TOT in New Front-end Electronics

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Outline

- Penning rate in new Magboltz
- Transfer function of front-end electronics
- Tail-cancellation filter setting
- Comparison with Fe-55
- Double-track resolution
- Separation power for PID methods
- Future plans
Gas Gain & Penning Rate

- Penning transfer rate
  \[ G = \exp\left(\sum_{\text{tube}} d\alpha(E(r)) \frac{\sum v_{i}^{\text{ion}}(E(r)) + \sum r v_{i}^{\text{exc}}(E(r))}{\sum v_{i}^{\text{ion}}(E(r))}\right) \]

- In Ar-CO2 gas mixtures:
  - Penning rate is below 50%

- New version of Magboltz 8.95
  - Ar cross section is updated

The gain curves correspond to Penning transfer rates of 0%, 20%, 30%, 40%, 60%, and 100% are compared with preliminary experimental data. This transfer occurs at a rate of 30%.

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Transfer Function

- Transfer Function: relation between the Laplace transform of the output and input pulse
  \[ H(s) = \frac{u_{out}(s)}{I_{in}(s)} \]

- Front-end electronics

1. **Preamplifier**
   \[ H_1(s) = \frac{-R_f p_1 p_2}{(p_1 + s)(p_2 + s)} \]

2. **Amplifier**
   - First shaping
   - Tail-cancellation filter + Second shaping
   \[ H_2(s) = \frac{-R_s}{R_p + R_z} \frac{(1 + s \tau_z)}{(1 + s \tau_p)(1 + s \tau_s)} \]
   \[ H_3(s) = \frac{-R_s}{[R_1 \tau_2 + R_2 \tau_1 + R_{sw}(\tau_1 + \tau_2)]} \frac{(s \tau_1 + 1)(s \tau_2 + 1)}{(s \tau_s + 1)(s - s_1)} \]
Preamplifier Response

Detector output pulse for Proton 0.5 GeV/c

Pulse after preamplifier

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Amplifier Response

Pulse after first shaper

Pulse after tail-cancellation filter
Tail-cancellation Setting

$\tau_1$ & $\tau_2$ setting

- Removing the ion tail
- Reducing undershoot

pulse after tail-cancellation filter for Proton 0.5 GeV/c

- not significant effect
- tail removed
- large undershoot

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TOT for Fe-55 Source
(5.9 keV X-ray & 2.9 keV Ar escape peak)

Simulated TOT

TOT spectrum in scope

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Double-track Resolution

Induced currents on group 1

Threshold level (100 μA)

Δx = 4 mm, Pions 0.5 GeV/c

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PID Based dE/dx

- Response of 24 single straws to 400 tracks
- Set the threshold low for good position resolution
- Normalize all the data to the first bin average
- Truncated Average for 24 straw layers by removing 30% of the highest numbers

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Distance Correction
(0.5 GeV/c particles)

TOT of proton without distance correction

TOT of pion without distance correction

TOT of kaon without distance correction

TOT of proton after distance correction

TOT of pion after distance correction

TOT of kaon after distance correction

Distance from wire (cm)

Distance from wire (cm)

Distance from wire (cm)
TOT vs. Charge (Threshold=100 μA)

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Separation-power Comparison

Separation power after distance correction

$p-\pi$

$K-\pi$

$K-p$

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Conclusion

- The preliminary simulation results show that with the new front-end electronics TOT works well for PID.

Future Plans

- Including dynamic range of amplifier
- Compare the simulation with recent Juelich tests
Thanks for Your Attention
Position Resolution

Threshold setting

Position resolution

Momentum 0.5 GeV/c
Threshold level 50 μA

Momentum 0.5 GeV/c
Threshold level 200 μA

Proton ─ Kaon ─ Pion

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TOT vs. Charge (Threshold=50 μA)

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