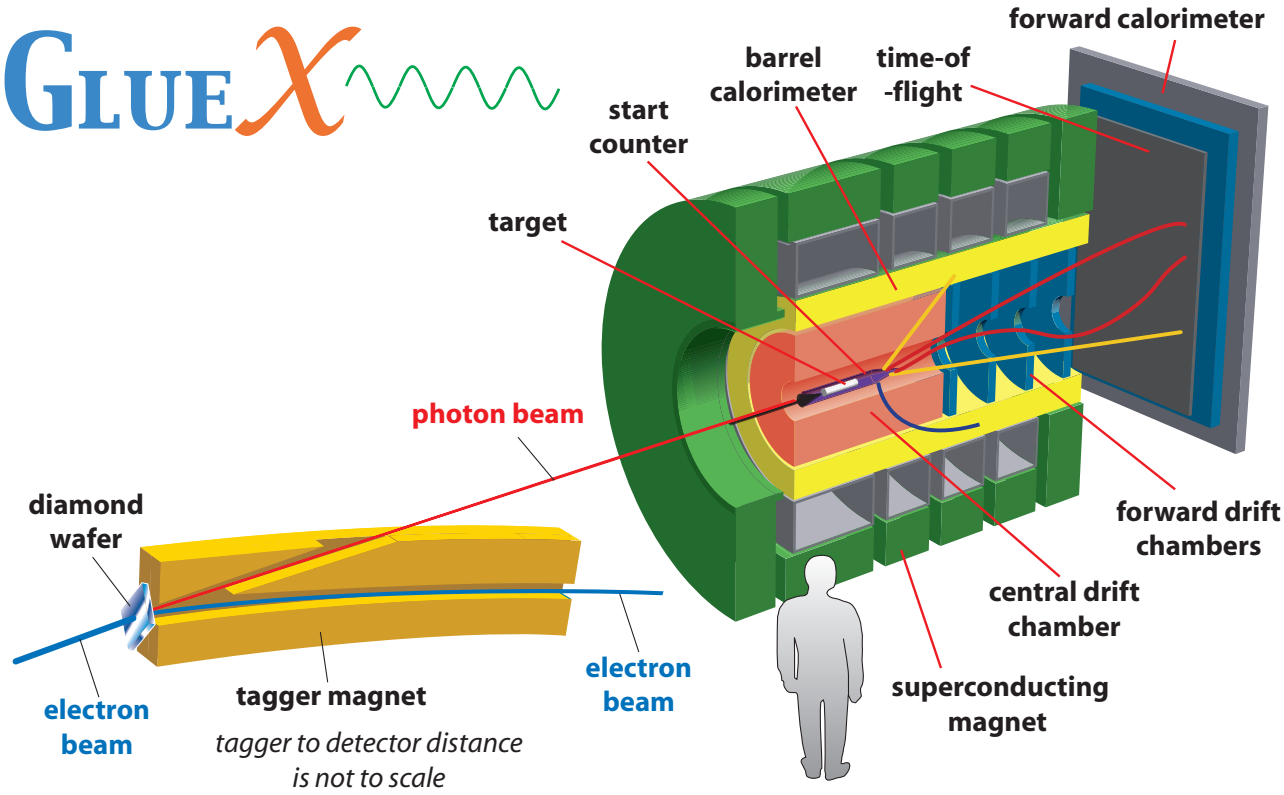
Preliminary Survey of the Photoproduction of $\pi^+\pi^-4\gamma$ Final State in GlueX Experiment

A. M. Foda, Z. Papandreou

Department of Physics

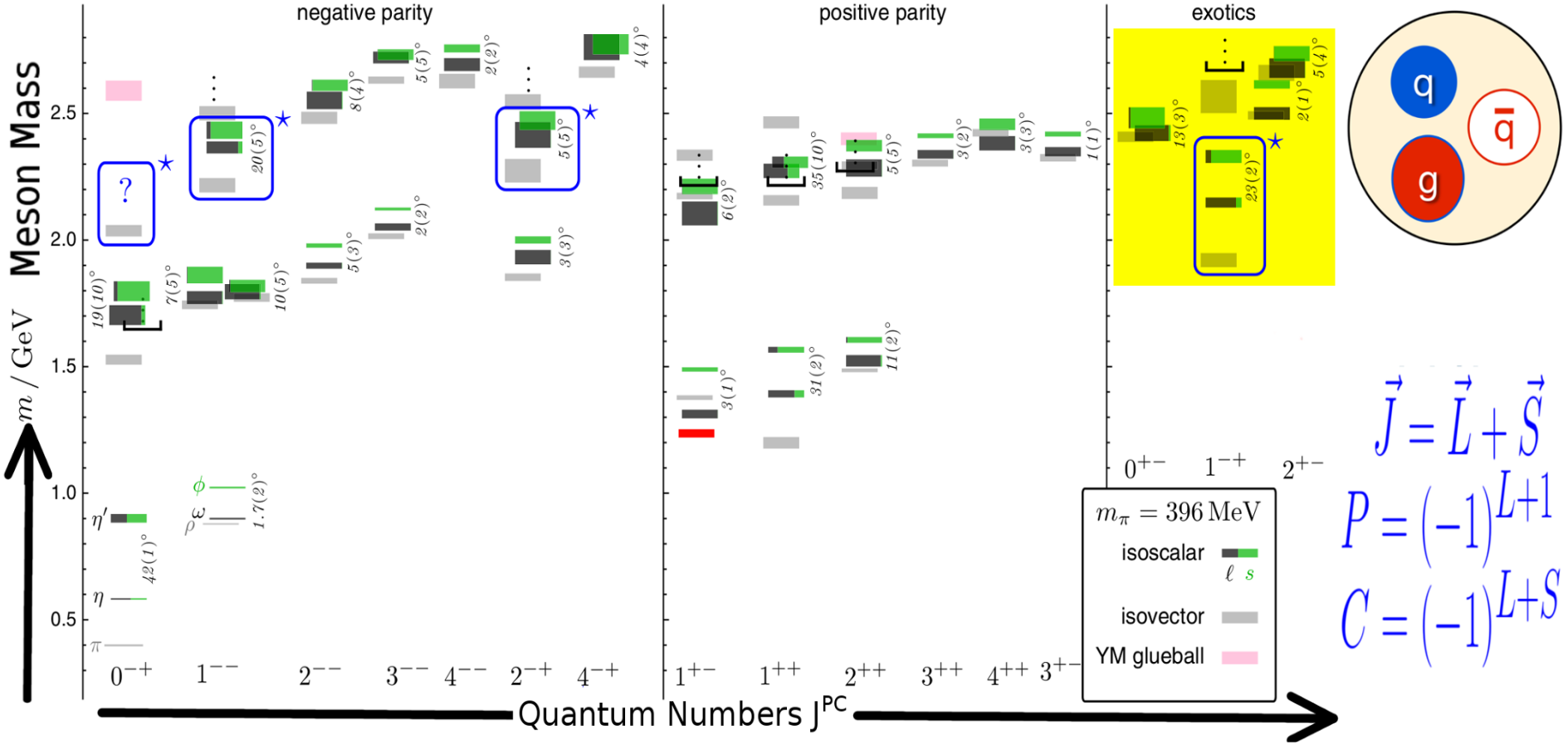
University of Regina

- Almost hermetic detector.
- 12 GeV electron beam.
- Linearly polarized coherent Bremsstrahlung peak 9 GeV.
- Liquid H_2 target.



A schematic of the GlueX detector and beam.

GlueX Physics Motivation



Lattice QCD computations for isoscalar and isovector light mesons at $M_\pi = 396$ *MeV* [1]. $b_1(1235)$ $J^{PC} = 1^{+-}$ meson shown in red.

[1] J. J. Dudek, Phys. Rev. D 84, 074023 (2011).

Event Selection Cuts

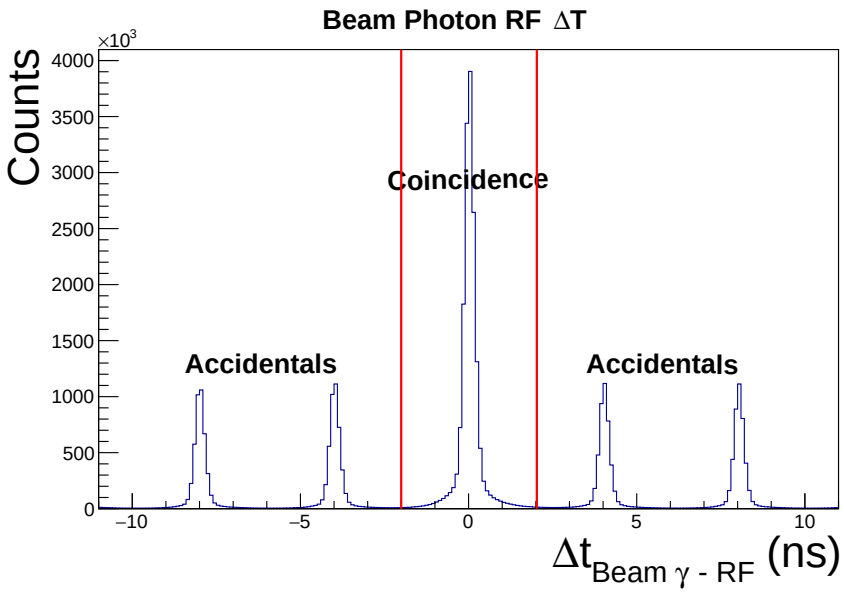
$$\gamma p \rightarrow p + \pi^+ + \pi^- + 4\gamma$$

Exclusive channel

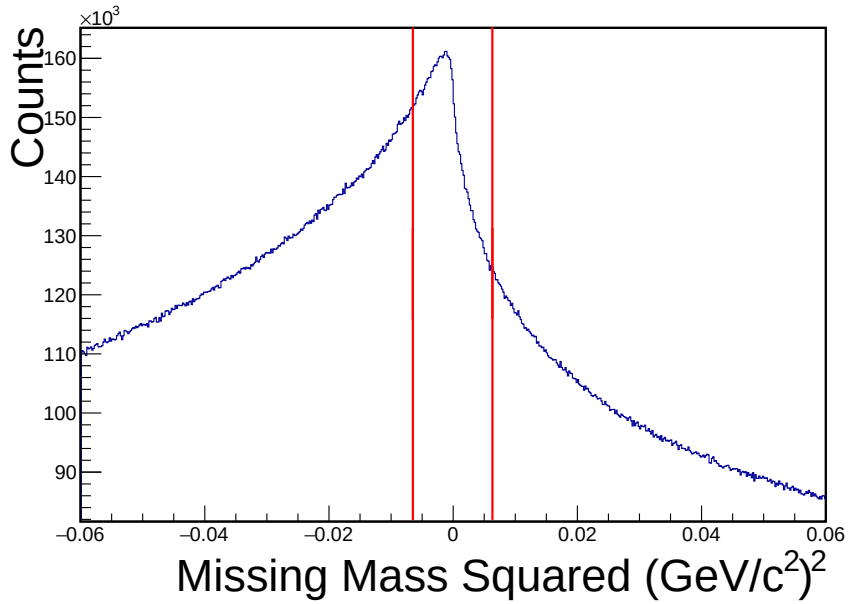
14.1×10^9 triggers ($\sim$ 60% Spring 2016 data).

- Missing Mass Squared $< 0.0064\ GeV^2/c^4$.
- PID DeltaT (BCAL, FCAL and TOF). $(dE/dX)_{proton}$.
- RF Cut Width = 1×RF.
- $E_{beam} > 6$ GeV.
- Target Vertex Cuts.
- Fiducial Cuts.

Event Selection Cuts

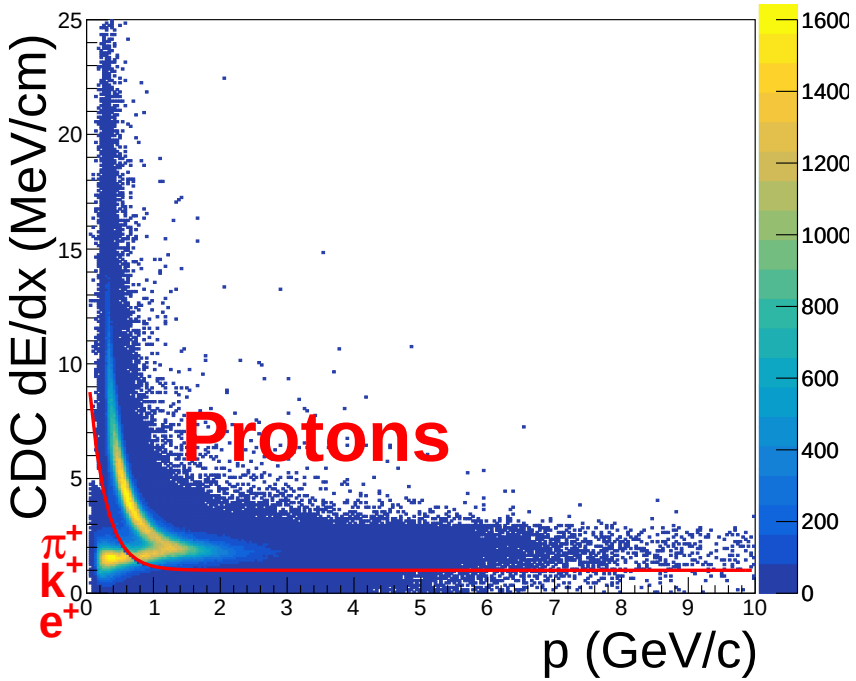


Beam bunch cut at $|\Delta T| < 2.004 ns$.

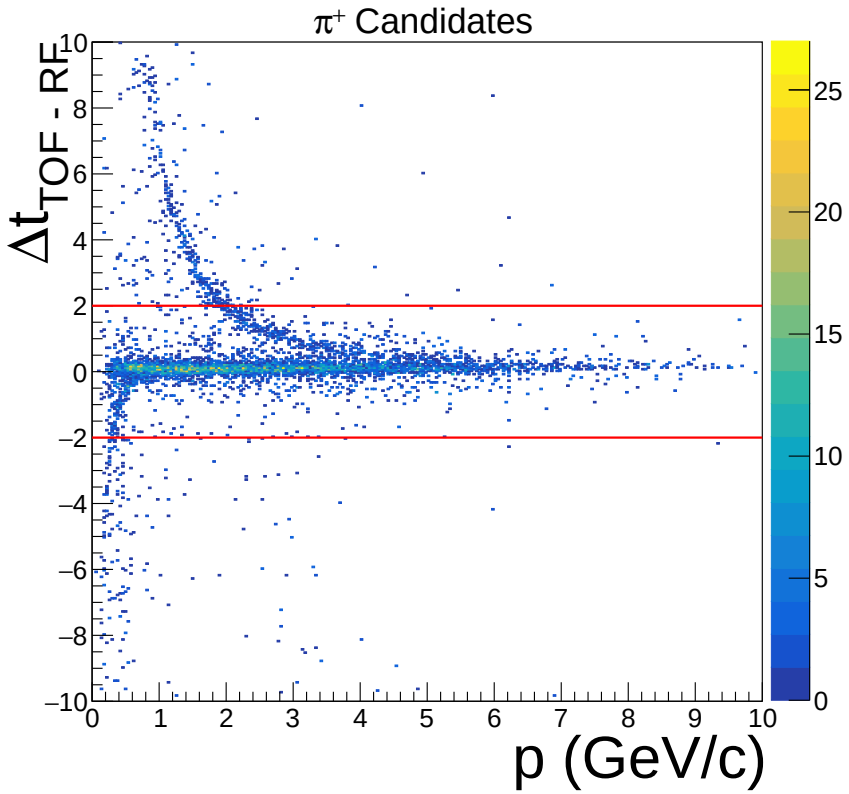


Exclusive channel, all particles are detected. Missing Mass Squared cut at $|MM|^2 < 0.0064\ GeV^2/c^4$.

Conservative Event Selection

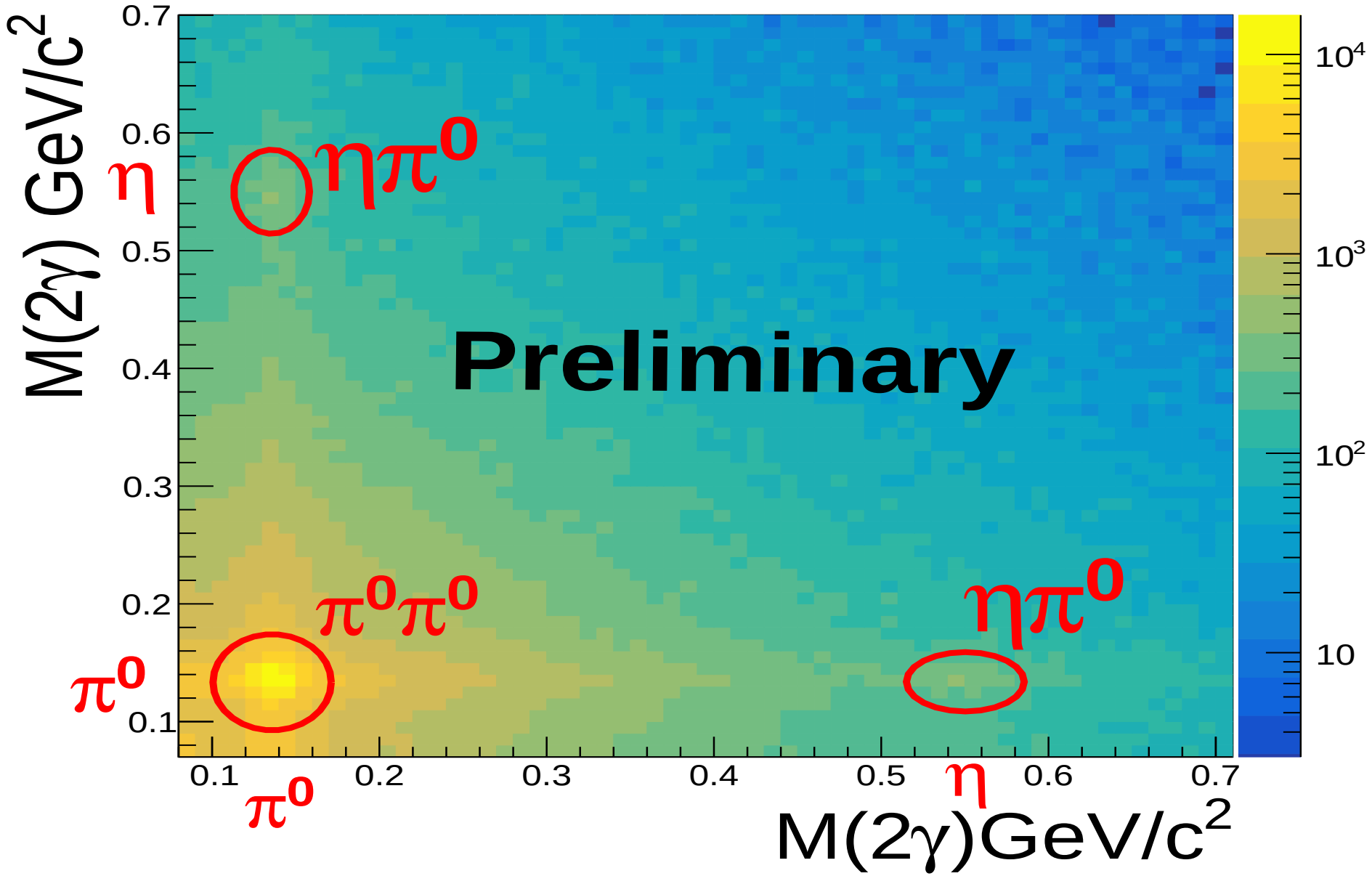


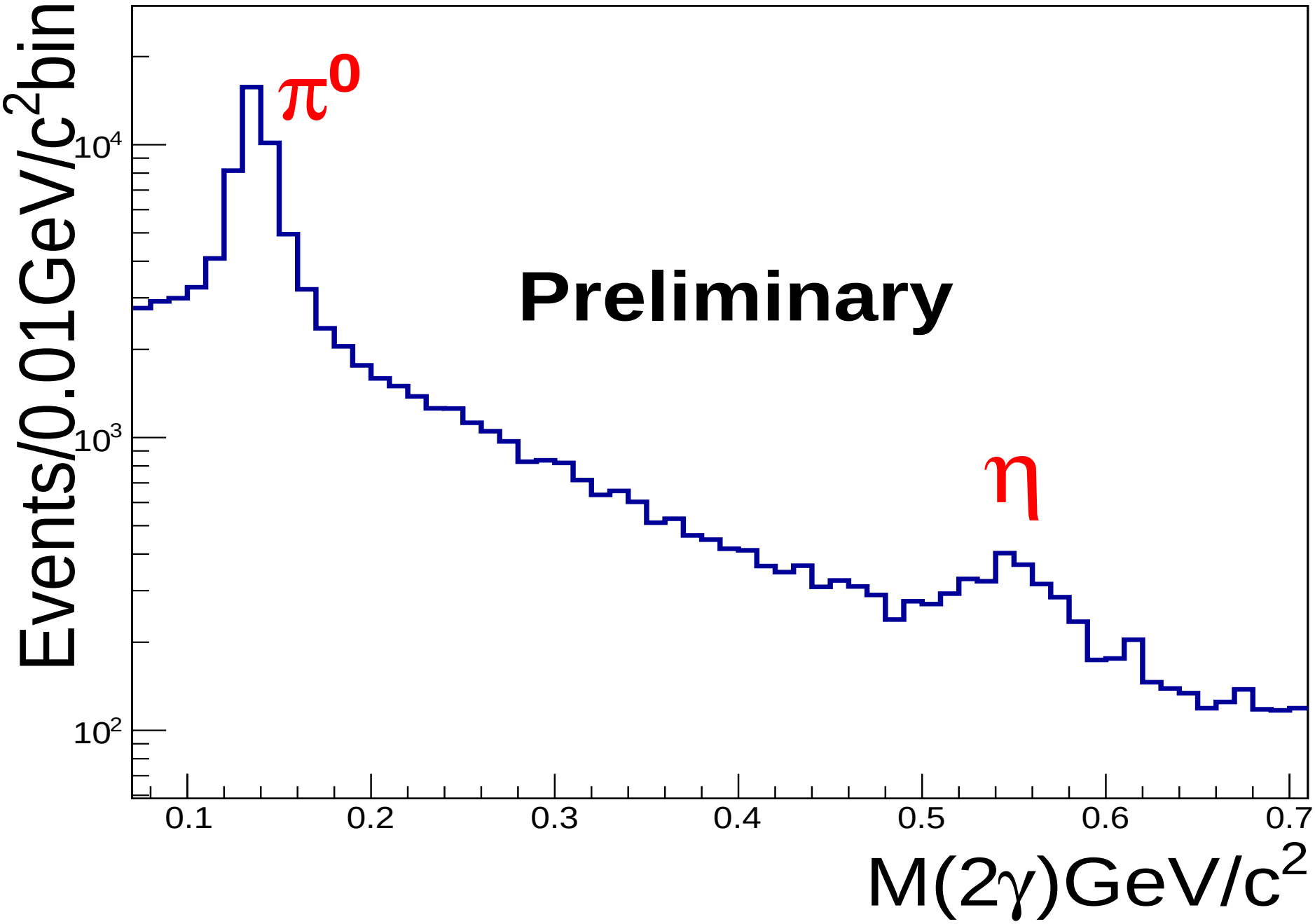
Central Drift Chamber dE/dX cut to select Protons from π^+, k^+ *and* e^+.

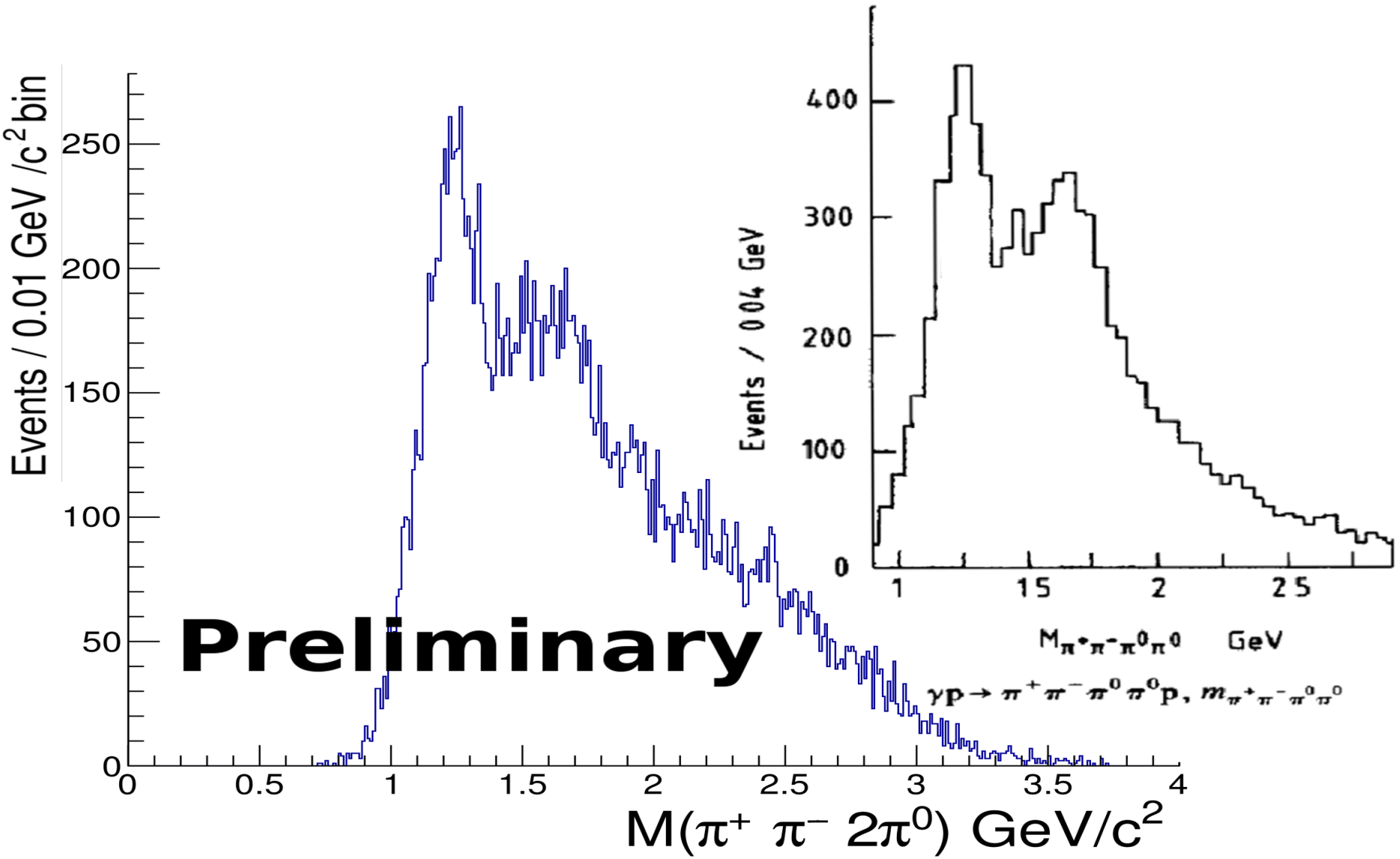


Time of flight cut to select π^+ at $|\Delta T| < 2.0$ ns.

4 γ Phase Space

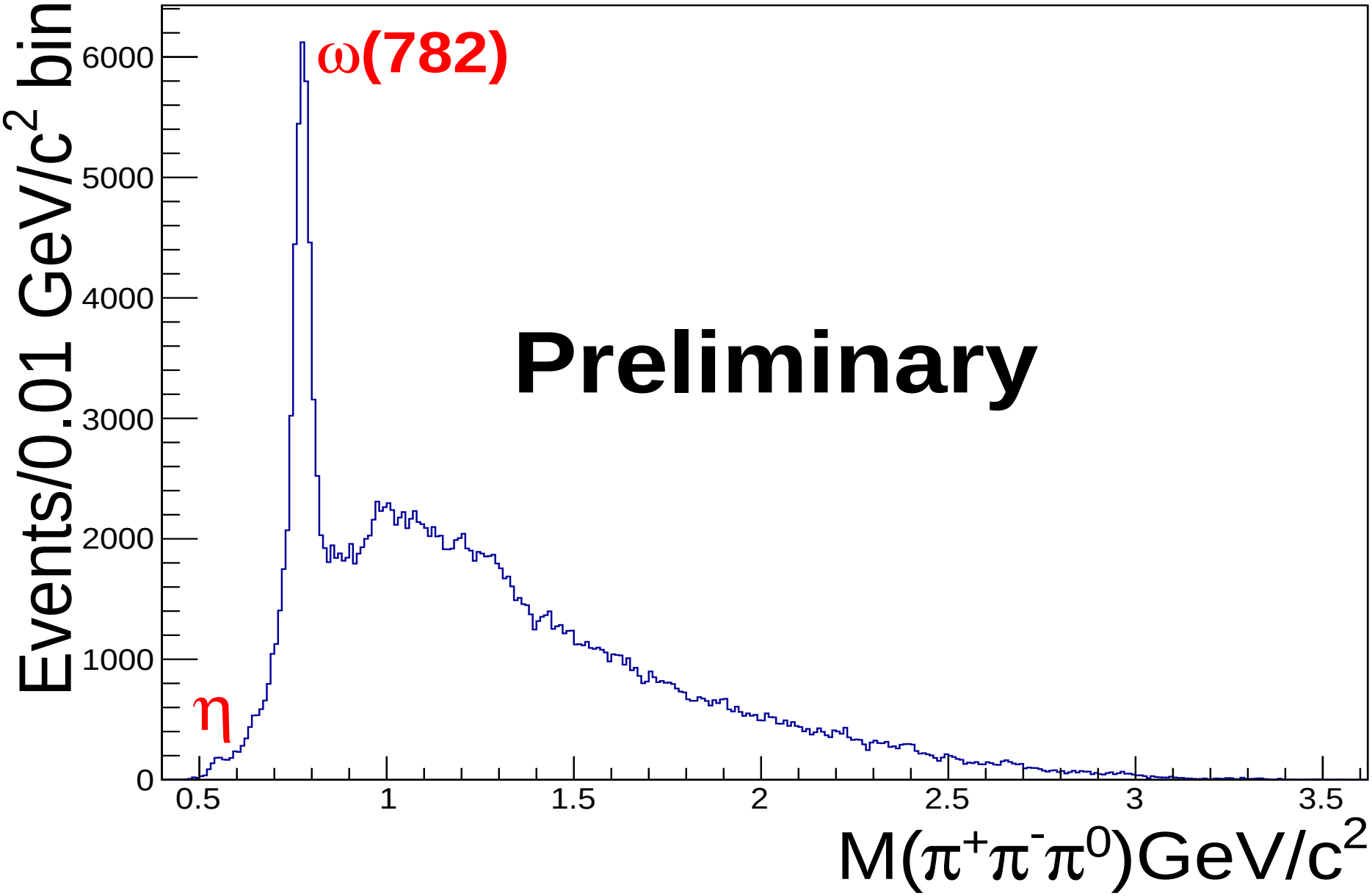



Events/0.01GeV/c^{2}bin
10^4
10^3
10^2
π^0
Preliminary
η
0.1
0.2
0.3
0.4
0.5
0.6
0.7
M(2γ)GeV/c^2

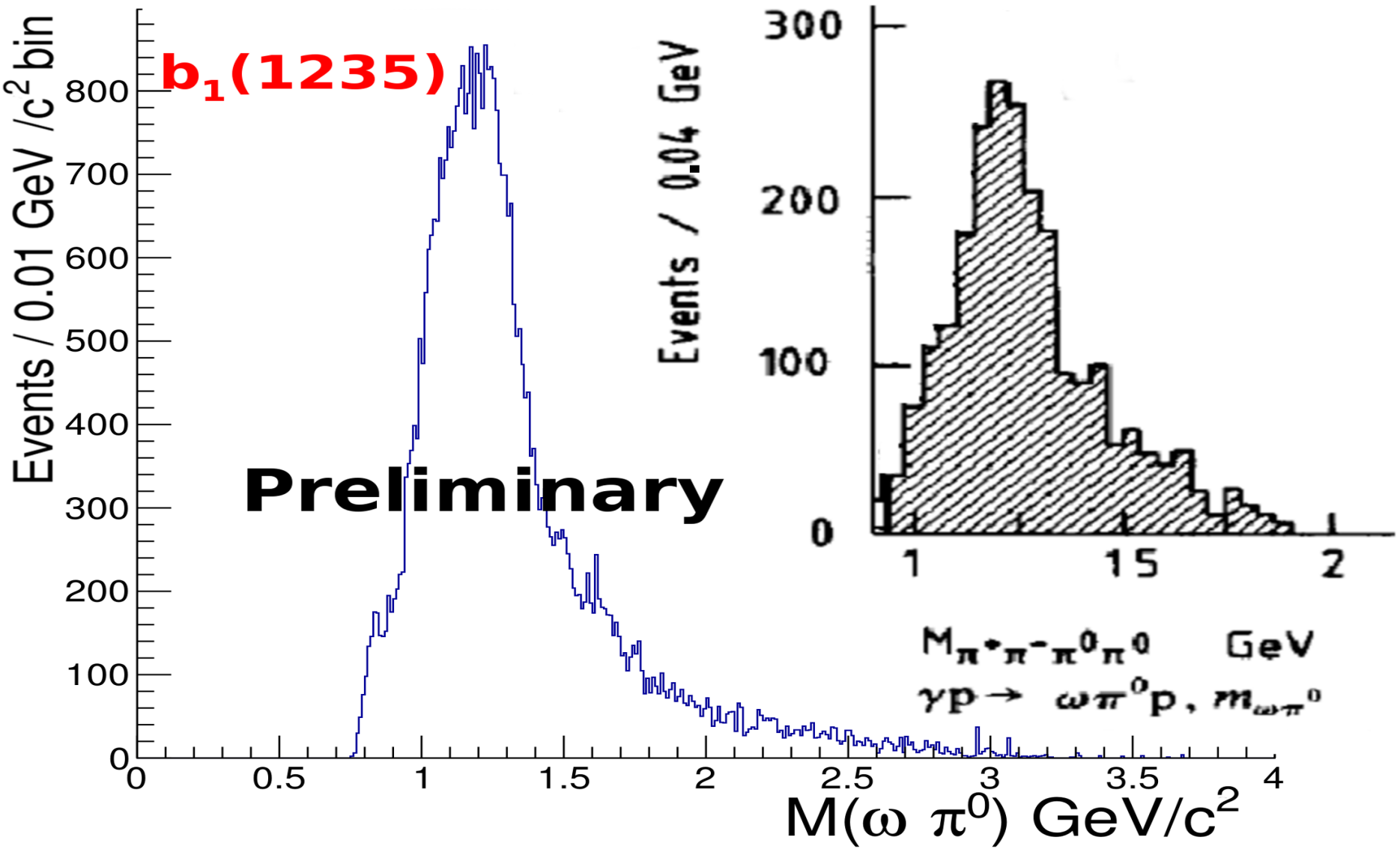


Insert shows results from the Omega Photon collaboration using 20-70 GeV plane polarized photon beam (M. Atkinson et al. N. Phys. B 243, 90382-1 (1984)).

$$\gamma p \to p \begin{bmatrix} \eta \\ \omega \end{bmatrix} \to p\pi^+\pi^-\pi^0$$



$\gamma p \to p b_1 \to p\omega\pi^0 \to p\pi^+\pi^-2\pi^0$



Insert shows results from the Omega Photon collaboration (M. Atkinson et al. N. Phys. B 243, 90382-1 (1984)).

Summary & Outlook

- More data to be recorded this Spring.
- Cuts to separate different decay channels.
  - Including split-offs and spurious decay modes.
- Dalitz plot analysis.
- Monte-Carlo simulations.
- Detector acceptance (charged and neutrals) $\Rightarrow$ cross section extraction.
- Long-term: PWA on various decay branches.

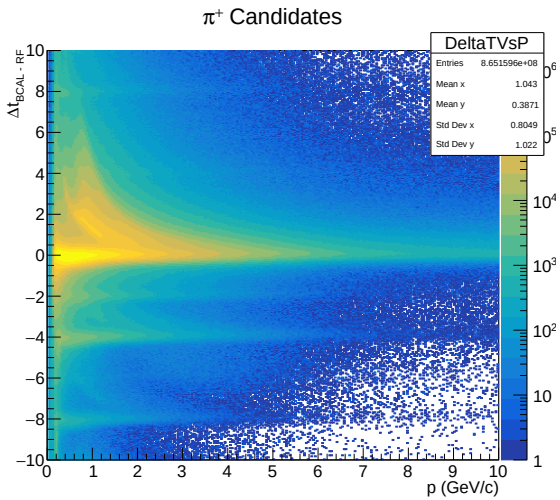
Thank You

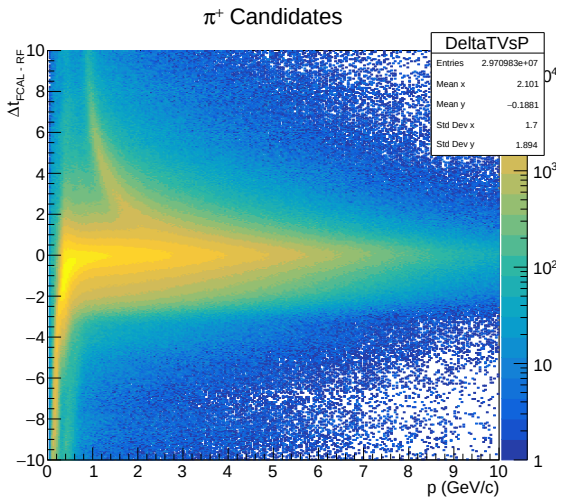
Questions ?

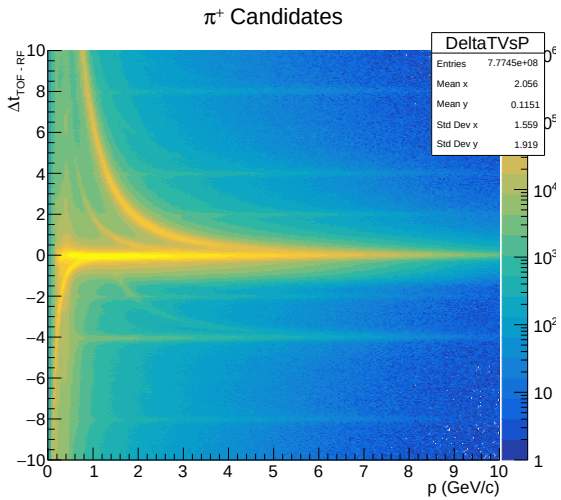
Backup Slides

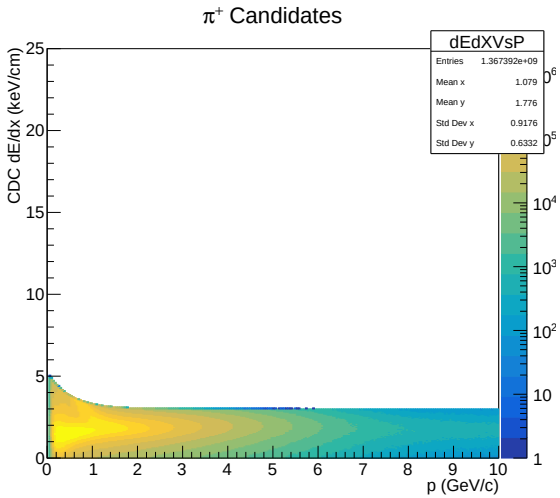
Meson	Relevant Decays	Final States
$\pi_1(1900)$	$b_1\pi^\dagger$, $\rho\pi^\dagger$, $f_1\pi^\dagger$, $a_1\eta$,$\eta'\pi^\dagger$	$\omega\pi\pi^\dagger$, $3\pi^\dagger$, 5π, $\eta 3\pi^\dagger$, $\eta'\pi^\dagger$
$\eta_1(2100)$	$a_1\pi$, $f_1\eta^\dagger$, $\pi(1300)\pi$	4π, $\eta 4\pi$, $\eta\eta\pi\pi^\dagger$
$\eta_1'(2300)$	$K_1(1400)K^\dagger$, $K_1(1270)K^\dagger$, $K^*K^\dagger$	$KK\pi\pi^\dagger$, $KK\pi^\dagger$, $KK\omega^\dagger$
$b_0(2400)$	$\pi(1300)\pi$, $h_1\pi$	4π
$h_0(2400)$	$b_1\pi^\dagger$, $h_1\eta$, $K(1460)K$	$\omega\pi\pi^\dagger$, $\eta 3\pi$, $KK\pi\pi$
$h_0'(2500)$	$K(1460)K$, $K_1(1270)K^\dagger$, $h_1\eta$	$KK\pi\pi^\dagger$, $\eta 3\pi$
$b_2(2500)$	$a_2\pi^\dagger$, $a_1\pi$, $h_1\pi$	4π, $\eta\pi\pi^\dagger$
$h_2(2500)$	$b_1\pi^\dagger$, $\rho\pi^\dagger$	$\omega\pi\pi^\dagger$, $3\pi^\dagger$
$h_2'(2600)$	$K_1(1400)K^\dagger$, $K_1(1270)K^\dagger$, $K_2^*K^\dagger$	$KK\pi\pi^\dagger$, $KK\pi^\dagger$

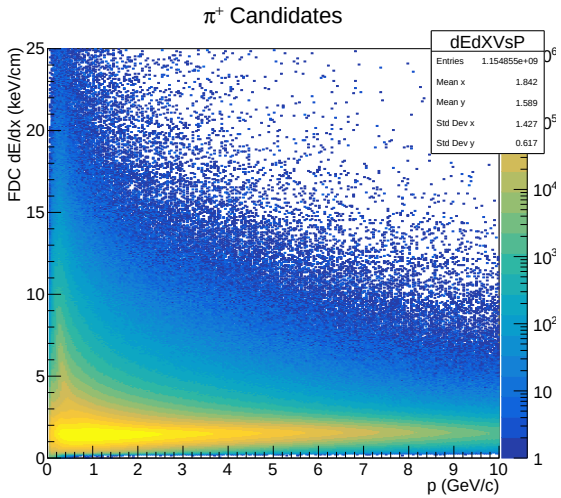
π^+

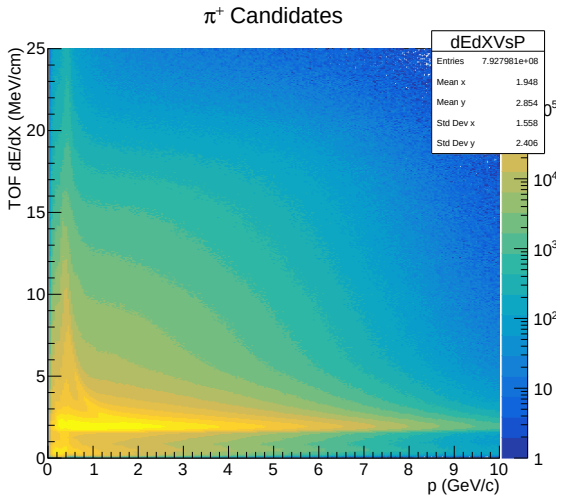

π^+ Candidates
DeltaTVsP
Entries 8.651596e+08
Mean x 1.043
Mean y 0.3871
Std Dev x 0.8049
Std Dev y 1.022
$\Delta t_{BCAL - RF}$
p (GeV/c)


π^+ Candidates
DeltaTVsP
Entries 2.970983e+07
Mean x 2.101
Mean y −0.1881
Std Dev x 1.7
Std Dev y 1.894
$\Delta t_{FCAL - RF}$
p (GeV/c)

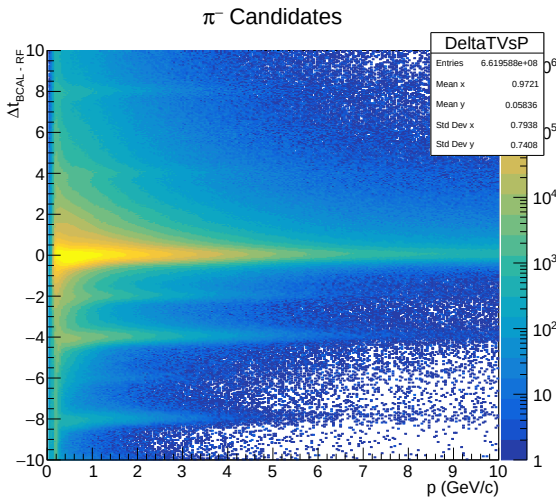

π^+ Candidates
DeltaTVsP
Entries 7.7745e+08
Mean x 2.056
Mean y 0.1151
Std Dev x 1.559
Std Dev y 1.919
$\Delta t_{TOF - RF}$
p (GeV/c)

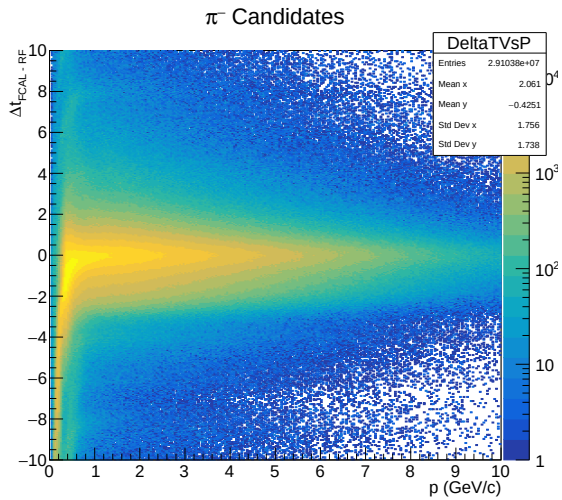

π^+ Candidates
dEdXVsP
Entries 1.367392e+09
Mean x 1.079
Mean y 1.776
Std Dev x 0.9176
Std Dev y 0.6332
CDC dE/dx (keV/cm)
p (GeV/c)

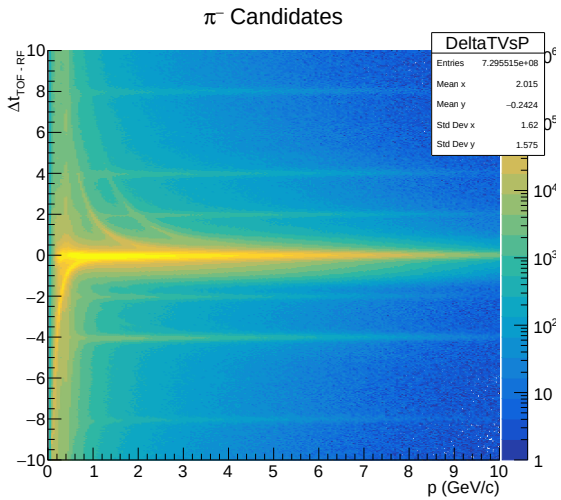

π^+ Candidates
dEdXVsP
Entries 1.154855e+09
Mean x 1.842
Mean y 1.589
Std Dev x 1.427
Std Dev y 0.617
FDC dE/dx (keV/cm)
p (GeV/c)

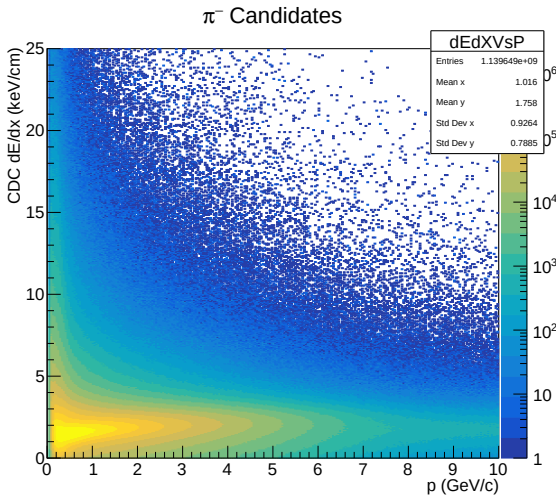

π^+ Candidates
dEdXVsP
Entries 7.927981e+08
Mean x 1.948
Mean y 2.854
Std Dev x 1.558
Std Dev y 2.406
TOF dE/dX (MeV/cm)
p (GeV/c)

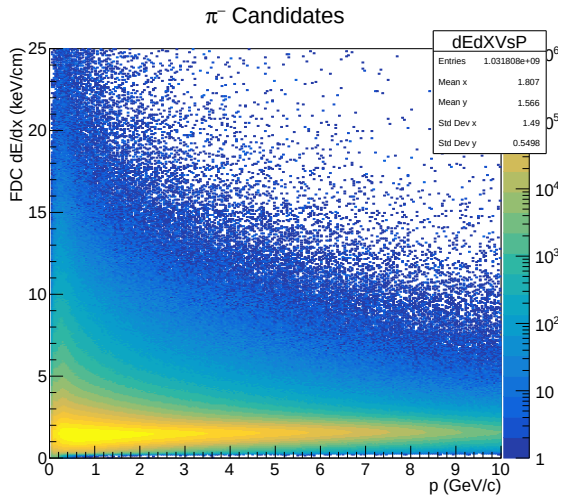
π^-

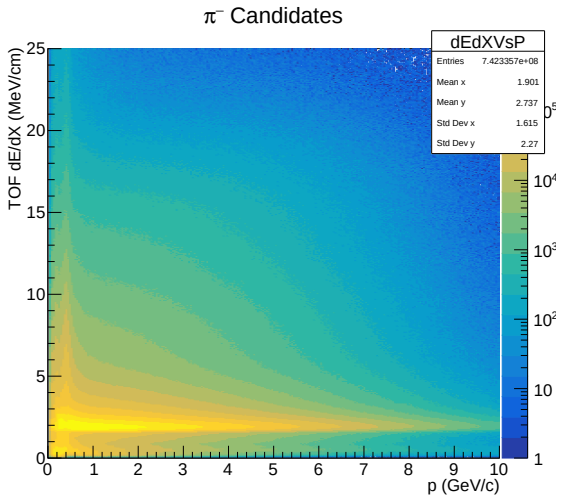

π⁻ Candidates
DeltaTVsP
Entries 6.619588e+08
Mean x 0.9721
Mean y 0.05836
Std Dev x 0.7938
Std Dev y 0.7408
Δt_BCAL - RF
p (GeV/c)


π⁻ Candidates
DeltaTVsP
Entries 2.91038e+07
Mean x 2.061
Mean y −0.4251
Std Dev x 1.756
Std Dev y 1.738
Δt_FCAL - RF
p (GeV/c)

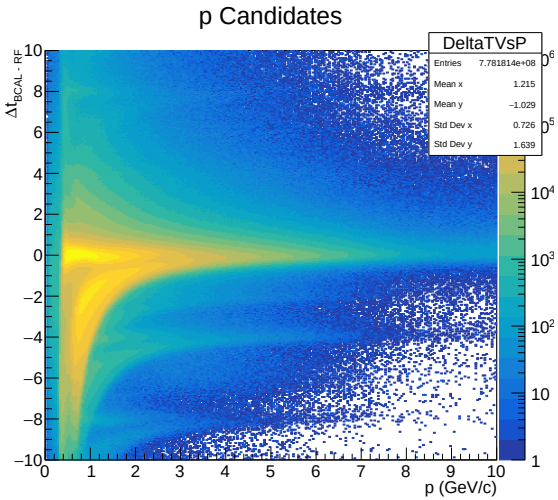

π⁻ Candidates
DeltaTVsP
Entries 7.295515e+08
Mean x 2.015
Mean y −0.2424
Std Dev x 1.62
Std Dev y 1.575
Δt_TOF - RF
p (GeV/c)

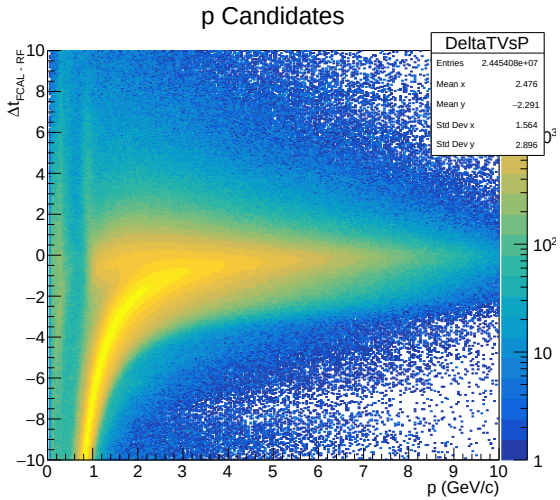

π⁻ Candidates
dEdXVsP
Entries 1.139649e+09
Mean x 1.016
Mean y 1.758
Std Dev x 0.9264
Std Dev y 0.7885
CDC dE/dx (keV/cm)
p (GeV/c)

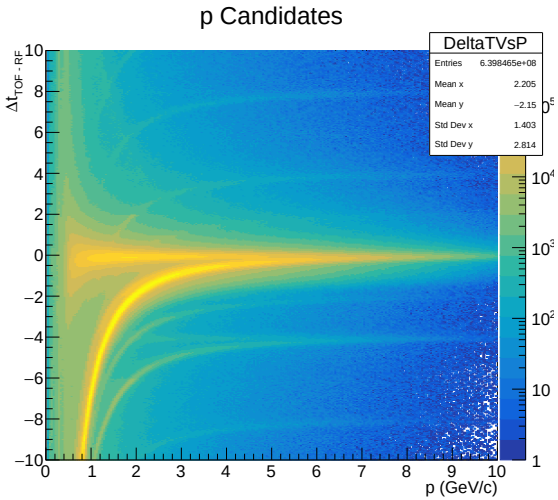

π⁻ Candidates
dEdXVsP
Entries 1.031808e+09
Mean x 1.807
Mean y 1.566
Std Dev x 1.49
Std Dev y 0.5498
FDC dE/dx (keV/cm)
p (GeV/c)

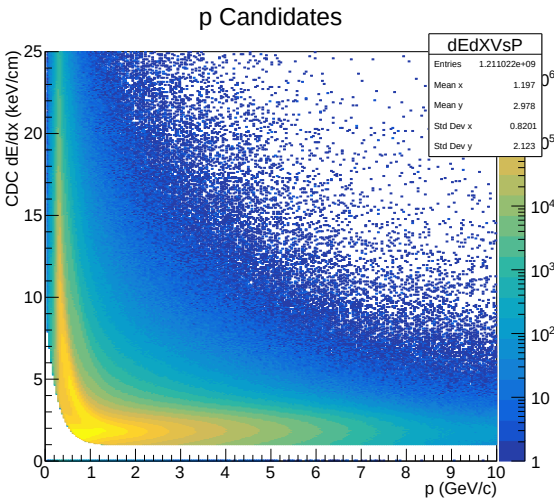

π⁻ Candidates
dEdXVsP
Entries 7.423357e+08
Mean x 1.901
Mean y 2.737
Std Dev x 1.615
Std Dev y 2.27
TOF dE/dX (MeV/cm)
p (GeV/c)

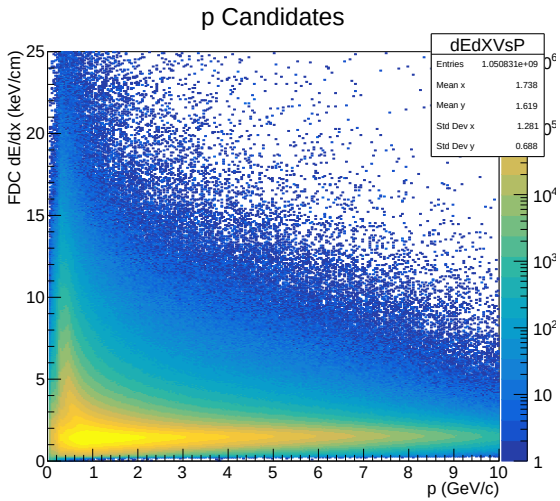
Proton

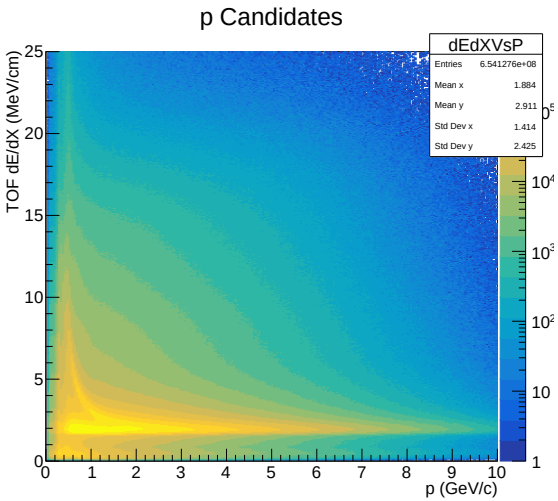

p Candidates
DeltaTVsP
Entries 7.781814e+08
Mean x 1.215
Mean y −1.029
Std Dev x 0.726
Std Dev y 1.639
$\Delta t_{BCAL - RF}$
p (GeV/c)


p Candidates
DeltaTVsP
Entries 2.445408e+07
Mean x 2.476
Mean y −2.291
Std Dev x 1.564
Std Dev y 2.896
$\Delta t_{FCAL - RF}$
p (GeV/c)

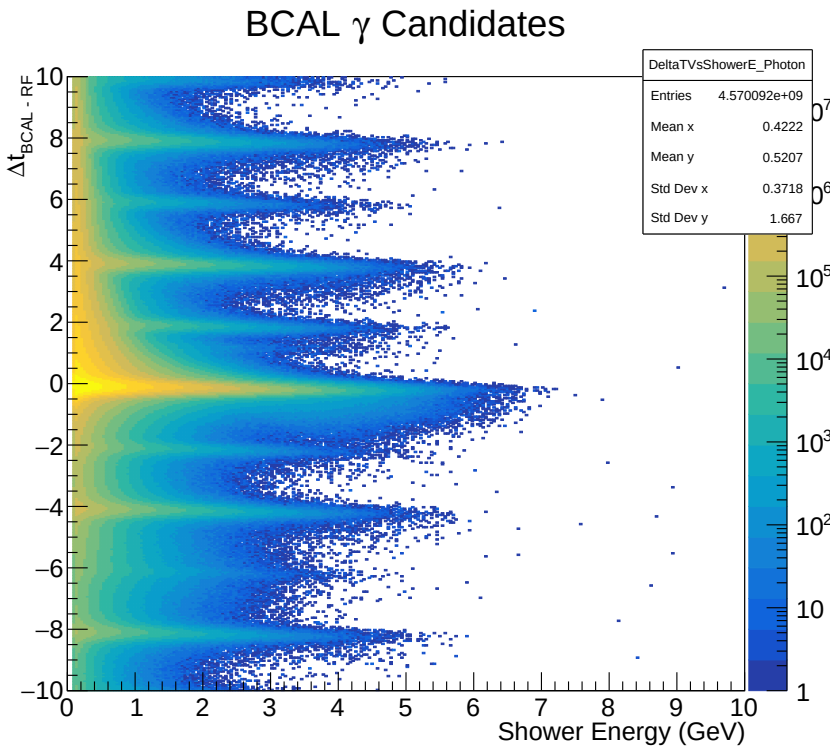

p Candidates
DeltaTVsP
Entries 6.398465e+08
Mean x 2.205
Mean y −2.15
Std Dev x 1.403
Std Dev y 2.814
$\Delta t_{TOF - RF}$
p (GeV/c)

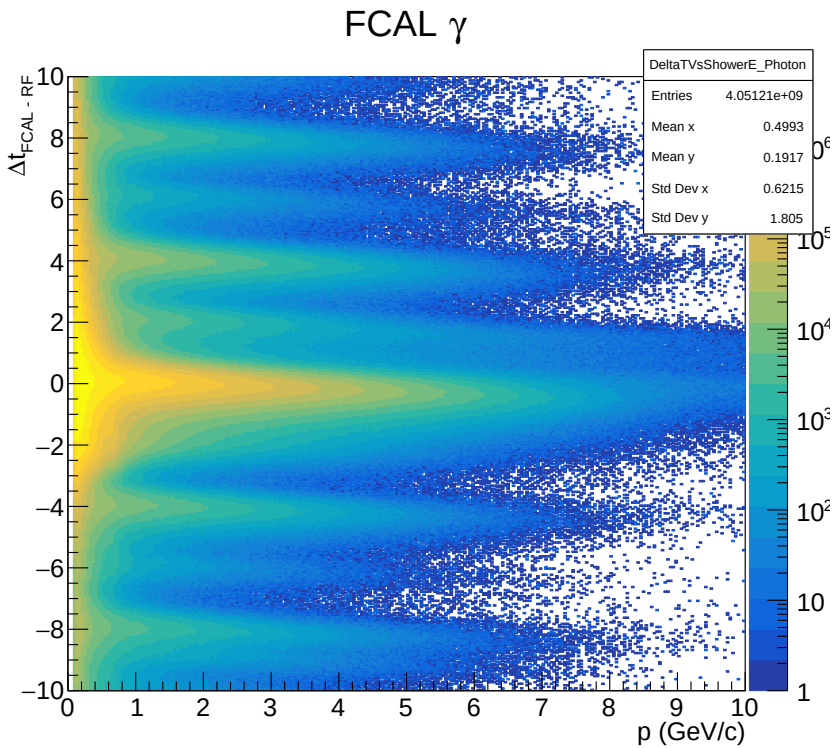

p Candidates
dEdXVsP
Entries 1.211022e+09
Mean x 1.197
Mean y 2.978
Std Dev x 0.8201
Std Dev y 2.123
CDC dE/dx (keV/cm)
p (GeV/c)


p Candidates
dEdXVsP
Entries 1.050831e+09
Mean x 1.738
Mean y 1.619
Std Dev x 1.281
Std Dev y 0.688
FDC dE/dx (keV/cm)
p (GeV/c)


p Candidates
dEdXVsP
Entries 6.541276e+08
Mean x 1.884
Mean y 2.911
Std Dev x 1.414
Std Dev y 2.425
TOF dE/dX (MeV/cm)
p (GeV/c)

γ


BCAL γ Candidates
DeltaTVsShowerE_Photon
Entries 4.570092e+09
Mean x 0.4222
Mean y 0.5207
Std Dev x 0.3718
Std Dev y 1.667
Δt_BCAL - RF
Shower Energy (GeV)


FCAL γ
DeltaTVsShowerE_Photon
Entries 4.05121e+09
Mean x 0.4993
Mean y 0.1917
Std Dev x 0.6215
Std Dev y 1.805
Δt_FCAL - RF
p (GeV/c)