Verification and CHIPS improvement of elastic scattering in Geant4.

Mikhail Kosov, G4 Physics Validation

Sept 20, 2006

1. **Introduction.**
2. **Verification and CHIPS upgrade of pA elastic scattering.**
3. **Method of global (p,A) parameterization.**

Introduction

1. *More than 400 papers are analyzed.*
2. *400 pictures (combined by 4) are presented.*
3. *More than 3000 data sets are combined in the 400 pictures.*
4. *Universal formulas for light and heavy nuclei are found.*
5. *All data are parameterized with all free parameters.*
6. *Par(p,A) parameterization search is started.*
7. *Nuclei: d,* ^3He, ^4He, ^6Li, ^7Li, *Be, C, Al, Cu, Sn, Pb.*
8. 10^6 *events are simulated by G4LElastic for each of 400 nucleus/energy (green).*
9. $2 \cdot 10^6$ *events are simulated by G4HadronElastic (8.1, blue).*

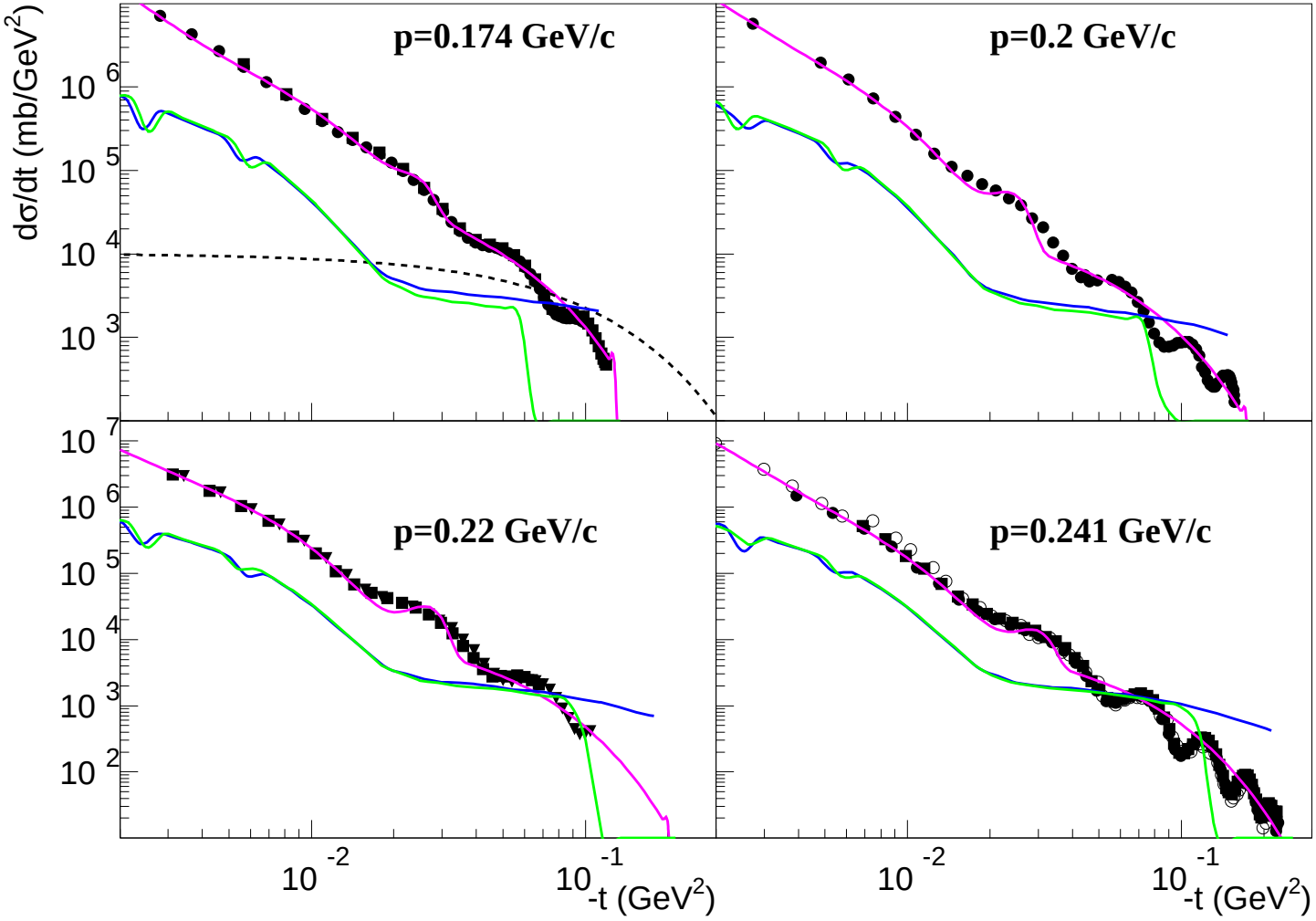
Approximation of pA elastic scattering for A>6

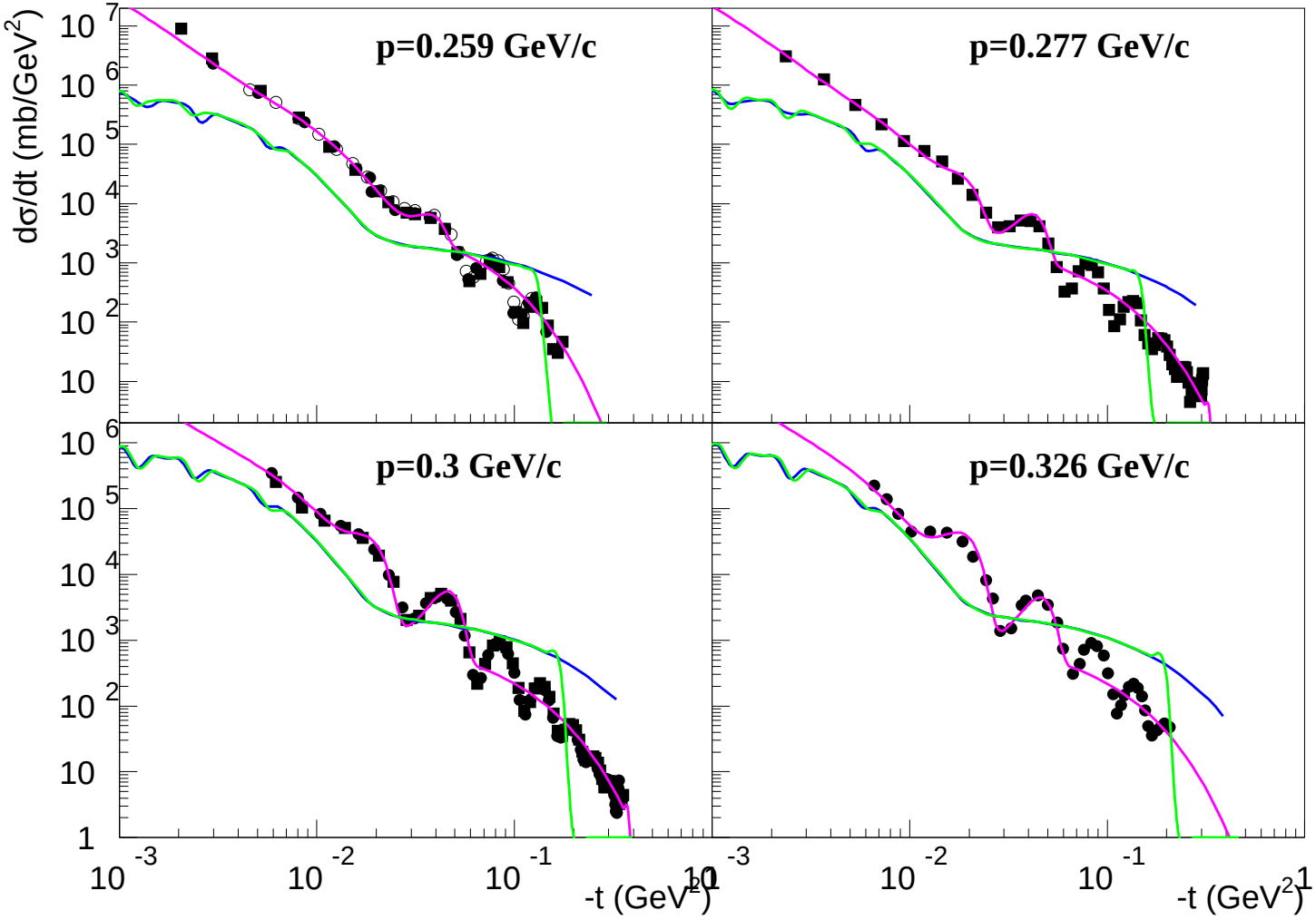
$$\frac{d\sigma}{dt} = A_1|t|^{-1/2}e^{-B_1|t|^{1/2}} + A_2(B_2 - 2C_2t)e^{t(B_2-C_2t)} +$$

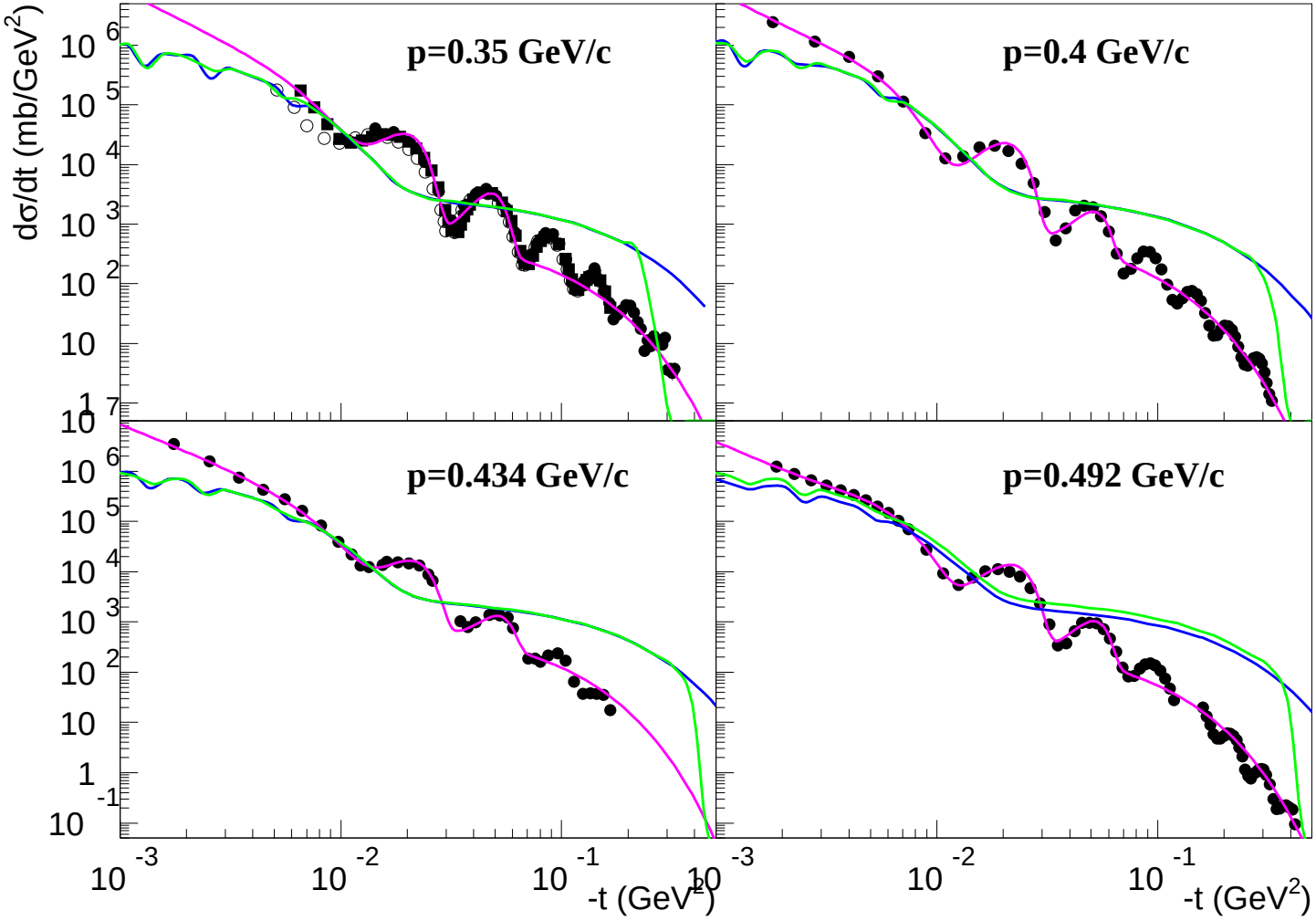
$$+A_3|t|^4e^{-B_3|t|^5} + A_4|t|^6e^{-B_4|t|^7} + A_5e^{B_5t}$$

1. Electromagnetic scattering.
2. The main maximum of diffraction (a diffraction cone).
3. The second maximum of diffraction.
4. The third maximum of diffraction.
5. An effective cone for all higher maxima.

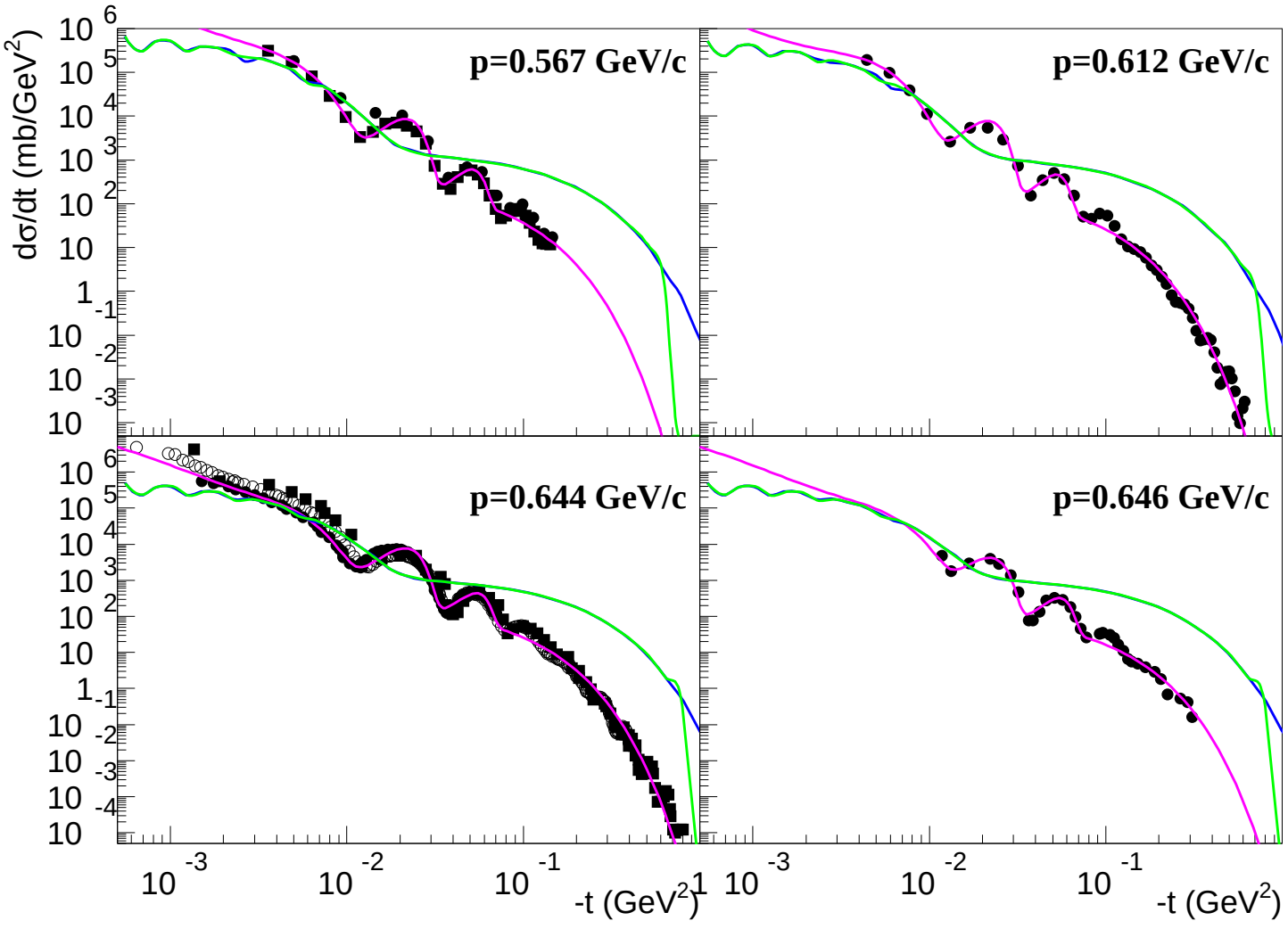
For high energies different Glauber models are used.

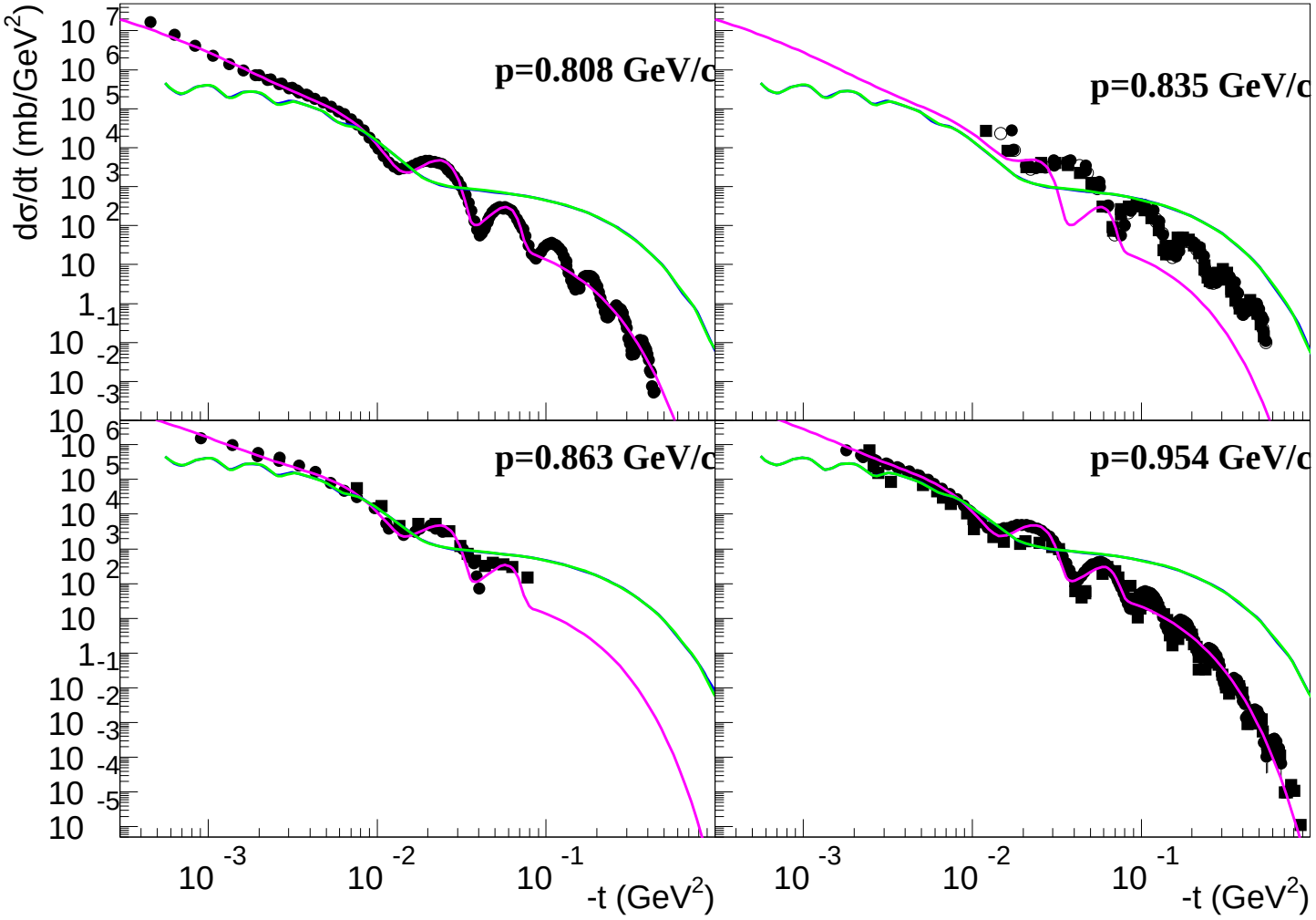

p=0.174 GeV/c
p=0.2 GeV/c
p=0.22 GeV/c
p=0.241 GeV/c
dσ/dt (mb/GeV²)
-t (GeV²)
-t (GeV²)


p=0.259 GeV/c
p=0.277 GeV/c
p=0.3 GeV/c
p=0.326 GeV/c
dσ/dt (mb/GeV²)
-t (GeV²)
-t (GeV²)

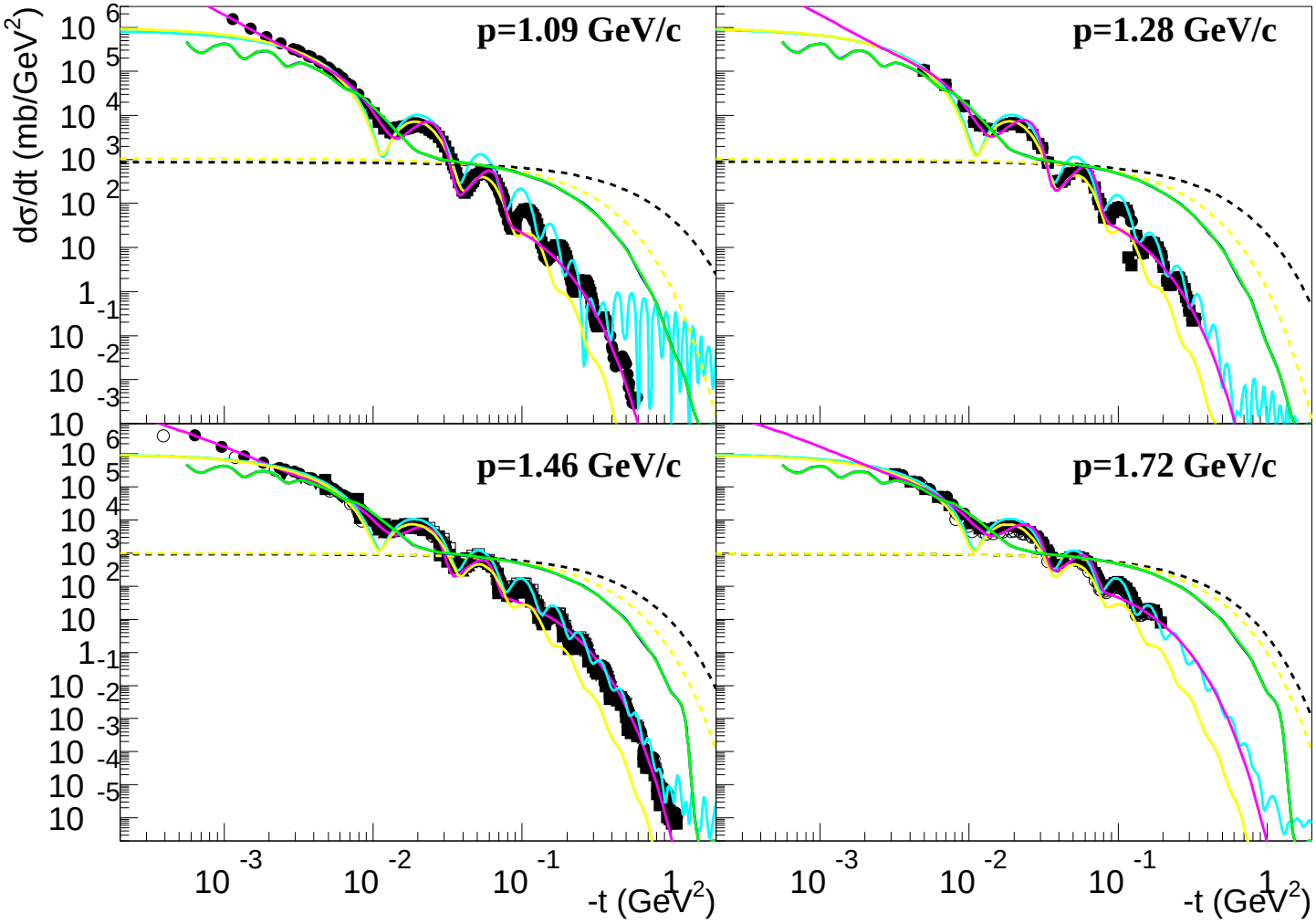

p=0.35 GeV/c
p=0.4 GeV/c
p=0.434 GeV/c
p=0.492 GeV/c
dσ/dt (mb/GeV²)
-t (GeV²)
-t (GeV²)

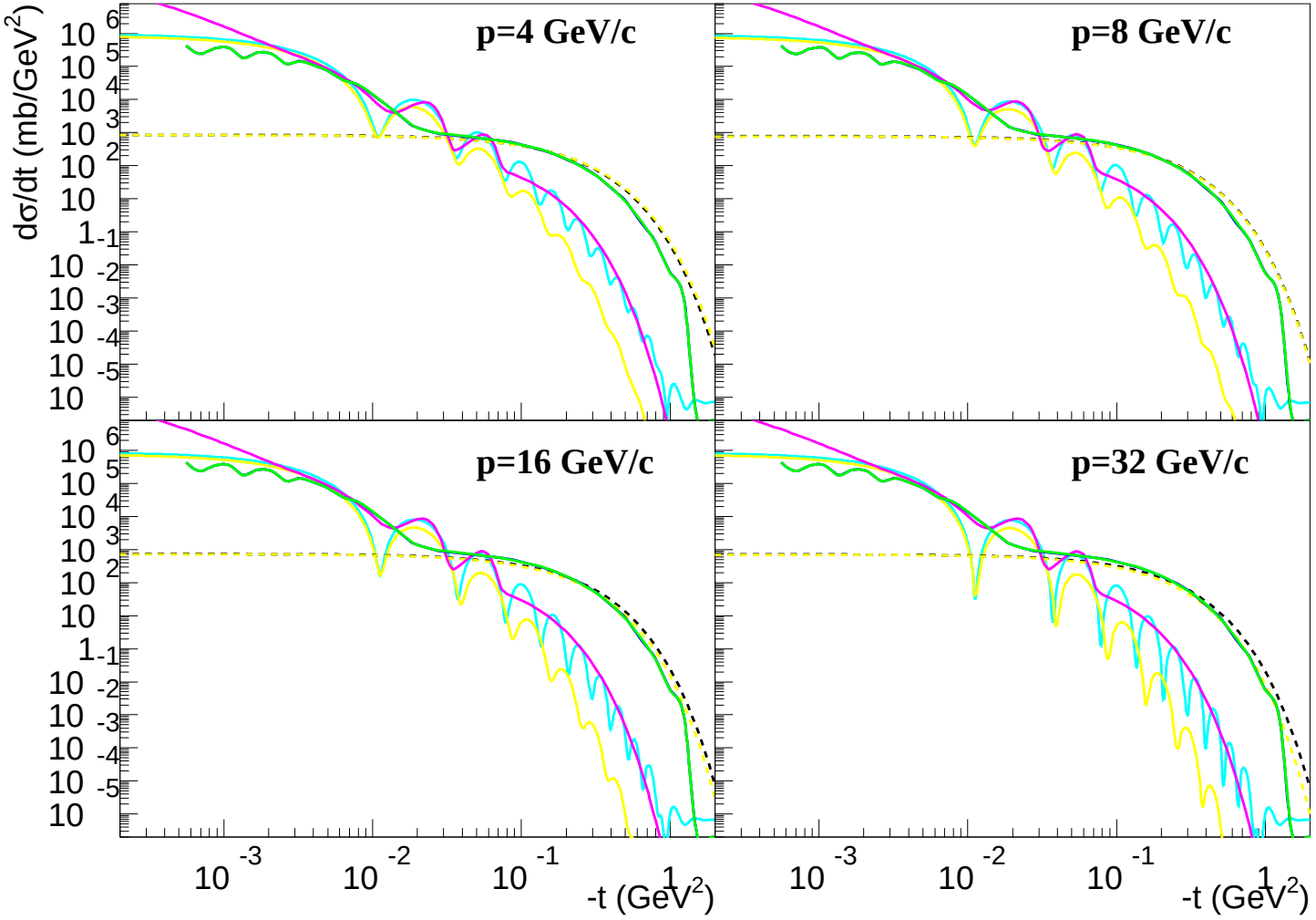
CERN

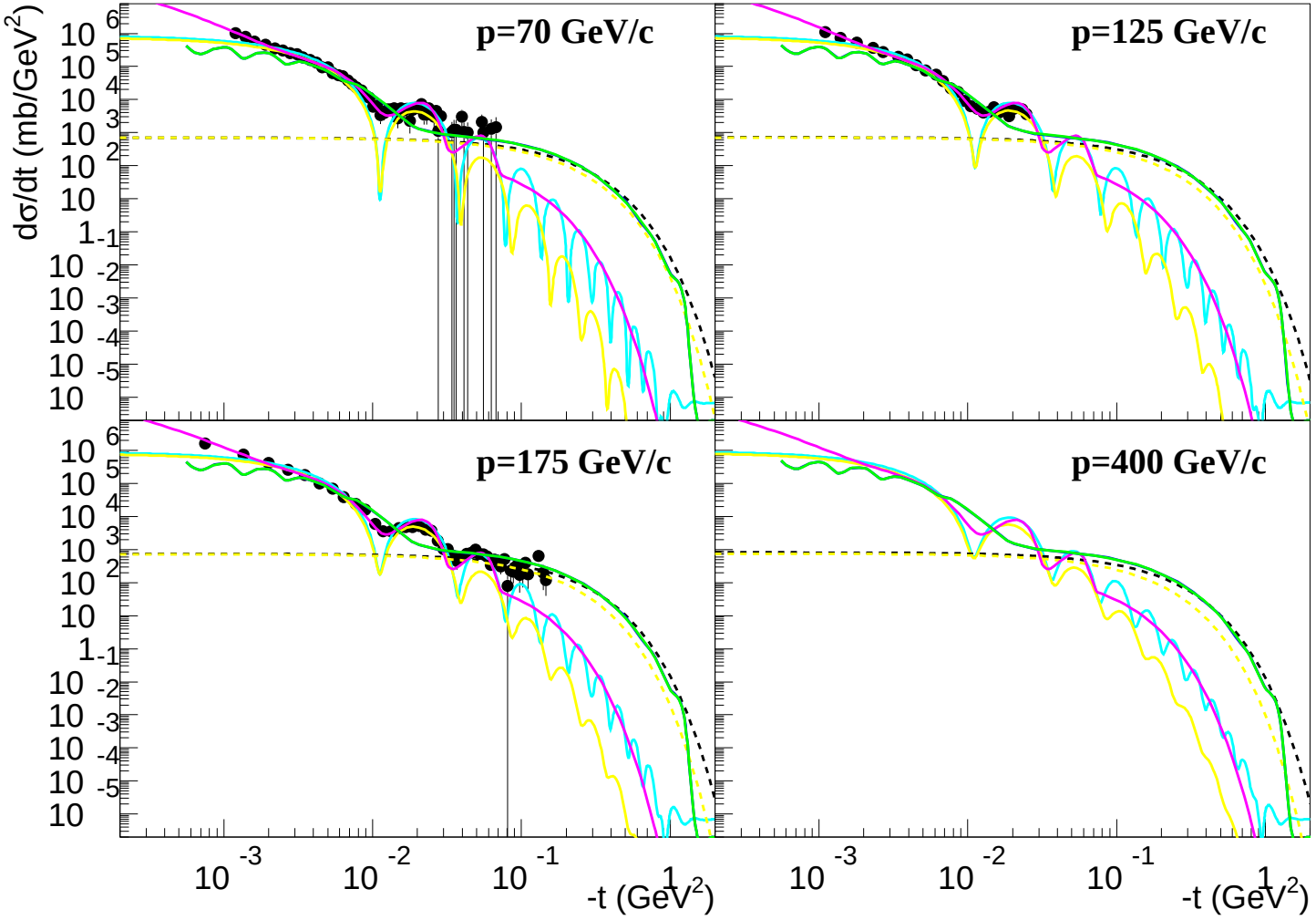

p=0.567 GeV/c
p=0.612 GeV/c
p=0.644 GeV/c
p=0.646 GeV/c
dσ/dt (mb/GeV²)
-t (GeV²)
-t (GeV²)

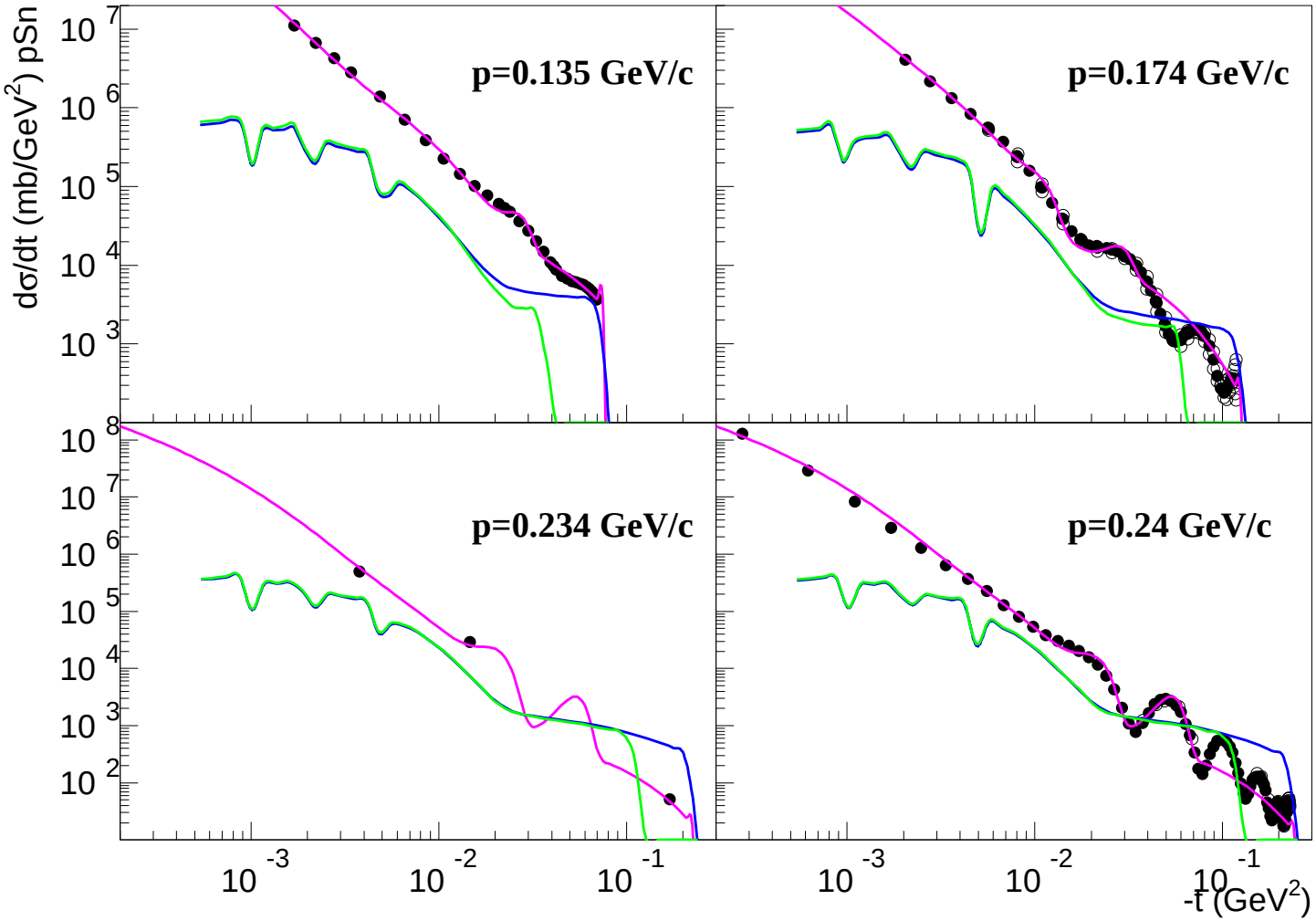

dσ/dt (mb/GeV²)
p=0.808 GeV/c
p=0.835 GeV/c
p=0.863 GeV/c
p=0.954 GeV/c
-t (GeV²)
-t (GeV²)

CERN

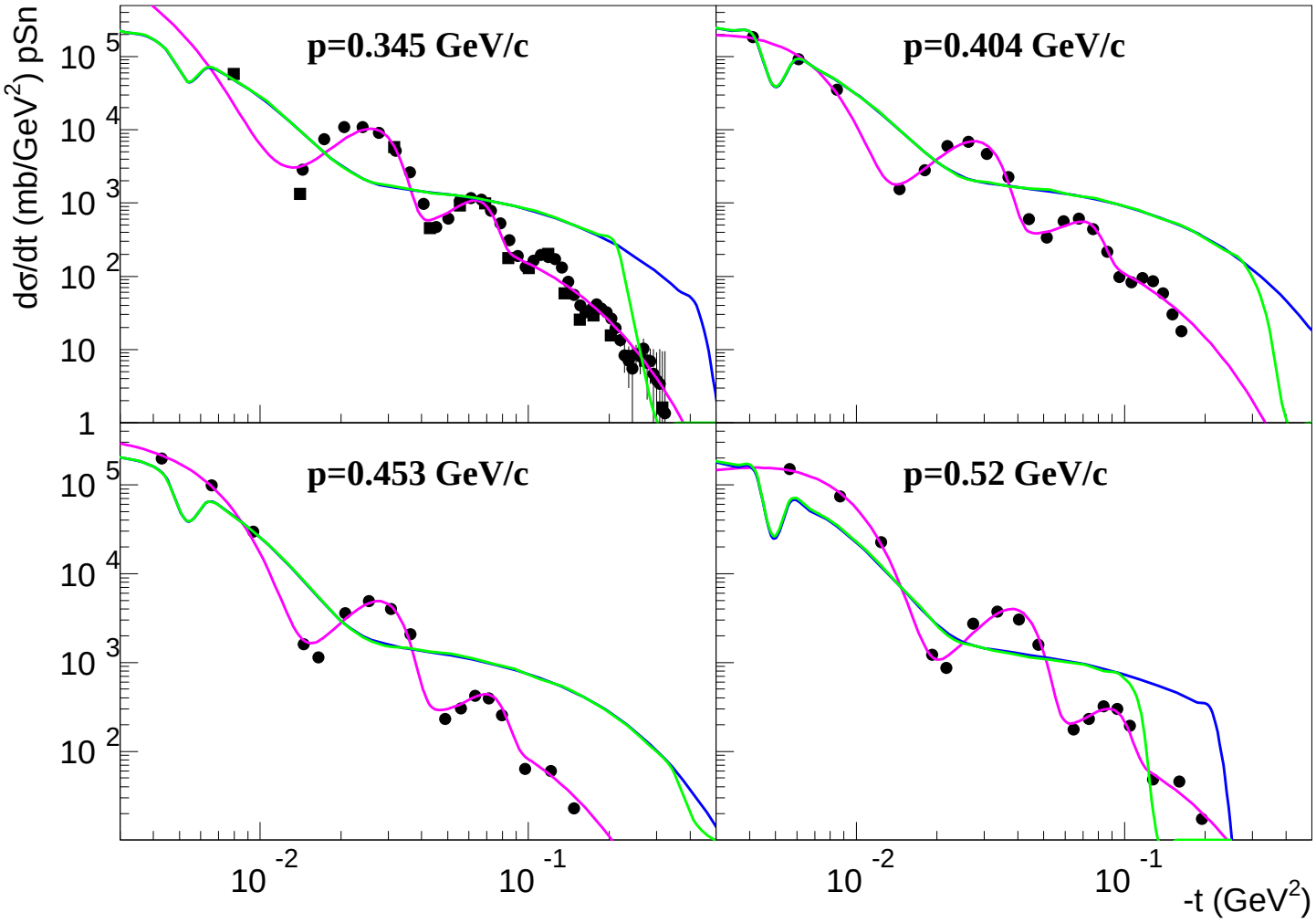

p=1.09 GeV/c
p=1.28 GeV/c
p=1.46 GeV/c
p=1.72 GeV/c
dσ/dt (mb/GeV²)
-t (GeV²)
-t (GeV²)

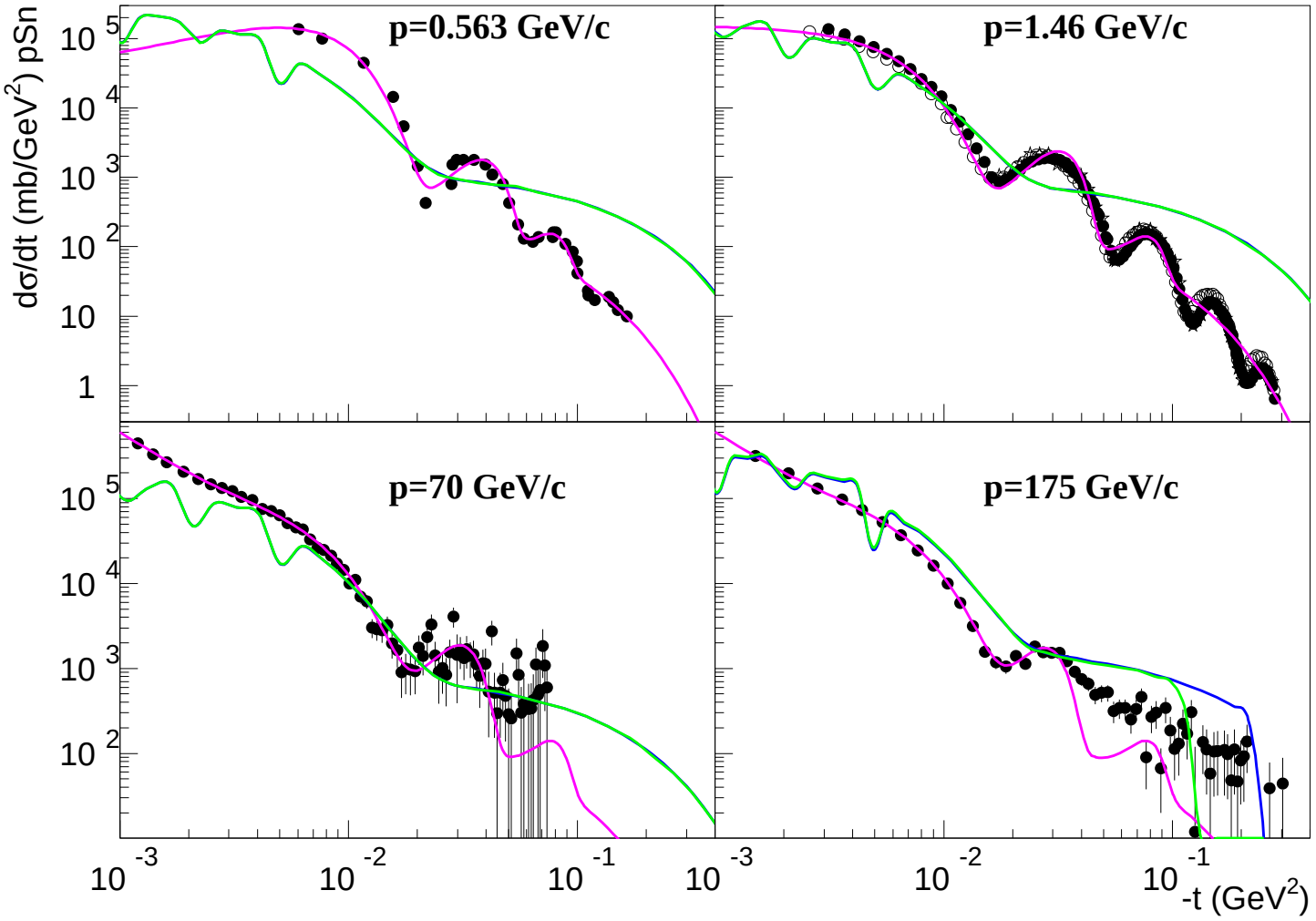

p=4 GeV/c
p=8 GeV/c
p=16 GeV/c
p=32 GeV/c
dσ/dt (mb/GeV²)
-t (GeV²)
-t (GeV²)

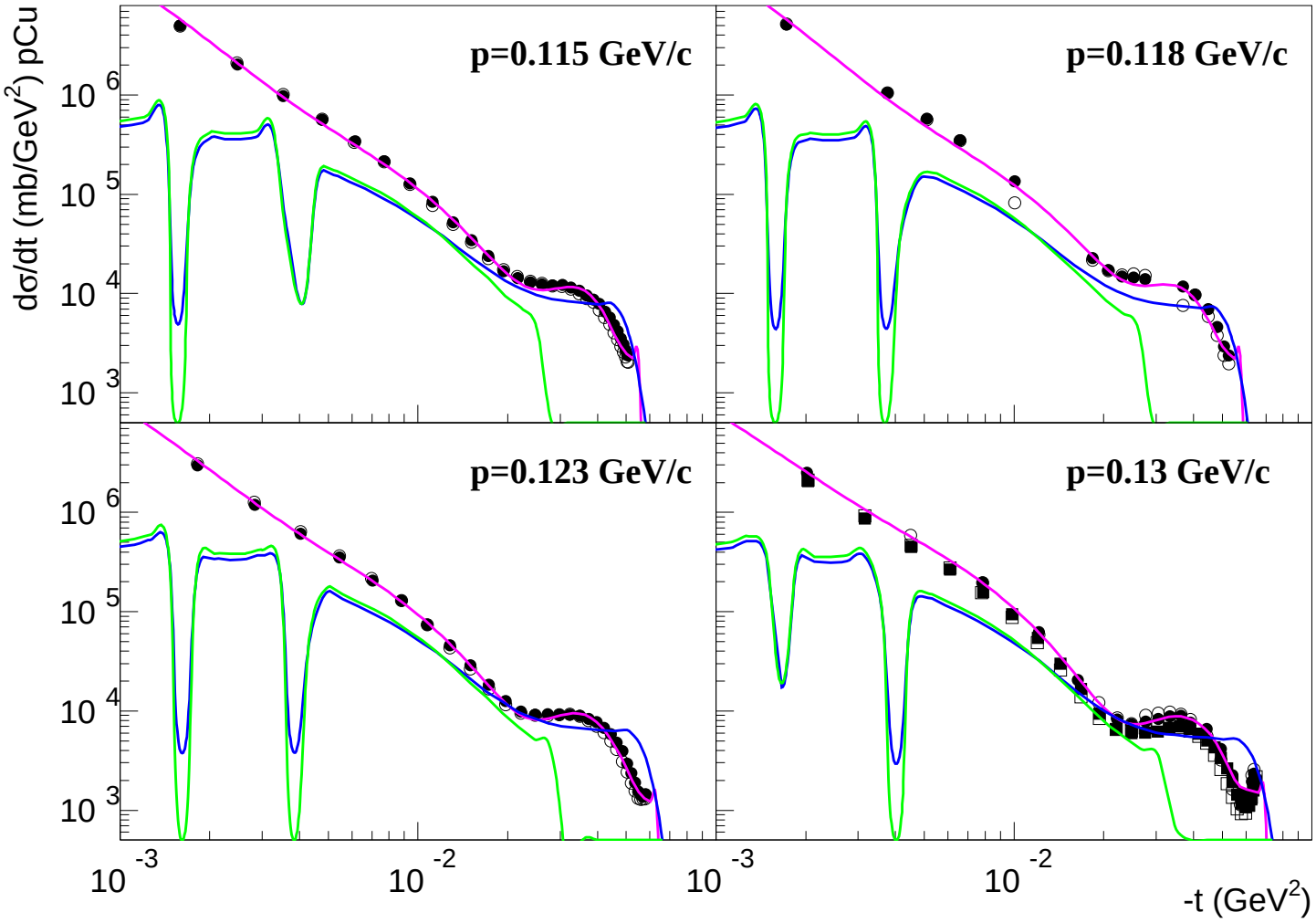

p=70 GeV/c
p=125 GeV/c
p=175 GeV/c
p=400 GeV/c
dσ/dt (mb/GeV²)
-t (GeV²)
-t (GeV²)

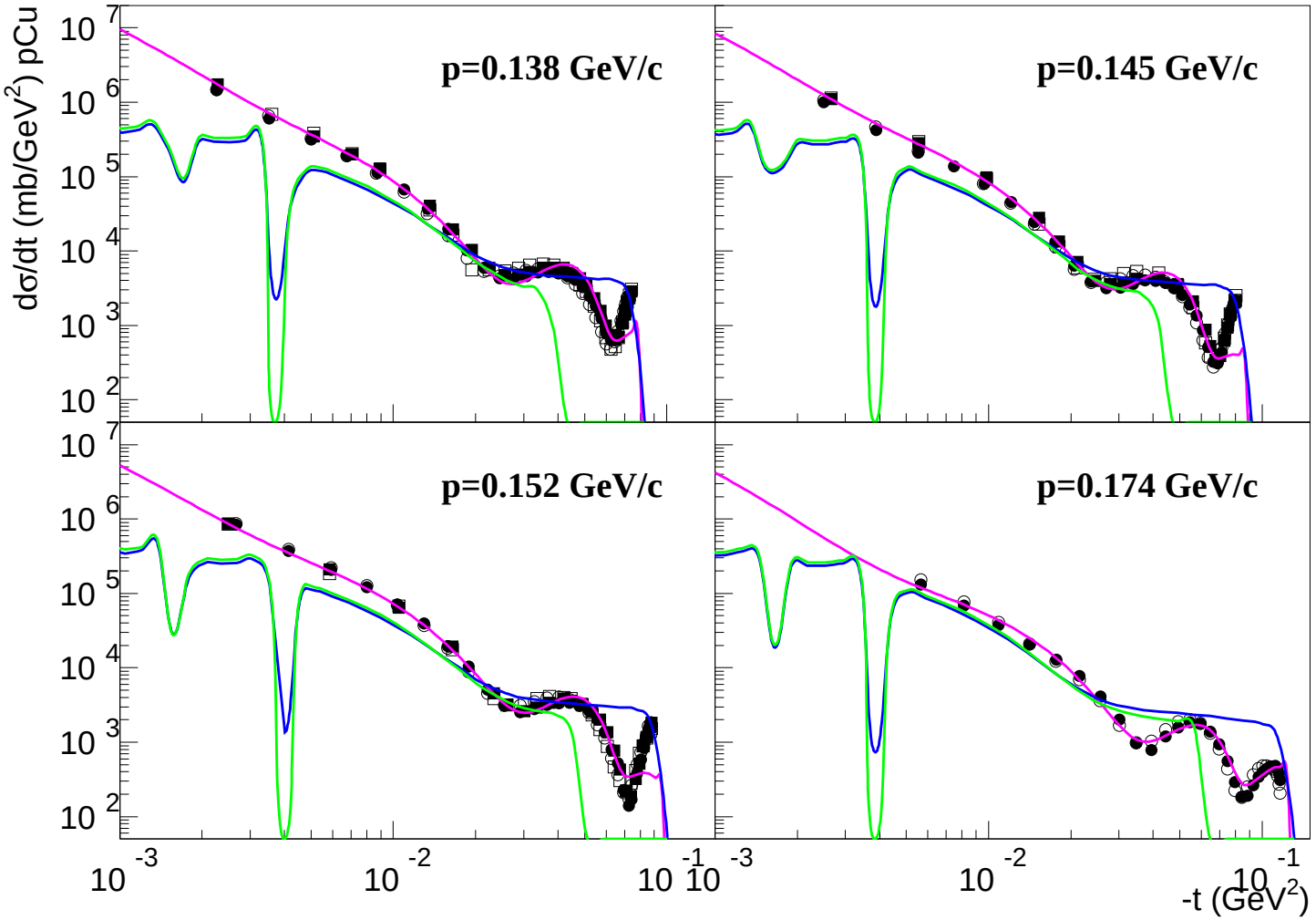

dσ/dt (mb/GeV^2) pSn
p=0.135 GeV/c
p=0.174 GeV/c
p=0.234 GeV/c
p=0.24 GeV/c
-t (GeV^2)

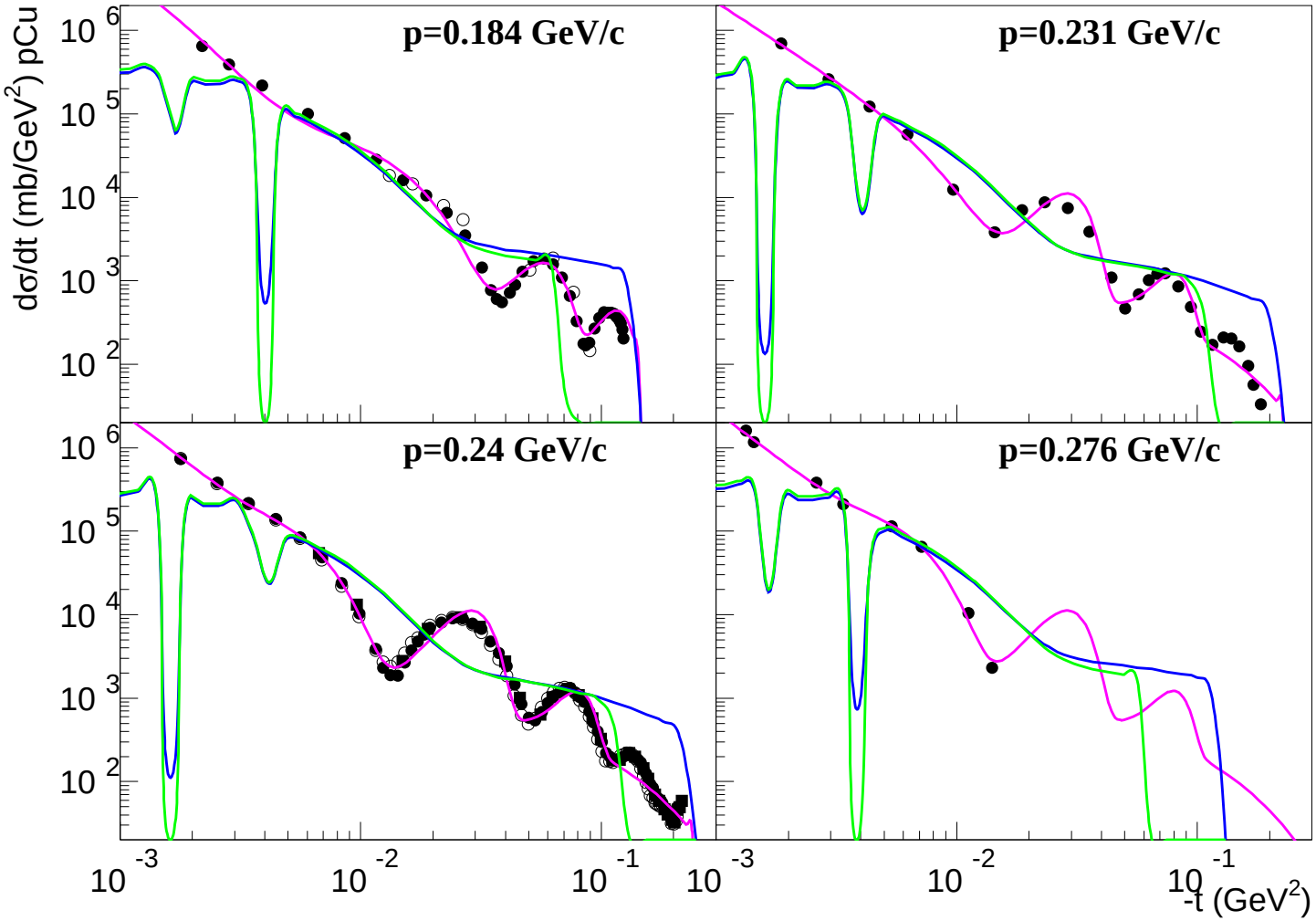
Verification and CHIPS improvement of elastic scattering in Geant4.

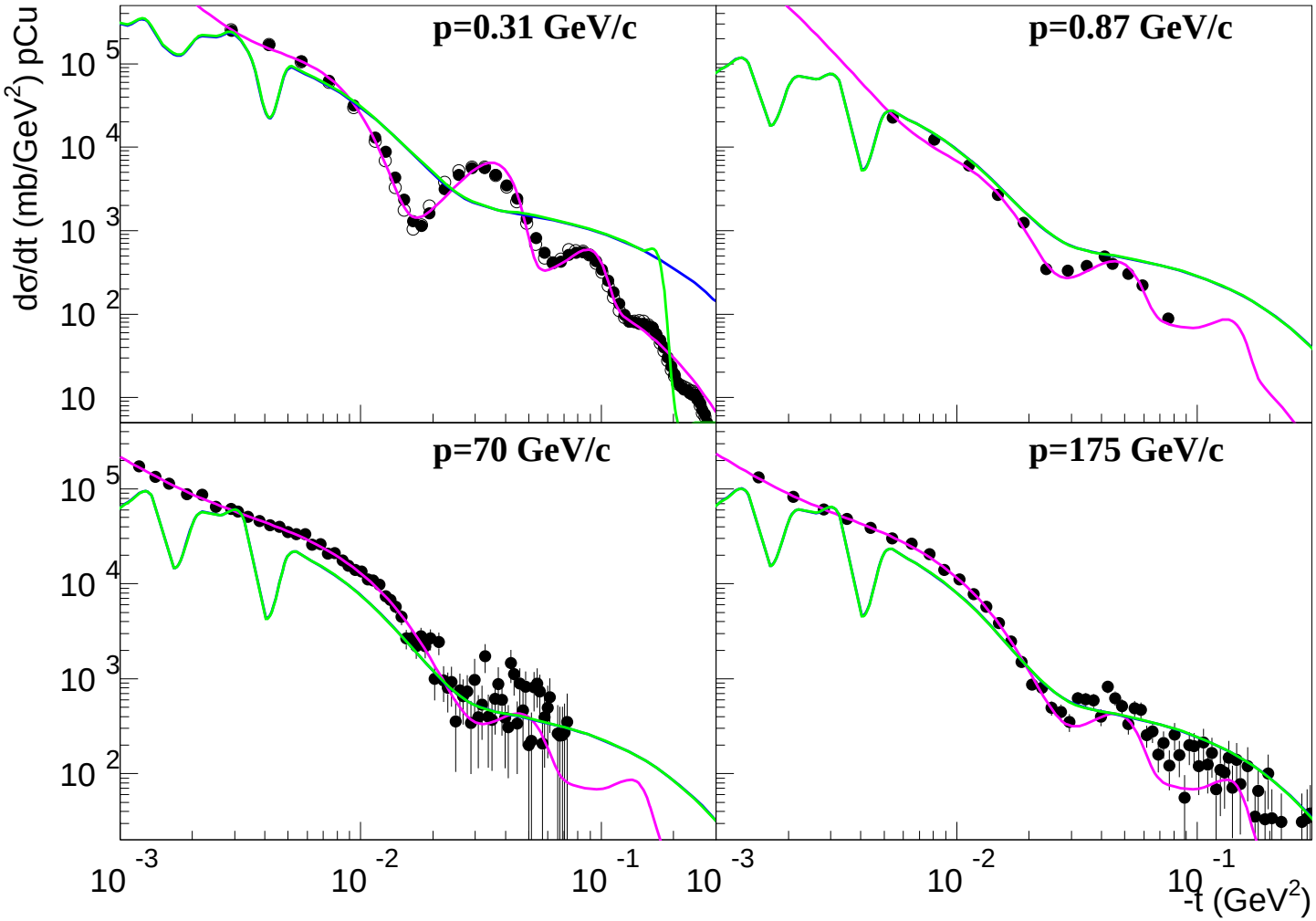


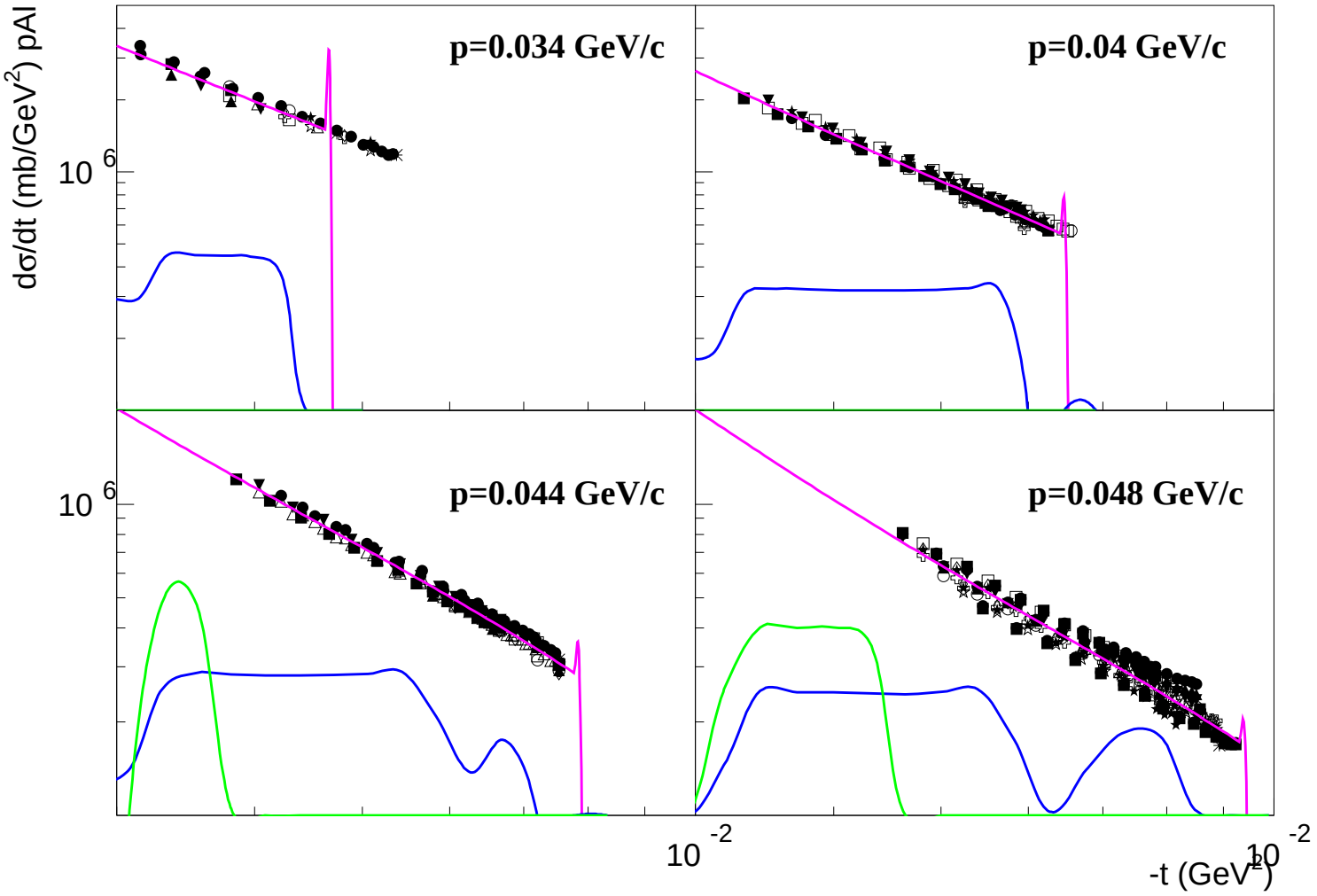

p=0.563 GeV/c
p=1.46 GeV/c
p=70 GeV/c
p=175 GeV/c
dσ/dt (mb/GeV²) pSn
-t (GeV²)

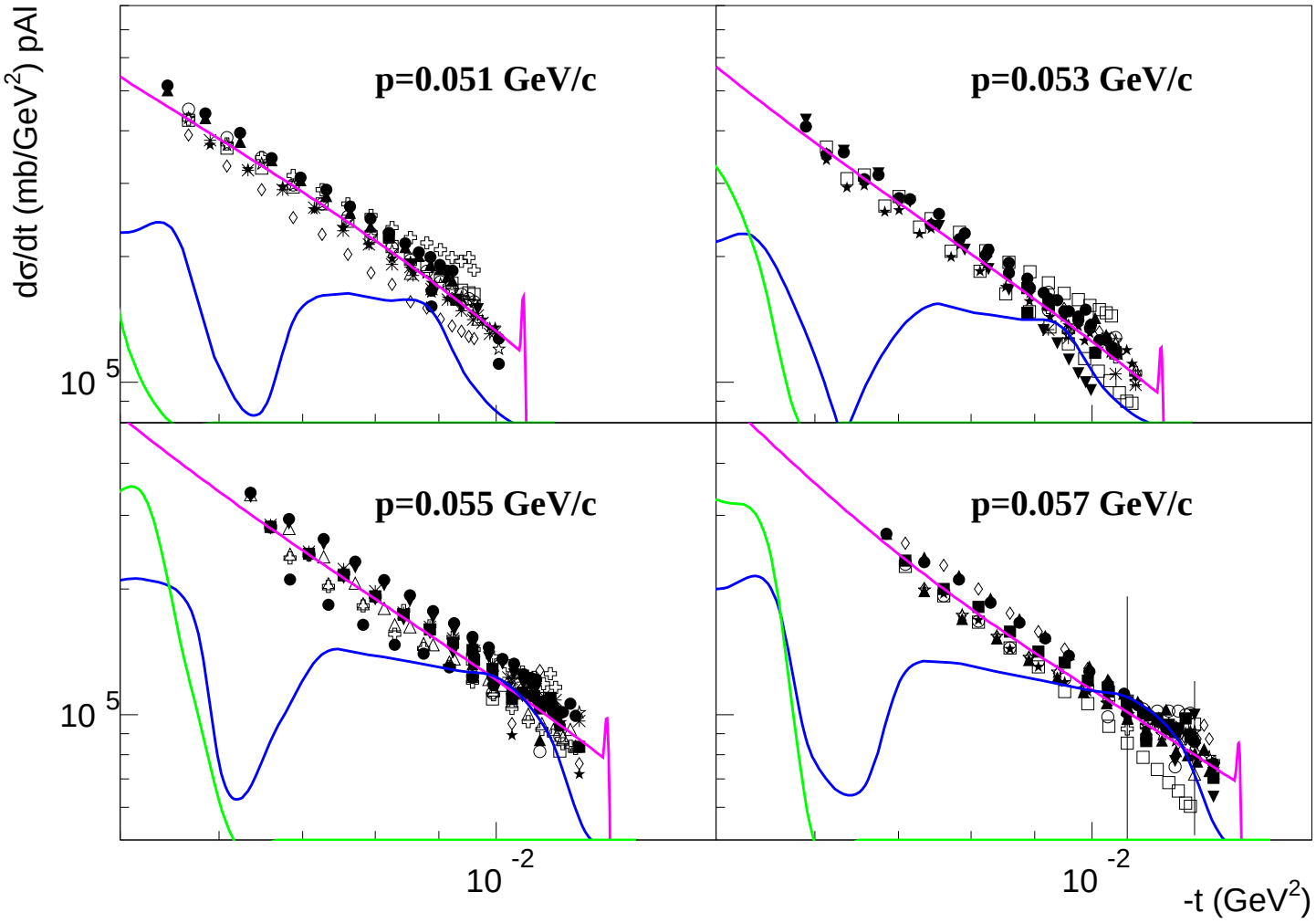

p=0.115 GeV/c
p=0.118 GeV/c
p=0.123 GeV/c
p=0.13 GeV/c
dσ/dt (mb/GeV^2) pCu
-t (GeV^2)
10^6
10^5
10^4
10^3
10^{-3}
10^{-2}

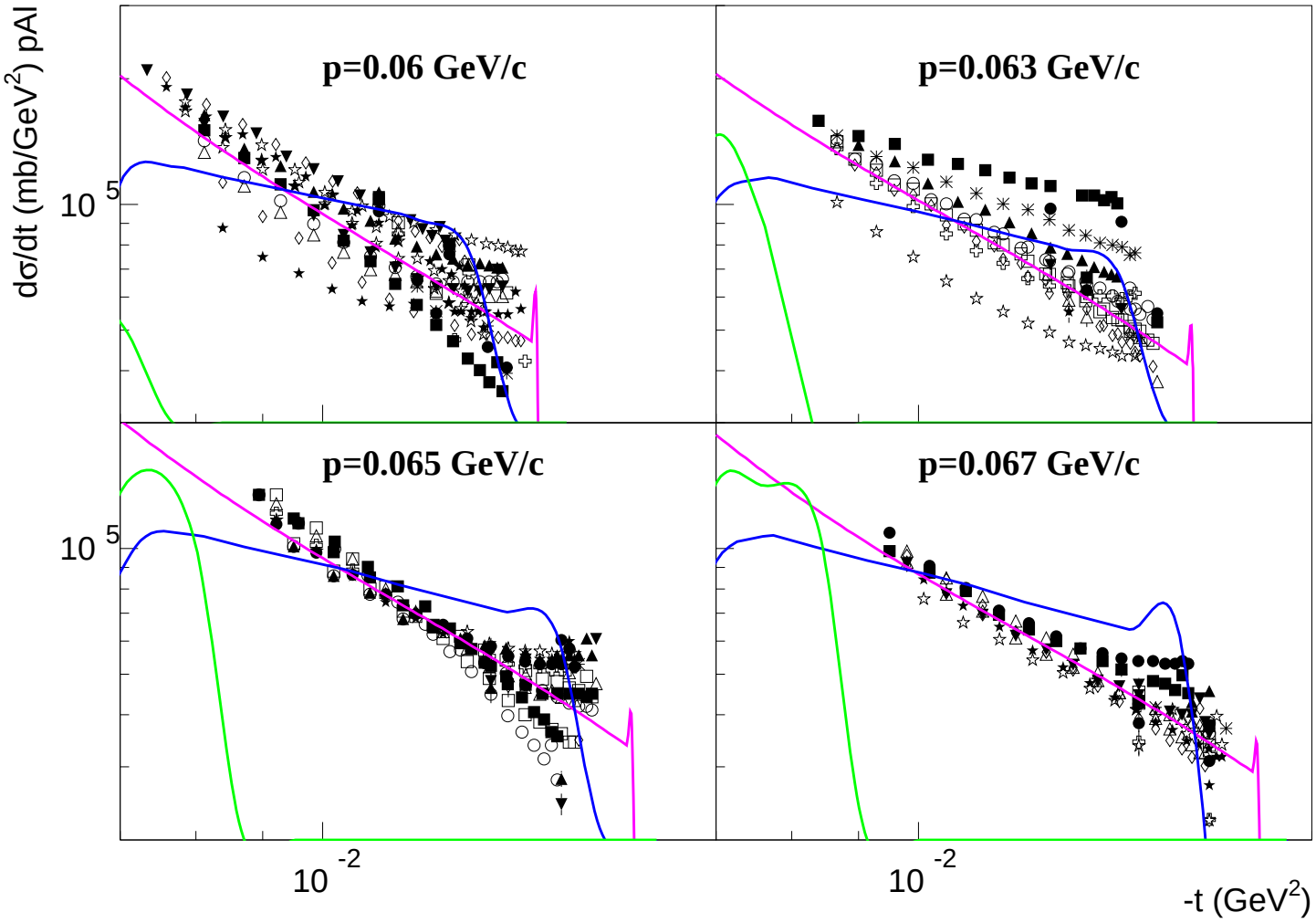

dσ/dt (mb/GeV^2) pCu
p=0.138 GeV/c
p=0.145 GeV/c
p=0.152 GeV/c
p=0.174 GeV/c
-t (GeV^2)

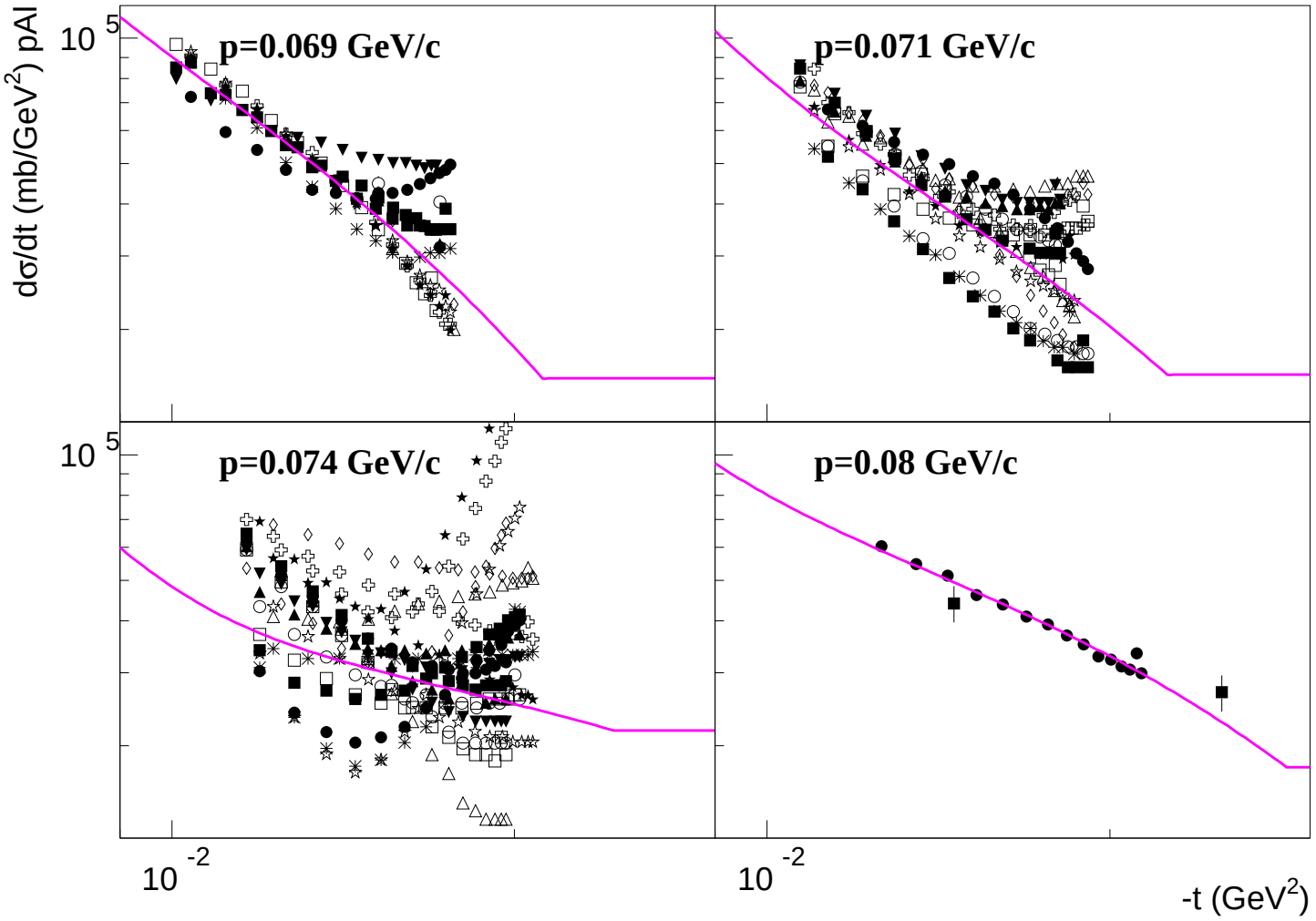

p=0.184 GeV/c
p=0.231 GeV/c
p=0.24 GeV/c
p=0.276 GeV/c
dσ/dt (mb/GeV²) pCu
-t (GeV²)

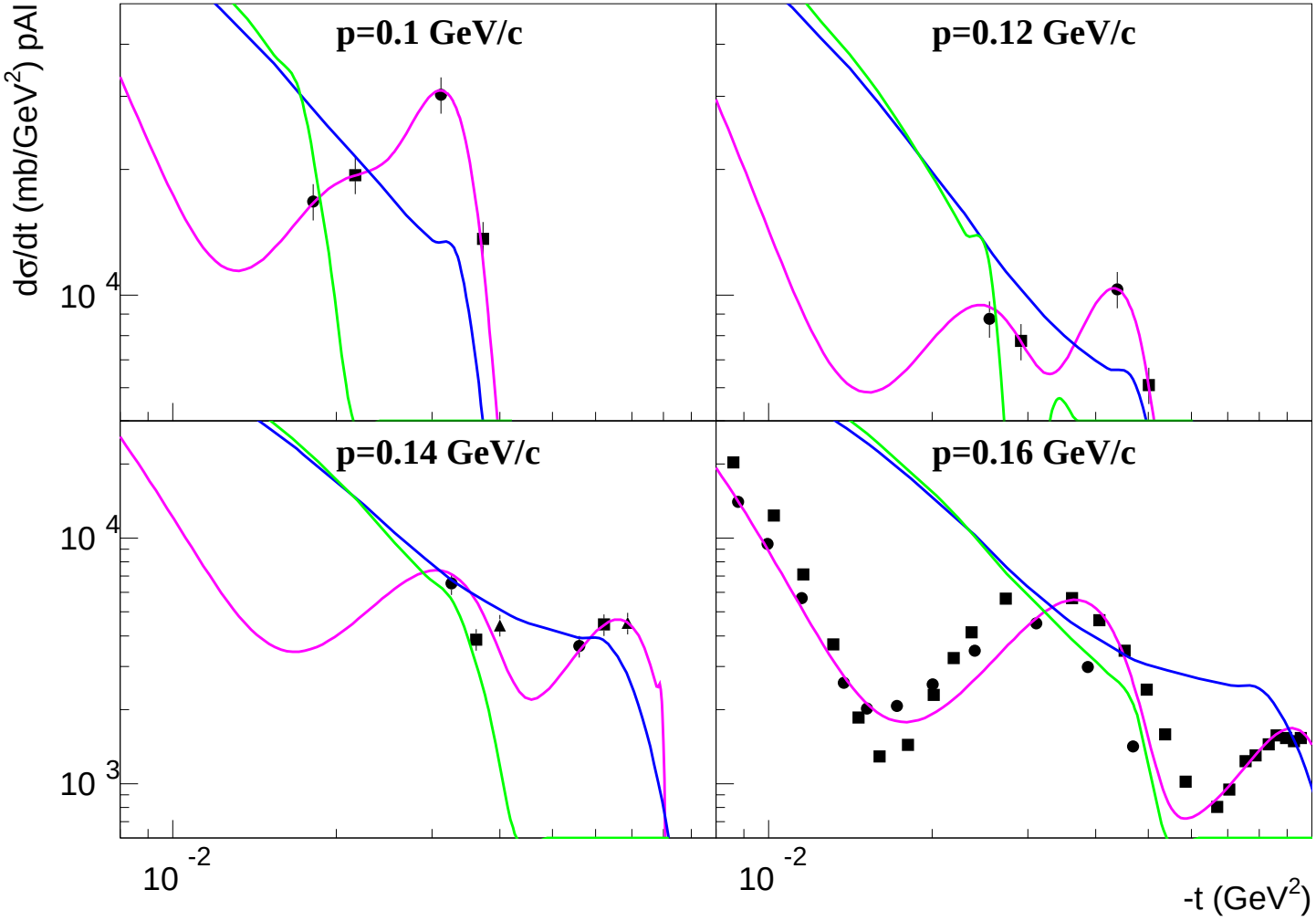

p=0.31 GeV/c
p=0.87 GeV/c
p=70 GeV/c
p=175 GeV/c
dσ/dt (mb/GeV²) pCu
-t (GeV²)

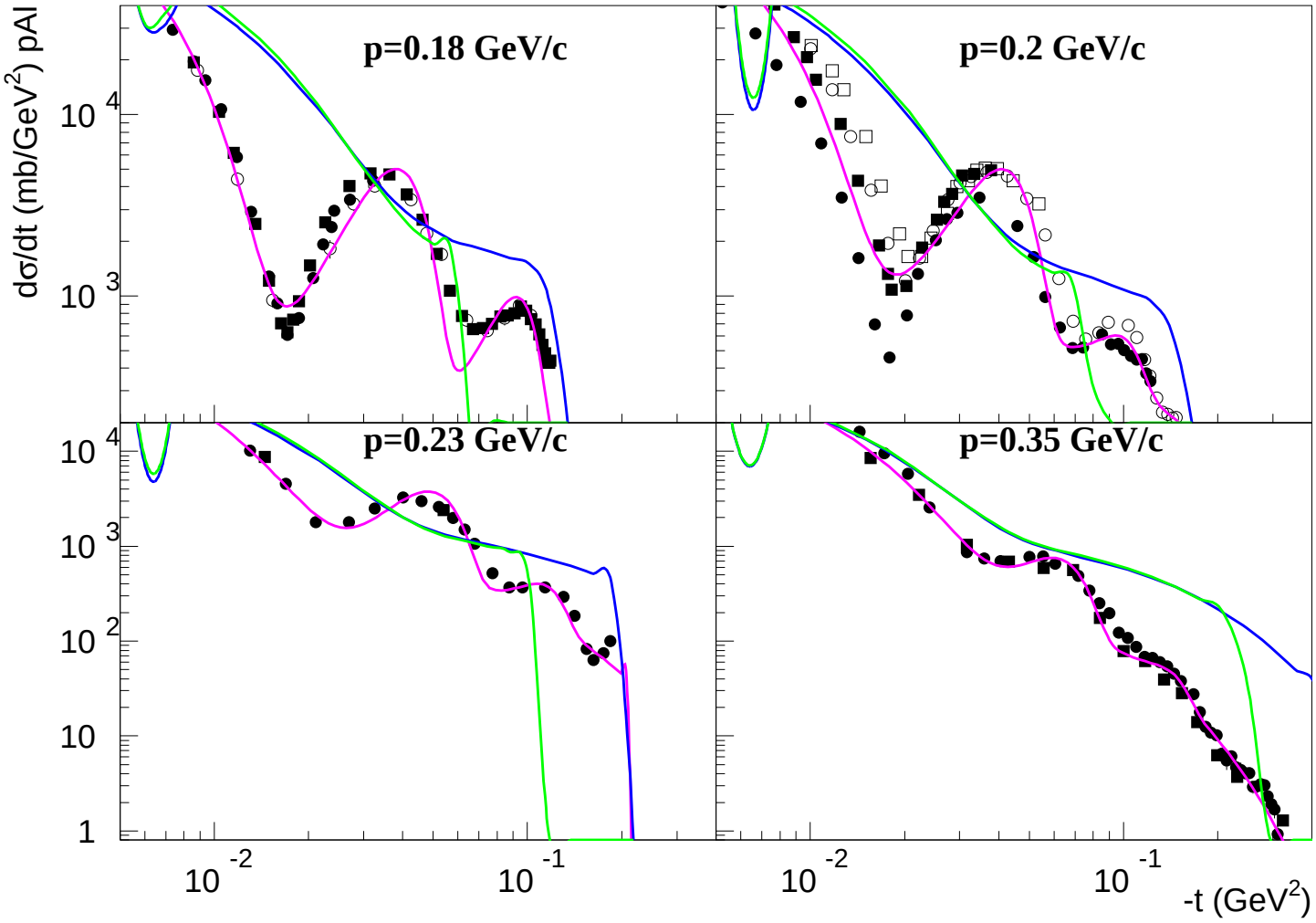

p=0.034 GeV/c
p=0.04 GeV/c
p=0.044 GeV/c
p=0.048 GeV/c
dσ/dt (mb/GeV²) pAl
10 6
10 6
10 -2
10 -2
-t (GeV²)

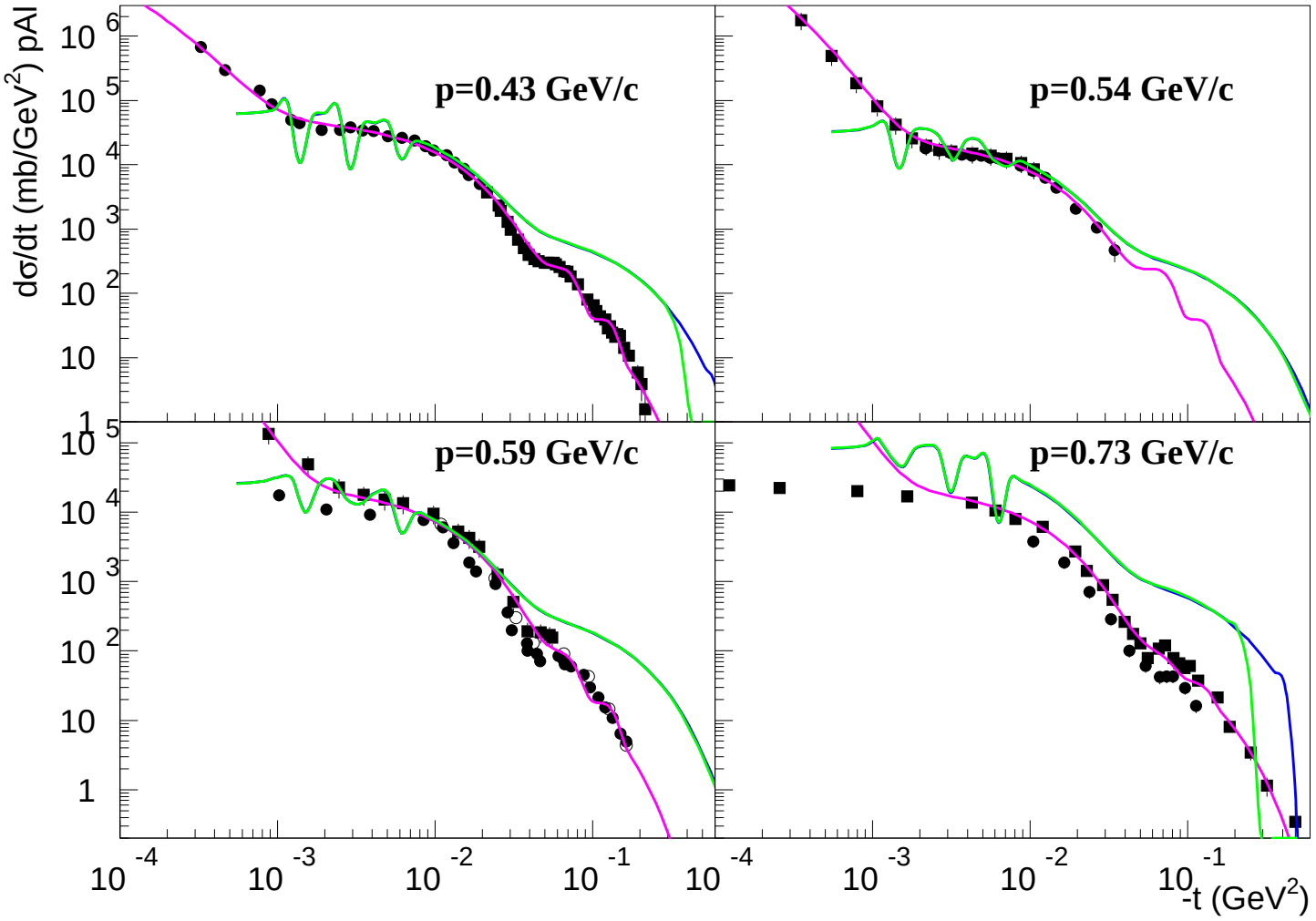

dσ/dt (mb/GeV^2) pAl
p=0.051 GeV/c
p=0.053 GeV/c
p=0.055 GeV/c
p=0.057 GeV/c
10 5
10 5
10 -2
10 -2
-t (GeV^2)

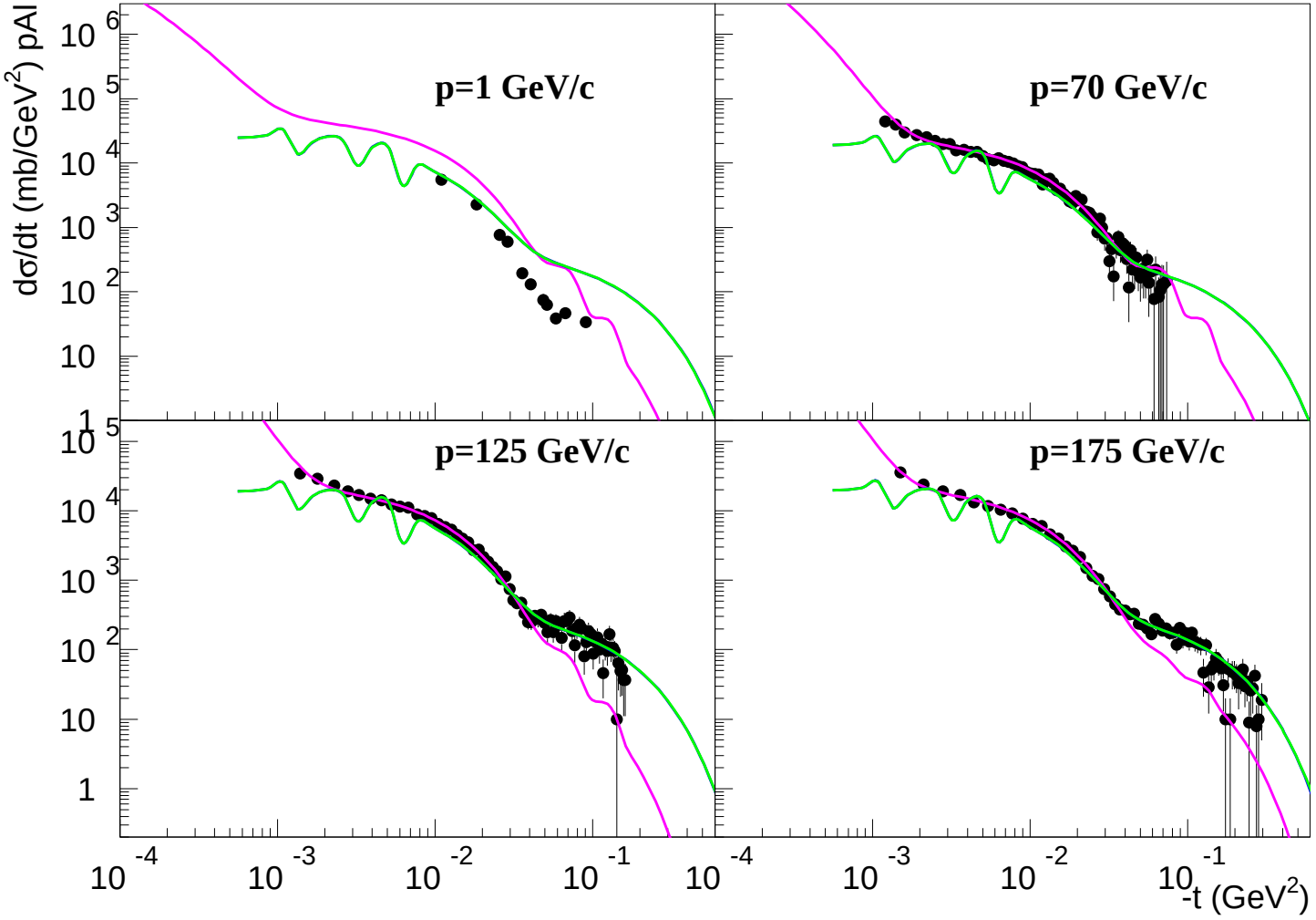

p=0.06 GeV/c
p=0.063 GeV/c
p=0.065 GeV/c
p=0.067 GeV/c
dσ/dt (mb/GeV²) pAl
10 5
10 5
10 -2
10 -2
-t (GeV²)

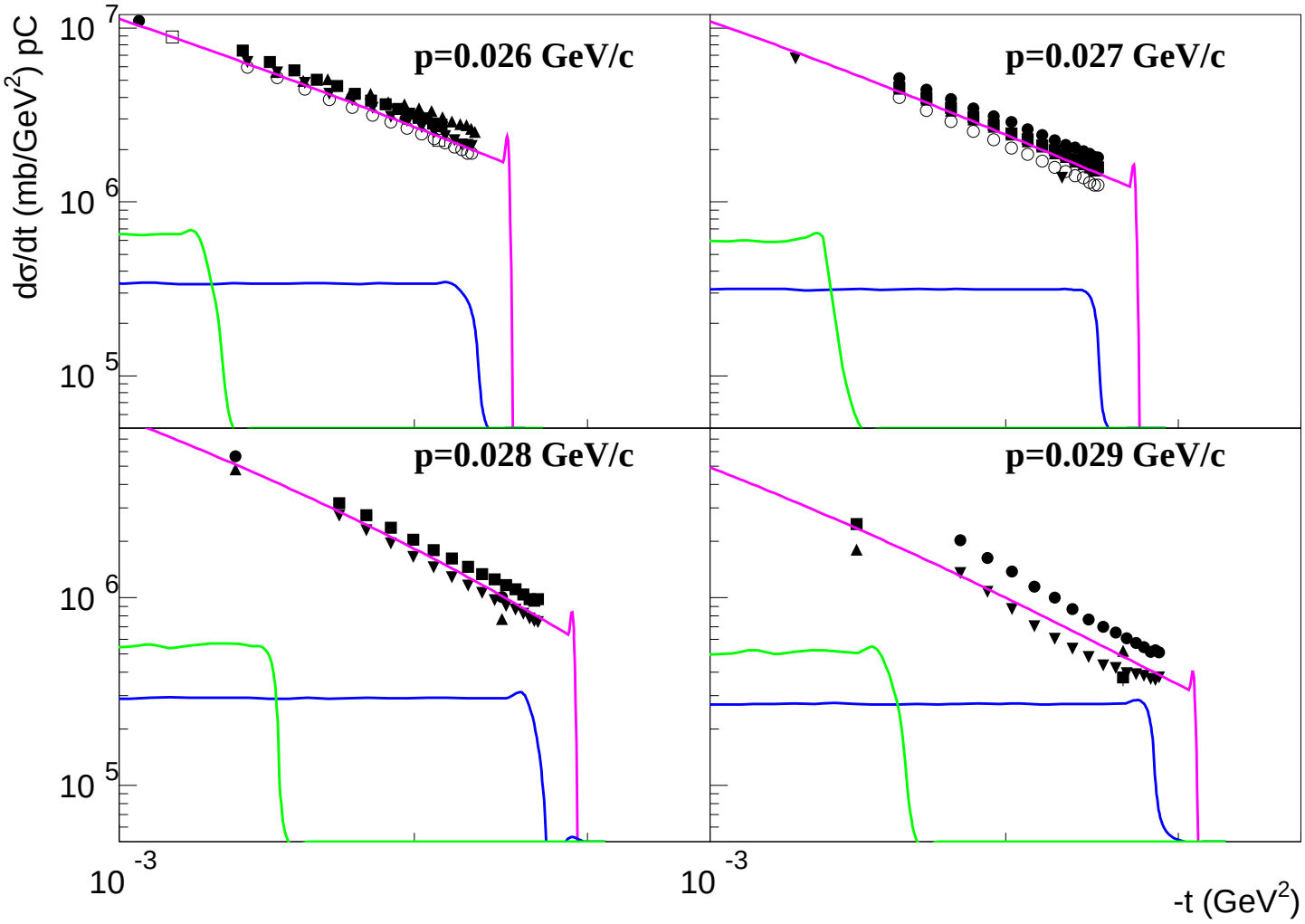

dσ/dt (mb/GeV^2) pAl
10^5
p=0.069 GeV/c
p=0.071 GeV/c
10^5
p=0.074 GeV/c
p=0.08 GeV/c
10^{-2}
10^{-2}
-t (GeV^2)

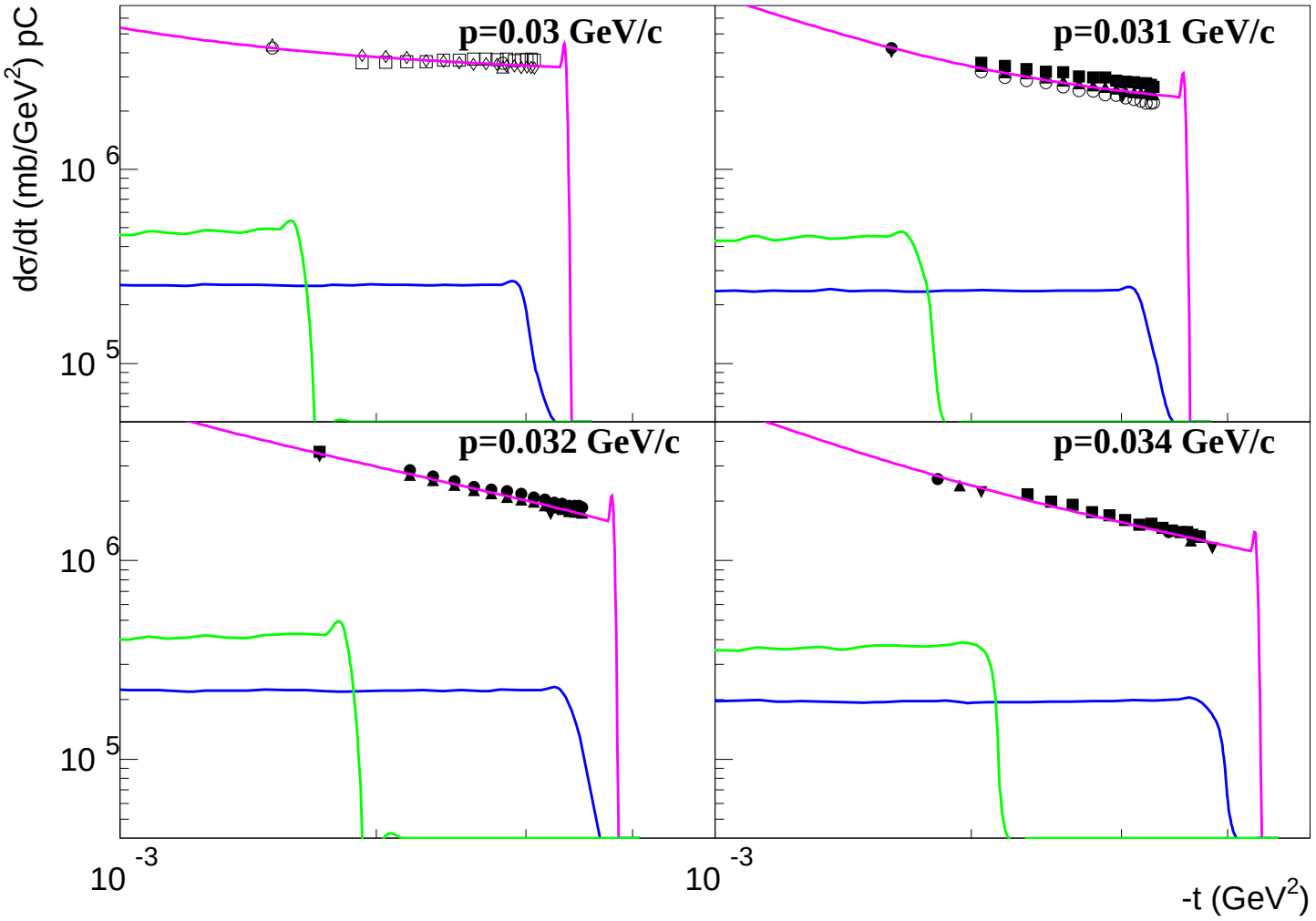

p=0.1 GeV/c
p=0.12 GeV/c
p=0.14 GeV/c
p=0.16 GeV/c
dσ/dt (mb/GeV^2) pAl
10 4
10 4
10 3
10 -2
10 -2
-t (GeV^2)

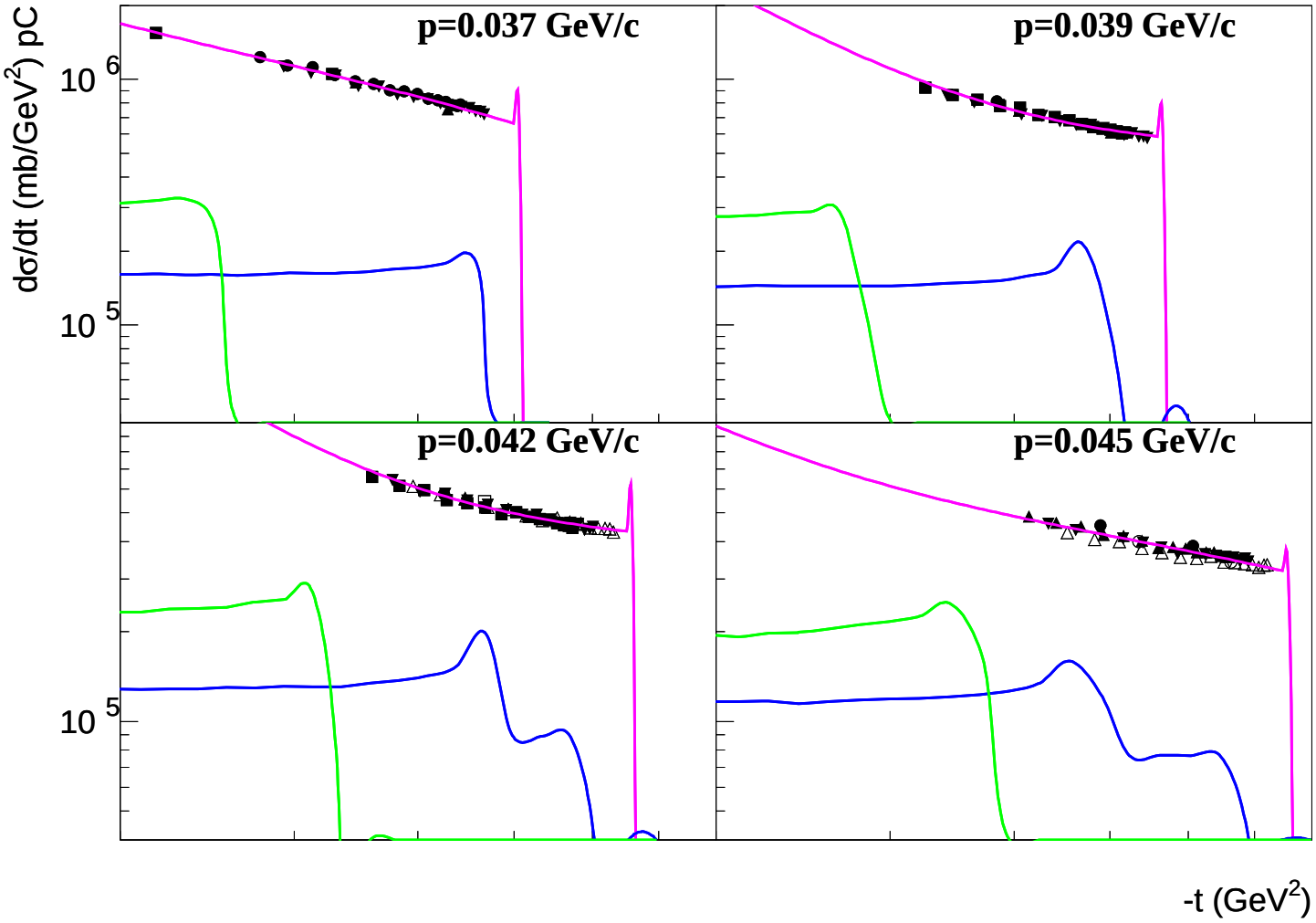

p=0.18 GeV/c
p=0.2 GeV/c
p=0.23 GeV/c
p=0.35 GeV/c
dσ/dt (mb/GeV²) pAl
-t (GeV²)

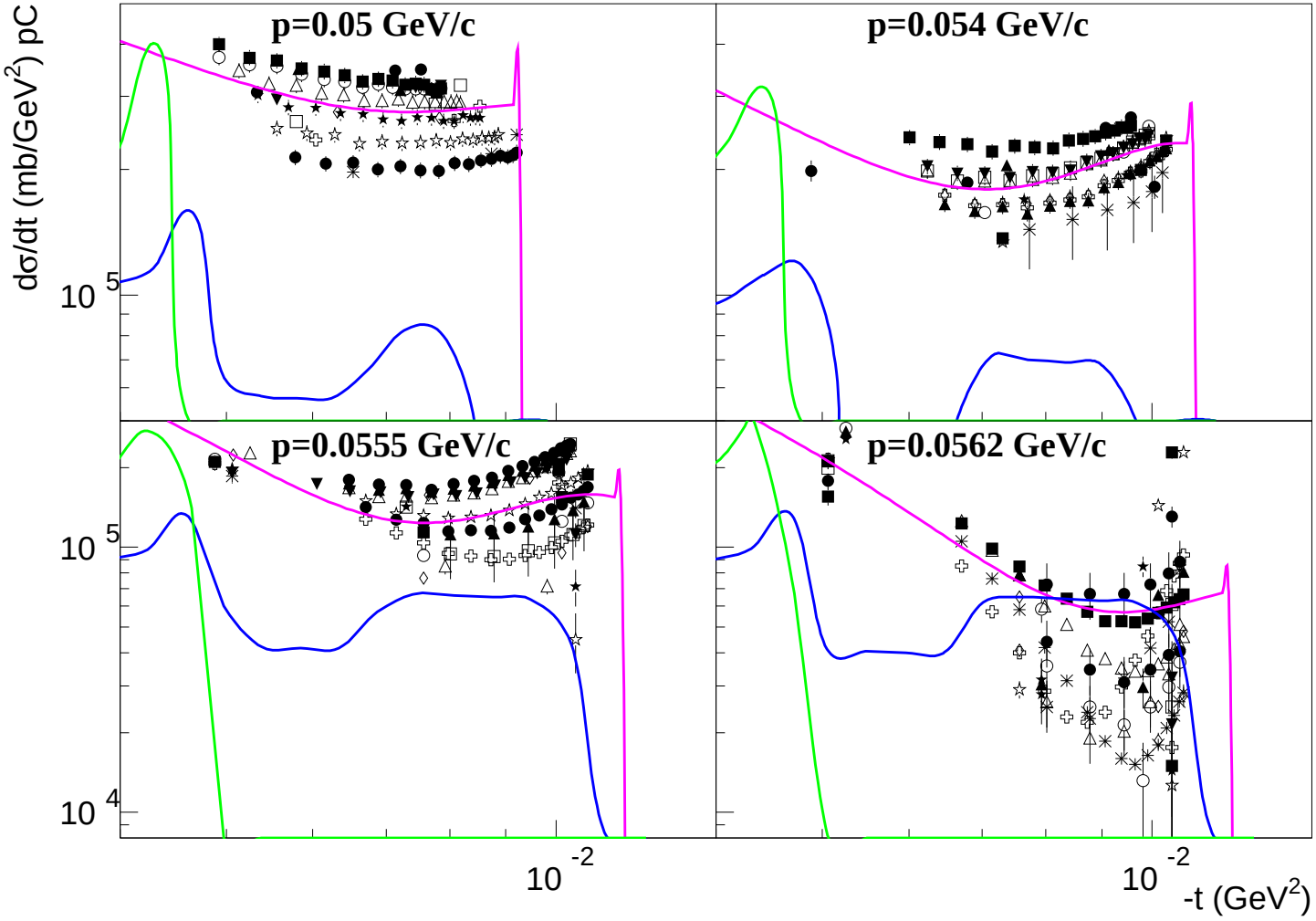

dσ/dt (mb/GeV^2) pAl
p=0.43 GeV/c
p=0.54 GeV/c
p=0.59 GeV/c
p=0.73 GeV/c
-t (GeV^2)

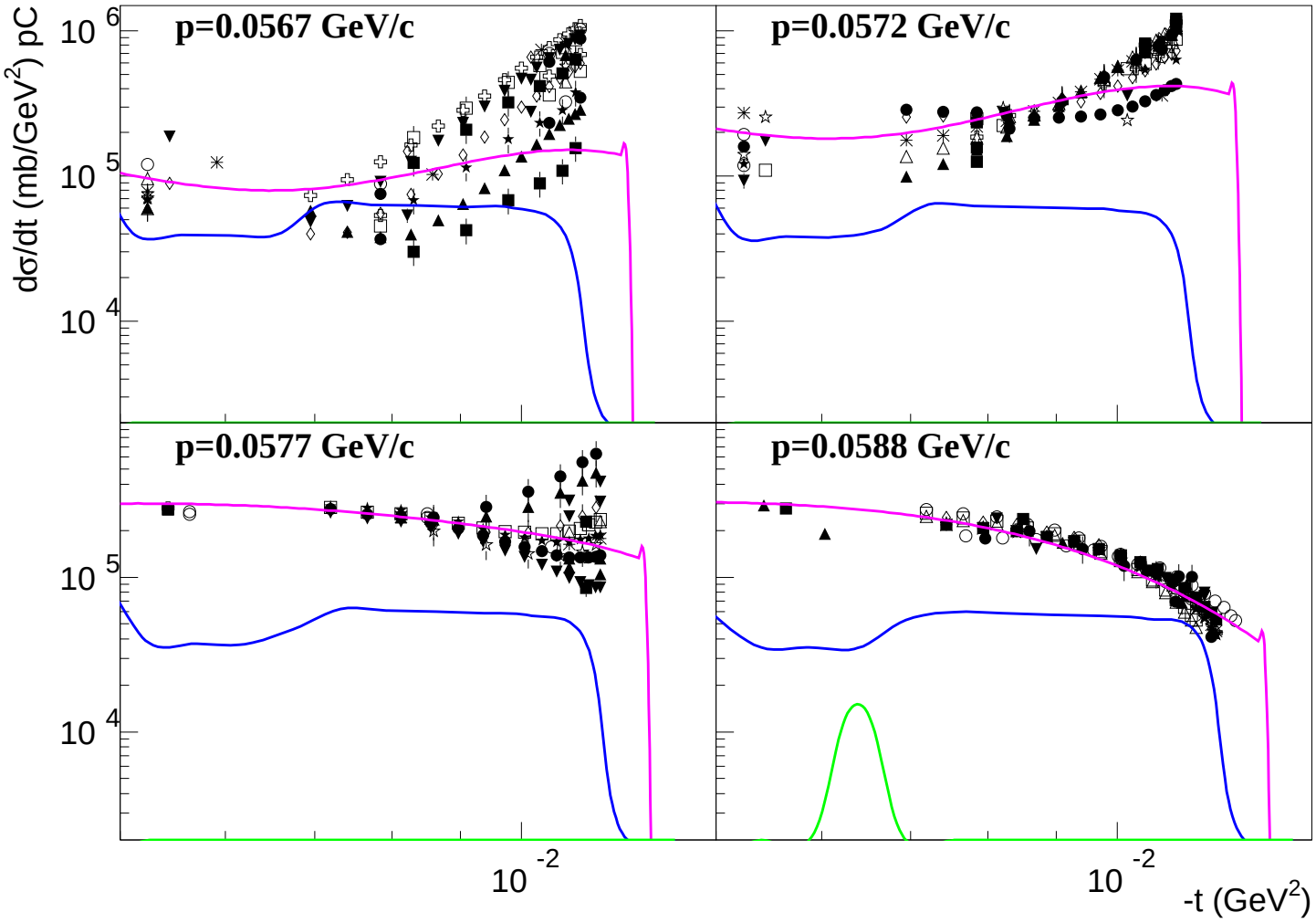

dσ/dt (mb/GeV²) pAl
p=1 GeV/c
p=70 GeV/c
p=125 GeV/c
p=175 GeV/c
-t (GeV²)

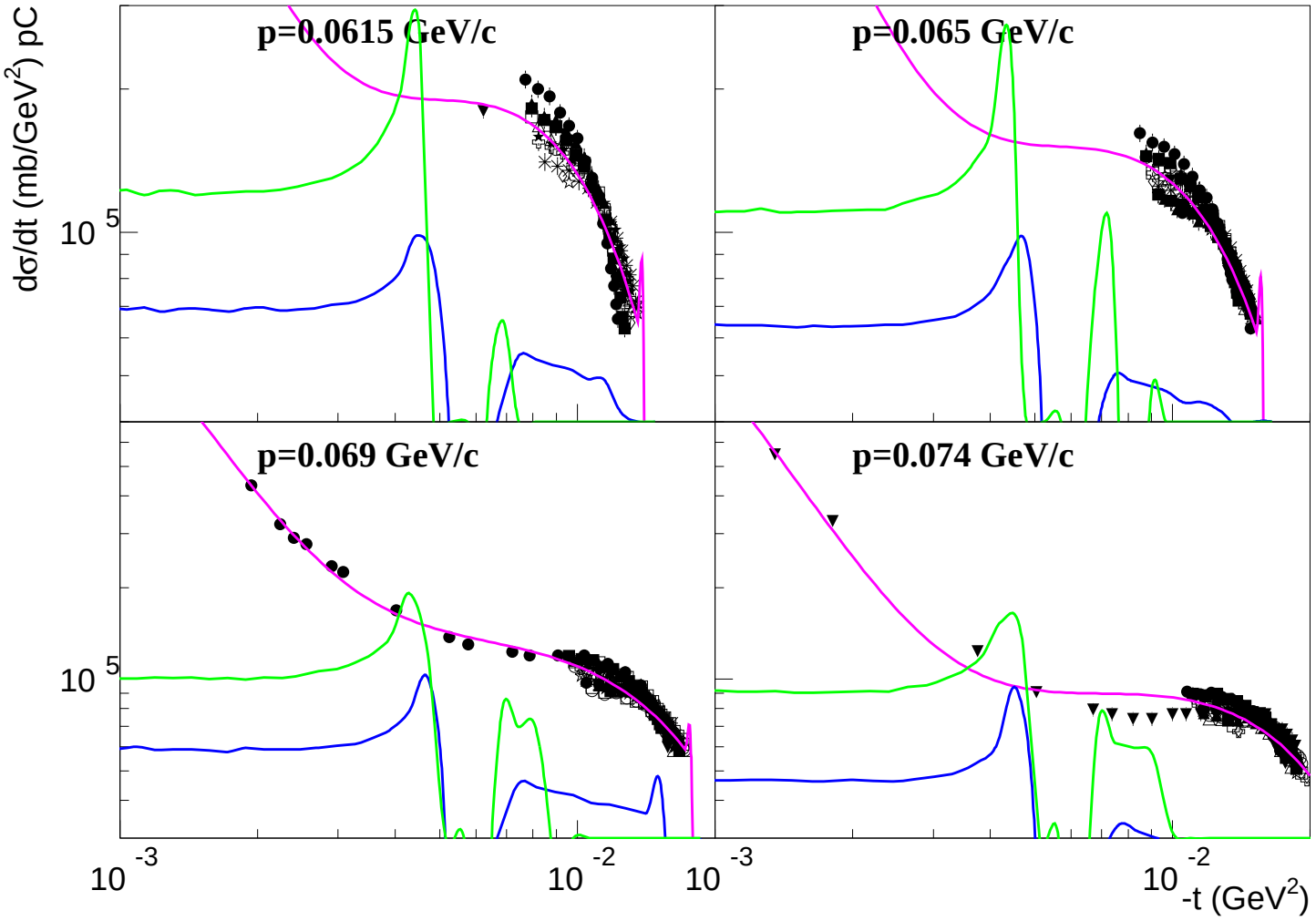

p=0.026 GeV/c
p=0.027 GeV/c
p=0.028 GeV/c
p=0.029 GeV/c
dσ/dt (mb/GeV²) pC
-t (GeV²)
10 7
10 6
10 5
10 -3

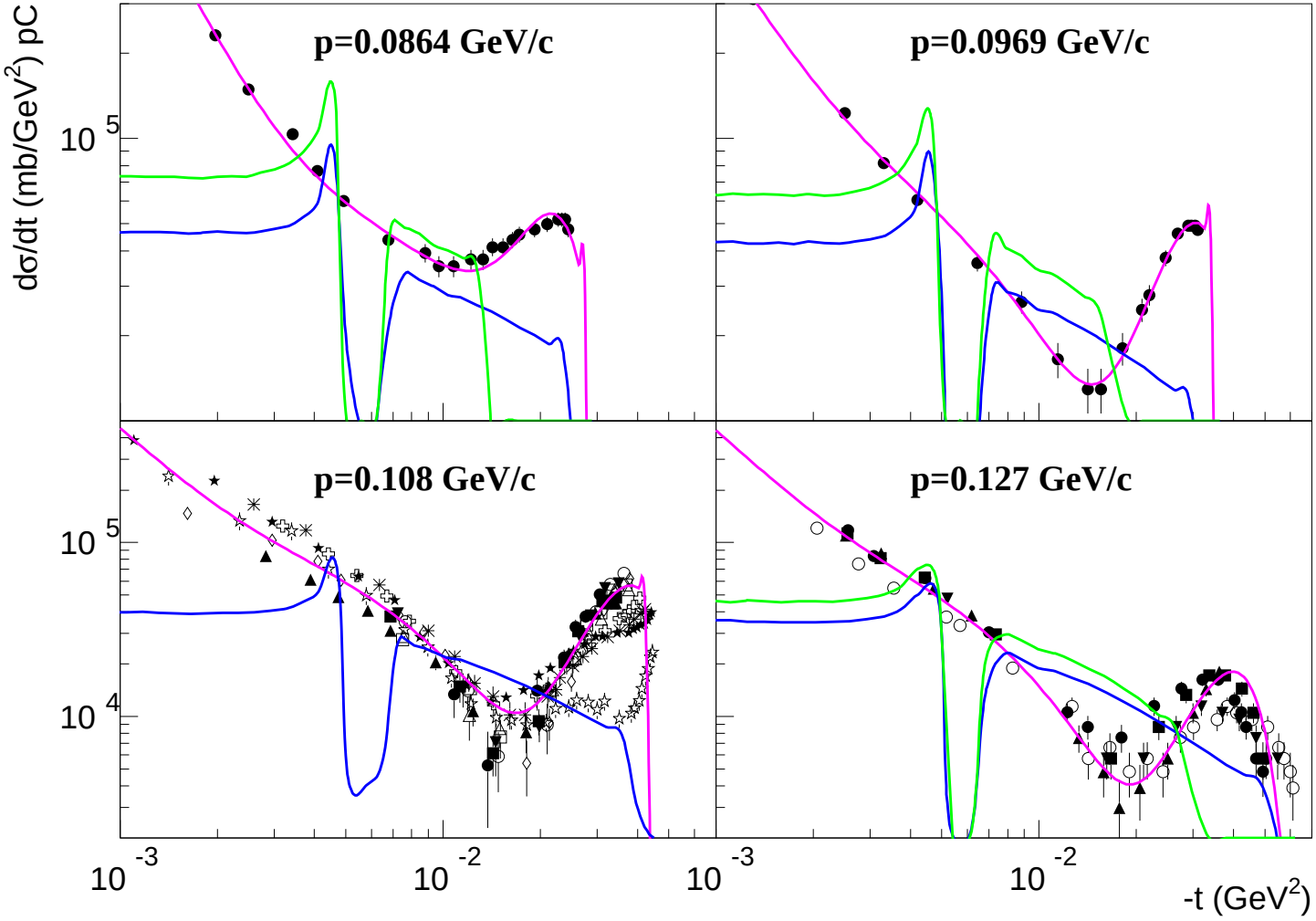

p=0.03 GeV/c
p=0.031 GeV/c
p=0.032 GeV/c
p=0.034 GeV/c
dσ/dt (mb/GeV^2) pC
10 6
10 5
10 -3
-t (GeV^2)

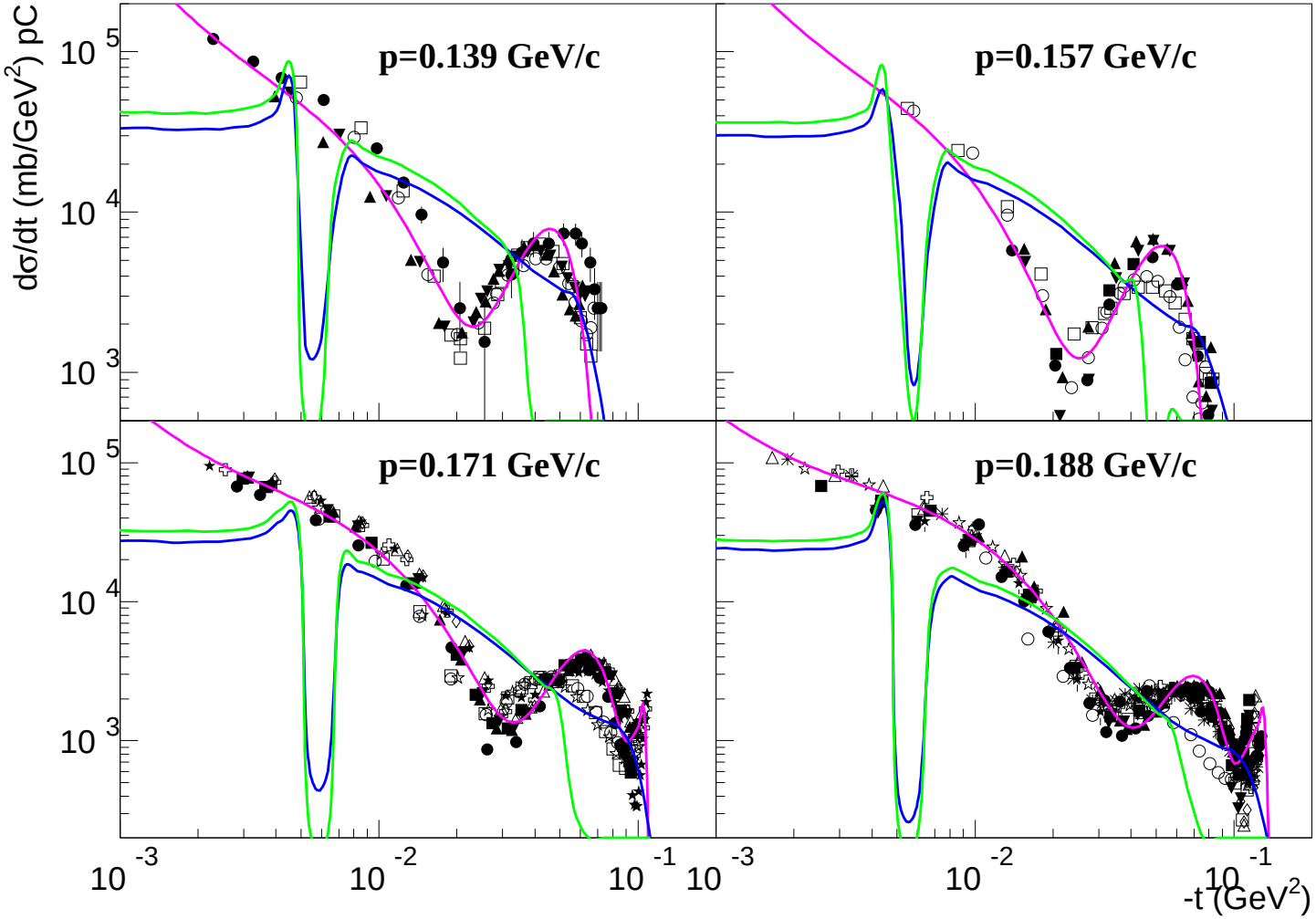

p=0.037 GeV/c
p=0.039 GeV/c
p=0.042 GeV/c
p=0.045 GeV/c
dσ/dt (mb/GeV²) pC
10 6
10 5
10 5
-t (GeV²)

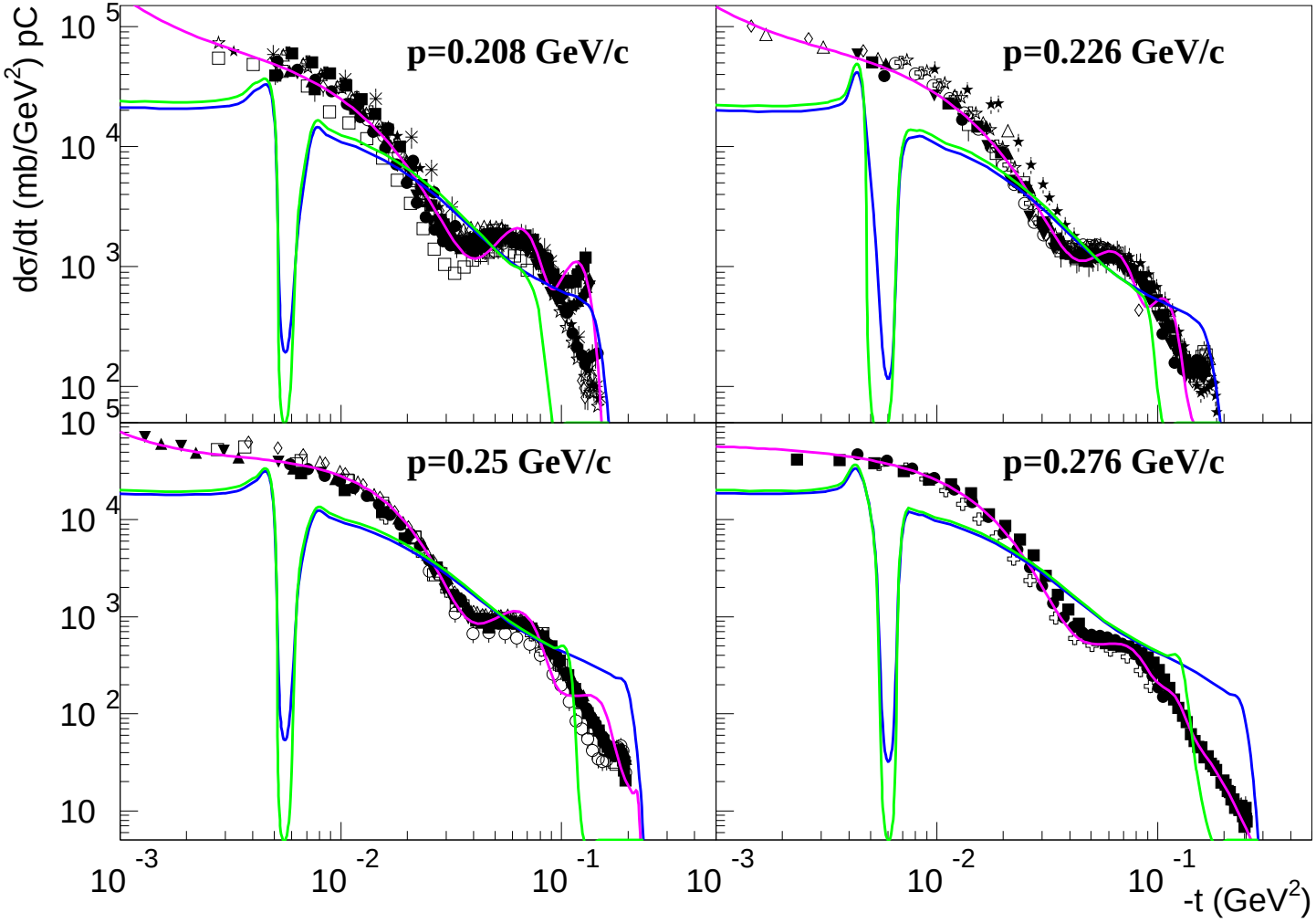

p=0.05 GeV/c
p=0.054 GeV/c
p=0.0555 GeV/c
p=0.0562 GeV/c
dσ/dt (mb/GeV²) pC
10 5
10 5
10 4
10 -2
10 -2
-t (GeV²)

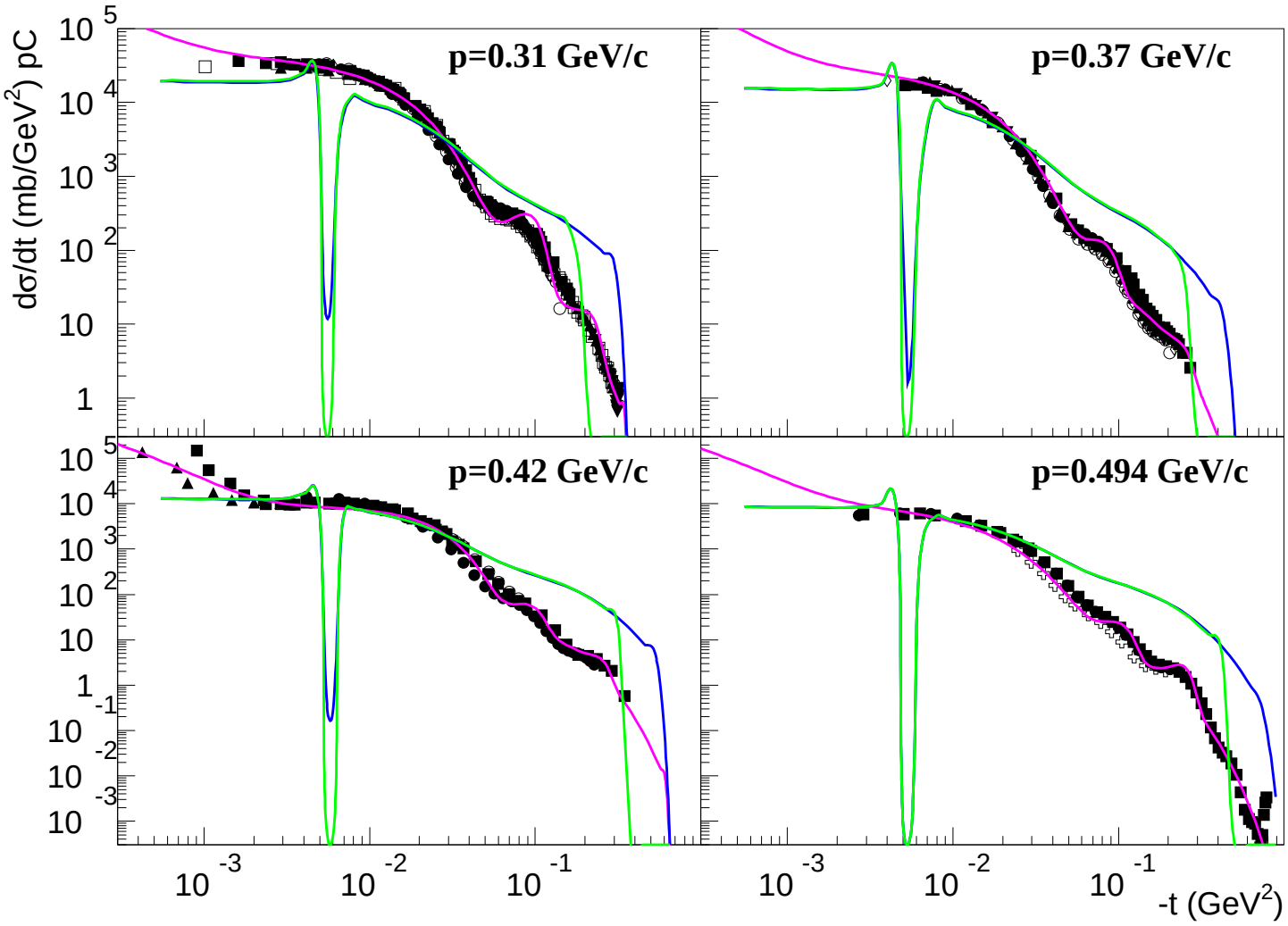

p=0.0567 GeV/c
p=0.0572 GeV/c
p=0.0577 GeV/c
p=0.0588 GeV/c
dσ/dt (mb/GeV²) pC
10 6
10 5
10 4
10 5
10 4
10 -2
10 -2
-t (GeV²)

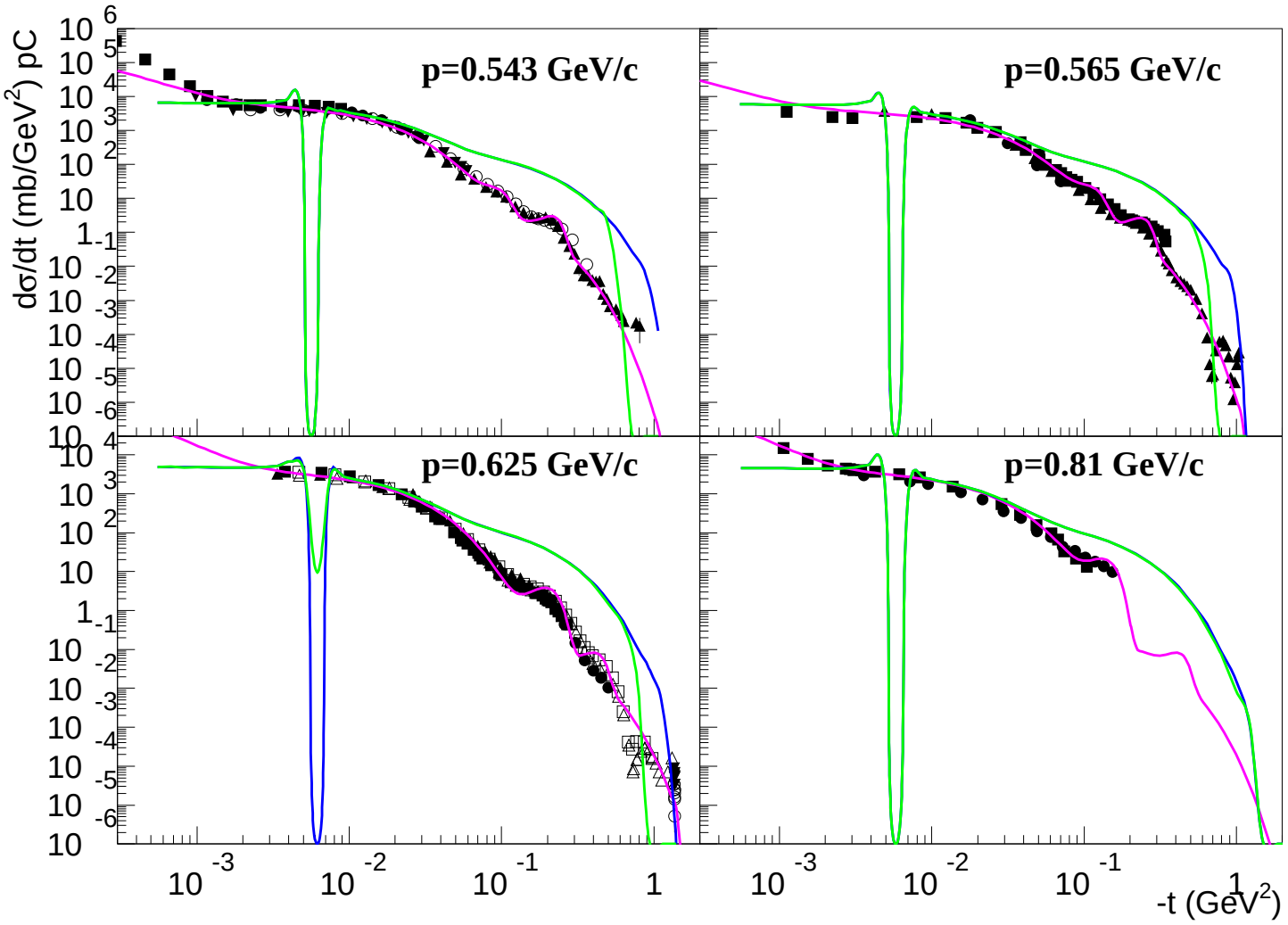

p=0.0615 GeV/c
p=0.065 GeV/c
p=0.069 GeV/c
p=0.074 GeV/c
dσ/dt (mb/GeV²) pC
10 5
10 5
10 -3
10 -2
10 -3
10 -2
-t (GeV²)

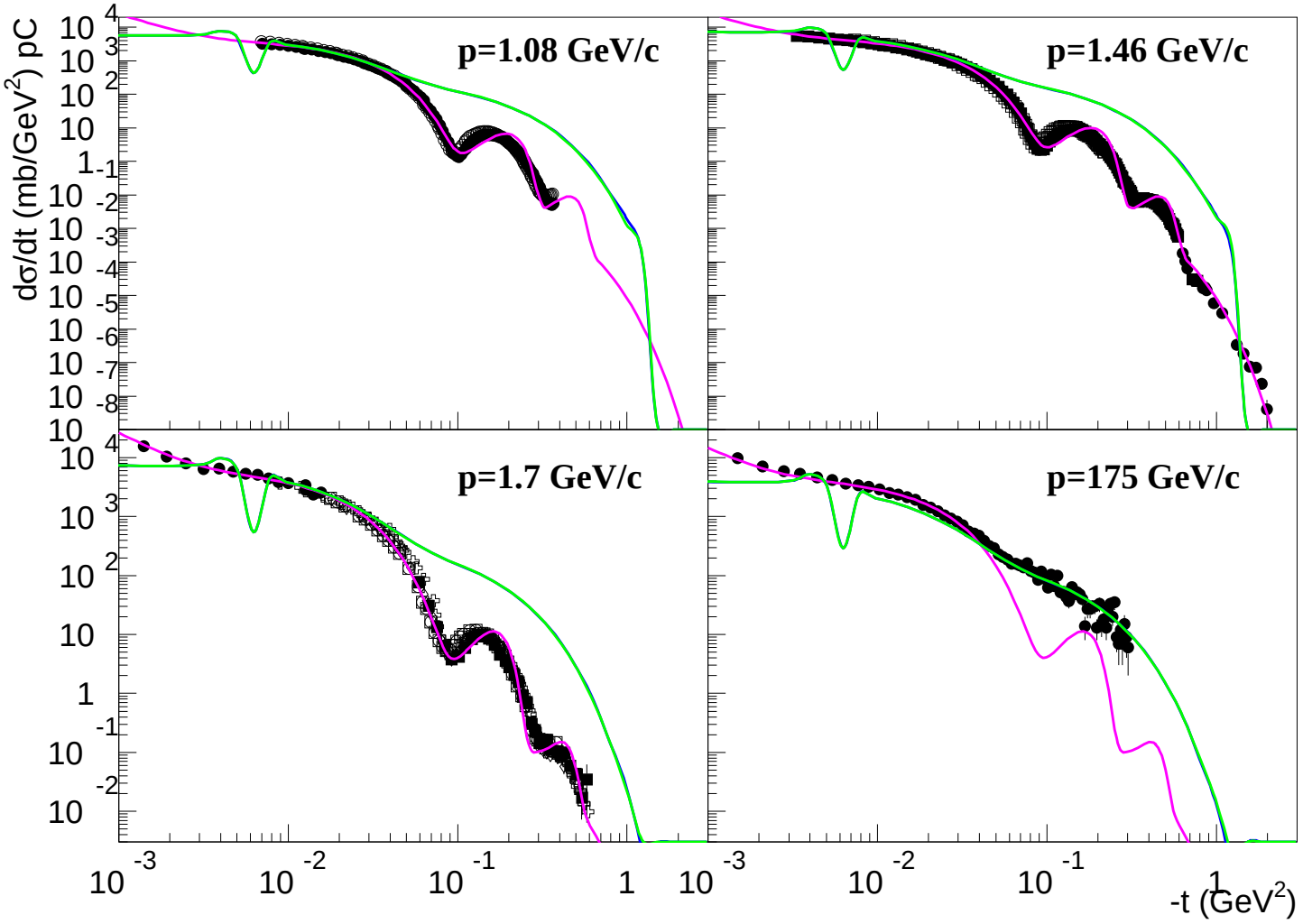

p=0.0864 GeV/c
p=0.0969 GeV/c
p=0.108 GeV/c
p=0.127 GeV/c
dσ/dt (mb/GeV²) pC
10 5
10 4
10 -3
10 -2
-t (GeV²)

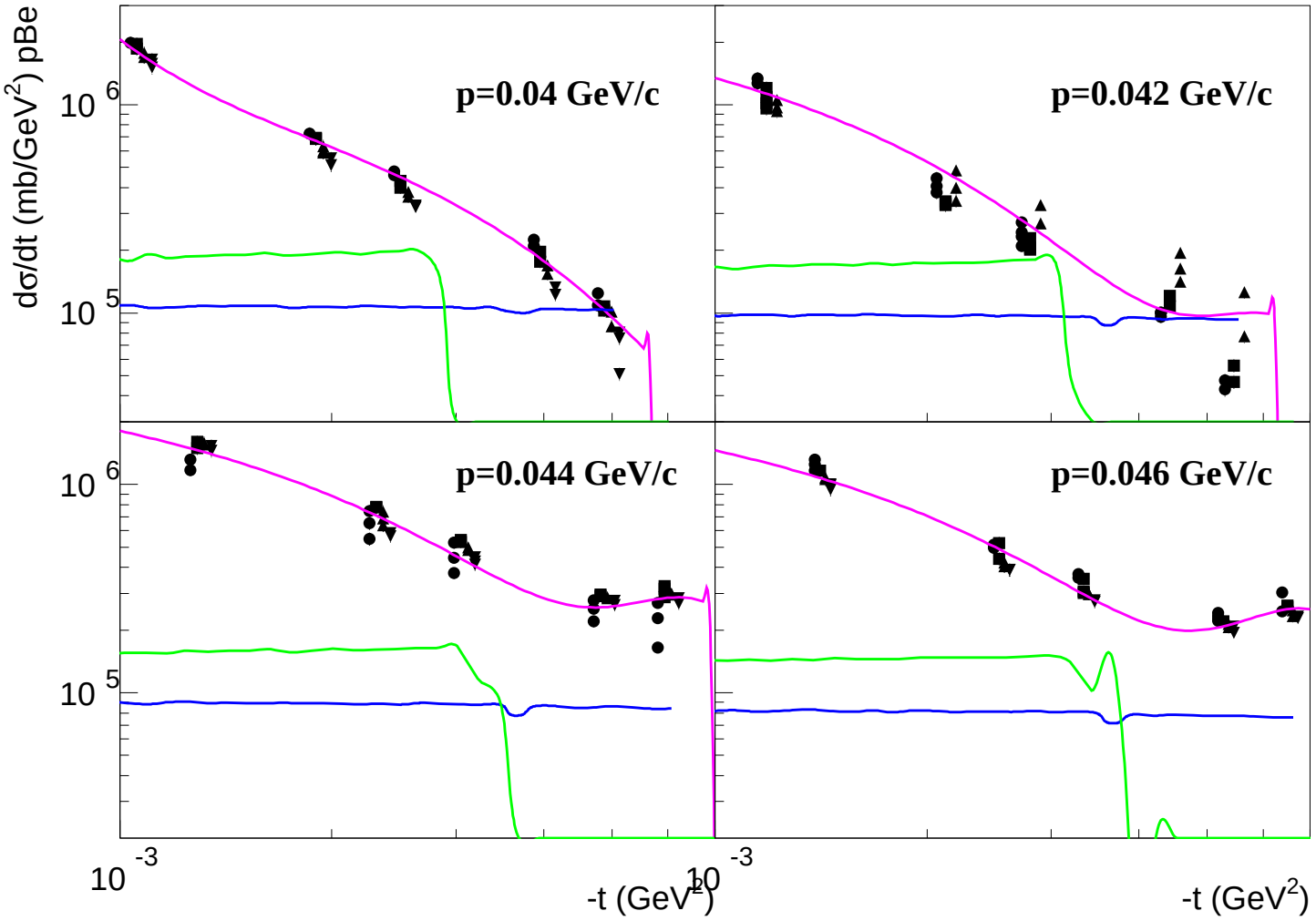

p=0.139 GeV/c
p=0.157 GeV/c
p=0.171 GeV/c
p=0.188 GeV/c
dσ/dt (mb/GeV²) pC
-t (GeV²)

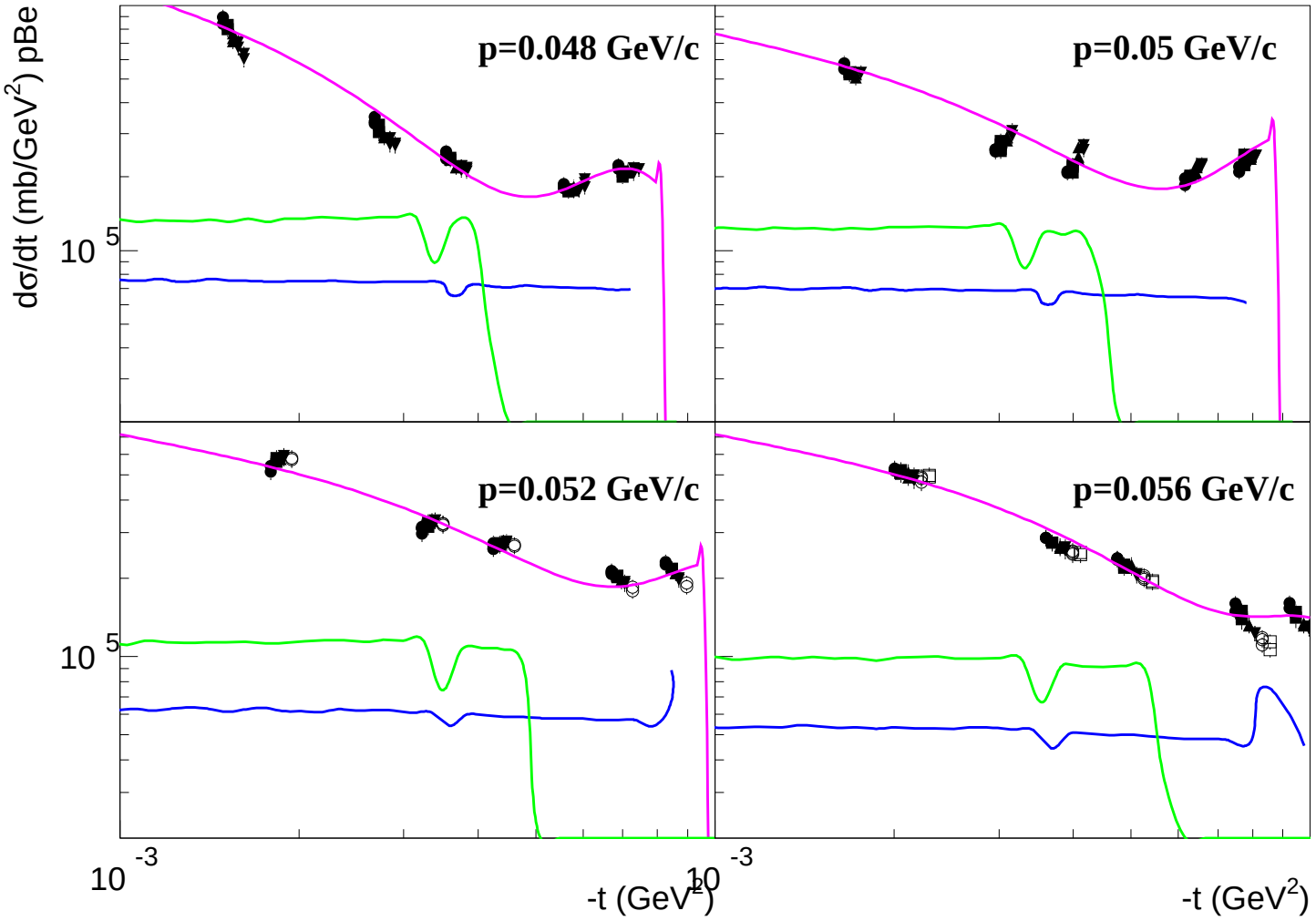

p=0.208 GeV/c
p=0.226 GeV/c
p=0.25 GeV/c
p=0.276 GeV/c
dσ/dt (mb/GeV²) pC
-t (GeV²)

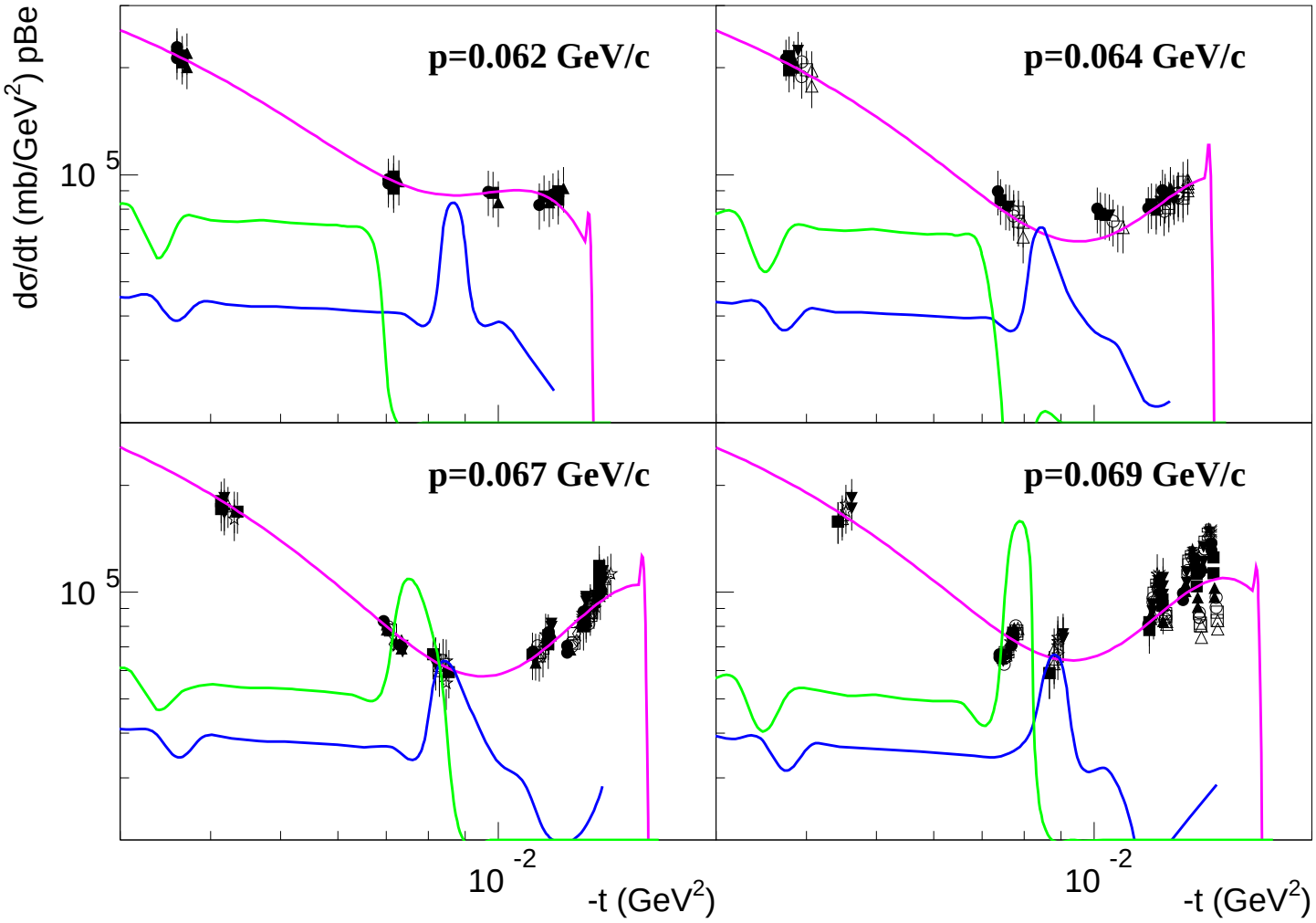

p=0.31 GeV/c
p=0.37 GeV/c
p=0.42 GeV/c
p=0.494 GeV/c
dσ/dt (mb/GeV²) pC
-t (GeV²)

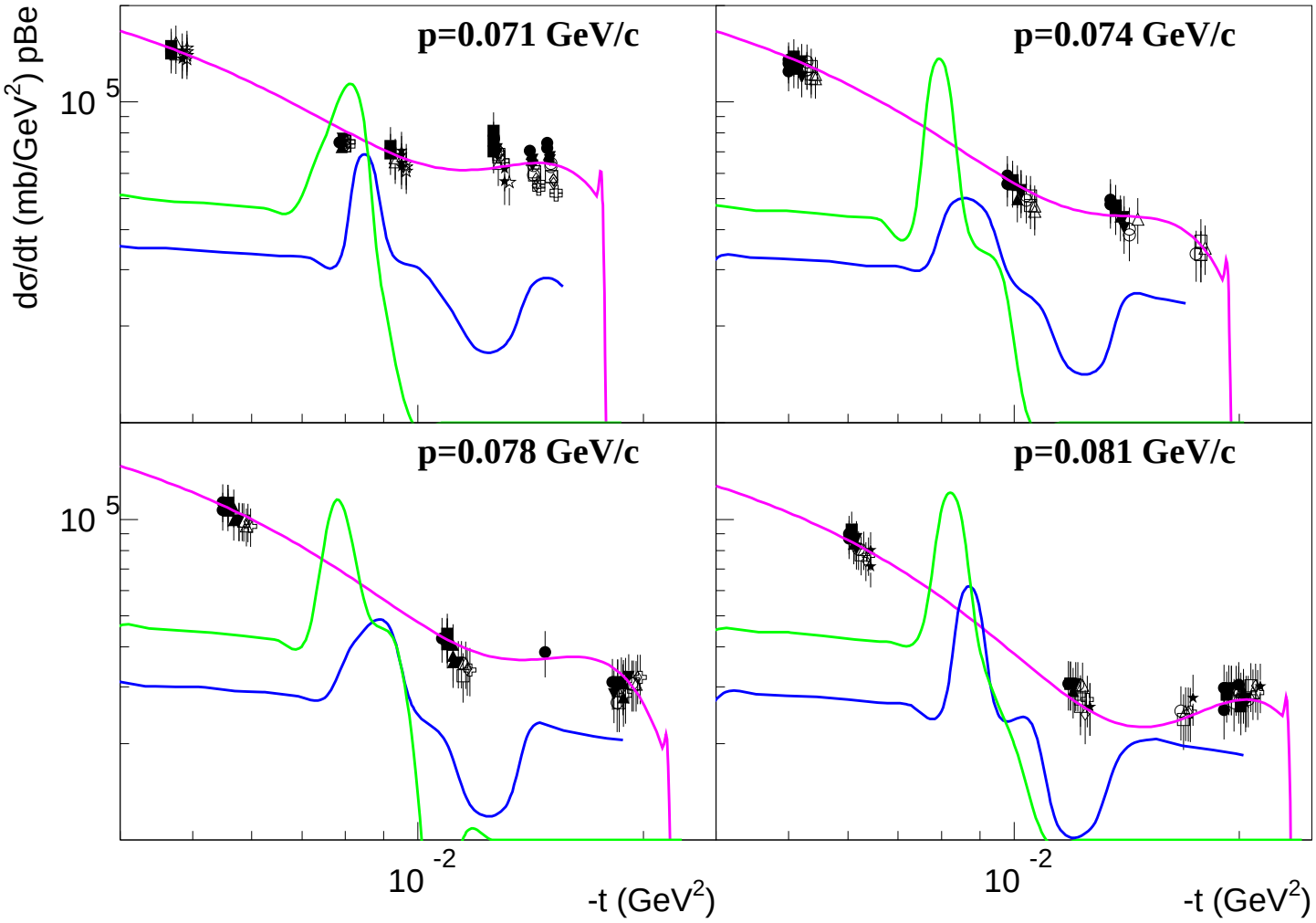

p=0.543 GeV/c
p=0.565 GeV/c
p=0.625 GeV/c
p=0.81 GeV/c
dσ/dt (mb/GeV²) pC
-t (GeV²)

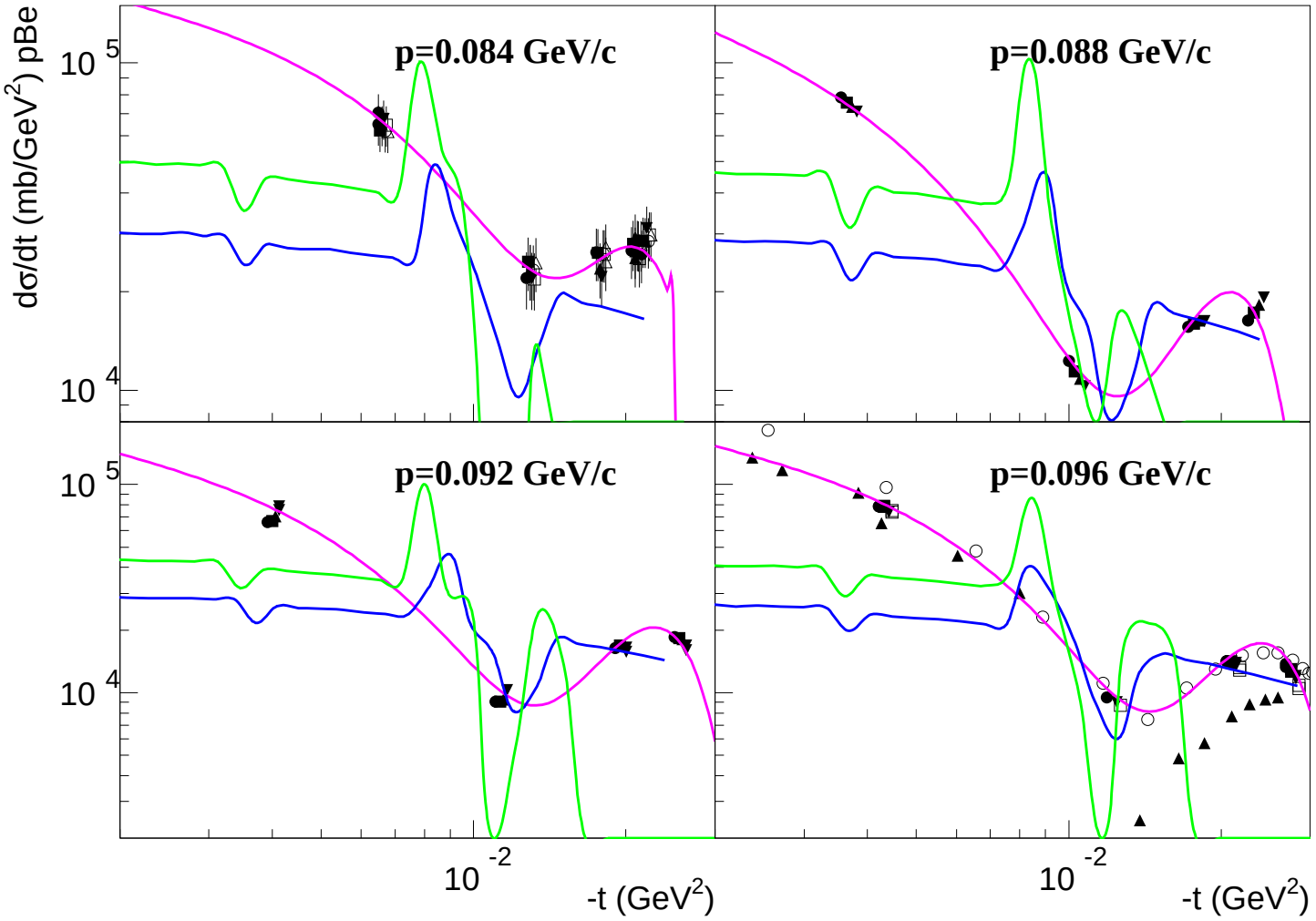

p=1.08 GeV/c
p=1.46 GeV/c
p=1.7 GeV/c
p=175 GeV/c
dσ/dt (mb/GeV²) pC
-t (GeV²)

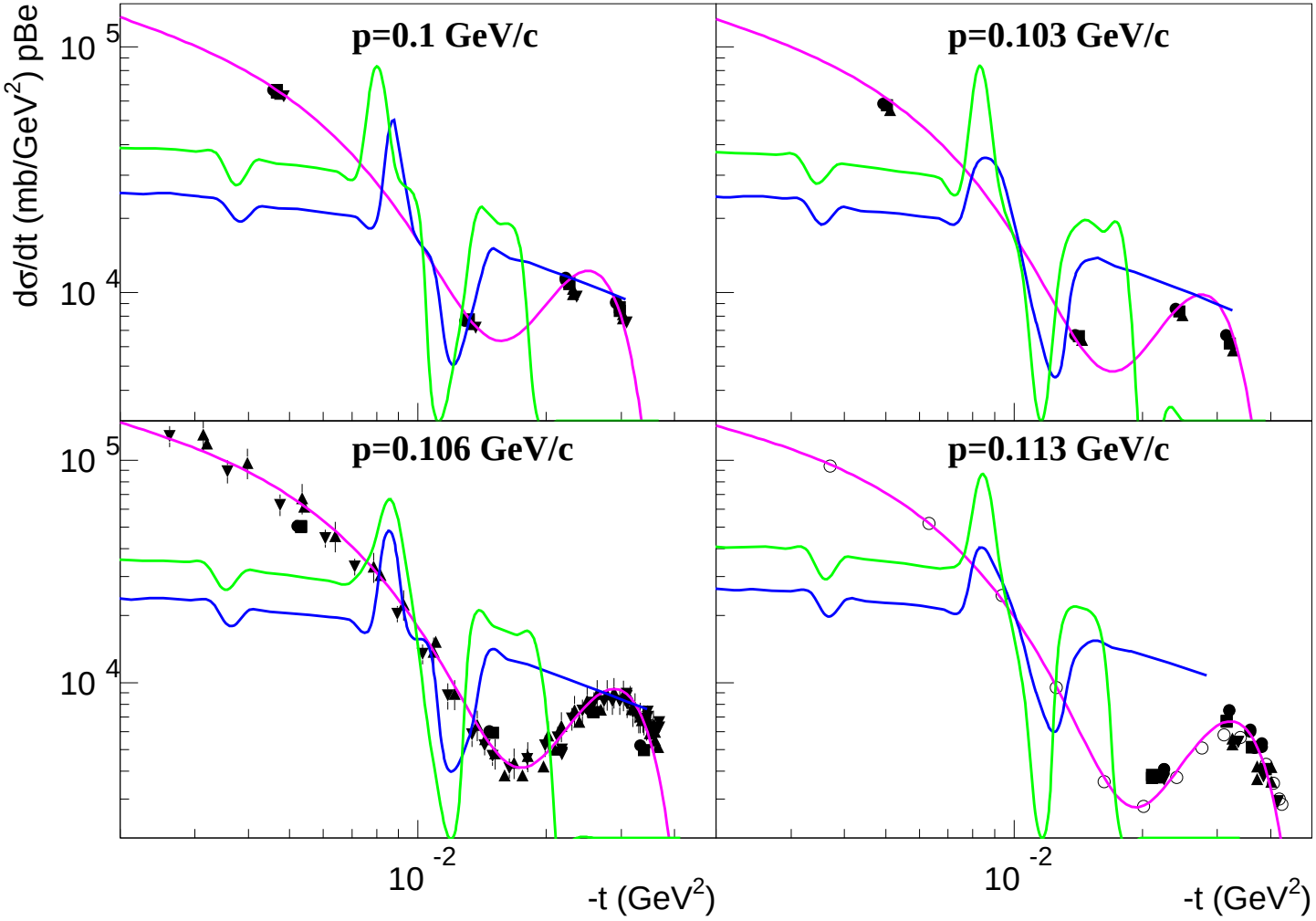

dσ/dt (mb/GeV^2) pBe
p=0.04 GeV/c
p=0.042 GeV/c
p=0.044 GeV/c
p=0.046 GeV/c
10^6
10^5
10^{-3}
10^{-2}
-t (GeV^2)

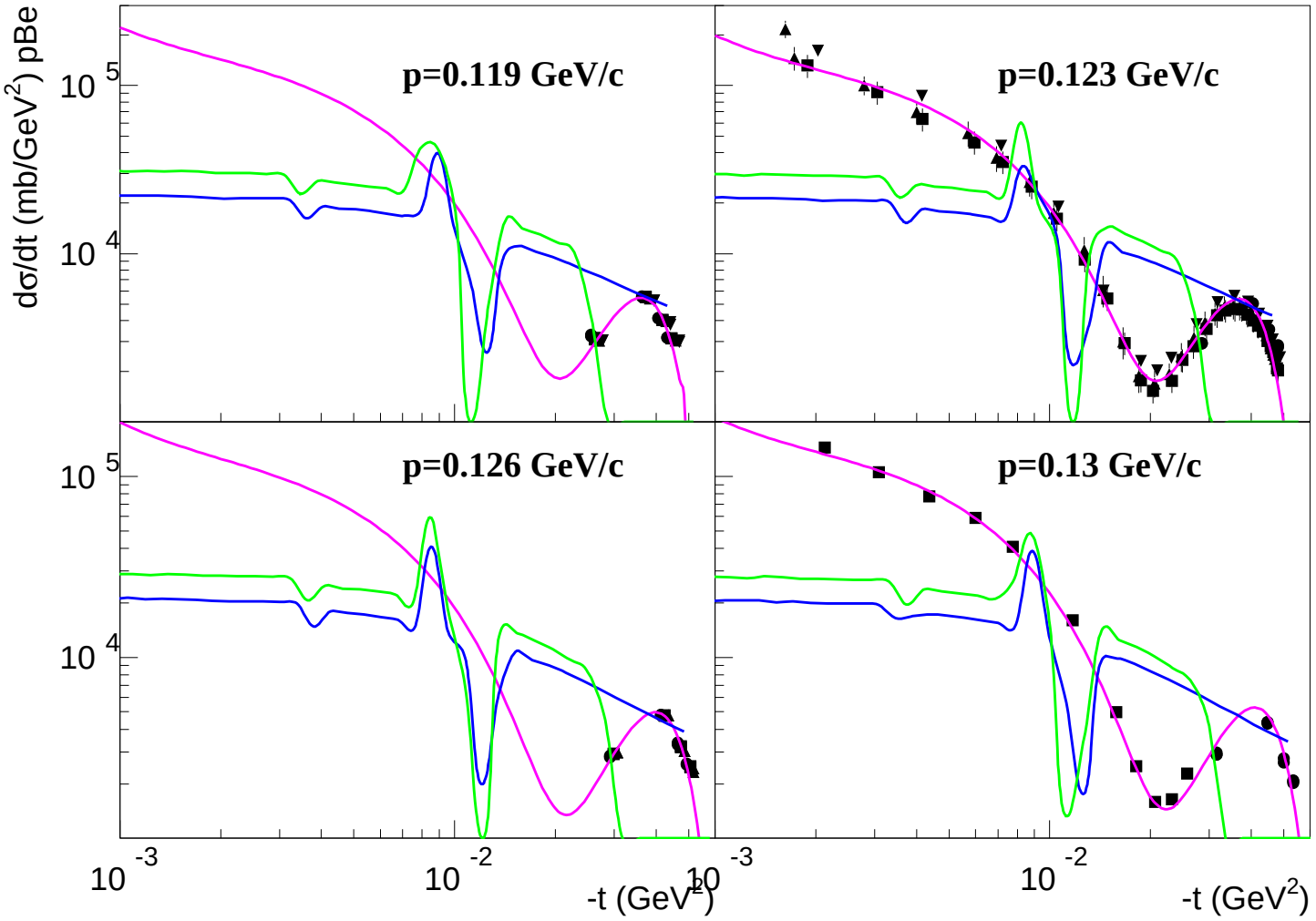

p=0.048 GeV/c
p=0.05 GeV/c
p=0.052 GeV/c
p=0.056 GeV/c
dσ/dt (mb/GeV²) pBe
10 5
10 5
10 -3
10 -3
-t (GeV²)
-t (GeV²)

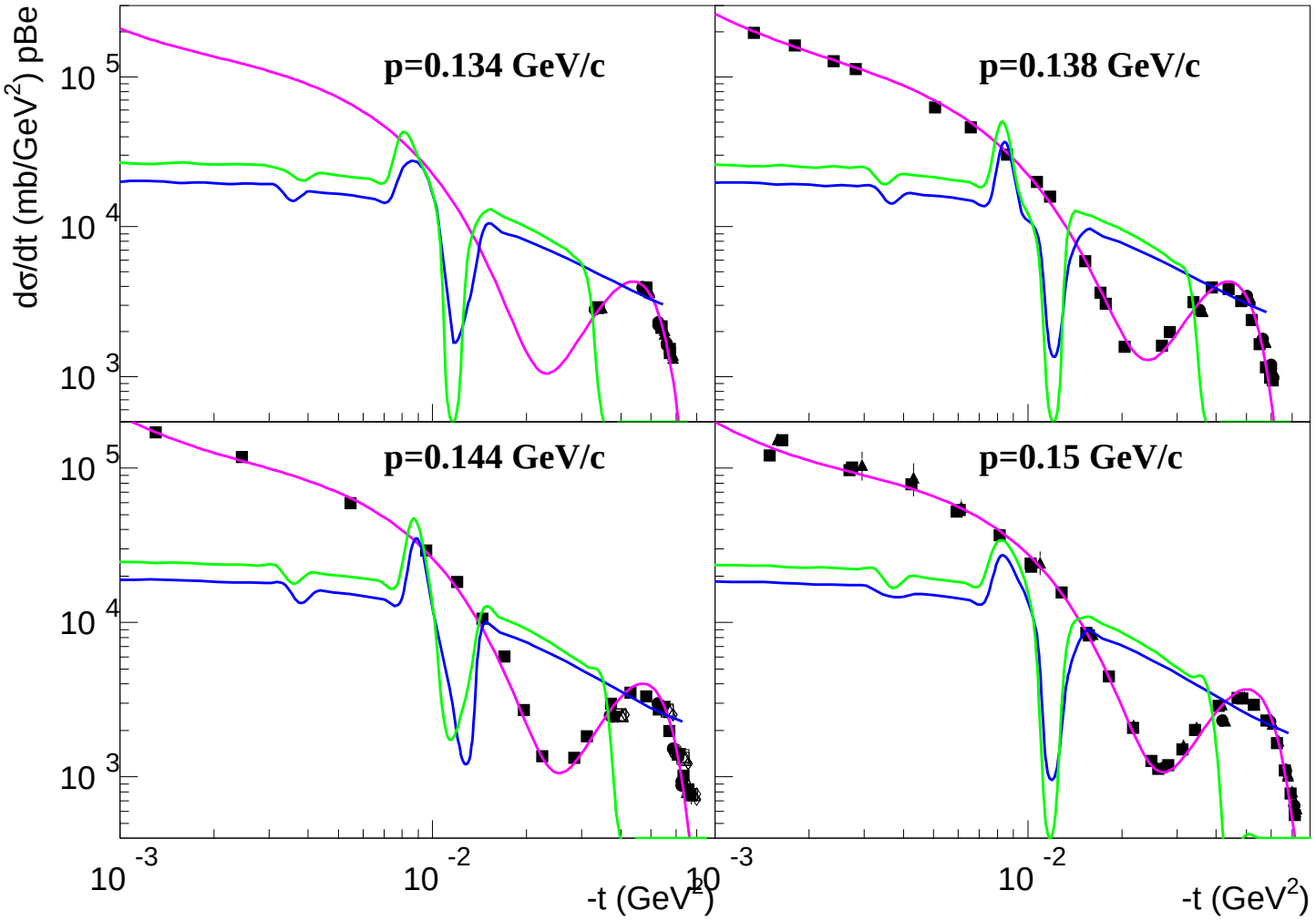

p=0.062 GeV/c
p=0.064 GeV/c
p=0.067 GeV/c
p=0.069 GeV/c
dσ/dt (mb/GeV^2) pBe
10 5
10 5
10 -2
10 -2
-t (GeV^2)
-t (GeV^2)

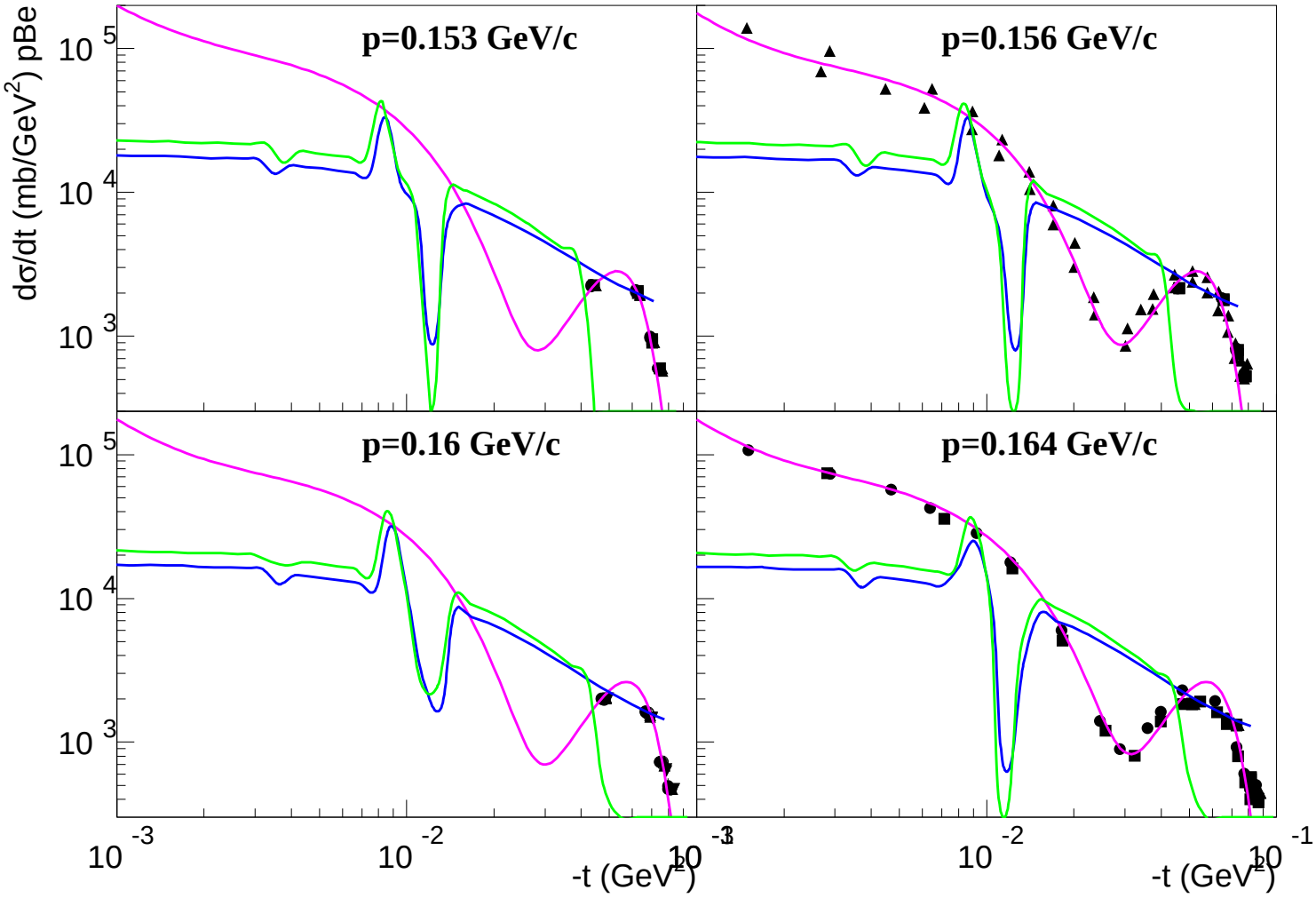

p=0.071 GeV/c
p=0.074 GeV/c
p=0.078 GeV/c
p=0.081 GeV/c
dσ/dt (mb/GeV^2) pBe
10 5
10 -2
-t (GeV^2)

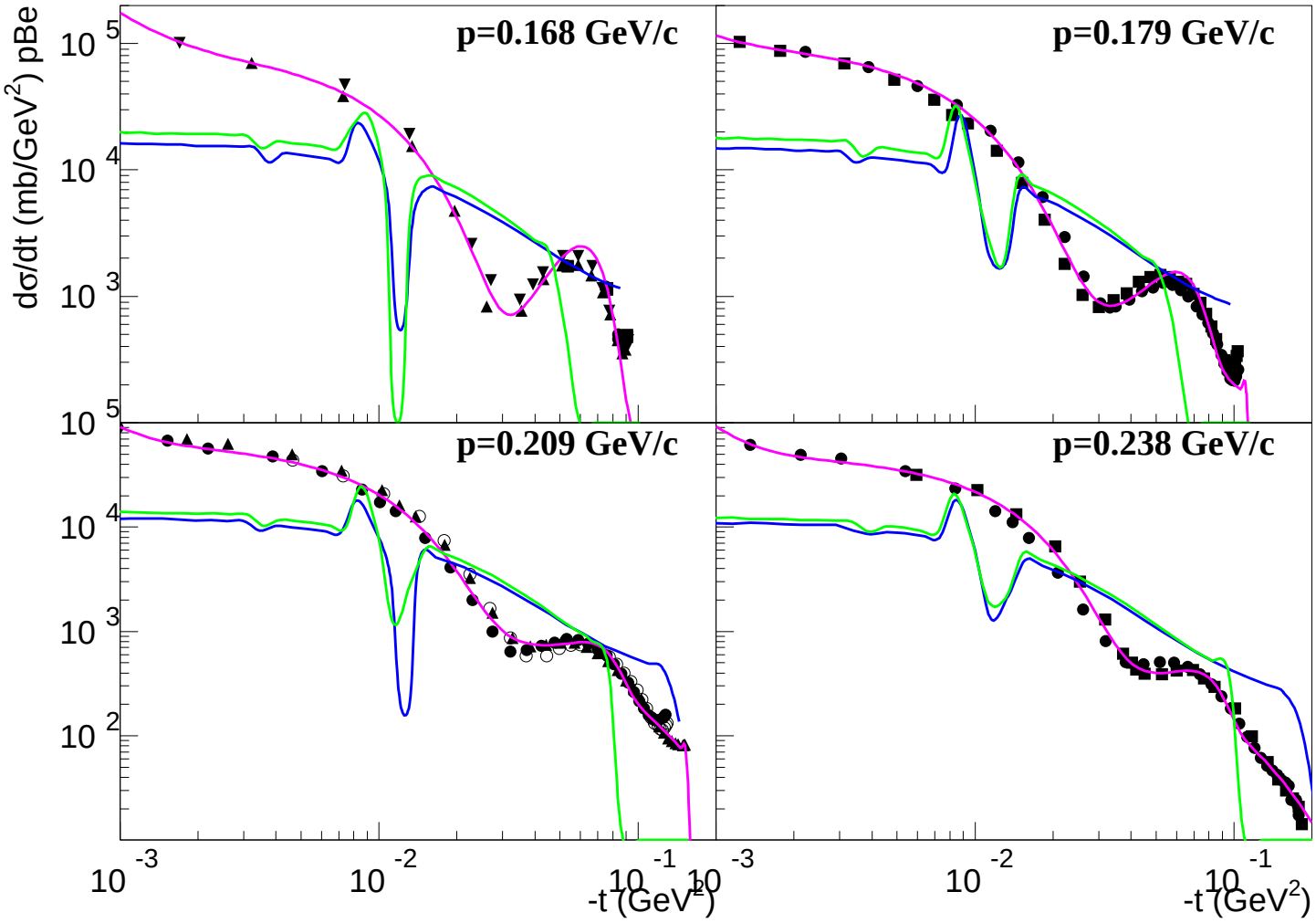

dσ/dt (mb/GeV^2) pBe
p=0.084 GeV/c
p=0.088 GeV/c
p=0.092 GeV/c
p=0.096 GeV/c
10^5
10^4
10^{-2}
-t (GeV^2)

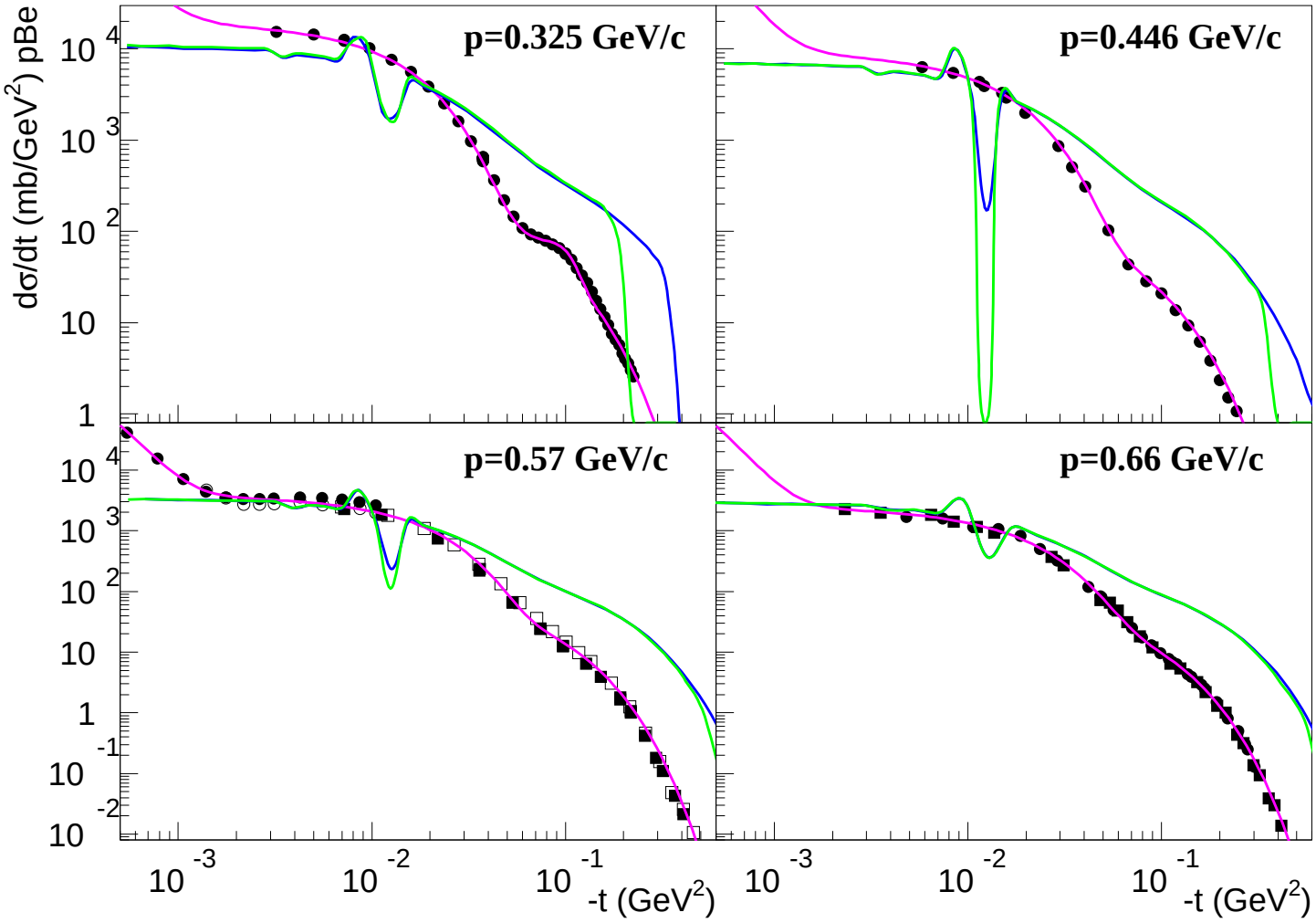

p=0.1 GeV/c
p=0.103 GeV/c
p=0.106 GeV/c
p=0.113 GeV/c
dσ/dt (mb/GeV^2) pBe
10^5
10^4
10^{-2}
-t (GeV^2)

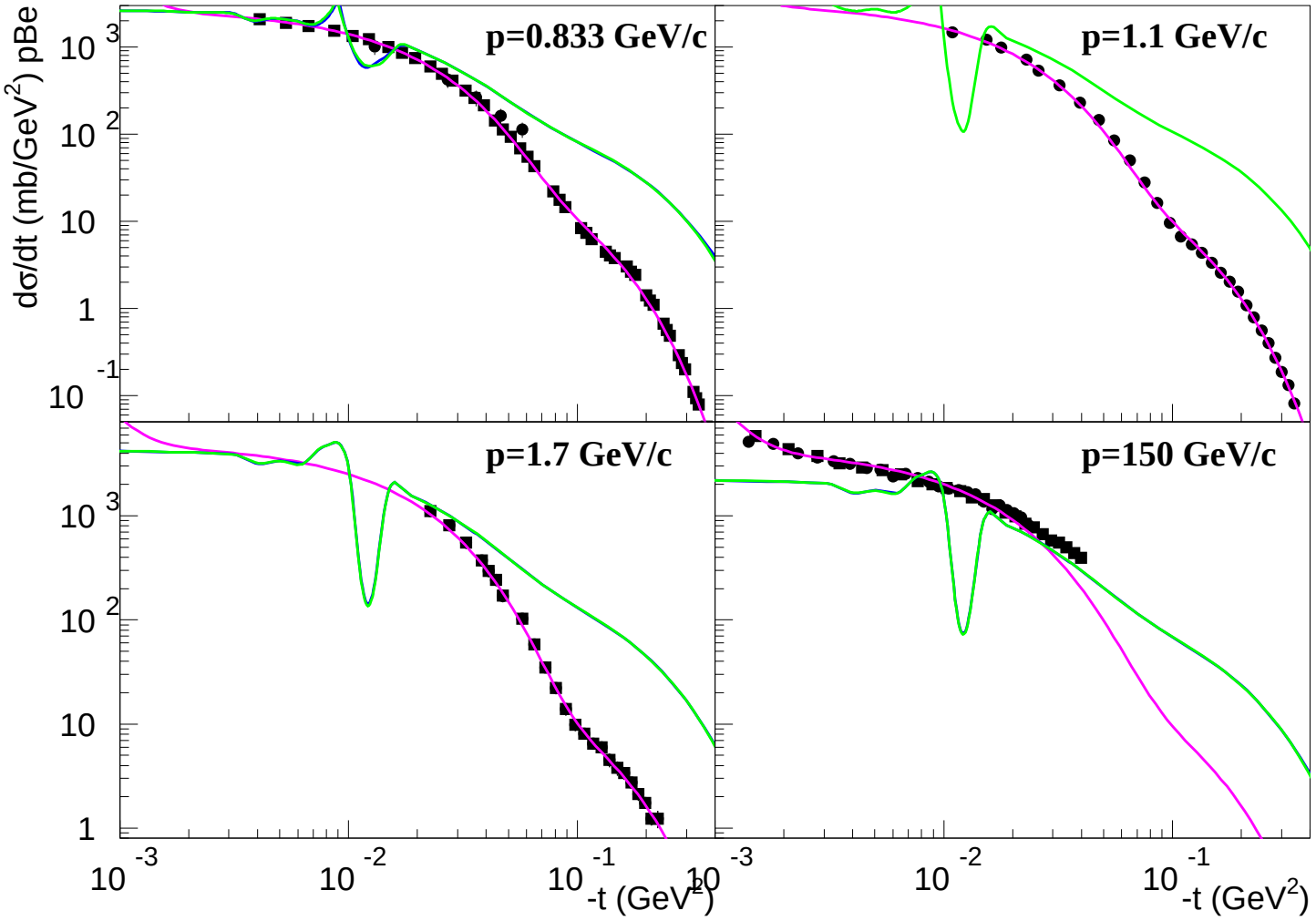

dσ/dt (mb/GeV^2) pBe
p=0.119 GeV/c
p=0.123 GeV/c
p=0.126 GeV/c
p=0.13 GeV/c
-t (GeV^2)
-t (GeV^2)

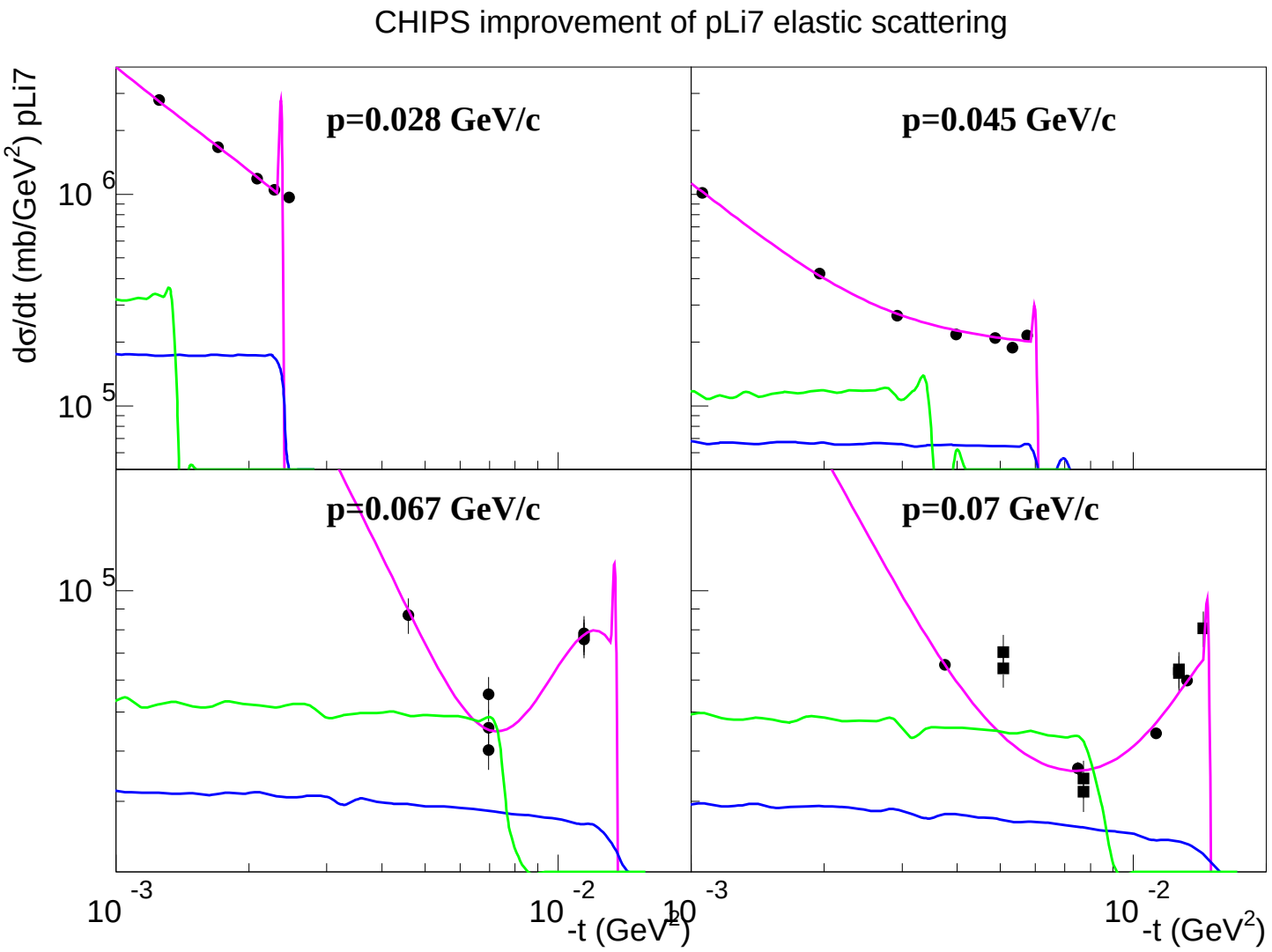

p=0.134 GeV/c
p=0.138 GeV/c
p=0.144 GeV/c
p=0.15 GeV/c
dσ/dt (mb/GeV²) pBe
-t (GeV²)
-t (GeV²)

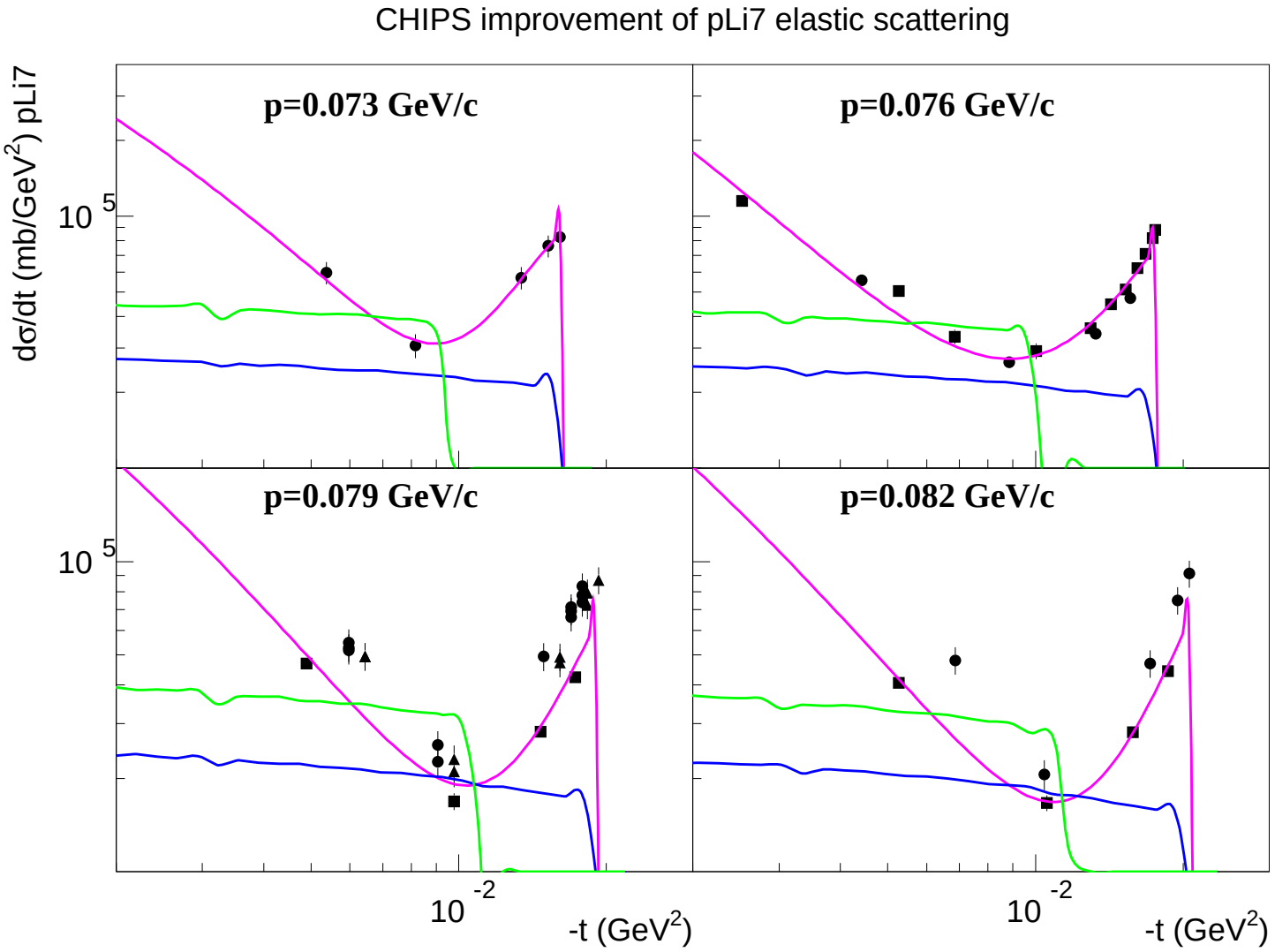

p=0.153 GeV/c
p=0.156 GeV/c
p=0.16 GeV/c
p=0.164 GeV/c
dσ/dt (mb/GeV²) pBe
-t (GeV²)
-t (GeV²)

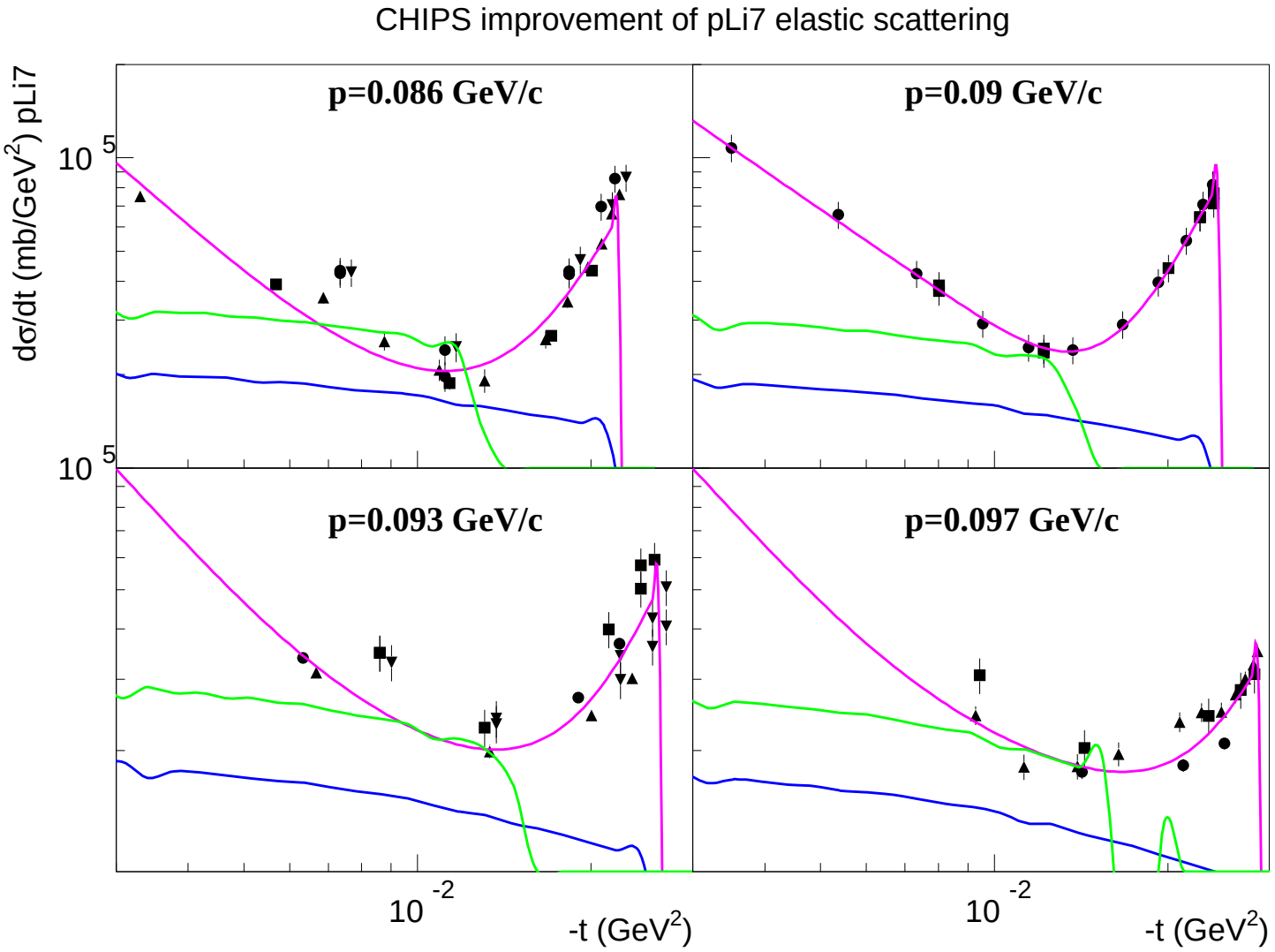

p=0.168 GeV/c
p=0.179 GeV/c
p=0.209 GeV/c
p=0.238 GeV/c
dσ/dt (mb/GeV²) pBe
-t (GeV²)
-t (GeV²)

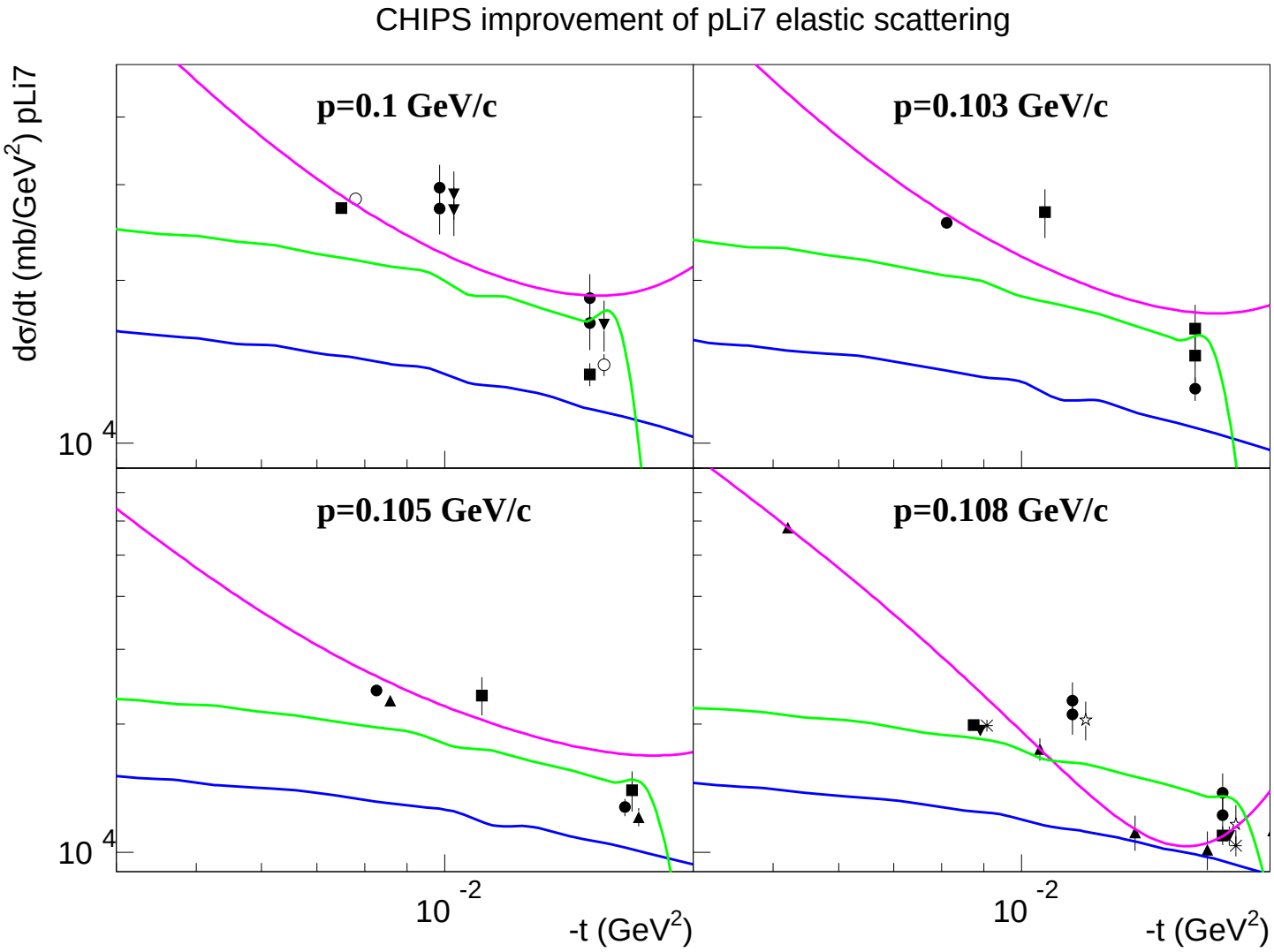

p=0.325 GeV/c
p=0.446 GeV/c
p=0.57 GeV/c
p=0.66 GeV/c
dσ/dt (mb/GeV²) pBe
-t (GeV²)
-t (GeV²)

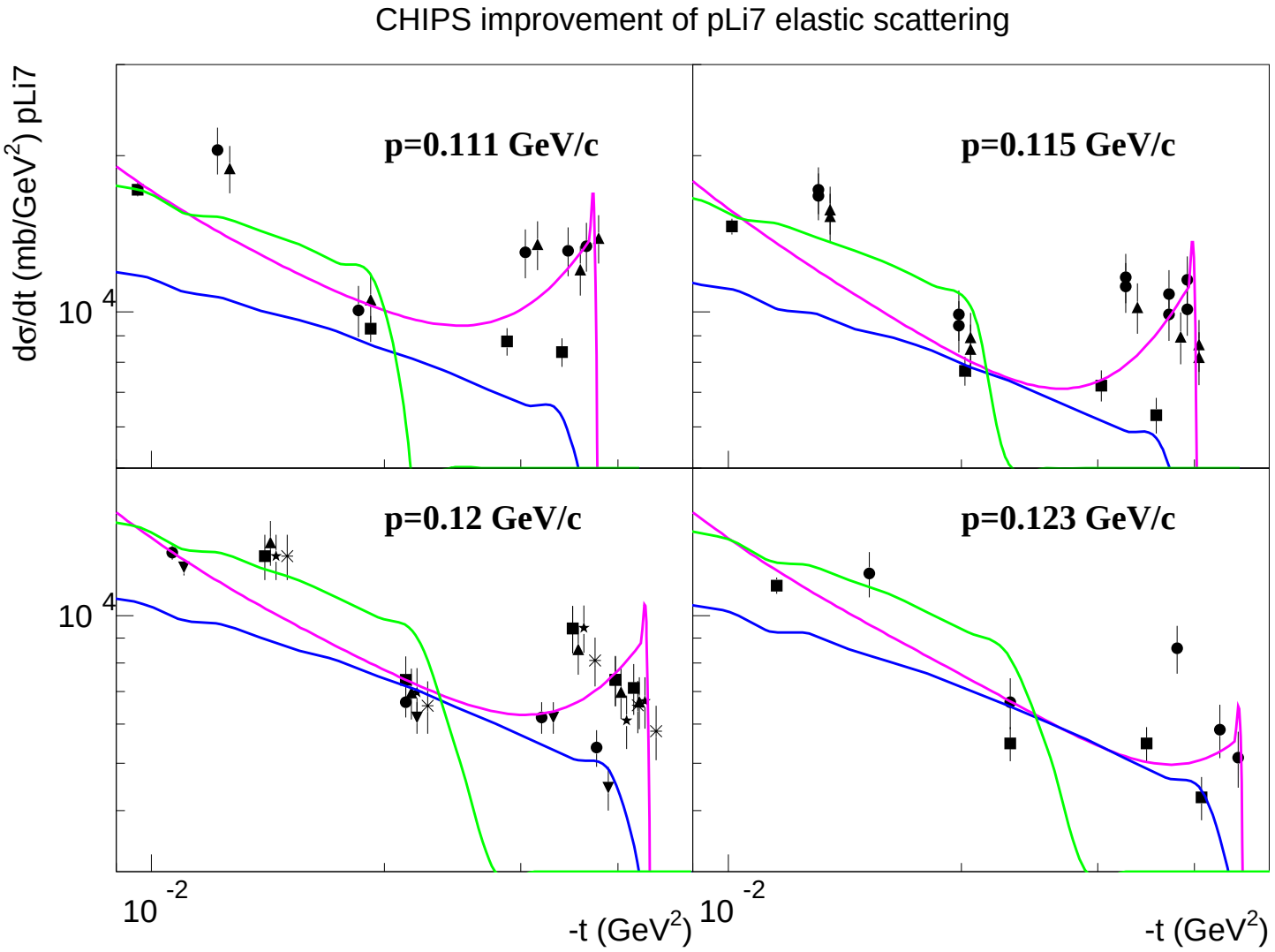

p=0.833 GeV/c
p=1.1 GeV/c
p=1.7 GeV/c
p=150 GeV/c
dσ/dt (mb/GeV²) pBe
-t (GeV²)
-t (GeV²)

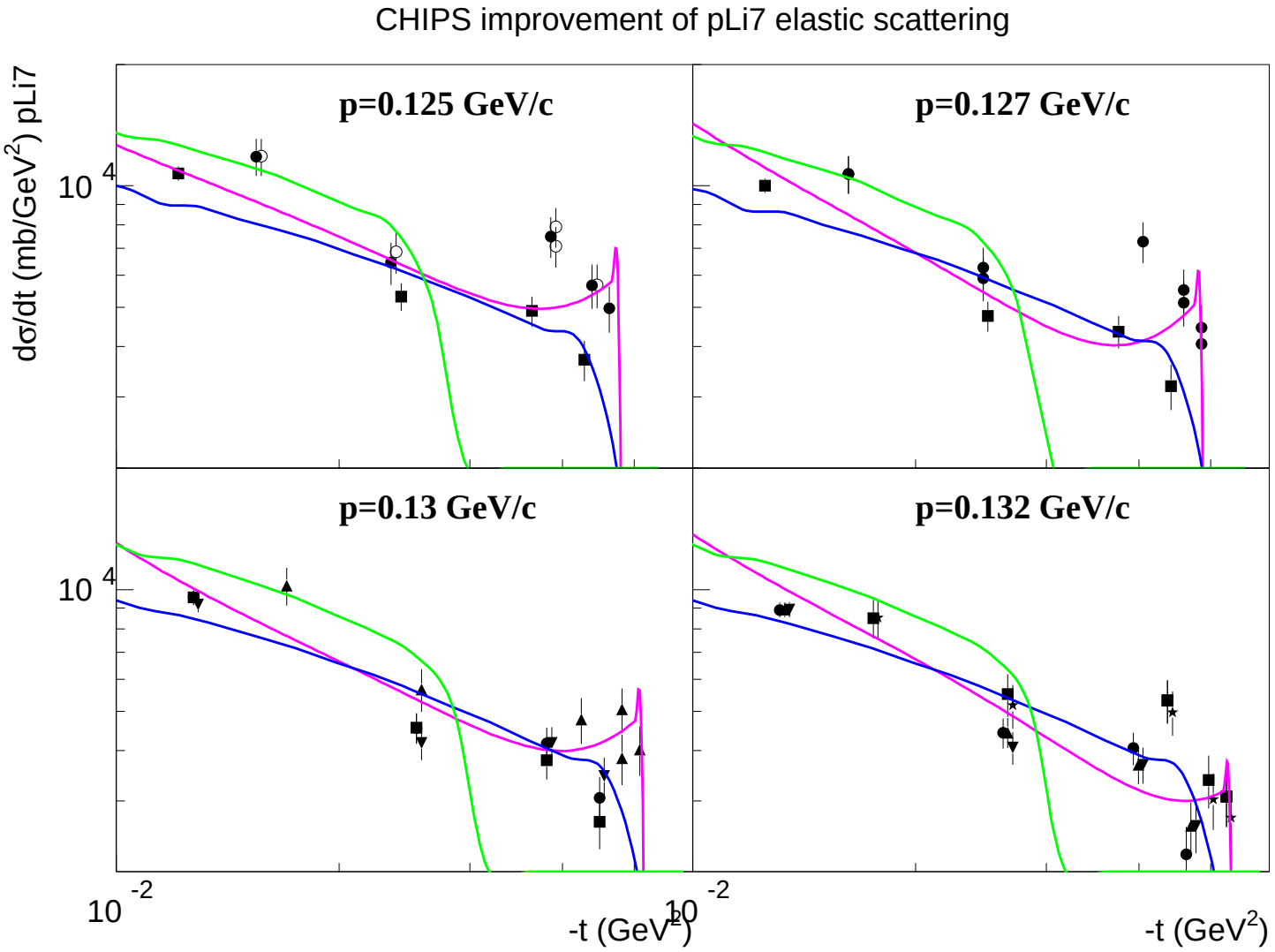

CHIPS improvement of pLi7 elastic scattering
dσ/dt (mb/GeV²) pLi7
p=0.028 GeV/c
p=0.045 GeV/c
p=0.067 GeV/c
p=0.07 GeV/c
10⁶
10⁵
10⁵
10⁻³
10⁻²
-t (GeV²)
10⁻³
10⁻²
-t (GeV²)

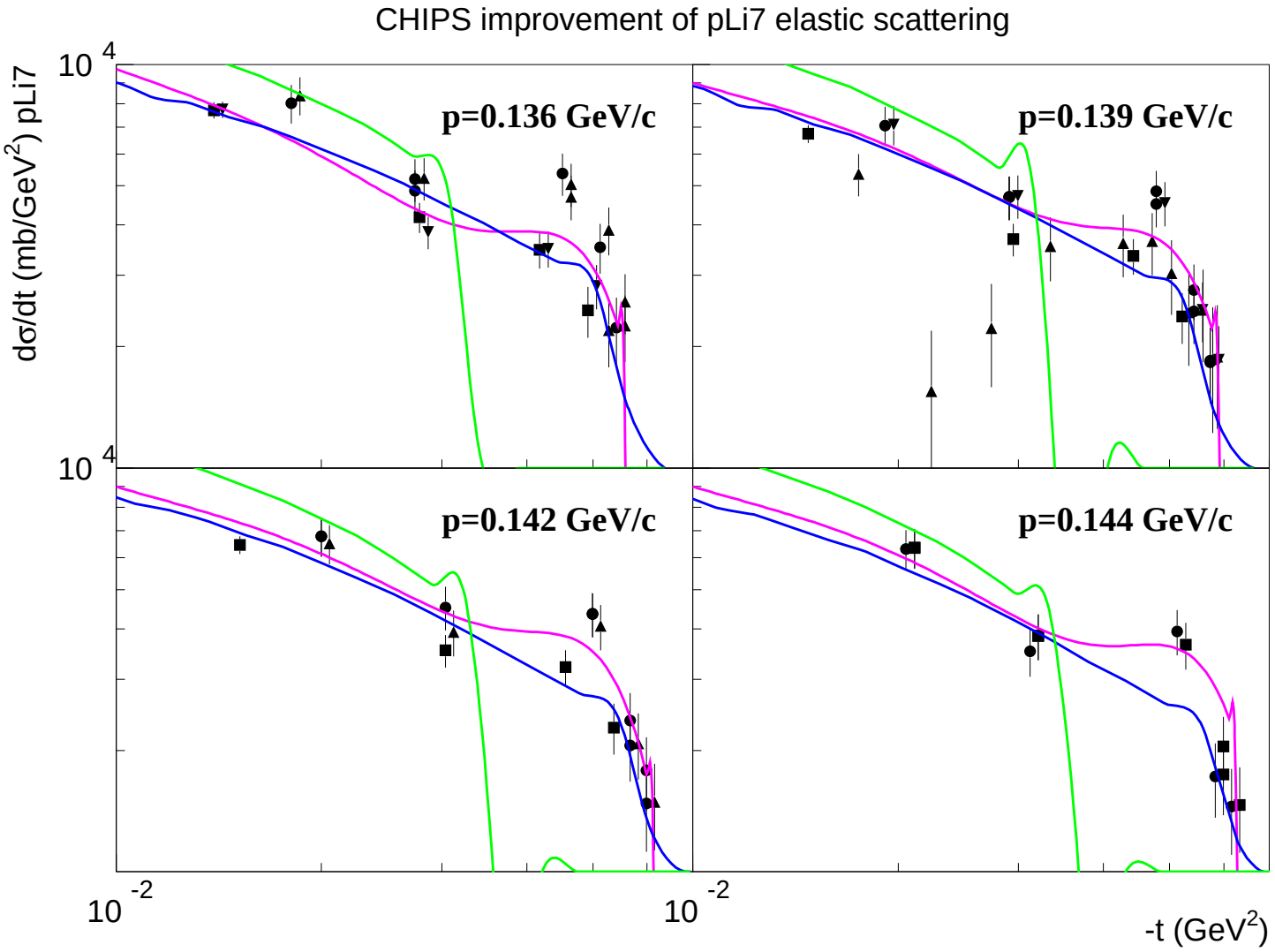

CHIPS improvement of pLi7 elastic scattering
dσ/dt (mb/GeV^2) pLi7
p=0.073 GeV/c
p=0.076 GeV/c
p=0.079 GeV/c
p=0.082 GeV/c
10 5
10 5
10 -2
10 -2
-t (GeV^2)
-t (GeV^2)

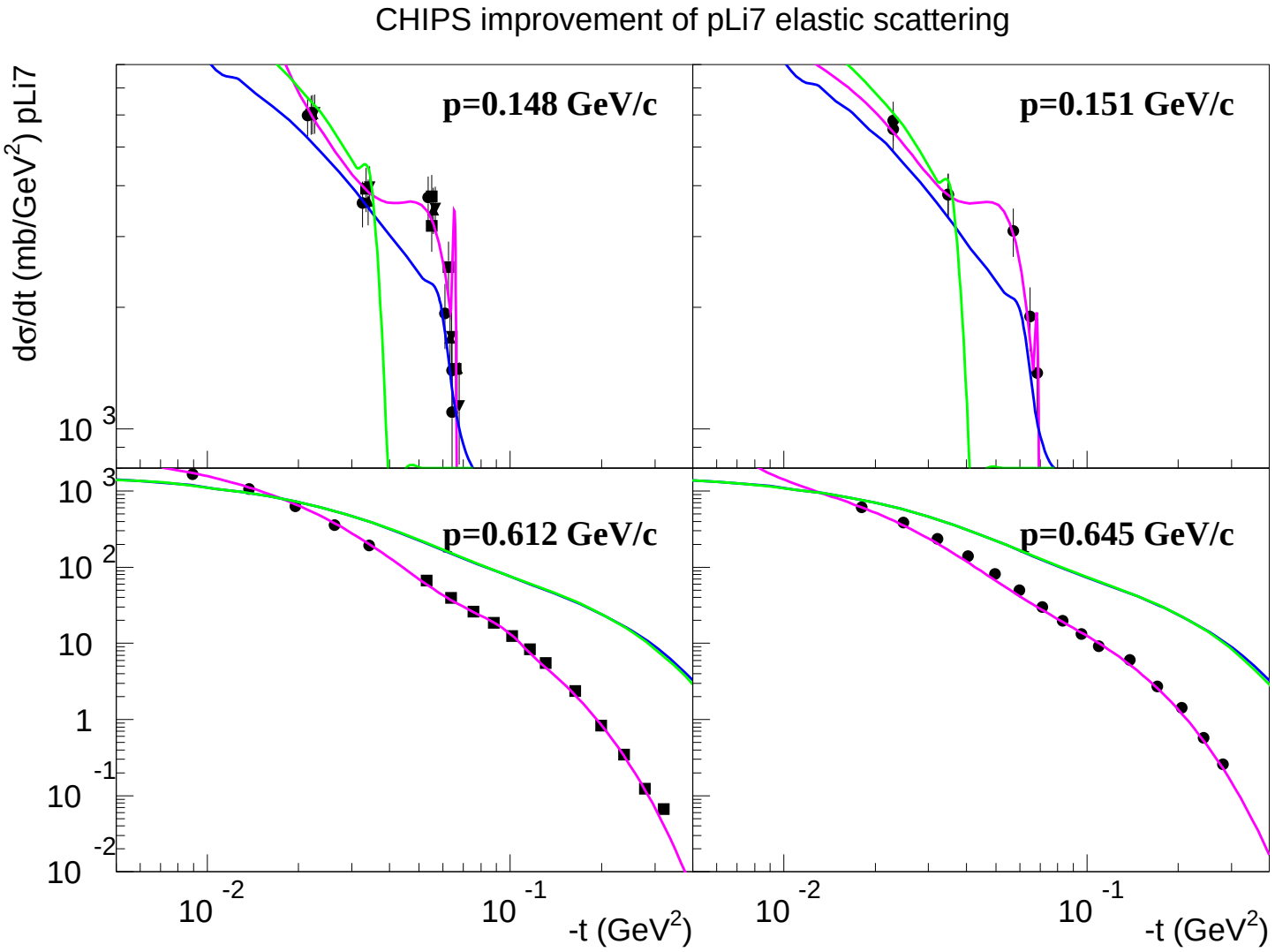

CHIPS improvement of pLi7 elastic scattering
dσ/dt (mb/GeV²) pLi7
p=0.086 GeV/c
p=0.09 GeV/c
p=0.093 GeV/c
p=0.097 GeV/c
10 5
10 5
10 -2
10 -2
-t (GeV²)
-t (GeV²)


CHIPS improvement of pLi7 elastic scattering
dσ/dt (mb/GeV^2) pLi7
p=0.1 GeV/c
p=0.103 GeV/c
p=0.105 GeV/c
p=0.108 GeV/c
10 4
10 4
10 -2
10 -2
-t (GeV^2)
-t (GeV^2)


CHIPS improvement of pLi7 elastic scattering
dσ/dt (mb/GeV^2) pLi7
p=0.111 GeV/c
p=0.115 GeV/c
p=0.12 GeV/c
p=0.123 GeV/c
10 4
10 4
10 -2
10 -2
-t (GeV^2)
-t (GeV^2)


CHIPS improvement of pLi7 elastic scattering
p=0.125 GeV/c
p=0.127 GeV/c
p=0.13 GeV/c
p=0.132 GeV/c
dσ/dt (mb/GeV²) pLi7
10 4
10 -2
-t (GeV²)


CHIPS improvement of pLi7 elastic scattering
dσ/dt (mb/GeV^2) pLi7
10^4
10^4
p=0.136 GeV/c
p=0.139 GeV/c
p=0.142 GeV/c
p=0.144 GeV/c
10^{-2}
10^{-2}
-t (GeV^2)


CHIPS improvement of pLi7 elastic scattering
dσ/dt (mb/GeV²) pLi7
p=0.148 GeV/c
p=0.151 GeV/c
p=0.612 GeV/c
p=0.645 GeV/c
-t (GeV²)
-t (GeV²)

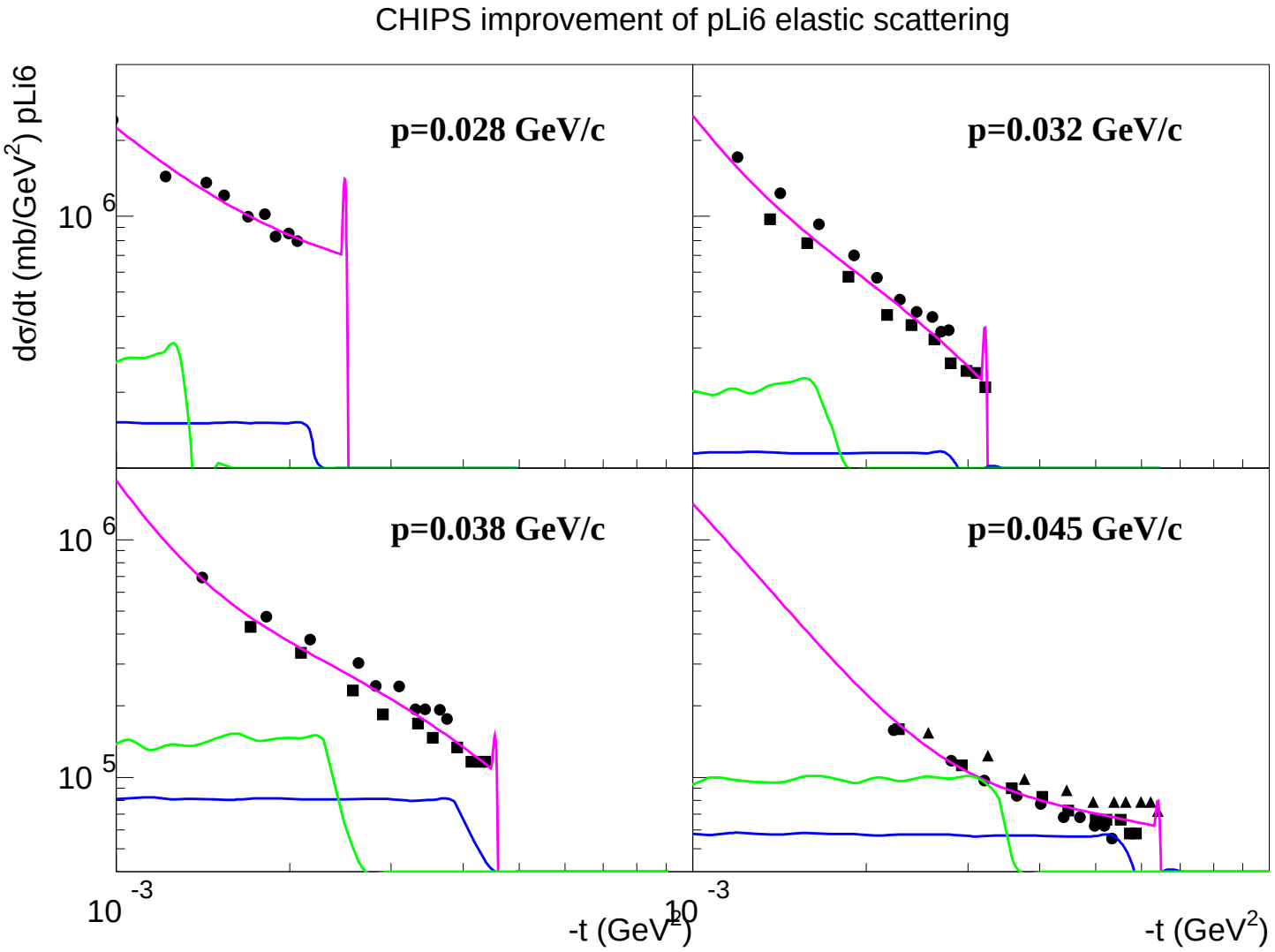
Approximation of pA elastic scattering for A<7

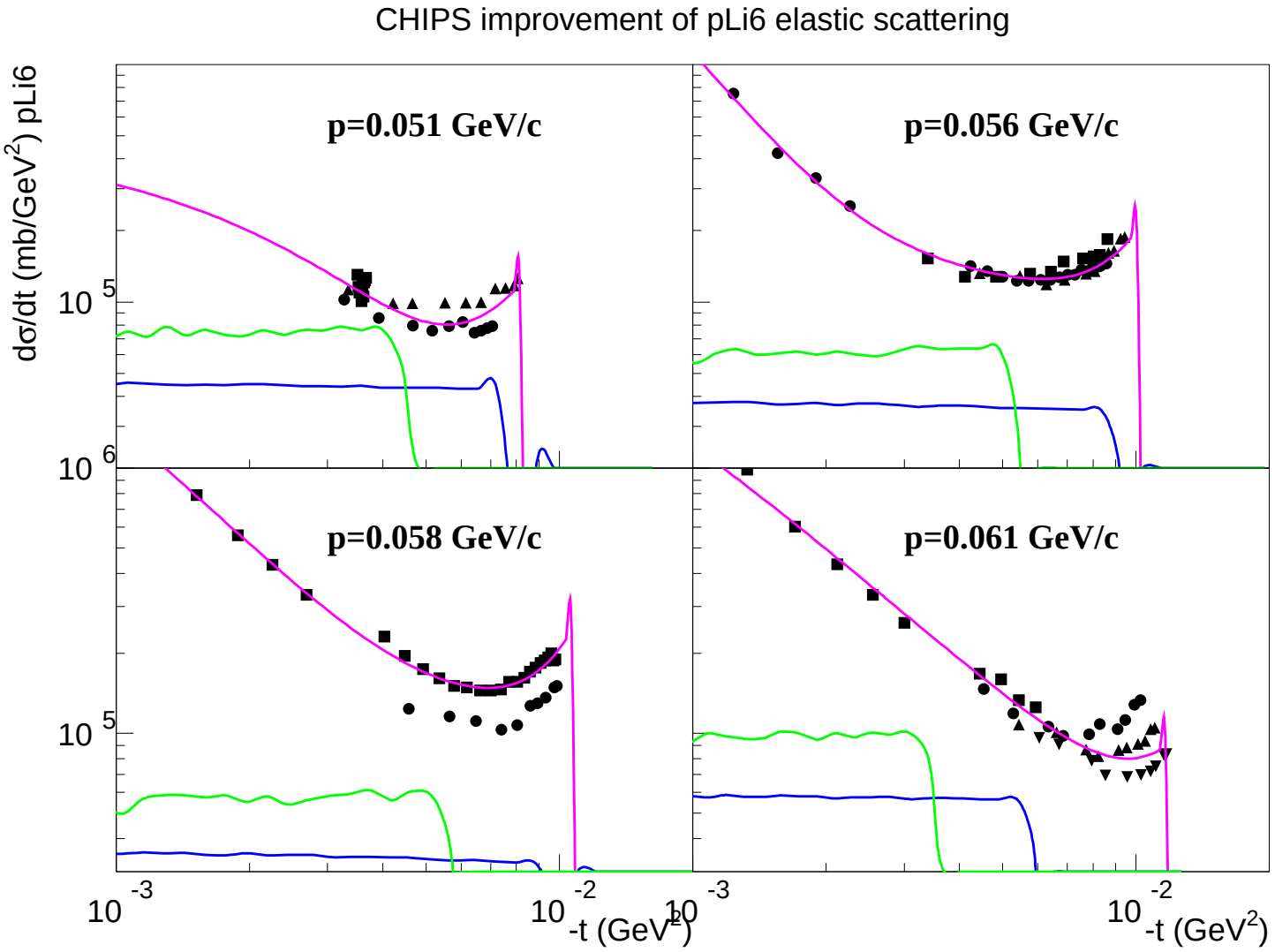
$$\frac{d\sigma}{dt} = \mathbf{A_2(B_2 - 2C_2t)e^{t(B_2-C_2t)} + A_3t^2e^{-B_3|t|^3} + A_4e^{B_4t} + A_5e^{B_5u}}$$

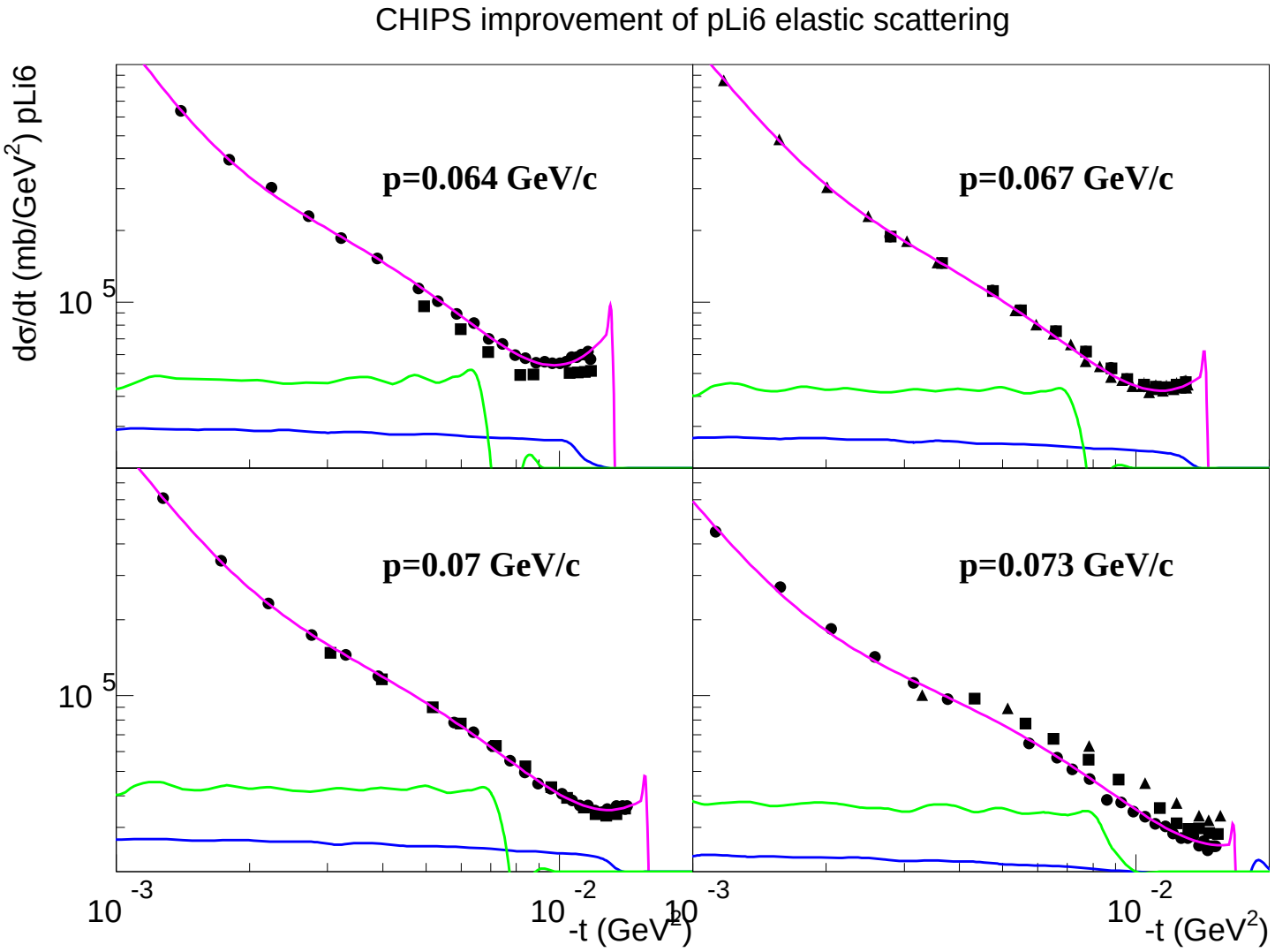
2. The main maximum of diffraction (a diffraction cone).
3. The second maximum of diffraction.
4. An effective cone for high maxima.
5. Nuclear gloria ($u = u_{Mond} + (M - m)^2$).

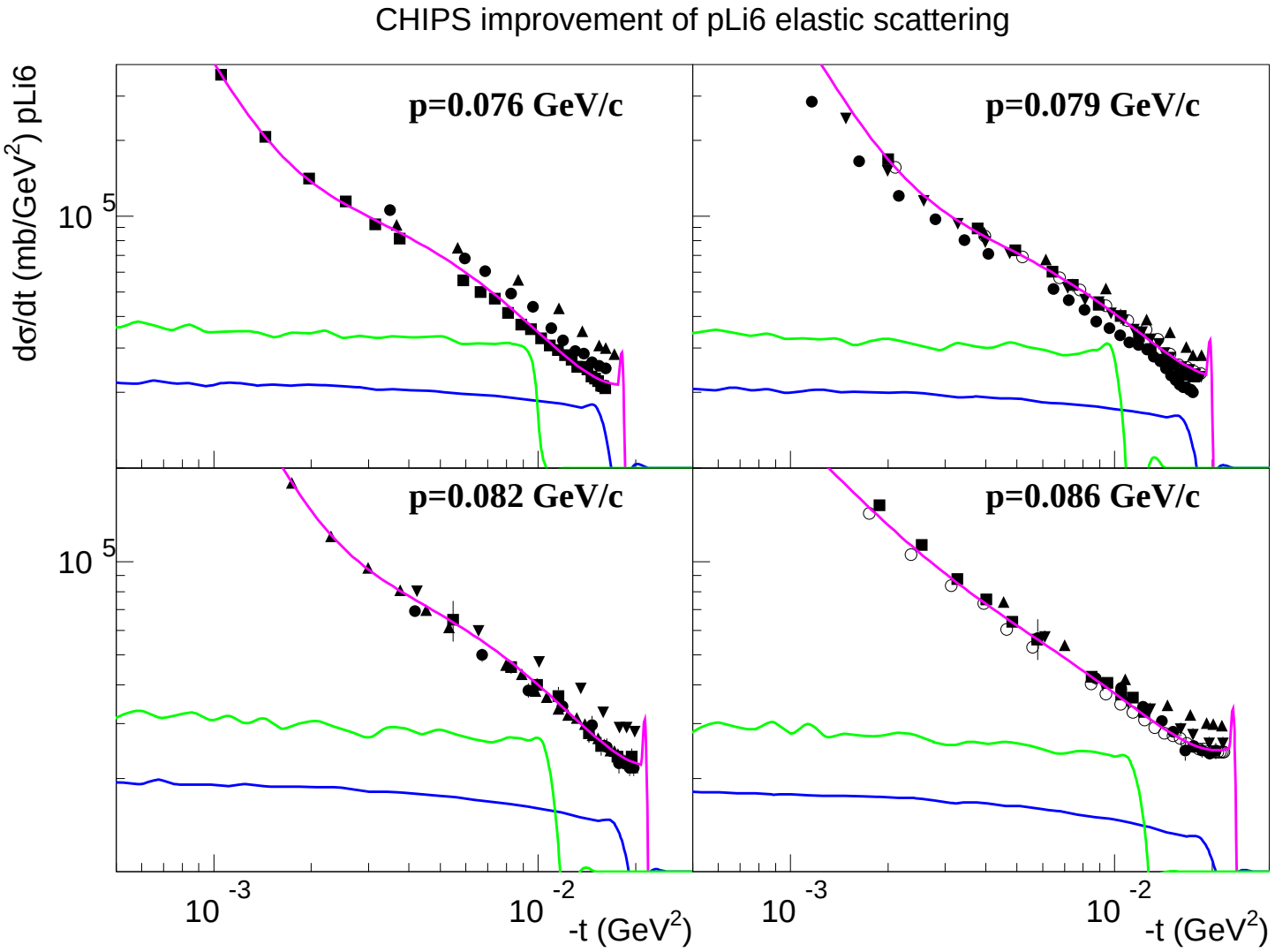
The EM term is not shown as it is the same as in the first formula.

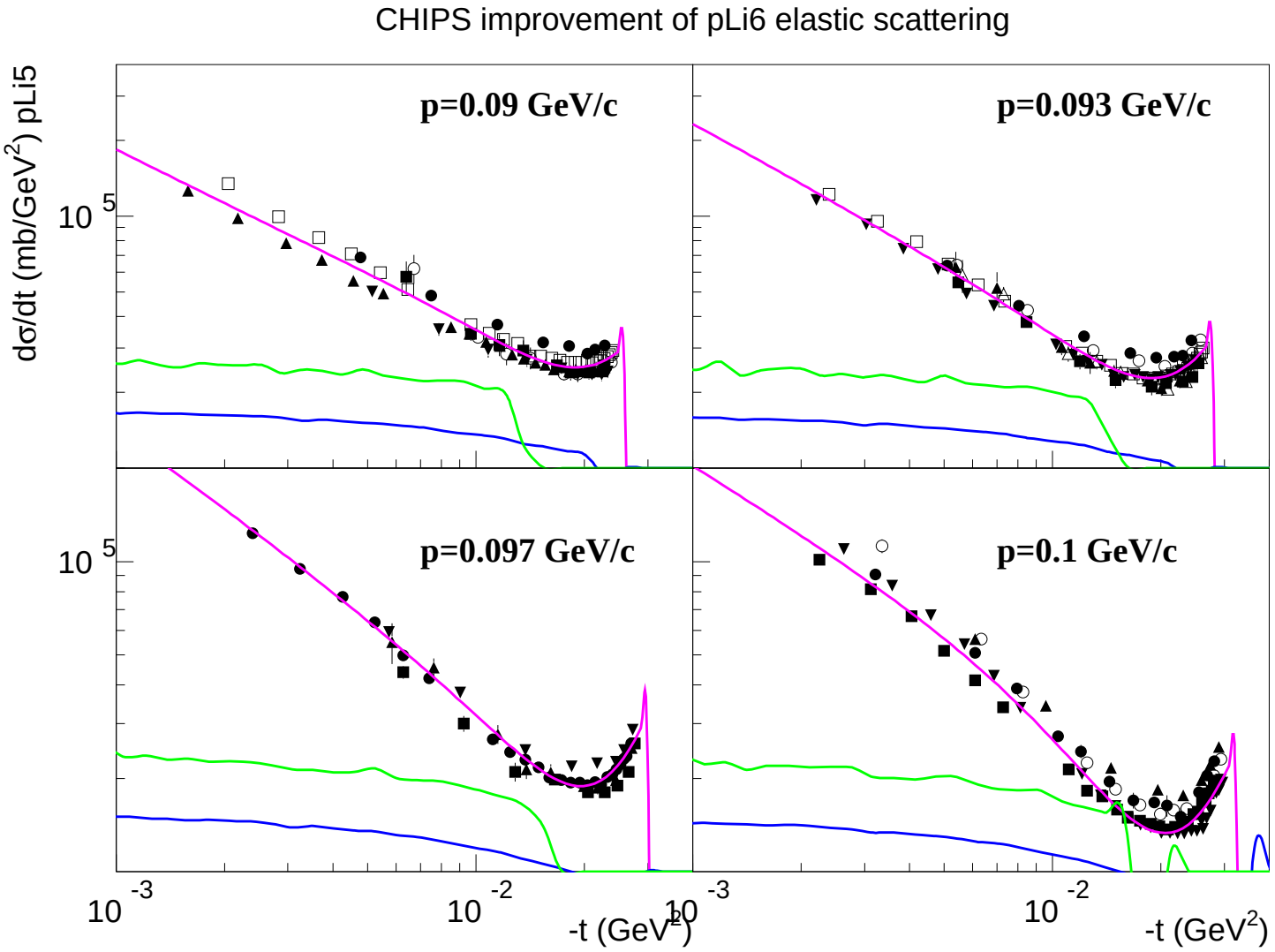
A set of the high diffraction maxima is approximated by one exponent.

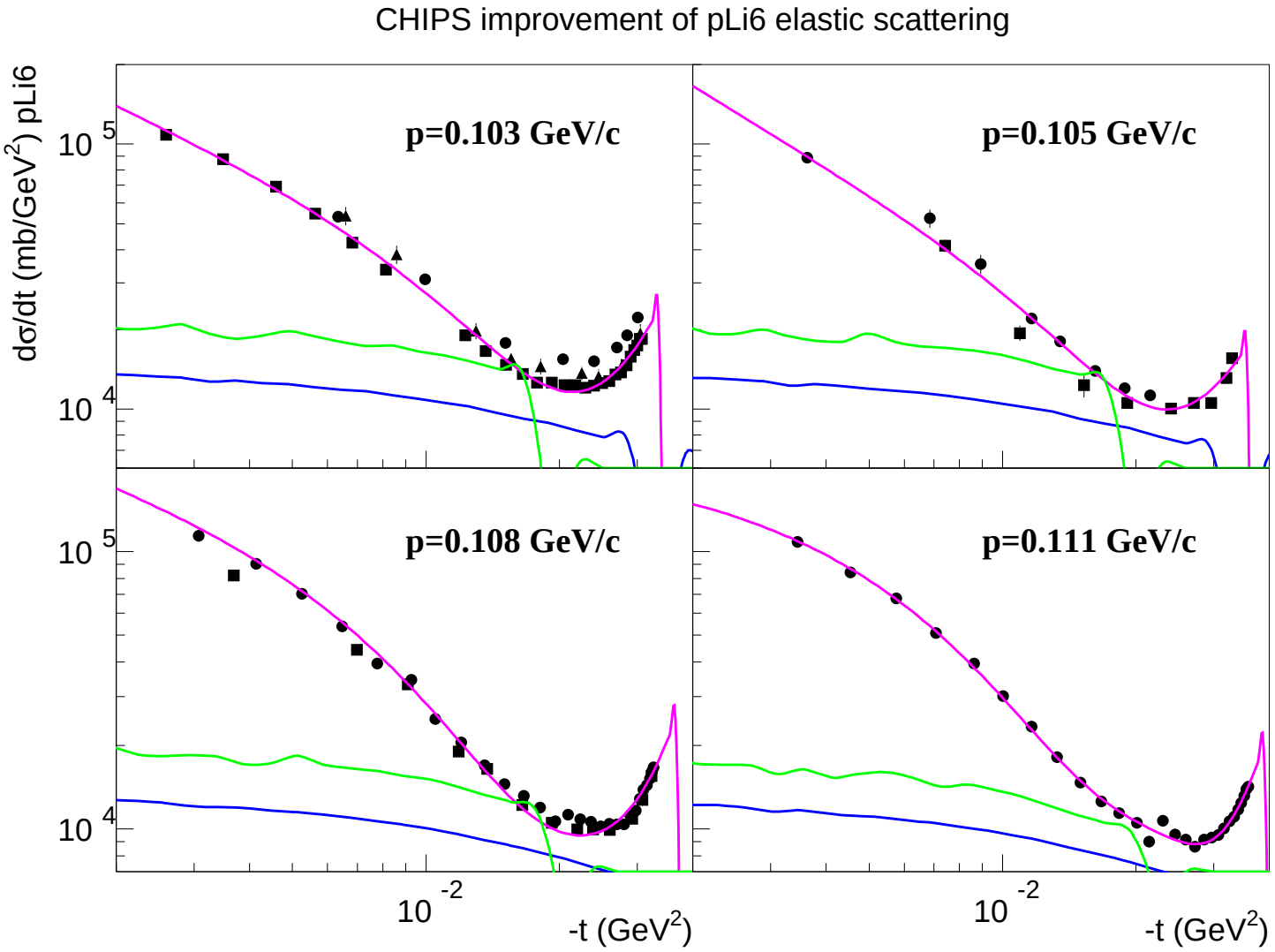

CHIPS improvement of pLi6 elastic scattering
dσ/dt (mb/GeV^2) pLi6
p=0.028 GeV/c
p=0.032 GeV/c
p=0.038 GeV/c
p=0.045 GeV/c
10 6
10 6
10 5
10 -3
10 -3
-t (GeV^2)
-t (GeV^2)

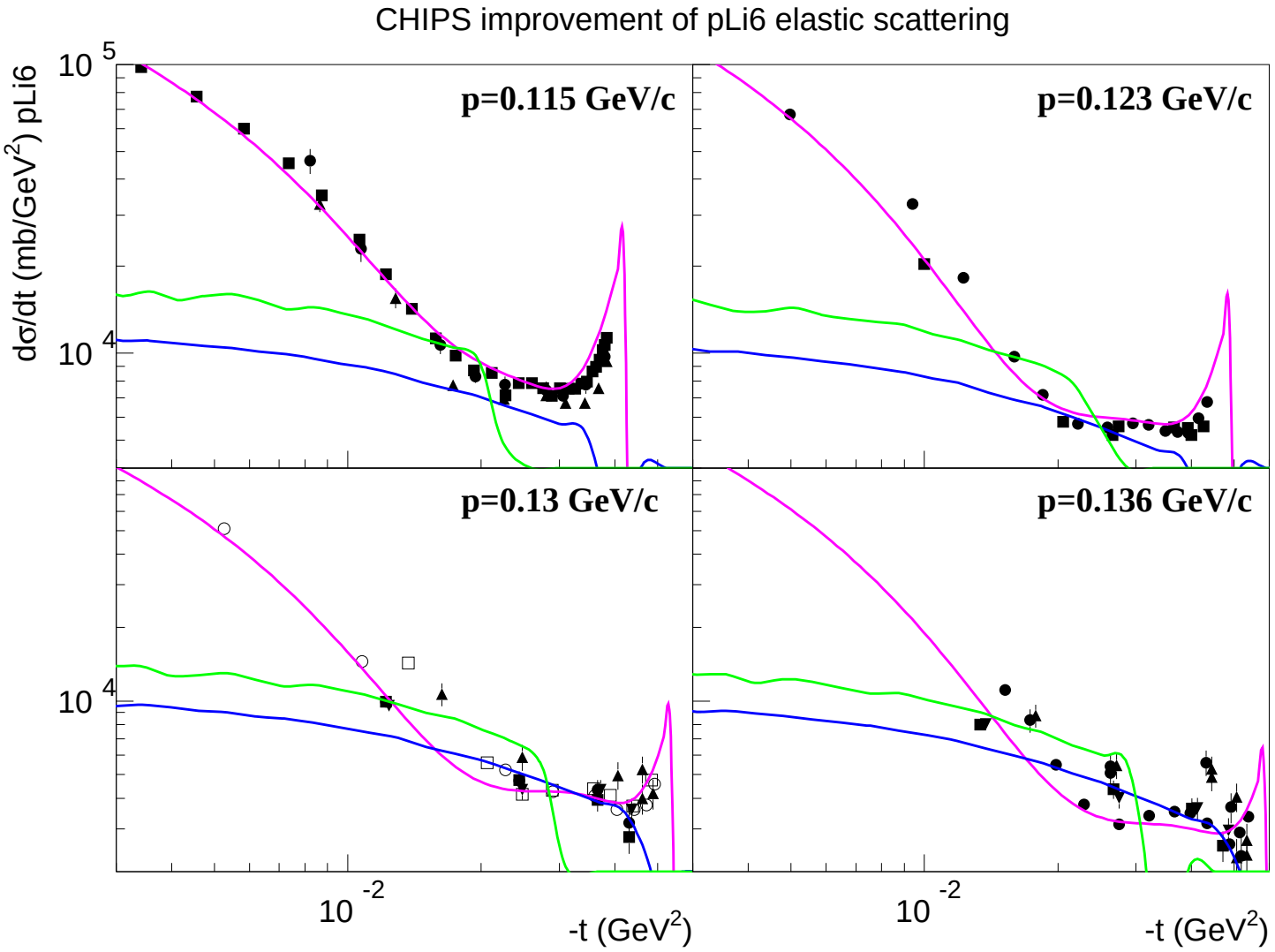

CHIPS improvement of pLi6 elastic scattering
dσ/dt (mb/GeV²) pLi6
p=0.051 GeV/c
p=0.056 GeV/c
p=0.058 GeV/c
p=0.061 GeV/c
10⁵
10⁶
10⁵
10⁻³
10⁻²
-t (GeV²)
10⁻³
10⁻²
-t (GeV²)

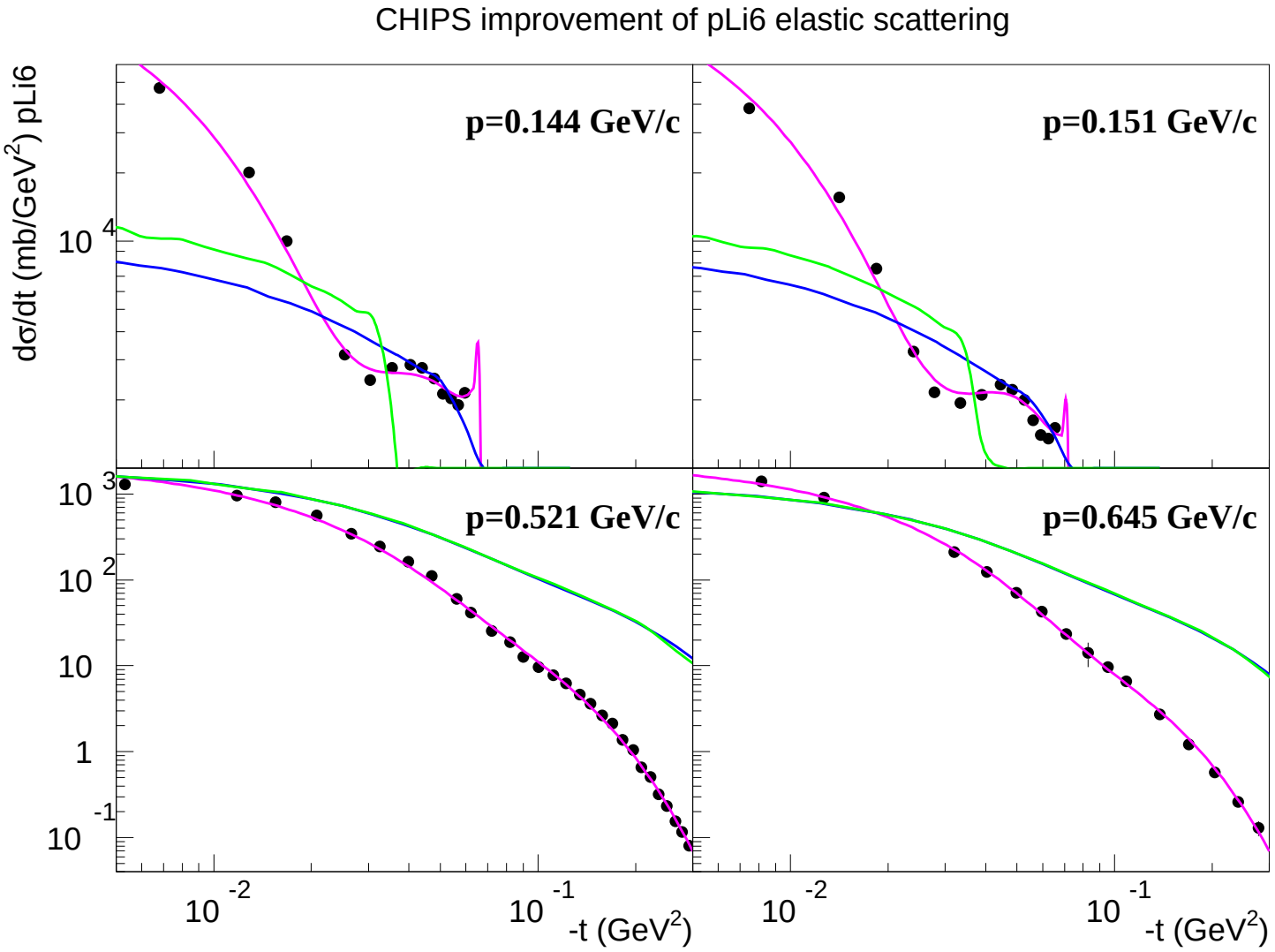

CHIPS improvement of pLi6 elastic scattering
dσ/dt (mb/GeV²) pLi6
p=0.064 GeV/c
p=0.067 GeV/c
p=0.07 GeV/c
p=0.073 GeV/c
10 5
10 5
10 -3
10 -2
-t (GeV²)
10 -3
10 -2
-t (GeV²)

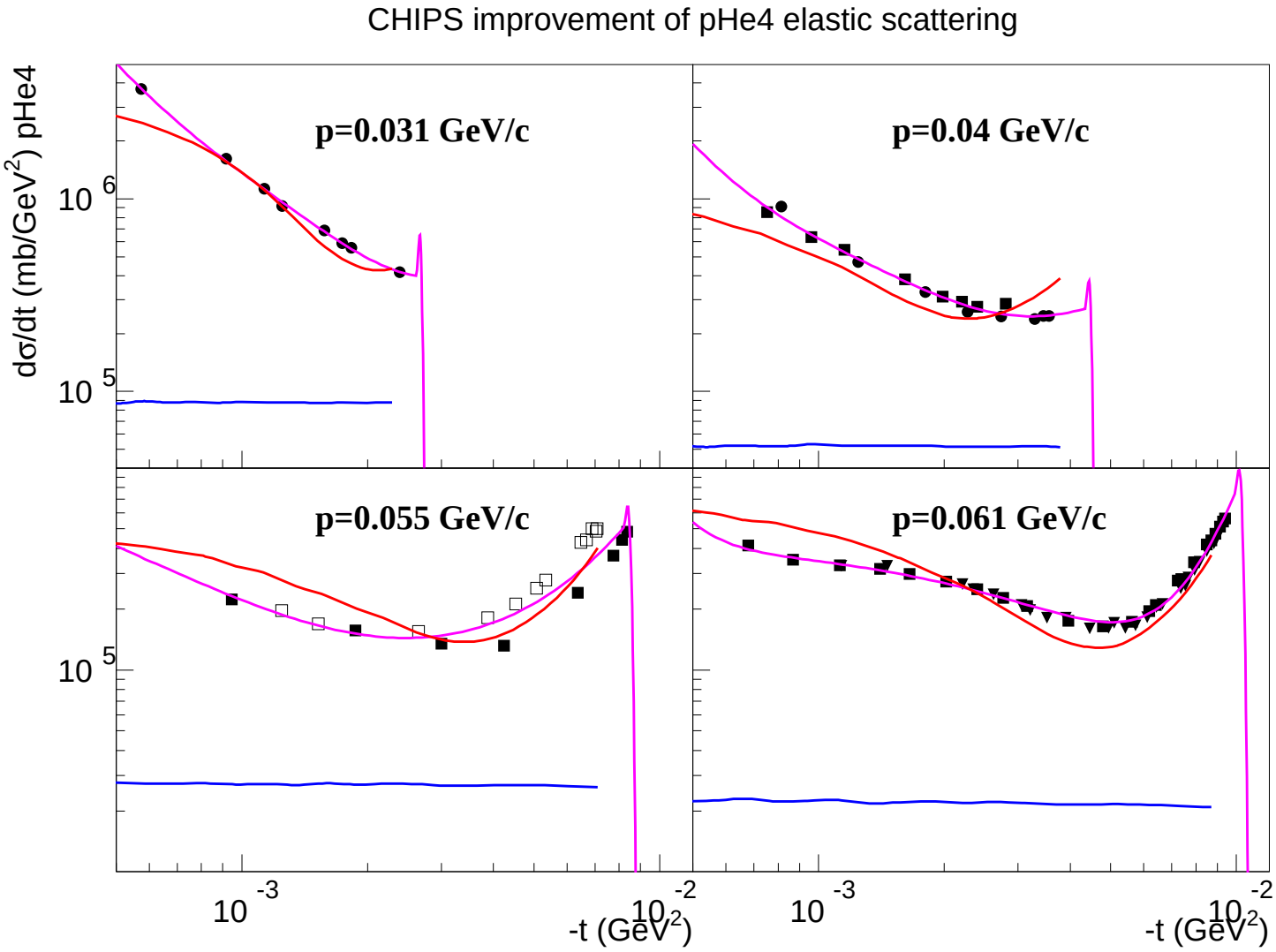

CHIPS improvement of pLi6 elastic scattering
dσ/dt (mb/GeV^2) pLi6
p=0.076 GeV/c
p=0.079 GeV/c
p=0.082 GeV/c
p=0.086 GeV/c
10 5
10 5
10 -3
10 -2
-t (GeV^2)
10 -3
10 -2
-t (GeV^2)

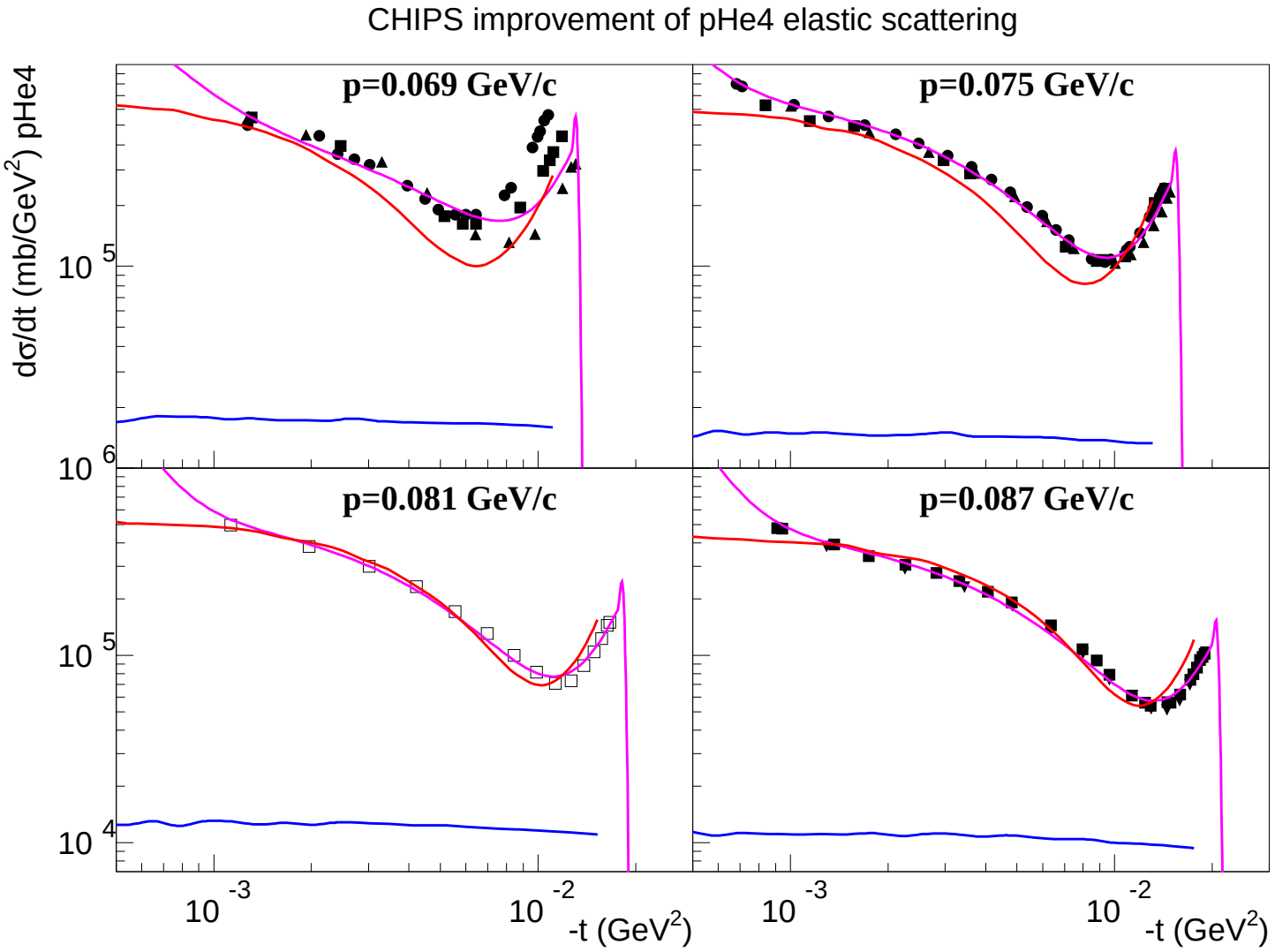

CHIPS improvement of pLi6 elastic scattering
dσ/dt (mb/GeV^2) pLi5
p=0.09 GeV/c
p=0.093 GeV/c
p=0.097 GeV/c
p=0.1 GeV/c
10 5
10 5
10 -3
10 -2
-t (GeV^2)
10 -3
10 -2
-t (GeV^2)

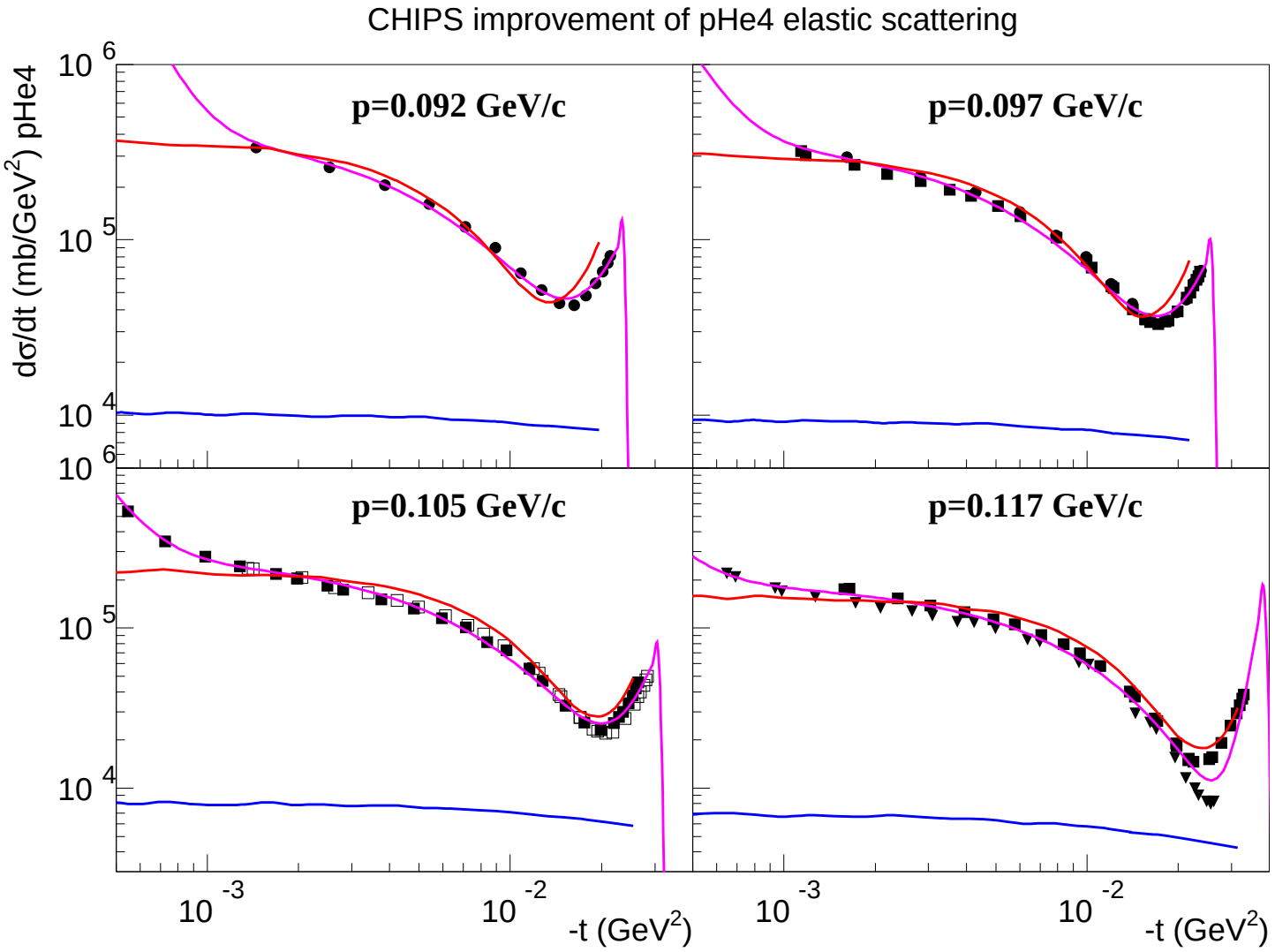

CHIPS improvement of pLi6 elastic scattering
dσ/dt (mb/GeV^2) pLi6
p=0.103 GeV/c
p=0.105 GeV/c
p=0.108 GeV/c
p=0.111 GeV/c
10^5
10^4
10^{-2}
-t (GeV^2)

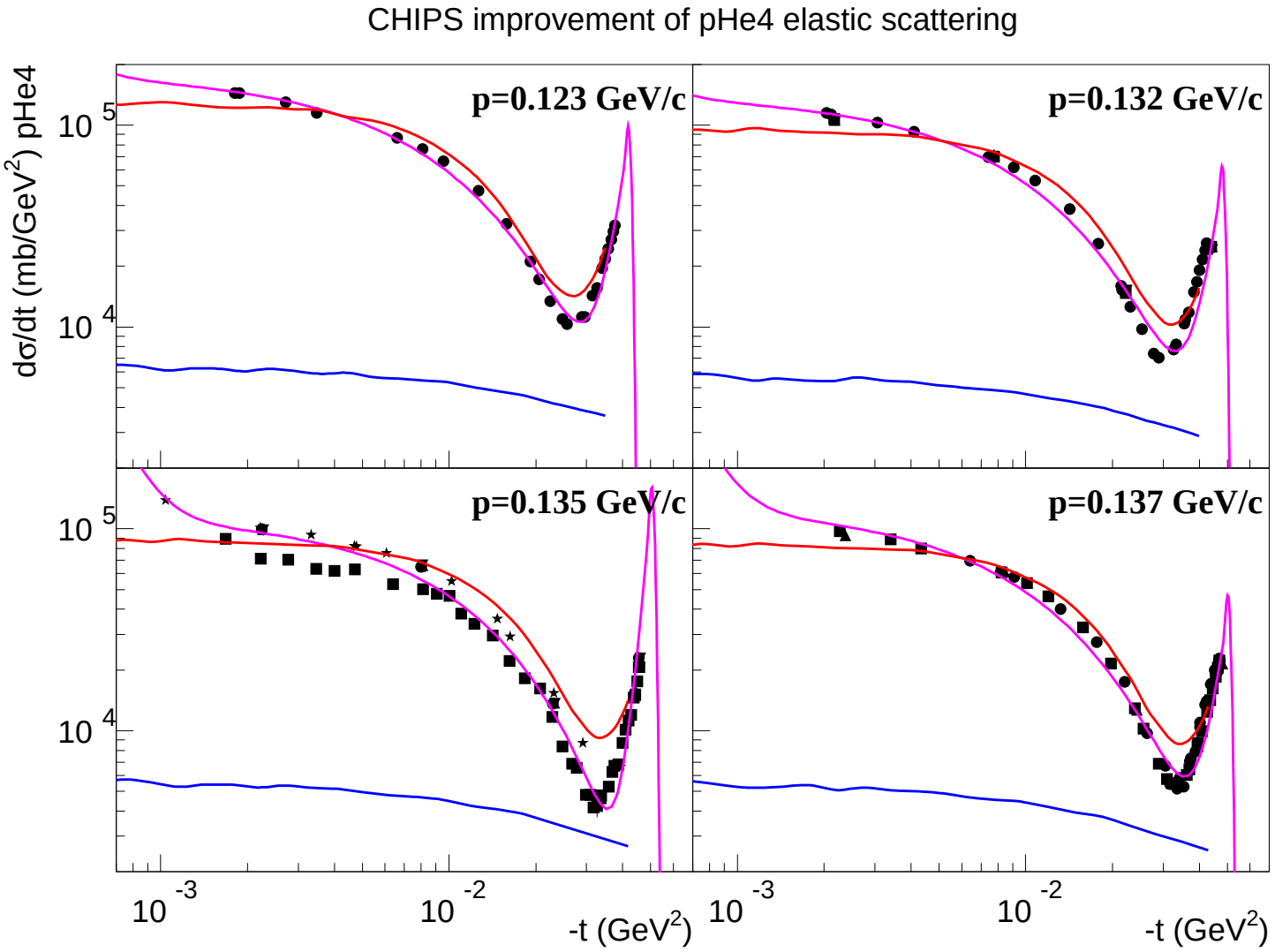

CHIPS improvement of pLi6 elastic scattering
dσ/dt (mb/GeV^2) pLi6
10^5
10^4
p=0.115 GeV/c
p=0.123 GeV/c
p=0.13 GeV/c
p=0.136 GeV/c
10^{-2}
-t (GeV^2)

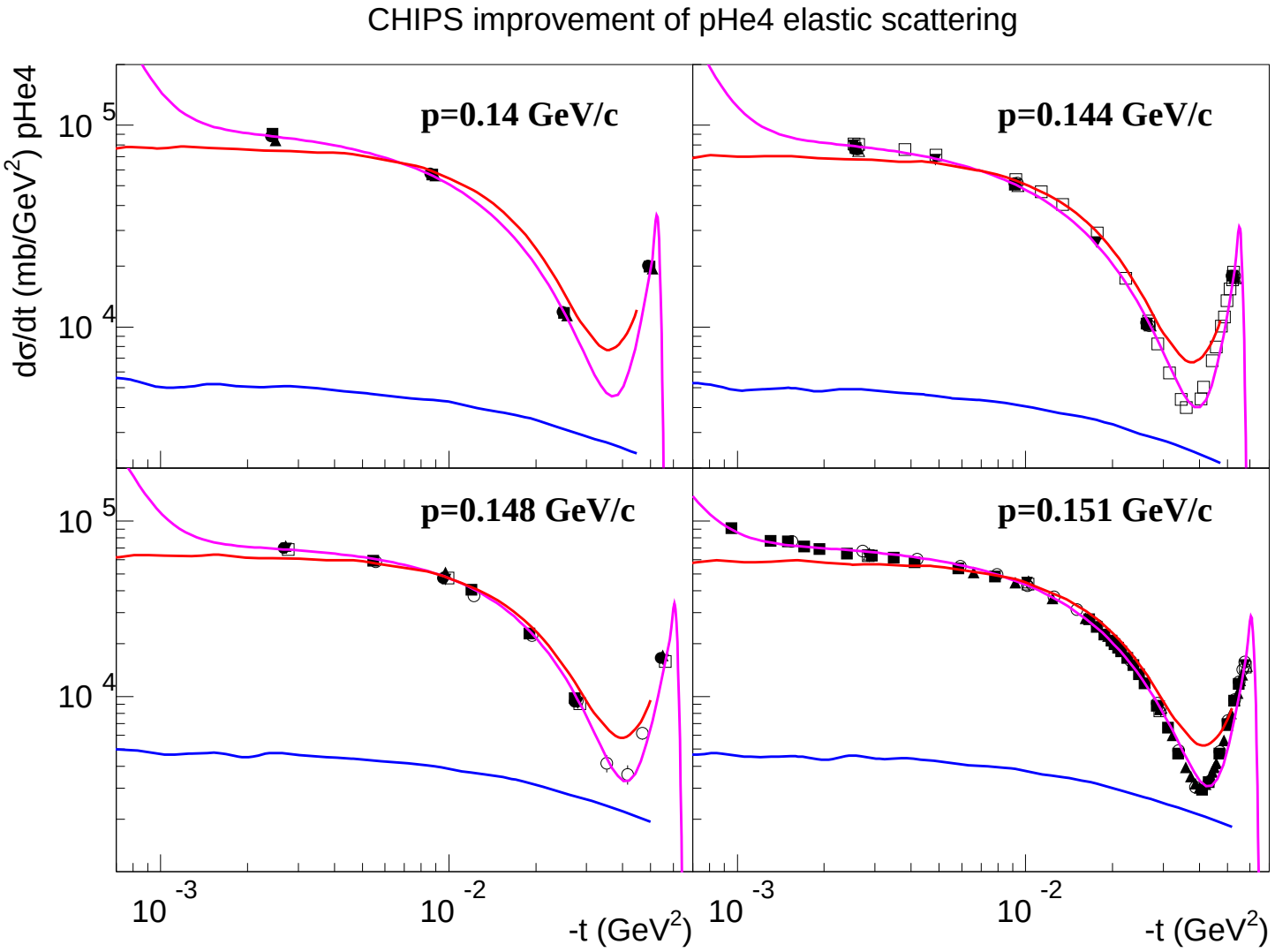

CHIPS improvement of pLi6 elastic scattering
dσ/dt (mb/GeV²) pLi6
p=0.144 GeV/c
p=0.151 GeV/c
p=0.521 GeV/c
p=0.645 GeV/c
-t (GeV²)
-t (GeV²)

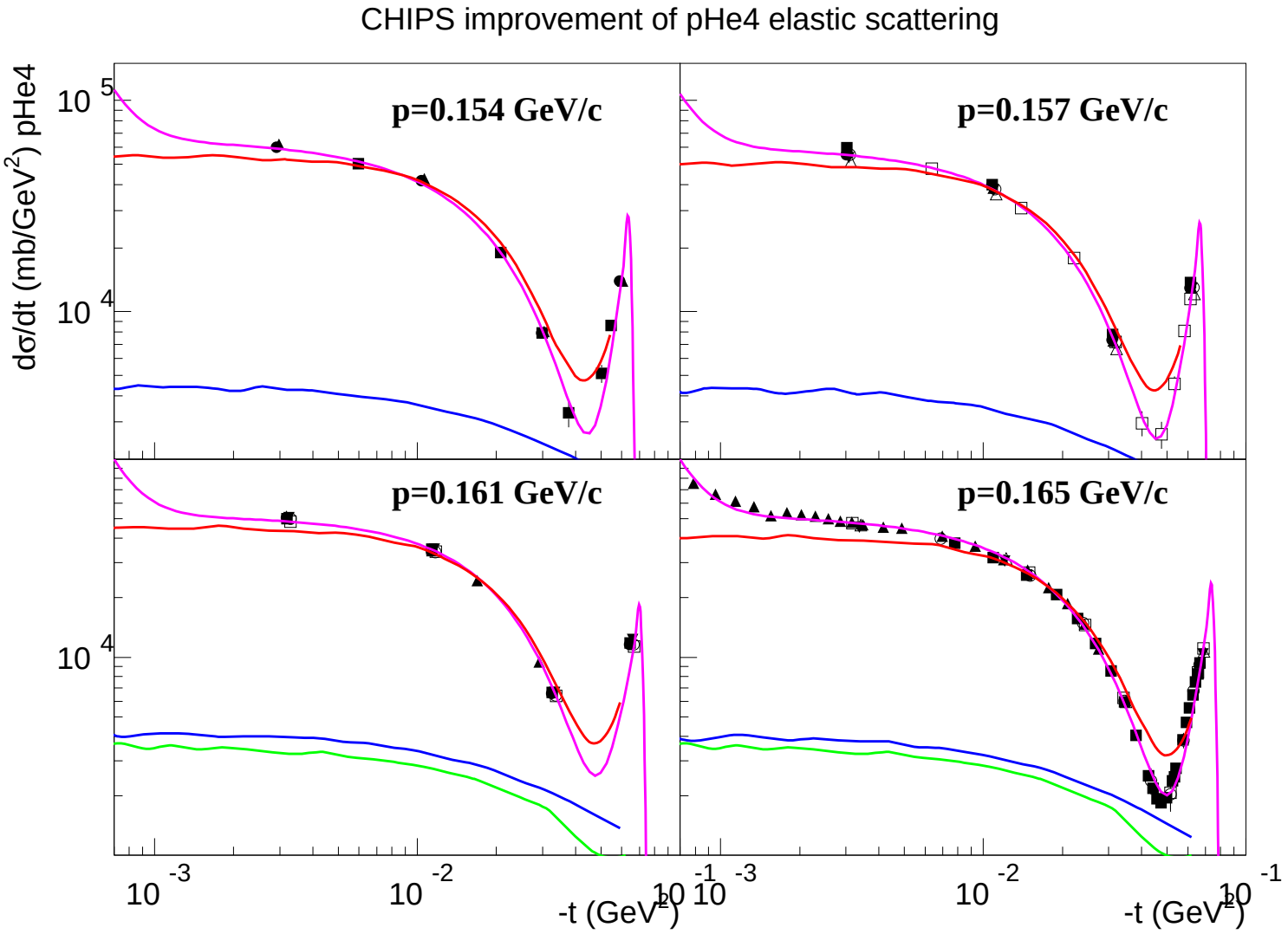

CHIPS improvement of pHe4 elastic scattering
dσ/dt (mb/GeV²) pHe4
p=0.031 GeV/c
p=0.04 GeV/c
p=0.055 GeV/c
p=0.061 GeV/c
10 6
10 5
10 5
10 -3
10 -2
-t (GeV²)

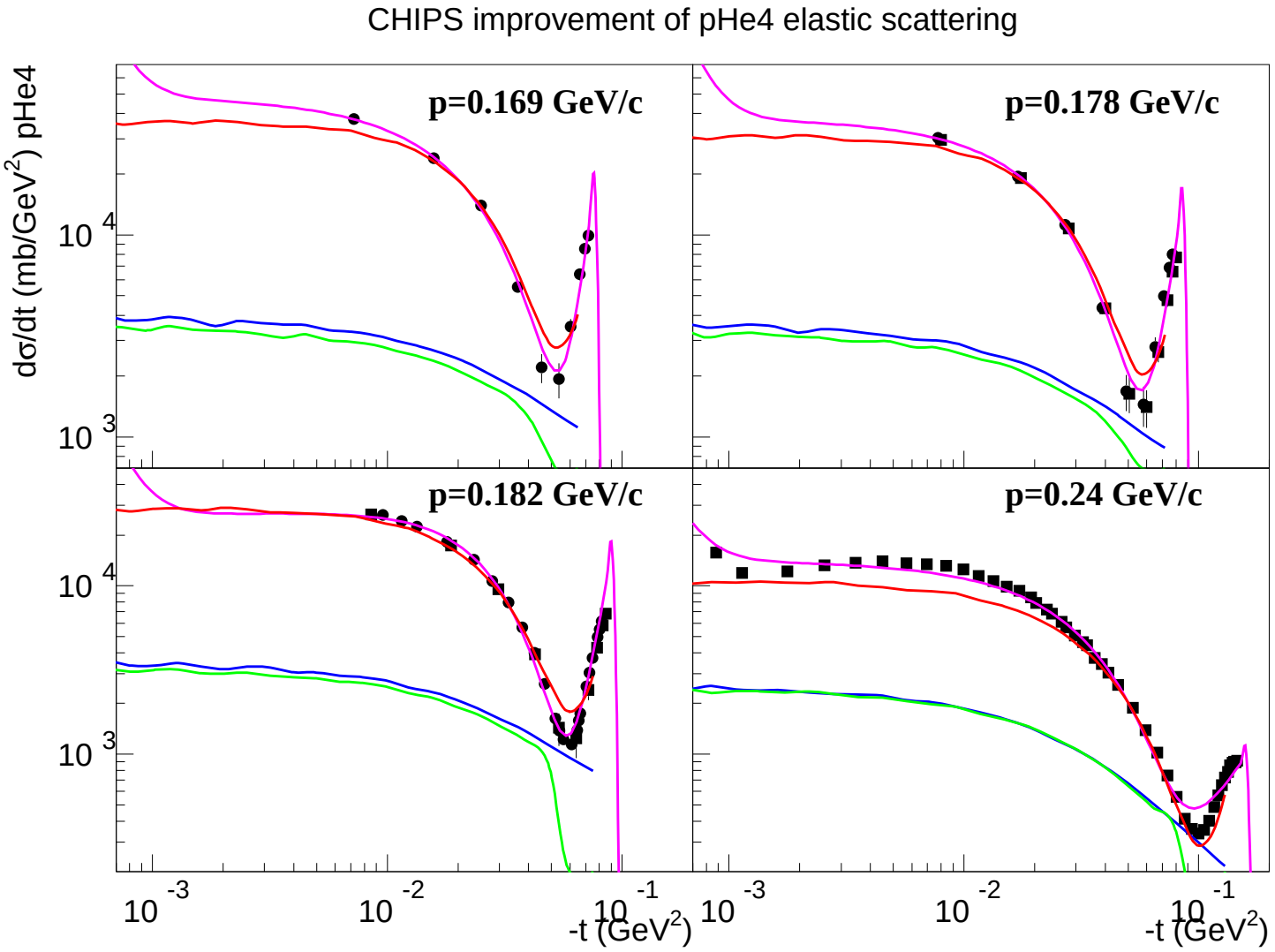

CHIPS improvement of pHe4 elastic scattering
p=0.069 GeV/c
p=0.075 GeV/c
p=0.081 GeV/c
p=0.087 GeV/c
dσ/dt (mb/GeV²) pHe4
10 5
10 6
10 5
10 4
10 -3
10 -2
-t (GeV²)

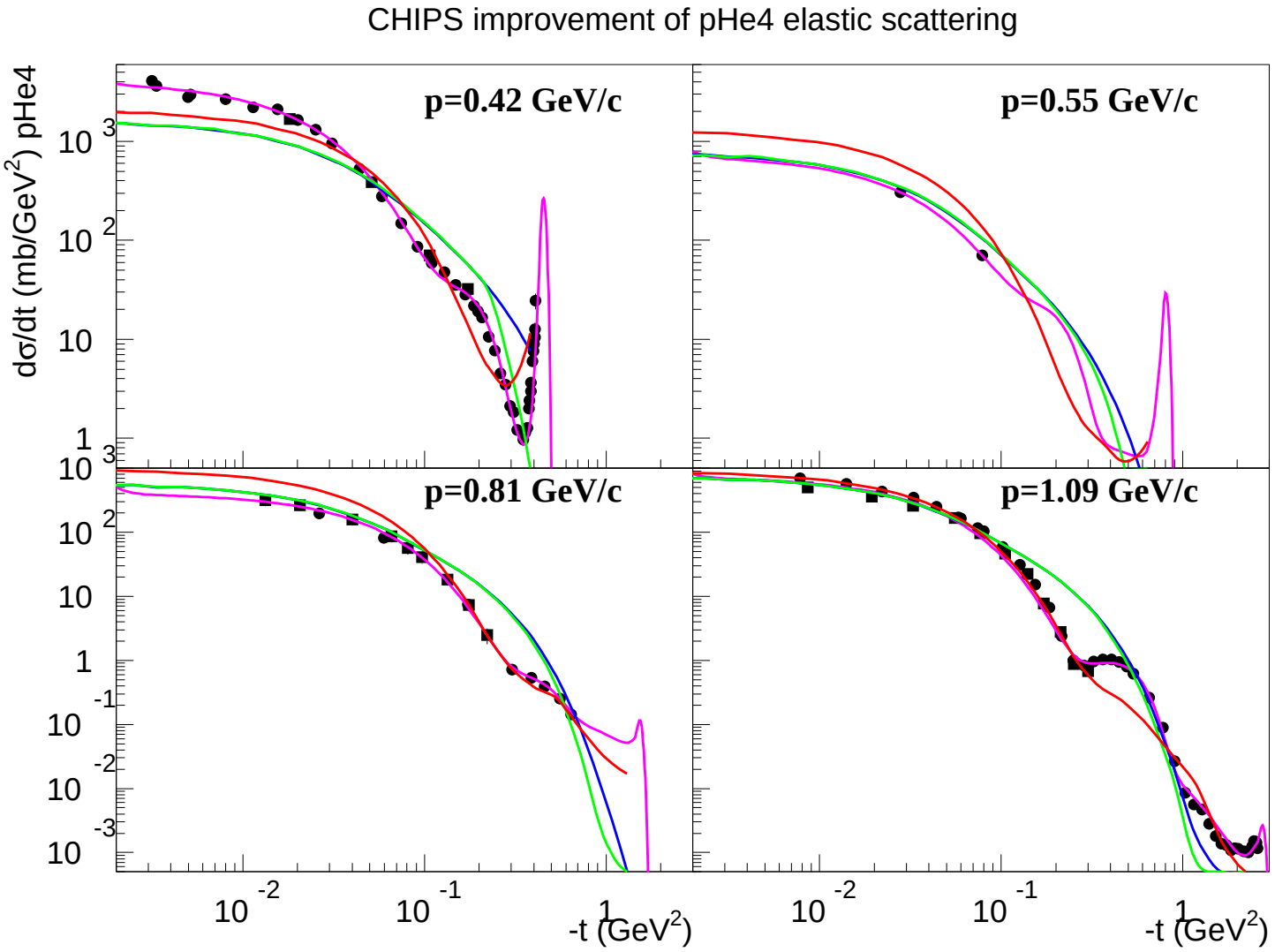

CHIPS improvement of pHe4 elastic scattering
dσ/dt (mb/GeV²) pHe4
p=0.092 GeV/c
p=0.097 GeV/c
p=0.105 GeV/c
p=0.117 GeV/c
-t (GeV²)
-t (GeV²)

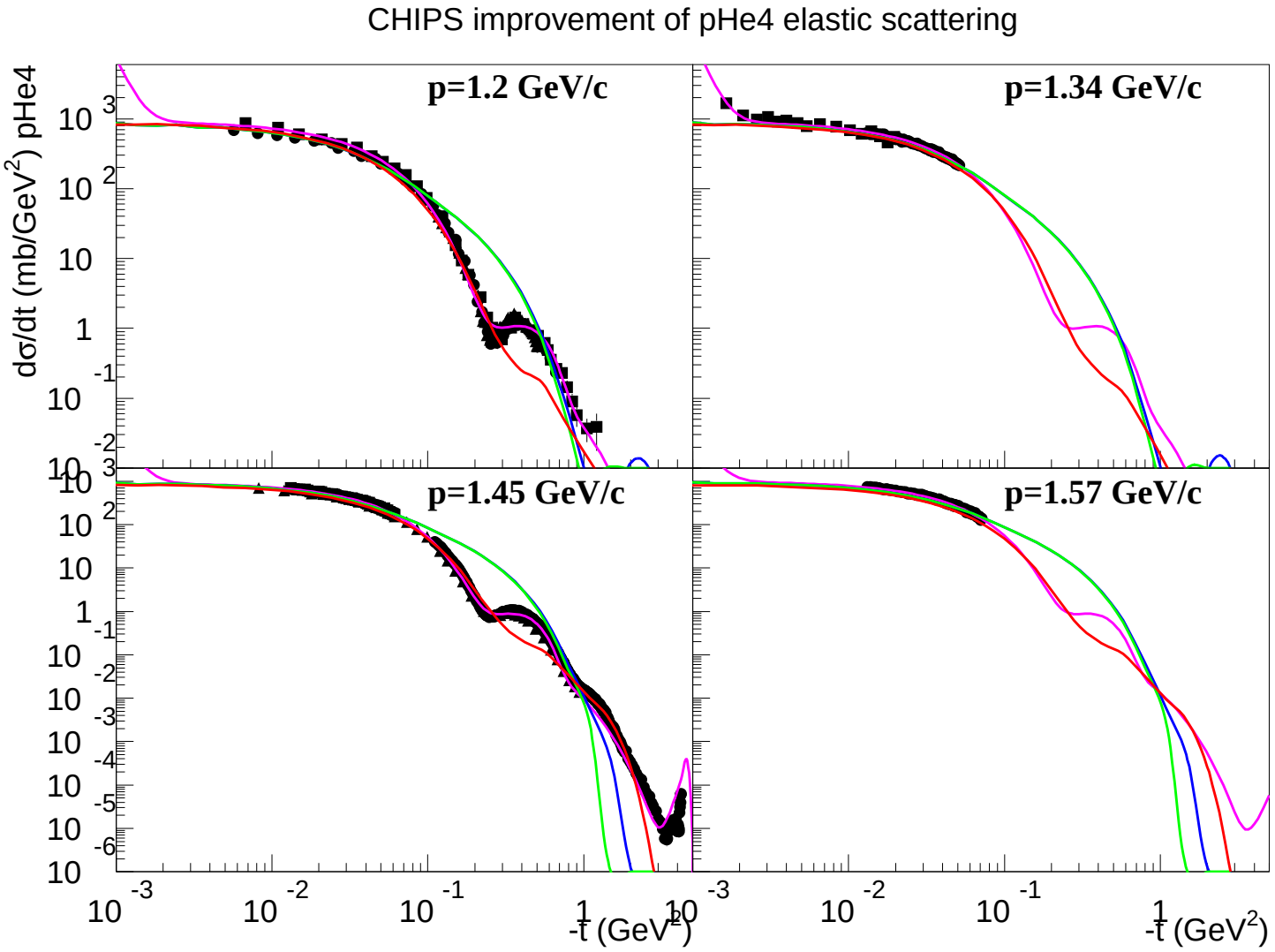

CHIPS improvement of pHe4 elastic scattering
dσ/dt (mb/GeV²) pHe4
p=0.123 GeV/c
p=0.132 GeV/c
p=0.135 GeV/c
p=0.137 GeV/c
10 5
10 4
10 -3
10 -2
-t (GeV²)

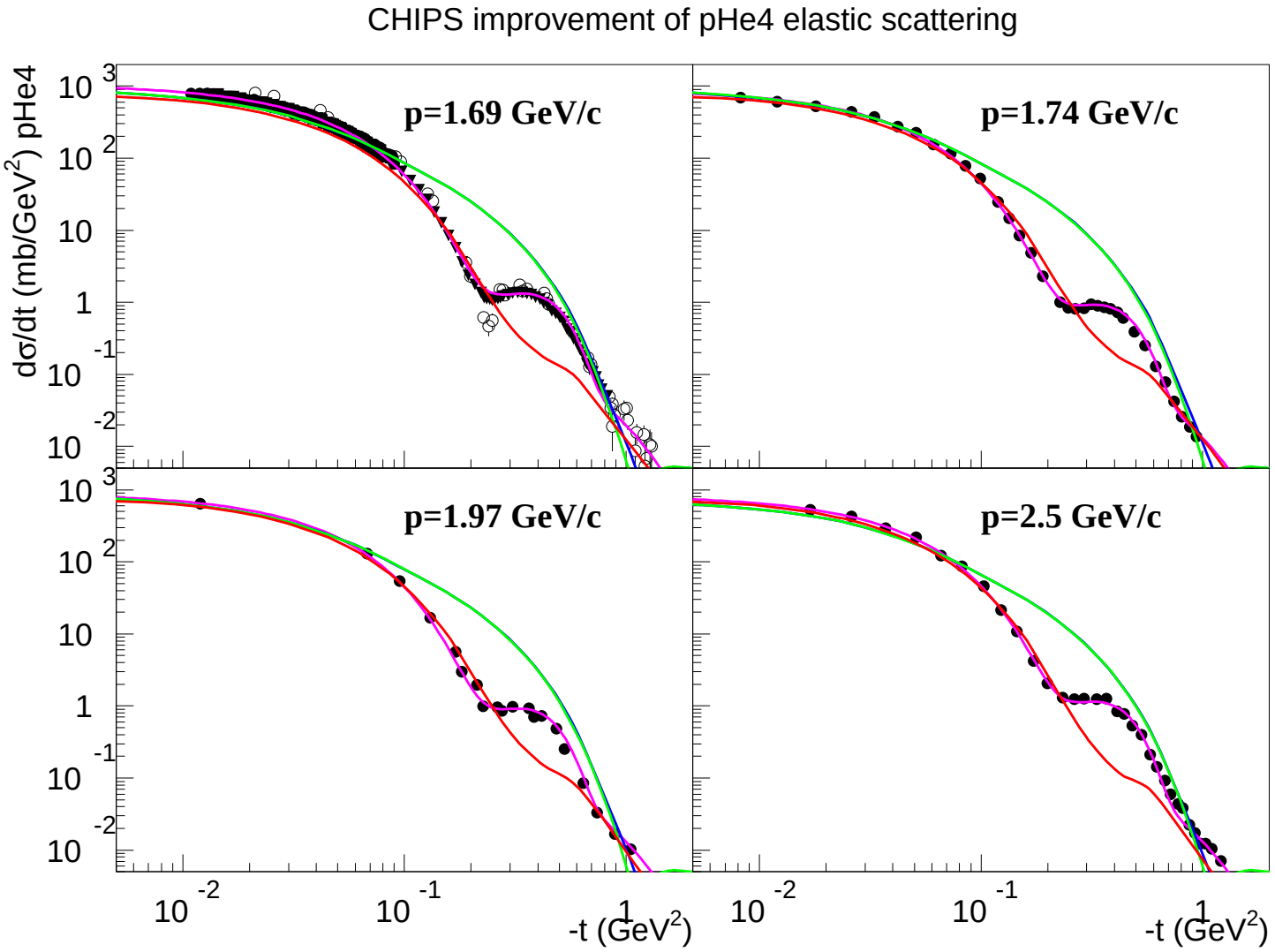

CHIPS improvement of pHe4 elastic scattering
dσ/dt (mb/GeV²) pHe4
p=0.14 GeV/c
p=0.144 GeV/c
p=0.148 GeV/c
p=0.151 GeV/c
-t (GeV²)
-t (GeV²)

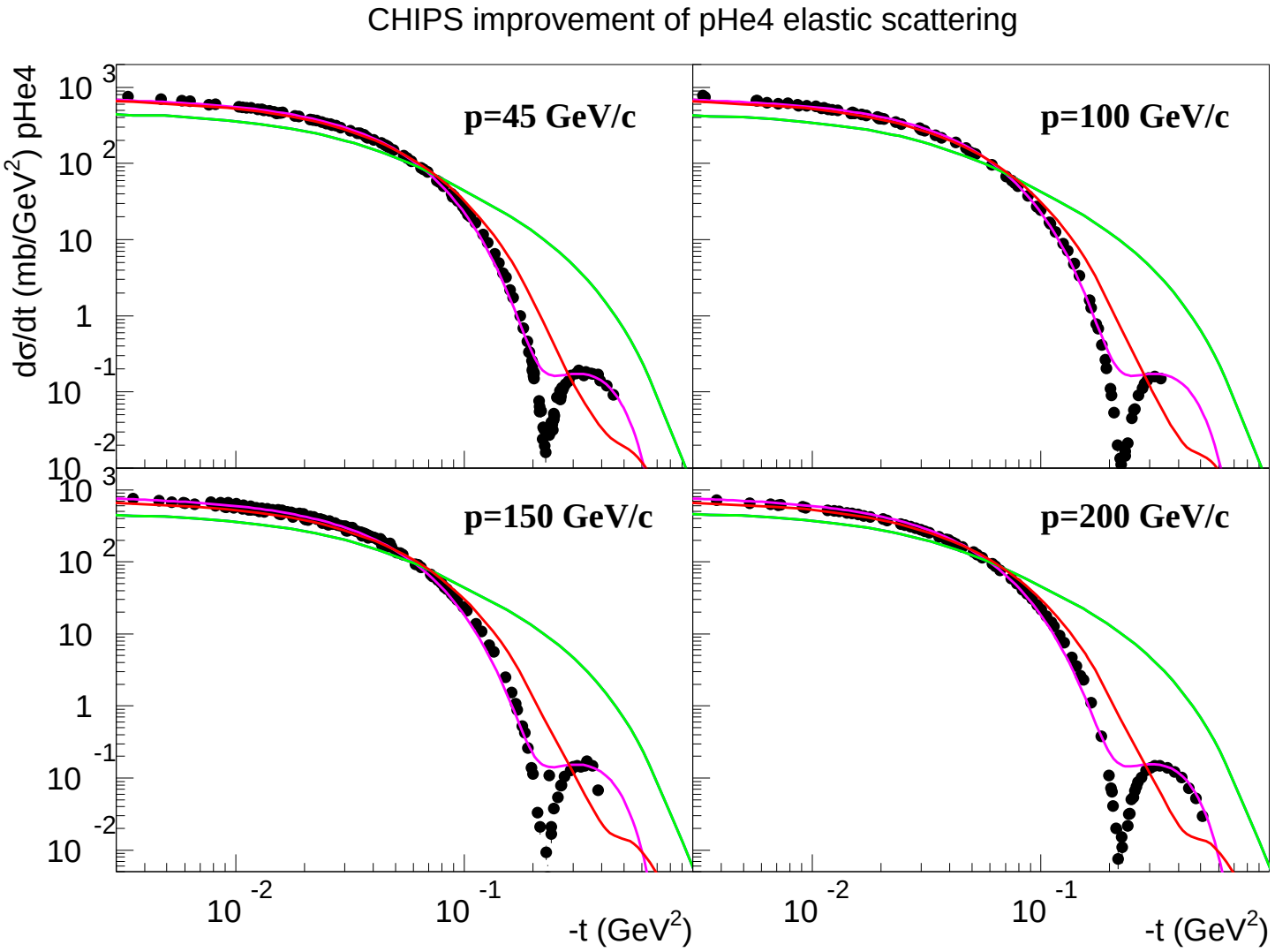

CHIPS improvement of pHe4 elastic scattering
dσ/dt (mb/GeV²) pHe4
p=0.154 GeV/c
p=0.157 GeV/c
p=0.161 GeV/c
p=0.165 GeV/c
-t (GeV²)
-t (GeV²)

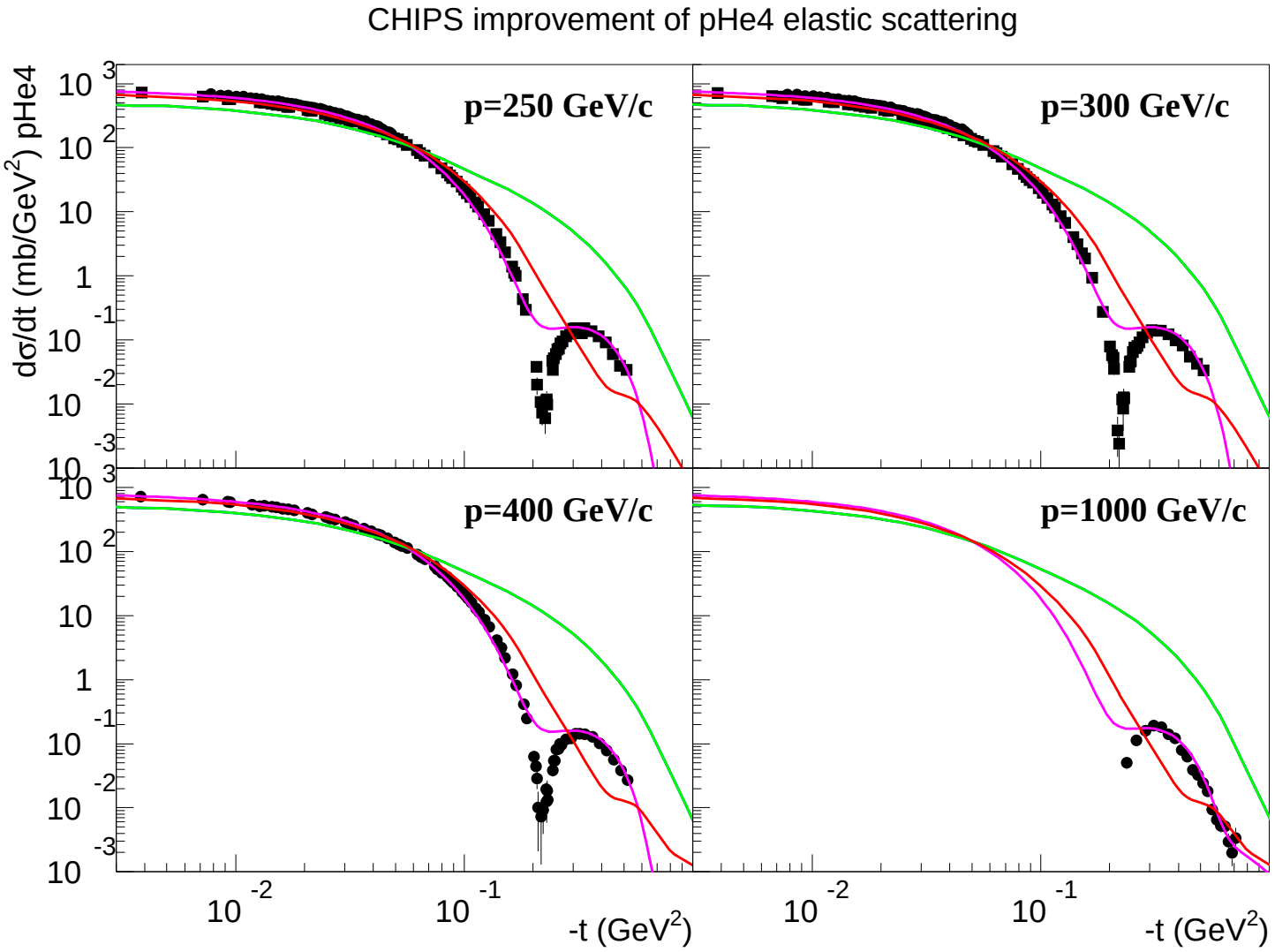

CHIPS improvement of pHe4 elastic scattering
dσ/dt (mb/GeV²) pHe4
p=0.169 GeV/c
p=0.178 GeV/c
p=0.182 GeV/c
p=0.24 GeV/c
10⁴
10³
10⁻³
10⁻²
10⁻¹
-t (GeV²)

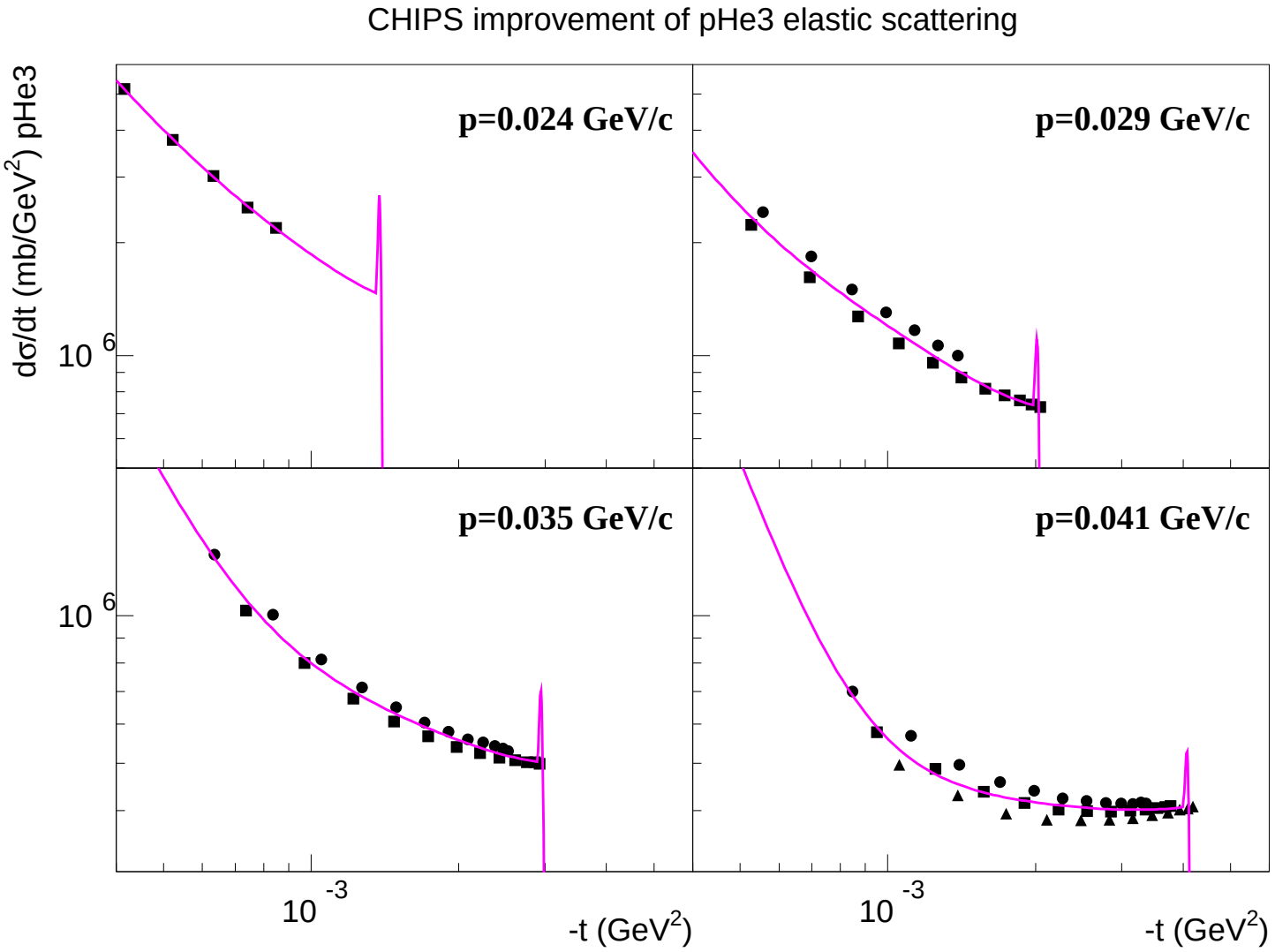

CHIPS improvement of pHe4 elastic scattering
dσ/dt (mb/GeV²) pHe4
p=0.42 GeV/c
p=0.55 GeV/c
p=0.81 GeV/c
p=1.09 GeV/c
-t (GeV²)
-t (GeV²)

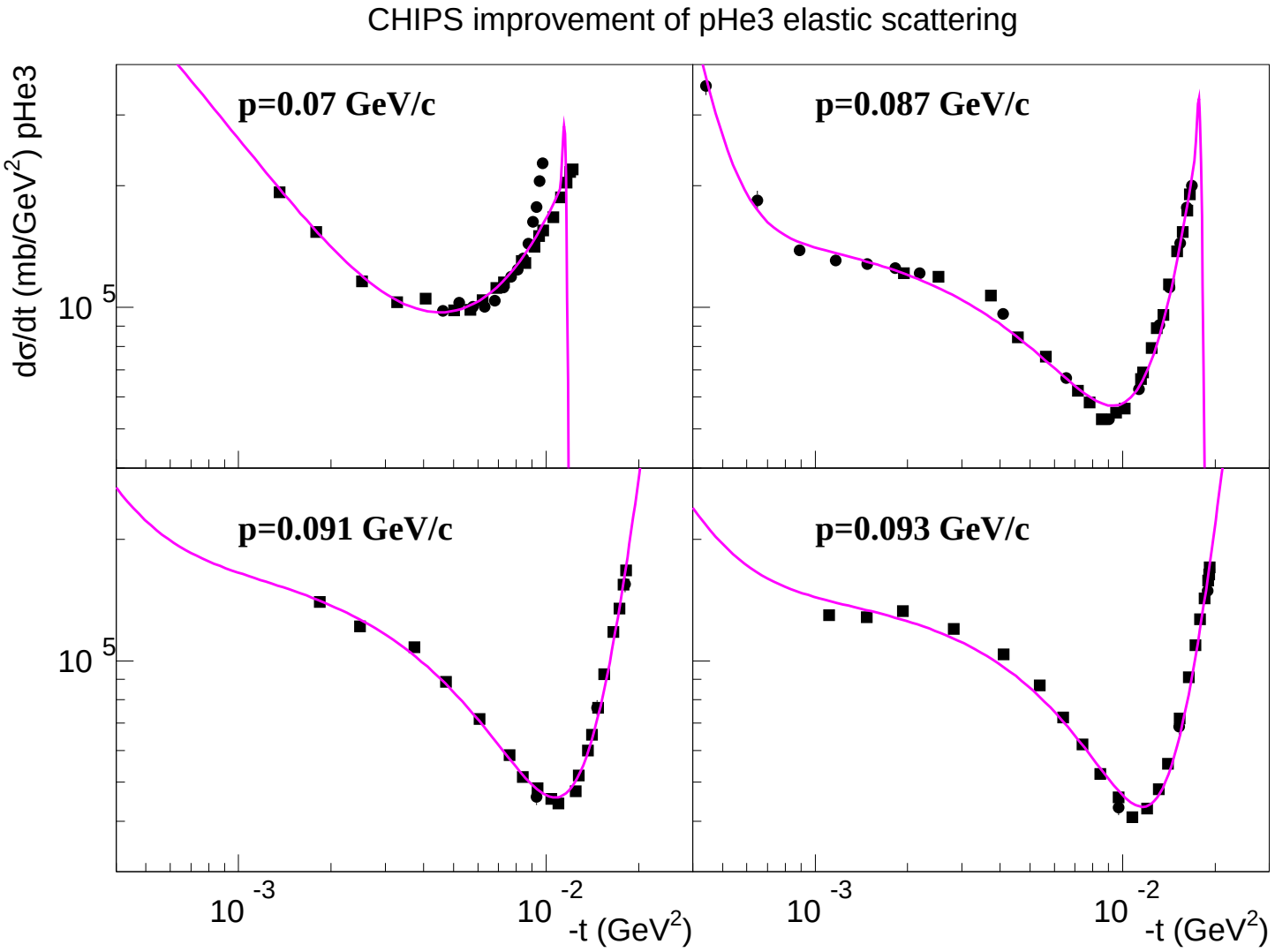

CHIPS improvement of pHe4 elastic scattering
p=1.2 GeV/c
p=1.34 GeV/c
p=1.45 GeV/c
p=1.57 GeV/c
dσ/dt (mb/GeV²) pHe4
-t (GeV²)
-t (GeV²)

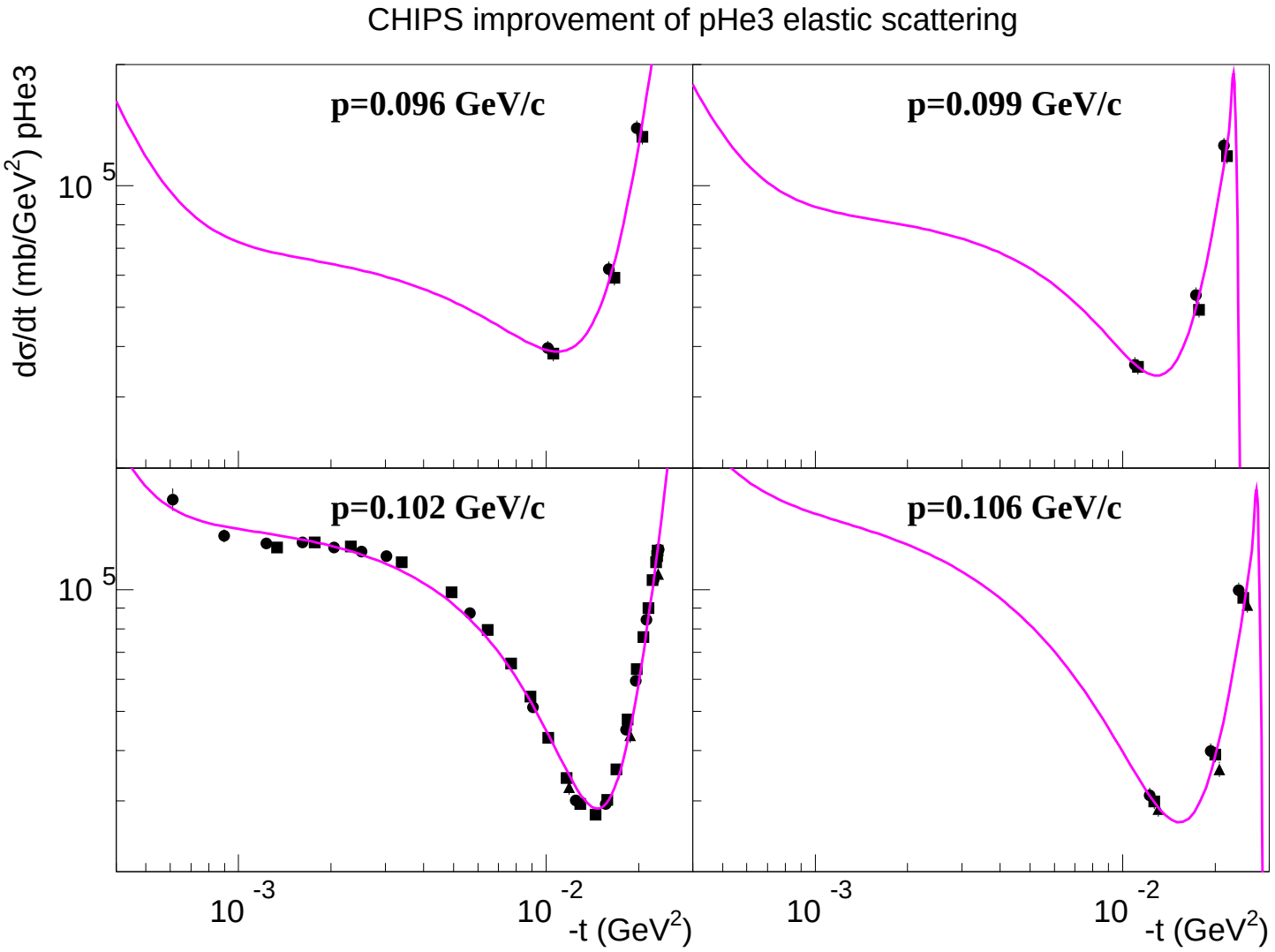

CHIPS improvement of pHe4 elastic scattering
dσ/dt (mb/GeV²) pHe4
p=1.69 GeV/c
p=1.74 GeV/c
p=1.97 GeV/c
p=2.5 GeV/c
-t (GeV²)
-t (GeV²)

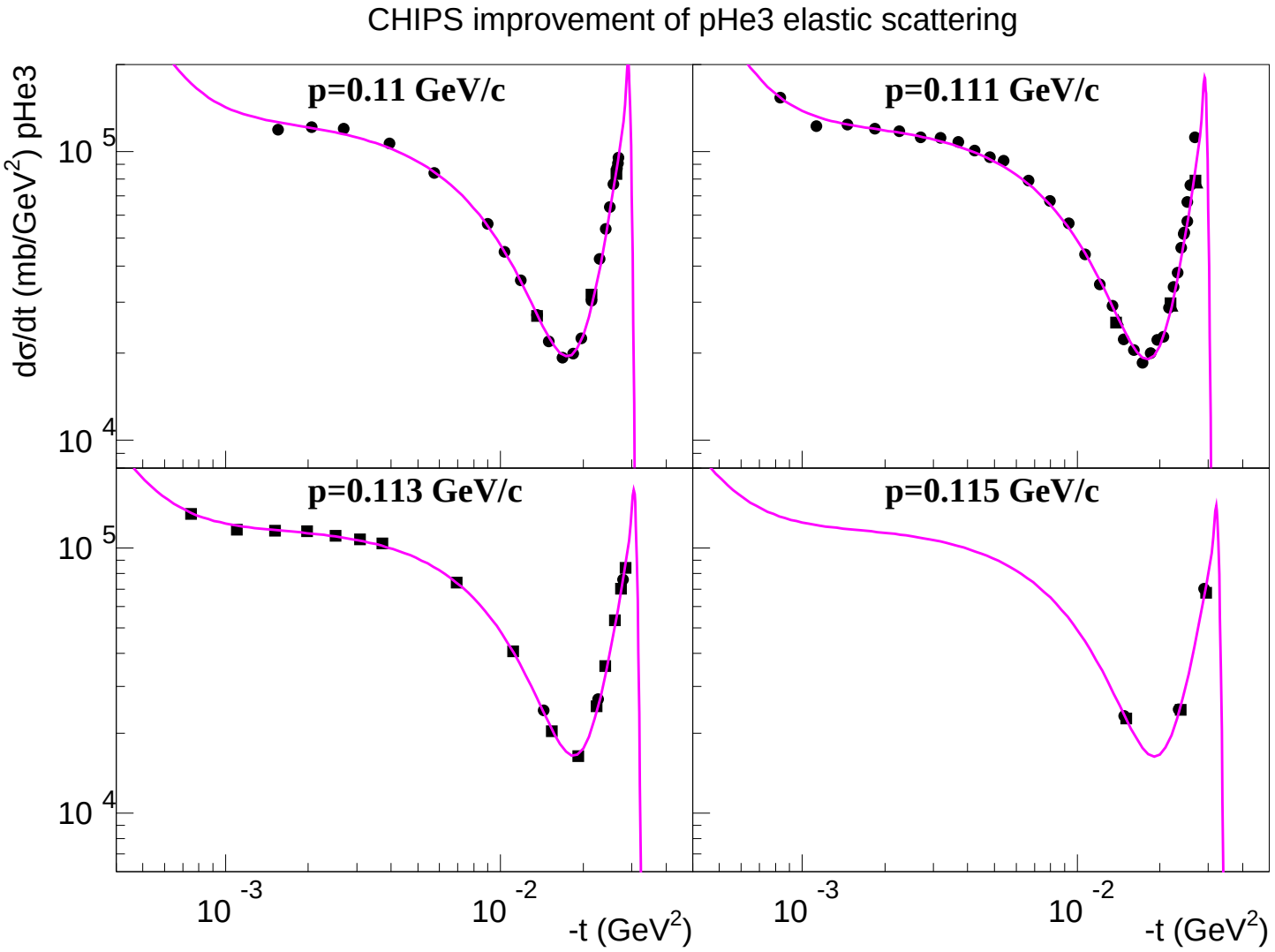

CHIPS improvement of pHe4 elastic scattering
dσ/dt (mb/GeV²) pHe4
p=45 GeV/c
p=100 GeV/c
p=150 GeV/c
p=200 GeV/c
-t (GeV²)
-t (GeV²)

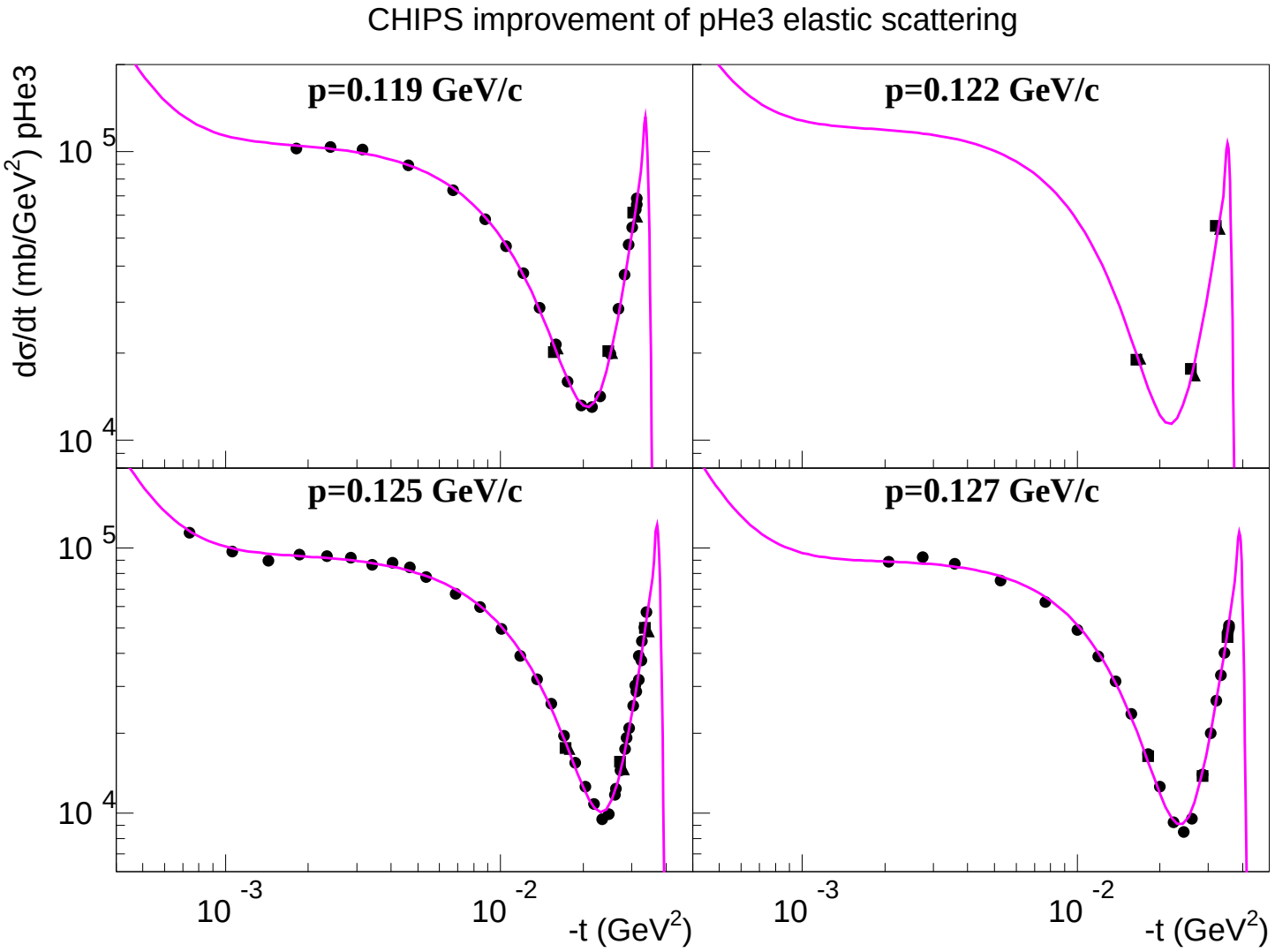

CHIPS improvement of pHe4 elastic scattering
dσ/dt (mb/GeV²) pHe4
p=250 GeV/c
p=300 GeV/c
p=400 GeV/c
p=1000 GeV/c
-t (GeV²)
-t (GeV²)

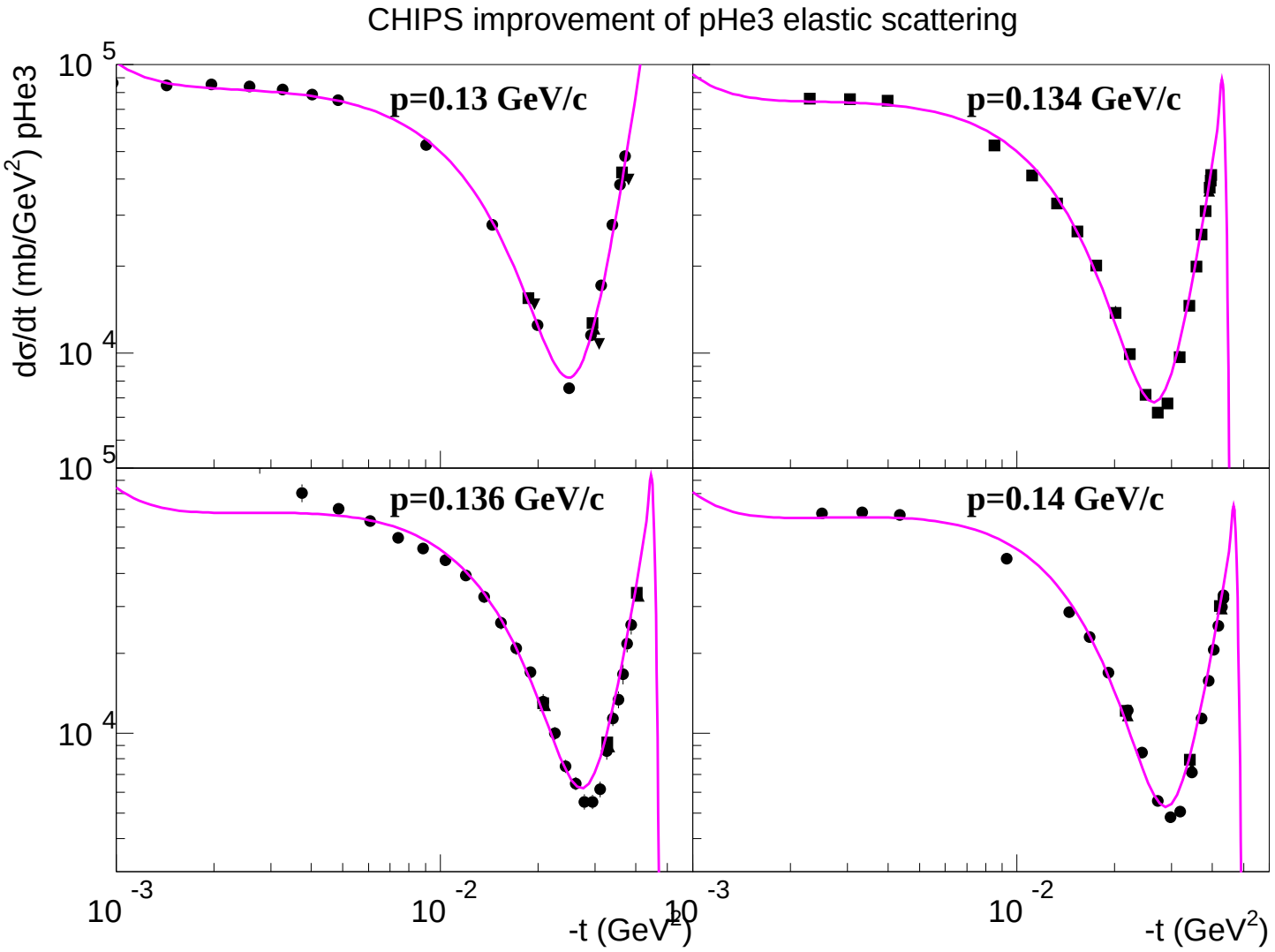

CHIPS improvement of pHe3 elastic scattering
dσ/dt (mb/GeV²) pHe3
p=0.024 GeV/c
p=0.029 GeV/c
p=0.035 GeV/c
p=0.041 GeV/c
10 6
10 6
10 -3
10 -3
-t (GeV²)
-t (GeV²)

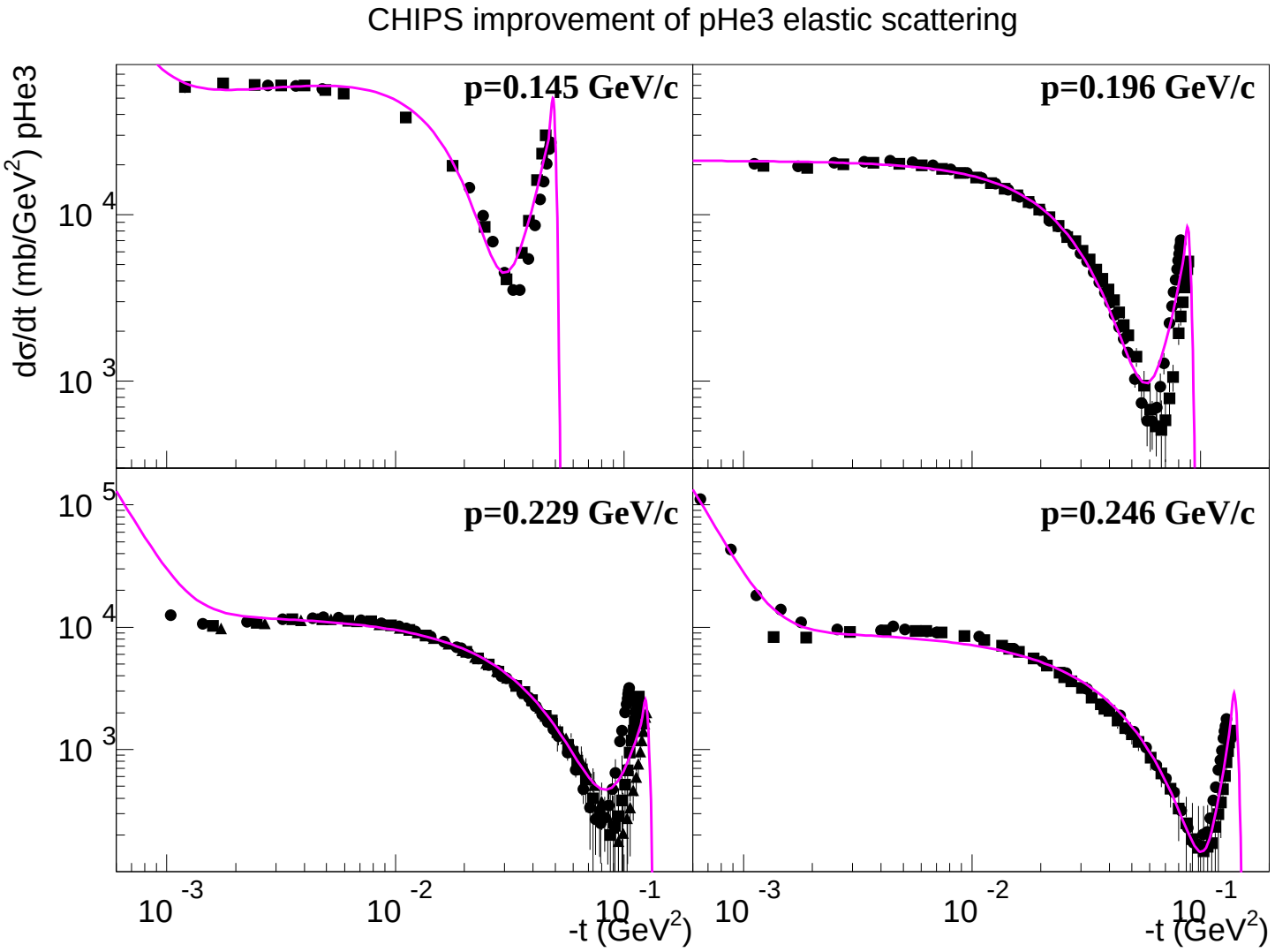

CHIPS improvement of pHe3 elastic scattering
dσ/dt (mb/GeV²) pHe3
p=0.07 GeV/c
p=0.087 GeV/c
p=0.091 GeV/c
p=0.093 GeV/c
10 5
10 -3
10 -2
-t (GeV²)

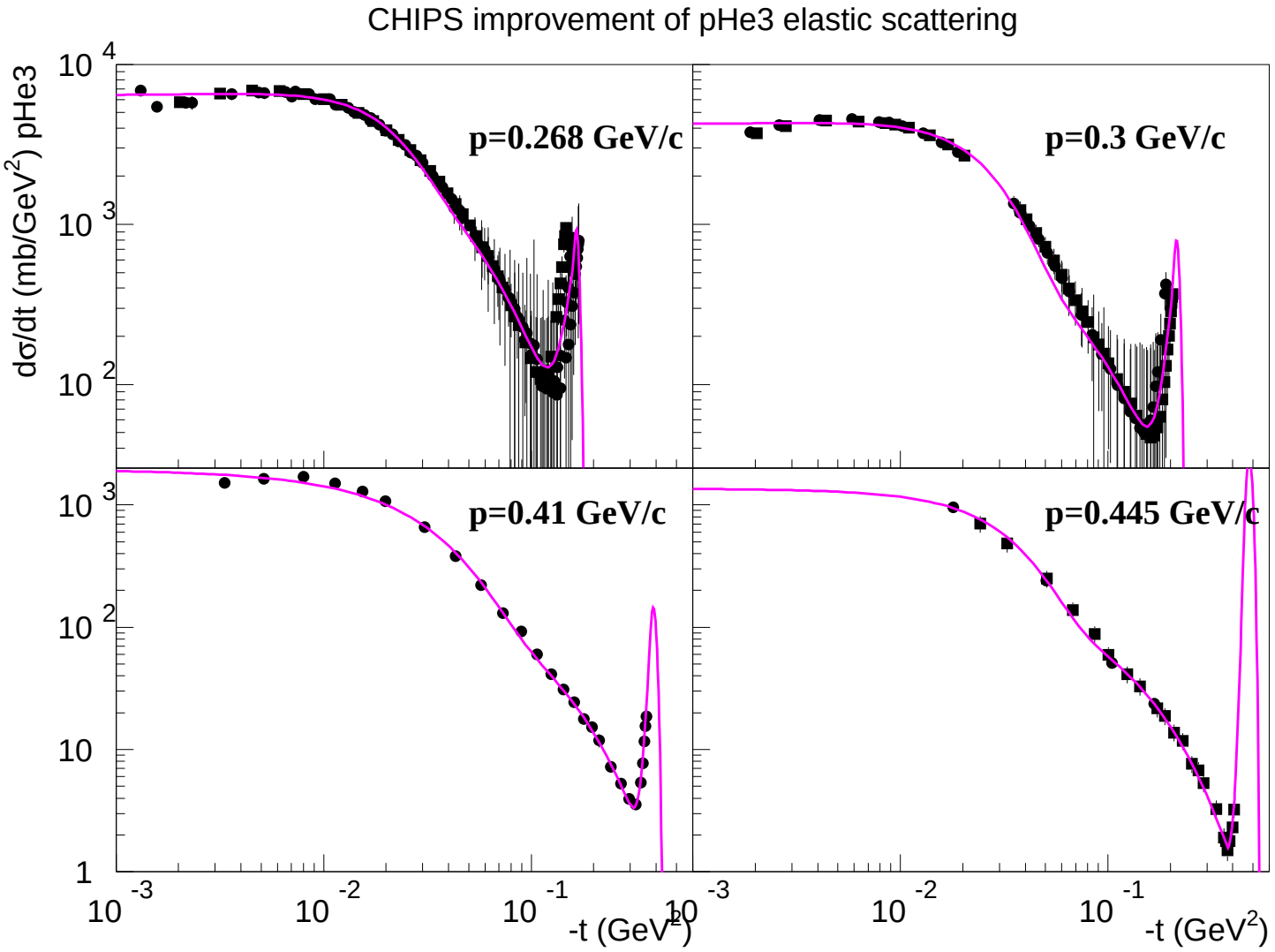

CHIPS improvement of pHe3 elastic scattering
dσ/dt (mb/GeV²) pHe3
p=0.096 GeV/c
p=0.099 GeV/c
p=0.102 GeV/c
p=0.106 GeV/c
10 5
10 5
10 -3
10 -2
-t (GeV²)
10 -3
10 -2
-t (GeV²)

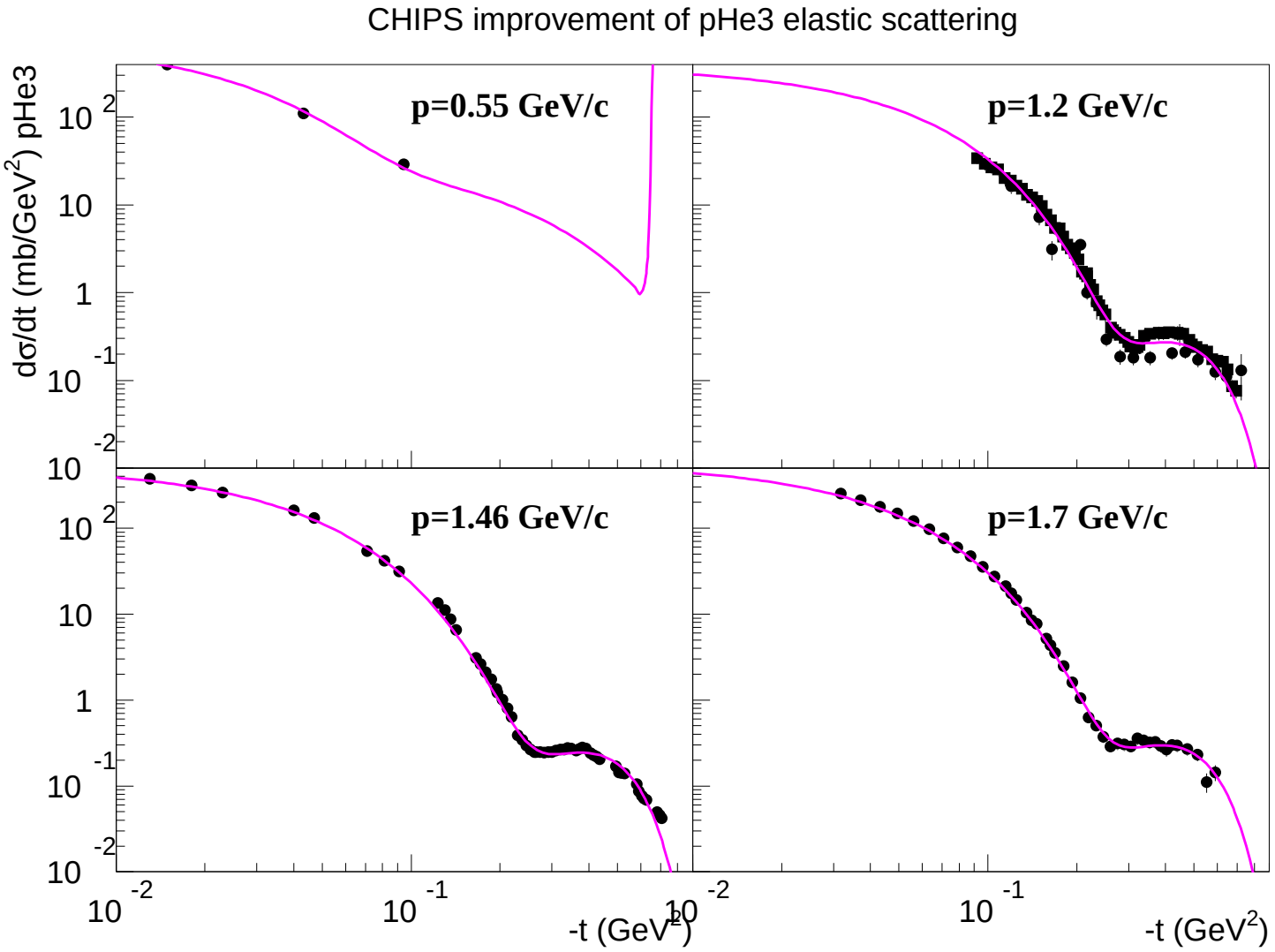

CHIPS improvement of pHe3 elastic scattering
p=0.11 GeV/c
p=0.111 GeV/c
p=0.113 GeV/c
p=0.115 GeV/c
dσ/dt (mb/GeV²) pHe3
10 5
10 4
10 -3
10 -2
-t (GeV²)

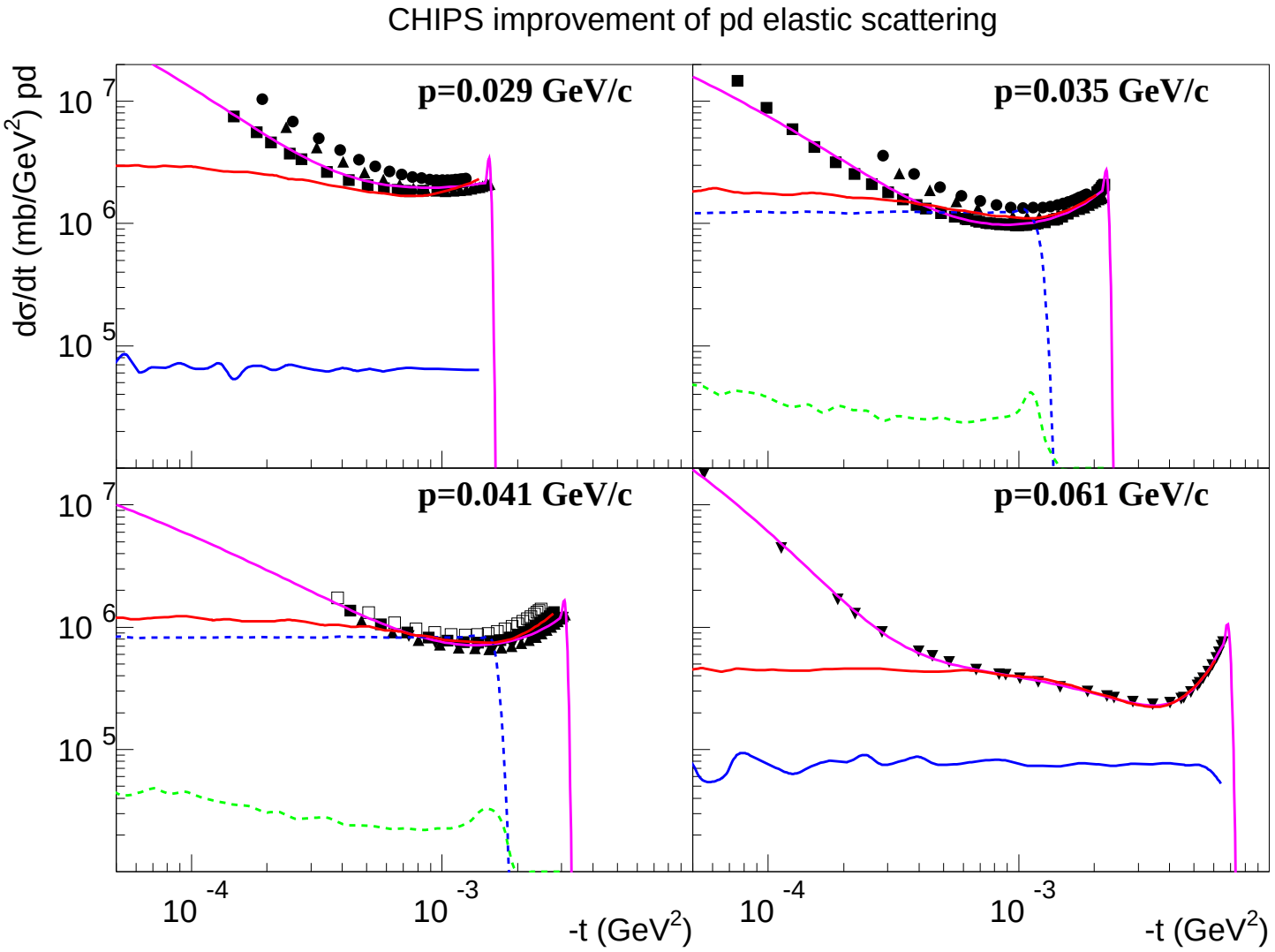

CHIPS improvement of pHe3 elastic scattering
p=0.119 GeV/c
p=0.122 GeV/c
p=0.125 GeV/c
p=0.127 GeV/c
dσ/dt (mb/GeV²) pHe3
10 5
10 4
10 -3
10 -2
-t (GeV²)

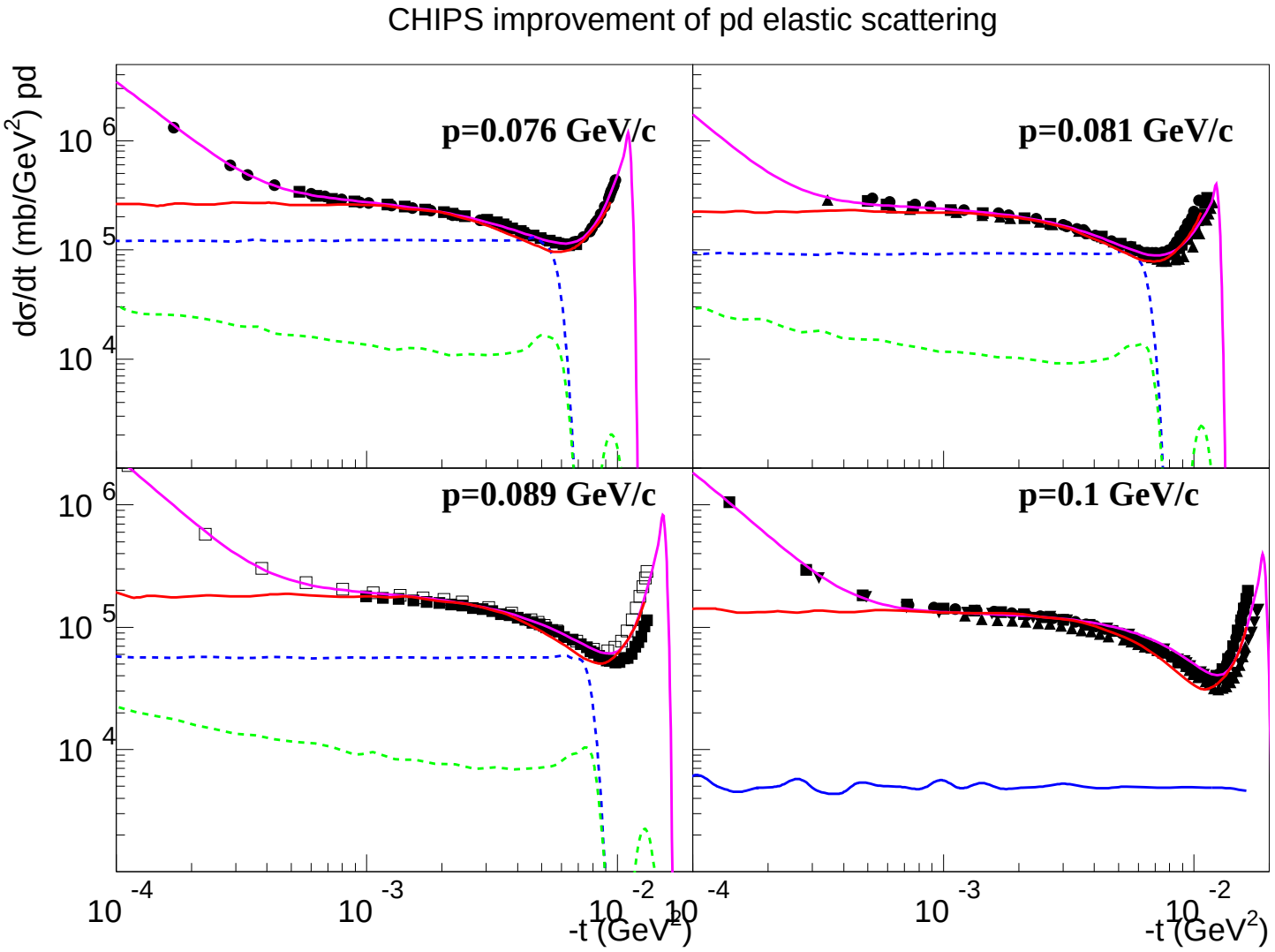

CHIPS improvement of pHe3 elastic scattering
dσ/dt (mb/GeV²) pHe3
p=0.13 GeV/c
p=0.134 GeV/c
p=0.136 GeV/c
p=0.14 GeV/c
-t (GeV²)
-t (GeV²)

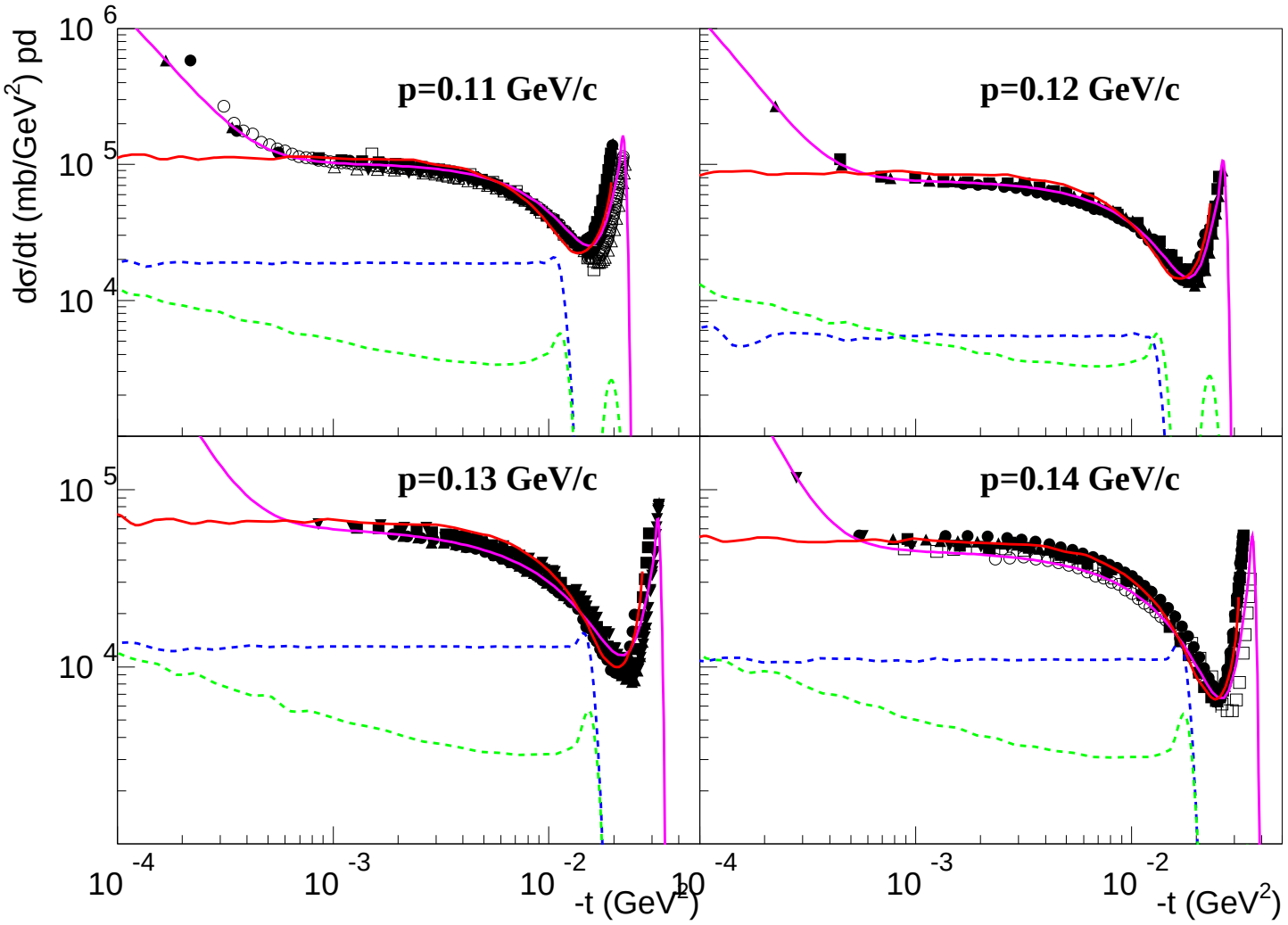

CHIPS improvement of pHe3 elastic scattering
dσ/dt (mb/GeV²) pHe3
p=0.145 GeV/c
p=0.196 GeV/c
p=0.229 GeV/c
p=0.246 GeV/c
-t (GeV²)
-t (GeV²)

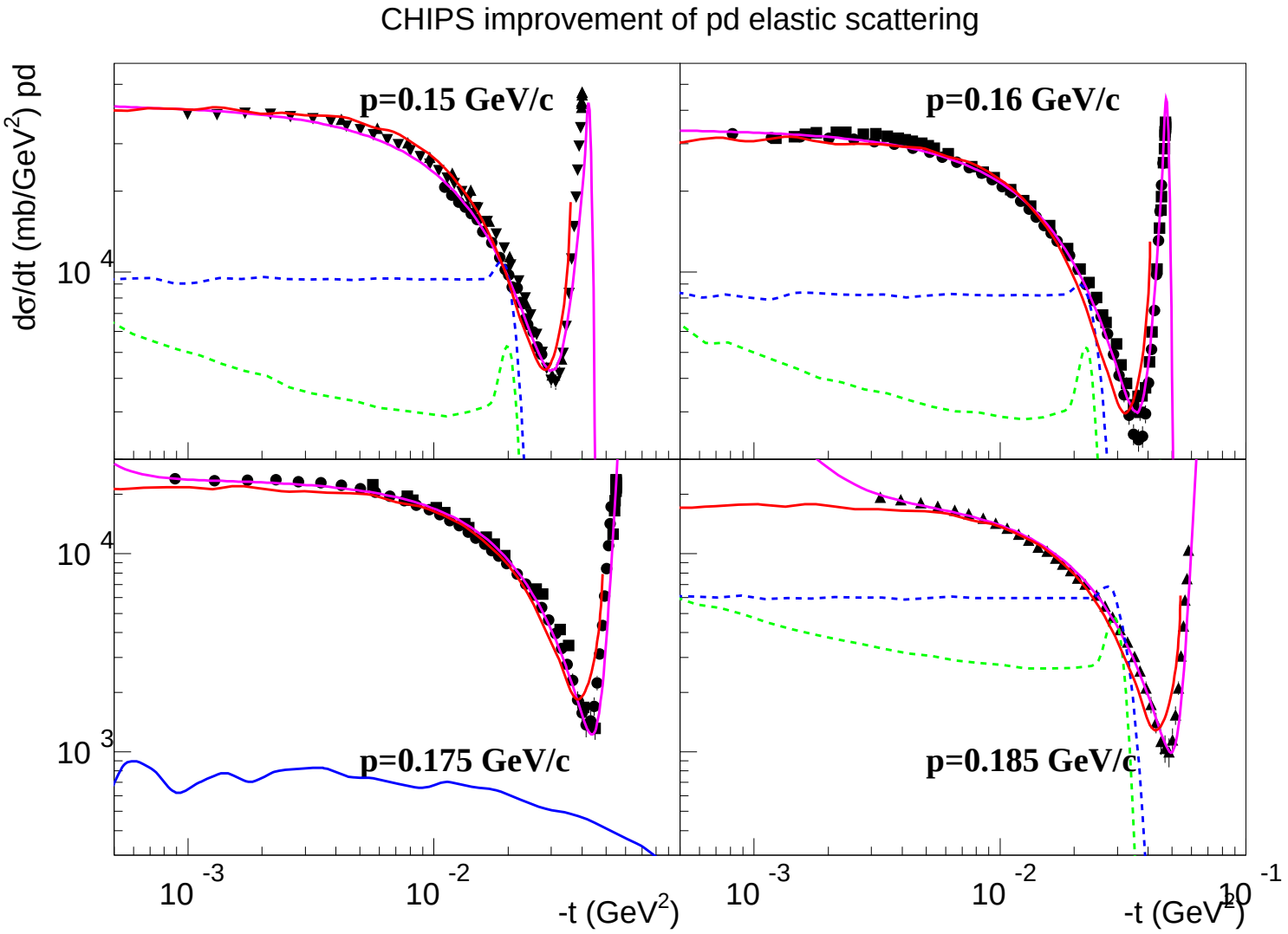

CHIPS improvement of pHe3 elastic scattering
dσ/dt (mb/GeV²) pHe3
p=0.268 GeV/c
p=0.3 GeV/c
p=0.41 GeV/c
p=0.445 GeV/c
-t (GeV²)
-t (GeV²)

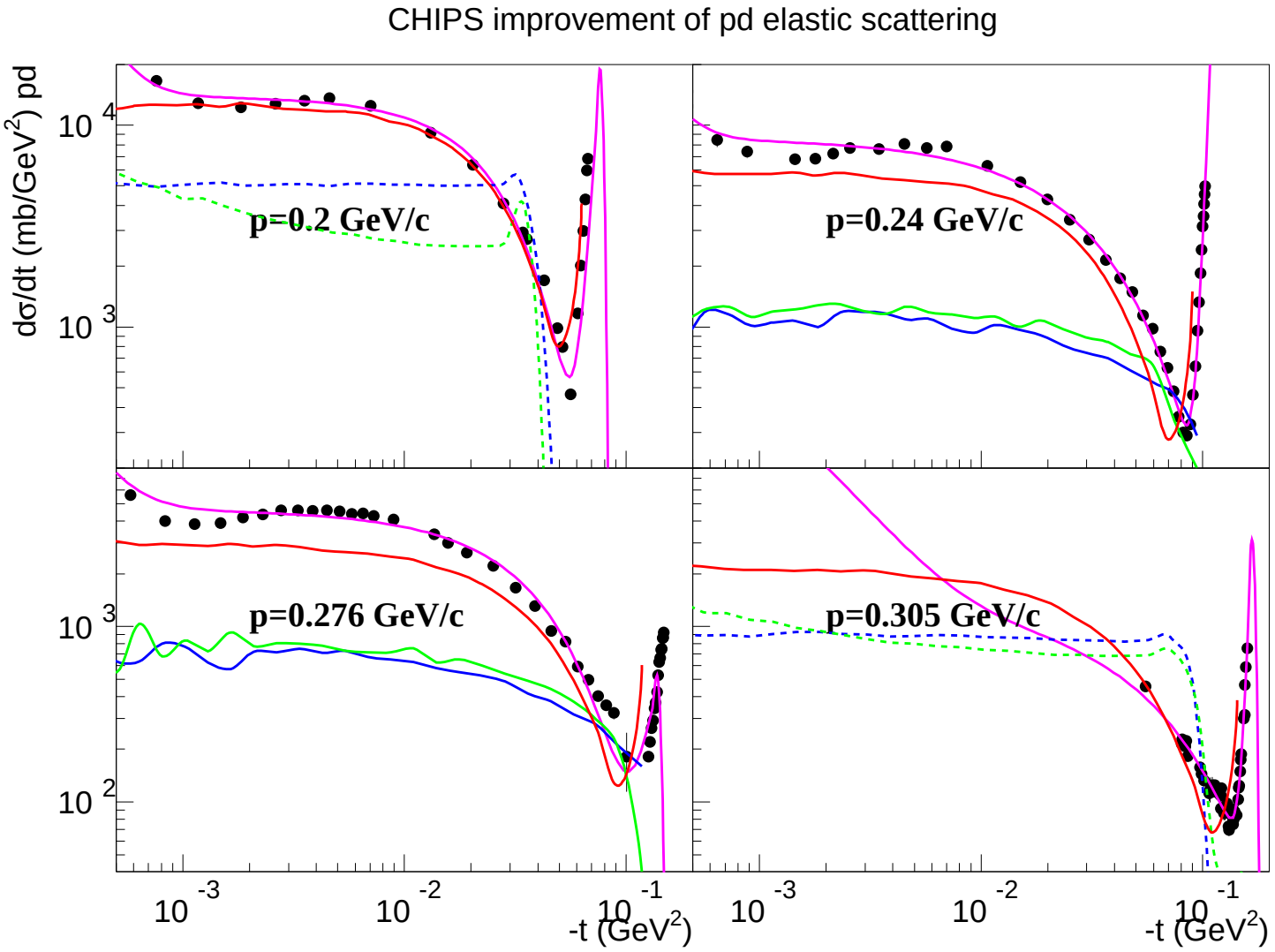

CHIPS improvement of pHe3 elastic scattering
dσ/dt (mb/GeV²) pHe3
p=0.55 GeV/c
p=1.2 GeV/c
p=1.46 GeV/c
p=1.7 GeV/c
-t (GeV²)
-t (GeV²)

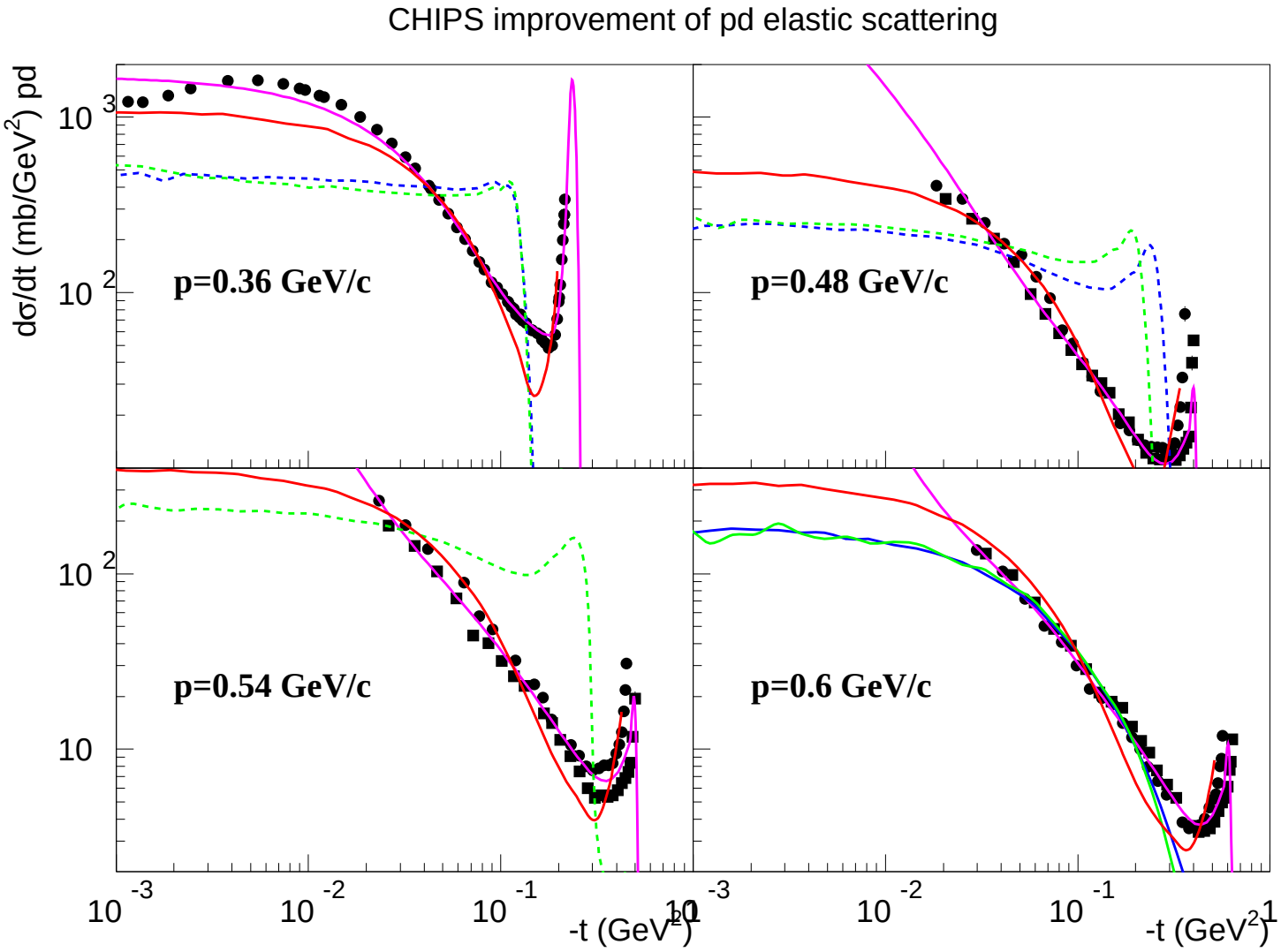

CHIPS improvement of pd elastic scattering
dσ/dt (mb/GeV²) pd
p=0.029 GeV/c
p=0.035 GeV/c
p=0.041 GeV/c
p=0.061 GeV/c
-t (GeV²)
-t (GeV²)

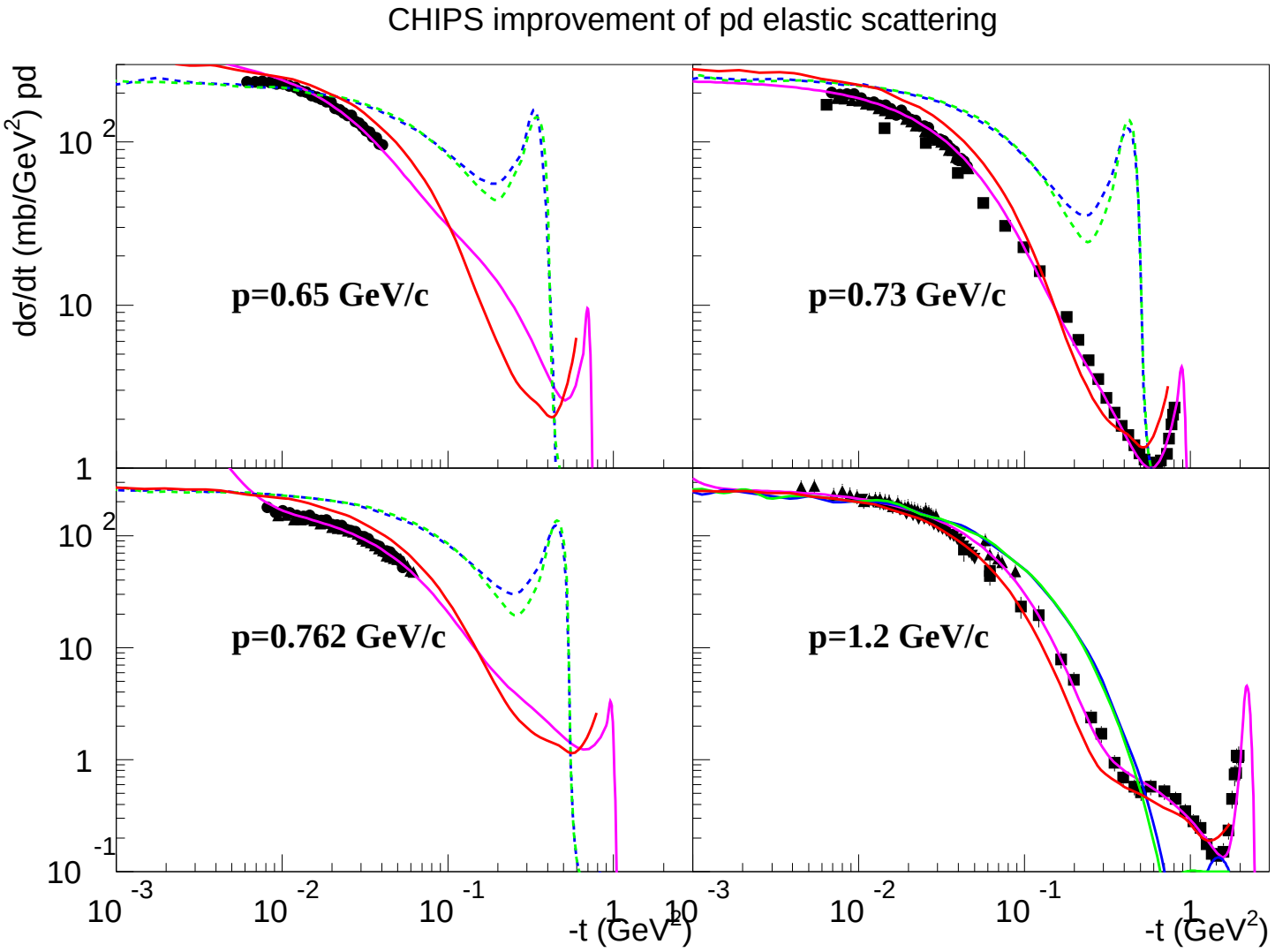

CHIPS improvement of pd elastic scattering
dσ/dt (mb/GeV²) pd
p=0.076 GeV/c
p=0.081 GeV/c
p=0.089 GeV/c
p=0.1 GeV/c
-t (GeV²)
-t (GeV²)

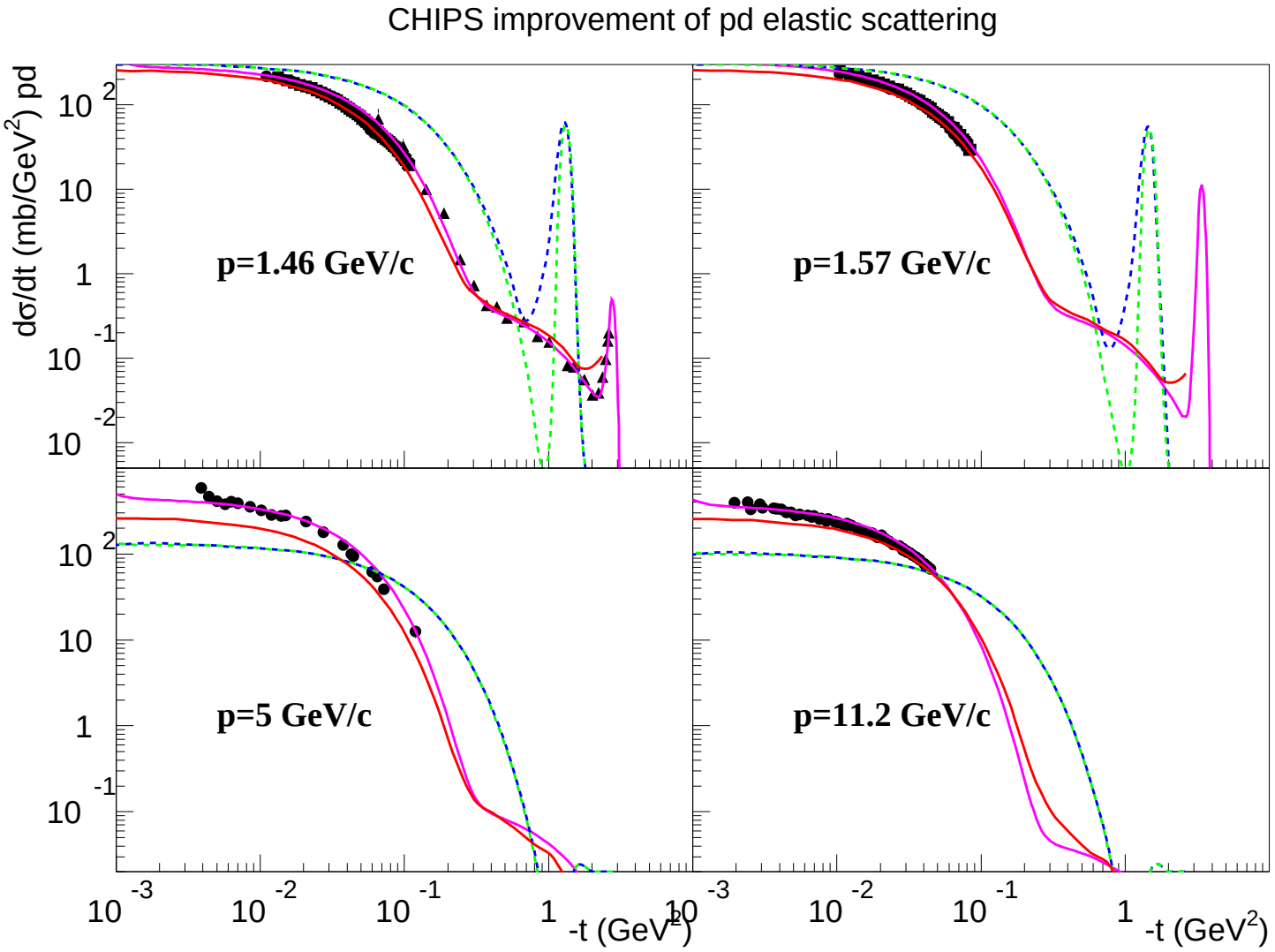

dσ/dt (mb/GeV²) pd
p=0.11 GeV/c
p=0.12 GeV/c
p=0.13 GeV/c
p=0.14 GeV/c
-t (GeV²)
-t (GeV²)

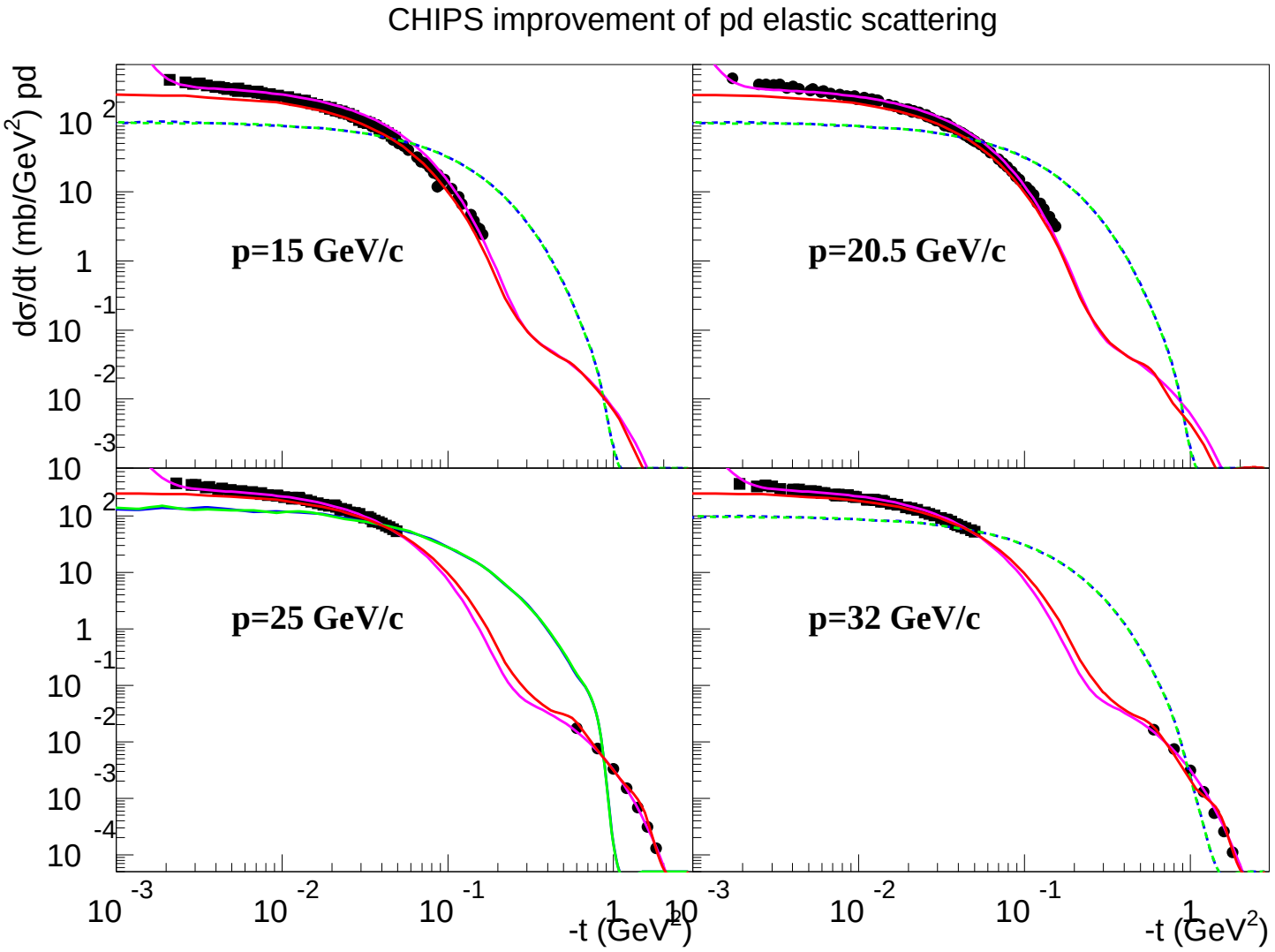

CHIPS improvement of pd elastic scattering
dσ/dt (mb/GeV²) pd
p=0.15 GeV/c
p=0.16 GeV/c
p=0.175 GeV/c
p=0.185 GeV/c
10⁴
10³
10⁻³
10⁻²
10⁻¹
-t (GeV²)

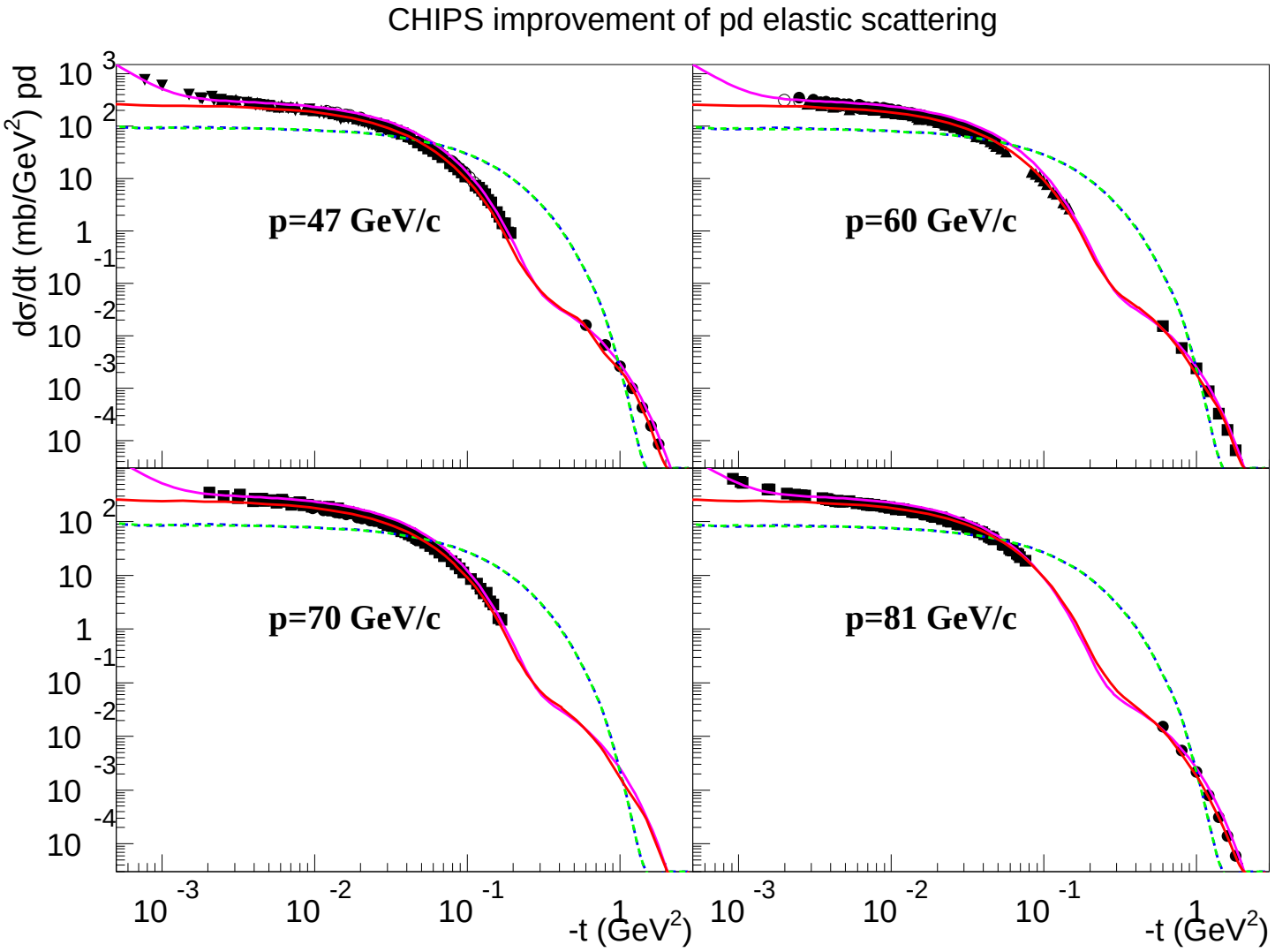

CHIPS improvement of pd elastic scattering
dσ/dt (mb/GeV²) pd
p=0.2 GeV/c
p=0.24 GeV/c
p=0.276 GeV/c
p=0.305 GeV/c
-t (GeV²)
-t (GeV²)

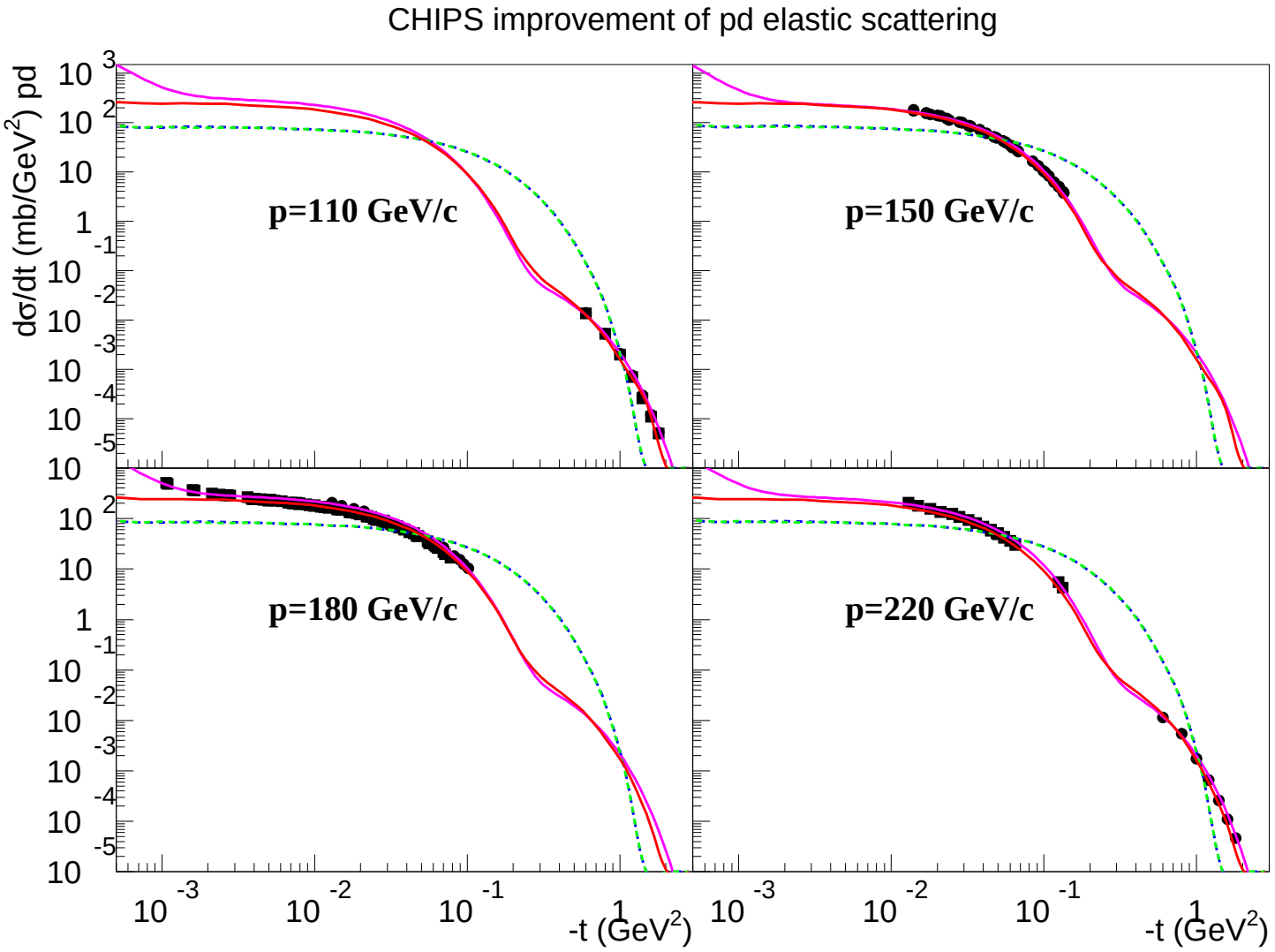

CHIPS improvement of pd elastic scattering
dσ/dt (mb/GeV²) pd
p=0.36 GeV/c
p=0.48 GeV/c
p=0.54 GeV/c
p=0.6 GeV/c
-t (GeV²)
-t (GeV²)

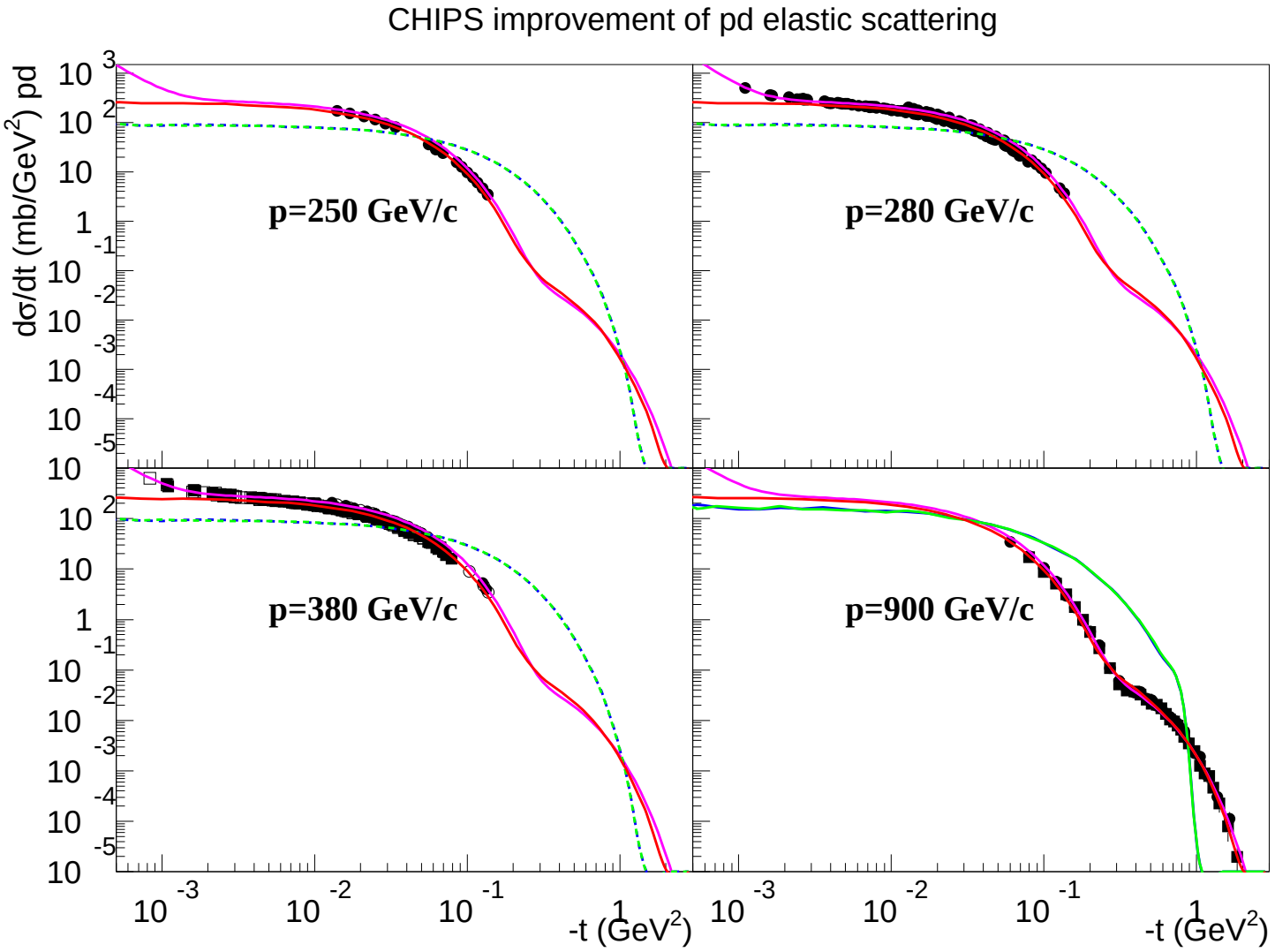

CHIPS improvement of pd elastic scattering
dσ/dt (mb/GeV²) pd
p=0.65 GeV/c
p=0.73 GeV/c
p=0.762 GeV/c
p=1.2 GeV/c
-t (GeV²)
-t (GeV²)

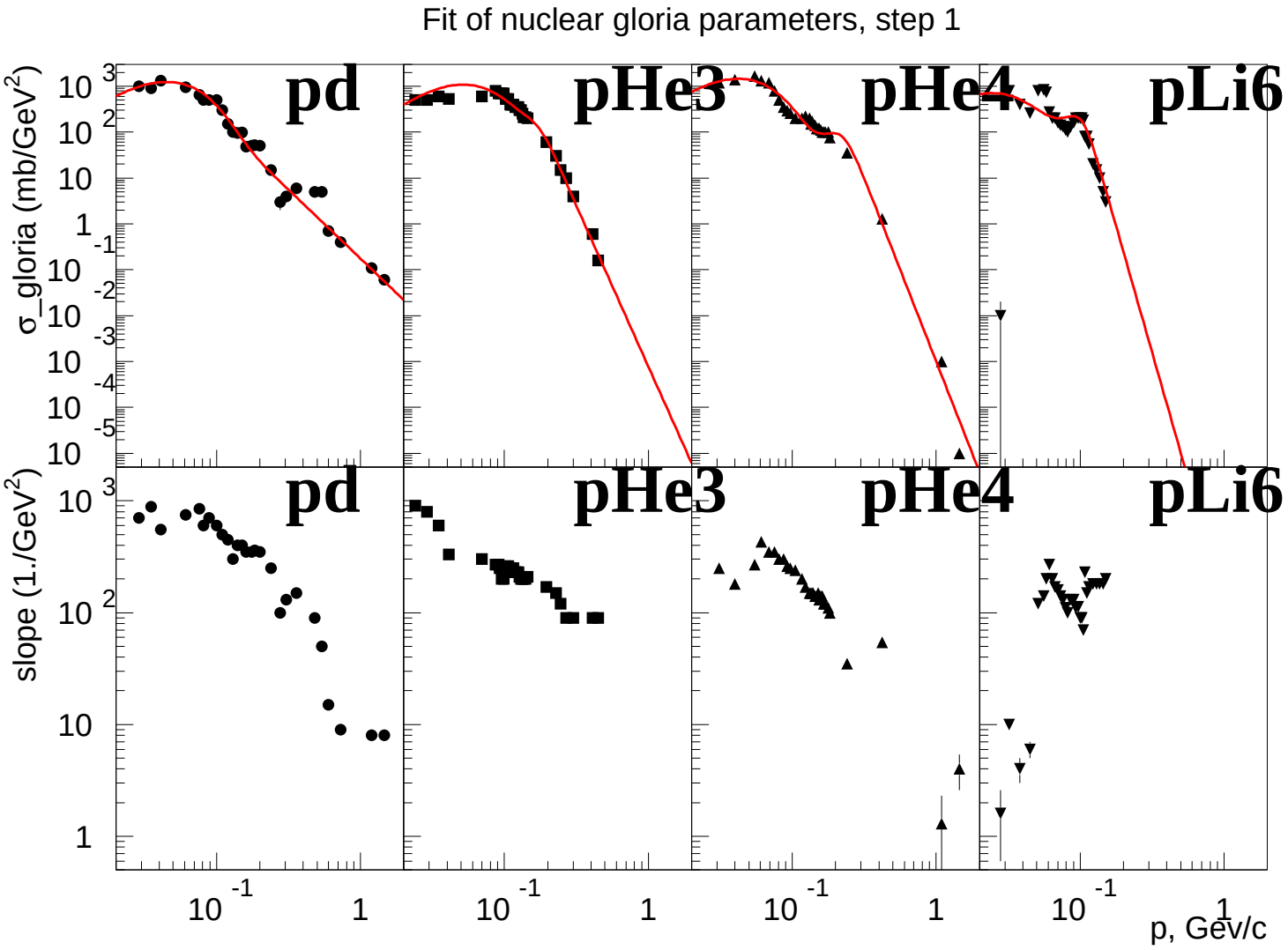

CHIPS improvement of pd elastic scattering
dσ/dt (mb/GeV²) pd
p=1.46 GeV/c
p=1.57 GeV/c
p=5 GeV/c
p=11.2 GeV/c
-t (GeV²)
-t (GeV²)


CHIPS improvement of pd elastic scattering
dσ/dt (mb/GeV²) pd
p=15 GeV/c
p=20.5 GeV/c
p=25 GeV/c
p=32 GeV/c
-t (GeV²)
-t (GeV²)


CHIPS improvement of pd elastic scattering
dσ/dt (mb/GeV²) pd
p=47 GeV/c
p=60 GeV/c
p=70 GeV/c
p=81 GeV/c
-t (GeV²)
-t (GeV²)


CHIPS improvement of pd elastic scattering
dσ/dt (mb/GeV²) pd
p=110 GeV/c
p=150 GeV/c
p=180 GeV/c
p=220 GeV/c
-t (GeV²)
-t (GeV²)


CHIPS improvement of pd elastic scattering
dσ/dt (mb/GeV^2) pd
p=250 GeV/c
p=280 GeV/c
p=380 GeV/c
p=900 GeV/c
-t (GeV^2)
-t (GeV^2)


Fit of nuclear gloria parameters, step 1
pd
pHe3
pHe4
pLi6
σ_gloria (mb/GeV²)
slope (1./GeV²)
p, Gev/c

(p,A) parameterization of $A_5(B_5)$ parameter (A<7)

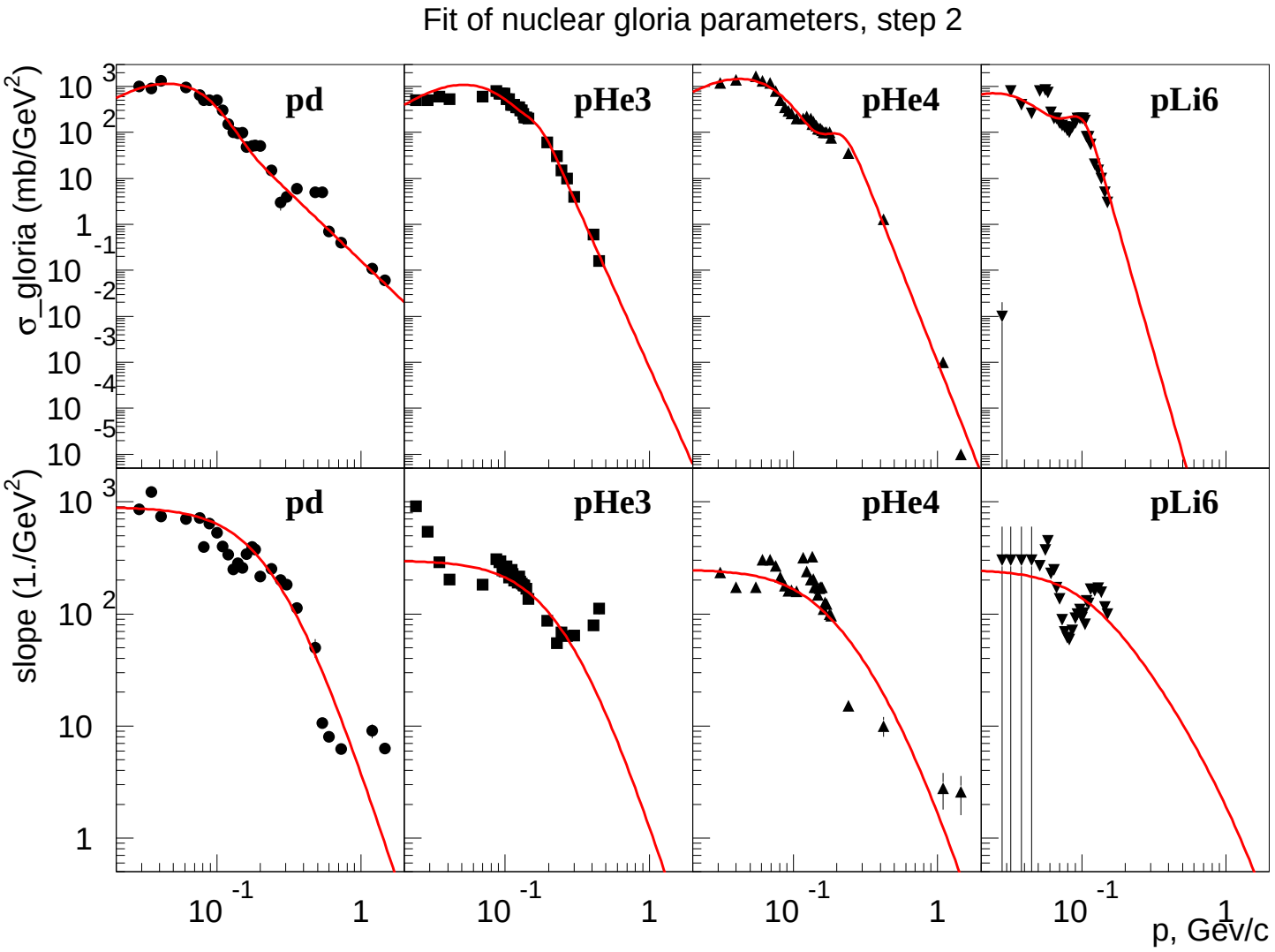
$$\mathbf{A_5 = p^2(p \cdot D \cdot e^{-p/E} + \frac{F}{1 + G \cdot p^H})}$$

$$\mathbf{A_5(d) = p^2(p \cdot 2.7E8 \cdot e^{-p/.014} + \frac{8.E4}{1 + 5.E5 \cdot p^5})}$$

$$\mathbf{A_5(^3He) = p^2(p \cdot 1.6E8 \cdot e^{-p/.017} + \frac{7.E3}{1 + 9.E6 \cdot p^9})}$$

$$\mathbf{A_5(^4He) = p^2(p \cdot 3.9E8 \cdot e^{-p/.014} + \frac{3.E3}{1 + 3.E6 \cdot p^{10}})}$$

$$\mathbf{A_5(^6Li) = p^2(p \cdot 10.E8 \cdot e^{-p/.008} + \frac{3.E4}{1 + 6.E12 \cdot p^{13}})}$$


Fit of nuclear gloria parameters, step 2
pd
pHe3
pHe4
pLi6
σ_gloria (mb/GeV²)
slope (1./GeV²)
p, Gev/c

(p,A) parameterization of B_5 parameter (A<7)

$$\mathbf{B_5} = \frac{\mathbf{D}}{\mathbf{1 + p^2 \cdot (E + p^2 \cdot F)}}$$

$$\mathbf{B_5(d)} = \frac{\mathbf{900.}}{\mathbf{1 + p^2 \cdot (40. + p^2 \cdot 200.)}}$$

$$\mathbf{B_5(^3He)} = \frac{\mathbf{300.}}{\mathbf{1 + p^2 \cdot (40. + p^2 \cdot 200.)}}$$

$$\mathbf{B_5(^4He)} = \frac{\mathbf{250.}}{\mathbf{1 + p^2 \cdot (50. + p^2 \cdot 100.)}}$$

$$\mathbf{B_5(^4He)} = \frac{\mathbf{250.}}{\mathbf{1 + p^2 \cdot (80. + p^2 \cdot 50.)}}$$

Conclusion

- The $G4QElastic$ process can give a detailed approximation of the existing data without a huge parameterization data base.
- Neither G4HadronCrossSection, nor G4HadronElasticProcess are sensitive for the isotope content of the G4Element, so a deuterium target can not be simulated. In G4.8.1 some formal efforts are made in this direction, but ^3He still can not be simulated.
- Below 100 MeV/c $G4LElastic$ does not produce a recoil nucleus;
- $G4LElastic$ includes quasi-elastic cross section (double-counting);
- G4ElasticHadrNucleusHE & G4ElasticCascadeInterface don't work.