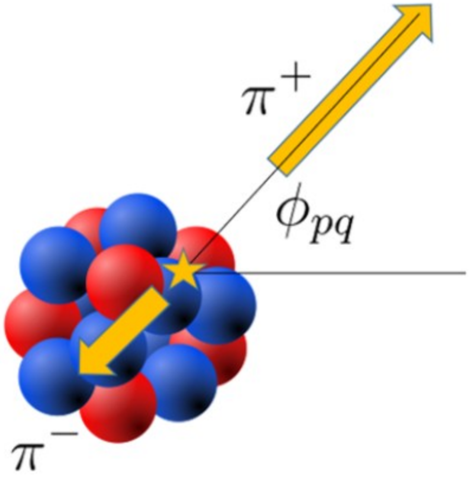
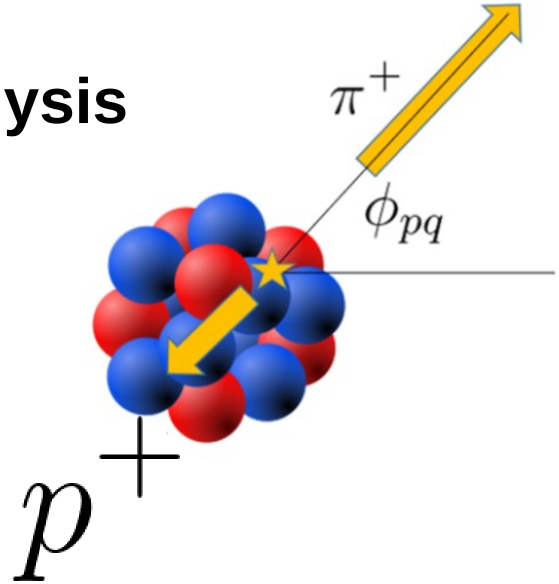
Update on
pion-pion and pion-proton analysis
in e-A DIS with EG2 data





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Observables

- Single-hadron multiplicity ratio

$$R_h(z, p_T^2, \nu, Q^2) = \frac{N_h^A(z, p_T^2, \nu, Q^2)/N_e^A(\nu, Q^2)}{N_h^D(z, p_T^2, \nu, Q^2)/N_e^D(\nu, Q^2)}.$$

- Double-hadron multiplicity ratio

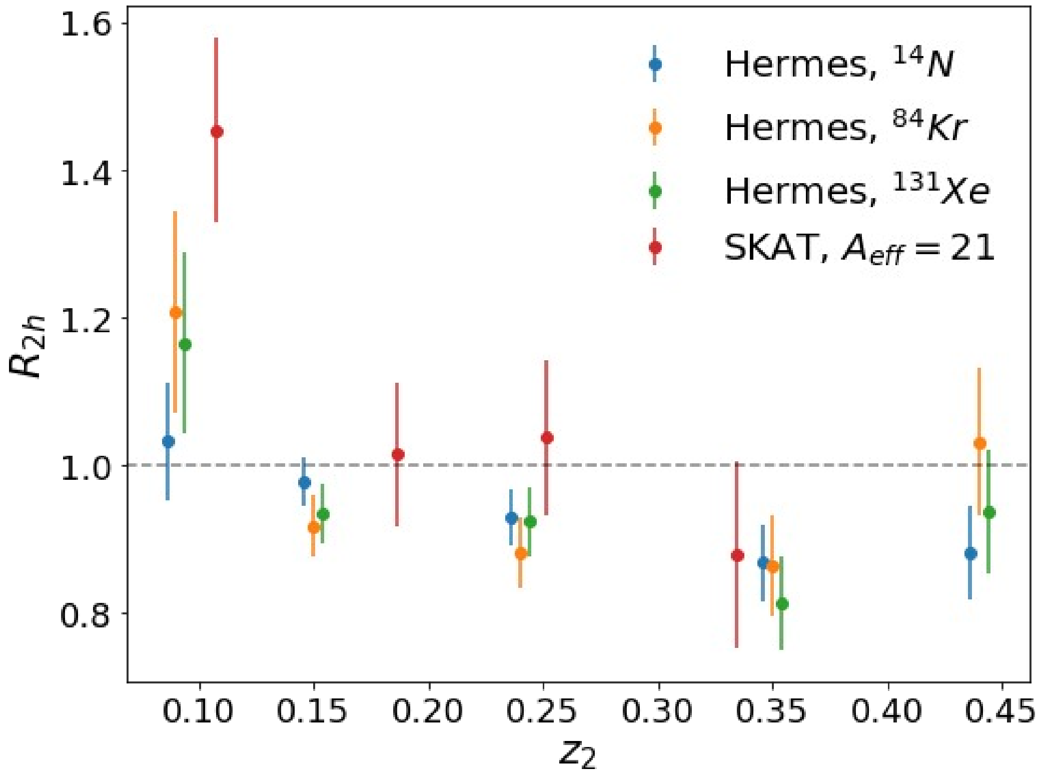
$$R_{2h}(z_2) = \frac{N_h^A(z_2|z_1 > 0.5)/N_h^A(z_1 > 0.5)}{N_h^D(z_2|z_1 > 0.5)/N_h^D(z_1 > 0.5)}.$$

Comparing the two allows to constrain correlations induced by nuclear effects

$$P(A \mid B) = \frac{P(A \cap B)}{P(B)},$$

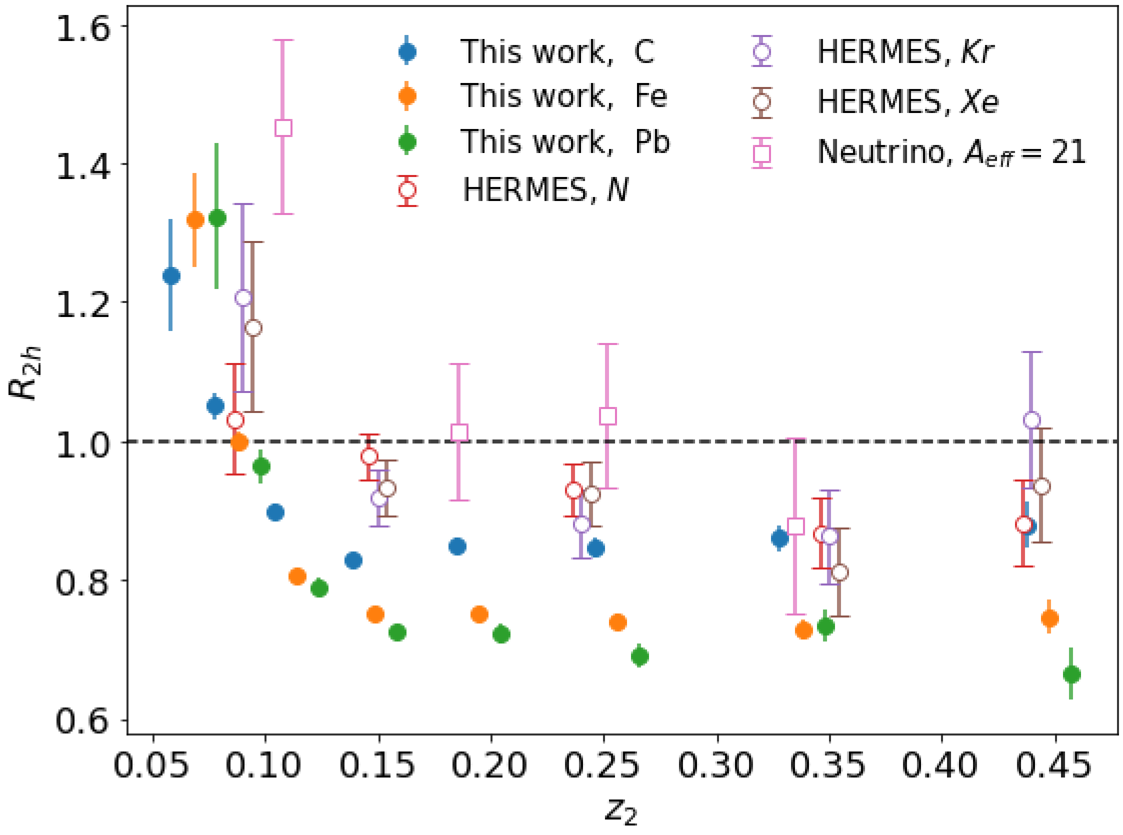
World’s data on double-hadron production in DIS off nuclei

$$R_{2h}(z_2) = \frac{N_h^A(z_2|z_1 > 0.5)/N_h^A(z_1 > 0.5)}{N_h^D(z_2|z_1 > 0.5)/N_h^D(z_1 > 0.5)}.$$



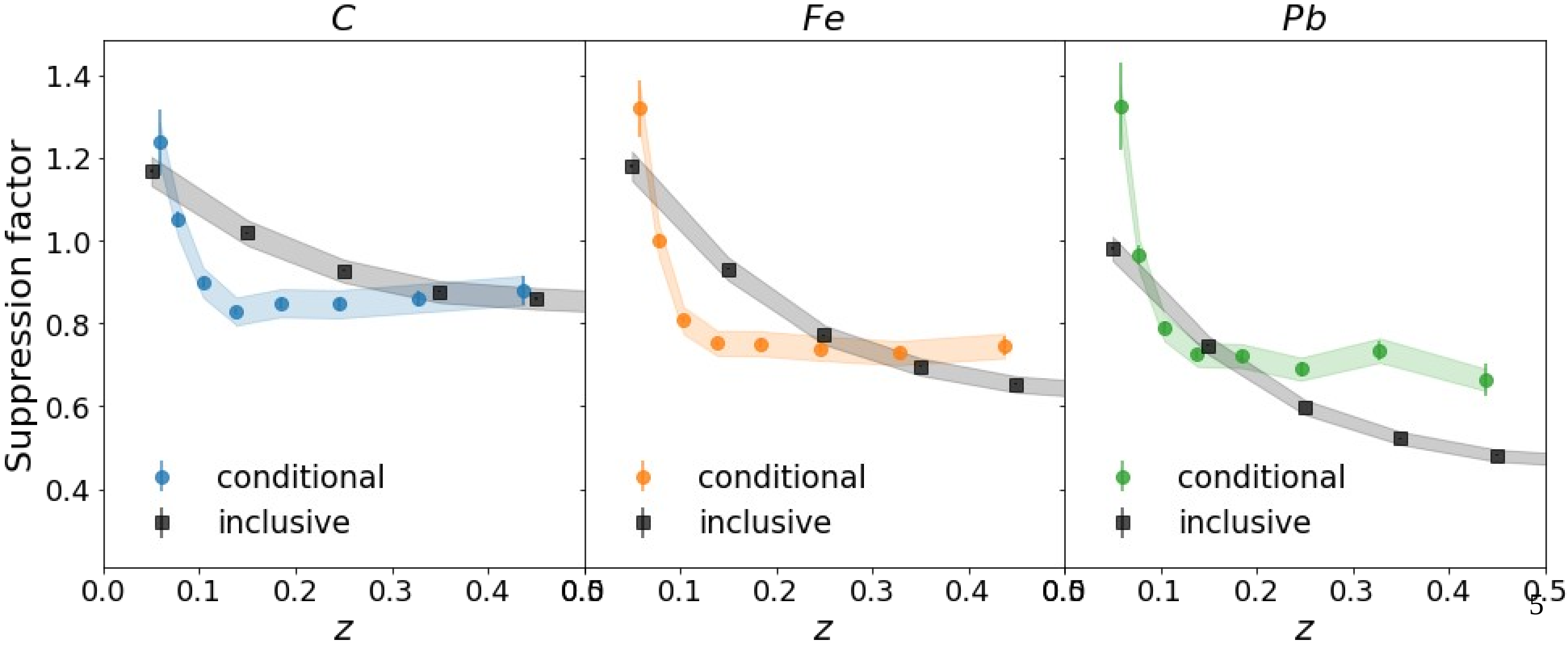
HERMES result:
Phys. Rev. Lett. 96, 162301

EG2 data (stat error only)

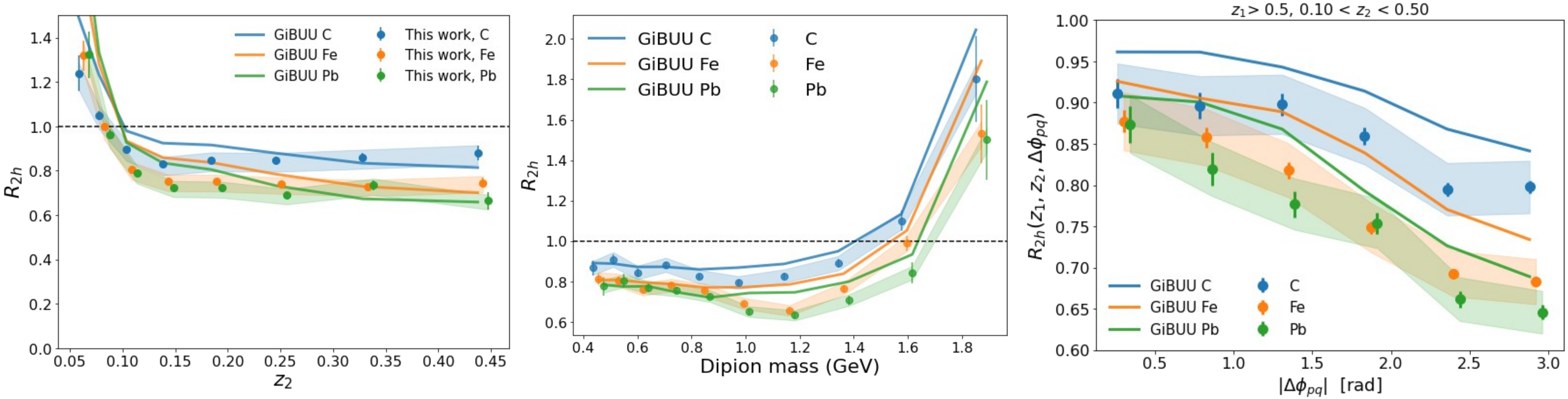


Single vs double suppression factor
(in absence of correlations induced by nuclear effects, they should be the same)

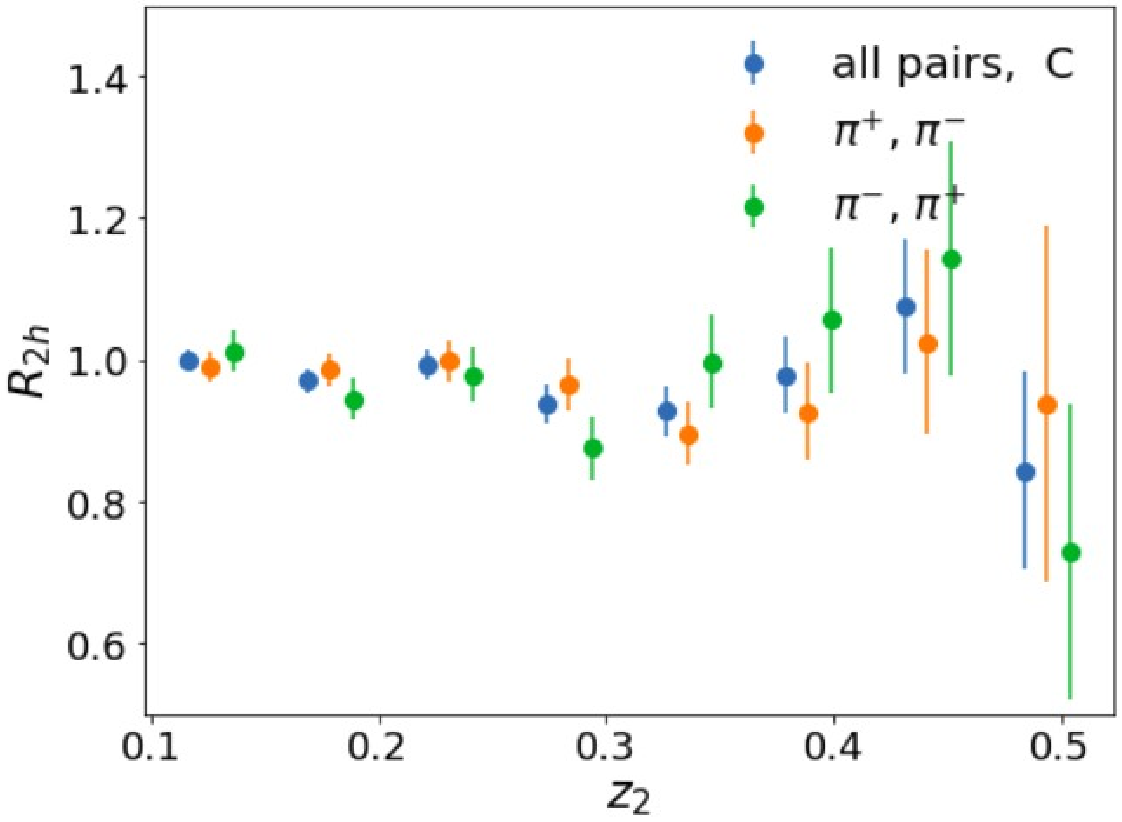
- Comparison with Sebastian's results (single-hadron suppresion)



Main results of pion-pion analysis



MC check for acceptance correction

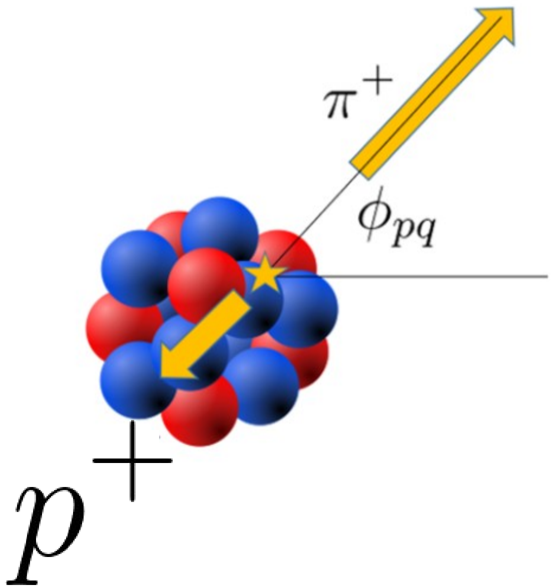


- Simulation does not contain signal but it has description of target and geometry in GEANT.
- Ratio should be unity provided acceptance effects cancel.
- Will perform studies with more sim but results indicate small effects, as expected

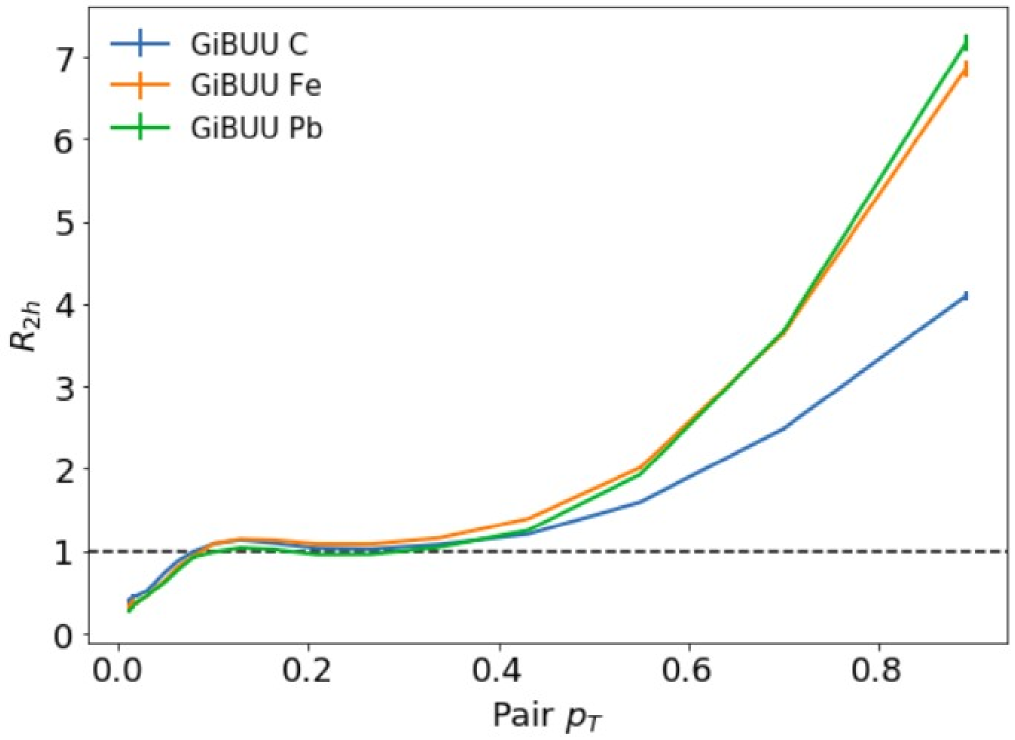
Status report on dipion correlations

- Results have been updated following latest version of single-pion analyzes (fiducial region optimization to minimize acceptance differences between targets).
- Most systematic uncertainties will cancel in ratio, and remaining ones are common to single-pion paper.
- We have drafted a dipion paper
- We will request a start of review of analysis note soon after single-pion analysis is approved (currently under review).

Now, let's expand to pion-proton case

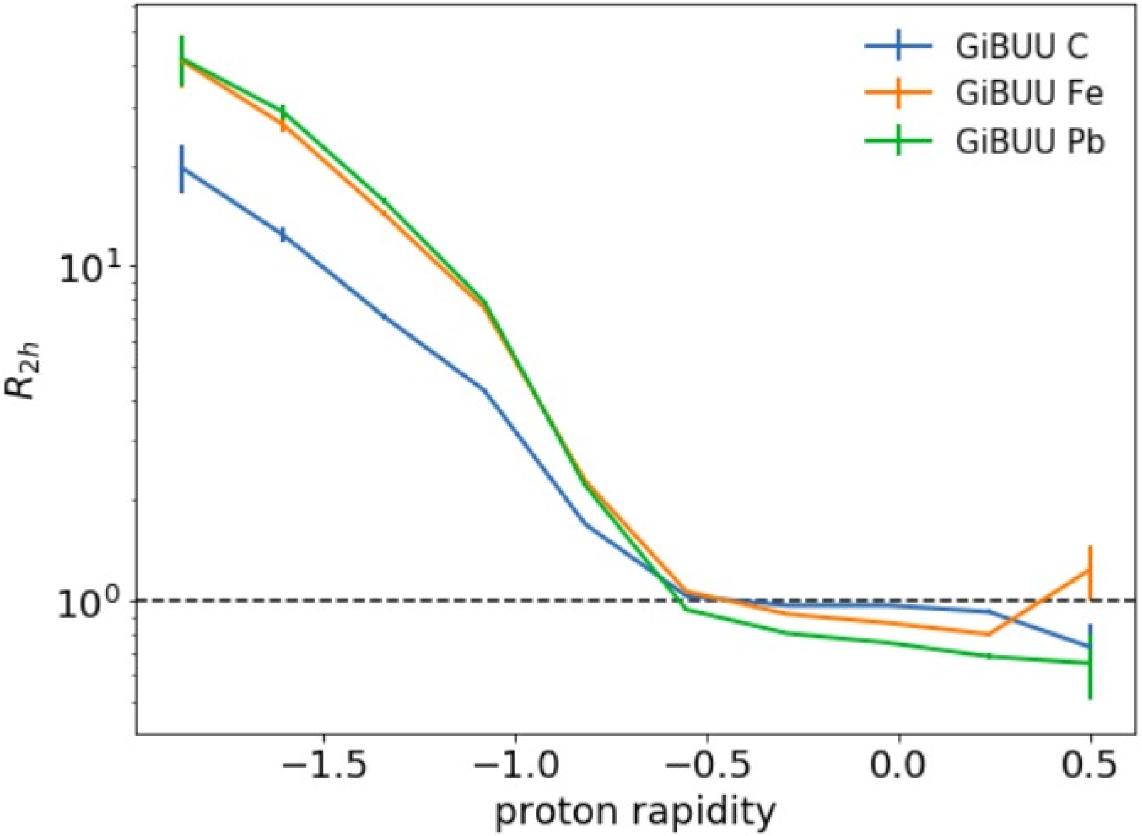


Predition for pion-proton pairs



- Pion-proton pairs predicted to be enhanced several fold in nuclei.

Predition for pion-proton pairs



- A high-z pion “knocks out” “spectator protons”

Rapidity

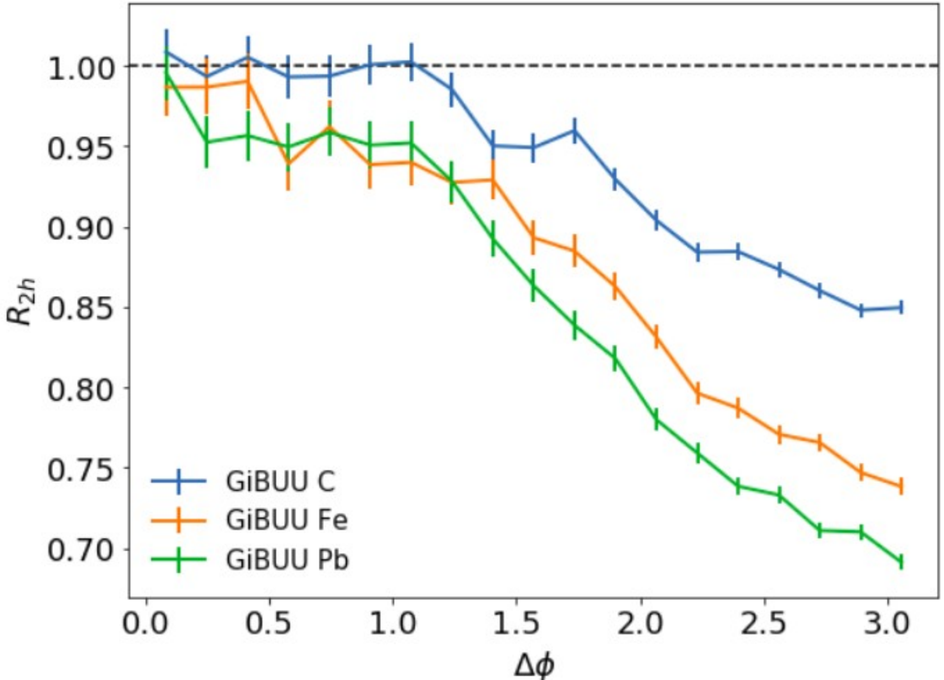
From Wikipedia, the free encyclopedia

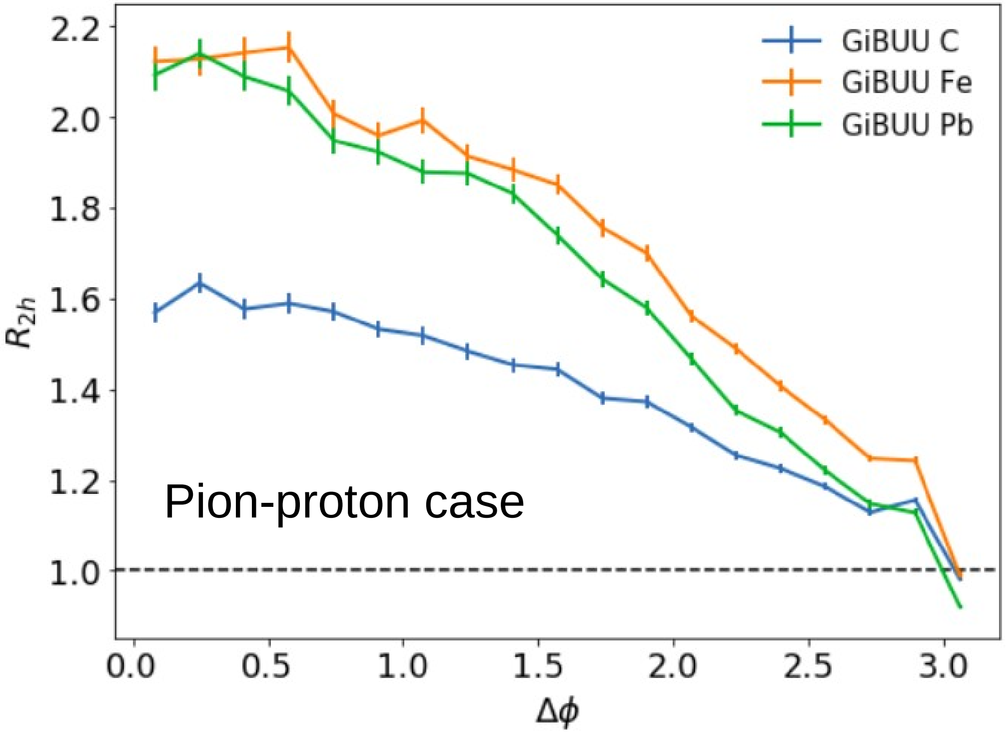
In relativity, **rapidity** is commonly used as a measure for relativistic velocity. Mathematically, rapidity can be defined as the hyperbolic angle that differentiates two frames of reference in relative motion, each frame being associated with distance and time coordinates.

$$y = \frac{1}{2} \ln \frac{E + p_z c}{E - p_z c},$$

where p_z is the component of momentum along the beam axis.[11] This is the rapidity of the boost along the beam axis which takes an observer from the lab frame to a frame in which the particle moves only perpendicular to the beam. Related to this is the concept of pseudorapidity.

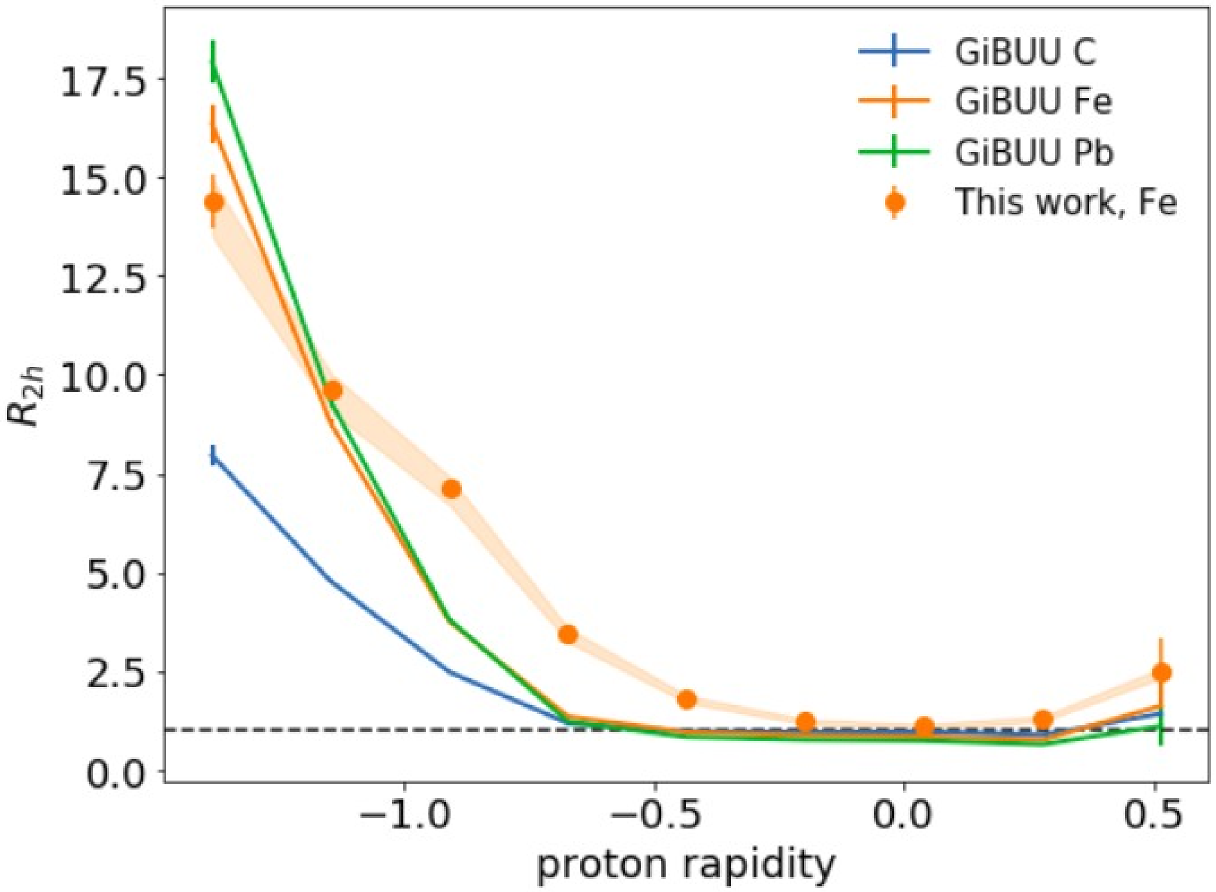
Pion-pion case



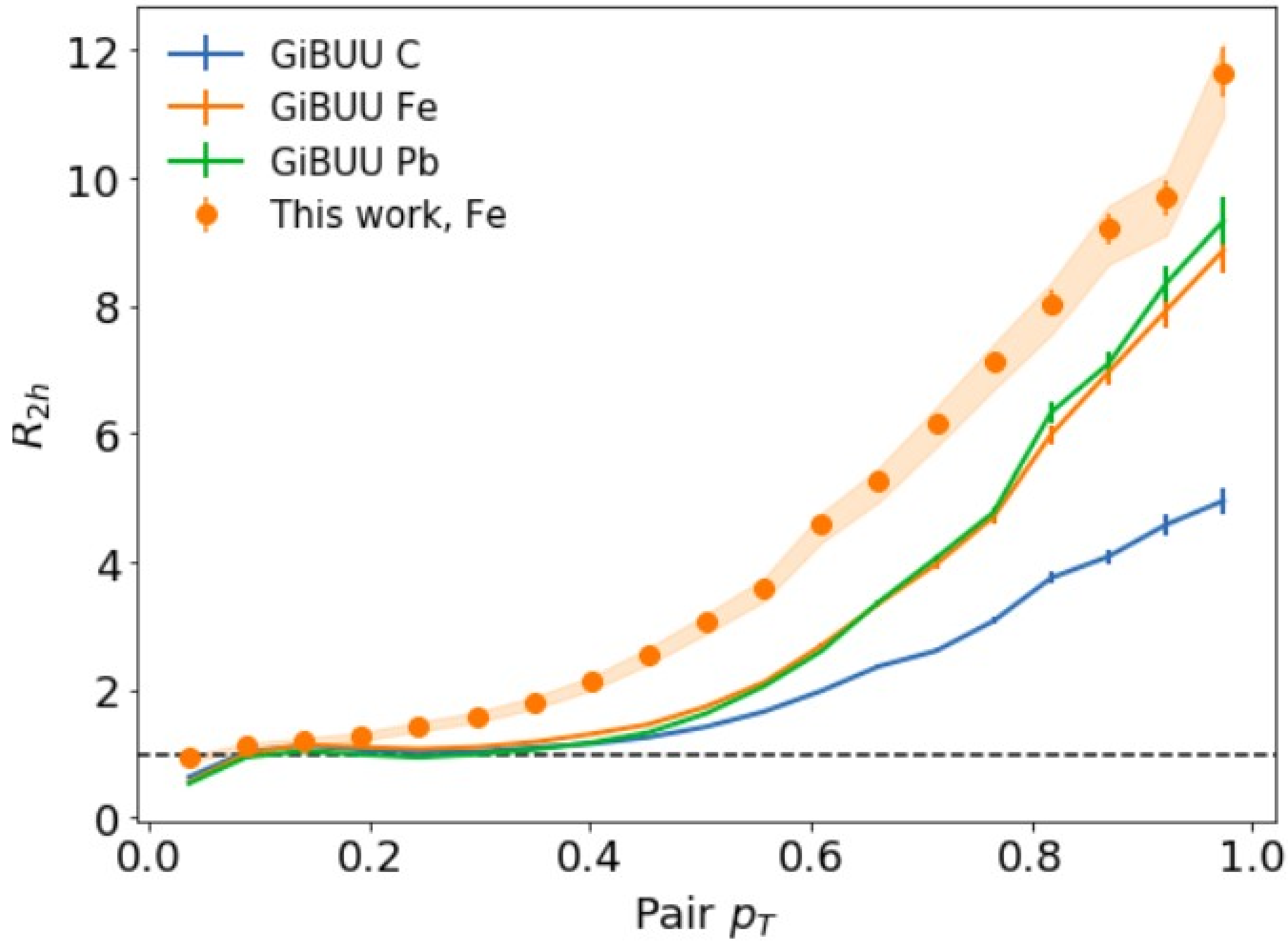


Pion-proton case

Very different behaviour.
Knock-out protons going in same azimuthal direction as high-z pion are enhanced.



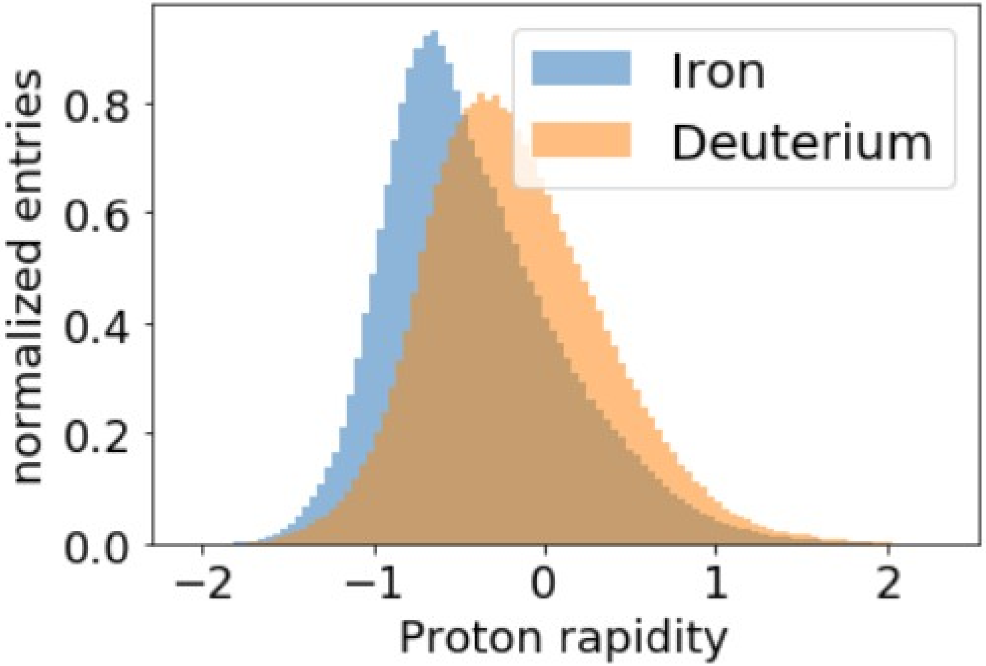
GiBUU C
GiBUU Fe
GiBUU Pb
This work, Fe
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
R_{2h}
−1.0
−0.5
0.0
0.5
proton rapidity

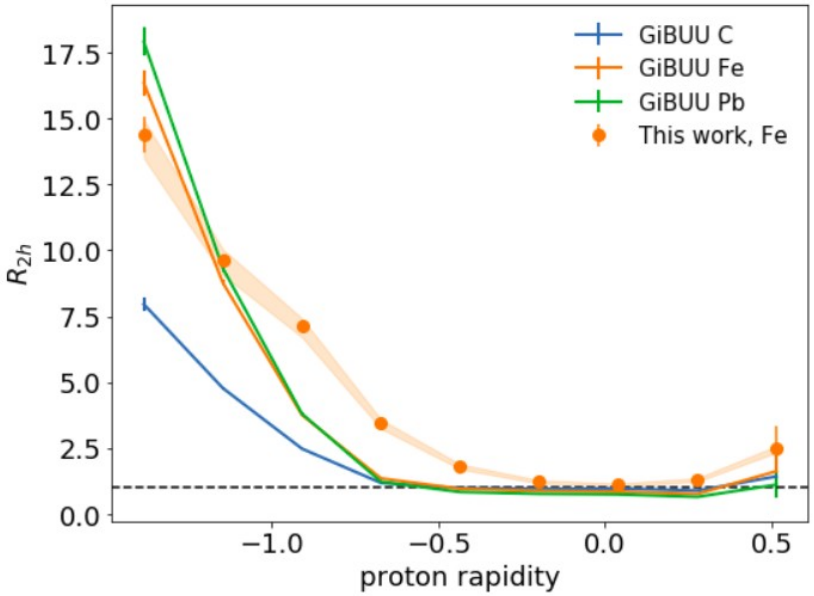


GiBUU C
GiBUU Fe
GiBUU Pb
This work, Fe
R_{2h}
Pair p_T
0
2
4
6
8
10
12
0.0
0.2
0.4
0.6
0.8
1.0

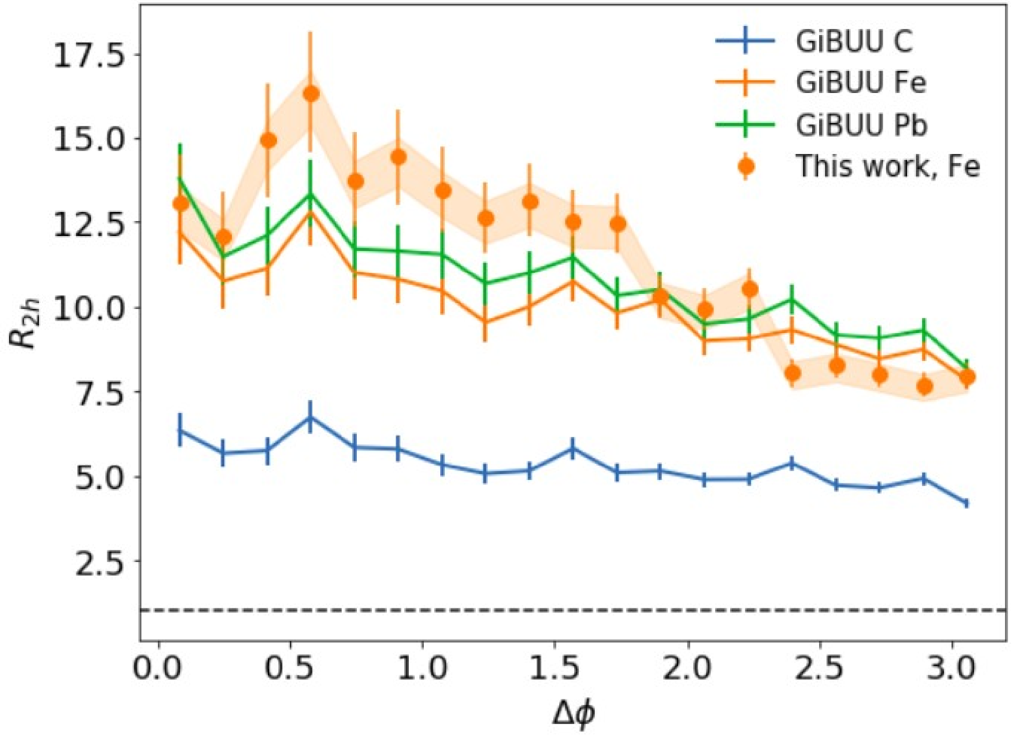
What explains such a large ratio?

- Rapidity distribution is noticeable shifted:





Focus on protons with rapidity <-1.0



- Enhacement of protons is rather weakly correlated with high-z pion Perhaps consistent with multiple interactions in the FSI cascade

Conclusions

- We will soon seek review of our dipion analysis (after single-pion analysis is approved)
- We are also starting pion-proton analysis with EG2 data, for which models predict rather dramatic signals → sensitive probe to FSI models