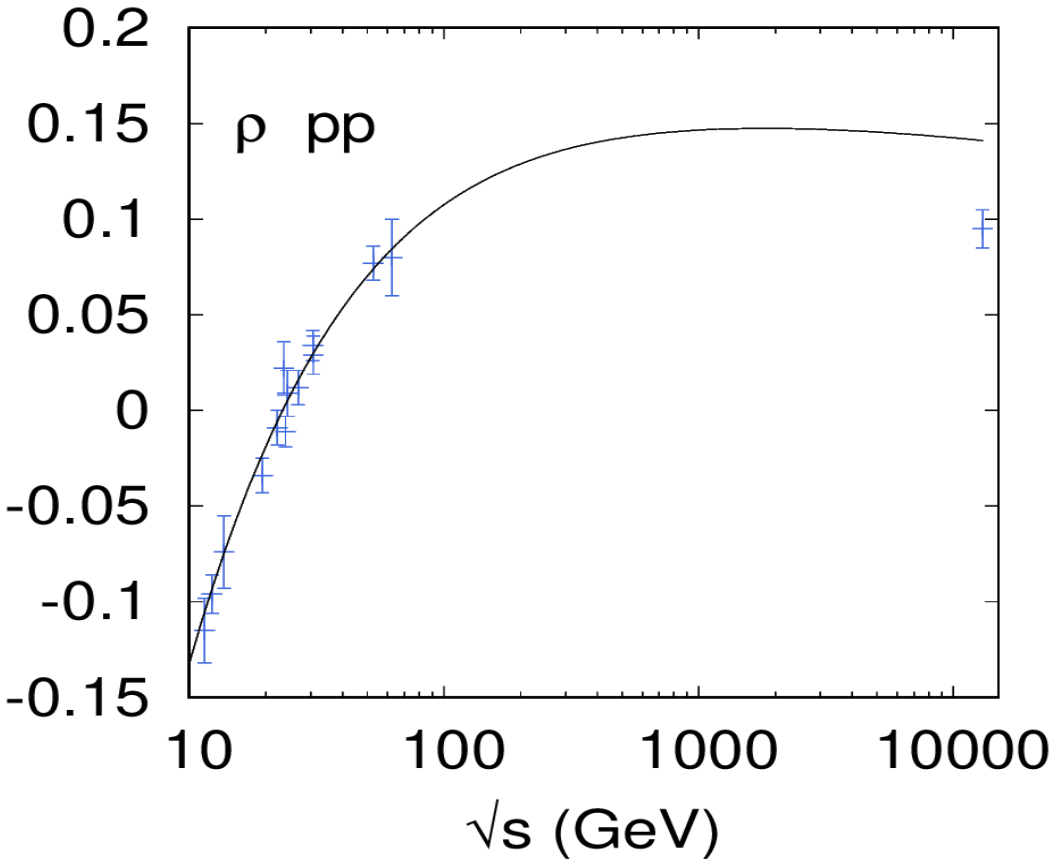
What is the value of rho at the LHC?



Small t elastic scattering and the ρ parameter

A. Donnachie (Manchester U.), P.V. Landshoff (Cambridge U.) (Apr 25, 2019)

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Lack of evidence for an odderon at small t

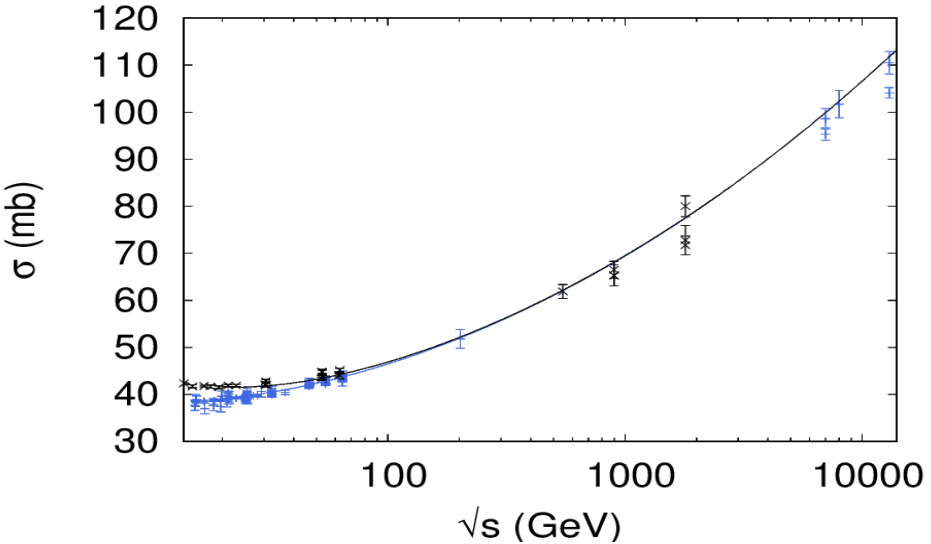
A. Donnachie (Manchester U.), P.V. Landshoff (Cambridge U.) (Mar 1, 2022)

Published in: *Phys.Lett.B* 831 (2022) 137199 • e-Print: 2203.00290 [hep-ph]

Regge theory (1959)

Sums the exchanges ρ, ω, f_2, a_2

They make the total cross section fall with increasing energy, so introduce “pomeron” exchange.



Odderon?

Pomeron exchange is probably the exchange of C=+ glueballs

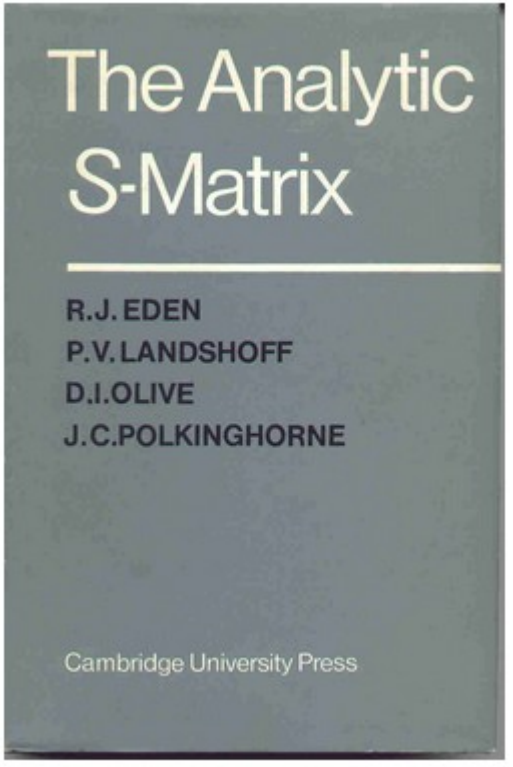
What about C=-glueballs? This is called “odderon” excange.

Has TOTEM discovered this?

We cannot calculate the contributions from the various exchanges – we have to make models.

The models must obey some known fundamental principles.

One is that the phase of the amplitude at each value of *t* is related to its energy variation at that *t.*

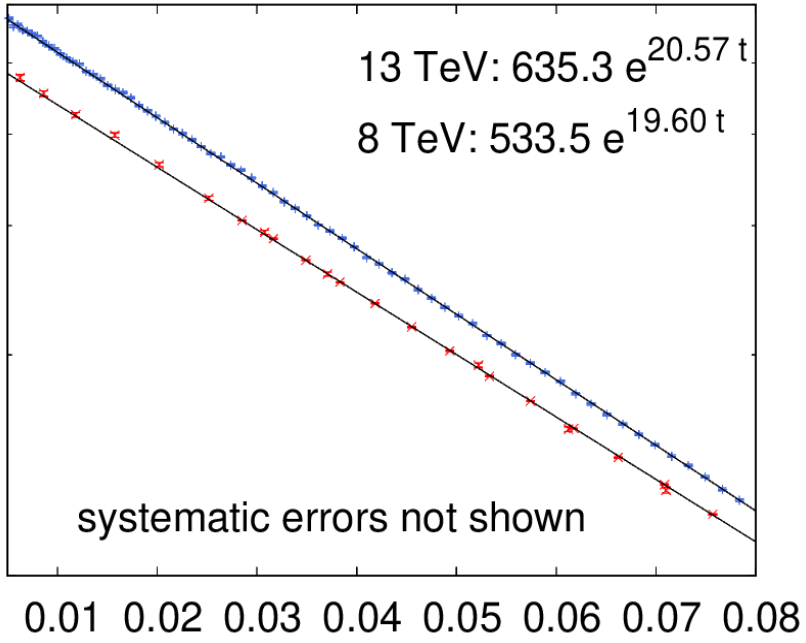


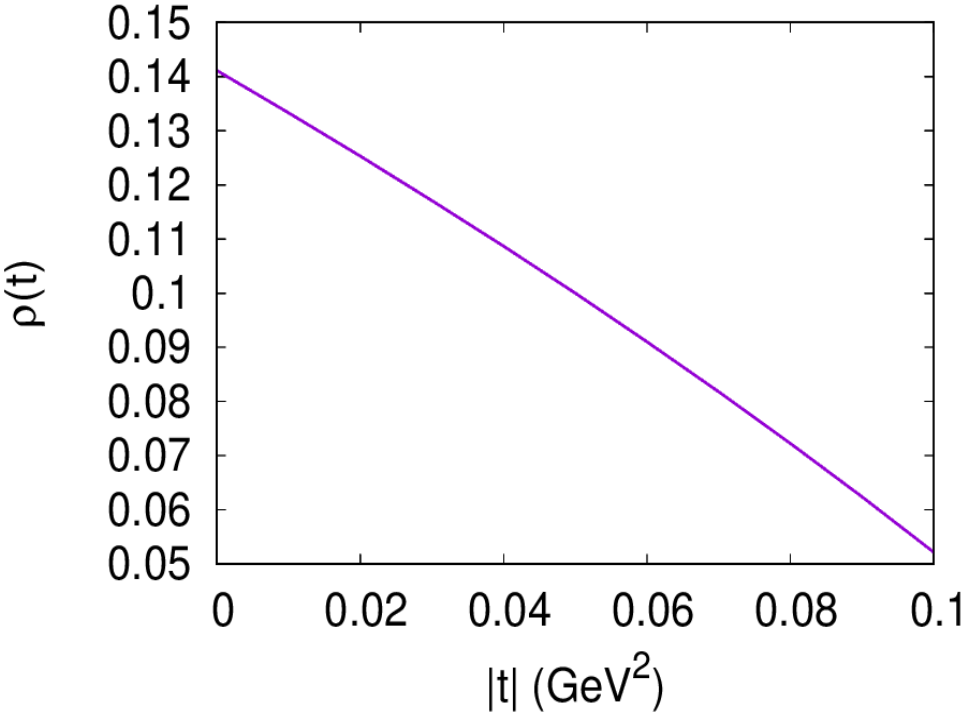
3 worries about the TOTEM analysis

If we repeat the TOTEM analysis with our model we agree with their result for ρ

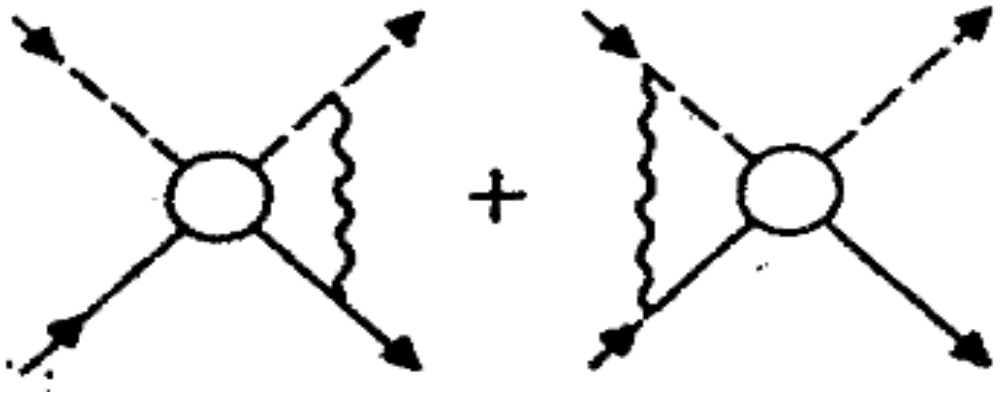
But this last point suggests it is unsafe to extract it from data by looking at just one energy. If we use the 13 and 8 TeV data together we get 0.14

(Re *A*) / (Im *A*) varies with *t*





West and Yennie (1968)



They claim that these diagrams give the Coulomb exchange term

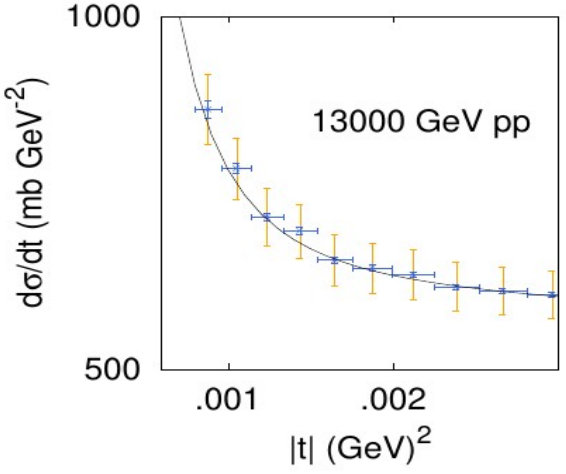
$$8\pi\alpha_{\rm EM}G(t)/t$$

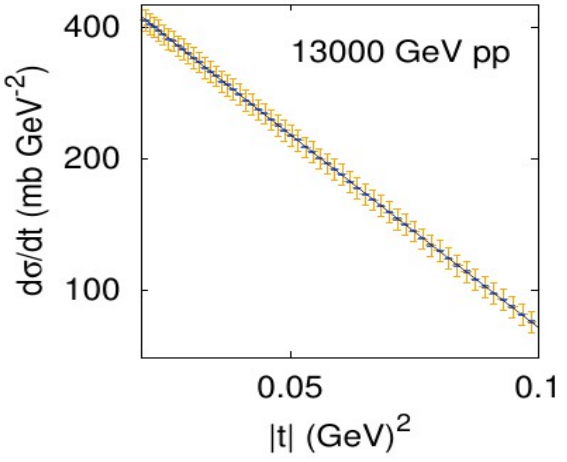
a significant complex phase. BUT these diagrams are not singular at *t*=0.

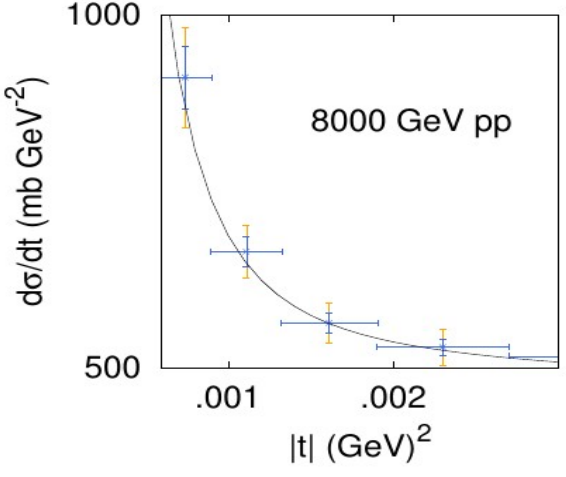
Our fit

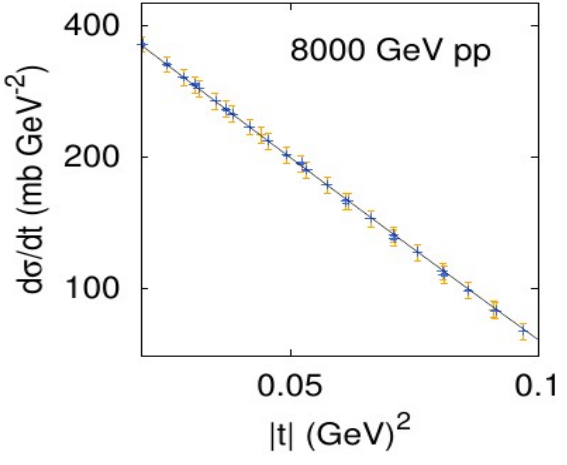
All total and differential proton-proton and proton-antiproton cross section data for energies between 13.77 and 13000 TeV.

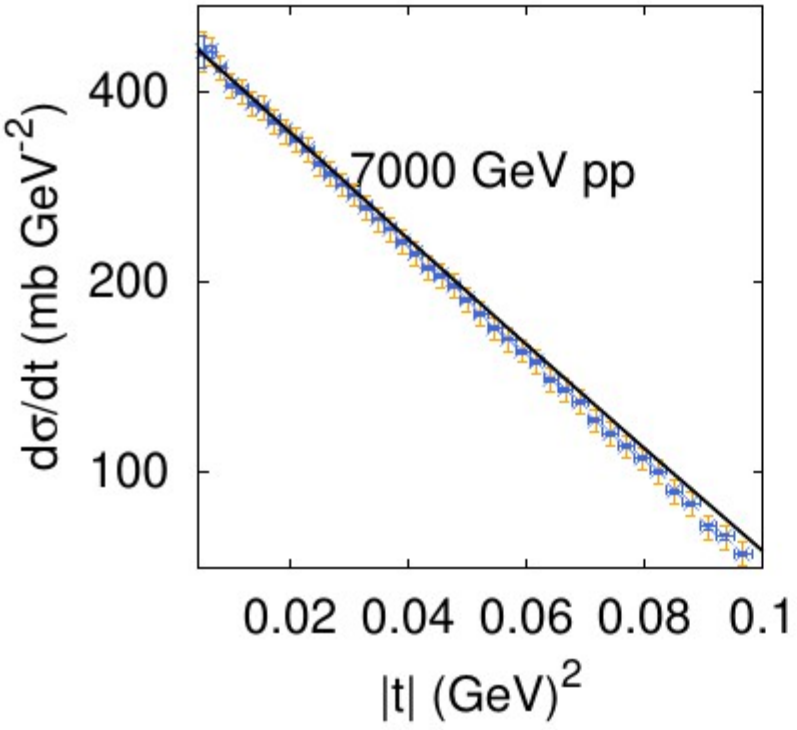
8 free parameters.

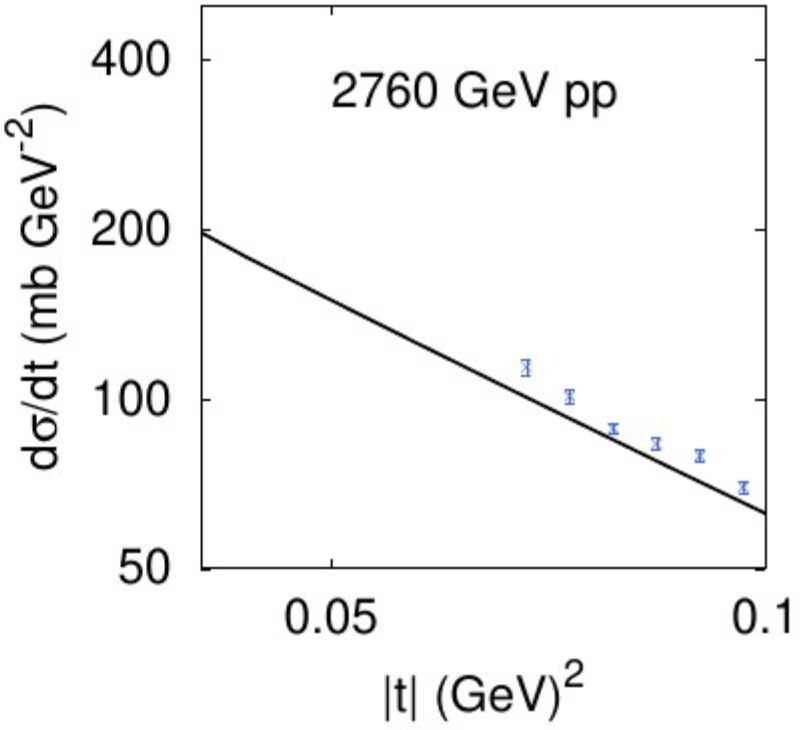

1000
500
dσ/dt (mb GeV-2)
13000 GeV pp
.001
.002
|t| (GeV)2

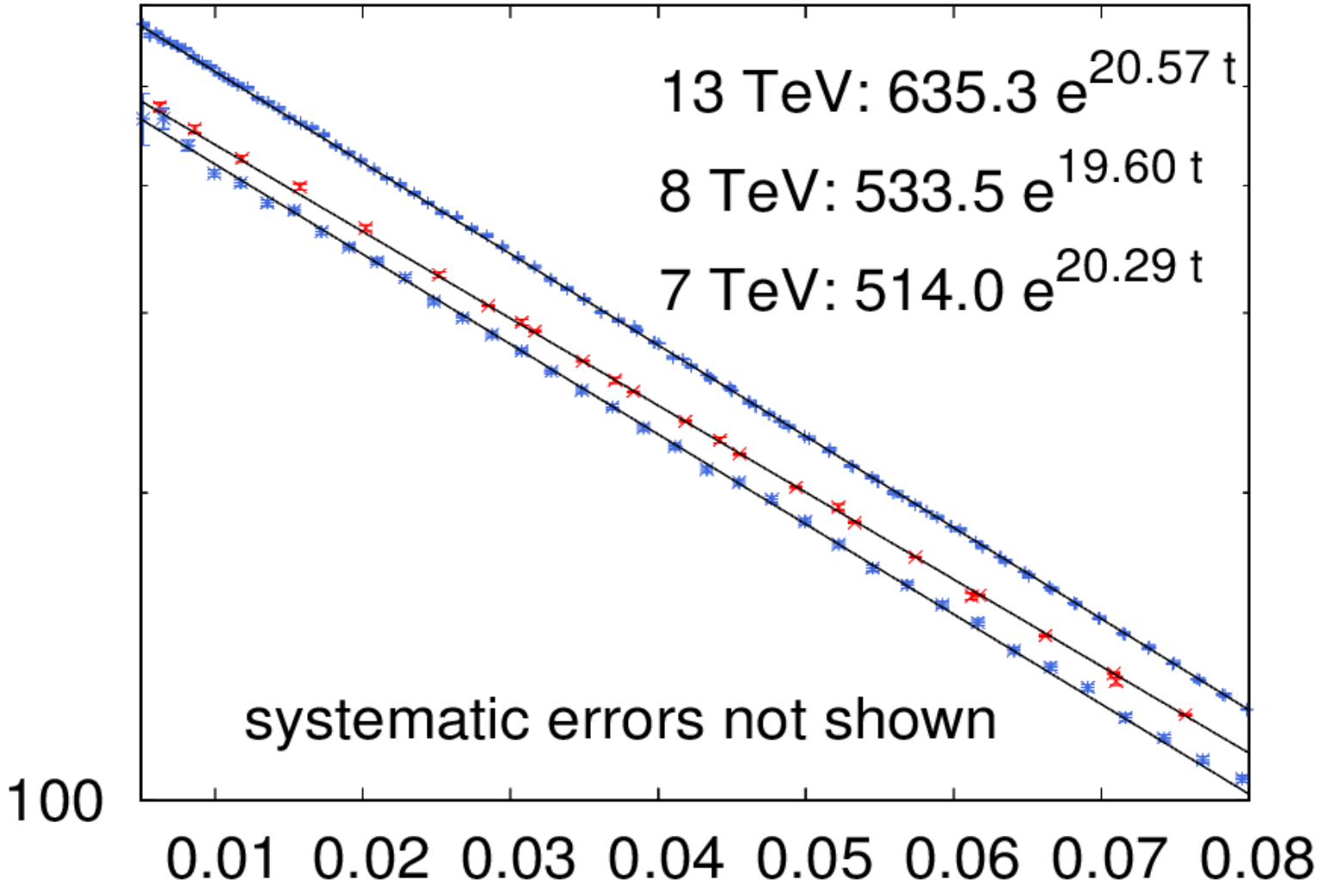

400
200
100
dσ/dt (mb GeV-2)
13000 GeV pp
0.05
0.1
|t| (GeV)2

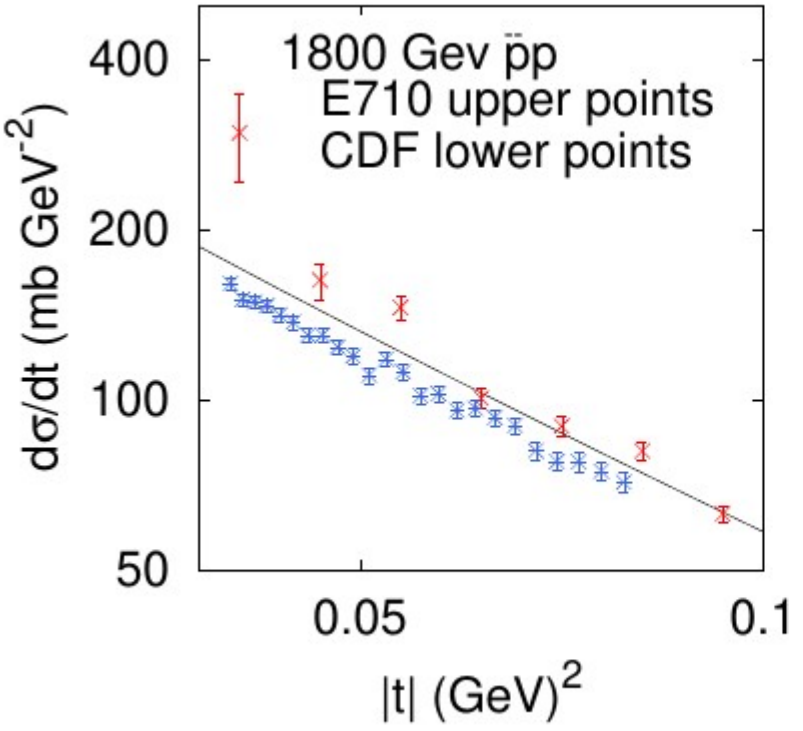

1000
500
dσ/dt (mb GeV-2)
8000 GeV pp
.001
.002
|t| (GeV)2

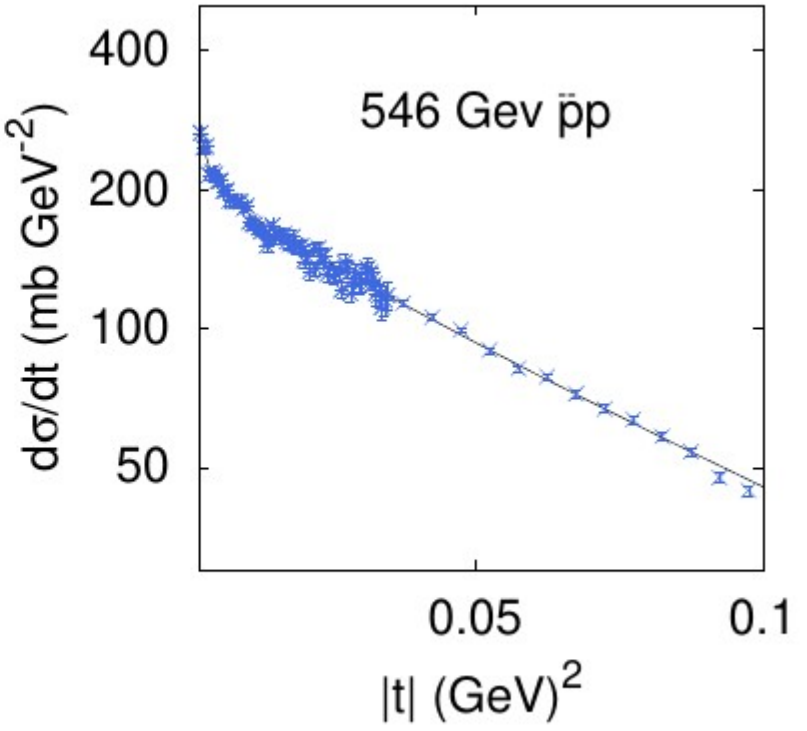

400
200
100
dσ/dt (mb GeV-2)
8000 GeV pp
0.05
0.1
|t| (GeV)2

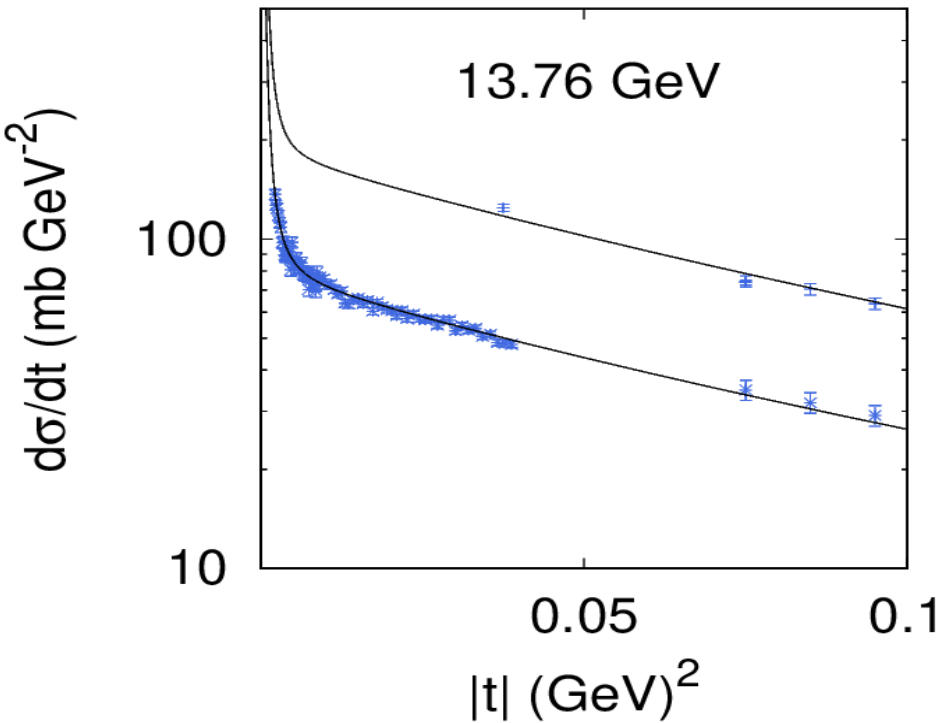

7000 GeV pp
dσ/dt (mb GeV^{-2})
400
200
100
0.02
0.04
0.06
0.08
0.1
|t| (GeV)^2

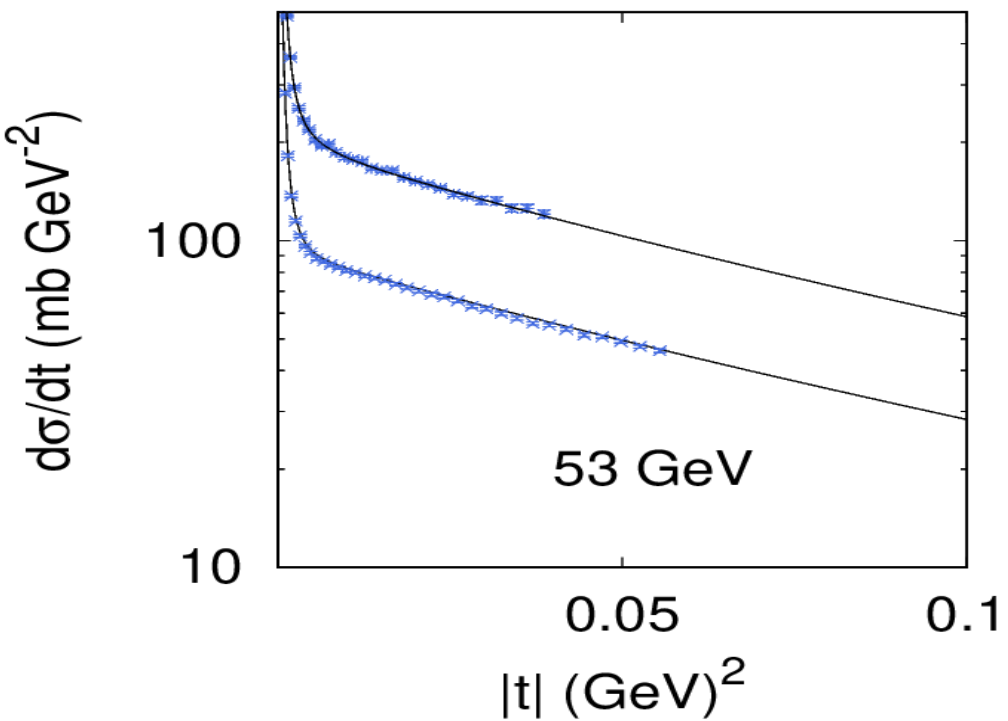

2760 GeV pp
dσ/dt (mb GeV^{-2})
400
200
100
50
0.05
0.1
|t| (GeV)^2


13 TeV: 635.3 e^20.57 t
8 TeV: 533.5 e^19.60 t
7 TeV: 514.0 e^20.29 t
systematic errors not shown
100
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08

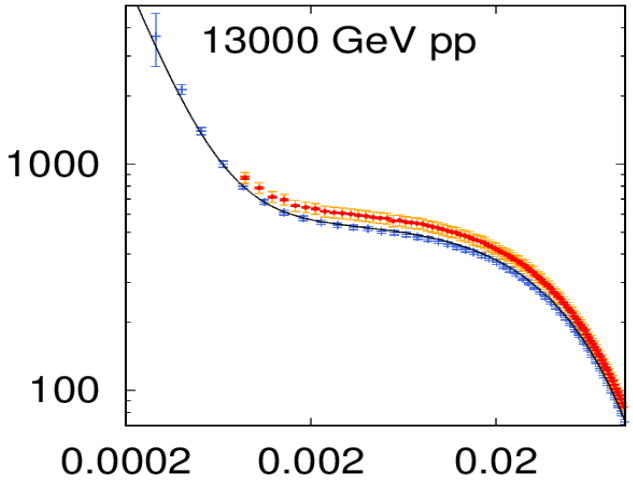

1800 Gev p̄p
E710 upper points
CDF lower points
400
200
100
50
0.05
0.1
dσ/dt (mb GeV-2)
|t| (GeV)2

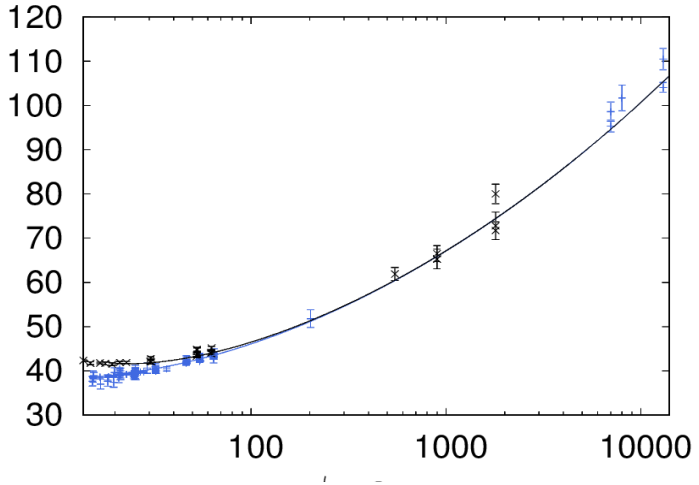

546 Gev p̄p
400
200
100
50
0.05
0.1
dσ/dt (mb GeV-2)
|t| (GeV)2

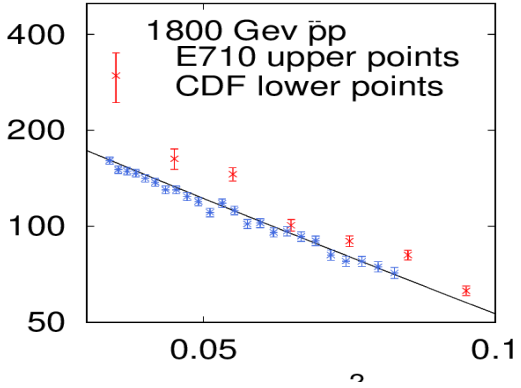

13.76 GeV
100
10
0.05
0.1
dσ/dt (mb GeV-2)
|t| (GeV)2

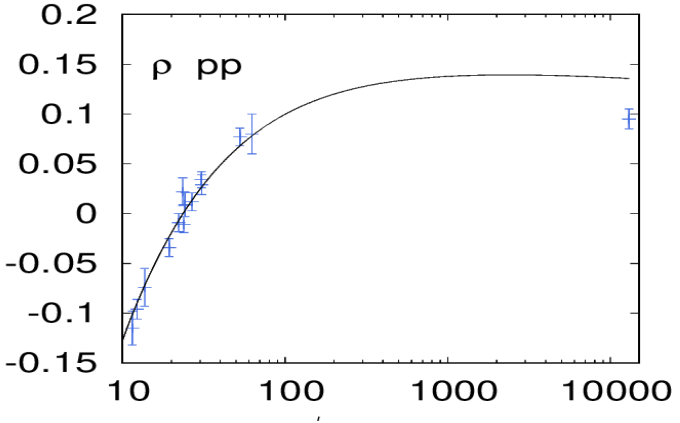

53 GeV
100
10
0.05
0.1
dσ/dt (mb GeV-2)
|t| (GeV)2

What happens if I use ATLAS 13 TeV data instead of TOTEM?









Conclusion

3 models give ρ between 0.135 and 0.15 at 13 TeV

Using West-Yennie makes little difference – ρ is determined mainly by the data beyond the Coulomb region .

It is possible that other models that obey the basic principles can give a significantly different answer, but unlikely.

So the evidence for an odderon at t=0 is weak.