Nuclear attenuation – 2 dimensional dependences at HERMES

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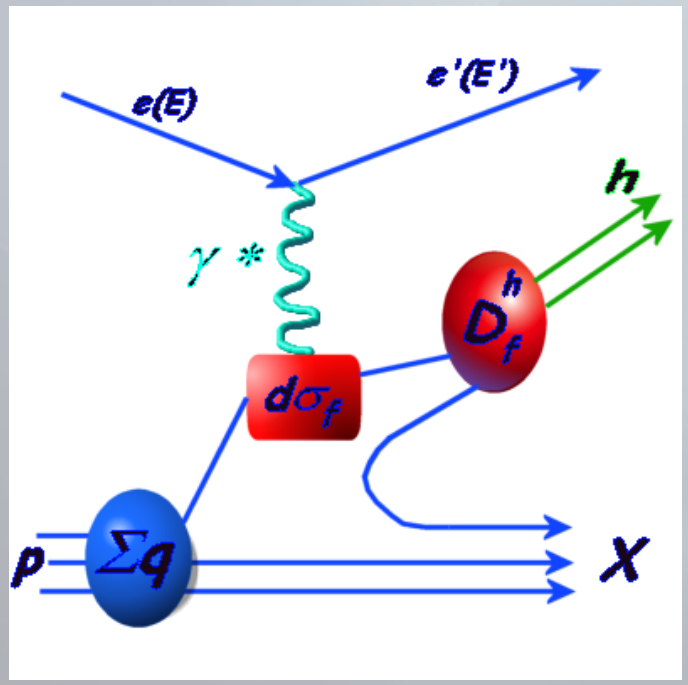
University of Glasgow
for the HERMES Collaboration
DIS2010, Florence, 20/04/2010

Experimental Method

- Semi-Inclusive DIS (SIDIS) on the Nucleon
  - Access parton fragmentation functions



$$d\sigma^h = \sum q \otimes d\sigma_f^h \otimes D_f^h$$

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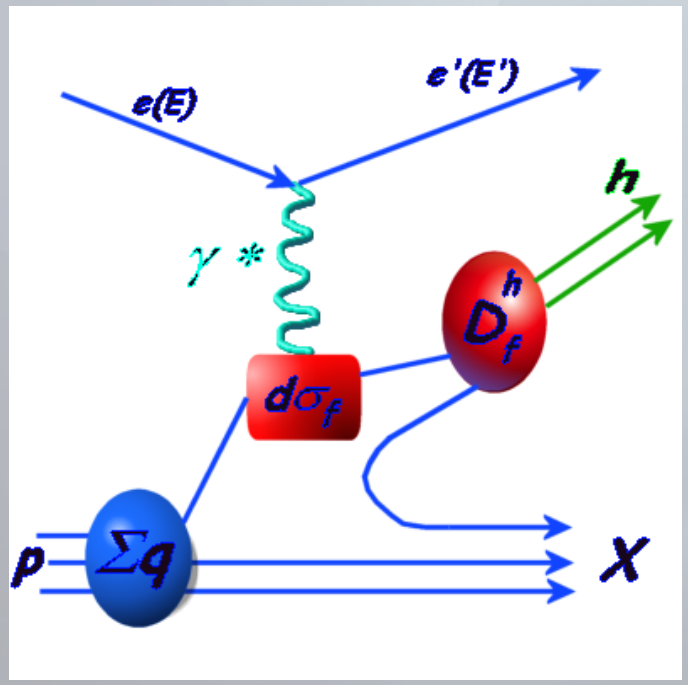
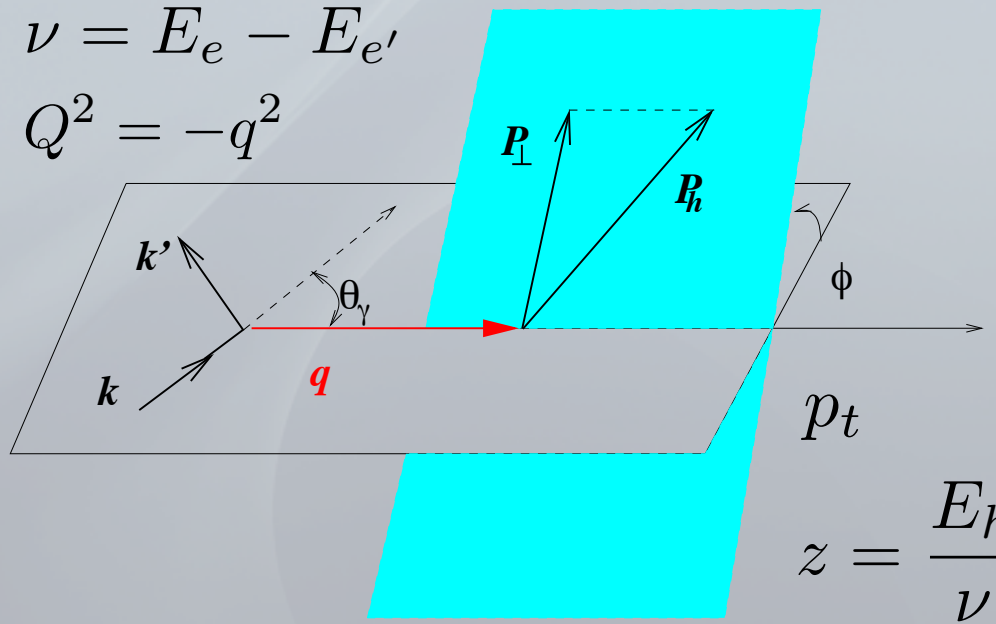


$$d\sigma^h = \sum q \otimes d\sigma_f^h \otimes D_f^h$$

$$\nu = E_e - E_{e'}$$

$$Q^2 = -q^2$$



$$p_t$$

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

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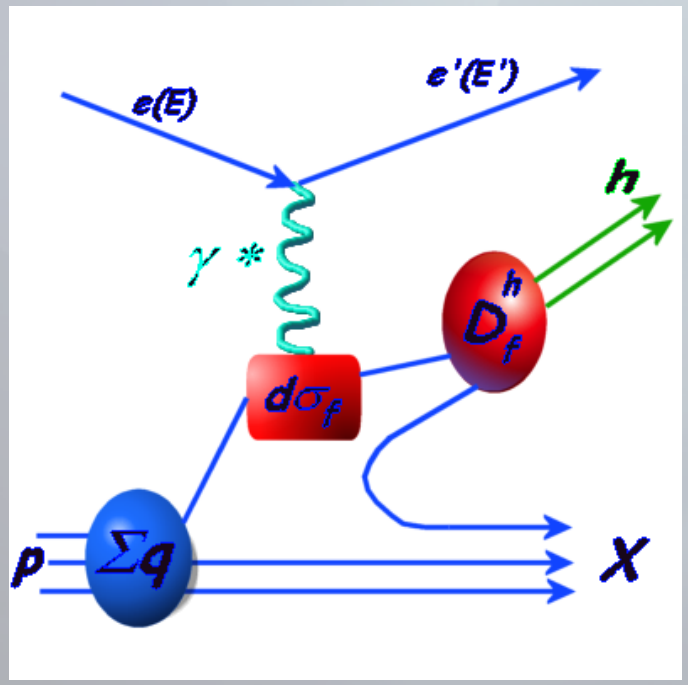

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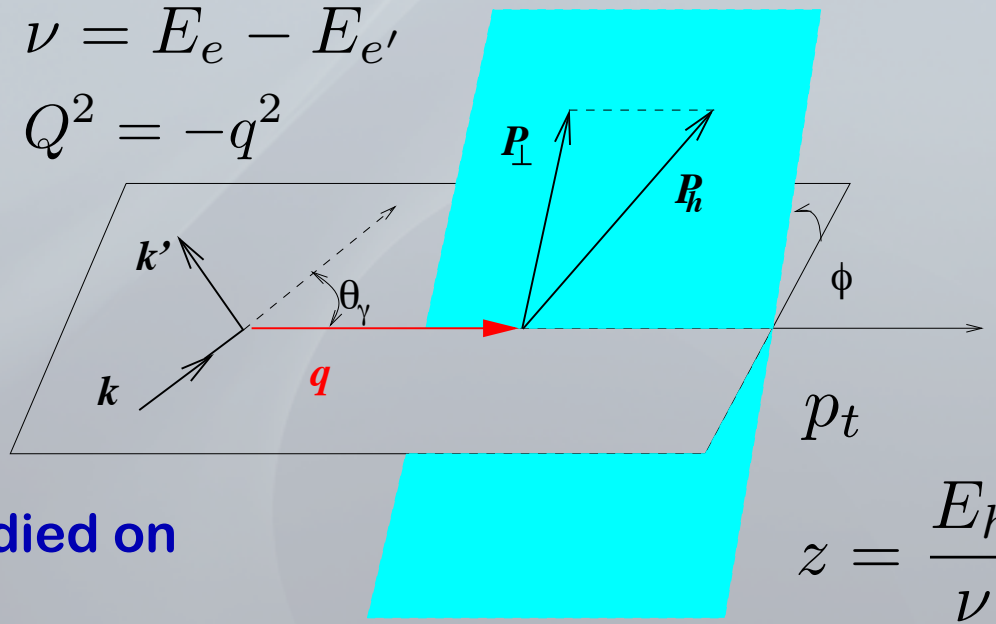
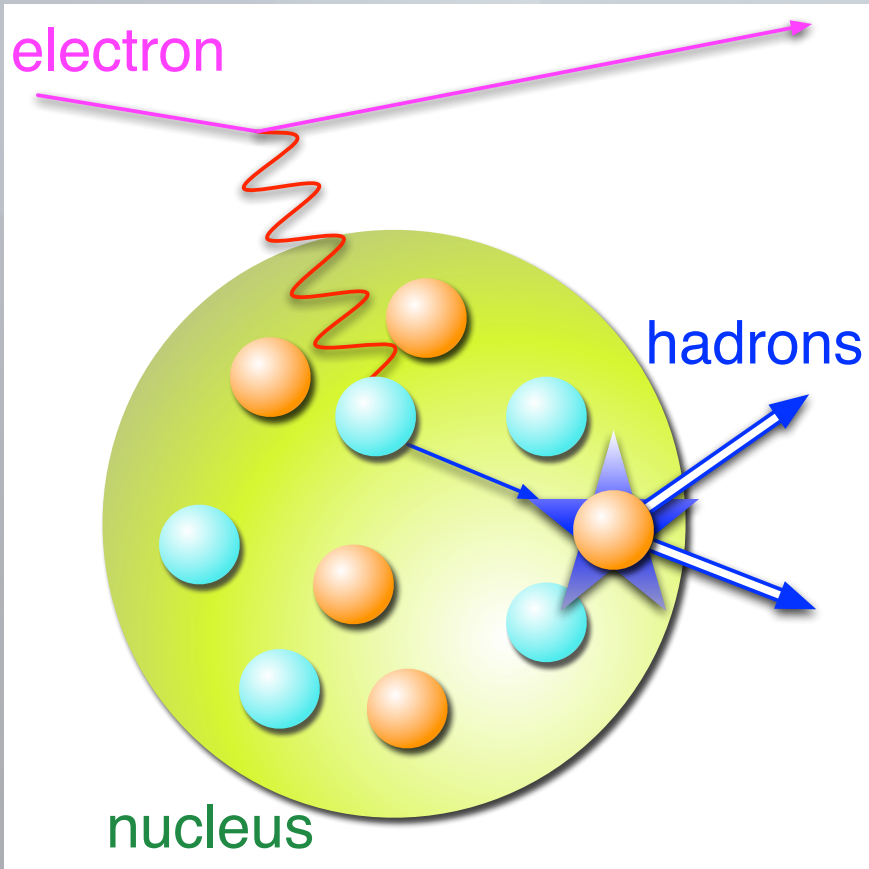


$$z = \frac{E_h}{\nu}$$

- Experimentally well studied on the nucleon
- Probabilistic interpretation

Measurements on the Nucleus

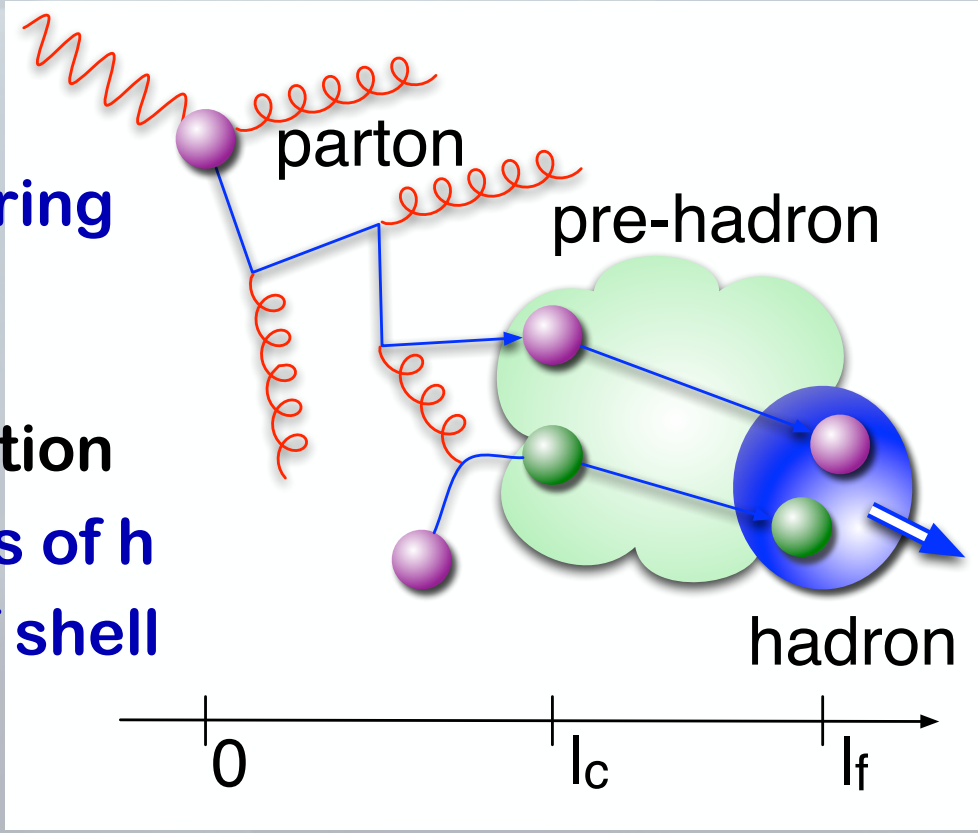
- Initial reaction identical to nucleon DIS
- Final state influenced by nuclear matter



- Compare several nuclei
- Information on FSI

Hadronisation in Matter

- Evolution in space and time
- Parton propagation
  - Gluon radiation
  - Partonic rescattering
  - length < l_c
- Pre-hadron propagation
  - Quantum numbers of h
  - Colourless but off shell
- Hadron formation
  - Formation length l_f up to 10fm (outside N)

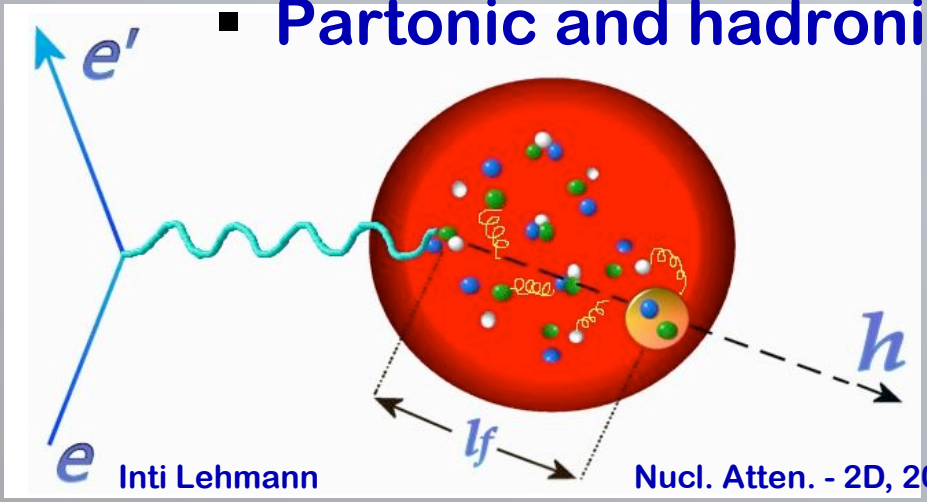


Experimental Observable

- Hadron multiplicity ratio
  - comparing nucleus A with deuterium D

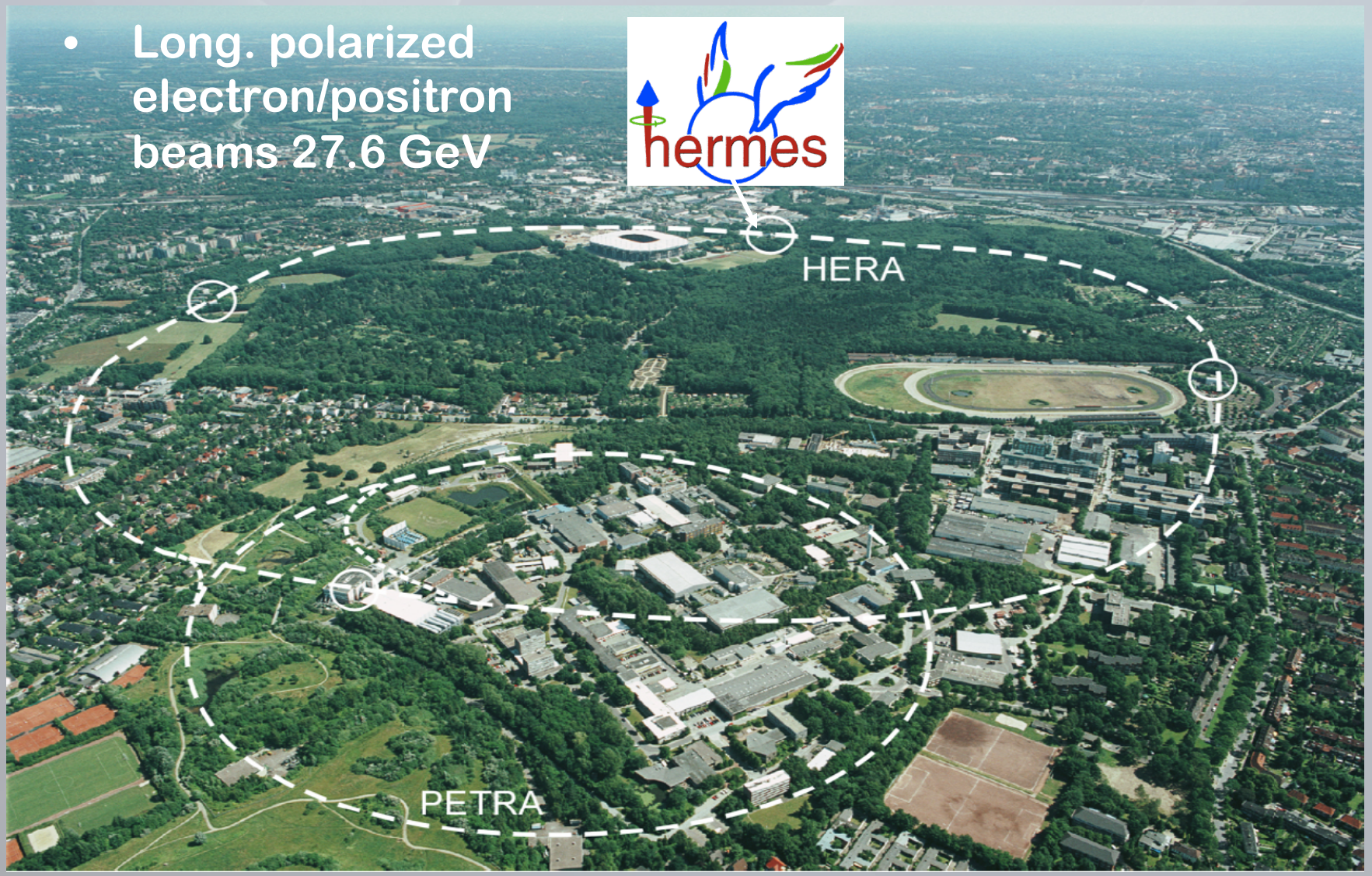
$$R_A^h(\nu, Q^2, z, p_t^2) = \frac{\left(\frac{N^h(\nu,Q^2,z,p_t^2)}{N^e(\nu,Q^2)}\right)_A}{\left(\frac{N^h(\nu,Q^2,z,p_t^2)}{N^e(\nu,Q^2)}\right)_D}$$

  - Exp. systematics cancel largely
  - Partonic and hadronic effects contribute

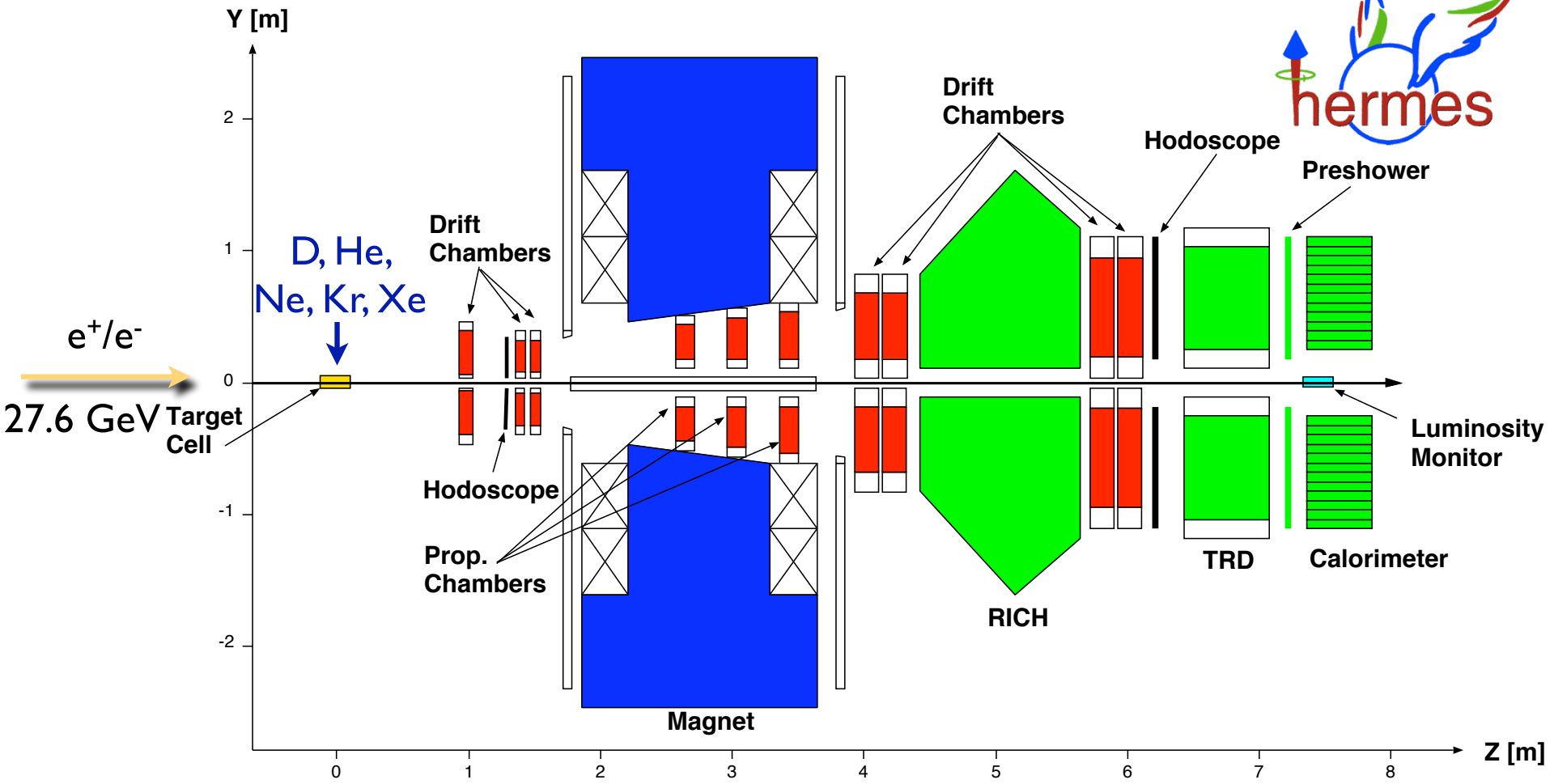


HERMES at HERA, DESY

- Long. polarized electron/positron beams 27.6 GeV

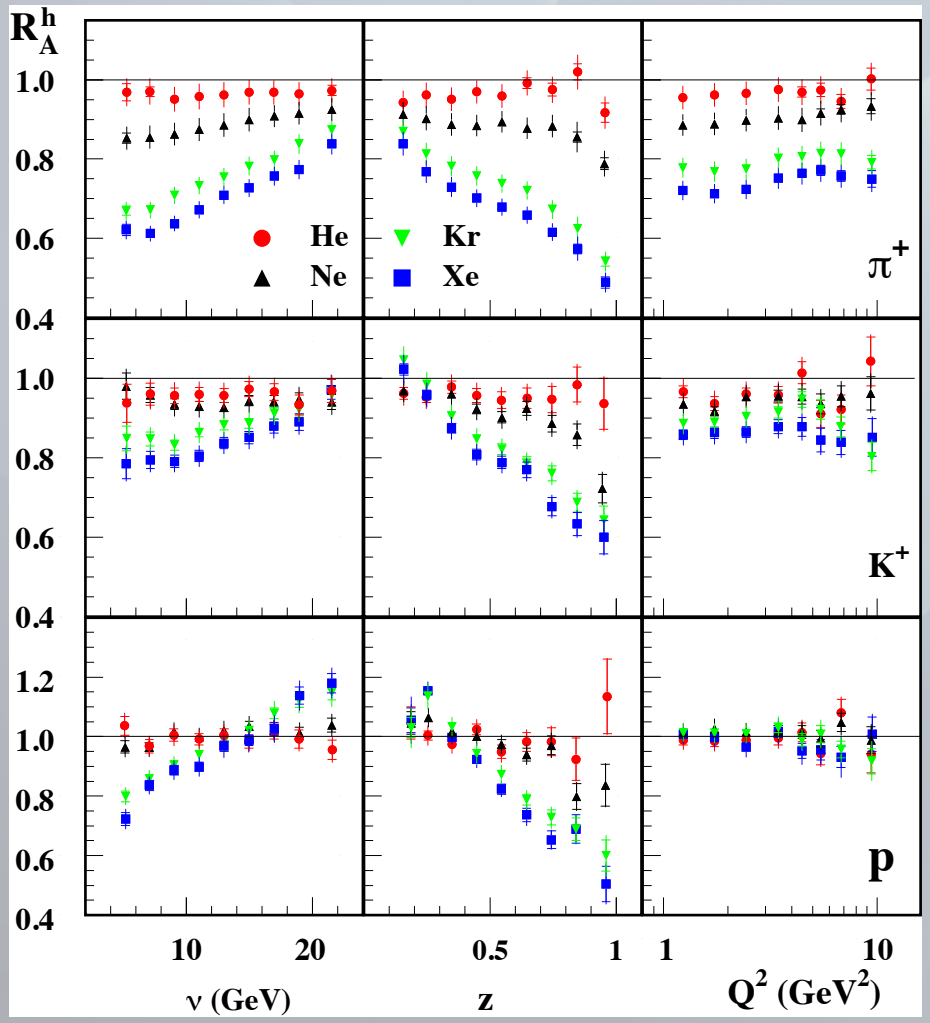


HERMES Spectrometer



Magnetic spectrometer with transv. and long. polarized targets

First Publication

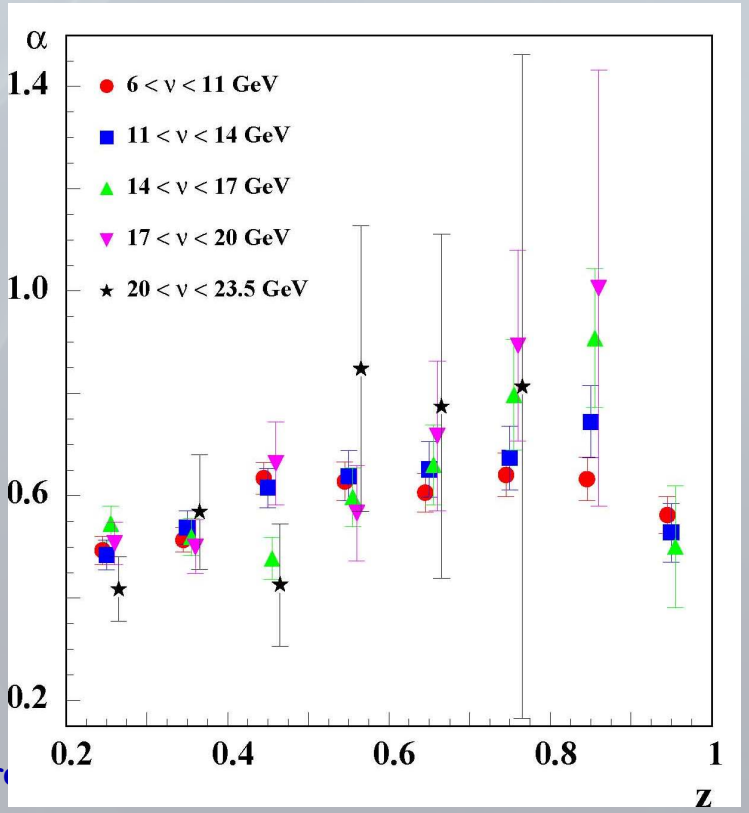


Nucl. Phys. B780 (2007)1-27

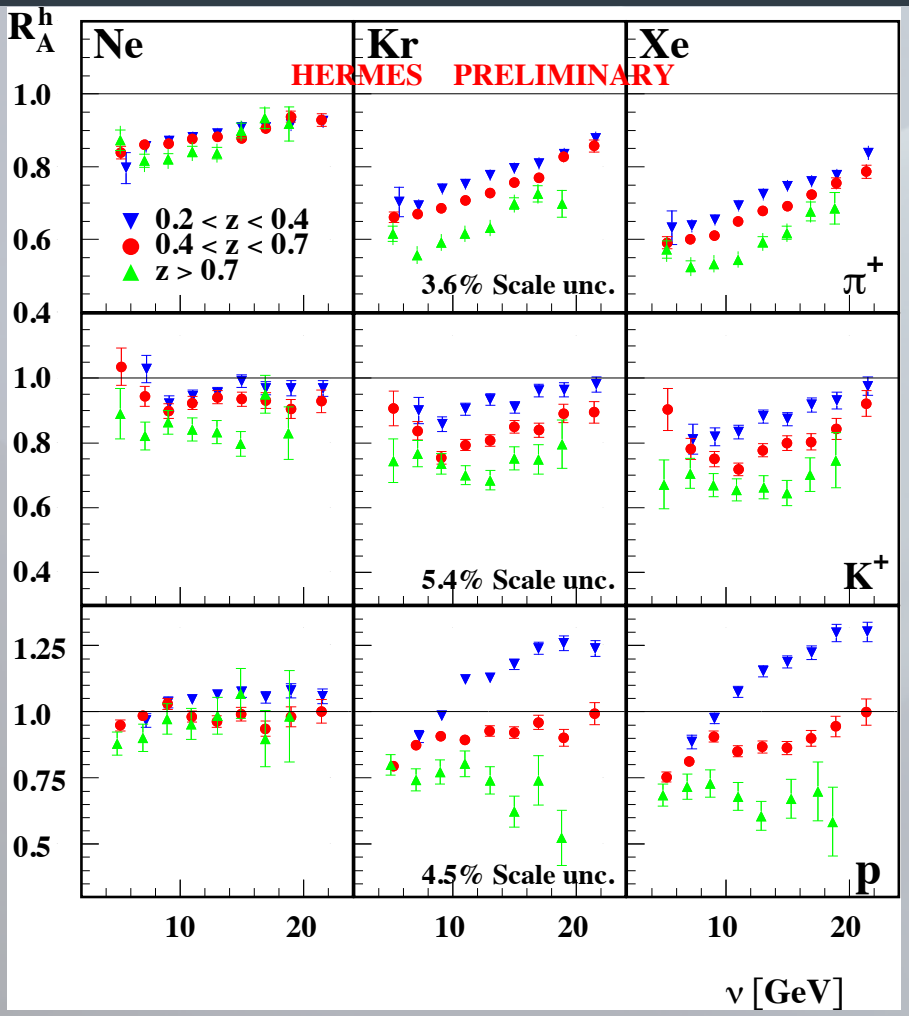
- Multiplicity ratio

$$R_A^h(\nu, Q^2, z, p_t^2)$$

  - 1D dependence
- A dependence
  - compatible with $A^{2/3}$

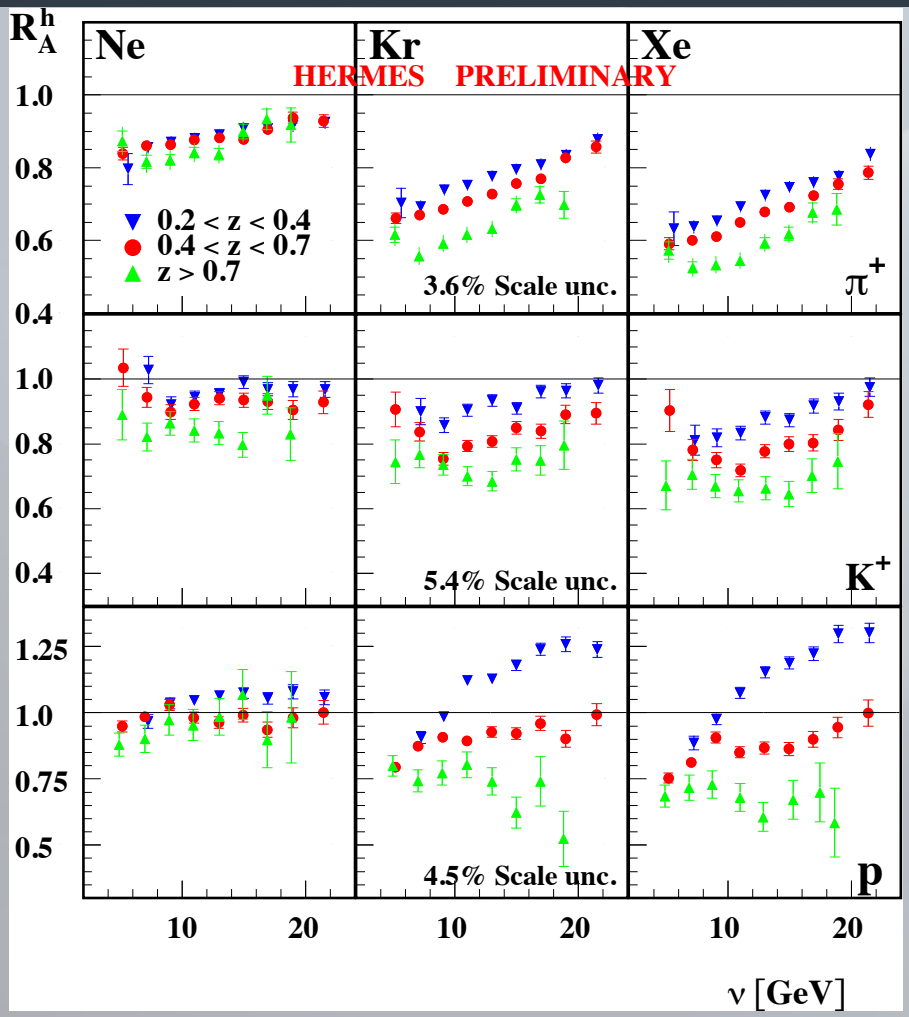


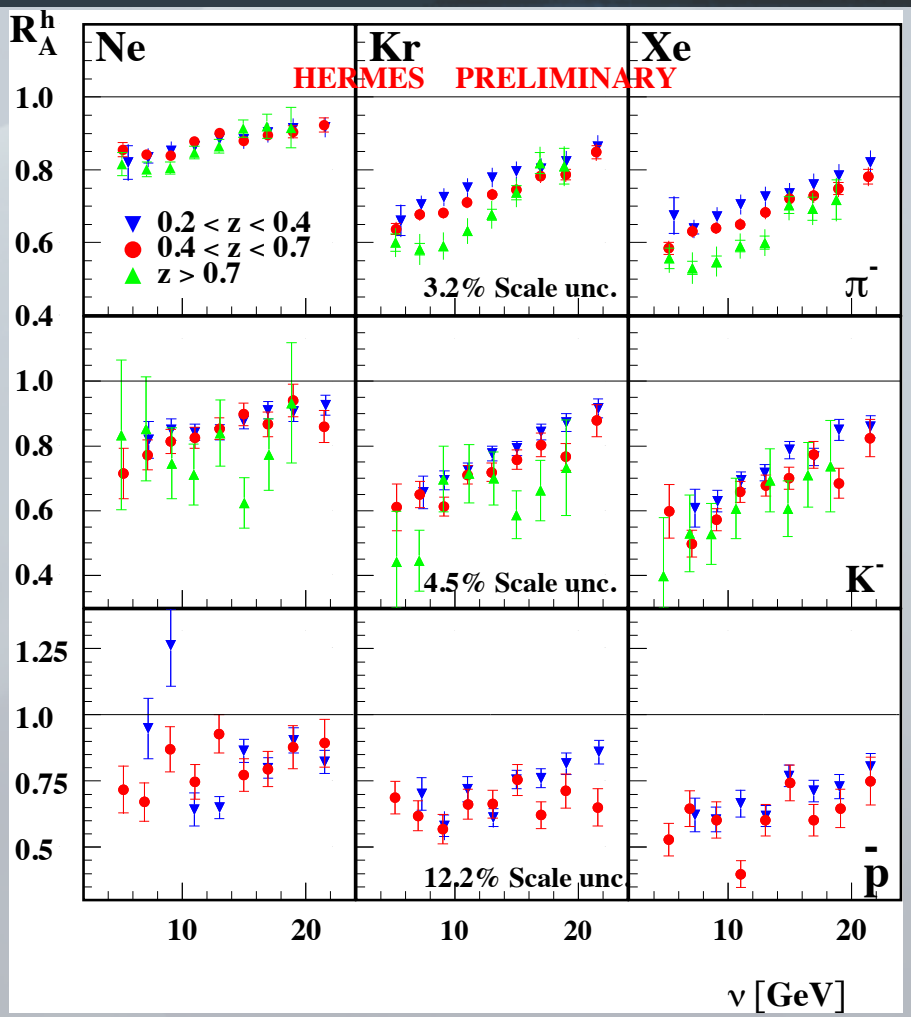
New Results - 2D Analysis



- 2D dependences extracted
  - variables:
    $\nu \quad z \quad p_t \quad Q^2$:
  - over 100 distributions
  - avoids integration
  - disentangles dependence
- ν dependence in z slices
  - substructures observed
  - π^+ and K^+ similar
  - protons pronounced differences for different z

New Results - 2D Analysis

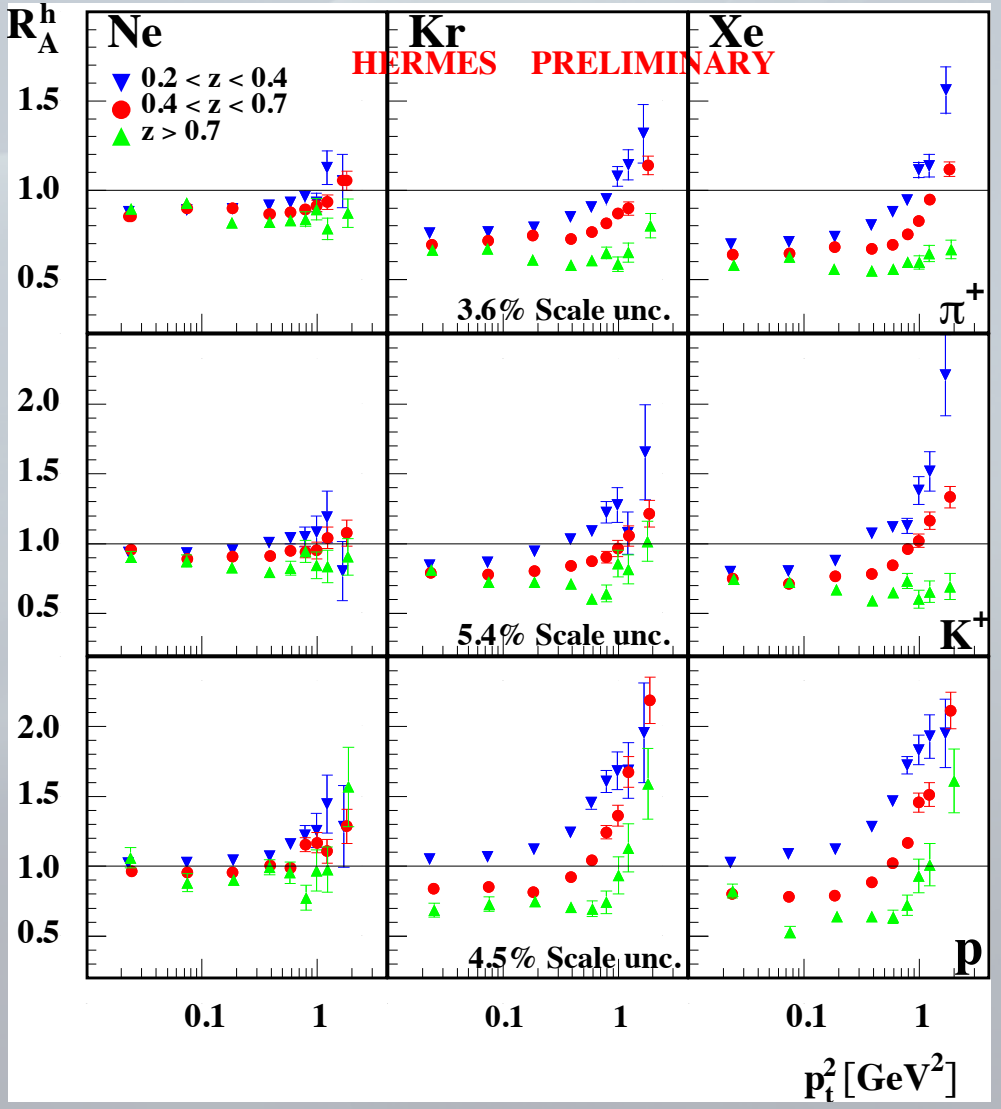




π^+ and π^- similar while K^- differ

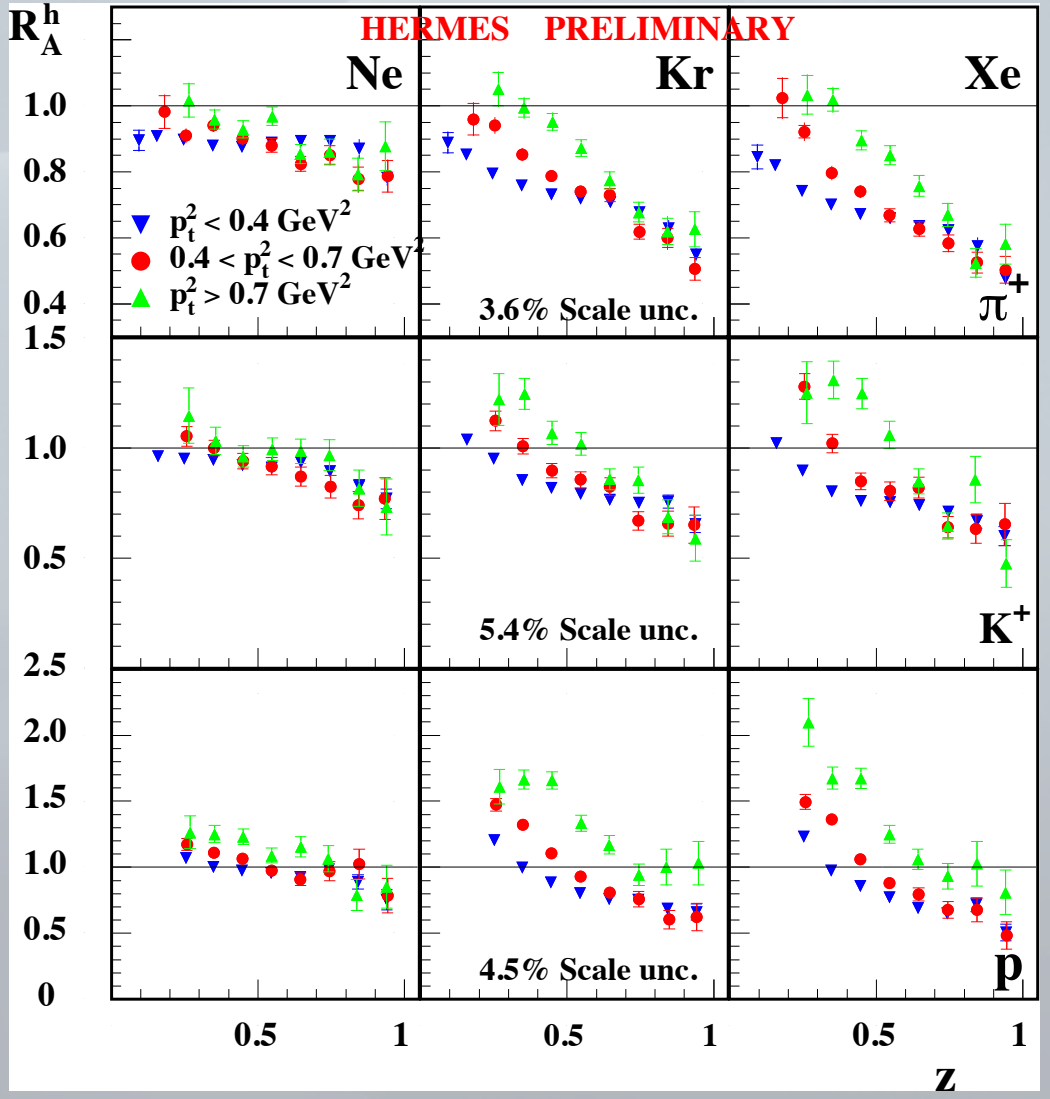
New Results - 2D Analysis

- p_t^2 dep. in z slices
  - Nuclear broadening – Cronin effect
    - Less than predicted in Nucl.Phys.A740 (2004)211
    - Disappears for high z
  - Compatible for negative hadrons



New Results - 2D Analysis

- z dep. in p_t^2 slices
  - z-dependence increases with p_t
  - p_t dependence disappears at high z

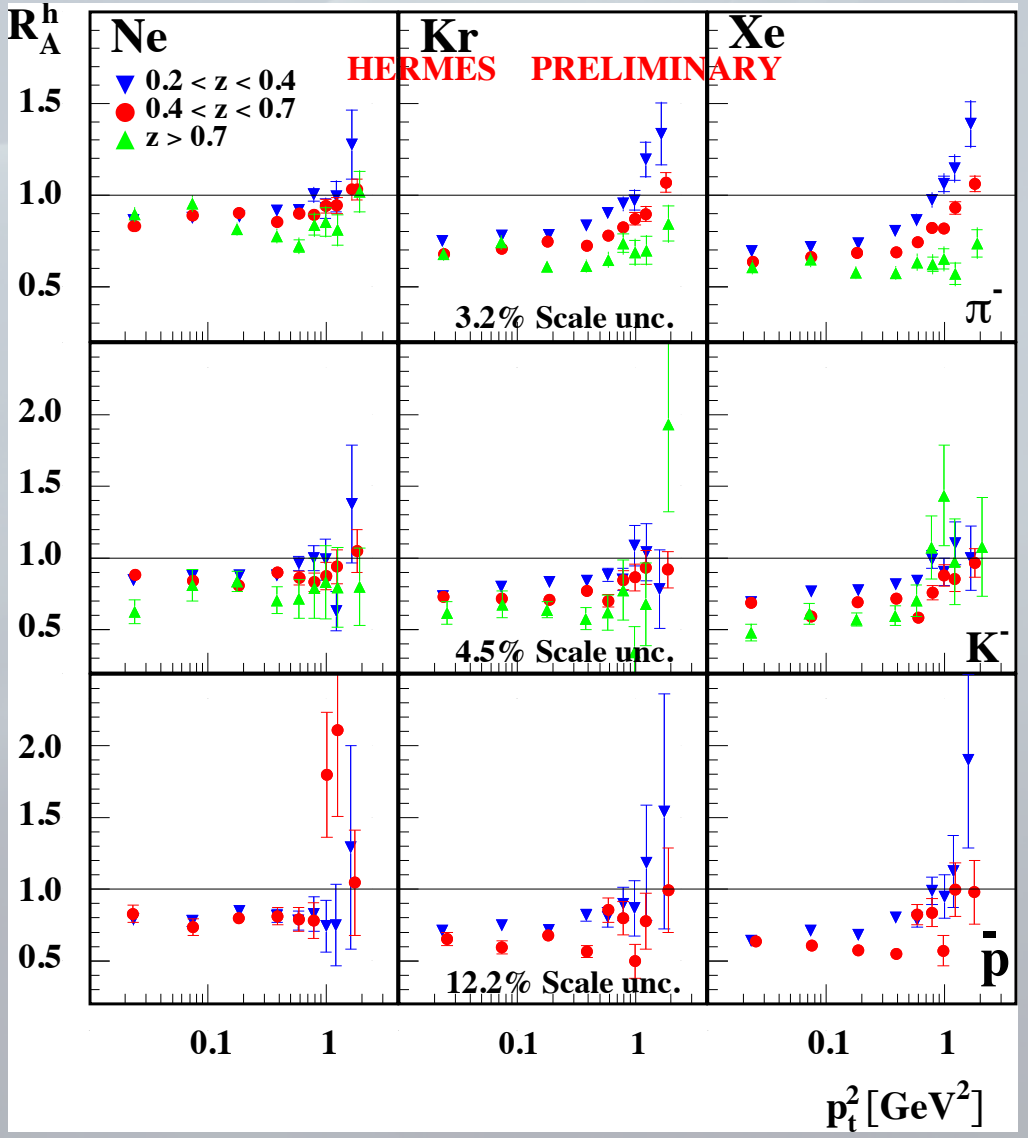


Summary

- Semi-Inclusive Deep Inelastic Scattering (SIDIS)
  - Nucleon: well studied
  - Nucleus: parton propagation + hadronisation
- HERMES Results
  - Strong nuclear effects on multiplicity ratio
  - 2D correlations (unexpected)
    - Only few highlighted here
    - Positive and negative kaons differ
    - Particular features for protons
    - Nuclear broadening z dependent
  - Paper in preparation
    - All dependencies will be published

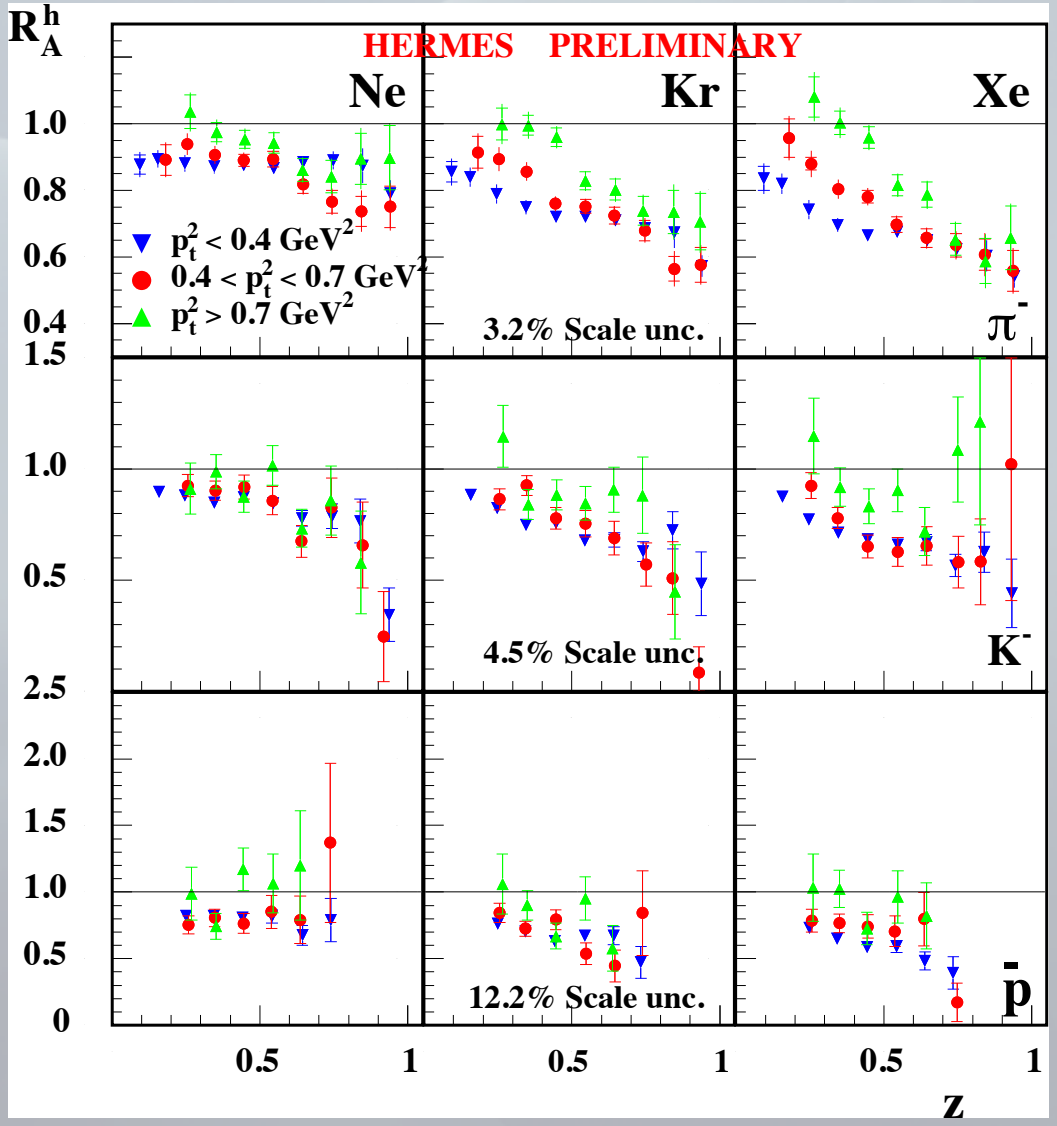
Backup

- pt in z slices (neg. hadrons)



Backup

- z in pt slices (neg. hadrons)



Backup

- Q in pt slices