# HNL production in MadGraph

- As Madgraph is better suited to model HNL decays as it can also handle correctly spin correlations
  - Use MadGraph+Pythia for HNL production/decay within ATLAS setup
  - Generate pp→μN (N→eμν), pp→μN+1jet, pp→μN+2jet
    - Do jet merging at Pythia level
- Run in ATLAS environment
  - In one directory with the run number have
    - MadGraphControl_HNL.py: main settings for HNL process
    - mc.MGPy8EG_A14N23LO_HNL10_mumue_LNC.py: include of above python script, MadGraphControl_HNL.py extract HNL mass, channel and LNC or LNV option from file name
    - Set-up 'stolen' from DMSimp_WtDM_tjDM process, the one proposed from VBF HNL process had issues with jet merging jobO part
   - MadSpin and filter code hooks present
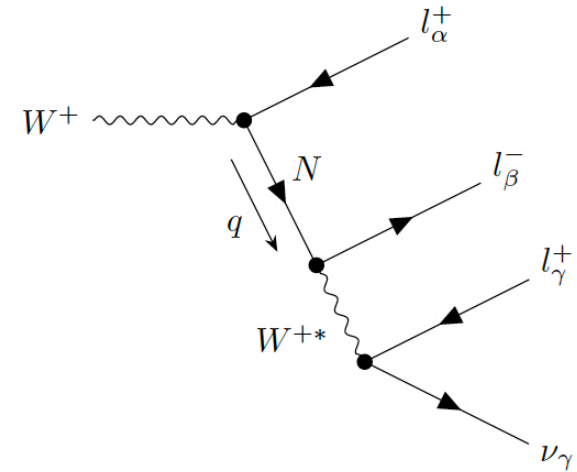
(a) LNC
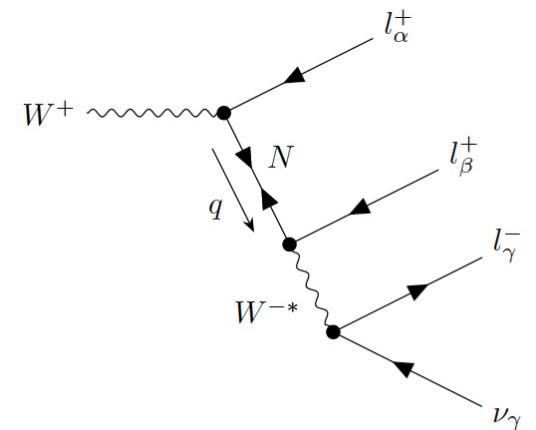
(b) LNV

Jet merging

- Run model with m(HNL) = 10 GeV
- No helicity option switched on in MadGraph (nhel=0)
- Jet merging in Pythia looks correct
 - Few events with +1 and +2 jets discarded in Pythia

Subprocess	Code	Number of events		
		Tried	Selected	Accepted
Les Houches User Process(es)	9999	10135	10135	10001
... whereof user classification code	0	8682	8682	8682
... whereof user classification code	1	1083	1083	1011
... whereof user classification code	2	370	370	308
sum		10135	10135	10001

- Following plots compared to results from Jean-Loup
  - Not exactly the same settings use, e.g. J-L uses other PDF

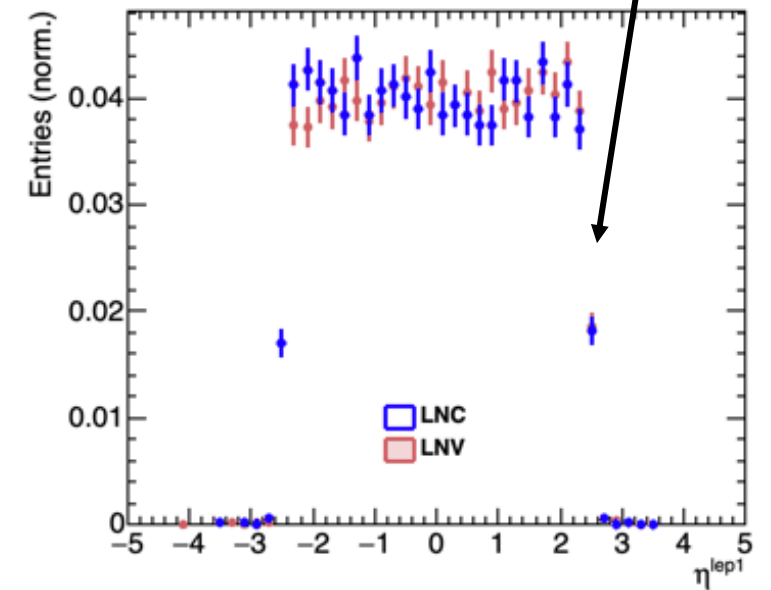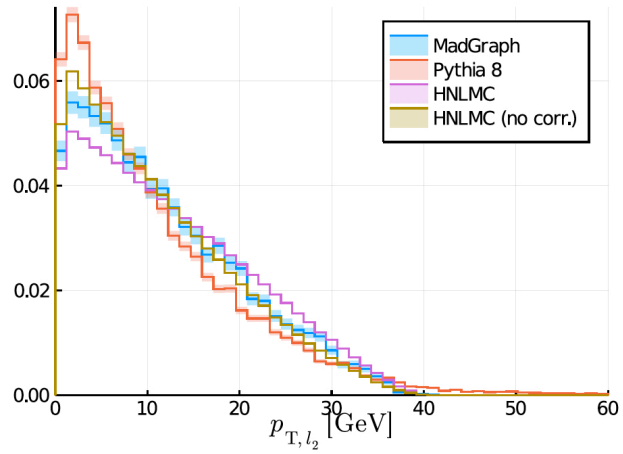# Particle level plots for lepton from W
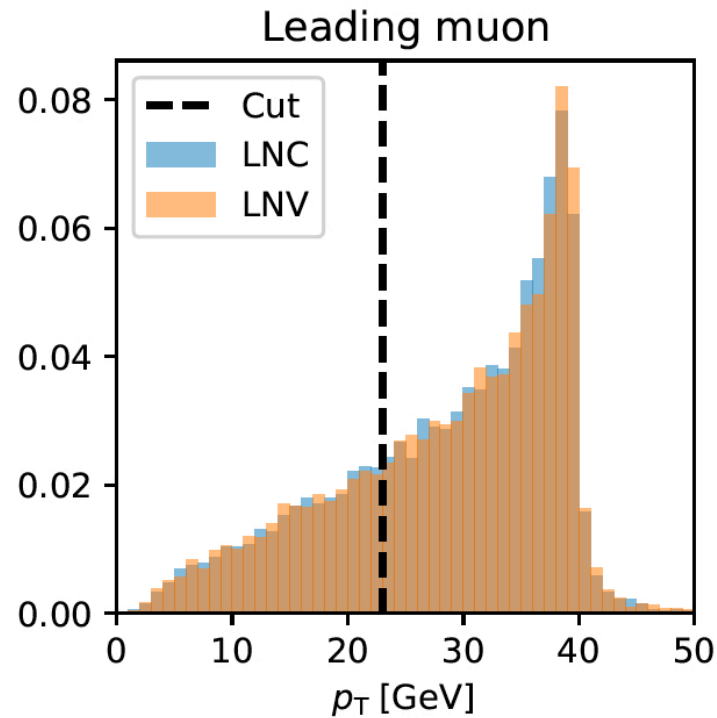
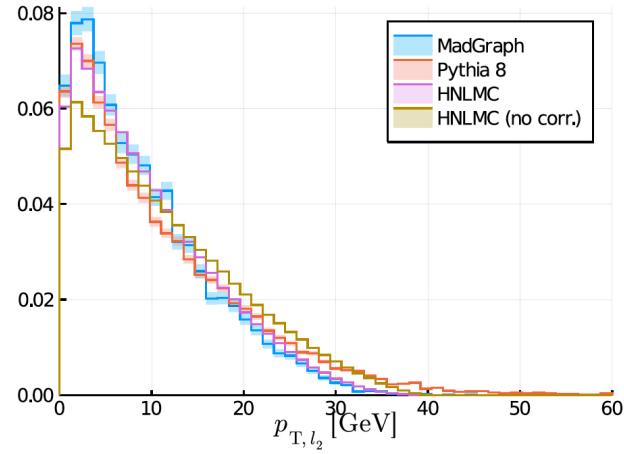Where does cut at pT=10 GeV come from? Answer: ATLAS default in run_card.dat
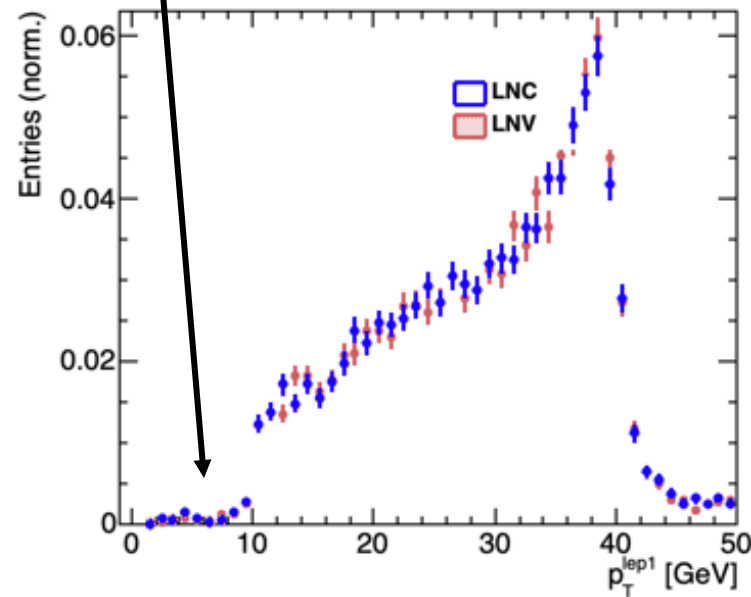
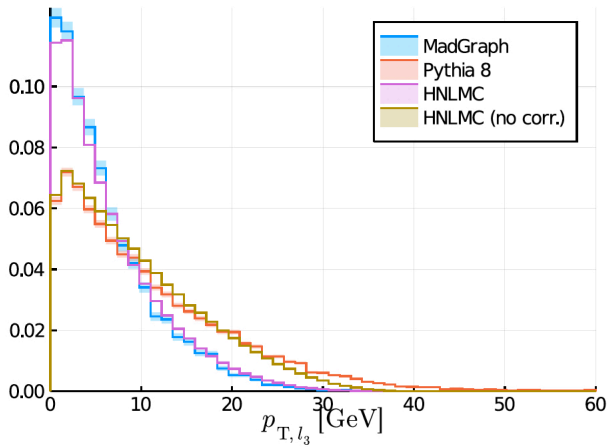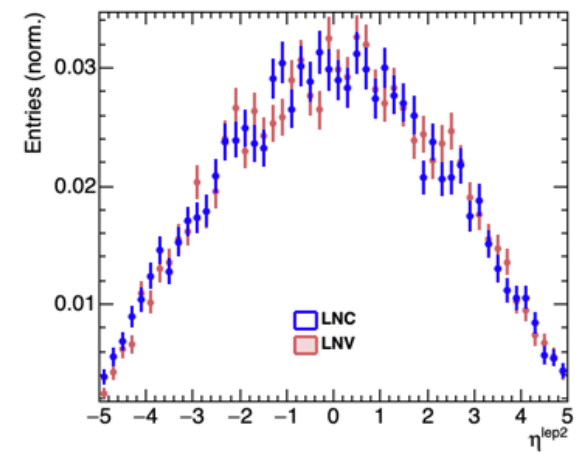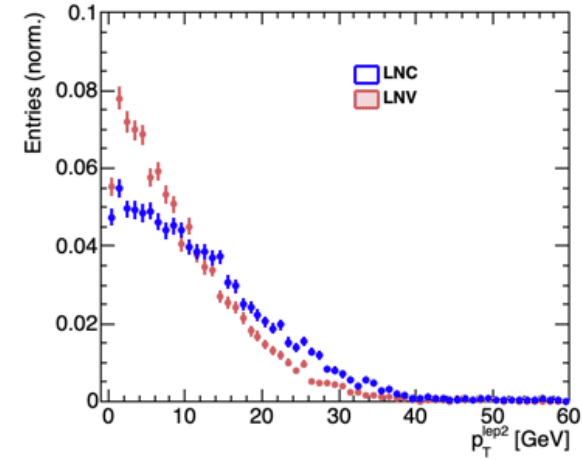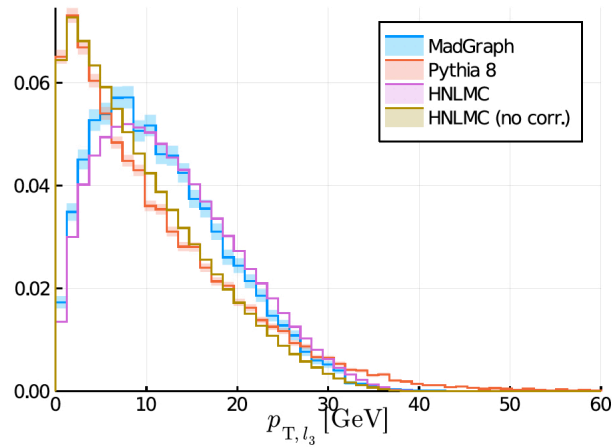Where does cut at |η|=2.5 come from? Answer: ATLAS default in run_card.dat
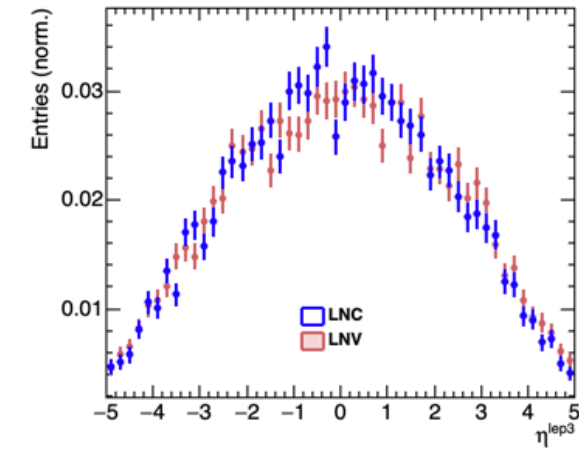
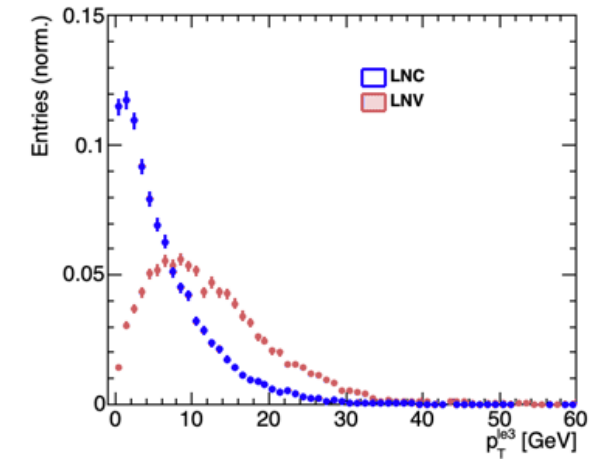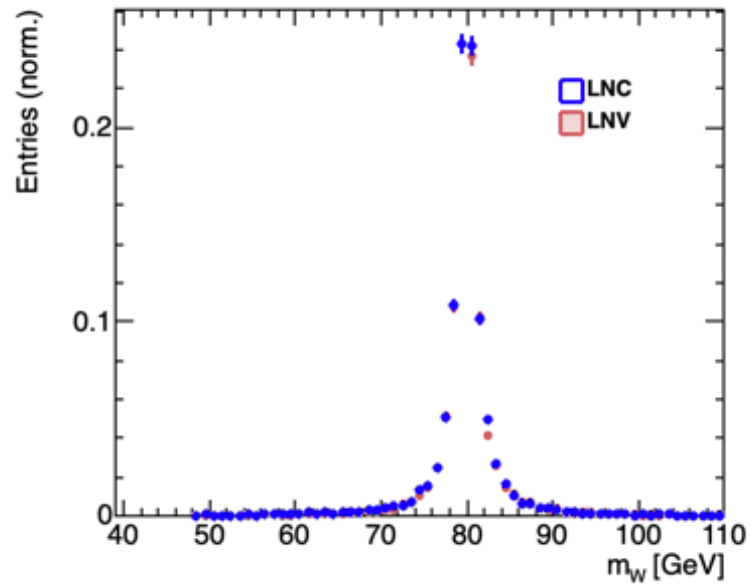# Particle level plots for leptons from neutrino decay

(a) LNC
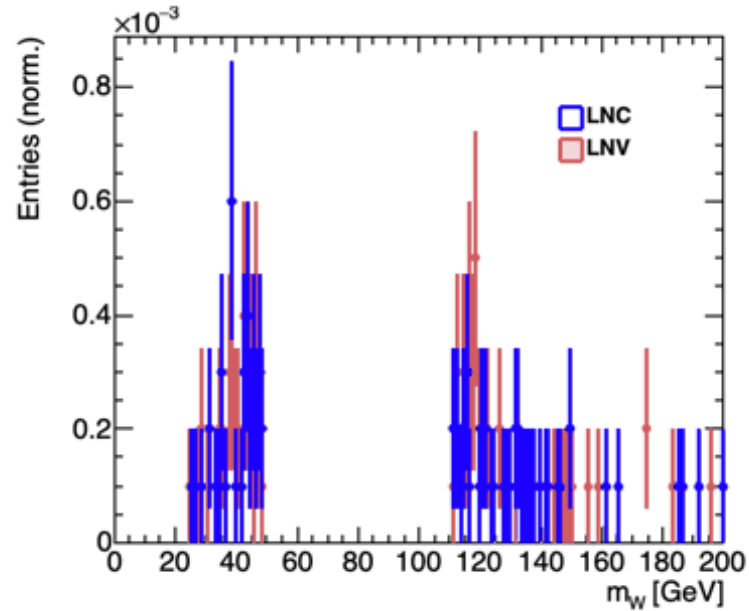
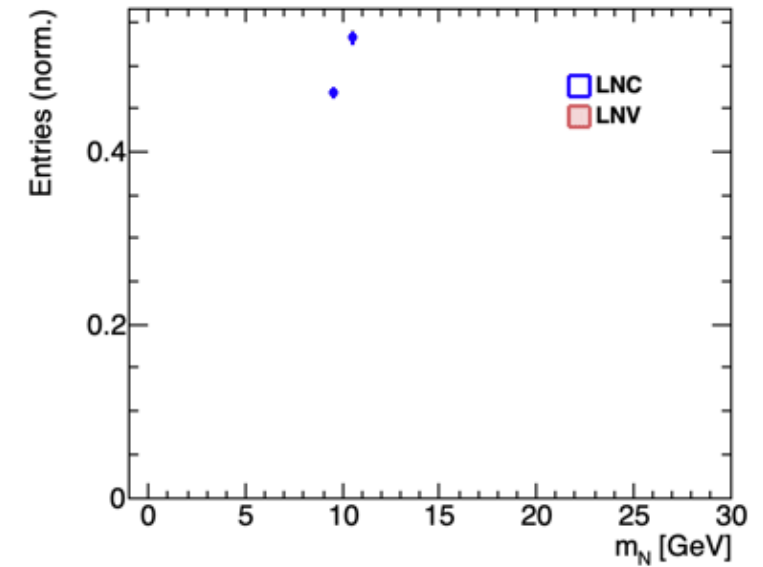(b) LNV

(a) LNC

(b) LNV

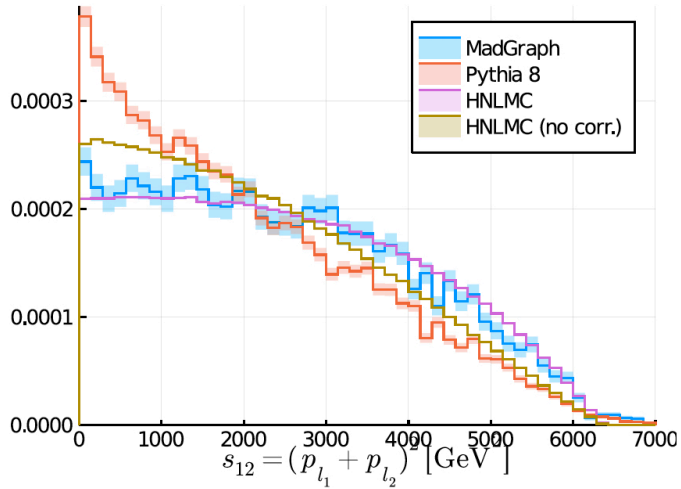# Invariant masses of W and HNL

W boson in truth block

No W boson in truth block, HNL, lep1 points back to quark

HNL mass

Monika Wielers (RAL)
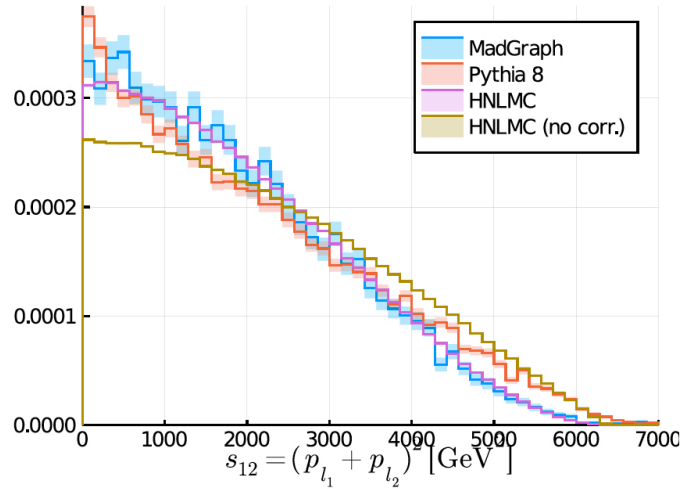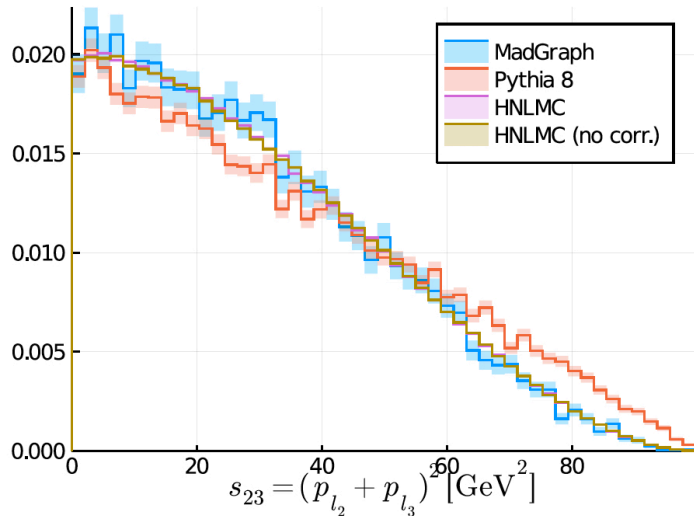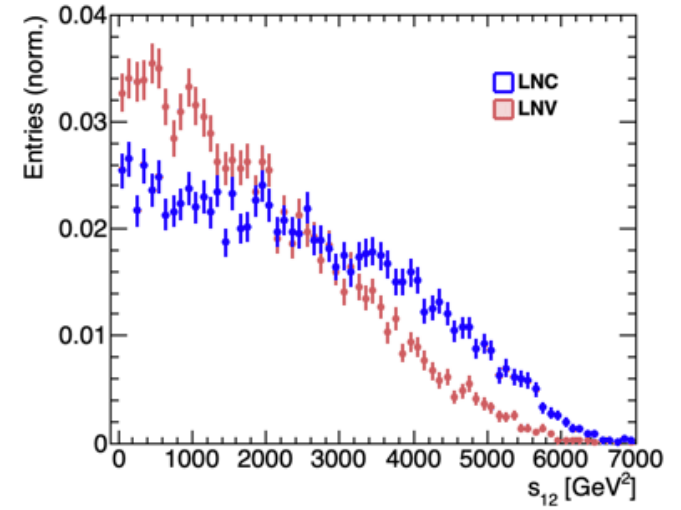
Spin correlation plots

(a) LNC

(b) LNV

(a) LNC

(b) LNV

Monika Wielers (RAL)
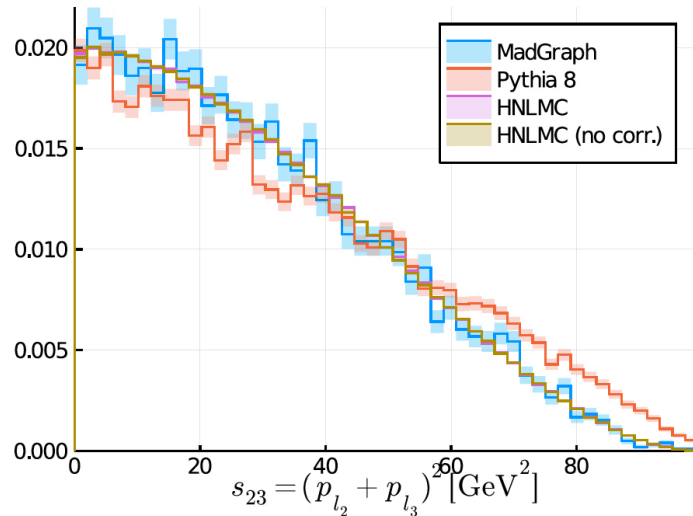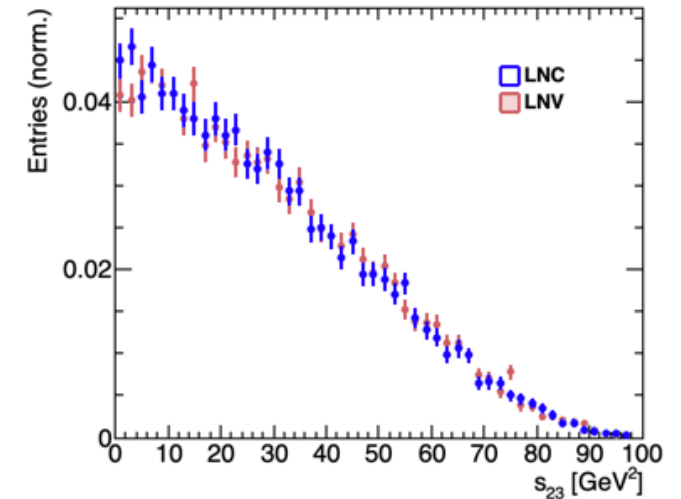
Summary and Outlook

- Madgraph HNL process running in ATLAS set-up
- 1st look at validation plots looks promising
- Next steps
  - Rerun without cut on lepton from W decay (ongoing)
  - Check traceback of 1st lepton to W boson in TRUTH3 derivations
  - Decide on filtering cuts
  - Test with MadSpin
  - Easy to extend to LLP?