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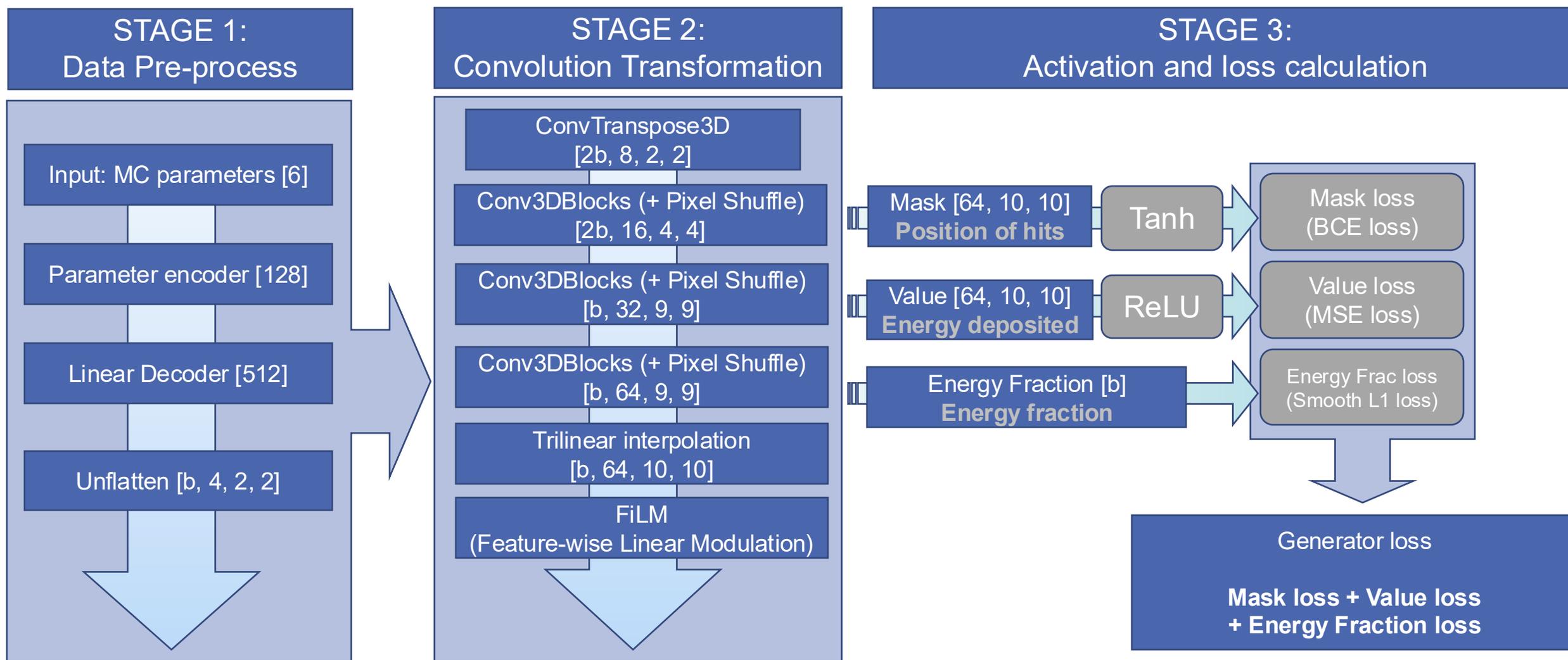
ZDC-ML Status update

2025/11/13

ZDC Internal weekly

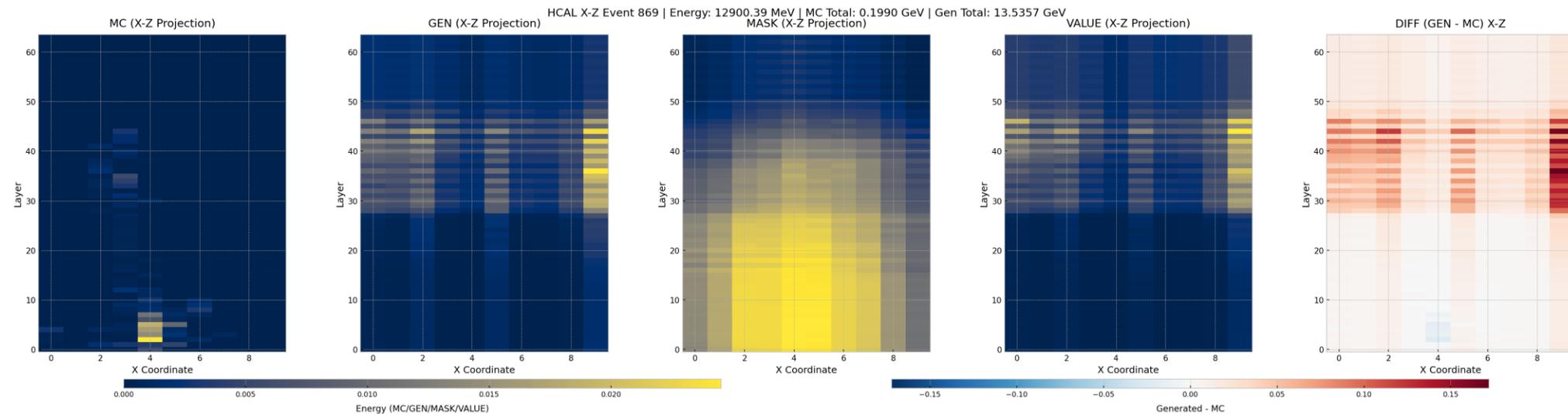
WAI YUEN CHAN

In ZDC-ML v5, we have added HCAL generator with energy fraction as a loss.

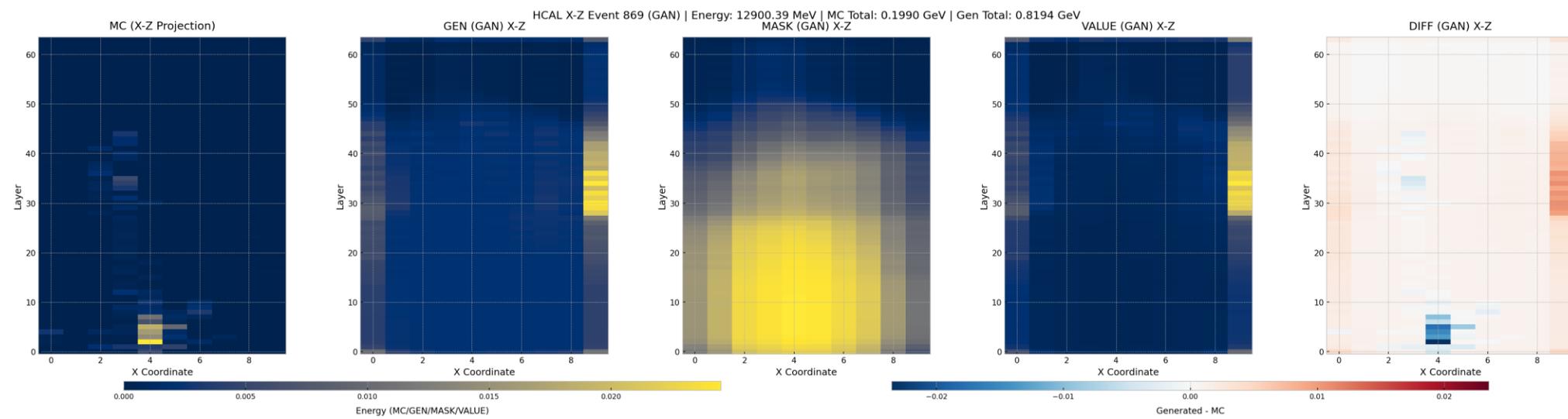


We make 2 key changes into the HCAL generator:

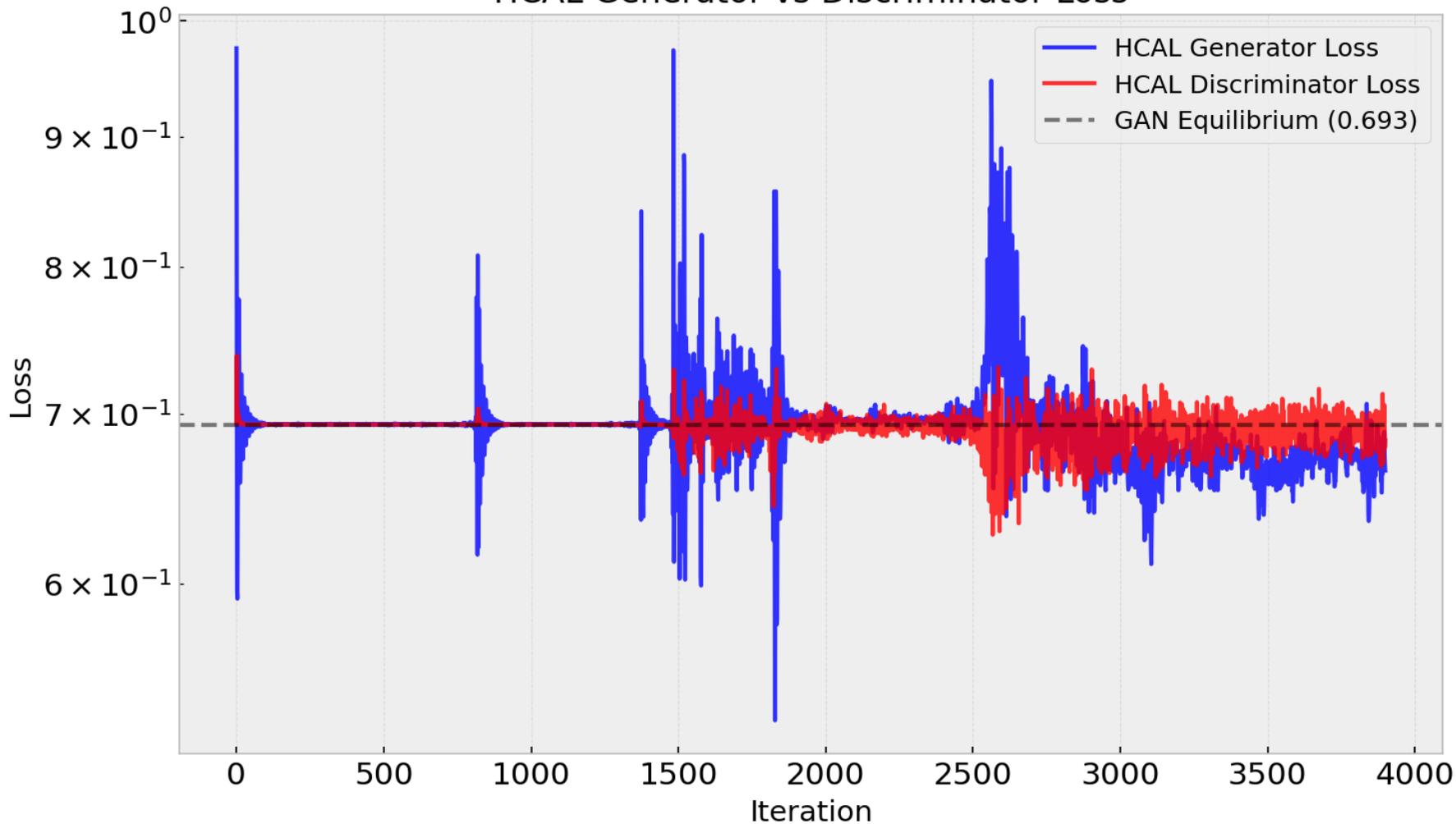
1. Mask Value Coupling: Before the logic is Mask + Value, the model learn them as 2 separated features.
 - Now we use Mask x Value, so that the model also consider their coupling
2. Layer-Layer interaction has been added into the model
 - Basic RNN, inspired by Hsin-Yu's slides in last ML meeting.
 - Simply run though the layers one-by-one to learn the energy distribution in X-Z plane.



Also, we need a extremely fine-tuning to ensure that the training is not going to weak or too strong.



HCAL Generator vs Discriminator Loss

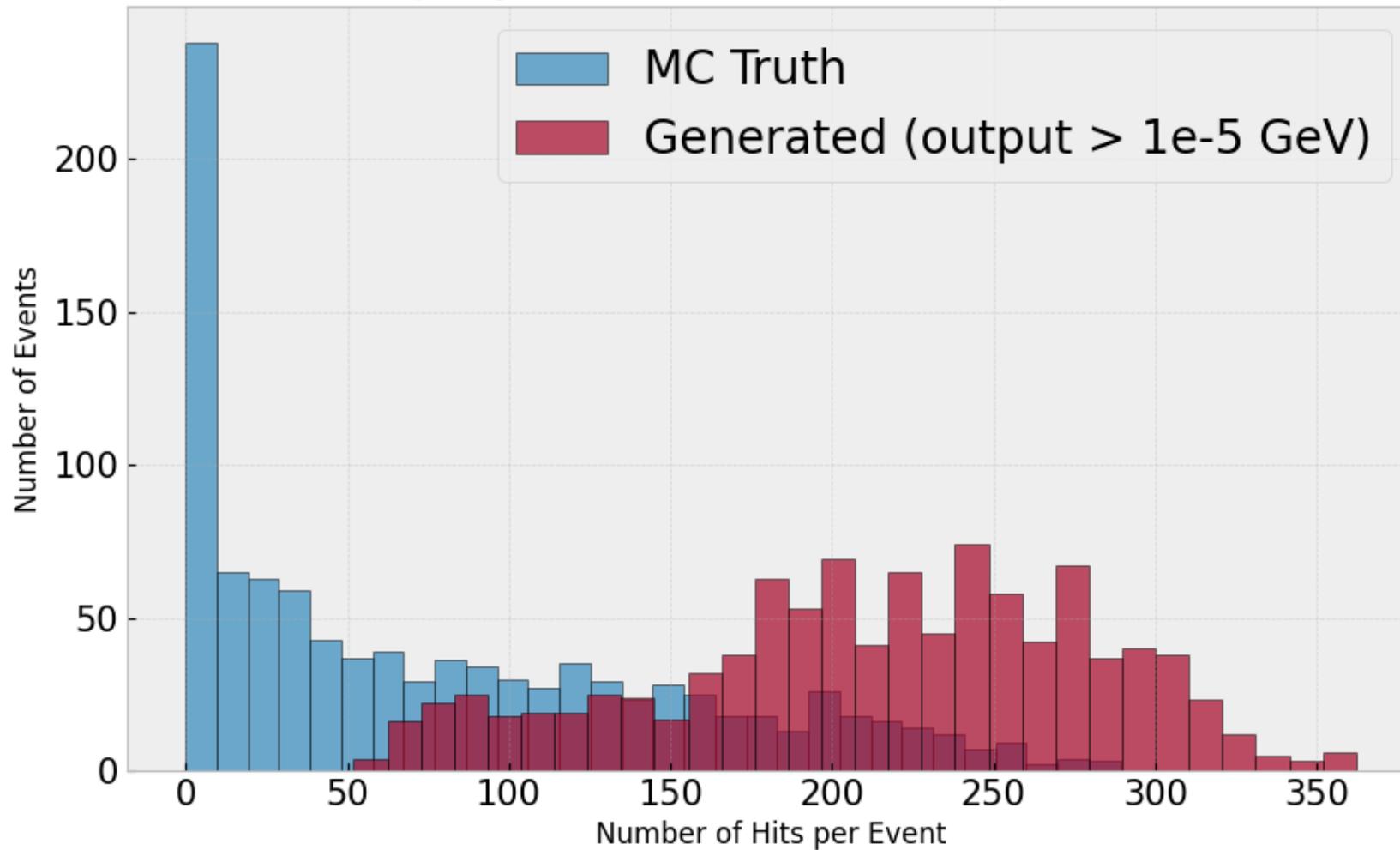


5000 samples, 50 epochs.

We can see that the loss curve is getting noise along the iteration.

Suggesting that the model become more unsure the pattern of the features.

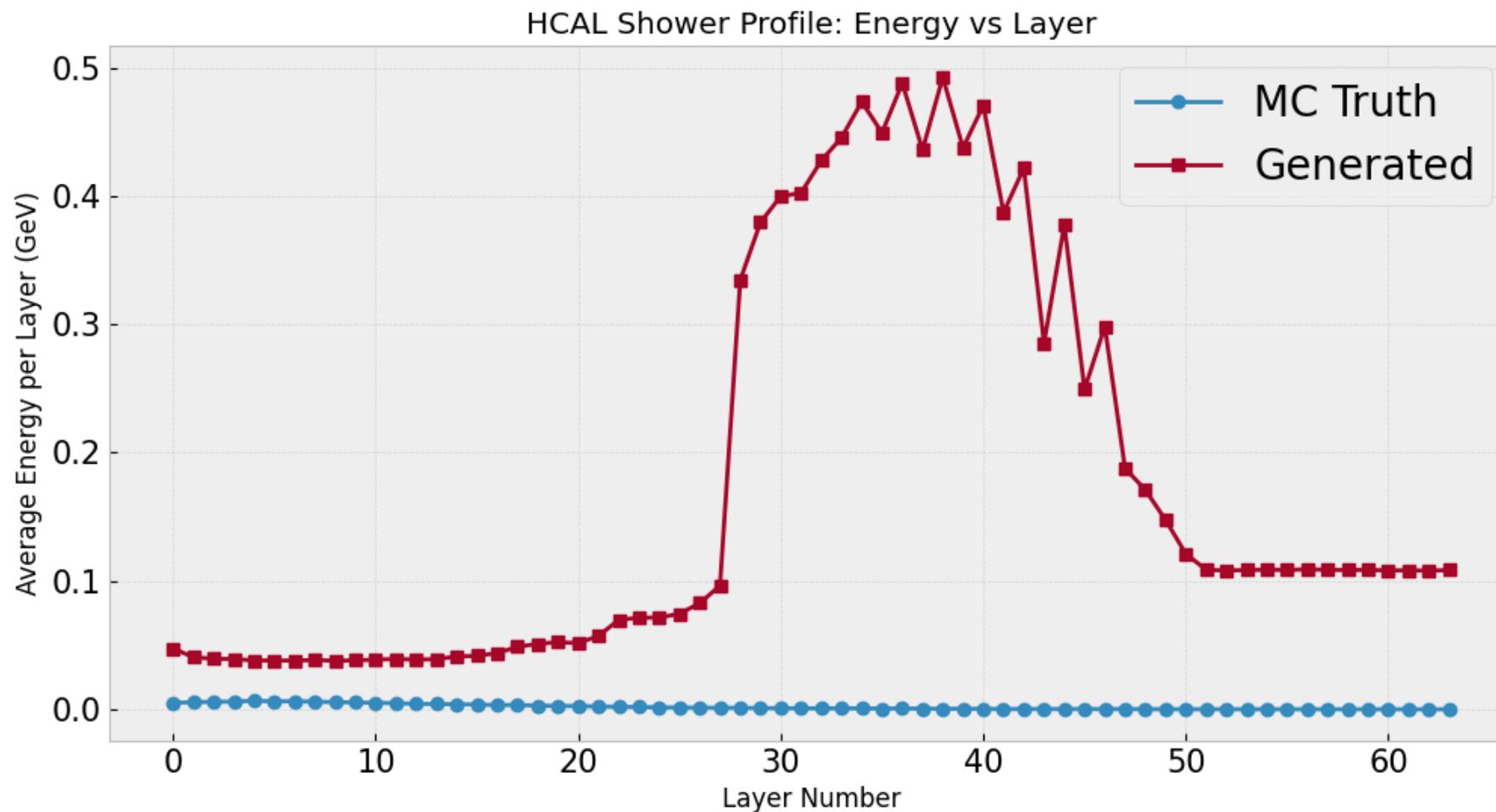
Hit Multiplicity Distribution (Generated: output > 1e-5 GeV)



5000 samples, 50 epochs.

Here we compare the amount of Target (MC truth) and generated hits per event.

It is clear that the model over-predict the number of hits in the HCAL.



5000 samples, 50 epochs.

Here we compare the AVG energy per layer.

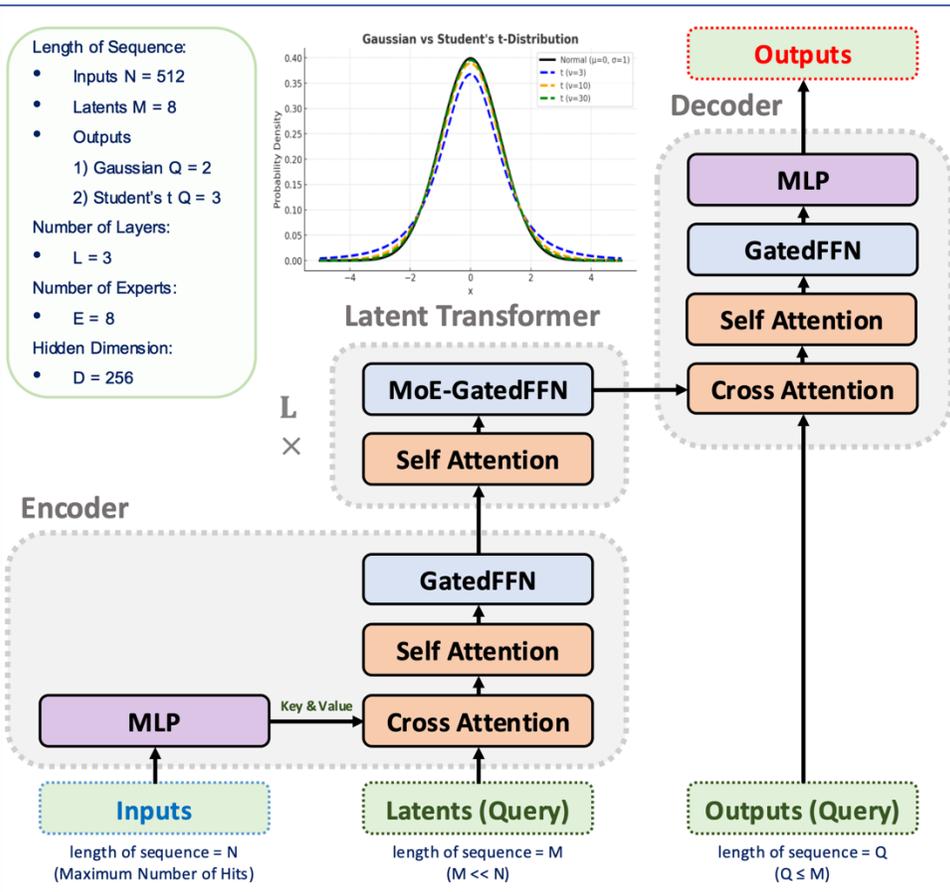
We know that the MC truth have a peak around layer 4, but the generated suggested that the peak is around layer 38.

We try to add more constraint into the model, but the fine-tuning is not practical.

Outlook

- The model should learn how to tune the MASK x VALUE coupling, and the Layer-Layer interaction by itself.
 - We can implement Hsin-Yu's method to do so (See next slides).
- We still need to wrap up the ECAL and HCAL information as there are still independent to each other.
 - We can make it as a first project for Yen-Chen.

This method can be used to constraint the Z-X interaction



For MASK x VALUE coupling, we can first try SwiGLU Gate; then MoE-GatedFFN

