BACHELOR THESIS PROGRESS SO FAR

RAFAEL DE ANDRADE

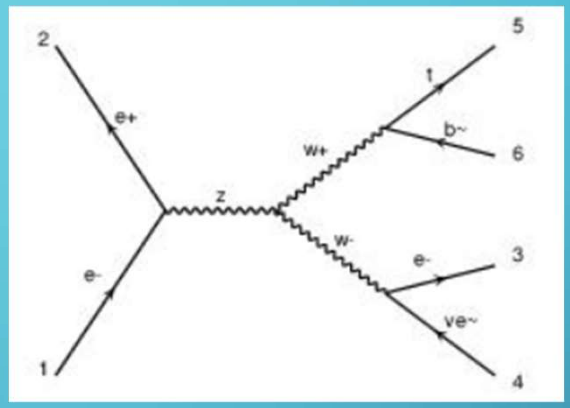
SINGLE TOP PRODUCTION AT FCC-EE

RECAP FROM THE LAST ONE:

- Learnt how to install and use different programs:
  - Madgraph
  - Pythia-Delphes
  - Generally how Linux Terminal Usage works
- Learnt how to use Stage1 Analysis
- Learnt how to read ROOT files and use them in python

PROCESS:

- The process in question is e+ e- -> t vl~ b~ e-
- Example feynmann diagramm by Madgraph:



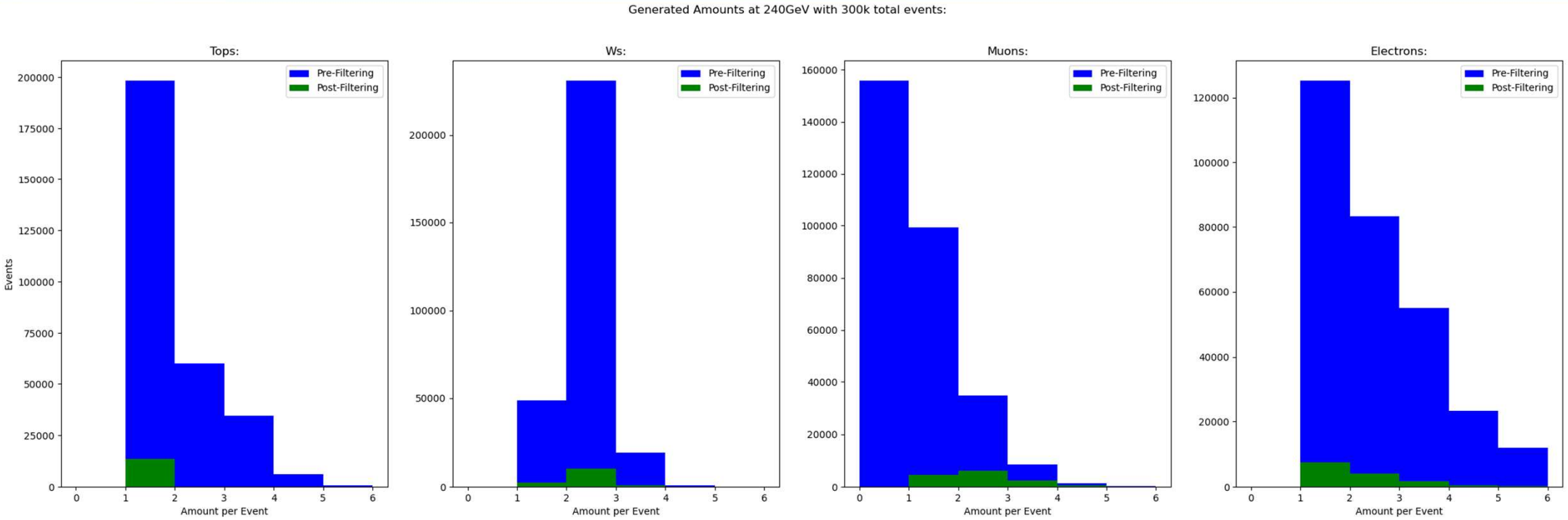
- Exactly 1 electron from non-top part, as imposed by the given process
- However the other side will have the top decay into a bottom and W boson
  - The W will either decay into Hadrons or Leptons
  - The leptonic decays will always end up with exactly 2 jets
  - In case of a leptonic decay, it'd turn into the (anti)lepton and corresponding neutrino
  - Theoretically any lepton, but tau decays too quick to be directly detected

CASES:

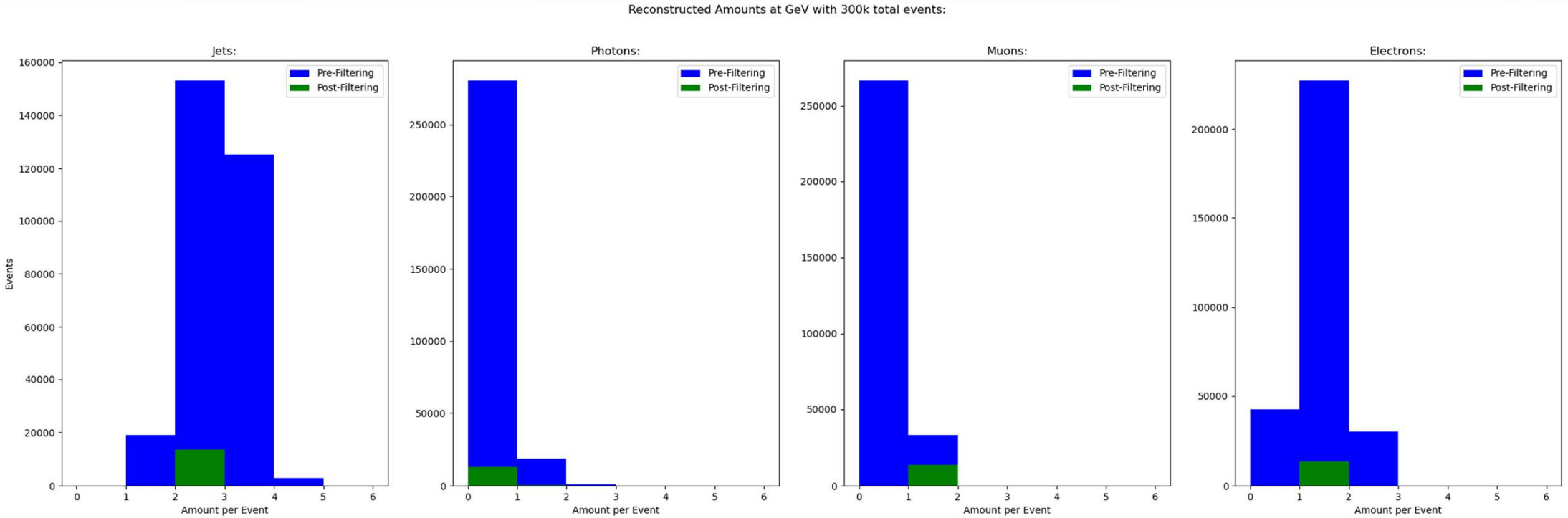
- Case 1:
  - n_μ=1
  - n_e=1
  - n_jets=2
- Case 2:
  - n_μ=0
  - n_e=2
  - n_jets=2

LOOKING AT DIFFERENT ENERGY FILES: CASE 1

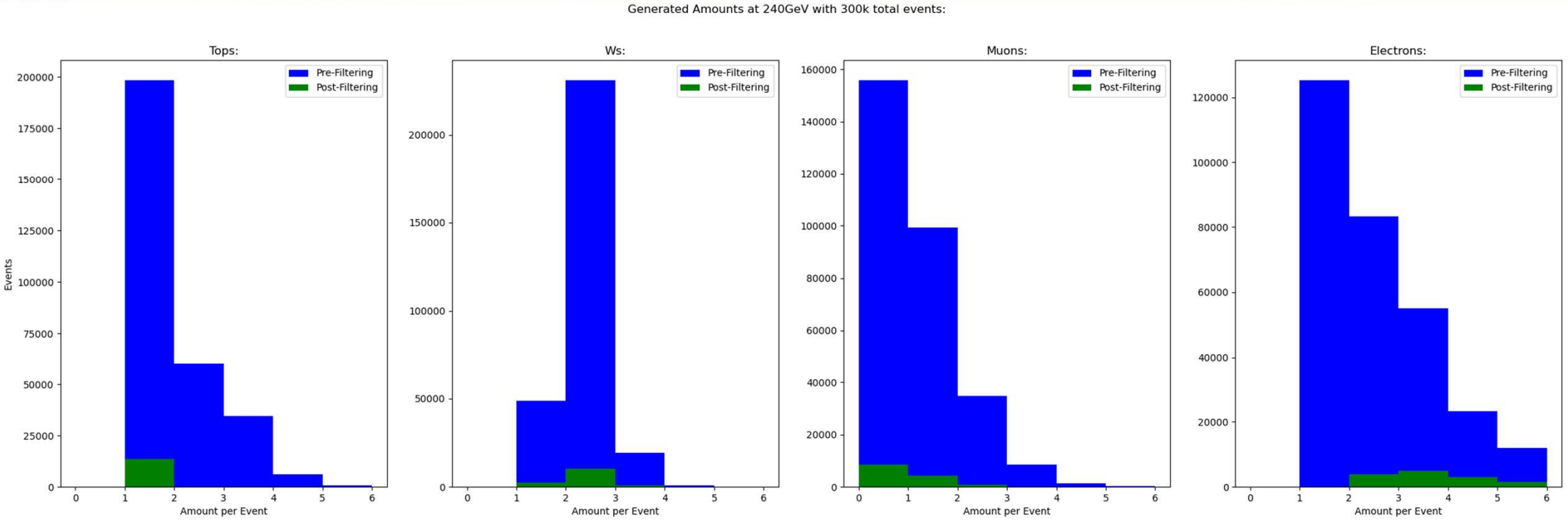
- Amounts before and after filtering based on the Reco Selection per Case:



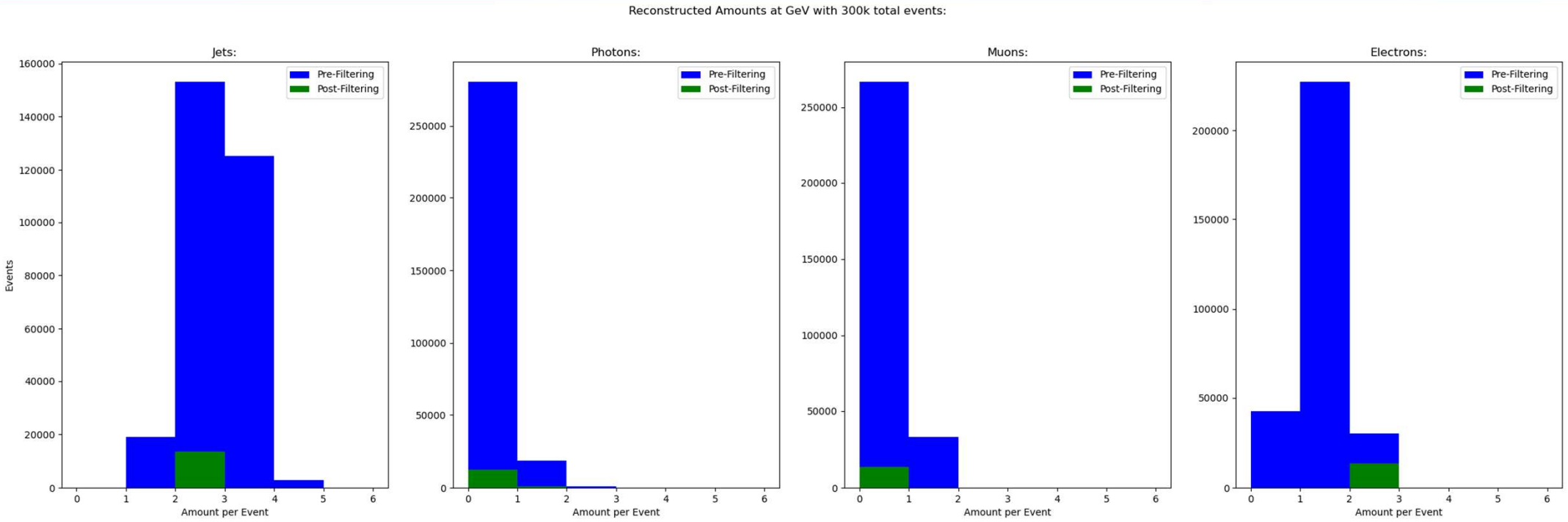
LOOKING AT DIFFERENT ENERGY FILES: CASE 1



LOOKING AT DIFFERENT ENERGY FILES: CASE 2



LOOKING AT DIFFERENT ENERGY FILES: CASE 2

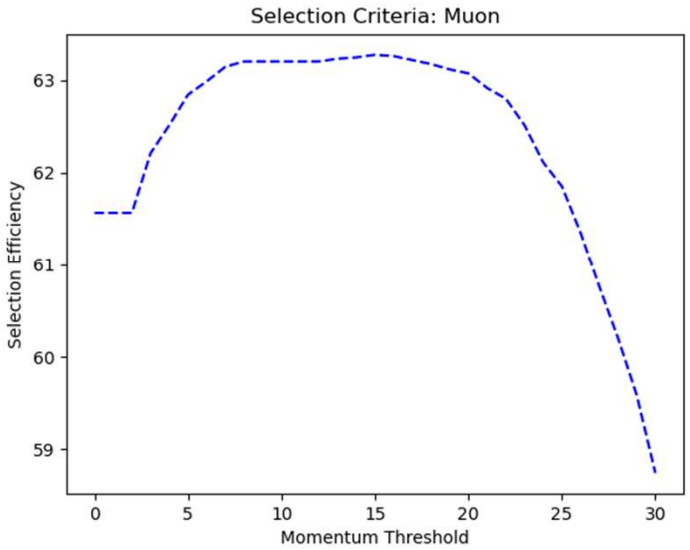


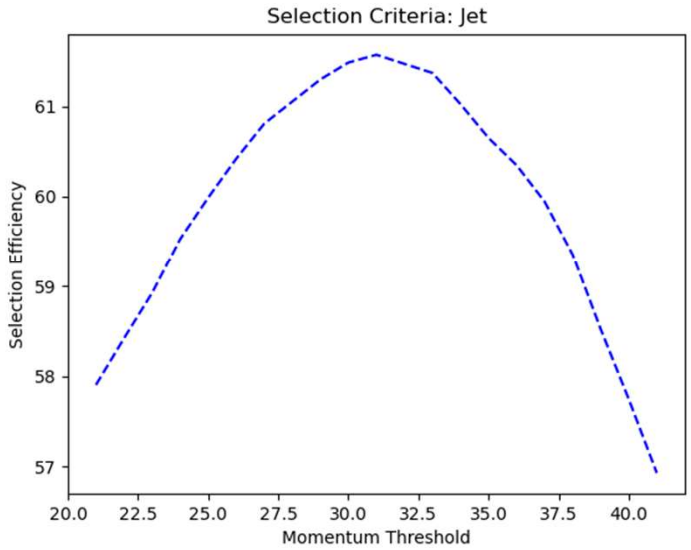
FIND OPTIMAL SELECTION THRESHOLDS:

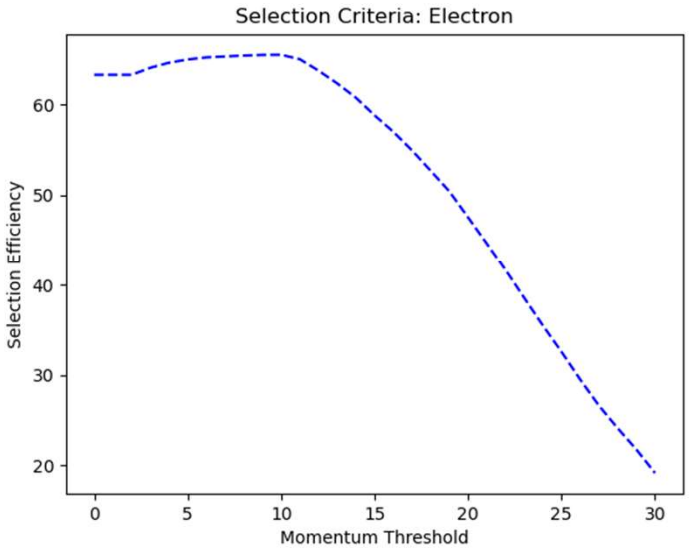
- To reduce the amount of processes to study in total, a selection based on momentum of different particles is introduced
- Also filtered based on isolation with $0{,}01 < r < 0{,}5$ and with $E < 25\%$ of the Lepton Energy
- First, all events are put through a filter based on Gen Information, requiring Gen-level objects to match the case requirement listed prior
- To find the optimal selection (momentum) threshold, one wants to have the highest ratio between Reco Selection and Gen Filtered counts, namely to maximize selection efficiency through threshold momentum

FIND OPTIMAL SELECTION THRESHOLDS:

- Example of plots for the optimal selection thresholds (Case1):







FIND OPTIMAL SELECTION THRESHOLDS:

- Results:

Case-ID	Threshold $p_\mu(GeV)$	Threshold $p_e(GeV)$	Threshold $p_\gamma(GeV)$	Threshold $p_{Jets}(GeV)$
1 ($n_\mu = 1, n_e = 1, n_{jets} = 2$)	15	10	1	31
2 ($n_\mu = 0, n_e = 2, n_{jets} = 2$)	10	9	1	28

- However the selection thresholds need to be impartial: we don‘t know which case it is in advance, and cannot impose a certain one
- A compromise was chosen as:

/	Threshold $p_\mu(GeV)$	Threshold $p_e(GeV)$	Threshold $p_\gamma(GeV)$	Threshold $p_{Jets}(GeV)$
Compromise:	12	10	1	30

DEEPER ANALYSIS:

- With the selection thresholds, a full analysis can be used for different Energies (parallel beam energies)
- Event Weight: $$W_{Events} = \frac{L \cdot \sigma}{N_0}$$
- Event Yield: $$\mathrm{N}_{Event;i} = \Sigma N_{Rec;i} \cdot W_{Event;i}$$

DEEPER ANALYSIS:

Case 1:

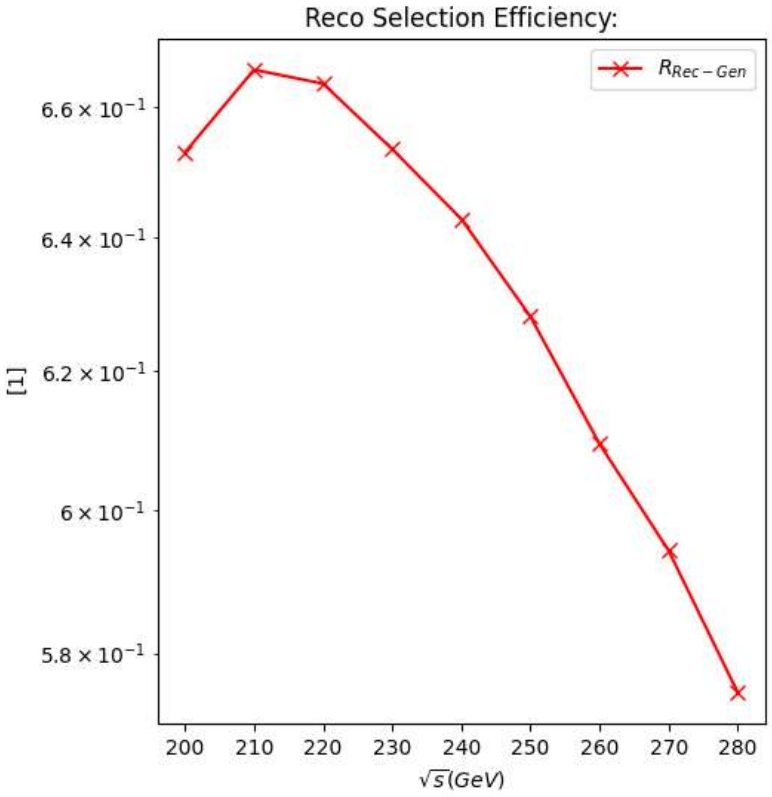
σ (pb)	E	$R_{Rec-Gen}$	W_{Events}	N_{Events}
1.55024e-09	200	0.652997	5.58086e-08	0.00111522
2.3696e-08	210	0.665897	8.53056e-07	0.015506
1.183e-07	220	0.663691	4.2588e-06	0.0709346
3.674e-07	230	0.653496	1.32264e-05	0.20038
8.8945e-07	240	0.642787	3.20202e-05	0.437844
1.8945e-06	250	0.628119	6.8202e-05	0.85498
4.273e-06	260	0.609473	0.000153828	1.90424
1.8905e-05	270	0.594282	0.00068058	9.21029
6.331e-05	280	0.574671	0.00227916	26.1442

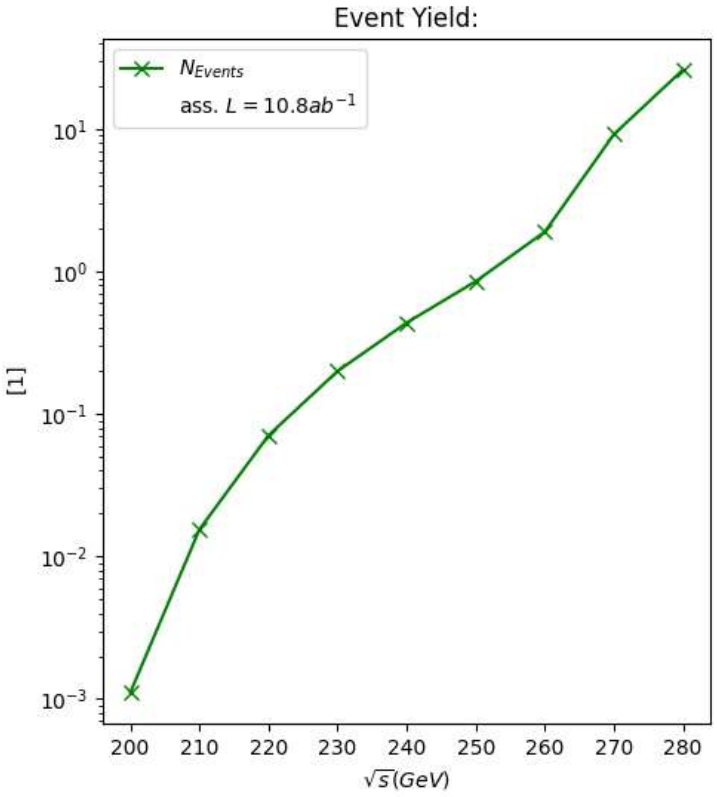
Case 2:

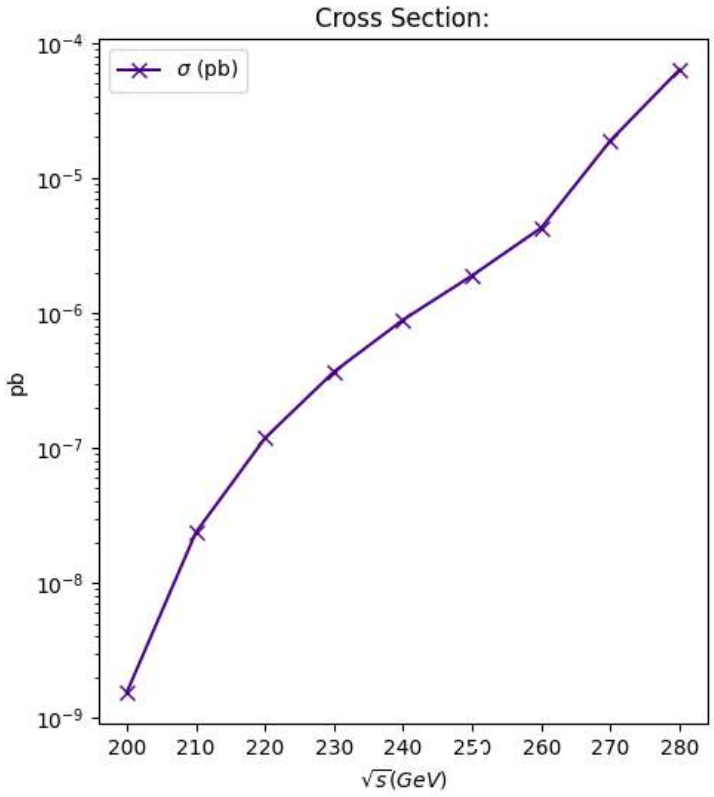
σ (pb)	E	$R_{Rec-Gen}$	W_{Events}	N_{Events}
1.55024e-09	200	0.639643	5.58086e-08	0.00107175
2.3696e-08	210	0.655456	8.53056e-07	0.0154284
1.183e-07	220	0.654692	4.2588e-06	0.0700062
3.674e-07	230	0.643777	1.32264e-05	0.196293
8.8945e-07	240	0.635105	3.20202e-05	0.433201
1.8945e-06	250	0.615255	6.8202e-05	0.848296
4.273e-06	260	0.596508	0.000153828	1.84455
1.8905e-05	270	0.577394	0.00068058	9.04287
6.331e-05	280	0.565696	0.00227916	25.4149

DEEPER ANALYSIS:

Case 1:

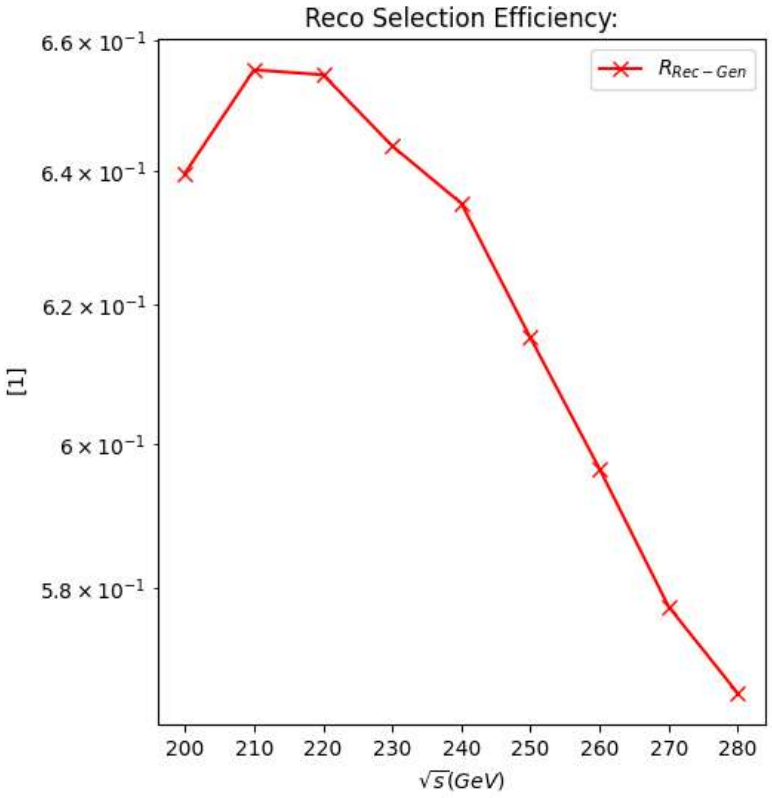


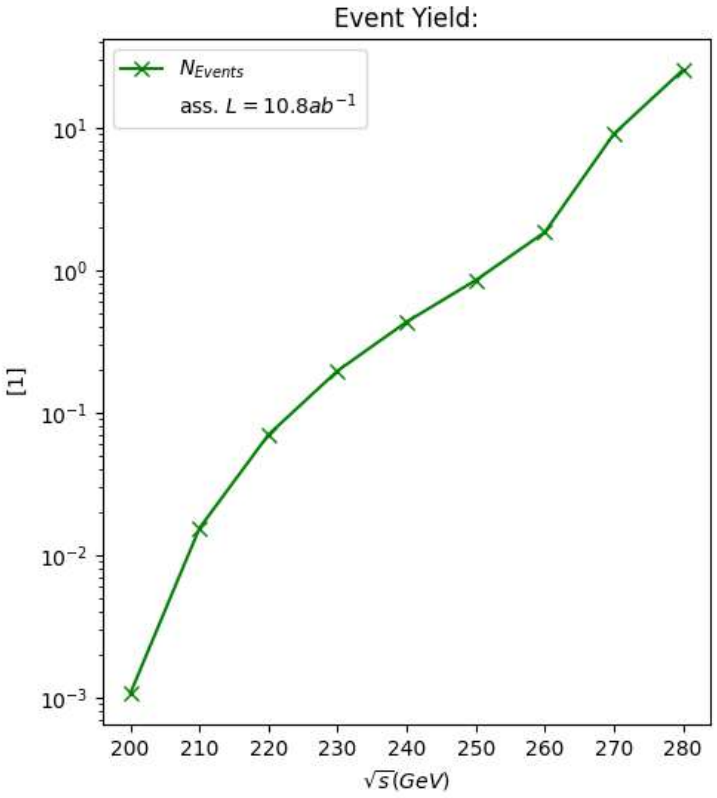


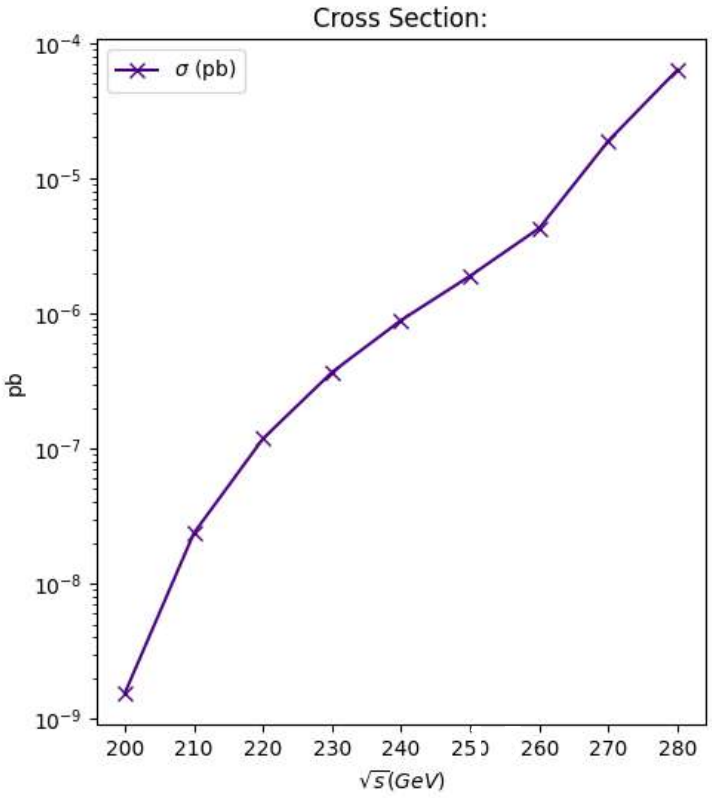


DEEPER ANALYSIS:

Case 2:







CONCLUSION AND NEXT STEPS

- Set up a multi-staged workflow to study selection efficieny for single top events
  - Focusing on electron/muon final states
- Optimized (momentum) threshold to achieve reasonable selection efficiency
- Low Cross Section from the process in general
  - Very few events are to be expected in the range of 200-280 GeV
  - More studies on how production cross section scales with the phase space selection (Alejandro)
- Background files are being processed to evaluate their event yield
- If SM isn‘t sensitive enough we could study FCNC production