

# Deep neural networks @ ECAP

Synergy of deep learning techniques among experiments



ERLANGEN CENTRE  
FOR ASTROPARTICLE  
PHYSICS



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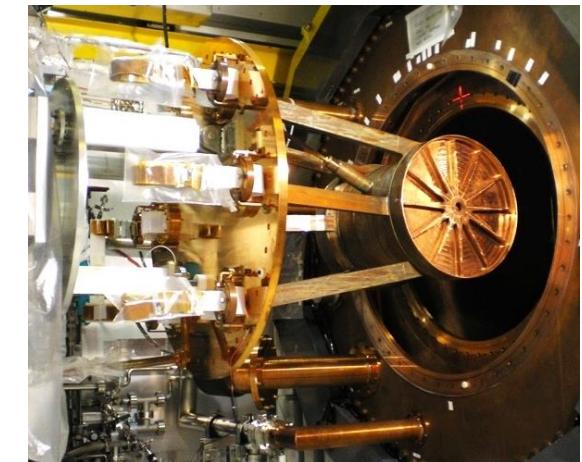
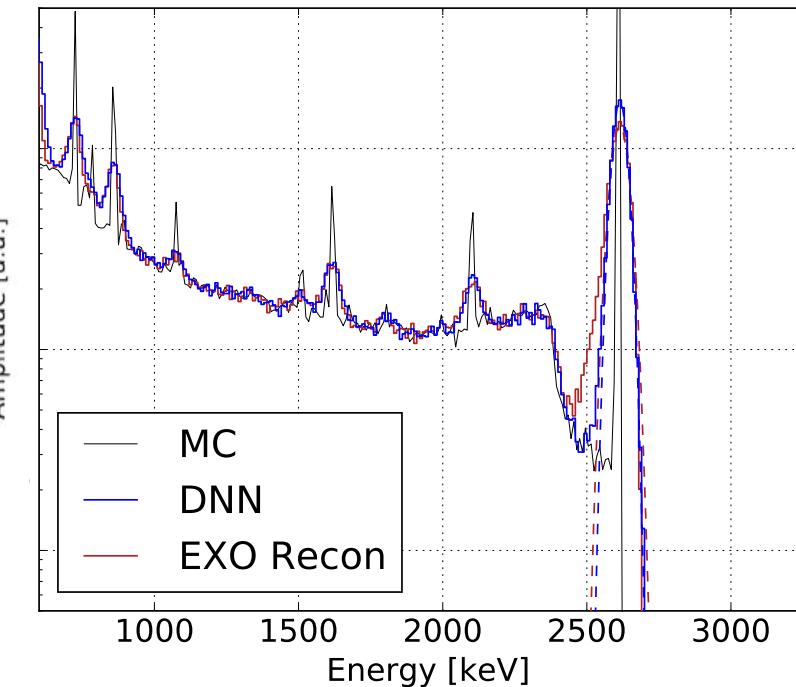
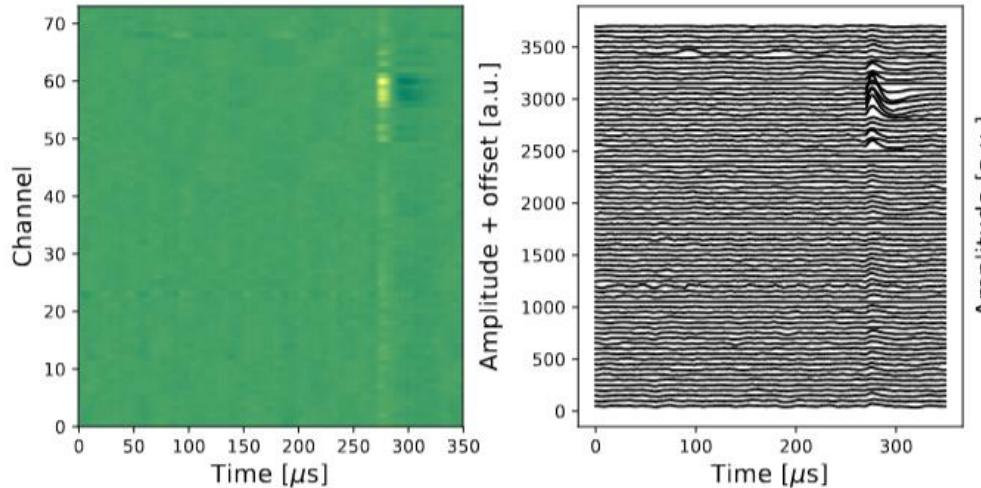
# Overview

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

# What we have done so far

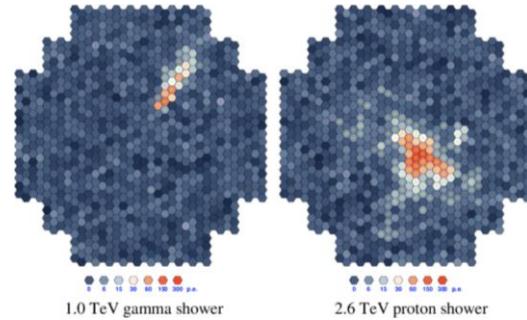
# Application 1: (1+1)-d data from EXO-200/nEXO

Energy reconstruction using  
raw charge signals trained on MC

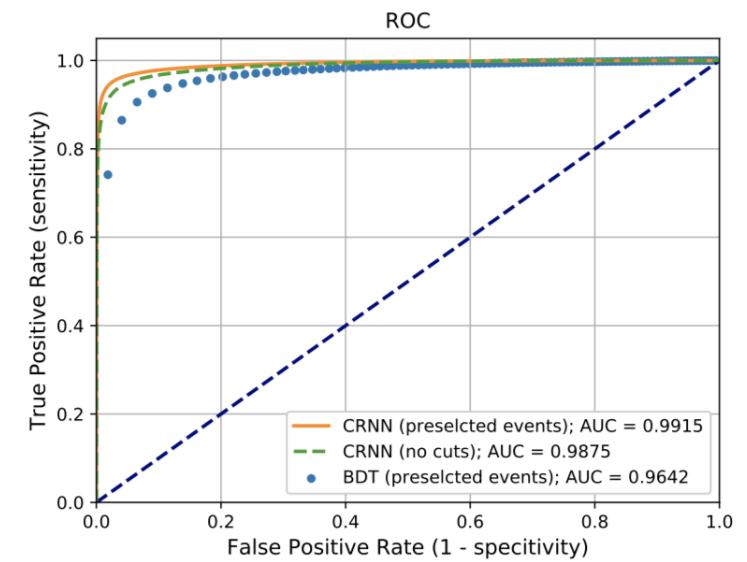
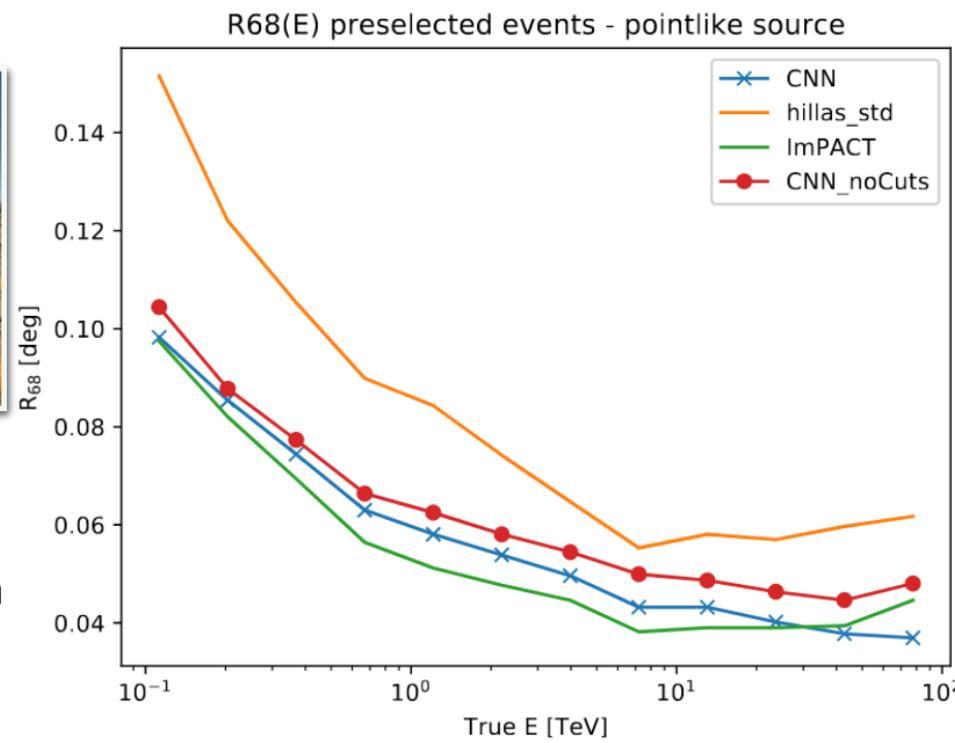
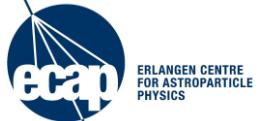


Publication on Event reconstruction  
(2018 JINST 13 P08023)

# Application 2: 2-d data from Hess/CTA



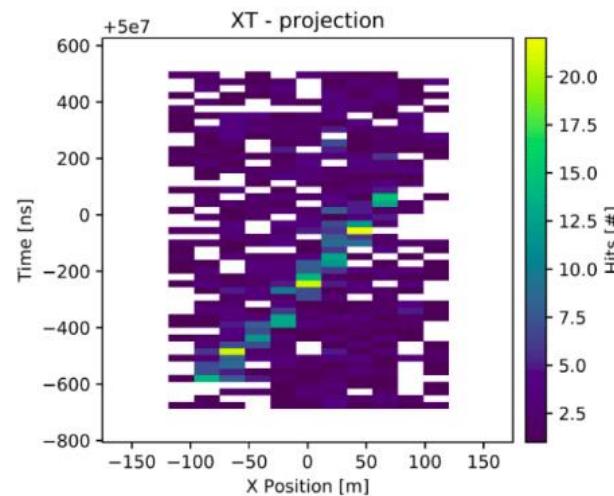
Publication on Event  
reconstruction / classification  
[1803.10698](https://arxiv.org/abs/1803.10698)



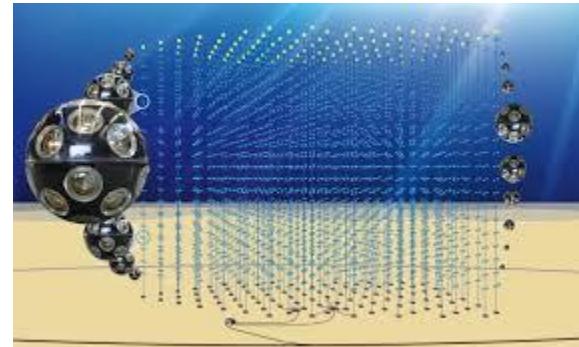
(a) ROC curves with matching AUC values.

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

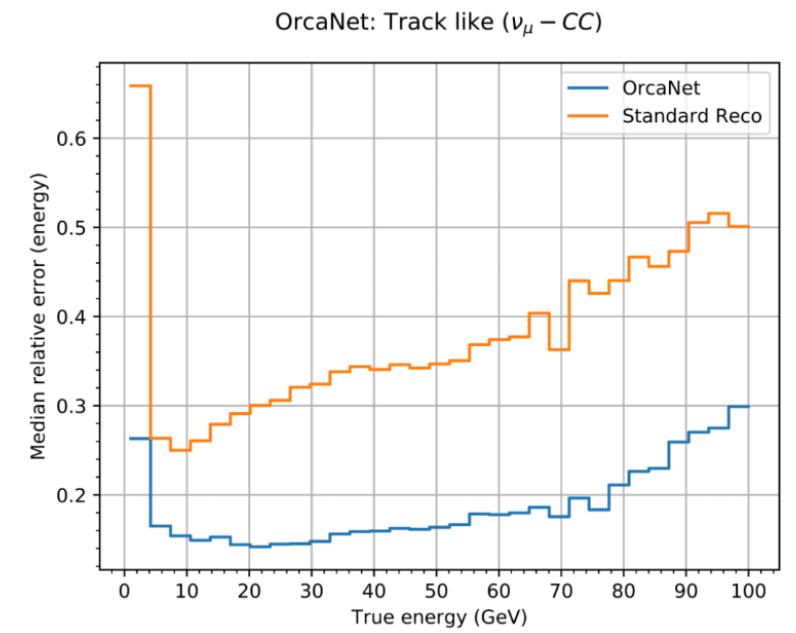
„projection technique“



XT projection of the 4D „image“ for a  $\nu_\mu$  - CC event



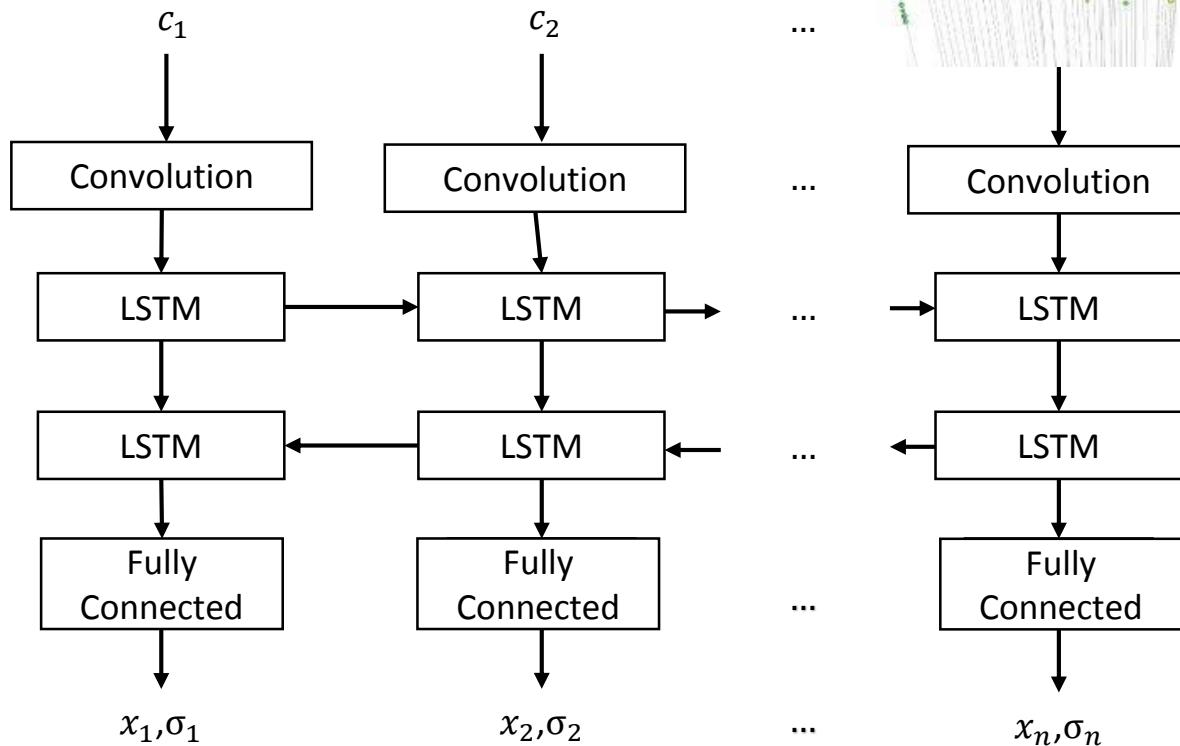
Particle ID / Energy reconstruction



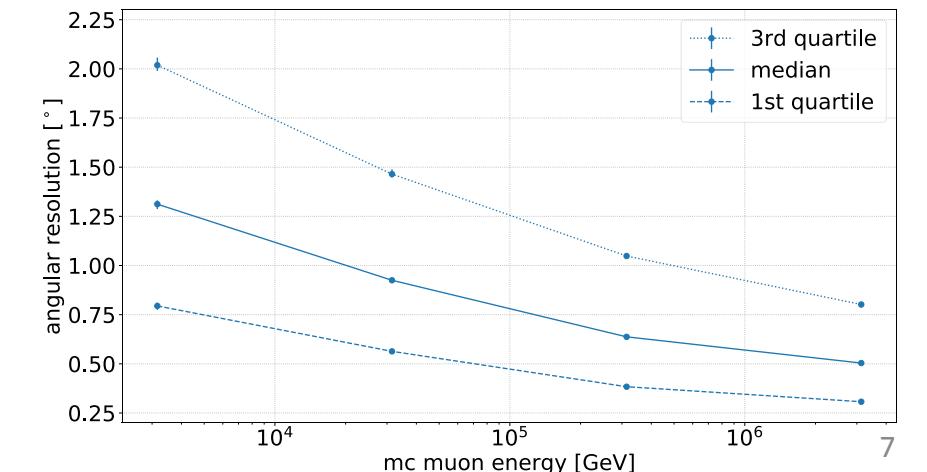
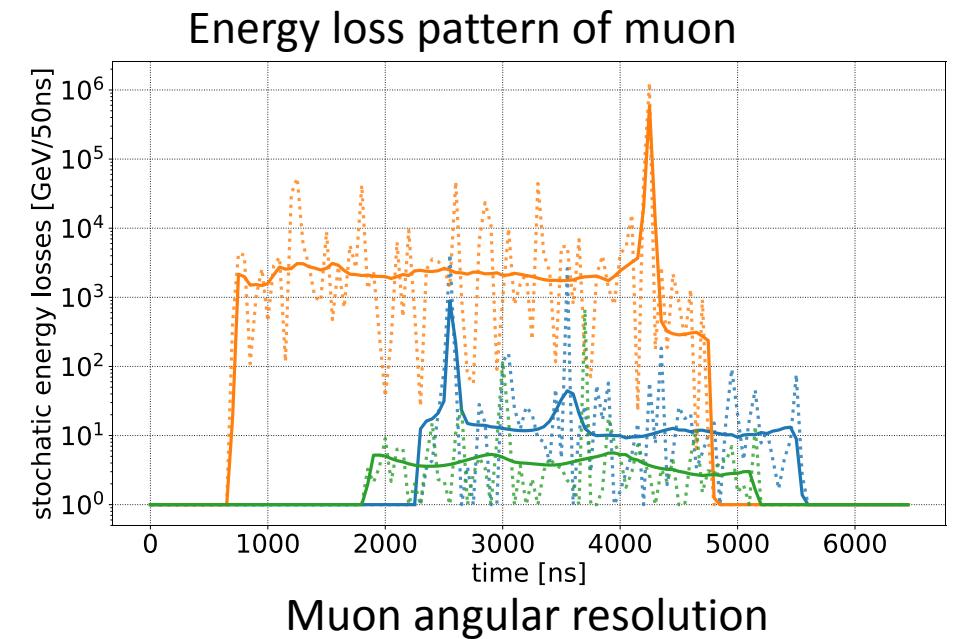
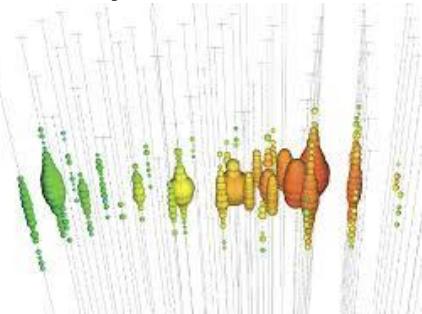
Preliminary

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

LSTM network  
(temporal structure)



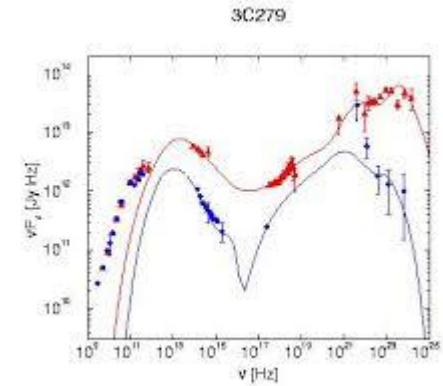
Preliminary



# What we want to do

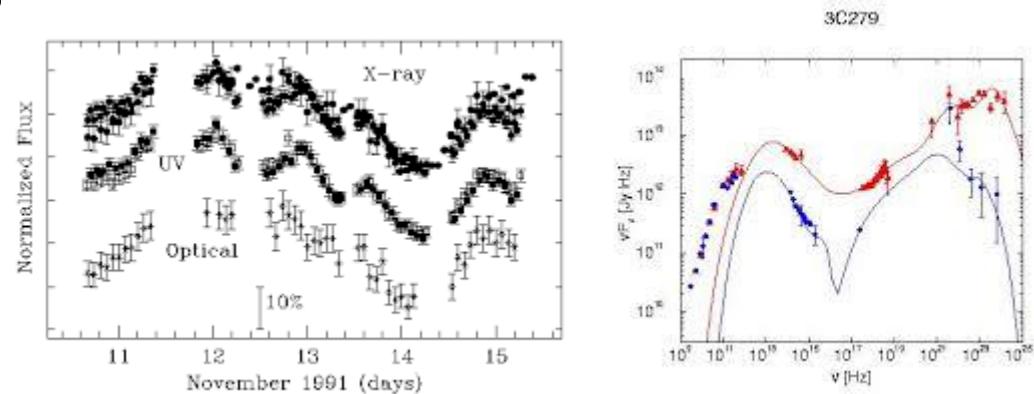
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- Studies of uncertainty estimation!
  - Various techniques on the market .. MC Dropout / Bayesian neural nets / Predicting uncertainty (like in variational autoencoder)
  - Thorough comparison
  - Leverage similarity between experiments (convolutional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



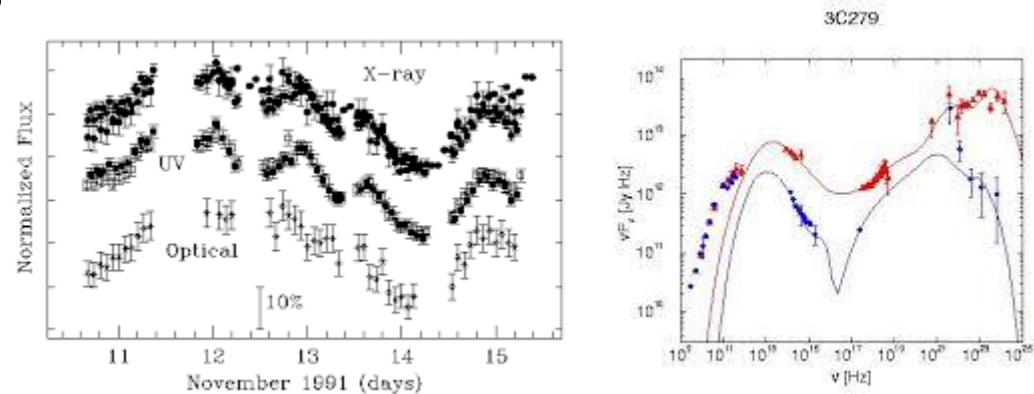
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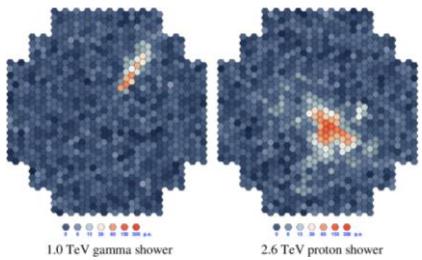
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- 1 PostDoc to oversee these developments full time



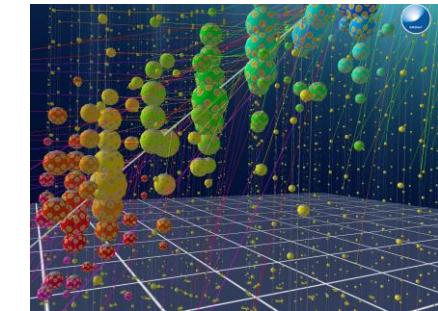
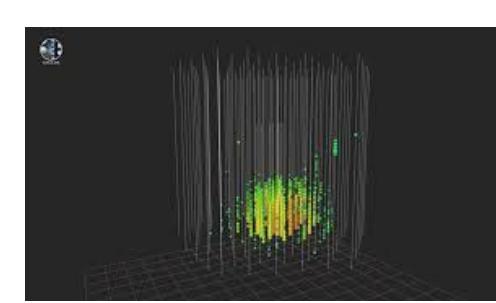
# Summary

- 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