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The Layout of the Straw Tube Tracker

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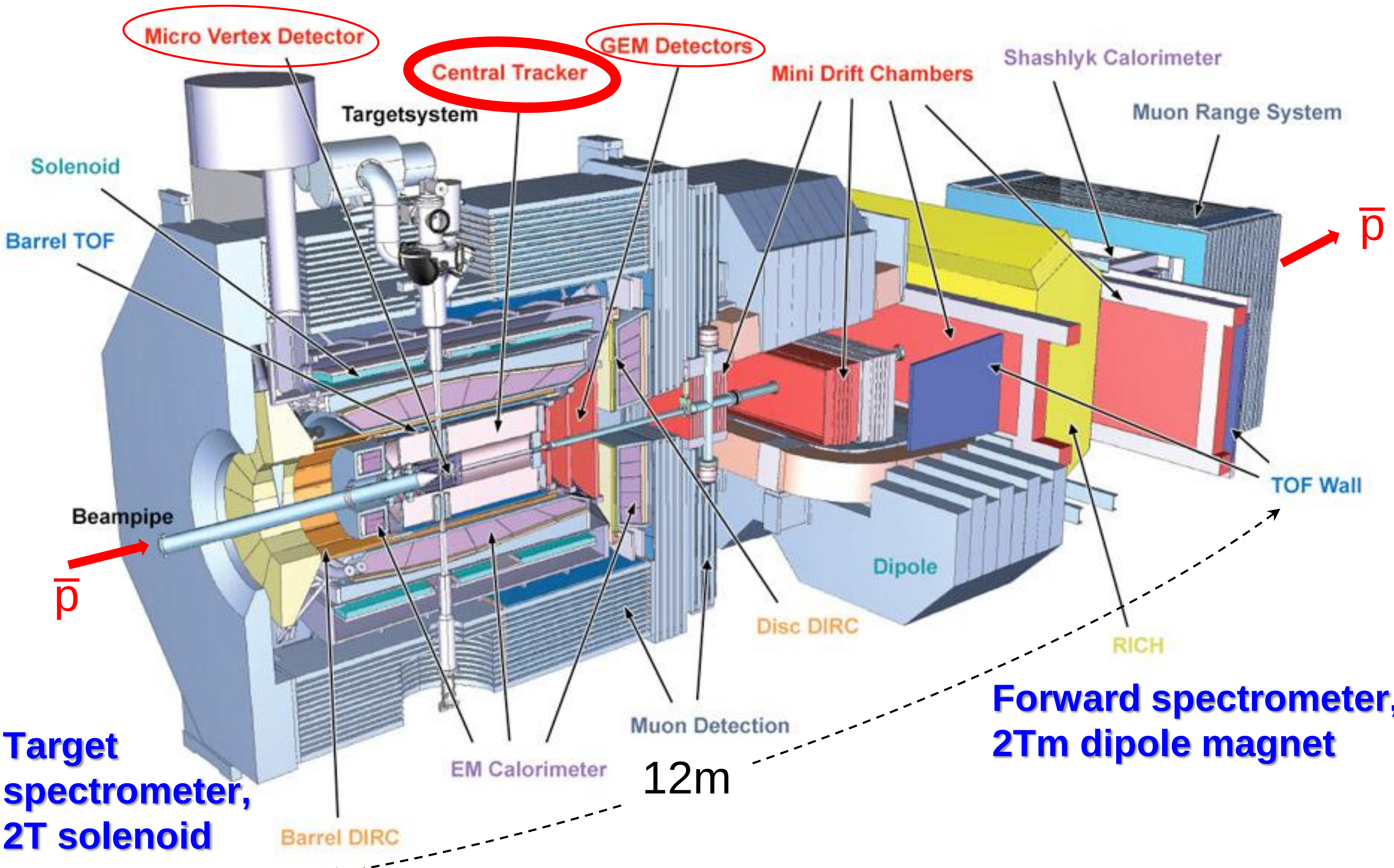
The PANDA Spectrometer



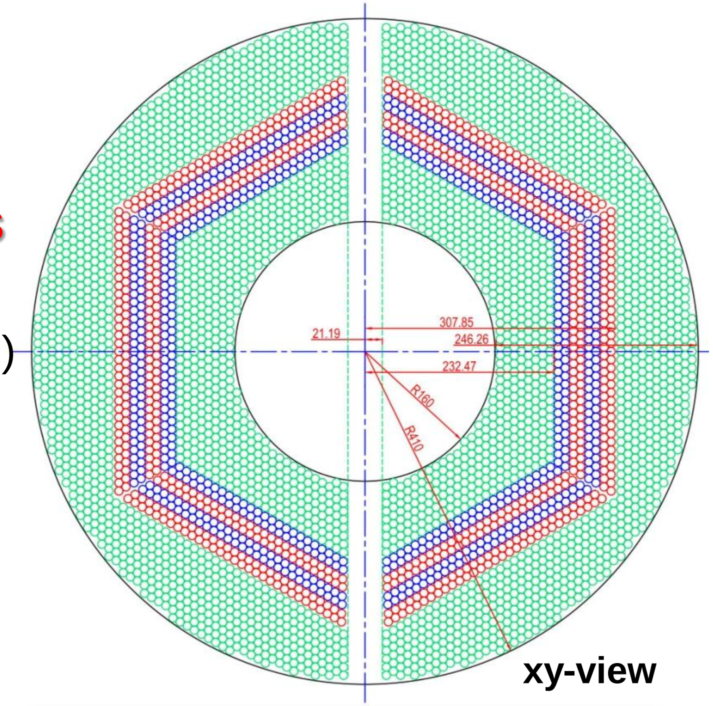
Target spectrometer, 2T solenoid

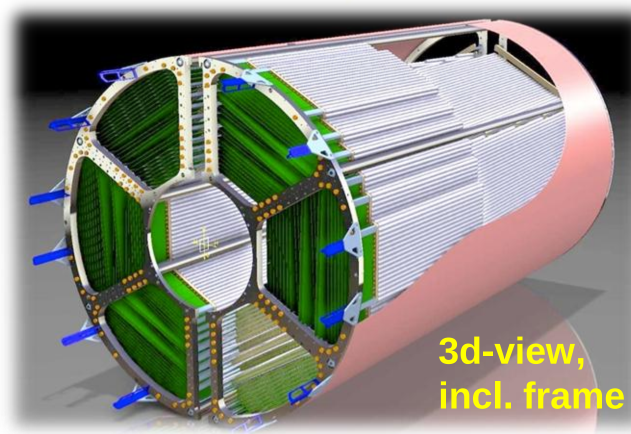
Forward spectrometer, 2Tm dipole magnet

Central Straw Tube Tracker

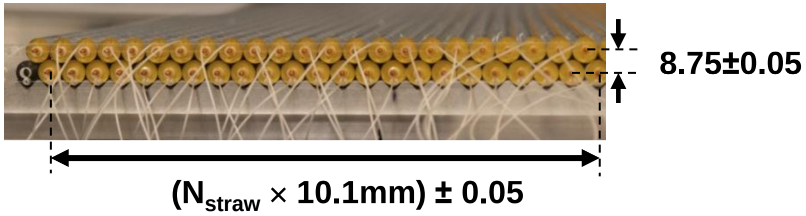
- 4636 Straw tubes in 2 semi-barrels
  - Al-Mylar film, d=27µm, ∅=10mm, L=1500mm
- 23-27 planar layers in 6 hexagonal sectors
  - 15-19 axial layers (green) in beam direction
  - 4 stereo double-layers, skew angle ±3° (blue/red)
- Time readout (isochrone radius)
- Amplitude readout (energy loss)
- $\sigma_{r\Phi}$< 150 µm, σ_z< 2.8 mm (single hit)
- σ_E /E < 8% (p/K, π/K separation)
- σ_p /p ~ 3% (at B=2T, STT alone)
- X/X_0 ~ 1.2% ($^2/_3$ tube wall + $^1/_3$ gas)

- STT dimensions
  - R_{in}/R_{out}= 150/420 mm (160/410mm active)
  - L= 1650mm incl. backward FEE (150mm)





STT Geometry



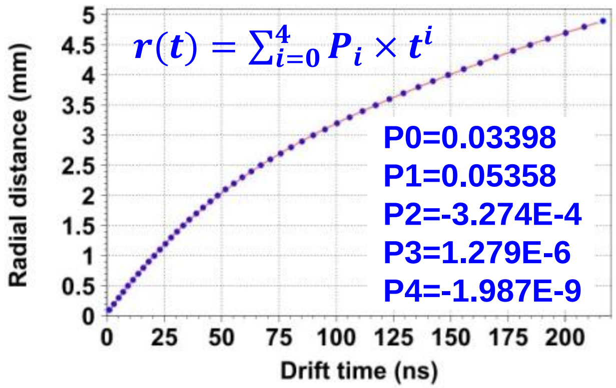
Helix reconstruction

- axial layers
  - helix circle in rφ-plane, up to 19 hits
  - 1st step of track pattern recognition
  - sectors with close-packed planar layers, straw distance: Δx=10.1mm, Δy=8.75mm
- stereo layers
  - helix slope in sz-plane, up to 8 hits
  - skew angle ±3° relative to axial sector layers
  - 2nd step of PR: associate skewed hits to found circle in rφ-plane

- low material budget inside STT
  - X/X_0 ~ 1.2% in radial direction
  - neglect MS, ΔE for (online) tracking
- curling tracks
  - p_{tr} ~ 50 .. 130 MeV/c with 2R ~ 16 .. 42cm at B=2T

STT Readout Information

- Readout information:
  - straw channel number: i, i = 0..4636
  - signal time: t_{hit}
  - signal amplitude (width): A_{hit} (Δt_{hit})



- Signal times t_{hit} for tracking
  - triggerless readout: $t_{hit} = t_0^{evt} + t_{drift}$ $(+t_{offs}+\Delta t_{\Delta L}+\Delta t_{tof})$
  - need drift times t_{drift} for isochrones: $r_{iso}(t_{dr})$
  - event time determination necessary: $t_{drift} = t_{hit} - t_0^{evt}$
  - no data bursts at event rate ~ 2×10^7 /s
    - *event mixing $<\Delta t_0^{evt}>$ ~ 50ns (average, but poissonian)*
    - *drift time range t_{drift} = 0..200ns*
    - *time frame: ±200ns with ~ 8 events, ~ 30 complete/incomplete tracks*

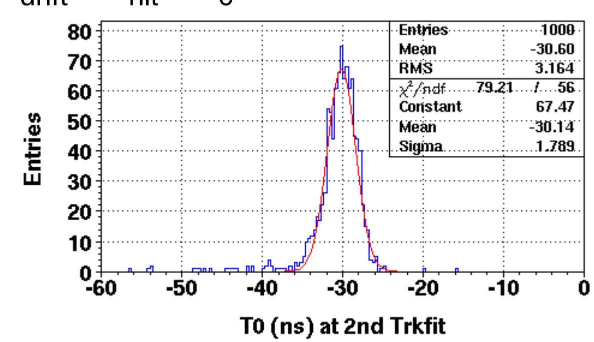
Track Pattern Recognition

Two methods

1. STT alone
   - *define **start hit, time t_{hit}** in inner STT region*
   - *find **hits within t_{hit} ±200ns** drift time window*
   - *associate all hits belonging to one track (track road, ..)*
   - *only coarse straw information: no isochrones, only wire positions, ~mm resol.*
   - ***event time (t_0^{evt}) determination** from STT hits and/or assoc. SciTil hits*
   - *isochrone information available for high resolution tracking*
2. SciTil times as reference
   - *data burst (≥2 hits) in SciTil defines event occurence and time (t^{evt})*
   - ***match STT** (outer) hits **to SciTil hits***
   - *match STT hit times (const. time offset), drift times available*
   - *pattern recognition can be based on isochrones*

T0 Determination Method

- STT standalone reconstruction method (idea)
- Pattern recognition in rφ-plane using straws as pads
  - Find hit cluster in STT, identify all hits within ±200ns
  - Calculate track circle in rφ-plane based on
    - *2× Midpoints of straw triplets: $(x_m, y_m) = 1/3 \times \Sigma (x_i, y_i)^{wire}$*
    - *IP point (0,0)*
  - Associate all hits belonging to one track road
- Calculate time t_0 using the inverse isochrone relation: $t(r_{iso})$
  - Compute expected drift times: $t_{guess}(r_{iso}) = \Sigma P_i \times r_{iso}^i$
  - Compare with hit times: $t_0 = \Sigma (t_{hit} - t_{guess}) / N_{hits}$
  - t_0 resolution of ~ 5ns (σ) for 1000 simulated tracks
  - Trackfit to isochrones with t_0-corrected drift times: $t_{drift} = t_{hit} - t_0$
  - Recalculate t_0
  - t_0 resolution of 1.8ns (σ) already for single tracks



Some Examples

Tracking without isochrones

- Straw triplet-cluster hits: $(x_m,y_m)=1/3\times\Sigma\,(x_i,y_i)^{wire}$
- black (small) circles, with ~ mm precision
- track circles in plots:
  - blue = true track
  - black = to triplet hits
  - red = fit to isochrones