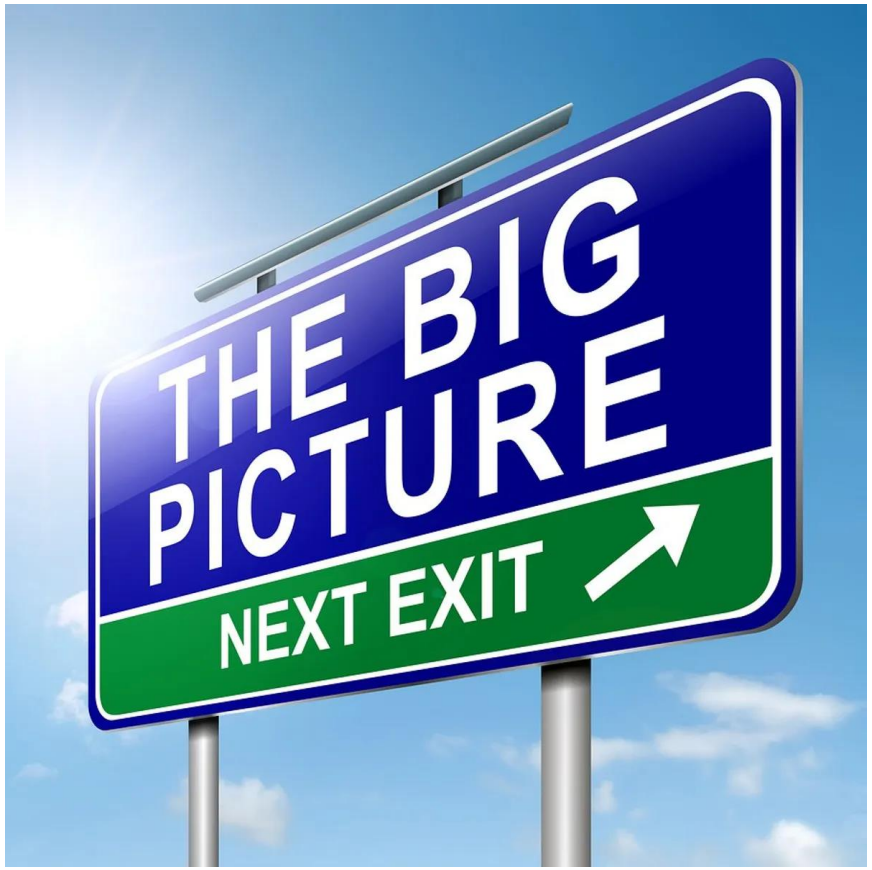
Big Picture

D. Hertzog

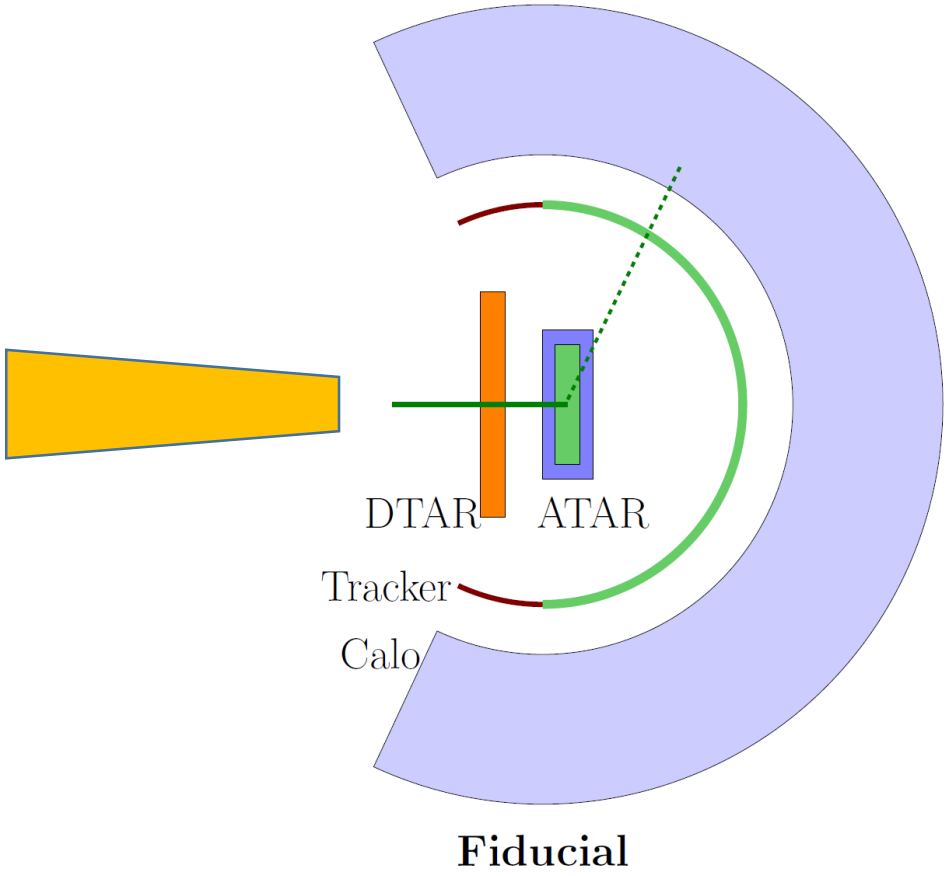
Oct 16, 2023



Topics …

- **Goals and Topics of the meeting (formal and informal)**
  - **Agreeing on the baseline**
  - Updates on technical choices
  - More effort into Simulations with specific questions posed to answer (i.e, homework)
  - **Collaboration formal organization**
  - Timescales … NP LRP & HEPAP PB reports; test beams (psi and cenpa), BVR report, requests for next year, funding timetables
- **Geometry Baseline Discussion**
  - What's good about it
  - What's challenging and/or unknown
  - Hardware Baseline and Alternatives
    - ATAR: LGADs vs PIN
    - Calo: LXe vs LYSO
    - Electronics digitization: ?
  - Beam: momentum / length / purity / rate optimization
  - Triggers (see discussion tomorrow)
- **Analysis and Simulations**
  - Wide use Simulation framework
  - (pseudo) Analysis program progress

Patrick's "icon" view you will see frequently



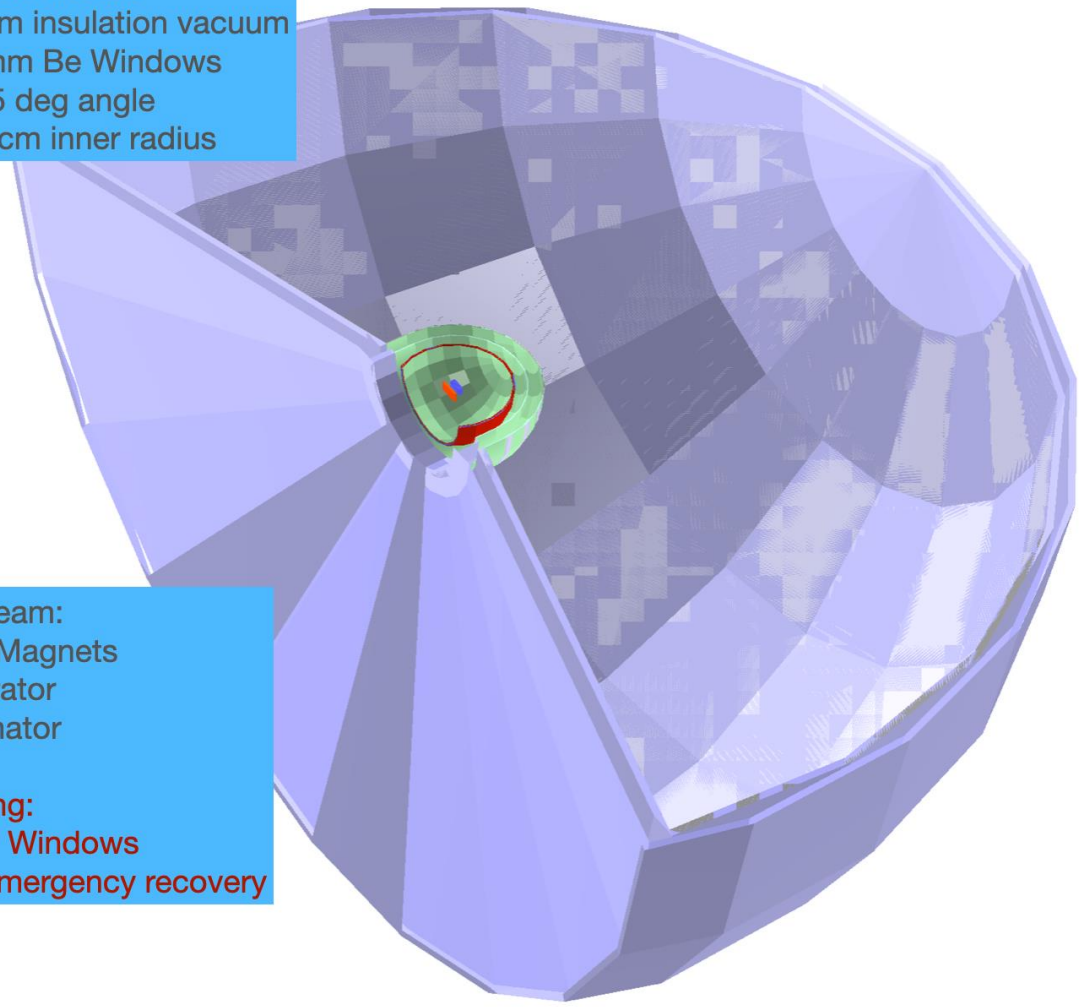
Some big questions:

- Beam: spot, purity, rate, momentum
- pi e nu net acceptance
- Update Trigger strategy vs Proposal

From the baseline GEANT Simulation

The Baseline Geometry Design

Calo:
25 X0 LXe
1 cm Al Walls
2 cm insulation vacuum
2 mm Be Windows
105 deg angle
10 cm inner radius



Upstream:
2 x 2 Magnets
Separator
Collimator

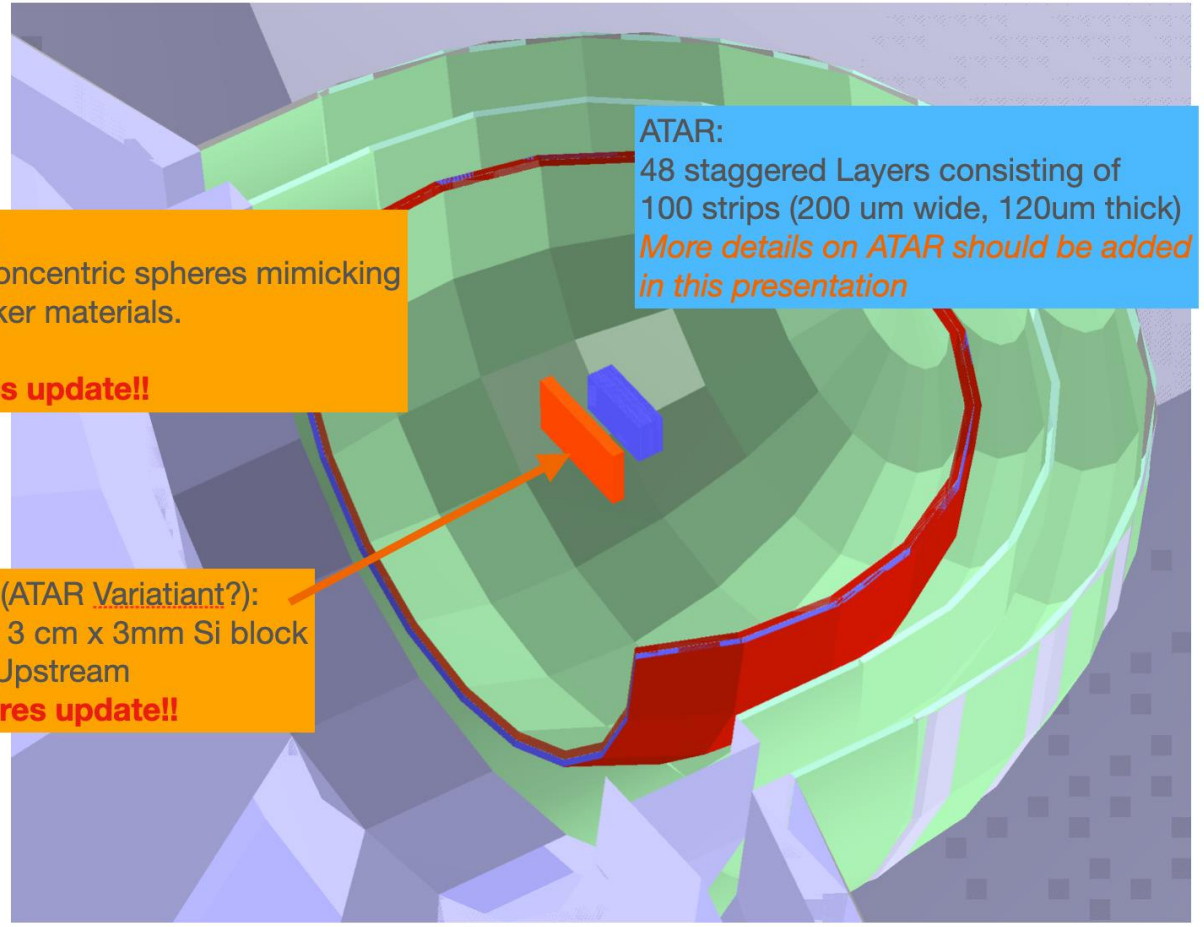
Missing:
Beam Windows
LXe emergency recovery

Tracker:
Set of concentric spheres mimicking the tracker materials.

Requires update!!

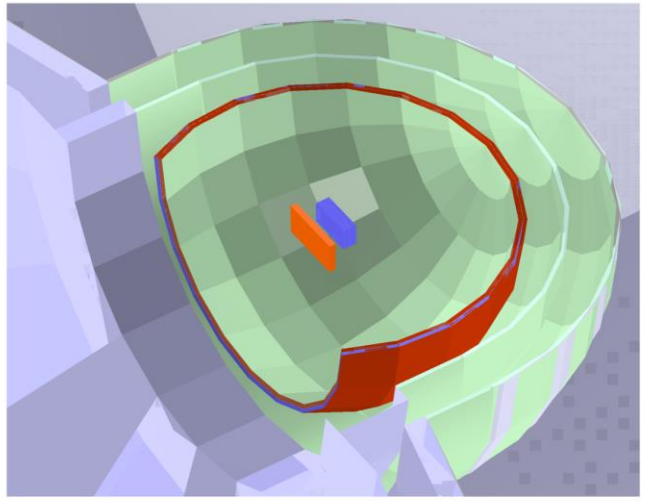
ATAR:
48 staggered Layers consisting of 100 strips (200 um wide, 120um thick)
More details on ATAR should be added in this presentation

DTAR (ATAR Variatiant?):
3cm x 3 cm x 3mm Si block
1 cm Upstream
Requires update!!

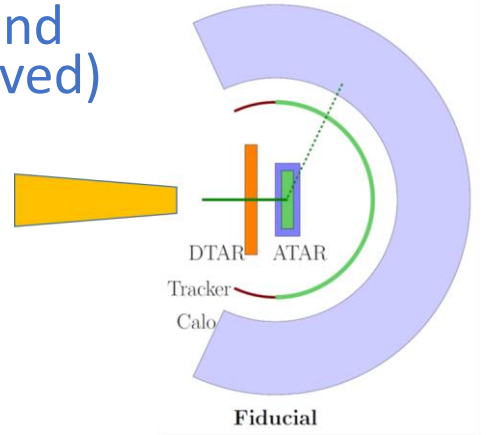


Where are the ATAR/DTAR Cables, Readouts, Support Structures ?!

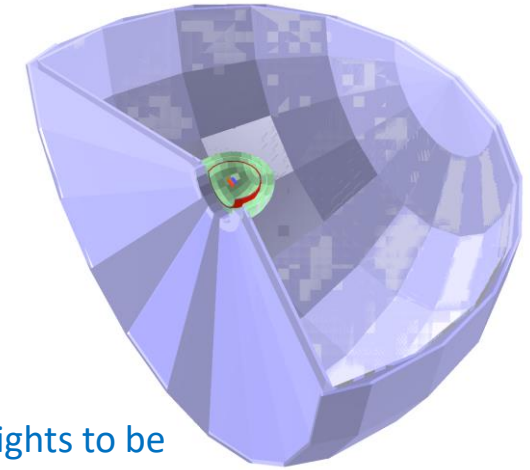
DTAR/ATAR/Tracker questions



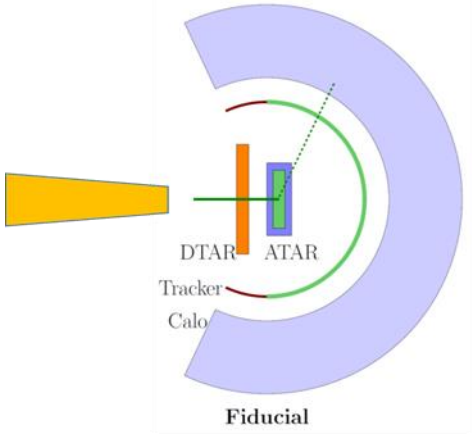
- Overall
  - relative *Z* placement optimization
  - cabling material plans/corridors
  - physical support structures (if they are in the FV)
- DTAR
  - lateral dimensions & thickness are tied to beam momentum and spot size
  - segmentation and particle ID requirements (i.e, MIP vs Pi/Mu arrivals)
- ATAR
  - Incorporate realistic **resolution, saturation, dead material** in event Recon efforts.
  - A practical study: how large can ATAR be before diminishing returns on E loss and Bhabha enter? (important; tied to Beam we might "get" if desired is not achieved)
- Tracker
  - Optimize location wrt to ATAR and Calo for use in recon (and avoiding albedo)
  - Thickness we can tolerate
  - Spatial resolution we need; what about time resolution?
  - How many planes ?



Calo physics questions



- Overall
  - Impact of Resolution and Depth on Ratio measurement (and tails)
  - Ideal inner radius for acceptance considerations
- LXe
  - Impact of **realistic window options** on resolution
  - Estimates of signals in the *n* hundred sensors vs entrance angles of electron (i.e, the dynamic range of pulse heights to be expected, which will guide electronics and calibrations)
  - **Pileup** from overlapping waveforms from Michel electrons
  - How important is photon tracking efforts within crystals or LXe volume?
  - Possibility of internal reflective baffles and a study of how many of these is "enough"
- LYSO crystals
  - Do our simulations match the test beam prediction? (to be determined soon)
  - What defines "Success" from upcoming PSI run? (Resolution; constant term)
  - If "yes" then, we must
    - Design tapered crystals, simulated response
    - Consider if the design can be evolved forward for the pibeta phase?
    - Can SICCAS make these crystals ? (assume 20 X0)
  - More so than for LXe, is resolution good enough? What does fine segmentation buy us?



- Overall: How do we come to a technical solution choice and then form just 1 Calo Team? (i.e, what 'big questions' should we articulate to help guide this decision and how can we work together?
- Recall, a Calo is much more than just the "material"
  - Sensors, Mechanics, Calibration System, LXe infrastructure *or* Crystal one by one testing and prep

Revisiting our Proposal and Where we are now …

- Need **2E8 pienu events** .. We need to update our efficiency with new geometry
- **Beam**: 55-70 MeV/c; dP/P ~2%; **10x10 mm**; 300 kHz
  - Range width for 55 vs 70 MeV/c goes from 0.4 mm to 0.8 mm
- **ATAR**: so far, still follows promises in Proposal, but completely new cabling scheme required to go from dream to reality; impact of dead material seems to be non trivial; sensors now testing with "pion like" high dE/dx protons
- **Calo**; >3π sr coverage reduced to 2π max for Pacman
  - 3π was naïve, but already showed problems in energy resolution vs polar angle in our proposal; lateral losses make significant tails; but also masked importance of albedo as Simulation added energy back
    - Relatively large ρ_M of LXe for Hamburger; forced small inner radius for LYSO to use PEN as outer
- **Tracker**: completely new and challenging geometry for Pacman; need to learn today about possibilities; we have been including its coordinates in our Simulations
- **Electronics/DAQ**; so far following script well
- **Triggers**: (perhaps discuss on Wednesday)
- **Simulations**. We now have a real framework for geometry and some proto-analysis efforts that allow for specific physics studies to be carried out (see Patrick et al)

OVERALL: Significant progress but we are not yet at a final design as 4 "ambitious" technical requirements must mature to a point we can count on them solidly

- **Beam** (realistic parameters at rate we need)
- **ATAR** (E res, cross talk; E saturation, mechanical, …)
- **Tracker** (thickness, precision, speed, mechanical)
- **Calo** (resolution, segmentation, speed, pileup handling)