New Results from the HERMES Recoil Detector

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for the HERMES collaboration

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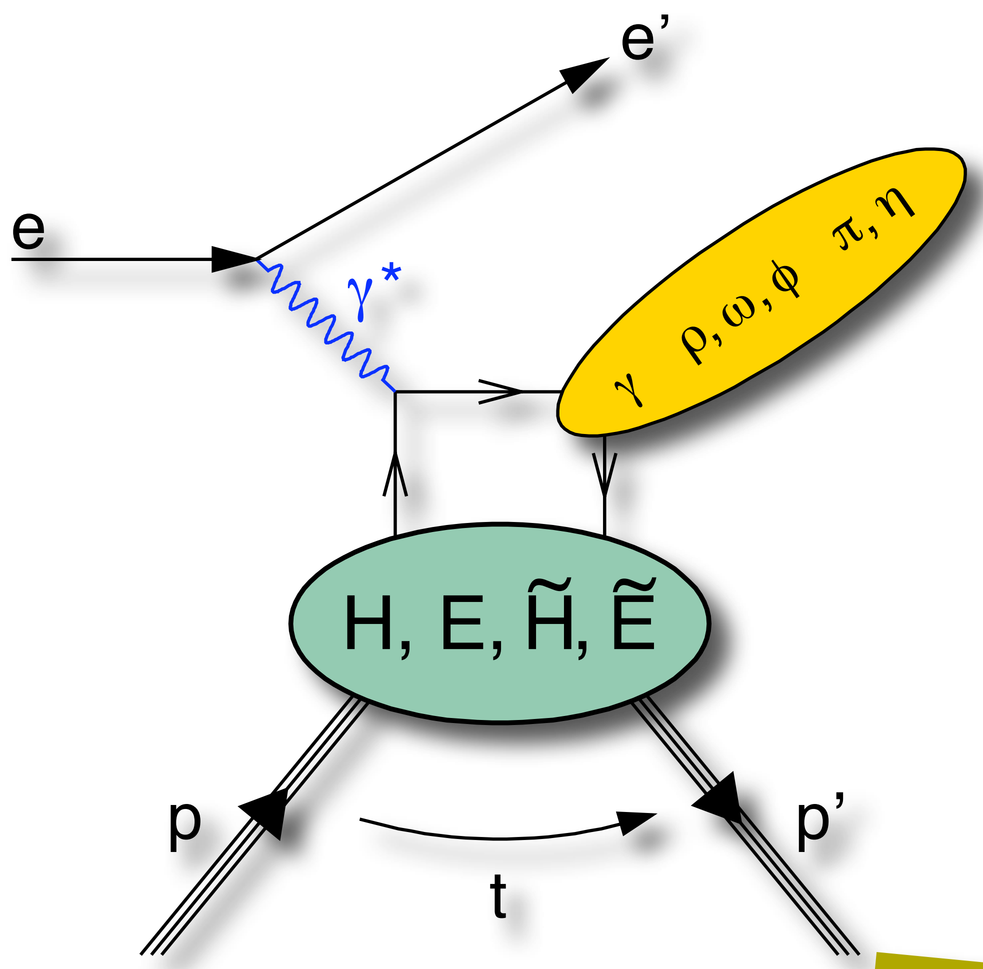
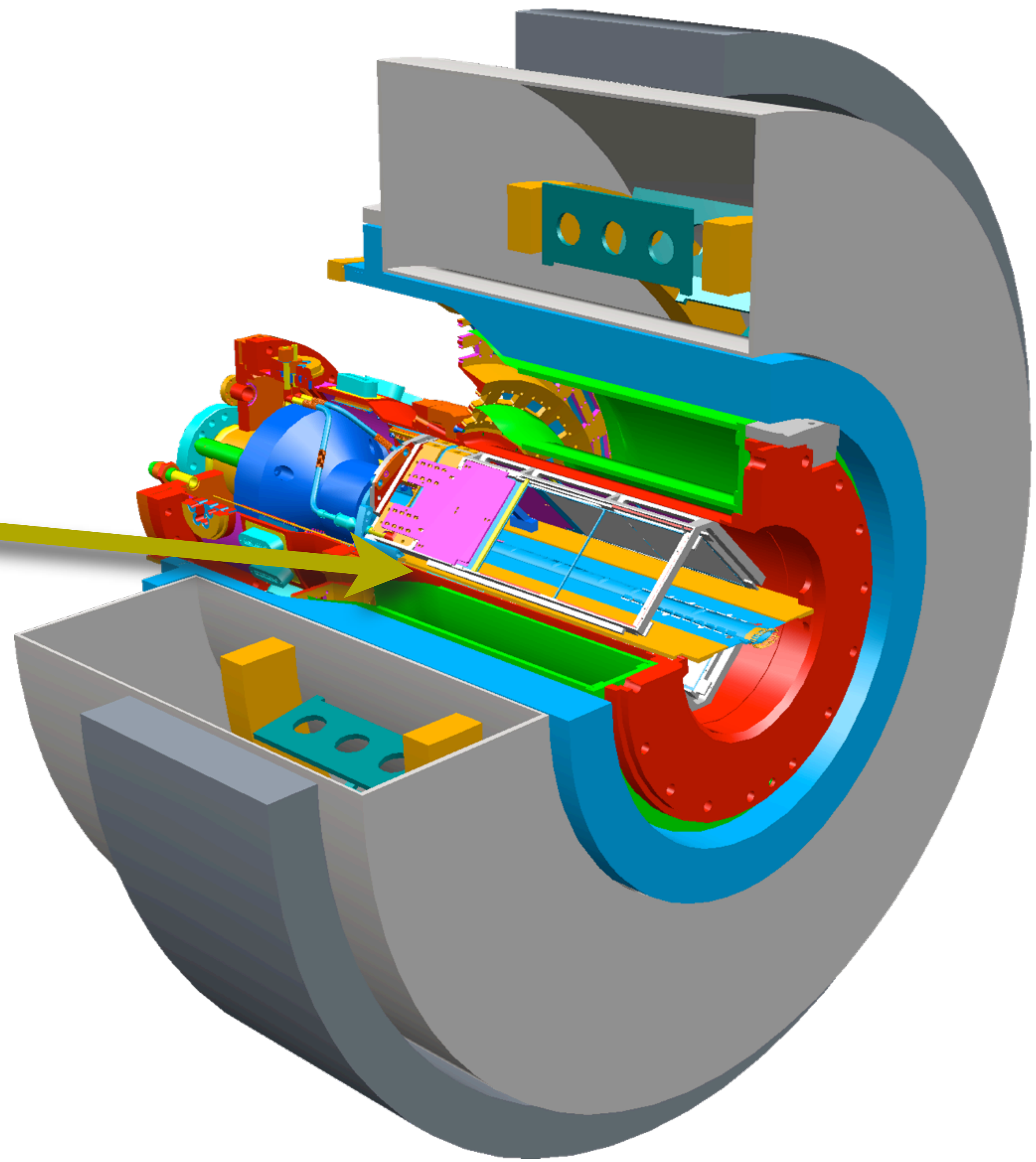
Exclusive DIS Measurements at HERMES





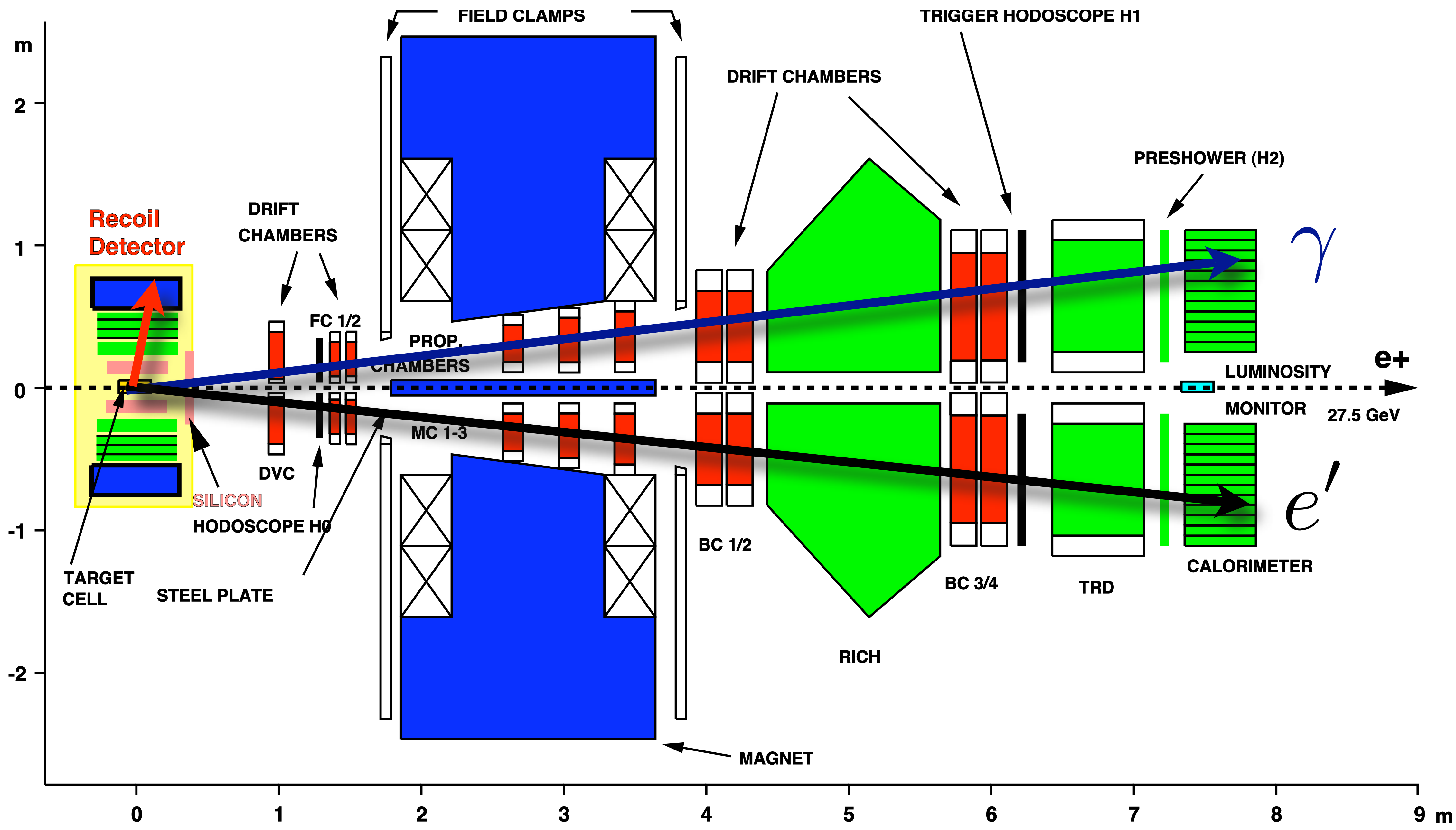
Without Recoil Detector

- Exclusivity via missing mass
- ~ 11% background

With Recoil Detector

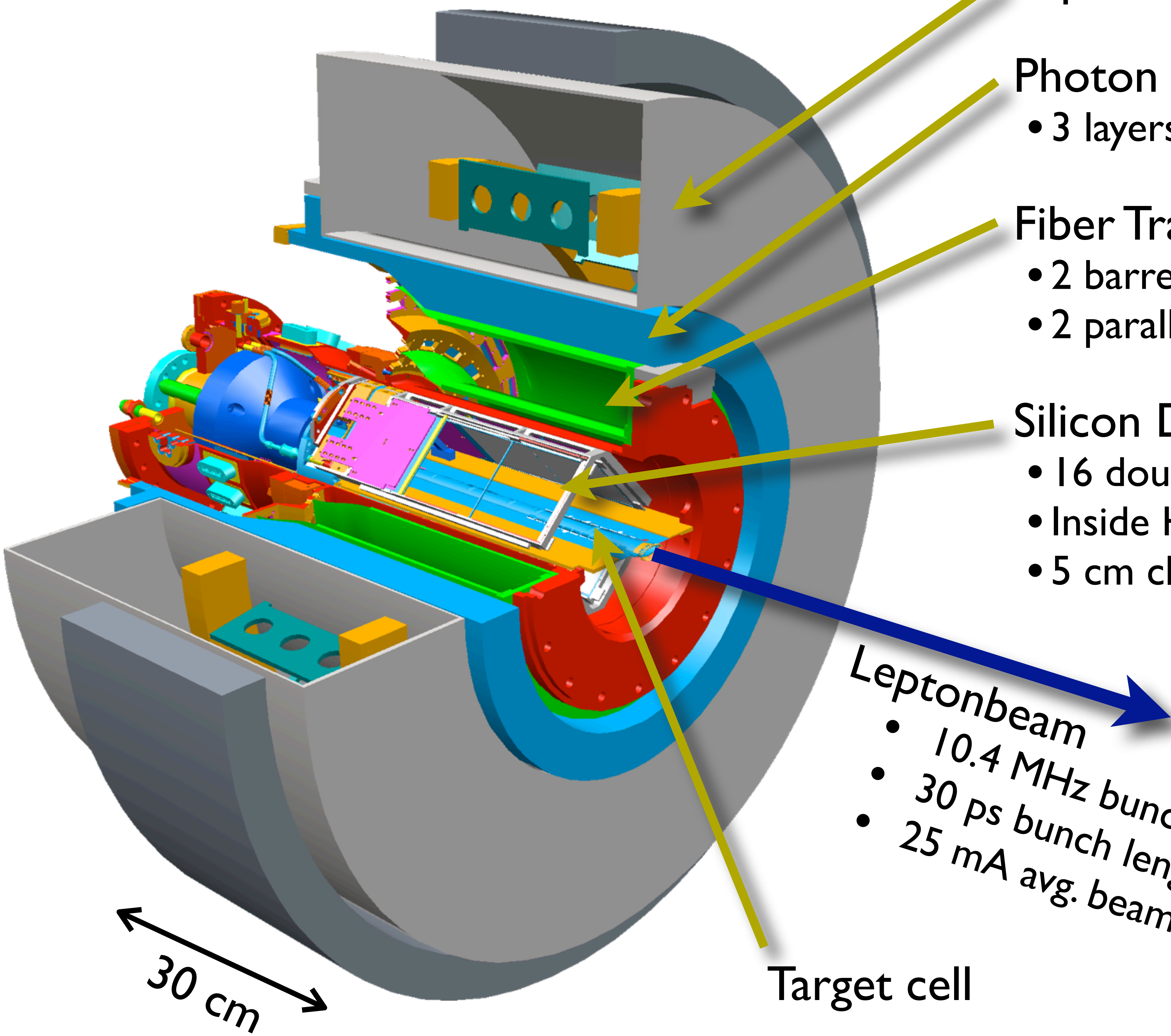
- Improved exclusivity
- < 1% background
- Improved t resolution

The HERMES Spectrometer (2006 - 2007)



- Recoil detector installed for the last two years of data taking at HERA
- 49.3M DIS events off Hydrogen target (21.5M DIS events 1996-2005)
- 12.4M DIS events off Deuterium target

The HERMES Recoil Detector



Superconducting Solenoid (1T)

Photon Detector (PD)

- 3 layers of Tungsten/Scintillator sandwich

Fiber Tracker (SFT)

- 2 barrels with 4 layers of scinillating fibers
- 2 parallel and 2 stero layers per barrel

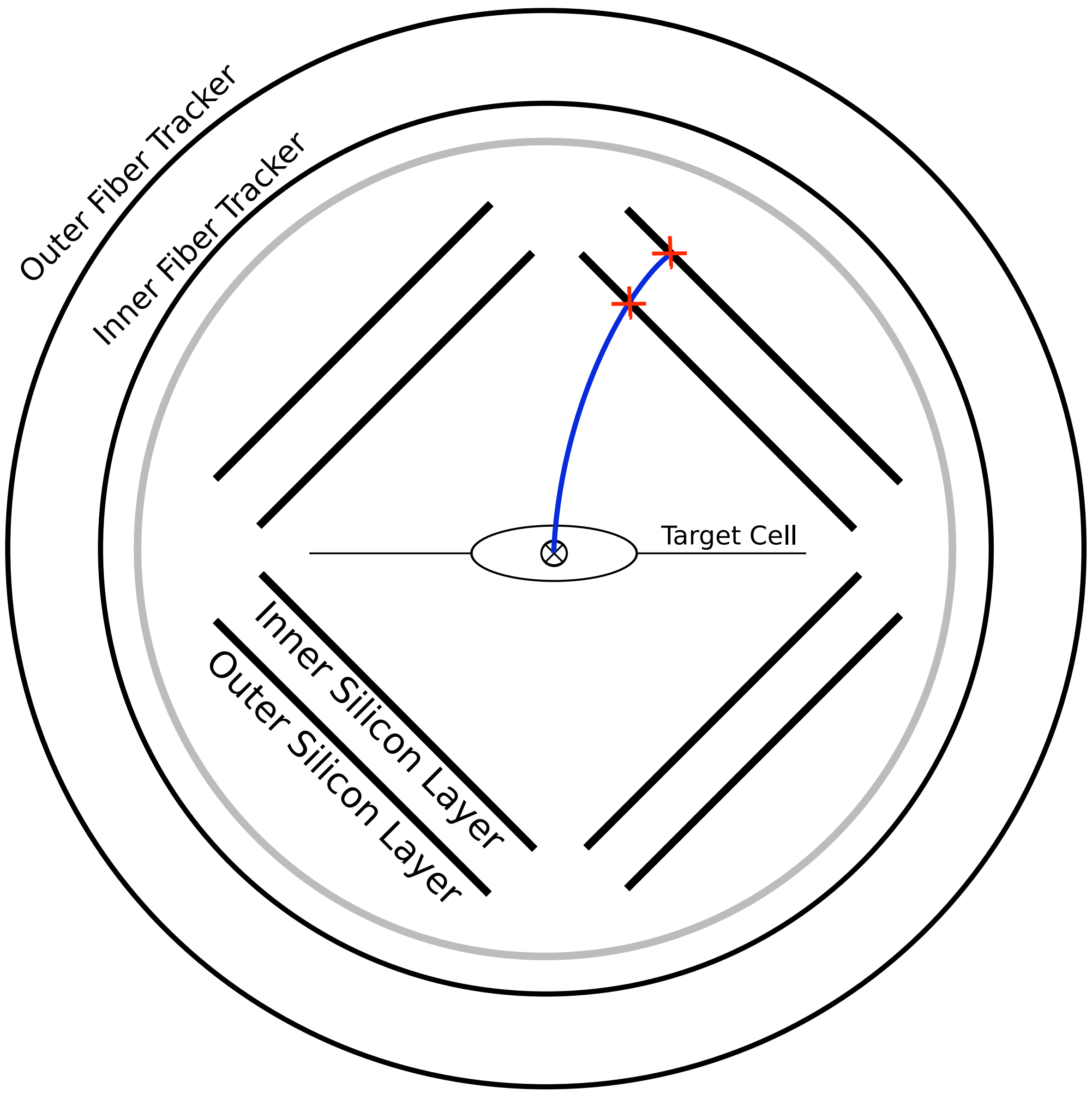
Silicon Detector (SSD)

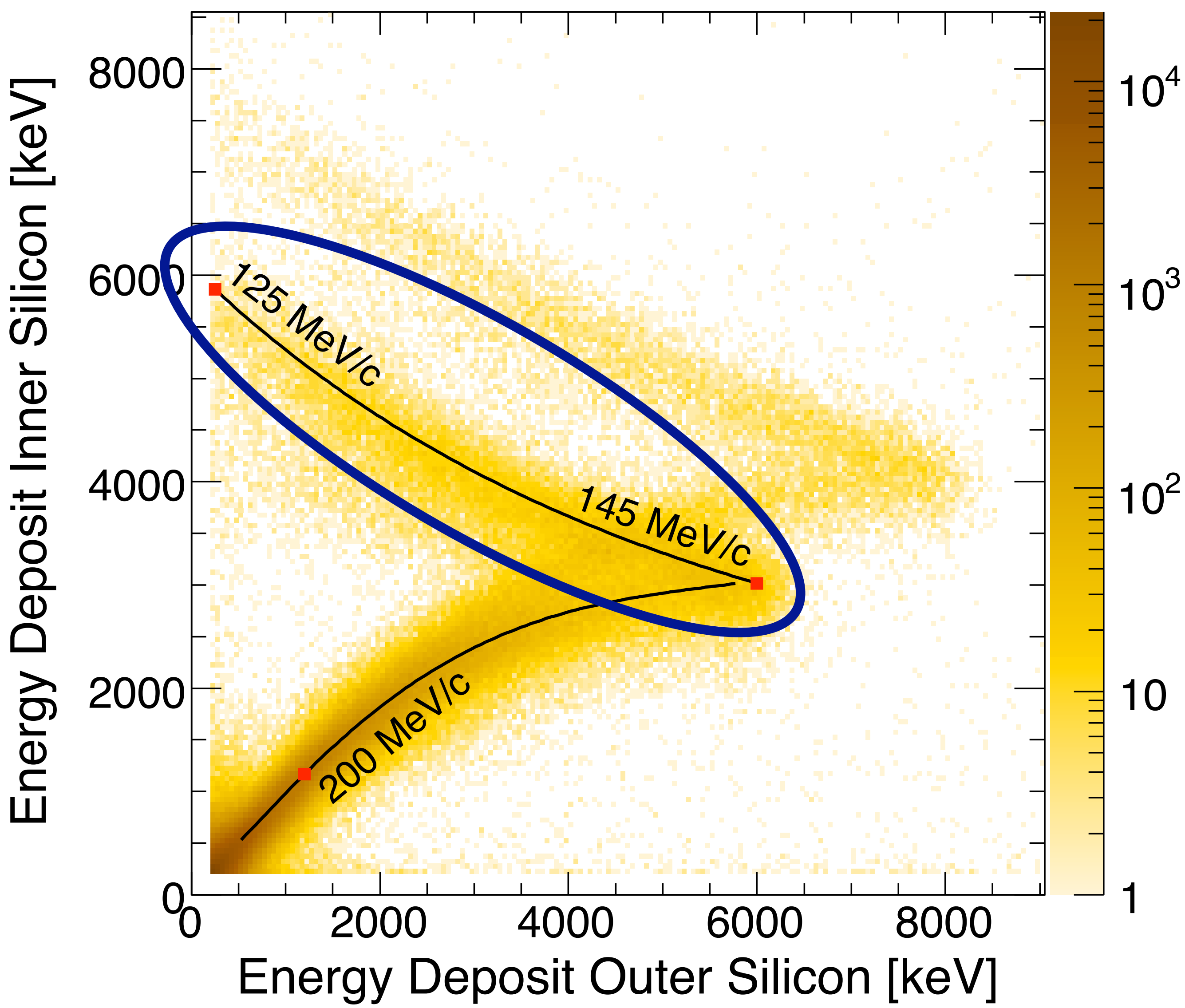
- 16 double-sided sensor in 2 layers
- Inside HERA vacuum
- 5 cm close to beam

Leptonbeam

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

Momentum Reconstruction



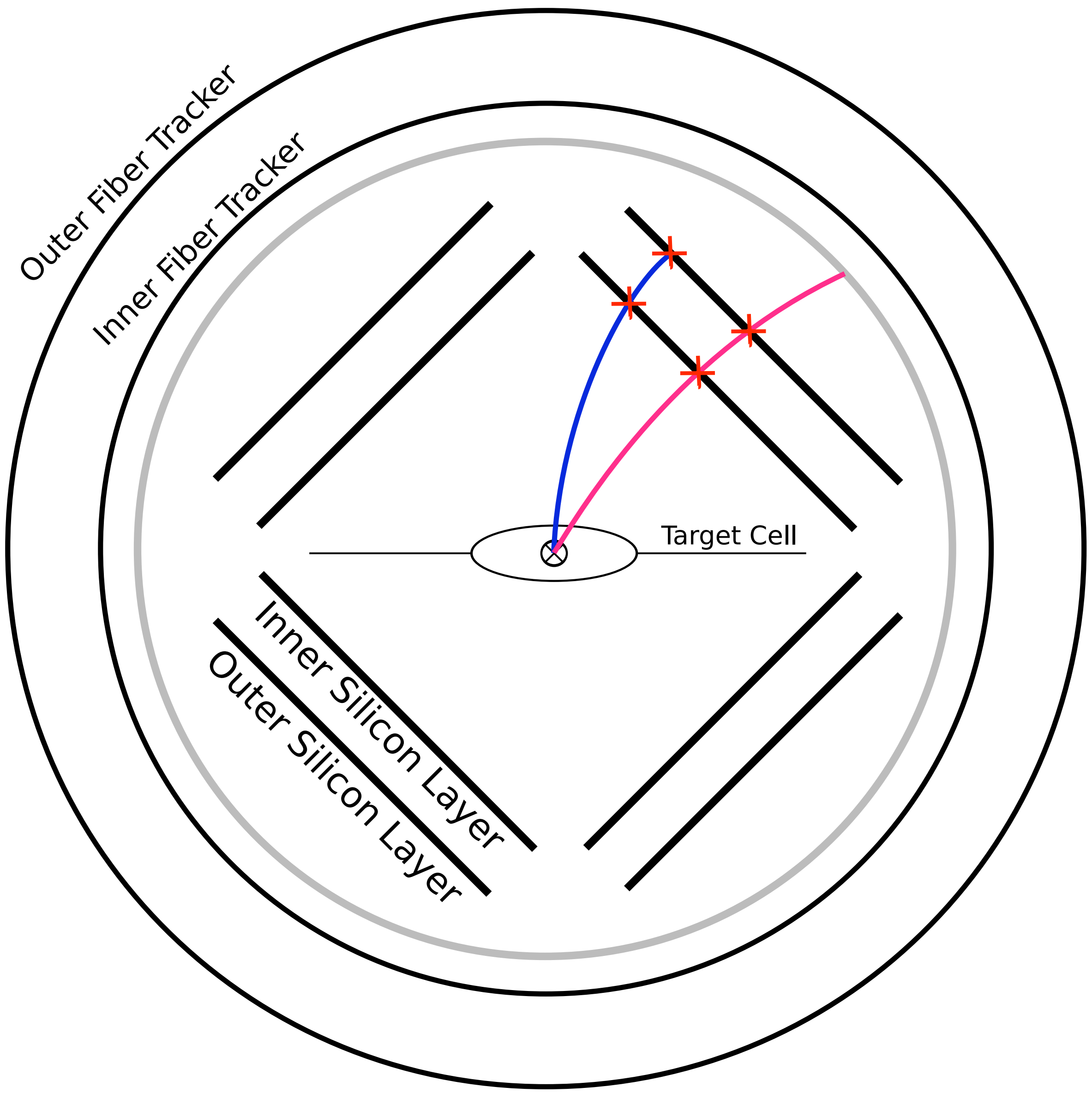


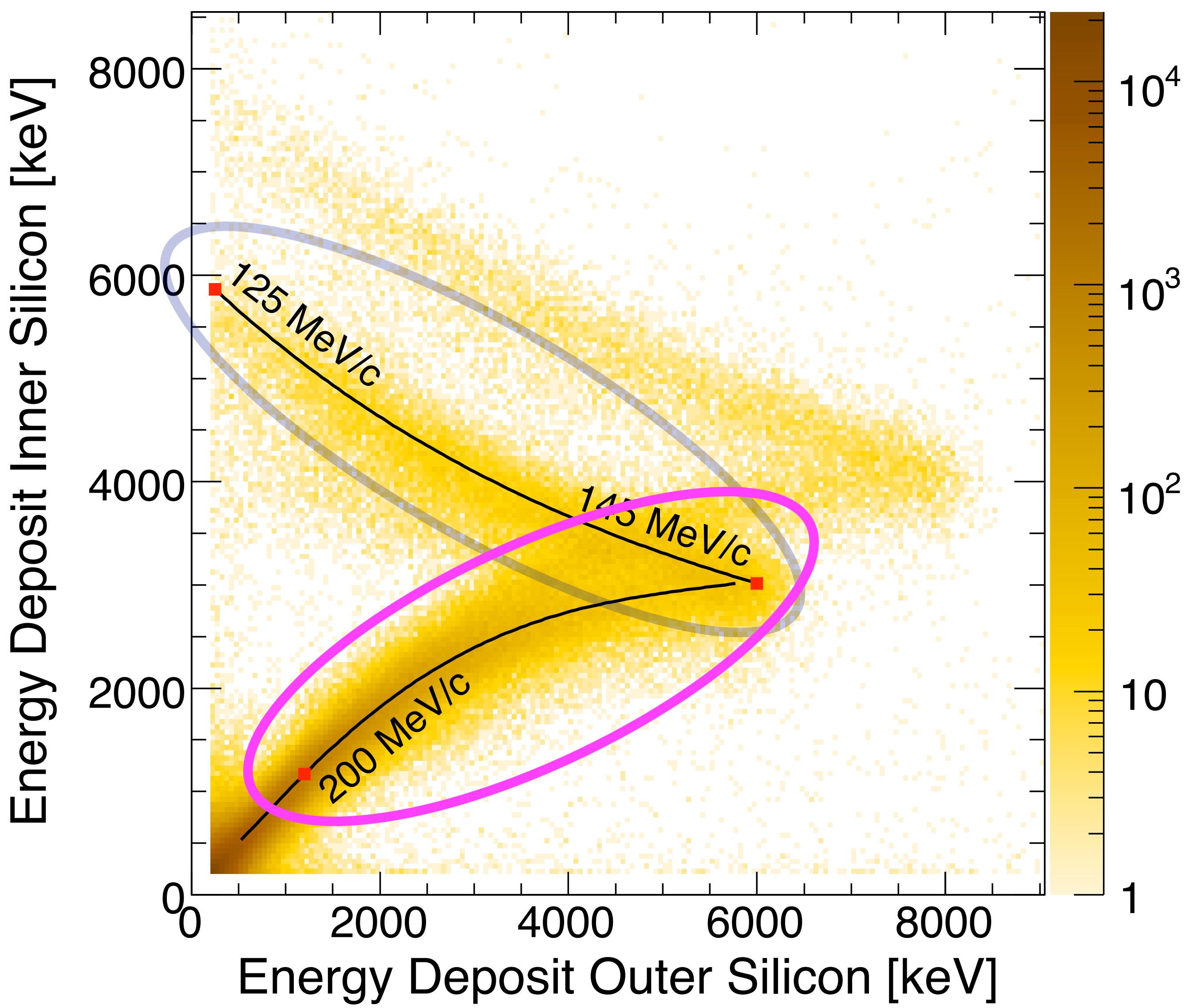
Low-energy protons

- Momentum via sum of energy deposits

$$125 \text{ MeV/c} < p < 145 \text{ MeV/c}$$

Momentum Reconstruction





Low-energy protons

- Momentum via sum of energy deposits

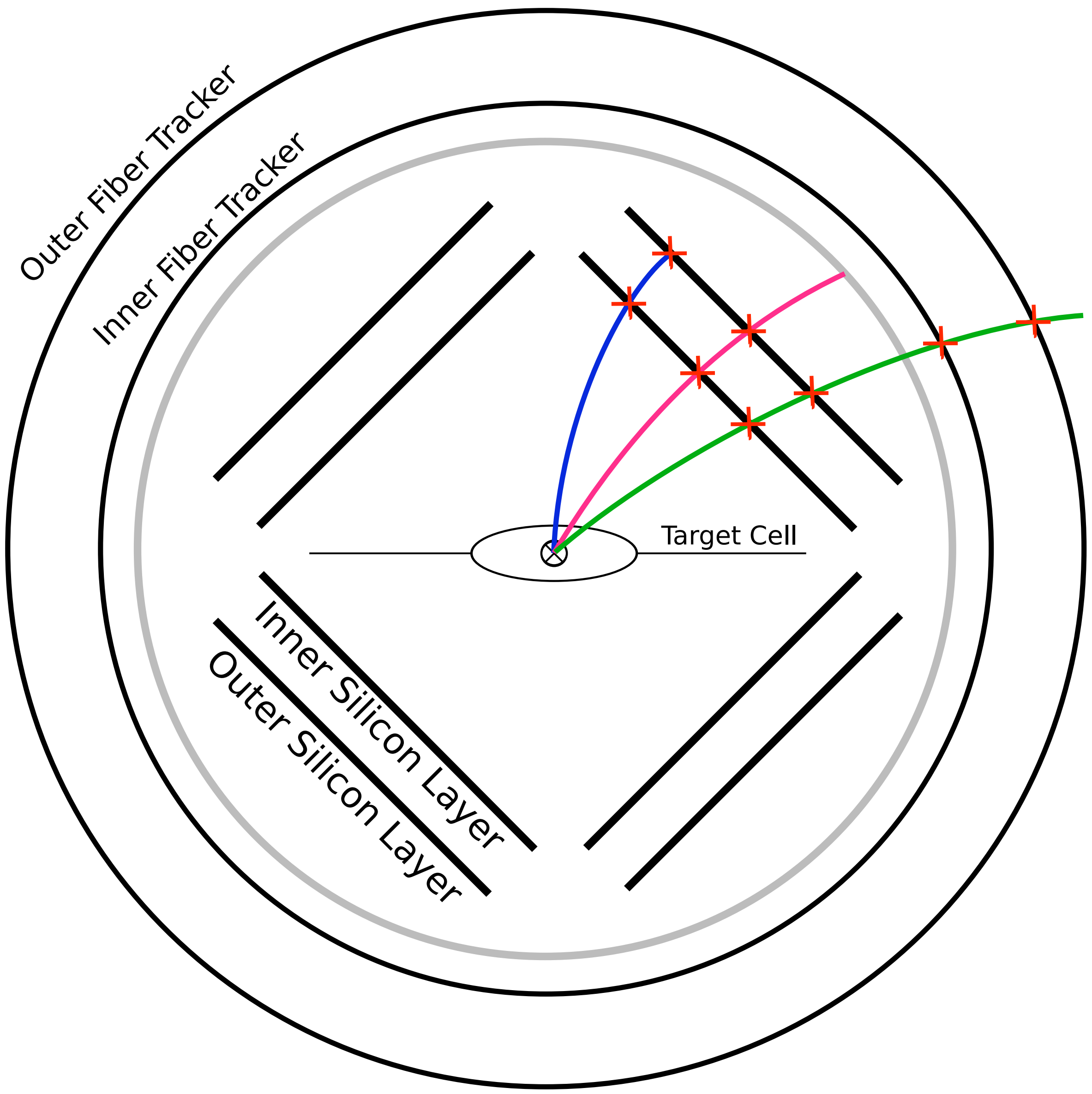
$125\ \mathrm{MeV/c} < p < 145\ \mathrm{MeV/c}$

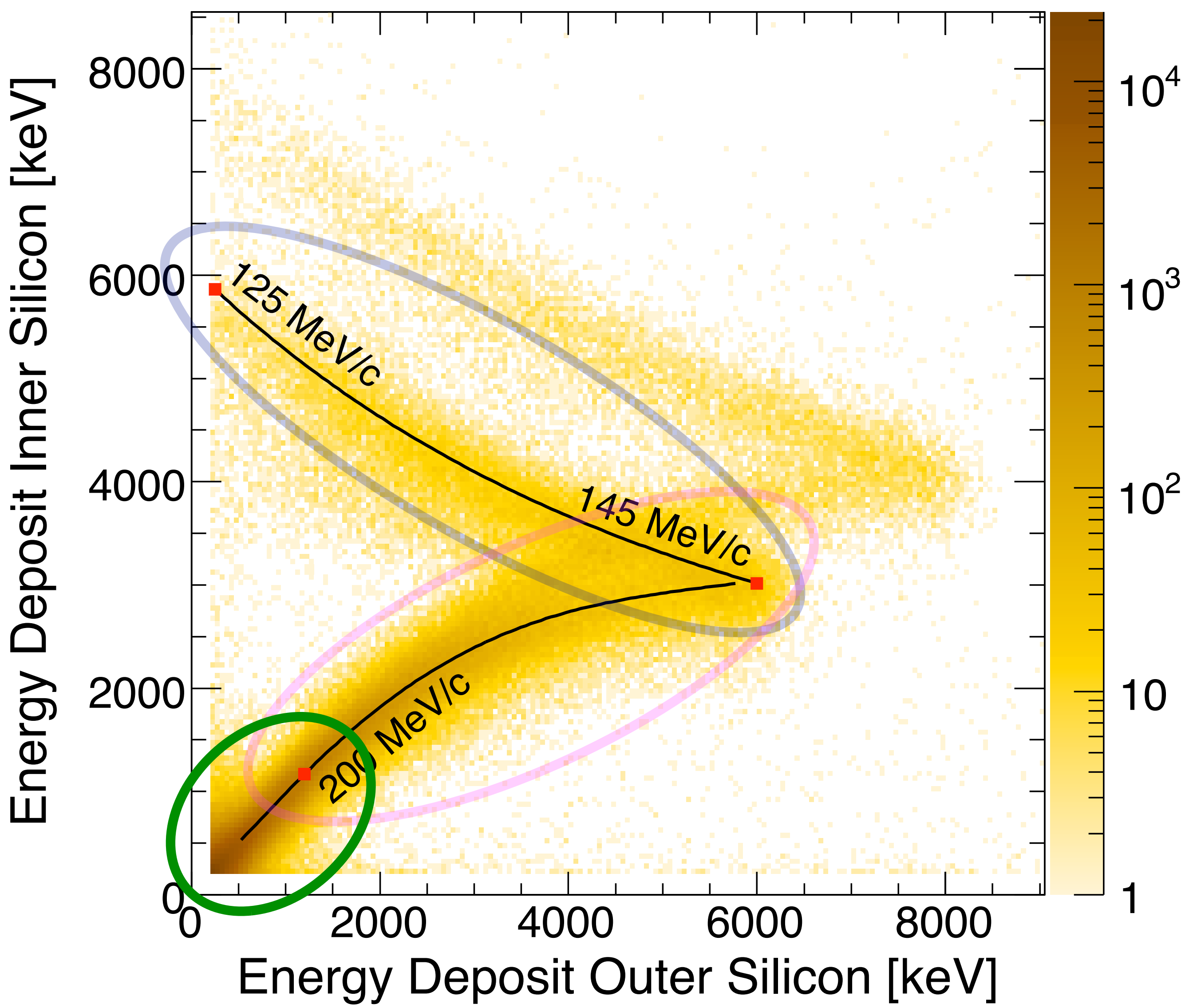
Medium-energy protons

- Momentum via dE/dx

$145\ \mathrm{MeV/c} < p < 250\ \mathrm{MeV/c}$

Momentum Reconstruction





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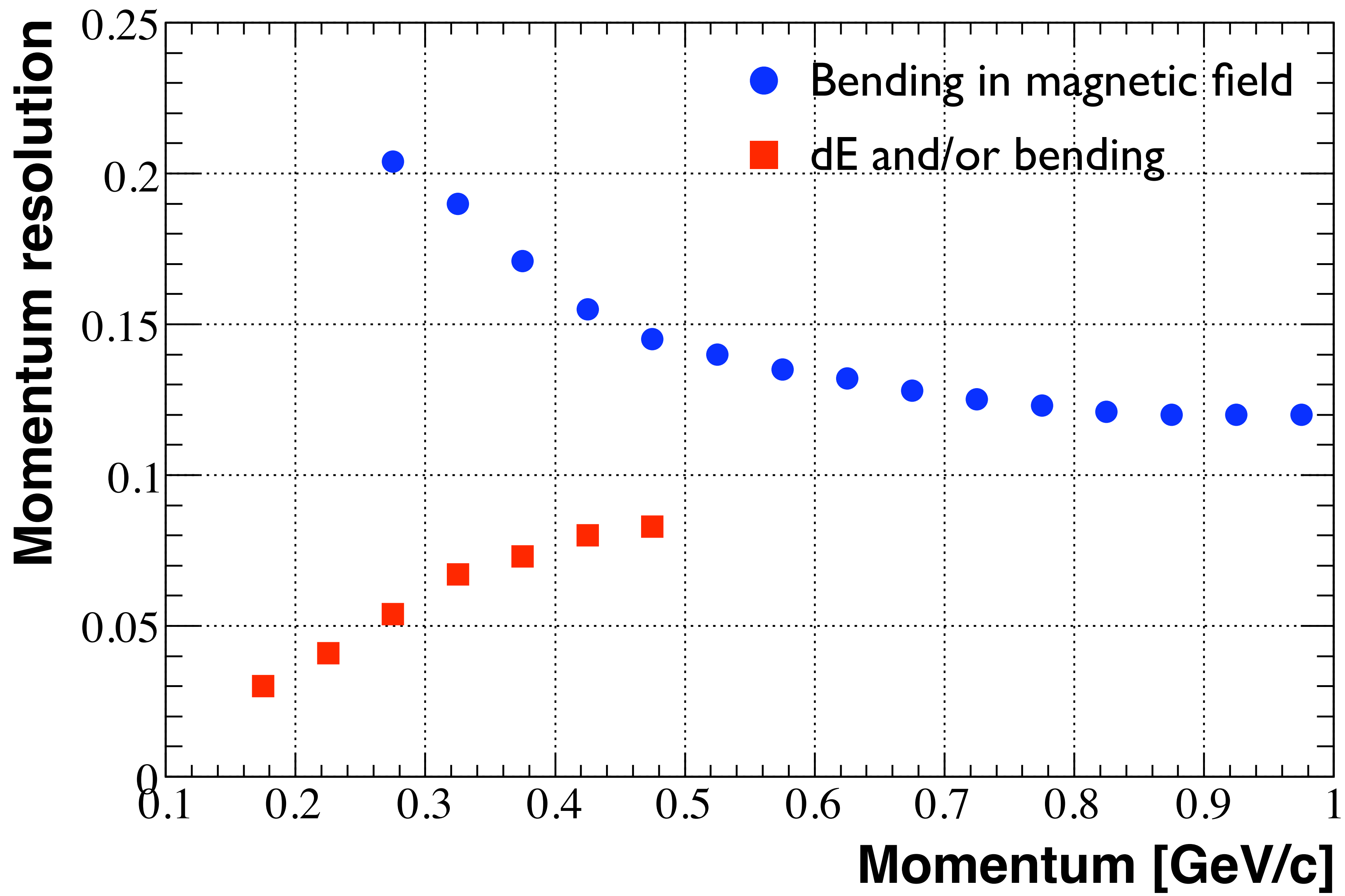
High-energy particles (protons/pions)

- Momentum via bending in magnetic field

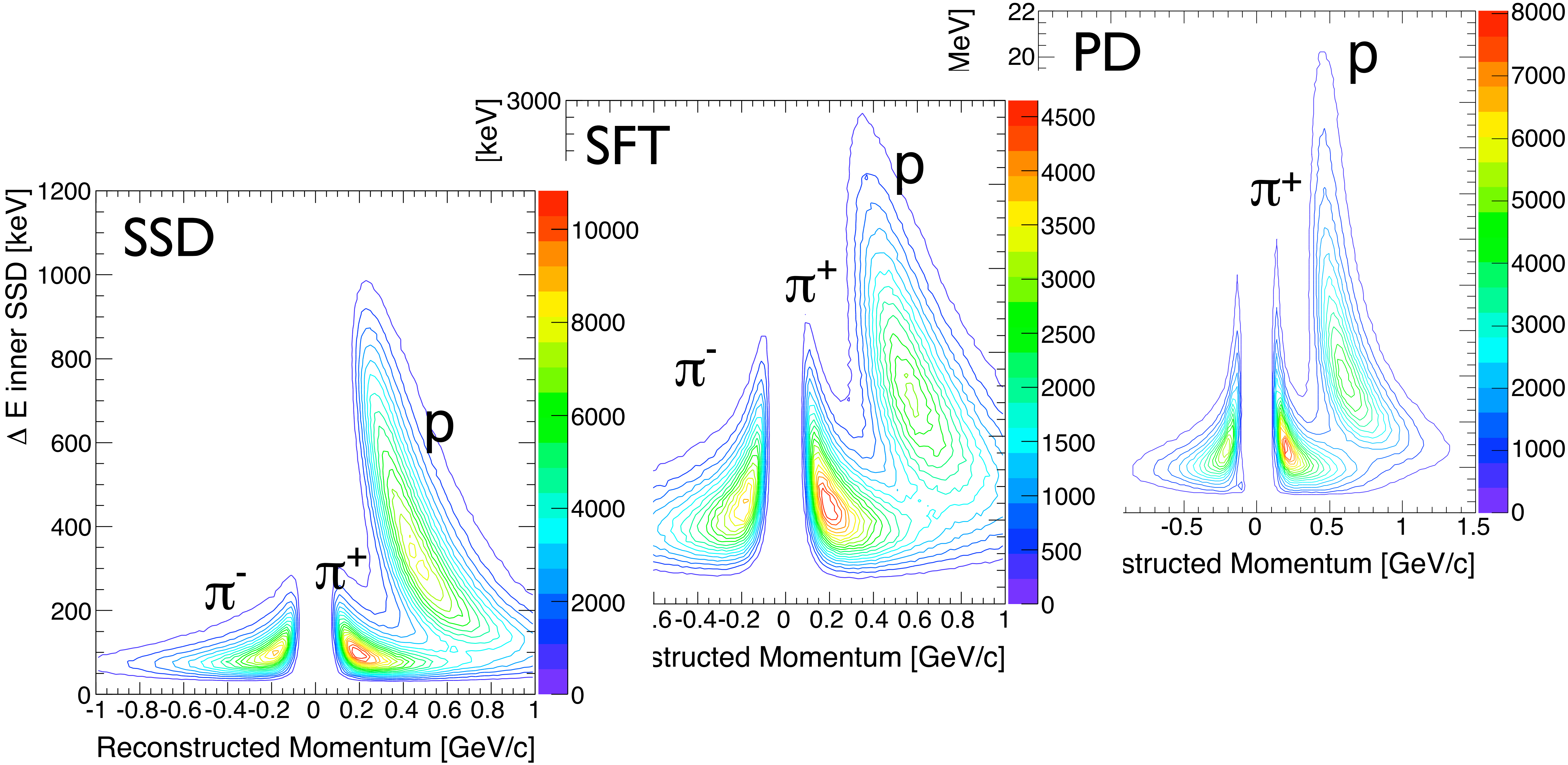
$p > 200\ \mathrm{MeV/c}$

Momentum Reconstruction

- Energy loss is taken into account for „long“ tracks ($p > 200\ \mathrm{MeV/c}$)
  - Each track is reconstructed twice
    - Pion
    - Proton
  - Significantly improves momentum resolution

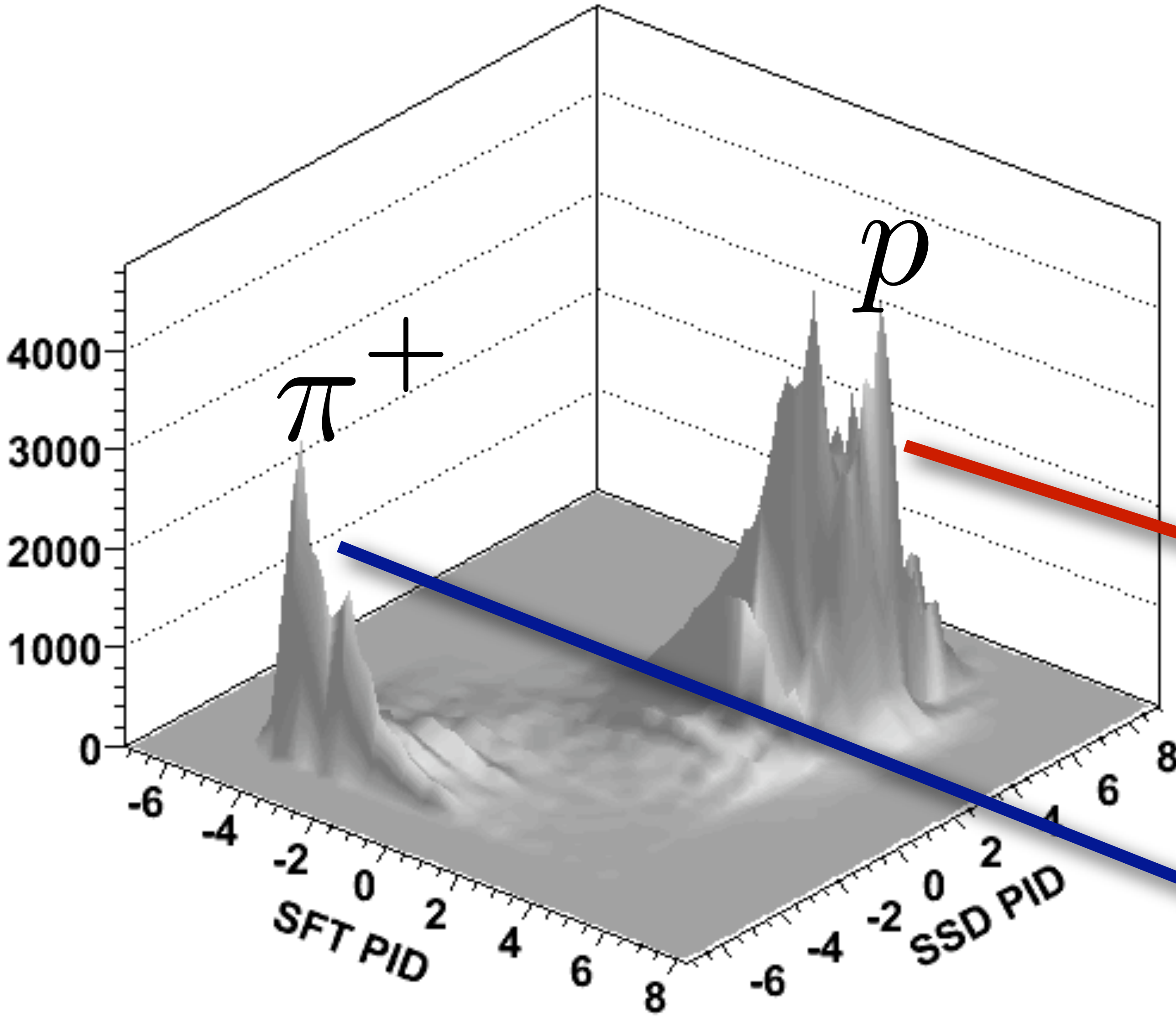


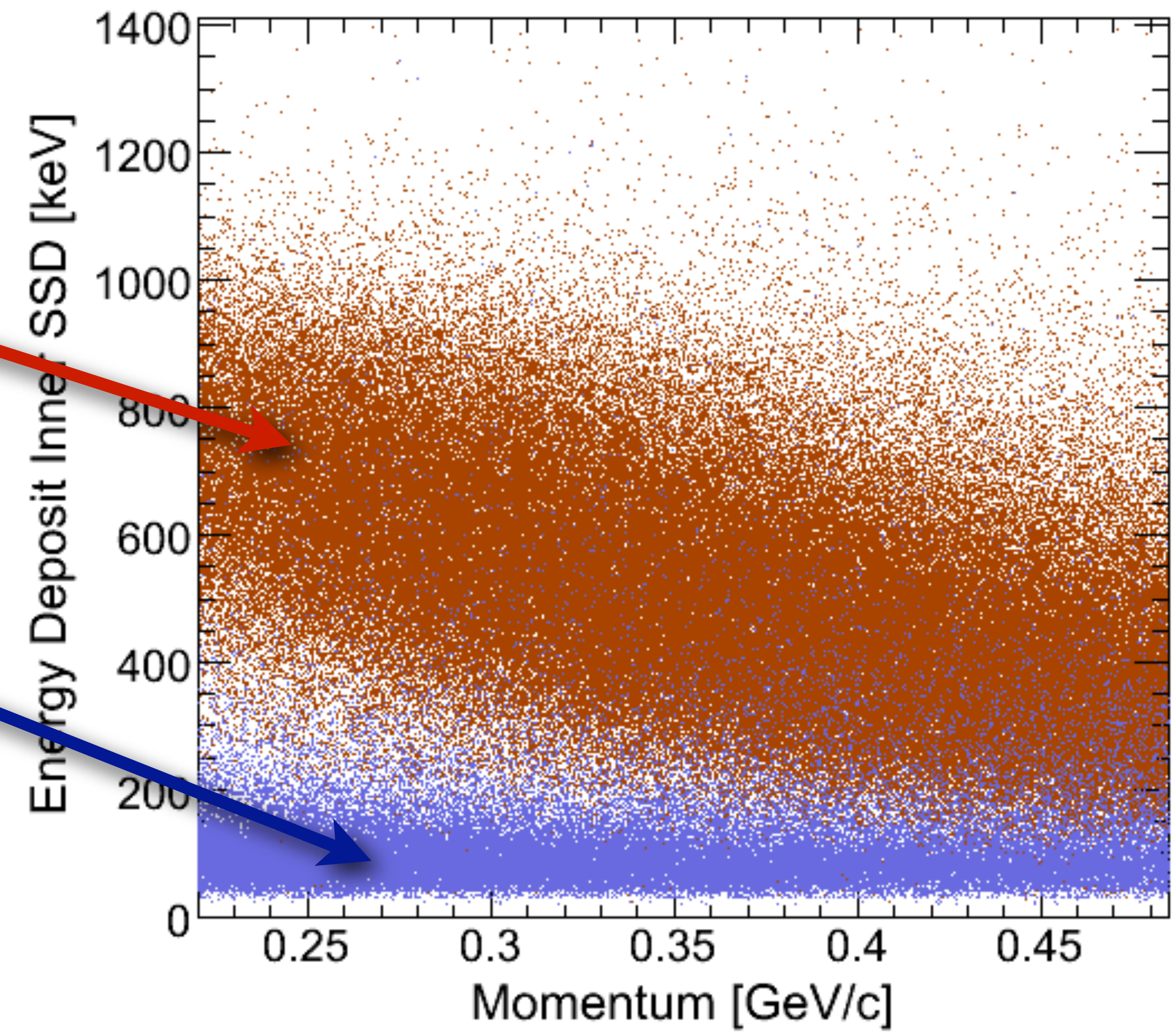
Particle Identification



- p/π^+ separation via energy deposits and parent distributions
- Information from up to 9 layers can be used (2 SSD, 4 SFT and 3 PD)
- $p < \approx 0.6$ GeV/c : SSD & SFT
- $p > \approx 0.6$ GeV/c : SSD & SFT & PD

Particle Identification





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

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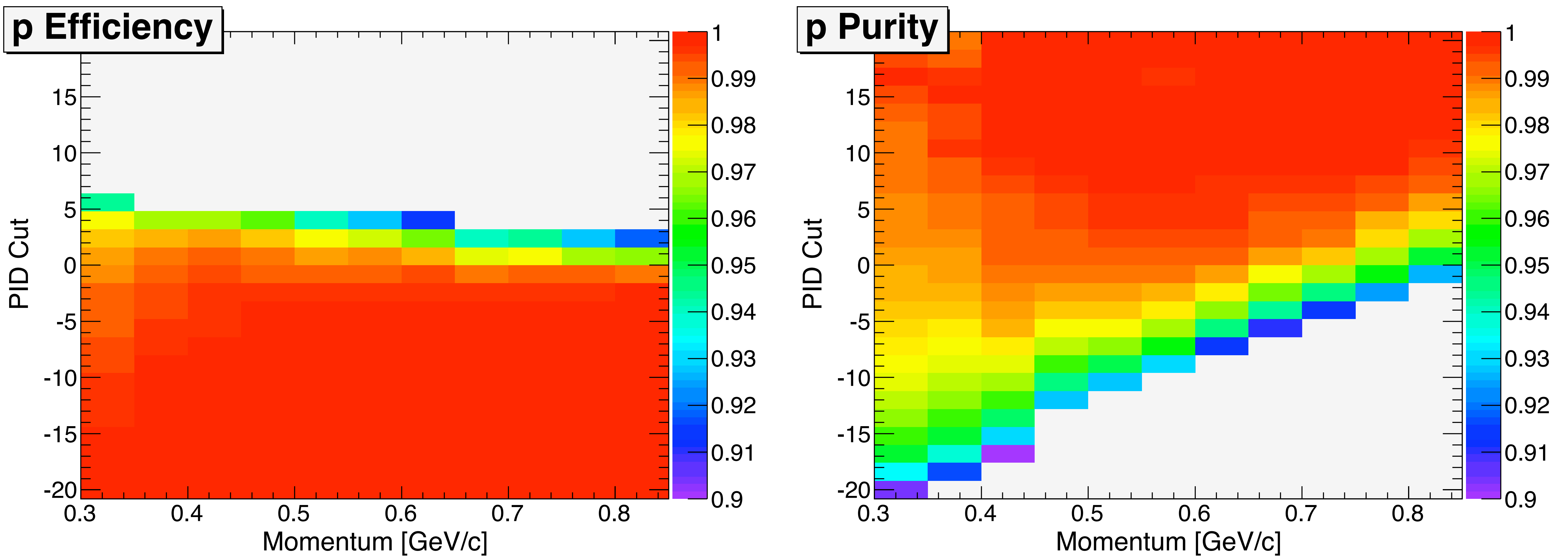
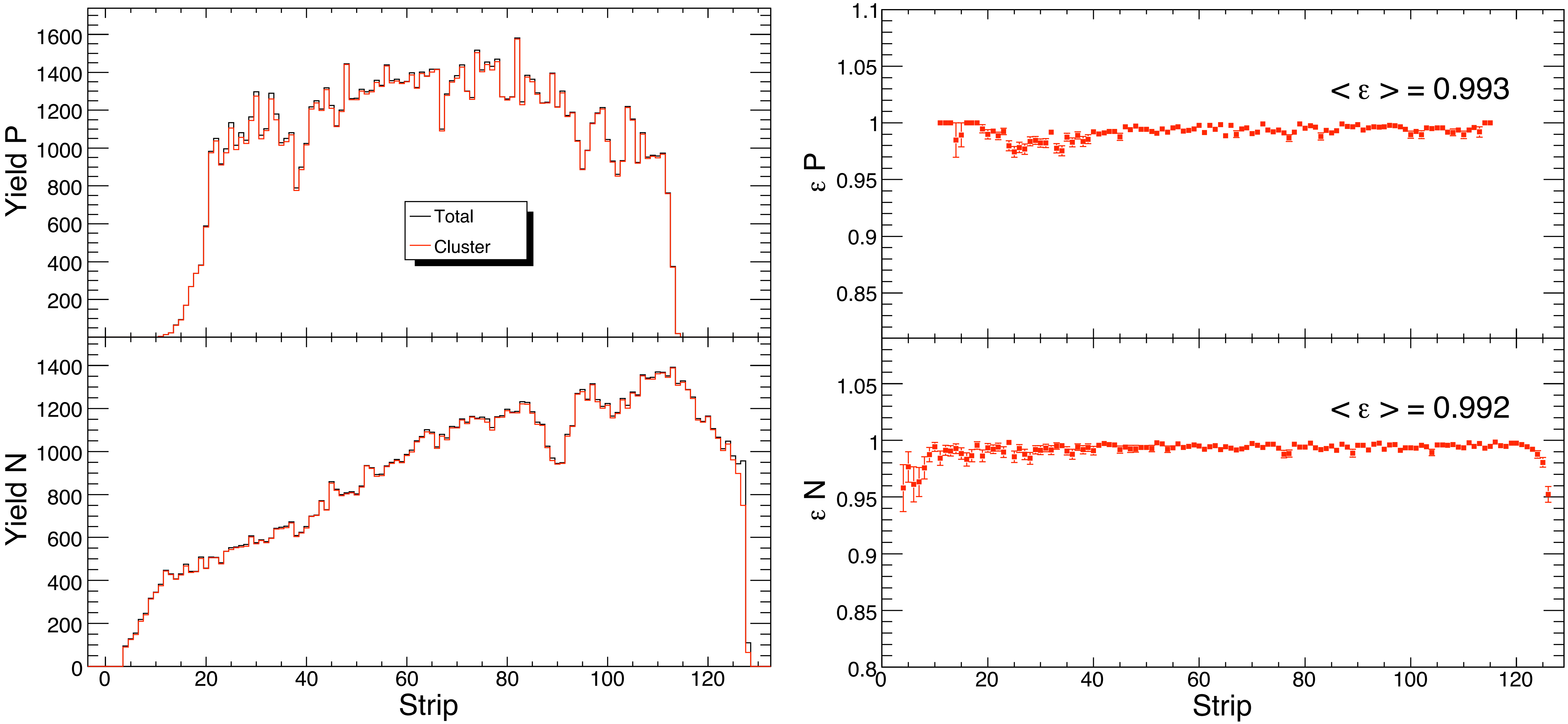
- $p > \approx 0.6\ \mathrm{GeV/c}$: SSD & SFT & PD

Particle Identification Performance

- Extract parent distributions from reconstructed MC data
  - Same method as for real data
- Combine individual PID values: $PID_{\text{total}} = \sum PID_i$
- Proton: $PID_{\text{total}} > PID_{\text{cut}}$
- Pion: $PID_{\text{total}} < PID_{\text{cut}}$
- Use true particle ID from MC to study PID performance

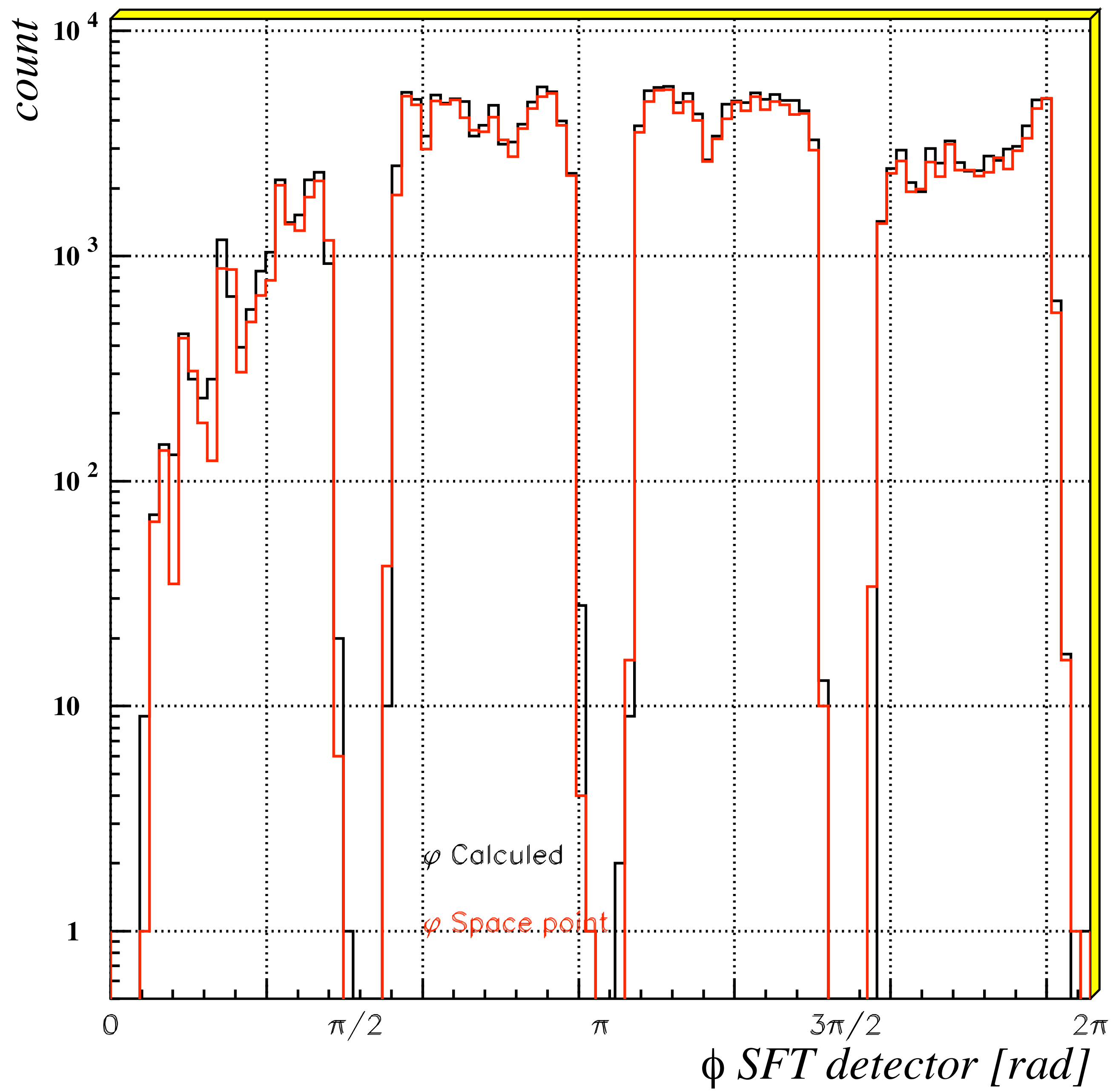


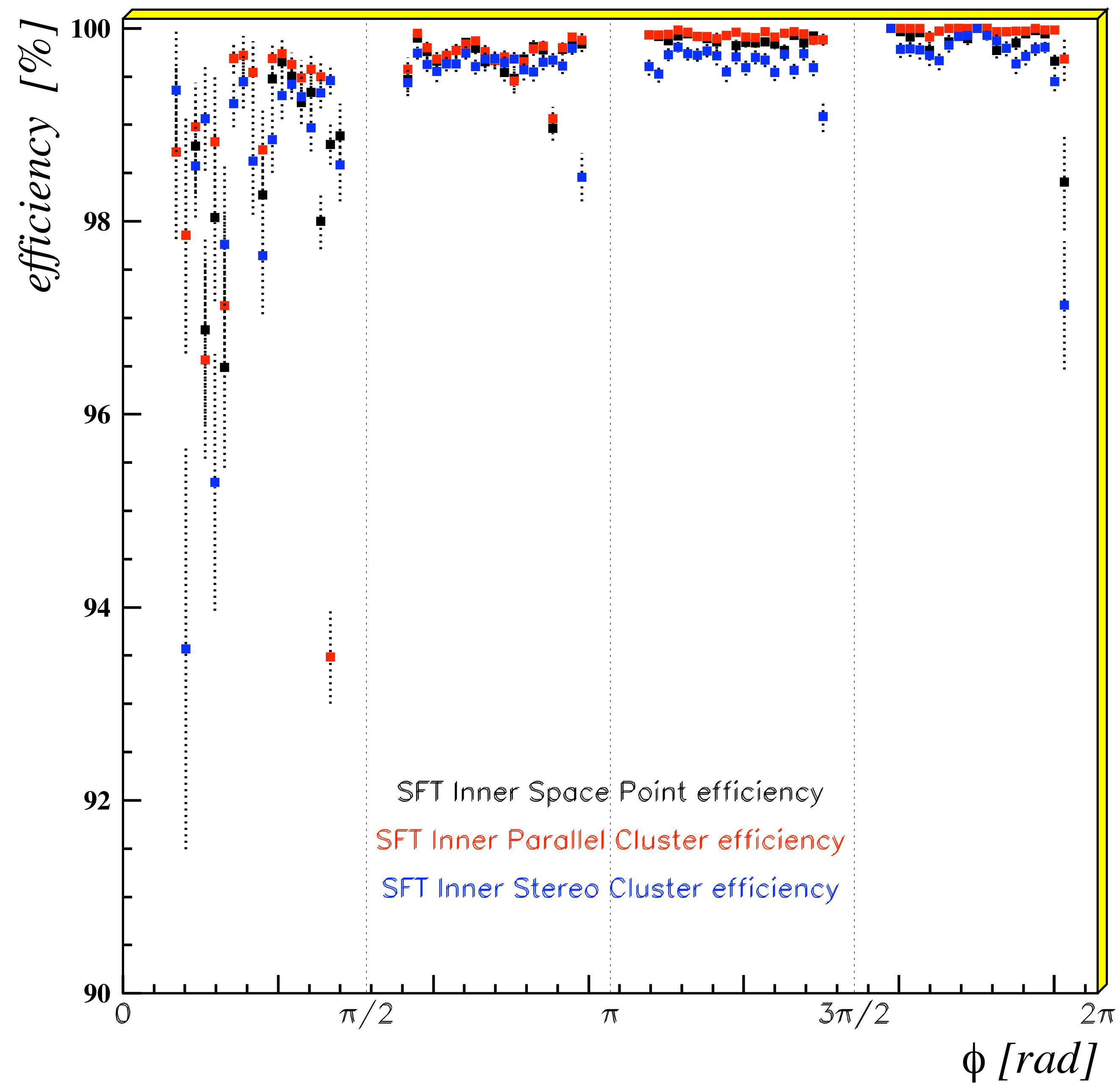
SSD Proton Efficiency



- 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



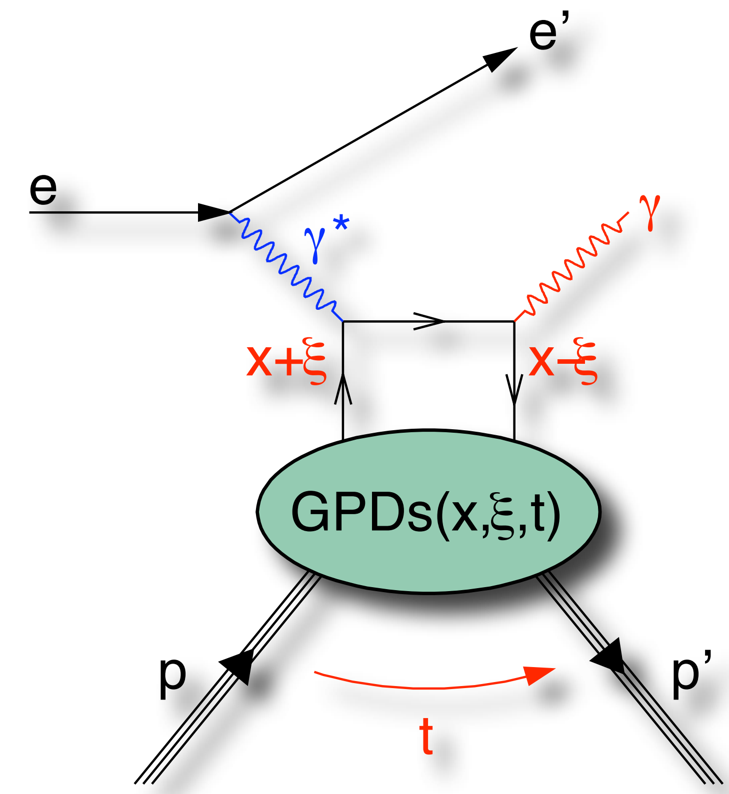


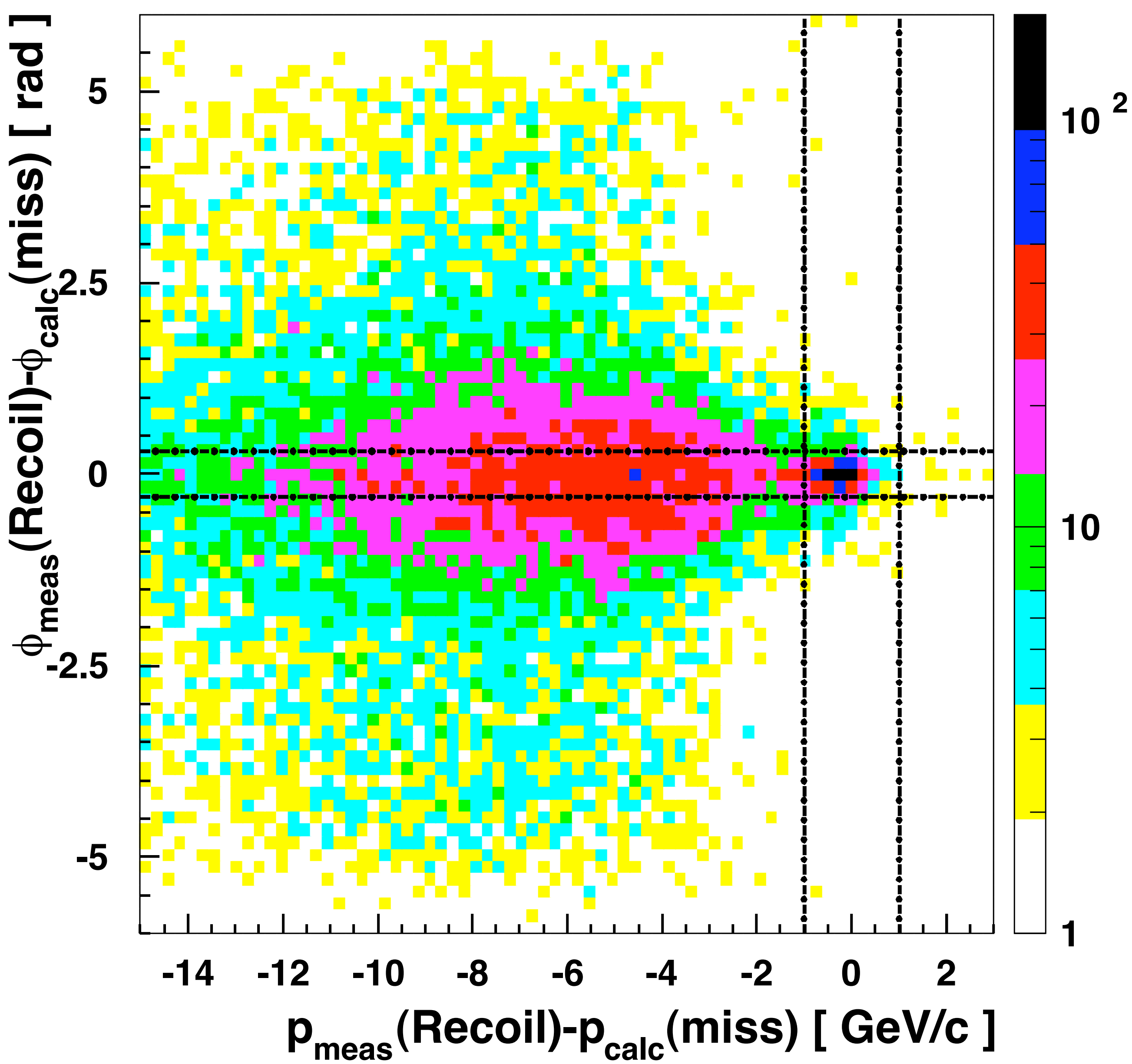
- Lower statistics and lower efficiency in first quadrant
- $\varphi < \pi/2: \quad \langle\varepsilon\rangle \approx 98.5\ \%$
- $\varphi > \pi/2: \quad \langle\varepsilon\rangle \approx 99.5\ \%$

A first look at DVCS with Recoil

- „Classic“ style HERMES DVCS analysis
  - Scattered beam lepton and one photon in forward spectrometer

    ➡ DVCS event candidate





- Calculate kinematics of recoiling proton
- Look for correlated track in RD
  - Use track with highest momentum and positive charge
  - No PID information used to select protons
  - $\Delta p = p_{\text{measured}} - p_{\text{calc.}}$
  - $\Delta \phi = \phi_{\text{measured}} - \phi_{\text{calc.}}$

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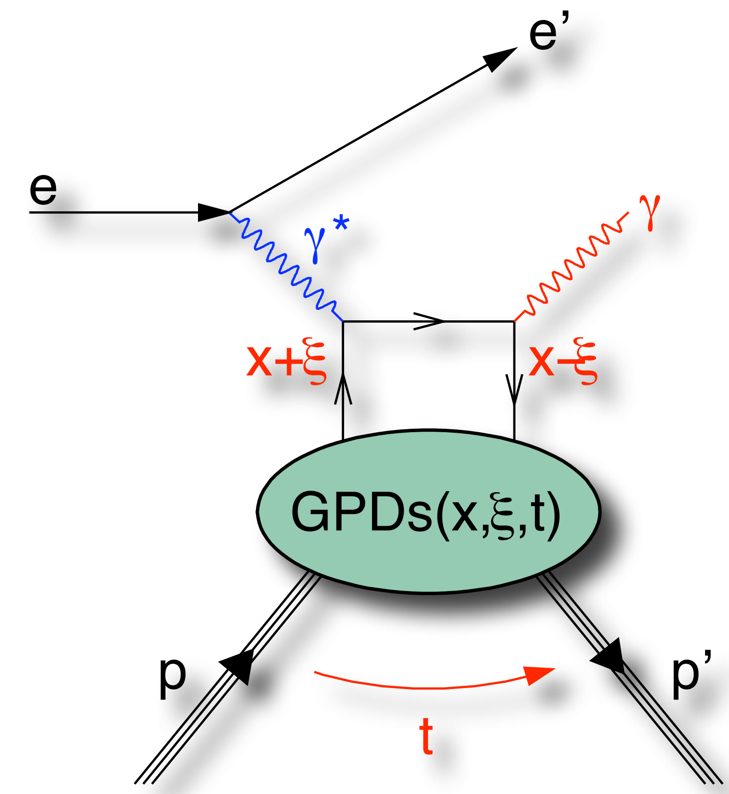

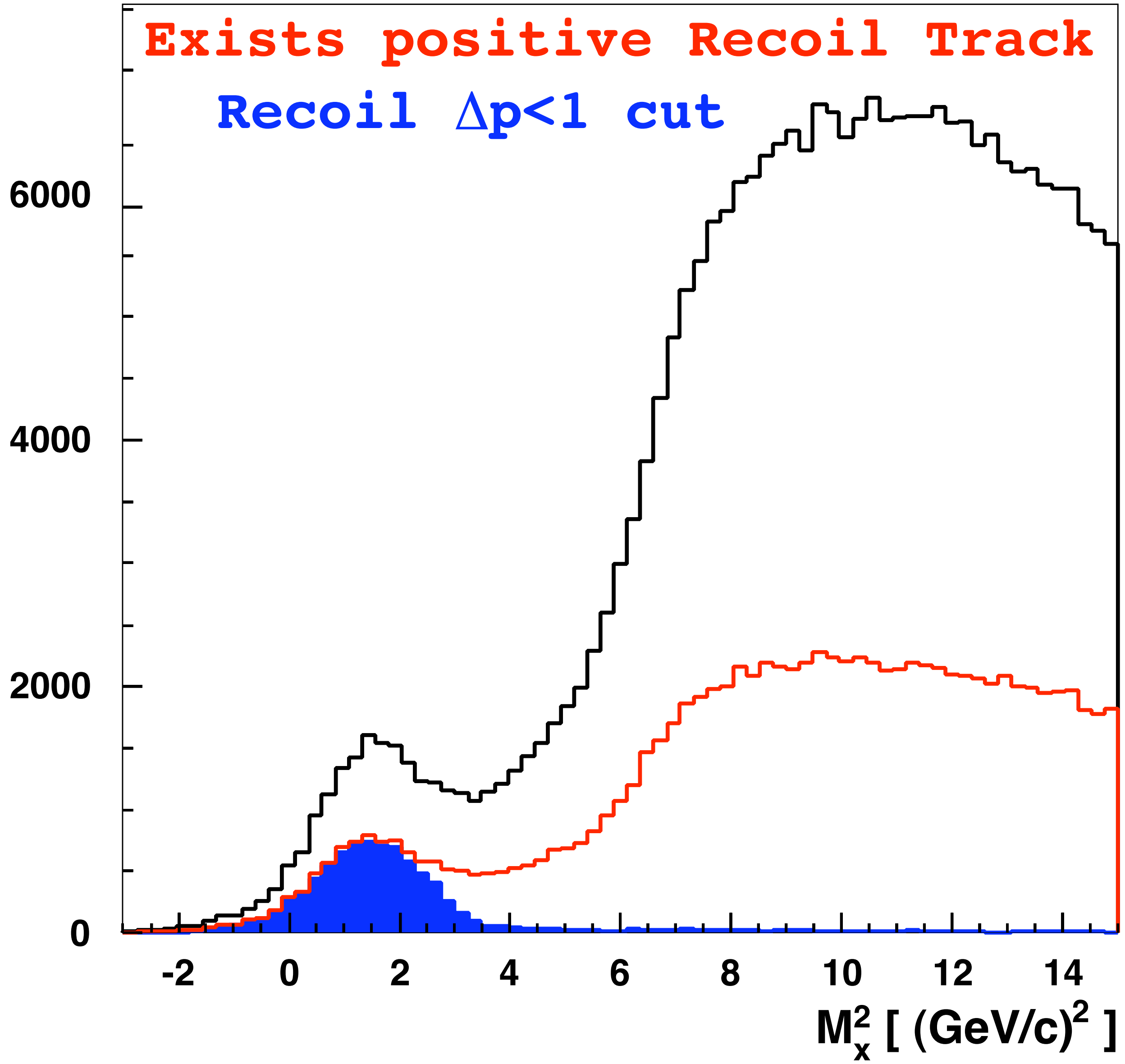

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  - $|\Delta p| < 1\ \text{GeV}/c$

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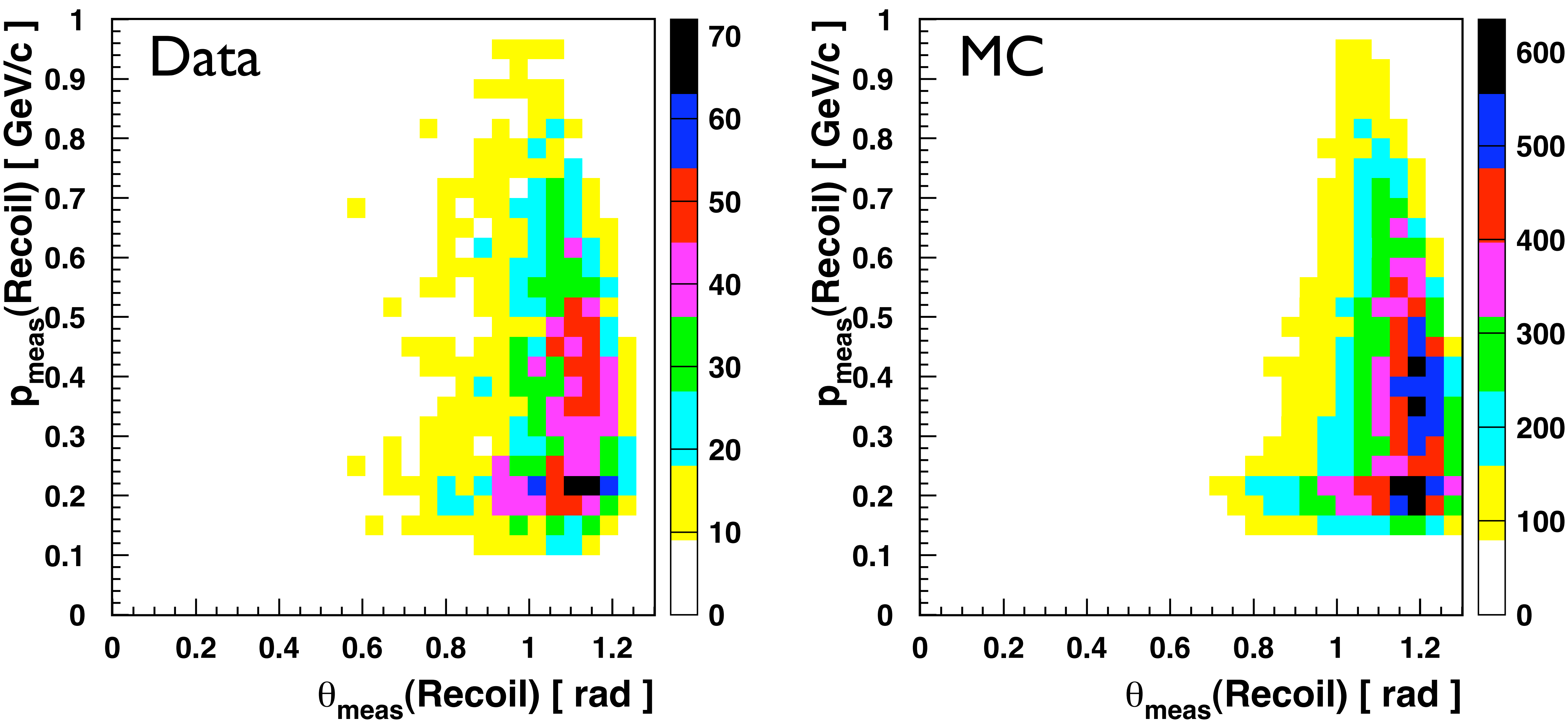

- Correlated track in recoil detector exists
- $|\Delta p| < 1 \text{ GeV/c}$
- Good agreement between Data and MC

Summary and Outlook

- Great progress in understanding the detector
  - All three sub-detectors calibrated
  - PID and Proton efficiencies look good
- First look at physics using Recoil Detector tracks looks promising
  - Deeply Virtual Compton Scattering
  - Exclusive ρ^0- production
- Exclusive physics
  - Improve event selection
  - Use PID to select recoiling proton
  - Include single hits in inner SSD to extend to even lower t
- Extract neutron structure function via spectator proton tagging
- Refinement of SSD energy calibration
- Fine-tuning of track reconstruction