TOT in New Front-end Electronics

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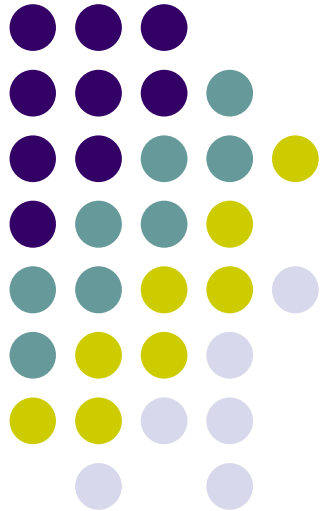

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INTERNATIONAL PHD PROJECTS IN APPLIED NUCLEAR PHYSICS AND INNOVATIVE TECHNOLOGIES

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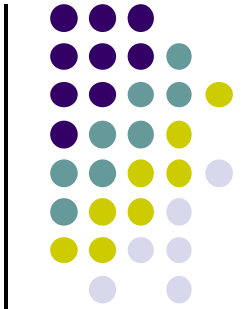
Outline



- 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

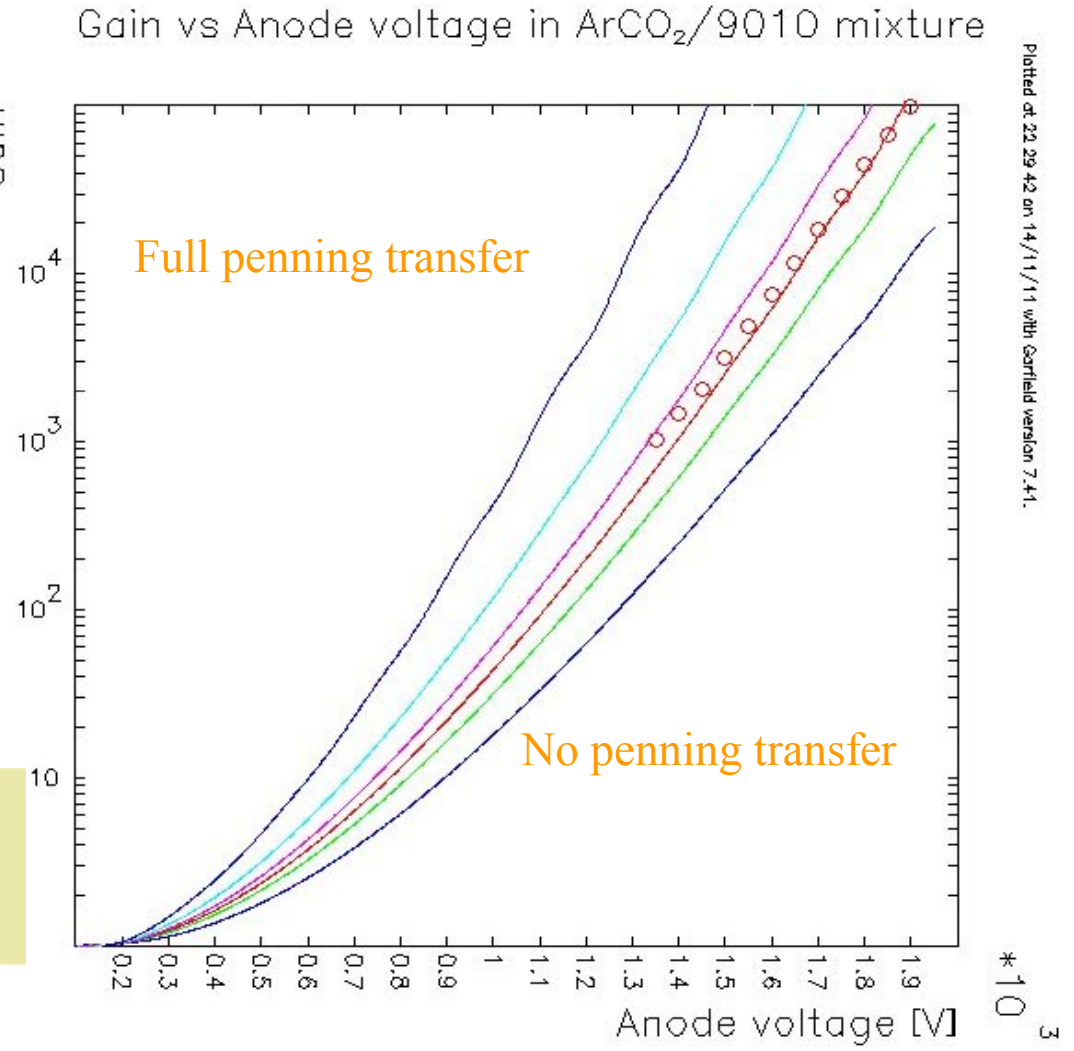
Gas Gain & Penning Rate

- Penning transfer rate

$$G = \exp \int_{tube}^{anode} dr \alpha(E(r)) \frac{\sum \nu_i^{ion}(E(r)) + \sum r_i \nu_i^{exc}(E(r))}{\sum \nu_i^{ion}(E(r))}$$

- 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%.



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**

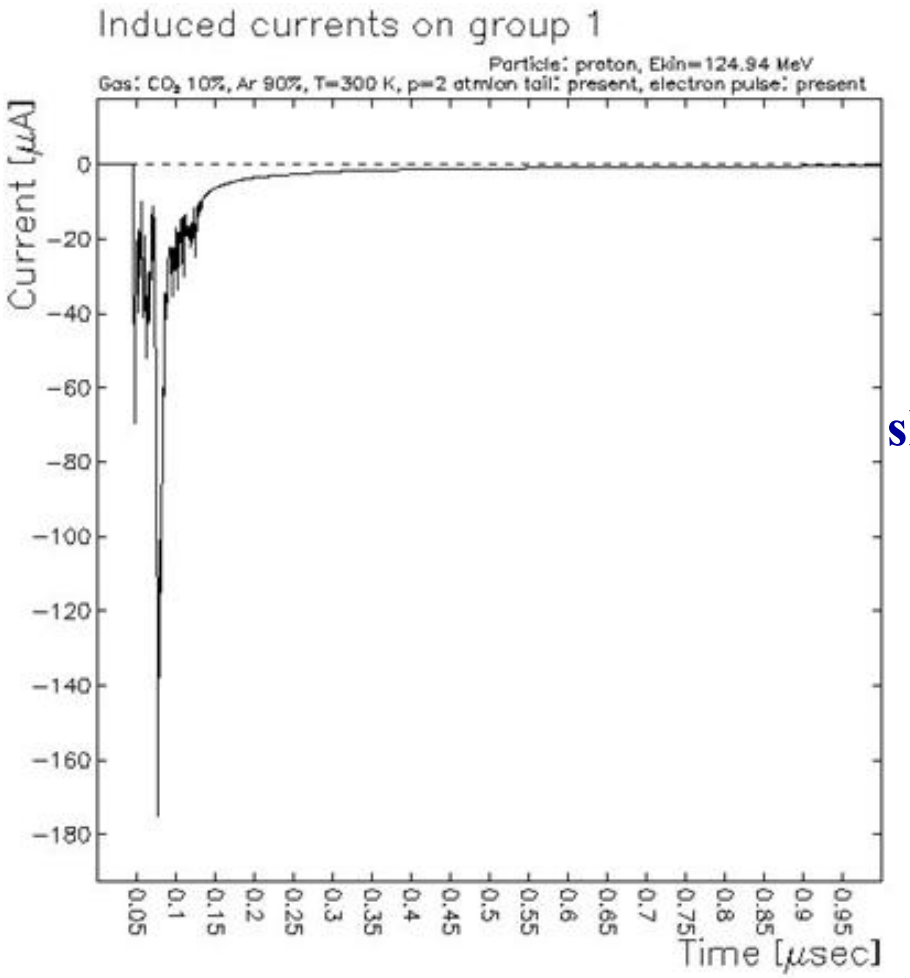
$$H_1(s) = \frac{-R_f p_1 p_2}{(p_1 + s)(p_2 + s)}$$

• 2 **Amplifier**
- First shaping
- Tail-cancellation filter + Second shaping

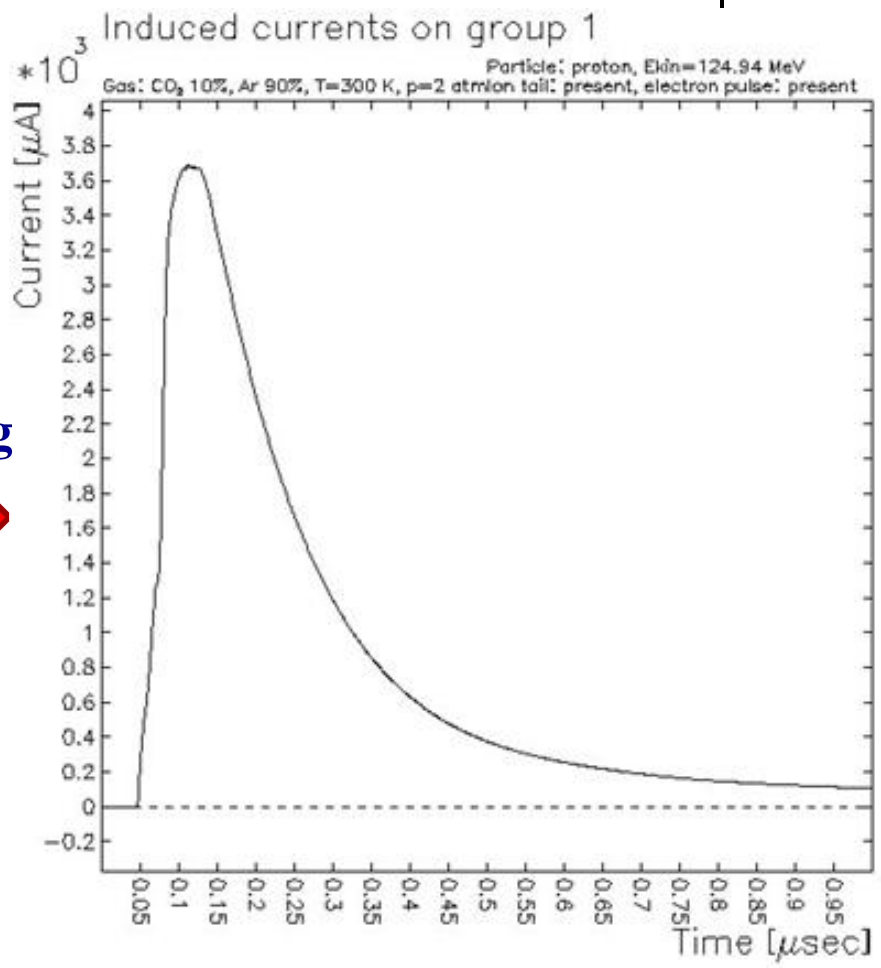
$$H_2(s) = \frac{-R_s}{R_p + R_z} \frac{(1 + s\tau_z)}{(1 + s\tau_p)(1 + s\tau_s)}$$

$$H_3(s) = \frac{-R_s}{[R_1\tau_2 + R_2\tau_1 + R_{sw}(\tau_1 + \tau_2)]} \frac{(s\tau_1 + 1)(s\tau_2 + 1)}{(s\tau_s + 1)(s - s_1)}$$

Preamplifier Response



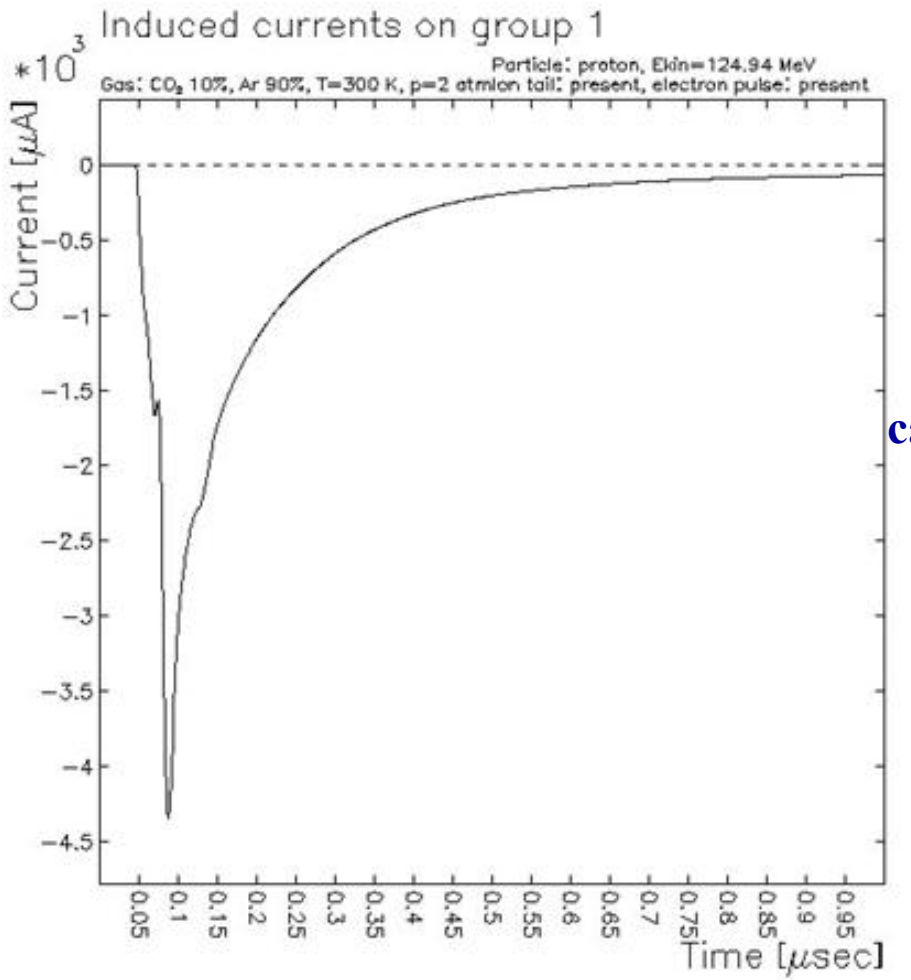
shaping



Detector output pulse for Proton 0.5 GeV/c

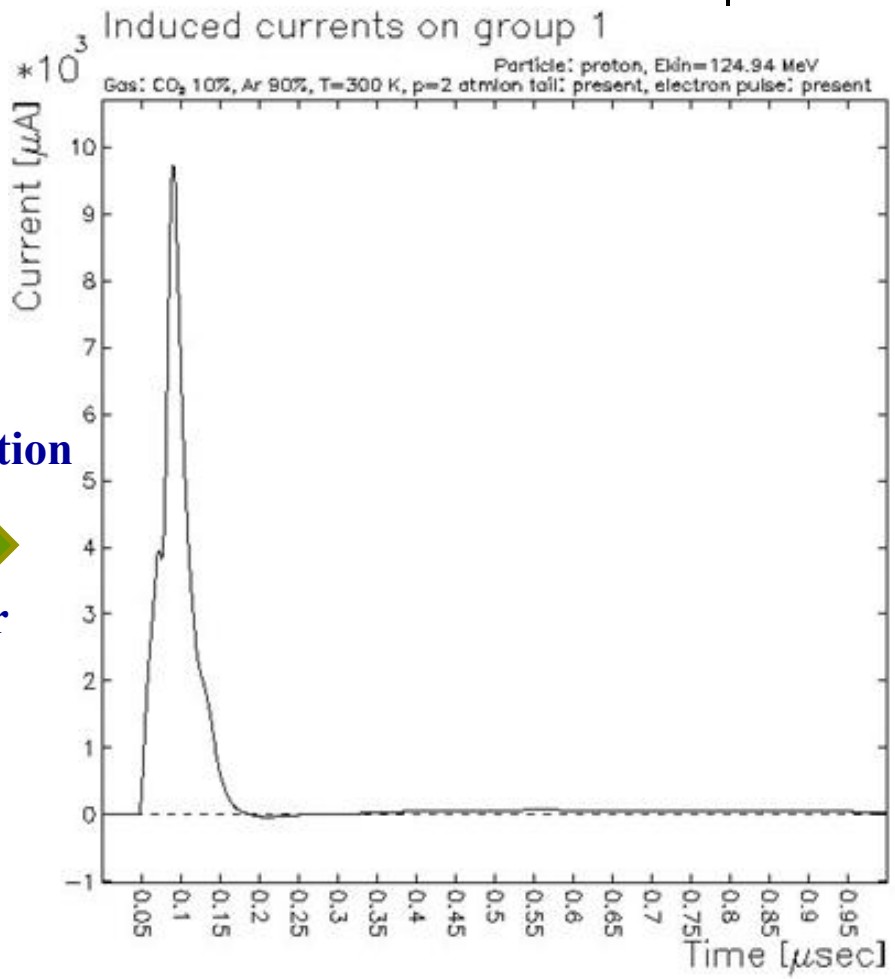
Pulse after preamplifier

Amplifier Response



Tail cancellation

filter



Pulse after first shaper

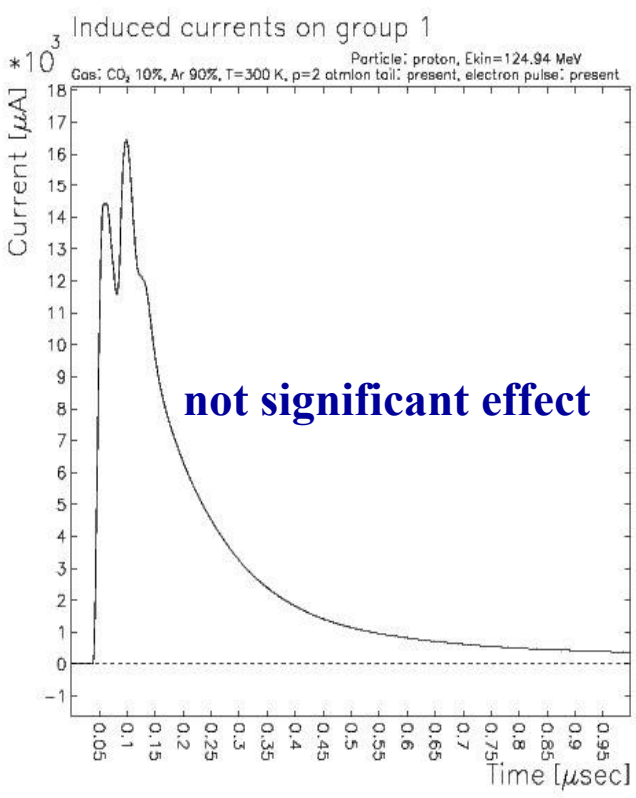
Pulse after tail-cancellation filter

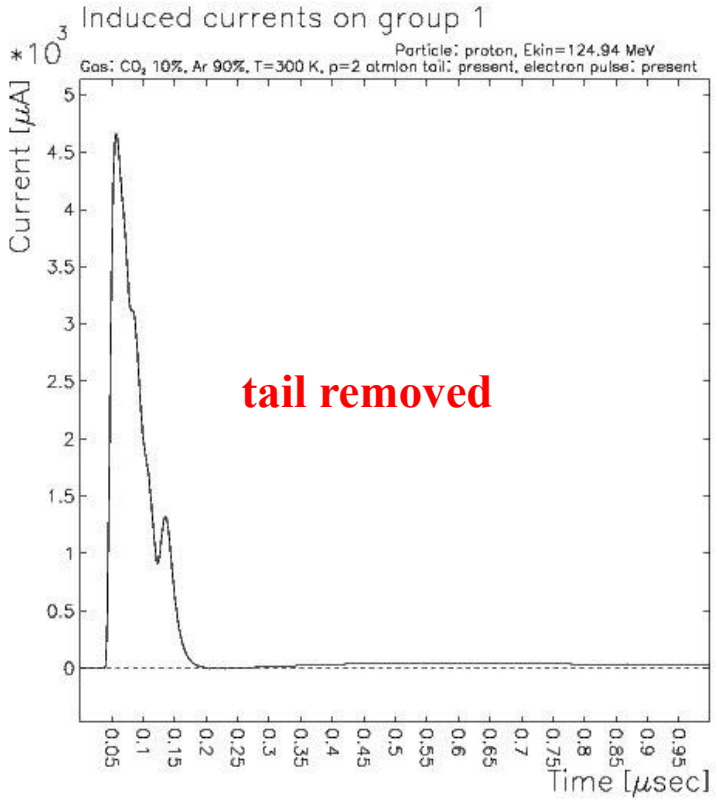
Tail-cancellation Setting

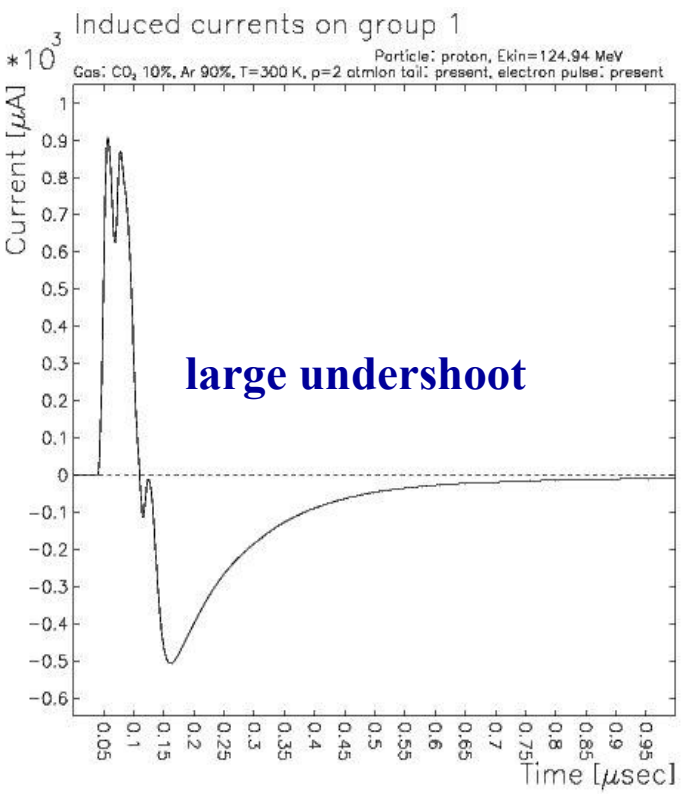
τ1 & τ2 setting

- Removing the ion tail
- Reducing undershoot

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

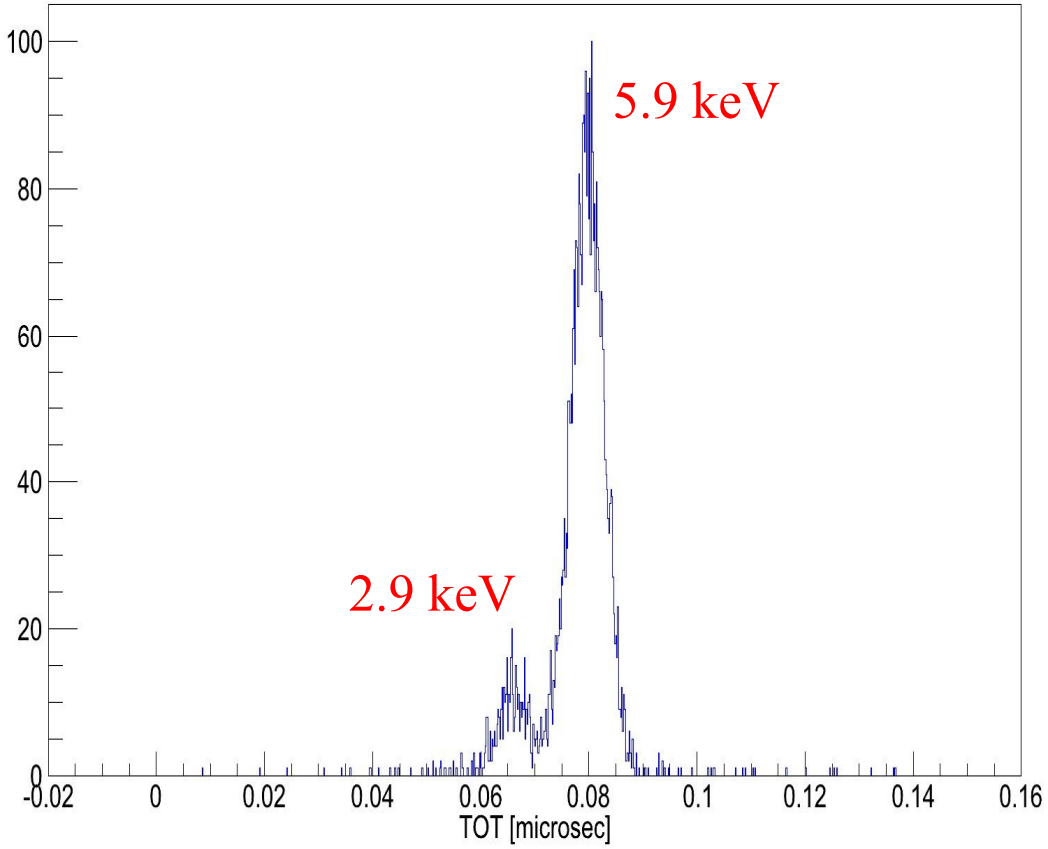




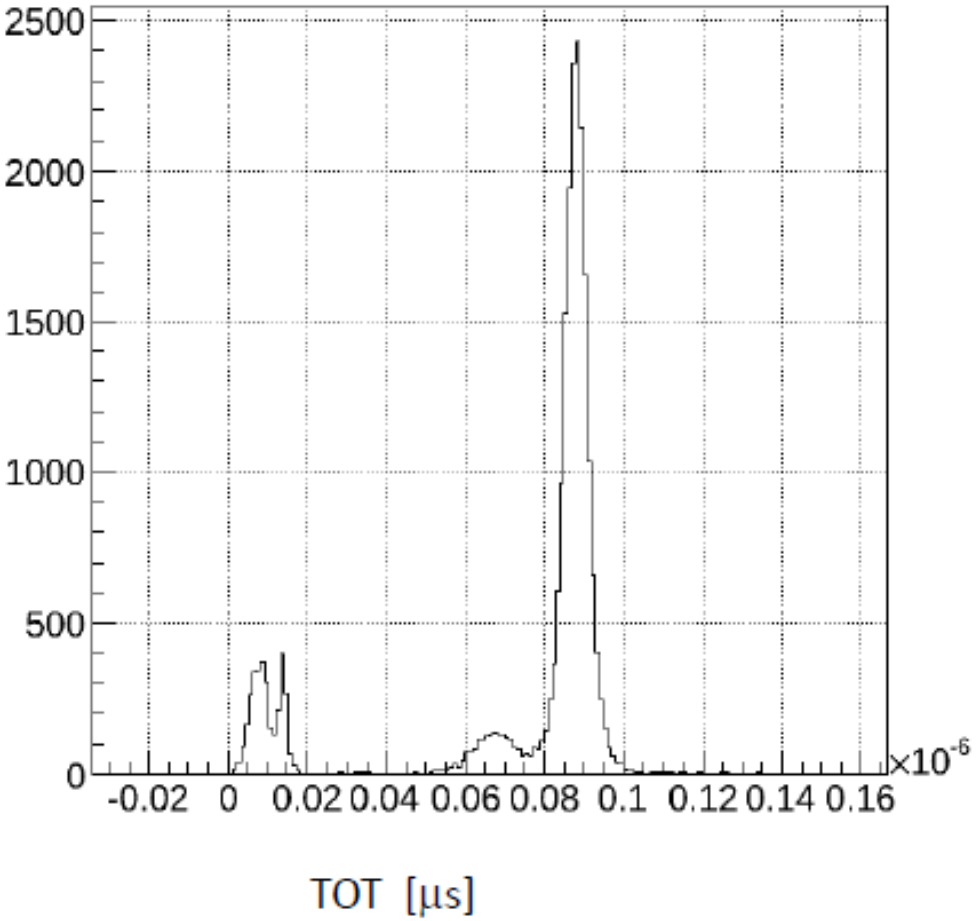


TOT for Fe-55 Source

(5.9 keV X-ray & 2.9 keV Ar escape peak)

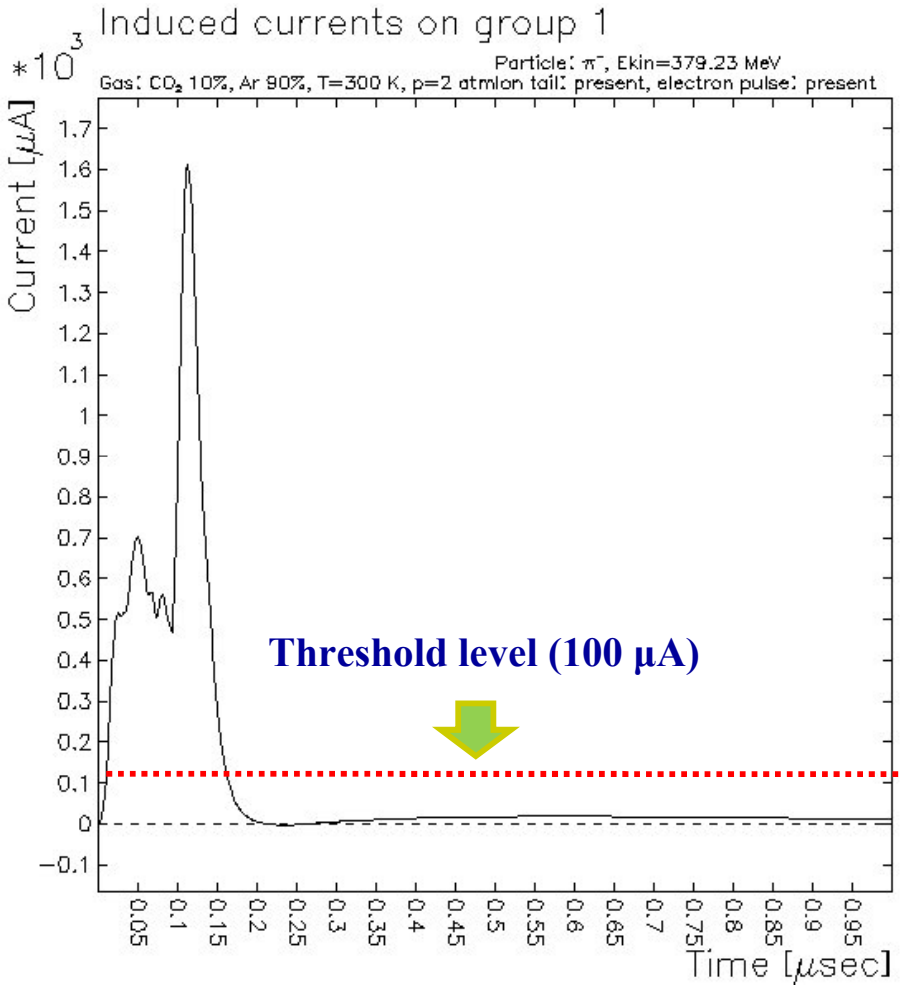


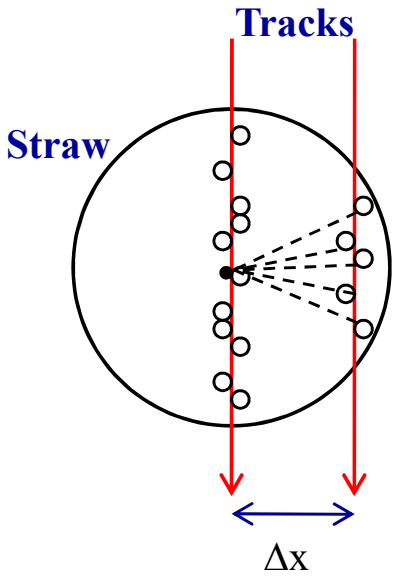
Simulated TOT



TOT spectrum in scope

Double-track Resolution

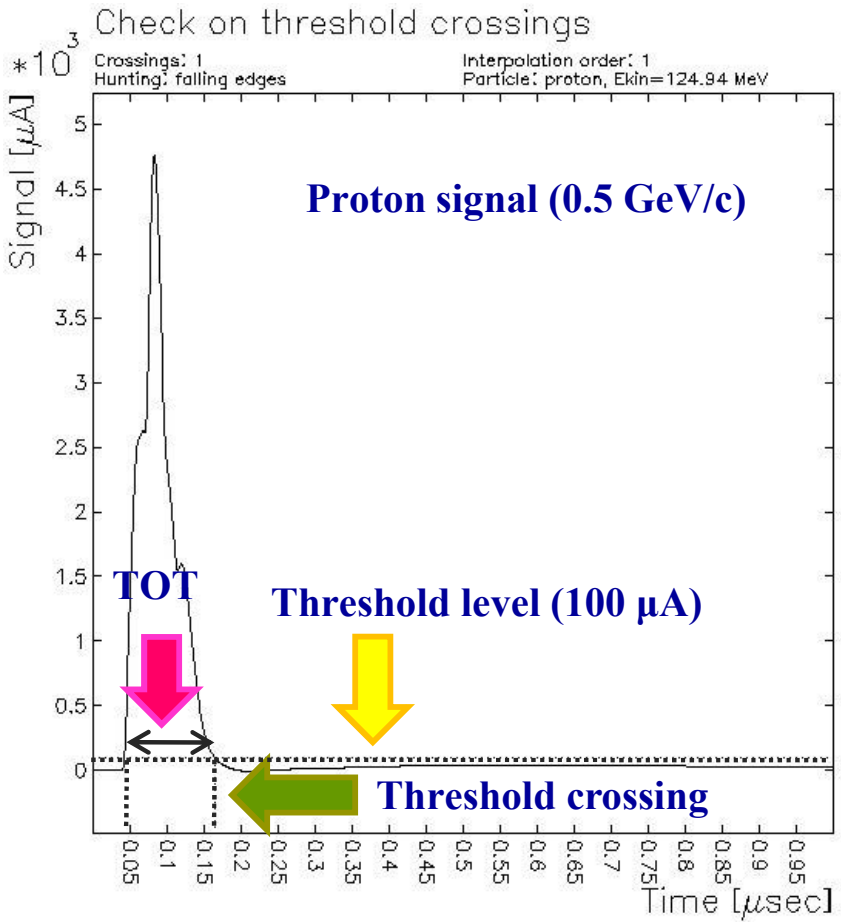




Δx= 4 mm, Pions 0.5 GeV/c

PID Based dE/dx

Threshold setting → **Distance correction** → **Truncated average**

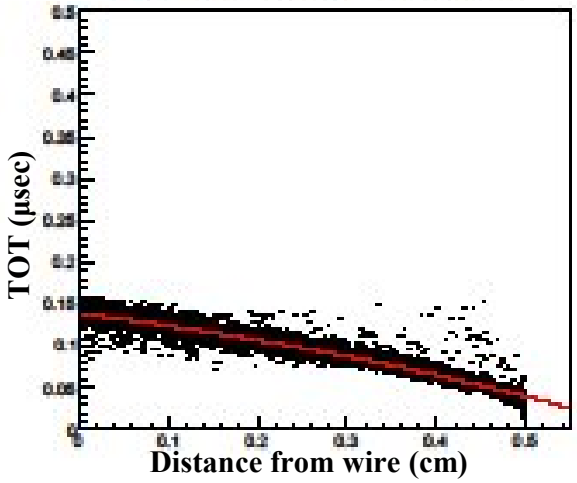


- Response of 24 single straws to 400 tracks
- Set the threshold low for good position resolution
- Normalize all the data to the first bin average
- Truncated Average for 24 straw layers by removing 30% of the highest numbers

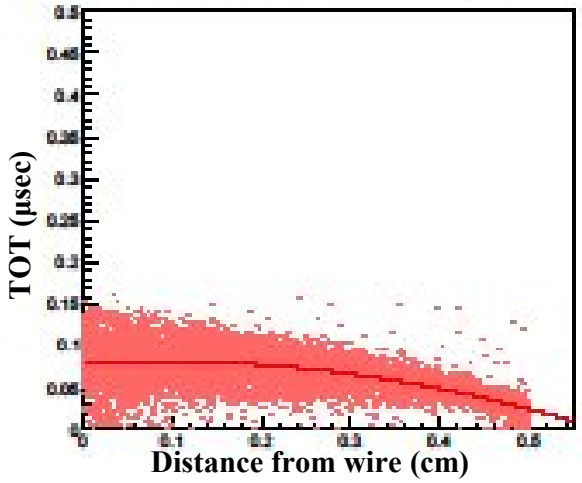
Distance Correction

(0.5 GeV/c particles)

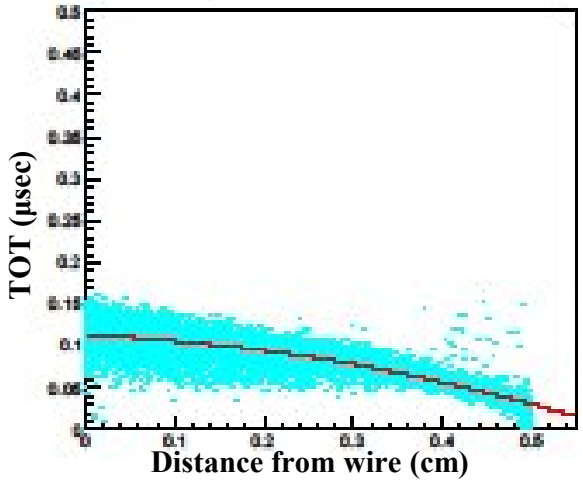
TOT of proton without distance correction



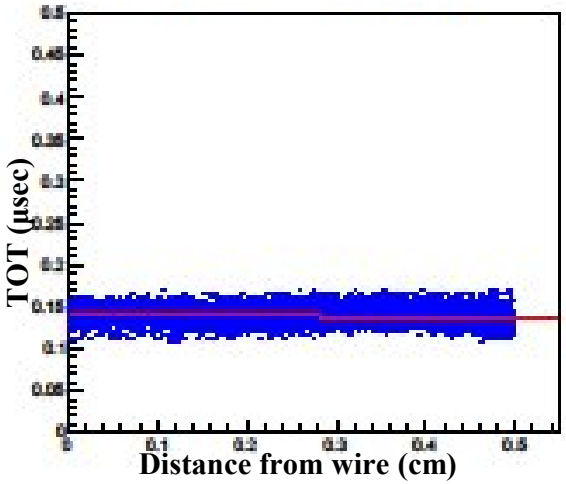
TOT of pion without distance correction



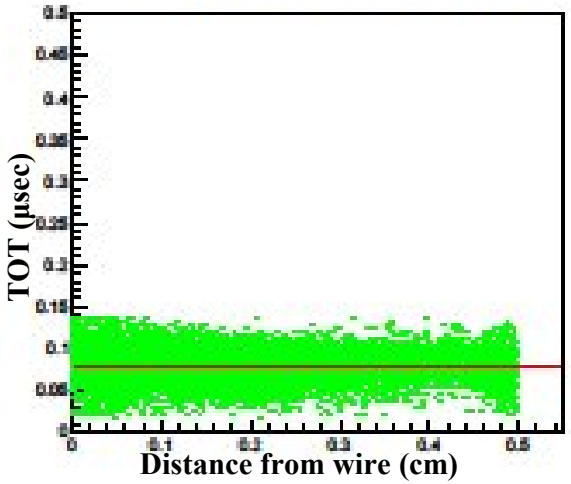
TOT of kaon without distance correction



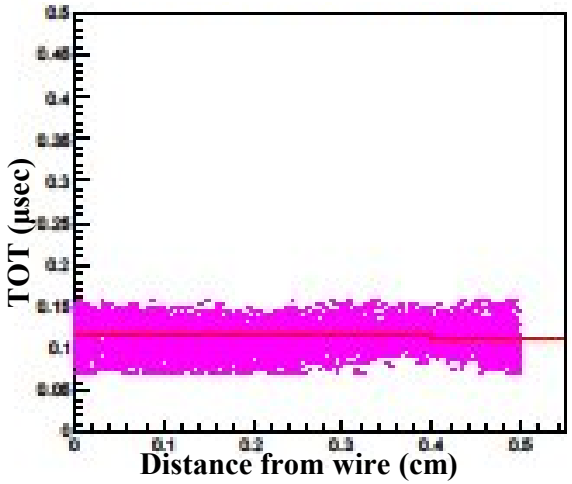
TOT of proton after distance correction



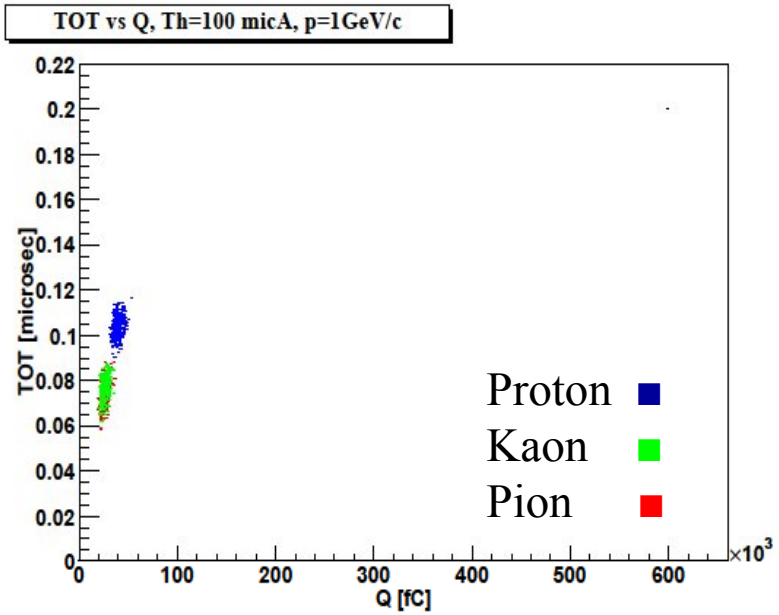
TOT of pion after distance correction

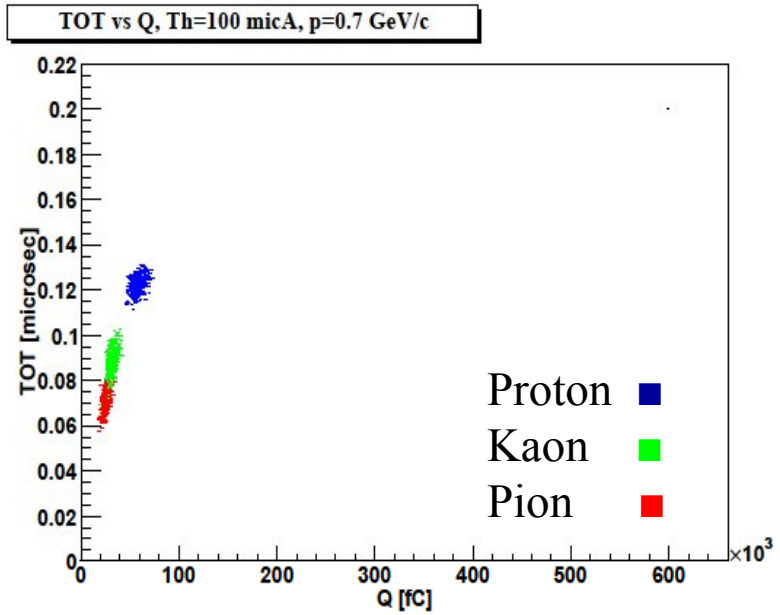


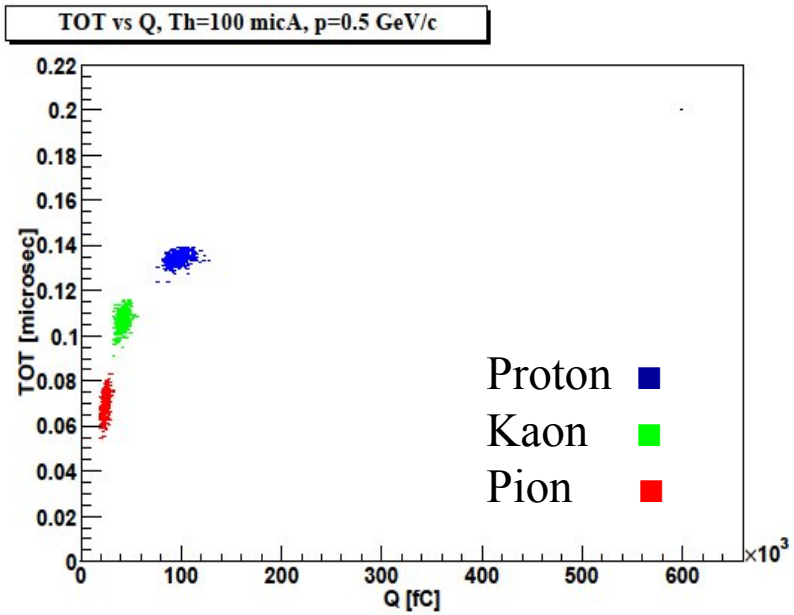
TOT of kaon after distance correction

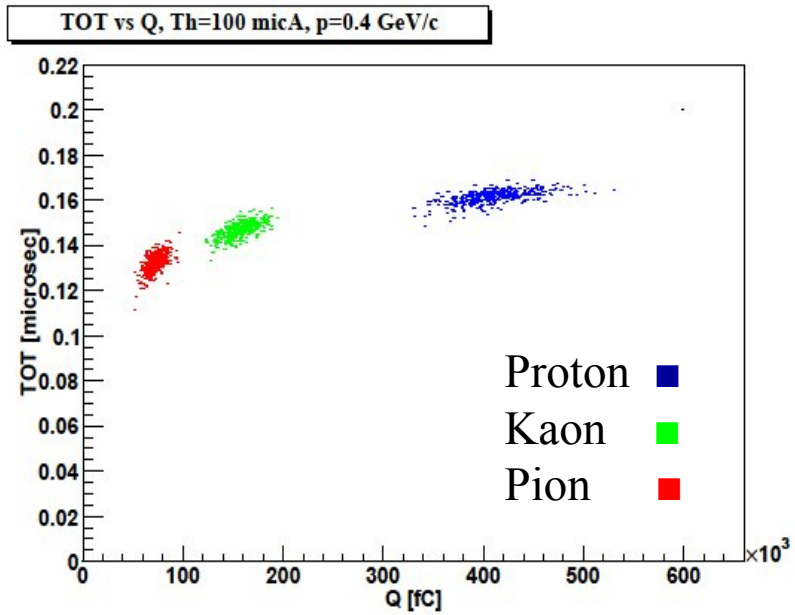


TOT vs. Charge (Threshold=100 µA)



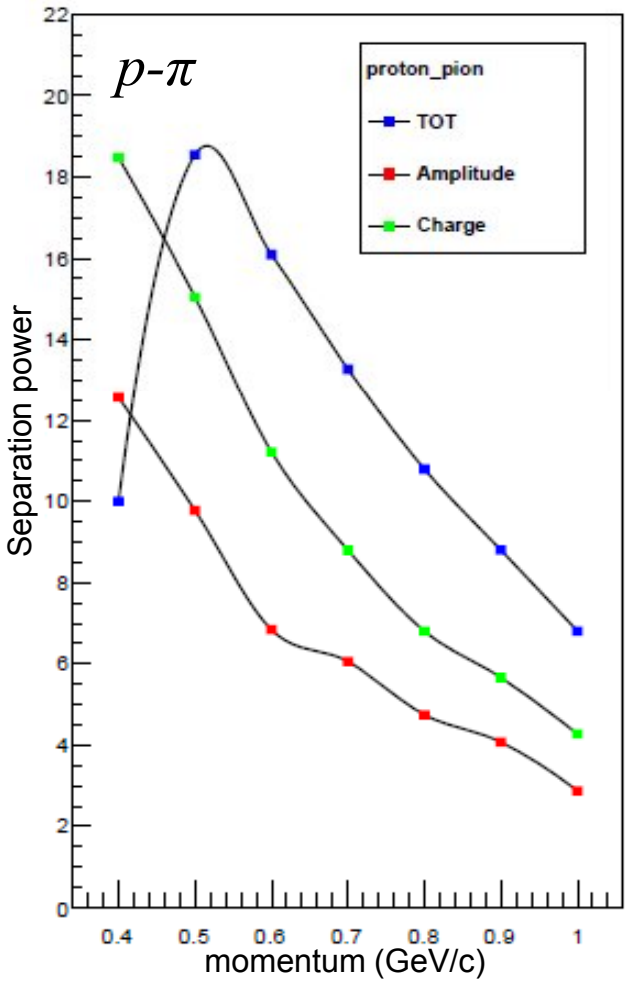


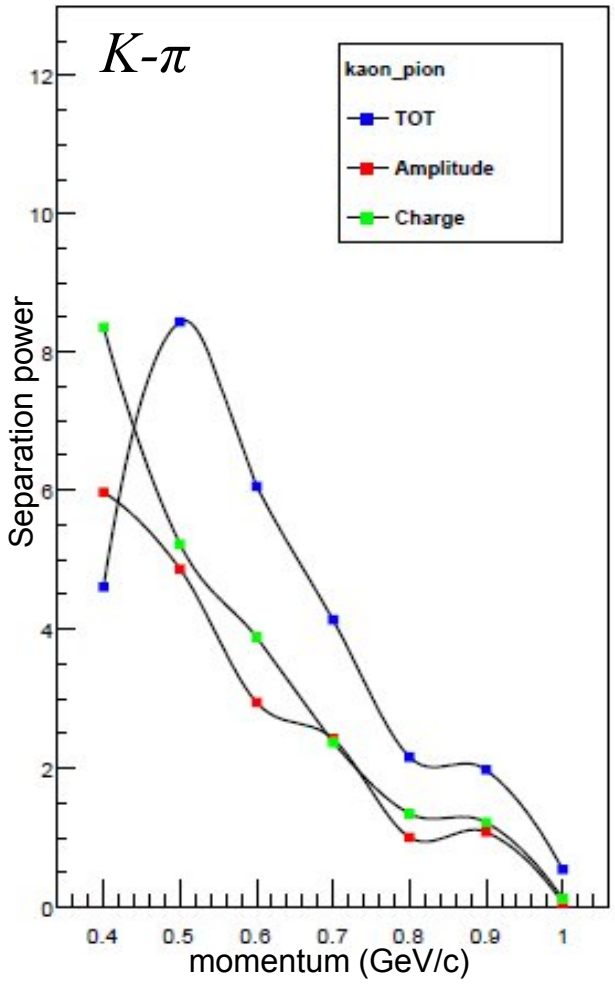


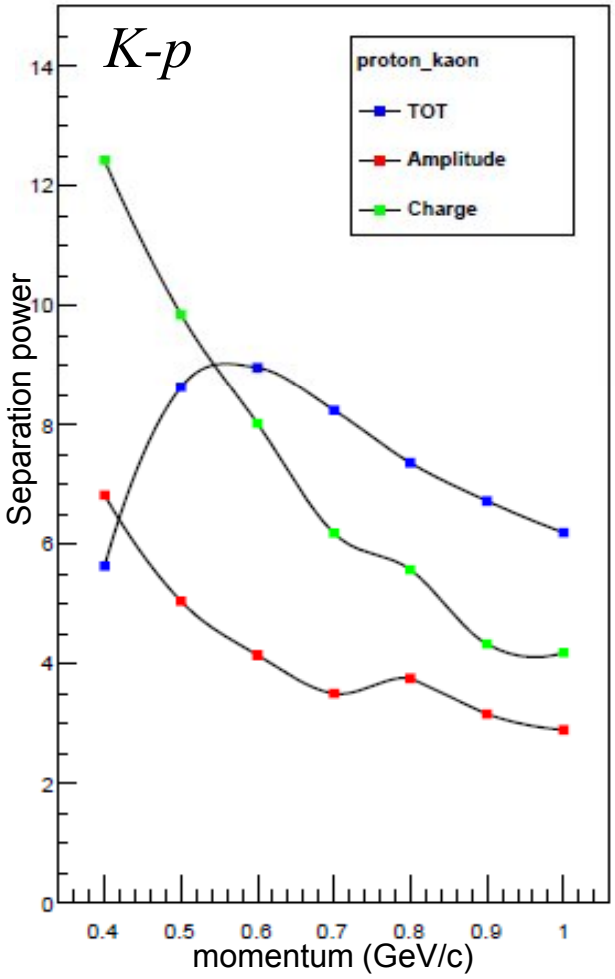


Separation-power Comparison

Separation power after distance correction







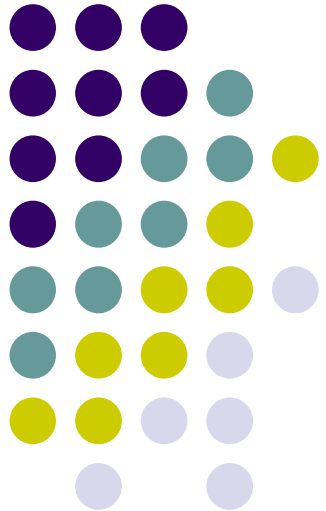
Conclusion

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

Future Plans

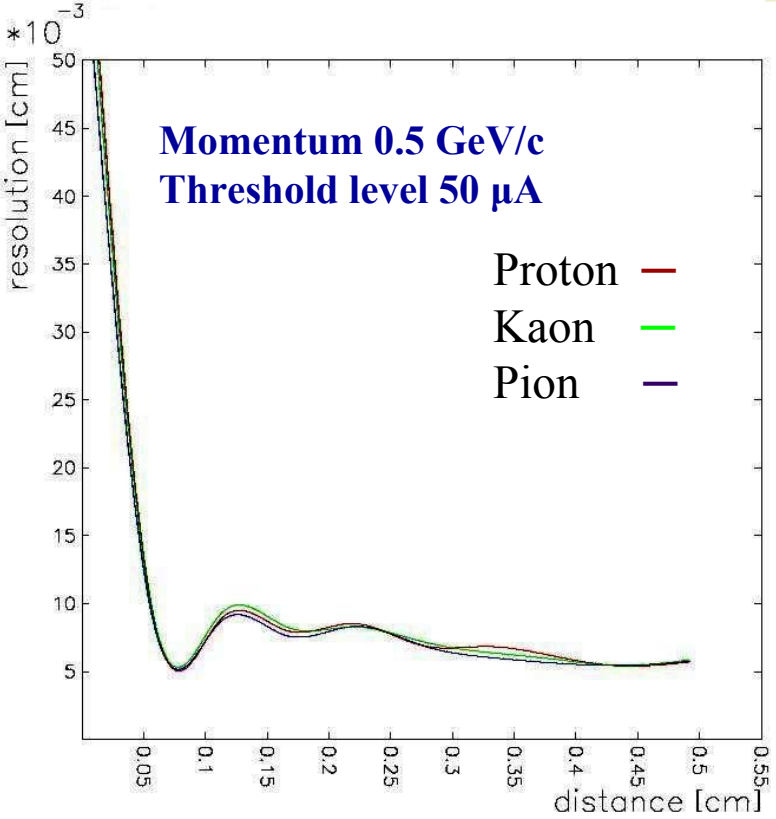
- Including dynamic range of amplifier
- Compare the simulation with recent Juelich tests

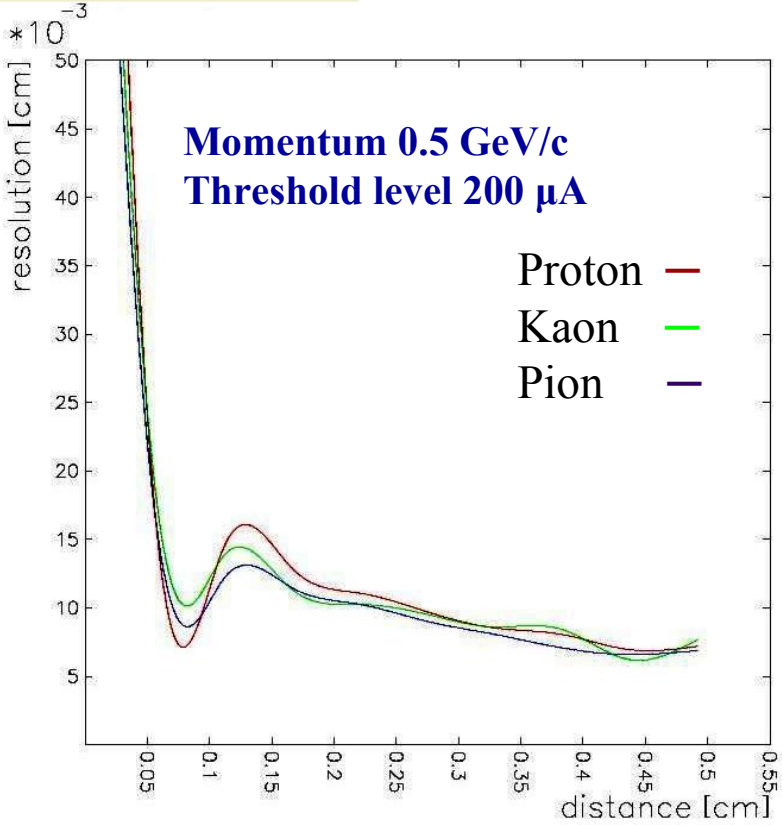
Thanks for Your Attention



Position Resolution

Threshold setting → **position resolution**





TOT vs. Charge (Threshold=50 μA)