

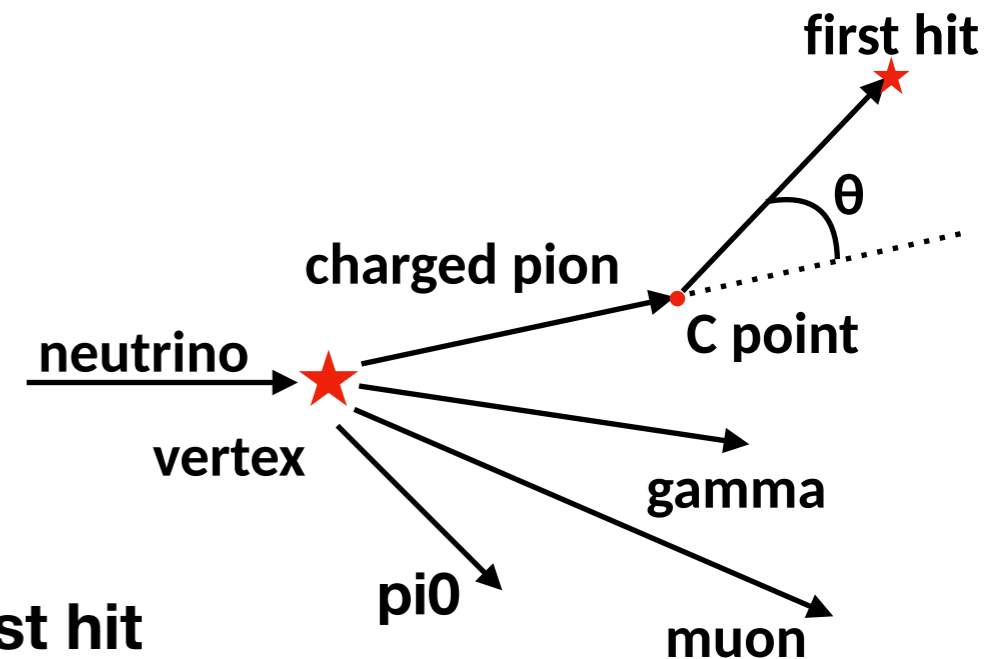
Secondary background in 3DST

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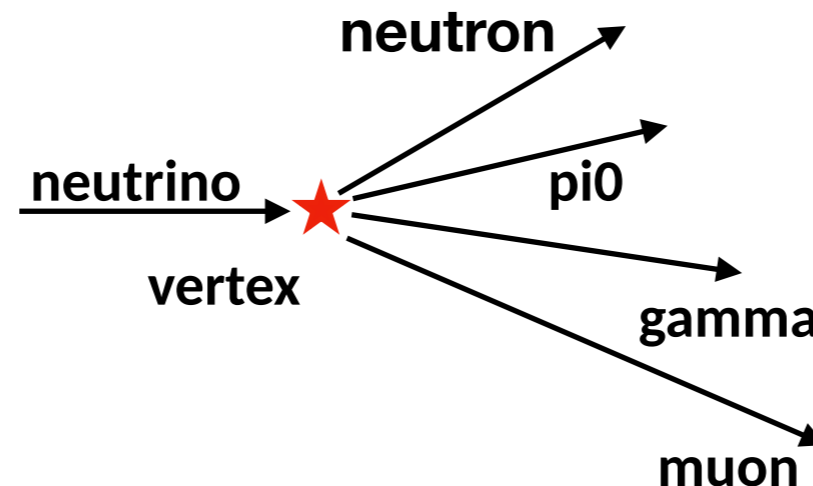
Reminder

- **Assumption:** we can select exclusive channels, $CC1P_{i\pm} 0P \times N 0P_{i0}$, $CC0p_{i\pm} 1P \times N 0p_{i0}$, $CC0p_{i\pm} 0P \times N 0p_{i0}$, x in integer.
- **4 categories:**
 - primary neutron: neutron from vertex
 - secondary neutron: other neutron
 - primary gamma: gamma from vertex
 - secondary gamma: other gamma
- **7 variables**
 - lever arm: distance between vertex and the first hit
 - time of flight: time difference between vertex and the first hit
 - CubeE: total energy inside the first cube
 - number of cube: number of fired cube cluster including the first cube
 - beta: relativistic beta, speed of particle/speed of light
 - angle: θ in the figure
 - distance between C point and hit
- **Training sample for BDT:**
 - signal (primary neutron)
 - background (secondary neutron+primary gamma+secondary gamma)
- **bugs fixed**



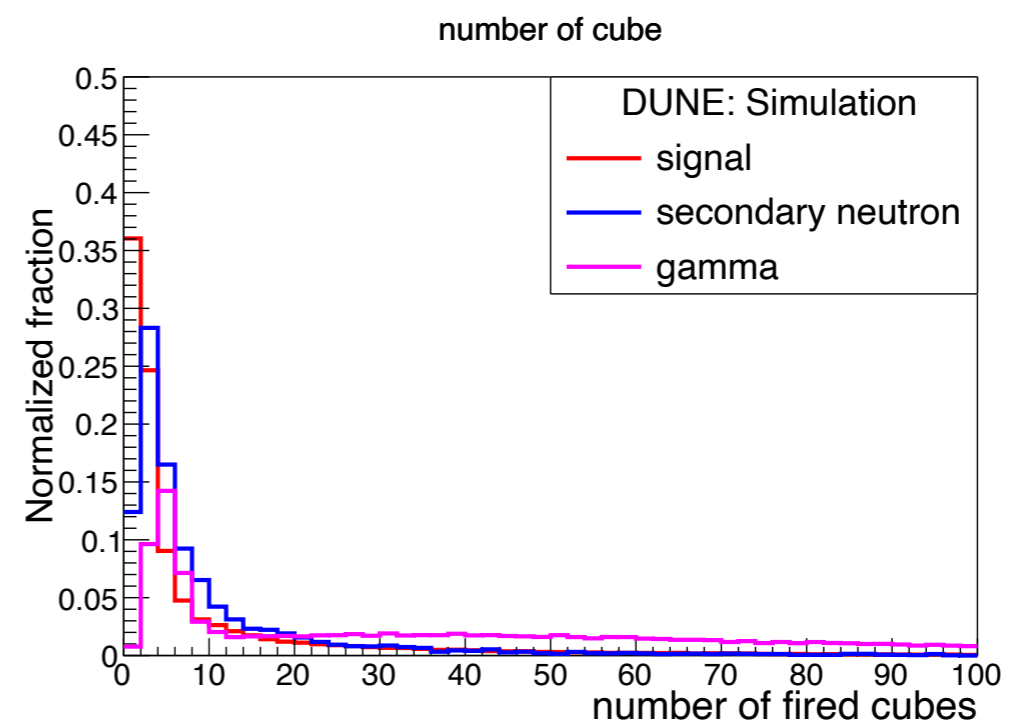
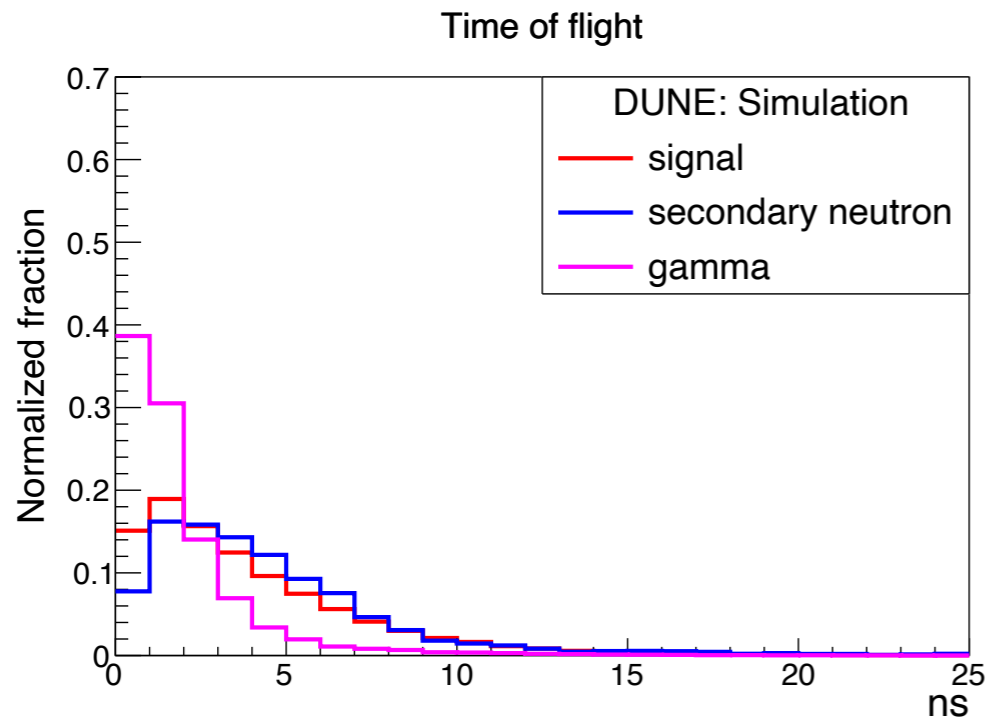
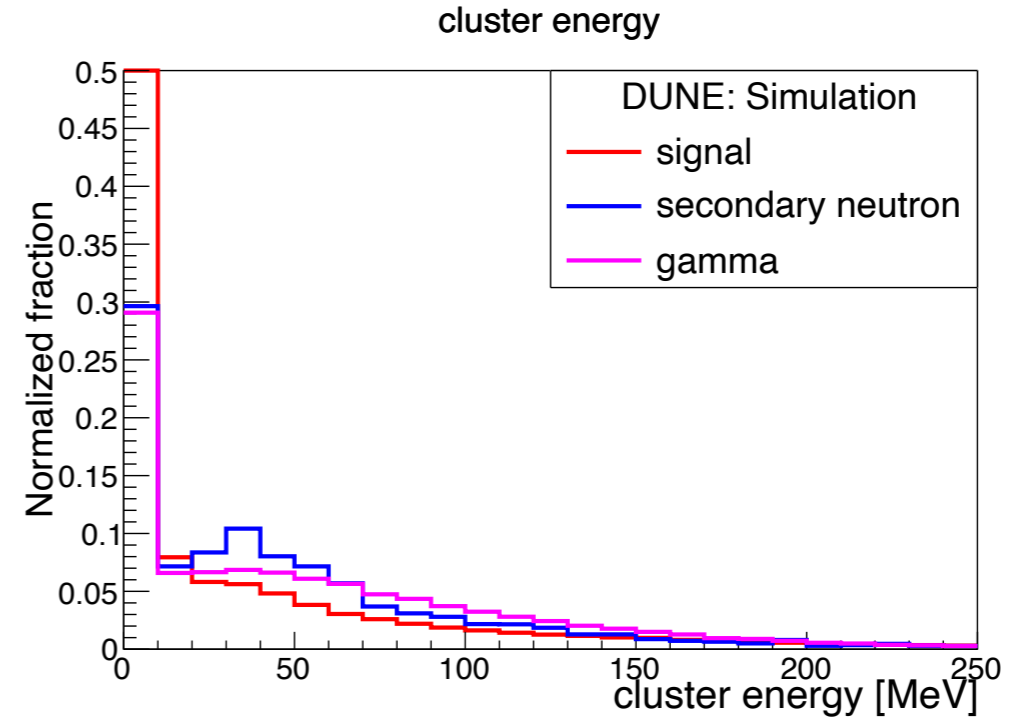
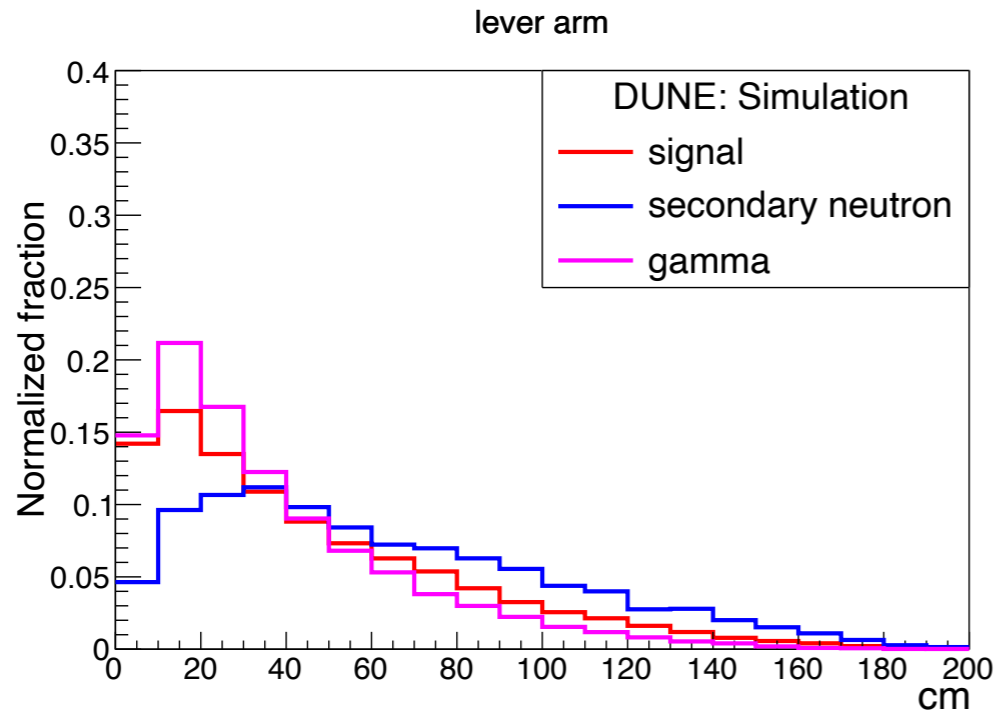
Channel with pi0 included

- Channel for BDT training: $CC0Pi+-0PxNyPi0 + NC1Pi+-0P0NyPi0$
x and y are integer and $x > 0$:

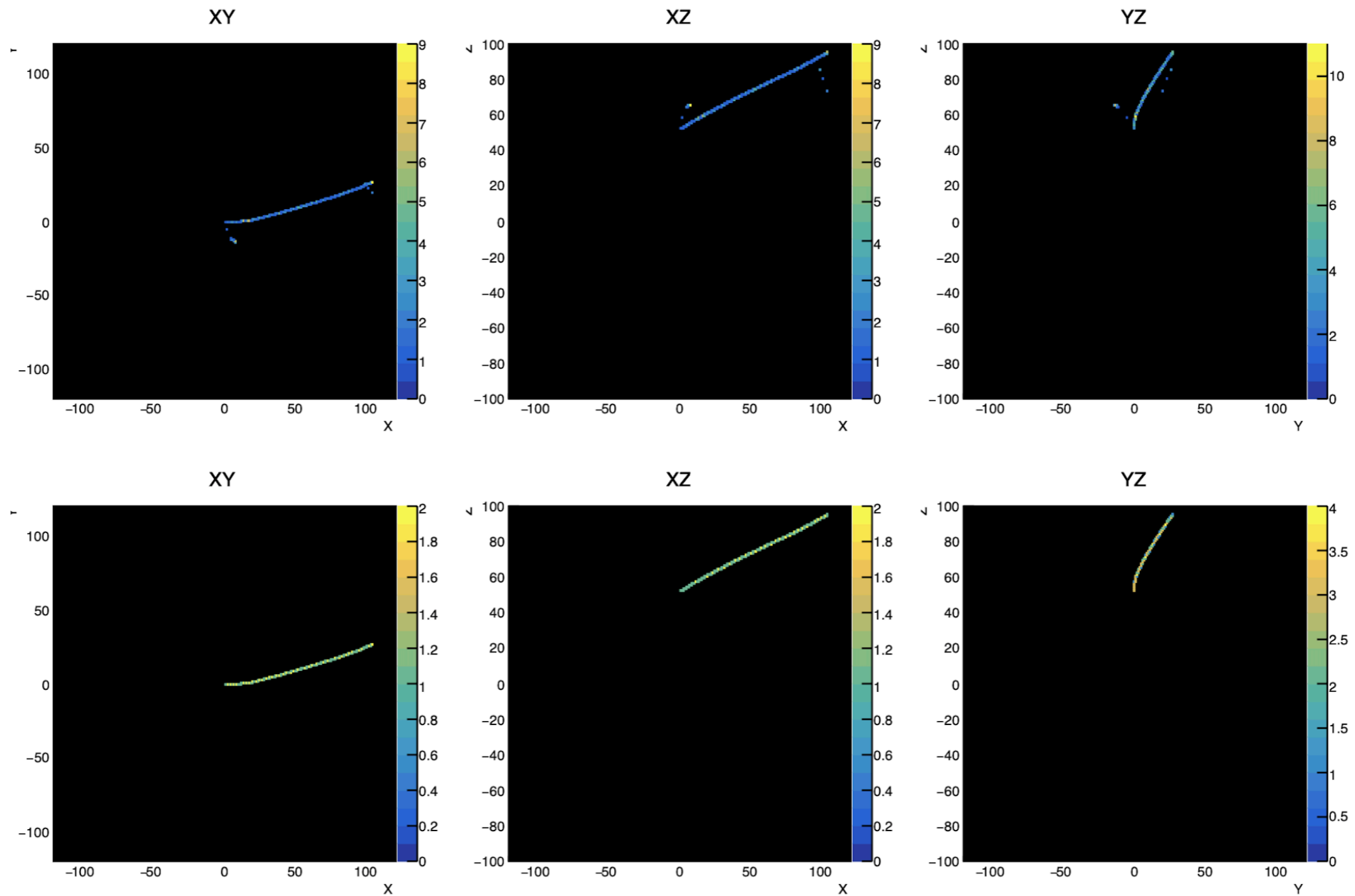


- 4 variables as an input of BDT training
 - lever arm: distance between the first hit and the vertex
 - time of flight (TOF): time difference between the first hit and the vertex
 - number of cubes: number of fired cube cluster including the first cube
 - cluster energy: sum of energy deposit in the cube cluster

Updated variable distributions



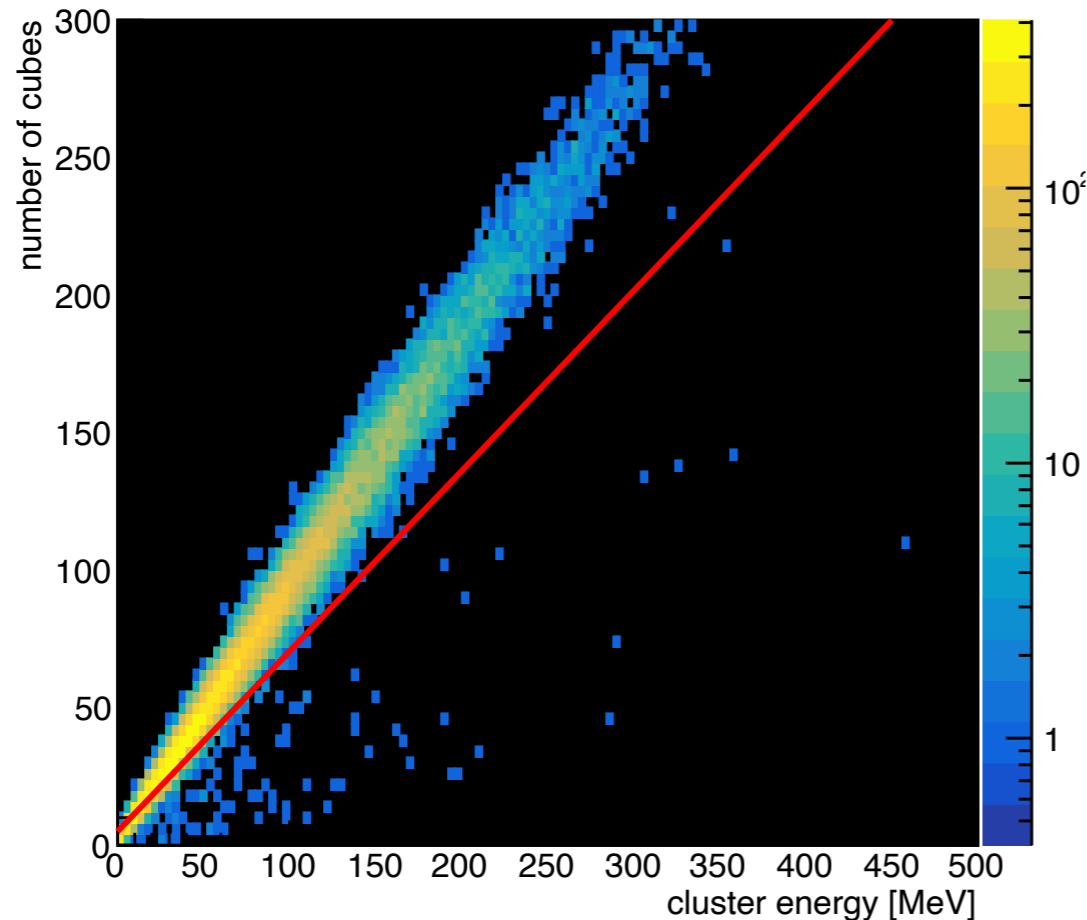
neutron event, $150 < nCube$



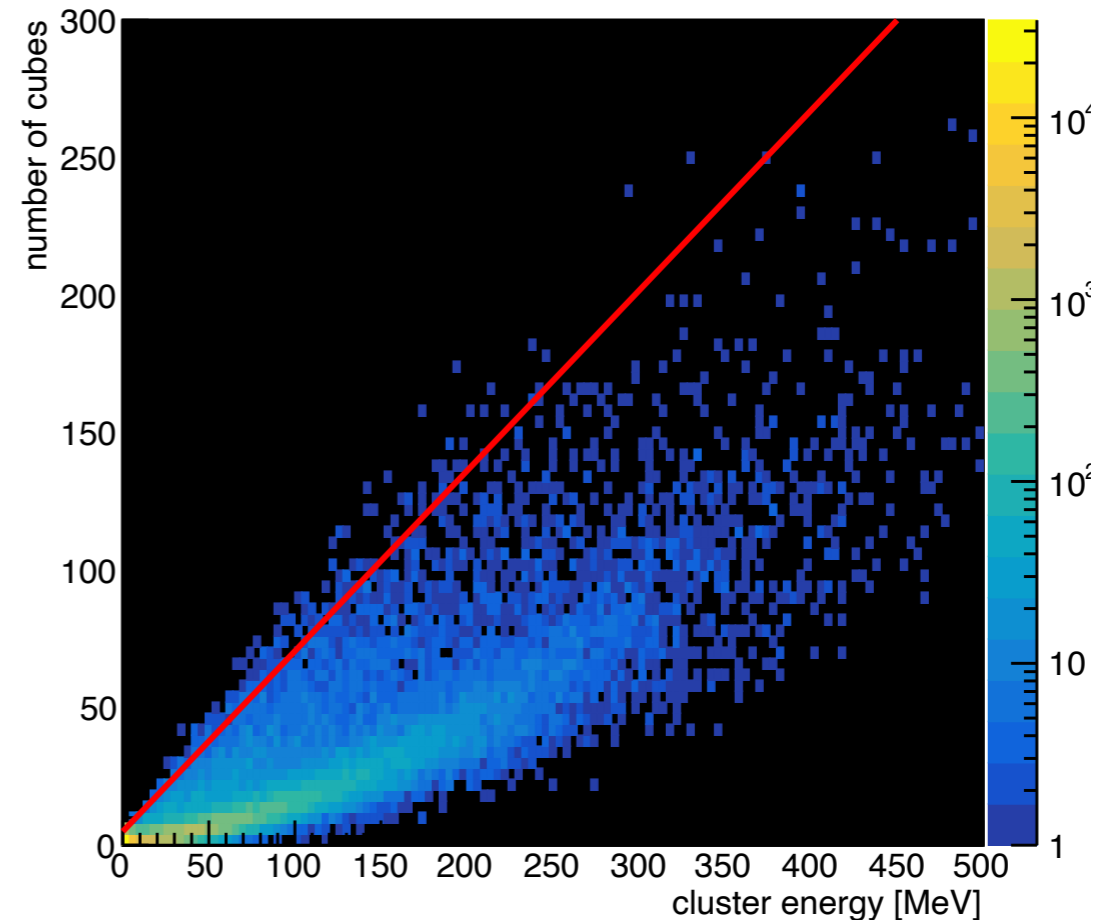
neutron could have long track

simple discrimination between gamma and neutron

gamma from pi0

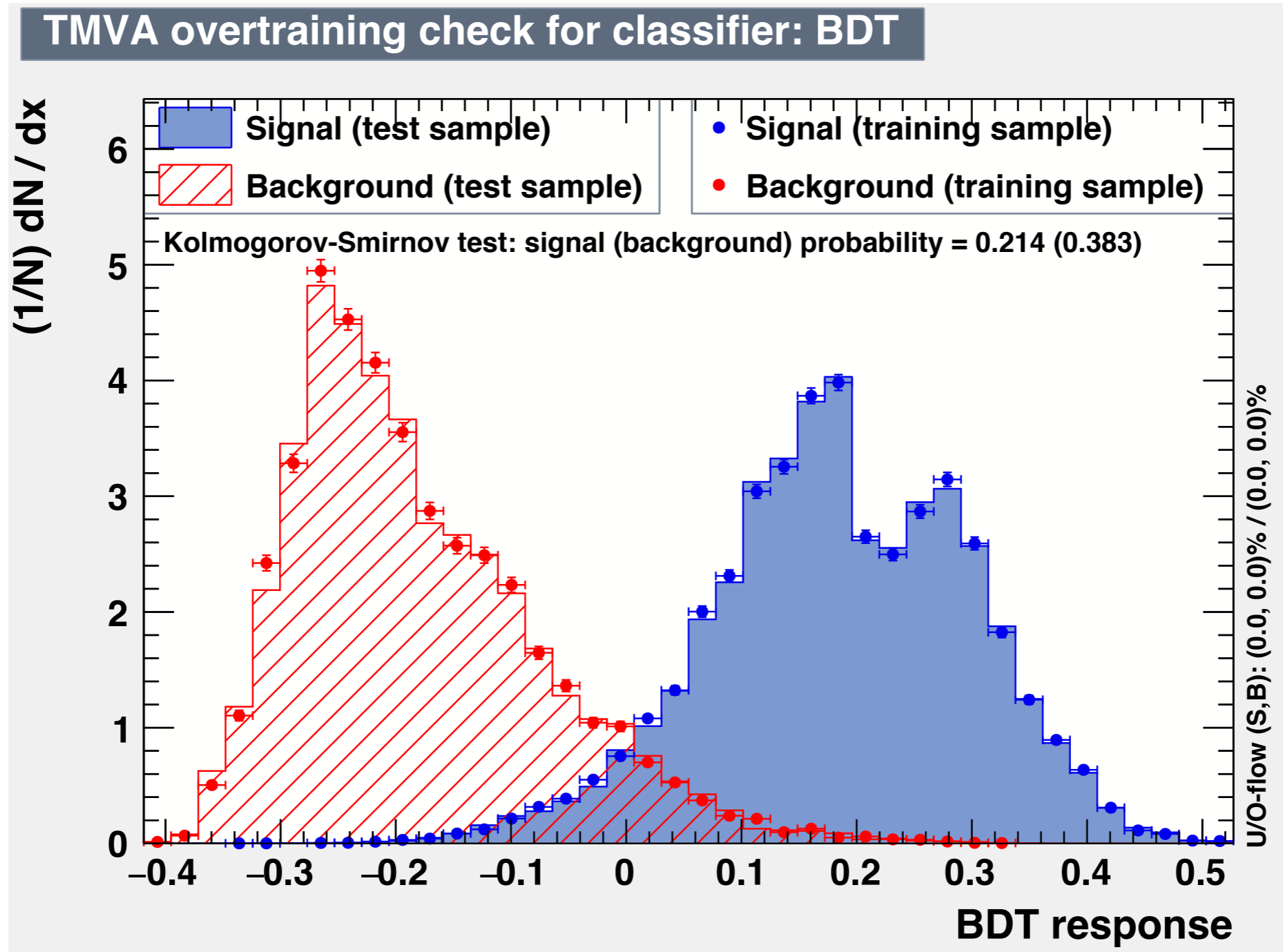


primary neutron



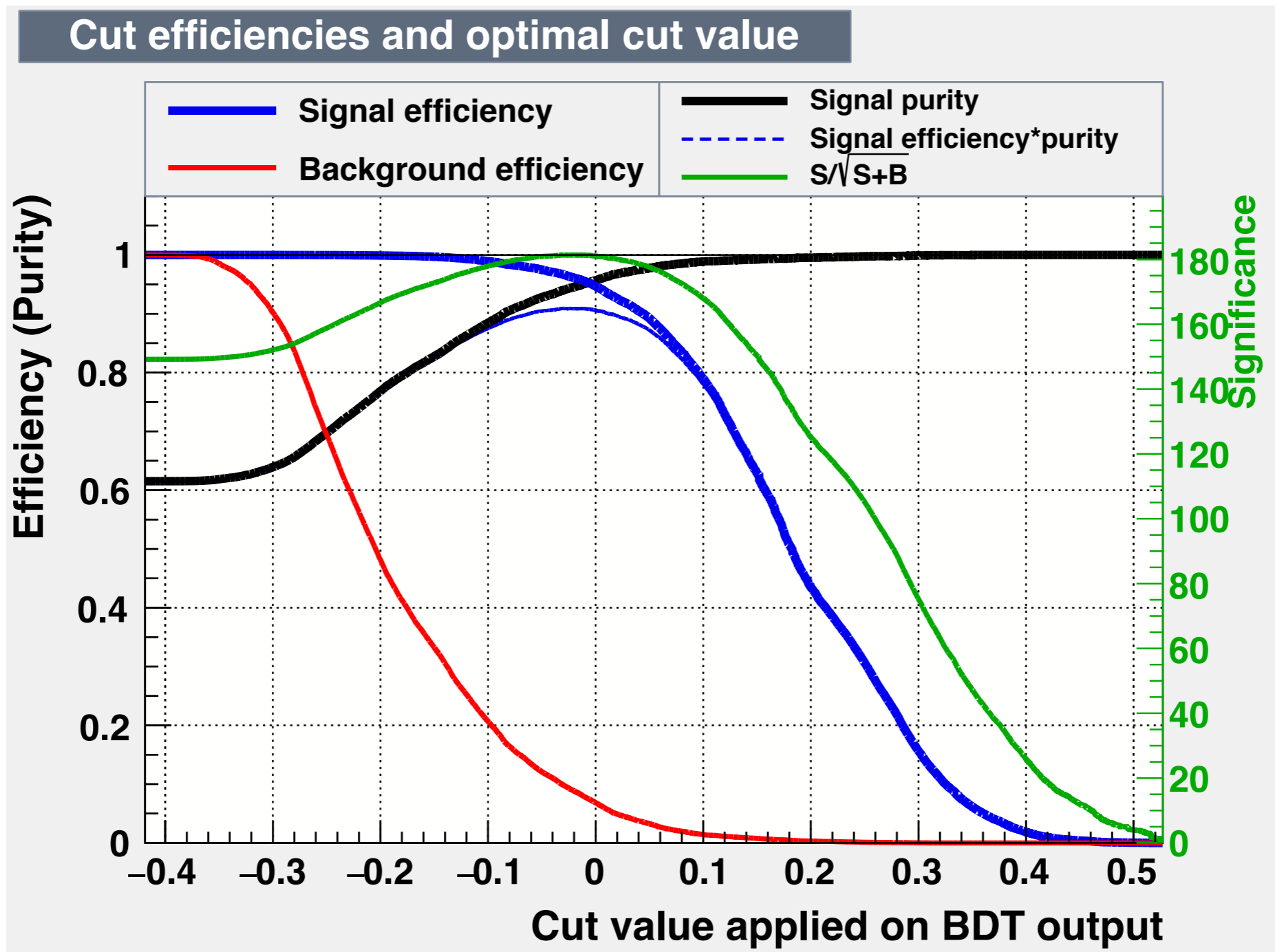
- gamma: CC1Pi0, neutron: CC1N
- We applied a 2D cut (the red line) and we got 99.7% for neutron and 9.7% for gamma with the cut.
- 2662 gamma, 82176 neutron in the below-cut region

BDT result



signal: 36174
background: 22625

BDT result



Signal: primary neutron + secondary neutron

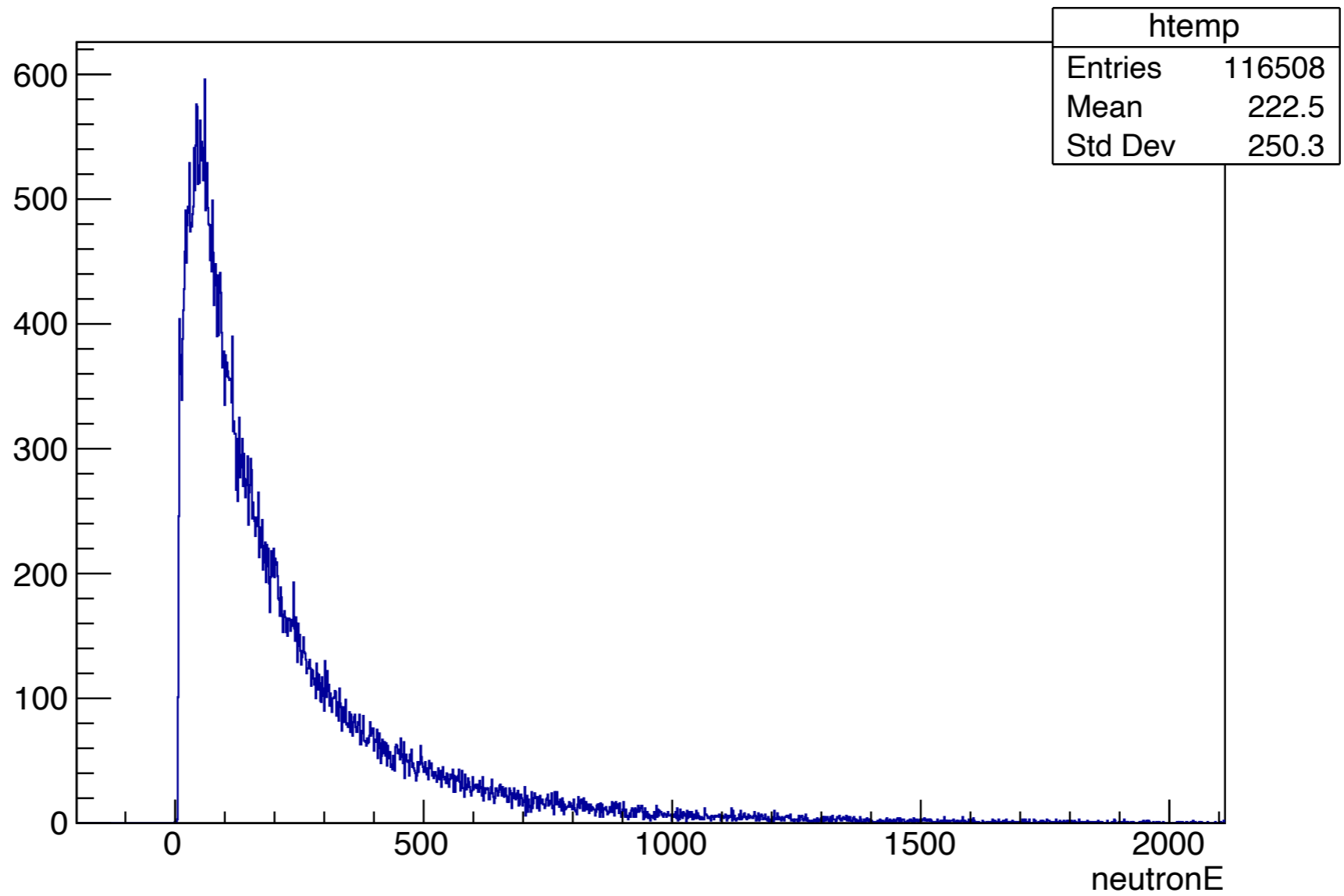
Background: primary gamma + secondary gamma

Summary

- **We studied a channel with π^0 and NC included according to CDR editor's suggestion**
- **gamma from π^0 and neutron are clearly separated.**
- **BDT also confirms the separation.**
- **We want to send back the new result to the editor.**

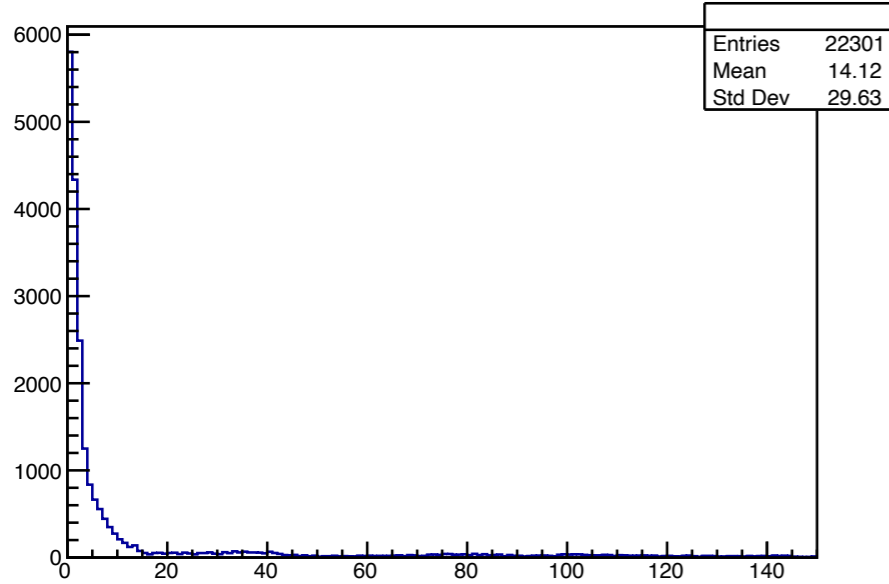
back up

neutronE

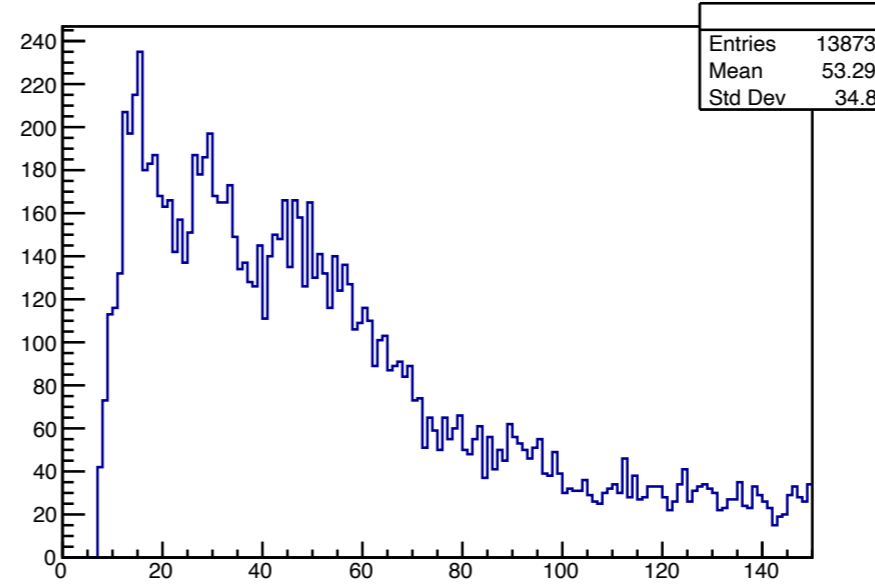


neutron trueE

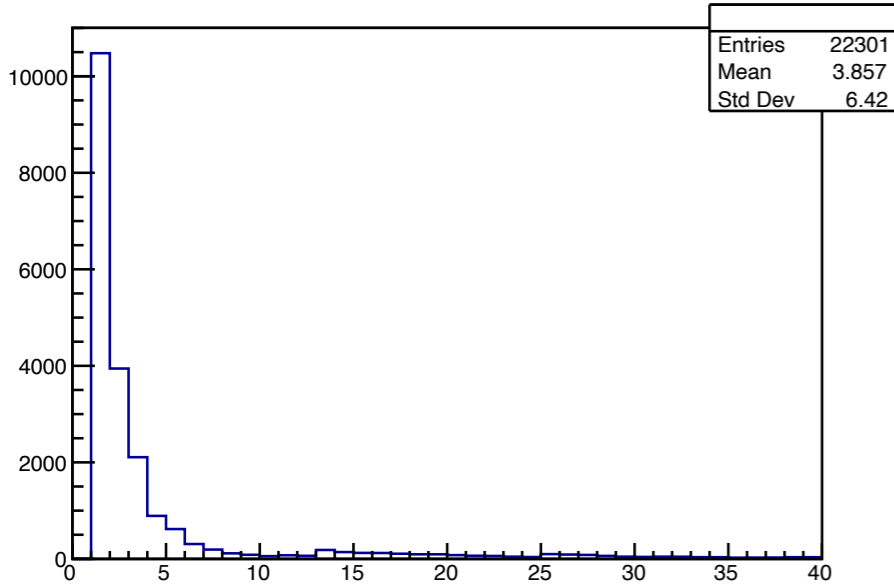
clusterE, neutron, BDT < 0.22



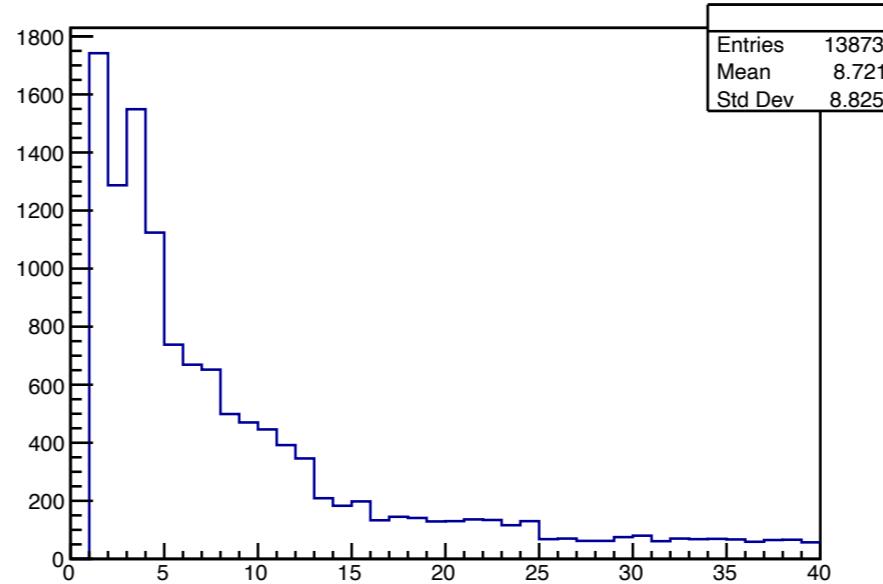
clusterE, neutron, BDT > 0.22



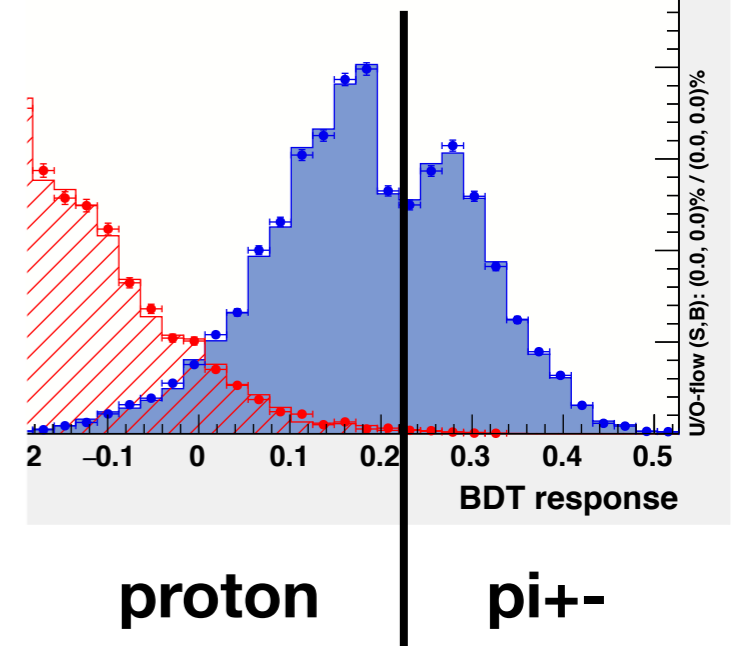
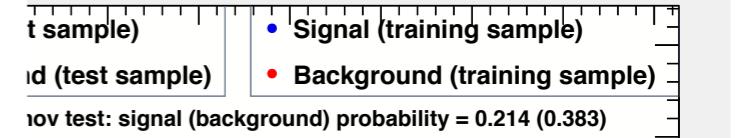
nCube, neutron, BDT < 0.22



nCube, neutron, BDT > 0.22



check for classifier: BDT

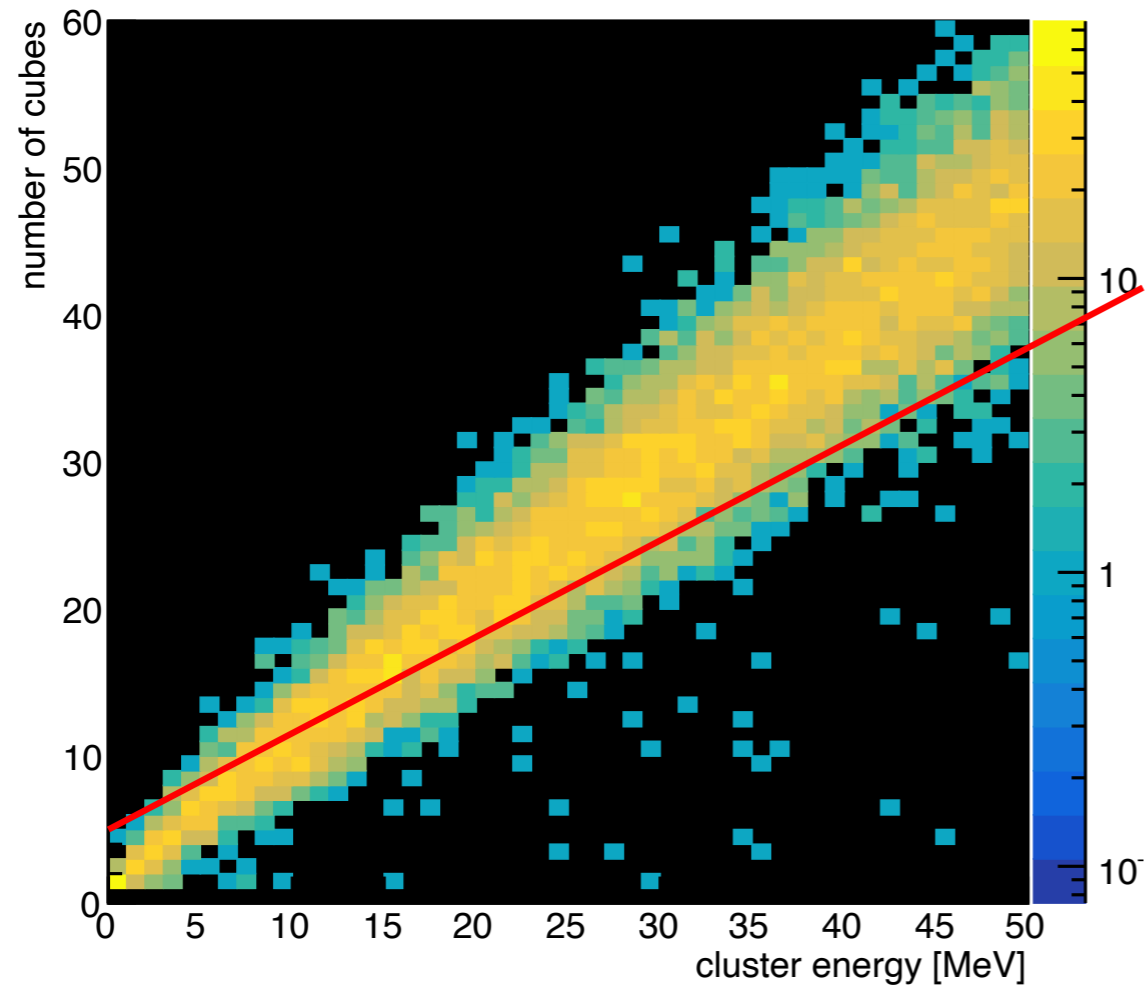


clusterE, nCube with BDT = 0.22 cut

BDT > 0.22 region: neutron induced charged pion

BDT < 0.22 region: neutron induced proton

gamma from pi0



primary neutron

