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

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1. Introduction
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4. γ-ray Imaging
5. Conclusions

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1. Introduction

TPC for sub-mm fine tracking

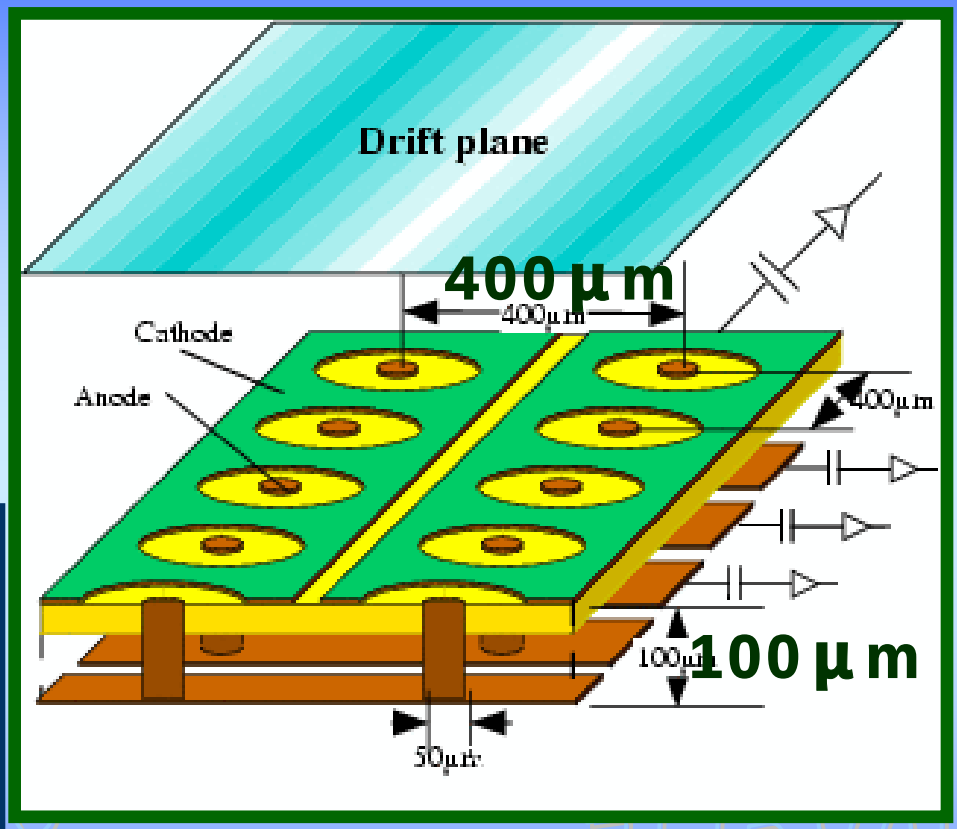
→ micro-TPC

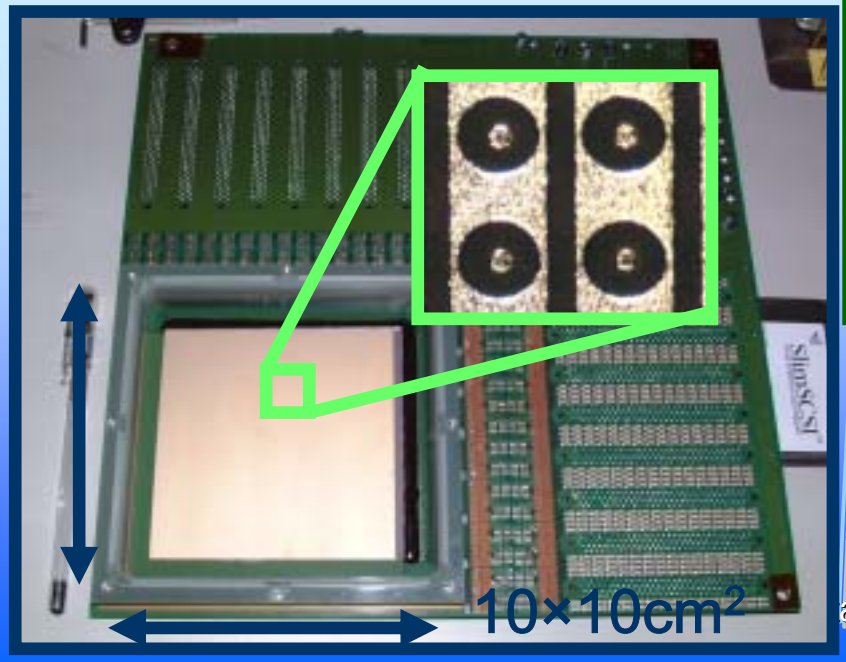
OUR GOAL: micro-TPC as an

"electric cloud chamber"

2. μ-PIC Detector

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



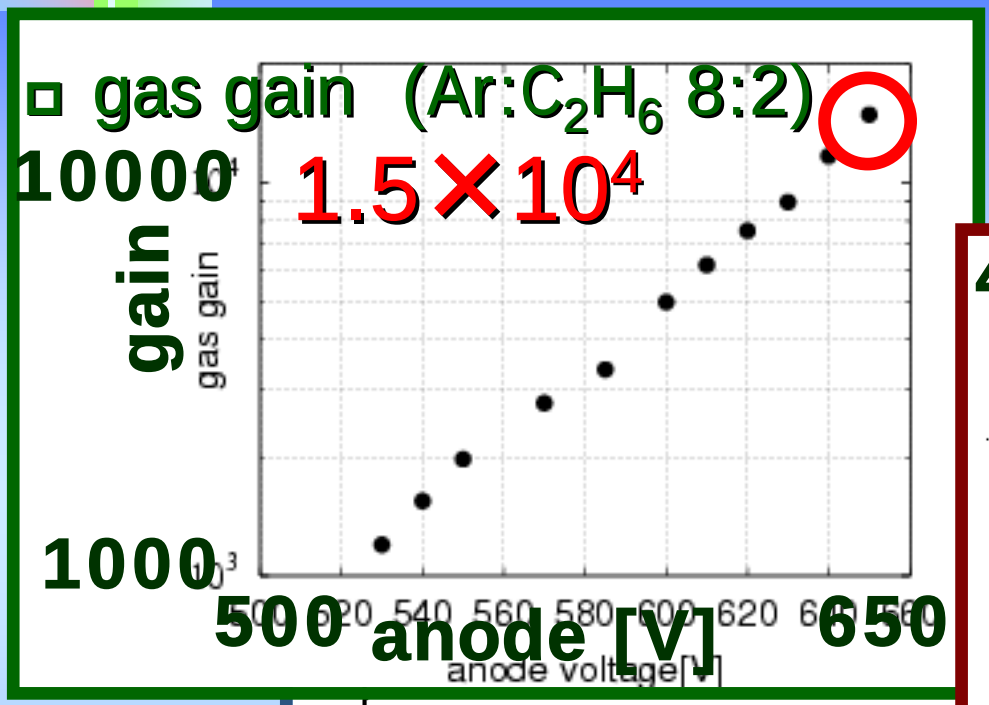


- Large area with cheap cost

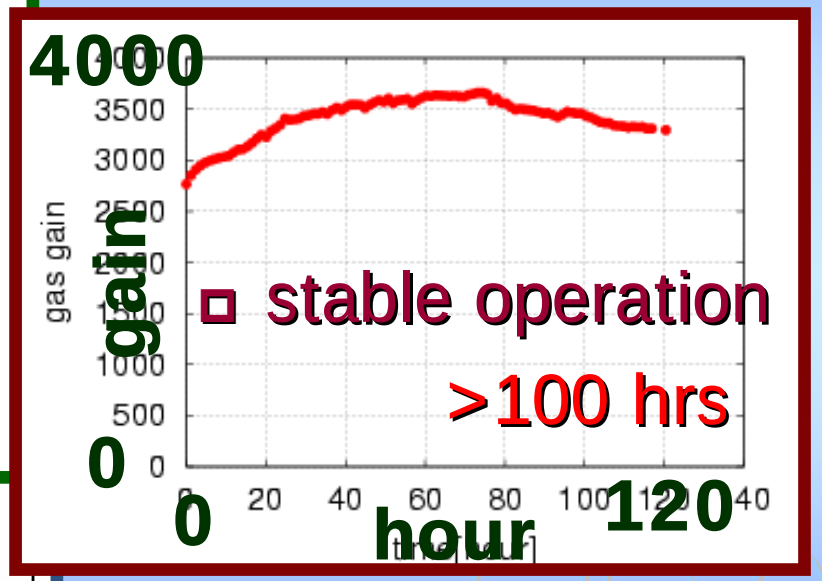
→ TPC readout

μ-PIC Detector: the performance

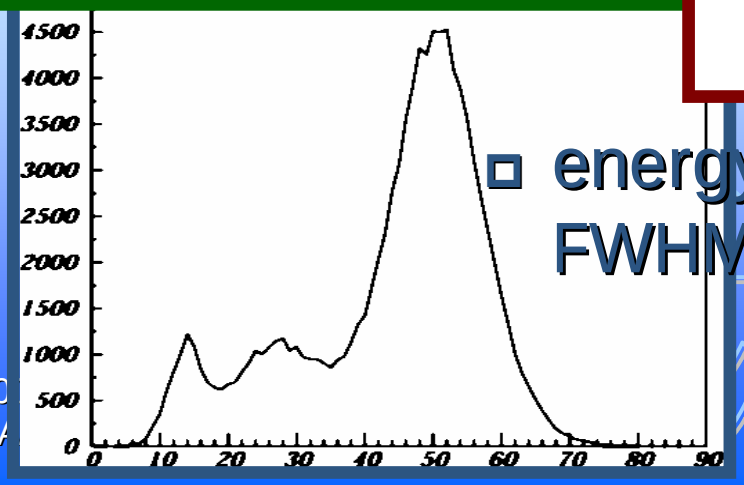
- gas gain (Ar:C_2H_6 8:2)



1.5×10^4



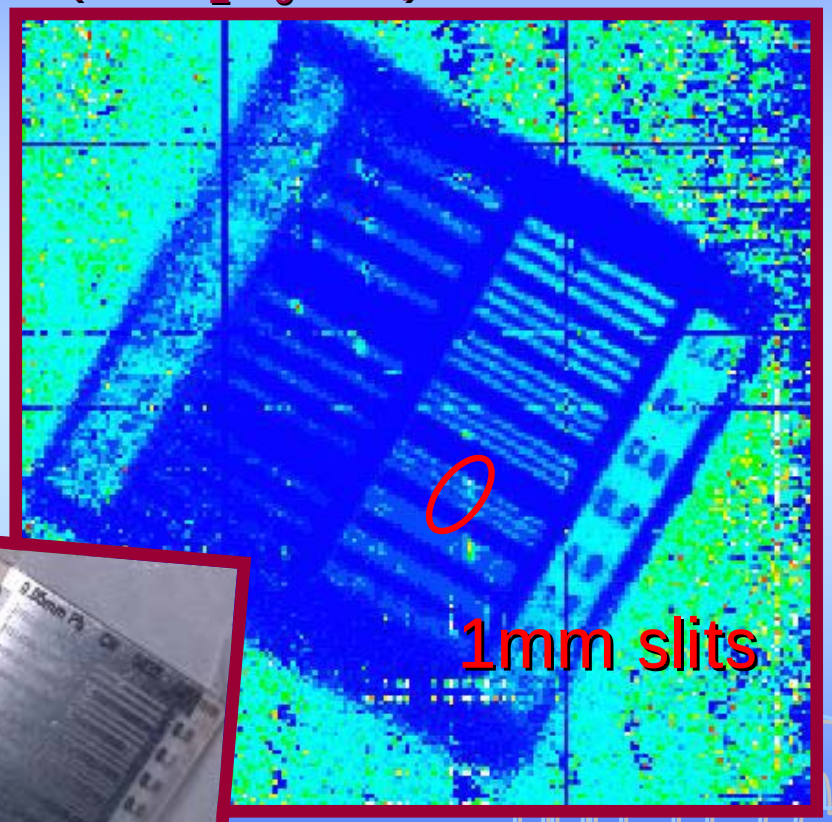
- stable operation
  >100 hrs



- energy resolution
  FWHM30%@5.9keV

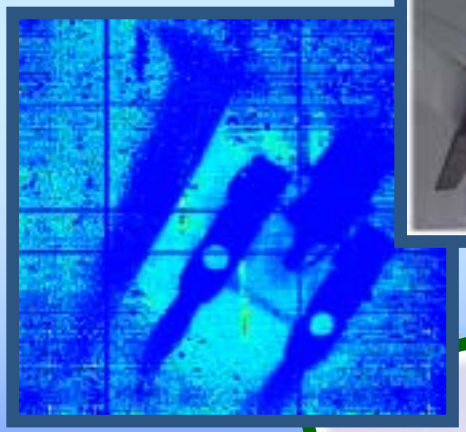
μ-PIC Detector: X-ray imaging

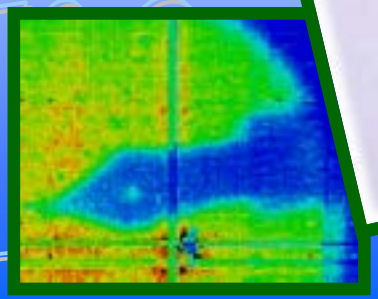
- test chart image
  (Xe:C_2H_6 7:3)



- spatial resolution
  - ✓ knife edge test
    400 μm resulution

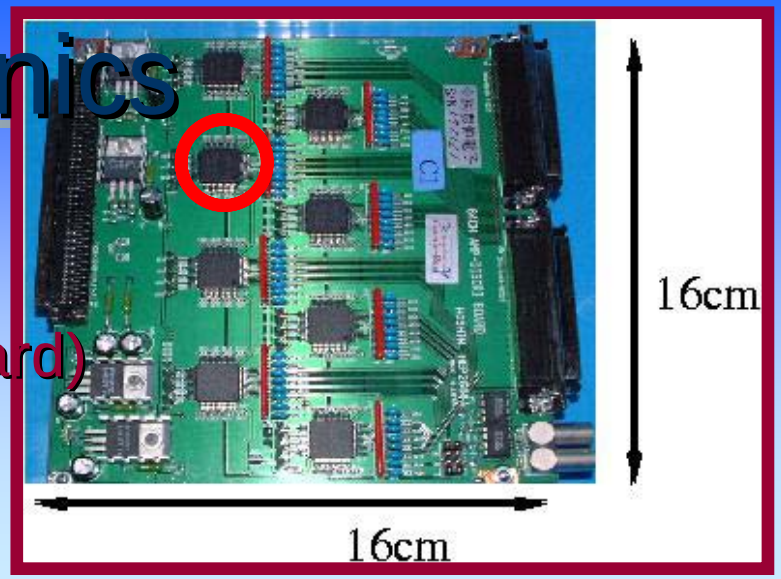
- other images

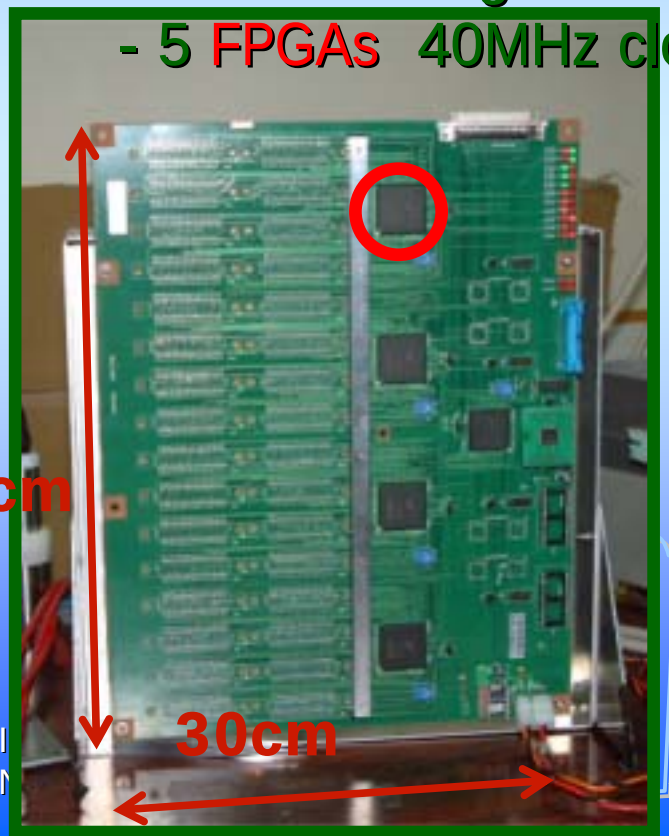


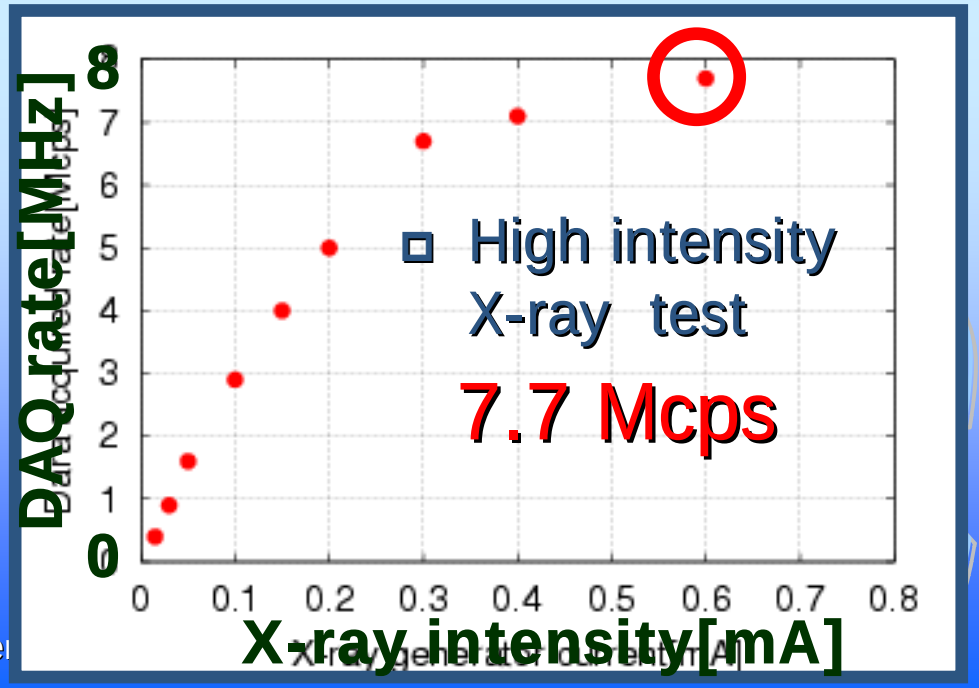


Readout Electronics

- Preamplifier
  - ATLAS amplifier shaper discriminator (ASD) chip (64ch/card)
- Position encoding module
  - 5 FPGAs 40MHz clock



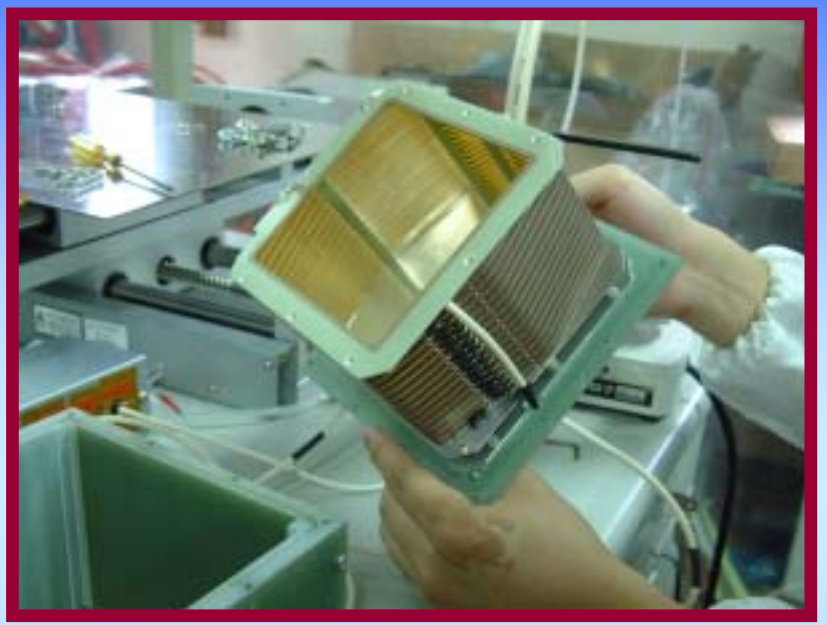




3. Micro-TPC, the Performance

- Field cage
  8cm drift length
  0.4 kV/cm electric field
  +10×10cm² μ-PIC

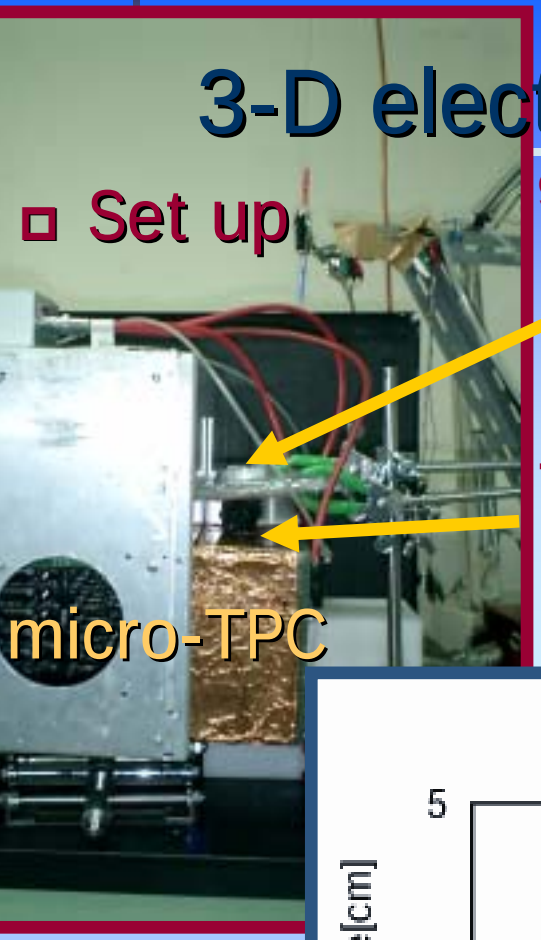
➡ micro-TPC



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

3-D electron tracks

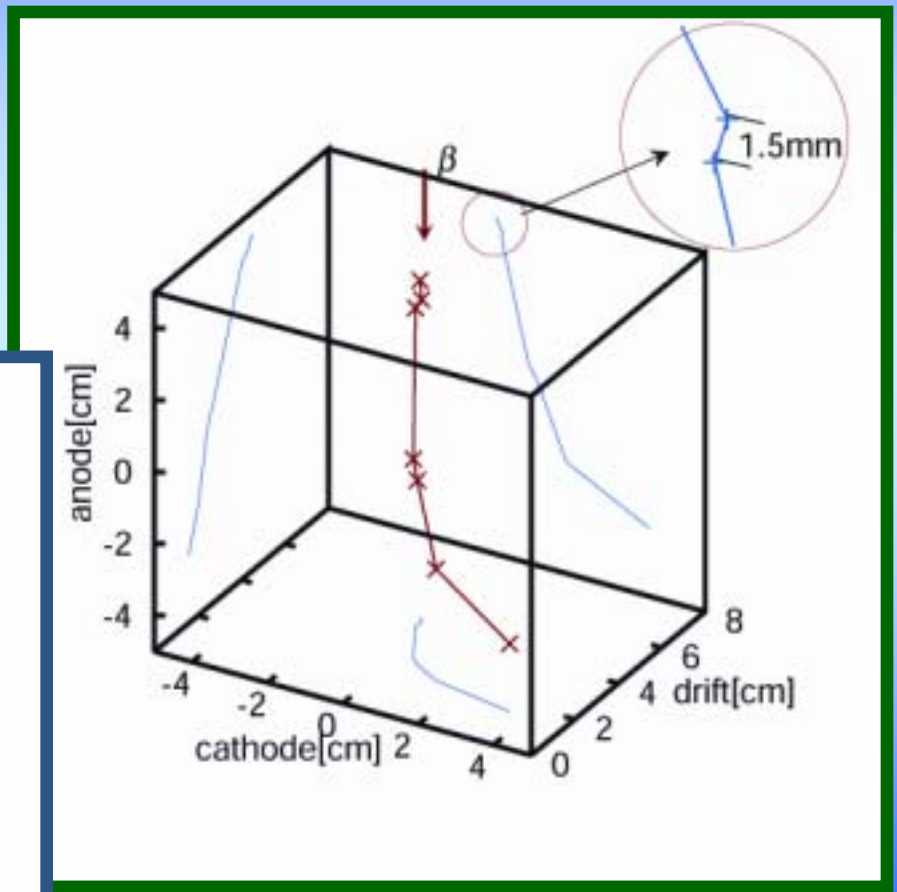
- Set up



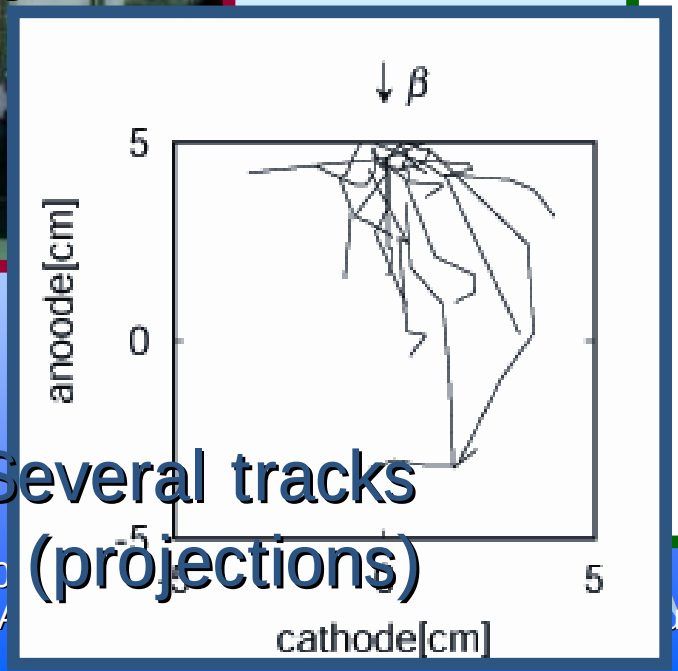
^{90}Sr (2.2MeV β)

Trigger scintillator

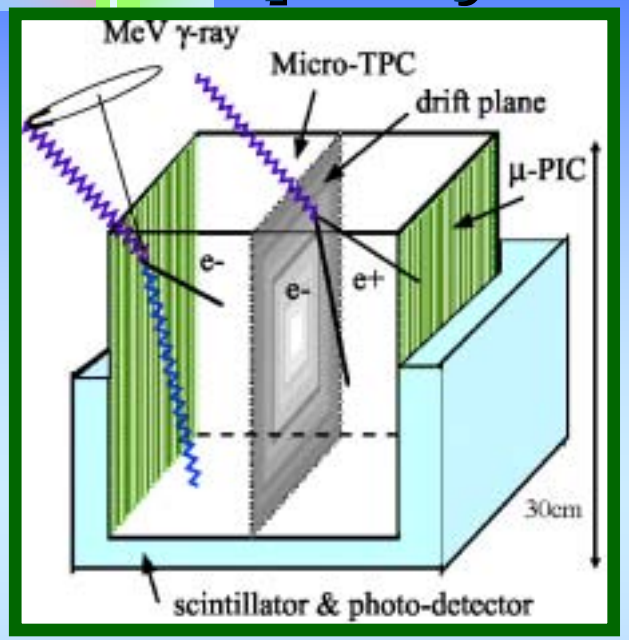
- Typical electron track (gain ~7000)



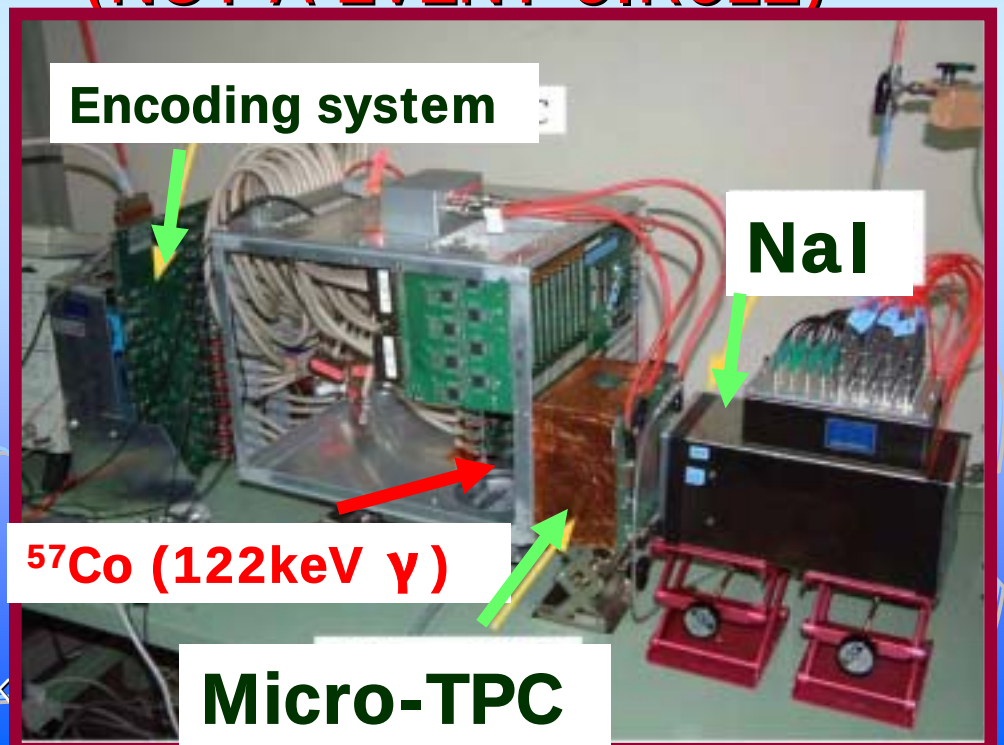
- Several tracks (projections)



4. γ -ray imaging with micro-TPC

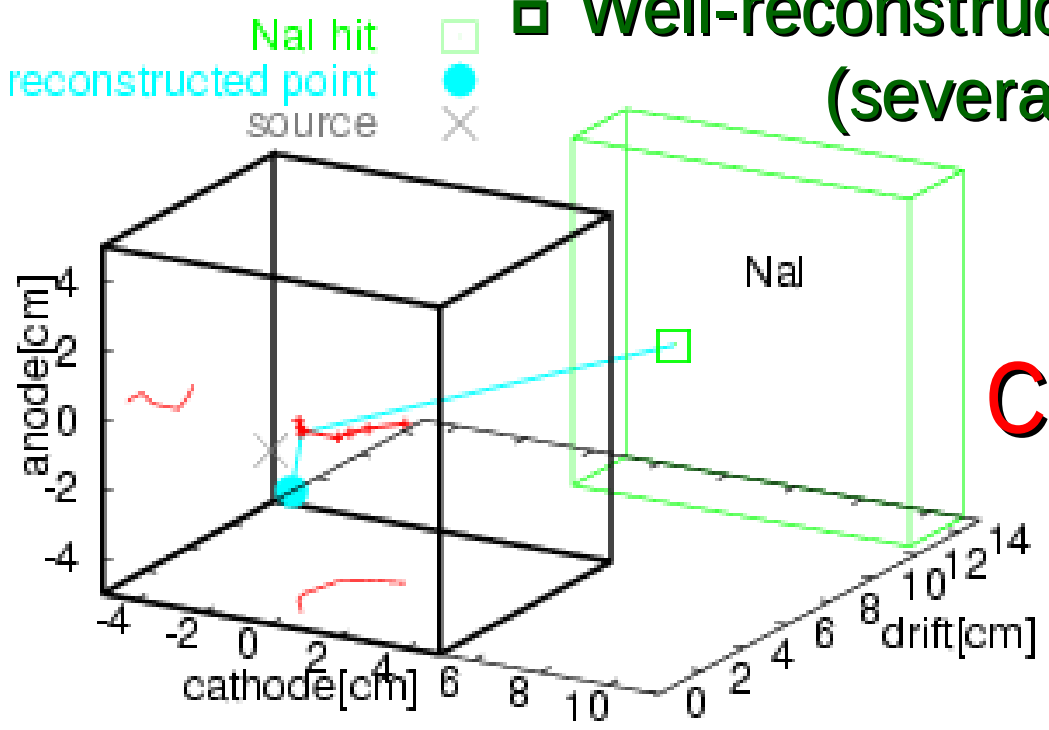


- Idea
  - ✓ micro-TPC : elecron energy & track
  - ✓ scintillator: scattered γ energy & positio
  - ➡ reconstruct the gamma-rays (NOT A EVENT CIRCLE)



- Prototype
  - ✓ microTPC
    - $10 \times 10 \times 8.0\ cm^3$
  - ✓ NaI
    - 4”×4”×1”+25 PMTs

γ-ray imaging with micro-TPC



- Well-reconstructed event (several events, for now...)
  - ✓ 30 hours
  - ✓ gain >5000

Concept --- OK.

assumption: $E_e = E_{source} - E_{NaI}$

FADC data(E_e) ➡ actual γ-ray imaging
higher efficiency

5. Conclusions

- μ-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