D.3: Timing and Tracking for the CB Detector

Inner Tracking

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Motivation:

- Inner tracking for the Crystal-Barrel Detector.
- External magnetic field.
  - → Access to neutral and charged final states.

Physics:

- Separation of N* and Δ* resonances.
- Clear strangeness identification by secondary vertex reconstruction.
- Self analyzing decay studies possible by measuring the decay plane of hyperons.
- Study of rare meson decays.

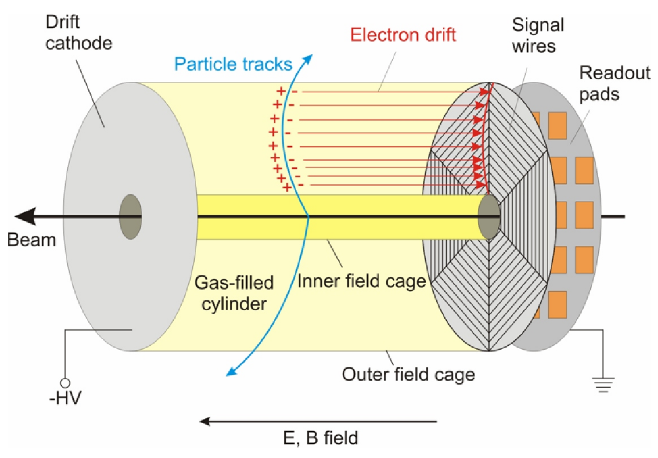
Constraints:

- Outer diameter not greater than 300 mm to fit inside the Crystal-Barrel Detector.
- Inner bore at least 52.5 mm radius not to interfere with the polarized targets.
  - → Polar angle coverage down to 12.7°.
- z-resolution = 1 mm.
- $r\phi$-resolution = 150 μm.
- Momentum resolution $dp/p < 10$ % @ 1GeV/c.
- ≥ 2 T magnetic field strength → continuous (dynamic) polarization of the target.

Principle of a TPC:

Time Projection Chamber (TPC):

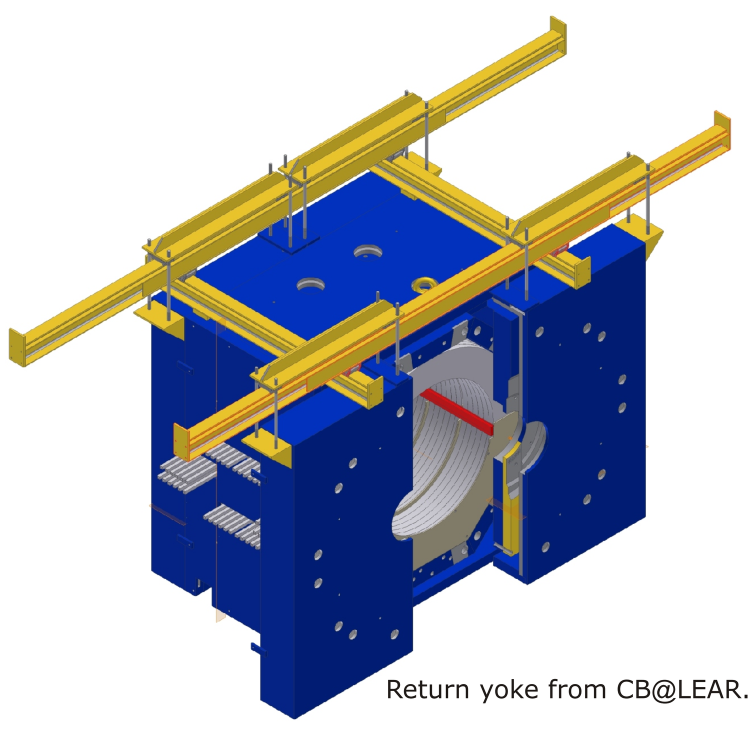
- Charged particles ionize the chamber gas along their tracks.
- Electron clouds drift to readout plane.
- Position sensitive readout (x, y) via Si-pads or MWPC of drifted charges.
- z-coordinate is determined by the drift time t ($t = z/v$).
- Parallel E and B fields suppress diffusion by cyclotron oscillations.
- Drift velocity in the order of cm/μs → Event mixing.
- External start detector needed to determine z-offset.



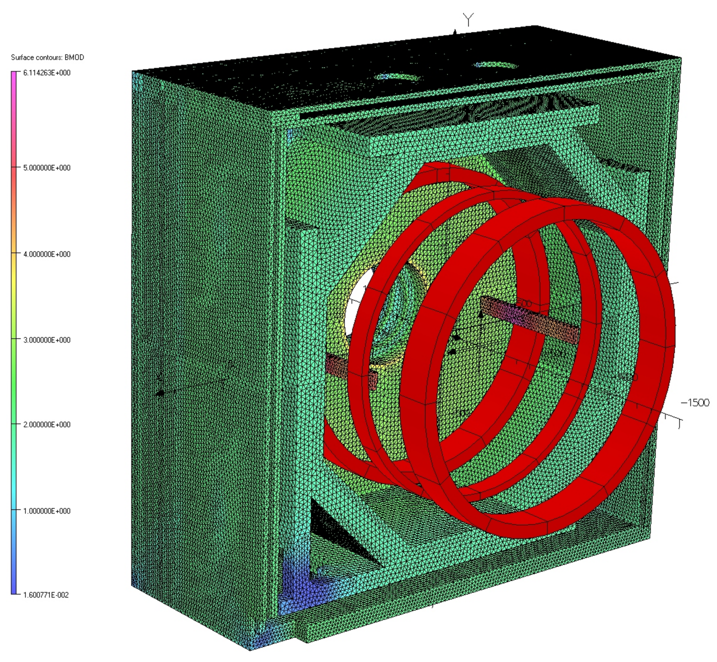
Superconducting Solenoid:

- Return yoke from CB@LEAR.
- New superconducting solenoid.
- A TPC needs a homogeneous magnetic field parallel to beam axis
  - → Solenoid.
- Homogenity $dB/B < 10^{-3}$.
- No passive material in front of the crystals
  - → Magnet covers whole Detector.
- Dimensions:
  - inner bore 1530 mm,
  - total length 2400 mm.
- Field strength increased to 2.5 T:
  - → better momentum resolution ($dp/p \sim 1/B$),
  - → dynamic polarization of the target.
- Closed loop liquid helium cooling cycle
  - → No external liquid helium.

A field and feasibility study done by ACCEL.

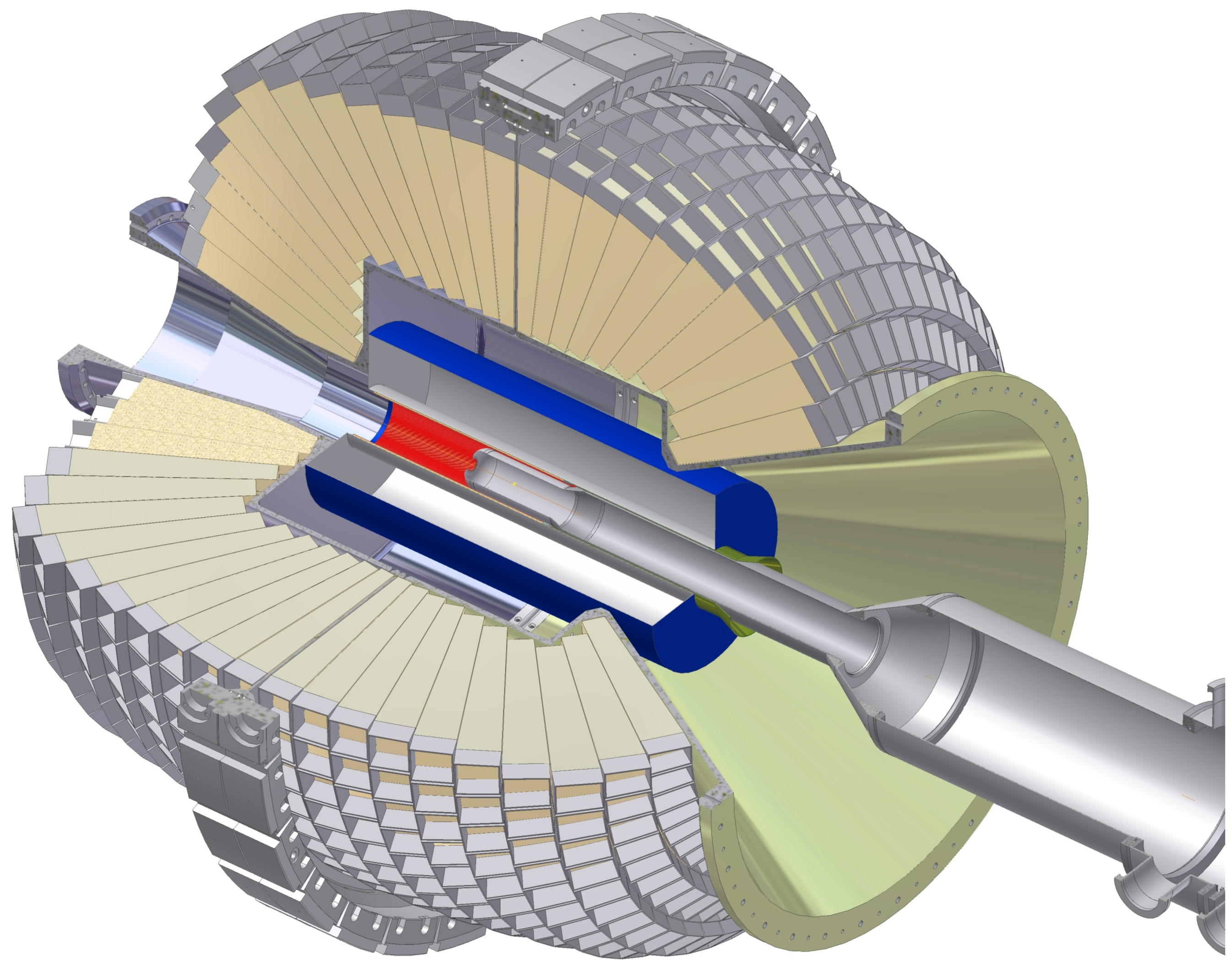


Return yoke from CB@LEAR.



Simulated magnetic field of the 3 superconducting coils and the return yoke.

Recent Design of the TPC:

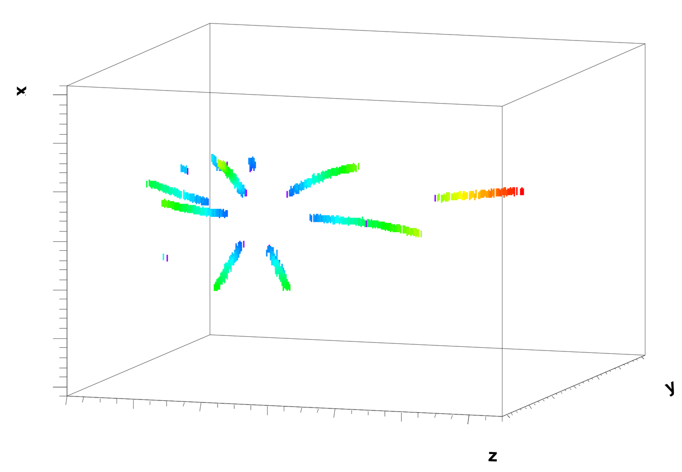


Crystal-Barrel Detector with sketched TPC volume (blue cylinder) and cryostat.

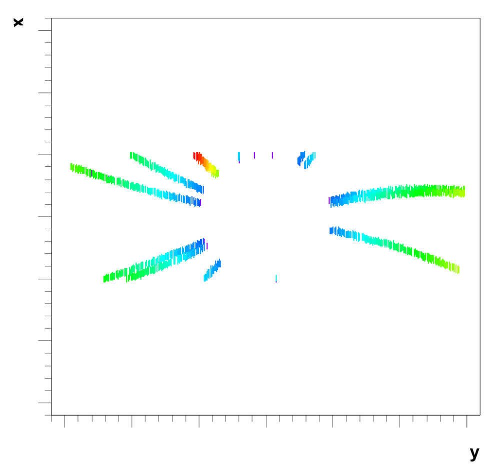
Detector parameter:

- Readout plane upstream (right hand side) with mounting flange.
- GEM amplification and readout with hexagonal shaped pads (r = 1.5 mm).
  - → 10000 pads.
- Front end electronics: N-XYTER or AFTER chip with sampling ADC.
- Driftgas: $NeCO_2$ (90:10).

First Simulation Results for the Crystal-Barrel TPC:



Simulated ionization of charged tracks inside the TPC volume.



Simulated ionization of charged particles viewed from readout plane, where the color represents time.

Collaboration for TPC Developement:

The TPC is developed and constructed in collaboration with:

- Technische Universität München, E18 (S. Paul, B.Ketzer)
- GSI Detectorlab (B. Voss, Chr. Schmidt)
- Helsinki Institute of physics
- Stefan Meyer Institute Wien (J. Zmeskal)
- FOPI@GSI
- CrystalBarrel@ELSA

The TPC acts as prototyp for the PANDA TPC.

Schedule:

- Mechanical design finished end of 2007 (except holding structure).
- Field and feasability study of the magnet done by ACCEL (until October 2007).
- Production of field cage starting January 2008.
- Prototype TPC equiped with AFTER chip will be tested in summer 2008 at ELSA.
- First tests of the detector with cosmics beginning 2009.
- Superconducting solenoid installed in summer 2009.
- Beam tests of TPC in the FOPI experiment at GSI in summer 2009.
- TPC available for Crystal Barrel experiment in fall 2009.
- Start data taking with the Crystal Barrel experiment and tracking spring 2010.

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