# BCAL Deep-Learning Update - 11th July 2019

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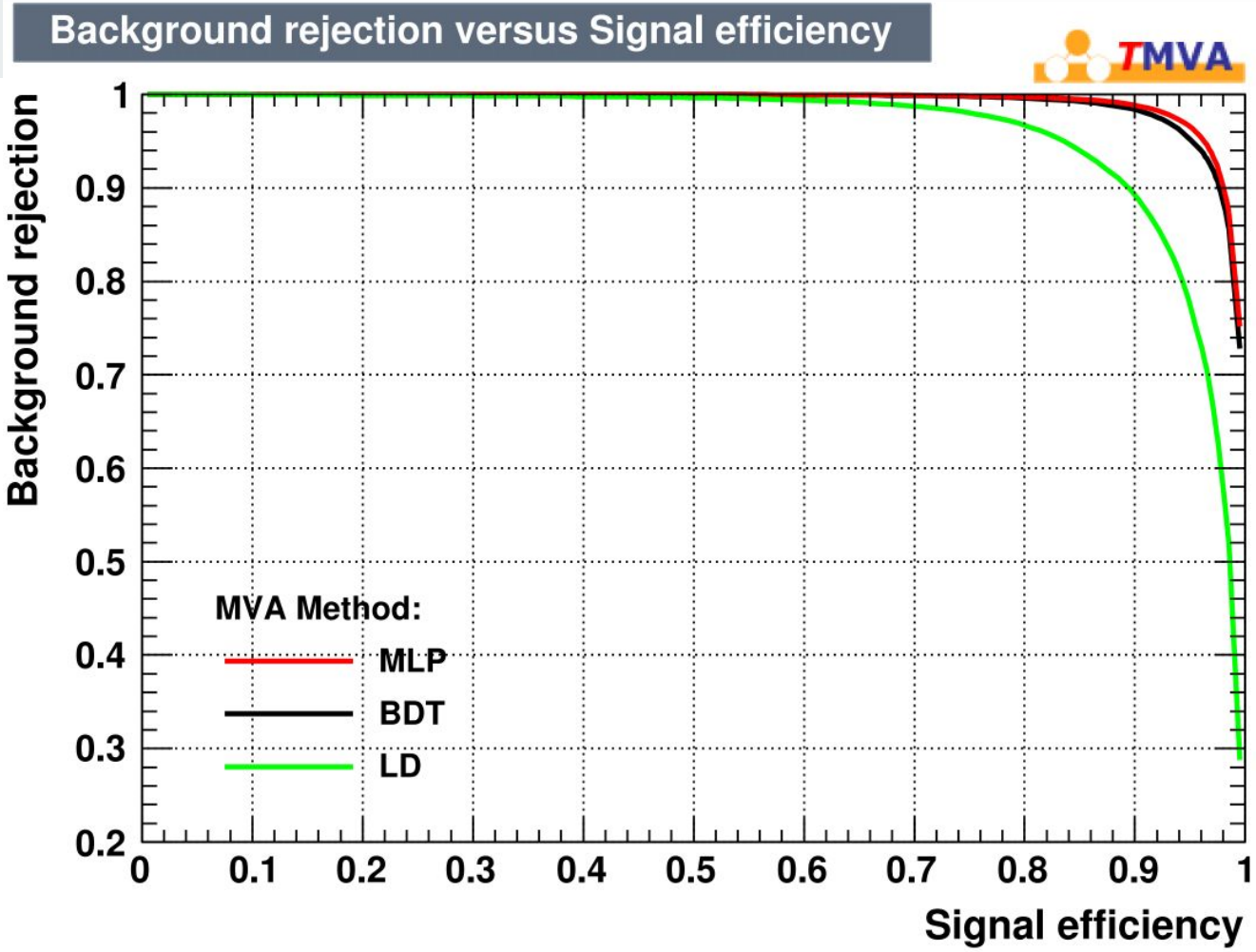
# Goals:

- Differentiate between charged vs neutral, hardronic vs electromagnetic (both charged and neutral)
- Explore possibilities of classifying photon showers vs neutron showers using Machine Learning.

# Machine Learning in BCAL (2014)

- In 2014, Tegan et al. developed a Boosted Decision Tree to differentiate between good photon shower vs poorly reconstructed shower.
- It was an early stage study and the main focus of that study was to improve the pi0 reconstruction, Now, resurrected the model back with a few modifications, The new BDT takes in 21 features of shower (del_E,del_z,del_phi, etc), these showers are generated from a bggen sample.
- Based on these features it predicts whether the shower is a good photon or any other shower.
- Extended the model to variety of problems like hardronic vs electromagnetic, neutral vs charged

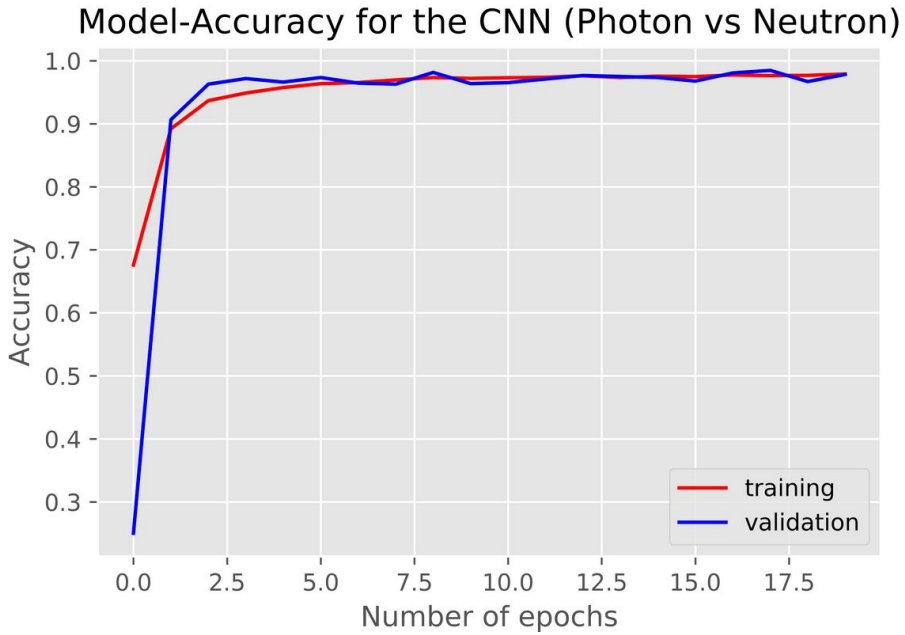
## Neutral Vs Charged

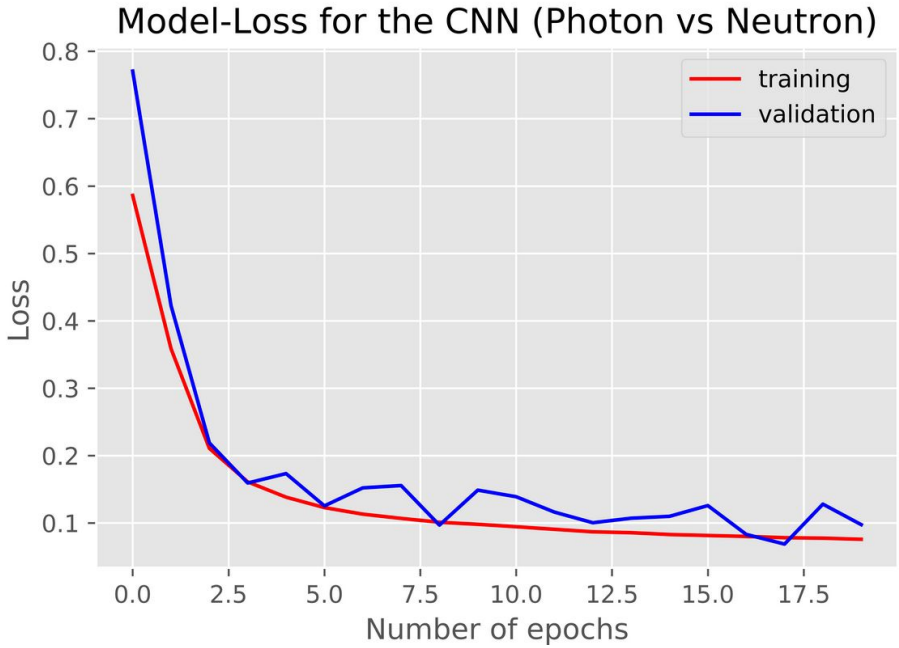


# Do the same using Point level features

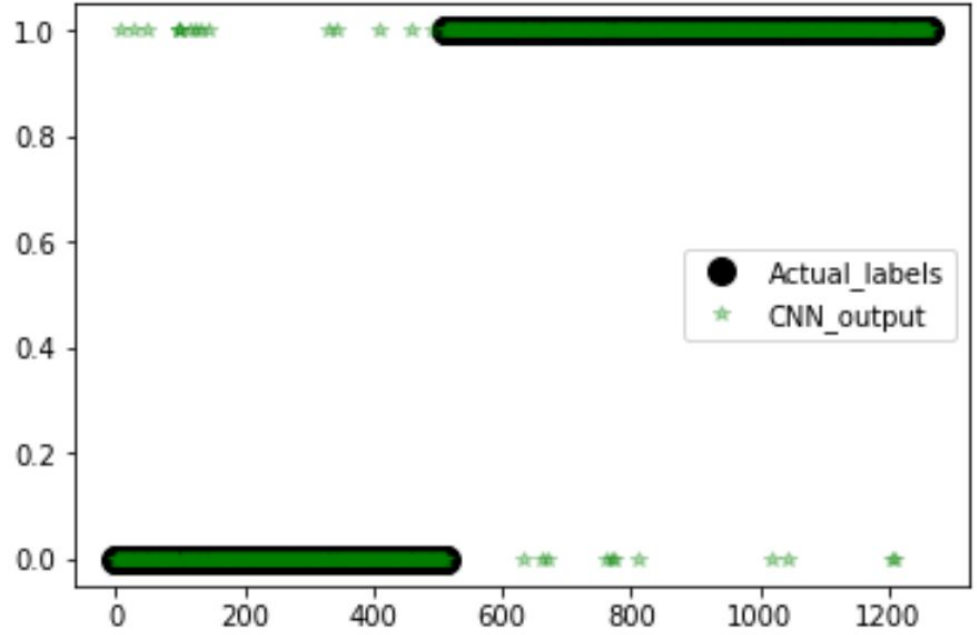
- Especially with the photon Vs neutron at lower and mid energies their shower level features look the same however their points look different (r,phi,z).
- We tried to develop a CNN model to predict photon Vs neutron, photon vs pions
- Choose particle gun and shoot photons and neutron with various energy into the BCAL. Run it through several checks to make sure there are no split offs and conversions before hitting the BCAL (all these models assume a perfect clusterizer algorithm)
- Then form a trimmed 3d image (r,phi,z) with 2 channels Energy and Time as input and predicts a binary output.
- A trimmed image is need because the data is too sparse. The CNN performs good for both Photon Vs Neutron, photon Vs pion but is not performing good for a multi class classification.

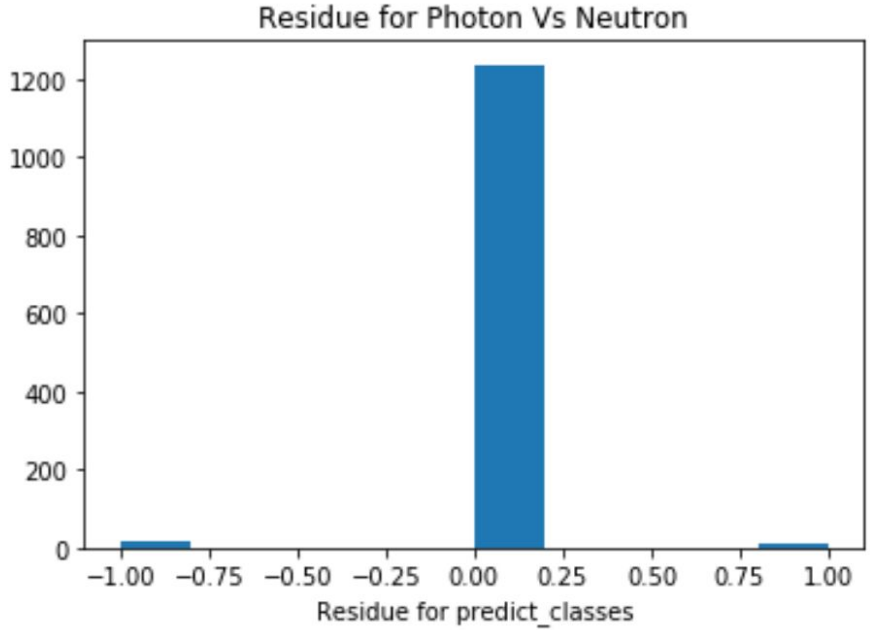
# Photon Vs Neutron Performace (CNN)



# Output of the CNN model



# Working on the following

- Extending this to neutral vs charged, hadronic vs electromagnetic
- Shoot the particles through out the bcal and also look to use differences in time, energy, r, phi, and z instead of their absolute value
- Use a bggen sample and then make predictions using the CNN.
- Looking on ways on how to compare the performance against the existing framework.
- Look at data to do classifications.