ZDC Simulation with ML

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* Time: 10:00-11:00 AM at Taiwan (GMT+8)

* Zoom link:

https://cern.zoom.us/j/66342263280?pwd=DBemHUOnO6QIiQyU5y2WbeaEaBGcyT.1

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Calorimetor simulation with the diffusion model

- A Comprehensive Evaluation of Generative Models in Calorimeter Shower Simulation
https://arxiv.org/abs/2406.12898

- **CaloDiffusion**
Denoising diffusion models with geometry adaptation for high fidelity calorimeter simulation
https://arxiv.org/abs/2308.03876 Phys. Rev. D, 108, 072014 (2023)
https://lss.fnal.gov/archive/2023/slides/fermilab-slides-23-052-ppd.pdf

- **CaloScore**
Score-based Generative Models for Calorimeter Shower Simulation
https://arxiv.org/abs/2206.11898 Phys. Rev. D 106, 092009 (2022)
CaloScore v2: Single-shot Calorimeter Shower Simulation with Diffusion Models
https://arxiv.org/abs/2308.03847
https://github.com/ViniciusMikuni/CaloScoreV2

- Choose Your Diffusion: Efficient and flexible ways to accelerate the diffusion model in fast high energy physics simulation
https://arxiv.org/abs/2401.13162

A Comprehensive Evaluation of Generative Models in Calorimeter Shower Simulation
https://arxiv.org/abs/2406.12898

- While GAN-based models can generate showers faster than other generative models, it is challenging to train GANs due to the difficulty of converging and 'mode collapse'.

- VAE-based models can generate samples of calorimeter showers faster than Geant4 and GAN. However, they lack in quality of samples. Nevertheless, VAE-based models are used along with other GAN-based models, Normalizing Flow (NF) and Diffusion models.

- Among the generative methods, NF and Diffusion-based models have shown promising performance in generating shower samples with high fidelity. However, Diffusion-based models are slower in sampling, and NFs require a constraint bijective mapping making flow models restrictive.

A Comprehensive Evaluation of Generative Models in Calorimeter Shower Simulation
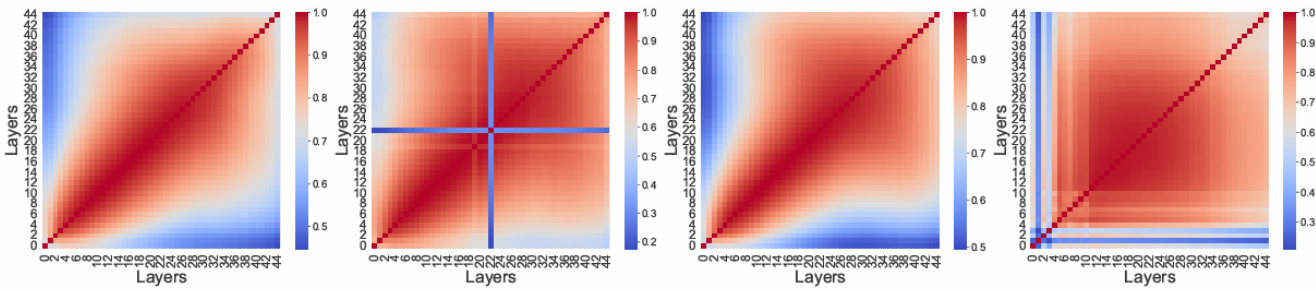## https://arxiv.org/abs/2406.12898
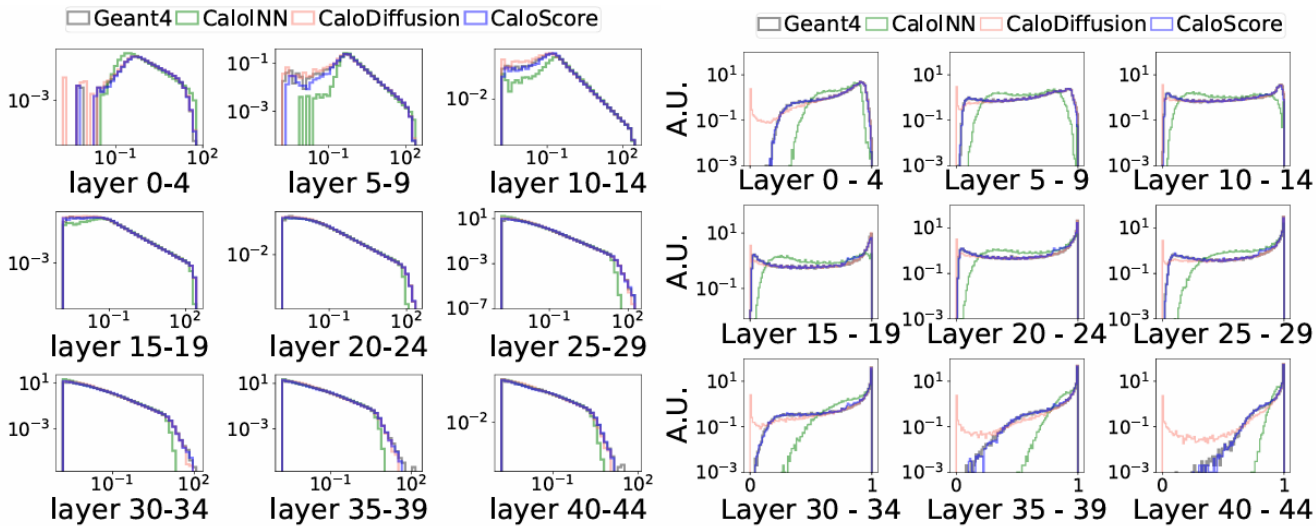
(a) Layer energy distribution (GeV)

(b) Distribution of sparsity

Figure 1: Histogram of two physics observables for dataset 2.

(a) Geant4

(b) CaloScore

(c) CaloDiffusion

(d) CaloINN

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- Our evaluation revealed that the CaloDiffusion and CaloScore generative models demonstrate the most accurate simulation of particle showers, yet there remains substantial room for improvement. We identified areas where the evaluated models fell short in accurately replicating Geant4 data.