p-C CNI polarimetry revisited

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BNL

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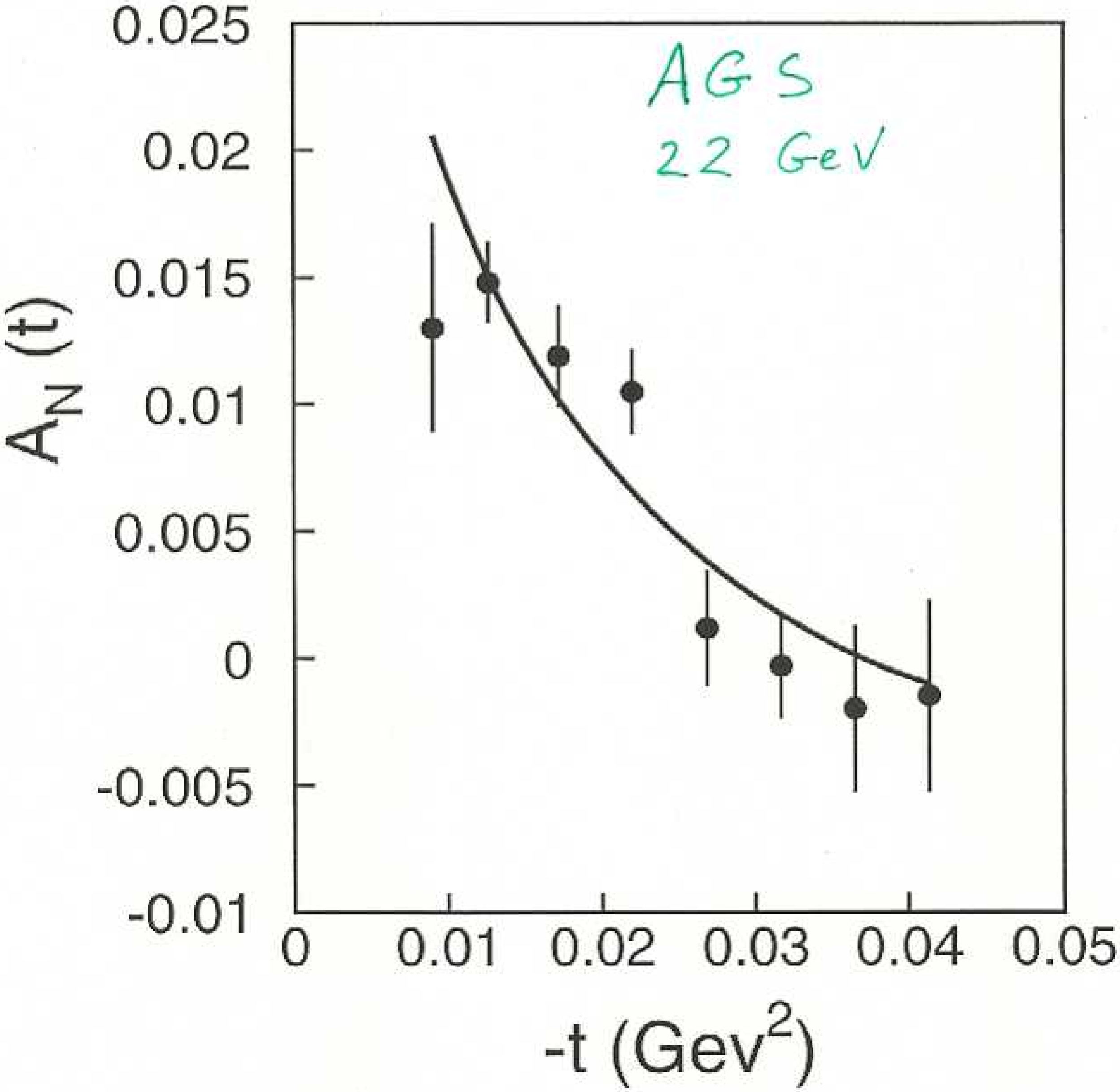


$Re\, r_5 = 0.084 \pm 0.042$

$Im\, r_5 = -0.156 \pm 0.170$

Comparison with hadronic data

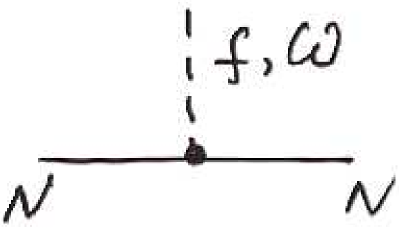
22 GeV is not a high enery. Where the observed r_5 originate from, $\mathbb{P}$omeron, Reggeons ?

The answer is crucial for predicting the higher energy behavior.

pN is known to have contributions from $\mathbb{P}$, f, ω, ρ, a_2

Since pN do not have poles in s-channel $f-\omega$ and $\rho-a_2$ must cancel in the Imaginary part, but add up in the Real part of the amplitude

is mostly spin-flip and small



is mostly non-flip and large

We know that from πN elastic and charge-exange.

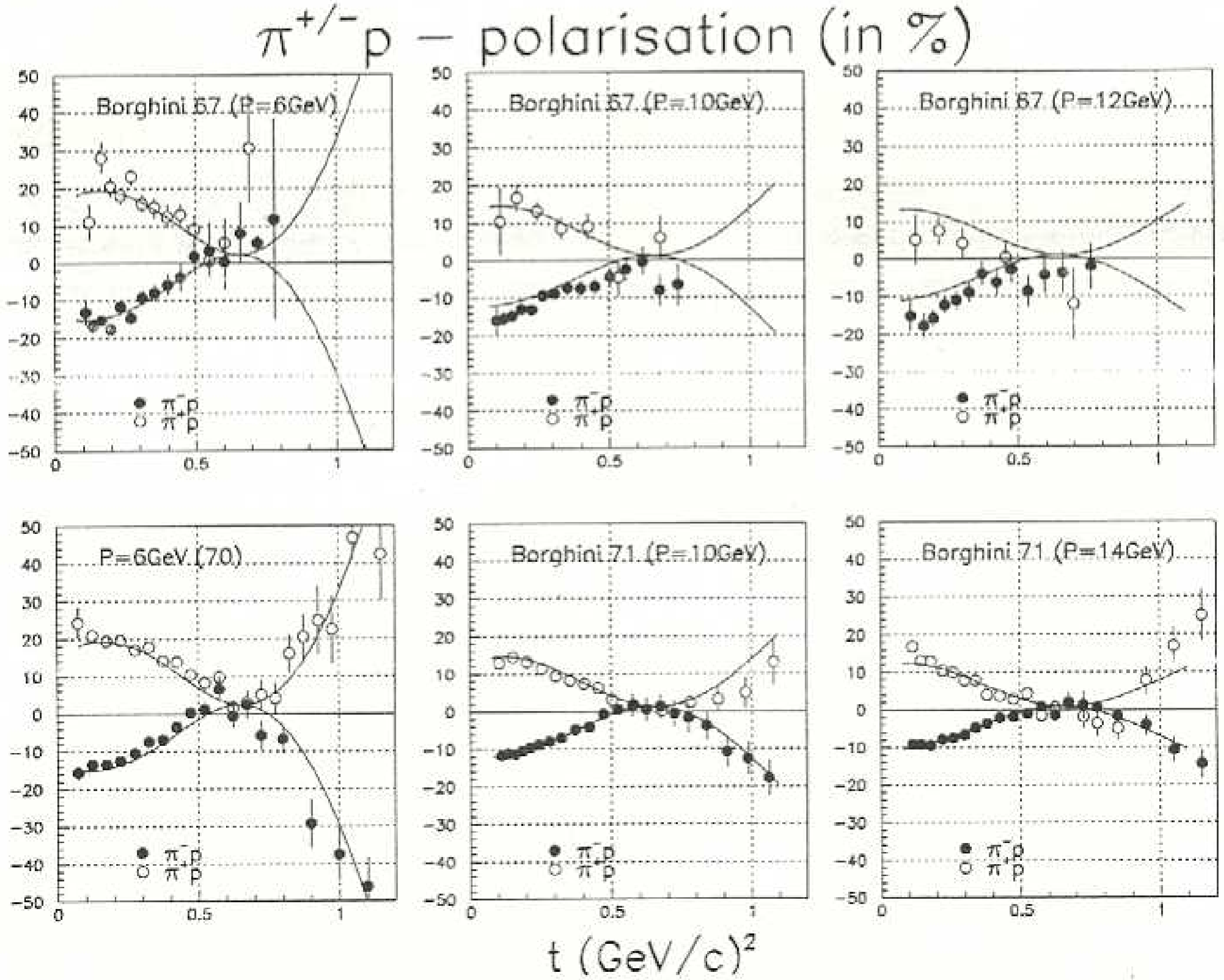
The symmetry for A_N in $\pi^{\pm} p$ elastic can be broken only by $I\!P$ and f, but it is rather precise.

★ One should expect a similar symmetry for A_N in pp and pn, but...

What do we know about the Pomeron spin-flip?

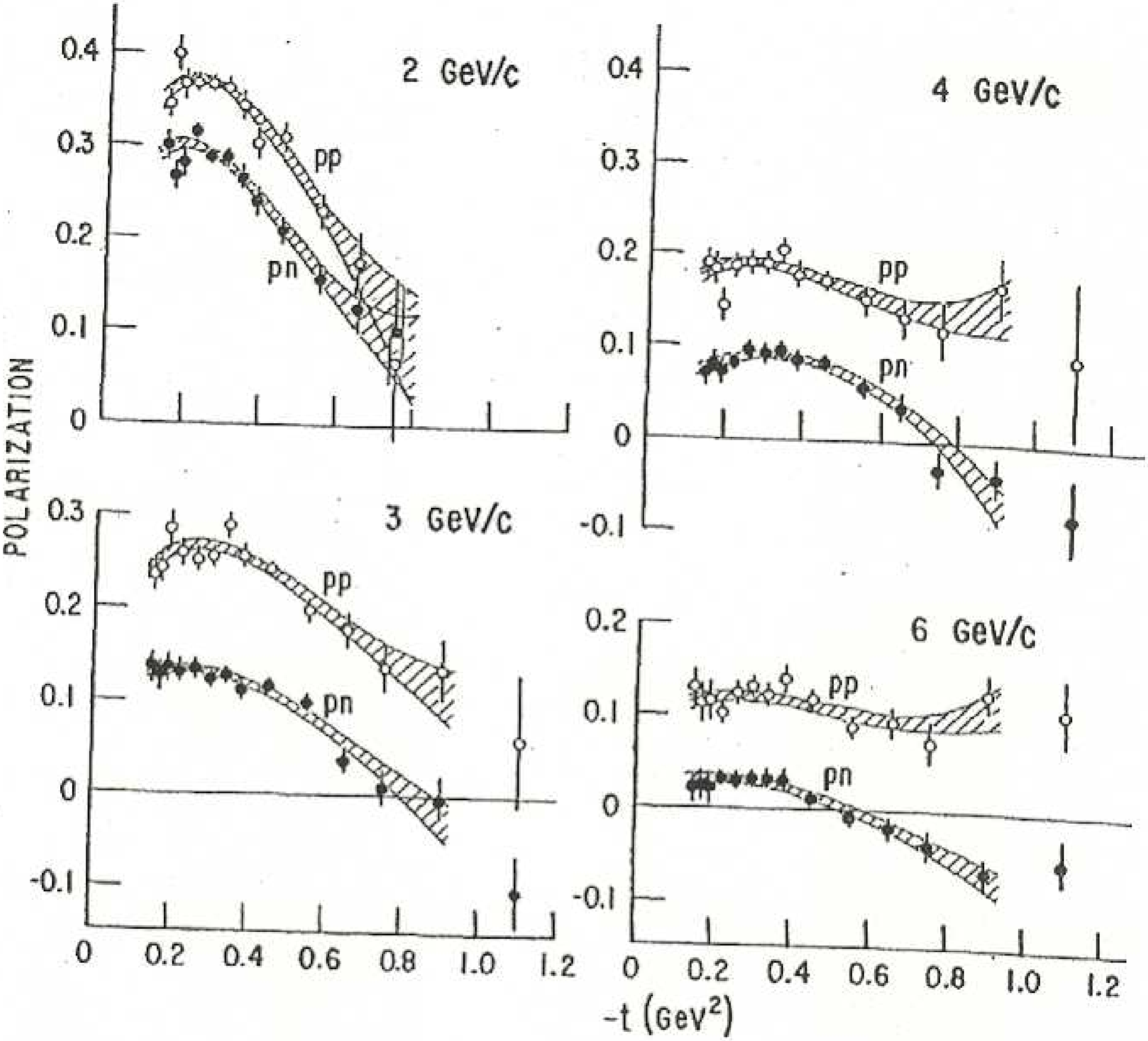
- $\pi^{\pm}p$ elastic scattering

$$A_N^{\pi p}(s,t) \propto \left(\frac{s}{s_0}\right)^{\alpha_\rho(t) - \alpha_{\mathbb{P}}(t)}$$

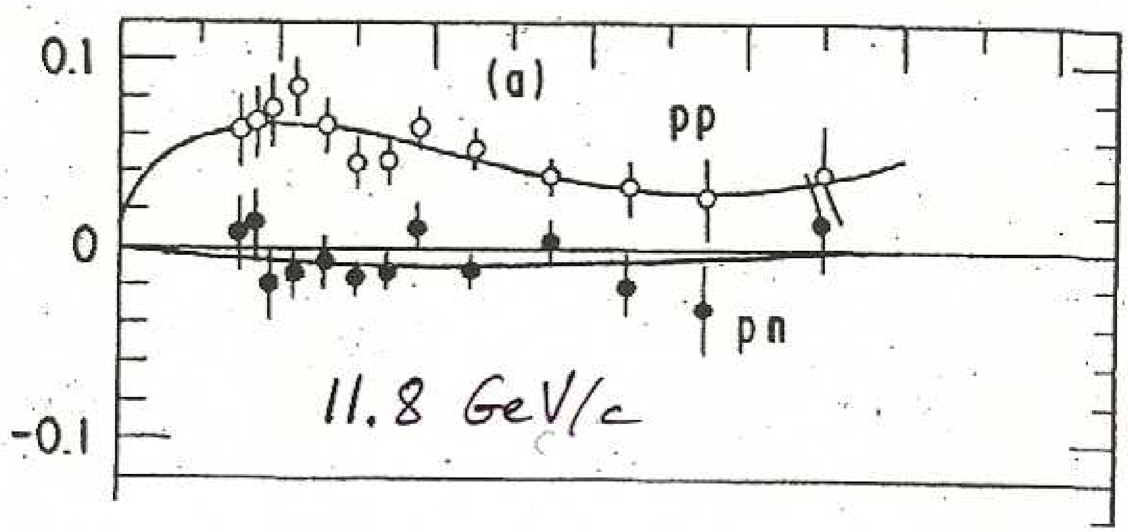


$$\begin{matrix}\Sigma_{\pi p}(s,t) \\ \Delta_{\pi p}(s,t)\end{matrix} = \delta_+(s,t)\, A_N^{\pi^+ p}(s,t) \pm \delta_-(s,t)\, A^{\pi^- p}(s,t)$$

Fit:



POLARIZATION
2 GeV/c
3 GeV/c
4 GeV/c
6 GeV/c
pp
pn
0.4
0.3
0.2
0.1
0
-0.1
0
0.2
0.4
0.6
0.8
1.0
1.2
-t (GeV²)



0.1
0
-0.1
(a)
pp
pn
11.8 GeV/c

Aparently, there is a large iso-scalar contribution to the spin-flip amplitude of NN which does not contribute to πN.

This is very important for pC where the iso-vector part is absent.

This might be a source of large iso-scalar spin-flip at 22 GeV.

S.L. Kramer et al.
PRD 17 (1978) 1709

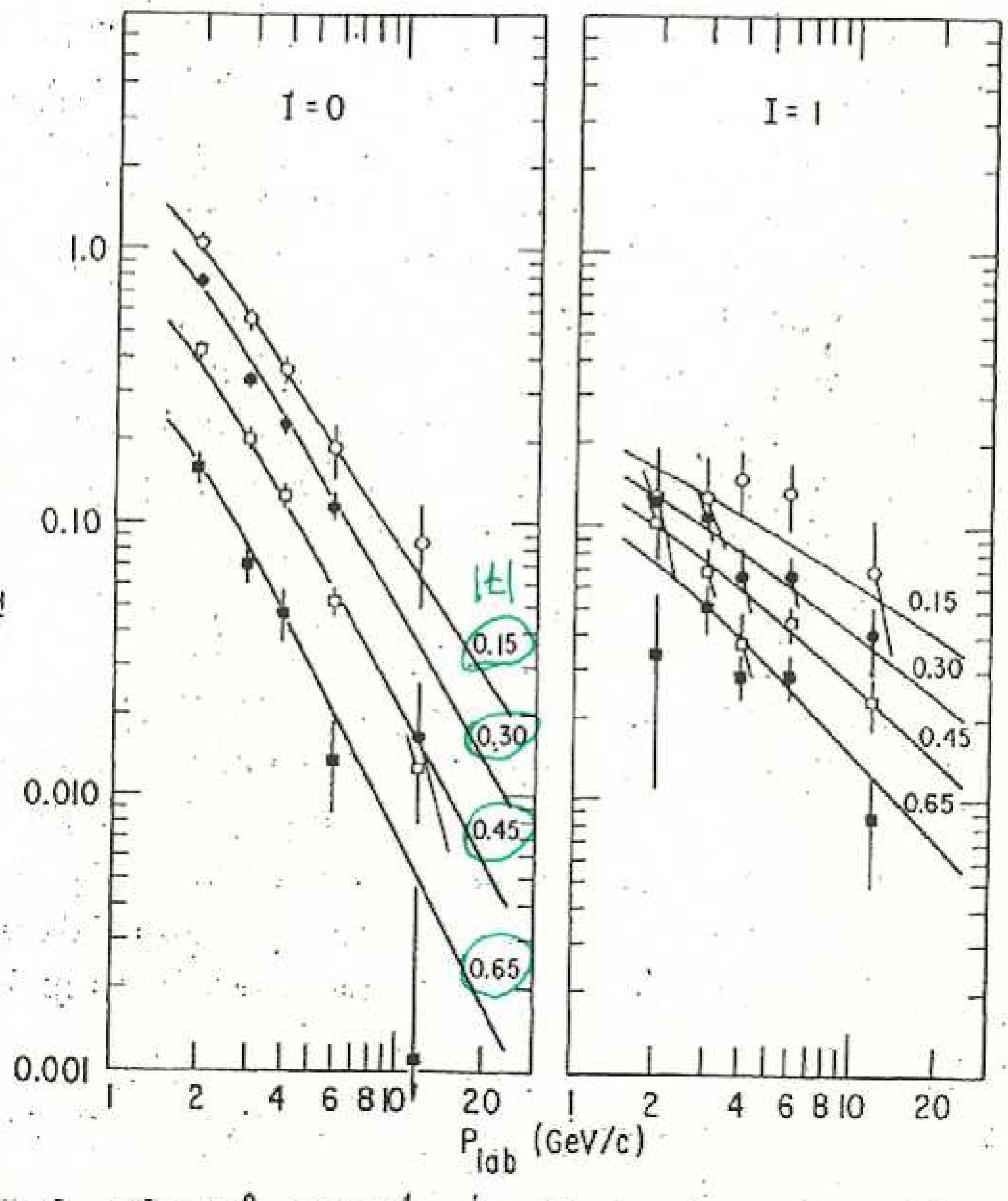


FIG. 2. The $N_{1\perp}^{0}$ and $N_{1\perp}^{1}$ amplitudes from Eqs. (6) and (7) as functions of $p_{\rm lab}$ for the t values (GeV^2) indicated. The curves are the results of fits based on Eq. (11) in the momentum range 3 to 11.8 GeV/c and $-t$ range 0.15 to 1.0 GeV^2; for $N_{1\perp}^{0}$ only the term corresponding to the low-lying σ trajectory was used (parameter C), while for $N_{1\perp}^{1}$ only the ρ-exchange term was used (parameter B).

$$N(s,t) \propto s^{\alpha_{eff}(t)-1}$$

$$\alpha_{eff}^{I=1}(t) = (0.69 \pm 0.17) + (0.95 \pm 0.44)\,t$$

$$\alpha_{eff}^{I=0}(t) = (-0.33 \pm 0.17) + (1.12 \pm 0.47)\,t$$

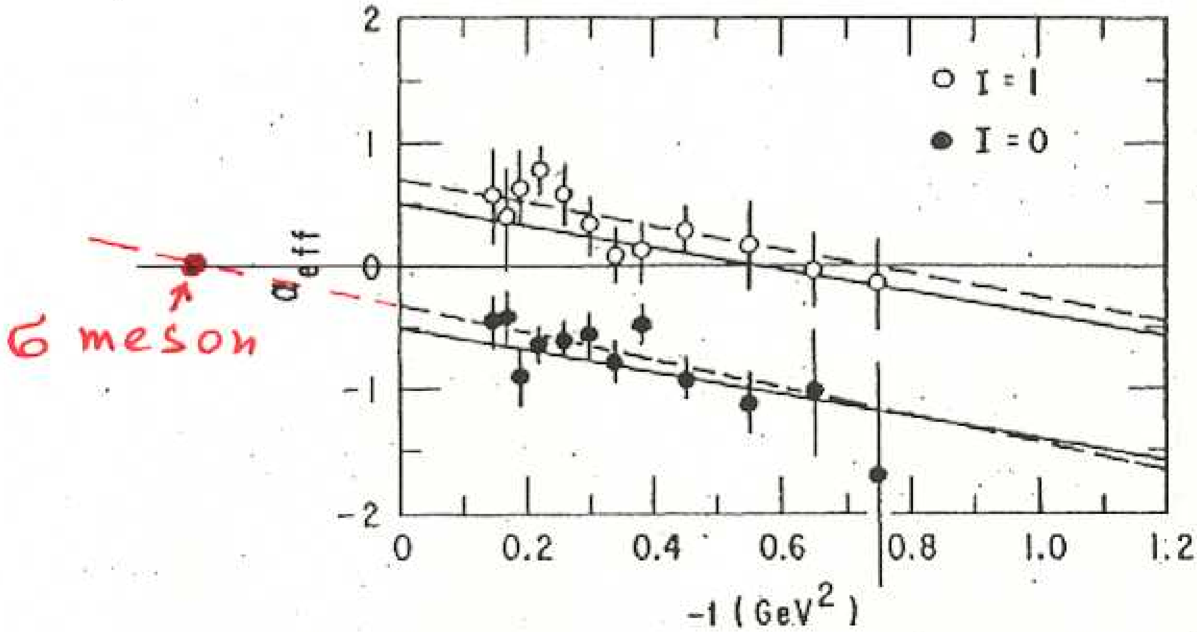


FIG. 3. The effective trajectories for N_{11}^0 and N_{11}^1 obtained from fits to Eq. (9). The solid lines represent the ρ trajectory, $\alpha = 0.5 + 0.9t$ from Ref. 21, and a low-lying trajectory displaced by one unit of α. The dashed lines are the result of the linear fits to $\alpha_{eff}(t)$ described in the text.

The first state on the Regge trajectory has mass $M_\sigma \sim 0.4$ GeV – σ meson

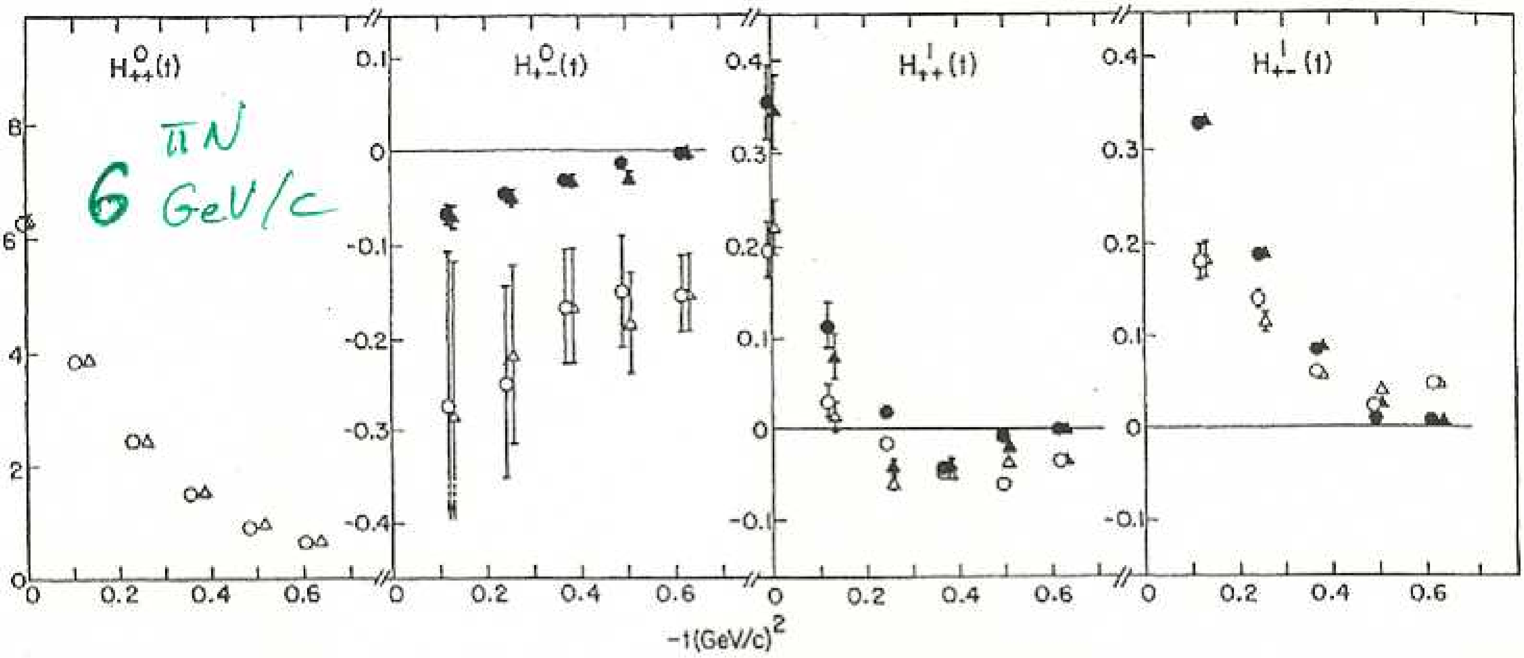
Extrapolating the Argonne data to 22 GeV we get

$$\mathrm{Re}\, r_5 (p_L = 22\,\mathrm{GeV}) \approx 0.02$$

This is confirmed by data from BNL (D.G. Crabb et al. NPB 121(1977) 231; B 201(1982) 365)

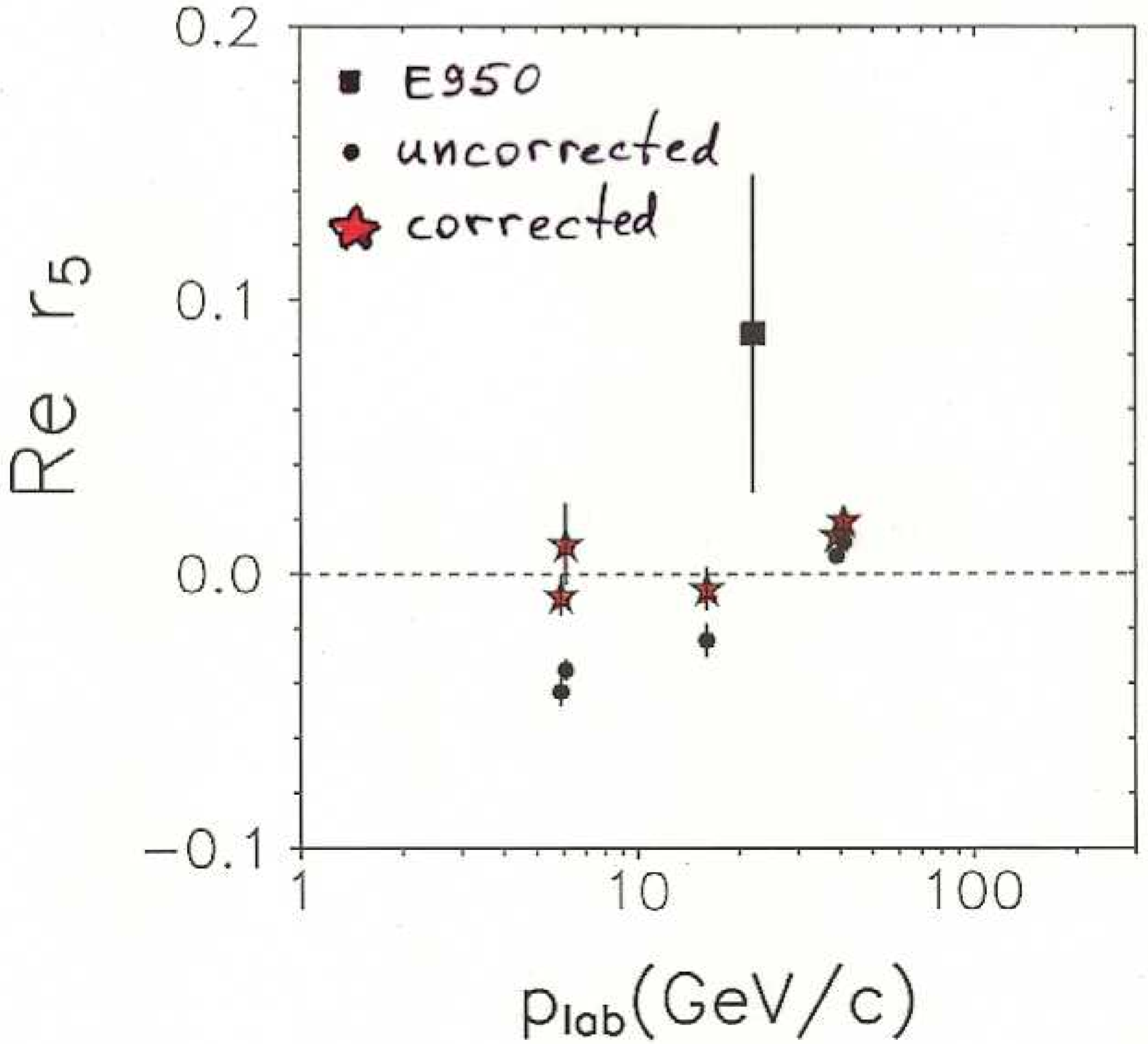
$$\mathrm{Re}\, r_5 (p_L = 24\,\mathrm{GeV}) = 0.016 \pm 0.01$$

This is much less than follows from the E950 data.

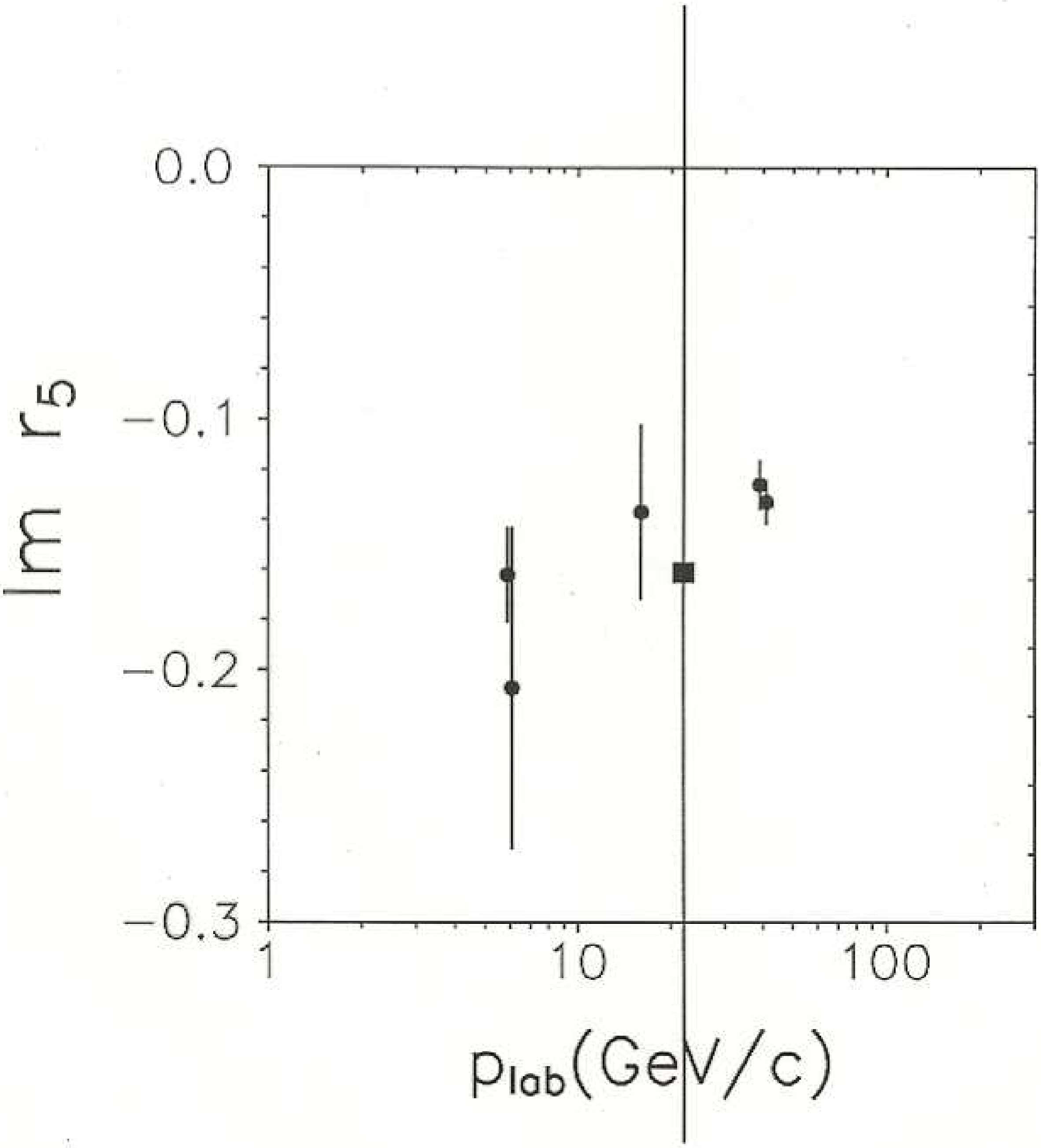


mplitudes at 6.0 GeV/c. The filled and hollow symbols represent real and imaginary
pectively. The triangles and circles are obtained by using σ^+ and σ^- data of Refs. 1
ints are at $-t = 0.0$, 0.125, 0.250, 0.375, 0.500, and 0.625 (GeV/c)^2.

More evidence for a small iso-scalar spin-flip comes from π-N data if one relies on Regge factorization.

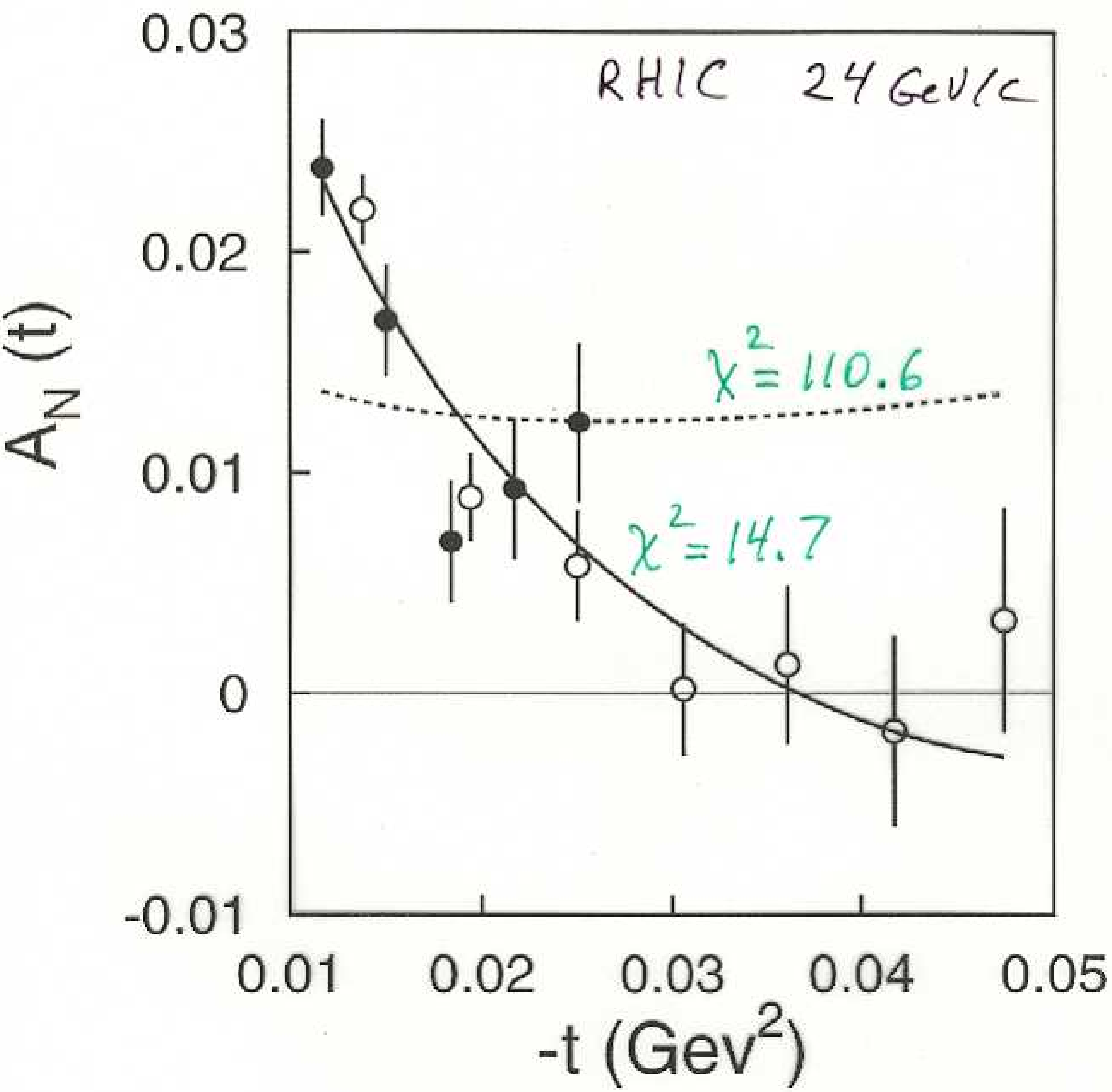


0.2
0.1
0.0
−0.1
1
10
100
E950
uncorrected
corrected
Re r5
plab(GeV/c)



0.0
−0.1
−0.2
−0.3
Im r5
1
10
100
plab(GeV/c)

Do the new RHIC data support a small $\mathrm{Re}\, r_5$? — No!



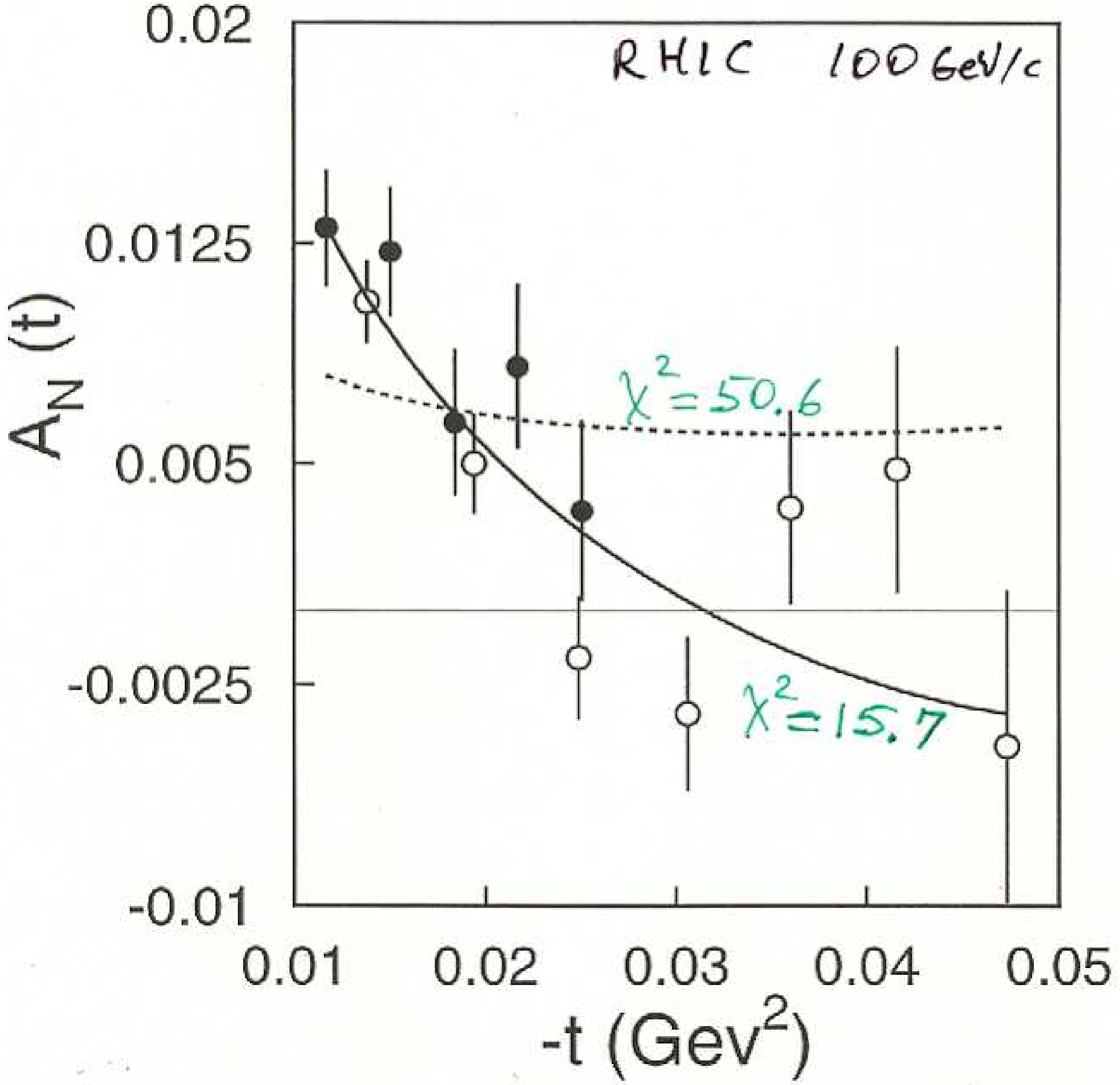
— $\mathrm{Re}\, r_5 = 0.084$ $\quad N = 1.447 \pm 0.073$

$\mathrm{Im}\, r_5 = -0.156$

The data must be divided by N

--- $\mathrm{Re}\, r_5 = 0$ $\quad N = 0.435 \pm 0.0254$

$\mathrm{Im}\, r_5 = -0.12$



—— Im r_5 = −0.156

Re r_5 = 0.058 ± 0.004   **N = 0.83 ± 0.098**

- - - - Re r_5 = 0

Im r_5 = −0.12   N = 0.28 ± 0.027

Conclusions

- New RHIC data at 24 and 100 GeV well agree with the results of E950
- Data for A_N at 24 GeV should be reduced by factor $1/N = 0.69$
- Data for A_N at 100 GeV should be increased by factor $1/N = 1.2$
- Data for NN and πN scattering demand a much smaller Re r_5 and are inconsistent with the results of pC CNI.
- This controvercy must be settled in order to make it sure that we understand what we are doing