VBF Jet Isolation Studies

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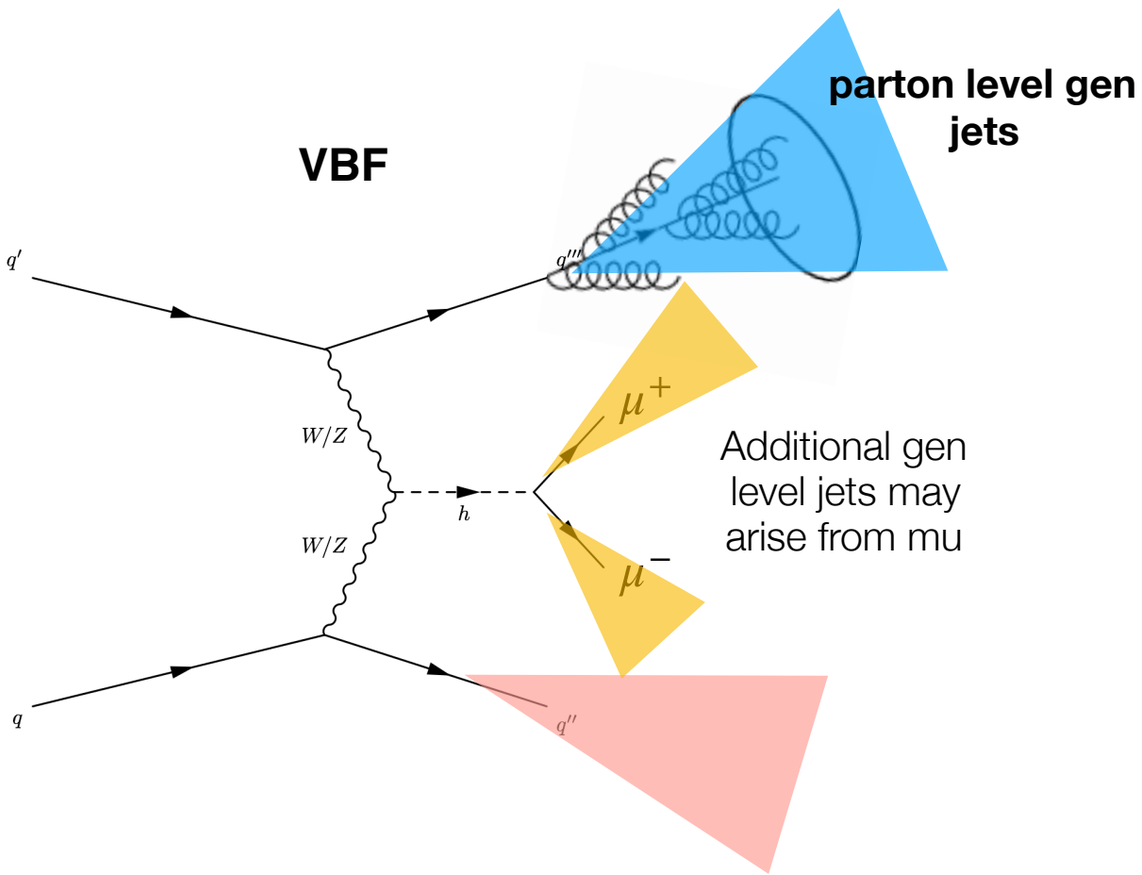
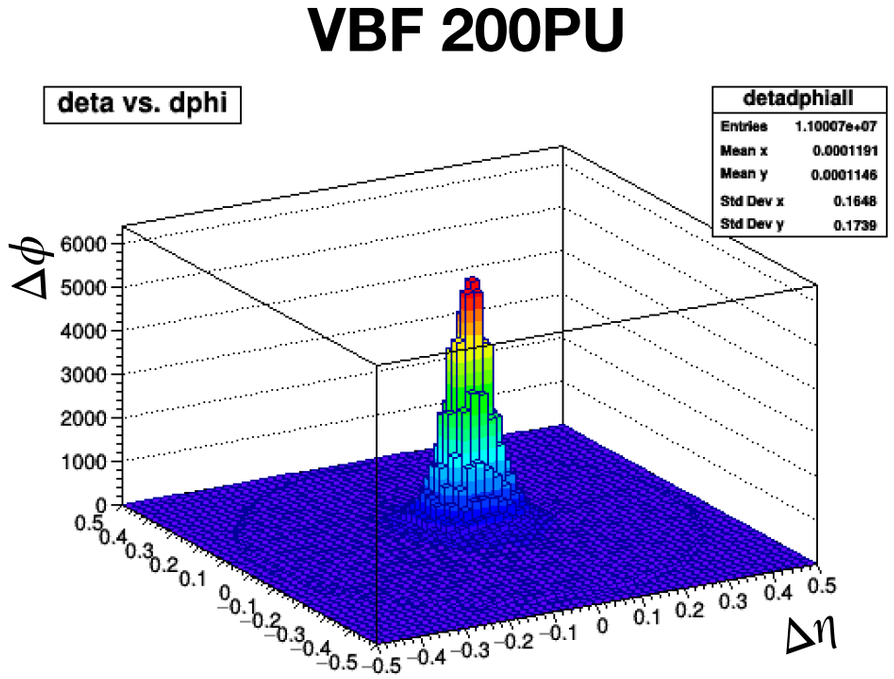
September 11, 2019

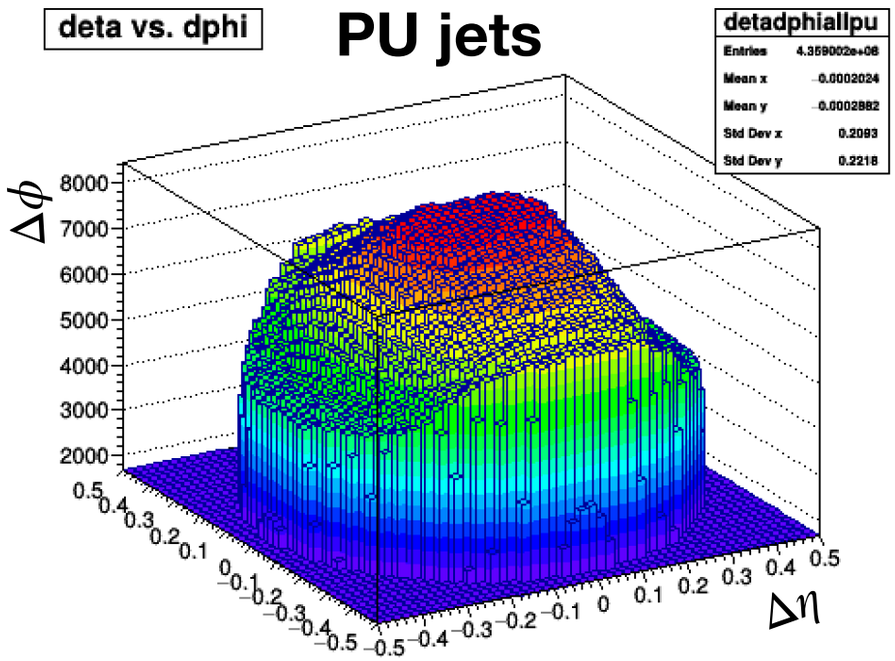
Overview

- We want to construct an algorithm for HGCAL to distinguish the VBF jets from Pile-Up (PU) jets

- VBF jets tend to be narrower than gluon jets which is the primary motivation of the study
- We want to use this idea to characterize Non-PU from PU jets and separate them at trigger level

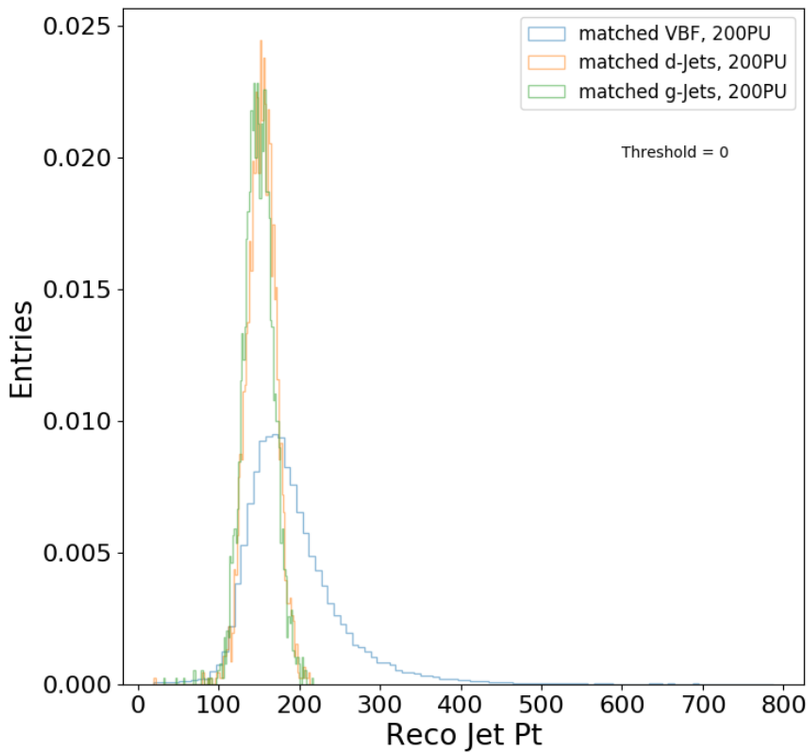


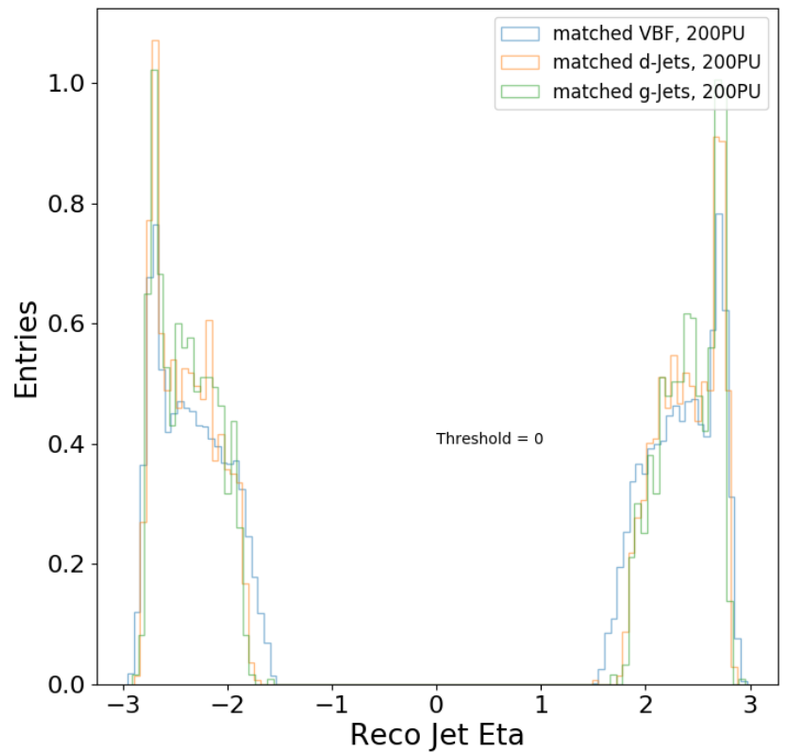




Jet Reconstruction and Requirements

- We cluster the final state trigger cells with algorithm using and with a cone radius, Minimum threshold on clustered jet Pt= 20 GeV
- We looked at:
  - VBF jets: produced from VBF event using pythia8, for both 0PU and 200PU
  - Particle guns: d-jets and g-jets, produced where there are two back-to-back gen partons going at pT =50 GeV/ 200 GeV
- To identify a VBF jet from all the final state jets, we do a matching of jets to the generated partons that are within dR=0.1

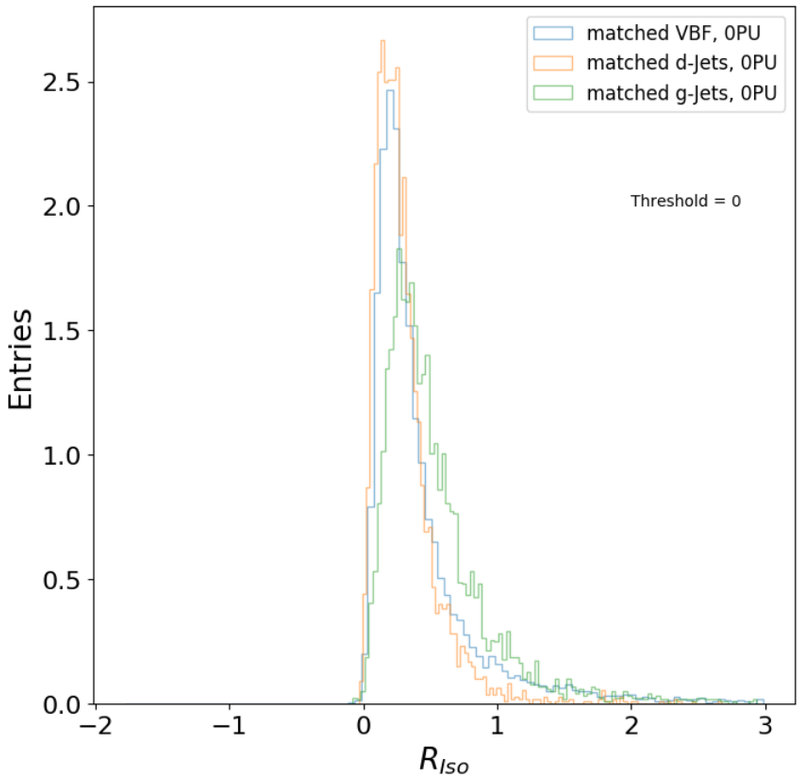


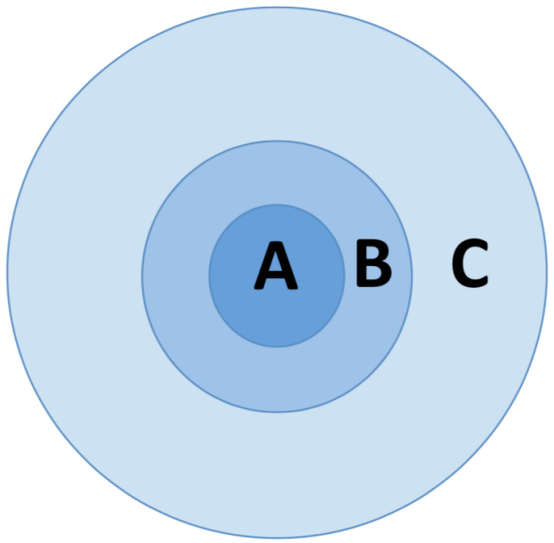


Jet Reconstruction & Isolation Metric

- We look at the pt distribution of trigger cells along clustered jet radius (for particle guns)
- Divide the jet area into three regions:
  - A: R<0.1
  - B: 0.1<R<0.2
  - C: R>0.4
- Assume a uniform distribution of PU jets, the pt sum scaled to area from C measures the PU pt

- **Definition of R_{iso} is the idea borrowed from Owen Long (UC Riverside)**

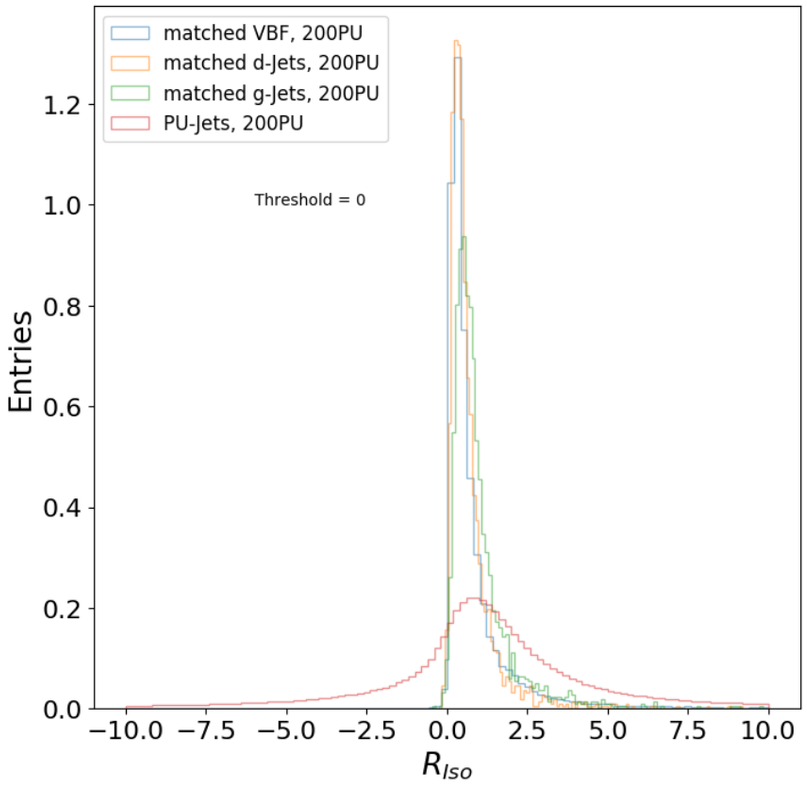




Ratio of energy in B over energy in A.

$$R_{\text{iso}} = \frac{\sum B - (3/12)\sum C}{\sum A - (1/12)\sum C}$$

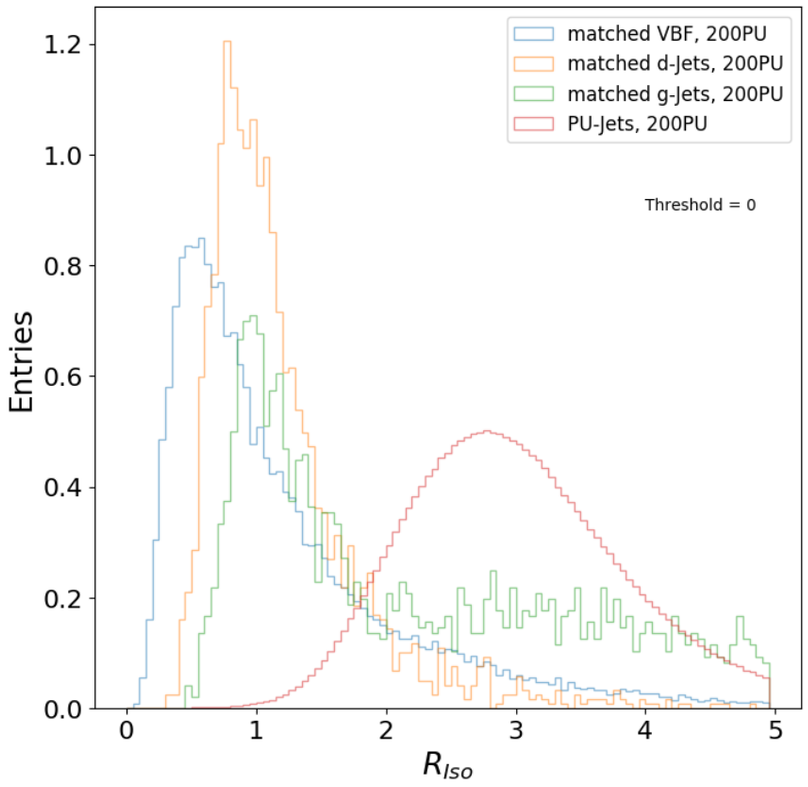
Isolation Metric with and without PU subtraction



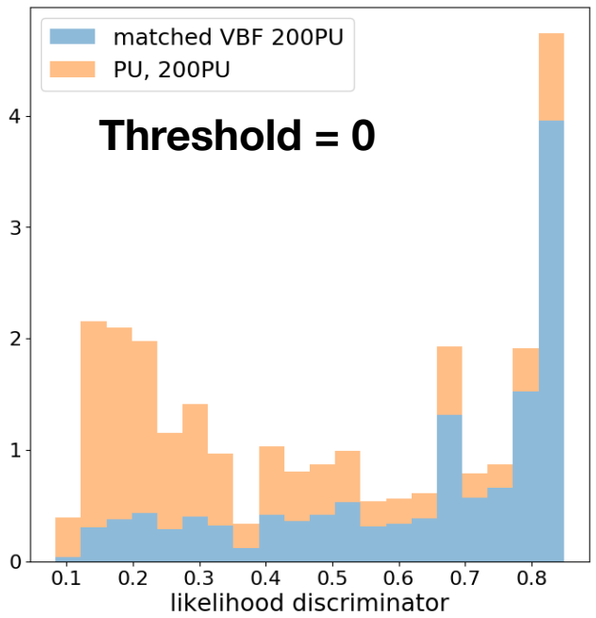
- For 200 PU scenario, we see a large contamination due to PU, for the isolation ratio definition

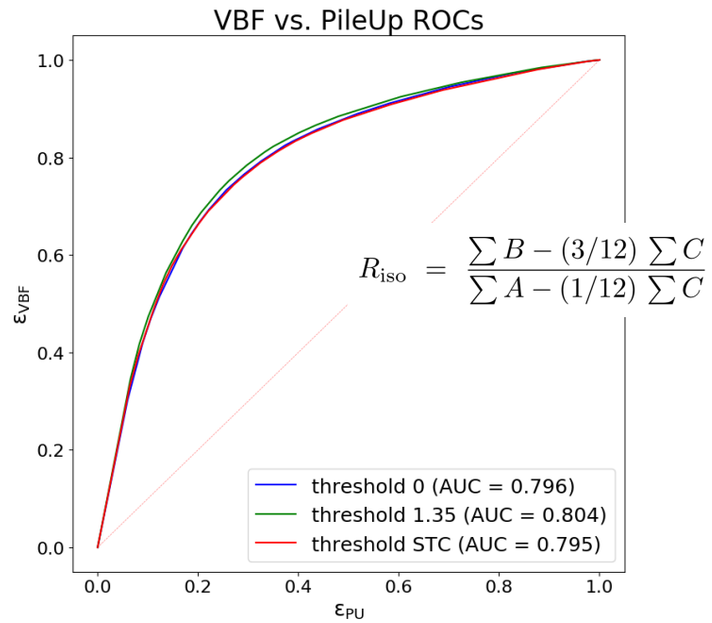
- If we do not perform any PU subtraction, we see a better discriminating power of Riso with the following definition

$$R_{iso} = \frac{\sum B}{\sum A}$$



Discriminant and ROC

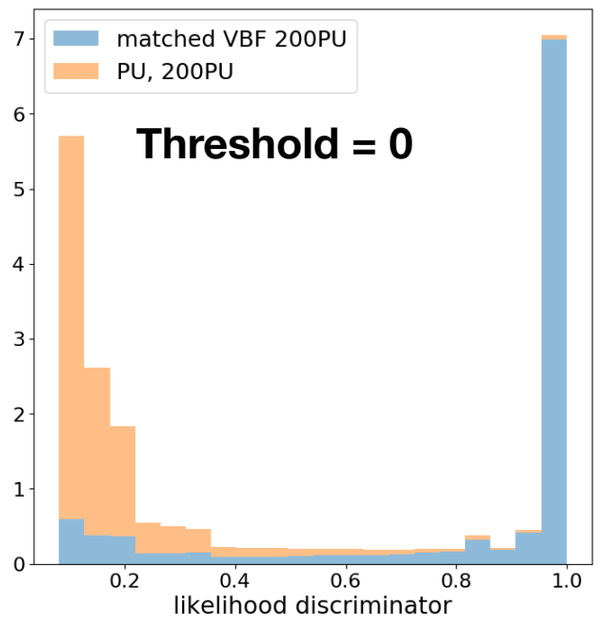


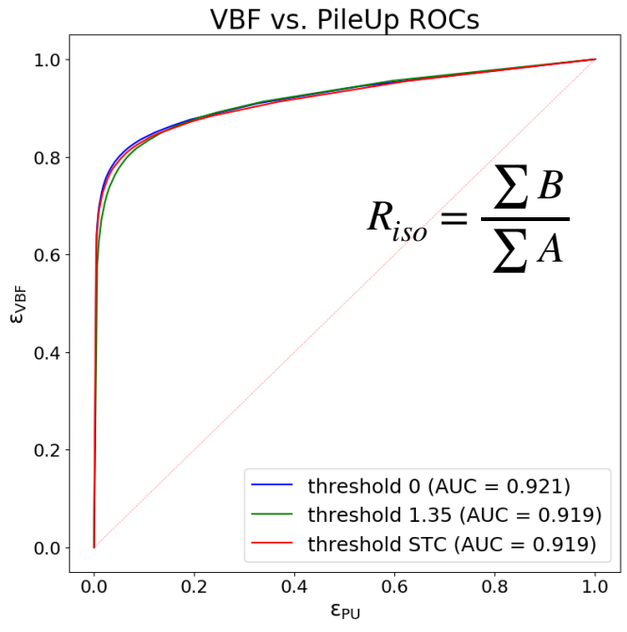


$$R_{\text{iso}} = \frac{\sum B - (3/12)\sum C}{\sum A - (1/12)\sum C}$$

- Likelihood discriminant is defined by taking the sig/sig+bkg. bin by bin
- From the liklihood, we compute ROC, by taking VBF as signal and PU as background
- With PU subtraction, we see poor discrimination power as compare to the plots below with no PU subtraction

- ~10% improvement in the ROC, when Riso is defined without any PU subtraction



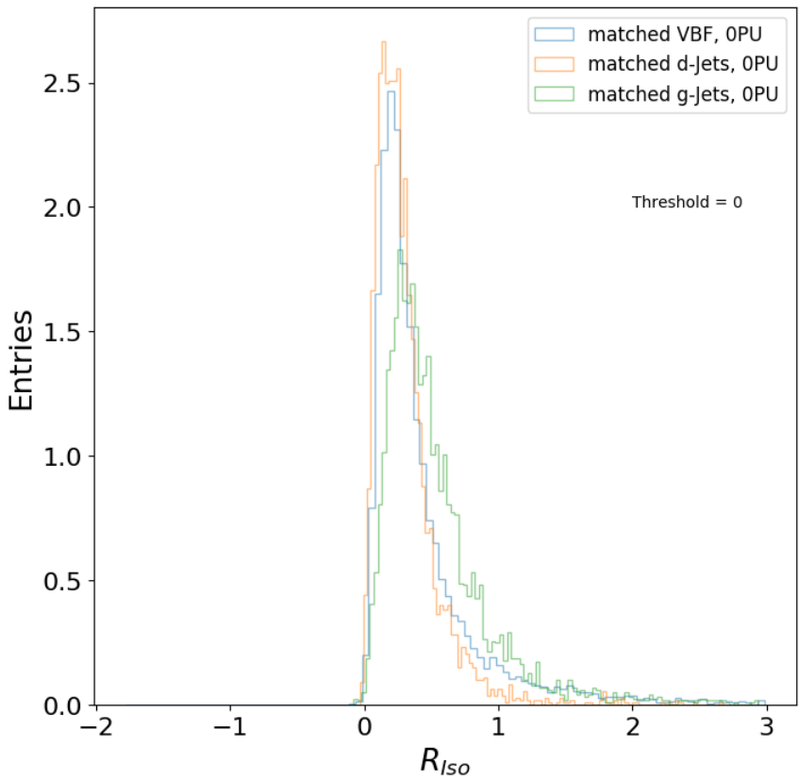


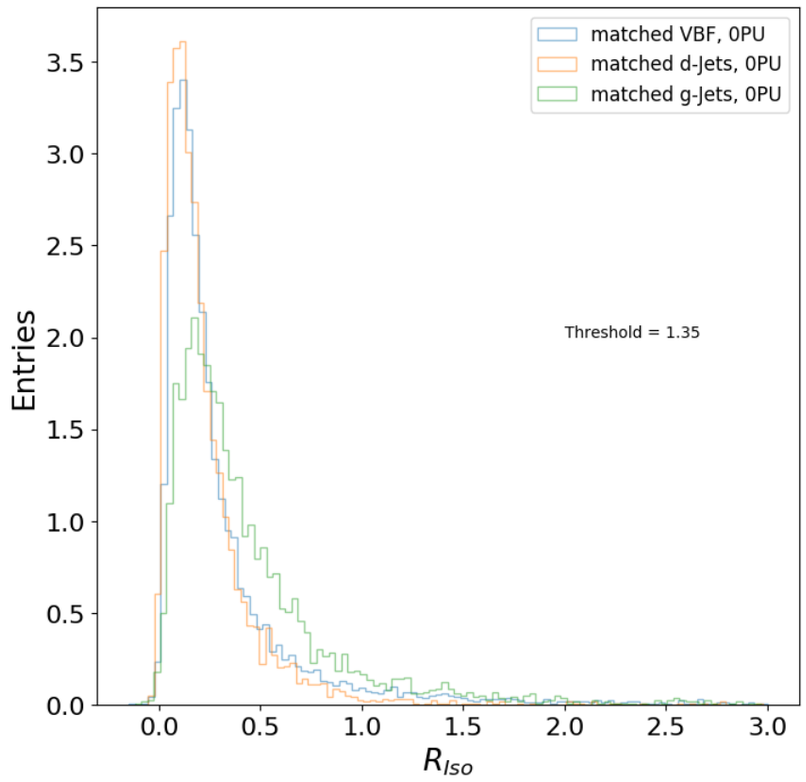
$$R_{iso} = \frac{\sum B}{\sum A}$$

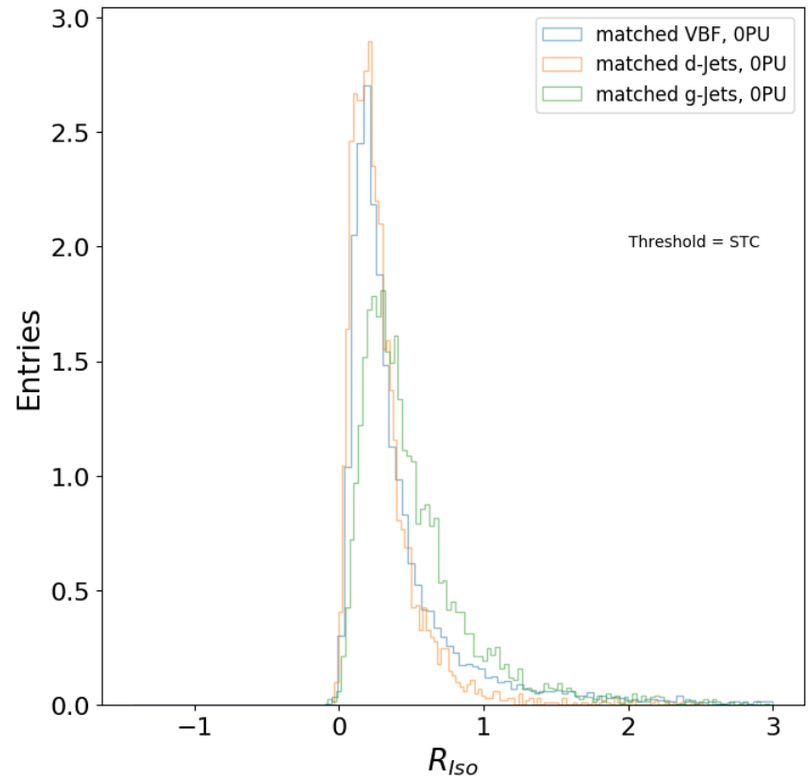
Summary

- We have a preliminary discriminating power of of the isolation ratio and the results look encouraging
- We are checking with particle gun samples (some of the studies in backup) and the likelihood discriminators and also with different trigger selections like mipt and STC

BACKUP0 PU Isolation



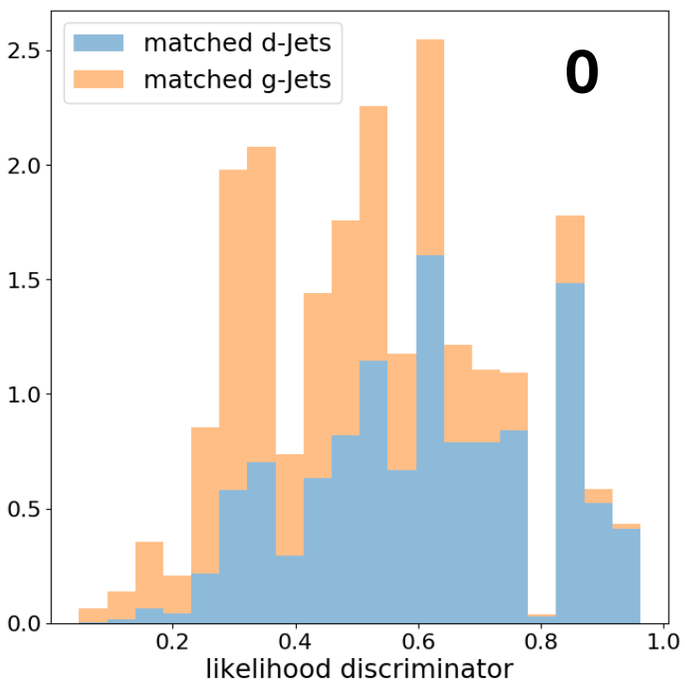


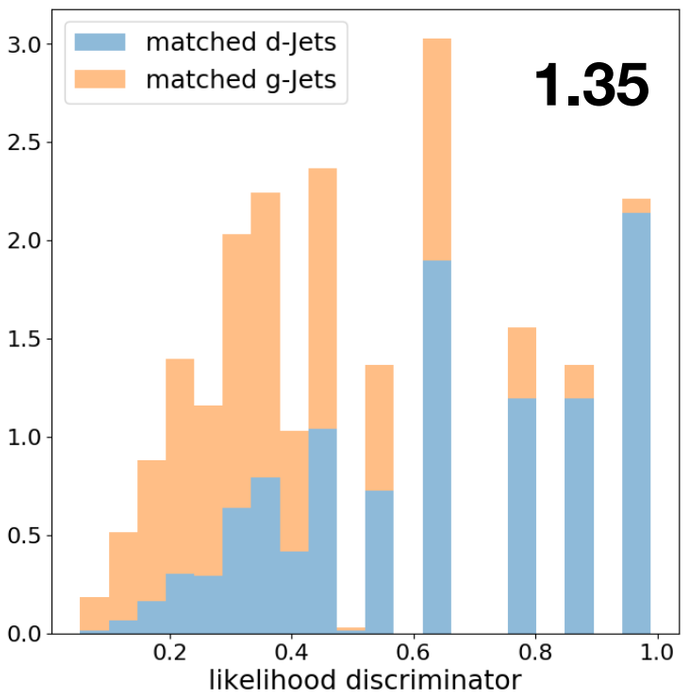


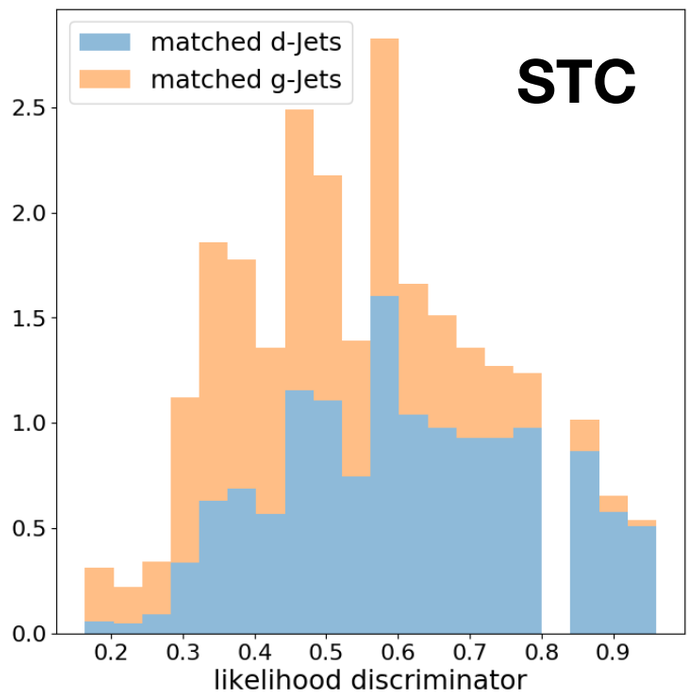
$$R_{Iso} = \frac{B - \frac{3}{12}C}{A - \frac{1}{12}C}$$

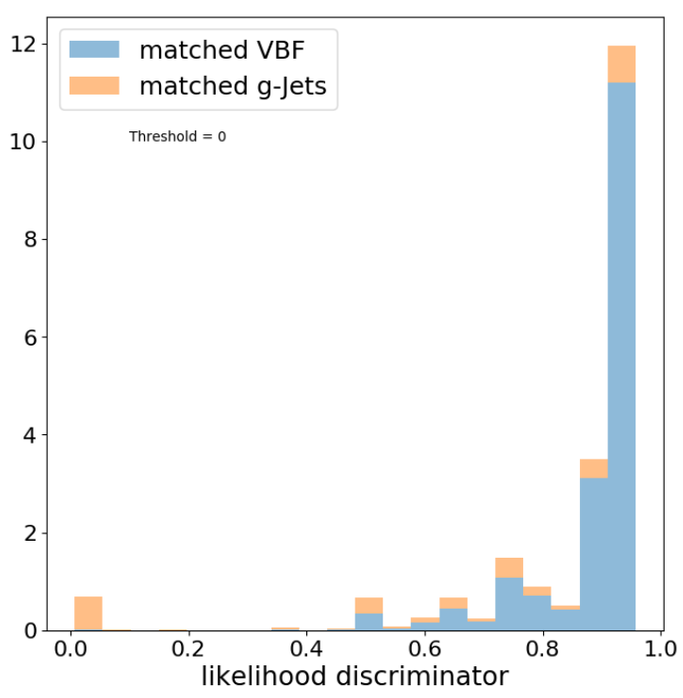
BACKUP

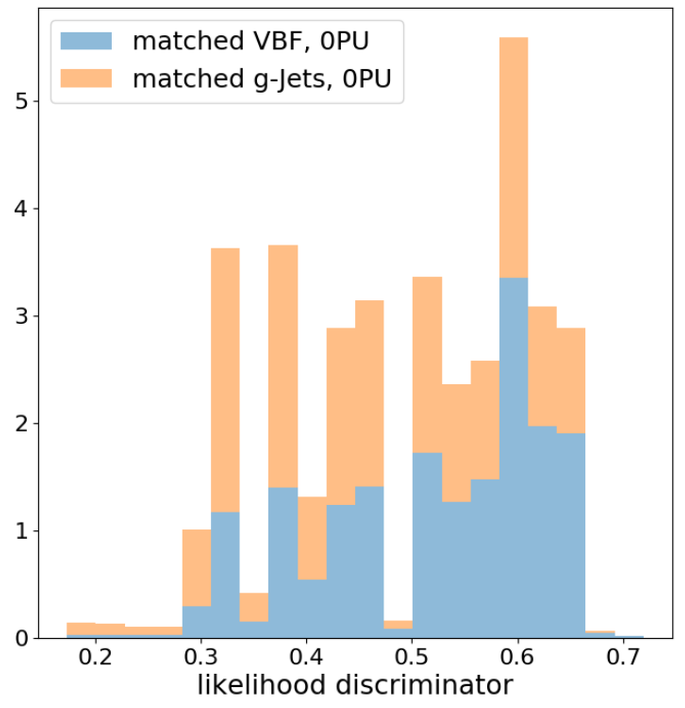
0 PU likelihood and ROCS

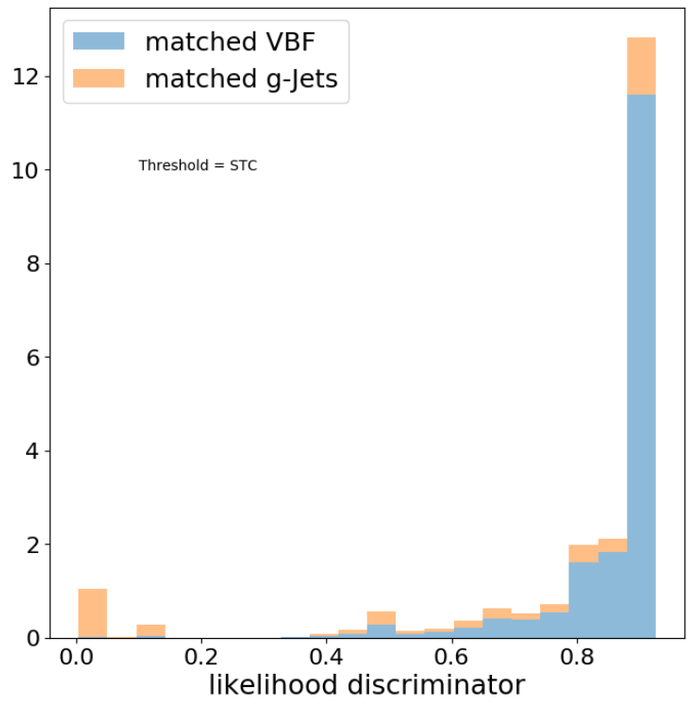






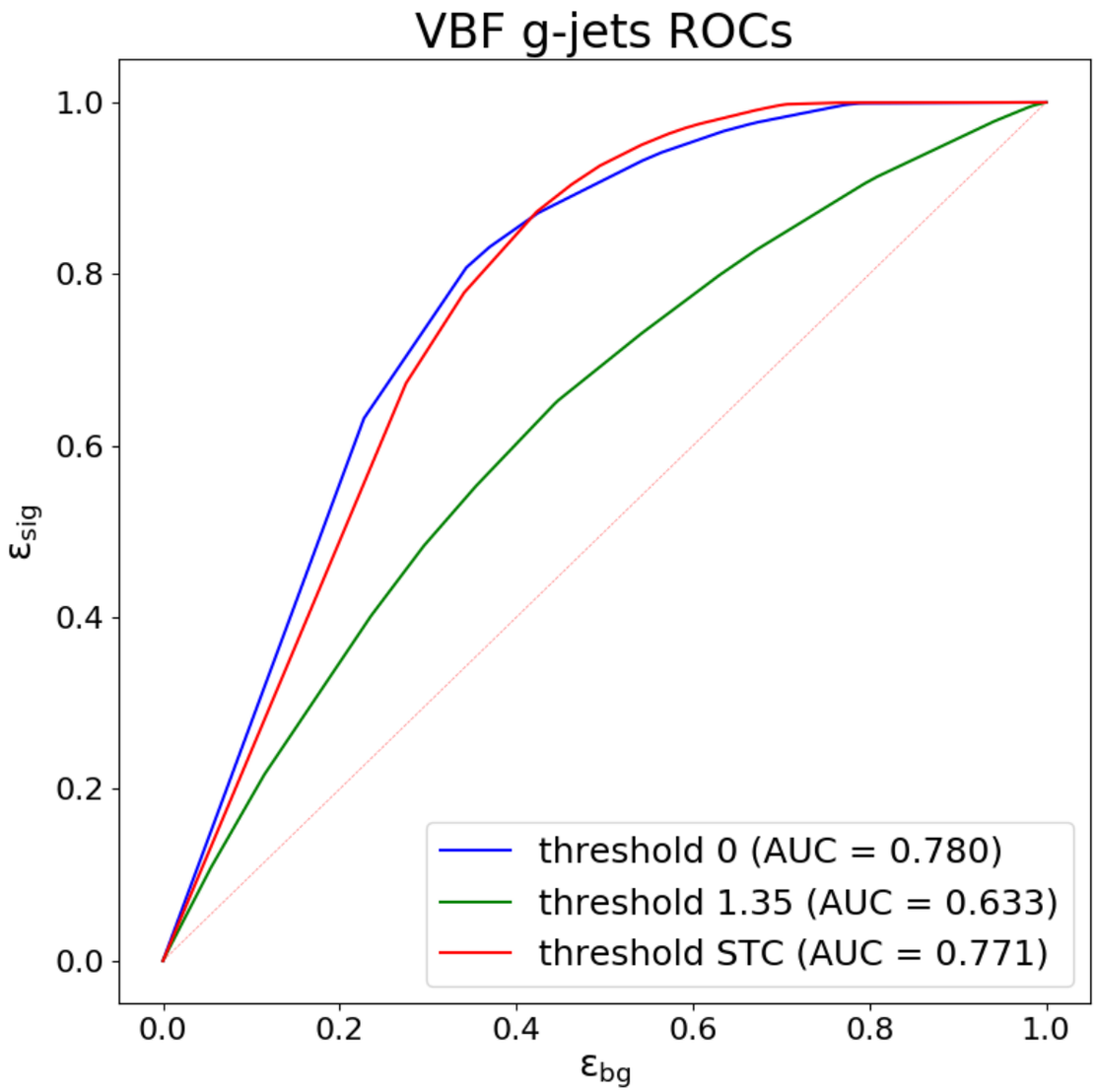


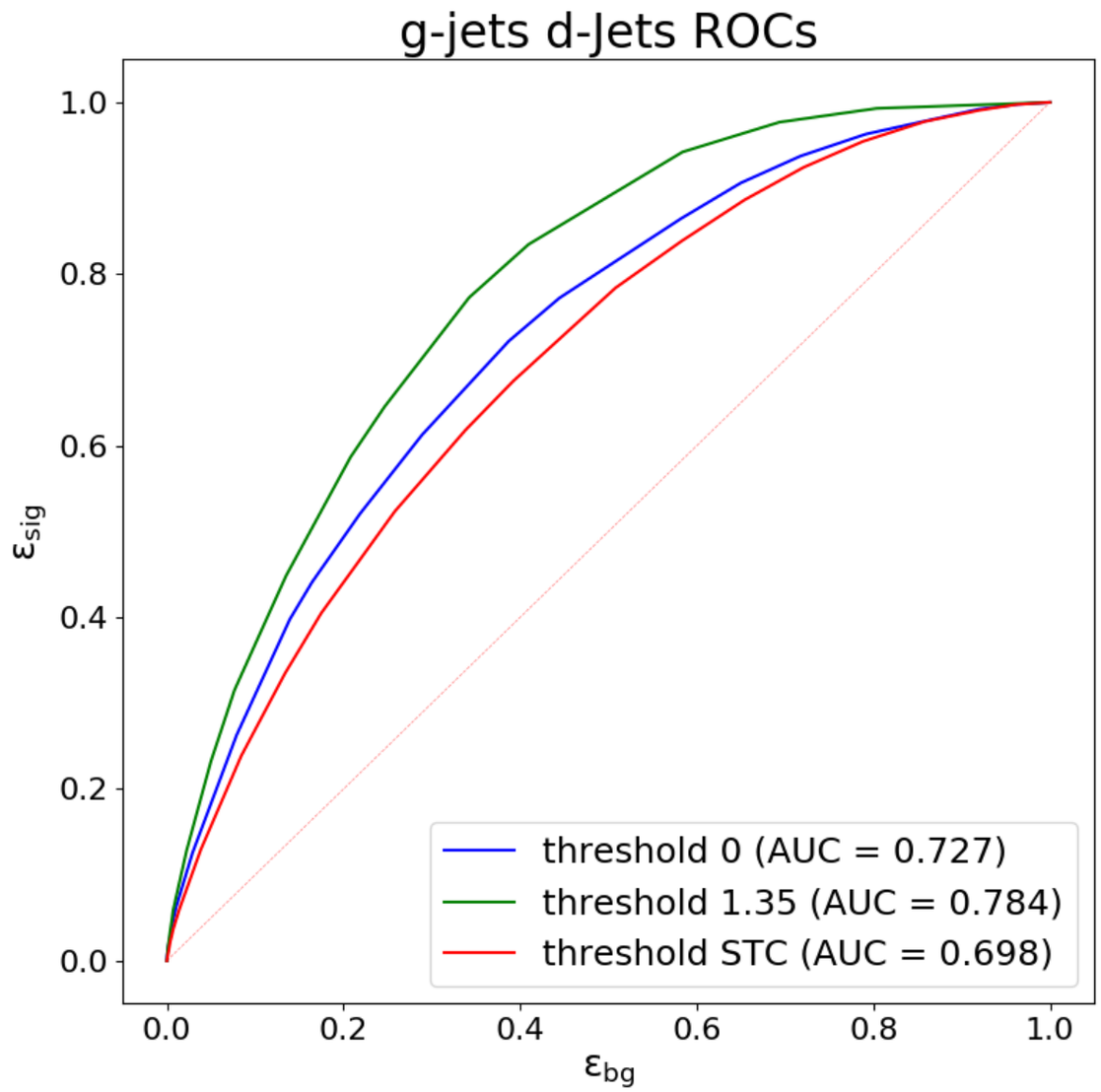




BACKUP

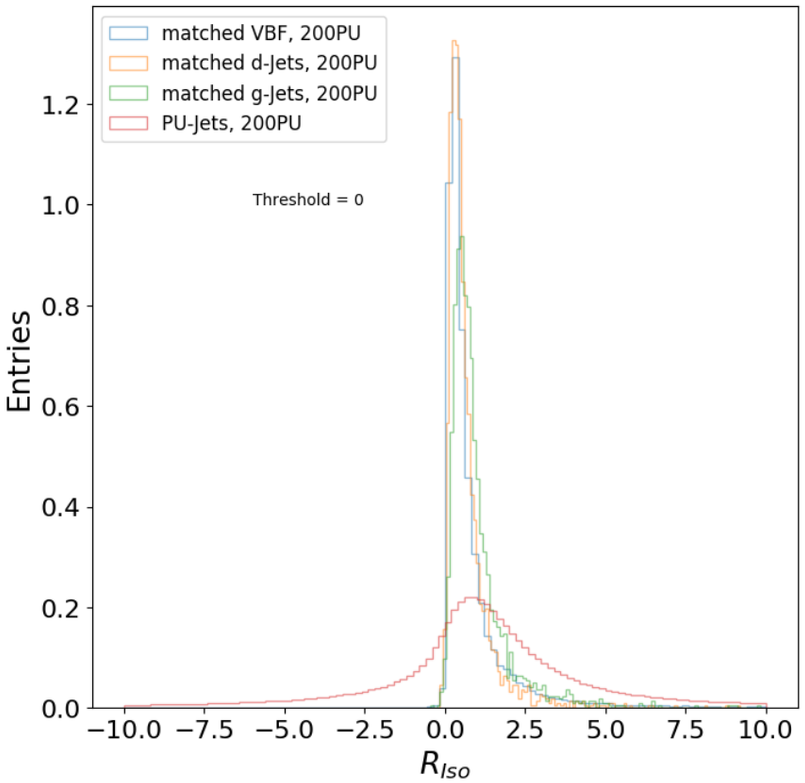
0 PU ROCS

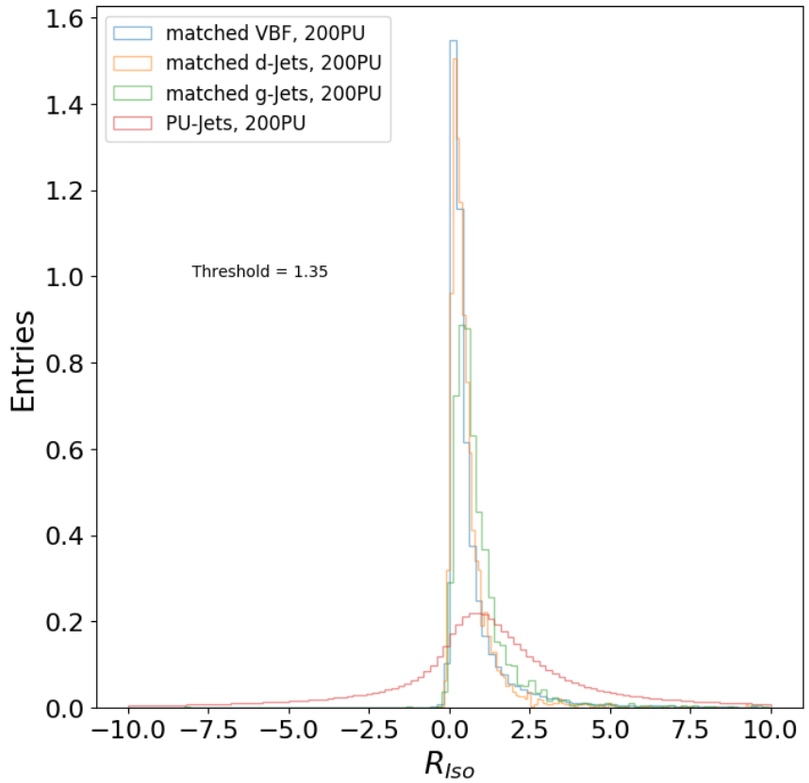


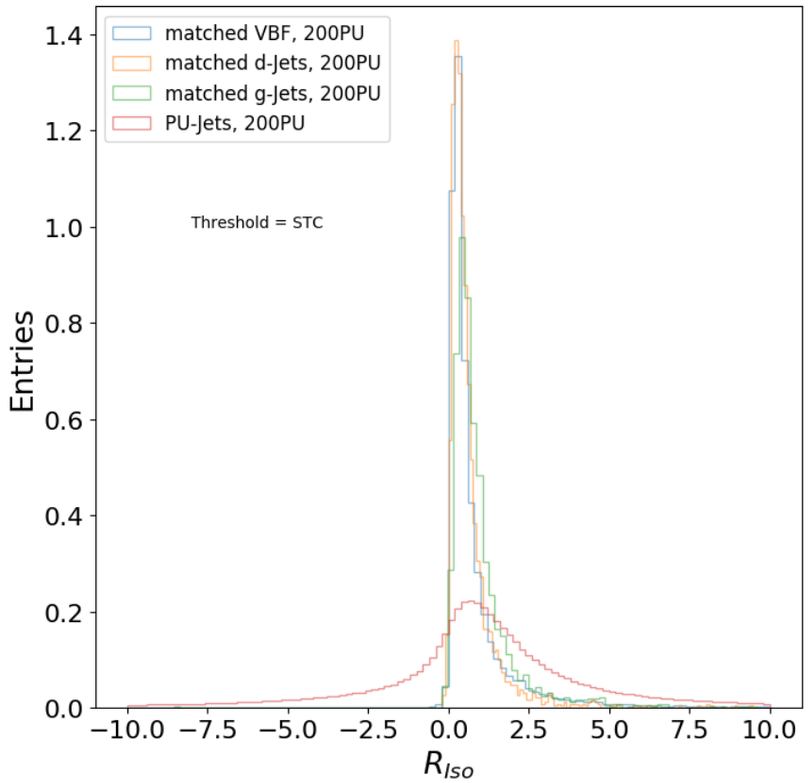


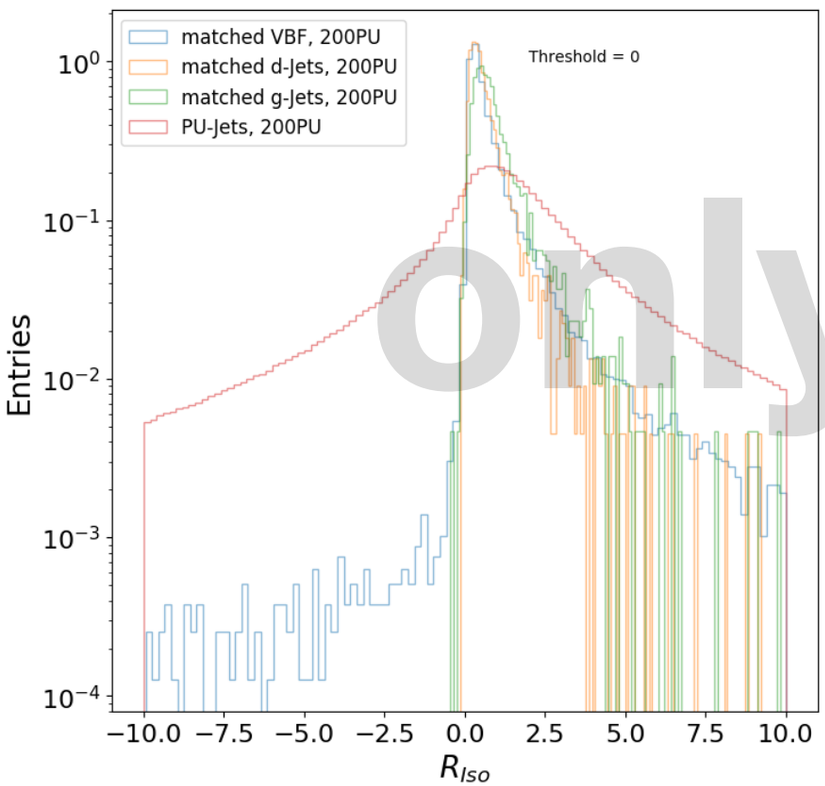
BACKUP

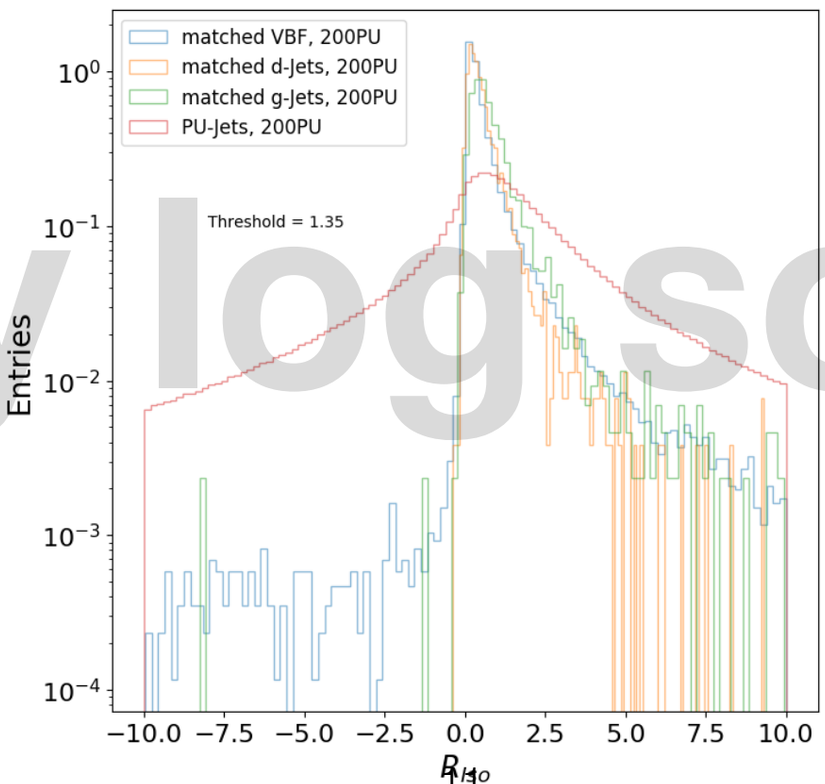
200 PU Isolation

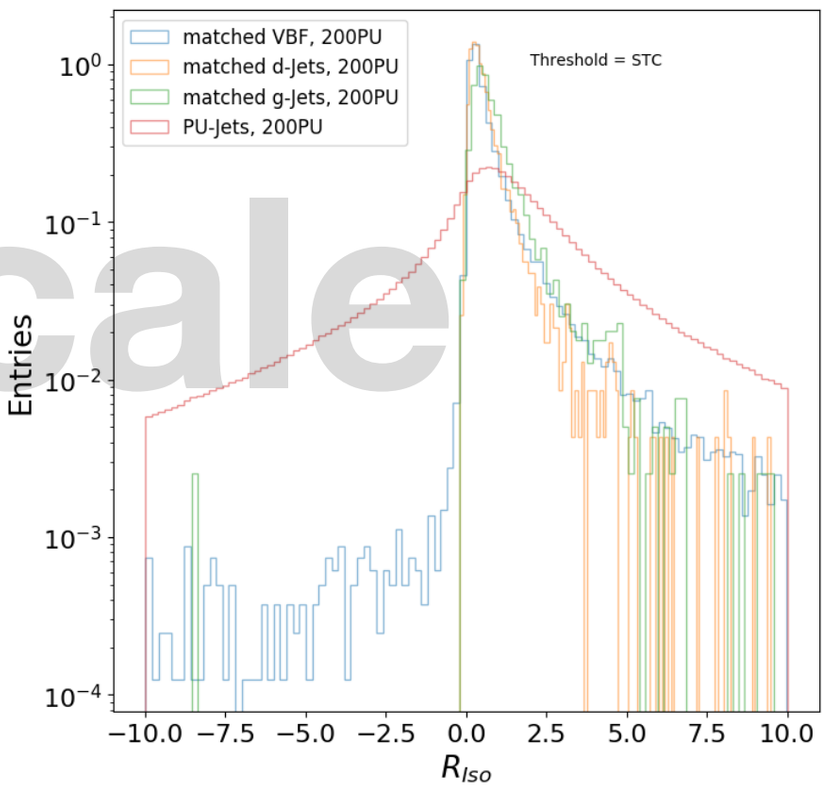






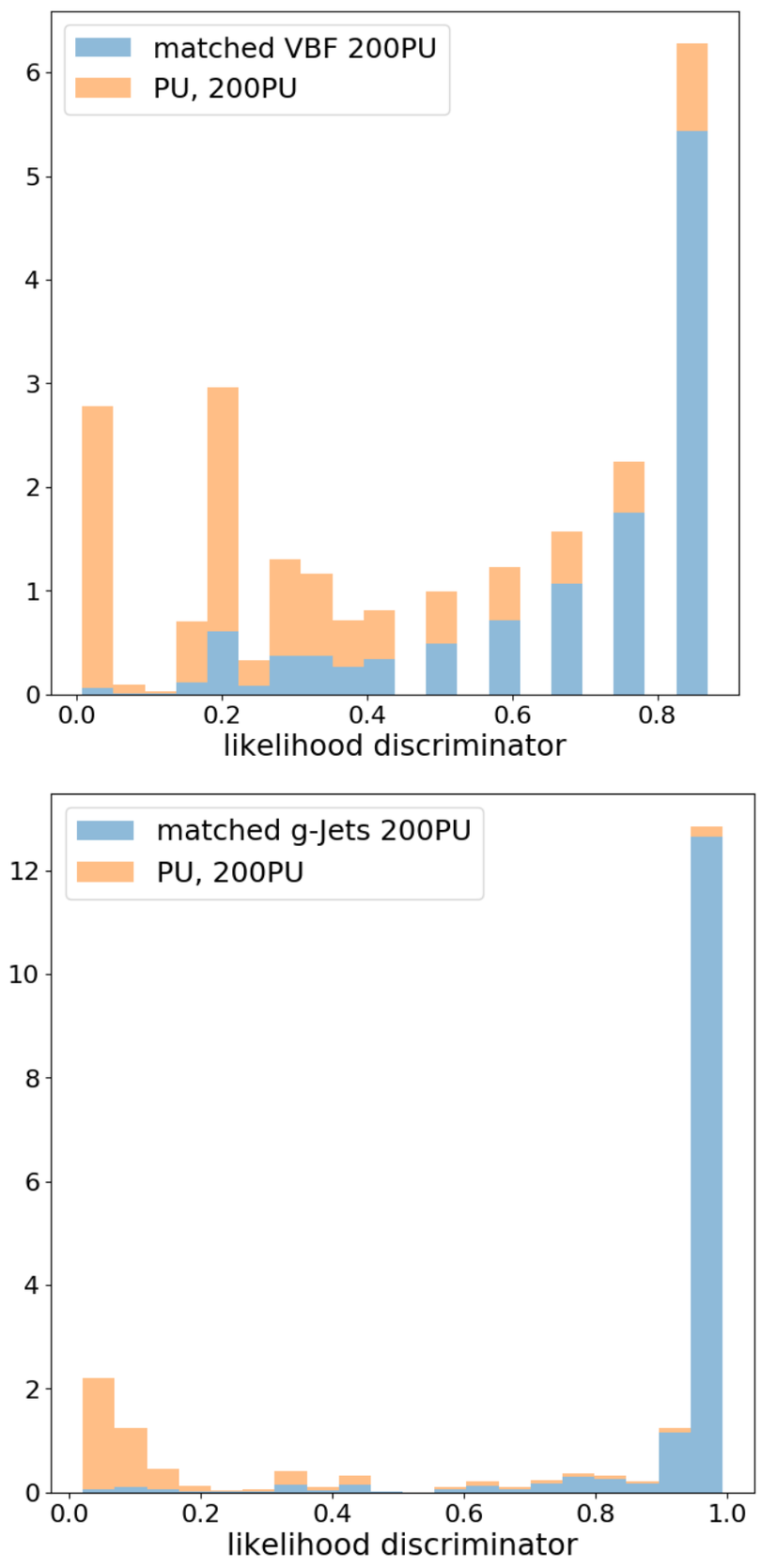


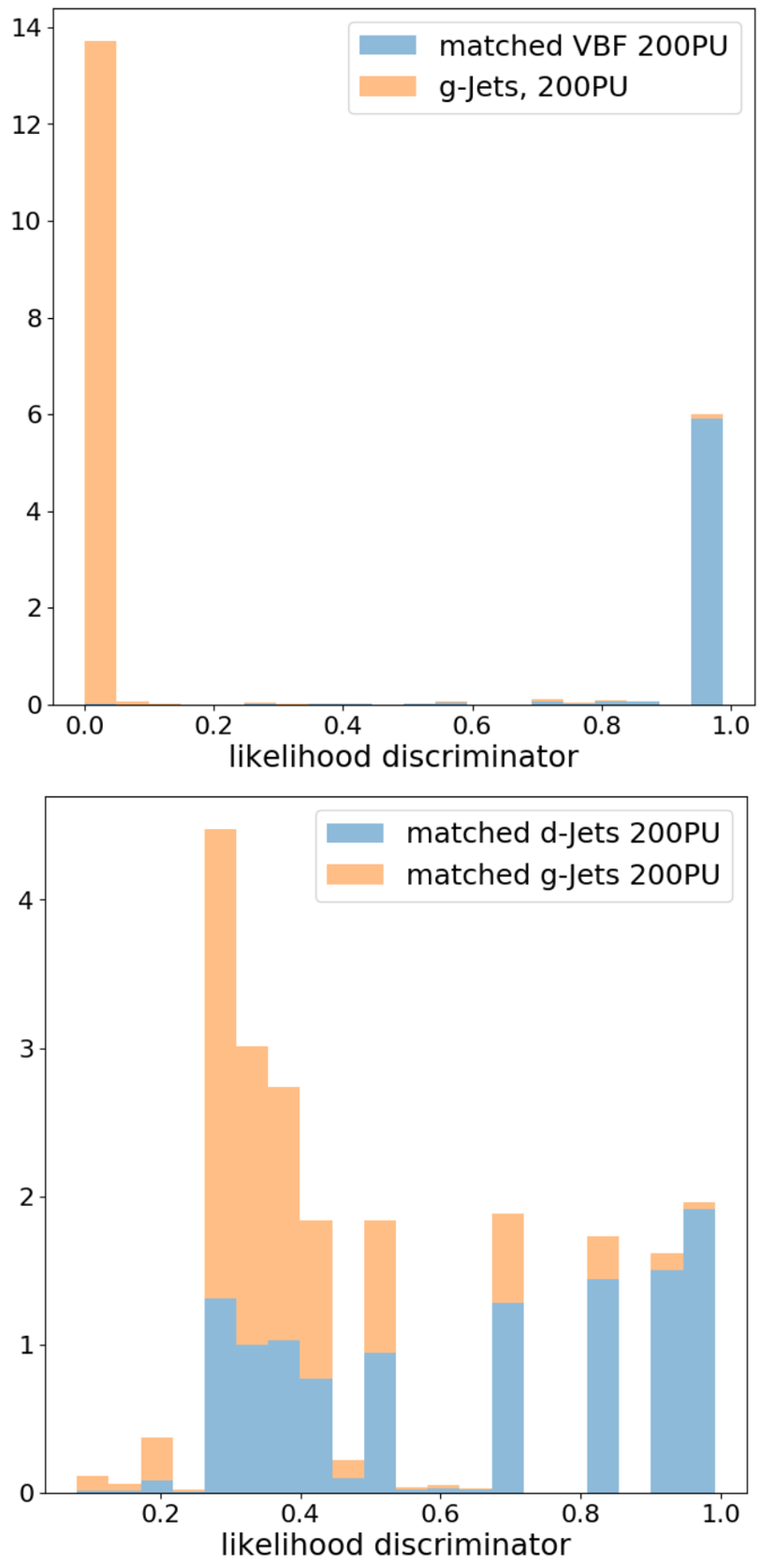




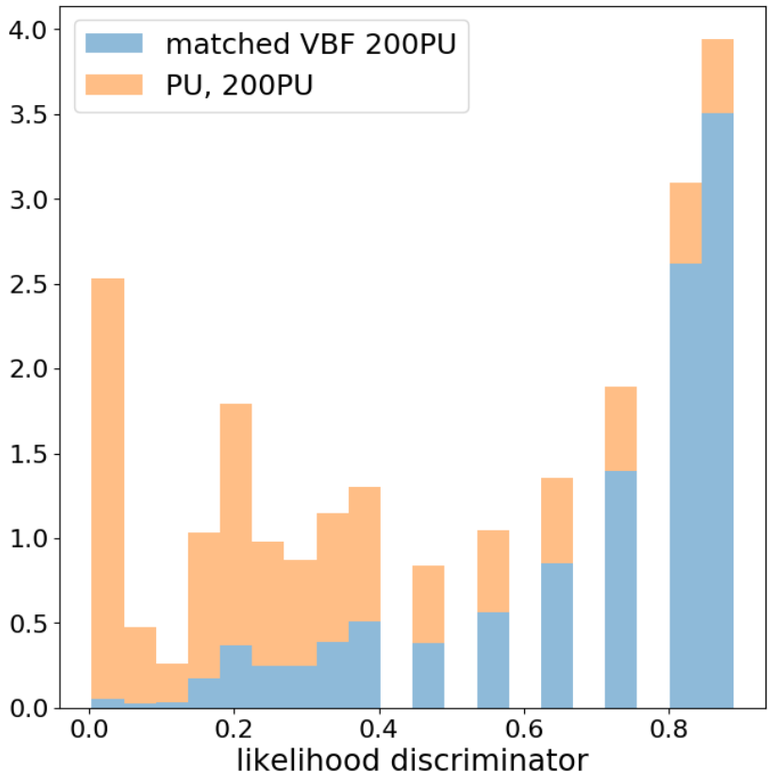
only log scale

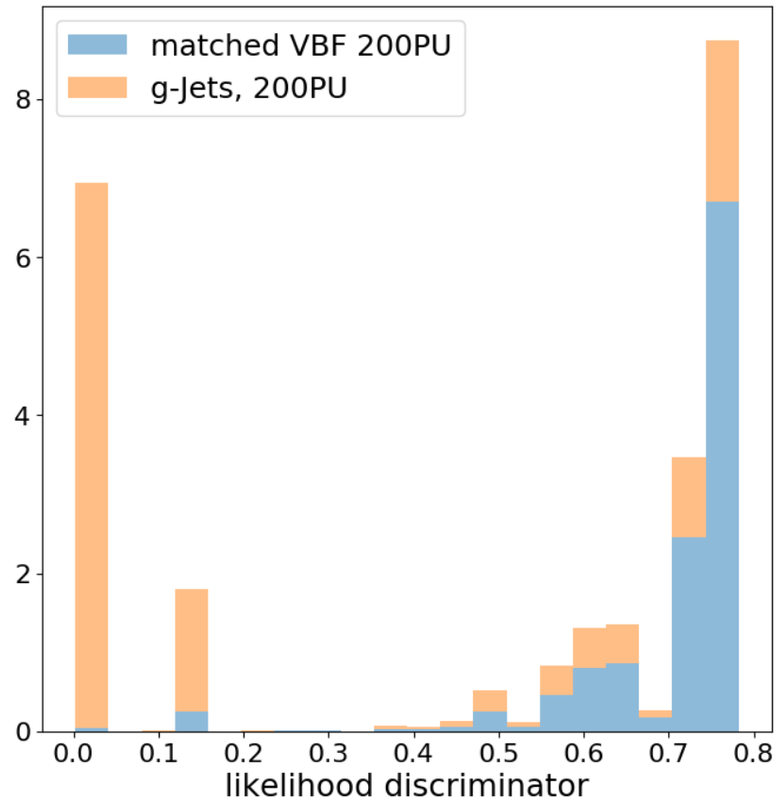
BACKUP Likelihood and ROCS:Threshold 0

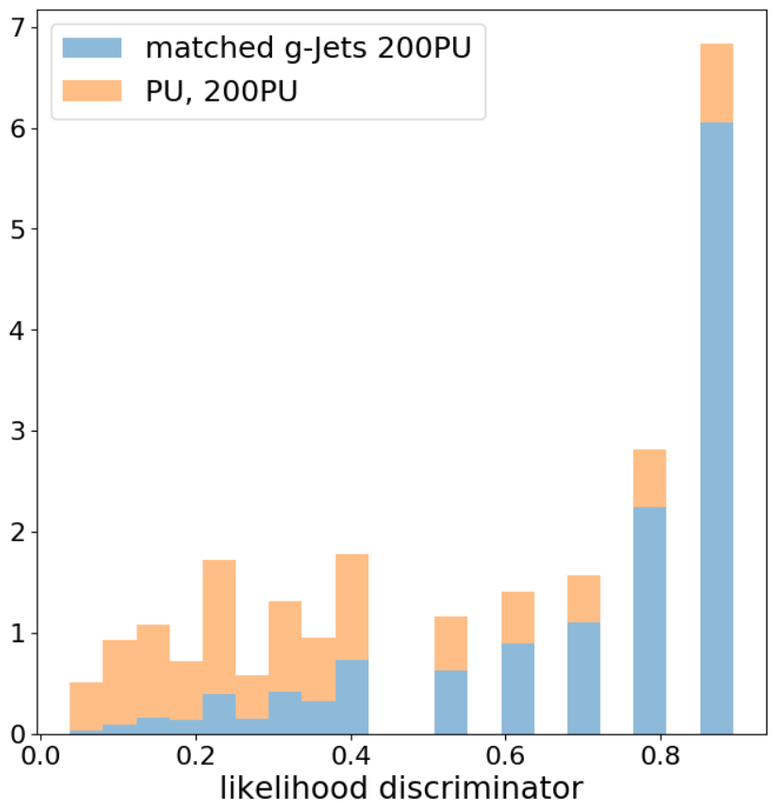


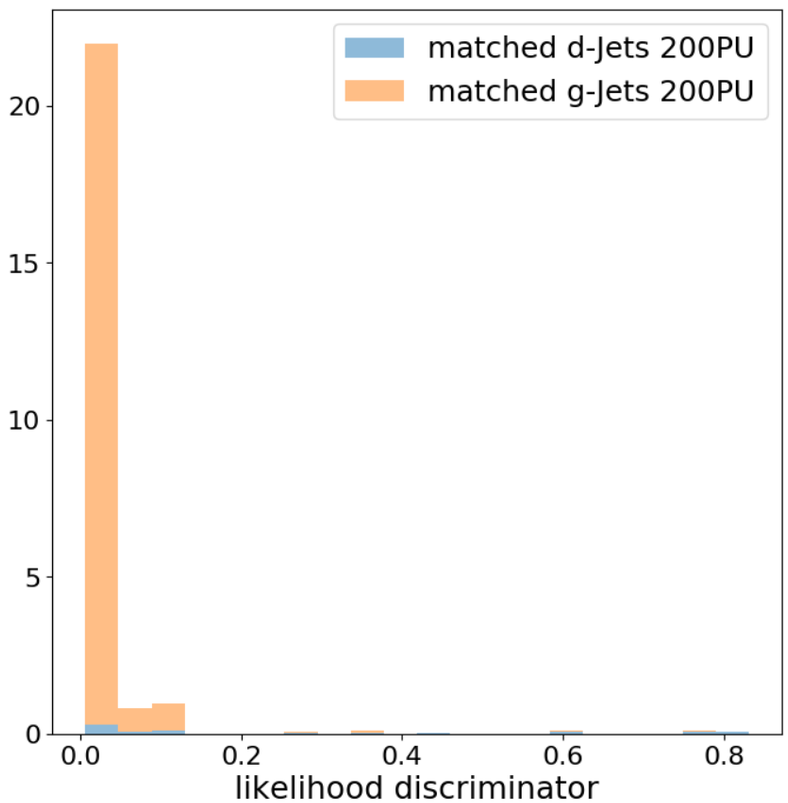


BACKUP Likelihood and ROCS:Threshold 1.35

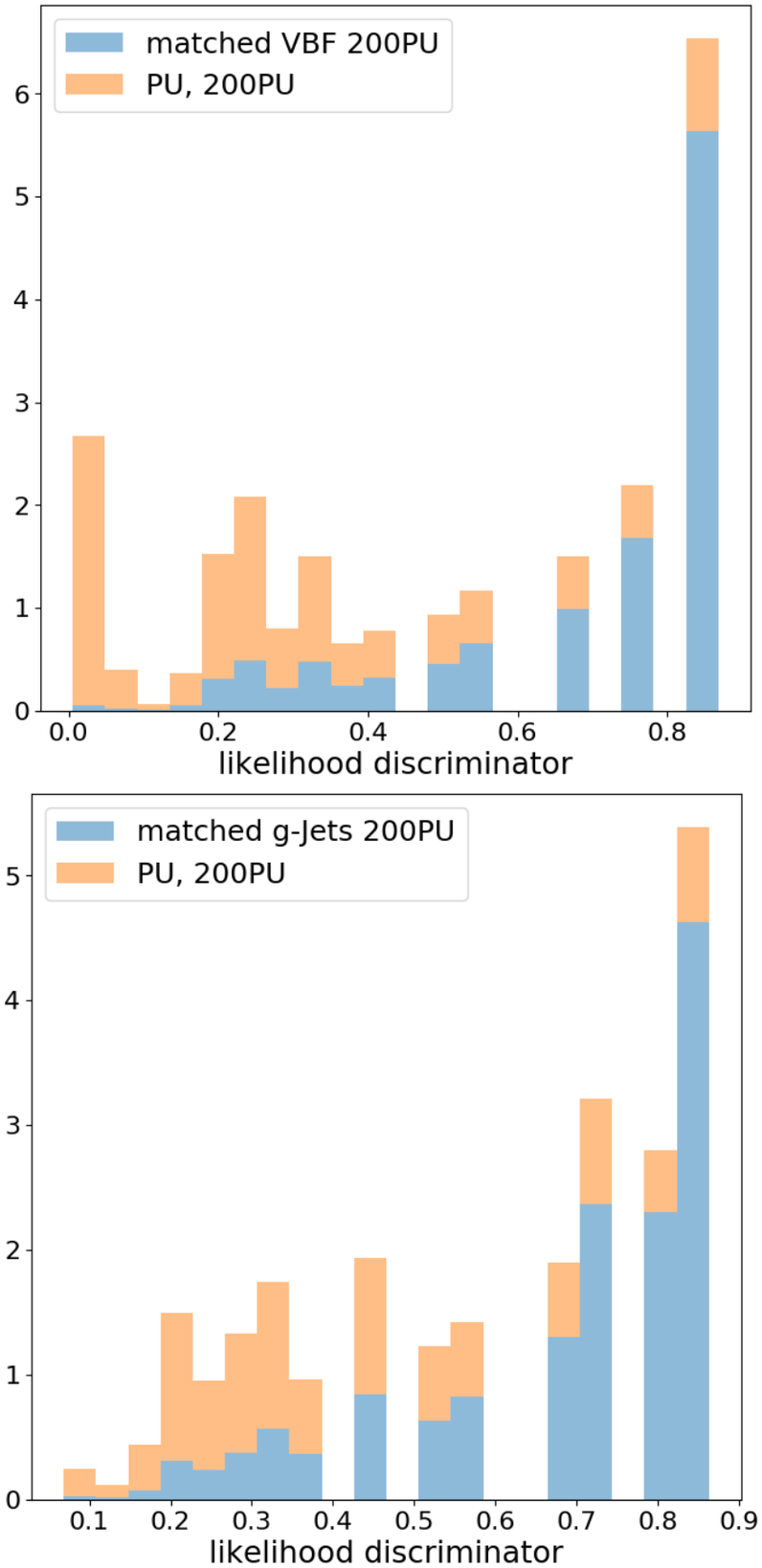


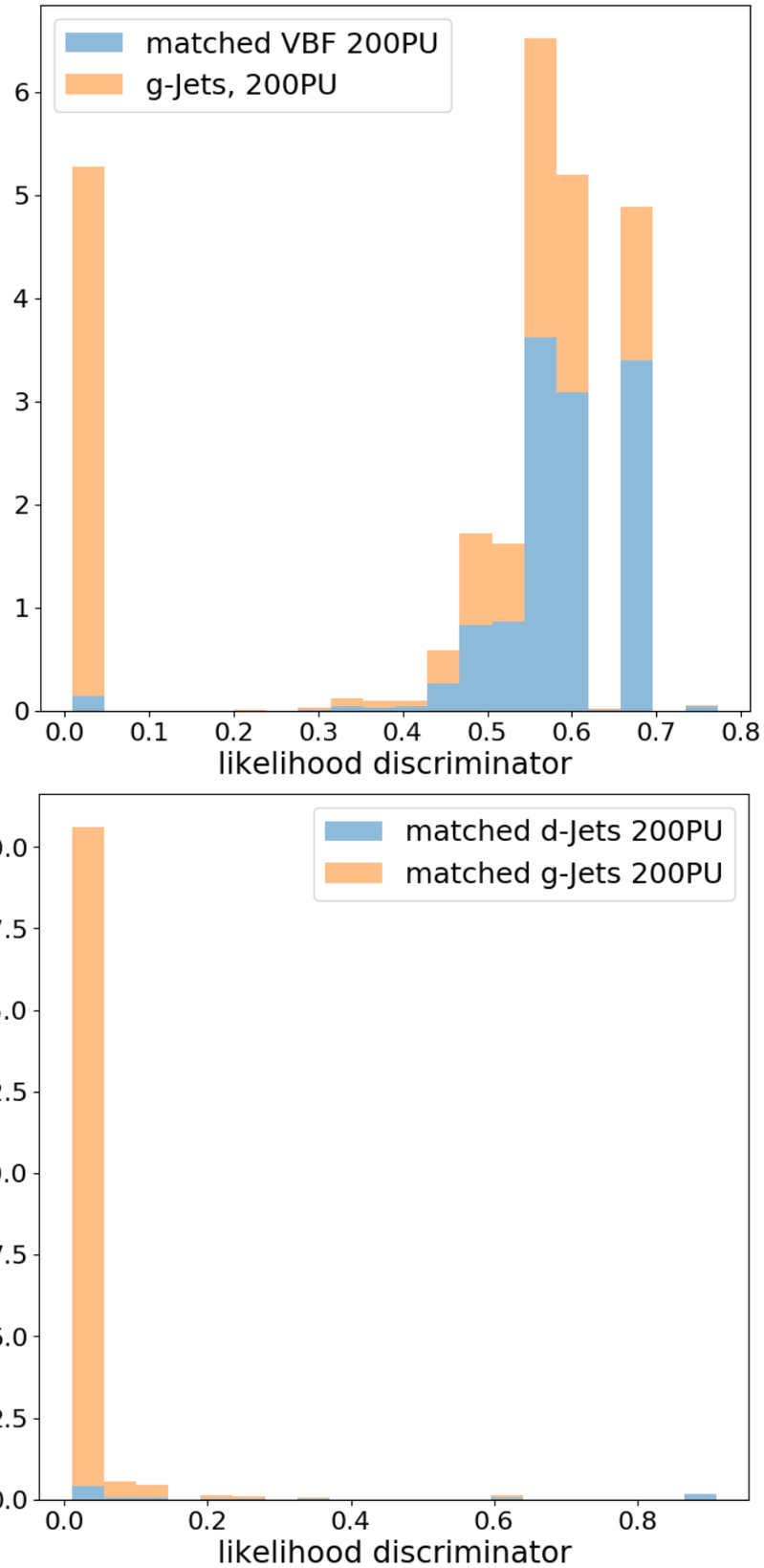
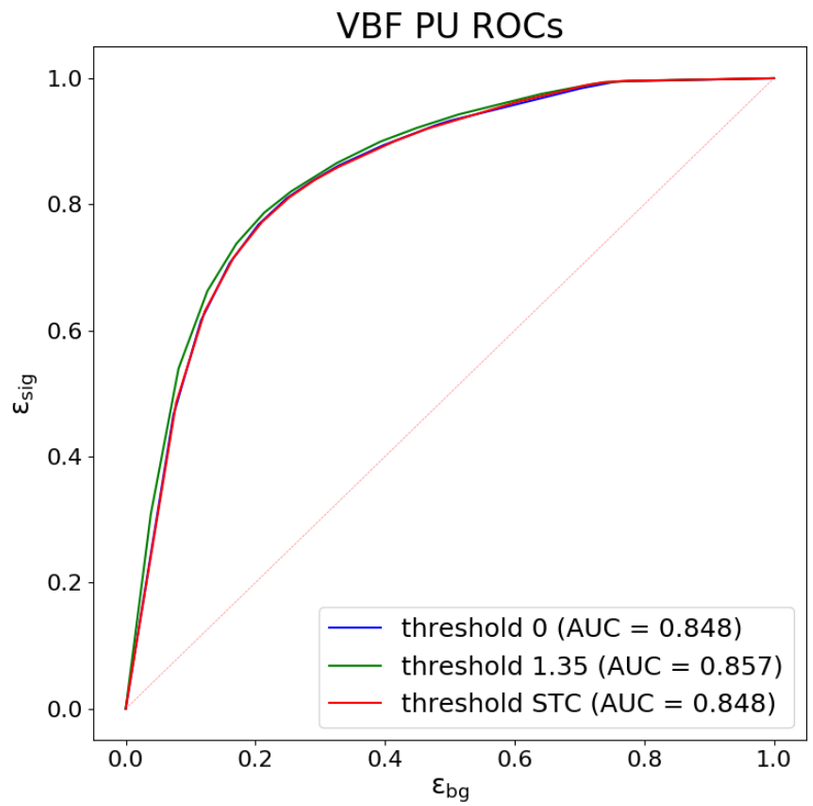
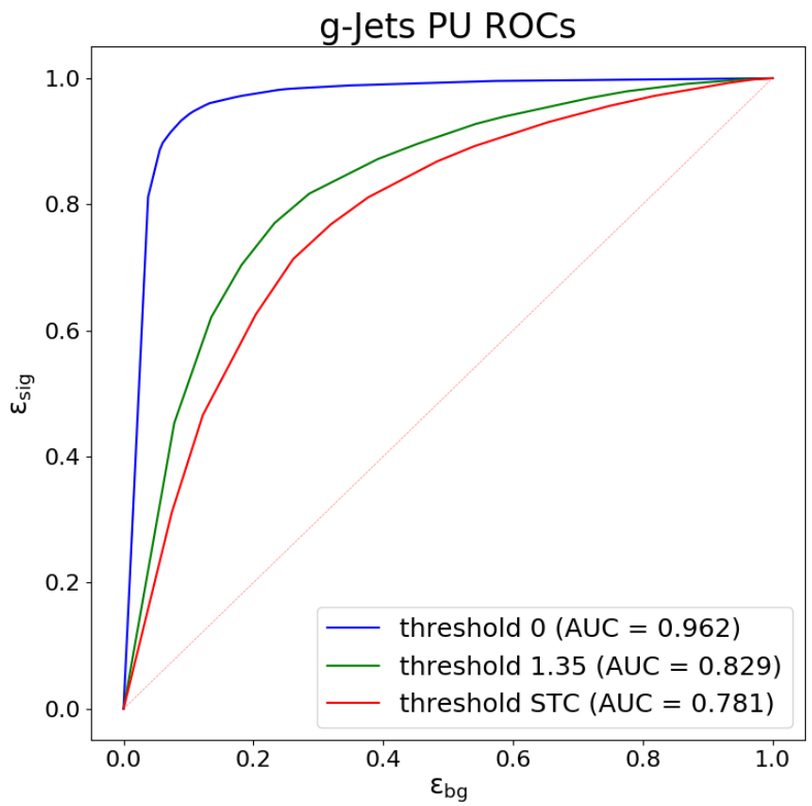
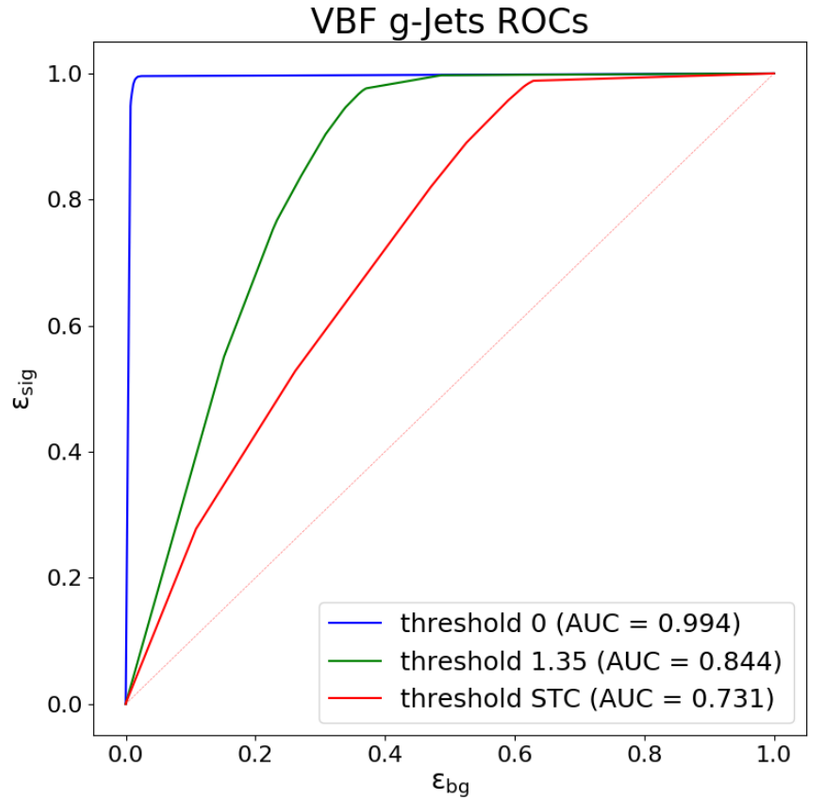
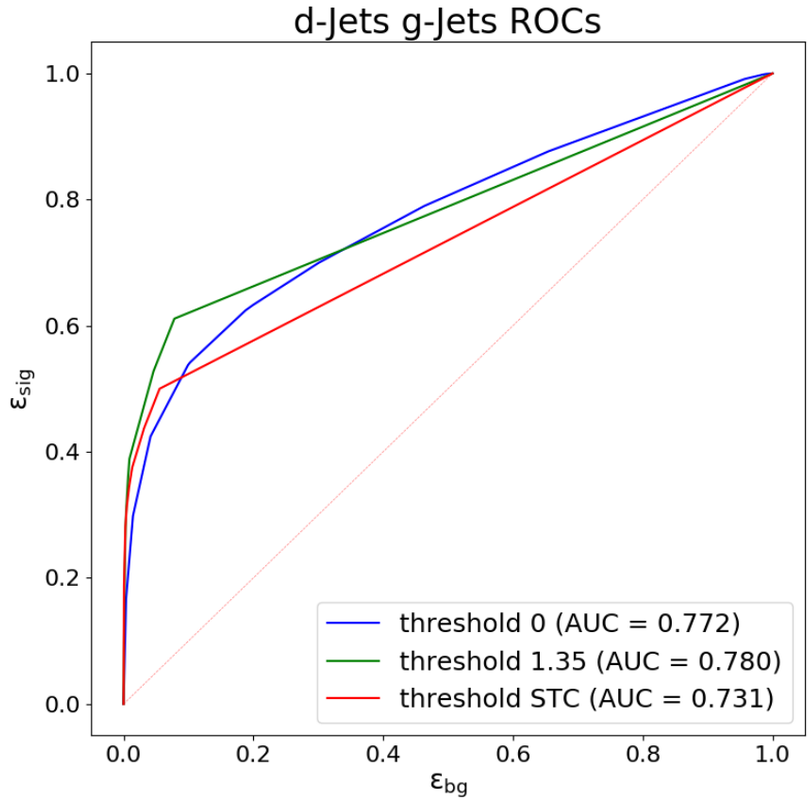






BACKUP Relihood and ROCS:Threshold STC





BACKUP 200 PU ROCS