IOP Institute of Physics

Nuclear and Particle Physics Divisional Conference (NPPD)

4–7 April 2011, University of Glasgow, UK

TACTIC and SHARC

Detector Developments at the University of York

Simon P. Fox

TACTIC

- *T*RIUMF *A*nnular *C*hamber for the *T*racking and *I*dentification of *C*harged Particles

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- Detector Requirements

  Measure dE/dx, E and timing to track and identify particle

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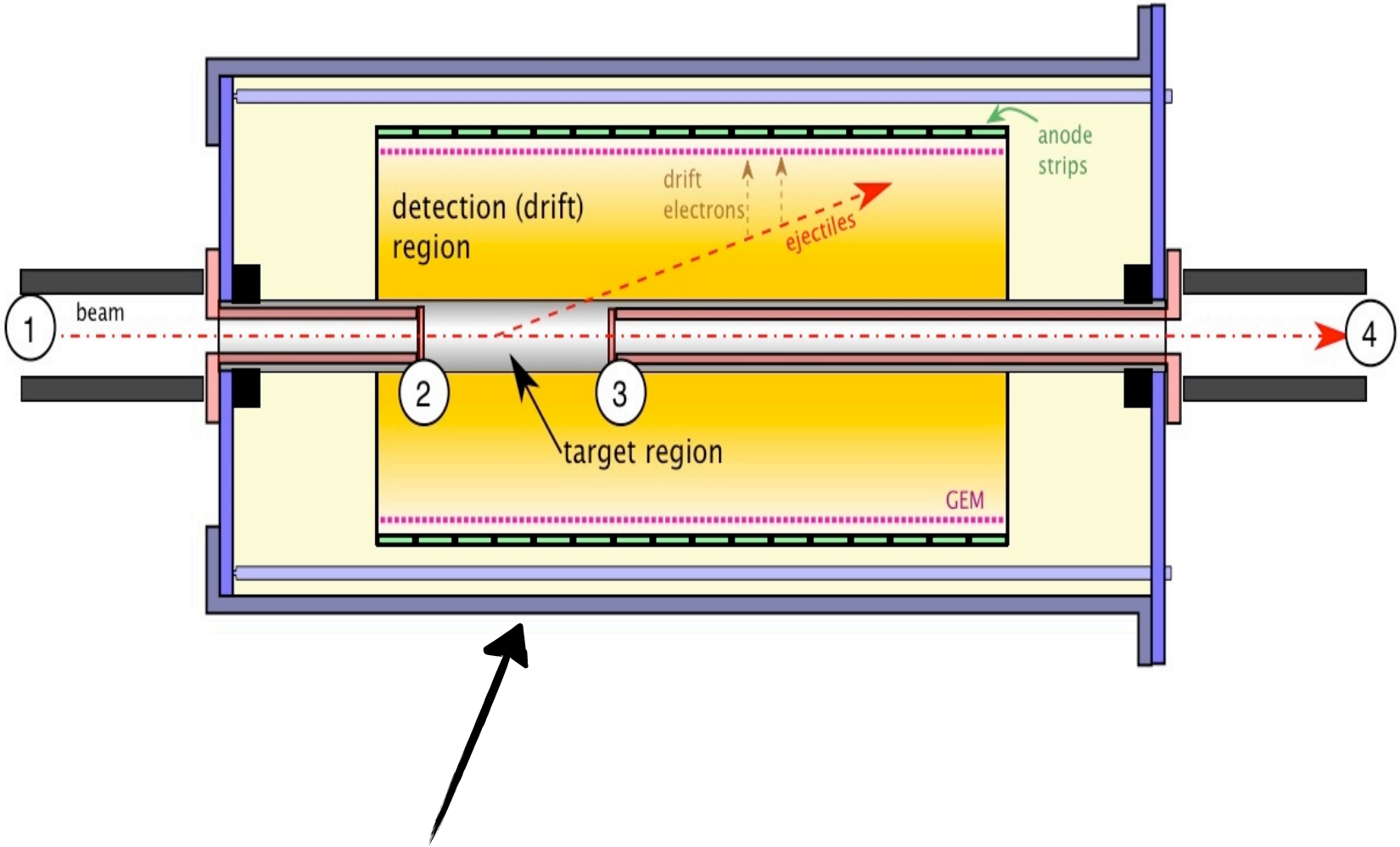
  Measure dE/dx, E and timing to track and identify particle

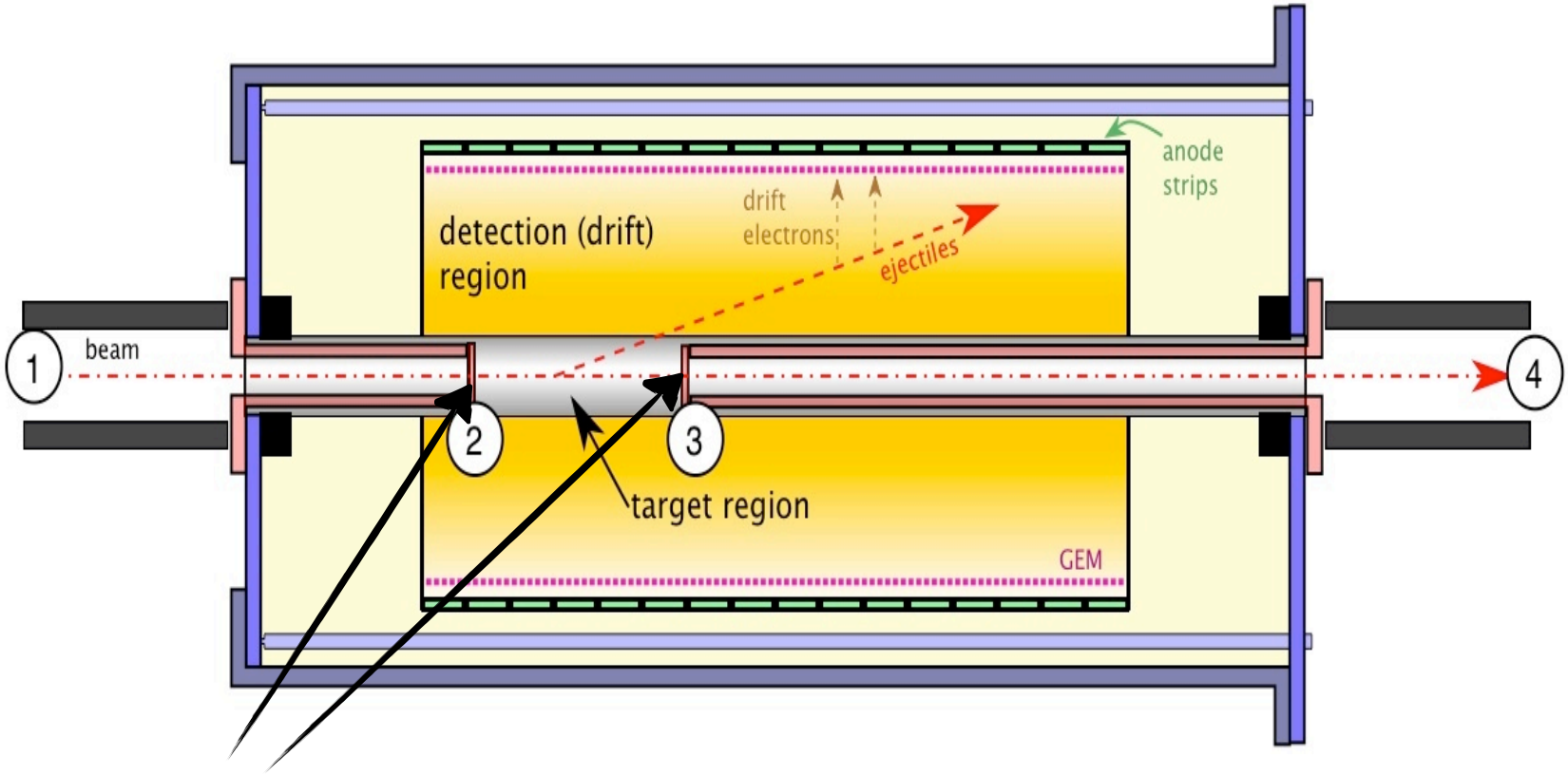
- $^{8}Li(\alpha,n)^{11}B$
  - Low Energy particles => Low Detection Threshold
    + Active Target
  - Low Yield => Require High Efficiency + High Beam Intensities

The TACTIC Detector



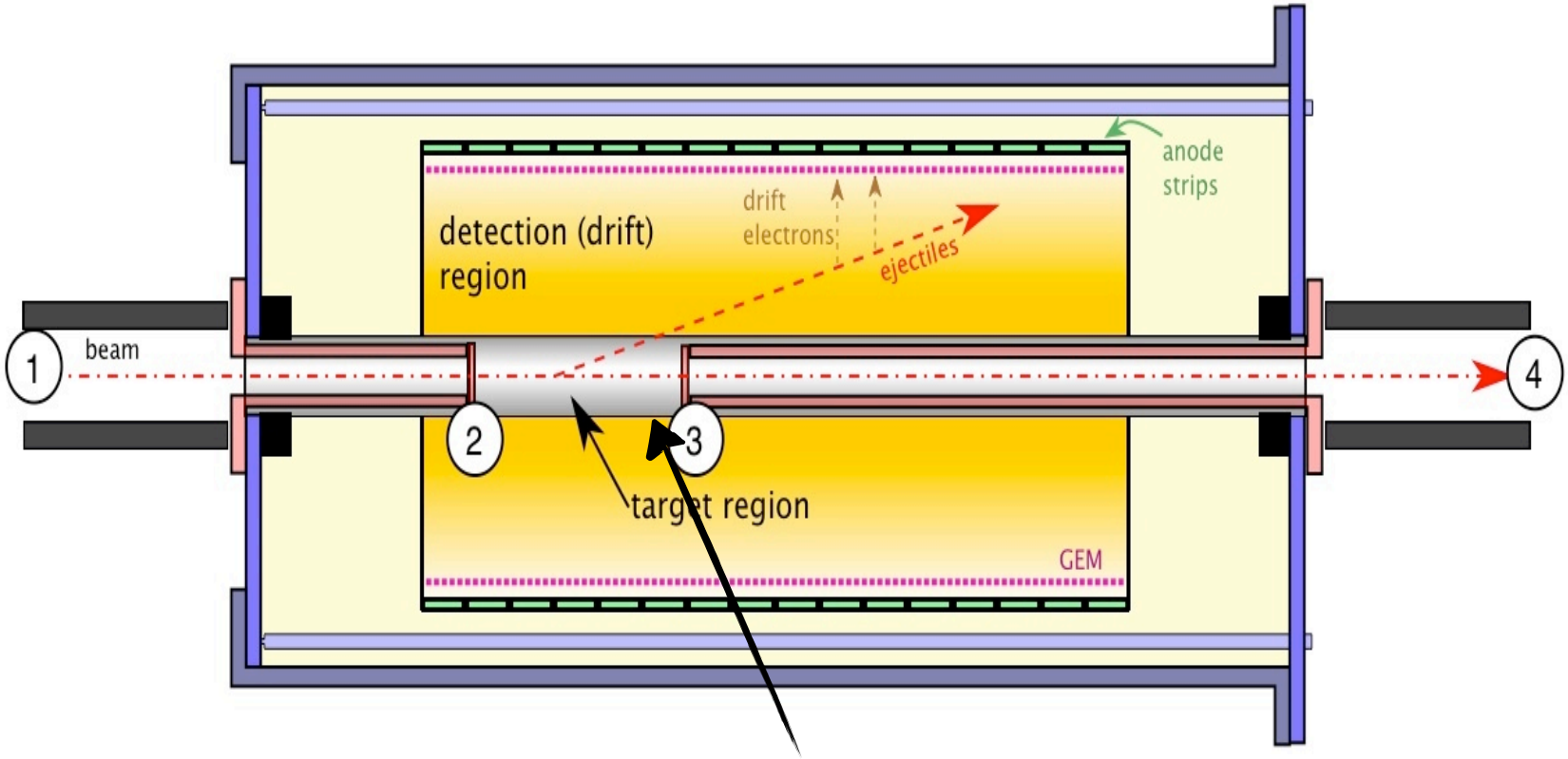
Cylindrical: High Efficiency

The TACTIC Detector



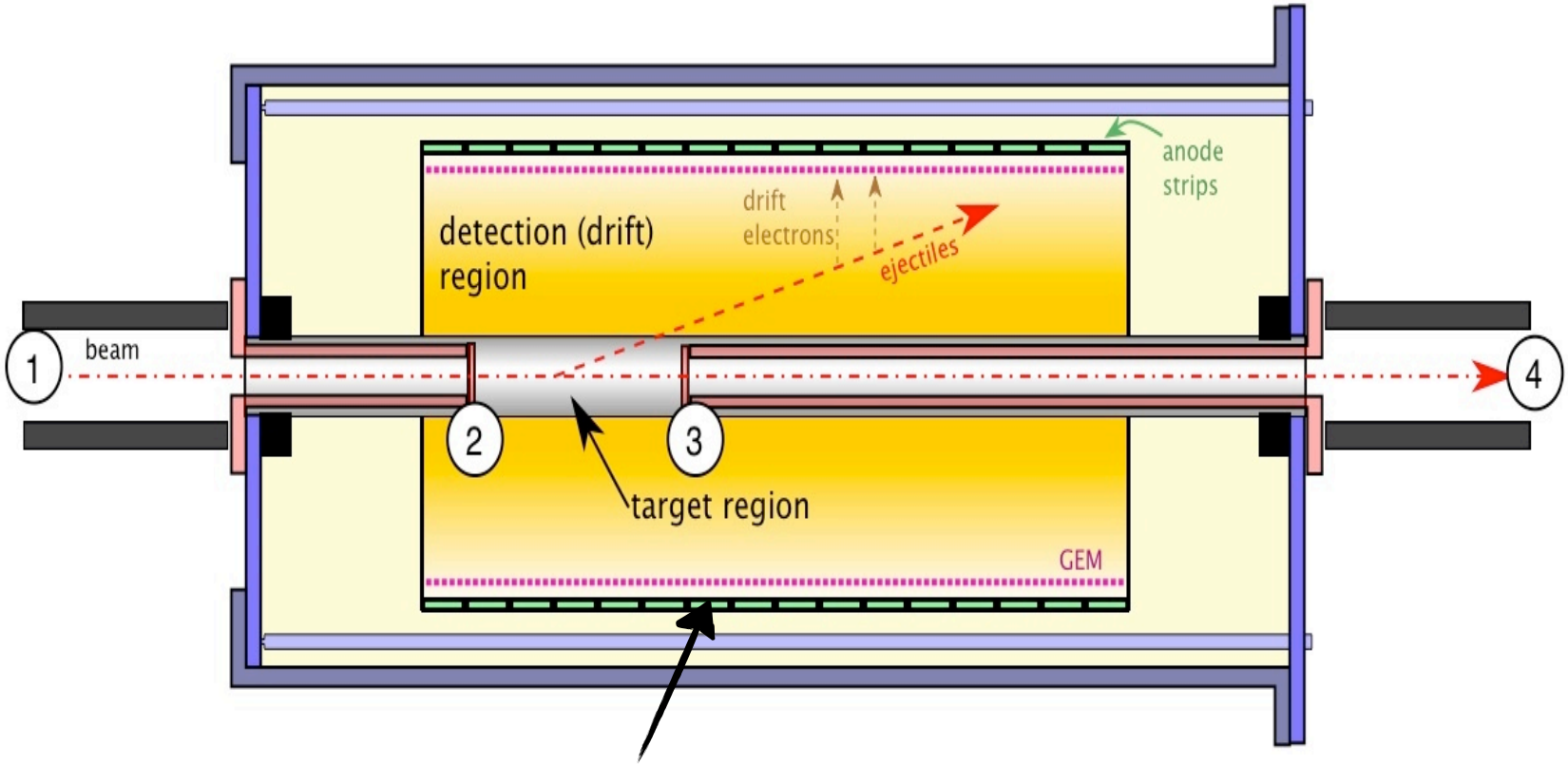
Windows

The TACTIC Detector



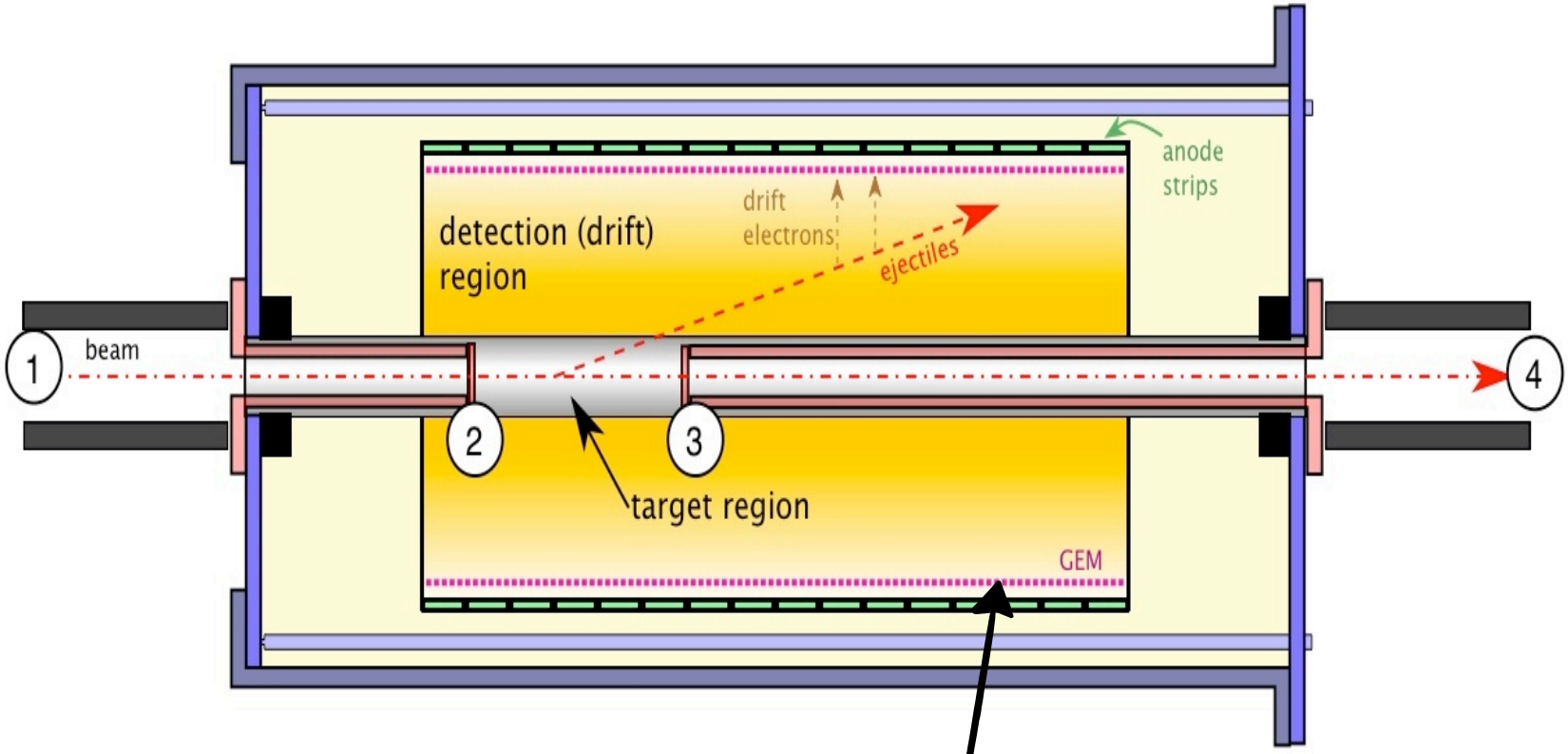
Cathode - wire cage

The TACTIC Detector



Anode: 480 segments (60 strips, 8 sectors)

The TACTIC Detector

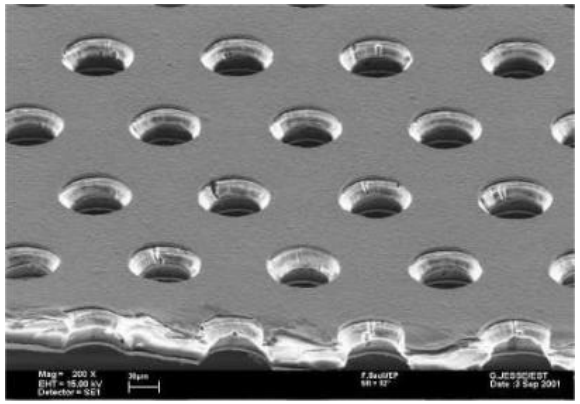


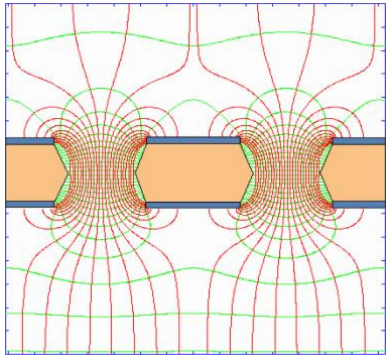
Gas Electron Multiplier

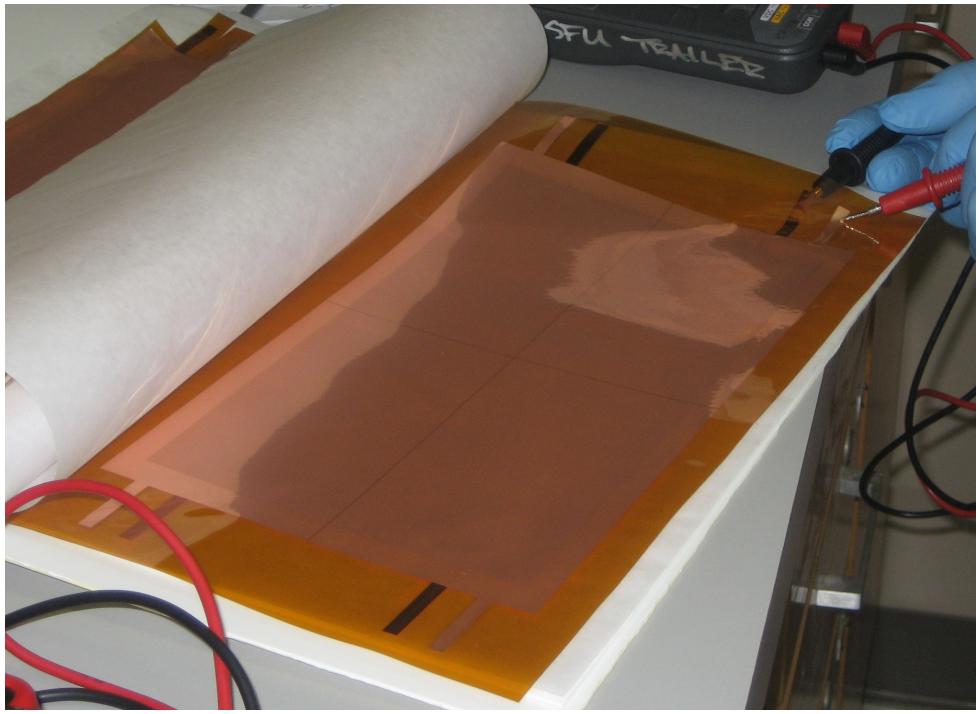
The TACTIC Detector

GEM

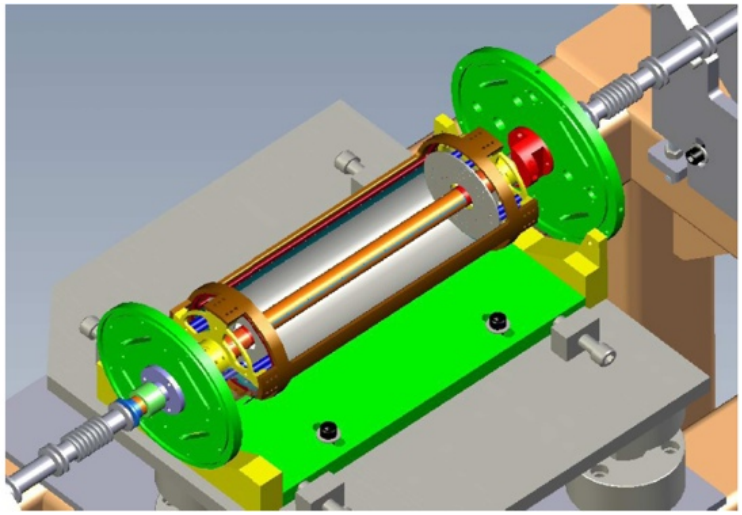
- Thickness 50 μm
- Holes:
  50 μm diameter
  150 μm pitch
- HV ≈ 350 V

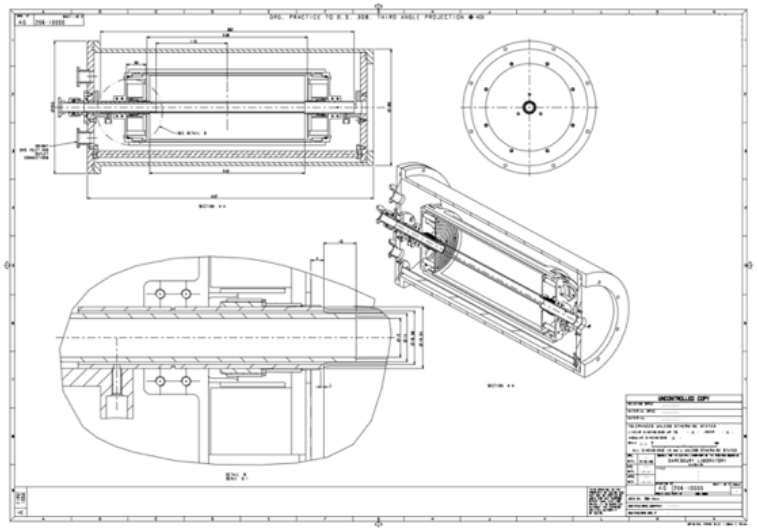






Design and Build of TACTIC





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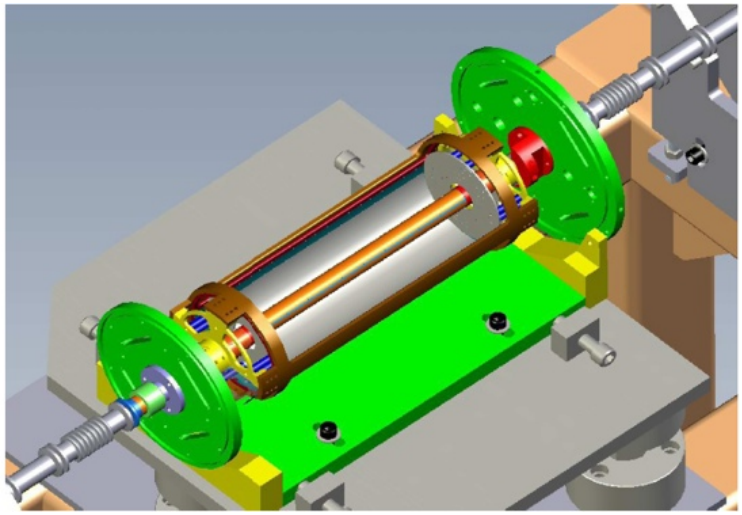

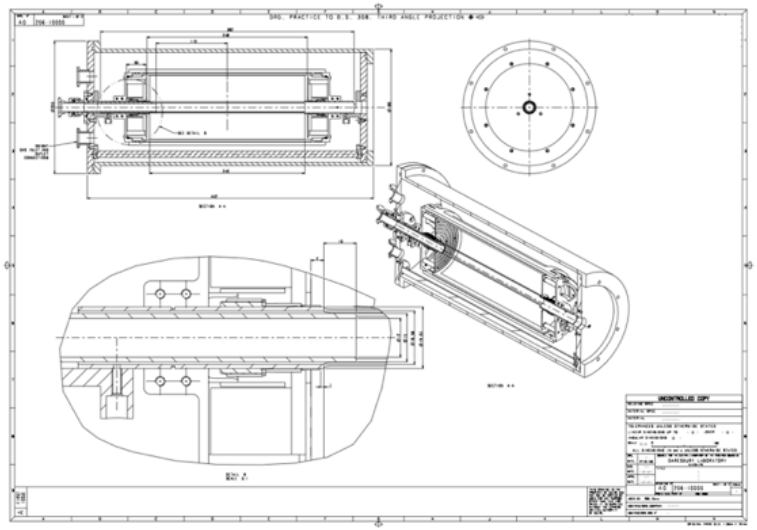

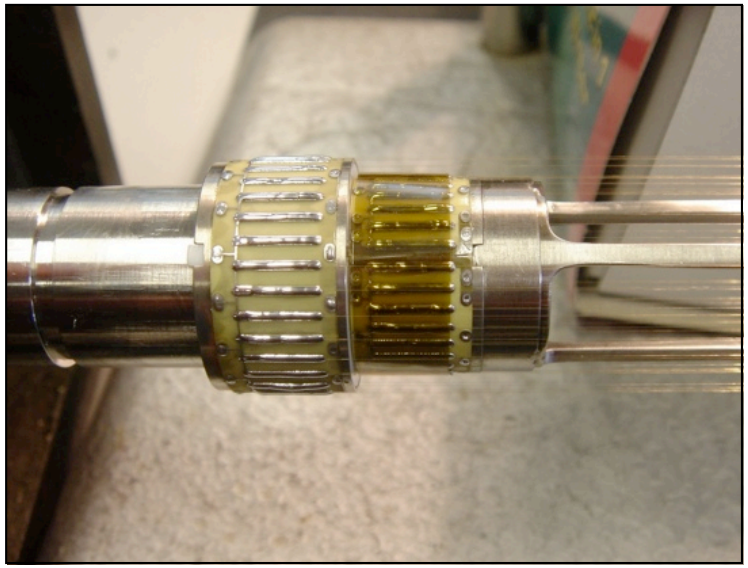

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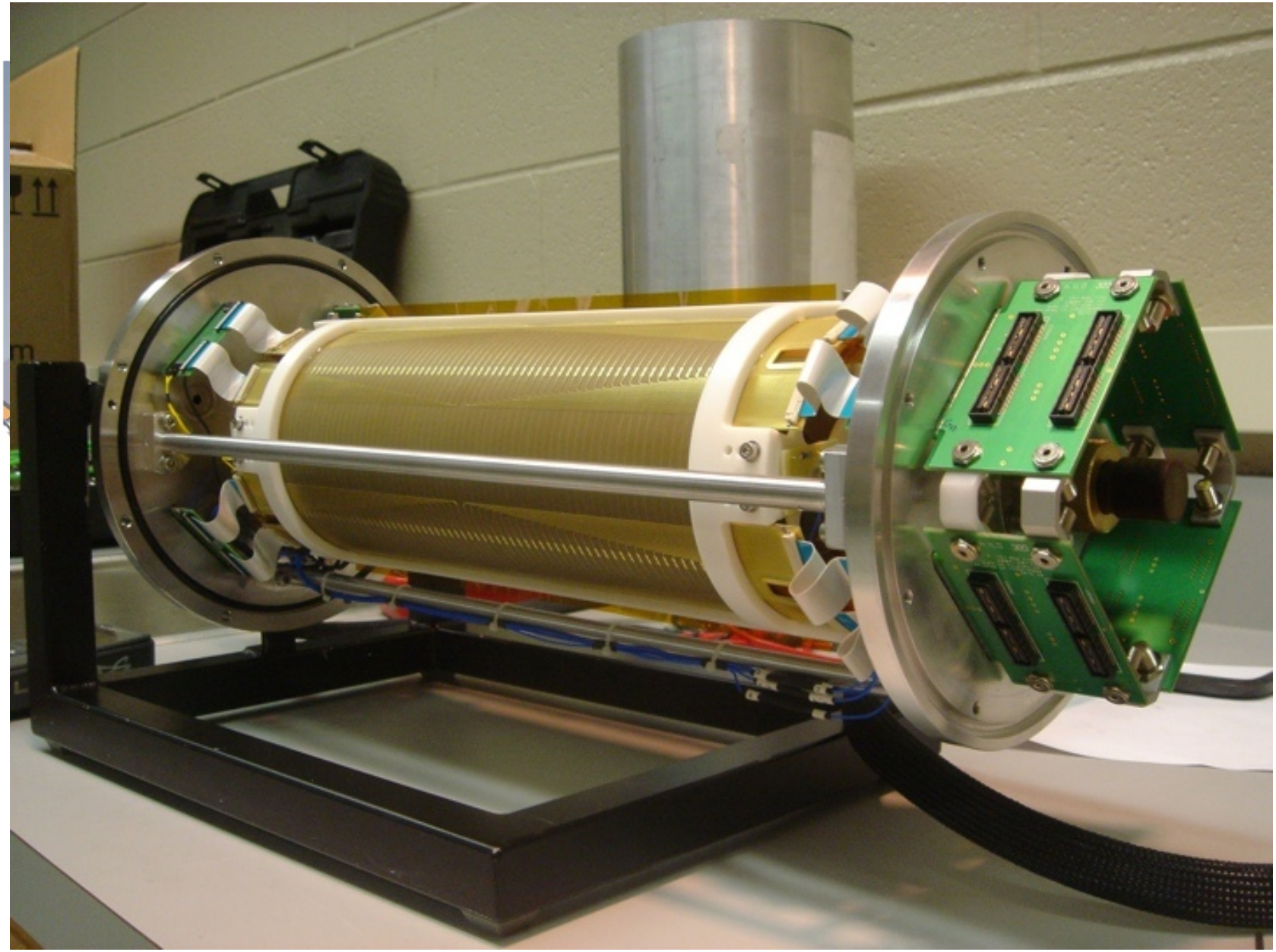

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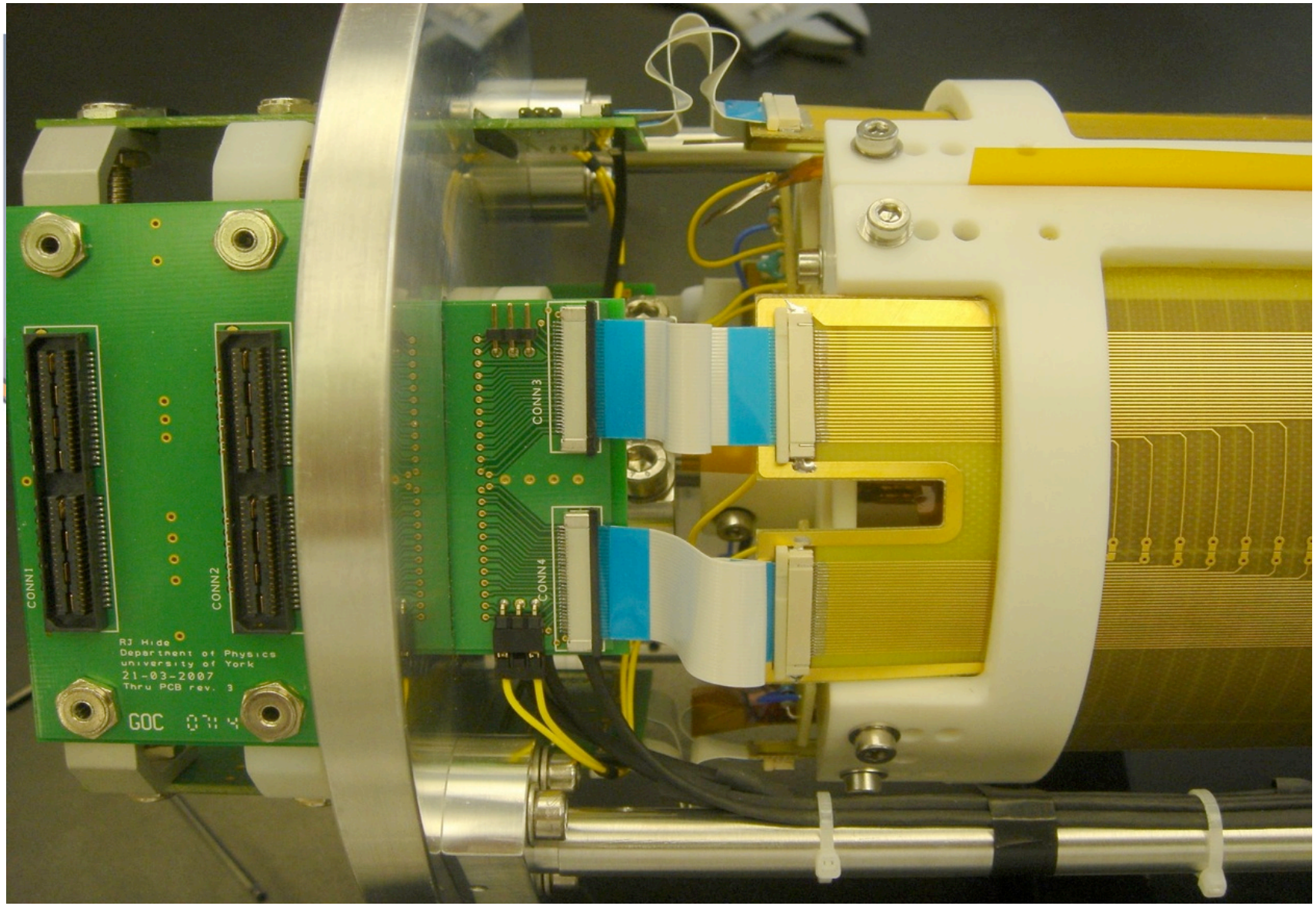
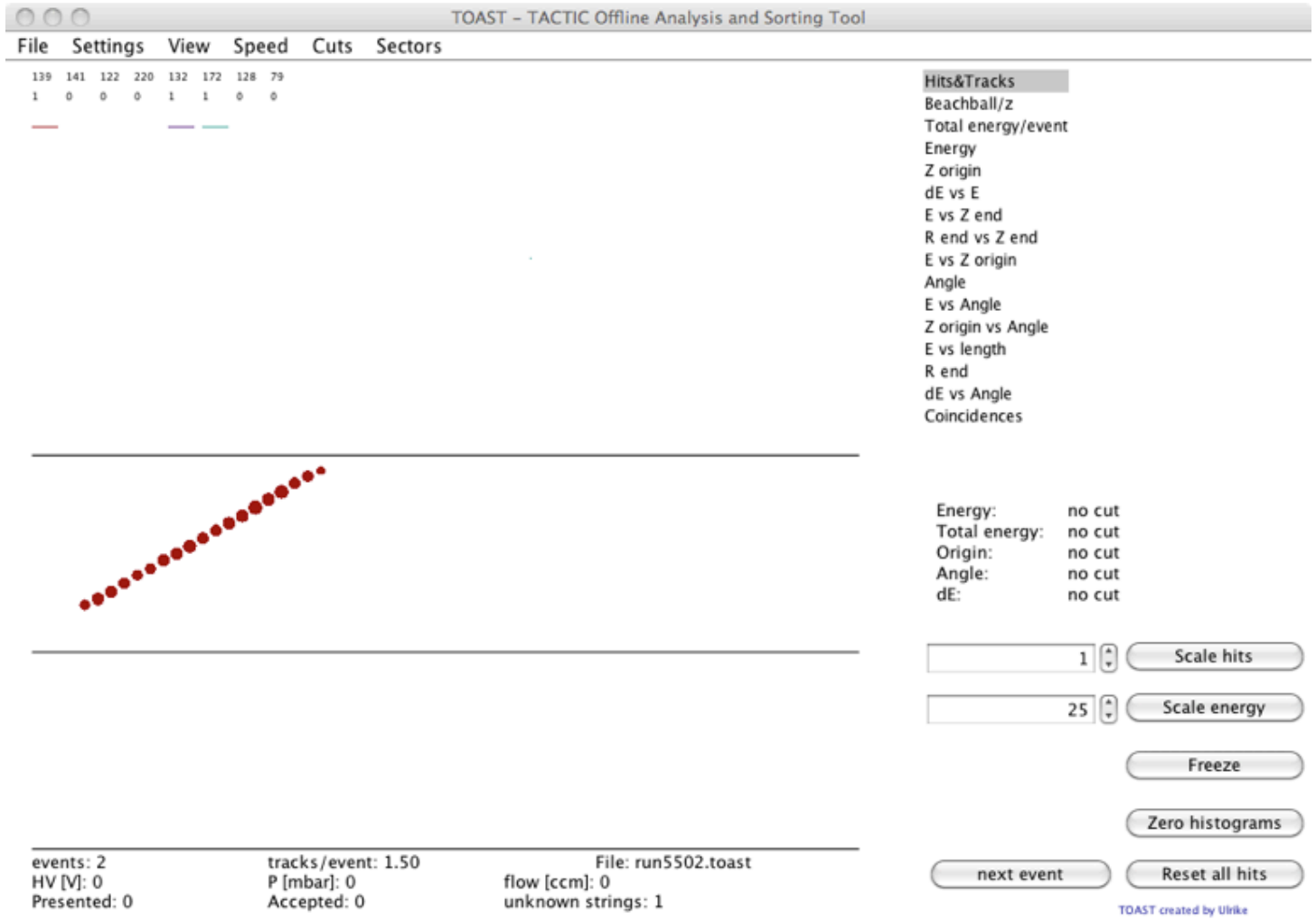


TACTIC: Performance

- Tracking works - vertex reconstruction ±2mm



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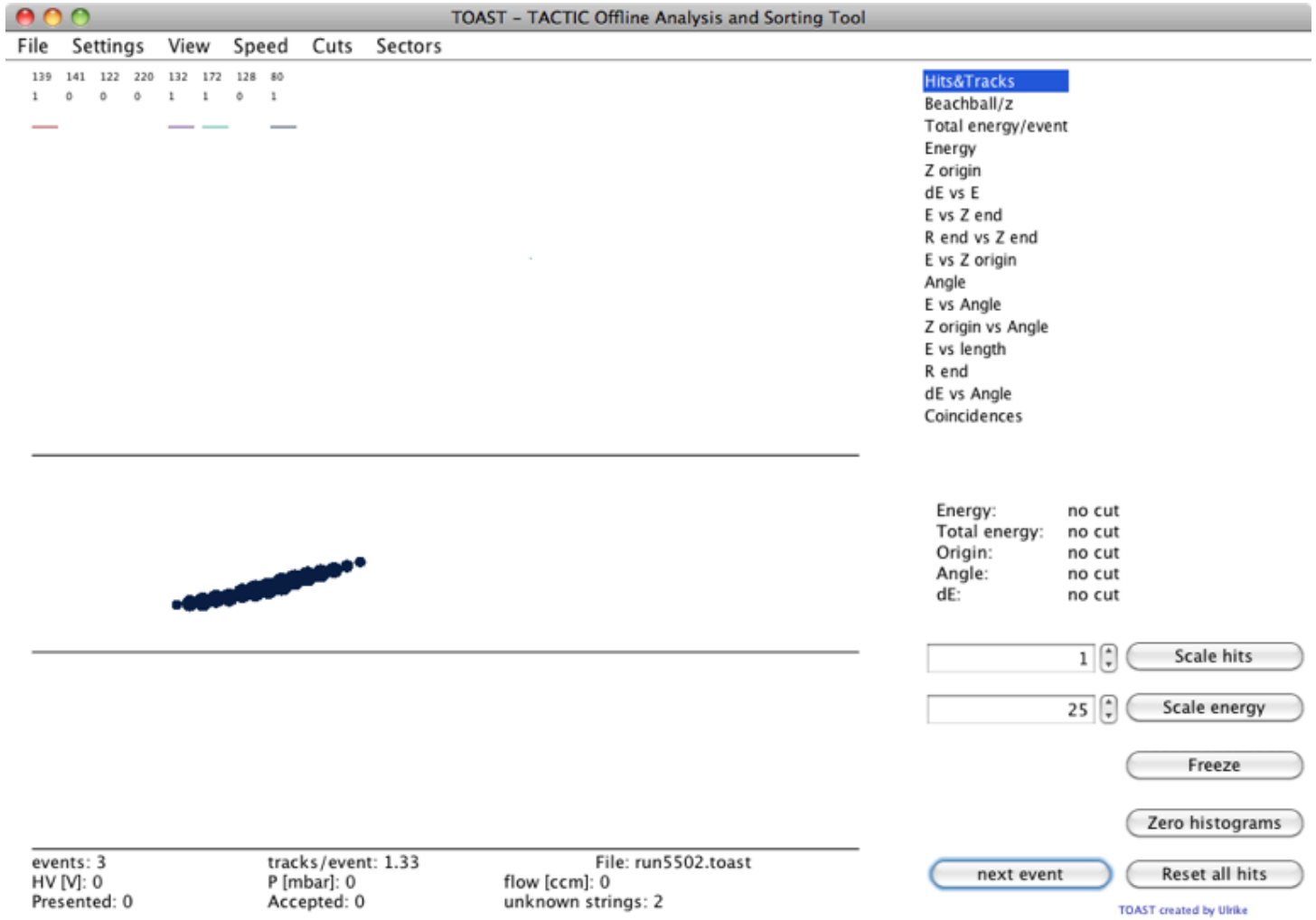

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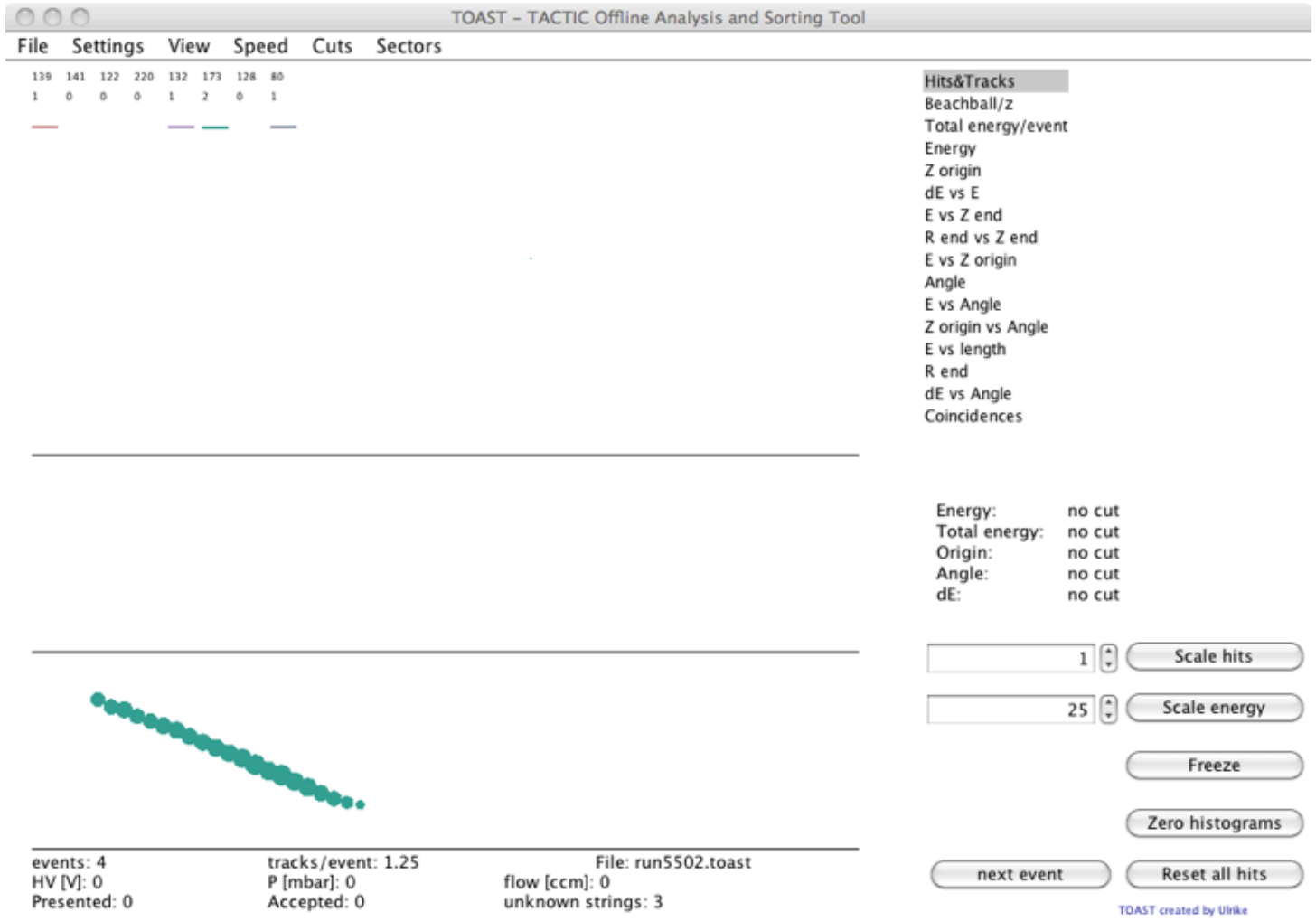

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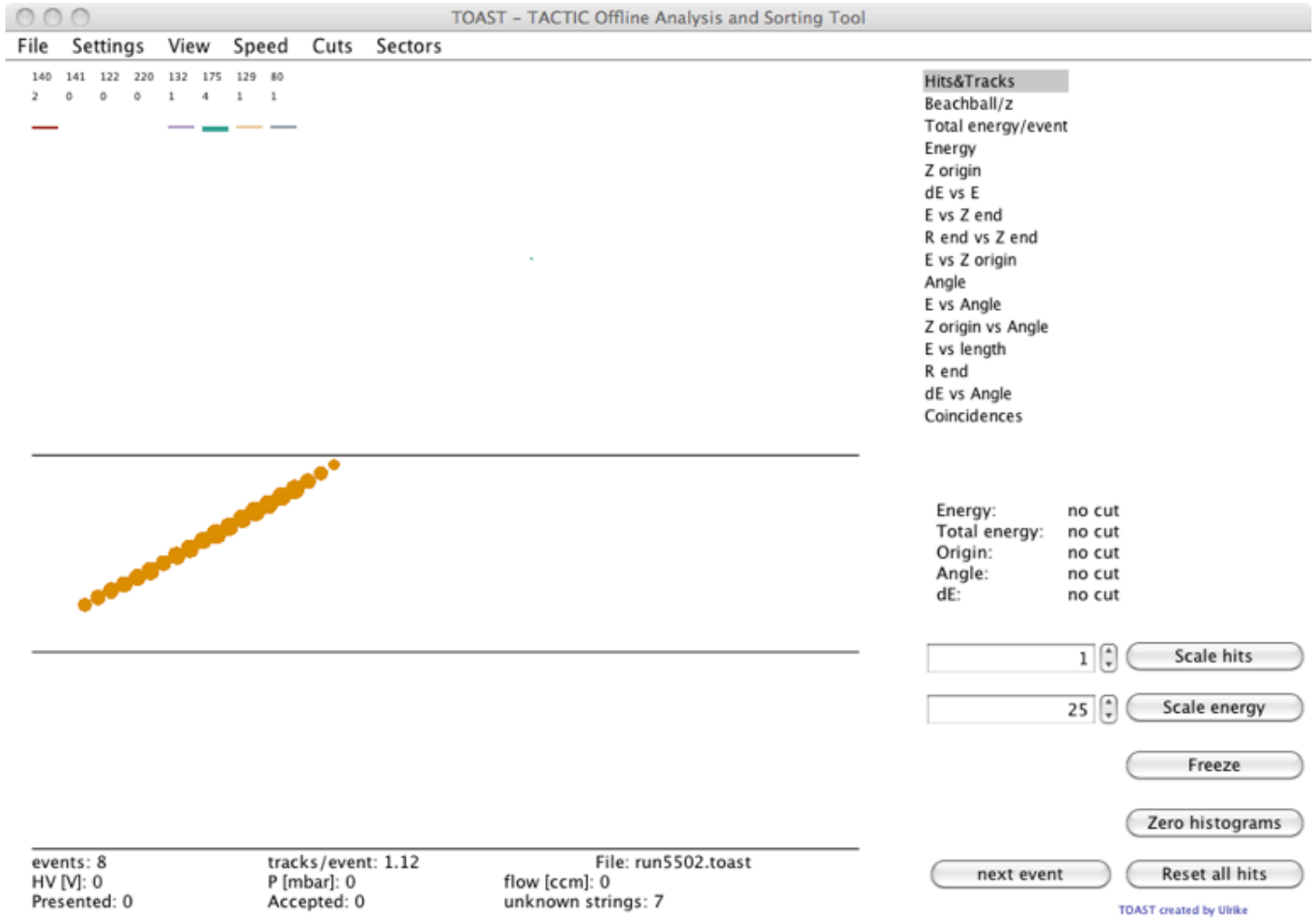

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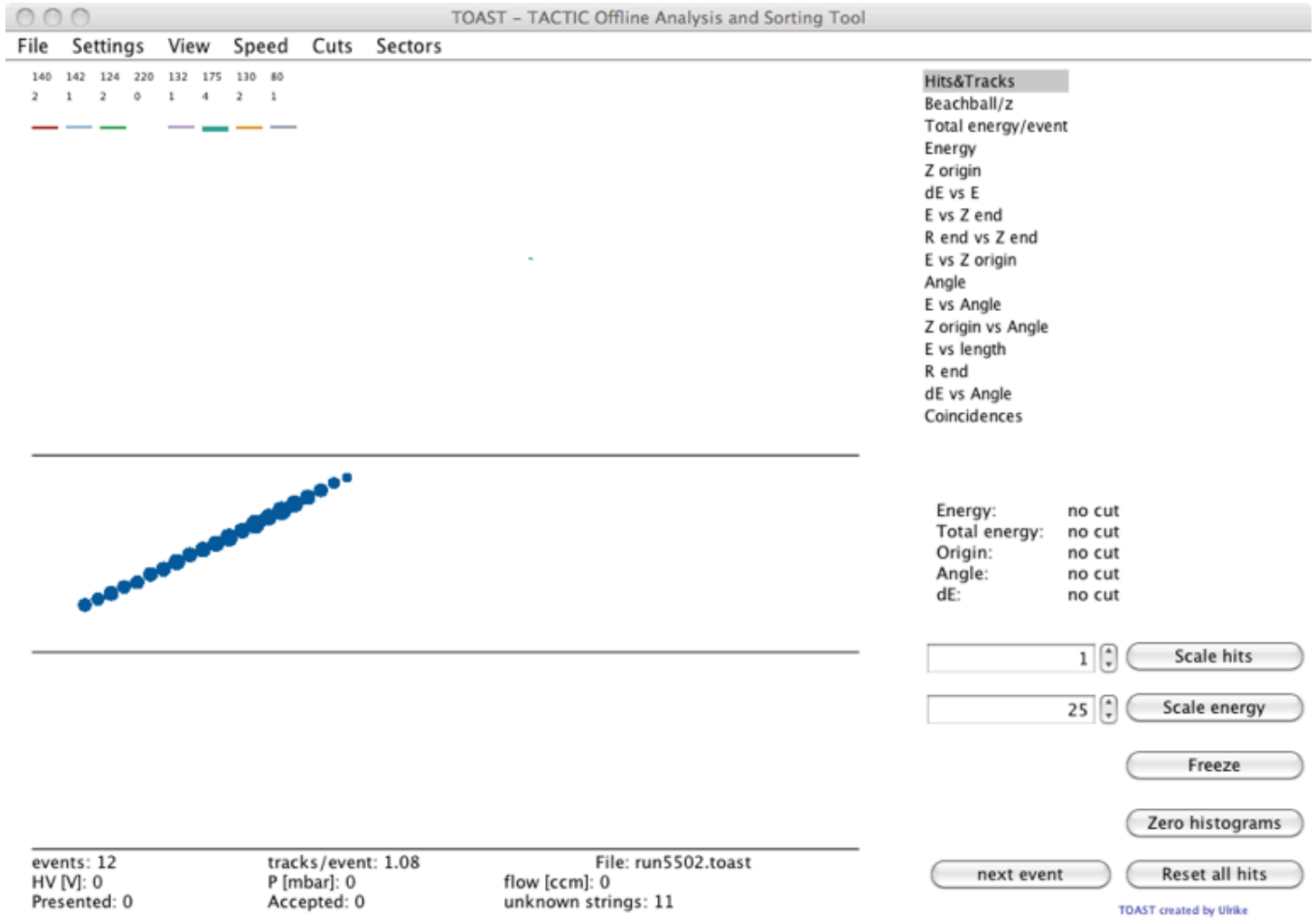

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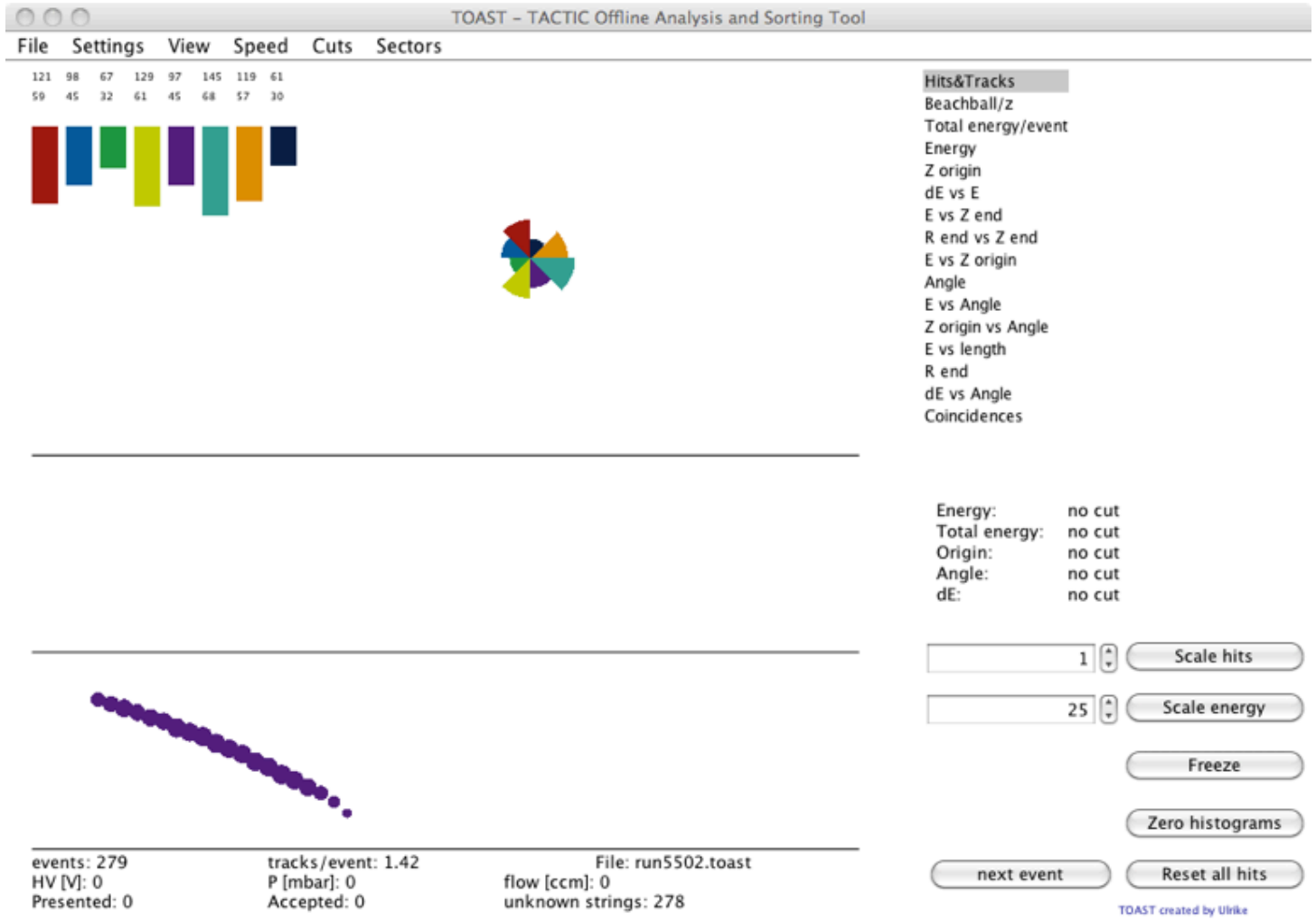

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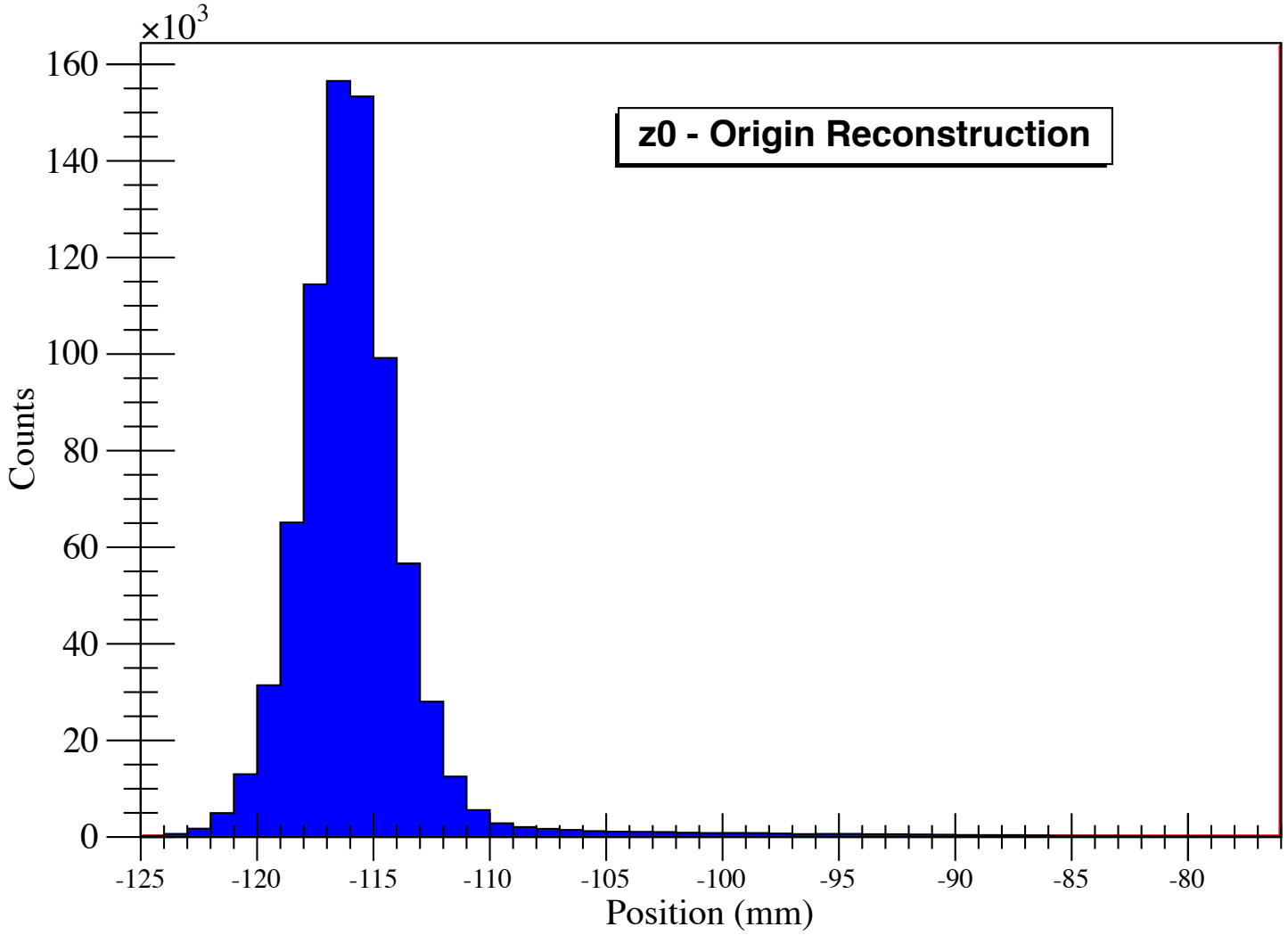

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- Cathode shielding works - but DAQ limited and introduces a “dead zone” onto the track

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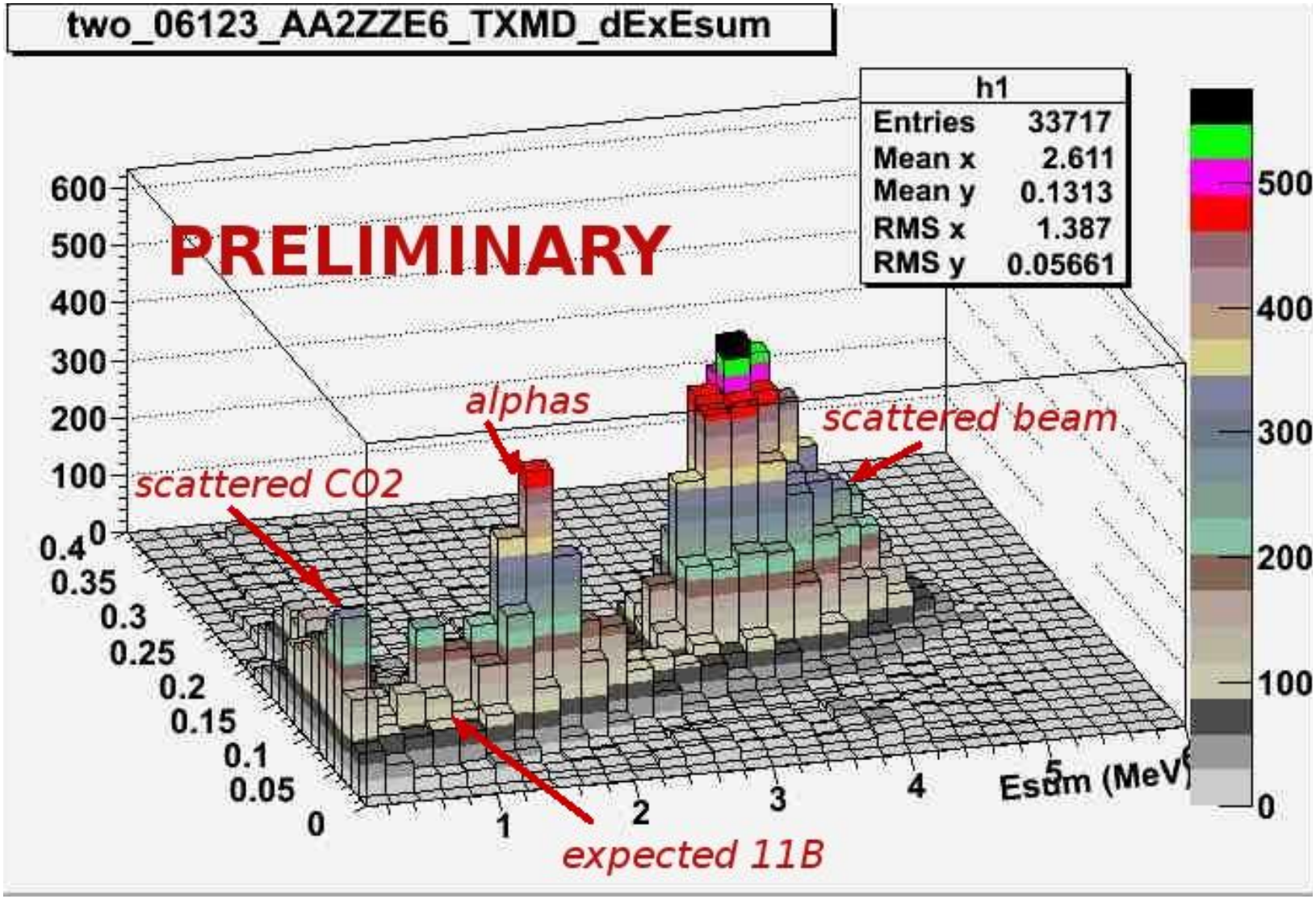
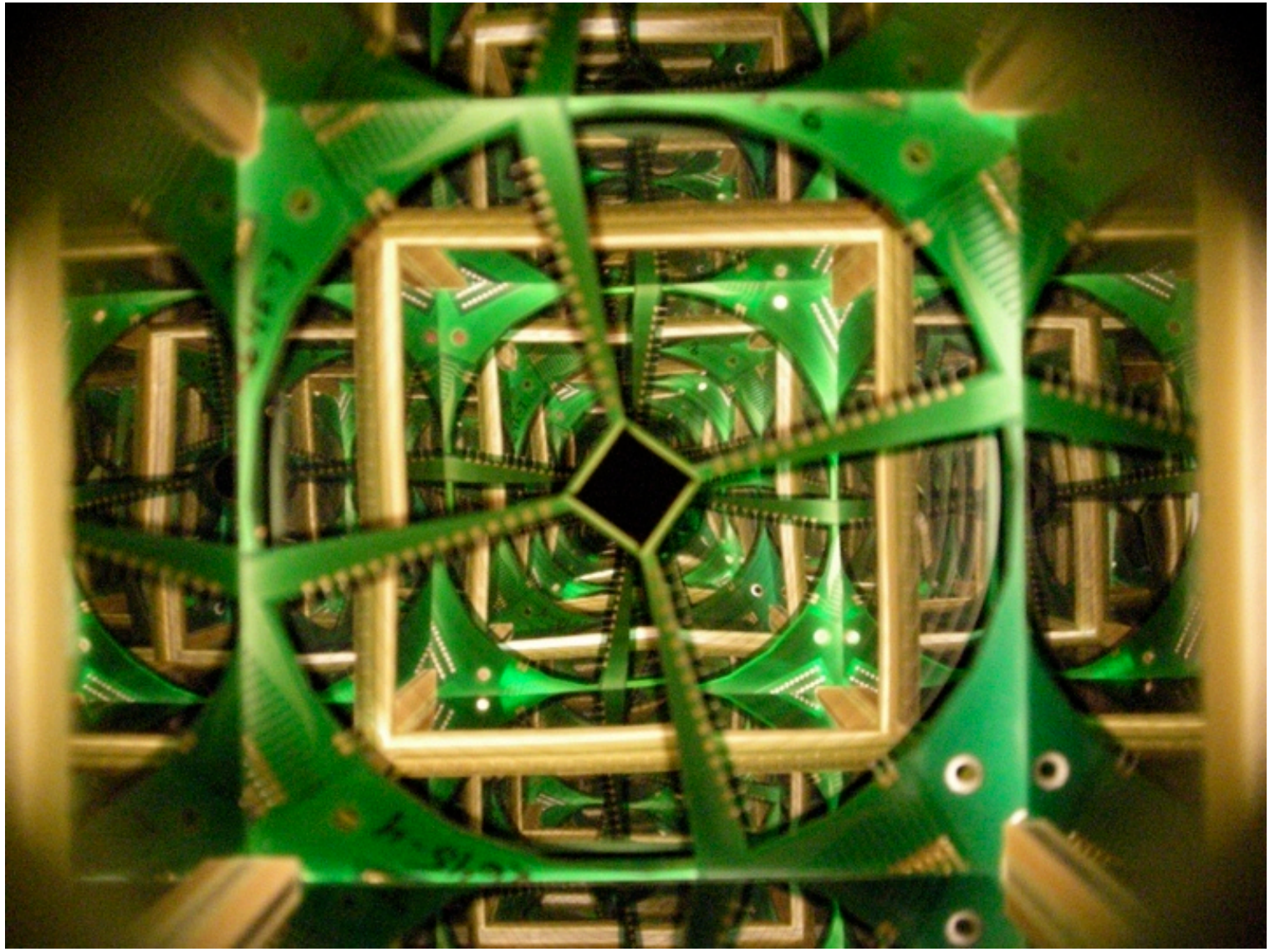
- Tracking works - vertex reconstruction ±2mm
- Cathode shielding works - but DAQ limited and introduces a “dead zone” onto the track
- Energy Resolution: ≈7% - needs improving.

TACTIC: Performance

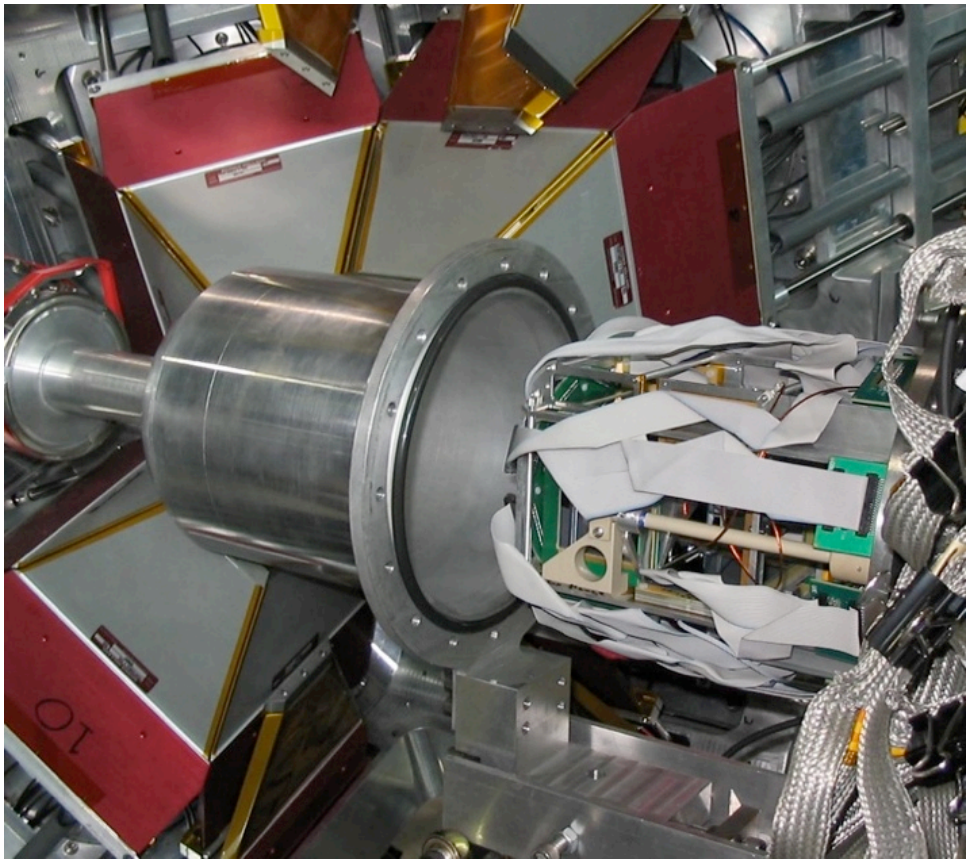


SHARC



SHARC

- **S**ilicon **H**ighly segmented **A**rray for **R**eactions and **C**oulex
- **T**RIUMF-**I**SAC **G**amma-**R**ay **E**scape **S**uppressed **S**pectrometer
  - Array of 12 HPGe γ detectors (Summer 2010).
  - 4 individual crystals in each detector.
  - Segmented contacts.
  - Digital electronics with pulse shape analysis for Doppler shift corrections.



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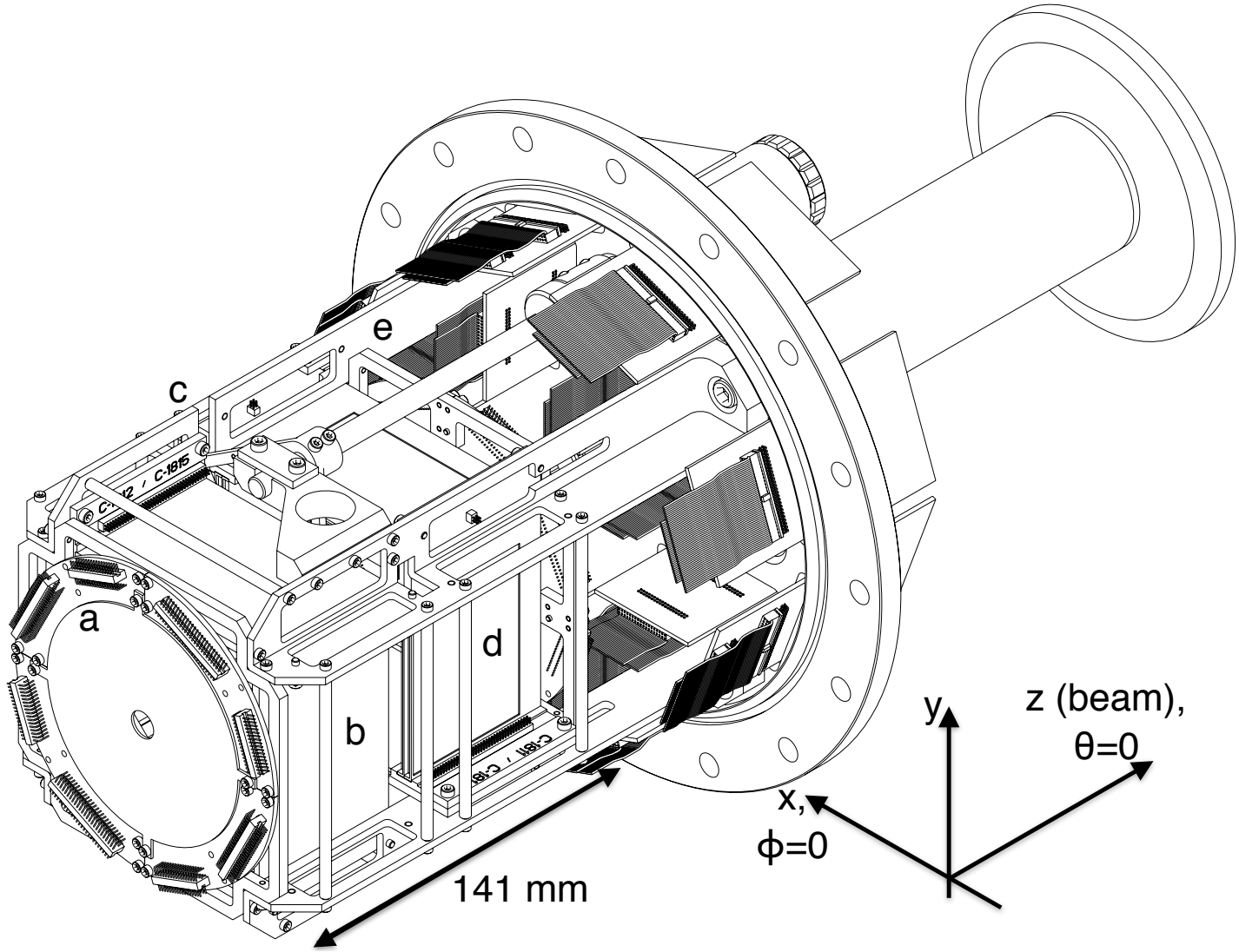
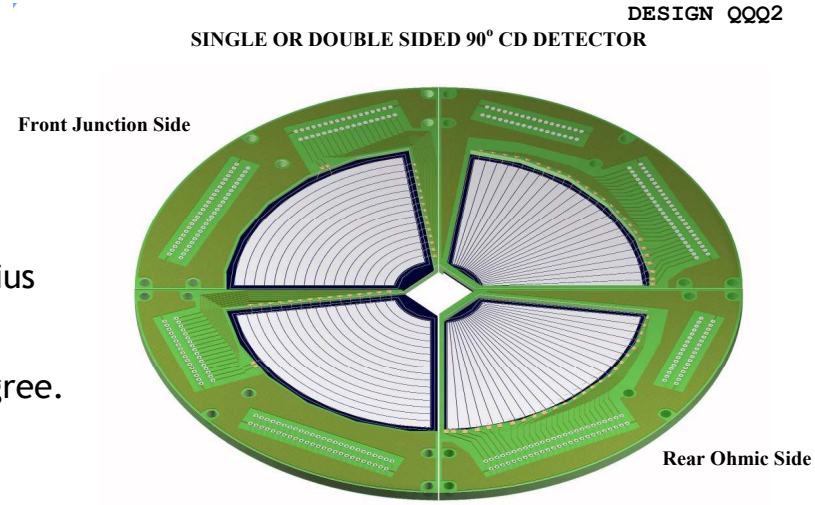


SHARC Detectors

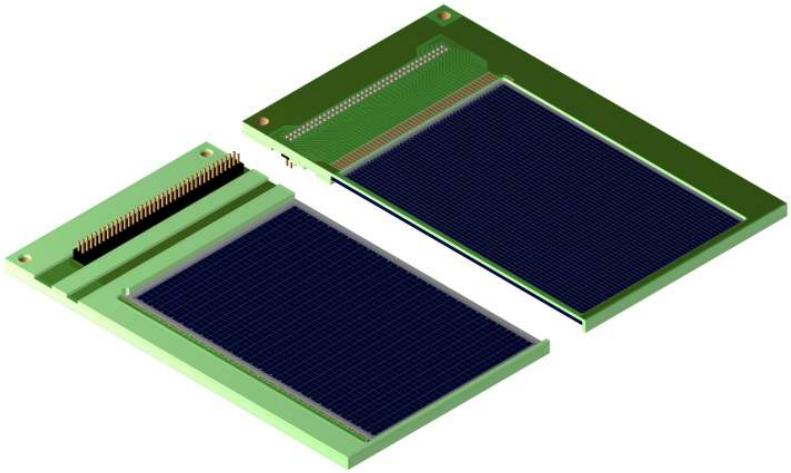
CD detectors (Micron QQQ2):

- Thickness: 80 μm (ΔE) + 1000 μm (E-pad)
- 4 quadrants each covering: 9.0 mm to 41 mm radius
- 16 annular strips and 24 radial sectors.
- 80% coverage for θ = 8.5–31.5 and 148.5–171.5 degree.



Box DSSSDs (Micron BB11)

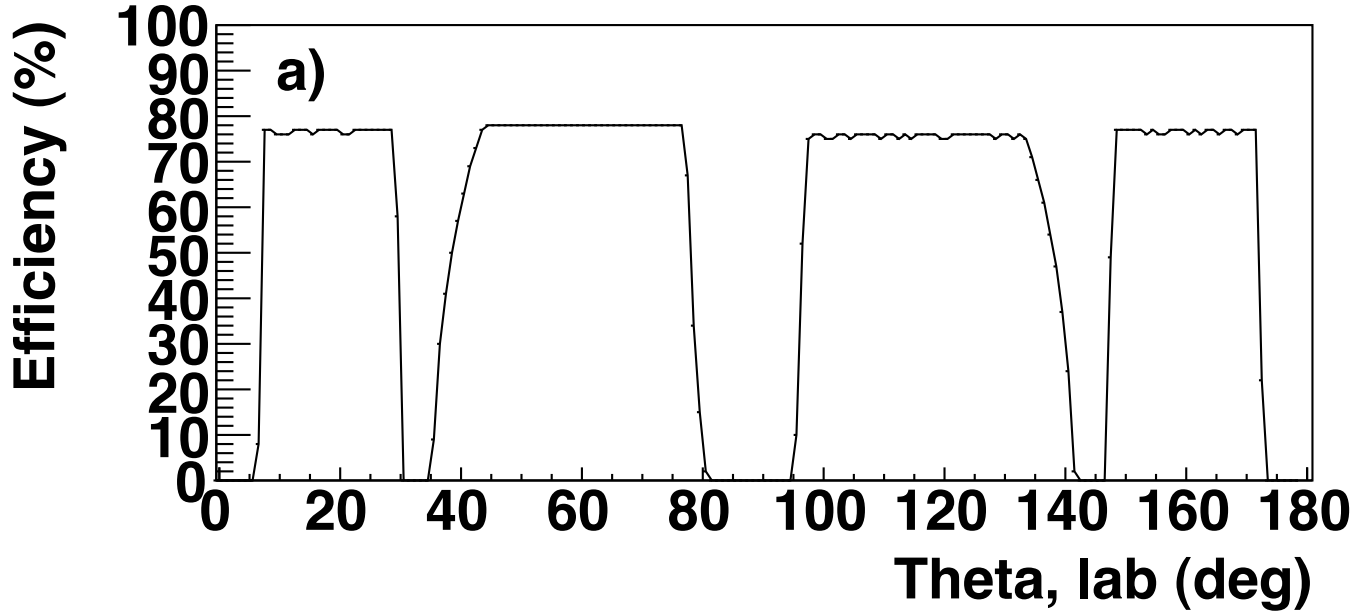
- 72 mm × 48 mm (24 × 48 strips).
- Thin Window design (50nm), 3% contact grid (750nm)
- Downstream box: thickness 140 μm, backed by 1000μm pad detectors (Micron MSX-35)
  75% coverage for θ = 136–99 deg.
- Upstream box: thickness 1000 μm
  37% coverage for θ = 44–81 deg.



BB11(DS) 7G Assembly front and Rear View.

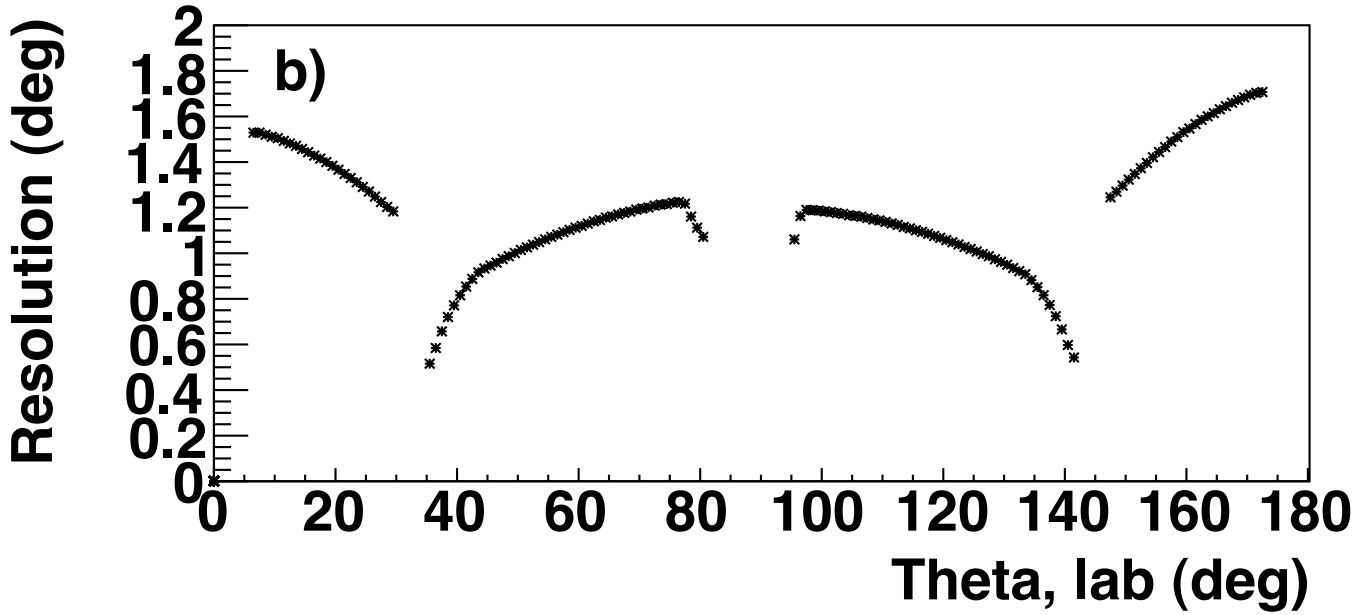
SHARC Performance

- Angular coverage: ≈ 2π.



SHARC Performance

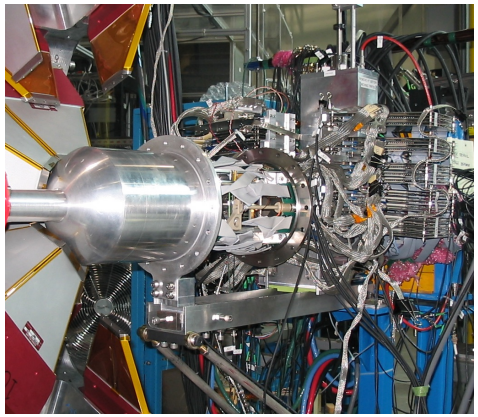
- Angular coverage: ≈ 2π.
- Angular resolution: δθ = 1.6 deg.

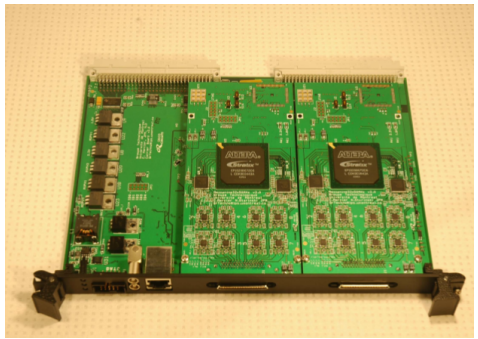


SHARC Performance

- Angular coverage: ≈ 2π.
- Angular resolution: δθ = 1.6 deg.
- Energy range: 12-600 MeV.

- Preamplifiers designed and built at TRIUMF (L. Kurchaninov).
- Intrinsic noise (analogue): 8 keV at 12 MeV dynamic range.
- Ranges: 12 MeV, 40 MeV, 180 MeV, 600 MeV,
- Pulse shape: 200 ns rise, 10 μs exponential fall.
- Readout: TIG-64 (ADC & FPGA).





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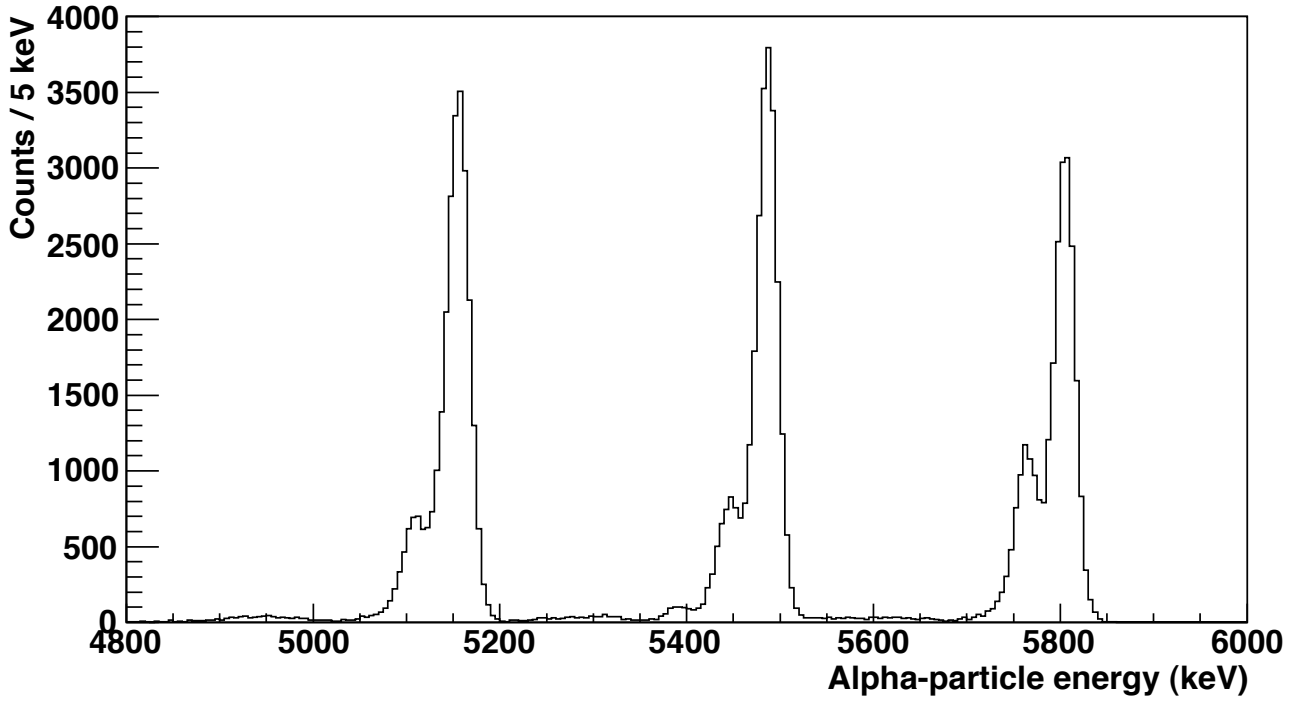
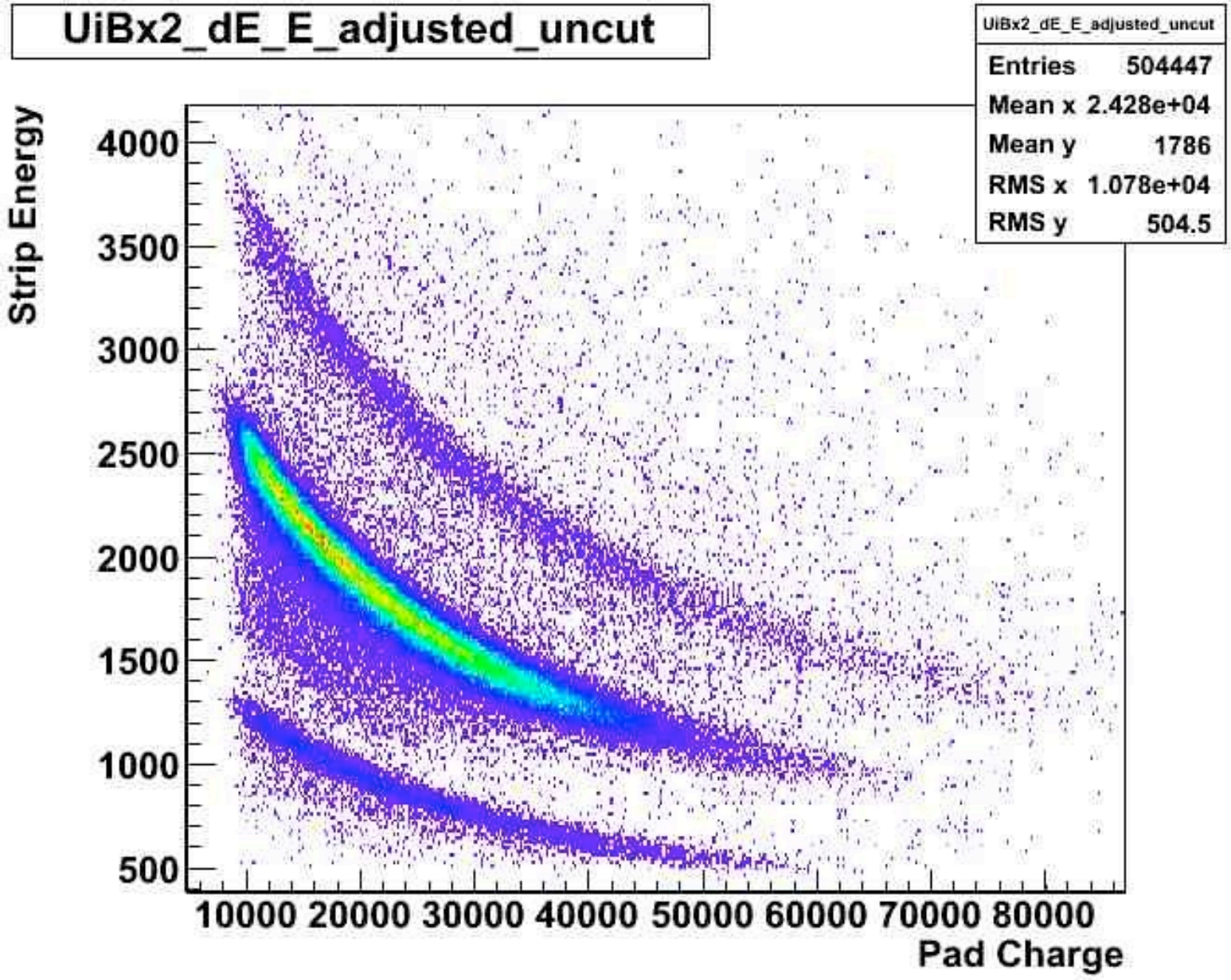
- Energy range: 12-600 MeV.
- Energy resolution: ≈ 30 keV.



SHARC Performance

- Angular coverage: ≈ 2π.
- Angular resolution: δθ = 1.6 deg.
- Energy range: 12-600 MeV.
- Energy resolution: ≈ 30 keV.
- Particle identification: δE-E

SHARC Performance



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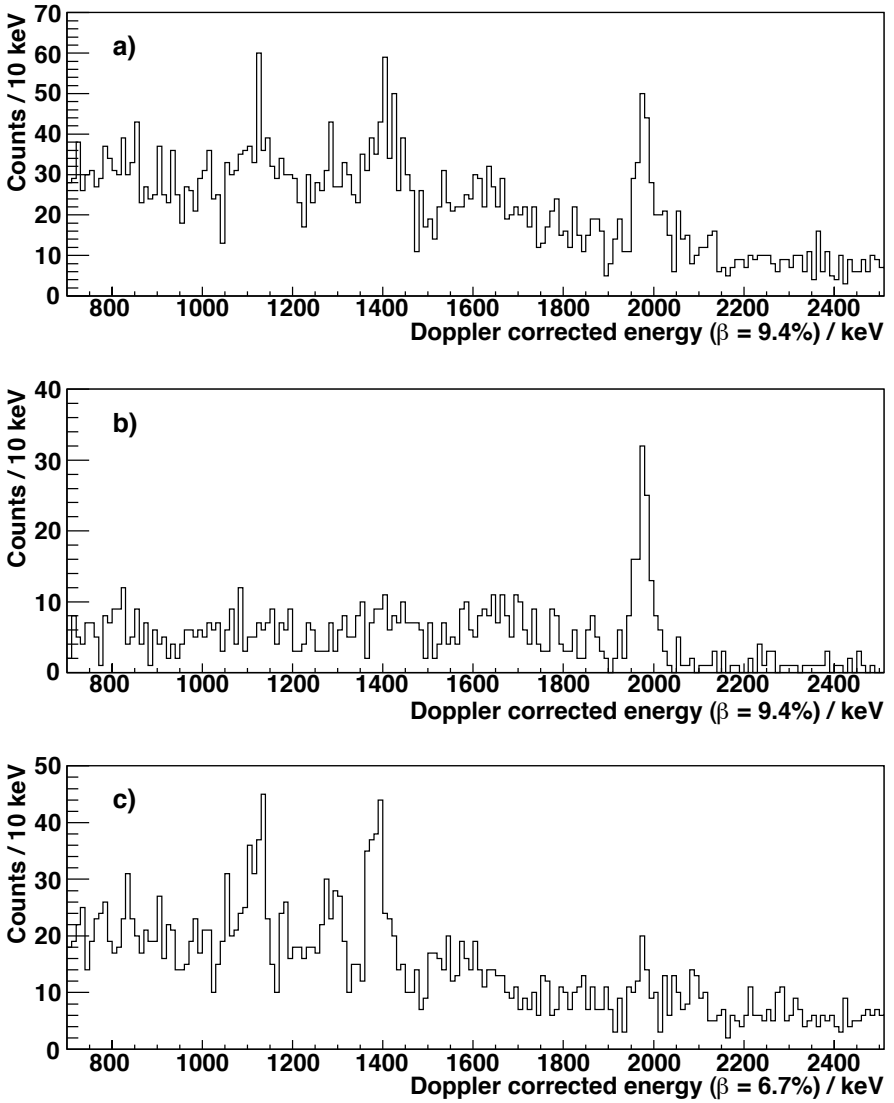
SHARC Performance

γ lines from reactions of 18O on a CD2 target. In a, b, and c are plotted: ungated, deuteron gated, and α gated spectra respectively. Spectra are Doppler corrected assuming (a, b) beam-like particle at ß = 9.4%, and (c) compound-nucleus reaction at ß = 6.7%.



The Future

TACTIC:

- Calibration
- Electronics - redesign preamplifiers
- Detector Modifications - double GEMs, reconfigure anode
- Data Acquisition - stability and data rate
- More experiments!

SHARC:

- Cross Talk - redesign internal cabling
- Detector Modifications - Redesign of S3/QQQ2
- Gas and Inert Target Handling systems
- Coupling to other systems:
  - Plunger
  - EMMA
  - DESCANT
  - Bragg Detector

With thanks to many collaborators....

SHARC and TIGRESS

UK - York, Manchester, Surrey: P. Adsley, W.N. Catford, C.Aa. Diget, B.R. Fulton, A. Smith, M. Taggart, G. Wilson

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USA - LSU,CSM: J. Blackmon, M. Matos, F. Sarazin, D. Smalley

TACTIC

UK - York: Alison Laird, Frances Charlwood, Edward Martin

Canada - TRIUMF: Lothar Buchmann, Götz Ruprecht, Lars Martin, Pierre Amaudruz

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