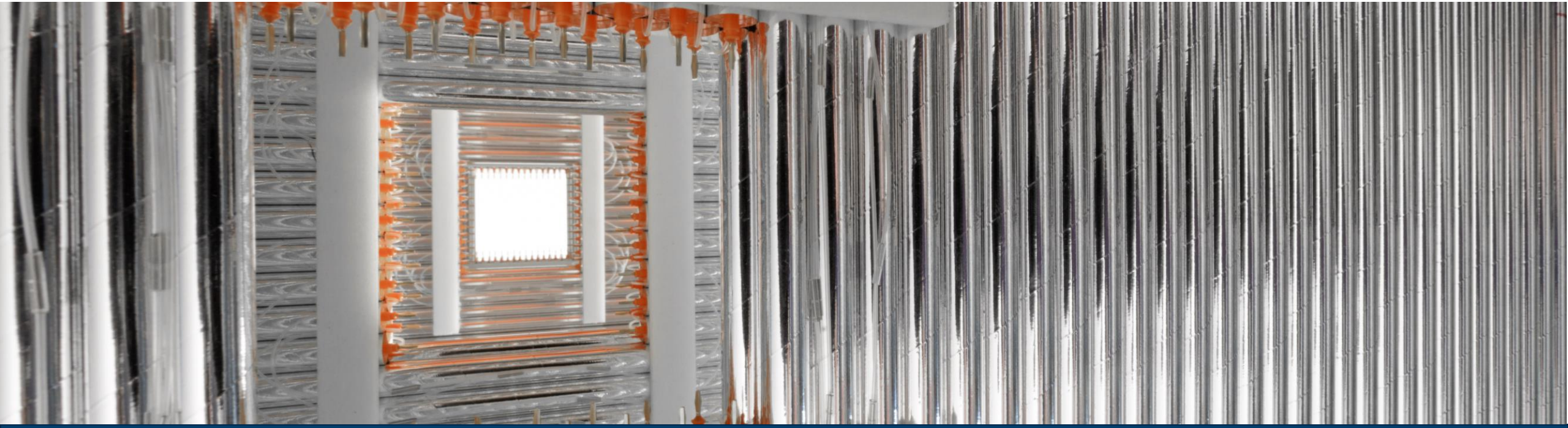


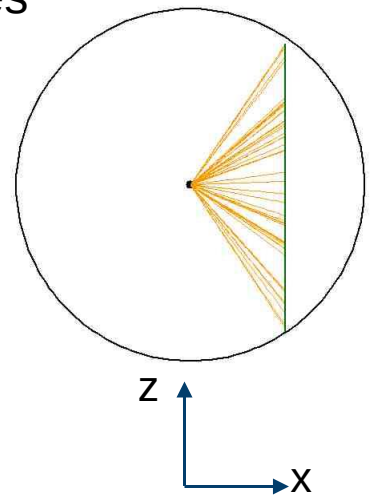
GARFIELD SIMULATION FOR STS

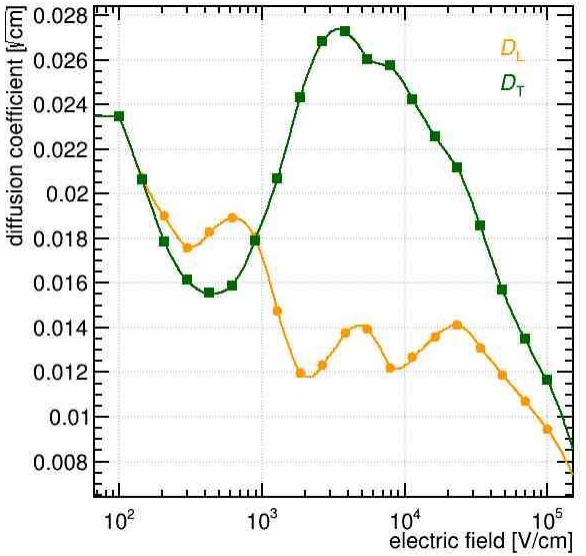
Peter Wintz (IKP, FZ Jülich)

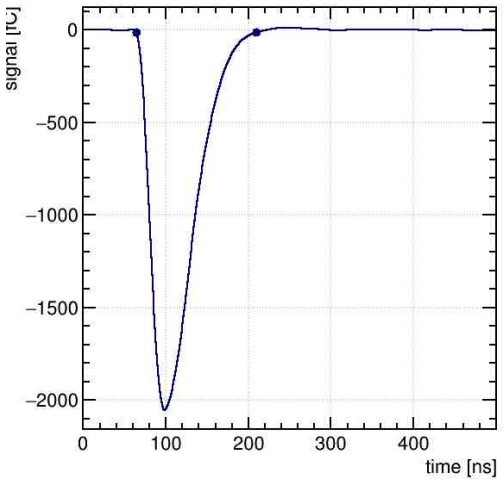
Garfield Simulation for STS

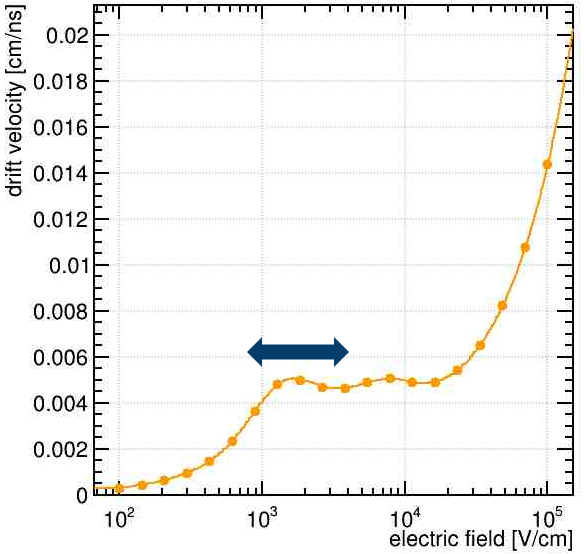
- Check beamtime STS data distributions and calibration issues
- Simulate straw effects and influence in time distributions
  - Simulation of drift time and time-over-threshold distribution
  - Different ASIC & HV setting
  - Signal threshold effect (high/low)
  - Off-centric straw wire (e.g. sag, tube bending)

- Garfield simulation
  - Straw geometry, electrodes and voltage, gas mixture
  - Calculates E-field, electron diffusion, drift velocity, ..
  - Gas ionisation by track, e - drift lines calculated
  - Charge signal generation and threshold crossing .
  - No delta-electrons, ..







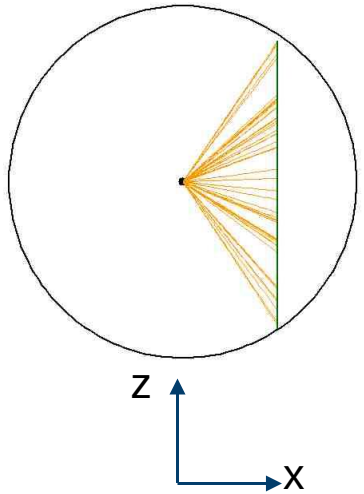


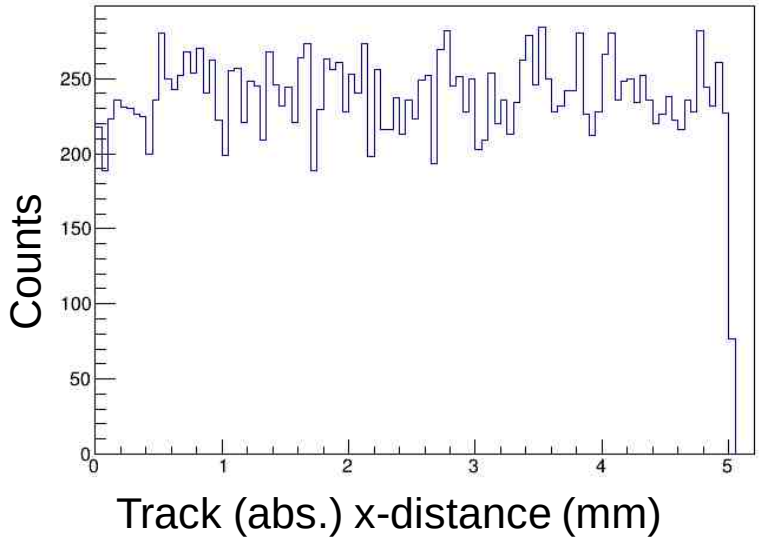
Garfield Simulation for STS

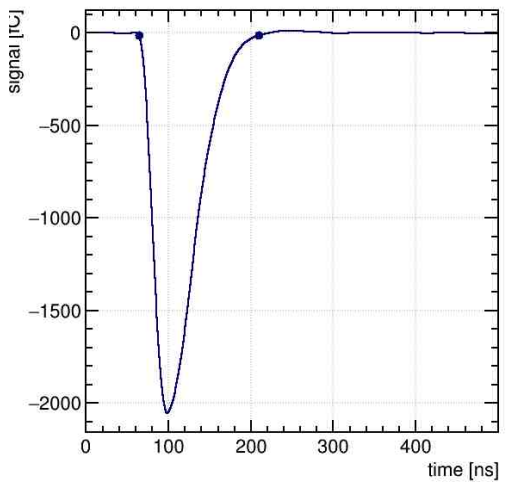
- Garfield simulation
  - 25000 proton tracks, 4 GeV kin. energy
  - x-distance randomized (-5 ↔ 5 mm)
  - tracks perpendicular to straw plane (STS@HADES)
  - Drift time and time-over-threshold determined

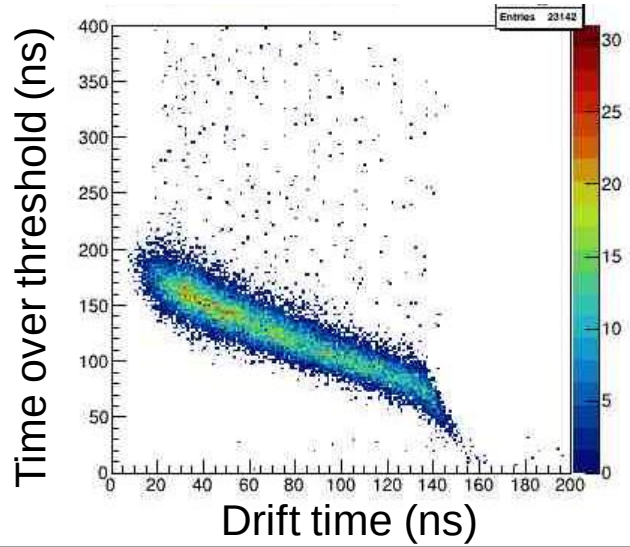
- Inputs (table)

Item	Setting	Remark
Gas mixture	Ar/CO2 (10%)	
Gas pressure, temperature	2 bar abs., 20°C	
Straw tube radius	5.025 mm	
Straw wire radius	10 µm	
Voltage	1700 V / 1800 V	
Transfer function	4th order unipolar shaping	
Peaking time	20 ns	
Gain factor	4 mV/fC / 1 mV/fC	rc6, rc2
Threshold	15 fC / 30 fC	A = 2×10^4





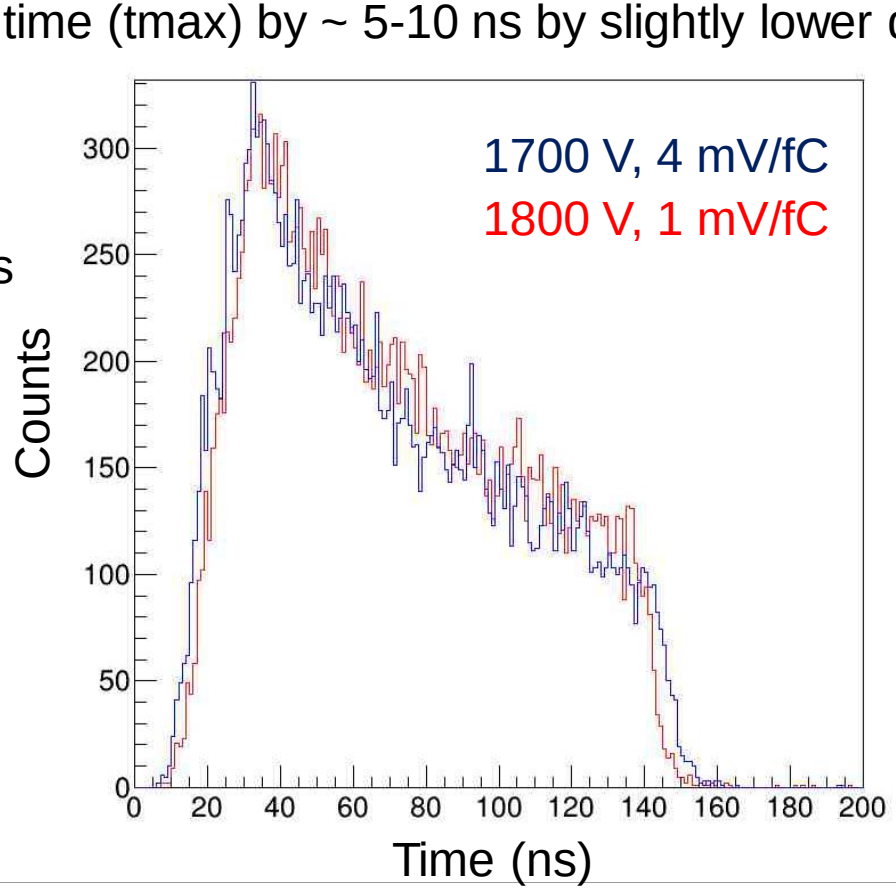


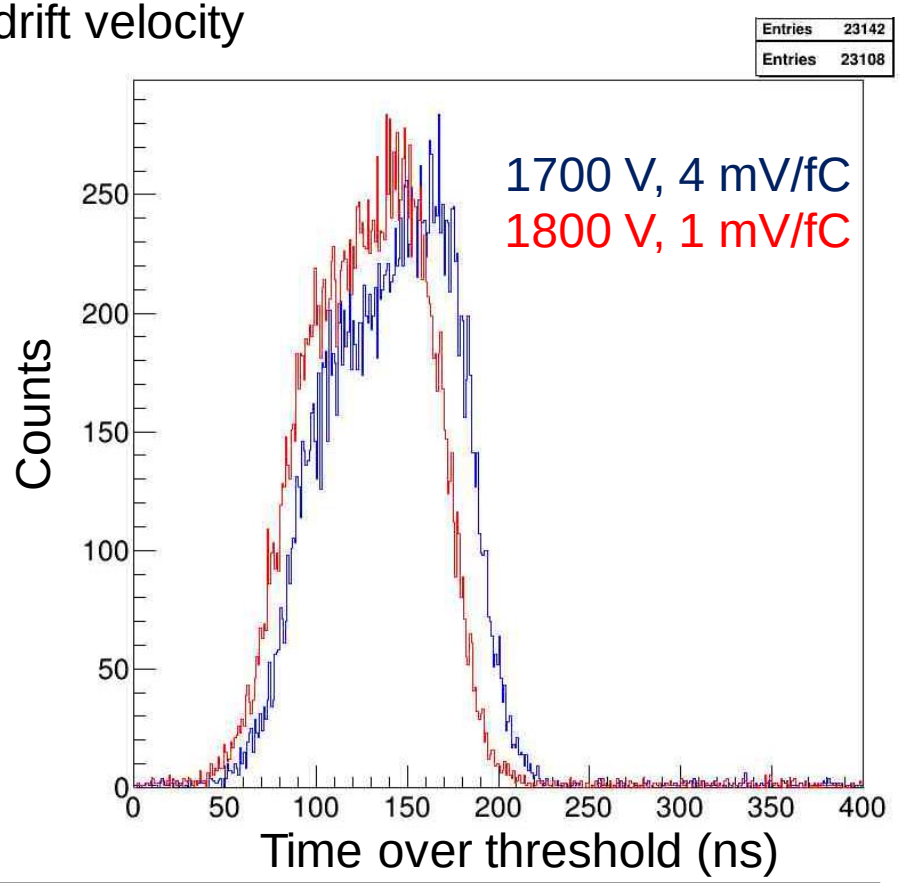


ASIC Setting Change

Influence on Drift time and Time-over-threshold

- ASIC setting and HV changed for 2022 beamtime (4mV/fC, 1700V)
  - Reason: ASIC intrinsic noise level lower at higher gain factor, verified by series QA
- Small increase of max. drift time (tmax) by ~ 5-10 ns by slightly lower drift velocity
- Earliest drift time shifted by ~ - 2ns (time offset)
- Small shift of ToT by ~ 20 ns





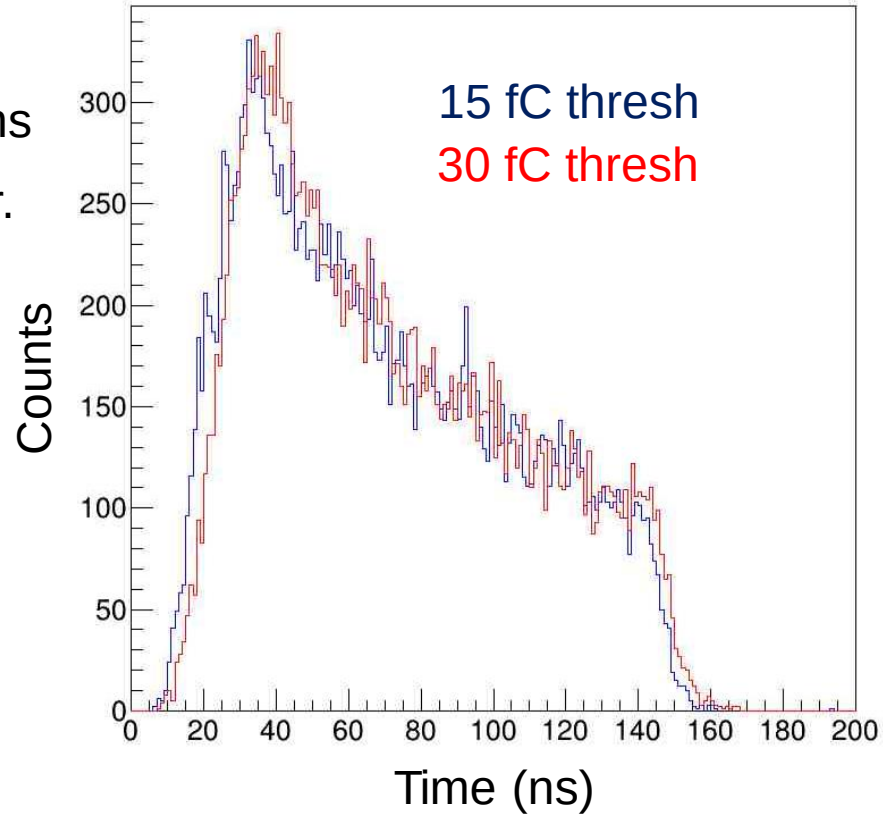
ASIC Threshold

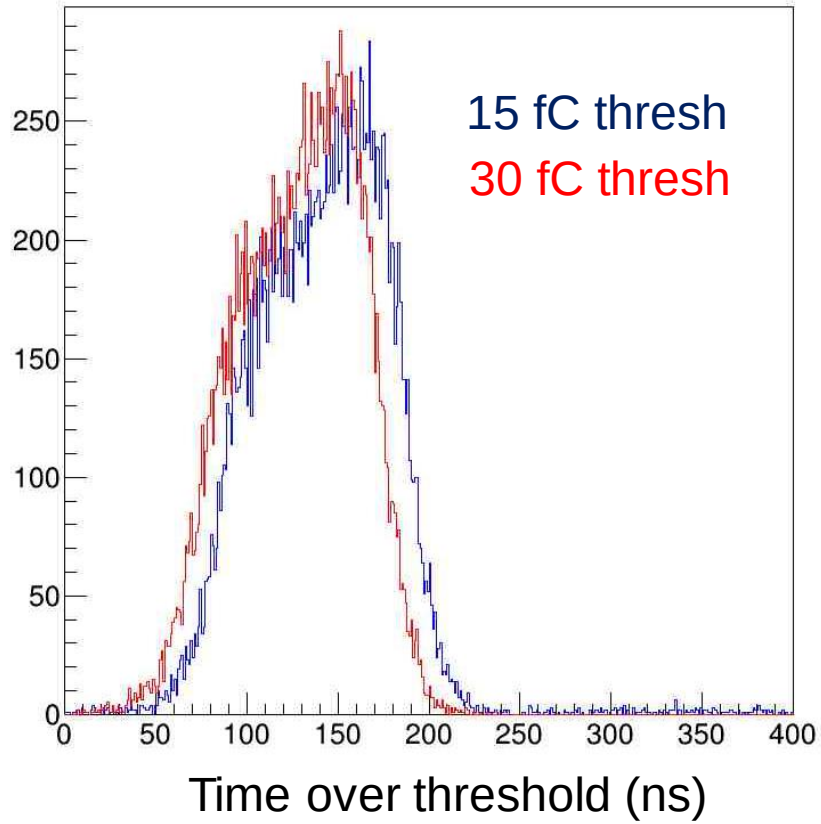
Influence on Drift Time and Time over Threshold

- Effect of ASIC threshold height on time distribution
  - STS1: 20mV, STS2: 40mV in 2022 beamtime
- Simulation for charge signal threshold of 15 fC and 30 fC

- Drift time edges shifted by ~ 5ns
- More prim. e- requ. to cross thr.

- ToT lowered by ~ 15-20ns by higher thresh.

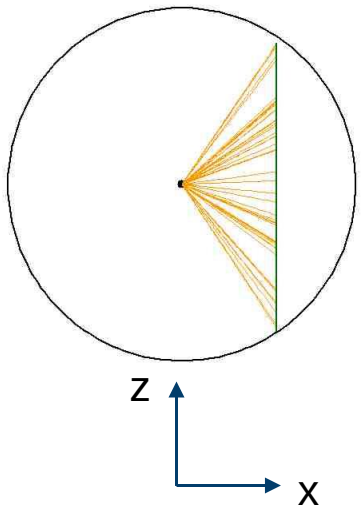


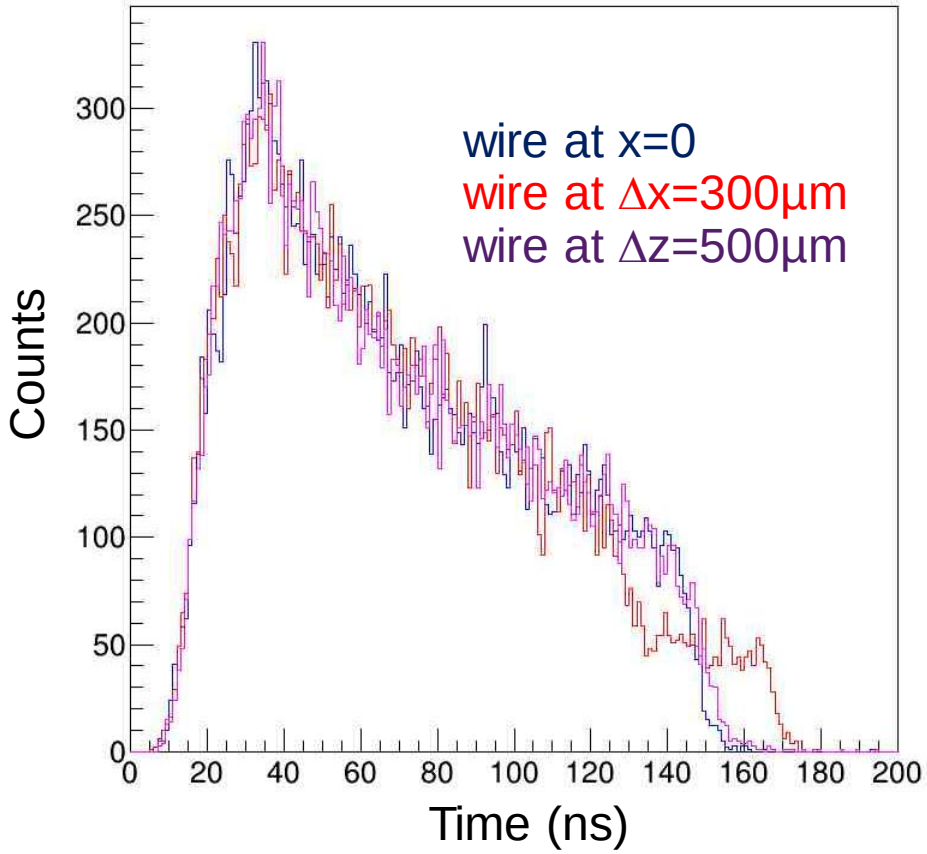


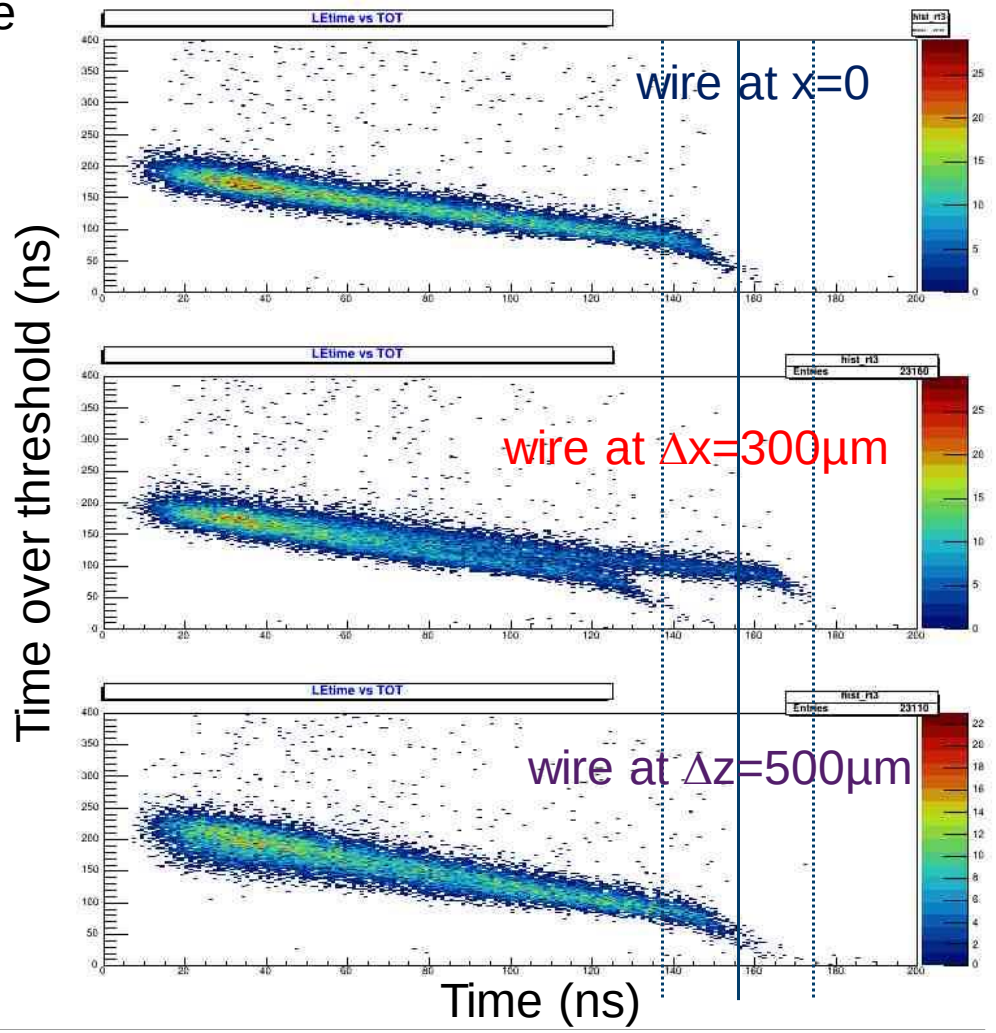
Wire Displacement

Influence on Drift Time and Time-over-threshold

- Distortion of cylindrical E-field, effect on drift velocity and drift time
- Simulated 25000 random tracks through straw tube:
  - wire Δx = +300µm
  - wire Δz = +500µm



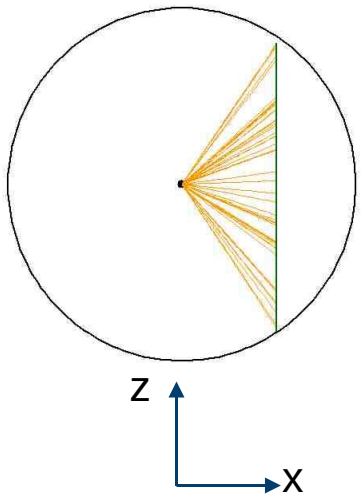


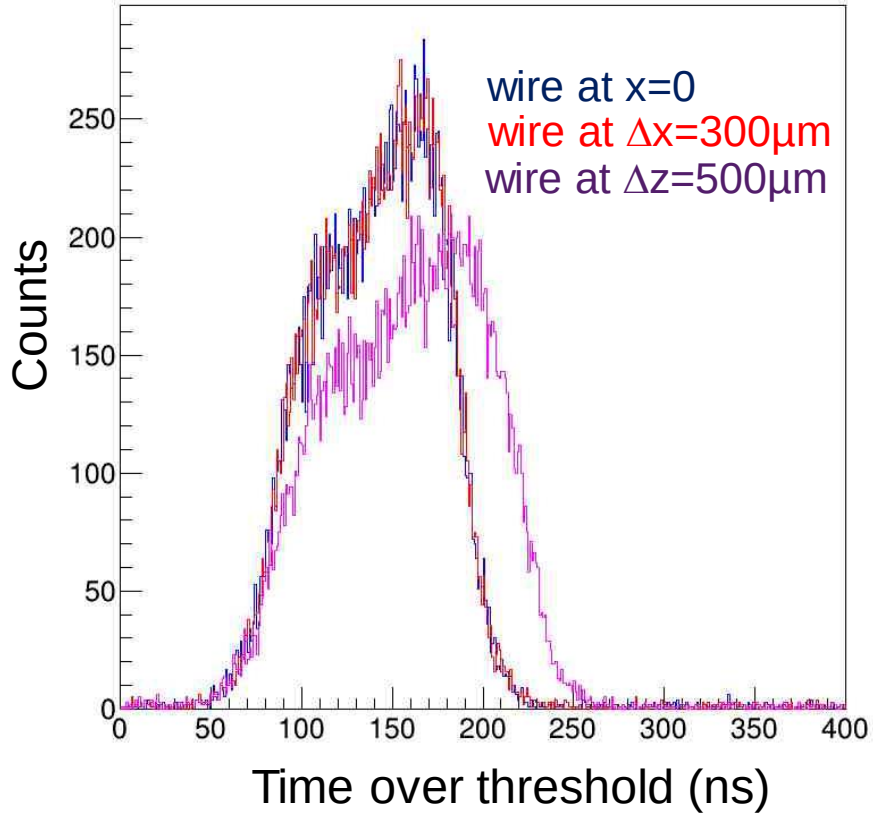


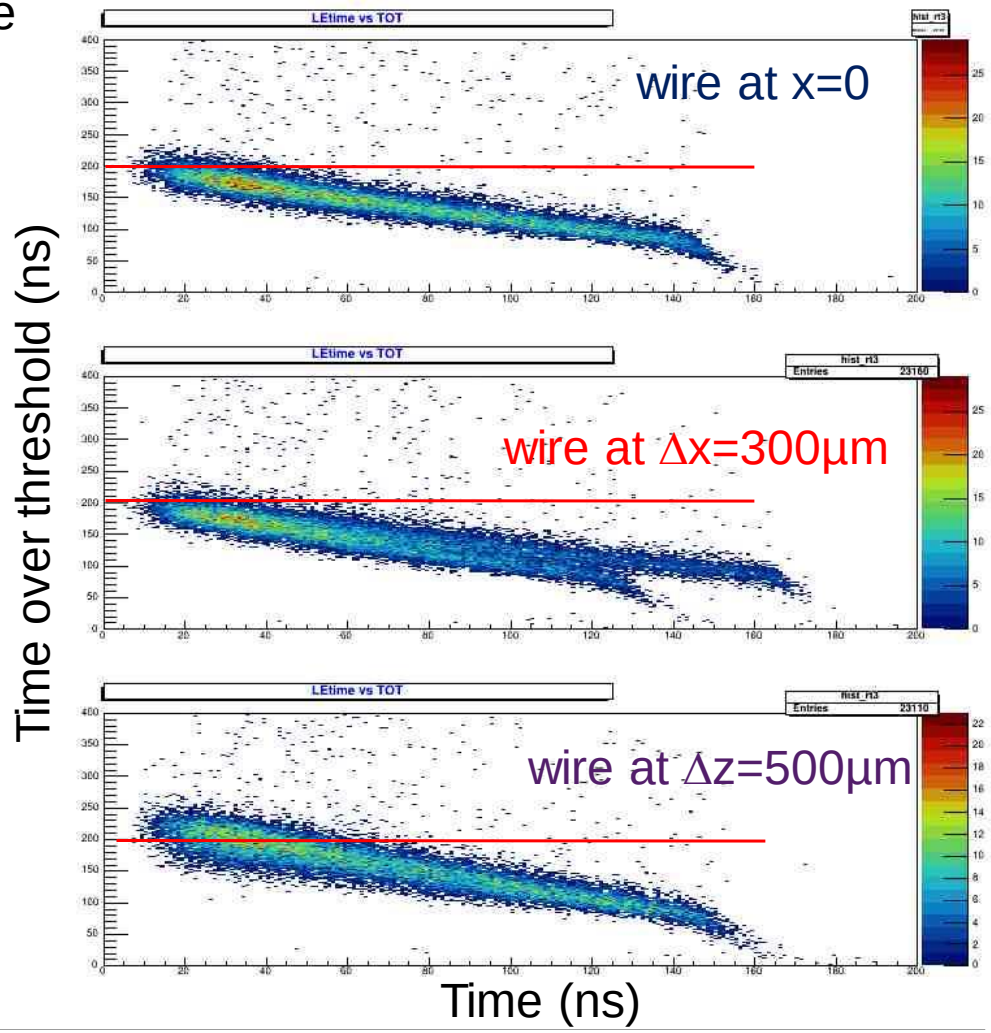
Wire Displacement

Influence on Drift Time and Time-over-threshold

- Distortion of cylindrical E-field, effect on drift velocity and drift time
- Simulated 25000 random tracks thhough straw tube:
  - wire Δx = +300µm
  - wire Δz = +500µm







Conclusion

- Garfield spectra are sharper with less smearing effects compared to data time distributions
- Quantitative study (relative comparison) of specific straw effects done for calibration checks

- Good agreement drift time simulation with data spectra
  - Drift time distribution shape and end of time spectra (tmax within ~10ns)
- ToT distribution shows characteristic shape TOT vs drift time
  - ToT mean and width differ from data (~50ns), but suited for relative comparisons

- Influence of ASIC threshold height investigated (factor 2 higher thresh)
  - Small ns shift of drift time edges, TOT shift by ~15-20ns

- Influence of wire displacement effects studied
  - Δx=300µm: wash out and shift of time spectra end (Δtmax ~ +20 ns), identify effect by “2nd leg“ (tot vs time)
  - Δz=500µm: minor effect on drift time, but broadens and shifts ToT distribution, identfy effect by tot shift

Thank you

for

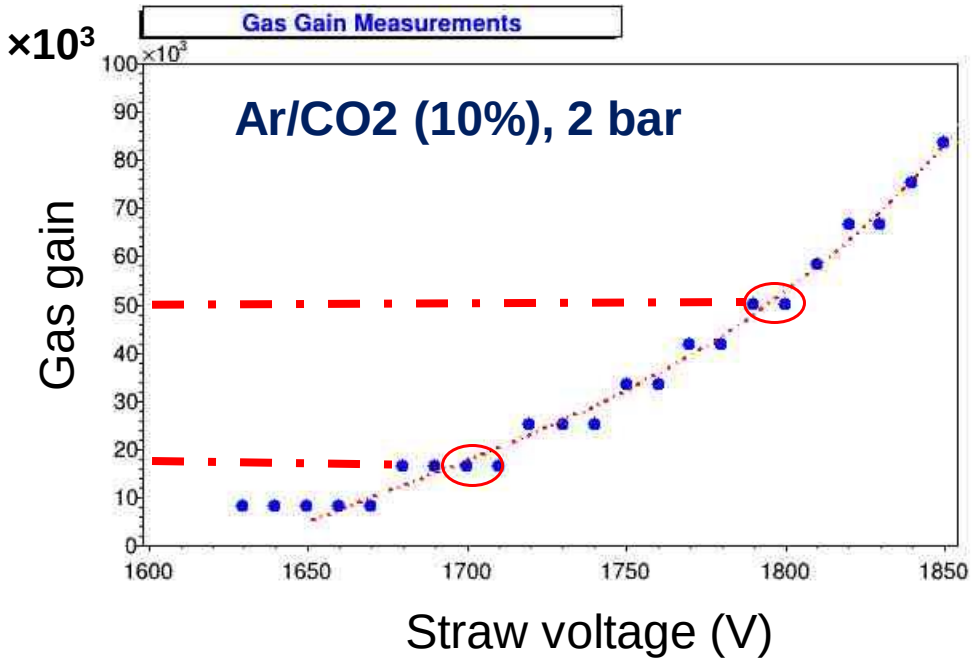
your attention

ASIC Setting Change

Lower Noise Level and Charge Load

- ASIC setting changed for 2022 beamtime
- Reason: lower intrinsic ASIC noise level at higher gain factor
- NL by PASTTREC FEB series QA verified

- 4mV/fC setting (rc6) in 2022 instead of 1mV/fC (rc2) in 2021
- Higher efficiency at lower gas gain
- Reduction of straw voltage by 100V (1800 → 1700V)
- Gas gain and charge load then reduced by factor 2-3



^{55}Fe (X-ray, 5.9 keV, 2.9 keV escape), 2nA current resolution