Status update of analysis note on "Hadronization studies via pi0 electroproduction"

Taisiya Mineeva

Universidad Técnica Federico Santa María

CLAS collaboration meeting 13-15 June

EX UMBRA IN SOLEM

CONICYT
Ministerio de Educación
Gobierno de Chile

FONDECYT
Fondo Nacional de Desarrollo
Científico y Tecnológico

Status update on the analysis note

https://www.jlab.org/Hall-B/secure/eg2/taya/review.html

Neutral pion electroproduction ratios off C, Fe, and Pb to D

Taisiya Mineeva

Universidad Tecnica Federico Santa Maria
Avenida Espana 1680, Valpariso, Chile
taya.mineeva@gmail.com

Review page of CLAS analysis note
The target journal is PRC or PRL

CLAS Analysis Note

Review committee: Yordanka Ilieva, Larry Weinstein and Michael Wood

The original analysis note submitted to the committee can be found here
The review was requested on March 25, 2014 and received on July 3, 2014

Questions

- The committee response to original note is here
- Larry W. supplementary comments are here

Answers

- Current form of corrected analysis note is here
- Response to committe's questions is here

Meeting discussions

- Multiplicities presentation
- Acceptance correction presentation
- Systematics due to DC fiducial cuts presentation
- Systematics due to fit to the invariant mass presentation
- Systematics due to model dependence of acceptance presentation
- 1D multiplicity, acceptance and RC corrected: presentation

My wiki page

Last update June13 2017

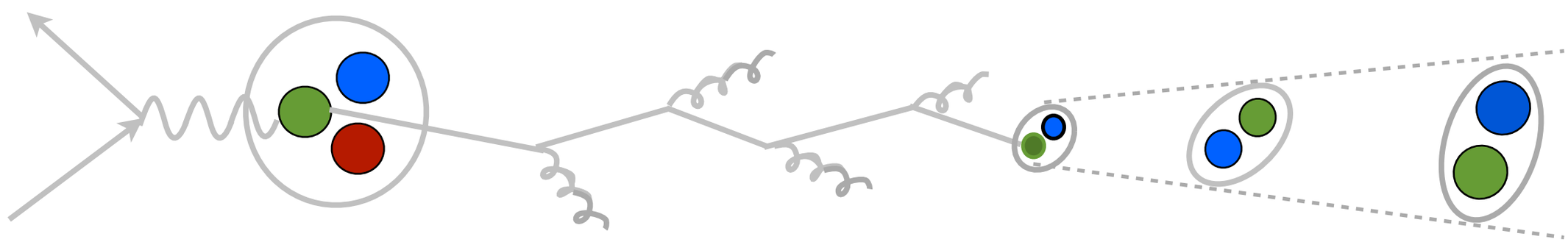
Hadronization

Hadronization: vacuum

Hadronization is the process by which energetic *q* and *g* evolve into hadrons

- Quark propagation: in hard hadronic processes, energetic partons can be temporarily liberated from hadrons; distribution of the color charge over an extended volume.

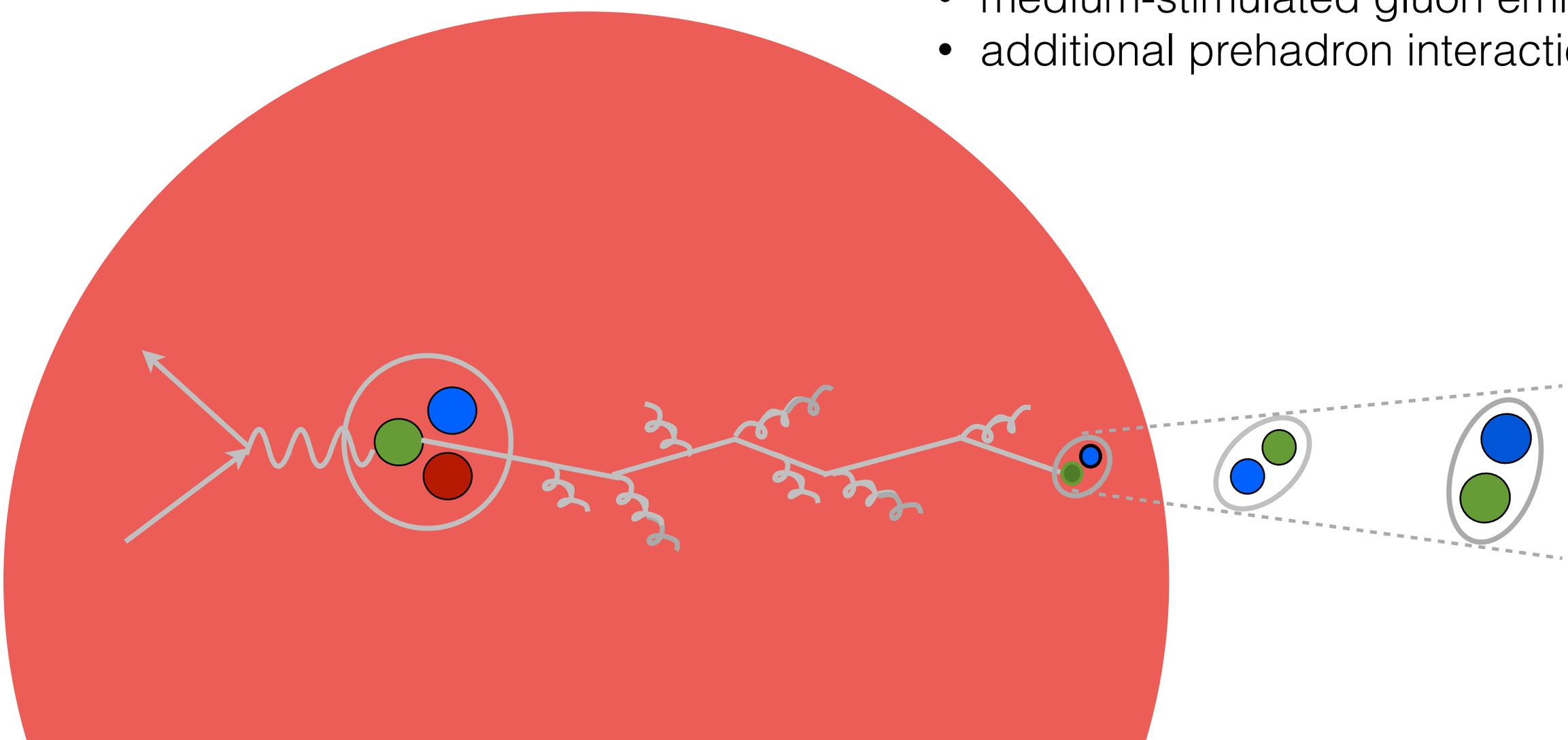
- Hadron formation: color charge is neutralized into color singlet hadrons.



Hadronization: in-medium

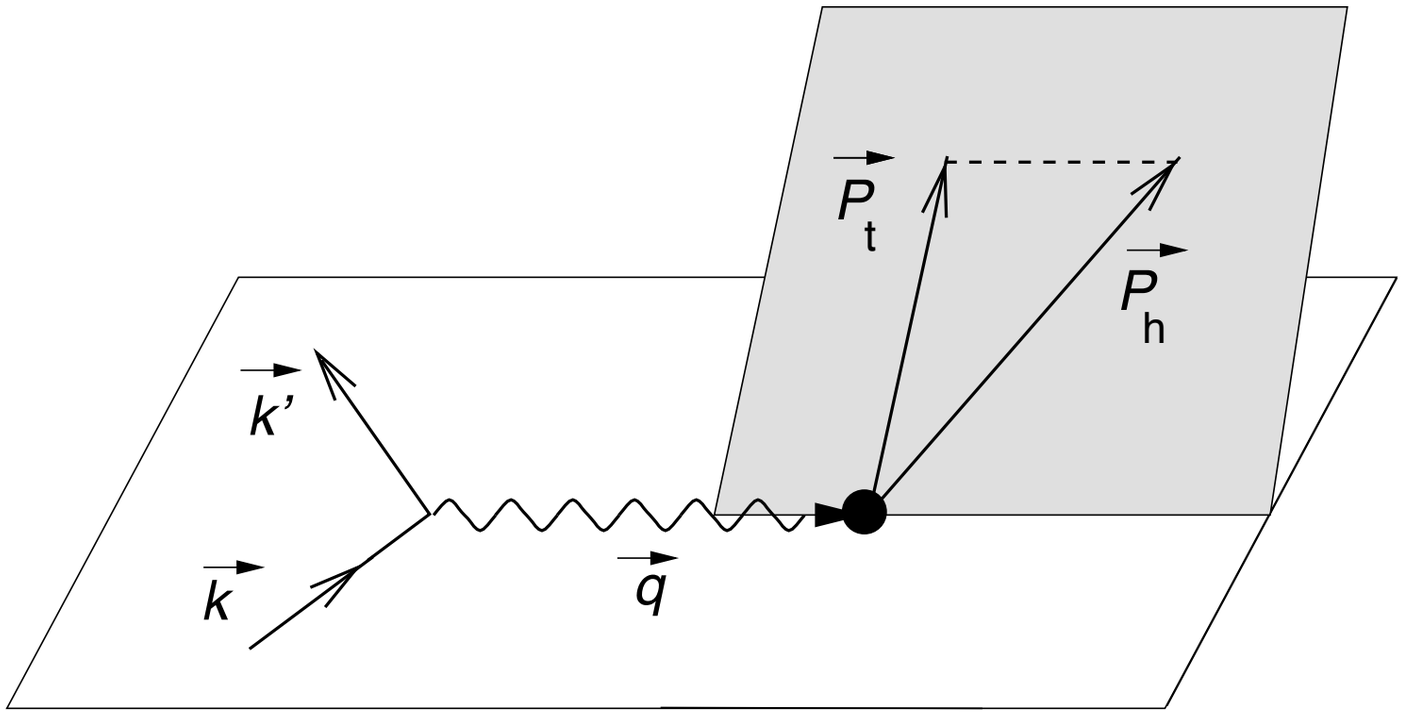
Nuclear medium of variable size acts as a ruler that provides space-time information on hadronization process

- partonic multiple scattering
- medium-stimulated gluon emission
- additional prehadron interaction



Observables

Kinematical variables of SIDIS

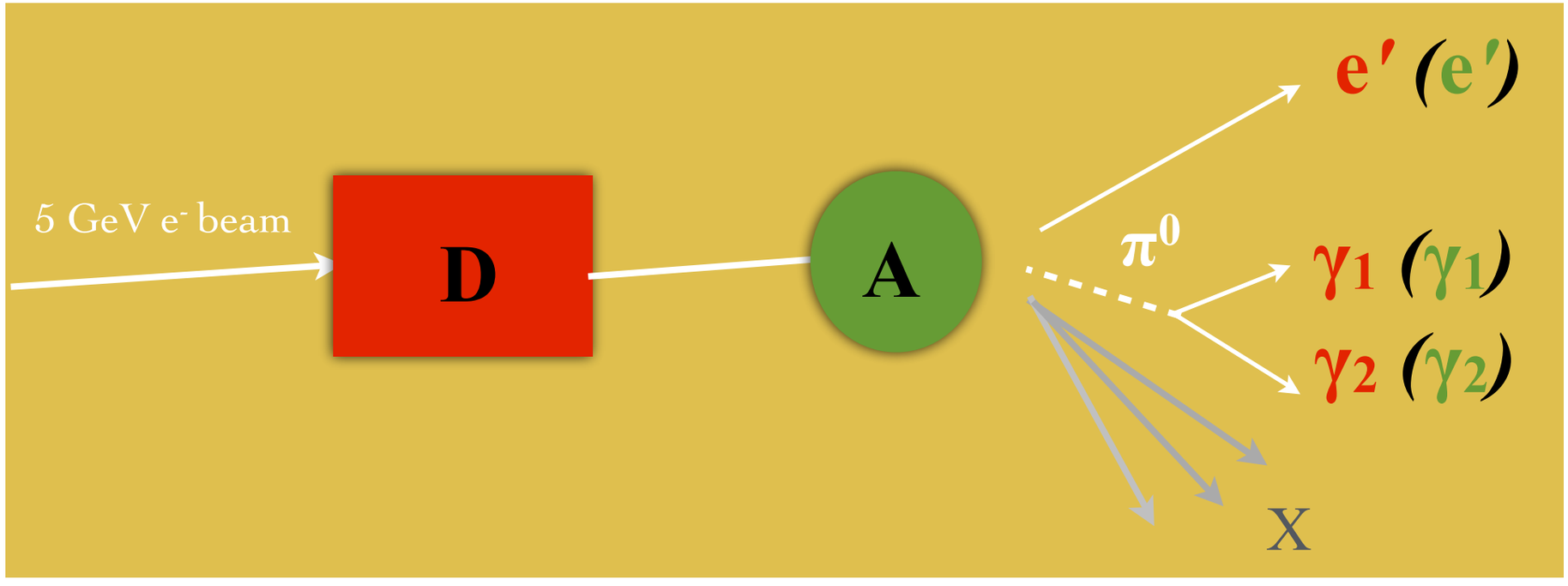


Q^2 = $-q^2$ four-momentum transferred by the electron;
ν = $E-E'$ (lab) energy transferred by the electron;
z = E_h/ν fraction of initial quark energy carried by hadron;
p_T hadron momentum transverse to γ^* direction;
φ angle between leptonic and hadronic planes

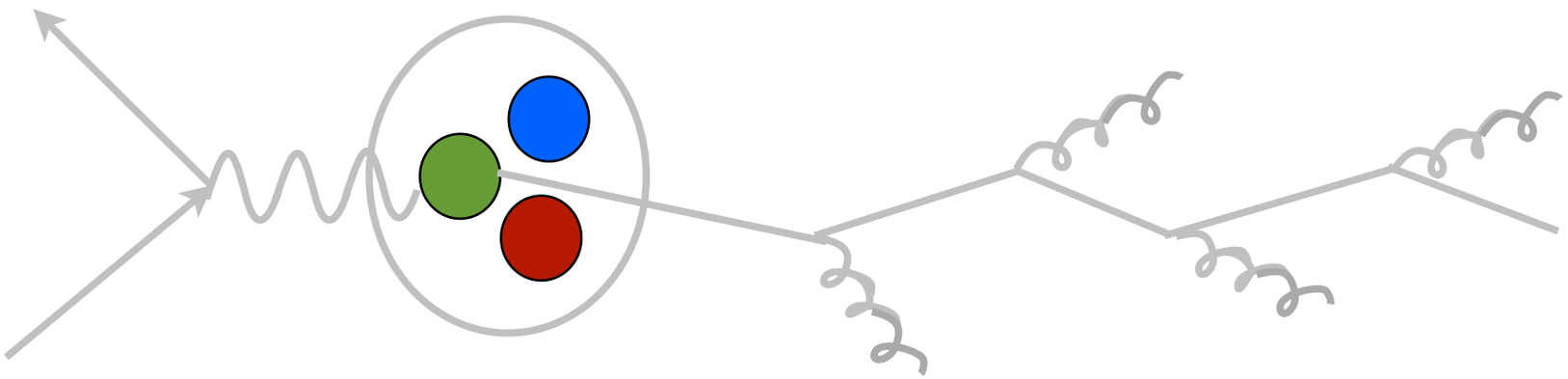
Reaction of interest: SIDIS π^0

DIS regime: $Q^2 > 1\ (\mathrm{GeV/c})^2$ and $W > 2$ GeV/c

$$e\ D \rightarrow e'\ \pi^0\ X$$
$$e\ A \rightarrow e'\ \pi^0\ X$$



Observables



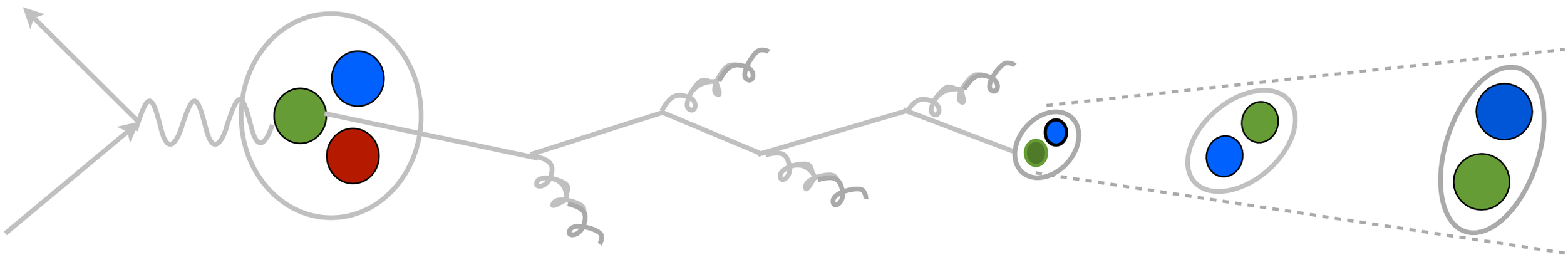
Transverse momentum broadening

$$\Delta p_T^2 = < p_T^2 >_{\mathrm{A}} - < p_T^2 >_{\mathrm{D}}$$

Connects to partonic phase

- in-medium scattering
- quark energy loss
- access to production time τ_p

Observables



Hadronic multiplicity ratio

$$R_{\mathrm{A}}^{h}\left(\nu, Q^{2}, z, p_{T}\right) = \frac{\left.\dfrac{N_h(\nu,Q^2,z,p_T)}{N_e(\nu,Q^2)|_{\mathrm{DIS}}}\right|_{\mathrm{A}}}{\left.\dfrac{N_h(\nu,Q^2,z,p_T)}{N_e(\nu,Q^2)|_{\mathrm{DIS}}}\right|_{\mathrm{D}}}$$

Connects to hadronic phase

hadron formation space-time mechanisms

Analysis note

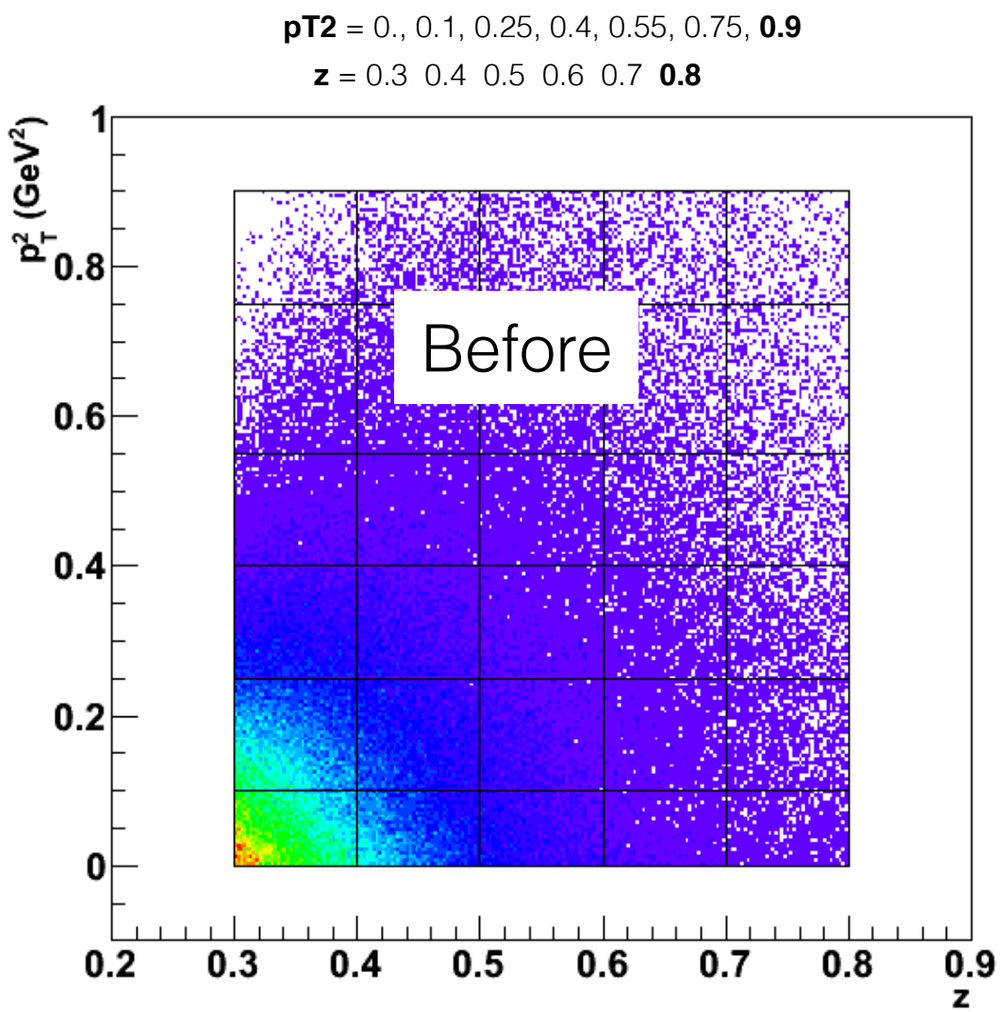
Analysis note

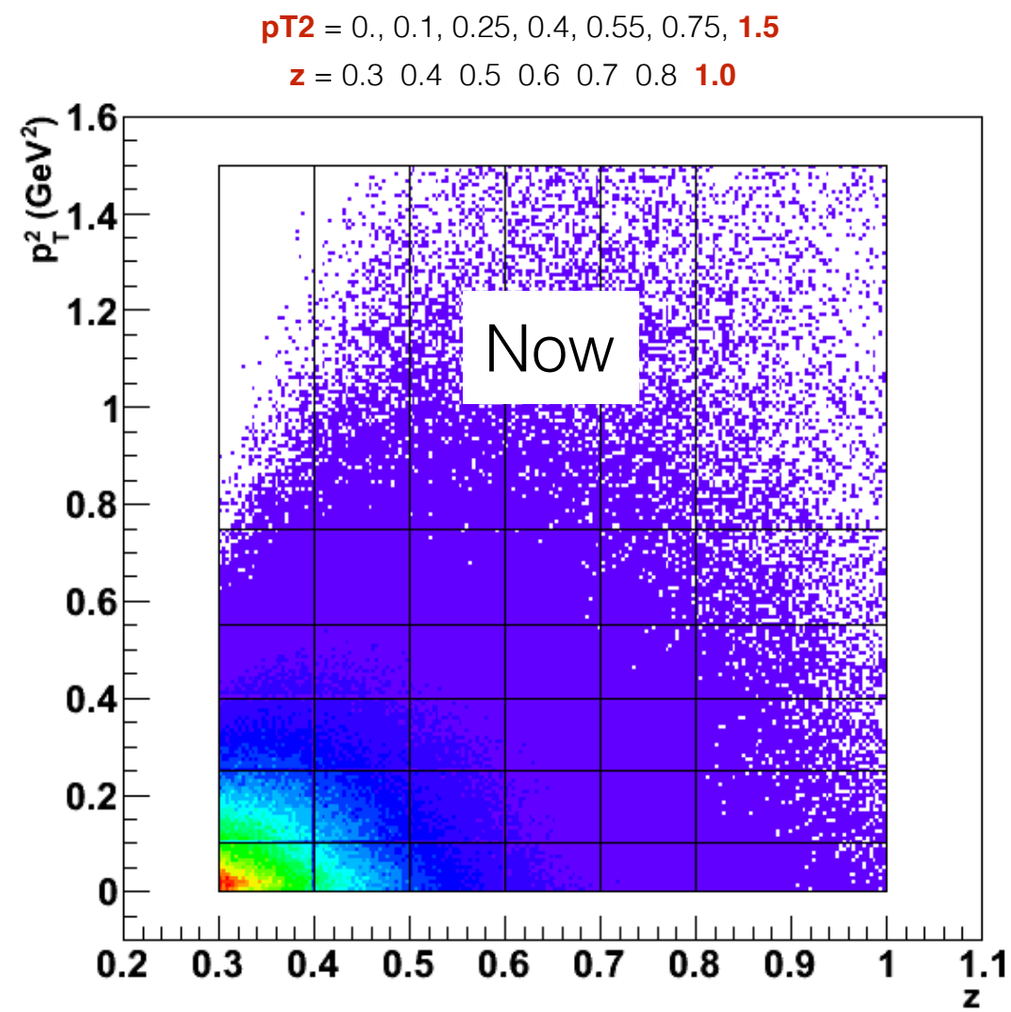
- Particle identification ✔
  - electron ID
  - photon ID
  - π^0 reconstruction
  - binning

- Corrections ✔
  - electron vertex
  - photon energy
  - e^- and π^0 acceptance
  - radiative corrections

- Systematic studies
  > DC fiducial cuts
  > radiative corrections

Phase-space of the analysis was expanded



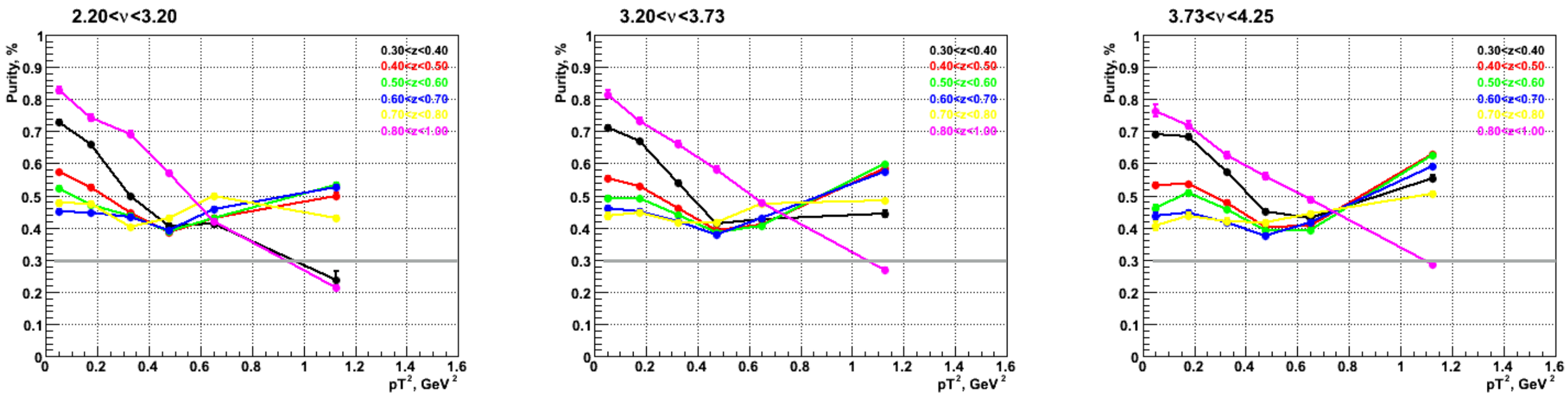


Entire analysis is binned in 2 sets of 3D bins: (v, z, pT^2) and (Q^2,v, z)

Purity-based bin exclusion in (v, z, pT^2)

Exclude bins for which Purity < $(1\sigma)^3$
which amounts to Purity below 30%

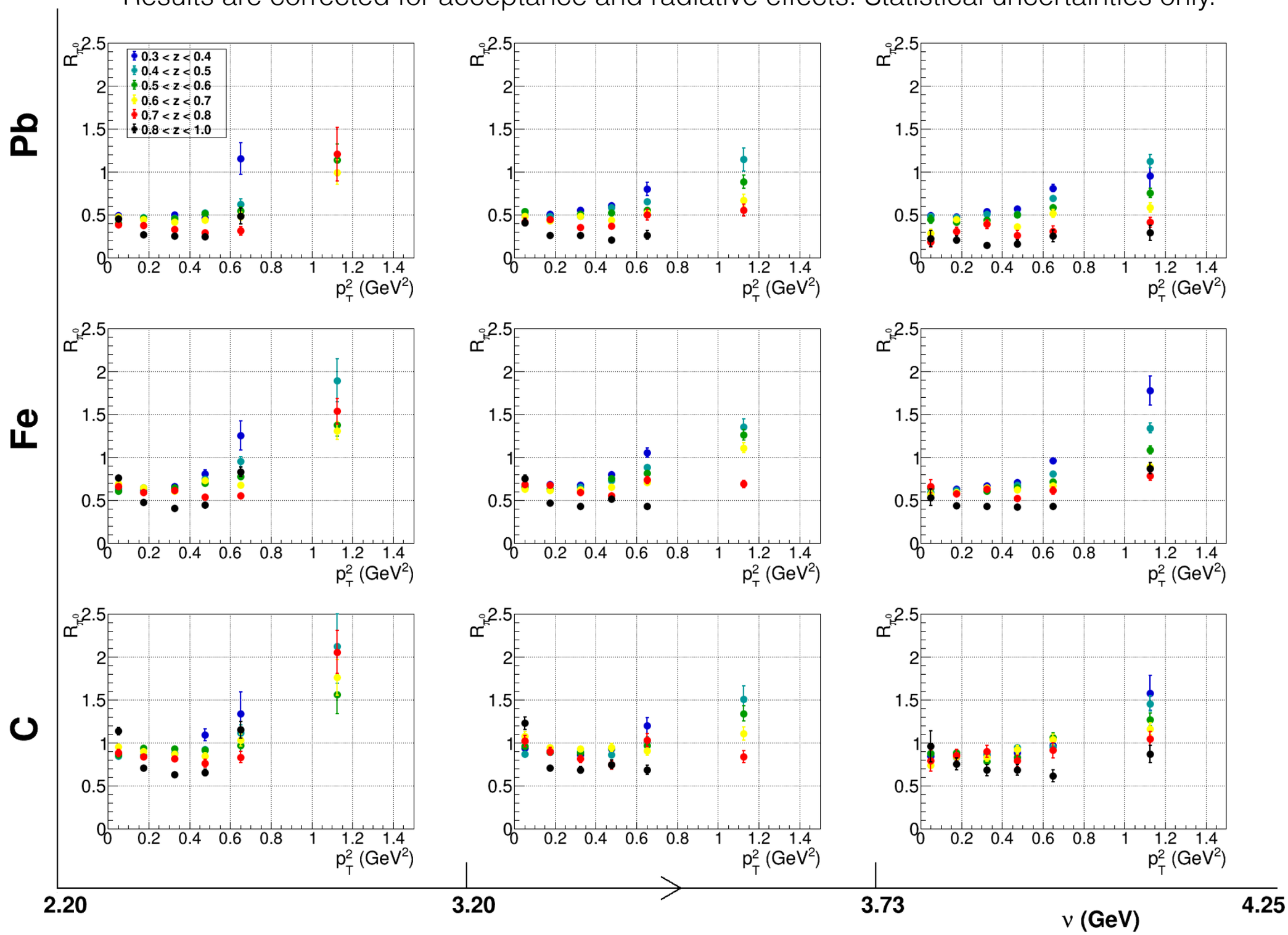
$$Purity = \frac{N^{rec}_{gen}}{N^{rec}}$$



Purity in (Q^2,v, z) set of bins exceeds 30% for all the bins

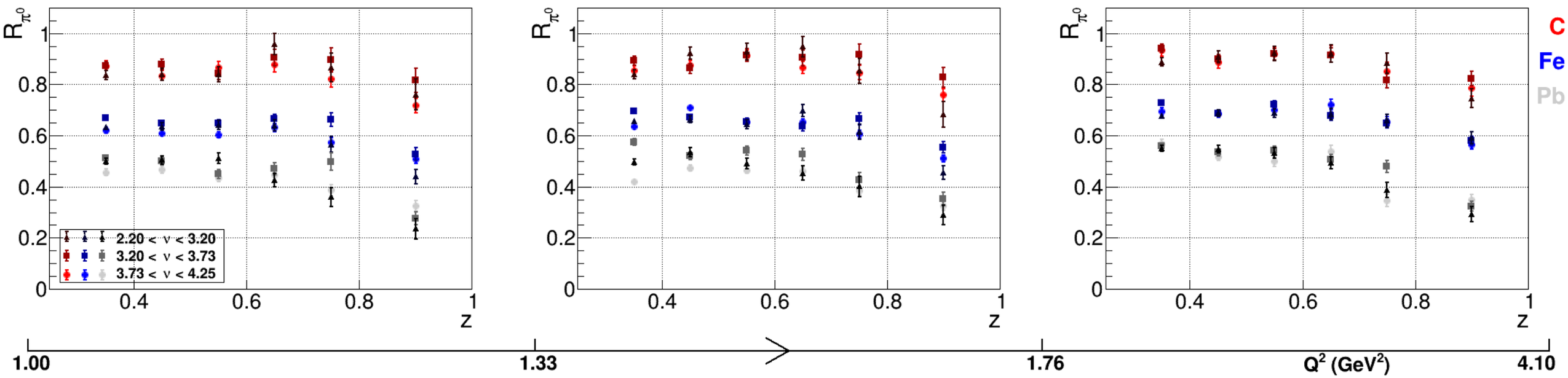
Multiplicity ratios in (v, z, pT²)

Results are corrected for acceptance and radiative effects. Statistical uncertainties only.



Multiplicity ratios in (Q^2,v, z)

Results are corrected for acceptance and radiative effects. Statistical uncertainties only.



Status summary of systematic uncertainties

Systematic uncertainties for C, Fe and Pb multiplicities in (Q^2, ν, z).

Systematic uncertainty	$\Delta^{C}_{RMS}(\%)$	Δ^{Fe}_{RMS} (%)	Δ^{Pb}_{RMS} (%)
Normalization type			
Target vertex cut	0.3	0.3	0.3
Target leakage	0.9	0.9	0.9
Sampling fraction cut	0.5	0.5	0.5
Photon energy cutoff	1.2	1.2	2.7
EC time (beta) cut	0.8	0.8	0.8
DC fiducial cuts	0.9	0.9	0.9
Radiative corrections			
Bin-by-bin basis			
Background shape	0.6	0.9	1.4
Signal shape	3.1	1.9	5.1
Acceptance in finite bin width	1.1	1.1	1.1
Total in (Q^2, ν, z)	3.9	3.1	6.3

Systematic uncertainties for C, Fe and Pb multiplicities in (ν, z, p^2_T) bins.

Systematic uncertainty	$\Delta^{C}_{RMS}(\%)$	Δ^{Fe}_{RMS} (%)	Δ^{Pb}_{RMS} (%)
Normalization type			
Target vertex cut	0.5	0.5	0.5
Target leakage	0.9	0.9	0.9
Sampling fraction cut	0.4	0.4	0.4
Photon energy cutoff	2.1	2.1	2.2
EC time (beta) cut	0.6	0.6	0.6
DC fiducial cuts	1.3	1.3	1.3
Radiative corrections			
Bin-by-bin basis			
Background shape	0.6	0.5	0.8
Signal shape	2.1	2.1	4.5
Acceptance in finite bin width	2.8	2.8	2.8
Total in (ν, z, p^2_T)	4.0	4.0	5.7

Work in progress: estimation of systematic uncertainties for the radiative corrections

People @ UTFSM

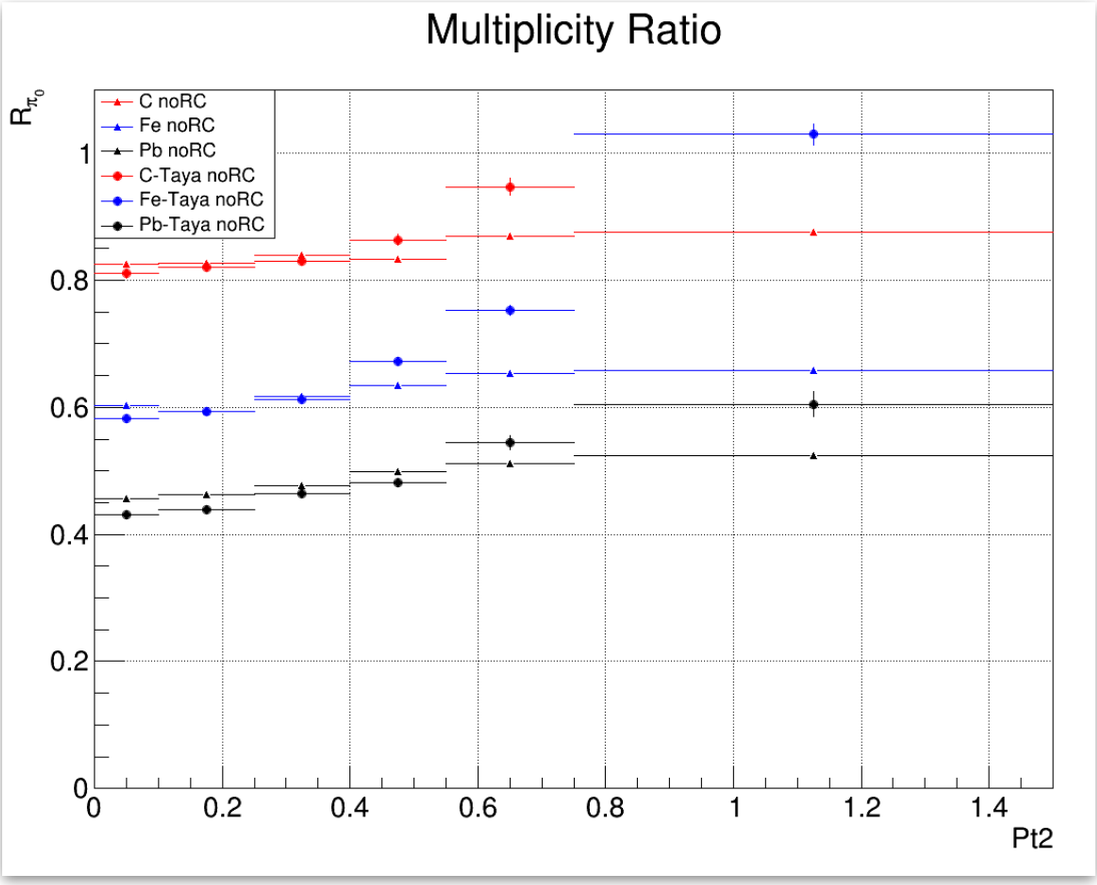
EG2 group at UTFSM

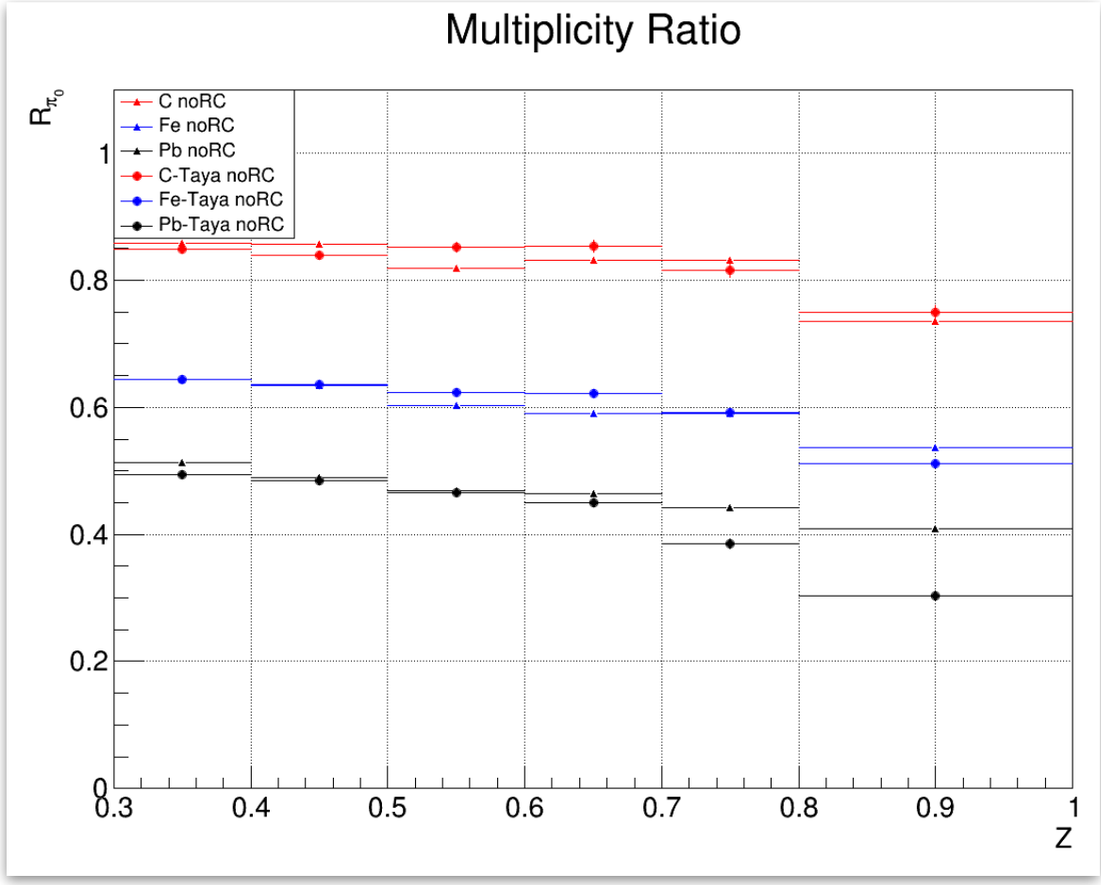
Will Brooks (Director)
Ahmed El Alaoui
Hayk Hakobyan
Taisiya Mineeva
Sebastián Moran
Jose Peña
Antonio Radic
Orlando Soto

Theory support

Boris Kopeliovich
Benjamin Guiot

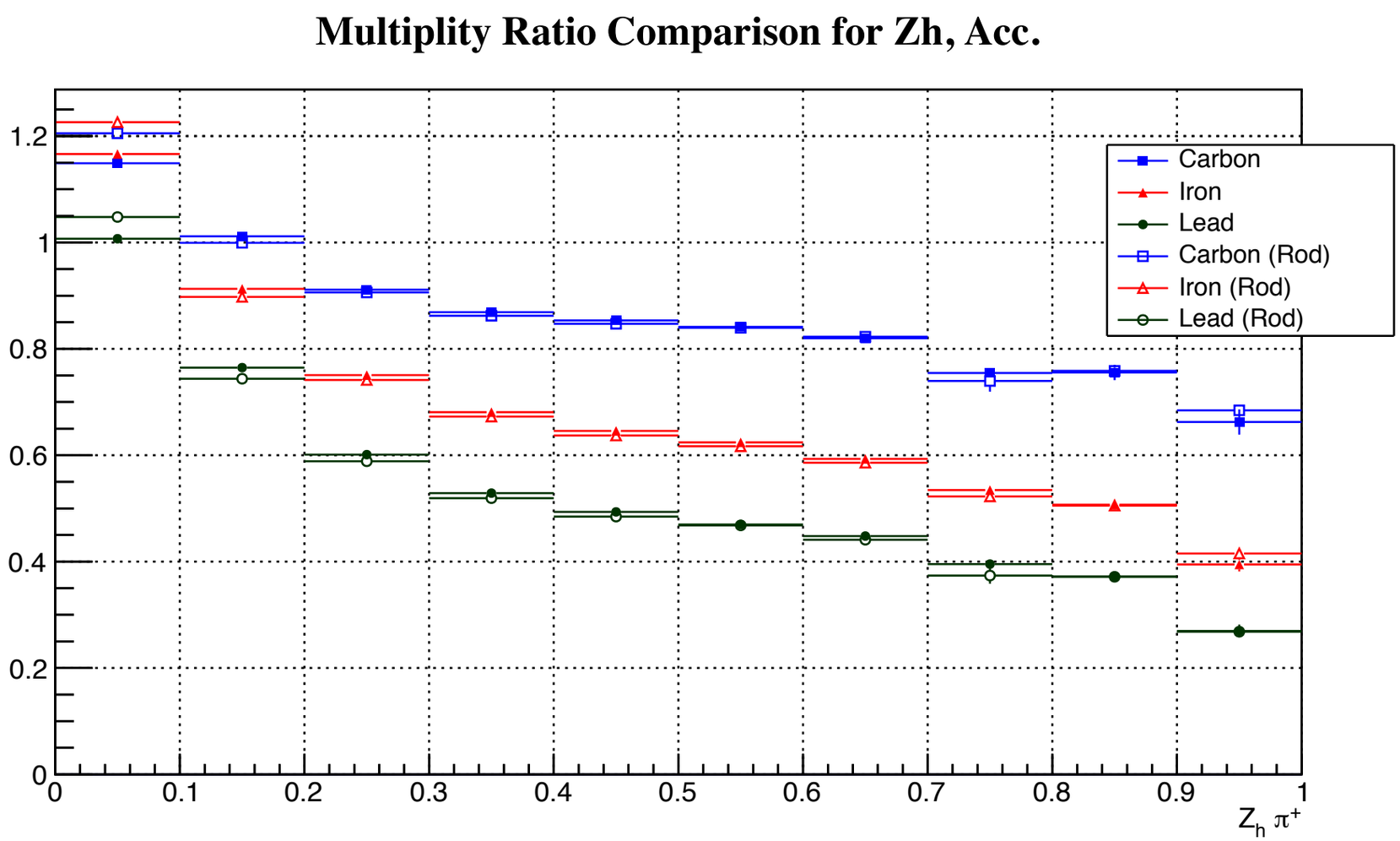
Independent cross checks of analysis: π^0 multiplicities





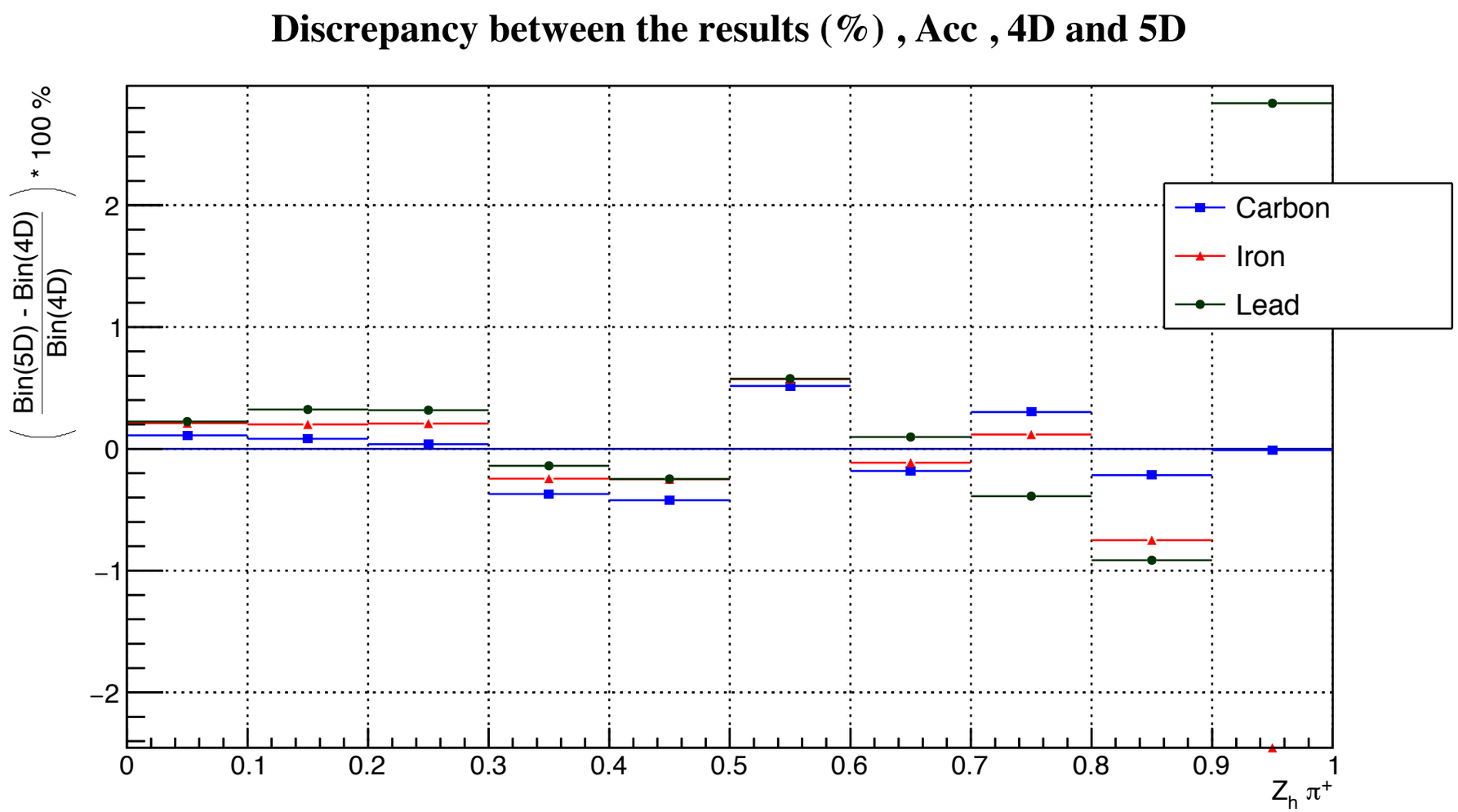
Orlando Soto

Independent cross checks of analysis: π^+ multiplicities



Sebastián Moran

Independent cross checks of analysis: π^+ acceptance



Sebastián Moran

Summary

- The phase space of the analysis was expanded up to z=1 and p_T^2=1.5 GeV^2
  Multiplicity ratios in two sets of bins, acceptance corrections, radiative effects and systematic uncertainties were reevaluated correspondingly

- The systematic uncertainties on the multiplicity ratio, w/o uncertainty on radiative corrections, are 3 - 6 % depending on the bin set and target type

- What remains: systematics on radiative corrections

- We plan to submit answers to the review committee within the next several months

7 th International Conference on High Energy Physics in the LHC era

8-12 January 2018

Universidad Técnica Federico Santa María
Valparaíso, Chile

Topics

Higgs Physics
Heavy Ion Collisions
Dark Matter Searches.
Astroparticle Physics
Hadron Spectroscopy
Neutrino Physics
High Energy QCD
Non Perturbative QCD
Future Experiments
Particle Detectors and Instrumentation
Beyond the Standard Model Physics
Ads/CFT Phenomenology

Organizing Committee

Diego Aristizábal
William Brooks
Antonio Cárcamo
Edson Carquín
Oscar Castillo-Felisola
Carlos Contreras
Gorazd Cvetic
Claudio Dib
Ahmed El Alaoui
Hayk Hakobyan
Boris Kopeliovich
Sergey Kovalenko
Sergey Kuleshov
Eugeny Levin
Sebastián Mendizábal
Jonathan Miller
Taisiya Mineeva
Fedor Prokoshin
Amir Rezaeian
Maximiliano Rivera
Iván Schmidt
Marat Siddikov
Pablo Ulloa
Nicolás Viaux
Alfonso Zerwekh

Contact

Email: hep-chile@usm.cl
Phone: (56)(32)2654636
Universidad Técnica Federico Santa María
Av. España 1680, Casilla 110-V, Valparaíso.

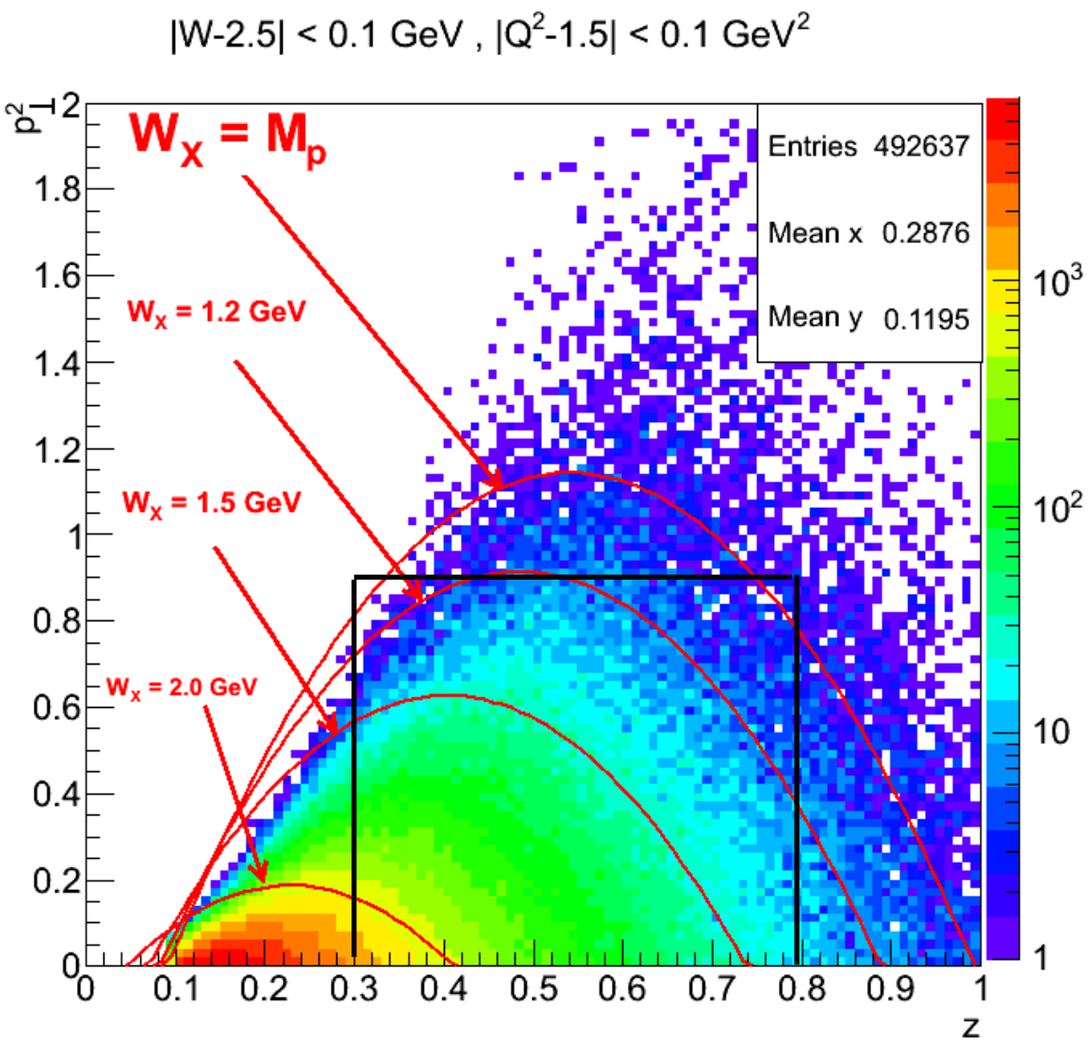
https://indico.cern.ch/e/hep2018

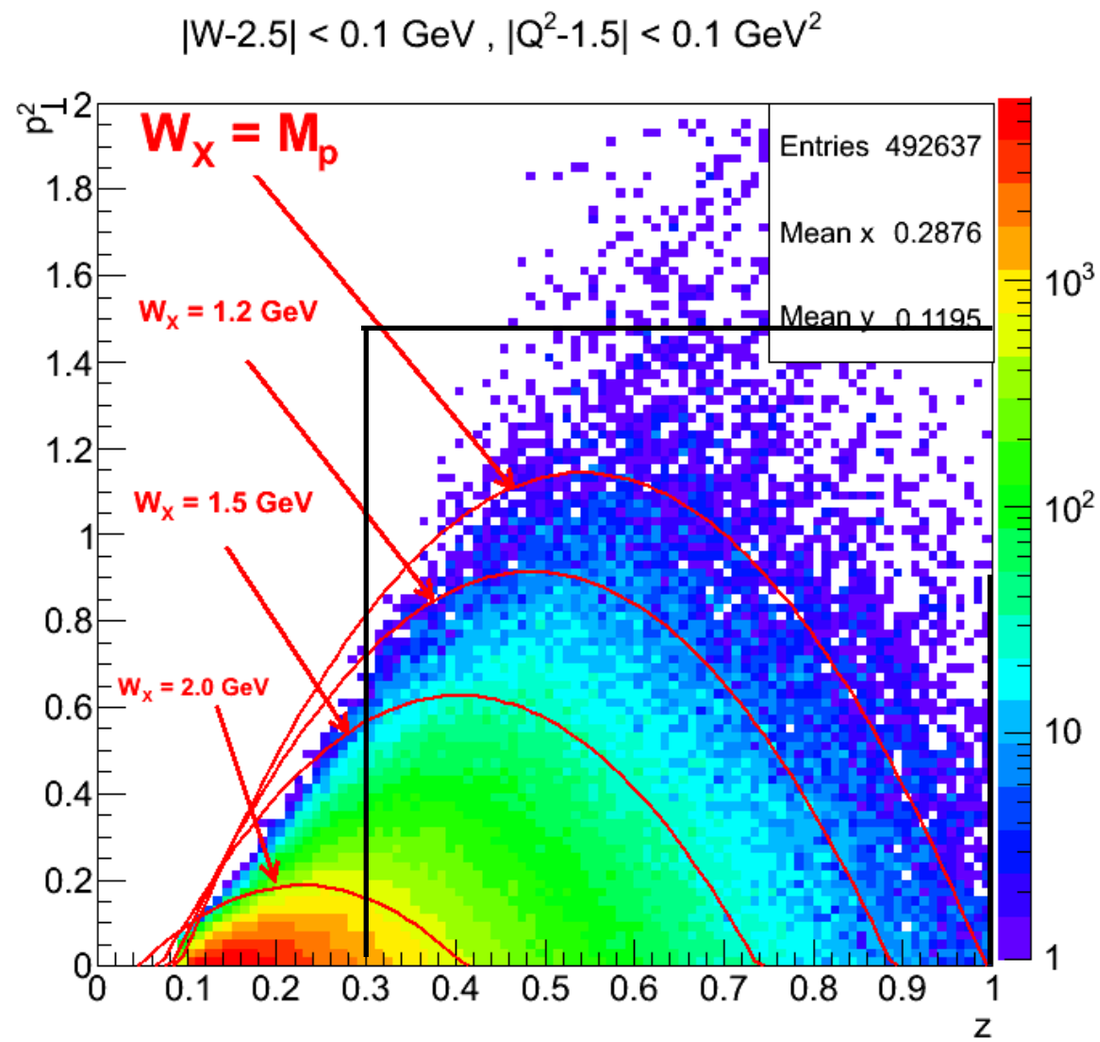
CCT Val

EX UMBRA IN SOLEM
UNIVERSIDAD TECNICA FEDERICO SANTA MARIA

Backup slides

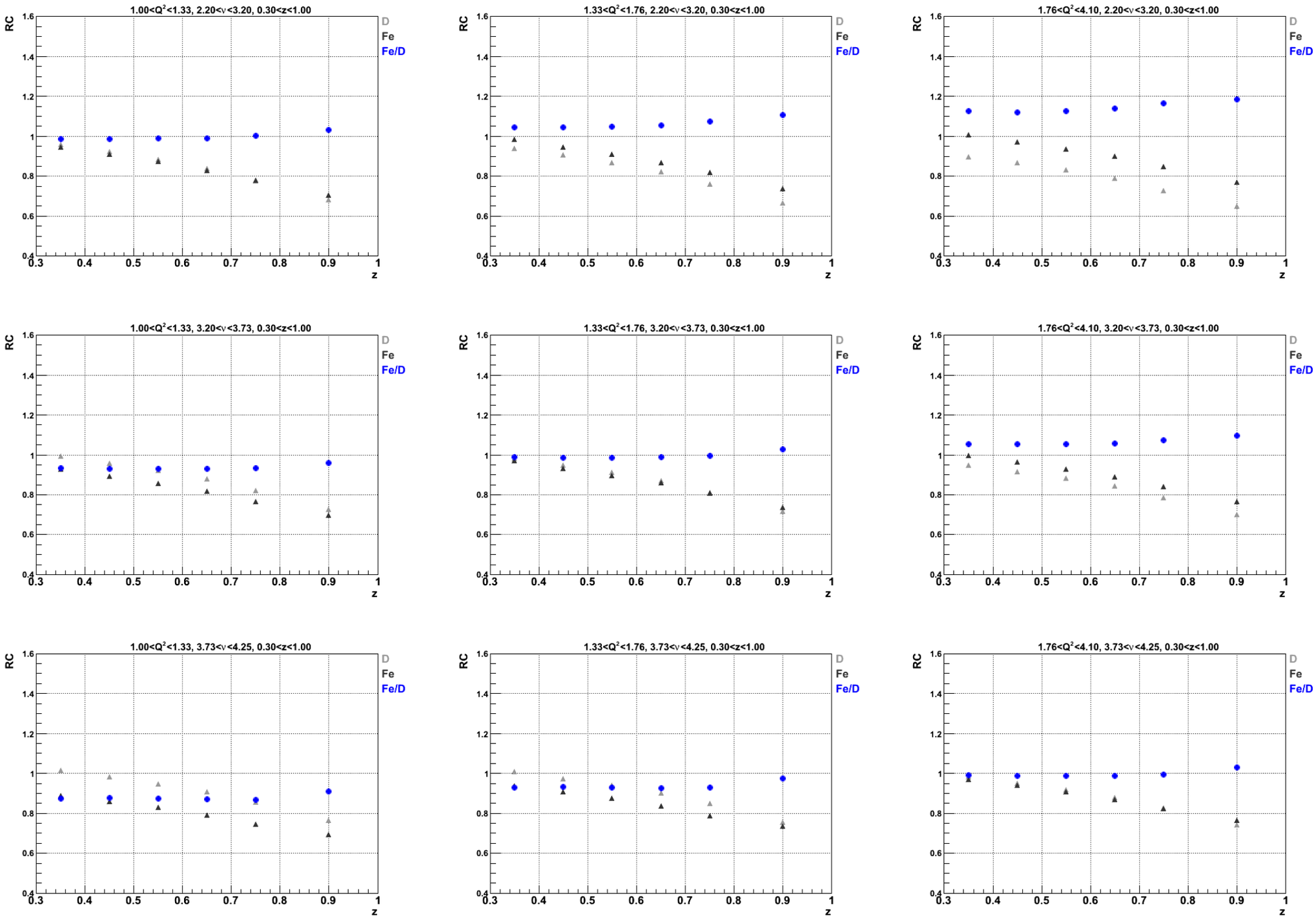
Missing mass curves as a function of (p_T2, z)





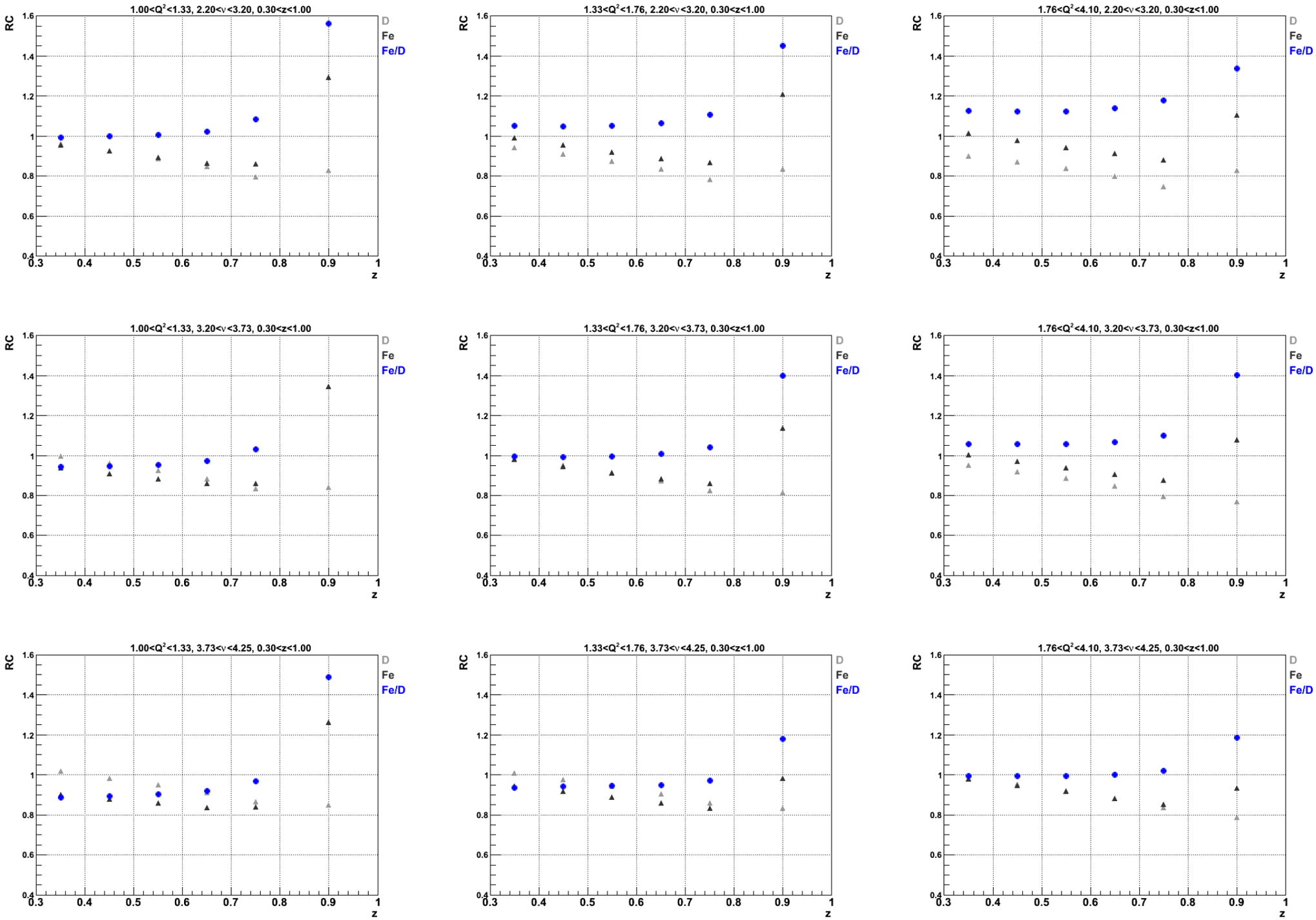
Radiative Corrections in (Q^2, ν, z): SIDIS

SIDIS contribution to RC factors for D, Fe and **Fe/D** ratio in set of (Q^2, ν, z)

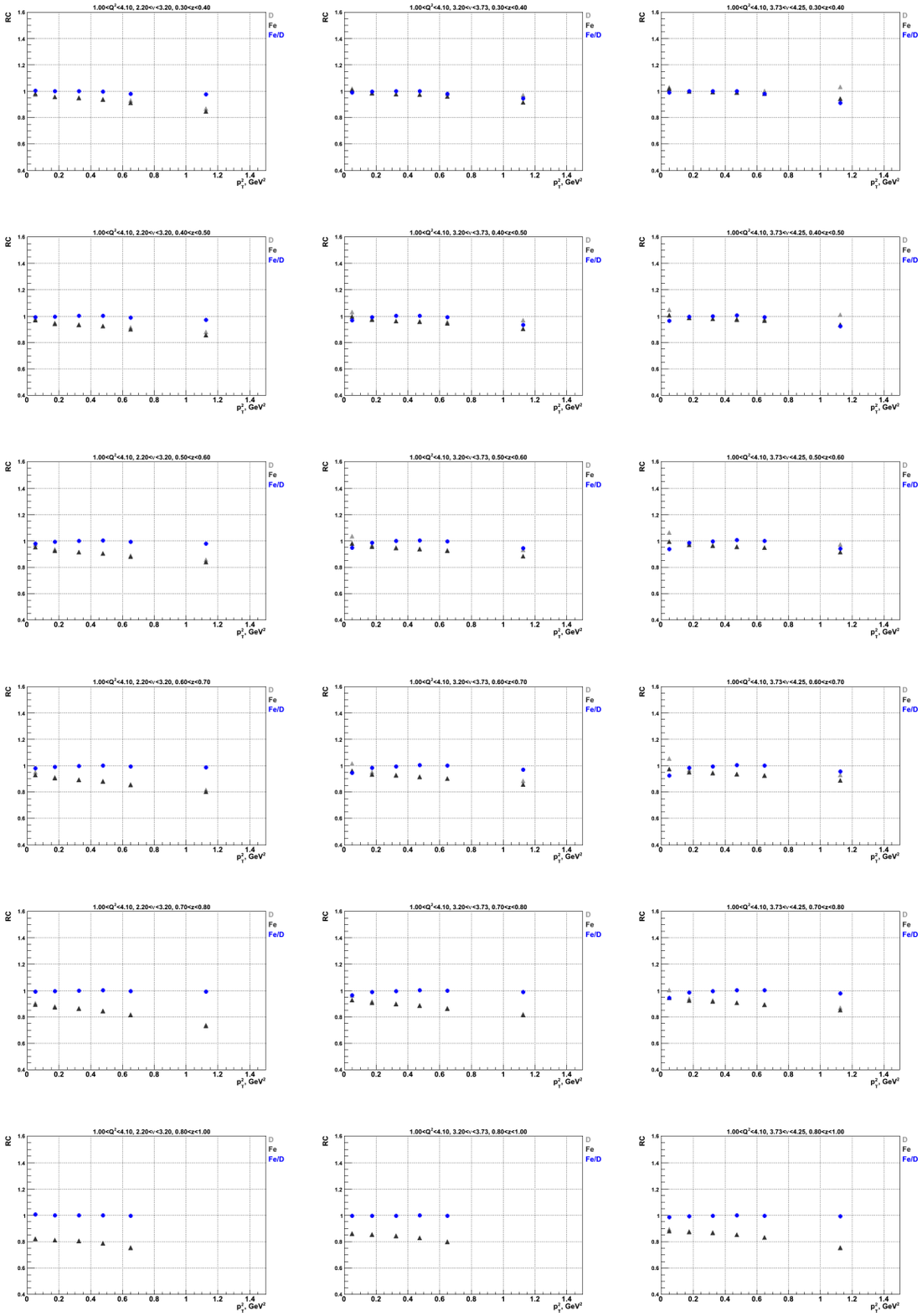


Radiative Corrections in (Q^2, ν, z): **SIDIS + Exclusive**

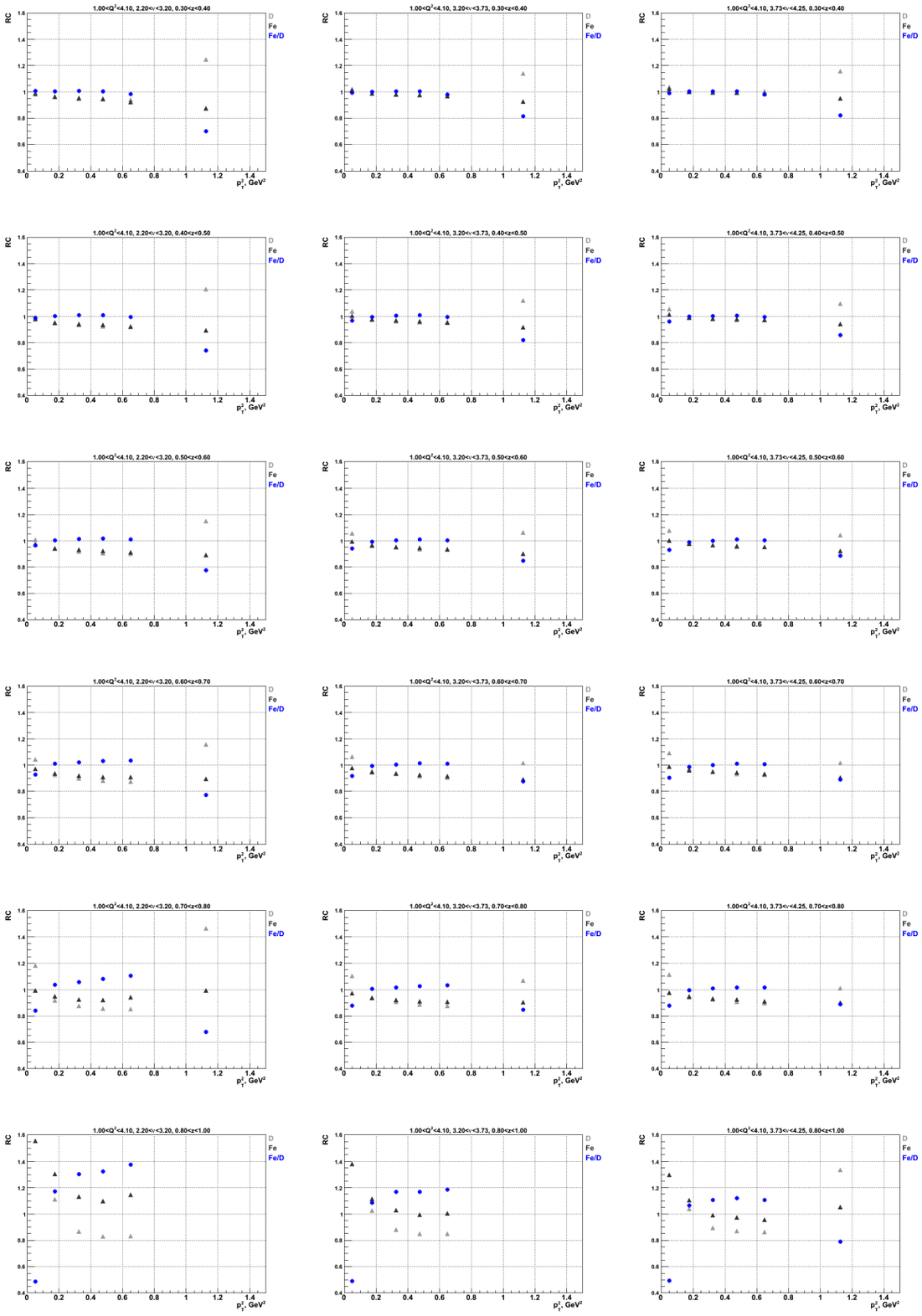
SIDIS + Exclusive contribution to RC factors for D, Fe and **Fe/D** ratio in set of (Q^2, ν, z)



Radiative Corrections in (ν, z, pT^2): SIDIS



Radiative corrections C in (ν, z, pT^2): SIDIS + Exclusive

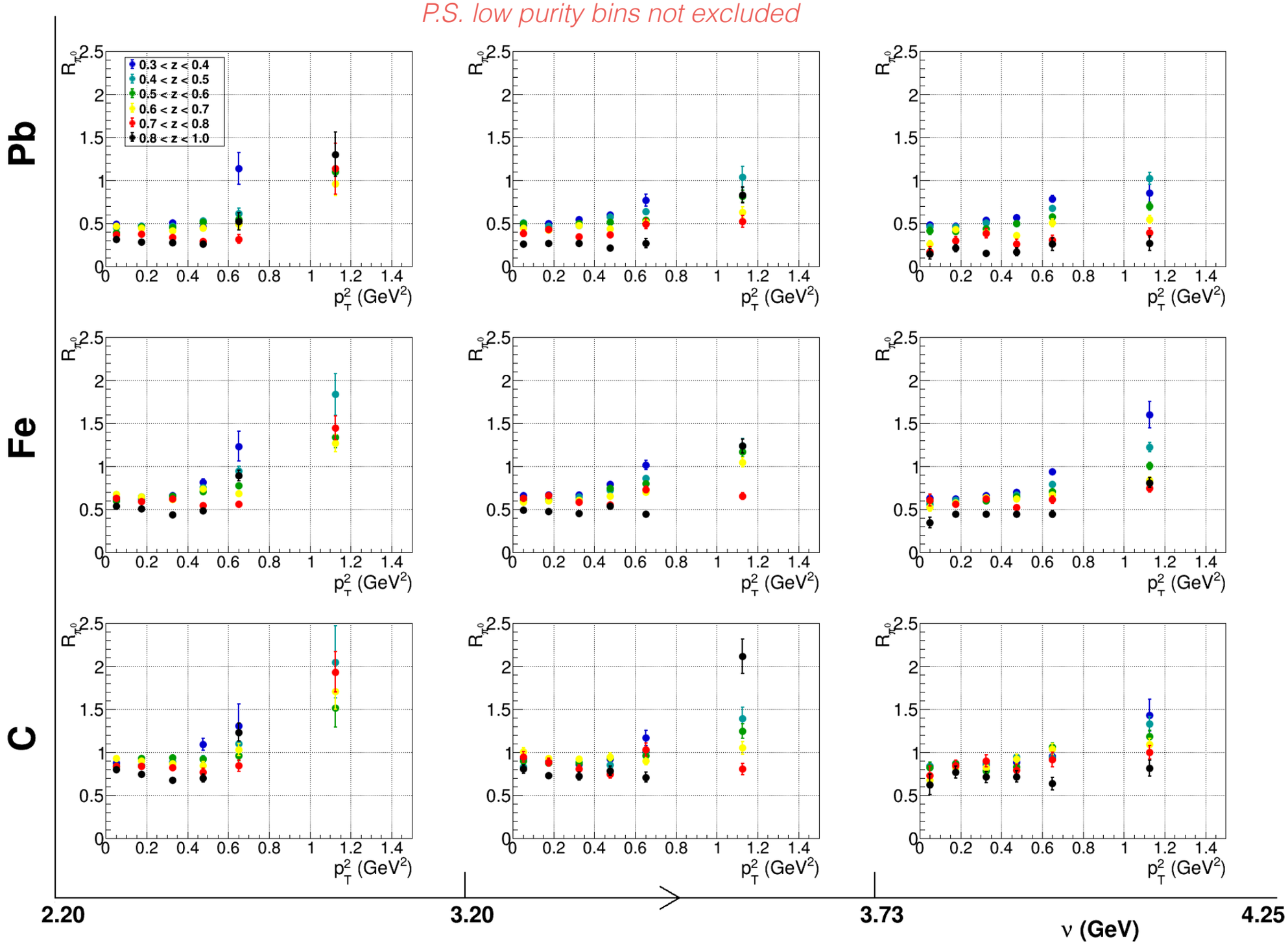


Multiplicity ratios

Multiplicity ratios in (v, z, pT²)

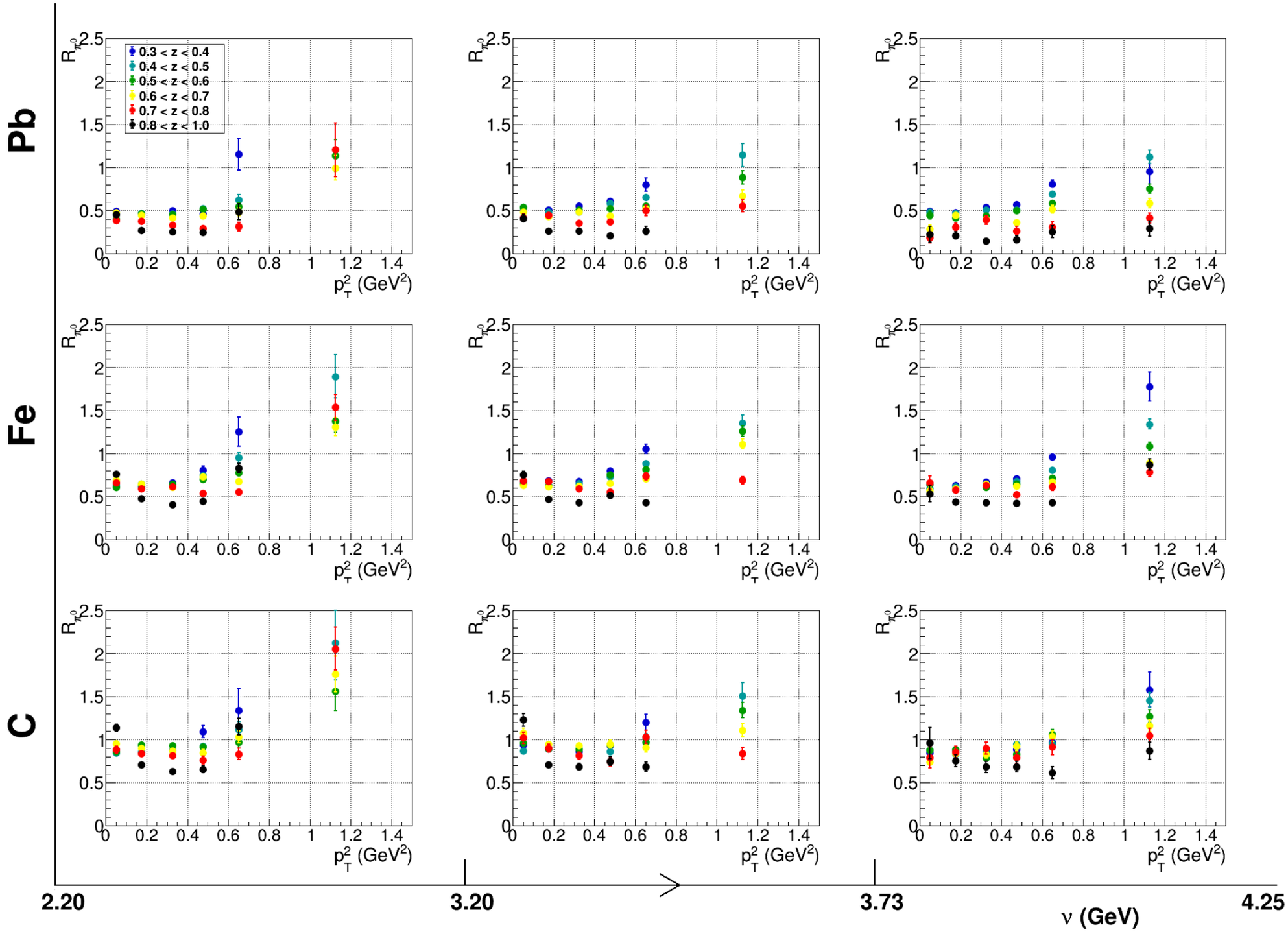
Corrected for ACCEPTANCE ONLY

P.S. low purity bins not excluded



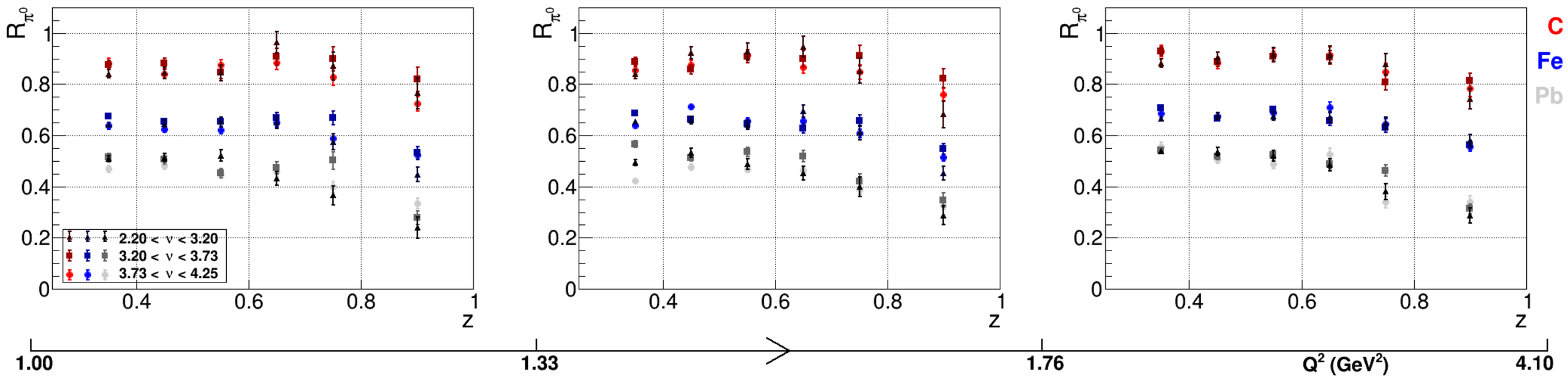
Multiplicity ratios in (v, z, pT²)

Corrected for ACCEPTANCE + Radiative corrections



Multiplicity ratios in (Q^2,v, z)

Corrected for ACCEPTANCE ONLY



Multiplicity ratios in (Q^2,v, z)

Corrected for ACCEPTANCE + Radiative Corrections