Nucleon form factors in PHOKHARA

an update of arXiv:1407.7995

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Barion form factors

H.C., J. H. Kühn, E. Nowak and G. Rodrigo,
Eur.Phys.J.C35(2004)527, first PHOKHARA implementation

Electromagnetic current describing production of baryon-antibaryon pair

$$J_\mu = -ie \cdot \bar{u}(q_2) \left(F_1^N(Q^2)\gamma_\mu - \frac{F_2^N(Q^2)}{4m_N} \left[\gamma_\mu, \not{Q}\,\right] \right) v(q_1) \ ,$$

$$G_M^N = F_1^N + F_2^N \ , \qquad G_E^N = F_1^N + \tau F_2^N \ ,$$

$$\tau = Q^2/4m_N^2, \, Q = q_1 + q_2$$

Nucleon form factors - new model

$$F^p_{1,2} = F^s_{1,2} + F^v_{1,2} \qquad F^n_{1,2} = F^s_{1,2} - F^v_{1,2}$$

$$F^s_1 = \frac{1}{2}\frac{\sum_{n=0}^{N} c^1_n BW_{\omega_n}(s)}{\sum_{n=0}^{N} c^1_n},$$

$$F^v_1 = \frac{1}{2}\frac{\sum_{n=0}^{N} c^2_n BW_{\rho_n}(s)}{\sum_{n=0}^{N} c^2_n},$$

$$F^s_2 = -\frac{1}{2} b \frac{\sum_{n=0}^{N} c^3_n BW_{\omega_n}(s)}{\sum_{n=0}^{N} c^3_n},$$

$$F^v_2 = \frac{1}{2} a \frac{\sum_{n=0}^{N} c^N_n BW_{\rho_n}(s)}{\sum_{n=0}^{N} c^N_n},$$

Nucleon form factors - new model

G. P. Lepage and S. J. Brodsky, Phys.Rev. D22, 2157(1980).

$$F_1 \sim \frac{1}{(Q^2)^2}, \quad F_2 \sim \frac{1}{(Q^2)^3},$$

$$BW_i(Q^2) = \frac{m_i^2}{m_i^2 - Q^2 - i m_i \Gamma_i \theta(Q^2)}.$$

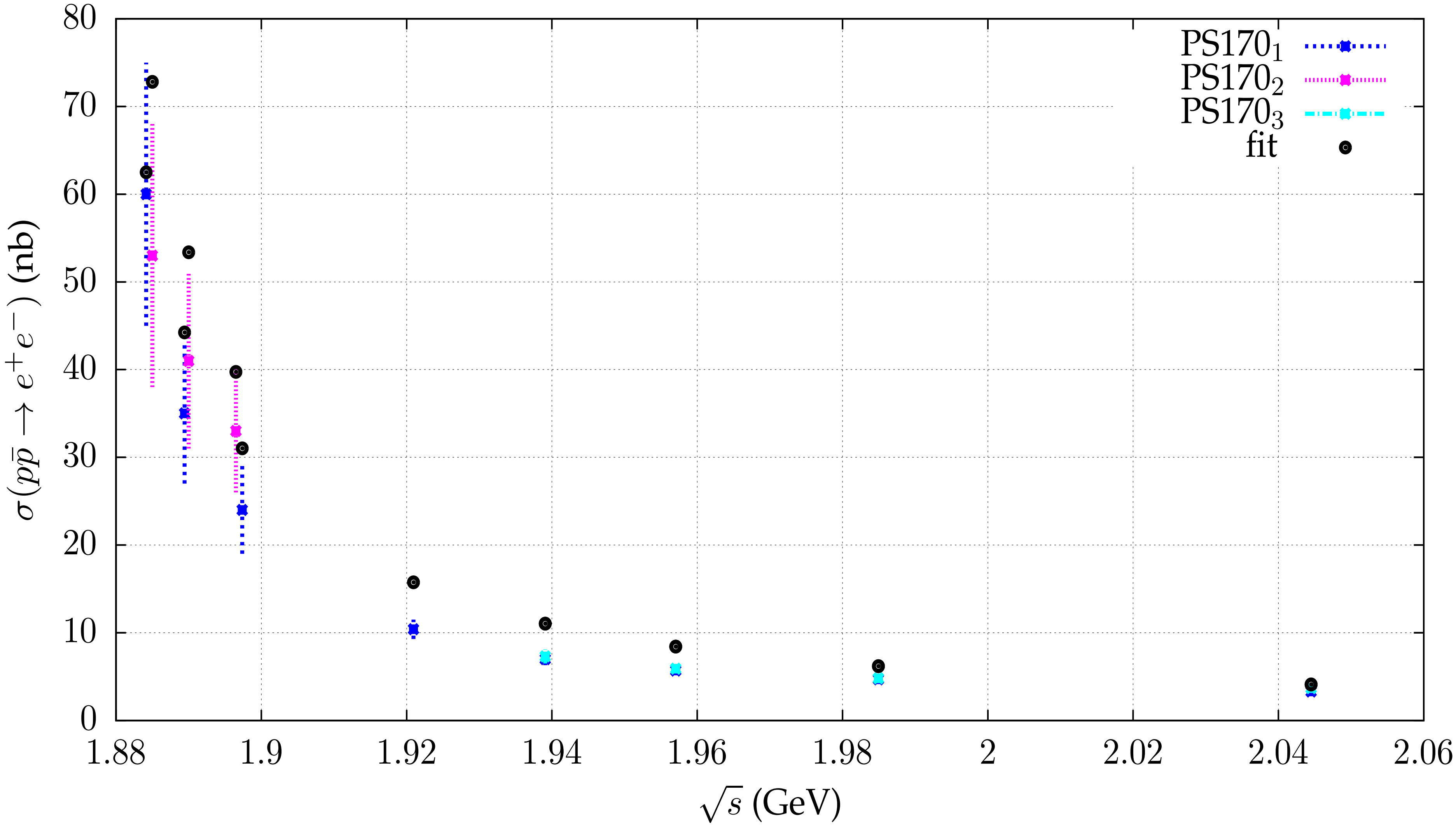
$$c_i^j = c_i^{jR} + i c_i^{jI} \theta(Q^2)$$

arXiv:1407.7995 fits, N=3

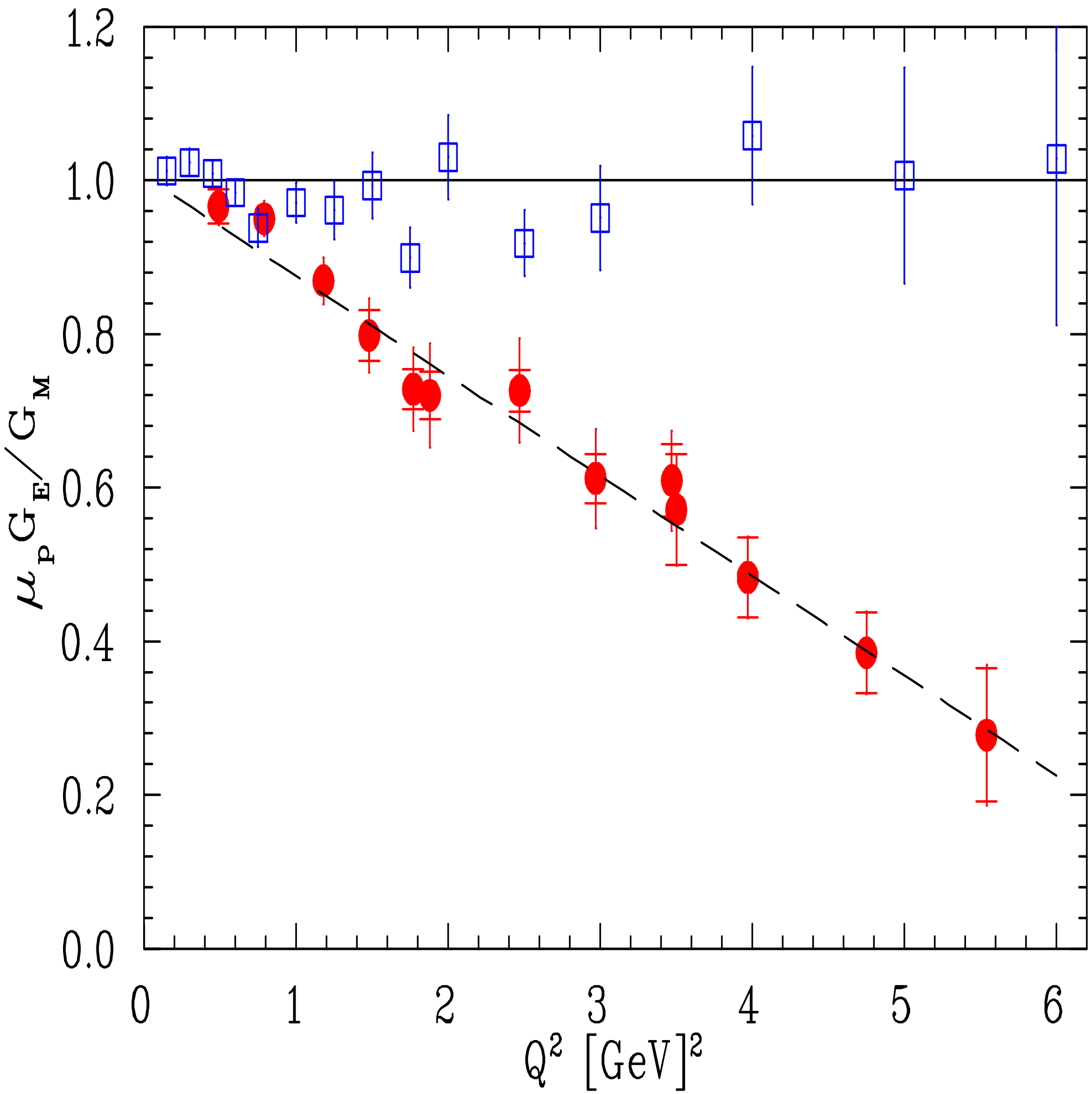
Experiment	nep	χ^2	Experiment	nep	χ^2
BaBar cs [12]	38	48	BaBar r [12]	6	5
$PS170_1$ cs [16]	8	120	PS170 r [16]	5	24
$PS170_2$ cs [17]	3	4	$PS170_2$ cs [18]	4	54
E760 cs [19]	3	3	$E835_1$ cs [20]	5	8
$E835_2$ cs [21]	2	2	DM2 cs [22, 23]	7	24
BES cs [24]	8	7	CLEO cs [25]	1	0.02
FENICE cs [26]	5	5	DM1 cs [27]	4	0.6
JLab 05 r [28]	10	4	JLab 02 r [29]	4	0.4
JLab 01 r [30]	13	14	JLab 10 r [31]	3	4
MAMI 01 r [32]	3	1	JLab 03 r [33]	3	4
BLAST 08 r [34]	4	2	FENICE cs [26]	4	2

$\chi^2 = 98$ for 118 data points and fitted 12 parameters

arXiv:1407.7995 fits, N=3

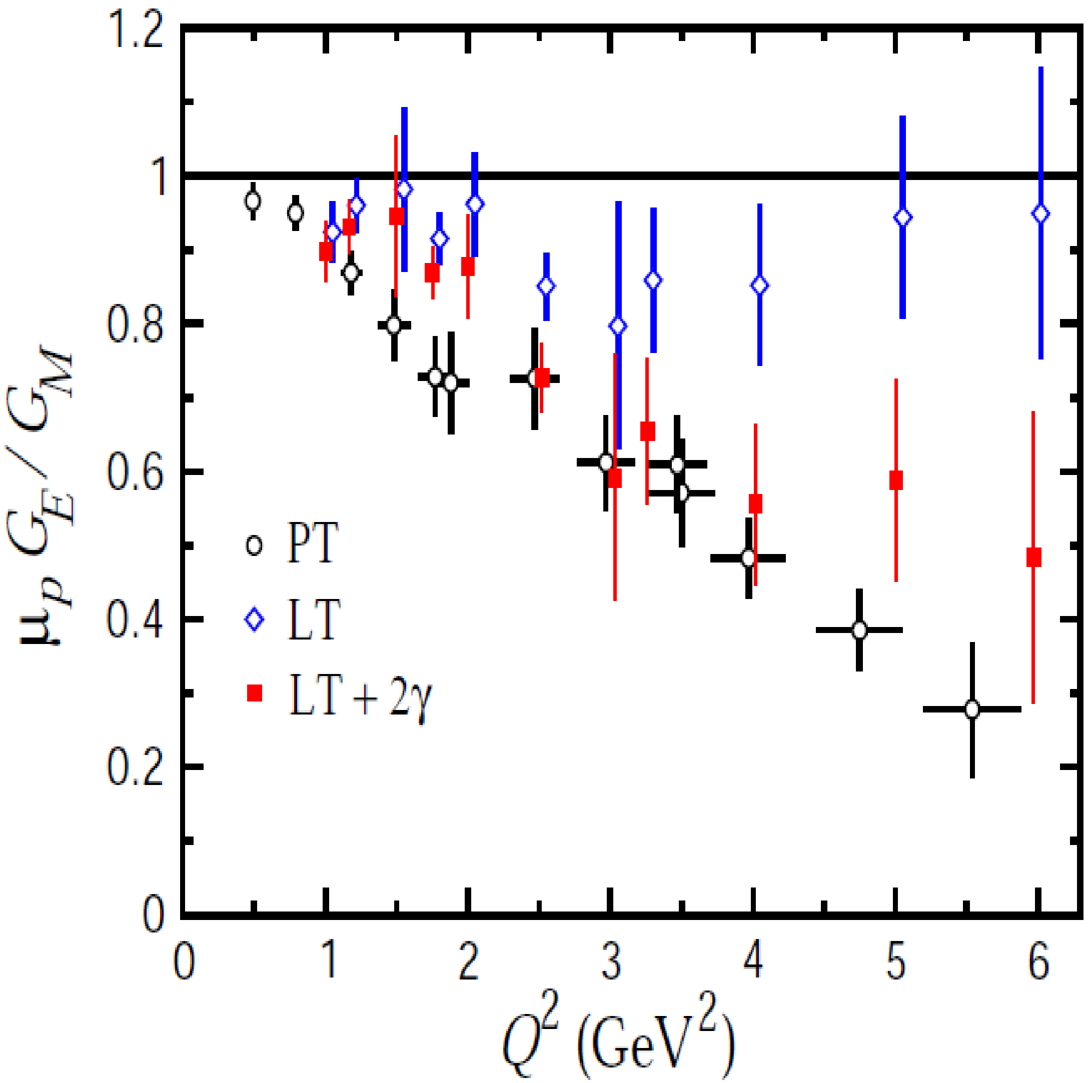


$ep \to ep$ data



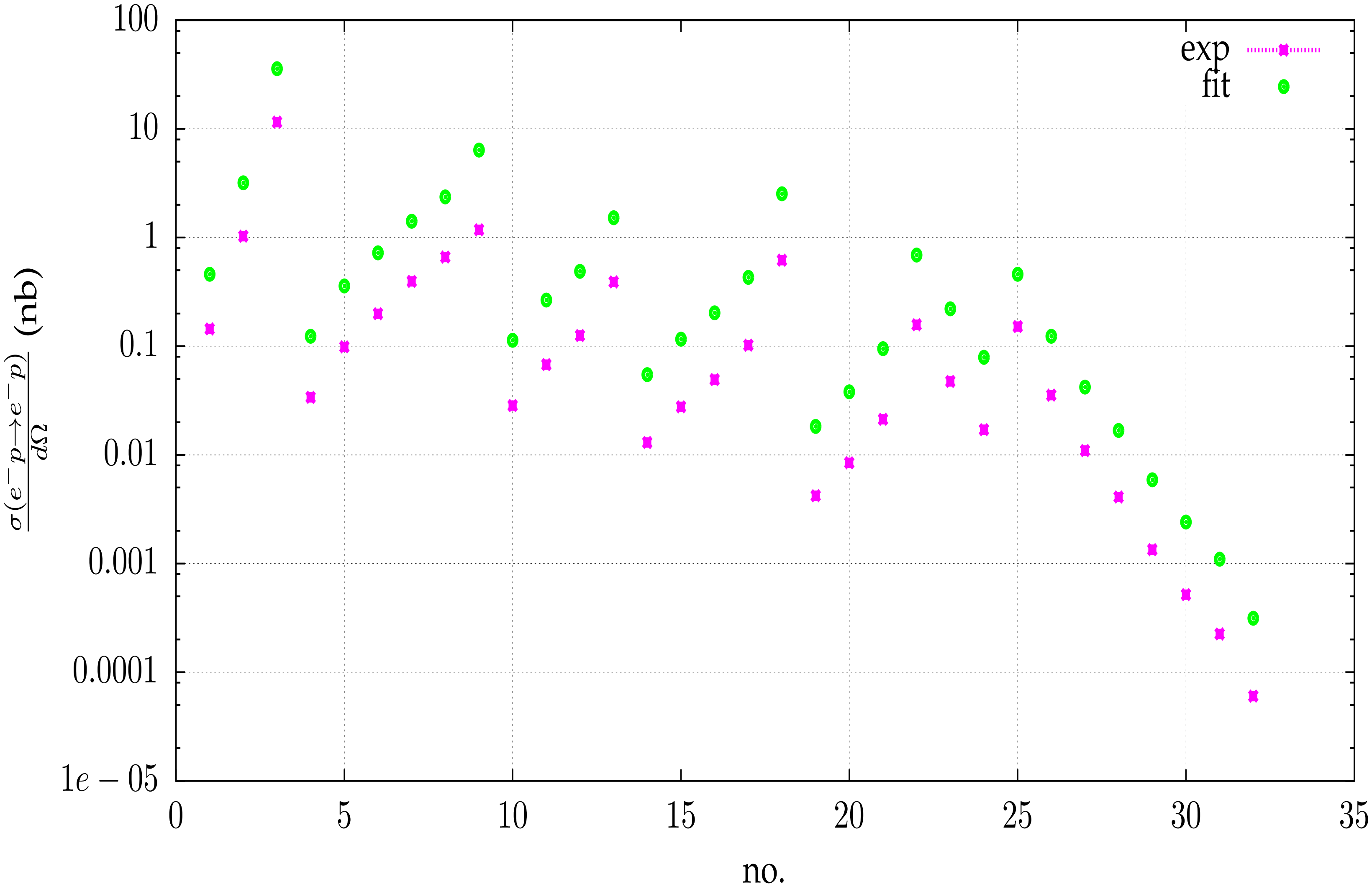
Arrington et al., Phys. Rev. **C 68** (2003) 034325

$ep \rightarrow ep$ data



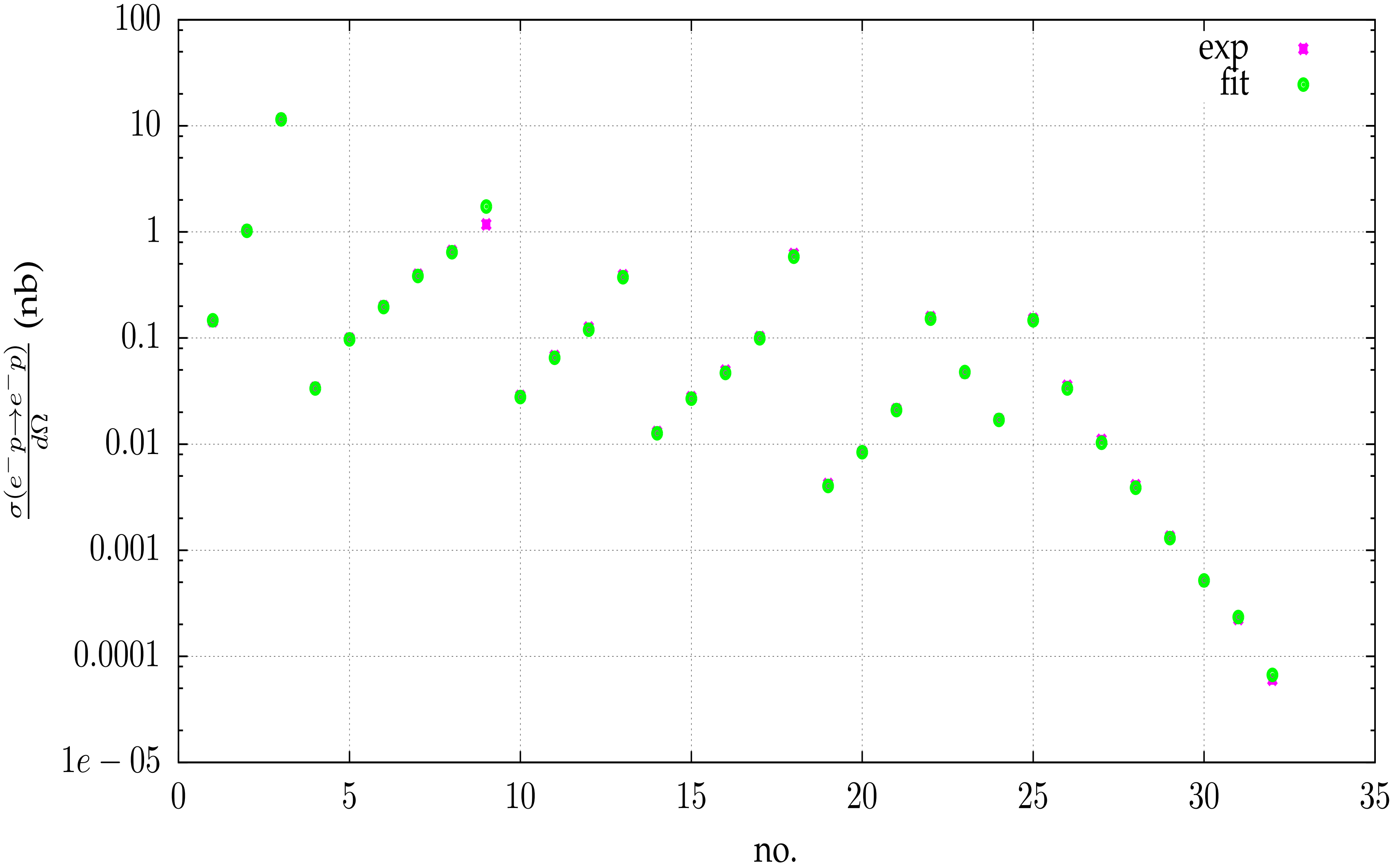
Carl E. Carlson , Marc Vanderhaeghen, Ann.Rev.Nucl.Part.Sci. 57 (2007) 171-204

arXiv:1407.7995 fits, N=3



L. Andivahis et al., Phys.Rev. D50, 5491 (1994).

arXiv:1407.7995v2 fits, N=4



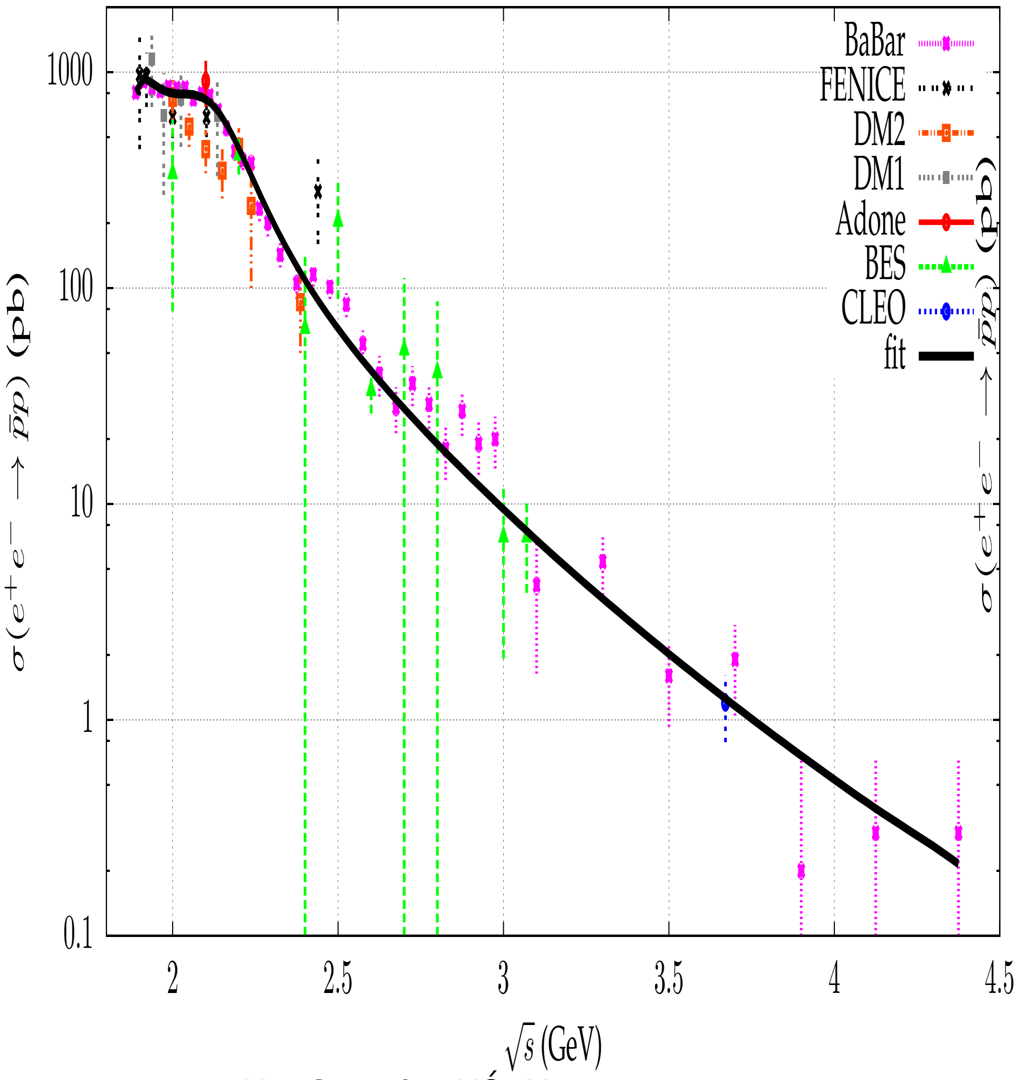
L. Andivahis et al., Phys.Rev. D50, 5491 (1994).

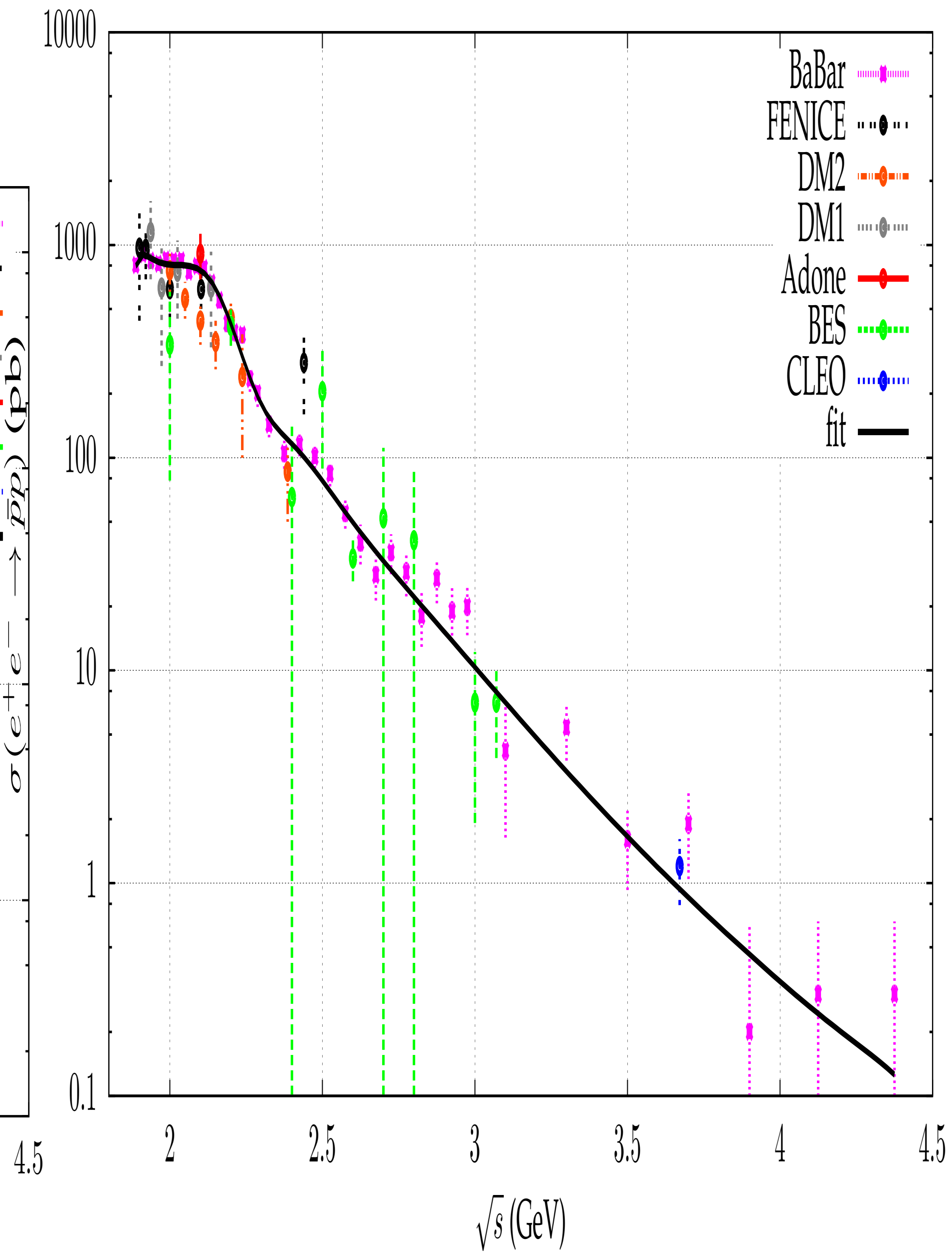
arXiv:1407.7995v2 fits, N=4

Experiment	nep	χ^2	Experiment	nep	χ^2
BaBar cs [12]	38	30	BaBar r [12]	6	0.6
$PS170_1$ cs [16]	8	109	PS170 r [16]	5	16
$PS170_2$ cs [17]	4	4	$PS170_3$ cs [18]	4	52
$E760_1$ cs [19]	3	0.5	$E835_1$ cs [20]	5	1
$E835_2$ cs [21]	2	0.03	DM2 cs [22, 23]	7	26
BES cs [24]	8	10	CLEO cs [25]	1	0.4
FENICE cs [26]	5	5	DM1 cs [27]	4	0.7
JLab 05 r [28]	10	16	JLab 02 r [29]	4	1
JLab 01 r [30]	13	10	JLab 10 r [31]	3	6
MAMI 01 r [32]	3	2	JLab 03 r [33]	3	6
BLAST 08 r [34]	4	6	FENICE cs [26]	4	0.6
			SLAC cs [35]	32	27

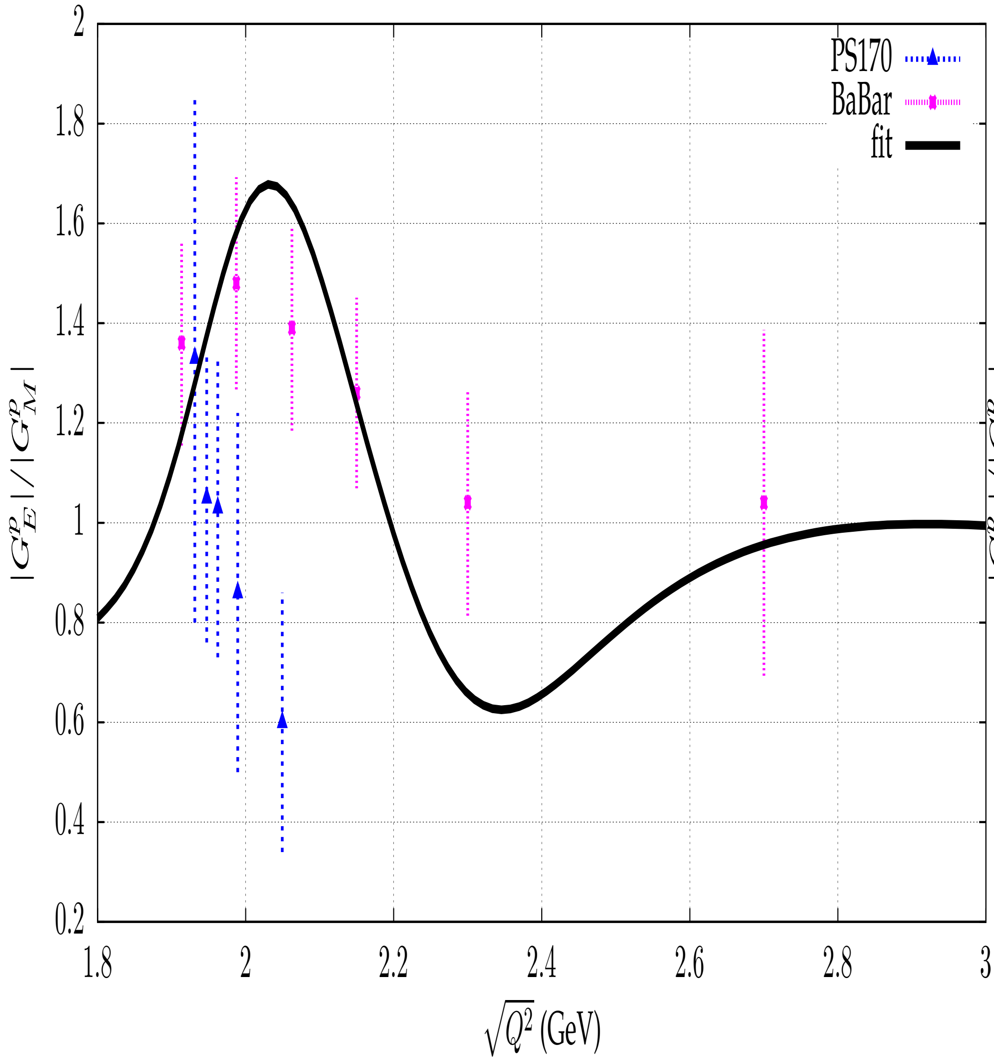
$\chi^2 = 124$ for 150 data points and fitted 20 parameters

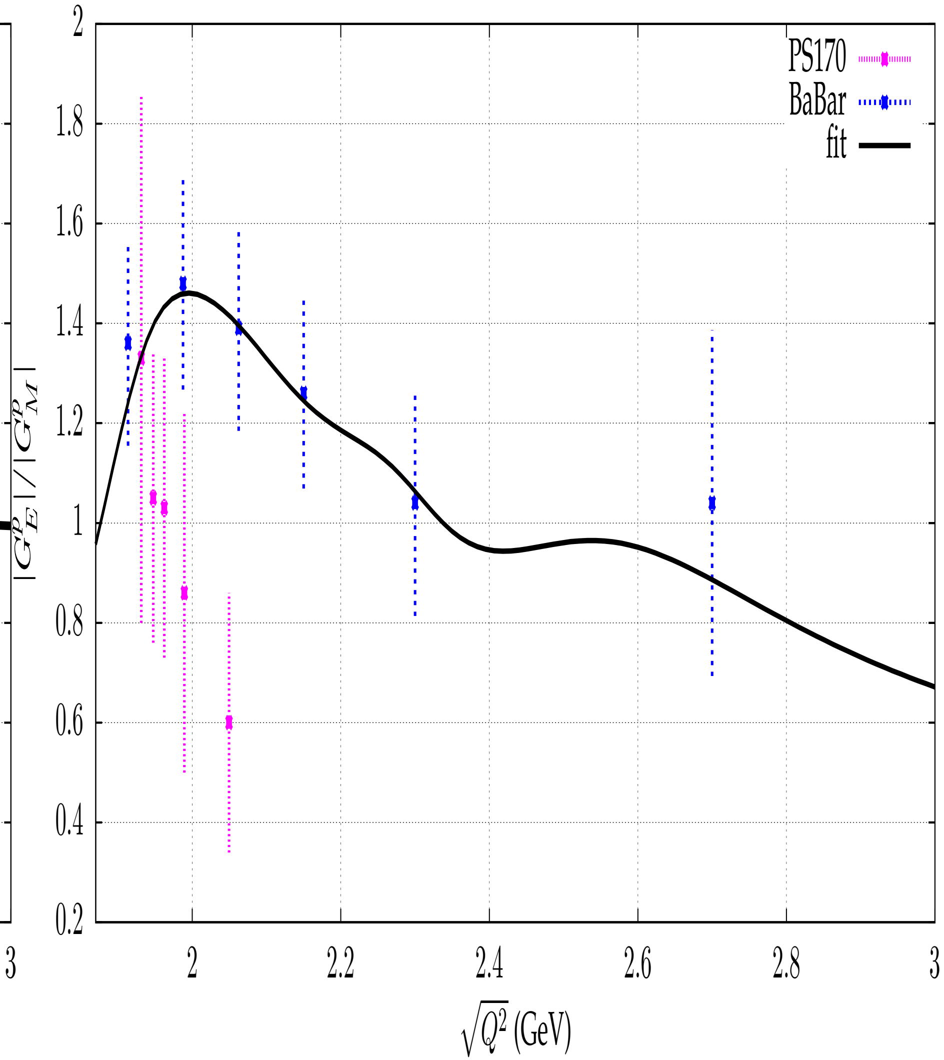
1407.7995v1 vs. 1407.7995v2



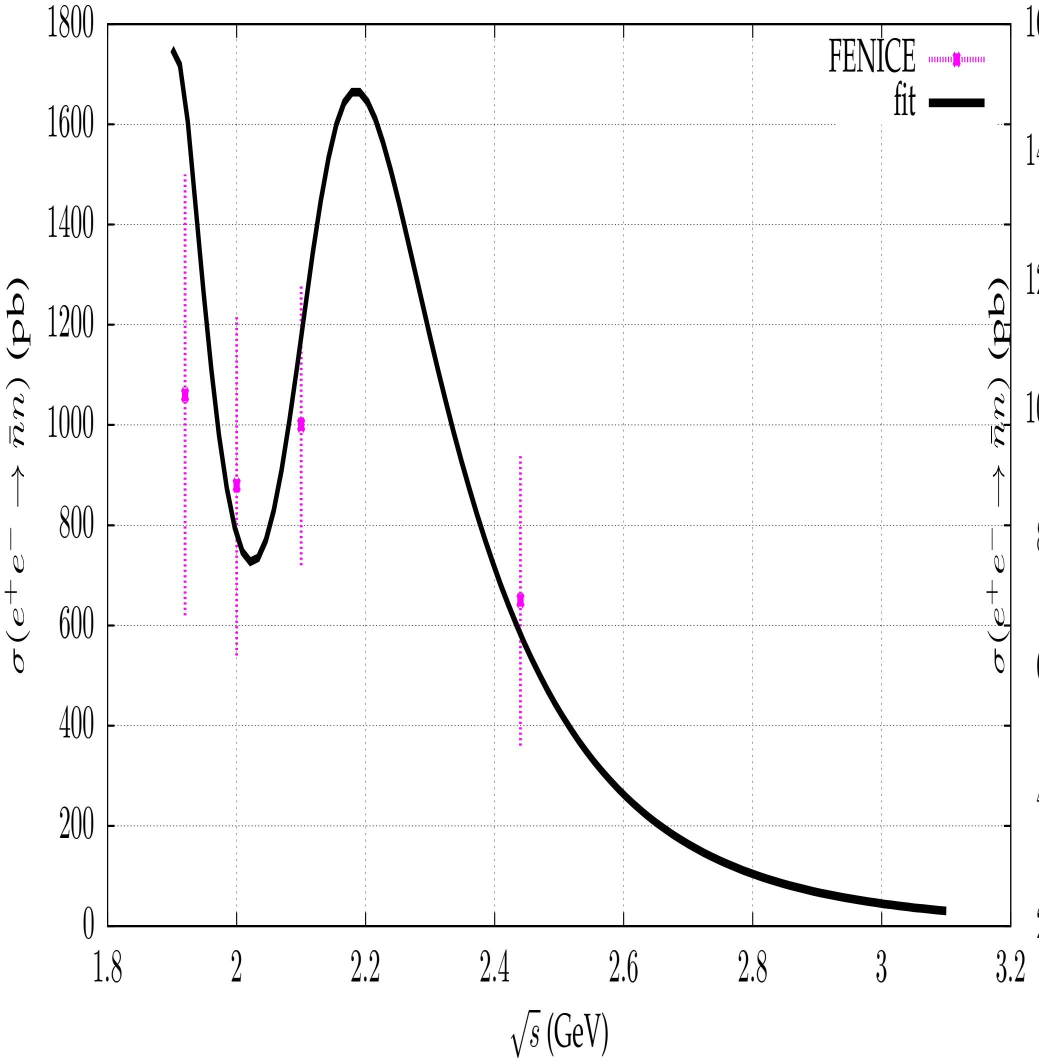


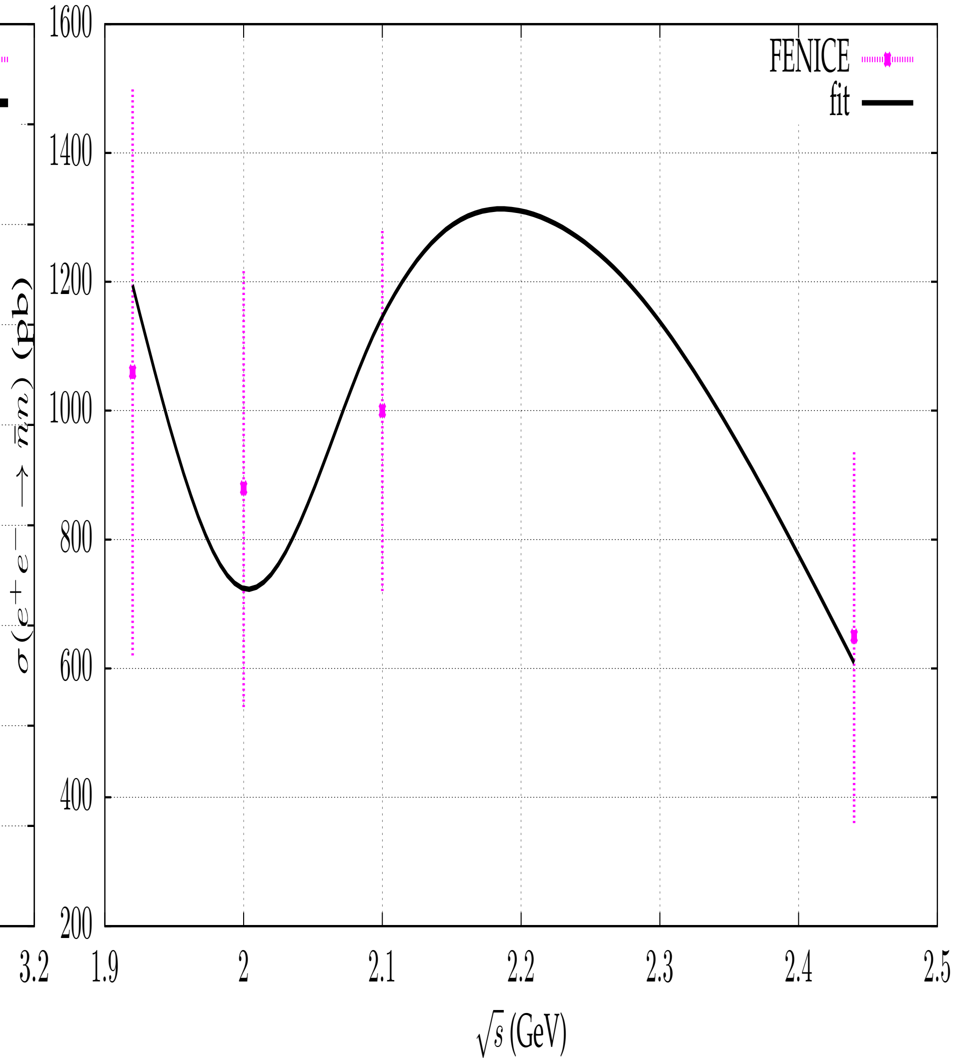
1407.7995v1 vs. 1407.7995v2



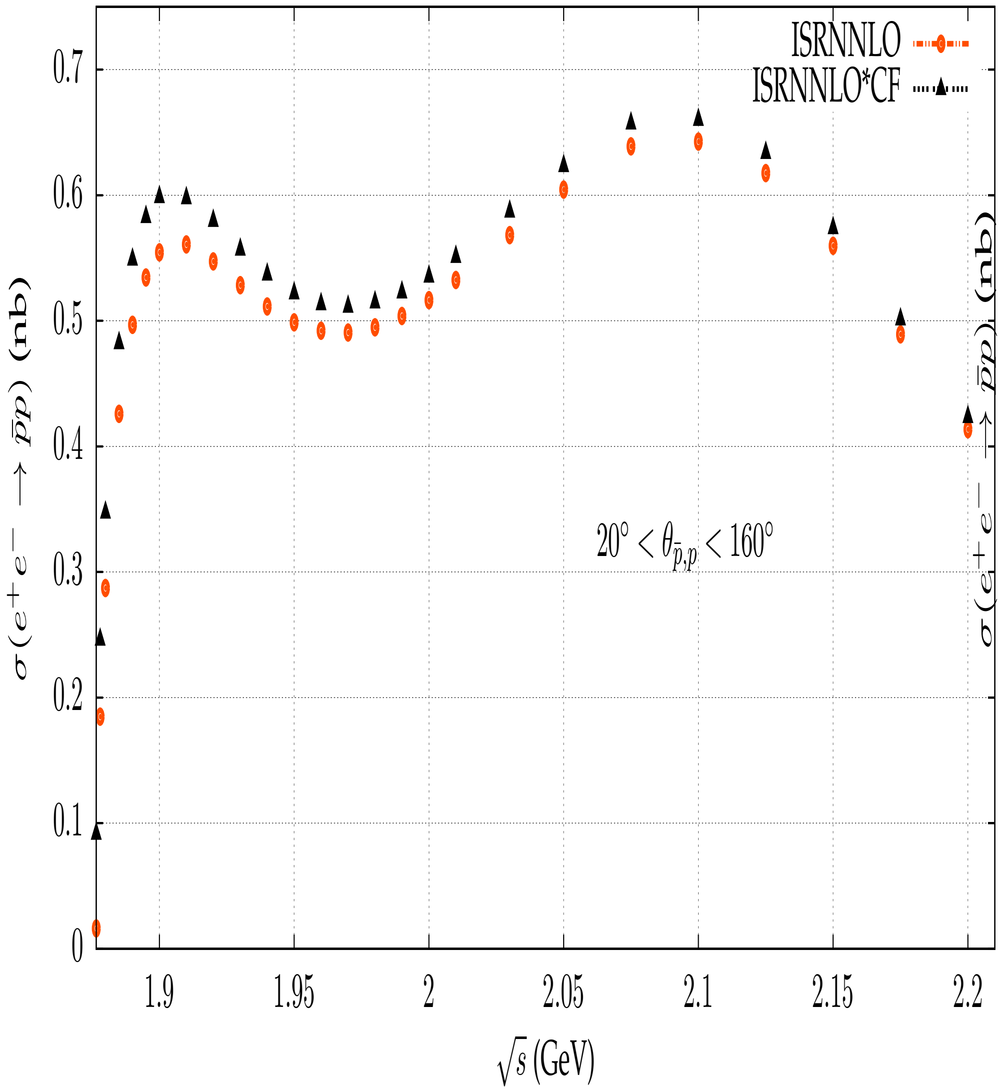


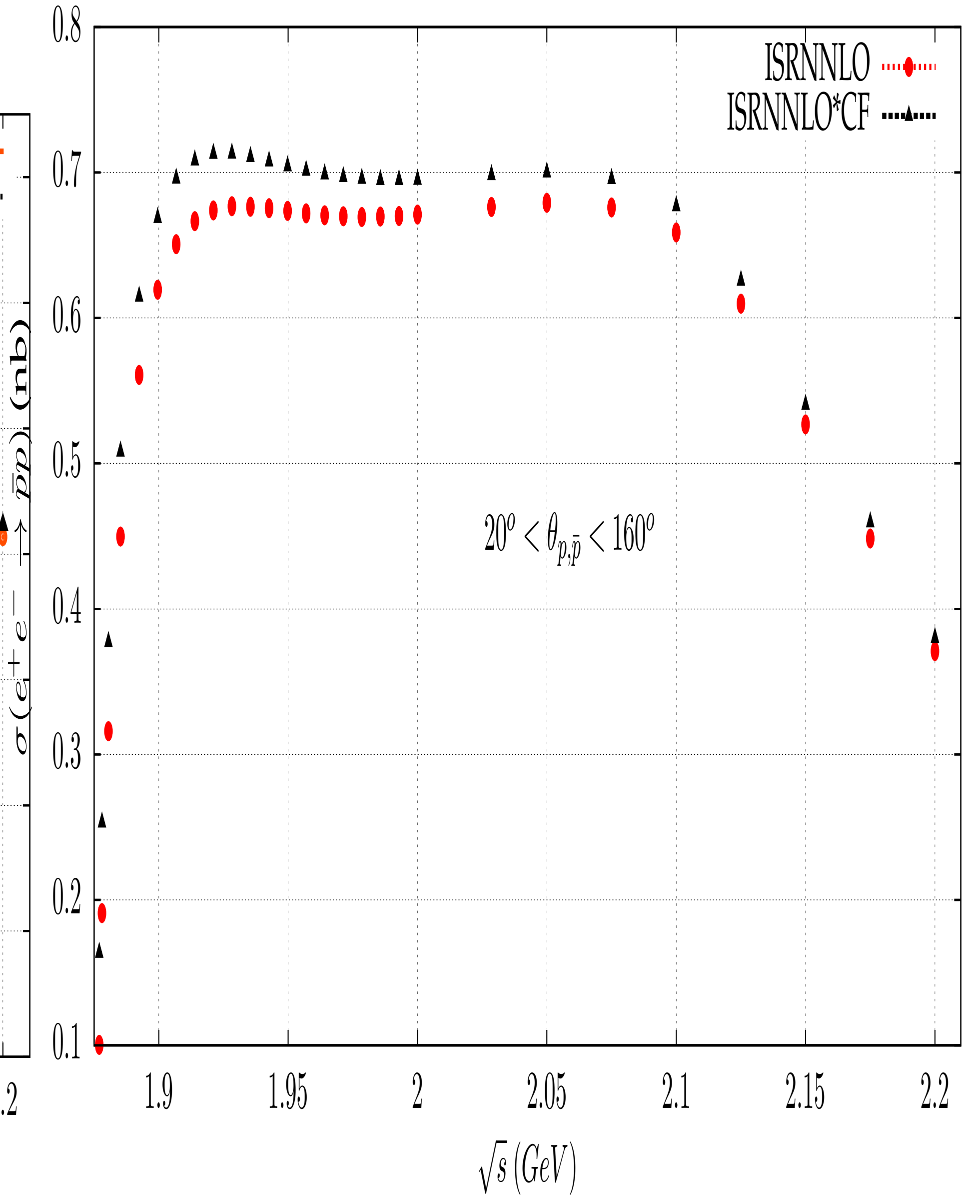
1407.7995v1 vs. 1407.7995v2





1407.7995v1 vs. 1407.7995v2

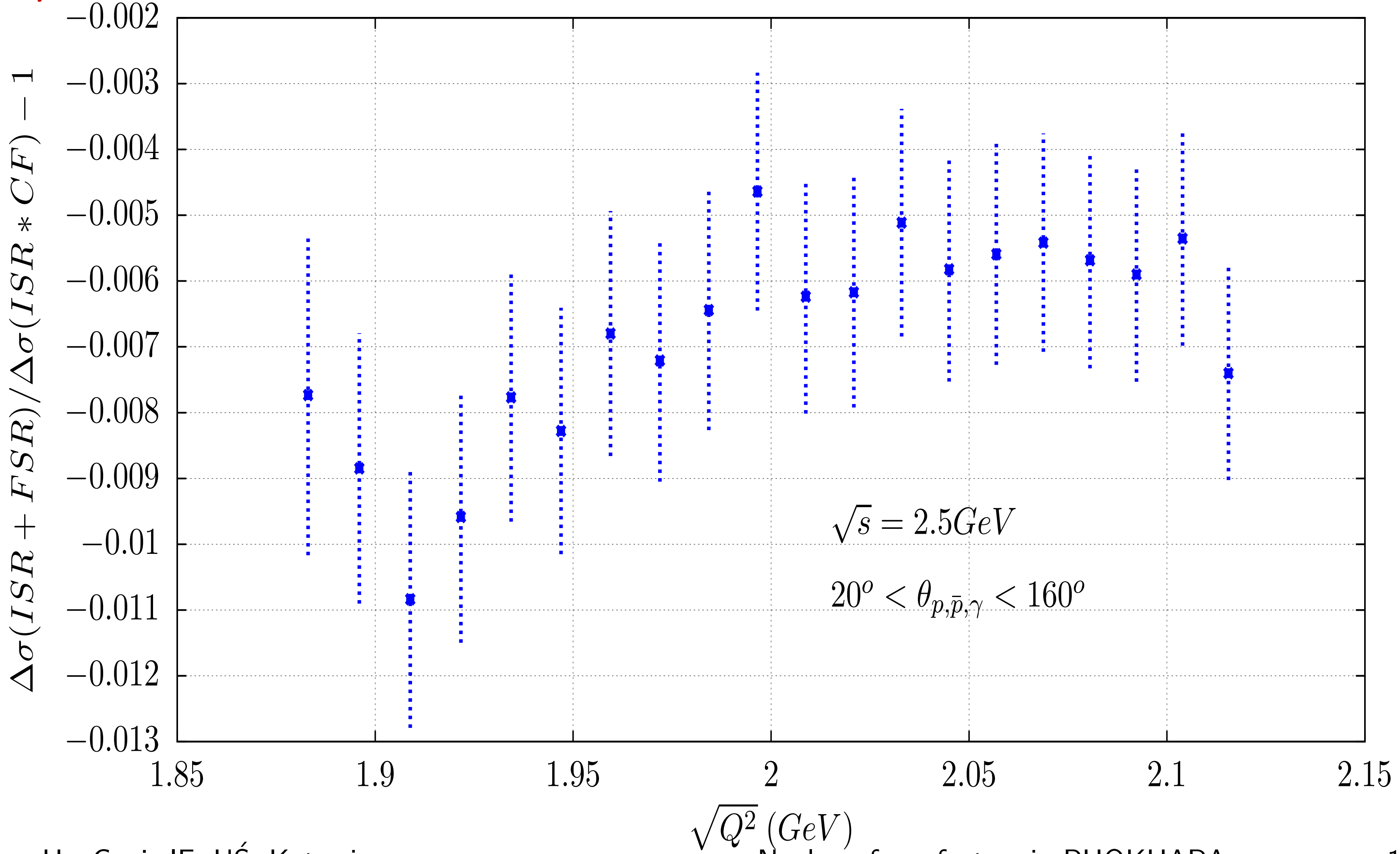




FSR modelling - few remarks

⇒ typical corrections - beyond CF are small

⇒ and not under control



FSR modelling - problems

$\Rightarrow$ 2 form factors for on shell particles

$\Rightarrow$ modelling of transition form factors necessary

$\Rightarrow$ it has to be addressed together with $ep \to ep$

Conclusions

for pragmatic reasons further FSR modelling postponed till $\cdots$