Overview of the recent Generative Adversarial Models and their use in High Energy Physics

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GANs-what are they?

D: Detective

A properly trained GAN can provide both:

- **Data Generator**
- **Data Discriminator**

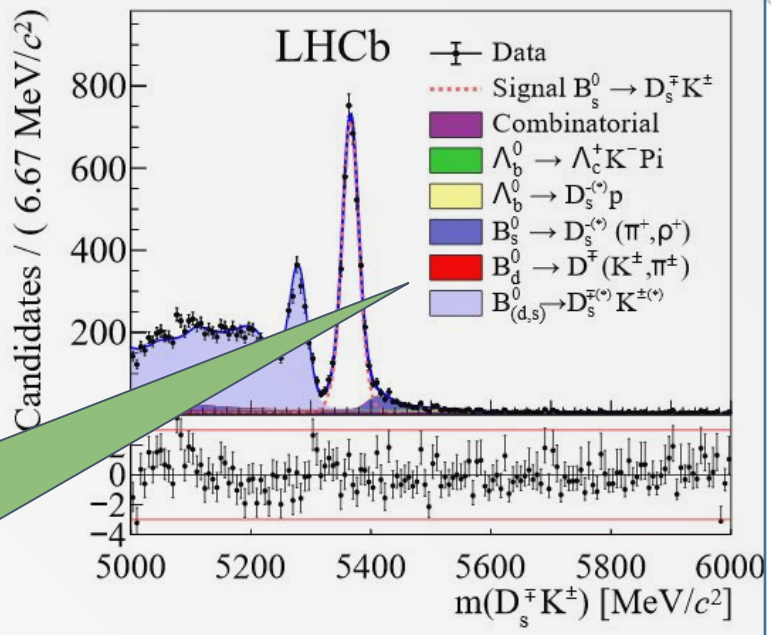
R: Real Data

G: Generator (Forger)

I: Input for Generator

What's the project about?

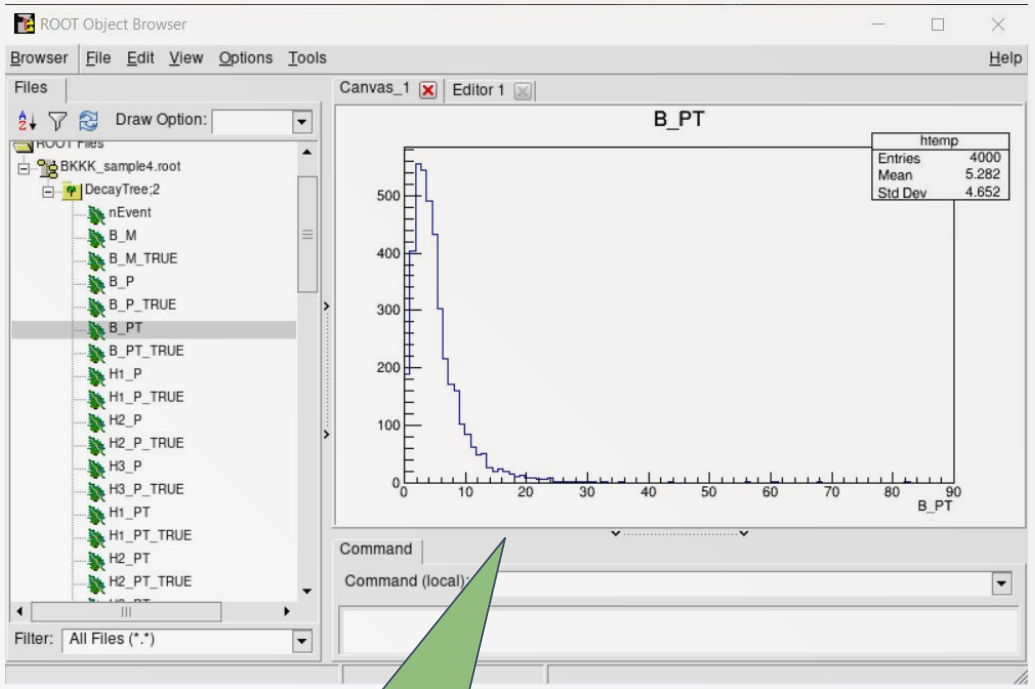
- The main goal of the project is to learn GAN to duplicate physical data of the rare physical decays
- The enhanced task, that may be continued based on the studies done so far, is to use the trained discriminator to selection process on the real data



Various decay channels are often similar to each other, which makes the selection process very tough, which is the place where GAN can be potentially used.

General information

- The *B->K+K-K+* decay was selected and generated using *RapidSim*
- Original data are stored in .root files
- The project was done using Python
- To incorporate the .root data into *Python*, the special I/O library *uproot* was used https://github.com/scikit-hep/uproot
- Keras implementation of non-standard variants of GANs were inspired by https://github.com/eriklindernoren/Keras-GAN
- The project was developing here: https://github.com/MichalKacprzak99/reconstruction_particle_mass_spectra/tree/master/files



Original data in the .root format

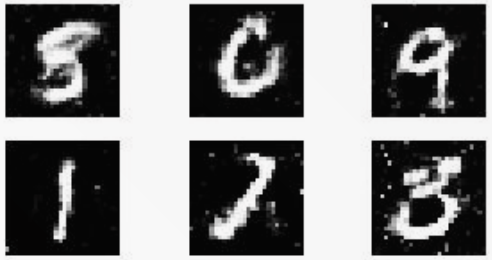
Top challenges for training

- Preventing GAN from overtraining
- Optimization of hyperparameters (training algorithm's step, number of hidden layers, batch size)
- Keeping both generator and disciminator at the same pace; **if one trains much faster than the second, the second will stop train at all!**
- Calculating the precision (choosing the loss function and quality evaluation)

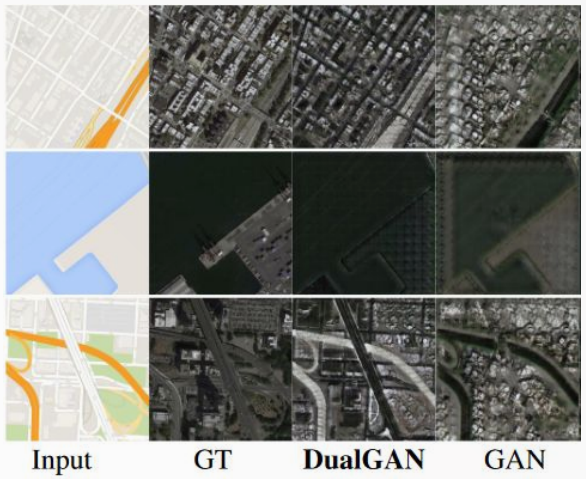
Various variants of GANs

Four most popular variants of GANs were taken under investigation

- GAN (Generative Adversarial Network)



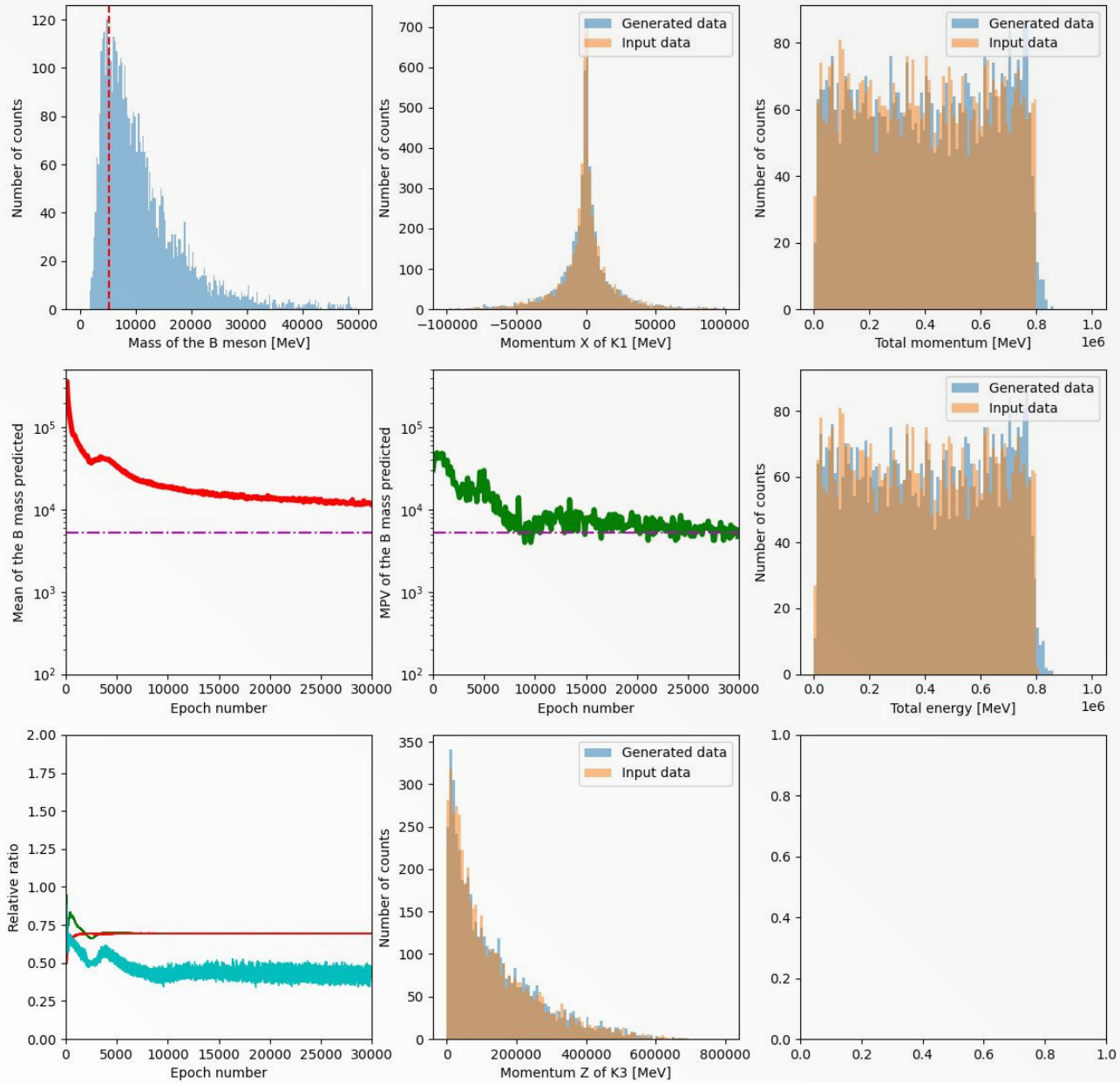
- DUALGAN



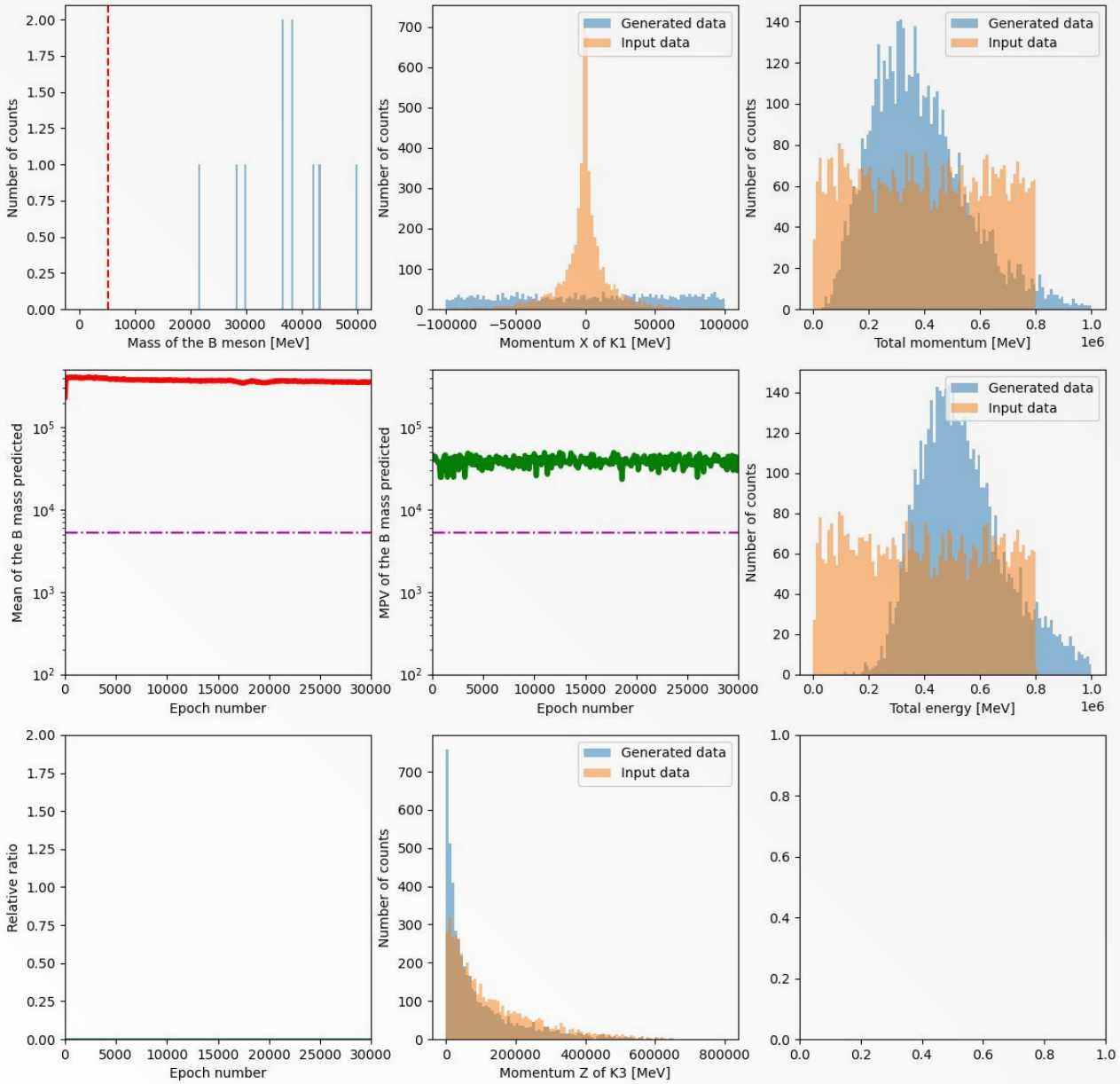
- WGAN (Wasserstein GAN)

- BGAN (Boundary-Seeking GAN)

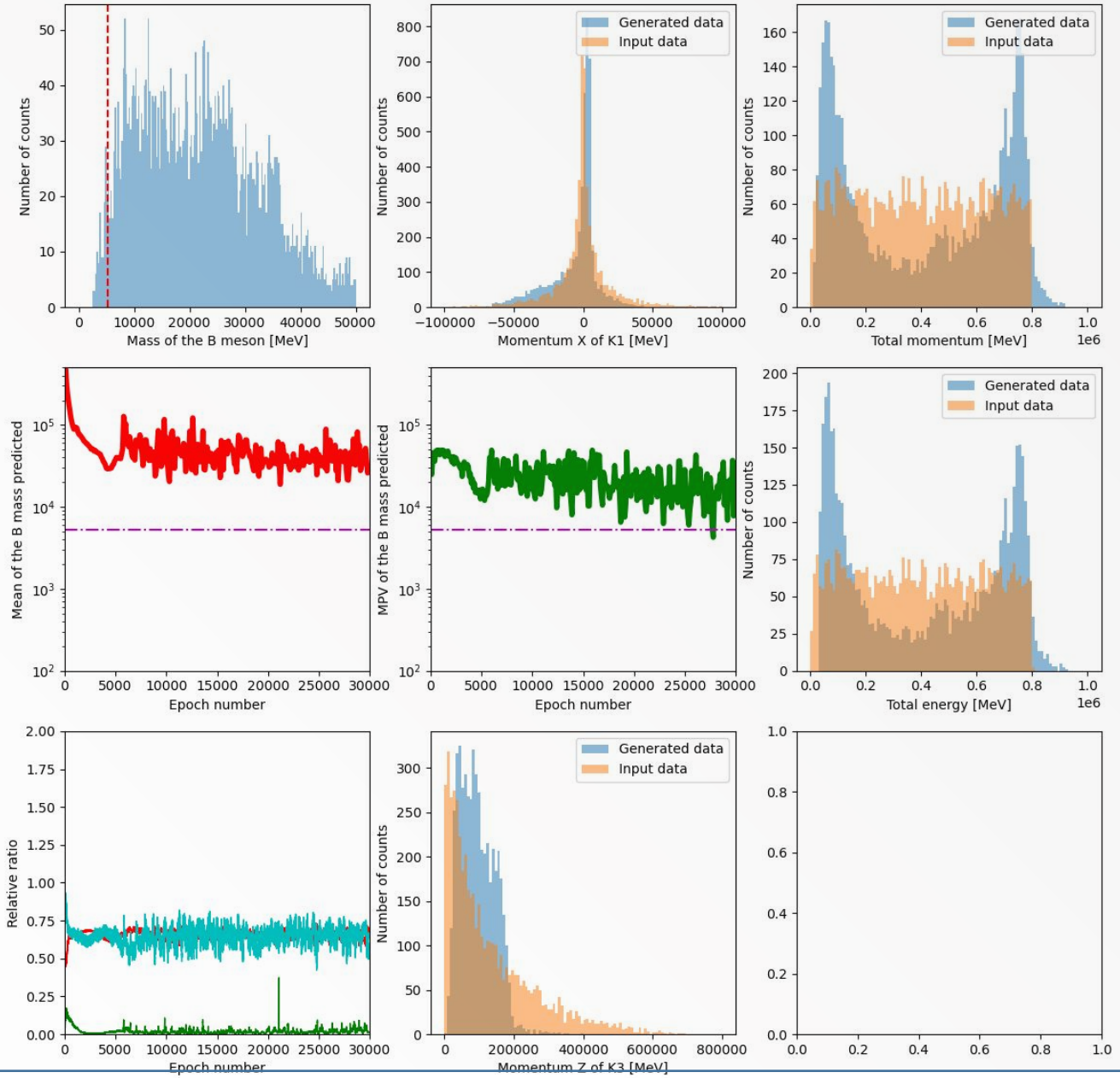
GAN - 30000 EPOCH



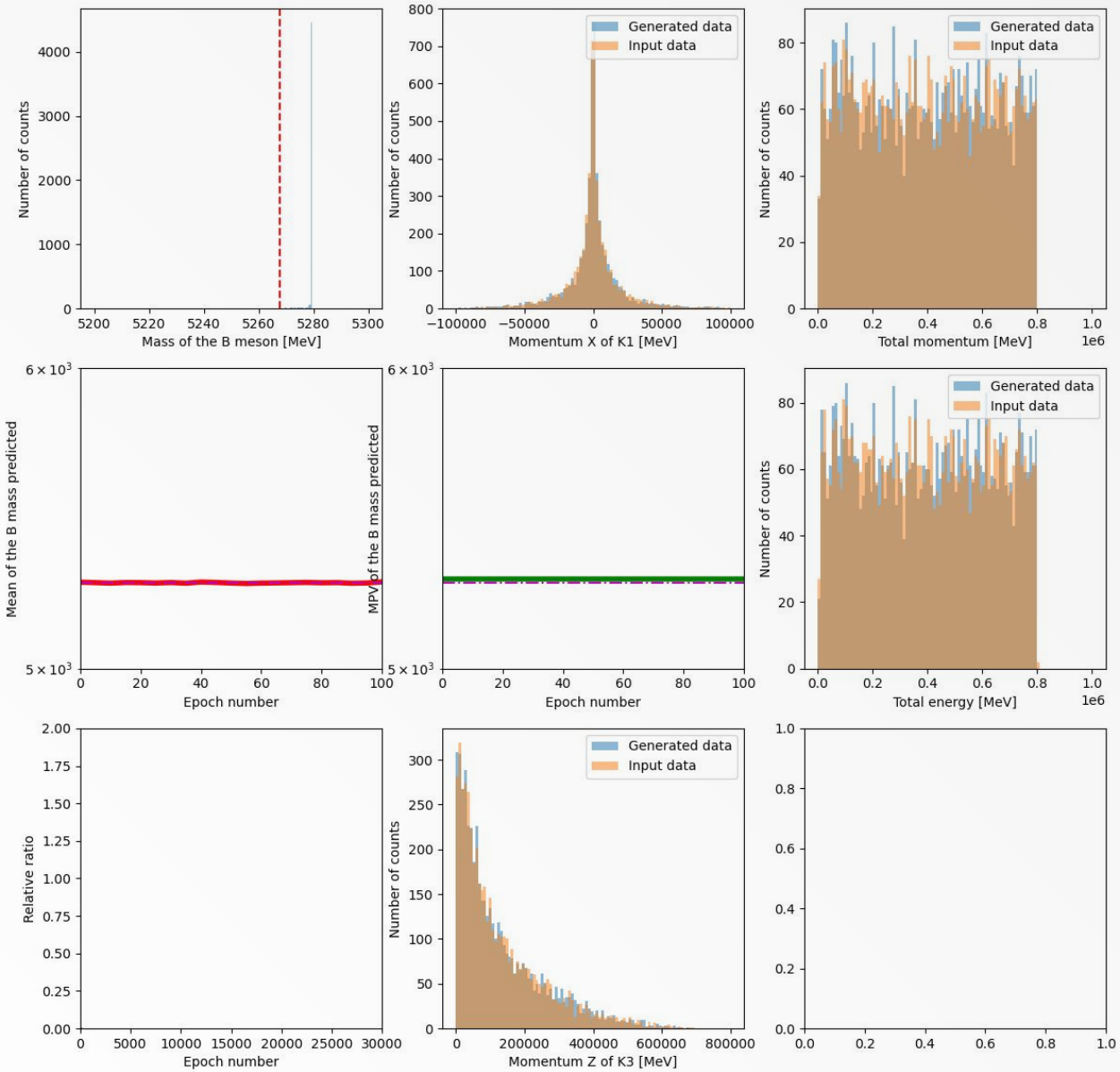
WGAN - 30000 EPOCH



BGAN - 30000 EPOCH



DUALGAN - 100 EPOCH



Thank you for attention