Supported by the DOE Award No.DE–SC0016583

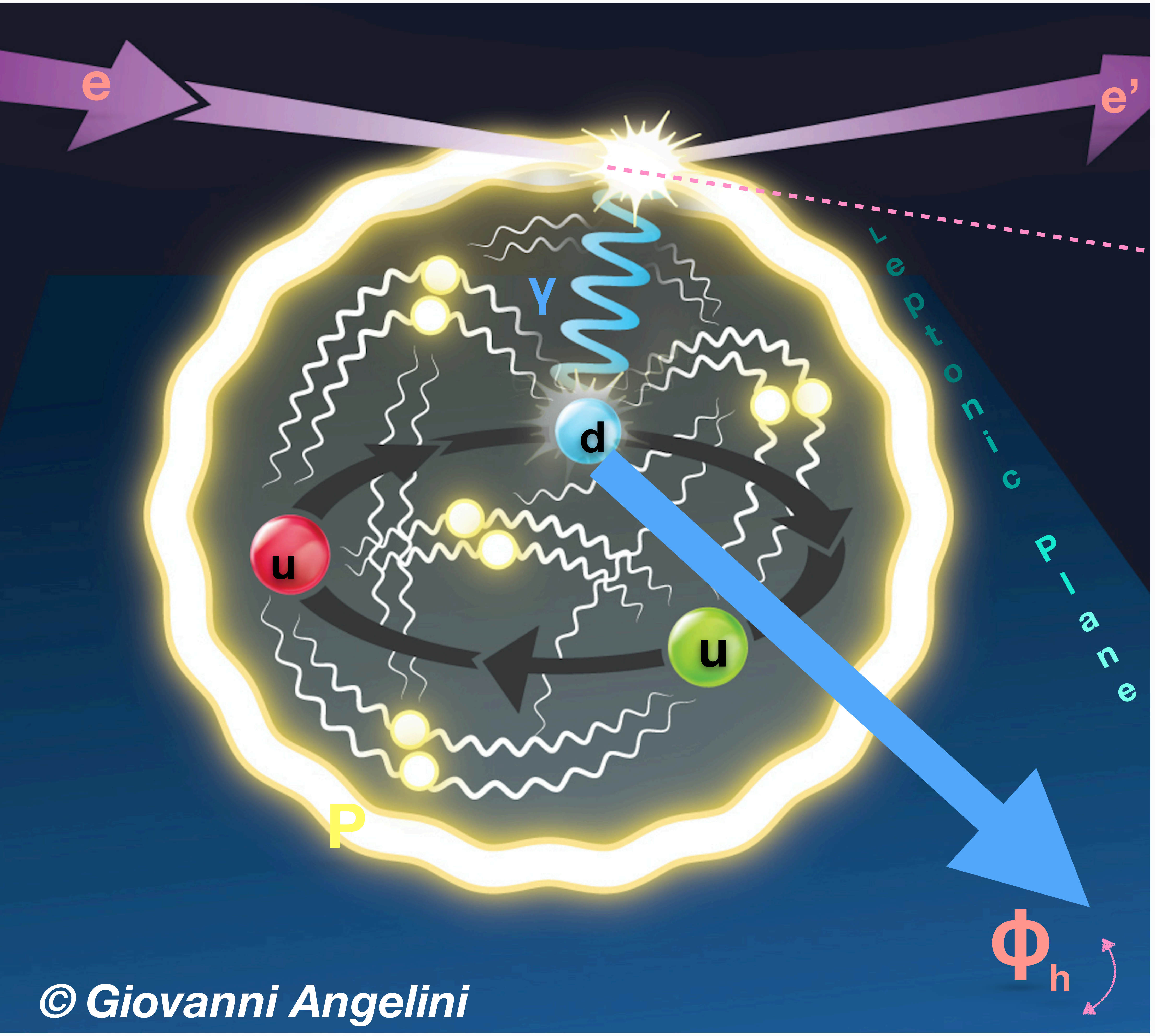
Neutral Pion DIS Multiplicity with CLAS12 Data

Giovanni Angelini (GWU), PhD candidate

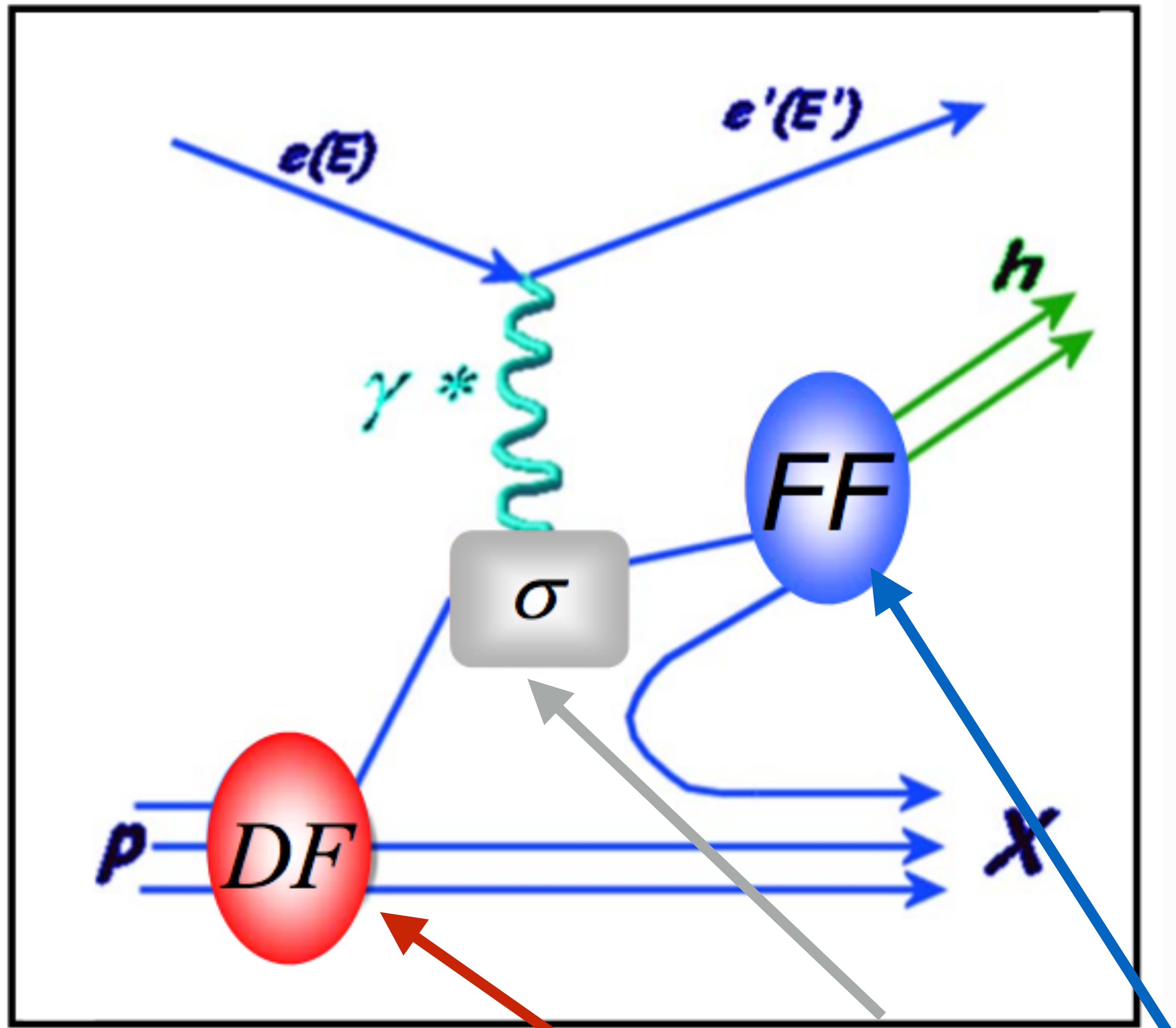
Outlook

- Multiplicity: Brief Motivation
- CLAS12: Detector Overview
- Data Selection.
- Preliminary analysis Multiplicity vs z
- Preliminary analysis Multiplicity vs PT
- Future plans

Semi Inclusive Deep Inelastic Scattering



SIDIS: The four-vector of the measured hadron can give us information on the proton's structure.



$$\sigma^{ep\to ehX} = \sum_q DF \otimes \sigma^{eq\to eq} \otimes FF$$

Structure Function: $F \propto DF \otimes FF$

Partonic Distribution Function. Fragmentation Function

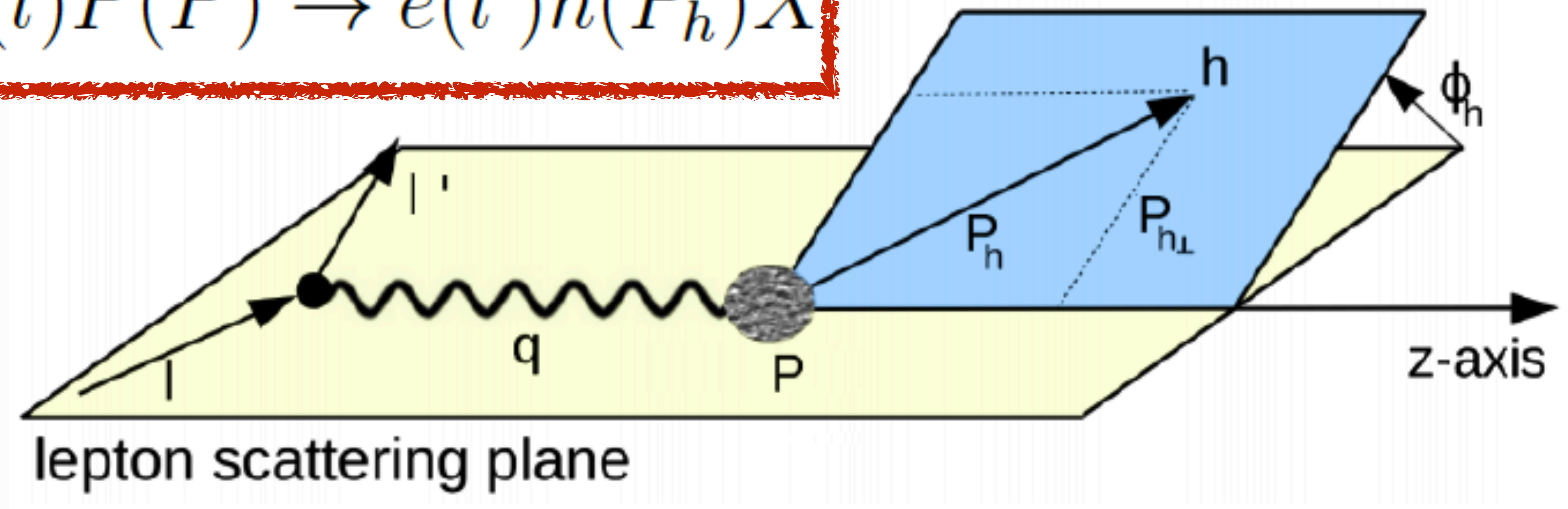
Observable: Multiplicity

Multiplicity:

$$m^h(Q^2,x,z,P_{hT}^2)=\frac{d\sigma^h_{SIDIS}/dQ^2\,dx\,dz\,dP^2_{hT}}{d\sigma^h_{DIS}/dQ^2\,dx}$$

SDIS:

$$\boxed{e(l)P(P)\to e(l')h(P_h)X}$$



$$m_N^h(x,z,P_{hT}^2,Q^2)=\frac{\pi F_{UU,T}(x,z,P_{hT}^2,Q^2)+\pi\,\varepsilon F_{UU,L}(x,z,P_{hT}^2,Q^2)}{F_T(x,Q^2)+\varepsilon F_L(x,Q^2)}$$

Kinematics factors drops in the ratio. Information on the FF can be extracted from it.

Assuming Gaussian distributions in k_T and p_T

$$m_N^h(x,z,P_{hT}^2)=\frac{\pi}{\sum_a e_a^2 f_1^a(x)}\times\sum_a e_a^2\, f_1^a(x)\underbrace{\boxed{D_1^{a\to h}(z)}}_{\text{FF}}\frac{e^{-P_{hT}^2/\left(z^2\langle k^2_{\perp,a}\rangle+\langle P^2_{\perp,a\to h}\rangle\right)}}{\pi\left(z^2\langle k^2_{\perp,a}\rangle+\langle P^2_{\perp,a\to h}\rangle\right)}$$

Some π0 advantages

$$\sigma_p^{eX} \propto 4u + d + \ldots$$

$$\sigma_p^{\pi 0} \propto 4uD^{u\rightarrow\pi 0} + dD^{d\rightarrow\pi 0} + \ldots$$

$$D^{u\rightarrow\pi 0} \approx D^{d\rightarrow\pi 0}$$

At large x (sea contribution can be neglected) the multiplicity should follow z-dependance of FF (after PT integration).

Fragmentation function for u and d quarks are the same at first approximation.

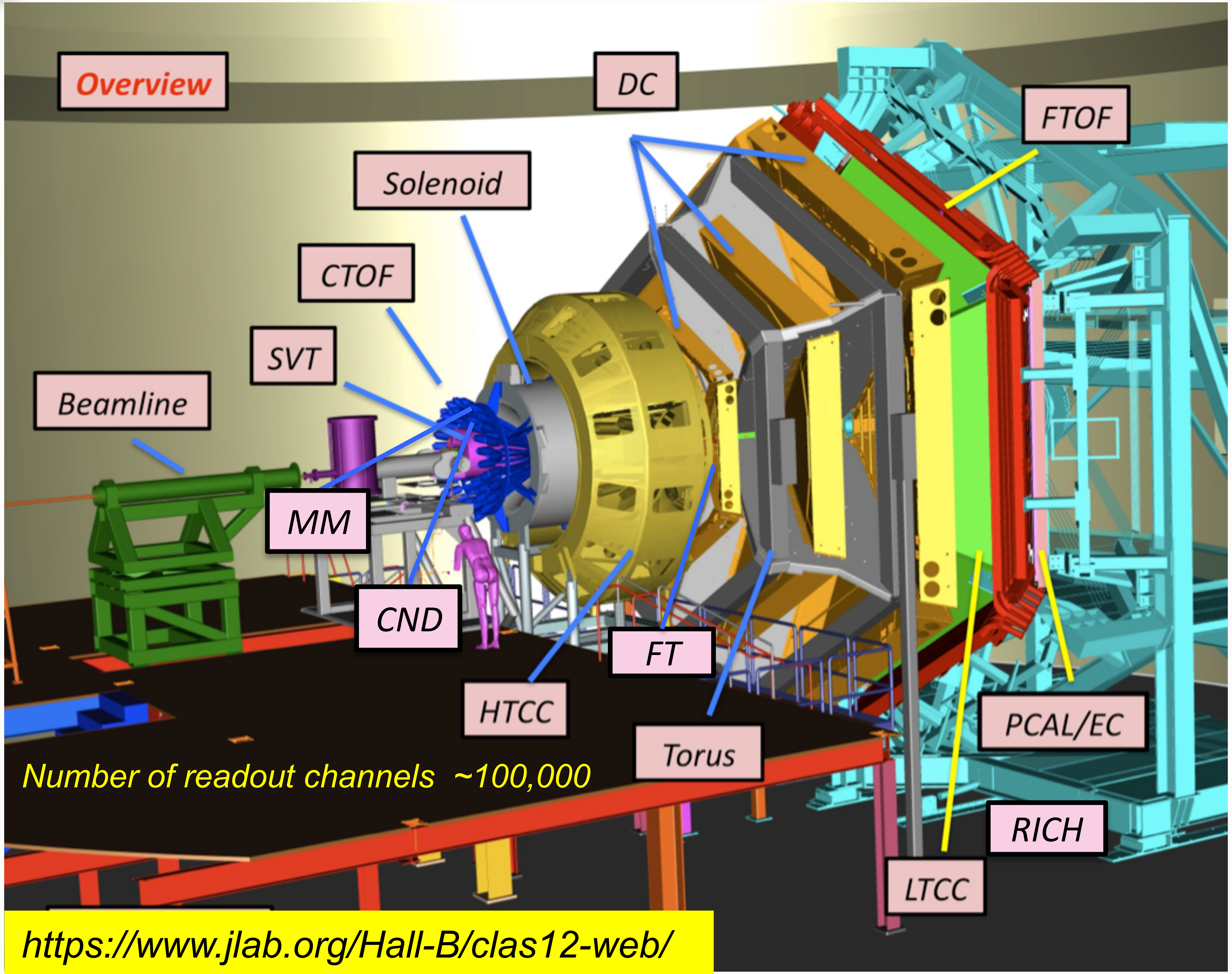
Suppression of spin-dependent fragmentation function for π0 since Collins FF has roughly equal magnitude but opposite sign in up and down quarks.

Suppression of higher-twist contributions at larger energy fraction (important at Jlab energy where small z are contaminated by target fragmentation).

Absence of ρ0 production that complicates the interpretation of charged single pion data.

In exclusive production the longitudinal photon contribution is suppressed with respect the transverse photon contribution which is higher twist. This suggest that longitudinal photon contribution to SIDIS will be also suppressed

CLAS12 Detector Overview

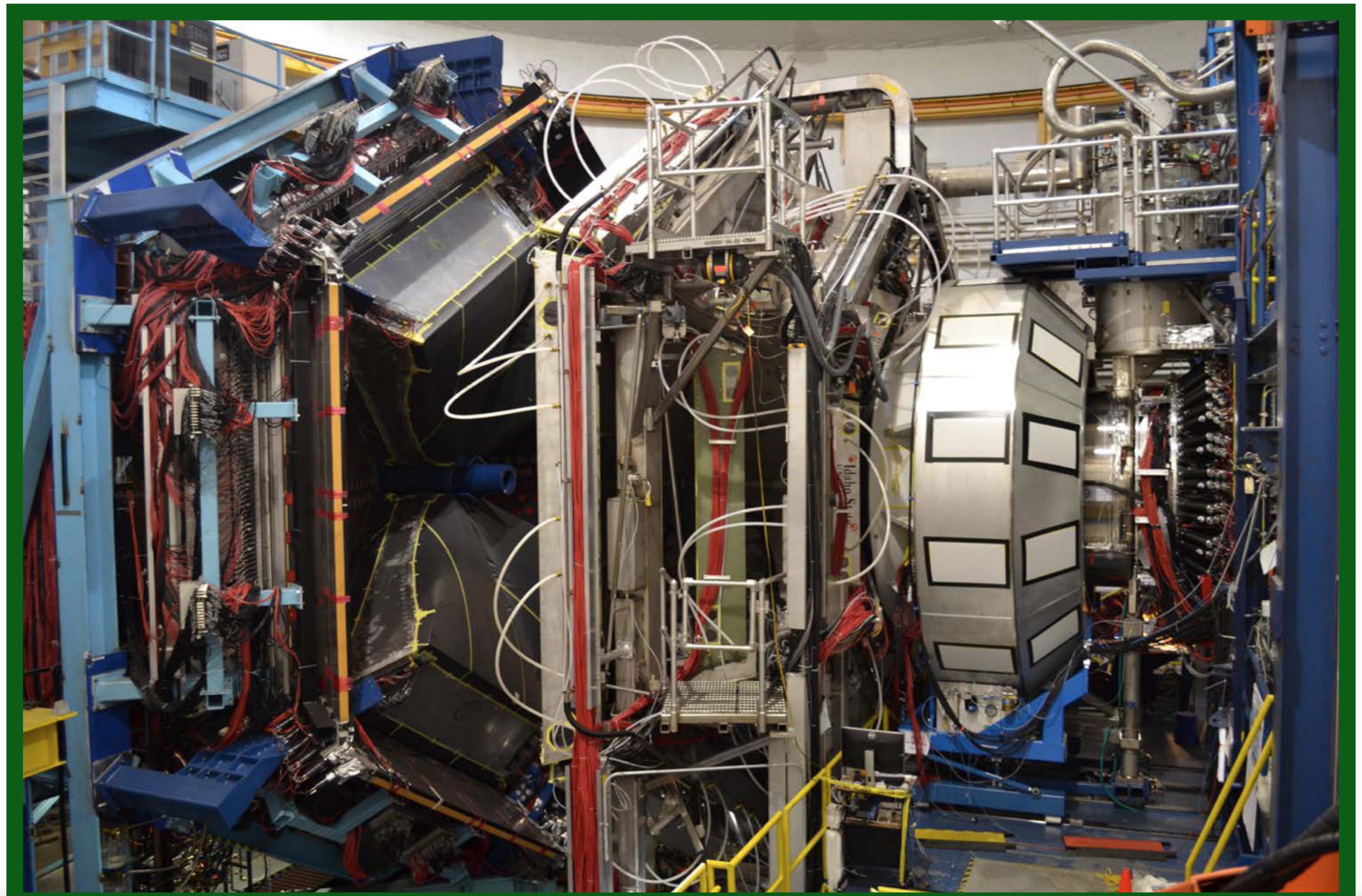


Forward Detector:
- Torus magnet
- Drift Chamber system
- Forward ToF System
- LT Cherenkov Counter
- HT Cherenkov Counter
- RICH
- Preshower calorimeter
- E.M. calorimeter (EC)
- Forward Tagger (FD)

Central Detector:
-Solenoid magnet
-Barrel Silicon Tracker
-Central Time-of-Flight
-Micromegas
-Neutron detector

CLAS12 Detector Overview

Installation Completed at the end of 2017



Target used: Unpolarized Liquid Hydrogen.
Polarized electron beam (85% of polarization)
E = 10.6 GeV

$$L = 10^{35}\ cm^{-2} s^{-1}$$

For this analysis: **Forward Detector**

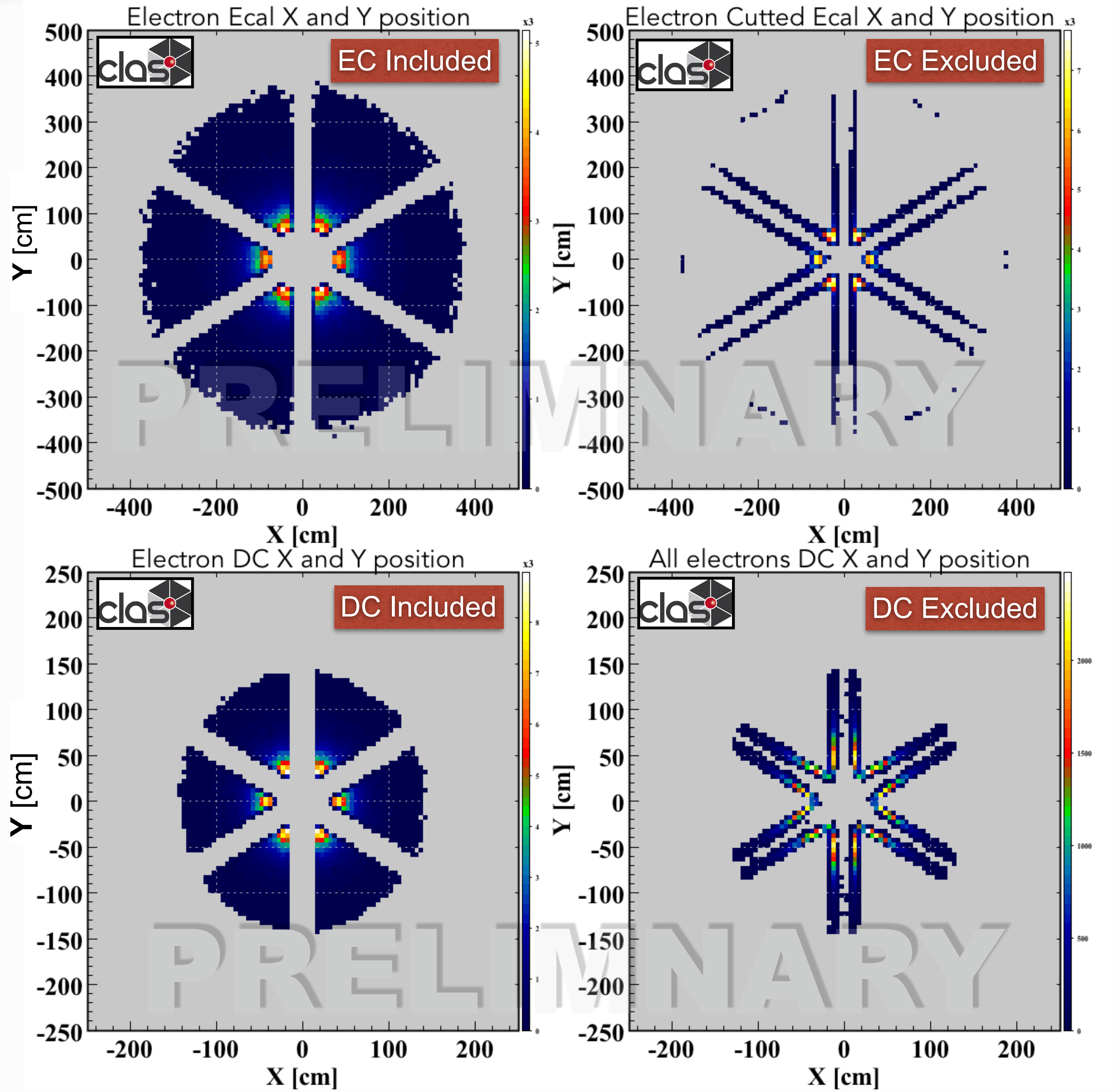
e' ID:	Track FTOF HTTC PCAL	γ ID:	β PCAL

Disclaimer

Very preliminary results based on < 1% of the data collected.
The data were processed with a preliminary reconstruction algorithm.
The collaboration has improved and updated these algorithms and is processing a large data sample.
In the future weeks I will extend this analysis to 10% of RUN- Group A.

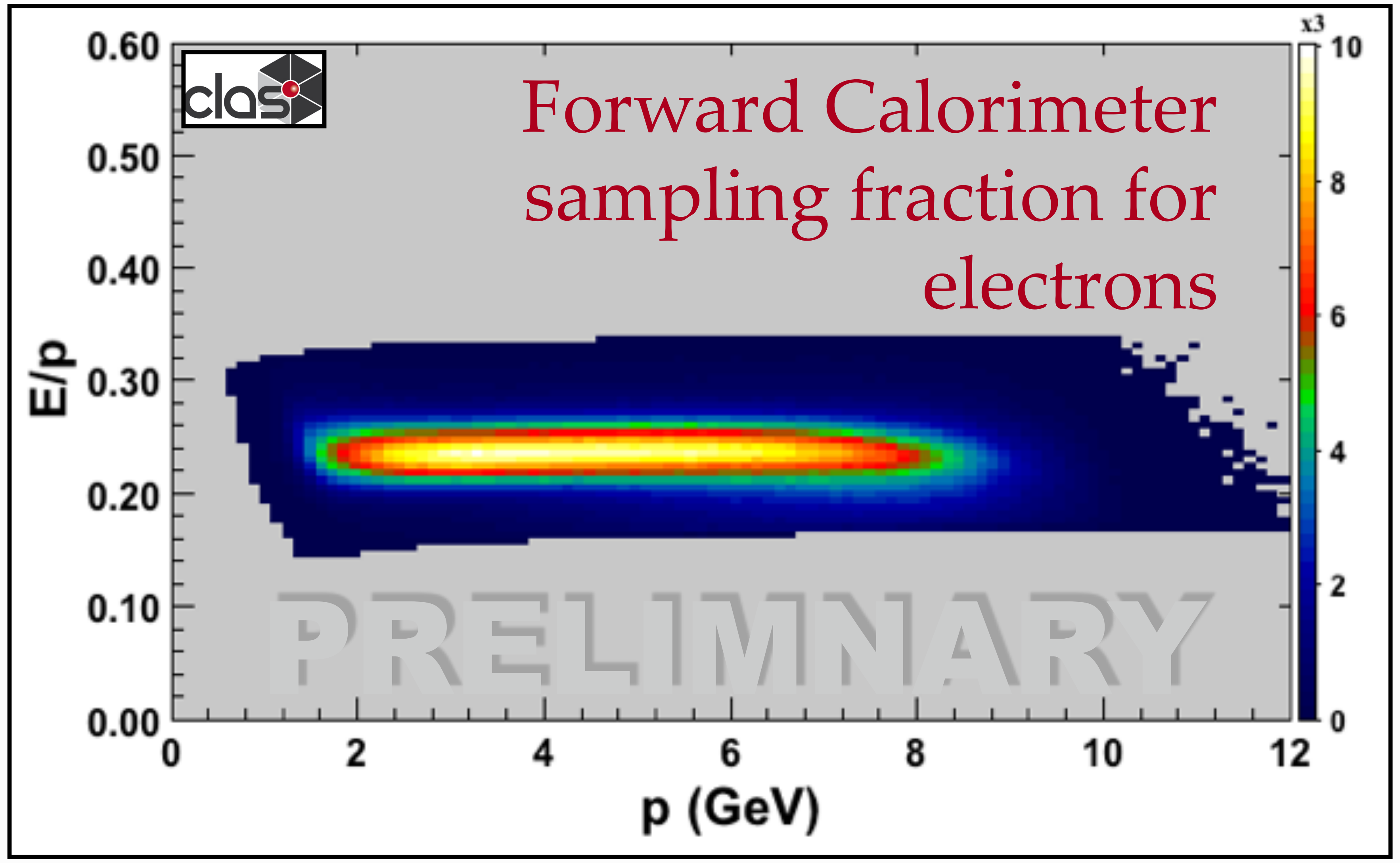
Data Selection: Scattered Electron Cuts

FIDUCIAL CUTS:

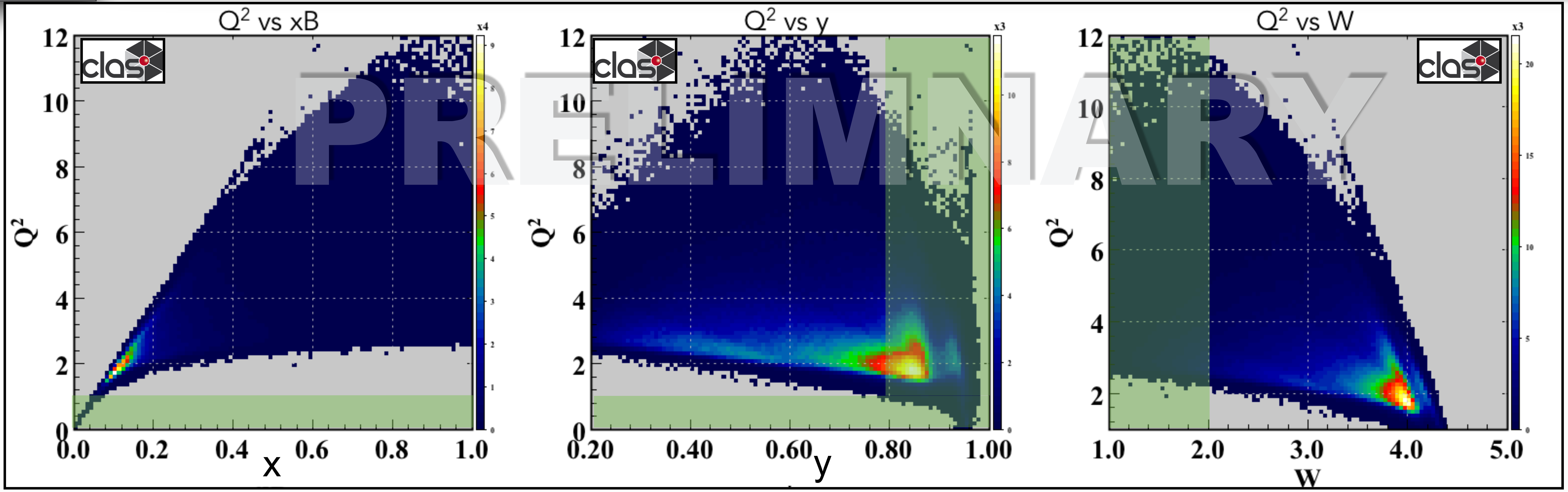


Data Sample:

SIDIS:	$e\ P \longrightarrow e'\ \pi 0\ X$
DIS:	$e\ P \longrightarrow e'\ X$



Data Selection: Scattered Electron

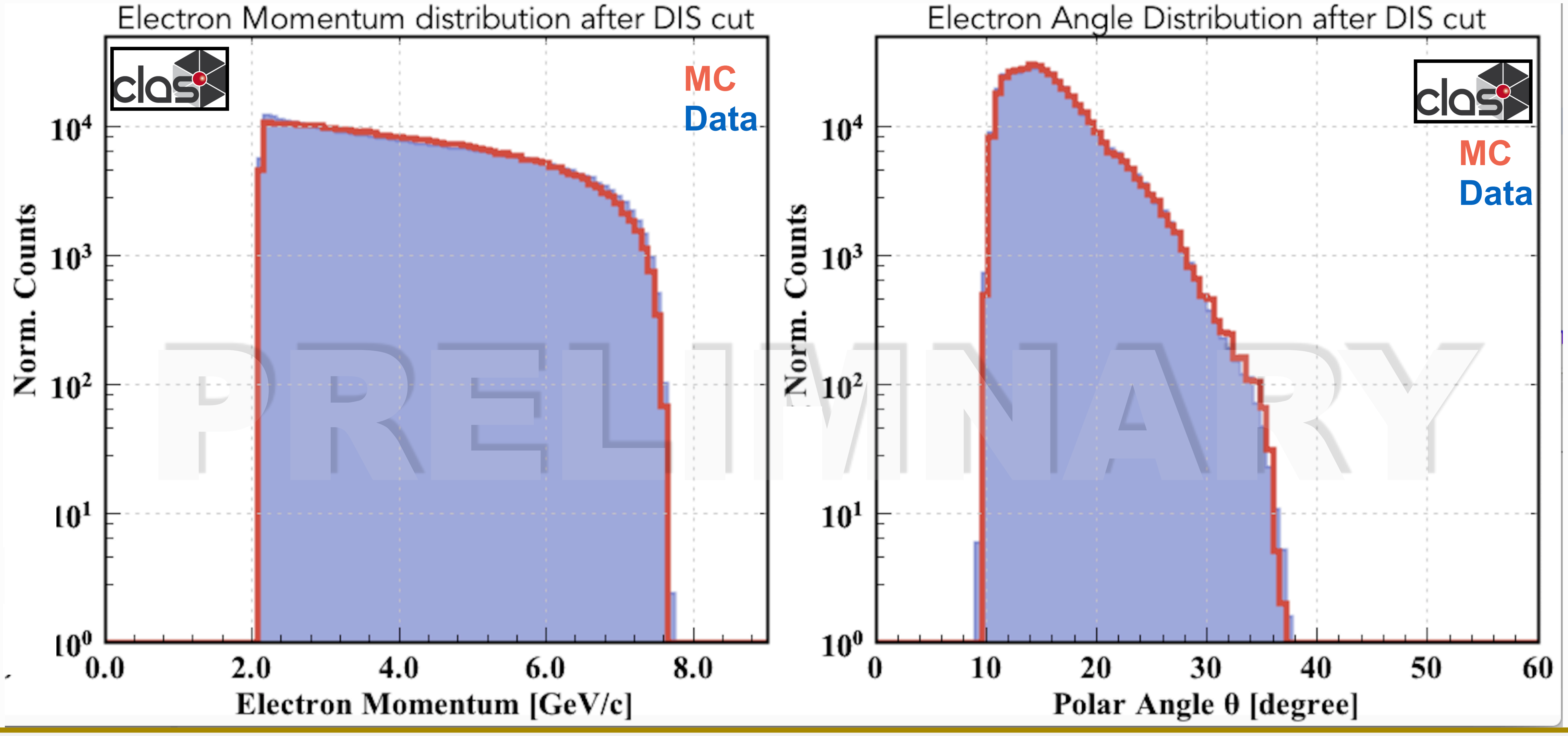


$Q^2 > 1\ \mathrm{GeV}^2$
$W > 2\ \mathrm{GeV}$
$y < 0.80$

MC:

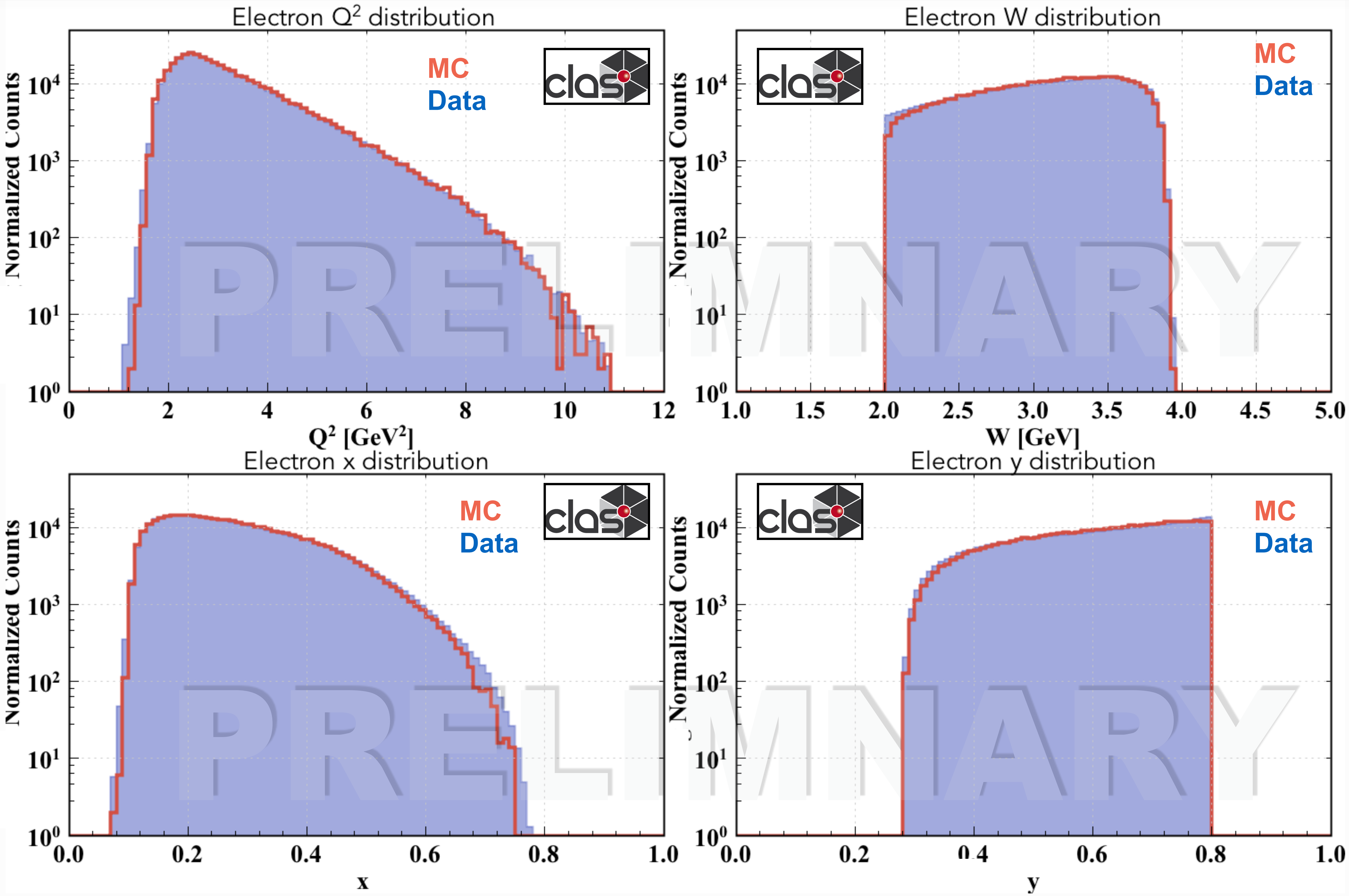
CLASDIS LUND Generator
Based on LEPTO-PEPSI

Hadronization:
Lund String Model



Reconstructed electrons kinematics

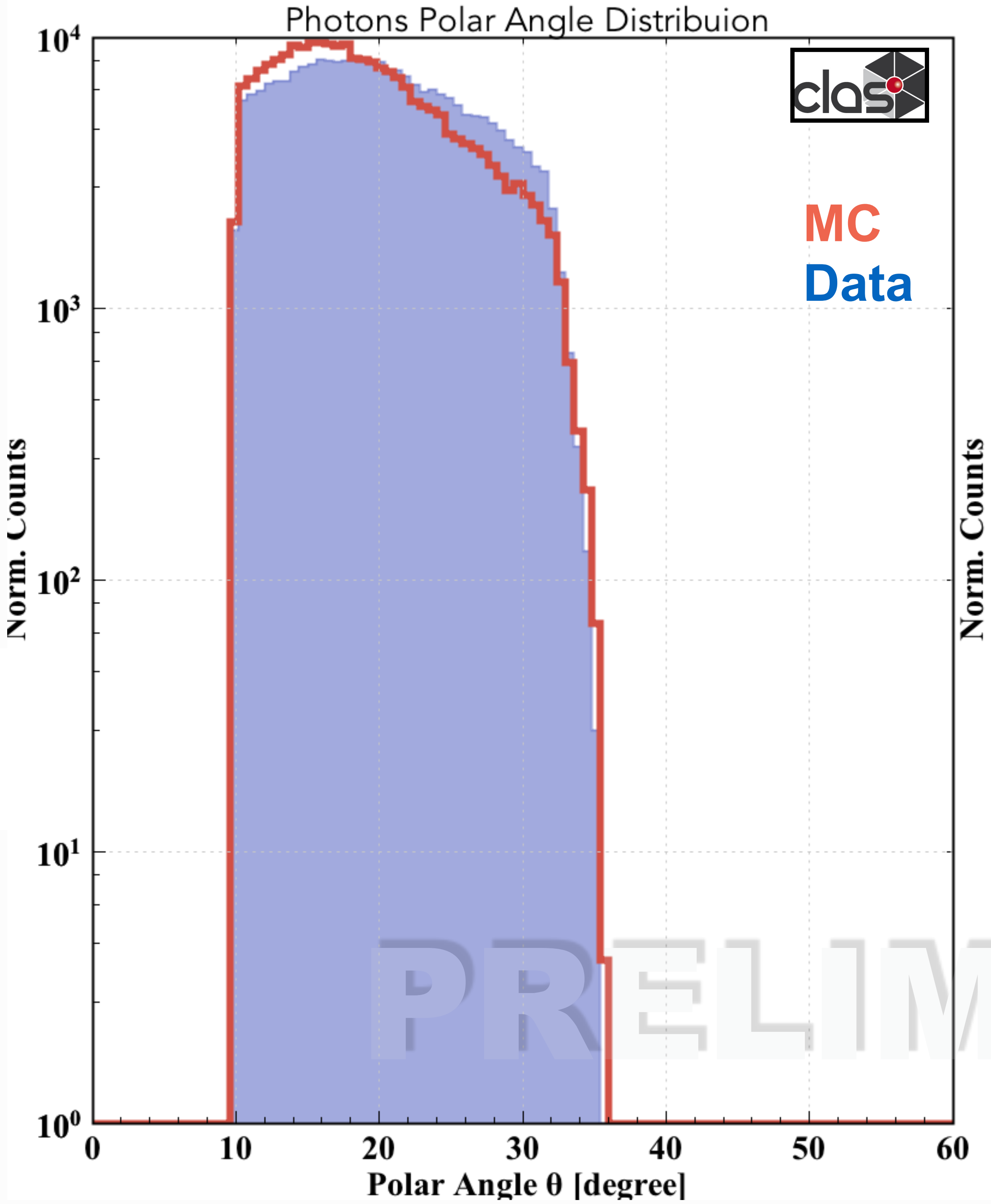
Data vs MC Kinematics

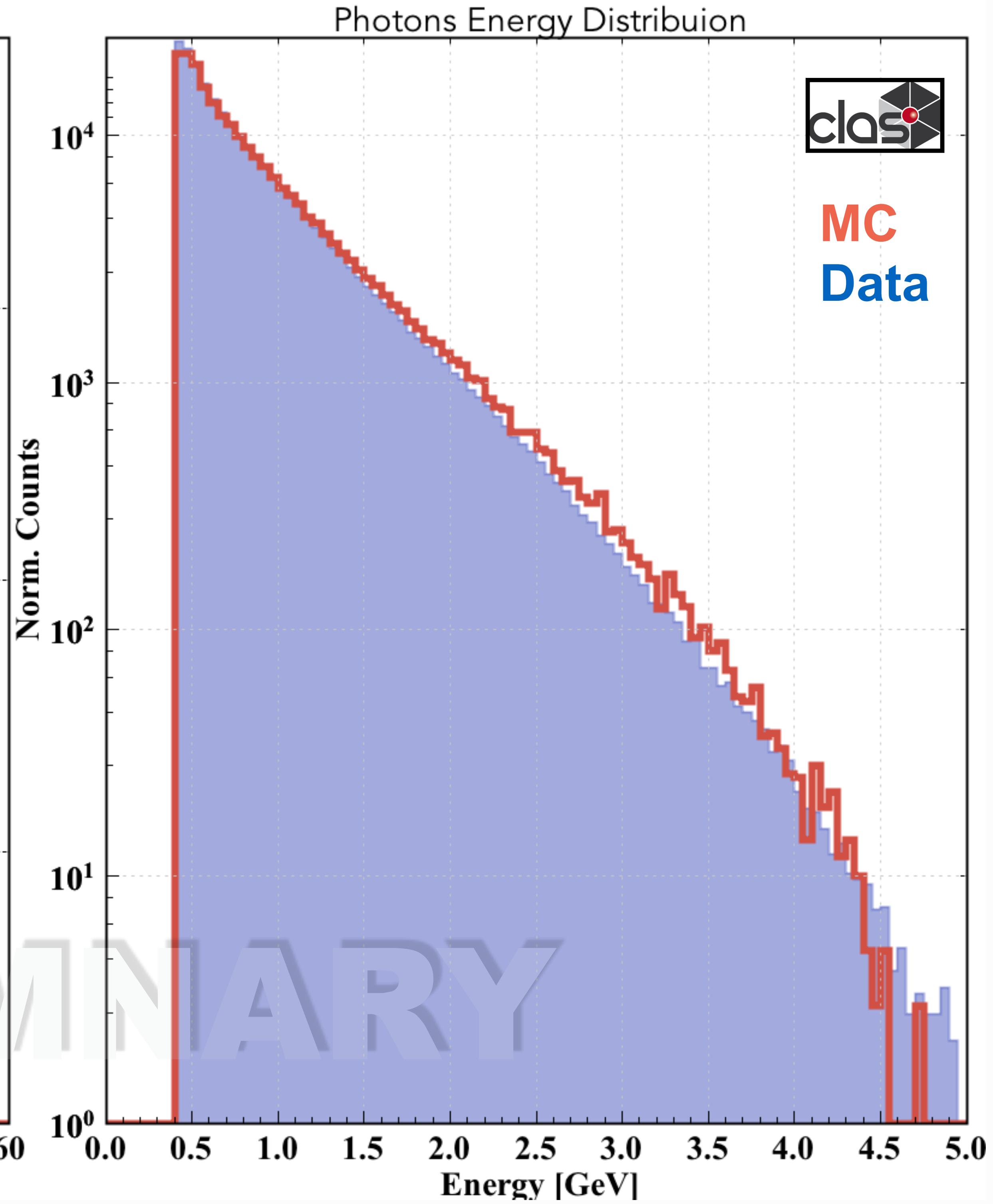


Reconstructed photons

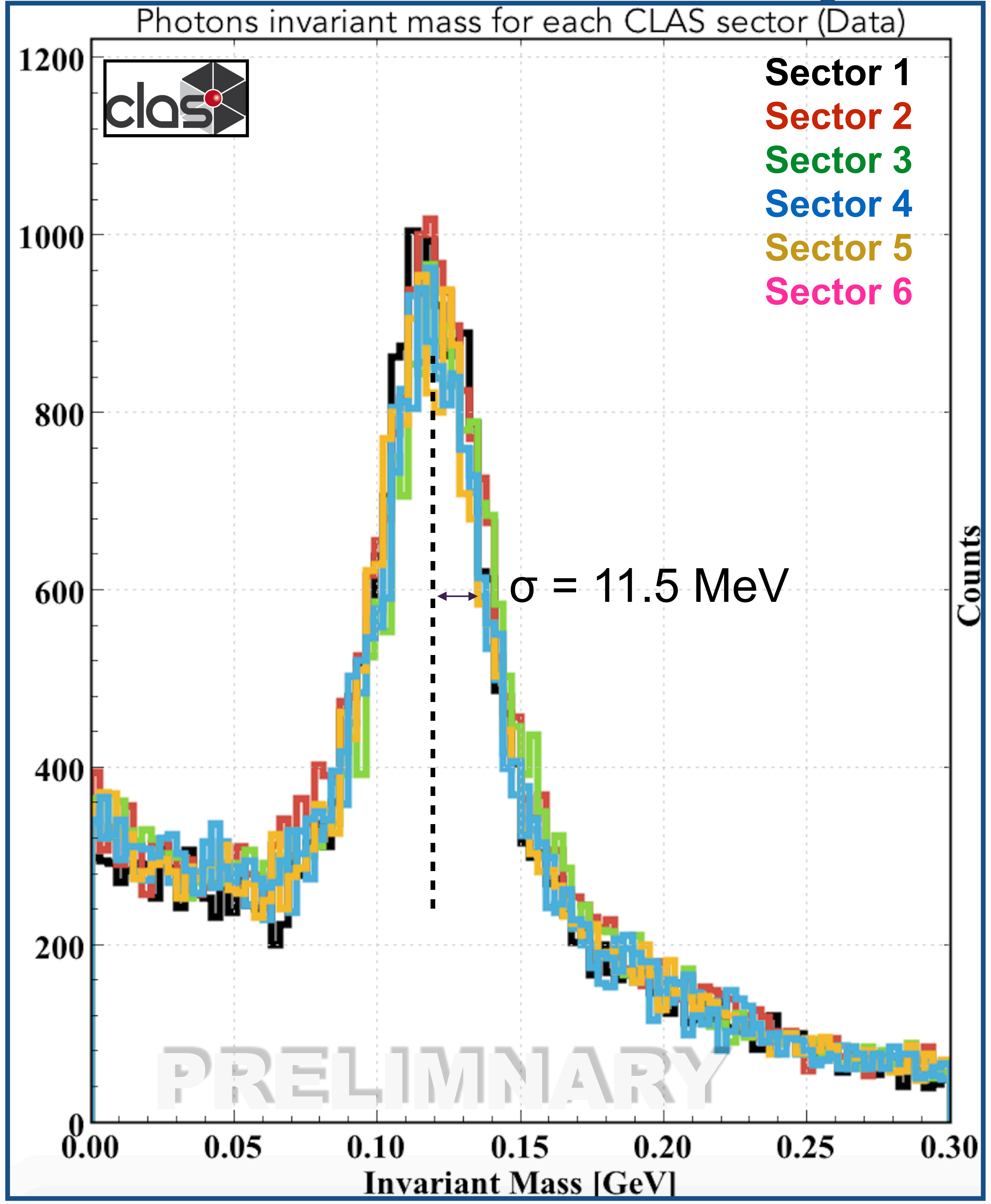
Photon selections

Photon Energy > 400 MeV
Photon with angle > 2 ° with respect e'





Cal. Sector Uniformity

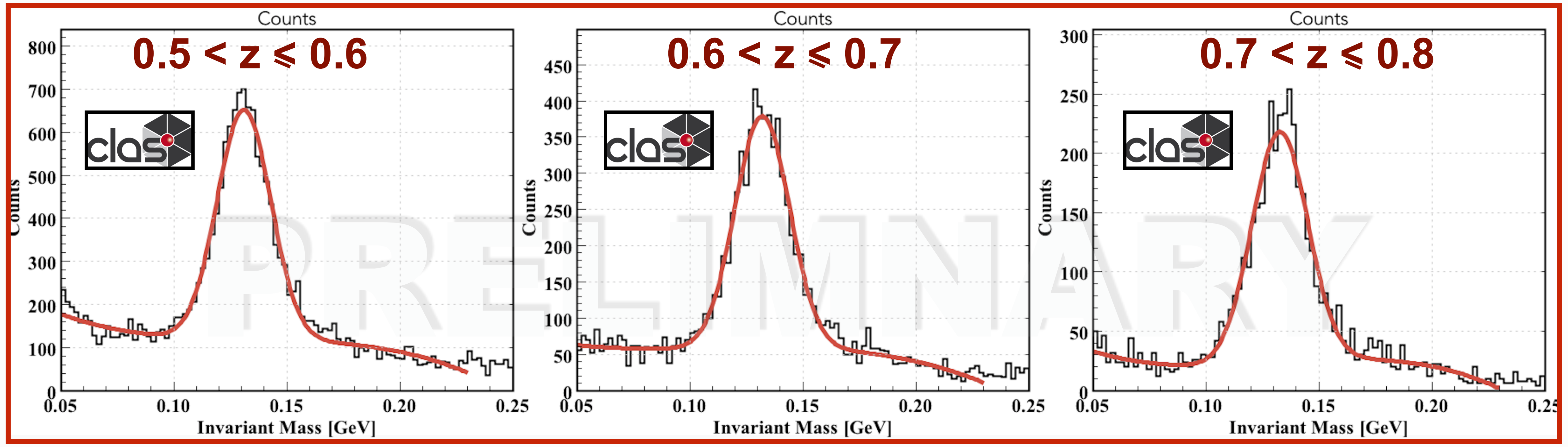


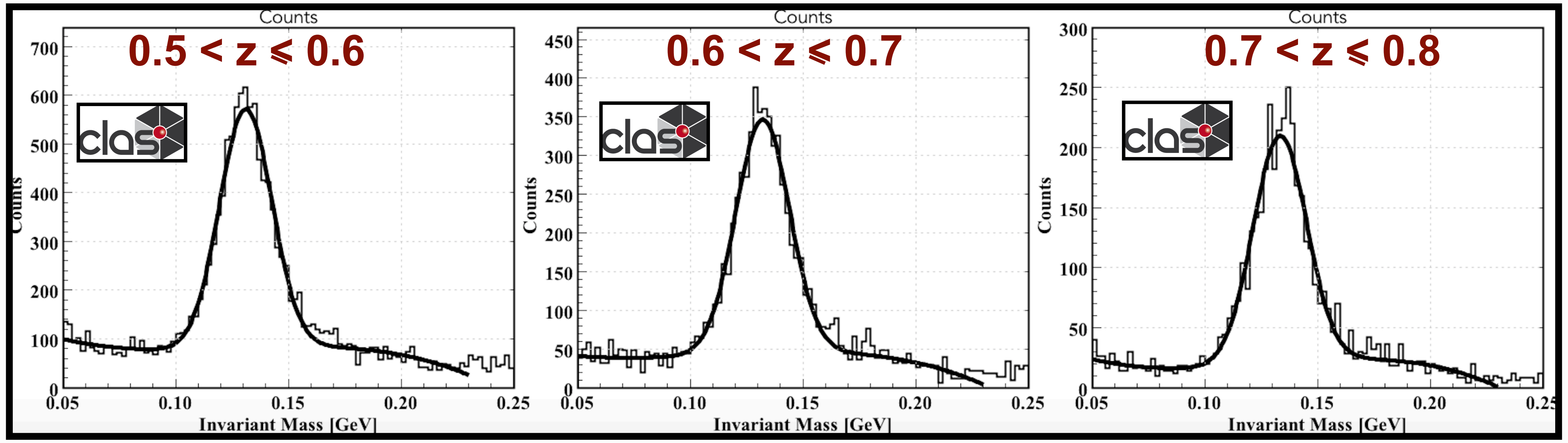
π0 Reconstruction in Z bins

Data divided in z bin (size 0.1)
$0.2 < z \leqslant 0.9$
Each bin has been fitted with : Gauss + Poly 3rd
π0 s obtained from the gaussian integral

Two methods:

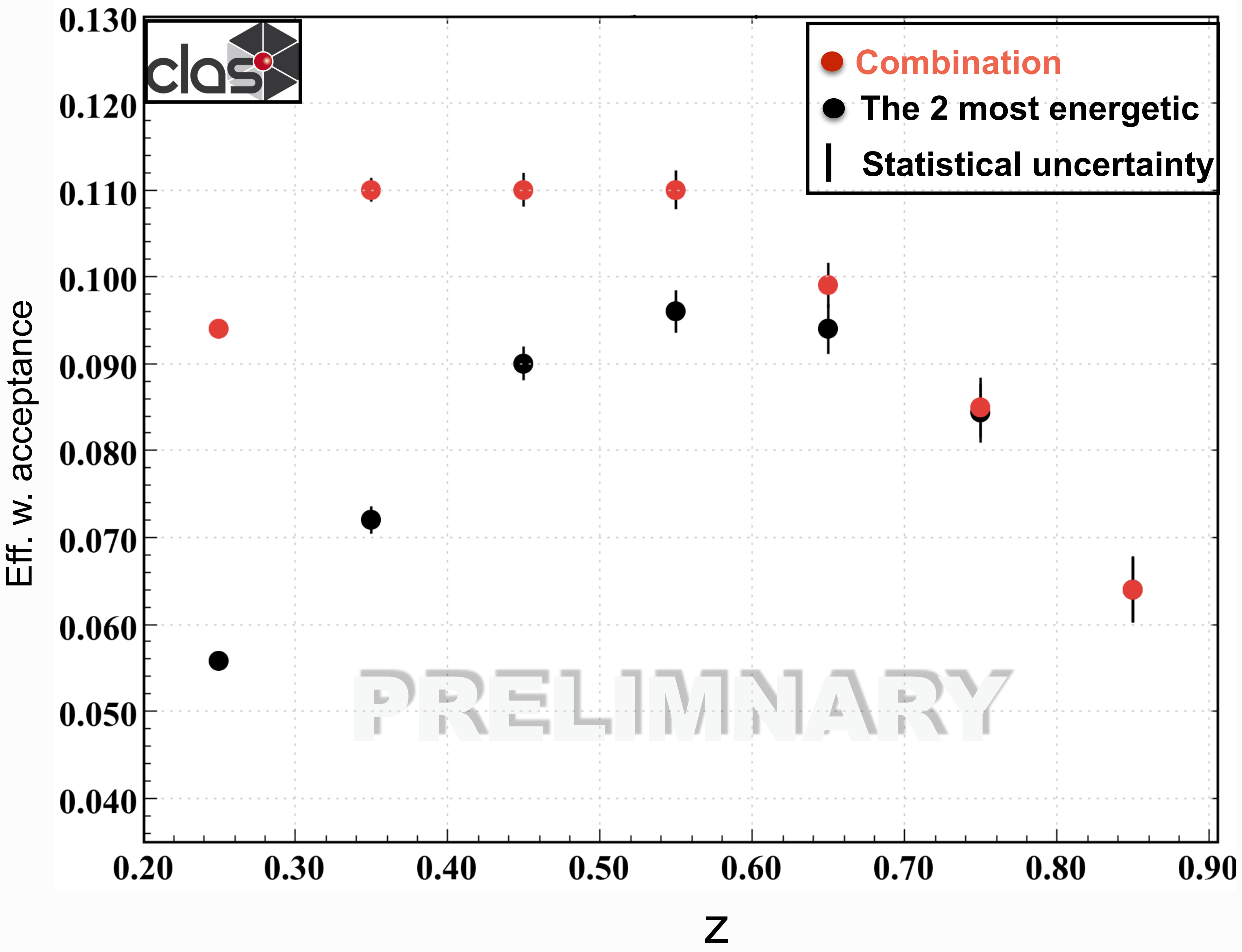
-) Combination of all photons pair in event
-) The 2 most energetic photons of the event

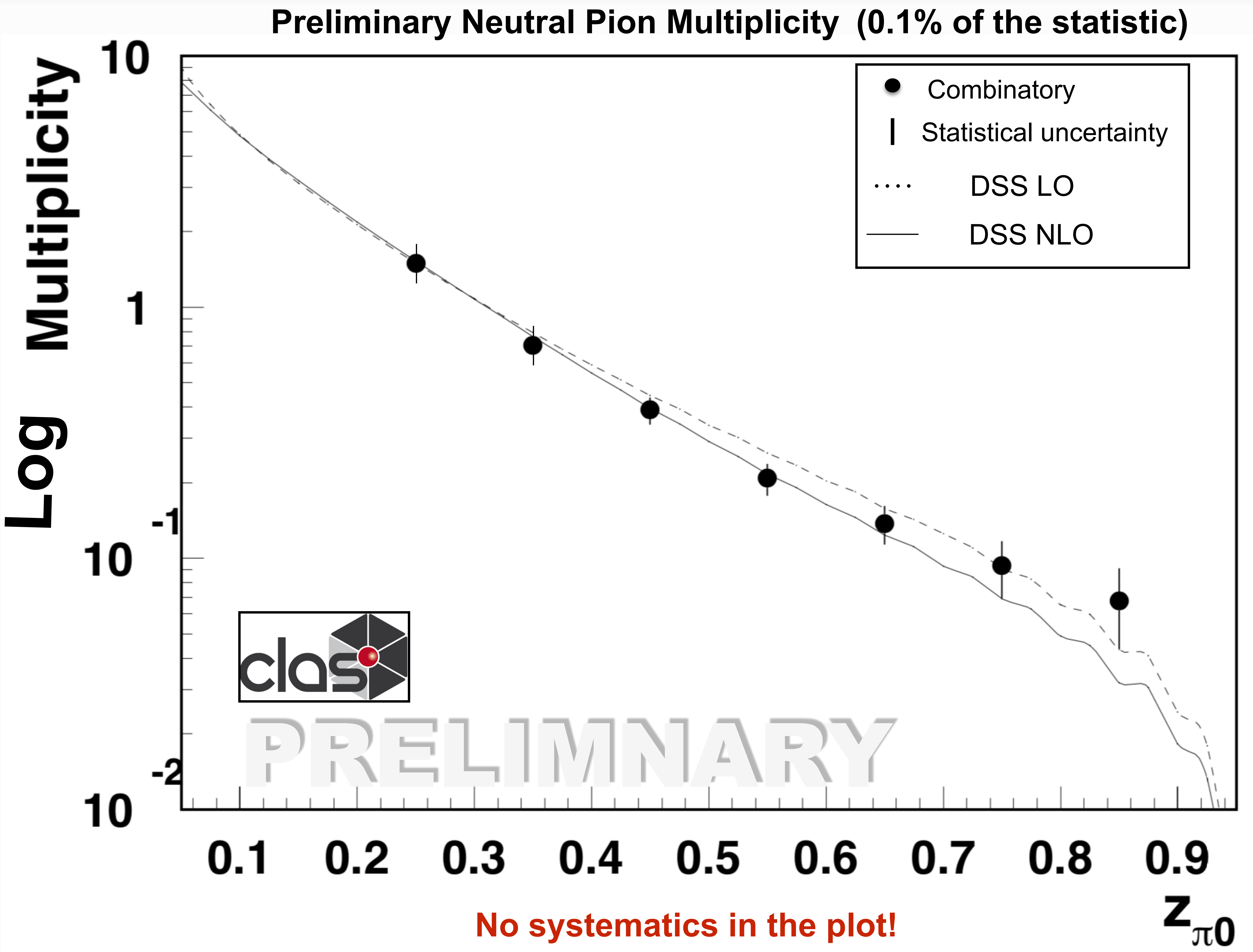




Efficiency w. Acceptance:

$$\frac{\pi0\text{s reconstructed from MC (within the cuts)}}{\pi0\text{s generated } (4\pi)}$$





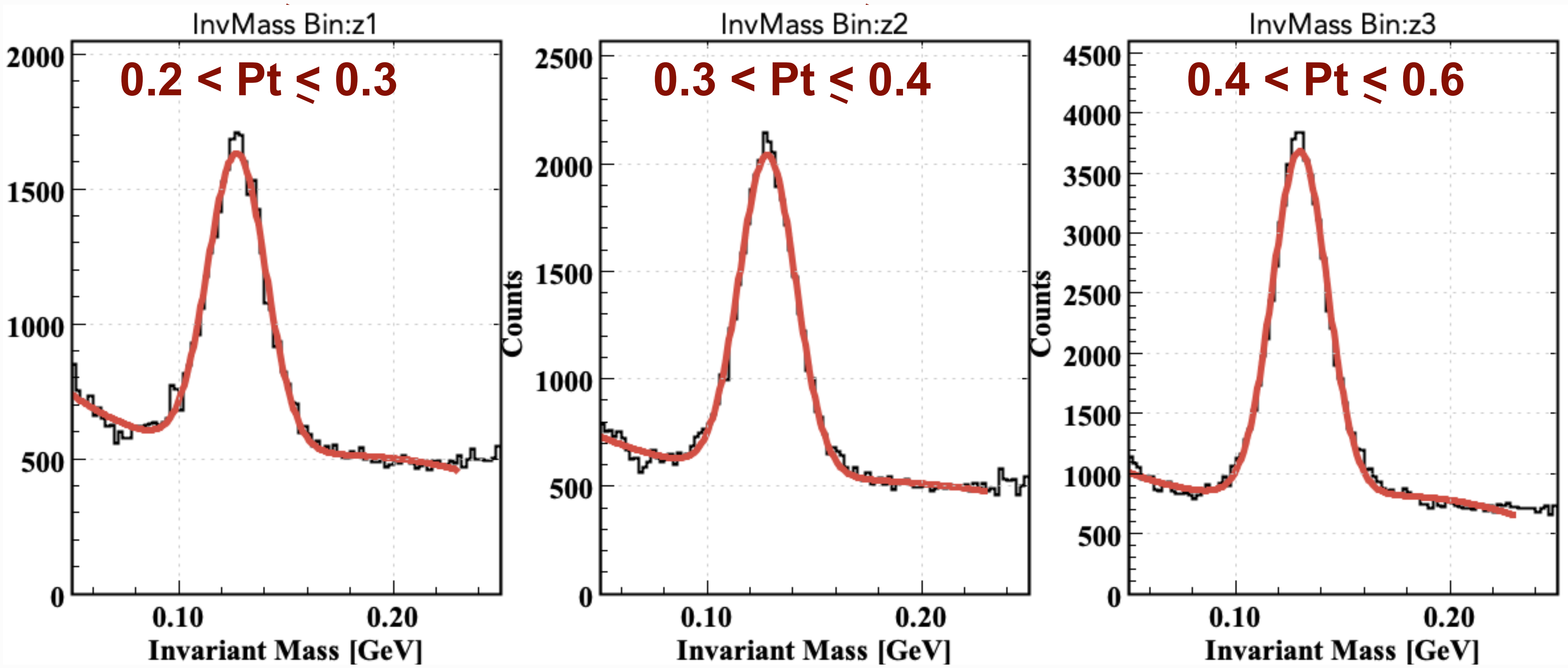
No systematics in the plot!

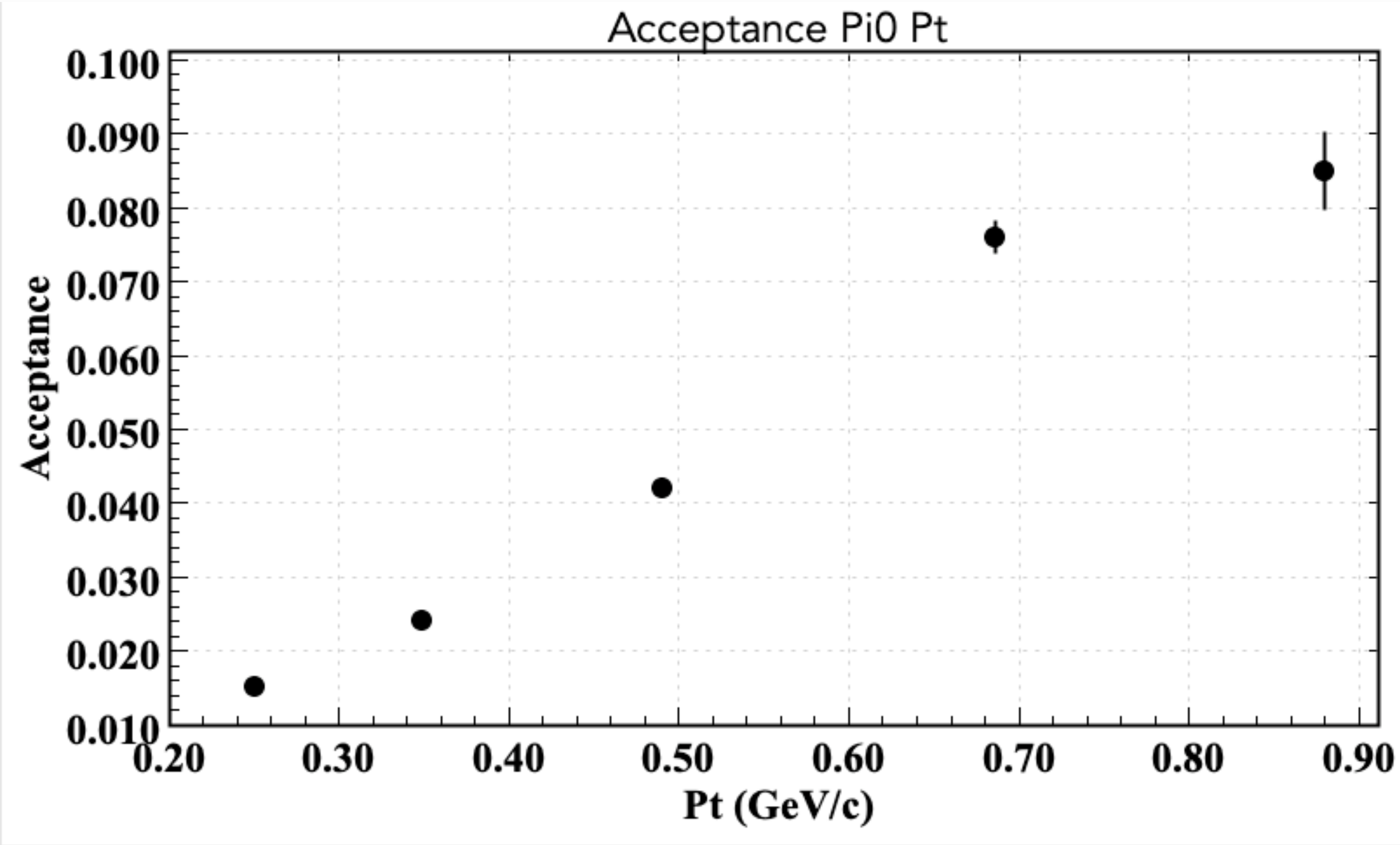
π0 Reconstruction in Pt bins

Data divided in Pt bin from 0.2 to 1GeV/c
Each bin has been fitted with : Gauss + Poly 3rd
π0 s obtained from the gaussian integral

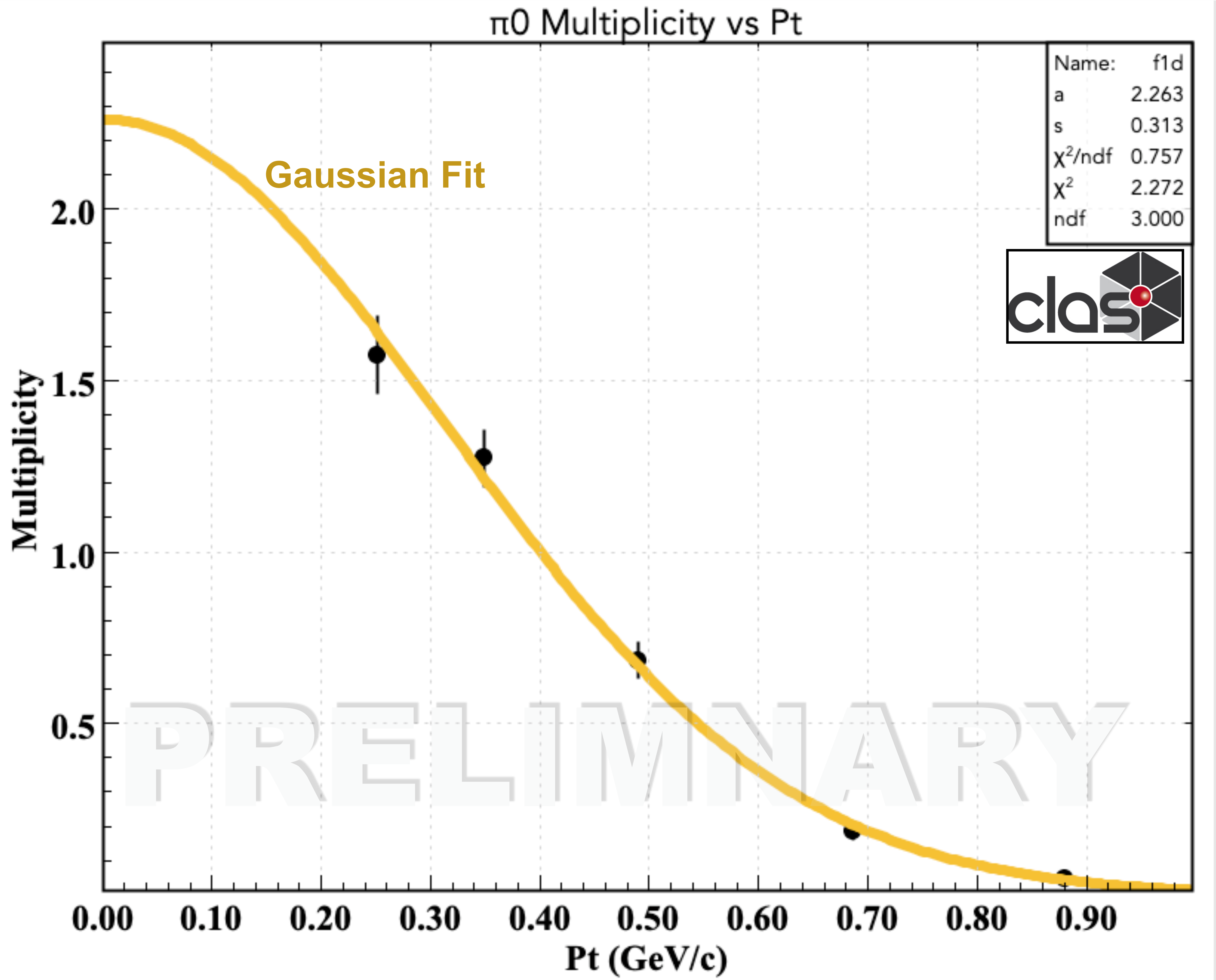
Efficiency w. Acceptance:

$$\frac{\text{π0s reconstructed from MC (within the cuts)}}{\text{π0s generated } (4\pi)}$$

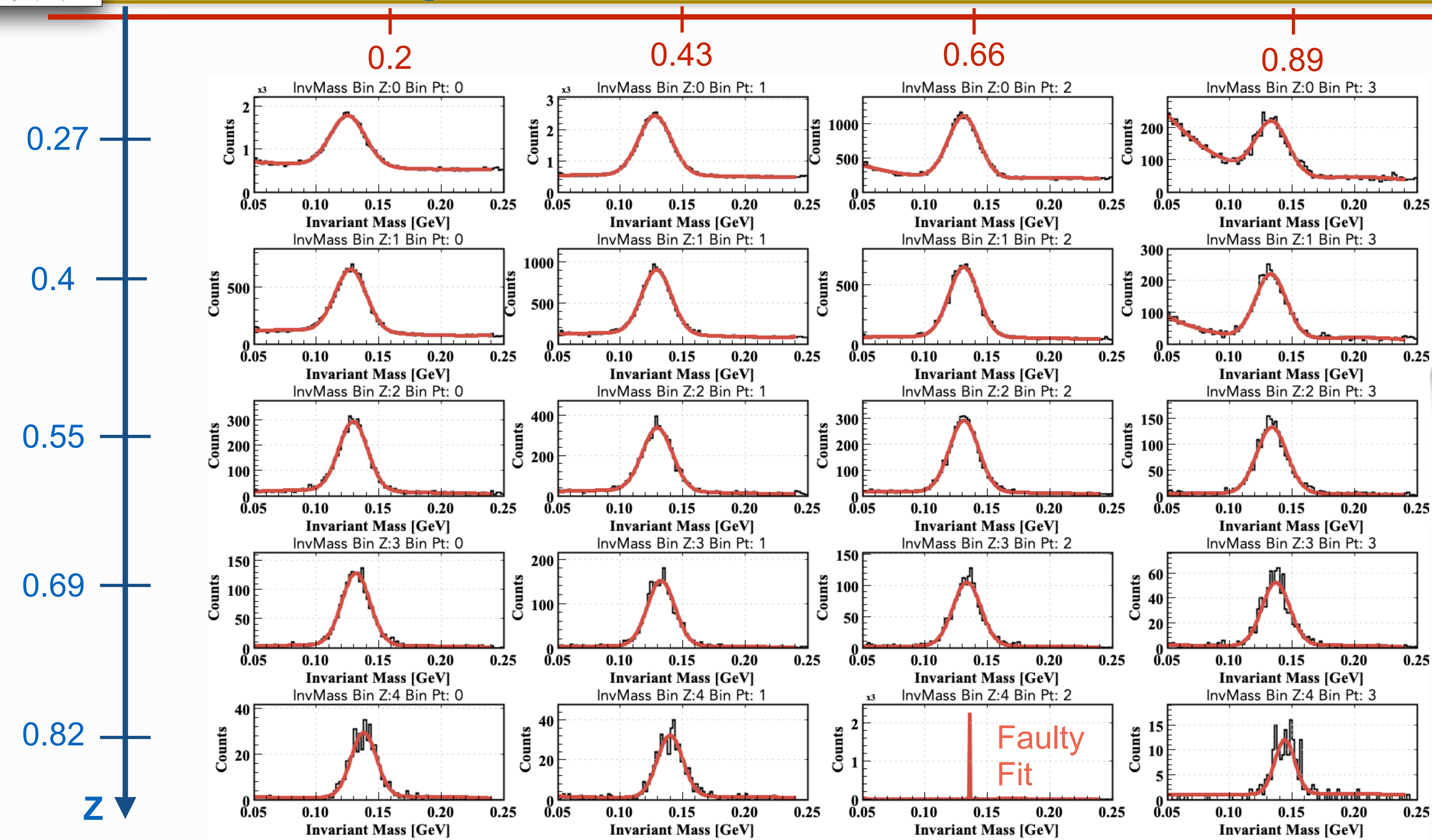




π0 Reconstruction in PT bins



Next Steps: Towards Multi Dimensional Analysis



-Getting more Statistic.
-Improving the fits

Obtained on <1% of the data sample. We will have statistics for a truly multidimensional analysis

Conclusions

Both the Z and PT distribution of neutral pion multiplicity look reasonable even if very preliminary data have been used for this analysis.

In the next months the analysis will be done with better quality data and higher statistics. Results will be obtained in multi dimensional bins.

By the end of this year I am planning to conclude this analysis and move to charged particles.