Simulation of forward protons using Pythia and Phojet

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on behalf of

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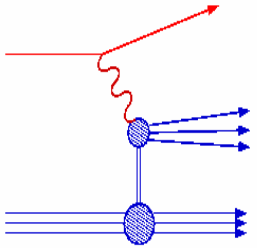
Pile-up

- Diffractive and elastic processes in the PU critical for forward-physics studies:
  → they produce forward protons in the same kinematic region as the signal
  → at luminosities with significant PU, fake diffractive events from overlap of diffractive PU events with non-diffractive process observed in the central CMS detector are the most pertinent background source

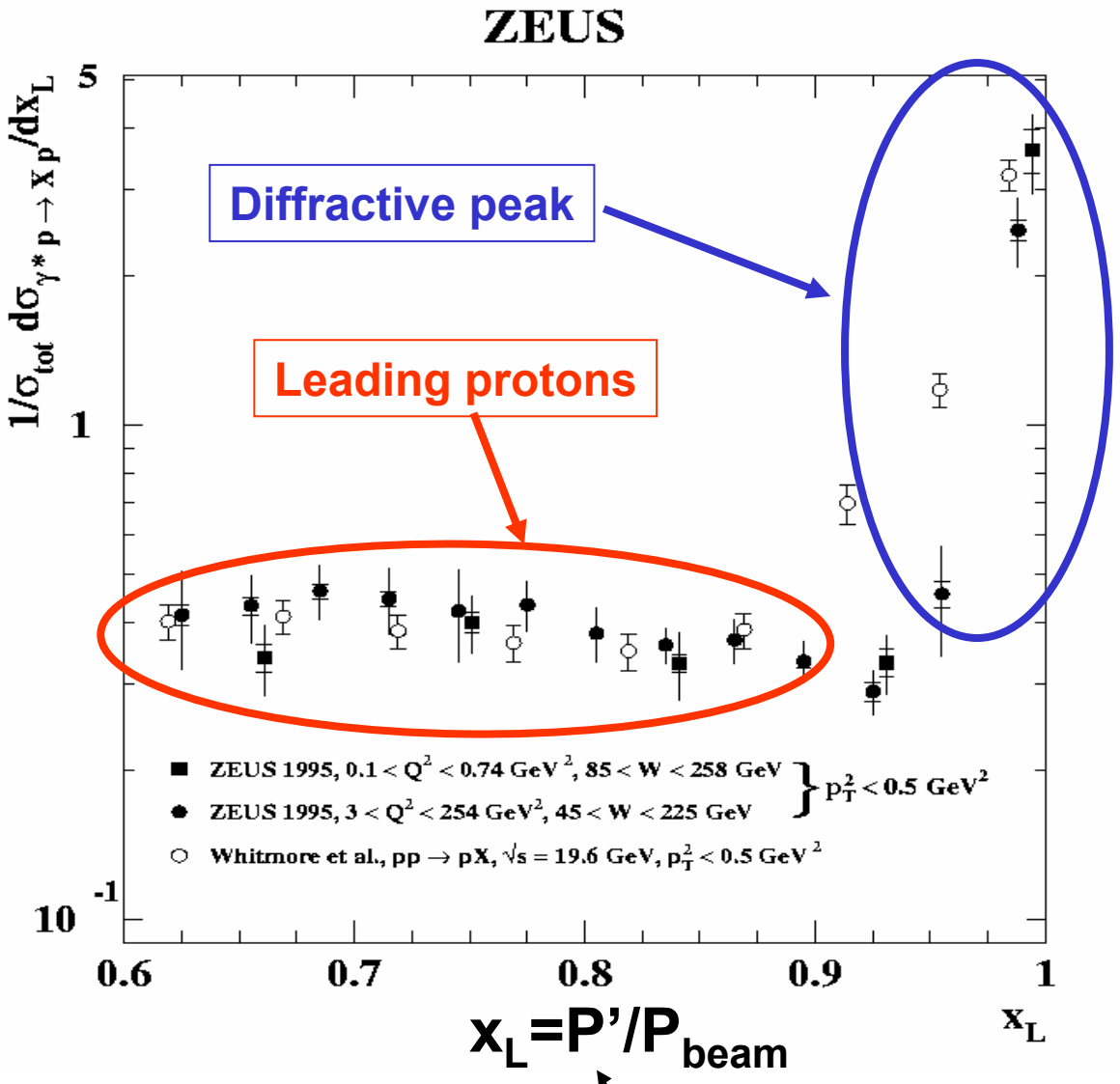
- Including elastic and diffractive events, there are on average
  7 PU events @ 2×10^{33} $cm^{-2}s^{-1}$
  35 PU events @ 1×10^{34} $cm^{-2}s^{-1}$

- Compared Pythia (MSEL=2) and Phojet with HERA leading proton spectra

What do we expect ?



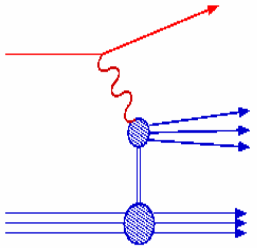
p



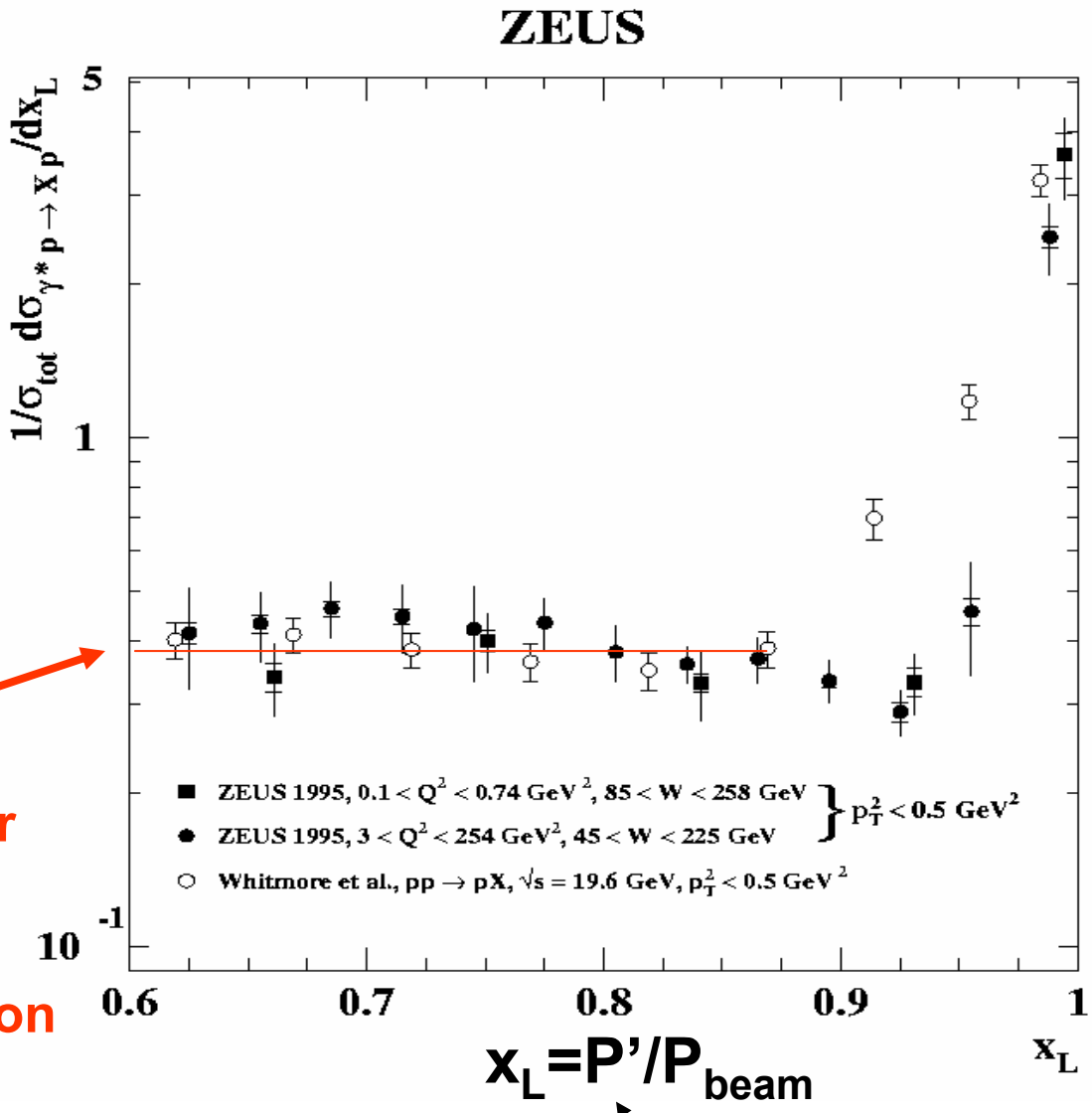
$x_L = P'/P_{beam}$

Fastest proton in the event

What do we expect ?



p



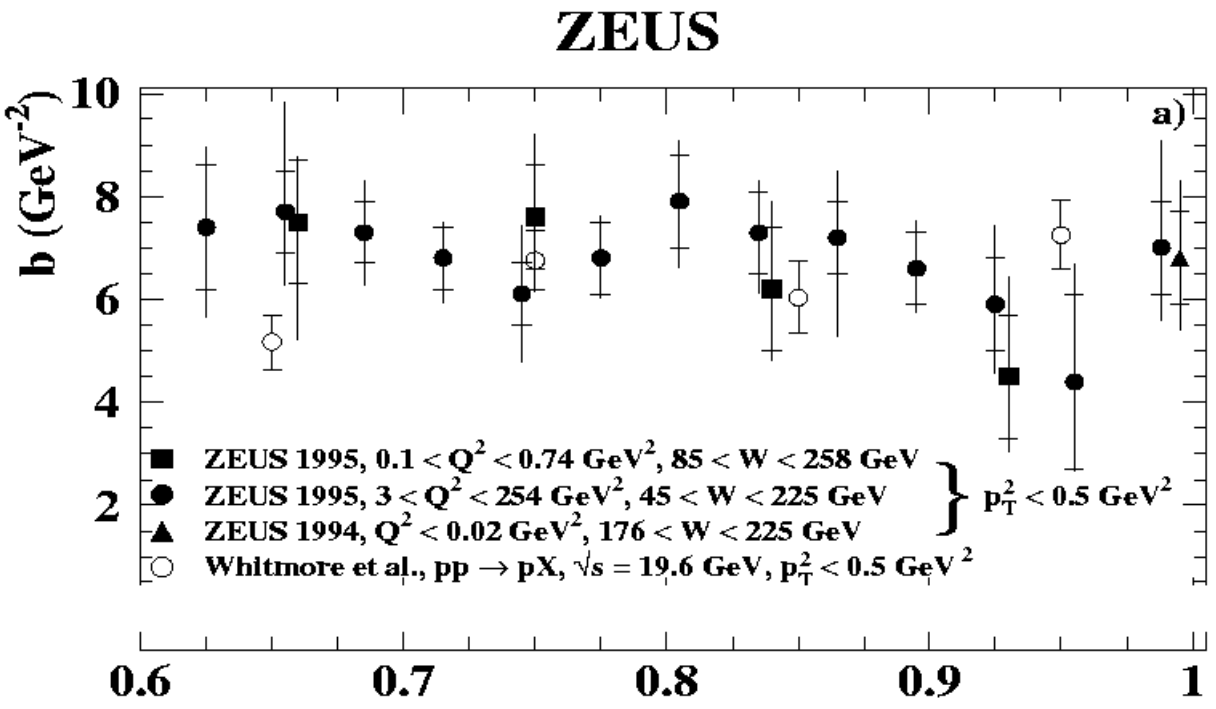
Universal number
Same for ep, pp
No surprise:
vertex factorisation

$x_L = P'/P_{beam}$

Fastest proton in the event

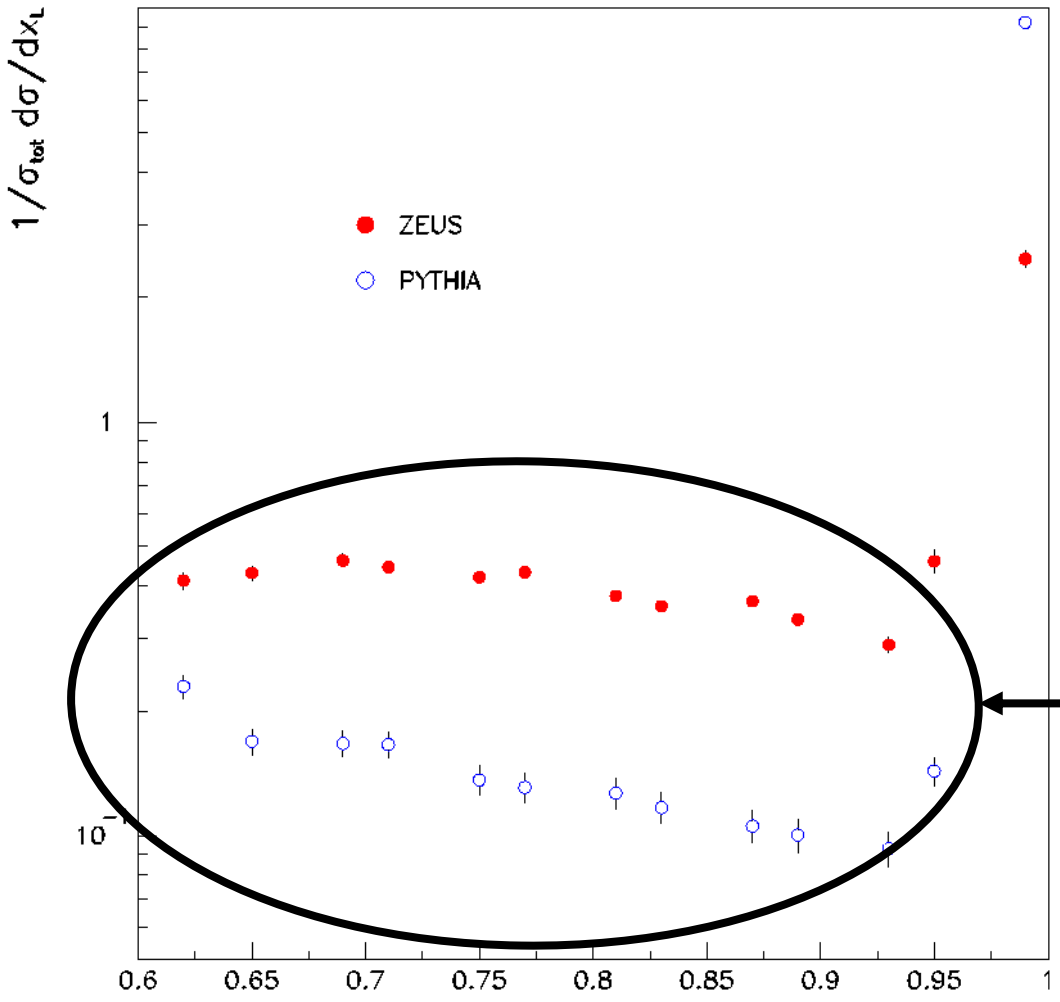
What do we expect ?

- Approximately exponential p_T^2 distributions
- Slope approx 5-7 GeV^{-2}



$x_L = P'/P_{beam}$

What we find

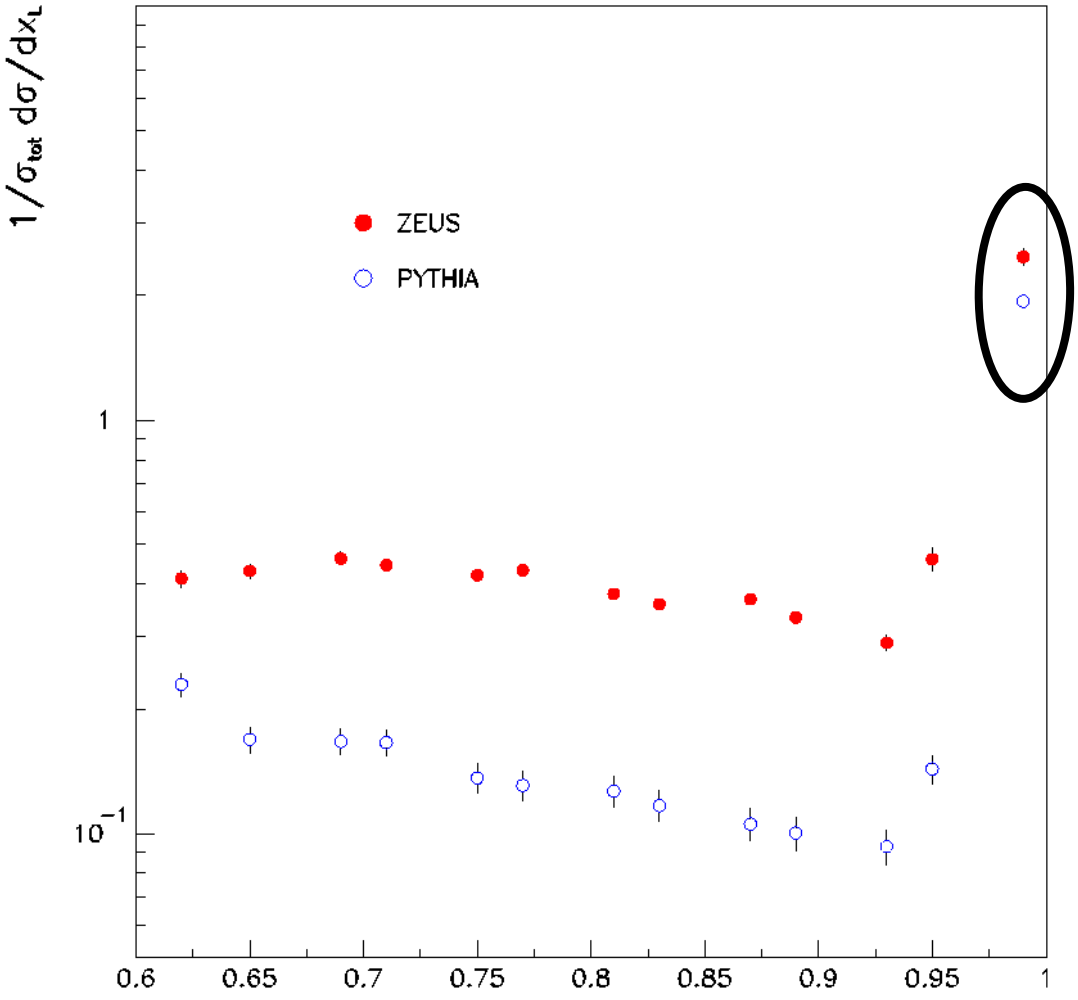


Pythia wrong in shape and normalisation outside diffractive peak (approx factor 2-3)

$x_L = P'/P_{beam}$

Fastest proton in the event

What we find

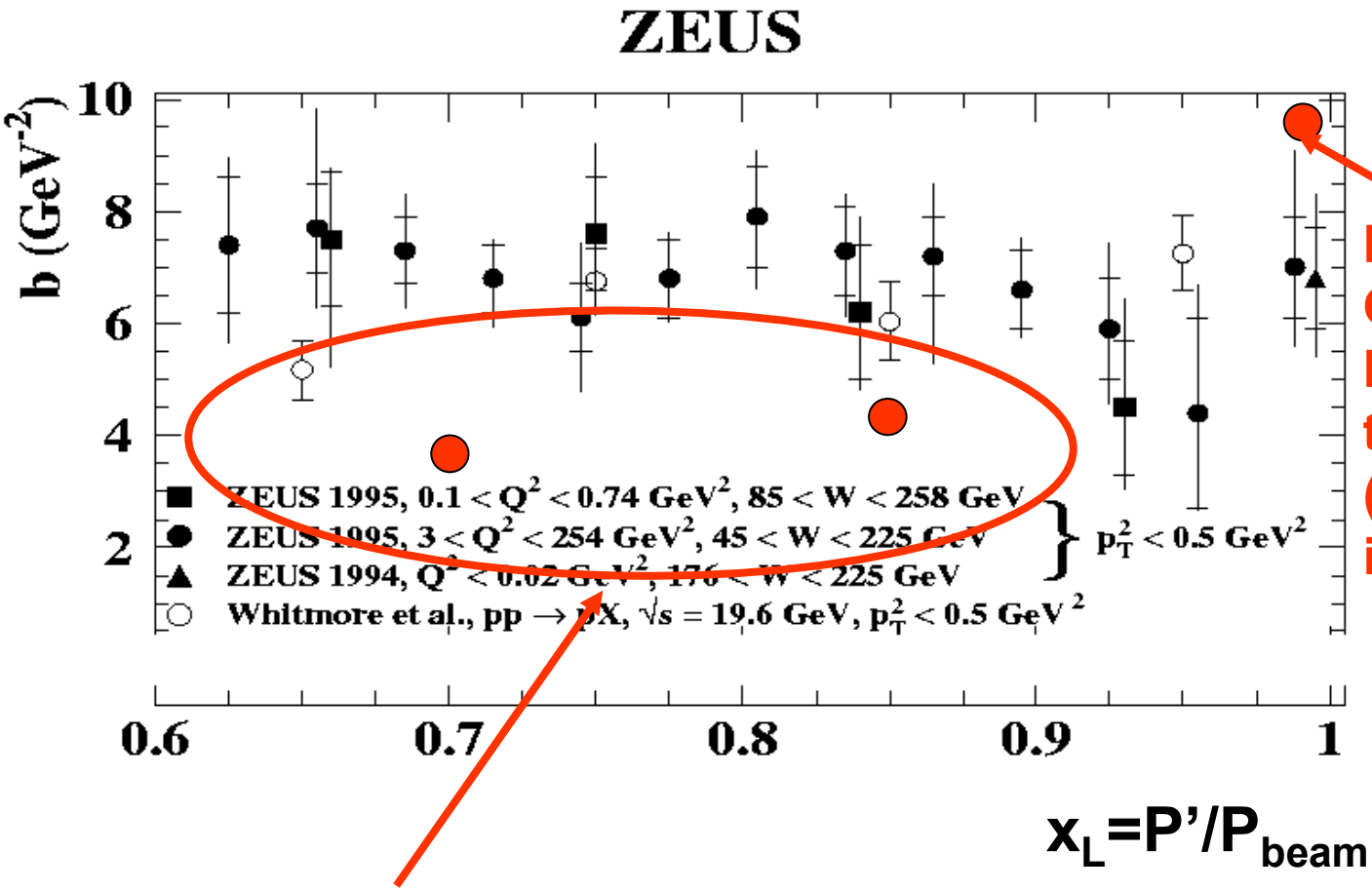


Pythia approx OK in diffractive peak (after removing elastic component, not there in HERA data)

$x_L = P'/P_{beam}$

Fastest proton in the event

What we find

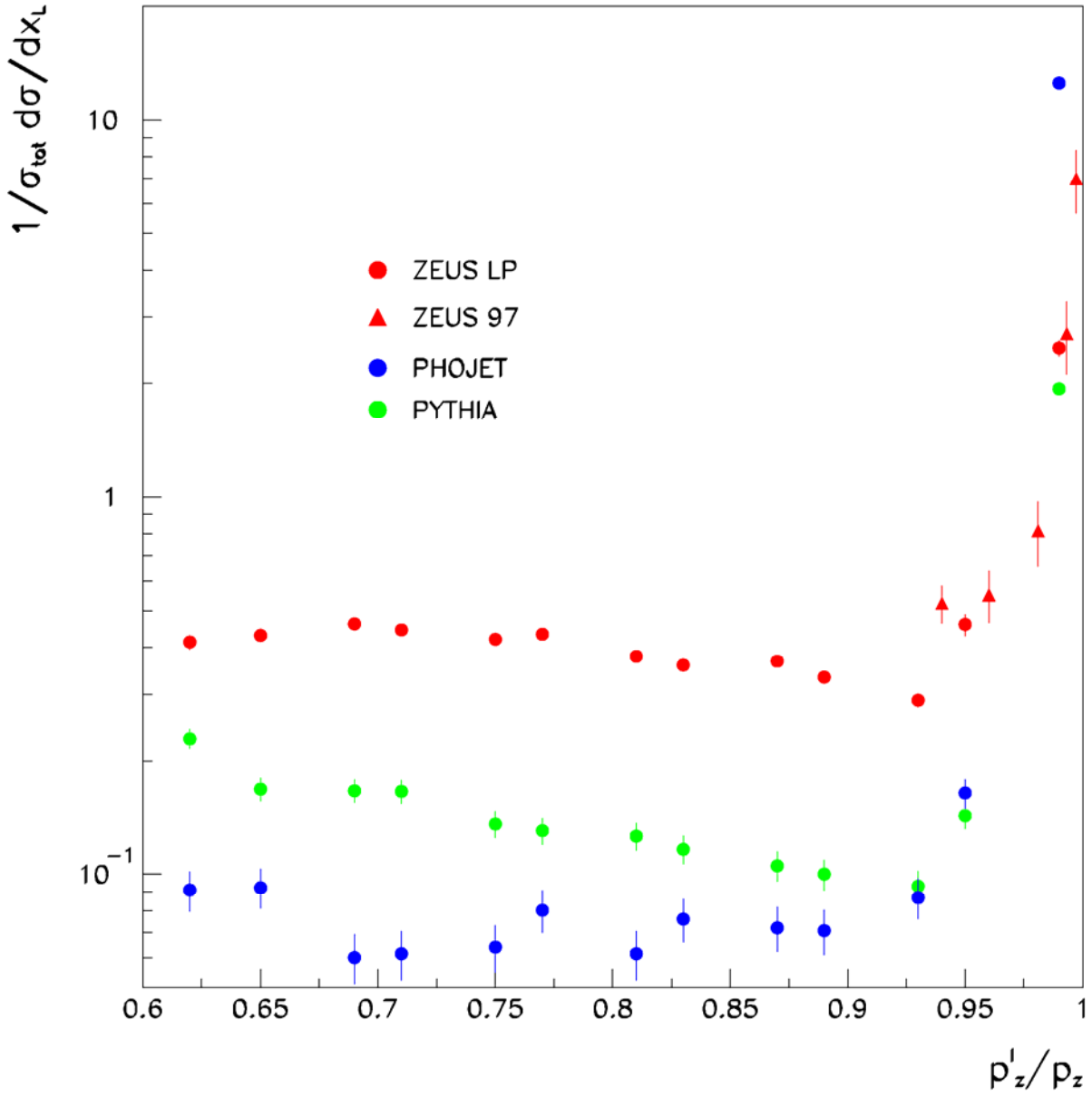


Pythia approx OK in diffractive Peak, after taking shrinkage ($b = b_0 + 4\alpha' \ln s$) into account

Pythia too low outside diffractive peak

- $b_{elastic}$ approx 21 GeV^{-2} (as expected)

Phojet a little worse than Pythia…



Summary

- A first look at pile-up files with diffraction and elastic scattering – concentrate on momentum spectra of scattered leading proton

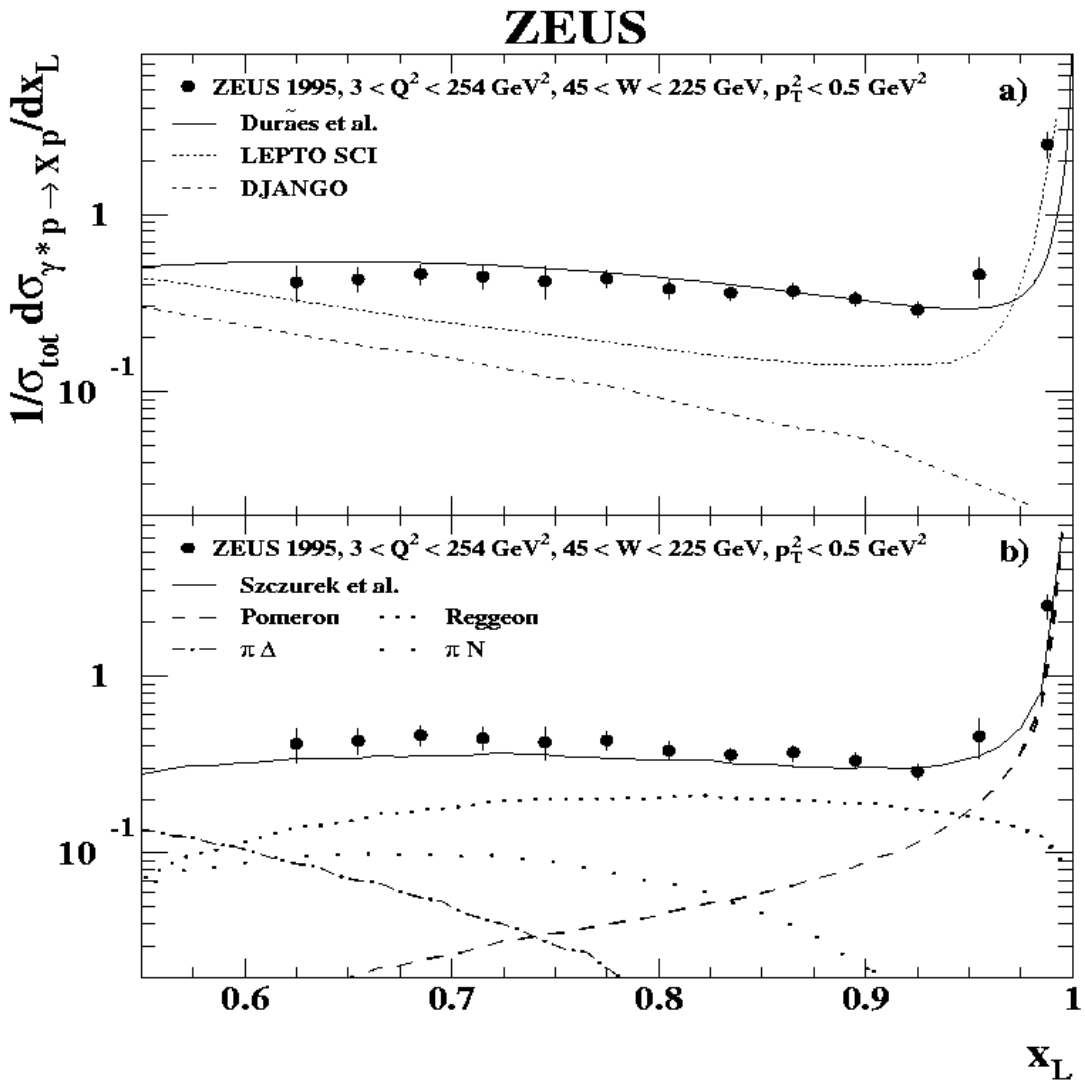
- Pythia underestimates (factor 2-3) the rate of leading protons outside the diffractive/elastic peak. Rescaling needed.

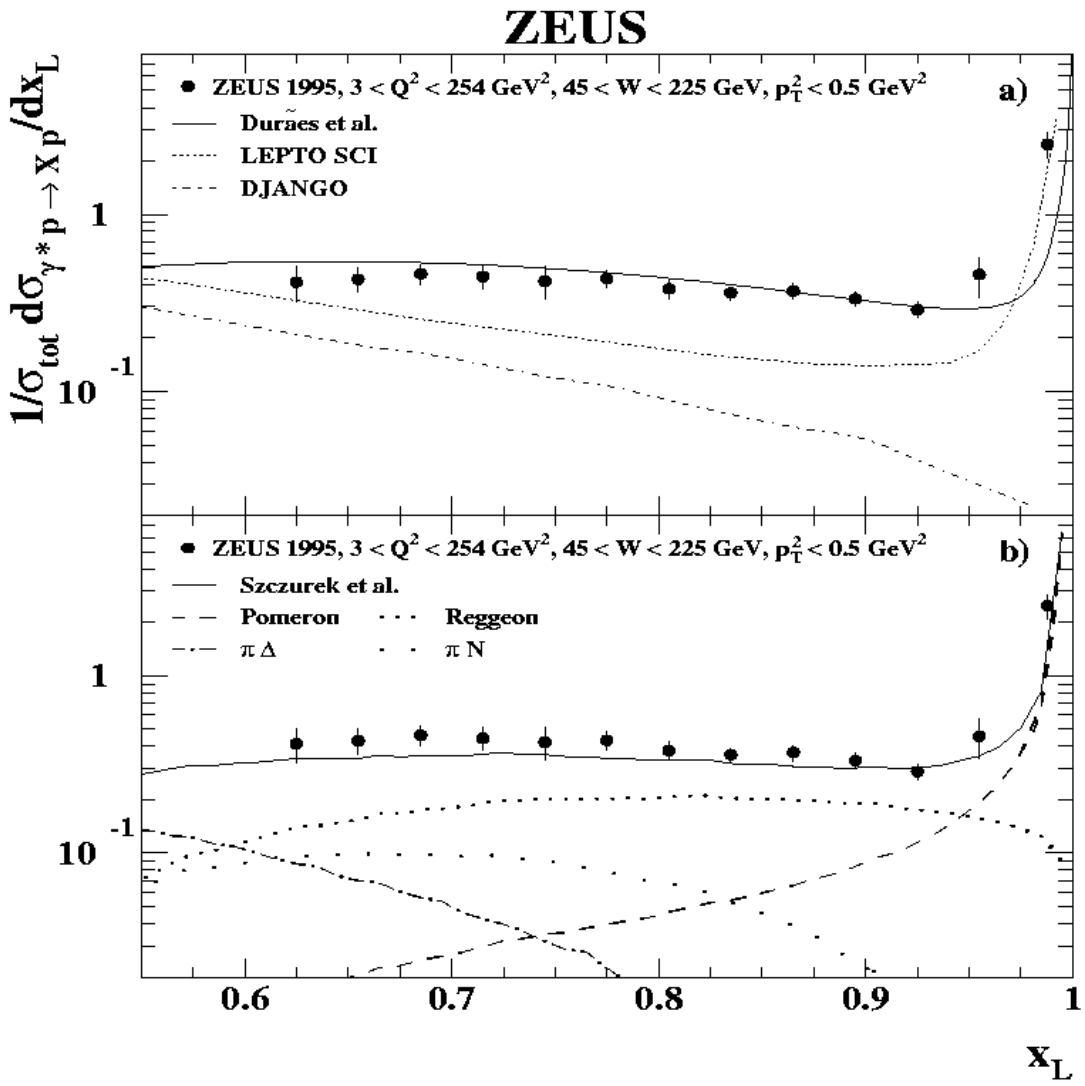
- p_T^2 slopes also factor 2 too low outside diffractive/elastic

- Approx OK in diffractive-peak region

- Similar situation for Phojet

CMS diffractive group is using correction function provided by Marta
Was already used for diffractive trigger rates included in CMS/PTDR2
→ Correction function should be made available in official CMS MC software so that everybody can use it
Where ?


ZEUS
ZEUS 1995, 3 < Q² < 254 GeV², 45 < W < 225 GeV, p²T < 0.5 GeV²
a)
Durães et al.
LEPTO SCI
DJANGO
ZEUS 1995, 3 < Q² < 254 GeV², 45 < W < 225 GeV, p²T < 0.5 GeV²
b)
Szczurek et al.
Pomeron
Reggeon
π Δ
π N
1/σtot dσγ*p→Xp/dxL
1
10-1
0.6
0.7
0.8
0.9
1
xL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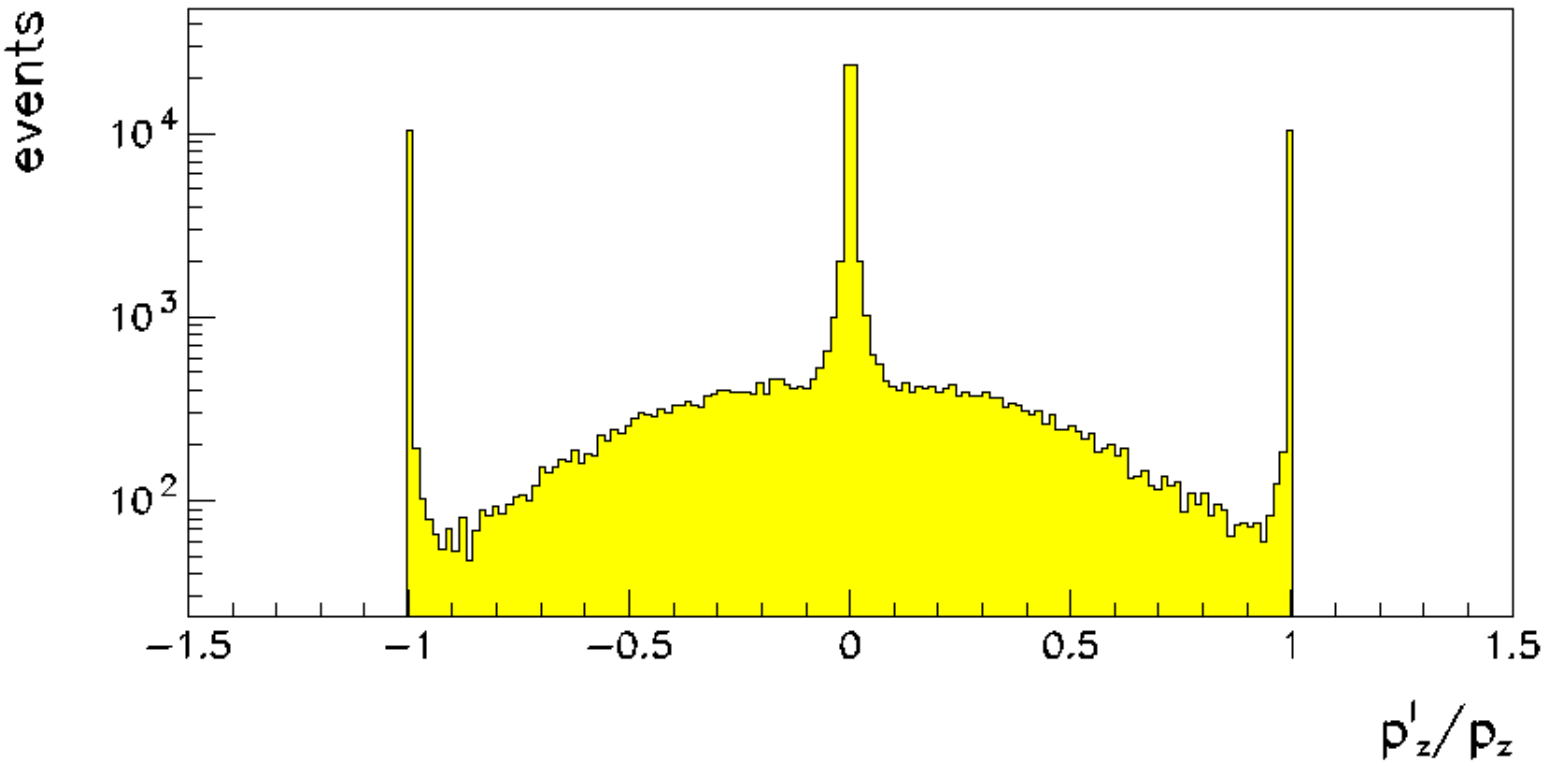
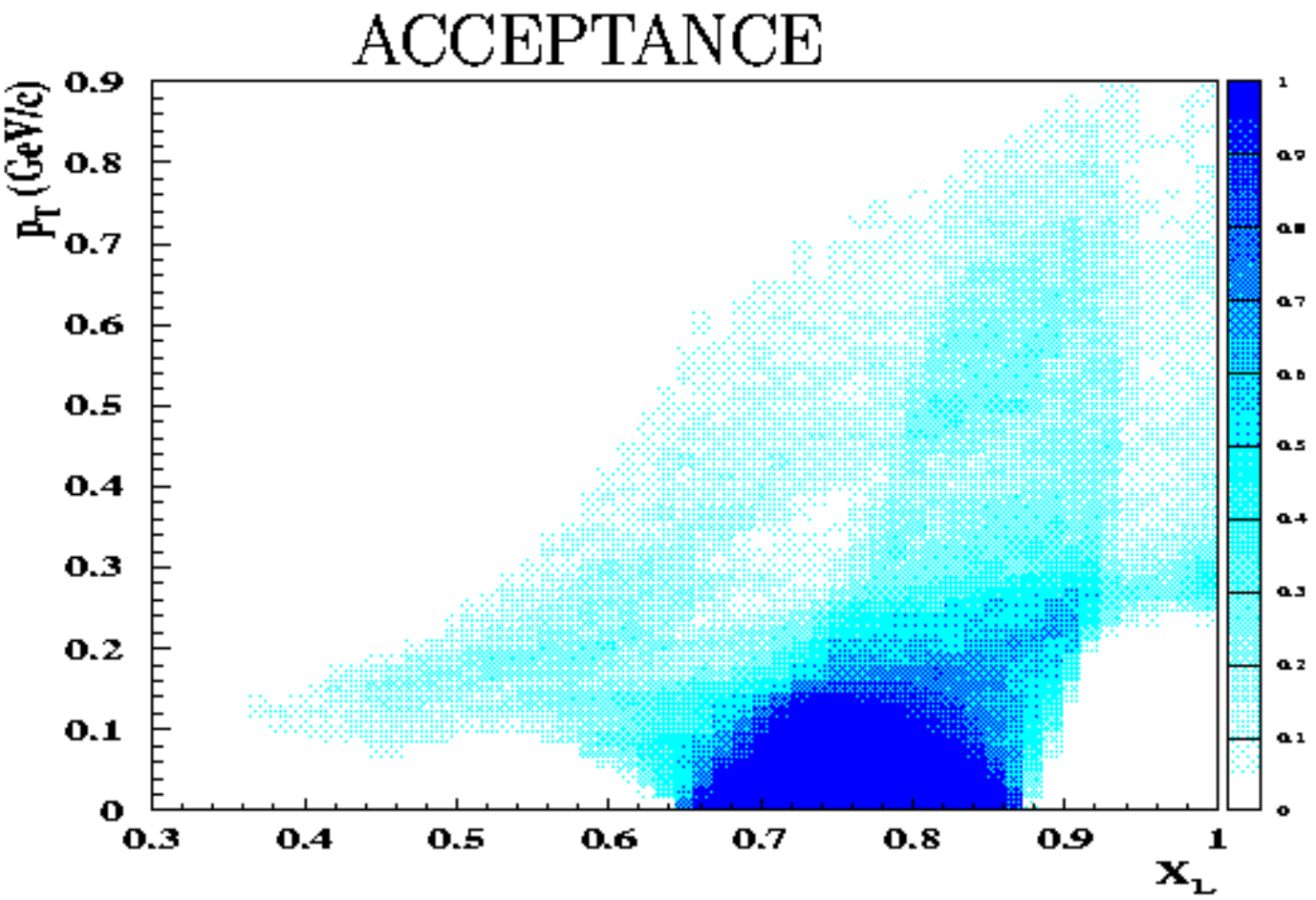
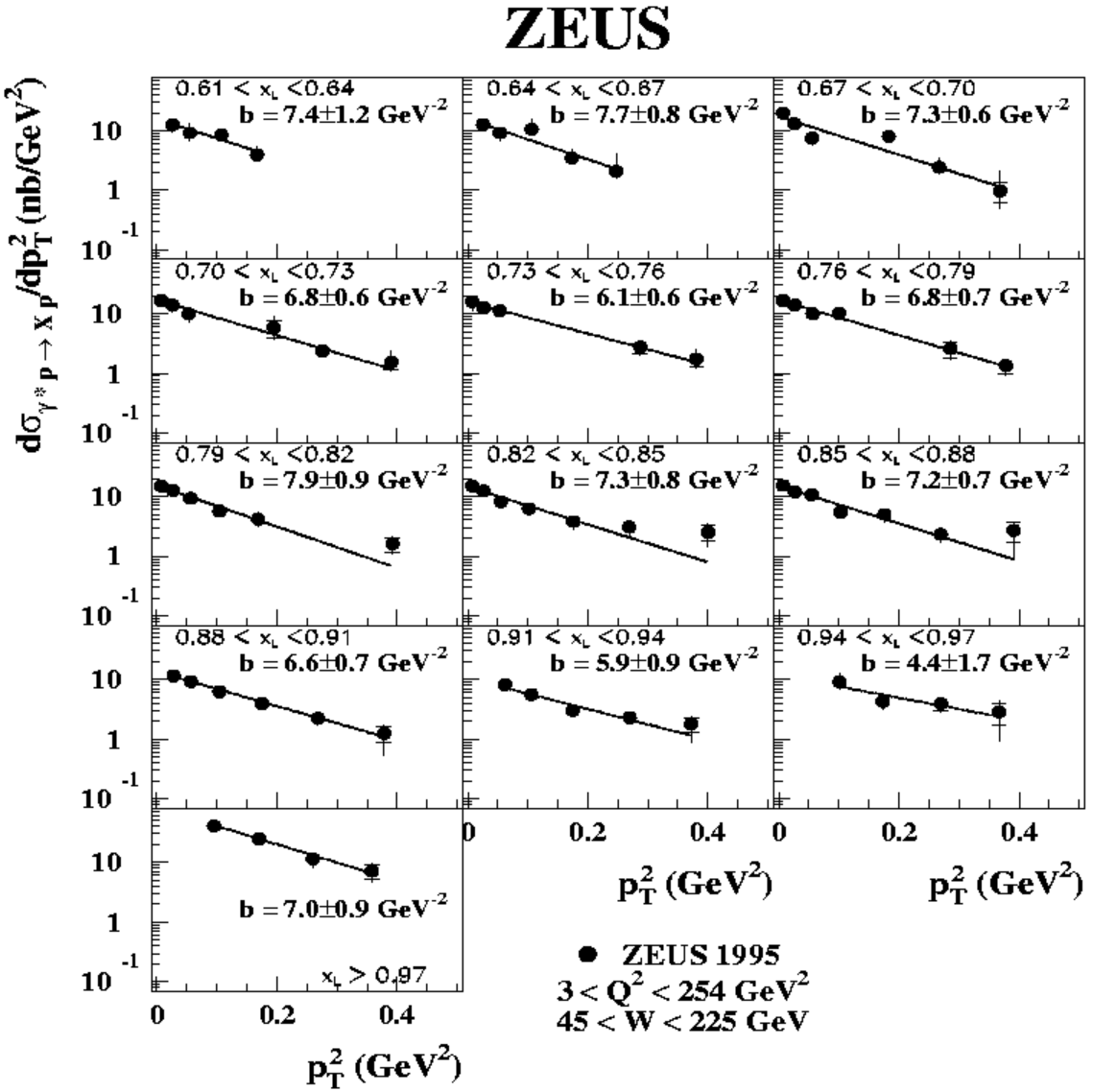
π Δ
π N
1/σtot dσγ*p→Xp/dxL
1
10-1
0.6
0.7
0.8
0.9
1
xL

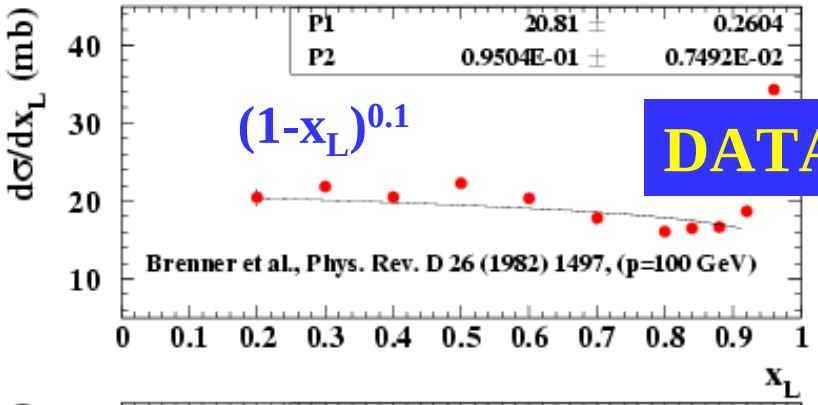

events
10^4
10^3
10^2
−1.5
−1
−0.5
0
0.5
1
1.5
p'_z/p_z

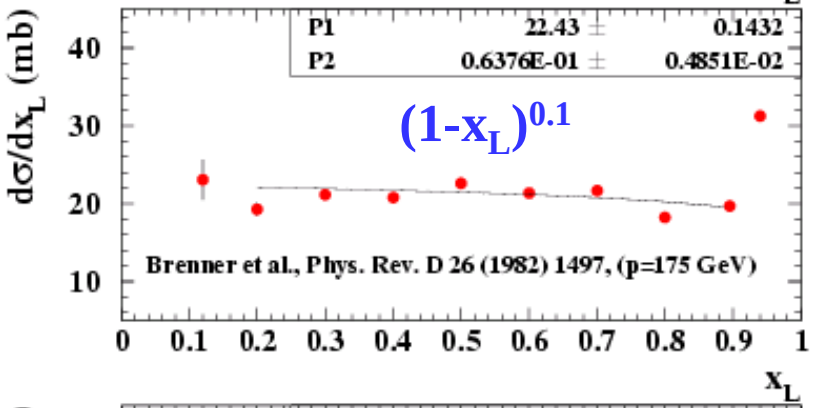

ACCEPTANCE
P_T (GeV/c)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
X_L

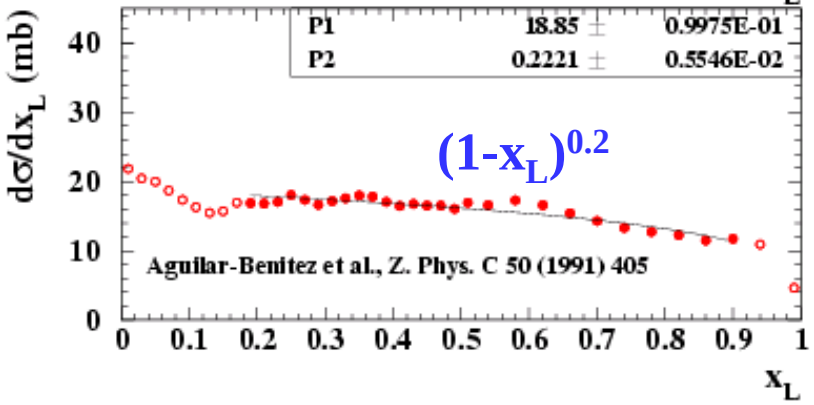

ZEUS
$d\sigma_{\gamma^* p \to X p}/dp_T^2$ (nb/GeV^2)
0.61 < x_L <0.64
b = 7.4±1.2 GeV^{-2}
0.64 < x_L <0.67
b = 7.7±0.8 GeV^{-2}
0.67 < x_L <0.70
b = 7.3±0.6 GeV^{-2}
0.70 < x_L <0.73
b = 6.8±0.6 GeV^{-2}
0.73 < x_L <0.76
b = 6.1±0.6 GeV^{-2}
0.76 < x_L <0.79
b = 6.8±0.7 GeV^{-2}
0.79 < x_L <0.82
b = 7.9±0.9 GeV^{-2}
0.82 < x_L <0.85
b = 7.3±0.8 GeV^{-2}
0.85 < x_L <0.88
b = 7.2±0.7 GeV^{-2}
0.88 < x_L <0.91
b = 6.6±0.7 GeV^{-2}
0.91 < x_L <0.94
b = 5.9±0.9 GeV^{-2}
0.94 < x_L <0.97
b = 4.4±1.7 GeV^{-2}
b = 7.0±0.9 GeV^{-2}
x_L > 0.97
p_T^2 (GeV^2)
ZEUS 1995
3 < Q^2 < 254 GeV^2
45 < W < 225 GeV

x_L distribution: DATA vs. MC

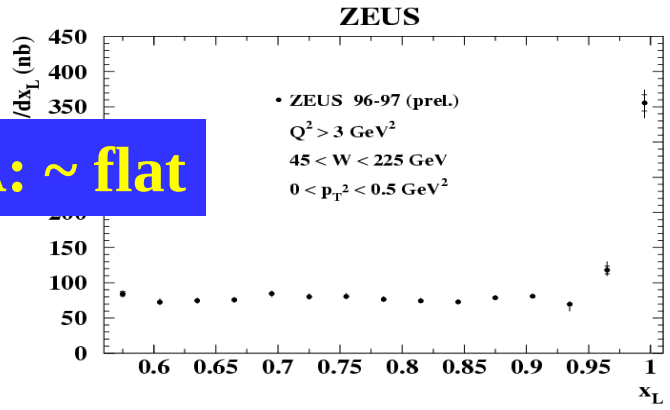
My own fits below the diffractive peak:

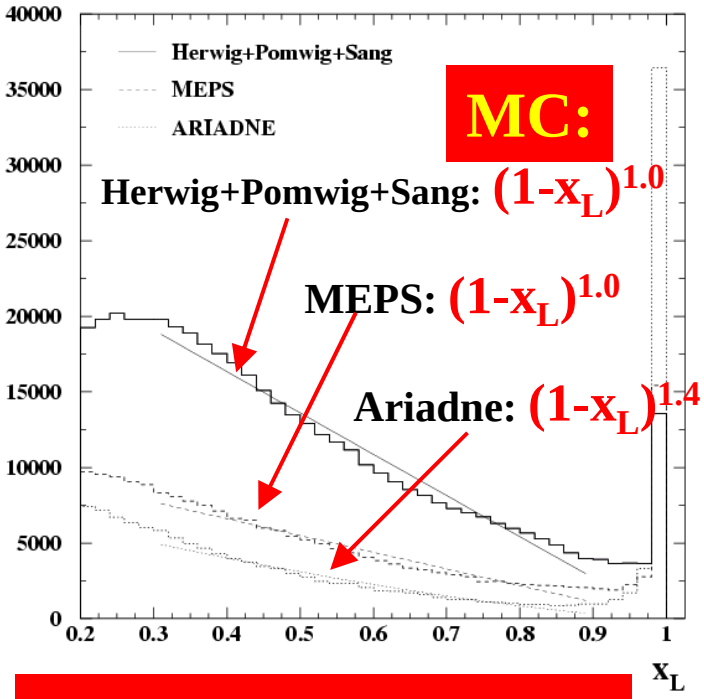




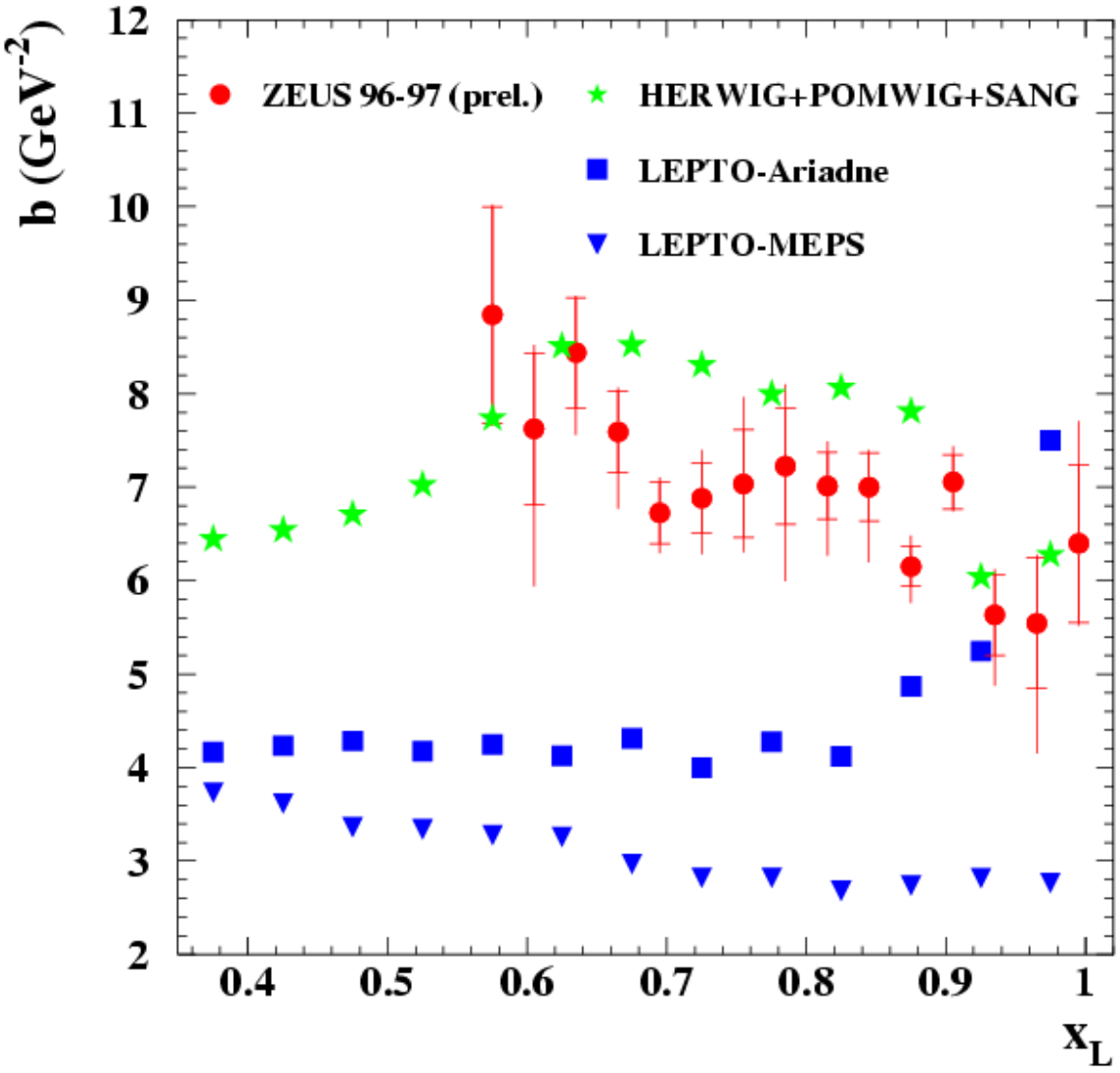


DATA: ~ flat





⇒ quite different!



A vs. MC

Fit $d\sigma/dp_T^2$ to $e^{-bp_T^2}$ in the range $p_T^2 < 0.5$ GeV^2

HERWIG

LEPTO