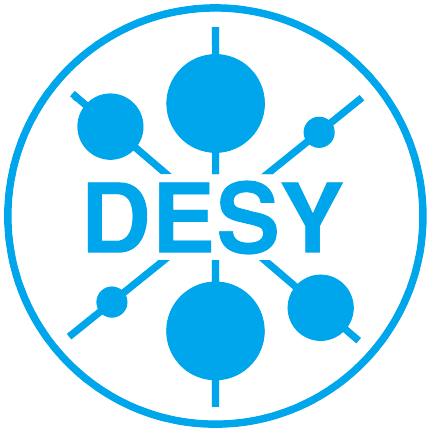
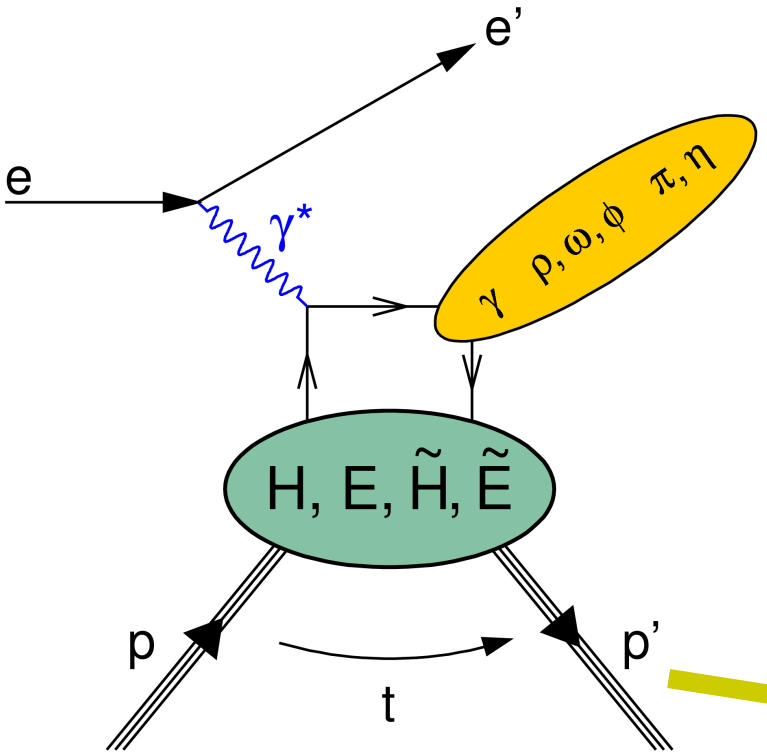
Status and Prospects of the HERMES Recoil Detector

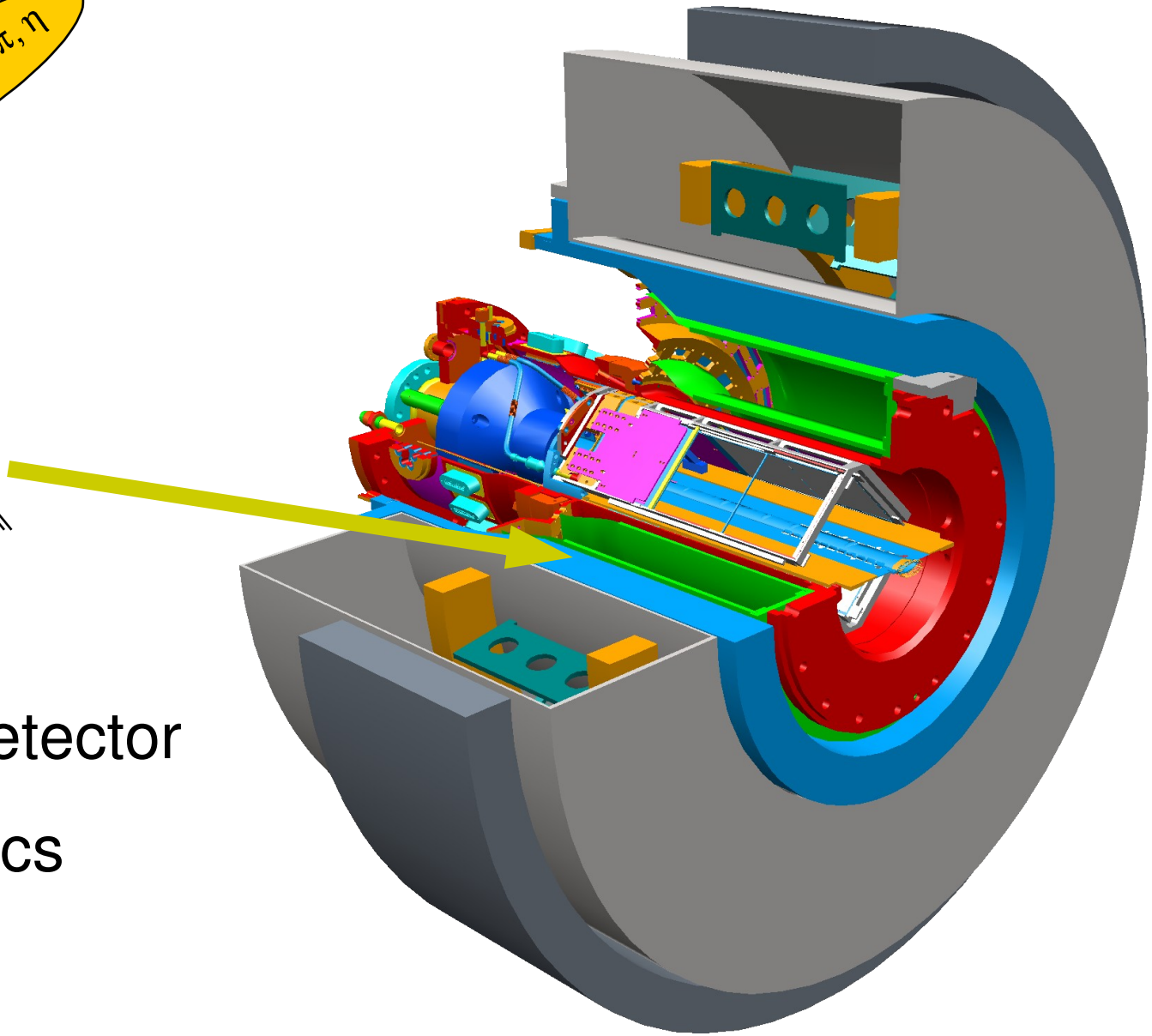
Andreas Mussgiller
for the HERMES collaboration



SPIN 2008 - 18th International Symposium on Spin Physics
October 6 – 11, 2008, University of Virginia

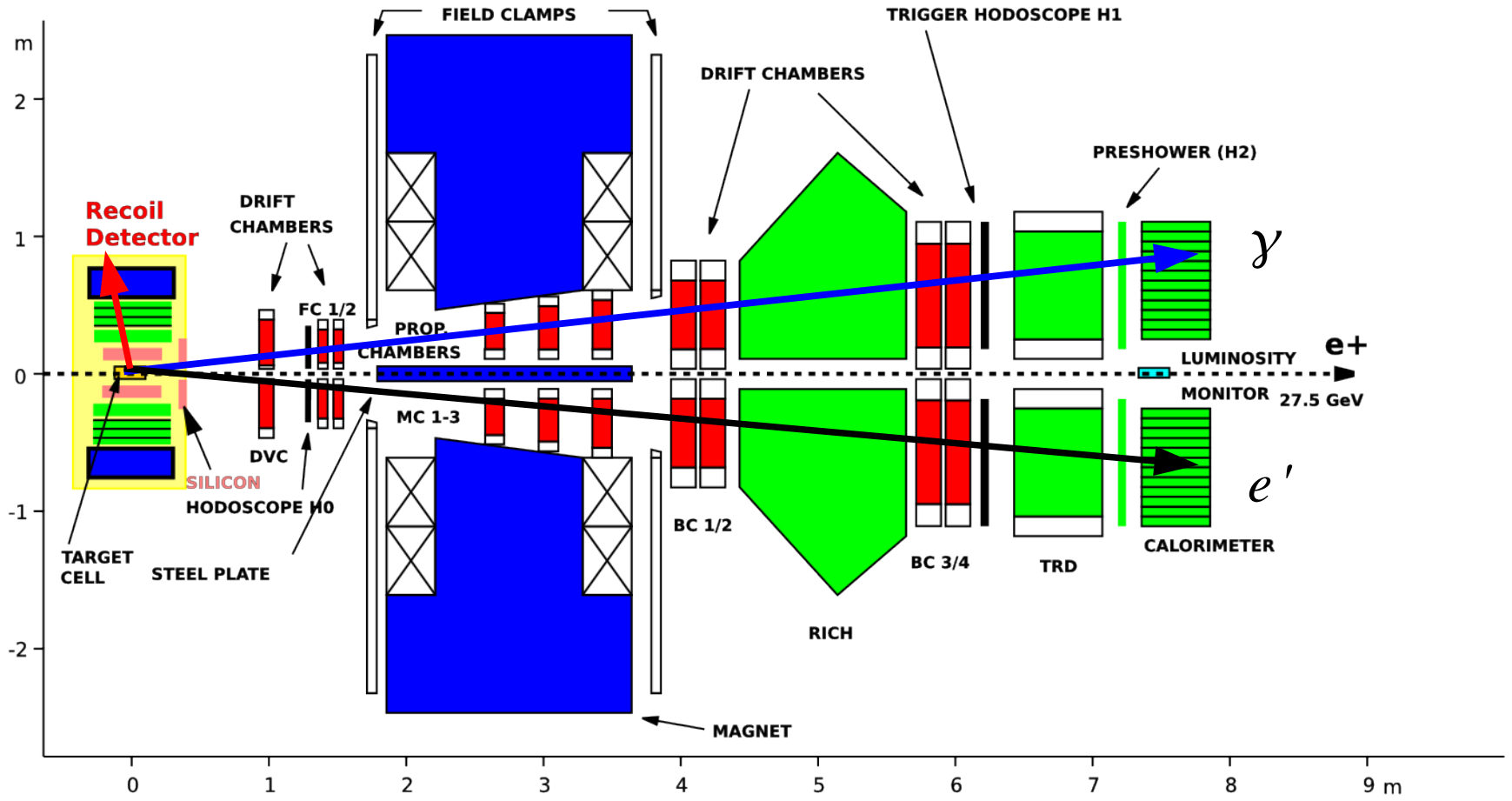
Exclusive DIS measurements at HERMES





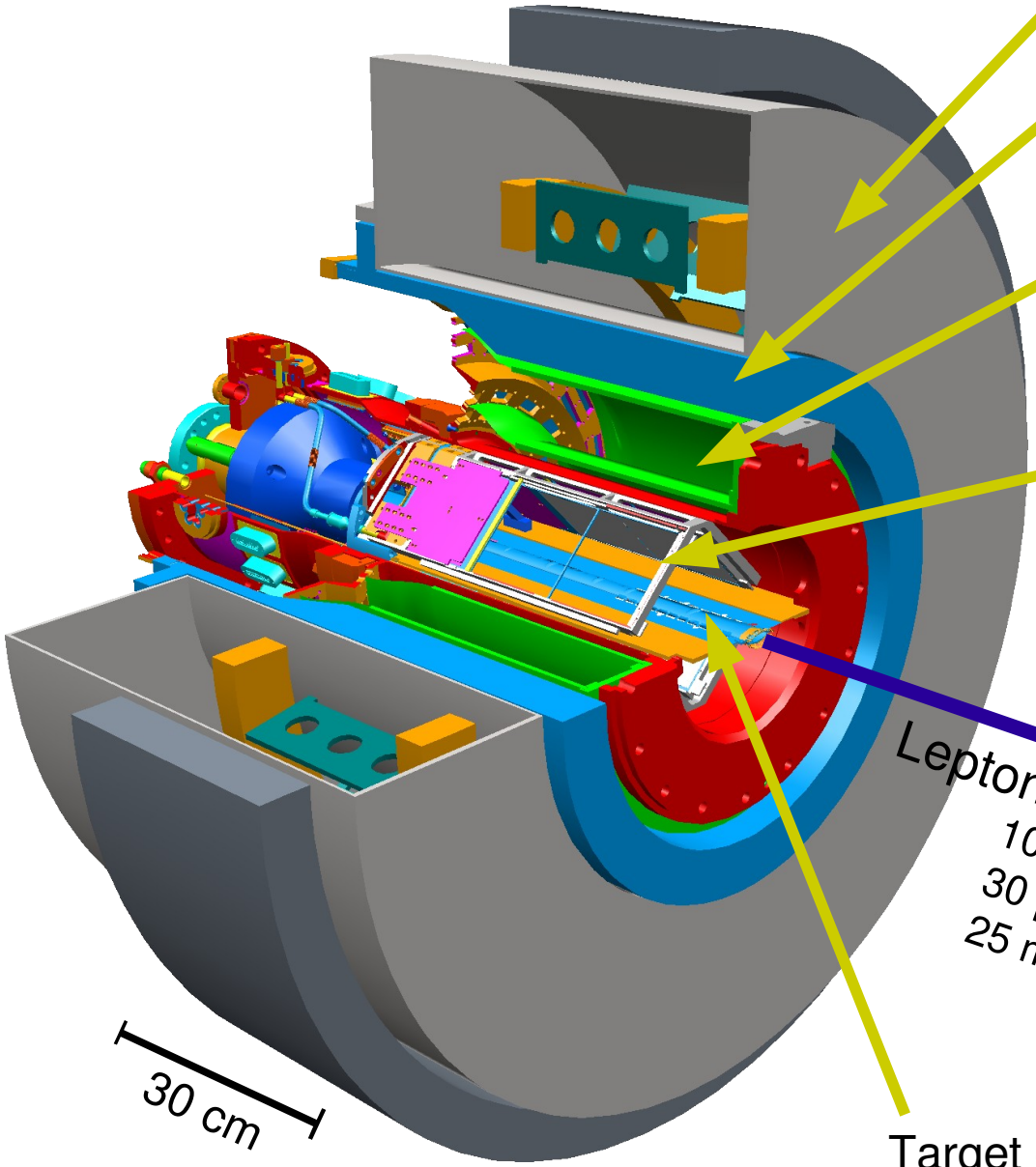
- Status of Recoil Detector
- First Look at Physics

The HERMES Spectrometer (2006 - 2007)



- Recoil detector installed for the last two years of data taking
- 23M DIS events off Hydrogen target
- 5.6M DIS events off Deuterium target

The HERMES Recoil Detector



Superconducting Solenoid (1T)

Photon Detector (PD)
- 3 layers of Tungsten/Scintillator sandwich

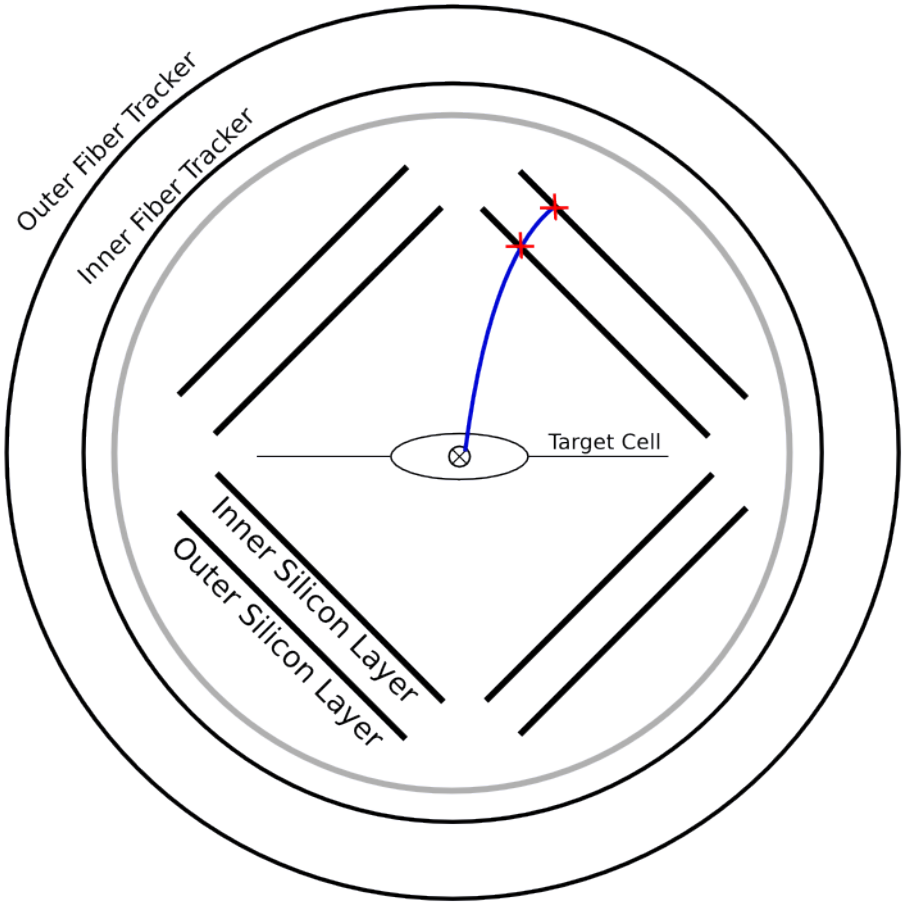
Fiber Detector (SFT)
- 2 barrels with 4 layers of scintillating fibers
- 2 parallel and 2 stereo layers per barrel

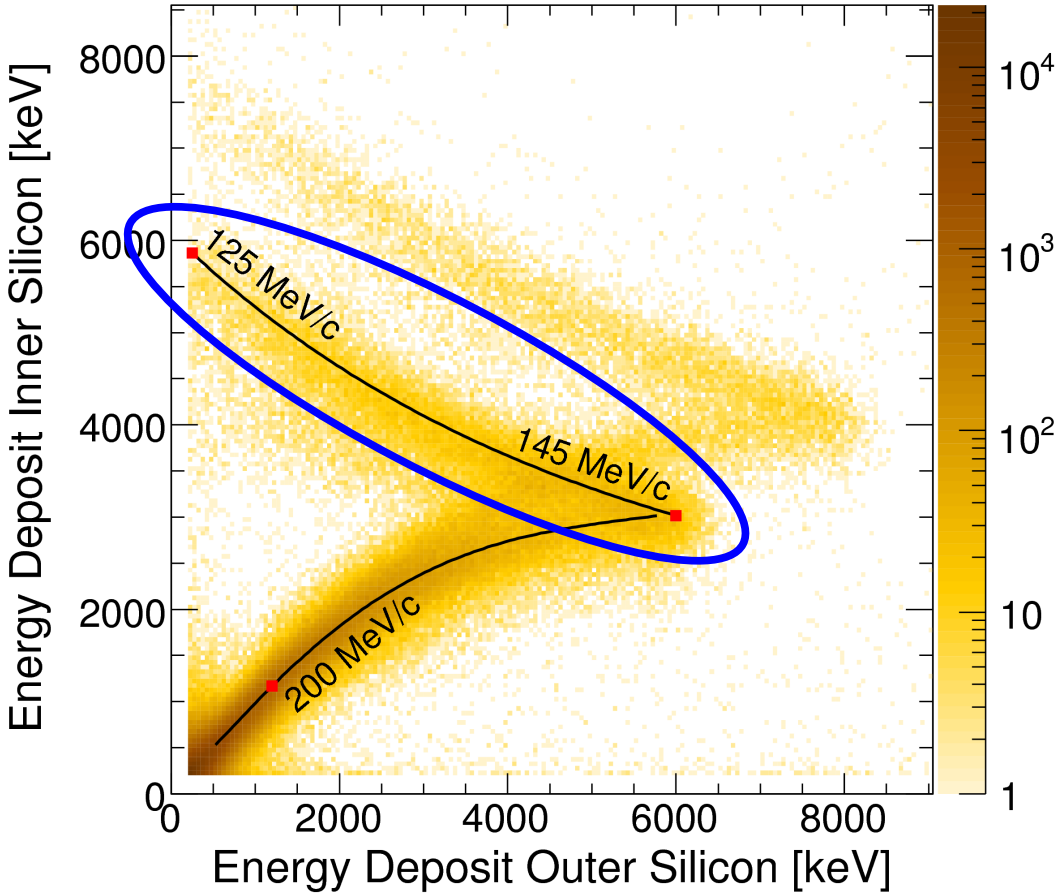
Silicon Detector (SSD)
- 16 double-sided sensors in 2 layers
- Inside HERA vacuum
- 5 cm close to beam

Lepton beam
10.4 MHz bunch frequency
30 ps bunch length
25 mA avg. beam current

Target cell

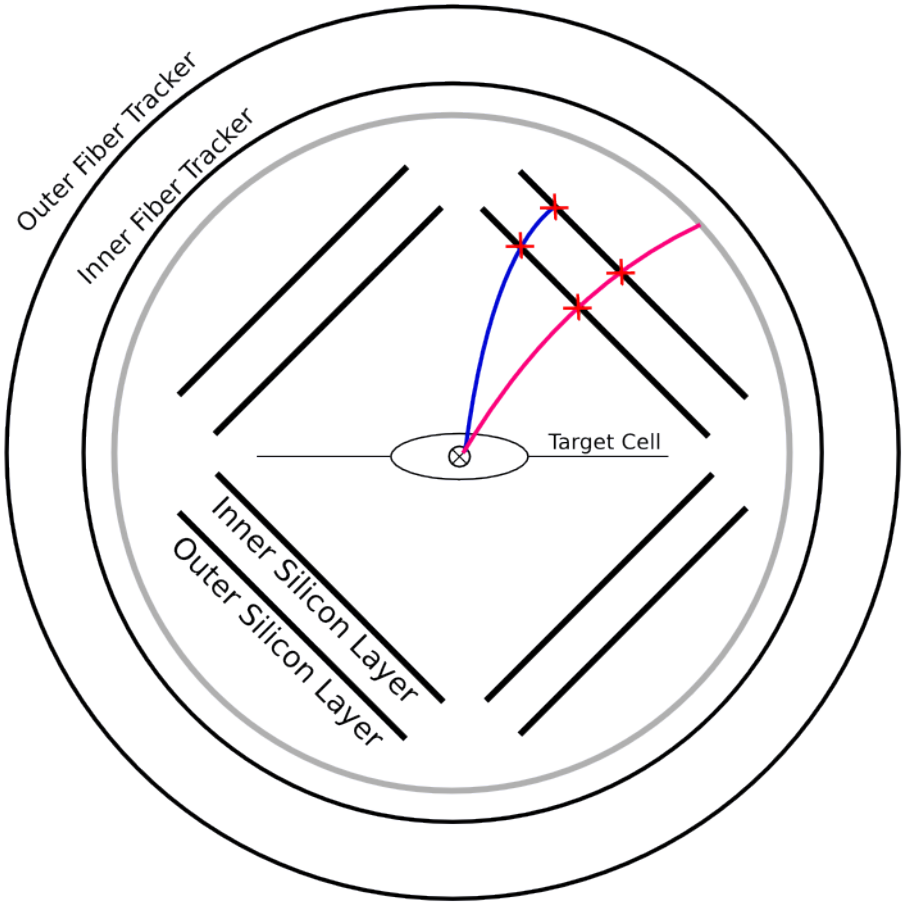
Momentum Reconstruction

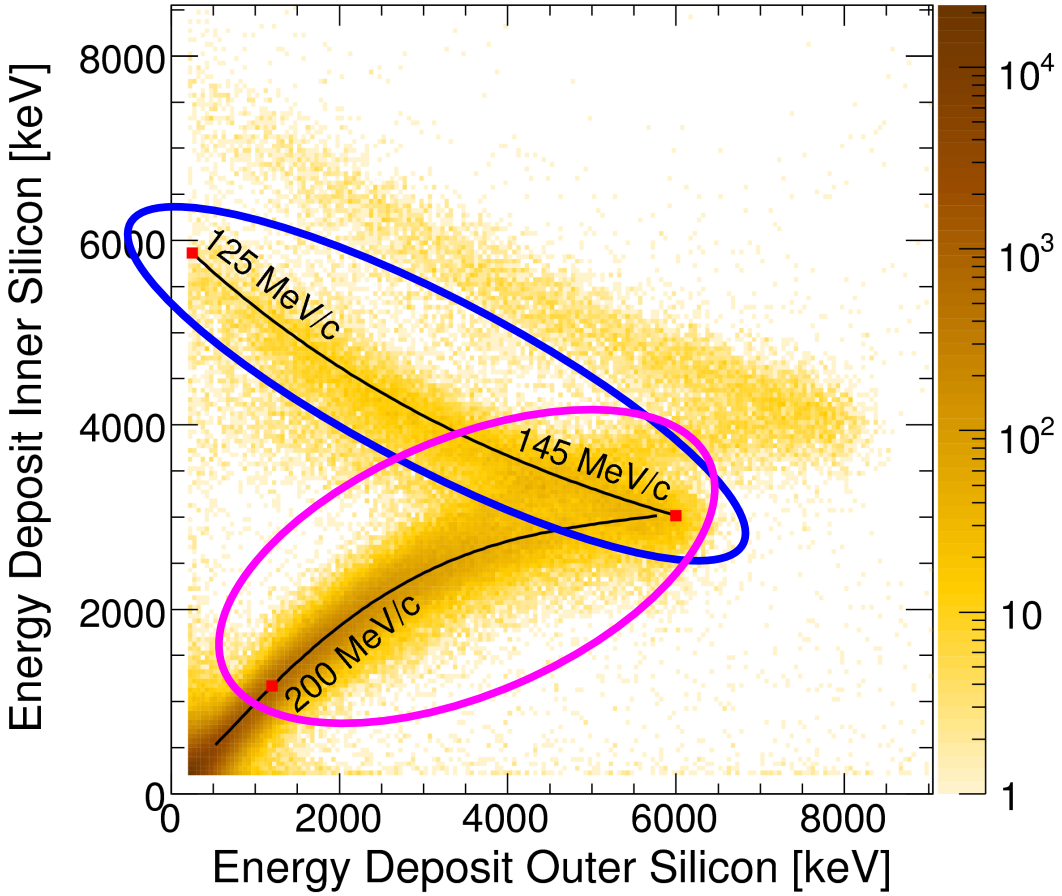




- Low-energy protons — 125 MeV/c < p < 145 MeV/c
  - ➔ Momentum via sum of deposited energies

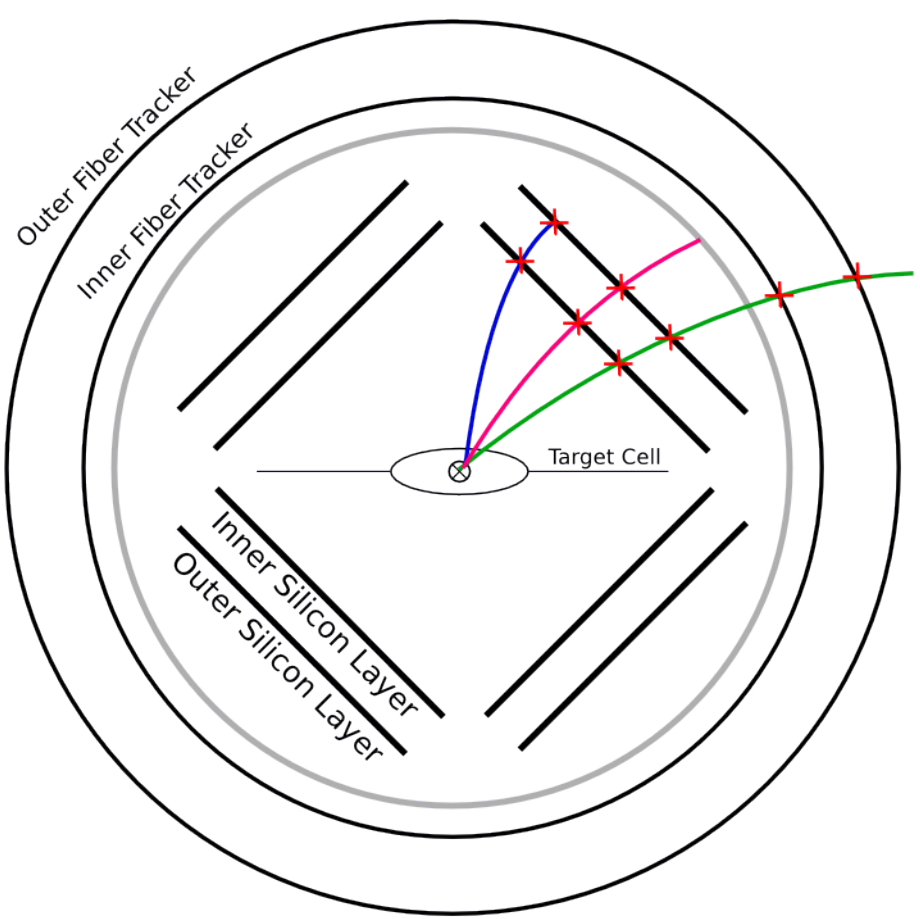
Momentum Reconstruction

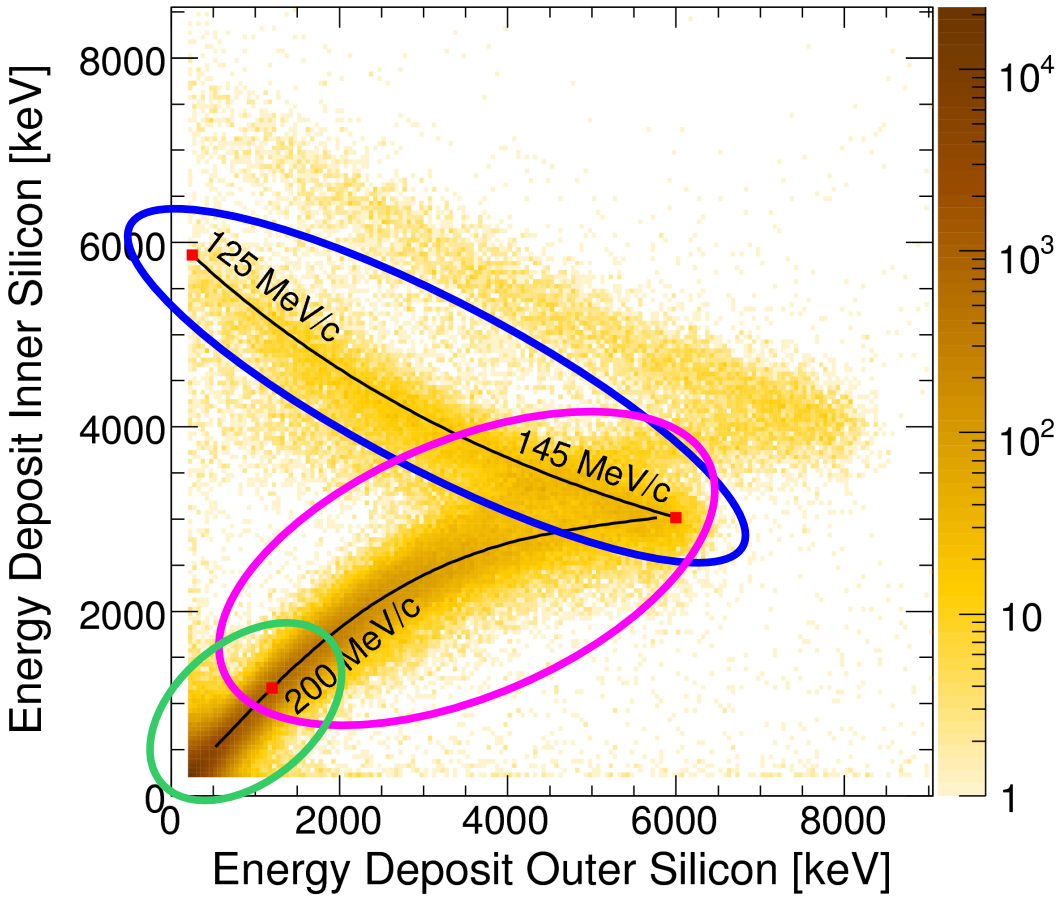




- Low-energy protons — 125 MeV/c < p < 145 MeV/c
  - ➔ Momentum via sum of deposited energies
- Medium-energy protons — 145 MeV/c < p < 250 MeV/c
  - ➔ Momentum via dE/dx

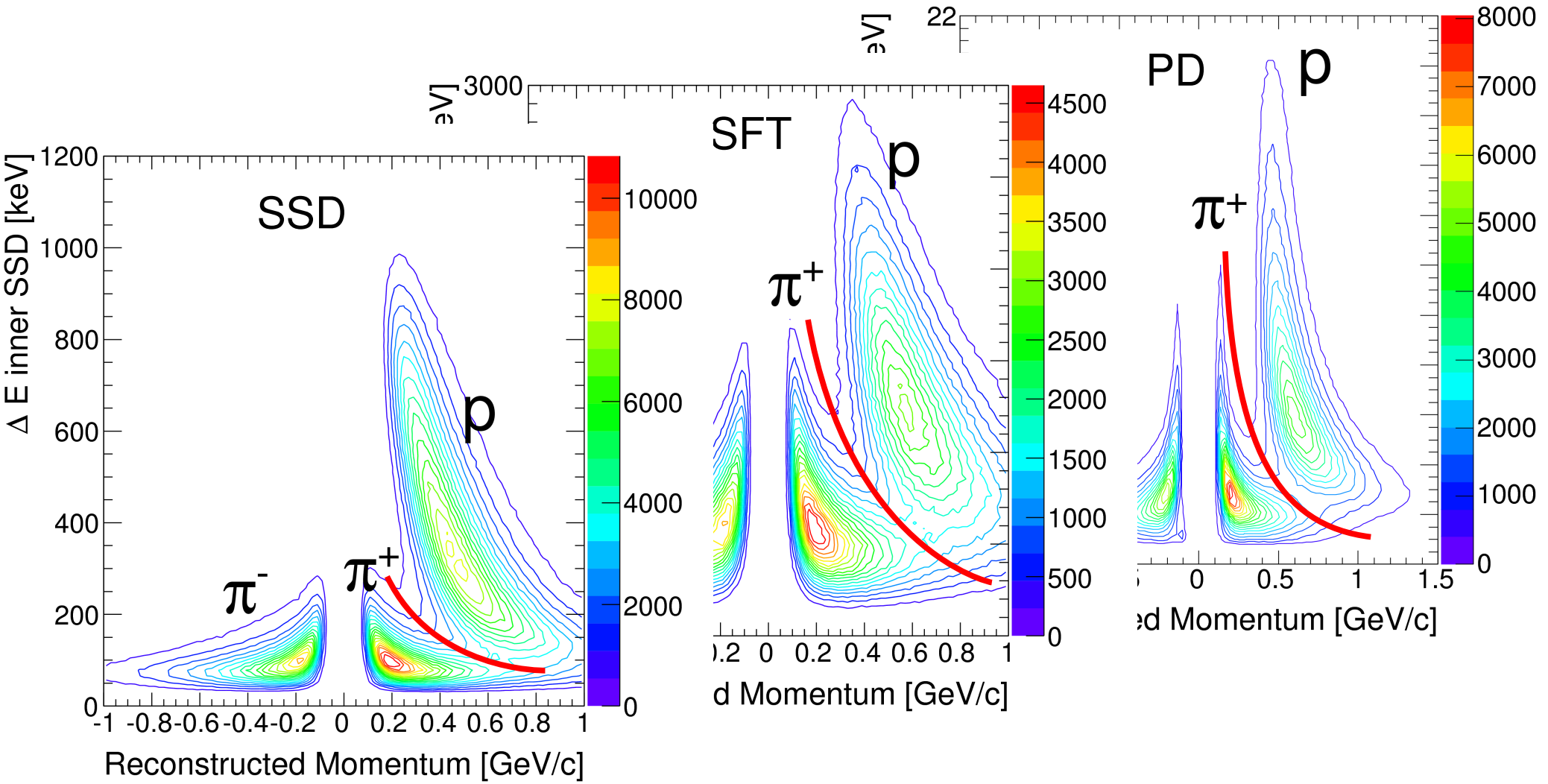
Momentum Reconstruction





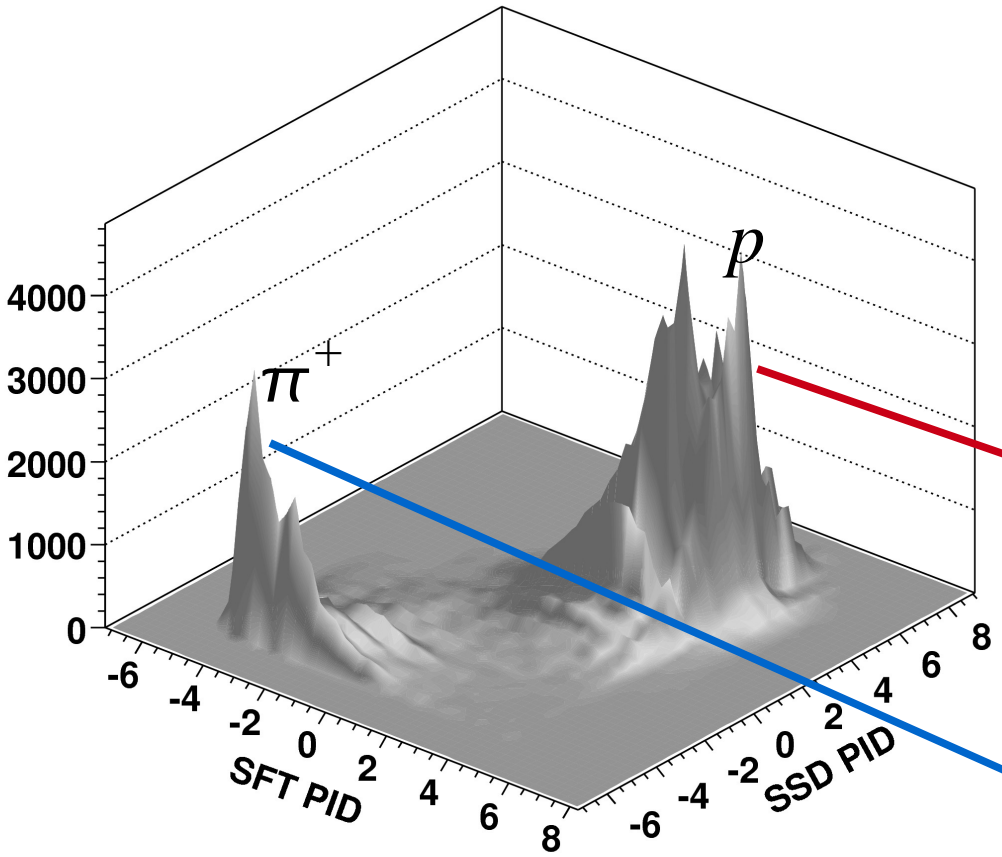
- Low-energy protons — 125 MeV/c < p < 145 MeV/c
  - ➔ Momentum via sum of deposited energies
- Medium-energy protons — 145 MeV/c < p < 250 MeV/c
  - ➔ Momentum via dE/dx
- High-energy particles (protons/pions) — p > 200 MeV/c
  - ➔ Momentum via bending in magnetic field

Particle Identification

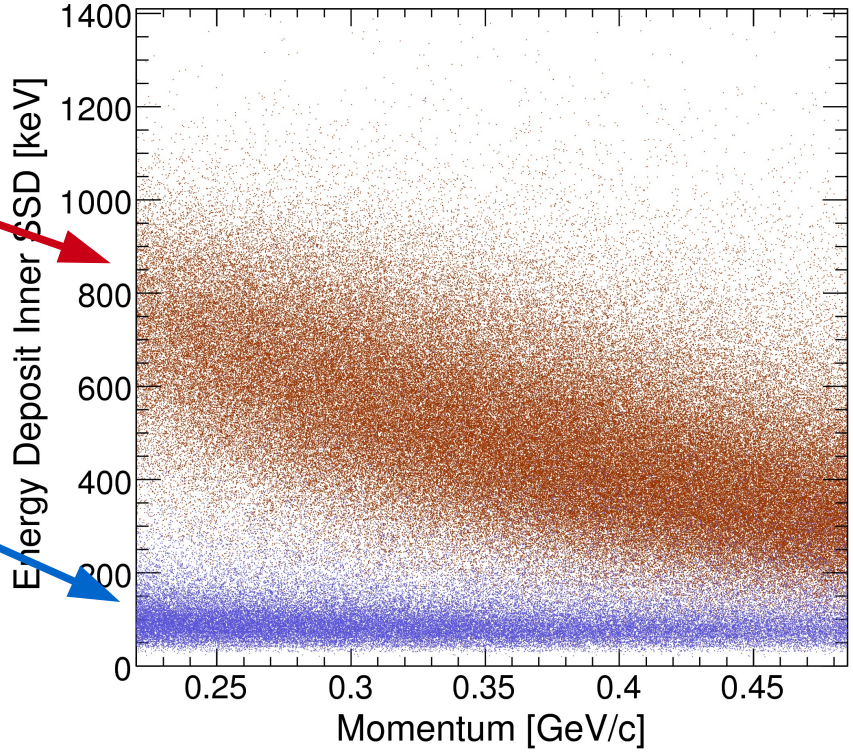


- p/π^+ separation via energy deposits and parent distributions
- $p < \sim 0.6\ GeV/c$: SSD & SFT
- $p > \sim 0.6\ GeV/c$: SSD & SFT & PD

Particle Identification (p > 0.2 GeV/c)



$$PID = \log_{10} \frac{P_p(dE, p)}{P_{\pi^+}(dE, p)}$$



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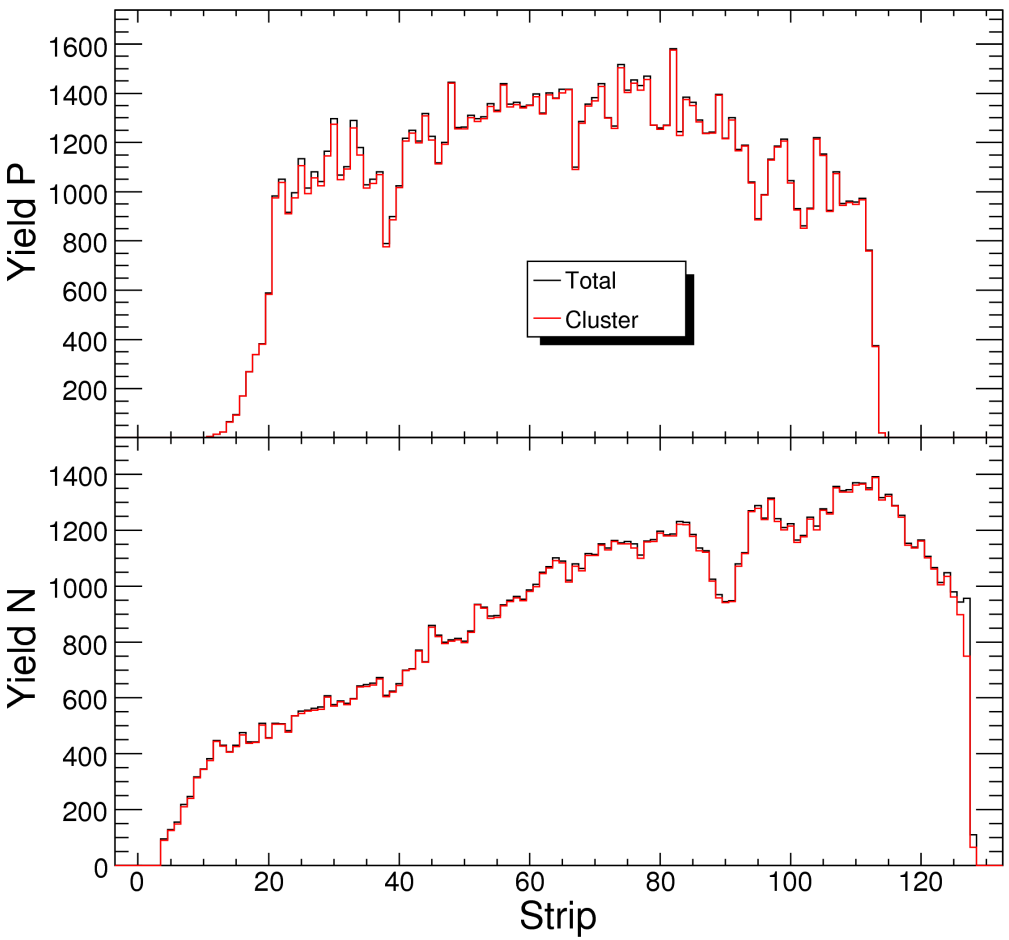
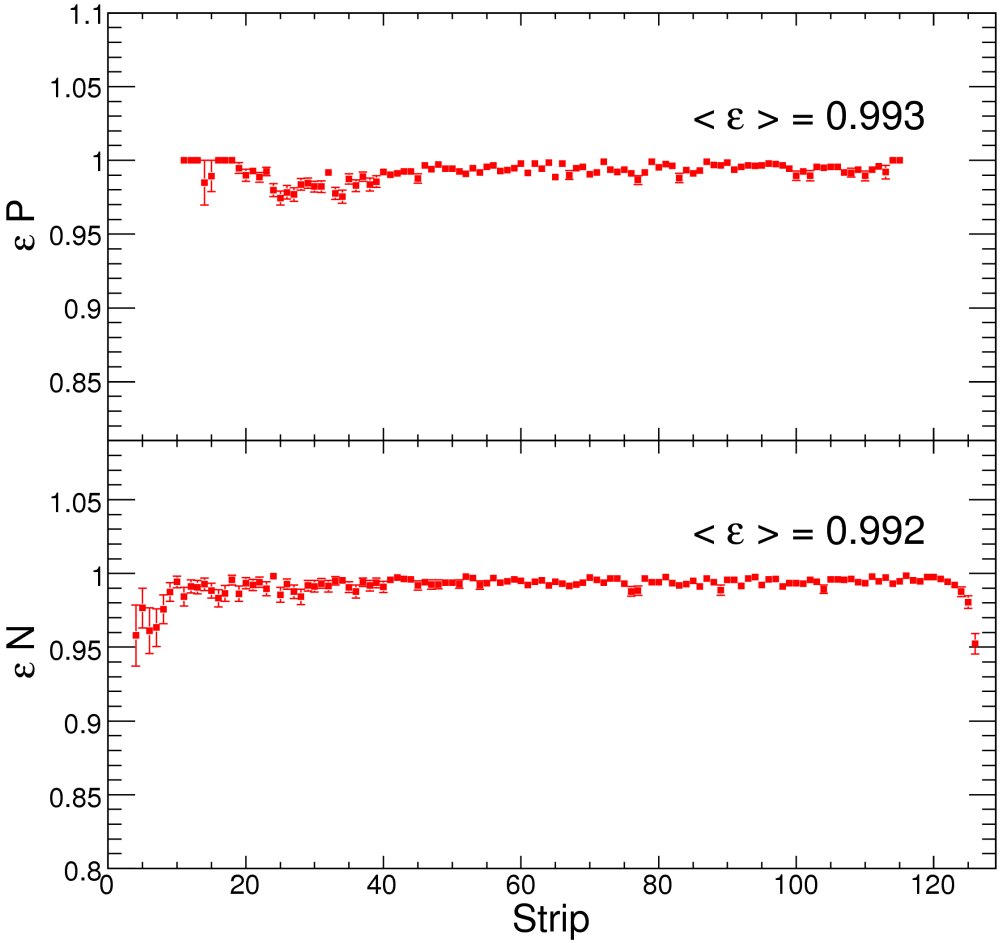
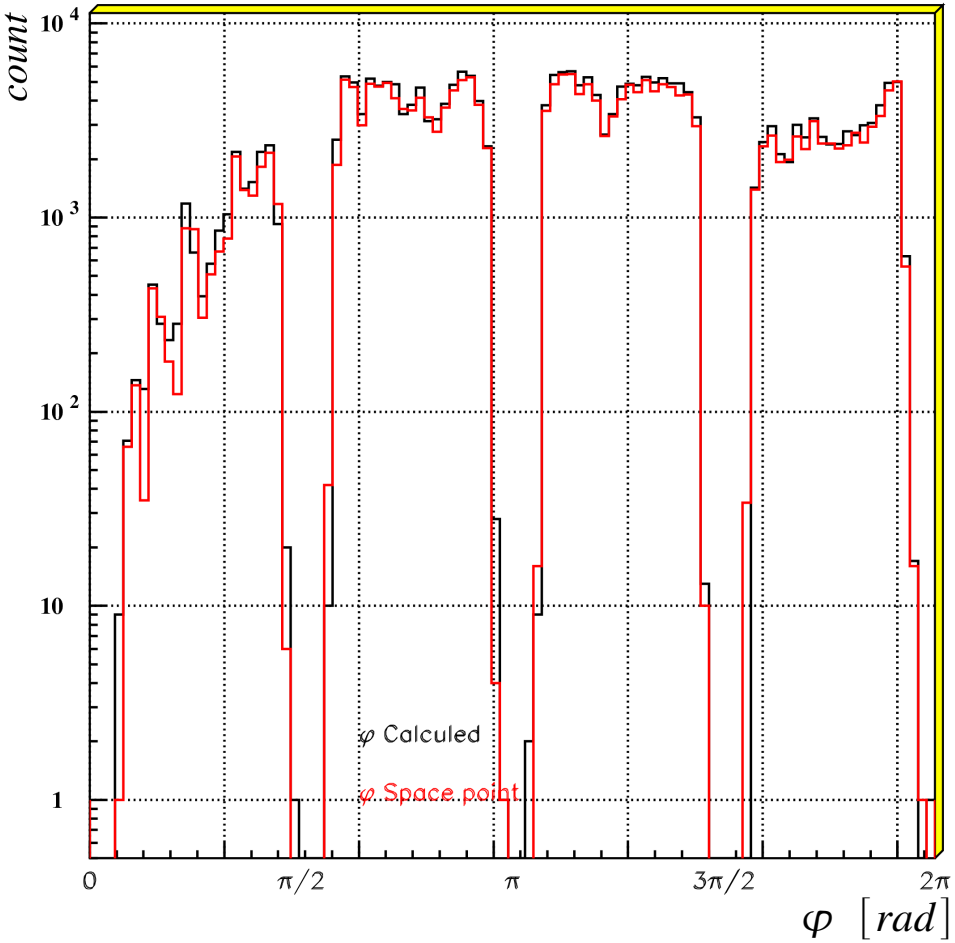
SSD Proton Efficiency

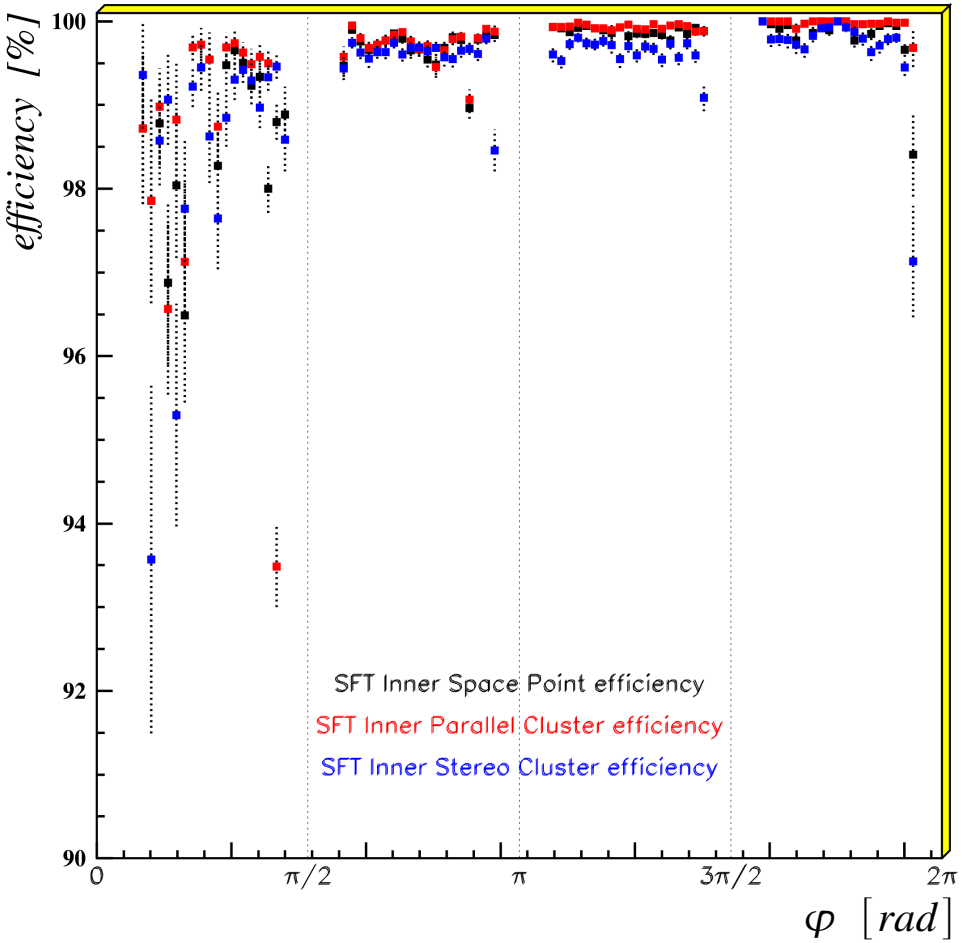




- Drops in statistics related to acceptance holes and dead strips in other silicon layer
- $\langle \varepsilon \rangle > 99\ \%$ for all 16 sensors

SFT Proton Efficiency

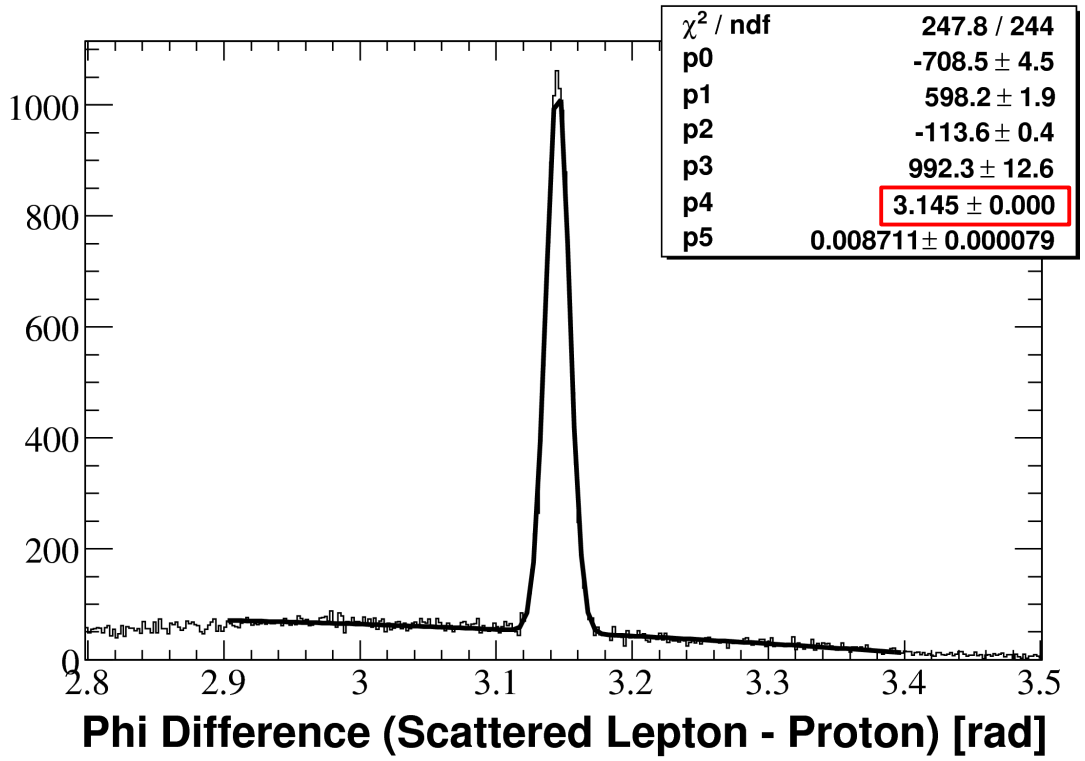


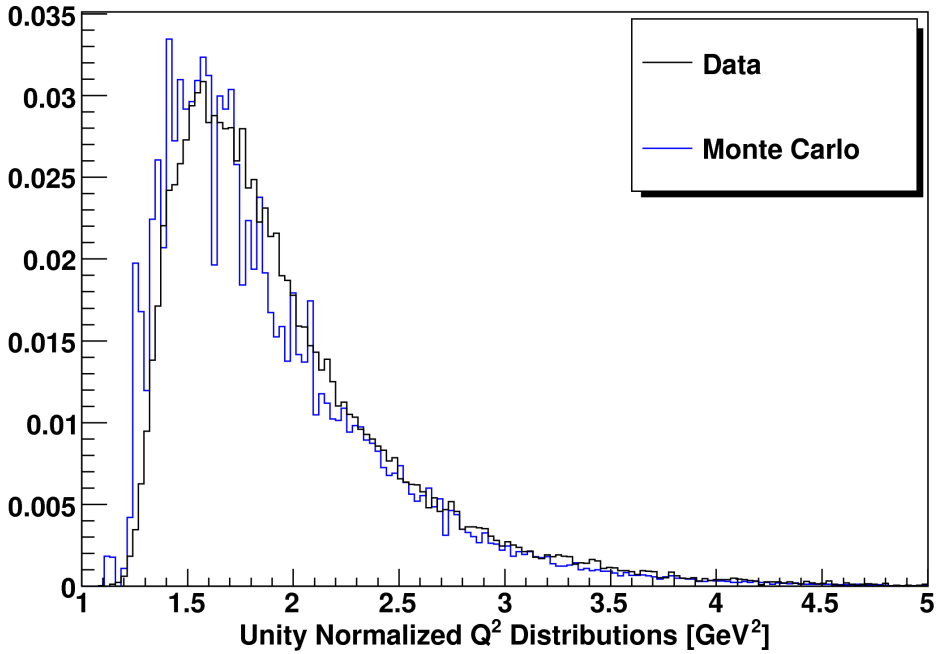


- Lower statistics and lower efficiency for first quadrant
- $\varphi < \pi/2: \quad \langle \varepsilon \rangle \approx 98.5\ \%$

  $\varphi > \pi/2: \quad \langle \varepsilon \rangle \approx 99.5\ \%$

ep - Elastic





- Single lepton in forward spectrometer (p > 25 GeV/c)
- Use Recoil Detector track with highest momentum and positive charge
- Will be used for Recoil alignment relative to HERMES

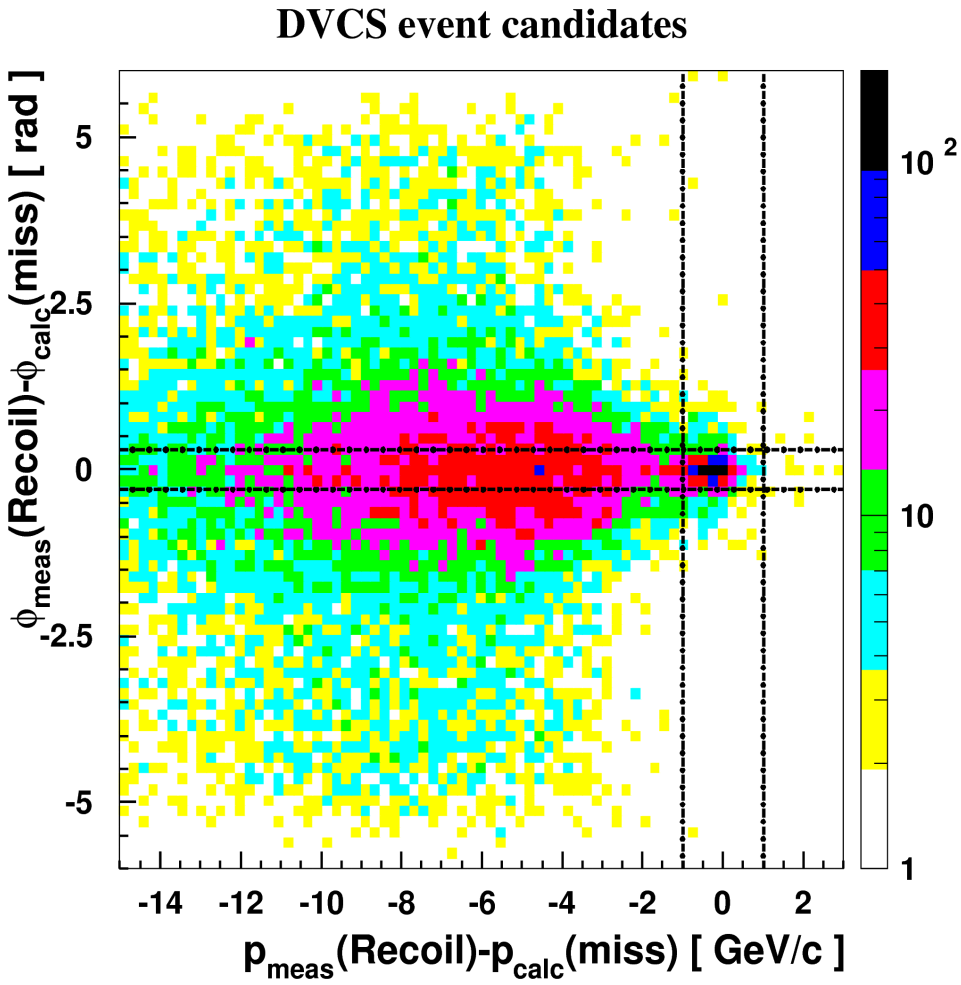
A first look at DVCS with Recoil

- "Classic" style HERMES DVCS analysis
  - Exactly one lepton and one photon in forward spectrometer

} DVCS candidate

- Calculate kinematics of recoiling proton

- Look for a correlated track in Recoil Detector
  - Use track with highest momentum and positive charge
  - No PID used to select protons
  - All track types: SSD-only & "long" tracks
  - $\Delta\phi = \phi_{measured} - \phi_{calc.}$
  - $\Delta p = p_{measured} - p_{calc.}$



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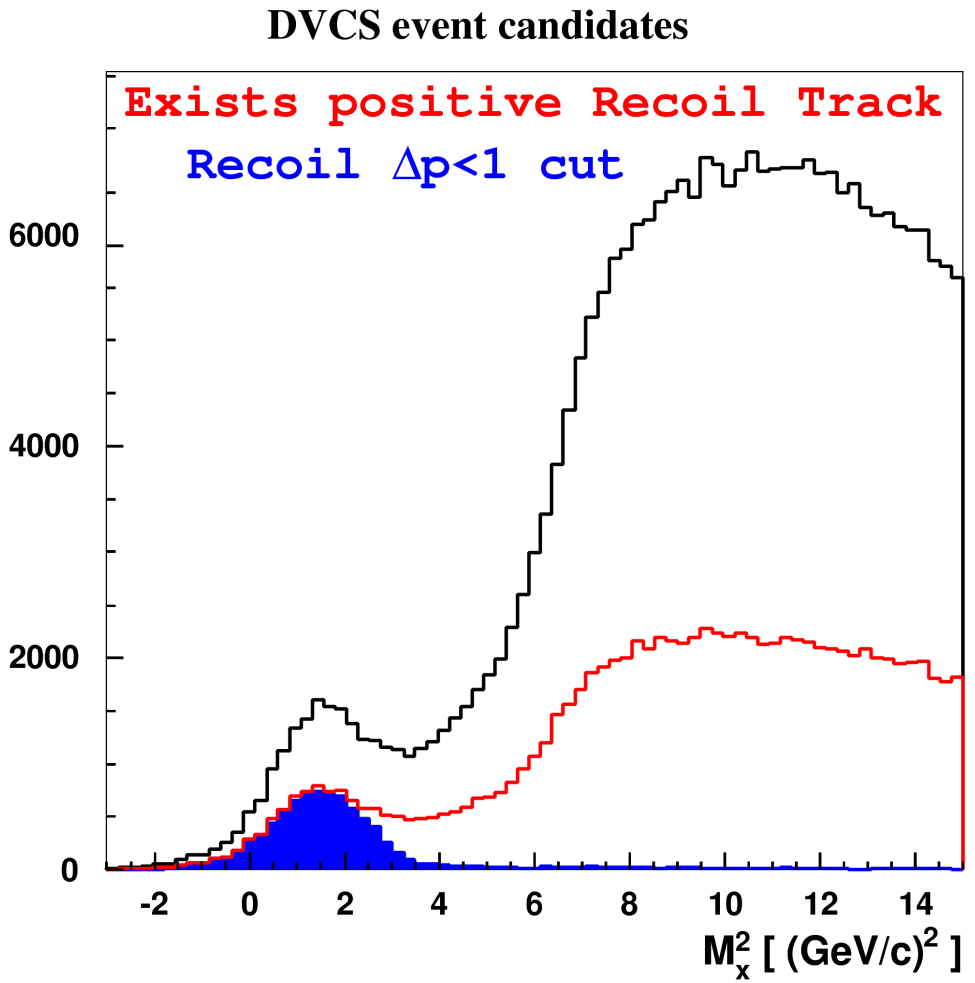
  - No PID used to select protons
  - All track types: SSD-only & "long" tracks
  - $\Delta\phi = \phi_{measured} - \phi_{calc.}$
  - $\Delta p = p_{measured} - p_{calc.}$
  - $|\Delta p| < 1\,\mathrm{GeV/c}$



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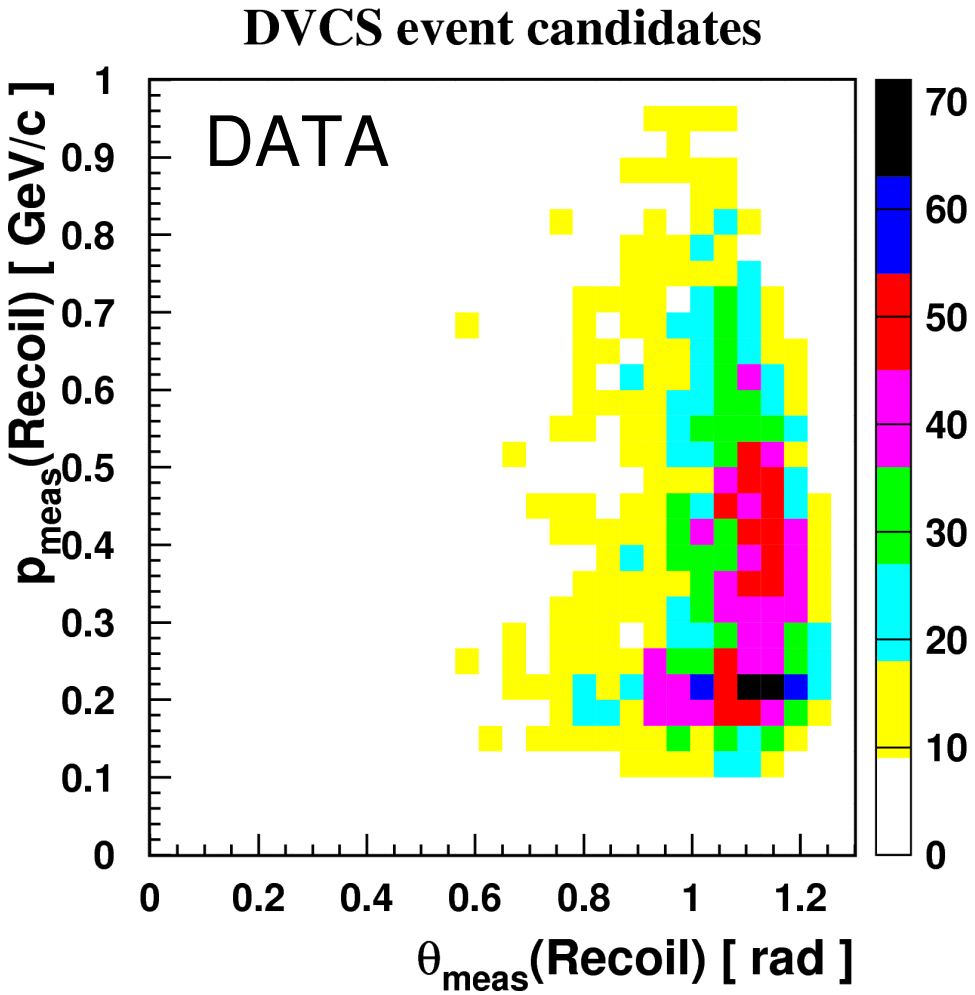
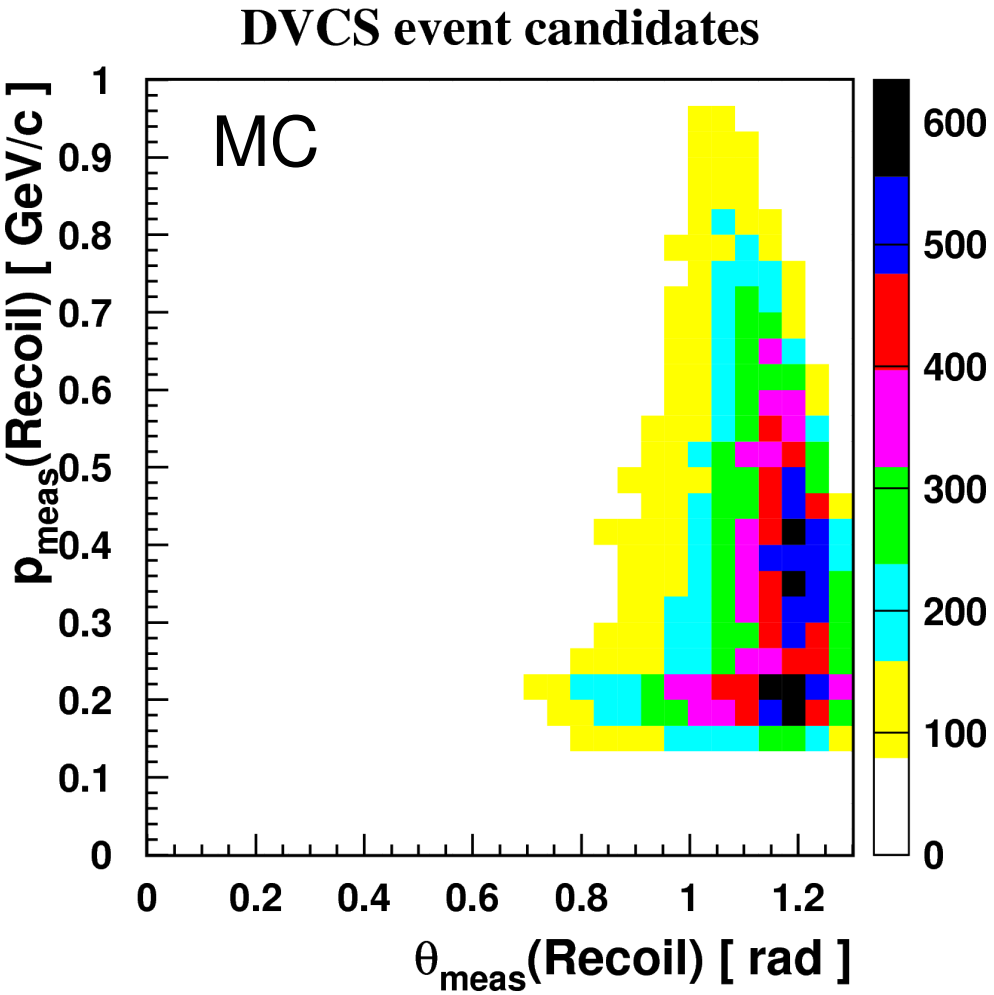
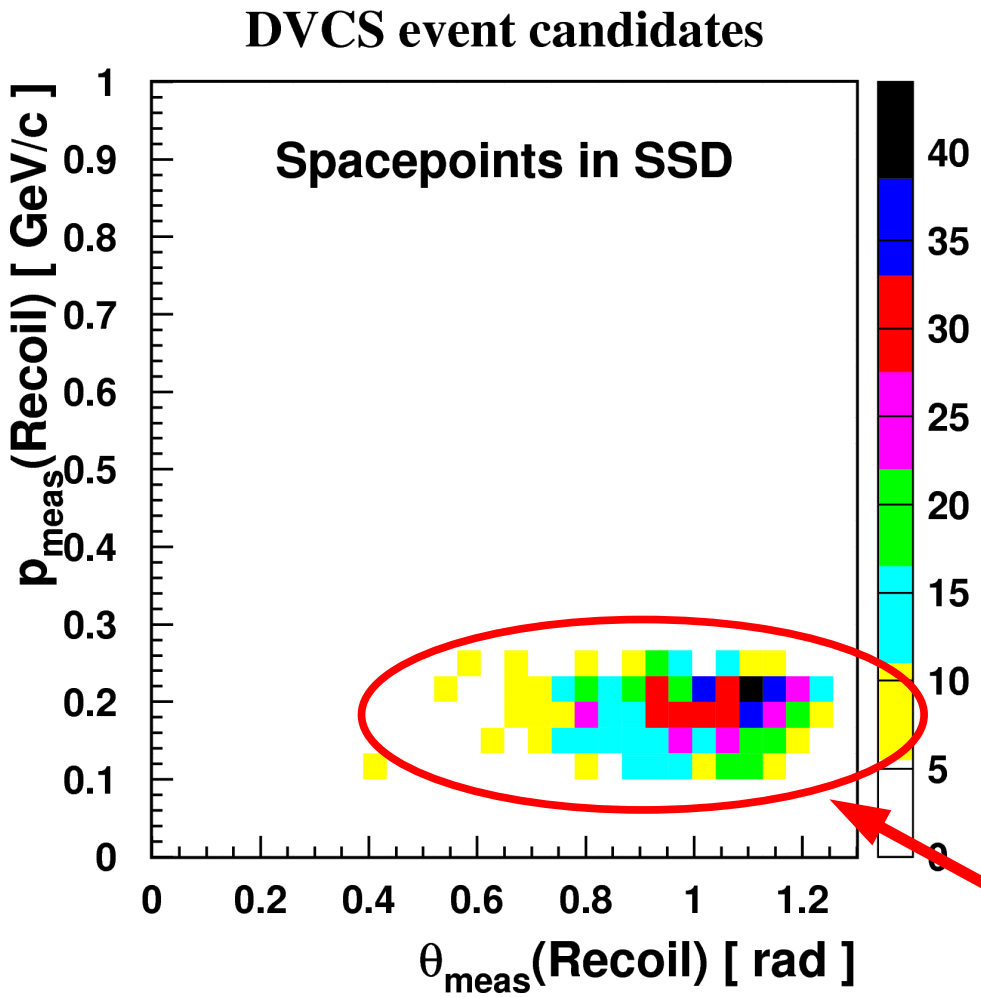
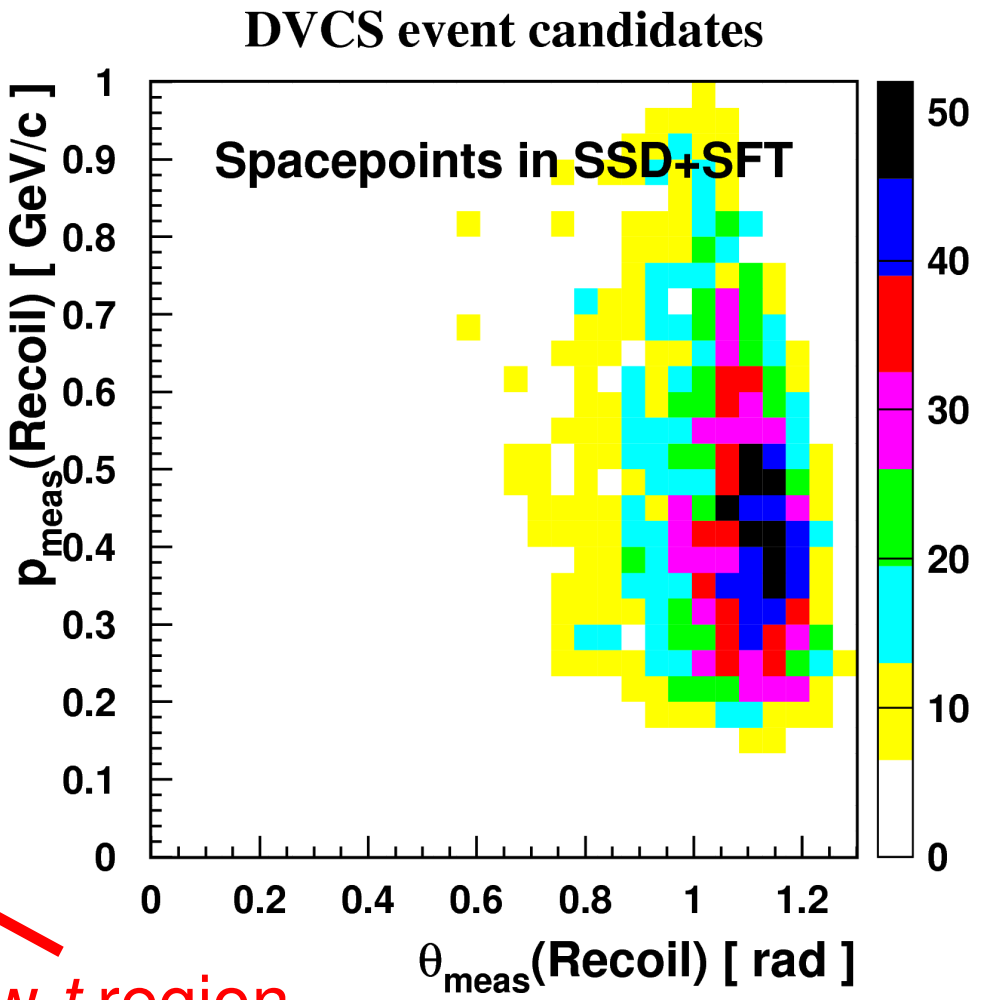




- Data and MC agree very well

A first look at DVCS with Recoil



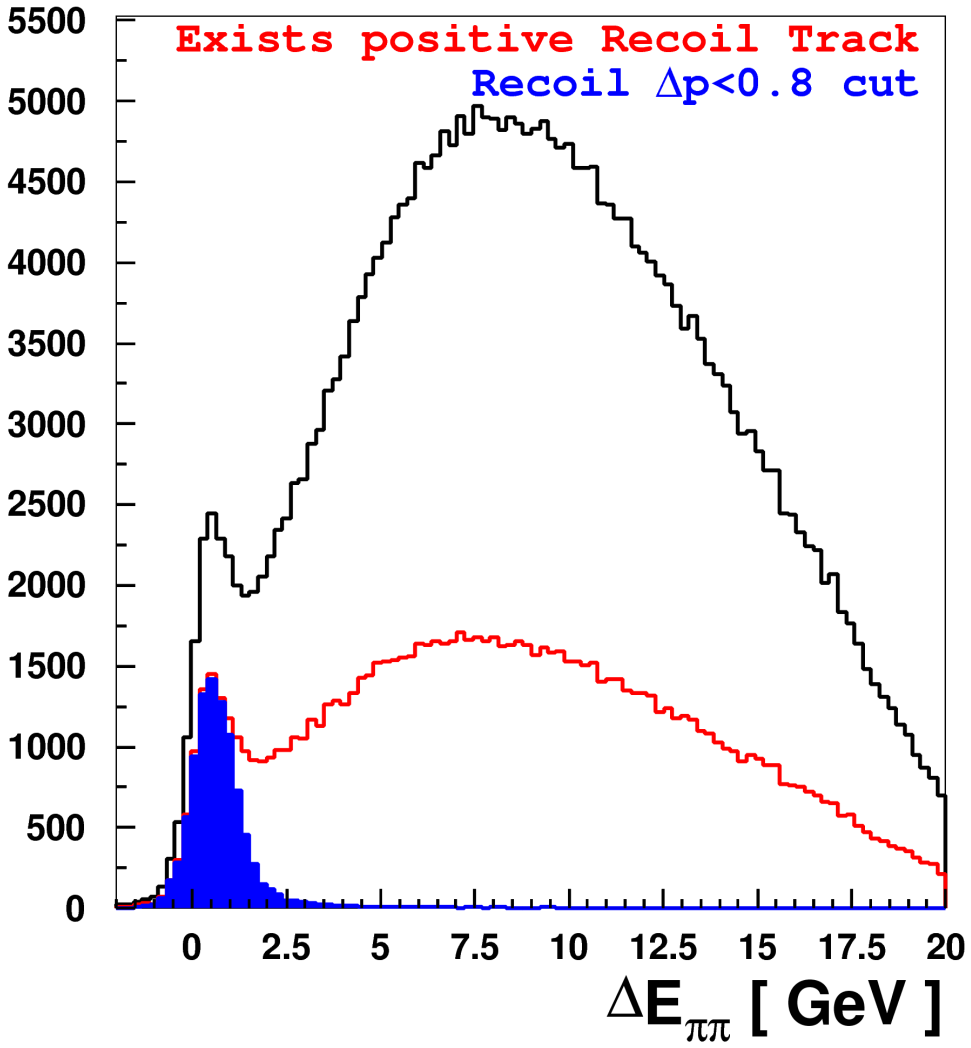


low *t* region

Ji Relation: $J_q = \lim_{t \to 0} \int_0^1 dx\, x \{ H_q + E_q \}$

Exclusive ρ^0 - Production

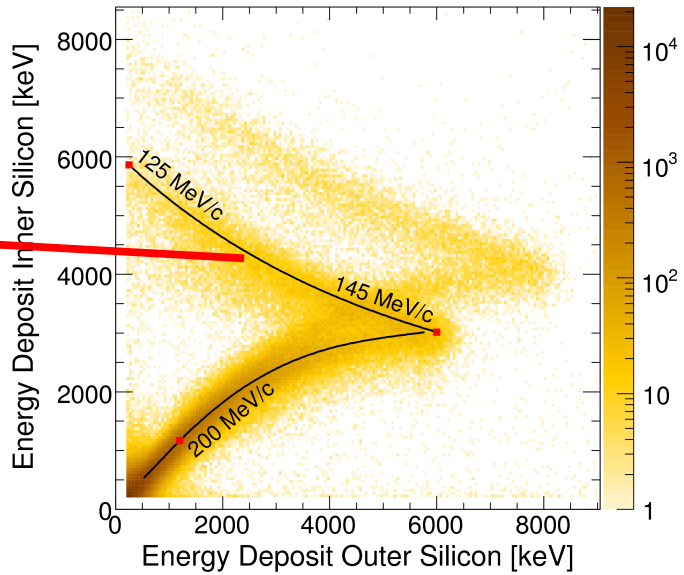
- "Classic" style HERMES ρ^0 analysis
- Calculate kinematics of recoiling proton
- Look for correlated track in Recoil Detector



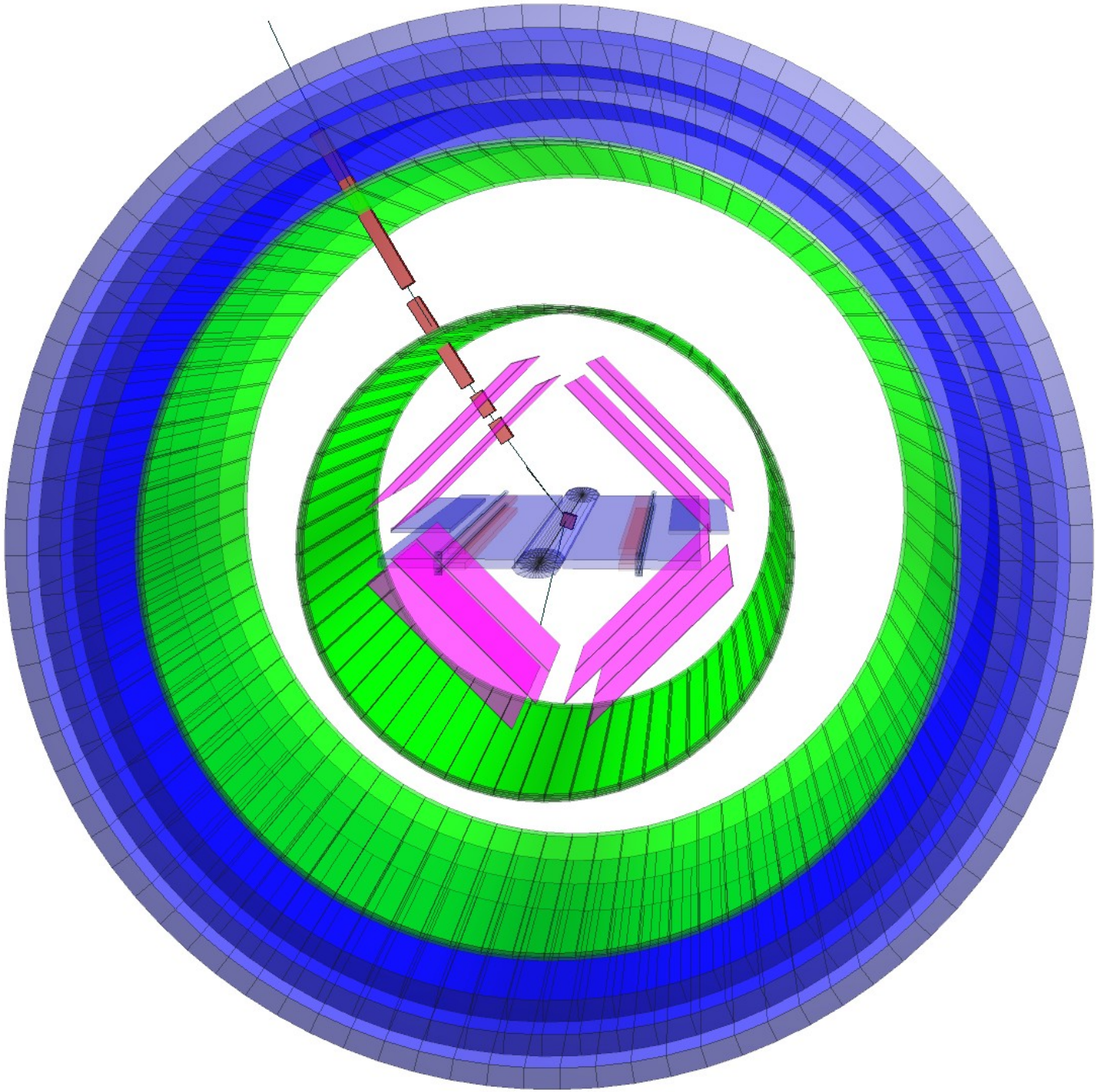
Summary and Outlook

- Great progress in understanding the detector
  - All three sub-detectors calibrated
  - PID and efficiencies look very good
- First look at physics using Recoil Detector tracks looks promising

- Exclusive physics
  - Improve event selection
  - Use PID to select recoiling proton
  - Separation of associated background by using PD
  - Include single hits in inner SSD to extend to lower *t*
- Extract neutron structure function via spectator proton tagging
- A bit more work needed for the SSD energy calibration



DVCS Event



BACKUP

Mx2 Comparison