

Jet merging for HNL process

- Process generated in Madgraph, showing done in Pythia

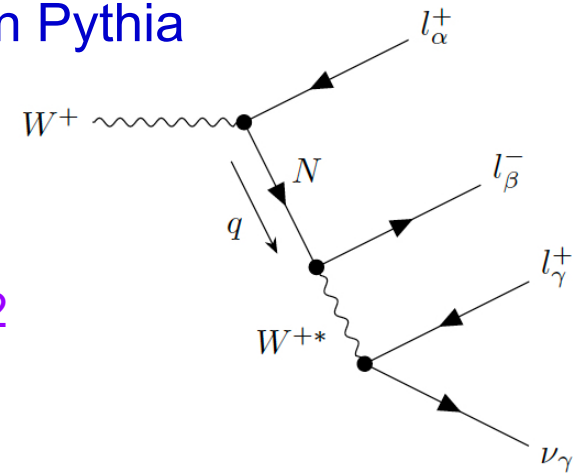
- Madgraph

- generate p p > mu+ n1, n1 > e- mu+ vm @ 0
- add process p p > mu+ n1 j, n1 > e- mu+ vm @ 1
- add process p p > mu+ n1 j j, n1 > e- mu+ vm @ 2

- Jet merging jobO part in Pythia

- nJetMax=2
- ktDurham=30
- dparameter=0.4
- process="pp>LEPTONS,NEUTRINOS"

```
if nJetMax>0:
    genSeq.Pythia8.Commands += ["Merging:mayRemoveDecayProducts = on",
                                "Merging:doKTMerging = on",
                                "Merging:ktType = 1",
                                "Merging:nJetMax = %i"%nJetMax,
                                "Merging:Process = %s"%process,
                                "Merging:TMS = %f"%run_settings['ktDurham'],
                                "Merging:nQuarksMerge = %s" %run_settings['maxjetflavor'],
                                "Merging:Dparameter = 0.4",
                                ]
```



(a) LNC

Jet merging for HNL process

- Run using release: AthGeneration,21.6.51
- Pythia log of output for process with $m(\text{HNL}) = 10 \text{ GeV}$

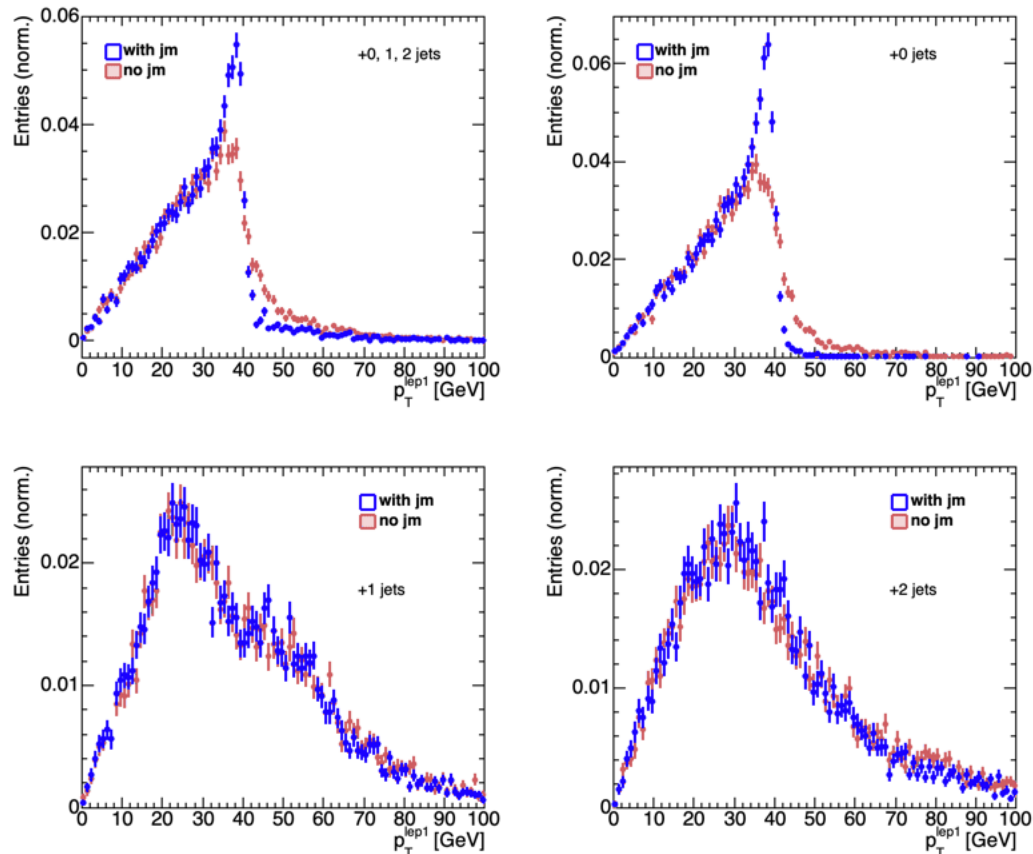
```
*----- PYTHIA Event and Cross Section Statistics -----*
```

Subprocess	Code	Number of events			sigma +- delta	
		Tried	Selected	Accepted	(estimated)	(mb)
Les Houches User Process(es)	9999	10157	10157	10000	2.283e-07	0.000e+00
... whereof user classification code	0	8653	8653	8653		
... whereof user classification code	1	1151	1151	1052		
... whereof user classification code	2	353	353	295		
sum		10157	10157	10000	2.283e-07	0.000e+00

```
*----- End PYTHIA Event and Cross Section Statistics -----*
```

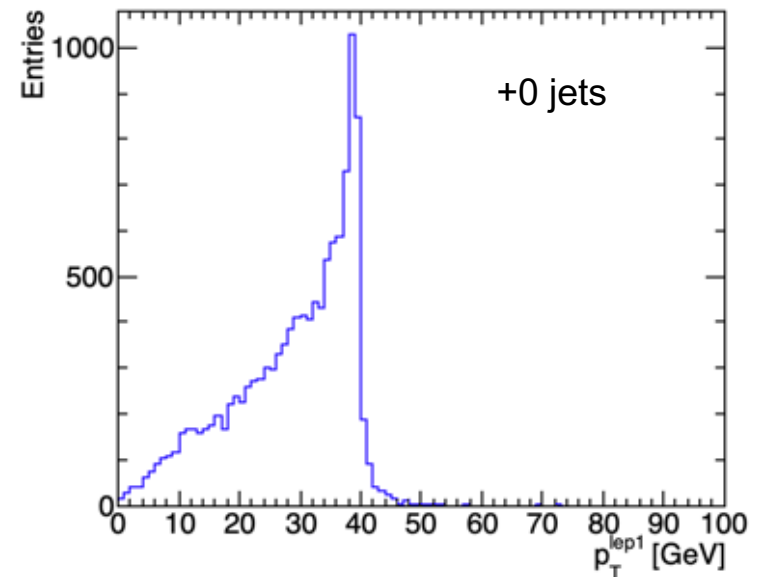
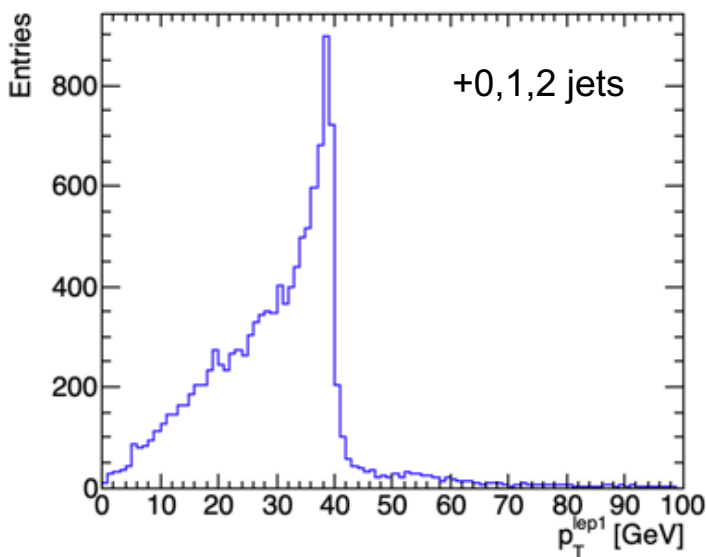
Jet merging for HNL process

- Findings: not expected a bit kinky pT distribution of lepton from W decay due to jet merging procedure
- Lepton pT distributions for different configurations in Madgraph for HNL production +n jets, n=0,1,2



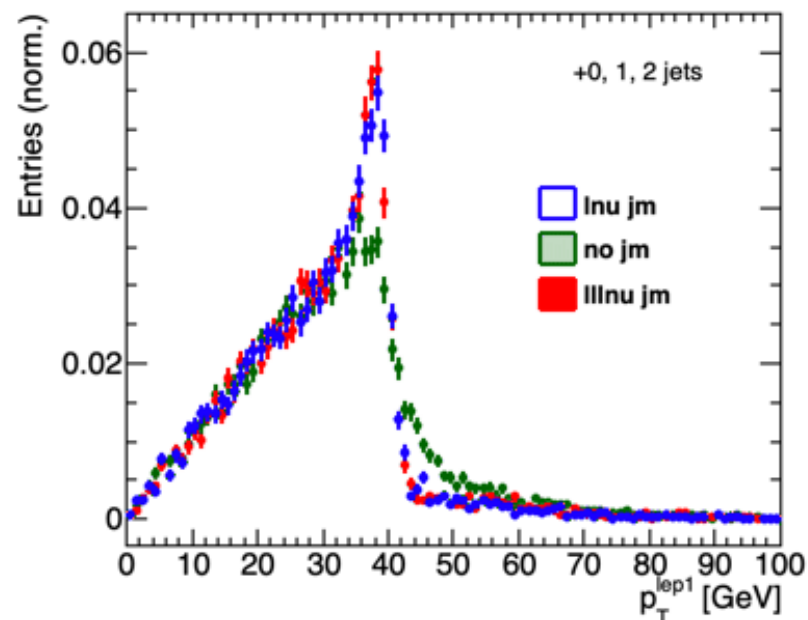
Look at LHE output

- LHE events produced by Madgraph identical if jet merging in Pythia is switched on or off
 - All modifications on spectrum down to Pythia
- pT spectrum of lepton from W from Madgraph



Change in process line

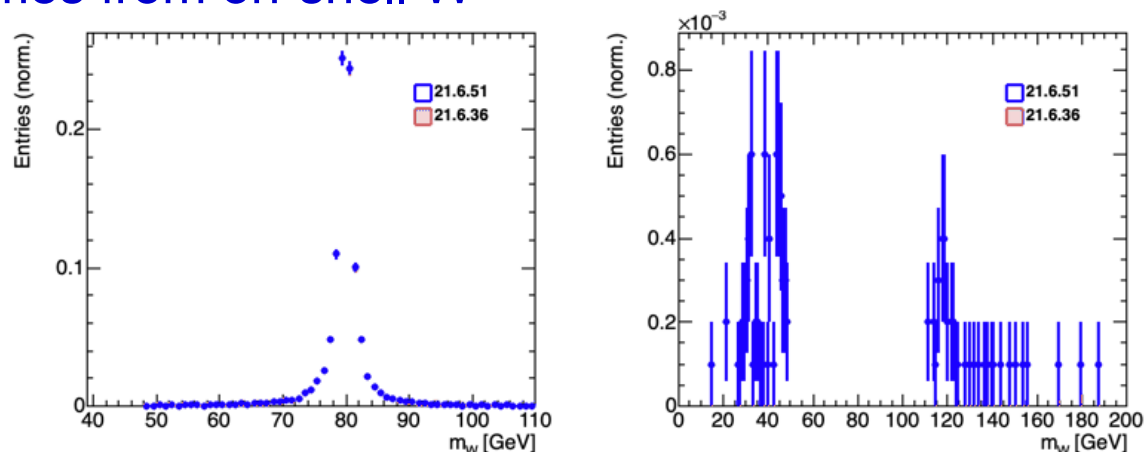
- Try process =
“pp>LEPTONS,LEPTONS,LEPTONS,
NEUTRINOS” for default process
+0,1,2 jets
- This changes jet merging behaviour
as seen from log file, but pT spectrum
of lepton from W stays similar as for
=“pp>LEPTONS, NEUTRINOS”



----- PYTHIA Event and Cross Section Statistics -----						
Subprocess	Code	Number of events			sigma +- delta (estimated) (mb)	
		Tried	Selected	Accepted		
Les Houches User Process(es)	9999	10147	10147	10000	2.287e-07	0.000e+00
... whereof user classification code	0	8645	8645	8645		
... whereof user classification code	1	1149	1149	1055		
... whereof user classification code	2	353	353	300		
sum		10147	10147	10000	2.287e-07	0.000e+00
----- End PYTHIA Event and Cross Section Statistics -----						

Change in bw cutoff

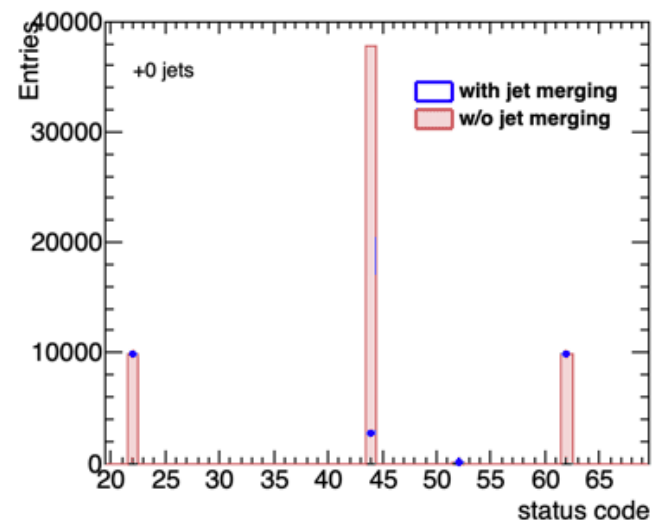
- Bwcutoff set to 15 (default), implies that in 99% of the events HNL comes from on-shell W



- Look in more detail at W's in truth block in HNL events with 0 additional jets produced in Madgraph

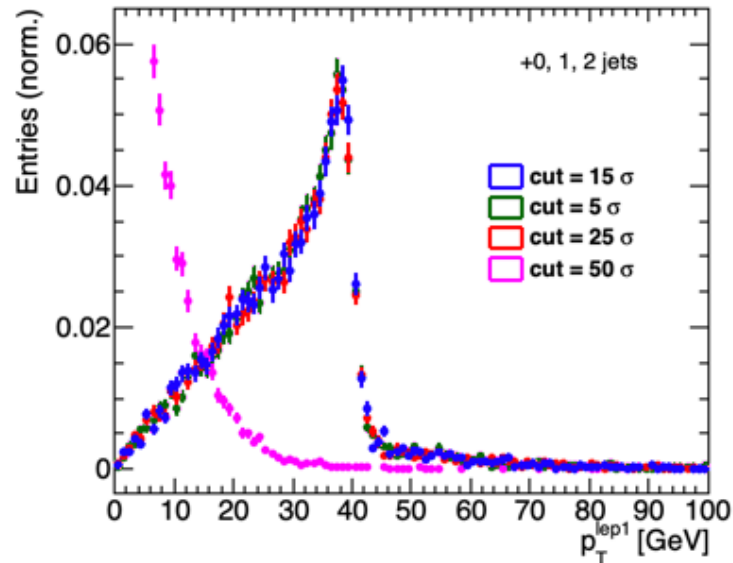
- Many more W entries found with status code 44 in sample w/o jet merging

- Highly suppressed initial state radiation



Change in bwcutoff

• Effect of varying bwcutoff



• Too large cut-off only seem to give off-shell W's

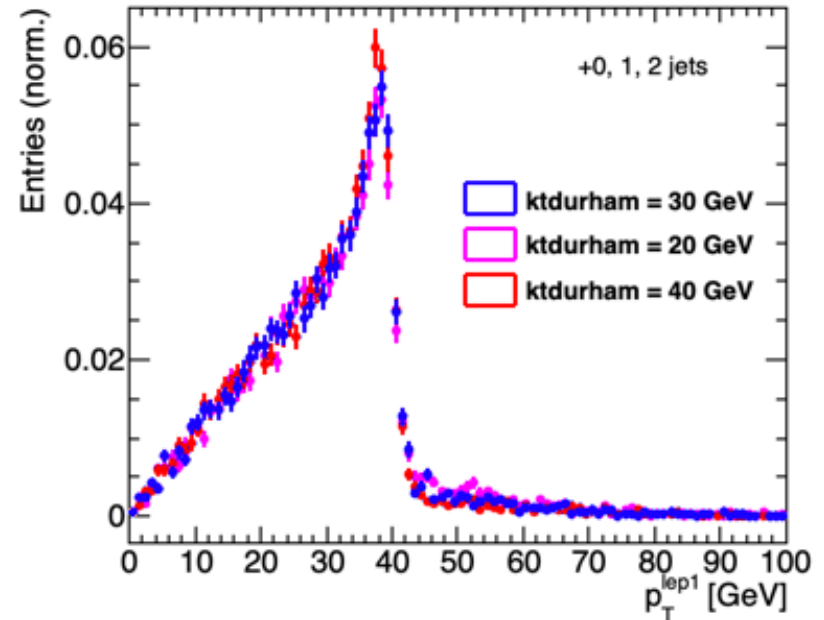
Change in ktdurham cut

- As expected if you lower cut the cutoff is smoother as madgraph produces jets with lower p_T
- Pythia log for ktdurham=20 GeV cut

9999		10382	10382	10002	
0		7922	7922	7922	
1		1776	1776	1573	
2		684	684	507	

- Pythia log for ktdurham=40 GeV cut

9999		10059	10059	10001	
0		9088	9088	9088	
1		752	752	717	
2		219	219	196	



Triggers mumue channel, LNV

- Request $|\eta| < 2.5$ and $p_{\text{tmin}}(\mu) > 3 \text{ GeV}$, $p_{\text{tmin}}(\text{ele}) > 4.5 \text{ GeV}$
- % of events passing cut at particle level
- Single mu trigger good for low, very high masses
- Mixed trigger become important for $m(\text{HNL}) \sim 40\text{-}70 \text{ GeV}$ masses

Mass [GeV]	5	10	30	40	50	60	70	75	80
Eta, pt cut	30	30	33	36	39	35	23	16	10
mu26	25	24	23	19	8	7	8	8	7
mu22_mu8	18	18	18	20	17	10	8	4	7
e17_mu14	10	10	11	12	14	13	10	8	6
e12_2mu10	8	8	9	12	16	17	5	4	6
All trigger	27	27	28	28	28	25	16	12	9

Triggers eemu channel, LNV

- Request $|\eta| < 2.5$ and $p_{\text{tmin}}(\mu) > 3 \text{ GeV}$, $p_{\text{tmin}}(\text{ele}) > 4.5 \text{ GeV}$
- % of events passing cut at particle level

Mass [GeV]	5	10	30	40	50	60	70	75	80
Eta, pt cut	28	28	32	35	38	35	22	13	10
e26	24	23	22	19	8	7	7	6	7
2e17	7	7	8	9	10	6	20	2	4
e17_mu14	12	11	13	15	16	13	11	7	7
2e12_mu10	8	7	9	11	15	15	4	3	5
All trigger	25	25	27	28	27	22	14	10	9

Triggers mumue channel, LNC

- Request $|\eta| < 2.5$ and $p_{\text{min}}(\mu) > 3 \text{ GeV}$, $p_{\text{min}}(\text{ele}) > 4.5 \text{ GeV}$
- % of events passing cut at particle level

Mass [GeV]	5	10	30	40	50	60	70	75	80
Eta, pt cut	23	23	31	36	39	37	31	17	11
mu26	19	19	20	18	7	5	20	4	5
mu22_mu8	10	11	13	16	15	8	13	3	5
e17_mu14	9	9	11	12	14	15	11	9	8
e12_2mu10	4	4	6	9	14	17	6	4	6
All trigger	21	20	24	28	27	24	24	11	9

Triggers eemu channel, LNC

- Request $|\eta| < 2.5$ and $p_{\text{tmin}}(\mu) > 3 \text{ GeV}$, $p_{\text{tmin}}(\text{ele}) > 4.5 \text{ GeV}$
- % of events passing cut at particle level

Mass [GeV]	5	10	30	40	50	60	70	75	80
Eta, pt cut	20	20	28	35	39	36	28	12	10
e26	17	17	18	18	7	5	18	4	5
2e17	27	3	4	6	8	5	4	2	3
e17_mu14	9	9	11	14	15	13	11	7	7
2e12_mu10	4	4	5	8	12	14	5	3	5
All trigger	18	18	22	26	25	21	22	8	8