Regression: Variable Angle Sample and Cleaning

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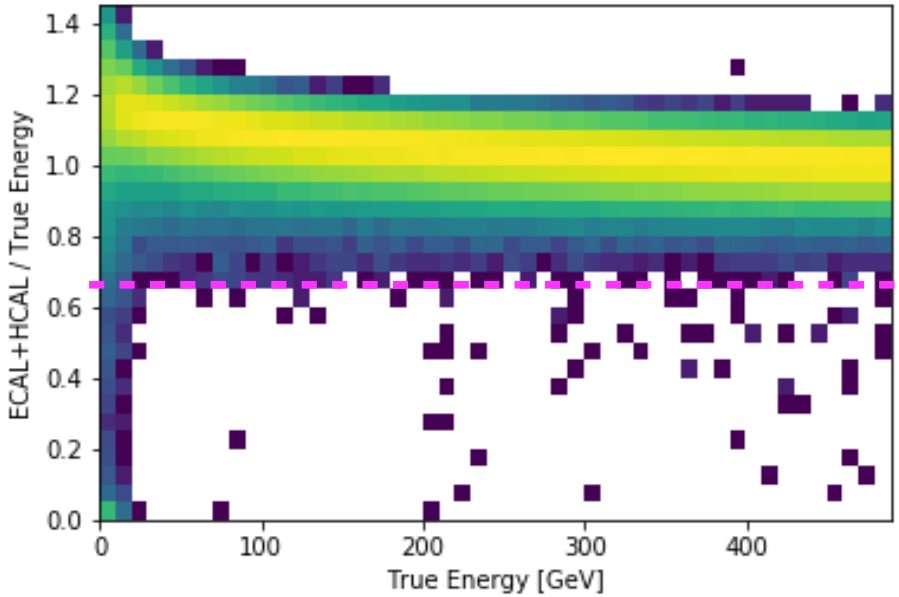
Overview

- Last week showed that outliers are affecting Variable Angle regression resolution results
  - Using simple RMS, sensitive to outliers
- This week: motivate and show final cleaning prescription
- Also show regression results vs eta

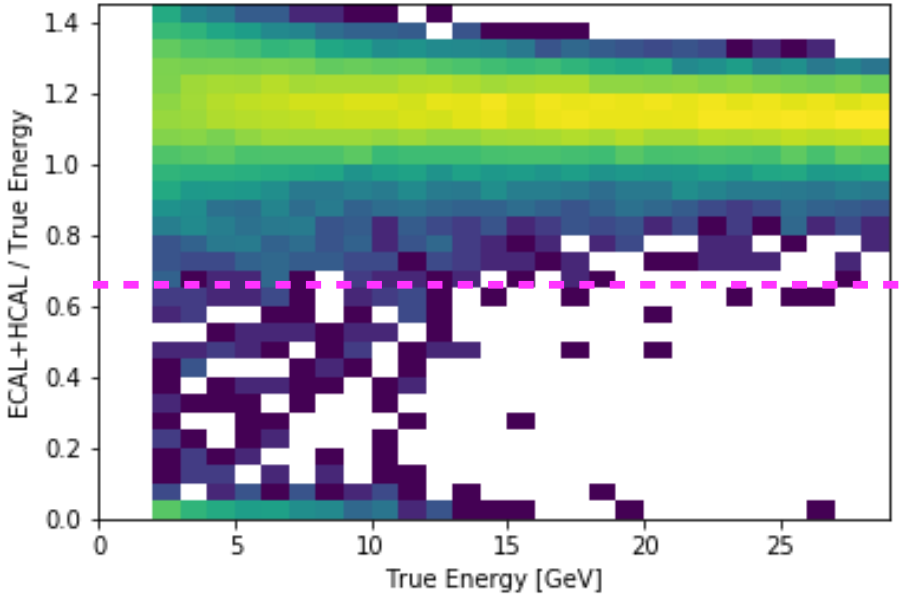
Reco / True Energy

- See small fraction of electrons where ECAL+HCAL energy within selected window is a small fraction of true E
  - More pronounced at low E
- Propose to cut at 0.66
  - Removes 0.08% of events overall, 0.5% at lowest E

All energies



Zoom on low energy



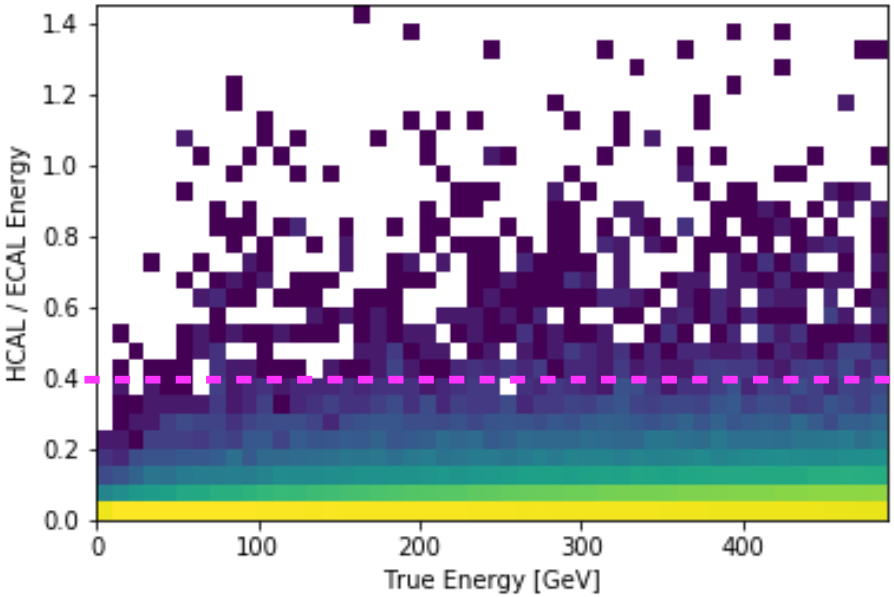
Log color scale

Variable Angle Electrons

HCAL / ECAL Energy

- After Reco/True cut, still see some high energy electrons where H/E is quite large
  - Would be anyway removed in any analysis selection
- Propose loose cut of H/E < 0.4
  - Removes about 0.1% of electrons overall

All energies

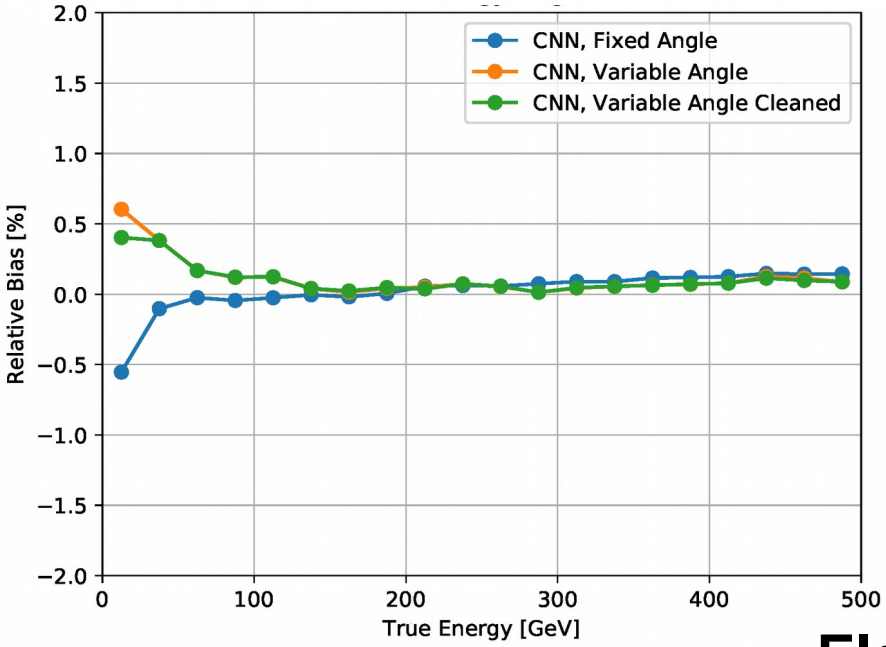


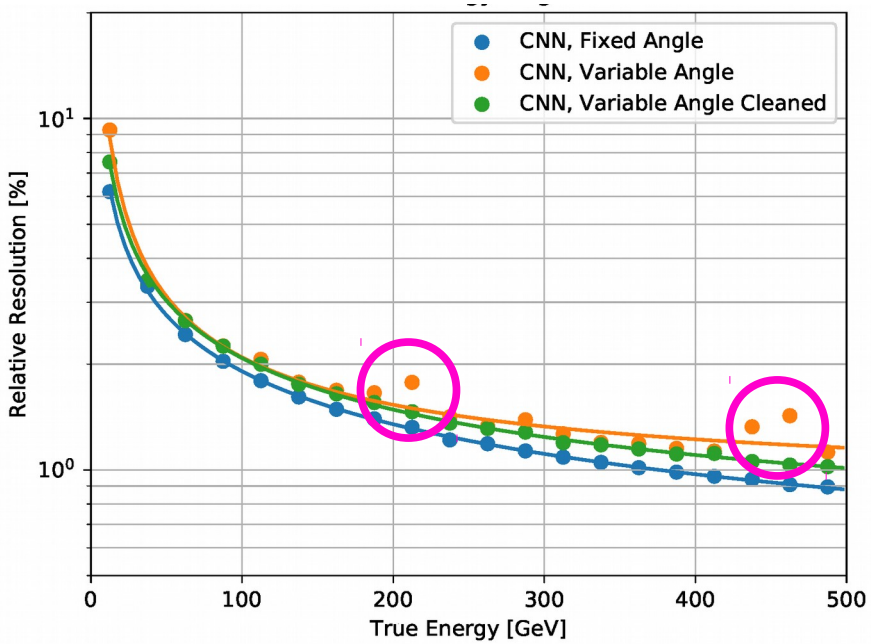
Log color scale

Variable Angle Electrons

Regression Results

- Smooths regression results at high Energy
- Variable angle performance is now close to Fixed angle





Electrons

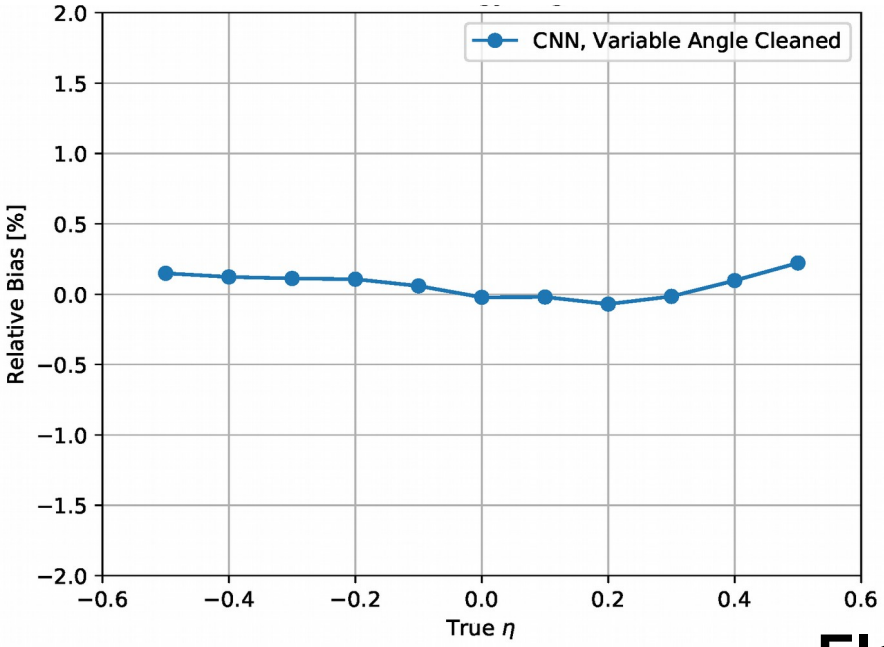
Cleaning Summary

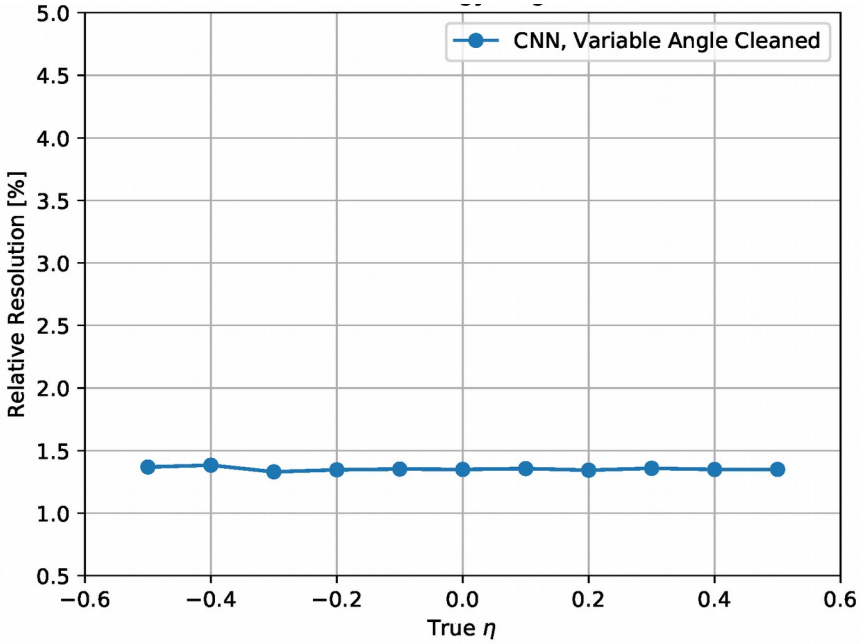
- Proposed cleaning cuts for Electrons, also Photons, Pi0s:
  - (ECAL_E + HCAL_E) > 0.66 * energy
  - HCAL_E / ECAL_E < 0.4
- Removes:
  - 0.2% overall for electrons
  - 0.6% overall for photons and pi0s
- Only applying for result plots at this time, not training
  - Would need to modify data loader in Triforce to deal with variable length input samples

- Not sure yet for charged pions
  - Fixed angle: was using (ECAL_E + HCAL_E) > 0.3 * energy
    - Removes around 0.2% in fixed, 1% in variable angle samples
  - Much wider spread of energies, so tighter cuts remove larger fraction of events

Regression vs Eta, E > 100

- Bias flat to ~0.3% with eta, resolution even flatter

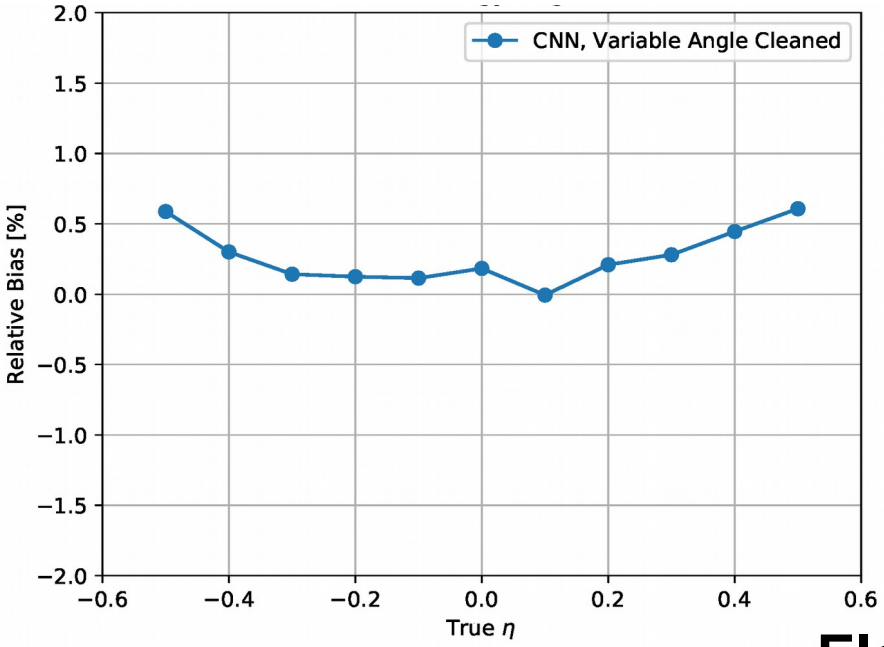


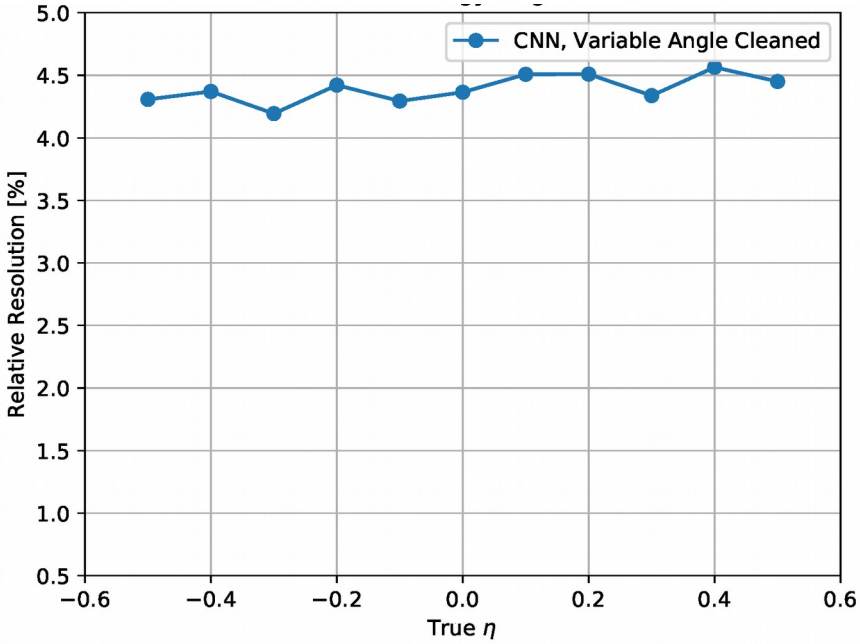


Electrons

Regression vs Eta, E < 100

- For lower E, bias increases at highest eta
- Resolution again flat to within around 0.5%





Electrons

Eta Summary

- Regression bias and resolution are pretty flat vs eta
  - Some slight bias at low E, high eta

- Means that variation in eta does NOT explain the residual resolution difference between Fixed and Variable angle samples

Bonus Slides

Samples / Details

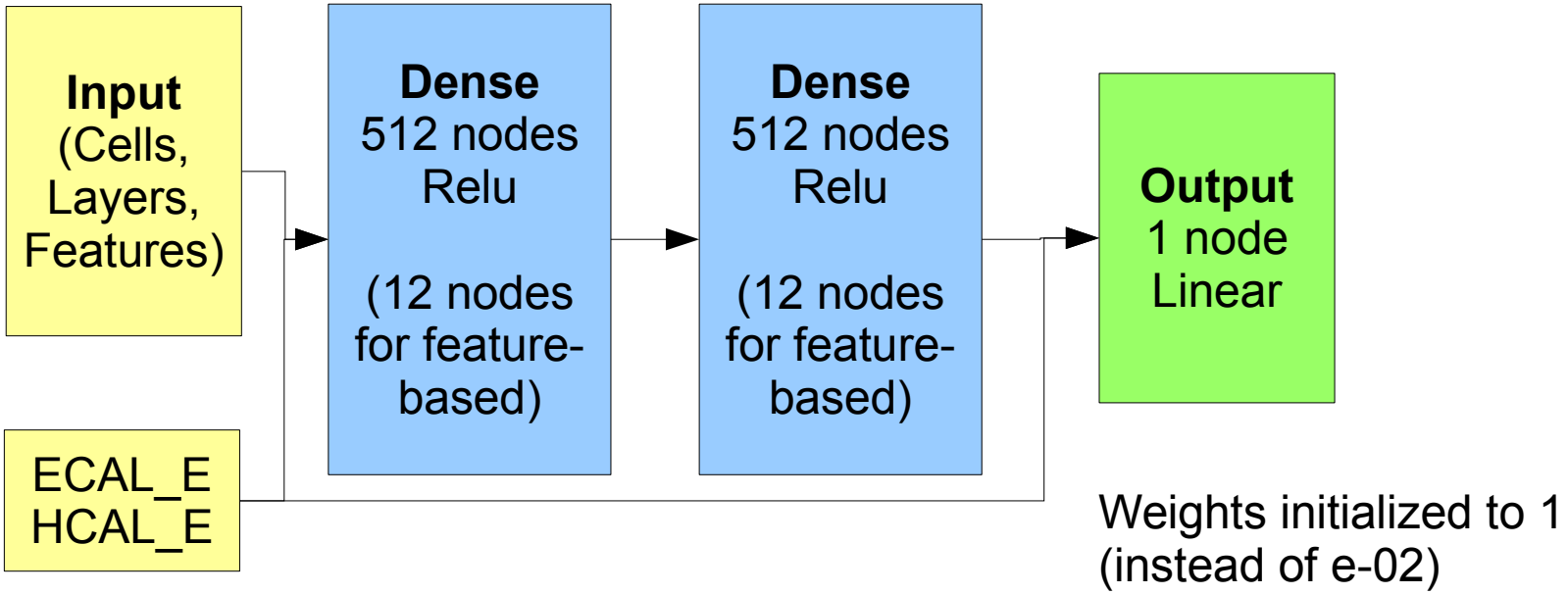
- Samples: new larger window samples, fixed angle, with features
  - On culture-plate at caltech:
    - /data/shared/LCDLargeWindow/fixedangle/*Escan/*.h5
    - /data/shared/LCDLargeWindow/varangle/*Escan/*.h5
  - Slimmed versions with only features (no images):
    - /data/shared/LCDLargeWindow/fixedangle/*Escan/merged_featuresonly/
    - /data/shared/LCDLargeWindow/varangle/*Escan/merged_featuresonly/
  - ~800k events, 70% train, 30% test

- Running XGBoost in python with:
  - maxdepth 3, up to 1000 rounds
  - Early stopping if test loss doesn't improve for 10 rounds

- Running DNNs / CNNs in pytorch, python3 using Triforce
  - Dropout 0.2
  - Adam, learning rate 0.001
  - L2 regularization 0.01 (“decayRate”)
  - Train for 5-10 epochs depending on window size

Skip Connections

- Basic idea: hardcode **Identity function** into network, to make other layers learn residual correction to identity
- Appropriate for our case: we know linear regression in ECAL_E, HCAL_E gets close to the right answer
- Performance is similar, training converges faster
  - For Feature Based NN, in 10-20 epochs instead of 40



NIPS CNN Architecture

- Modifications:
  - 51x51x25 ECAL input
  - 11x11x60 HCAL input
  - 3 conv filters for HCAL
  - Skip connections for ECAL_E, HCAL_E