STT News & Status

Peter Wintz (FZ Jülich) for the STT group

LII. PANDA CM Giessen, TRK session, Mar-18th, 2015

STT Status

- News
- Project Plan
- Construction Status
- Plans 2015
- Review Beam Tests 2014
- Summary

News - Personnel

- **Sedigheh Jowzaee** finished her Ph.D. (Jerzy Smyrski's group, Jagiell. Univ.), PID with time-over-threshold simulations, COSY-TOF straw tracker, pp $\rightarrow$pKλ analysis

- Next: **Dominik Przyborowski** (Ph.D. thesis, AGH Krakov), **Harout Ohannessian** (master thesis, FZJ)

- **Alexandros Apostolou** (Johann's group, KVI Groningen) started his Ph.D. research visit in Jülich, working on STT, beam data analysis
- **Solmaz Vejdani** (Johann's group, KVI Groningen) joined STT group, participates in next beam time

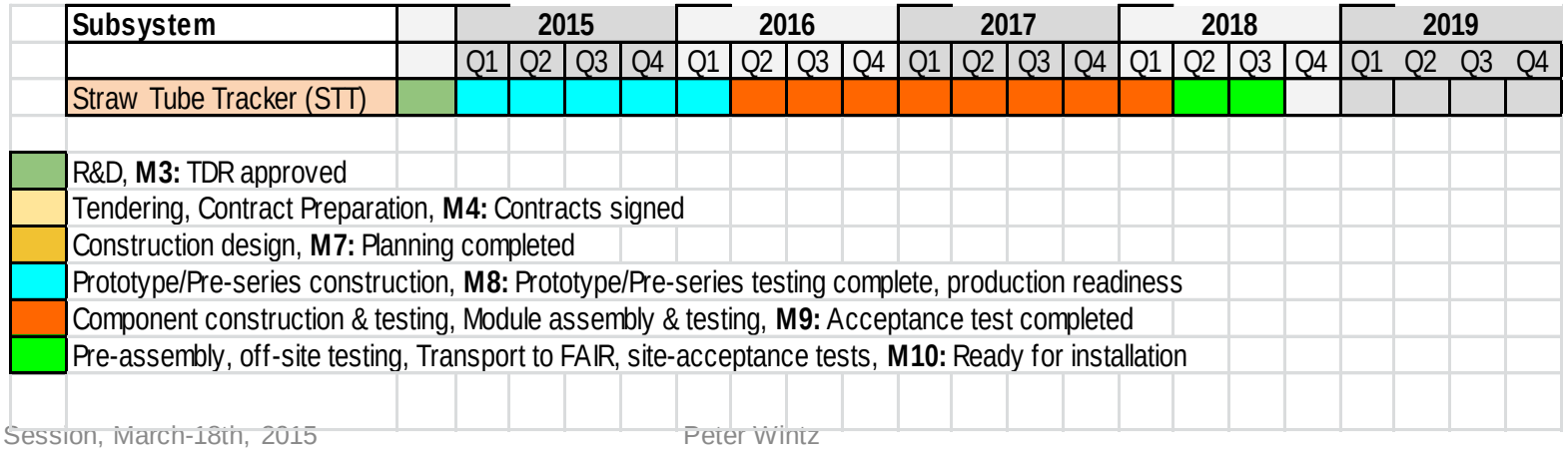
Upcoming Events

- **March-25/26th**: Frascati-Juelich WShop, STT+CFrame prototype assembly
- **April-9/10th**: PANDA DAQT-FEE Wshop at GSI
- **April-27/28th**: PANDA Mechanical WShop at GSI
- **May 4th-10th**: test beam week at COSY (STT + FT), BigKarl beam area

- **Summer**: installation of STT test systems in new beam area (COSY-TOF)
- **Sep/Nov**: further beam tests planned (proton / deuteron), larger test setups
- **Q4 / 2015**: Pre-series test system assembly, one STT sector, ~ 700 straws
- **Q1 / 2016**: Pre-series STT sector with test beam

Project Plan

- System timelines separated in construction schedule & installation schedule
- STT construction timelines below (milestone loaded schedule)
- Propose to extend off-site testing Q2/ 2018 → Q2-Q3/ 2018
  - option for full pre-commissioning of STT with beam off-site
  - Test all channels & replace faulty readout boards, full access
  - Tune readout settings, thresholds with beam (most time consuming task)
- Then concentrate on mechanical installation of STT system at FAIR
- Definition of installation procedures and schedule in progress ..



STT Status – Mech. Construction

- STT construction & system design
  - Straw mass production ongoing
  - Profile plate for straw module gluing ordered (new straw pitch 10.14mm)
  - Next step: straw module gluing (quad-layers)
- Overall system design
  - Assembly of STT / Central Frame prototype (Frascati/Juelich)
  - Next: mounting & alignment of straw modules in STT frame
- General installation, rack positions, cabling scheme .. ongoing
- Set up new test & assembly area in Juelich
  - COSY-TOF beam area, in-beam tests, cosmic tests
  - Option: STT set up area ..

STT Status – Electronic Readout

- Setting up larger-scale readout system ongoing (~ 700 ch)
- New PASTTREC(v1) ASIC readout chip
- FE-board produced, chips bonded, functional tests done
- TRB readout system set up, 10× TRB boards, crate architecture, ..
- New: ASIC setting/control by FPGA in TRB

  → Reports by Dominik & Pawel

- FADC readout system, FEE-free layout design (HV supply & pre-amp backend), system architecture defined, rack design, connectors ongoing

Beam Requests for 2015

Beam time	Beam	Momentum (GeV/c)	Area	Setups
1 week (May 4th-10th)	Proton	3.0, 0.8, 0.6	Big Karl	Existing (2014) + new readout, PANDA-FT prototype
2 weeks (in late Q3)	Proton	3.0, 2.0, 1.3, 1.0, 0.8, 0.6	COSY-TOF	Larger straw and readout setups
1 week (in Q4)	Deuteron	2.0, 1.3, 1.0	COSY-TOF	Same as before

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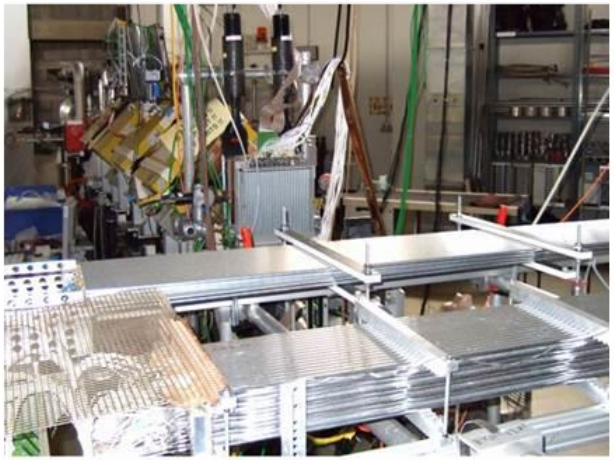
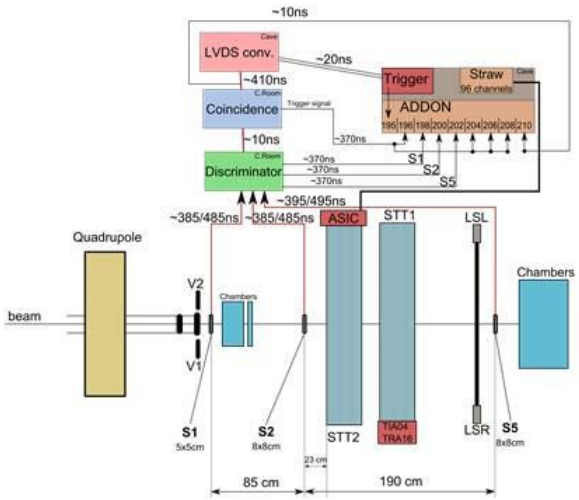
- Beam test week in May approved, STT + FT tests
- Beam time for 2nd half 2015 decided at next CBAC meeting (Jun-29/30th)

Beam Test Series In 2014

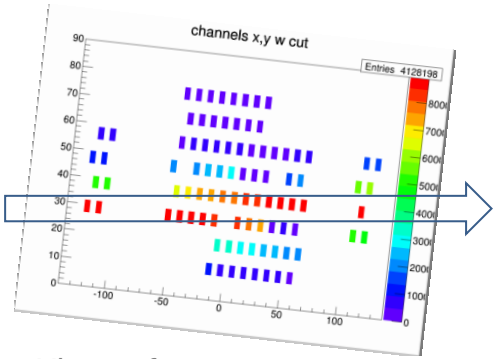
- 3x 1 week (July / Sep / Dec) at COSY Big Karl beam area
- Coverage of large dE/dx region, large signal dynamic range for PID test
  - 6× different proton momenta (0.6, 0.8, 1.0, 1.3, 2.0, 3.0 GeV/c)
  - 3× different deuteron momenta (1.0, 1.3, 2.0 GeV/c)
- 2 Straw setups for both readouts: time-over-threshold / amplitude readout
- Additional scintillators, straw chambers, GEM for triggering & beam monitor



Two straw test setups in Big Karl area. Additional straw and GEM detectors for beam monitoring (beam from back).



Sketch of setups and data-acquisition for the ASIC/TRB readout (beam from the left).



Hitmap for one straw setup. Boxes mark straw positions and hit rate by color. Arrow indicates the beam position.

Data Analysis - Track Reconstruction

Calibration method

- Time offset and time-over-threshold shifts for individual channels corrected
- Determine isochrone radius – drift time relation, global (same) for all straws
  - 1st step: from time spectra (integration/number of entries)
  - 2nd step: isochrone – drift time re-fit by reconstructed tracks

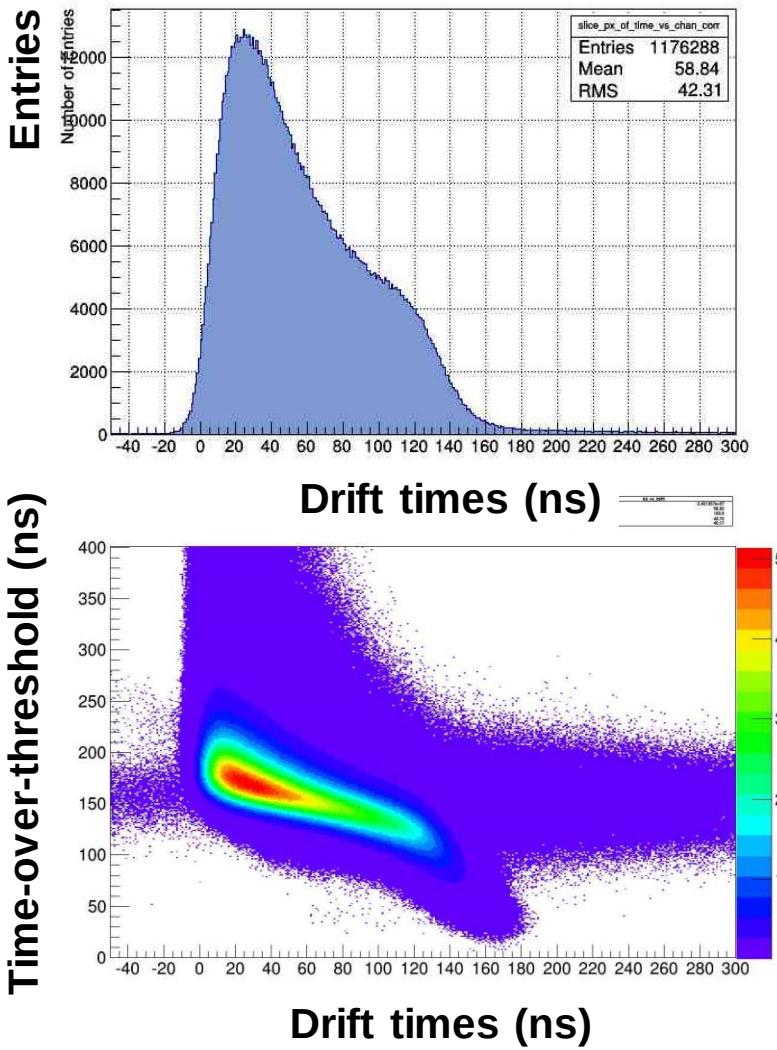
Track reconstruction (minor hit cuts)

- χ^2 – fit of straight line to isochrone circles
- Cut on minimal number of hits (7), on average 12 hits per track (10-15 hits)
- Removal of single outlier (δ-electron) hits (distance > 3σ)
- No further cuts on track quality (no χ^2 - cut, ..)
- Still some background hits present (multi-tracks, improper timing, ..)
- Straggling not corrected, ..

→ Susanna's & Harout's talk

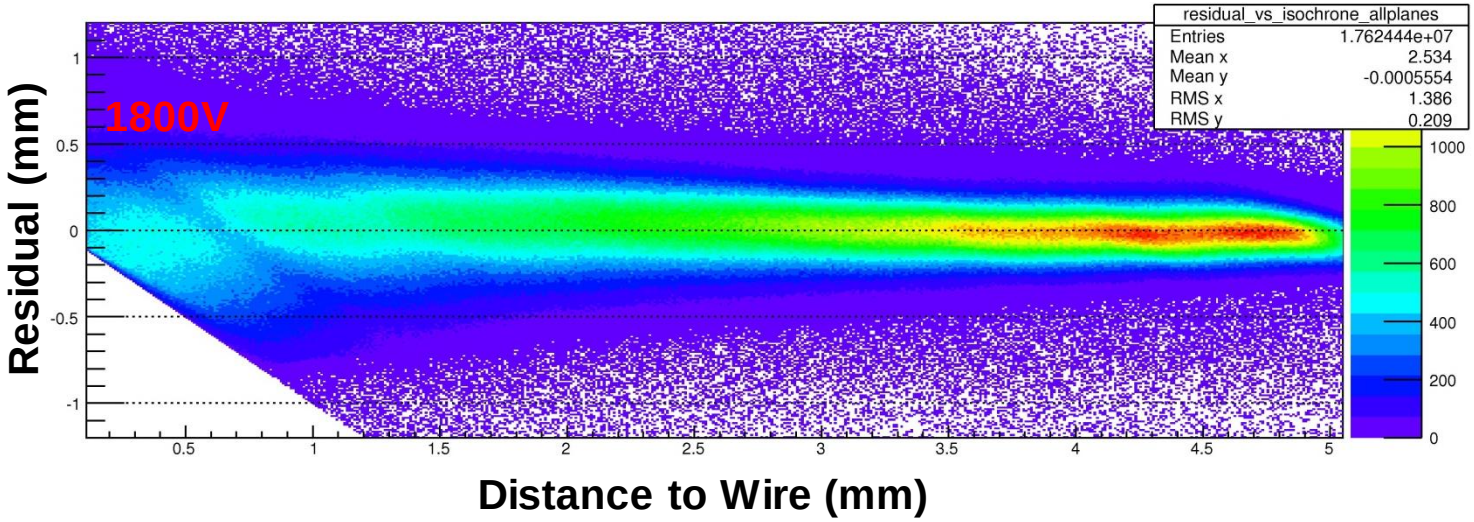
Data Analysis - Raw Tíme Spectra

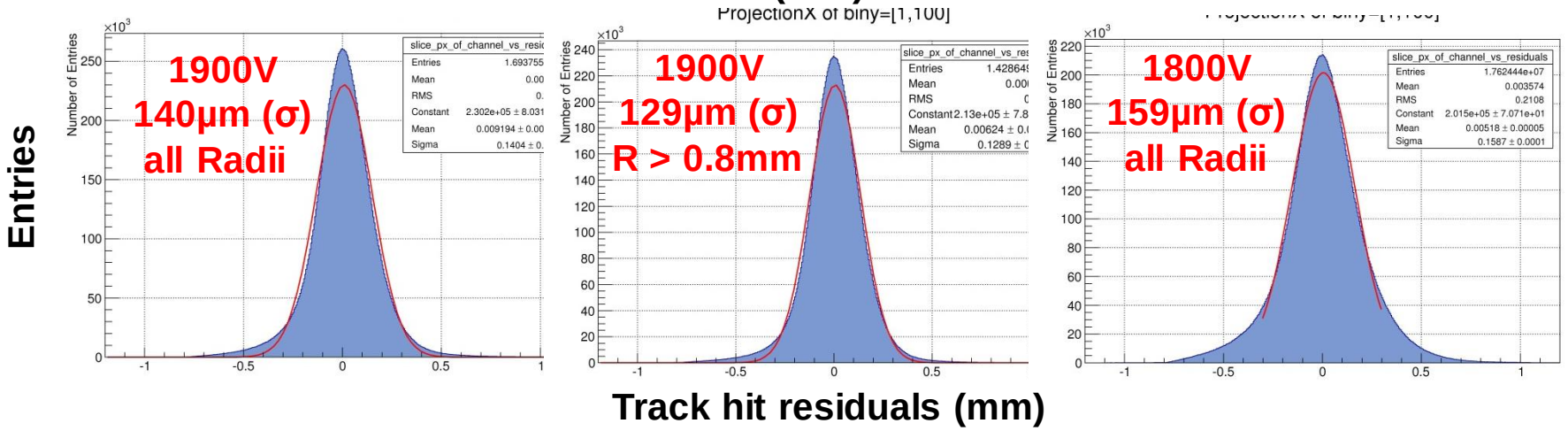
- Here: ASIC/TRB readout data shown
- Clean beam data, similar for FADC data
- Drift time spectra (all channels)
  - Time range ~ 160ns
- Time-over-threshold (ToT) vs drift times
  - ToT function of dx, but not linear
  - Landau tail in ToT visible
- Beam-related background hits visible (multiple tracks), low % level



Data Analysis - Track Hit Residuals

- Radial distribution of track hit residuals (all straws)





Spatial Resolution Results (Pre-lim)

- List of obtained residuals for 800 MeV/c proton data at different gas gains
- Some worst-case conditions → results being upper limits (safety margin)
- Beam position at tube middle → max. wire sag (+ deflection) up to 70µm
- Perpendicular beam on ~mm wire spot → E-field distortion by space charge
- Further room for improvements (some systematic errors still present)
  - Calibration of isochrone – drift time relation for individual straws
  - Straggling of tracks not corrected (track passes through 24 straws)
  - New ASIC with less amplification dispersion
- Final goal (150µm) already in reach with prototype ASIC
- Resolutions at 1900V prove mechanical set up precision
- Similar results for FADC readout

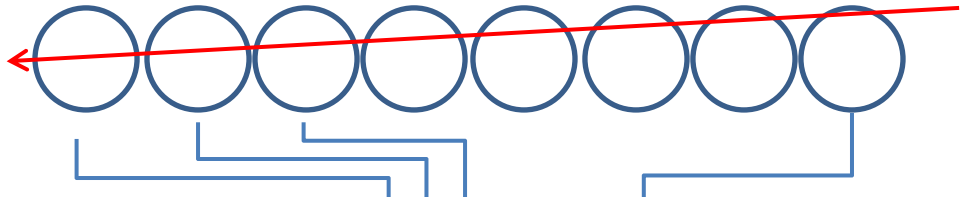
Residuals (µm) for different high voltages

High voltage	1800V	1850V	1900V
Gas gain	5×10^4	8×10^4	13×10^4
Residuals all hits	186	161	140
Only R > 0.8 mm	171		129
Central gaussian	159	142	

default for STT

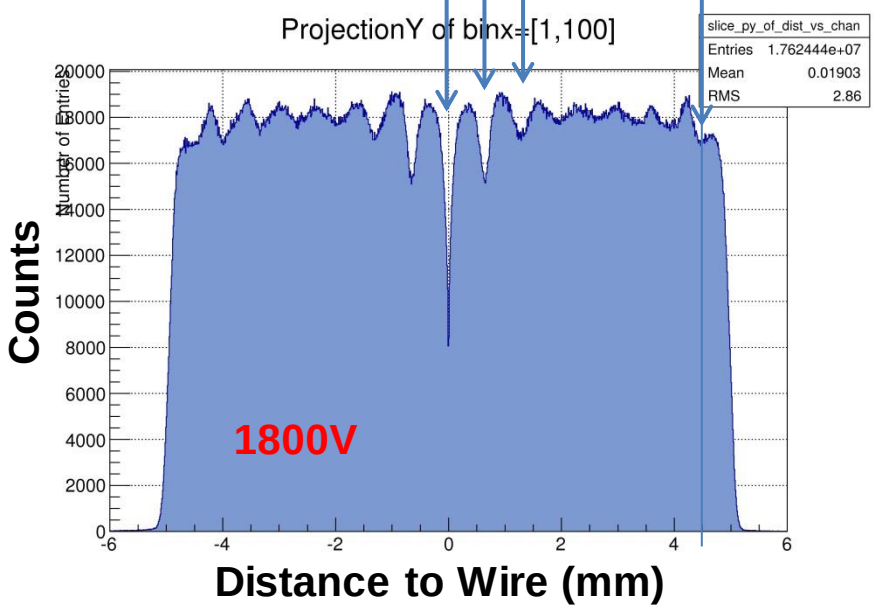
Radial Distribution Of Straw Hits

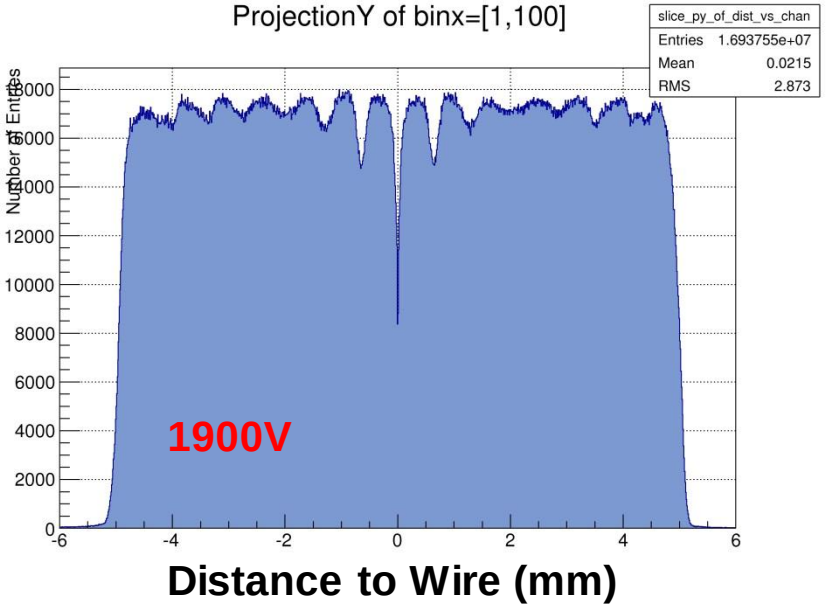
- Distance to wire position from reconstructed tracks if straw hit (all straws)
- Inefficiency pattern from tracks with low number of hits (rejected if <7hits)
  - Per layer 12 straws (16-4), up to ~ 4 missing hits from close to wire or close to tube wall
  - Estimation: few % inefficiency, disappears if larger setups, more straw hits per track



Beam inclination:

- 1.6cm / 10.1mm x 23 straws
- ~ 650µm per straw diameter



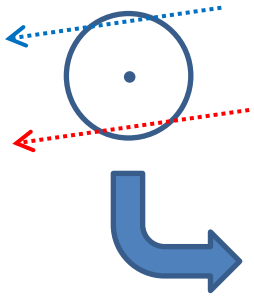


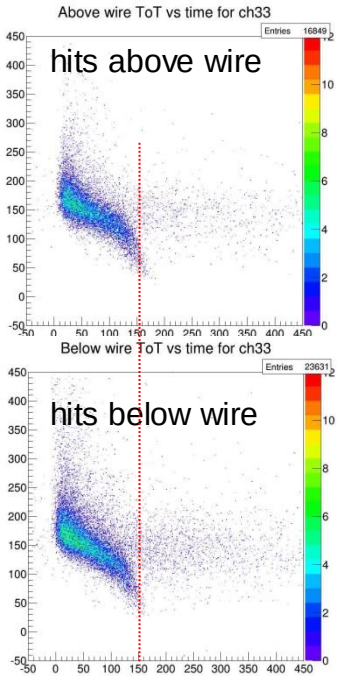
Straw – Beam Tomography

- New method developed to check wire in-tube centering: intrinsic & raw data
- Measure: end region of time-over-threshold versus drift time is sensitive to tracks passing close to straw tube wall
- Check time differences for track hits above and below the wire position
- Further studies ongoing, ~100 µm precision ?

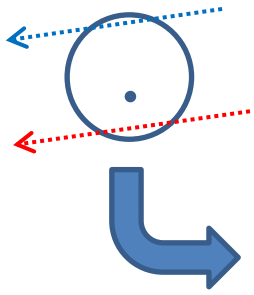
time-over-thresh
versus drift time

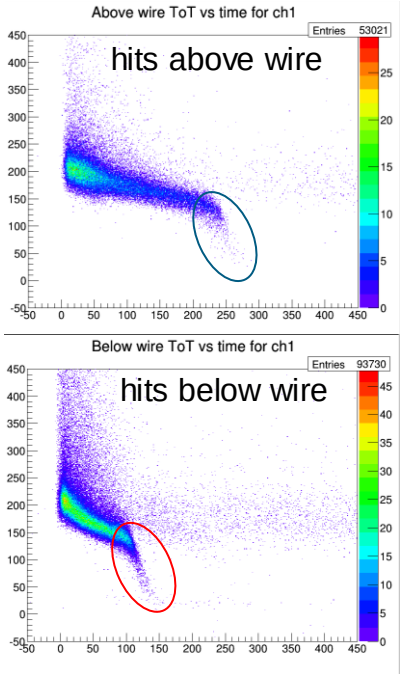
wire in center





wire off
tube center





Summary STT Status

- Spatial resolution goal (150µm) already in-reach with protoype readout & no high-precision mechanical straw frame setup
- dE/dx analysis for PID still ongoing, results soon (truncation, ..)
- Time-offset extraction in raw data to be investigated (triggerless readout)
- Calibration, track reconstruction & dE/dx analysis methods in development

- Alignment concept of straw modules in frame approved by beam data
- Intrinsic method (raw data) for straw wire / tube position measurement developed (straw tomography with slightly inclined beam)

- Robust straw operation demonstrated, even if ~1mm wire displacement
  - No straw operation failure with high-rate beam observed
  - Data cleaning by selecting hits above/below the wire, 2-fold calibration

Thank you for your attention