

Deep neural networks @ ECAP

Synergy of deep learning techniques among experiments



ERLANGEN CENTRE
FOR ASTROPARTICLE
PHYSICS



Bundesministerium
für Bildung
und Forschung

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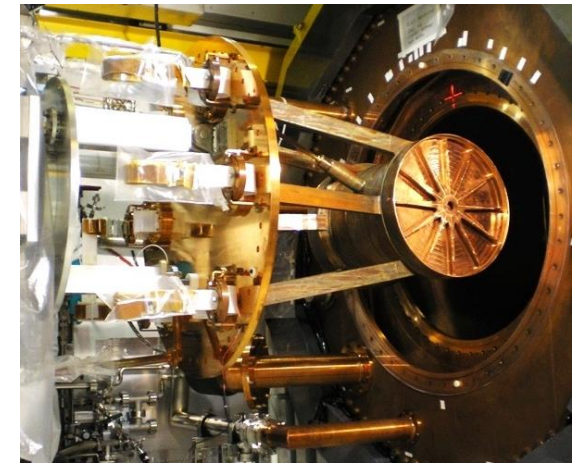
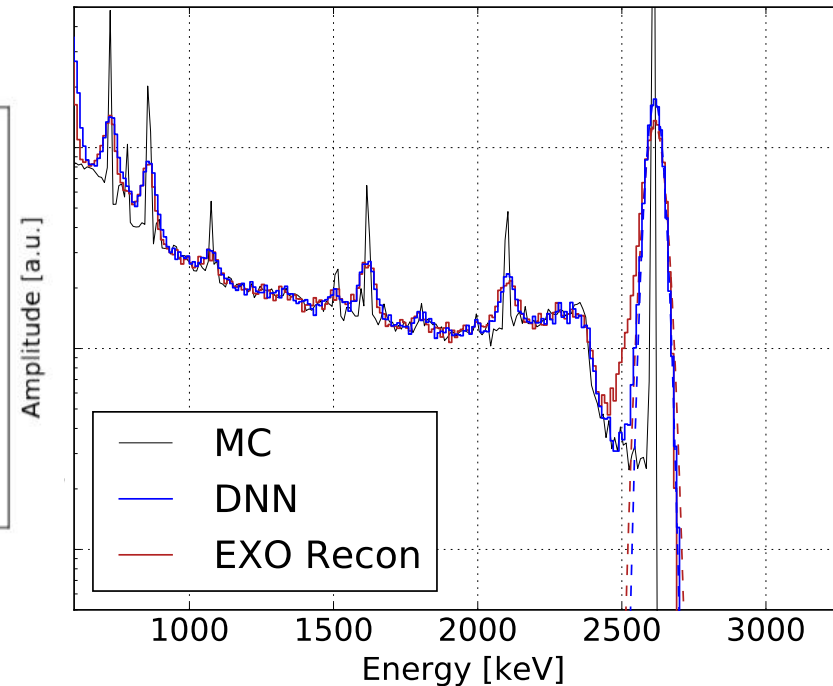
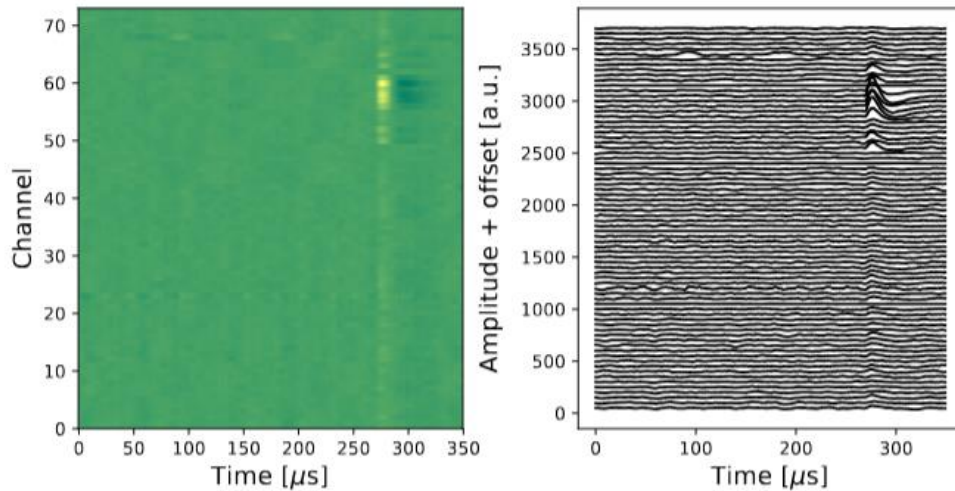
Overview

- What we have done so far
- What we plan to do

What we have done so far

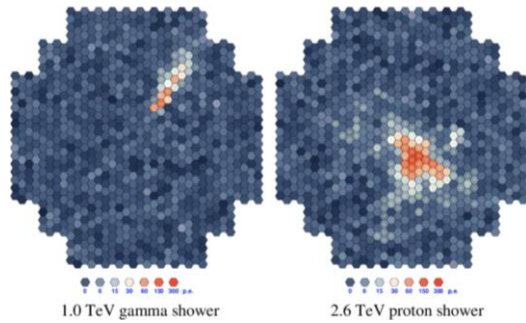
Application 1: (1+1)-d data from EXO-200/nEXO

Energy reconstruction using
raw charge signals trained on MC



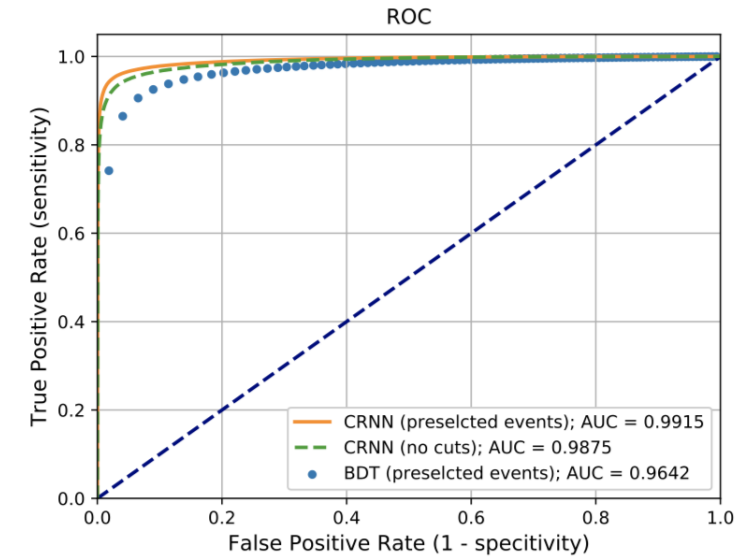
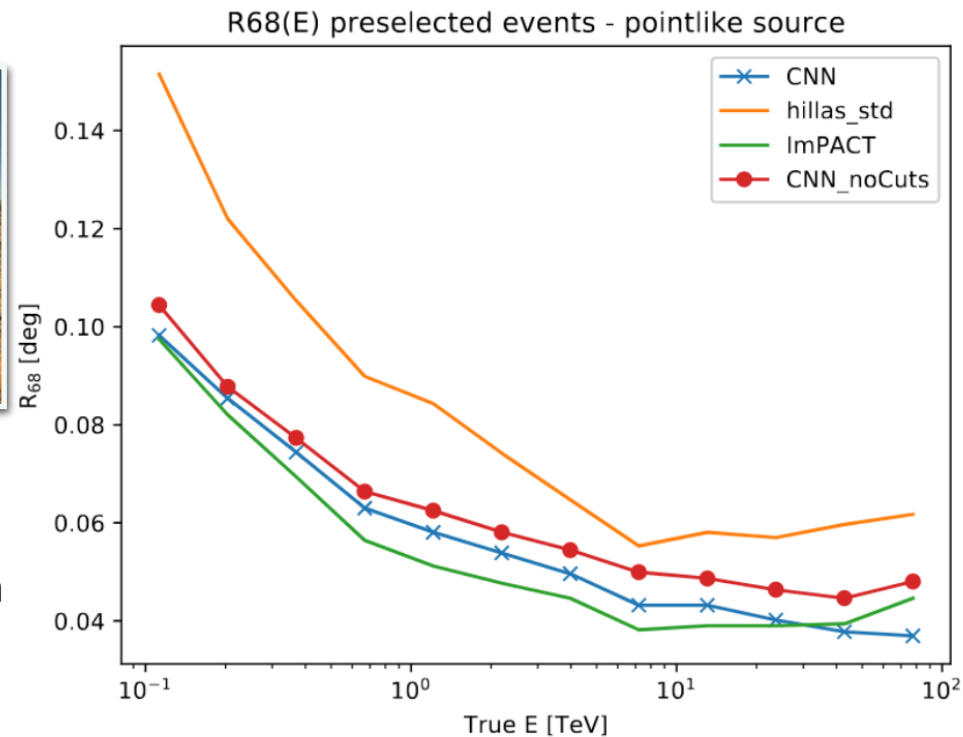
Publication on Event reconstruction
(2018 JINST 13 P08023)

Application 2: 2-d data from Hess/CTA



Publication on Event
reconstruction / classification

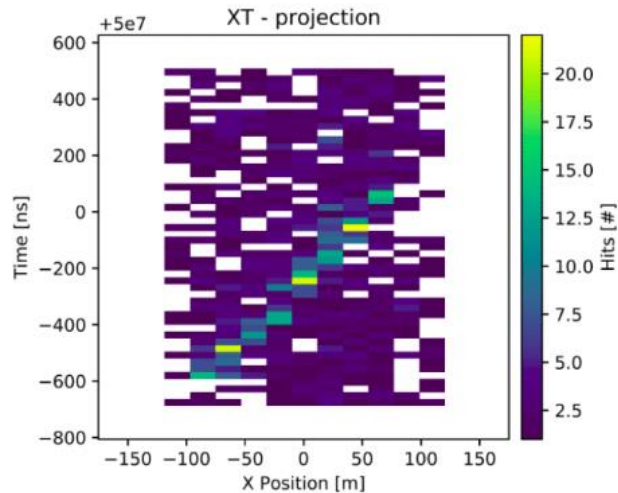
[1803.10698](https://arxiv.org/abs/1803.10698)



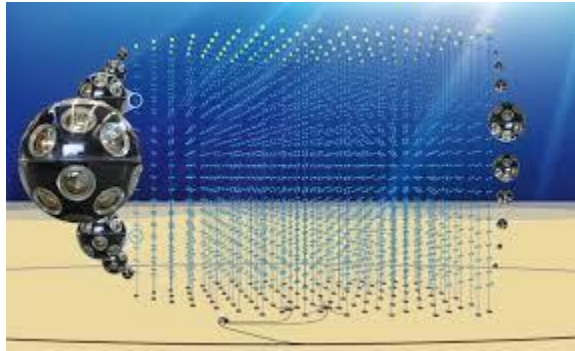
(a) ROC curves with matching AUC values.

Application 3: 3+1-d data from Orca/Arca

„projection technique“

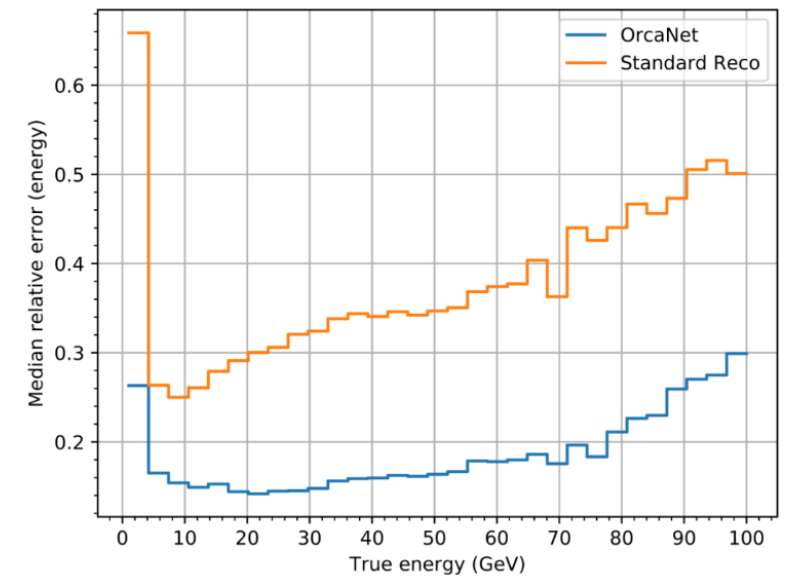


XT projection of the 4D „image“ for a ν_μ - CC event



Particle ID / Energy reconstruction

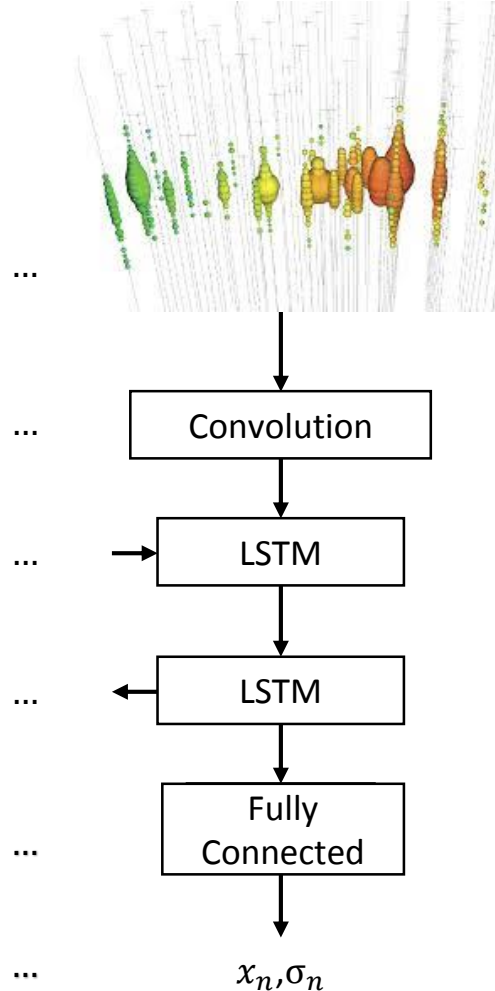
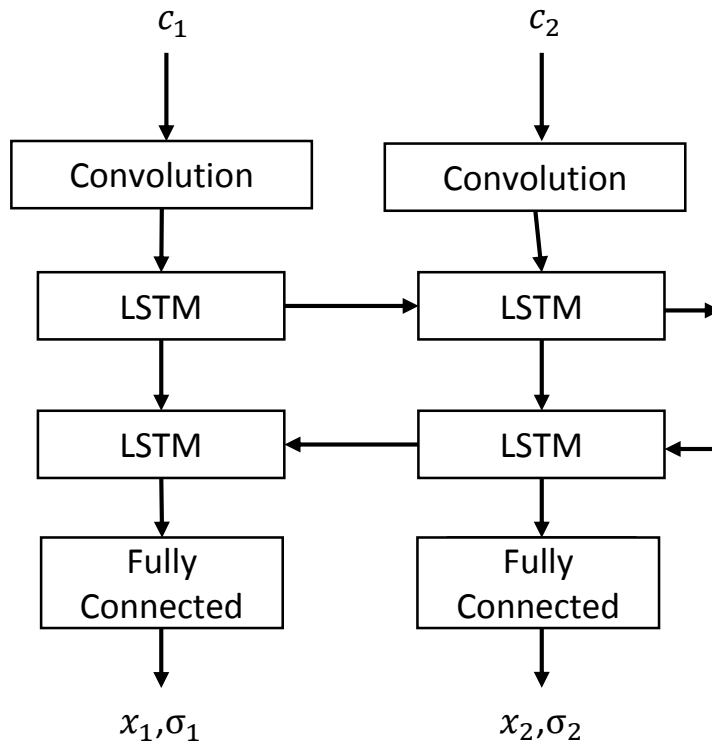
OrcaNet: Track like (ν_μ - CC)



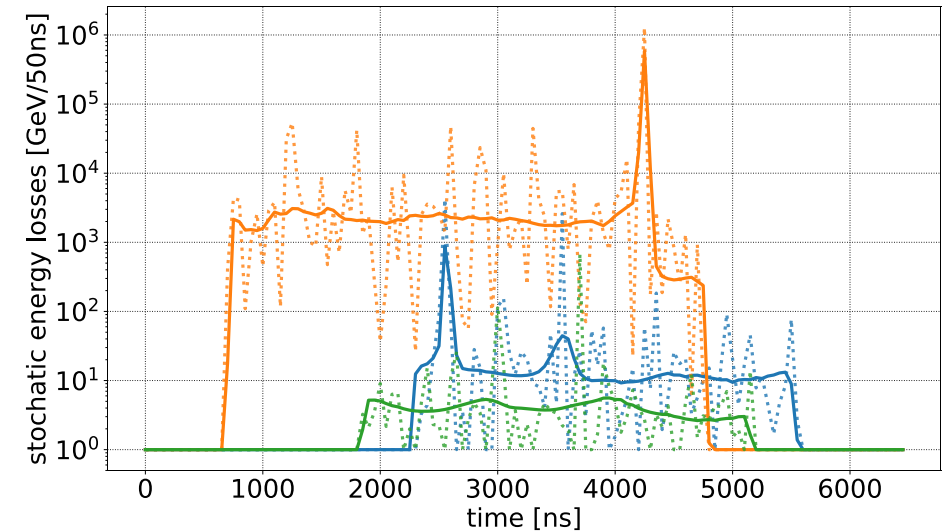
Preliminary

Application 4 (3+1)-d data from IceCube

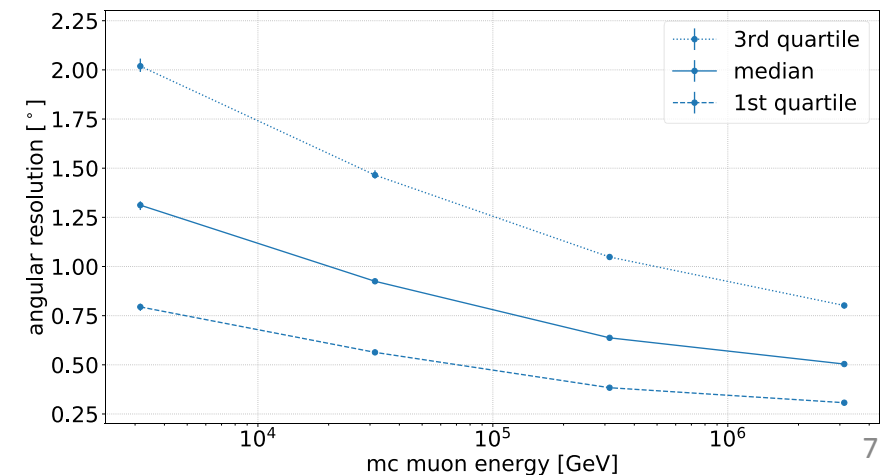
LSTM network
(temporal structure)



Energy loss pattern of muon



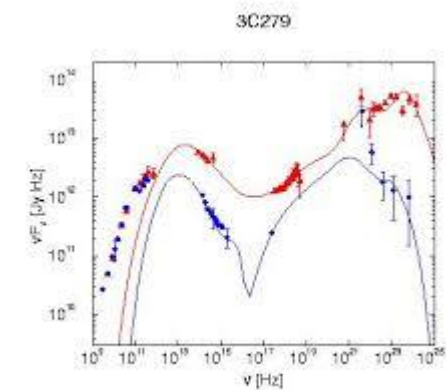
Muon angular resolution



What we want to do

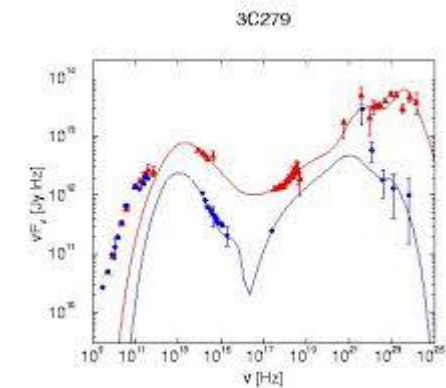
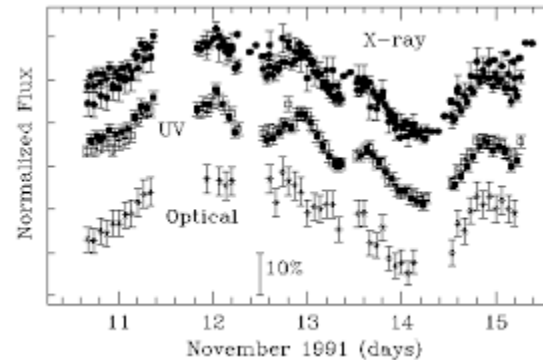
What we want to do

- Studies of uncertainty estimation!
 - Various techniques on the market .. MC Dropout / Bayesian neural nets / Predicting uncertainty (like in variational autoencoder)
 - Thorough comparison
 - Leverage similarity between experiments (convolutional , convolutional+lstm)



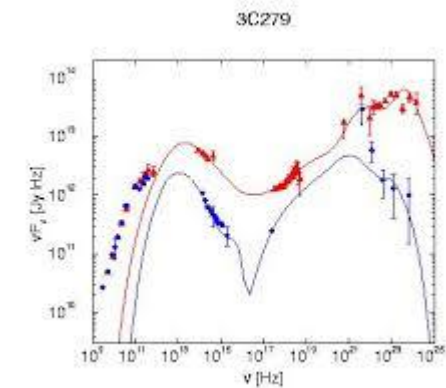
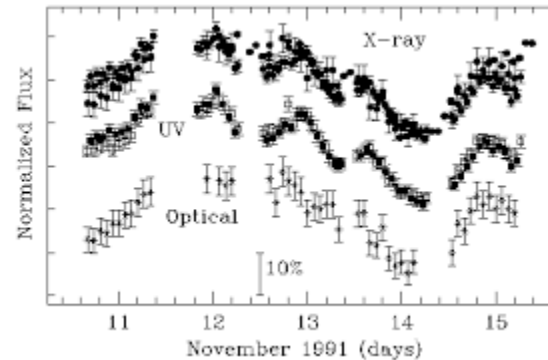
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 - Investigate unsupervised techniques



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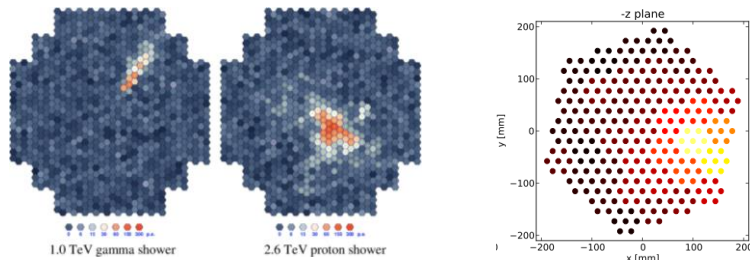
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 - Investigate unsupervised techniques
- 1 PostDoc to oversee these developments full time



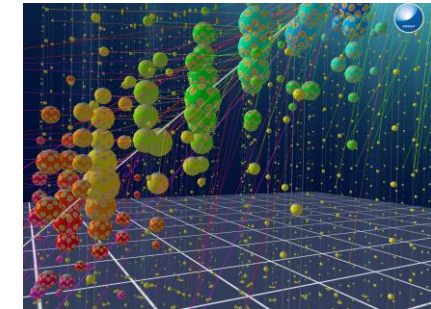
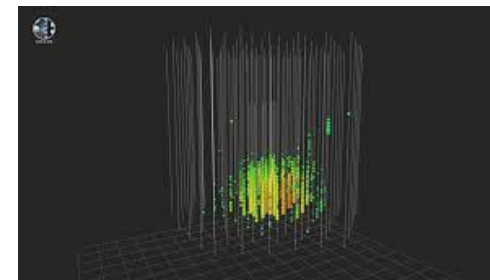
Summary

- Data structures vary slightly between experiments

2d (Hess/CTA/n-EXO)



(3+1)d (IceCube/Arca/Orca)



- **But:** Similar techniques
Combinations of convolutional Neural nets / LSTMs
- Uncertainty quantification
MC-Dropout / Predicting uncertainties
- Unsupervised astronomical use case: blazar spectra