Discussion on Tracking Technology

2nd FCC Italy & France Workshop

Venezia, 4-6 November 2024

INFN MILANO

UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI FISICA

DETECTOR LAYOUTS

INFN MILANO
UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI FISICA

Detector layout optimizations

- A clear area for common work is simulation of detector performance
  - generic detector geometries
    - radial (barrel) and z (endcap) location
    - curved or stave-base geometry for inner vertex
    - number of layers
    - ...
  - parametric detector parameters
    - pitch size
    - depletion depth
    - dE/dx performance
    - timing resolution
    - ...
- But also open mechanical issues

Need also background simulation

"generic" digitizer?

Topics to study

- Minimal radius of the vertex detector
  - hit rate background dominated
  - define bandwidth/power consumption
  - may triggering on the Z or on-detector clusterization reduce service requirements?
- Intermediate silicon layers
  - low pT particle acceptance and identification
  - forward tracking performance
- Inner radius of the drift chamber
  - performance background-dominated?
  - acceptance for particle ID

Topics to study

- Si-wrapper layout
  - mechanical structure
  - cooling distribution
  - how it is supported to guarantee alignment stability
- Module size
  - CMOS reticle size ~2x3 cm2
  - Better module modularity: assume $n \times m$ cells (?) optimize per region and radial position (especially in the endcaps)
  - stitching and overlaps
- Particle ID
  - Acceptance of drift chamber for particle ID
  - Can the loss of hits in the forward regions be compensated by silicon measurements:
    - dE/dx by pulse height measurement in silicon layers
    - timing is fashionable, but is it really needed and where?

Topics to study

- Others?

TECHNOLOGY DEVELOPMENTS

INFN MILANO
UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI FISICA

Silicon for Tracking

- Depleted MAPS
  - Two technologies presented today
    - TPSCo 65 nm
    - ARCADIA LFoundry 100 nm
    - **Platforms available through DRD7.6**
  - Others are on the market (HVCMOS 180 nm and 55 nm...)
  - Is it important to keep more options open?
    compromise: **resources ↔ opportunities**
- Some technologies will also develop timing capabilities
  - LGAD and RSD will be discussed in the PID session

Silicon for Tracking

- TPSCo 65nm
  - strong drive from the ALICE upgrades
  - communities both in Italy and France
  - can be the seed for a common FCCee development
  - which detector area to target:
    inner vertex, outer vertex, wrapper
- ARCADIA
  - mostly INFN developer team, open to international involvement
  - sensor technology demonstrate and scalable
  - may also target some shorter-term experiments, before FCCee
  - which detector area to target:
    inner vertex, outer vertex, wrapper

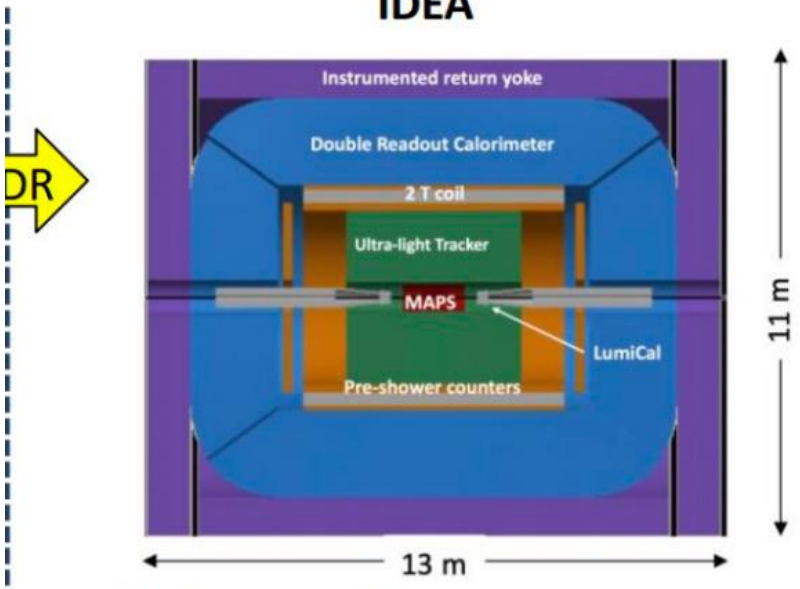
DMAPS Feature Development

Features	Earlier experiments	FCC inner vertex	FCC outer vertex	FCC wrapper
10 um pitch				
"effective" 10 um pitch with charge sharing				
20 ns time-stamping				
30 ps time resolution				
Serial powering capability				
Chip-to-chip data transmission				
10 mW/cm2 power				
50 mW/cm2 power				
100 mW/cm2 power				
Extreme stitching (20 cm size sensors)				
Moderate stitching (4 cm size sensors)				

Central Gas Tracker

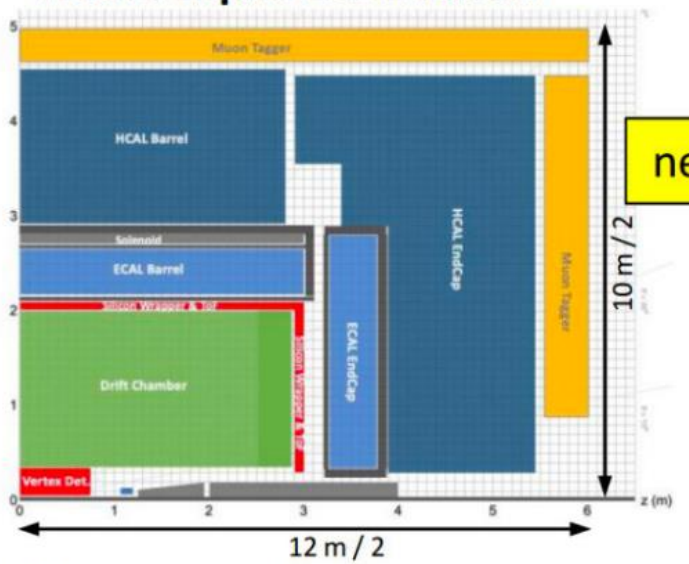
- IDEA and ALLEGRO communities share the Drift Chamber concept
- Which are possible synergies or work sharing?

IDEA



- A bit less established design
  - But still ~15y history
- Si vtx detector; ultra light drift chamber w powerful PID; compact, light coil;
- Monolithic dual readout calorimeter;
  - Possibly augmented by crystal ECAL
- Muon system
- Very active community
  - Prototype designs, test beam campaigns, …

Noble Liquid ECAL based



- A design in its infancy
- Si vtx det., ultra light drift chamber (or Si)
- High granularity Noble Liquid ECAL as core
  - Pb/W+LAr (or denser W+LKr)
- CALICE-like or TileCal-like HCAL;
- Coil inside same cryostat as LAr, outside ECAL
- Muon system.
- Very active Noble Liquid R&D team
  - Readout electrodes, feed-throughs, electronics, light cryostat, …
  - Software & performance studies

BACKUP

INFN MILANO
UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI FISICA