First CENF-ND-WG2 Meeting

Marco Martini and Federico Sanchez

1. Few words about the twiki page

2. Open discussion about the WG2 actions

The CENF-NDWG2 twiki page

https://twiki.cern.ch/twiki/bin/view/CENF/NearDetectorWG2

- Each member of the mailing list can edit and modify the page
- Feel free to post material, add link to documents, events, …

WG2: Cross-section (Theory) and generators

Mailing list: CENF-ND-Wg2

members

Conveners

- Marco Martini (CEA, Paris)
- Federico Sanchez (IFAE/BIST, Barcelona)

This working group will focus on the capability of theoretical models and Monte Carlo generators to describe neutrino interactions. Starting from a thorough comparison of existing models with experimental data, the group will foster and participate in the improvement of event generators.

NEW Reminder: **Next CENF-ND general meeting (via vydio) in September**

- In preparation of that meeting, the WGs should auto-organise: define conveners and set regular WG meetings.
- Given the heterogeneity of the membership, and the need to appropriate the existing knowledge, the first meeting could be devoted to summarise, merge and digest the existing studies for the topics of interest of each WG.
- Feel free to post material, add link to documents, events etc in the twiki

↓ Topics
↓ Documentation

Topics

- Review status of theoretical models and neutrino generators vs data, identify areas of development.
- Comparisons with electron scattering data if available in the generators.
- Generate a test database with available data.
- Stimulate new/complementary experimental programs where needed.
- Address in detail the electron-muon and neutrino-antineutrino differences, extrapolate achievable precision.
- Lattice calculation of form factors.
- Breemstrahlung correction for electron neutrino interactions.
- Active promotion of the field inside the nuclear physics community in Europe.

We will discuss these points later…

Documentation

Recent review papers

- NuSTEC White Paper: Status and Challenges of Neutrino-Nucleus Scattering, L. Alvarez-Ruso et al.
- Neutrino-Nucleus Cross Sections for Oscillation Experiments, T. Katori, M. Martini
- Neutrino Interactions with Nucleons and Nuclei: Importance for Long-Baseline Experiments, U. Mosel
- Neutrino-nucleus interactions and the determination of oscillation parameters, O. Benhar, P. Huber, C. Mariani, D. Meloni
- Recent Advances and Open Questions in Neutrino-induced Quasi-elastic Scattering and Single Photon Production, G. T. Garvey et al.
- Progress and open questions in the physics of neutrino cross sections, L. Alvarez-Ruso, Y. Hayato, J. Nieves

Recent review talks

- Present status of neutrino cross sections, L. Alvarez-Ruso, EPS-HEP 2017
- Theory of Neutrino Cross Sections, J. Nieves, Neutrino Telescopes 2017
- Status and challenges of neutrino cross-sections, M. Martini, NuPhys2016, arXiv:1704.08903
- Neutrino-Interactions with nuclei and Long Baseline Experiments, U. Mosel, ICHEP 2016, PoS ICHEP2016 (2016) 504
- Theoretical challenges in neutrino scattering studies, J. Nieves, Neutrino 2016
- Review of progress in measurements of neutrino-nucleus scattering, K. Mahn, Neutrino 2016
- Future experimental programme for neutrino cross sections, S. Bolognesi, Neutrino 2016
- The physics of neutrino cross sections: theoretical studies, L. Alvarez-Ruso, NuPhys2015, arXiv:1605.04861
- Cross Sections - current status, F. Sanchez, NuPhys2015
- Theoretical models of neutrino-nucleus cross sections, M. Martini, EPS-HEP 2015, PoS EPS-HEP2015 (2015) 088
- Neutrino Cross Sections: Models, M. Martini, Neutrino Telescopes 2015, PoS NEUTEL2015 (2015) 012
- Theory and Phenomenology of Neutrino Interactions, J. Sobczyk, Neutrino 2014, AIP Conf.Proc. 1666 (2015) 060001
- Review of Neutrino Interactions, F. Sanchez, Neutrino 2014, AIP Conf.Proc. 1666 (2015) 060003

Conferences and workshops

- NuFact 2017
- NuInt 2017
- IPPP/NuSTEC topical meeting on neutrino-nucleus scattering
- INT Seattle Workshop 2016: Theoretical Developments in Neutrino-Nucleus Scattering
- NuFact 2016

Inverse chronological order

Comparison theory-experiment

- CCQE, CCQE-like and CC0pi
  - MiniBooNE (neutrino and antineutrino): Martini, M. et al. Phys.Rev. C80 (2009) 065501; Nieves, J. et al. Phys.Rev. C83 (2011) 045501; Bodek, A. et al. Eur.Phys.J. C71 (2011) 1726; Martini, M. et al. Phys.Rev. C84 (2011) 055502; Nieves, J. et al. Phys.Lett. B707 (2012) 72-75; Nieves, J. et al. Phys.Lett. B721 (2013) 90-93; Martini, M. et al. Phys.Rev. C87 (2013) 065501; Gallmeister, K. et al. Phys.Rev. C94 (2016) 035502; Pandey, V. et al. Phys.Rev. C94 (2016),054609; Megias, G.D. et al. Phys.Rev. D94 (2016), 093004
  - MINERvA (neutrino and antineutrino): Gran, R. et al. Phys.Rev. D88 (2013) 113007; Mosel, U. et al. Phys.Rev. D89 (2014) 093003; Meucci, A. et al. Phys.Rev. D89 (2014) 117301; Megias, G.D. et al. Phys.Rev. D94 (2016), 093004
  - MINERvA (nu_e): Megias, G.D. et al. Phys.Rev. D94 (2016), 093004
  - T2K on carbon: Abe, K. et al. Phys.Rev. D93 (2016) 112012 (comparisons with Martini et al. and Nieves et al. models); Megias, G.D. et al. Phys.Rev. D94 (2016), 093004; Van Cuyck, T. et al. Phys.Rev. C95 (2017) 054611
  - T2K on water: Abe, K. et al. arXiv:1708.06771 (comparisons with Martini et al. and Megias et al. models)
- CC inclusive
  - T2K (nu_mu and nu_e): Martini, M. et al. Phys.Rev. C90 (2014) 025501; Meucci, A. et al. Phys.Rev. D91 (2015) 093004; Martini, M. et al. Phys.Rev. C94 (2016) 015501; Gallmeister, K. et al. Phys.Rev. C94 (2016) 035502; Megias, G.D. et al. Phys.Rev. D94 (2016), 093004; Pandey, V. et al. Phys.Rev. C94 (2016),054609; Van Cuyck, T. et al. Phys.Rev. C95 (2017) 054611

Comparisons with electron scattering data

- Large comparisons: Ankowski, A. et al. Phys.Rev. D91 (2015) 033005; Pandey, V. et al. Phys.Rev. C92 (2015) 024606; Megias, G.D. et al. Phys.Rev. D94 (2016) 013012
- Some comparisons: Gil, A. et al. Nucl.Phys. A627 (1997) 543-598; Leitner, T. et al. Phys.Rev.C79 (2009) 034601; Martini,M. J.Phys.Conf.Ser. 408 (2013) 012041; Rocco, N. et al. Phys.Rev.Lett. 116 (2016) 192501; Lovato, A. et al Phys.Rev.Lett. 117 (2016) 082501; Gallmeister, K. et al. Phys.Rev. C94 (2016) 035502; Van Cuyck, T. et al. Phys.Rev. C94 (2016) 024611; Van Cuyck, T. et al. Phys.Rev. C95 (2017) 054611

Neutrino versus antineutrino

- Martini, M. et al. Phys.Rev. C81 (2010) 045502; Nieves, J. et al. Phys.Lett. B721 (2013) 90-93; Ericson, M. et al. Phys.Rev. C91 (2015) 035501; Gallmeister, K. et al. Phys.Rev. C94 (2016) 035502; Megias, G.D. et al. Phys.Rev. D94 (2016), 093004

Nu_mu versus nu_e

- Day, M. et al. Phys.Rev. D86 (2012) 053003; Akbar, F. et al. Int.J.Mod.Phys. E24 (2015) no.11, 1550079; Martini, M. et al. Phys.Rev. C94 (2016) 015501; Ankowski, A. arXiv:1707.01014

A-dependence and Argon studies

- Martini, M. et al. Phys.Rev. C80 (2009) 065501; Meucci, A. et al. Phys.Rev. D88 (2013) 013006; Gallmeister, K. et al. Phys.Rev. C94 (2016) 035502; Mosel, U. et al.Phys. Rev. C94 (2016) 034610; Amaro, J.E. et al. Phys.Rev. C95 (2017) 065502; Van Dessels, N. arXiv:1704.07817; Akbar, F. arXiv:1708.00321

- Work in progress, many parts to be added (MC papers and links, CC1π,…)
- Feel free to modify
- Philosophy: **not exhaustive but updated** (some example in the next slides)

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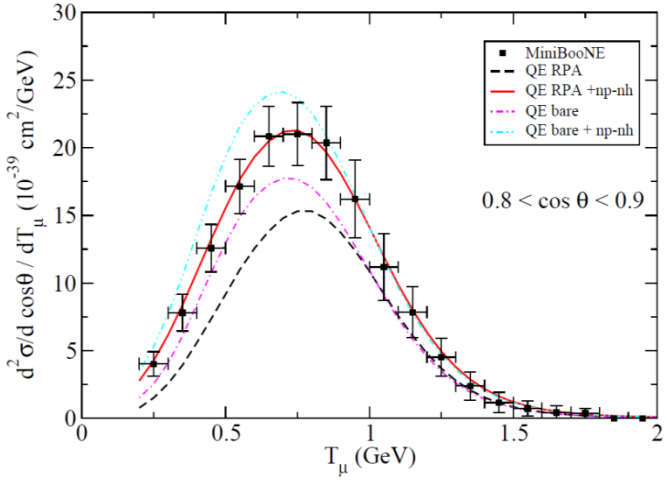
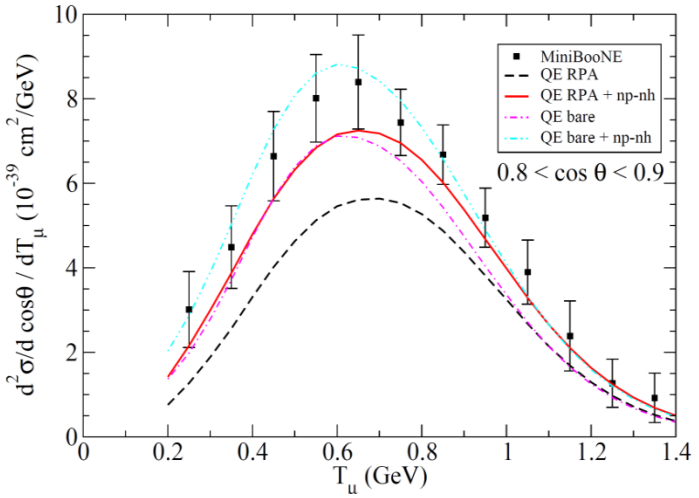
Martini et al.

PRC 84 (2011)





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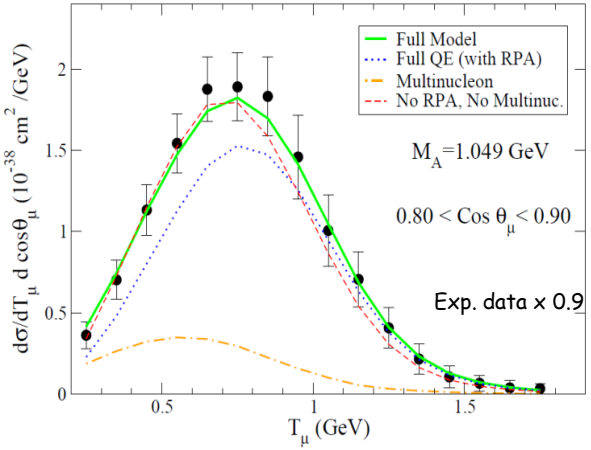
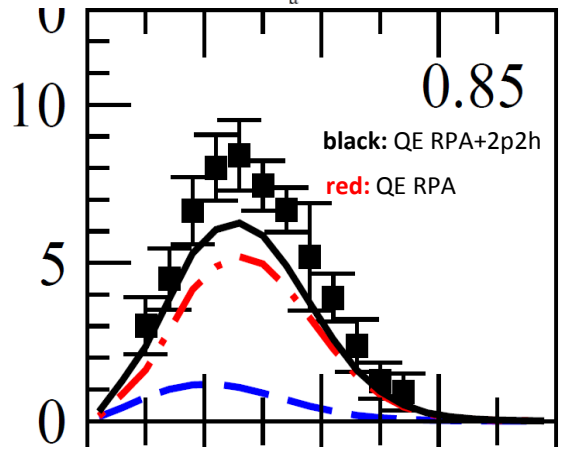
PRC 87 (2013)

Nieves et al.

PLB 707 (2012)

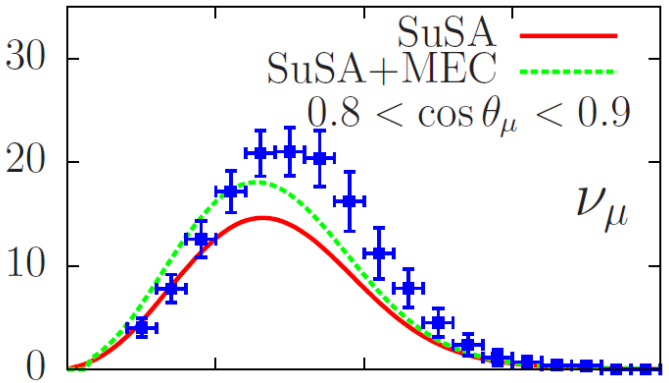


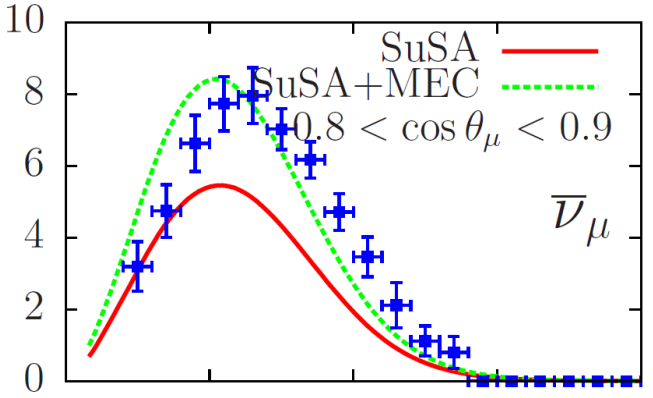


PLB 721 (2013)

Amaro et al.

PLB 696 (2011)





PRL 108 (2012)

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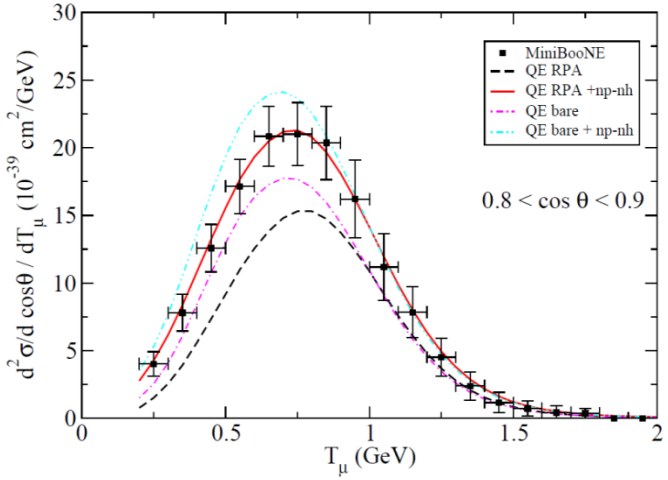
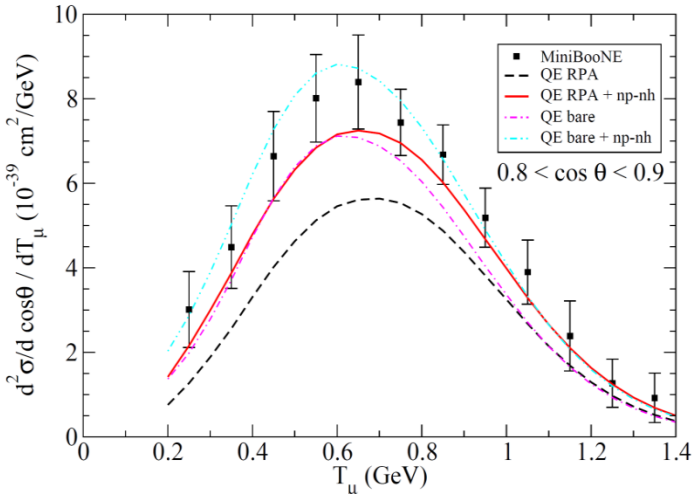
Martini et al.

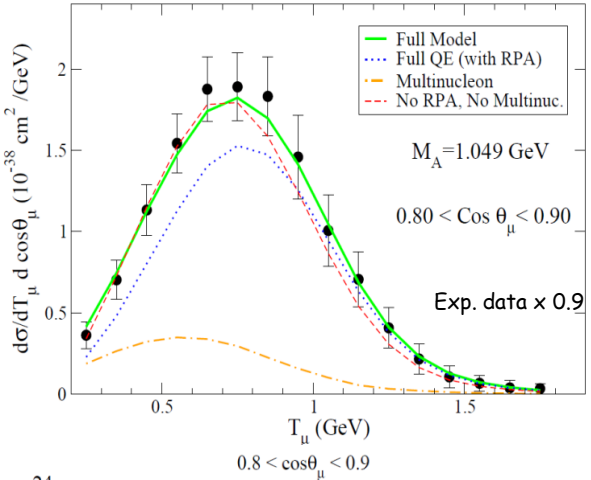


PRC 84 (2011)



PRC 87 (2013)

Nieves et al.



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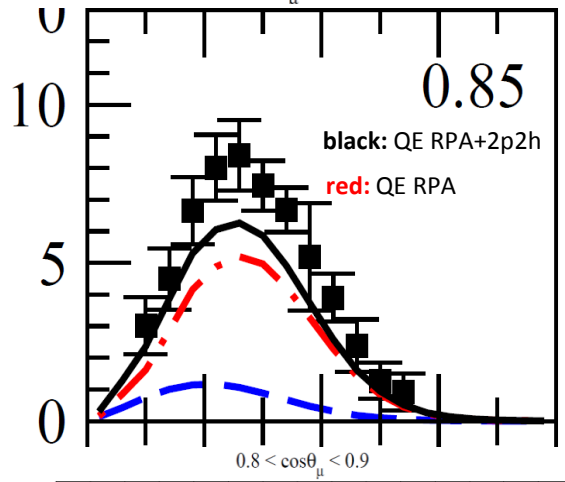
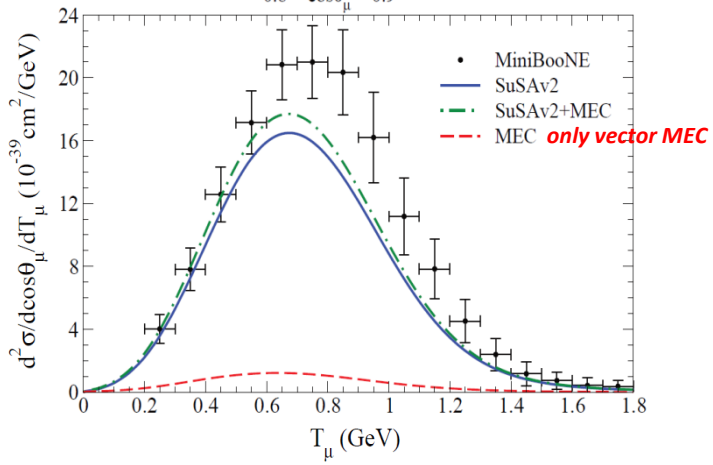
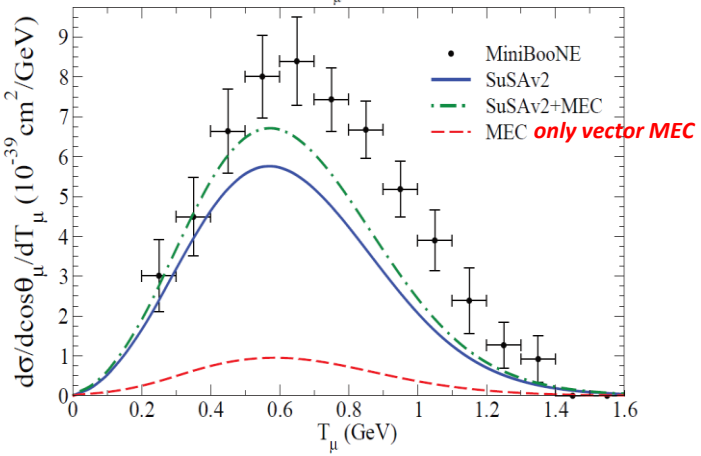


PLB 721 (2013)

Megias et al.



PRD 91 (2015)



PRD 91 (2015)

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Martini et al.

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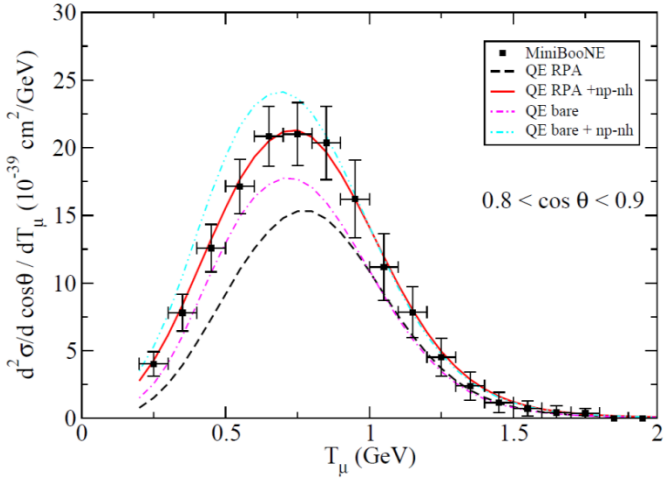

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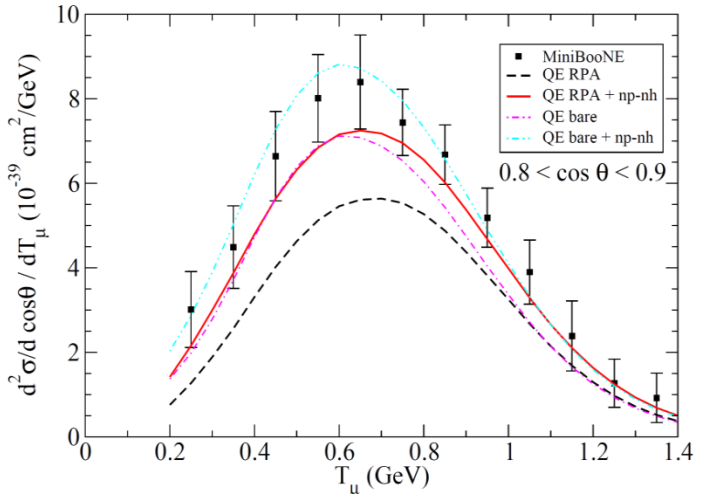
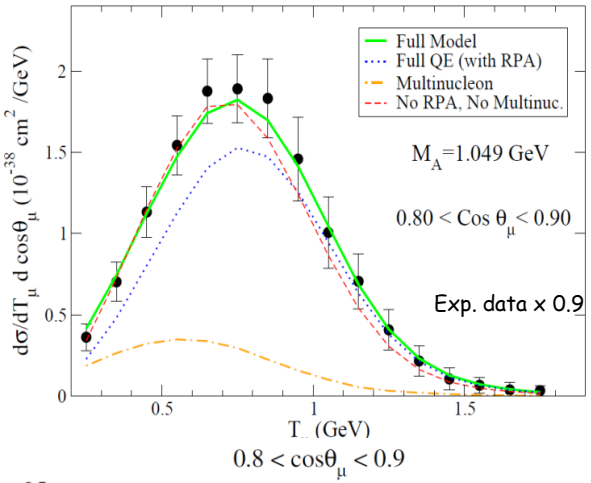
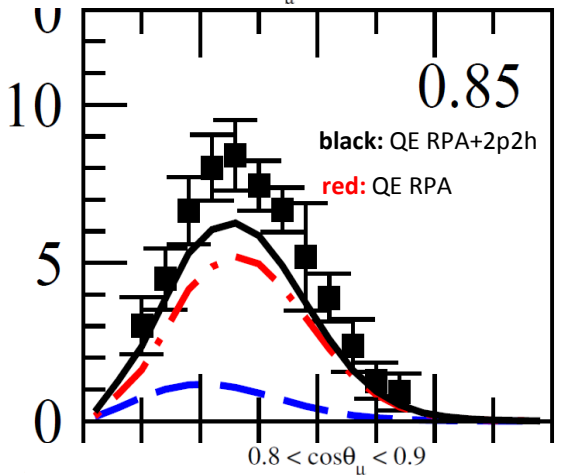


PRC 87 (2013)

Nieves et al.

PLB 707 (2012)



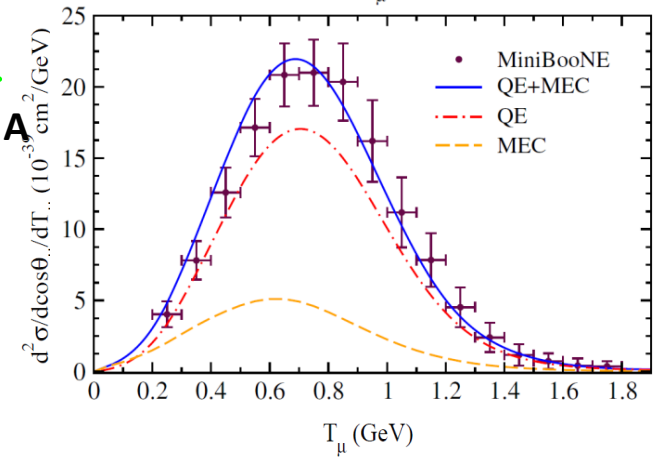


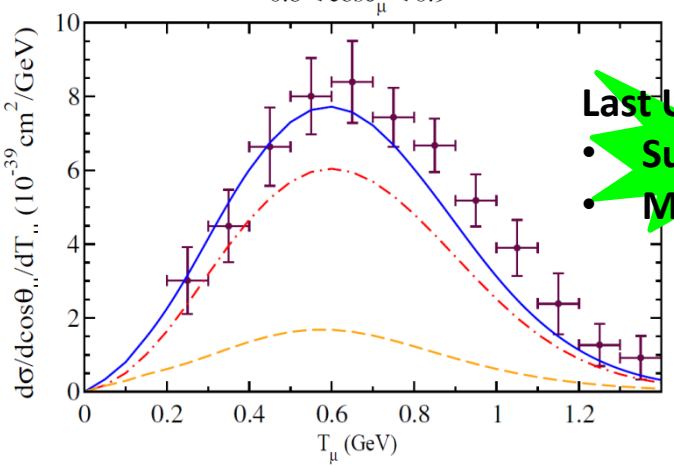
PLB 721 (2013)

Last Update:
- **SuSAv2**
- **MEC V and A**

Megias et al.

PRD 94 (2016)





Last Update:
- **SuSAv2**
- **MEC V and A**

PRD 94 (2016)

Philosophy: not exhaustive but updated

- To summarize the example of the three previous slides:

the papers of Amaro et al. Megias et al. considering SuSA instead of SuSAv2 and vector MEC instead of Vector+Axial MEC are not included in the “Comparison Theory-experiment” neither in “Neutrino versus antineutrino”

- Another example: 2p-2h in GiBUU

the paper in which the 2p-2h response function is deduced from electron scattering data (Gallmeister et al. PRC 94 2016) is preferred to the paper in which 2p-2h are obtained by fitting MiniBooNE CCQE-like data (Lalakulich et al. PRC 86 2012)

Coming back to Topics in order to start the discussion…

Topics

- Review status of theoretical models and neutrino generators vs data, identify areas of development.
- Comparisons with electron scattering data if available in the generators.
- Generate a test database with available data.
- Stimulate new/complementary experimental programs where needed.
- Address in detail the electron-muon and neutrino-antineutrino differences, extrapolate achievable precision.
- Lattice calculation of form factors.
- Breemstrahlung correction for electron neutrino interactions.
- Active promotion of the field inside the nuclear physics community in Europe.

Coming back to Topics in order to start the discussion…

Other points:

- Coordinate the European effort
- Attract new people:
  CERN (high energy) theorists; European (low energy) nuclear structure theorists
- Synergies with NuSTEC
- Organization of topical workshops with the support of CERN.
- Evaluation of potential useful observables to be proposed as future experiments or experimental measurements.
- Stress the impact of the model uncertainties on the oscillation analyses.
  - Strong coordination with the WG in charge of these studies.