

8th Forward Physics Facility Meeting

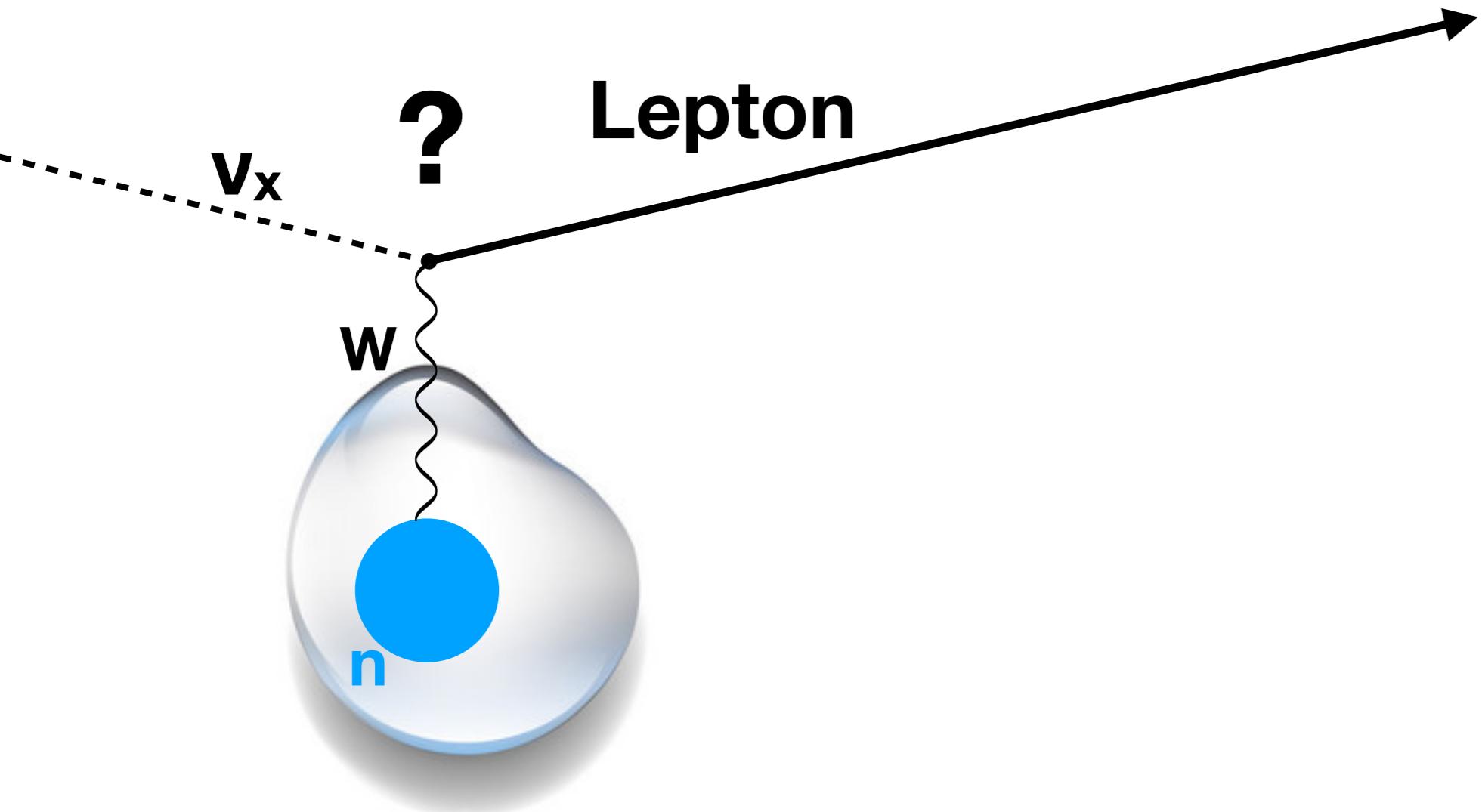
Status of neutrino interactions with GENIE



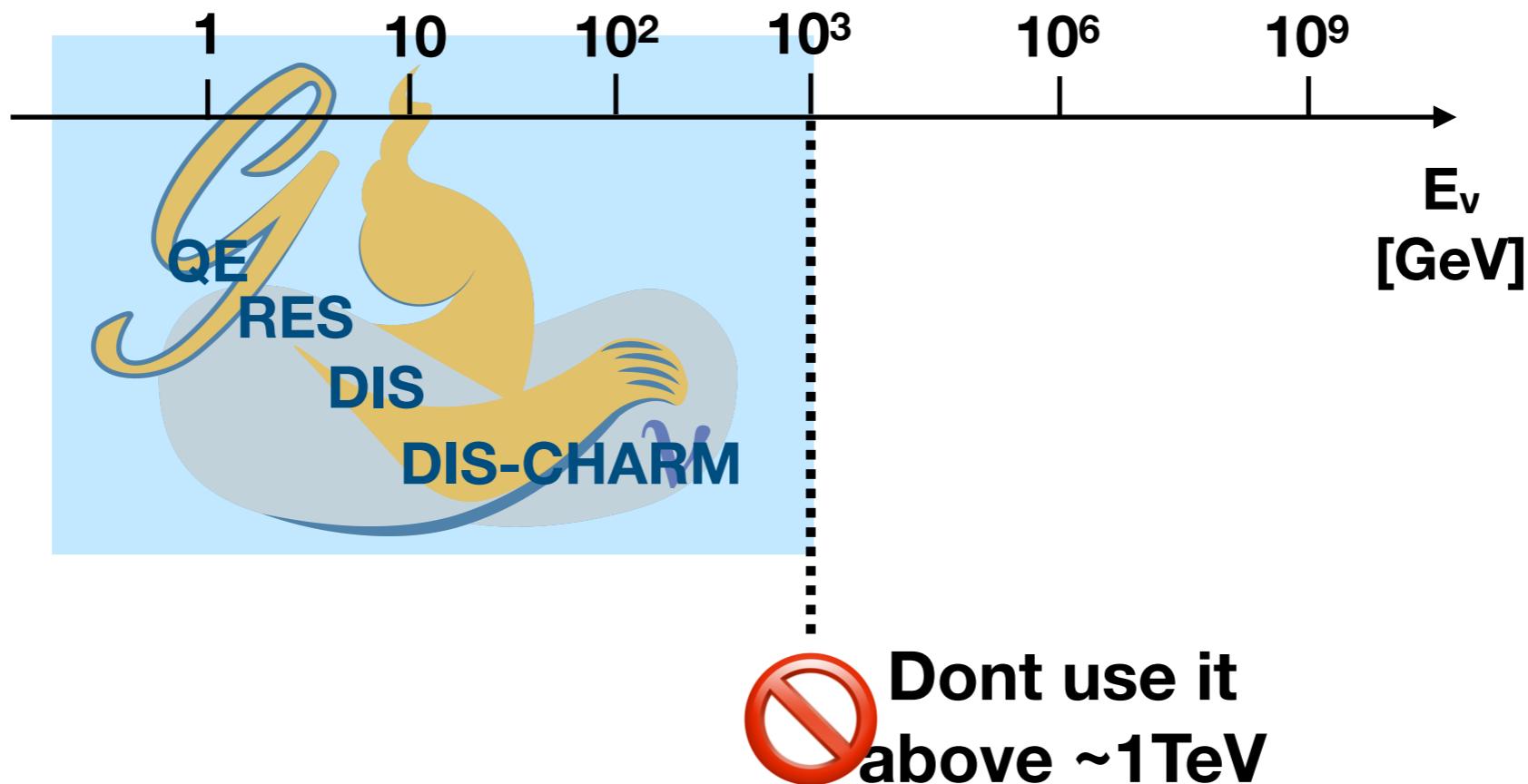
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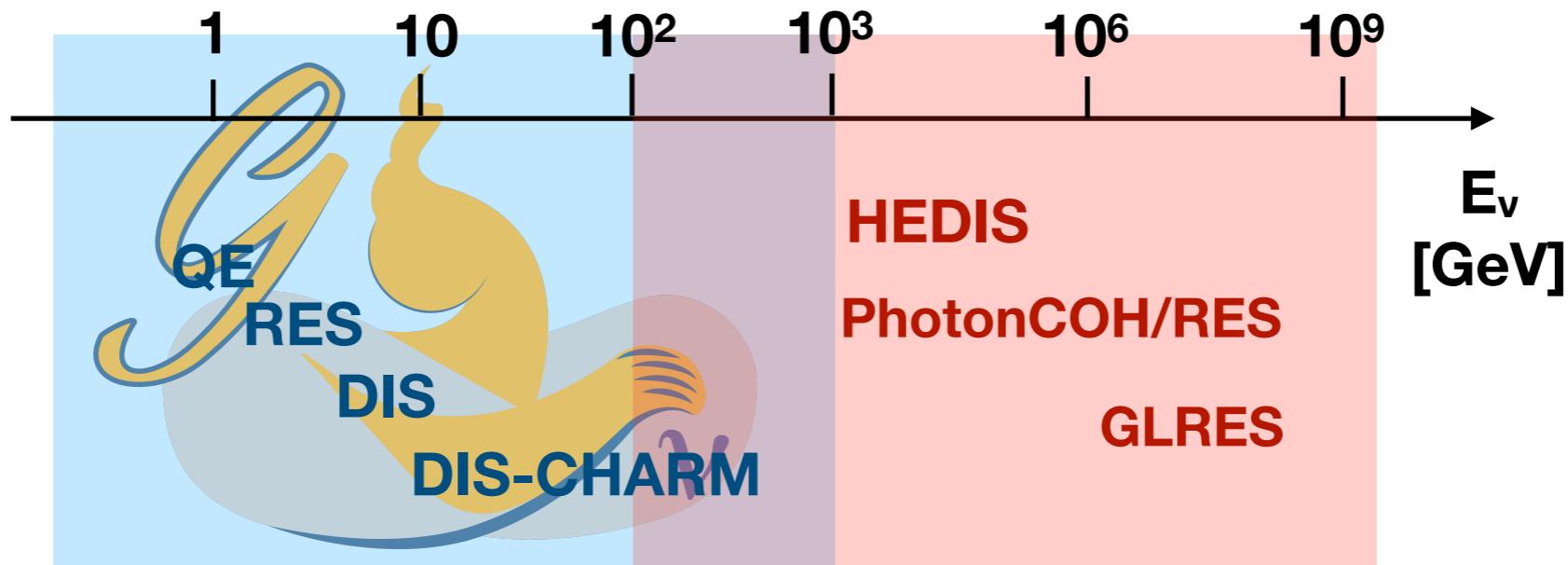
Lepton level



- Current status of GENIE in the high energy regime:
 - DIS based on Bodek-Yang model -> optimised for low Q^2 .
 - Structure Function = $C_{ij} \text{ LO} \otimes \text{PDF LO}$ (GRV98 $Q^2[0.8, 2 \cdot 10^6]$).
 - Contributions from heavy quarks are not included.



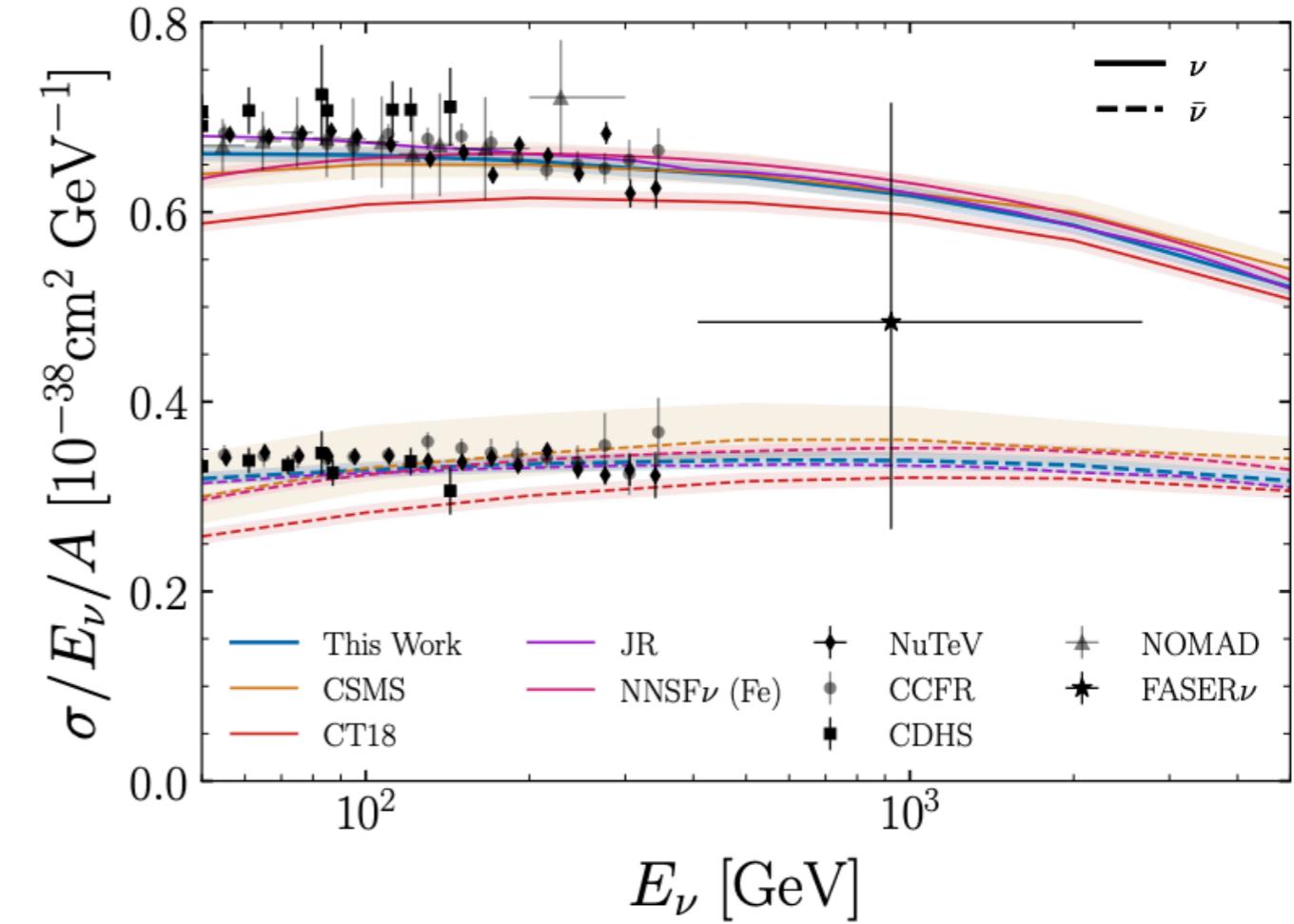
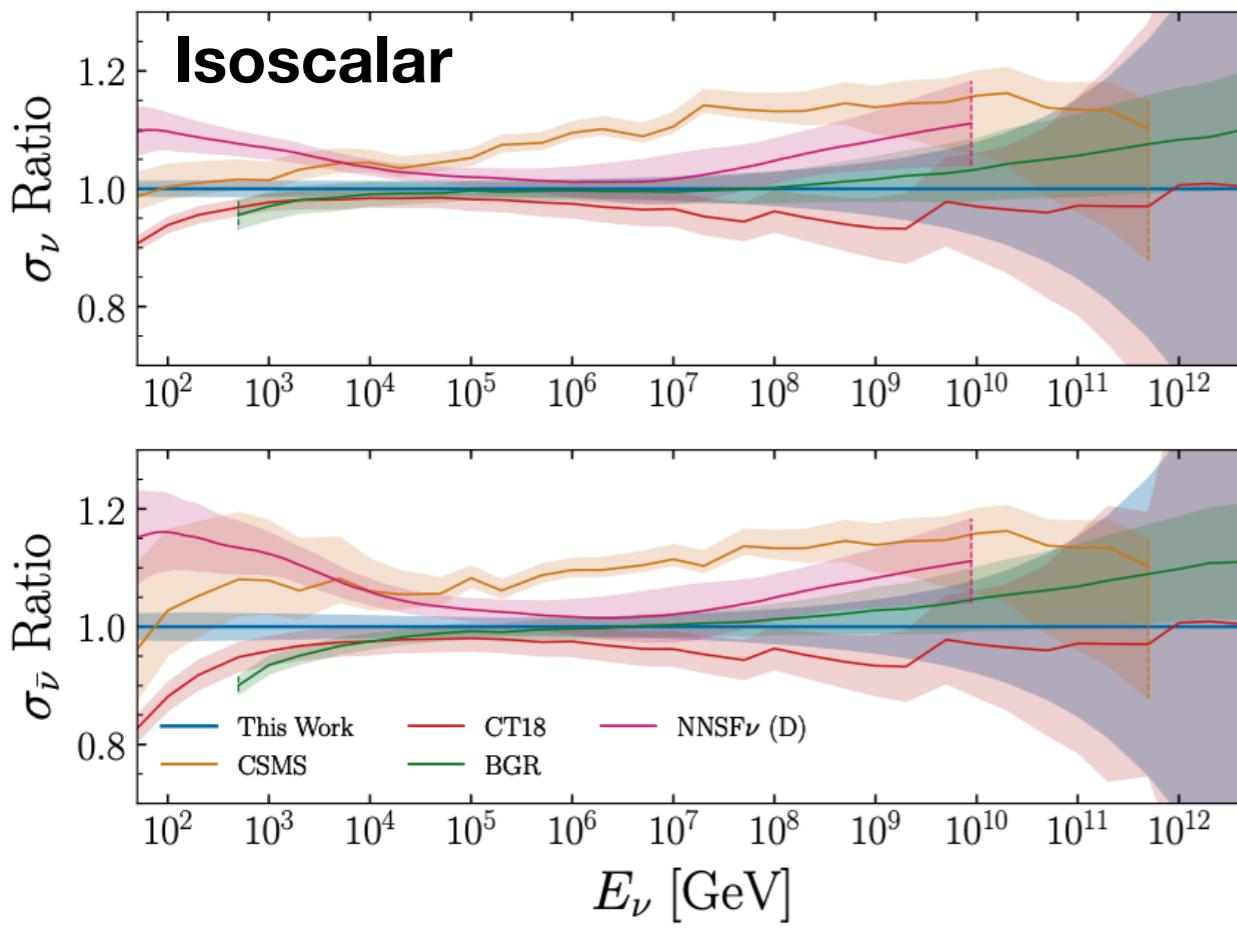
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- New extension allows UHE interaction -> HEDIS
 - Newer PDFs with broader Q^2 phase space.
 - Structure Functions = $C_{ij} \text{ NLO} \otimes \text{PDF NLO}$.
 - Account for the heavy quark contributions.

Total cross sections

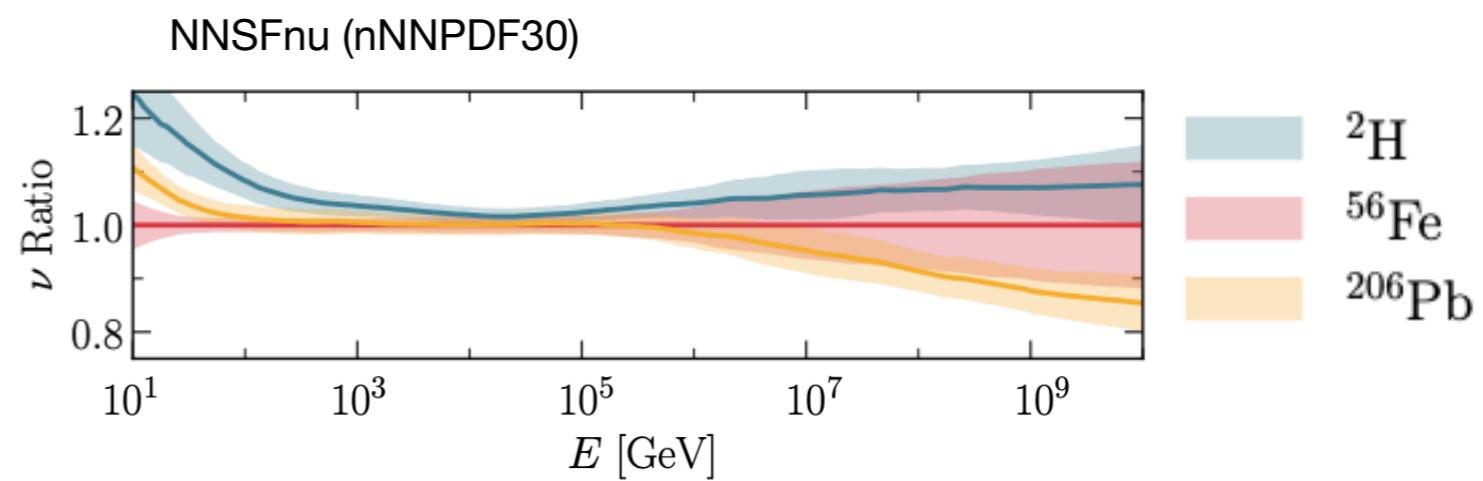
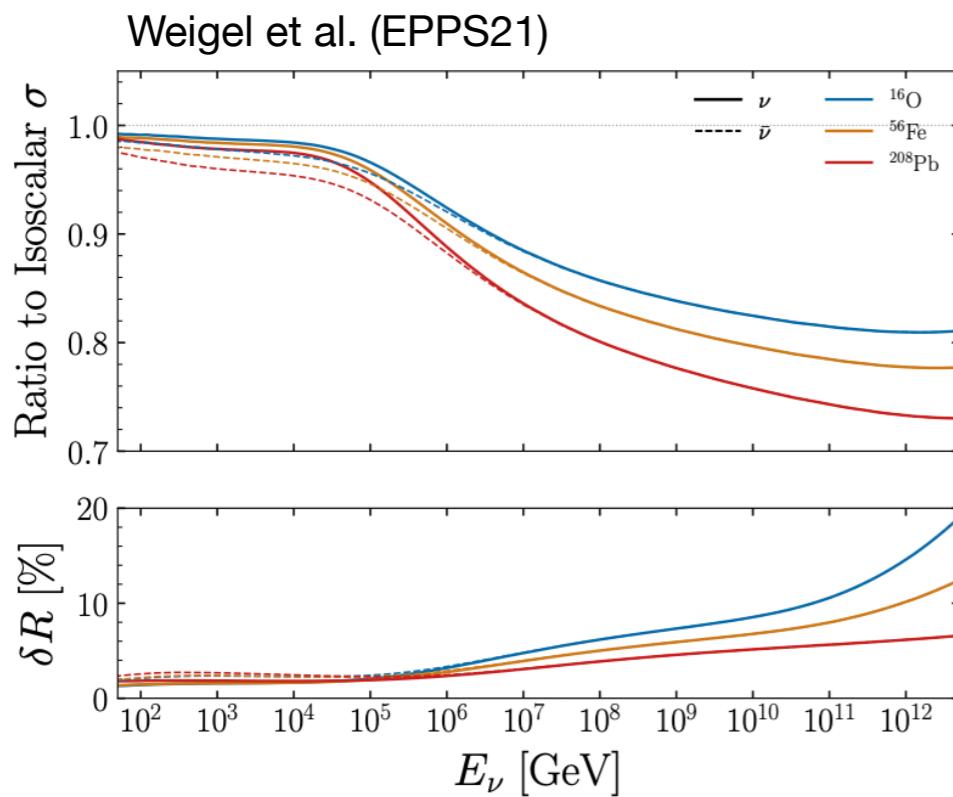
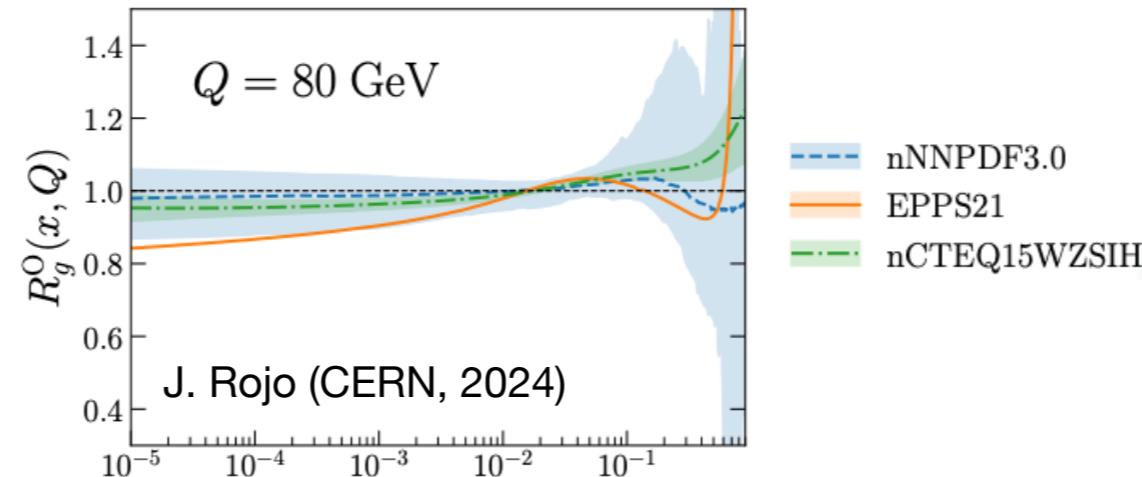
- Main points:
 - Treatment of top quark production impacts the TeV-PeV regime.
 - NNSF ν in Deuterium shows enhancement at $E < 100\text{GeV}$.
 - Low Q₂ contributions relevant at $E < 1\text{TeV}$.



Weigel et al. (2024)

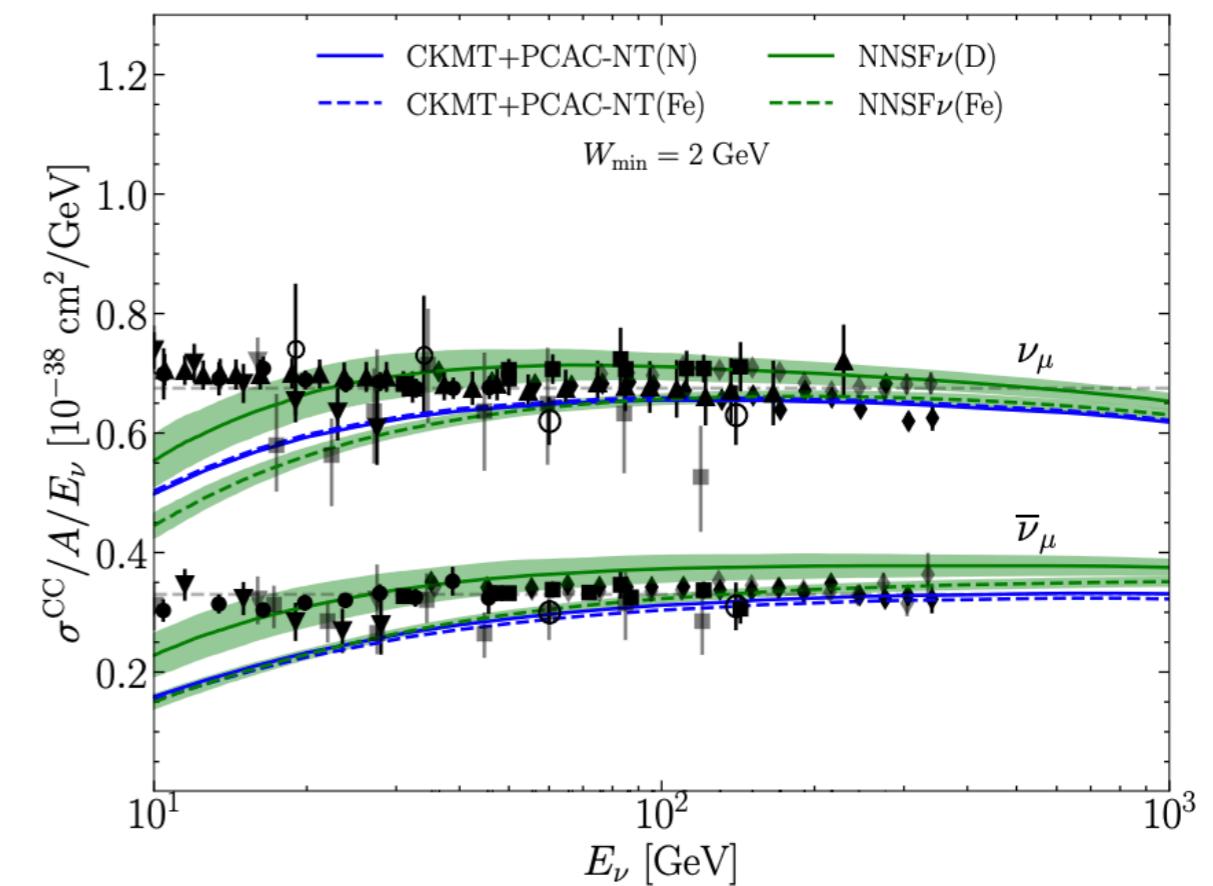
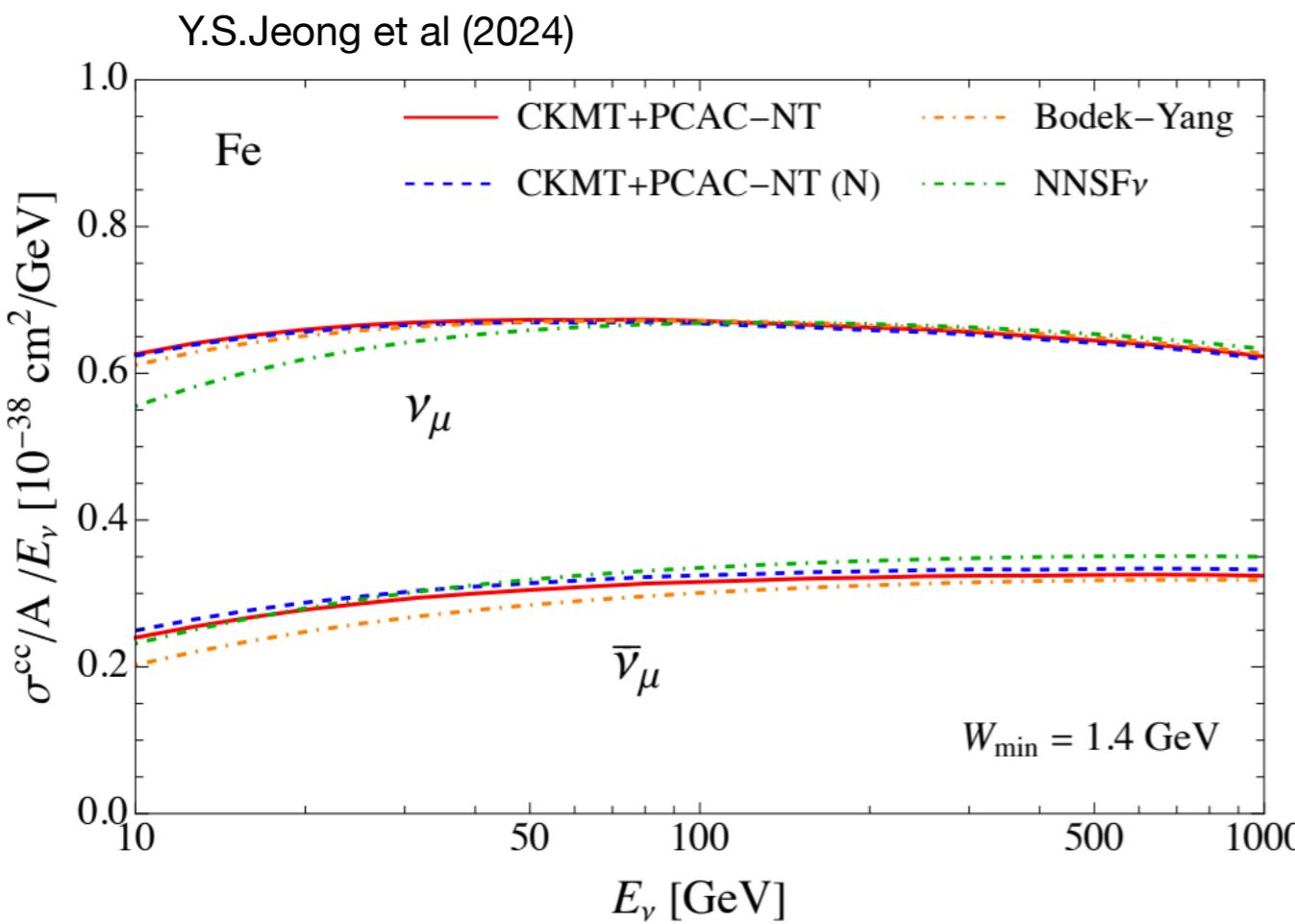
From nucleons to nuclei

- Nuclear effects through nPDFs:
 - Different behavior of high- Q^2 region depending on the PDF set.



Other corrections

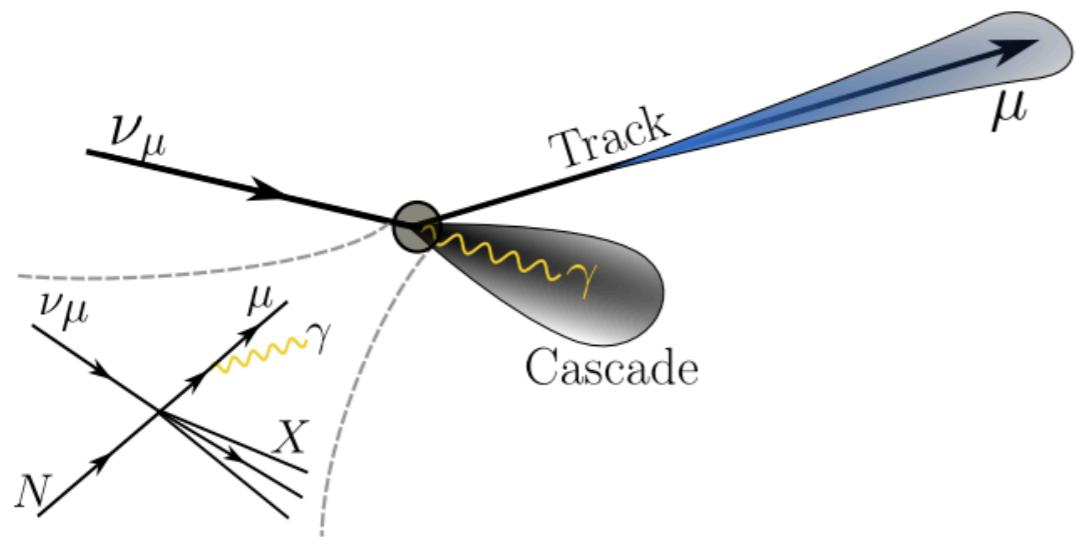
- Low-Q₂ modifications:
 - Different approaches: NNSFnu, JR, Bodek-Yang.
 - Impact of nuclear effects unclear.



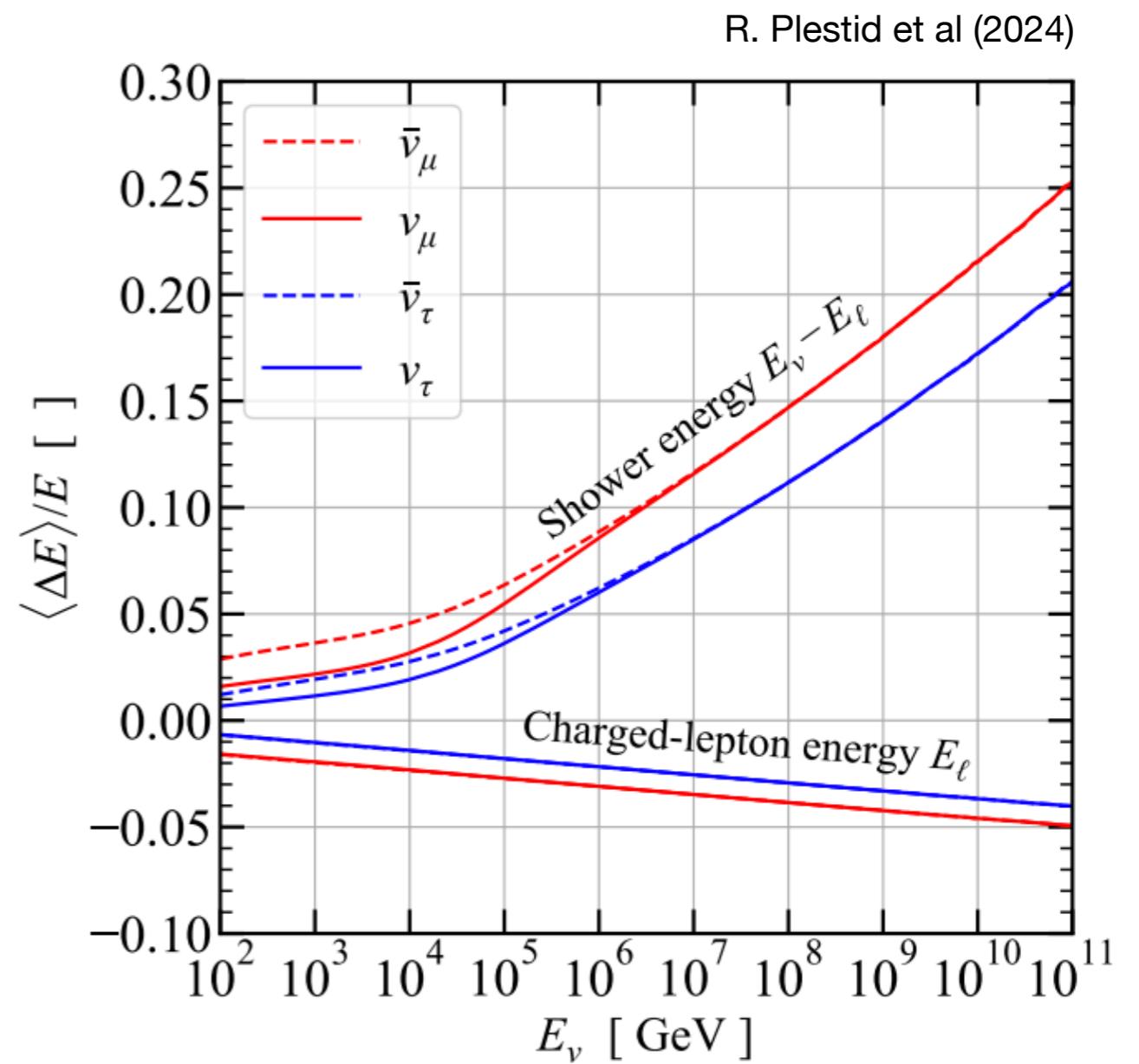
Other corrections

- Final state radiation

- Flavor and nu/nubar dependent.
- 1-3% shift in the outgoing energy of charged lepton in the TeV regime.

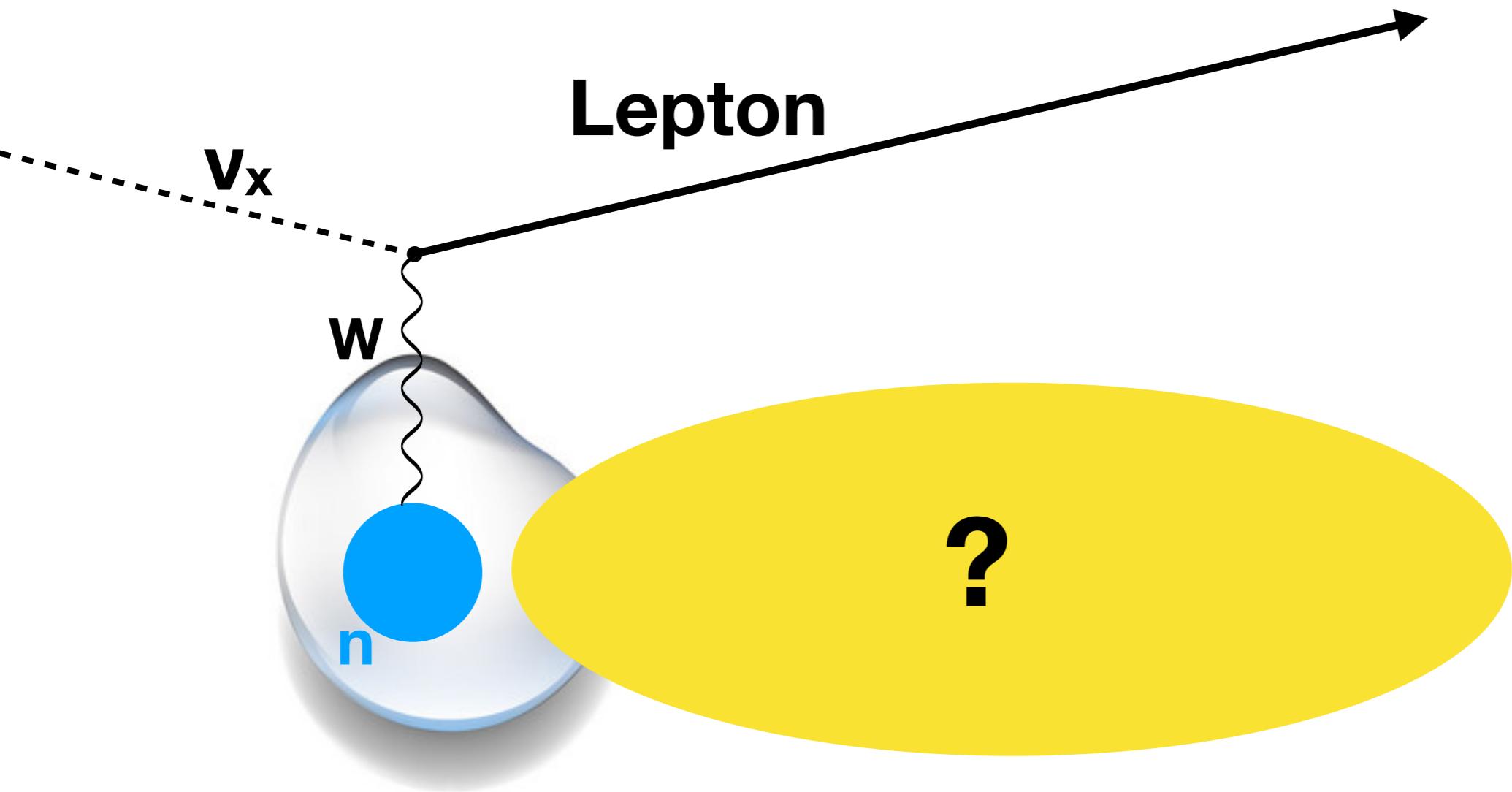


$$\frac{d\sigma^{(1)}}{dE_\ell} = \frac{\alpha}{2\pi} \int dy \int dz \frac{d\sigma^{(0)}}{dy} \delta(E_\ell - (1-y)zE_\nu) \times \log\left(\frac{s}{m_\ell^2}\right) \left[\frac{1+z^2}{[1-z]_+} + \frac{3}{2}\delta(1-z) \right]$$



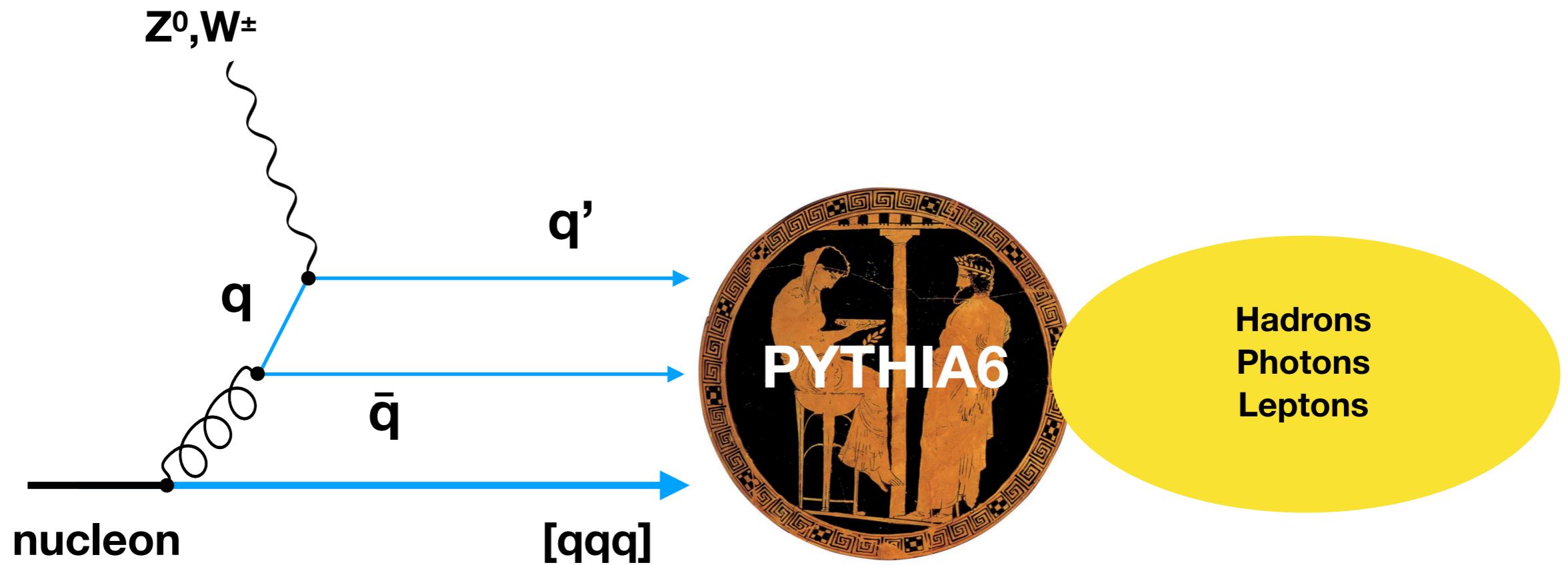
Hadron level

Hadron level



Hadronization-Genie

- Quark combination input to PYTHIA6.

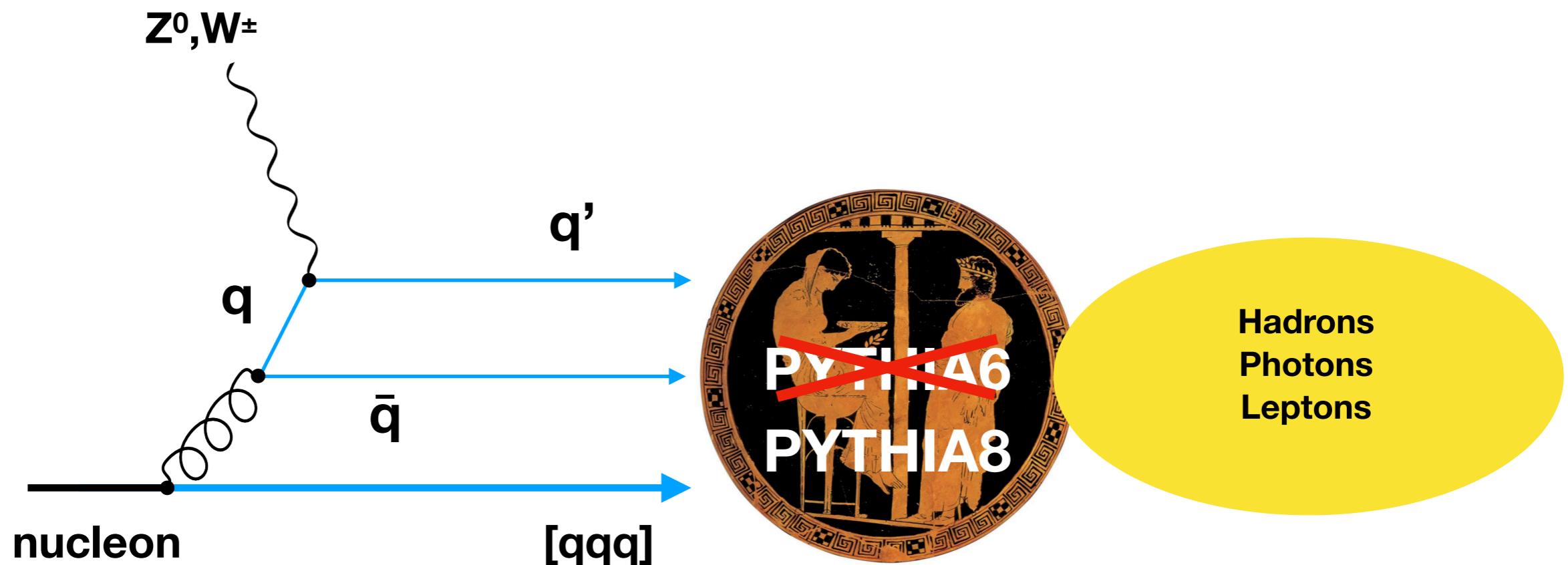


Hadronization-Genie

Since tagged version R-3_06_00

- Quark combination input to ~~PYTHIA6~~.

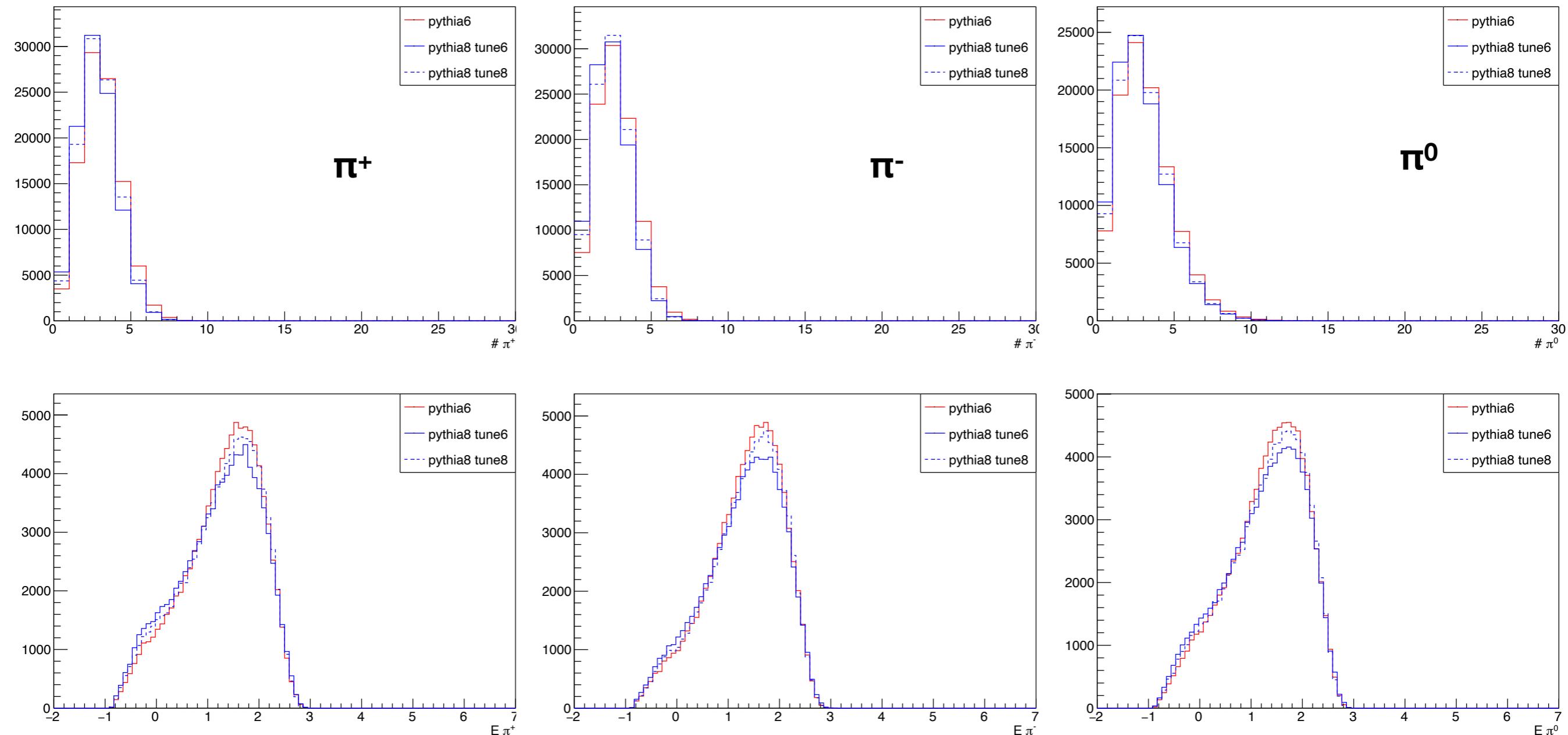
PYTHIA8



First tests

- First look into multiplicities and kinematics using PYTHIA8 with HEDIS.

100k NC (hitting s quark) interactions at 1 TeV



Conclusions

- FPF offers a unique opportunity for neutrino cross section measurements.
- Multiple effects can be tested with these detectors.
- Kinematics of primary outgoing lepton is well understood.
- Promising prospects for more precise treatment of hadronization.