Reconstruction & PID Track

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2nd AI4EIC Workshop, W&M, October 2022

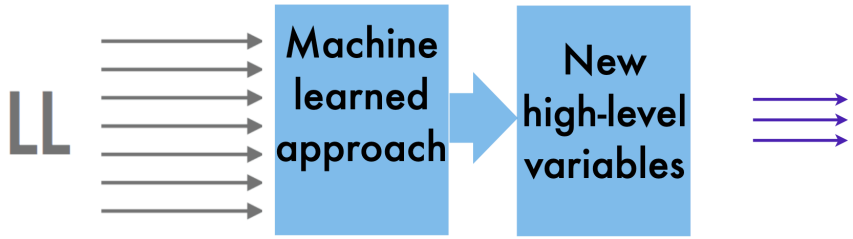
We had a dense schedule…

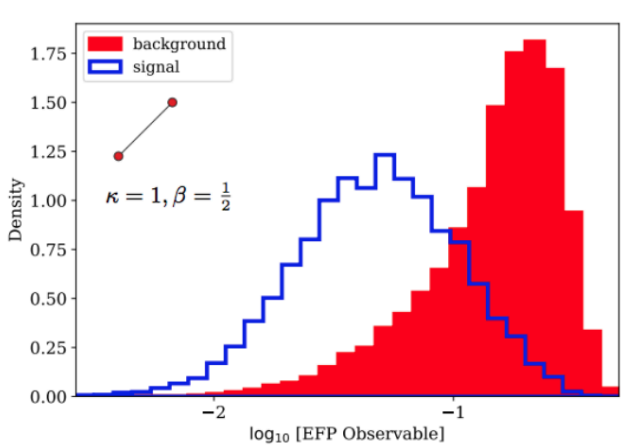
- Lots of activity, not possible to cover all in one session
- Focused on exemplary work and work specific to the EIC→8 contributions
- Reconstruction/PID of calorimeter response
  - Daniel Whiteson → DNN assisted high-level feature finding
  - Will Phelps→MuonID at ECCE
  - Chao Peng → AI/ML using input from imaging Athena ECAL
  - Nathan Branson→Extracting features from pixelated calorimeters for cluster separation
- Jet Classification
  - Raghav K. Elayavalli→ Using Vector of Locally Aggregated Descriptors (VLAD) to tag Heavy Flavor Jets
- Tracking
  - Corentin Allaire→ML in ACTS
- Data driven approaches and domain adaption
  - James Giroux → data driven one-class classification
  - Matthew McEneaney →GNNs with adversarial networks to overcome differences in training (simulation) and data

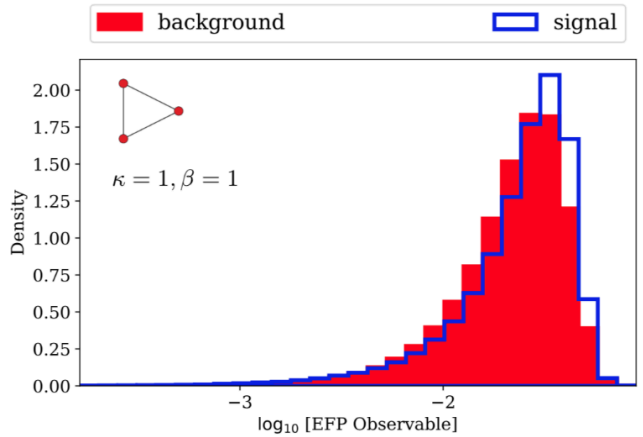
Interpretable Networks for Identifying Leptons	*Daniel Whiteson*	
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		10:00 - 10:25
Q/A		
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		10:25 - 10:30
Tagging heavy flavor jets @ RHIC	*Raghav Kunnawalkam Elayavalli*	
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		10:30 - 10:55
Q/A		
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		10:55 - 11:00
Muon Identification with Deep Learning at EIC	*William Phelps*	
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		11:00 - 11:15
Q/A		
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		11:15 - 11:18
Coffee break		
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		11:18 - 11:28
Machine Learning in ACTS	*Corentin Allaire*	
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		11:28 - 11:45
Q/A		
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		11:45 - 11:48
ML particle identification with measured shower profiles from calorimetry	*Chao Peng*	
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		11:48 - 12:03
Q/A		
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		12:03 - 12:06
Lambda event tagging at CLAS12	*Matthew McEneaney*	
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		12:06 - 12:21
Q/A		
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		12:21 - 12:24
ML for calorimetry	*Nathan Branson*	
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		12:24 - 12:39
Q/A		
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		12:39 - 12:42
Data-driven learning: Flux+Mutability	*James Giroux*	
room 1019, William & Mary, Raymond A. Mason School of Business, Alan B. Miller Hall		12:42 - 12:57

Daniel Whiteson: Interpretable Networks for identifying Leptons

- Energy Flow Polynomials form base for interpretable high level features that can be found using a DNN (compare performance)





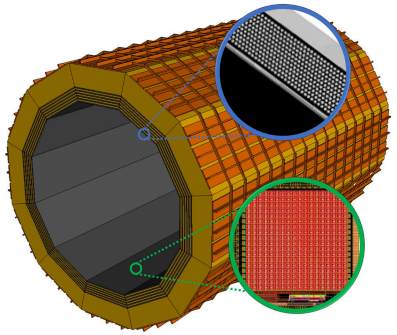


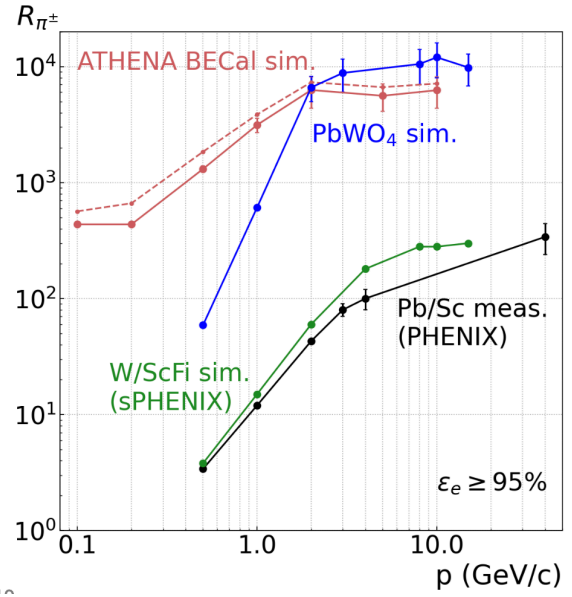
$$= \sum_{a,b=1}^{N} z_a z_b \theta_{ab}^{\frac{1}{2}}$$

$$= \sum_{a,b,c=1}^{N} z_a z_b z_c \theta_{ab} \theta_{bc} \theta_{ca}$$

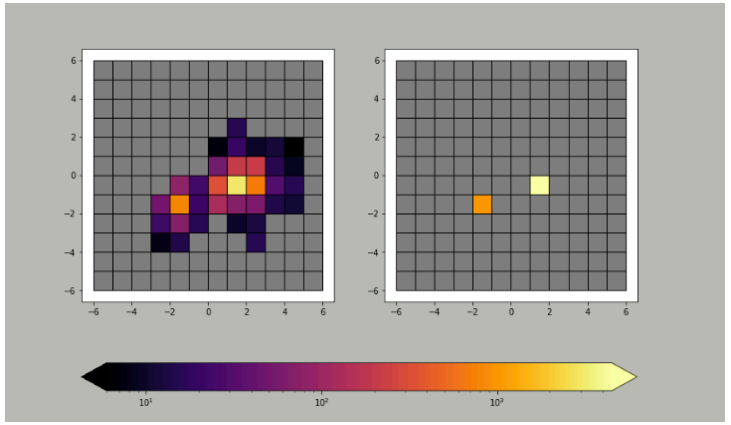
ML with Imaging/Pixelated ECALs

- Chao Peng: ML particle identification with measured shower profiles from calorimetry
- Use Imaging Calorimeter+ML leads to competitive performance to $PbWO_4$ with E/p
- CNN+MLP





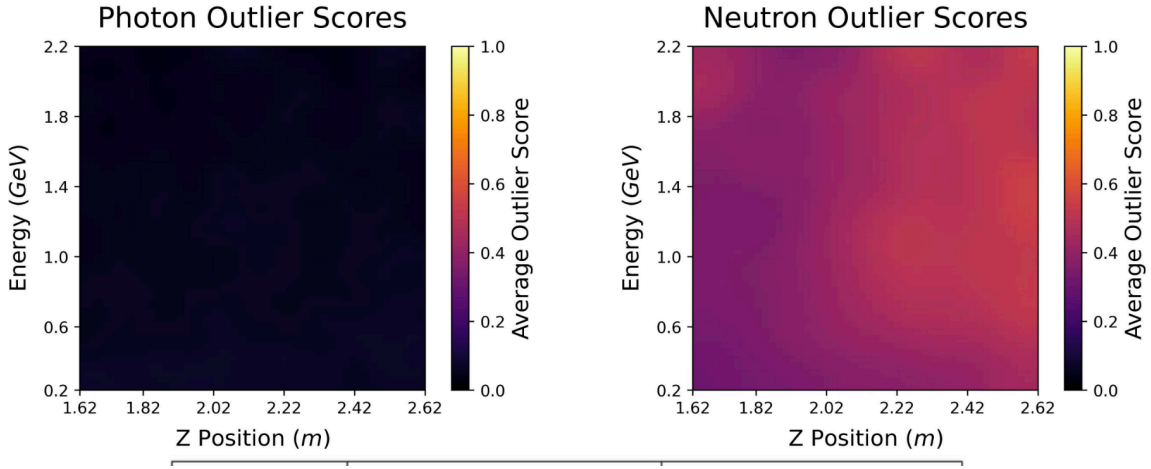
- Nathan Branson: ML for Calorimetry
- Cluster Separation in pixelated Calorimeter
- Autoencoder to reduce to features that allow cluster separation
- Transferable to FPGA



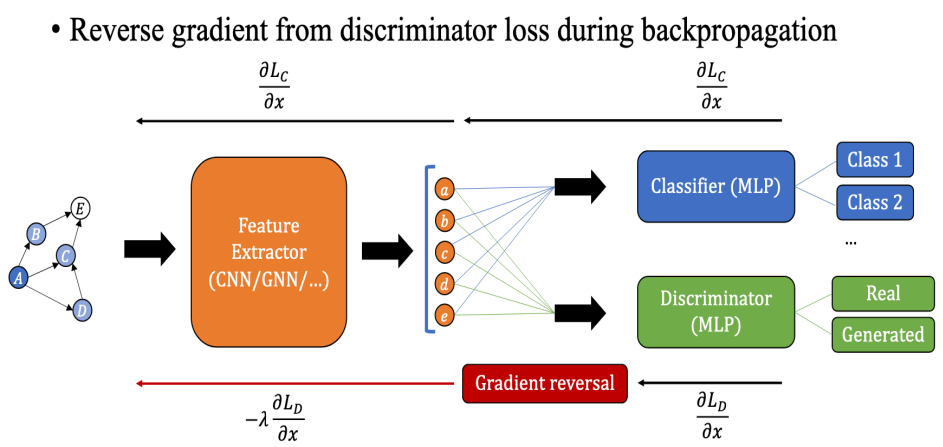
Addressing Simulation Challenges: Data driven and domain adaption approaches

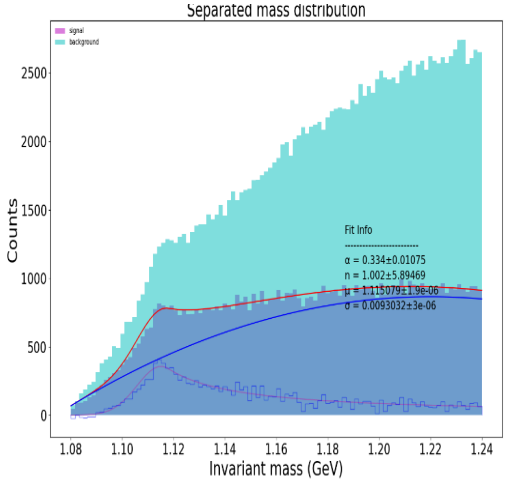
- James: Giroux Data-driven learning: Flux+Mutability
- Augmented features with residuals from autoencoder output
- Compare to reference population generated via autoregressive flow
- One-class classification (can be data driven) →no need to know BGs.

γ/n Separation at GlueX - Results

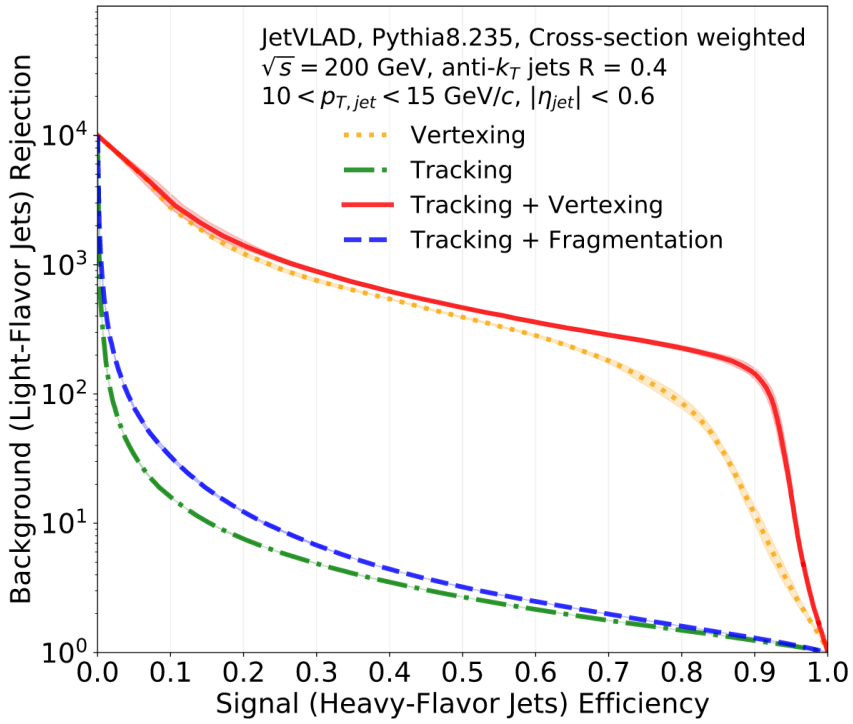


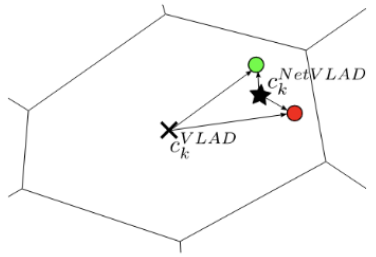
- Matthew McEneaney: Lambda Tagging at CLAS12
- Domain Adversarial Networks only use features that are the same in Data and Simulation

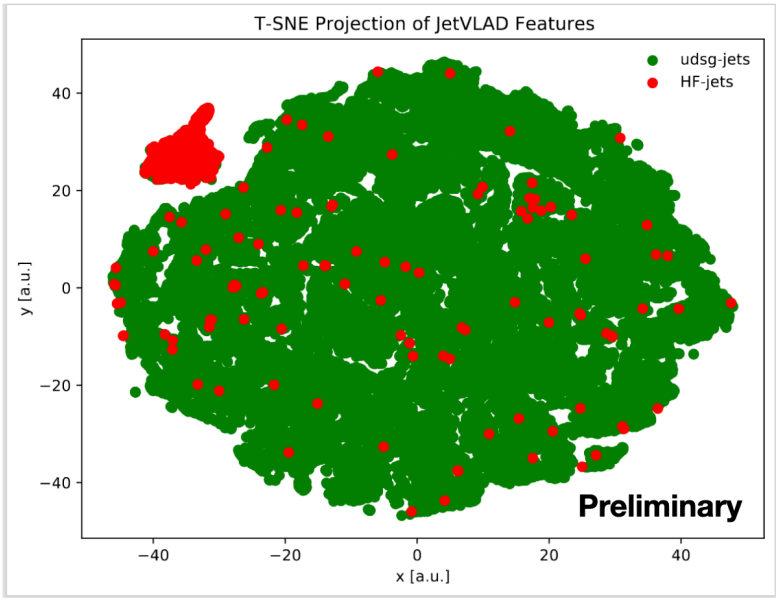




Raghav Kunnawalkam Elayavalli: Tagging heavy flavor jets @ RHIC







- Using Vector of Locally Aggregated Descriptors (VLAD provides very competitive performance in HF tagging

Corentin Allaire: Machine Learning in ACTS

- Summary Slide

  - ACTS is an Open Source tracking toolkit
  - Provides virtual ODD detector to test different algorithm
  - Great environment to develop new Machine learning based solution for track reconstruction :
    - Hashing for track reconstruction
    - Parameter auto-tuning for tracking algorithm (available in Acts)
    - GNN for track finding (also available)

Open Data Detector: