MicroBooNE physics sensitivities via LArSoft

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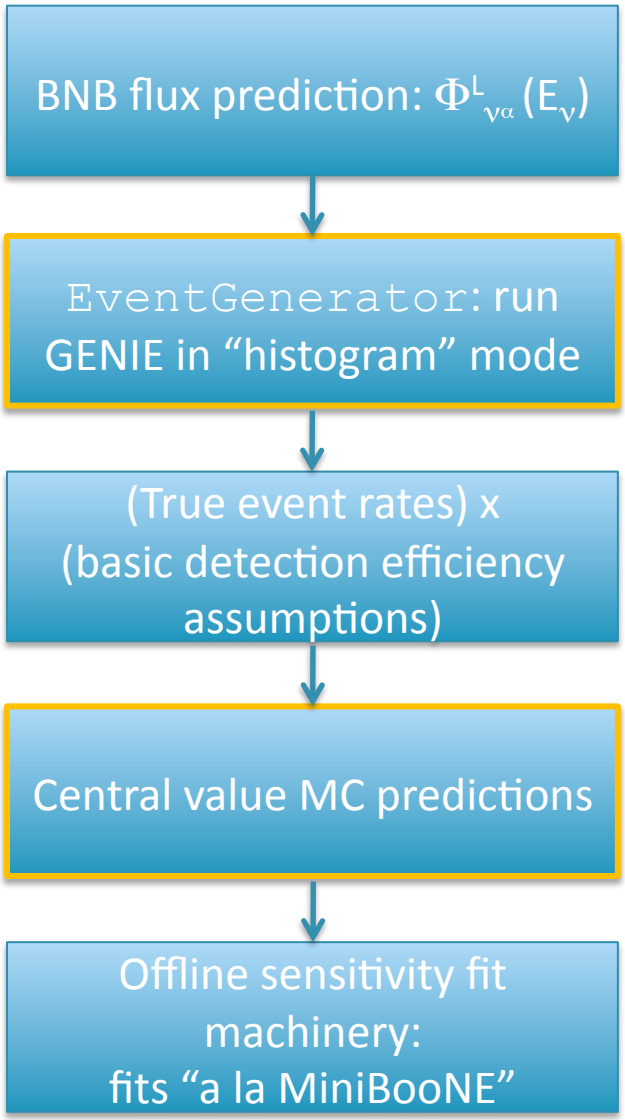
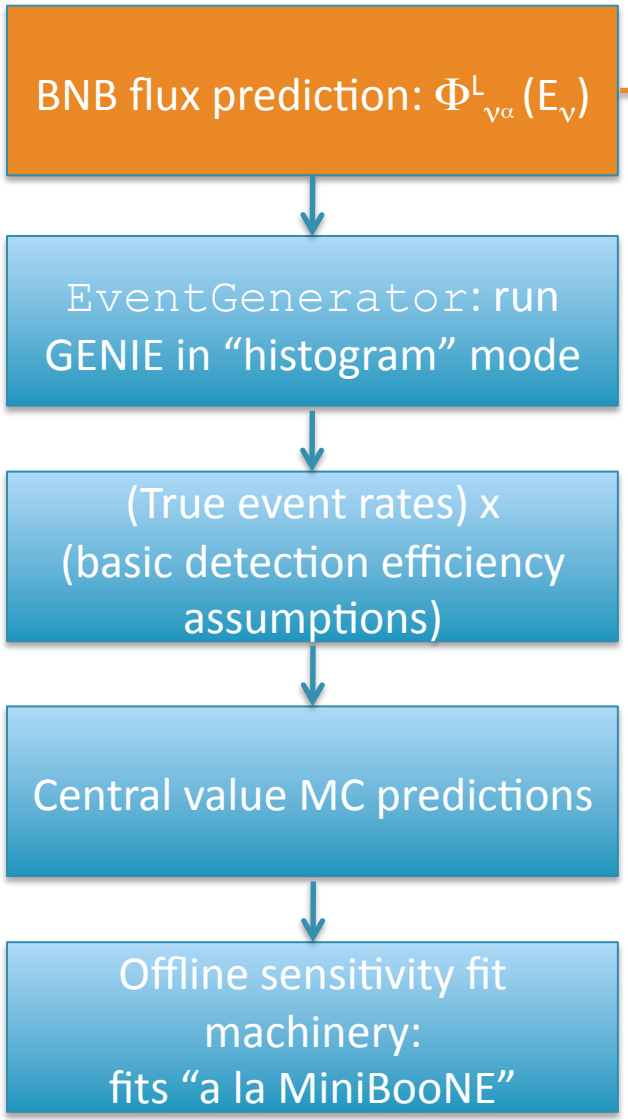
Our task: BNB short-baseline LArTPC physics sensitivities



Steps involving LArSoft

How we get there: step-by-step



Predicted neutrinos at distance L from (downstream face of) BNB proton target, within beam cross-sectional area corresponding to radius R (just large enough to inscribe detector face); per neutrino flavor & sign

Issue:
No parent, L information available! Plan to switch to new flux file format ("simple_flux").

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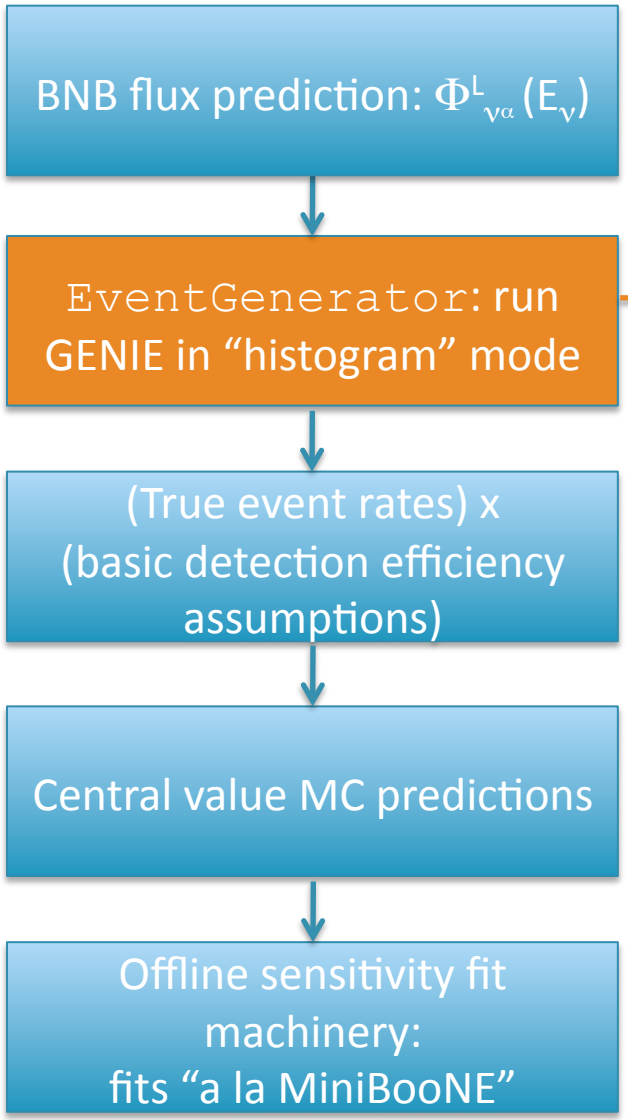

This step requires running on condor!

Events generated in "volTPC" of detector geometry.
At first stage of running this step, final states were not propagated through LArG4; that stage is being done now.

Minor issues:

1) A lot of (unexpected) trouble-shooting for understanding event rates; it would be very useful to have a detailed (and relatively up to date) geometry description of each detector documented on the wiki.
2) Event rate truth information format:
   This may be entirely due to my limited experience with GENIE, but sifting through interaction products to identify specific particle interaction (e.g. NC resonant D→Nγ) seems painful; having an additional tag ("nuance-like") for each neutrino interaction identifying interaction channel would be useful (direct comparison to MiniBooNE rates). Can channel info be easily appended to MC truth output info?
3) Limited condor space?
   /grid/fermiapp/uboone/condor-tmp/ → ~20 G or so
   /grid/data/uboone/outstage/ → have not run out of room yet

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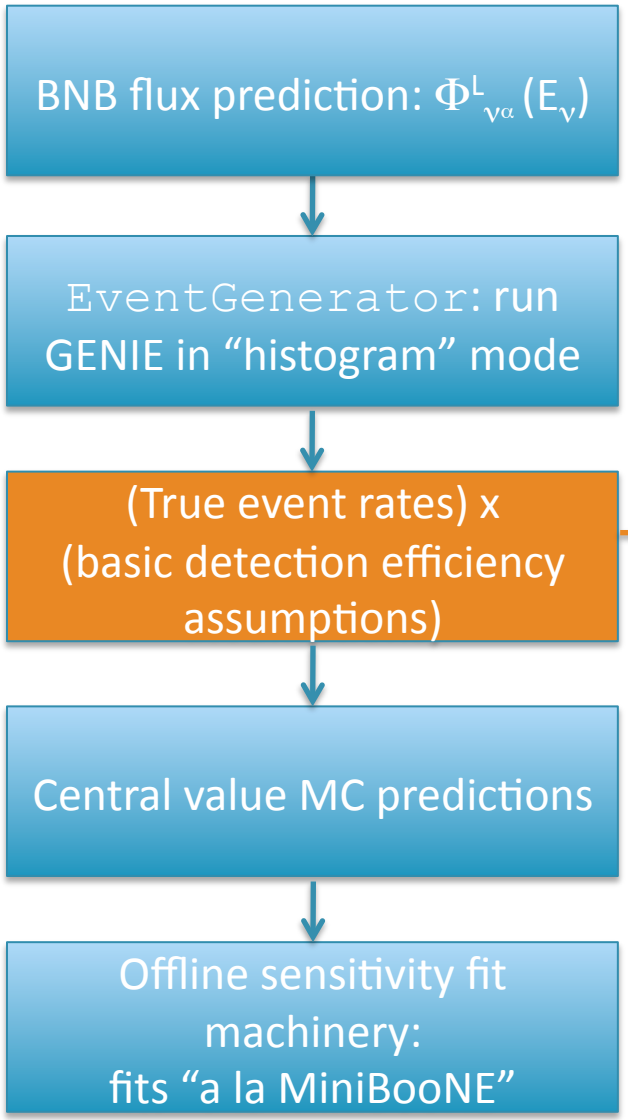

This is where reconstruction and pid steps will come in eventually !!!

For now, resorting to quick-and-dirty way of folding in reconstruction and pid efficiencies: simple scaling, energy-independent.
Our estimated values come from LBNE:
B. Fleming, LBNE osc meeting, Jul. 26 2010 (derives from Tufts hand-scanning 2006 study, T2K 2km studies, NuMI off-axis hand scanning

[Those scalings are actually applied during next step.]

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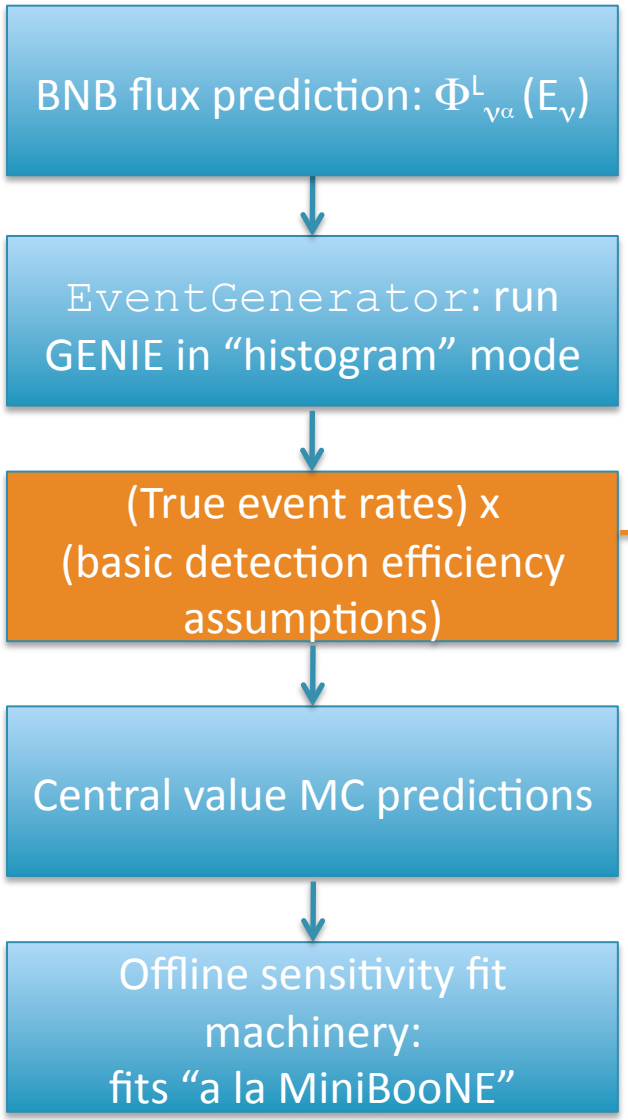

This is where our efforts are focused now!

This is where reconstruction and pid steps will come in eventually !!!

For now, resorting to quick-and-dirty way of folding in reconstruction and pid efficiencies: simple scaling, energy-independent; plus energy smearing.
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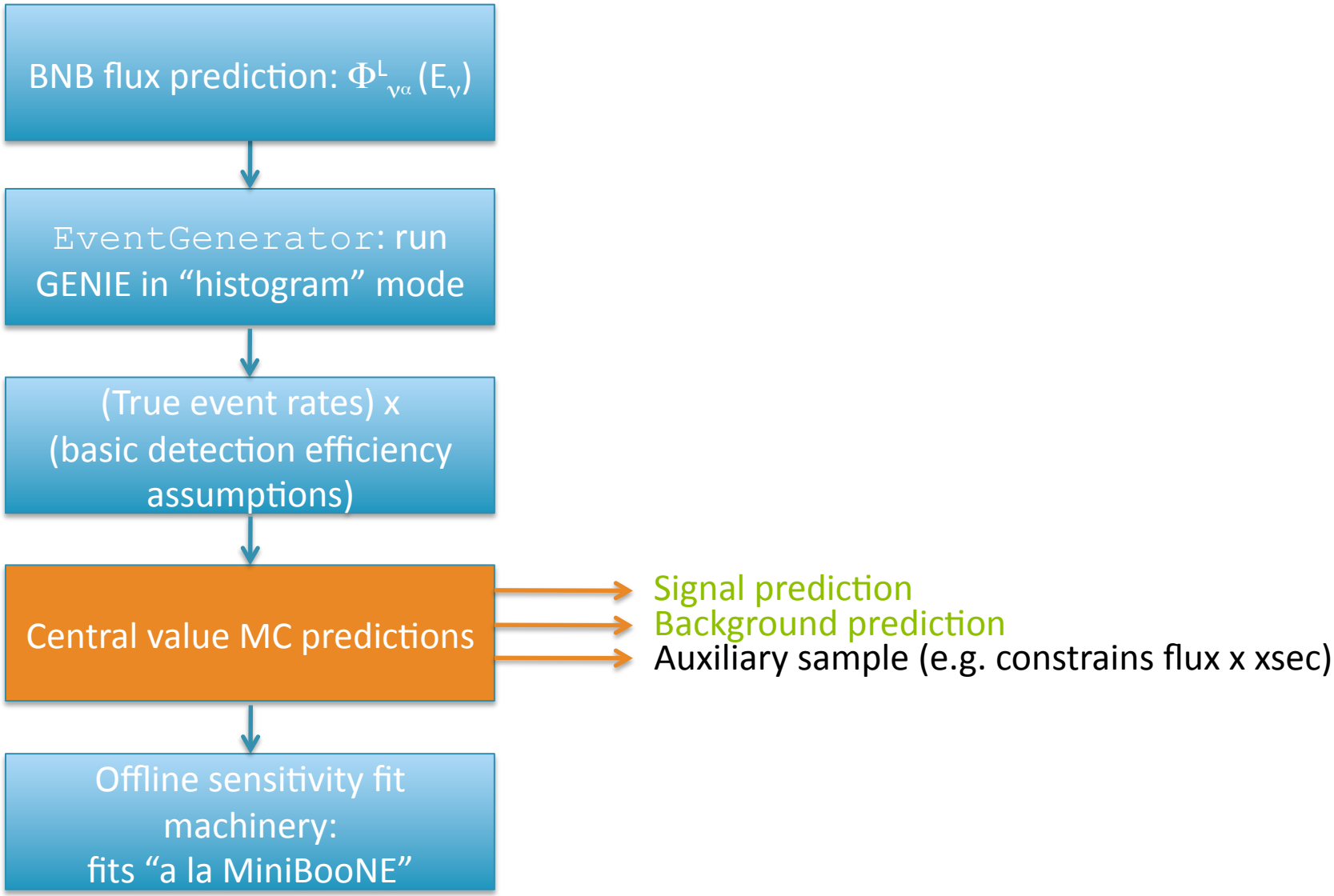

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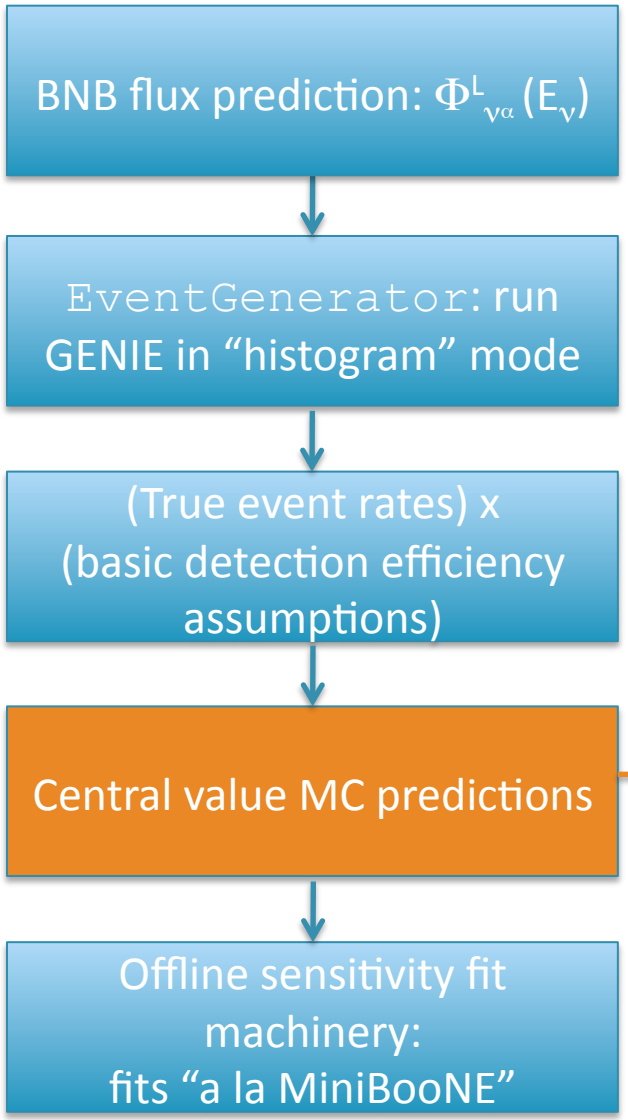
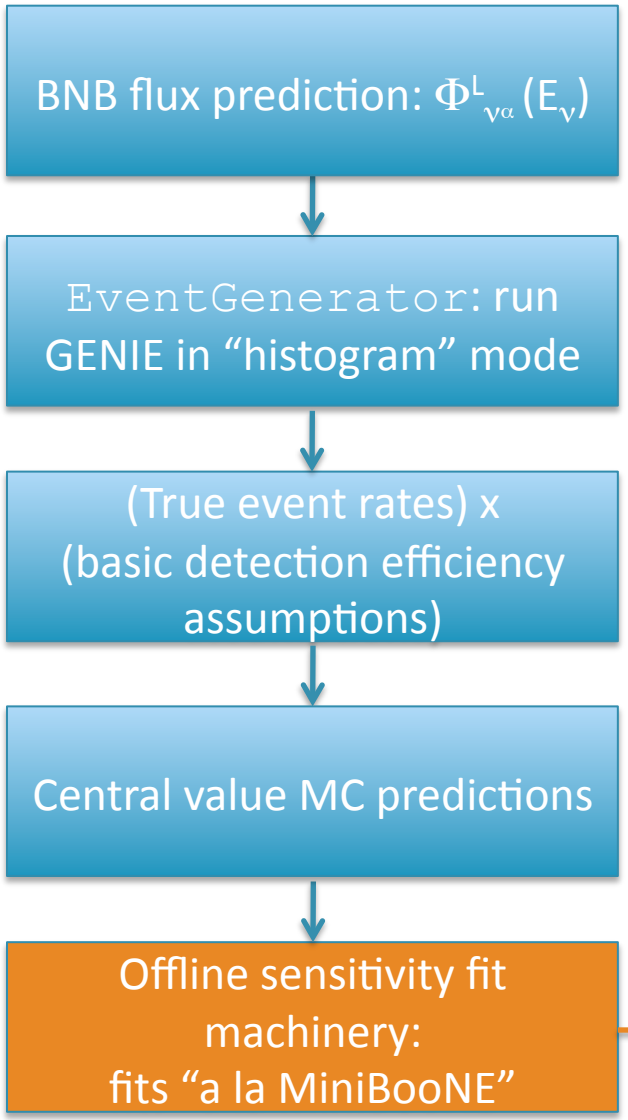


Wrote separate LArSoft package/module:
`GENIEextracter/NuAna`
(already developed)
Puts useful variable info from EventGenerator in format needed by the fit machinery:

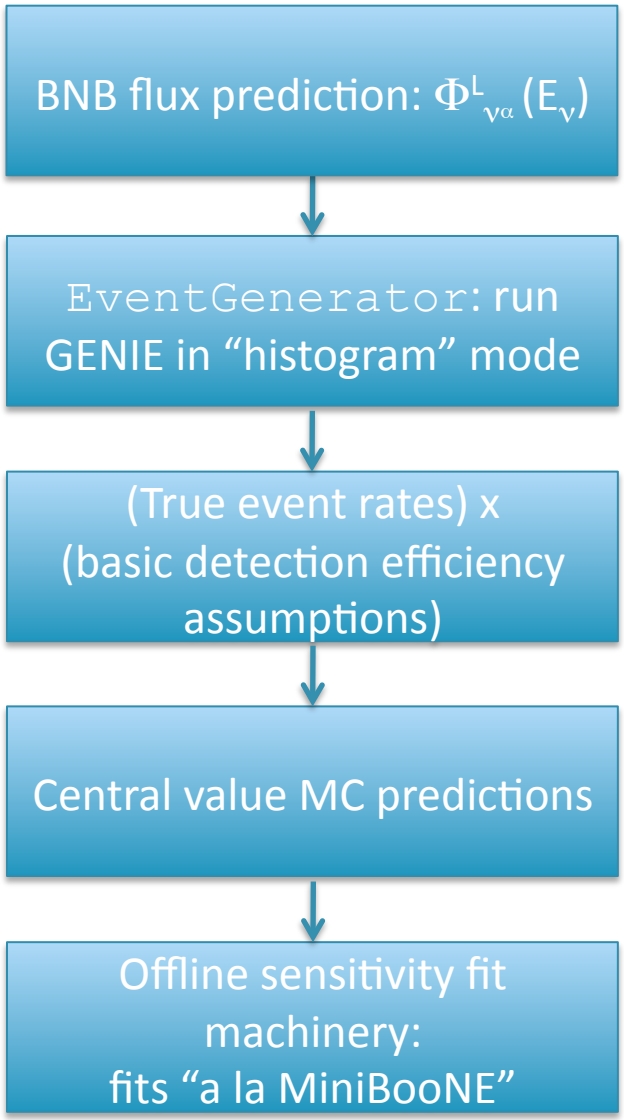
Eg. for oscillation fits:
True E, True L for signal prediction
Rec E for signal and background
Tags: nu, nubar, signal, background, auxiliary, interaction channel (for channels of interest)

How we get there: step-by-step



At the moment, fit machinery is oscillation-specific, but modifications for low E sensitivities are easy.

Status



We have event rate information (no final state effects) for all baseline/detector combinations we need to consider in the study.

[Final states being run through LarG4 as we speak.]

We have successfully run through full chain and produced first oscillation sensitivity estimates for MicroBooNE at L=540m.

Right now: cross-checking with past MicroBooNE sensitivities

Achilles' heel:

reconstruction+pid efficiency assumptions

What we would like to know for our physics studies

• Reconstruction and PID efficiencies for ν_e CCQE (single-electron) events
in the range 200-2000 MeV (reconstructed neutrino energy).

• Reconstruction and PID efficiencies for single-photon events
in the range 100-2000 MeV (visible energy).

• Can we push low energy threshold down?

• Energy resolution/smearing?

• Rate of mis-ID and other indistinguishable backgrounds to
- ν_e CCQE (single-electron) events
- single-photon events
as a function of energy.
    - Which backgrounds contribute in each case? Are there any processes we missed?
    - In which energy range do NC backgrounds get (mis-)reconstructed?

• How well can we differentiate $\nu/\overline{\nu}$ CCQE?

Some more thoughts…

- How do we calculate systematic uncertainties? Flux, cross-section, detector,…
- I have my own ideas (based on MiniBooNE)… I'm sure so do others

- Systematics calculations will require some new analysis module(s)
    - Within LArSoft or standalone?
    - Is that LArSoft or Physics Analysis task?