

# Nucleon-Nucleus Total, Inelastic and Elastic Cross Sections

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## Abstract

Nucleon-nucleous cross sections are discussed. New class G4NucleonNuclearCrossSections implementing data of ( V.S. Barashenkov, Nucleon-Nucleous Cross Section, Preprint Dubna P2-898-770) is tested. Different GEANT4 models are compared with experimental data.

# 1 Introduction

Here it is reported on verification of total and inelastic cross-sections for p and n on different targets:  $\sigma_{tot} = \sigma_{in} + \sigma_{el}$ ,  $\sigma_{in} = \sigma_{prod} + \sigma_{qel}$ . What we have in GEANT4 are the following models:

1. G4HadronCrossSections class for **inelastic and elastic** hadron (inelastic and elastic) cross sections in the spirit of GHEISHA.
2. G4Pi/ **Nucleon** NuclearCrossSection class for Barashenkov data interpolation for pions/nucleons on nuclei. Now total, inelastic and elastic cross sections are available.
3. G4Proton/NeutronInelasticCrossSection class for HPW-Axen parametrization model. Inelastic cross section only.
4. G4GlauberGribovCrossSection class for **total and inelastic** hadron cross sections in the spirit of Glauber model with Gribov correction.

$$\sigma_{el} = \sigma_{tot} - \sigma_{in}.$$

Data were taken basically from <http://wwwppds.ihep.su> IHEP-Compass database and Dubna set <http://wwwnea.fr/html/dbdata/bara.html>.

## 2 Barashenkov Method

The Barashenkov interpolation is essentially based on quasi-optical model for high energies ( $T > 2$  GeV) and on phenomenology like  $\pi r_o A^{2/3}$ ,  $r_o \sim 1$  fm with corrections. The total, inelastic (and elastic) cross sections are interpolated using:

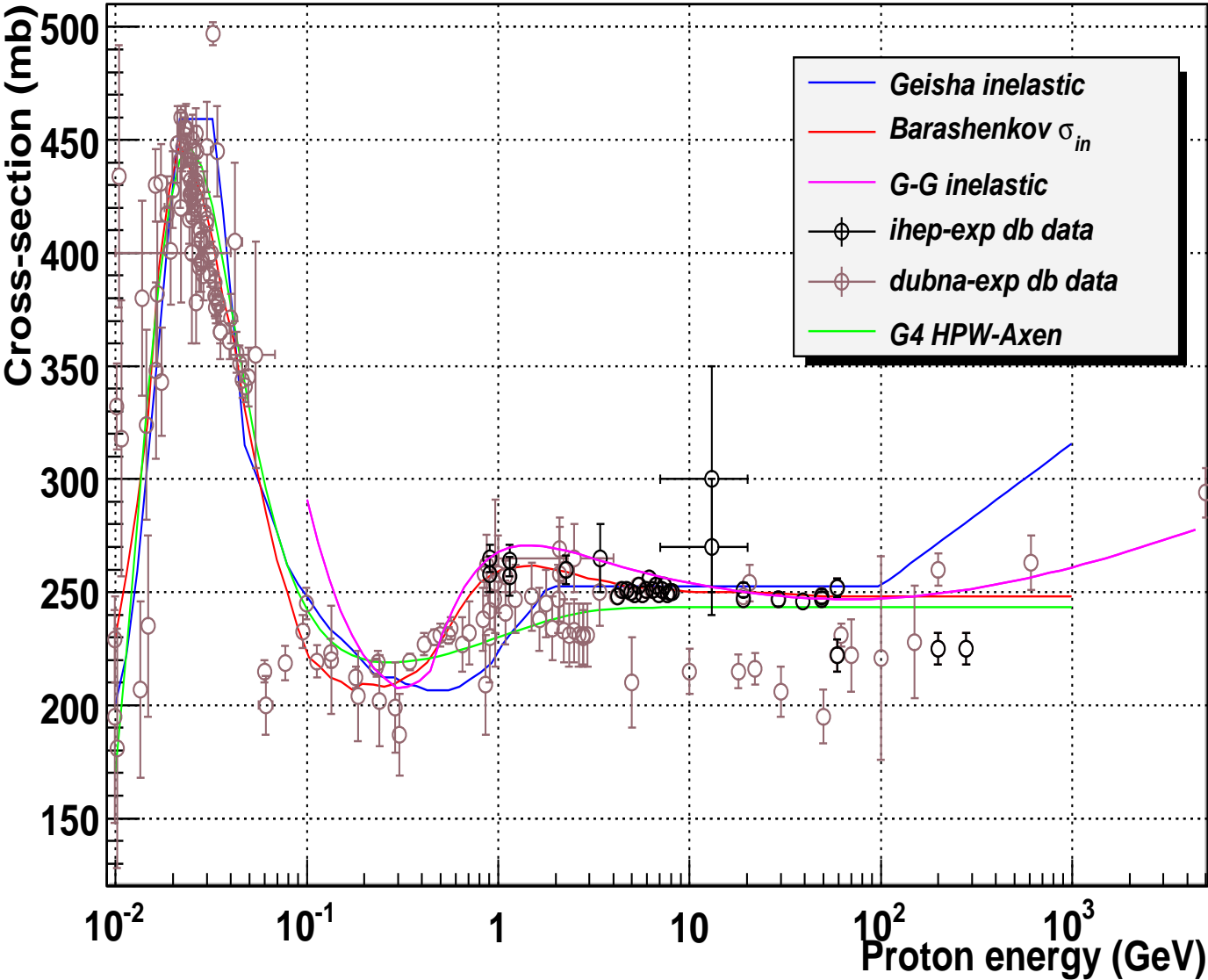
$$\sigma(T, A) = \pi \left[ r_o A^{1/3} + \lambda(T, A) \right]^2 f(T) \phi(A)^{\alpha(T)},$$

where  $\lambda$  is de Brojlie length of projectile in cms,  $T$  is the kinetic energy of projectile in lab,  $A$  is the atomic weight, and  $r_o \sim 1$  fm. Functions  $f(T)$ ,  $\phi(A)$  and  $\alpha(T)$  are series like:

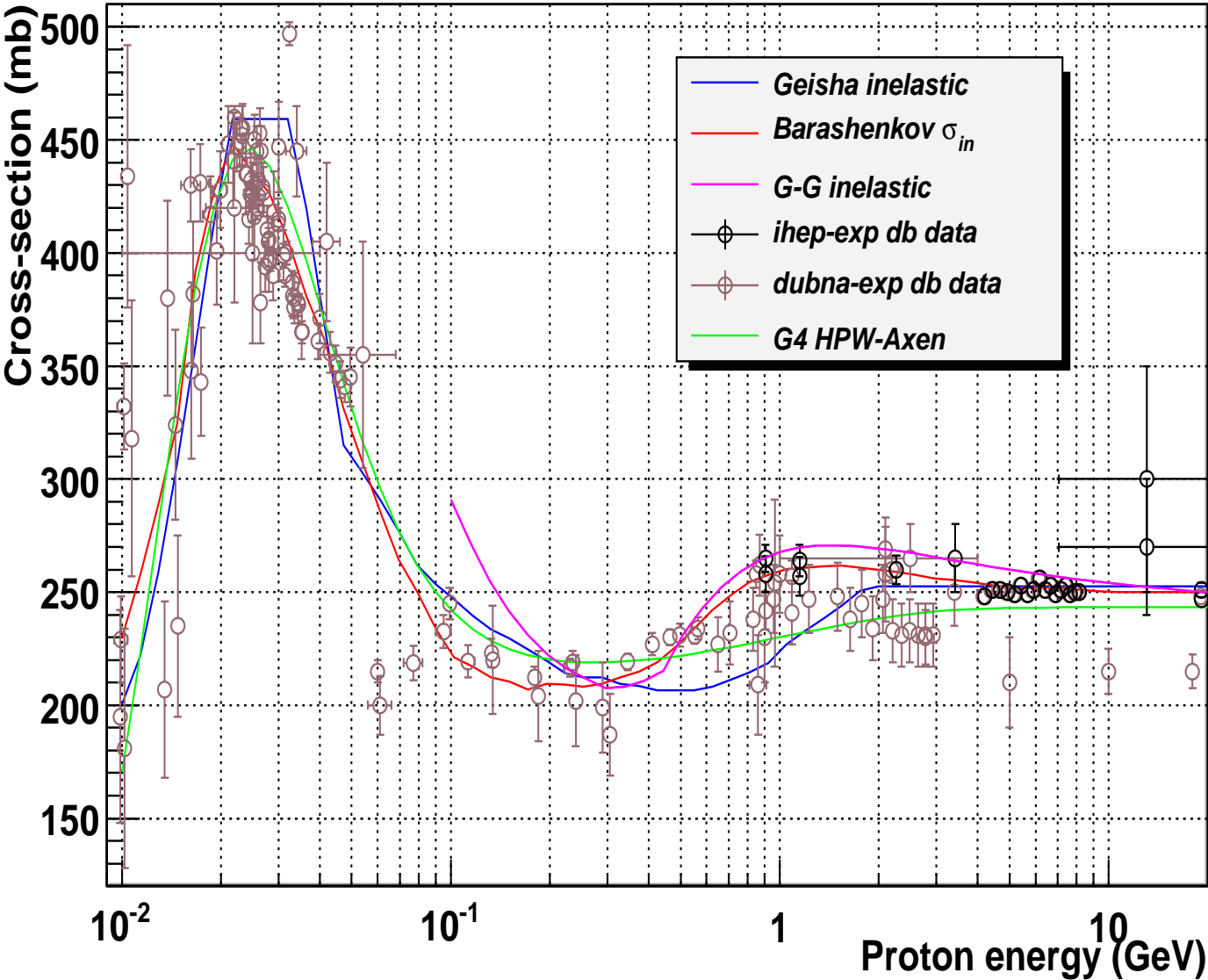
$$\sum_i a_i T^{b_i} \quad \text{and} \quad \sum_i a_i A^{b_i}.$$

In some cases (see below) inelastic data from <http://wwwnea.fr/html/dbdata/bara.html> are corrected on quasi-elastic cross sections in the form  $0.1\pi r_o A^{2/3}$

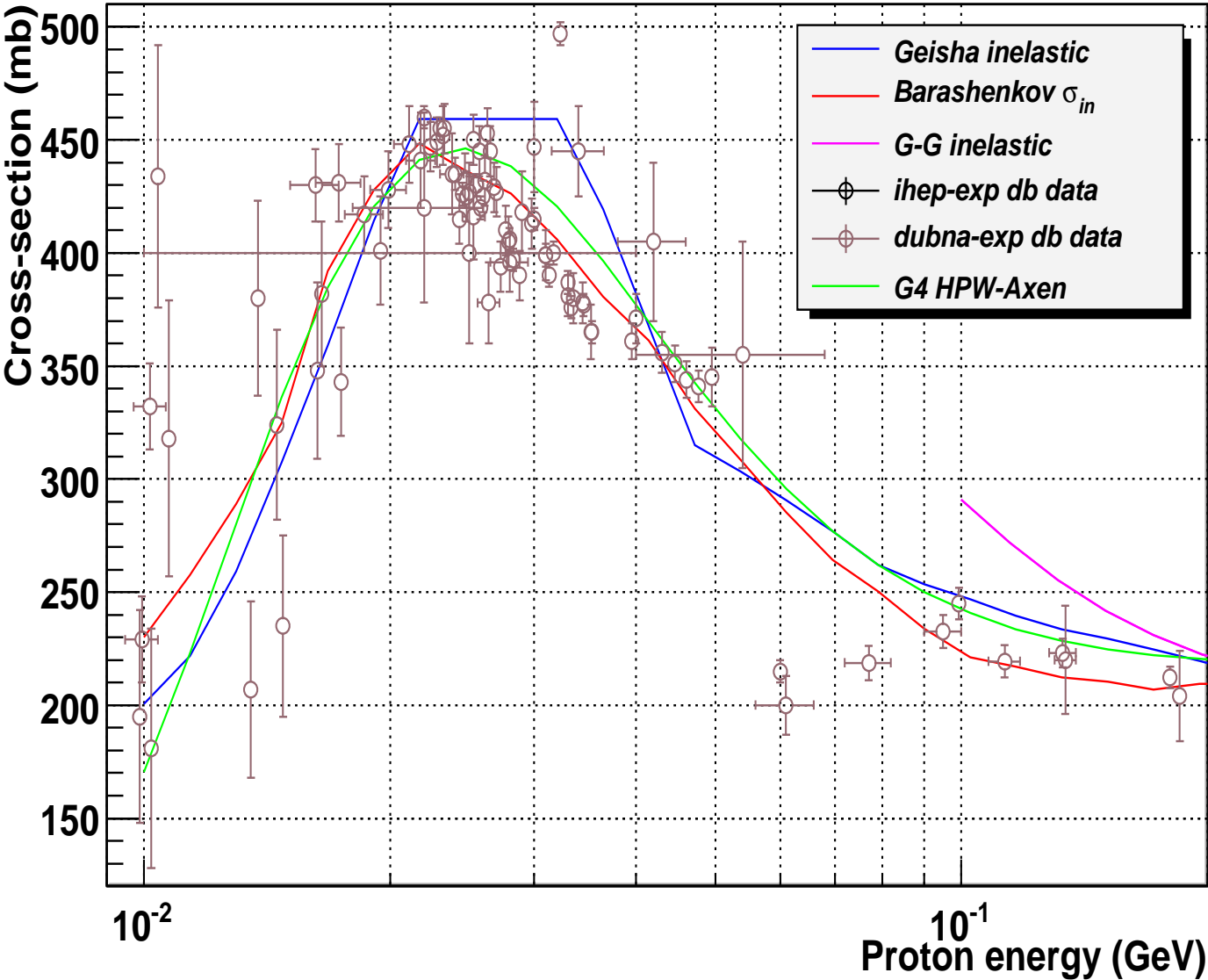
p-C inelastic cross-section

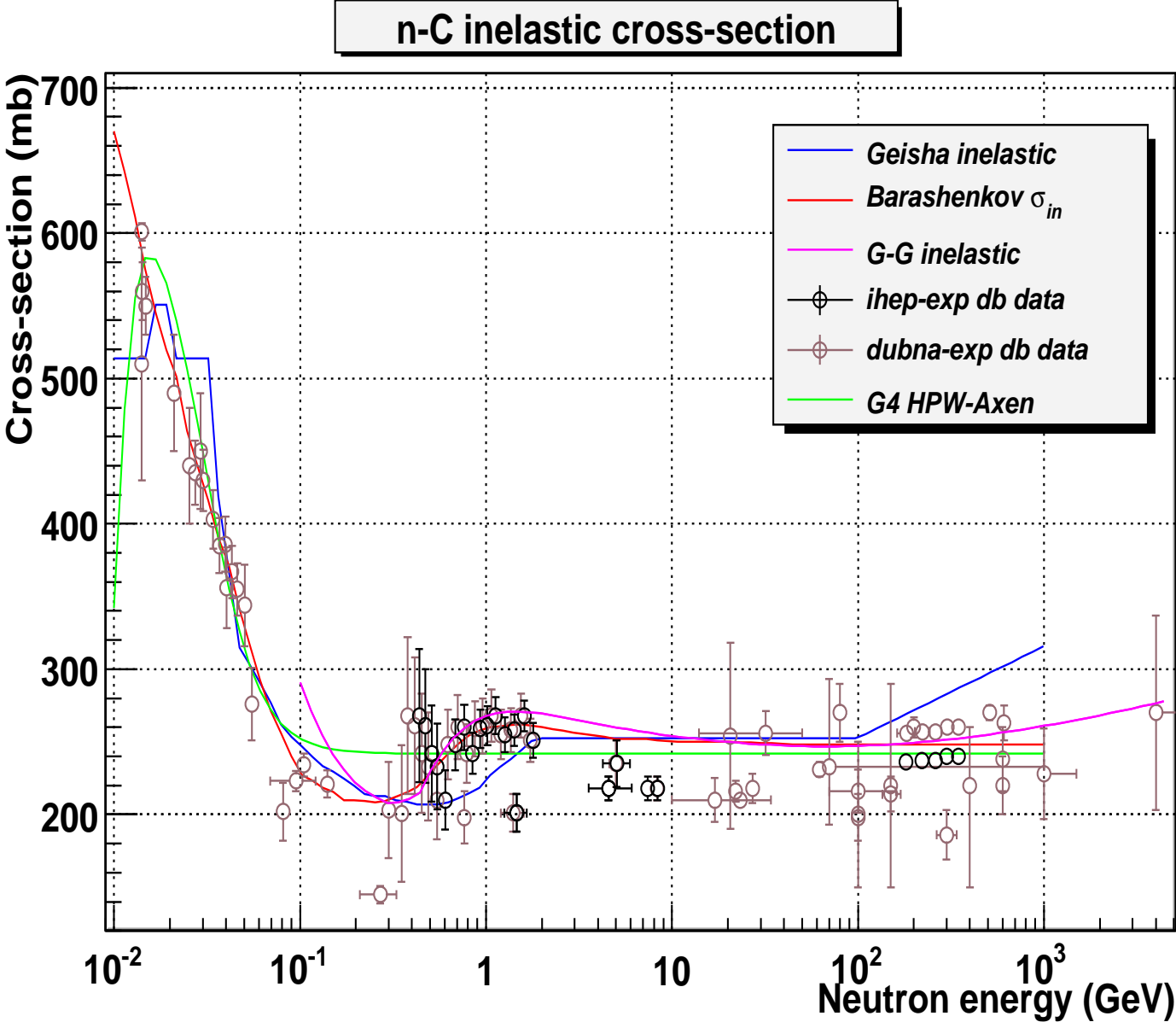


p-C inelastic cross-section

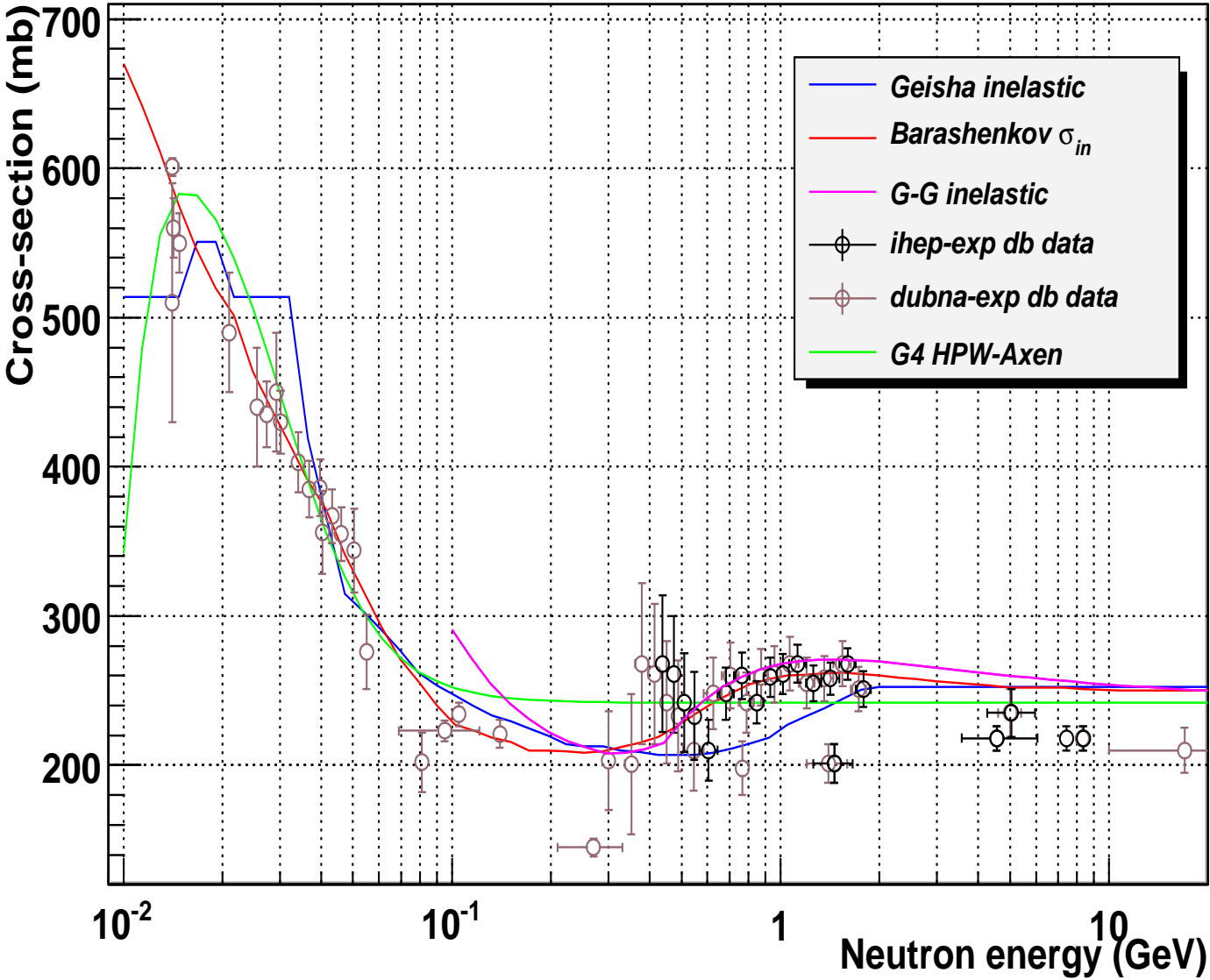


**p-C inelastic cross-section**



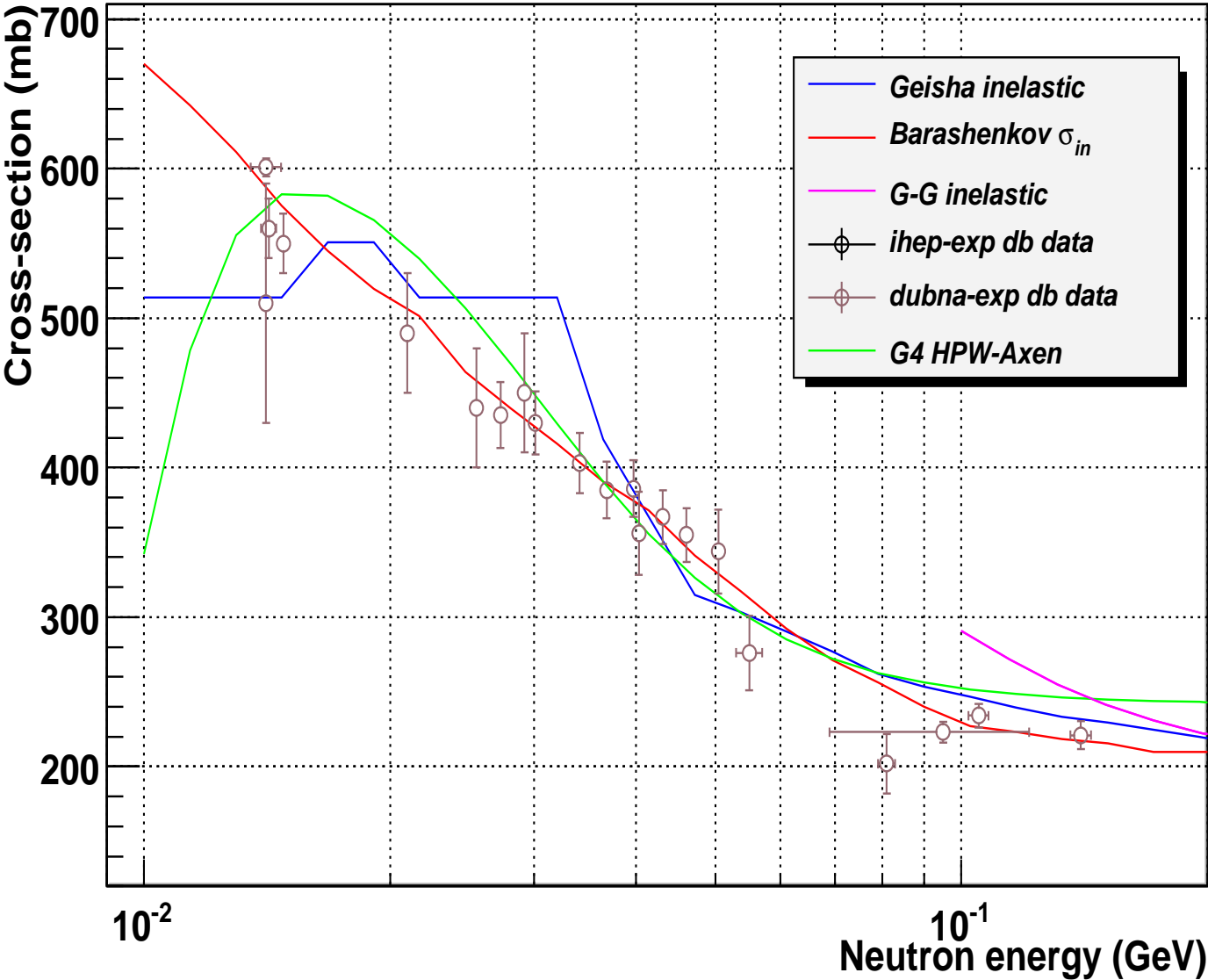


n-C inelastic cross-section

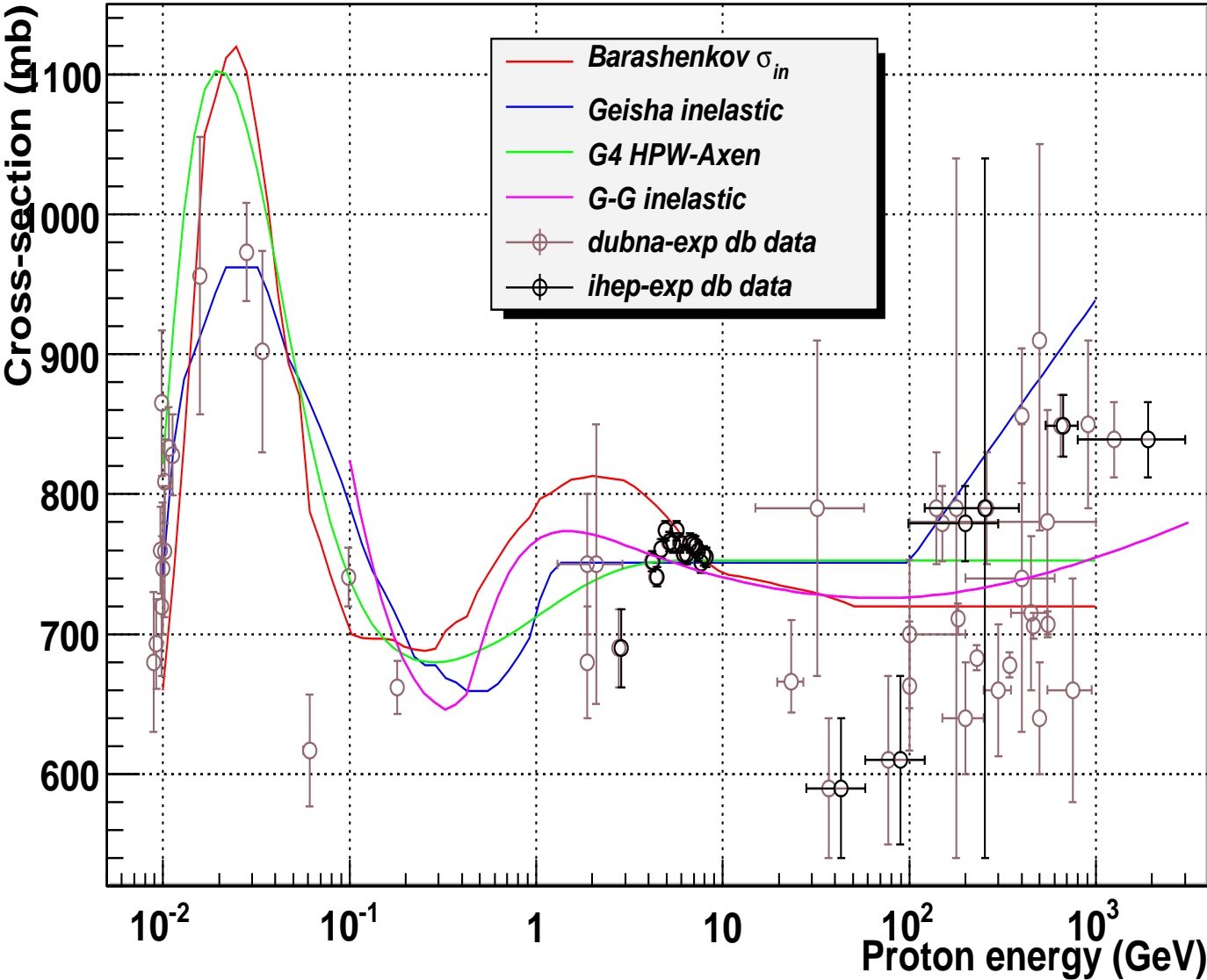


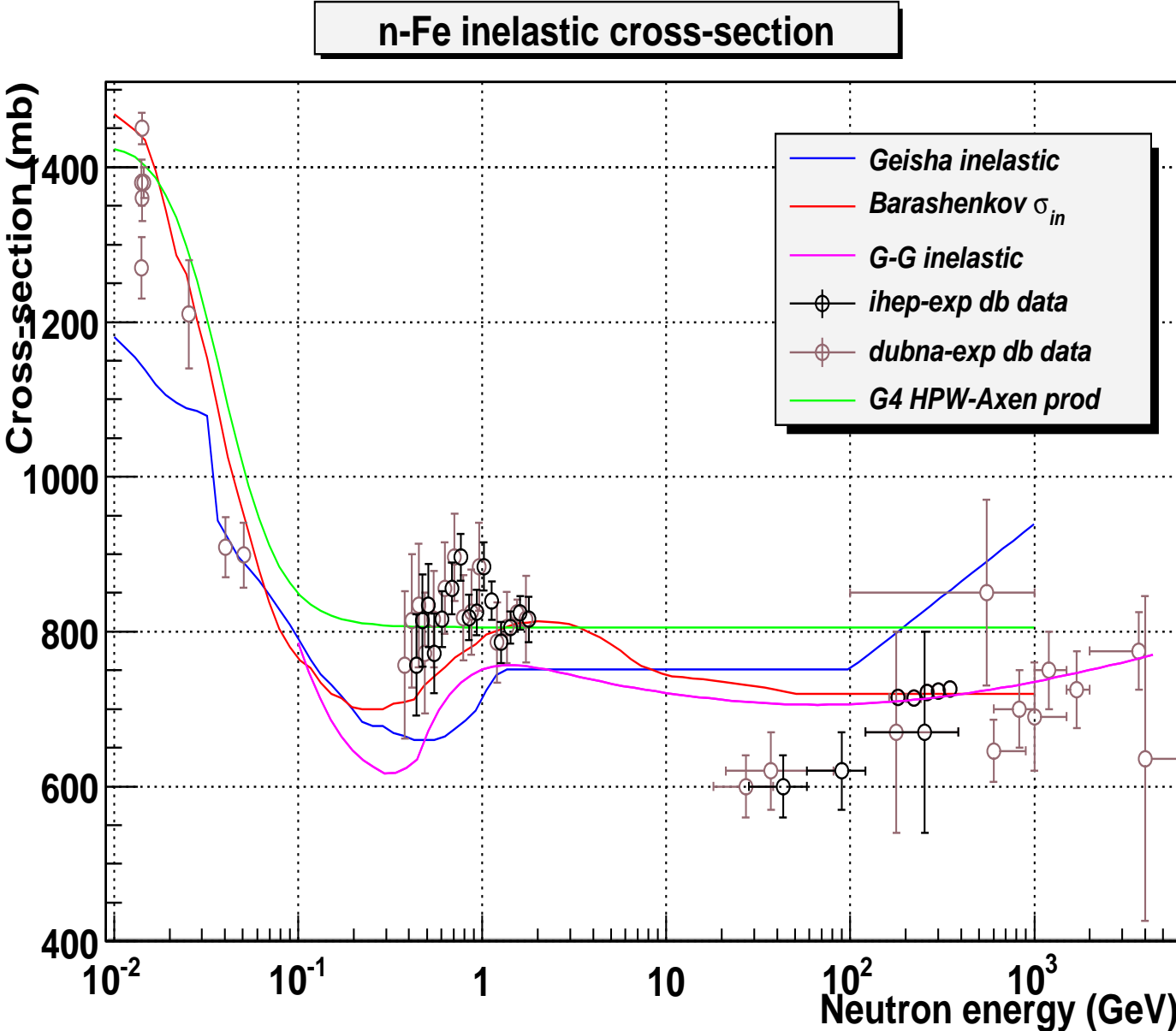


n-C inelastic cross-section

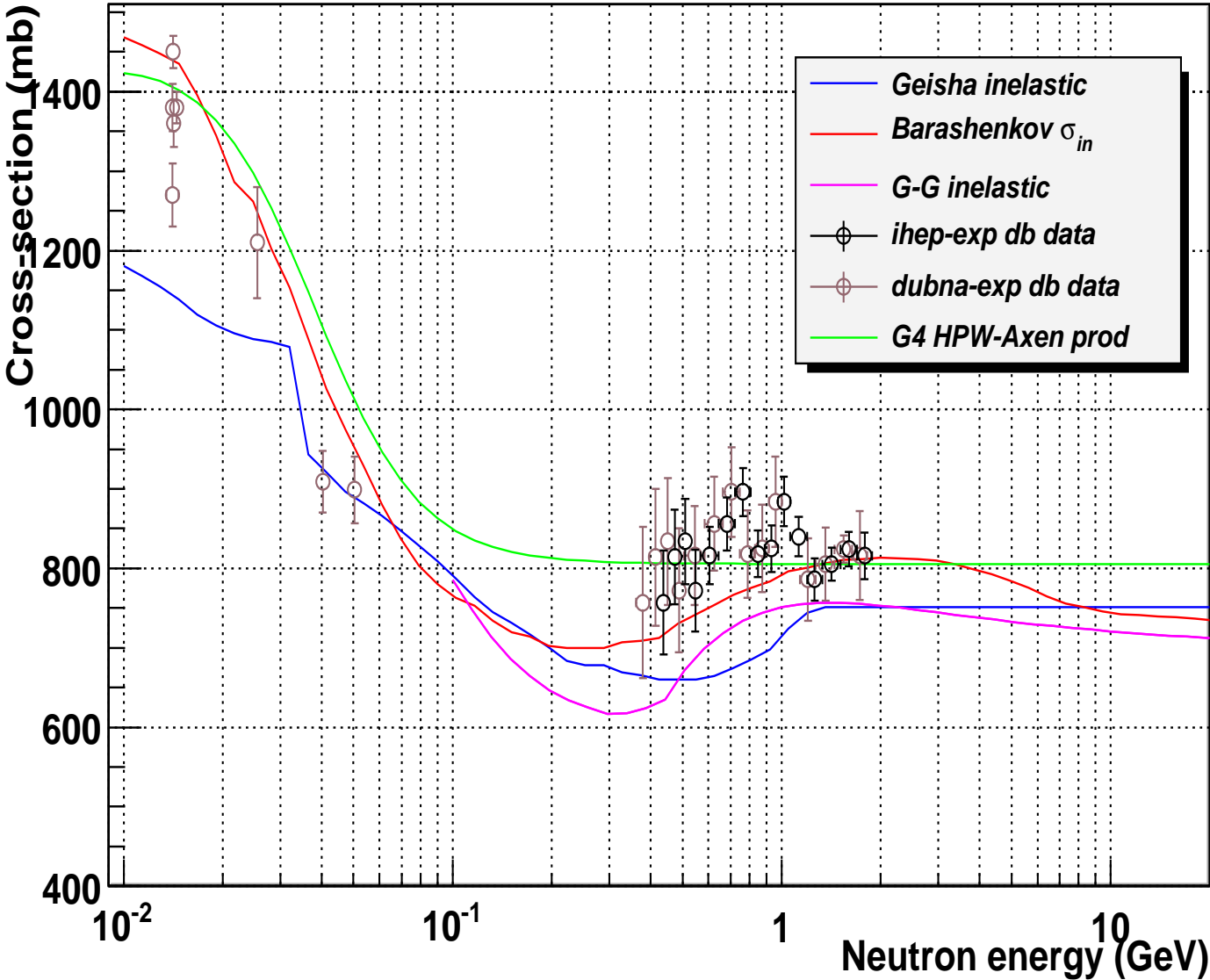


p-Fe inelastic cross-section

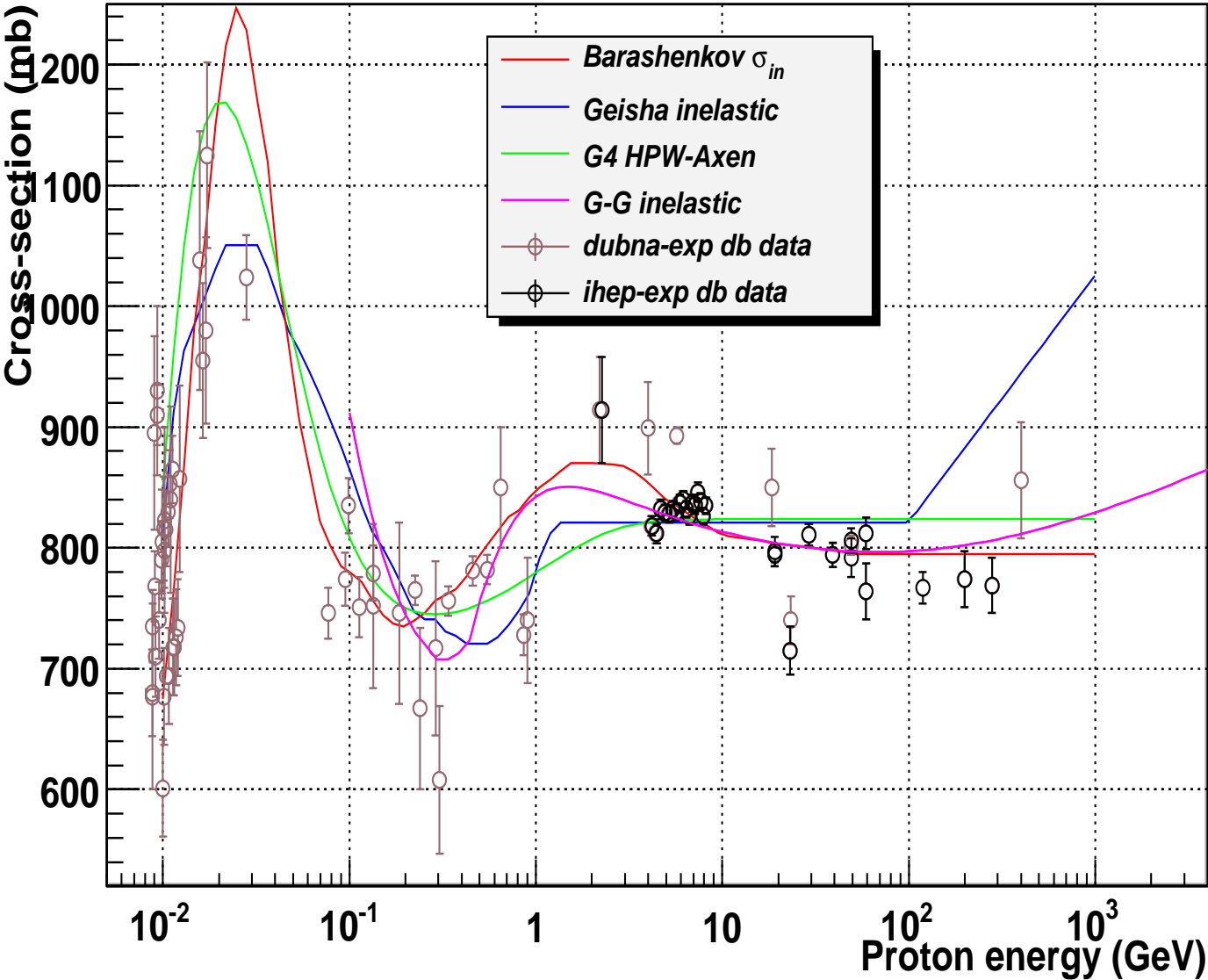




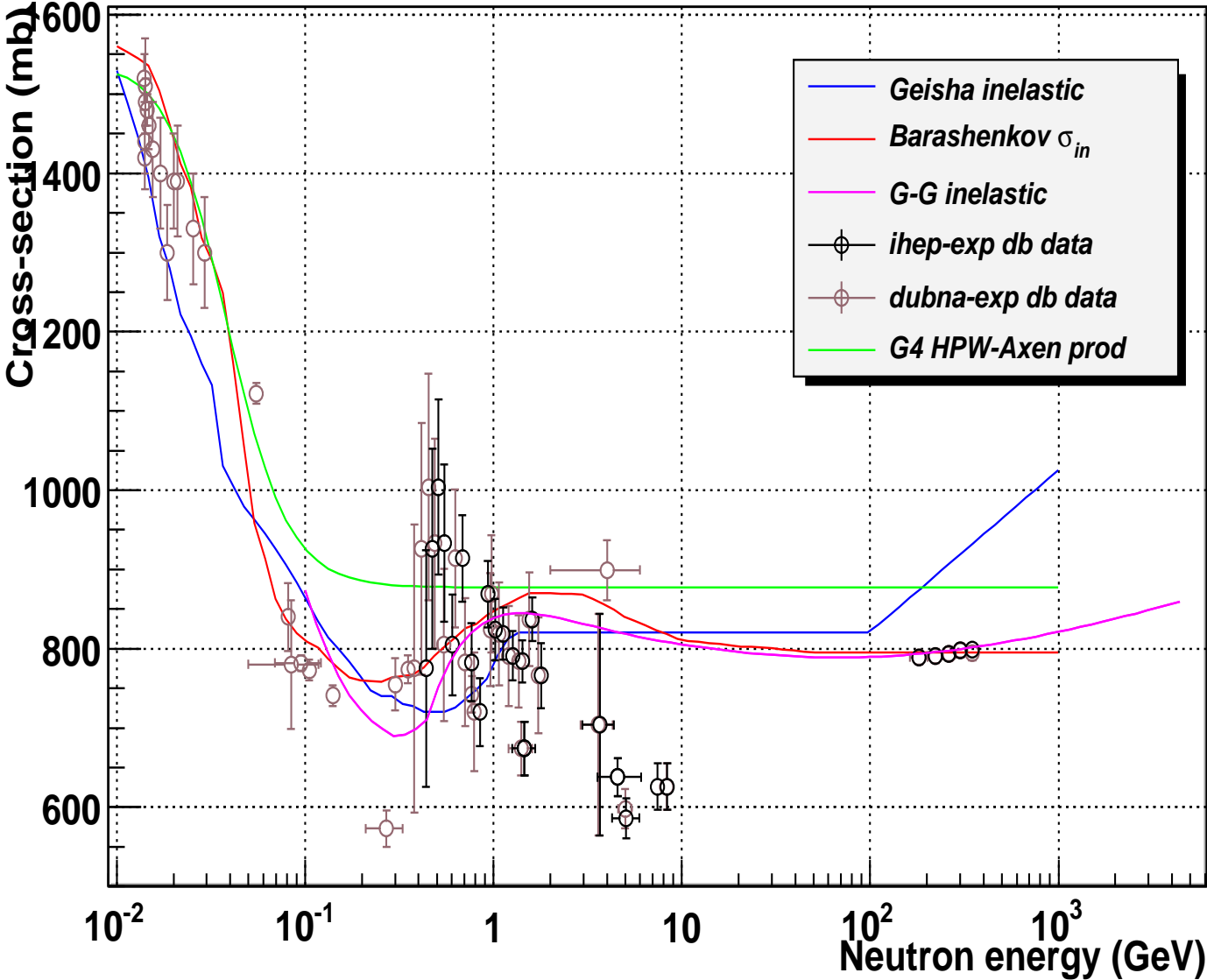
n-Fe inelastic cross-section



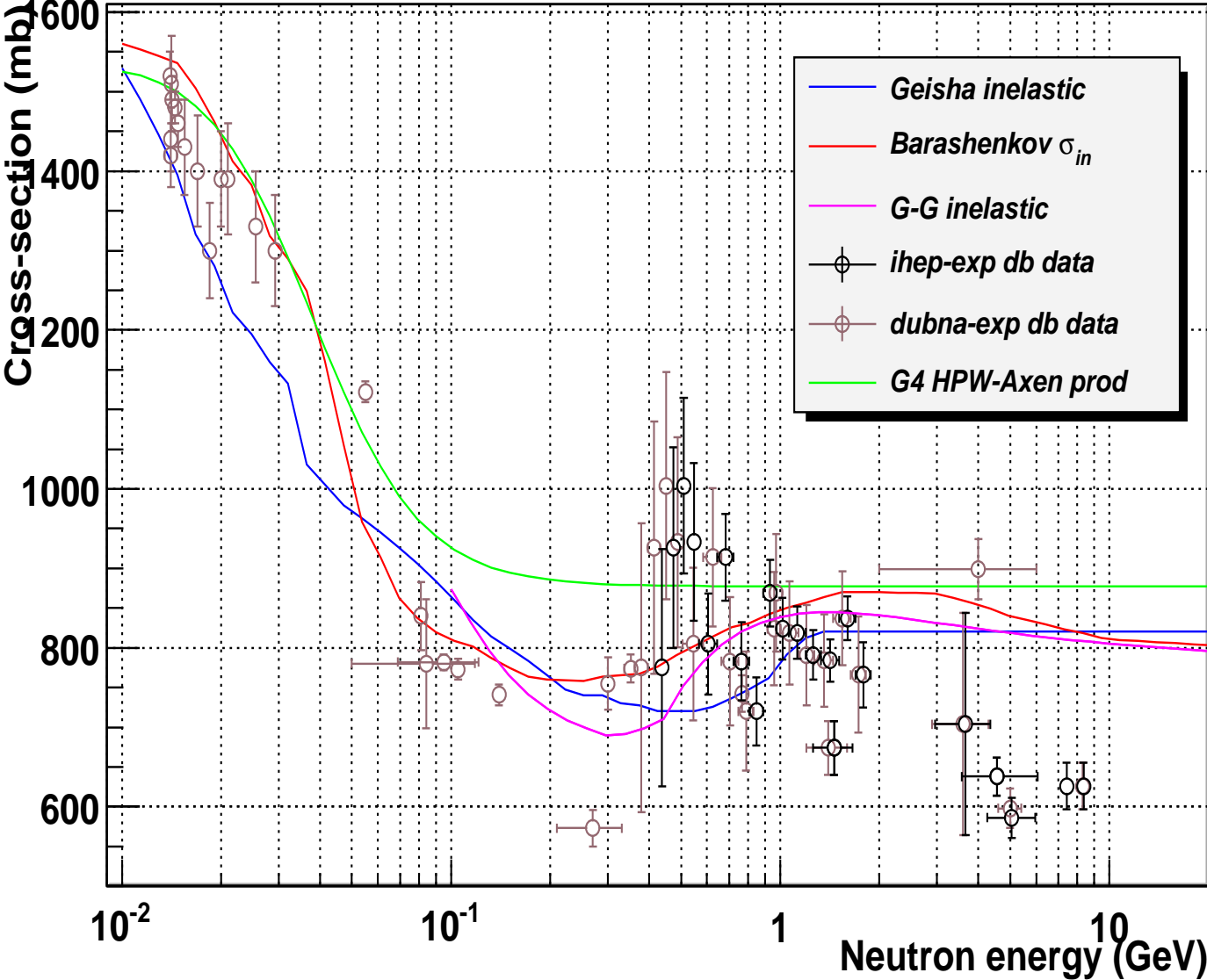
p-Cu inelastic cross-section



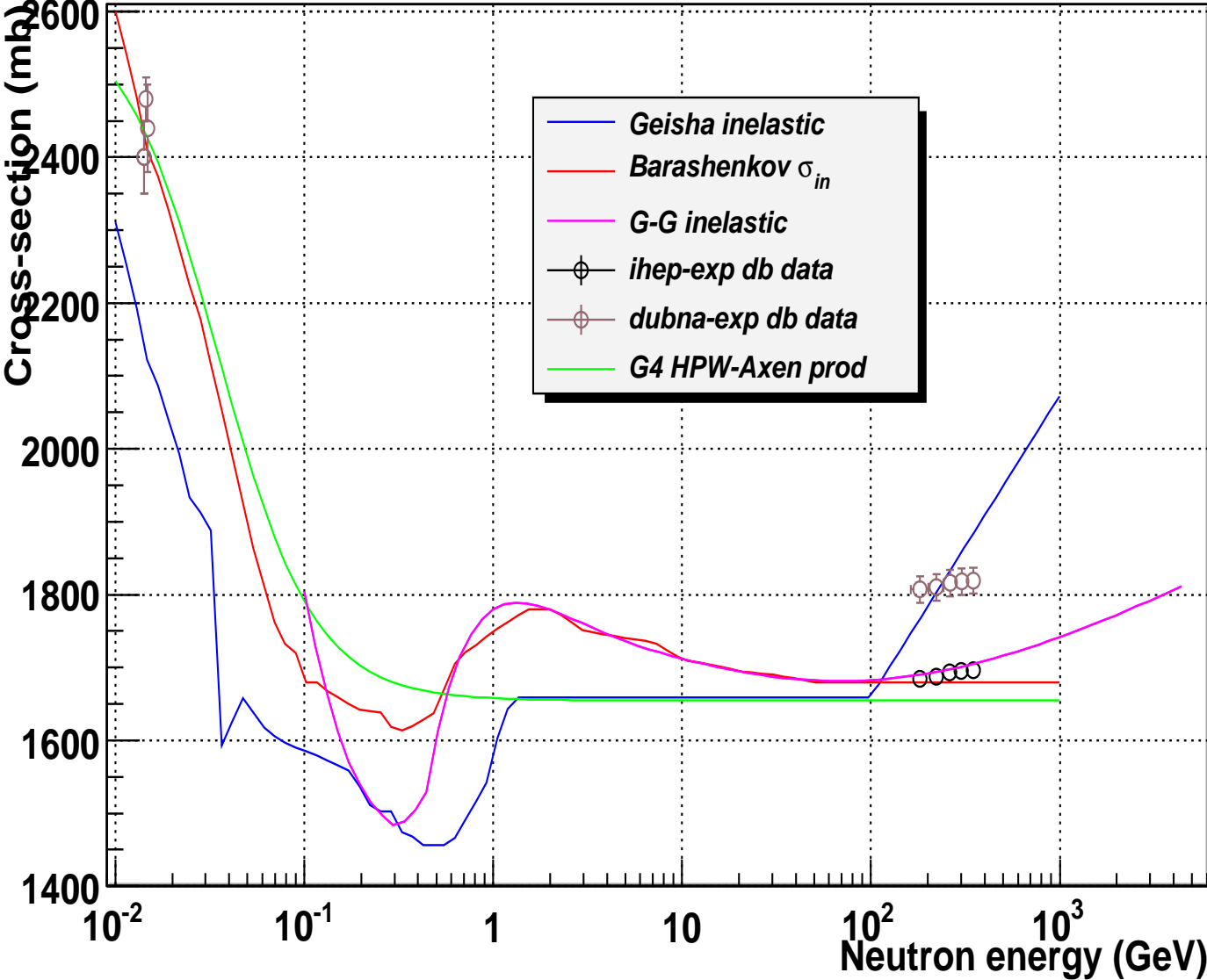
n-Cu inelastic cross-section



n-Cu inelastic cross-section

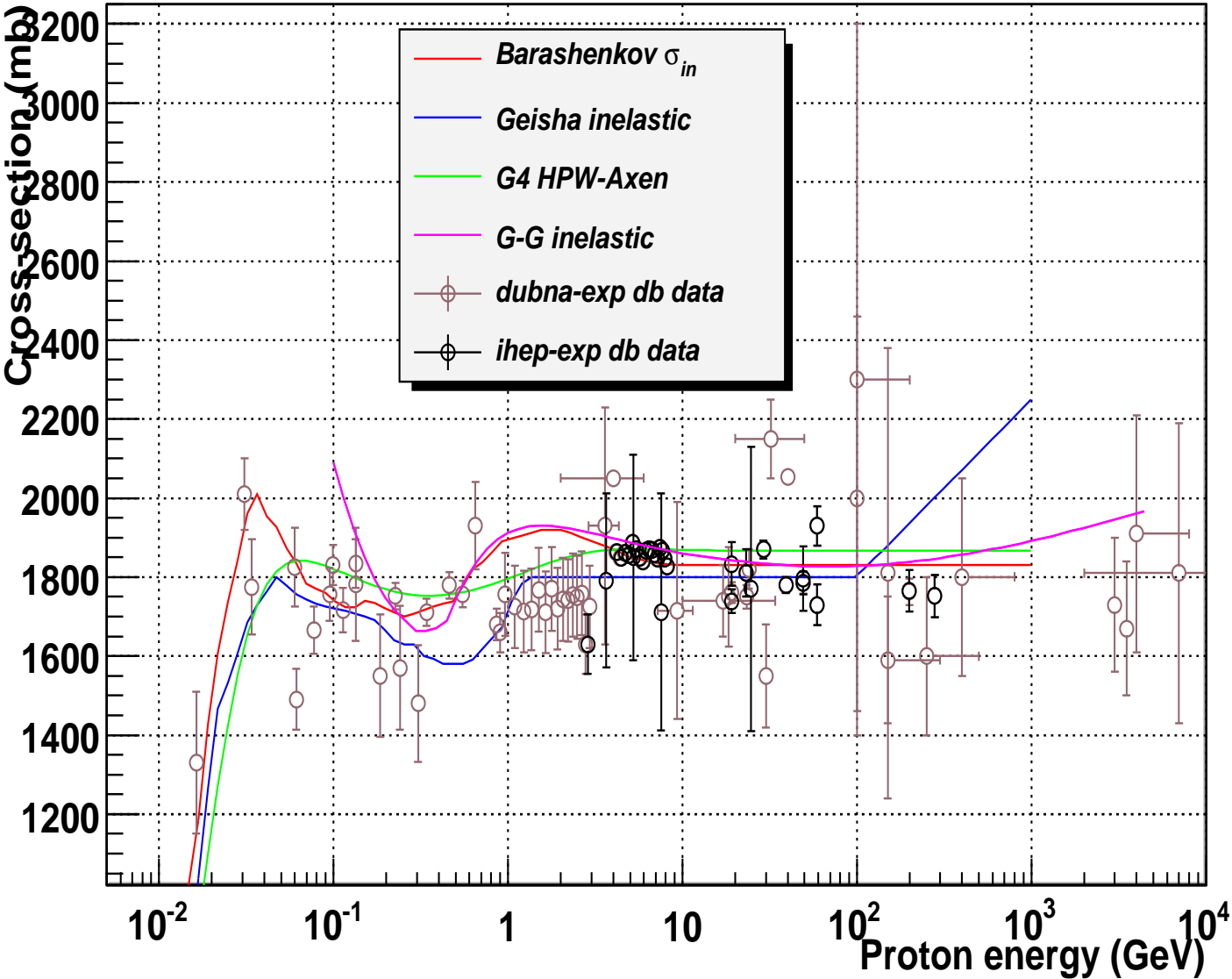


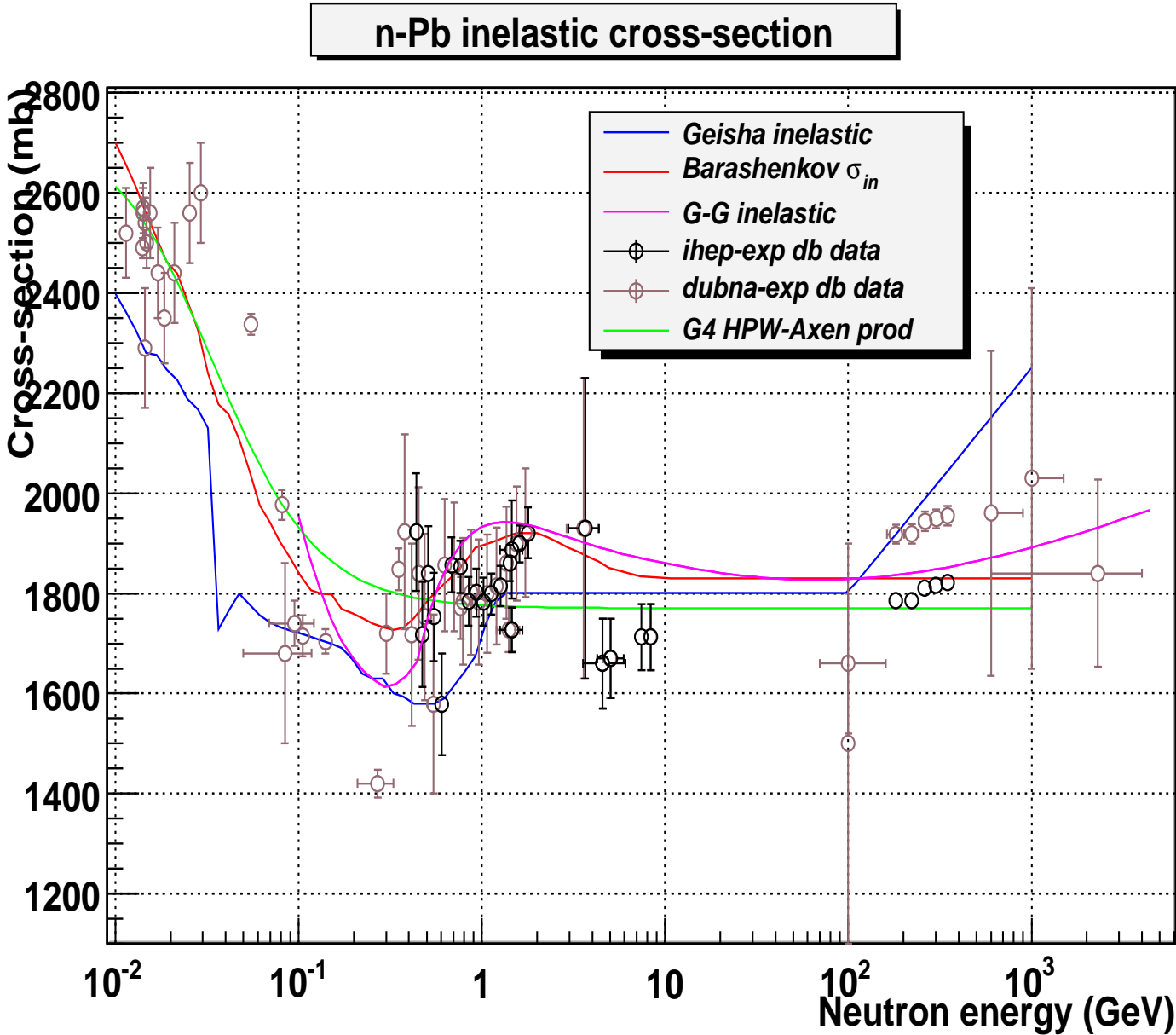
n-W inelastic cross-section



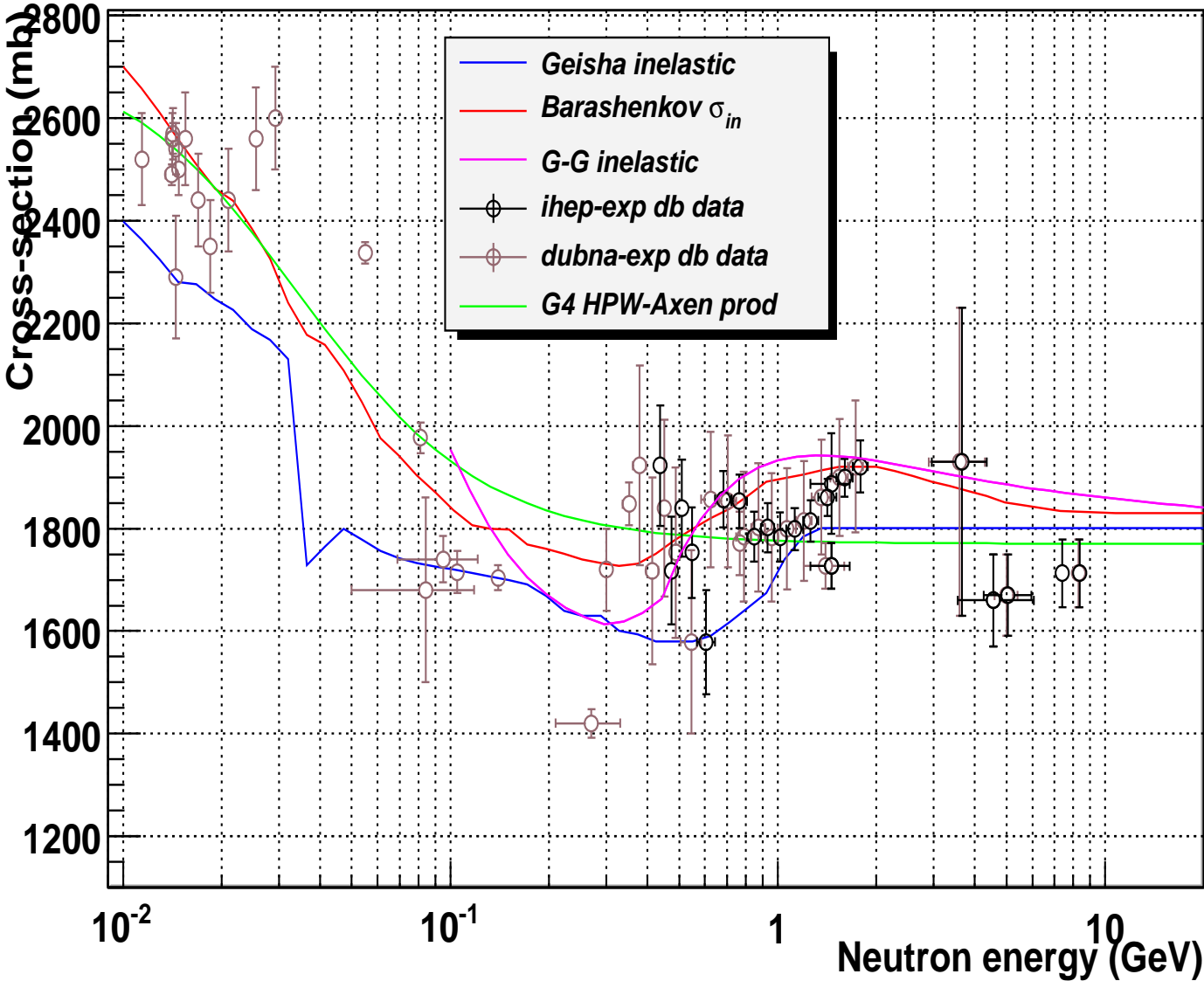


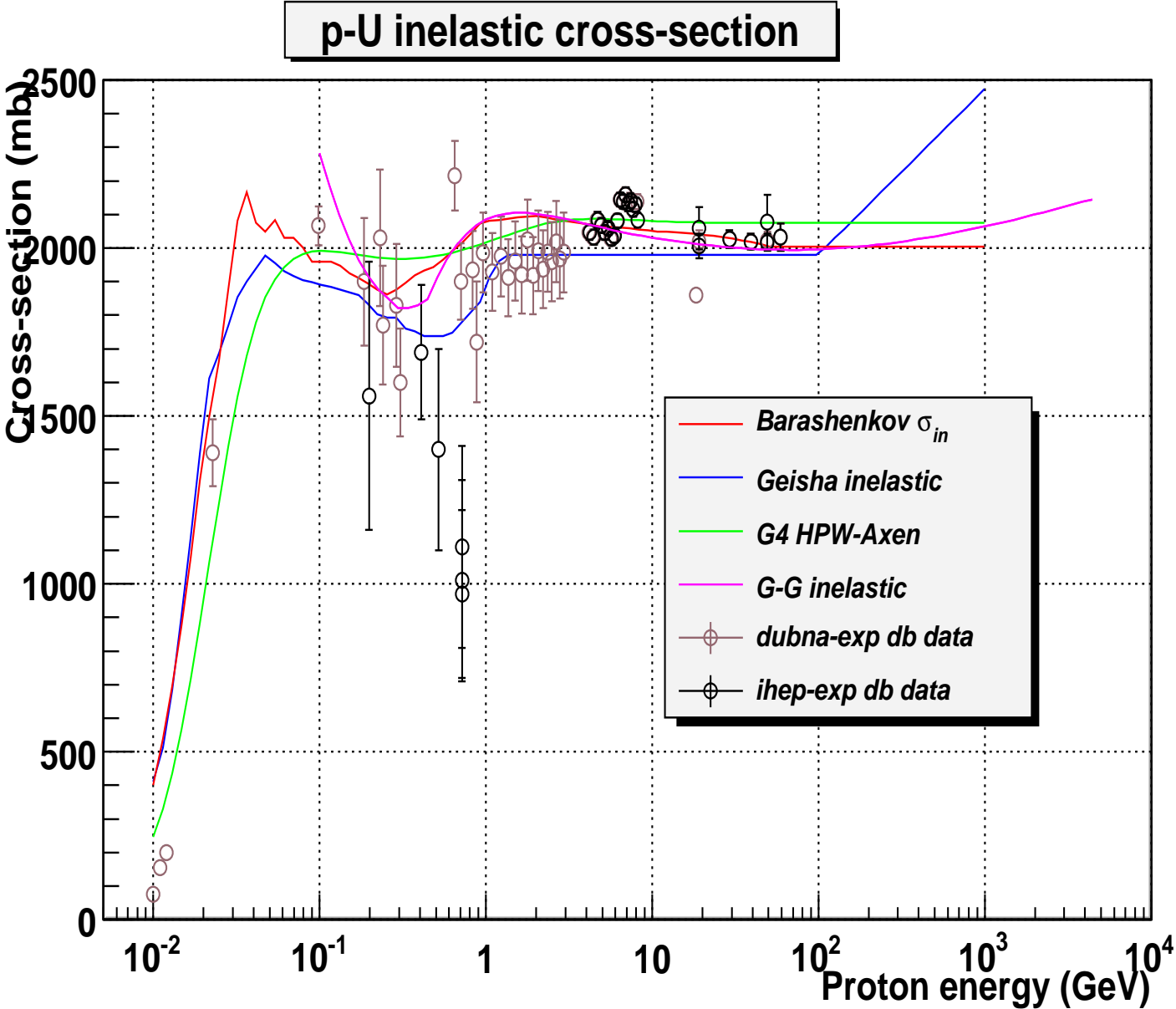
p-Pb inelastic cross-section

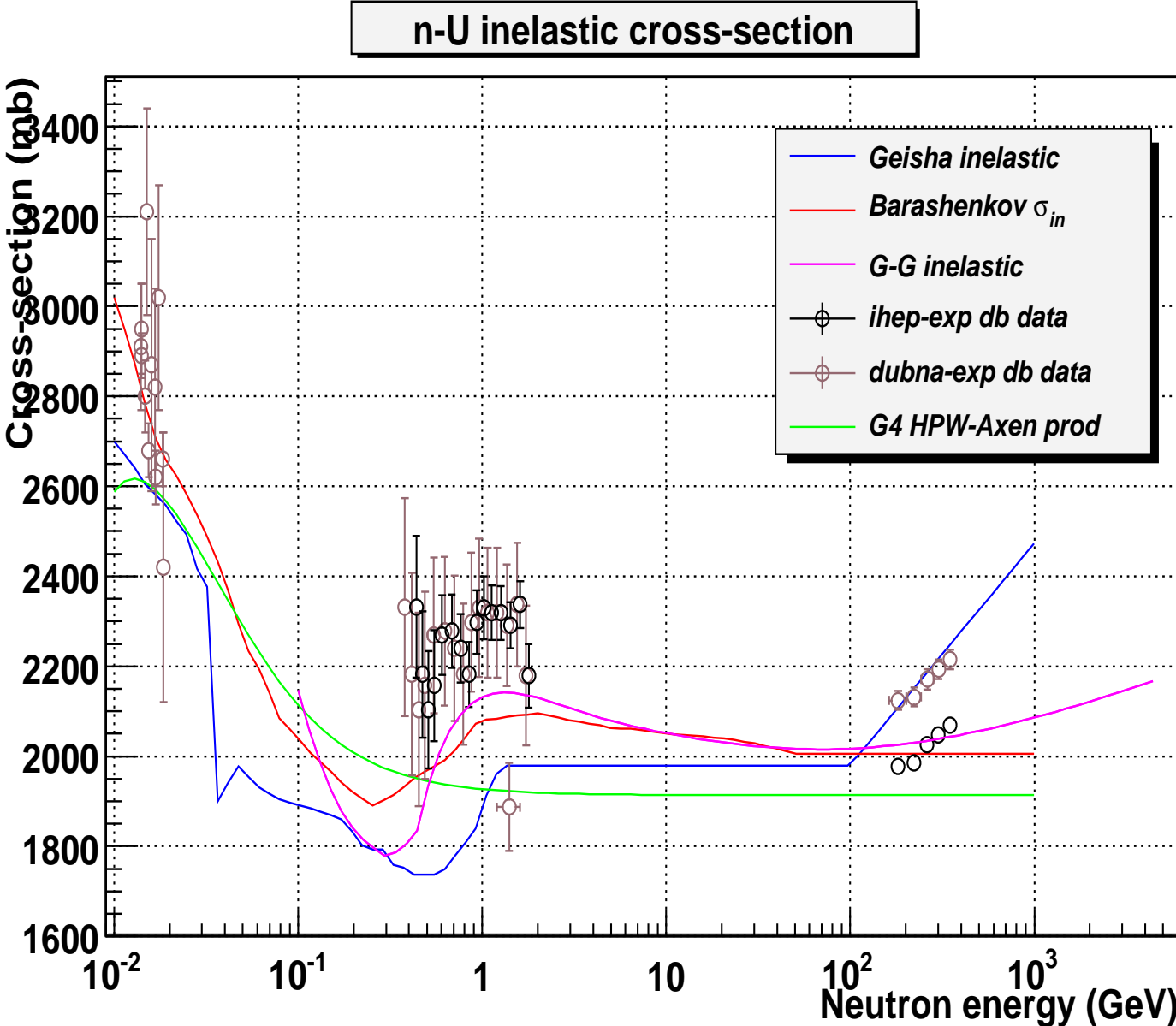




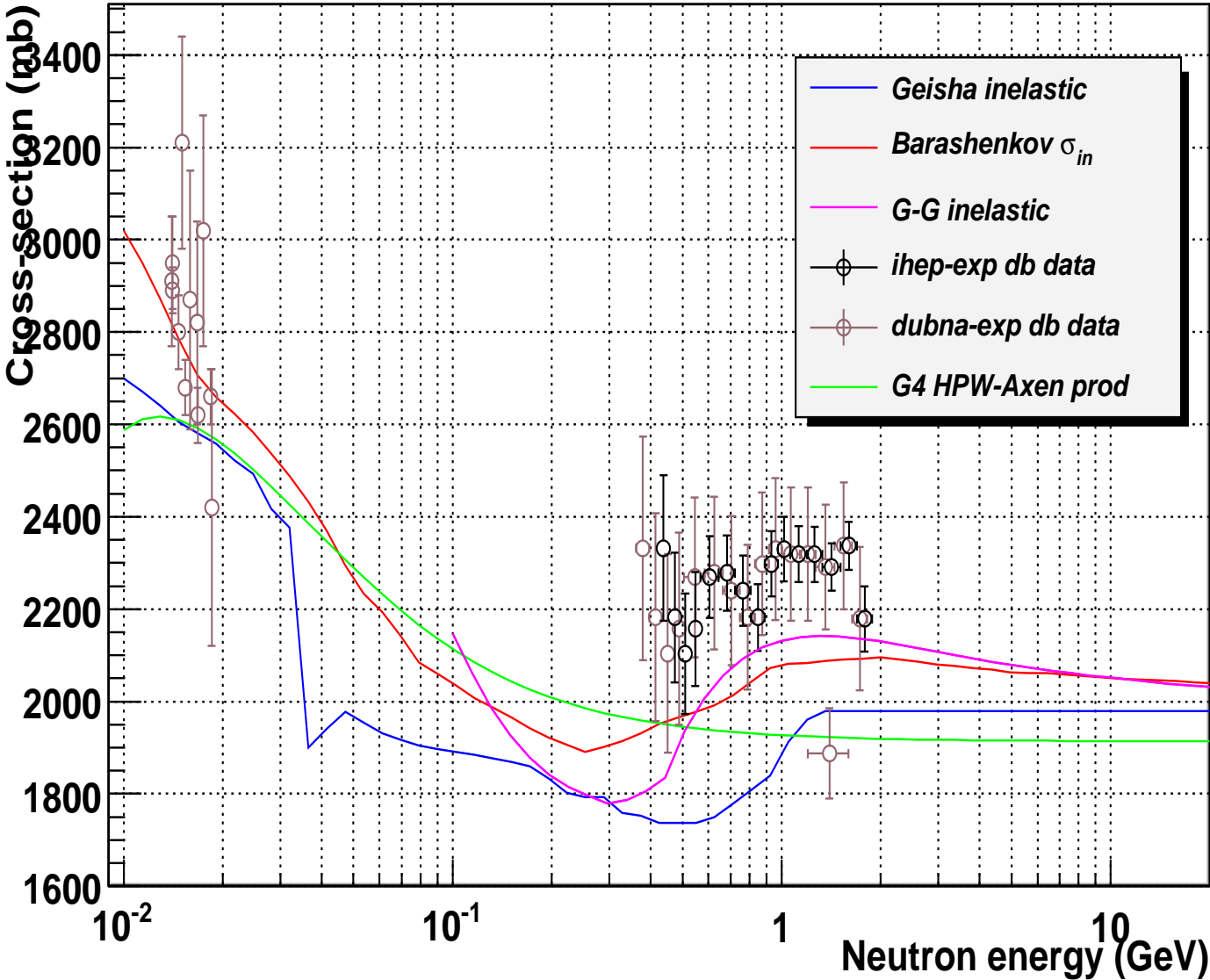
n-Pb inelastic cross-section

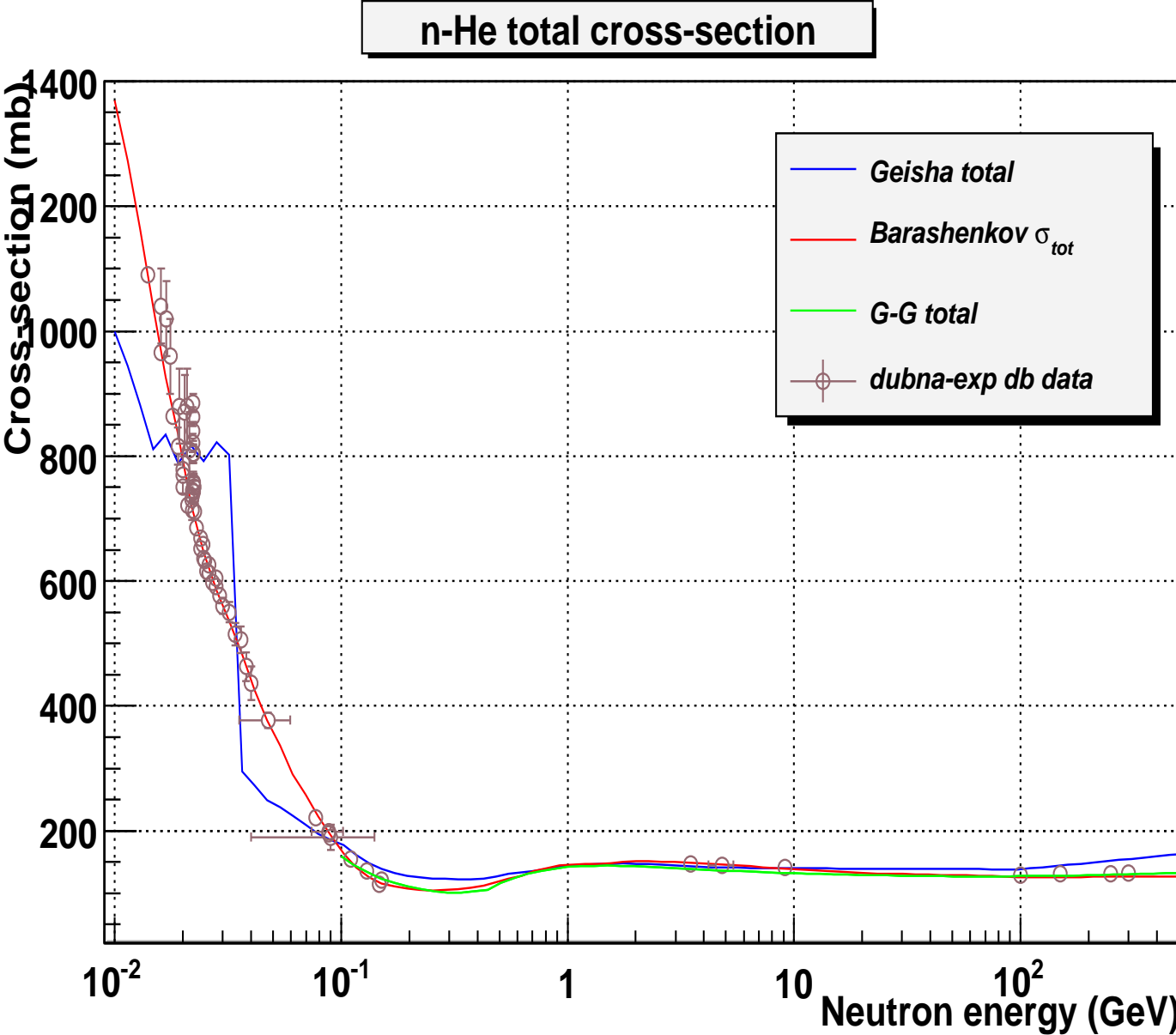


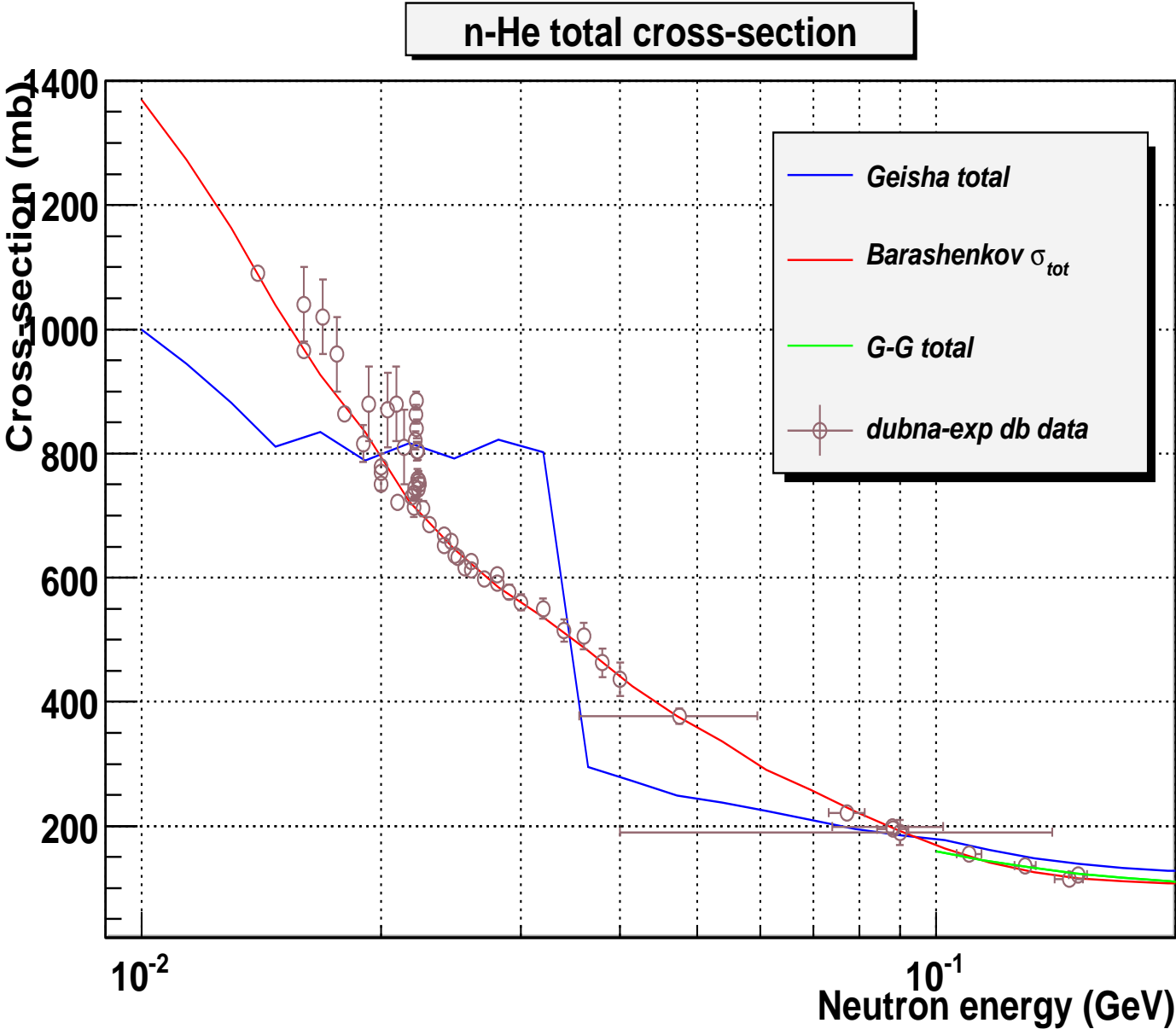




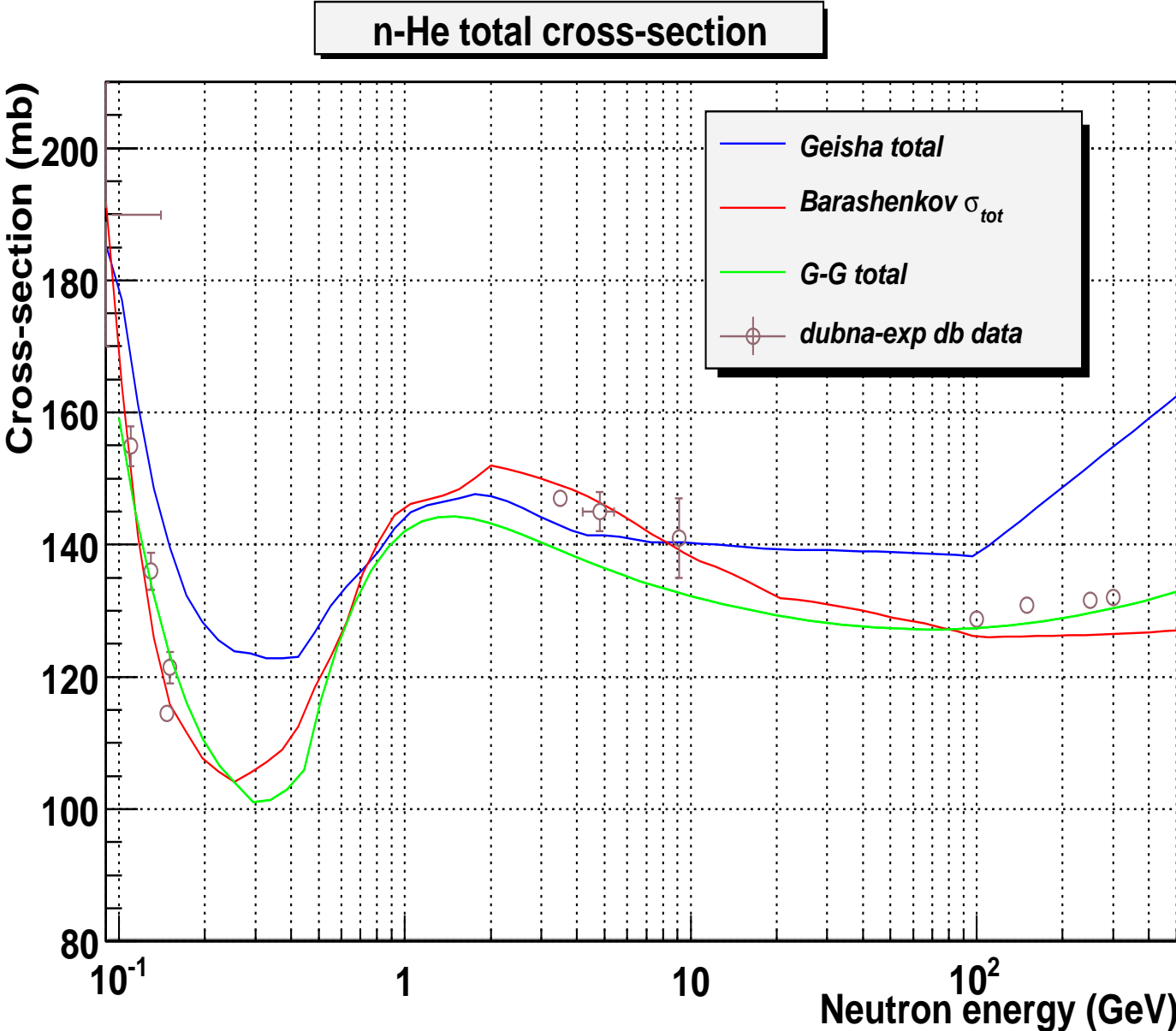
n-U inelastic cross-section

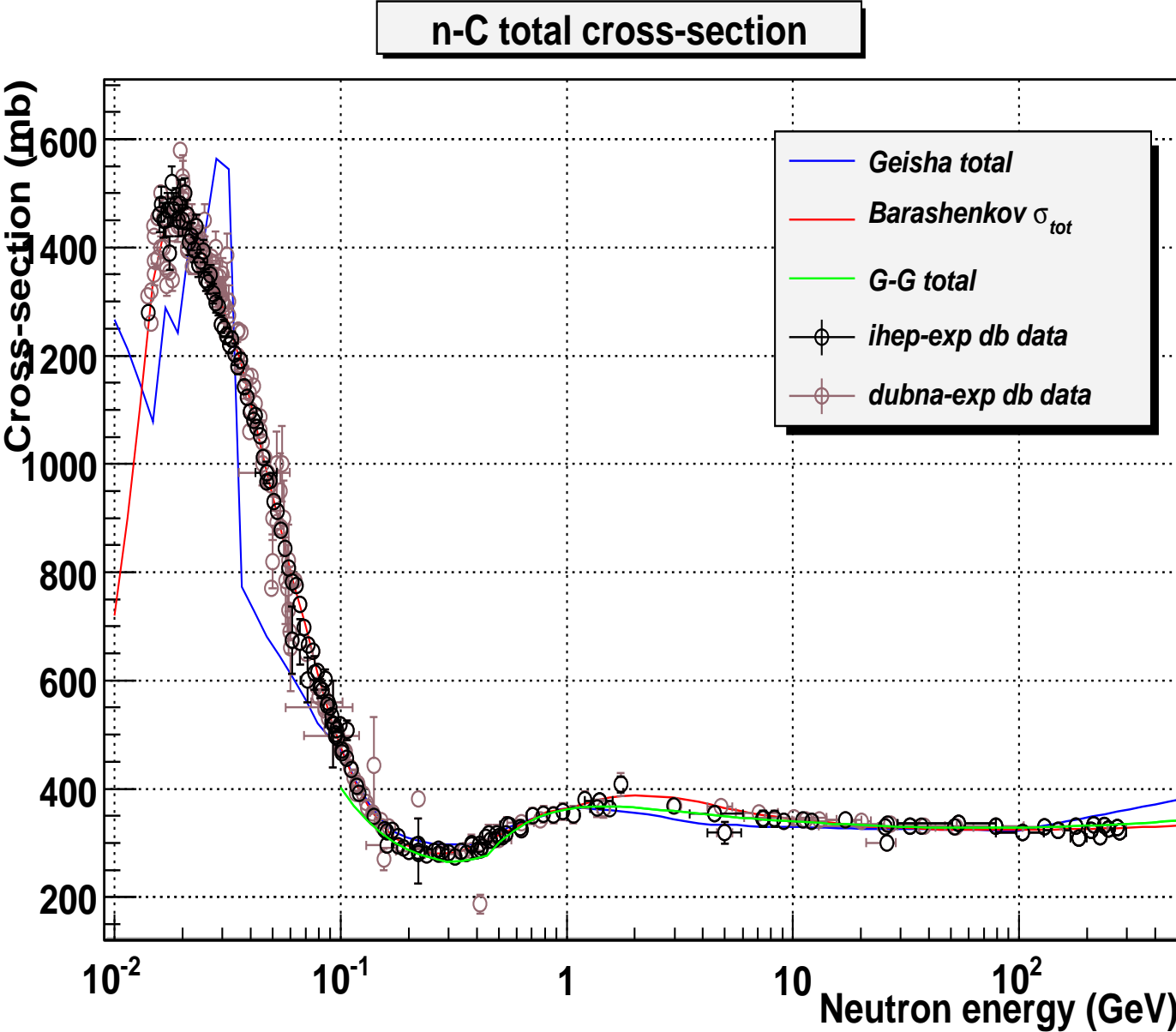


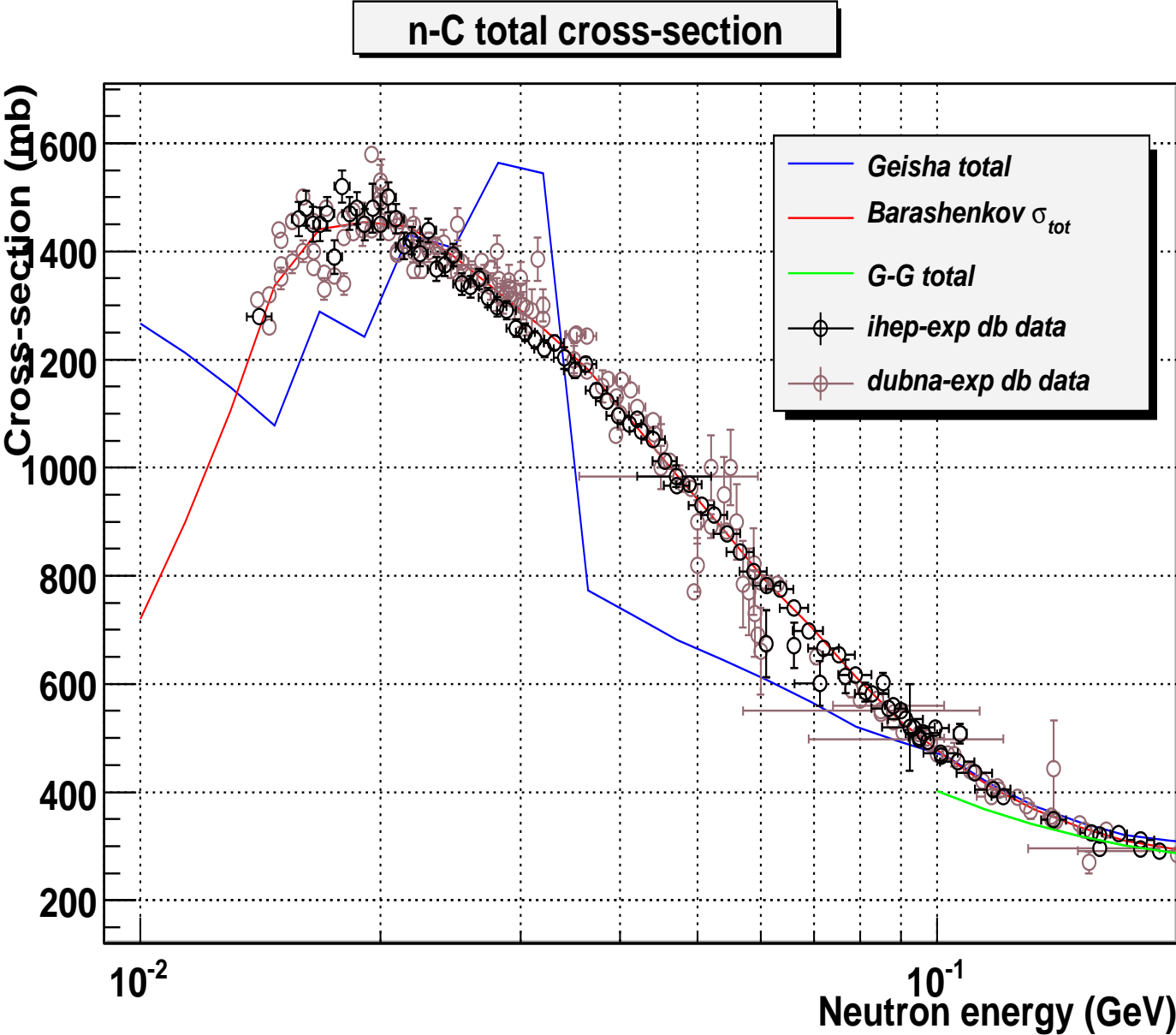


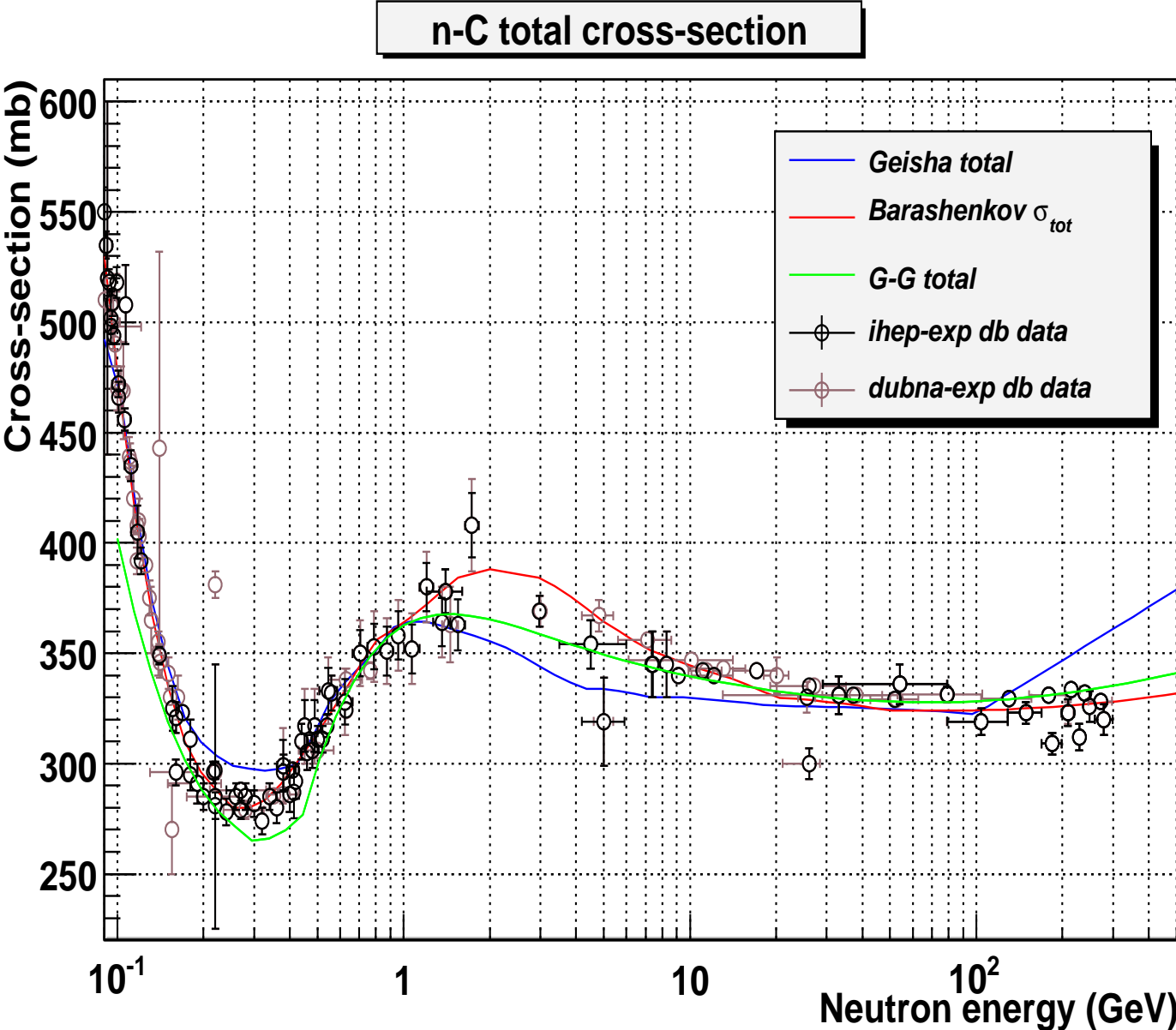


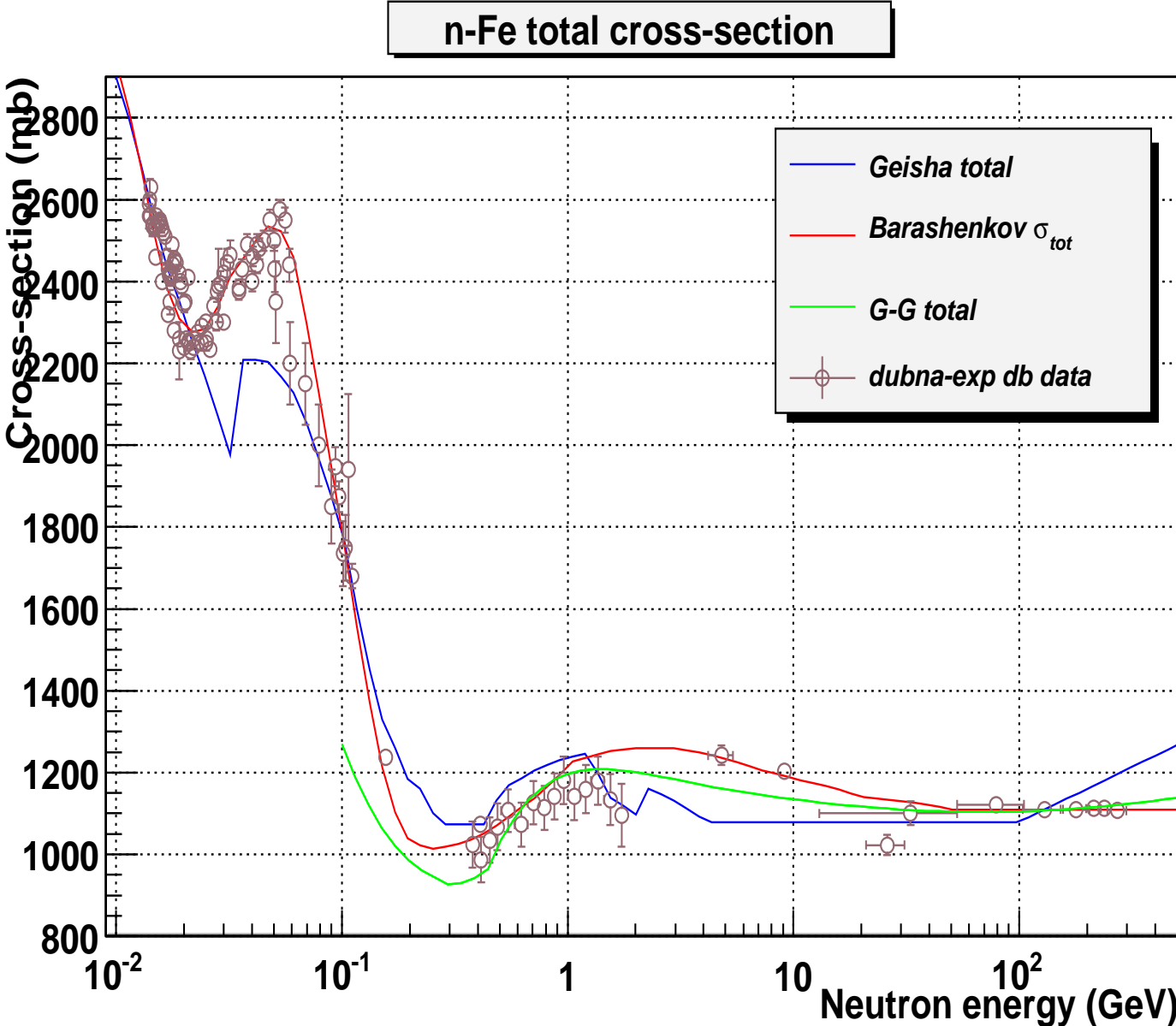


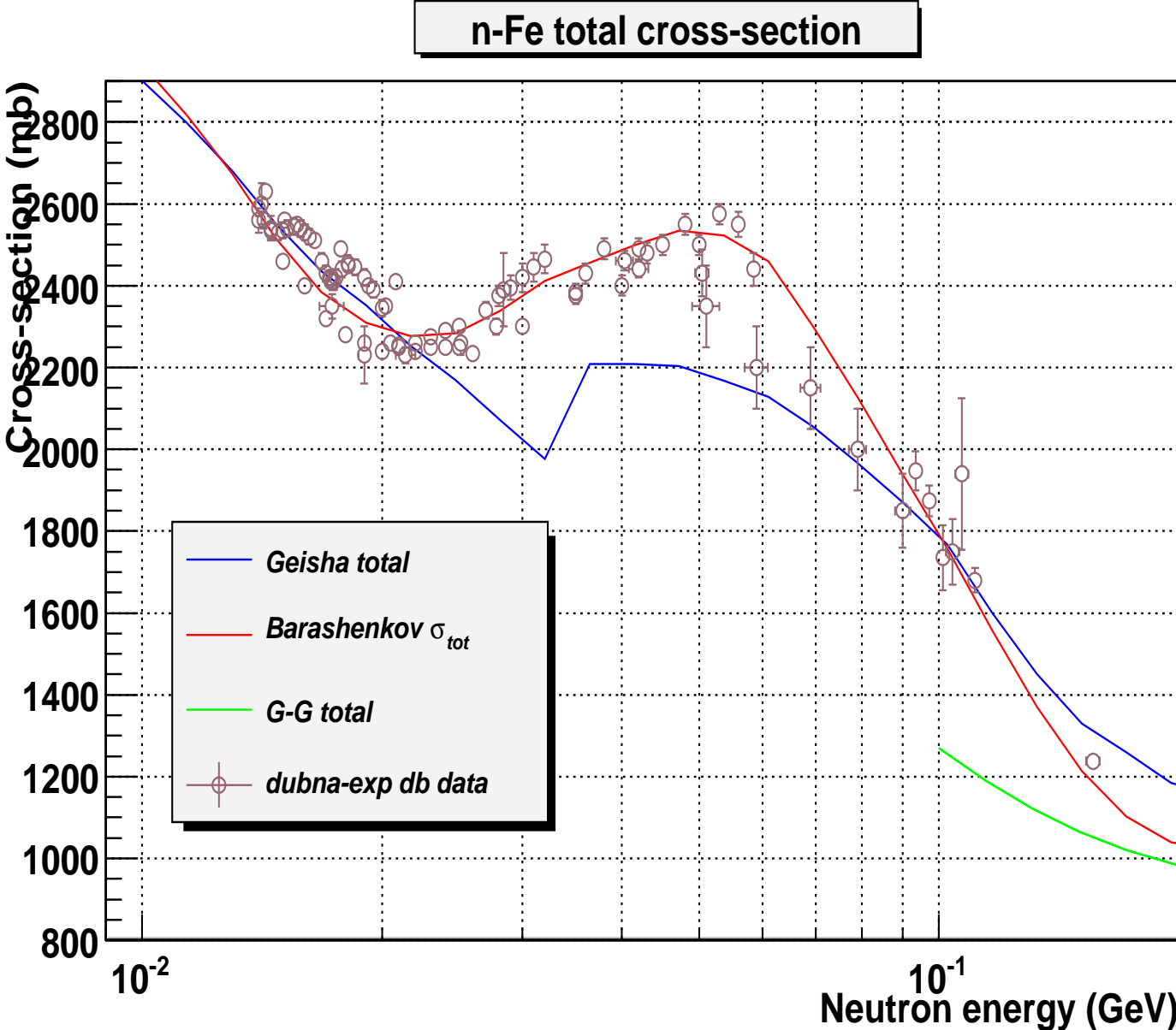


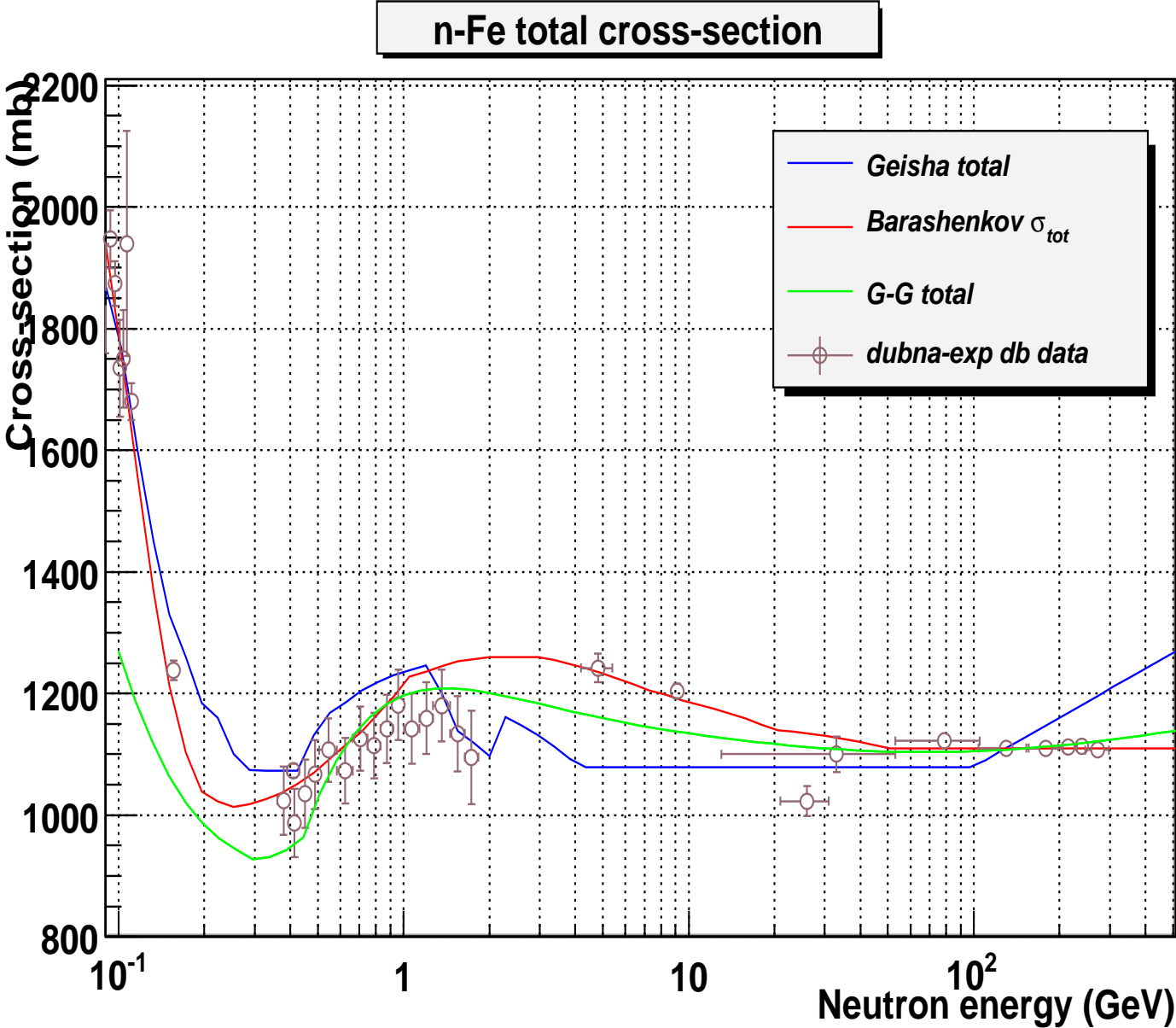


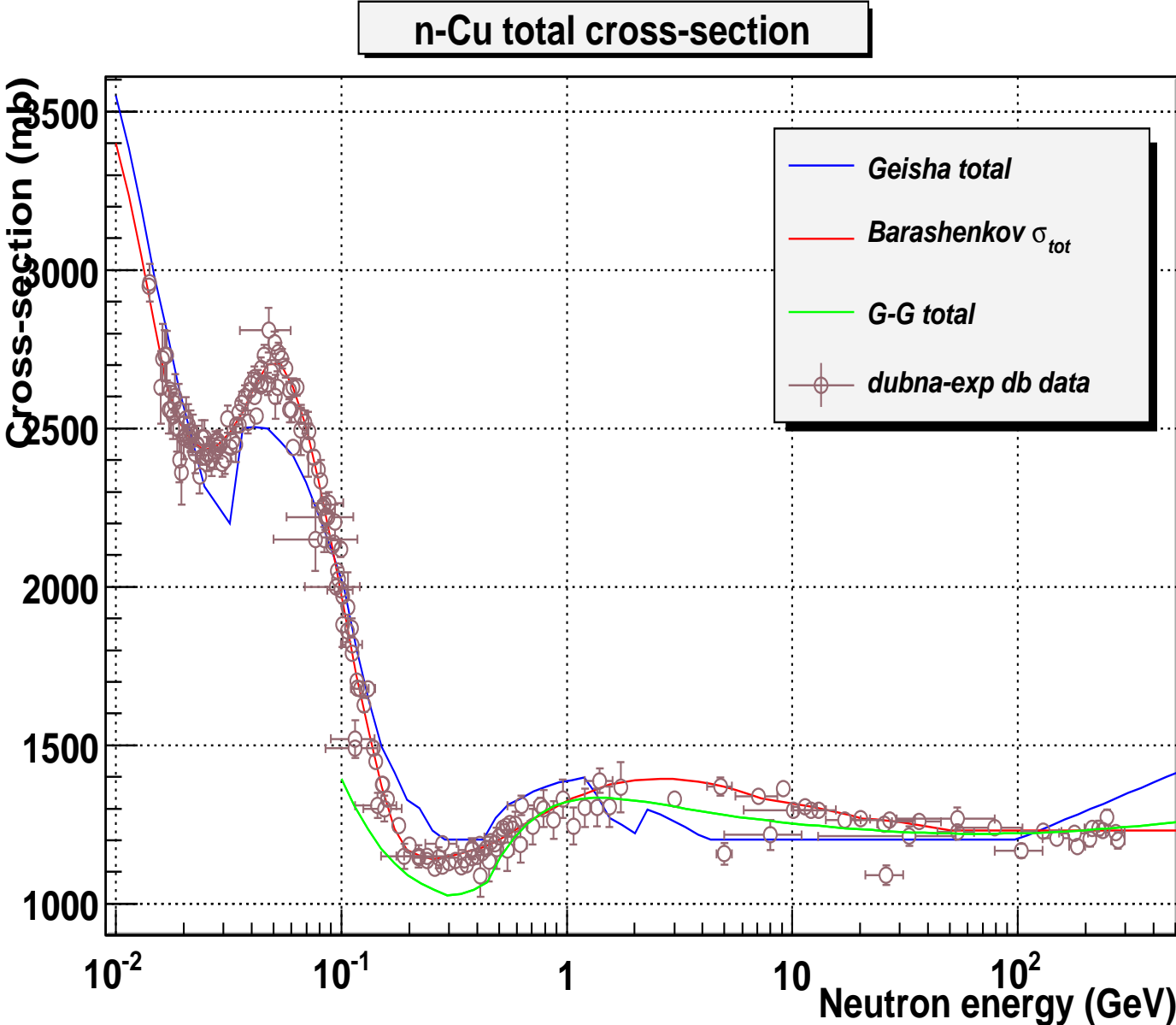




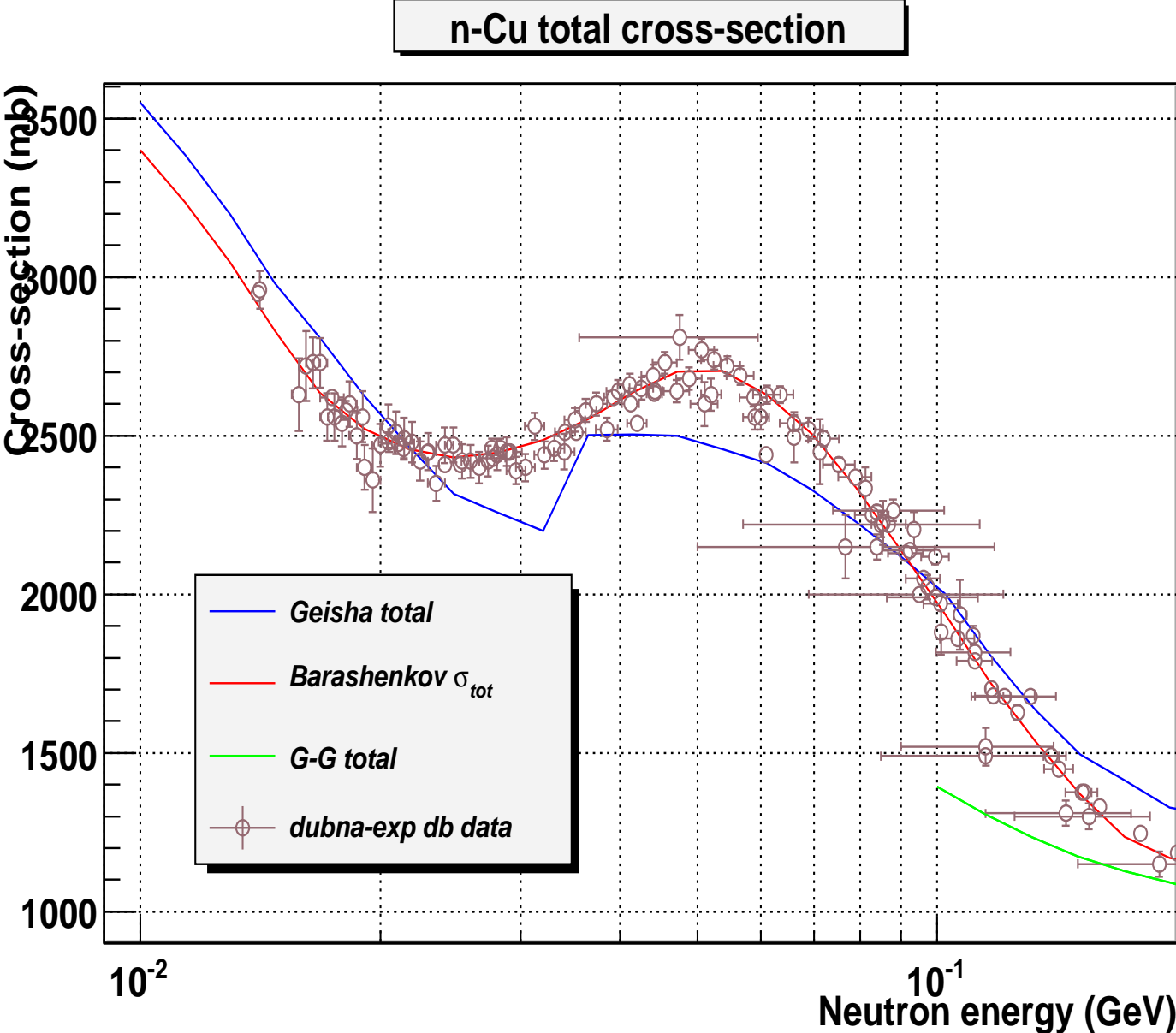


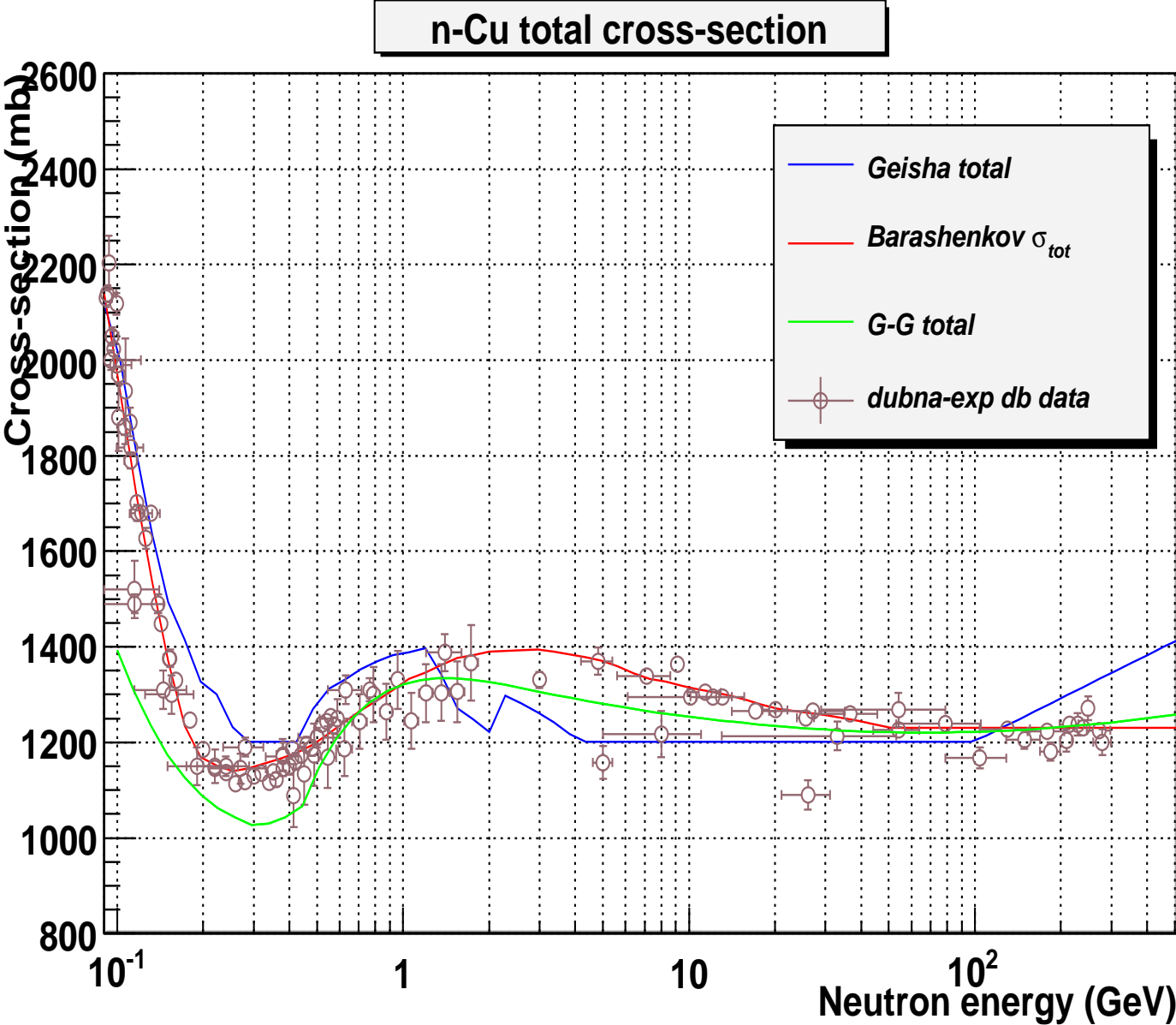


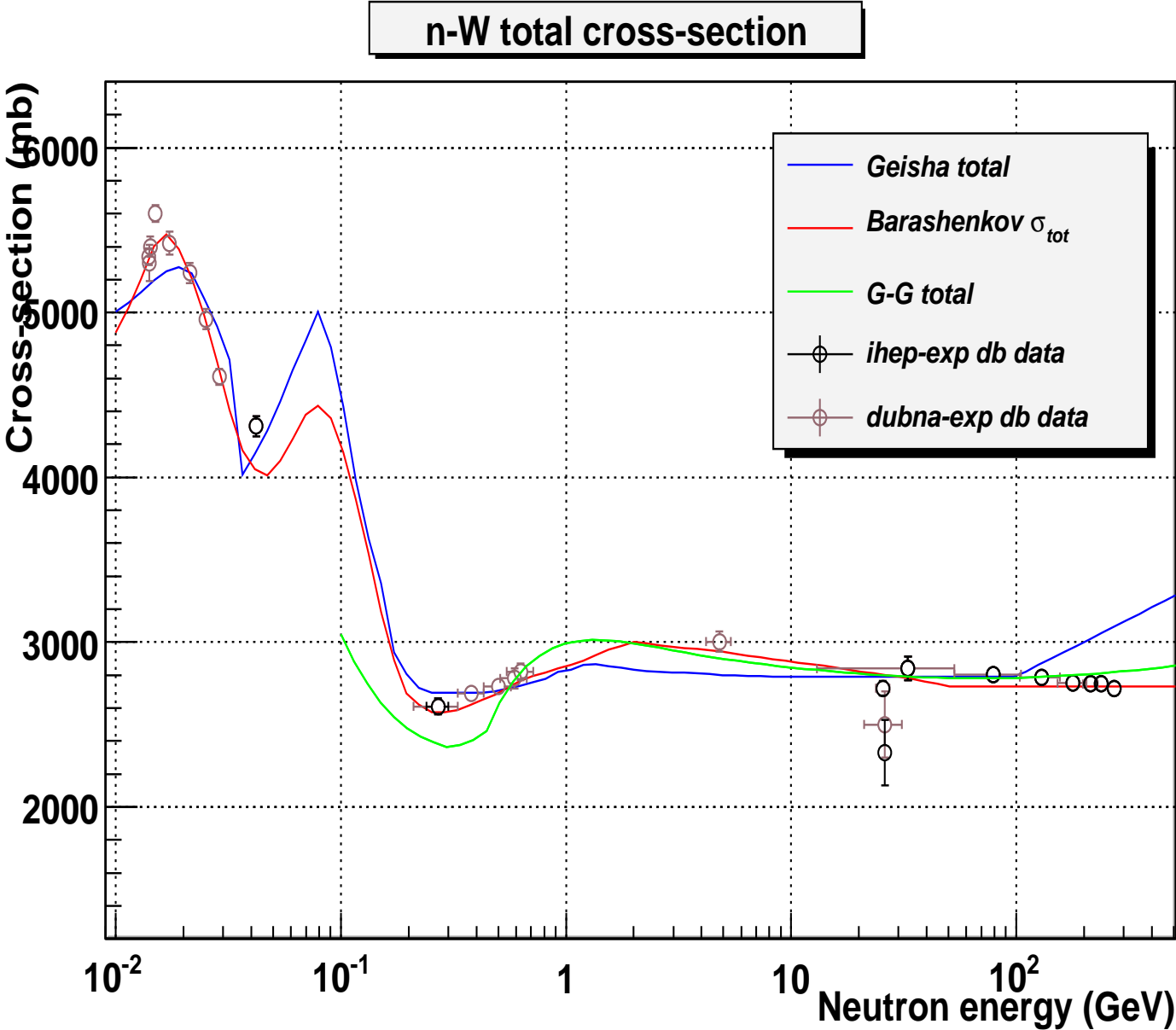


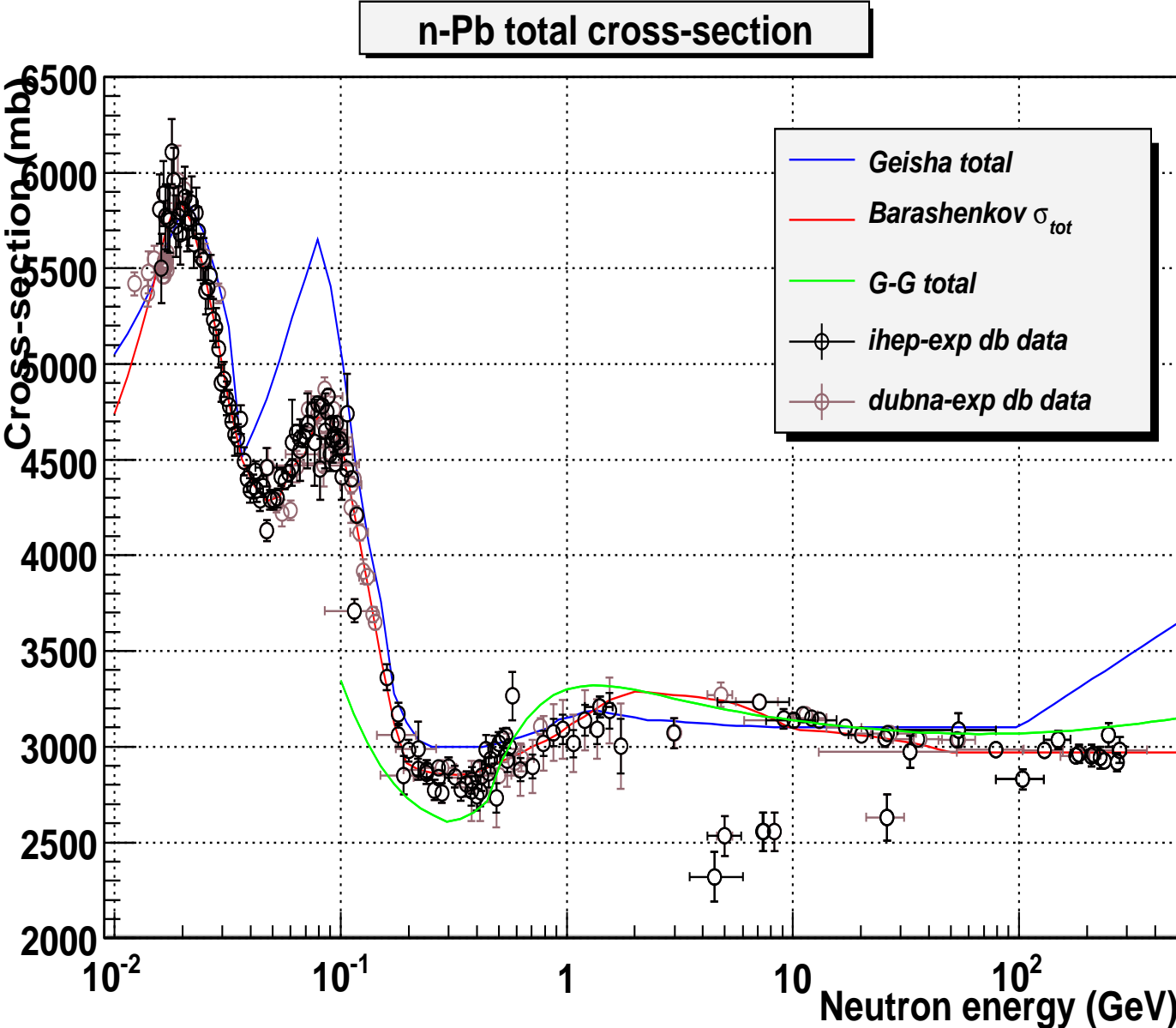


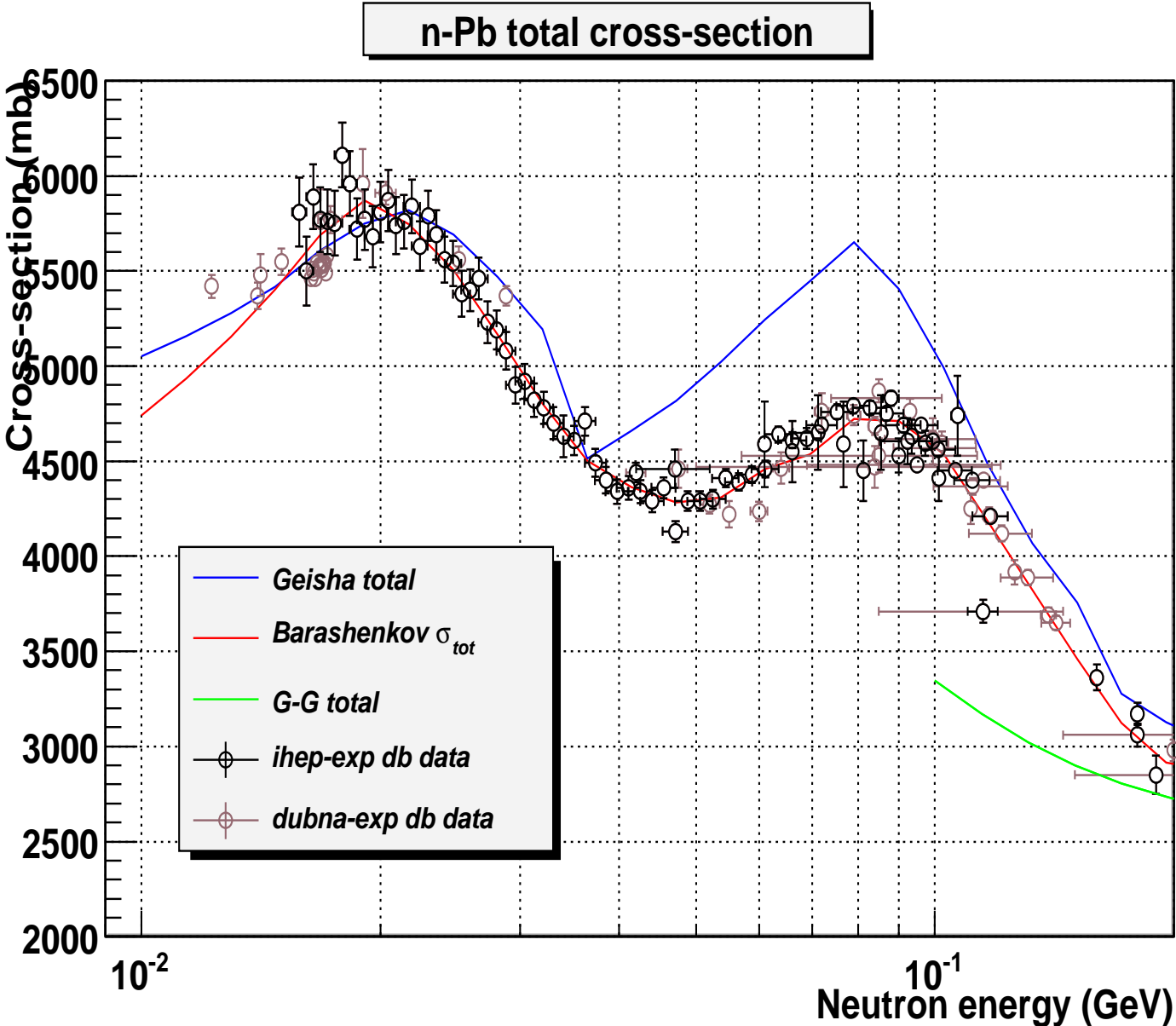


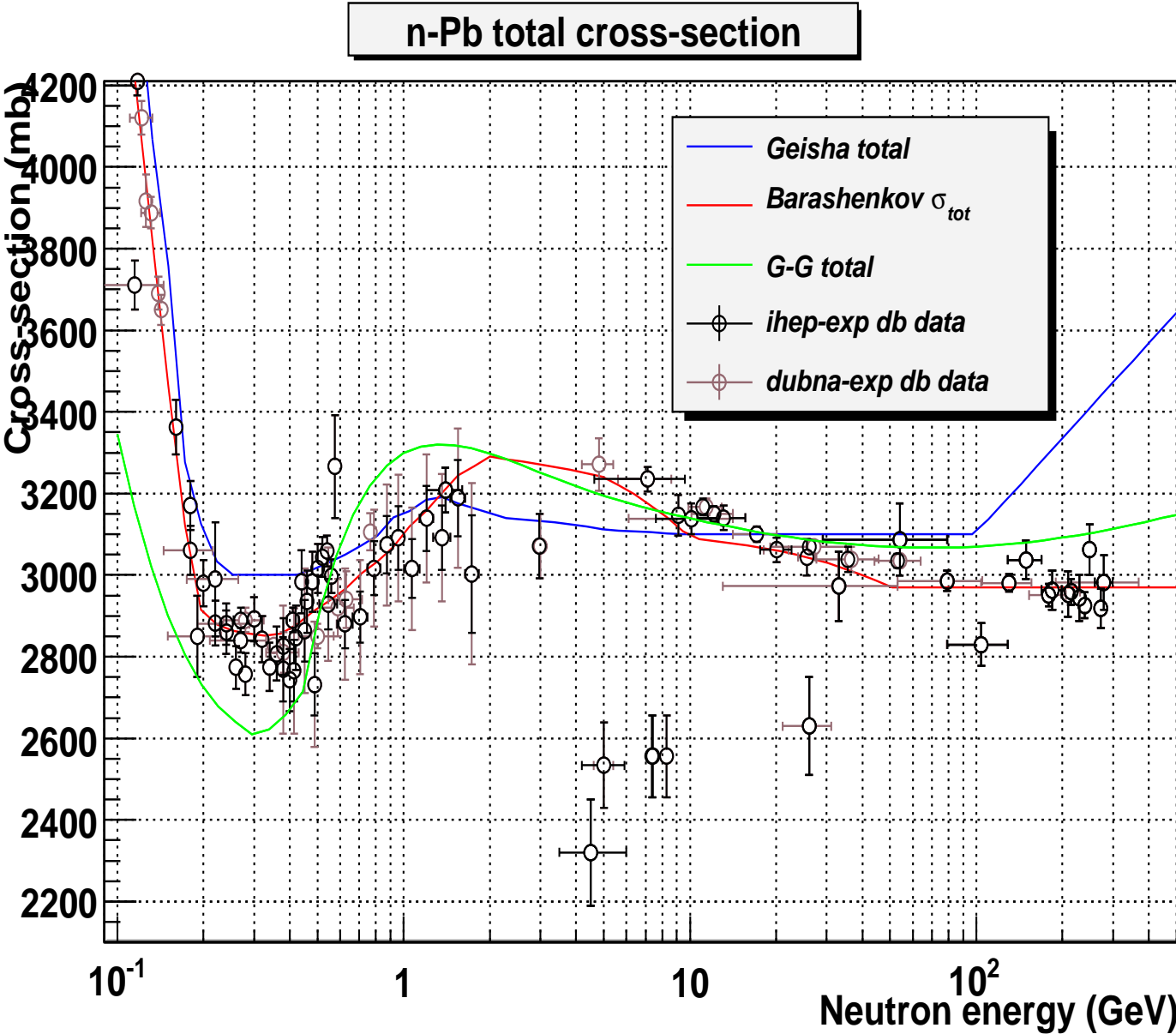


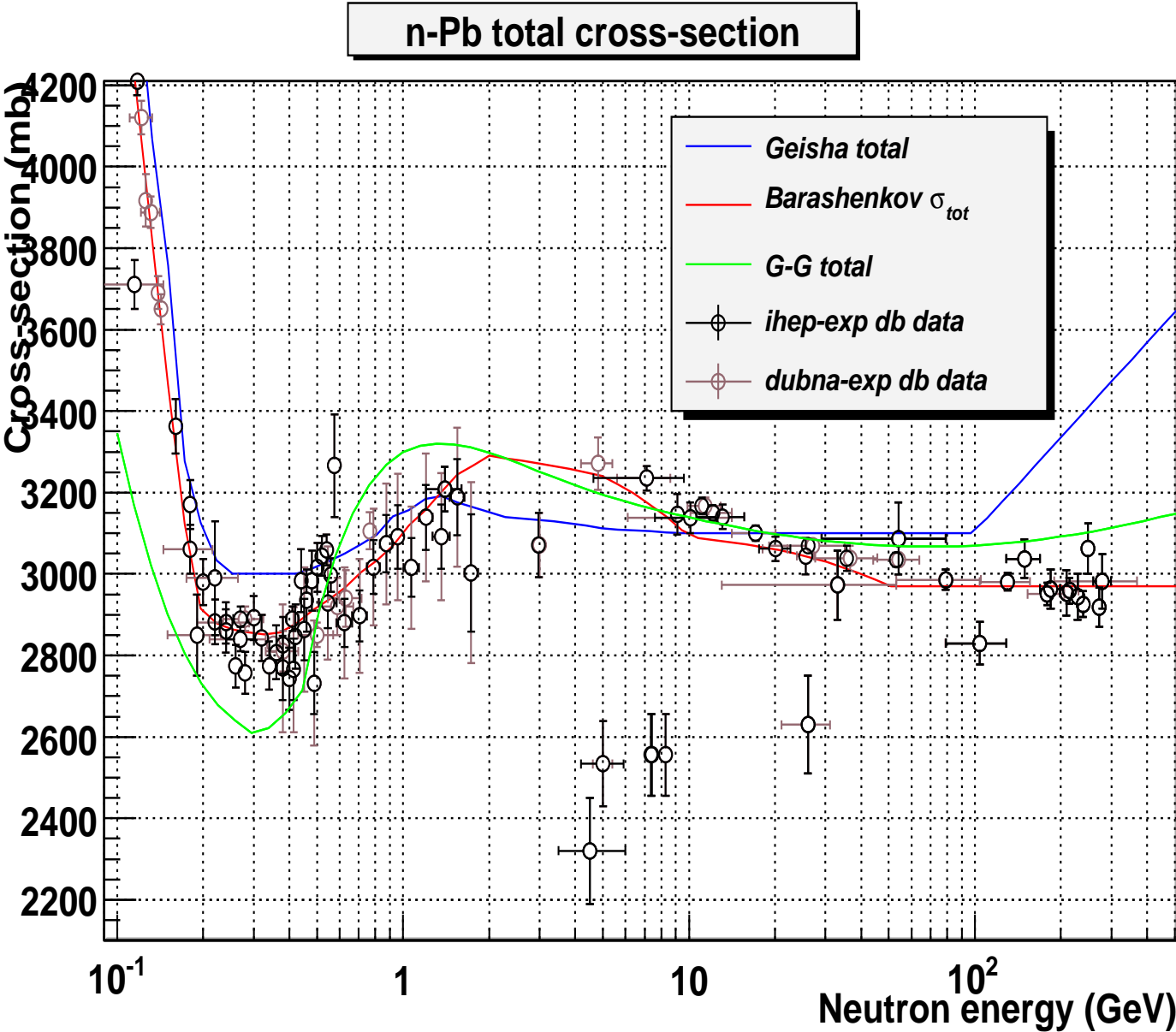


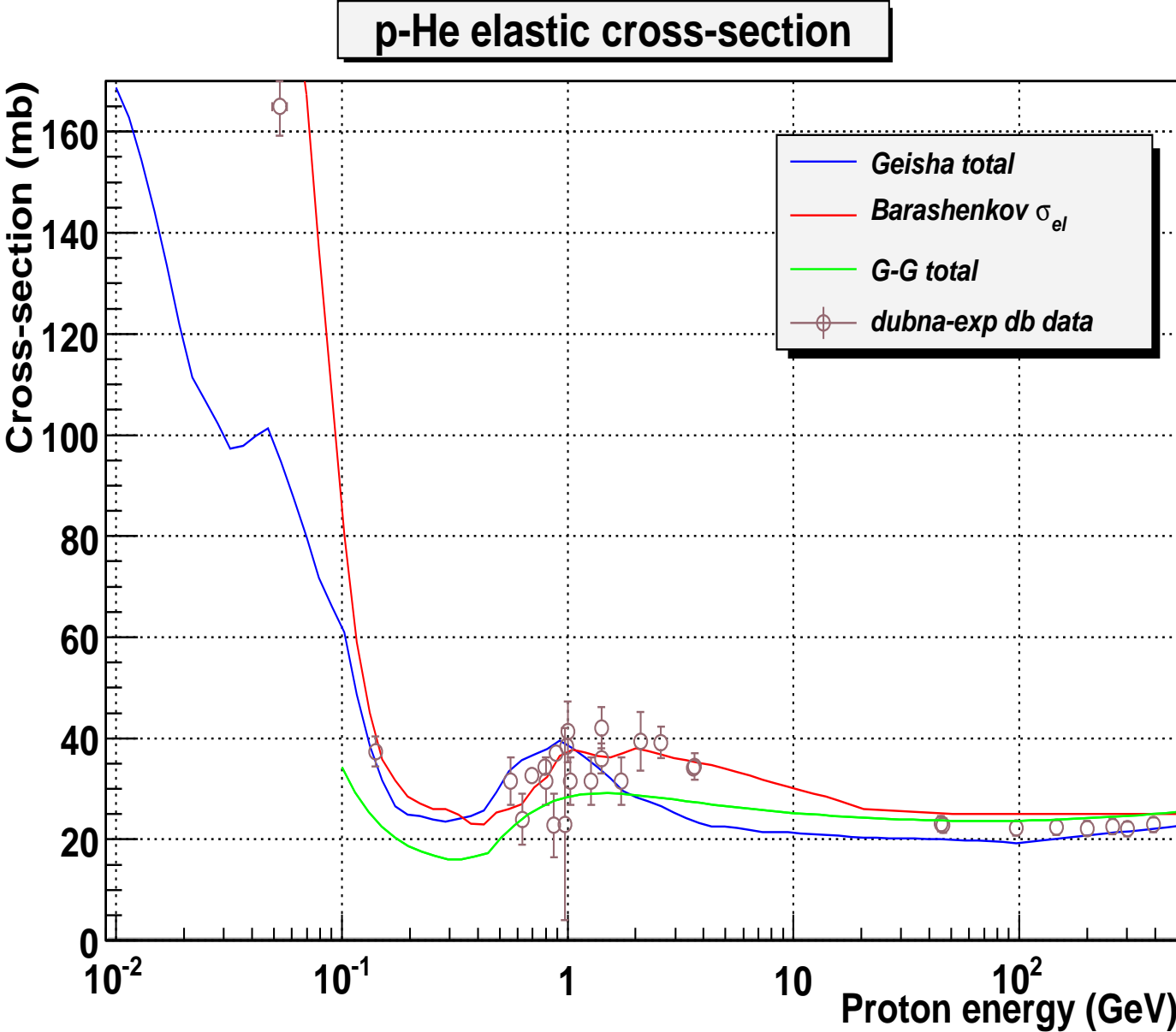




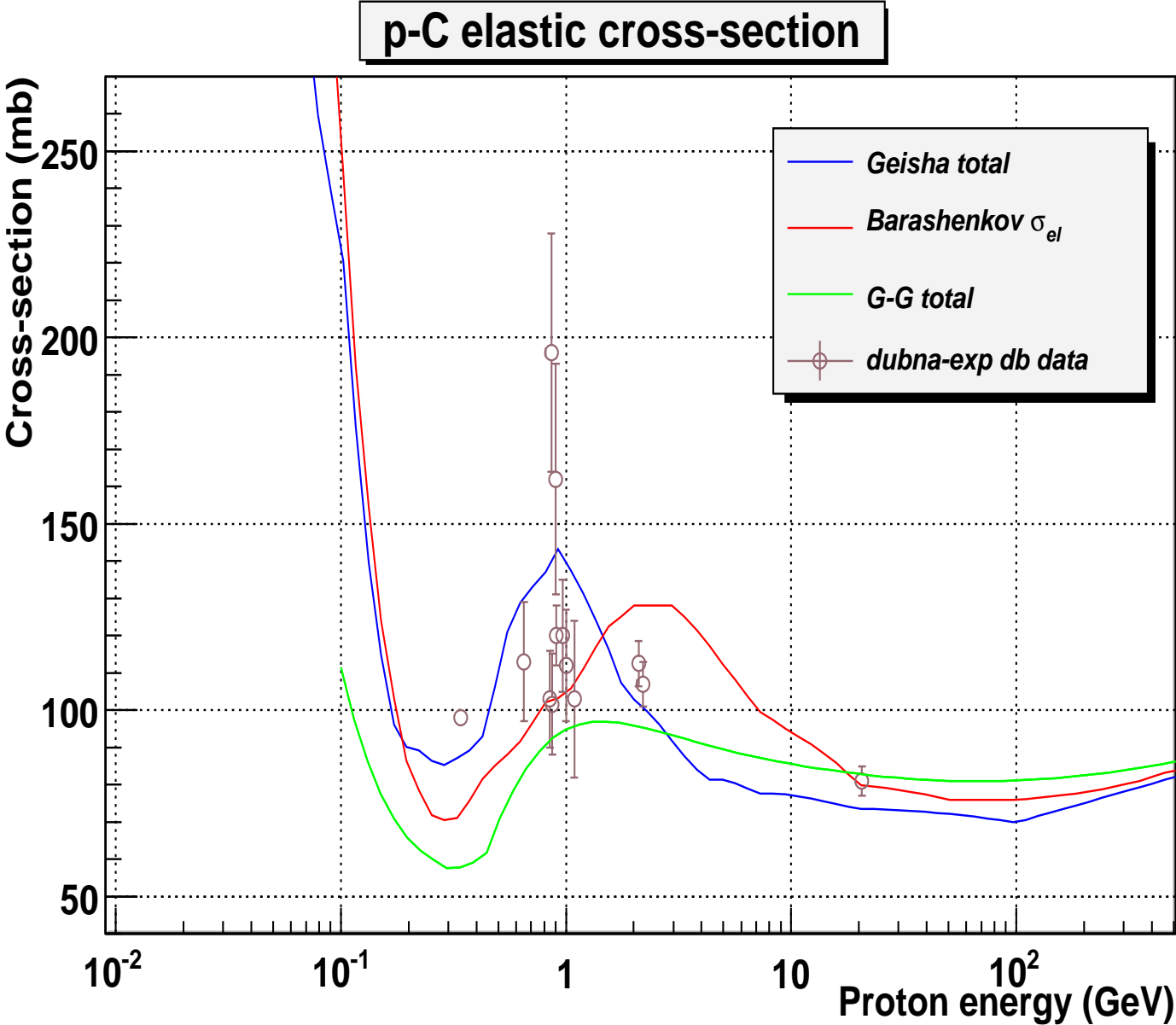


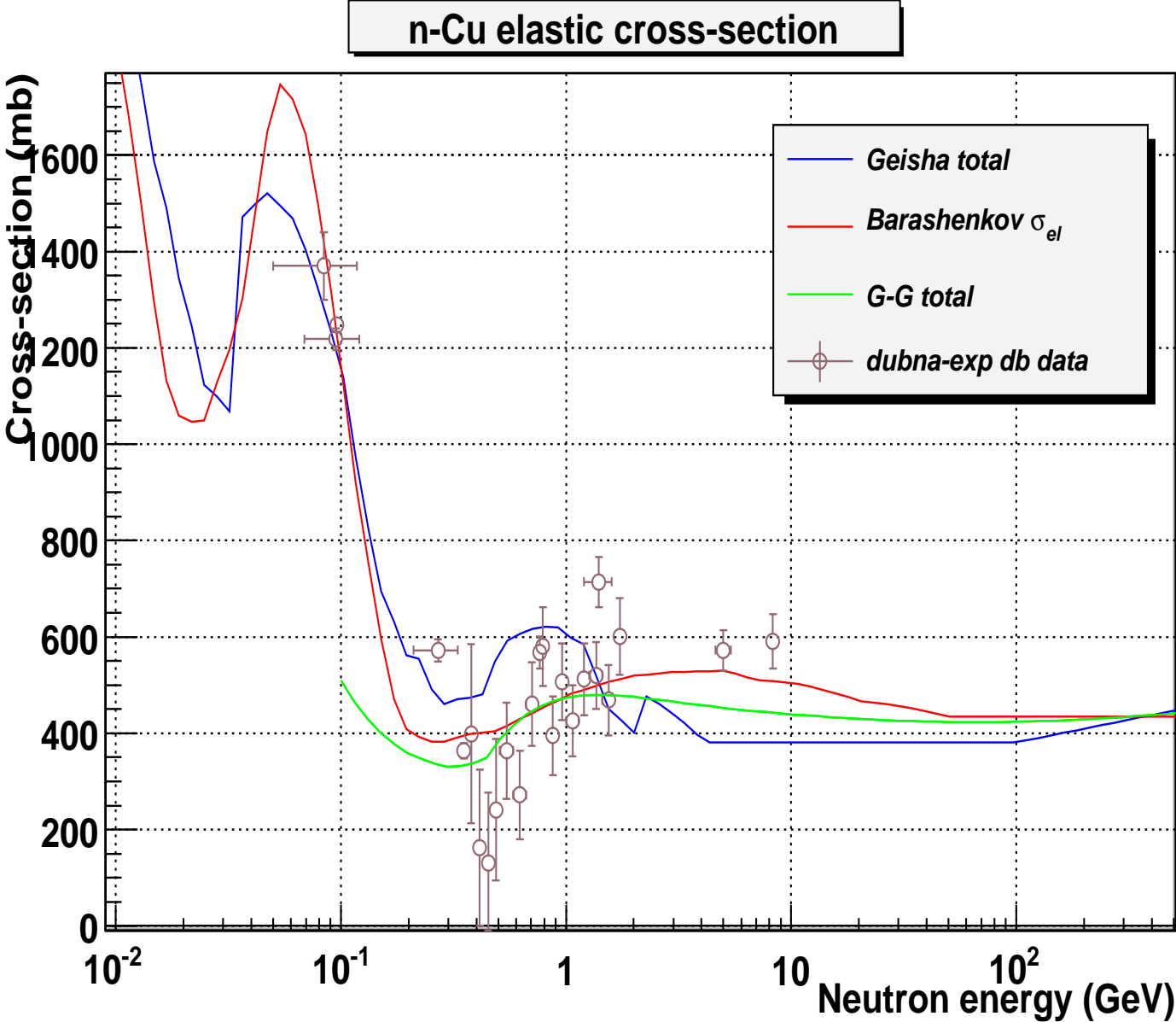












### 3 Conclusions

1. Barashenkov data for nucleons on nuclei were implemented as GEANT4 class (like inelastic cross section for pions). G4NucleonNuclearCrossSection class allows us to get inelastic, total and elastic cross sections in the range 10 MeV - 1 TeV.
2. G4NucleonNuclearCrossSection class based on Barashenkov parametrization shows good agreement with experimental data for total, inelastic and elastic cross sections in the wide energy range 10 MeV - 1 TeV.
3. Glauber-Gribov model can be used as prolongation of Barashenkov cross sections for the energy range  $> 100$  GeV.