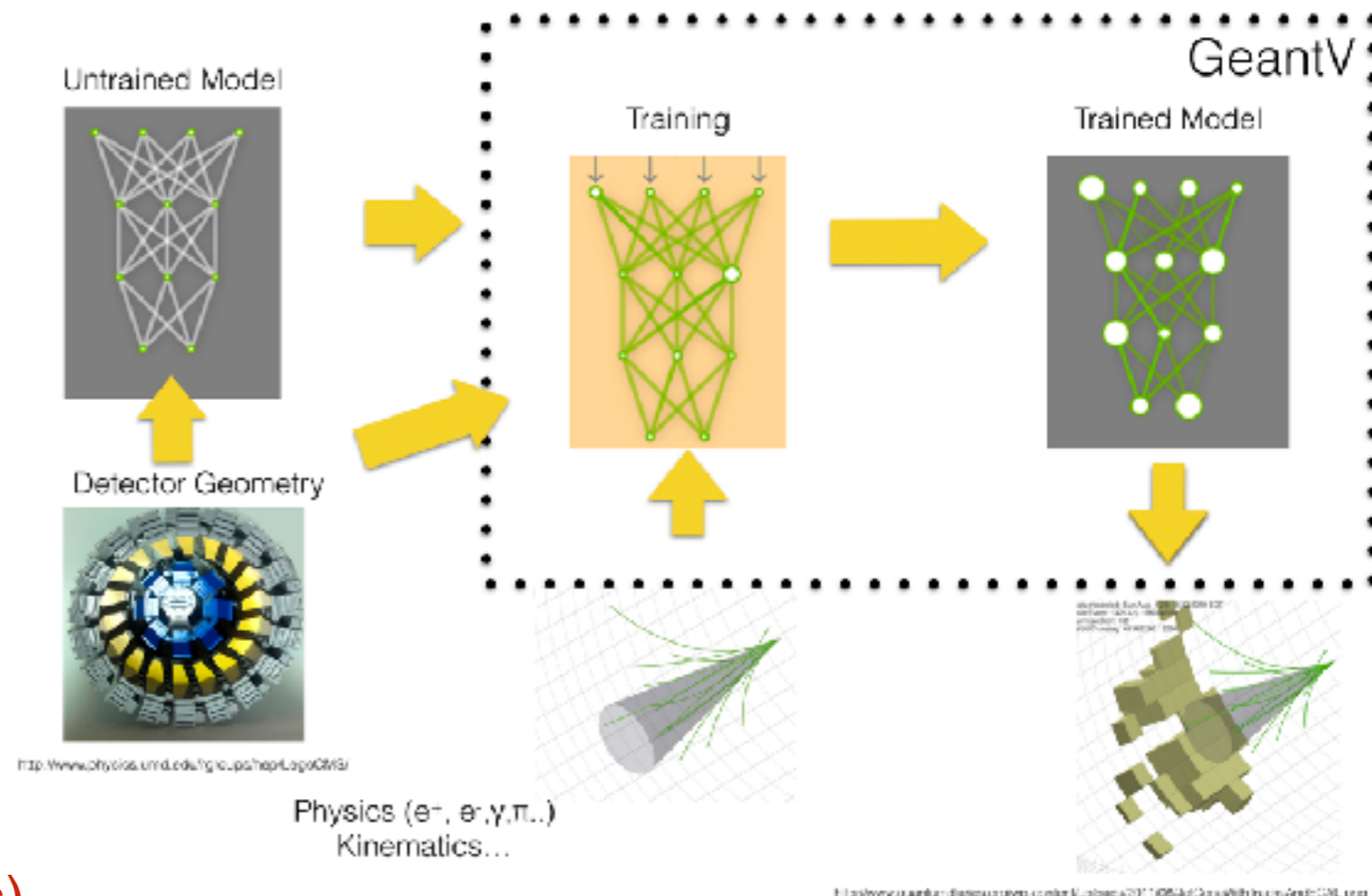


GANs for fastsim in GeantV

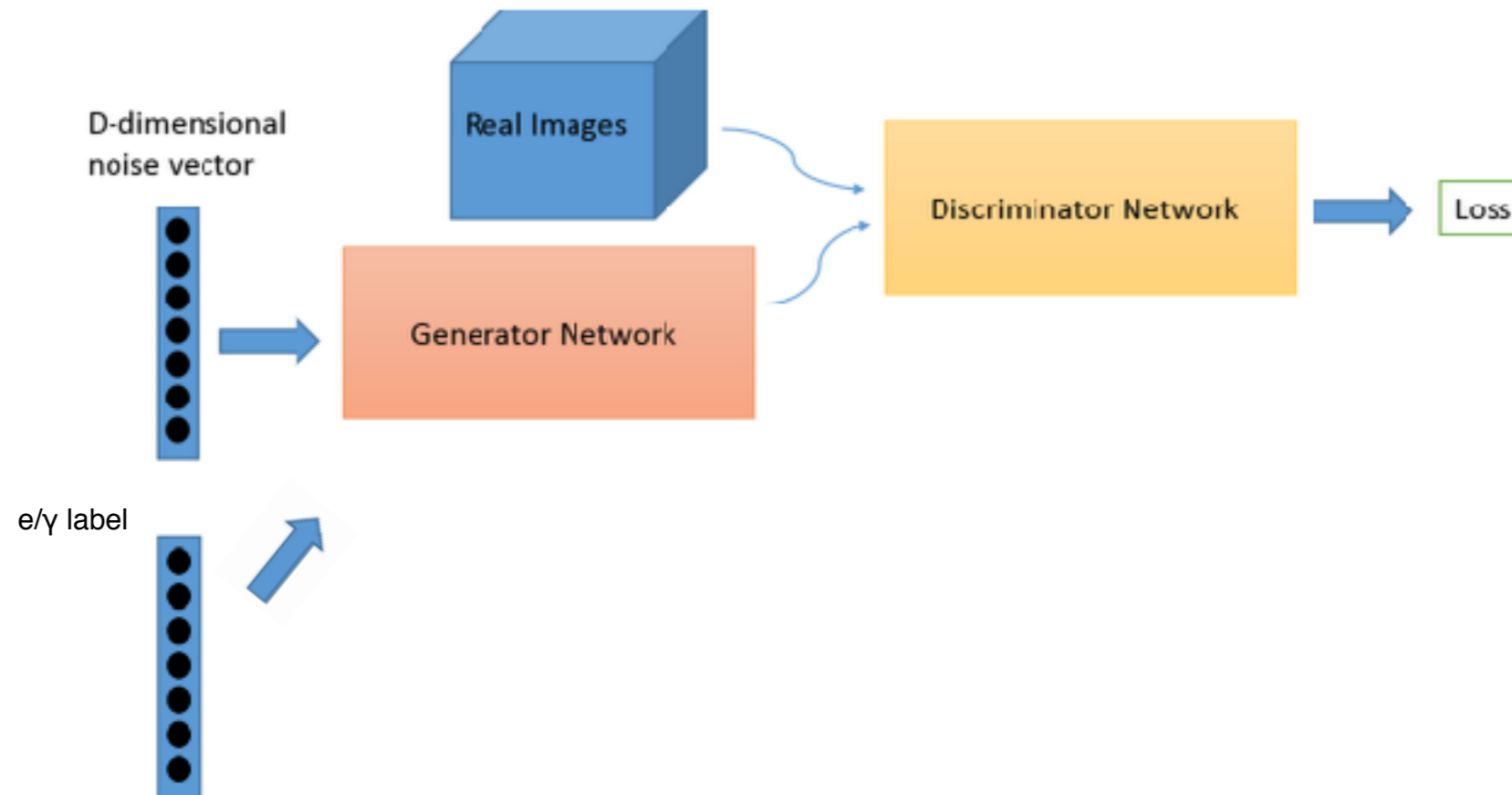
- Fully integrated in GeantV
- Configurable interface
- Train on full simulation
- Test training on real data
- Test different techniques
- Predictive Clustering Trees & Standard Perceptron (TMVA)
- **Generative adversarial networks (GANs)**
- Test different models
- Multi Objective regression, Feature extraction
- Later: embedded algorithm for hyper-parameters tuning and meta-optimization
- Possibly back-ported to Geant4



GAN model

arXiv:1406.2661v1

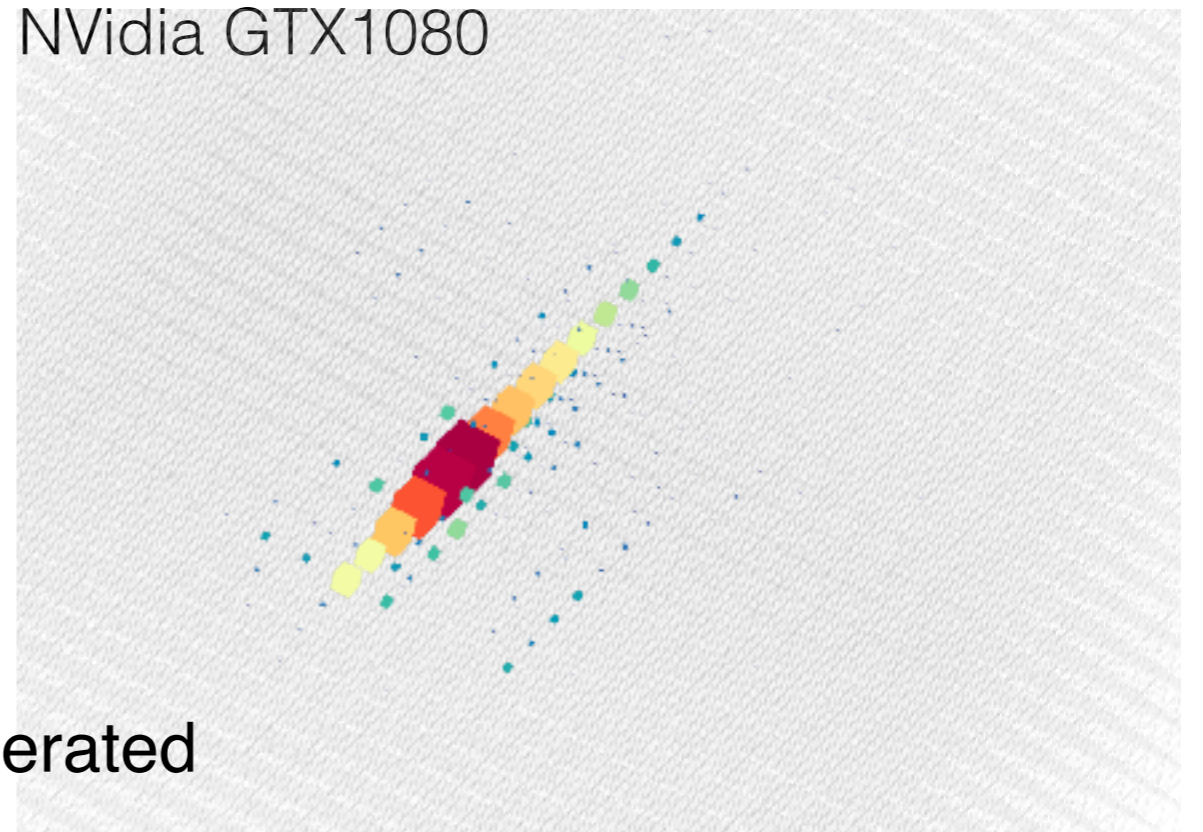
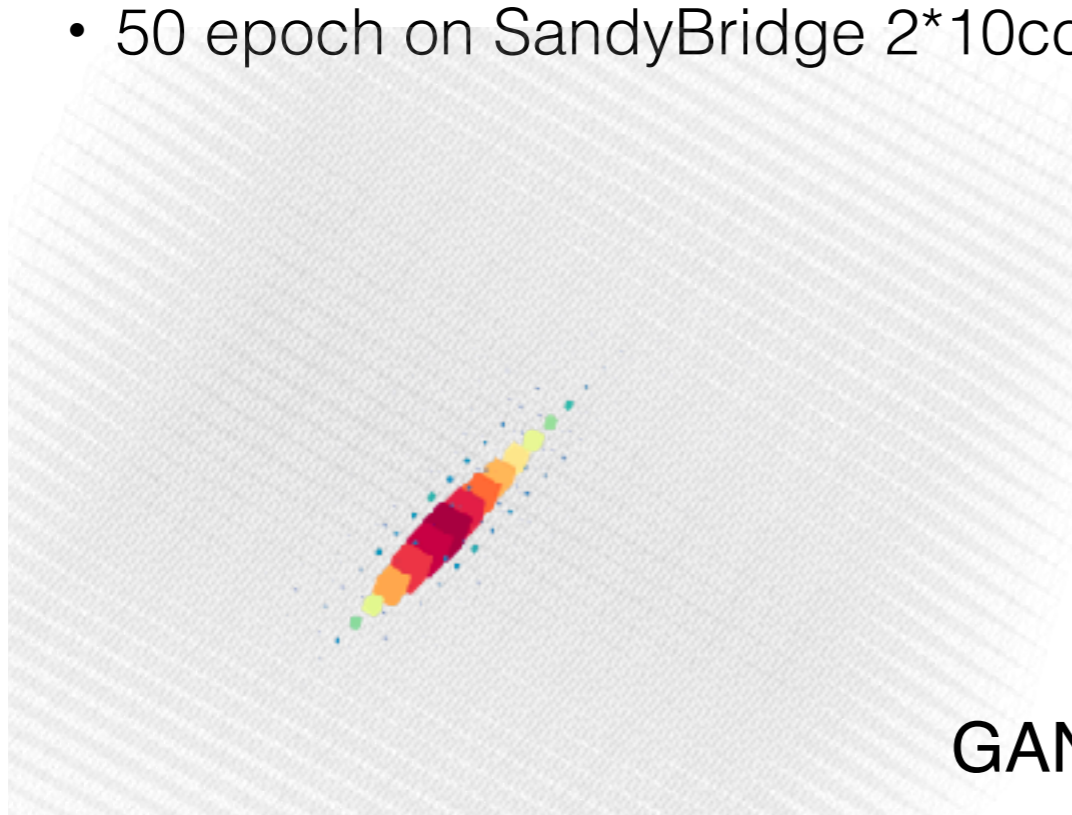
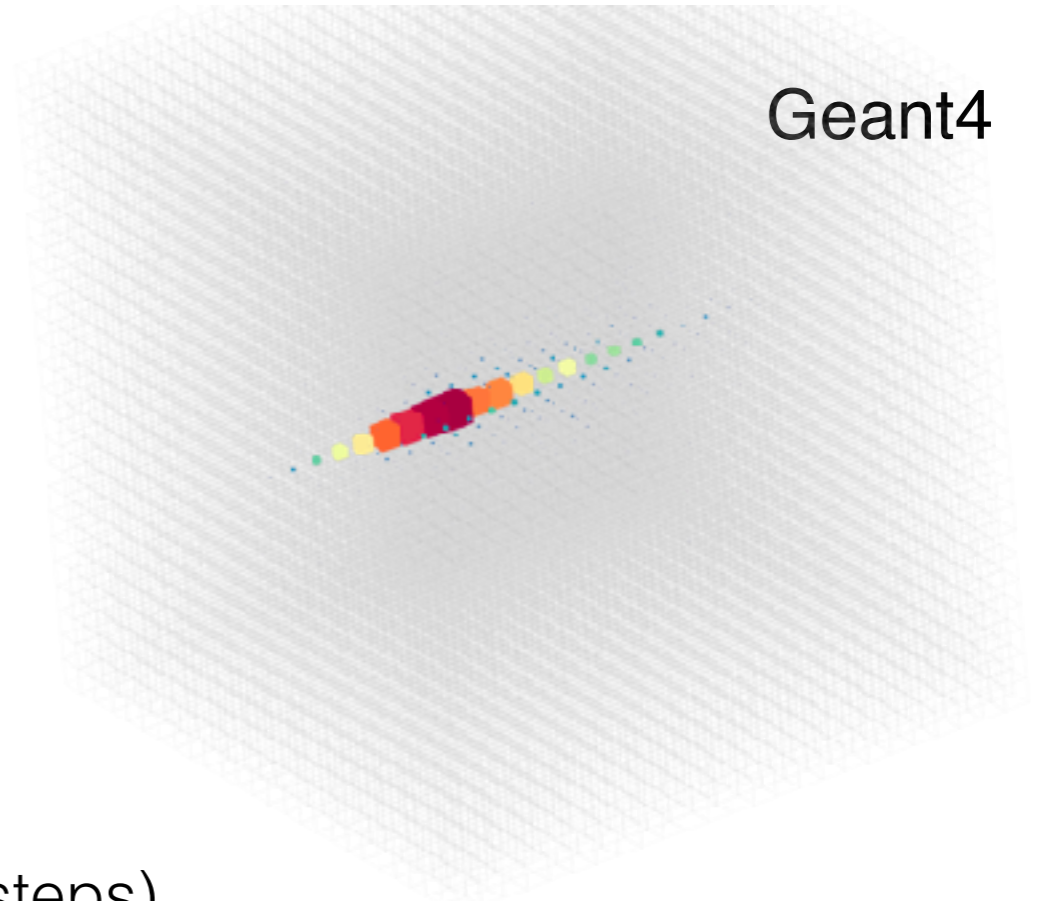
- Simultaneously train two models:
 - Generative model G that captures the data distribution
 - Discriminative model D that estimates the probability that a sample came from the training data rather than G



- Models implemented in keras (tensorflow backend)
 - blocks of Conv3D, Rectified Linear Units, Batch normalisation

Training GANs

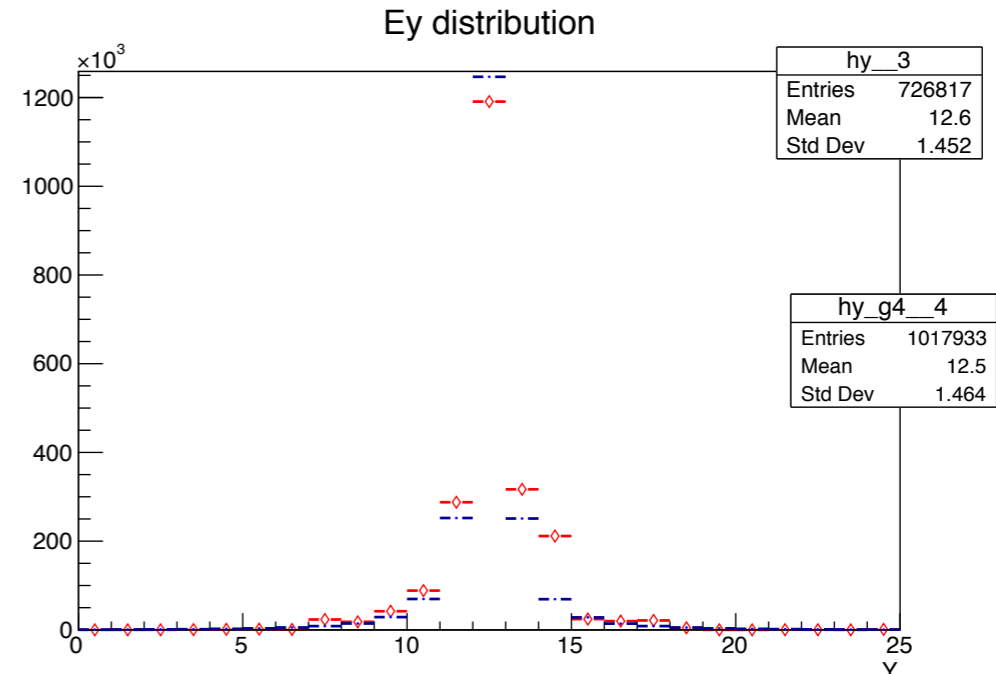
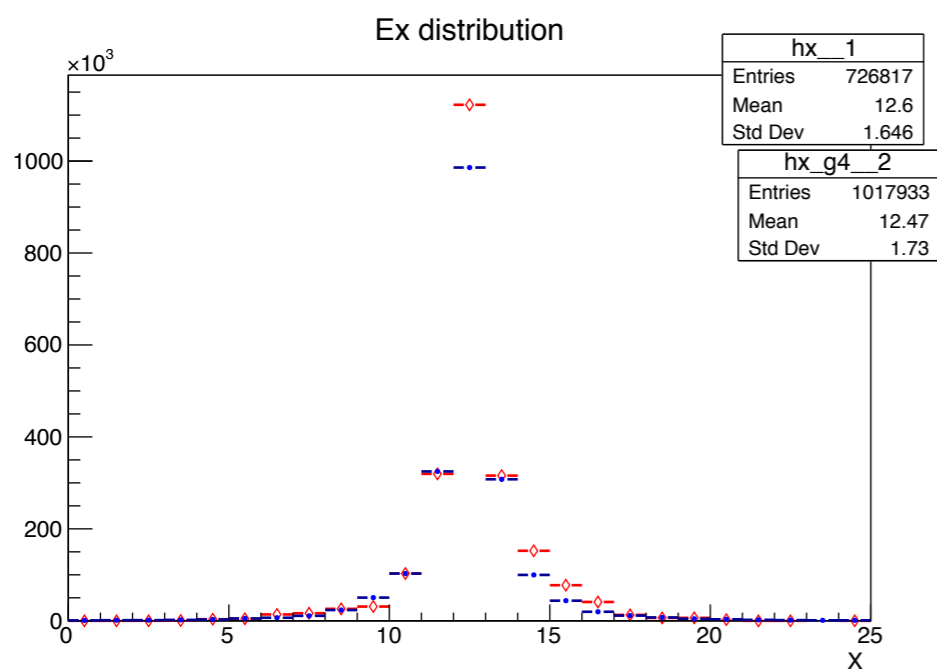
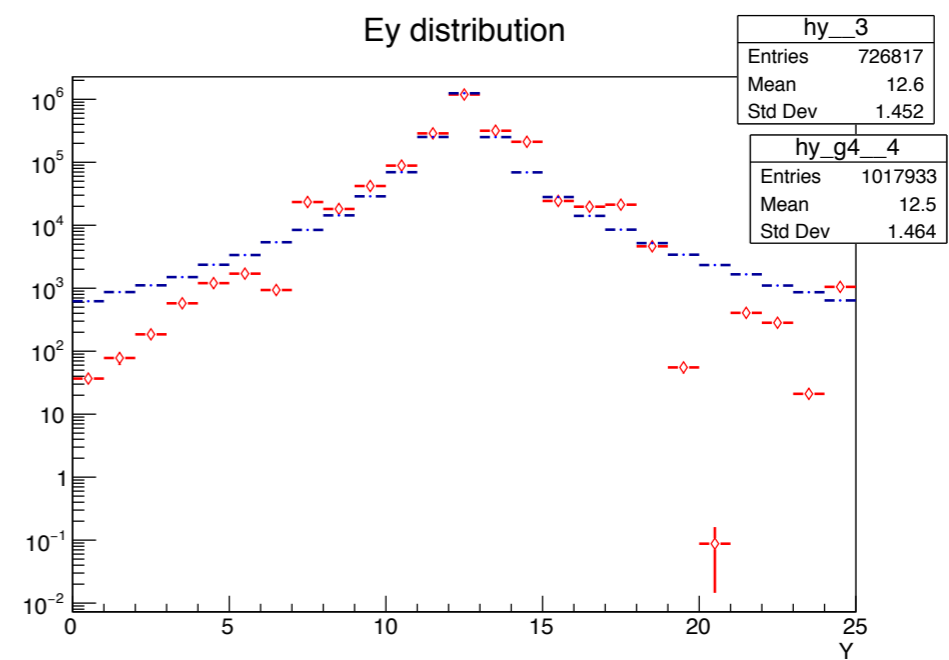
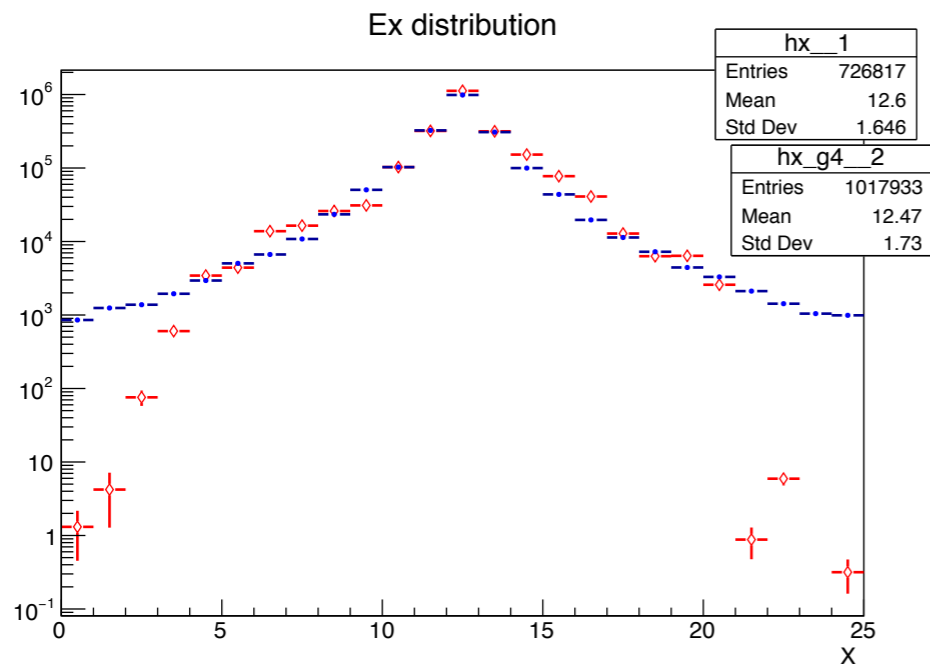
- Preprocess LCD data
 - Mean/RMS
 - shuffle e/gamma events ($95 < E < 105$ GeV)
- Training
 - Adam optimiser
 - Gradient descent (discr/gen alternating steps)
 - batched training (size=100)
 - 50 epoch on SandyBridge 2*10cores + NVidia GTX1080



GAN generated

Transverse distributions

- Reasonable x,y mean
- underestimate tails
- larger core distribution



Longitudinal Profile

- GAN shower start earlier along the z axis

Next steps:

- Fix preprocessing
- Introduce minibatch discrimination to help convergence (arxiv.org/1606.03498)
- Set up higher level criteria for validation
 - PandoraPFA for shower reconstruction (<https://github.com/pandorapfa/LCContent>) and CALICE electron/pion/proton selection (2015 JINST 10 P12006)

