15th International Conference on Elastic & Diffractive Scattering (15th "Blois Workshop")

FINLAND (SAARISELKÄ)
September, 09-13

"Models of the hadron structure and Data of the TOTEM Collaboration

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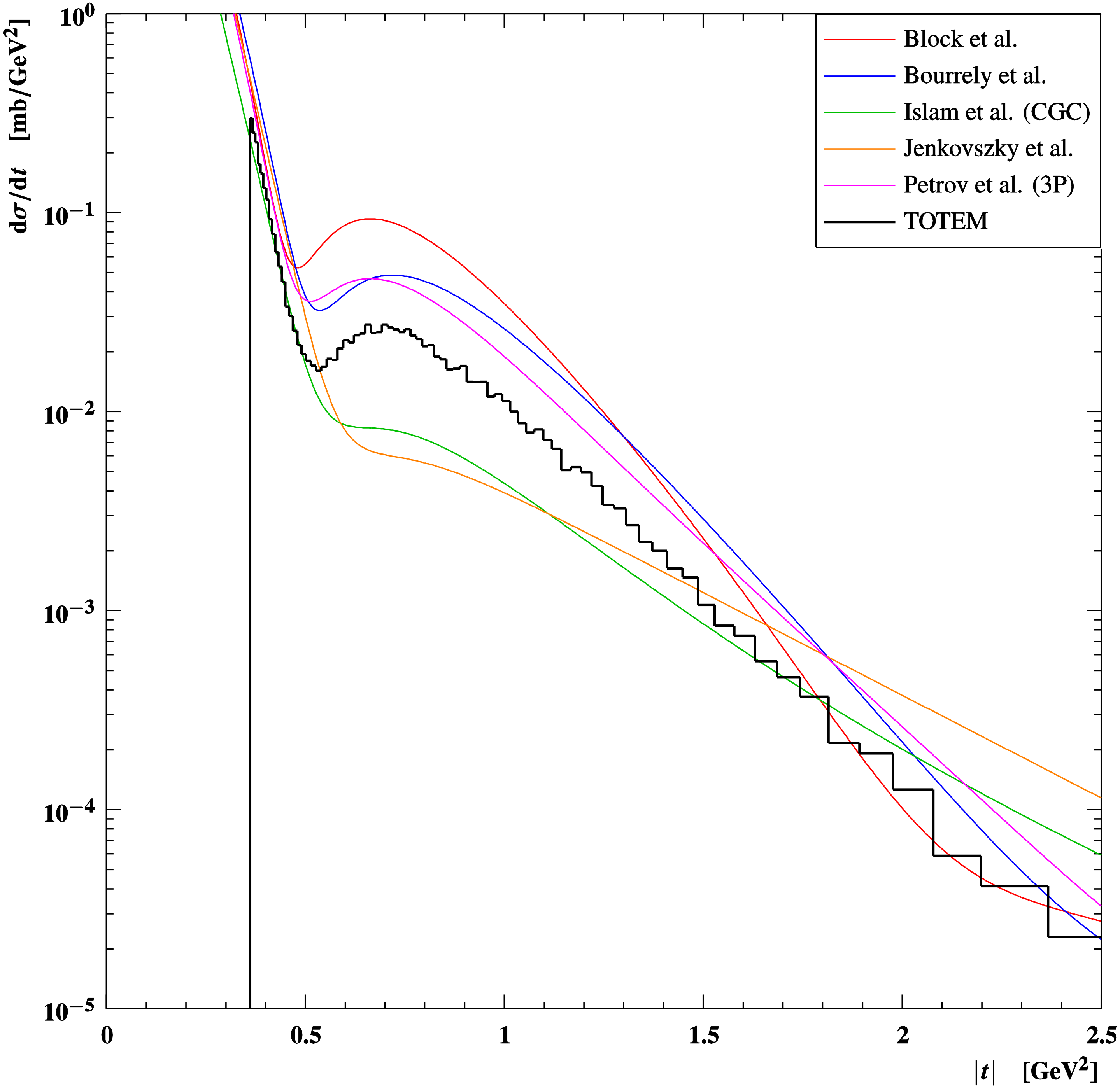
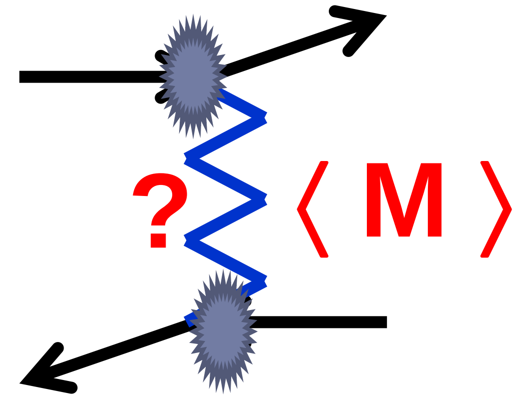


Block et al.
Bourrely et al.
Islam et al. (CGC)
Jenkovszky et al.
Petrov et al. (3P)
TOTEM
dσ/dt [mb/GeV²]
|t| [GeV²]
10⁰
10⁻¹
10⁻²
10⁻³
10⁻⁴
10⁻⁵
0
0.5
1
1.5
2
2.5

Scattering process described in terms of Helicity Amplitudes ϕ_i

All dynamics contained in the Scattering Matrix M

(Spin) Cross Sections expressed in terms of



observables:

3 ×-sections

5 spin asymmetries

- spin non–flip $\phi_1(s,t) = \langle ++ | M | ++ \rangle$
- double spin flip $\phi_2(s,t) = \langle ++ | M | -- \rangle$
- spin non–flip $\phi_3(s,t) = \langle +- | M | +- \rangle$
- double spin flip $\phi_4(s,t) = \langle +- | M | -+ \rangle$
- single spin flip $\phi_5(s,t) = \langle ++ | M | +- \rangle = -\langle ++ | M | -+ \rangle$

identical spin ½ particles

Pomerons

Regge theory

$\sigma_{tot}(s)\sim$

Landshoff 1984 – soft Π

$\alpha = 0.08$

Simple pole – $(s/s_0)^{\alpha}$

Double pole – Ln (s/s_0)

Triple pole – $Ln^2(s/s_0)$ +C

1976 BFKL (LO) - Π –$\alpha_2 = 0.4$

1988 HERA data (Landshoff) – hard Π

$\alpha_2 = 0.45$

2005 – Kovner – 7 Π –$\alpha_\iota = 0. ..0.4. .0.8$

Impact parameters dependence

$$T(s,t) = is\int_0^\infty b\,db\,J_0(bq)\,(1-\exp[i\,\chi(s,b)])$$

Saturation and non-linear equation

J.-R. Cudell, E.Predazzi, O.V. S., Phys.Rev.D79:034033,2009

J.-R. Cudell, O.S., Phys.Rev.Lett.102:032003,2009

$$\frac{dN}{dy} = (-Ln[1-N])\,(1-N);$$

Factorization The Froissart bound

$$\chi(s,b) = h(s)\,f(b); \quad h(s) \approx s^{\Delta} \quad \sigma_{tot}(s) \le a\,\log^2(s)$$

High energy elastic hadron scattering models

I) Hadron as whole

T.T.Wu, B. McCoy, "Theory "bags" with scattering", P.R. D9 (1974);

B. Schrempp, F. Schrempp
"Strong interaction - a tunnelling phenomenon?", N.Phys. B163 (1980))

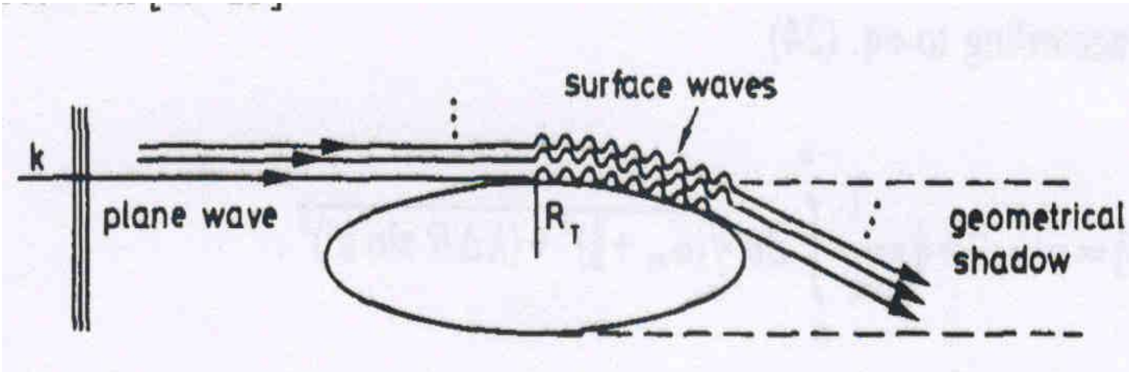


FIG. 5

II) Composite hadron

L. Van Hove, "The diffraction pattern of pp elastic scattering and the composite structure of the proton", N.Phys. B122 (1977)

M.Block, R. Fletcher, F. Halzen, B. Margolis, P. Valin:" Theoretical implications of Fermilab Tevatron total and elastic differential-cross –section measurements", Phys.Rev., D41 (1990).

$$\chi^{even}(s,b) = \chi_{qq}(s,b) + \chi_{qg}(s,b) + \chi_{gg}(s,b)$$

D.A. Faqundes, E.G.S. Luna, M.J. Menon, A.A. Natale, "Testing parameters in an eikonalized dynamical gluon mass model" in Nucl.Phys. A , arXiv:[1308.1206]

III) Factorization [Reggions + Form Factors (FF)]

Chow-Yang model (**1968)** **- hadrom form factor -**
Charge distributions - electromagnetic form factors

T.T. Chou, C.N. Yang, Phys.Rev.Lett. 20 (1968)

E. Leader, U. Maor, P.G. Williams, J. Kasman, Phys.Rev. D14 (1976)
"The Chou-Yang Hypothesis – A Critical Assessment",

Form factors

Mittenen (1973) – “matter distribution”

Bourrely-Soffer-Wu (1978) -

$$G(t)=(\frac{1}{1-t/m_2^2})(\frac{1}{1-t/m_2^2})(\frac{a^2+t}{a^2-t})\ ;$$

G(t) –”stands for the proton “nuclear form factor” parametrized like the e-m form factor, as a two poles, the slowly varying function reflect the approximate proportionality between the charge density and hadronic matter distribution inside a proton.”

Broniowski – Arriola (2008)

"..The gravitation form factors, related to the matrix elements of the energy-momentum tensor [1] in a hadronic state and thus providing the distribution of matter within the hadron..."

General Parton Distributions (GPDs)

Sanielevici-Valin (1984) –Valon model – Phys.Rev.D29 (1984).

"matter form factor" (MFF) measures the interaction of a gluonic probe with the excited matter of the overlapping hadrons and should incorporate the static matter distributions of the participating hadrons…"

$$M_{AB}(s,t) = K_A(q^2)\ K_B(q^2)\, V(s,q^2);$$

$$K_p(q^2) = \frac{1}{3}\int_0^1 dx\,[2L_p^U(x)\,T_p^U(\vec{k}) + L_p^D(x)\,T_p^D(\vec{k})];\ \vec{k} = (1-x)\vec{q}.$$

$$L_p^U(x) = 7.98x^{0.65}(1-x)^2;\ L_p^D(x) = 6.01x^{0.35}(1-x)^{2.3};$$

$$T_p^U(\vec{k}) = e^{-6.1k^2}; T_p^U(\vec{k}) = e^{-3k^2}; \qquad k^2 = (1-x)^2 q^2.$$

GPDs

Fallowing to A. Radyushkin

Phys.ReV. D58, (1998) 114008

$$lmit\ \ Q_{\gamma}^{2}=0,\ \ and\ \ \xi=0$$

X.Ji Sum Rules (1997)

$\Phi_{\xi=0}(x;t) = \Phi(x;t)$

$$F_1^q(t)=\int_{-1}^{1}dx\ H^q\left(x,\xi,t\right);\qquad F_2^q(t)=\int_{-1}^{1}dx\ E^q\left(x,\xi,t\right);$$

$H^q(x;t) = H^q(x,0,t) + H^q(-x,0,t)$ $\qquad$ $E^q(x;t) = E^q(x,0,t) + E^q(-x,0,t)$

$$F_1^q(t)=\int_{0}^{1}dx\ \mathrm{H}^q\left(x,\xi,t\right);\qquad F_2^q(t)=\int_{0}^{1}dx\ \boldsymbol{\mathcal{E}}^q\left(x,\xi,t\right);$$

H. Pagels, Phys.Rev., v.144, (1966)

"Energy-Momentum Structure Form Factors of Particles"

$$\left\langle p_1 \,|\, \theta_{\mu\nu}(0) \,|\, p_2 \right\rangle = \left(\frac{m^2}{p_0^1 p_o^2}\right)^2 \left[\frac{\bar{u}(p_1 s_1)}{4m}\right]\left[G_1(q^2)(l_\mu \gamma_\nu + l_\nu \gamma_\mu) + \frac{G_2(q^2) l_\mu l_\nu}{m} + \frac{G_3(q^2)(q^2 g_{\mu\nu} - q_\mu q_\nu)}{m}\right] u(p_2, s_2).$$

"$G_i(q^2)$ *are the mechanical form factors describing the mechanical structure of the spin* $1/2$ *system.*"

$G_1(0) + G_2(0) = m$ "in analogy to the condition $F_1(0) = e$

M. Polyakov, Phys.Lett., B555 (2003);
K. Goeke, … M. Polyakov, Phys.Rev. , D78 (2008)
"Nucleon form-factors of the energy momentum tensor in CQSM model

$$\int_{-1}^{1} dx\, x \sum_f H^f(x,\xi,t) = M_2^Q(t) + \frac{4}{5} d_1^Q(t)\xi^2;$$

$$M_2(0) = \frac{1}{m_N} \int d^3r\, T_{00}(\vec{r},\vec{s}) = 1;$$

Gravimagnetic form factor

$$\int_{-1}^{1} dx\ x[H^q(x,\xi,t)+E^q(x,\xi,t)] = A_q(\Delta^2)+B_q(\Delta^2)\ ;$$

$$A^q(t)=\int_0^1 dx\ x\ \mathrm{H}^q(x,t); \qquad B^q(t)=\int_0^1 dx\ x\ \mathcal{E}^q(x,t);$$

Our ansatz

O.S., O. Terayev, Phys.Rev.D79:033003,2009
Found.Phys.40:1042,2010

1. Simplest;

2. Not fare from Gaussian representation

3. Satisfy the $(1\text{-}x)^n$ (n>= 2)

4. Valid for large t

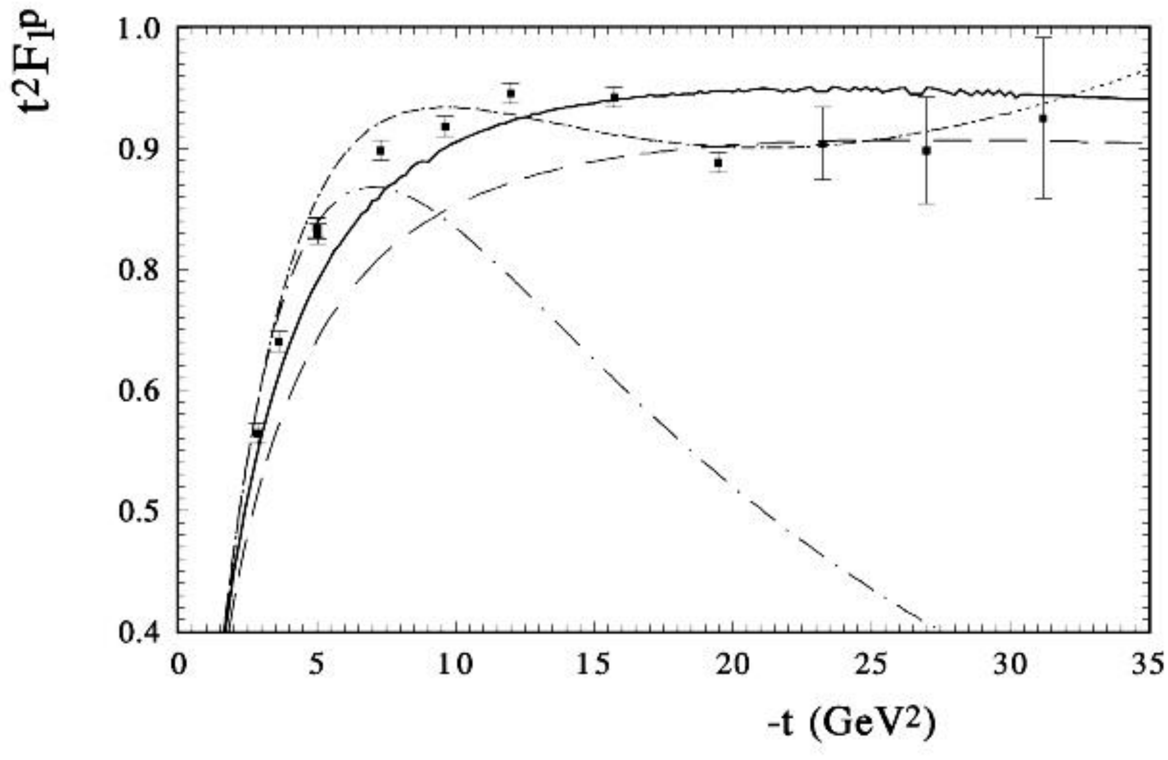
$$\mathrm{H}^{q}(x,t) \square q(x)\exp[a_{+}\frac{(1-x)^{2}}{x^{0.4}}t];$$

q(x) is based on the MRST2002

$$u(x)=0.262\,x^{-0.69}\,(1-x)^{3.50}\,(1+3.83\,x^{0.5}+37.65\,x);$$

$$d(x)=0.061\,x^{-0.65}\,(1-x)^{4.03}\,(1+49.05\,x^{0.5}+8.65\,x);$$

$F_{1p} * t^2$



Martin – 2002 // H. KHANPOUR..-2012 (1205.5194)

$$x q_\nu(x,Q_0) = A_0\, x^{A_1}(1-x)^{A_2}\,(1+A_3 x^{A_4} + A_5\, x^{A_6})$$

Pumplin et al. 2002 (CTEQ6M)

$$x q_\nu(x,Q_0) = A_0\, x^{A_1}(1-x)^{A_2 x}\, e^{A_3}\,(1+e^{A_4 x}x)^{A_5}$$

Martin et al. 2002 (MRST02) .– Martin -2009 (LO, NLO, NNLO)

$$x q_\nu(x,Q_0) = A_0\, x^{A_1}(1-x)^{A_2}\,(1+A_3 x^{0.5} + A_4\, x)$$

Gluck-Pisano 2008

$$x q_\nu(x,Q_0) = A_0\, x^{A_1}(1-x)^{A_2}\,(1+A_3 x^{0.5} + A_4\, x + A_5 x^{1.5})$$

Alekhin et al. 2012 (ABM12)

$$x q_\nu(x,Q_0) = \frac{2\delta_{qu} + \delta_{qd}}{N_q^\nu}\, x^{a_q}(1-x)^{b_q}\; x^{\gamma_{1,q}x+\gamma_{2,q}x^2+\gamma_{3,q}x^3}$$

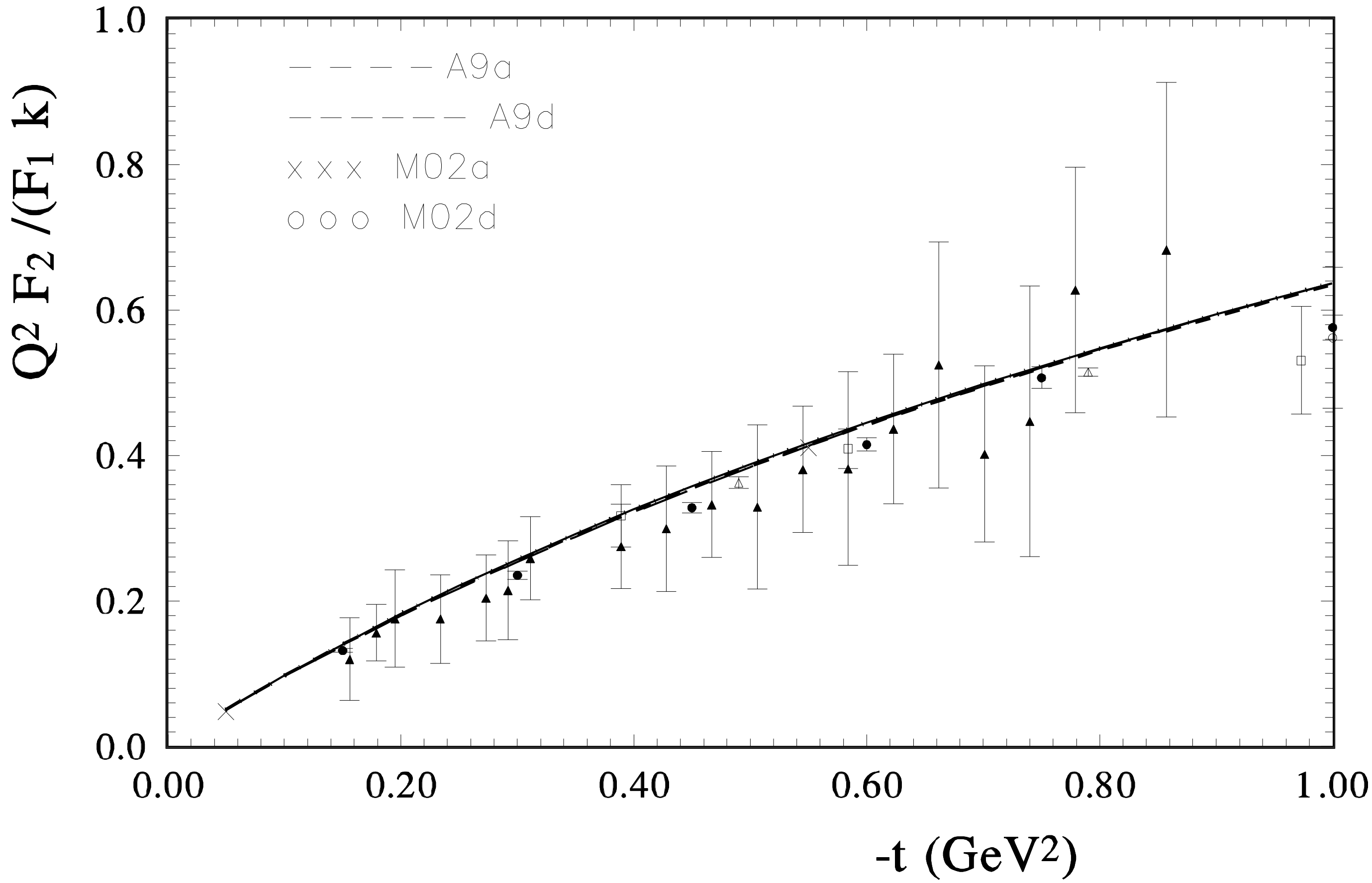
$$H^u(x,t) \Box\, u(x)\exp[2\alpha_1(\frac{(1-x)^{p_1}}{(x_0+x)^{p_2}}t];$$

O.S., talk on Intern. Conf. "SPIN in High Energy Physics" (2012)

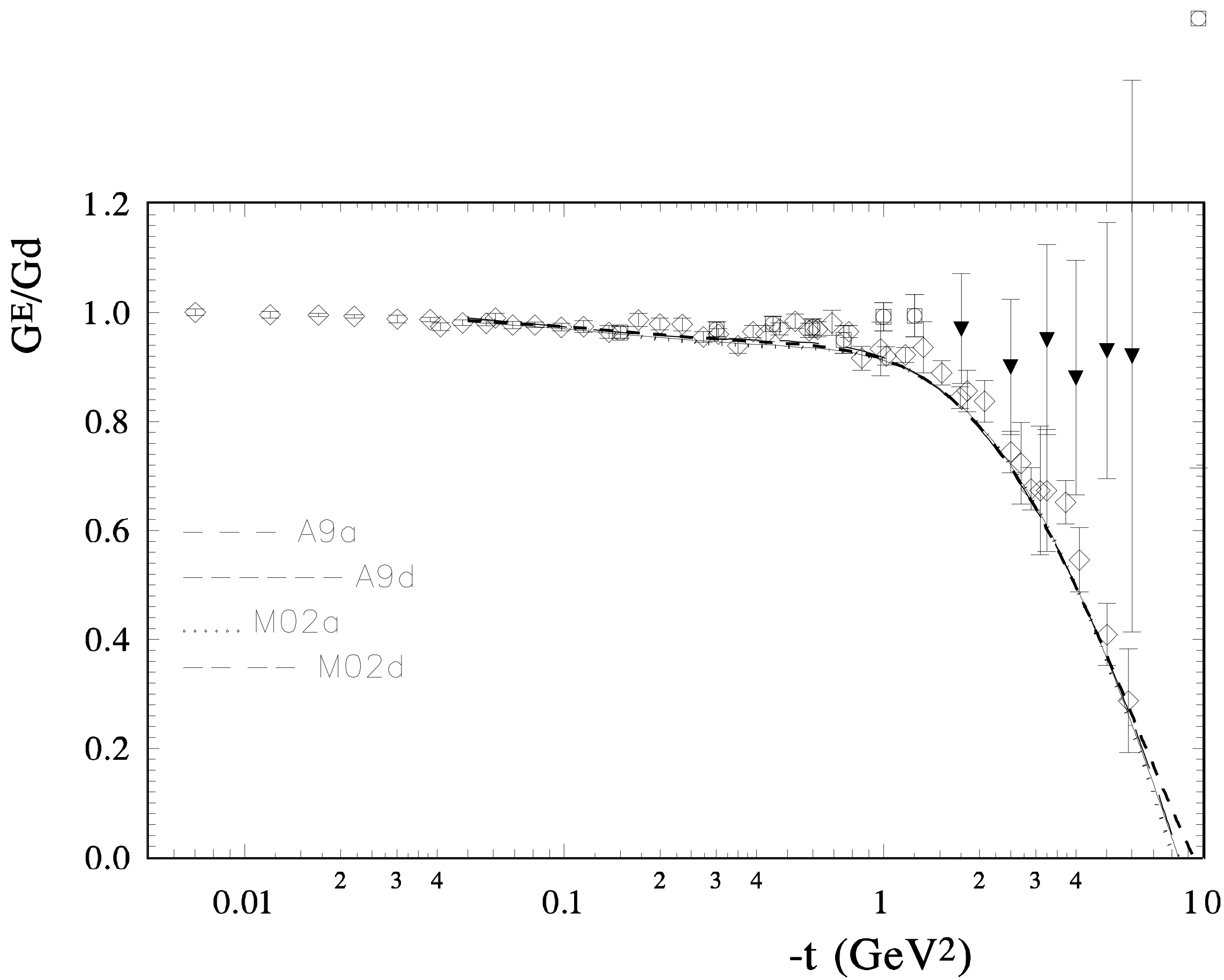
$$H^d(x,t) \Box\, d(x)\exp[2\alpha_1(\frac{(1-x)^{p_1(*k_d)}}{(x_0+x)^{p_2}}+d*x*(1-x)t]$$

	a1	a2	a3	a4	a5	a6	a7	a8	a9
	p1	p2	♋📂 ☎👆✆	♋📄☎ ☜✆	du	dd	x0	k	d
Al-09	2.03	0.5	0.4	0.39	2.4	-0.14	0.006	0.41	-1.61
Al-09-0	2.-fix	0.5	0.38	0.39	2.6	0.03	0.007	1.-fix	------
G-07-a	1.88	0.43	0.6	0.6	1.7	-0.14	0.013	0.54	-1.
G-07-a0	2.-fix	0.34	0.68	0.73	1.7	-0.14	0.003	1 - fix	------
R4	1.89	0.51	0.5	0.43	2.6	0.5	0.01	0.35	-2.
R4-0	2.- fix	0.42	0.57	0.56	2.2	0.15	0.005	1 - fix	-------
M-09NN	1.92	0.4	0.57	0.66	0.93	-1.1	0.008	0.58	-0.61
M-09NN	2- fix	0.35	0.6	0.7	1.5	-0.5	0.003	1. fix	--------
G07NL	1.49	0.35	0.6	0.71	0.58	-1.05	0.007	0.89	0.46

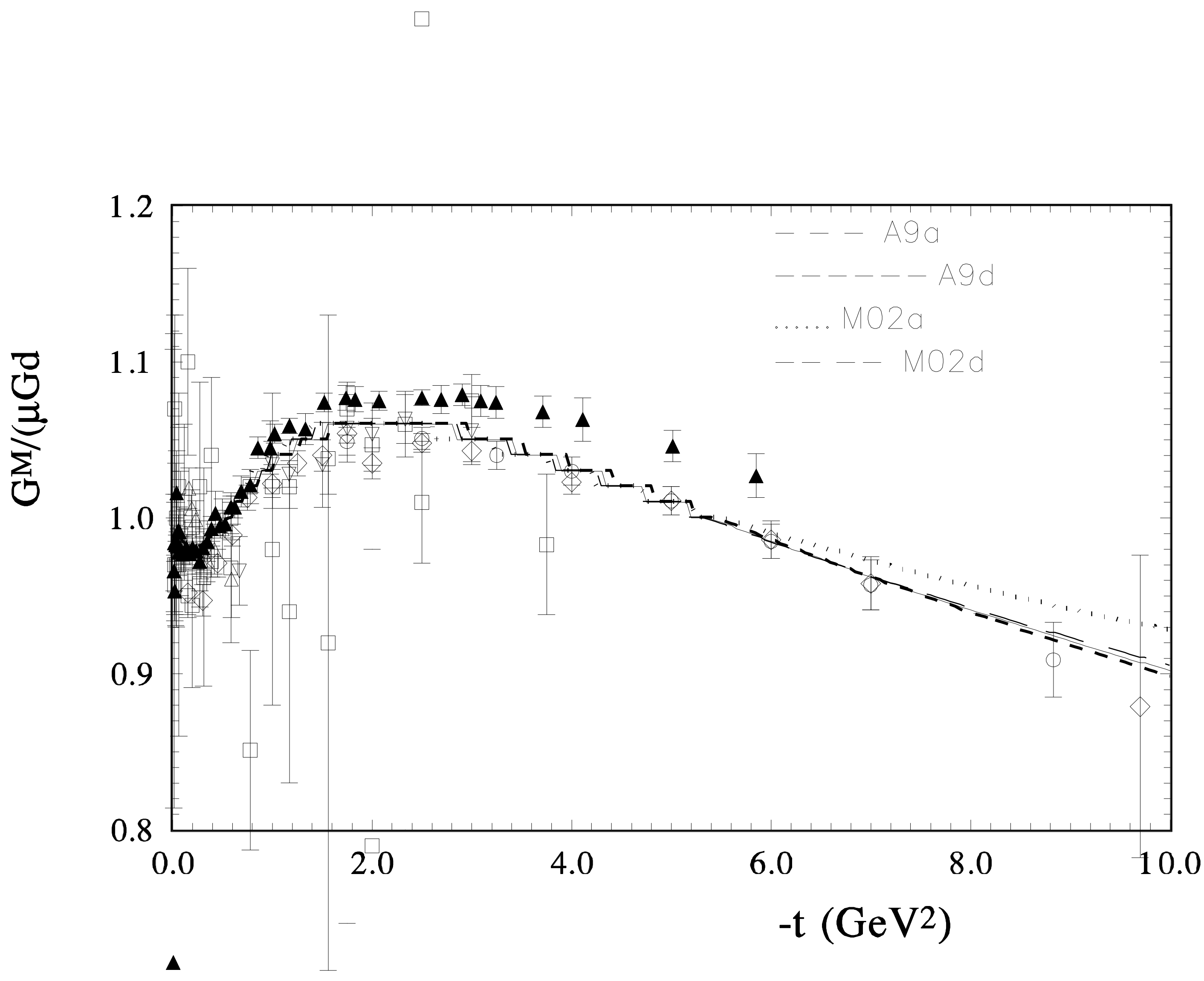
	469b	A1 a8 a9	A1 a8	a8	basic
1	AL-09	1152	1236	1274	1349
2	AL-12	1183	1325	1359	1384
3	KK12A	1248	1442	1497	1500
4	KK12B	1242	1424	1424	1436
5	R4	1245	1293	1306	1419
6	M09-Lo	1304	1384	1878	2197
7	M09-NIo	1322	1333	1425	1836
8	M09-NNLo	1227	1242	1285	1731
9	GP-08 NIo	1305	1434	1987	3064
10	GP-08 NNLo	3504	4180	5680	5689
11	G07-Lo	1198	1211	1836	2168
12	G-07-NLo	1303	1321	7686	9077
13	G-07-MS-a	1187	1222	1258	1558
14	G-07-MS-b	1254	1344	1365	1624
15	Pum-02	1247	1330	1395	1766



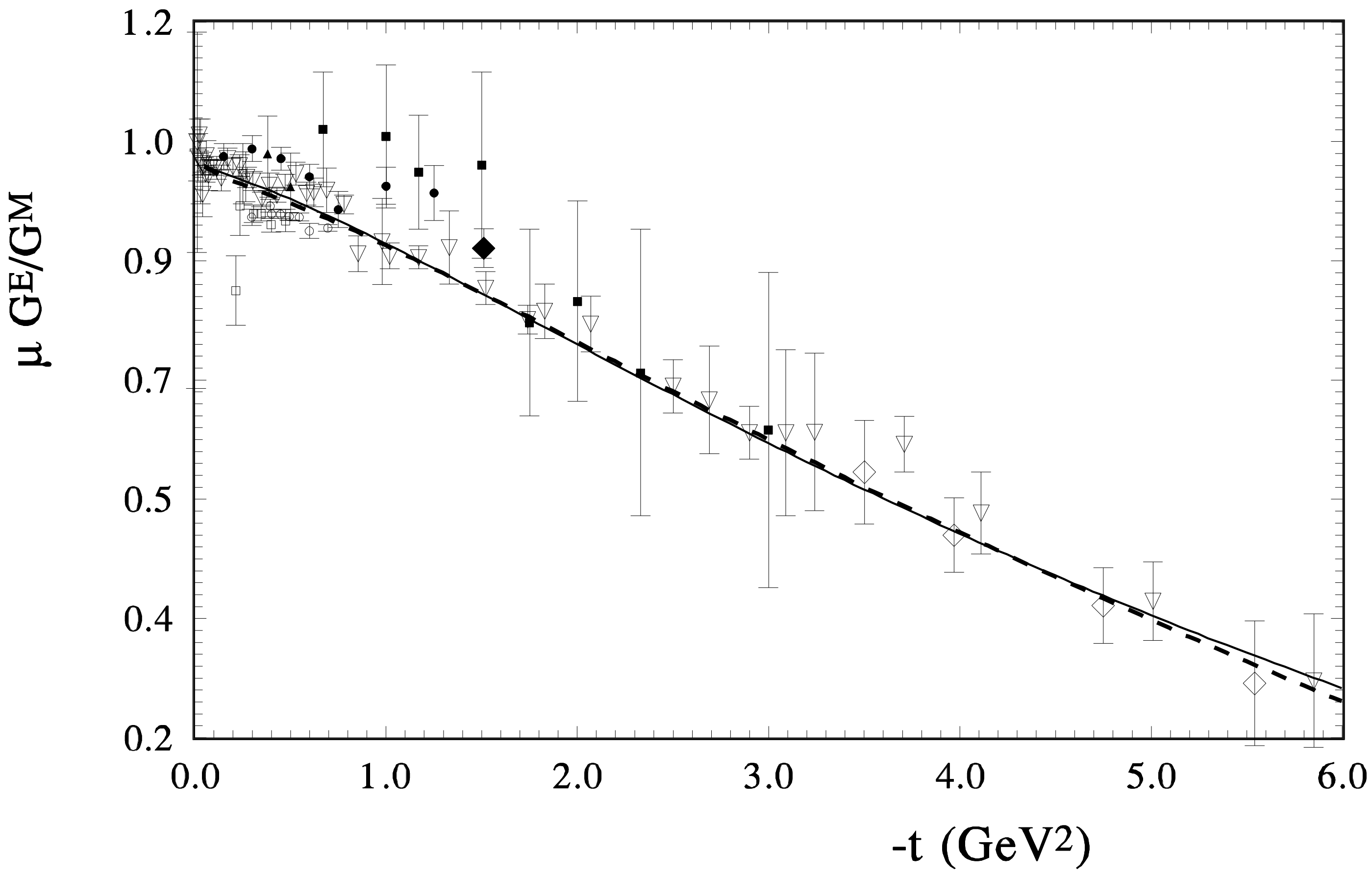
1.0
0.8
0.6
0.4
0.2
0.0
Q2 F2 /(F1 k)
A9a
A9d
M02a
M02d
0.00
0.20
0.40
0.60
0.80
1.00
-t (GeV2)



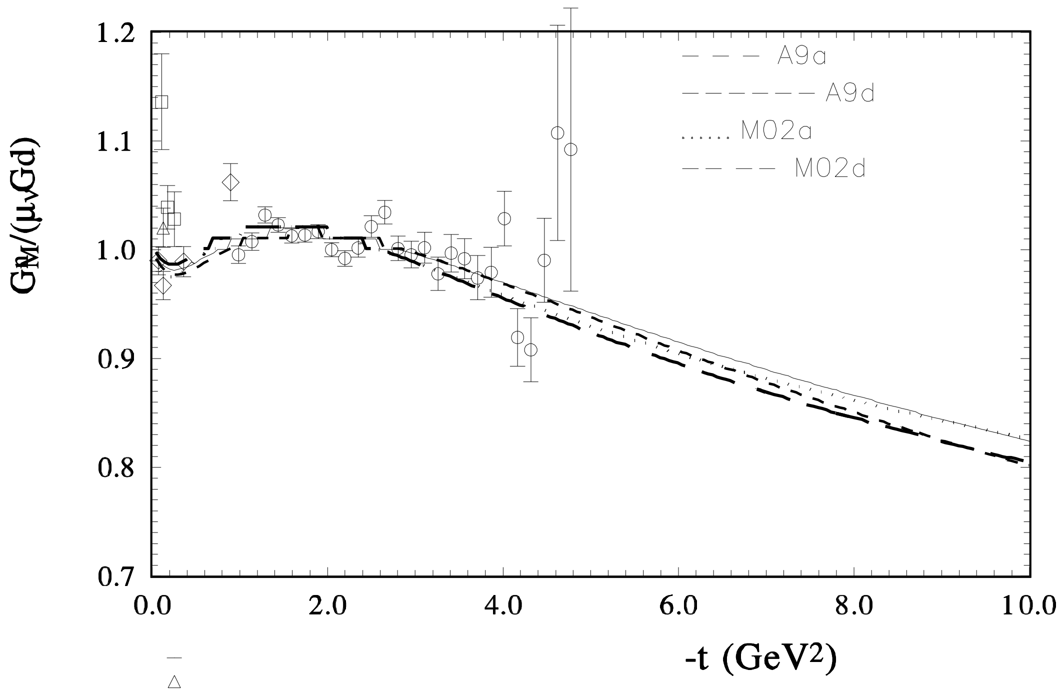
GE/Gd
1.2
1.0
0.8
0.6
0.4
0.2
0.0
A9a
A9d
M02a
M02d
0.01
0.1
1
10
2
3
4
-t (GeV2)



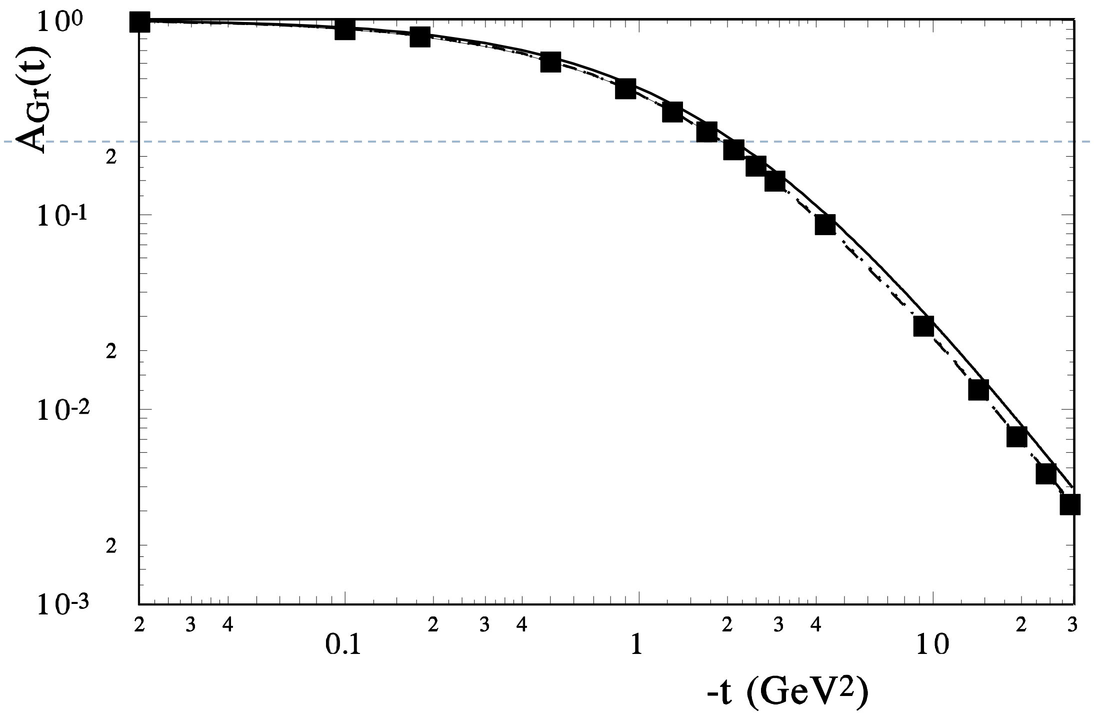
A9a
A9d
M02a
M02d
GM/(μGd
-t (GeV2)
1.2
1.1
1.0
0.9
0.8
0.0
2.0
4.0
6.0
8.0
10.0



1.2
1.0
0.9
0.7
0.5
0.4
0.2
μ GE/GM
0.0
1.0
2.0
3.0
4.0
5.0
6.0
-t (GeV2)



1.2
1.1
1.0
0.9
0.8
0.7
0.0
2.0
4.0
6.0
8.0
10.0
A9a
A9d
M02a
M02d
GM/(μνGd)
-t (GeV2)



$$G_A(t) = \frac{\Lambda_A^4}{(\Lambda_A^2 - t)^2};\qquad \Lambda_A^2 = 2\ (1.8)\ \ GeV^2;$$

Elastic nucleon scattering

General Parton Distributions -GPDs

Electromagnetic form factors (charge distribution)

Gravitation form factors (matter distribution)

$$F_1^D(t) = \frac{4M_p^2 - t\,\mu_p}{4M_p^2 - t} G_D(t);$$

$$G_D(t) = \frac{\Lambda^4}{(\Lambda^2 - t)^2};$$

$$G_A(t) = \frac{\Lambda_A^4}{(\Lambda_A^2 - t)^2};$$

$\hat{s} = s\, e^{i\pi/2};$

O.V.S. - Eur. Phys. J. C (2012) 72:2073

$$F_1^B(s,t) = h_1 G_{em}(t)\ (\hat{s})^{\Delta_1} e^{\alpha_1 t \ln(\hat{s})}; \quad F_2^B(s,t) = h_2 G_A(t)^2\ (\hat{s})^{\Delta_1} e^{\alpha_1/4\, t \ln(\hat{s})};$$

$$F^B(s,t) = F_1^B(s,t)(1 + r_1/\sqrt{\hat{s}})] + F_2^B(s,t)(1 + r_2/\sqrt{\hat{s}})];$$

$$\chi(s,b) = 2\pi \int_0^\infty q\, e^{i\vec{q}\vec{b}}\ J_0(bq)\ F^B(s,q)\, dq$$

$$F(s,t) = \frac{i}{2\pi} \int_0^\infty b\, e^{i\vec{q}\vec{b}}\ J_0(bq)\ [1 - e^{-\chi(s,b)}]\, db$$

$h_1 = 0.74;\ h_2 = 0.23;\ \Delta_1 = 0.11;$

$n = 980;\ 0.00075 < |t| < 10\ GeV^2;\ 52.6 \le \sqrt{s} \le 1960\ GeV;\ \sum \chi^2/n = 2.$

$$F_1^{em}(t) = \alpha f_1^2(t) \frac{s - 2m^2}{t}; \quad F_3^{em}(t) = F_1^{em};$$

and for spin-flip amplitudes:

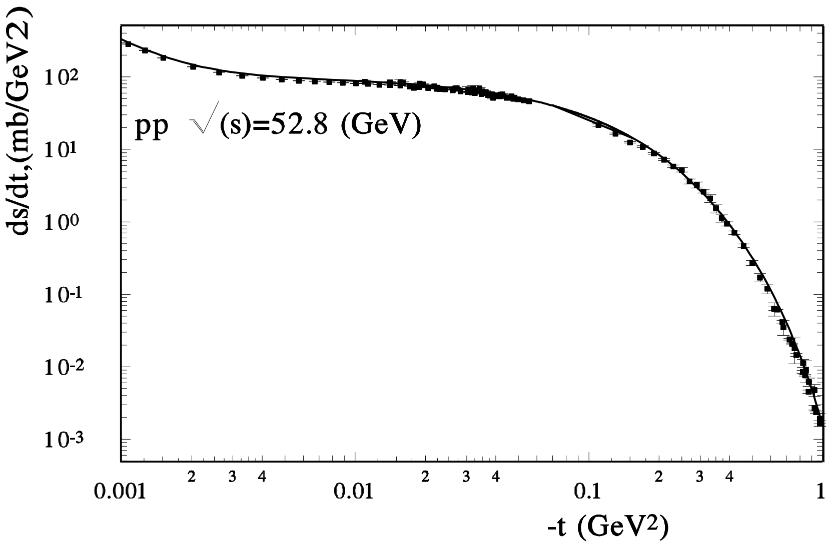
$$F_2^{em}(t) = \alpha \frac{f_2^2(t)}{4m^2} s; \quad F_4^{em}(t) = -F_2^{em}(t),$$

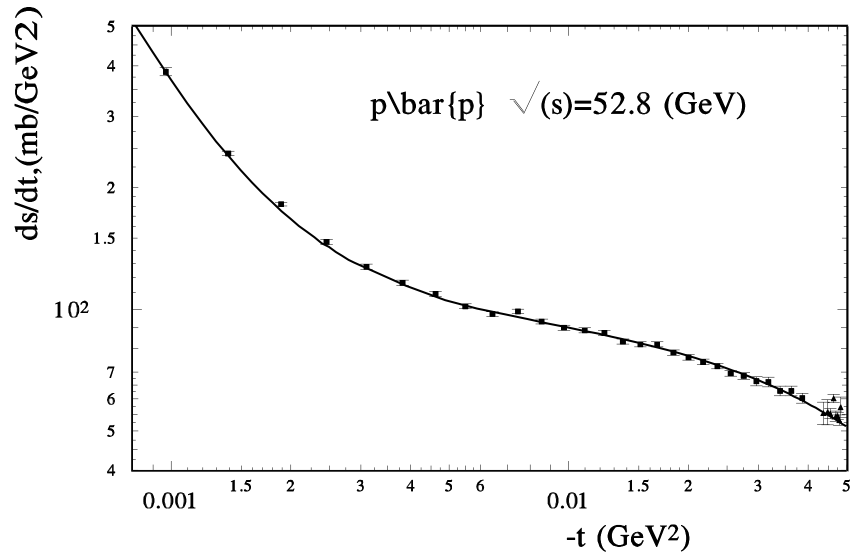
$$F_5^{em}(t) = \alpha \frac{s}{2m\sqrt{|t|}} f_1(t)\ f_2(t),$$

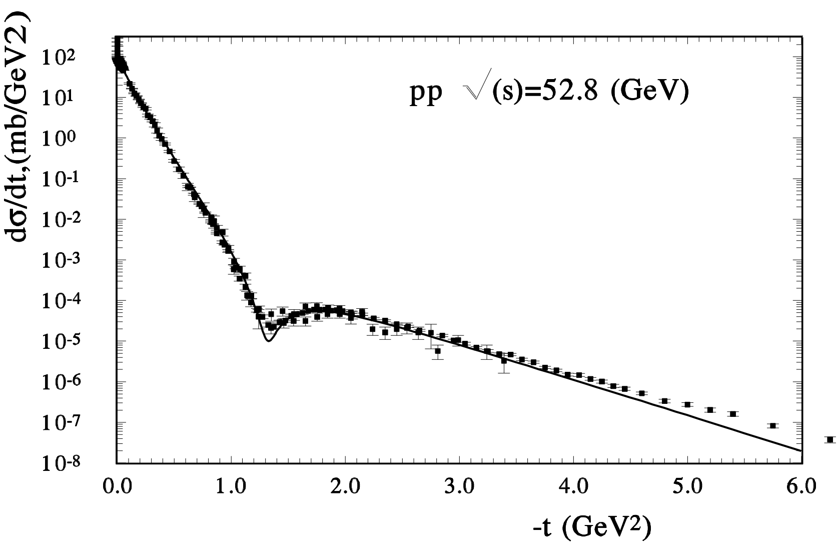
where the form factors are:

$$f_1(t) = \frac{4m_p^2 - (1+k)\ t}{4m_p^2 - t} G_d(t);$$

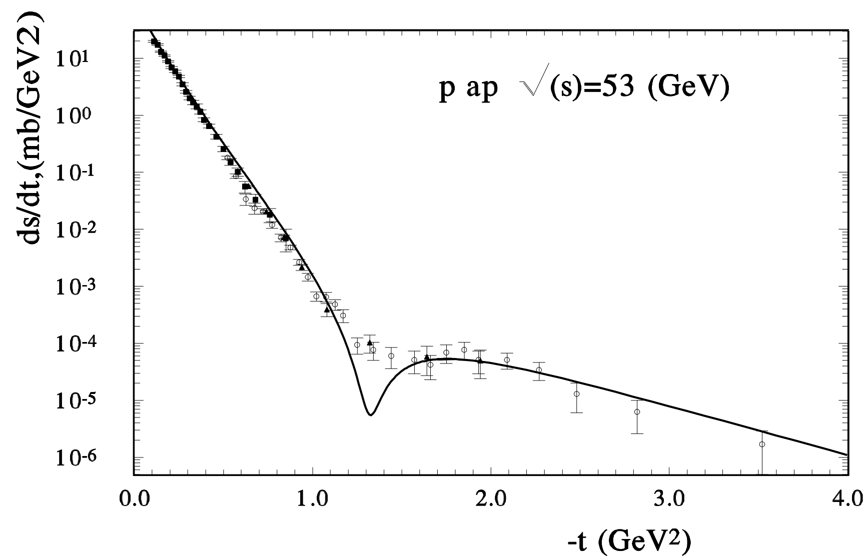
$$f_2(t) = \frac{4m_p^2\ k}{4m_p^2 - t}\ G_d(t);$$


ds/dt,(mb/GeV2)
pp √(s)=52.8 (GeV)
10^2
10^1
10^0
10^-1
10^-2
10^-3
0.001
0.01
0.1
1
-t (GeV2)

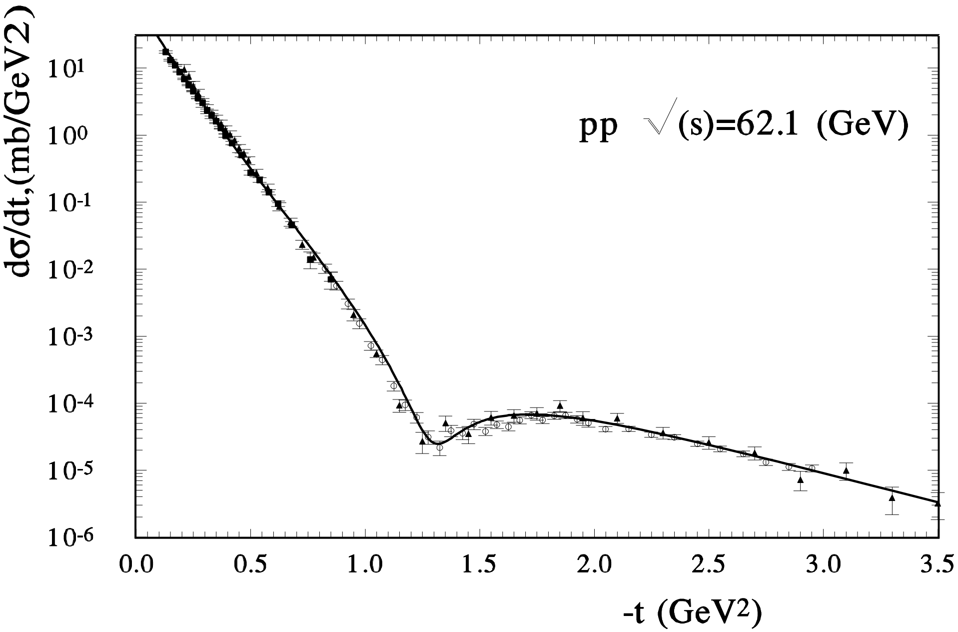

ds/dt,(mb/GeV2)
p\bar{p} √(s)=52.8 (GeV)
10^2
0.001
0.01
-t (GeV2)



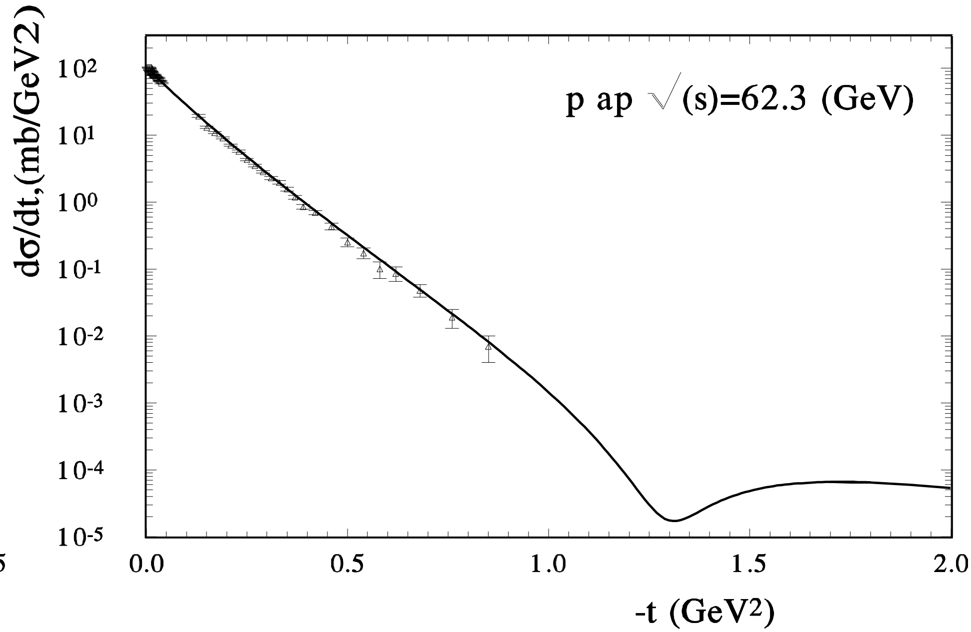
pp √(s)=52.8 (GeV)
dσ/dt,(mb/GeV2)
-t (GeV2)



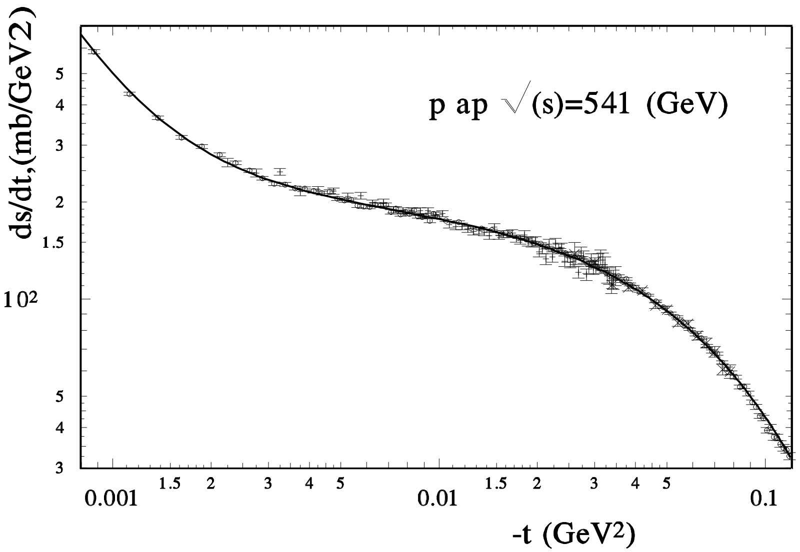
p ap √(s)=53 (GeV)
ds/dt,(mb/GeV2)
-t (GeV2)

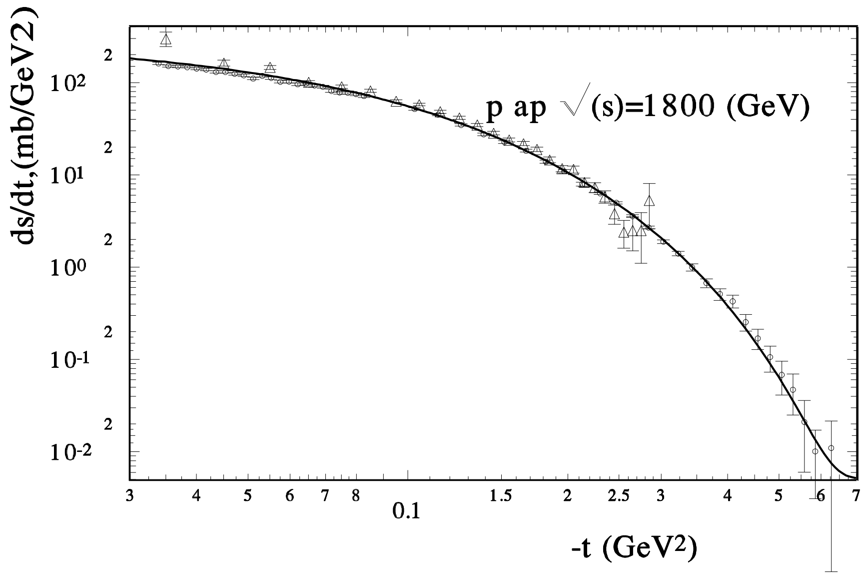


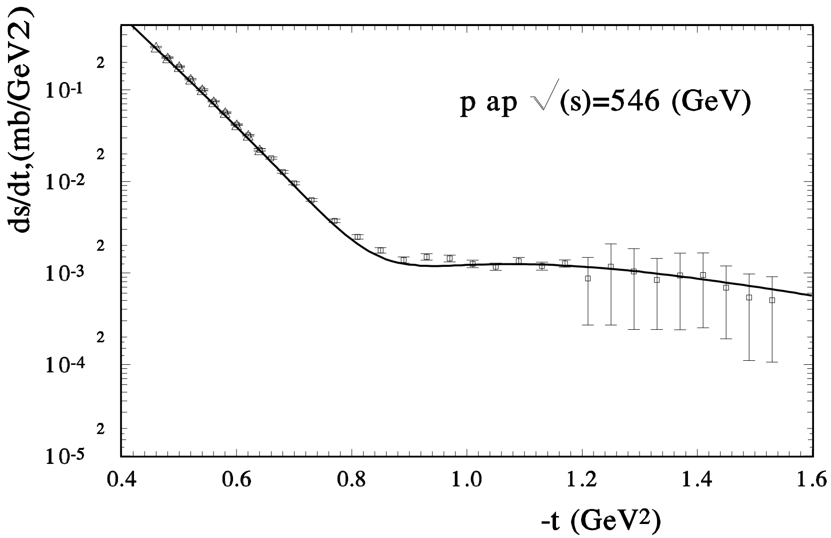
dσ/dt,(mb/GeV2)
pp √(s)=62.1 (GeV)
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
-t (GeV2)

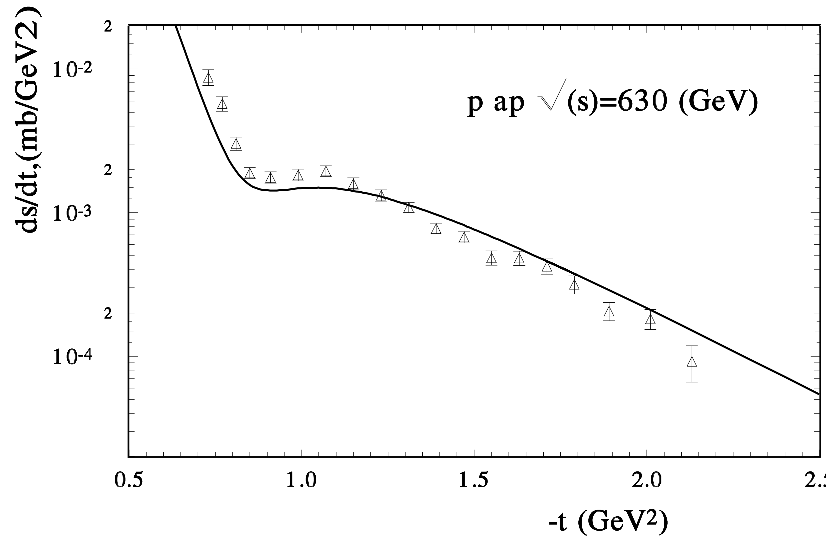


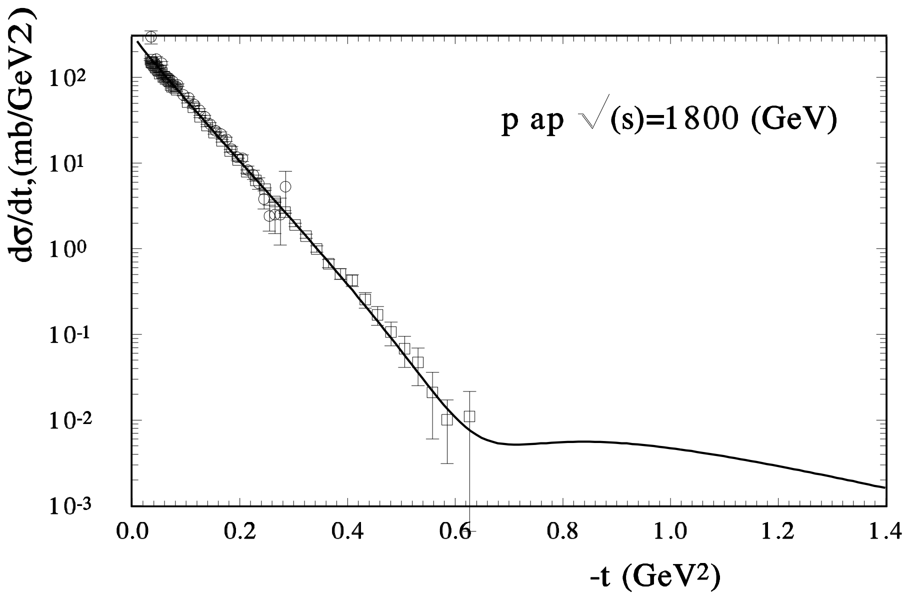
dσ/dt,(mb/GeV2)
p ap √(s)=62.3 (GeV)
10^2
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
0.0
0.5
1.0
1.5
2.0
-t (GeV2)


ds/dt,(mb/GeV2)
p ap √(s)=541 (GeV)
-t (GeV2)
0.001
0.01
0.1
1 0^2

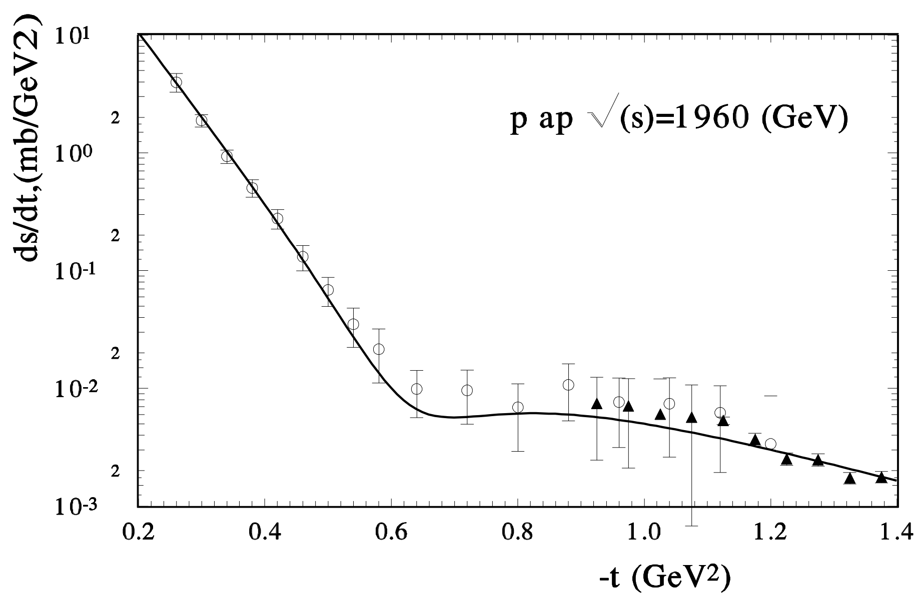

ds/dt,(mb/GeV2)
p ap √(s)=1800 (GeV)
-t (GeV2)
0.1
1 0^2
1 0^1
1 0^0
1 0^-1
1 0^-2


p ap √(s)=546 (GeV)
ds/dt,(mb/GeV2)
-t (GeV2)
0.4
0.6
0.8
1.0
1.2
1.4
1.6
10-1
10-2
10-3
10-4
10-5

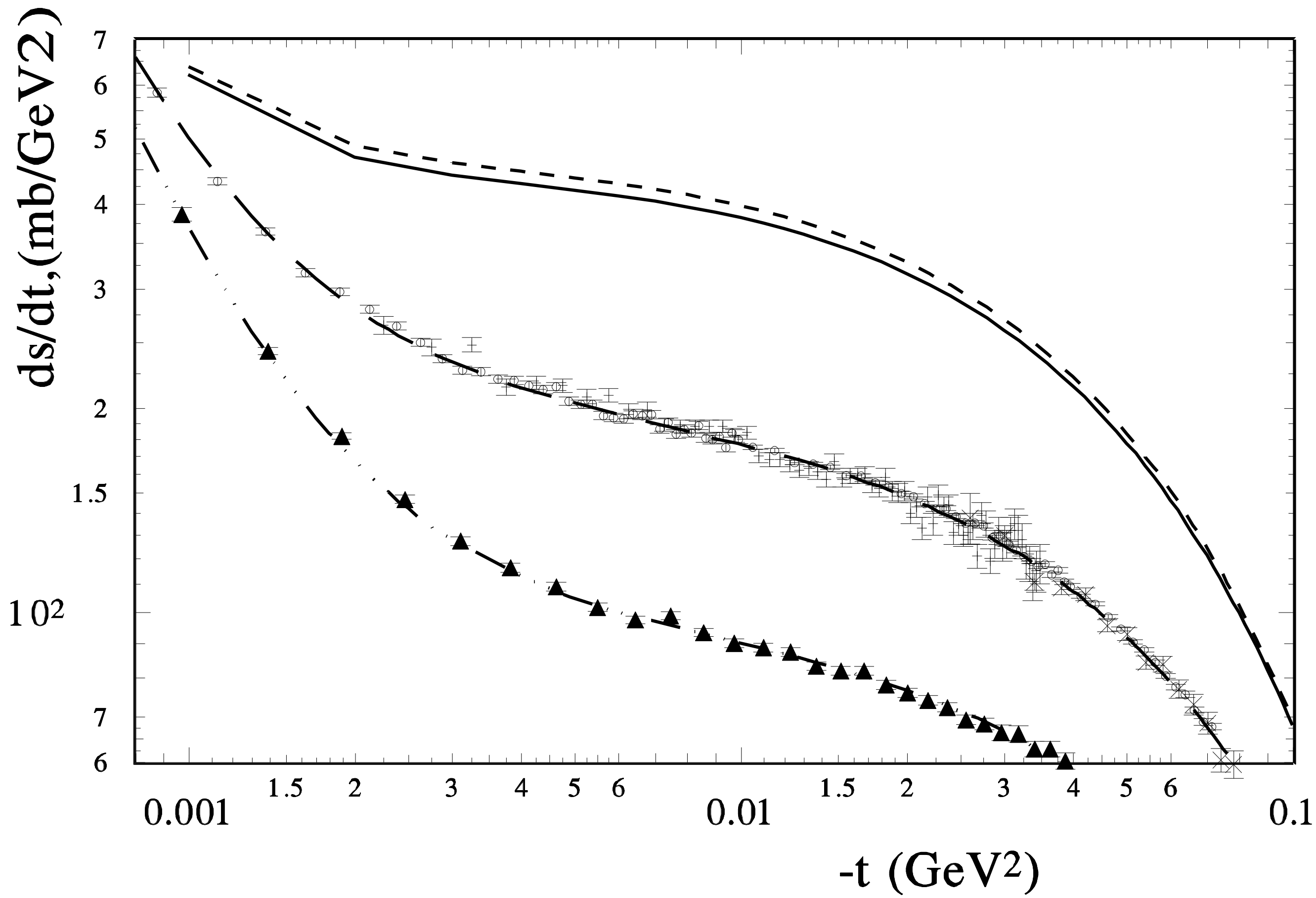

p ap √(s)=630 (GeV)
ds/dt,(mb/GeV2)
-t (GeV2)
0.5
1.0
1.5
2.0
2.5
10-2
10-3
10-4



dσ/dt,(mb/GeV2)
p ap √(s)=1800 (GeV)
10-3
10-2
10-1
100
101
102
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
-t (GeV2)



ds/dt,(mb/GeV2)
p ap √(s)=1960 (GeV)
101
2
100
2
10-1
2
10-2
2
10-3
0.2
0.4
0.6
0.8
1.0
1.2
1.4
-t (GeV2)

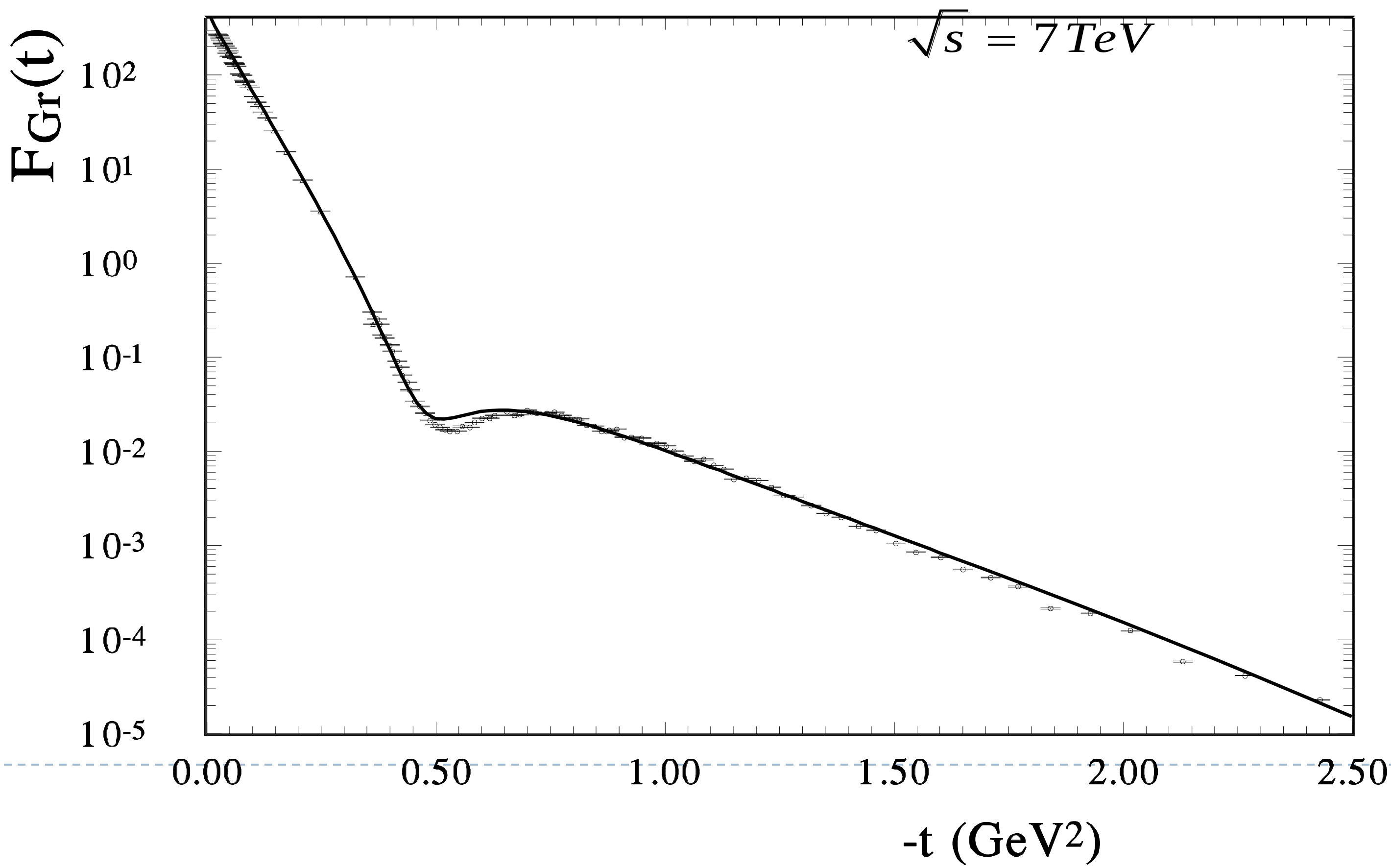


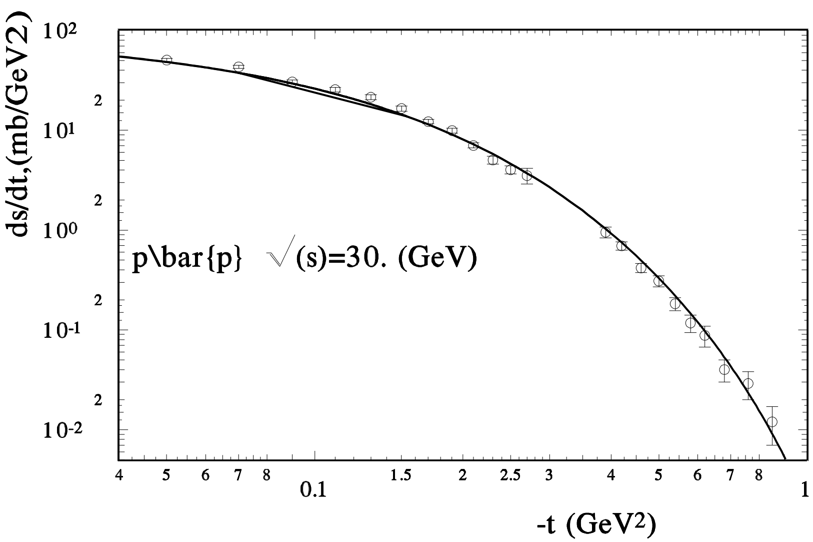
ds/dt,(mb/GeV2)
7
6
5
4
3
2
1.5
10²
7
6
0.001
1.5
2
3
4
5
6
0.01
1.5
2
3
4
5
6
0.1
-t (GeV²)

Fit exp. data $52.8\,GeV <= \sqrt{s} <= 1.8\,TeV$

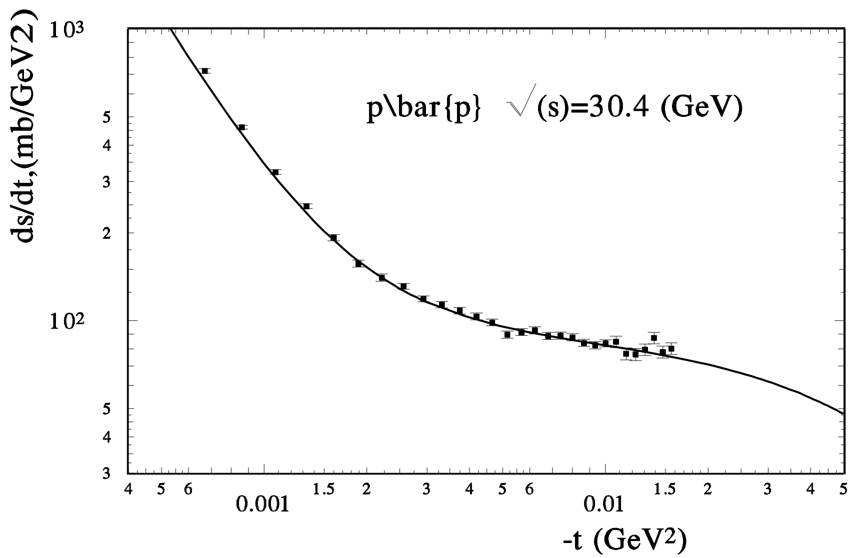
O.S. EPJC (2012); arXiv: 1204.4418

predictions

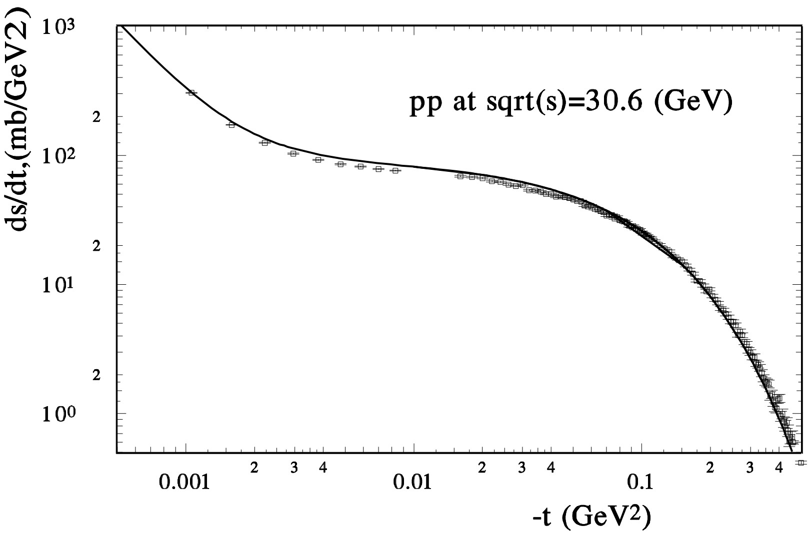




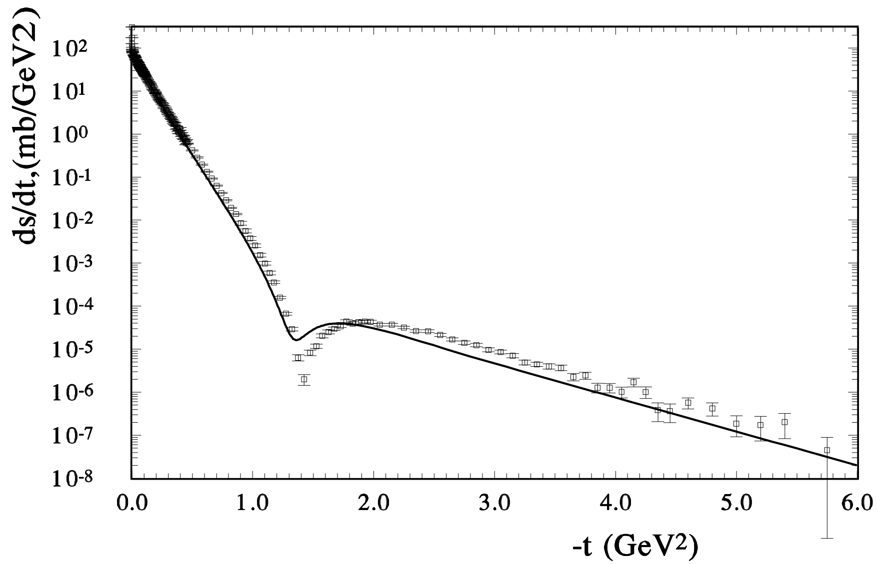
ds/dt,(mb/GeV2)
p\bar{p} √(s)=30. (GeV)
-t (GeV2)
0.1
1



ds/dt,(mb/GeV2)
p\bar{p} √(s)=30.4 (GeV)
-t (GeV2)
0.001
0.01



pp at sqrt(s)=30.6 (GeV)
ds/dt,(mb/GeV2)
-t (GeV2)
0.001
0.01
0.1



ds/dt,(mb/GeV2)
-t (GeV2)
0.0
1.0
2.0
3.0
4.0
5.0
6.0

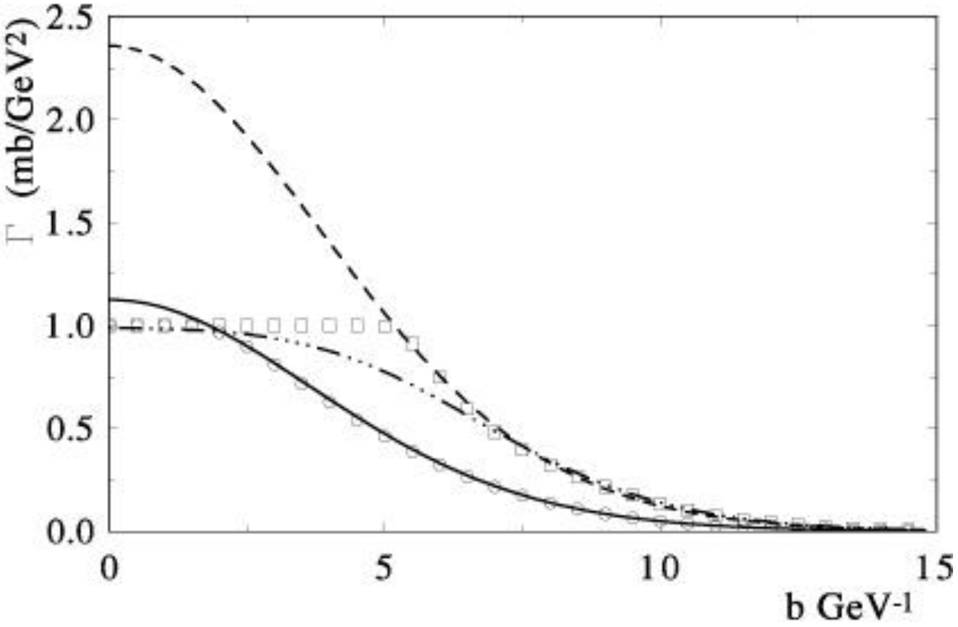
Soft and hard Pomeron

Donnachie-Landshoff model;

Schuler-Sjostrand model

$$T_1(s,t) = [h_1(\frac{s}{s_0})^{\Delta_1} e^{\alpha_1 t \ln(s/s_0)}$$

$$+ h_2(\frac{s}{s_0})^{\Delta_2} e^{\alpha_2 t \ln(s/s_0)}] F^2(t)$$



Hard pomeron

O.S., Nucl.Phys. A 903 (2013) 54-64; arxiv[1205.5867]

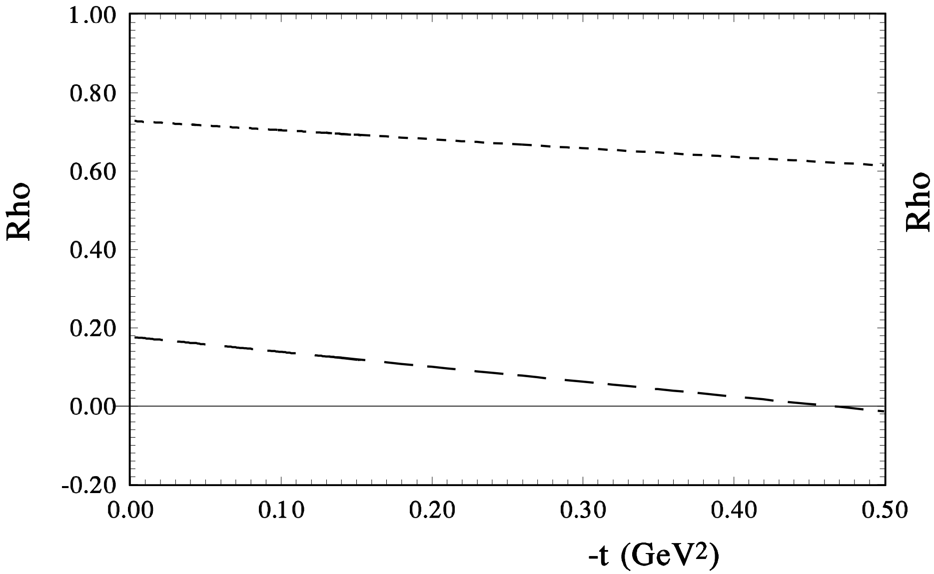
$$T_1(s,t) = [h_1(\frac{s}{s_0})^{\Delta_1} e^{\alpha_1 t \ln(s/s_0)}$$

$$+ h_2(\frac{s}{s_0})^{\Delta_2} e^{\alpha_2 t \ln(s/s_0)}] G_{em}^2(t)$$

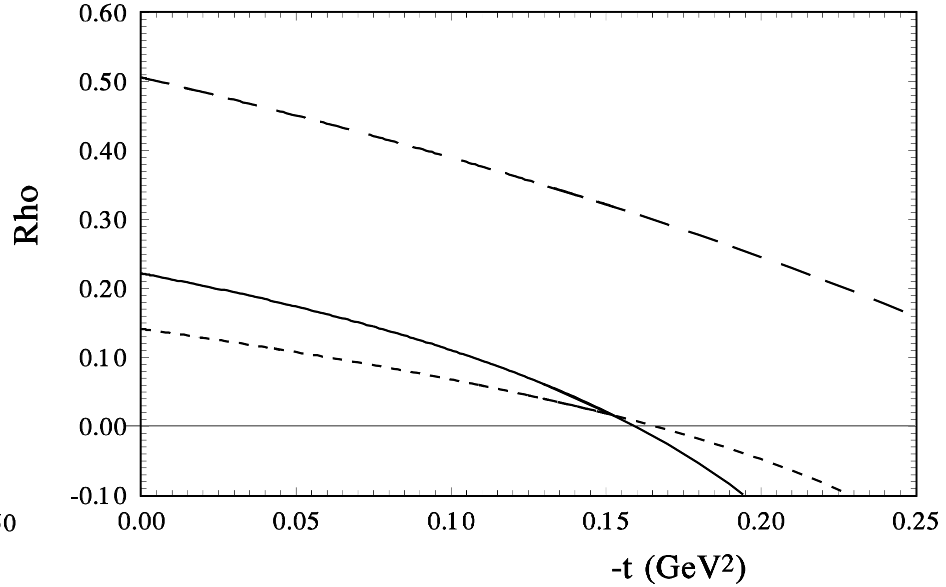
$\alpha_1 = 0.25;\ \Delta_1 = 0.1;$ $\alpha_2 = 0.1;\ \Delta_2 = 0.4;$

Soft and hard pomeron

Born amplitude



After the eikonalization



Hard Pomeron in the HEGS model calculation

O.S., Nucl.Phys. A 903 (2013) 54-64; arxiv[1205.5867]

$h_{hardPom.}, GeV^{-2}$	Δ_2	α'_{hp}, GeV^{-2}	$\sum_1^n \chi_i^2$
$0. \pm 0.01$	0.4_{fixed}	0.1_{fixed}	1783
-0.008 ± 0.001	0.4_{fixed}	$< 0.$	1713
-0.02 ± 0.01	0.33 ± 0.04	$< 0.$	1698
-0.012 ± 0.01	0.4_{fixed}	0.08 ± 0.01	1731

A. Donnachie, P.V. Landshoff- arxiv[1309.1292]

Expanding of model (HEGS)

$$20 \le \sqrt{s} \le 7000\, GeV;$$

$$n = 980 \to 2020; \;\; 0.00075 < |t| < 10 \to 15\ GeV^2;$$

$$\hat{s} = s\, e^{i\pi/2};$$

$$F_1^B(s,t) = h_1 G_{em}(t)\, (\hat{s})^{\Delta_1} e^{\alpha_1 t \ln(\hat{s})}; \qquad F_2^B(s,t) = h_2 G_A(t)^2\, (\hat{s})^{\Delta_1} e^{\alpha_1/4\, t \ln(\hat{s})};$$

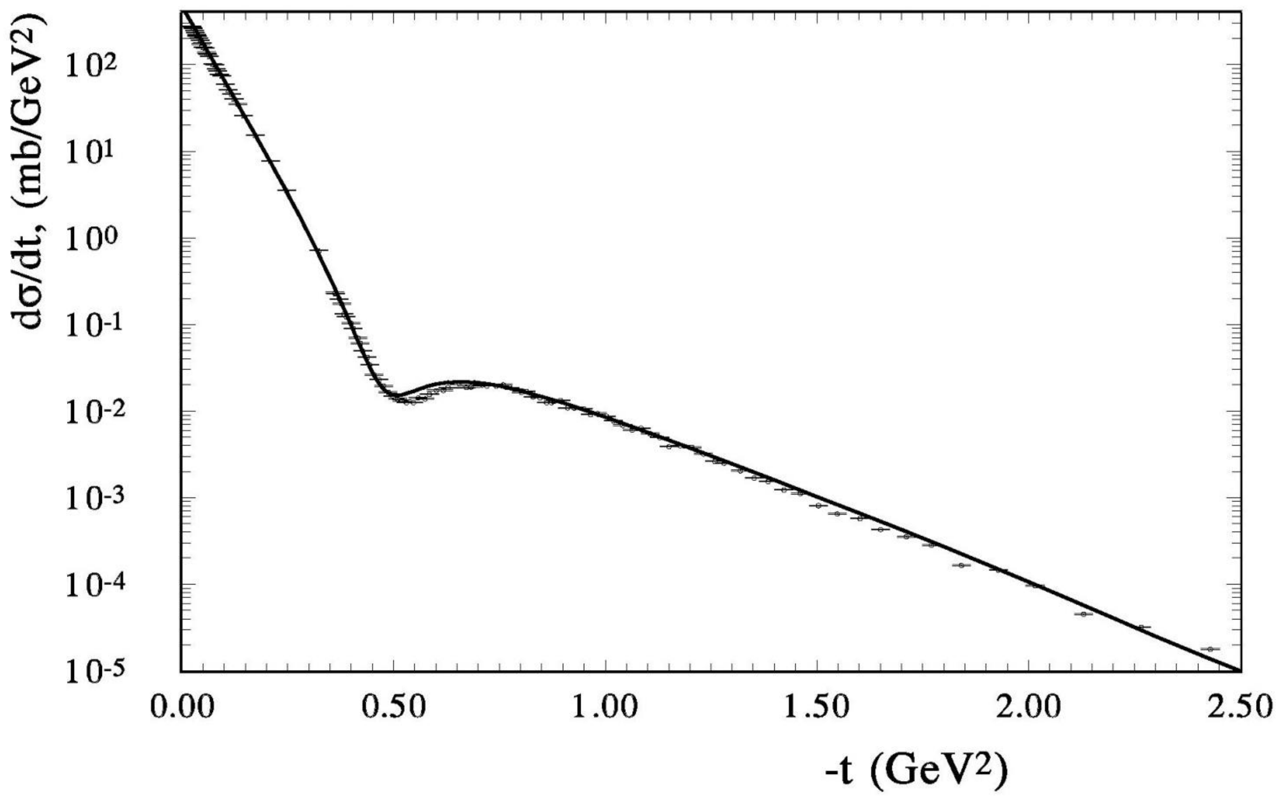
$$F^B(s,t) = F_1^B(s,t)(1 + r_1/\sqrt{\hat{s}})] + F_2^B(s,t)(1 + r_2/\sqrt{\hat{s}})];$$

$$F_{Odd}^B(s,t) = h_{Odd} G_A(t)^2\, (\hat{s})^{\Delta_1} \frac{t}{r_0^2 + t} e^{\alpha_1/4\, t \ln(\hat{s})};$$

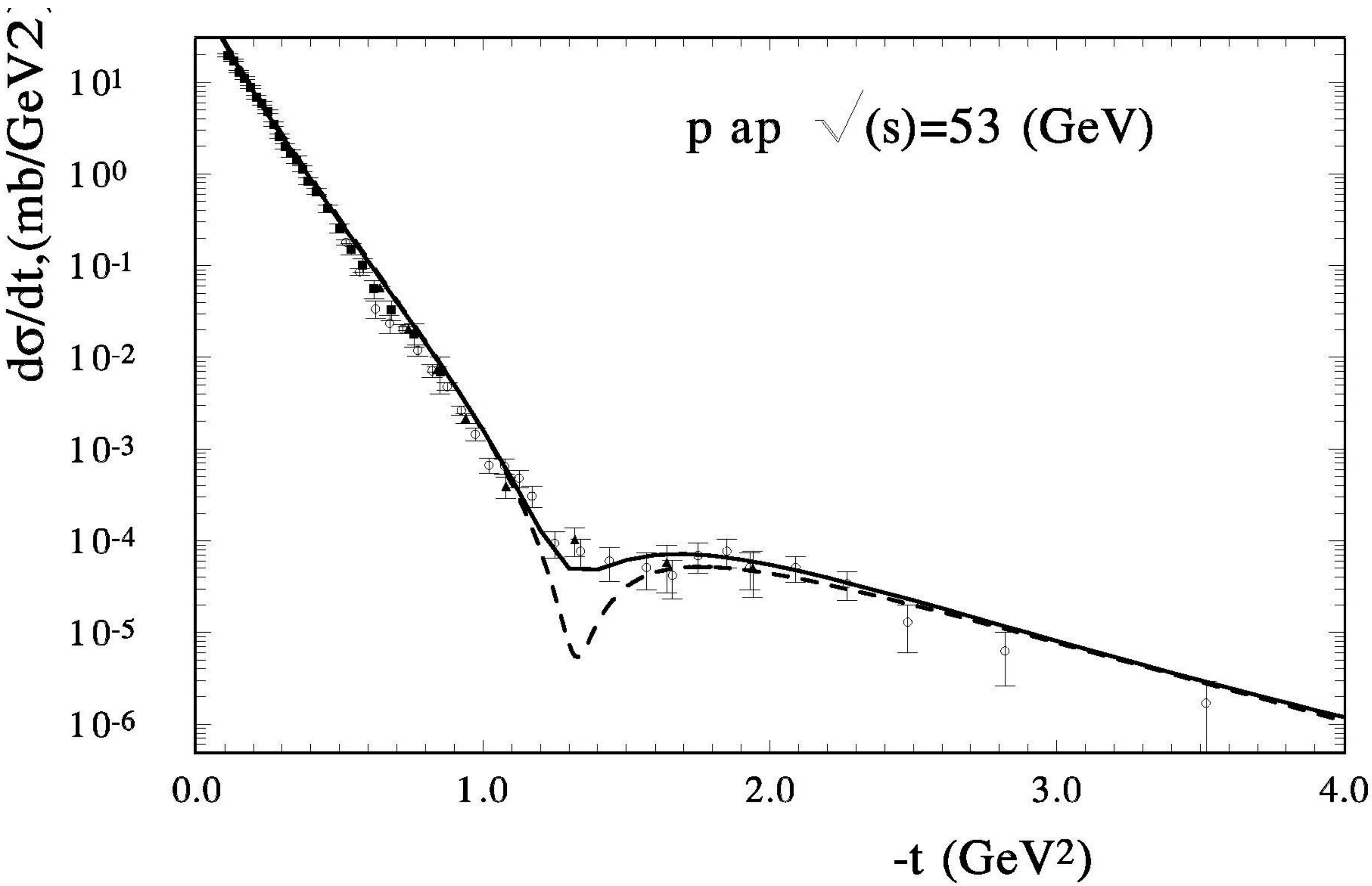
$$F^{+-}(s,t) = h_{sf} G_A(t)^2\, e^{\mu t}; \qquad h_{sf} = 0.02\, GeV^{-2}; \quad \mu = 0.5\, GeV^{-2}$$

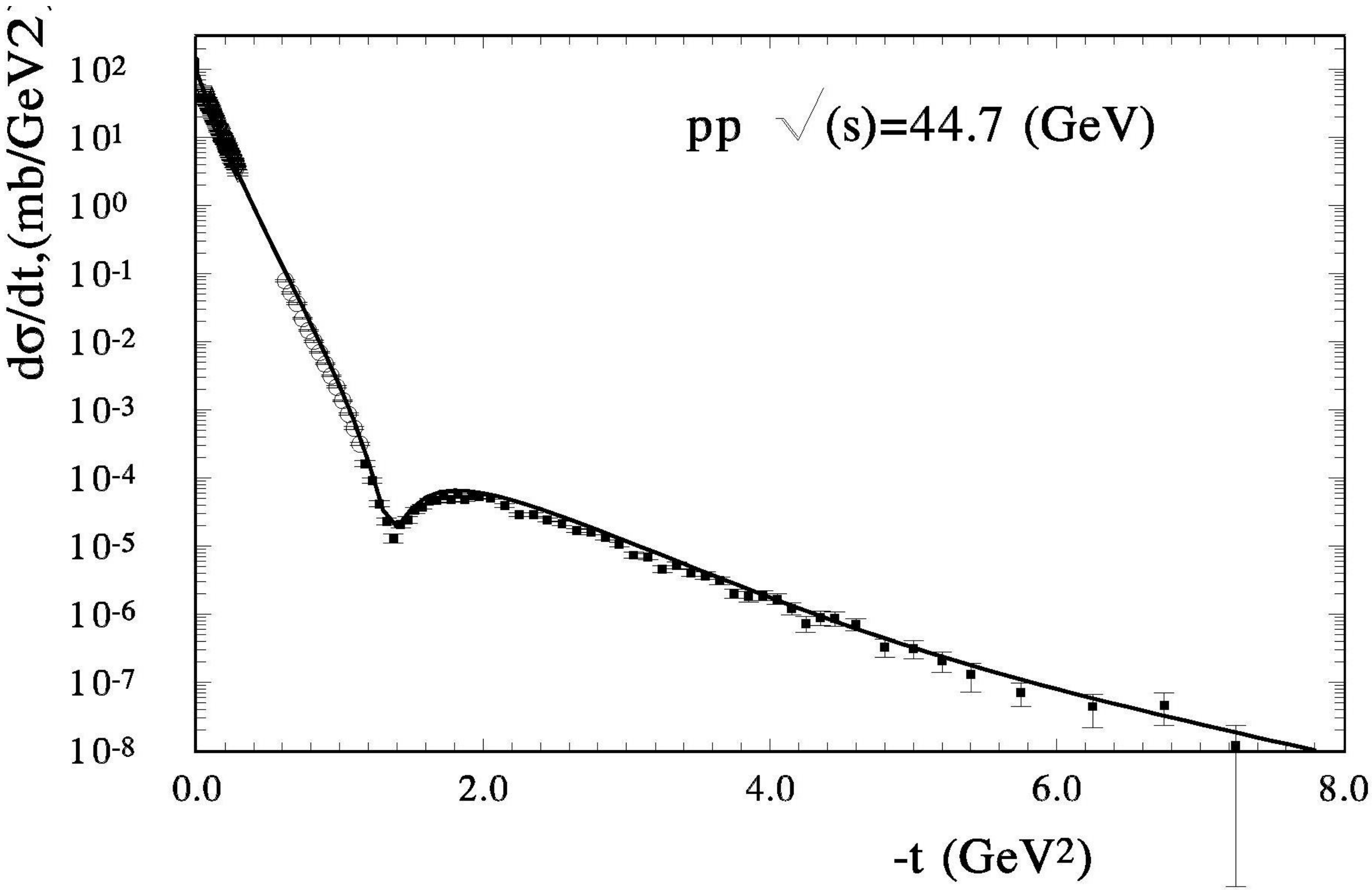
$$h_1 = 0.74; \;\; h_2 = 0.23; \;\; \Delta_1 = 0.11;$$

$$20 \le \sqrt{s} \le 7000\, GeV; \sum \chi^2 / n = 1.6$$

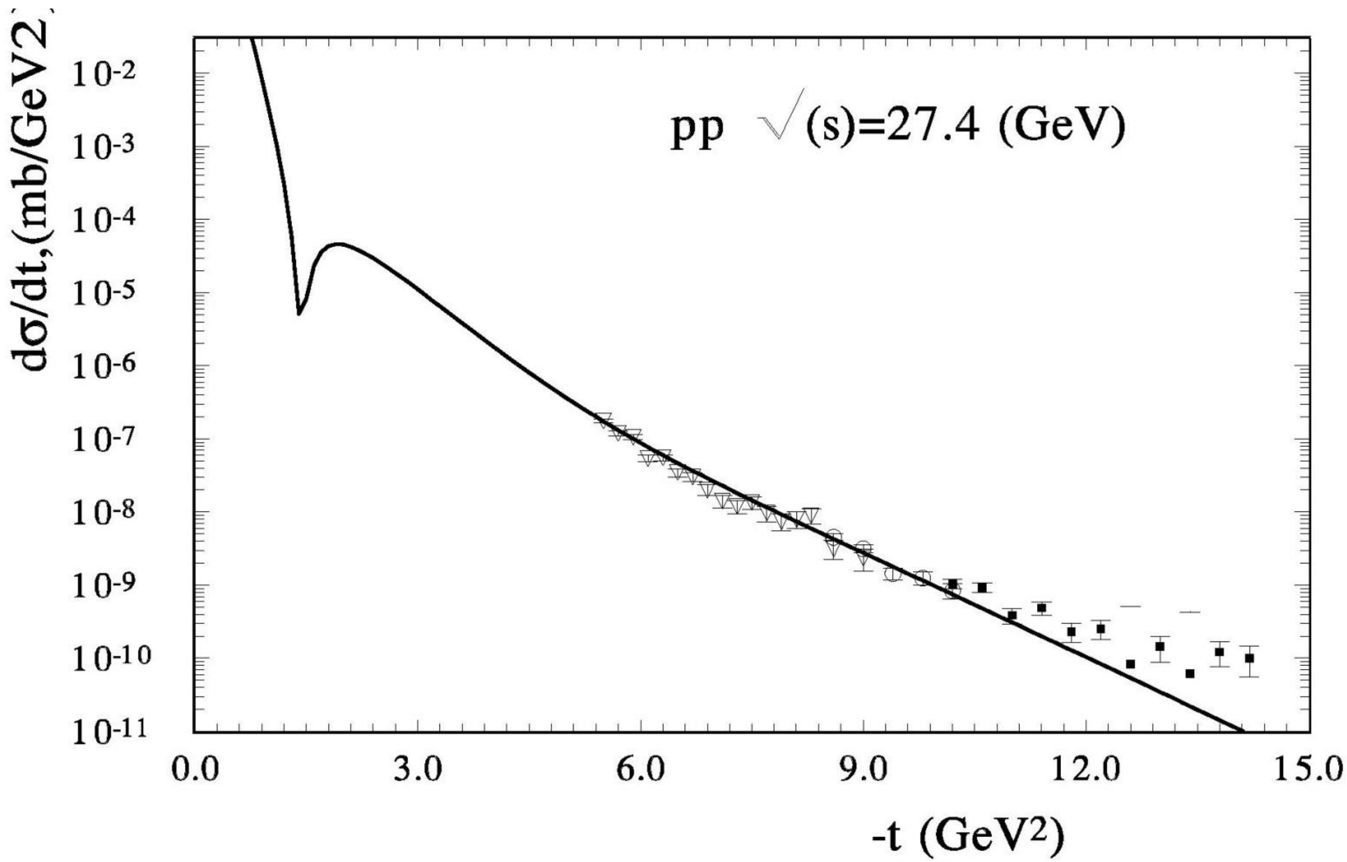


dσ/dt, (mb/GeV2)
10^2
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
0.00
0.50
1.00
1.50
2.00
2.50
-t (GeV2)

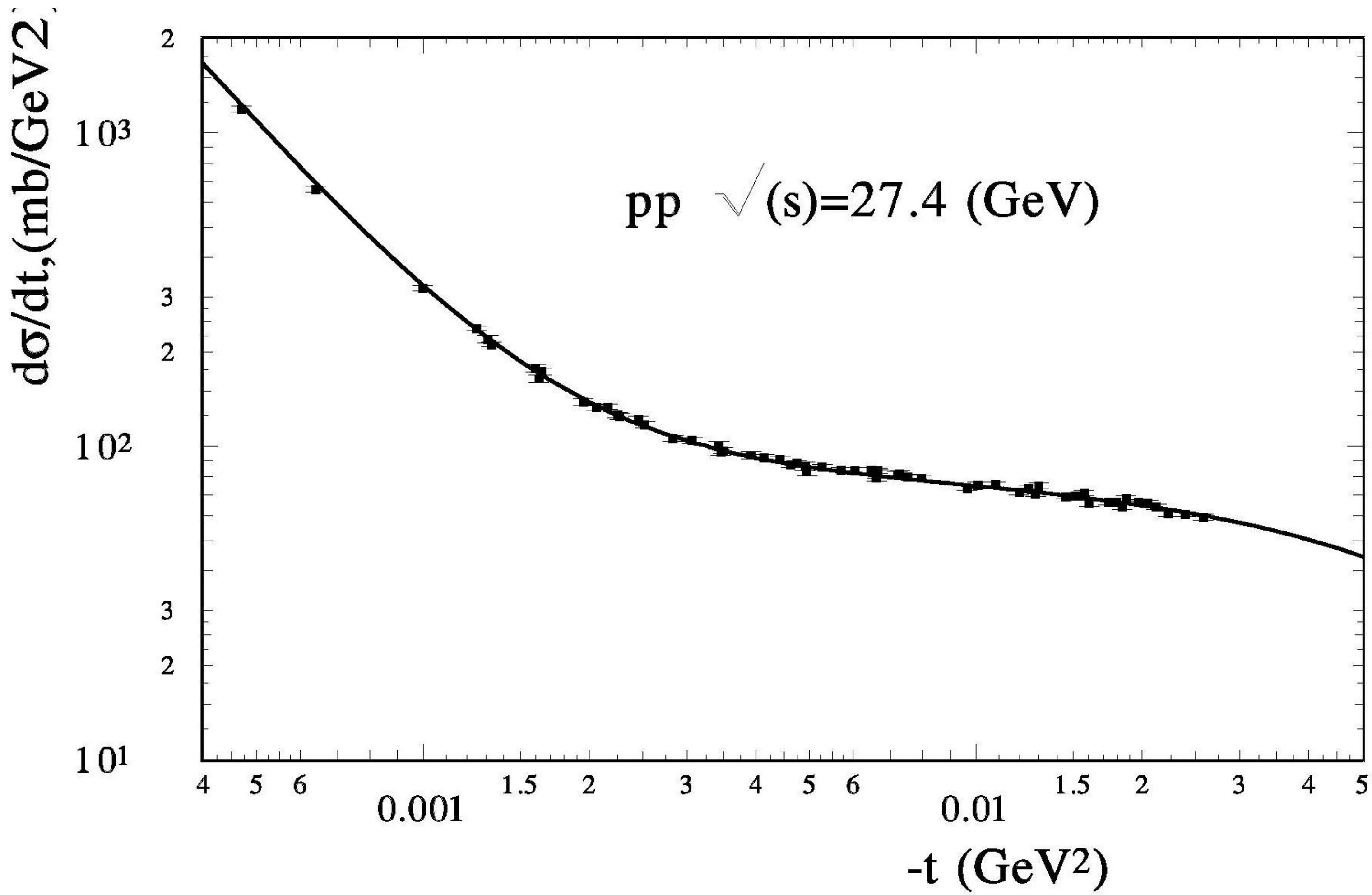

dσ/dt,(mb/GeV2)
p ap √(s)=53 (GeV)
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
0.0
1.0
2.0
3.0
4.0
-t (GeV^2)



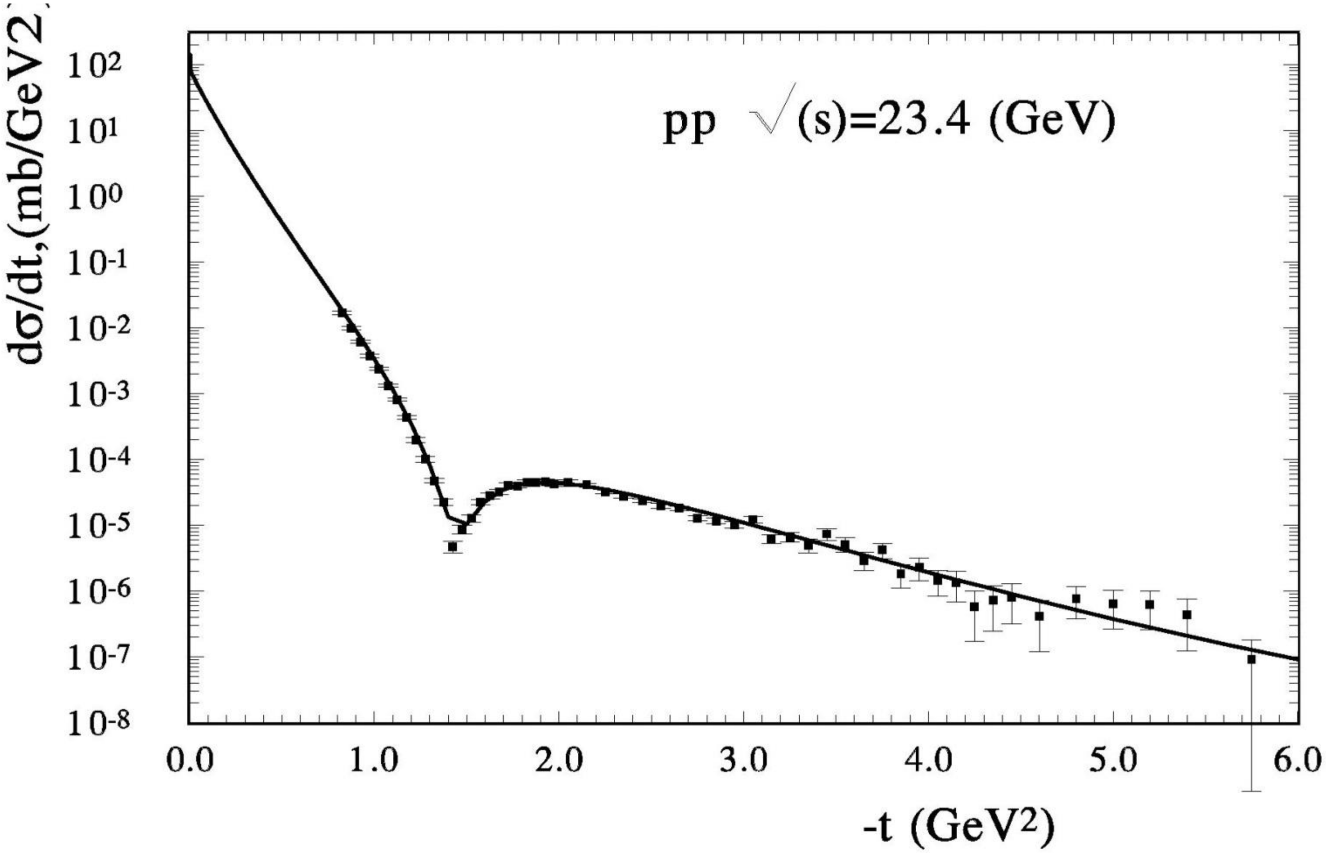
pp √(s)=44.7 (GeV)
dσ/dt,(mb/GeV2)
10^2
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
10^-8
0.0
2.0
4.0
6.0
8.0
-t (GeV^2)



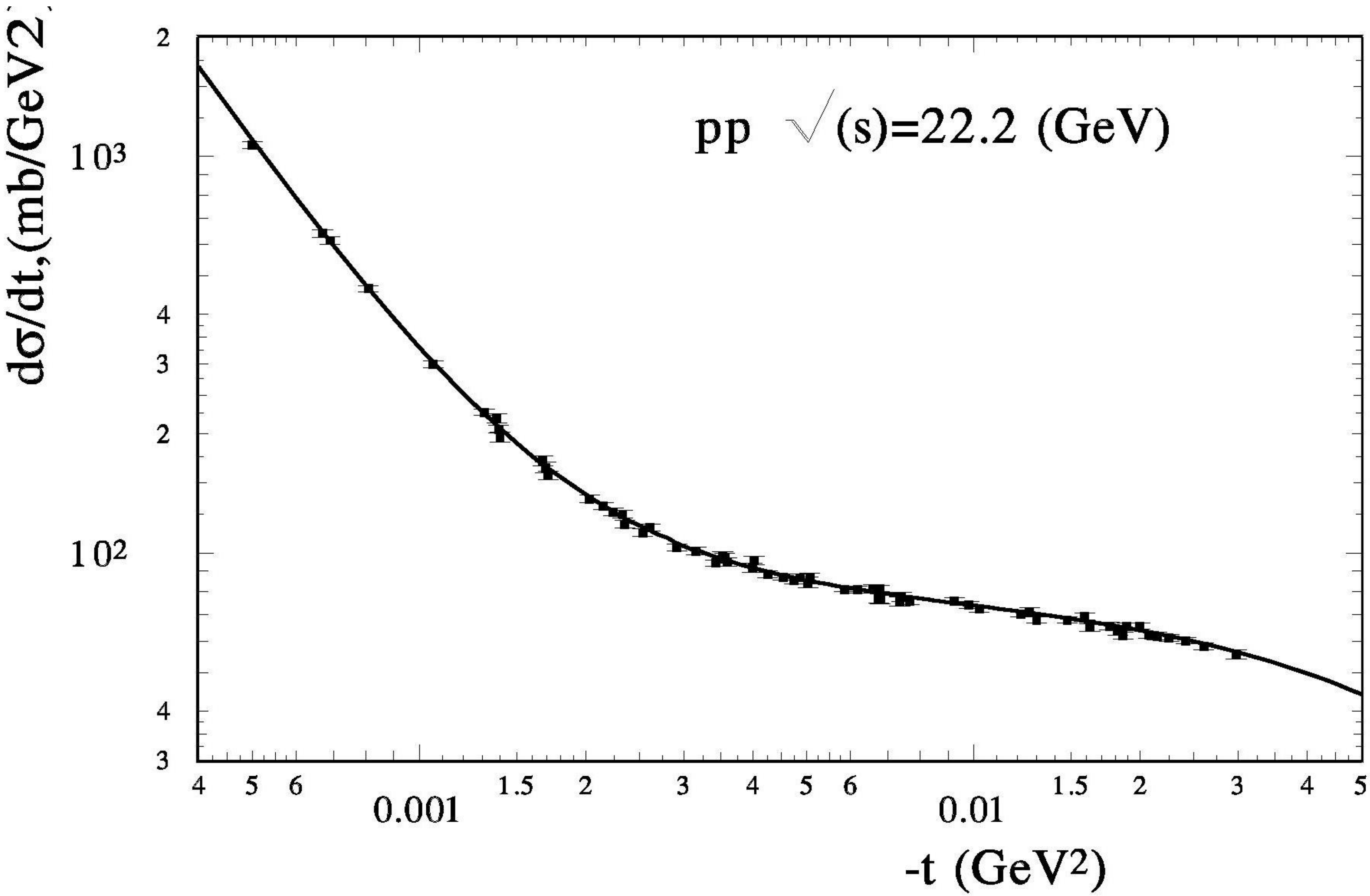
pp √(s)=27.4 (GeV)
dσ/dt,(mb/GeV2)
10-2
10-3
10-4
10-5
10-6
10-7
10-8
10-9
10-10
10-11
0.0
3.0
6.0
9.0
12.0
15.0
-t (GeV2)



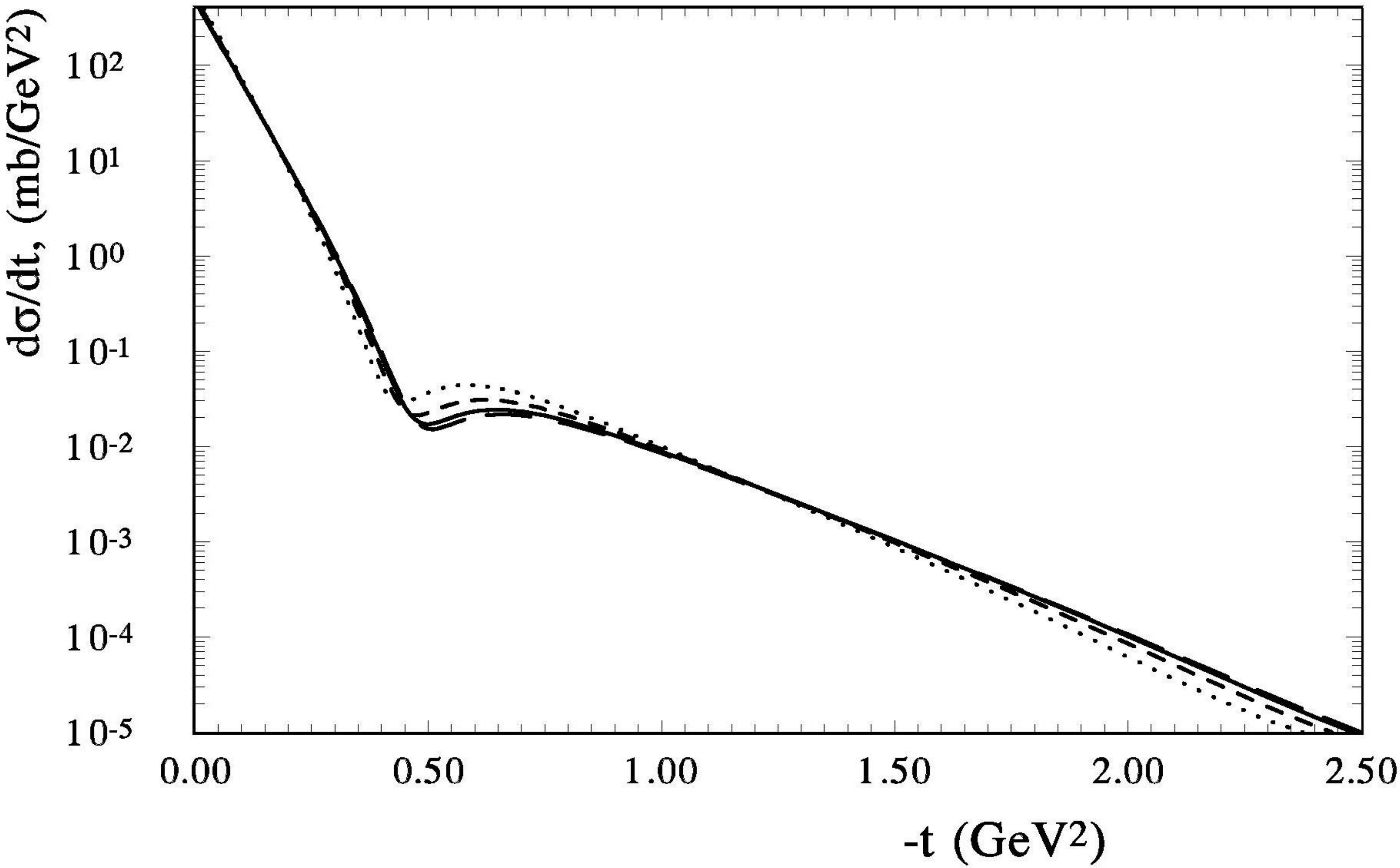
dσ/dt,(mb/GeV2)
pp √(s)=27.4 (GeV)
10^3
10^2
10^1
0.001
0.01
-t (GeV2)



pp √(s)=23.4 (GeV)
dσ/dt,(mb/GeV2)
10^2
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
10^-8
0.0
1.0
2.0
3.0
4.0
5.0
6.0
-t (GeV^2)



pp √(s)=22.2 (GeV)
dσ/dt,(mb/GeV2)
-t (GeV2)
10³
10²
0.001
0.01


dσ/dt, (mb/GeV2)
102
101
100
10-1
10-2
10-3
10-4
10-5
0.00
0.50
1.00
1.50
2.00
2.50
-t (GeV2)

$\sqrt{s}\ GeV$	$\sigma_{tot}(s)\ mb$	$\rho(s,t=0)$
22.2	**39.85**	**0.0013**
52.8	42.85	0.076
541	61.91	0.128
1800	76.25	0.127
7000	95.9	0.121
8000	98	0.12
10000	101.6	0.119
140000	107.3	0.117

Summary

1. The elastic scattering reflects the generalized structure of the hadron.

2. The our model GPDs leads to the well description of the proton and neutron electromagnetic form factors and its elastic scattering simultaneously.

3. The new High Energy Generalized structure model (HEGS) gives the quantitatively description of the elastic nucleon scattering at high energy with only 3 fitting high energy parameters.

4. The model leads to the good coincides the model calculations with the preliminary data at 7 TeV.

Summary

5. In the framework of the model the contribution of the hard pomeron do not feeling.

6. The extending variant of the model show the contribution of the odderon and the spin-flip amplitude with the small energy dependence.

7. The model open the new way to determine the true form of the GPDs and standard parton distributions.

END

THANKS

FOR YOUR

ATTENTION

Hard Pomeron

$$f(s) \sim s^{\Delta} \quad (\Delta_h = 0.4)$$

Odderon

$$f(s) \sim ? \quad [\ 1/\sqrt{s}; \quad const.; \quad s^{\Delta} \quad (\Delta_s = 0.1) \quad]$$

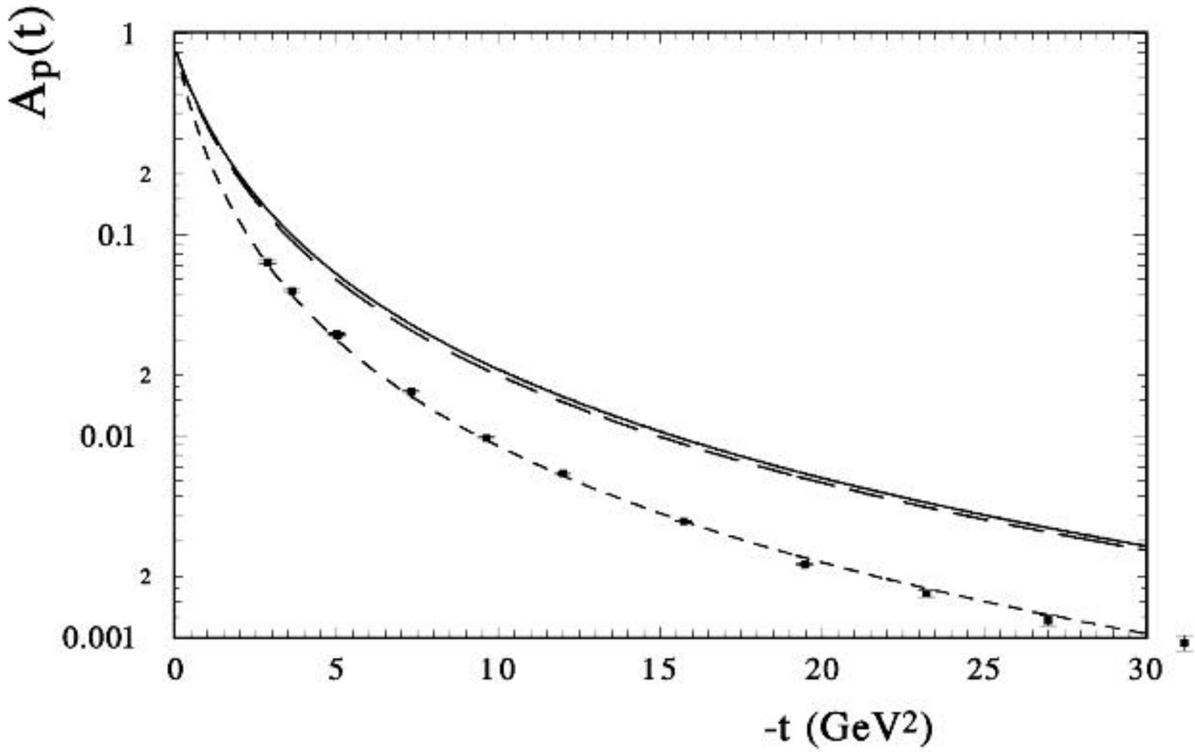
$$F(s,t) \sim t/(r^2 - t)\ s^{\Delta_s} \exp[Bt]\ G^2_{gr.}(t)$$

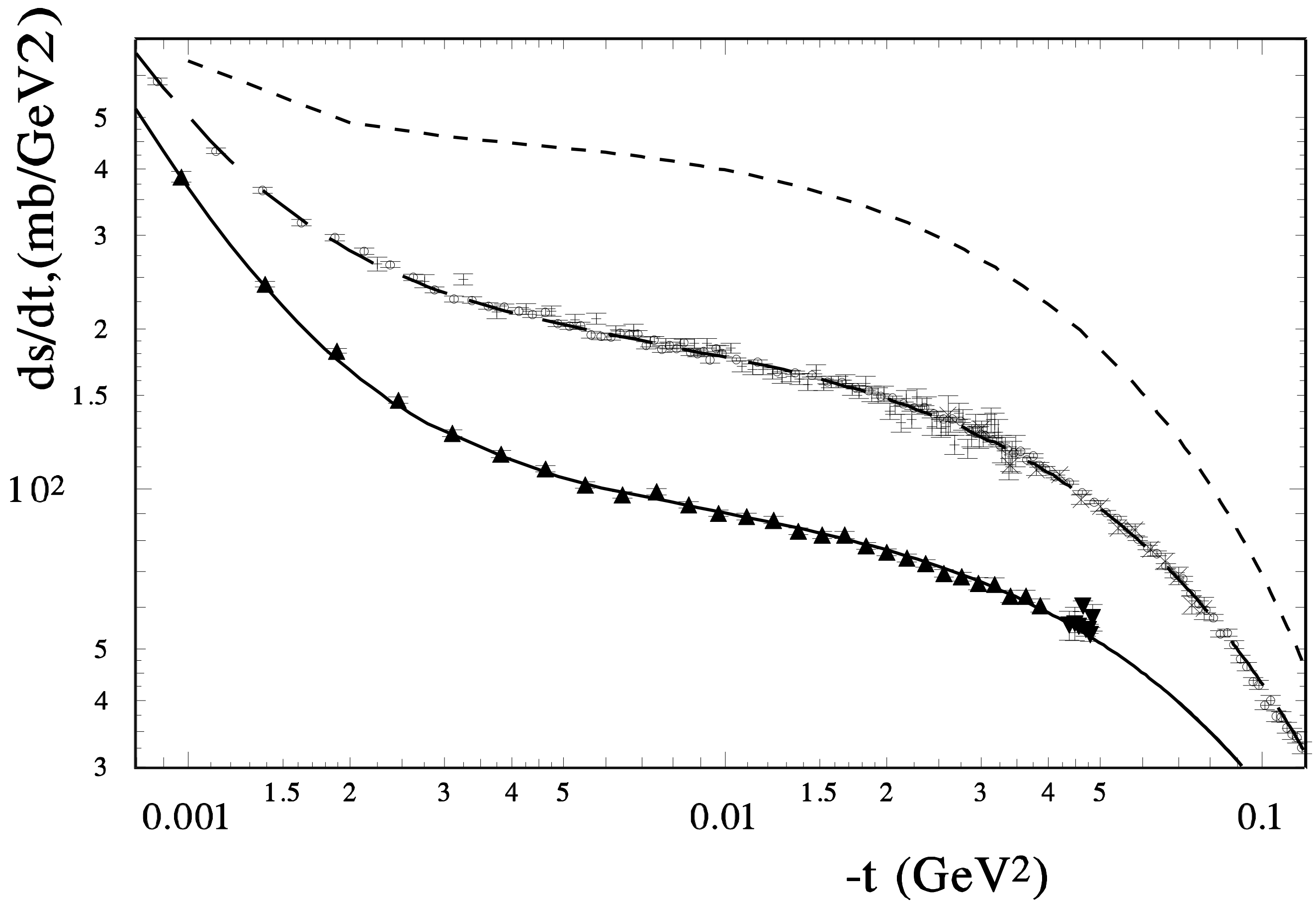
Spin-flip

$$f(s) \sim ? \quad (1/\sqrt{s}; \quad cons; \quad Ln(s) \quad)$$

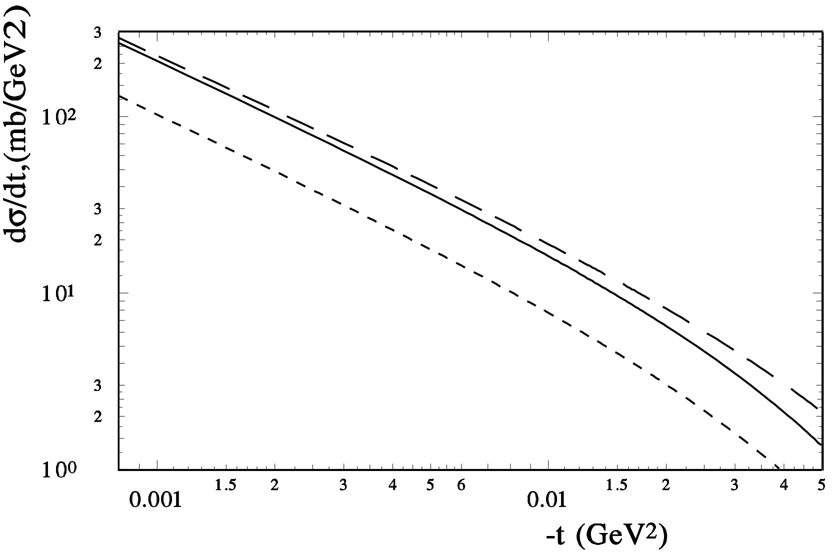
$$F^{+-}(s,t) \sim q^3 \exp[B_{sf}\ t] G^2_{gr}$$

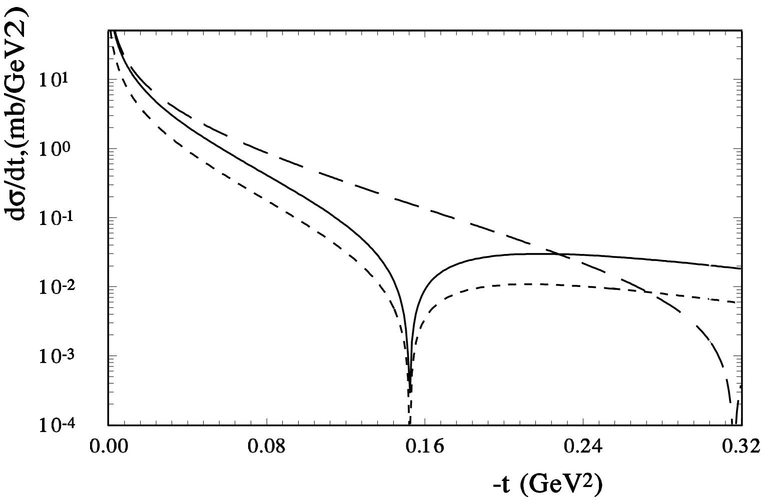
$A_p(t)$ Gravitation form factor A_p and proton Dirac FF




ds/dt,(mb/GeV2)
5
4
3
2
1.5
10²
5
4
3
1.5
2
3
4
5
1.5
2
3
4
5
0.001
0.01
0.1
-t (GeV²)

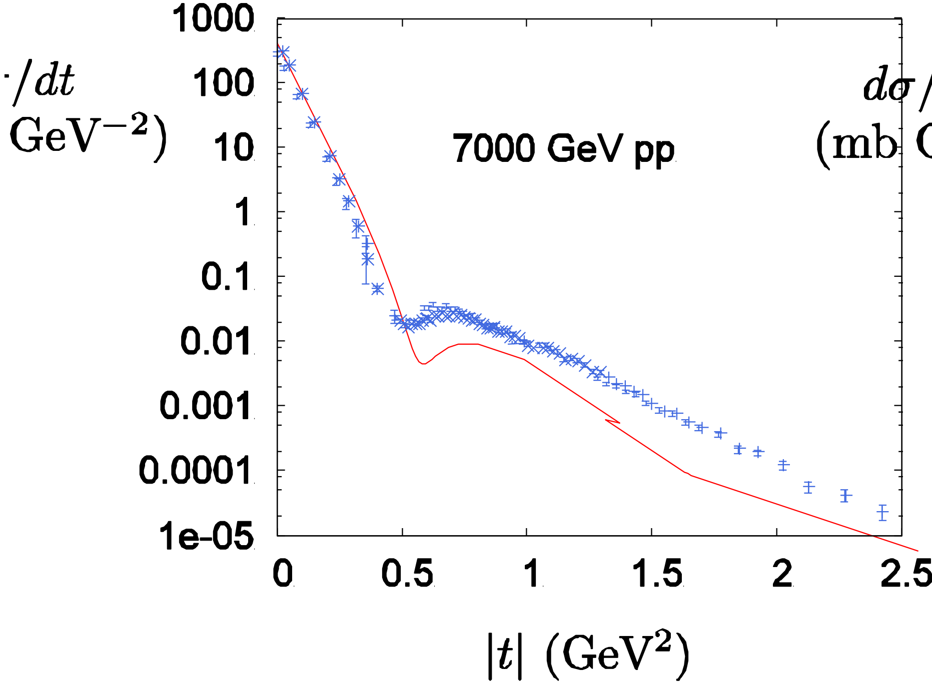
|CNI term|

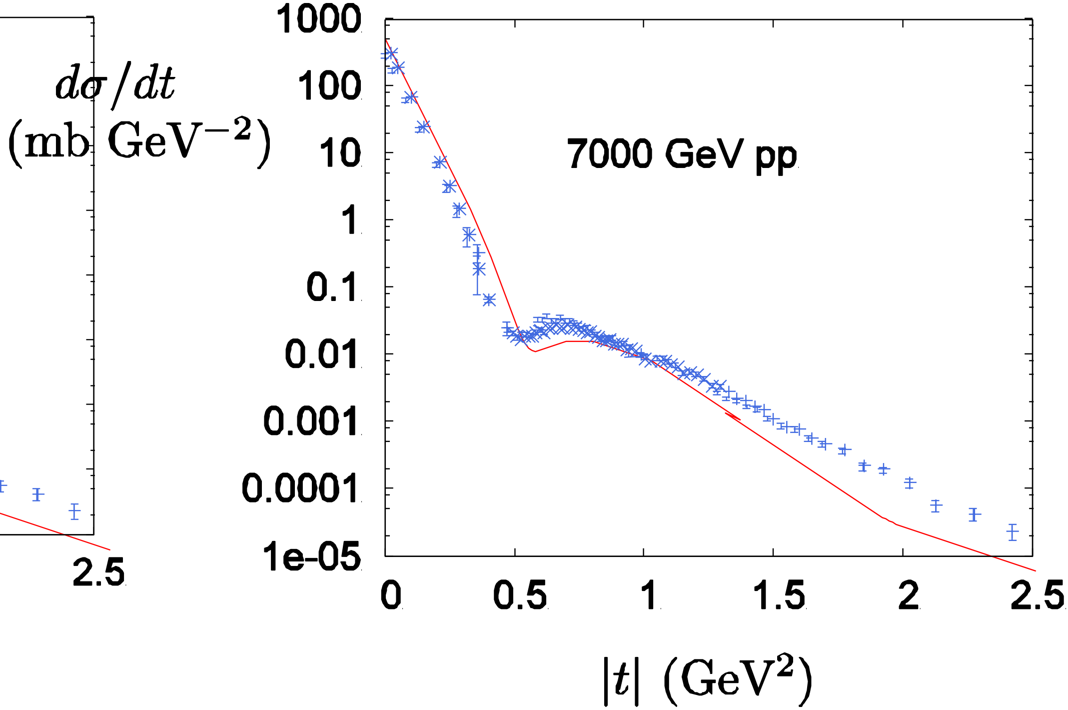




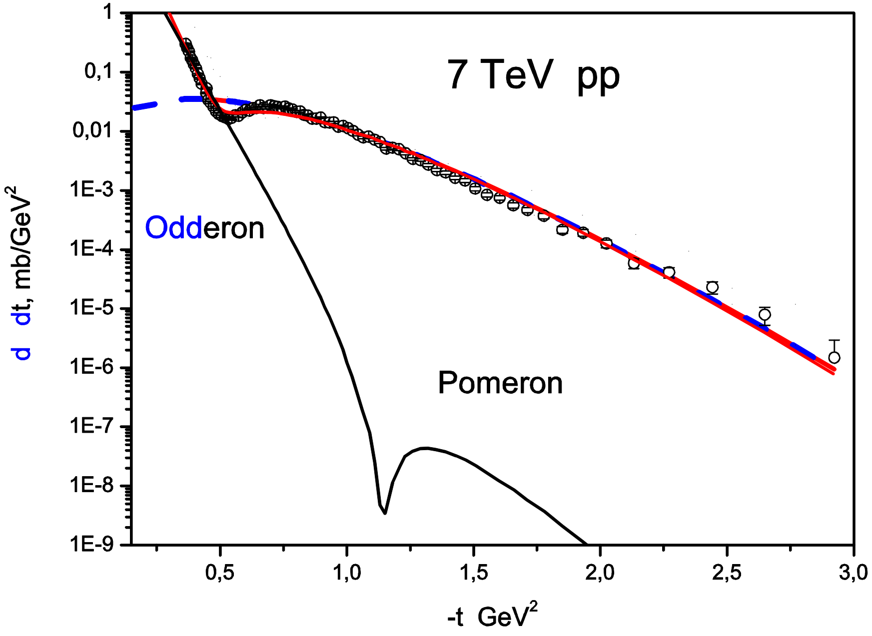
$$\frac{1}{\pi}\frac{d\sigma(s,t)}{dt} = (F_C^2(t) + (1+\rho^2(s,t)\,\mathrm{Im}\,F_N^2(s,t) + 2(\rho(s,t)+\alpha\varphi(s,t))F_C\,\mathrm{Im}\,F_N)$$

A. Donnachie, P.V. Landshoff (arXiV: 1112. 2488)





Lengyel-Tarics (2012) –arXiv:1206.5817
(odderon contribution)



General Parton Distributions -GPDs

Electromagnetic form factors (charge distribution)

Gravitation form factors (matter distribution)

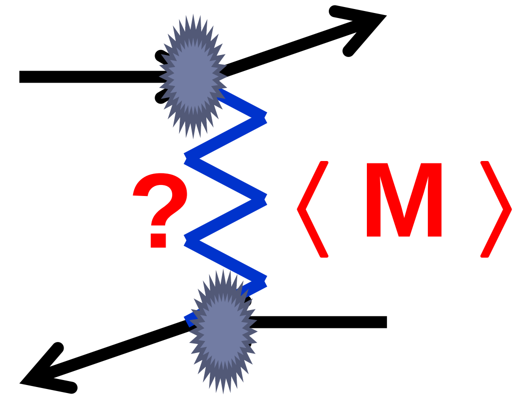
Elastic nucleon scattering

$$T_B(s,t) = h_1\, G_E^2(t)\left(\frac{s}{s_0}\right)^{\Delta_1} e^{\alpha_1 t \ln(s/s_0)} + h_2\, G_B^2(t)\left(\frac{s}{s_0}\right)^{\Delta_1} e^{\alpha_1/4t \ln(s/s_0)}$$

Scattering process described in terms of Helicity Amplitudes ϕ_i

All dynamics contained in the Scattering Matrix M

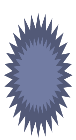
(Spin) Cross Sections expressed in terms of



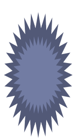
observables:
3 ×-sections
5 spin asymmetries

spin non–flip	$\phi_1(s,t) = \langle ++ \| M \| ++ \rangle$
double spin flip	$\phi_2(s,t) = \langle ++ \| M \| -- \rangle$
spin non–flip	$\phi_3(s,t) = \langle +- \| M \| +- \rangle$
double spin flip	$\phi_4(s,t) = \langle +- \| M \| -+ \rangle$
single spin flip	$\phi_5(s,t) = \langle ++ \| M \| +- \rangle = -\langle ++ \| M \| -+ \rangle$

identical spin ½ particles



- GPDs → electromagnetic FF



- GPDs → gravimagnetic FF

Summary

1. Proposed the new simple t- dependence of the GPDs

2. The well description of the proton and neutron electromagnetic form factors are obtained.

3. It is shown that in the framework of the same model assumptions the "Rosenbluch" and "Polarization" data of FF can be obtained using the difference slopes of the $F_{2.}$

4. The compare the calculations and full row of the data shows the preference the "Polarization" case.

5. The corresponding gravitation form factors of the proton are calculated.

The forward magnetic densities - $\mathcal{E}$ is proportional to the $\mathcal{H}$ with assitional factor ***as in*** Cuidal et al. hep-ph:041025 (v.1-2005 – v.2-2009)

$$\mathcal{E}_1^u(x) = \frac{k_u}{N_u}(1-x)^{\eta_u} u_v(x); \quad \mathcal{E}_1^d(x) = \frac{k_d}{N_d}(1-x)^{\eta_d} d_v(x);$$

Where the normalization factors :

$$N_u = \int_0^1 dx(1-x)^{\eta_u} u_v(x); \qquad N_d = \int_0^1 dx(1-x)^{\eta_d} d_v(x);$$

$$F_2^u(t) = \int_0^1 dx(1-x)^{\eta_u} u_v(x) G_u(x,t); \quad F_2^d(t) = \int_0^1 dx(1-x)^{\eta_d} d_v(x) G_d(x,t);$$

Elastic scattering amplitude

$$pp \rightarrow pp \qquad\qquad p\bar{p} \rightarrow p\bar{p}$$

$$\frac{d\sigma}{dt} = 2\pi [|\Phi_1|^2 + |\Phi_2|^2 + |\Phi_3|^2 + |\Phi_4|^2 + 4|\Phi_5|^2]$$

$$\Phi_i(s,t) = \Phi_i^h(s,t) + \Phi_i^e(t)\, e^{i\alpha\varphi}$$

$$\varphi(s,t) = \mp [\gamma + \ln(B(s,t)|t|/2) + \nu_1 + \nu_2]$$

$\gamma = 0,577...$ (*the Euler constant*)

ν_1 *and* ν_2 *are small correction terms*