

## GEANT4 lepton (gamma) hadronic interactions

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### Abstract

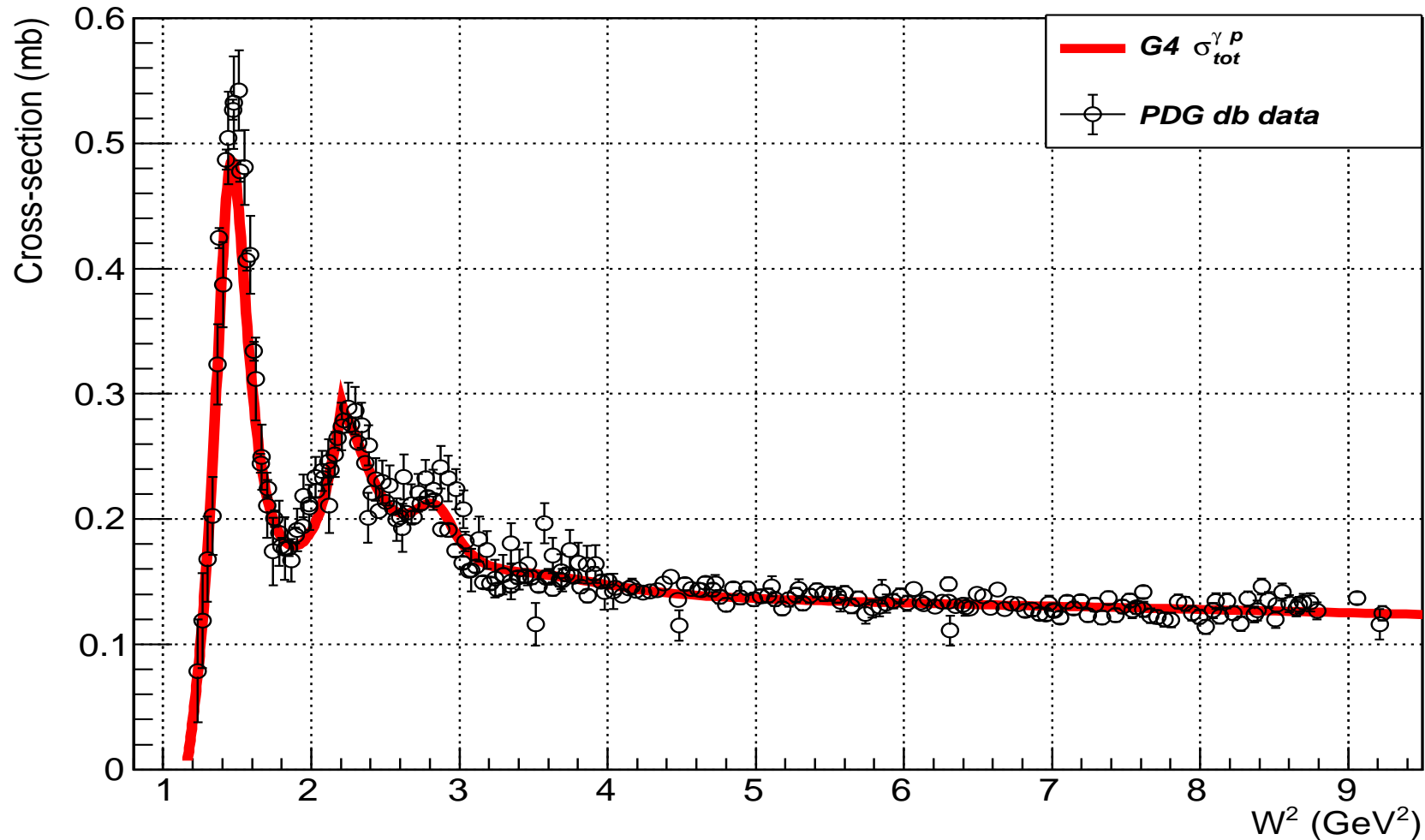
Recent GEANT4 developments for electron, gamma and neutrino hadronic interactions are discussed in the framework of structure function approach. Comparisons with experimental data are presented.

# 1 Outline

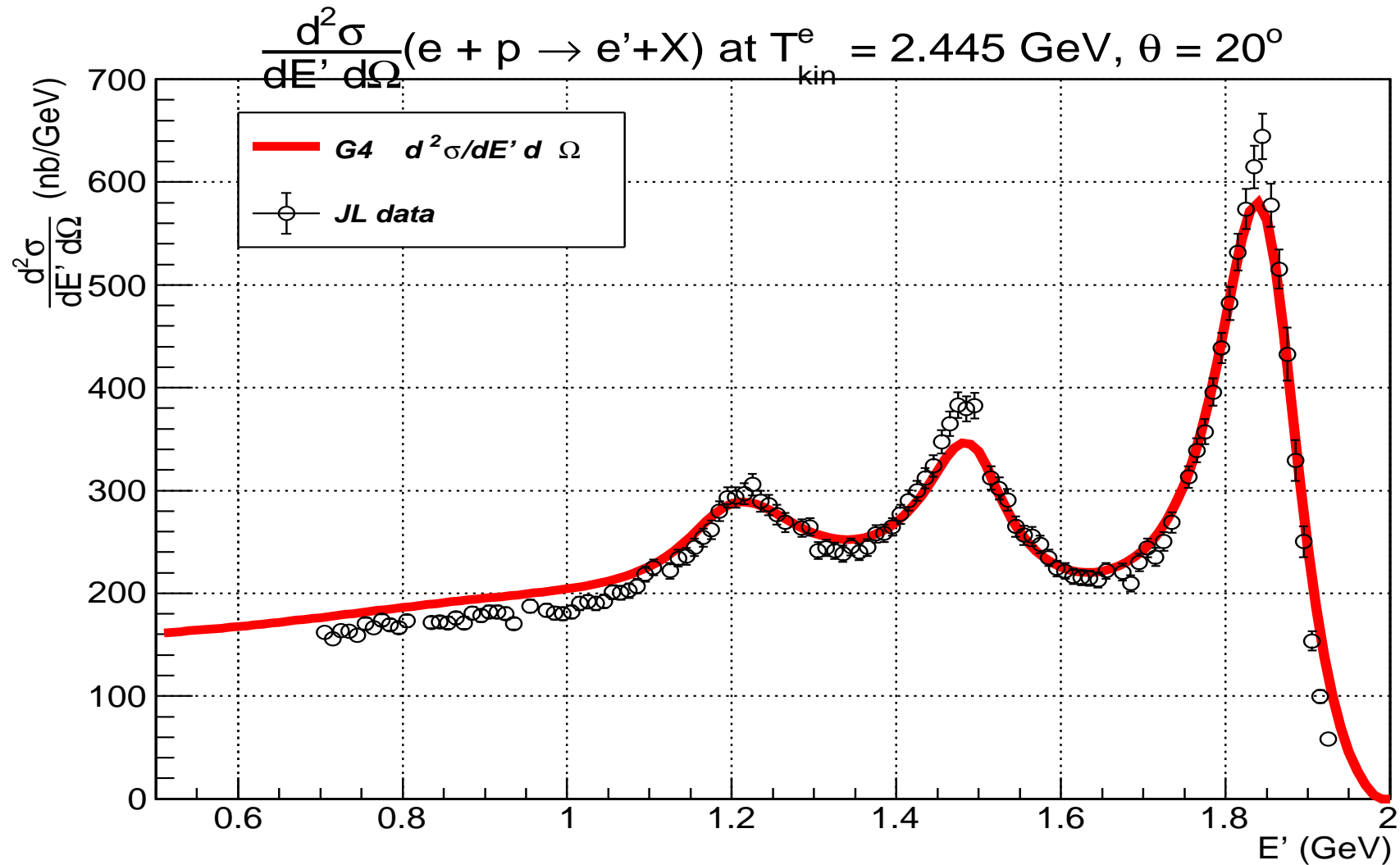
1. Lepton-nucleon interactions.
2. Comparison with experimental data.
3. Summary.

## 2 Lepton-nucleon interactions

1. Lepton (gamma) hadronic interactions can be described based on the nucleon (nucleus) structure function (SF) approach developed for DIS region and extended to low energy-momentum transfer domain.
2. Low energy-momentum transfer extension (quasi-elastic, coherent pions, resonances) is based on the Capella-Kaidalov-Merino-Tanh (CKMT) approach with resonances included for some regions of  $x$  and  $Q^2$ .

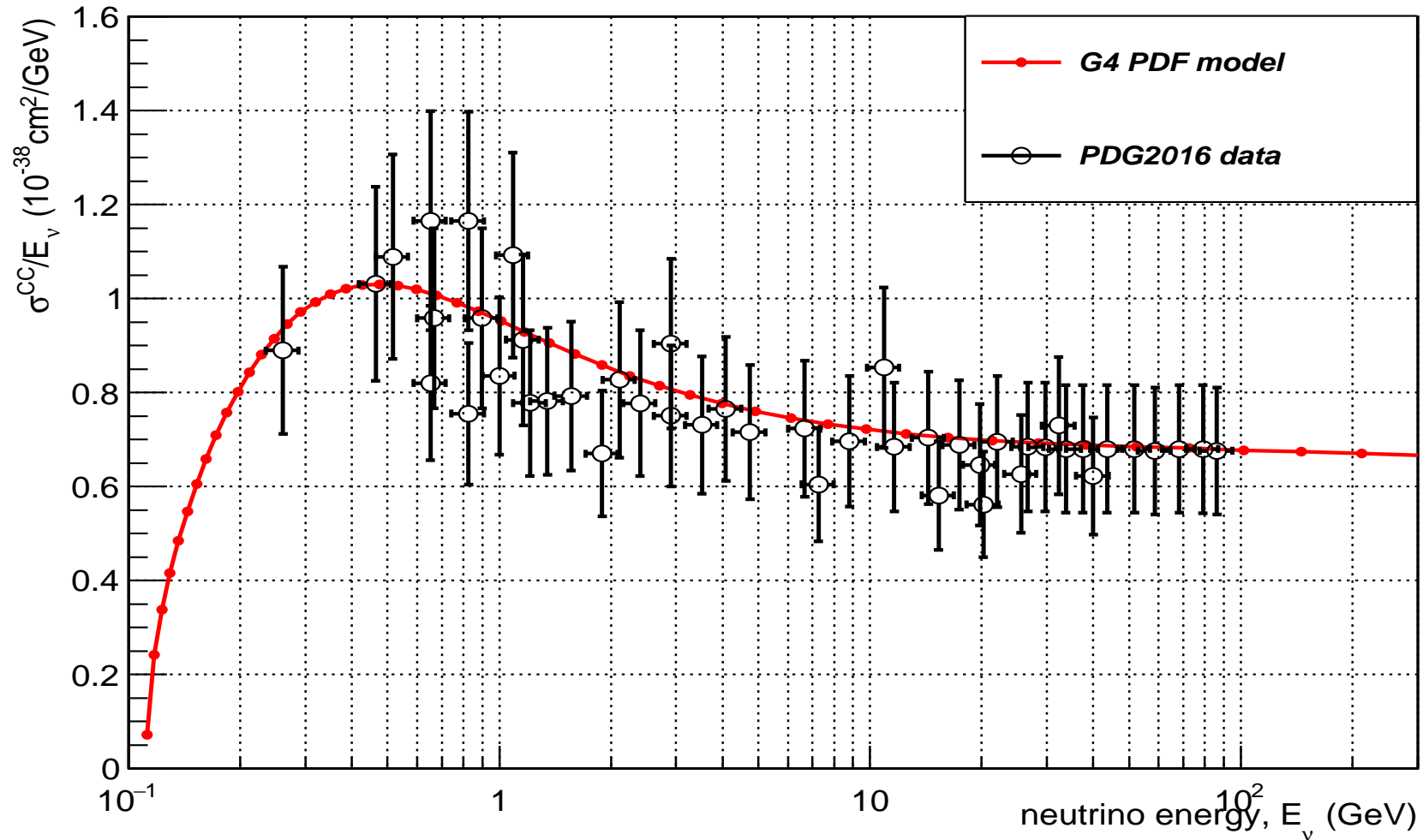
$\gamma$ -p total cross section

Gamma-proton total-cross-section (SF approach). Resonances are: 1232, 1520-1535, 1650-1680 MeV. Small at 1440 and around 1950 MeV.



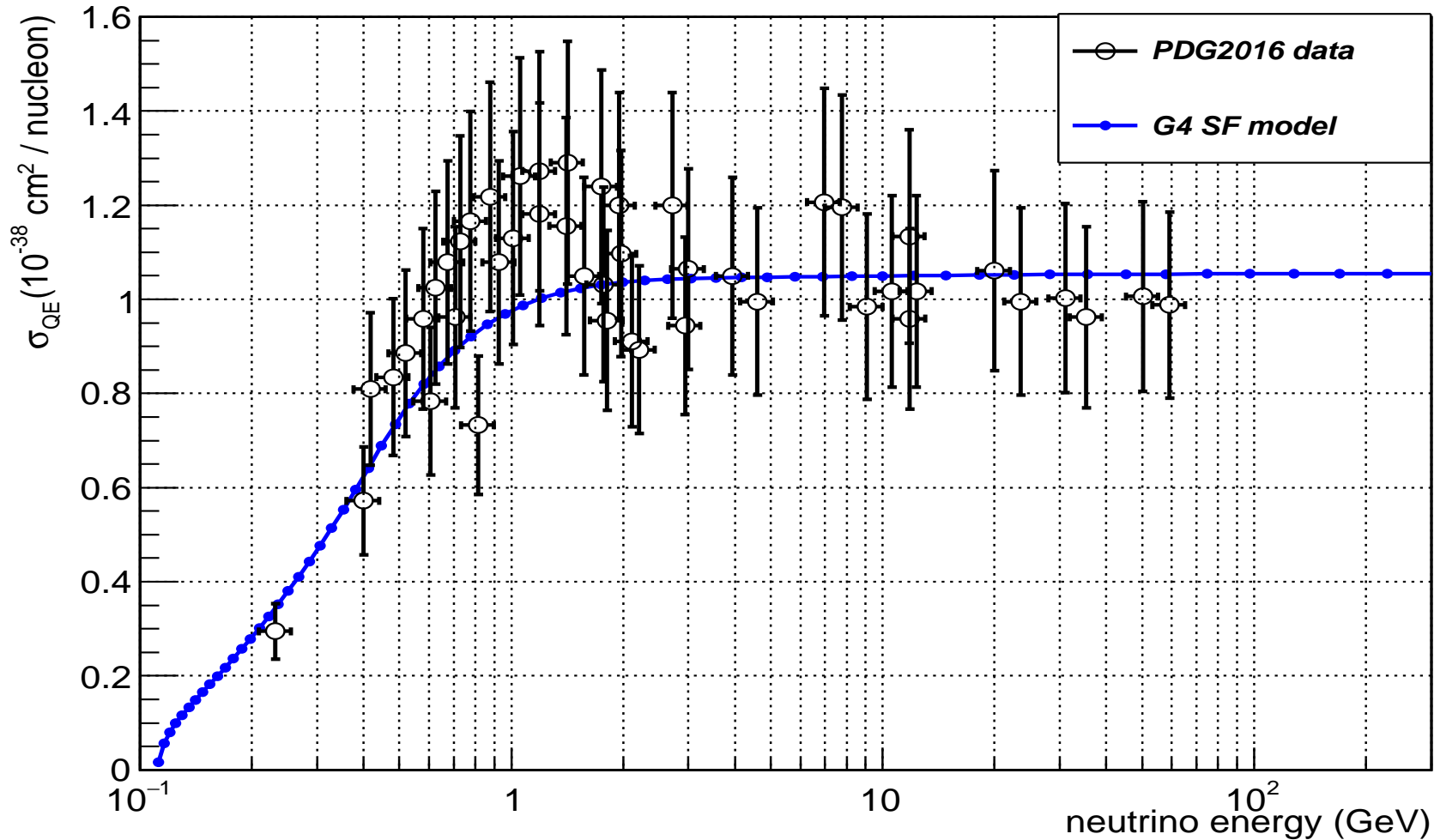
Double differential e-p cross-section (SF approach).

The total cross section of  $\nu_\mu N \rightarrow \mu^- X$  vs. neutrino energy



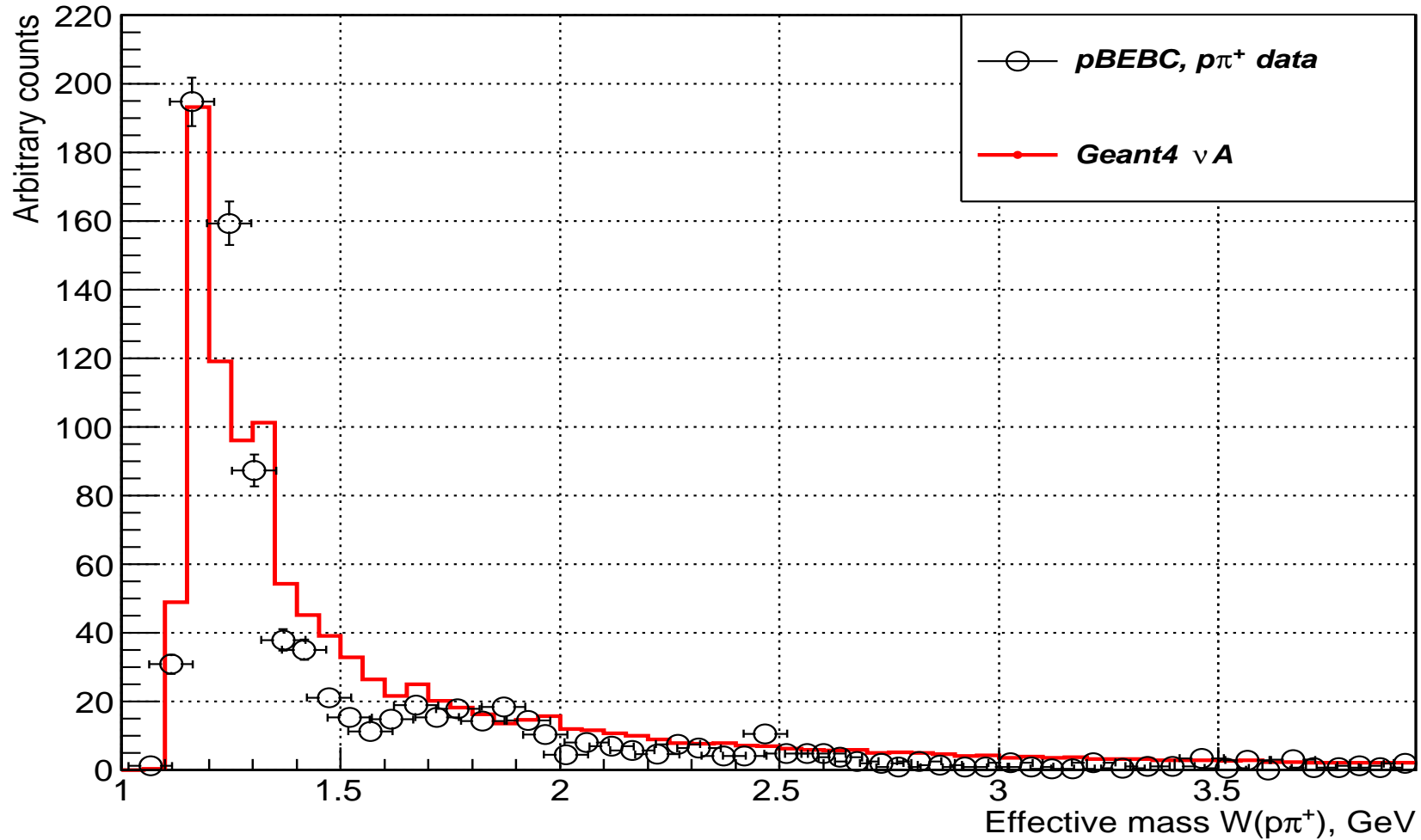
The total cross-section of muon neutrino on nucleons (SF approach).

### Quasielastic cross section vs. neutrino energy



The quasielastic cross-section of muon neutrino on nucleons (SF approach).

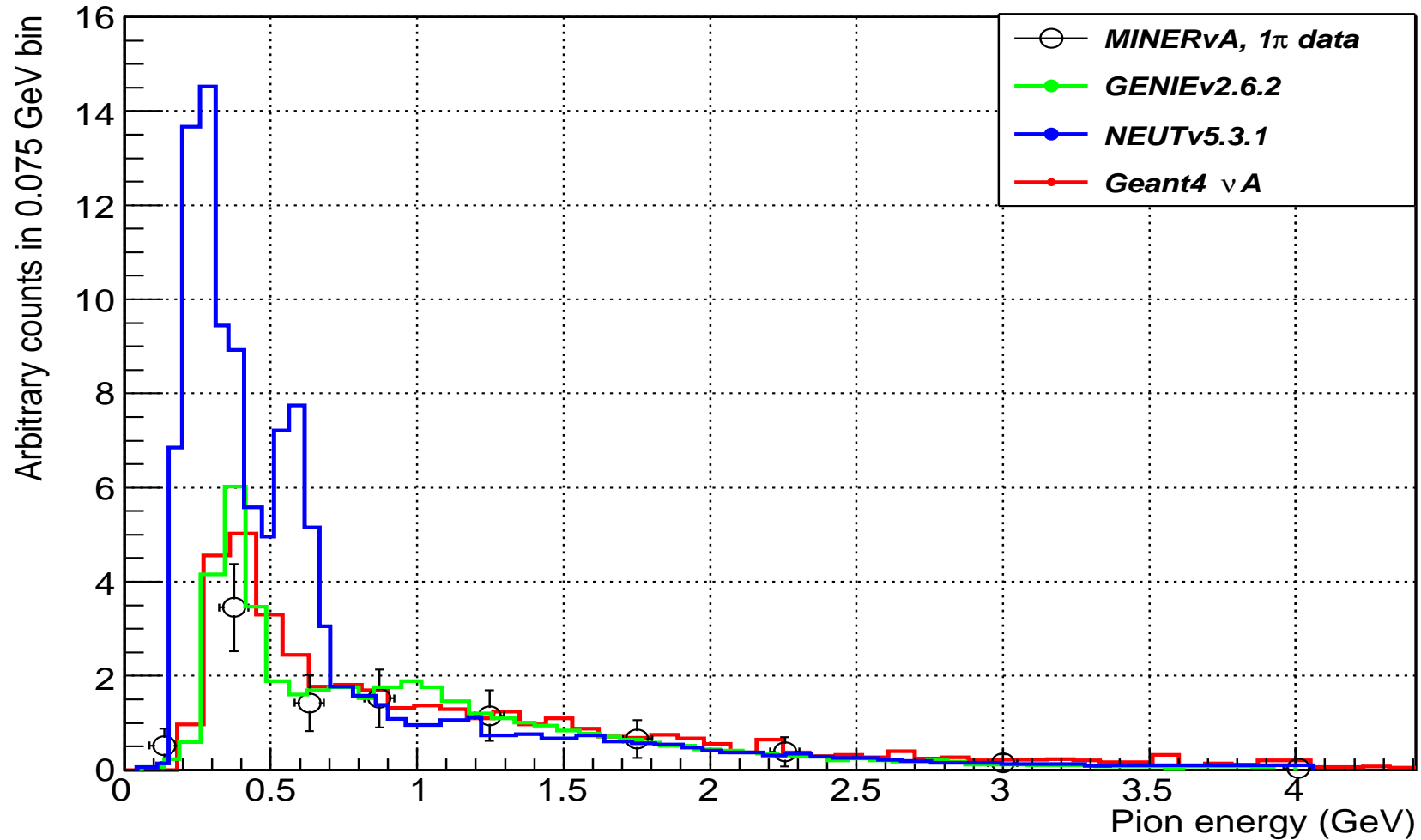
Effective mass distribution  $W(\rho\pi^+)$  for  $\nu_\mu p$  reaction



Spectrum of invariant mass for the pion-proton system (pBEBC data).



Energy distribution for one-pion reactions  $\nu A \rightarrow \mu^- \pi^+ A$



Spectrum of coherent pions (MINERvA, FNAL).

### 3 Summary

1. Lepton-, gamma- nucleon cross-sections are satisfactory described based on the SF approach.
2. GEANT4 R&D is under progress to combine different SF representations in one consistent set.
3. Performance is an issue in some cases for the sampling of final state (two dimensional sampling  $x, Q^2$ ).