Detector Concepts Impressions and Plans

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Detector Concepts Working Group
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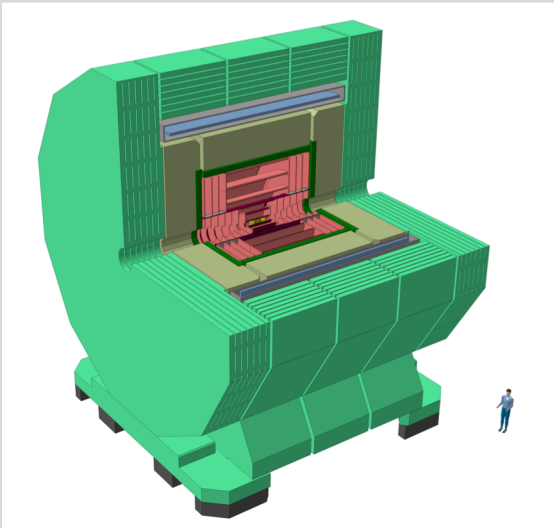
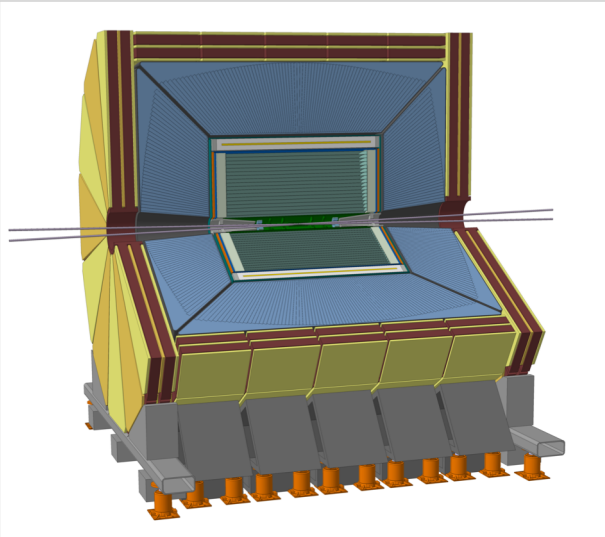
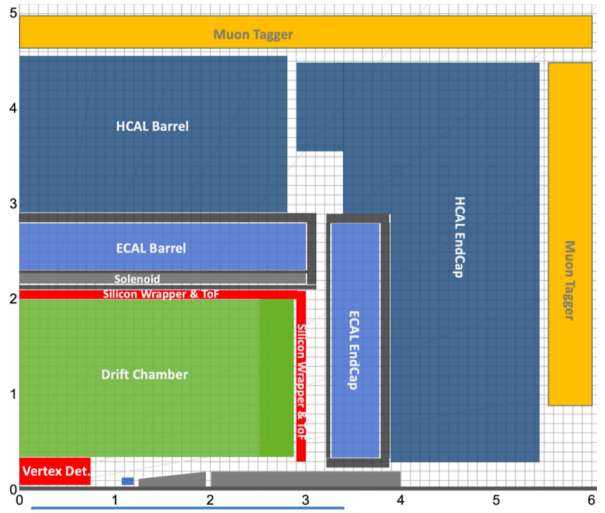






Outline

1. A few selected impressions from the workshop that made us happy

2. Plans up to Mid-Term Review

A TPC for FCC-ee ?

TPC operability at circular colliders

Paul Colas (CEA/Irfu Université Paris Saclay)

TPC is the main tracker for the ILD detector concept. At ILC, it profits from a beam time structure allowing power switching and gating. ILD is considering adapting the concept in case a circular collider is built first.

SUMMARY

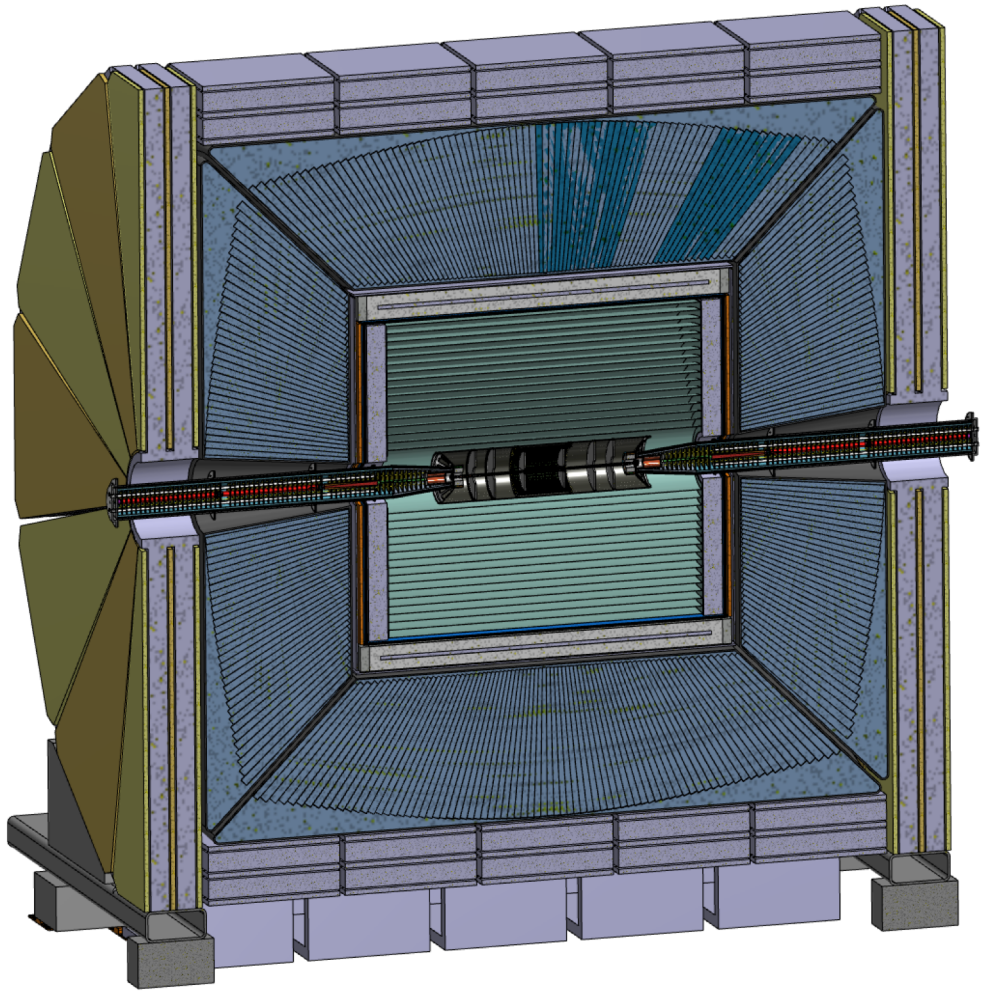
- Running a TPC @ Z pole @ 2. 10^{36} cm^{-2} s^{-1} is not trivial
- 65 kHz of Z decays means 1 decay every 1.2 mm on average
- The positive ions of 22 000 Zs will accumulate in the TPC volume before drifting out, causing distorsion of several 100 µm at least
- The ion backflow has to be suppressed drastically
- A continuous DAQ and tracking will be necessary, with real-time corrections for space point distortions
- The experience from ALICE at LHC (50 kHz of Pb-Pb collisions) will be crucial
- Control of beam-induced BGs will be crucial, not only at the Z but also at HZ.

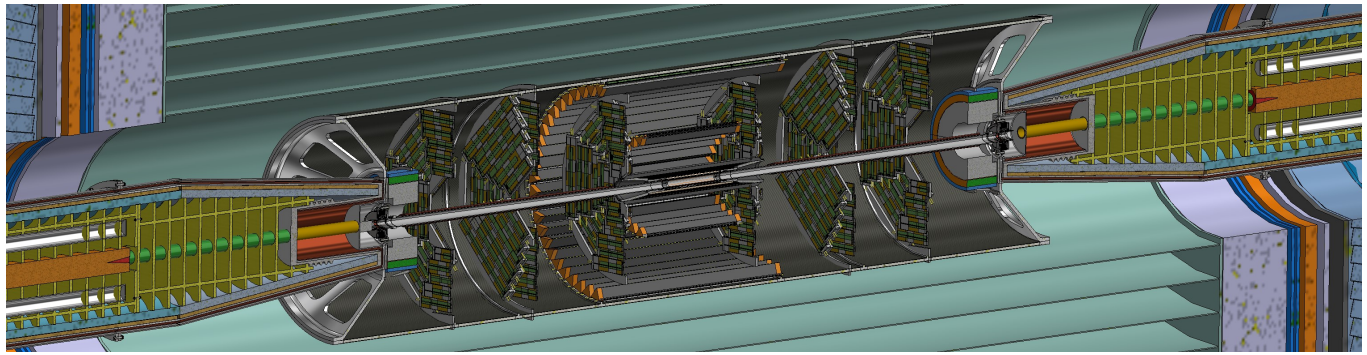
MDI Region Taking Shape

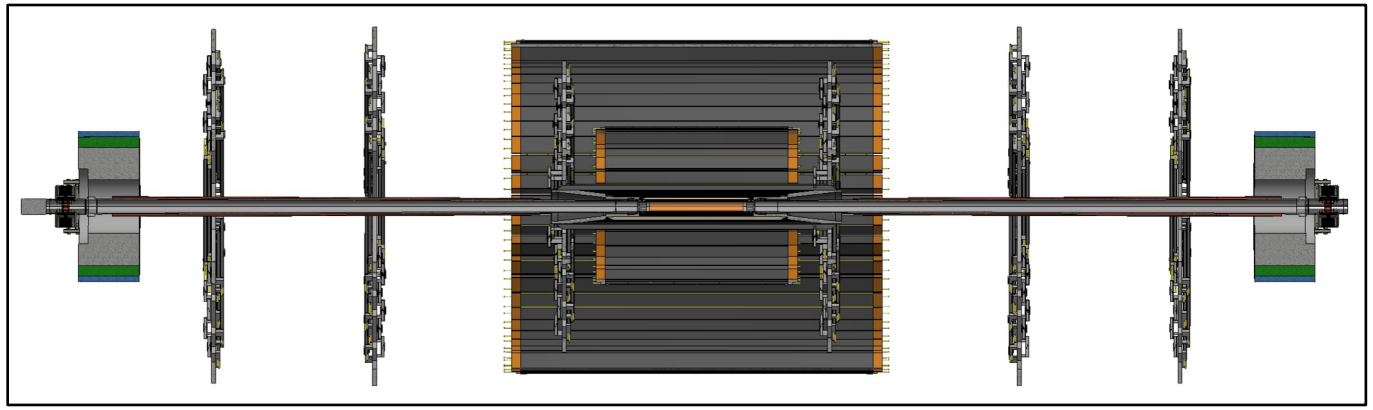
Detector integration in the interaction region

F. Bedeschi (INFN-Pisa)
on behalf of

M. Boscolo (LNF), F. Bosi (Pisa), F. Fransesini (LNF),
S. Lauciani (LNF), F. Palla (Pisa), L. Pellegrino (LNF)



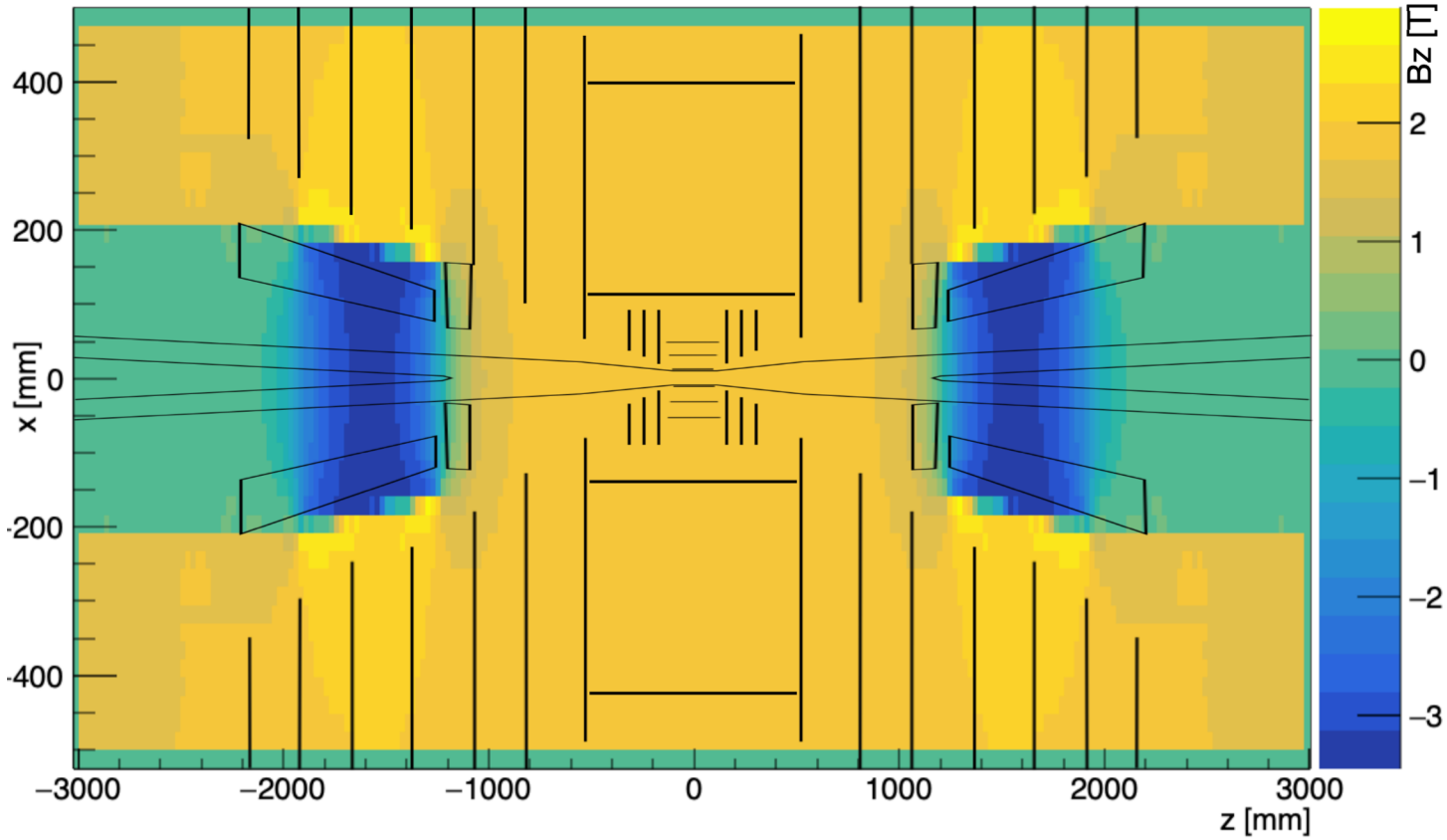




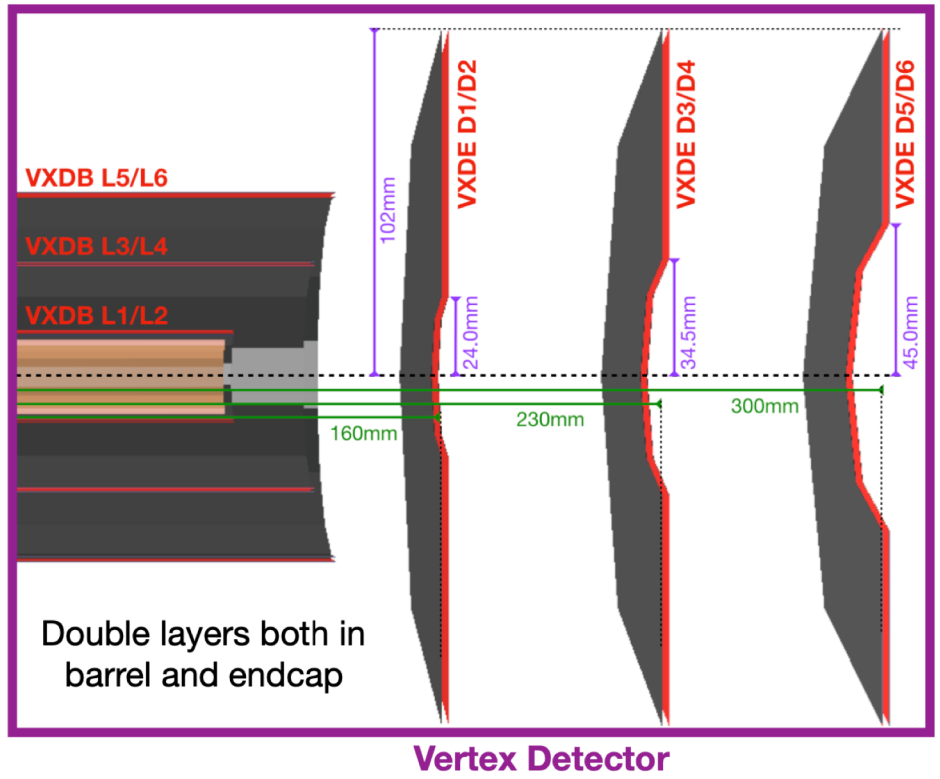
Realistic Magnetic Field

Andre Ciarma

Magnetic Field in the Detector Area



CLD Subdetectors: Trackers and Vertex



No noticeable effect for **IPC** backgrounds, as produced at the IP

Progress on the ARC RICH Detector

Martin Tat

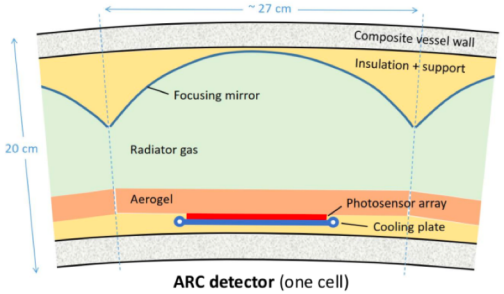


Figure 4: ARC has a cellular structure, similar to an insect's compound eyes

- Adapted to fit into the CLD experiment concept, taking 10% from the tracker volume
  - Radial depth of 20 cm, radius of 2.1 m and a length of 4.4 m
  - Aim to keep material budget below $0.1X_0$
- Aerogel and gas radiators with a spherical mirror
  - Aerogel also acts as thermal insulation between gas and detector

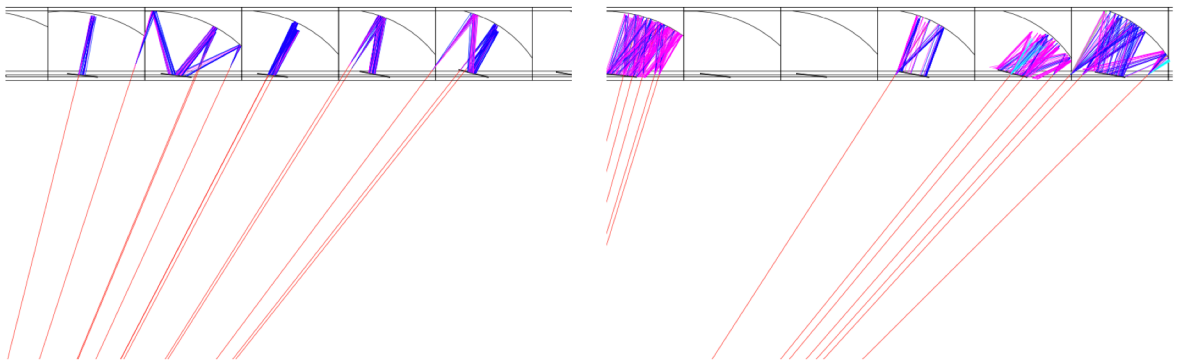


Figure 9: Tracking of photons from gas radiator (left) and aerogel radiator (right) through the ARC optics

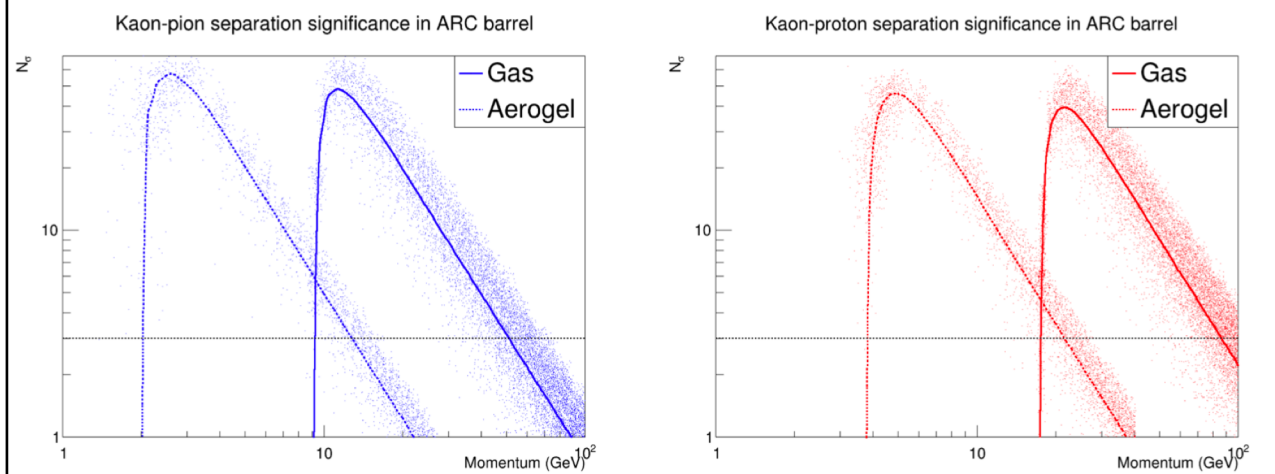
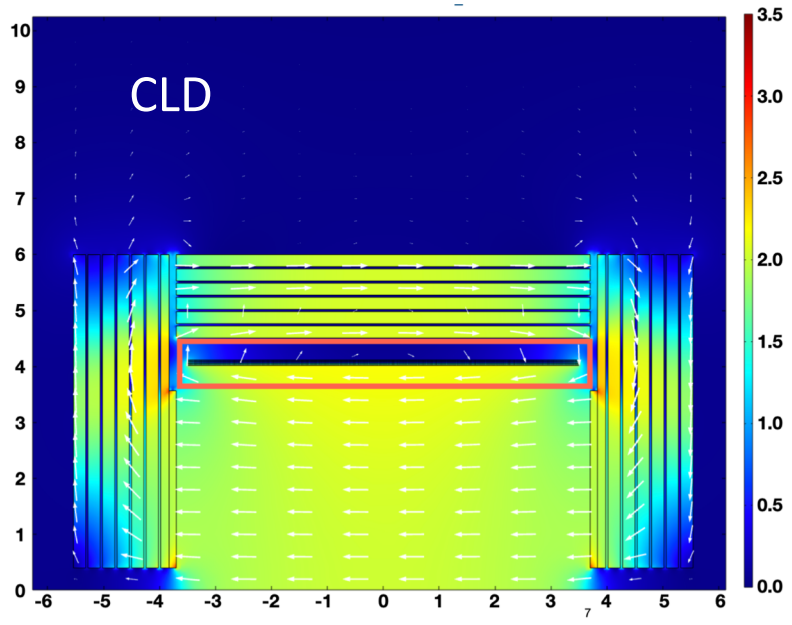


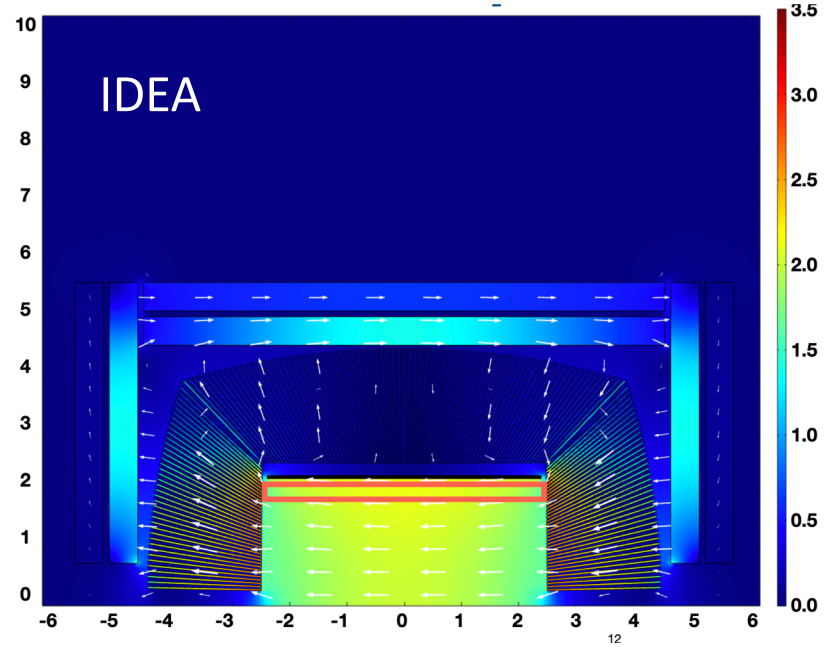
Figure 10: Separation significance per track for π-K (left) and p-K (right)

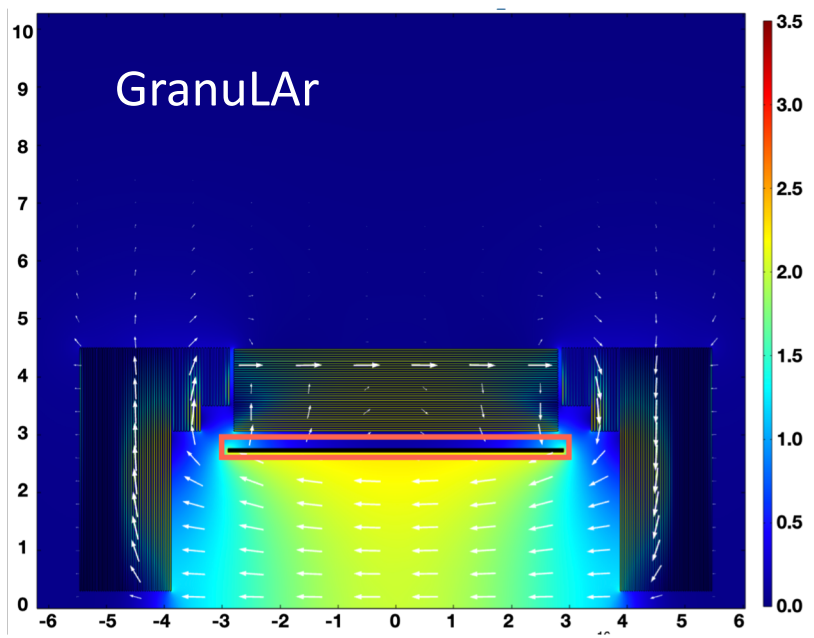
- Gas (aerogel) provides over 3σ pion-kaon separation in the range 10-50 GeV (2-10 GeV)

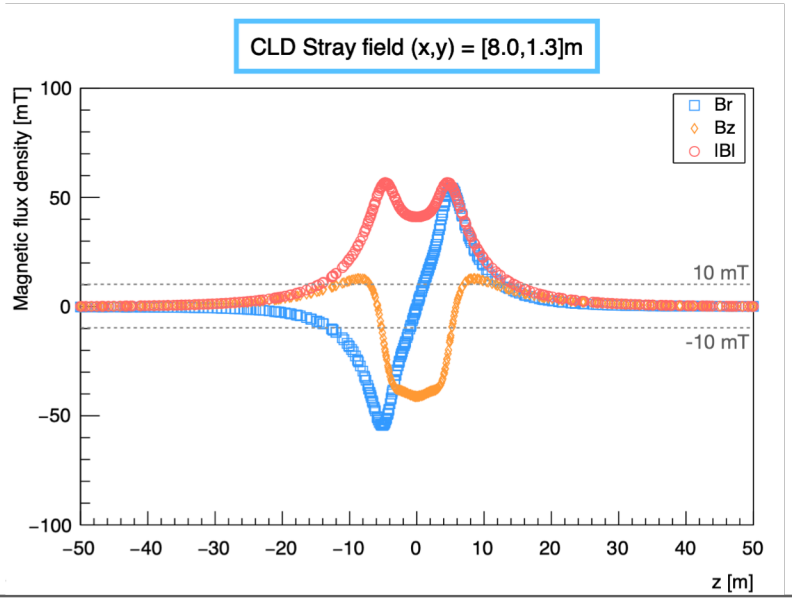
Field maps including Stray Fields

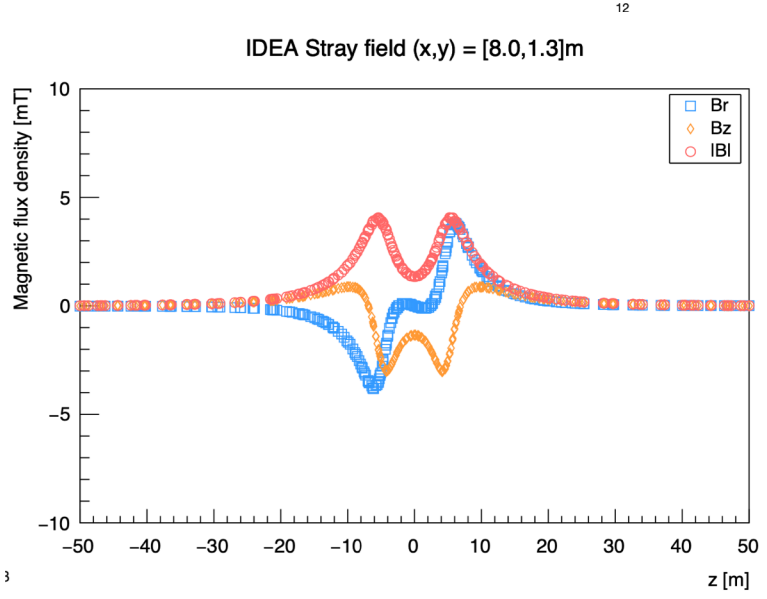
N. Deelen

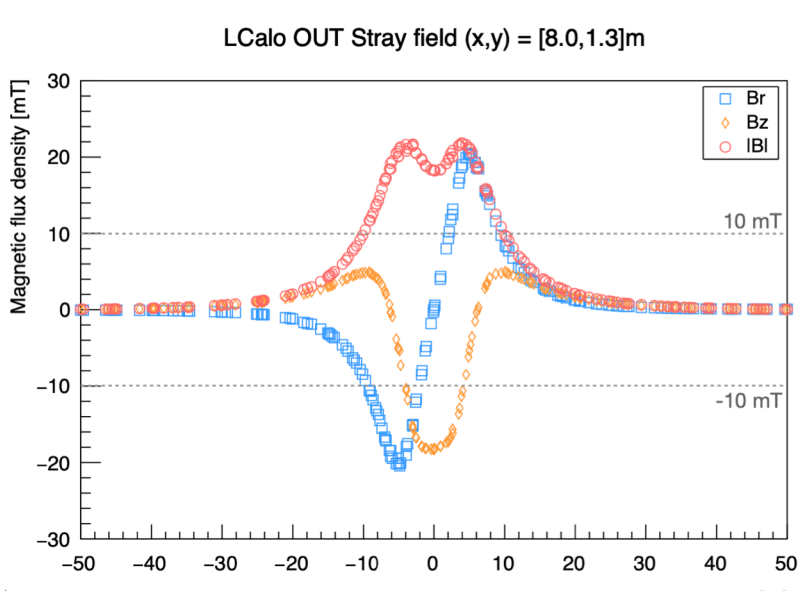






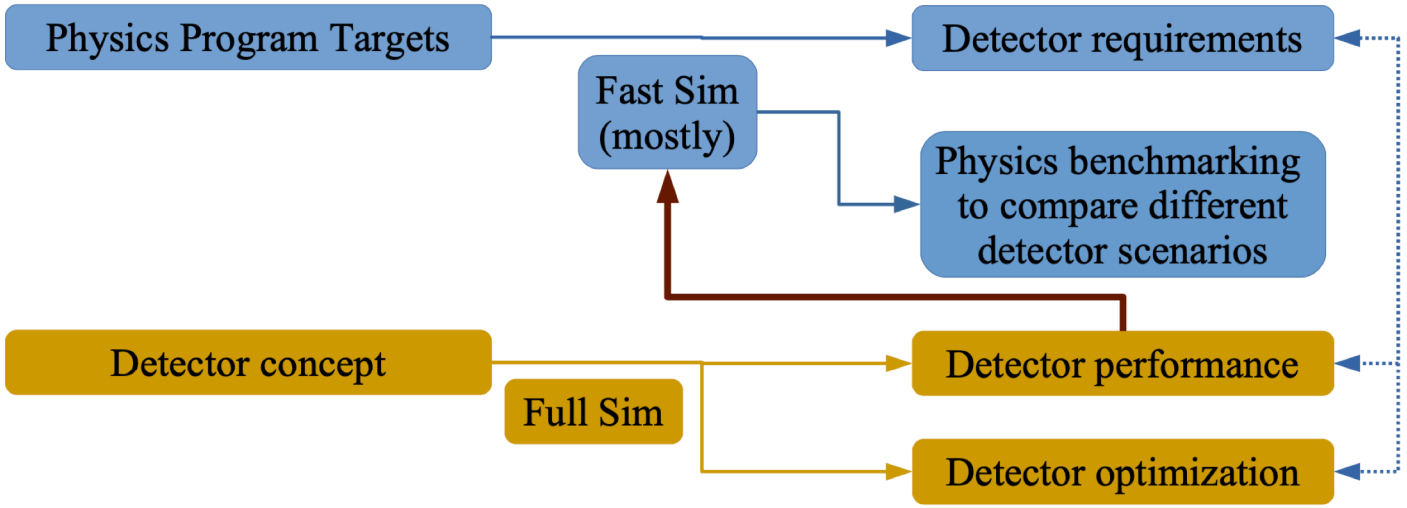


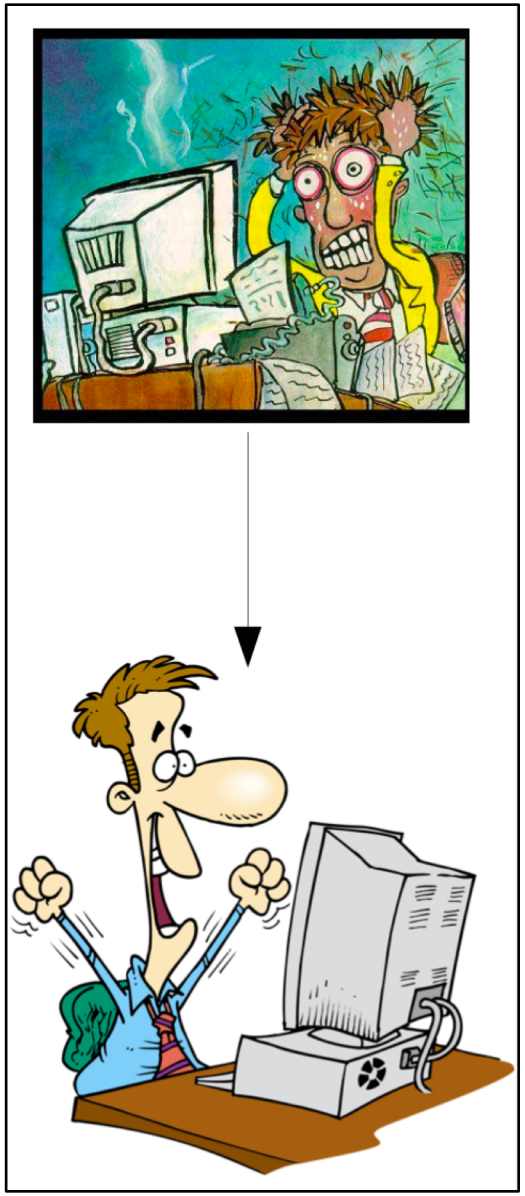




Detector Software Strategy and Plans

Brieuc Francois





- Comparing detector scenarios based on a few performance metrics is not enough
  - How do they combine together?
  - May want to define some key analyses (families) to assess detector scenarios potential
  - Unrealistic to perform all the Full Sim key analyses for each detector scenario
  - Way easier to plug detector parameters in Delphes to evaluate its physics performance
- Full simulation is one of the corner stone of Detector R&D
  - We are getting there but a lot of work still has to be done
  - Ultimate goal pursued: **full inter-operability of sub-detectors** (eased by DD4Hep plug-and-play approach) and **reconstruction algorithms** (dataformat, more challenging)

Plans

Plans up to Mid-Term review (i)

Tentative plans up to the mid-term review includes:

- Requirements from Detectors on Experimental Sites
  - Consult with accelerator group on the placement of the Booster Ring and its shielding from the Detector stray field
    - Arrive on decision on booster ring positioning
  - Document this and other outcomes of the October review on Civil Engineering and Technical Intrastructure

- Provide guidance for coherent detector R&D efforts to address FCC detector requirements
  - Continue collaborative work with Physics Performance and Software groups on definition of detector requirements
  - Presentation of detector requirements and needed R&D
    - …with focus on DRD groups and ECFA Mini-Workshops
    - …in written form also for a wider community

- Machine Detector Interface issues
  - Continue collaboration with MDI group on the IR layout

Plans up to Mid-Term review (ii)

- Detector concepts software usage for benchmarking and optimisation
  - Promote the use of the common FCCSW software platform & tools, including the development of the sub-detector geometrical description, simulation, and local reconstruction;
  - Overview document with the status of full simulation of (sub-)detector components inside FCCSW

- Detector Concepts costing
  - The existing Detector Concepts are at rather different stages of engineering maturity
    - May be difficult to produce cost estimates at the same level of confidence
    - Main cost drivers may be identified
  - Will shortly kick-off activity on costing (headed by an ”impartial expert”)
    - First goal: arrive at an agreed-upon methodology with all involved parties

Extras

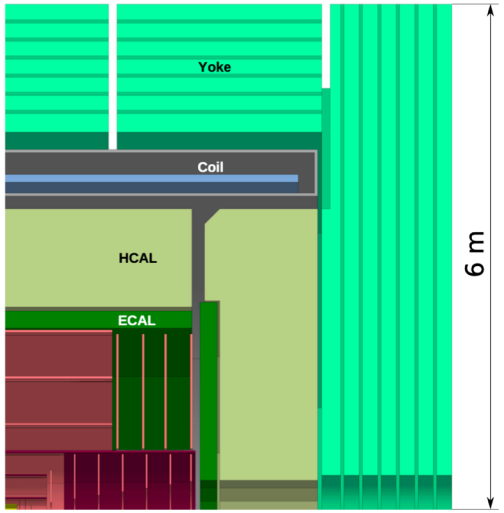
Conclusions

- Much progress since last workshop
  - TPC main tracker ?
  - Compact, light RICH
  - MDI layout
  - Realism of detector descriptions including magnetic field maps
  - Software including full simulation
  - …

- Short-term (!) plans for mid-term review being fleshed out

FCC-ee Detector Concepts Fast Overview

CLD



CDR

Conceptually extended from CLIC detector design

- Full silicon tracker
- High granularity silicon-tungsten ECAL
- High granularity scintilator-steel HCAL
- Instrumented return-yoke for muon detection
- Large 2 T coil surrounding calorimeter system

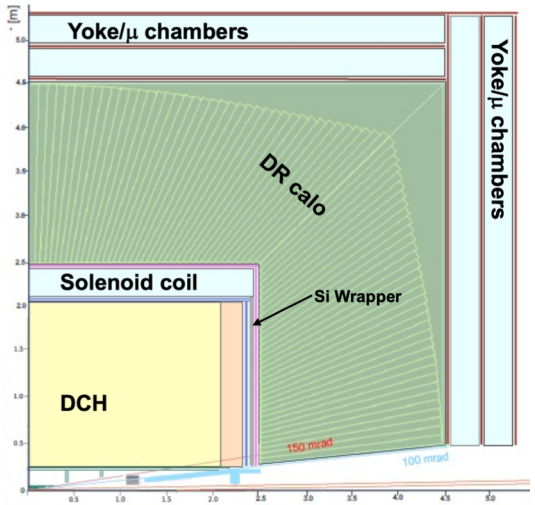
Engineering needed for adaptation to continous beam operation (no power pulsing)

- Cooling of Si-sensors & calorimeters

Possible detector optimisations

- Improved ECAL and momentum resolutions
- Particle identification (TOF and/or RICH)

IDEA



Specifically designed for FCC-ee (and CEPC)

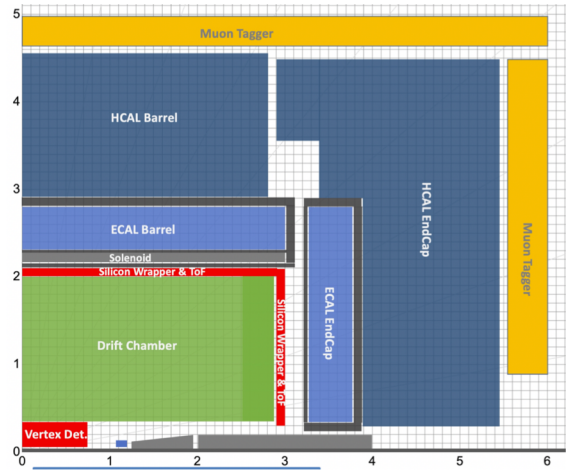
- Silicon vertex detector
- Low X_0 drift chamber with high-resolution particle ID via ionisation measurement
- Silicon wrapper around drift chamber
- Light, thin 2T coil inside calorimeter system
- Pre-shower detector based on MPGC
- Dual-readout calorimeter; copper-scintilating/Cherenkov fibres
- Instrumented yoke with MPGC muon system

Possible detector optimisation

- Much improved EM energy resolution via crystal ECAL in front of coil

Noble-Liquid ECAL based

new



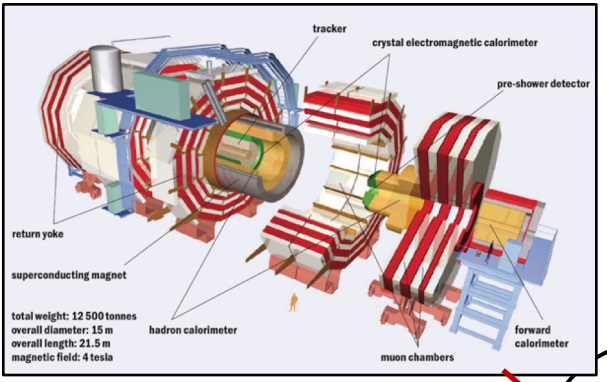
Specifically designed for FCC-ee, recent concept, under development

- Silicon vertex detector
- Low X_0 drift chamber with high-resolution particle ID via ionisation measurement
- Light, thin 2T coil inside same cryostat as ECAL
- High granularity Lead/Noble Liquid (LAr, possibly LKr) ECAL
- HCAL and muon systems to be specified

Detector Concept Working Group Goals and Methods

- Demonstrate that detectors can be built to fully exploit the FCC-ee physics opportunities
- Invigorate detector concepts software usage for benchmarking and optimisation
  - Promote the use of the common FCCSW software platform & tools, including the development of the sub-detector geometrical description, simulation, and local reconstruction;
- Provide guidance for coherent detector R&D efforts to address FCC detector requirements
- Function as a forum, where progress, ideas, and results from individual R&D efforts and test-beam activities are presented, discussed and reviewed

FCC-ee Detector Concept



From mandate document

A Detector Concept includes

- Assembly of sub-detectors including magnet system
- Systems for data acquisition, processing, powering and cooling based on estimate of data rates and size
- Software implementation of detector allowing performance evaluation
- Overview of services, consumables, power consumption, and ecological impact
- Evaluation of construction and operating costs