HERMES and Multiplicities

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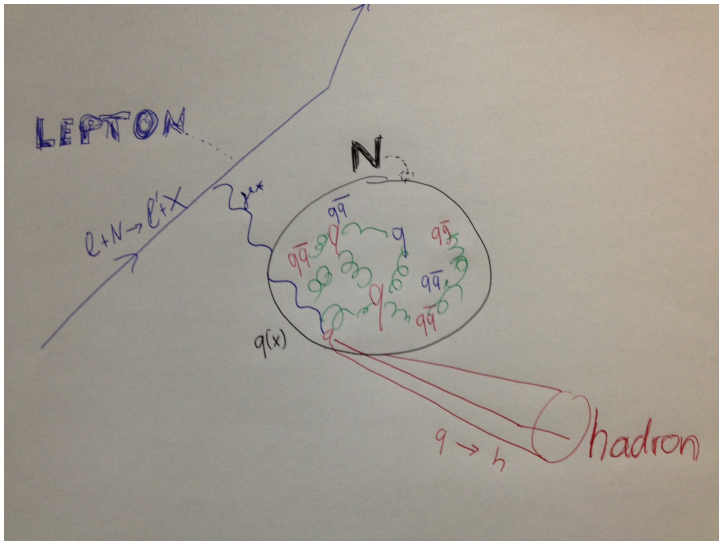
Fragmentation Functions (FF)

Complete picture of QCD $\rightarrow$ understanding hadronization processes

FF$\rightarrow D_f^h$ with $\sum_f \int_z dz\, D_f^h(z) = 1$

SIDS can be factorized and described with

- FF: the hadronization
- PDF: quark contents
- hard scattering cross section σ



favored and unfavored FF i.g.:

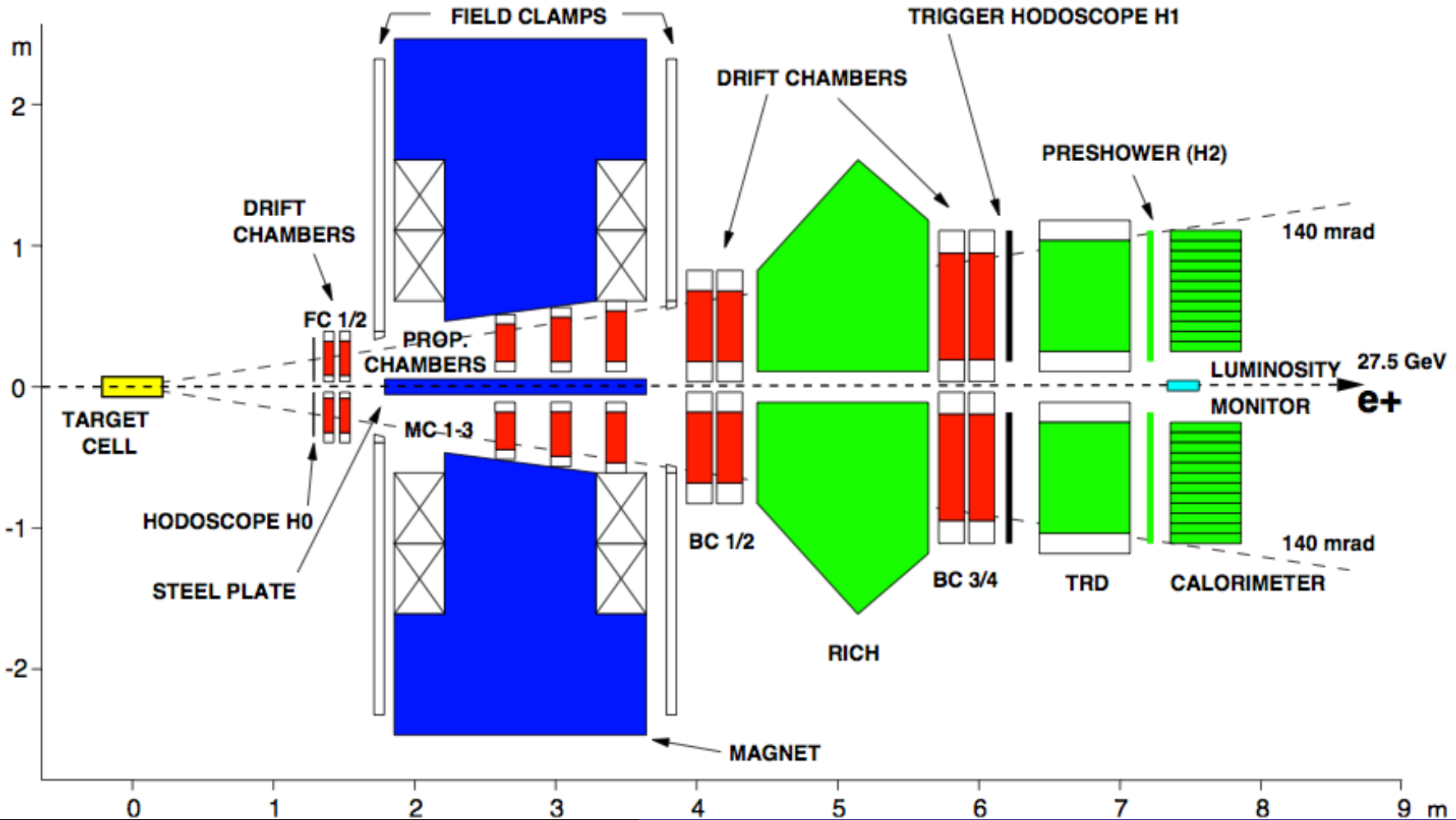
HERMES vs. COMPASS

Both are fixed target experiments!

- Beam: 30 - 50 mA $e^{\pm}$ with $3 \cdot 10^{17}\mathrm{s}^{-1}$
- Gas target (H or D): $10^{14}\mathrm{cm}^{-1}$
- Luminosity: $\approx 10^{31}\mathrm{cm}^{-1}\mathrm{s}^{-1}$
- Symetric half forward spectrometer
- DC,RICH, H0, H1, H2, Calo, etc...

COMPASS: $3.0{\cdot}10^{17}\mathrm{s}^{-1}$ and $10^{25}\mathrm{cm}^{-1}$
30 times more lumi

The HERMES Experiment



Data Selection

HERMES

- Trigger: $H_{0,1,2}$, ECAL and bunch signal
- lepton $'$ highest momentum and target cut
- geometric acceptance: up to 170 mrad (9.7°)

COMPASS

- inclusive μ trigger, CM and spill signal
- μ' with conditions, target pointing and cuts
- geometric acceptance: up to 180 mrad (10.3°)

Data Selection Kinematic Cuts

HERMES	COMPASS
$Q^2>1$	$Q^2 > 1$
$W^2>10$	$W^2 > 5$
$0.1 > y > 0.85$	$0.2 > y > 0.85$
$0.2 > z > 0.8$	$0.2 > z > 0.85$
$2 > P_h > 15$ (RICH)	$12 > P_h > 50$ (RICH)

HERMES rejects events at high z due to exclusive processes

PID

Lepton-hadron separation:
TRD, preshower detector, calorimeter and RICH

RICH with two fillings: aeogel and C_4F_{10}

Multiplicities

$$M_n^h(x, Q^2, z, P_{h\perp})$$

$$= \frac{1}{\frac{d^2 N_{DIS}(x,Q^2)}{dx\, dQ^2}} \frac{d^5 N^h(x, Q^2, z, P_{h\perp}, \Phi)}{dx\, dQ^2\, dz\, dP_{h\perp}\, d\Phi}$$

$$= \frac{1}{\frac{d^2 \sigma_{DIS}(x,Q^2)}{dx\, dQ^2}} \frac{d^5 N^h(x, Q^2, z, P_{h\perp}, \Phi)}{dx\, dQ^2\, dz\, dP_{h\perp}\, d\Phi}$$

hadron type h produced from target type n
Born multiplicities in (x, z, $P_{h\perp}$) or (Q^2 ,z, $P_{h\perp}$)
No Φ binning

Corrections

Charge-Symetric Background

$\pi^0 \rightarrow e^+ + e^-$
1 - 2 % corrections!

Trigger Efficiencies

With calibration triggers:
95% to 99% efficient trigger

Acceptance

LEPTO/JETSET: Experiment and QED corrections
RADGEN: Radiative processes and vertex correction

RICH

RICH efficiencies in matrix (like in COMPASS):
True hadrons vs Identified hadrons

$$\begin{pmatrix} I_\pi \\ I_K \\ I_p \\ I_X \end{pmatrix} = \begin{pmatrix} P_\pi^\pi & P_K^\pi & P_p^\pi \\ P_\pi^K & P_K^K & P_p^K \\ P_\pi^p & P_K^p & P_p^p \\ P_\pi^X & P_K^X & P_p^X \end{pmatrix} \cdot \begin{pmatrix} T_\pi \\ T_K \\ T_p \end{pmatrix}$$

$$T = P_{trunc.}^{-1} \cdot I$$

Systematics: 0.5% for pions and 1.5 % for kaons

Exclusive Vector-Meson Contribution

ρ^0, ω or ϕ contirbutions from γ^*
Described by Vector Meson Dominance
Mesons decay into lighter quarks
Found in final state!
Cross section with $1/Q^6$
found in higher and lower z

Simulated in Monte Carlo using PYTHIA

Not done in COMPASS: Necessary?

Results

- Fig. 4: hadron multi for pions and kaons (H and D)
- Fig. 5: Vector meson contribution
- Fig. 8: hadron multi in x, Q^2, $P_{h\perp}$
- Fig. 6: Asymetry

proton π^+ > deuteron π^- $\rightarrow$ valence quarks and favoured
strange supression
K^- not favored
Reminder: K^+: $u\bar{s}$ and K^-: $\bar{u}s$

Weak x and Q^2 dependance $\rightarrow$ universality

Conmparison wiht LO calculation

Fig. 9 and 10:
Different modell: DSS, HKNS, Kretzer (PDF taken from CETQ6L)