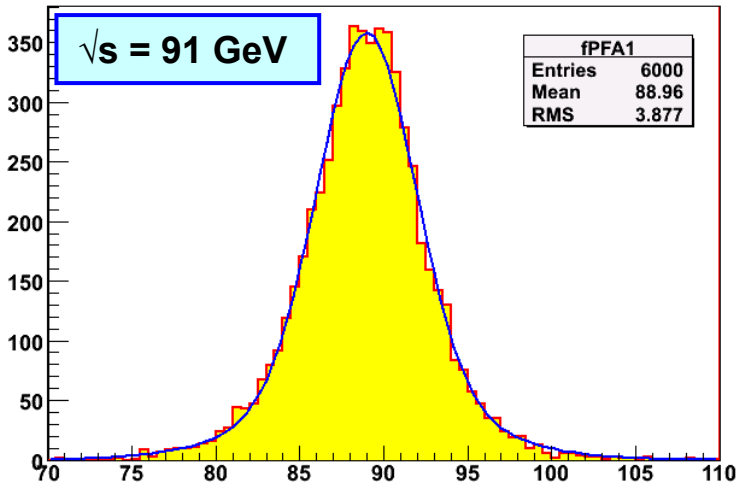
- One of the main factors in the design of LDC is the assumption that PFA is the way forward

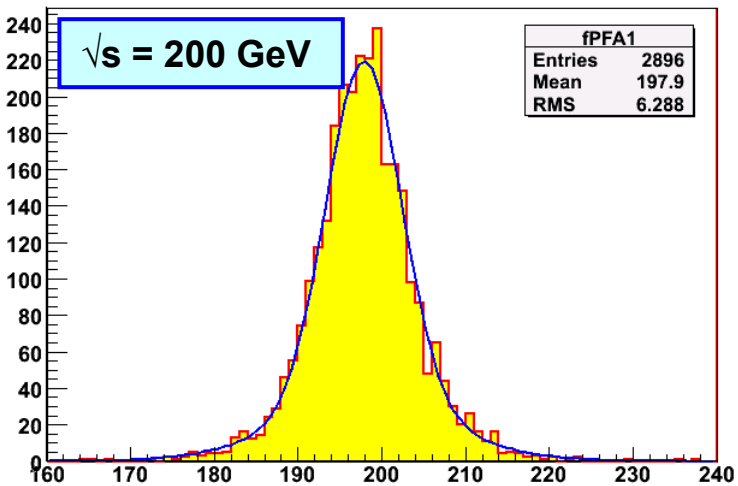
IS IT FIT FOR PURPOSE ?

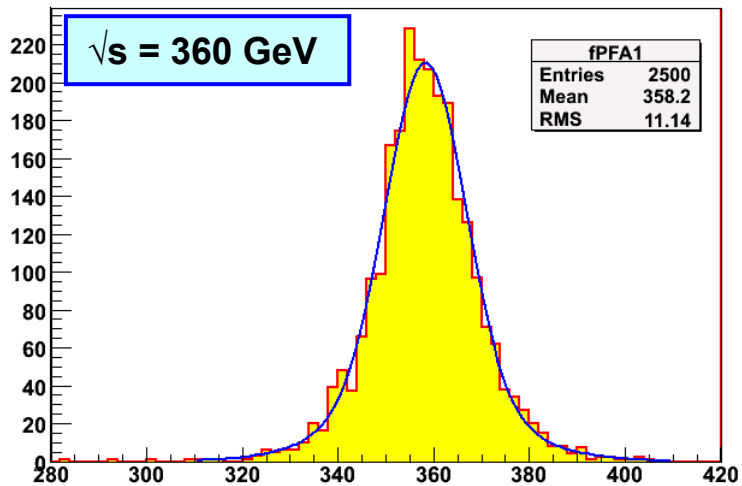
Current PFA performance

What was used:

- ★ PandoraPFA v01-01
- ★ LDC00Sc (TESLA)
- ★ B = 4 T
- ★ 3x3 cm HCAL (63 layers)
- ★ Z → uds (no ISR)
- ★ TrackCheater



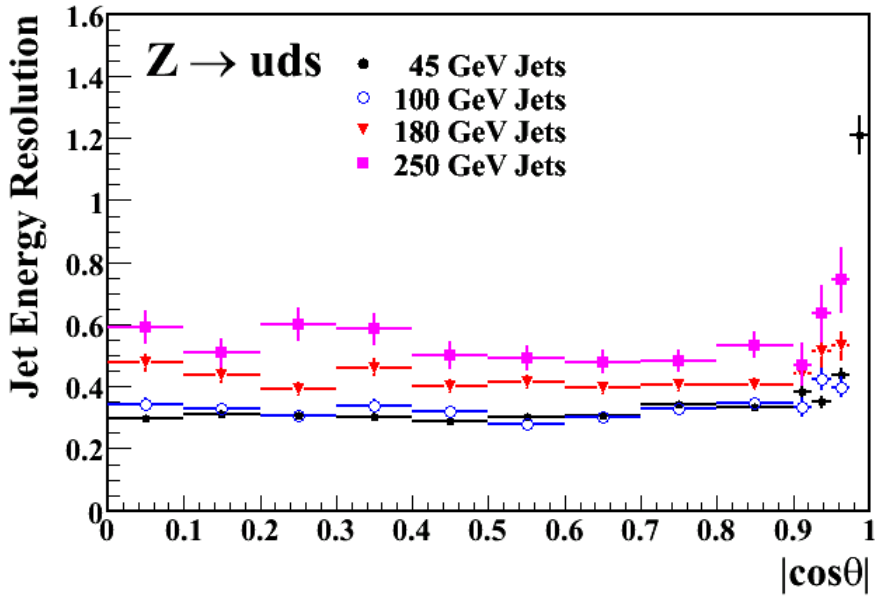




Current performance

rms90

E_{JET}	$\sigma_E/E = \alpha\sqrt{(E/GeV)}$ $\lvert\cos\theta\rvert<0.7$
45 GeV	0.295
100 GeV	0.305
180 GeV	0.418
250 GeV	0.534



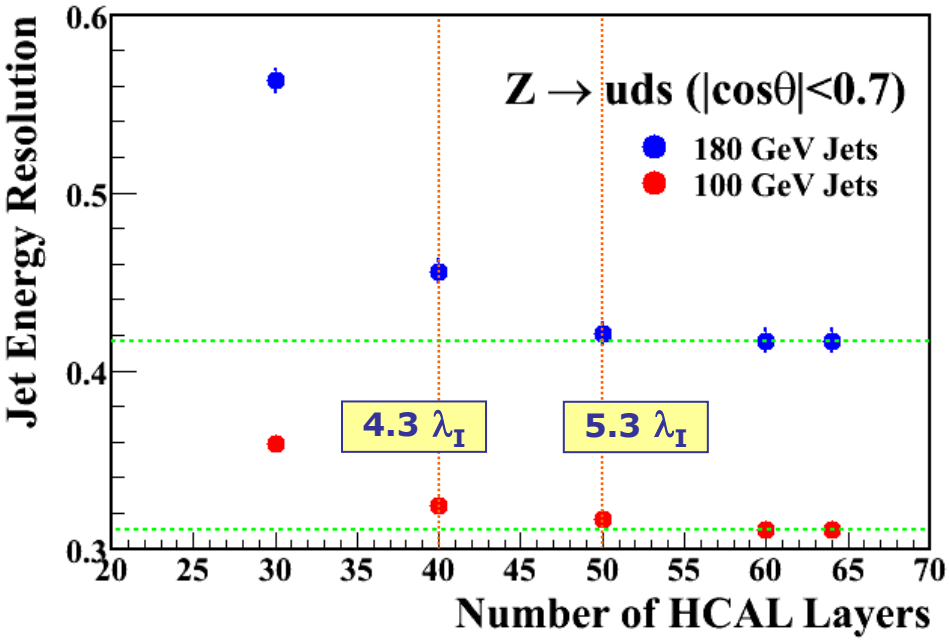
Caveat:

- ★ Is the current PFA performance good enough to start to characterise the PFA performance of the LDC detector ?
- ★ Don't forget : ultimately want multiple PFA algorithms
  - – check robustness of any conclusions

Assuming it is, what can we learn…

HCAL Depth

★ Investigated HCAL Depth (interaction lengths)
- Generated **Z→uds** events with a large HCAL (63 layers)



- HCAL leakage is significant for high energy
- Argues for ~ **5 λ_I HCAL**
- Consistent with J-C's talk

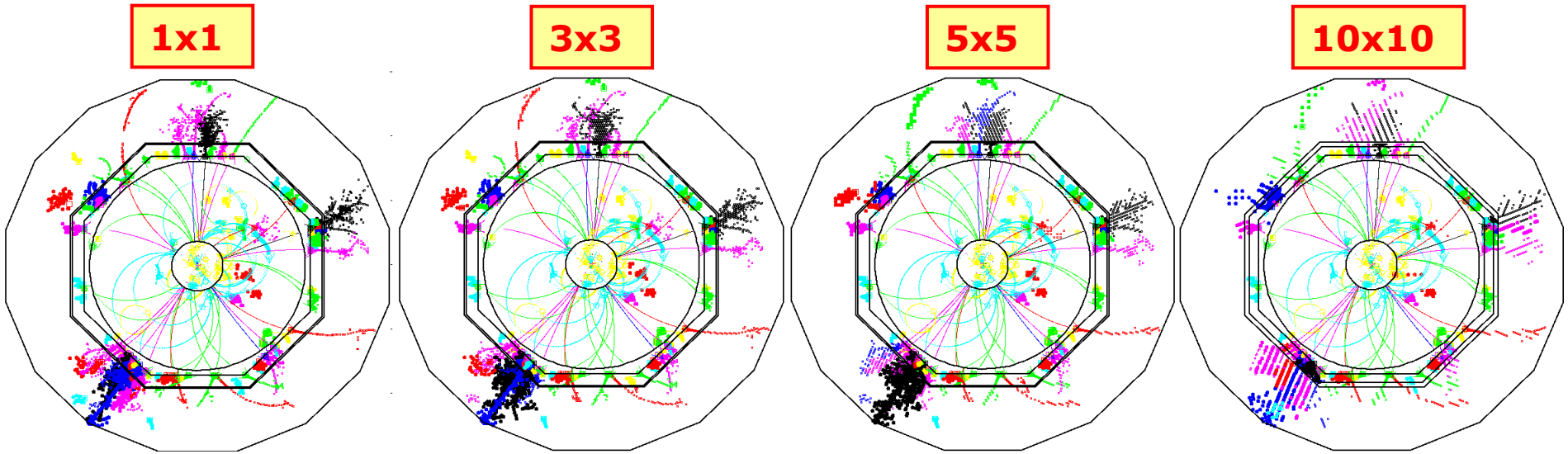
NOTE: no attempt to account for leakage – i.e. using muon hits - this is a worse case

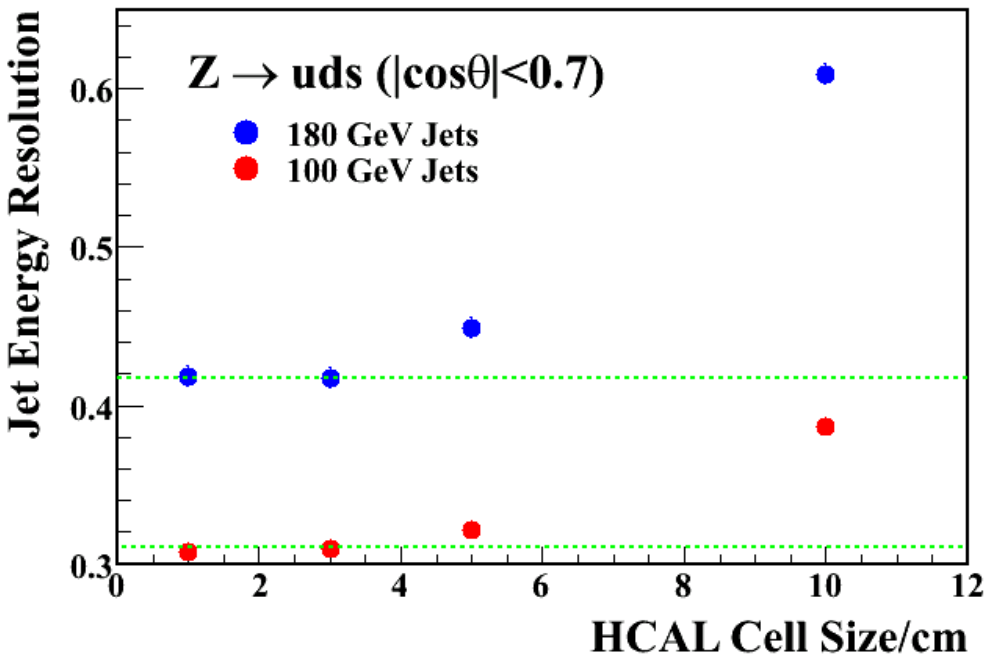
Increase number of HCAL layers in "default" LDC model

Also study alternative with current HCAL depth to study use of muon chamber as tail-catcher (personpower?)

I doubt this is an option unless the coil can be made "thin"

✶ Analogue scintillator tile HCAL : change tile size 1x1 ➞ 10x10 mm²





"Preliminary Conclusions"

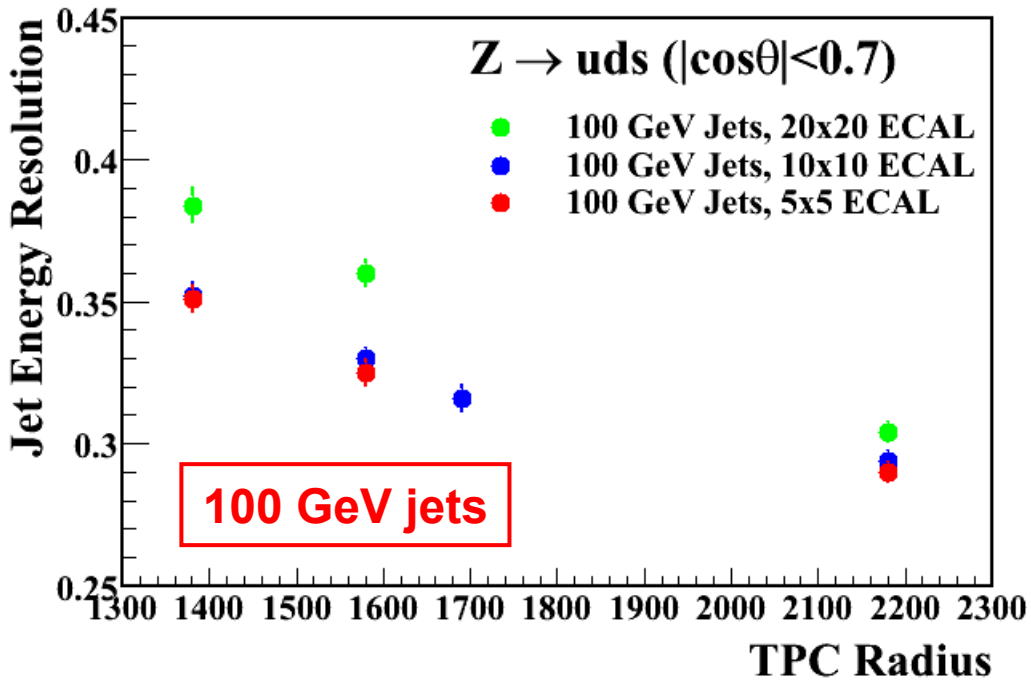
- 3x3 cm² cell size ☺

➡ **No change**

Could probably decrease segmentation deeper in HCAL (any significant cost benefit ?)

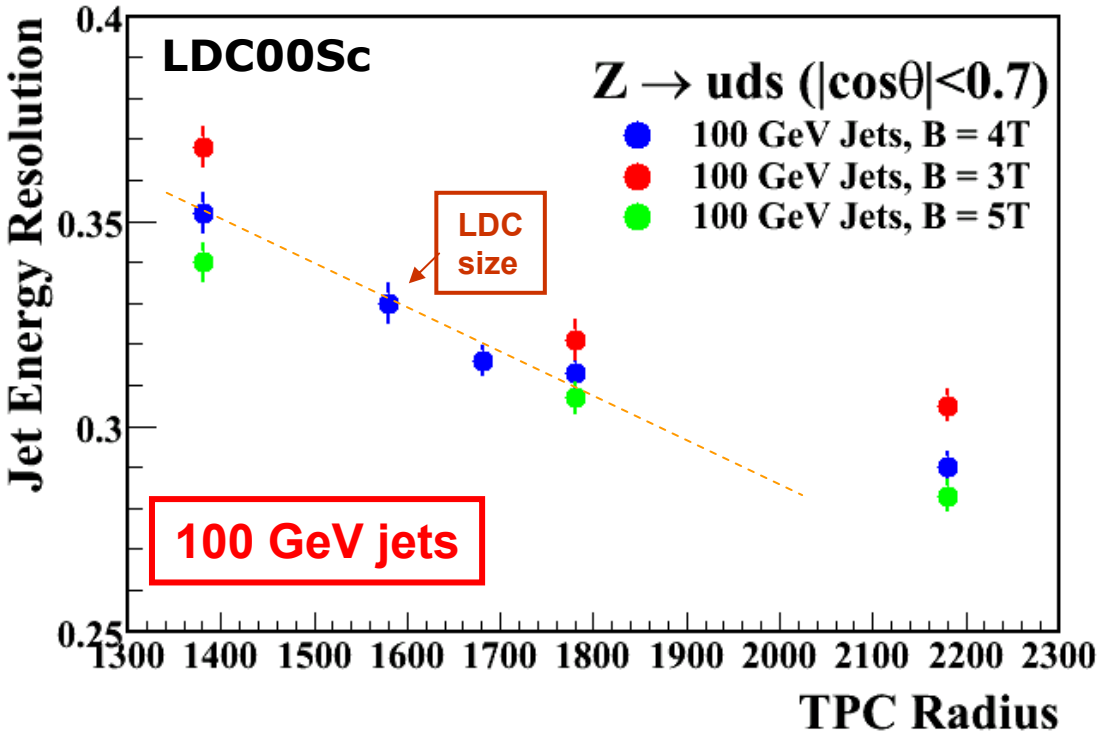
ECAL Transverse Granularity

- Use Mokka to generate Z → uds events @ 200 GeV with different ECAL segmentation: 5x5, 10x10, 20x20 [mm^2]



For PFA : LDC ECAL segmentation looks about right (well matched to Moliere radius)

Radius vs Field



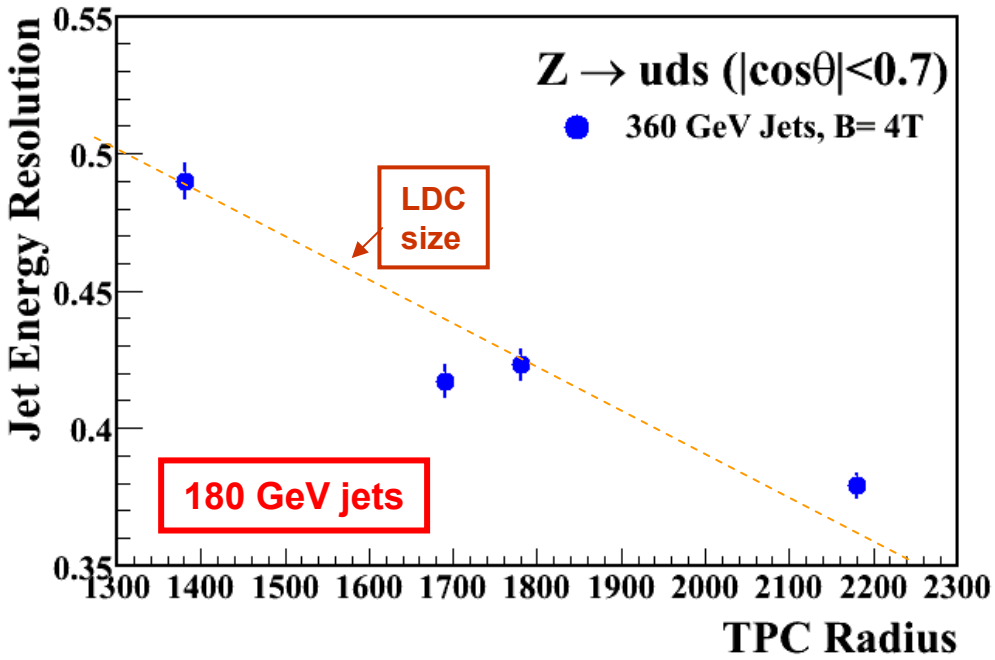
Radius more important than B-field

Suggests : size ⇕
B ⇕

Cost benefit of going to 3.0 T or 3.5 T ?

- Cost related to stored energy: Stored energy ~ LB^2R^2

Radius vs Field



B-field studies on the way…

Radius is even more important for higher energy jets

LDC too small ?

★ One of the main motivations for the design of LDC is PFA

★ The L in LDC stands for LARGE – currently from the point of view of PFA the detector is probably not large enough…

LDC in Mokka

- For studies of Physics Performance of LDC what do we need…

- What parameters for the next version of the LDC detector?
  - increase number of HCAL layers ?
  - larger TPC radius ?
- What needs to be in Mokka?
  - muon chambers (already there)
  - HCAL ring must be included
    (don't need perfect Engineering design at this stage)
  - Is description of LumiCAL and forward ECAL
    (and "overlap") adequate
    Include in PFA for physics studies?

In Mokka make LCAL square ?
(allows study the physics benefit)

Prompted by Henri's talk

Other Design issues for PFA

(at Snowmass LDC/GLD/SiD came up with list of questions)

★Have "answers" to some of these questions (marked in green)

The A-List (in some order of priority)

1) B-field : why 4 T ? Does B help jet energy resolution
2) ECAL inner radius/TPC outer radius
3) TPC length/Aspect ratio
4) Tracking efficiency – forward region
5) How much HCAL – how many interactions lengths 4, 5, 6…
6) Impact of dead material
7) Longitudinal segmentation – pattern recognition vs sampling frequency for calorimetric performance
8) Transverse segmentation ECAL/HCAL
   ECAL : does high/very high granularity help ?
9) Compactness/gap size
10) HCAL absorber : Steel vs. W, Pb, U…
11) Circular vs. Octagonal TPC (are the gaps important)
12) HCAL outside coil…
13) TPC endplate thickness and distance to ECAL
14) Material in VTX – how does this impact PFA

★What about the other issues…

Conclusions

- ★ At this stage should not under-design the detector
- ★ Be careful to get locked into a non-ideal design at EDR stage
- ★ Cost is important but if the detector is not competitive there's a risk...
- ★ Would like to attempt a cost/PFA performance optimization using Henri's cost model (size/field/CAL costs) and current parameterization of PFA performance vs. radius/field/HCAL size

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