Central Tracking with a TPC

- Requirements from Simulations

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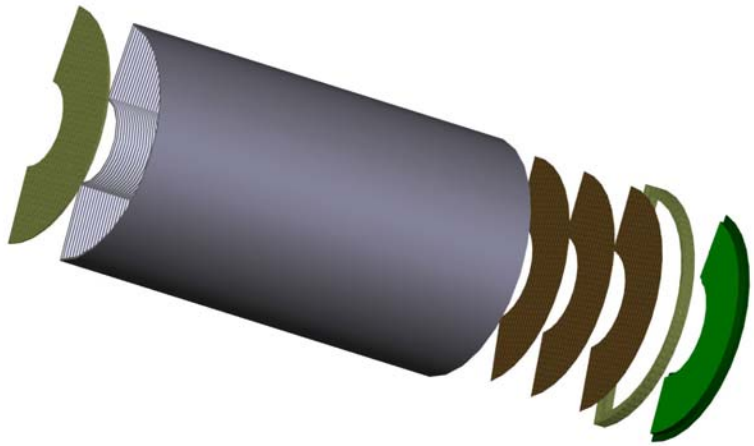
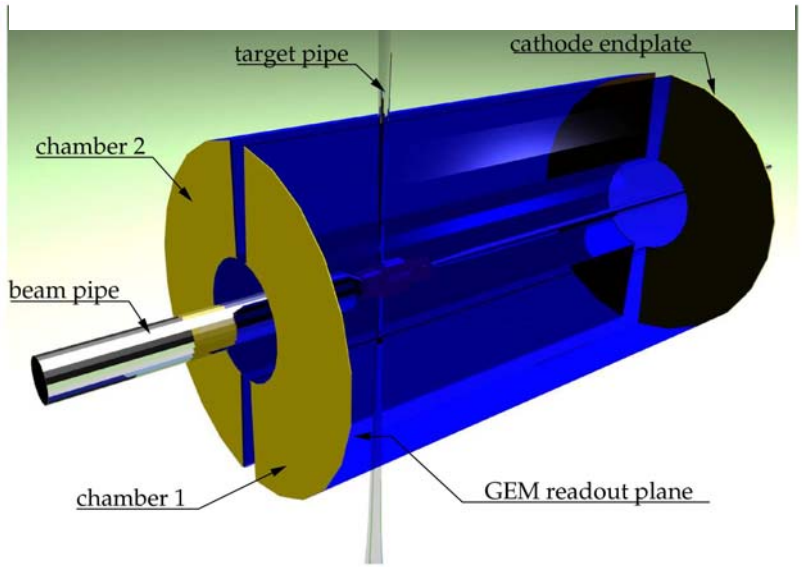
General Layout

Parameter	Value
Length (cm)	150 (z=-40...110)
Inner radius (cm)	15
Outer radius (cm)	42
Drift field (V/cm)	400
Gas	Ne/CO_2 (90/10)
Electron drift velocity (cm/μs)	2.8
Pad size	~ 2 mm x 2 mm
Channels	~ 100.000





TPC Performance – State of the Art

- 20000 charged tracks in one TPC picture
- Spatial resolution in rϕ: $\sigma_{r\phi}$ = 100-200 μm
- Spatial resolution in z: σ_z = 0.2-1 mm
- Momentum resolution: σ_p/p = 1.2 – 1.5% (MIP)
- Energy deposit: $\sigma_{E\ dep}/E$ = 2.5-5.5%
- Material budget: x/X_0 = 2 – 4 %
- Track finding efficiency > 90%
- Two track resolution ~ 1 cm

Central Tracker FoM

1. **Point resolution vs. θ, p_T**
   - 3D residual distributions for single tracks
   - 3D vertex resolution for V^0 (hyperons)
2. **Momentum resolution vs. θ, p_T**
   - single tracks
   - V^0
3. **Reconstruction efficiency**
   - single tracks
   - V^0
4. **Reconstruction efficiency & purity w/ pile-up**
   - tracks
   - V^0
5. **Material budget X_0, λ_I vs θ,ϕ**
6. **dE/dx separation power vs p**

Physics Channels

V^0: hyperon decays ($c\tau$~8 cm)

- $p\bar{p} \to \Lambda\bar{\Lambda} \to p\pi^- \bar{p}\pi^+$
- $p\bar{p} \to \Xi\bar{\Xi} \to \Lambda\pi\bar{\Lambda}\pi$

Charged particles:

- $p\bar{p} \to D\bar{D}, \quad D^{\pm} \to K^{\mp}\pi^{\pm}\pi^{\pm}, \quad D^0 \to K^{\mp}\pi^{\pm}$

Background:

- $p\bar{p} \to p\bar{p}$
- $p\bar{p}$ annihilation in π
- $\bar{p}A$
- beam structure & fluctuations

PID:

- $p\bar{p} \to D\bar{D}$
- $p\bar{p} \to \eta_c \to \phi\phi$

Simulations for TPC FEE

- Shaping time, sampling rate, buffer depth
  - track rate
  - energy deposit, diffusion

  ⇨ FoM: occupancy distribution vs r,ϕ, dynamic range

  ⇨ Channels: background

TPC Performance Optimization

- **Pad geometry, size:**
  - ⇨ FoM: point, momentum resolution
  - ⇨ single tracks, V^0
- **Gas, B/E field inhomogeneities, ion backflow:**
  - ⇨ FoM: point, momentum resolution
  - ⇨ single tracks (+ background as input)
- **Track matching, pile-up:**
  - ⇨ FoM: reconstruction efficiency & purity
  - ⇨ single tracks, V^0 + background
- **Event deconvolution:**
  - ⇨ FoM: reconstruction effiency & purity
  - ⇨ single tracks + background