Analysis of the ω Meson in eg2 Data

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Hadronization at Hall B

Hadron	cτ	Mass (GeV)	J^P	Institution
π^0	25 nm	0.13	0^-	URich, UConn
$\pi^{+,-}$	7.8 m	0.14	0^-	ANL,UConn, ODU
η	0.17 nm	0.55	0^-	URich, UConn
ω	23 fm	0.78	1^-	Canisius College
η'	0.98 pm	0.96	0^-	URich, UConn
ϕ	44 fm	1.0	1^-	UNH, OhioU
f_1	8 fm	1.3	1^+	Canisius College
$K^{+,-}$	3.7 m	0.49	0^-	UNH, OhioU
K^0	27 mm	0.50	0^-	UNH, OhioU

Study of the dynamics of quark confinement and hadron formation.

Goal: analyze a broad spectrum of hadrons (baryons not shown in the table).

Study with respect to mass, quark content, quark flavor, etc.

Observables

$$e + A \rightarrow e' + \omega + X$$

1. Knock a quark out of a proton (neutron) with an electron.
2. Detect the particle that is created from the free quark.
3. Use a nucleus as a ruler (compare to deuterium).

p_T Broadening

$$\Delta p_T^2 = p_T^2(A) - p_T^2(^2H)$$

Long propagation time means more quark interactions with the nucleus and more transverse momentum.

Particle Multiplicity

$$R_M^h(z,\nu) = \frac{\left\{ \frac{N_h(z,\nu)}{N_e(\nu)} \right\}_A}{\left\{ \frac{N_h(z,\nu)}{N_e(\nu)} \right\}_{^2H}}$$

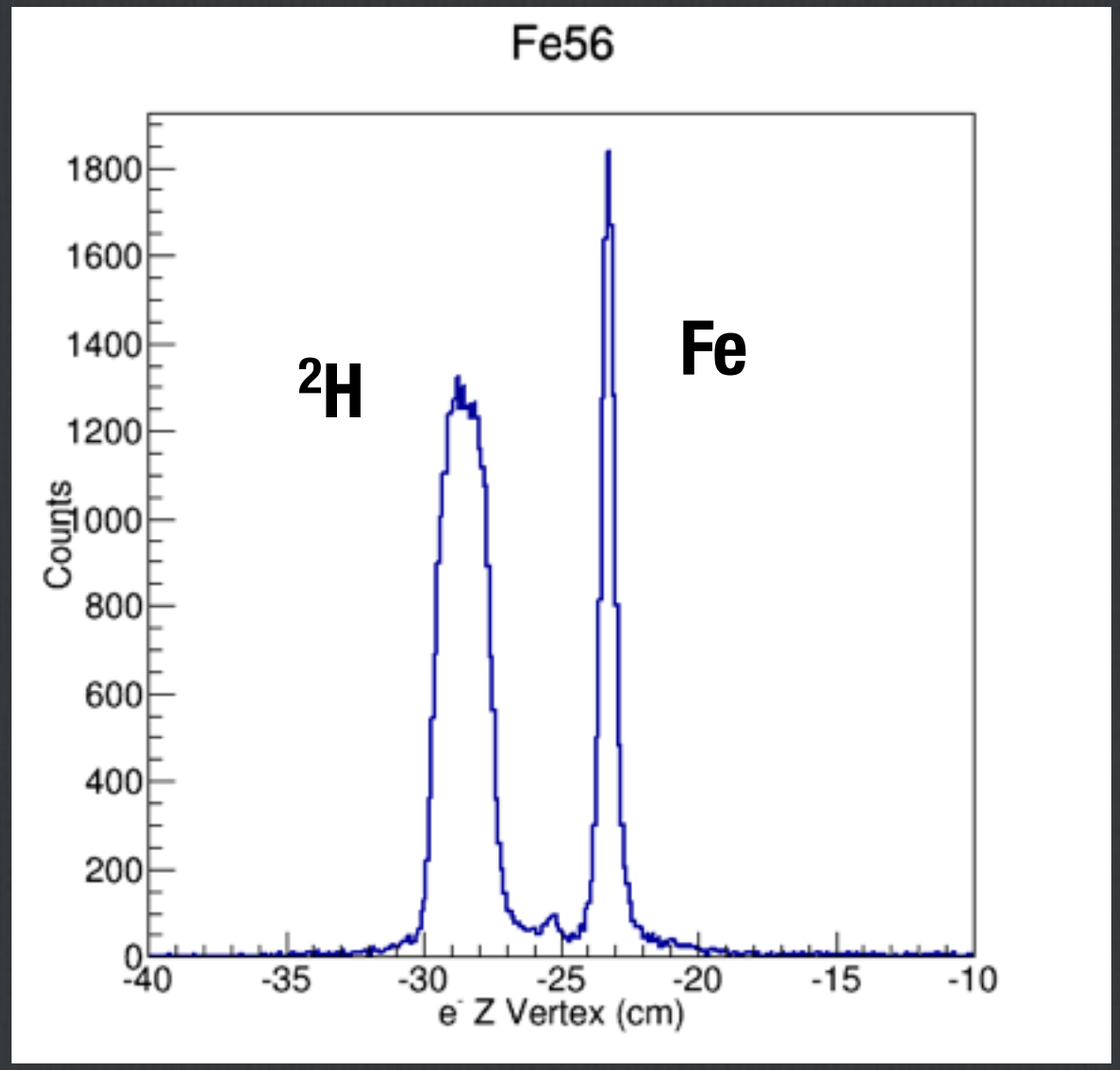
More particles implies long formation times. If carbon produced the same number of particles as Pb, formation time is small.

Fractional hadron energy: $z = {}^{E_h}/_{\nu}$

The eg2 Experiment

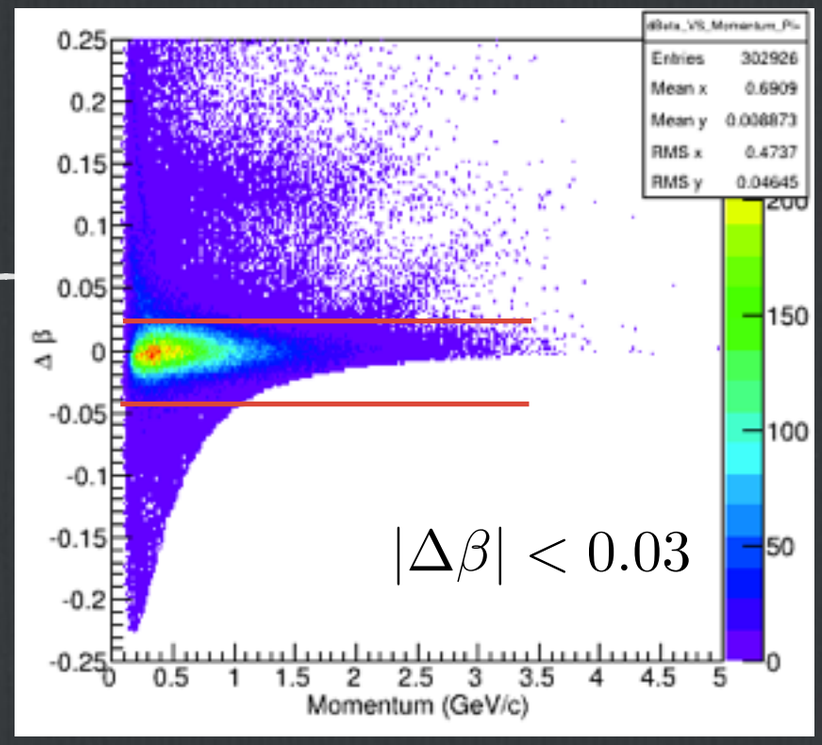
Key facts about eg2

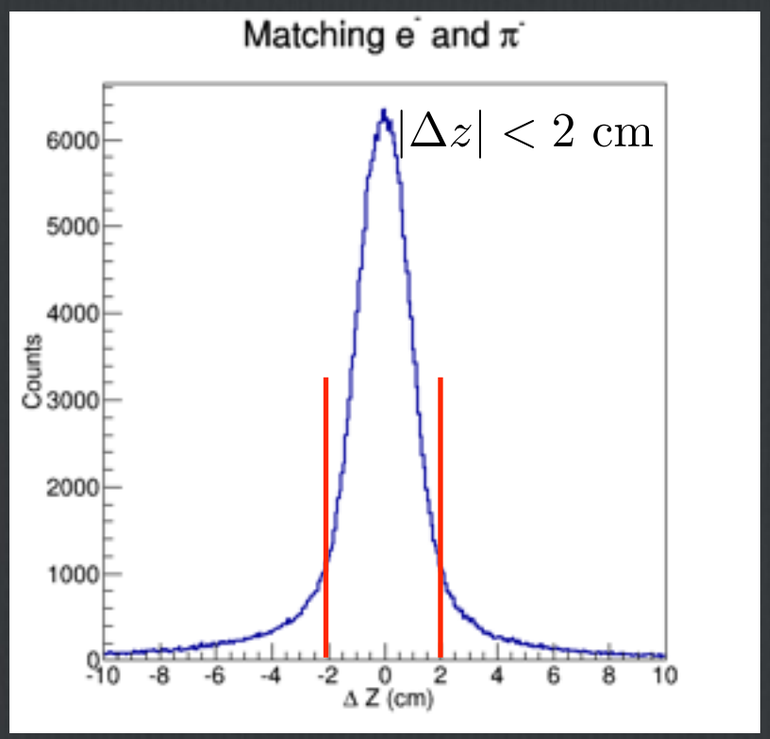
- Electron scattering experiment at JLab in Hall B with CLAS
- Designed for two measurements
  - E04-104 - Studies of Hadronization
  - E02-110 - Search for Color Transparency
- Collected data in 2003-2004 over three run periods
  - eg2a - E_e = 4.0 GeV
  - eg2b - E_e = 4.5 GeV
  - eg2c - E_e = 5.014 GeV
- Targets: ^{2}H, C, Al, Sn, Fe, and Pb
- Two targets in beam simultaneously (^{2}H and heavy target)

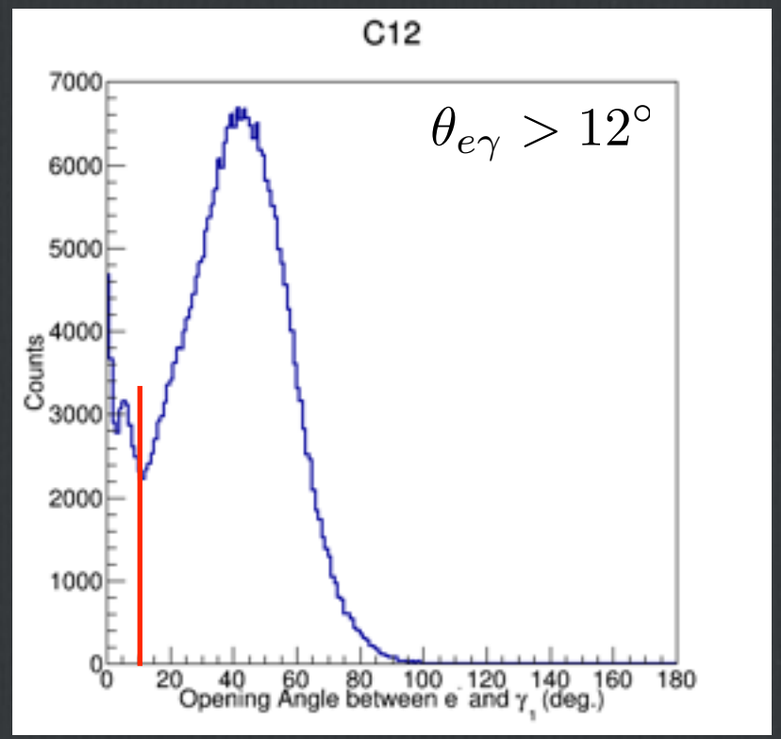


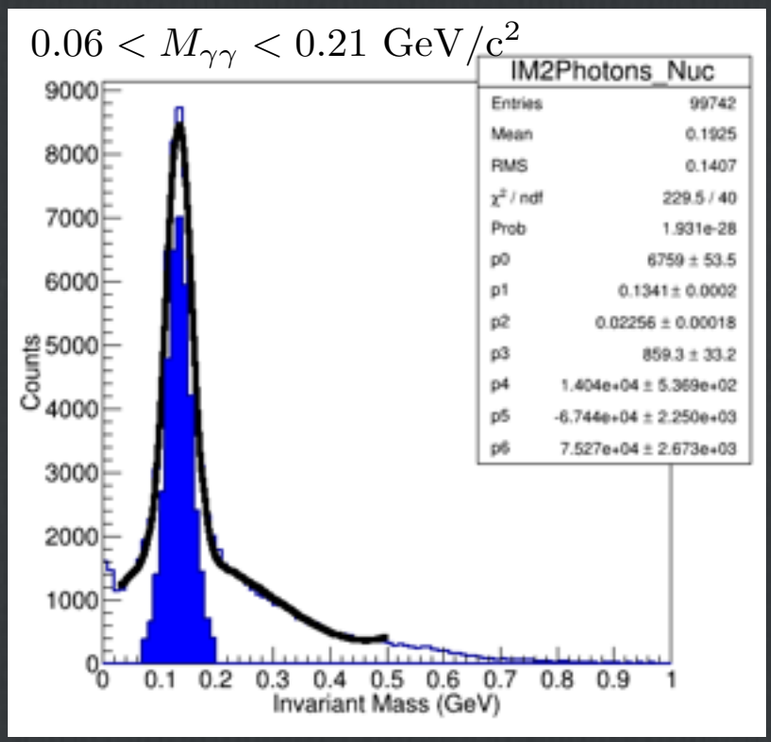
Cuts

- Started with standard e- EC and CC cuts.
- DIS cuts: $Q^2>1$ GeV^2 and W>2 GeV.
- Vertex cuts to select target.
- Applied additional kinematic cuts.



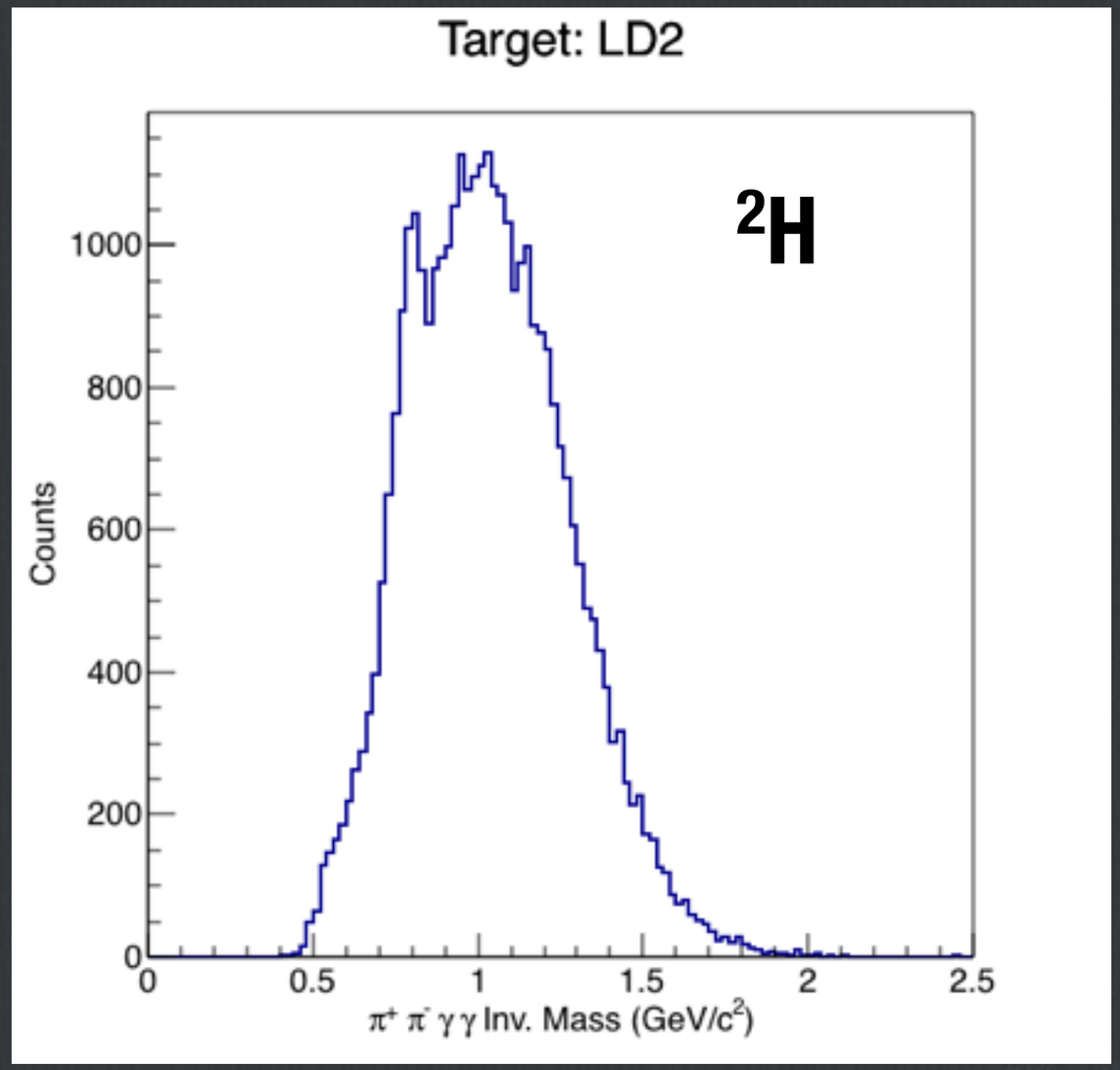


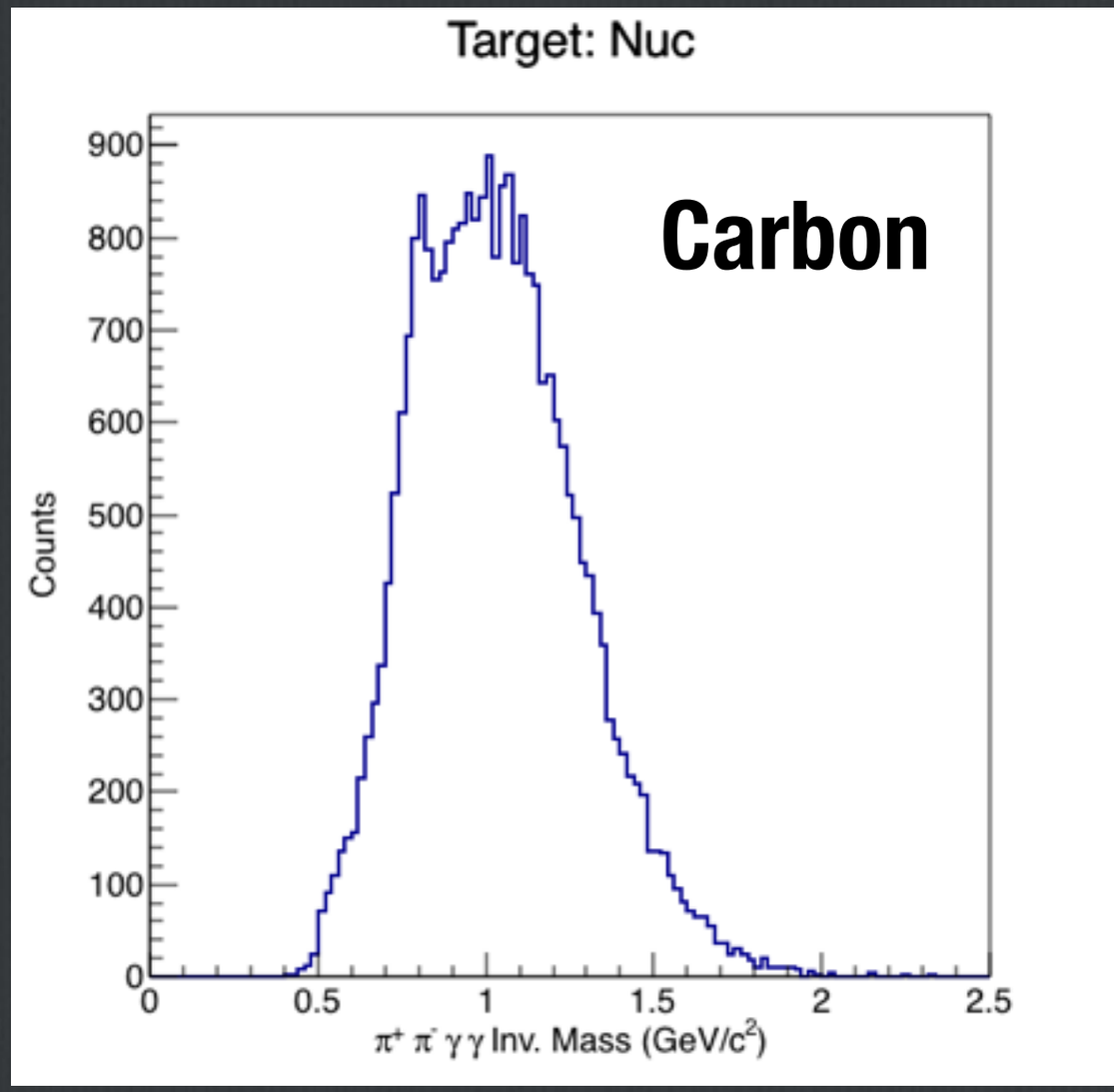




Invariant Mass

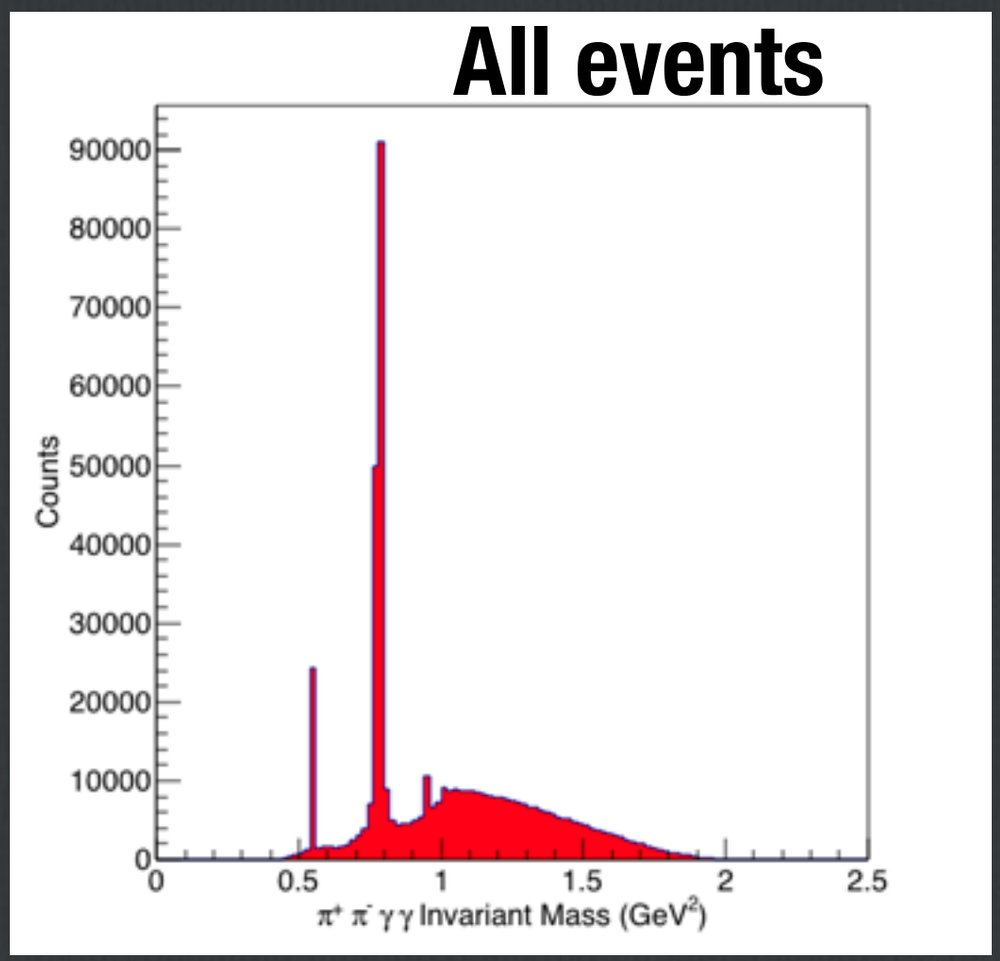
$\omega \rightarrow \pi^+ + \pi^- + 2\gamma$

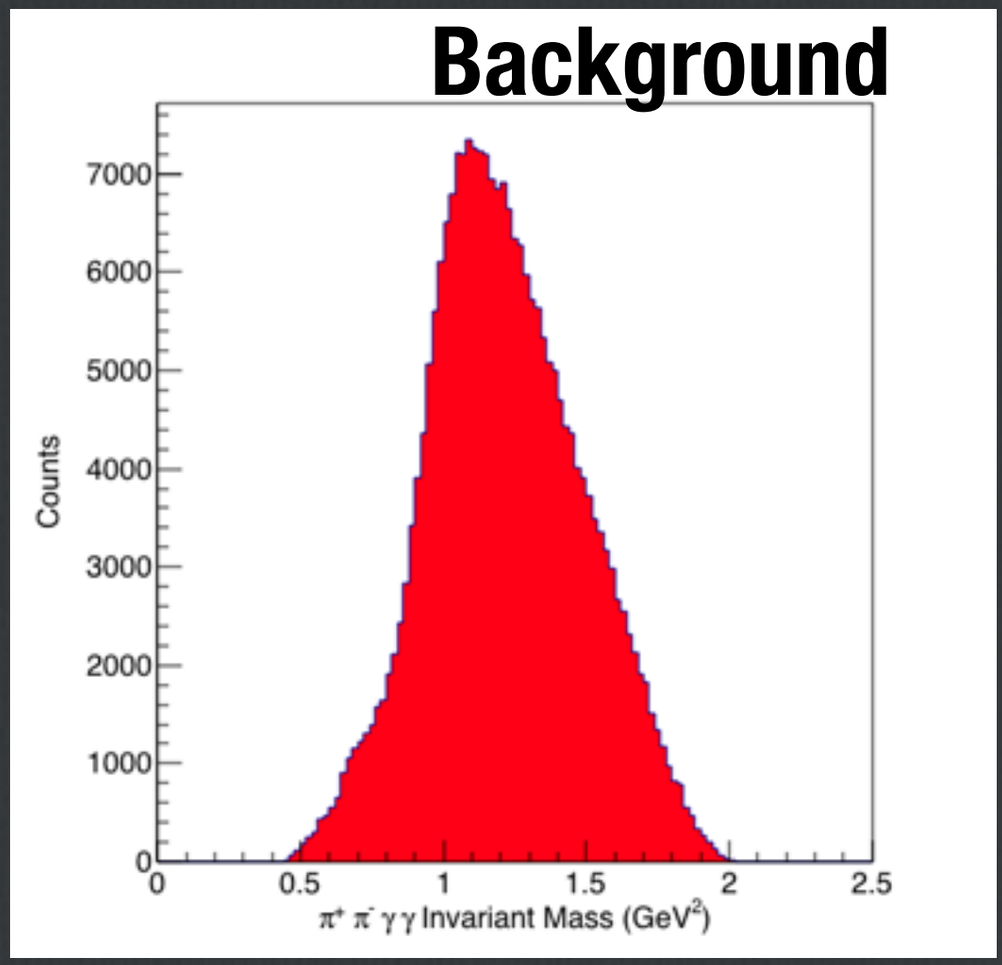




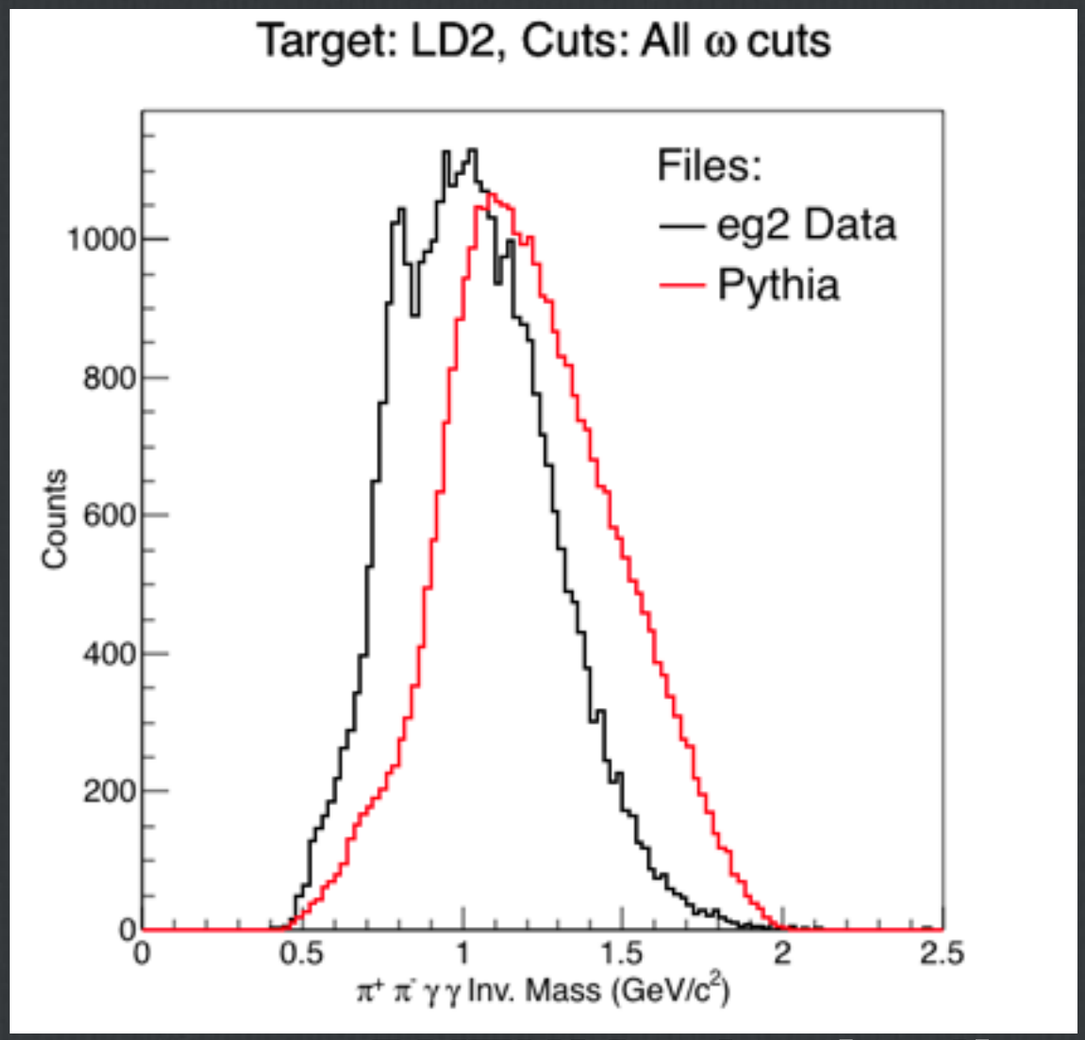
Simulated Background

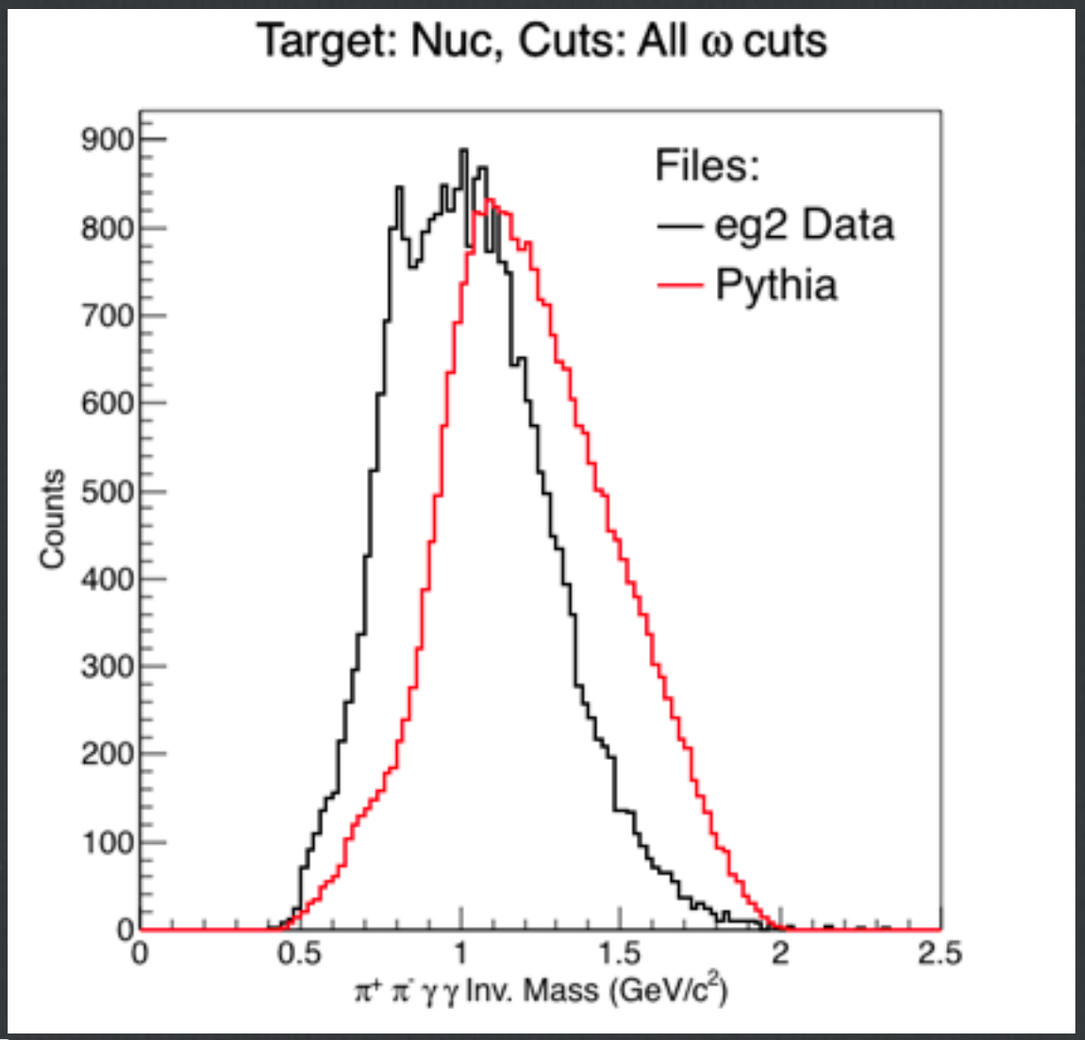
Event generator: PYTHIA electroproduction off of the proton.





Data vs. Background





PYTHIA plot is directly from the generator.
Needs to be put through GSIM.

Summer 2017

Two projects

1. Background simulation (Trent Schrader)- put generated PYTHIA events through full CLAS6 simulation (GSIM, GPP, USER_ANA, etc.). Use PYTHIA cross sections to normalize to data luminosity. Extract yields by subtracting simulated background.
2. Detector acceptance (Giuseppe Campanella) - analyze the simulations by Ahmed El Alaoui (UTFSM). Uses the GENIE event generator. Determine detector acceptance for ω meson observables.

Off-site Analysis

- ☐ We have a 12-core workstation and a 20-TB server in our lab at Canisius College.
- ☐ We want to run the simulations locally.
- ☐ To avoid spending time building the CLAS6 software, we are using Docker. The CLAS6 packages are built on JLab computers and run in a Docker container on our local machine.
- ☐ The CLAS6 Docker container was developed by Nick Tyler at the Univ. of South Carolina (https://github.com/tylern4/docker-clas6)

Summary

This will be the first measurement of the ω meson hadronization.

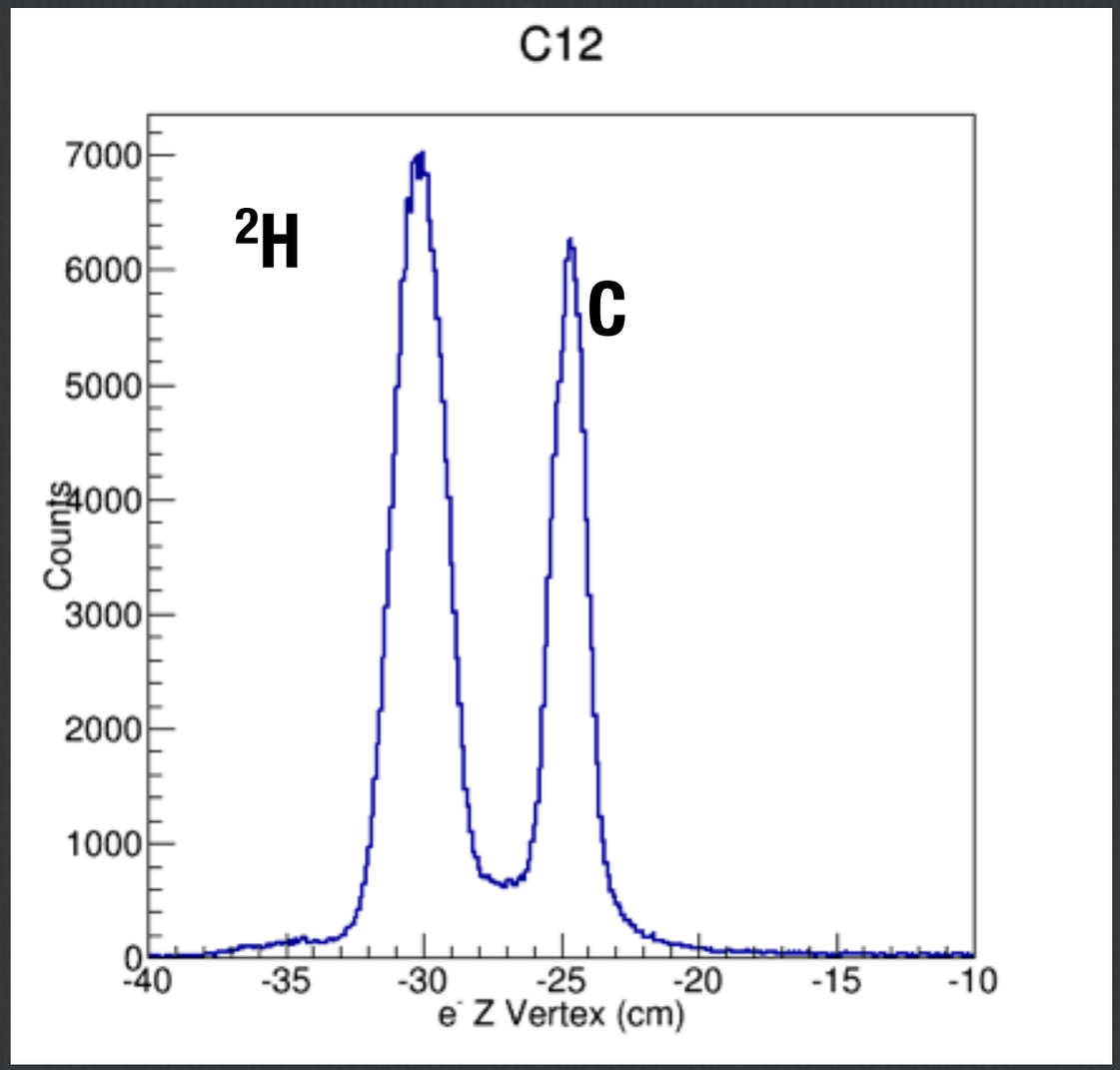
Not enough data for an extensive analysis, probably 1 or 2 bins for transverse momentum and multiplicity.

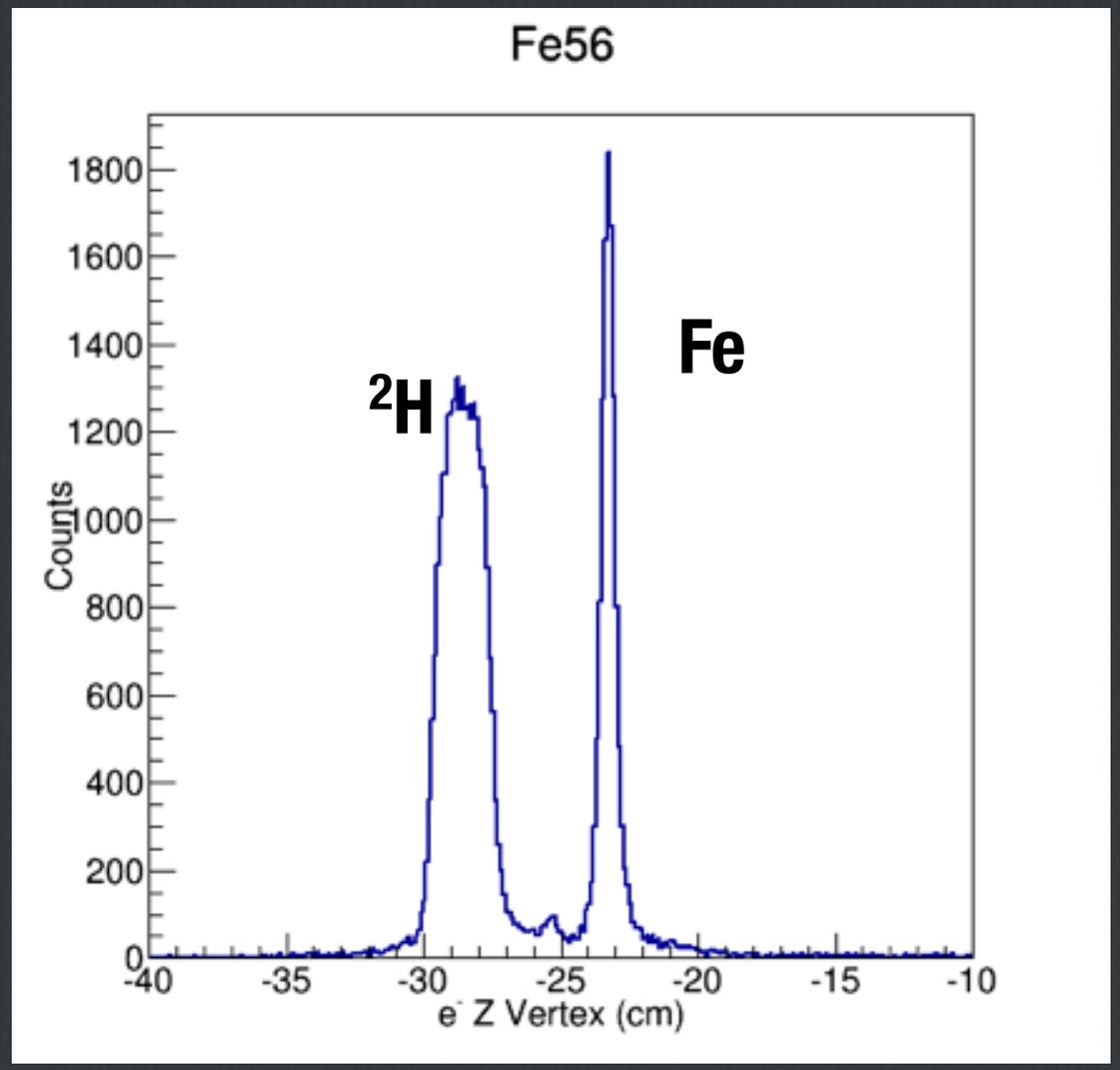
Working on simulations for both acceptance and background subtraction.

Looking forward to higher statistics with CLAS12.

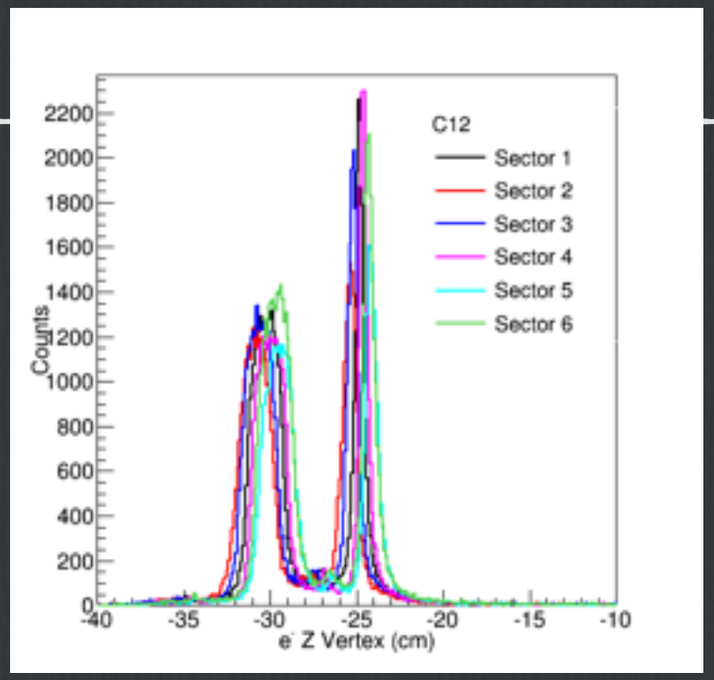
Extra Slides

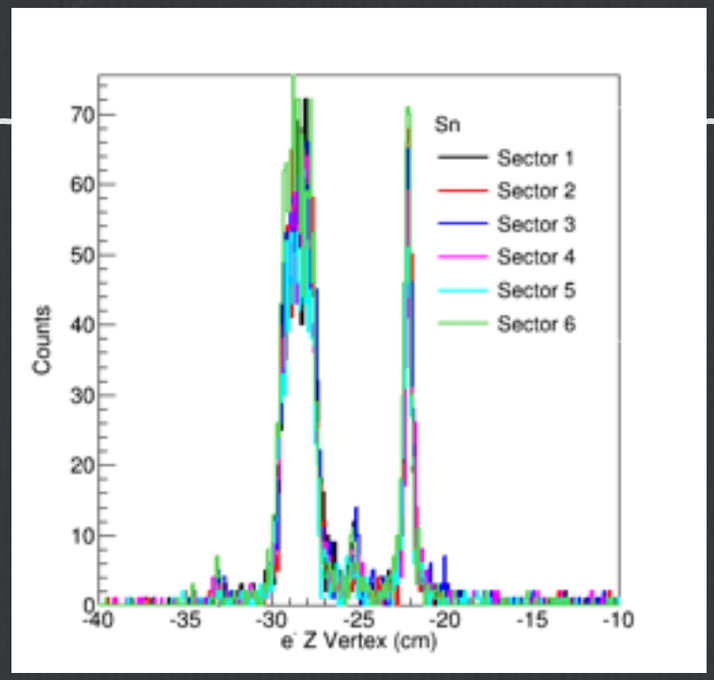
Target Vertex Corrections

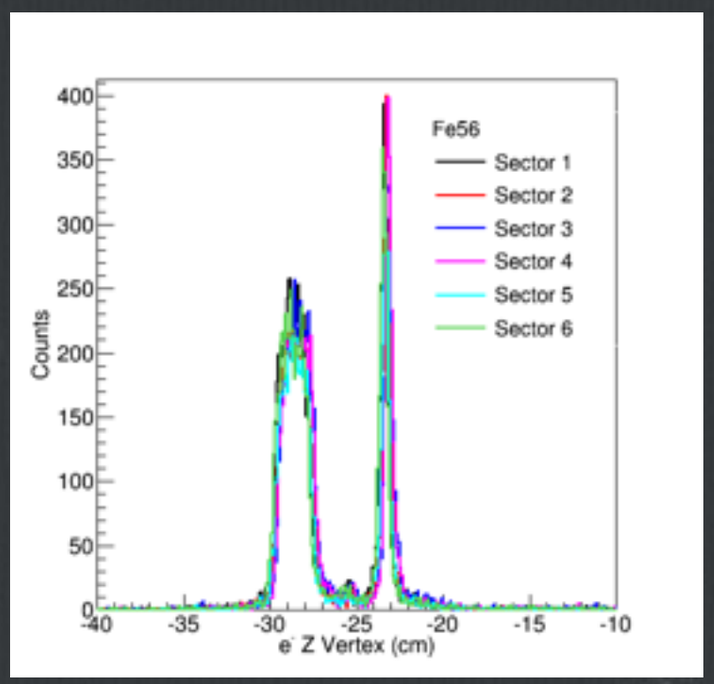


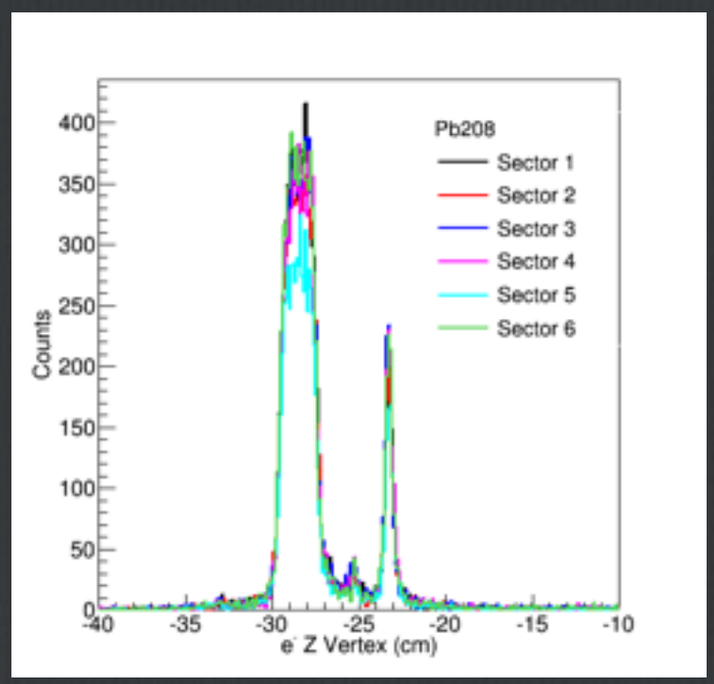


Target Vertex Corrections

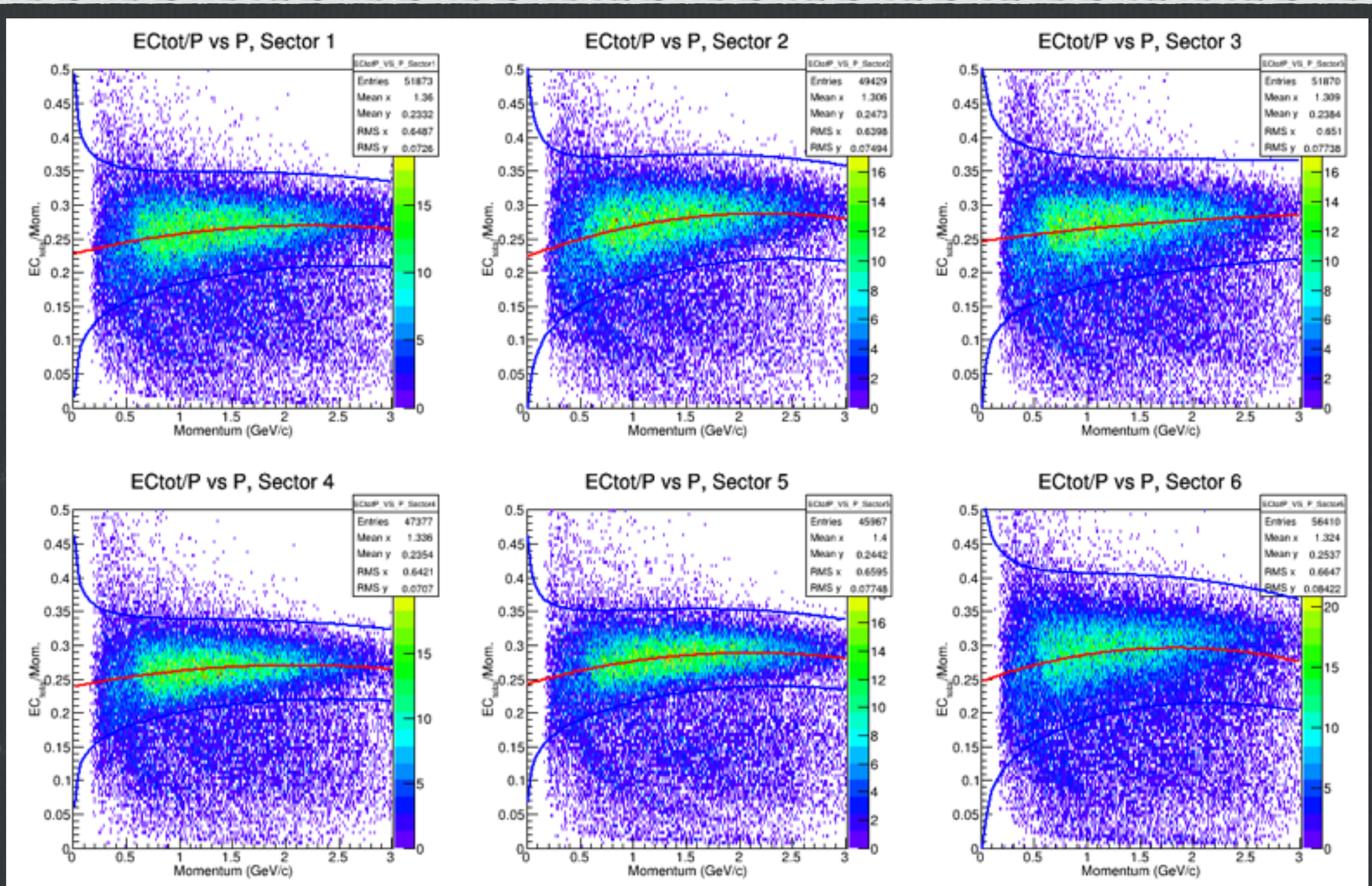




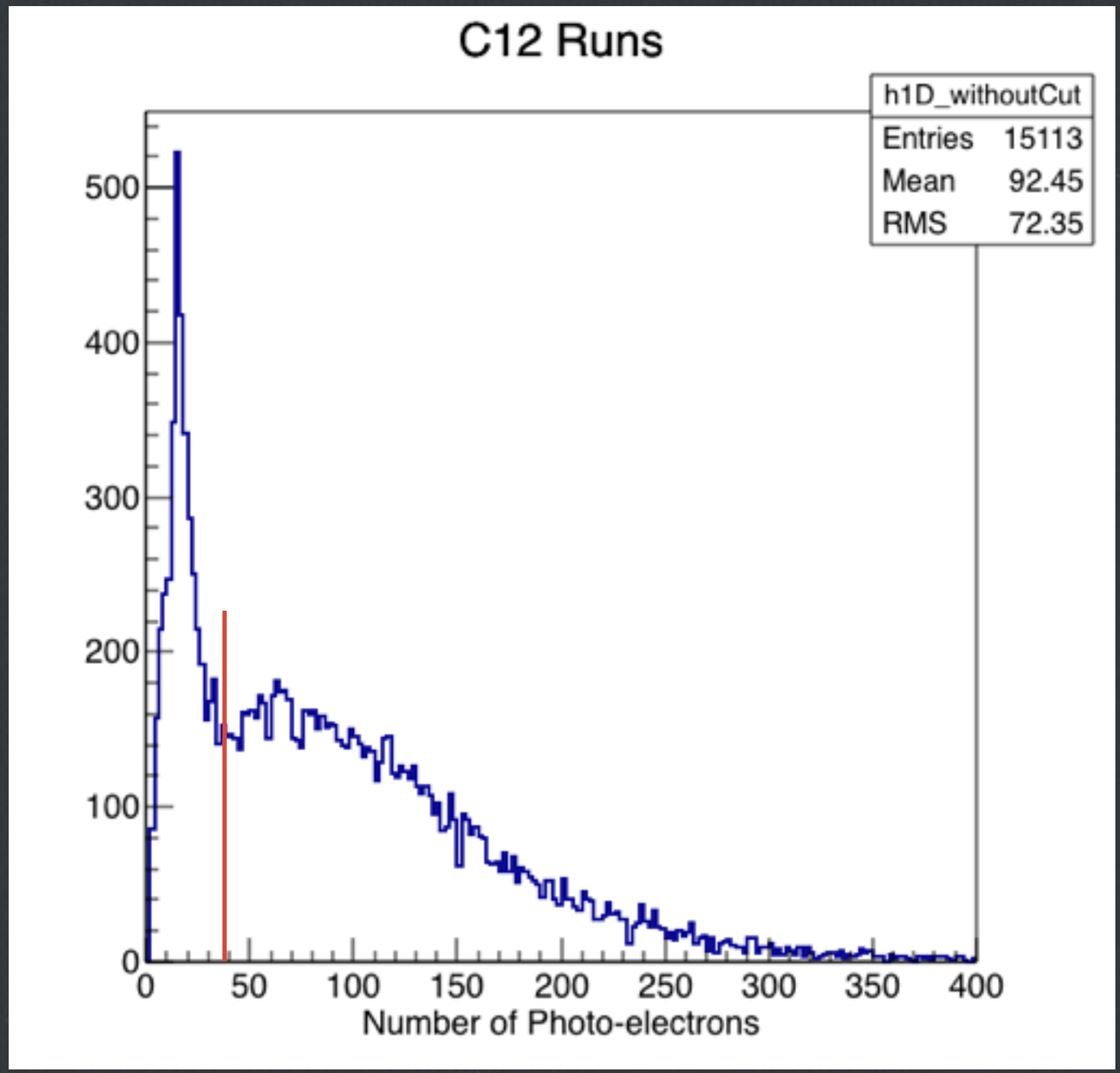




e- EC Cuts


ECtot/P vs P, Sector 1
Entries 51873
Mean x 1.36
Mean y 0.2332
RMS x 0.6487
RMS y 0.0726
ECtot/P vs P, Sector 2
Entries 49429
Mean x 1.306
Mean y 0.2473
RMS x 0.6398
RMS y 0.07494
ECtot/P vs P, Sector 3
Entries 51870
Mean x 1.309
Mean y 0.2384
RMS x 0.651
RMS y 0.07738
ECtot/P vs P, Sector 4
Entries 47377
Mean x 1.336
Mean y 0.2354
RMS x 0.6421
RMS y 0.0707
ECtot/P vs P, Sector 5
Entries 45967
Mean x 1.4
Mean y 0.2442
RMS x 0.6595
RMS y 0.07748
ECtot/P vs P, Sector 6
Entries 56410
Mean x 1.324
Mean y 0.2537
RMS x 0.6647
RMS y 0.08422
Momentum (GeV/c)

e- CC Cuts


C12 Runs
h1D_withoutCut
Entries 15113
Mean 92.45
RMS 72.35
500
400
300
200
100
0
0 50 100 150 200 250 300 350 400
Number of Photo-electrons