Tracking Session at CM LI

chaired by Peter Wintz (Forschungszentrum Jülich)

Tuesday, 9 December 2014 from **09:00** to **13:10** (Europe/Berlin)
at **FZ Jülich (INM-5, Room 379)**
Lecture Hall INM-5, Building 05.3, Room 379

Tuesday, 9 December 2014

09:00 - 09:05 Welcome *5'*

09:05 - 09:30 News & Activities, Beam Test Summary (2nd-leg effect) *25'*
Speaker: Peter Wintz (Forschungszentrum Jülich)

09:30 - 09:50 Preliminary results of December beamtime (ASIC/TRB) *20'*
Speaker: Harout Ohannessian (FZ Jülich)

09:50 - 10:10 Preliminary results of the December beamtime (FADC readout) *20'*
Speaker: Krzysztof Pysz (Institute of Nuclear Physics PAN, Krakow, Poland)

10:10 - 10:30 Preliminary analysis of proton/deuteron data (July/Oct beamtime, FADC readout) *20'*
Speaker: Susanna Costanza (INFN Pavia)

11:00 - 11:20 ~~Time-over-Threshold Analysis and Results *20'*~~
~~Speaker: Jacek Biernat (Jagellonian University Krakow)~~

11:20 - 11:40 Status ASIC/TRB Readout *20'*
Speakers: Pawel Strzempek (Jagiellonian University), Mr. Grzegorz Korcyl (Jagiellonian University)

11:40 - 12:00 Structure of ADC-based DAQ-system *20'*
Speaker: Andreas Erven (Forschungszentrum Juelich)

12:00 - 12:20 Analog Part of the FADC Readout *20'*
Speaker: Henner Ohm (Forschungszentrum Jülich)

News & Activities
& Beam Test Summary

9. Dec. 2014 | Peter Wintz

LI. PANDA CM, TRK session, Dec-9th, 2014

Topics

- News (STT + FT)
- Status & Timelines
- Project Controlling
- Publication Policy
- Beam Tests in 2014 (“2nd-leg“ effect)
- Summary

News

- New STT member: Alexandros Apostolou (Ph.D., KVI Groningen)
- Gianluigi Boca official contact person for STT software issues
- German funding of STT budget approved and available (Oct-2014)
  - $\sim 1/3 \times$ total STT budget
  - Money flow defined for 2014-2018, connected to milestones
- Funding process for (Italy, Poland, Romania) still in progress
- Beam test series in 2014 (3×1 week) successfully finished
- Beam time request for 2015 submitted (series of 1+2+1 week)

News cont'd

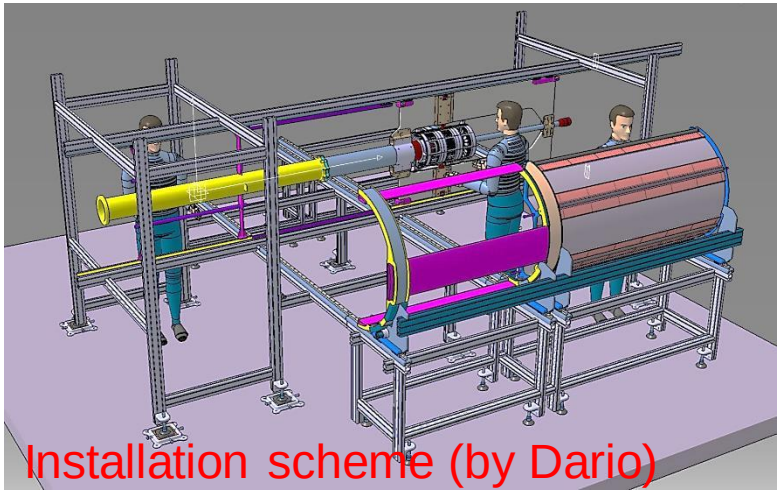
- Mechanical Workshop at GSI, Oct-28/29th
  - Central systems integration: MVD, bEMC, STT (+beam pipe)
  - STT system & installation scheme presented by Dario

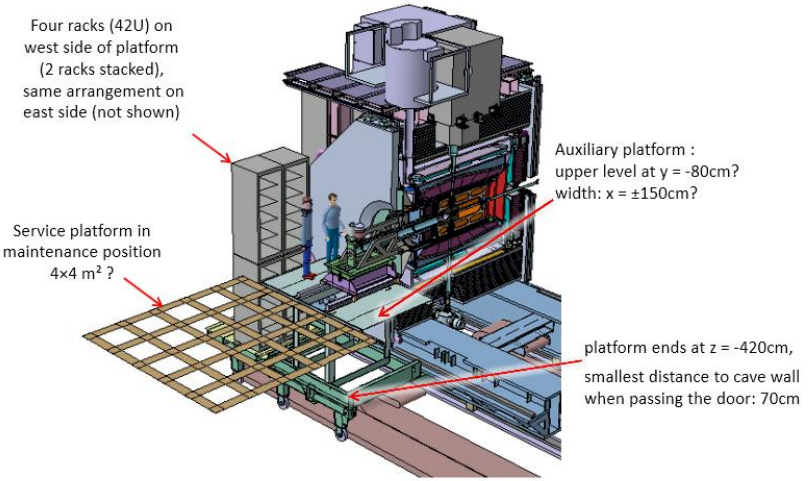
- STT mech. frame and Central frame structure incl. rail system transferred from Frascati to Juelich for test mountings

- New experimental area set up in preparation
- Test area for STT and Forward Tracker setups
- Plan to install setups in new area till summer 2015
- COSY-TOF vacuum spectrometer (20 m^3) removed from beam-line
- Beam tests in new area planned for Q3/Q4 2015

STT Construction Status

- STT system layout & installation:
  - STT system split into 2 semi-barrels including cable-routing frame
  - Mounting skeleton for moving STT systems left / right to Central Frame
  - 2 readout racks + patch panels booked for STT
  - Rack positions 1× left & 1× right, at front on auxiliary platform
  - Maintenance of Central-System without any STT dis-cabling (optional)
    - STT systems move (left/right) to rack positions, free access to MVD





STT Construction Status cont‘d

- Straw productions and front-end gas supply:
  - Straw mass production ongoing
  - Straw layer gluing tests finished (glue type, glue gap)
  - Straw pitch definition, long-term test finished soon (Artur)
  - Final layout of all straw positions, incl. stereo layers, incl. shorter straws
  - Integration of straw modules in mechanical frame, adapters
  - Integration of gas manifold layout in mechanical frame (by Artur)
    - Stainless steel pipes (0.1 mm wall)

STT Construction Status cont'd

- STT readout electronics
  - ToT-ASIC/ TRB readout
    - PASTTRECv1 – ASIC delivered, 40 chips (×8ch), CMOS 0.35µm
    - Tests currently in AGH Krakov, bonding on FEE-boards, 1st tests at JU
    - TRB boards (10x) avail. soon, tests / FPGA-programming at JU
    - New: FPGA-control of ASIC settings
  - FEE-free FADC system
    - Straws connected to coax cables, 12m length, 1.1 mm diameter
    - Straw signal on HV level, HV decoupling and amplifier backend
    - 128ch, tests in October/December beam time successfull
    - FADC/FPGA architecture design (high channel number)
    - Integration of amplifier in FADC board, HV supply

More details in talks by Pawel/Greg, Andreas, Henner

STT Timelines

- 2014: Straw series production started, pre-series electronics in construction
- Q1-Q2/2015: Preparation of (new) experimental beam test area at COSY
- Q1-Q2/2015: Installation of larger straw setups with pre-series electronics
- Q2&Q4/2015: Beam tests of setups (beam time requested, not yet approved)
- Q4/2015: Production of pre-series module (full STT sector incl. readout)
- Q1/2016: Pre-series testing complete & production readiness (M8)
- 2016-2017: STT main construction phase
- 2016/2017: Further beam tests for readout and analysis optimisations
- Q4/2017: Pre-commissioning with beam at COSY (optional)
- Q1/2018: Acceptance test completed (M9)
- Q2/2018: Approval for installation (M10)
- Q3/2018: Ready for beam (M11)
- Q4/2018: Ready for operation (M12)

in red: official milestones

Forward Tracker

- Forward Tracker prototype system
  - 3 modules in production
  - 32 straws each module, straw length 68cm, 1cm diameter
  - FEE boards with ASIC, TRB readout
  - Lab testing in Krakov (straws / electronics)
  - Plan to install setup in Juelich in 1st half 2015
  - Preparatory cosmic tests
  - Beam test together with STT, same DAQ

Project Controlling

- Serious project development control by TechCoord (Lars Schmitt) and CollabBoard has started
- System status reports requested at every CM
- Tracking system definition: STT + FT + GEM
- Project plans (milestone schedules) are followed-up
- Risks in development to be evaluated continuously
- No delays without serious justification and discussion

Project Deliverables (2015-2016)

- Definition of STT deliverables for 2015-2016
- Based on FAIR-ECE evaluation of TDR in Dec-2012
- TDR approved: design feasible, no show-stoppers seen
- FAIR-ECE (expert committee experiments) as further advisors
- Recommendations, based on their experience with large-scale experiment facilities
  - Tight readout development, the 2 approaches need more in-beam tests
  - Beam studies with varying energy to expose the developing electronic chain to the full dynamic range of physical pulse heights
  - Pre-series test of 1st production module (full STT sector) including readout and supplies, full functional & radiation tests
  - Failure studies of single straws (gas loss, broken wire)
  - General robustness tests (loss of gain & efficiency, worse mechanical tolerance, pressure and temperature variation, ..)

ongoing or in preparation

Publication Policy

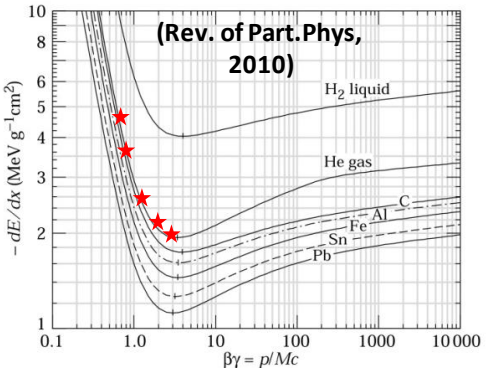
- Publications (i.e. paper, talk, poster, conference proceeding, ..) have to be submitted to PANDA PubComm at least 3 weeks prior to planned publication
- All details about publication process on PANDA page

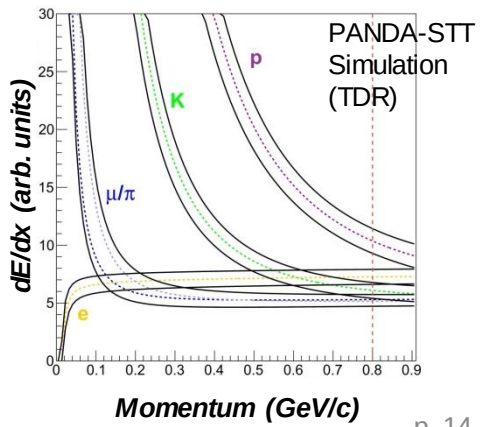
- PANDA-STT related publications:
  - Group has to be informed about publication (STT responsible: P. Wintz)
  - Basis for authorised information: TDR and STT project page*
  - TDR evaluated and approved, clear definition and deliverables for the STT
  - New designs, results, decisions to be discussed in group meeting
  - SeeVogh meeting on request to inform the group
  - Author list:
    - Author and/or group of authors involved
    - Add: “on behalf of the PANDA collaboration“
  - In general: avoid unclear, divergent opinions, private remarks, ...

*https://panda-wiki.gsi.de/foswiki/bin/view/STT/WebHome

Beam Test Series in 2014

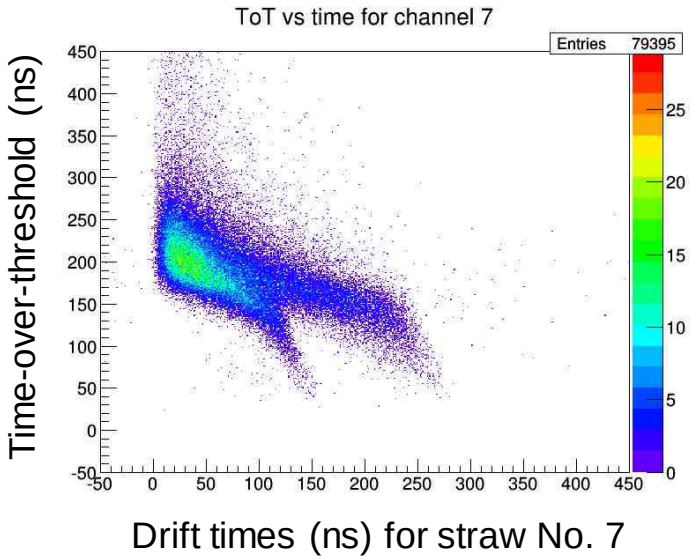
- 3x 1 week (July / Sep / Dec) at COSY (external Big Karl area)
- Main goal: dE/dx measurements for PID:
  - proton / deuteron separation in COSY momentum range 0.6 – 3.0 GeV/c
  - ~ p / K separation task at PANDA < 0.9 GeV/c
  - Cover full dynamical physical signal range
  - dE/dx (p) reconstruction (non-linear fit)
  - ~ 5× proton momenta (0.6, 0.8, 1.0, 1.3, 2.0, 2.95 GeV/c)
  - ~ 3× deuteron momenta (1.0, 1.3, 2.0 GeV/c)
  - Time-over-threshold / amplitude readout
  - 2 straw setups for both readouts
- Resolution goals: $\sigma_{r\Phi}$ < 150µm, σ (dE/dx) < 10%
- Rich data-base, analysis ongoing

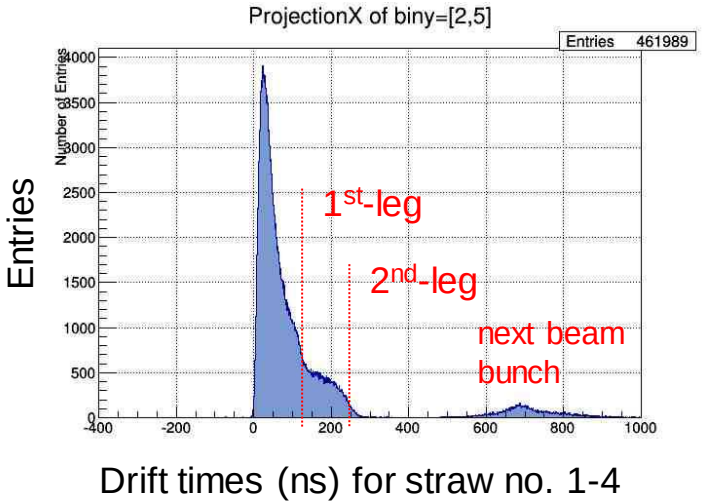




The "2nd-Leg": Observation

- Observed effect of delayed straw hit times with beam
  - 1st-leg: end at t_{drift} ~ 130..150ns (150ns expected from simulation)
  - 2nd-leg: delayed hits up to t_{drift} ~ 200..250 ns
- Effect more or less pronounced for different beams, straw settings, ..
- Calibration (isochrone) and tracking resolution only 300-350 µm
- Effect in both setups, stronger in setup with ASIC-readout



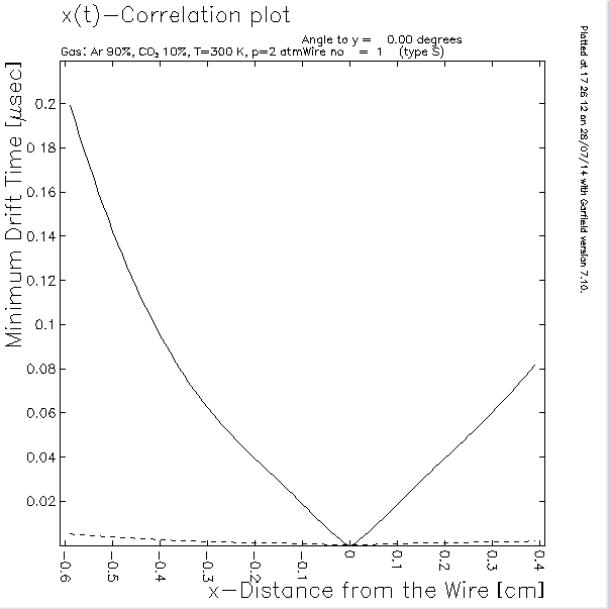


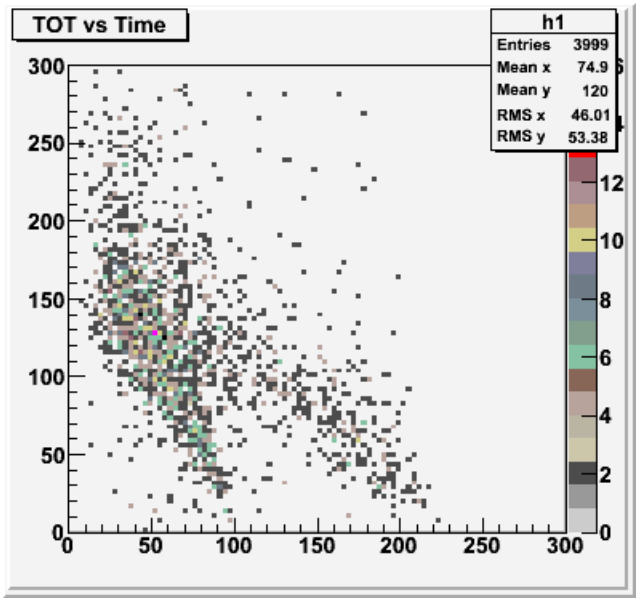
The "2nd-Leg": Investigation

- Possible sources:
  - Beam-related background by multiple tracks & improper trigger/timing
  - Beam extraction: time structure & beam position
  - Electronics
  - Straw intrinsic
  - Space charge effect, beam intensities ~ 10 - 200 kHz / cm wire
- Investigation:
  - 1st beam time (July): delayed straw hits visible on oscilloscope (Jerzy) for certain straw couples, effect was established.
  - 2nd-leg not visible for cosmic rays
  - 2nd beam time (Oct): clean, non-divergent beam, straw setup inclined by ~3° deg. to horizontal beam, different heights of straw setup in-beam
  - Data analysis and clear 2nd-leg data-tagging method found!
  - Systematic study possible with data

The “2nd-Leg“: Simulation

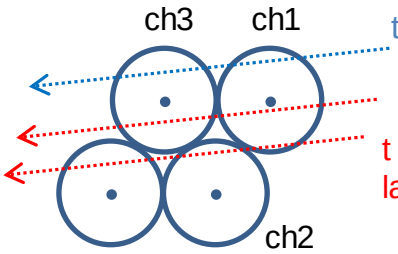
- Jerzy started straw simulation (Garfield) after July beam time
- Drift time vs time-over-threshold topology of 2nd-leg produced by wire displacement
- But: leg position different than in data (1st-leg < 100ns, data: 120..150 ns)





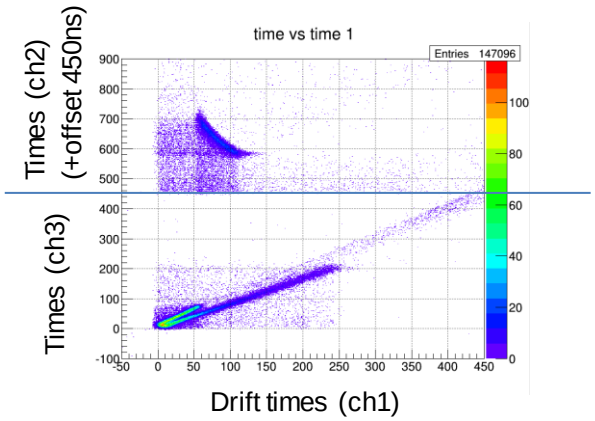
The “2nd-Leg“: Tagging Method

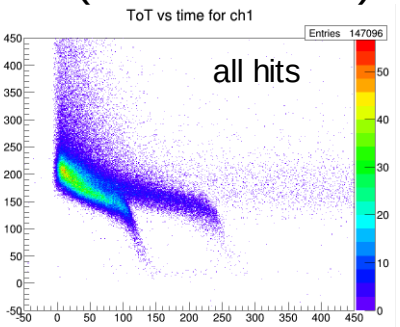
- Hit correlation in adjacent straws analysed (ch1-ch3-ch2)
- 2nd-leg hits from above wire
- 1st-leg hits from below wire
- Clean tagging by hit times

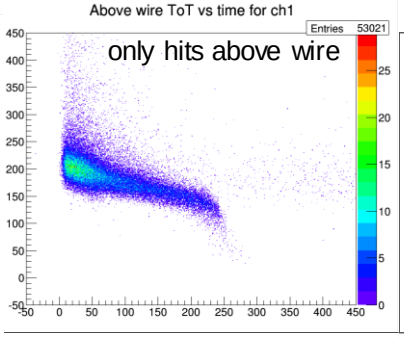


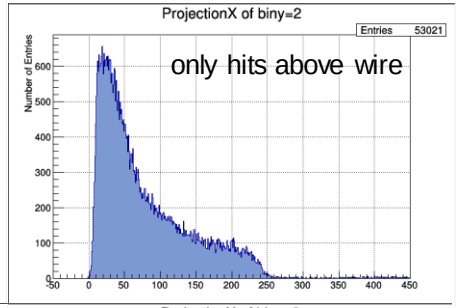
t (ch1) > t (ch3): hits above wire

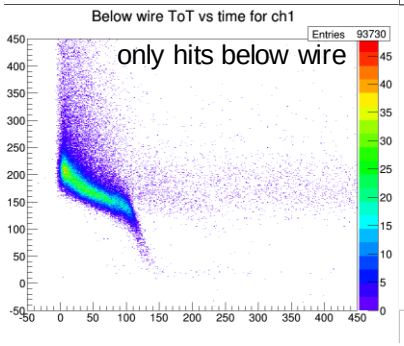
t (ch1) < t (ch3) or hit in lower layer (ch2): hits below wire (ch1)

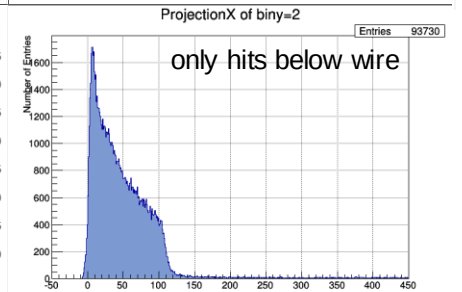












The "2nd-Leg": Explanation

- Wire not in straw center by mis-aligned straw ends: straw ends (= wire position) too low compared to straw z-middle position (= in-beam position)
- Reasons:
  - Straw modules were mounted, aligned to mechanical frames
  - No dedicated mechanical frames for prototype setups, bending of (standard) frame bars (2m length) observed
  - Old-type straws (COSY-STT) used for prototype tests (full beam!), some twisting of straw modules (known), straw pitch slightly too tight (known)

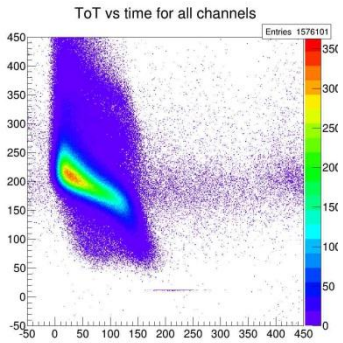
- Consequences for PANDA-STT:
  - Already improved since longer time (2013): new straw type (softer winding), less twisting, dedicated straw module gluing tests, long-term tests for straw pitch
  - Self-supporting feature of the straw modules in the mechanical frame structure
  - High-precision mechanical frame structure
  - Expected wire grav. sag at straw middle position: ~35 µm maximal (@50g tension)
  - 2nd-leg test can serve as alignment check of PANDA-STT

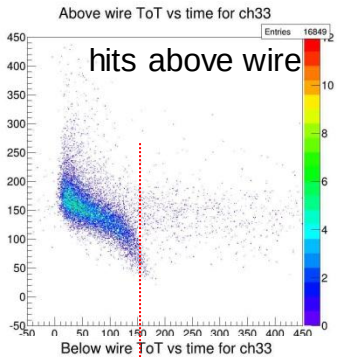
The "2nd-Leg": Conclusion

Last week beam time:

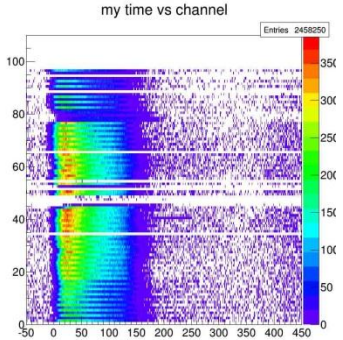
- 2nd-leg tagging was done (on-line) and straw modules were re-adjusted by identifying leg-distance
- Data spectra after few iterations, no 2nd-leg visible anymore (<10ns):

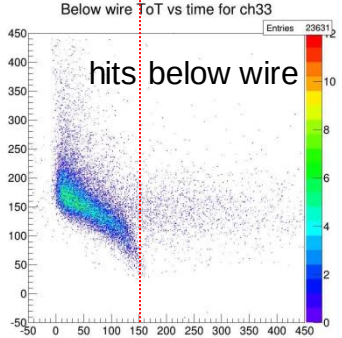
ToT vs time

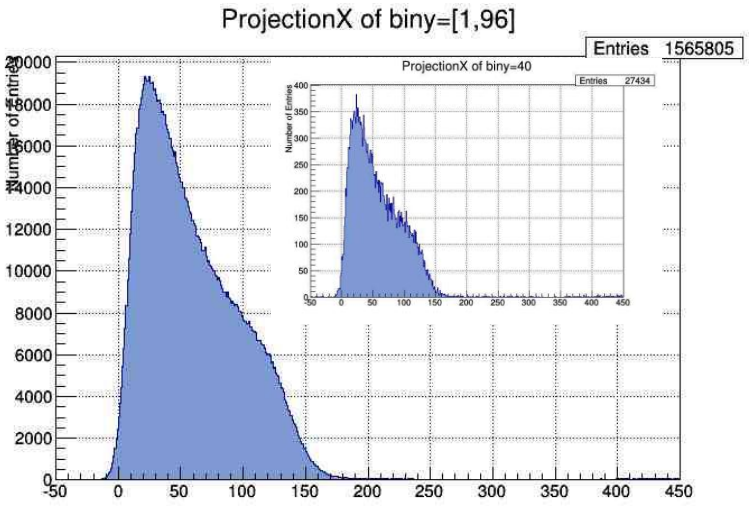




Time vs channel







Drift time (ns) for all channels

Summary

- Beam test series in 2014 for STT successfully finished (3 weeks)
  - 6 different proton momenta, 3 diff. deuteron momenta for dE/dx (p) fit
  - Stable straw, readout and DAQ setups
  - Stable settings (threshold, noise levels, ..) allow clear comparison
  - Large dynamical physical signal range covered by proton / deuteron
  - Data analysis ongoing

- Strange pattern in time spectrum ("2nd leg") clarified and solved
- Can include "2nd leg" test in STT commissioning

- Beam time request for 2015 submitted (series of 1+2+1 week)
  - Larger straw setups, new pre-series electronics, new beam area