

Validation of hadron elastic models

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Outline

Objectives

test30 and elastic scattering models

Experimental data

Multiple electromagnetic scattering

Tuning of G4HadronElastic

- Preliminary results of validation testing

Future plans

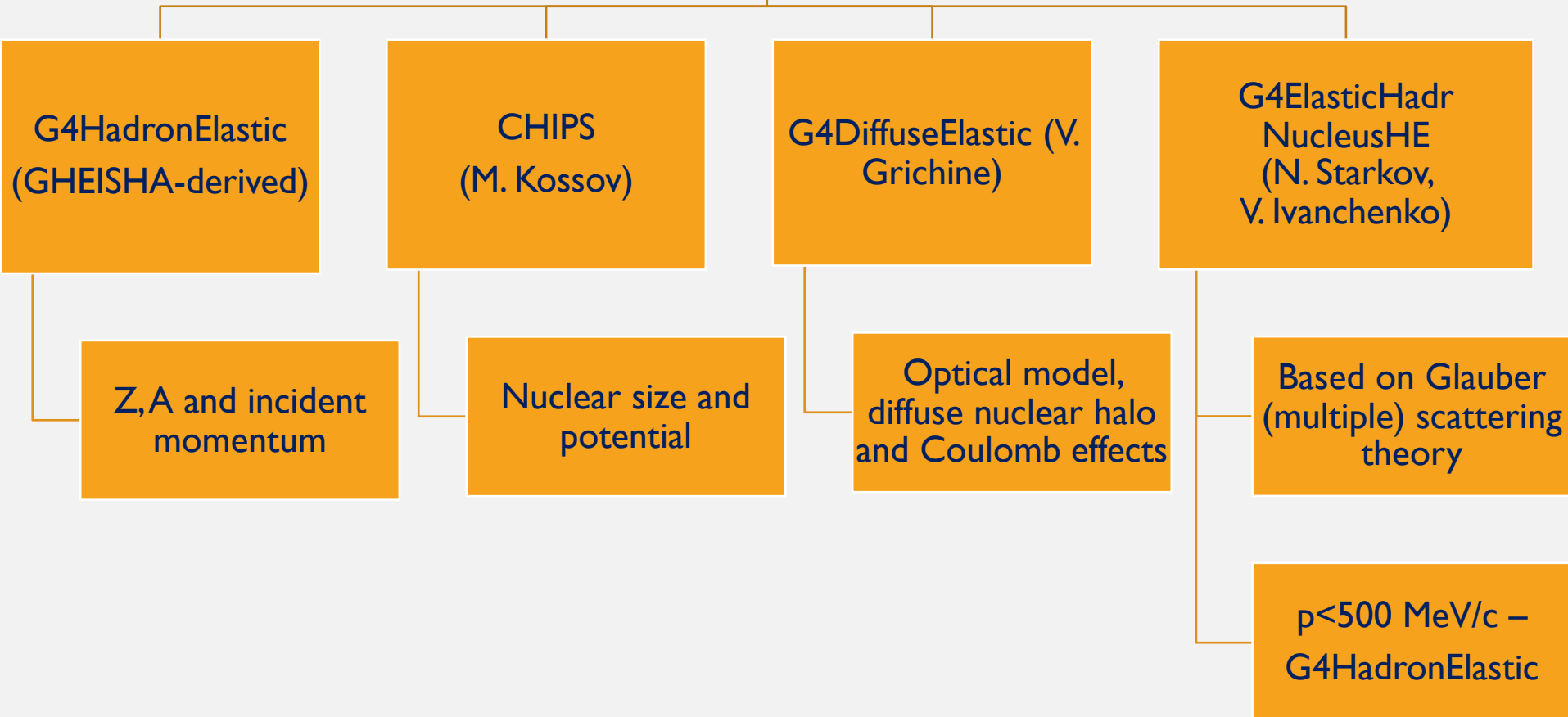
Objectives

test30 - Model level test allowing to compare simulation of differential cross-sections vs. experimental data

- Check established models of elastic scattering of pions on nuclei in the resonance energy region $<1\text{GeV}$ on experimental data
- Make improvements to existing models

* Data from original publications and EXFOR is given for Θ in center-of-mass system

Test30 for hadron elastic



Proton Elastic Scattering Geant4 10.5

$p + \text{Fe} \rightarrow p + X, E = 400 \text{ MeV}$

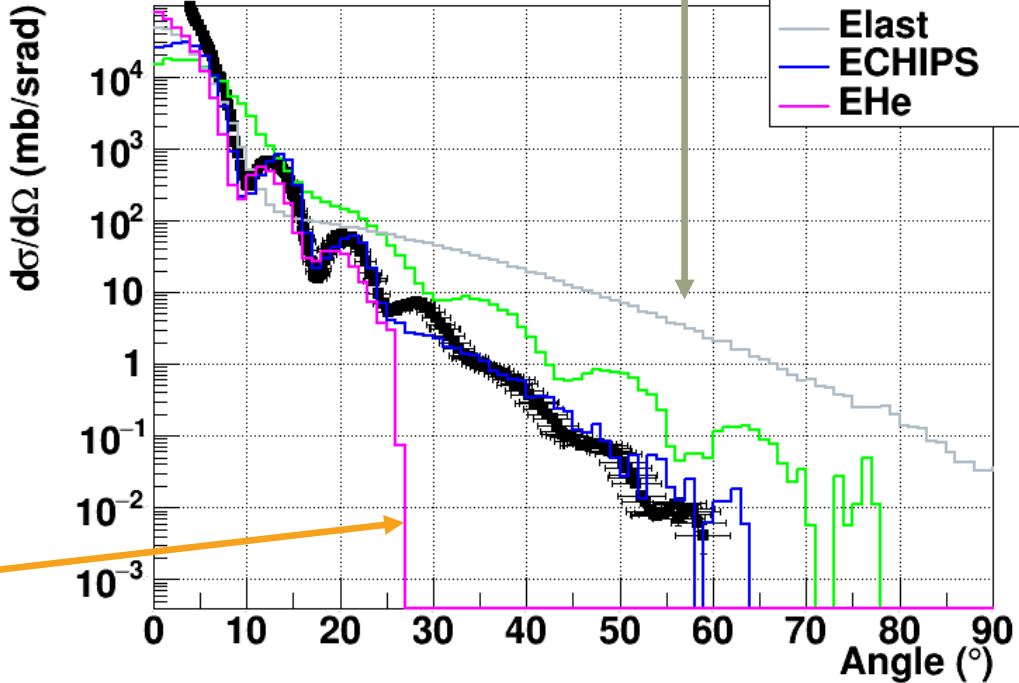
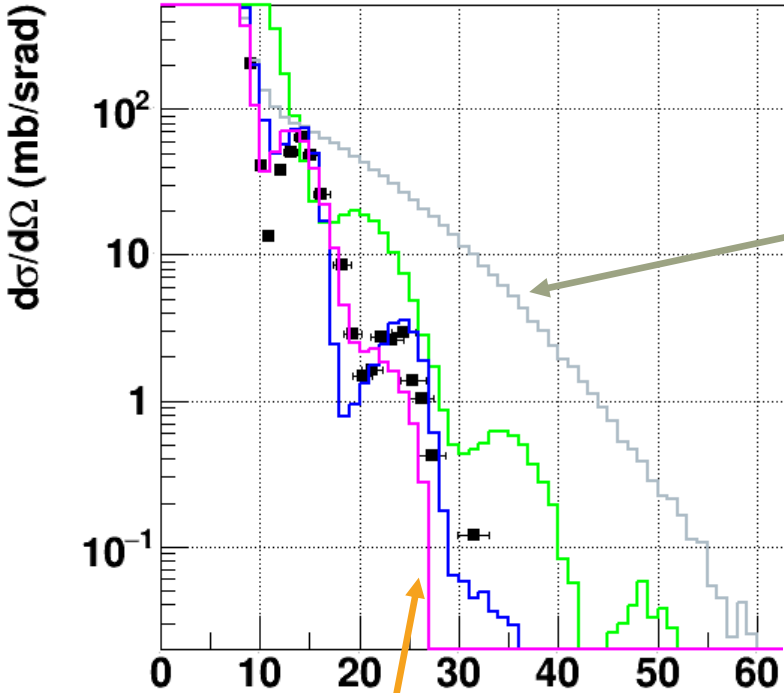
- Data
- EDiff
- Elast
- ECHIPS
- EHe

Second exponent overshoot exp. data

Angle limitaion

$p + \text{Pb} \rightarrow p + X, E = 200 \text{ MeV}$

- Data
- EDiff
- Elast
- ECHIPS
- EHe



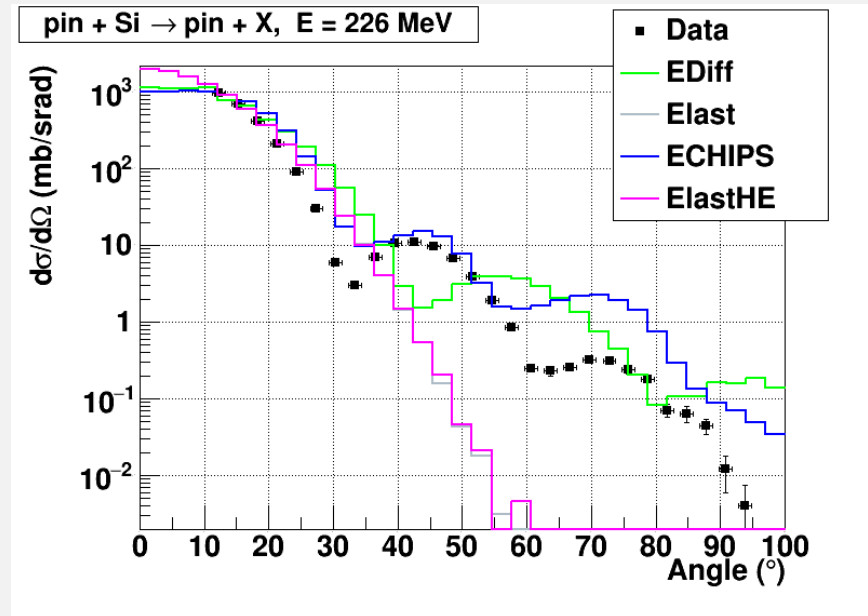
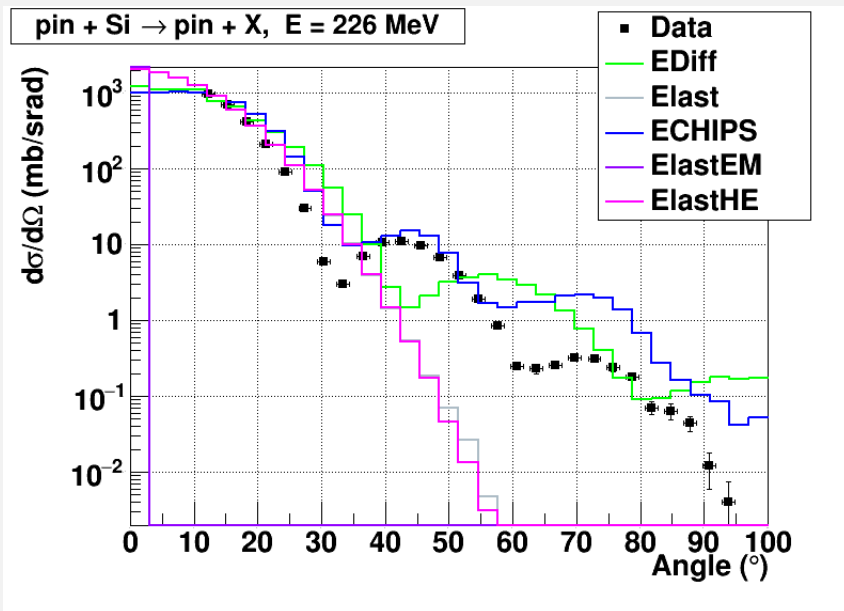
New experimental data

In a framework of this project we extend test30 by addition of extra data for π^\pm elastic scattering from EXFOR database and original publications:

1. **Takahashi et al., [1995](#) (*Physical Review C*, 51(5)):**
 - ${}_6\text{C}^{12}$ -610, 790, 895 MeV/c
 - ${}_{82}\text{Pb}^{208}$ - 790 MeV/c
2. **Aoki et al., [2007](#) (*Physical Review C*, 76(2)):**
 - ${}_6\text{C}^{12}$ - 995 MeV/c
3. **Preedom et al., [1979](#) (*Nuclear Physics A*, 326(2-3)):**
 - ${}_{14}\text{Si}^{28}$ - 130, 180, 226 MeV/c
4. **Binon et al., [1970](#) (*Nuclear Physics A*)**
 - ${}_6\text{C}^{12}$ -180, 230, 280 MeV/c
5. **Marlow et al., [1984](#) (*Physical Review C*, 30(5), pp.1662-1670.)**
 - ${}_6\text{C}^{12}$ - 800 MeV/c
 - ${}_6\text{Ca}^{12}$ - 800 MeV/c

Contribution of multiple electromagnetic scattering

- Inside the target particles undergo multiple Rutherford scattering
- Rutherford scattering is very peaked at 0
- It is concluded that in the experiments authors of articles choose parameters of the target so as to minimize this EM contribution
- EM multiple scattering wasn't included before, now G4WentzelVI model is used to sample scattering off target which is added to any hadron scattering (though has a small effect)



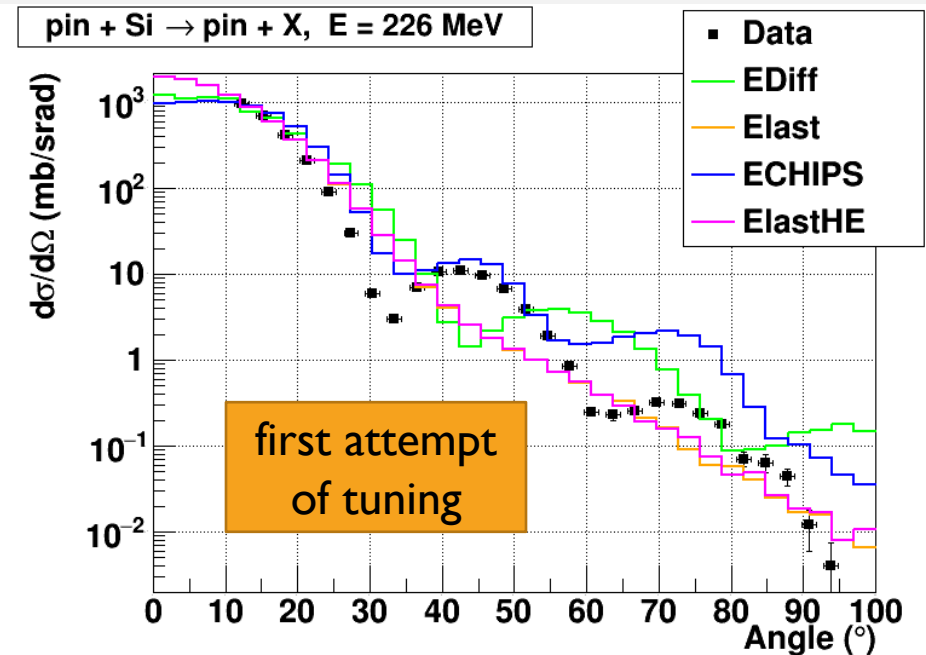
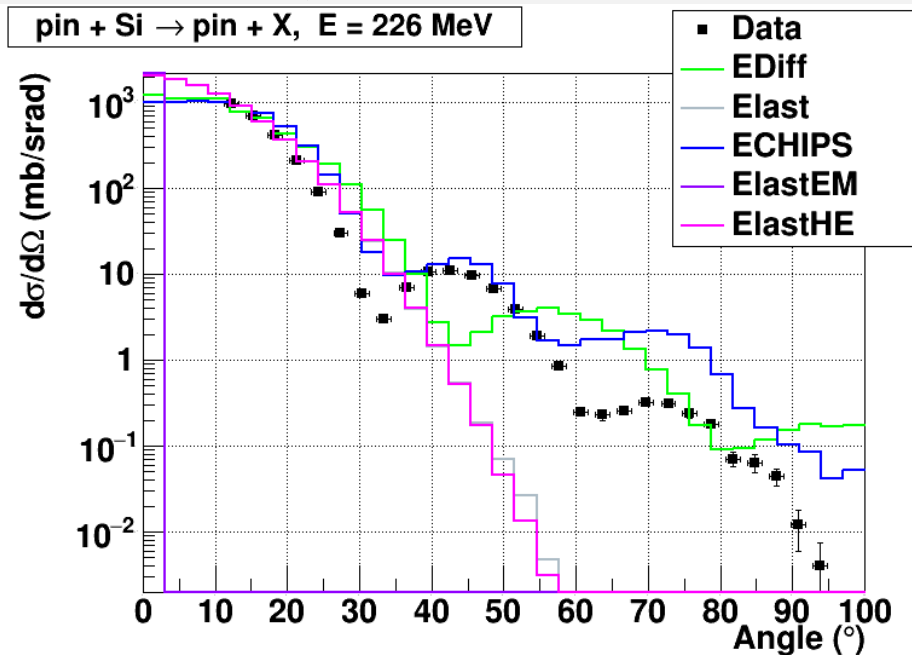
Tuning of G4HadronElastic

- Differential cross-section is a combination of two exponents
 - First describes **first diffraction maximum**
 - Second describes **satellite maxima**
- We were trying to improve parametrization of exponent parameters

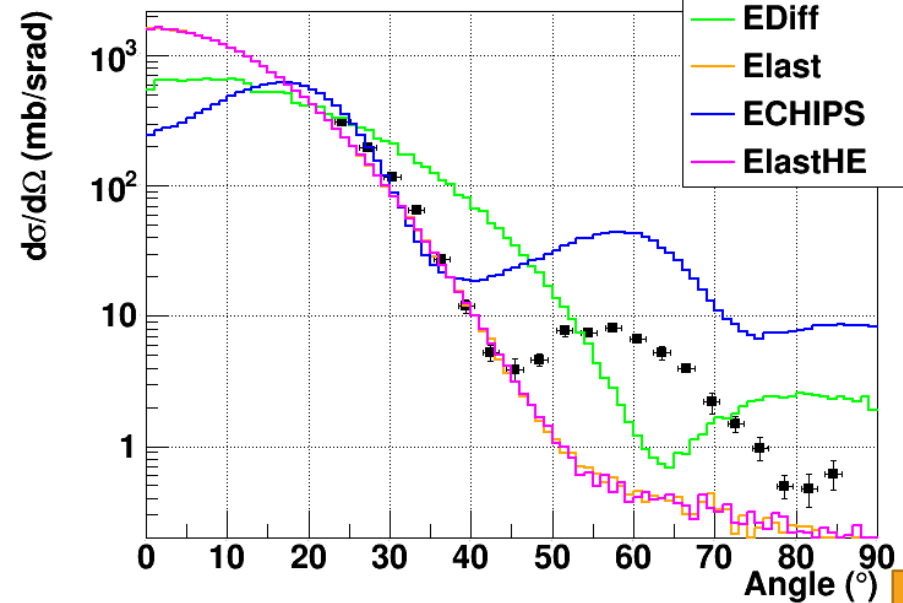
Old plot -

*Second exponent is "turned off"

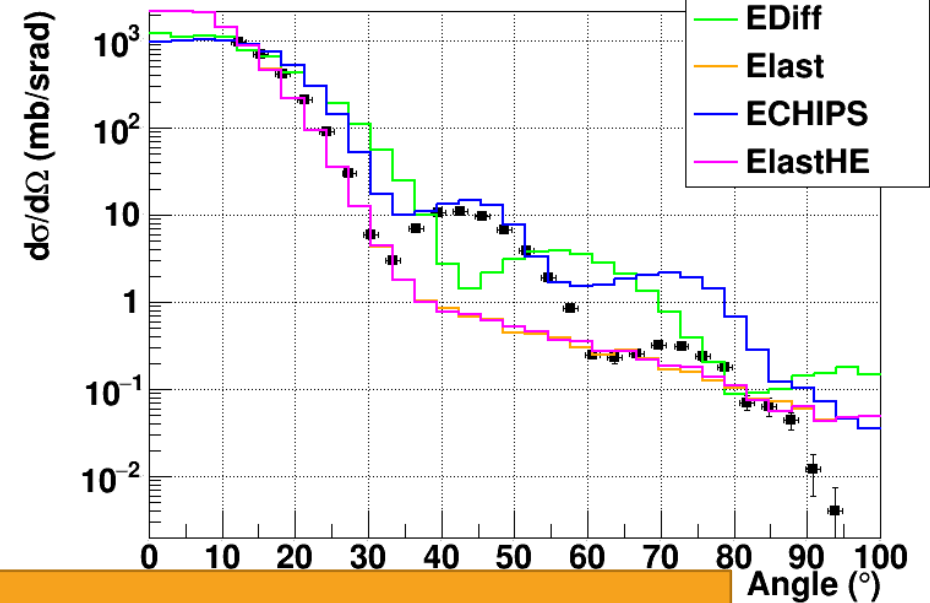
*EM differential cross-section displayed separately



$\text{pin} + \text{Si} \rightarrow \text{pin} + \text{X}, E = 130 \text{ MeV}$

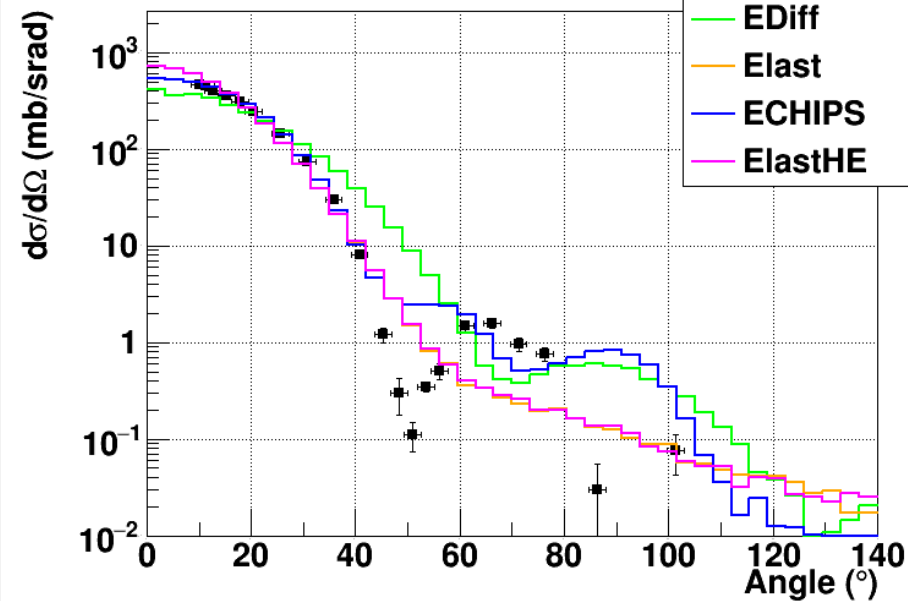


$\text{pin} + \text{Si} \rightarrow \text{pin} + \text{X}, E = 226 \text{ MeV}$

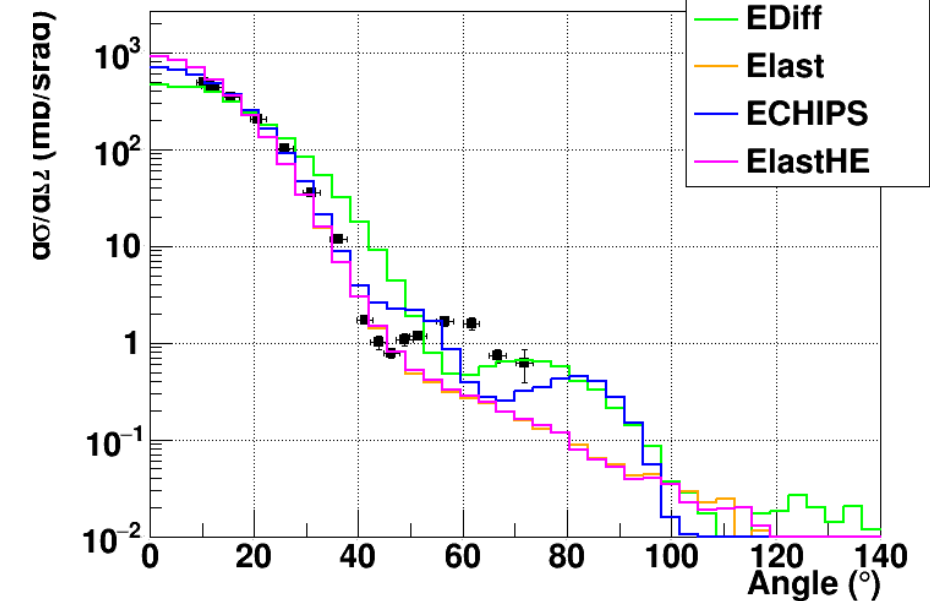


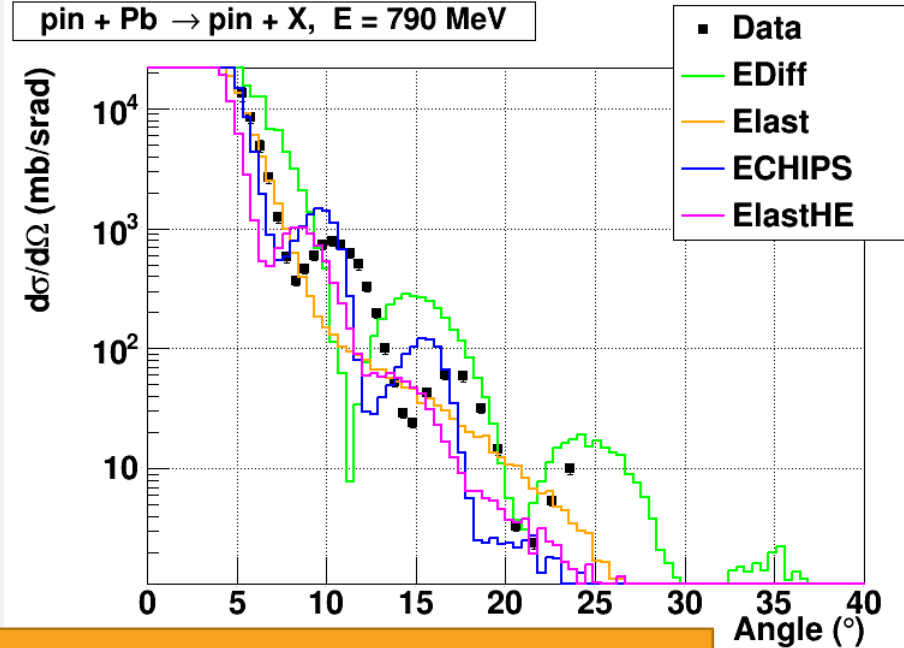
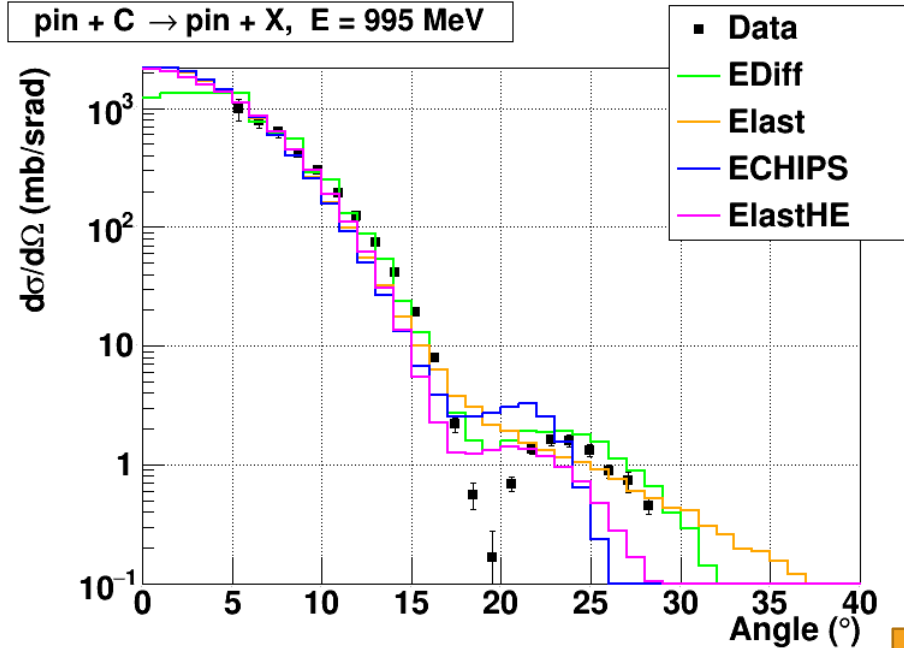
Most recent results, Low energy

$\text{pin} + \text{C} \rightarrow \text{pin} + \text{X}, E = 180 \text{ MeV}$

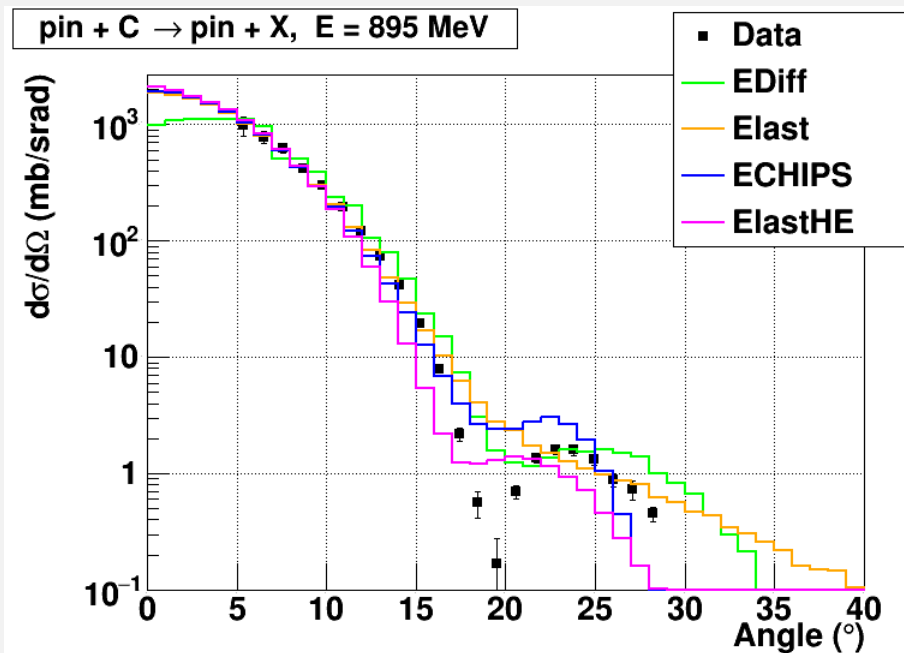
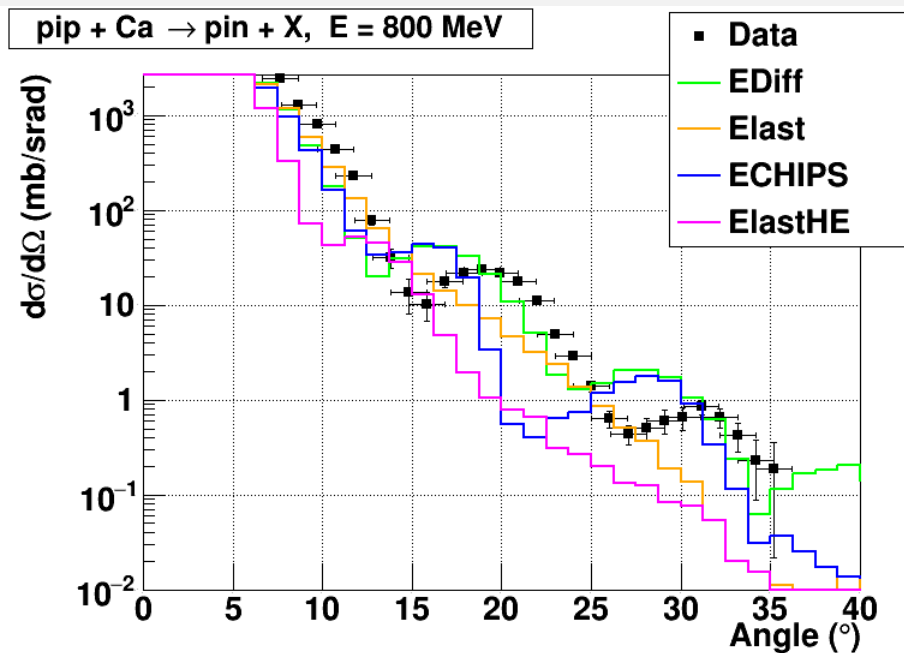


$\text{pin} + \text{C} \rightarrow \text{pin} + \text{X}, E = 230 \text{ MeV}$





Most recent results, High energy



SUMMARY

- New experimental data is going to be added to repository of Geant4
- G4HadronElastic parametrization was modified for protons and pions
- ElasticHE model's range of energies is increased to start from 0

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