



Deep learning for fast simulation: development for distributed computing systems

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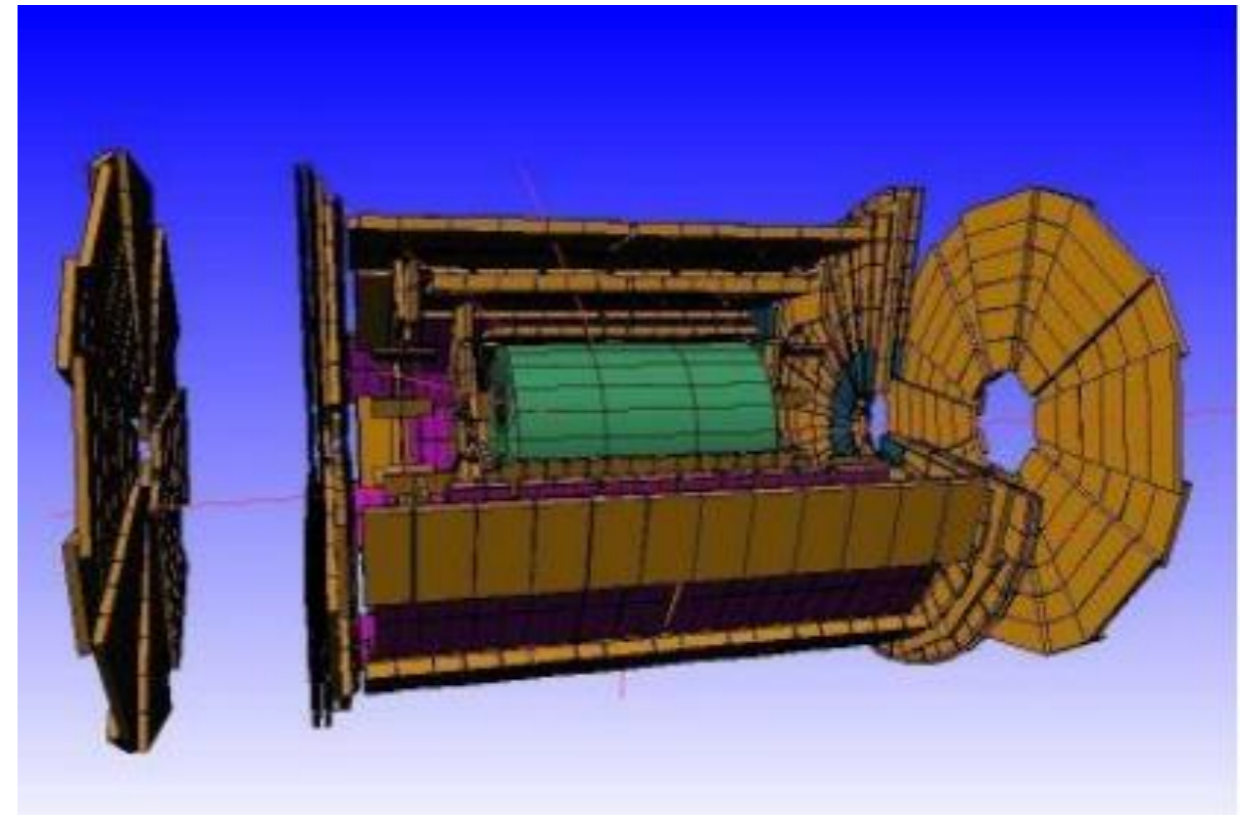
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Outline

- Introduction
- GANs
- Our model
- Results and conclusion

Background: what is Geant4?

- C++-based toolkit used to simulate the passage of particle through matter
- Geant4 is the dominant full detector simulation program and has been for years
- Geant4 can't use processor cores efficiently
- It can't be easily restricted to include this support



Geant4 gallery - ATLAS detector

GeantV

A new prototype for a particle transport simulation developed to improve physics accuracy and performance on modern computer architectures.

We want to:

- have a generic interface in GeantV capable of using different fastsim options including ML based
- reproduce particle interactions with matter in a detector and provide related quantities such as energy or particle type

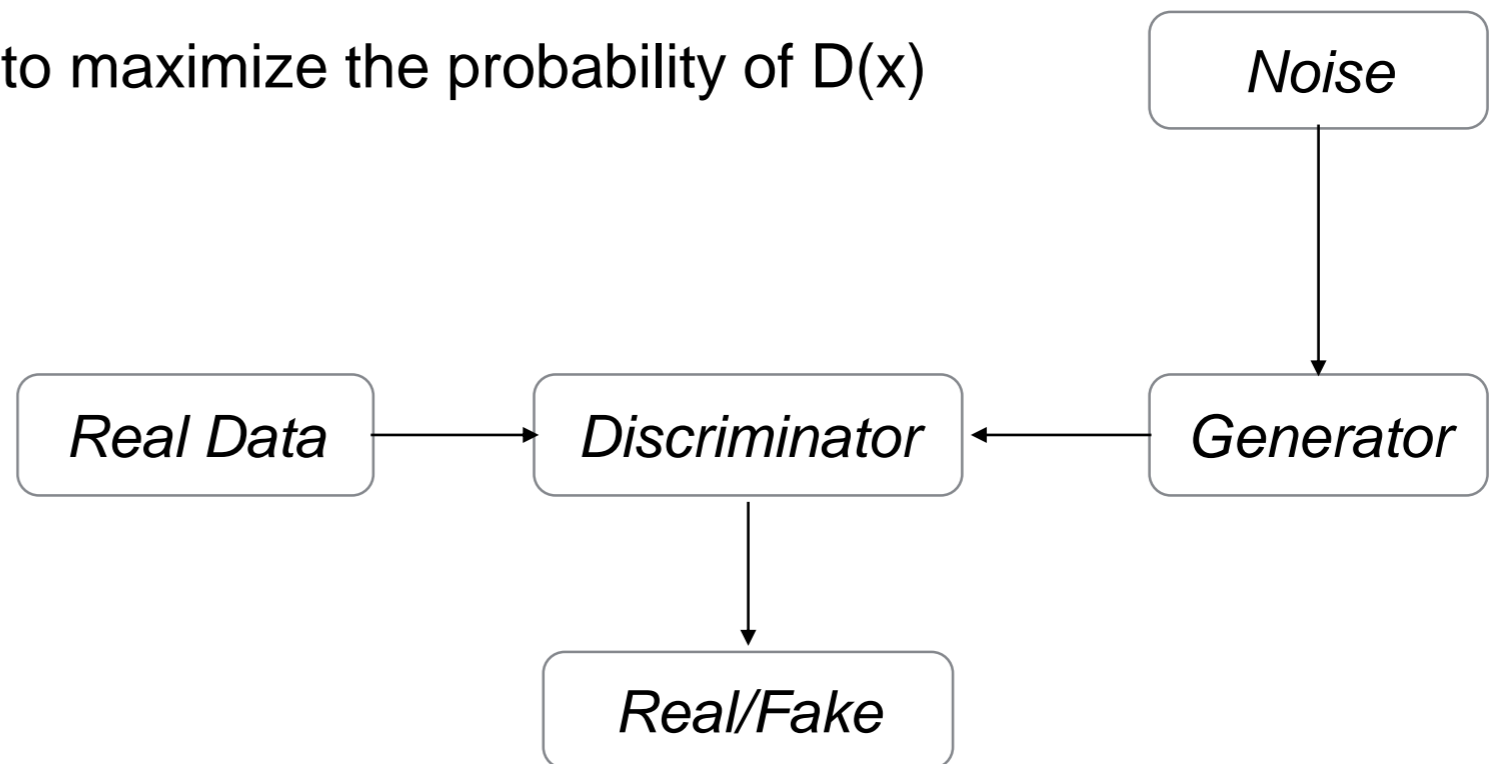
Generative Adversarial Networks!

Generative Adversarial Networks

Two models:

- $D(x)$ classifies images: fake or real
- $G(x)$ produces images taking as input some random noise

Training procedure for $G(z)$ is to maximize the probability of $D(x)$ making a mistake



GAN results



Samples of images of bedrooms generated by a DCGAN trained on the LSUN dataset.

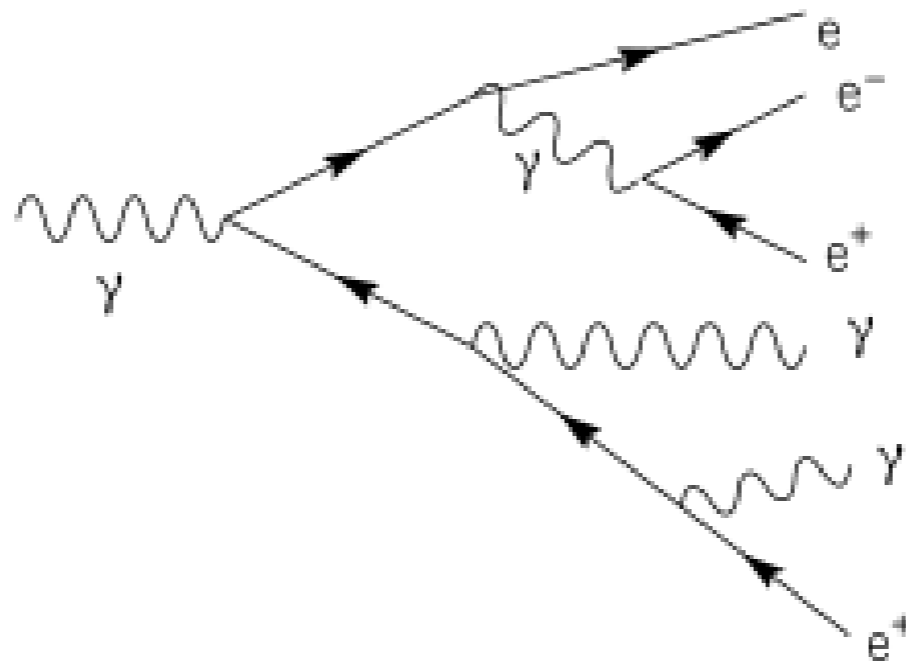


Samples drawn trained on the CIFAR-10 dataset

<https://arxiv.org/pdf/1701.00160v1.pdf>

My task

- build the GANs to simulate a particle shower in a detector



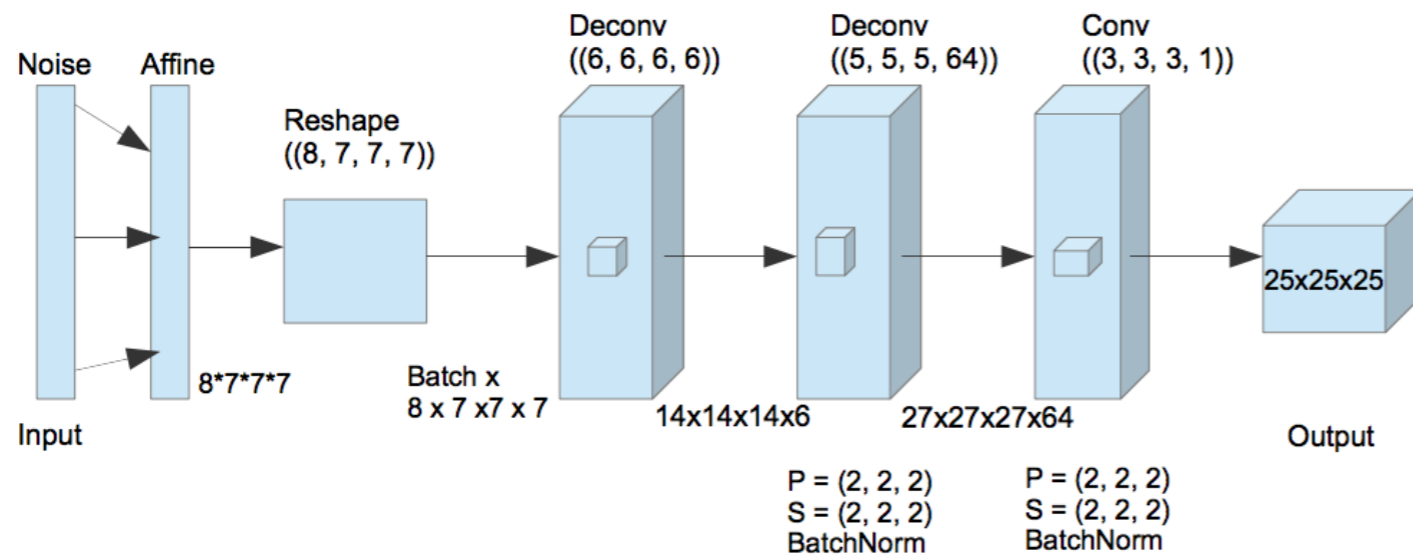


neon

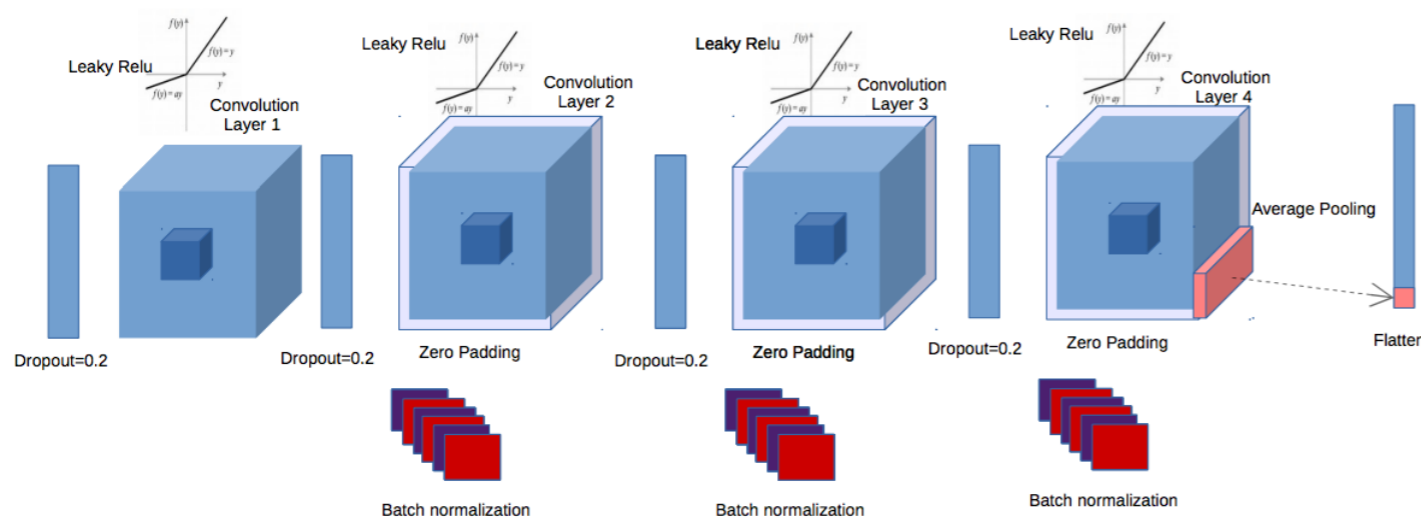
- new deep learning framework committed to best performance on all hardware
- designed for ease-of-use, extensibility and « out-of-the-box » scaling through multiple nodes.

<http://neon.nervanasys.com/index.html/>

neon model



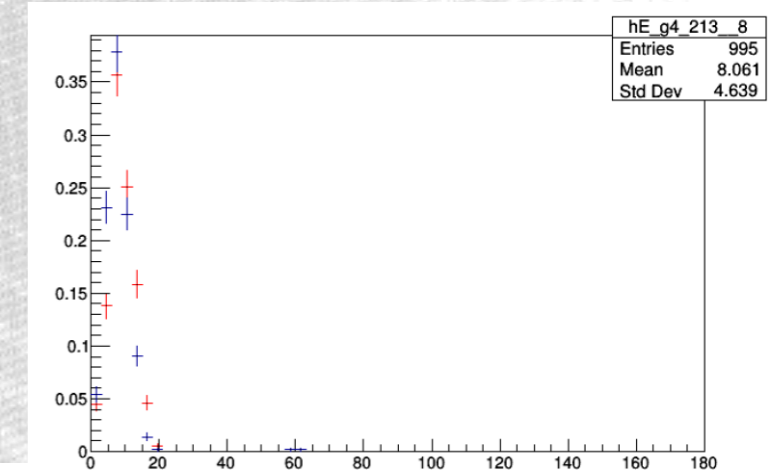
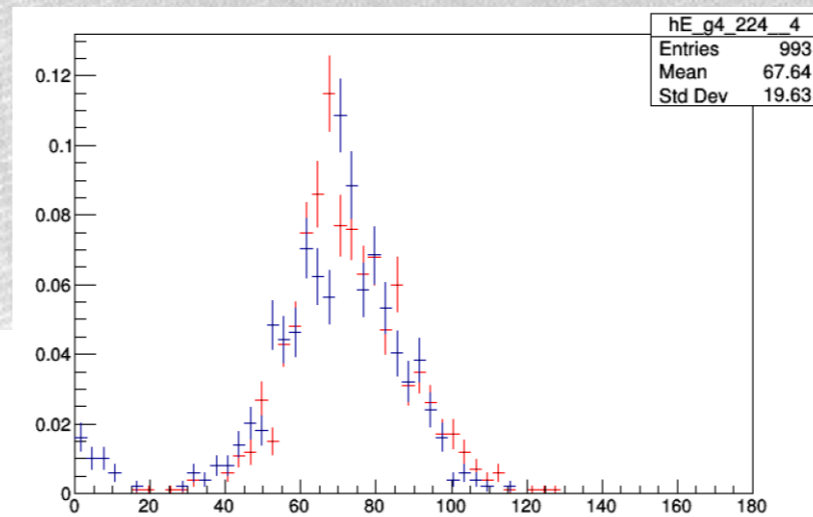
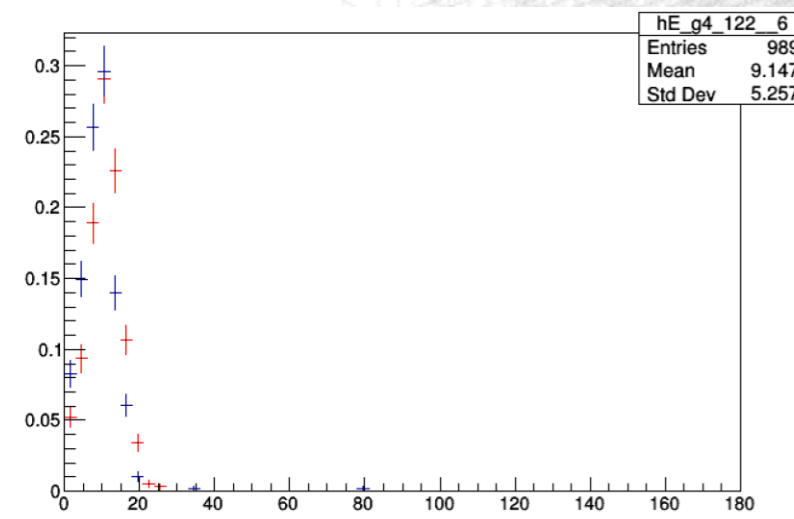
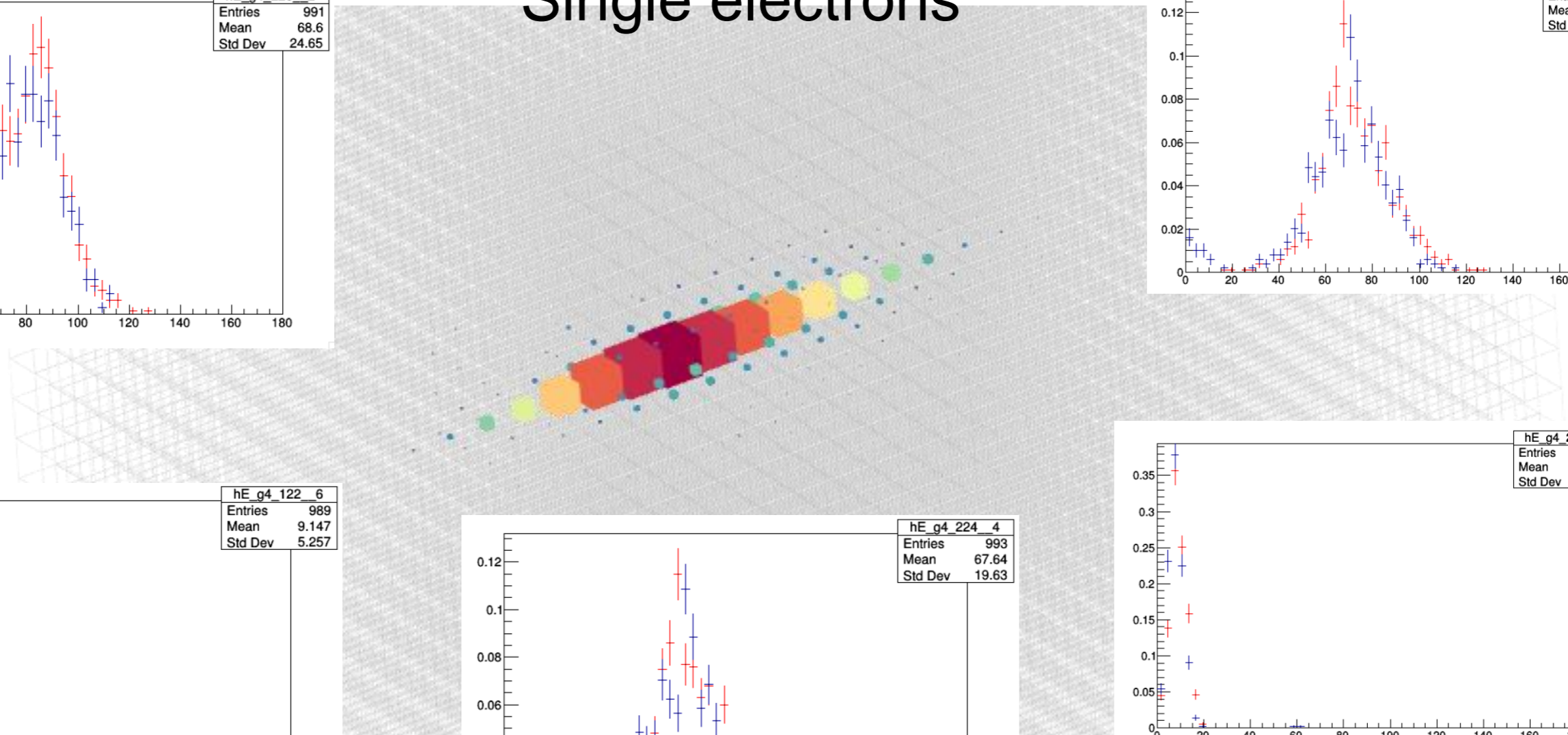
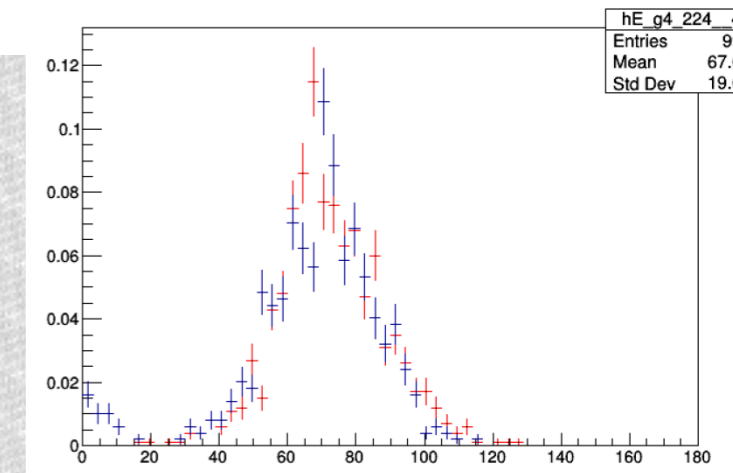
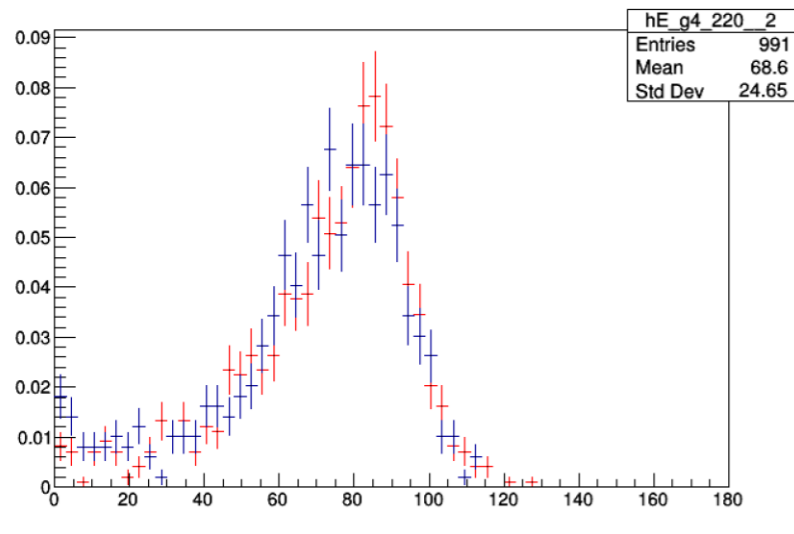
Generator



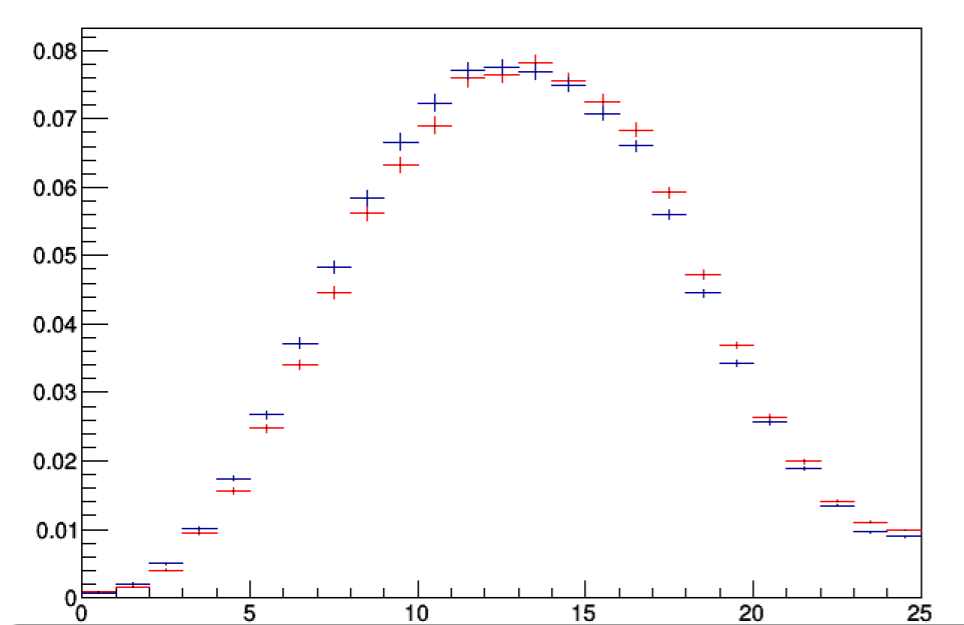
Discriminator

LCD calorimeter showers

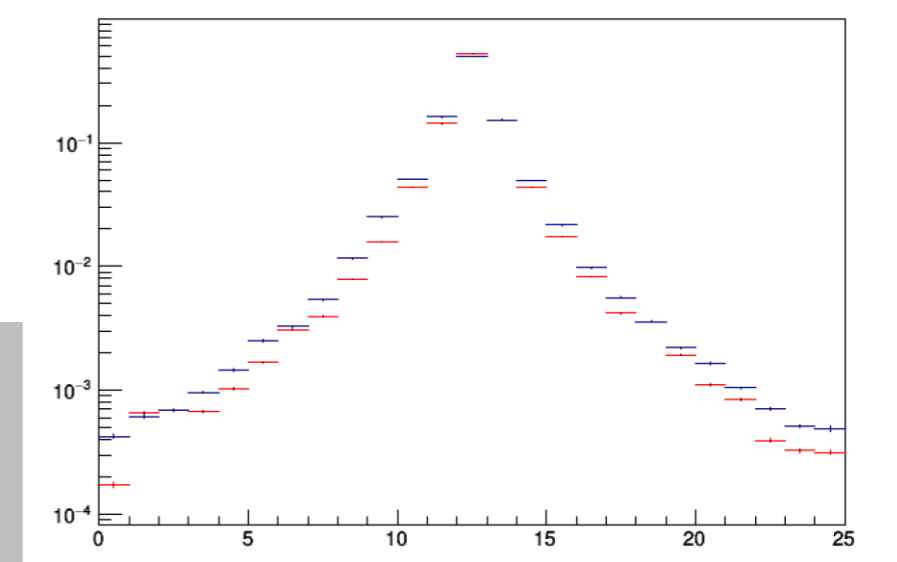
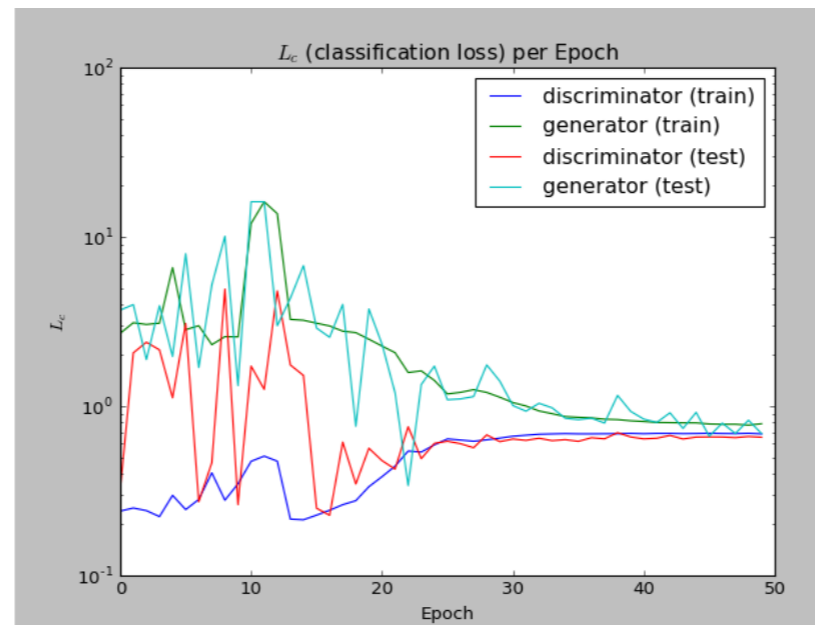
Single electrons



LCD calorimeter showers



Shower longitudinal section



Shower transverse section

Conclusion and plans

- keep working on implementation
- add parametrisation
- testing with different parameters on different architectures
- train on CPU clusters not only GPU clusters

Thank you!