THERA Meeting *DESY*

19 October 2000 *Hamburg*

Prospects for Measurements of Diffractive Vector-Meson Photoproduction at High Momentum Transfer at THERA

☞ Recent Observations from ZEUS

☞ Open Questions for THERA

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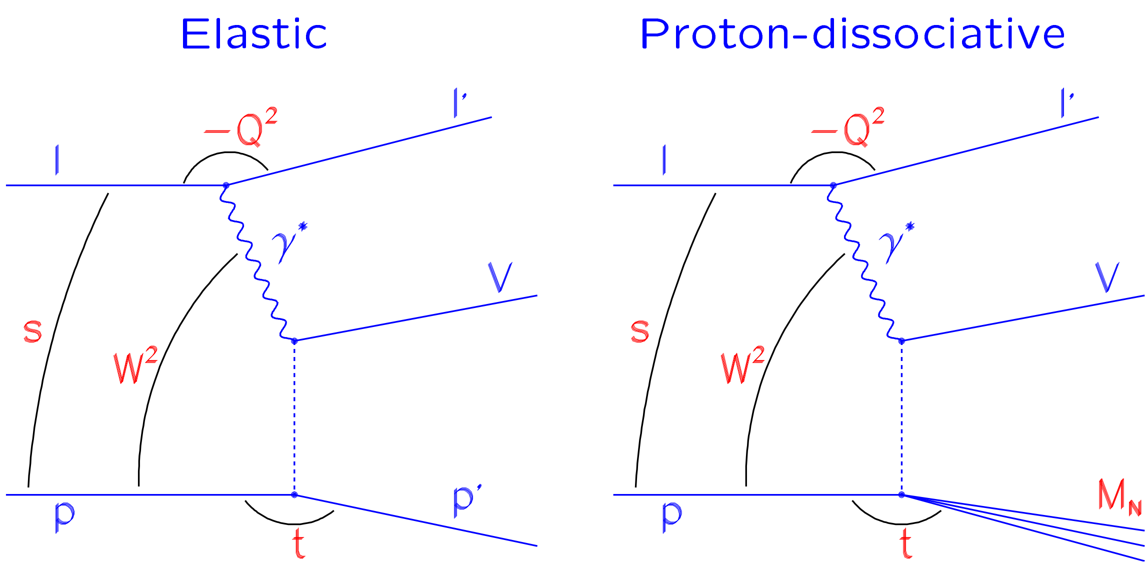
Diffractive Photoproduction of Vector Mesons



$\sqrt{s}$: Center–of–mass energy of e–p system
HERA (1996/97): 300 GeV

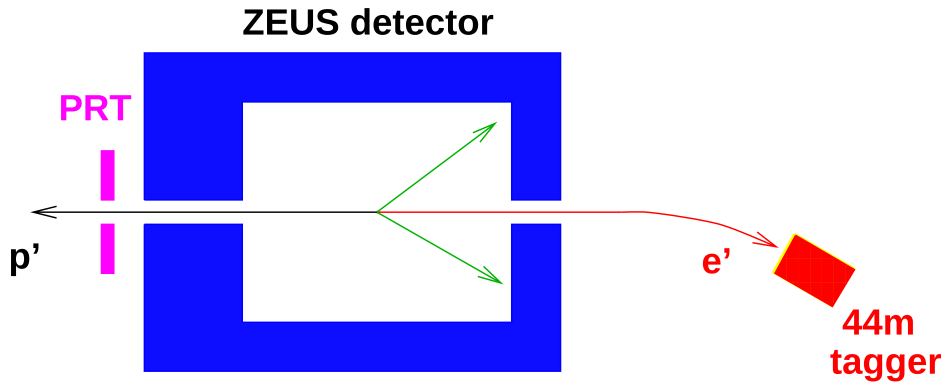
W: Center–of–mass energy of γ^*–p system
This analysis (ZEUS 1996/97 preliminary):
$80 < W < 120$ GeV

Q^2: Photon virtuality
This analysis: $Q^2 < 0.01$ GeV^2 ($\Rightarrow t \simeq -P_T^2$(V))

t: Square of the momentum transfer
This analysis: $-11 < t < -1.5$ GeV^2
Proton-dissociative process dominates

M_N: Mass of the dissociated proton system
This analysis: $M_p^2 < M_N^2 < -100 * t$

Photoproduction Tagging at $W \simeq$ 100 GeV



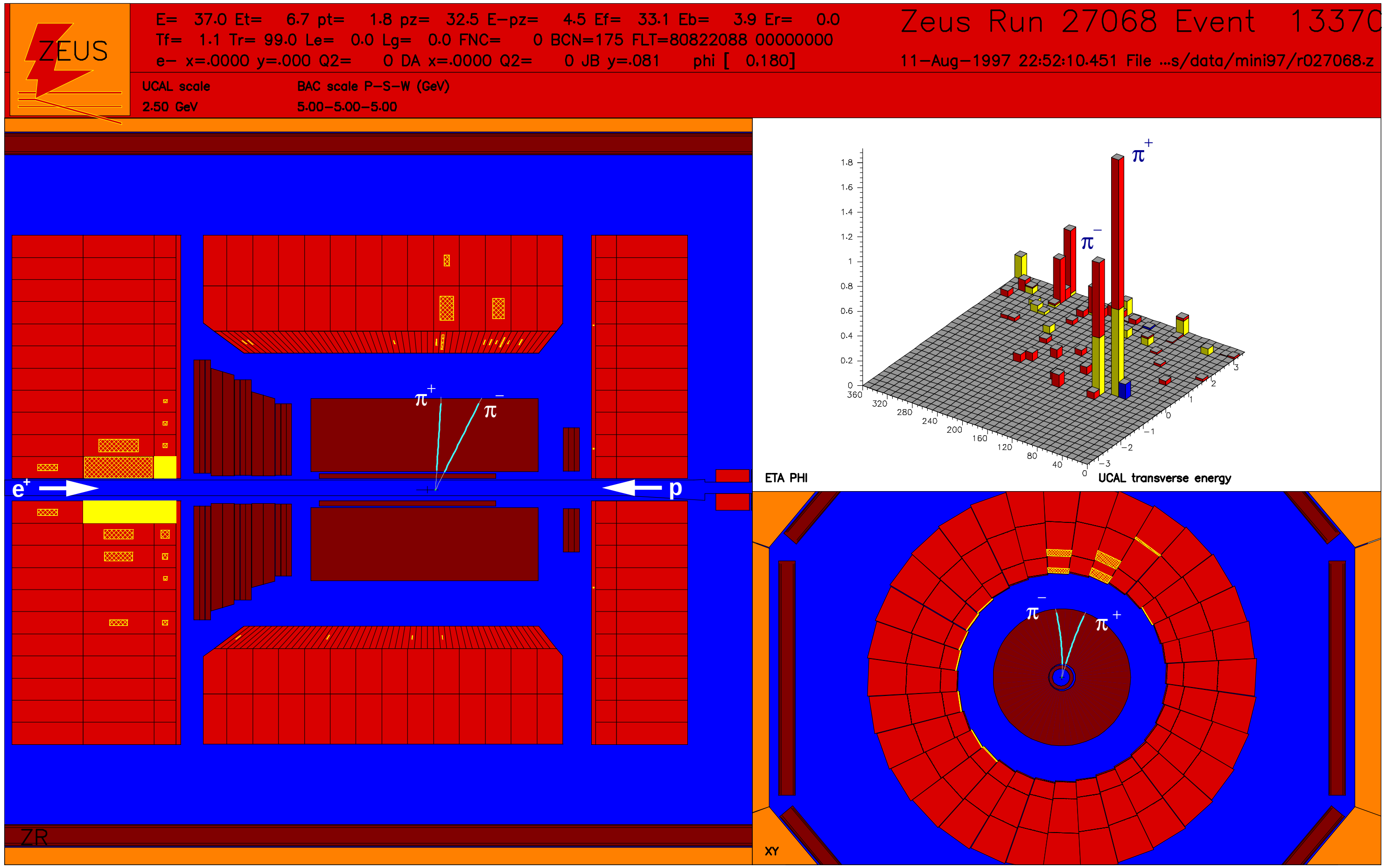
$$Q^2 < 0.01 \text{ GeV}^2$$
$$23 < E_{e'} < 25 \text{ GeV}$$
$$(\Rightarrow 80 < W < 120 \text{ GeV})$$

ZEUS 1996/97 preliminary

Integrated luminosity: 24 pb^{-1}

ρ^0: $\simeq$ 18k
ϕ: $\simeq$ 2k
J/ψ: $\simeq$ 150

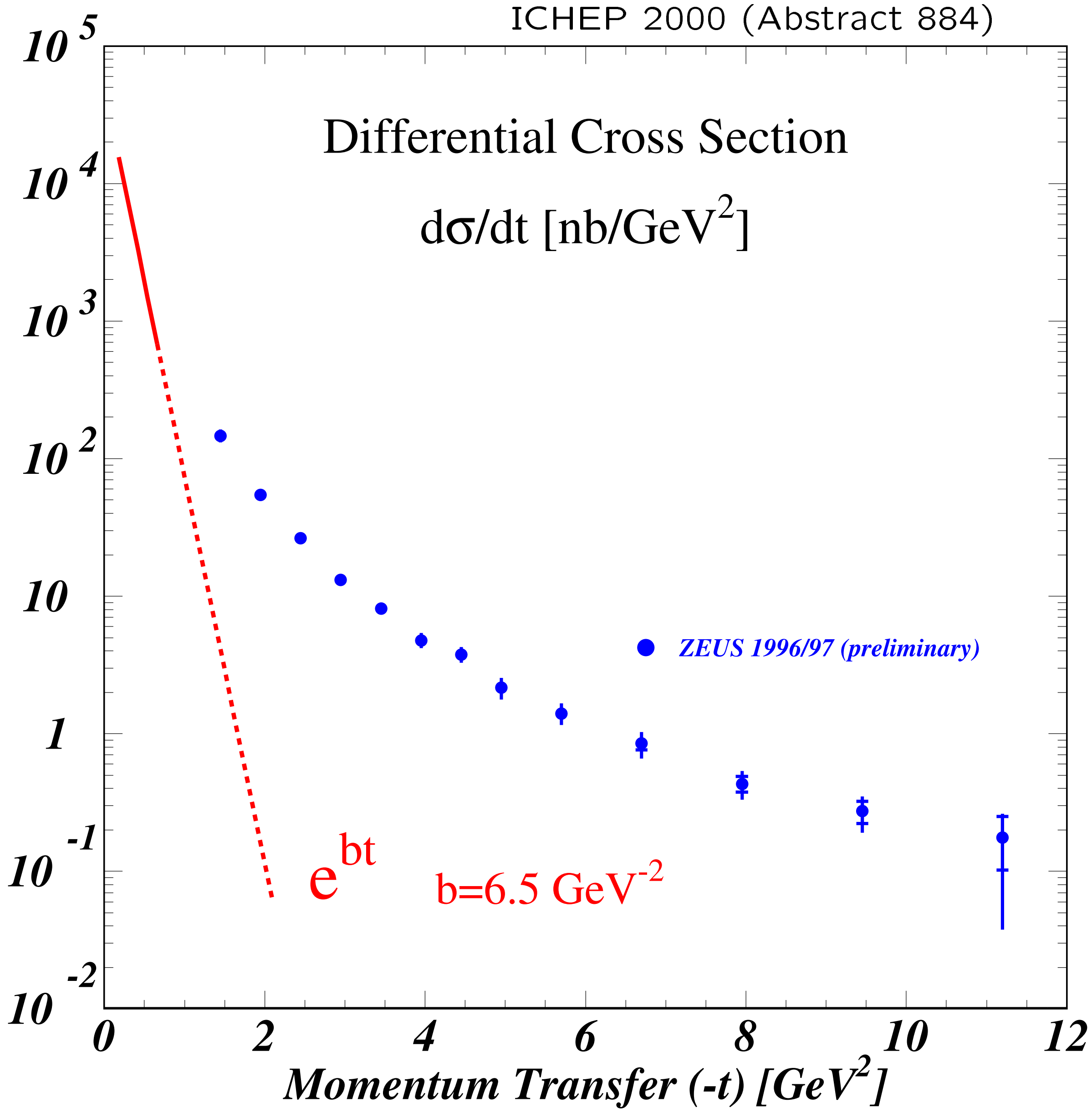
Candidate for ρ^0 Photoproduction at High $|t|$



$$e^+p \to e^+N\,\rho^0 \to e^+N\,\pi^+\pi^- \qquad M_{\pi^+\pi^-} = 0.78 \text{ GeV},\ t = -10.0 \text{ GeV}^2,\ W = 81 \text{ GeV}$$

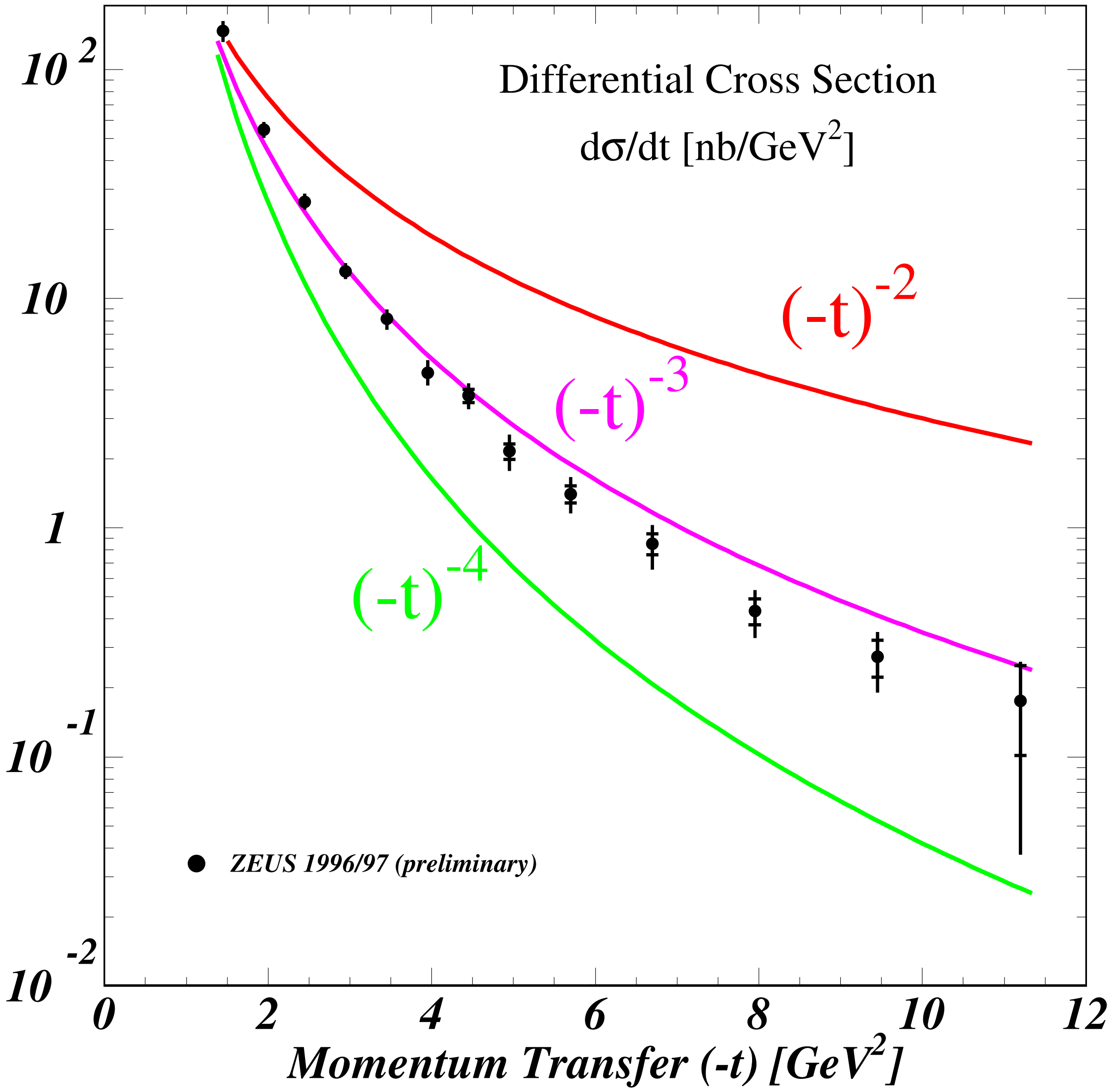
Diffractive ρ^0 Photoproduction (I)

$$\gamma + p \to \rho^0 + N$$



Asymptotic region

Diffractive ρ^0 Photoproduction (II)



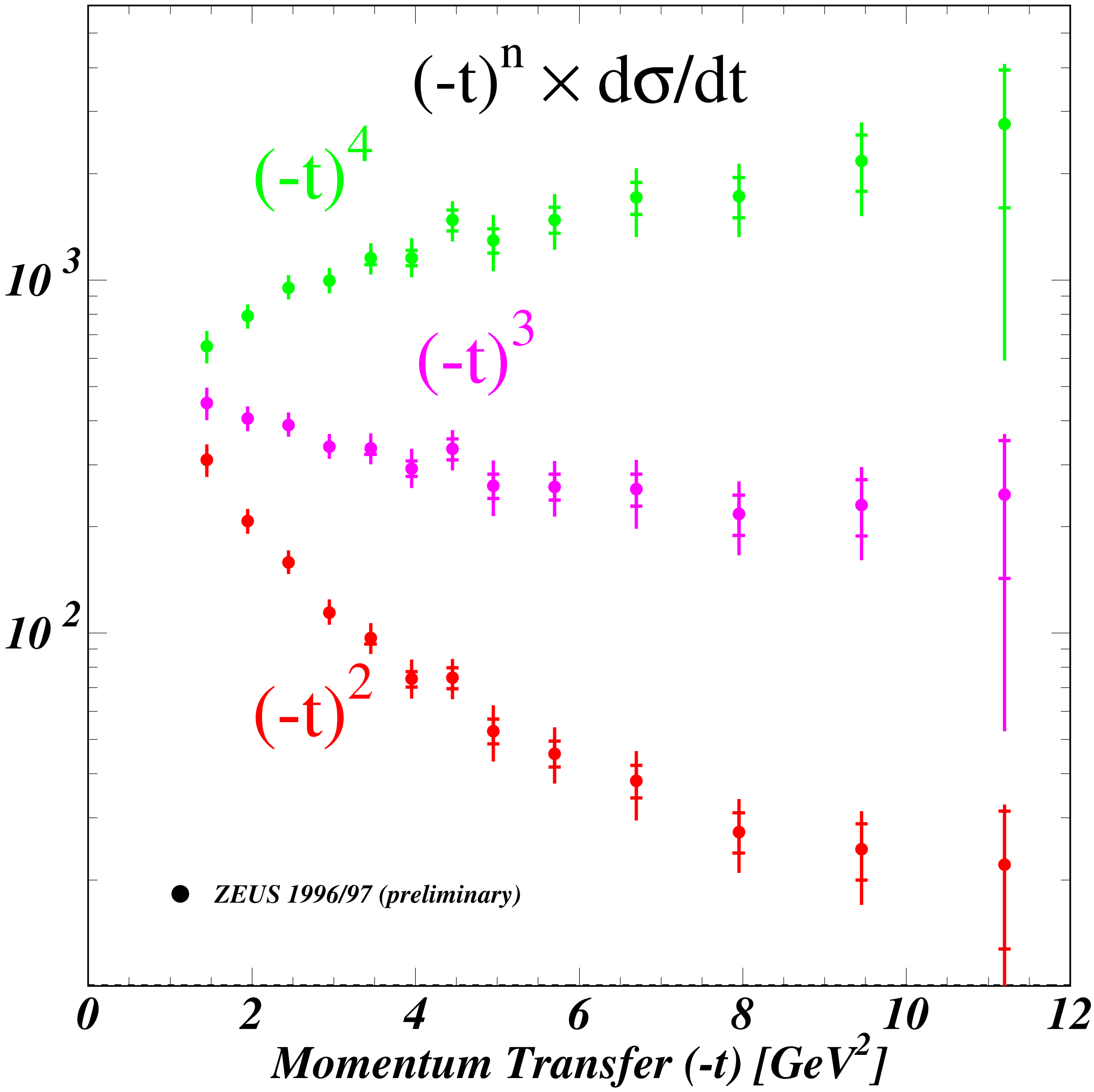
Scaling Property

Power dependence with

$n = 3$

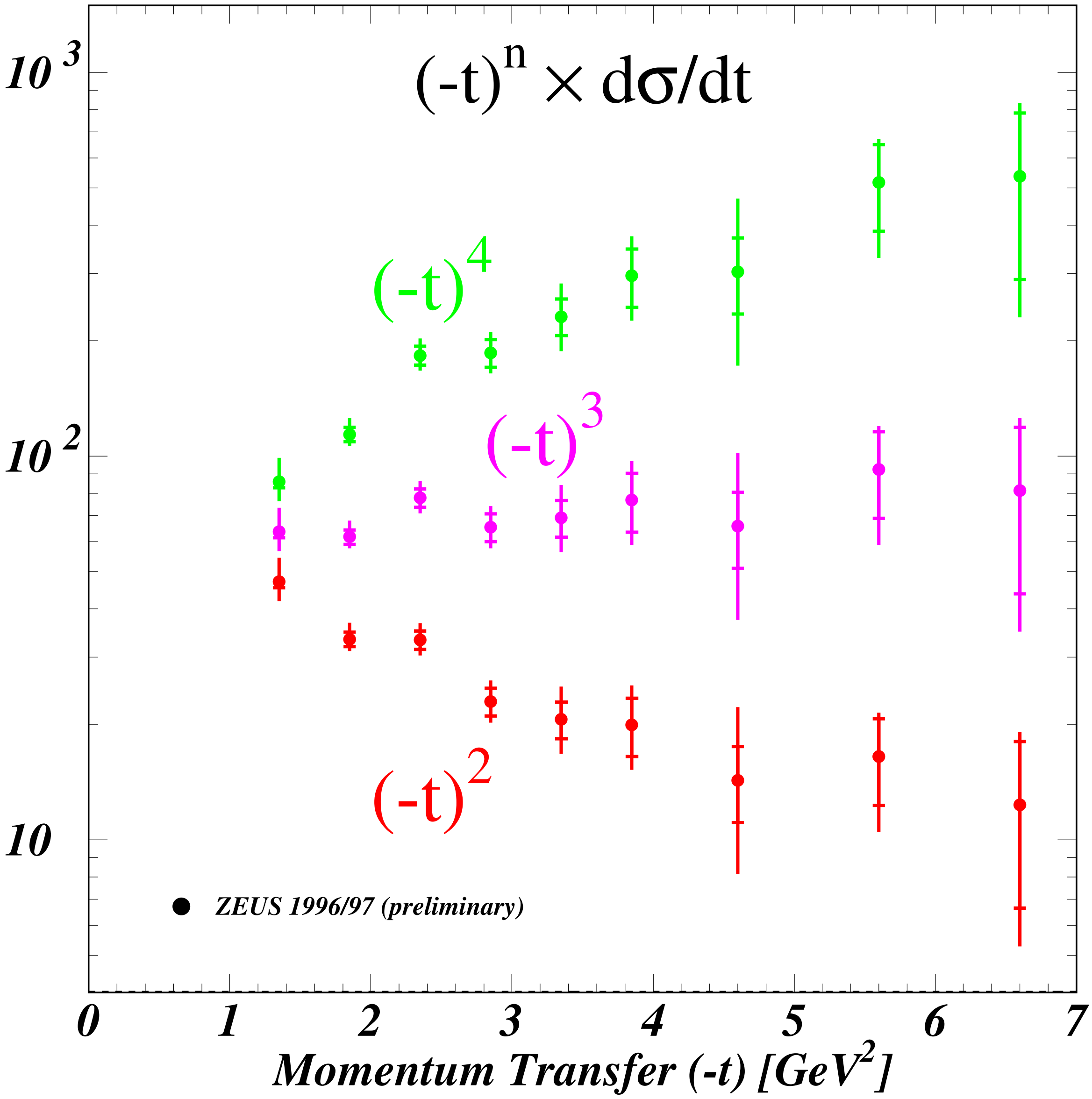
matches the data fairly well

Diffractive ρ^0 Photoproduction (III)



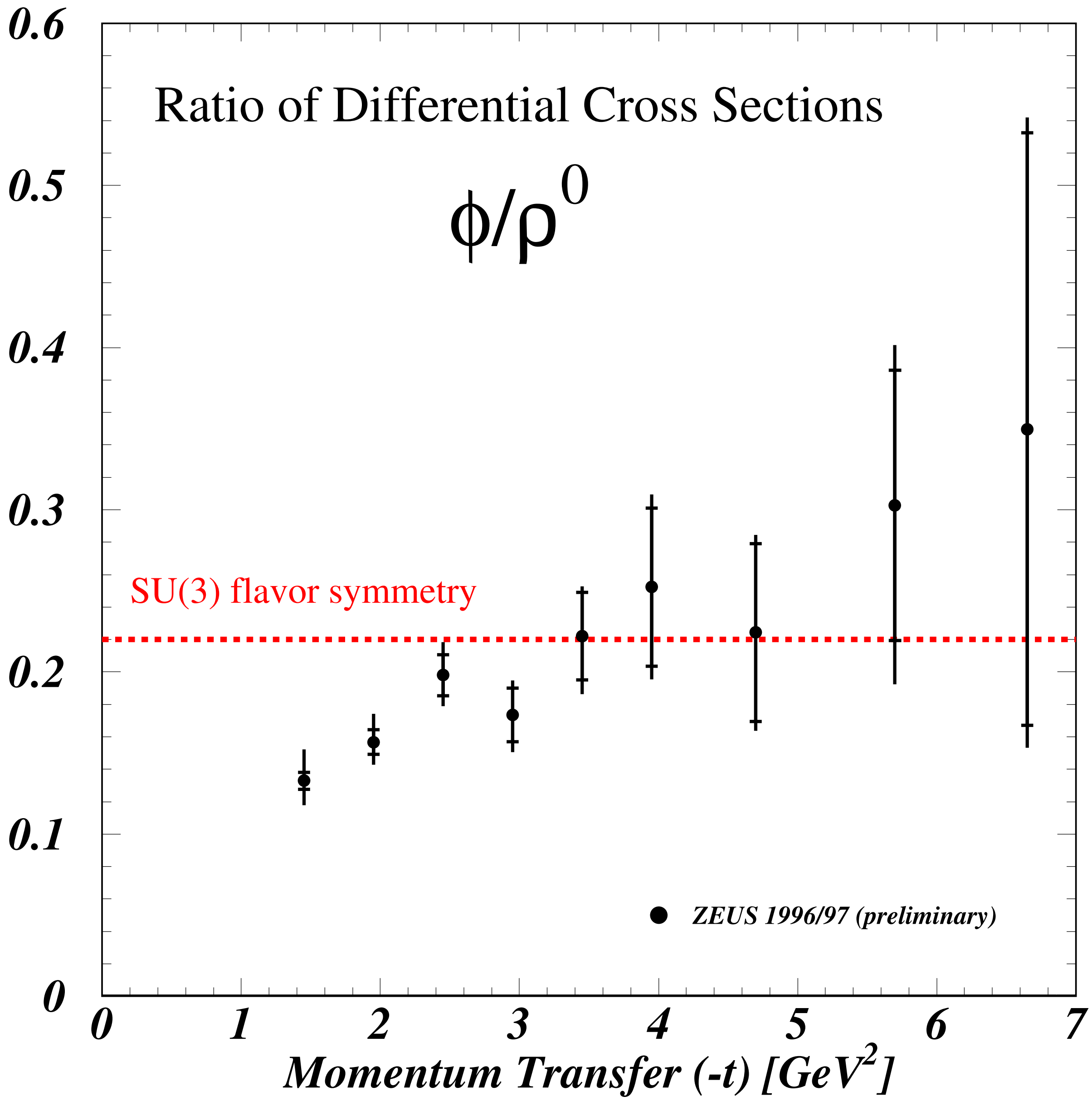
Scaling with $(-t)^n$

Diffractive ϕ Photoproduction



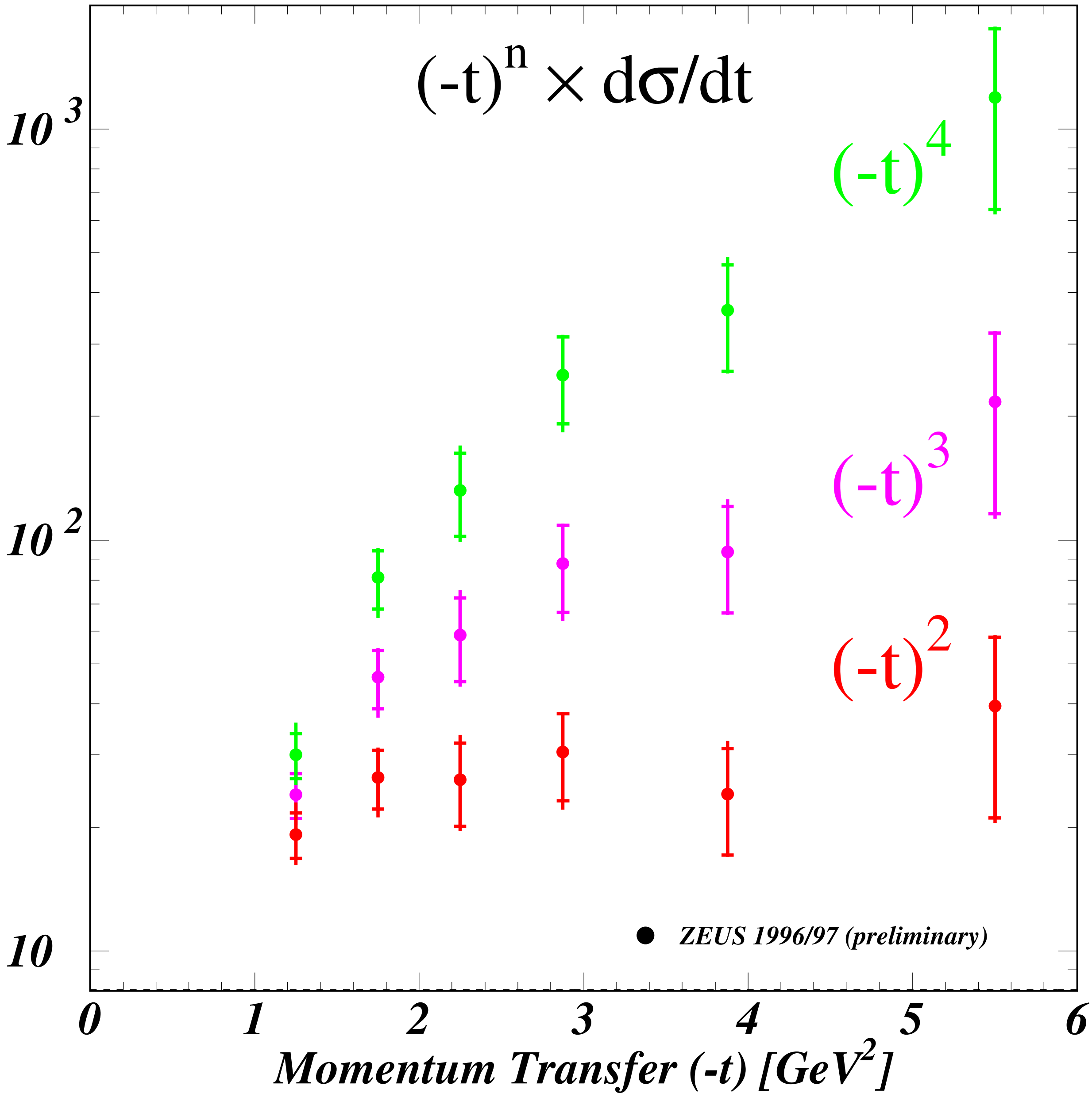
Scaling with $(-t)^n$

Ratio of ϕ to ρ^0 Production



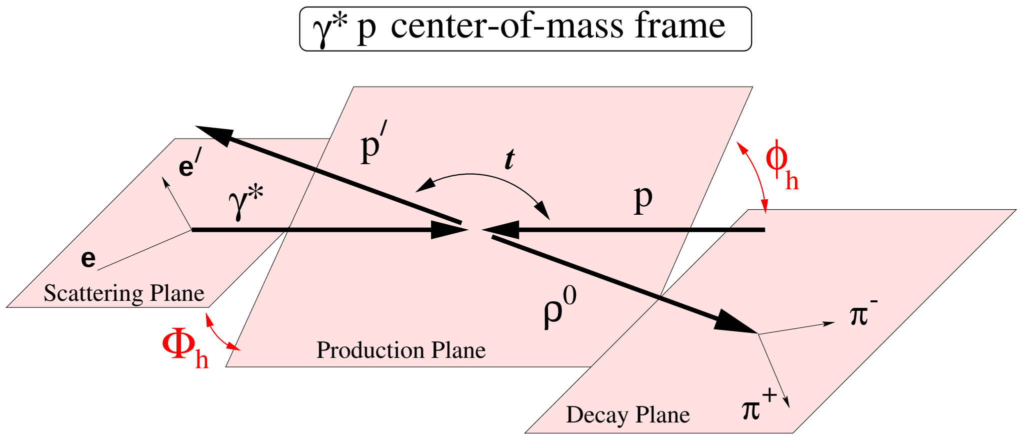
SU(3) flavor symmetry observed at high $|t|$

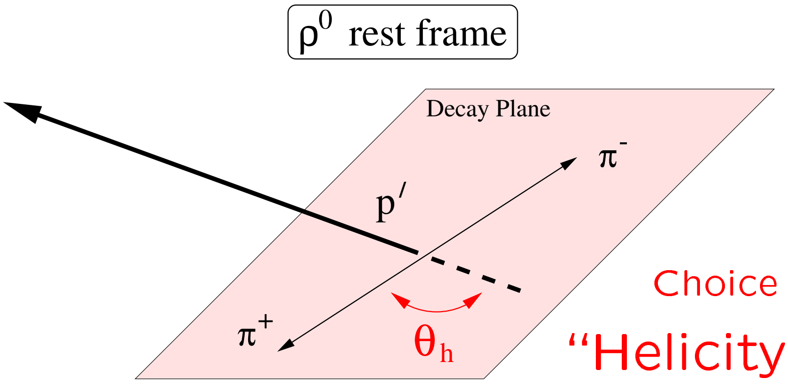
Diffractive J/ψ Photoproduction



Scaling with $(-t)^n$

Decay-Angle Analysis (I)





Choice of Z-axis:

"Helicity Frame"

- Φ_h Angle between the electron scattering plane and the ρ^0 production plane
- θ_h Polar angle of π^+ in the ρ^0 rest frame
- ϕ_h Azimuthal angle of π^+

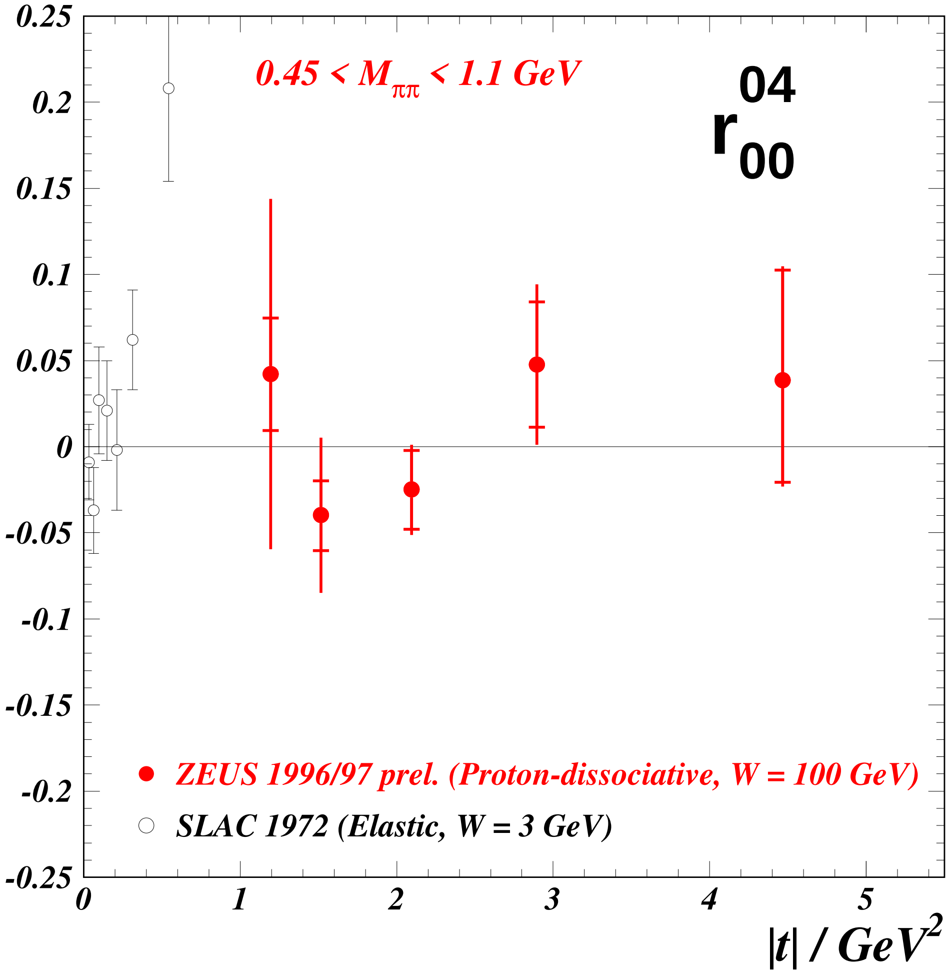
At low Q^2, Φ_h poorly measured, so integrate over it:

$$W(\cos\theta_h, \phi_h) = \frac{3}{4}\left[\frac{1}{2}(1 - r^{04}_{00}) + \frac{1}{2}(3r^{04}_{00} - 1)\cos^2\theta_h - \sqrt{2}\mathrm{Re}(r^{04}_{10})\sin 2\theta_h \cos\phi_h - r^{04}_{1-1}\sin^2\theta_h \cos 2\phi_h \right]$$

Decay-Angle Analysis (II)

$$r^{04}_{00} \simeq \frac{T^2_{01}}{T^2_{01}+T^2_{11}+T^2_{1-1}}$$

r^{04}_{00} measures the degree of longitudinal polarization



Tranverse polarization dominates

General Remarks

- These are the first measurements of vector-meson photoproduction at values of t comparable to the Q^2 values in deep inelastic scattering which led to the discovery of Bjorken scaling and charged proton constituents.

- This is presumably a strong interaction

- These values for t exceed the mass scales for ρ^0 and ϕ and Λ_{QCD} $\Rightarrow$ Asymptotic region

  The t dependence characterizes the interaction.

- We observe an extremely hard t spectrum $\Rightarrow$ low-order process

- Field theory for interaction without color exchange?

Conclusions I

High-t vector-meson photoproduction
presents an opportunity to study
the dynamics of diffractive processes

In the asymptotic region of
momentum transfer

ρ^0 photoproduction exhibits a
very hard spectrum

$$\frac{\mathrm{d}\sigma}{\mathrm{d}t} \propto (-t)^{-n} \quad n \simeq 3$$

The final-state ρ^0 are predominantly
transversely polarized

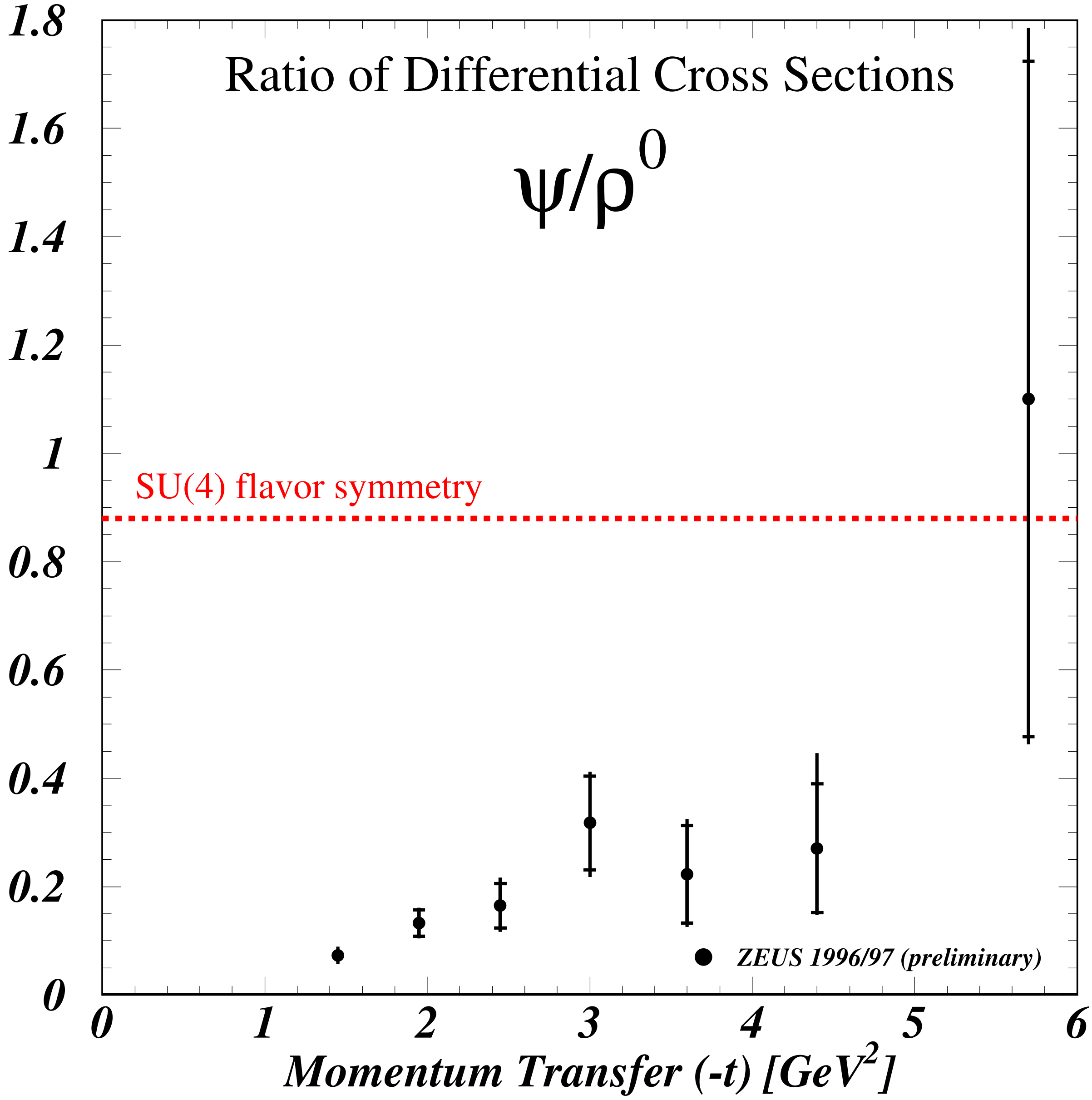
The ratio of ϕ to ρ^0 exhibits
SU(3) flavor symmetry

Conclusions II

At THERA the kinematics permit
reach to higher momentum transfer

The energy dependence is of
essential importance to clarify
the underlying physical process

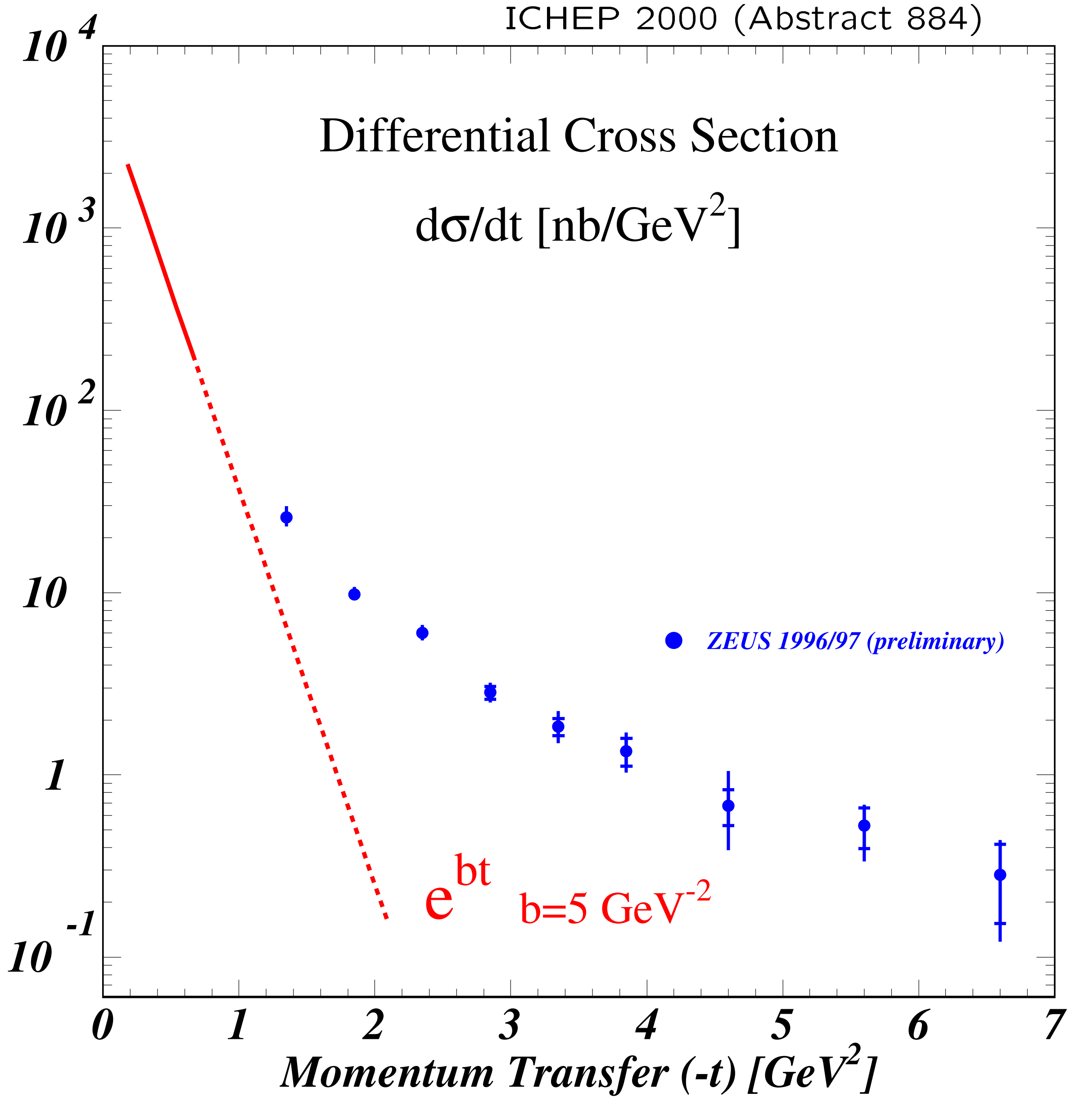
Ratio of J/ψ to ρ^0 Production



Diffractive ϕ Photoproduction (I)

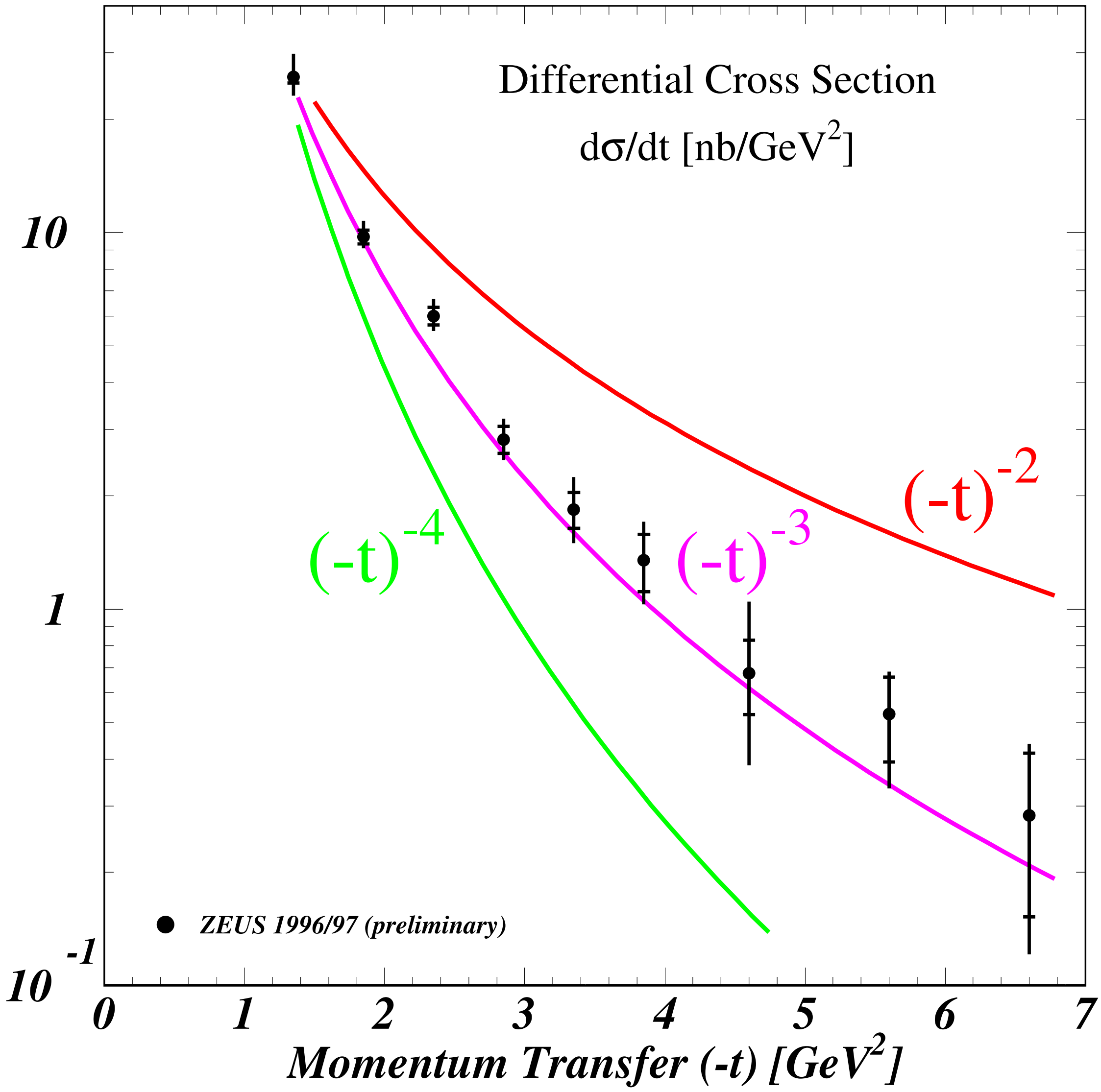
$$\gamma + p \rightarrow \phi + N$$

ICHEP 2000 (Abstract 884)



Asymptotic region

Diffractive ϕ Photoproduction (II)



Scaling Property

Power dependence with
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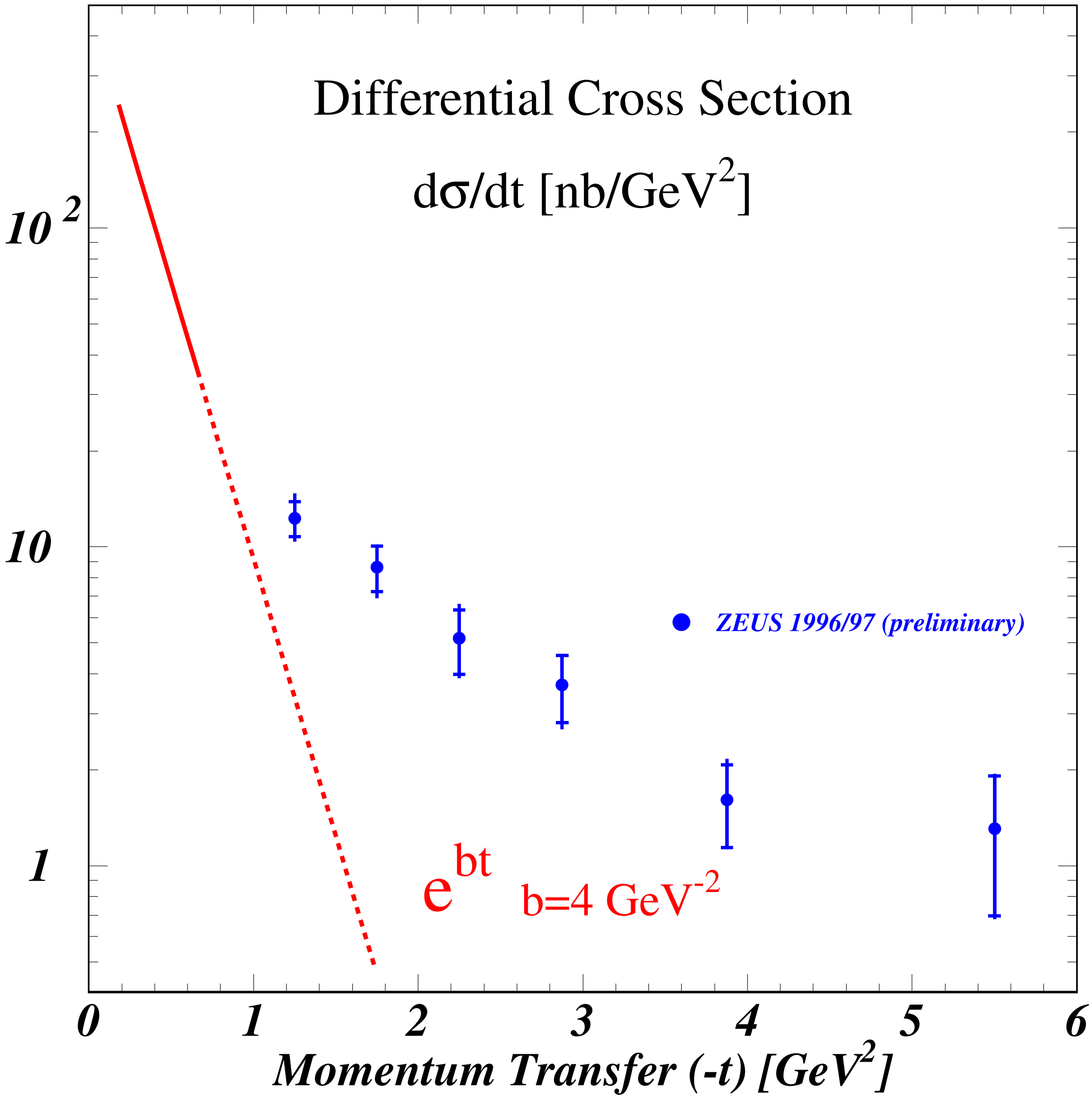
Diffractive J/ψ Photoproduction (I)

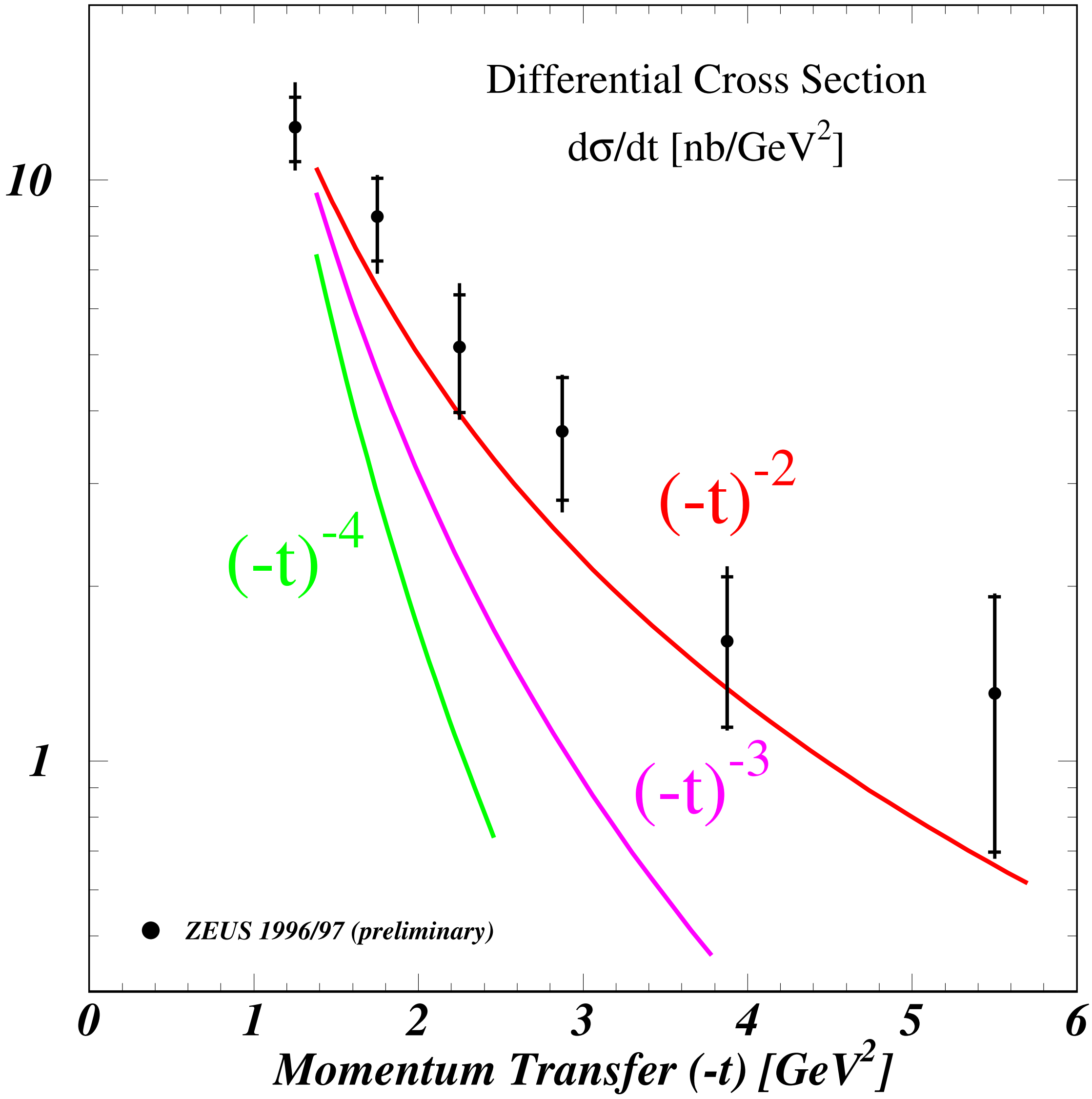
$$\gamma + p \rightarrow J/\psi + N$$

ICHEP 2000 (Abstract 884)



NOT asymptotic region

Diffractive J/ψ Photoproduction (II)



Scaling Property

Power dependence with

$n = 2$

matches the data fairly well