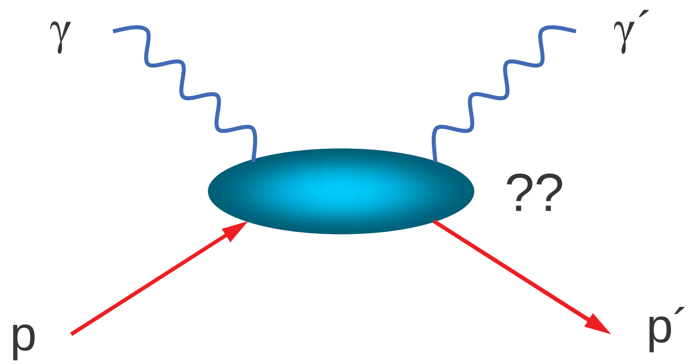
Real Compton Scattering from the proton

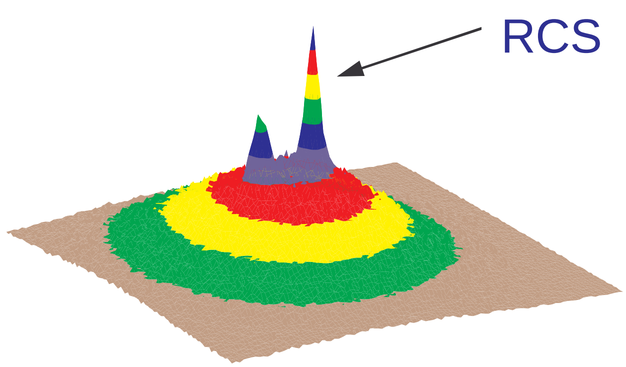
Vahe Mamyan, for Hall A and RCS collaboration

Jefferson Lab/Yerevan Physics Institute

Experiment E99-114

- Spokespersons – Charles Hyde-Wright, Alan Nathan Bogdan Wojtsekhowski
- Students – Areg Danagoulian, David Hamilton, Vahe Mamyan, Michael Roedelbronn





- Introduction
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- Status of the E99-114

RCS collaboration

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Factorization of cross section

$s, t, u >> m_p^2$ →

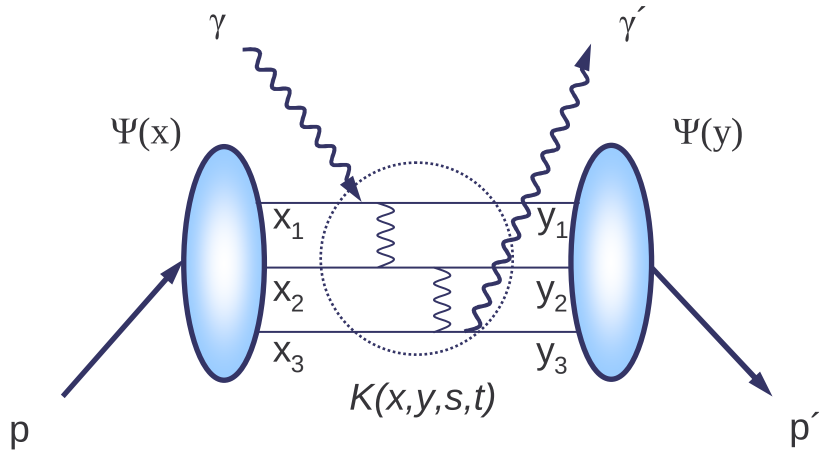
Factorization of the transition amplitude into the convolution of a perturbative hard scattering amplitude, which involves the coupling of the external photons to the active quarks, with an overlap of initial and final soft wave functions, which describes the coupling of the active quarks to the proton.

$$T_{if}(s,t) = \Psi_f \otimes K(s,t) \otimes \Psi_i$$

$K(s,t)$	Parturbative hard scattering amplitude
Ψ	Soft wave function

1. Constituent counting rule and scaling
2. Handbag mechanism, introduction of RCS form factors

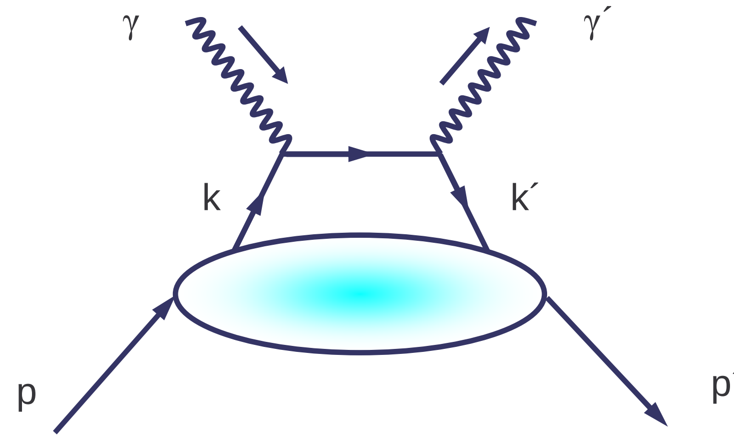
Theory of RCS



$$T_{\nu\mu}(s,t) = \int d^3x d^3y \Psi(y) \otimes K_{\nu\mu}(x,y,s,t) \otimes \Psi(x)$$

3 active quarks. Leading to asymptotic counting rule and scaling.

$$\frac{d\sigma}{dt} = \frac{f(\theta_{CM})}{s^{n-2}}$$



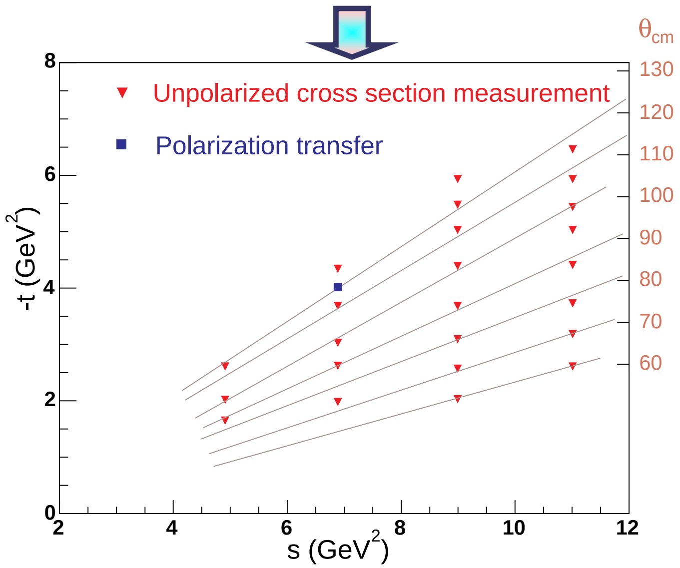
1 active quark. Factorization of hard and soft subprocesses.

Introduction of form factors for RCS

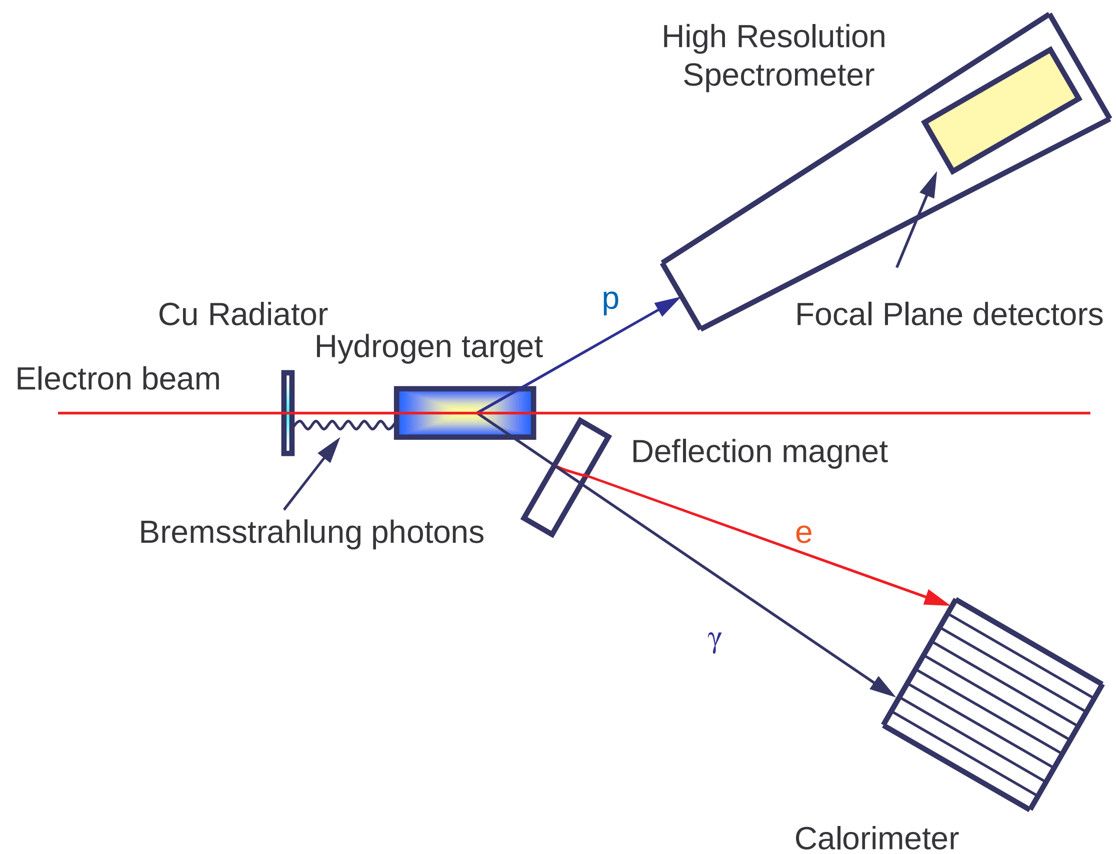
$$\frac{d\sigma}{d\sigma_{KN}} = f_V R_V^2 + (1 - f_V) R_A^2$$

Experimental Setup

Kinematics coverage



- Mixed electron/photon beam
- High photon flux
- Excellent angular resolution to subtract $\pi^o \rightarrow \gamma\gamma$ background
- Deflection magnet used to identify *(e,e´p)*



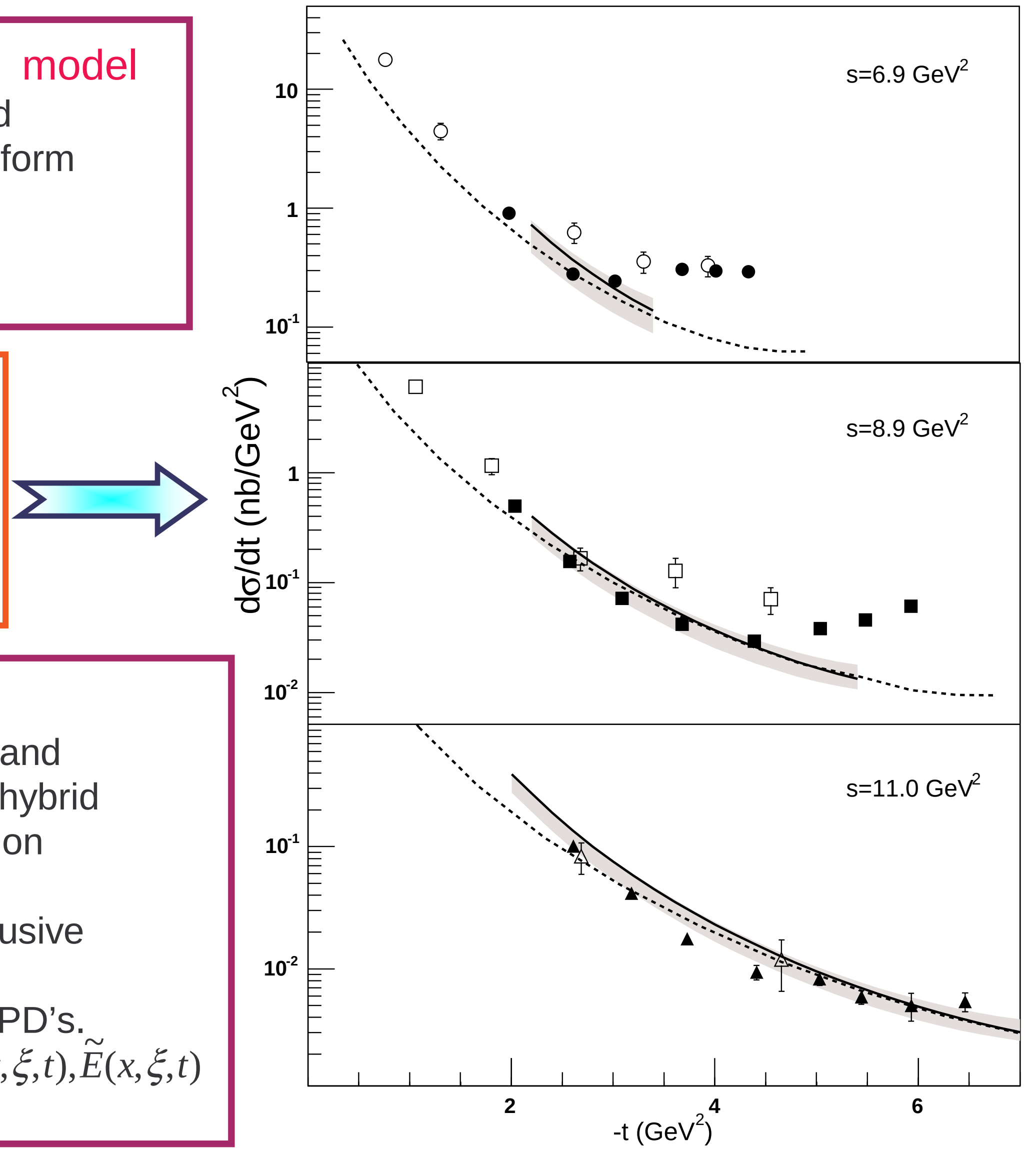
Polarization measurement allows to access form factor R_A !

Cross section and handbag model

G. Miller – Relativistic Constituent Quark model

- Wave function that provides a reasonably good description of all four nucleon electromagnetic form factors to evaluate the handbag diagram.
- Relativistic and quark mass effects induce violation of hadronic helicity conservation.

- Open points – Cornell data
- Full points – RCS data
- Dashed lines – RCQ model
- Solid lines – GPD calculations



Kroll, Radyushkin – GPD

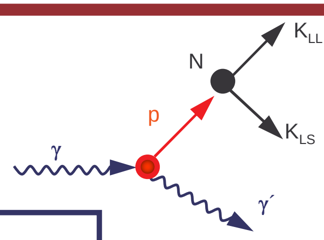
- Generalization of Feynman parton distribution and electromagnetic form factors of the nucleon to hybrid functions related to the non-parturbative, reaction independent structure of the nucleon.
- Self consistent approach to describe hard exclusive reactions.
- Form factors of the nucleon are moments of GPD's.
- Four GPD functions: $H(x,\xi,t), E(x,\xi,t)$ and $\tilde{H}(x,\xi,t), \tilde{E}(x,\xi,t)$

Polarization measurement

Polarization transfer coefficients

$$K_{LL}\frac{d\sigma}{dt}=\frac{d\sigma(\mu=\uparrow,\lambda'=\uparrow)}{dt}-\frac{d\sigma(\mu=\uparrow,\lambda=\downarrow)}{dt}$$

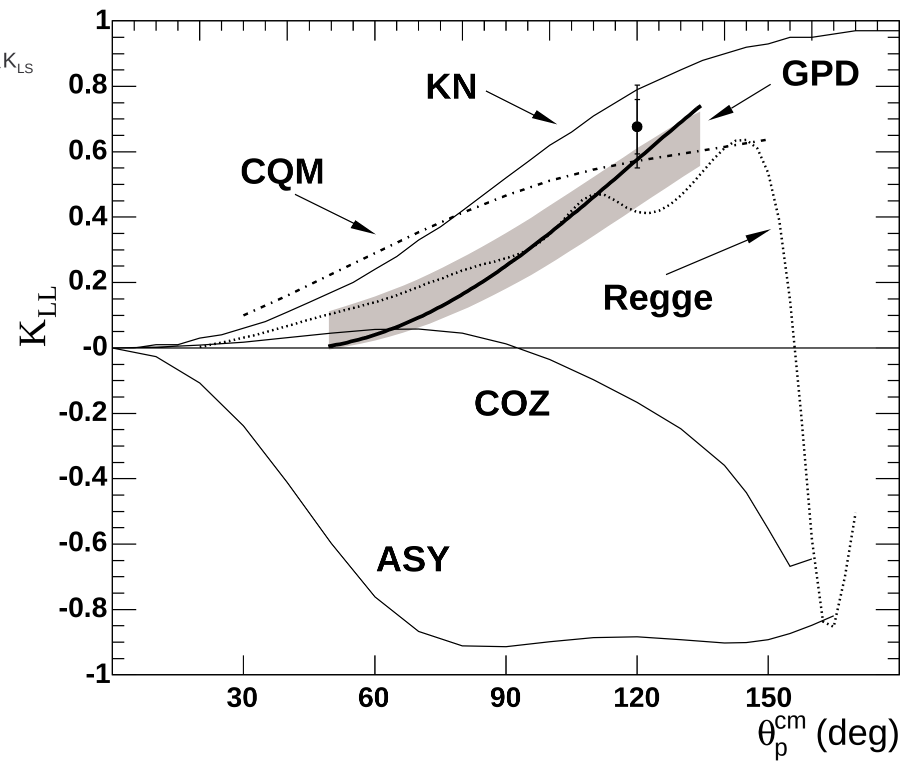
$$K_{LS}\frac{d\sigma}{dt}=\frac{d\sigma(\mu=\uparrow,\lambda'=\rightarrow)}{dt}-\frac{d\sigma(\mu=\downarrow,\lambda=\rightarrow)}{dt}$$



$$K_{LL}\approx\frac{R_A}{R_V}K_{LL}^{KN}\left[1-\frac{t^2}{2(s^2+u^2)}\left(1-\frac{R_A^2}{R_V^2}\right)\right]^{-1}$$

$-t=4\ \mathrm{GeV}^2$

$$R_A/R_V=0.81\pm0.11$$



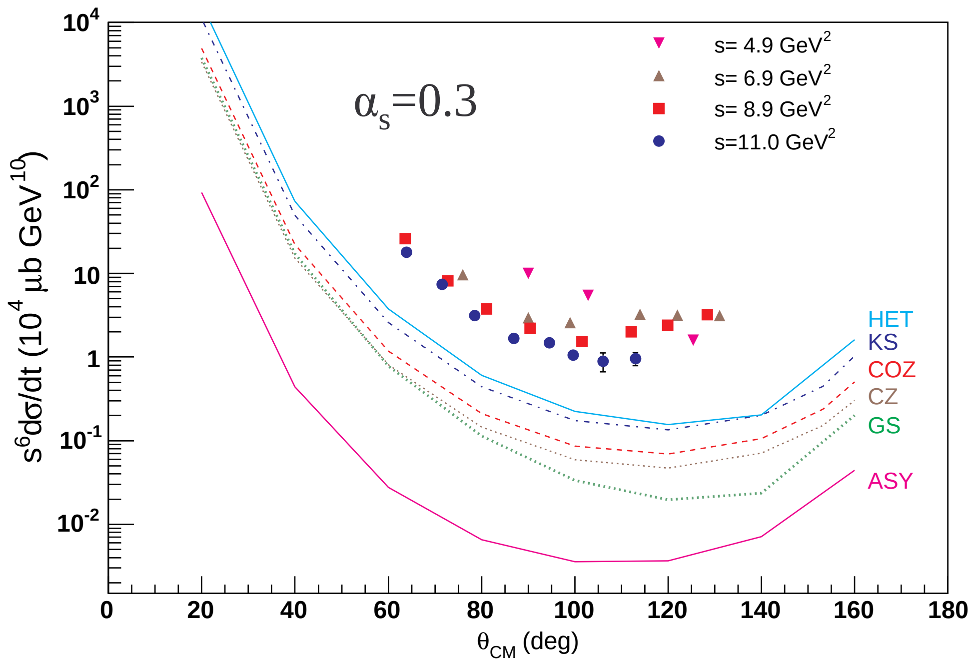
Allows access to axial form factor R_A

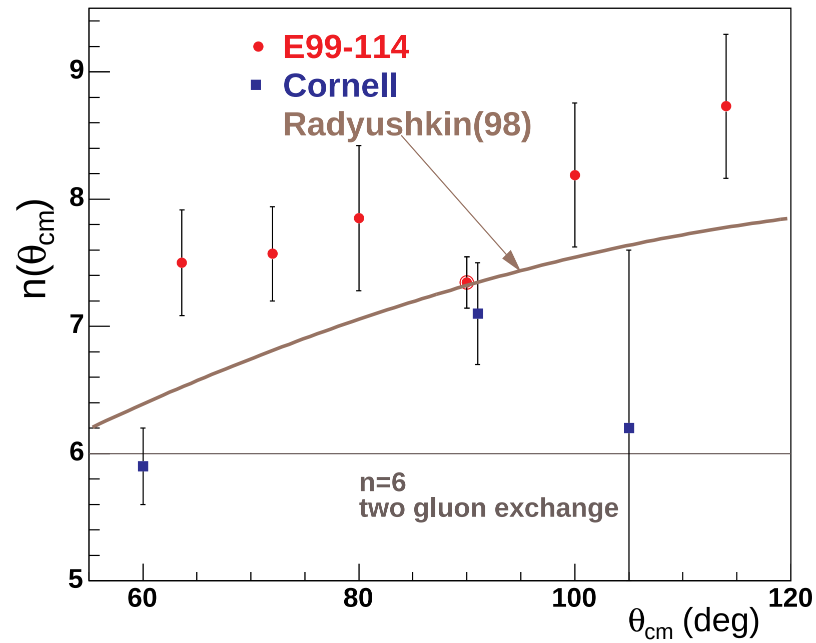
K_{LL}= 0.678±0.083 ±0.04

K_{LS}= 0.114 ±0.078 ±0.04

Final !

Cross section scaling



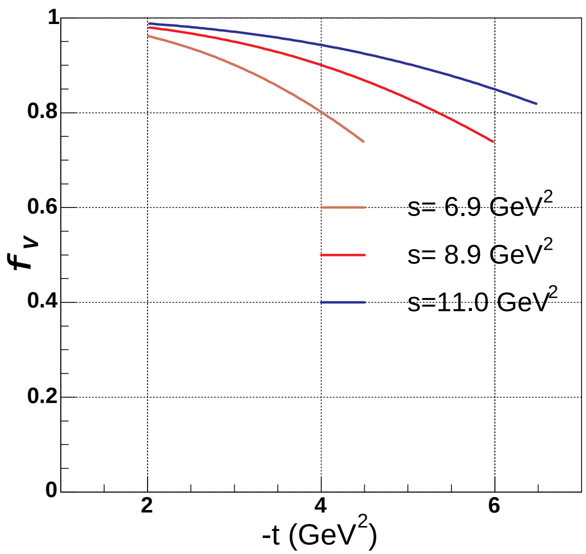


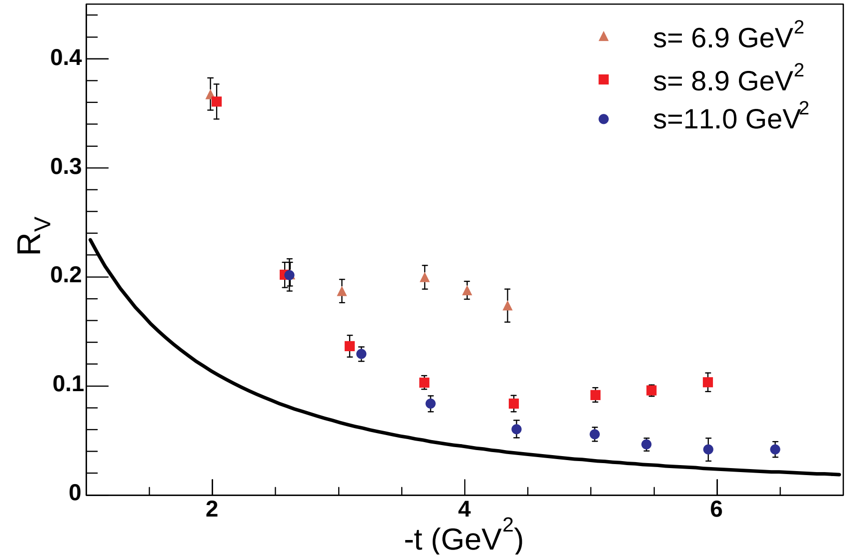
- Curves correspond to different distribution amplitudes.
- Calculations are lower at the order of magnitude.

- Scaling power n is higher then predicted by 2 gluon exchange mechanism.
- n depends from θ_{CM} .

Form factors of RCS

$$\frac{d\sigma}{d\sigma_{KN}} = f_V R_V^2 + (1 - f_V) R_A^2$$



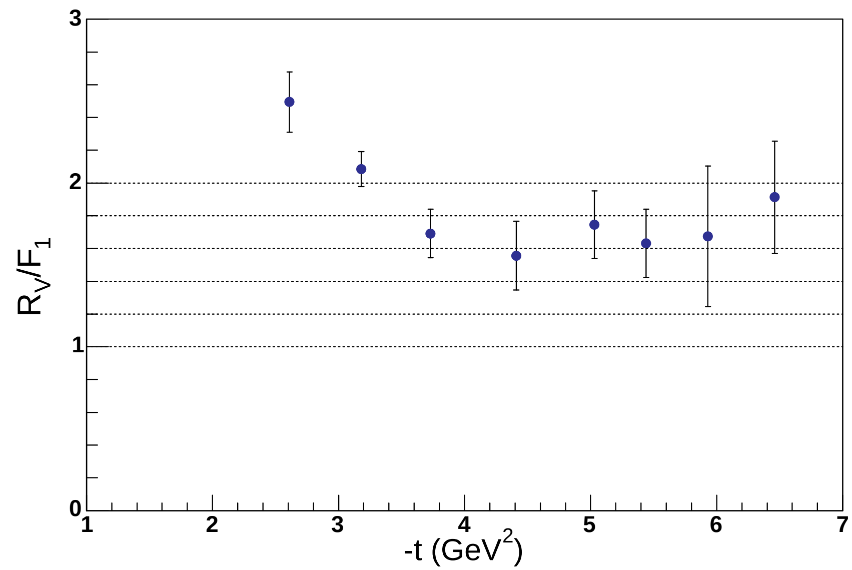


Vector form factors

$$R_V(t) = \sum_a e_a^2 \int_{-1}^{+1} \frac{d\bar{x}}{\bar{x}} H(x,\xi,t)$$

$$F_1(t) = \sum_a e_a \int_{-1}^{+1} dx H(x,\xi,t)$$

Form factor for RCS ??



Conclusion

- The results of analysis show that two gluon exchange mechanism is playing a minor role in RCS in few GeV energy region.
- Most likely the handbag mechanism is the dominant one.

Status of the E99-114

- Thesis was defended by David Hamilton.
- Polarization measurement paper was submitted to Physics Review Letters (nucl-ex/0410001).
- My thesis is almost ready.
- Publication for Armenian Physics Journal is coming.
- ALLRCS proposal was submitted to PAC27.