AFB studies at 500 GeV

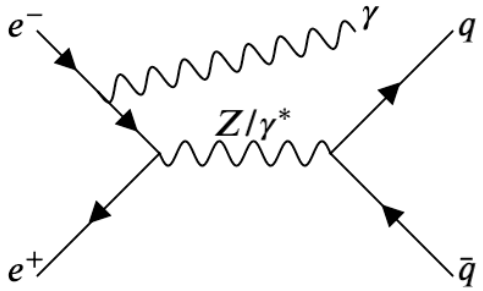
500 GeV qq sample validation

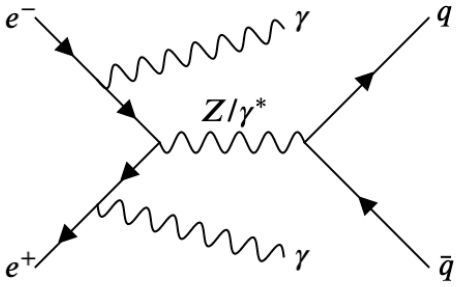
ILD Top/HF group meeting
27/09/22

Jesús P. Márquez Hernández

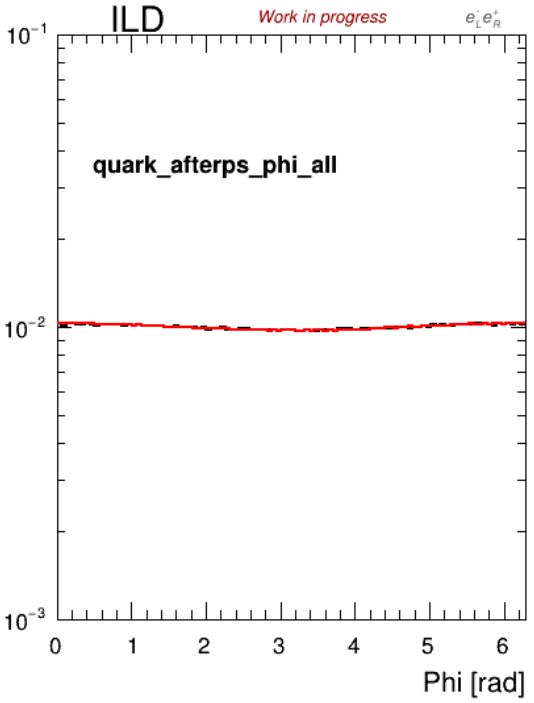
Sample info

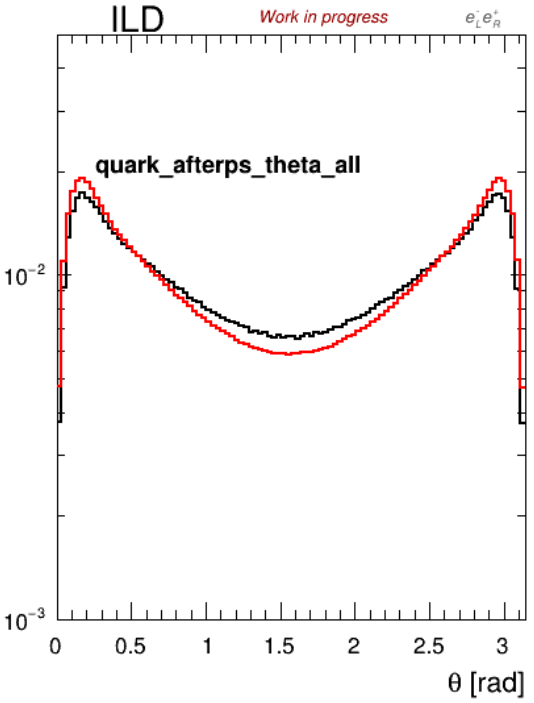
- We define “signal” as those events whose ISR total energy is below 50 GeV.
  - We define “radiative events” has those with E_{ISR} > 50 GeV.
- Samples:
  - Old sample (IDR samples):
    - 46.4 and 47.0 fb^{-1} (e_L_p_R & e_R_p_L).
    - Whizard 1.9.5.
    - ILD_l5_v02
    - ILCSoft v02-02-01.
  - New sample (2022 samples):
    - 241.1 and 429.6 fb^{-1} (e_L_p_R & e_R_p_L).
    - Whizard 2.8.5.
    - ILD_l5_v02
    - LCSoft v02-02-03.

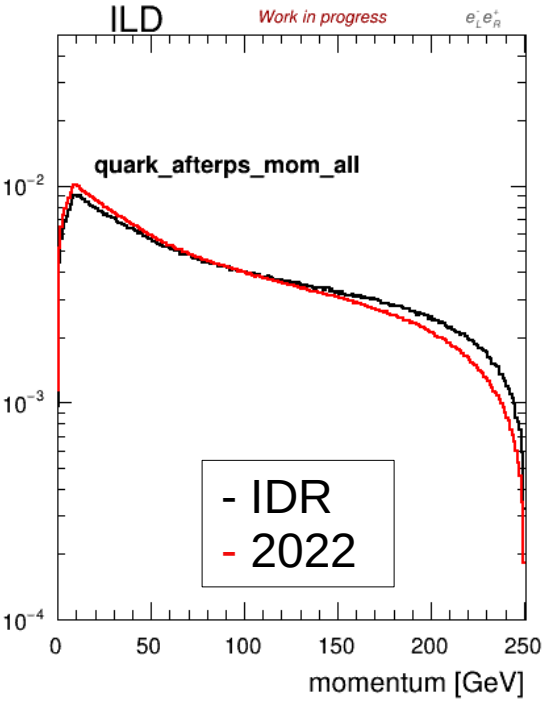




Generator Level: QCD

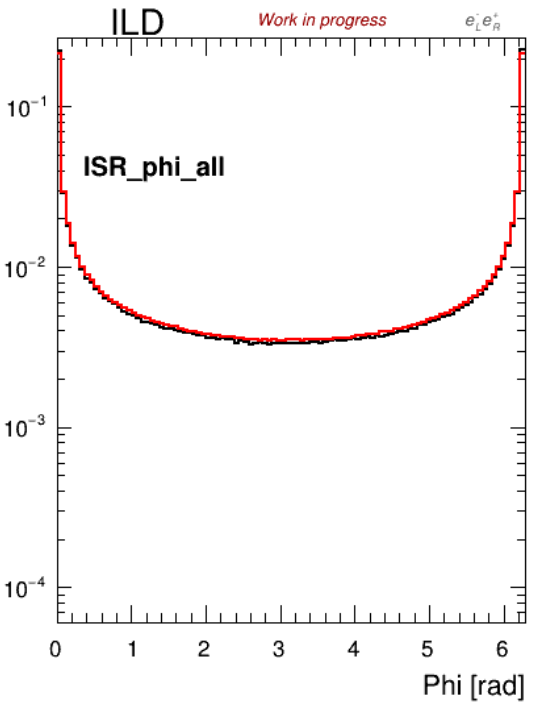


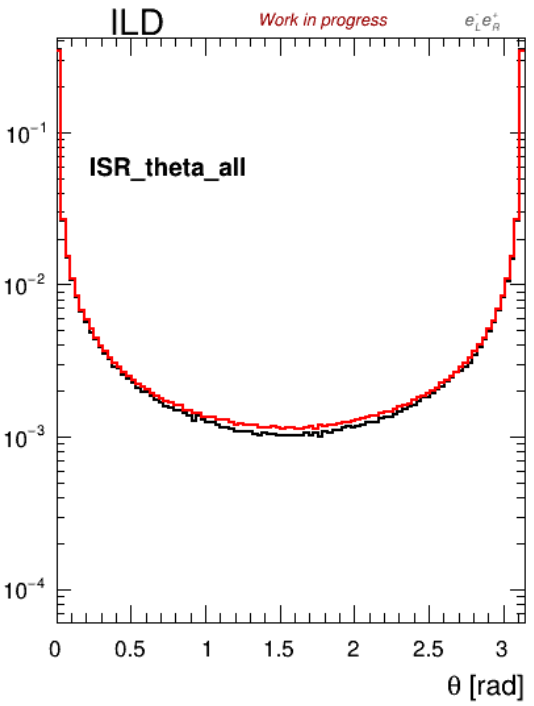


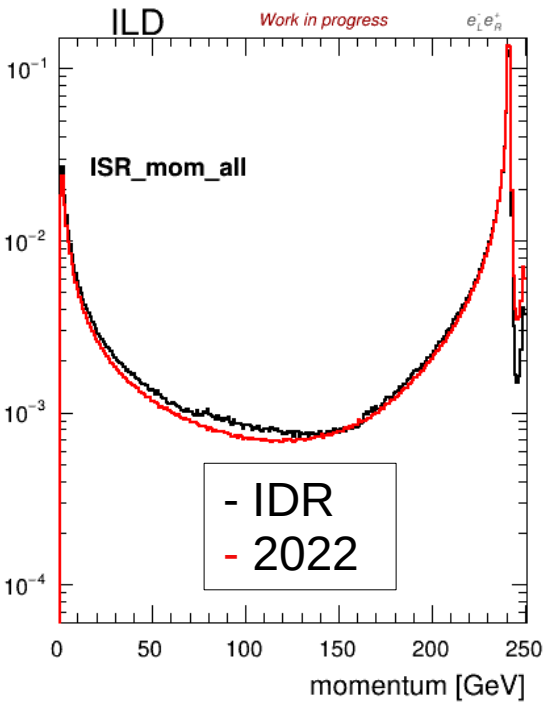


- Kinematics of the quarks after QCD PS.

Generator Level: ISR

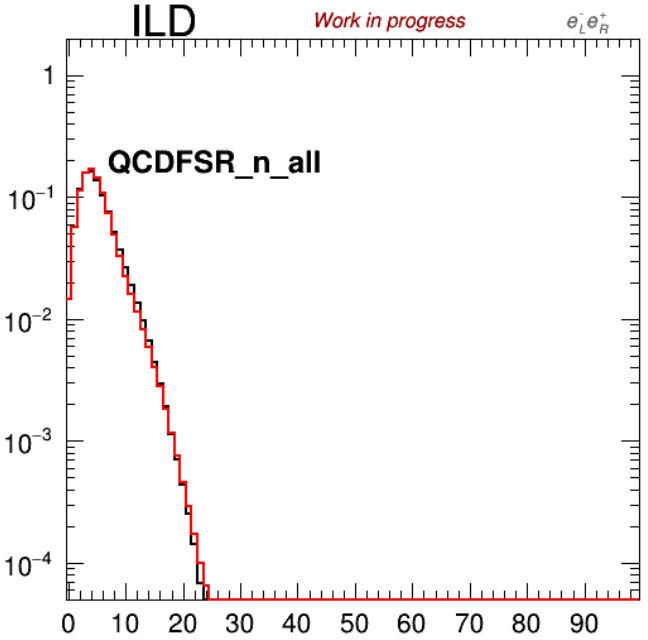


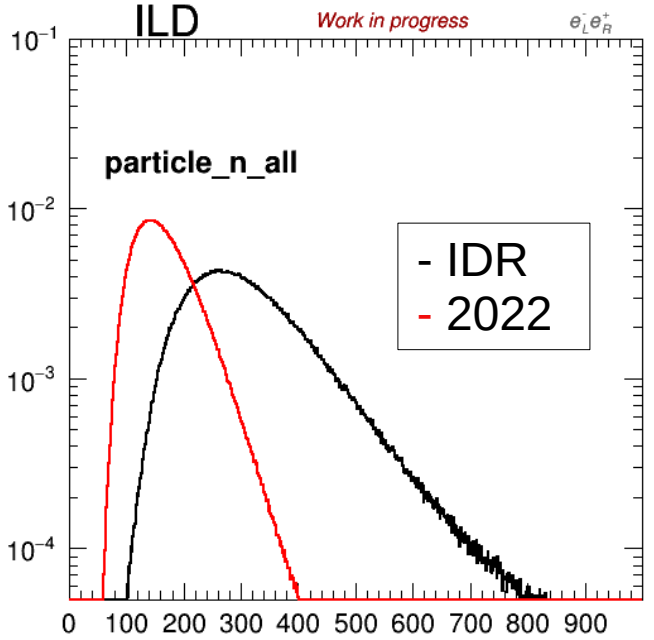




- Kinematics of photon ISR (from both incoming particles).

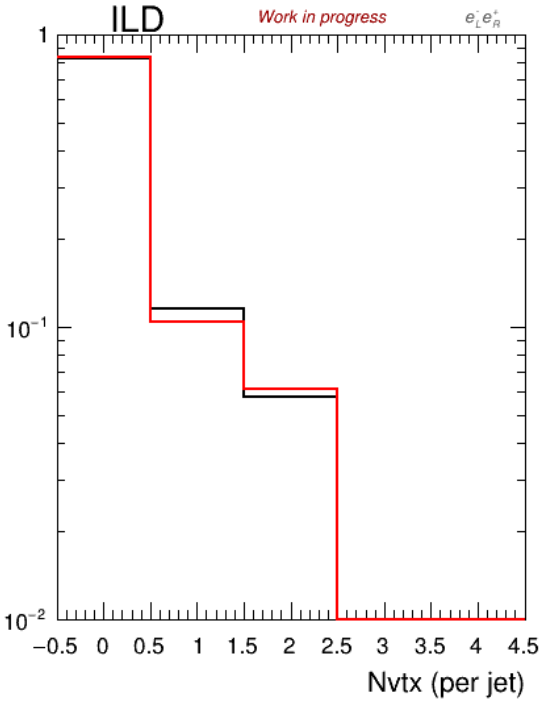
Generator level: Particles produced

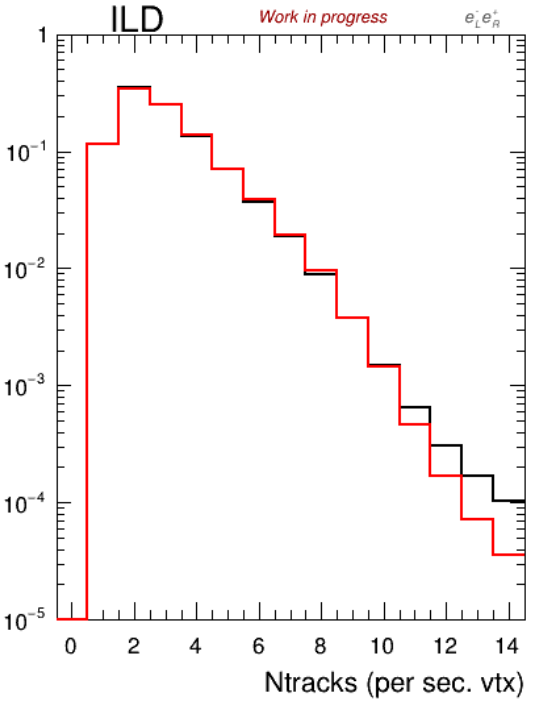


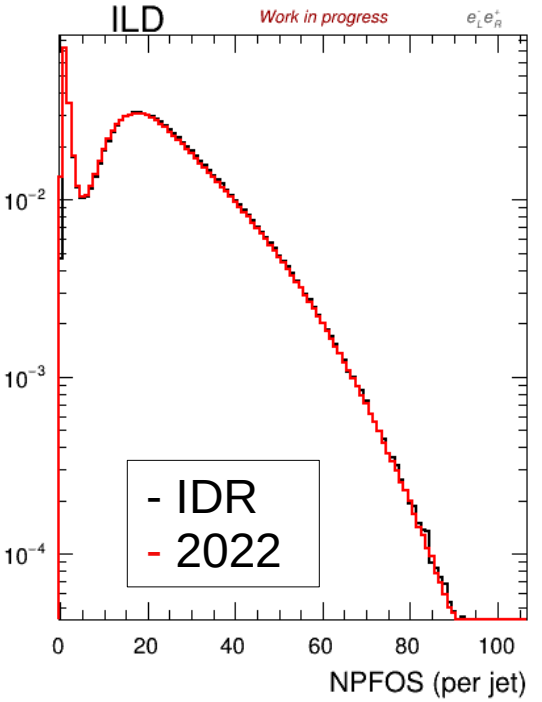


- Partons produced during PS (Left plot).
- Stable particles before the detector (Right plot).

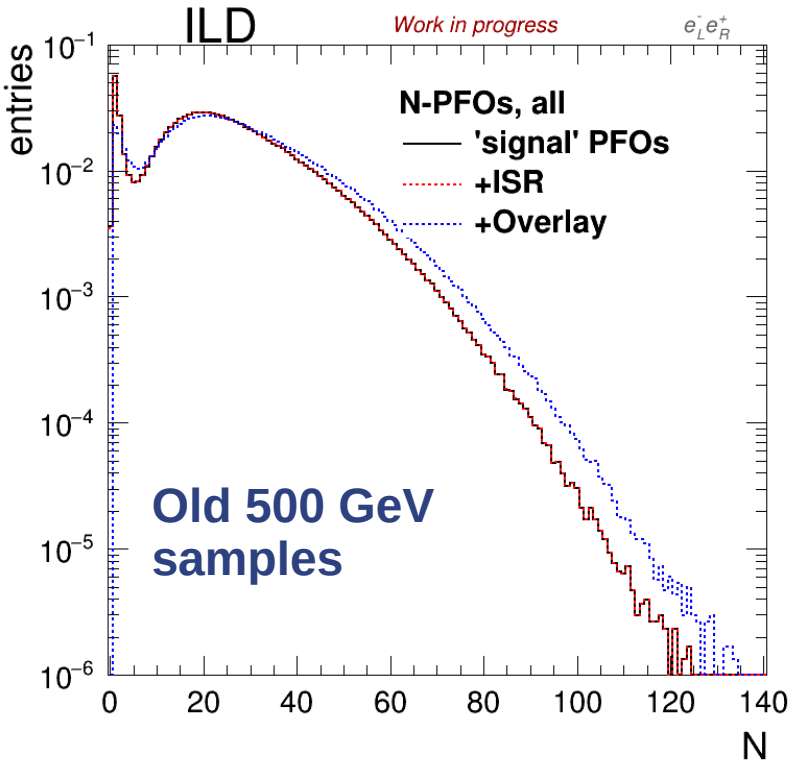
Reconstruction level

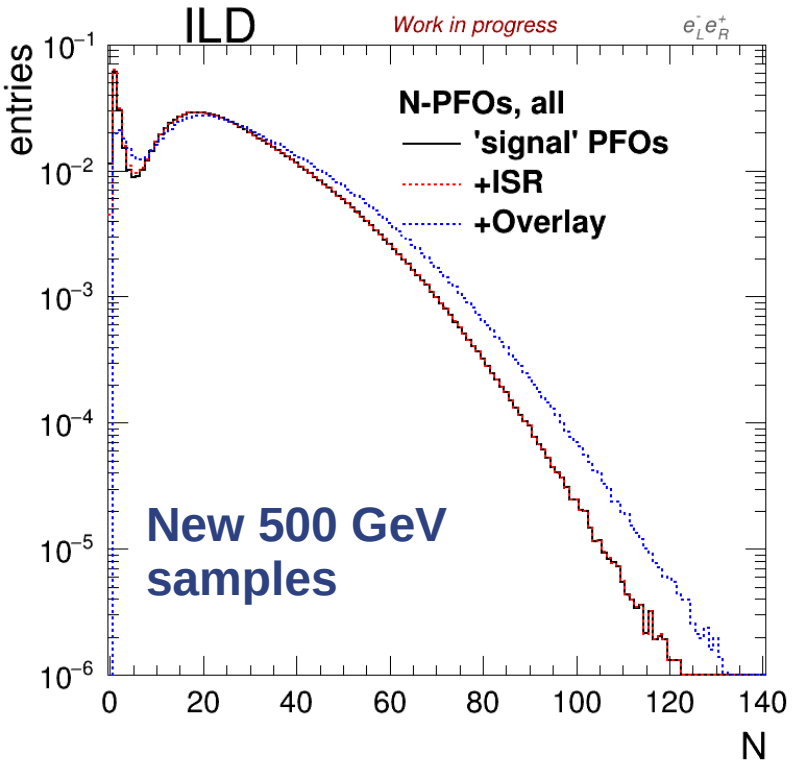




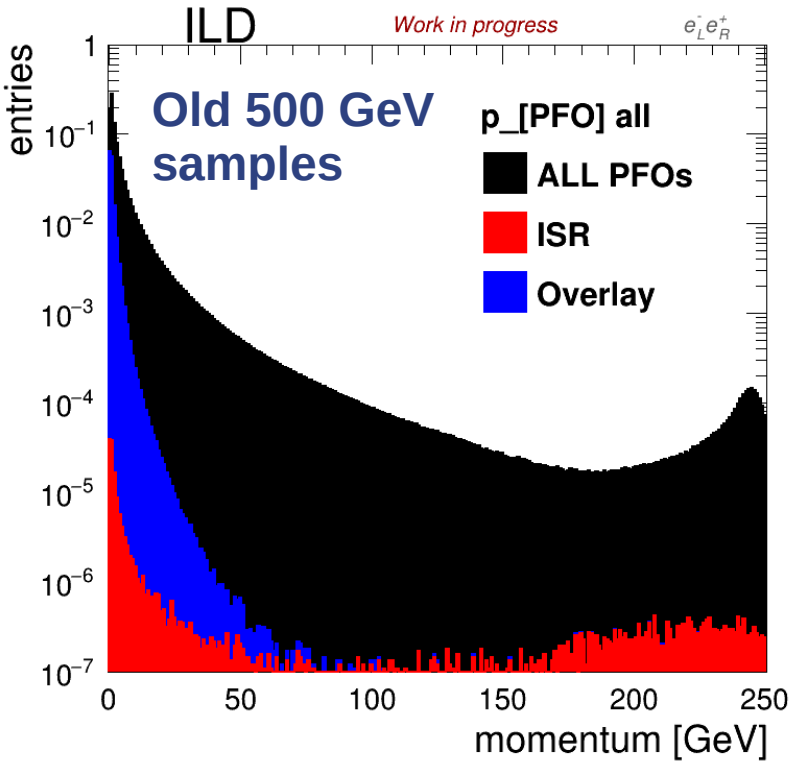


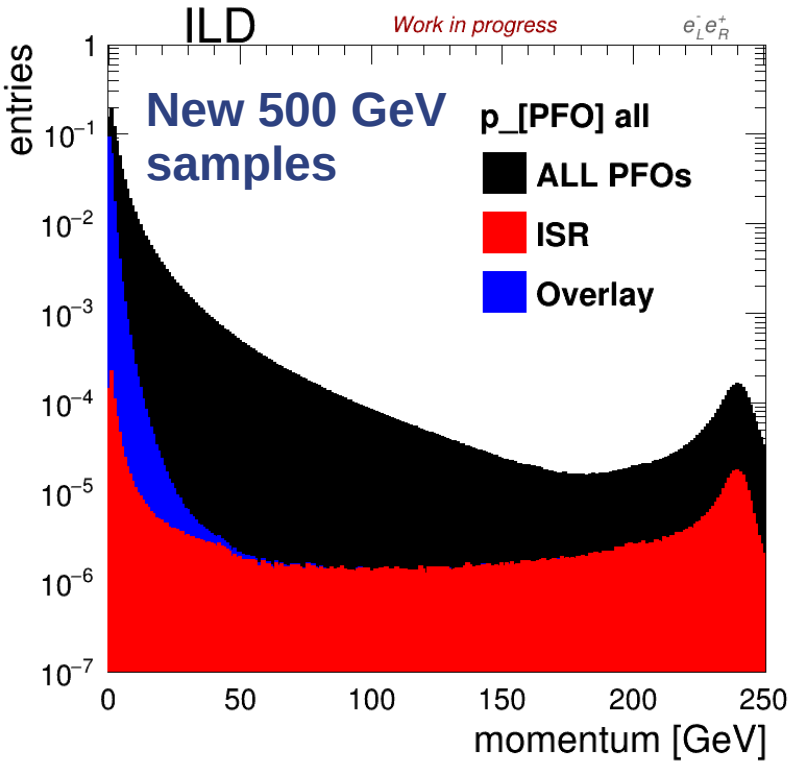
Reco. level: Overlay BKG (Signal)



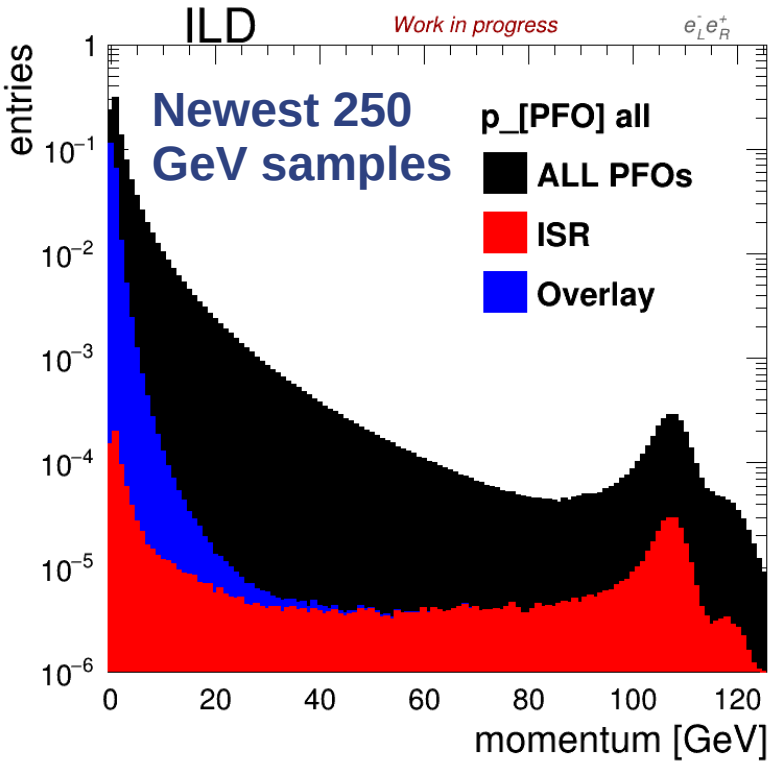


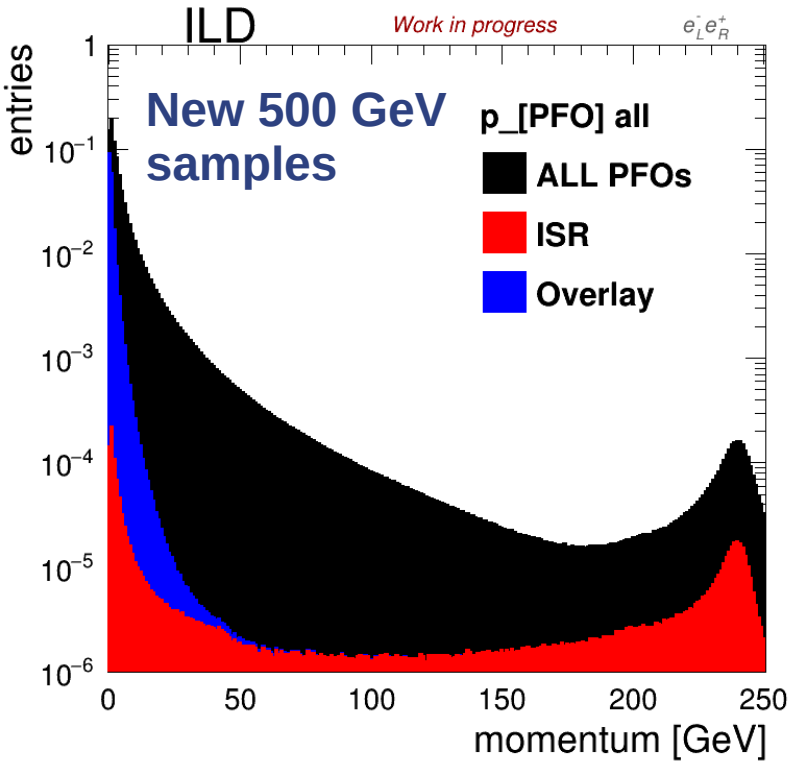
Reco. level: Energy of PFOs



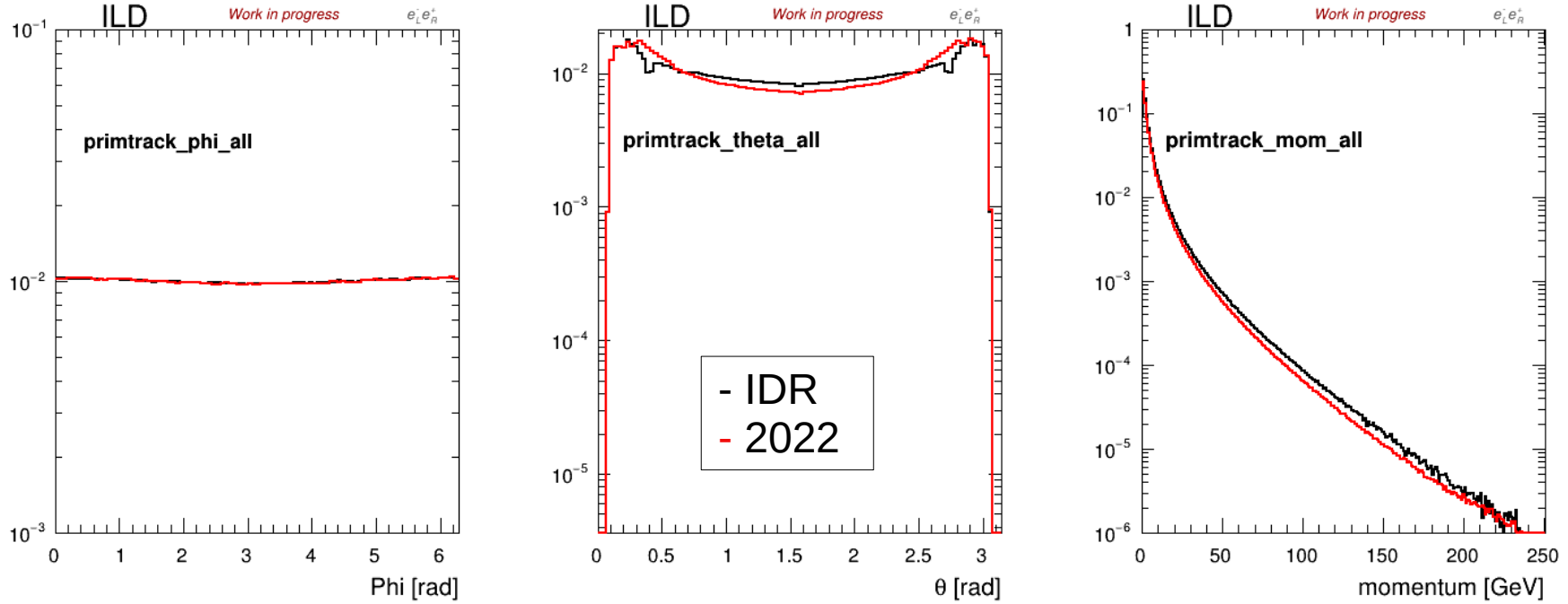


Reco. level: Energy of PFOs



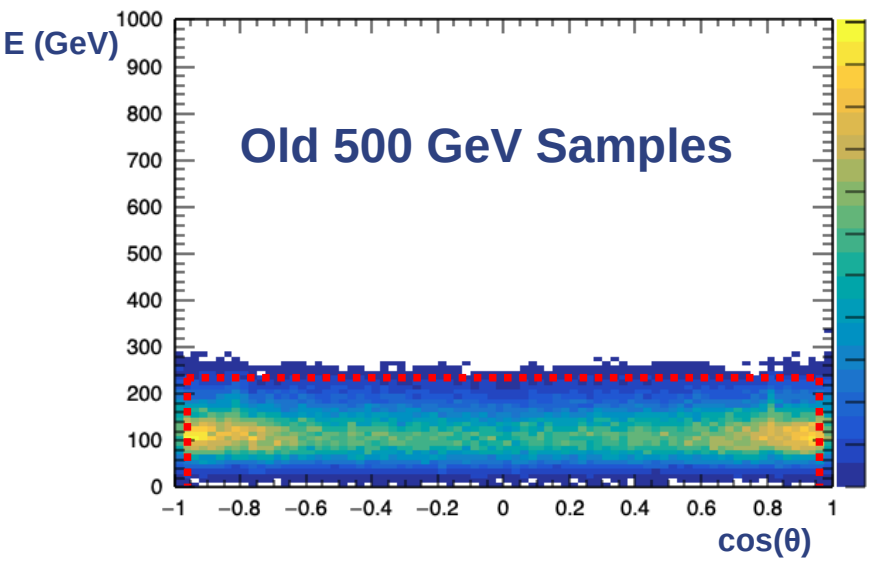


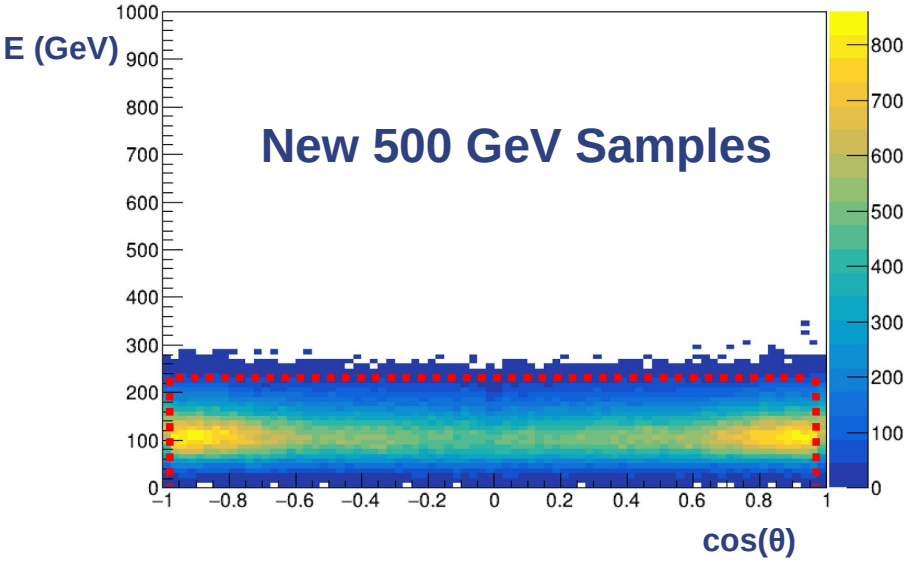
Reco. level: Primary tracks kinematics



- These two “inverted horns” in the forward/backward distribution disappear.
  - Mismatch between tracks and calorimeter objects in the ECAL barrel-endcap transition).

High Level Reco: ISR Photon ID



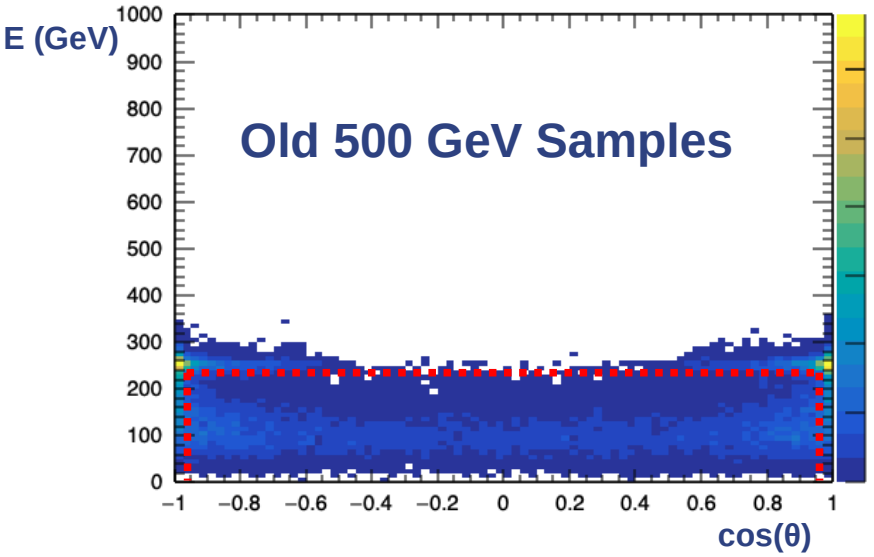


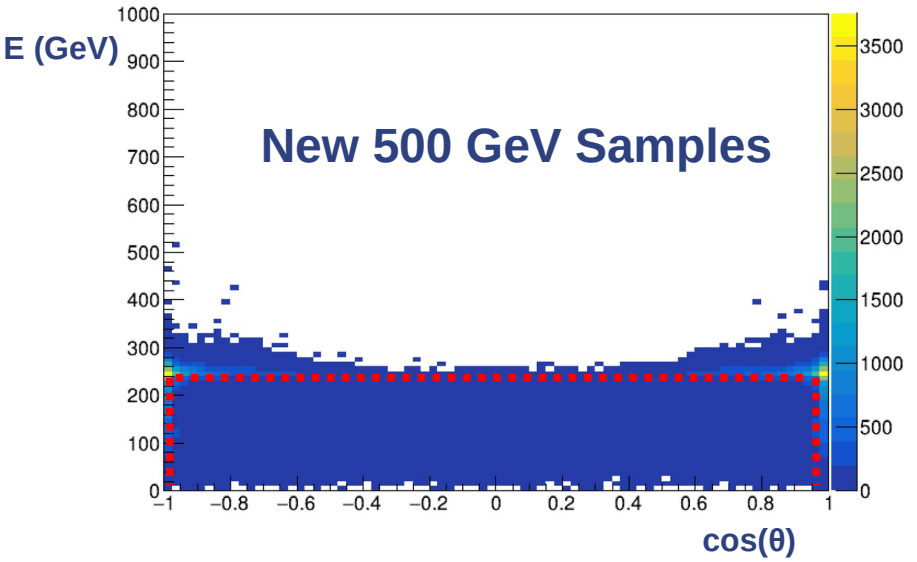
$q\bar{q}$ events (uds)

E_{ISR} < 50 GeV

- Energy vs θ distribution of neutral pfos (photon ISR candidates), identified with PandoraPFO. Useful for ISR removal (1st cut to preselect the $q\bar{q}$ signals).

High Level Reco: ISR Photon ID



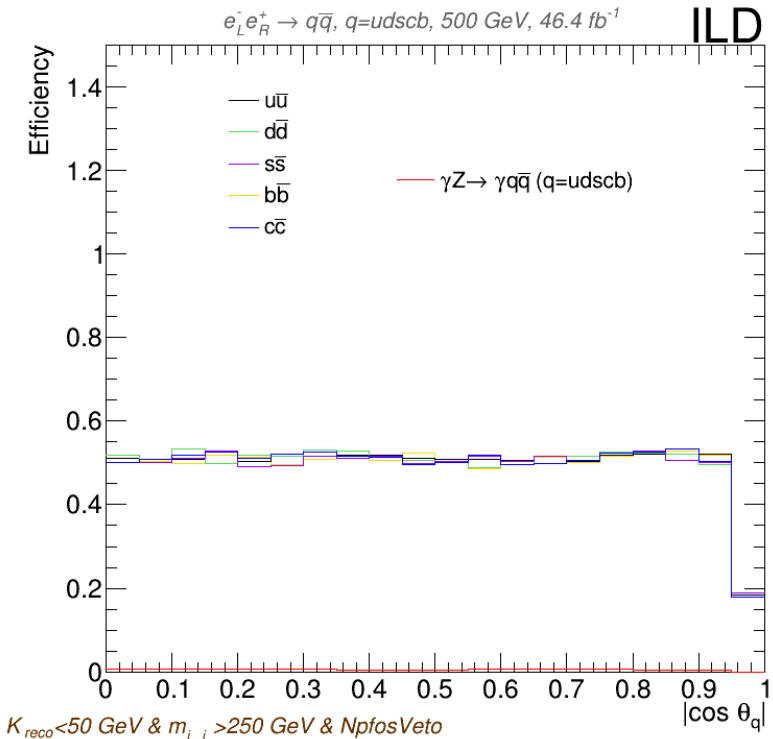


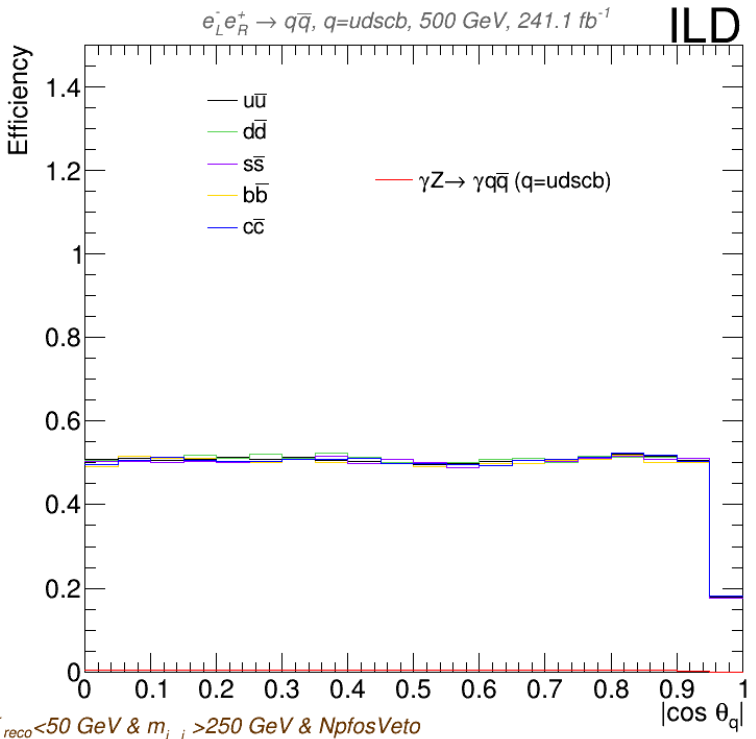
ISR events

E_{ISR} > 50 GeV

- Energy vs θ distribution of neutral pfos (photon ISR candidates), identified with PandoraPFO. Useful for ISR removal (1st cut to preselect the $q\bar{q}$ signals).

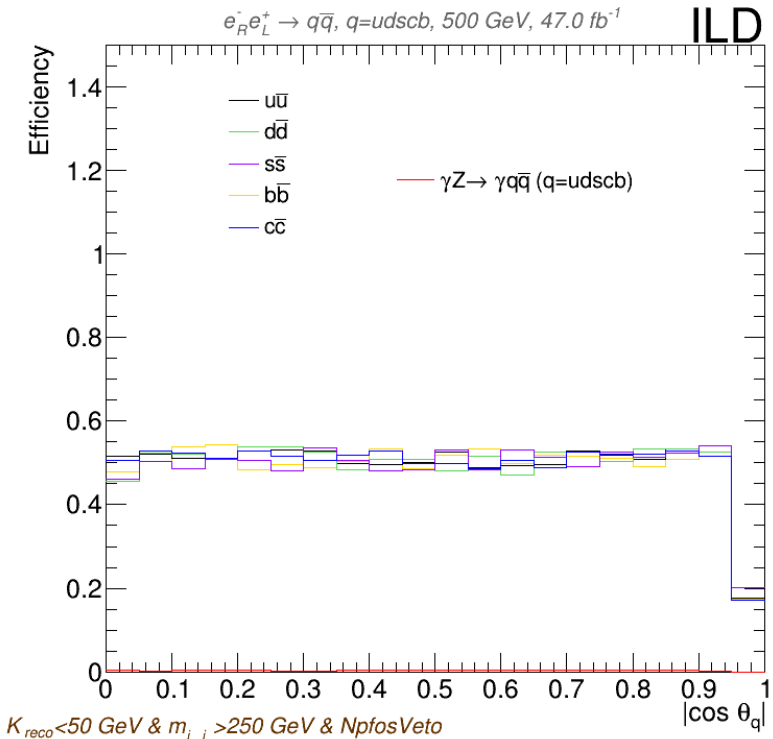
High Level Reco: Signal preselection

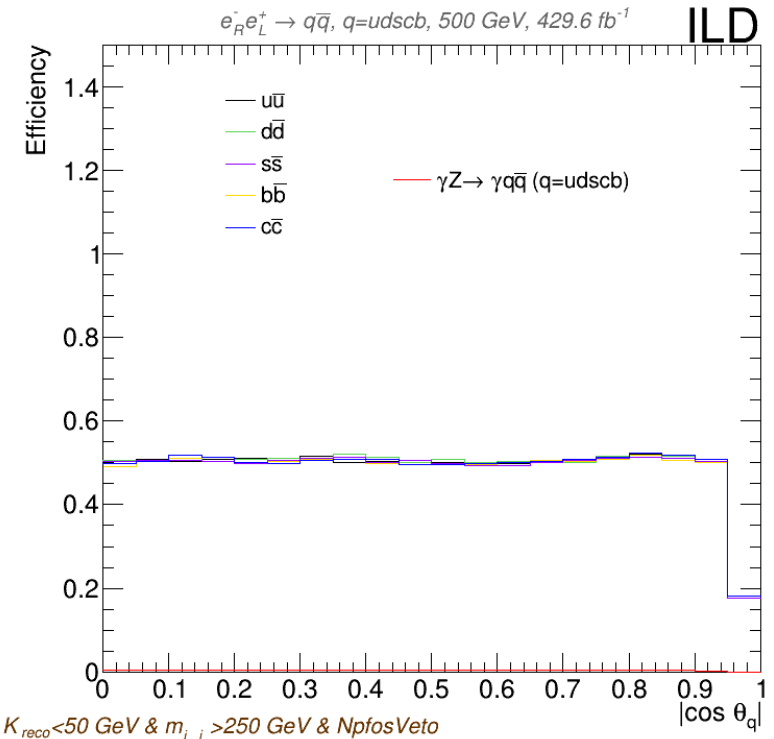




Old 500 GeV Samples

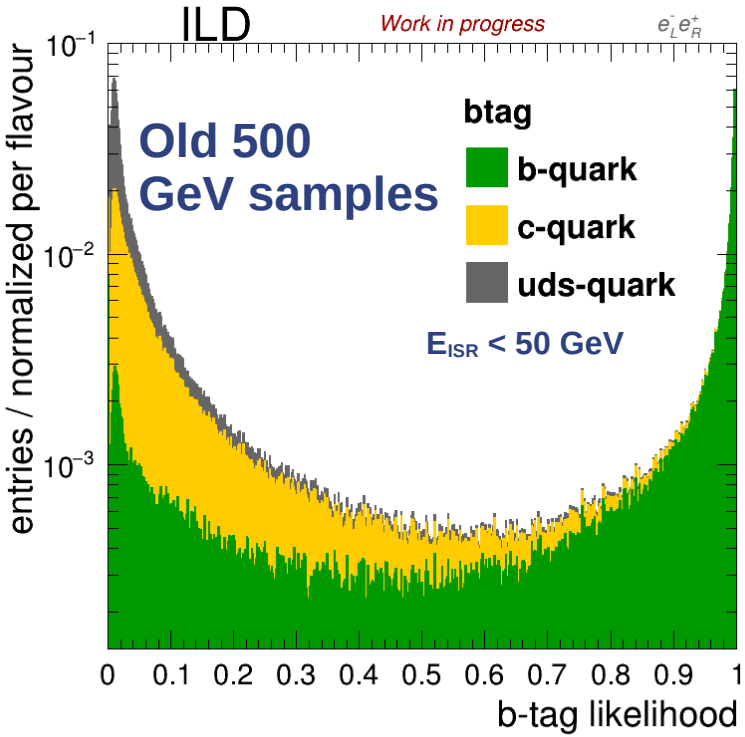
High Level Reco: Signal preselection

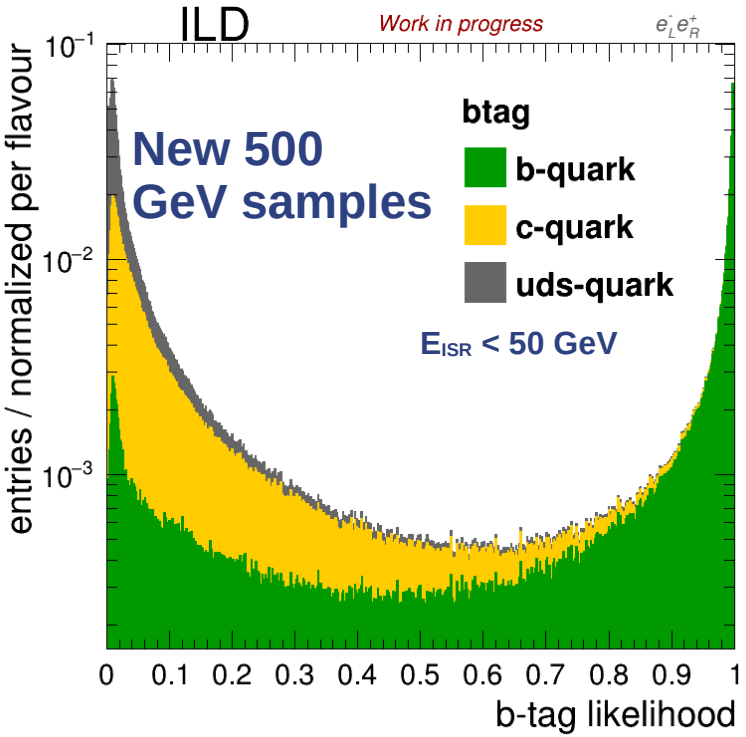




New 500 GeV Samples

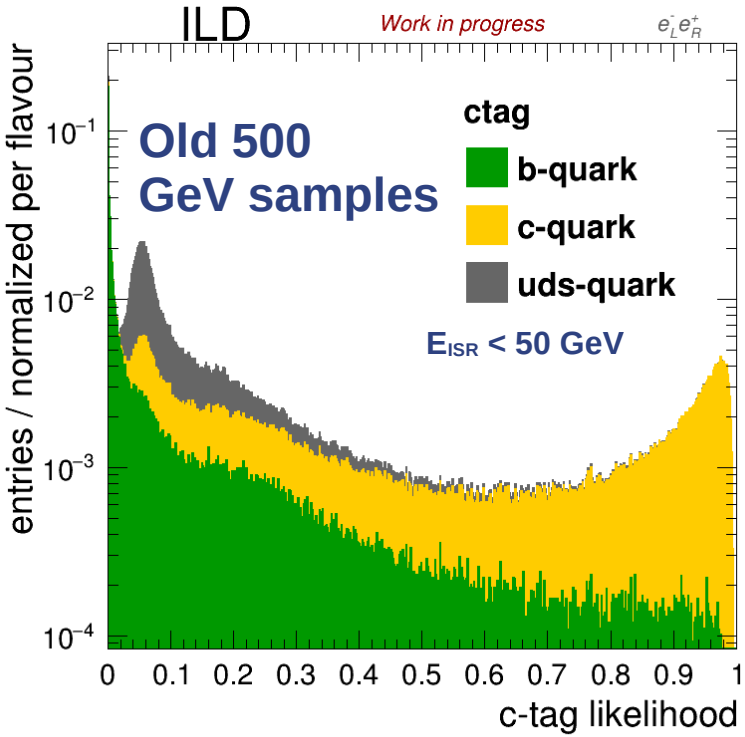
High Level Reco: b-tag

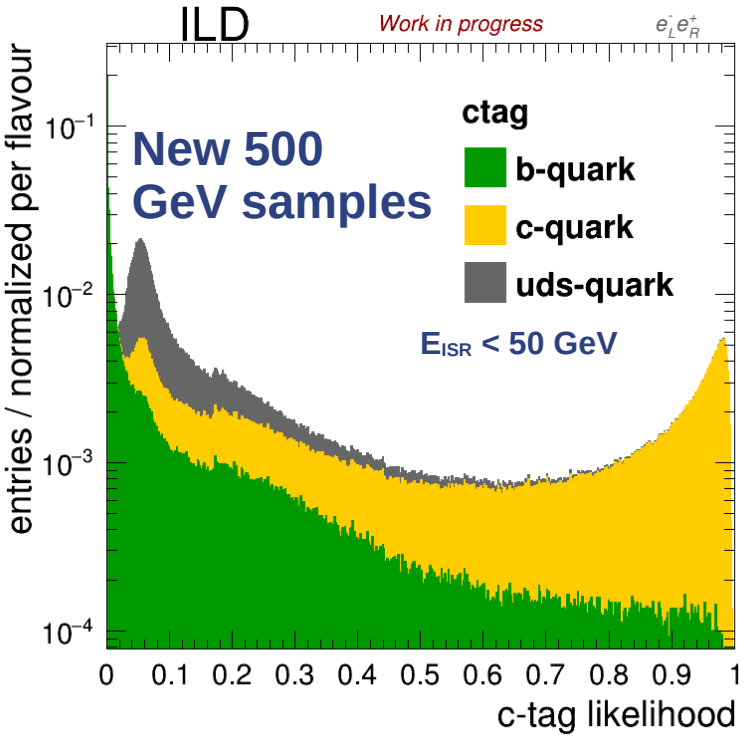




- Weight files: 2q250_v04_p00_ildl5 - files
- VTX files: d0probv2_ildl5_2q250.root (and z0)

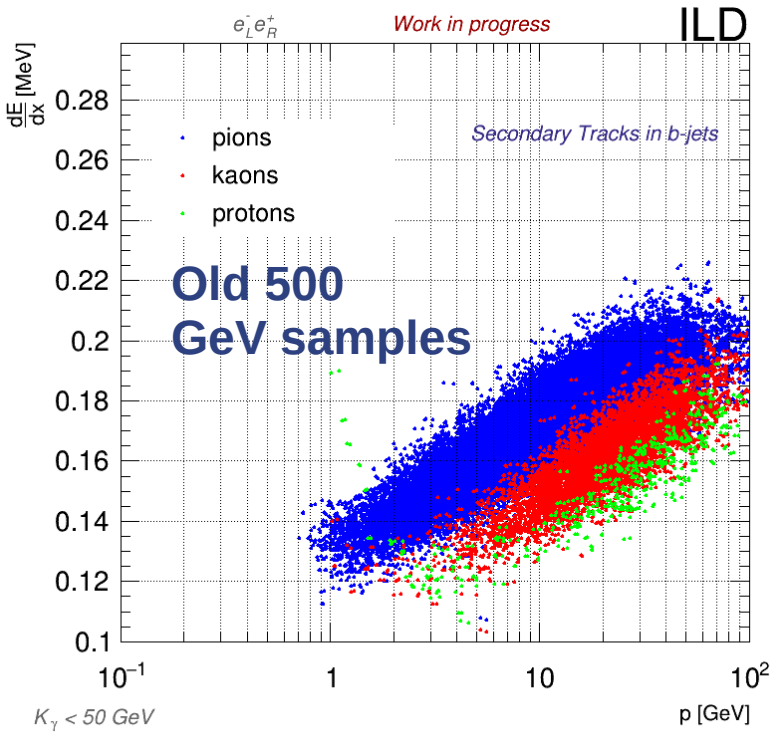
High Level Reco: c-tag

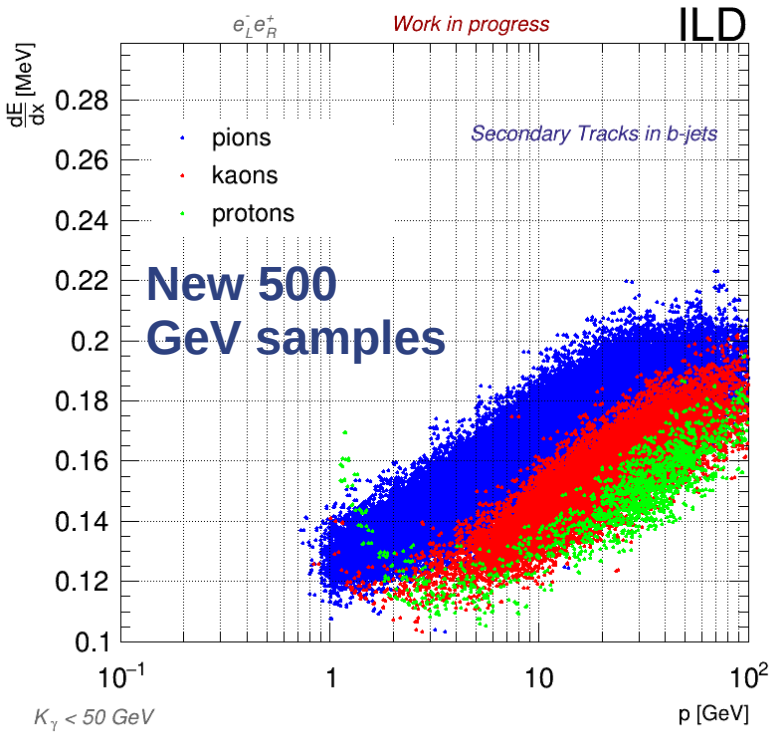




- Weight files: 2q250_v04_p00_ildl5 - files
- VTX files: d0probv2_ildl5_2q250.root (and z0)

High Level Reco: dEdx





- Higher statistics in the new samples and very similar distributions for the produced hadrons.
  - Didn't get to check if there's angular dependence (TBD).

To be done, future studies

- Sample Testing:
  - More high level reconstruction studies:
    - Particle ID for Kaons, Pions and protons.
      - Including dE/dx & TOF
  - Look for the full performance of the Preselection process and refine it.

- Flavour tagging:
  - Use physical samples from the new simulation to get new FT weight files.
  - Working on a high-level optimization for the LCFI+ weight files:
    - Test to avoid overtraining when running ROOT's TMVA for FT.
    - Study for the different of the LCFI+ categories separately.
    - Improve the performance of the BDTs.

PSO

PSO - Overview

- Particle Swarm Optimization is a Gradient-free, bio-inspired, stochastic, population-based algorithm to optimize any kind of process towards a certain goal:
  - No maths involved in the optimization (no gradients or loss function used).
  - It just keeps trying configurations and saves the best-performing one.
- How it works:
  - We have N “particles”, in our case: configurations of the BDT. Then:
    1) The BDT runs with the configuration of the particle.
    2) When finished, each particle gets a performance score.
       -We define a Function Of Merit (FOM) for this scoring.
       -And we test for overfitting.
    3) We track each particle’s best configuration and the best global one.
    4) The particles moves to a new configuration, approaching a better one using the previous results.

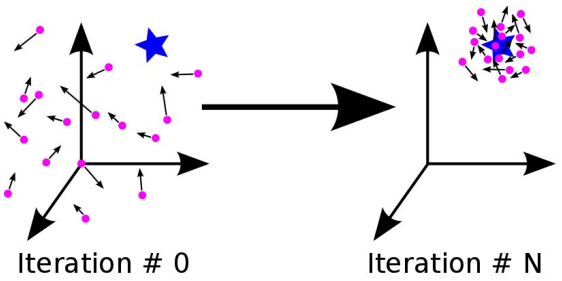


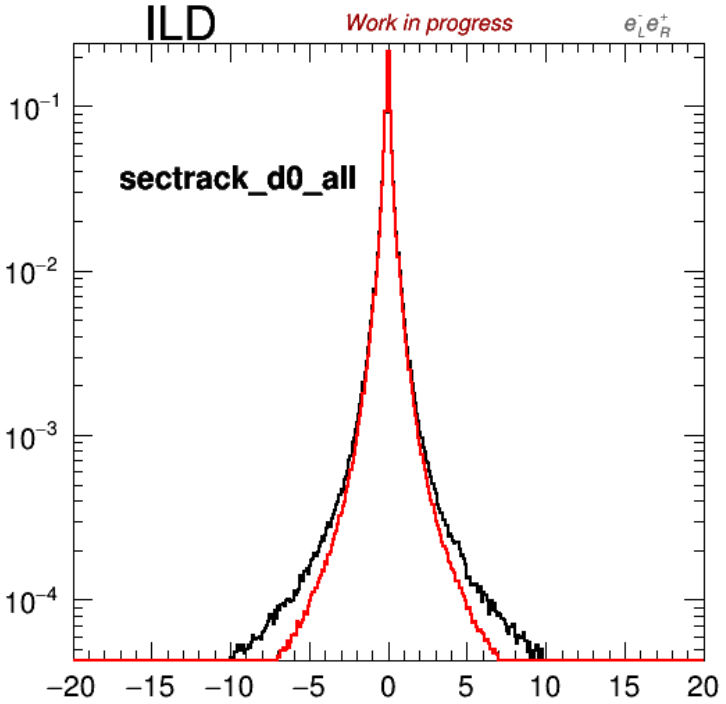
Image taken from a website

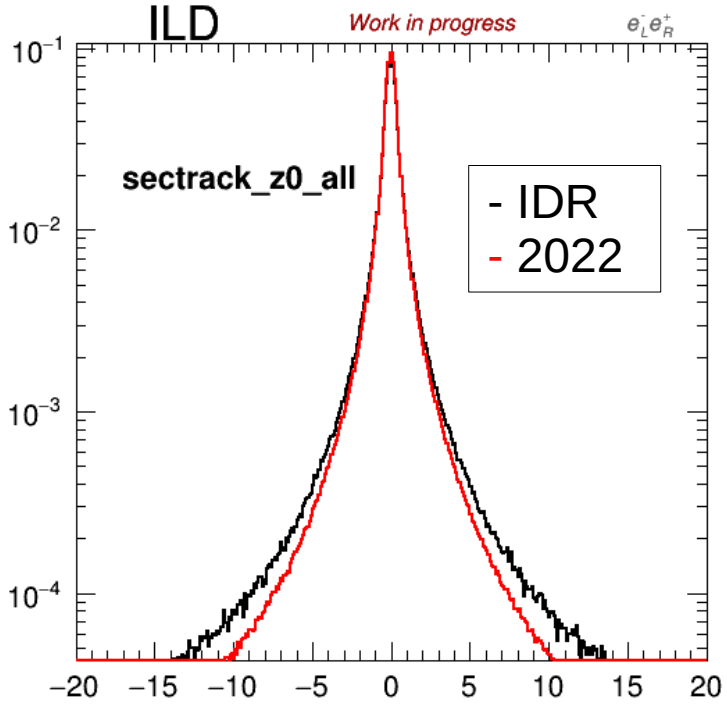
For each iteration

After N iterations we will have optimal classification while avoiding overfitting

Back-up

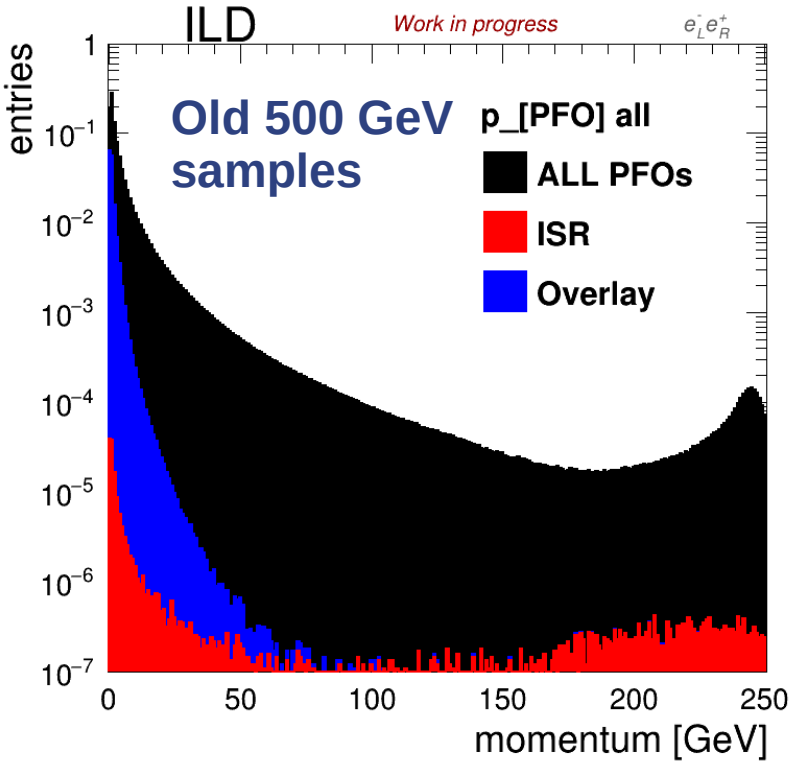
Reco. level: Sec. tracks impact parameters

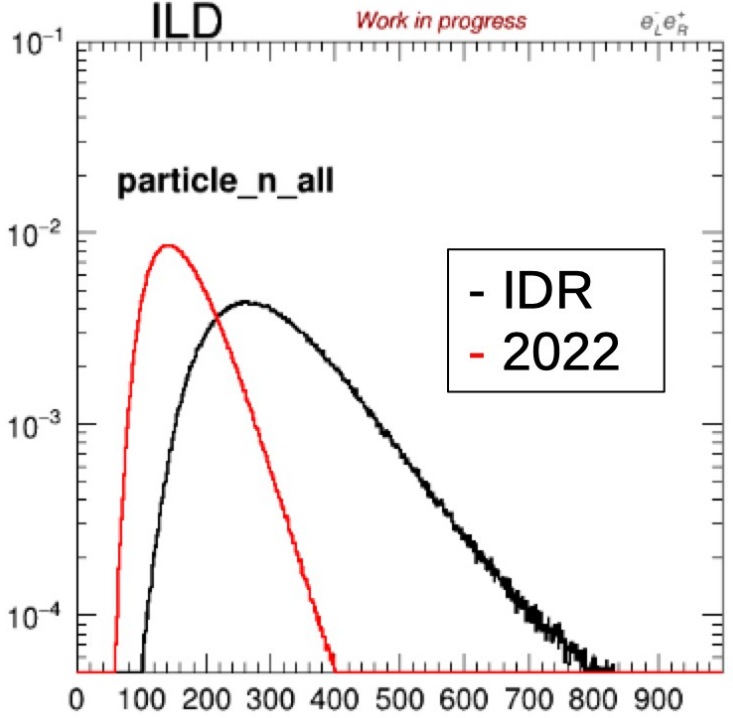




- Secondary tracks slightly more collimated in the new samples.

ISR PFOs and stable particles issue (in old samples)





- ISR PFOs weren't properly tag in the old samples.
- The number of stable particles were almost 2x in the old samples.

- IDR
- 2022

ISR PFOs and stable particles issue (in old samples)

Old 500 GeV samples

```
 collection name : MCParticle
 parameters:

--------------- print out of MCParticle collection ---------------

  flag:  0x0
  simulator status bits: [sbvtcls]  s: created in simulation b: backscatter v: vertex is not endpoint of parent t: decayed in tracker c: decayed in calorimeter l: has left detector s: stopped o: overlay

[   id   ]index|      PDG |    px,     py,        pz    | px_ep,   py_ep , pz_ep      | energy  |gen|[simstat ]| vertex x,     y   ,   z     | endpoint x,    y  ,   z     |    mass |  charge |            spin             | colorflow | [parents] - [daughters]

[00000254]    0|       11| 1.75e+00, 0.00e+00, 2.50e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.50e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [] - [2,3,4,5]
[00000255]    1|      -11| 1.75e+00, 0.00e+00,-2.50e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.50e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00| 1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [] - [2,3,4,5]
[00000256]    2|       11| 6.72e+01, 6.46e+01,-9.24e+00| 0.00e+00, 0.00e+00, 0.00e+00| 9.37e+01| 2 |[        ]| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [0,1] - [6,7]
[00000257]    3|      -11| 1.28e+00,-3.40e-04,-1.84e+02| 0.00e+00, 0.00e+00, 0.00e+00| 1.84e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00| 1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [0,1] - [6,7]
[00000258]    4|       22|-6.51e+01,-6.46e+01, 1.98e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.18e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [0,1] - [8]
[00000259]    5|       22| 5.04e-03, 4.54e-04,-7.13e-01| 0.00e+00, 0.00e+00, 0.00e+00| 7.13e-01| 2 |[        ]| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [0,1] - [9]
[00000260]    6|        5| 5.63e+01, 7.33e+01,-9.02e+00| 0.00e+00, 0.00e+00, 0.00e+00| 9.29e+01| 2 |[        ]| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00|-3.33e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [2,3] - [10]
[00000261]    7|       -5| 1.22e+01,-8.71e+00,-1.84e+02| 0.00e+00, 0.00e+00, 0.00e+00| 1.84e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00| 3.33e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [2,3] - [11]
[00000262]    8|       22|-6.51e+01,-6.46e+01, 1.98e+02|-0.00e+00,-0.00e+00, 0.00e+00| 2.18e+02| 1 |[    c s ]| 0.00e+00, 0.00e+00,-5.15e-02|-7.95e+02,-7.90e+02, 2.41e+03| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [4] - [166,167,168,169,170,171,172,173,174,175,176,
177,178,179,180,196,197,198]
[00000263]    9|       22| 5.04e-03, 4.54e-04,-7.13e-01| 5.04e-03, 4.54e-04,-7.13e-01| 7.13e-01| 1 |[     l  ]| 0.00e+00, 0.00e+00,-5.15e-02| 1.06e+02, 9.54e+00,-1.50e+04| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [5] - []
[00000264]   10|        5| 5.63e+01, 7.33e+01,-9.02e+00| 0.00e+00, 0.00e+00, 0.00e+00| 9.29e+01| 2 |[        ]| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00|-3.33e-01| 0.00e+00, 0.00e+00,-1.00e+00|  (0, 0)   | [6] - [12]
[00000265]   11|       -5| 1.22e+01,-8.71e+00,-1.84e+02| 0.00e+00, 0.00e+00, 0.00e+00| 1.84e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00, 0.00e+00,-5.15e-02| 0.00e+00| 3.33e-01| 0.00e+00, 0.00e+00, 1.00e+00|  (501, 0)  | [7] - [12]
```

- Notice how in this event ISR photons (ids 4 & 5) immediately decay to other particles.
  - ISR #4 decay into a photon #8, which then produced ***many*** e^- and e^-e^+ pairs (next slide).
    - Not physically accurate.
  - ISR #5 decay into a photon #9. which is stable.
    - It's the same ISR but now *we will count it as a neutral PFO*. (less ISR counts)

ISR PFOs and stable particles issue (in old samples)

Old 500 GeV samples

```
[00000420]  166|       11|-8.97e-05,-1.38e-03,-2.57e-03| 0.00e+00, 0.00e+00,-0.00e+00| 2.96e-03| 0 |[s vt  s ]|-8.45e+02,-1.04e+03, 2.25e+03|-8.45e+02,-1.05e+03, 2.24e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000421]  167|       11|-8.47e-04, 8.40e-05,-1.21e-03|-0.00e+00,-0.00e+00,-0.00e+00| 1.56e-03| 0 |[s vt  s ]|-1.01e+03,-8.16e+02, 2.28e+03|-1.01e+03,-8.17e+02, 2.28e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000422]  168|       11|-8.20e-04,-4.55e-04,-1.75e-03| 0.00e+00,-0.00e+00, 0.00e+00| 2.05e-03| 0 |[s vt  s ]|-9.15e+02,-7.88e+02, 2.24e+03|-9.16e+02,-7.89e+02, 2.24e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000423]  169|       11|-6.15e-04, 9.70e-04,-1.07e-03|-0.00e+00, 0.00e+00,-0.00e+00| 1.65e-03| 0 |[s vt  s ]|-1.07e+03, 9.10e+02,-2.25e+03|-1.08e+03, 9.09e+02,-2.25e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000424]  170|       11|-6.46e-04,-2.53e-03,-2.11e-03|-0.00e+00, 0.00e+00,-0.00e+00| 3.39e-03| 0 |[s vt  s ]|-8.77e+02,-1.01e+03, 2.30e+03|-8.74e+02,-1.01e+03, 2.30e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000425]  171|       11| 9.68e-05,-4.44e-04,-2.64e-03| 6.01e-05, 2.15e-04,-9.67e-04| 2.73e-03| 0 |[s vt    ]|-5.35e+02,-2.79e+02,-2.34e+03|-5.36e+02,-2.83e+02,-2.37e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000426]  172|       11|-3.01e-03, 2.91e-04,-1.14e-02|-3.12e-03, 5.00e-04,-3.81e-03| 1.18e-02| 0 |[s vt    ]|-1.40e+03, 1.09e+02,-2.29e+03|-1.41e+03, 1.05e+02,-2.39e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000427]  173|       11| 8.47e-04,-1.71e-03,-1.73e-03| 0.00e+00, 0.00e+00, 0.00e+00| 2.63e-03| 0 |[s vt  s ]|-8.00e+02,-1.13e+03, 2.24e+03|-7.96e+02,-1.13e+03, 2.24e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000428]  174|       11|-9.29e-04,-2.12e-03,-5.66e-04| 0.00e+00,-0.00e+00, 0.00e+00| 2.44e-03| 0 |[s vt  s ]|-8.90e+02,-1.36e+03, 2.34e+03|-8.89e+02,-1.36e+03, 2.34e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000429]  175|       11| 1.23e-03, 1.11e-03,-2.68e-03| 1.39e-04,-7.40e-04, 1.30e-03| 3.19e-03| 0 |[s vt    ]|-4.65e+01,-7.41e+01, 1.07e+03|-4.56e+01,-7.29e+01, 1.08e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000430]  176|       11| 2.33e-04,-3.54e-03,-7.09e-03|-0.00e+00, 0.00e+00, 0.00e+00| 7.94e-03| 0 |[s vt  s ]|-8.23e+02,-8.72e+02, 2.29e+03|-8.24e+02,-8.73e+02, 2.25e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000431]  177|       11| 1.31e-04, 9.59e-04,-1.05e-03|-0.00e+00, 0.00e+00,-0.00e+00| 1.52e-03| 0 |[s vt  s ]|-8.11e+02,-6.94e+02, 2.25e+03|-8.10e+02,-6.94e+02, 2.24e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000432]  178|       11|-2.84e-03,-1.04e-03,-2.93e-03| 0.00e+00, 0.00e+00, 0.00e+00| 4.24e-03| 0 |[s vt  s ]|-1.02e+03,-8.83e+02, 2.24e+03|-1.01e+03,-8.84e+02,-2.24e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000433]  179|       11|-7.84e-04,-8.83e-04,-2.13e-03| 0.00e+00, 0.00e+00,-0.00e+00| 2.49e-03| 0 |[s vt  s ]|-8.88e+02,-9.17e+02, 2.24e+03|-8.88e+02,-9.17e+02, 2.24e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000434]  180|       11|-3.69e-05, 3.85e-03,-3.39e-03|-0.00e+00,-0.00e+00,-0.00e+00| 5.16e-03| 0 |[s vt  s ]|-8.45e+02,-6.64e+02, 2.34e+03|-8.48e+02,-6.64e+02, 2.32e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - [181]
[00000435]  181|       22| 6.72e-04,-4.39e-04,-6.06e-04| 0.00e+00,-0.00e+00, 0.00e+00| 1.01e-03| 0 |[s v c s ]|-8.49e+02,-6.67e+02, 2.33e+03|-6.34e+02,-7.59e+02, 2.42e+03| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [180] - []
[00000436]  182|       22| 7.66e-02,-7.25e-02,-1.48e+00| 0.00e+00,-0.00e+00,-0.00e+00| 1.49e+00| 0 |[s v c s ]| 1.27e+02,-1.15e+02,-2.41e+03| 1.27e+02,-1.15e+02,-2.41e+03| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [100] - [195]
[00000437]  183|       22| 1.84e-02,-1.75e-02,-3.58e-01| 0.00e+00,-0.00e+00,-0.00e+00| 3.58e-01| 0 |[s v c s ]| 1.27e+02,-1.15e+02,-2.41e+03| 1.27e+02,-1.15e+02,-2.41e+03| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [100] - []
[00000438]  184|       22| 2.42e-01,-2.29e-01,-4.70e+00| 0.00e+00,-0.00e+00,-0.00e+00| 4.71e+00| 0 |[s v c s ]| 1.27e+02,-1.15e+02,-2.41e+03| 1.27e+02,-1.15e+02,-2.41e+03| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [100] - []
[00000439]  185|       22| 1.34e-03,-1.27e-03,-2.60e-02| 0.00e+00,-0.00e+00,-0.00e+00| 2.61e-02| 0 |[s v c s ]| 1.27e+02,-1.15e+02,-2.41e+03| 1.27e+02,-1.16e+02,-2.42e+03| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [100] - []
[00000440]  186|       11| 2.08e-04, 1.17e-03, 1.02e-03|-0.00e+00,-0.00e+00, 0.00e+00| 1.65e-03| 0 |[s vt  s ]| 1.26e+02, 1.77e+03, 1.15e+03| 1.24e+02, 1.77e+03, 1.15e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [100] - []
[00000441]  187|       11|-9.53e-04, 1.25e-03, 3.41e-04|-0.00e+00, 0.00e+00, 0.00e+00| 1.68e-03| 0 |[s vt  s ]| 1.67e+02,-2.18e+01,-2.41e+03| 1.67e+02,-2.18e+01,-2.41e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [100] - []
[00000442]  188|       11|-5.85e-04, 1.74e-03, 3.01e-03|-0.00e+00,-0.00e+00, 0.00e+00| 3.56e-03| 0 |[s vt  s ]| 1.33e+02,-9.70e+01,-2.41e+03| 1.33e+02,-9.69e+01,-2.41e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [100] - []
[00000443]  189|      -11| 3.44e-04, 1.02e-03, 2.19e-03| 0.00e+00,-0.00e+00, 0.00e+00| 2.49e-03| 0 |[s vt  s ]| 1.33e+02,-9.70e+01,-2.41e+03| 1.33e+02,-9.69e+01,-2.41e+03| 5.11e-04| 1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [100] - []
[00000444]  190|       11| 1.20e-03,-6.27e-04, 2.20e-03| 0.00e+00,-0.00e+00,-0.00e+00| 2.63e-03| 0 |[s vt  s ]| 8.42e+02,-4.57e+02, 2.25e+03| 8.42e+02,-4.54e+02, 2.25e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [100] - []
[00000445]  191|       11| 1.43e-03,-1.73e-04, 3.48e-04| 0.00e+00,-0.00e+00, 0.00e+00| 1.57e-03| 0 |[s vt  s ]| 3.32e+02,-2.88e+02,-2.32e+03| 3.32e+02,-2.84e+02,-2.32e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [100] - []
[00000446]  192|       11| 1.85e-04,-4.66e-04, 1.49e-03|-0.00e+00,-0.00e+00, 0.00e+00| 1.65e-03| 0 |[s vt  s ]| 9.42e+02,-1.50e+03, 2.81e+02| 9.43e+02,-1.50e+03, 2.83e+02| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [100] - []
[00000447]  193|       11| 1.14e-03,-3.69e-04, 1.11e-03| 0.00e+00, 0.00e+00, 0.00e+00| 1.71e-03| 0 |[s vt  s ]| 3.54e+02,-1.99e+02,-2.24e+03| 3.55e+02,-1.97e+02,-2.24e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [100] - []
[00000448]  194|       11| 4.69e-05, 1.82e-03, 1.68e-03| 3.37e-04, 2.12e-03, 1.48e-04| 2.53e-03| 0 |[s vt    ]| 1.29e+02,-1.10e+02,-2.41e+03| 1.30e+02,-1.08e+02,-2.41e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [100] - []
[00000449]  195|       11| 1.10e-03,-5.37e-04, 8.22e-04| 0.00e+00,-0.00e+00,-0.00e+00| 1.56e-03| 0 |[s vt  s ]| 3.27e+02,-1.33e+02,-2.27e+03| 3.29e+02,-1.32e+02,-2.27e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [182] - []
[00000450]  196|       11|-1.75e-03, 5.44e-04,-1.72e-03| 0.00e+00,-0.00e+00, 0.00e+00| 2.56e-03| 0 |[s vt  s ]|-9.24e+02,-8.35e+02, 2.32e+03|-9.23e+02,-8.37e+02, 2.31e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000451]  197|       11|-3.19e-03, 9.09e-04,-2.28e-03| 0.00e+00,-0.00e+00,-0.00e+00| 4.06e-03| 0 |[s vt  s ]|-9.75e+02,-7.88e+02, 2.34e+03|-9.77e+02,-7.93e+02, 2.32e+03| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
[00000452]  198|      -11|-5.86e-03, 1.06e-03,-4.52e-03|-1.17e-03,-3.48e-04, 1.92e-03| 7.50e-03| 0 |[s vt    ]|-9.75e+02,-7.88e+02, 2.34e+03|-9.72e+02,-7.81e+02, 2.37e+03| 5.11e-04| 1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8] - []
```

ISR photon decaying to multiple e^- and e^+

ISR PFOs and stable particles issue (in old samples)

Old 500 GeV samples

```
 collection name : MCParticle
 parameters:

--------------- print out of MCParticle collection ---------------

  flag:  0x0
  simulator status bits: [sbvtcls]  s: created in simulation b: backscatter v: vertex is not endpoint of parent t: decayed in tracker c: decayed in calorimeter l: has left detector s: stopped o: overlay

[   id   ]index|      PDG |    px,     py,        pz    | px_ep,   py_ep , pz_ep      | energy  |gen|[simstat ]| vertex x,     y   ,   z     | endpoint x,    y  ,   z     |    mass |  charge |            spin             | colorflow | [parents] - [daughters]

[00000321]    0|       11| 1.75e+00, 0.00e+00, 2.50e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.50e+02| 2 |[        ]| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [] - [2,3,4,5]
[00000322]    1|      -11| 1.75e+00, 0.00e+00,-2.50e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.50e+02| 2 |[        ]| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00| 1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [] - [2,3,4,5]
[00000323]    2|       11| 5.51e-02,-5.40e-03, 9.95e+00| 0.00e+00, 0.00e+00, 0.00e+00| 9.95e+00| 2 |[        ]| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [0,1] - [6,7]
[00000324]    3|      -11| 1.75e+00, 3.90e-18,-2.50e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.50e+02| 2 |[        ]| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00| 1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [0,1] - [6,7]
[00000325]    4|       22| 1.69e+00, 5.40e-03, 2.40e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.40e+02| 2 |[        ]| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [0,1] - [8]
[00000326]    5|       22| 3.89e-16,-5.38e-19,-5.56e-14| 0.00e+00, 0.00e+00, 0.00e+00| 5.56e-14| 2 |[        ]| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [0,1] - [9]
[00000327]    6|        5|-1.38e+01,-2.87e+01,-2.02e+01| 0.00e+00, 0.00e+00, 0.00e+00| 3.77e+01| 2 |[        ]| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00|-3.33e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [2,3] - [10]
[00000328]    7|       -5| 1.56e+01, 2.87e+01,-2.20e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.23e+02| 2 |[        ]| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00| 3.33e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [2,3] - [11]
[00000329]    8|       22| 1.69e+00, 5.40e-03, 2.40e+02| 1.69e+00, 5.40e-03, 2.40e+02| 2.40e+02| 1 |[     1  ]| 0.00e+00, 0.00e+00, 6.26e-02| 1.06e+02, 3.38e-01, 1.50e+04| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [4] - []
[00000330]    9|       22| 3.89e-16,-5.38e-19,-5.56e-14| 0.00e+00,-0.00e+00,-0.00e+00| 5.56e-14| 1 |[    c s ]| 0.00e+00, 0.00e+00, 6.26e-02| 7.01e+01,-9.68e-02,-1.00e+04| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [5] - []
[00000331]   10|        5|-1.38e+01,-2.87e+01,-2.02e+01| 0.00e+00, 0.00e+00, 0.00e+00| 3.77e+01| 2 |[        ]| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00|-3.33e-01| 0.00e+00, 0.00e+00,-1.00e+00|  (0, 0)   | [6] - [12]
[00000332]   11|       -5| 1.56e+01, 2.87e+01,-2.20e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.23e+02| 2 |[        ]| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00, 0.00e+00, 6.26e-02| 0.00e+00| 3.33e-01| 0.00e+00, 0.00e+00, 1.00e+00|  (501, 0)   | [7] - [12]
```

- Notice how in this event ISR photons (ids 4 & 5) immediately decay to themselves.
  - It's the same ISR but now *it will be counted as a neutral PFO*. (less ISR counts)

ISR PFOs and stable particles issue (in old samples)

New 500 GeV samples

```
 collection name : MCParticlesSkimmed
 parameters:

--------------- print out of MCParticle collection ---------------

  flag:  0x0
  simulator status bits: [sbvtcls]  s: created in simulation b: backscatter v: vertex is not endpoint of parent t: decayed in tracker c: decayed in calorimeter l: has left detector s: stopped o: overlay

[   id   ]index|      PDG |    px,     py,        pz    | px_ep,   py_ep , pz_ep      | energy  |gen|[simstat ]| vertex x,     y   ,   z     | endpoint x,    y  ,   z     |    mass |  charge |           spin            | colorflow | [parents] - [daughters]

[00000542]    0|       11| 1.75e+00, 0.00e+00, 2.50e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.50e+02| 4 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [] - [2,3]
[00000543]    1|      -11| 1.75e+00, 0.00e+00,-2.50e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.50e+02| 4 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01| 5.11e-04| 1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [] - [2,3]
[00000544]    2|       11| 1.75e+00, 0.00e+00, 2.50e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.50e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [0,1] - [4,6]
[00000545]    3|      -11| 1.75e+00, 0.00e+00,-2.50e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.50e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01| 5.11e-04| 1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [0,1] - [5,7]
[00000546]    4|       11| 1.75e+00,-1.49e-16, 2.50e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.50e+02| 3 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01| 5.11e-04|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [2] - [8,9]
[00000547]    5|      -11| 1.75e+00, 3.06e-06,-2.50e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.50e+02| 3 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01| 5.11e-04| 1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [3] - [8,9]
[00000548]    6|       22| 2.54e-18, 3.93e-18, 2.14e-18| 0.00e+00, 0.00e+00, 0.00e+00| 5.15e-18| 1 |[   t  s ]| 0.00e+00, 0.00e+00,-2.42e-01| 7.33e+00, 1.13e+01, 5.94e+00|-7.31e-26| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [2] - []
[00000549]    7|       22| 1.03e-05,-3.06e-06,-7.07e-04|-0.00e+00,-0.00e+00,-0.00e+00| 7.07e-04| 1 |[    c s ]| 0.00e+00, 0.00e+00,-2.42e-01| 6.17e+00,-2.25e+01,-3.20e+03|-1.46e-11| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [3] - []
[00000550]    8|       -4| 2.32e+01, 3.91e+01,-2.46e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.50e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01|-2.70e-06|-6.67e-01| 0.00e+00, 0.00e+00, 1.00e+00|  (0, 1)   | [4,5] - [10]
[00000551]    9|        4|-1.97e+01,-3.91e+01, 2.46e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.50e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01|-3.81e-06| 6.67e-01| 0.00e+00, 0.00e+00,-1.00e+00|  (1, 0)   | [4,5] - [10]
[00000552]   10|       94| 3.50e+00, 3.06e-06, 1.67e-01| 0.00e+00, 0.00e+00, 0.00e+00| 5.00e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01| 5.00e+02| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8,9] - [11,12]
[00000553]   11|       -4| 1.82e+01, 2.97e+01,-1.87e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.68e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01| 1.90e+02|-6.67e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 500) | [10] - [13,14]
[00000554]   12|        4|-1.47e+01,-2.97e+01, 1.87e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.32e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01| 1.33e+02| 6.67e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (500, 501)   | [10] - [15,16]
[00000555]   13|       -4| 1.13e+00, 5.90e+00,-2.18e+02| 0.00e+00, 0.00e+00, 0.00e+00| 2.22e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01| 4.13e+01|-6.67e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (501, 502)   | [11] - [17,18]
[00000556]   14|       21| 1.70e+01, 2.38e+01, 3.14e+01| 0.00e+00, 0.00e+00, 0.00e+00| 4.63e+01| 2 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01| 1.74e+01| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (502, 503)   | [11] - [19,20]
[00000557]   15|        4| 2.66e+01,-4.74e+01, 1.77e+02| 0.00e+00, 0.00e+00, 0.00e+00| 1.85e+02| 2 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01| 1.08e+01| 6.67e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (503, 504)   | [12] - [21,22]
[00000558]   16|       21|-4.13e+01, 1.77e+01, 9.83e+00| 0.00e+00, 0.00e+00, 0.00e+00| 4.62e+01| 2 |[        ]| 0.00e+00, 0.00e+00,-2.42e-01| 0.00e+00, 0.00e+00,-2.42e-01| 4.29e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (504, 505)   | [12] - [23,24]
```

- In this case the ISR photons are neutral PFOs since the moment they're produced.

ISR PFOs and stable particles issue (in old samples)

New 500 GeV samples

```
 collection name : MCParticlesSkimmed
 parameters:

--------------- print out of MCParticle collection ---------------

  flag:  0x0
  simulator status bits: [sbvtcls]  s: created in simulation b: backscatter v: vertex is not endpoint of parent t: decayed in tracker c: decayed in calorimeter l: has left detector s: stopped o: overlay
```

[id]	index	PDG	px, py, pz	px_ep, py_ep , pz_ep	energy	gen	[simstat]	vertex x, y , z	endpoint x, y , z	mass	charge	spin	colorflow	[parents] - [daughters]
[00000282]	0	11	1.75e+00, 0.00e+00, 2.50e+02	0.00e+00, 0.00e+00, 0.00e+00	2.50e+02	4	[ ]	0.00e+00, 0.00e+00, 3.29e-02	0.00e+00, 0.00e+00, 3.29e-02	5.11e-04	-1.00e+00	0.00e+00, 0.00e+00, 0.00e+00	(0, 0)	[] - [2,3]
[00000283]	1	-11	1.75e+00, 0.00e+00,-2.50e+02	0.00e+00, 0.00e+00, 0.00e+00	2.50e+02	4	[ ]	0.00e+00, 0.00e+00, 3.29e-02	0.00e+00, 0.00e+00, 3.29e-02	5.11e-04	1.00e+00	0.00e+00, 0.00e+00, 0.00e+00	(0, 0)	[] - [2,3]
[00000284]	2	11	1.75e+00, 0.00e+00, 2.51e+02	0.00e+00, 0.00e+00, 0.00e+00	2.51e+02	2	[ ]	0.00e+00, 0.00e+00, 3.29e-02	0.00e+00, 0.00e+00, 3.29e-02	5.11e-04	-1.00e+00	0.00e+00, 0.00e+00, 0.00e+00	(0, 0)	[0,1] - [4,6]
[00000285]	3	-11	1.75e+00, 0.00e+00,-2.50e+02	0.00e+00, 0.00e+00, 0.00e+00	2.50e+02	2	[ ]	0.00e+00, 0.00e+00, 3.29e-02	0.00e+00, 0.00e+00, 3.29e-02	5.11e-04	1.00e+00	0.00e+00, 0.00e+00, 0.00e+00	(0, 0)	[0,1] - [5,7]
[00000286]	4	11	-1.20e+01,-1.42e+01, 3.75e+01	0.00e+00, 0.00e+00, 0.00e+00	4.19e+01	3	[ ]	0.00e+00, 0.00e+00, 3.29e-02	0.00e+00, 0.00e+00, 3.29e-02	5.11e-04	-1.00e+00	0.00e+00, 0.00e+00, 0.00e+00	(0, 0)	[2] - [8,9]
[00000287]	5	-11	1.19e+00,-2.32e-02,-1.70e+02	0.00e+00, 0.00e+00, 0.00e+00	1.70e+02	3	[ ]	0.00e+00, 0.00e+00, 3.29e-02	0.00e+00, 0.00e+00, 3.29e-02	5.11e-04	1.00e+00	0.00e+00, 0.00e+00, 0.00e+00	(0, 0)	[3] - [8,9]
[00000288]	6	22	1.38e+01, 1.42e+01, 2.10e+02	0.00e+00, 0.00e+00, 0.00e+00	2.11e+02	1	[t s]	0.00e+00, 0.00e+00, 3.29e-02	2.95e+01, 3.03e+01, 4.49e+02	4.67e-06	0.00e+00	0.00e+00, 0.00e+00, 0.00e+00	(0, 0)	[2] - [146,147]
[00000289]	7	22	5.41e-01, 2.36e-02,-7.73e+01	5.41e-01, 2.36e-02,-7.73e+01	7.73e+01	1	[l]	0.00e+00, 0.00e+00, 3.29e-02	1.05e+02, 4.57e+00,-1.50e+04	-1.35e-06	0.00e+00	0.00e+00, 0.00e+00, 0.00e+00	(0, 0)	[3] - []
[00000290]	8	-2	1.46e+01, 6.84e+01,-9.44e+01	0.00e+00, 0.00e+00, 0.00e+00	1.17e+02	2	[ ]	0.00e+00, 0.00e+00, 3.29e-02	0.00e+00, 0.00e+00, 3.29e-02	-1.91e-06	-6.67e-01	0.00e+00, 0.00e+00, 1.00e+00	(0, 1)	[4,5] - [10]
[00000291]	9	2	-2.55e+01,-8.26e+01,-3.81e+01	0.00e+00, 0.00e+00, 0.00e+00	9.44e+01	2	[ ]	0.00e+00, 0.00e+00, 3.29e-02	0.00e+00, 0.00e+00, 3.29e-02	1.35e-06	6.67e-01	0.00e+00, 0.00e+00,-1.00e+00	(1, 0)	[4,5] - [10]
...														
[00000427]	145	22	-4.28e-01,-2.05e+00,-8.19e-01	-0.00e+00,-0.00e+00,-0.00e+00	2.25e+00	1	[t s]	-2.20e-04,-1.07e-03, 3.25e-02	-3.62e+02,-1.73e+03,-6.93e+02	-5.16e-08	0.00e+00	0.00e+00, 0.00e+00, 0.00e+00	(0, 0)	[135] - [158,159]
[00000428]	146	11	1.61e+00, 1.65e+00, 2.45e+01	-0.00e+00, 0.00e+00,-0.00e+00	2.46e+01	0	[s c s]	2.95e+01, 3.03e+01, 4.49e+02	1.52e+02, 1.83e+02, 2.53e+03	5.11e-04	-1.00e+00	0.00e+00, 0.00e+00, 0.00e+00	(0, 0)	[6] - [155,156,157]
[00000429]	147	-11	1.22e+01, 1.25e+01, 1.86e+02	-0.00e+00,-0.00e+00,-0.00e+00	1.87e+02	0	[s c s]	2.95e+01, 3.03e+01, 4.49e+02	1.61e+02, 1.63e+02, 2.47e+03	5.11e-04	1.00e+00	0.00e+00, 0.00e+00, 0.00e+00	(0, 0)	[6] - [148,149,150]
[00000430]	148	22	7.27e-01, 7.46e-01, 1.11e+01	0.00e+00, 0.00e+00, 0.00e+00	1.11e+01	0	[s v c s]	3.02e+01, 3.11e+01, 4.61e+02	1.62e+02, 1.66e+02, 2.47e+03	0.00e+00	0.00e+00	0.00e+00, 0.00e+00, 0.00e+00	(0, 0)	[147] - []
[00000431]	149	22	9.63e+00, 9.89e+00, 1.47e+02	0.00e+00, 0.00e+00, 0.00e+00	1.48e+02	0	[s v c s]	3.06e+01, 3.14e+01, 4.67e+02	1.63e+02, 1.68e+02, 2.49e+03	0.00e+00	0.00e+00	0.00e+00, 0.00e+00, 0.00e+00	(0, 0)	[147] - []
[00000432]	150	22	4.34e-02, 4.47e-02, 6.61e-01	0.00e+00, 0.00e+00, 0.00e+00	6.64e-01	0	[s vt s]	3.17e+01, 3.25e+01, 4.83e+02	9.47e+01, 9.75e+01, 1.44e+03	0.00e+00	0.00e+00	0.00e+00, 0.00e+00, 0.00e+00	(0, 0)	[147] - [151,152]

- When one ISR photon (#6) decays it is converted into 1 e^- e^+ pair.
- The other ISR photon is stable (#5).

The new samples are the ones with a more physical behavior

Old preselection for K_{reco}<50 GeV ($e_L p_R$)

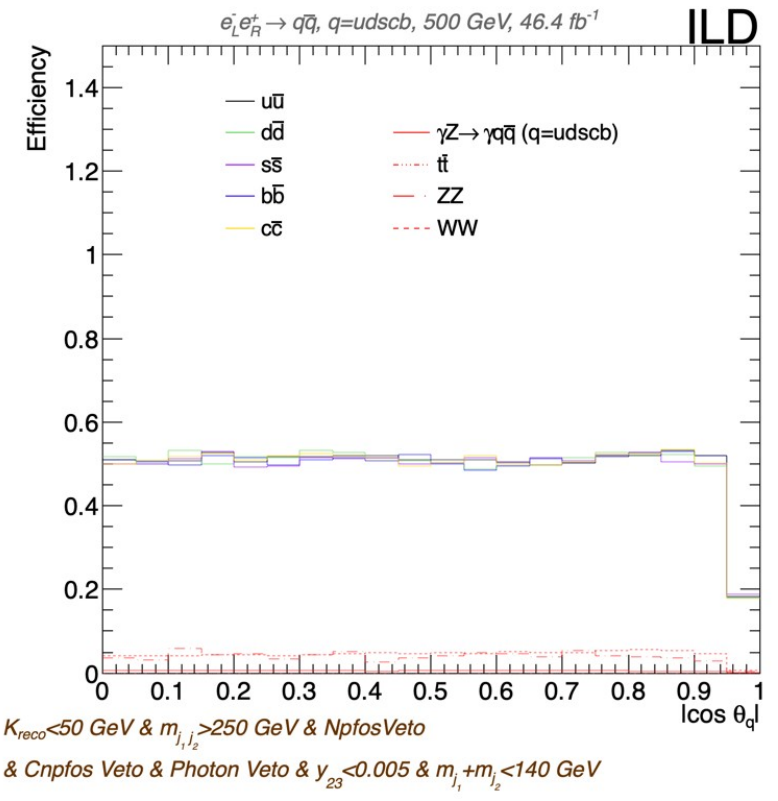
Cuts:

- K_{reco} < 50 GeV
- m_{2jets} > 250 GeV
- Charged N pfos > 0.5
- Neutral N pfos > 3.5
- Photon veto
- y_{23} < 0.005
- $m_{j1}+m_{j2}$ < 140 GeV

VLC Algorithm parameters:

- R = 1.0
- γ = 0.0
- β = 1.0

	Efficiency (%)			Background/Signal			
	$b\bar{b}$	$c\bar{c}$	$q\bar{q}$	ISR	WW	ZZ	$t\bar{t}$
No cut	100	100	100	3.50	1.06	0.09	0.10
+ Cut 1	74.9	74.7	74.7	0.76	0.77	0.06	0.01
+ Cut 2	74.8	74.6	74.7	0.74	0.77	0.06	0.01
+ Cut 3	74.8	74.5	74.3	0.16	0.77	0.06	0.01
+ Cut 4	74.7	74.5	74.1	0.11	0.77	0.06	0.01
+ Cut 5	72.1	71.7	71.1	0.05	0.58	0.05	0.01
+ Cut 6	49.6	49.7	49.6	0.03	0.09	0.01	1e-04
+ Cut 7	48.6	48.7	48.7	0.02	0.06	5e-03	5e-06



Old 500 GeV samples

1st test preselection for K_{reco}<50 GeV ($e_L p_R$)

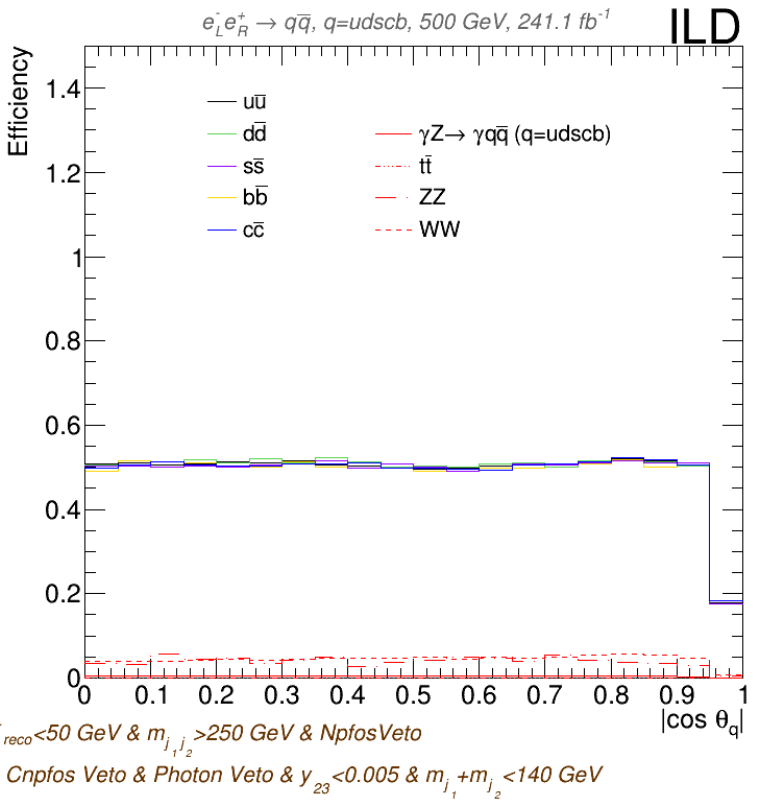
Cuts:

- K_{reco} < 50 GeV
- m_{2jets} > 250 GeV
- Charged N pfos > 0.5
- Neutral N pfos > 3.5
- Photon veto
- y_{23} < 0.005
- $m_{j1}+m_{j2}$ < 140 GeV

VLC Algorithm parameters:

- R = 1.0
- γ = 0.0
- β = 1.0

	Efficiency (%)			Background/Signal			
	$b\bar{b}$	$c\bar{c}$	$q\bar{q}$	ISR	WW	ZZ	$t\bar{t}$
No cut	100	100	100	5.43	1.56	0.14	0.14
+ Cut 1	75.0	75.2	75.1	1.23	1.12	0.08	0.01
+ Cut 2	75.0	75.2	75.1	1.21	1.12	0.08	0.01
+ Cut 3	74.9	75.1	74.9	0.22	1.12	0.08	0.01
+ Cut 4	74.7	74.8	74.7	0.15	1.12	0.08	0.01
+ Cut 5	72.3	72.4	71.8	0.07	0.84	0.07	0.01
+ Cut 6	49.0	49.5	48.9	0.03	0.13	0.01	2e-04
+ Cut 7	47.9	48.2	48.3	0.03	0.09	7e-03	8e-06



New 500 GeV samples

Old preselection for K_{reco}<50 GeV ($e_R p_L$)

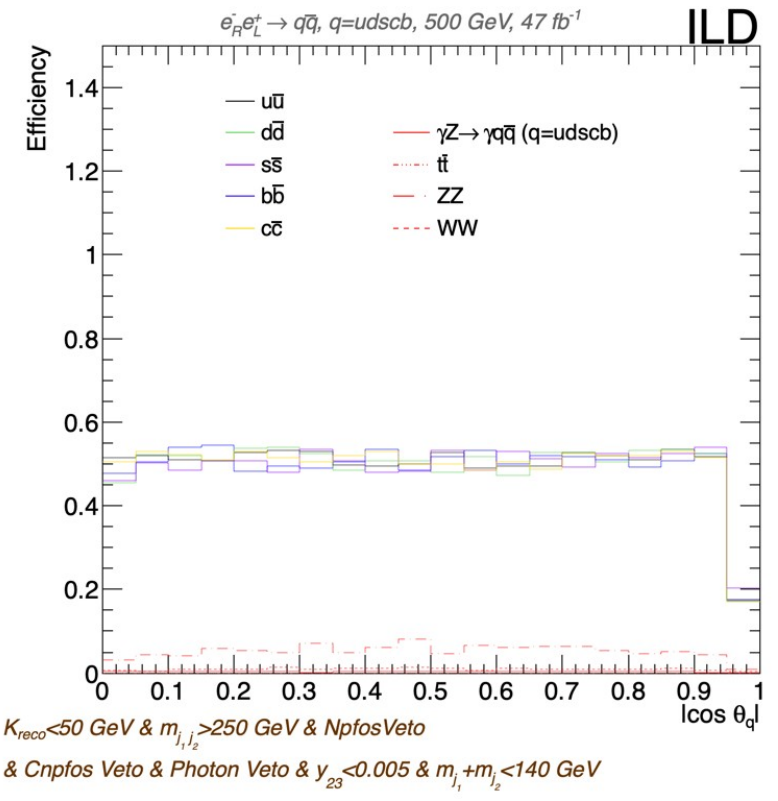
Cuts:

- K_{reco} < 50 GeV
- m_{2jets} > 250 GeV
- Charged N pfos > 0.5
- Neutral N pfos > 3.5
- Photon veto
- y_{23} < 0.005
- $m_{j1}+m_{j2}$ < 140 GeV (optional)

VLC Algorithm parameters:

- R = 1.0
- γ = 0.0
- β = 1.0

	Efficiency (%)			Background/Signal			
	$b\bar{b}$	$c\bar{c}$	$q\bar{q}$	ISR	WW	ZZ	$t\bar{t}$
No cut	100	100	100	6.51	0.01	0.11	0.10
+ Cut 1	74.6	74.6	75.0	1.45	0.01	0.07	0.01
+ Cut 2	74.5	74.5	75.0	1.43	0.01	0.07	0.01
+ Cut 3	74.5	74.4	74.7	0.26	0.01	0.07	0.01
+ Cut 4	74.5	74.4	74.5	0.18	0.01	0.07	0.01
+ Cut 5	71.9	71.7	71.5	0.07	0.01	0.06	0.01
+ Cut 6	49.5	49.6	49.6	0.03	5e-04	0.01	9e-05
+ Cut 7	48.5	48.8	48.7	0.03	3e-04	8e-03	3e-06



Old 500 GeV samples

1st test preselection for K_{reco}<50 GeV ($e_R p_L$)

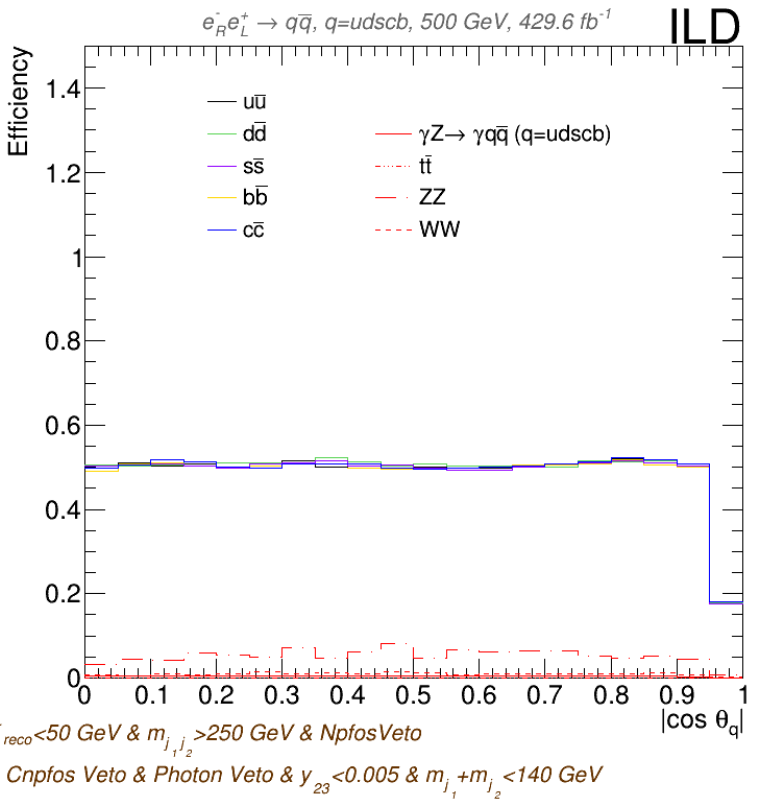
Cuts:

- K_{reco} < 50 GeV
- m_{2jets} > 250 GeV
- Charged N pfos > 0.5
- Neutral N pfos > 3.5
- Photon veto
- y_{23} < 0.005
- $m_{j1}+m_{j2}$ < 140 GeV (optional)

VLC Algorithm parameters:

- R = 1.0
- γ = 0.0
- β = 1.0

	Efficiency (%)			Background/Signal			
	$b\bar{b}$	$c\bar{c}$	$q\bar{q}$	ISR	WW	ZZ	$t\bar{t}$
No cut	100	100	100	4.78	0.01	0.09	0.08
+ Cut 1	75.2	75.2	75.1	1.08	0.01	0.06	0.01
+ Cut 2	75.1	75.2	75.1	1.06	0.01	0.06	0.01
+ Cut 3	75.1	75.1	74.8	0.20	0.01	0.06	0.01
+ Cut 4	75.1	75.1	74.6	0.14	0.01	0.06	0.01
+ Cut 5	72.5	72.3	71.8	0.06	0.01	0.05	0.01
+ Cut 6	49.1	49.4	49.2	0.03	4e-04	0.01	7e-05
+ Cut 7	48.0	48.3	48.2	0.03	2e-04	6e-03	3e-06



New 500 GeV samples