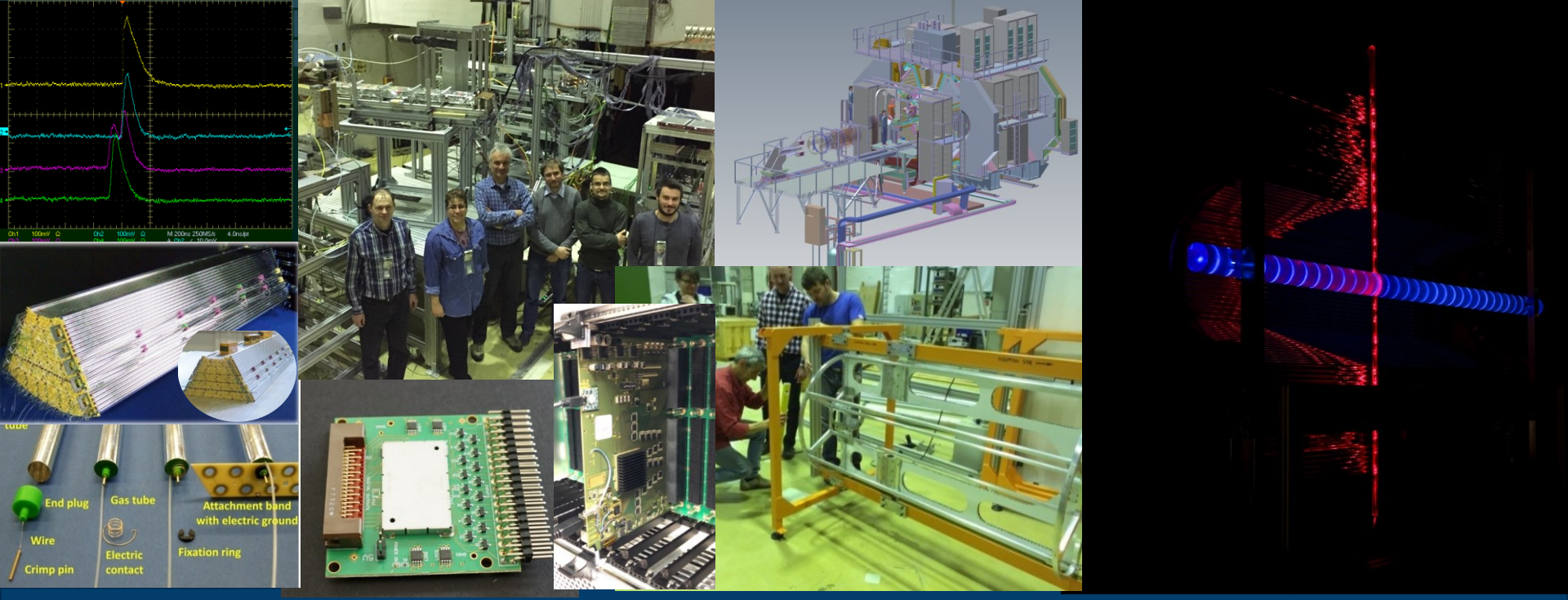


STT TRACKING & PID STATUS

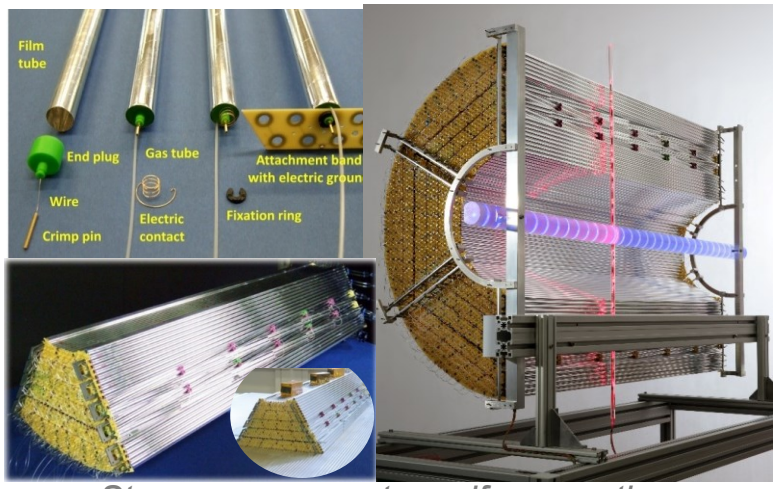
6 JUNE 2018 | PETER WINTZ

OUTLINE

- System Overview
- Tracking & PID
- Methods & Results (Data)

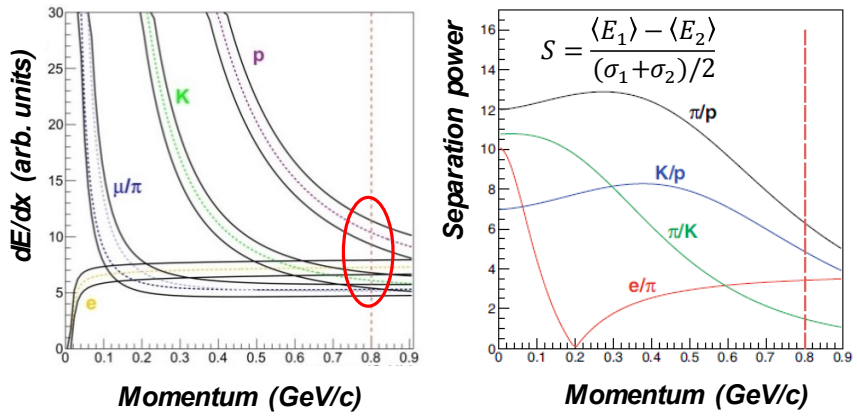
CENTRAL STRAW TUBE TRACKER

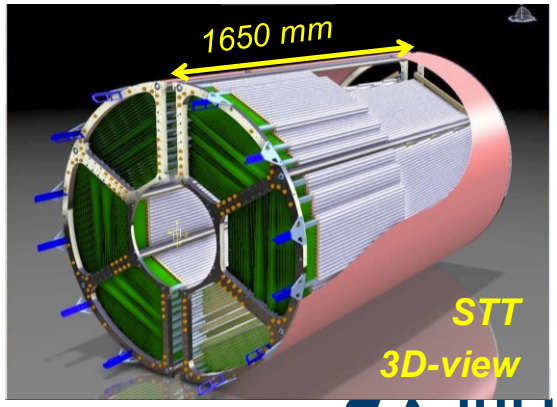
- 4224 straws in 19 axial and 8 stereo (±3°) layers
  - 27µm Al-Mylar, 1400 mm length, 10 mm diameter
  - Ar/CO_2 gas mixture at 1 bar overpressure
- X/X_0 = 1.25% by self-supporting straw layers
- Drift time & charge readout for PID (dE/dx)
- Continuous data stream readout (~ 15GB/s)
- Real-time tracking & input to SW trigger (event ID)



Straw components, self-supporting sector and STT prototype (half-barrel)

dE/dx simulation for STT (TDR, Eur.Phys.J. A49 (2013) 25)

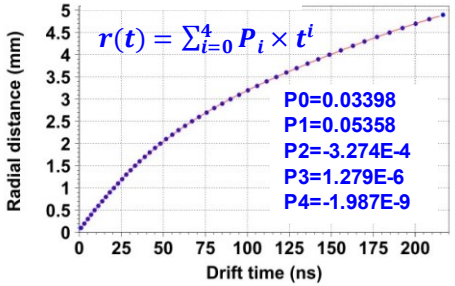


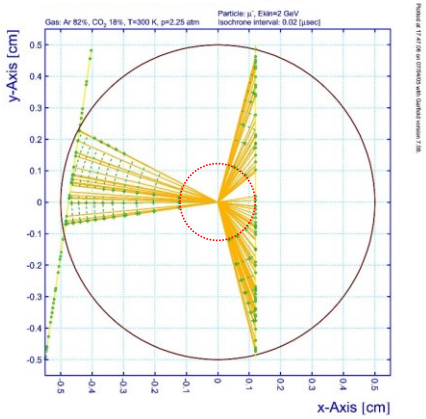


STT MEASUREMENTS

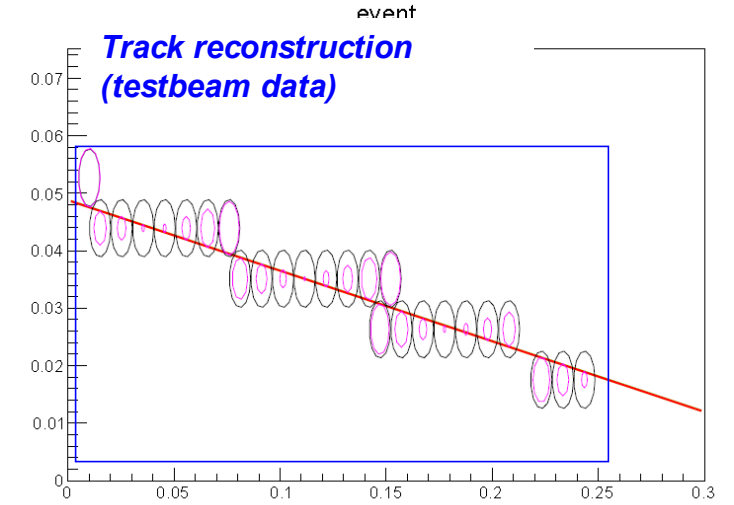
- Channel number (layer number)
- Signal leading edge time → drifttime → isochrone radius $r(t_{dr})$
- Signal pulse width or area for charge information (dE/dx) → PID

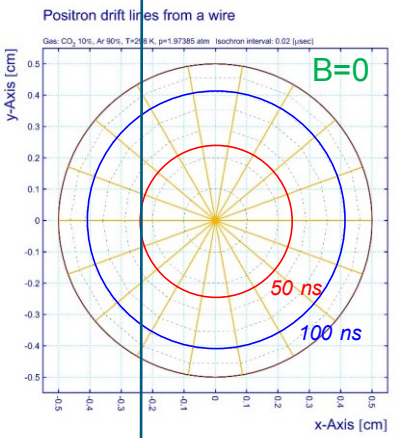
r(t) relation

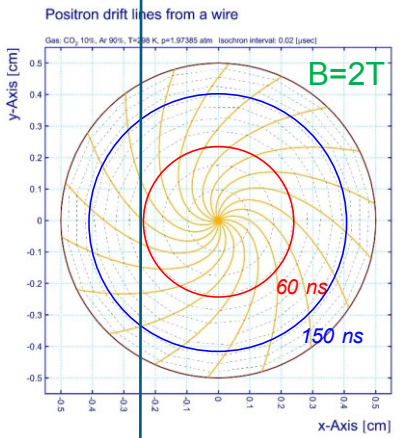




Track reconstruction (testbeam data)



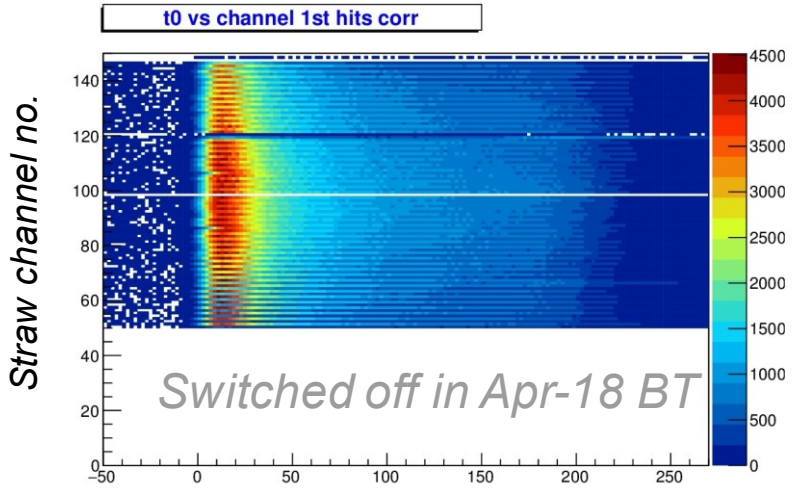


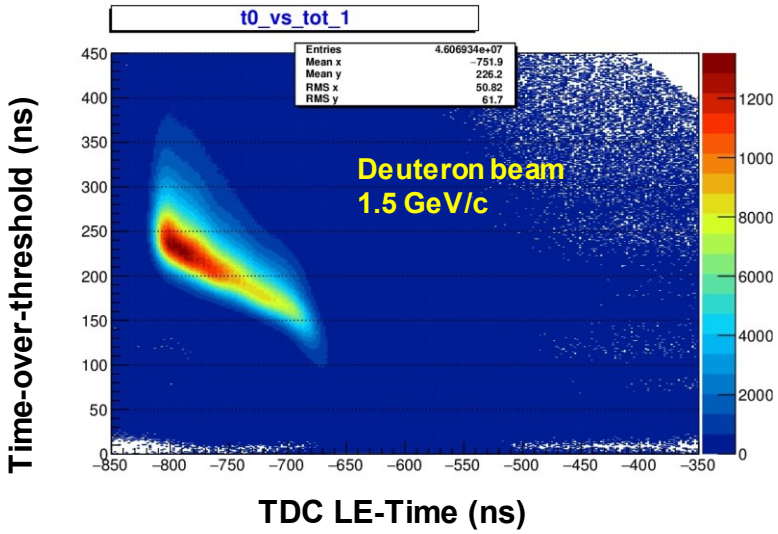


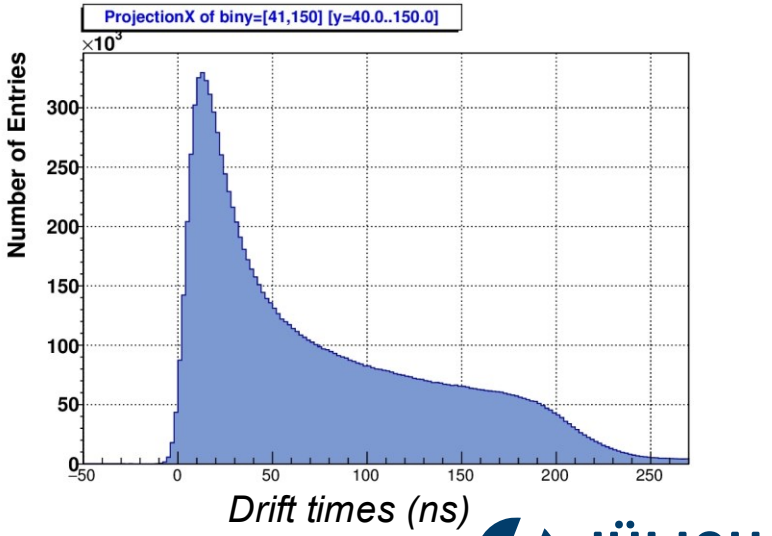
Charged particle

STT MEASUREMENTS

- Channel number (layer number)
- Signal leading edge time (spectrum)
  - *T0 determination*
  - *r(t) calibration*
- Signal pulse width (ToT) or area
  - *which observable for PID ?*

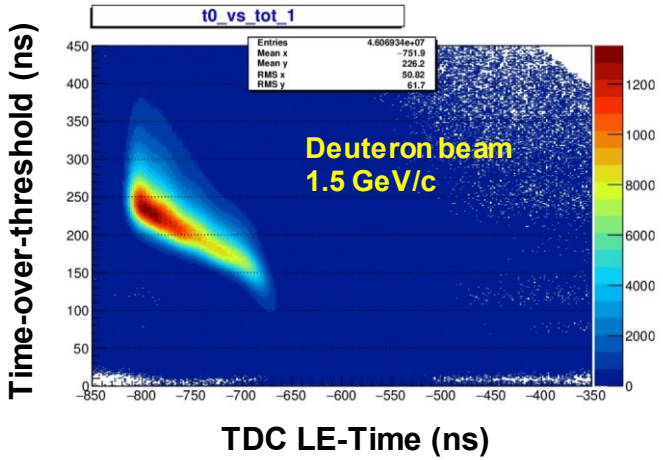


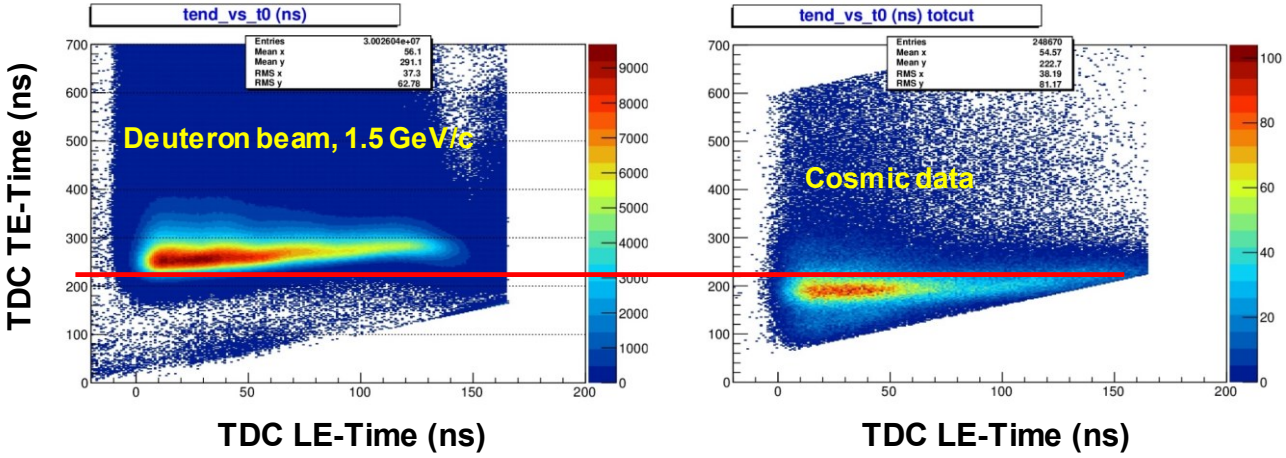




RAW HIT TIMES

- Signal leading edge (LE) and trailing edge time (TE-time)
- TE-time gives some absolute time information
- TE-time depends on pulse width, dE/dx specific
- TE-time not same for all tracks of one event

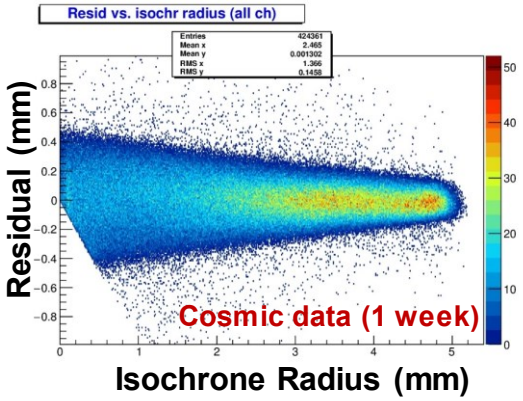


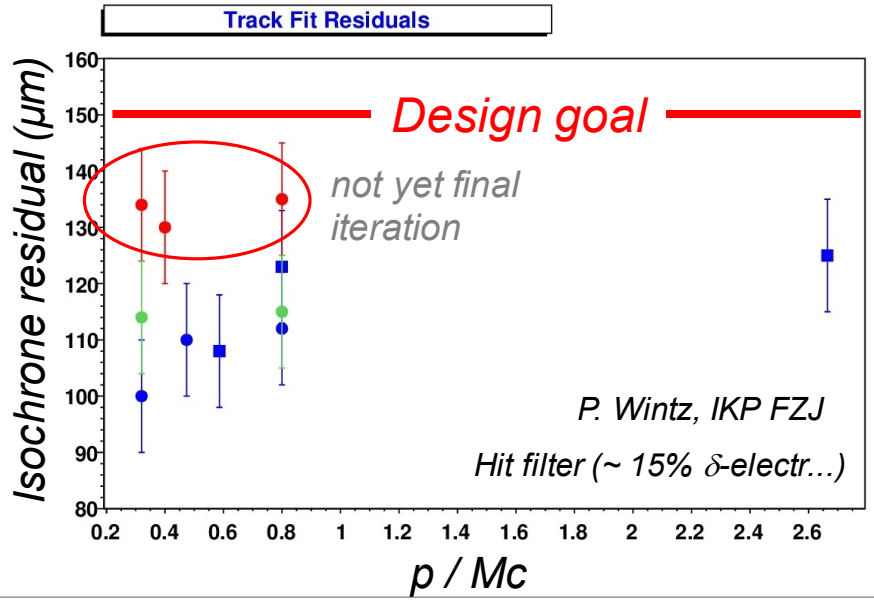


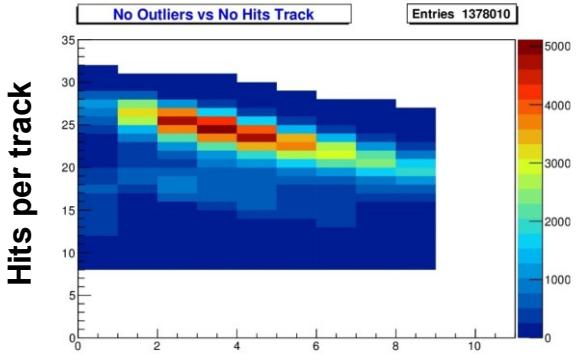
SPATIAL RESOLUTION

ASIC/TRB Readout

- Results for testbeams & cosmic data-taking, dE/dx range: ~ 5-50 keV/cm
- Results for ASIC/TRB RO, but similar for ADC RO
- Spat. resolution well below design goal (150µm σ)
- Method: iterative r(t) calibration, wire position
- Single hit filter (~15% of hits, e.g. δ-electrons)

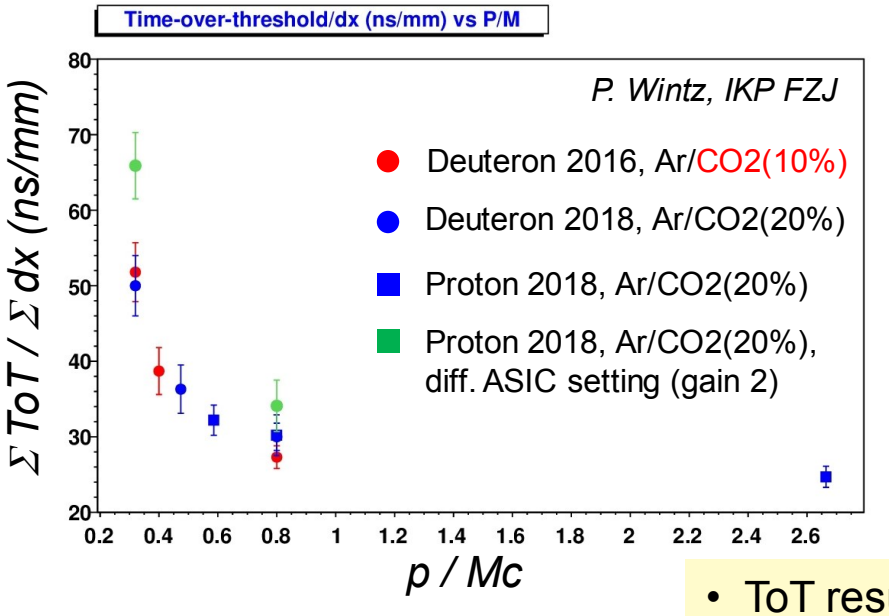


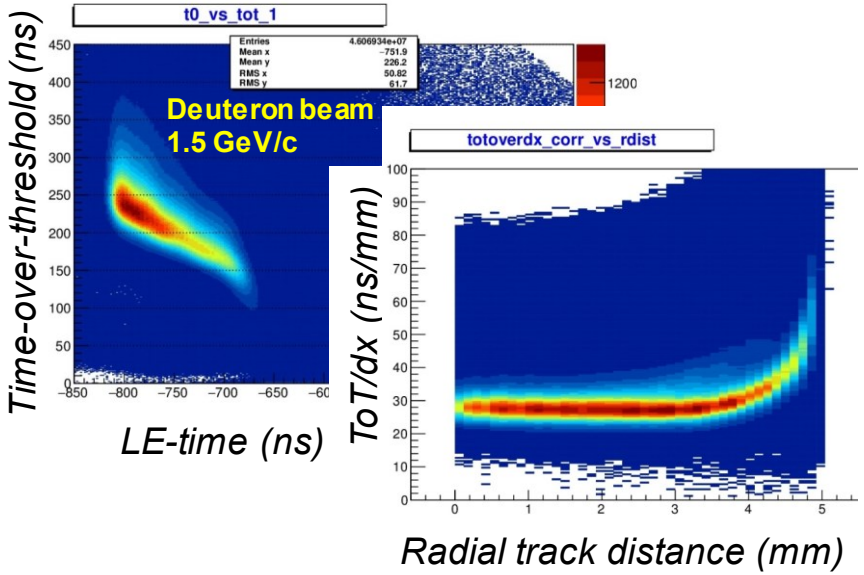


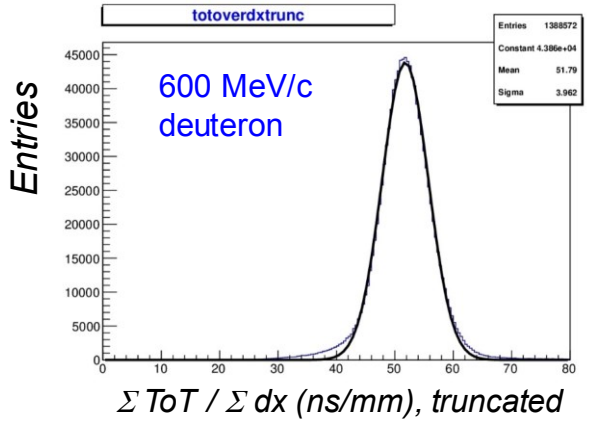


PRELIMARY PID RESULTS

ASIC/TRB READOUT



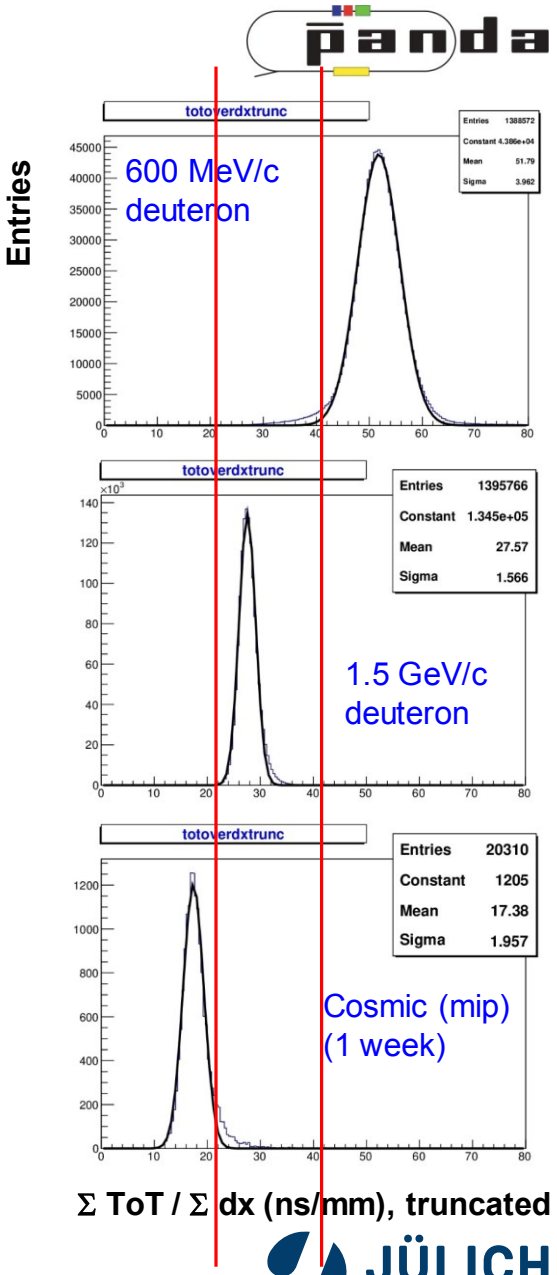




- ToT results (deuteron, proton beam & cosmics)
- PID separation observable here: Σ ToT / Σ dx
  - S ~ 3.3 (K/p @ 750 MeV/c, TDR, dE/dx:: S ~ 6)
  - S ~ 9 (π/p @ 300 MeV/c, TDR: S ~ 13)
- Optional: ToT – charge calibration done (non-linear)
- All TDR separation power w/ 10% dE/dx resolution
- ~ 60-70% of TDR separation power reached by ToT
- But: low truncation yet, analysis ongoing

PID Resolution

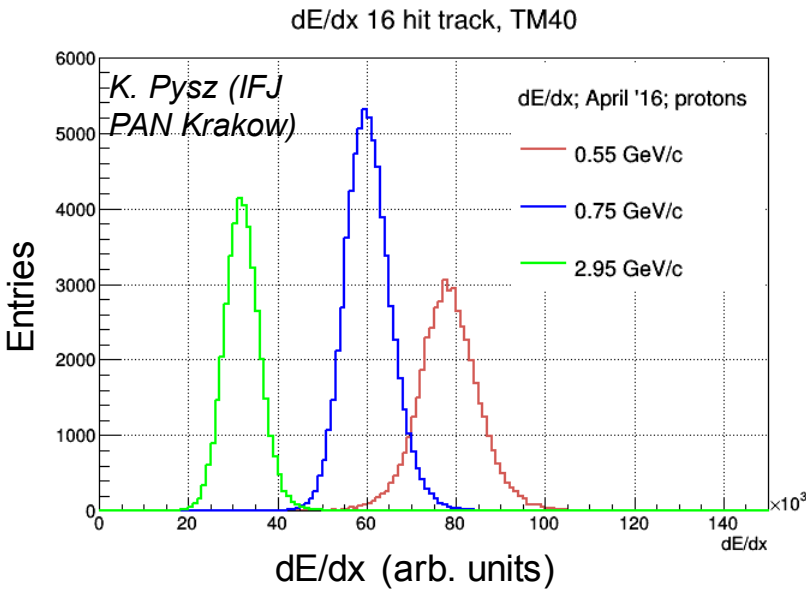
- Results for ASIC/TRB here (time-over-threshold)
- Full dE/dx range covered: ~ 5-50 keV/cm
- Proposed observable for PID: $\Sigma ToT / \Sigma dx$
  - other possible, e.g. ToT time-corrected (polynomial)
  - ToT – charge calibration (non-linear relation)
- ADC readout maybe better PID separation
  - larger dynamical range (pulse area)

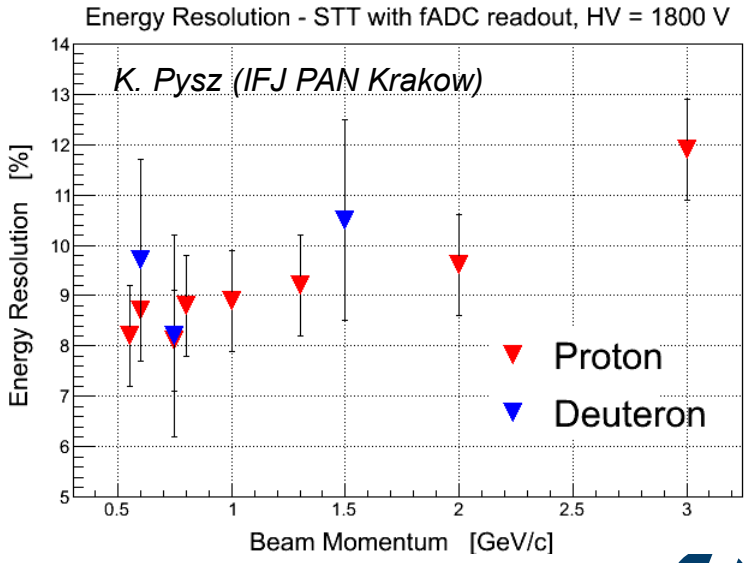


PID RESULTS ADC-SYSTEM

FADC PROTOTYPE SYSTEM

- Results for FADC (240 MHz) prototype system and direct straw cabling
- Raw mode readout with full WF information, no real-time FPGA pulse analysis
  - Example: separation of 2.95/0.75 GeV/c protons (p/K @ 750 MeV/c): S ~ 6
- New SADC (160 MHz, 12 bit), Op-Amp board brought into operation in April
  - ToDo: Op-amp dynamic range to be tested (5-50 keV/cm)
  - ToDo: real-time FPGA readout, data stream output (HW)





Thank you

for your

attention

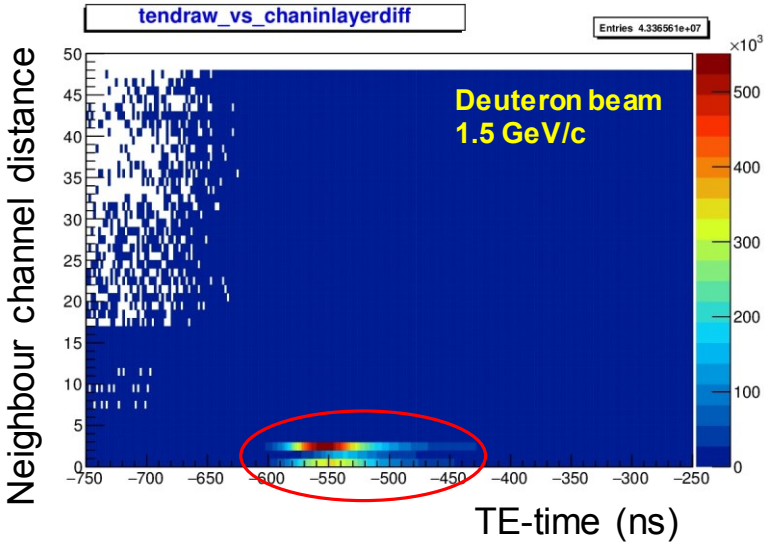
Method: T0 Determination by STT

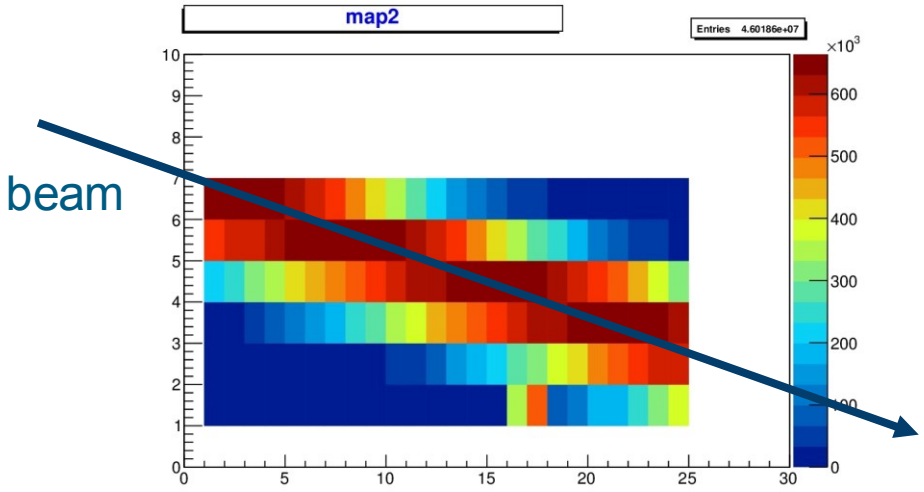
- Task: extract absolute time information from STT raw hits
- Ref. time from other detectors (MVD, SciTil) not existend for all tracks in STT
- STT raw hits: signal LE-time & TE-time, time-over-threshold

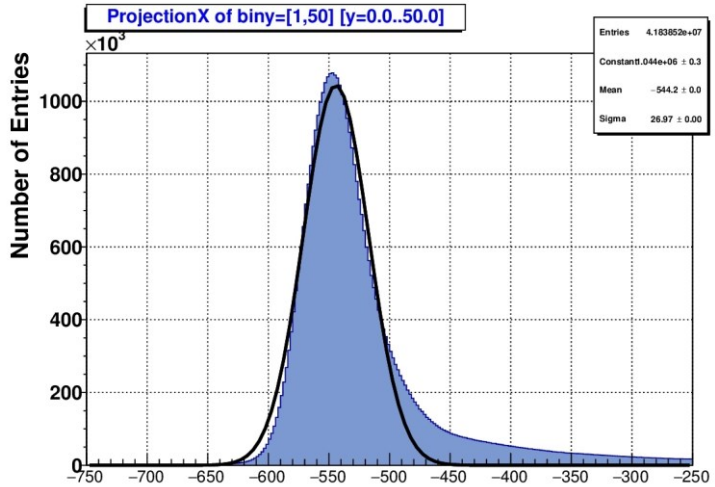
- Procedure for T0 determination
  - Step 1: hit to track association using raw hits
    - Channel cluster (neighbour hits)
    - Time cumulation
  - Step 2: Simple T0 calculation from sum of track hits (no fit!)
    - $\Sigma\, r(t) / N_{hits} \sim 2.5\ mm$ (= avg. isochrone radius)
    - Simplified $r(t) \sim P_0 + P_1 \times (t_{dr} - t_0)$
    - Extract t_0

T0 Determination by STT (Step 1)

- Hit cluster finder
  - check neighbour straw (next layer)
  - 3D-space: Δchan / ΔTE-time / ΔLE-time
- TE-time: σ ~ 27 ns, but landau shape
- ~ 20-30% of hits in Landau tail
- Track angle dependence to be checked

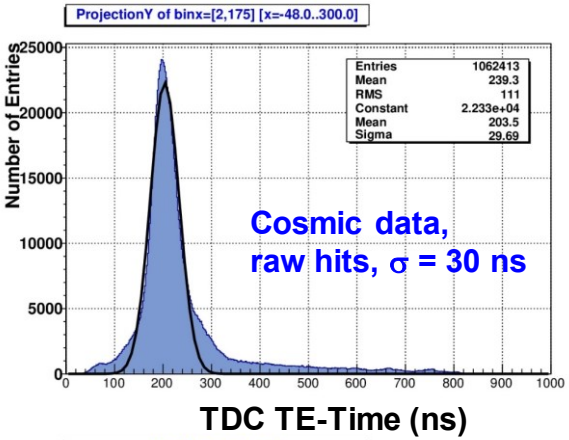


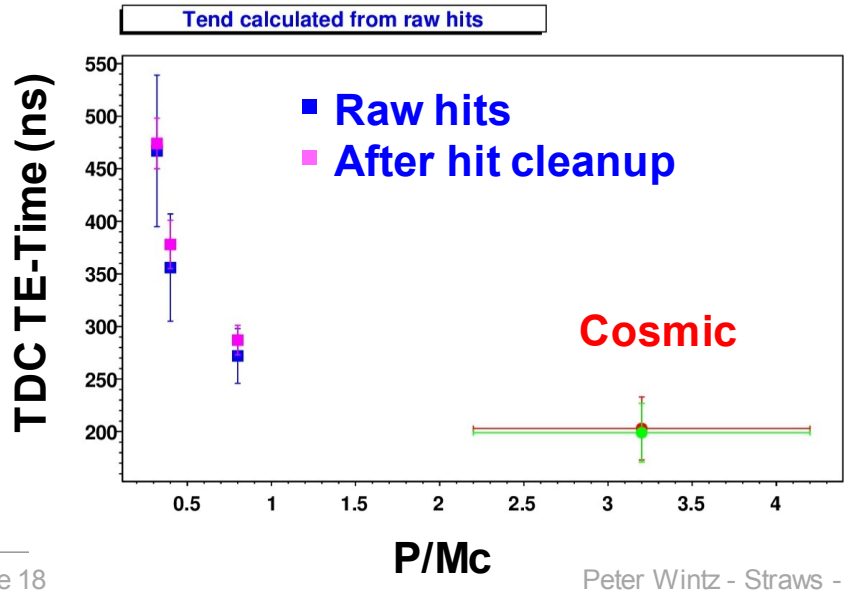


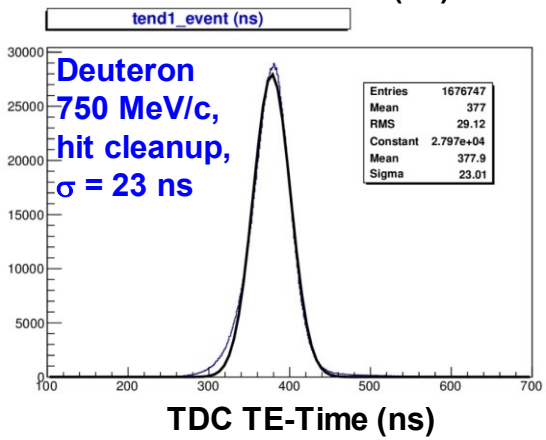


T0 Determination by STT (Step 1)

- Check TE-time resolution (deuteron testbeam & cosmic)
- Covered dE/dx range ~ 5-50 keV/cm (= full signal dynamical range)
- Cosmic tracks w/ large θ-angle range, but only 2D-tracking
- Resolution: σ ~ 25 ns (after cleanup)
- Resolution worse (σ~30ns) for cosmics as expected
- TE-time only for individual track (dE/dx)







T0 Determination by STT (Step 2)

- Calculate T0 from raw TDC candidate hits (sum up hits, T0=shift)
- Calculated T0 in good agreement with T0 from TDC spectra
- Note: single channel time offset shifts (TDC)
- T0-resolution: σ = 7 ns (~ 6 ns after hit cleanup)