Studies on Muon Collider's Target with G4Beamline (11/17/2025)

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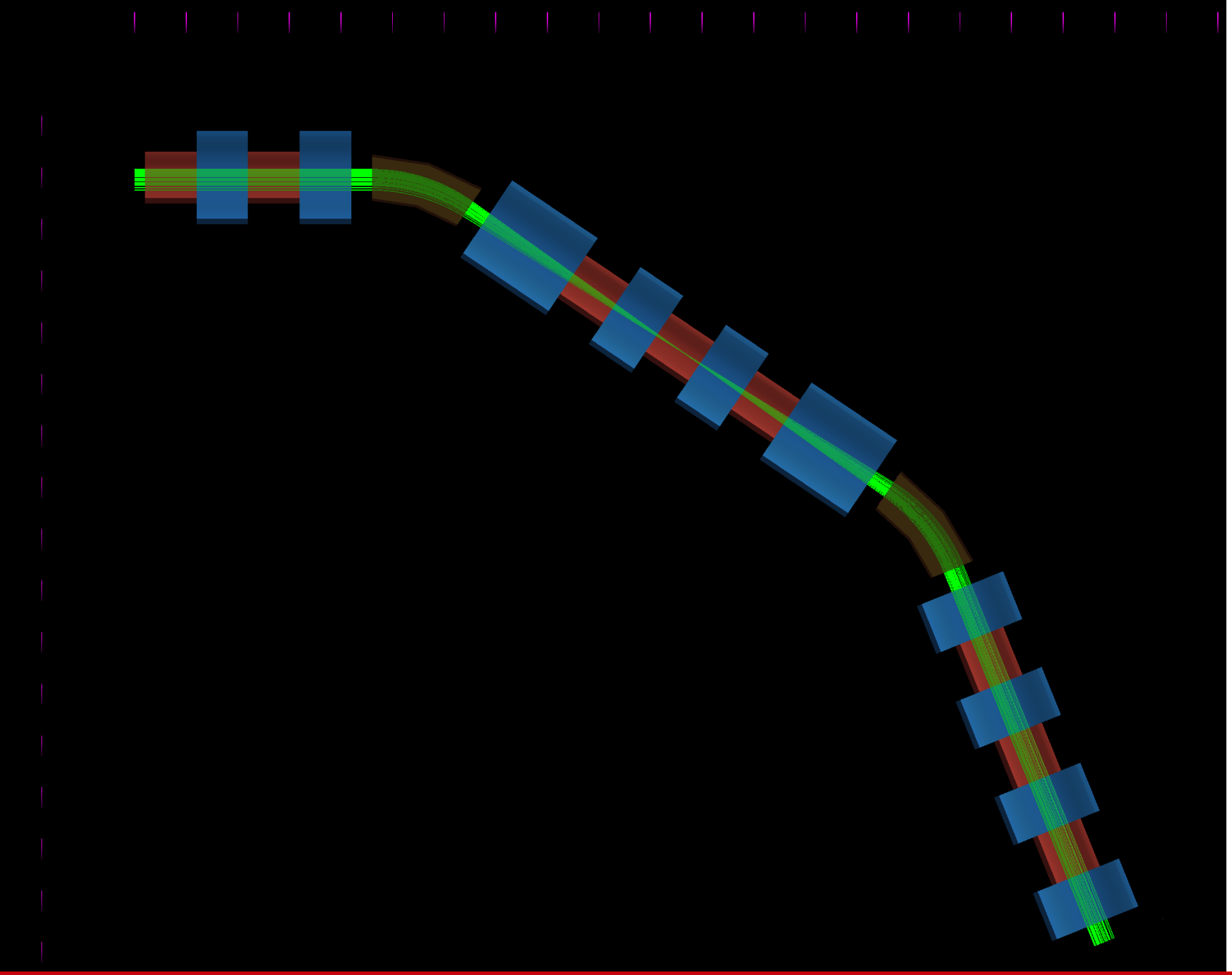
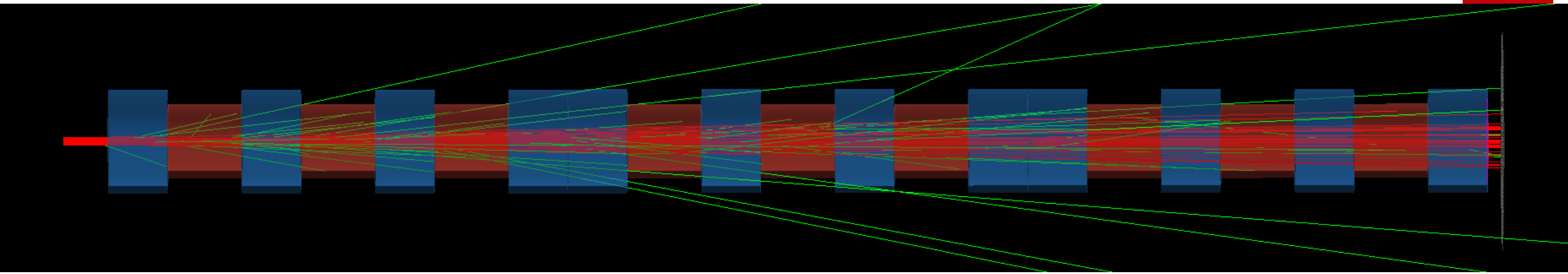
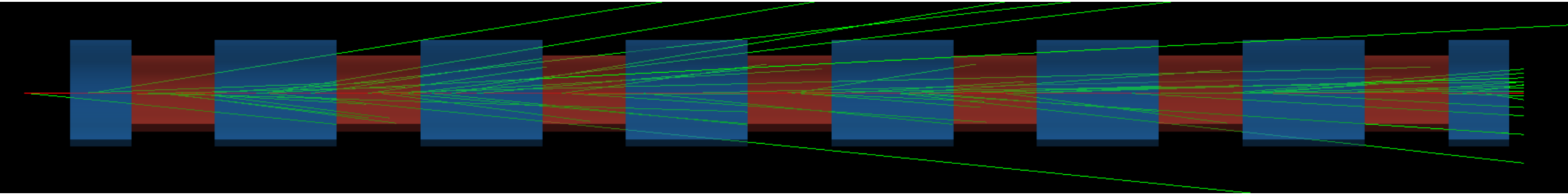


Pion Decay Channel (Triplet)

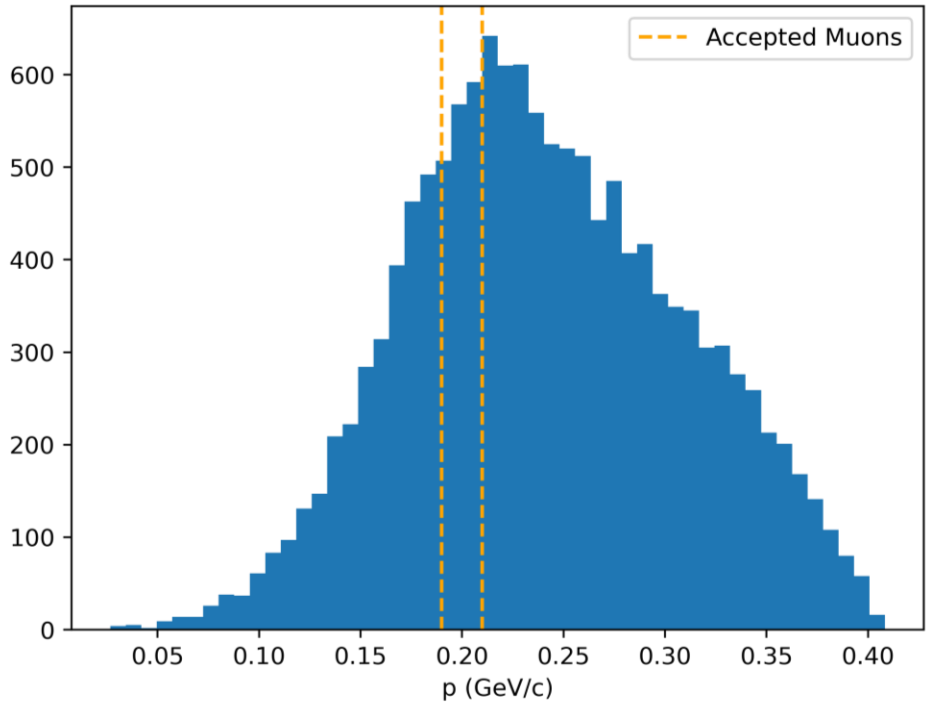


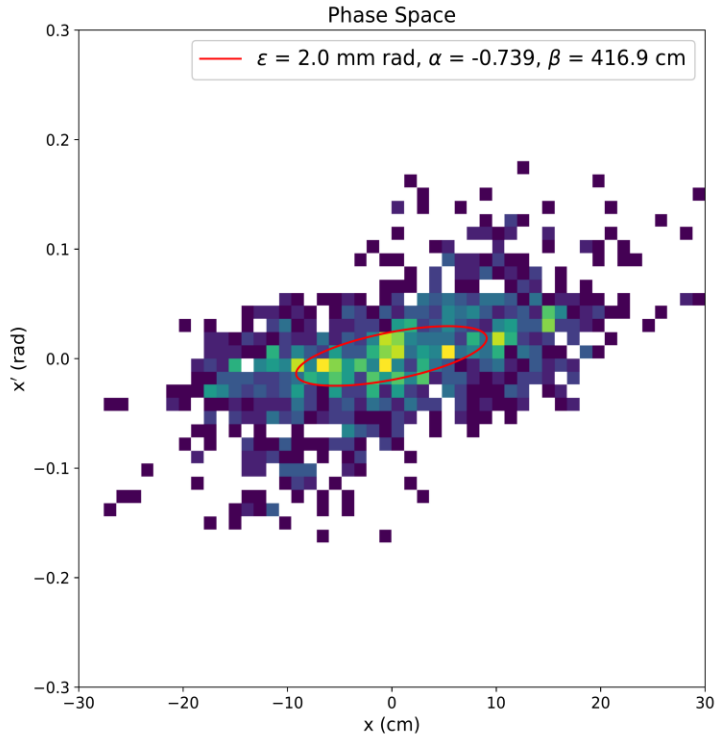
Pion Decay Channel (FODO)

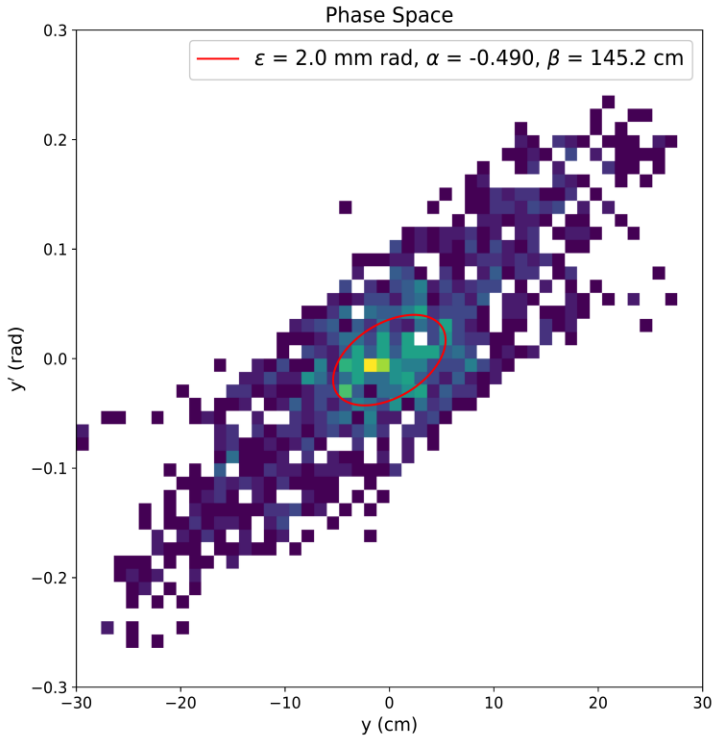


Pion Decay Channel (Triplet) (IMCC)

- Muons from decays of pions with **270 ± 50% MeV/c** momentum and maxiumum **2 mm rad** single particle emittance
- Muons with **190-210 MeV/c** momentum
  - diffuse beam – **red** ellipse indicates **2 mm rad** single particle emittance



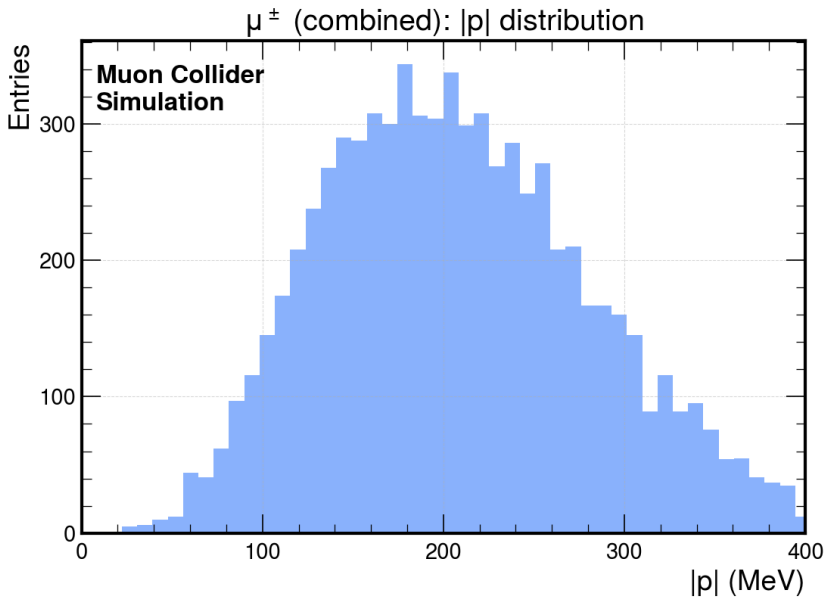


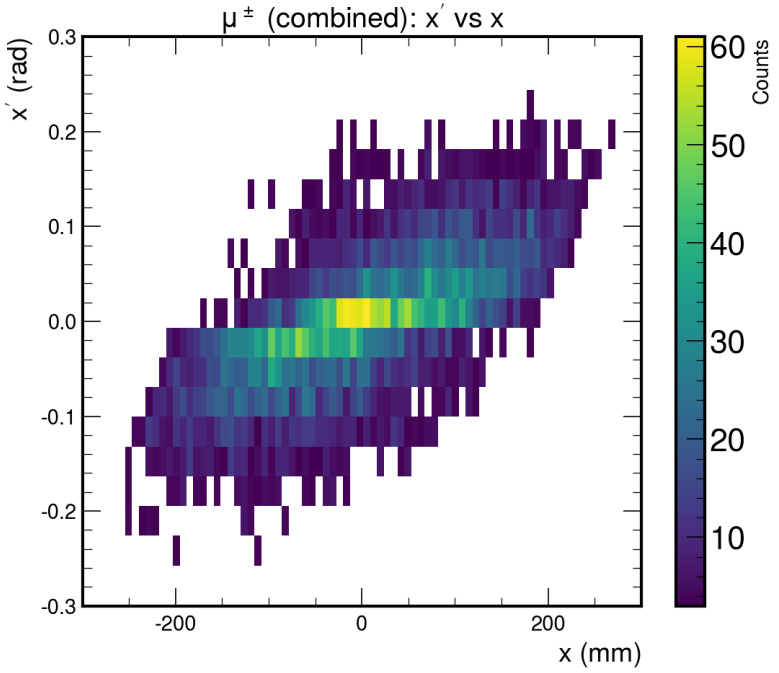


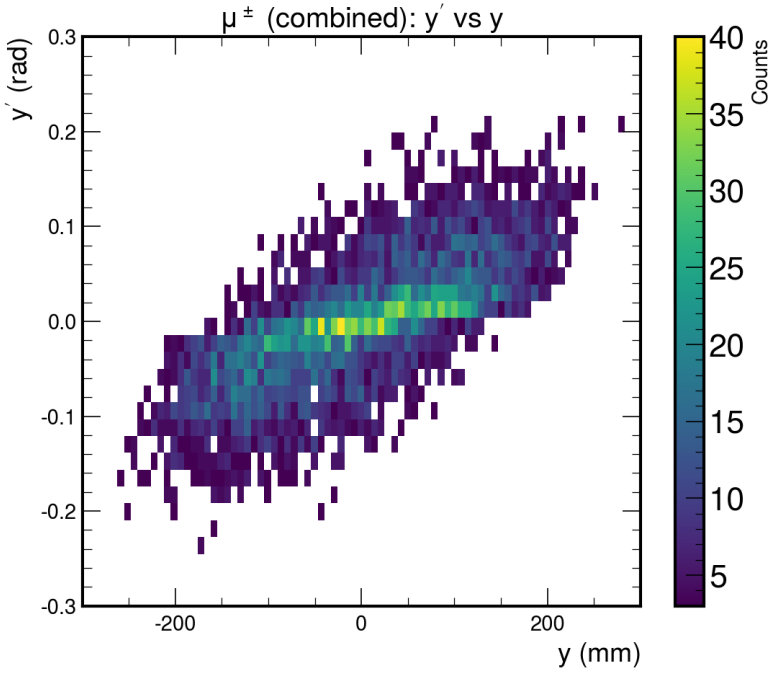
Pion Decay Channel (Triplet) (my results)

- Simulated pion-decay channel (triplet section) using **Gaussian π^+/π^- beams** as input:

  beam gaussian particle=pi± meanMomentum=270 sigmaP=90.0 sigmaX=10 sigmaY=10 sigmaXp=0.01 sigmaYp=0.01 nEvents=50000 beamZ=-500.0
- The **μ^+/μ^- combined |p| distribution** agrees well with the IMCC results — same overall peak and momentum spread.
- **Phase-space plots (x′ vs x, y′ vs y)** show the expected ellipticalappear **slightly skewed** compared to the IMCC reference.

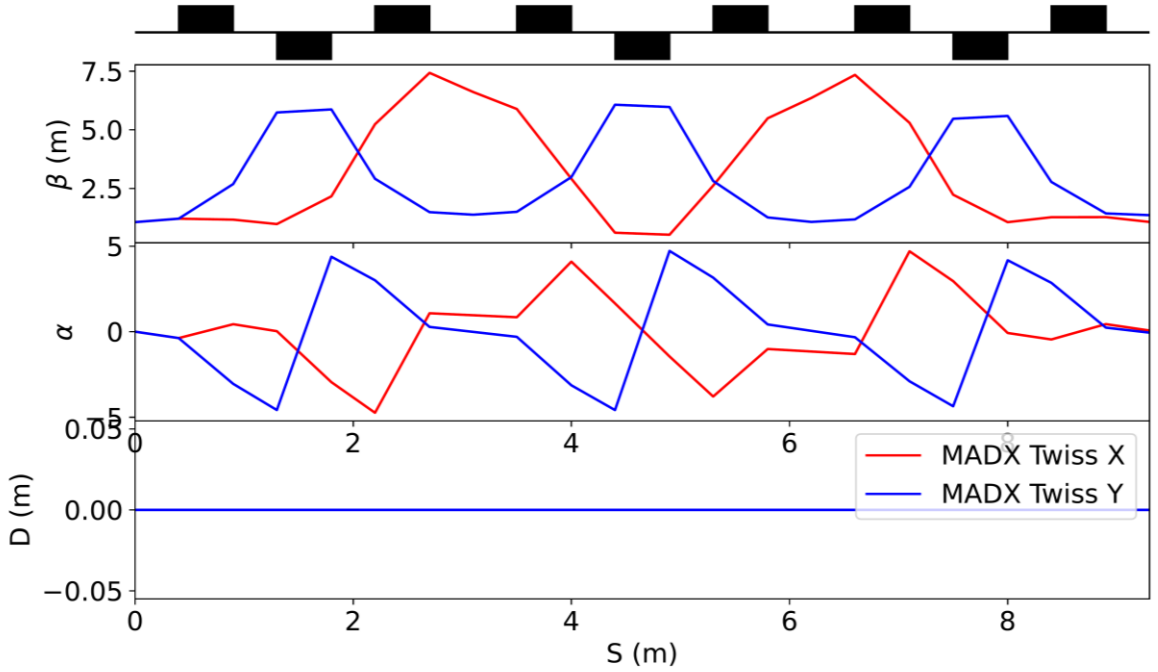






Pion Decay Channel (Triplet) (IMCC)

- Based on three **quadrupole triplets**
  - Same solution currently considered for **TT7** and **CTF3**
  - 9.5 m lattice, ~ **40%** pions decay at 300 MeV/c
- Large pion momentum acceptance: ~ ± 50%
- Low pion beta function to reduce losses



Pion Decay Channel (Triplet) (my results)

Define slopes (paraxial)

- Use *fixed* p_0(optics reference) to avoid momentum-coupling bias
- $x' = \frac{P_x}{p_0}, y' = \frac{P_y}{p_0}$

Momentum deviation & optional cut

- Relative deviation: $\delta = \frac{|\mathbf{p}| - p_0}{p_0}$
- Keep *core* beam only: $|\ \delta\ | \leq 0.25$

Remove horizontal dispersion (per slice)

- Regress linearly (least squares):
- $x \approx D\,\delta, x' \approx D'$
- Subtract fitted pieces: $x_\beta = x - D\delta,\ \ x'_\beta = x' - D'\delta$

Compute centered second moments (betatron)

- With mean-centering, per slice: $\left\langle x_\beta^2 \right\rangle, \left\langle x_\beta'^2 \right\rangle, \left\langle x_\beta x'_\beta \right\rangle$

Twiss from moments (per slice)

- Determinant: $\Delta = \langle x_\beta^2 \rangle \langle x_\beta'^2 \rangle - \langle x_\beta x'_\beta \rangle^2$
- Geometric emittance: $\varepsilon_x = \sqrt{\Delta}$

Beta/alpha:

- $\beta_x = \frac{\langle x_\beta^2 \rangle}{\varepsilon_x}, \alpha_x = -\frac{\langle x_\beta x'_\beta \rangle}{\varepsilon_x}$
- Repeat for $y \to (\varepsilon_y, \beta_y, \alpha_y)$