Neutron Reconstruction at Belle II

MANTRA Meeting
03/03/2025

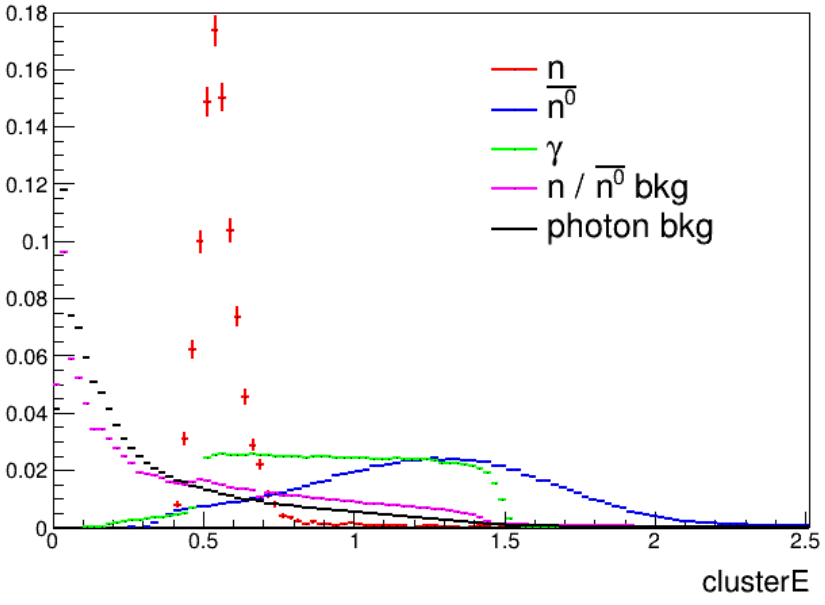
Recap:

- 300K particle gun events.
- ClusterE, clusterE9E21, clusterLAT, clusterSecondMoment, clusterNHits, can be used to discriminate between neutrons and anti-neutrons in Belle II.

Today:

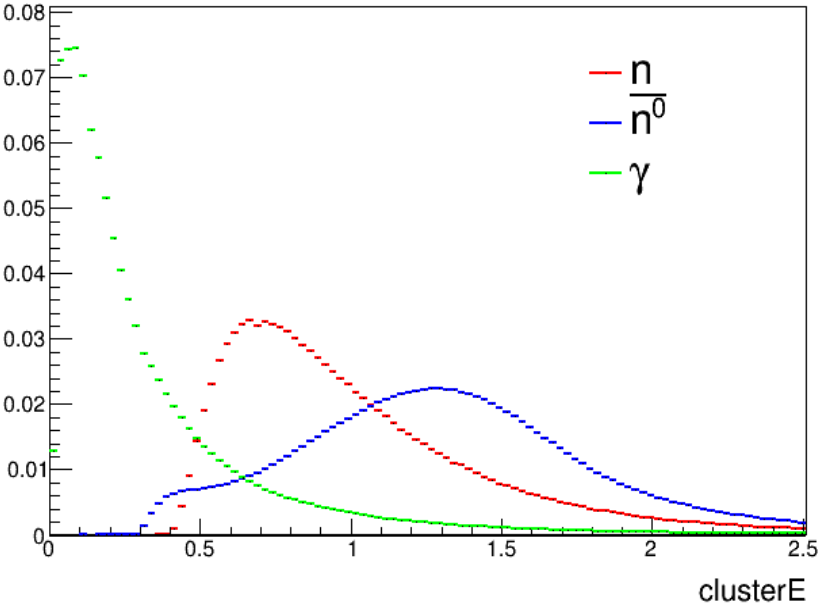
- MC16 (qq^{bar} (q= u,d,c,s), charged, mixed, taupair)
  - MC matched
- Comparison of all ECL variables (particlegun and MC16)

Particle Gun



Neutrons: mcPDG==2112 && genMotherPDG ==0
Anti-neutrons: mcPDG== - 2112 && genMotherPDG ==0
Photons: mcPDG==22 && genMotherPDG ==0

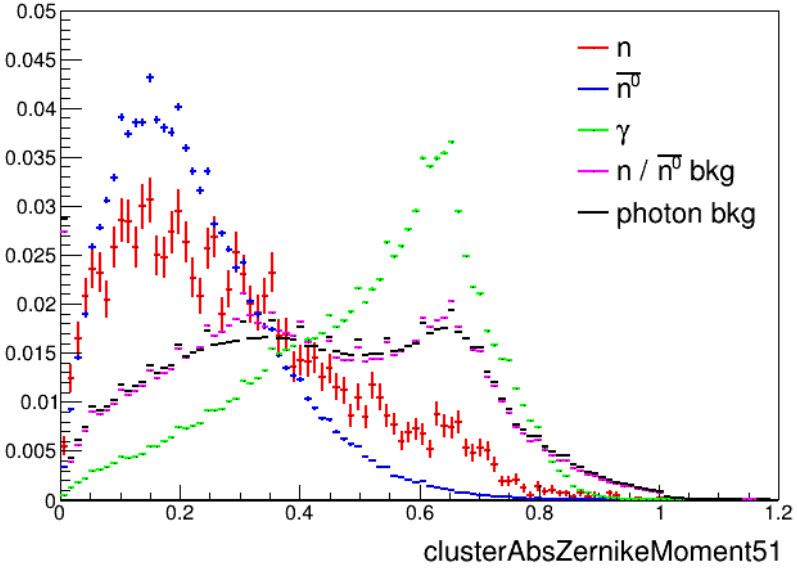
MC16

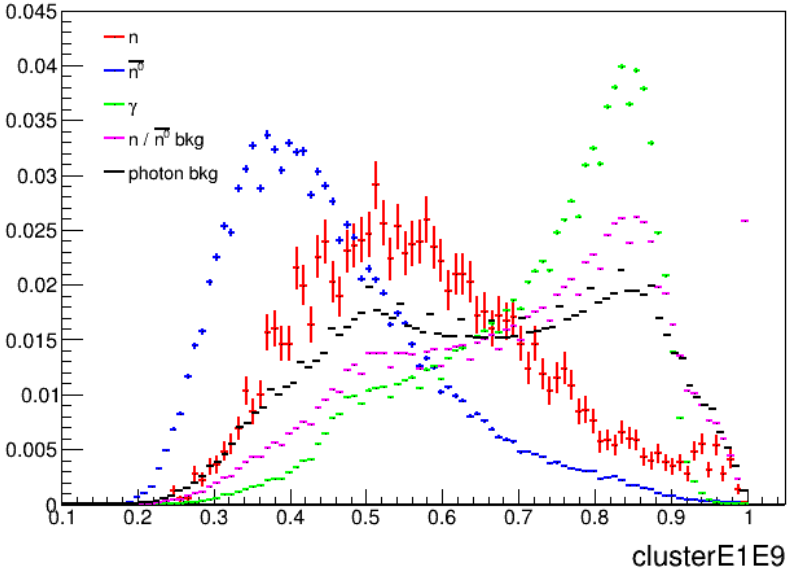


Neutrons: mcPDG==2112
Anti-neutrons: mcPDG== - 2112
No candidates for !(abs(mcPDG)==2112)

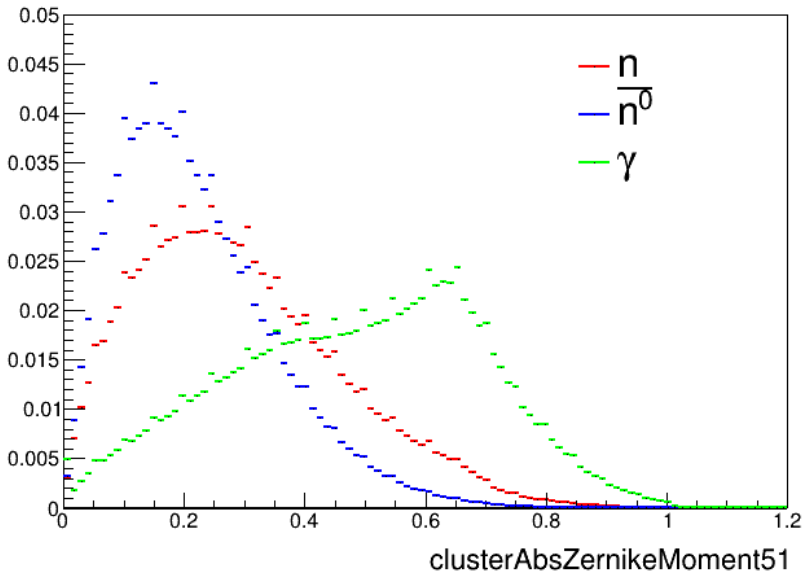
Photons: isSignal==1
No candidates with isSignal!=1

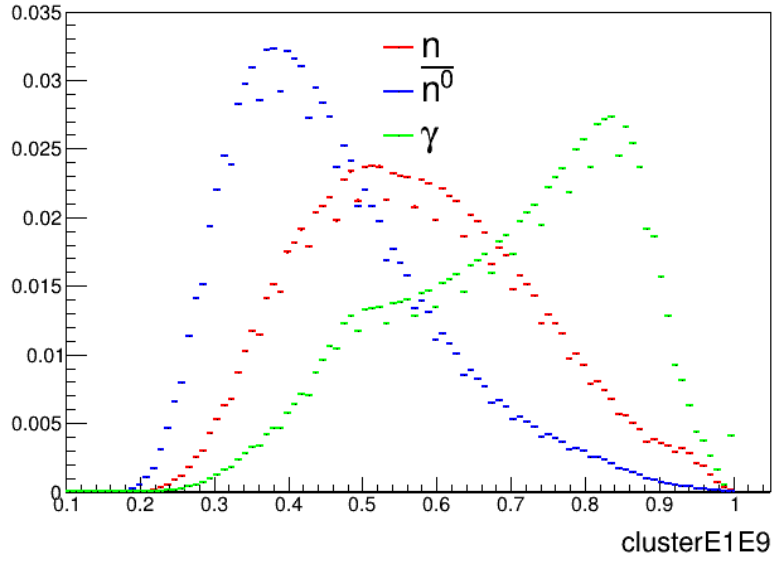
Particle Gun



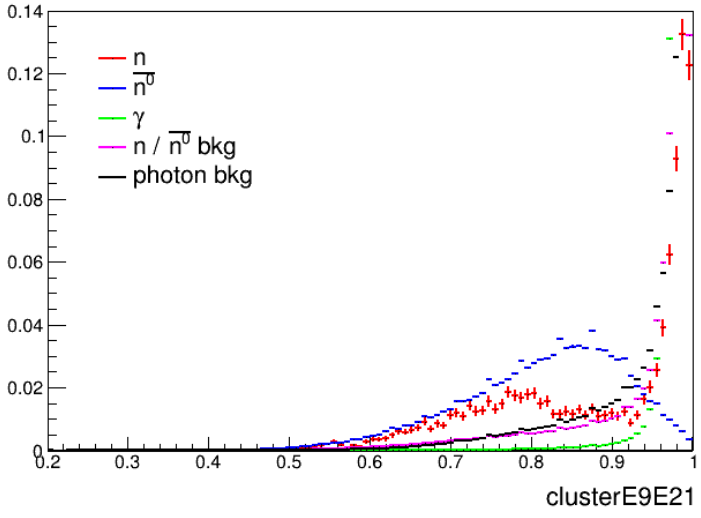


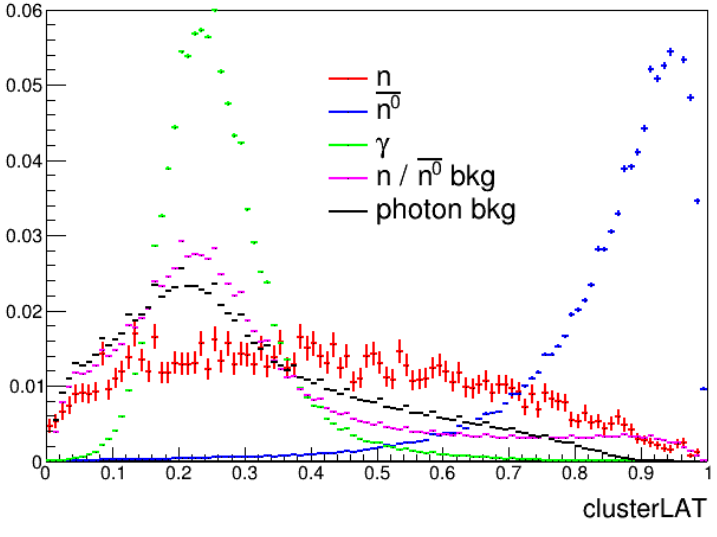
MC16



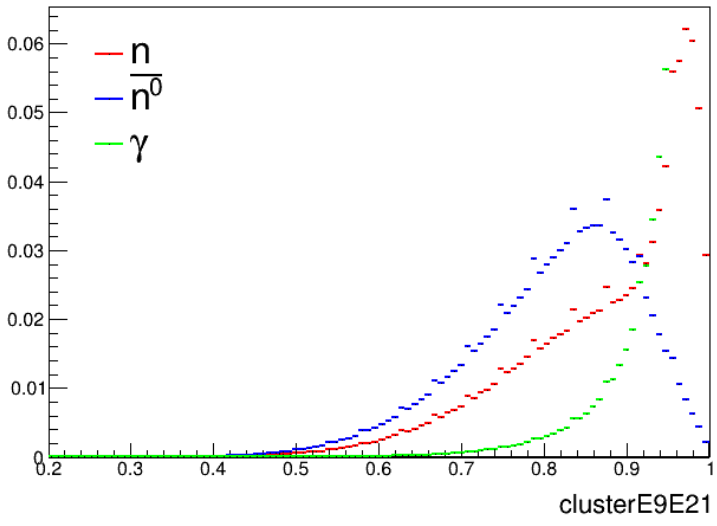


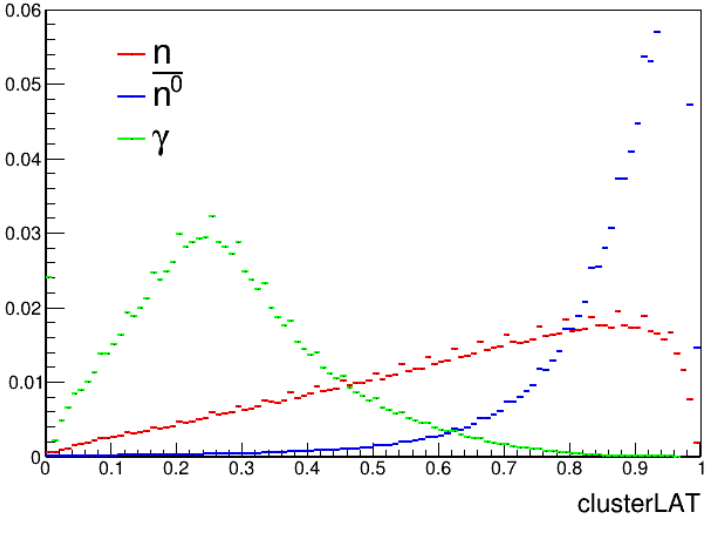
Particle Gun



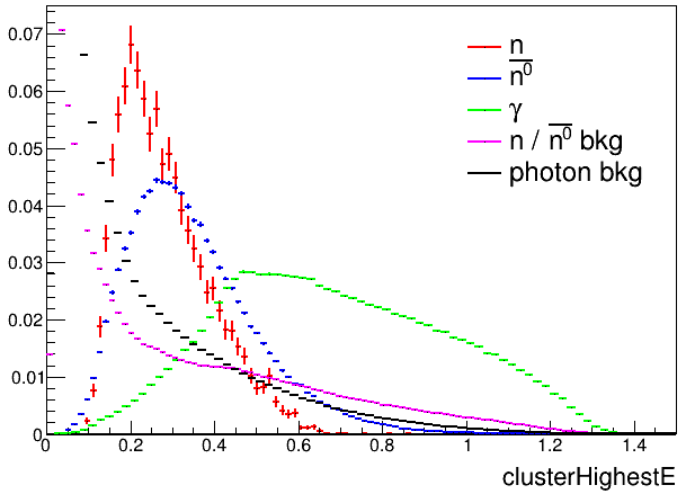


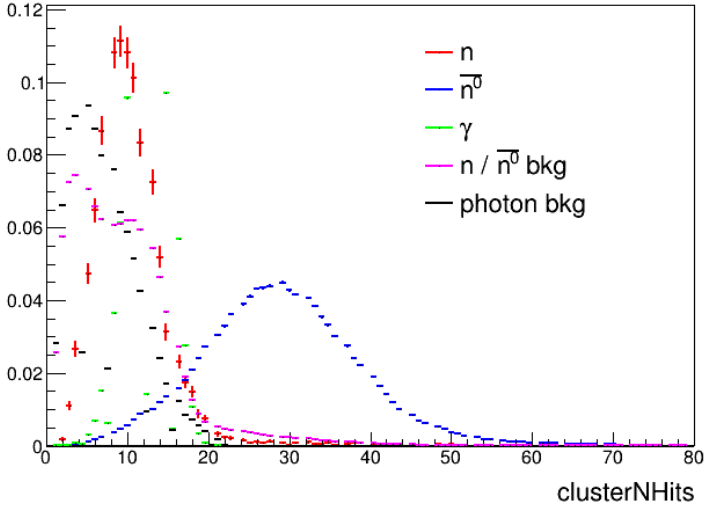
MC16



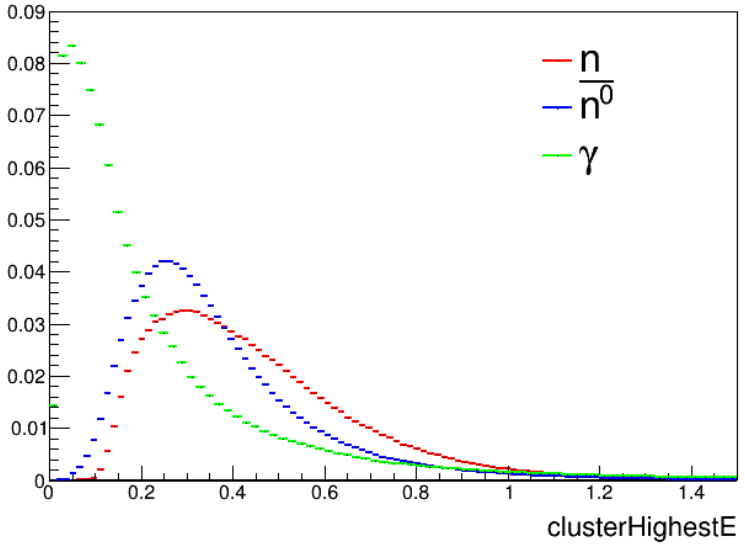


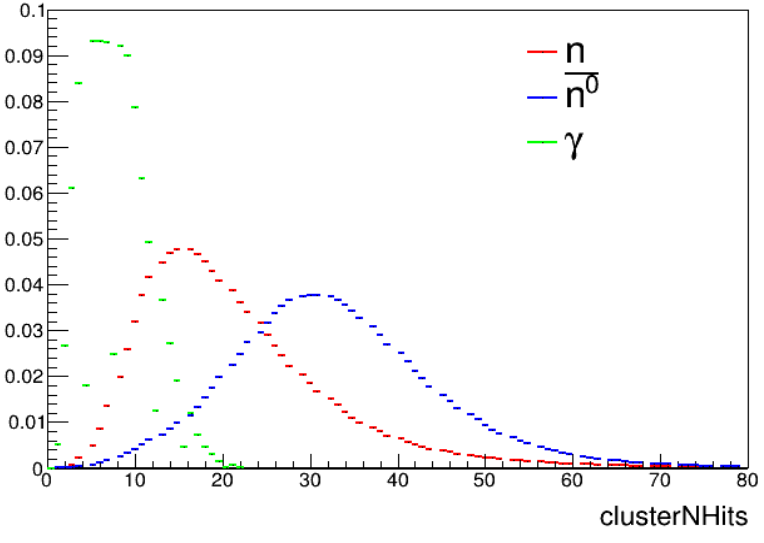
Particle Gun



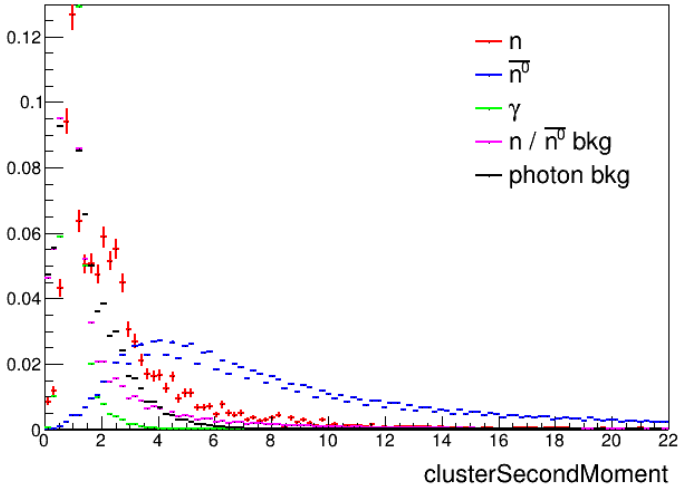


MC16

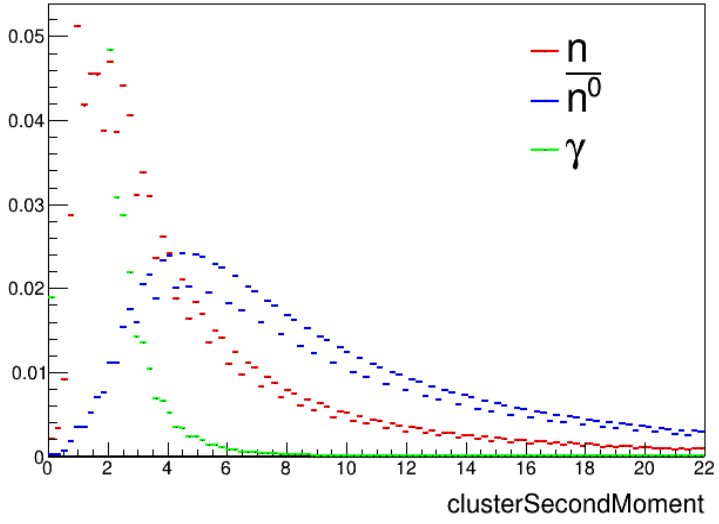


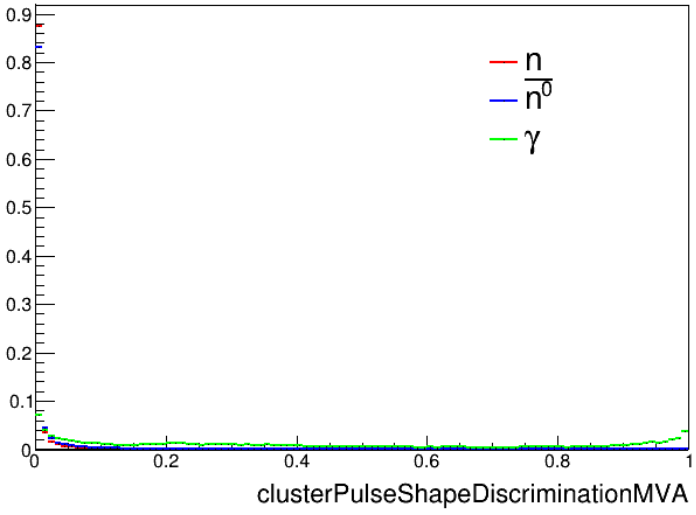


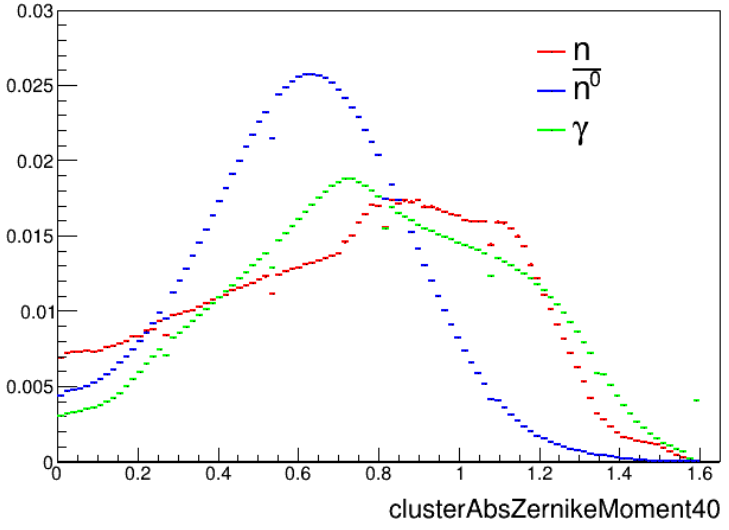
Particle Gun

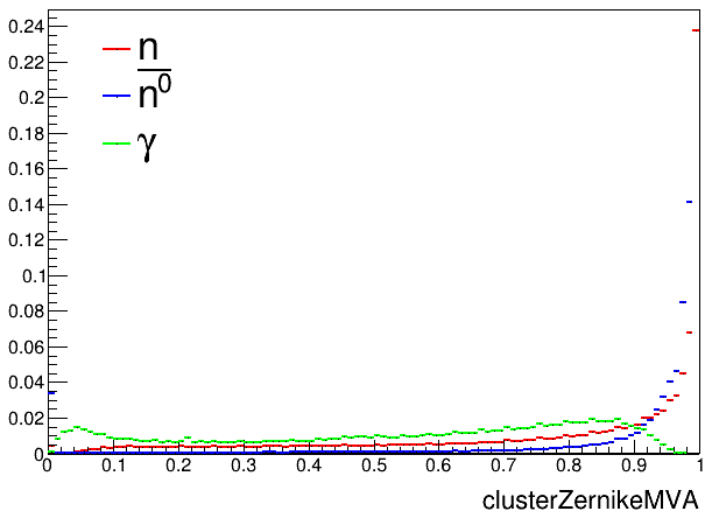


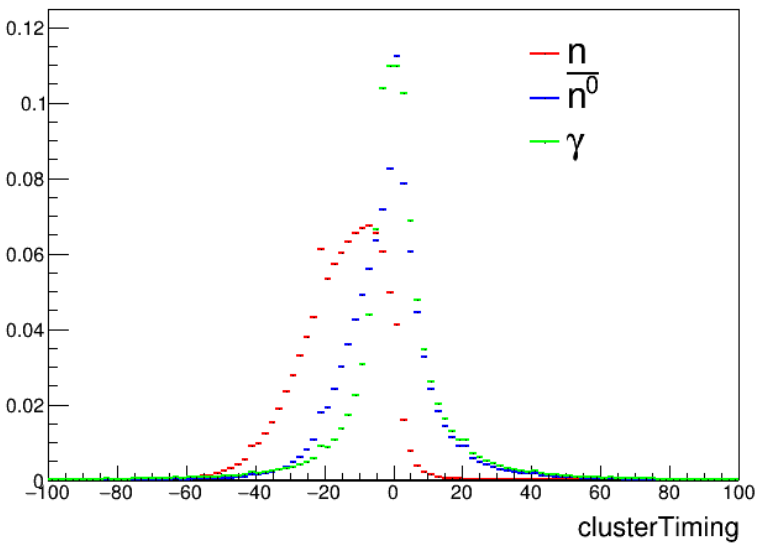
MC16




n
$\overline{n}^0$
γ
clusterPulseShapeDiscriminationMVA


n
$\overline{n}^0$
γ
clusterAbsZernikeMoment40


n
$\overline{n}^0$
γ
clusterZernikeMVA


n
$\overline{n}^0$
γ
clusterTiming

Summary:

- Comparision of ECL variables wih particle gun and MC16

Next:

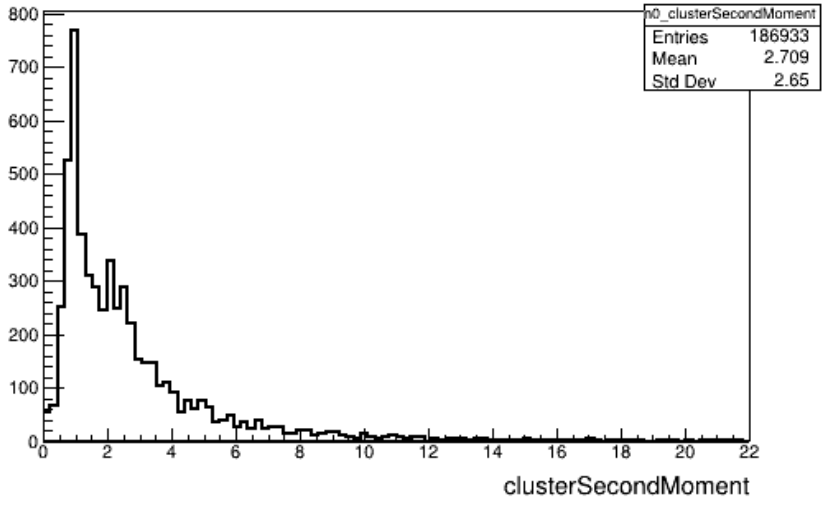
- Find cuts to be applied on the sample.

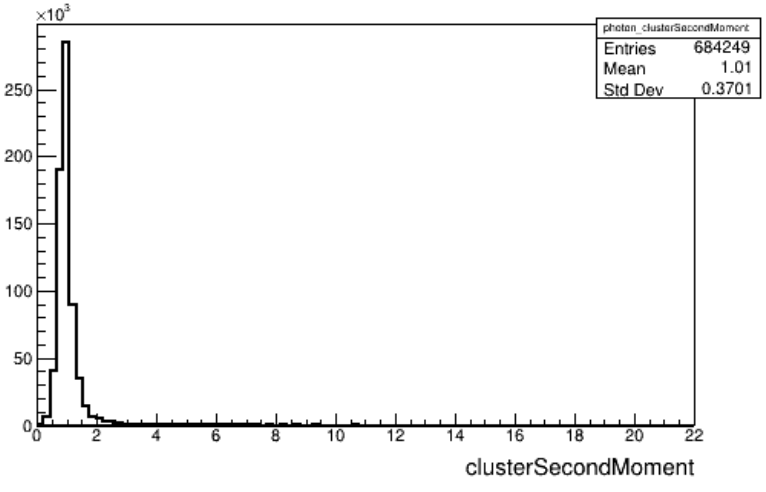
Backup Slides

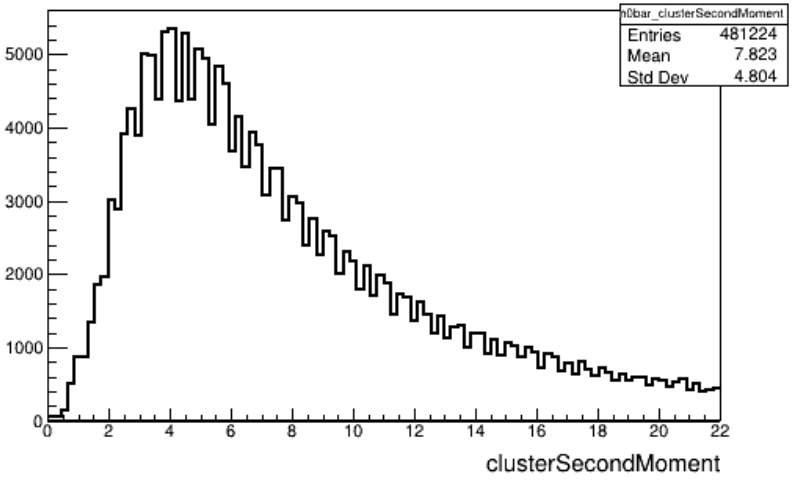
```
root [2] photons->Scan("mcPDG:genMotherPDG","isSignal==1")
***********************************
*    Row   *     mcPDG * genMother *
***********************************
*        0 *        22 *       111 *
*        1 *        22 *       111 *
*        2 *        22 *       111 *
*        3 *        22 *      -211 *
*        4 *        22 *       111 *
*        5 *        22 *       111 *
*        6 *        22 *       111 *
*        7 *        22 *       111 *
*        8 *        22 *       111 *
*        9 *        22 *       111 *
*       10 *        22 *       111 *
*       11 *        22 *       111 *
*       12 *        22 *       111 *
*       13 *        22 *       111 *
*       14 *        22 *       111 *
*       15 *        22 *       111 *
*       16 *        22 *      -211 *
*       17 *        22 *       111 *
*       18 *        22 *       111 *
*       19 *        22 *       111 *
*       20 *        22 *       211 *
*       21 *        22 *       111 *
*       22 *        22 *       211 *
*       23 *        22 *       111 *
*       24 *        22 *       111 *
```

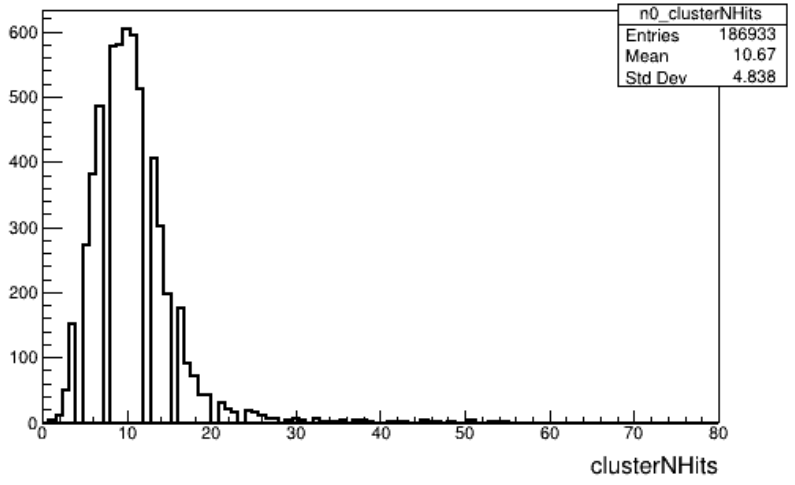
```
root [2] neutrons->Scan("genMotherPDG","mcPDG==-2112")
************************
*    Row   * genMother *
************************
*        0 *     -1114 *
*        1 *     -3122 *
*        3 *     -3112 *
*        4 *     -3112 *
*        5 *     -3112 *
*       12 *     -3112 *
*       13 *     -1114 *
*       18 *        23 *
*       19 *        23 *
*       21 *        23 *
*       25 *        23 *
*       26 *        23 *
*       27 *        23 *
*       28 *        23 *
*       29 *     -3222 *
*       30 *        23 *
*       32 *     -1114 *
*       35 *     -1114 *
*       36 *     -1114 *
*       38 *     -2114 *
*       39 *     -2214 *
*       41 *     -3122 *
*       42 *     -3122 *
*       43 *        23 *
*       45 *        23 *
```

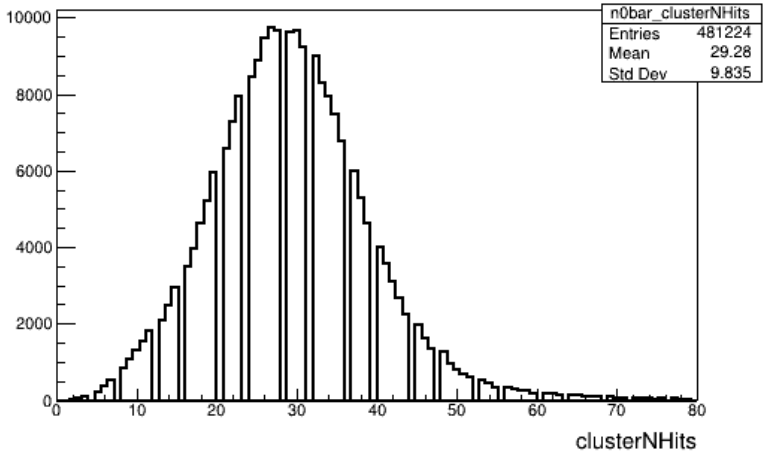
```
root [3] neutrons->Scan("genMotherPDG","mcPDG==2112")
************************
*    Row   * genMother *
************************
*        2 *      3122 *
*        6 *      3122 *
*        7 *      3122 *
*        8 *      3222 *
*        9 *        23 *
*       10 *      3112 *
*       11 *      3122 *
*       14 *      3122 *
*       15 *      3112 *
*       16 *        23 *
*       17 *        23 *
*       20 *      3122 *
*       22 *      3222 *
*       23 *      4122 *
*       24 *      -321 *
*       31 *       130 *
*       33 *      3222 *
*       34 *      1114 *
*       37 *      -321 *
*       40 *      3124 *
*       44 *      3222 *
*       46 *      -321 *
*       47 *        23 *
*       48 *      2214 *
*       53 *      4122 *
```

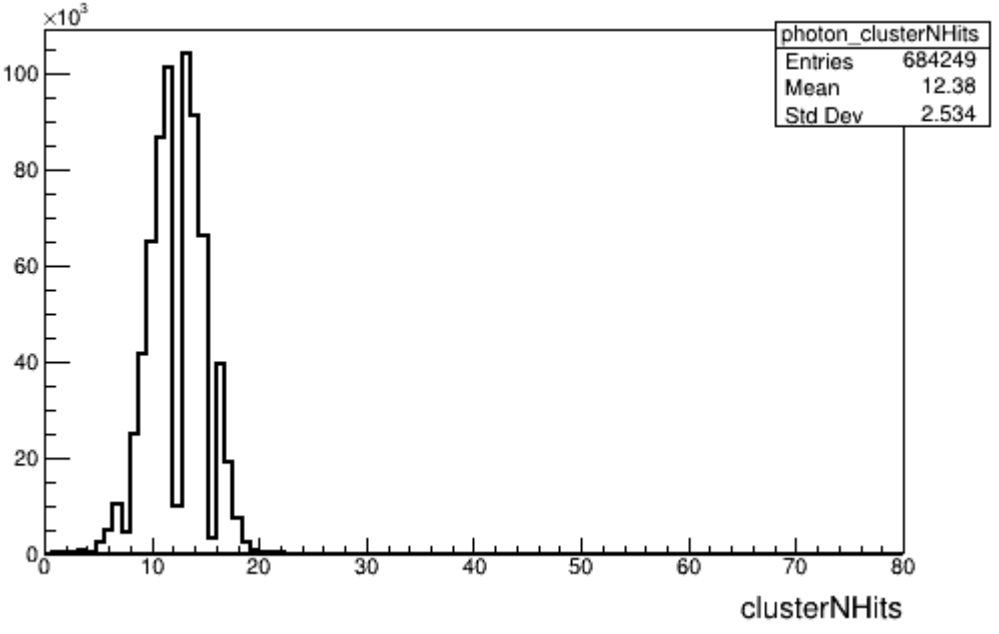

n0_clusterSecondMoment
Entries 186933
Mean 2.709
Std Dev 2.65
clusterSecondMoment


×10³
photon_clusterSecondMoment
Entries 684249
Mean 1.01
Std Dev 0.3701
clusterSecondMoment


n0bar_clusterSecondMoment
Entries 481224
Mean 7.823
Std Dev 4.804
clusterSecondMoment


n0_clusterNHits
Entries 186933
Mean 10.67
Std Dev 4.838
clusterNHits


n0bar_clusterNHits
Entries 481224
Mean 29.28
Std Dev 9.835
clusterNHits


×10^3
photon_clusterNHits
Entries 684249
Mean 12.38
Std Dev 2.534
clusterNHits