Iguana Algorithms

`FiducialFilter` — `PhotonGBTFilter`

Gregory Matousek

Duke
UNIVERSITY

Iguana

FiducialFilter

- ★ Filtering algorithm added by PR#226 that handles drift chamber edge cuts for *electrons, pions,* and *protons*
- ★ Depending on the `pid` and `torus`, a sector dependent (θ,φ) or (x,y) cut is made
  - The parameterizations are identical to those referred to in the RG-A analysis note
  - Currently only contains pass1 parameterizations (will be updated for pass2)
  - Requires `torus=[-1,1]` otherwise the algorithm filters out all particles (warning message)

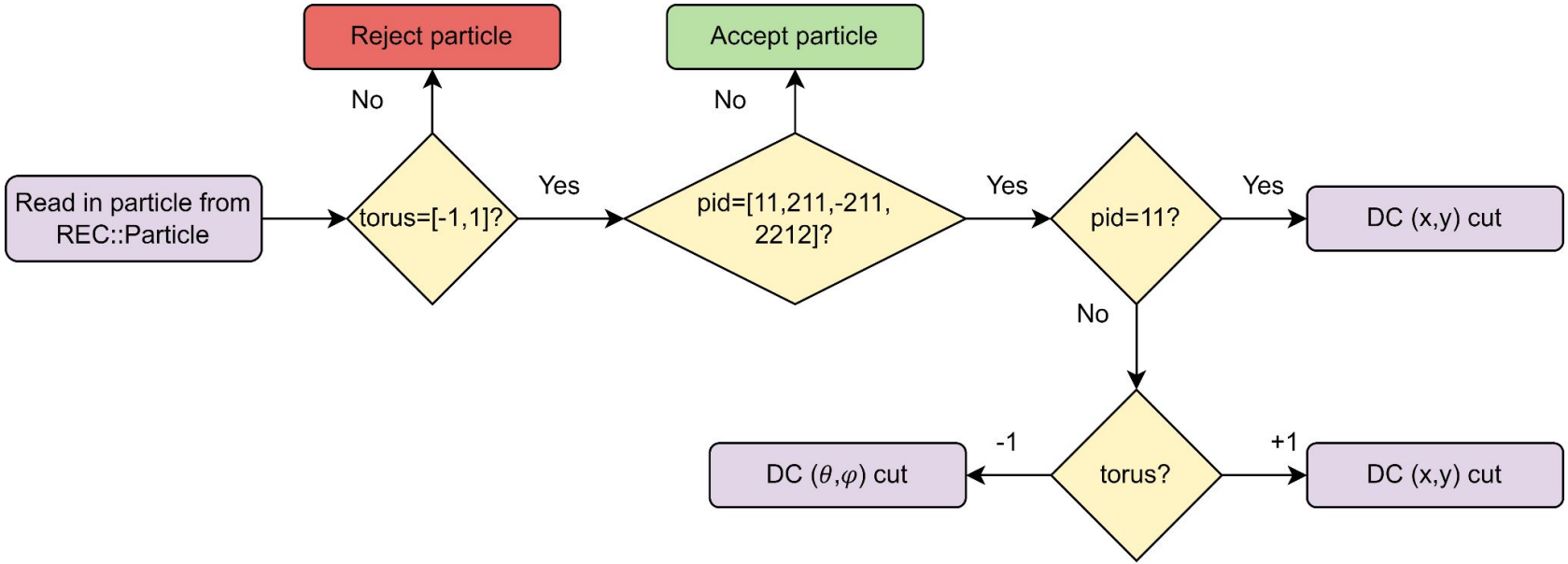
- ★ Program reads **upstream** REC::Particle, REC::Traj banks
  - Purpose is to avoid placing cuts on already removed particles
  - Uses `pindex` to connect REC::Particle rows to REC::Traj rows

```
const double maxparams_in_theta_phi_pass1[6][6][3][4] = {
  {{{-37.5489,27.4543,-1.11484,0.00522935},{-29.7228,26.7512,-1.52592,0.0122397},{-20.3559,23.1586,-1.47441,0.0133898}},
  {{-36.2719,25.1427,-0.817973,0.00233912},{-28.2118,25.0664,-1.29748,0.00947493},{-20.6015,22.9639,-1.39759,0.012069}},
  {{-34.1013,25.9343,-1.23555,0.00959955},{-24.0285,22.9346,-1.165,0.00846331},{-8.04969,12.5436,-0.268326,0.03561e-11}},
  {{-48.8546,36.1076,-2.07362,0.0161268},{-24.7286,22.9355,-1.12754,0.00796483},{-12.5292,24.1624,-1.52361,0.0137042}},
  {{-40.4295,30.8386,-1.77195,0.0156553},{-26.7149,23.5322,-1.1011,0.00718225},{-10.9822,13.8127,-0.312534,1.32292e-05}},
  {{-38.1396,28.0524,-1.19166,0.00613966},{-26.1238,24.3235,-1.28254,0.00950751},{-19.0376,22.042,-1.32482,0.0113948}}},
  {{{-1.67037e-08,12.8334,-0.820443,0.00818882},{-6.23823,14.8659,-0.776403,0.00624484},{-5.75713,11.4787,-0.227124,6.61281e-10}},
  {{-6.09637e-07,12.7972,-0.813133,0.00808401},{-5.51055,13.9682,-0.639287,0.00441366},{-7.90046,12.5383,-0.271117,1.66929e-10}},
  {{-2.84217e-14,13.0836,-0.864047,0.00869759},{-6.70639,15.3367,-0.827197,0.00677168},{-4.8928,11.1884,-0.221965,1.51263e-10}},
  {{-3.8595e-09,12.9673,-0.841224,0.0083938},{-4.01784,12.9989,-0.557548,0.00367493},{-1.95023,9.69687,-0.157901,5.33239e-09}},
  {{-6.43496e-10,12.9304,-0.850651,0.00863353},{-5.10299,13.9958,-0.671087,0.00409619},{-6.03313,11.7973,-0.249435,1.2754e-11}},
  {{-2.94932e-10,13.1854,-0.859032,0.00840181},{-6.05945,14.7331,-0.742818,0.00558374},{-5.63811,11.6686,-0.247509,2.33147e-13}}},
  {{{-2.66279e-07,12.95,-0.846226,0.00845788},{-14.6317,19.1874,-1.09244,0.00899541},{-38.1515,29.8688,-1.59229,0.0120068}},
  {{-0.996514,13.9379,-0.964686,0.00982941},{-15.9613,20.2461,-1.16106,0.00955431},{-39.9455,29.0996,-1.586,0.0122175}},
  {{-1.14284e-07,13.6815,-0.966952,0.0101523},{-15.5288,20.3845,-1.20523,0.0102808},{-34.2682,26.4216,-1.20609,0.0078434}},
  {{-1.70075e-08,13.0005,-0.832325,0.00817159},{-7.66776,15.4526,-0.779727,0.00585967},{-26.0035,23.9995,-1.2322,0.0094206}},
  {{-9.53804e-10,13.2563,-0.898206,0.00917629},{-6.85083,14.8485,-0.722803,0.0053221},{-39.3606,31.5412,-1.83015,0.0148302}},
  {{-7.66835e-07,13.937,-1.05153,0.0118223},{-9.7913,16.925,-0.913158,0.00712552},{-27.722,23.9412,-1.1314,0.00761088}}},
  {{{-22.1832,20.4134,-0.764848,0.00310923},{-31.8044,28.2369,-1.715,0.0145145},{-9.52175,18.7932,-1.38896,0.0150233}},
  {{-21.5845,20.2457,-0.762109,0.00305359},{-19.5601,21.5945,-1.18955,0.00939109},{-1.57084,13.3989,-0.823161,0.00795227}},
  {{-16.052,16.6264,-0.444308,2.82701e-06},{-13.8291,18.6541,-1.01549,0.00625776},{-1.92223e-05,13.0305,-0.881089,0.00925281}},
  {{-19.821,18.4301,-0.516168,2.17199e-10},{-30.6285,28.0989,-1.71897,0.0146585},{-9.23709,17.1585,-1.03955,0.00943673}},
  {{-16.1795,16.7121,-0.448883,1.53774e-11},{-23.6418,24.5748,-1.48652,0.01254},{-4.2626e-09,12.899,-0.845374,0.00872171}},
  {{-9.74791,15.0287,-0.531727,0.00192371},{-41.0848,33.1802,-1.97671,0.0158146},{-4.12428,14.3361,-0.820483,0.00725632}}},
  {{{-1.05499e-08,12.7347,-0.800158,0.00789171},{-3.78358,13.3272,-0.620589,0.0043452},{-31.0947,26.2276,-1.33783,0.00961276}},
  {{-3.20100e-05,13.2084,-0.89232,0.00907651},{-11.5913,18.4403,-1.08132,0.00895511},{-26.4998,23.4434,-1.09815,0.00695521}},
  {{-1.54979e-07,13.3849,-0.912541,0.00919697},{-4.77271,14.366,-0.750675,0.00582608},{-31.7681,27.2978,-1.49603,0.0115217}},
  {{-8.46957e-07,13.135,-0.863007,0.00850261},{-5.91254,14.7345,-0.748863,0.00564354},{-27.2818,24.4544,-1.24541,0.009006}},
  {{-0.97242e-09,12.8923,-0.825914,0.00815967},{-6.91507,16.0014,-0.917916,0.00756705},{-18.1359,18.5543,-0.695074,0.00311518}},
  {{-2.50141e-08,13.1356,-0.864227,0.00854005},{-6.62648,15.5763,-0.861224,0.00697927},{-19.9356,18.969,-0.647219,0.00209364}}},
  {{{-31.056,26.1595,-1.20596,0.00948356},{-44.4944,36.2986,-2.35276,0.0201162},{-12.2855,21.0109,-1.61628,0.0171215}},
  {{-27.3898,25.1282,-1.2366,0.00728902},{-24.9794,23.2357,-1.09342,0.00656412},{-16.9519,23.0236,-1.78734,0.0175541}},
  {{-28.7906,26.9219,-1.49542,0.0104976},{-22.0922,23.6046,-1.37835,0.0110503},{-5.24383,16.5267,-1.15701,0.011306}},
  {{-3.92728,12.8692,-0.872323,0.0011559},{-23.5702,22.3459,-1.04378,0.00649998},{-17.3561,24.4119,-1.93535,0.0204532}},
  {{-30.442,26.0012,-1.2191,0.00674906},{-54.5014,42.354,-2.8256,0.0242569},{-8.751452,13.9234,-0.958253,0.00952713}},
  {{-31.216,26.1169,-1.20087,0.00650951},{-31.0314,28.4075,-1.70479,0.0137299},{-13.8981,22.326,-1.72999,0.0176742}}}};
```

Sample parameters

from `Pass1CutData.h`

FiducialFilter Flowchart



★ Particles (REC::Particle rows) that fail the drift chamber cuts are filtered out

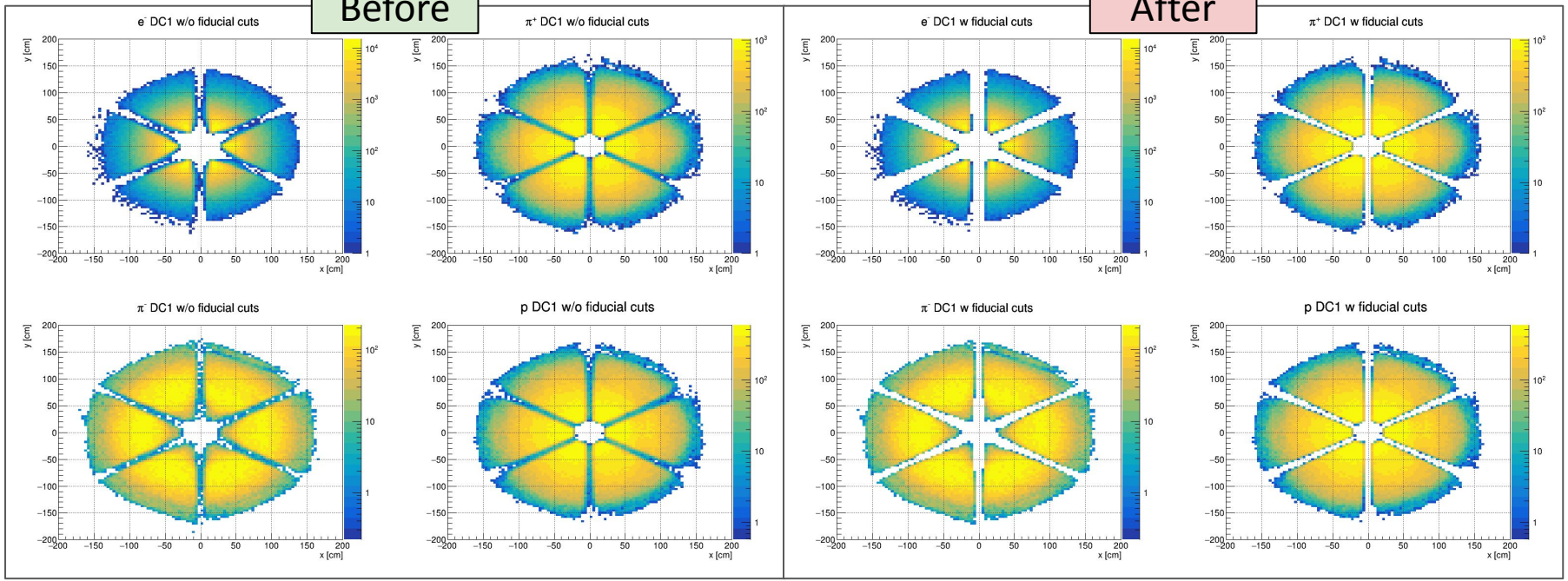
- i.e. Not considered for further downstream filters (speeds up longer form analyses)

FiducialFilter Validator

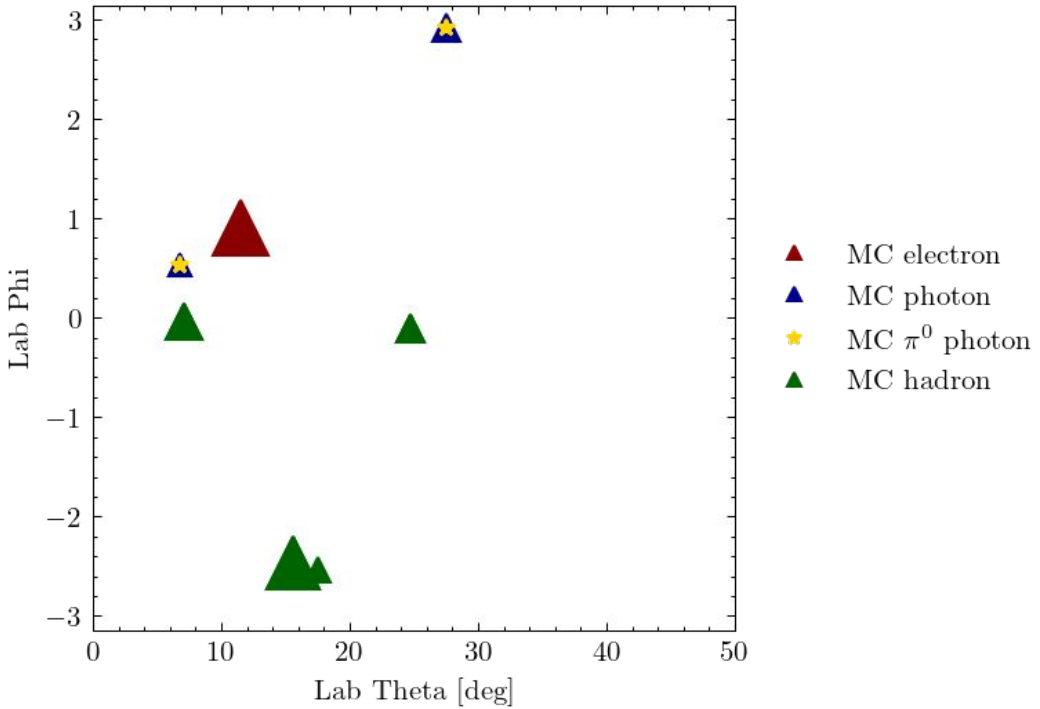
```
meson test validator-clas12-FiducialFilter --verbose --test-args '\-f
/cache/clas12/rg-a/production/recon/fall2018/torus-1/pass1/v1/dst/train/nSidis/nSidis_005036.hipo \-n 0 \-o
../validator_output'
```

Before

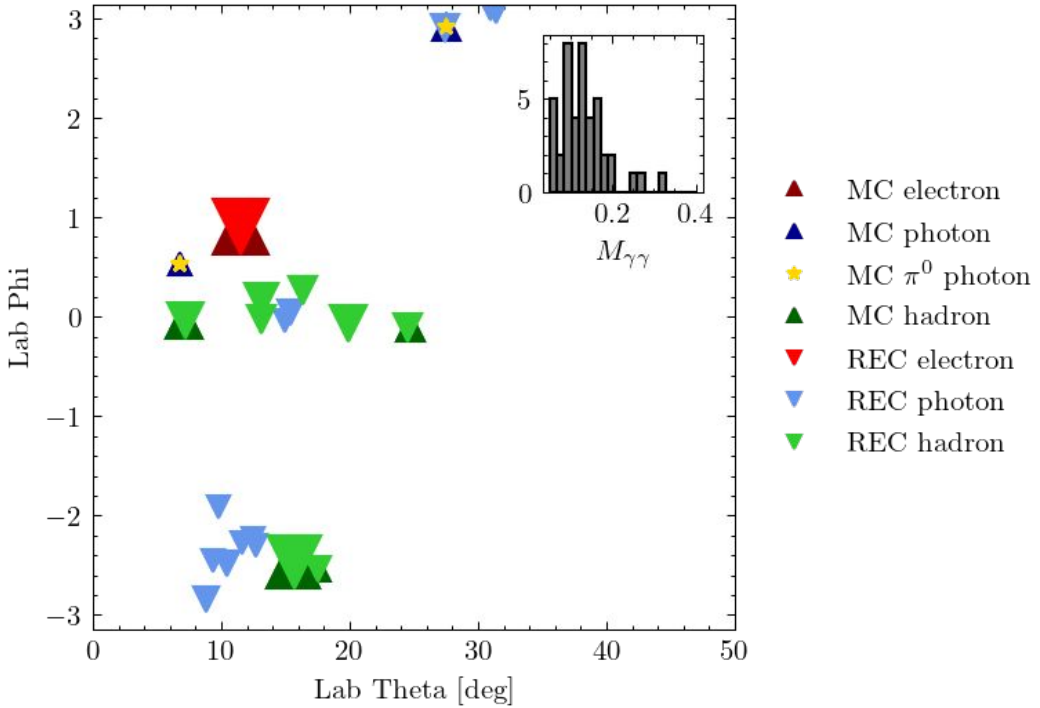
After



Sample Monte Carlo Event *pass1*



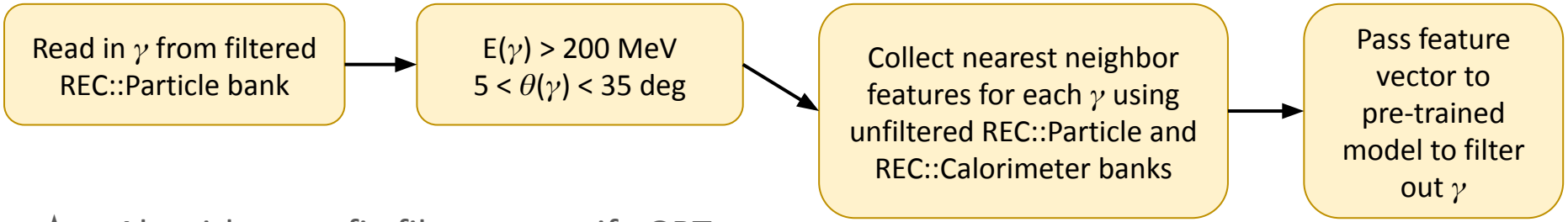
Sample Monte Carlo Event *pass1*



PhotonGBTFilter

★ PR#216 added a new Algorithm to the CLAS12 iguana framework for filtering false photons using pre-trained gradient boosted decision trees

- Each γ that passes upstream filters is classified
- Unfiltered REC::Particle and REC::Calorimeter banks read in nearest neighbor features for each γ
- 5 Pre-trained models produced using pass1/pass2 Monte Carlos, as well as RG-A & RG-C Monte Carlos
- Pre-trained models produced using https://github.com/Gregtom3/clas12_photon_classifier

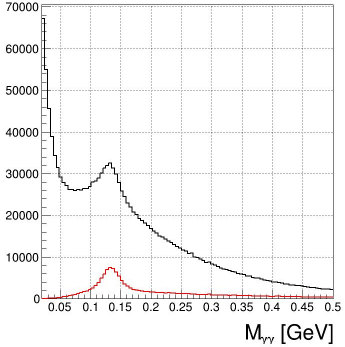


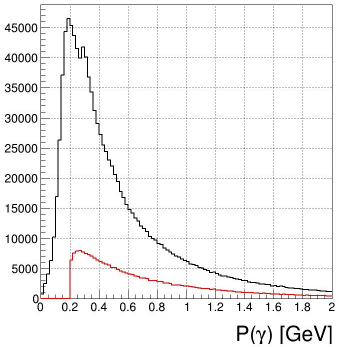
★ Algorithm config file can specify GBT "p" signal threshold [0,1] and pass number {1,2}

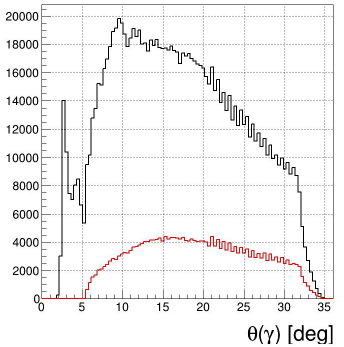
★ **FAST ⟳ :** Can filter all photons in nSidis run 5032 in ~30s

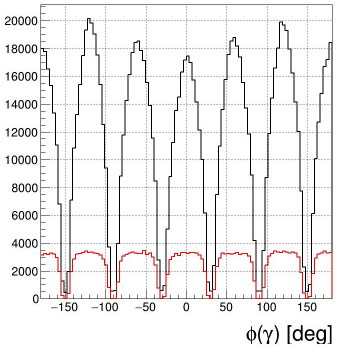
PhotonGBTFilter Validator

★ Validator program included to show impact of GBT output (see below)









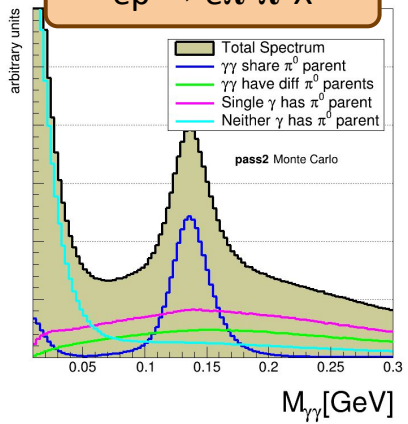
Black = Unfiltered photons

Red = Filtered photons

★ Background shape underneath π^0 peak more accurately resembles the physical combinatorial background seen in Monte Carlo

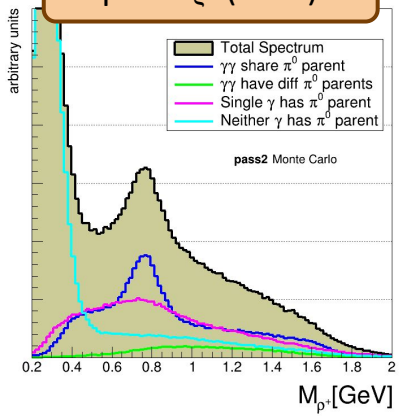
★ pass2 ★ Impact on … SIDIS $\pi^+\pi^0$… Exclusive ϱ^+, ω

$ep \rightarrow e\pi^+\pi^0X$



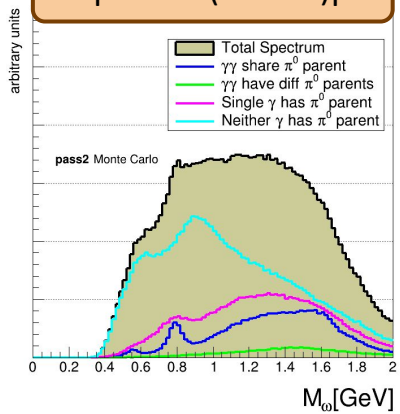
$\pi^0 \rightarrow \gamma\gamma$ background is a mix of true combinatoric (**LIME GREEN**) and false combinatoric (**MAGENTA** and **TEAL**)

$ep \rightarrow e\varrho^+(\pi^+\pi^0)n$



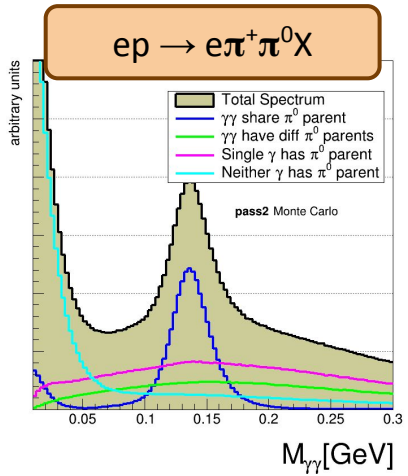
Exclusive ρ^+ ($M_{miss} < 1.2$ GeV) region is *dominated* by false combinatoric backgrounds (**MAGENTA** and **TEAL**)

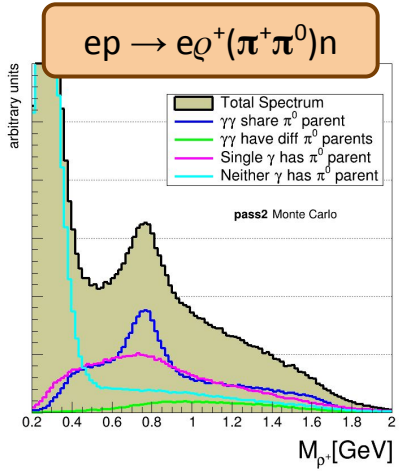
$ep \rightarrow e\omega(\pi^+\pi^0\pi^-)p$

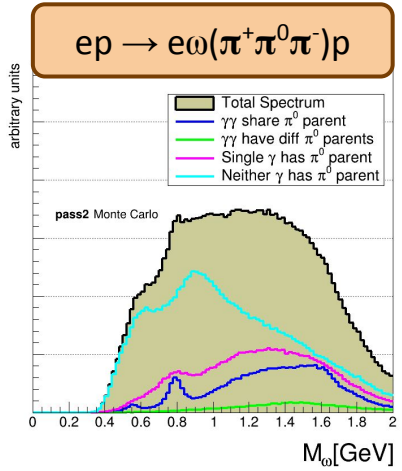


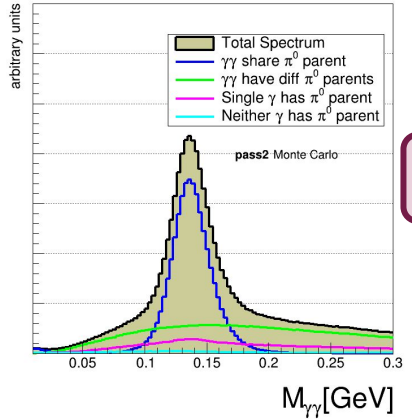
Exclusive ω ($M_{miss} < 1.2$ GeV) region is *dominated* by false combinatoric backgrounds (**MAGENTA** and **TEAL**)

★ pass2 ★ Impact on … SIDIS $\pi^+\pi^0$… Exclusive ϱ^+, ω

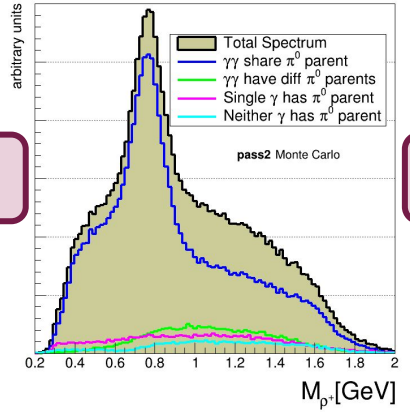








★ ML ★



★ ML ★