# GENIE v3

## Models Comparison

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October 16, 2018

http://www.genie-mc.org/

# GENIE version 3
## Comprehensive Model Configurations(CMC)



- G00_00 series: Historical default configuration.

| G00_00a | G00_00b |
|---|---|
| No MEC | with (empirical) MEC |

- From G00_00 to G18_01 series: adiabatic evolution of old default.

| | G00_00 | G18_01 |
|---|---|---|
| Hadron Transport Model | HAIntranuke/HNIntronuke | HAIntranuke2018/HNIntranuke2018<br>Added diffractive and Lambda production |

- From G18_01 to G18_02 series:

| | G18_01 | G18_02 |
|---|---|---|
| RES | Rein-Sehgal | Berger-Sehgal |
| COH | Rein-Sehgal | Berger-Sehgal |

- From G18_01 to G18_10 series: theory driven configuration.

| | G18_01 | G18_10 |
|---|---|---|
| Nuclear Model | FGM BodekRitchie | Local Fermi Gas (LFG) |
| QEL | LwlynSmitch | Nieves |
| 2p2h(CC) | Empirical | Nieves |
| RES | Rein-Sehgal | Berger-Sehgal |

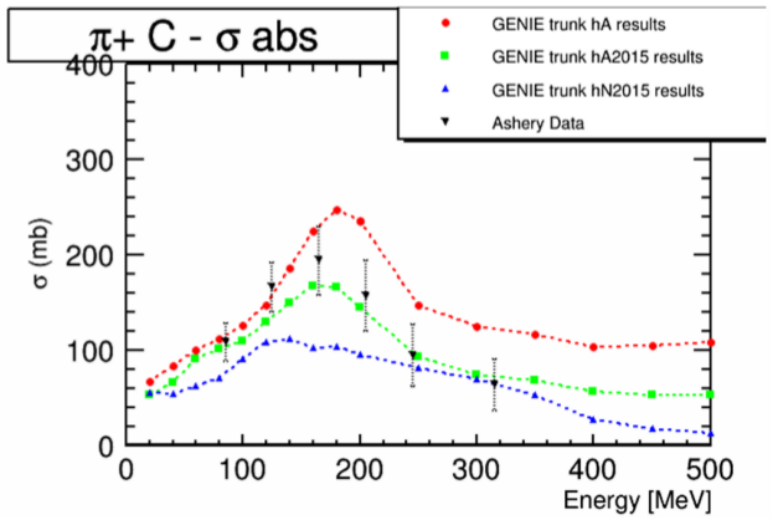
**Note: in all the G18_** series, G18_**a has the hA model; G18_**b has the hN model**

# FSI Strategy



Comparison between hN and hA

| hN2018 | hA2018 |
|---|---|
| Intranuclear Cascade(INC) | data-driven/simplified version |
| with medium correction for $\pi$(Oset), and nucleons(Pandharipande/Pieper) | with medium correction for nucleons |
| Multiple Scattering | models QE peak |
| | fully reweightable |
| less absorption | much absorption |
| too little scattering at low E | |




- The figure on the left shows the pion absorption.
- new hN has much less pion absorption than hA.

# Comparison of different CMCs to experimental data



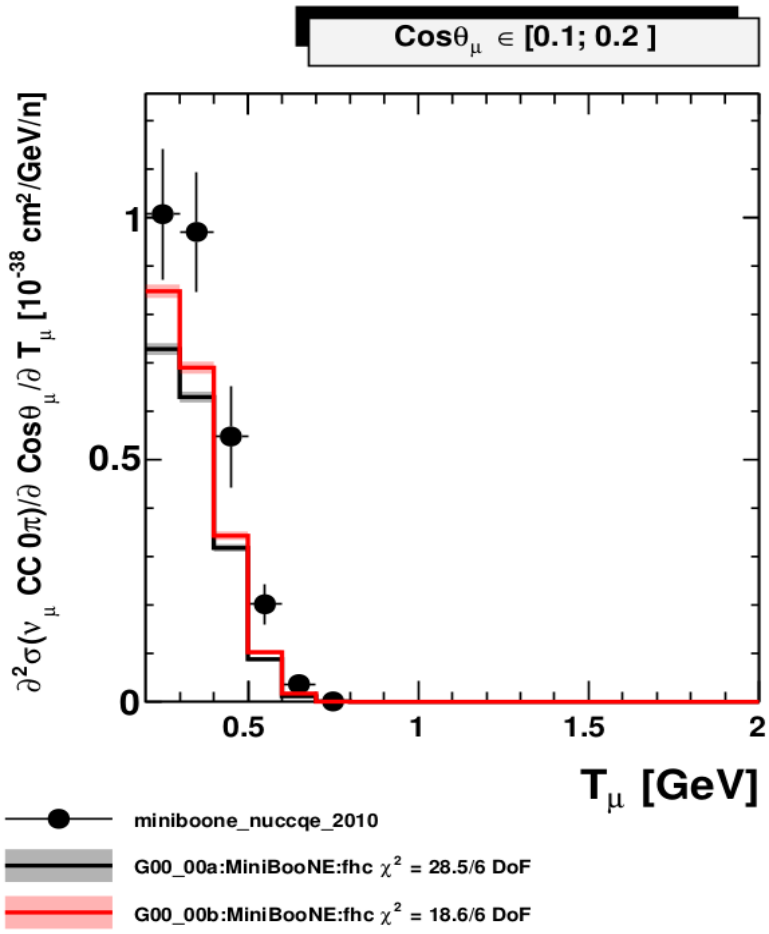
- Experiment data: MINERvA, MiniBooNE
- Experimental datasets: QE-like, Pion Production, Coherent and CC-Inclusive.
- Models to test:

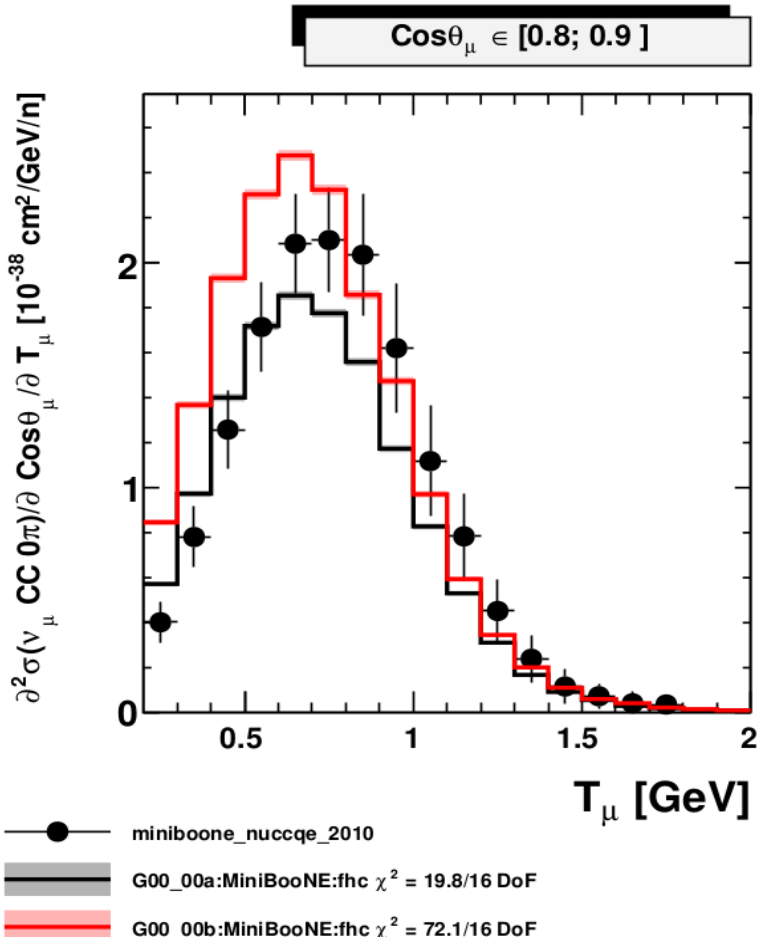
| QE | L-S | Nieves |
|---|---|---|
| | Free nucleon<br>no medium effects | includes Random Phase Approximation(RPA),<br>tuned to MB data<br>in-medium propagator effects<br>and Coulomb effect<br>MEC |
| $\pi$ Production | Rein-Sehgal | Berger-Sehgal |
| | Limit $m_\mu = 0$ | Non-zero $m_\mu$<br>New form factors |
| Coherent $\pi$ | Rein-Sehgal | Berger-Sehgal |
| | uses pion Deuterium<br>experimental result | parameterize the cross section<br>using experimental data |

# GENIE model comparison with MiniBooNE QE-like sample



- Figures below show the comparison between G00_00a(**with MEC**), G00_00b(**without MEC**) and MiniBooNE data.
- More QE-like signal produced with the MEC production.

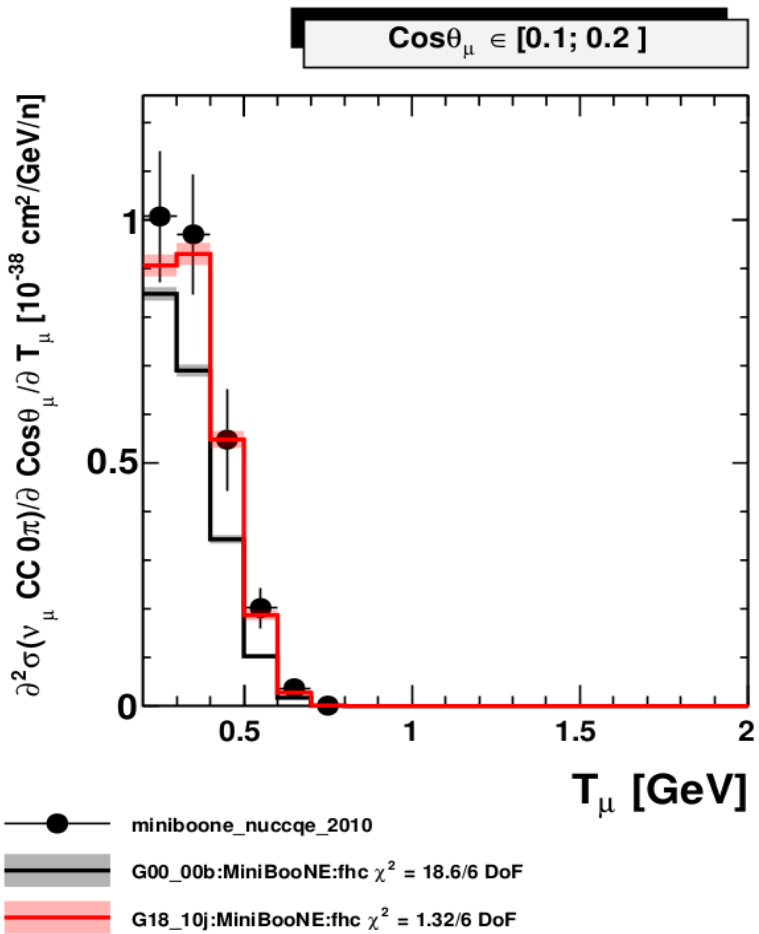


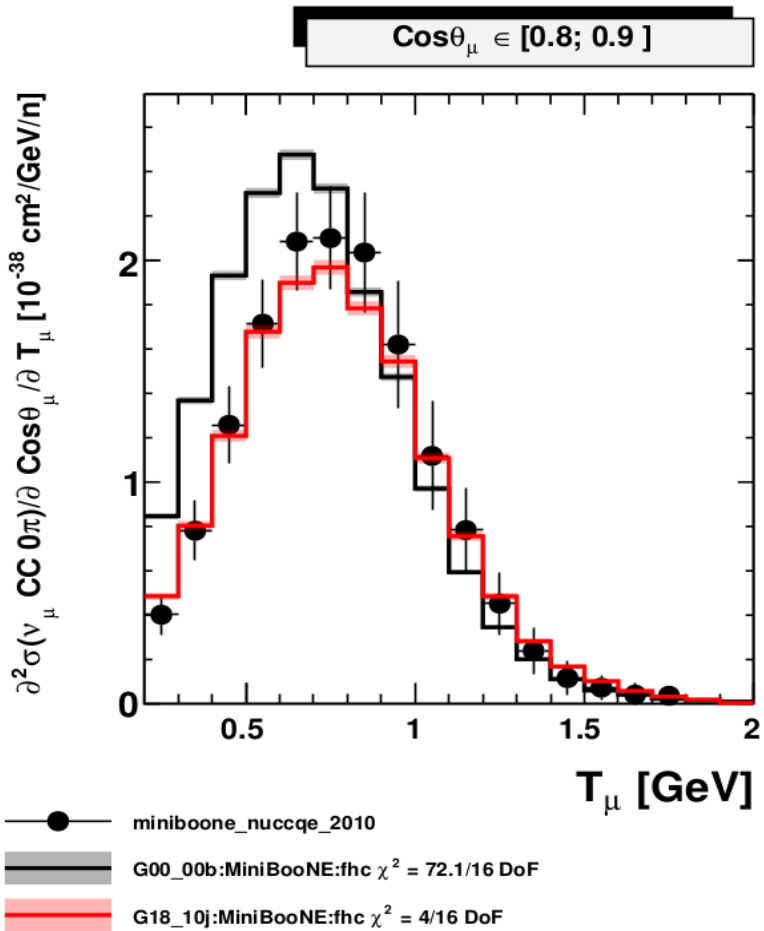



# GENIE model comparison with MiniBooNE QE-like sample



- Figures below show the comparison between G00_00b (**with LS**), G18_10j (**with Nieves model**) and MiniBooNE data;
- With MEC and other corrections, Nieves's result agree with the data much better than LS.

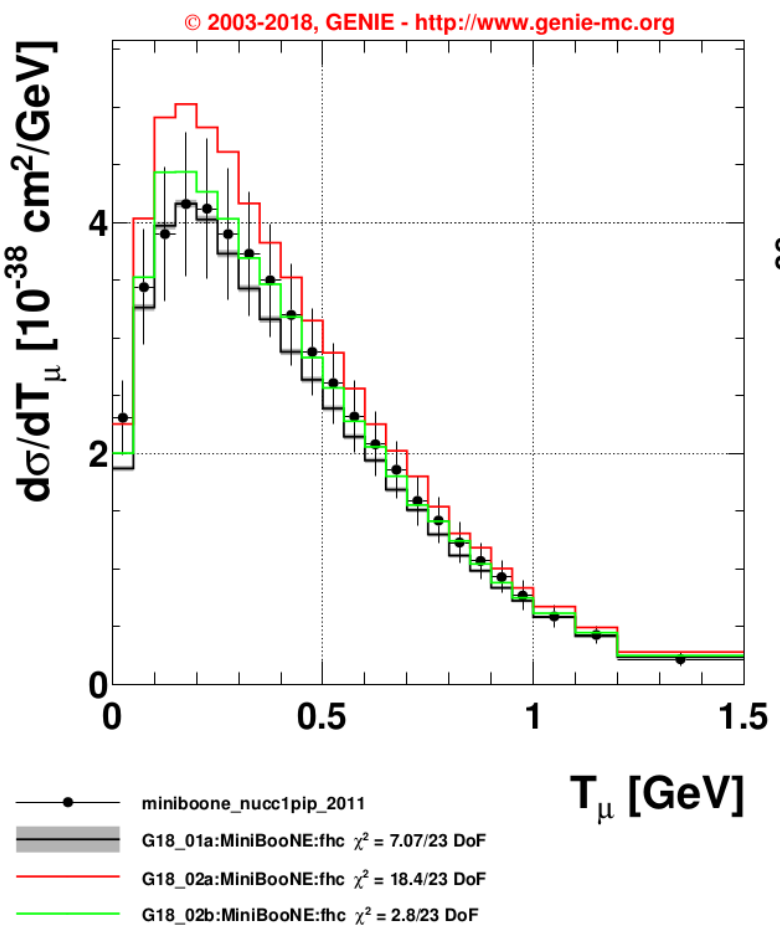


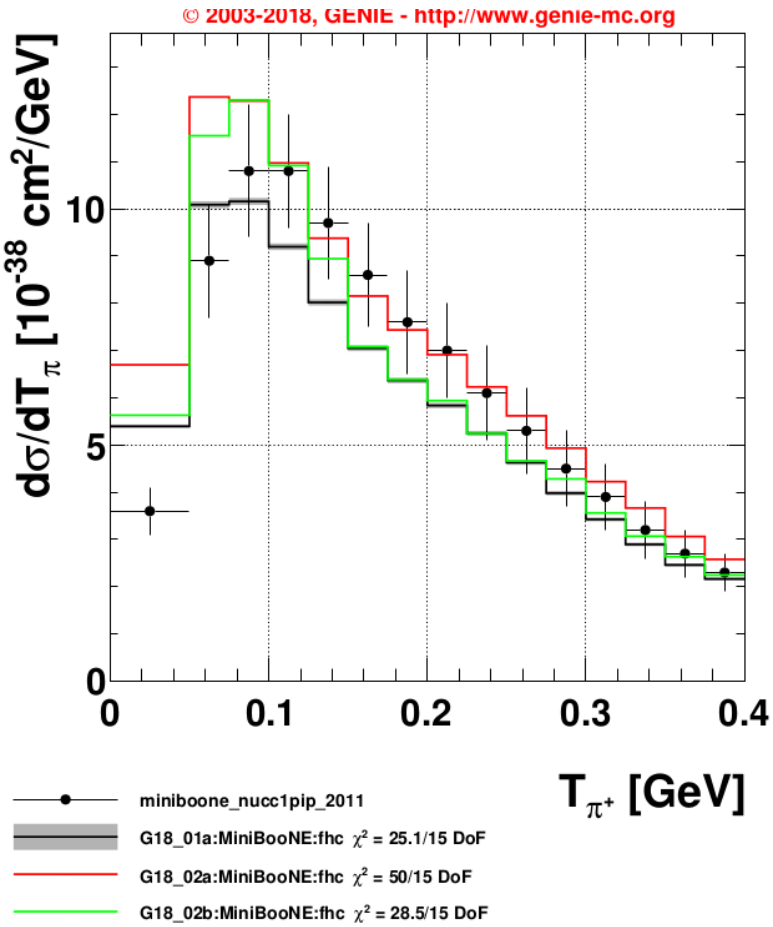



# GENIE model comparison with MiniBooNE CC1$\pi^+$ Sample



- Figures below show the comparison between G18_01a (**Rein-Sehgal**), G18_02a (**Berger-Sehgal+new Form Factors, hA**) and G18_02b (**Berger-Sehgal+new Form Factors, hN**) with MiniBooNE data.
- BS+new form factors improve agreement, new FSI increases cross section again.

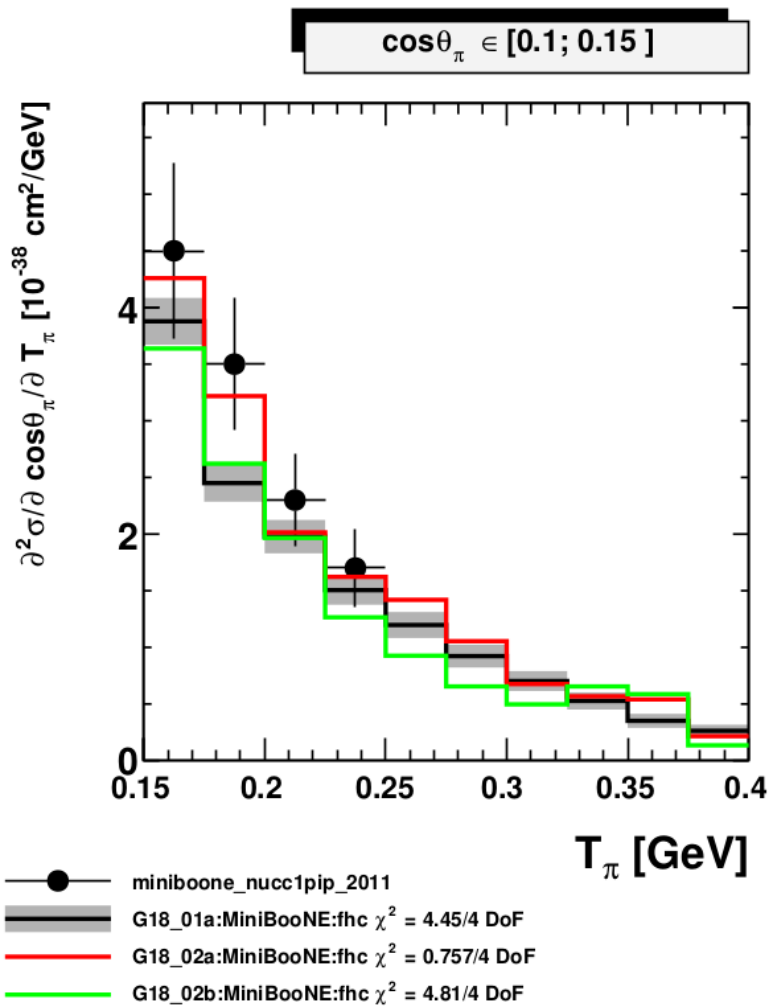


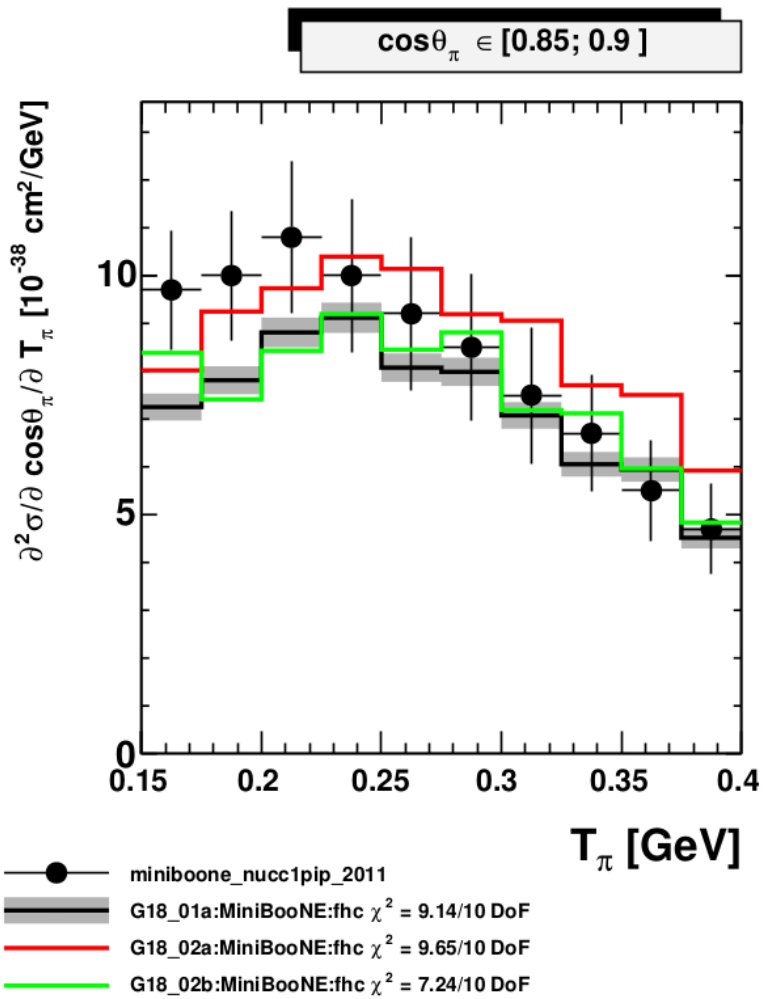



# GENIE model comparison with MiniBooNE CC1$\pi^+$ Sample



- Figures below show the comparison of $T_\mu$ between G18_01a (**Rein-Sehgal**), G18_02a (**Berger-Sehgal+new Form Factors, hA**) and G18_02b (**Berger-Sehgal+new Form Factors, hN**) with Miniboone data in two different $\theta_\mu$ bins
- Changes in model increase magnitude, small changes in shape.



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- Figures below show the comparison of $T_\mu$ between G18_01a (**Rein-Sehgal**), G18_02a (**Berger-Sehgal+new Form Factors, hA**) and G18_02b (**Berger-Sehgal+new Form Factors, hN**) with Miniboone data in two different $\theta_\mu$ bins
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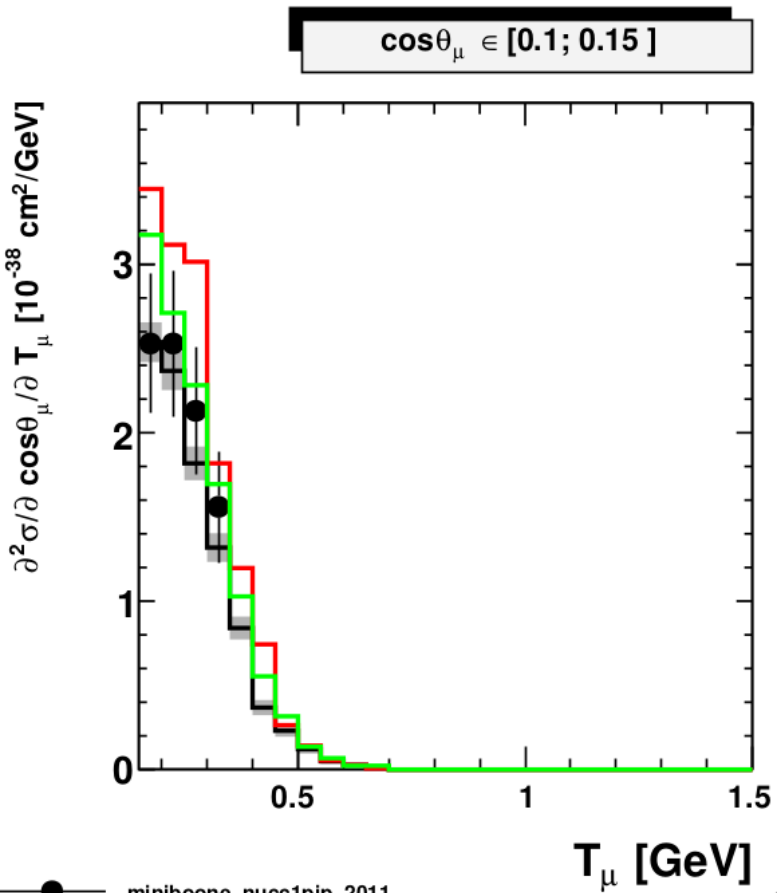
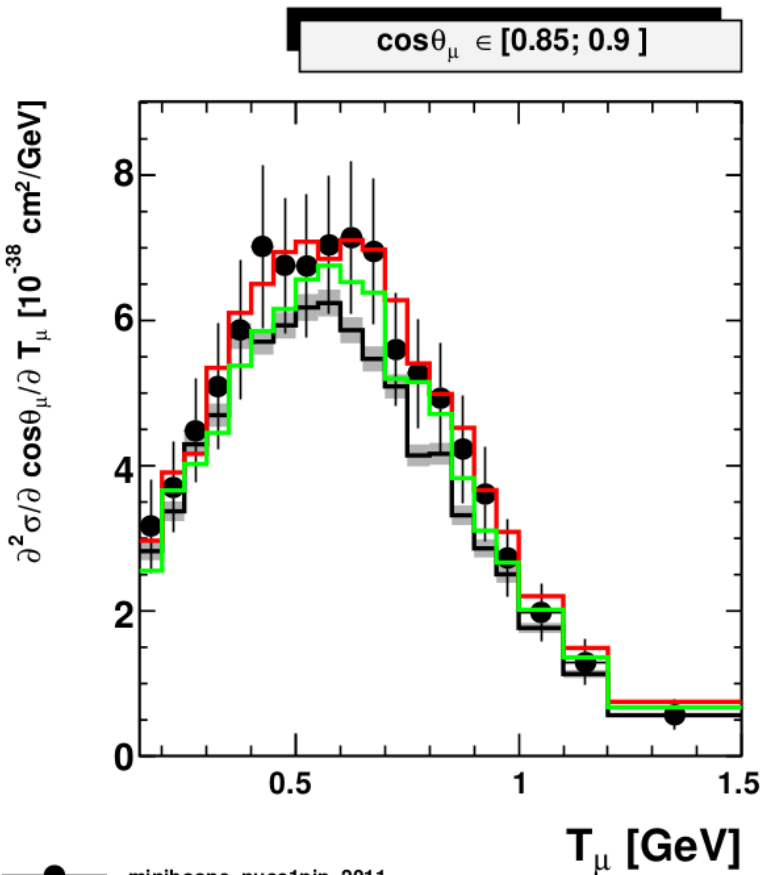
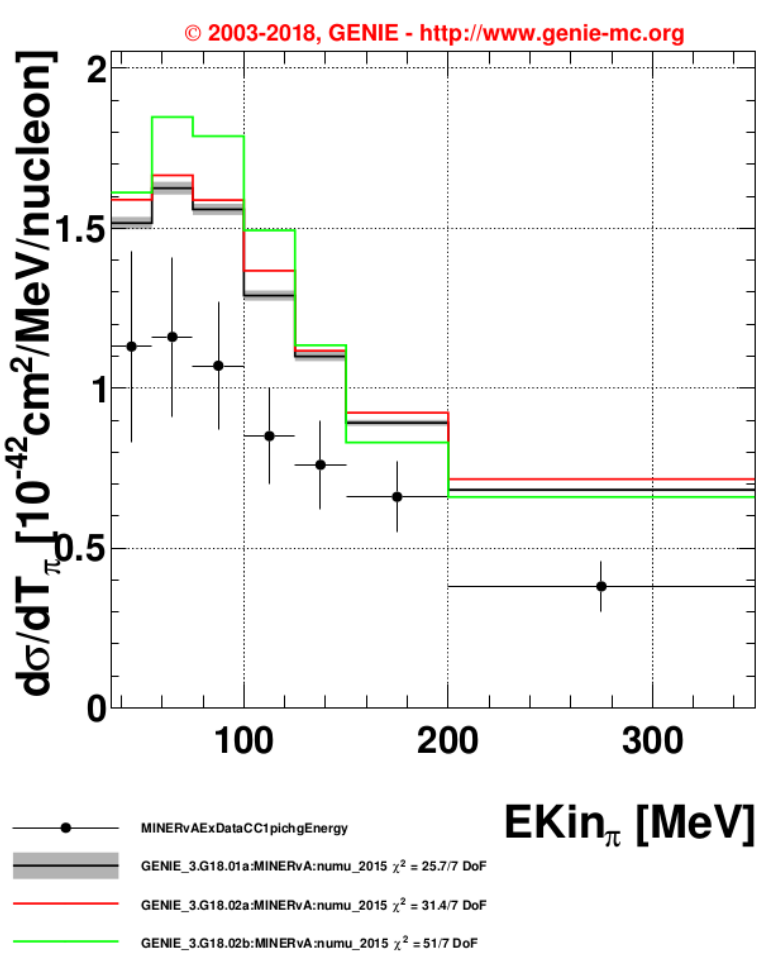


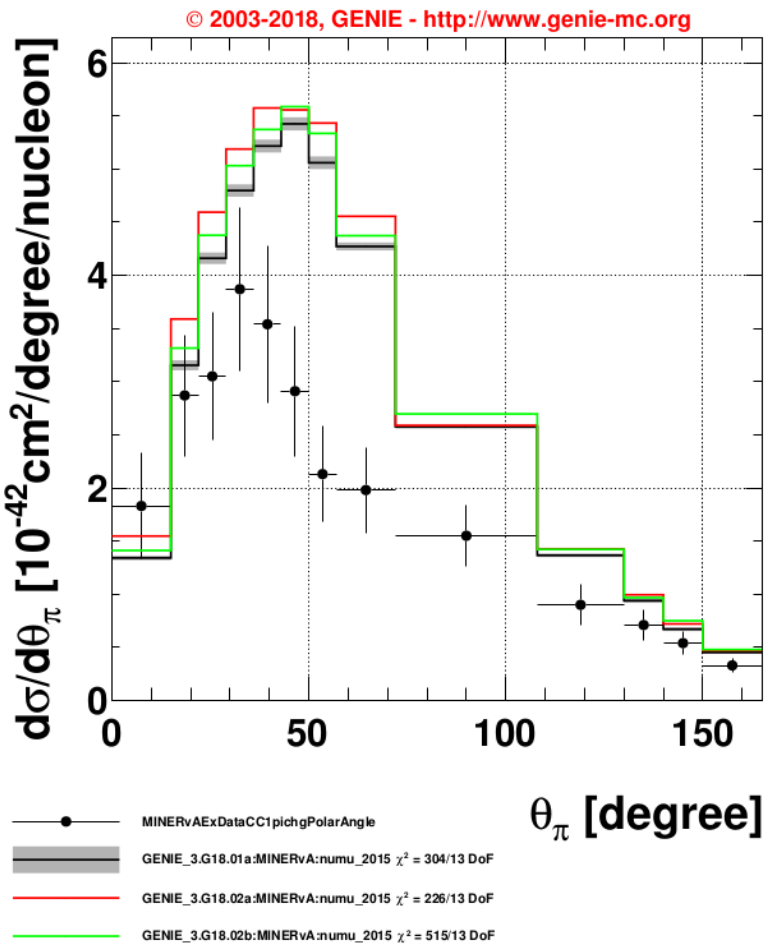



# GENIE model comparison with MINERvA CC1$\pi^+$ Sample



- Figures below show the comparison between G18_01a (**Rein-Sehgal**), G18_02a (**Berger-Sehgal+new Form Factors, hA**) and G18_02b (**Berger-Sehgal+new Form Factors, hN**) with MINERvA data.
- Changes in model increase magnitude, small changes in shape

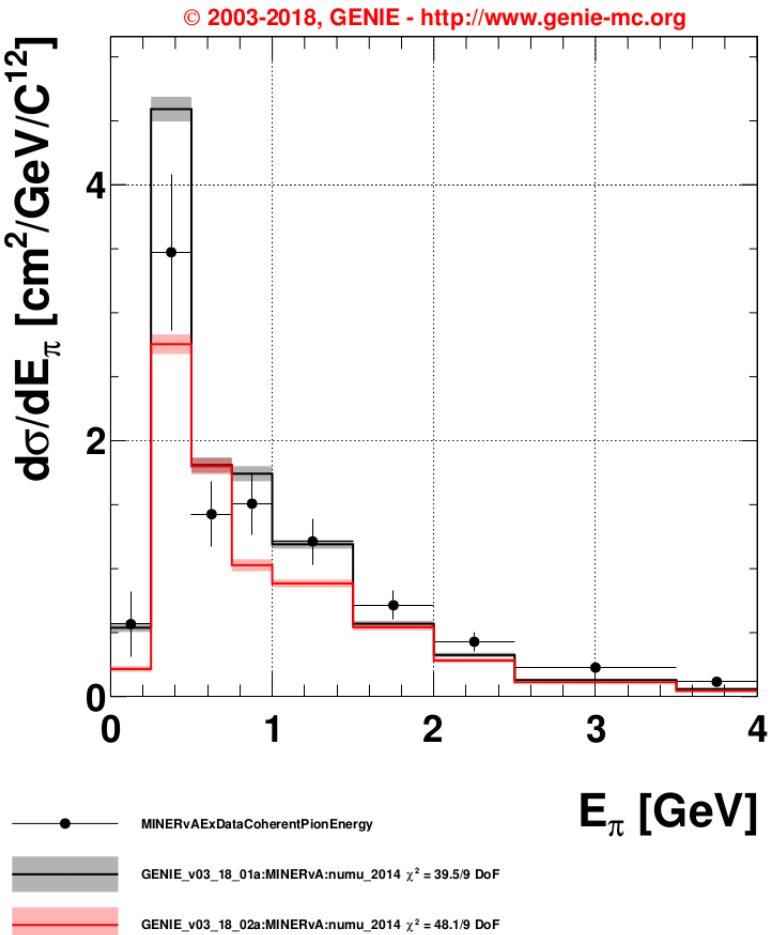


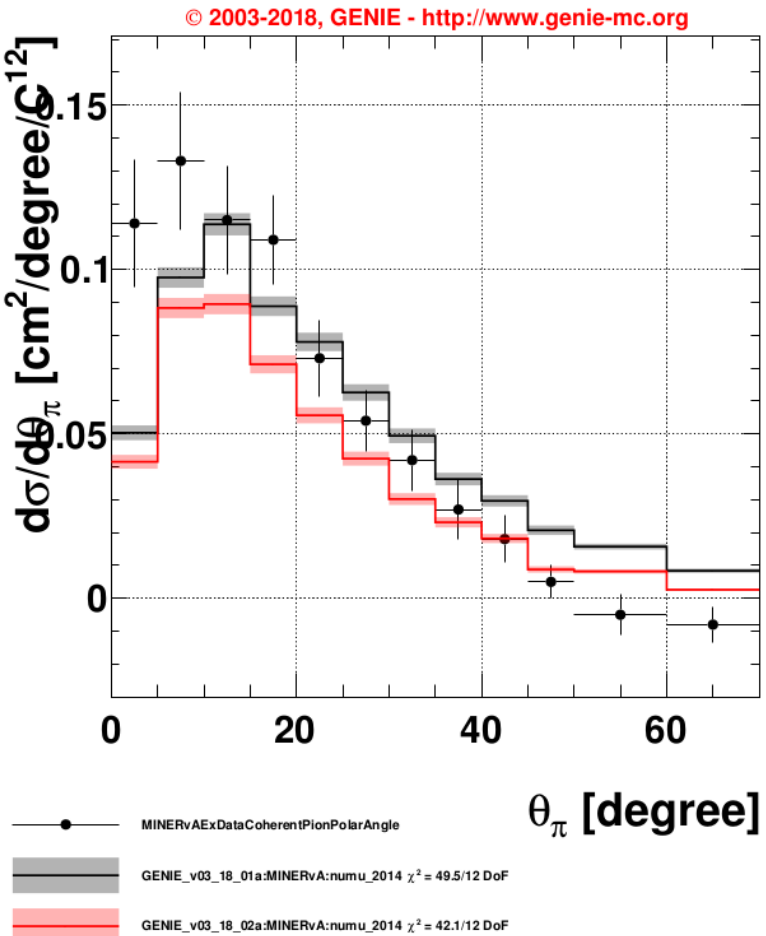



# GENIE model comparison with MINERvA CC-Coherent Sample



- Figures below show the comparision between G18_01a (**Rein-Sehgal**) and G18_02a (**Berger-Sehgal**) with MINERvA data.
- In the low $E_\pi$ region, the cross section of G18_02a is lower than G18_01a because of the Berger-Sehgal model used.

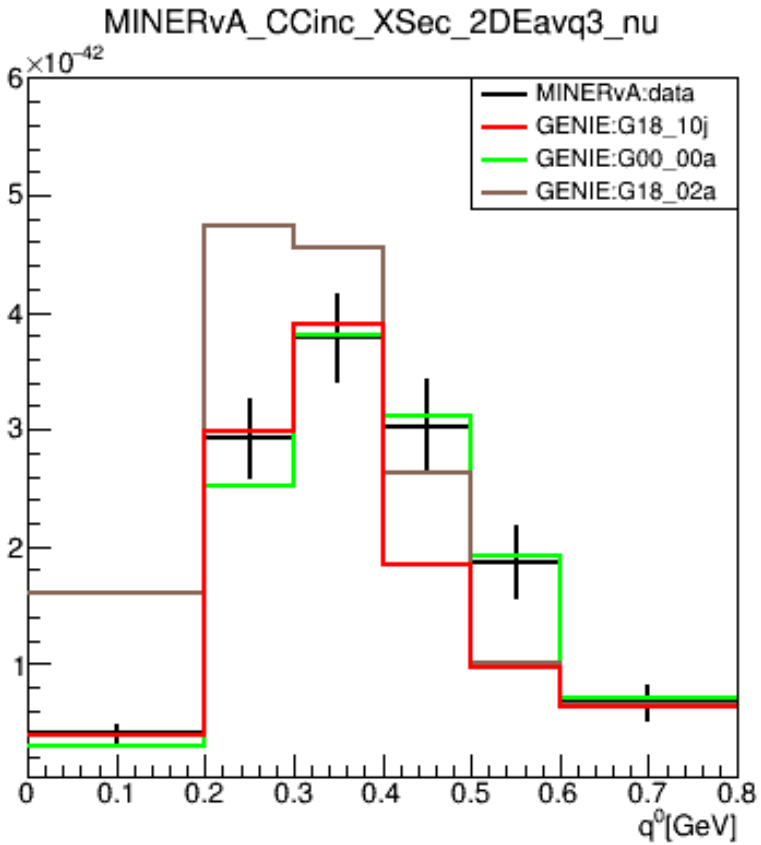


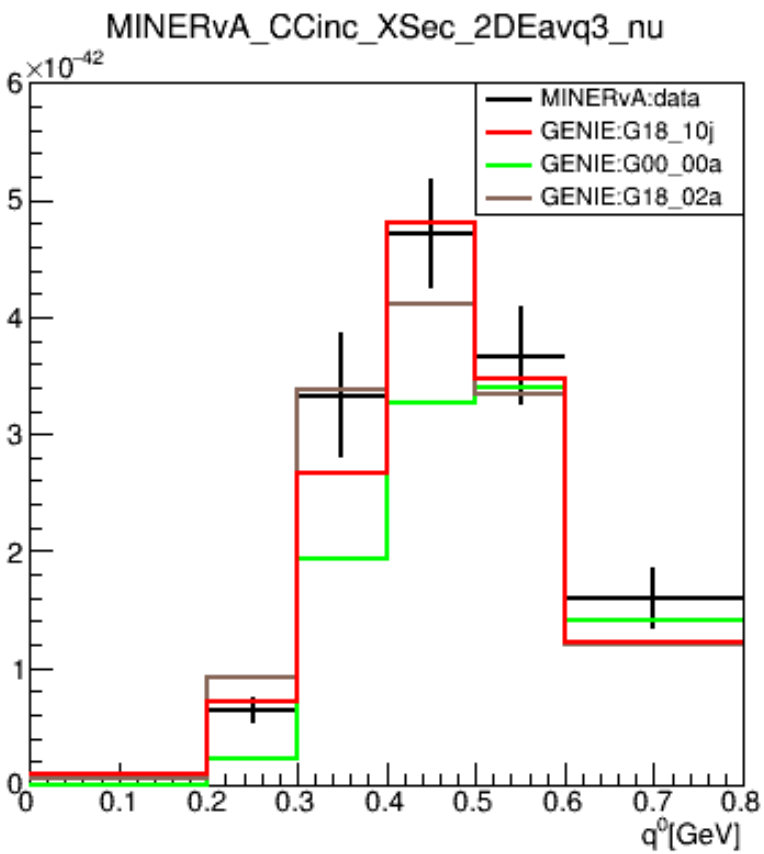



# GENIE model comparisons with MINERvA CC-Inclusive Sample



- Figures below shows the distribution of the MINERvA CCinclusive cross section with respect to the energy transfer $q^0$ in different q3 bins.
- Left: 0.2<q3<0.3GeV; Right: 0.5<q3<0.6GeV. Newer models match q3 dependence better.



# Summary and Conclusion



- GENIE v3 was officially released.
- Instead of setting the default version, GENIE v3 provide multiple comprehensive model configurations for using.
- Many of the new models were developed by theorists in response to previous data.
- We have ability to compare against many datasets, small number of them were shown here.
- New models are were matched to the MiniBooNE datasets. The tension between MiniBooNE $1\pi^+$ and MINERvA $1\pi^+$ remains.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