Software, Simulations, and Computing Group Plans

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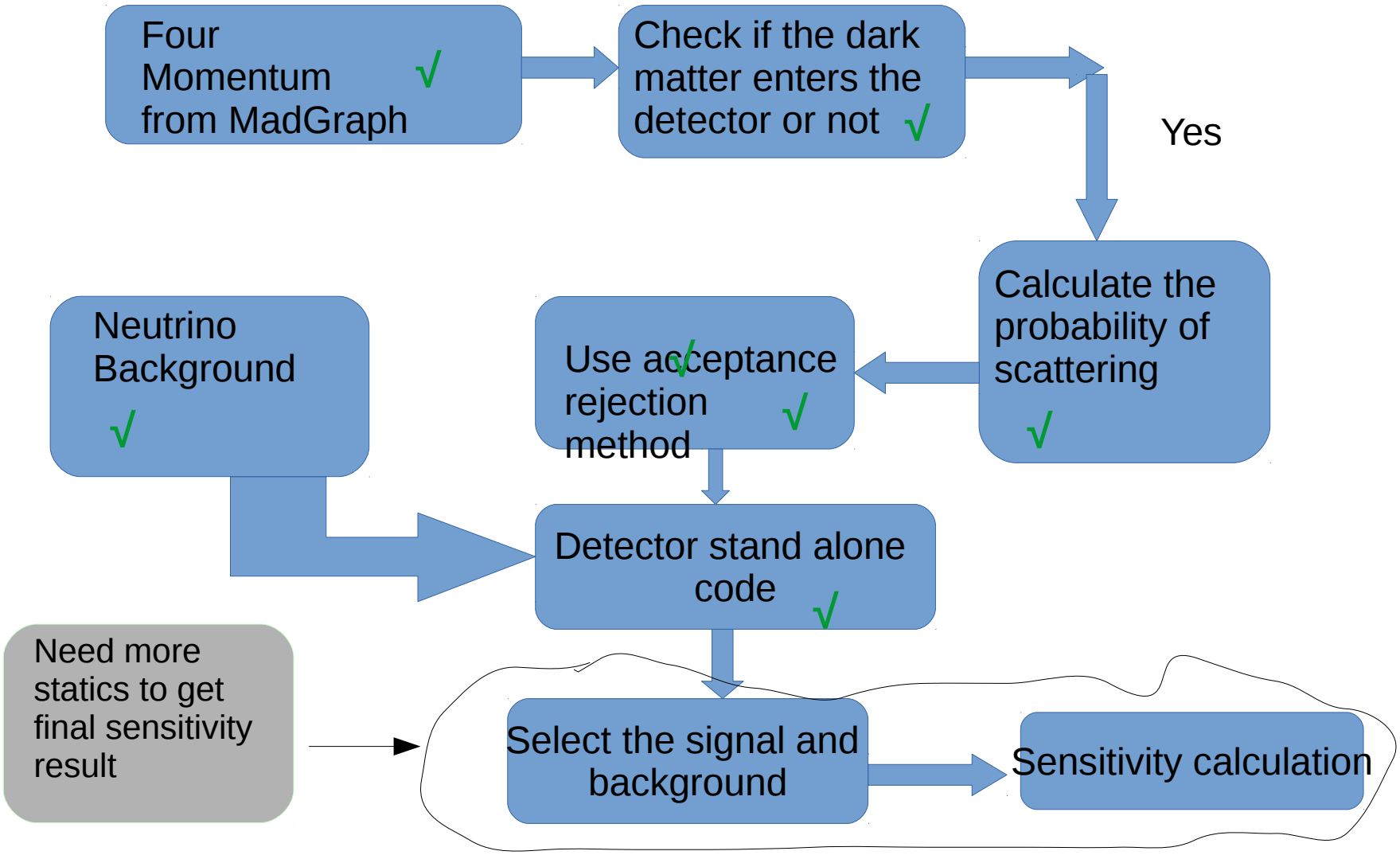
Content

- **Status & plans:**
  - → **Low mass Dark matter analysis**
  - → **Large Extra dimensions analysis**

- **Plans for simulation tools**

LDM Analysis:Schematic diagram



MadGraph Setup @FNAL Cluster

- Need to generate dark matter events for 6x10^20 POT for each dark matter parameter
- 10^20 POT correspond to more than 10 million events (depends on production cross section)
- Each run takes about 10 min with 8 threads on my personal 3.4Ghz 8 core computer. Leading to a run time of about 2 months
- A more viable option is to use Fermilab cluster to distribute the runs as jobs
- We plan to use Fermilab's grid with condor as the job manager to accomplish this.

MadGraph Setup @FNAL Cluster

- I talked with Thomas Junk regarding grid job submission at FNAL Cluster, his suggestion was
- For small need we can build and test in application directory and run the job
- But that will be private user job
- For long term and many user, it needs to be installed CVMFS
- To do so, I or some representative from the BSM group should have access to the cvmfs installation machine
- We can request DUNE Computing coordinators about this

Test Setting up MadGraph for Dark Matter Generation on the Grid

ssh to Fermilab gpvn

cd /dune/app/users/<username>/

>wget http://launchpad.net/madgraph5/2.0/2.6.x/+download/MG5_aMC_v2.6.0.tar.gz

>tar xf MG5_aMC_v2.6.0.tar.gz

>cd MG5_aMC_v2_6_0

>cp –r /path_to_DarkPhotonDM models

>./bin/mg5_aMC

MG5_aMC>import DarkPhotonDM

MG5_aMC>generate p p > chi chi~

MG5_aMC>export darkphoton

MG5_aMC>launch darkphoton

10,000 Events are generated on the spot according to settings in the param card and run card.

Setting up MadGraph for Dark Matter Generation with Condor (TODO)

- First we need to consult with the Fermi computing services for permission to run madgraph jobs.
- Next, a python script will be made to edit the param_card and run MadEvent in condor cluster mode to submit a job for each parameter.
- When the status of the jobs is complete then we can download the results.

Task for this week to complete the job submission setup in Fermi grid

LED(AS, S. DeRijck) :Status and plan

- Oscillation probability of LED model has been implemented in GLOBES
- Oscillation probability will be square of

$$\mathcal{A}(\nu_\alpha \to \nu_\beta) = \sum_{i,j,k=1}^{3} \sum_{n=0}^{+\infty} U_{\alpha i} U^*_{\beta k} W^{(0n)*}_{ij} W^{(0n)}_{kj} \times \exp\left[i \left(\frac{\lambda^{(n)}_j}{R} \right)^2 \left(\frac{L}{2E} \right) \right],$$

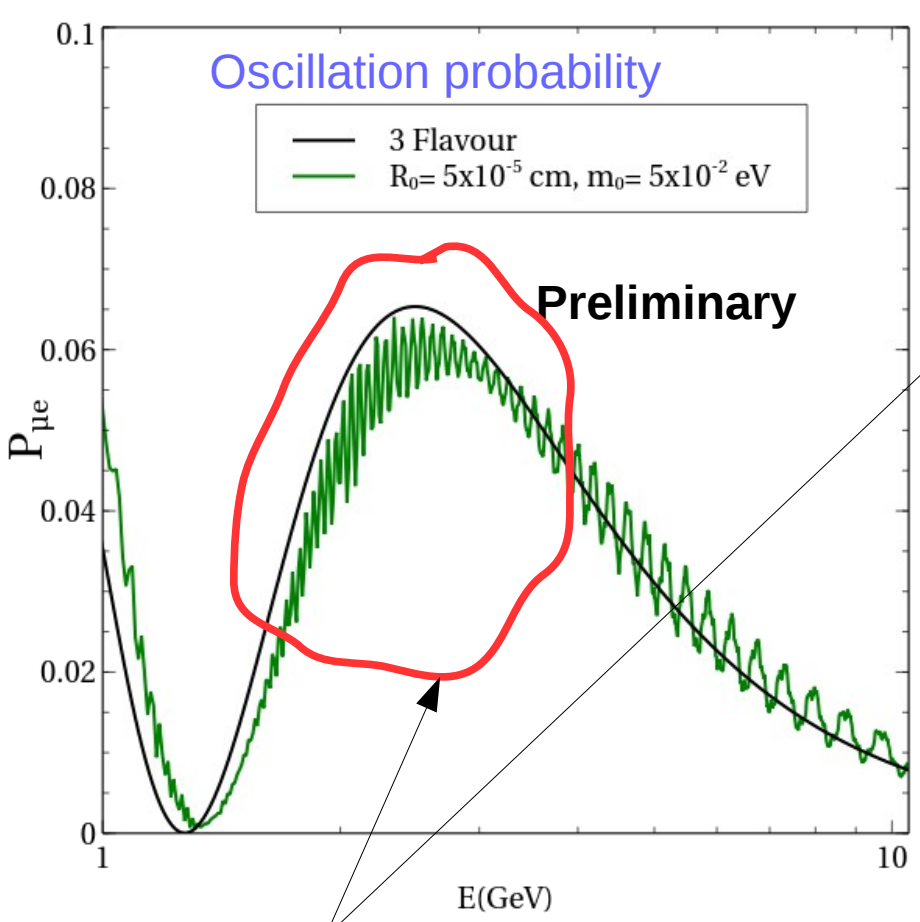
LED parameters

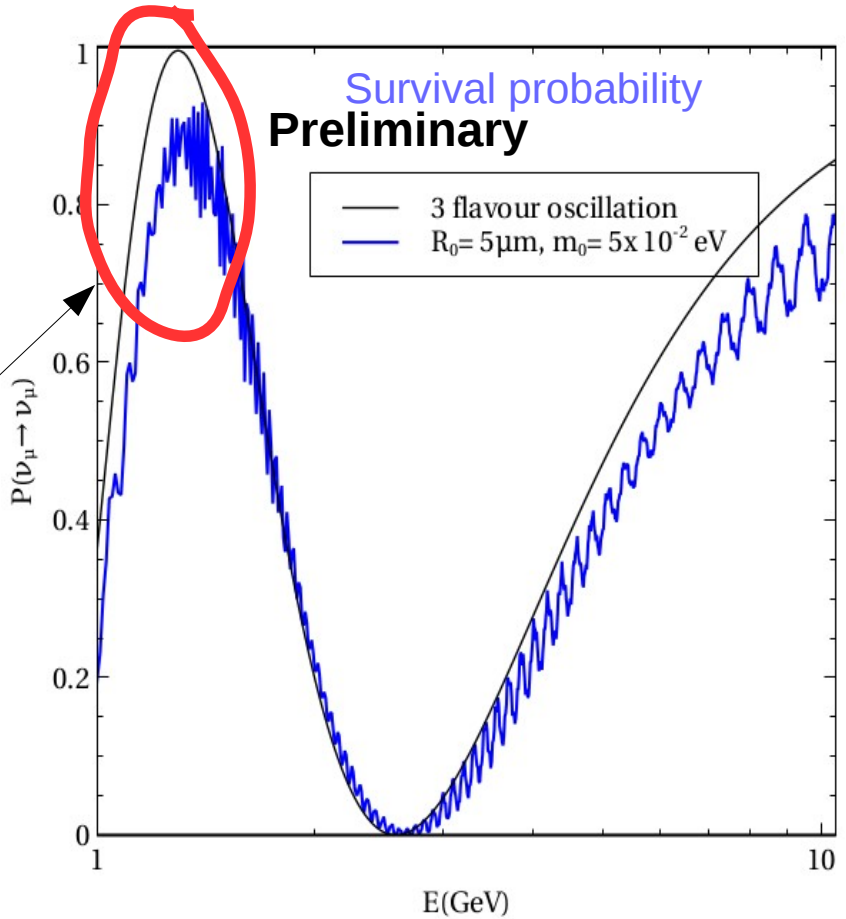
Parameter	Normal Hierarchy
$\sin^2\theta_{12}$	0.304 ± 0.014
$\sin^2\theta_{13}$	$(2.19 \pm 0.12) \times 10^{-2}$
$\sin^2\theta_{23}$	$0.514^{+0.055}_{-0.056}$
Δm^2_{21}	$(7.53 \pm 0.18) \times 10^{-5}$ eV^2
Δm^2_{31}	$(2.51 \pm 0.06) \times 10^{-3}$ eV^2

Event simulation:

- DUNE latest glb file used
- Far detector of 40kT
- 3.5 yrs of run both for neutrino and anti-neutrino
- Systematic uncertainties used as defined within glb file.
- Events plotted with 0.125 GeV bin

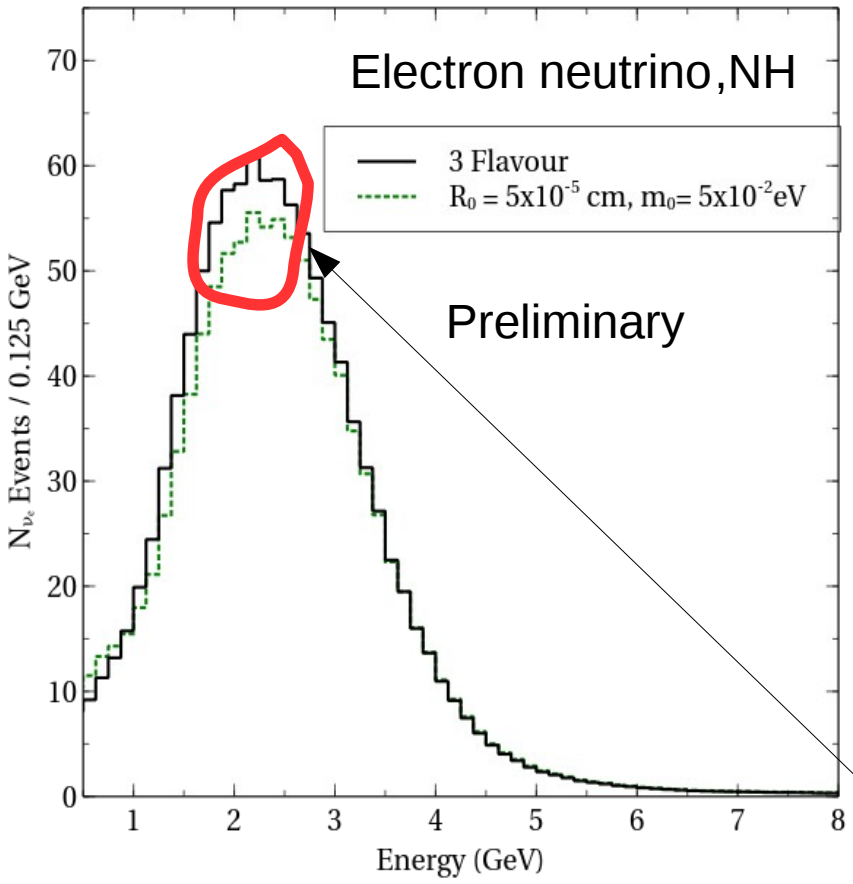
Probability

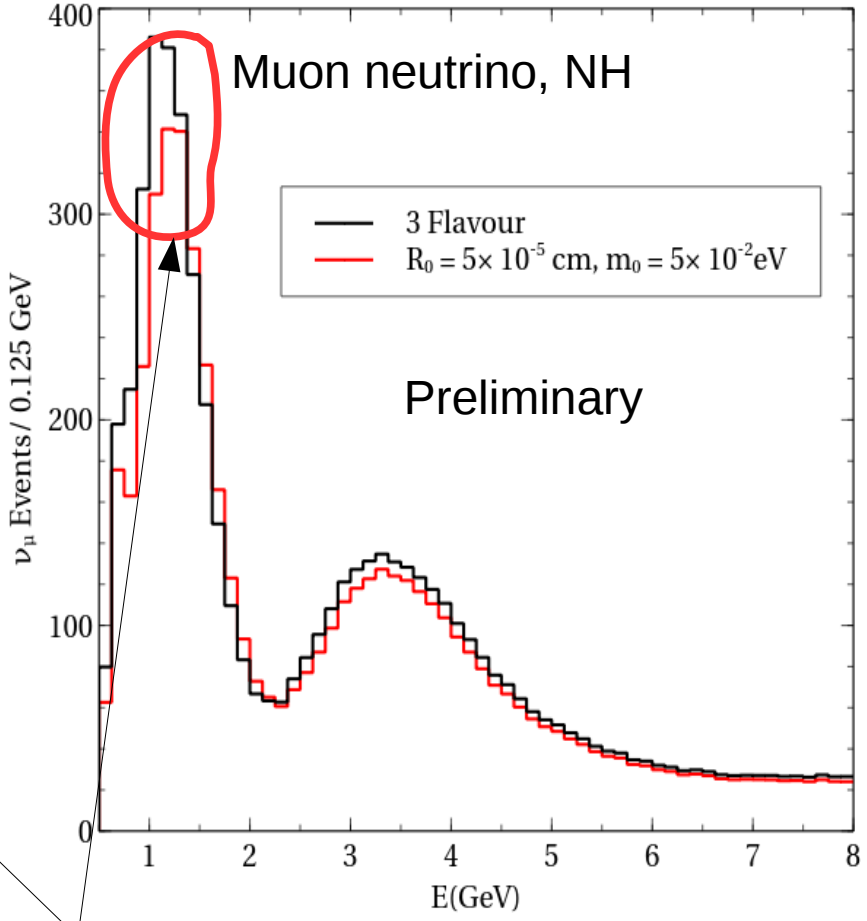




Significant effect on the oscillation probability

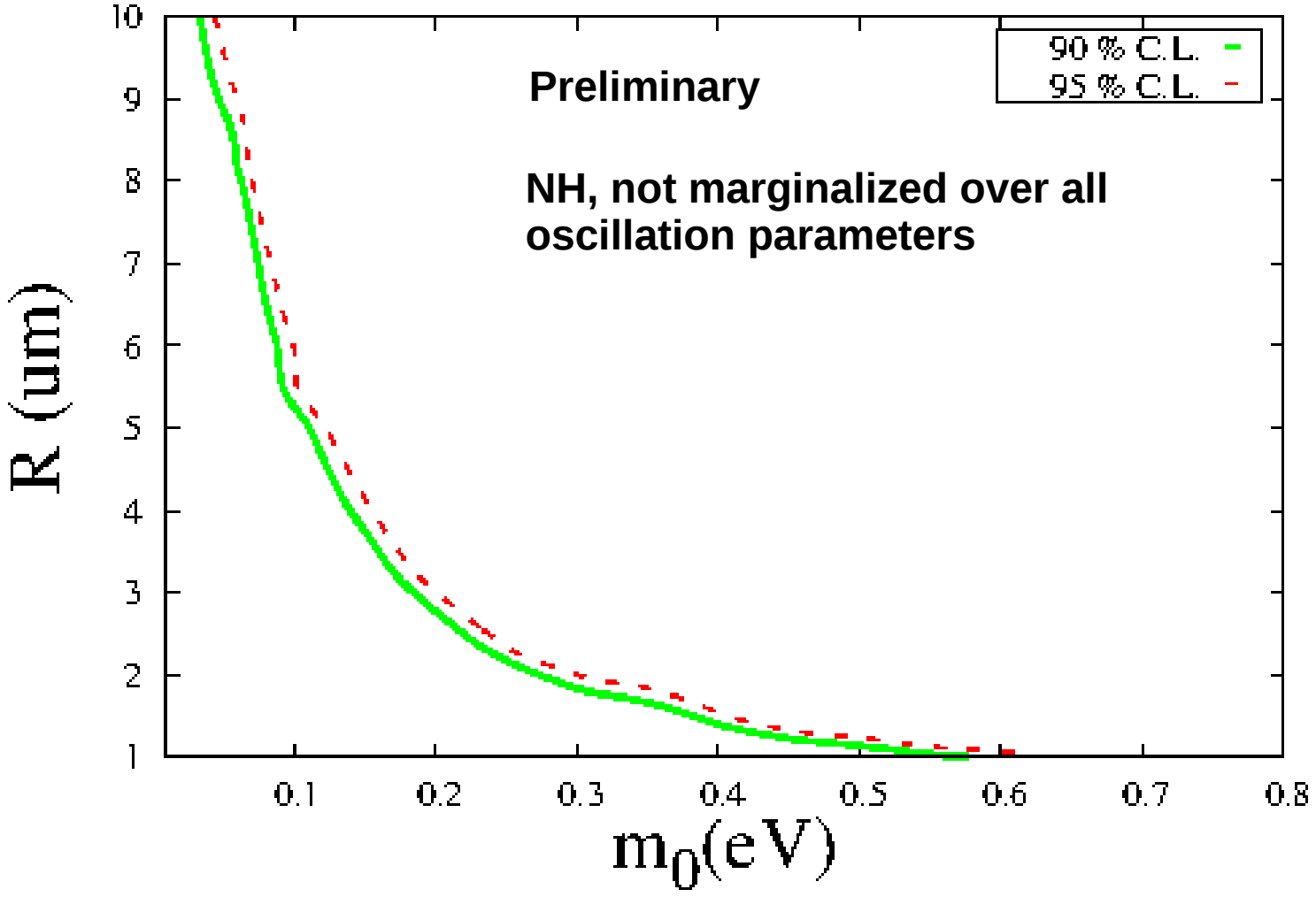
Events at DUNE (3.5 yrs)





Effects are seen at event level too

Constraints on LED parameters



Future Plan : LED

- Probability and events plot shows that LED effect is visible for DUNE
- Constraints on the LED parameters for full marginalization of oscillation parameter needs to be done
- We will push the code in the BSM repository and work this week along with Alex and Simon.
- Need volunteer to run the jobs and generate final results

Group Plan

- We are going to create different sub-directory within BSM repository for different physics topics
- Each subgroup leader will have the access to push the code within the repository
- We should also finalize detector response functions and systematic uncertainties from DUNE FD/ND group and use the value to generate the final results