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Pions SIDIS Multiplicity

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Why multiplicity ?

Most prominent leading twist observable on the Φ integrated cross-section is the unpolarized structure function Fuu. In the TMDs formalism the unpolarized structure function is:

$$F_{UU}(x,z,P_{hT}) = x\sum_q e_q^2 \int d^2\mathbf{k}_T\, d^2\mathbf{p}_T \delta^{(2)}(\mathbf{p}_T + z\mathbf{k}_T - \mathbf{P}_{hT}) f_1^q(x,k_T^2) D_1^q(z,P_{hT}^2)$$

(in parton model)

One prefer to measure multiplicity instead of the cross section:

$$\frac{\mathrm{d}^2 M^{\mathrm{h}}(x,Q^2,z,P_{\mathrm{hT}}^2)}{\mathrm{d}z\mathrm{d}P_{\mathrm{hT}}^2} = \left(\frac{\mathrm{d}^4\sigma^{\mathrm{h}}}{\mathrm{d}x\mathrm{d}Q^2\mathrm{d}z\mathrm{d}P_{\mathrm{hT}}^2}\right) \Big/ \left(\frac{\mathrm{d}^2\sigma^{\mathrm{DIS}}}{\mathrm{d}x\mathrm{d}Q^2}\right).$$

In this way the electron acceptance cancels out in the ratio.

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

The multiplicity depends on the fragmentation function D1:

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

Where the standard approximation for a Gaussian distribution of the transverse momentum has been used.

Cross Check for BSA

$$M_h = \frac{1}{N_{e-}^{DIS}} \frac{(N_h^+ + N_h^-)}{\epsilon_h}$$

Where e' acceptances have been simplified from numerator and denominator

Hadron Efficiency/Acceptance from MC

I produced MC for SIDIS
100 M inbending
20 M outbending

$$BSA = \frac{N_h^+ - N_h^-}{N_h^+ + N_h^-} \frac{1}{P}$$

Same sample as BSA.

It is simple to extract BSA from my same sample , same hadrons kinematic, same fiducial cuts. I can provide cross-checks for the BSA publication.

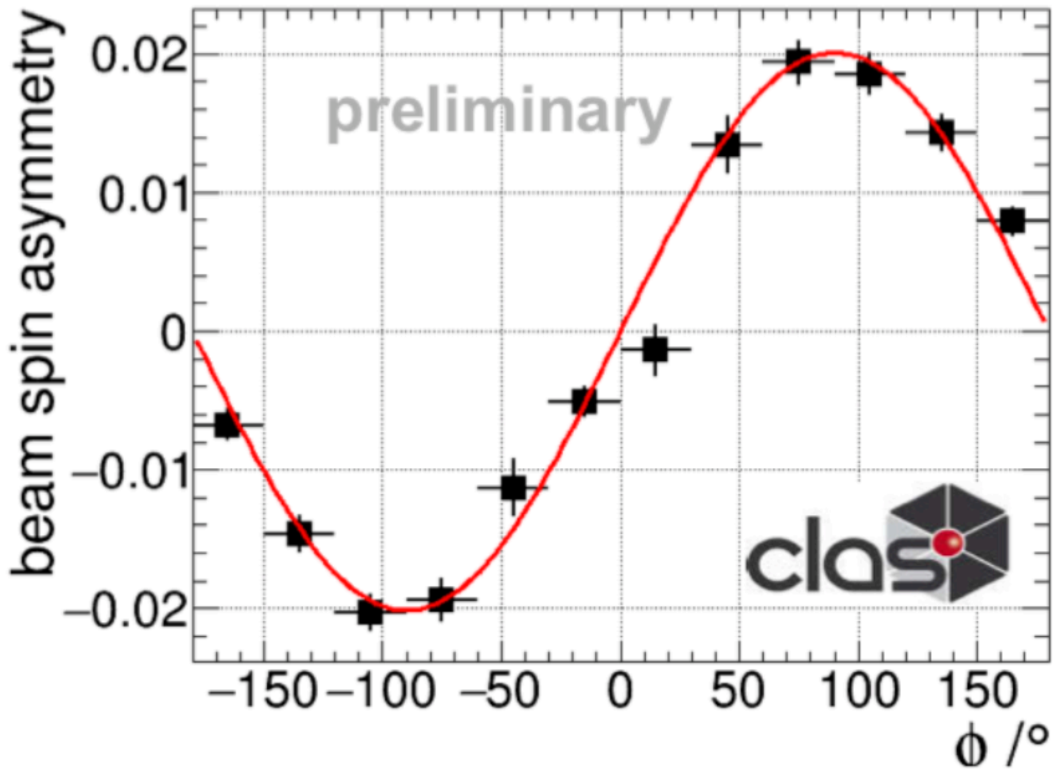
Common MC and Fiducial cuts with BSA. Similar time-line: we can aim for close publications.

From Collaboration meeting March 7 2019:

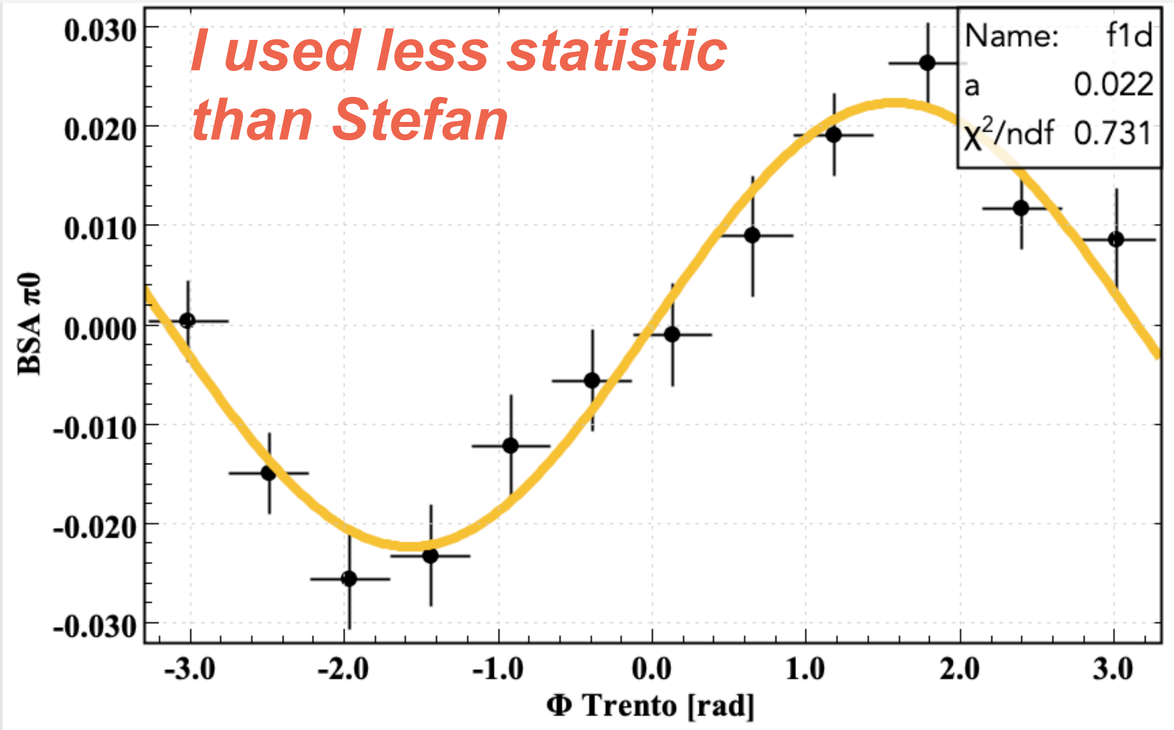
I will provide cross-check for BSA.

I need to find an analyzer that will cross check mine.

Stefan BSA DNP18



Giovanni BSA



Cuts

$Q^2 > 1\ GeV^2$ $W > 2\ GeV$ $y < 0.8$ In this presentation in addition I have used: $0.1 < xb < 0.9$

- Electron Momentum between 2 and 8 GeV/c

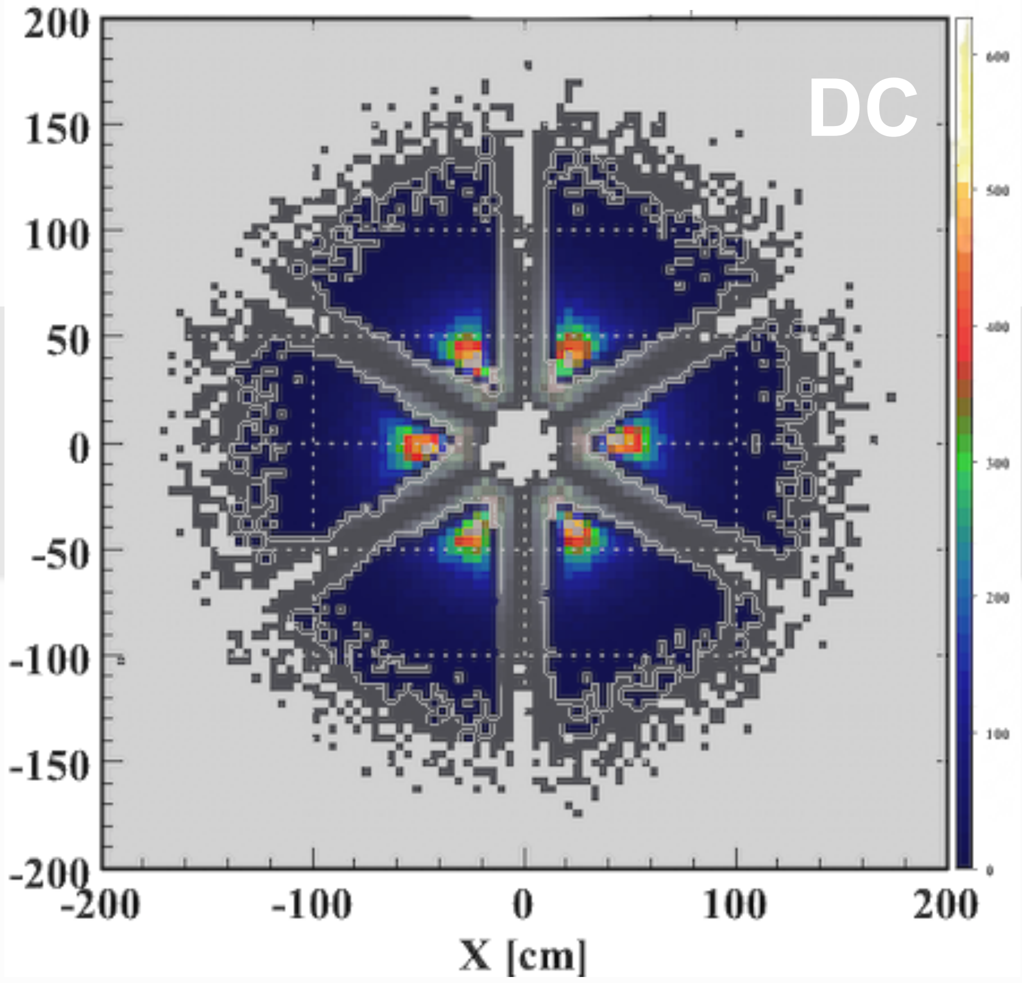
- Charged hadrons selected form Reconstructed banks with Chi squared smaller than 3.

- The most energetic hadron has been selected, with a minimum threshold energy of 1.2 GeV/c

- Hadron angle cut: $5° < \theta h < 35°$

- For neutral pion, each photon has been required to have a PCAL signal, minimum energy of 400MeV, and an angle bigger than 3 degrees from the scattered electron.
- Only photons in the same sector used.

Standard approved cuts have been applied
As fiducial cuts on PCAL and Drift Chambers



MC for SIDIS

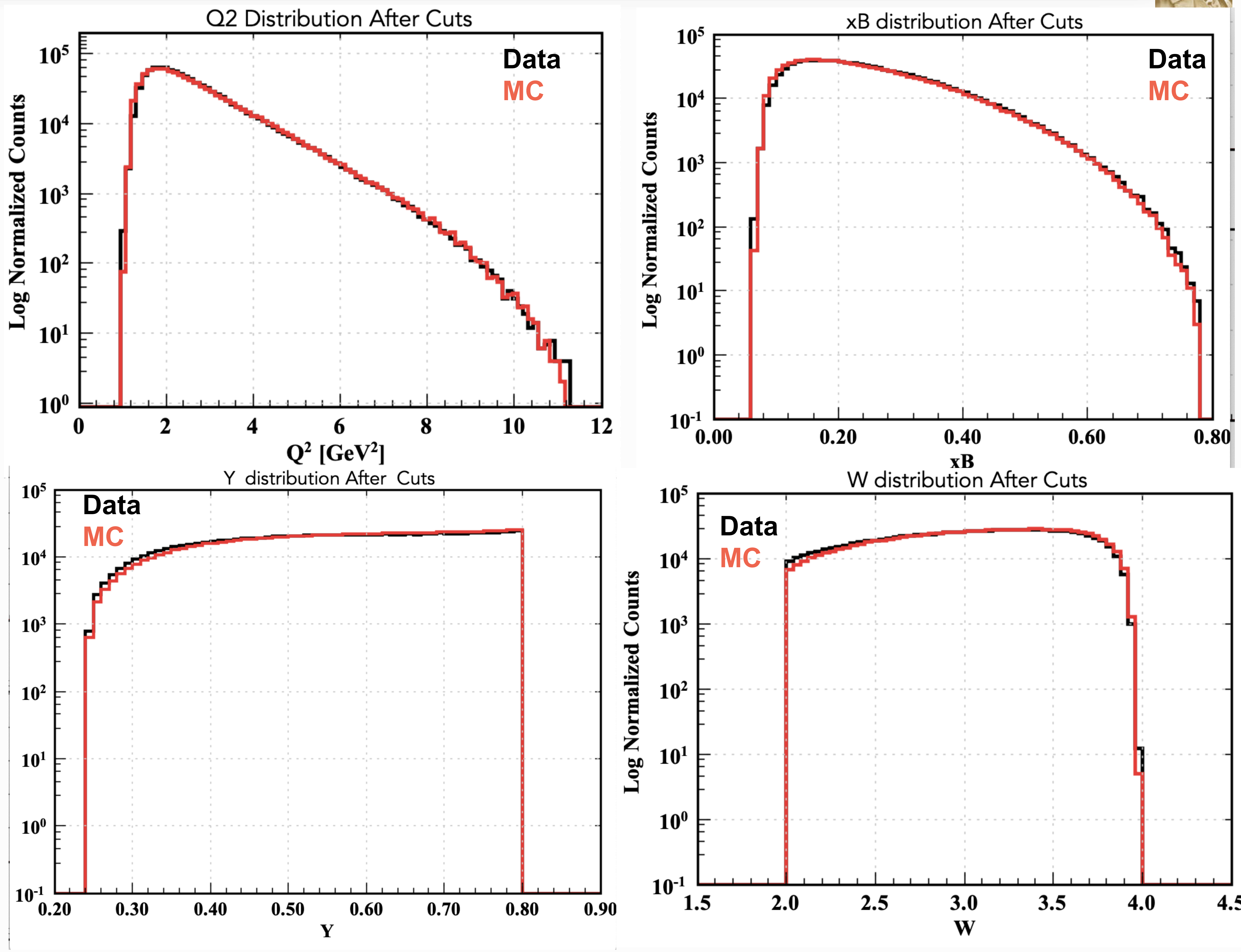
MC based on LEPTO with LUND string model for hadronization is in place thanks effort of Harut Avakian.

100 M inbending events cooked:

/w/hallb-scifs17exp/clas12/gangel/Simu_DNP19/T-1.00_S-1.0

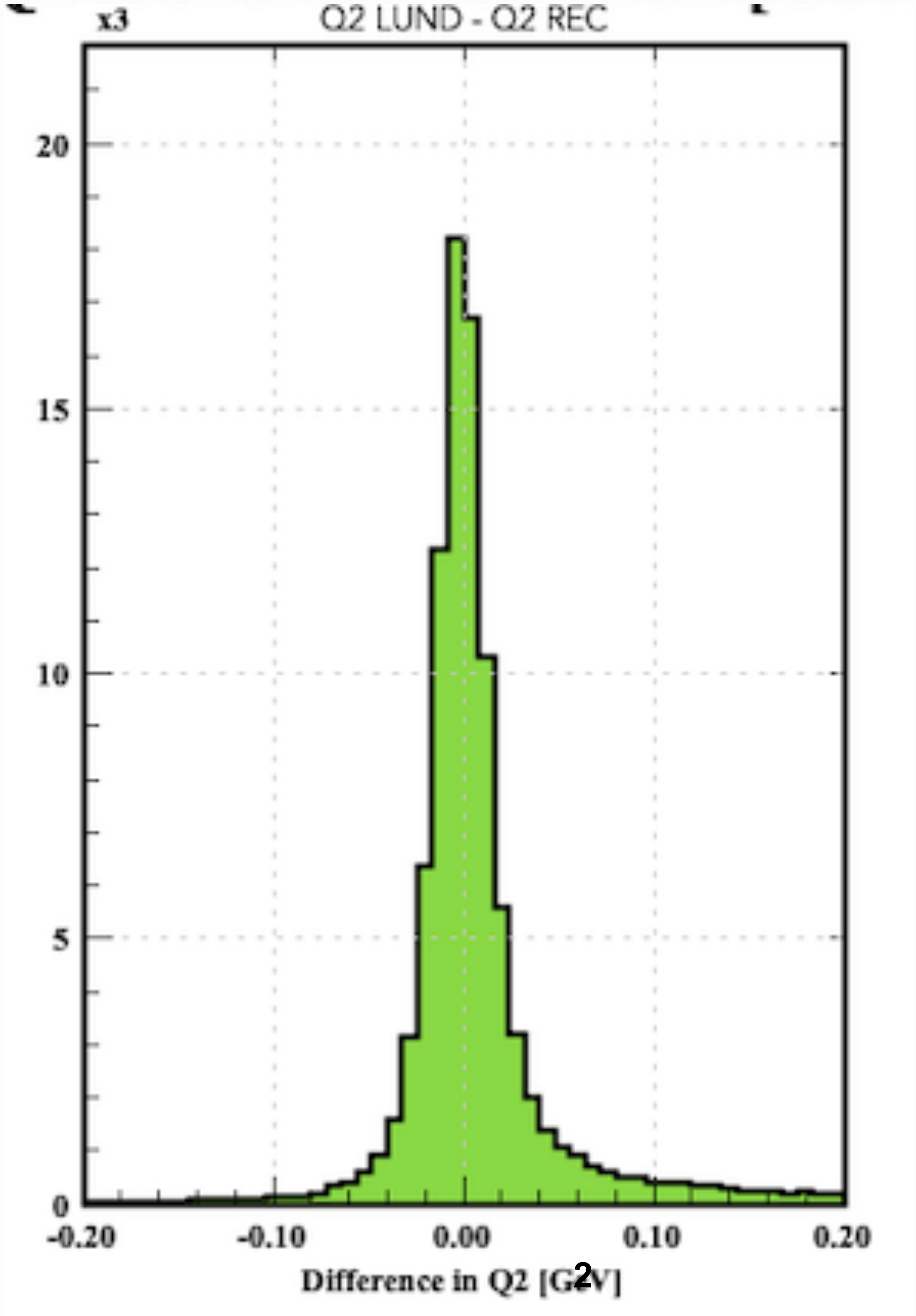
20 M inbending cooked:

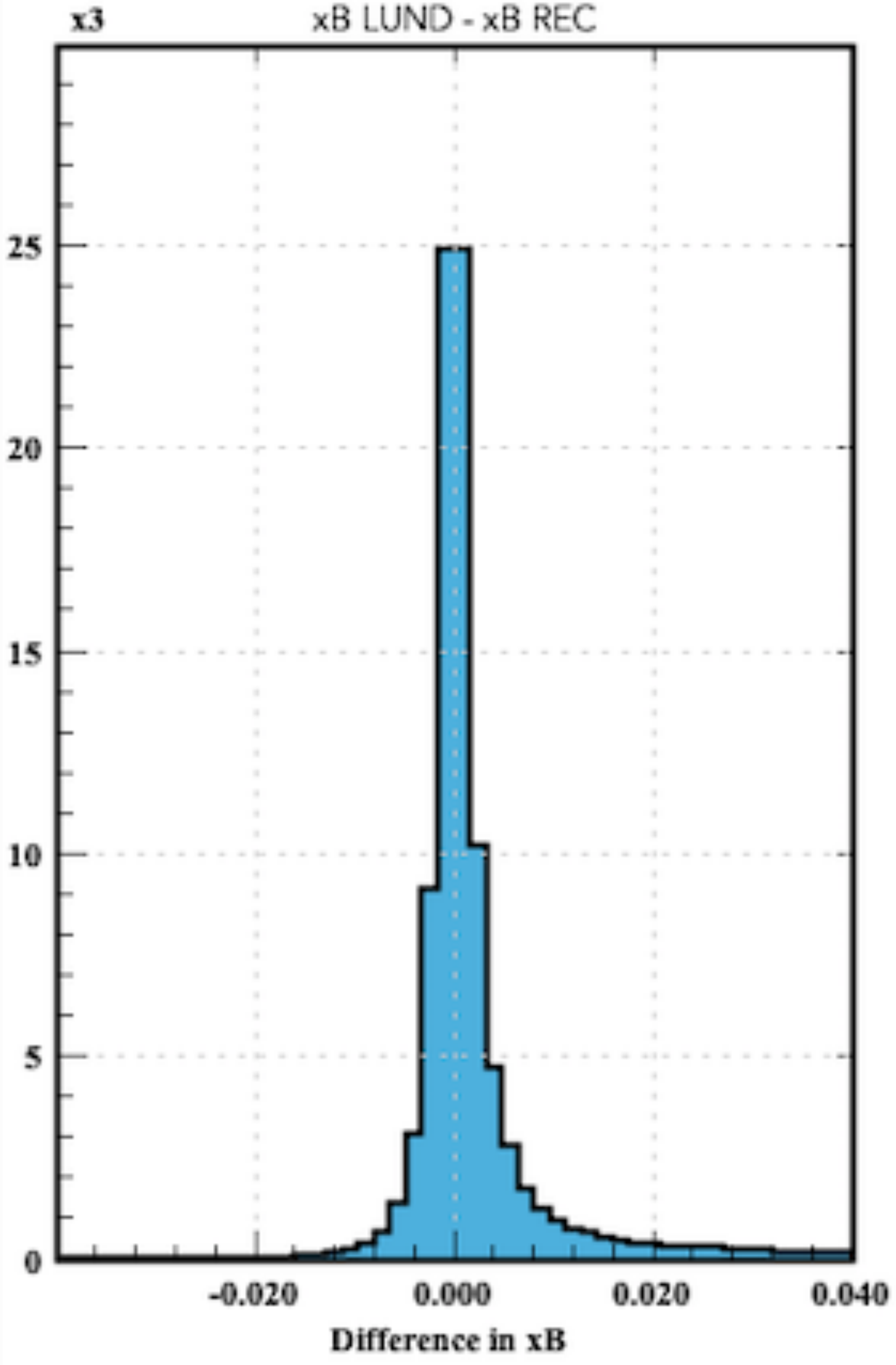
`/w/hallb-scifs17exp/clas12/gangel/Simu_DNP19/T+1.00_S-1.0`

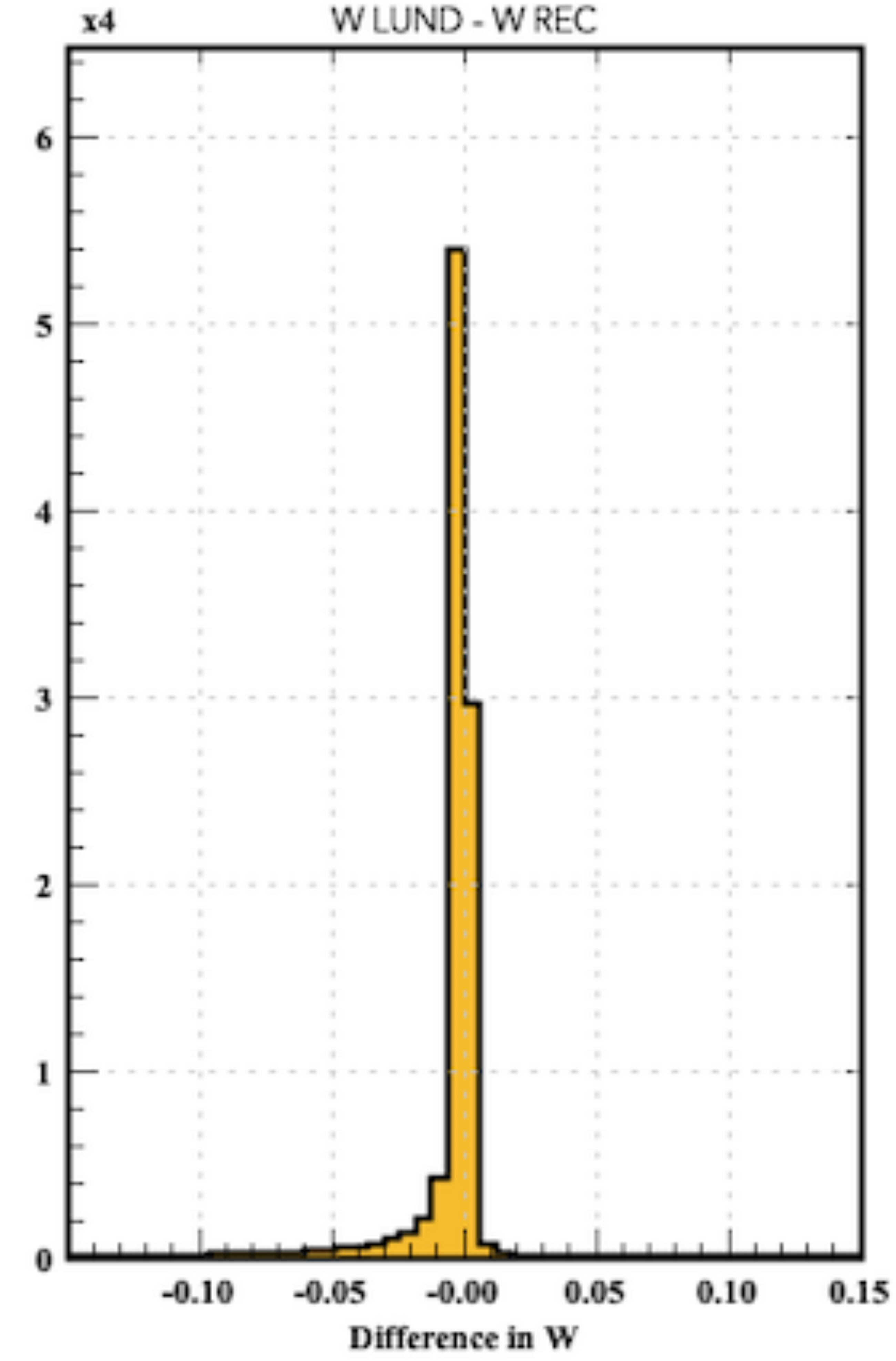


MC Reconstruction

Kinematic distributions generated - reconstructed

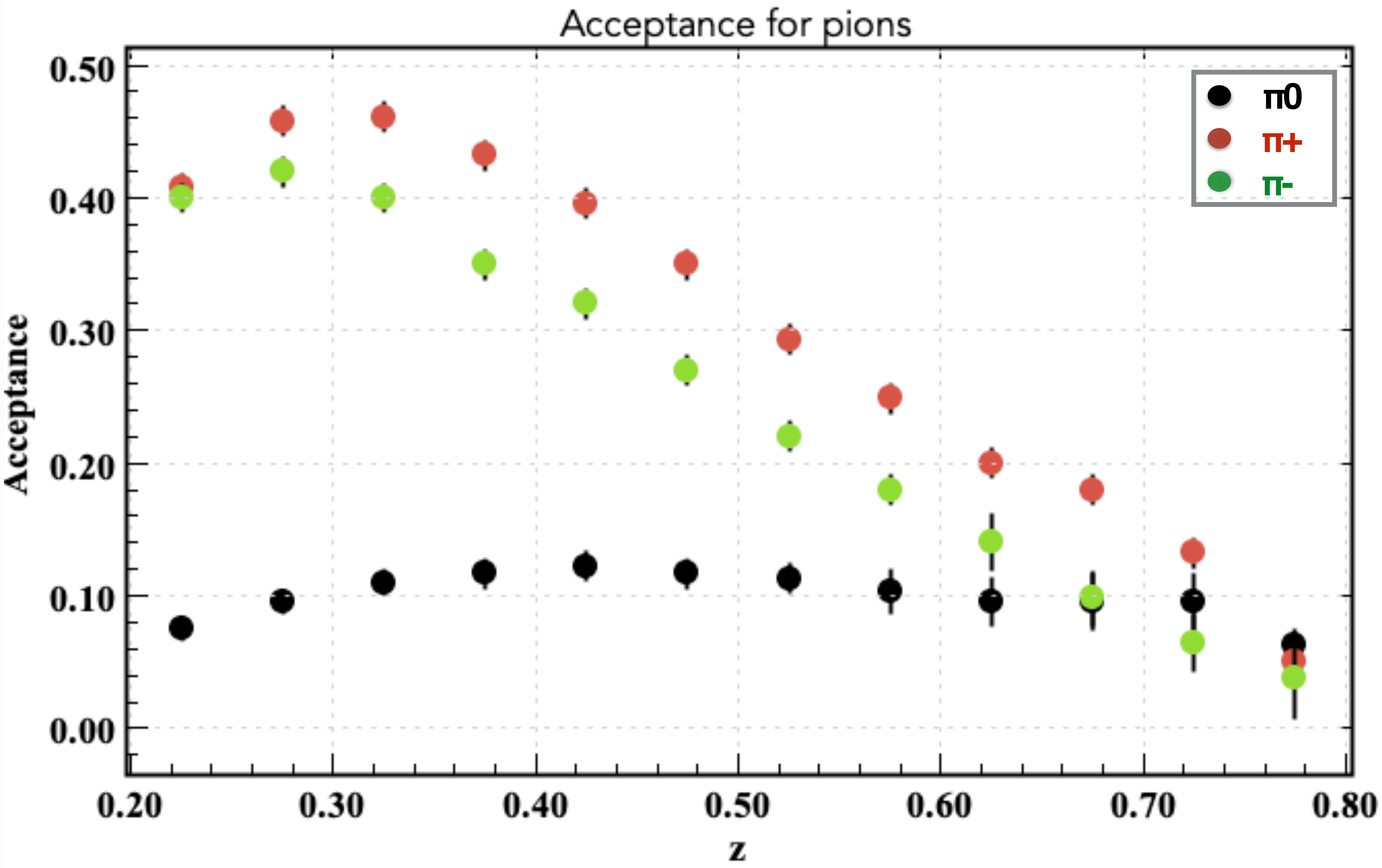






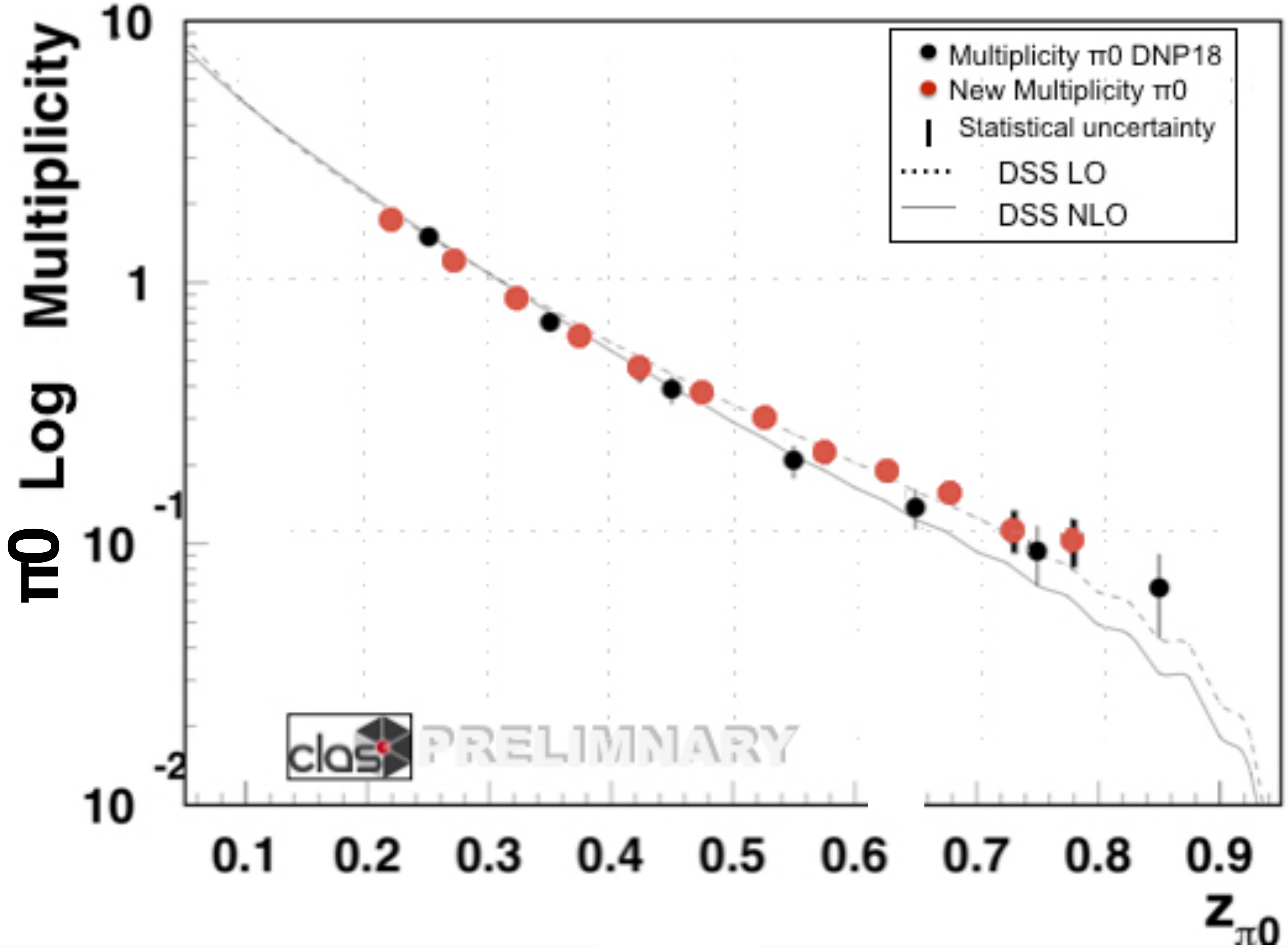
Acceptance

Efficiency and acceptance are computed using the MC



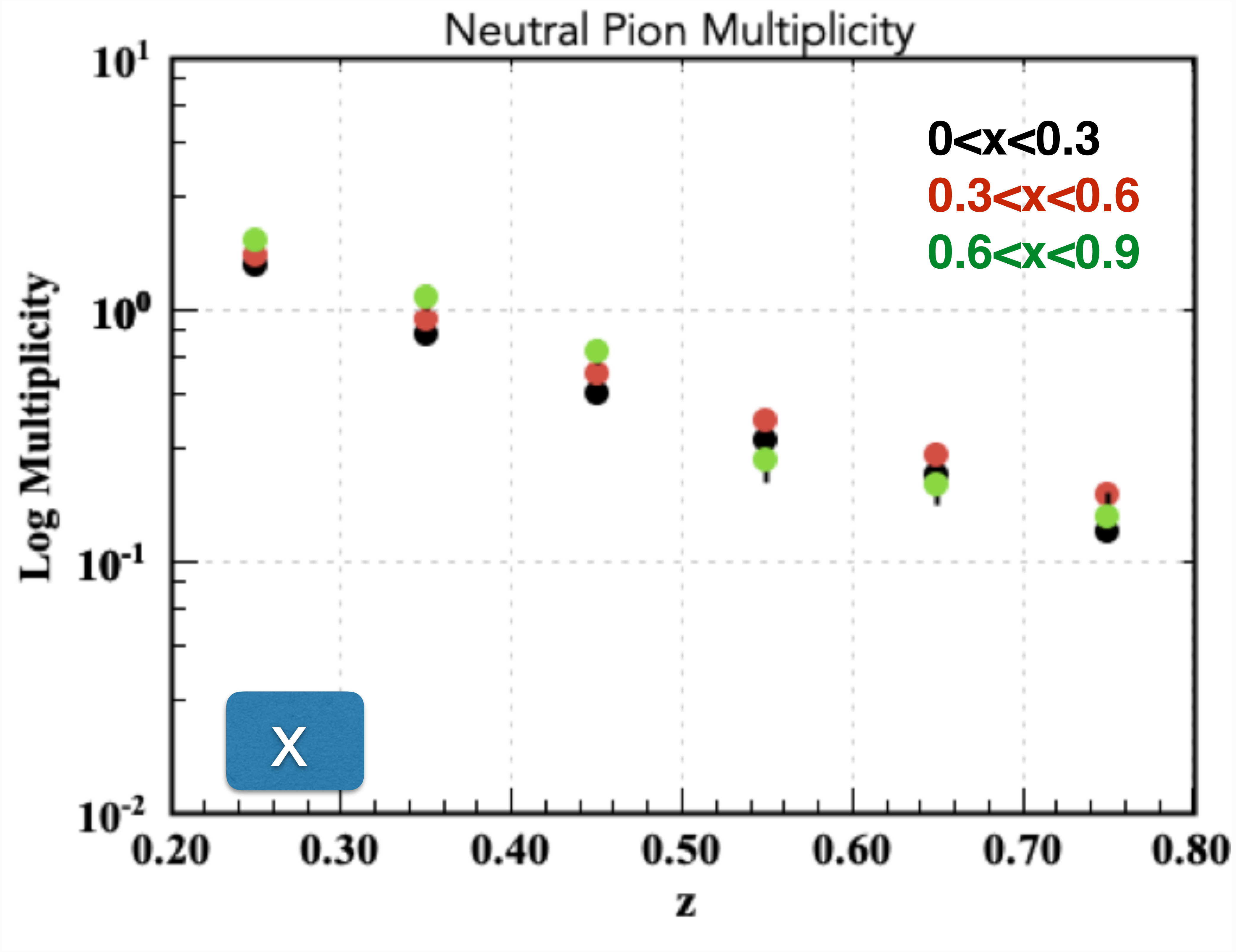
Multiplicity for neutral pions

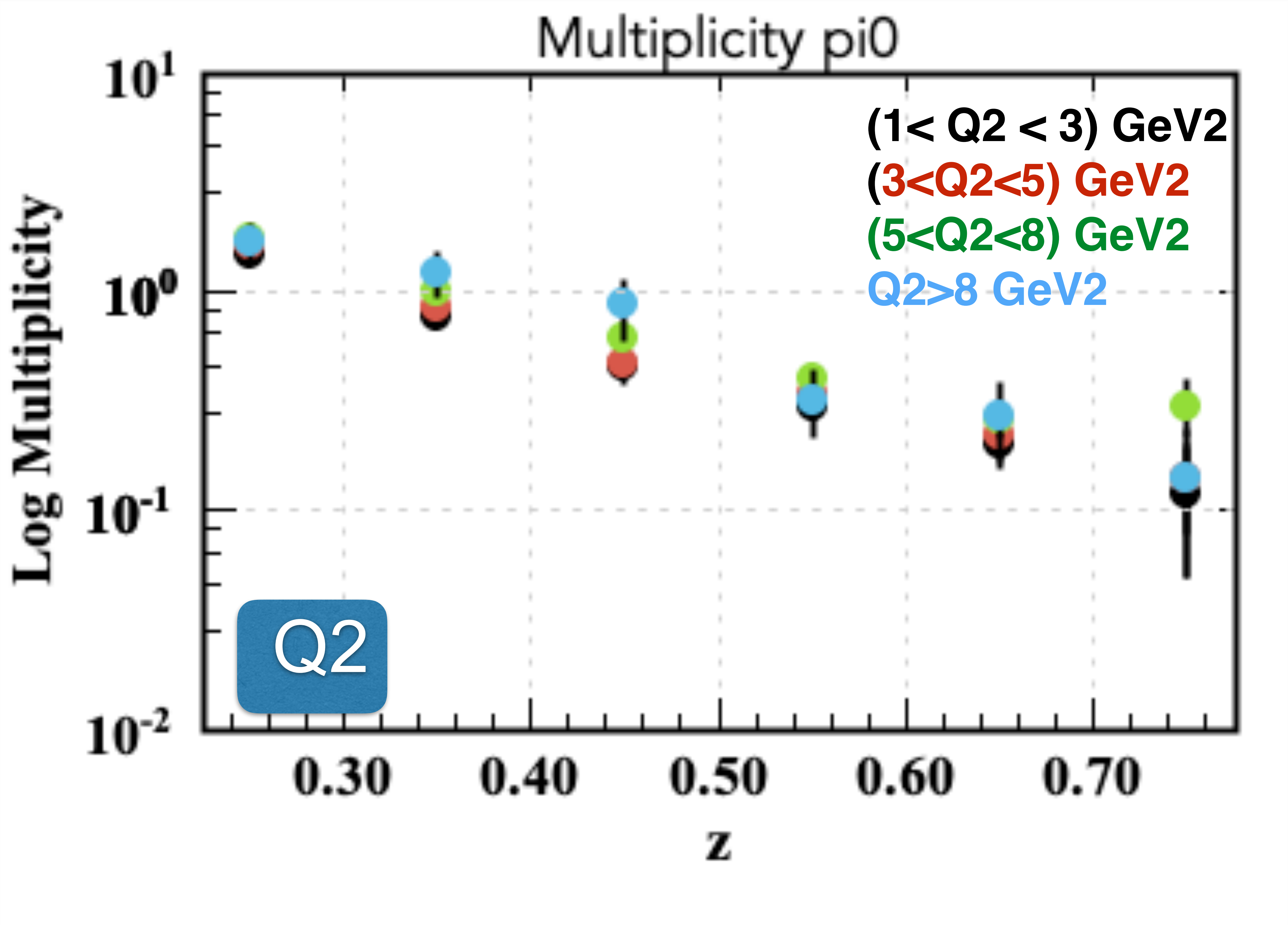
DNP 18 I used 0.2-0.3% of the approved beam time,
now 1.2-1.3%. (MC production didn't allow me to go higher).



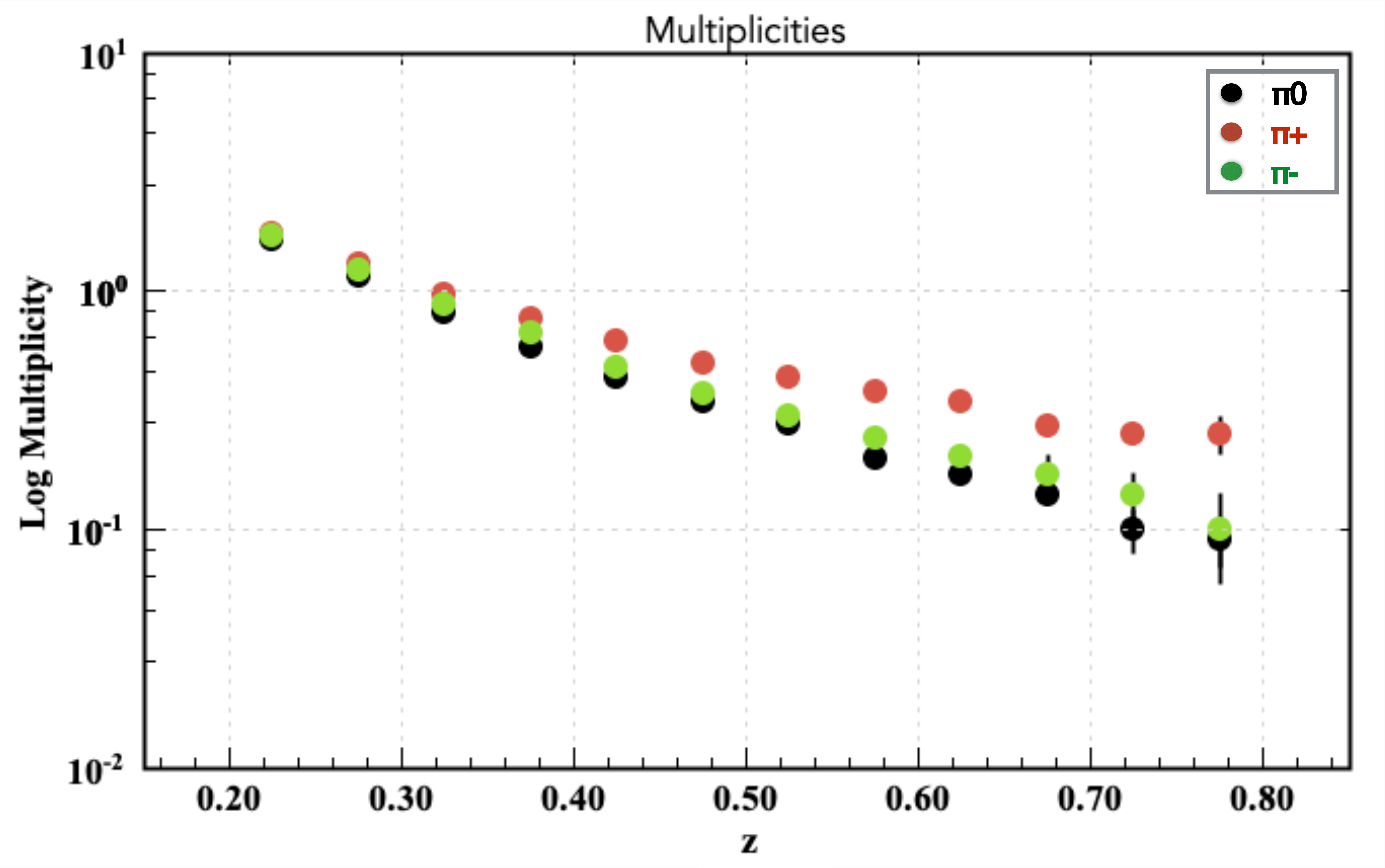
Toward a multi-dimensional analysis

Just as a proof of concept, while more MC statistics is been collected.

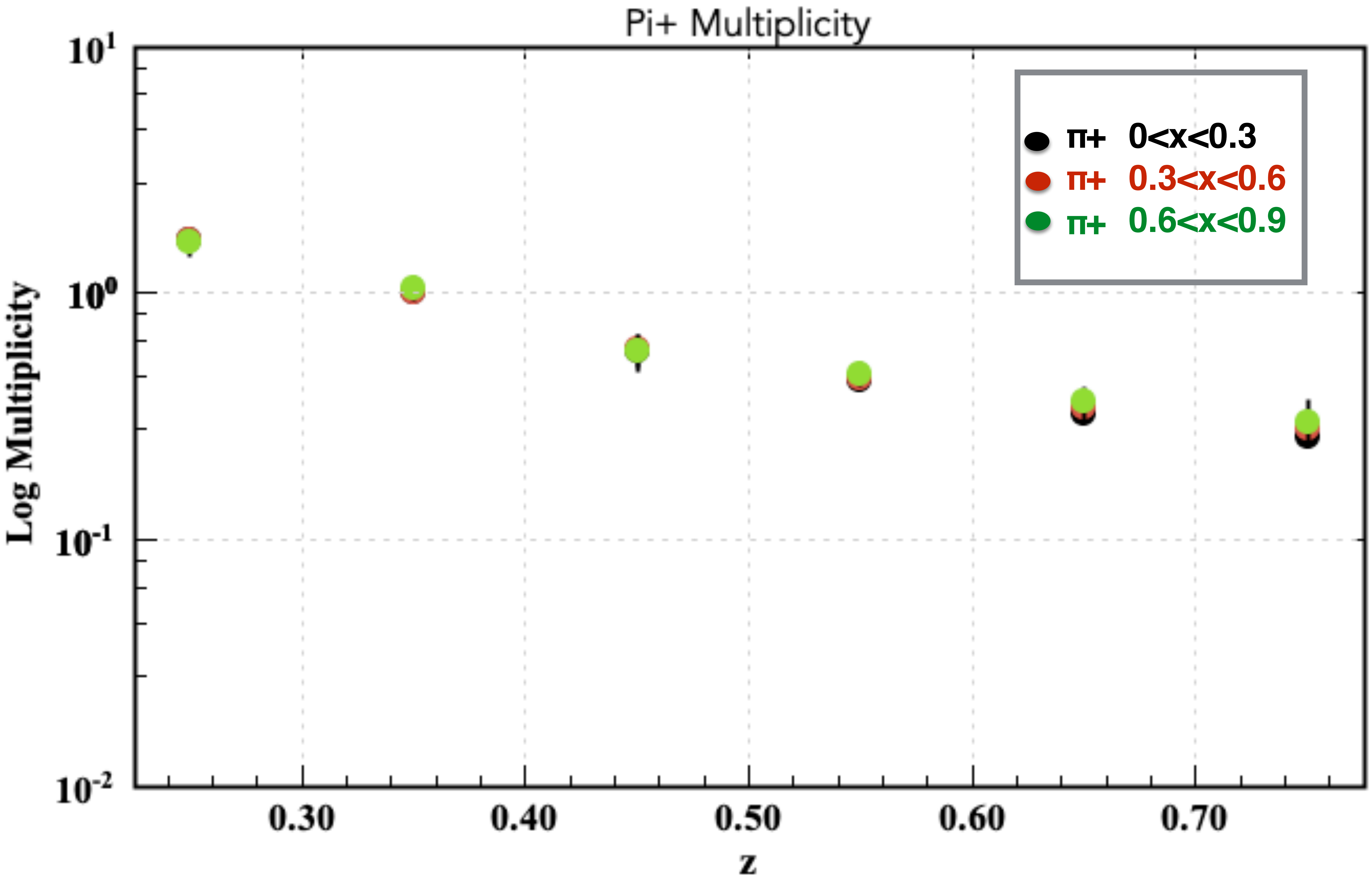




Multiplicities as function of z



π+ Multiplicity



Future Plans

By December I want to get 200 M inbending + 100M outbending to keep developing the analysis.

Needed amount of MC > 1Bilion. We have to wait for the final Software version for publication.

Will provide cross checks for BSA analysis.

Similar time line of BSA.

Some Low Lumi Files calibrated and cooked needed