Forward Physics Facility
4rd Meeting

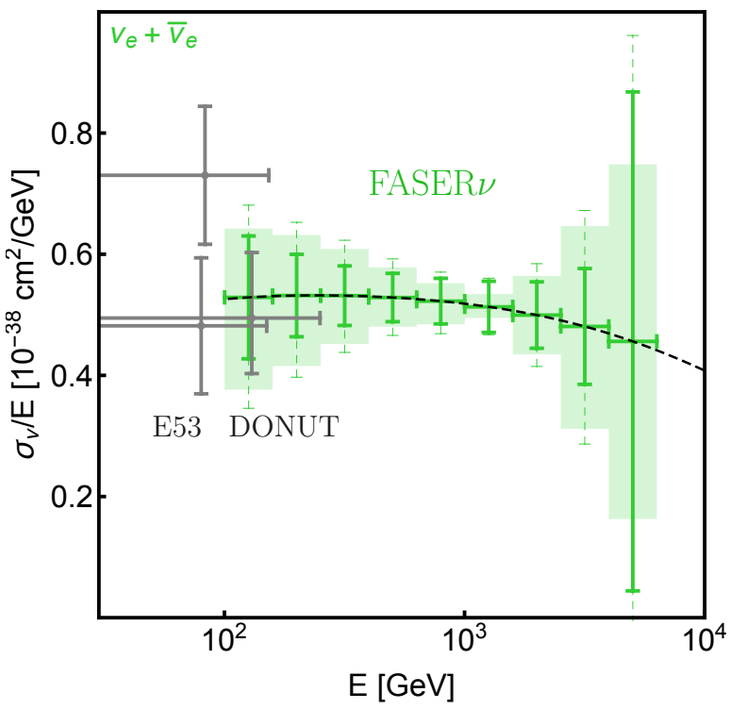
TeV Neutrino Cross Sections

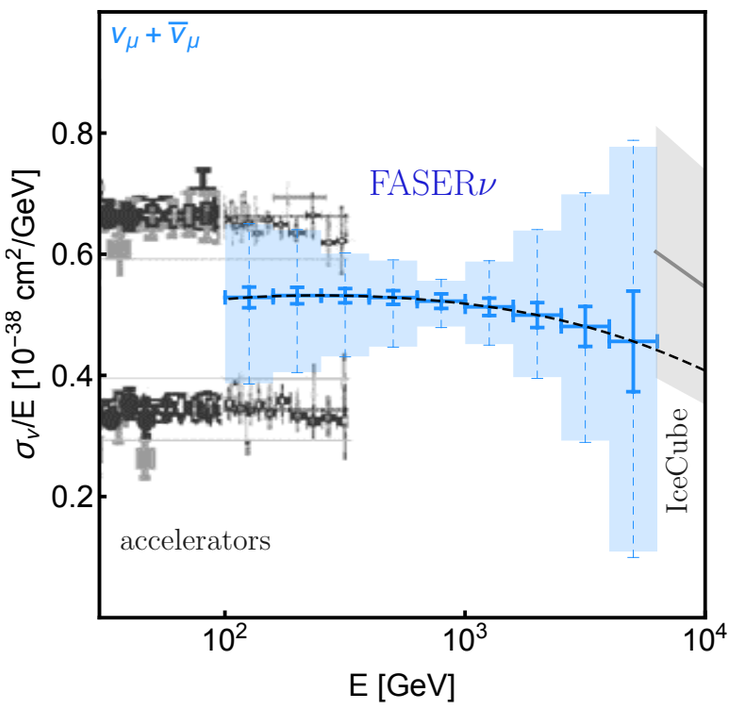
Alfonso Garcia

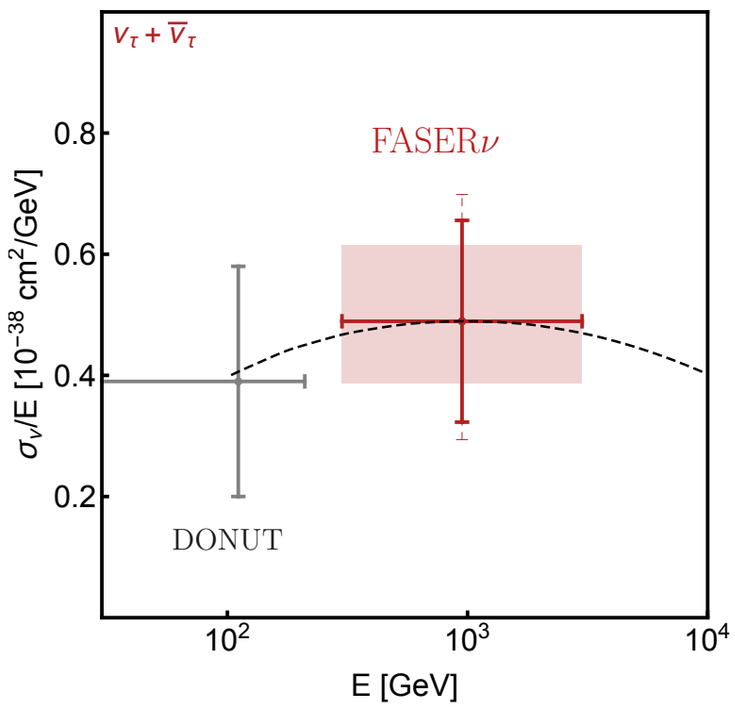
alfonsogarciasoto@fas.harvard.edu

Cross section

- FPF detectors will be able to measure neutrino cross sections in the unexplored TeV regime.
  - <400GeV: Accelerator based experiments measured nu and nubar separately.
  - >10TeV: Icecube measured nu+nubar flux-averaged cross section. Below the absorption effect becomes negligible and measurements very correlated with flux normalisation.
- What neutrino cross-section predictions do we have?

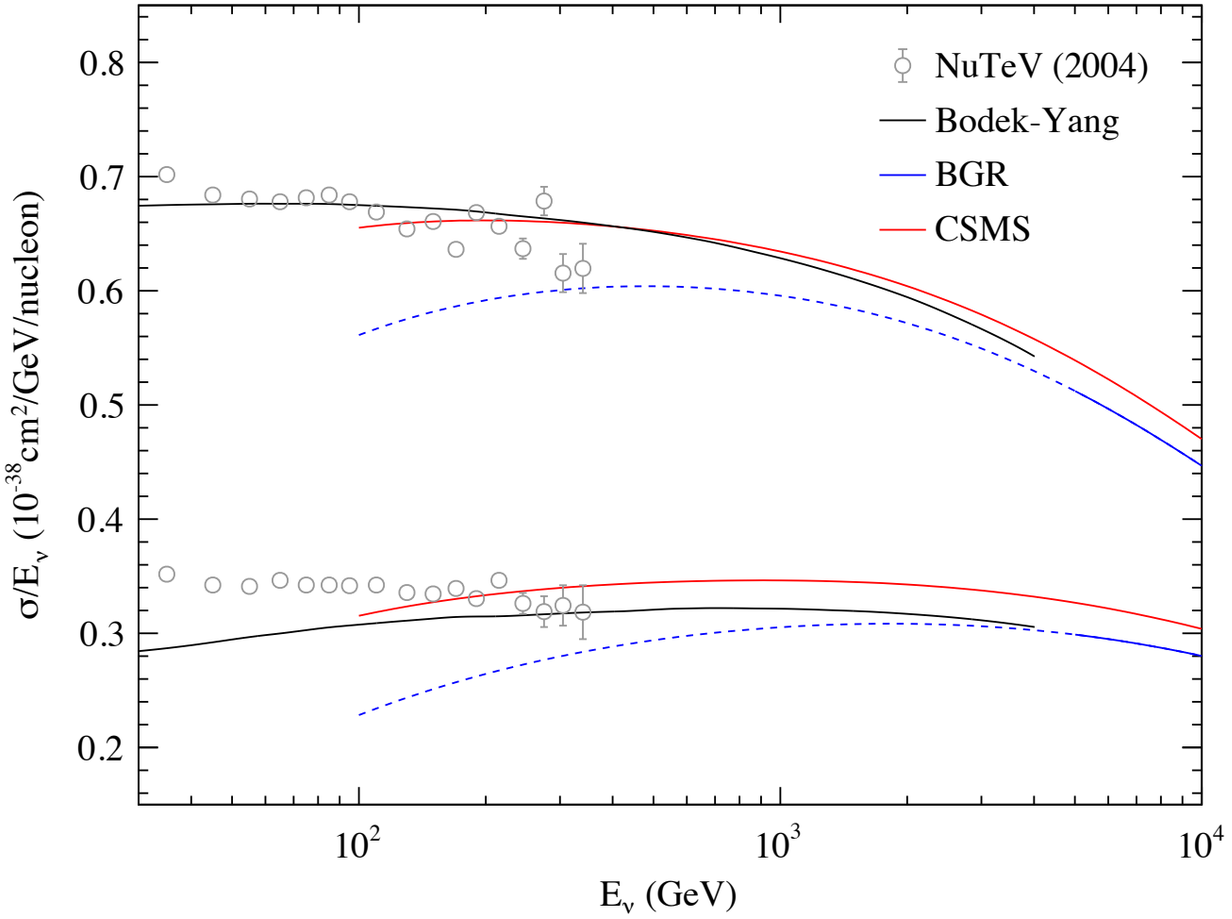






Data Vs Model

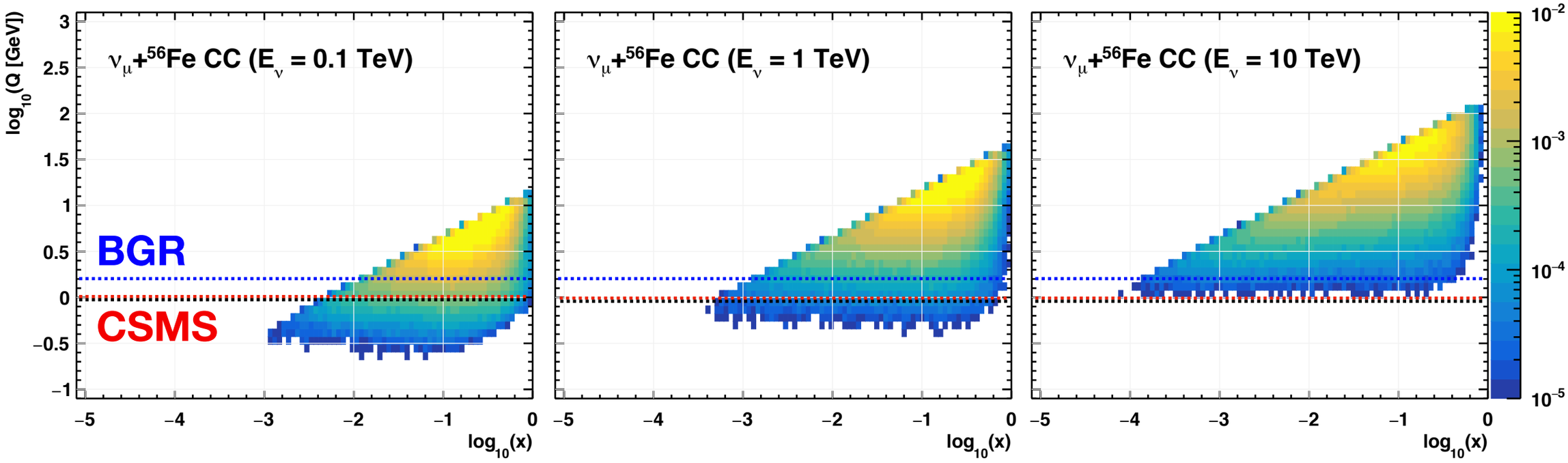
- DIS becomes dominant in this energy regime.
- Structure functions are the key ingredient.
  - Bodek-Yang: structure functions constructed using LO expressions and including correction factors to describe the low Q^2. Widely used in the few GeV regime.
  - CSMS/BGR: structure functions using NLO coefficient function in pQCD. Main models used in the neutrino telescope community.



Difference of ~5%. Why?

x-Q^2 phase space

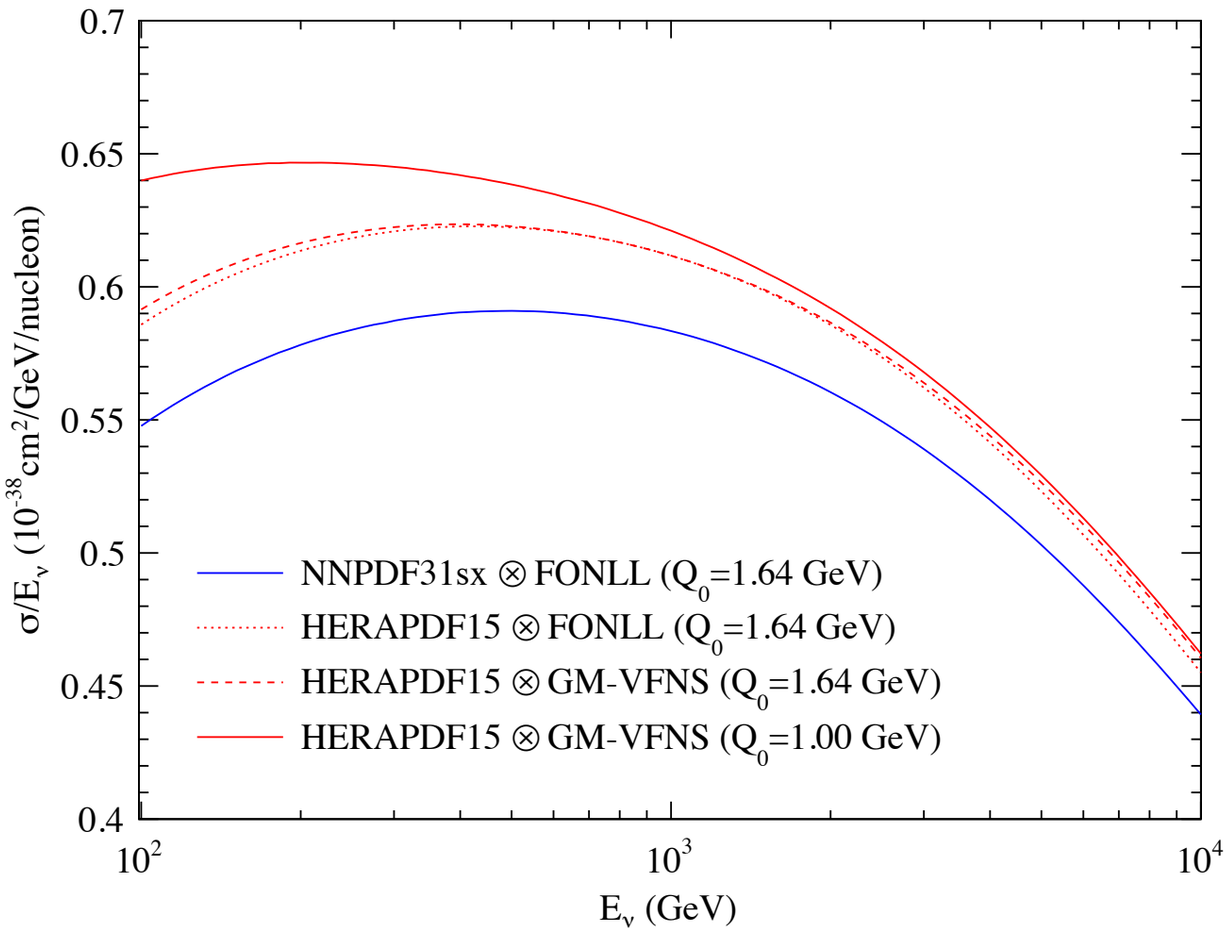
- Neutrino-nucleon interactions probe different regions of the x-Q^2 phase space
  - <1TeV: Low Q^2 become relevant.
    - pQCD formalism fails for low Q^2 -> models apply a low Q2 bound.



*10^6 events using Bodek-Yang DIS

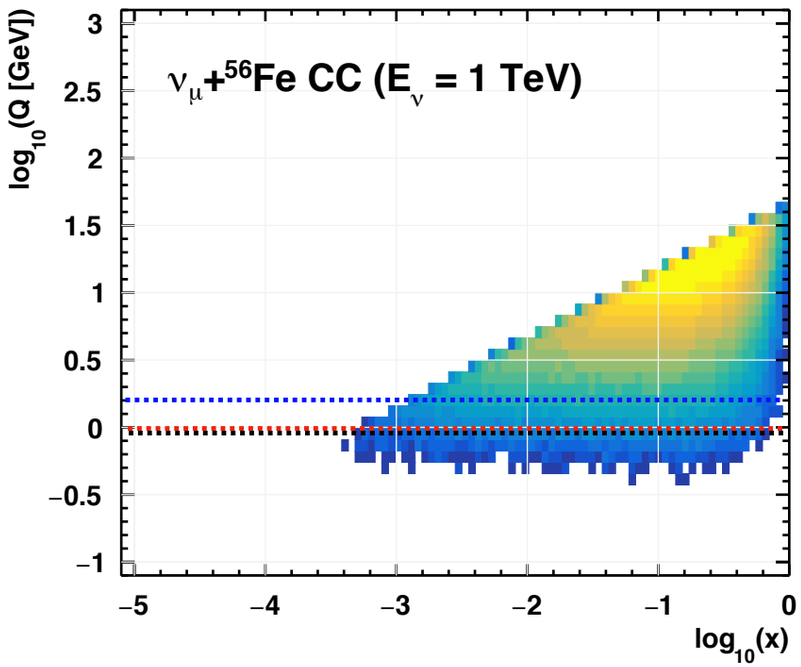
pQCD

- Lower Q^2 bound has a significant impact at E<1TeV.
- 10-15% contribution from charm production:
  - CSMS and BGR use different heavy quark formalisms -> almost identical charm contribution.
- Using same integration boundaries and heavy quark formalism, still 5% discrepancies.

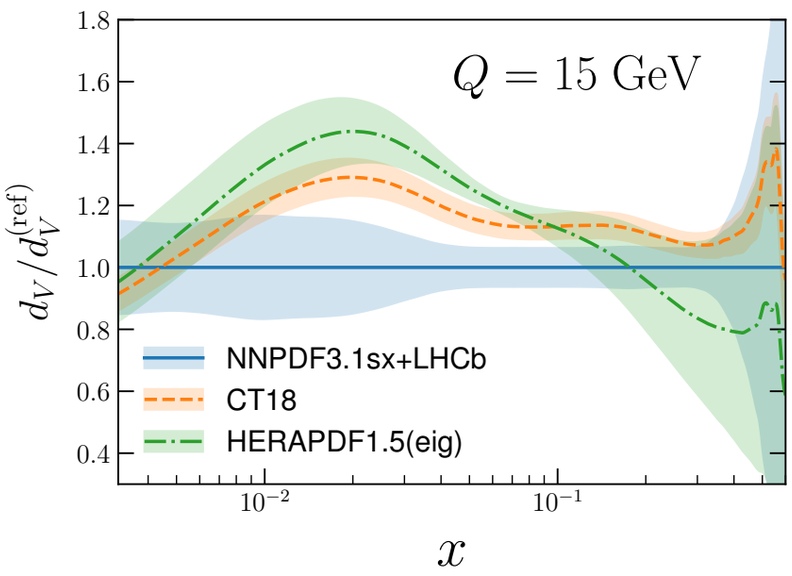


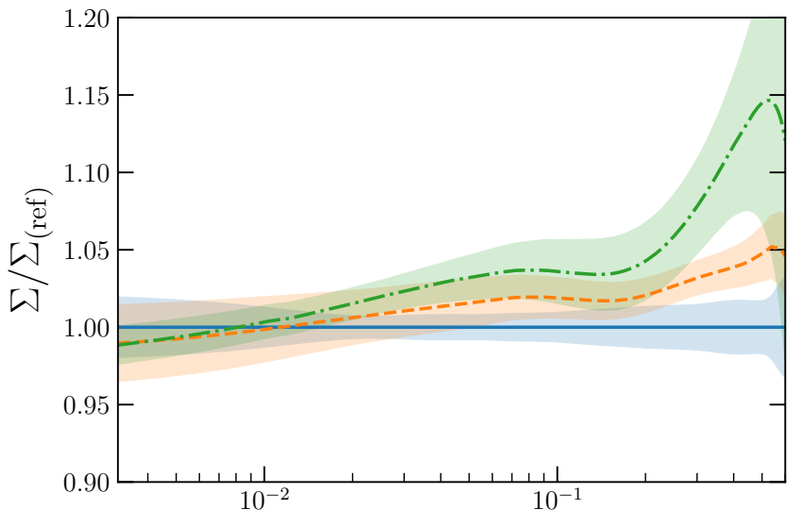
PDFs

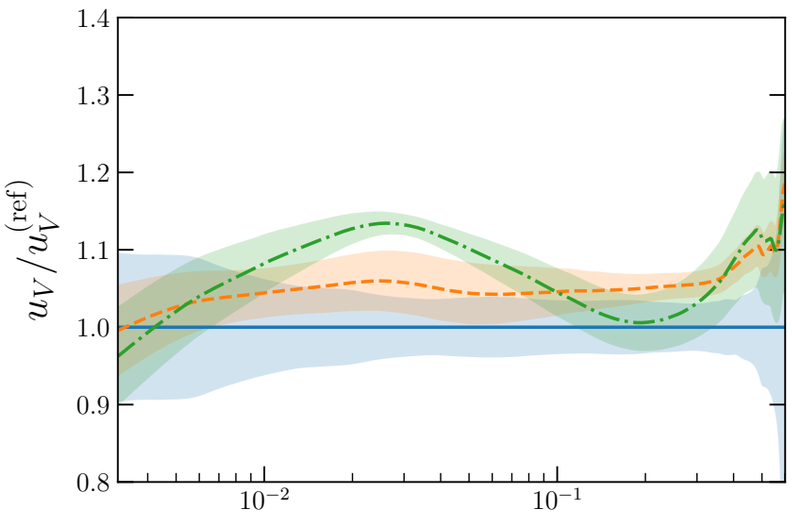
- In the TeV regime x>0.01 and Q~10GeV dominates.



- PDFs disagreement ~5-10% in this region ($F_3 \sim u_v/d_v$ and $F_2 \sim \sum$).







Conclusions

- FPF offer a unique opportunity to measure neutrino interaction in the TeV regime.
- Different formalisms are available to explore neutrino cross sections in this range.
- Several aspects still unclear.
  - A single model can not describe DIS from few GeV to PeV energies.
  - Effect of nucleon and nuclear PDFs.
  - Parton showers using >LO formalism.

Acknowledgements

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 101025085.