

# Energy dependence of $\sigma_{TOT}(\gamma p)$ at HERA

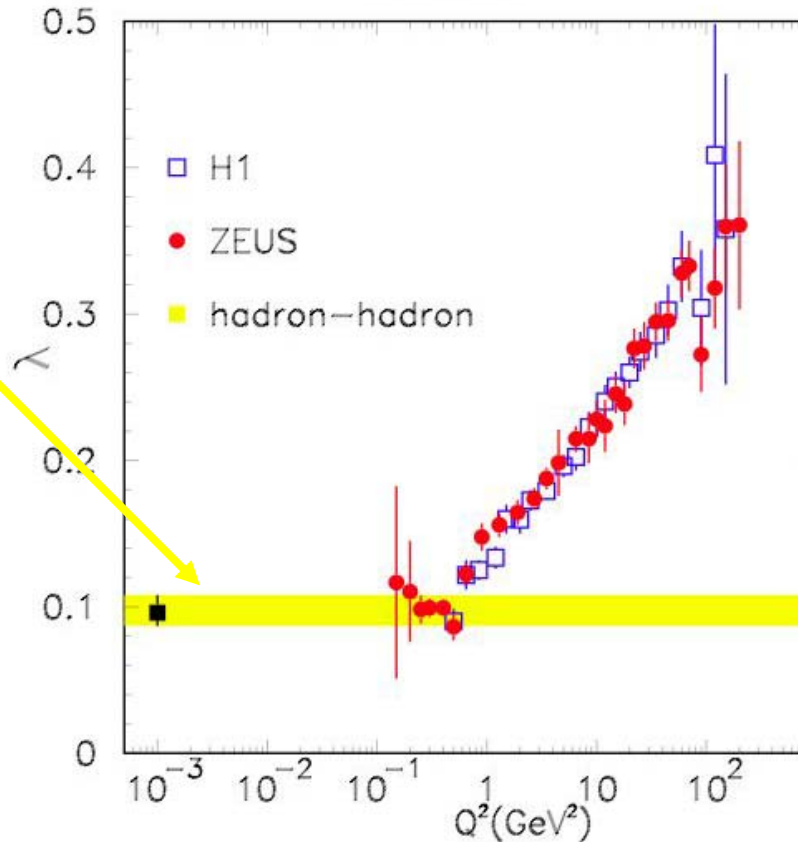
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On behalf of the ZEUS collaboration

# soft $\rightarrow$ hard

$\lambda$  HERA

$$\sigma \propto s^{0.096}$$

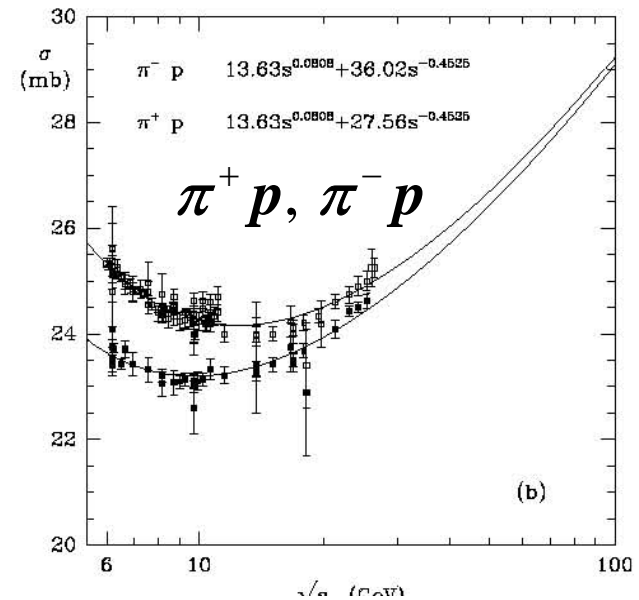
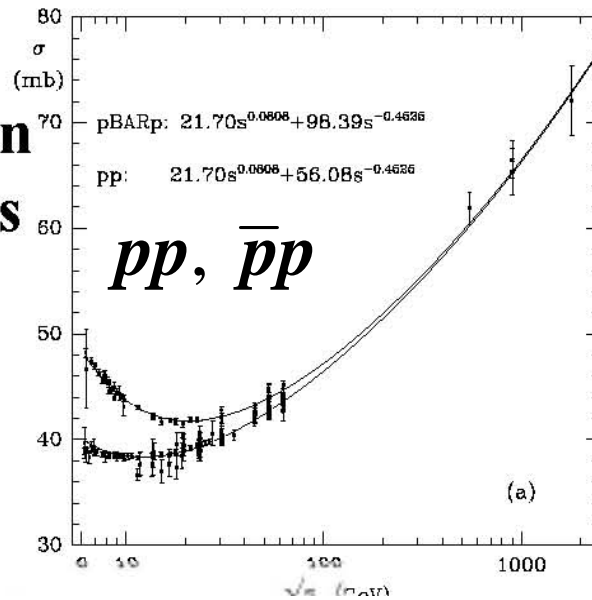


$$F_2 \sim x^{-\lambda(Q^2)}$$

Where exactly is the band? How narrow can one make it? Need to have a precise determination of  $W$  dependence of  $\sigma_{\text{TOT}}$ .

# Hadron-hadron: DL

**Hadron-hadron  
scattering cross  
section versus  
CM energy**



**Donnachie and Lanshoff (DL) - universal behavior of  
total hadron-hadron cross section :**

$$\begin{aligned}
 \sigma_{tot}(h-h) &= A s^{\alpha_{IP}(0)-1} + B s^{\alpha_{IR}(0)-1} \\
 &= A s^{0.0808} + B s^{-0.4525}
 \end{aligned}$$

# Hadron-hadron: DL

How was the DL fit done?

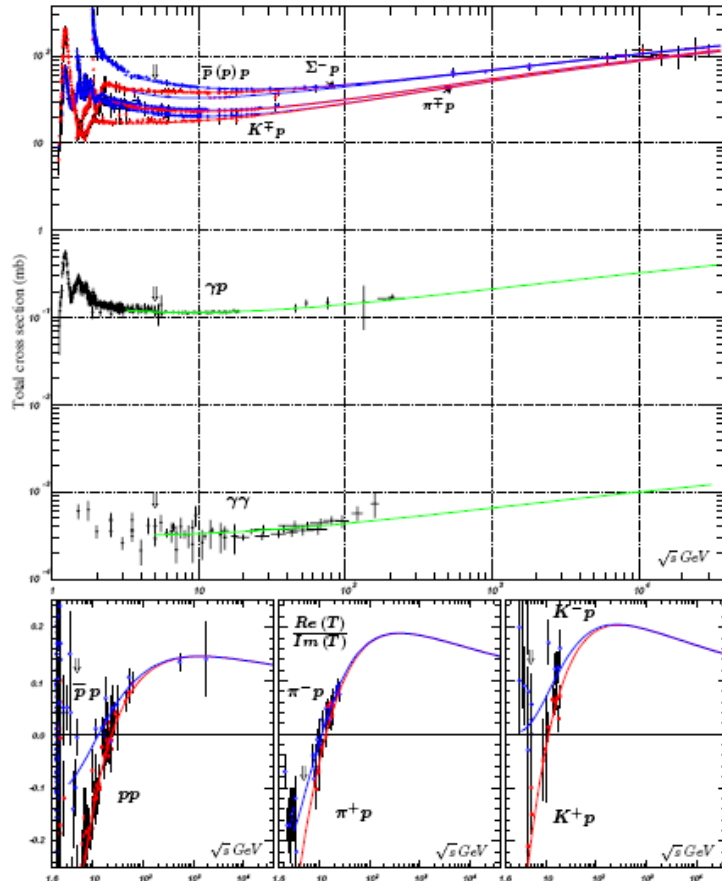
Fit the two powers only from  $pp$  and  $p\bar{p}$  data above  $W=10$  GeV

Get  $\chi^2/df=410/130=3.16 \Rightarrow$  do not give uncertainties on parameters

**“ Notice also that the quality of the data is such that the precise values of our parameters should not be taken too seriously”**  
(Phys. Lett. B296, 227 (1992))

After fixing the 2 parameters find A, B for other reactions.

# Cudell (CKK)



Cudell, Kang, Kim (PL B395, 311 (1997))

Repeat DL analysis, data only if  $1\sigma$  or  $2\sigma$  from average. Use also data on  $\rho$  (real/imaginary part of amplitude). Add separate intercepts of the  $C=+$  and  $C=-$  meson trajectories.

Get:

$$\varepsilon = 0.096^{+0.012}_{-0.009}$$

but

“feel that intercepts as high as 1.11 and as low as 1.07 are possible”

# Cudell (CEKLT)

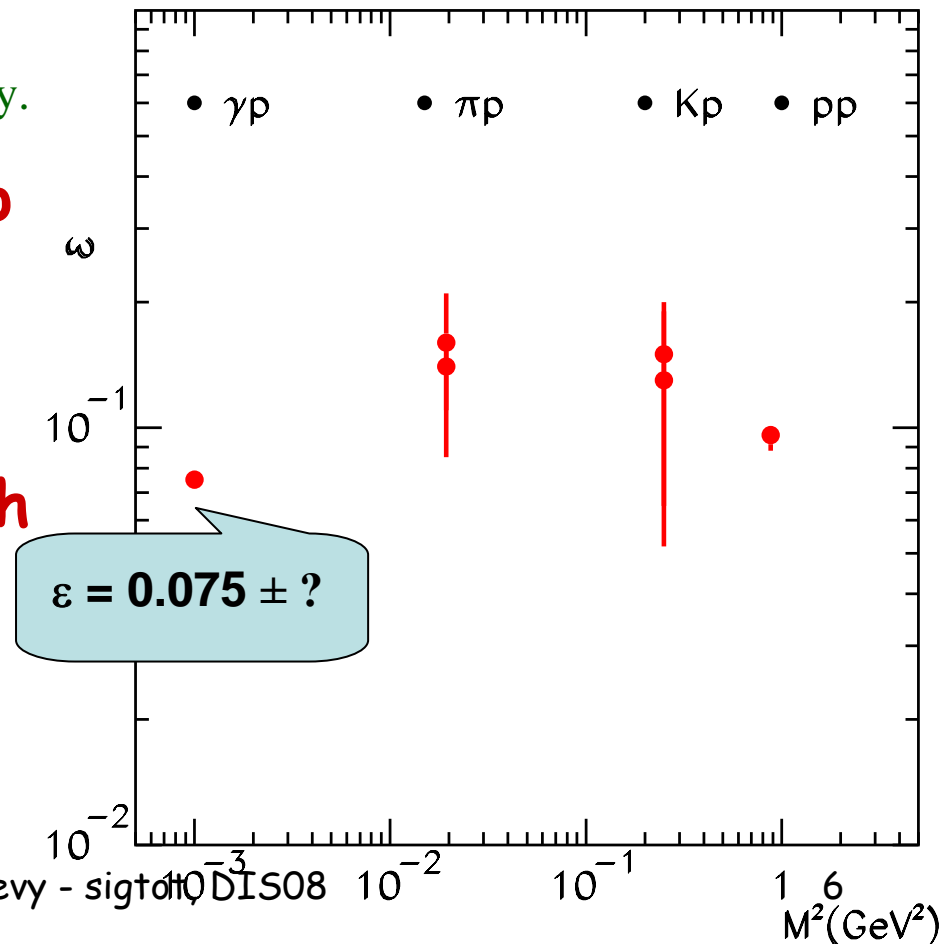
Cudell, Ezhela, Kang, Lugovsky, Tkachenko PR D61, 034019 (2000)  
Repeat CKK with  $W_{\min} = 9 \text{ GeV}$

Get:  $\varepsilon = 0.093 \pm 0.002$  - mainly from  $pp, \bar{p}p$

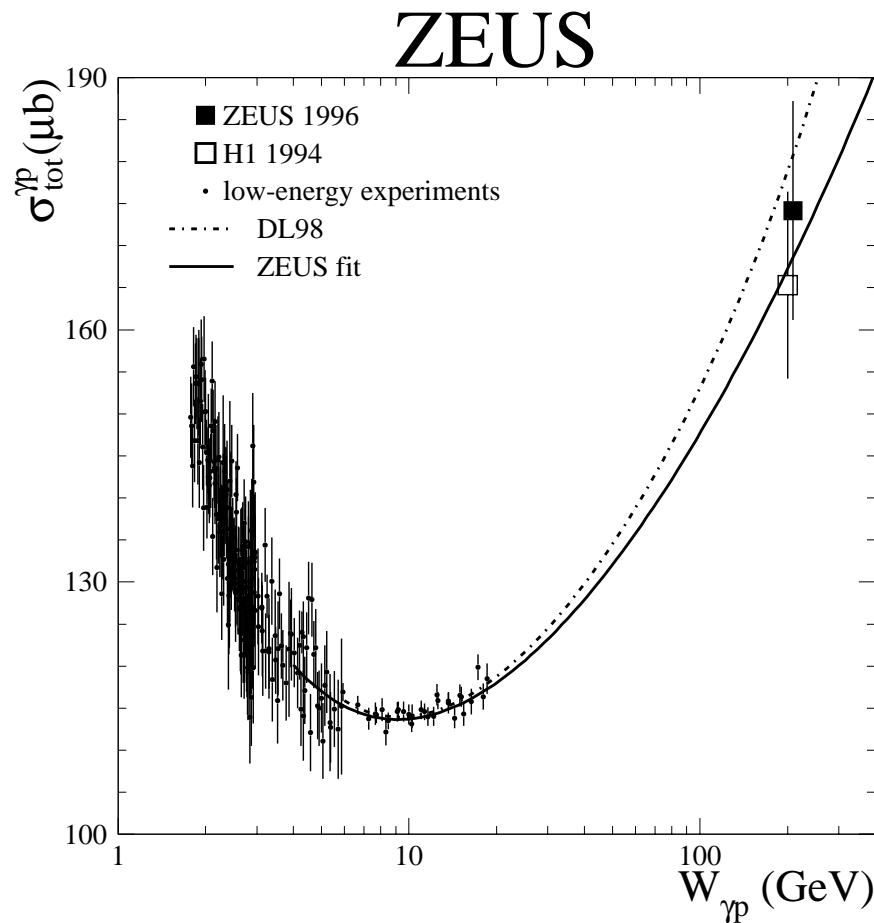
“Furthermore, the parameters of the  $C=+1$  trajectory are highly correlated to those of the Pomeron.”

Fix meson intercepts, fit reactions separately.

“ We have not included the  $\gamma p$  data, as there is some uncertainty regarding these. They would lead to an intercept of order 0.075 with large error bars”



# $\sigma_{\text{TOT}}(\gamma p)$ at HERA



At HERA:

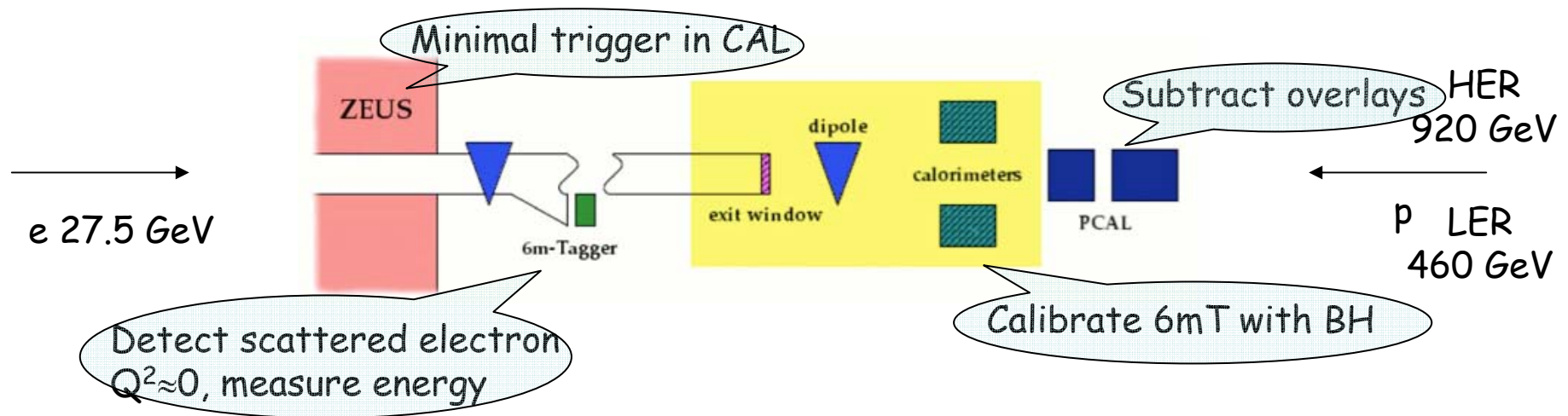
H1 ( $W=200$  GeV),  $165 \pm 2 \pm 11 \mu\text{b}$

ZEUS ( $W=209$  GeV),  $174 \pm 1 \pm 13 \mu\text{b}$

Large systematic uncertainties  
from 35m tagger acceptance  
and Calorimeter acceptance.

Want to reduce the  
large systematic error  
on total cross section  
by measuring ratios at  
different  $W$ .

# W dependence of $\sigma_{\text{tot}}(\gamma p)$



Expect CAL acceptances at different  $W$  to be same - (checked with PYTHIA). Tagger acceptance under control - practically 100%.



# W dependence of $\sigma_{\text{tot}}(\gamma p)$

ZEUS preliminary

$$R = \frac{\sigma_{\text{HER}}^{\gamma p}}{\sigma_{\text{LER}}^{\gamma p}} = \frac{N_{\text{evt}}^{\text{HER}}}{N_{\text{evt}}^{\text{LER}}} \cdot \frac{L_{\text{LER}}}{L_{\text{HER}}} \cdot \frac{f_{\text{LER}}}{f_{\text{HER}}}$$

Uncertainties:

$\pm 0.52\%$ (stat.)  $\pm 1.05$ (sys.)  $\pm 1\%$   $\pm 3.5\%$

from:

signal measurement

LUMI tag6  
(to be improved)

$$\varepsilon = 0.070 \pm 0.007(\text{stat.}) \pm 0.021(\text{syst.}) \pm 0.050(6\text{mT})$$

# Comments

- Result preliminary -  
shows that the principle works
- Can improve -  
reduce systematic uncertainty
- Will use also data  
from intermediate run ( $E_p = 575 \text{ GeV}$ )