# Separating $\pi^0$ and $\gamma$ signals in the SCT Calorimeter

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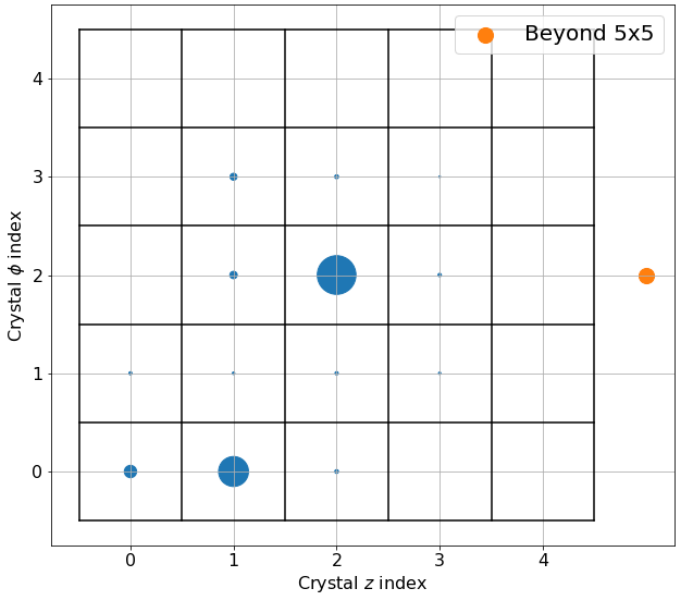
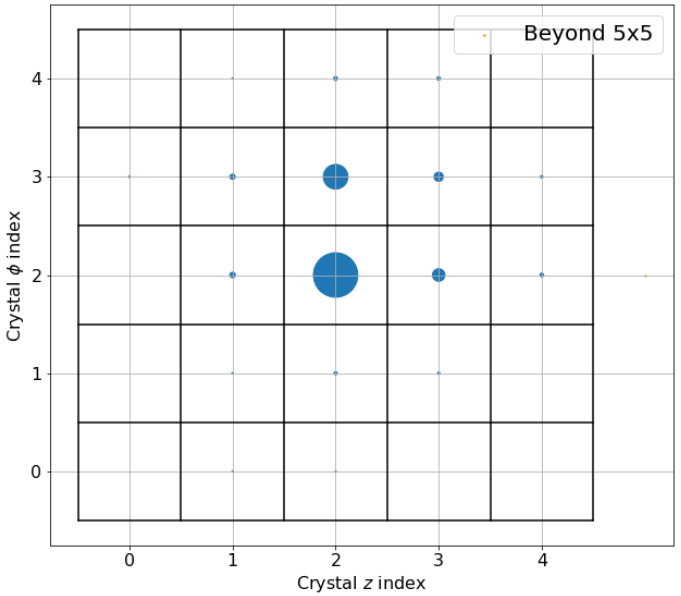
# The Merged cluster problem

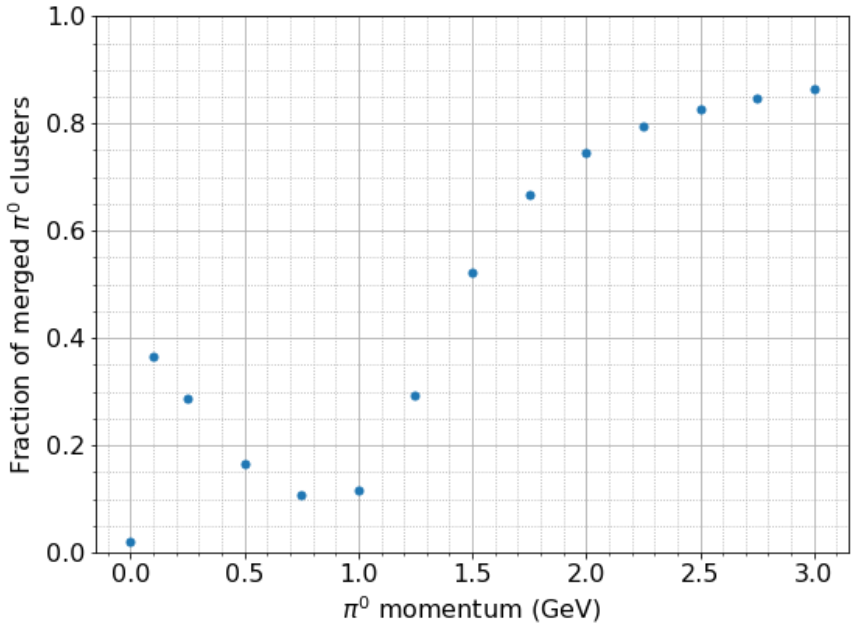
- Generator: particle gun (single $\gamma$ or single $\pi^0 \to 2\gamma$) with polar angle between $\pi/4$ and $3\pi/4$
- Full Geant4 simulation plus reconstruction algorithm by Vyacheslav Ivanov
- About 20% $\pi^0$ signals are reconstructed as single cluster at $1\ \mathrm{GeV}$ momentum and more then 75% at momentum above $2\ \mathrm{GeV}$

Typical merged $\pi^0$ cluster at $2\ \mathrm{GeV}$



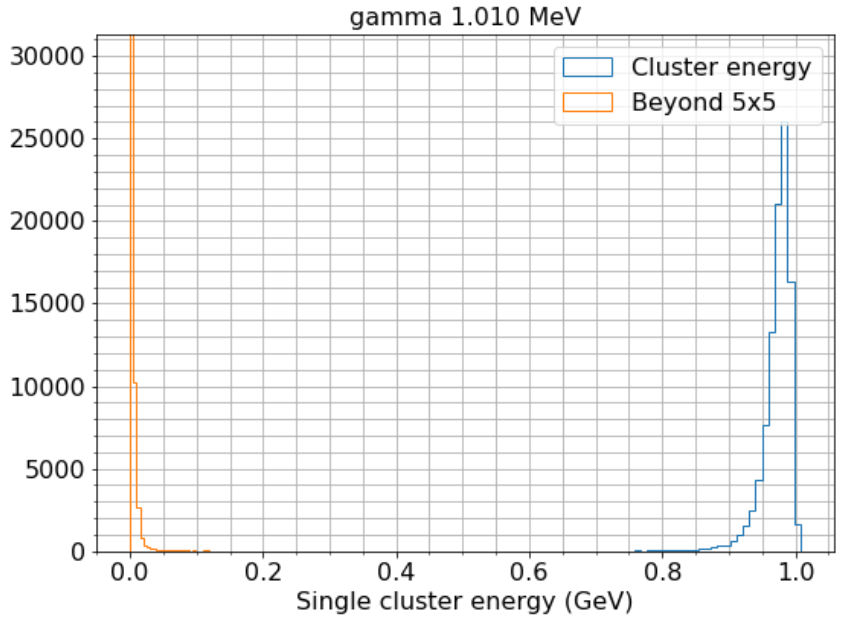

Typical $\gamma$ cluster at $2\ \mathrm{GeV}$

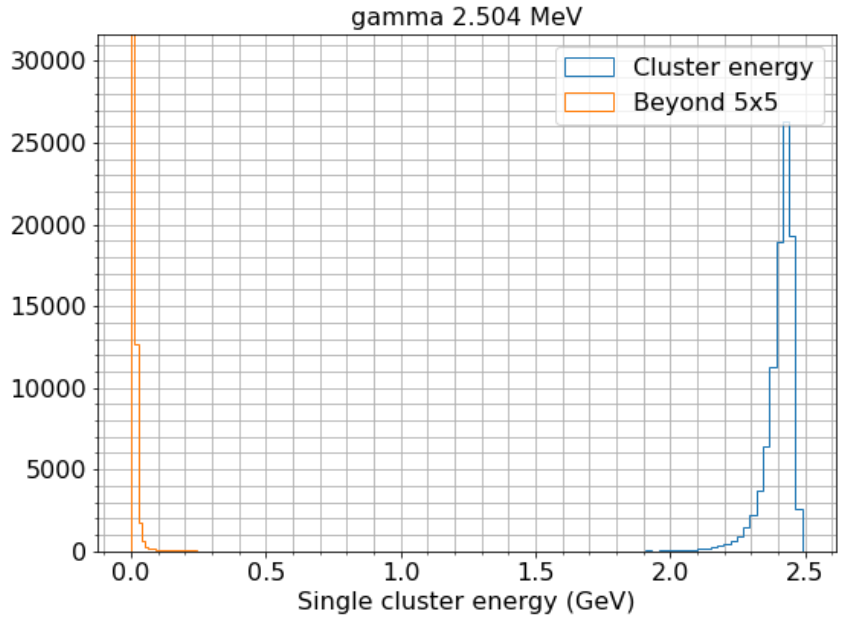


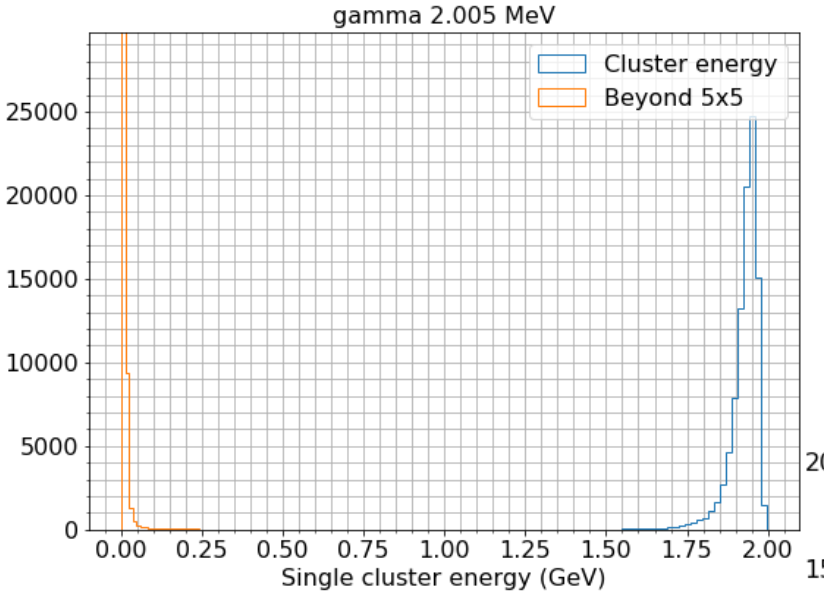




- Center of a cluster is defined as crystal with maximal energy deposition
- Input data – 26 float values:
  - *geometrically ordered* $5 \times 5$ energy depositions
  - sum of energy depositions beyond the $5 \times 5$ center

# Photons


gamma 1.010 MeV
Cluster energy
Beyond 5x5
Single cluster energy (GeV)


gamma 2.504 MeV
Cluster energy
Beyond 5x5
Single cluster energy (GeV)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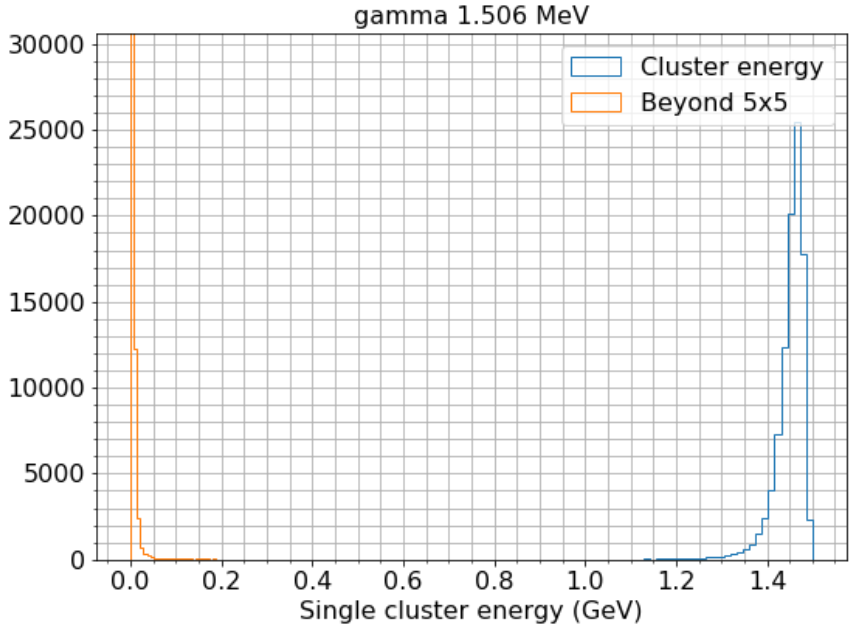
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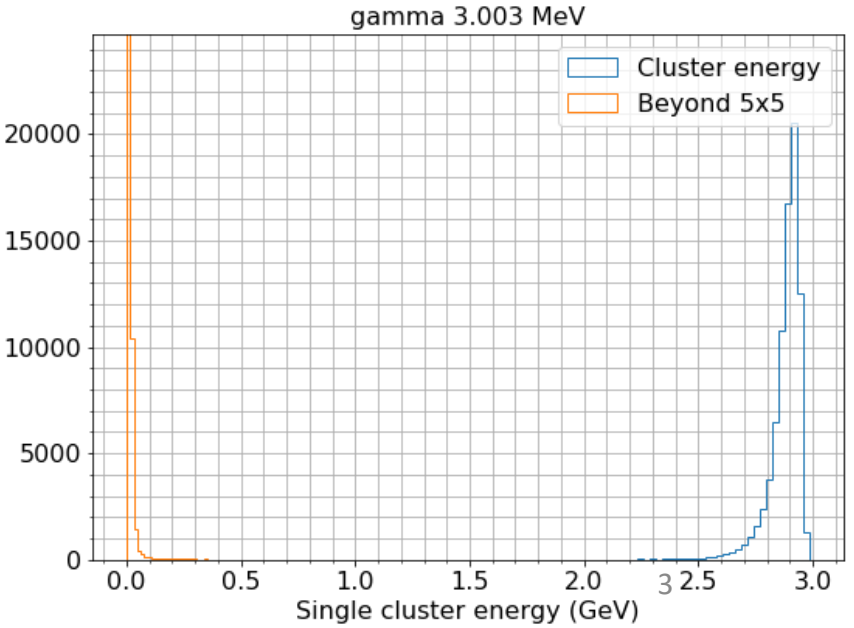
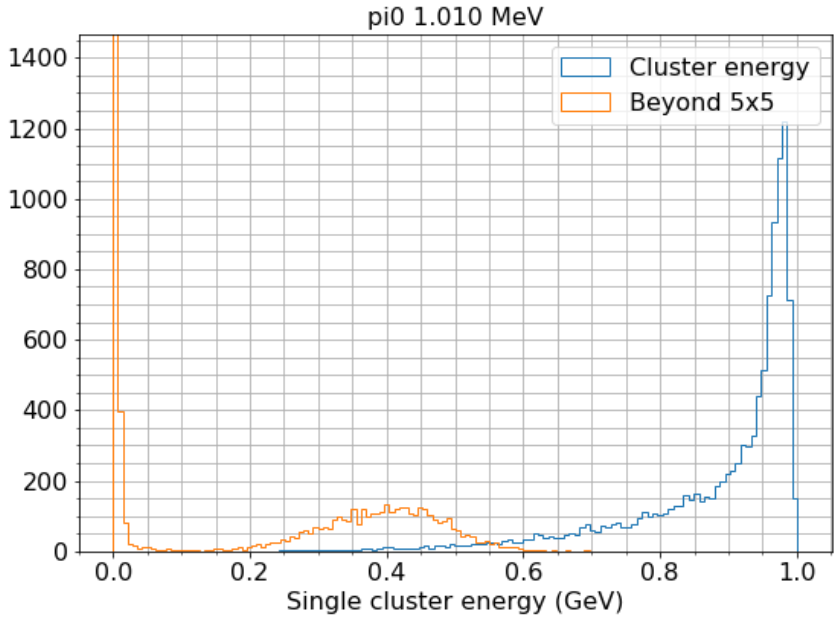

gamma 3.003 MeV
Cluster energy
Beyond 5x5
Single cluster energy (GeV)

# $\pi^{0\prime}s$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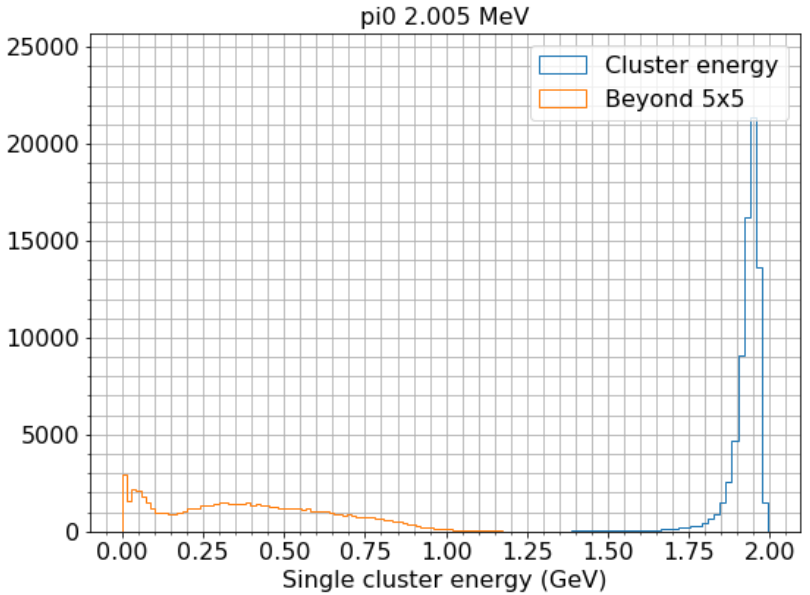
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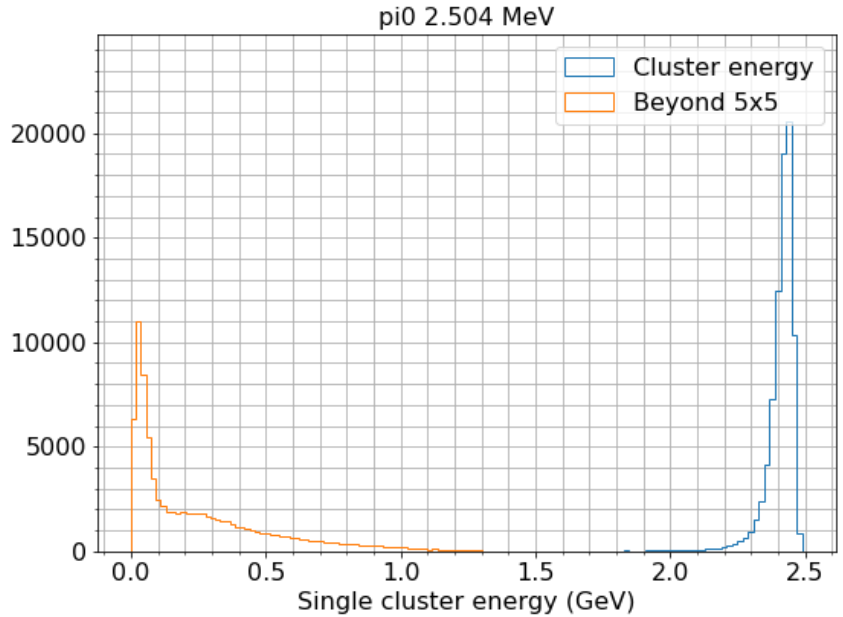
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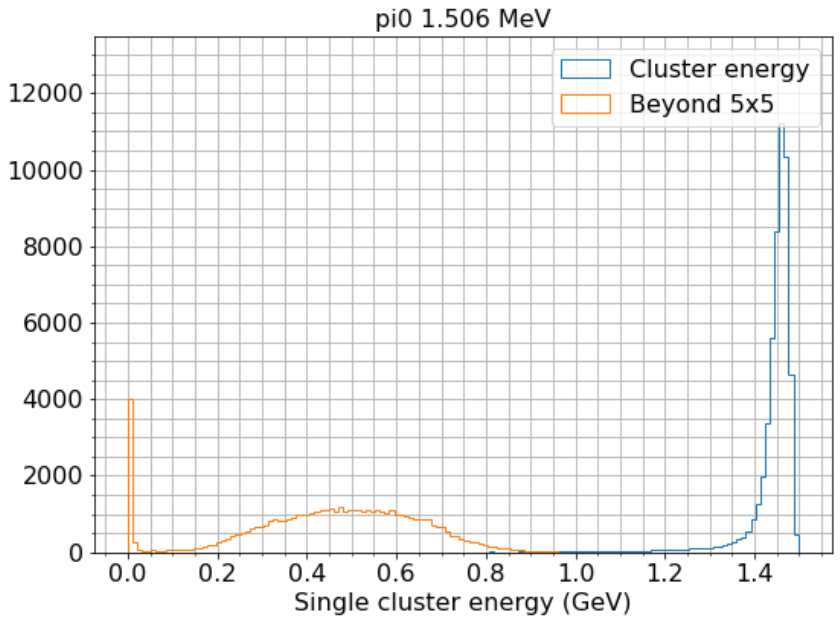
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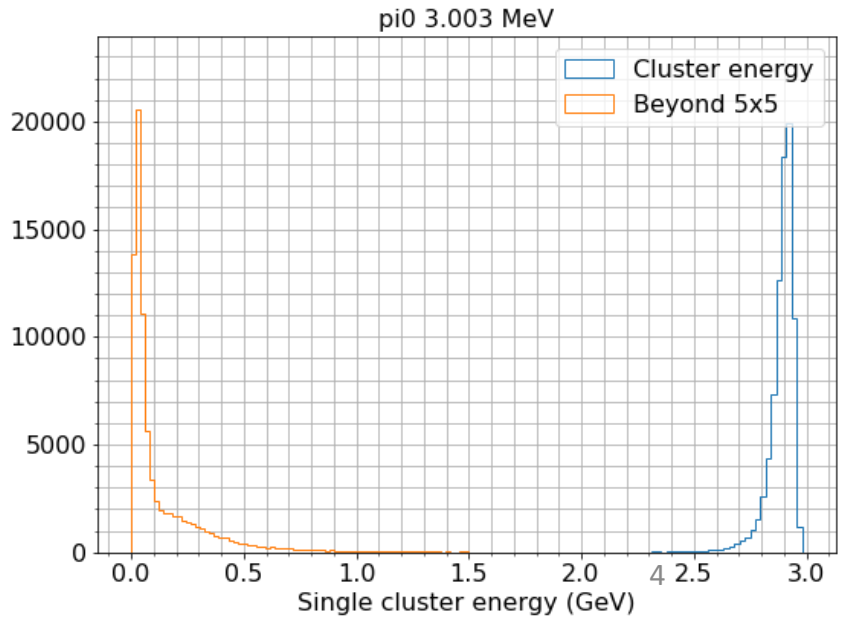
pi0 3.003 MeV
Cluster energy
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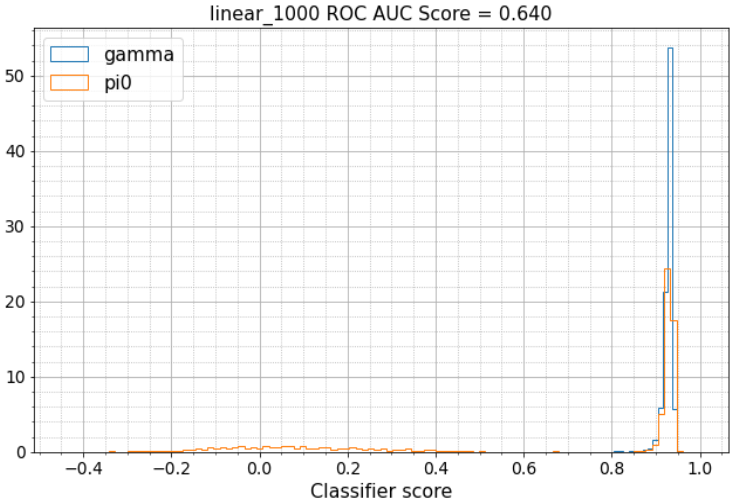
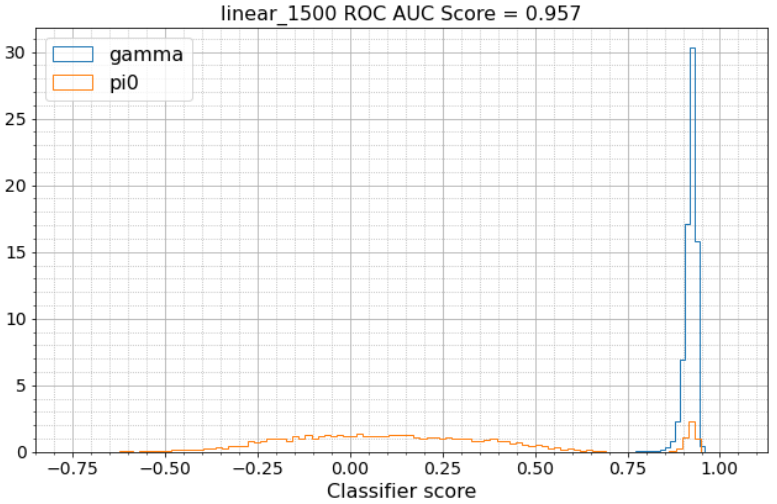
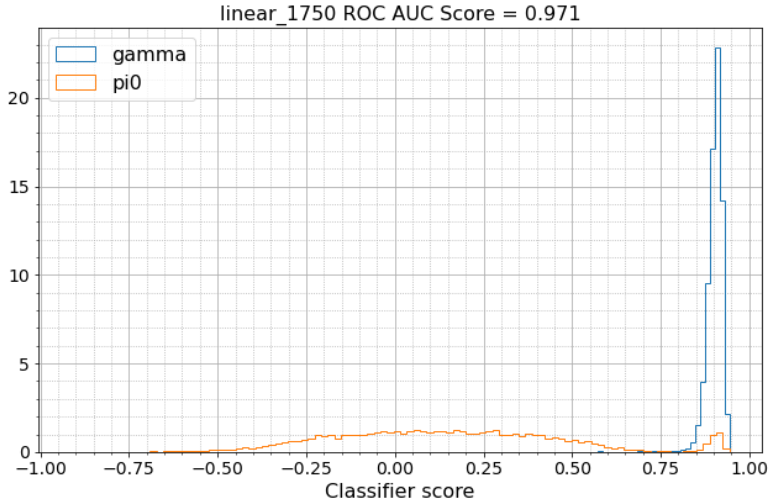
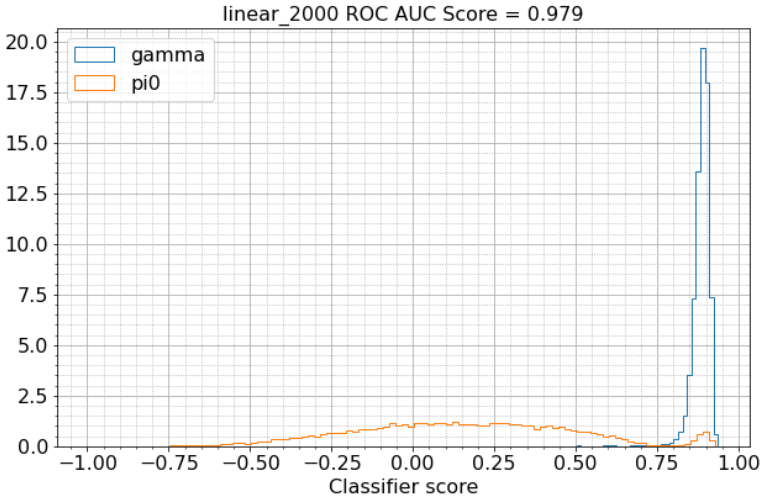
Single cluster energy (GeV)

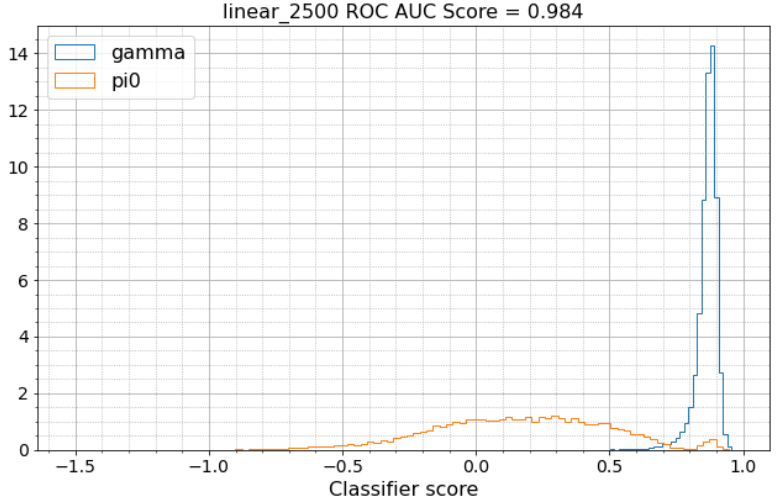
# Baseline: linear classificator

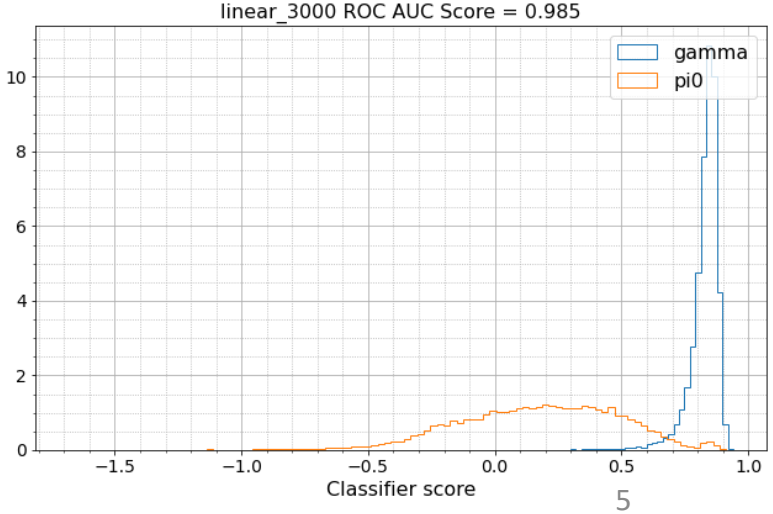


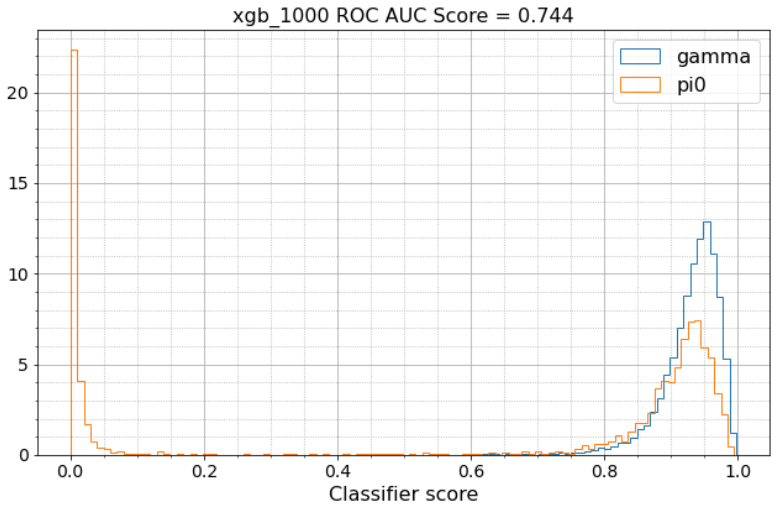



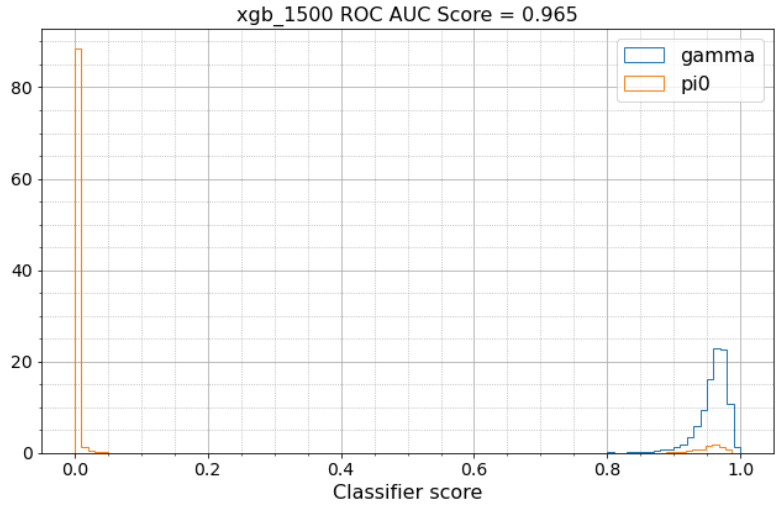



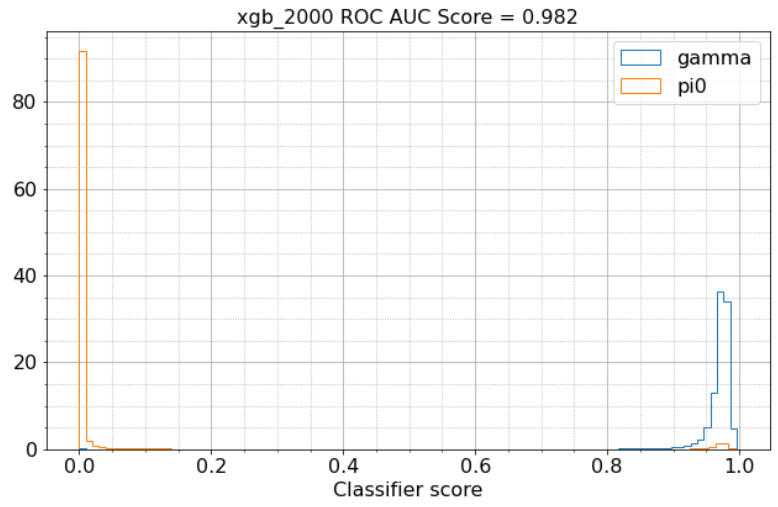



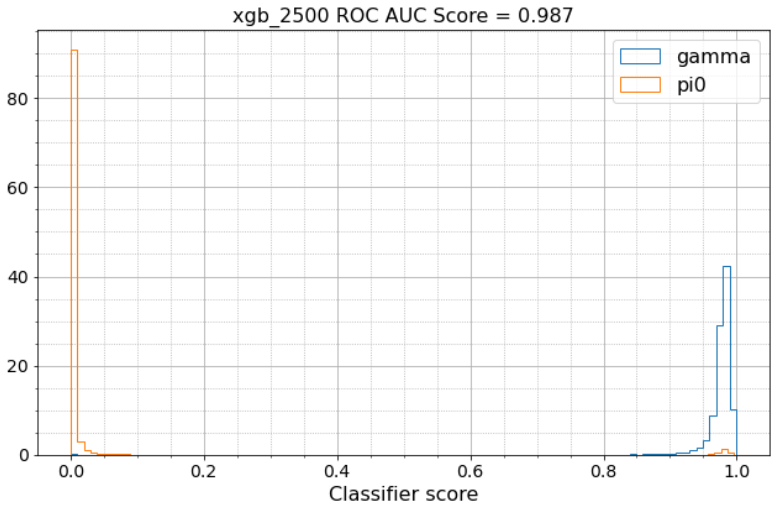



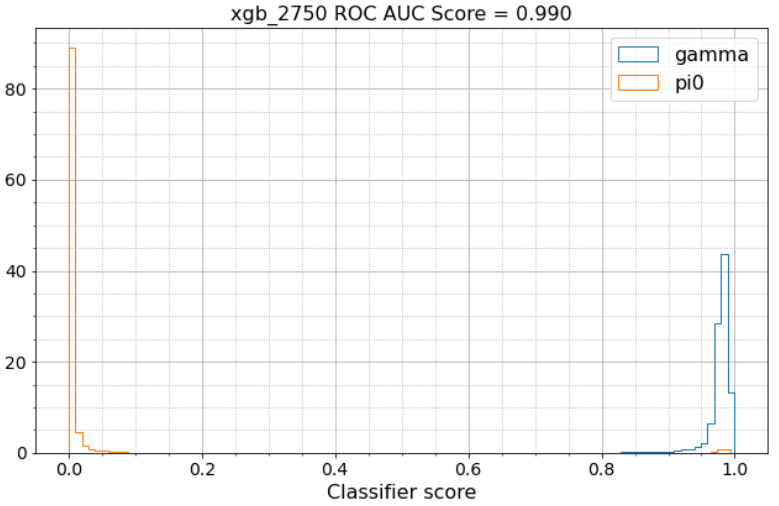
# XGBoost with default configuration

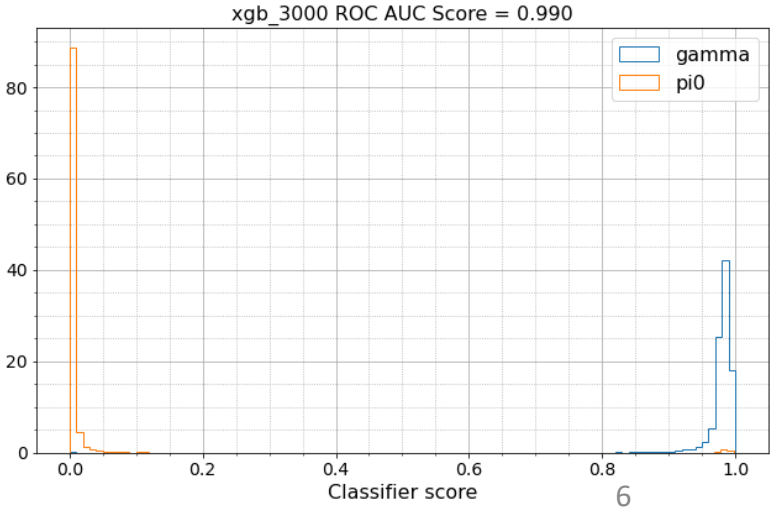


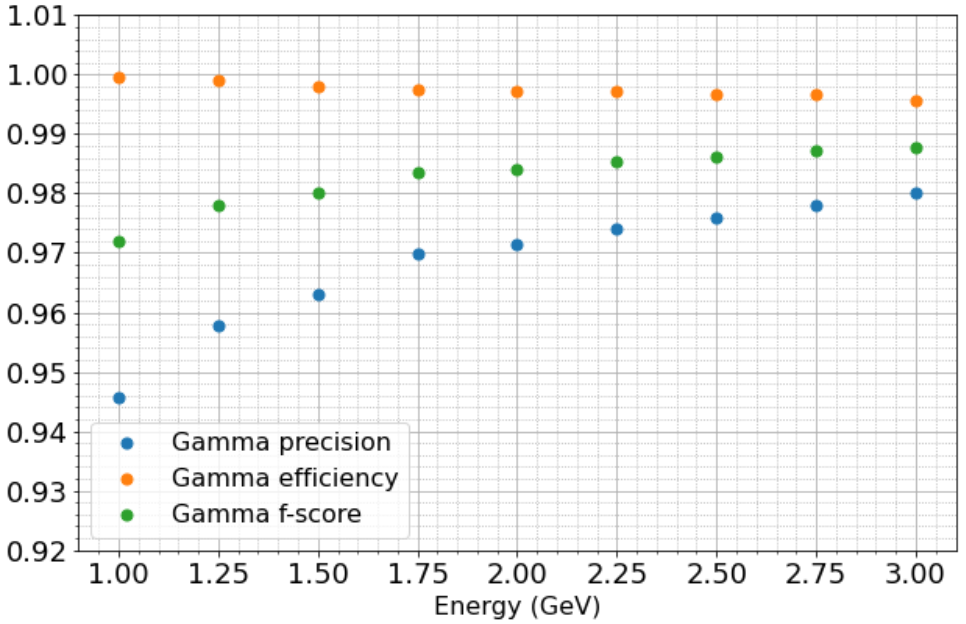



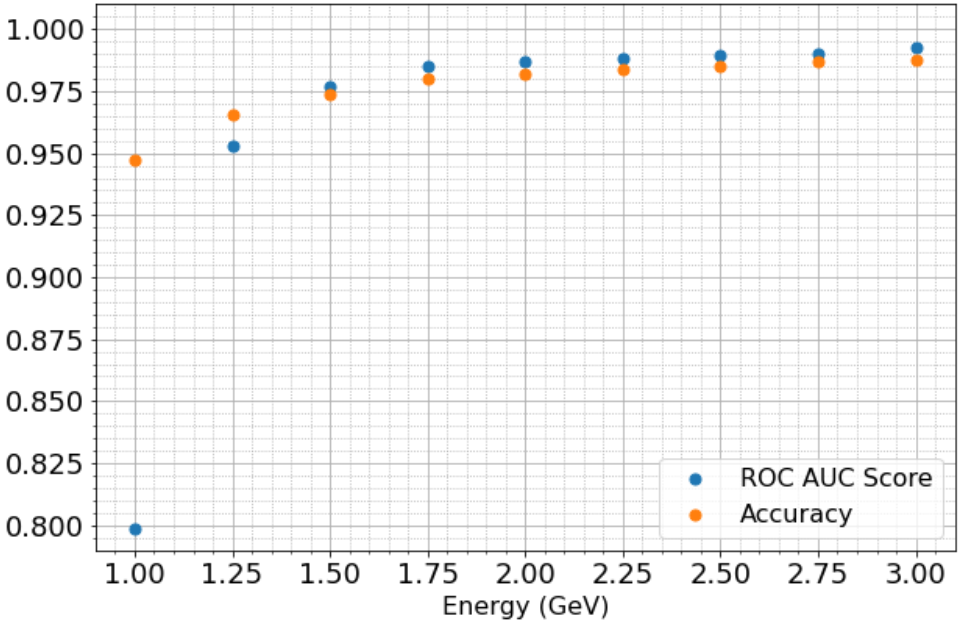



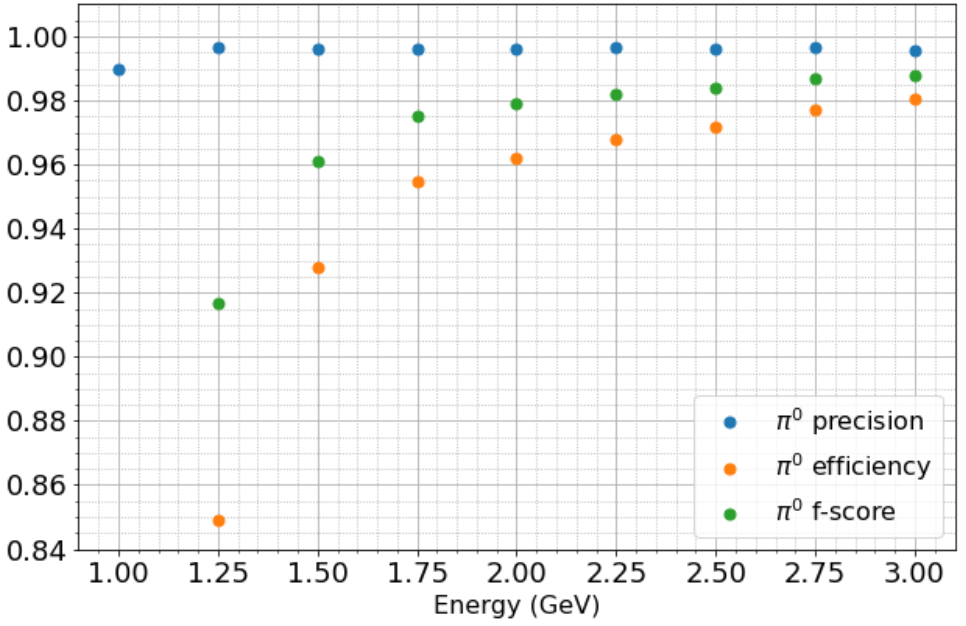



# XGBoost Metrics

- Recall (efficiency)
- Precision
- Accuracy
- F-score
- AUC ROC score

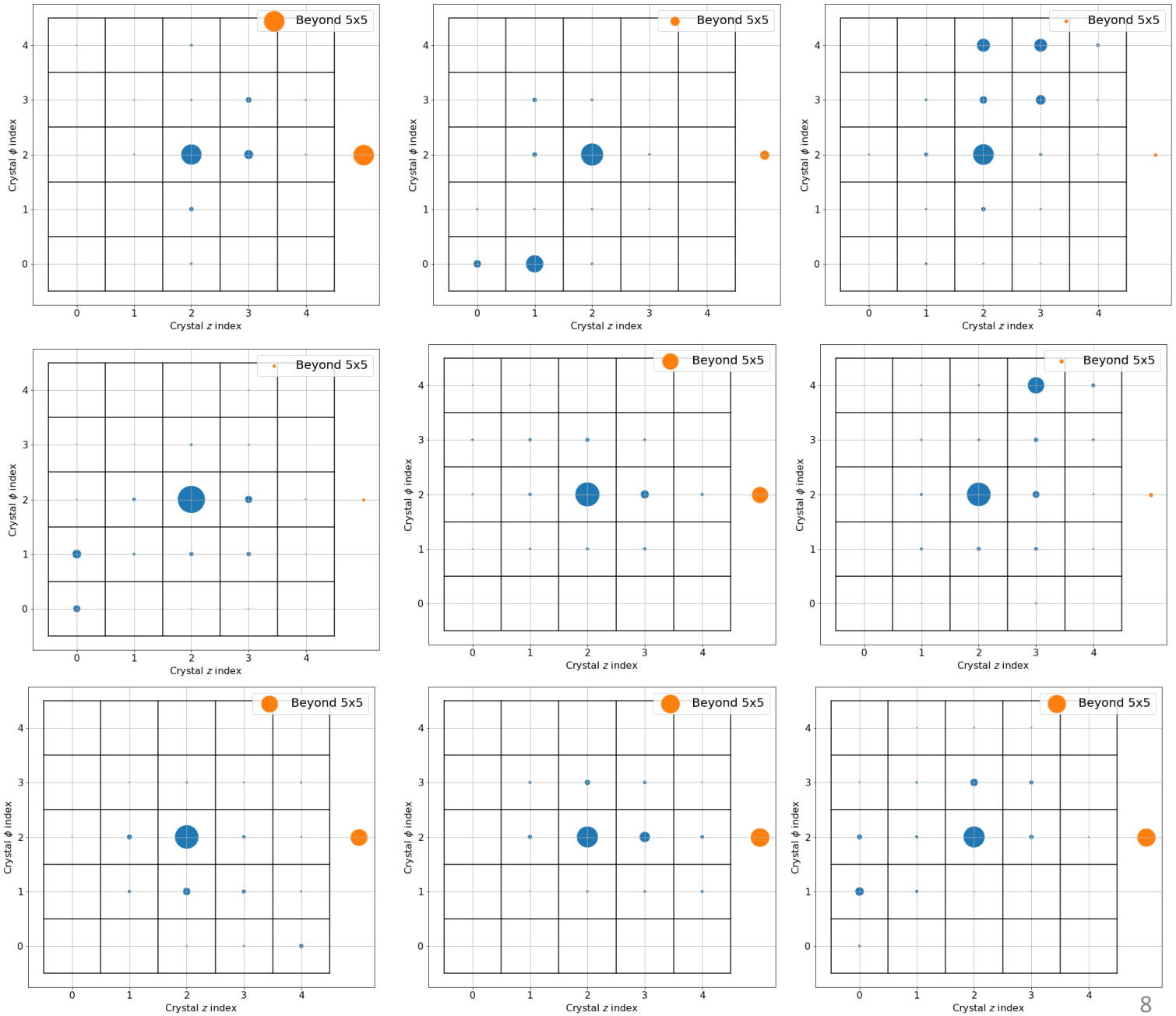


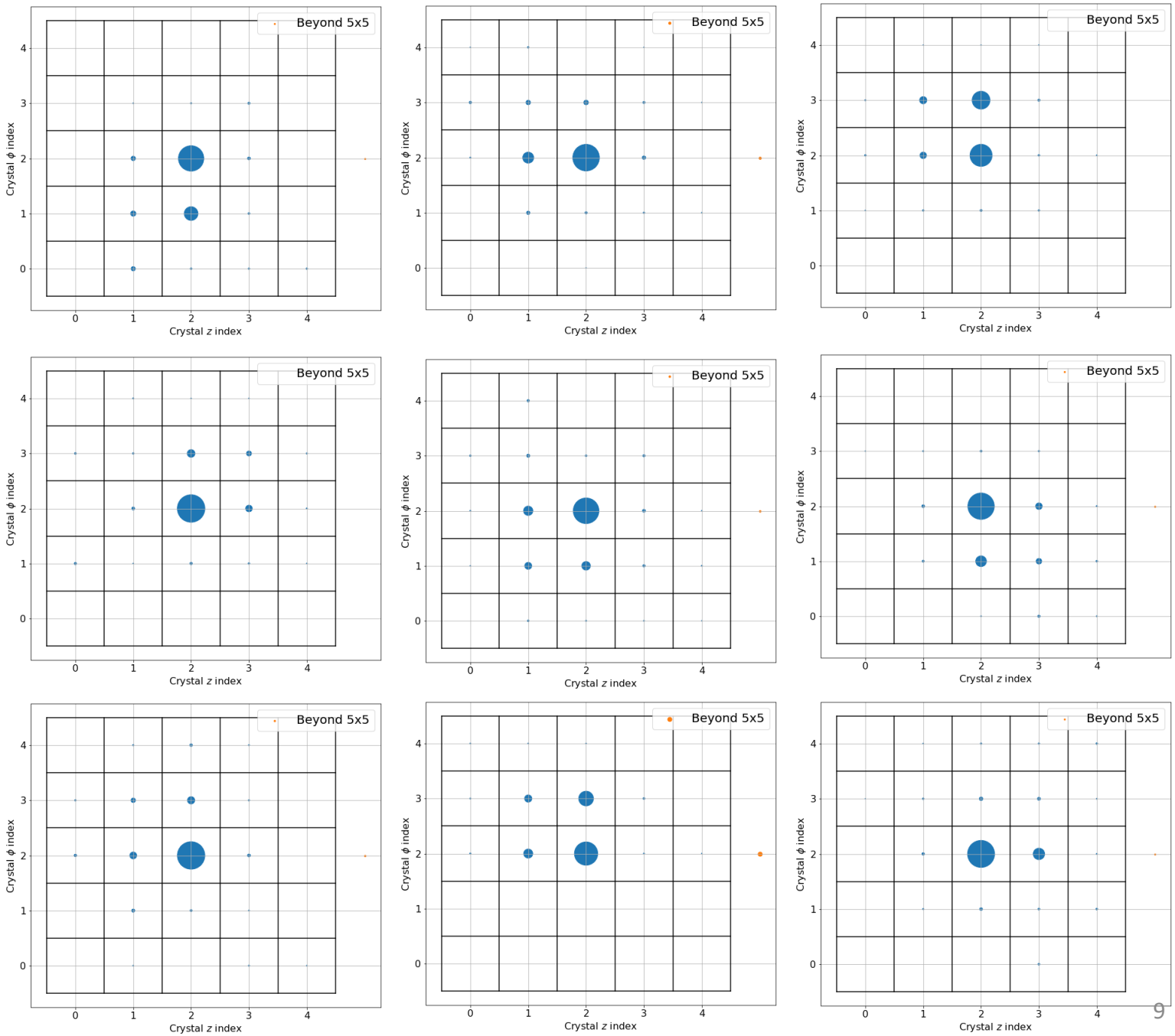



# Simple cases

- Scores $> 0.99$



# Hard cases

- Scores $< 0.01$