Topic 3: Systematics accounting for SBN Analyses

Ibrahim Safa and **Andy Mastbaum**

background

Part of the broader effort to reach physics quality data and perform the first joint SBN analysis in 2024.

For that purpose, the upcoming SBN Analysis workshop was set up to:

1) 2D drift simulation and deconvolution integrated in both SBND and ICARUS.
2) SBND and ICARUS simulation/reconstruction convergence.
3) Develop methods to assess full systematics envelope for SBND and ICARUS for a first analysis, with a focus on detector and G4 systematics.
4) 2024 SBN results strategy (selection type / POT / timeline)

this talk

goals

- Evaluating detector and geant4 uncertainties will be crucial not just for a first joint analysis, but ultimately for every SBND/ICARUS analysis.

- If you are planning on doing an analysis, contributing to efforts on systematics is a good way to help out everyone else while still making progress on your own work.

samples

Requested a GENIE CV sample for both SBND and ICARUS, as well as several detector variation samples

We were able to get **2D simulation and 2D signal processing** in the SBND MC samples generated for this workshop! Massive thanks to Lynn, Ewerton, Henry, Lan, Mateus, and Fran for putting a lot of effort towards this.

Stats will be evolving throughout the week, but we should have enough samples to start making useful plots.

detector systematics

We are constrained by compute hours, cannot produce high-stat simulation sets for every possible variation. More than one solution to this problem.

Calorimetry detector systematics through re-reconstruction

- UTA group has implemented a “re-reconstruction” scheme to evaluate recombination systematics
- MC samples were produced to test this method against direct MC variations.

plots at various selection stages comparing distributions of re-reco vs MC variation

Leo Aliaga
Shweta Yadav
Rhiannon Jones
Bear Carlson

two detector correlations

To what degree can we constrain detector systematics with detector correlations?

We have a simulation set where we consistently vary recombination parameters (α/β) and diffusion parameters in both SBND and ICARUS.

Make plots to study detector correlations!

Nupur Oza
Leo Aliaga
Shweta Yadav
Rhiannon Jones
Filippo Varanini

e.g look at low-level variables in both detectors. How correlated are charge amplitude/width distributions when β is changed in the same way in both detectors?

two detector correlations

— To study differences in detector response between SBND and ICARUS, it would be informative to look at identical neutrino interactions propagated through both detectors.

Produce a mini-set with identical vertices in both SBND and ICARUS

Steven Gardiner
Tom Junk

reco efficiency uncertainties

- We need to understand better how detector variations affect efficiency of various reconstructions.

- Using the generated samples, we can try to investigate hit efficiency, track efficiency, shower efficiency, trigger efficiency etc.

plot above efficiencies for CV vs detvar samples. evaluate uncertainty for a given selection

Guadalupe Moreno Granados
Tom Junk
Mun Jung

resolution studies

- We need to understand how our energy, momentum, vertex etc resolutions are affected by detector variations.

plot resolution for CV vs detvar samples.
evaluate uncertainty for a given selection

Guadalupe Moreno Granados
Tom Junk
Mun Jung
Lynn Tung
Shweta Yadav
Bruce Howard
Leo Aliaga
Nupur Oza
Will Foreman

ICARUS wiremod

- A lot of work put in to implement the wiremod tools into icarus code.

- Right now only gaussian implementation. Code development needed to allow arbitrary functional forms.

- Validate gaussian implementation of wiremod
- Are there regions in the detector where gaussian approach is sufficient?

Harry Hausner
Lynn Tung

geant4 systematics

- GeantReweight developed for DUNE and adopted by MicroBooNE.

- Publicly available tool: github.com/calcuttj/GeantReweight

A version of sbn software that includes GeantReweight which compiles and runs

Rhiannon Jones
Bruce Howard
Daisy Kalra
!Filippo Varanini

cross section uncertainties

- re-run CAFmaker on SBND simulation using “nusystematics" tool and study relevant cross section systematics for available selections. (Afro, Jaesung)

- Create fcls to use nusystematics in sbnd
- Compare uncertainties to sbneventweight output

Afro
Mun Jung
Jaesung Kim
Guadalupe Moreno Granados
!Filippo Varanini

plan

- We will meet daily for a roundtable discussion / update.

- For those joining remotely, we will have this zoom open pretty much the whole week:

https://columbiauniversity.zoom.us/j/99000182125?pwd=ZWcxekRkalRScUZlTXE4S1pKQ3ZyQT09

Meeting ID: 990 0018 2125
Passcode: 290824

setup

- Depending on your specific task, your needs will vary. We can discuss individual needs offline.

- At the very least, setting up areas for sbndcode / icaruscode: https://sbnsoftware.github.io/sbndcode_wiki/How_to_setup_your_directory_and_launch_your_first_job.html

- For work on plots/event selections, if you prefer python, I can help you get set up on the gpvms to do event selections / plotting in a jupyter notebook