



π^0 Mass Reconstruction from g4 Truth Parameters

Hannah Rogers

π^0 Meeting - June 11, 2019

Sample Creation

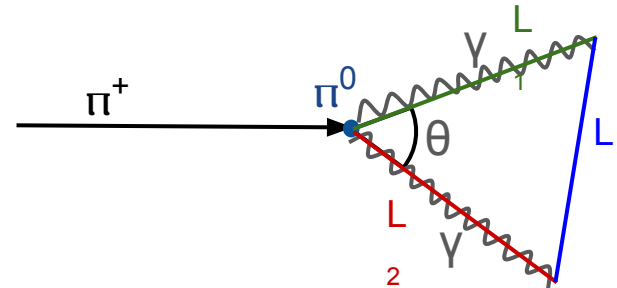
- Gen: π^+ (6700 each of 1 GeV and 2 GeV)
 - Based on protoDUNE_gensingle.fcl
 - Located in protoDUNE test beam
 - ✓ **Completed!**
- G4 with sim deposits
 - Simulated with and without data-driven space charge
 - **In progress**
- Detsim from g4 with sim deposits
 - ✗ **Not yet begun**
- G4 and detsim without sim deposits
 - G4 simulated with and without data-driven space charge
 - This g4 stage was used for further analysis
 - ✓ **Completed!**

π^0 Mass Reconstruction

$$m_{\pi^0} = \sqrt{2E_{\gamma_1} E_{\gamma_2} (1 - \cos \theta)}$$

- Use MCParticle to find gamma daughters from π^0 s
 - Energy, initial position, and final position of each gamma is given by MCParticle
 - Position information used to determine the length of each gamma (L_1 and L_2), the distance between the ends of the gammas (L), and calculate the angle between the gammas:

$$\cos \theta = \frac{L_1^2 + L_2^2 - L^2}{2L_1 L_2}$$



Applying Space Charge Distortions

- MCParticle uses truth information - no SCE distortions applied
 - To see effect, SCE distortions must be added
- Spatial distortions change $\cos\theta$
 - Apply SCE spatial distortions from data-driven map to start and end of gammas before calculating L_1 , L_2 , and L
- Electric field distortions change E_1 and E_2

$$E' = E_0 \times \frac{R(\mathcal{E}_0)}{R(\mathcal{E}')}$$

$$R(\mathcal{E}) = \frac{1}{\xi} \ln(\alpha + \xi)$$

$0.212 \frac{\text{kV}}{\text{cm}} \frac{\text{g}}{\text{cm}^3} \frac{\text{cm}}{\text{MeV}}$

$\xi = \frac{\beta}{\rho \mathcal{E}} \frac{dE}{dx}$

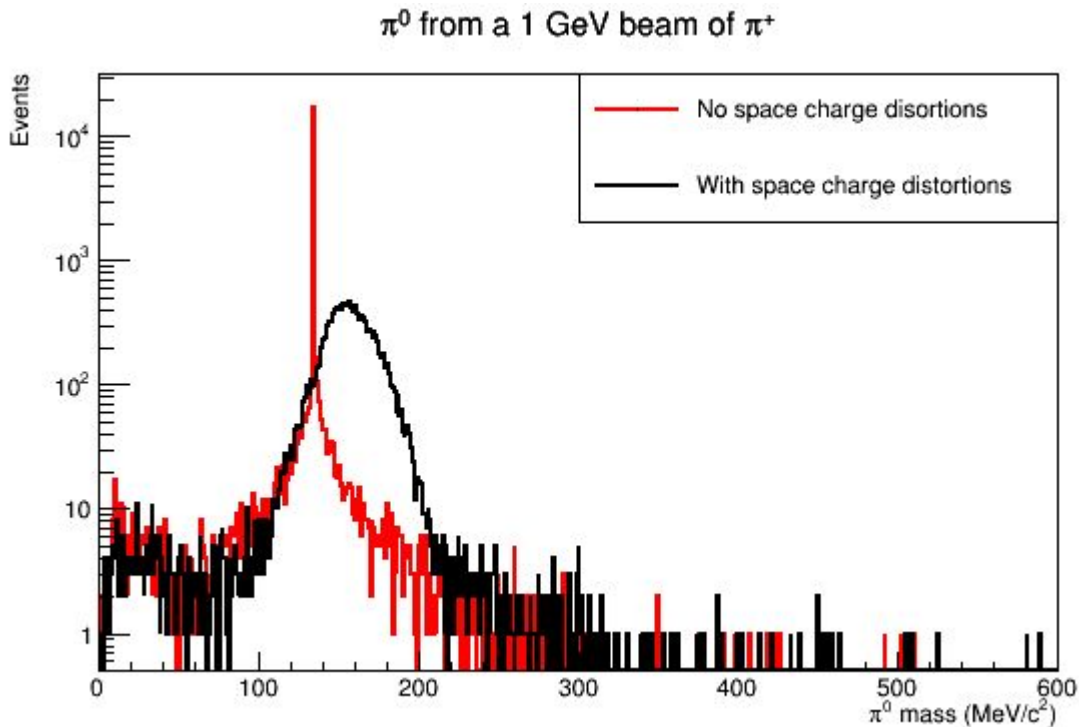
1.396 g/cm^3

0.93

2 MeV/cm
 (single MIP)

Results from 1 GeV

- π^0 mass with no SCE
134.9766 MeV
- π^0 mass with SCE
 157 ± 14 MeV
- Mass width is 2×10^6
times larger with SCE



Results from 2 GeV

- π^0 mass with no SCE
134.9766 MeV
- π^0 mass with SCE
159 \pm 14 MeV
- Mass width is 2×10^6 times larger with SCE

