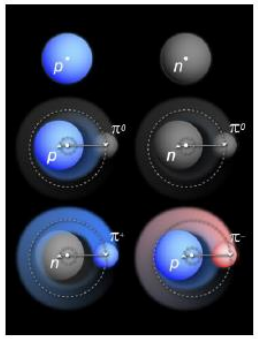
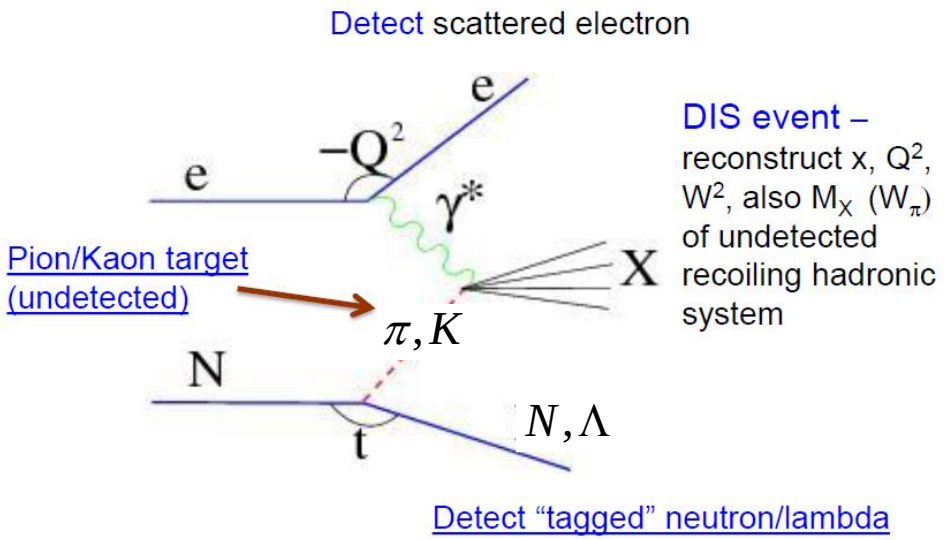
Sullivan Process (Tagged processes of DIS)

Physics Objects for Pion/Kaon Structure Studies

- Sullivan process – scattering from nucleon-meson fluctuations

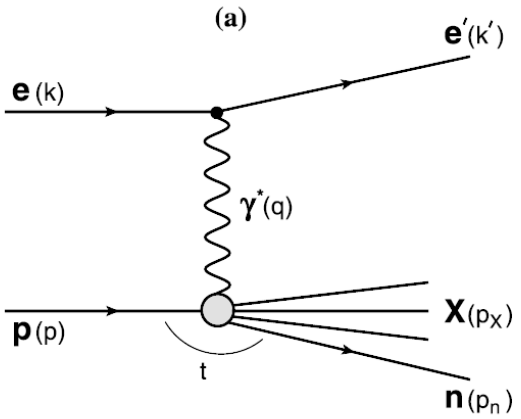


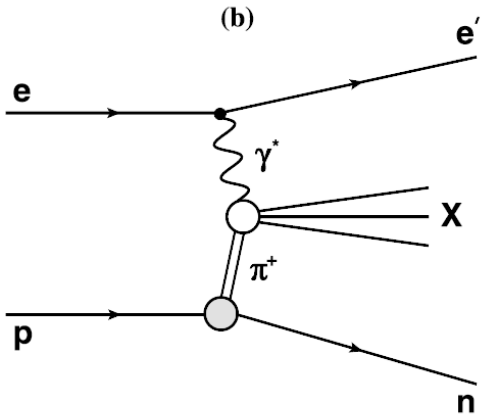


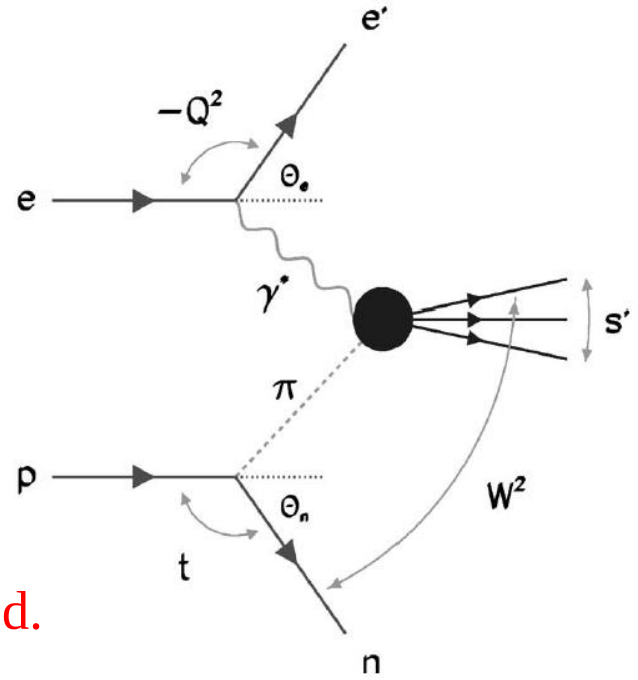
https://indico.bnl.gov/event/8315/contributions/36990/attachments/28487/43882/CFNS-Pion-Kaon-Structure-Horn-nbk.pdf

https://arxiv.org/abs/1907.08218

Reaction Diagrams and Kinematic Variables







PYTHIA 8; DIS

t and p_T of n are correlated.

$$Q^2 = -q^2, \qquad x = \frac{Q^2}{2p\cdot q}, \qquad y = \frac{p\cdot q}{p\cdot k}, \qquad y = q\cdot P/(k\cdot P) \simeq Q^2/(sx)$$

$$W^2 = (P + k - k')^2 = m_p^2 + Q^2(1-x)/x$$

$$x_L = 1 - \frac{q\cdot(p-p_n)}{q\cdot p} \simeq E_n/E_p,$$

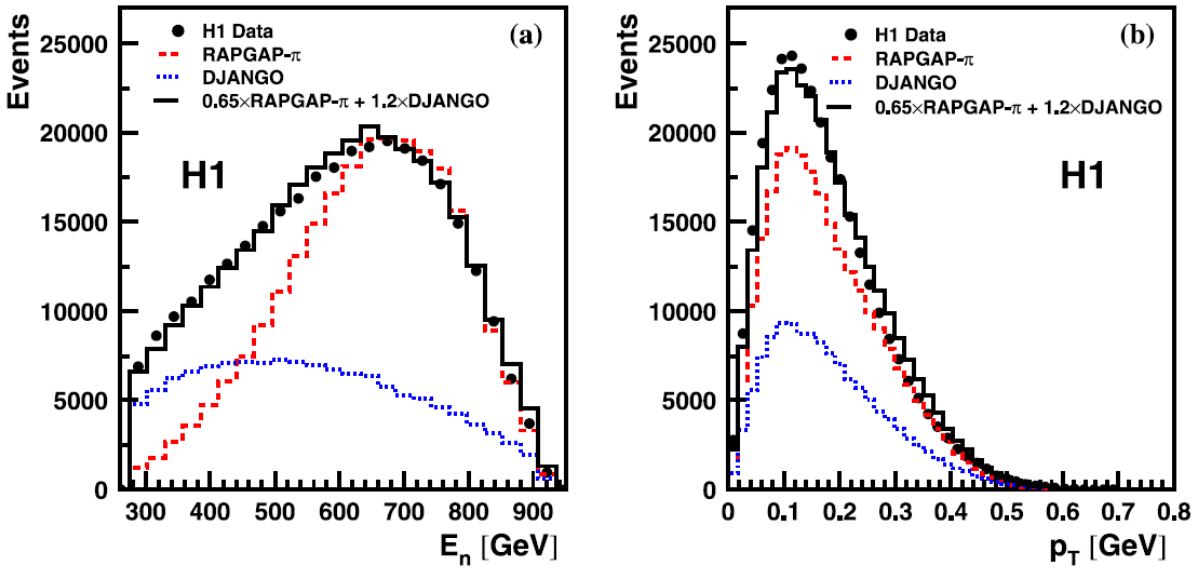
$$t = (p-p_n)^2 \simeq -\frac{p_T^2}{x_L} - (1-x_L)\left(\frac{m_n^2}{x_L} - m_p^2\right),$$

$$p_T \simeq x_L E_p \theta_n$$

$$x_\pi = \frac{x}{1-x_L}$$

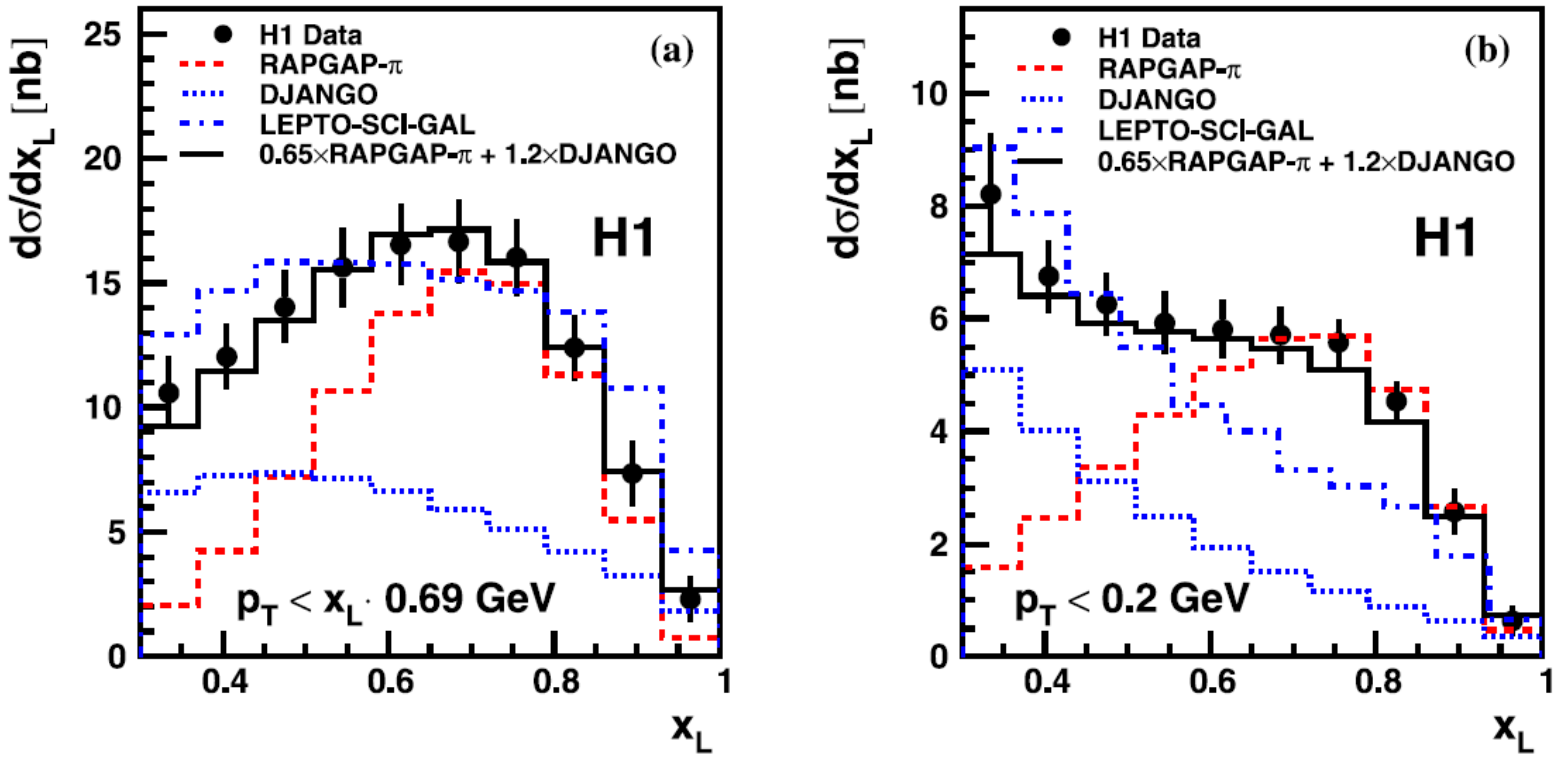
Differential cross sections

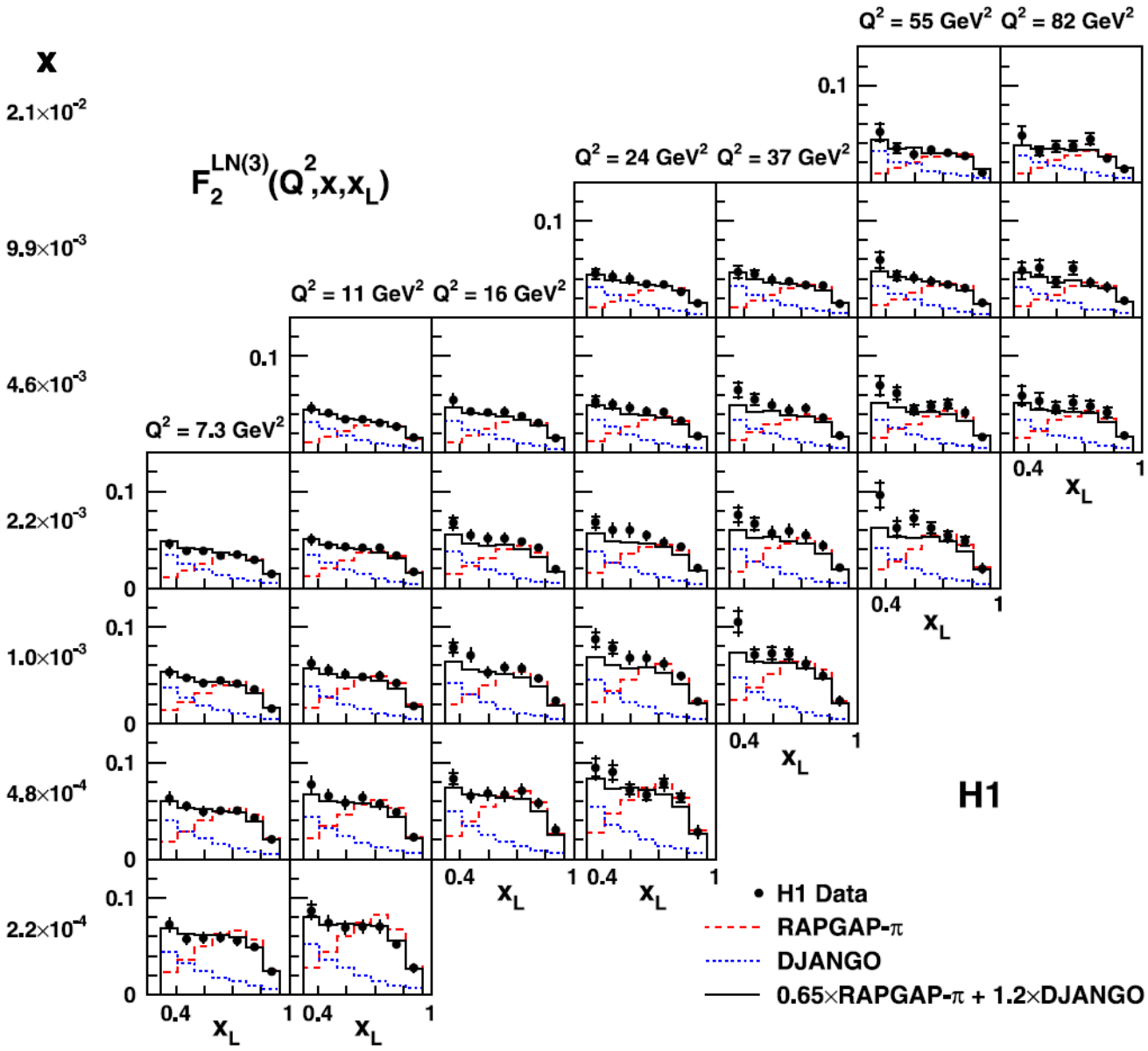
Fig. 3 The observed neutron energy (**a**) and transverse momentum (**b**) distributions in the kinematic range $6 < Q^2 < 100\ \text{GeV}^2$ and $1.5 \cdot 10^{-4} < x < 3 \cdot 10^{-2}$. The data are compared to the predictions of RAPGAP-π (*dashed line*) and DJANGO (*dotted line*) Monte Carlo simulations. Also shown is a weighted combination of those two simulations (*full line*), as described in Sect. 3.4



tion in this region. The best description of the data is achieved if the predictions of the RAPGAP-π and DJANGO Monte Carlo programs are added, using weighting factors of 0.65 and 1.2 for RAPGAP-π and DJANGO, respectively. This Monte Carlo combination is labelled as "0.65× RAPGAP-π + 1.2×DJANGO" in the figures and is used to correct the data.

Differential cross sections




x
$F_2^{LN(3)}(Q^2,x,x_L)$
Q^2 = 7.3 GeV^2
Q^2 = 11 GeV^2
Q^2 = 16 GeV^2
Q^2 = 24 GeV^2
Q^2 = 37 GeV^2
Q^2 = 55 GeV^2
Q^2 = 82 GeV^2
2.1×10^{-2}
9.9×10^{-3}
4.6×10^{-3}
2.2×10^{-3}
1.0×10^{-3}
4.8×10^{-4}
2.2×10^{-4}
0.1
0
0.4
1
x_L
H1
H1 Data
RAPGAP-π
DJANGO
0.65×RAPGAP-π + 1.2×DJANGO

Feature	**LEPTO**	**PYTHIA (standalone)**
Remnant Modeling	Implements a detailed model: the nucleon remnant is split based on color flow and spectator partons are treated accordingly.	Handles the remnant more generically; less accurate for DIS if not specially tuned.
Beam Remnant Mass	Calculates and assigns mass, momentum, and color structure using PDFs and a spectator model.	Assigns remnant typically by balancing momentum and color, often simplified unless extended.
Remnant Fragmentation	Uses **Lund string model** via interface with PYTHIA, but with DIS-specific constraints on remnant.	Also uses Lund string, but assumes simpler beam remnants unless configured for DIS.
Initial State Configuration	More accurately handles DIS initial conditions and color flow specific to a lepton-nucleon collision.	Designed for pp/p$\bar{p}$, so must be adapted for DIS context.

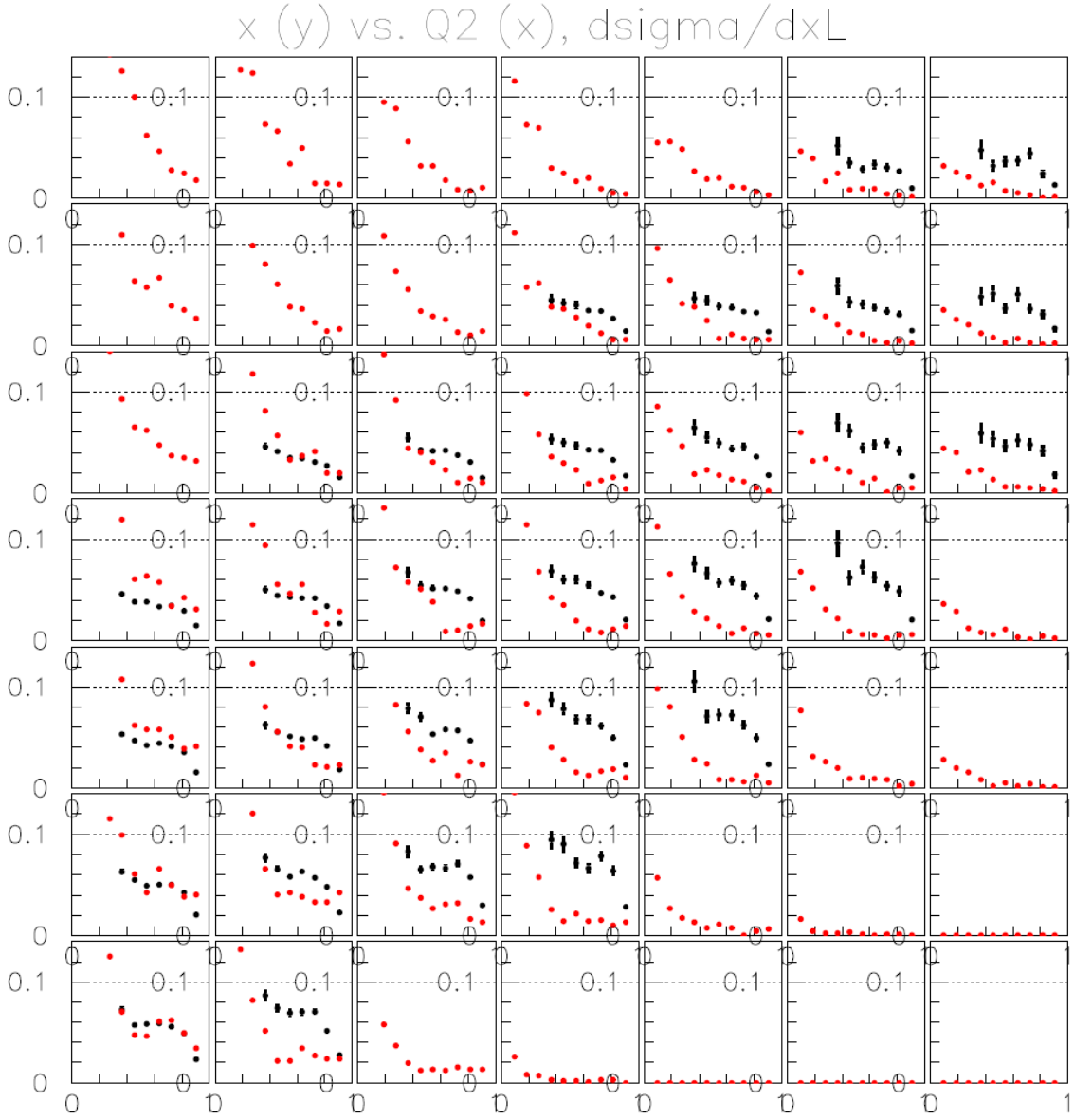
🎯 Visualization (Simplified String Schematic)

sql

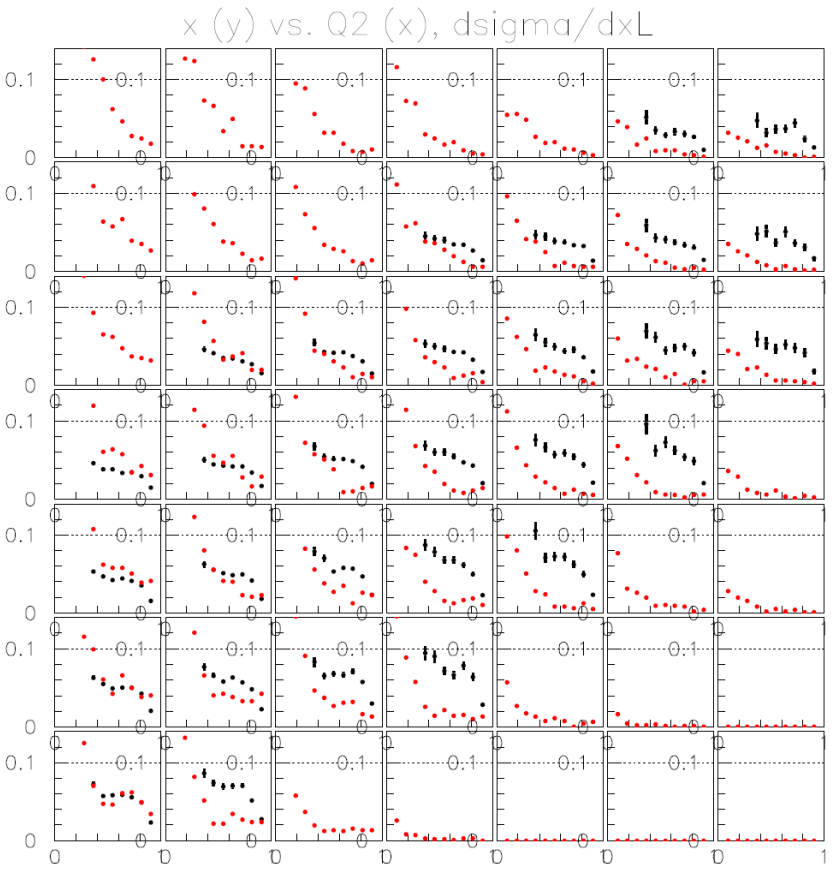
複製 編輯

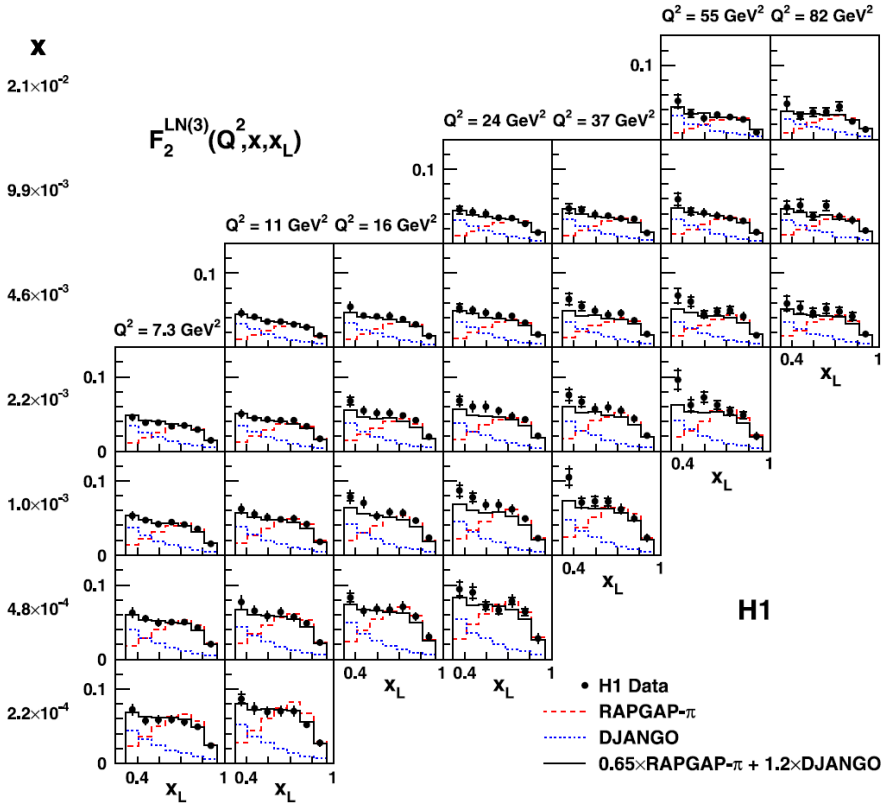
```
 LEPTO Color String:
 -------------------
 e- → γ* → u   (scattered quark, jet)
           \
            [string]
           /
(ud diquark remnant) — slow baryonic system

 PYTHIA (default):
 -----------------
 e- → γ* → u
           \
            [string]
           /
remnant blob (simplified, possibly no diquark handling)
```

PYTHIA 8; DIS



PYTHIA 8; DIS


x (y) vs. Q2 (x), dsigma/dxL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x_L
H1
H1 Data
RAPGAP-π
DJANGO
0.65×RAPGAP-π + 1.2×DJANGO

LEPTO

https://github.com/JeffersonLab/clasdis