Performance of the TPC with Micro Pixel Chamber readout: micro-TPC

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1. Introduction

TPC for sub-mm fine tracking

→ micro-TPC

OUR GOAL: micro-TPC as an

"electric cloud chamber"
2. PIC Detector

- Micro Pixel Chamber
  - 256 anode + 256 cathode strips
- Fine position resolution
- High gain
- Discharge damage: small

- Large area with cheap cost

TPC readout
-PIC Detector: the performance

- Stable operation: >100 hrs
- Energy resolution: FWHM 30% @ 5.9 keV

Graphs showing:
- Gas gain (Ar:C₂H₆ 8:2) vs. anode voltage (V) with gain at 1.5 × 10⁴ at anode voltage of 650 V.
- Gain vs. time (hour) with stable operation indicated for >100 hrs.
-PIC Detector: X-ray imaging

- Test chart image
  (Xe:C₂H₆ 7:3)

- Spatial resolution
  - Knife edge test
  - 400 mm resolution

- Other images
Readout Electronics

- **Preamplifier**
  - ATLAS amplifier shaper
discriminator (ASD) chip (64ch/card)

- **Position encoding module**
  - 5 FPGAs
  - 40MHz clock

- **X-ray test**
  - High intensity
  - 7.7 Mcps

- **DAQ rate [MHz]**

- **X-ray intensity [mA]**

- **Graph**

- **Dimensions**
  - 16cm
  - 40cm
  - 30cm
3. Micro-TPC, the Performance

- Field cage
  - 8 cm drift length
  - 0.4 kV/cm electric field
  - +10 μ 10 cm$^2$ - PIC

→ micro-TPC

- Drift velocity 4.7 cm/μ s
- No gain decrease for long drift length

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3-D electron tracks

- Set up
- $^{90}\text{Sr}$ (2.2MeV γ)
- Trigger scintillator
- Several tracks (projections)

Typical electron track (gain ~7000)
4. γ-ray imaging with micro-TPC

- Idea
  - micro-TPC: electron energy & track
  - scintillator: scattered γ energy & position
  - reconstruct the gamma-rays (NOT A EVENT CIRCLE)

- Prototype
  - microTPC
    - 10 mm × 10 mm × 8.0 cm³
  - NaI
    - 4 × 4” × 1” + 25 PMTs

- 57Co (122keV γ)
-ray imaging with micro-TPC

Well-reconstructed event
(several events, for now...)

- 30 hours
- gain >5000

Concept --- OK.

assumption: $E_e = E_{\text{source}} - E_{\text{Nal}}$

FADC data($E_e$) actual -ray imaging
5. Conclusions

- PIC improvements
  gain: $>10^4$
  stable operation with gain $>5000$

- Readout electronics
  DAQ rate: 7.7 Mcps

- Micro-TPC
  3D electron tracks

- Gamma-ray imaging
  gamma-rays: reconstructed