

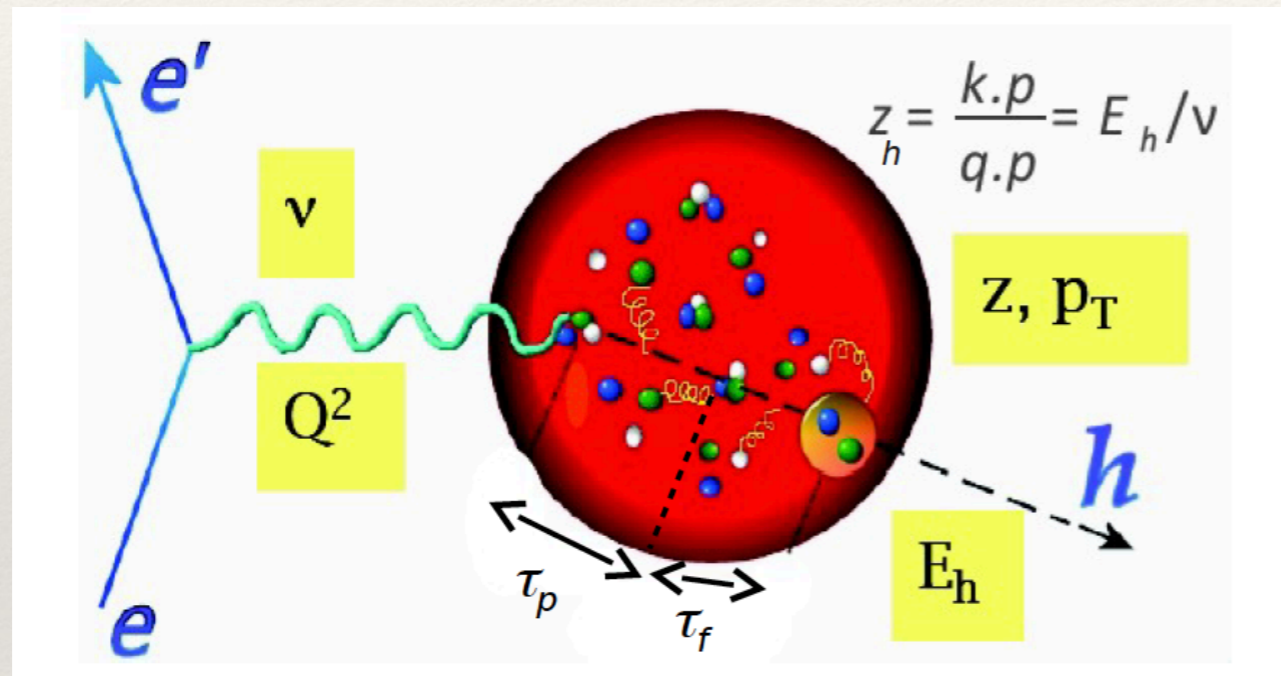
Hadronization Analysis of Protons with eg2 Data

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Hadronization

Study hard processes in nuclei to probe the QCD confinement dynamics:
Color propagation (CP) and fragmentation - **Hadronization process**



Motivation - $E_{e^+} = 27$ GeV studies by Hermes

Production time τ_p : Time spent by a deconfined quark to neutralize its color charge. Stimulated by energy loss to the medium by gluon exchange.

Observable: transverse momentum broadening.

$$\Delta p_T^2 = \langle p_A^2 \rangle - \langle p_D^2 \rangle$$

Formation time τ_f : Time required to form a regular hadron. Interactions with hadron cross sections.

Observable: multiplicity ratios

$$R_M^h = \frac{\left[\frac{N_h^{DIS}}{N_e^{DIS}} \right]_A}{\left[\frac{N_h^{DIS}}{N_e^{DIS}} \right]_D}$$

The eg2 Hadronization Program

Mesons

π^+ , π^- - S. Moran, R. Dupre, H. Hakobyan (Analysis review)

π^0 - T. Mineeva (Ad hoc review)

K^0 - A. How do the mesons and baryons compare?

η - O. How does the $\Lambda(1520)$ and proton compare?

ω - A. Borquez

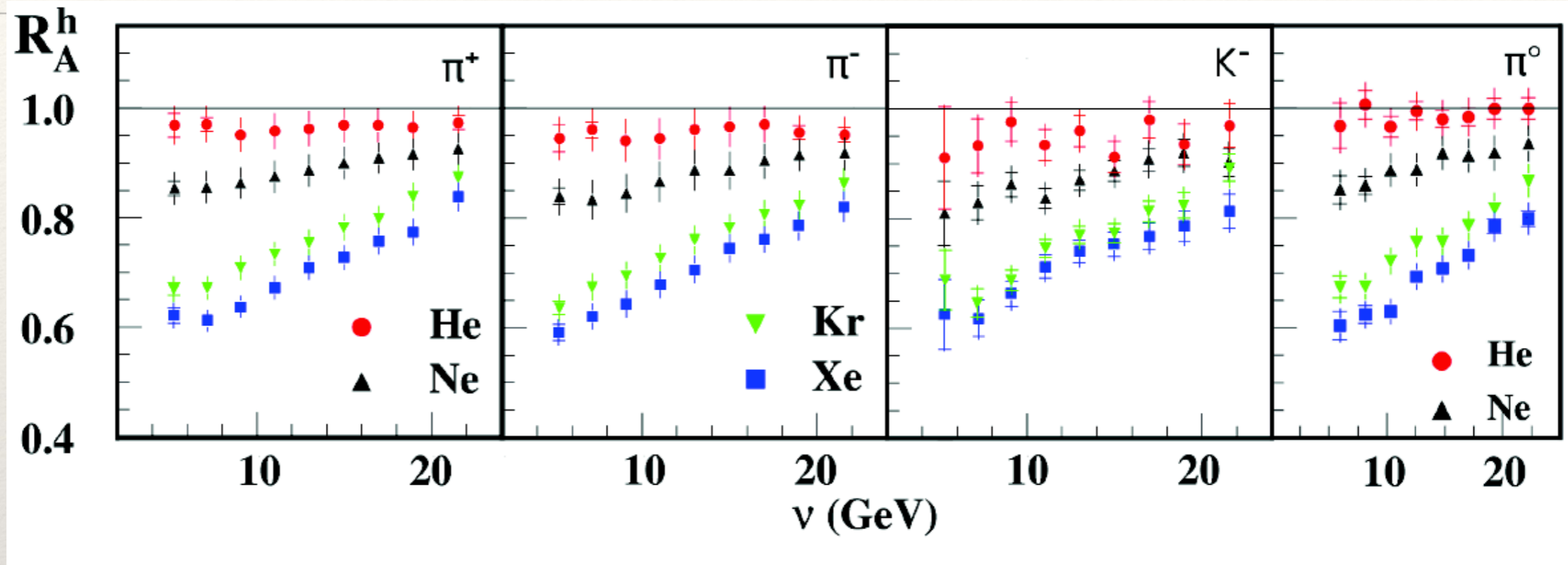
Di-pions - A. Radic, M. Arratia

Baryons

$\Lambda(1520)$ - T. Chetry, L. El Fassi (Analysis review)

Proton - M. Wood

Results from Hermes

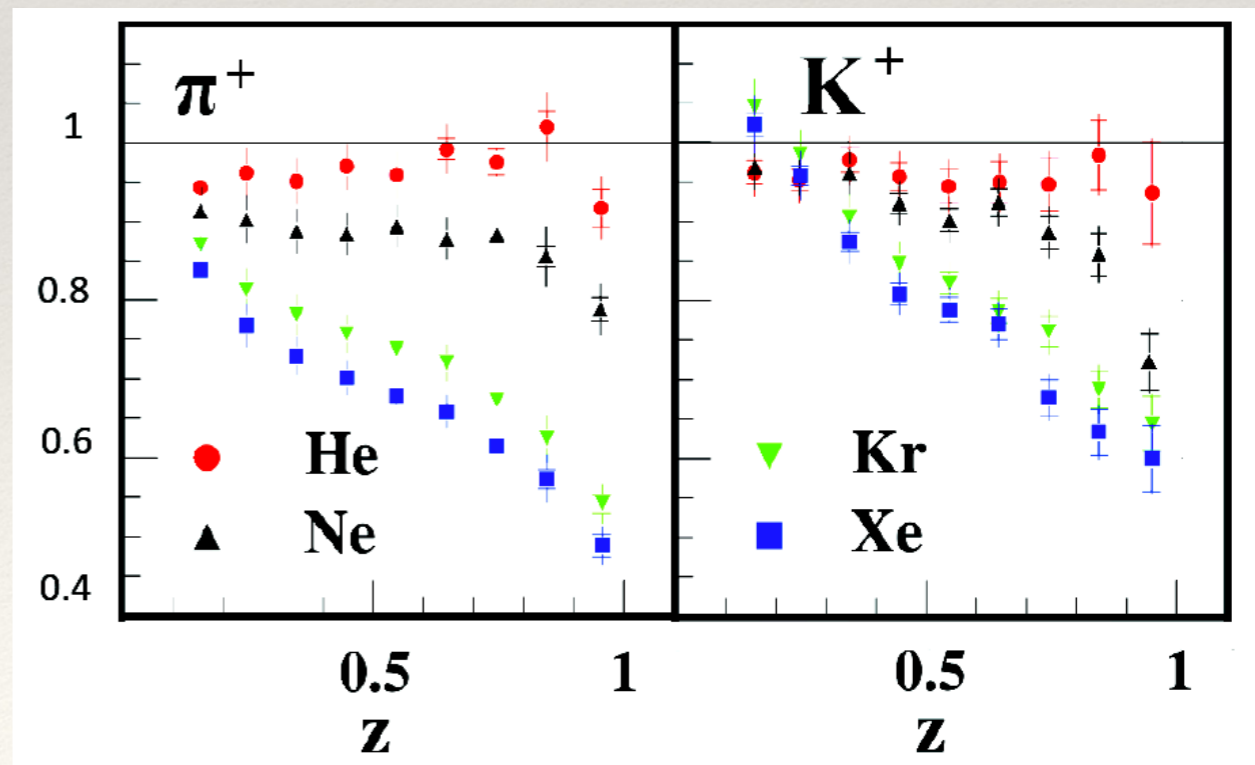


Hermes results

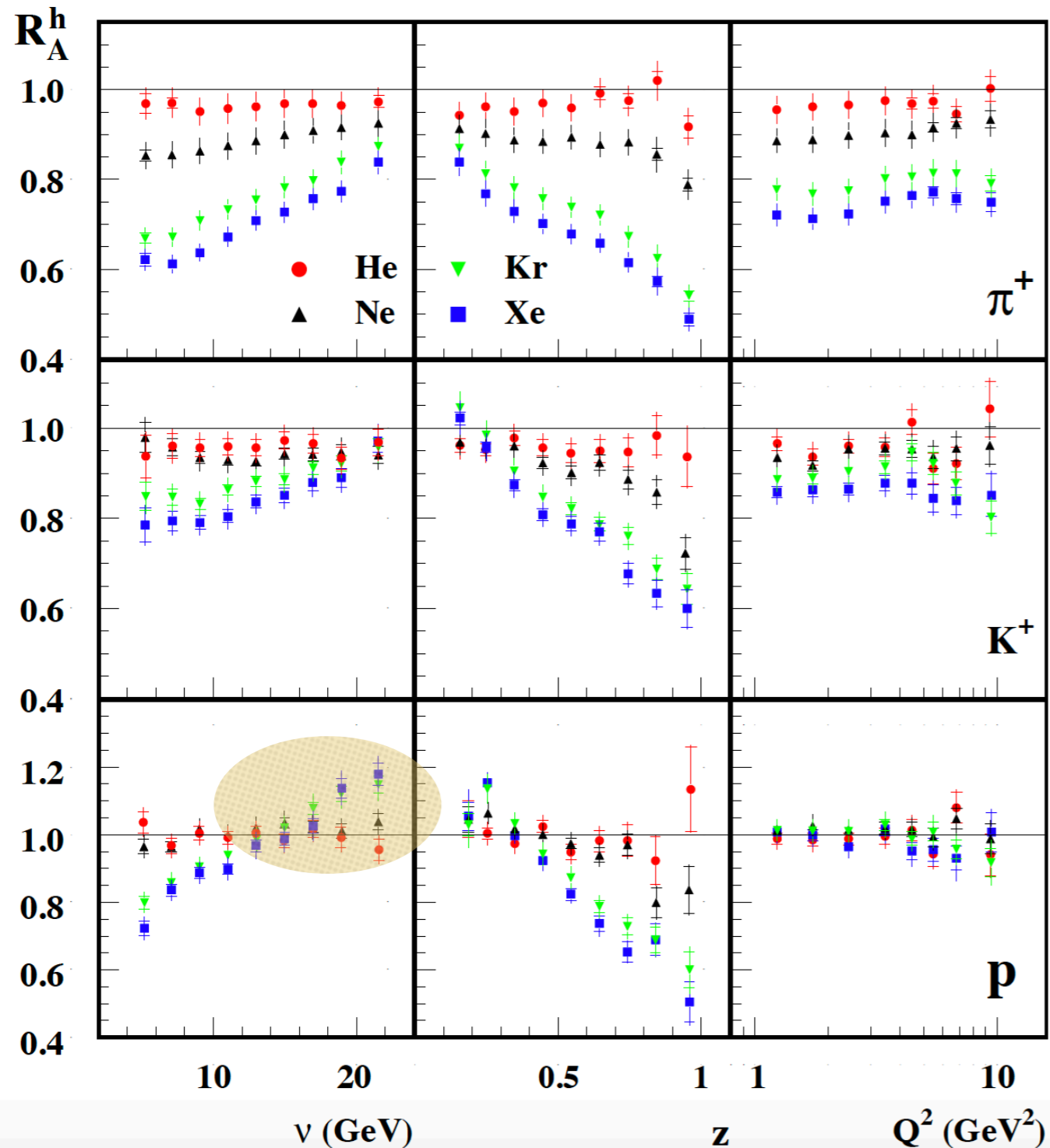
A. Airapetian, *et al.*, Nucl. Phys. B
780 (2007) 1.

$E = 27$ GeV; Positron beam

Pions and kaons give similar
attenuation



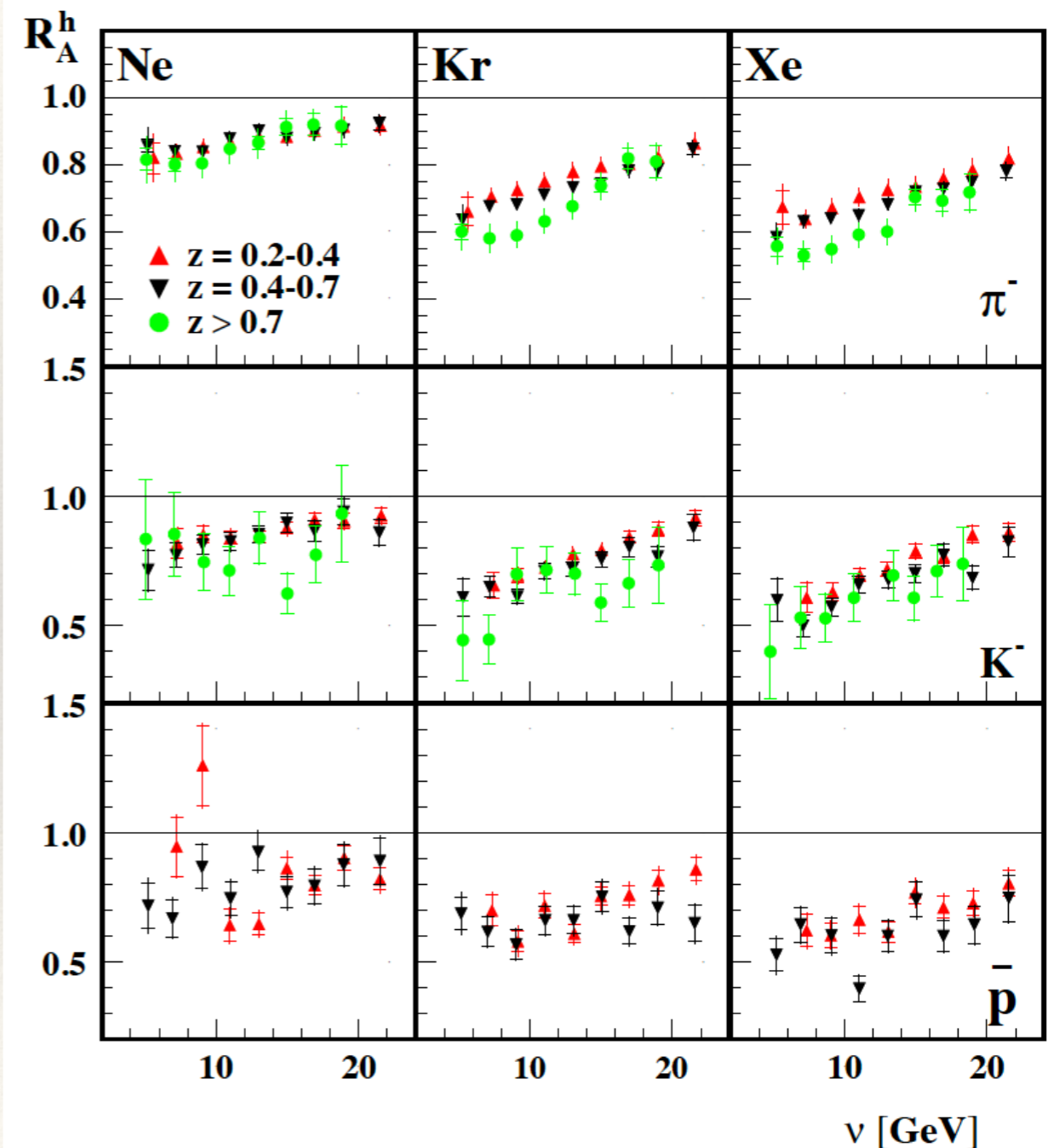
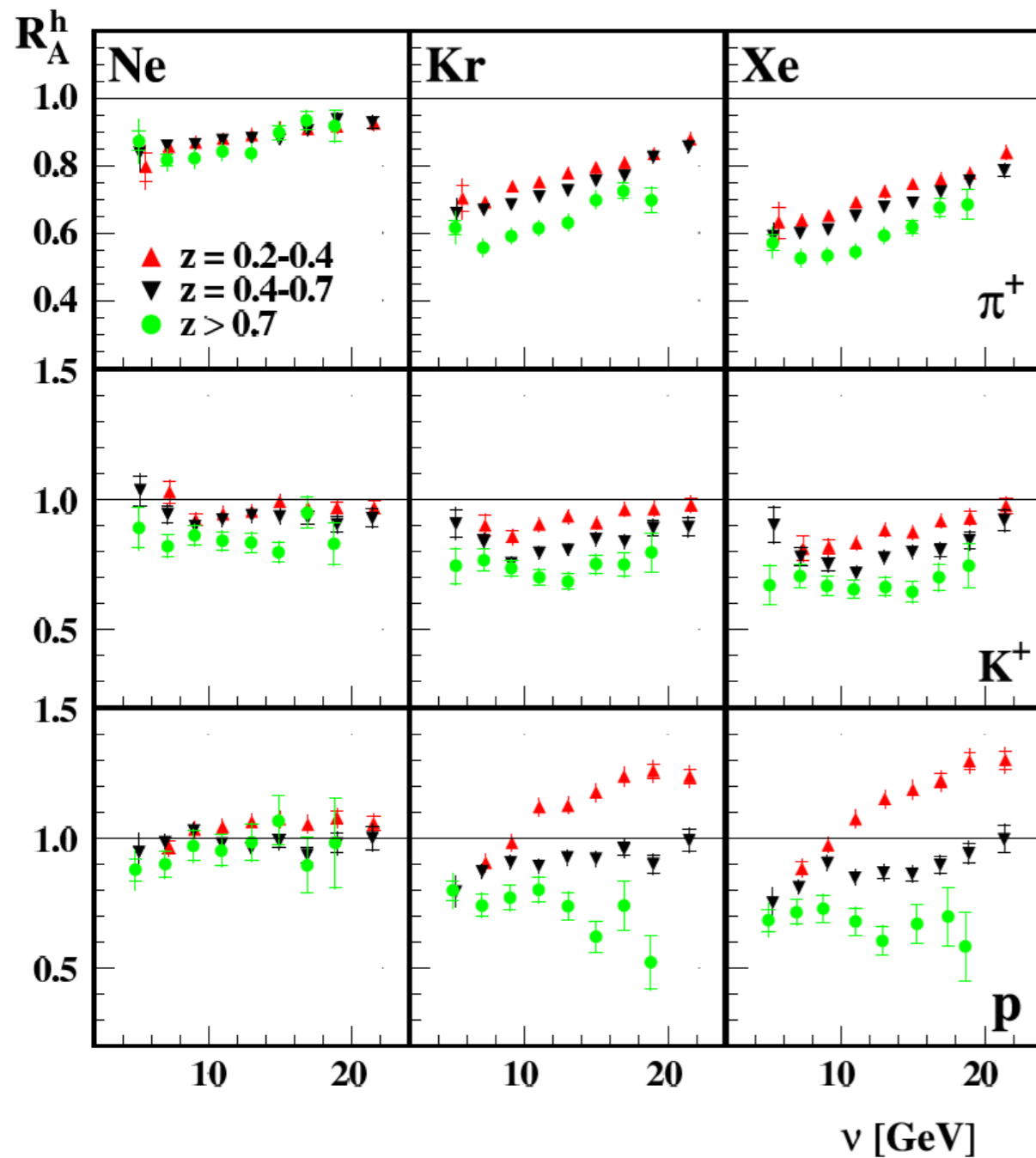
Results from Hermes



The results for protons cannot really be related to those for any of the other particles. Because protons are already present in a nucleus, an appreciable fraction of them may not come from hadronization.

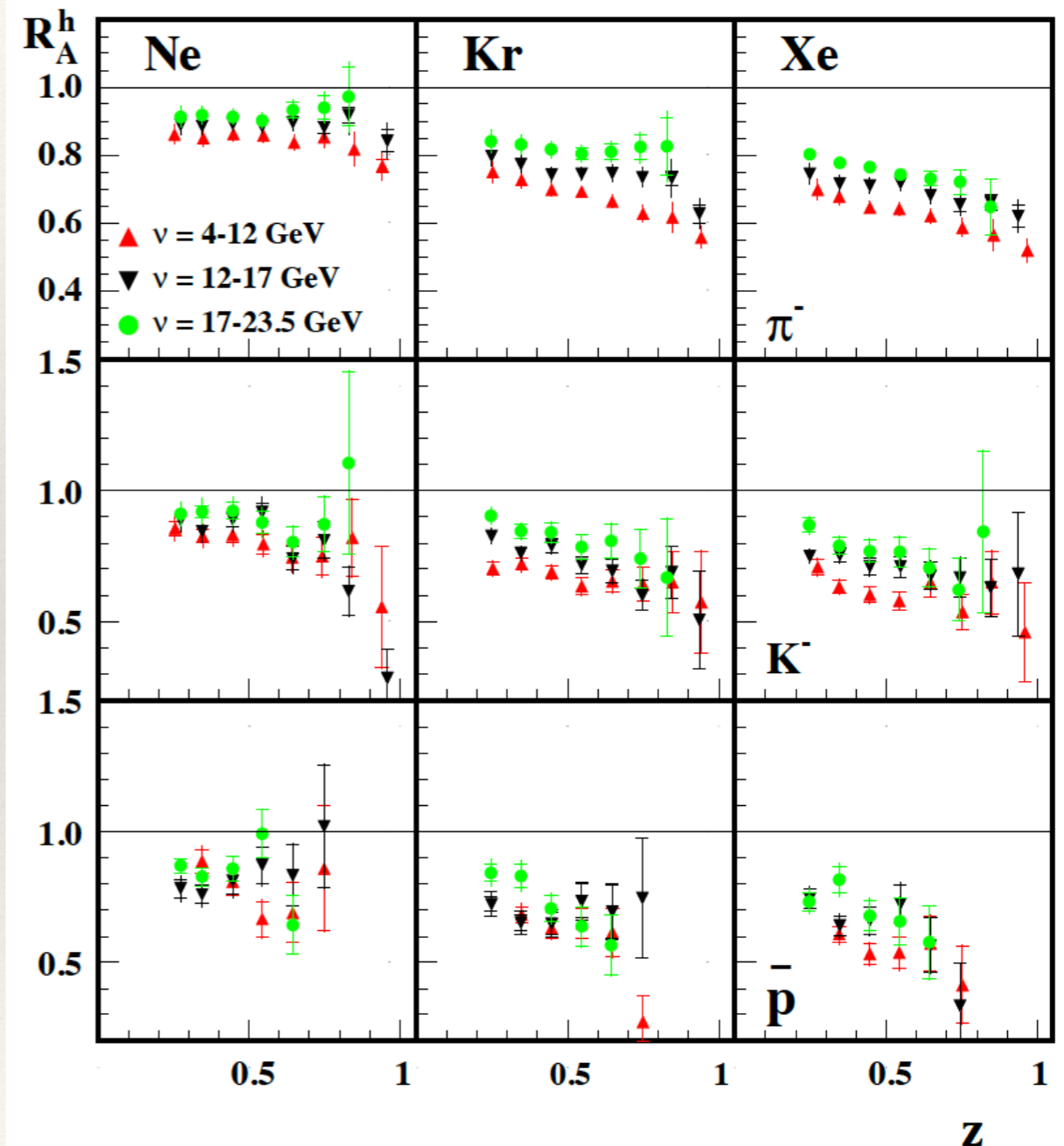
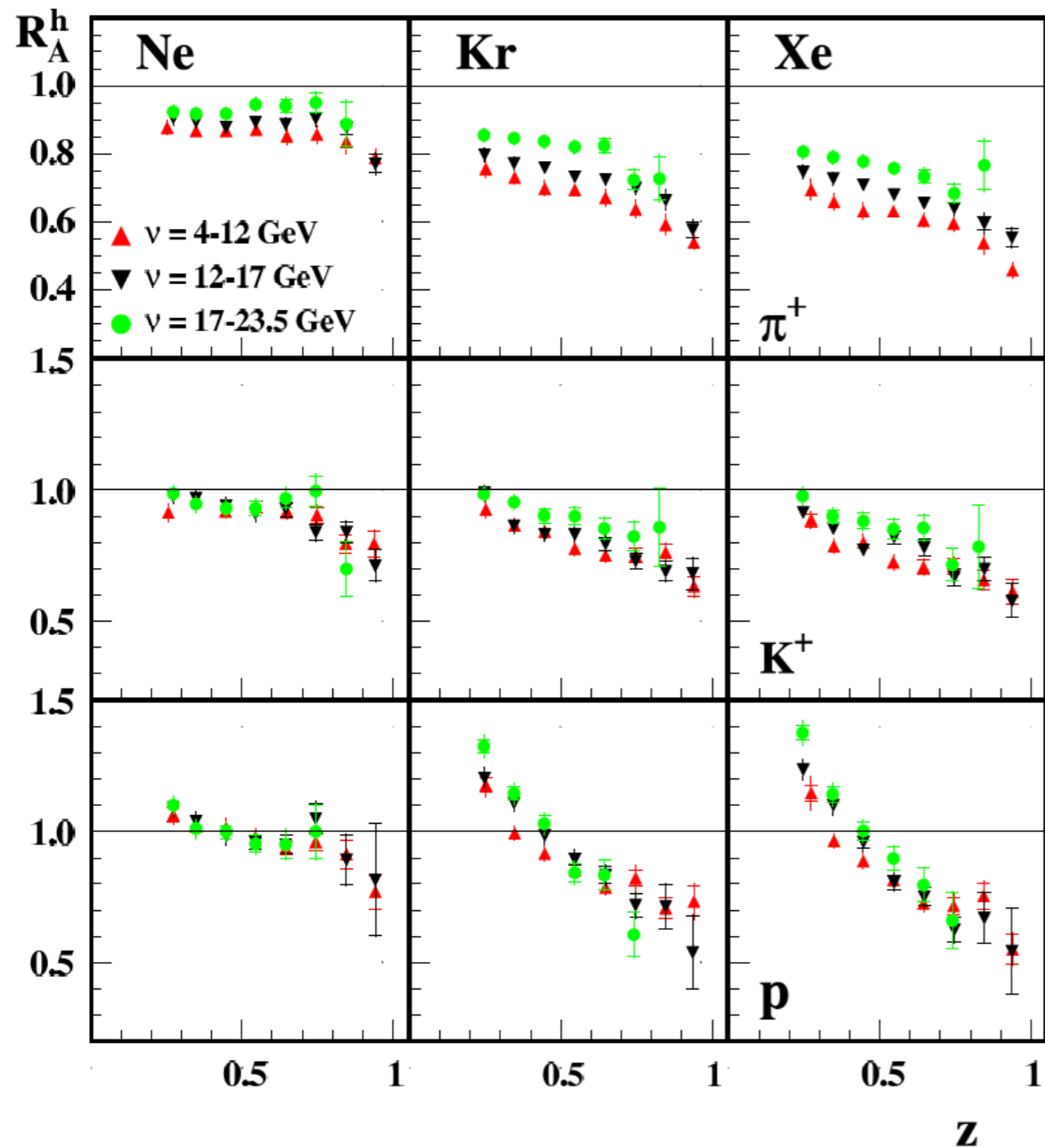
Multidimensional Analysis by HERMES

A. Airapetian, *et al.*, Eur. Phys. J. A (2011) 47: 113

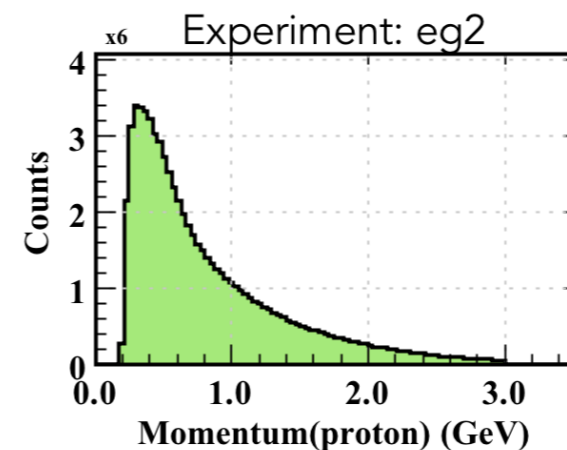
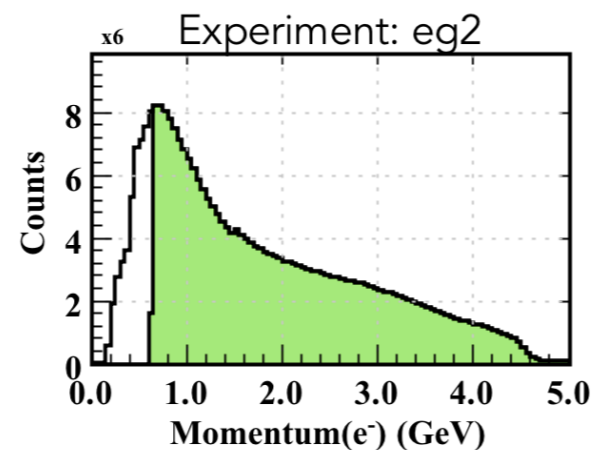
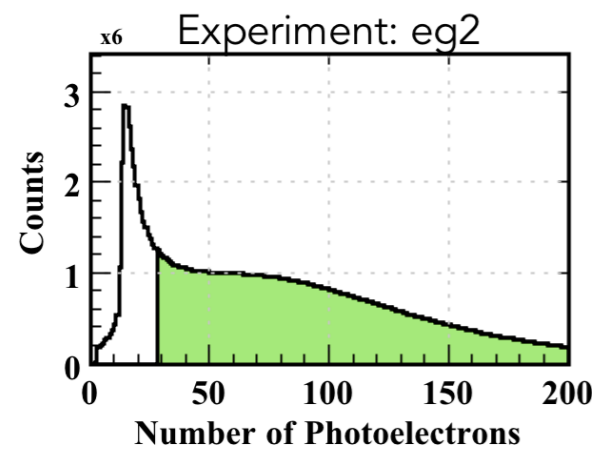
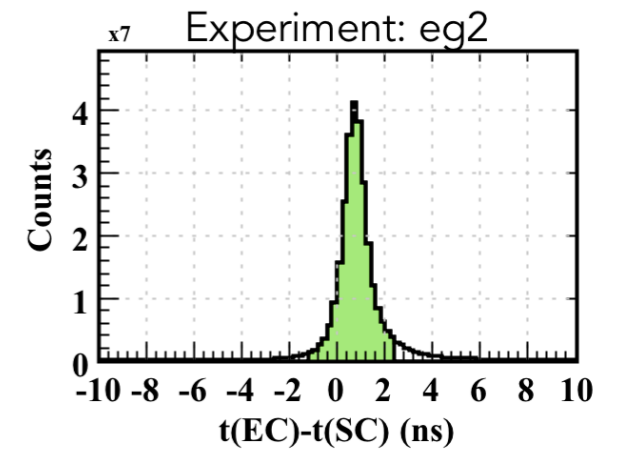
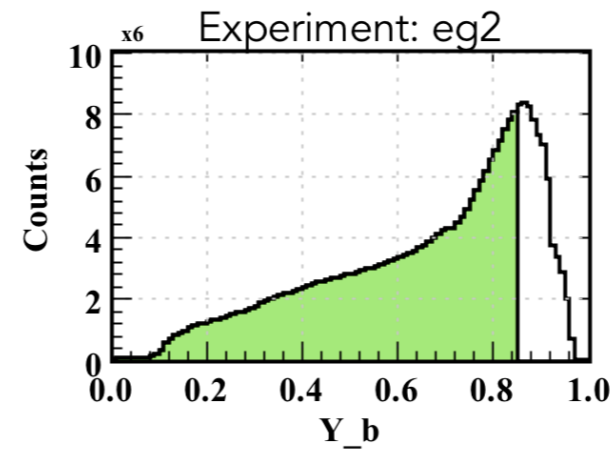
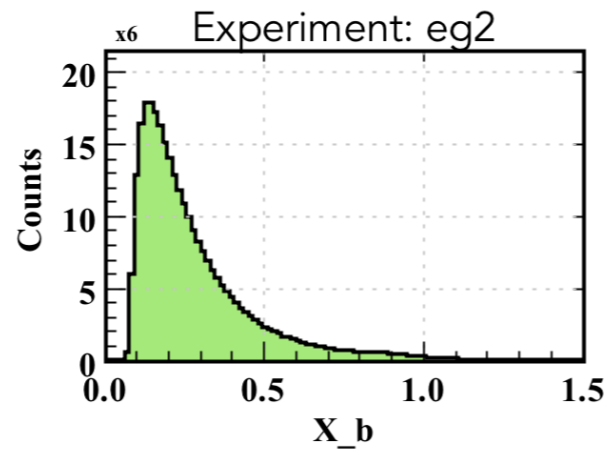
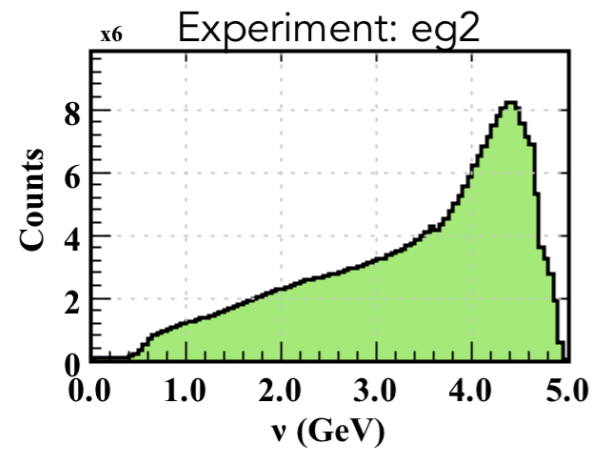
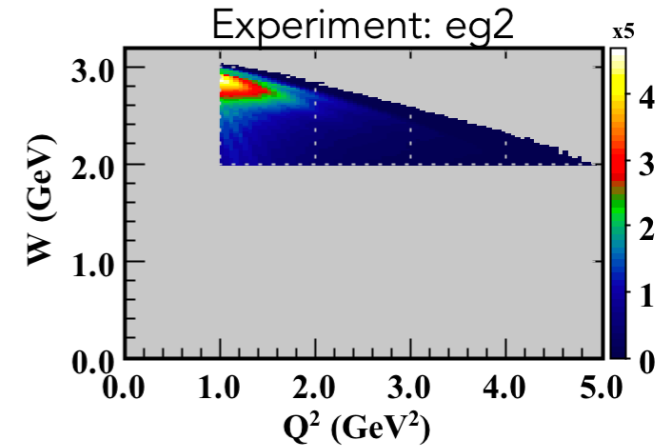
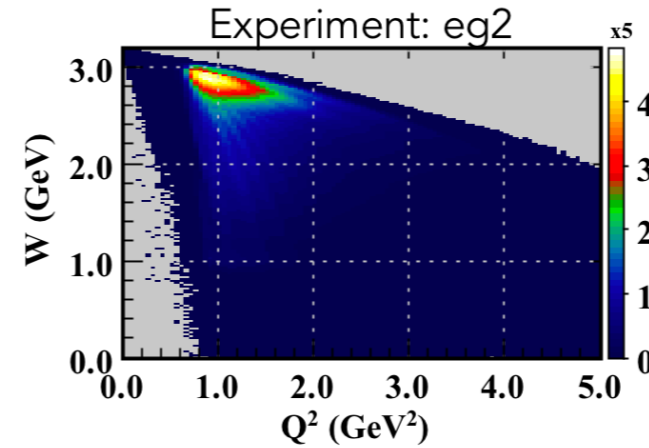
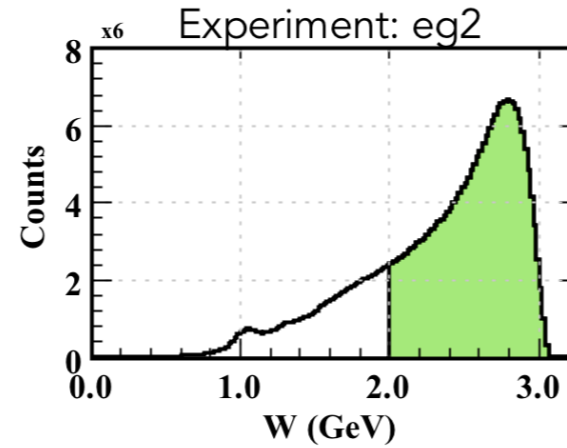
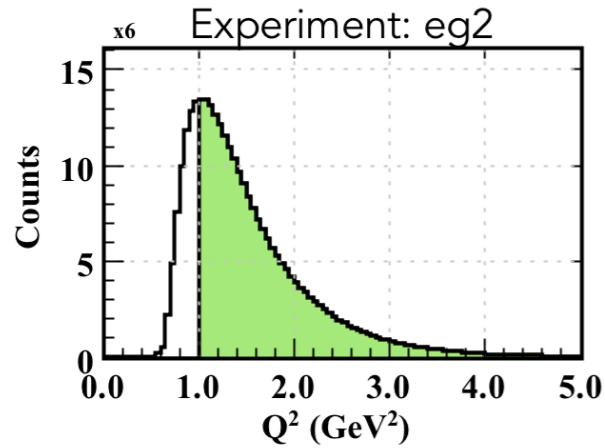


Multidimensional Analysis by HERMES

A. Airapetian, *et al.*, Eur. Phys. J. A (2011) 47: 113



Kinematics



$$Q^2 \geq 1 \text{ GeV}^2$$

$$W \geq 2 \text{ GeV}$$

$$y = \frac{\nu}{E_e} \leq 0.85$$

Event Selection

Applied electron ID cuts

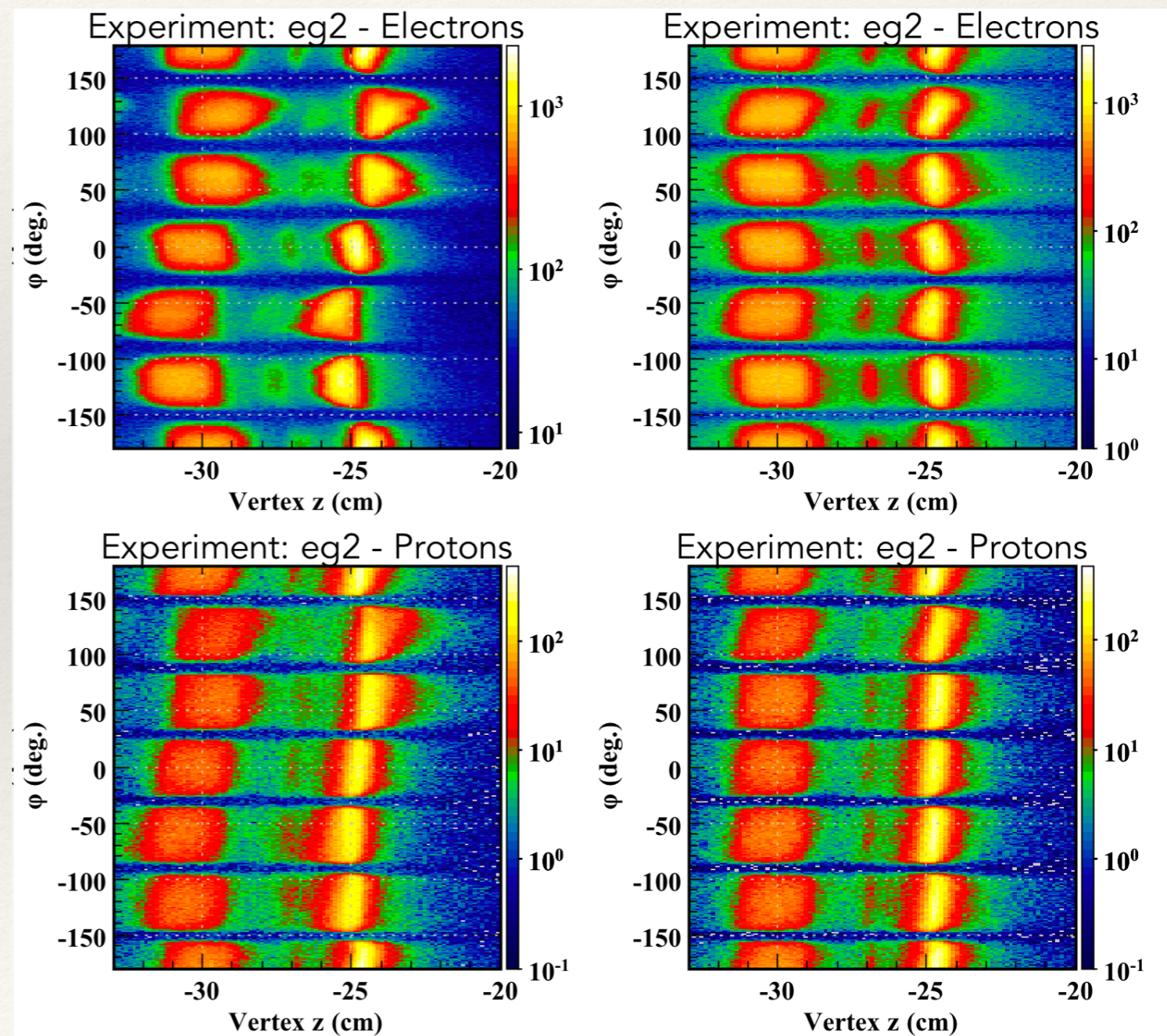
EC E_{tot}/P sampling
fraction

CC # photo-electrons > 28

EC $E_{\text{IN}} > 60$ MeV

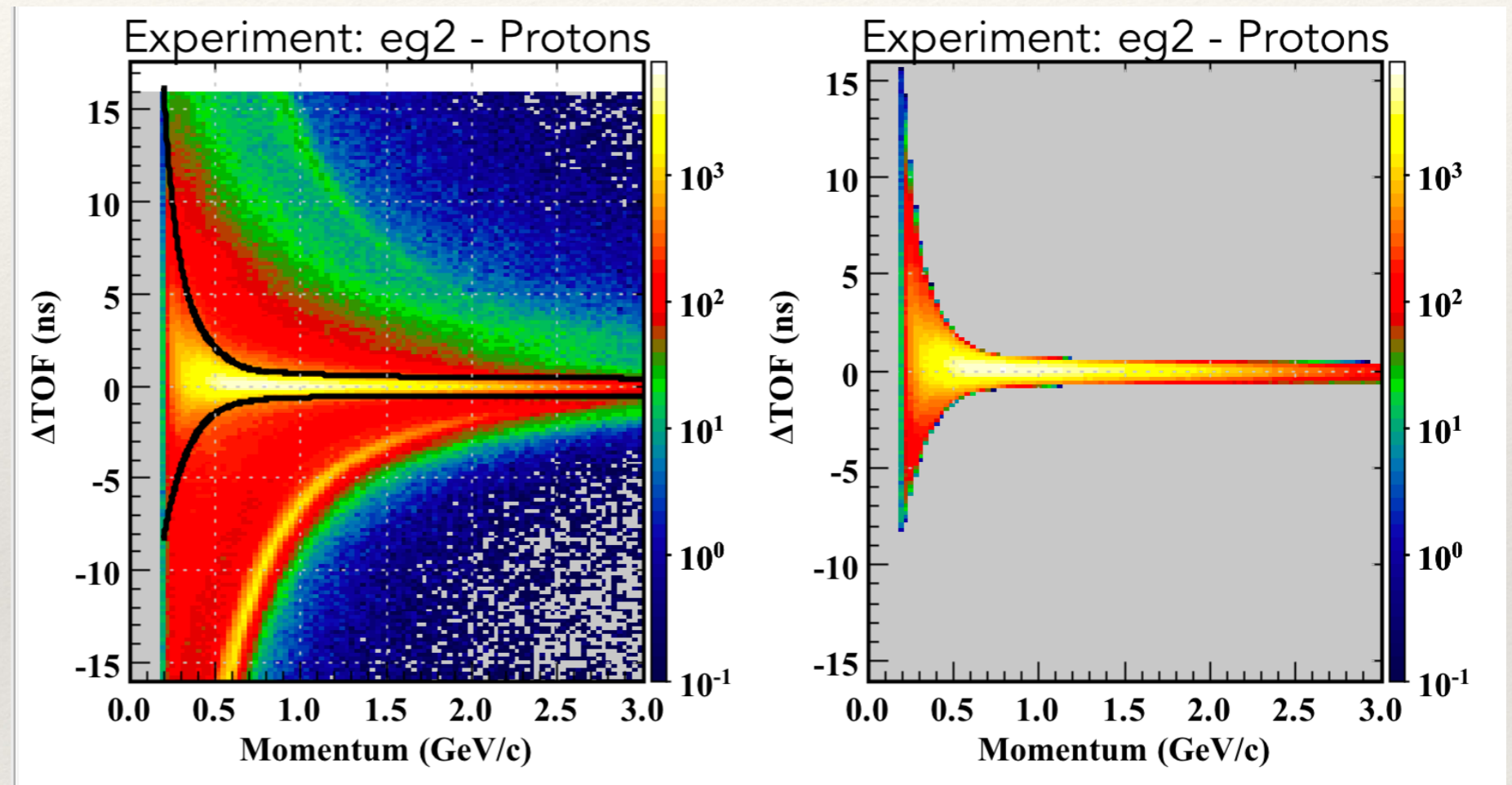
Momentum > 650 MeV

eg2 Vertex Corrections



Proton ID

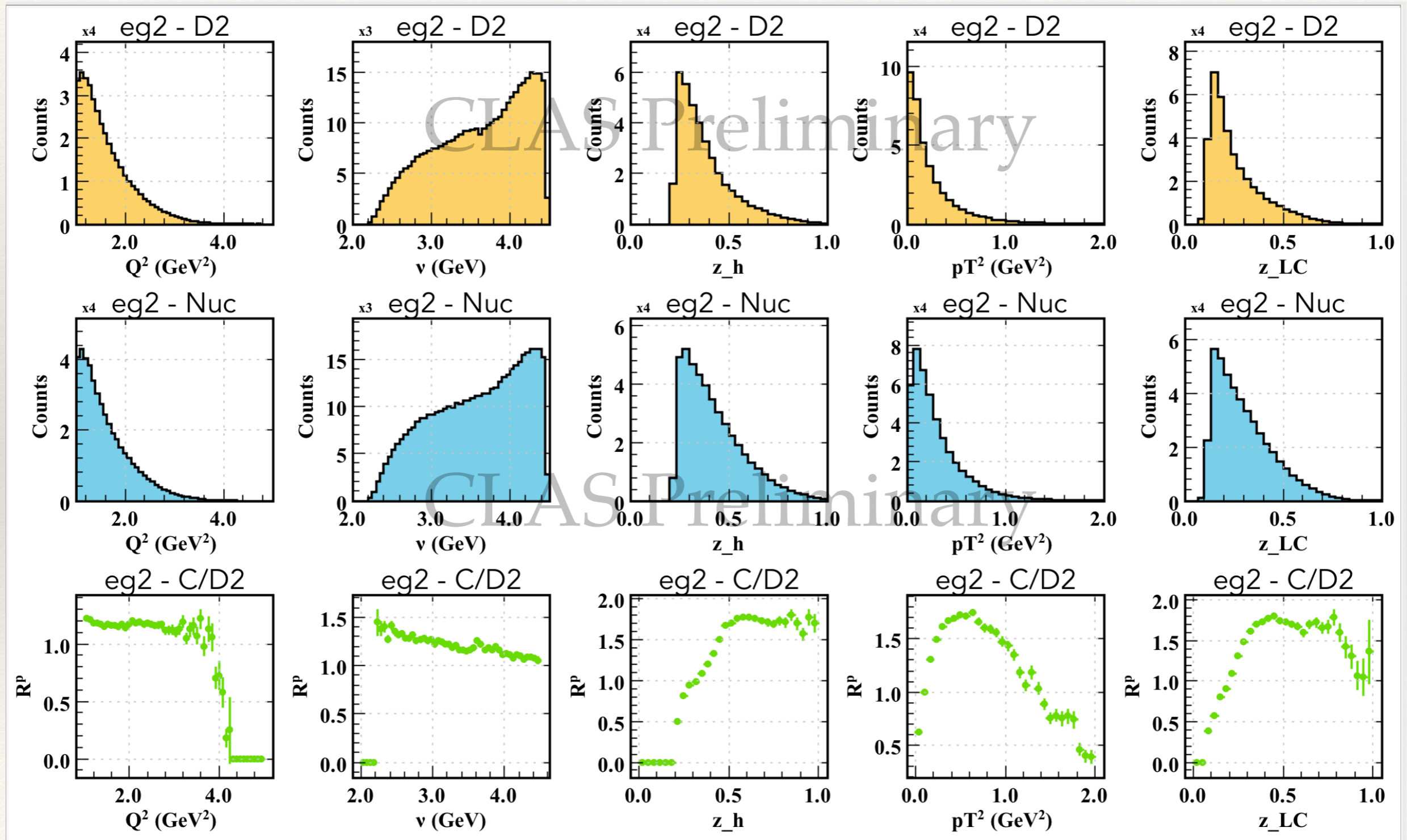
Select positively charged particles and make a cut on the TOF based on the proton mass.



Number of protons per target

Run Period	D2	Solid
C	9.8M	13.2M
Fe	17.4M	36.0M
Pb	16.1M	19.9M

Multiplicity Ratios - Carbon



z_{LC} - Light Cone z_h

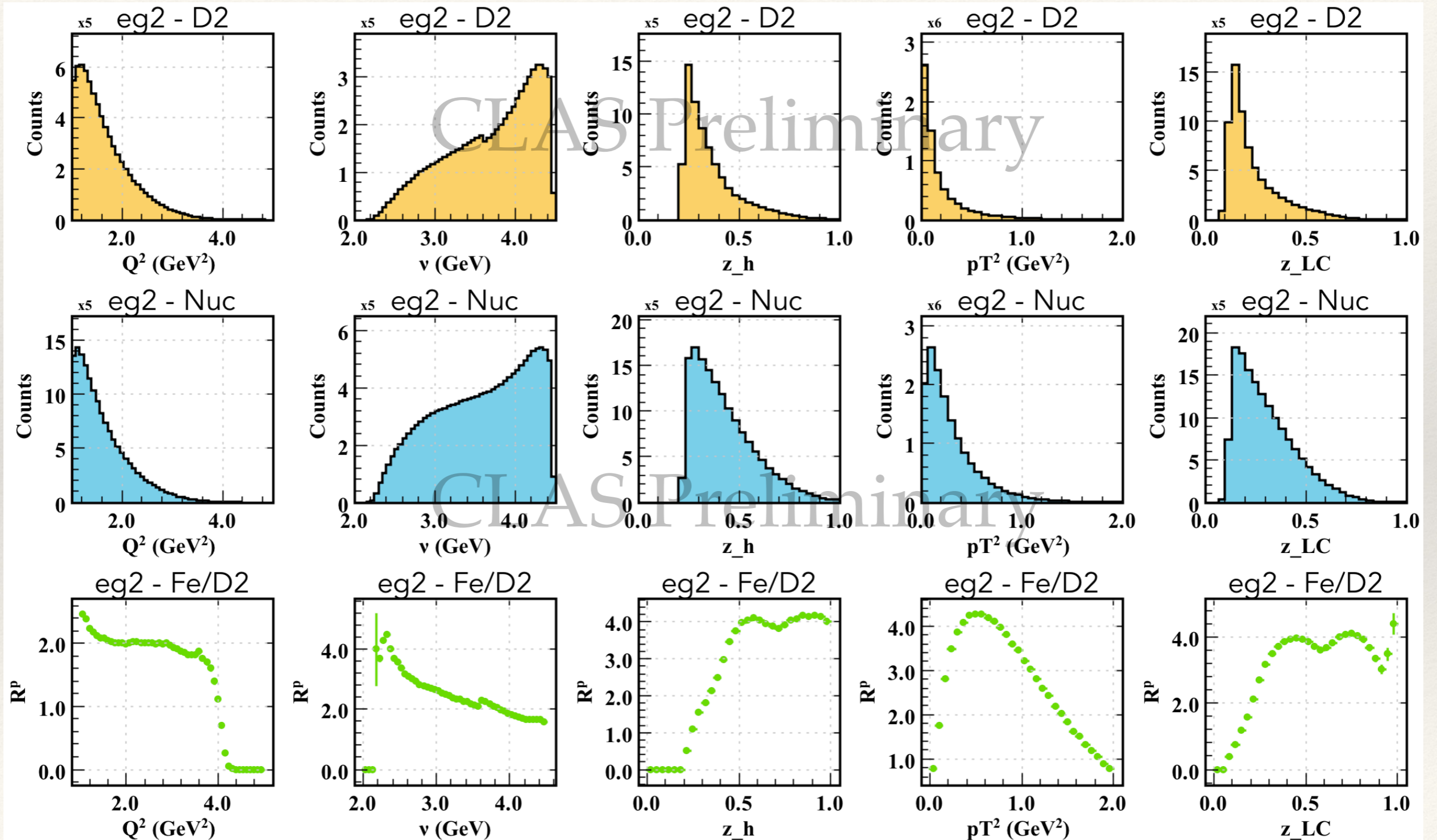
Fraction of hadron energy to the virtual photon energy

$$z_h = \frac{E_h}{\nu}$$

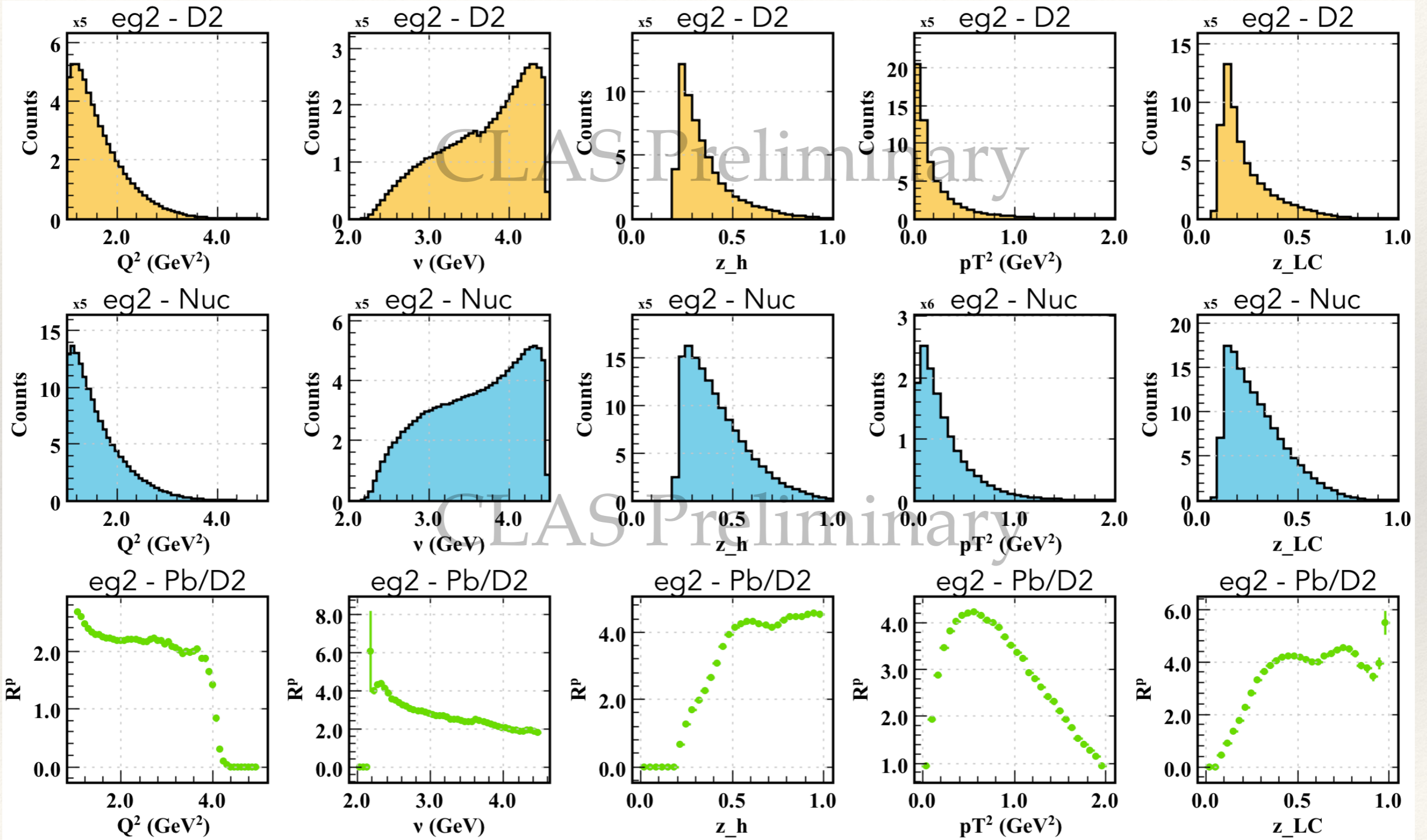
Expand the range by transforming onto the Light Cone.

$$z_{LC} = \frac{p_h^+}{P^+} = \frac{E_h + p_{z,h}}{M_h + \nu}$$

Multiplicity Ratios - Iron



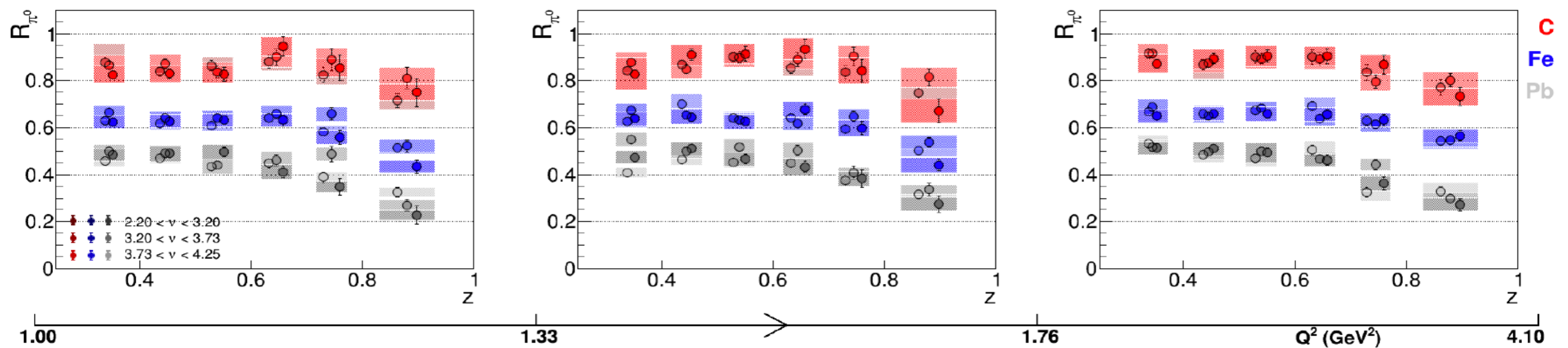
Multiplicity Ratios - Lead



Multiplicity Ratios - 3D

Neutral pions - results by T. Mineeva

3D binning - Q^2 , ν , z_h

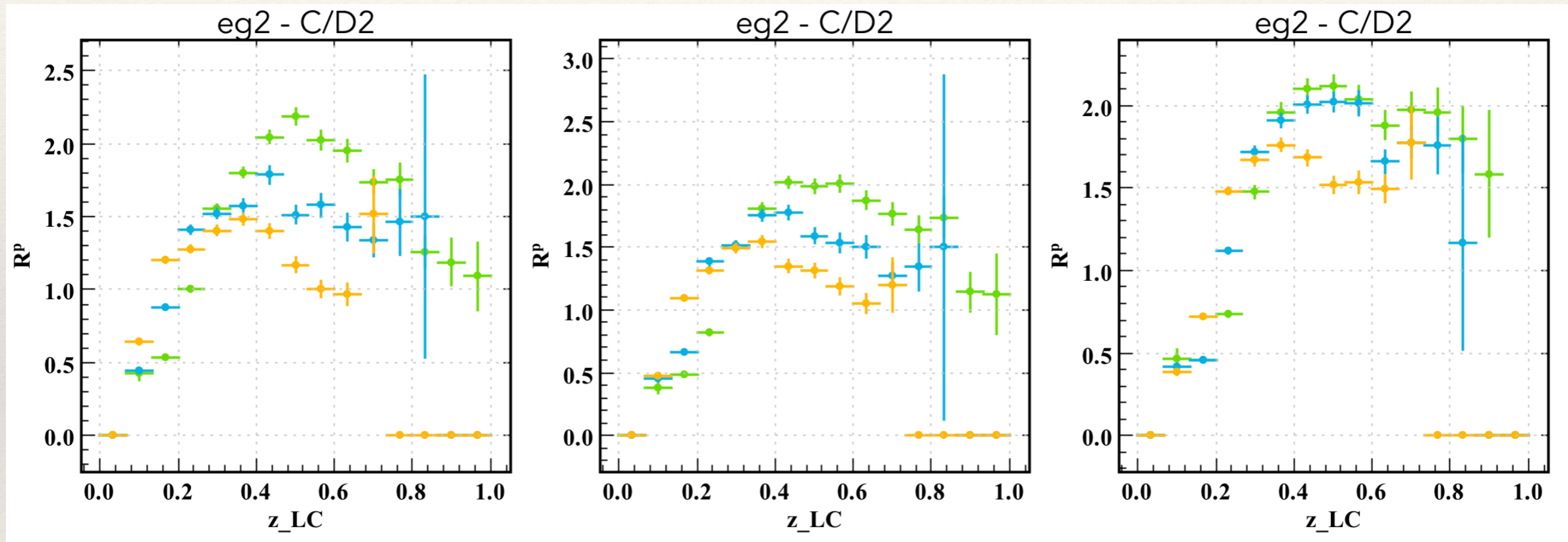


Currently under review.

Multiplicity Ratios - 3D

Carbon - uncorrected

7 runs



1.00

1.33

1.76

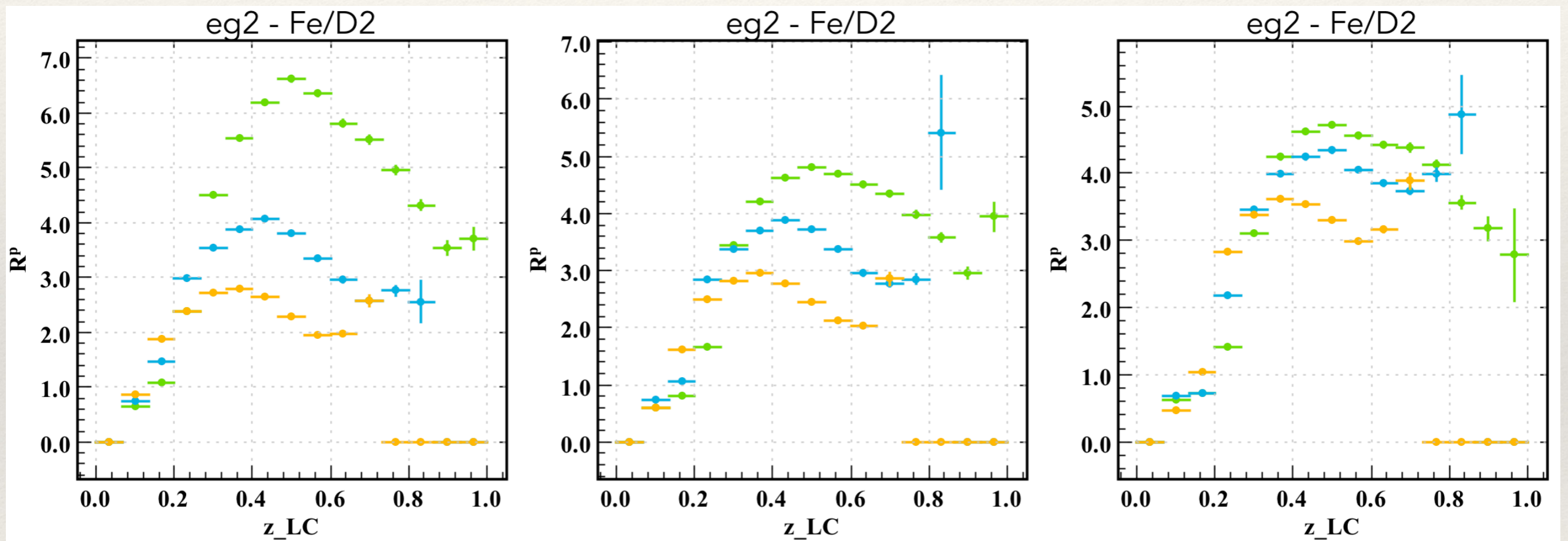
4.10

- $2.20 < \nu < 3.20$
- $3.30 < \nu < 3.73$
- $3.30 < \nu < 4.25$

Multiplicity Ratios - 3D

Iron - uncorrected

Full statistics



1.00

1.33

1.76

Q^2 (GeV²)

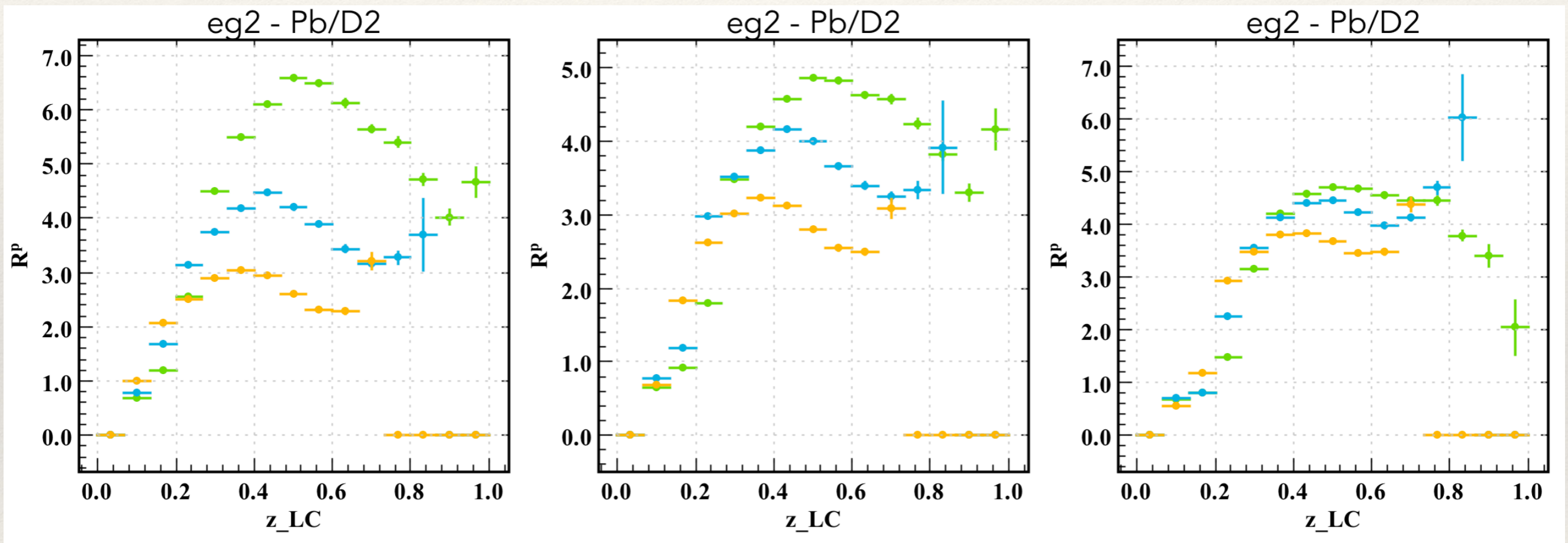
4.10

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Multiplicity Ratios - 3D

Lead - uncorrected

Full statistics



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Q^2 (GeV²)

4.10

- $2.20 < \nu < 3.20$
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The Plan

The analysis is proceeding

- Analysis of eg2 data (M. H. Wood)
- Running the simulations (Juan Pablo Garces, UTFSM undergraduate)

Next steps

Apply fiducial cuts

Apply acceptance correction

Apply e- normalization

Apply other corrections

Study p_T^2 and $\langle \Delta p_T^2 \rangle$

Backup slides

The Program

DIS channels: *stable* hadrons, accessible with 11 GeV
JLab experiment PR12-06-117



Actively underway with existing 5 GeV data

<i>meson</i>	$c\tau$	mass	flavor content	<i>baryon</i>	$c\tau$	mass	flavor content
π^0	25 nm	0.13	$u\bar{u}d\bar{d}$	p	stable	0.94	ud
π^+, π^-	7.8 m	0.14	$u\bar{d}, d\bar{u}$	\bar{p}	stable	0.94	$\bar{u}\bar{d}$
η	170 pm	0.55	$u\bar{u}d\bar{d}s\bar{s}$	Λ	79 mm	1.1	uds
ω	23 fm	0.78	$u\bar{u}d\bar{d}s\bar{s}$	$\Lambda(1520)$	13 fm	1.5	uds
η'	0.98 pm	0.96	$u\bar{u}d\bar{d}s\bar{s}$	Σ^+	24 mm	1.2	us
ϕ	44 fm	1.0	$u\bar{u}d\bar{d}s\bar{s}$	Σ^-	44 mm	1.2	ds
f_1	8 fm	1.3	$u\bar{u}d\bar{d}s\bar{s}$	Σ^0	22 pm	1.2	uds
K^0	27 mm	0.50	$d\bar{s}$	Ξ^0	87 mm	1.3	us
K^+, K^-	3.7 m	0.49	$\bar{u}s, u\bar{s}$	Ξ^-	49 mm	1.3	ds