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Calibration of the Straw Tracker for COSY-TOF

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June 16, 2009 | Matthias Röder, Jim Ritman, Pierre Voigtländer, Peter Wintz
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Outline

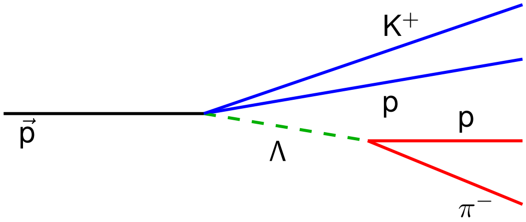
Introduction to the new COSY-TOF STT

Calibration of the COSY-TOF STT

Conclusions for PANDA STT Calibration

Motivation for new STT in COSY-TOF

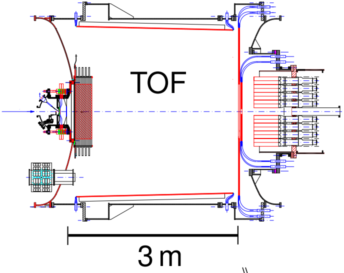
- Investigate SU(3) flavour symmetry w/ strangeness physics
- Determine spin-triplet pΛ scattering length to 0.3 fm accuracy
- Measure pΛ invariant mass spectrum in $\vec{p}p \rightarrow pK\Lambda$ with 5 MeV/c^2 resolution

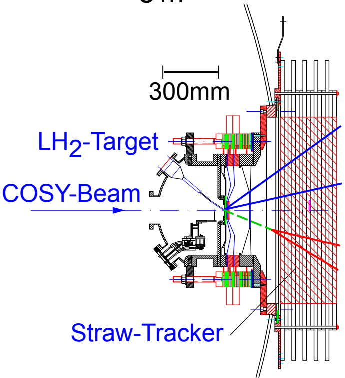


$\Rightarrow$ Need new Tracker with

- $\leq$ 150 μm spatial resolution
- factor 2 improvement in pKΛ reconstruction efficiency

The New Vacuum Straw Tracker

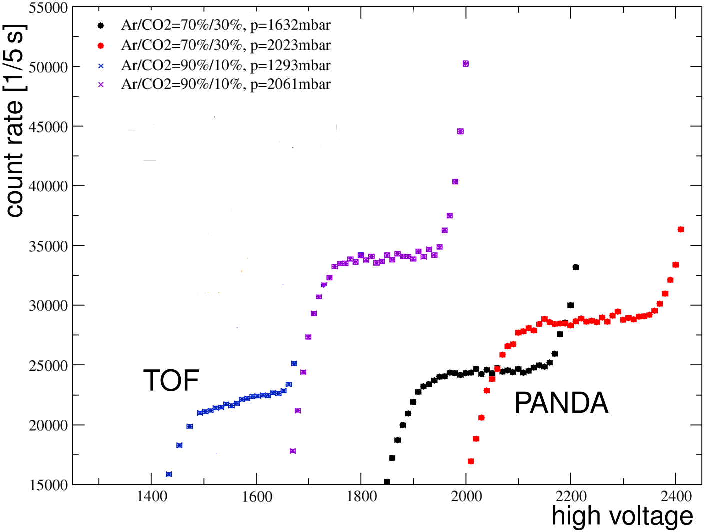




- 2740 drift tubes (ℓ=1m, $\oslash$=10cm)
- Arranged in 26 layers
- $Ar:CO_2$ 9:1 at 1.2 bar pressure
- Operated in Vacuum $\leq 5 \cdot 10^{-3}$ mbar

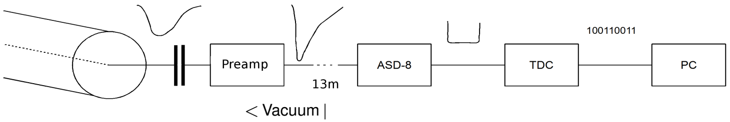
  $\Rightarrow$ Gas leakage on permeation level
- Single straw performance:
  - 98% efficiency
  - 150 μm resolution
  - To be shown under experiment conditions

Gas Parameters



- COSY-TOF Ar:CO_2 9:1 with 1600 V anode voltage
  - Purest drift gas
  - Linear space drift time relation

Readout Electronics (by ZEL-FZJ)



TOF

- Discriminator: ASD8
  - 8 channel Amplifier Shaper LE/TE Discriminator
  - Designed for direct straw readout (M. Newcomer, U. Penn)
  - Not operable in vacuum
- Signal feeding
  - Preamplifier in Vacuum ($<$ 3 mW heat loss)
  - 13 m cabling with vacuum feed through
- Acam GPX multihit TDC

PANDA

- Dedicated readout (PID interesting)

COSY-TOF beam times with the STT

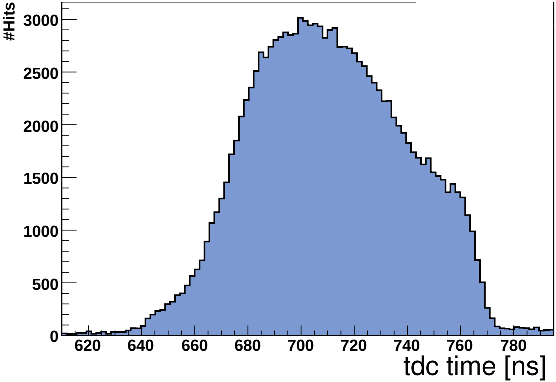
2008

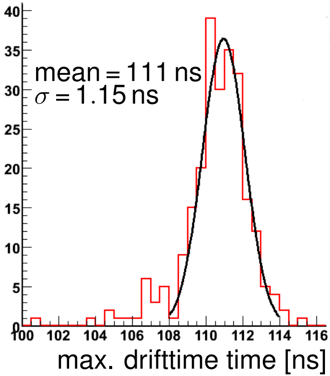
- 40 hours in August for commissioning
- 12 hours in October for commissioning

2009

- 2 weeks in May for physics measurement

Sum TDC Spectra for All Channels





- little variations in spectrum width/shape of different straws

⇒ common calibration for all straws

Calibration Method

- Assume homogeneous straw illumination

$\Rightarrow$ constant density: $N/R = \int_0^{t_r} n(t)\,dt / r(t_r)$

$\Leftrightarrow$ $r(t_r) = R/(N \cdot \int_0^{t_r} n(t)\,dt)$

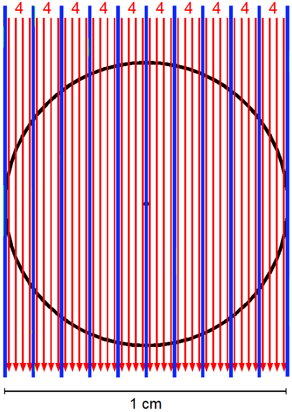
$n(t)$ spectrum entries at time t

N overall number of entries in the spectrum

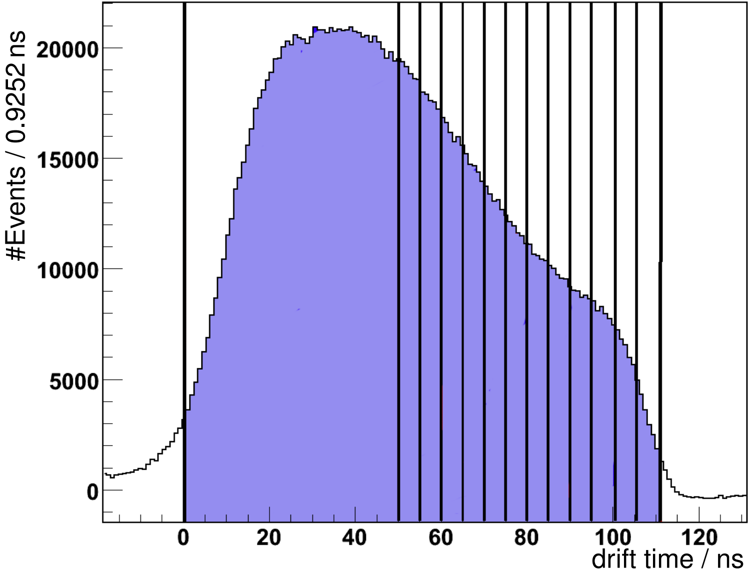
R straw radius,

t_r drift time,

$r(t_r)$ track distance



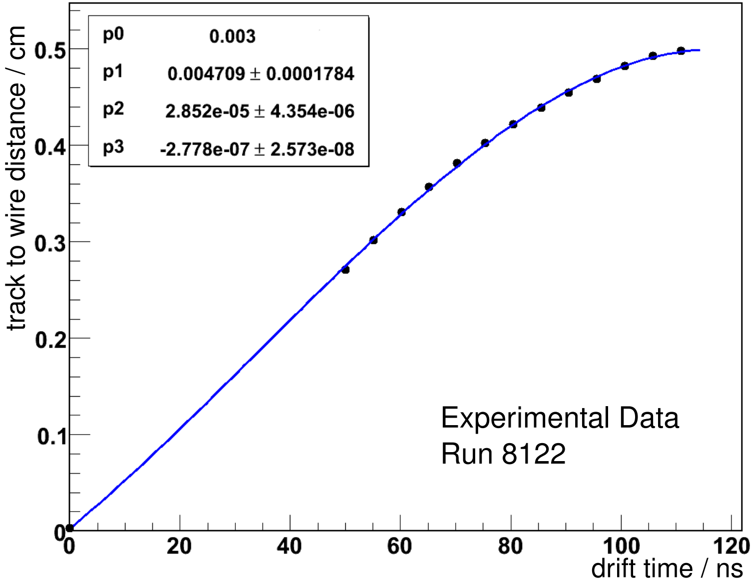
Spectrum Intervals



- One interval covers the broad edge (cluster effect)

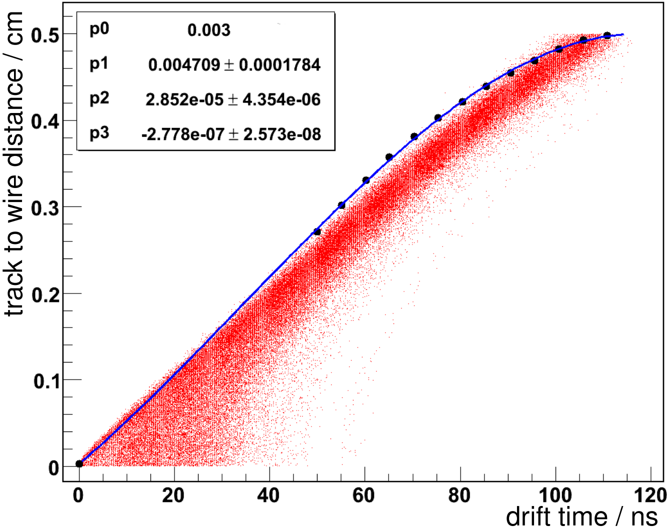
⇒ Broadening effect cancels out

Calibration Curve



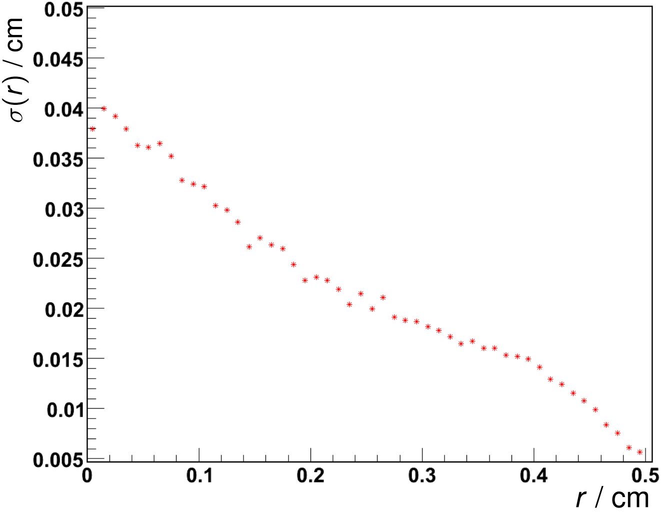
- Calibration curve described by a 3rd order polynomial

Comparison with Simulation



- Example GARFIELD simulation (red dots):
  - agrees with linear shape and max. drift time
  - shows broad smearing due to low gas pressure

Spatial Resolution from Simulations



- Single straw mean spatial resolution ≈ 220 μm
- To be confirmed with data

Conclusion and Outlook

Conclusion

- Common drift time to radius calibration for whole STT done

Next steps

- Iterative improvement of calibration:
  - Tracking with STT
  - Geometrical alignment of all COSY-TOF detectors
  - Refine calibration
- Determine efficiency and resolution

Conclusions for PANDA STT Calibration

- Straw tube operation experience
- COSY-TOF calibration methods adoptable
  - Drift time radius relation
  - Tracking with geometrical alignment

Similarities

- COSY-TOF STT 26 Layers $\approx$ PANDA STT geometry
- Same straw tube geometry (except length)

Deviations

- Driftgas pressure and mixing ratio
- Readout electronics
- COSY-TOF has no magnetic field