Comparison of MC codes

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Results prepared by:

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Observables	Generators
ArgoNeuT MicroBooNE MINERvA	**GENIE** **NEUT** **NUANCE** **NUWRO**

ArgoNeuT

NuMu

3 GeV

CC

Argon

No meson in final state

Multiplicity of protons

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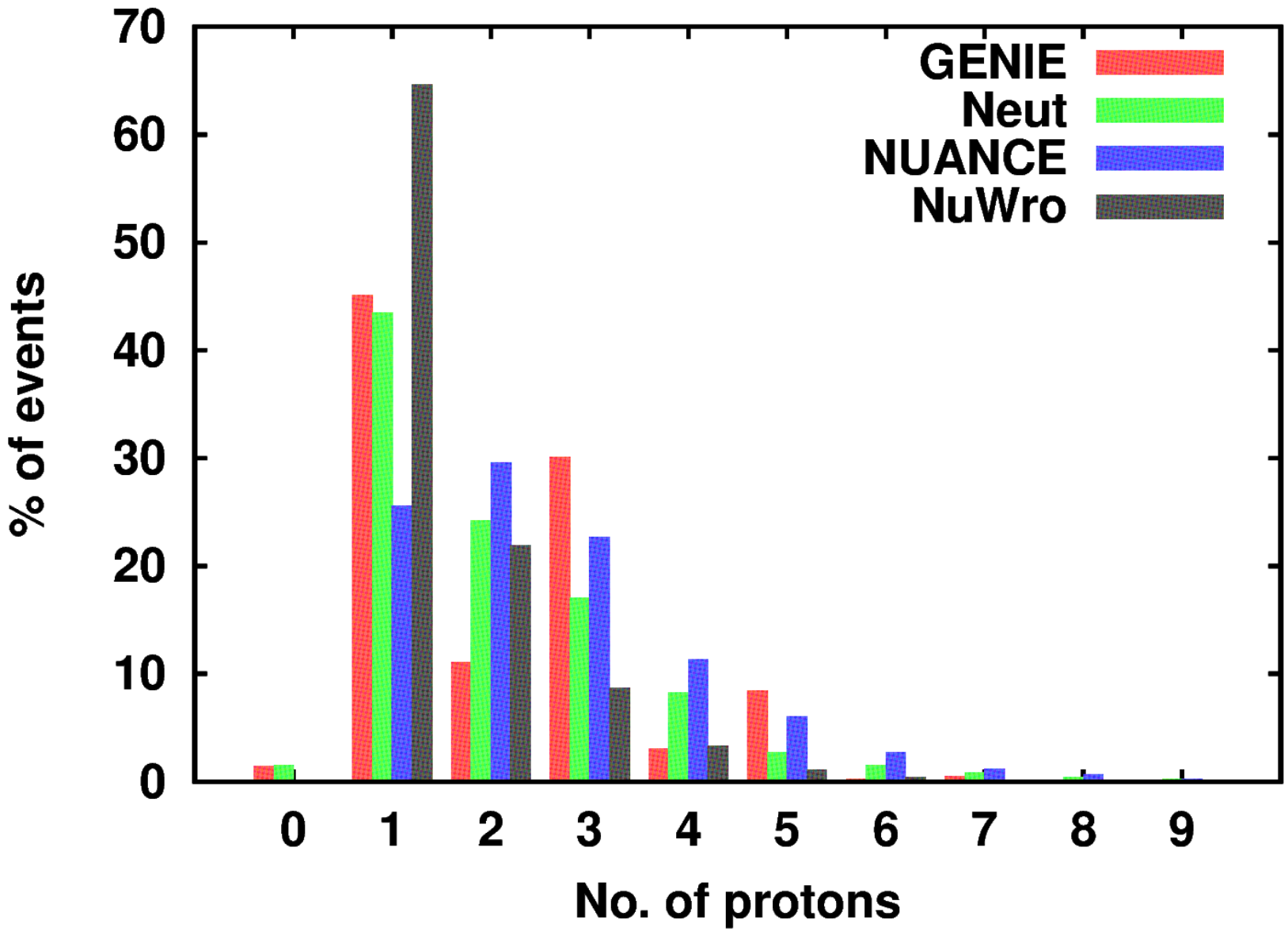
ArgoNeuT

Numu, 3 GeV, CC, Argon

No meson in final state



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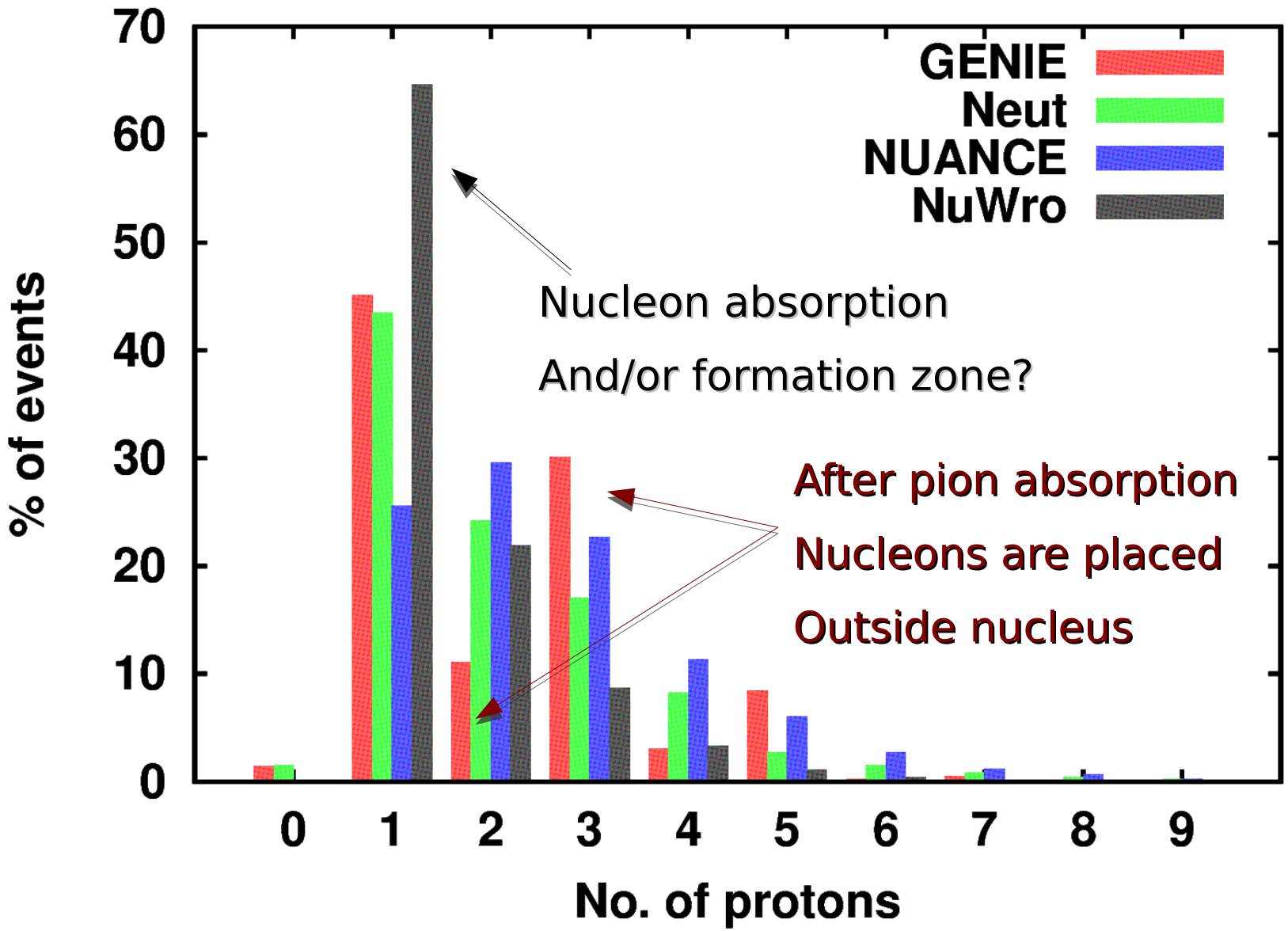
ArgoNeuT

Numu, 3 GeV, CC, Argon

No meson in final state



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ArgoNeuT

NuMu

3 GeV

CC

Argon

No meson in final state

Multiplicity of protons with Tk > 50 MeV

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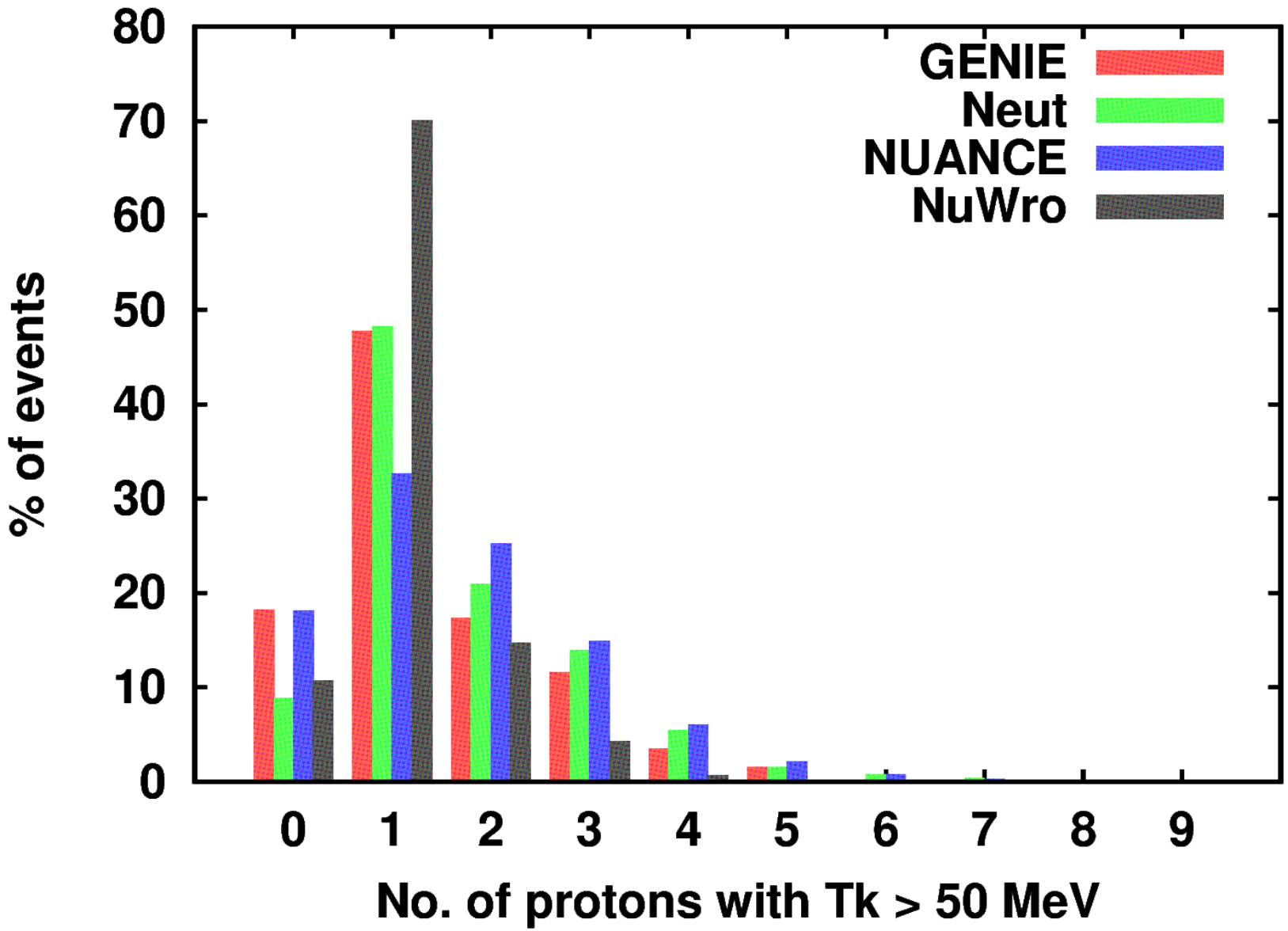
ArgoNeuT

Numu, 3 GeV, CC, Argon

No meson in final state



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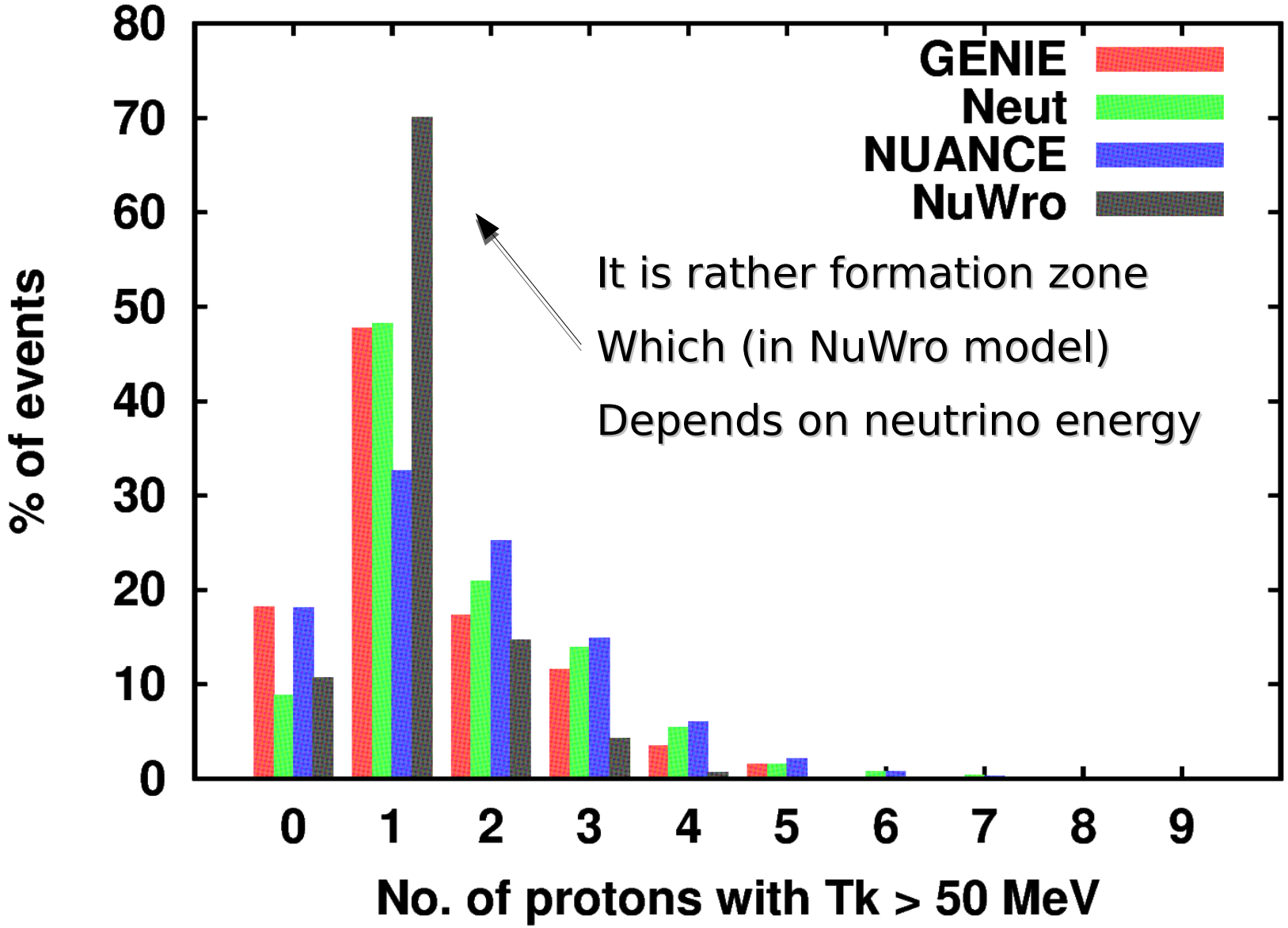
ArgoNeuT

Numu, 3 GeV, CC, Argon

No meson in final state



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MicroBooNE

NuMu

1 GeV

CC

Argon

No meson in final state

Multiplicity of protons

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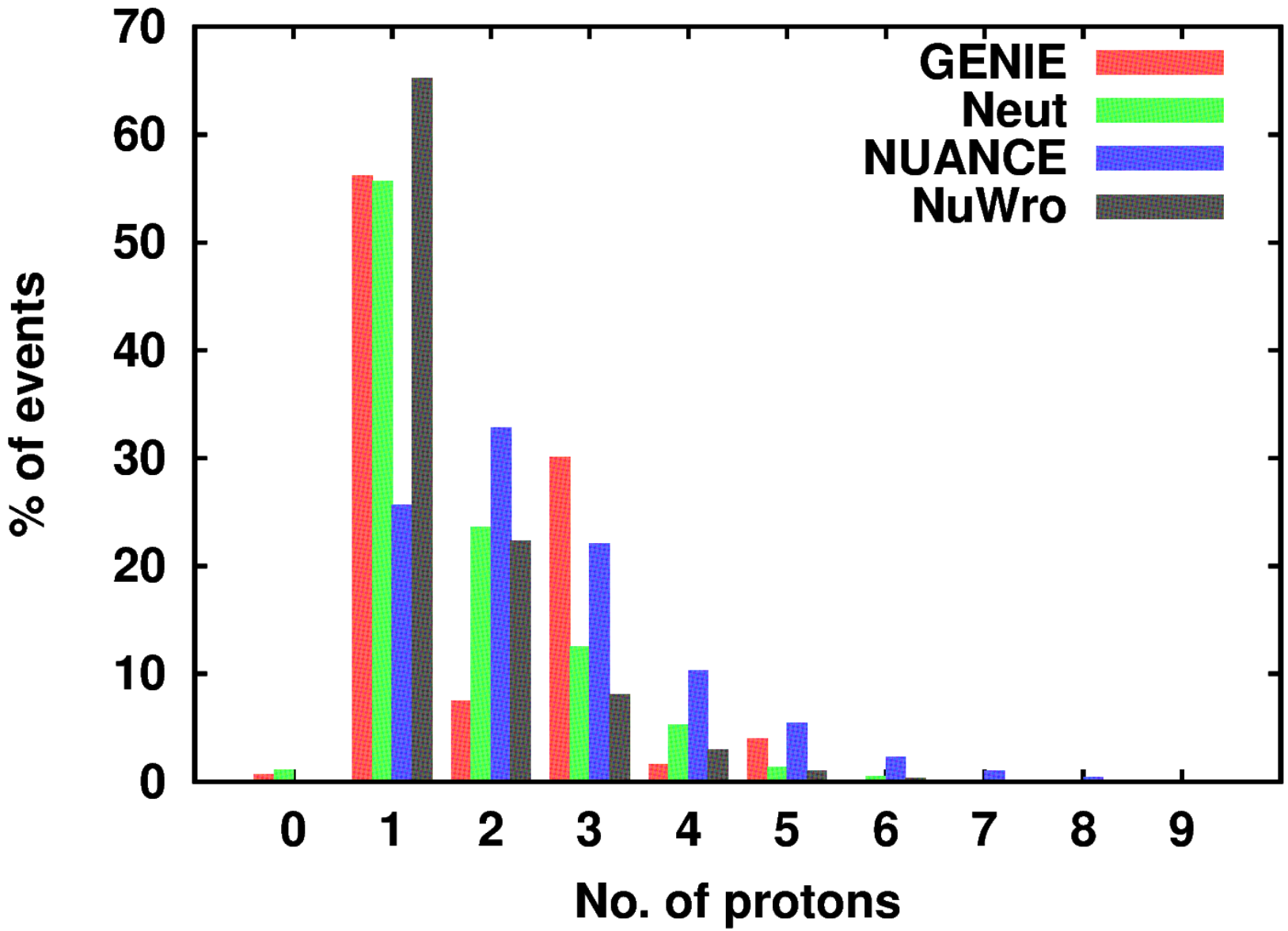
MicroBooNE

Numu, 1 GeV, CC, Argon

No meson in final state



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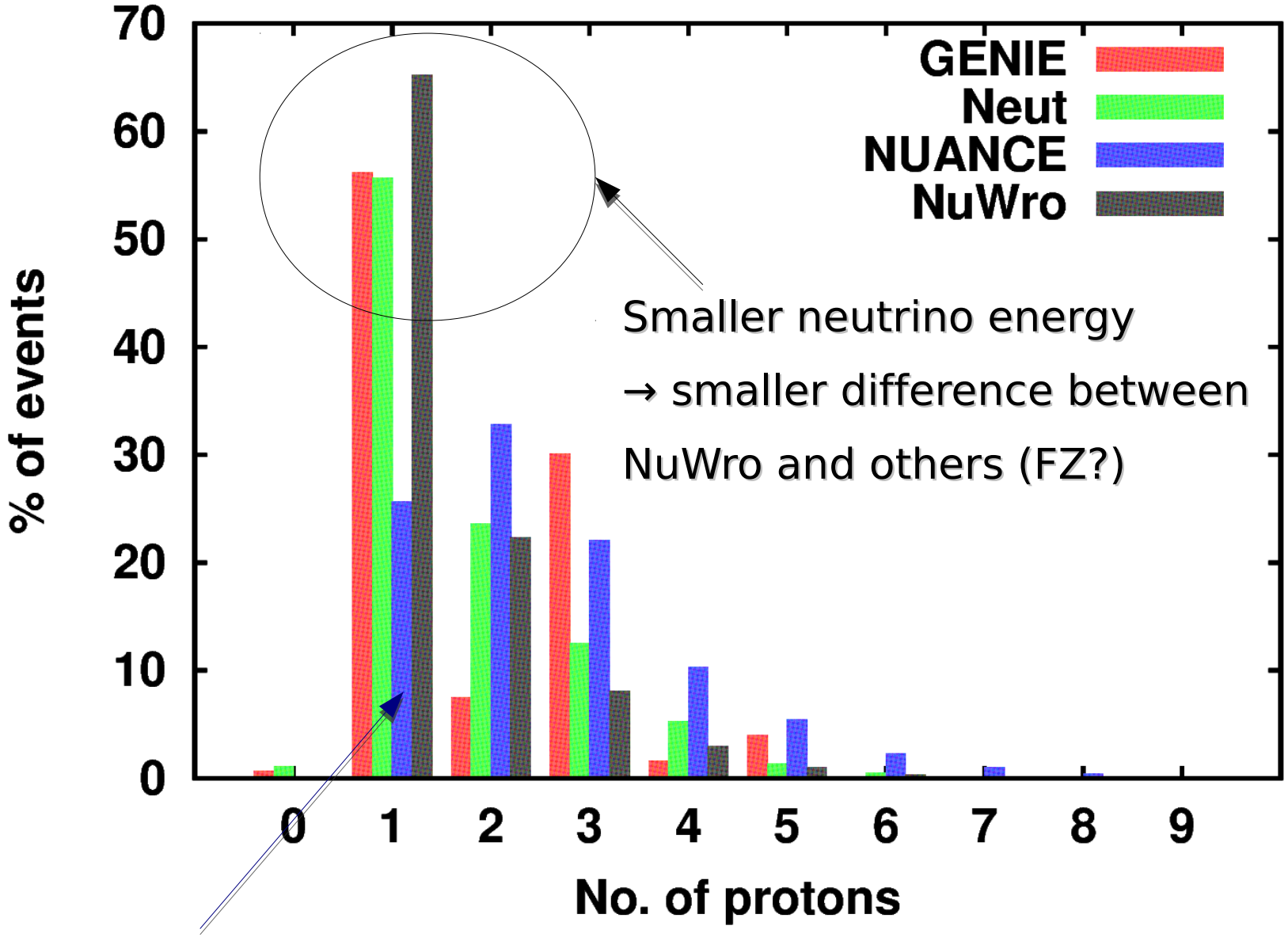
MicroBooNE

Numu, 1 GeV, CC, Argon

No meson in final state



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Why does NUANCE have so many protons?

MicroBooNE

NuMu

1 GeV

CC

Argon

No meson in final state

Multiplicity of protons with Tk > 50 MeV

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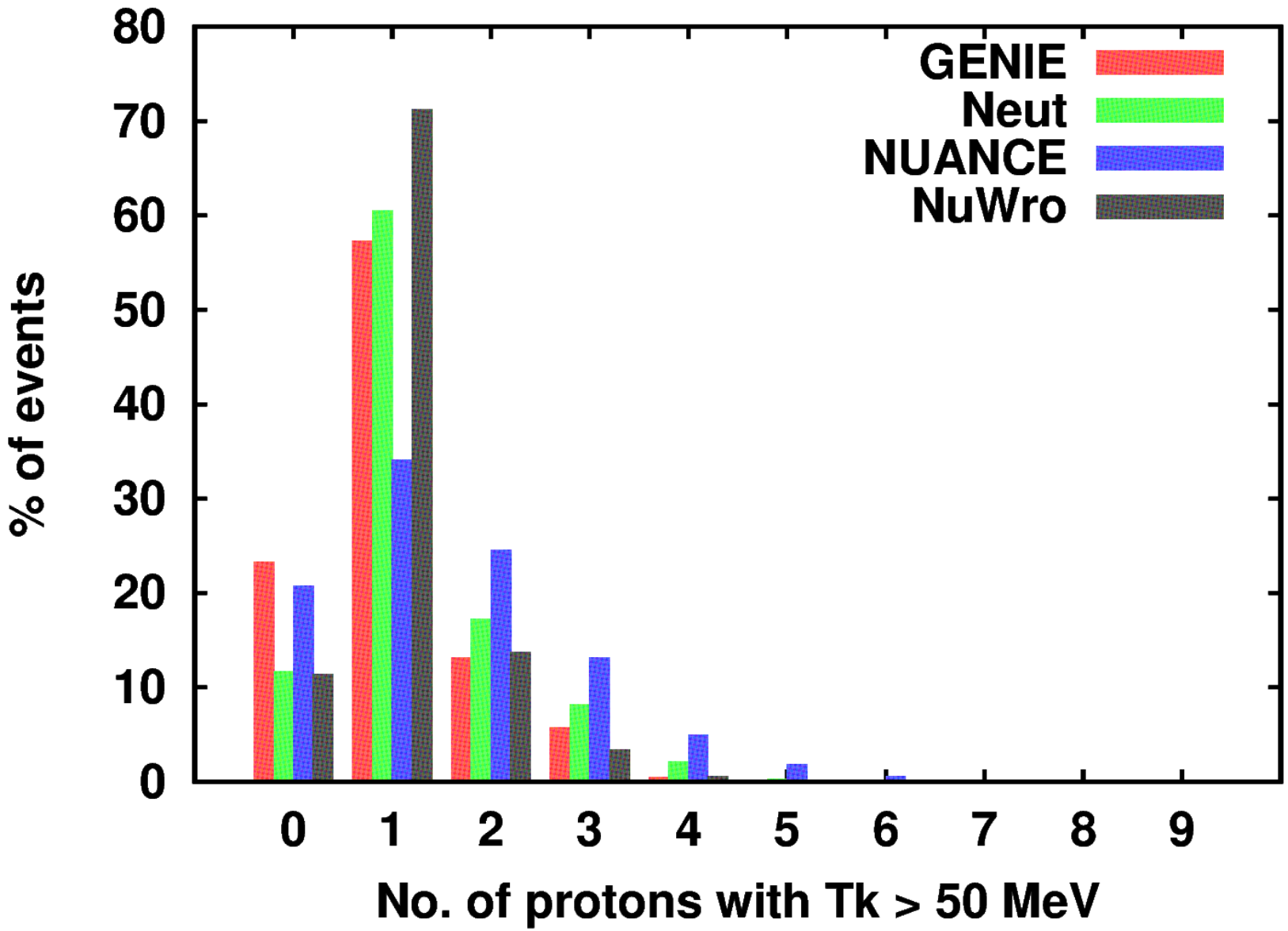
MicroBooNE

Numu, 1 GeV, CC, Argon

No meson in final state

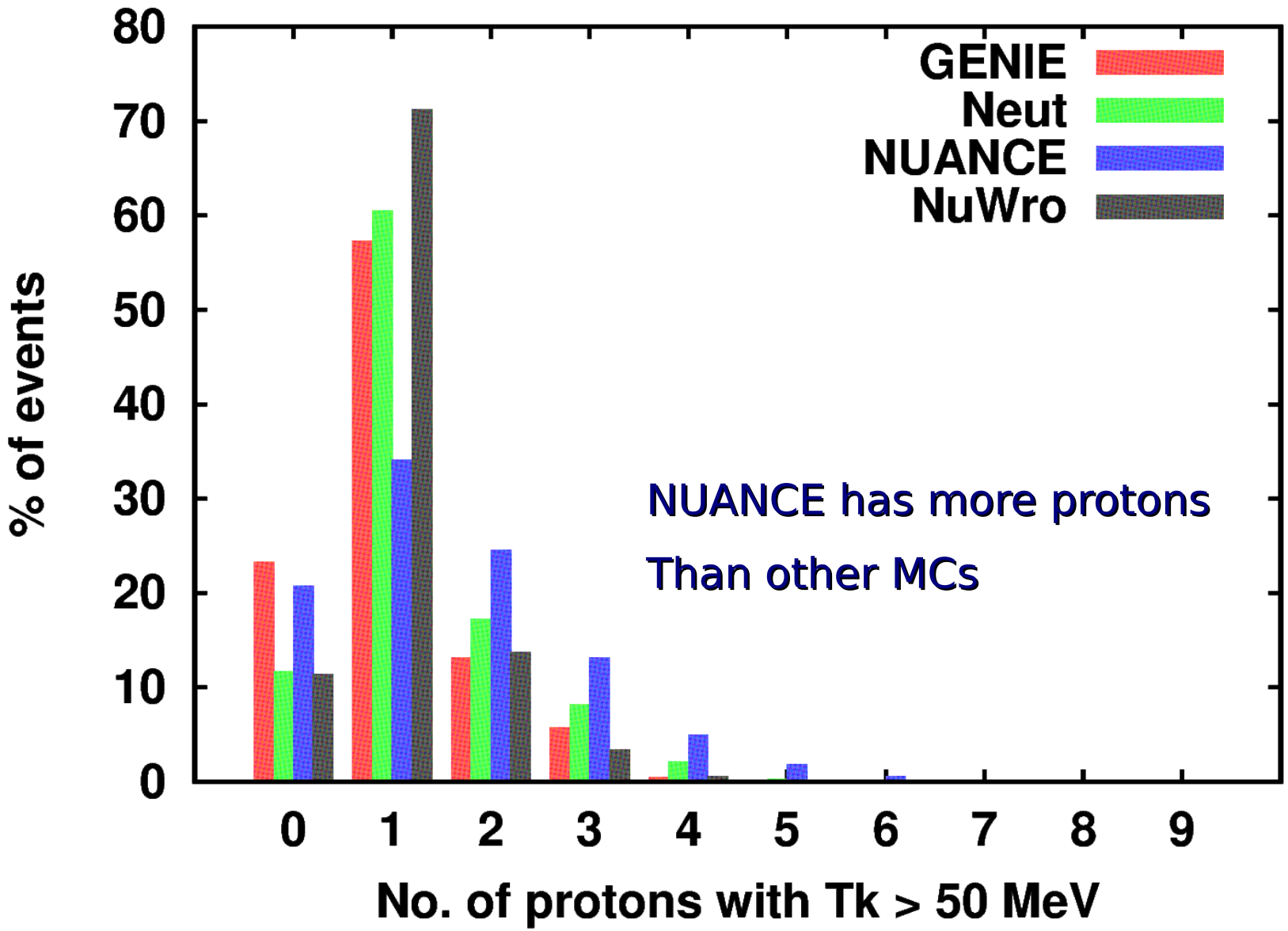


22.10.

MicroBooNE

Numu, 1 GeV, CC, Argon

No meson in final state



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Partial Summary

1. For higher neutrino energy NuWro has less protons than other Monte Carlo. Probably reason is formation zone which in NuWro model depends on a formation zone.

2. Why there is so many protons in NUANCE?

3. In such simple observable Monte Carlo should have better agreement...

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ArgoNeuT

NuMu

3 GeV

CC

Argon

No selection

Total visible energy

(protons Ek + leptons and mesons E)

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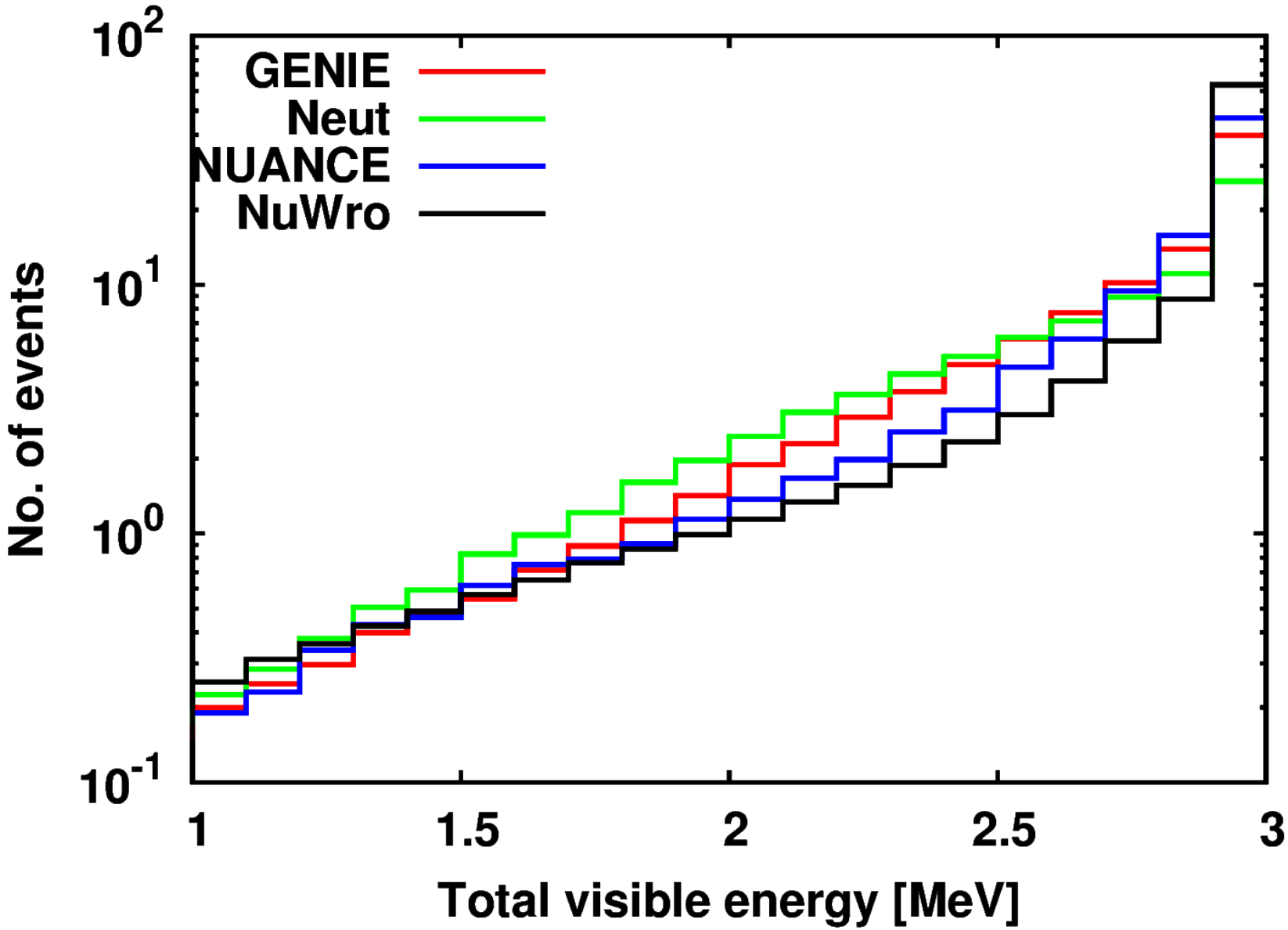
ArgoNeuT

Numu, 3 GeV, CC, Argon



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MicroBooNE

NuMu

1 GeV

CC

Argon

No selection

Total visible energy

(protons Ek + leptons and mesons E)

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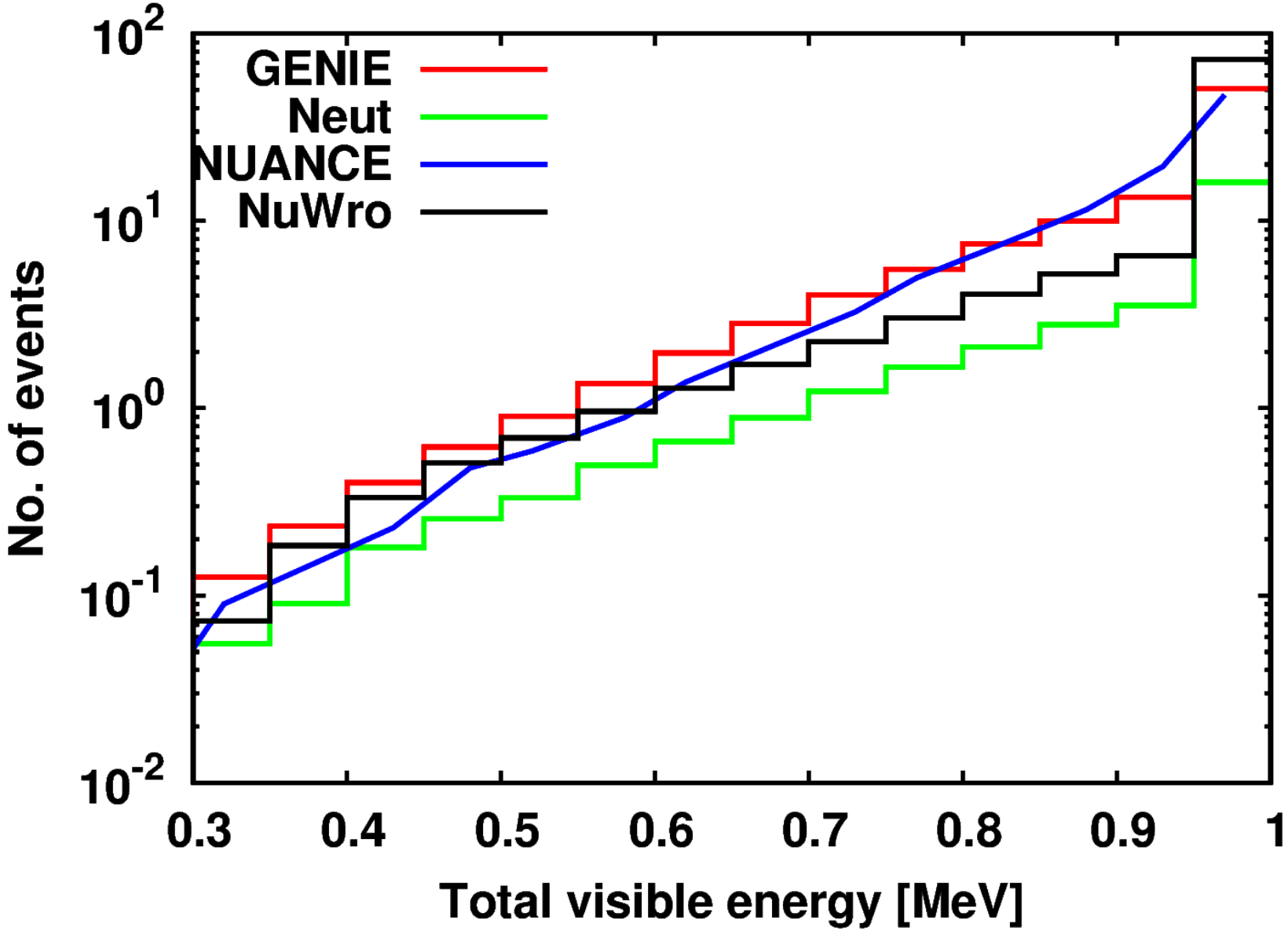
MicroBooNE

Numu, 1 GeV, CC, Argon



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MicroBooNE

NuMu

1 GeV

CC

Argon

No meson in final state

Momentum of most energetic proton

(counting only proton with Tk > 50 MeV)

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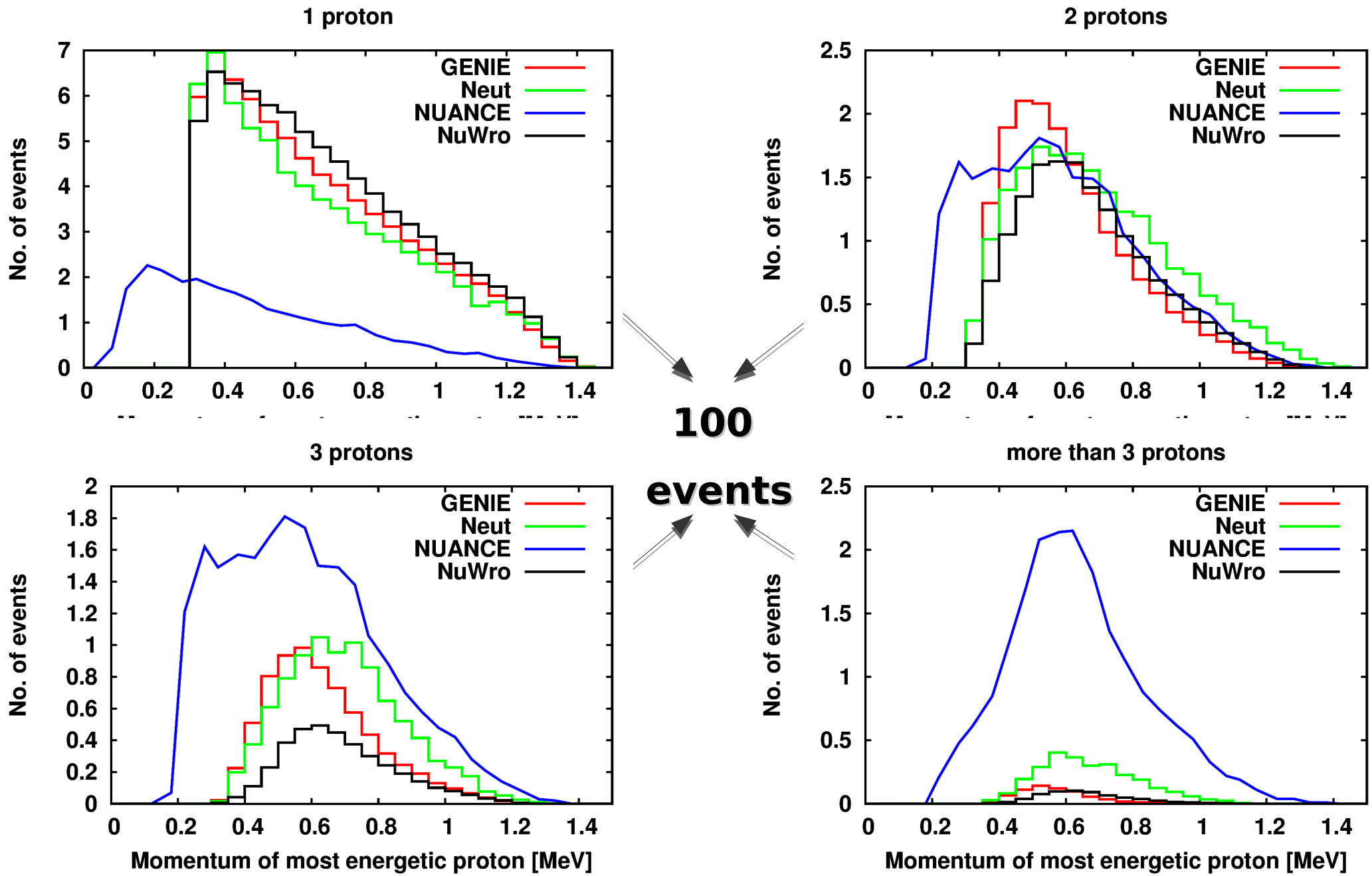
MicroBooNE

Numu, 1 GeV, CC, Argon

No meson in final state



MINERva

NuMu

5 GeV

CC

Carbon

Single pi+ in final state

Pi+ energy vs cosine

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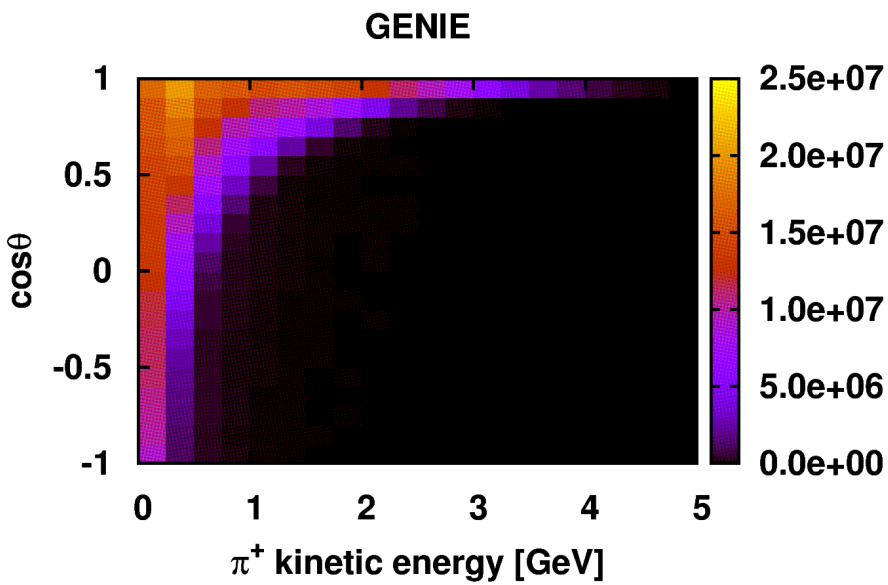
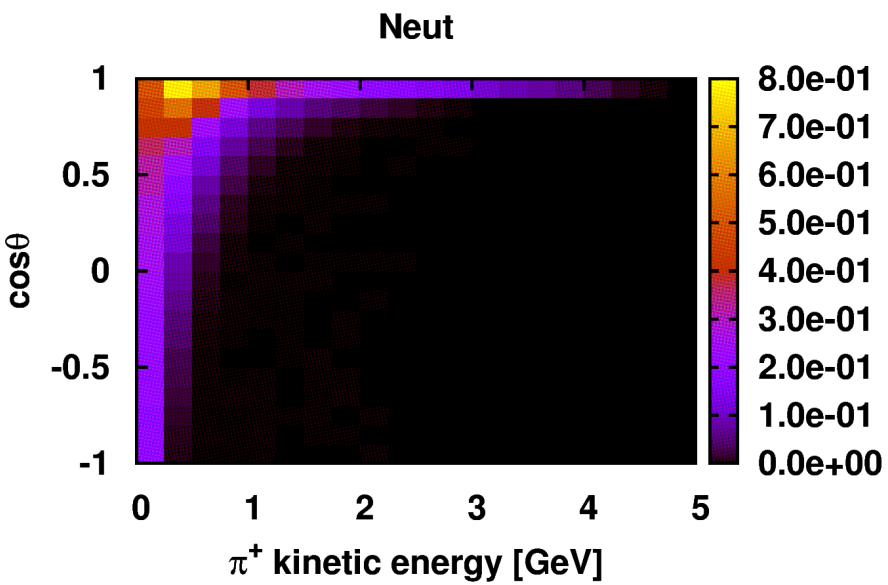
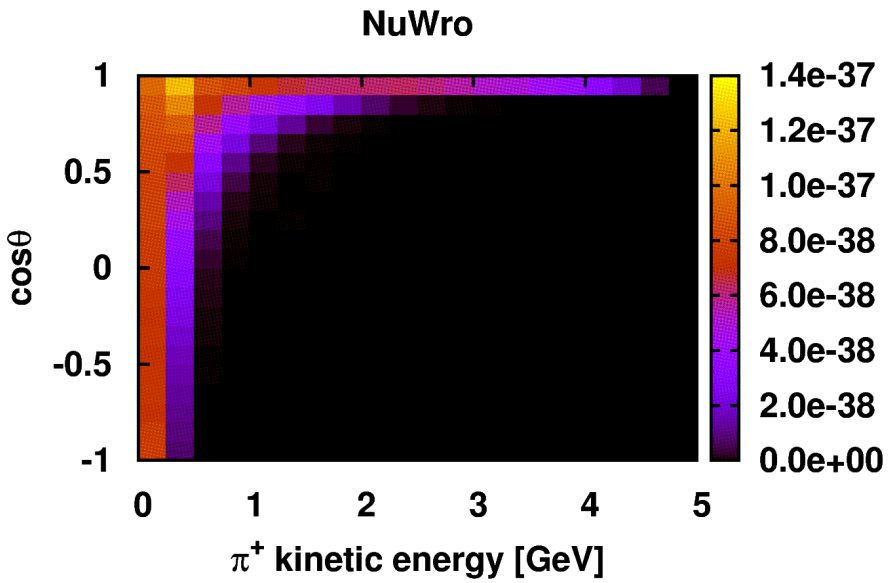
MINERvA

Numu, 5 GeV, CC, Carbon

Single pi+ in final state







Note:

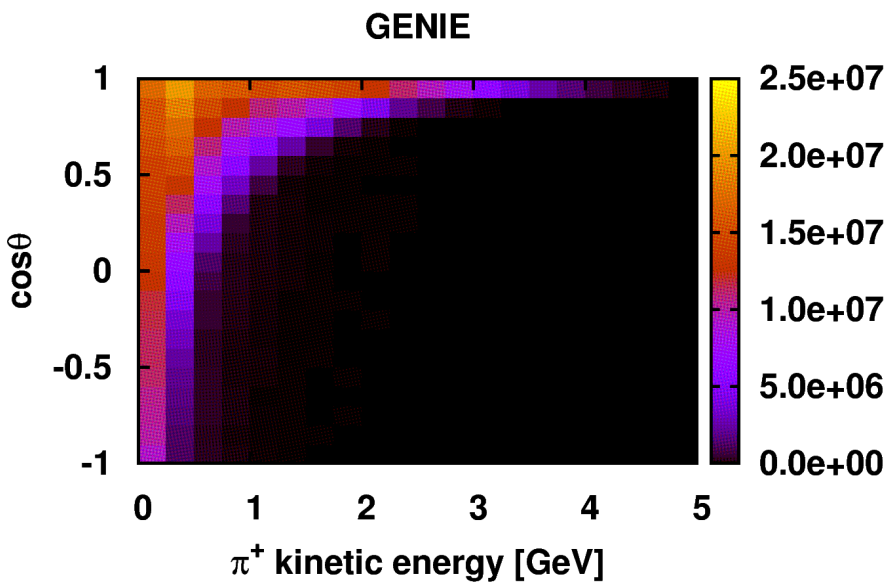
Each generator is normalized

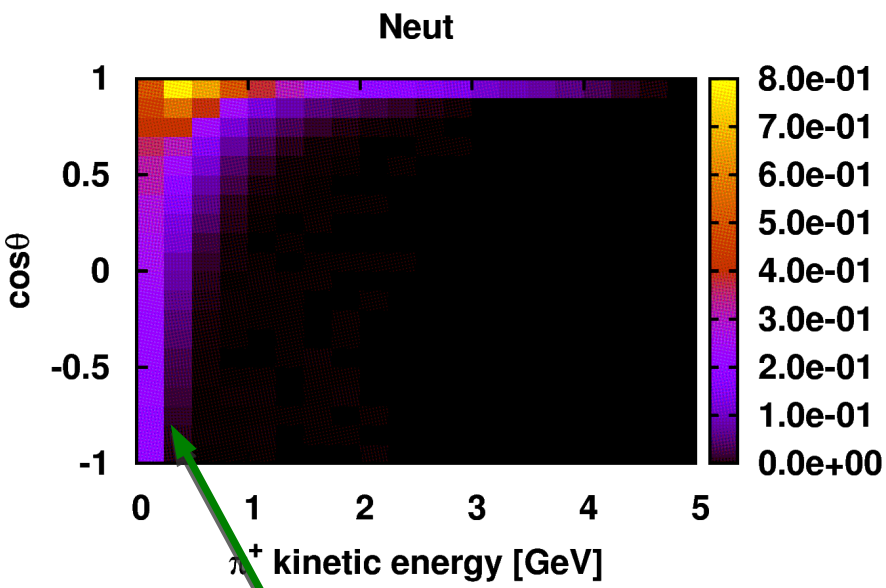
To different number of events

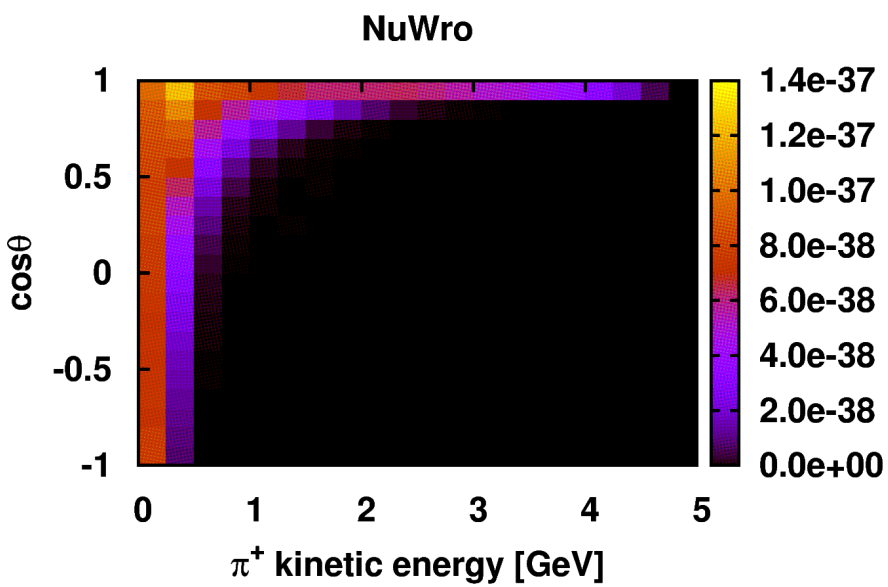
MINERvA

Numu, 5 GeV, CC, Carbon

Single pi+ in final state







There is less backward pions

Than in other MCs

MINERva

NuMu

5 GeV

CC

Carbon

Single pi- in final state

Pi- energy vs cosine

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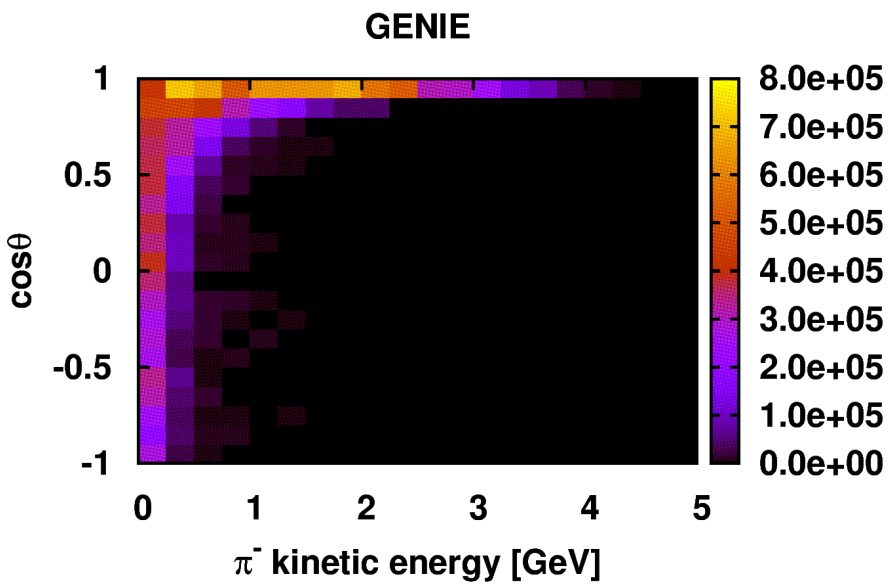
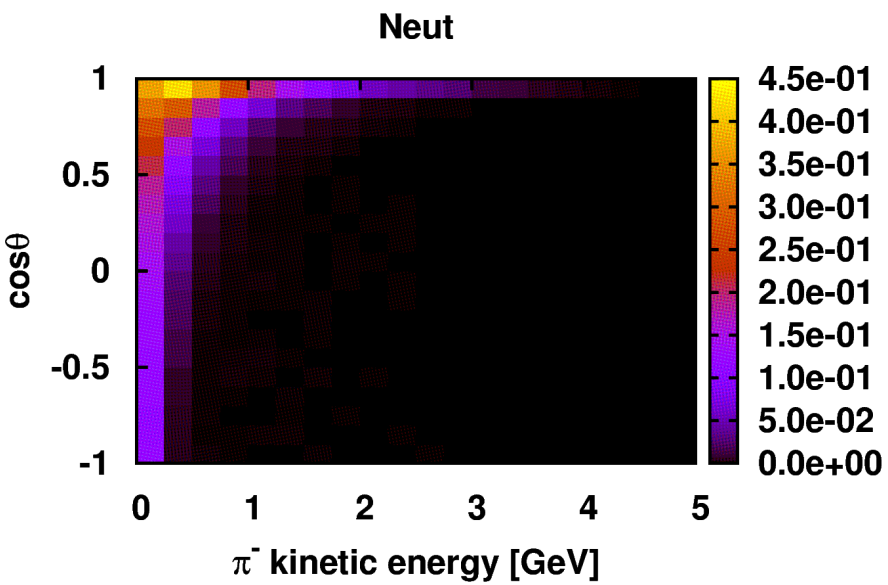
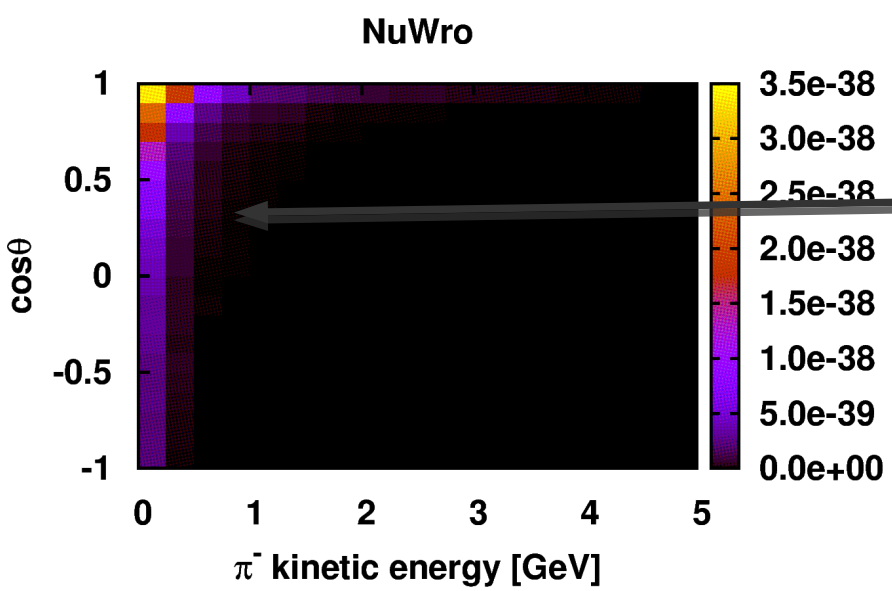
MINERvA

Numu, 5 GeV, CC, Carbon

Single pi- in final state







In opposite to pi+

There is not so much

Backward pi-

MINERva

NuMu

5 GeV

CC

Carbon

Single pi0 in final state

Pi0 energy vs cosine

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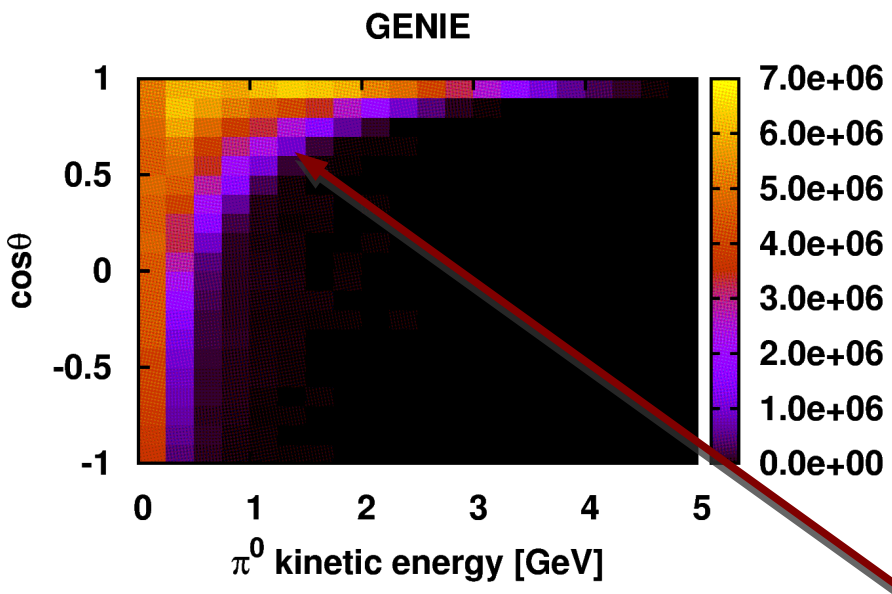
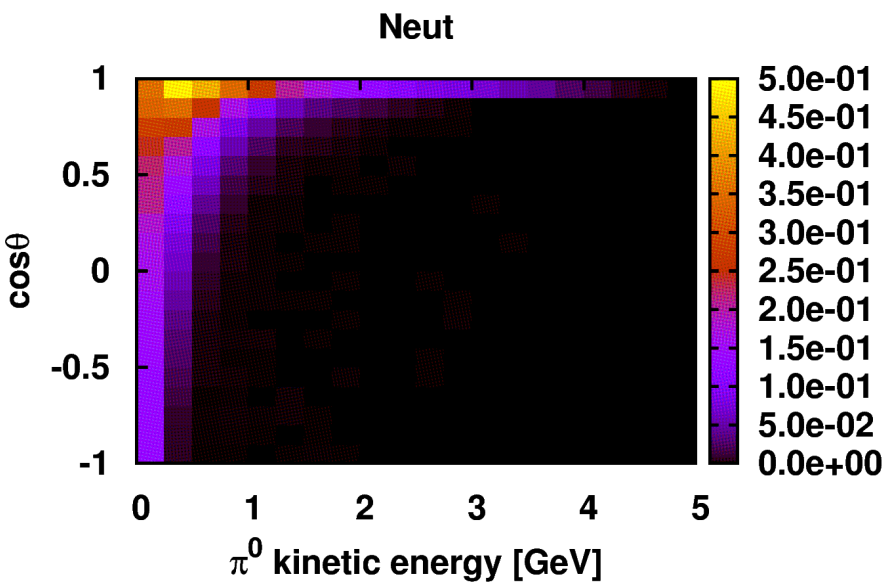
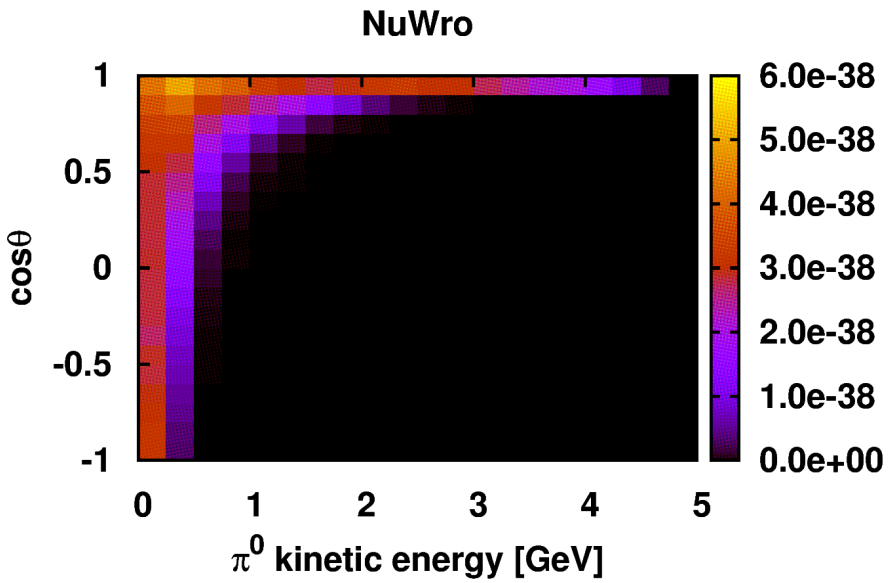
MINERvA

Numu, 5 GeV, CC, Carbon

Single pi0 in final state







Result is more smeared

Around maximum

Than other MCs

MINERva

NuMu

5 GeV

CC

Carbon

No pion in final state / 1 pion in final state

(Total kinetic energy in all protons) /

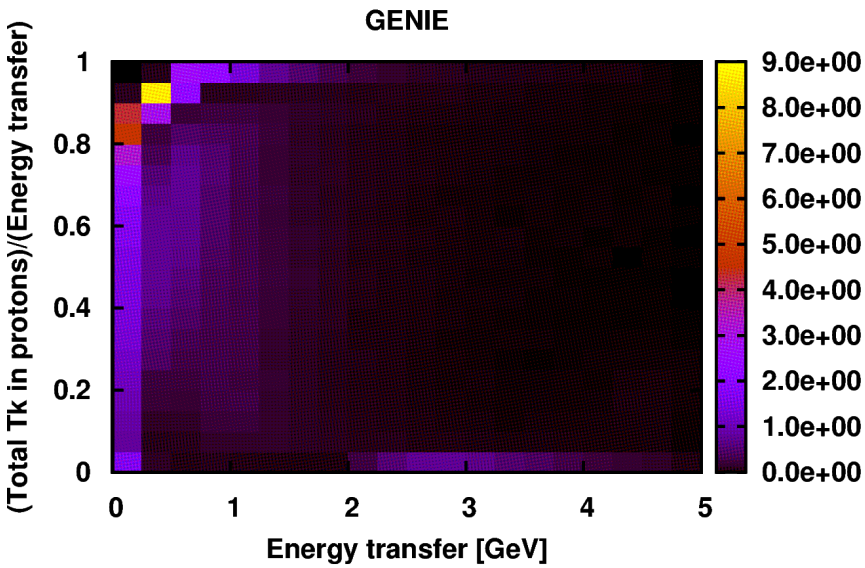
(Energy transfer)

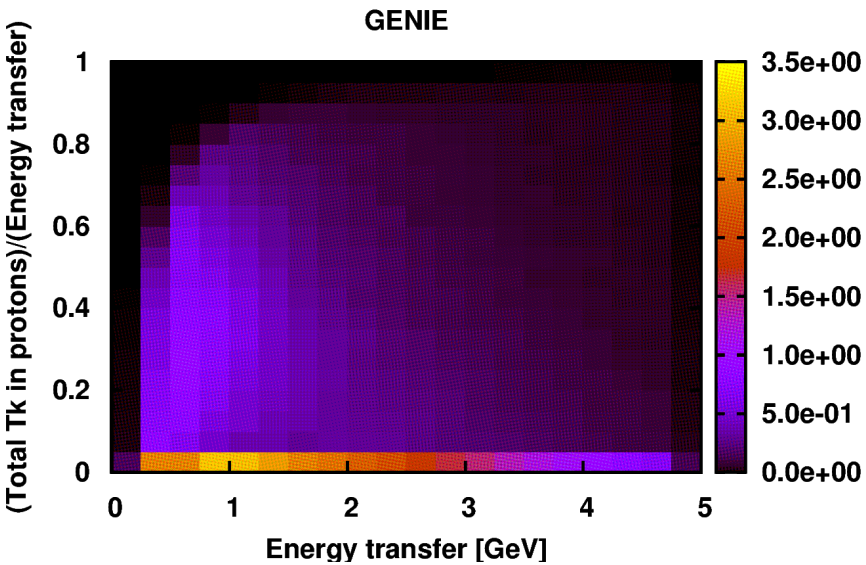
22.10.2012

MINERvA

Numu, 5 GeV, CC, Carbon

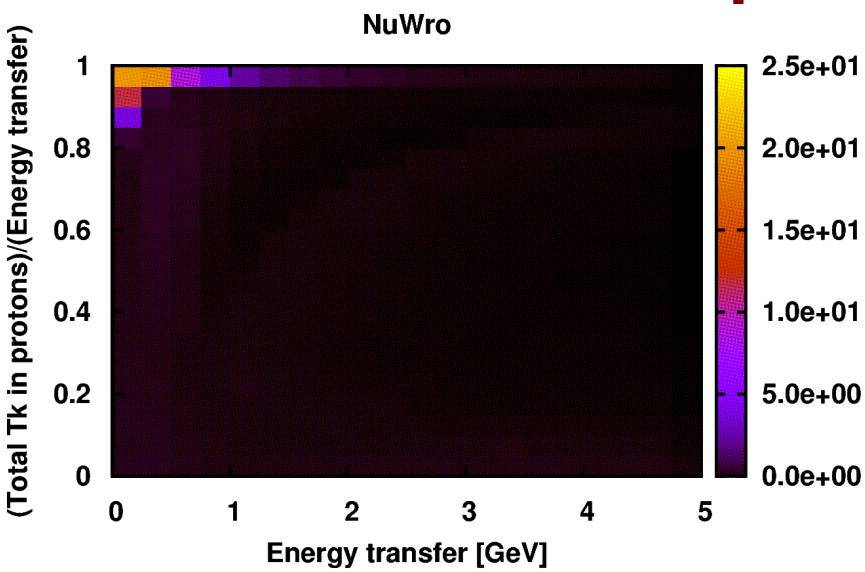
No pion in final state / 1 pi in FS

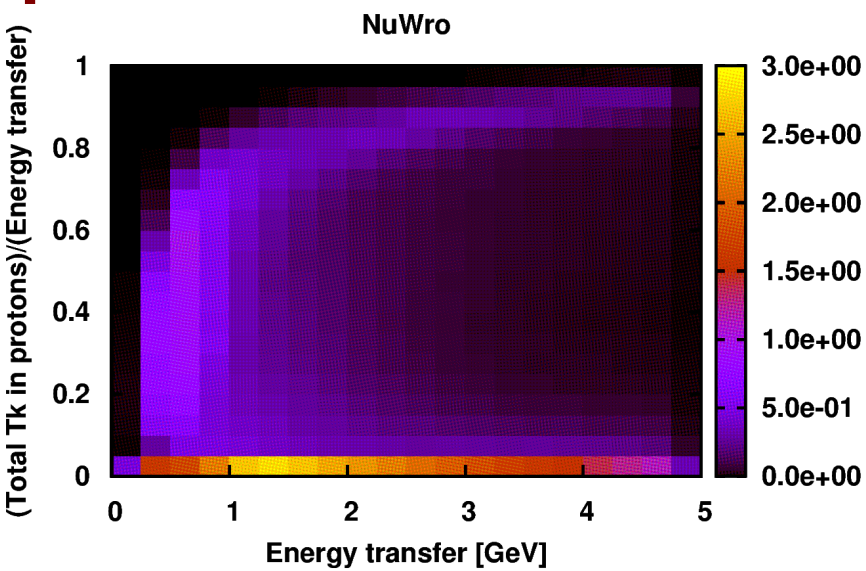




No pion

1 pion





MINERva

NuMu

5 GeV

CC

Carbon

2 pions in final state / more than 2 pi in FS

(Total kinetic energy in all protons) /

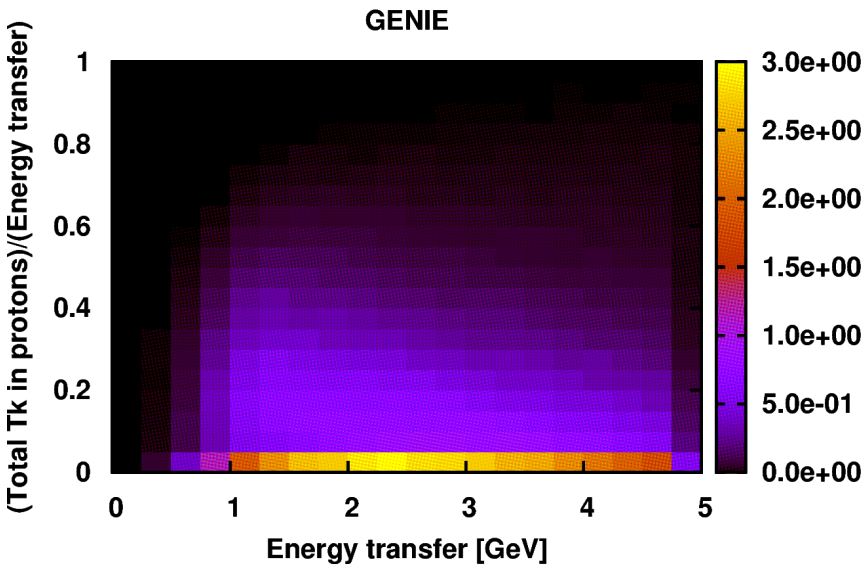
(Energy transfer)

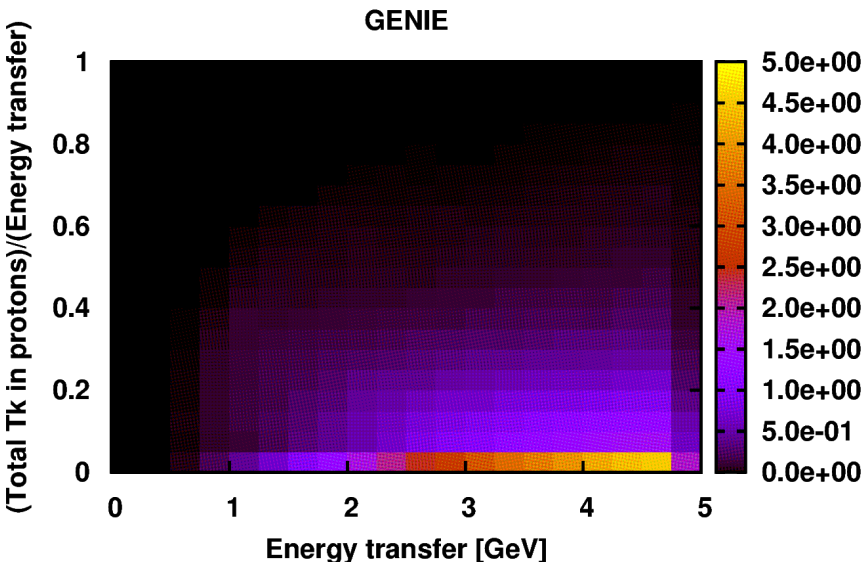
22.10.2012

MINERvA

Numu, 5 GeV, CC, Carbon

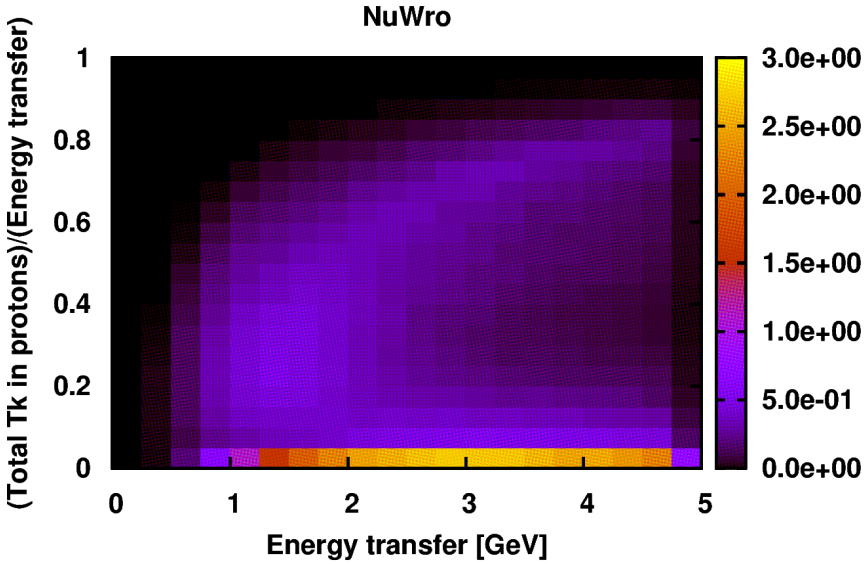
2 pions in final state / more tha n 2 pi in FS

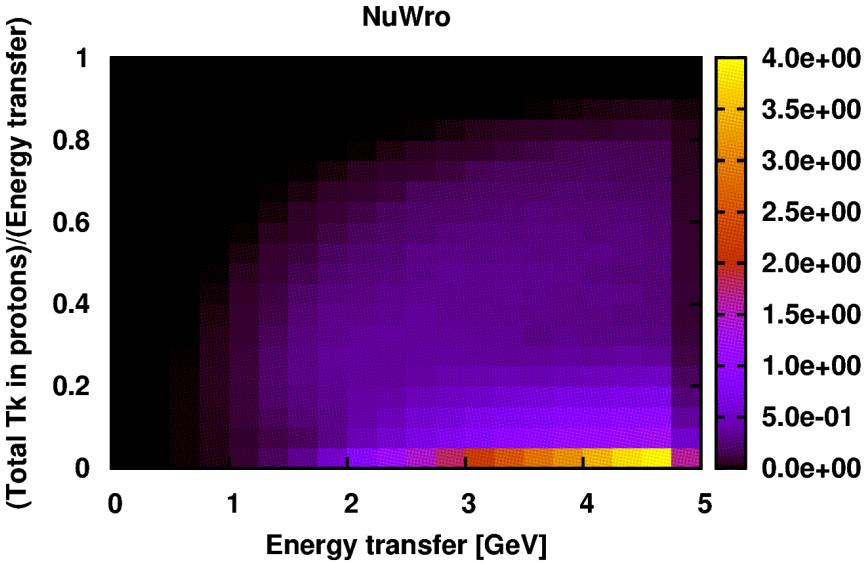




2 pions

more than 2 pions





Summary

1. On the comparision an agreement between generators is good, but not excelent.

2. Probably the weakest point of each MC is nucleon cascade.

3. More comparision between generators and looking for reasons of disagreement may be helpful.

We should go deeper...

22.10.2012

OBRIGADO!

22.10.2012

Backup slides

22.10.2012

MINERva

Anti NuMu

5 GeV

CC

Carbon

Single pi+ in final state

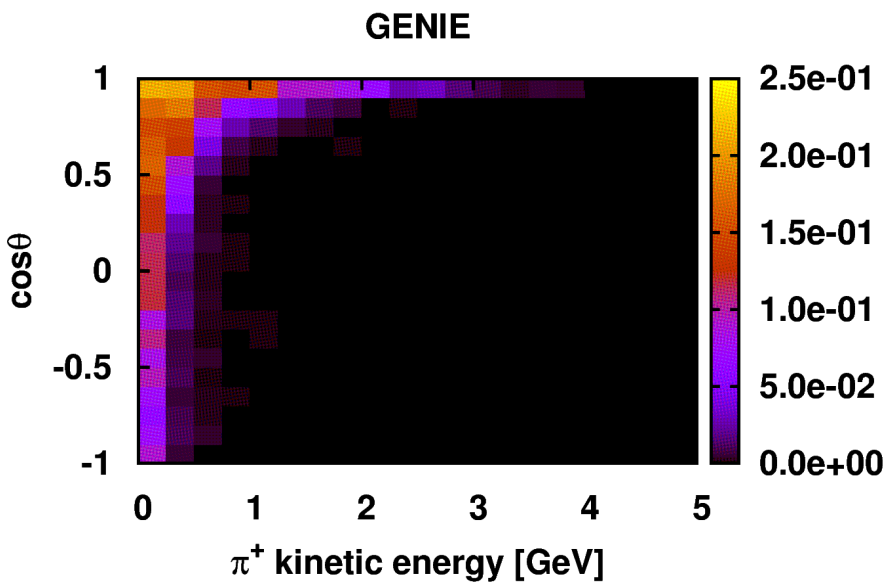
Pi+ energy vs cosine

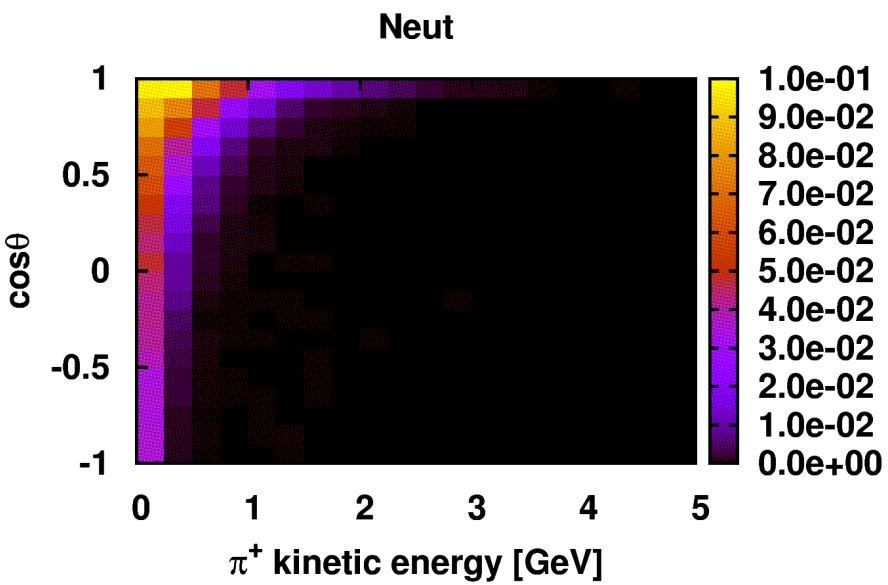
22.10.2012

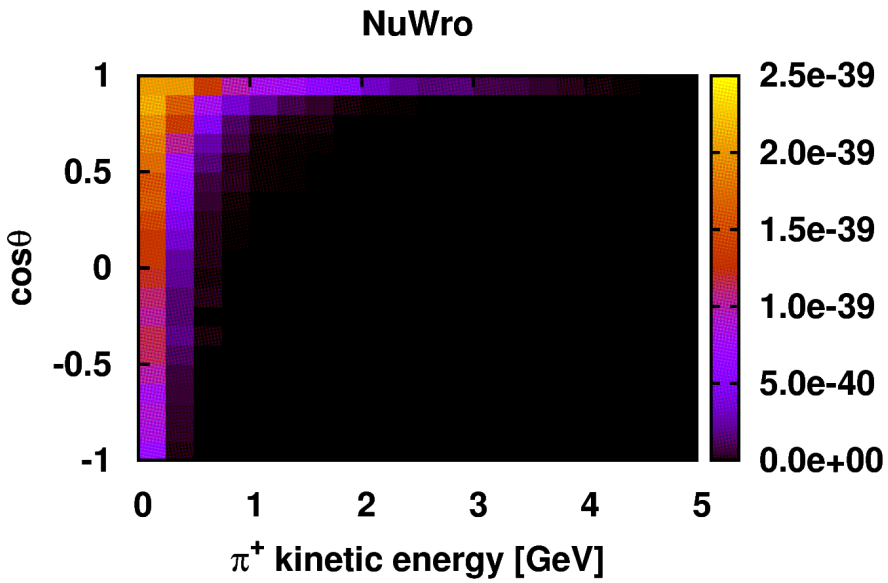
MINERvA

Anti Numu, 5 GeV, CC, Carbon

Single pi+ in final state







MINERva

Anti NuMu

5 GeV

CC

Carbon

Single pi- in final state

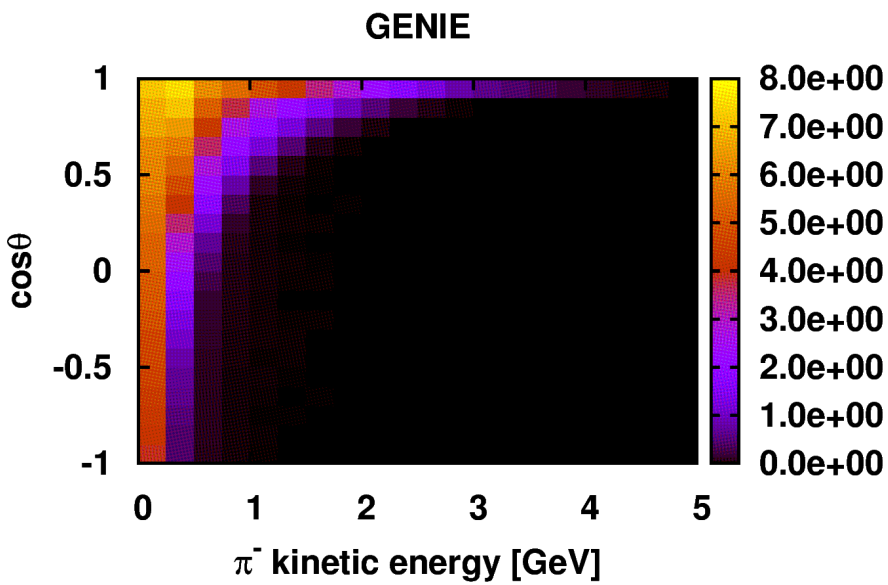
Pi- energy vs cosine

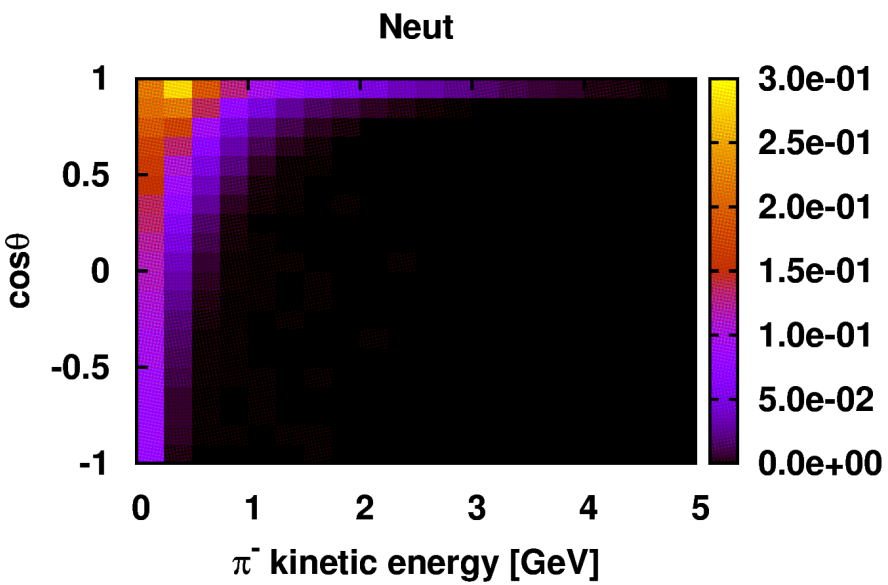
22.10.2012

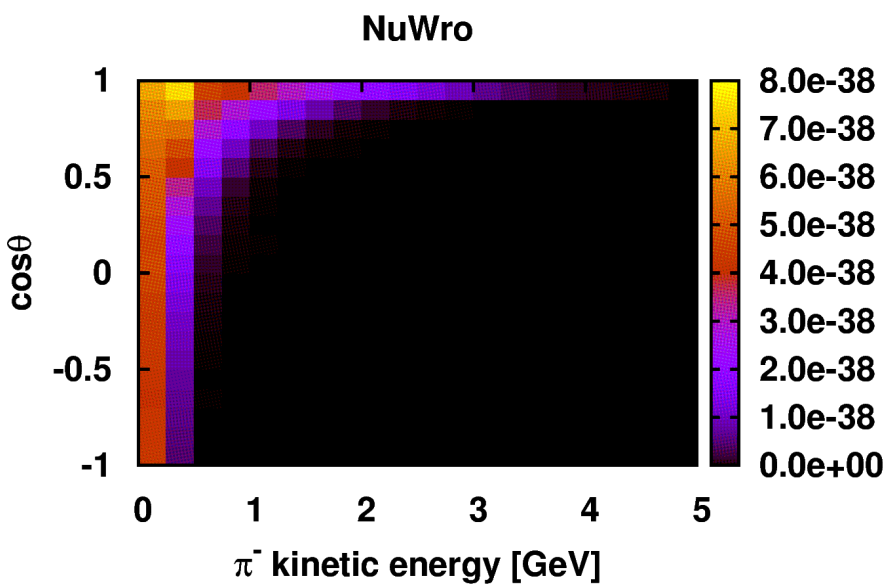
MINERvA

Anti Numu, 5 GeV, CC, Carbon

Single pi- in final state







MINERva

Anti NuMu

5 GeV

CC

Carbon

Single pi0 in final state

Pi0 energy vs cosine

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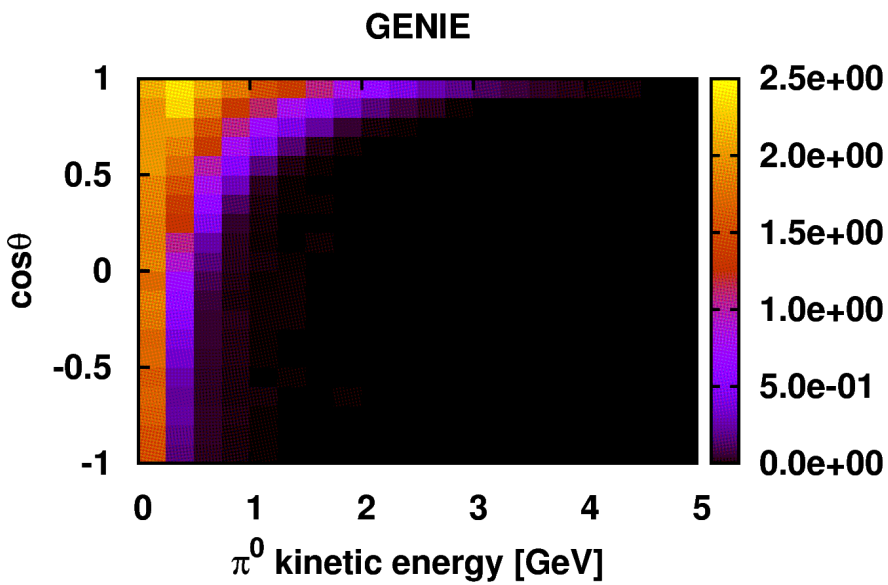
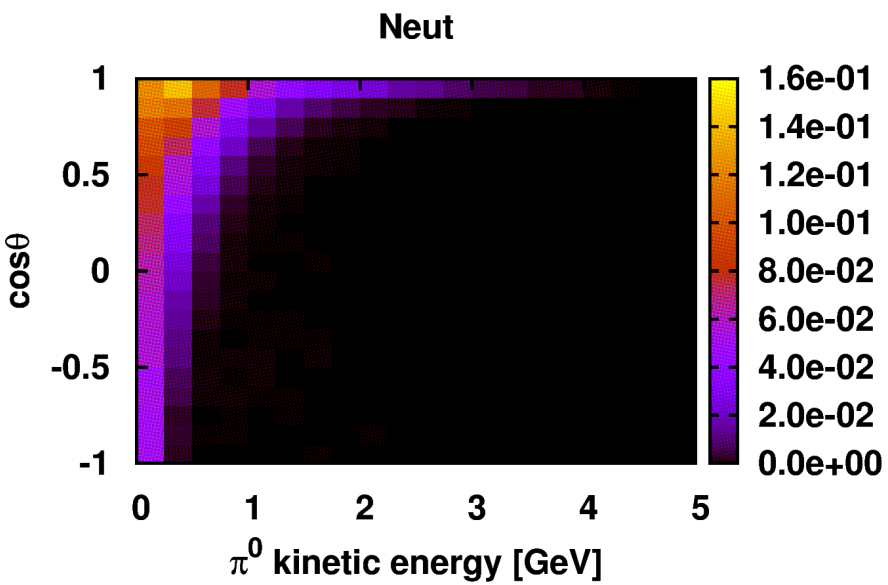
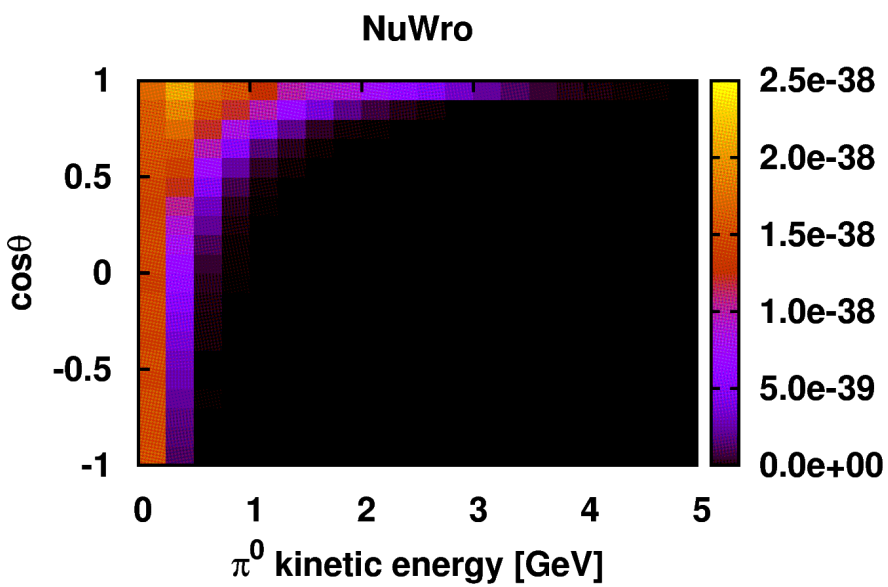
MINERvA

Anti Numu, 5 GeV, CC, Carbon

Single pi0 in final state







MINERva

Anti NuMu

5 GeV

CC

Carbon

No pion in final state

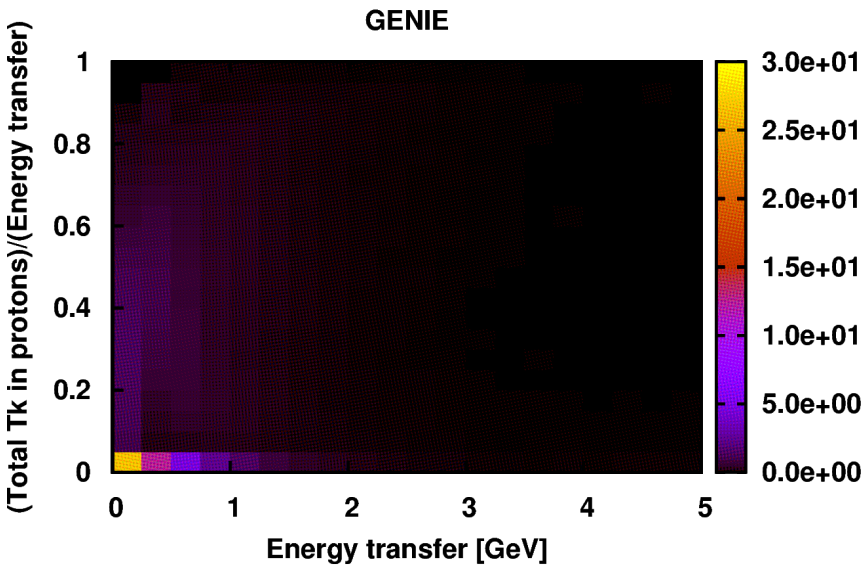
(Total kinetic energy in all protons) / (Energy transfer)

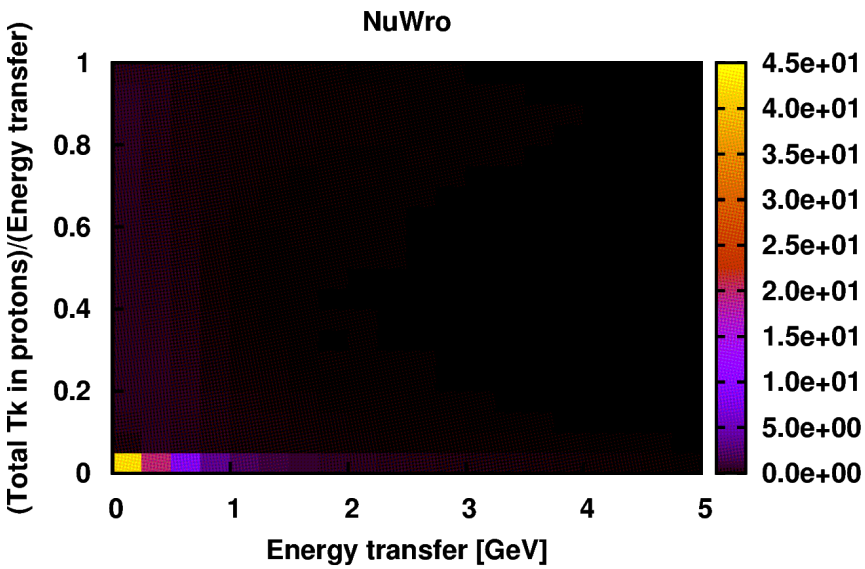
22.10.2012

MINERvA

Anti Numu, 5 GeV, CC, Carbon

No pion in final state





MINERva

Anti NuMu

5 GeV

CC

Carbon

1 pion in final state

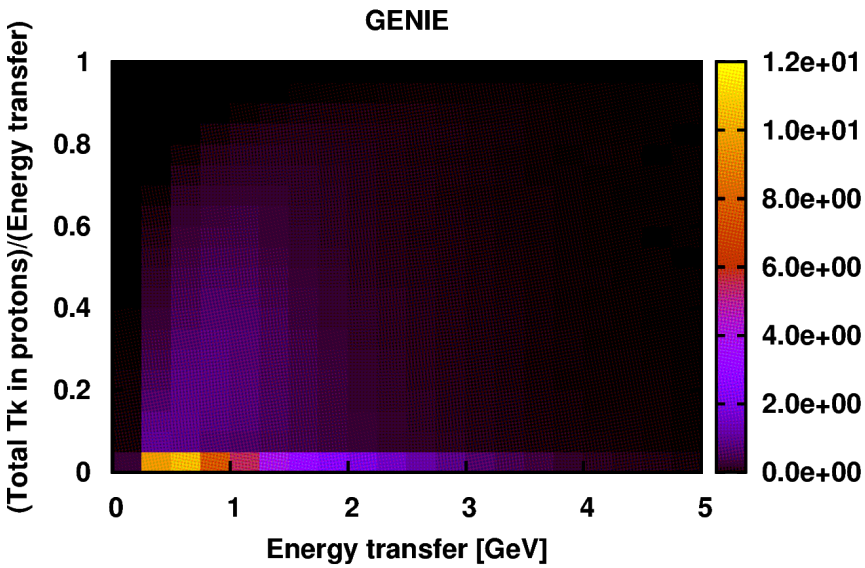
(Total kinetic energy in all protons) / (Energy transfer)

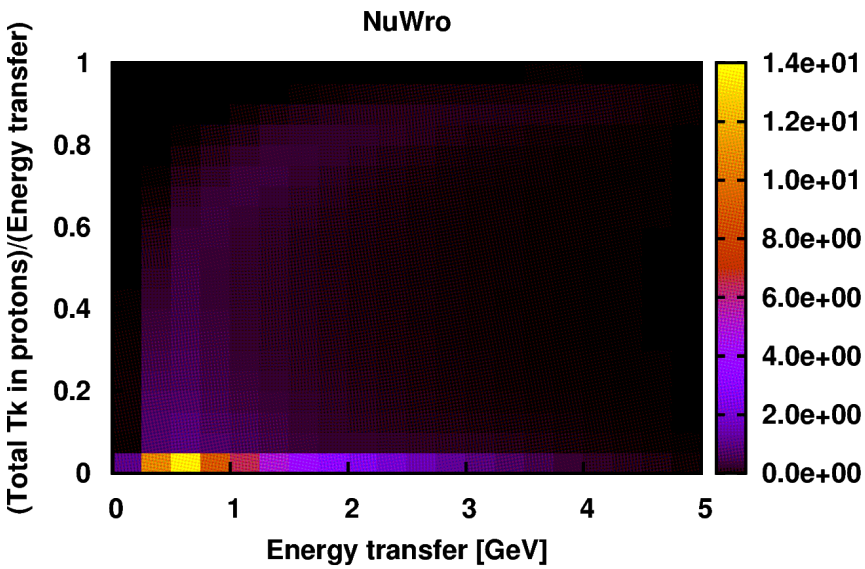
22.10.2012

MINERvA

Anti Numu, 5 GeV, CC, Carbon

1 pion in final state





MINERva

Anti NuMu

5 GeV

CC

Carbon

2 pions in final state

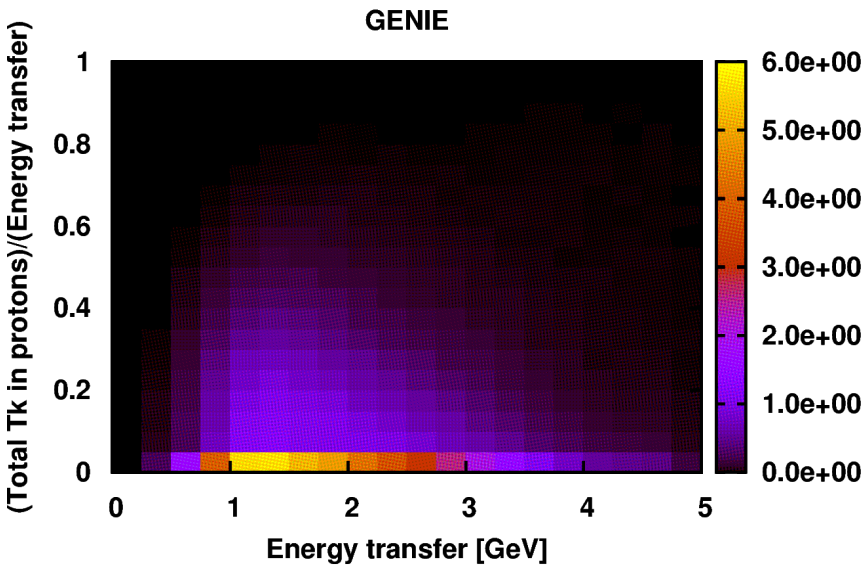
(Total kinetic energy in all protons) / (Energy transfer)

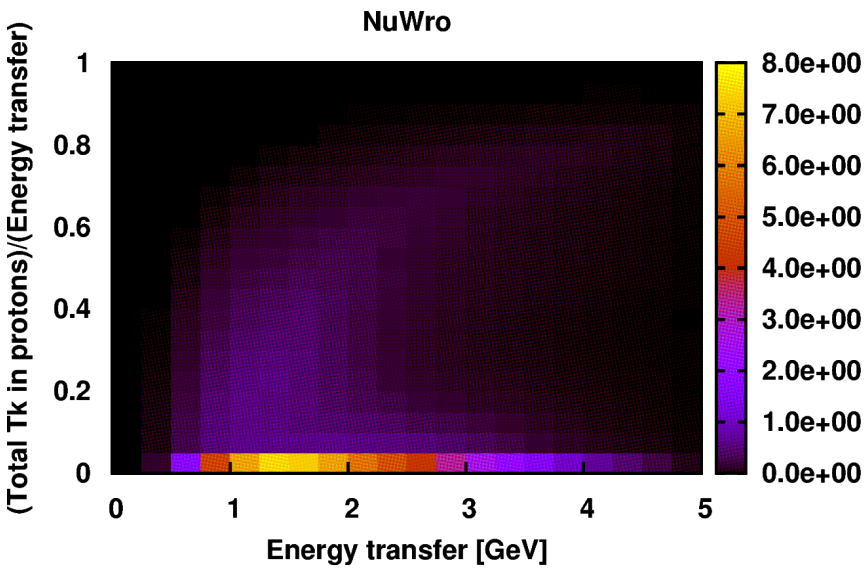
22.10.2012

MINERvA

Anti Numu, 5 GeV, CC, Carbon

2 pions in final state





MINERva

Anti NuMu

5 GeV

CC

Carbon

More than 2 pions in final state

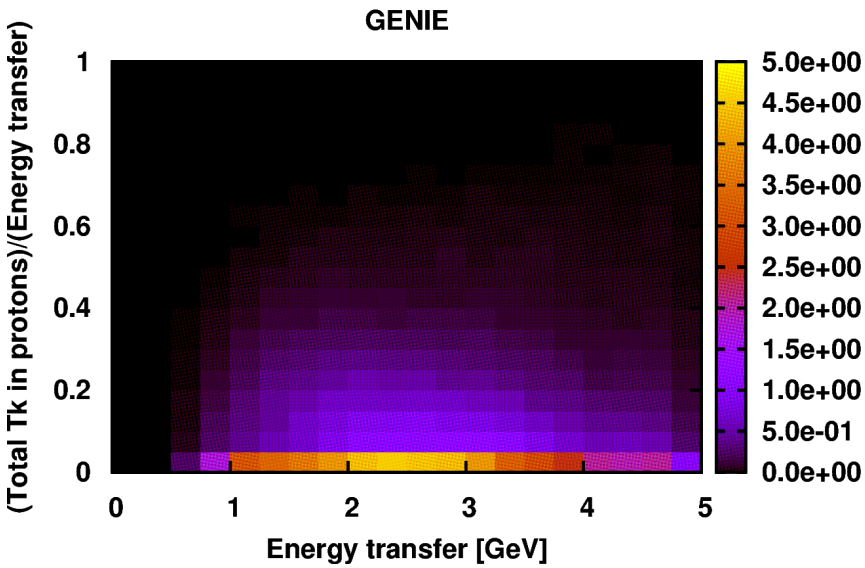
(Total kinetic energy in all protons) / (Energy transfer)

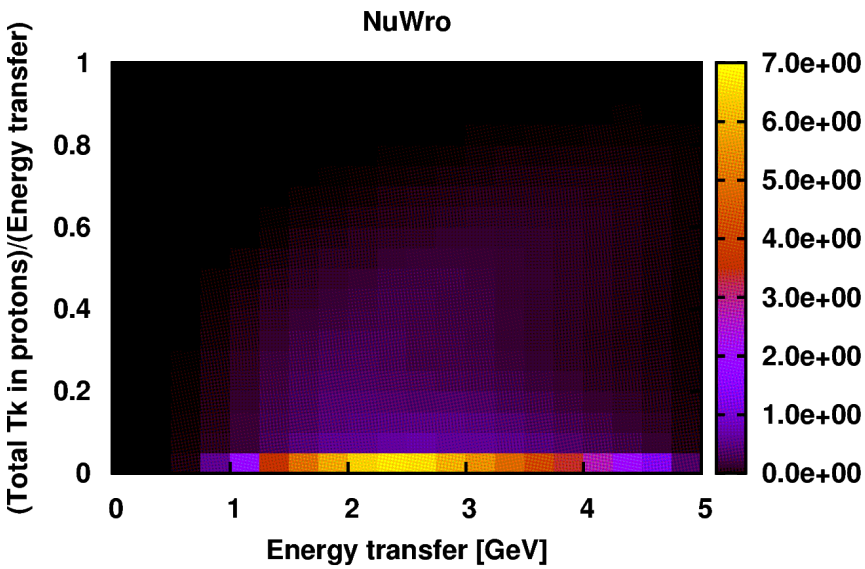
22.10.2012

MINERvA

Anti Numu, 5 GeV, CC, Carbon

More than 2 pions in final state





MINERva

NuMu

5 GeV

CC

Carbon

No pion in final state

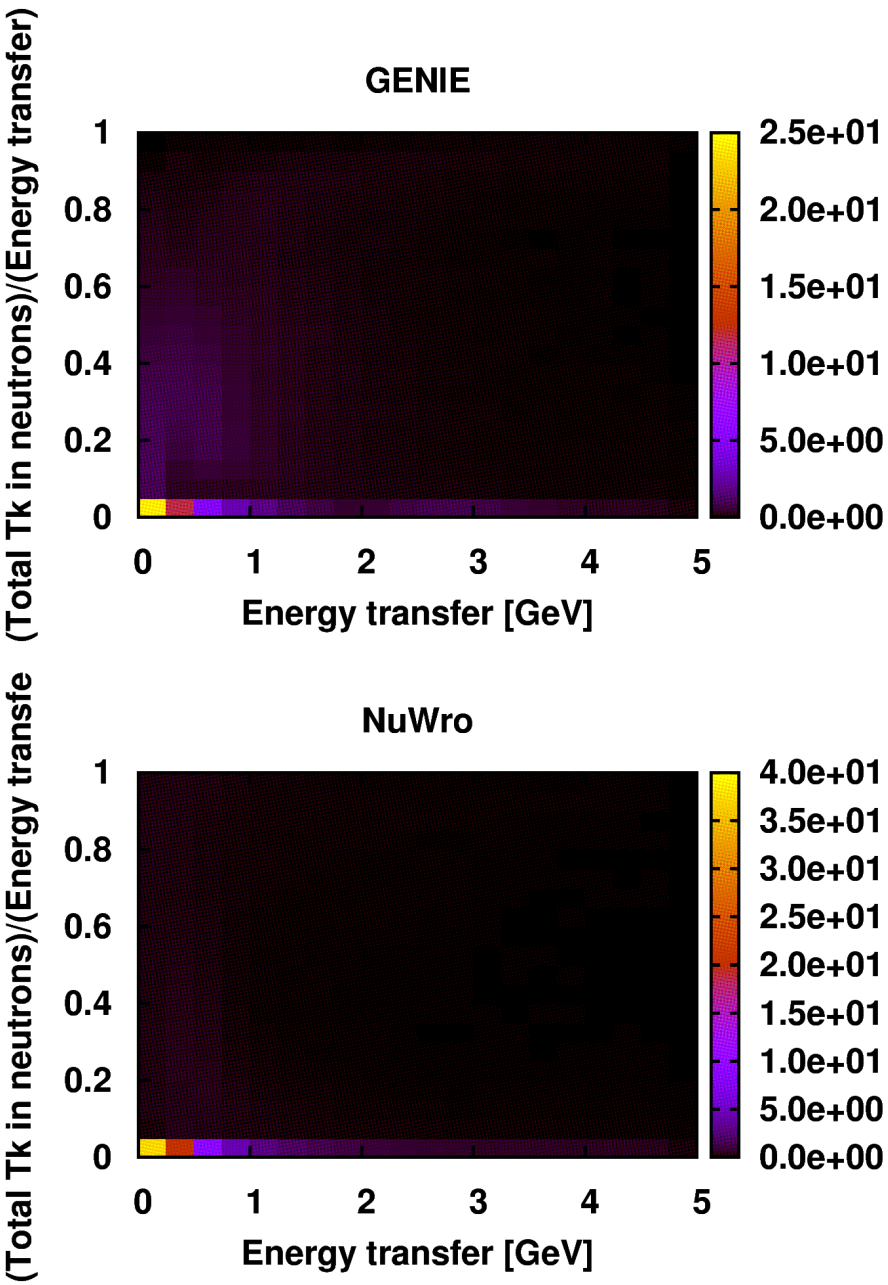
(Total kinetic energy in all neutrons) / (Energy transfer)

22.10.2012

MINERvA

Numu, 5 GeV, CC, Carbon

No pion in final state



MINERva

NuMu

5 GeV

CC

Carbon

1 pion in final state

(Total kinetic energy in all neutrons) /

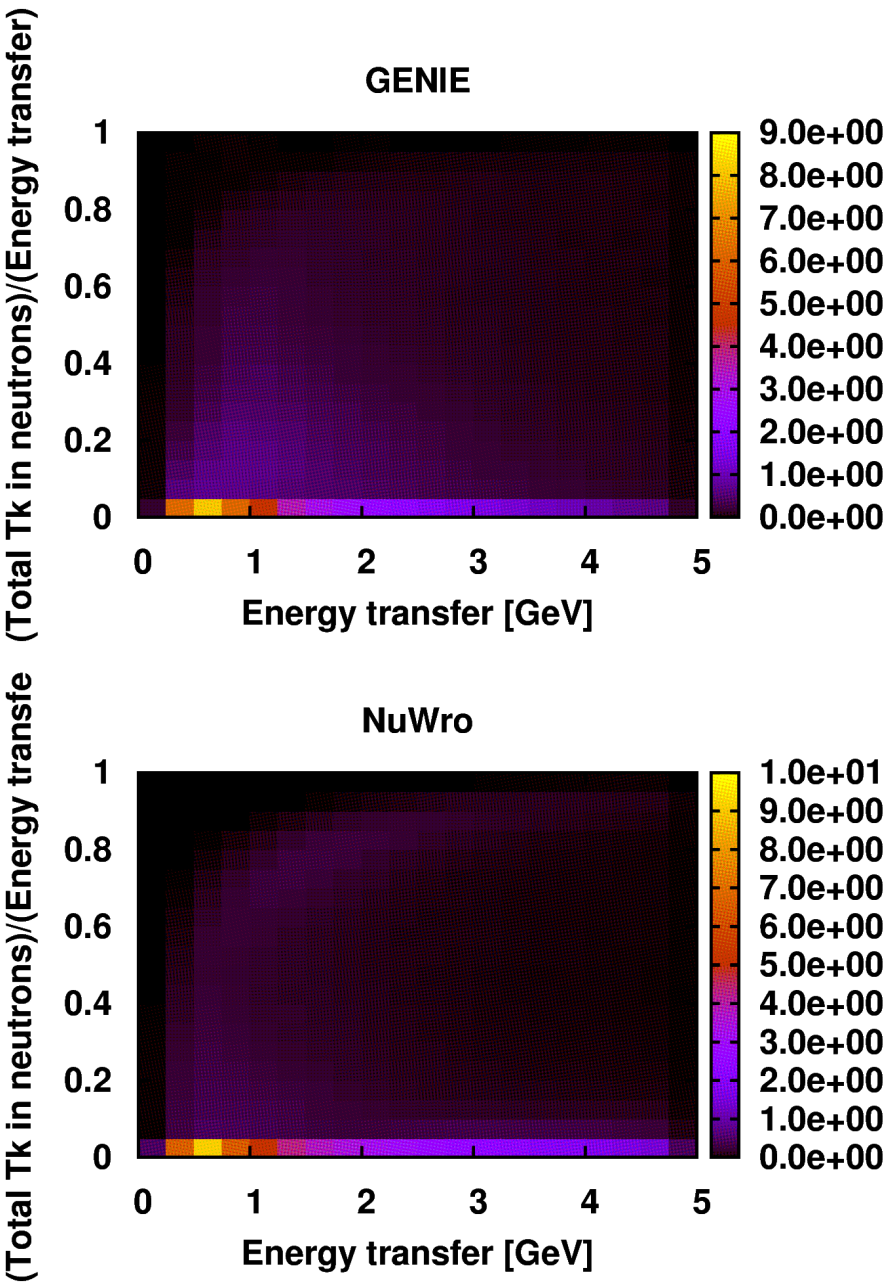
(Energy transfer)

22.10.2012

MINERvA

Numu, 5 GeV, CC, Carbon

1 pion in final state



MINERva

NuMu

5 GeV

CC

Carbon

2 pions in final state

(Total kinetic energy in all neutrons) /

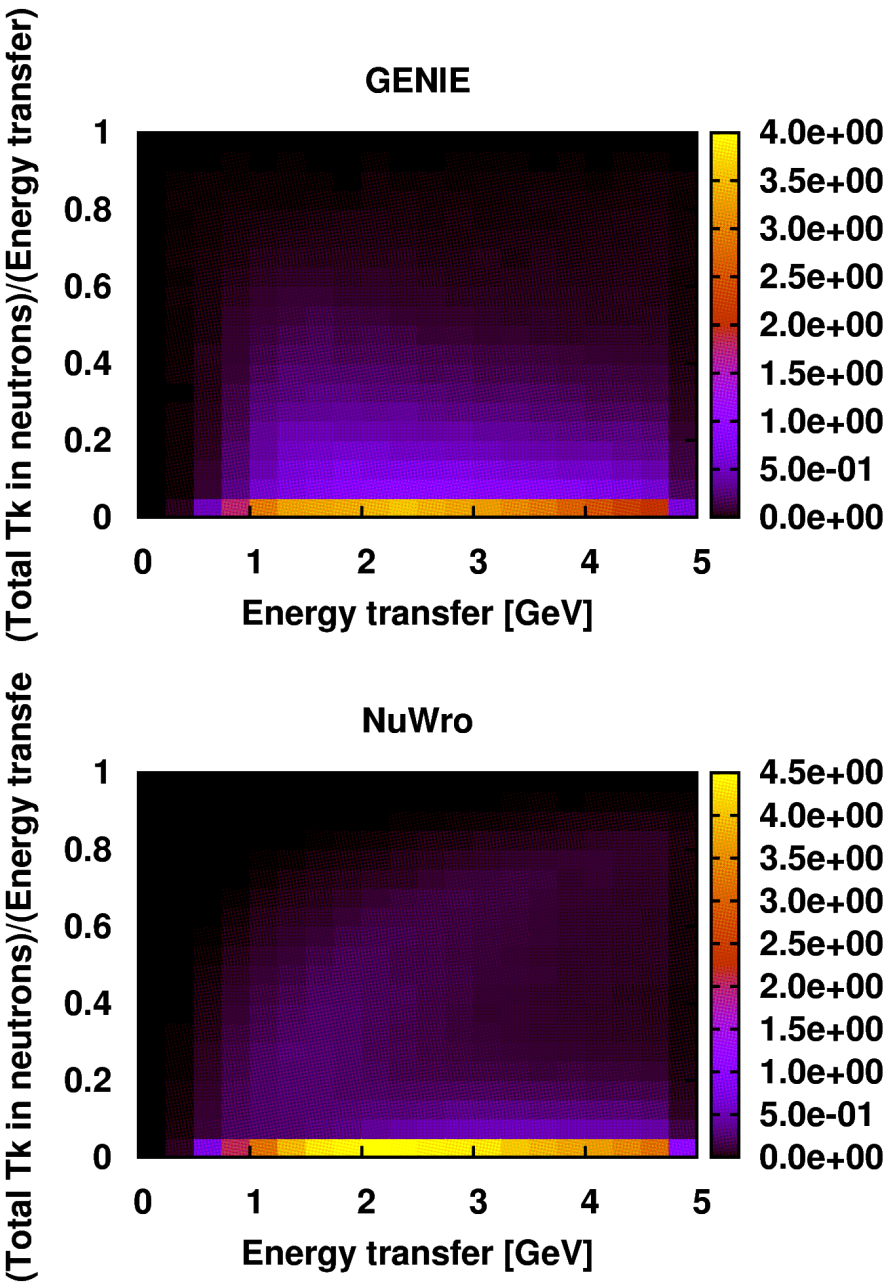
(Energy transfer)

22.10.2012

MINERvA

Numu, 5 GeV, CC, Carbon

2 pions in final state



MINERva

NuMu

5 GeV

CC

Carbon

More than 2 pions in final state

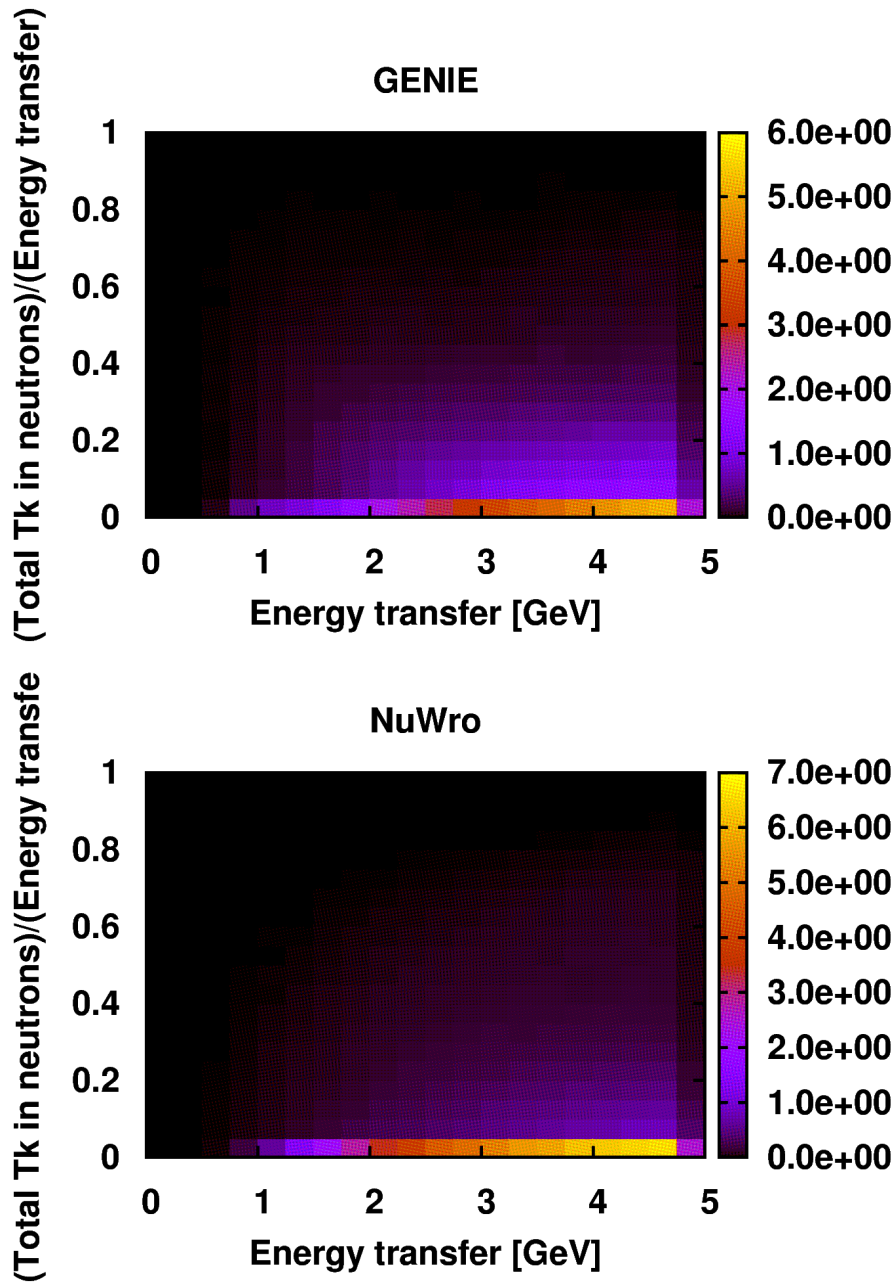
(Total kinetic energy in all neutrons) / (Energy transfer)

22.10.2012

MINERvA

Numu, 5 GeV, CC, Carbon

More than 2 pions in final state



MINERva

Anti NuMu

5 GeV

CC

Carbon

No pion in final state

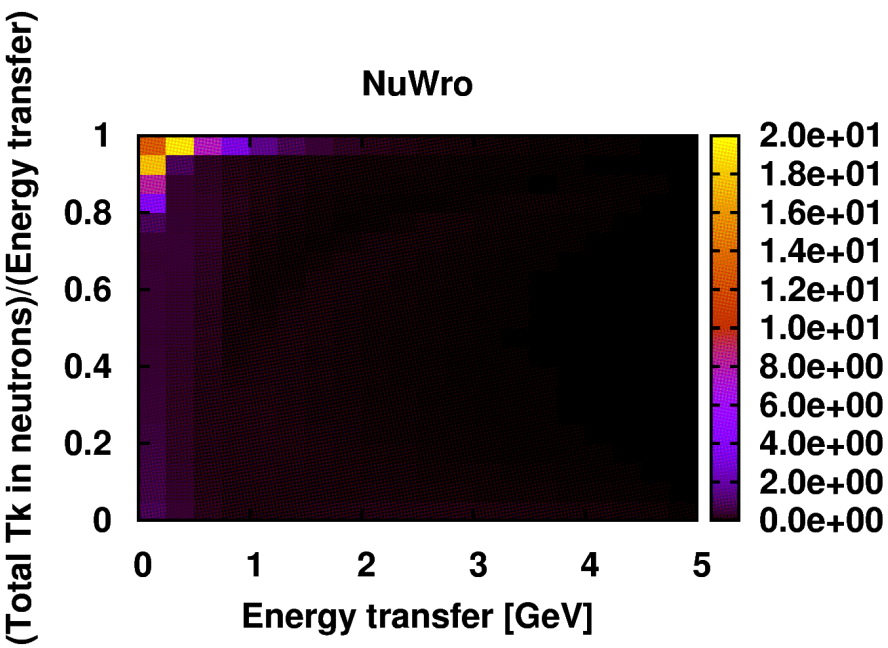
(Total kinetic energy in all neutrons) / (Energy transfer)

22.10.2012

MINERvA

Anti Numu, 5 GeV, CC, Carbon

No pion in final state



MINERva

Anti NuMu

5 GeV

CC

Carbon

1 pion in final state

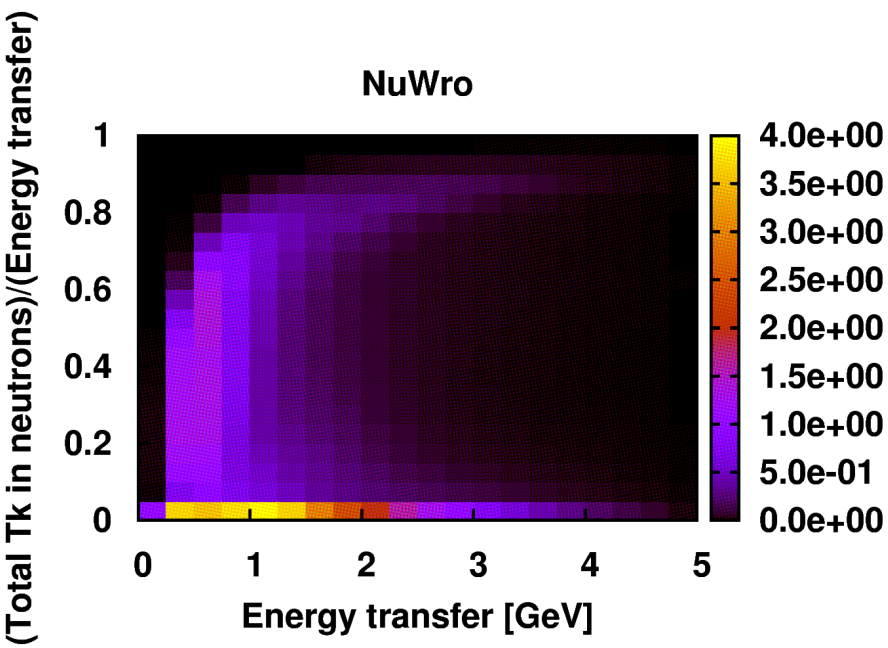
(Total kinetic energy in all neutrons) / (Energy transfer)

22.10.2012

MINERvA

Anti Numu, 5 GeV, CC, Carbon

1 pion in final state



MINERva

Anti NuMu

5 GeV

CC

Carbon

2 pions in final state

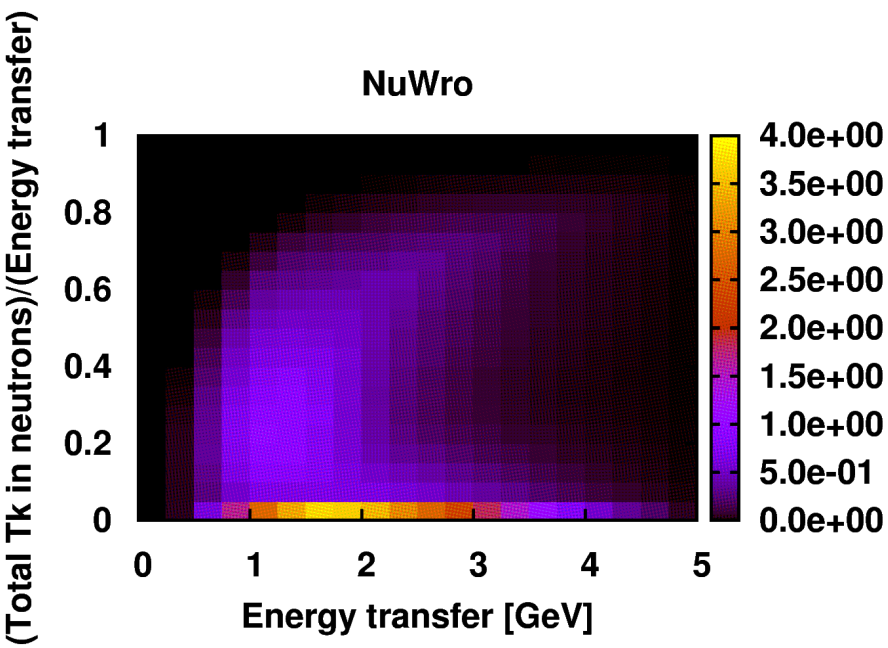
(Total kinetic energy in all neutrons) / (Energy transfer)

22.10.2012

MINERvA

Anti Numu, 5 GeV, CC, Carbon

2 pions in final state



MINERva

Anti NuMu

5 GeV

CC

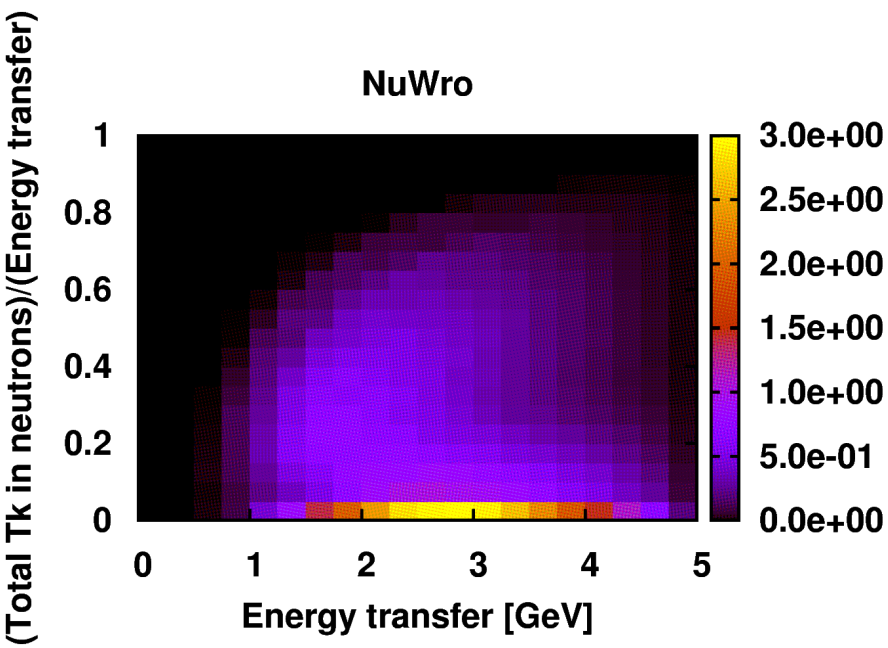
Carbon

More than 2 pions in final state

(Total kinetic energy in all neutrons) / (Energy transfer)

22.10.2012

MINERvA

Anti Numu, 5 GeV, CC, Carbon

More than 2 pions in final state