thoughts on overcoming limited generator systematics

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For DUNE NDPWG
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Salvador Dali, 1956
Saint Surrounded by Three Pi Mesons

This week: Rik's thoughts.
Next meeting: followup from Kendall, T2K experience

Overarching suggestion,
we identify a small number of weaknesses
and probe them using FastMC.

Then expand to the full set.

Don't need to be perfect.
Benefit from making smart guesses.

Processes not in generator

are probably more important
than modifications to processes already in the generator
some ask “will DUNE or ND handle unknown unknowns”

Lets pick a process that is brand new to generator
(or not new, but was unknown)
and probe what would happen if we didn't know it.

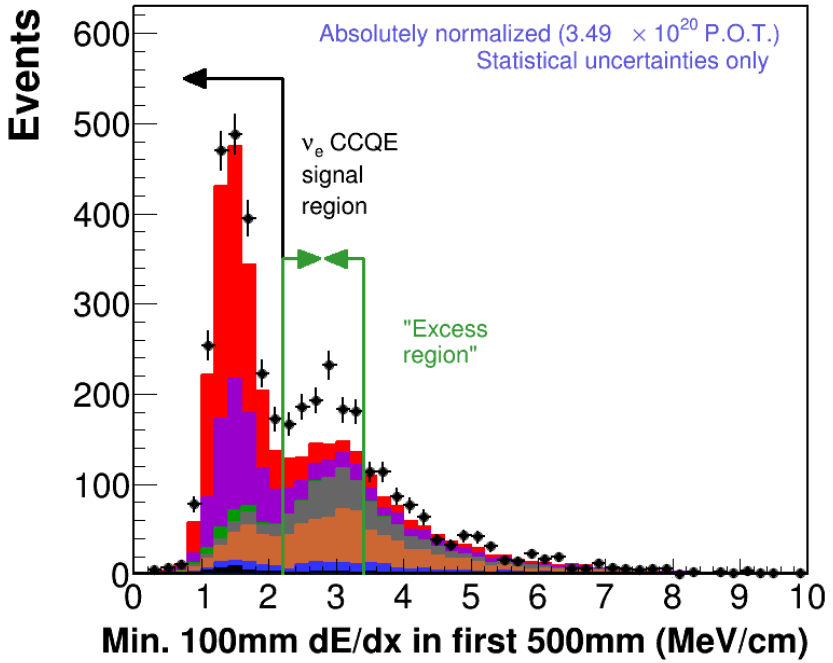
Obvious, fashionable example: 2p2h processes
there is now working GENIE code (not in repository)
being used by MINERvA
also T2K and NuWro have code they use
and there is a publication trail about why its important.

These 2p2 codes derive from a common base, by design
can accept Hadron Tensor input from multiple model authors.

Processes not in generator other examples

MINERvA has identified some processes consistent with diffractive scattering off hydrogen. (Well, not much of that in LAr, but...)

And GENIE has a latent model by D. Rein that isn't really used and might not be fully implemented.



Unpredicted photon-like excess from the sideband to CCQE nue MINERvA result
J. Wolcott, W&C, Sept. 2015

Wait, but those processes ARE in generators

Concept: use them to set up a mock data study
where the thing we want to know is not
how wrong do we get oscillation parameters
but what mechanisms are in play
(and then what a ND needs to do)

We have good guesses about the 2p2h:
has different final state nucleons that QE, Δ
modifies the reconstructed energy scale
for both calorimetry and from QE hypothesis
(publication trail on this topic)

Hmm. once we pick a process
need to also design a mock data study.

FSI uncertainties

The good: generically difficult, not impossible to constrain

Still good: they lead to energy scale and resolution errors

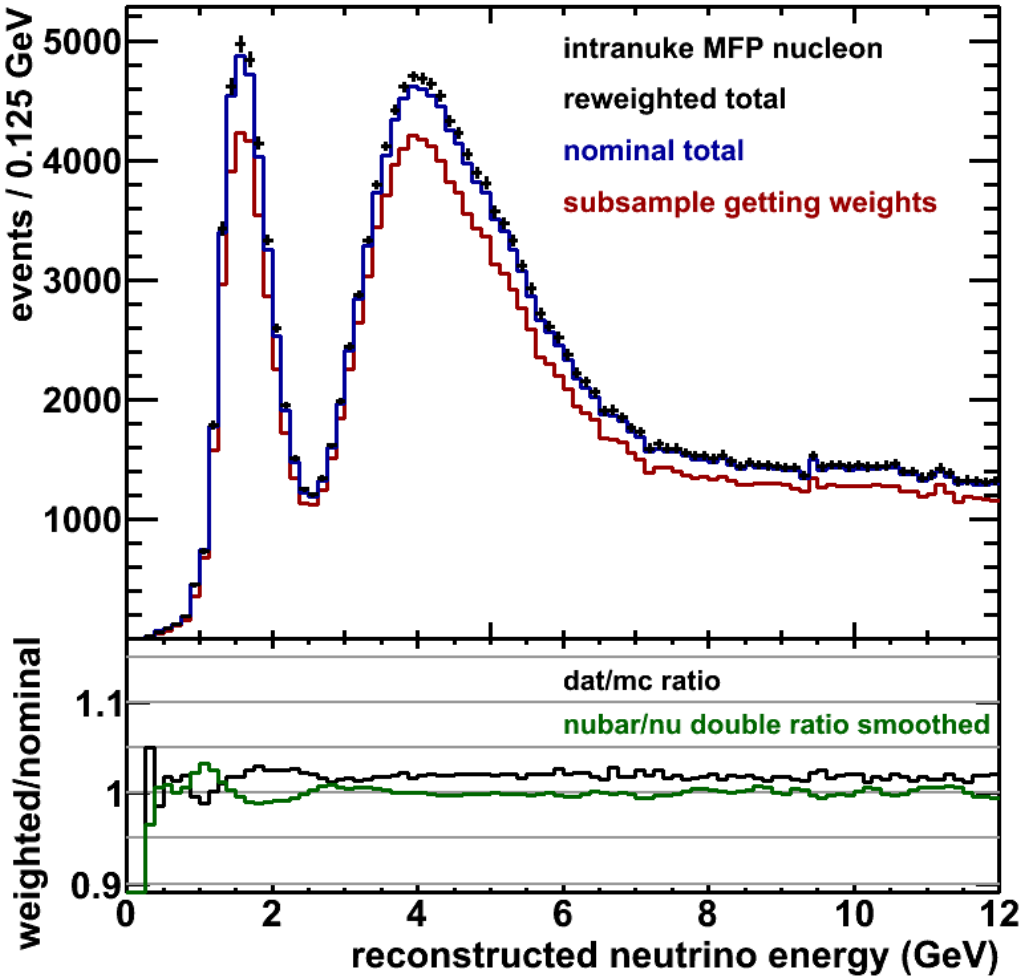
The bad: A^x dependent, need to measure on Ar.

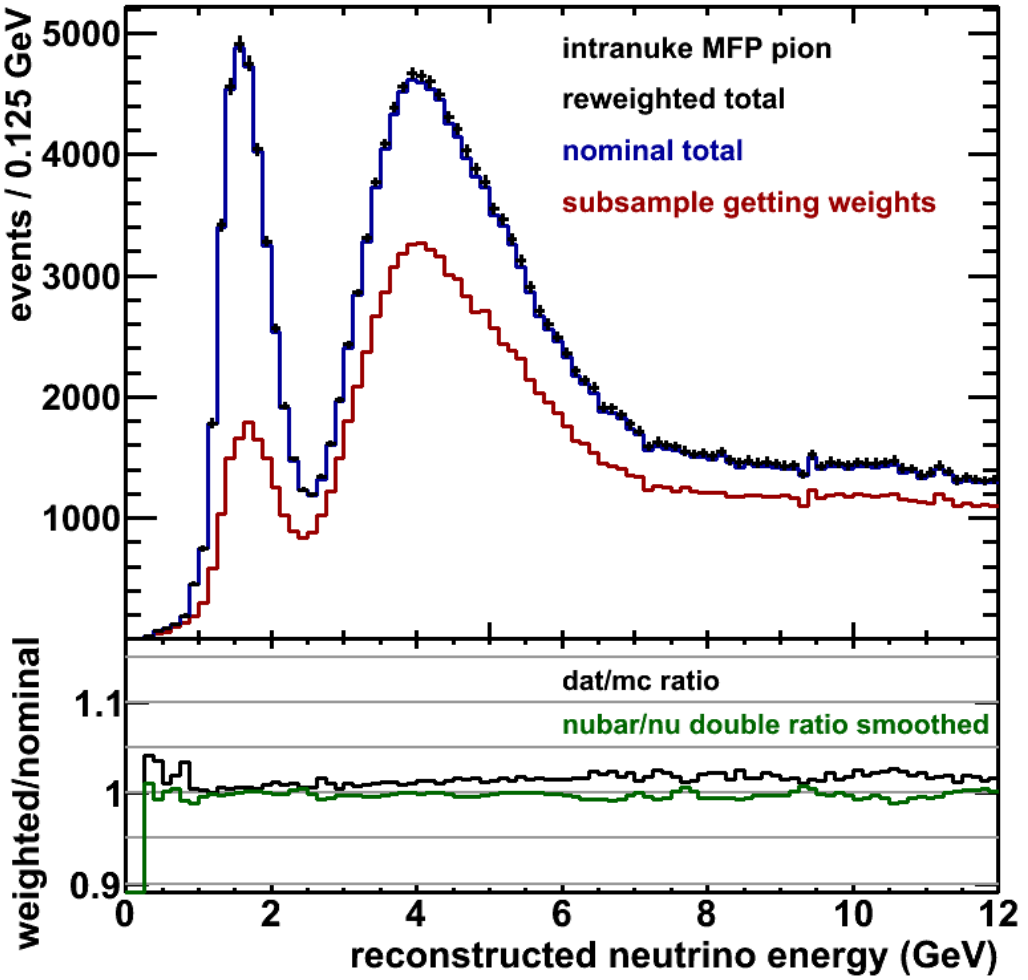
The worse: isospin of nucleus means different effects for neutrino and anti-neutrino scattering.

The “worse” might be a green field for us.
Dan and I started to look into the bad with the FastMC
MINERvA has started to look into the good.

FSI very early FastMC disappearance study

Increase MFP means less rescattering = higher reco enu
but affects the NC background at low reco enu.





Had 3% nubar/nu asymmetry, using default GENIE knob.

In LBNE, Mindy Jen and Va. Tech were looking in this direction.

Energy dependence

Ansatz: energy dependence of the cross section changes smoothly once above 1.5 GeV or so at least for the neutrino case

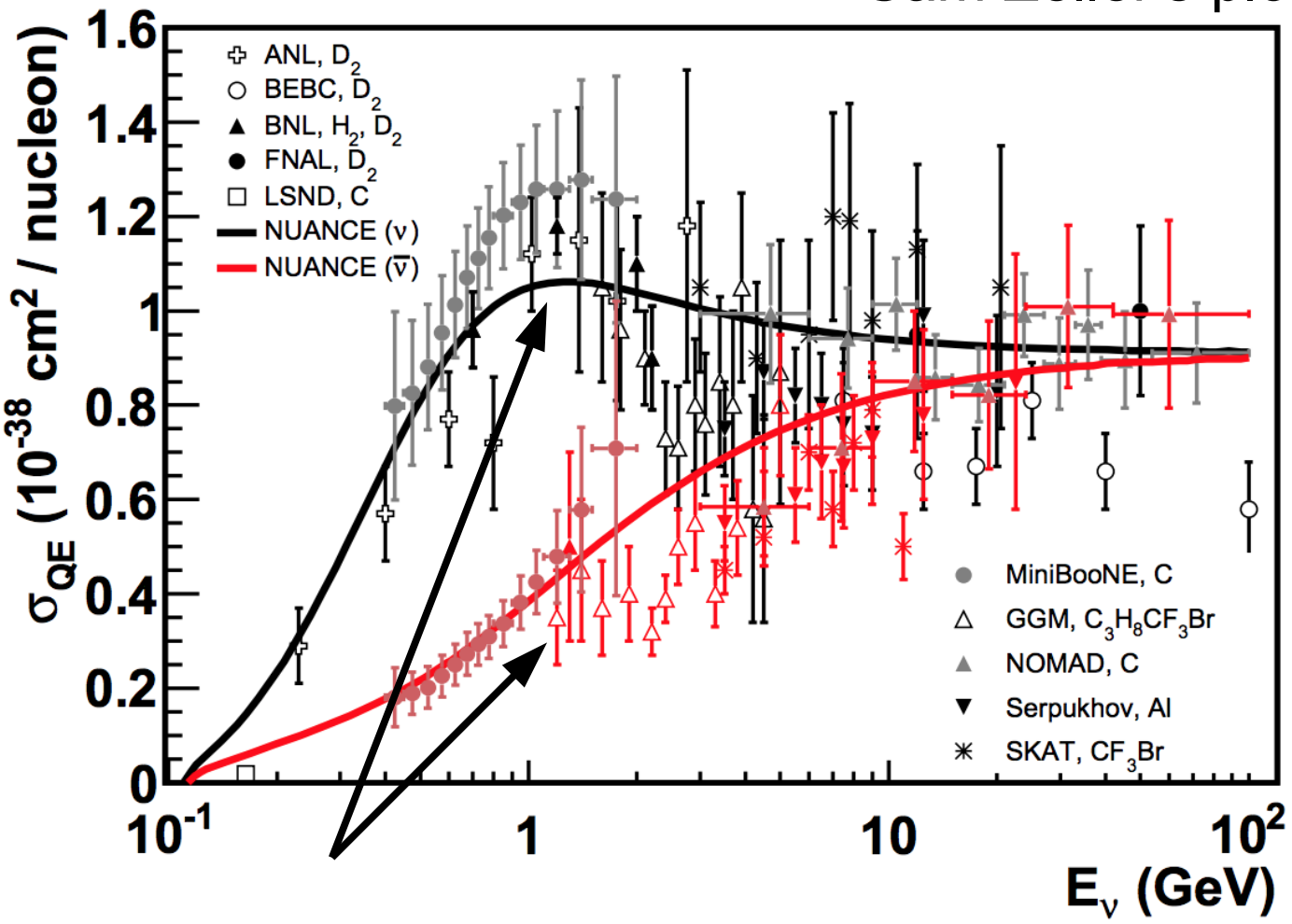
DIS goes as E
QE is almost flat (changing VA interference term)
Resonance...
Coherent has smooth energy dependence

The low-nu method depends on this
almost all models have this baked in

Thats good. whatever we model poorly
we also mis-model with smooth energy dependence
measure how poorly we model it
and extrapolate smooth to the far detector.
If we did all our physics at 2 GeV, then maybe okay.

Low energy QE

Sam Zeller's plot from PDG



This is the “easiest” (?) process to describe in nuclei
The structure at 1 GeV comes from two things
the opening of high Q2 kinematics with energy
The fall of the axial&vector interference term (anti-nu rises)
get σ(E) AND the reco σ(E) correct here.

Discussion

We will continue with Kendall's list next meeting.
she will have some other favorites.
You probably have some favorites too.

I didn't mention pion production at all
but have more on my list than I presented today.

If we picked one today what is the next step?

Your other concerns here ?