Improving Precision Calculation for LHC

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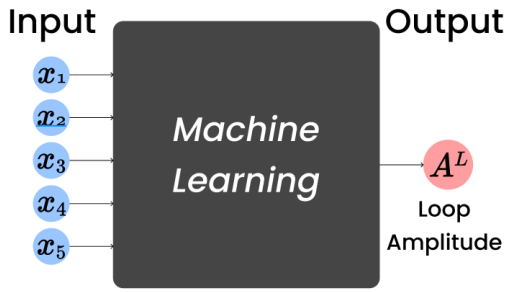
Project: Approximating and Simplifying Loop Amplitude

Research project

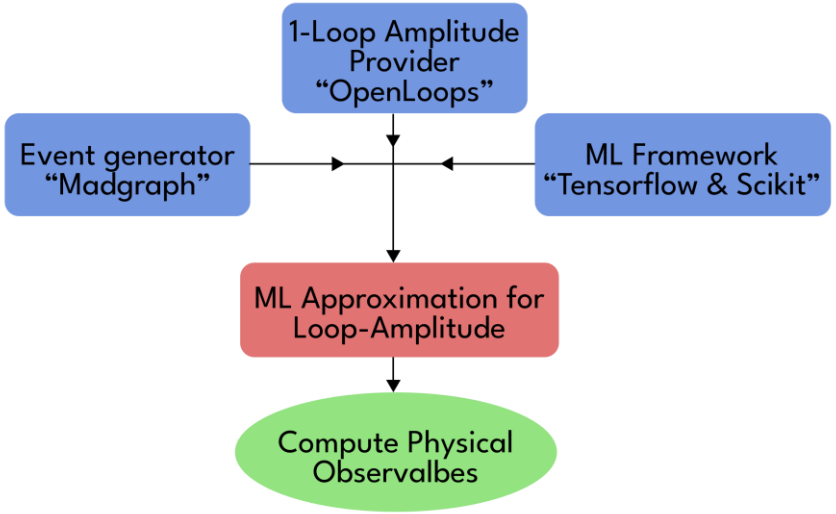


Employ ML to approximate scattering amplitude
Evaluating $A^{(L)}$ is often time consuming
ML will speed up evalution for σ calculation

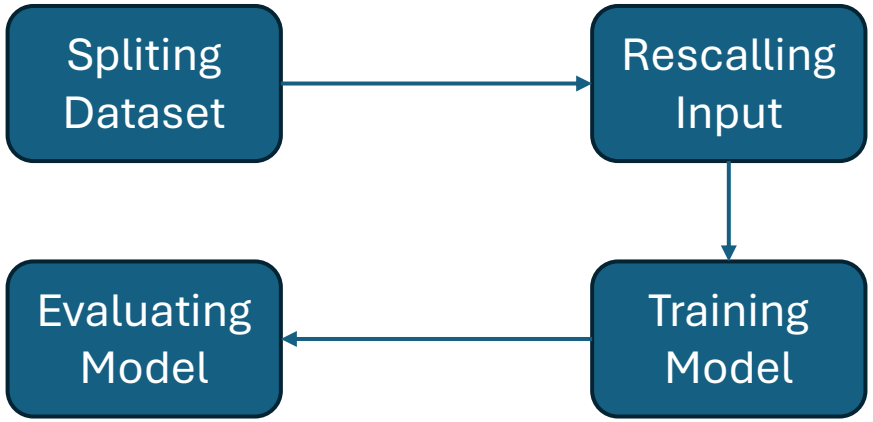
Achievements

1. Constructing a **framework** to apply **machine learning** for **loop scattering** amplitude evaluation
2. Application for simple case [$e^+e^- \rightarrow t\bar{t}$] **(Presented in interim presentation)**
3. Application for complicated case [$u\bar{u} \rightarrow t\bar{t}\gamma$]
    1. Optimization for **small number** of dataset (5.000 dataset)
    2. Check the approximation for **physical observables**

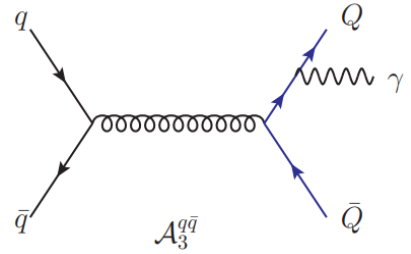
System Framework

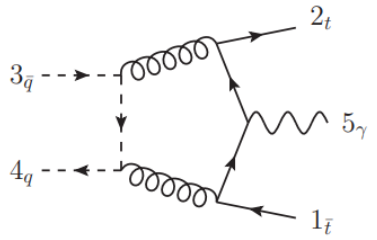


Machine Learning Framework



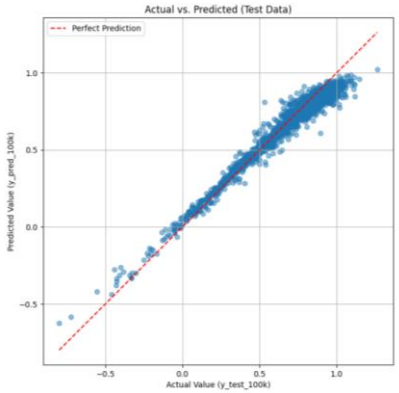
$u\bar{u} \rightarrow t\bar{t}\gamma$





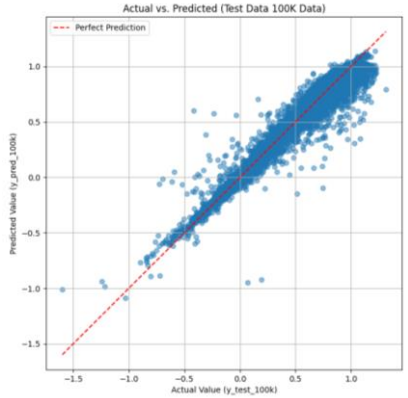
Amplitude: function of 5-variable

After Tuning



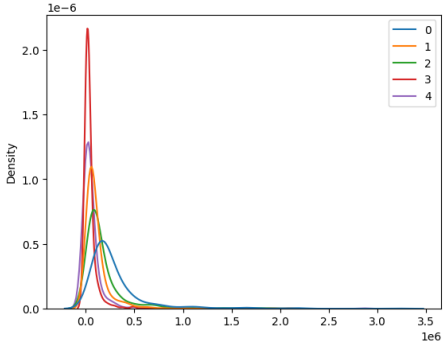
Evaluation Metrics
MSE: 0.00222480
MAE: 0.03739464
R^2 Score: 0.9437

Before Tuning

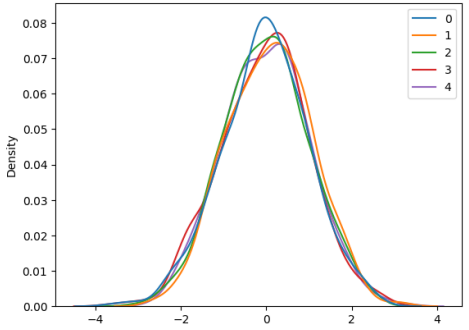


Evaluation Metrics
MSE: 0.00105169
MAE: 0.01511651
R^2 Score: 0.9716

Input Before Scalling



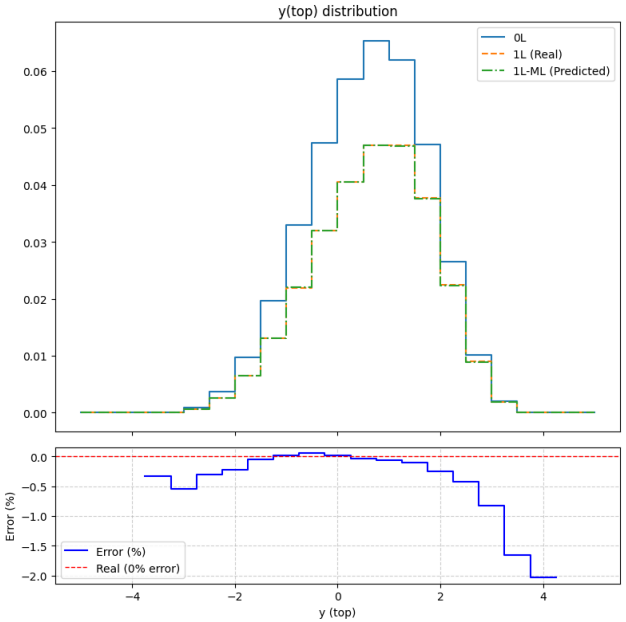
Input After Scalling

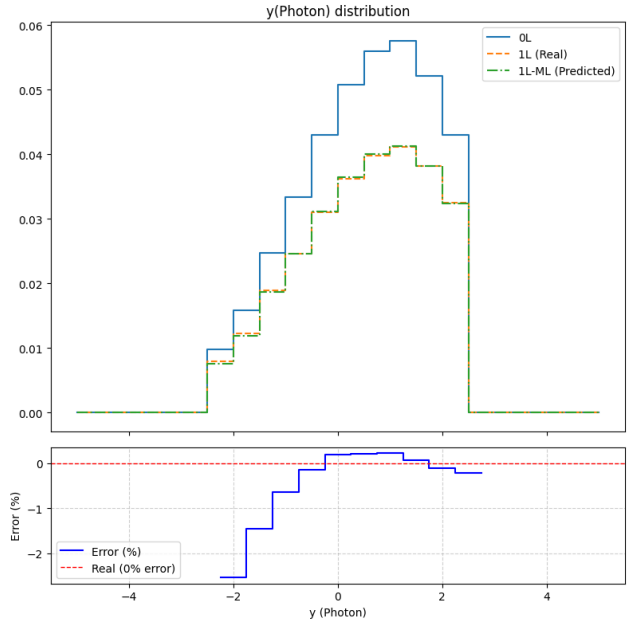


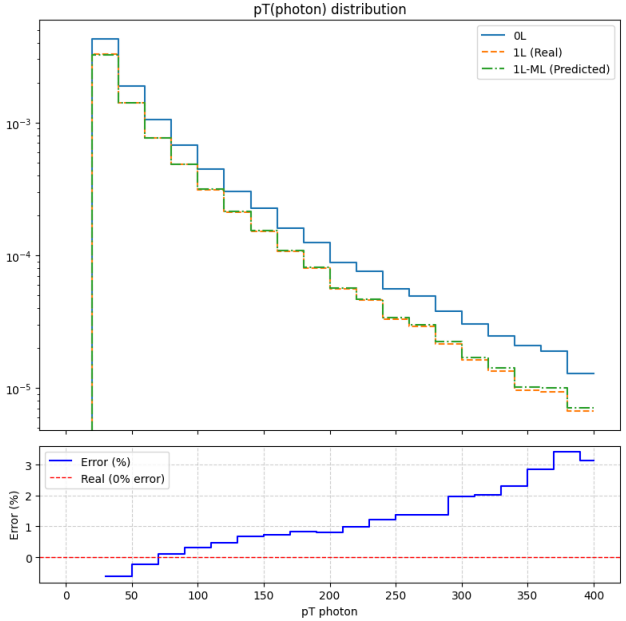
Cross Section

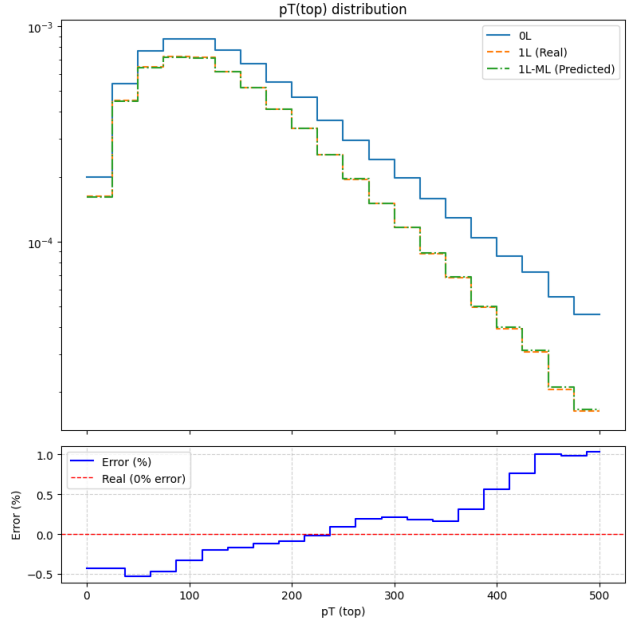
tree level: **0.193111 pb**
one-loop (exact amplitude): **0.141319 pb**
one-loop (approximated amplitude) (10K Dataset): **0.140657 pb**
one-loop (approximated amplitude) (5K Dataset) **[After Tuning]**: **0.140938 pb**

approximation for **physical observables**









Outlook

Try the framework on the two loop amplitude