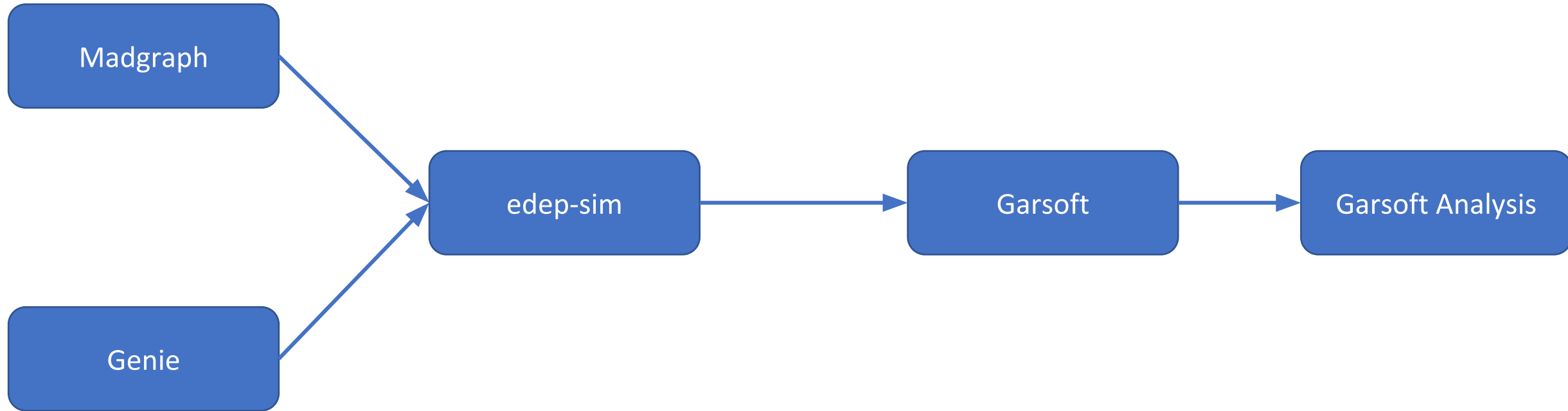


# HNL software

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# HNL simulation chain



1. Production of HNL vertices in rootracker format

2. Energy depositions with Geant

3. Detector readout and reconstruction

4. Analysis modules to write the reco output in root flat trees

# HNL production as input for Genie:

- Starting point : Neutrino Fluxes(FHC or RHC mode).
- Selecting muon and electron neutrino fluxes separately and then scale them following to Silvia's method :
  - Eg : you apply a kinematic scale factor, mass independent to get the number of HNLs production per POT. (HNL flux per POT per cm<sup>2</sup> before the decay process)
- Given the HNL mass , coupling detector Geometry and POT ==> Compute expected number of HNLs in ND :
  - for each coupling and mass points you need a file as input to GENIE. so you need a grid of points.
- You end up with : 4 files for each point from the grid. (e , mu flavour \* 2 (FHC or RHC polarisation ) .
- Information needed as input for GENIE : mass , energy , angle and position.

# Production of rootracker format

- Rootracker format is required by edep-sim for the geant4 simulation
- Genie can automatically produce rootracker files
- I have written a macro to write the madgraph output in the rootracker format
  - Josu's text files are used as a first madgraph input from here <https://www.dropbox.com/sh/nz2t9kpivhcf0l4/AABmGVAMg92aU52iDb5aAl3ka?dl=0>
- Note: rootracker format doesn't include specific heavy neutrino parameters (mass, mixing parameters, etc). If we want to save them then we need to update the production of rootracker files. Could be non-trivial to propagate this info downstream the simulation in garsoft.

# Processing HNL events

- I used Josu's files to generate HNL vertices and then propagate the decay products in the gas TPC
- Simulation chain completed for all 4 steps
- Still need to go into some extensive validation and add missing pieces
  - in contact with Garsoft experts Tom Junk and Brianne Eldwan
    - A reminder that the Garsoft software is still at early stages and developing
- I started processing neutrino events (background to HNL decays) from the latest Garsoft production, should have some results soon

# Considerations for HNL production

- Events need to be scaled by protons-on-target
- How to add pile-up? Is it important?
  - Decay of two or more HNL in the same spill or decay of 1 HNL and one neutrino interaction in the gas volume in the same spill
- Need to make sure that we produce HNL vertices in the gas volume only
  - HNL decays in the magnet would be invisible so we don't need to simulate them