Towards new Front-End Electronics for the HADES Drift Chamber System

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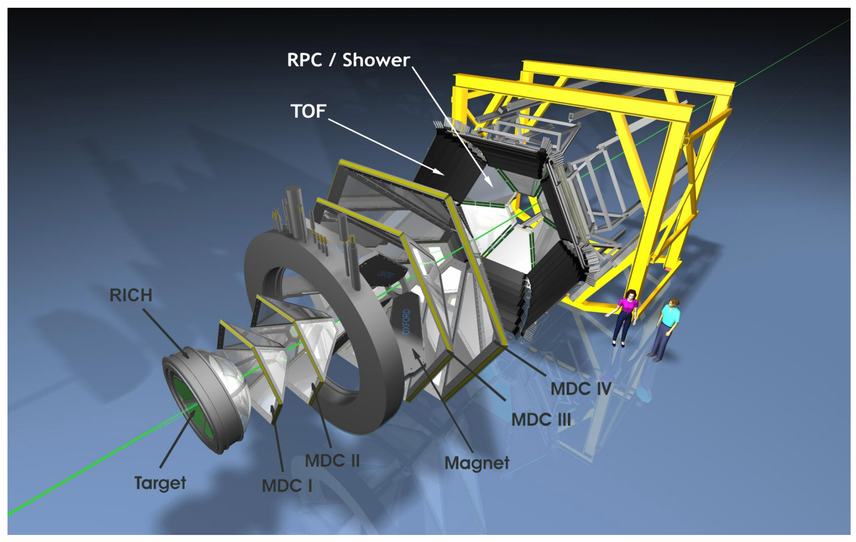
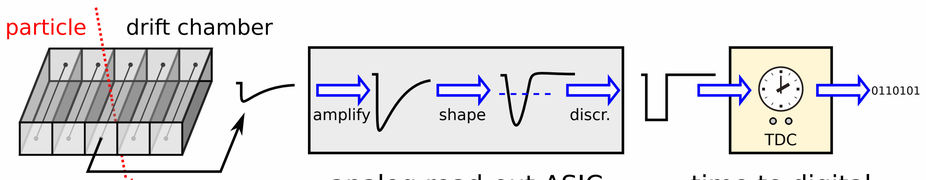


HADES

HADES (**H**igh **A**cceptance **DiE**lectron **S**pectrometer), located at GSI, is a versatile detector for precise spectroscopy of e+ e- pairs and charged hadrons produced in a 1-3.5 GeV kinetic beam energy region on a fixed target. The main experimental goal is to investigate properties of dense nuclear matter created in heavy ion collisions and learn about in-medium hadron properties.

Drift Chambers + Electronics

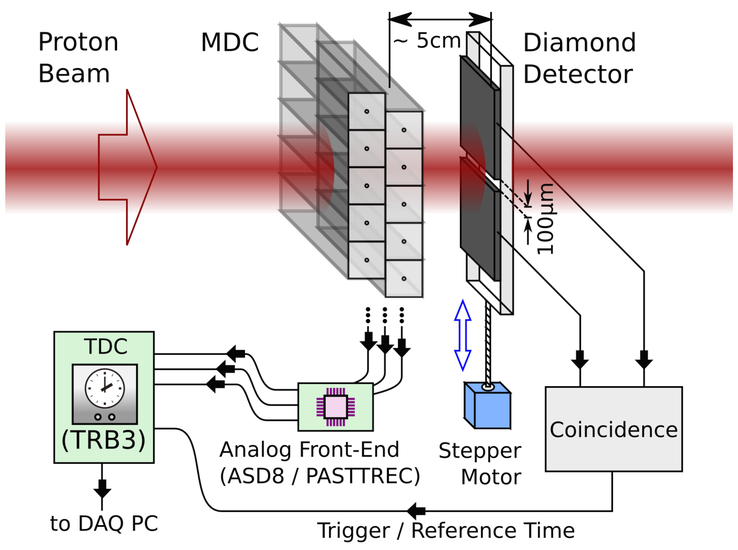
In the HADES set-up 24 low-mass Mini Drift Chambers (MDC) allow for **track reconstruction** and determining the particle momentum by exploiting charged particle deflection in a magnetic field. In addition, the drift chambers contribute to **particle identification** by measuring the specific energy loss.
Each sensing wire is equipped with **amplifier + analog pulse shaper + discriminator + TDC**.

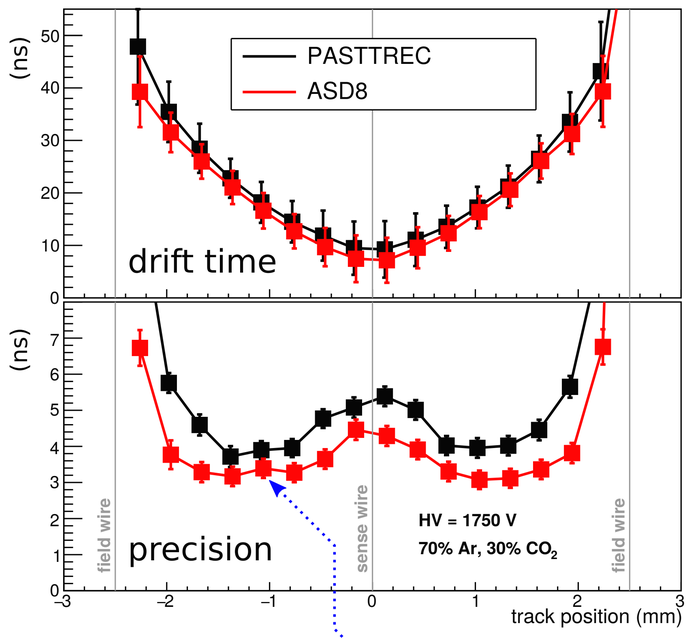


Current hardware:
- ASD8 ASIC + TDC ASIC
- Problems with pickup noise/self oscillation, lacking multi-hit capability
- ASD8 no longer available

New hardware:
- Improve sensitivity for high rate / high occupancy operation at SIS-100, **FAIR**
- Multi-hit FPGA based TDC
- **PASTTREC** (PANDA straw tube read-out ASIC, dev. by JU Krakow) promising ASD8 replacement candidate → **under investigation**

Beam Test

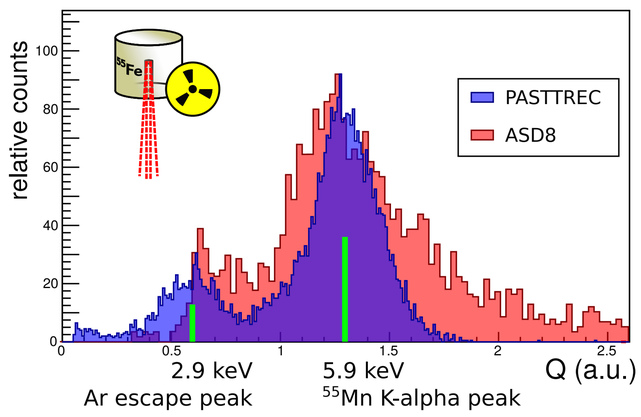




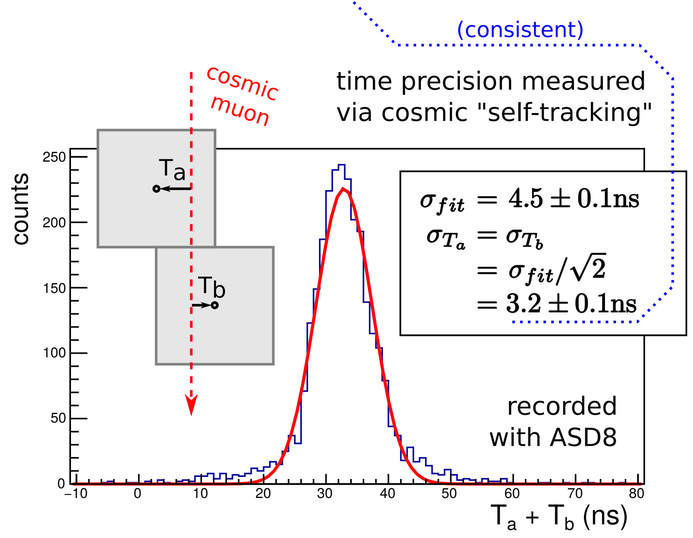
Time precision
- Most crucial performance parameter of detector + electronics
- Assessed at COSY accelerator (Juelich) using 2.7 GeV/c protons (MIPS)
- A diamond detector provides trigger + reference time, selects narrow beam slice (<100 µm) parallel to sensing wire, can trigger on perpendicular tracks at any position within drift cell.
- Default conditions: HV=1750 V, 70% Ar 30% CO_2
- ASD8 delivers better time precision, PASTTREC shows better signal-to-noise ratio, less susceptibility to self-oscillation at low thresholds

Lab Tests

charge spectrum measured with ^{55}Fe



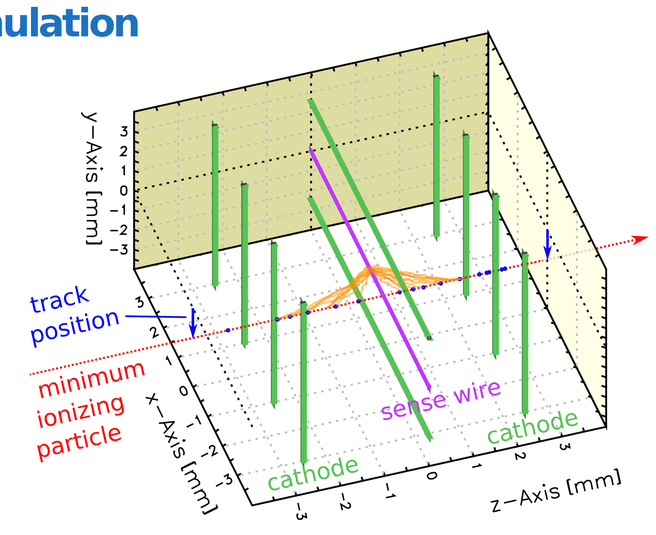
time precision measured via cosmic "self-tracking"



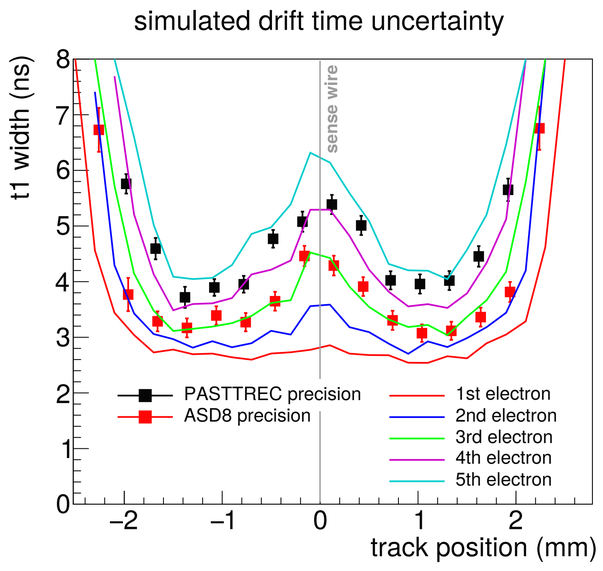
Energy measurement precision
- ^{55}Fe source (E_γ = 5.9 keV) deposits constant charge in detector gas (ca. 230 ionizations)
- In contrast to ASD8, PASTTREC can separate the ^{55}Mn K-alpha peak from its Ar escape peak
- Separation over wide range (factor 15) of gas gain

Time precision via self-tracking
- The two middle wire layers are displaced against each other by half a cell pitch
- Correlating (summing) drift times of cosmic muons in overlapping cells allows for assessing time precision
- Set-up helped tuning operation parameters prior to beam test
- Measured precisions in agreement with beam test

Simulation



simulated drift time uncertainty



Input data (3D-GARFIELD simulation)**:**
- Gas mixture
- Wire radii + geometry + voltages
- Beam particle type + energy

Output data:
- Drift time + drift time uncertainty (precision) as function of track position for n-th arriving electron
- Measured precision is only reproduced when gaussian jitter of 2 ns is superimposed on simulated drift times (affects the depth of the "W" shape valleys)

Interpretation:
- ASD8 sensitive to 3rd arriving electron, PASTTREC sensitive to 4th electron due to different peaking times (7 ns vs 15 ns)

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