PARTON DISTRIBUTION OF STRANGE QUARKS RE-EVALUATED

XXII. International Workshop on Deep-Inelastic Scattering and Related Subjects
Warsaw, 28 April - 2 May 2014

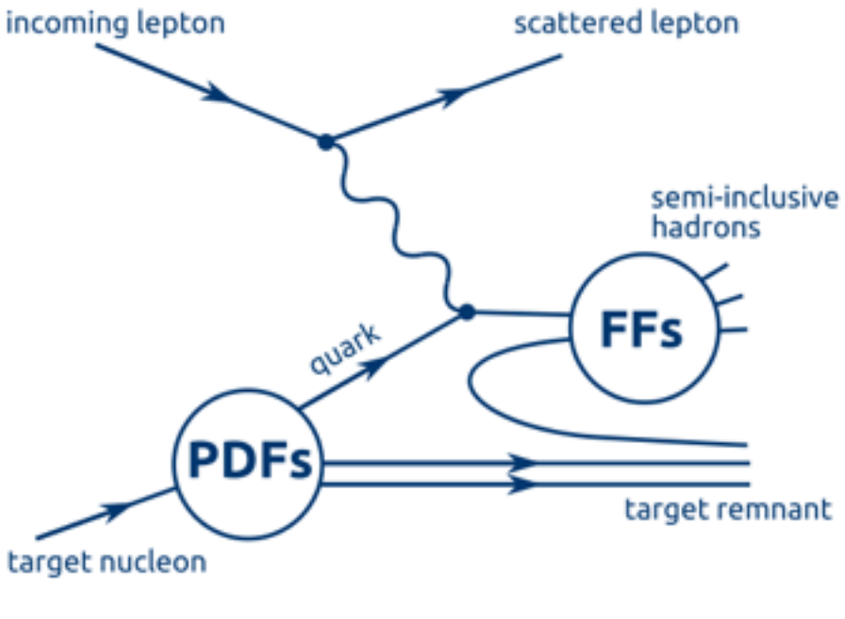
Francesca Giordano, for the Hermes collaboration

DIS 2014

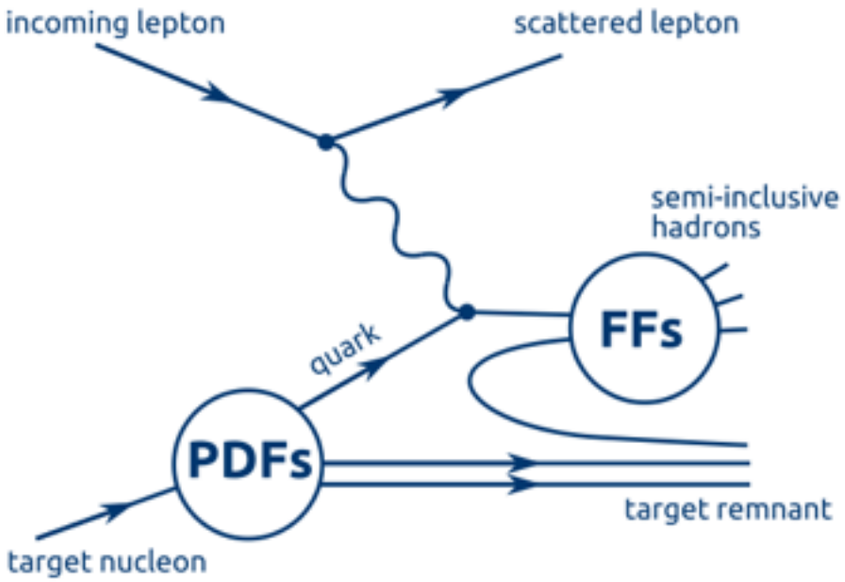
ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

hermes

Semi-Inclusive DIS



Semi-Inclusive DIS

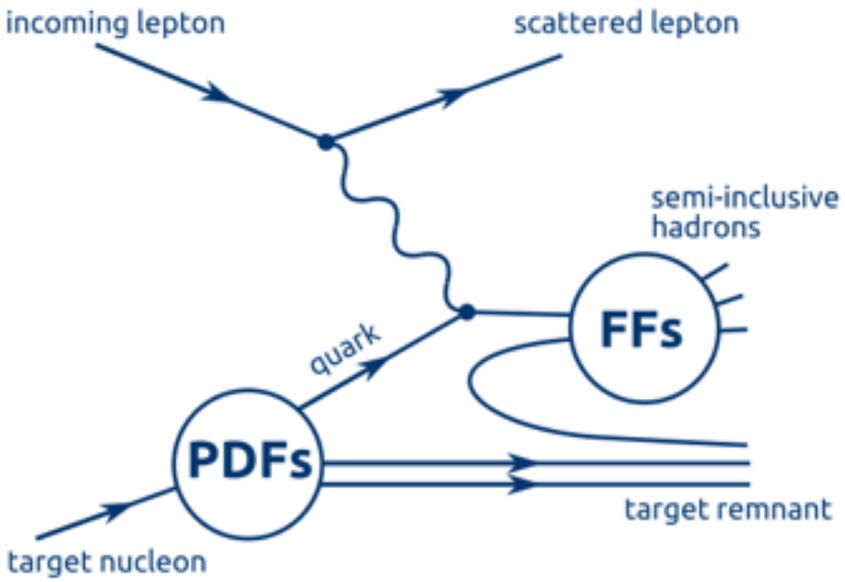


$$K = K^+ + K^-$$

$$\frac{d^2N^K(x)}{d^2N^{DIS}(x)}$$

= Multiplicities

Semi-Inclusive DIS



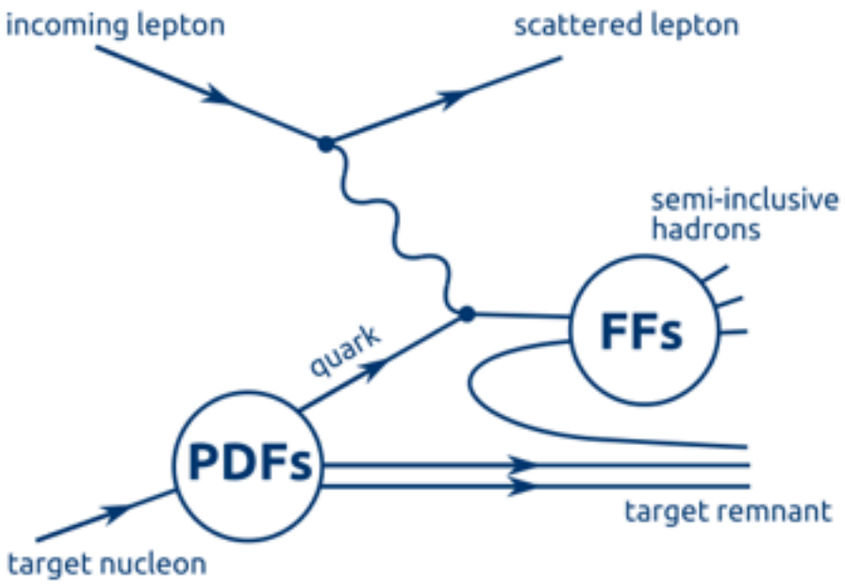
$$K = K^+ + K^-$$

$$\frac{d^2N^K(x)}{d^2N^{DIS}(x)} \overset{\text{LO}}{=} \frac{Q(x)\int D_Q^K(z)dz + S(x)\int D_S^K(z)dz}{5Q(x) + 2S(x)}$$

isoscalar target (D)

= Multiplicities

Semi-Inclusive DIS



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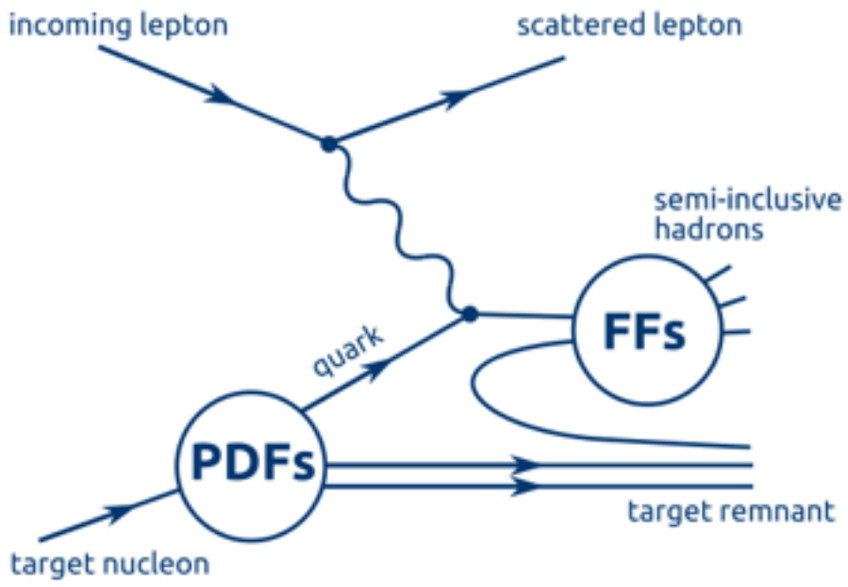
Parton distribution function — Fragmentation function — Parton distribution function — Fragmentation function

= Multiplicities

Semi-Inclusive DIS



$$Q(x) \equiv u(x) + \overline{u}(x) + d(x) + \overline{d}(x)$$

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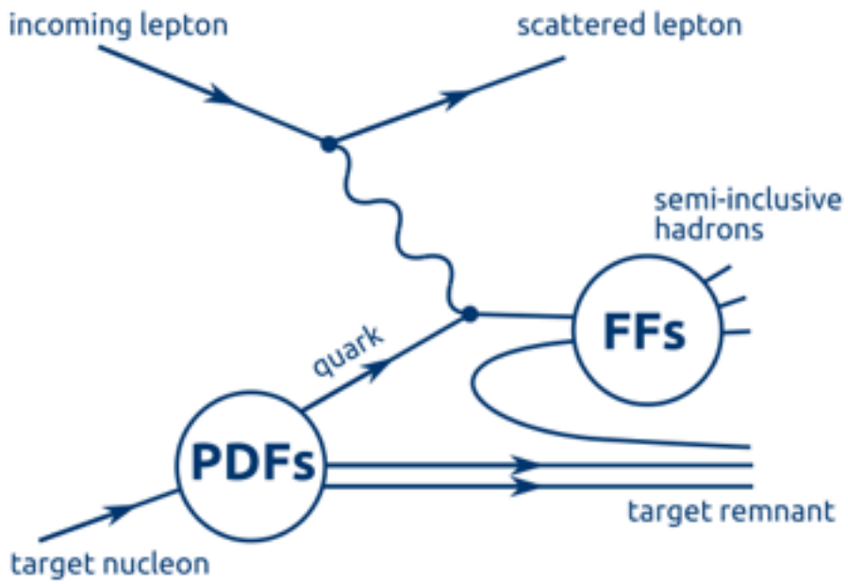

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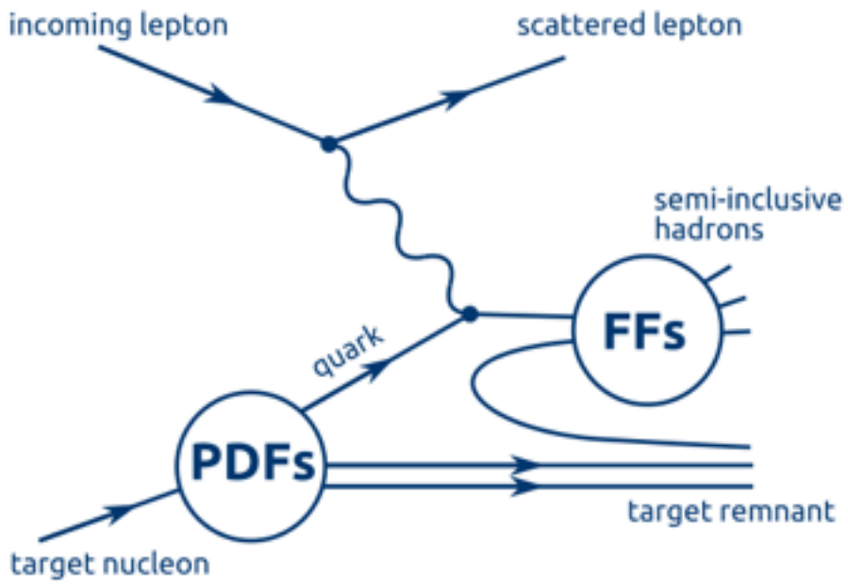

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isoscalar target (D)

= Multiplicities

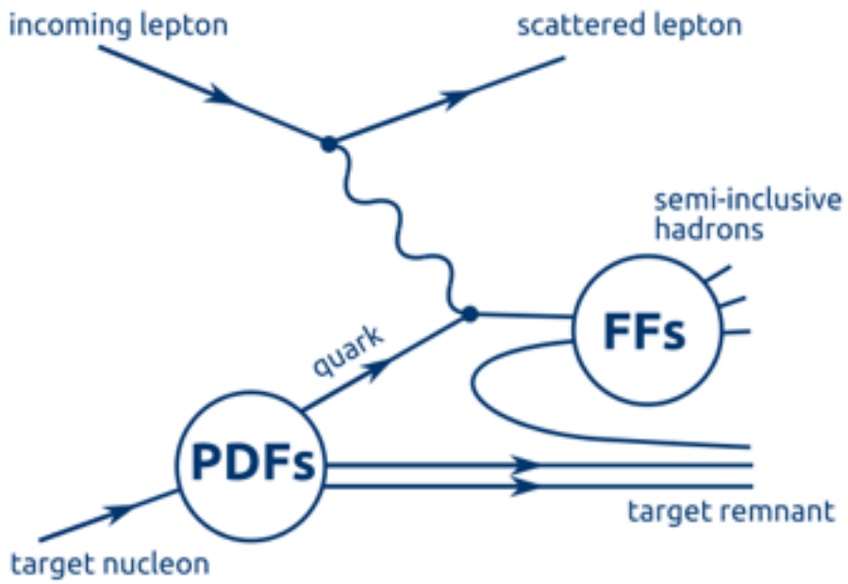
Q^2 Negative squared 4-momentum transfer to the target

$\mathbf{x}$ Parton fractional momentum

$\mathbf{z}$ Fractional energy transfer to the produced hadron

$P_{h\perp}$ Hadron transverse momentum with respect to the virtual photon direction

Semi-Inclusive DIS



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isoscalar target (D)

= Multiplicities

First Hermes extraction:
Phys.Lett. B666, 446 (2008)

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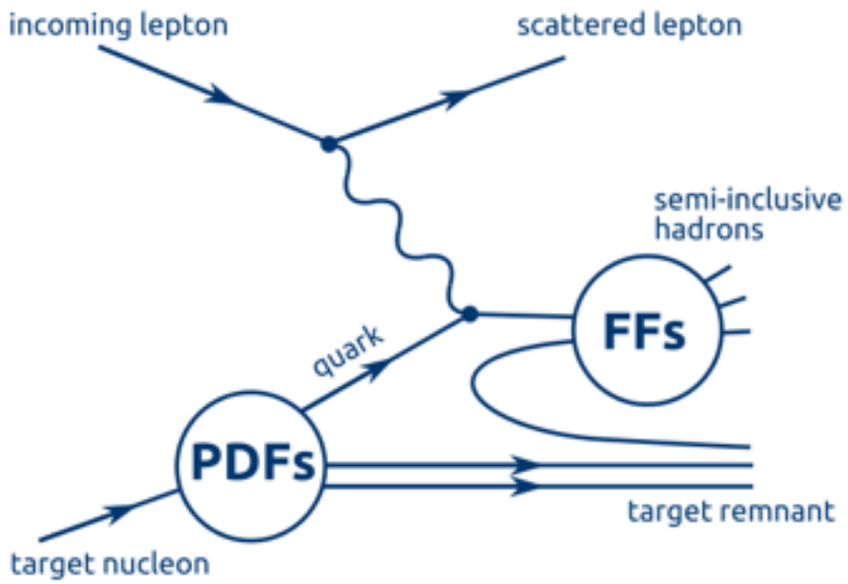
Semi-Inclusive DIS



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Updated and final data now!

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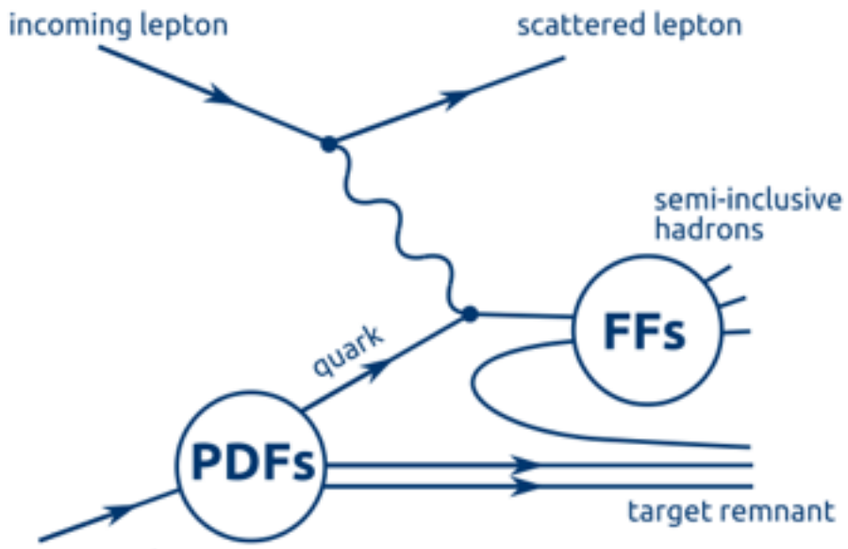

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arXiv:1312.7028, submitted to PRD

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HERMES @ HERA


Norway
Finland
Helsinki
St Petersburg
Stockholm
Tallinn
Baltic Sea
Estonia
Latvia
Lithuania
North Sea
Denmark
United Kingdom
Hamburg
hermes
Berlin
Belarus
Ireland
Netherlands
London
Poland
Belgium
Germany
Prague
Kyiv
Czech Rep
Paris
Celtic Sea
Munich
Vienna
Slovakia
Ukraine
Austria
Moldova
Hungary
France
Zagreb
Romania
Bay of Biscay
Croatia
Bucharest
Serbia
Black Sea
Italy
Bulgaria
Rome
Istanbul
Portugal
Madrid
Spain
Greece
Athens
Algiers
Tunis

HERMES @ HERA

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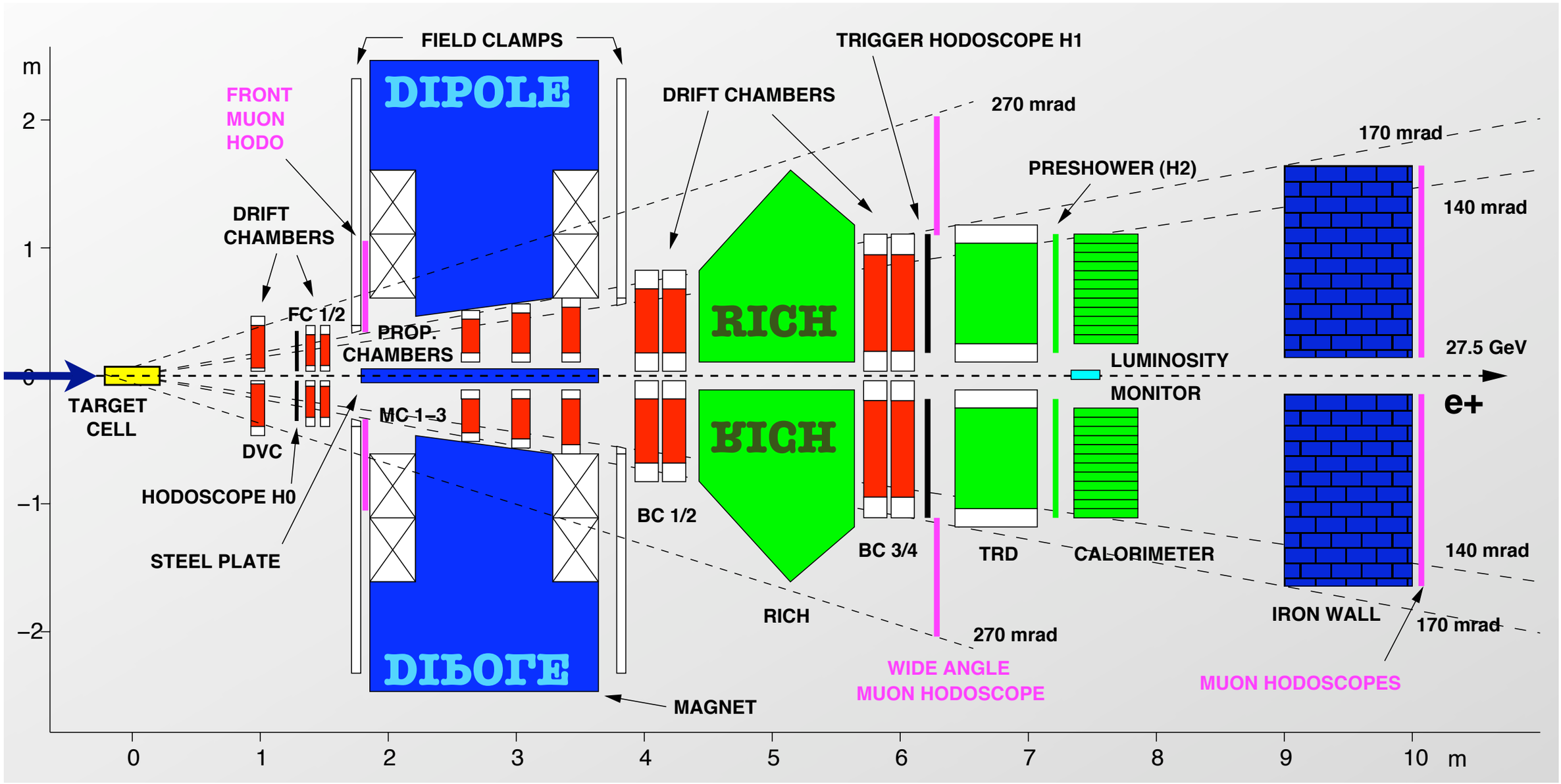
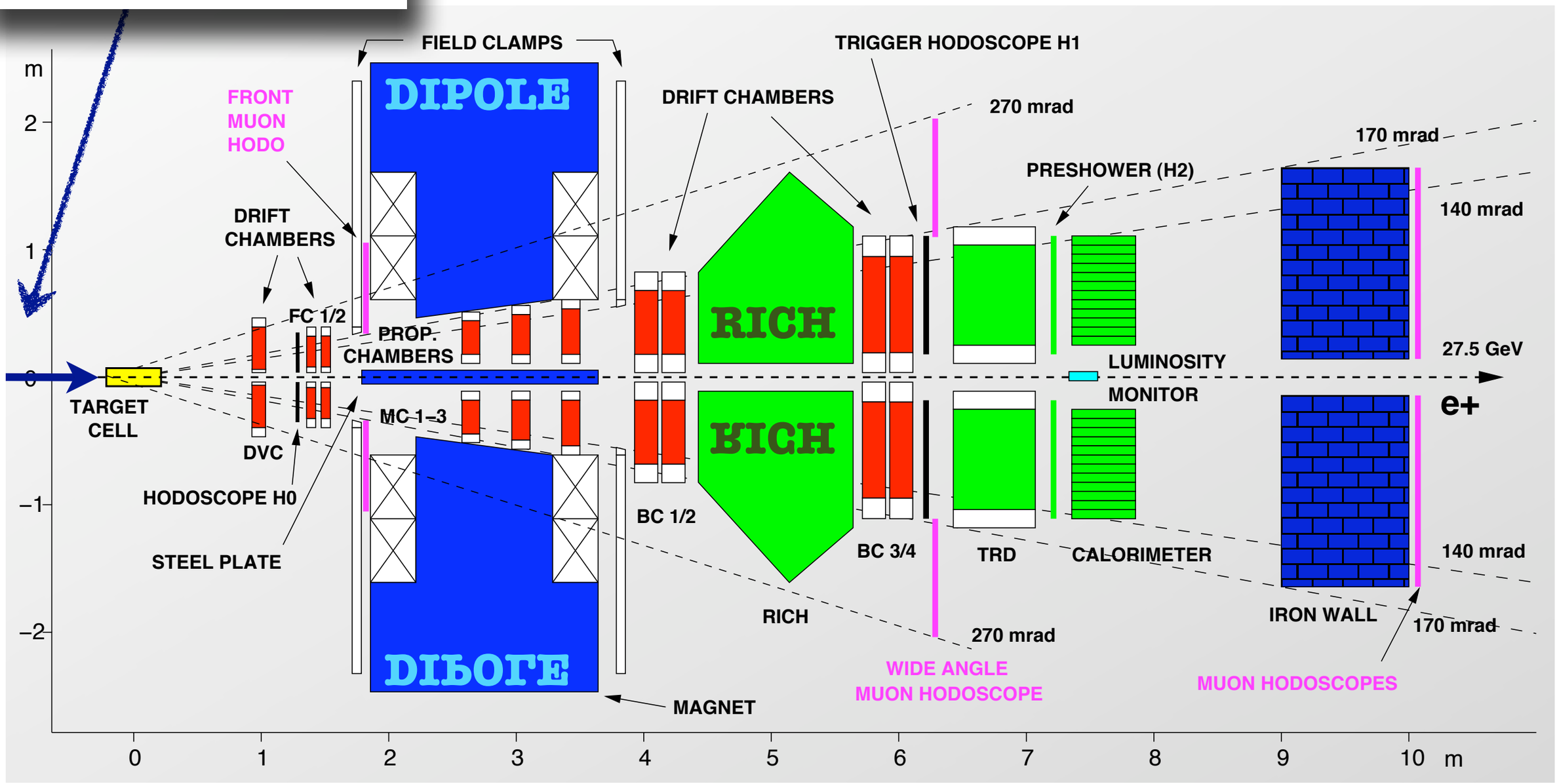
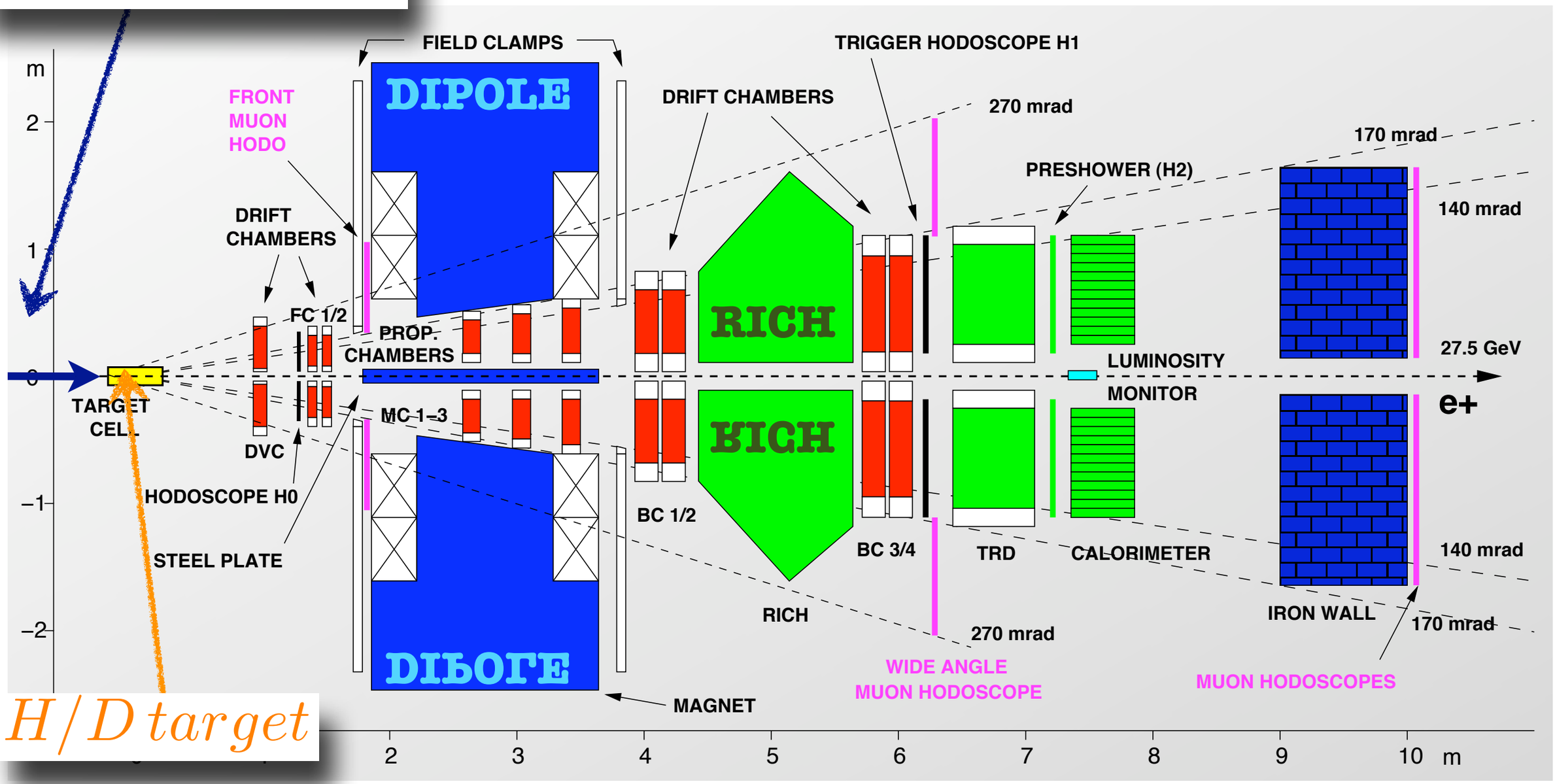
27.6 GeV (e^+/e^-) lepton beam off D/H target


FIELD CLAMPS
TRIGGER HODOSCOPE H1
DIPOLE
FRONT MUON HODO
DRIFT CHAMBERS
270 mrad
170 mrad
PRESHOWER (H2)
DRIFT CHAMBERS
140 mrad
FC 1/2
PROP. CHAMBERS
RICH
LUMINOSITY
27.5 GeV
TARGET CELL
MONITOR
e+
MC 1–3
DVC
HODOSCOPE H0
BC 1/2
BC 3/4
TRD
CALORIMETER
STEEL PLATE
140 mrad
RICH
IRON WALL
270 mrad
170 mrad
WIDE ANGLE MUON HODOSCOPE
MUON HODOSCOPES
MAGNET
m
2
1
0
−1
−2
0
1
2
3
4
5
6
7
8
9
10
m

$27.6\,GeV\ e^{\pm}\ beam$



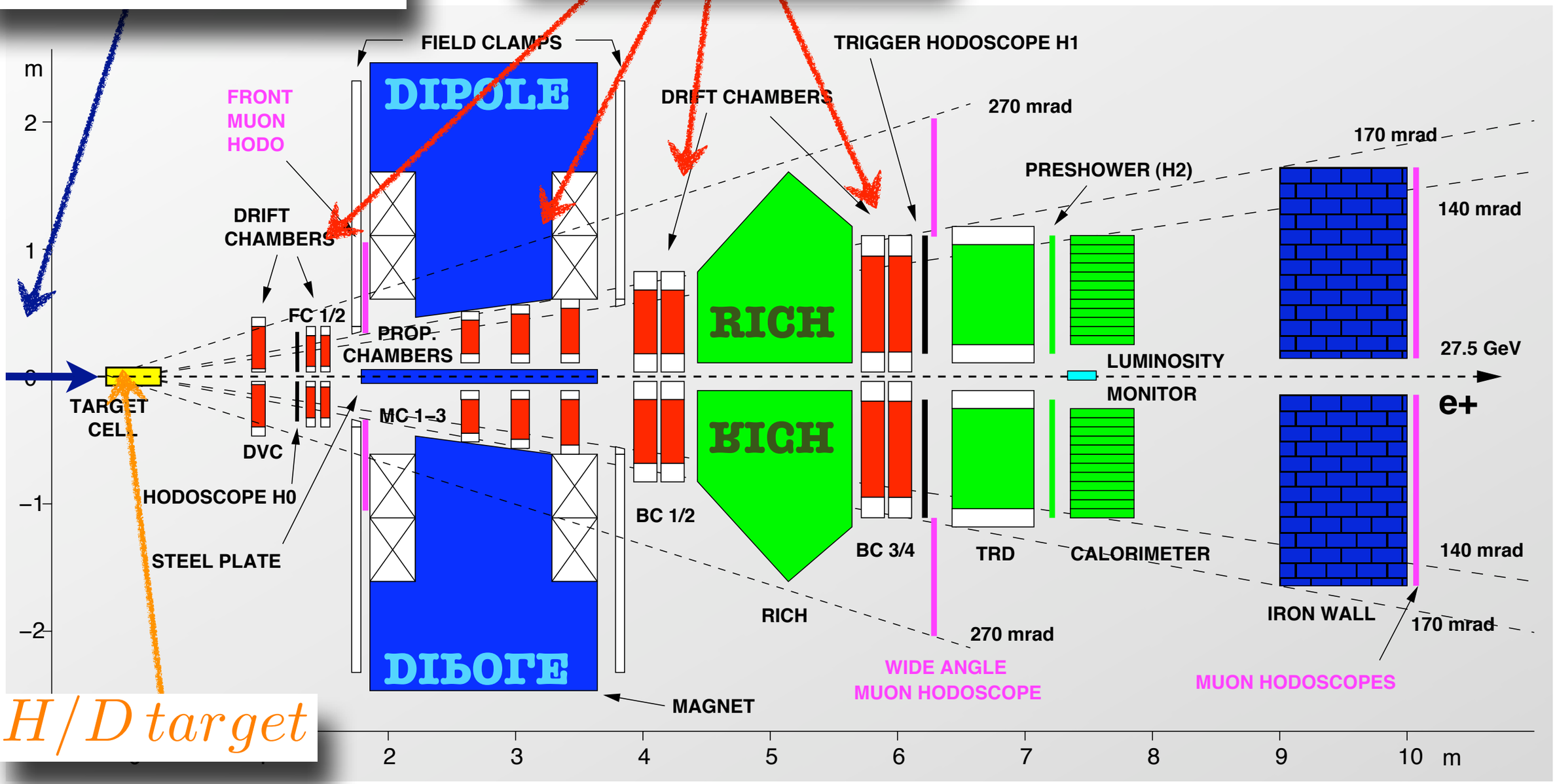
$27.6\,GeV\ e^{\pm}\ beam$



$H/D\ target$

$27.6\,GeV\ e^{\pm}\ beam$

tracking detectors



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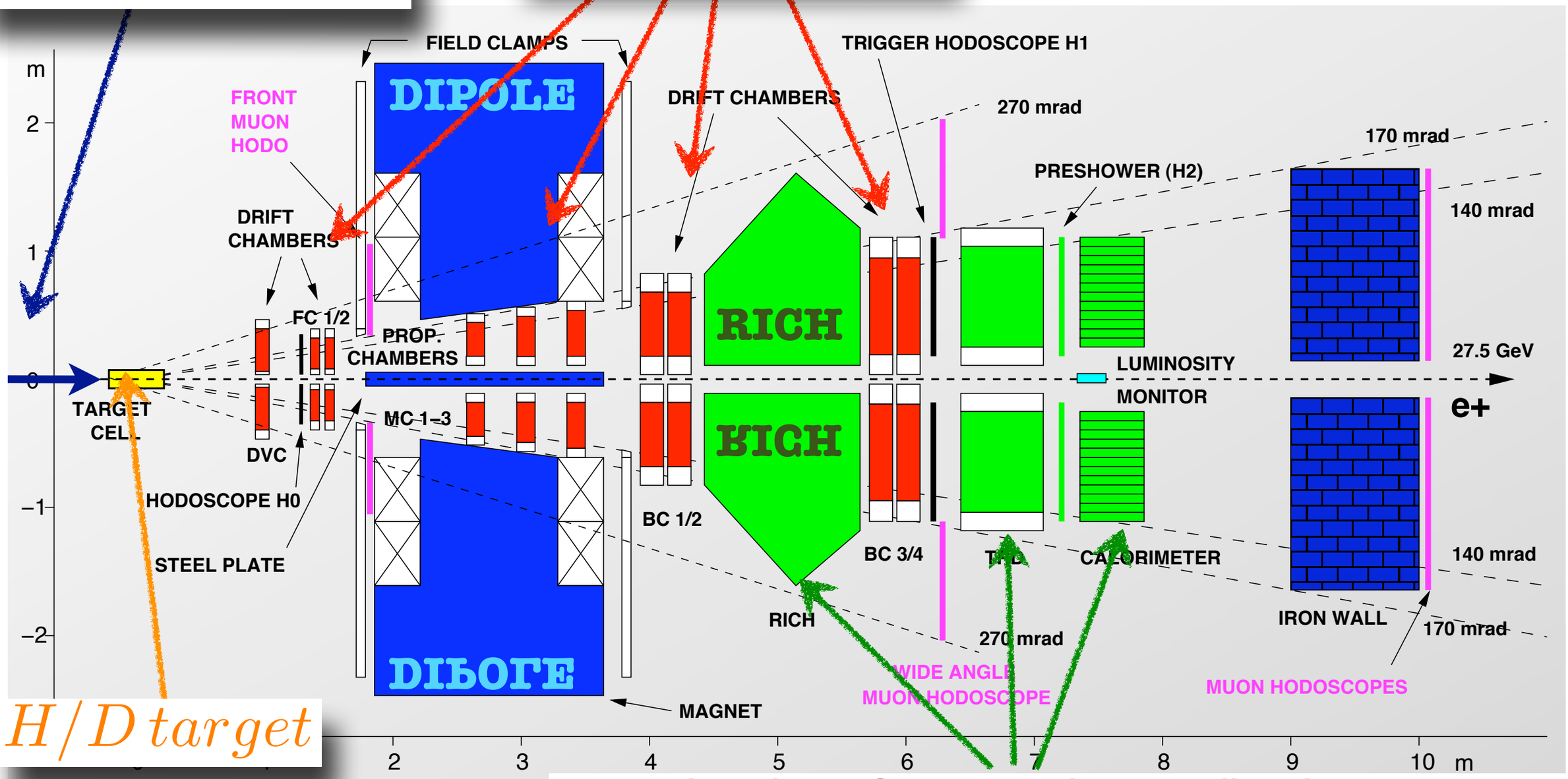
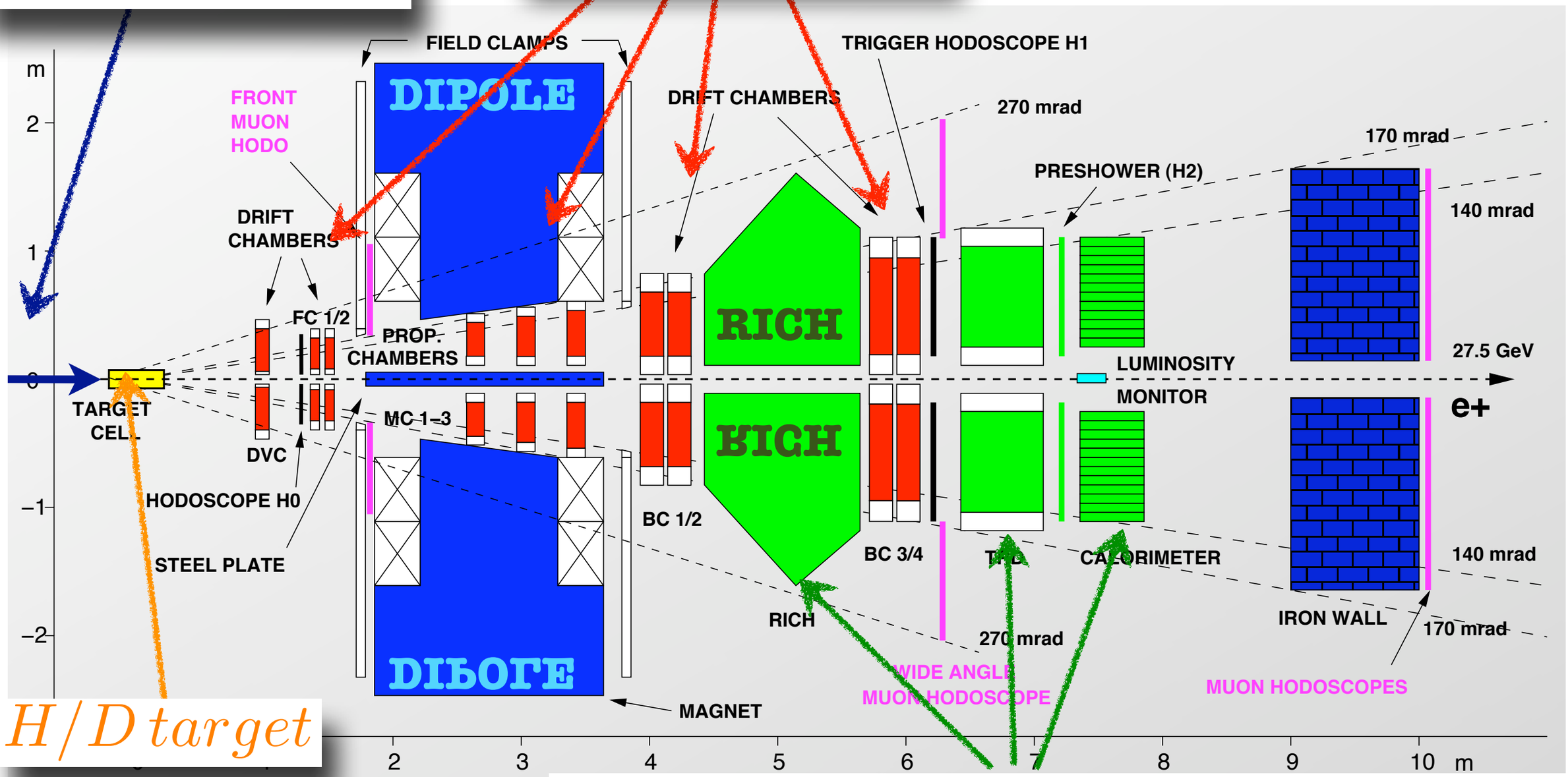


$H/D\ target$

particle identification: lepton/hadron separation

$27.6\,GeV\ e^{\pm}\ beam$

tracking detectors



$H/D\ target$

particle identification: lepton/hadron separation

RICH: discrimination between charged π / K / p

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$27.6\,GeV\ e^{\pm}\ beam$

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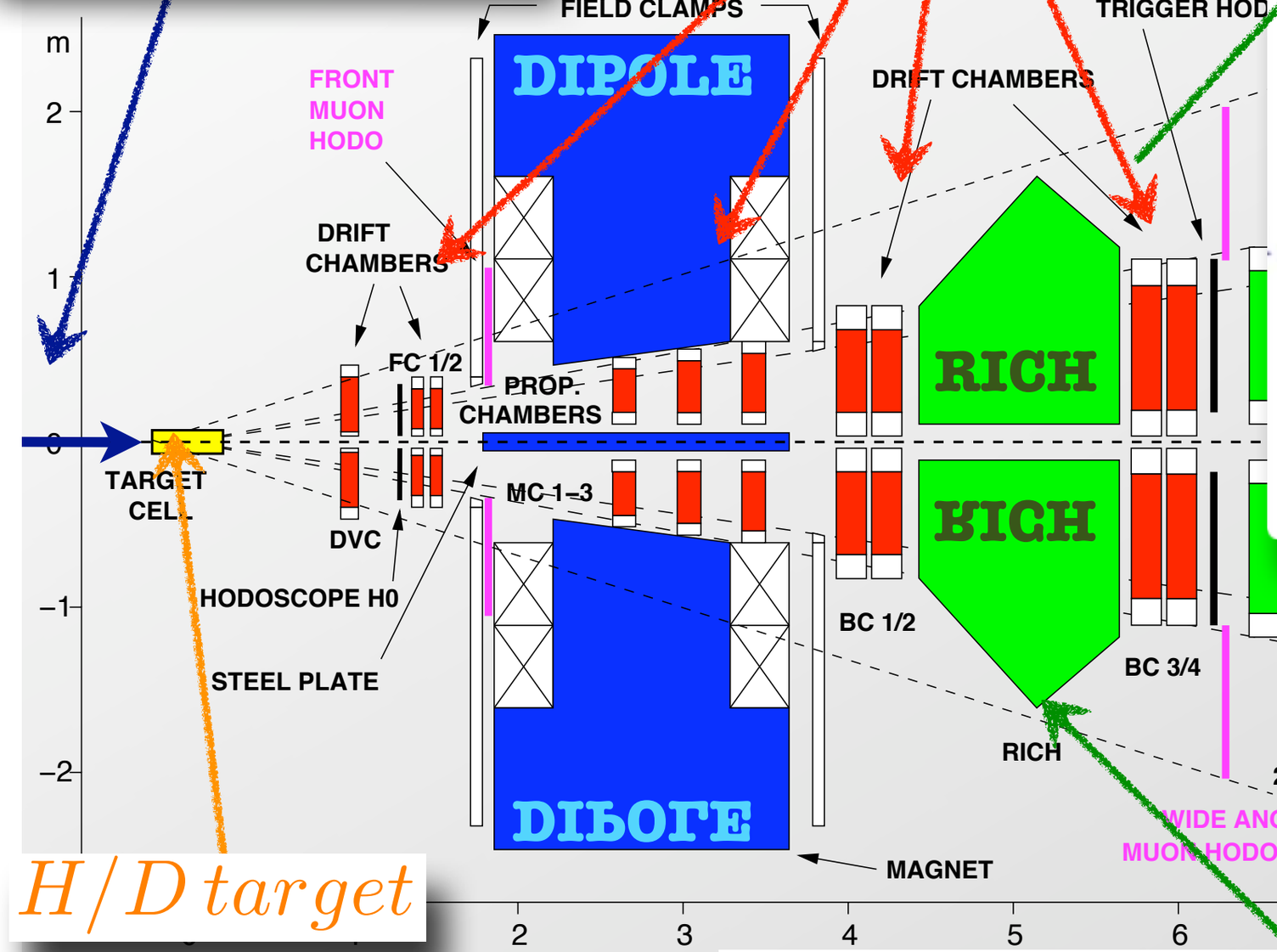

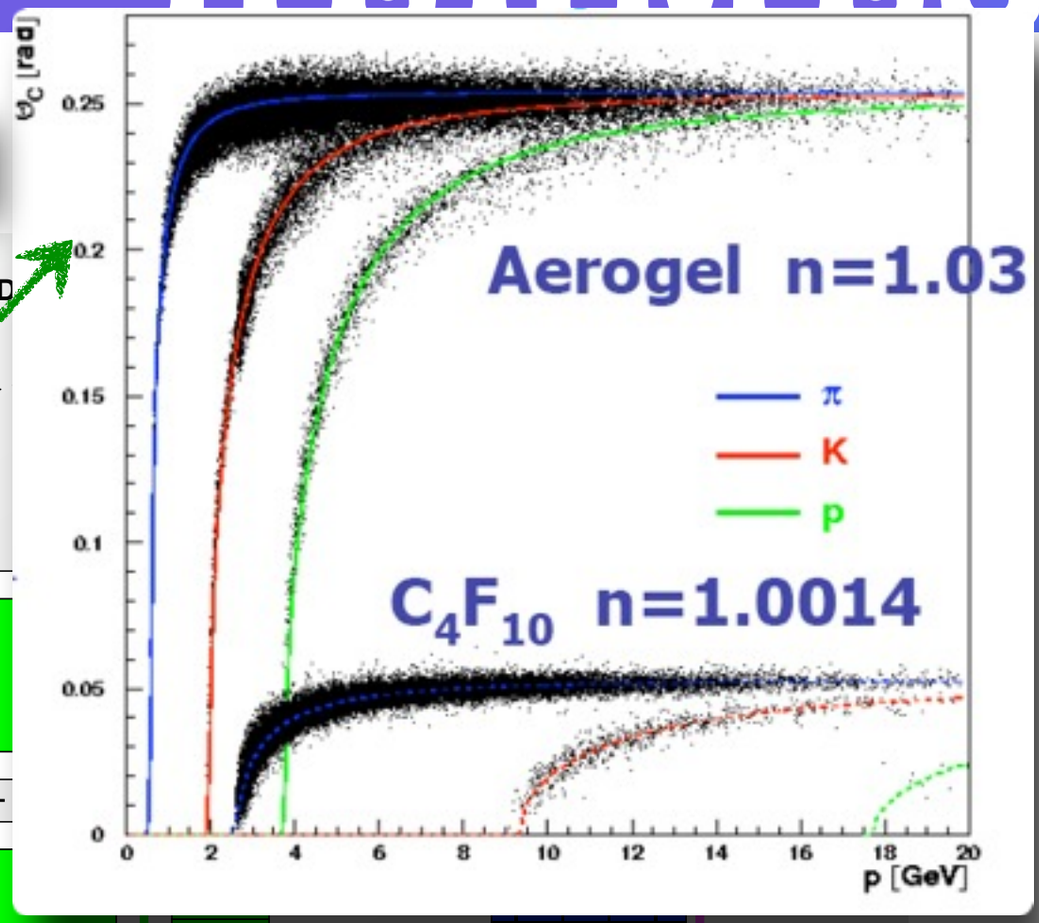

$H/D\ target$

particle identification: lepton/hadron separation

RICH: discrimination between charged π / K / p

New multiplicities

- More data (~ factor 2)
- New 3-dimensional (x-z-$P_{h\perp}$) unfolding to correct for acceptance, radiative effects, smearing, decay in flight and secondary strong interactions
- Final 3-dimensional results corrected to 4π Born

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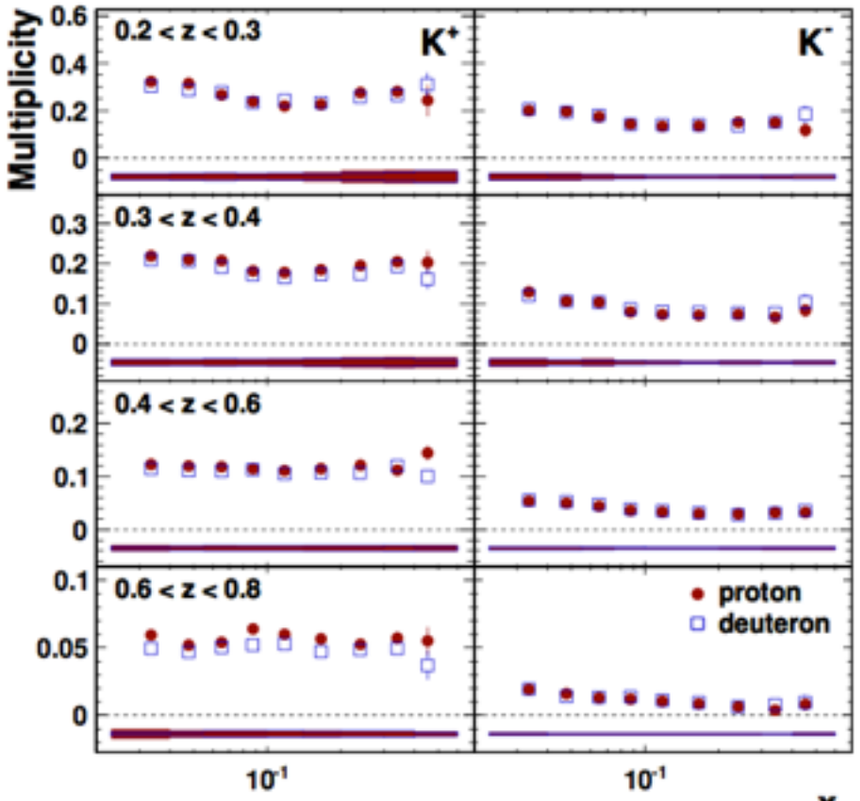

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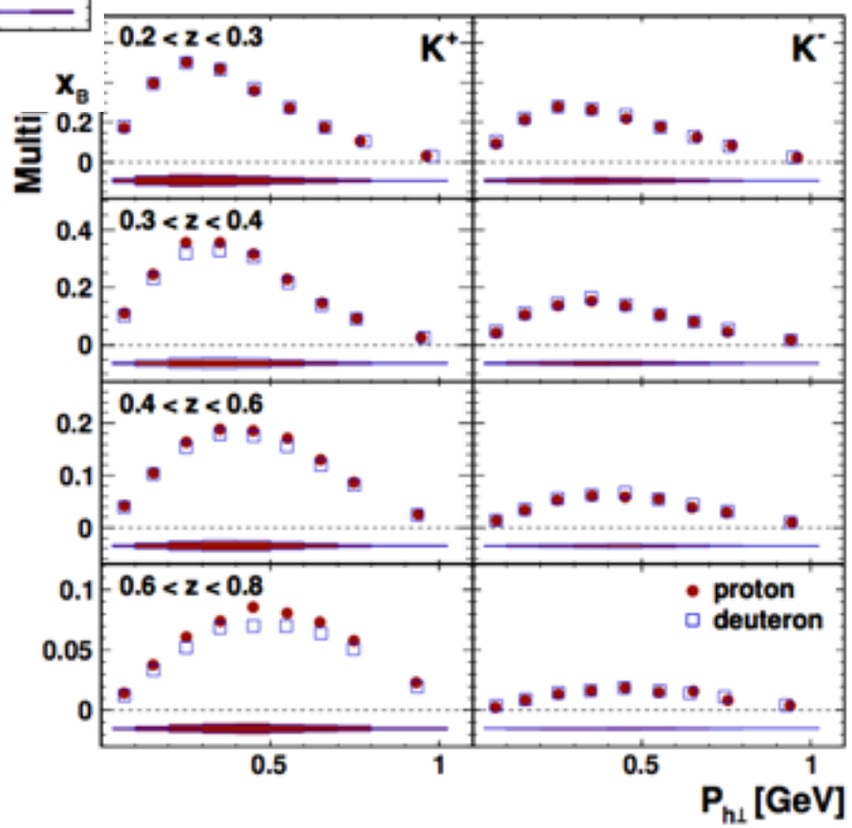

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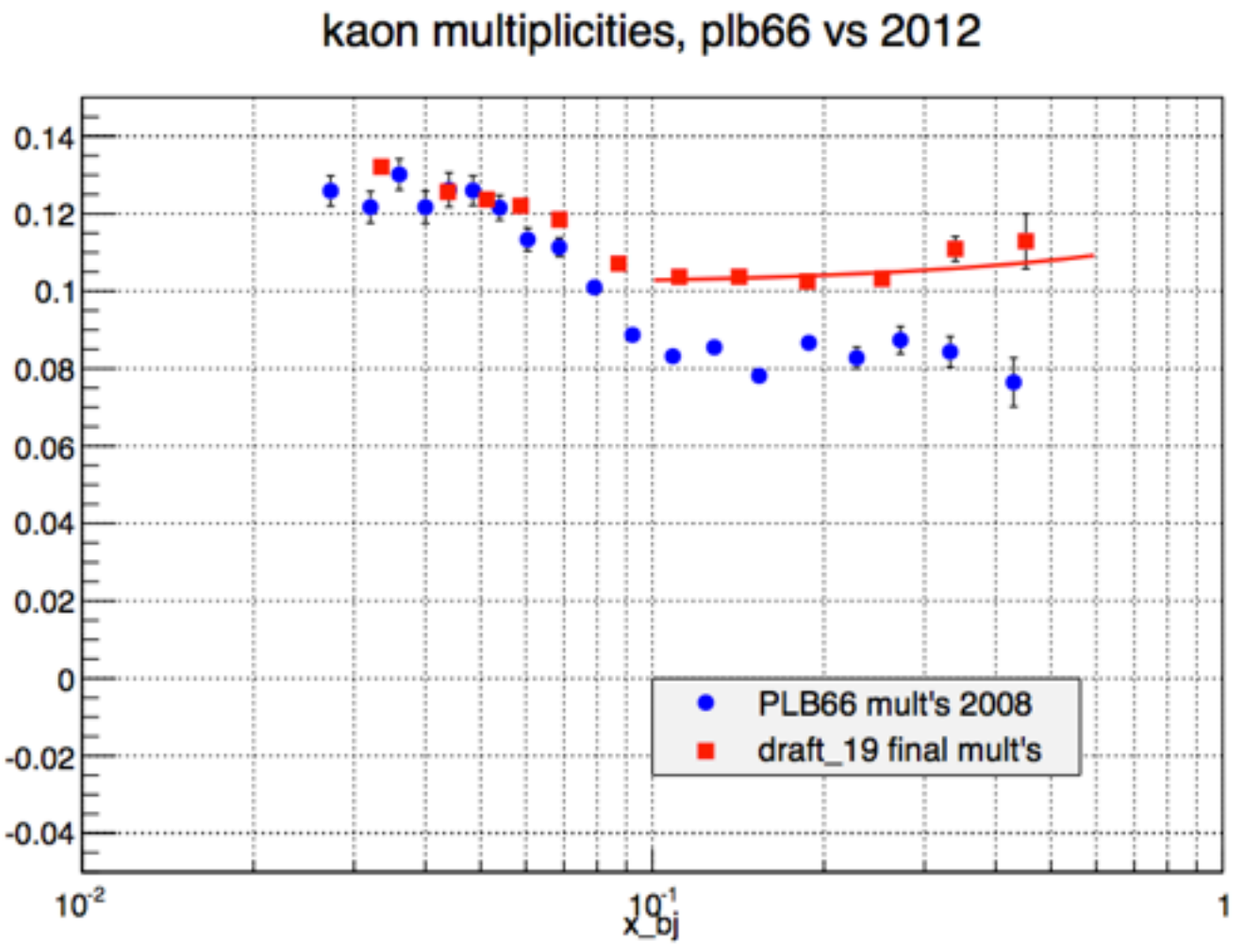
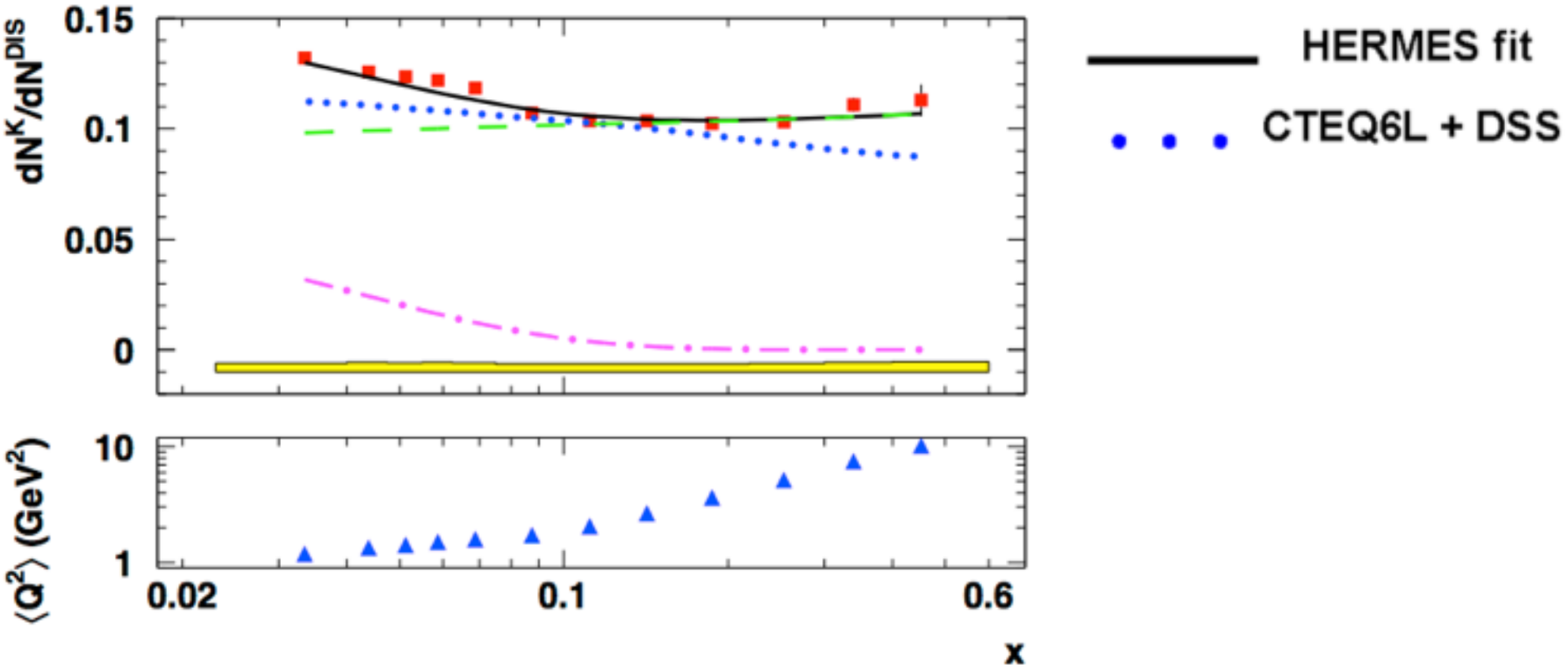


Valence region



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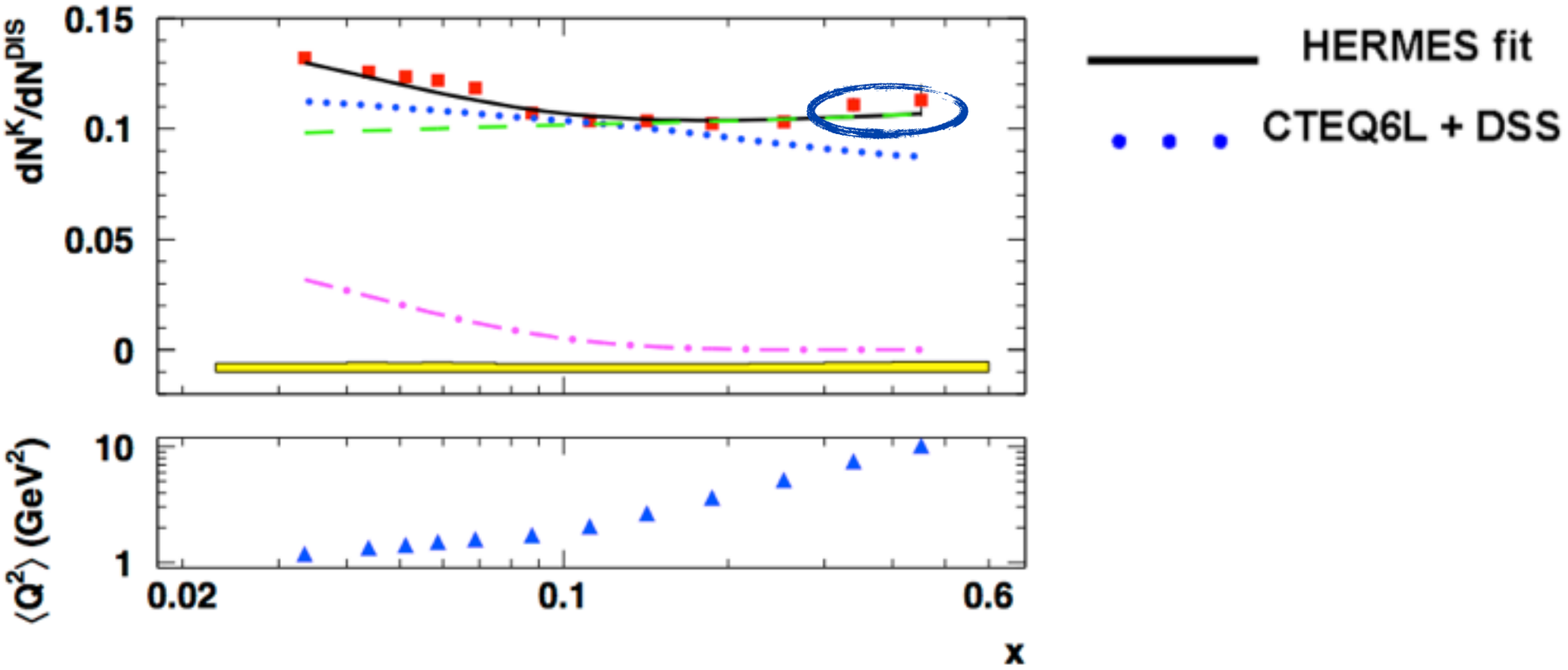

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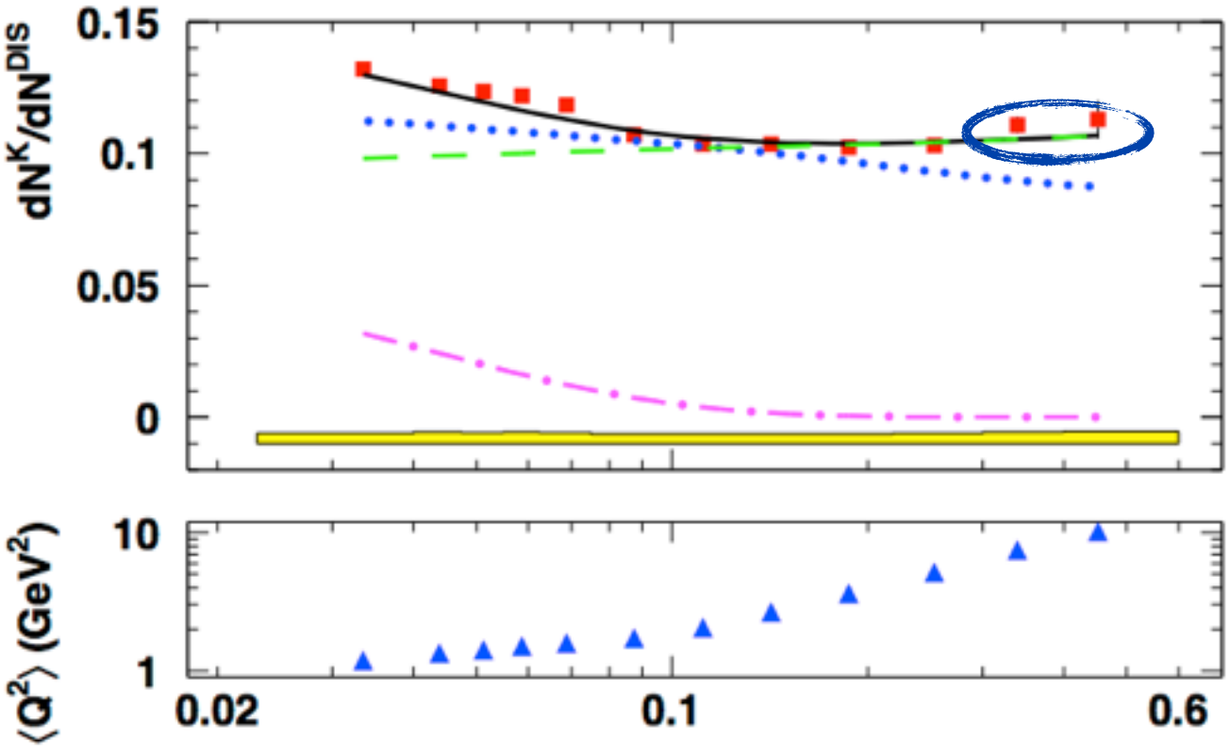

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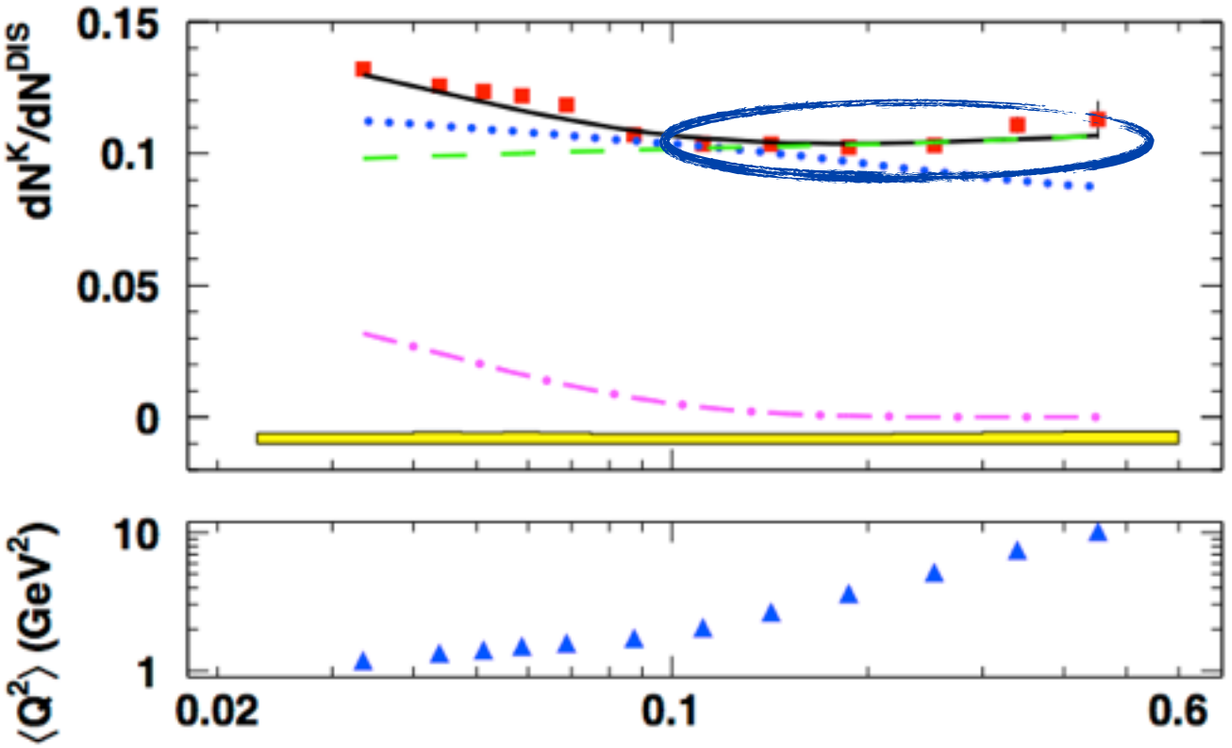
x>0.35

$S(x) \to 0$

$$\frac{\int D_Q^K(z)dz}{5}$$

Valence region



HERMES fit

CTEQ6L + DSS

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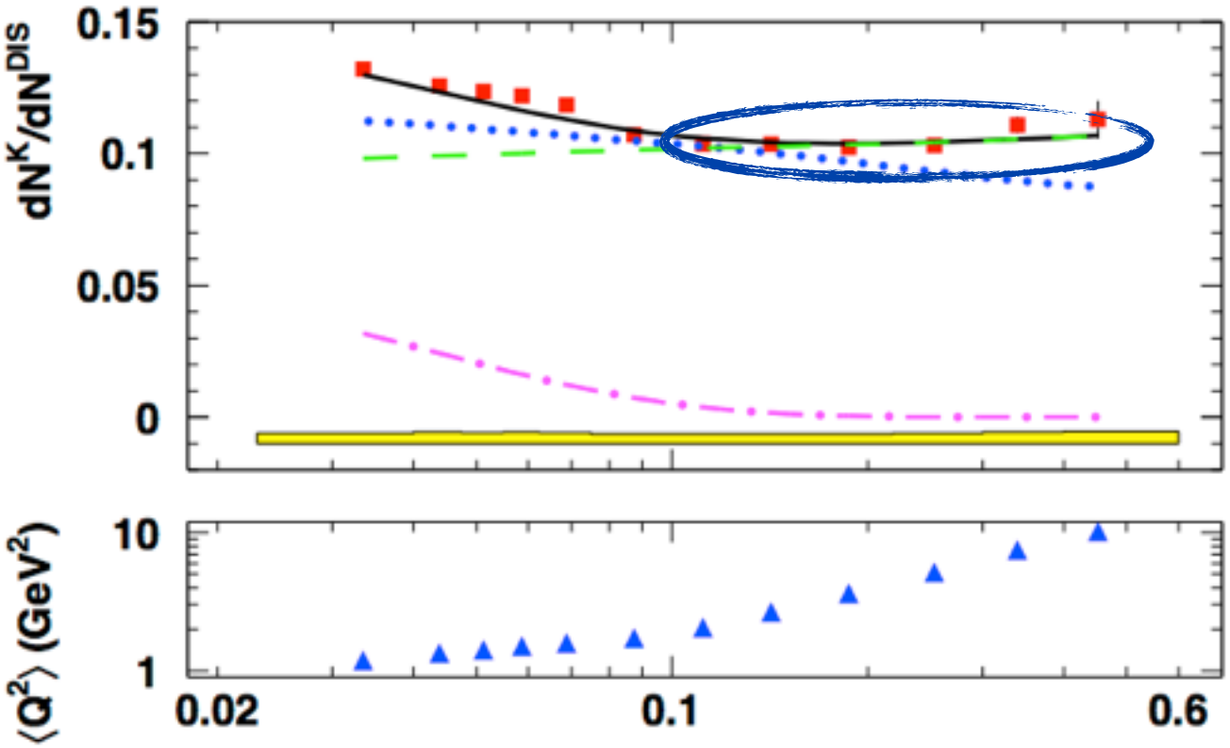

HERMES fit

CTEQ6L + DSS

non-Strange component

(linear fit for x>0.1)

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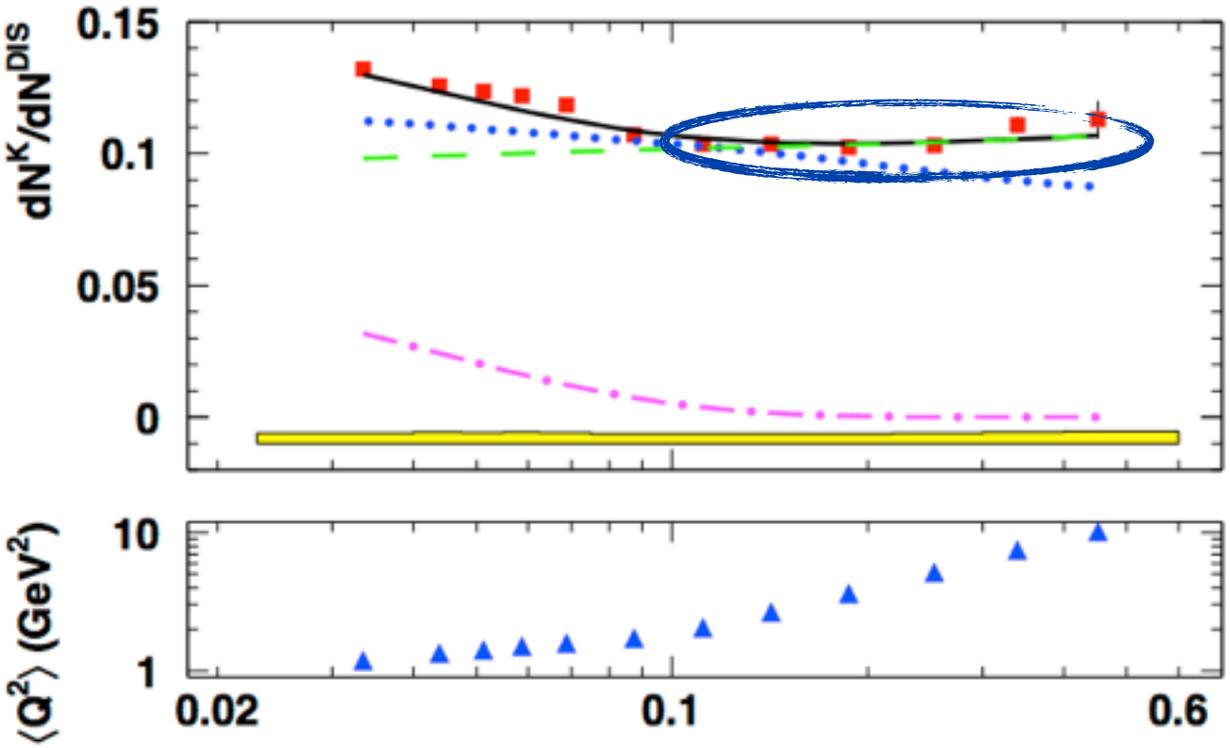

HERMES fit

CTEQ6L + DSS

non-Strange component

(linear fit for x>0.1)

$$\int_{0.2}^{0.8} D_Q^K(z,Q^2)dz = 0.514 \pm 0.010$$

$$Q^2 = 2.5\,GeV$$

$$\frac{d^2N^K(x)}{d^2N^{DIS}(x)} \overset{\text{LO}}{=} \frac{Q(x)\int D_Q^K(z)dz + S(x)\int D_S^K(z)dz}{5Q(x)+2S(x)}$$

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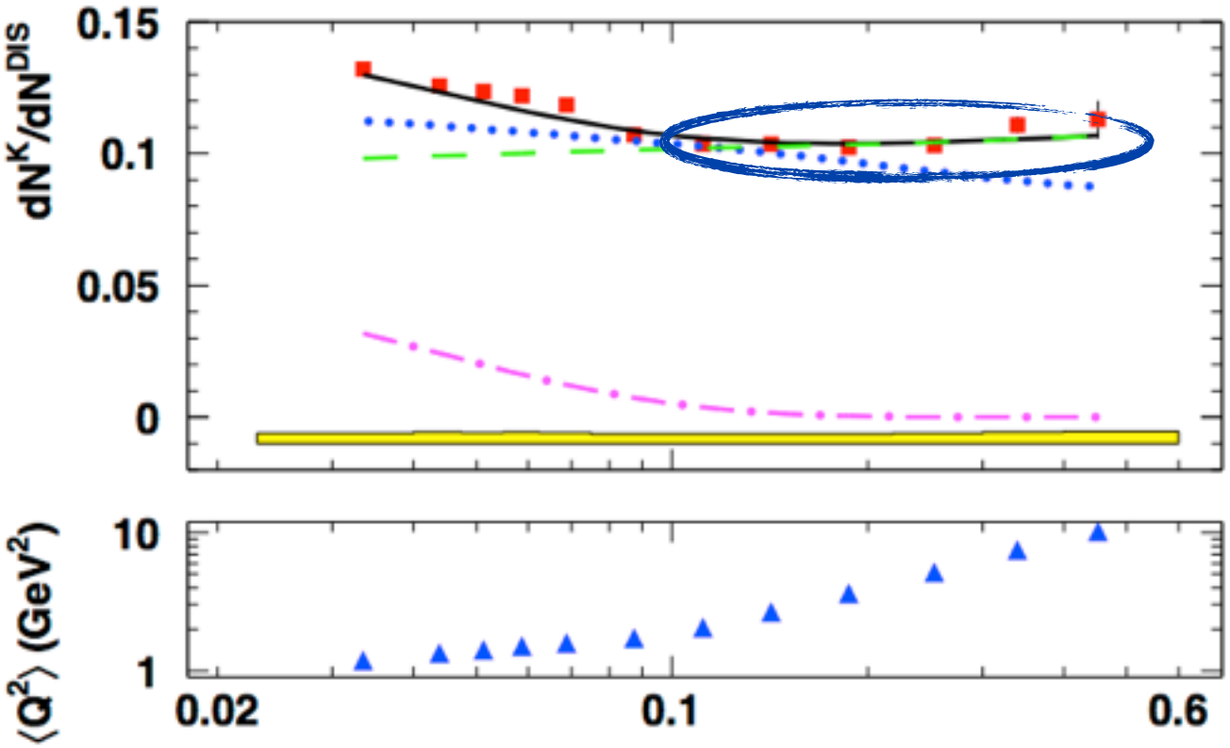

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DSS => 0.435 ± 0.044

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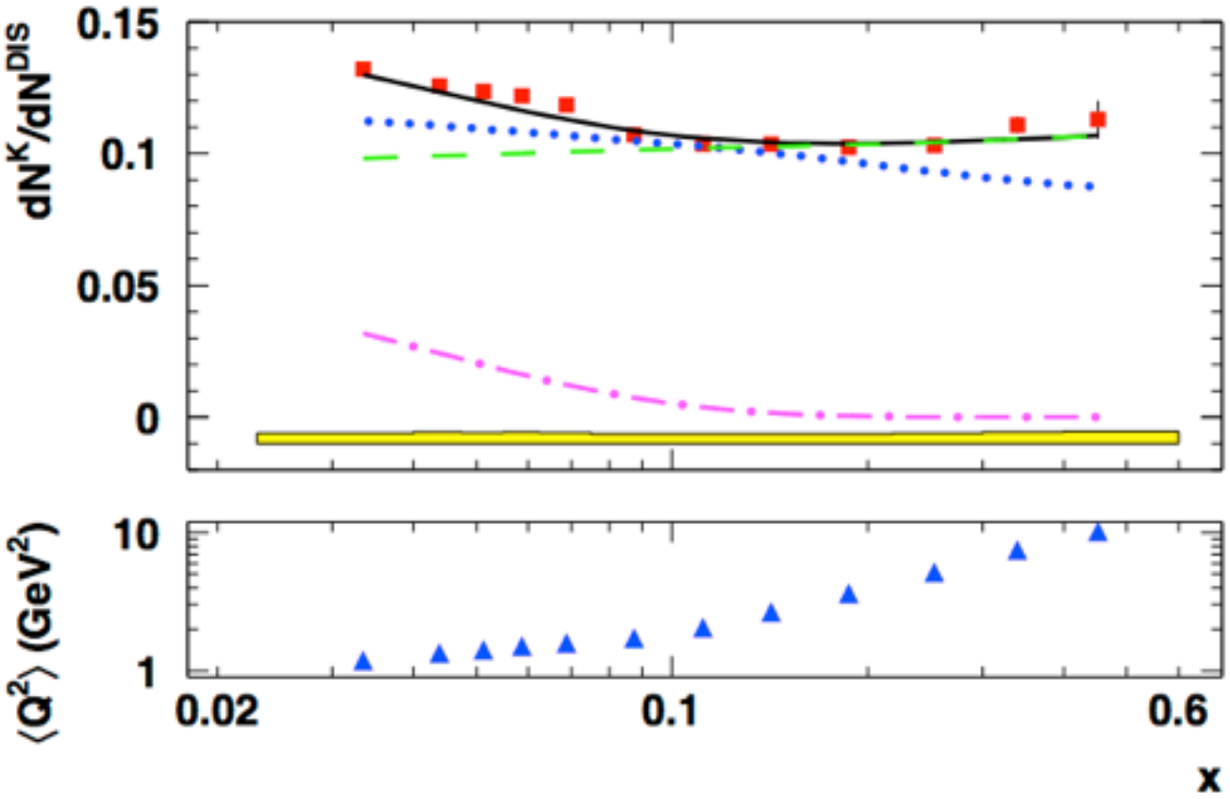
Low-x region



HERMES fit

CTEQ6L + DSS

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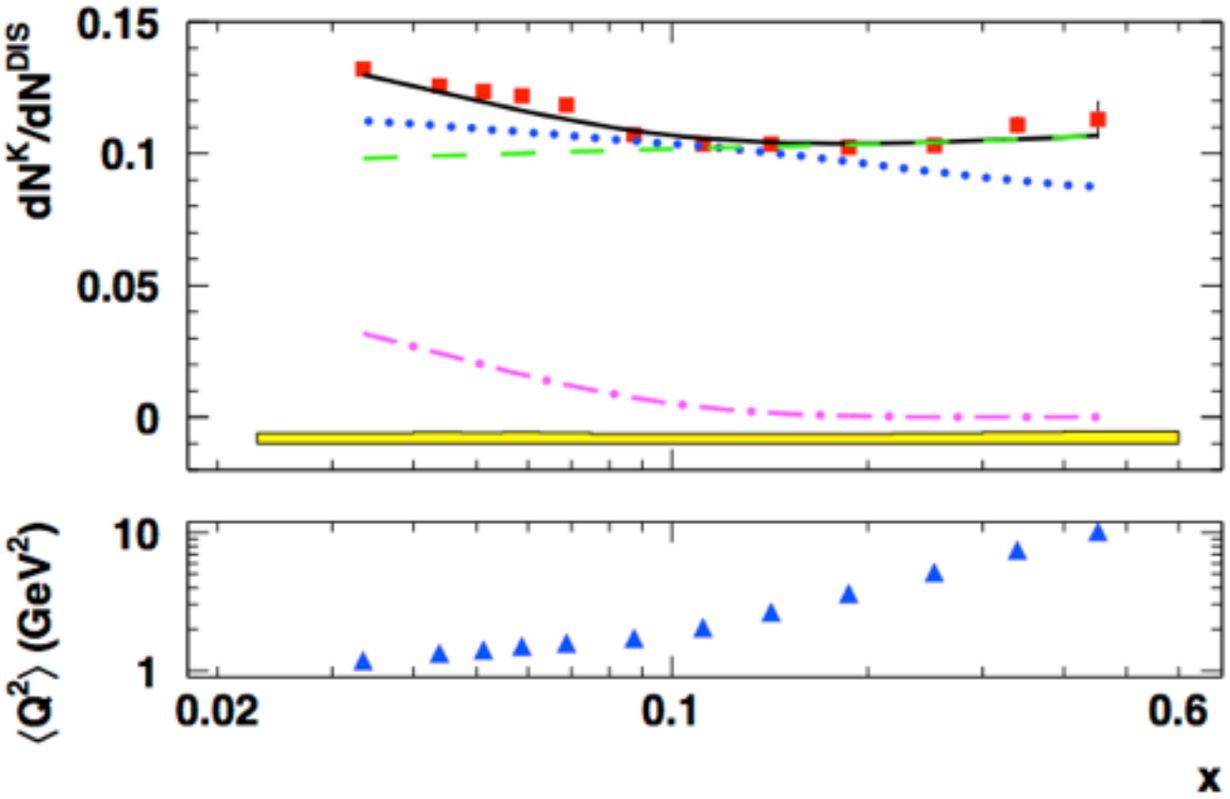
$$Q^2 = 2.5\,GeV$$

$$S(x)\int D_S^K(z)dz \overset{\text{LO}}{\sim} Q(x)\left[5\frac{d^2N^K(x)}{d^2N^{DIS}(x)} - \int D_Q^K(z)dz\right]$$

Low-x region



HERMES fit

CTEQ6L + DSS

non-Strange component

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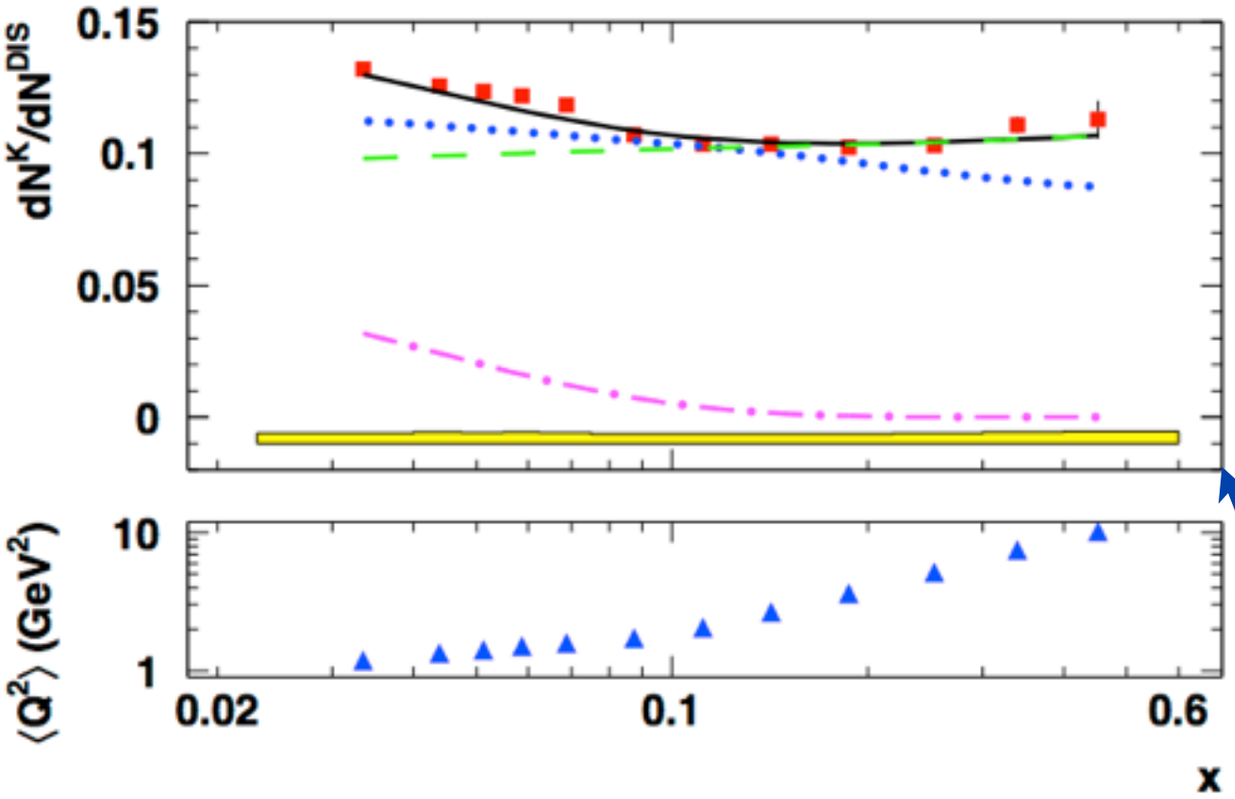

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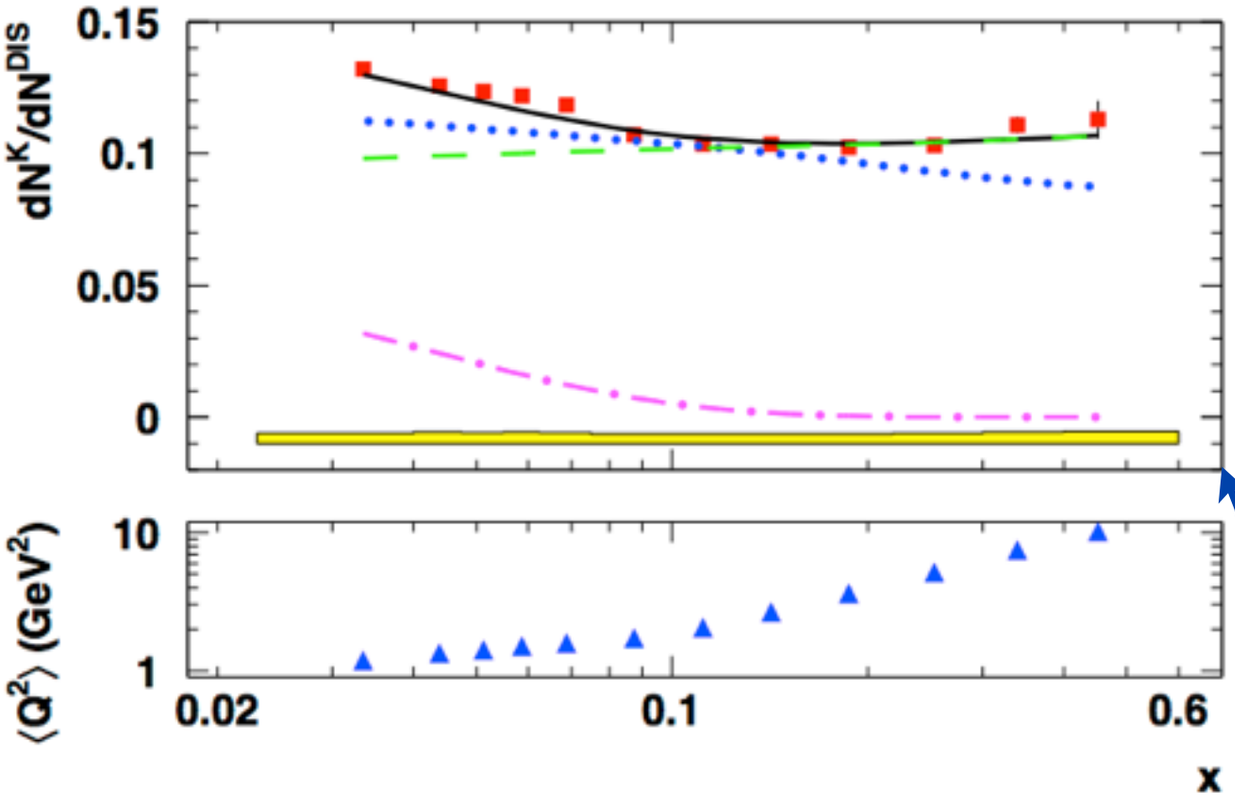
$$\int_{0.2}^{0.8} D_Q^K(z,Q^2)dz = 0.514 \pm 0.010$$

$$Q^2 = 2.5\,GeV$$

$$S(x)\int D_S^K(z)dz \overset{LO}{\sim} Q(x)\left[5\frac{d^2N^K(x)}{d^2N^{DIS}(x)} - \int D_Q^K(z)dz\right]$$

Low-x region



HERMES fit

CTEQ6L + DSS

non-Strange component

(linear fit for x>0.1)

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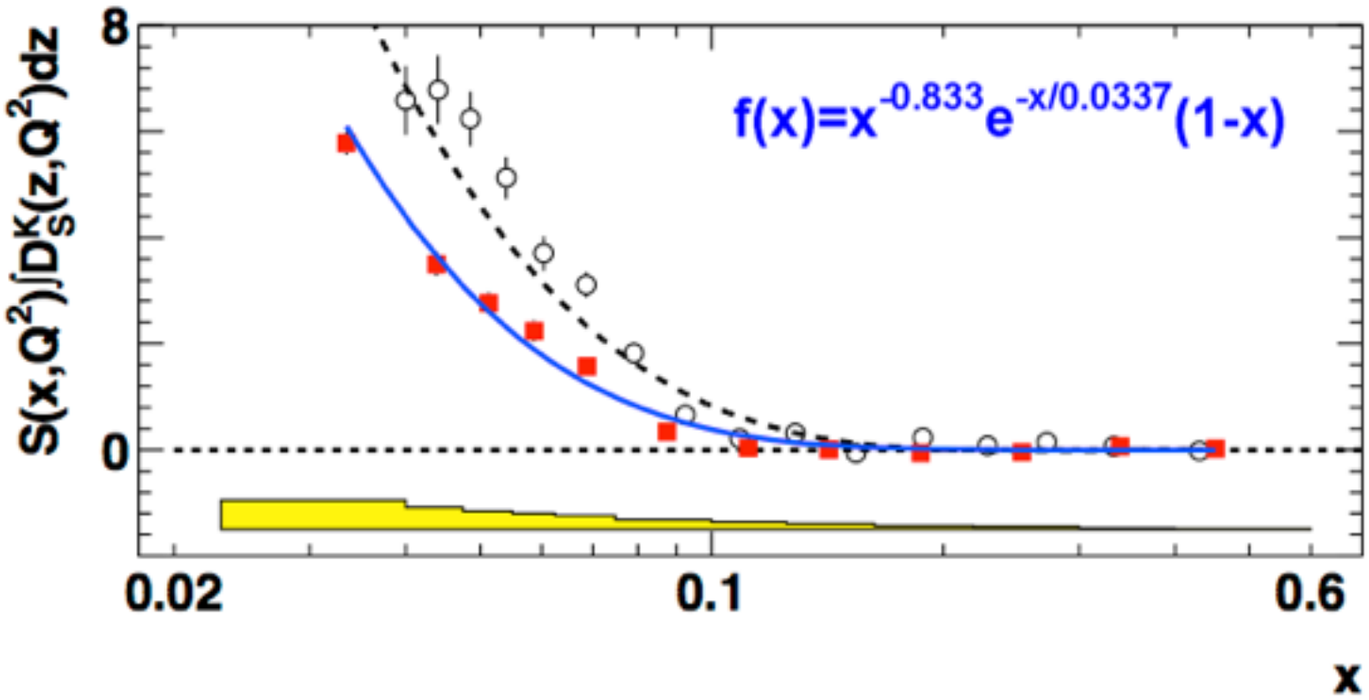
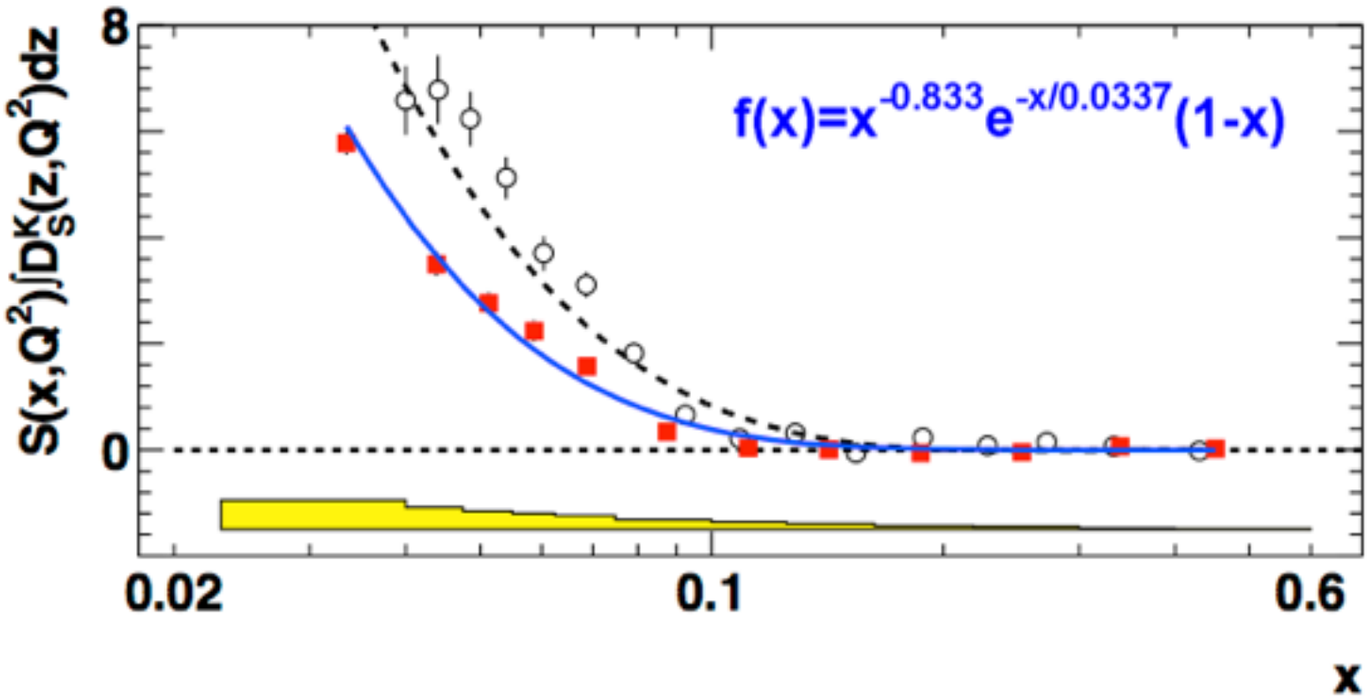
CTEQ6L

$S(x)\int D_s^K(z)$



- Hermes Re-evaluation
- Hermes old evaluation

$S(x)\int D_s^K(z)$



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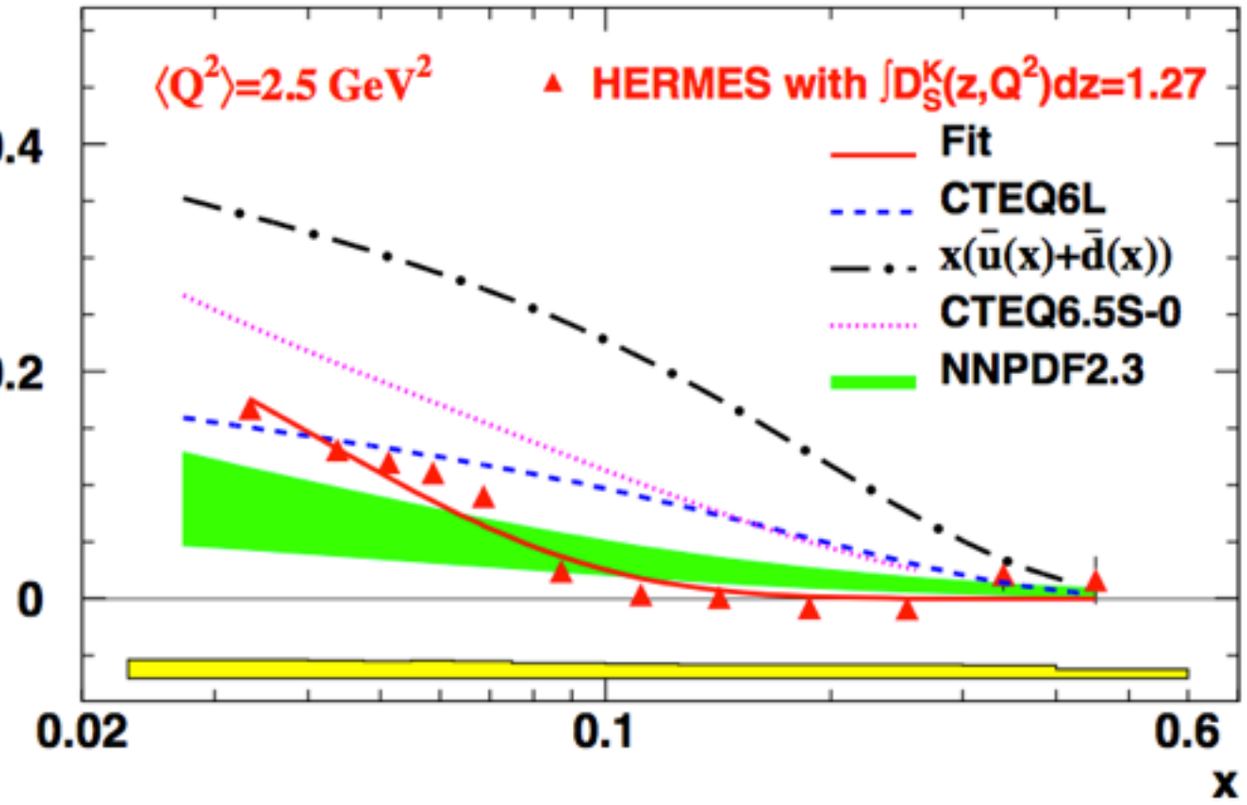
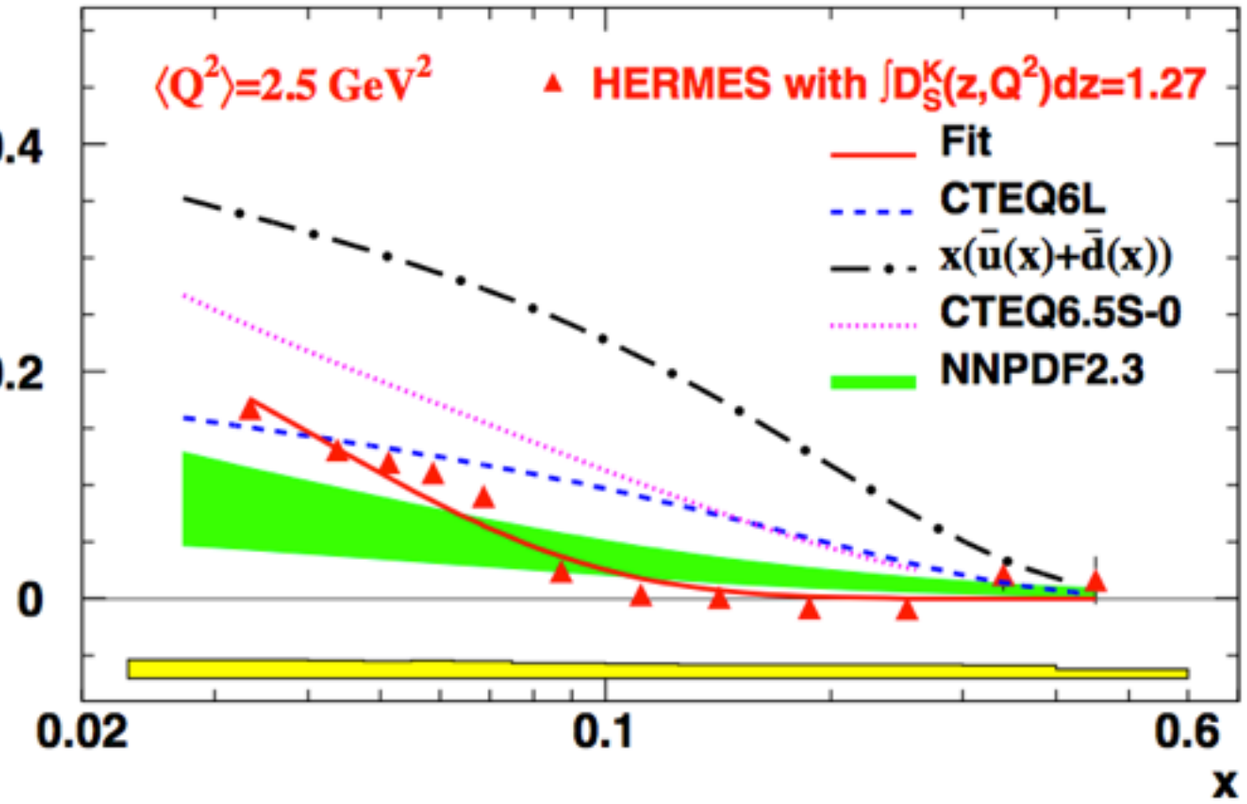
No significant differences if using using NNPDF2.3LO instead of CTEQ6L for Q(x).

S(x)



$$S(x)\int D_S^K(z)dz$$

S(x)

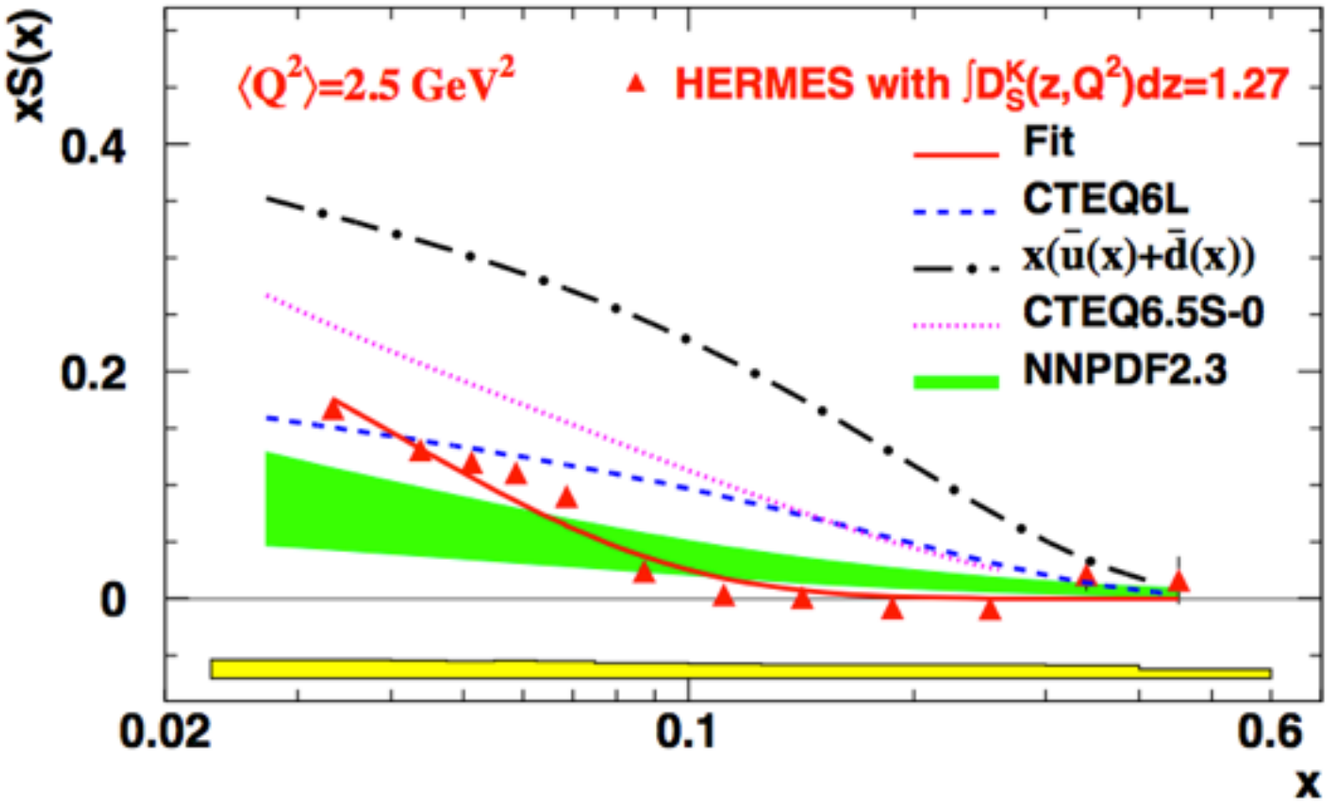


$$S(x)\int D_S^K(z)dz$$

$$\int D_S^K(z)dz = 1.27$$

From DSS at Q^2 = 2.5 GeV

S(x)



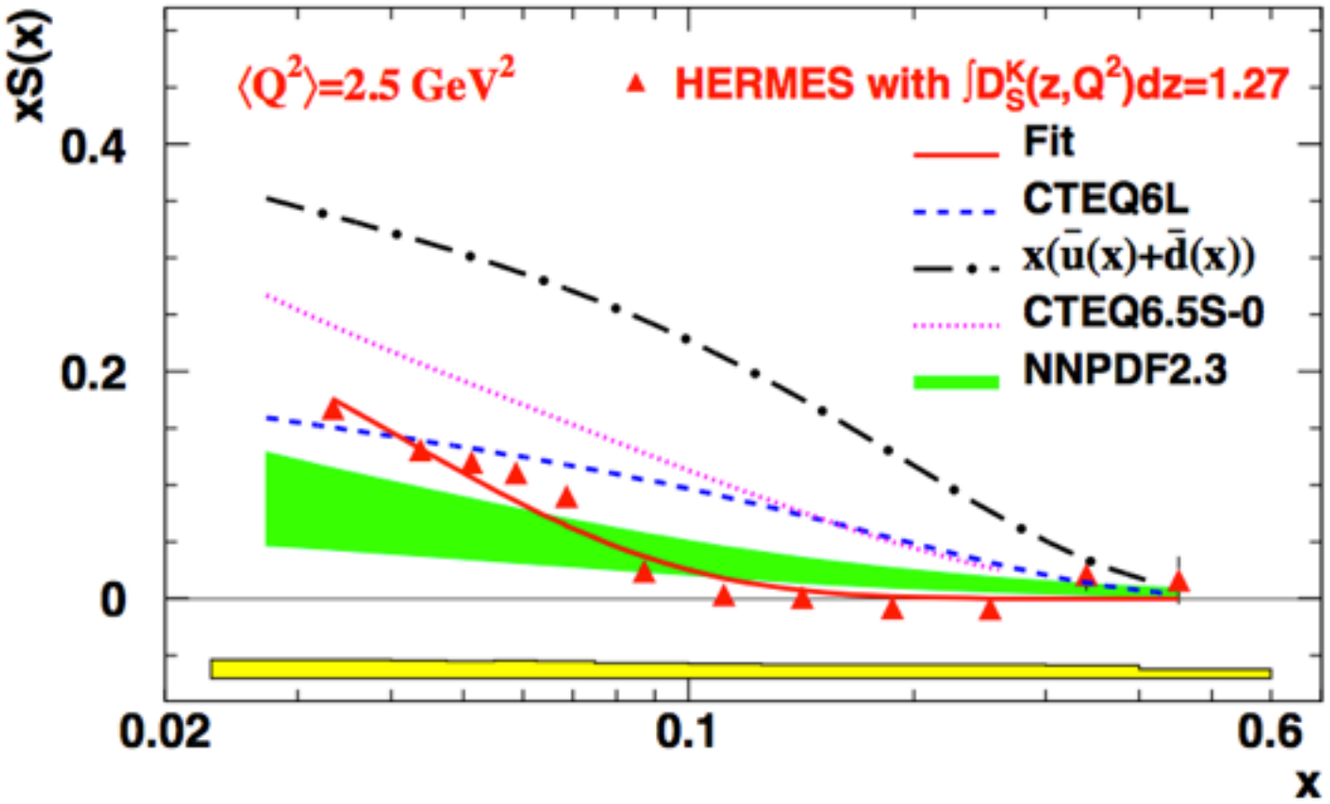
evolved to Q^2 = 2.5 GeV* ⟵ $S(x)\int D_S^K(z)dz$

$$\int D_S^K(z)dz = 1.27$$

From DSS at Q^2 = 2.5 GeV

* Q2 evolution factors from CTEQ6L and DSS, higher twist neglected

S(x)



evolved to Q^2 = 2.5 GeV* ⟵ $S(x)\int D_S^K(z)dz$

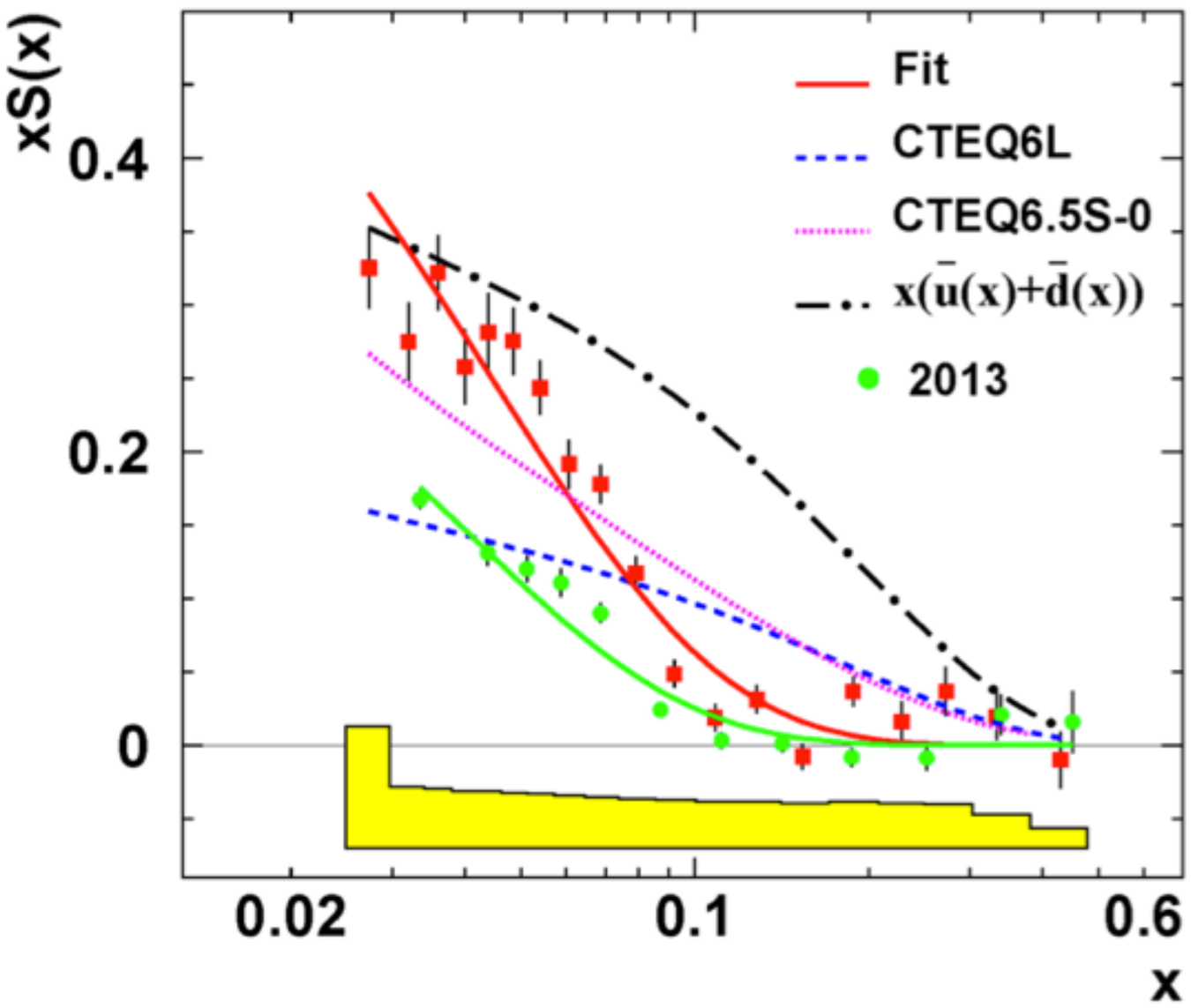
$$\int D_S^K(z)dz = 1.27$$

From DSS at Q^2 = 2.5 GeV

Absolute value strictly depends on the normalization used for the strange Kaon fragmentation

* Q2 evolution factors from CTEQ6L and DSS, higher twist neglected

Old versus new S(x)



Summary

- An updated LO evaluation of the Strange PDF is available using the revisited and improved kaon multiplicities published by Hermes

- The new S(x) present similar shape but smaller magnitude (~ 0.6 factor) than the old extraction

- As Hermes, recent predictions of the NNPDF collaboration (NPB 855, 153 (2012)) favors S(x) small/compatible with zero

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