Charged hadron multiplicities at the HERMES experiment

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(On behalf of the HERMES Collaboration)

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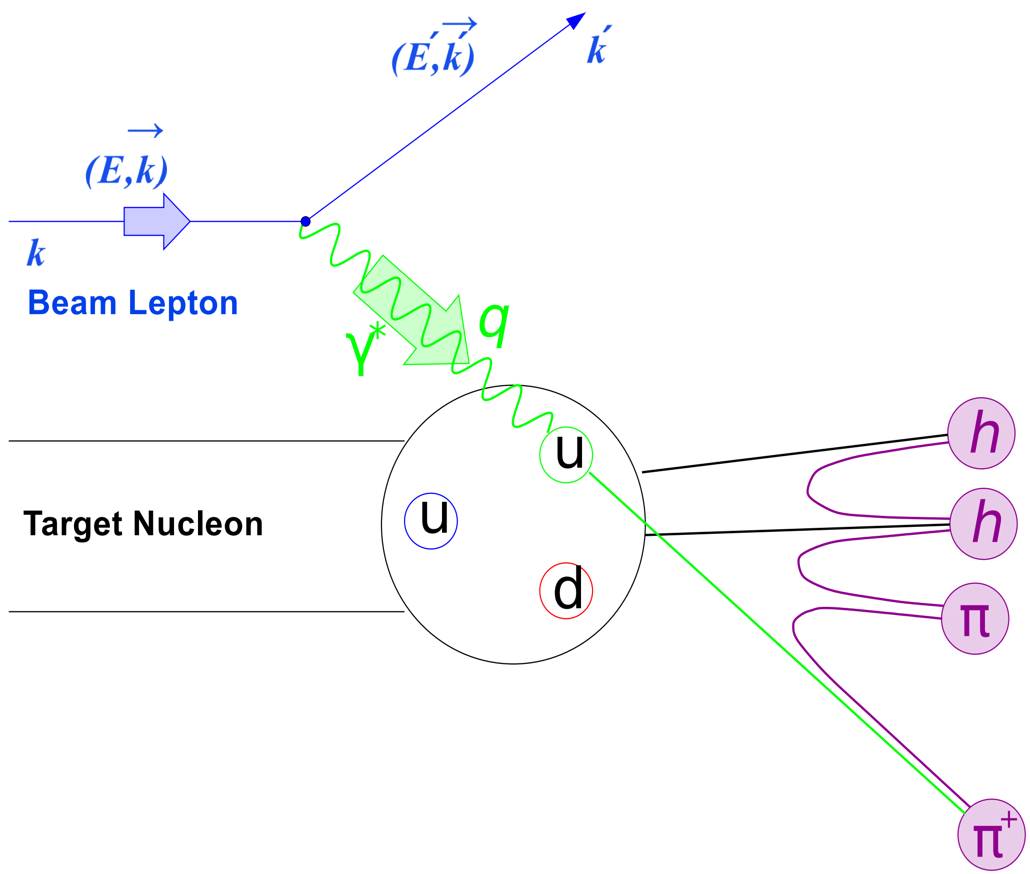
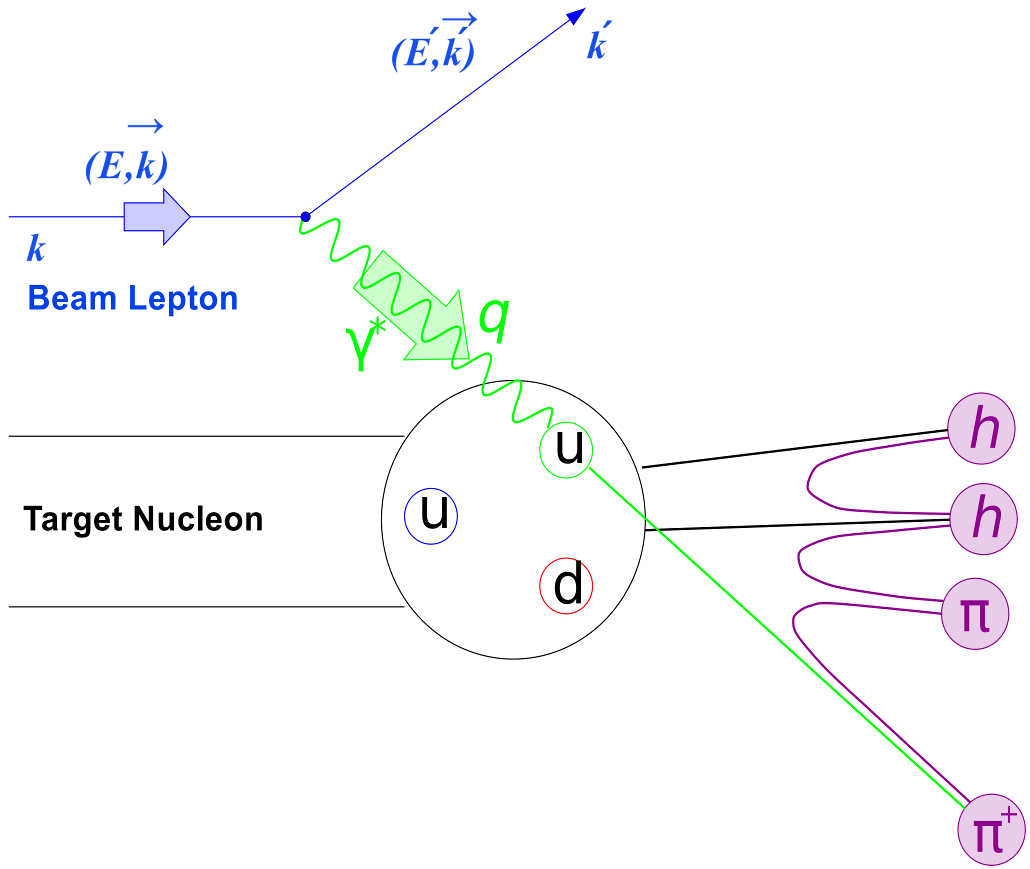
Overview

- **Semi-Inclusive Deep-Inelastic Scattering (SIDIS)**
- **Experiment**
- **Data Extraction**
- **Results**
- **Summary**

SIDIS

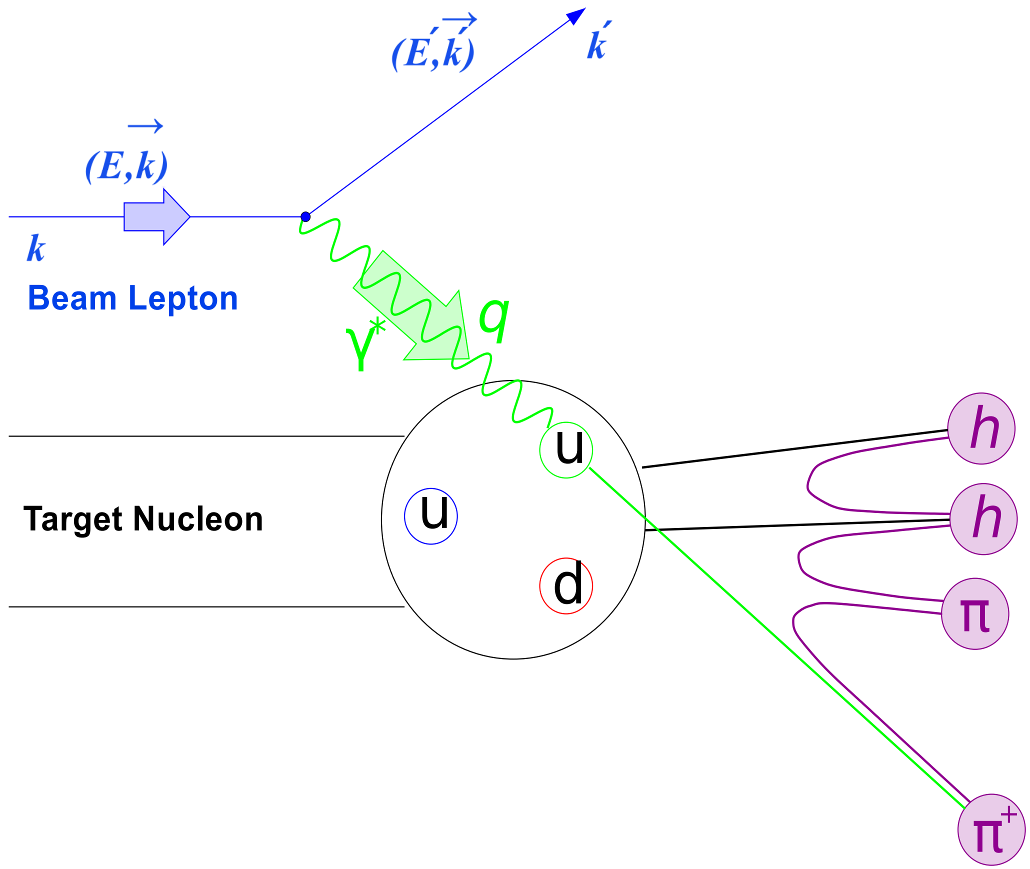


SIDIS



Nucleon probing resolution

SIDIS



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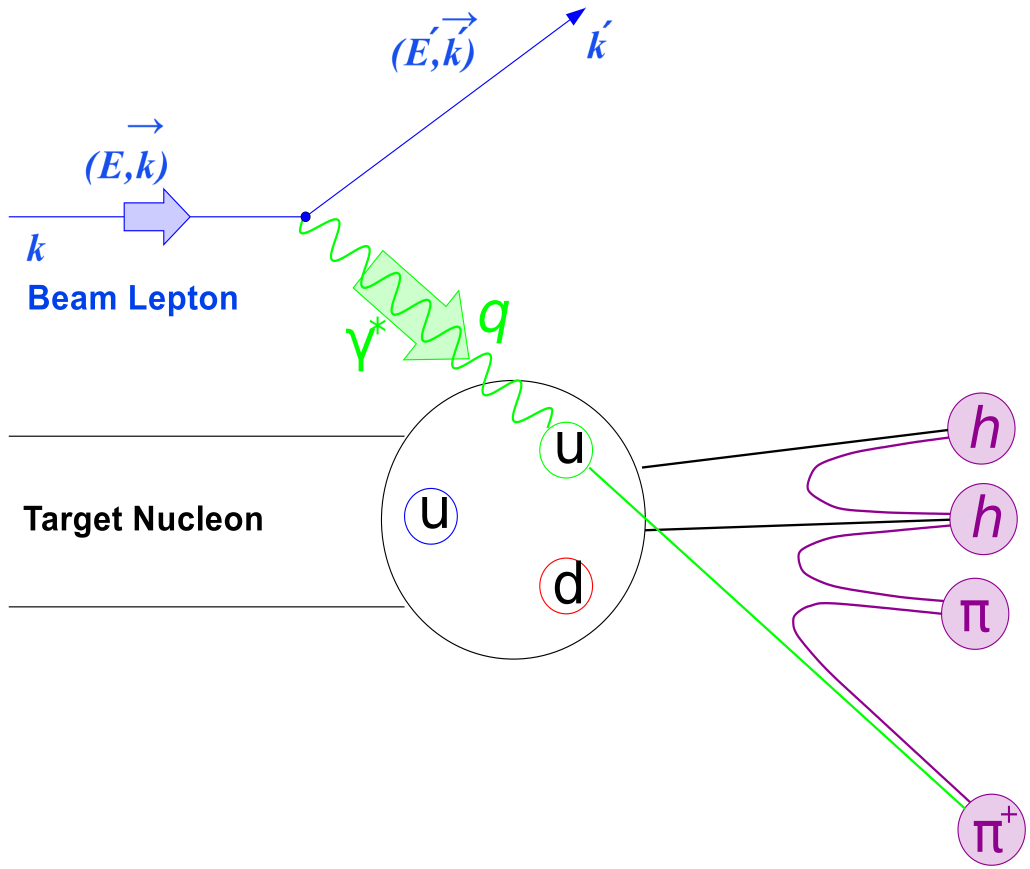
SIDIS



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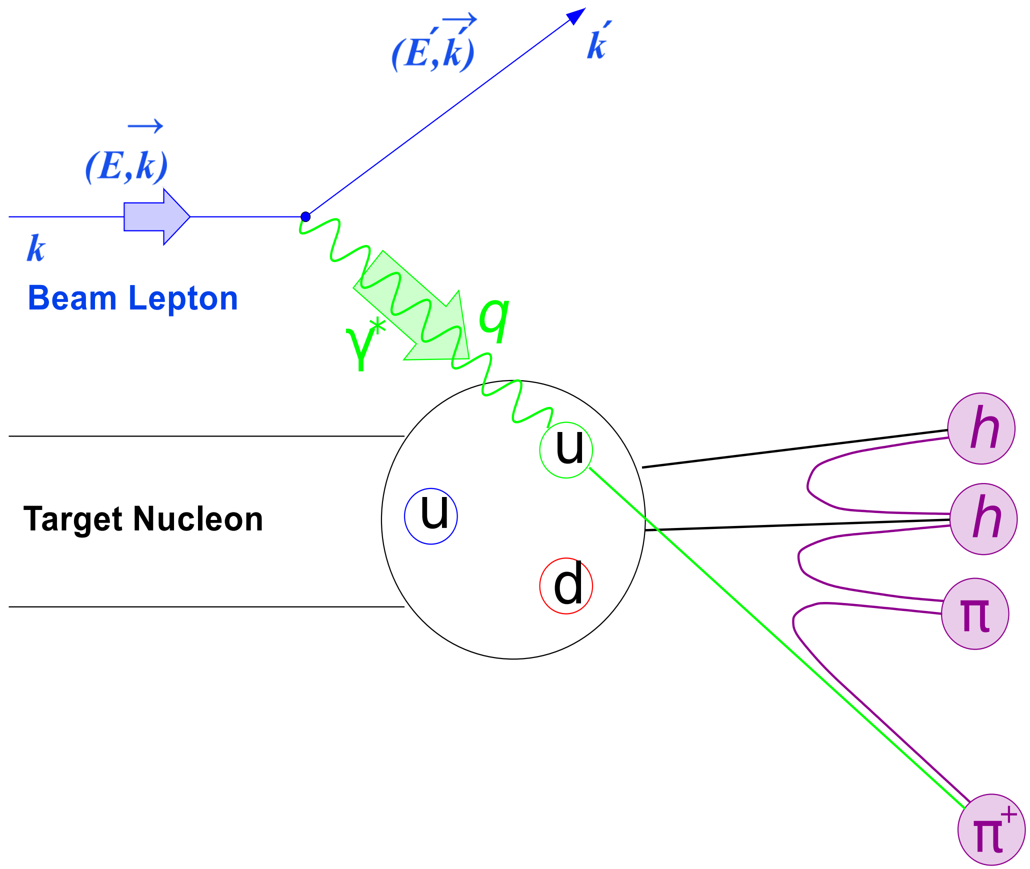
Invariant mass square

SIDIS



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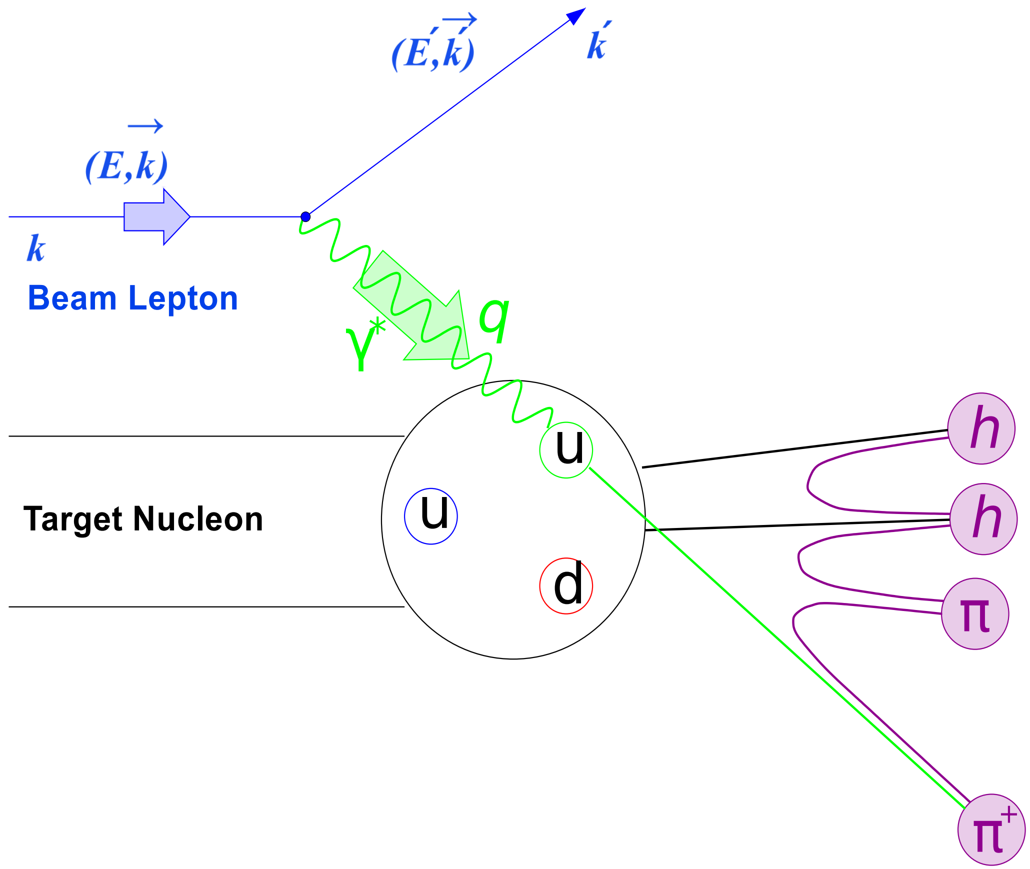

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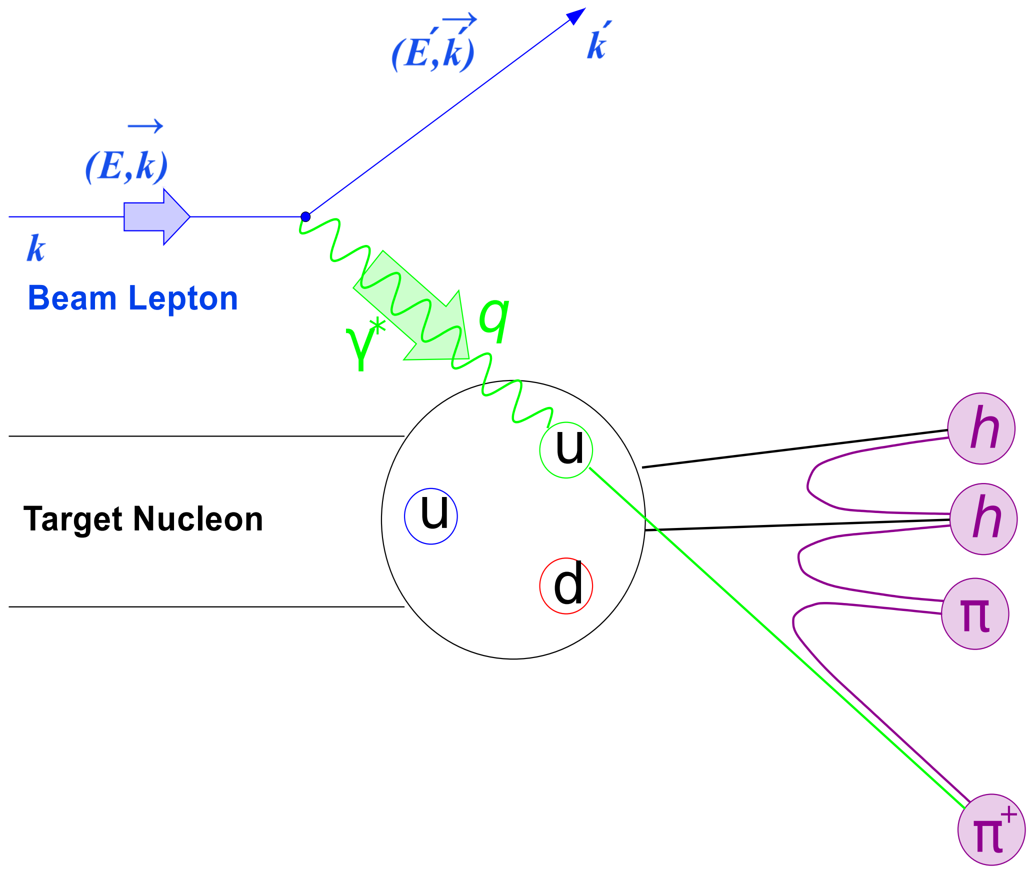
Energy transfer

SIDIS



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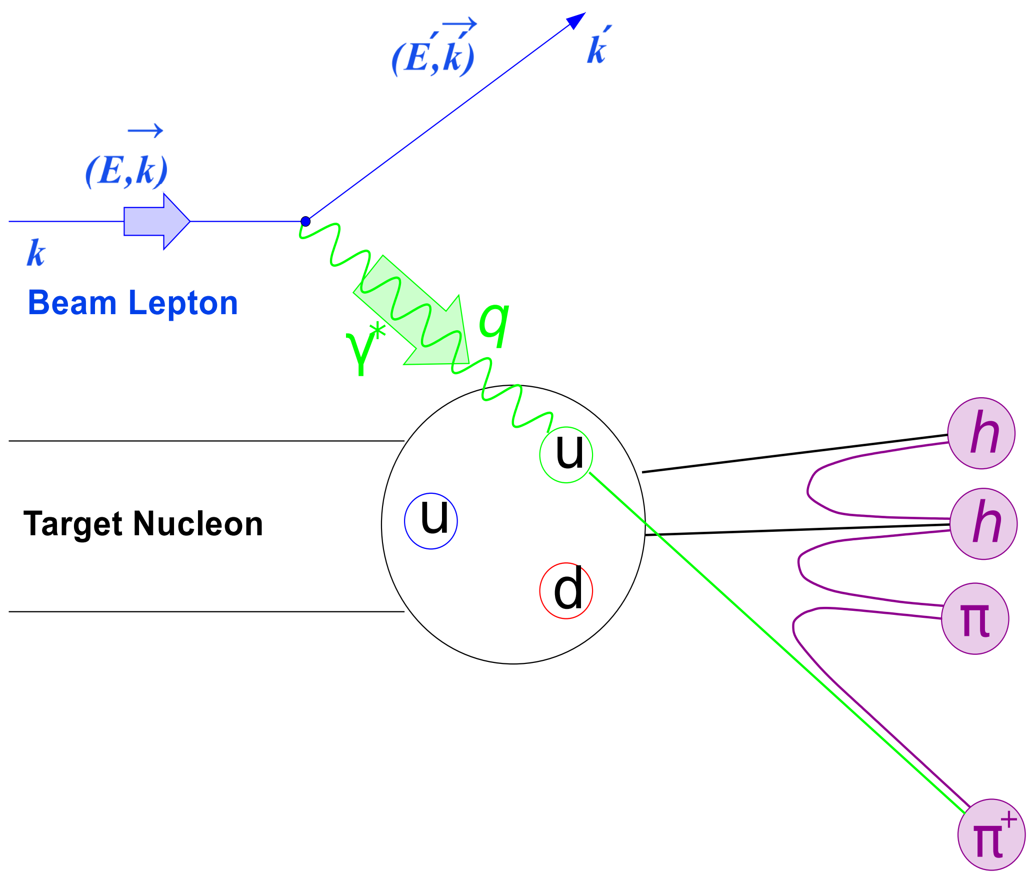

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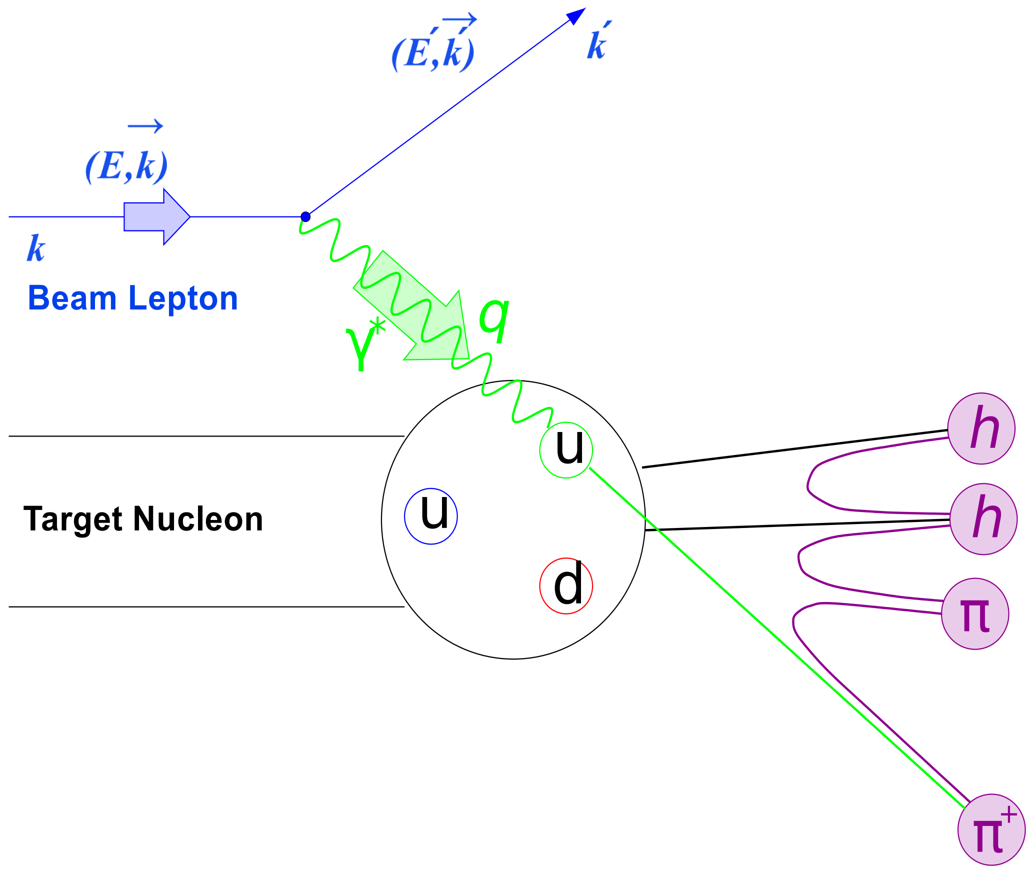
The Bjorken variable

SIDIS



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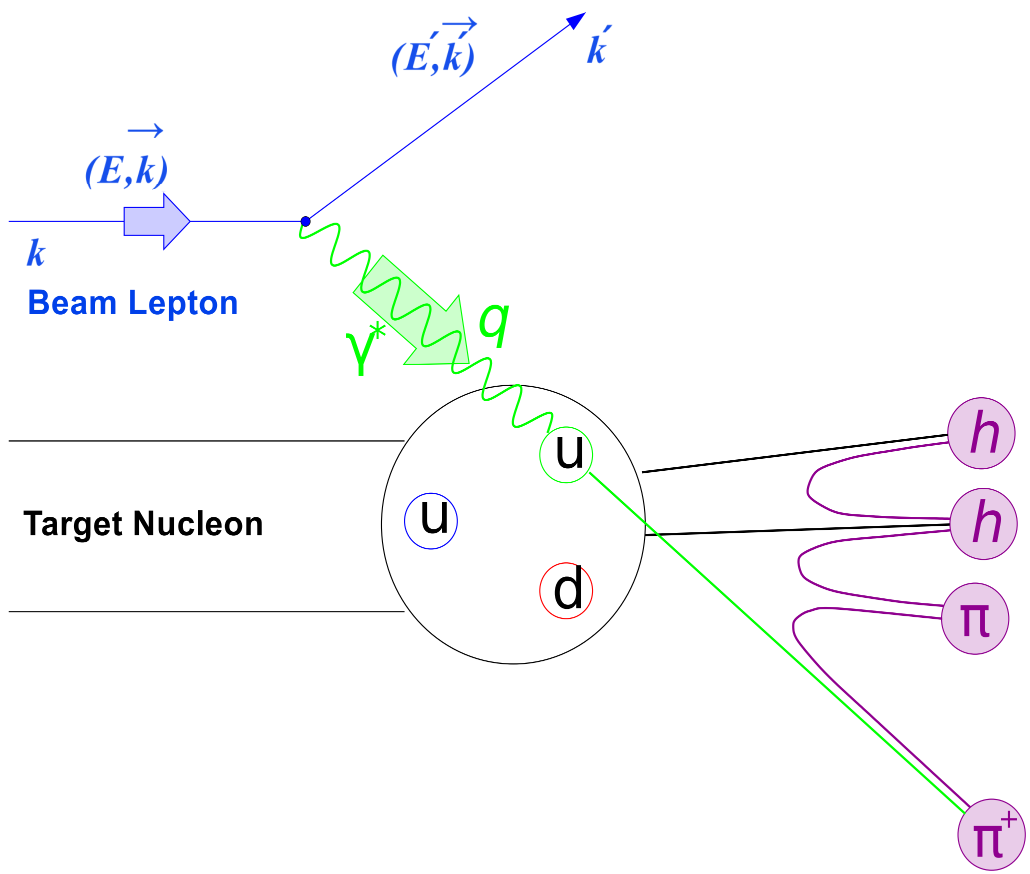
SIDIS



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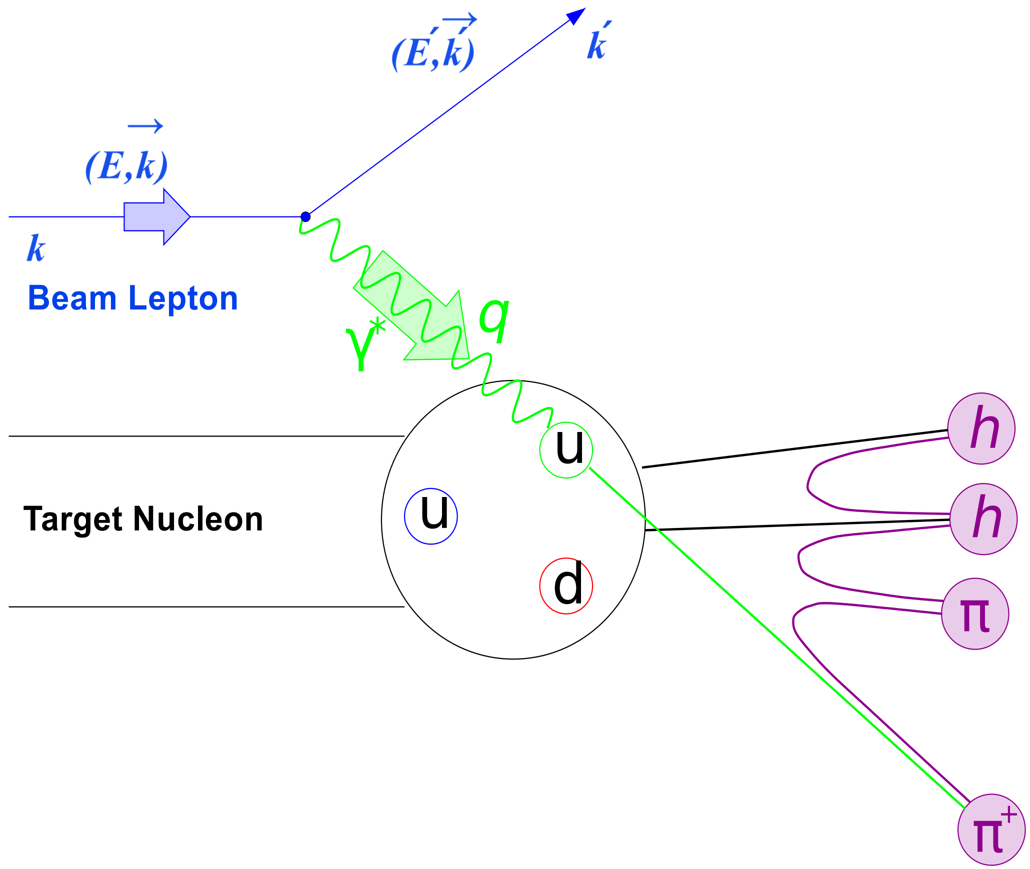
Hadron's fractional energy

SIDIS



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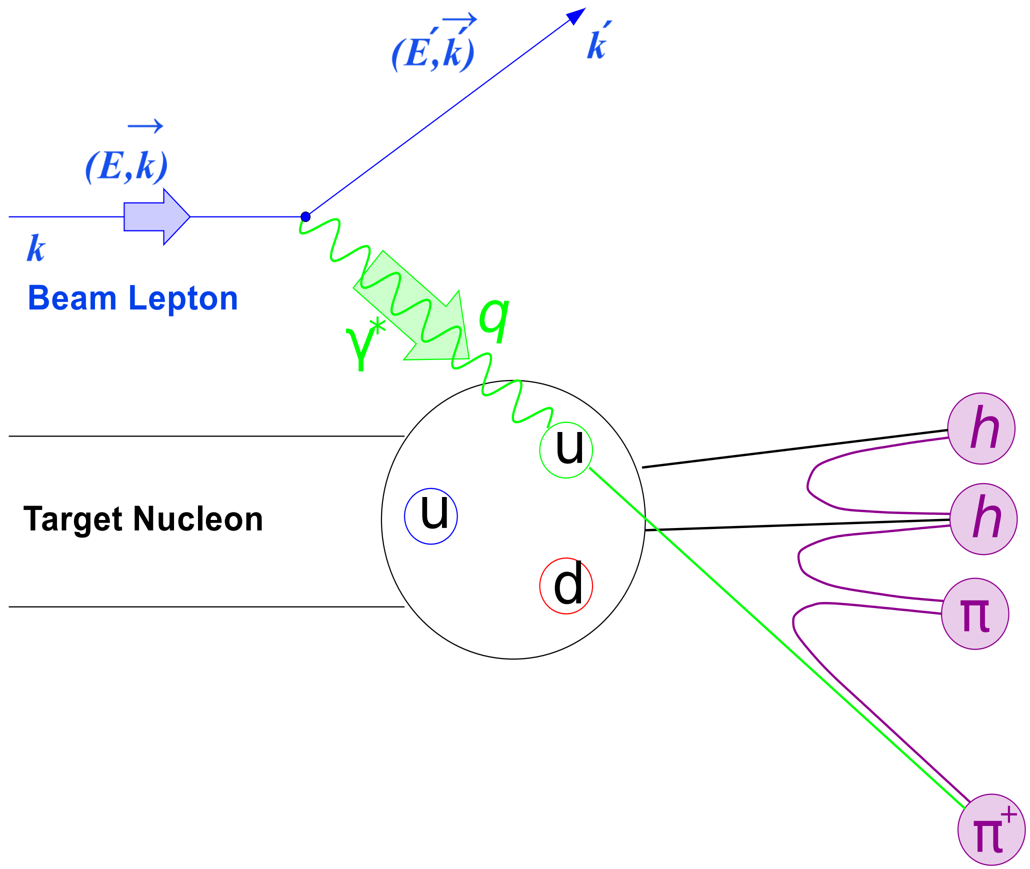

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Transverse momentum

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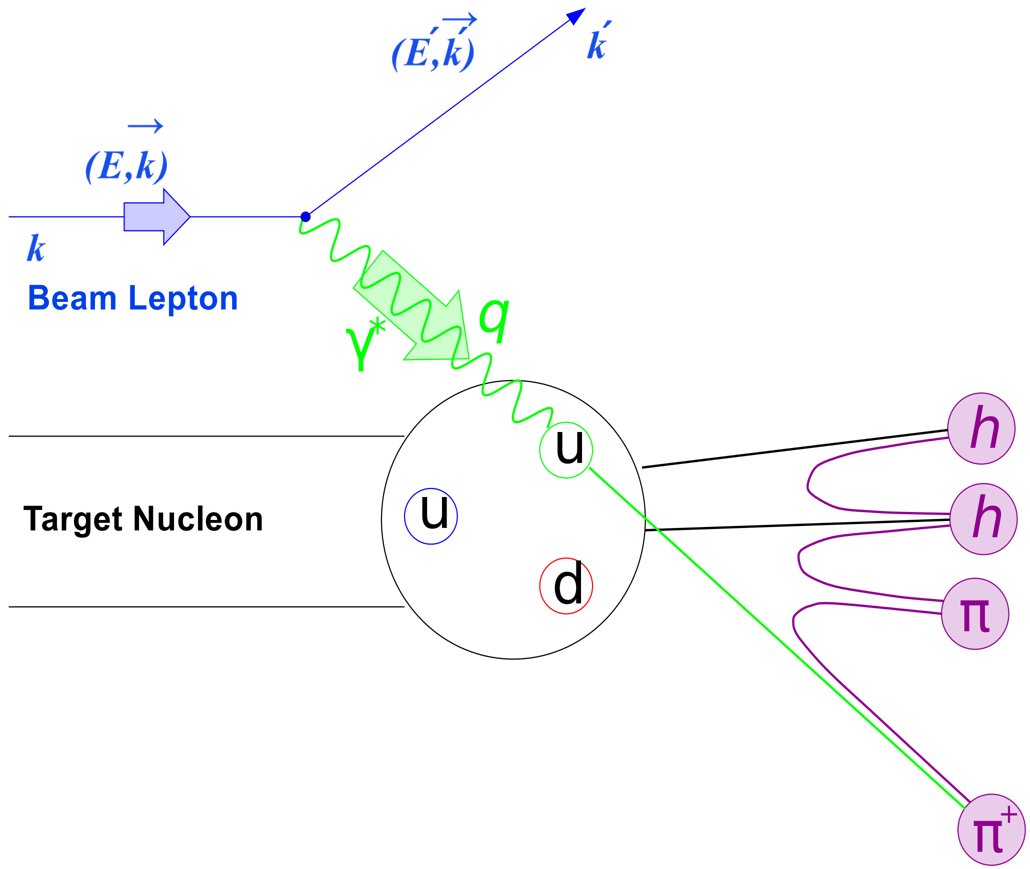

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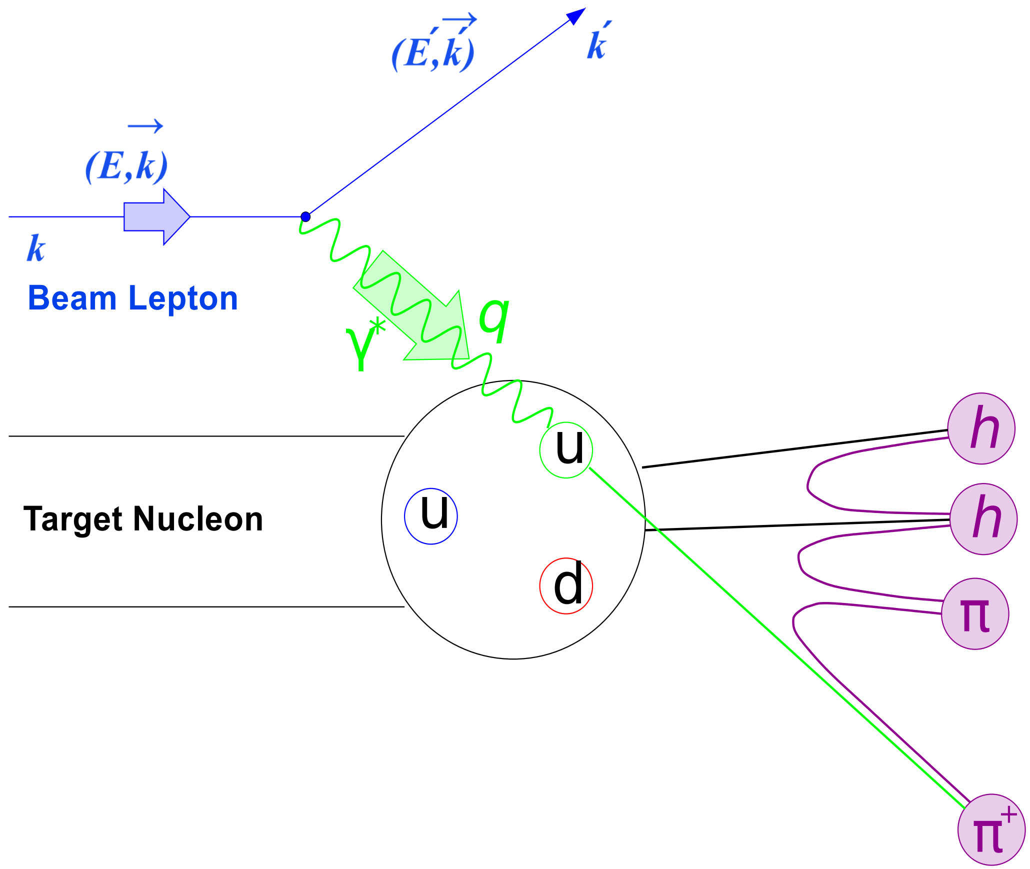

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$$\sigma^{\mathbf{eN \to ehX}} \propto \sum_{\mathbf{f}} \mathbf{e_f^2} \cdot \mathbf{q_f}(\mathbf{x_{Bj}}, \mathbf{Q^2}) \cdot \sigma^{\mathbf{eq \to eq}} \cdot \mathbf{D_f^h}(\mathbf{z_h}, \mathbf{Q^2})$$

SIDIS

$$\mathbf{M_h^{mult}}(\mathbf{x_{Bj}}, \mathbf{Q^2}, \mathbf{z}, \mathbf{P_{h\perp}}, \phi) = \frac{\mathbf{N_h}(\mathbf{x_{Bj}}, \mathbf{Q^2}, \mathbf{z}, \mathbf{P_{h\perp}}, \phi)}{\mathbf{N_e}(\mathbf{x_{Bj}}, \mathbf{Q^2})}$$

SIDIS

$$\mathbf{M_h^{mult} \sim \frac{\sum_f e_f^2 \cdot q_f(x_{Bj}, Q^2) \cdot D_f^h(z_h, Q^2)}{\sum_f e_f^2 \cdot q_f(x_{Bj}, Q^2)}}$$

SIDIS

$$\mathbf{M_h^{mult}} \sim \frac{\sum_f \mathbf{e_f^2} \cdot \text{PDF} \cdot \mathbf{D_f^h(z_h, Q^2)}}{\sum_f \mathbf{e_f^2} \cdot \text{PDF}}$$

SIDIS

$$\mathbf{M_h^{mult}} \sim \frac{\sum_f \mathbf{e_f^2} \cdot \mathbf{q_f}(\mathbf{x_{Bj}}, \mathbf{Q^2}) \cdot \textbf{FF}}{\sum_f \mathbf{e_f^2} \cdot \mathbf{q_f}(\mathbf{x_{Bj}}, \mathbf{Q^2})}$$

SIDIS

$$M_h^{mult} \sim \frac{\sum_f e_f^2 q_f(x_{Bj}, Q^2) D_f^h(z_h, Q^2)}{\sum_f e_f^2 q_f(x_{Bj}, Q^2)}$$

PDF's are well known

SIDIS

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$$M_h^{mult} \sim \frac{\sum_f e_f^2 \, q_f(x_{Bj}, Q^2) \, D_f^h(z_h, Q^2)}{\sum_f e_f^2 \, q_f(x_{Bj}, Q^2)}$$

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Collinear framework

SIDIS

$$\mathrm{M}_{\mathrm{h}}^{\mathrm{mult}} \sim \frac{\sum_{\mathrm{f}} \mathrm{e}_{\mathrm{f}}^{2}\, \mathrm{q}_{\mathrm{f}}(\mathrm{x}_{\mathrm{Bj}}, \mathrm{Q}^{2})\, \mathrm{D}_{\mathrm{f}}^{\mathrm{h}}(\mathrm{z}_{\mathrm{h}}, \mathrm{Q}^{2})}{\sum_{\mathrm{f}} \mathrm{e}_{\mathrm{f}}^{2}\, \mathrm{q}_{\mathrm{f}}(\mathrm{x}_{\mathrm{Bj}}, \mathrm{Q}^{2})}$$

CTEQ6L, GRV, ...

DSS, Kretzer, ...

Universality

Cross Section $\left(e + \mathrm{N}, e^{-} + e^{+}, \mathrm{p} + \mathrm{p} \right)$

SIDIS

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charge separated FF

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charge separated FF

flavor separated FF

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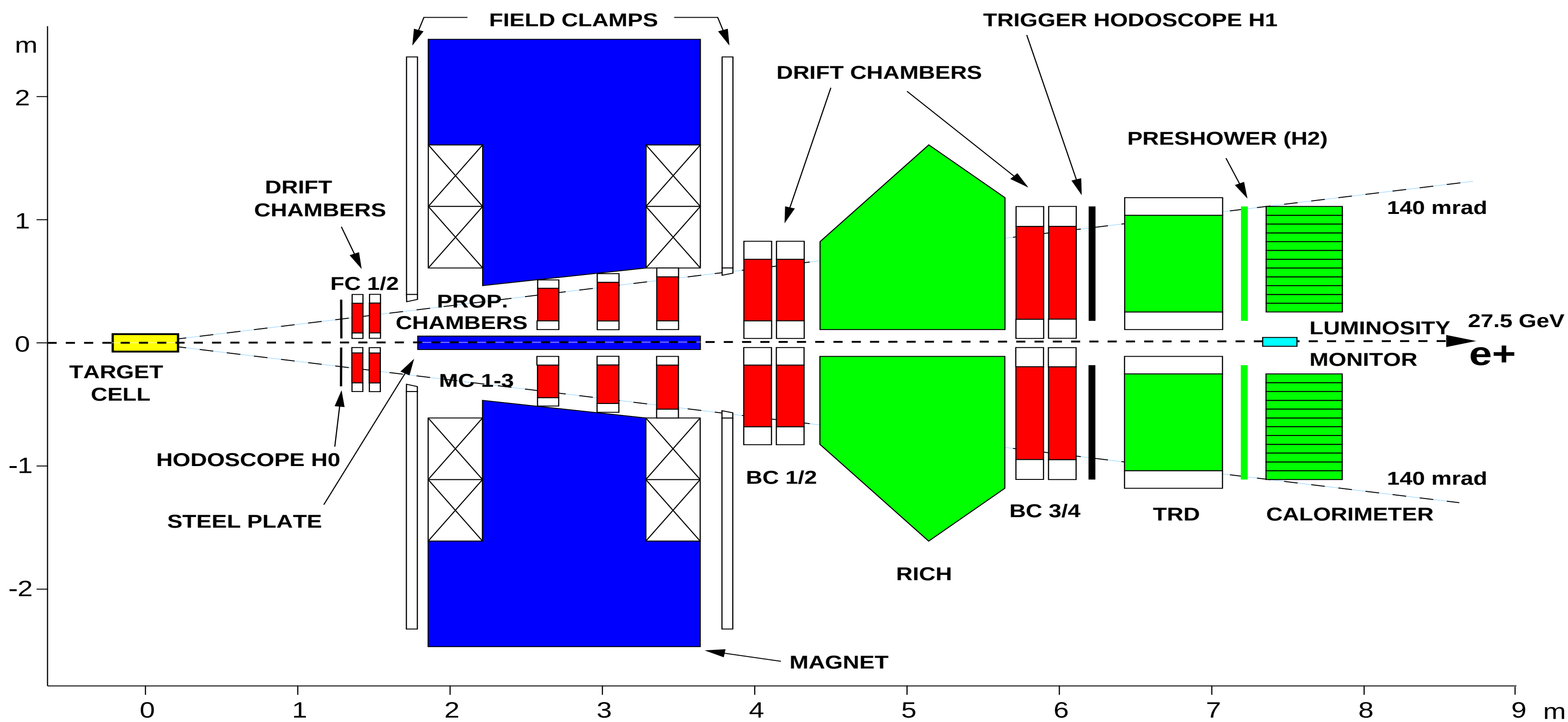
input for the global analysis

Experiment



- $e^{\pm}$ beam of 27.6 GeV energy
- Target(H, D)
- Good Momentum Resolution($\Delta \mathrm{p}/\mathrm{p} < 2\%$)
- Excellent Particle Identification Capabilities

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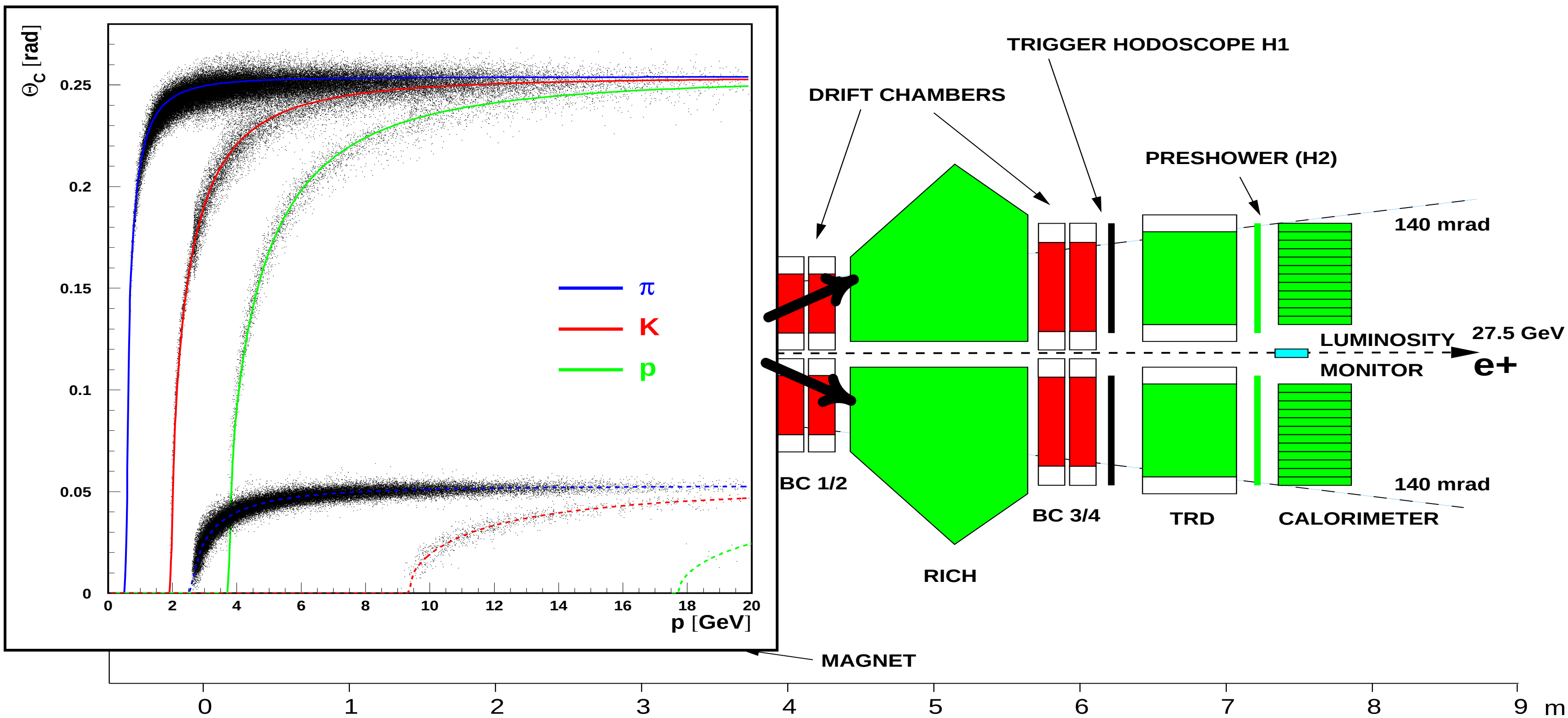

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Data Extraction

$$2 < P_h < 15\,\mathrm{GeV},\; 0.2 < z < 0.8$$

SIDIS hadron yields

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DIS event yields

$$Q^2 > 1\,\mathrm{GeV}^2, W^2 > 10\,\mathrm{GeV}^2, 0.1 < \nu/E_{beam} < 0.85$$

Data Extraction

- **Charge Symmetric Background**

Data Extraction

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Data Extraction

- Charge Symmetric Background
- Trigger Efficiency
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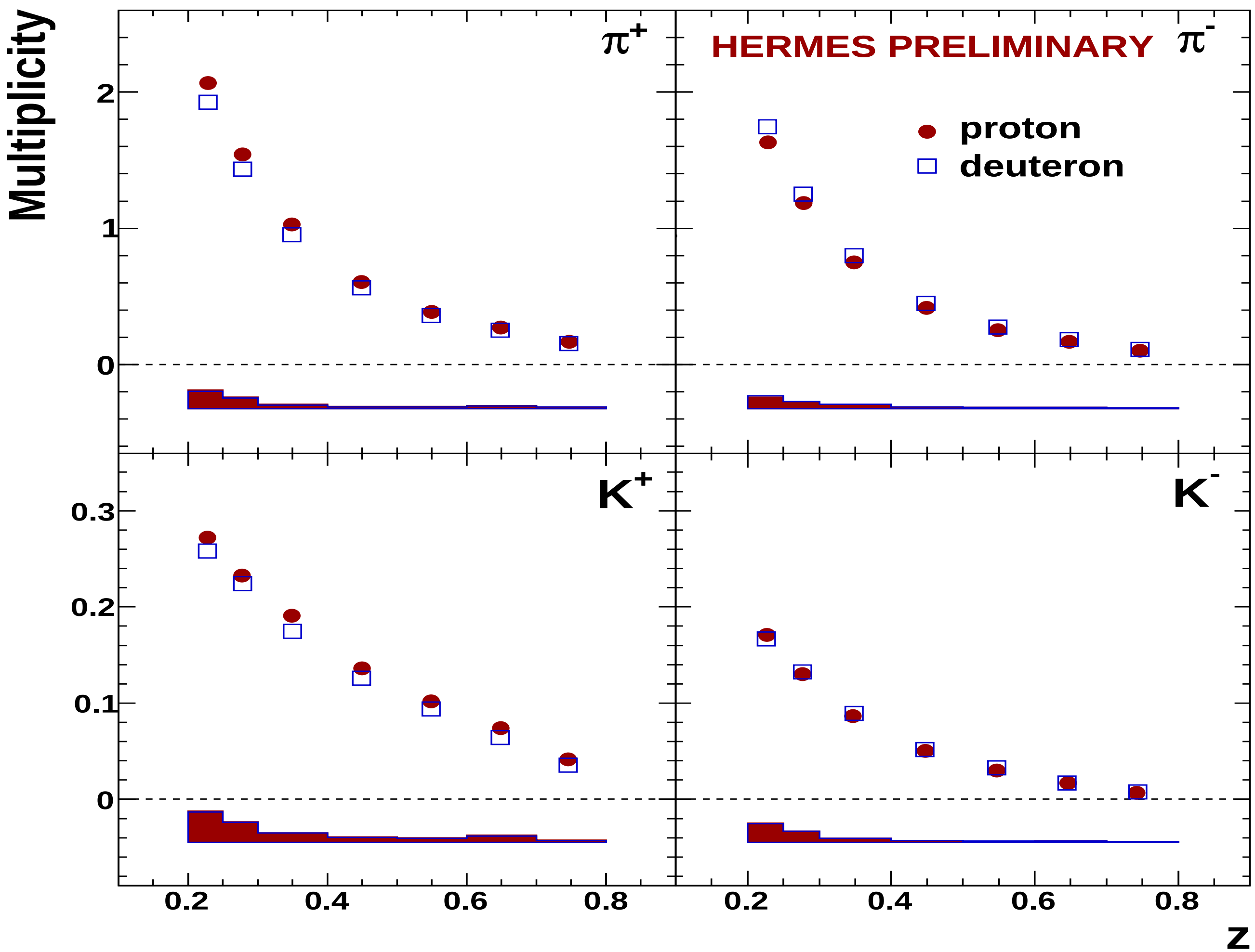
- Vector Meson Contribution
- Acceptance and Radiative Effects

Results

$$M_h^{mult}(x_{Bj}, Q^2, z, P_{h\perp})$$



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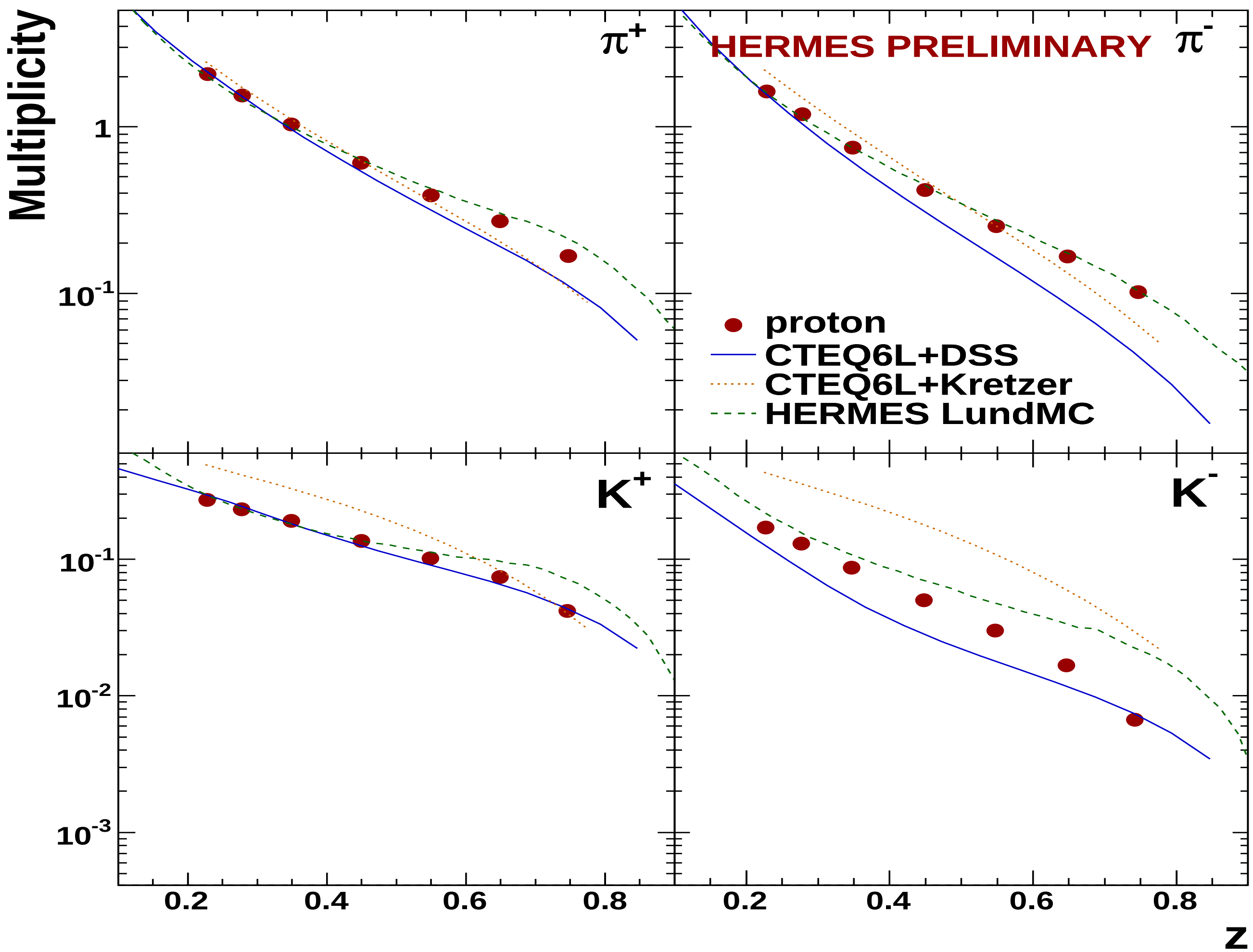

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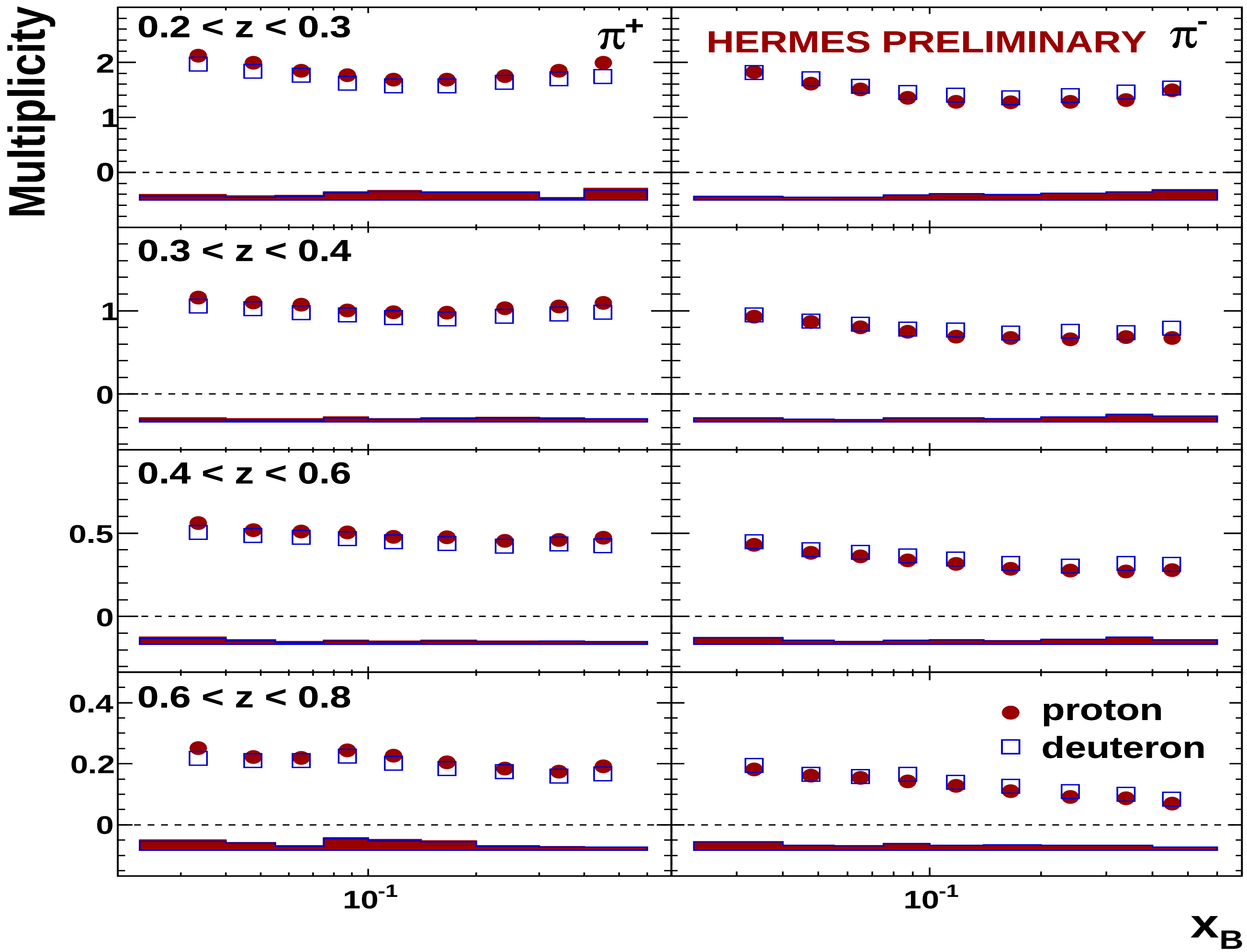

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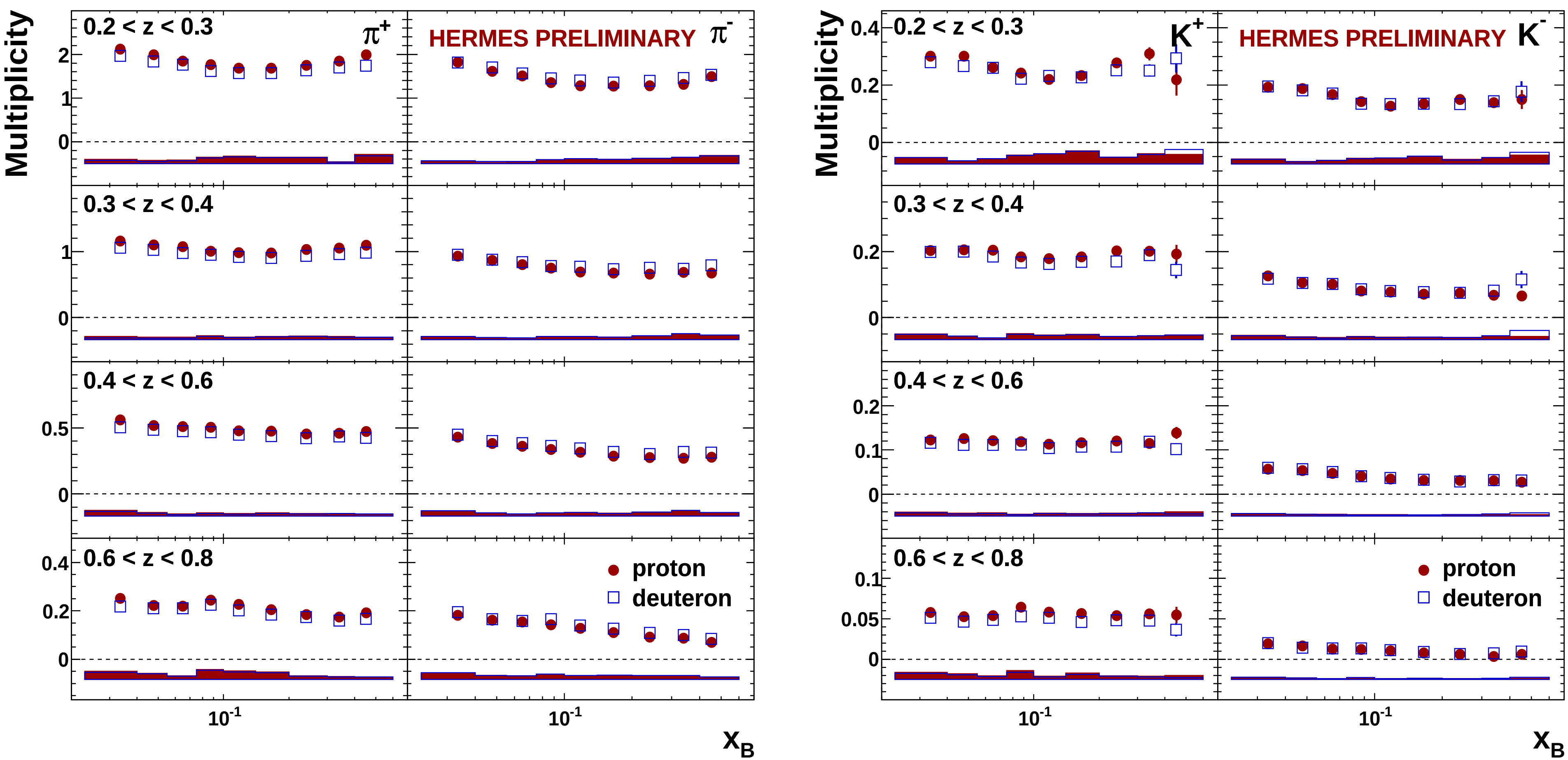

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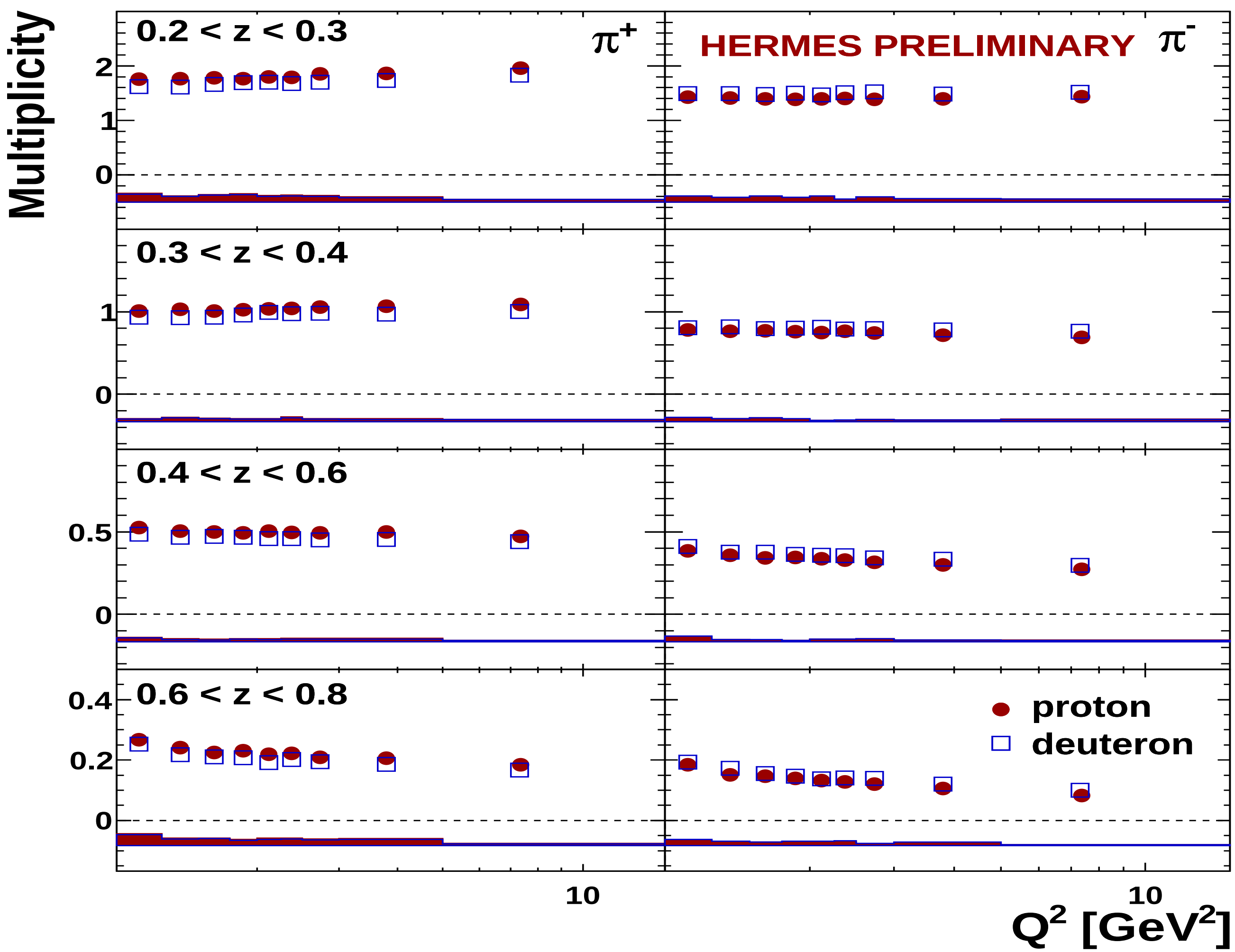

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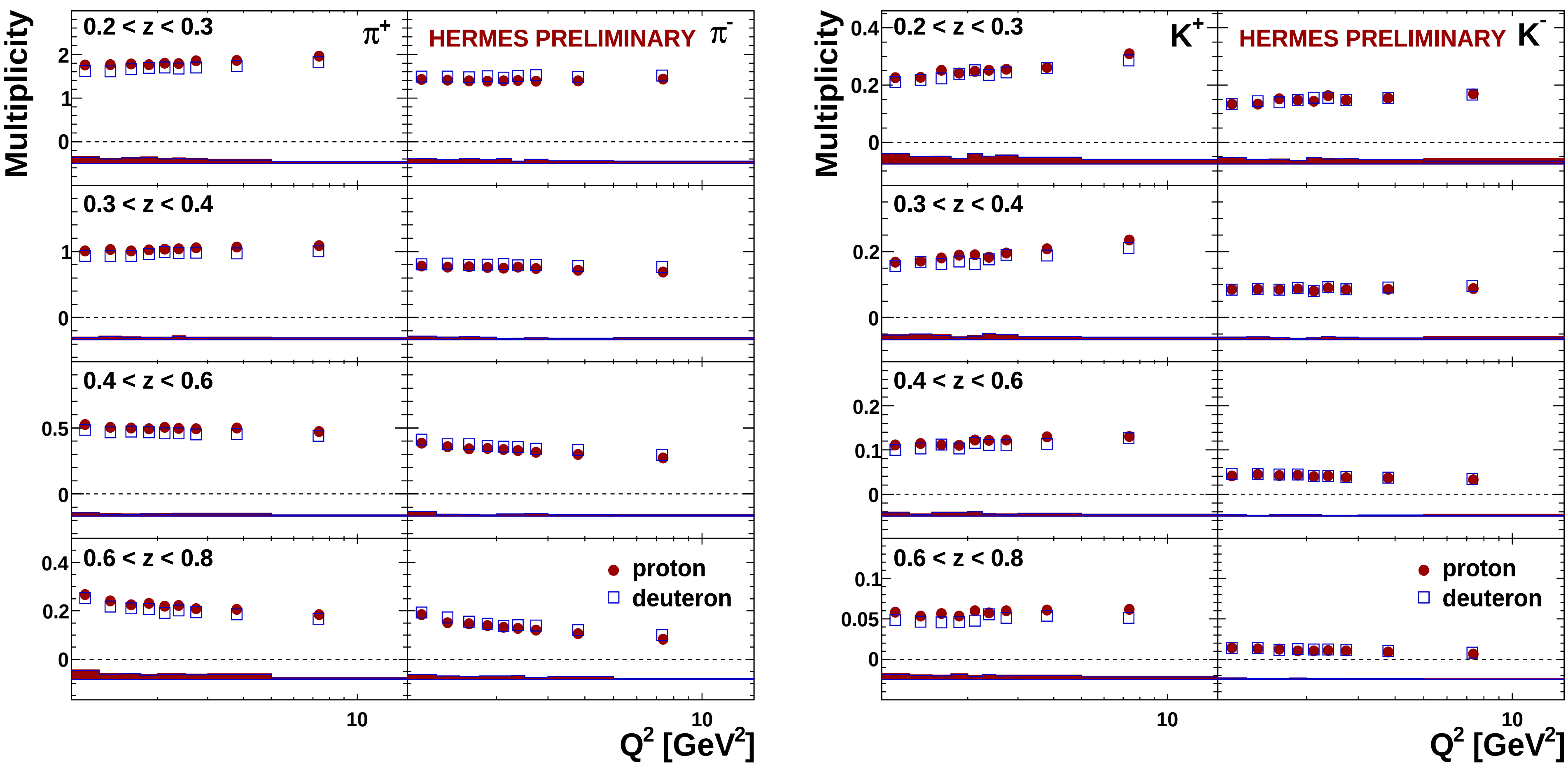

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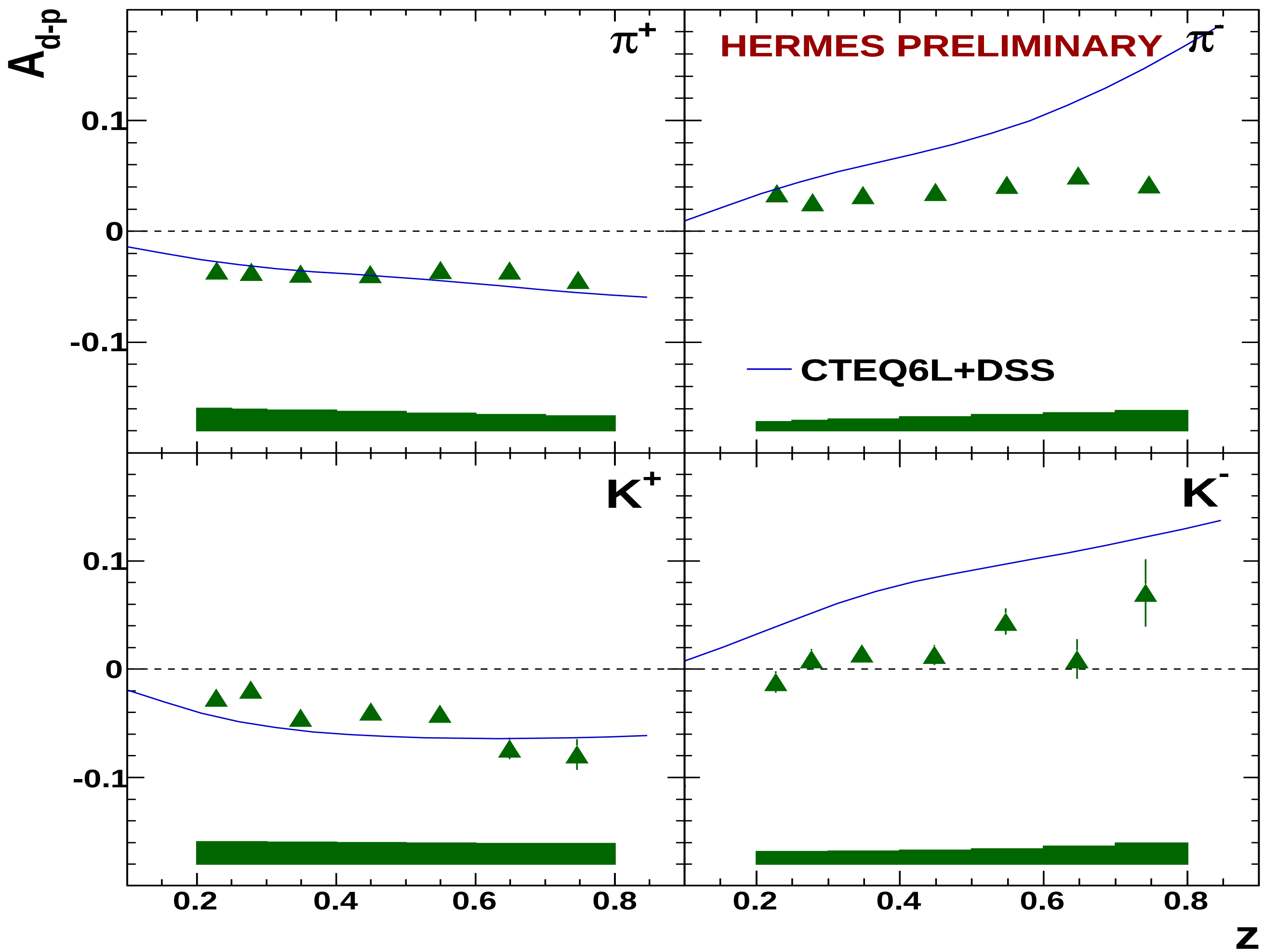

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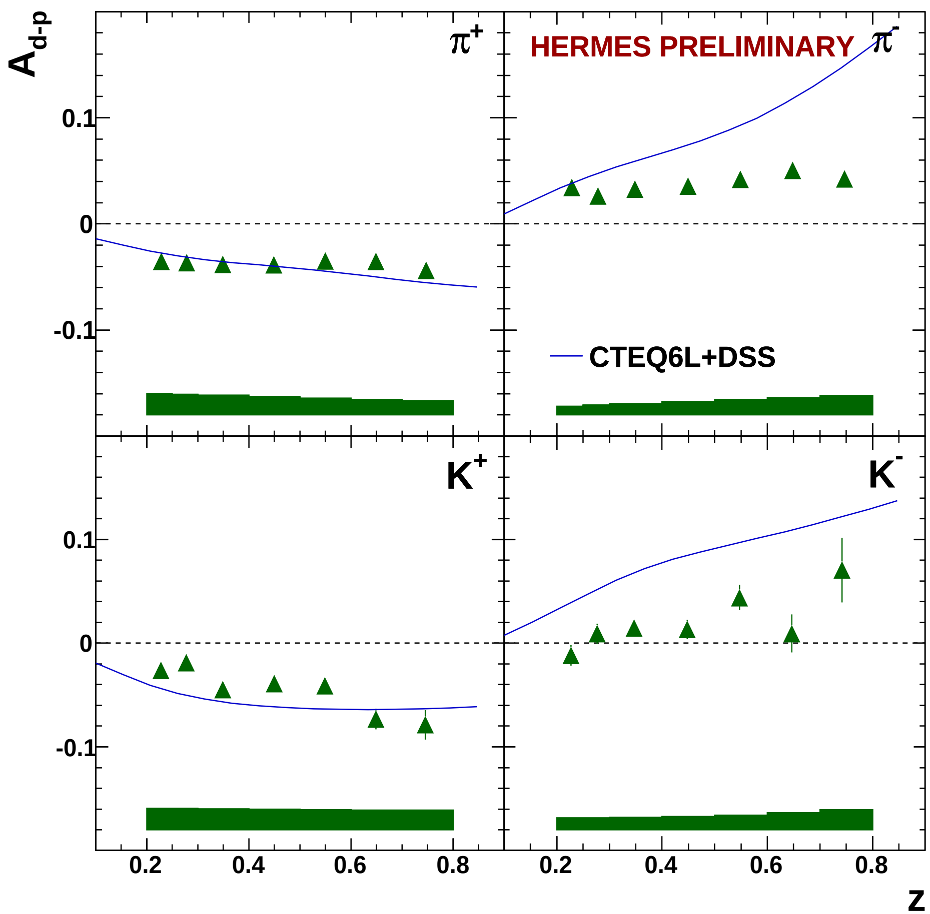

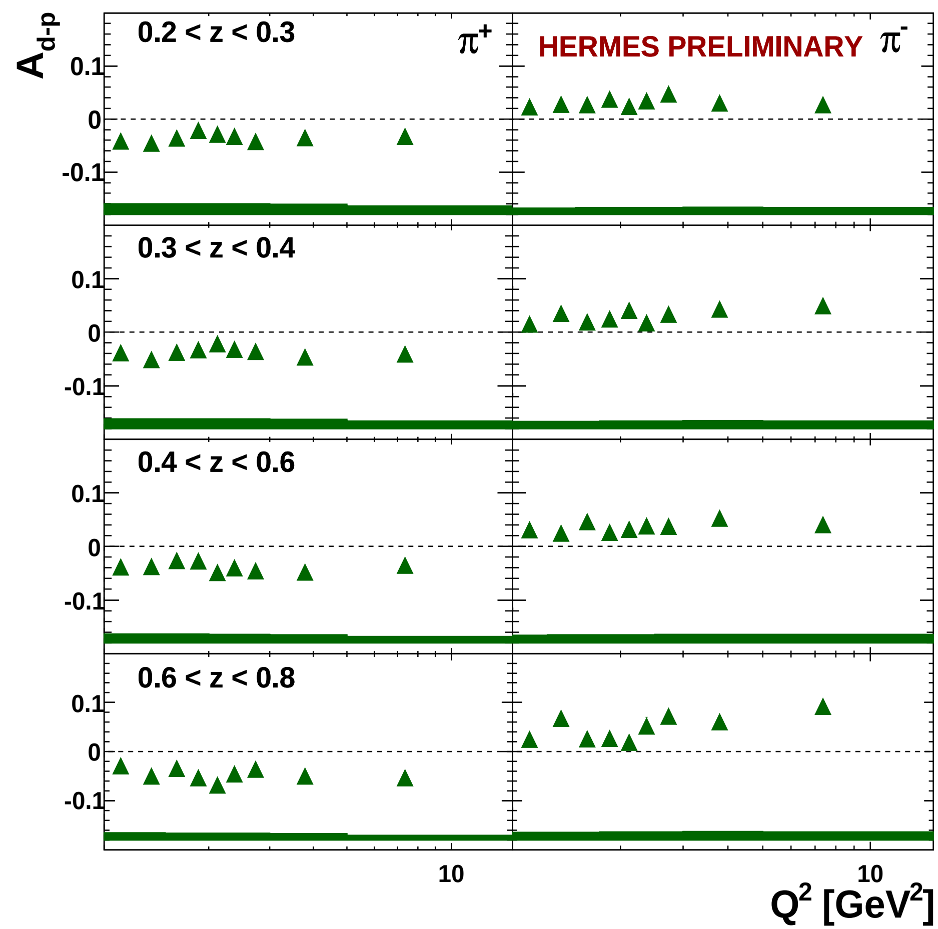

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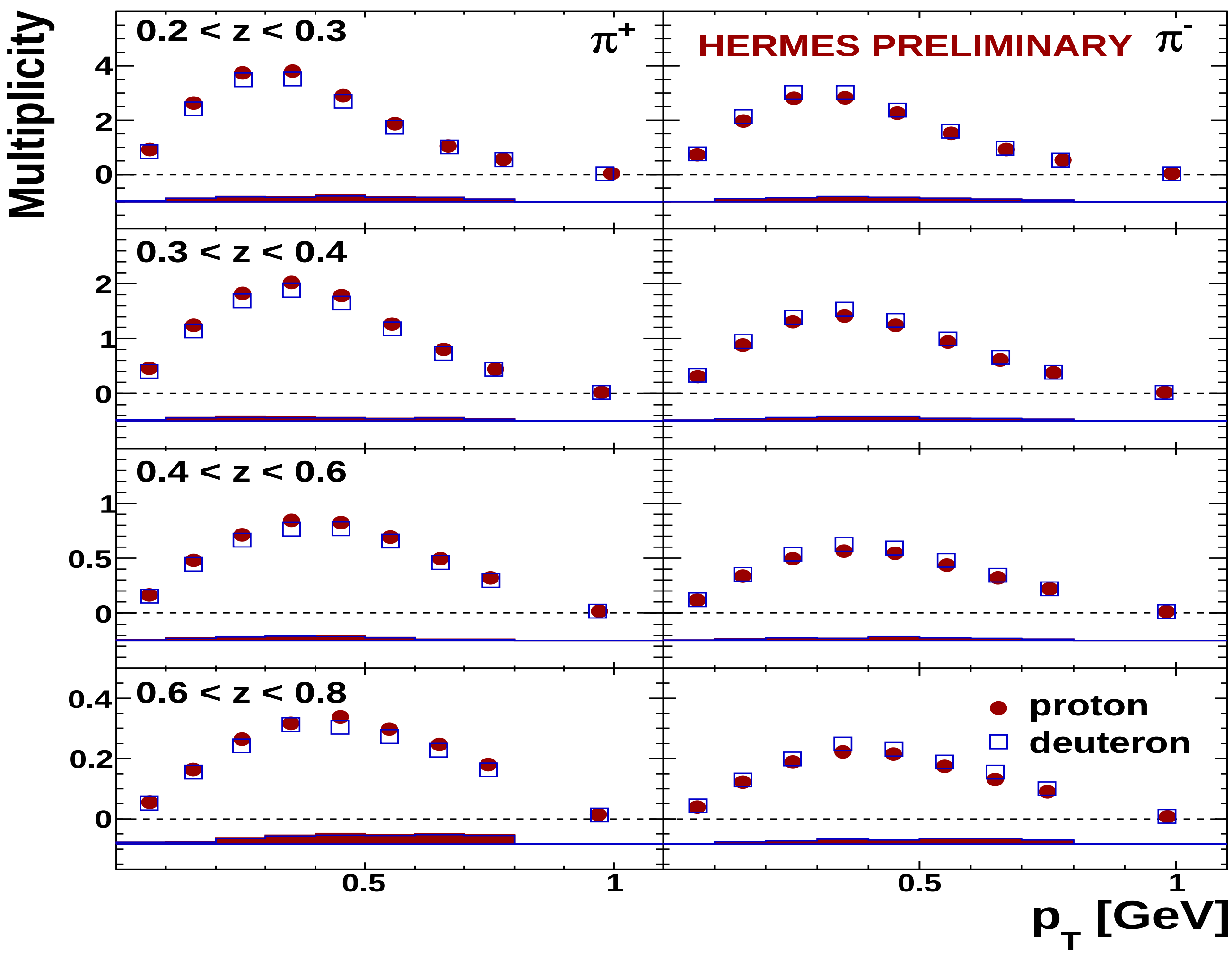

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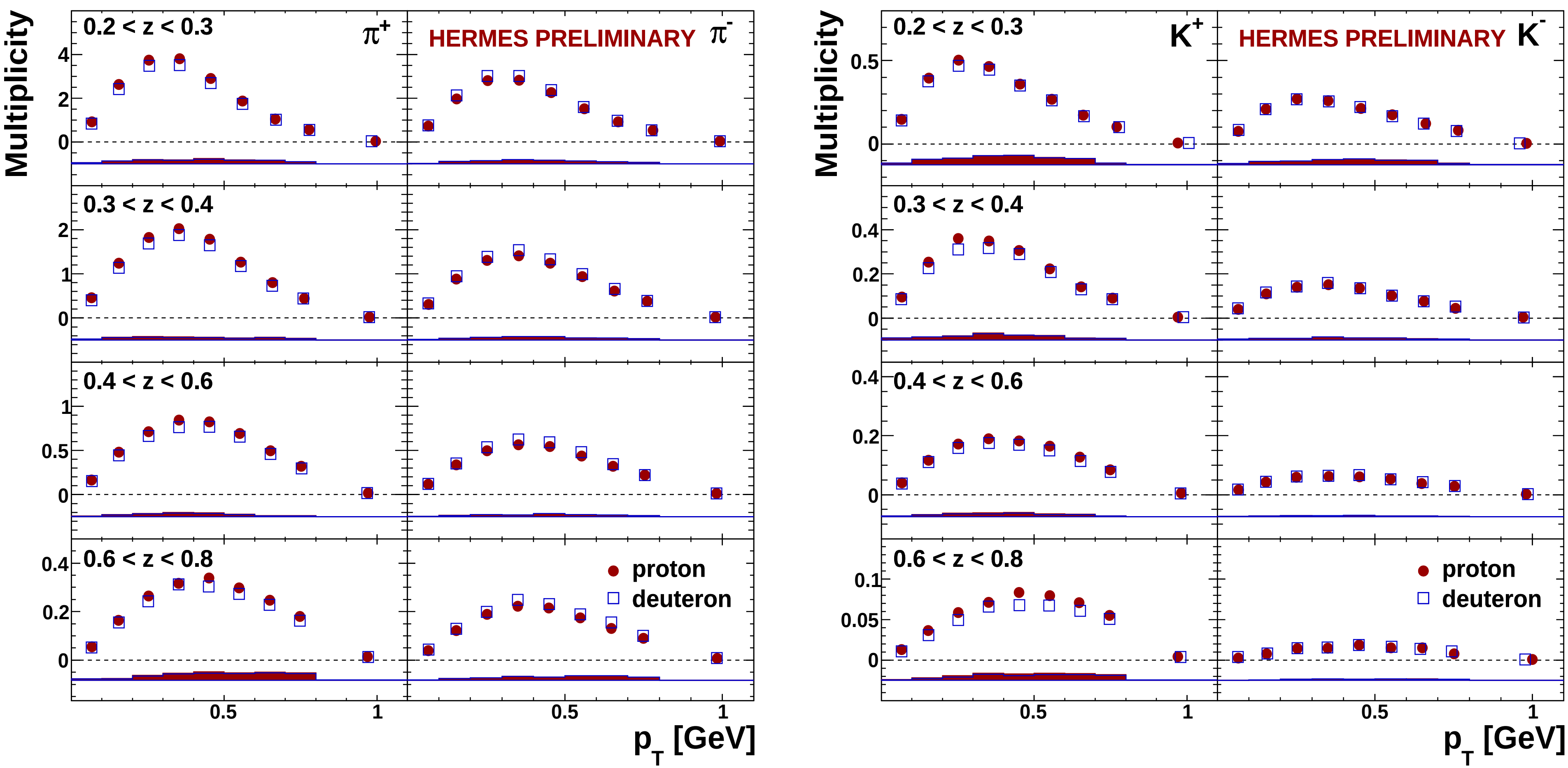

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- Fragmentation is favored for the hadrons containing the struck quark as a valence quark.
- Data will allow more reliable extraction of unfavored fragmentation function.
- Multiplicity dependences on $P_{\mathrm{h}\perp}$ will provide constraints on the models of the fragmentation process.