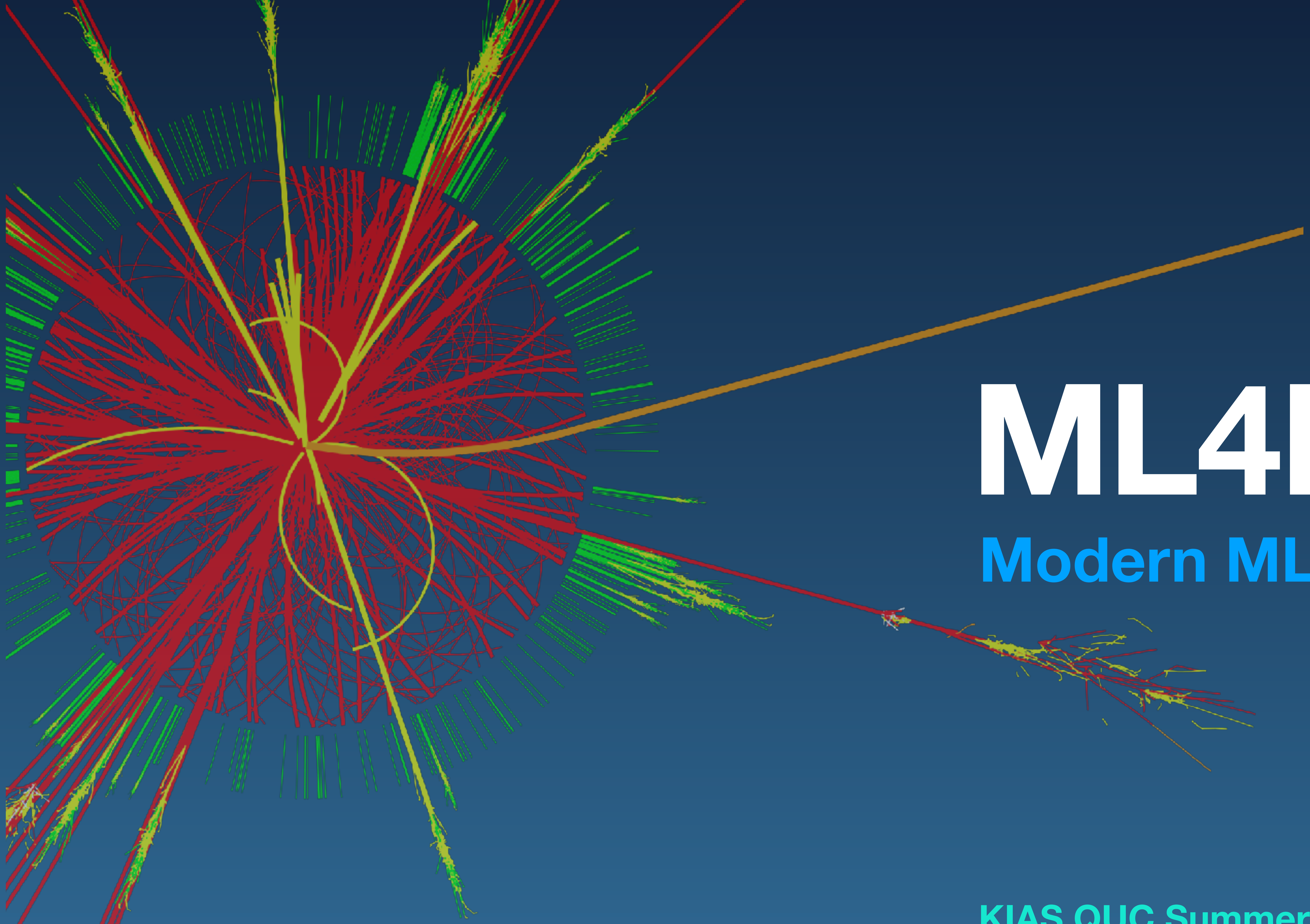


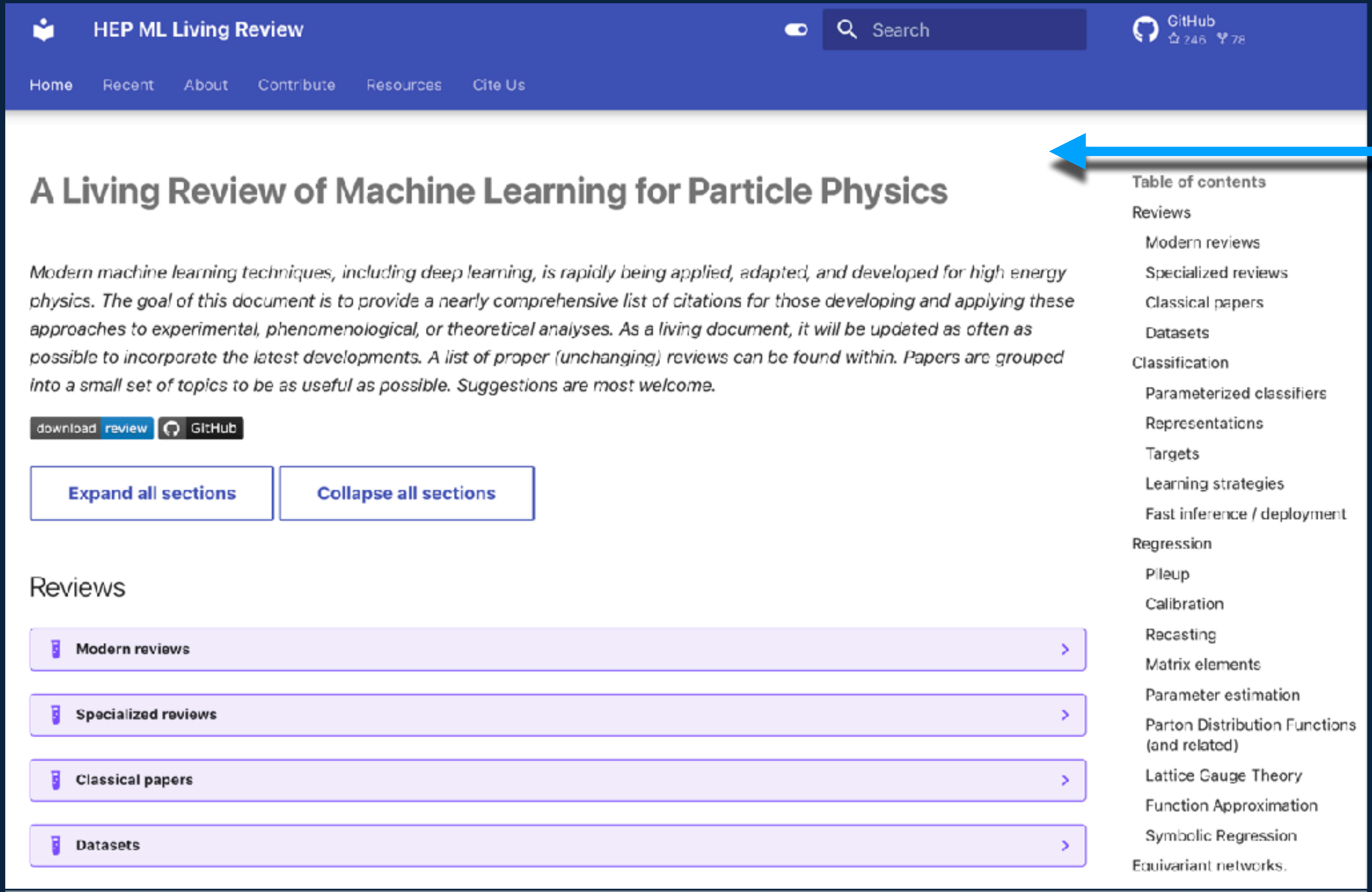
ML4HEP

Modern ML for particle physics

KIAS QUC Summer School 2023 —
A.I. in High Energy Physics

Ramon Winterhalder — UC Louvain

ML4HEP Review



- Check LivingReview for many **ML4HEP applications**
- Got a facelift recently!

HEPML-Review

Plan of attack

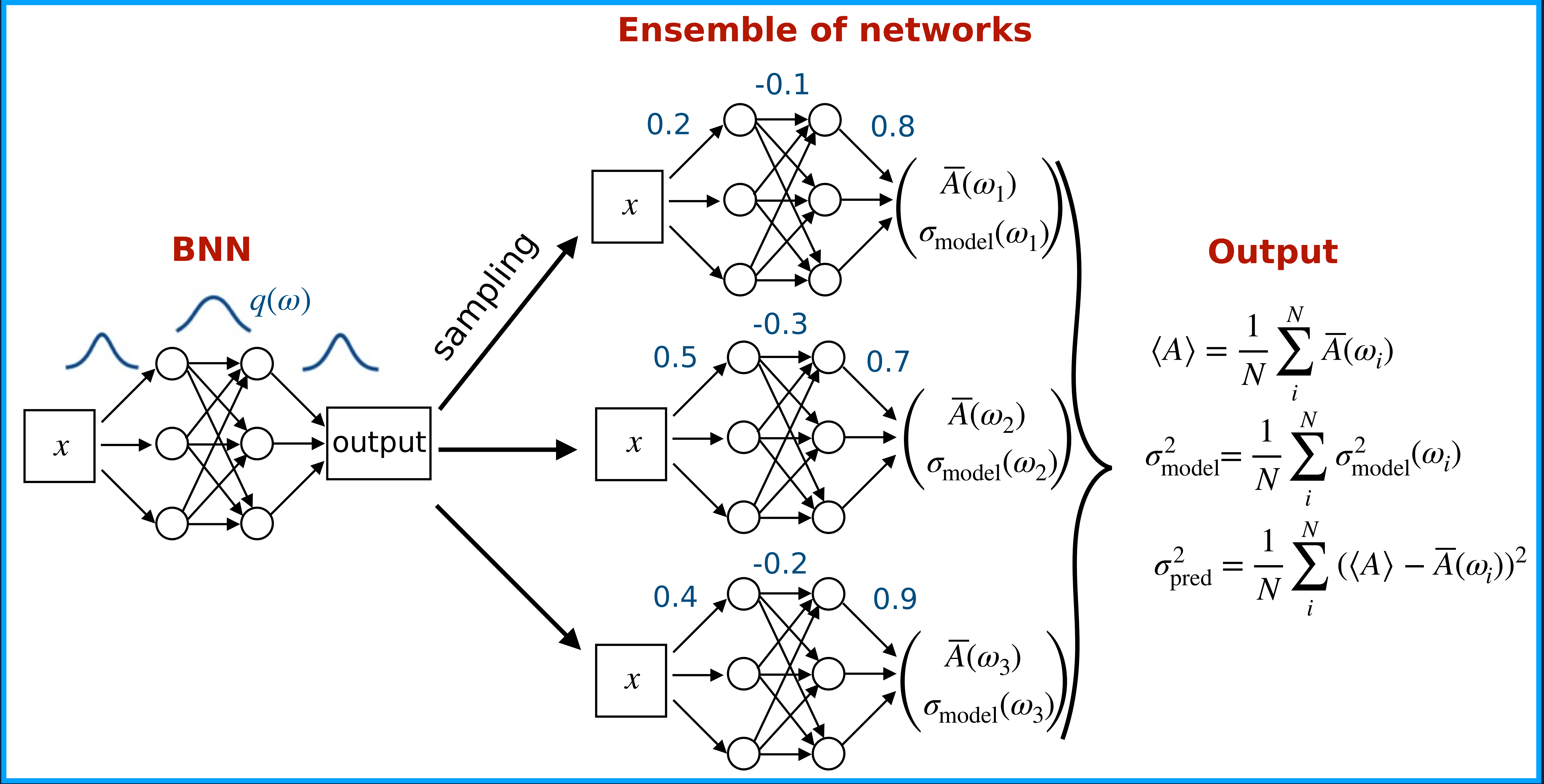
1. Bayesian Neural Networks
2. Generative Models I — GAN and VAE
3. Generative Models II — Normalizing Flows
4. Anomaly Detection

Bayesian Neural Networks

Errors and regularization

Blackboard — Session I

Bayesian Networks — Overview

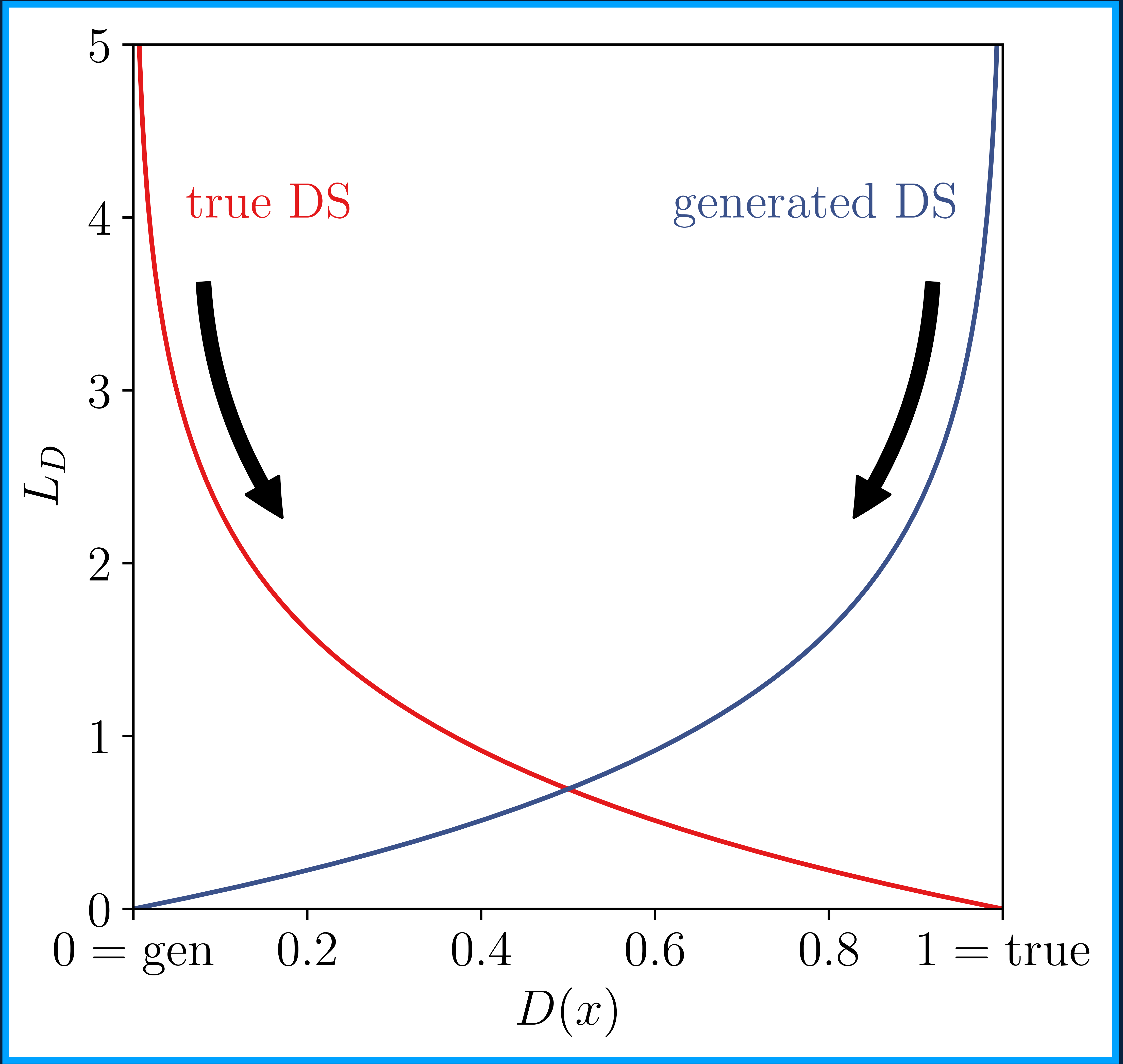


Generative Models I

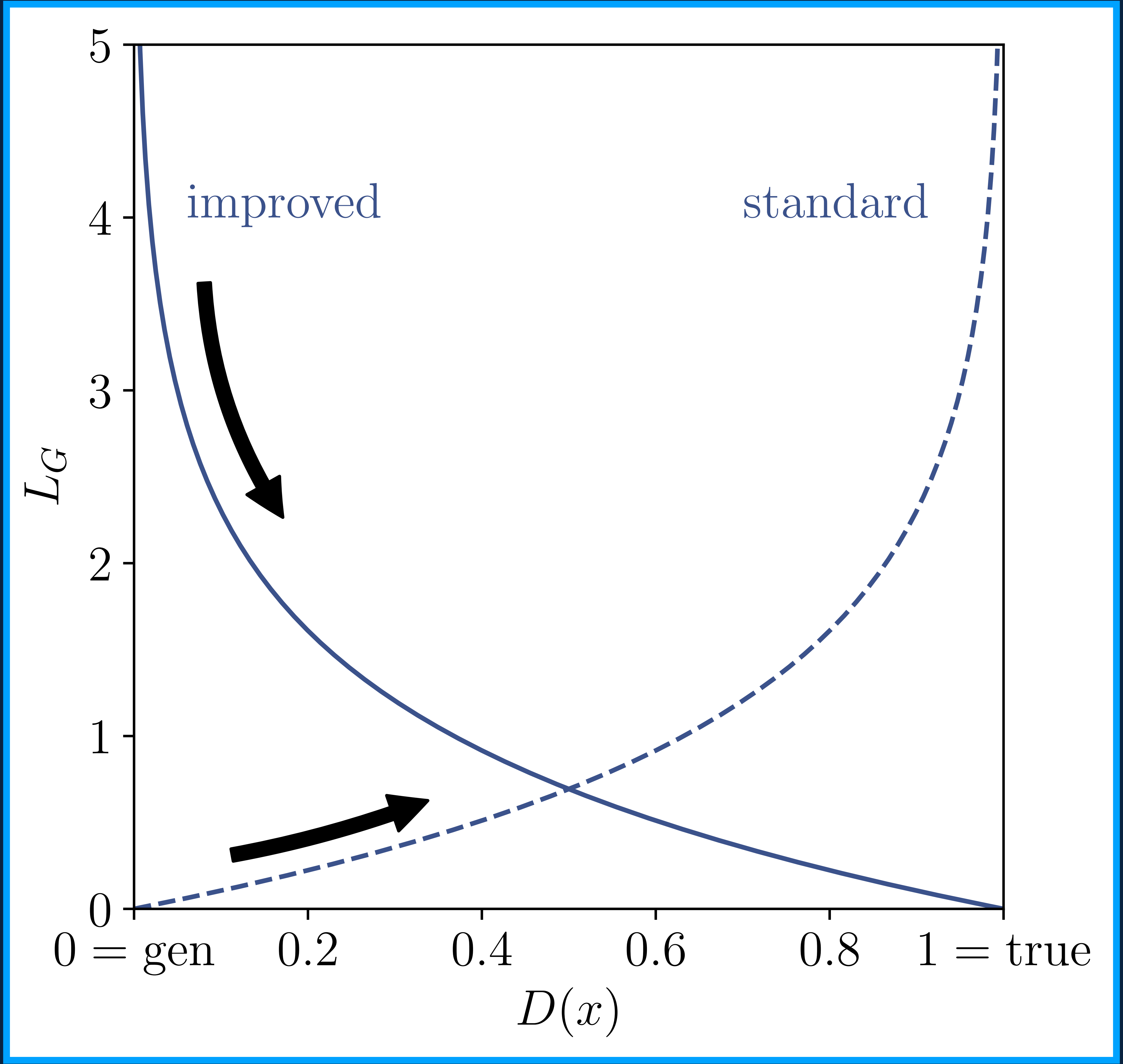
GANs and VAEs

Blackboard — Session II

GAN Loss

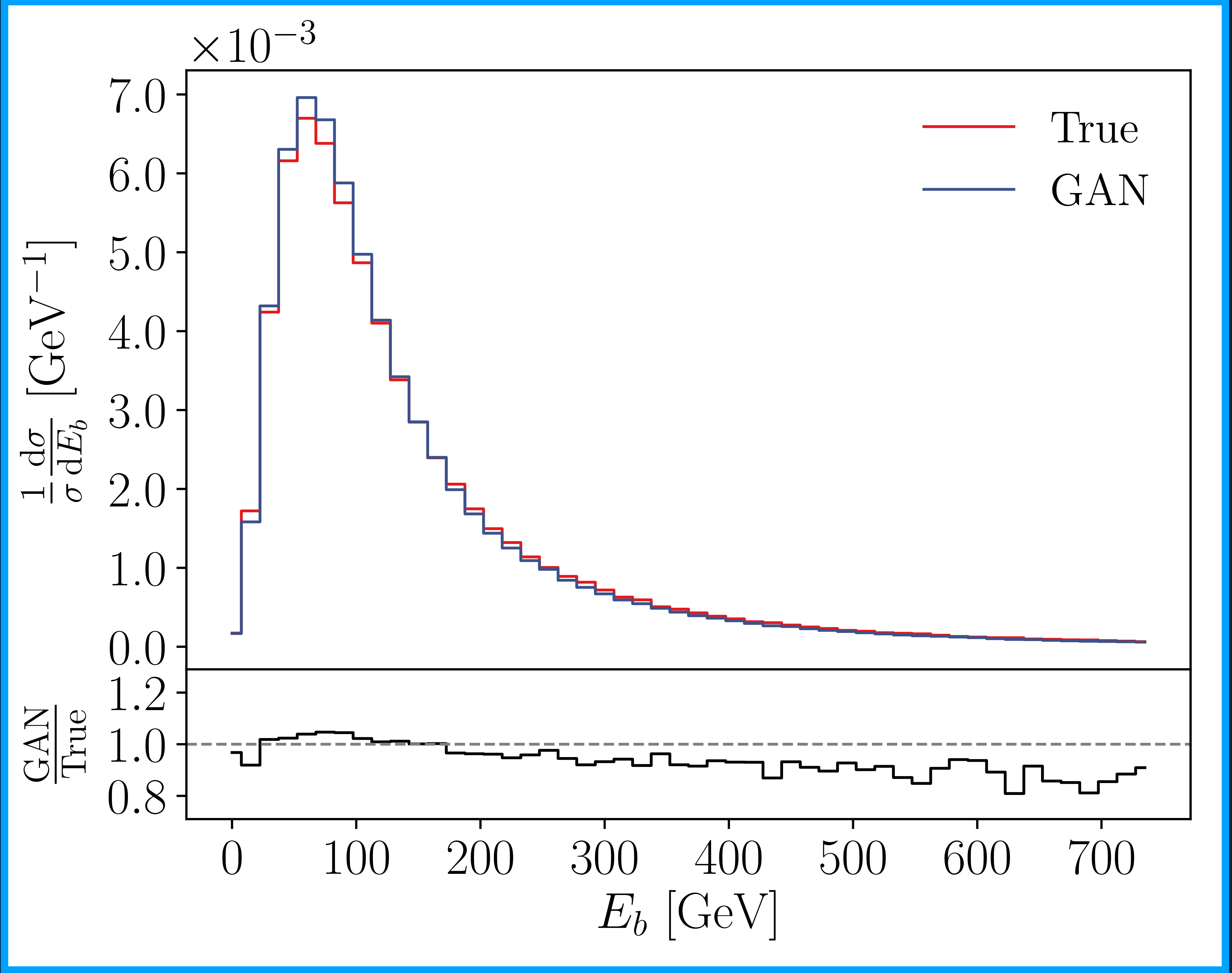


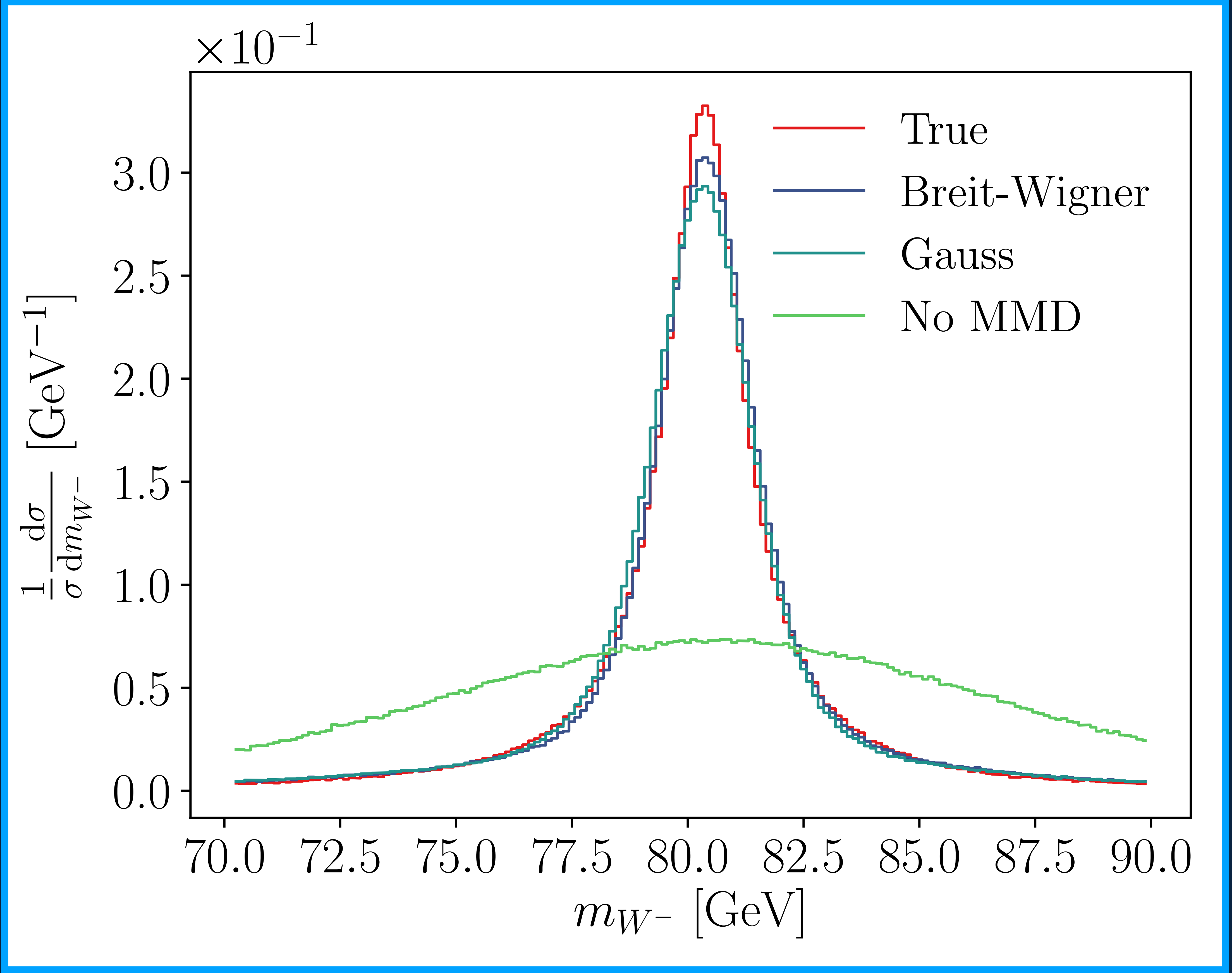
5
4
3
2
1
0
L_D
true DS
generated DS
0 = gen
0.2
0.4
0.6
0.8
1 = true
$D(x)$



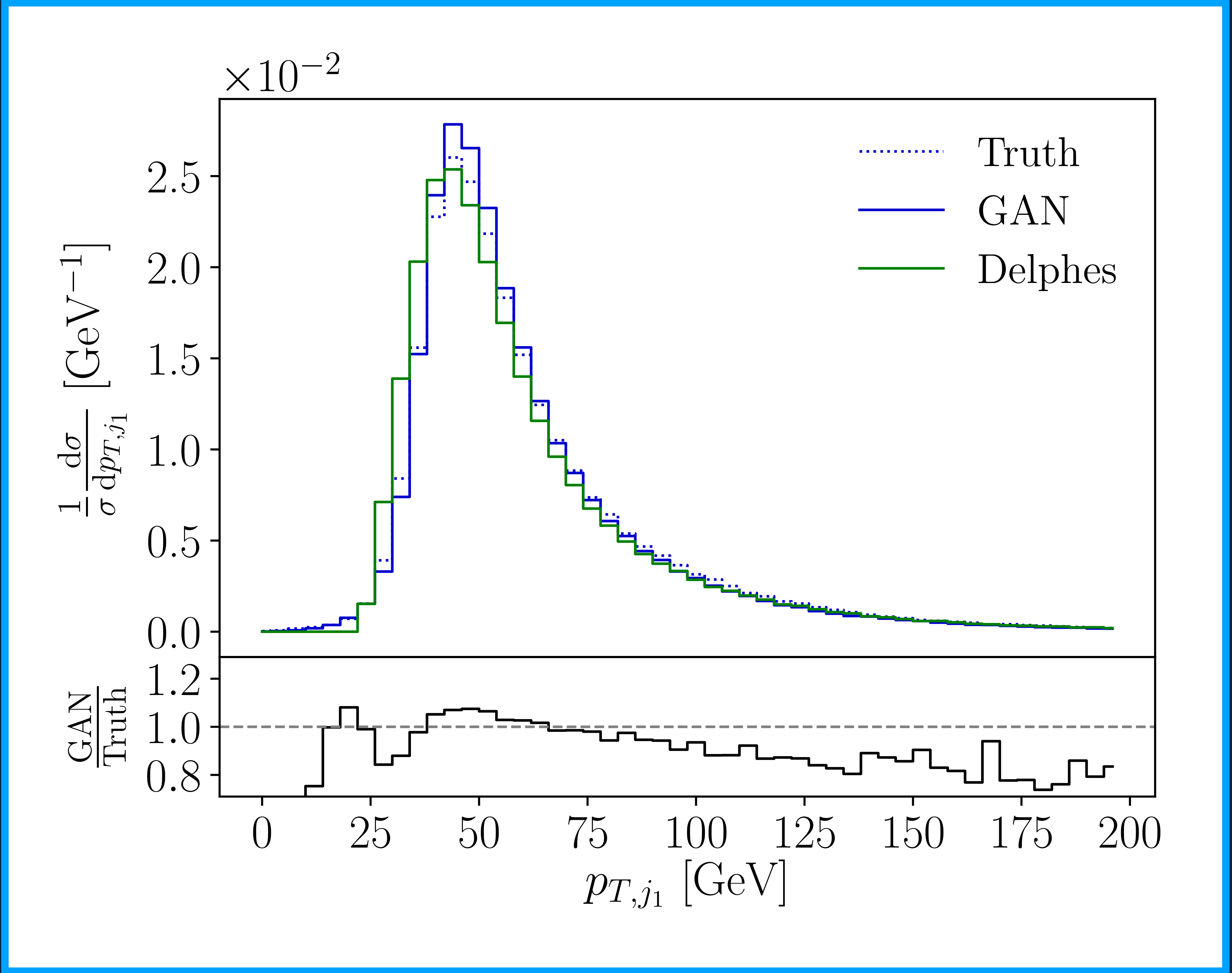
5
4
3
2
1
0
L_G
improved
standard
0 = gen
0.2
0.4
0.6
0.8
1 = true
$D(x)$

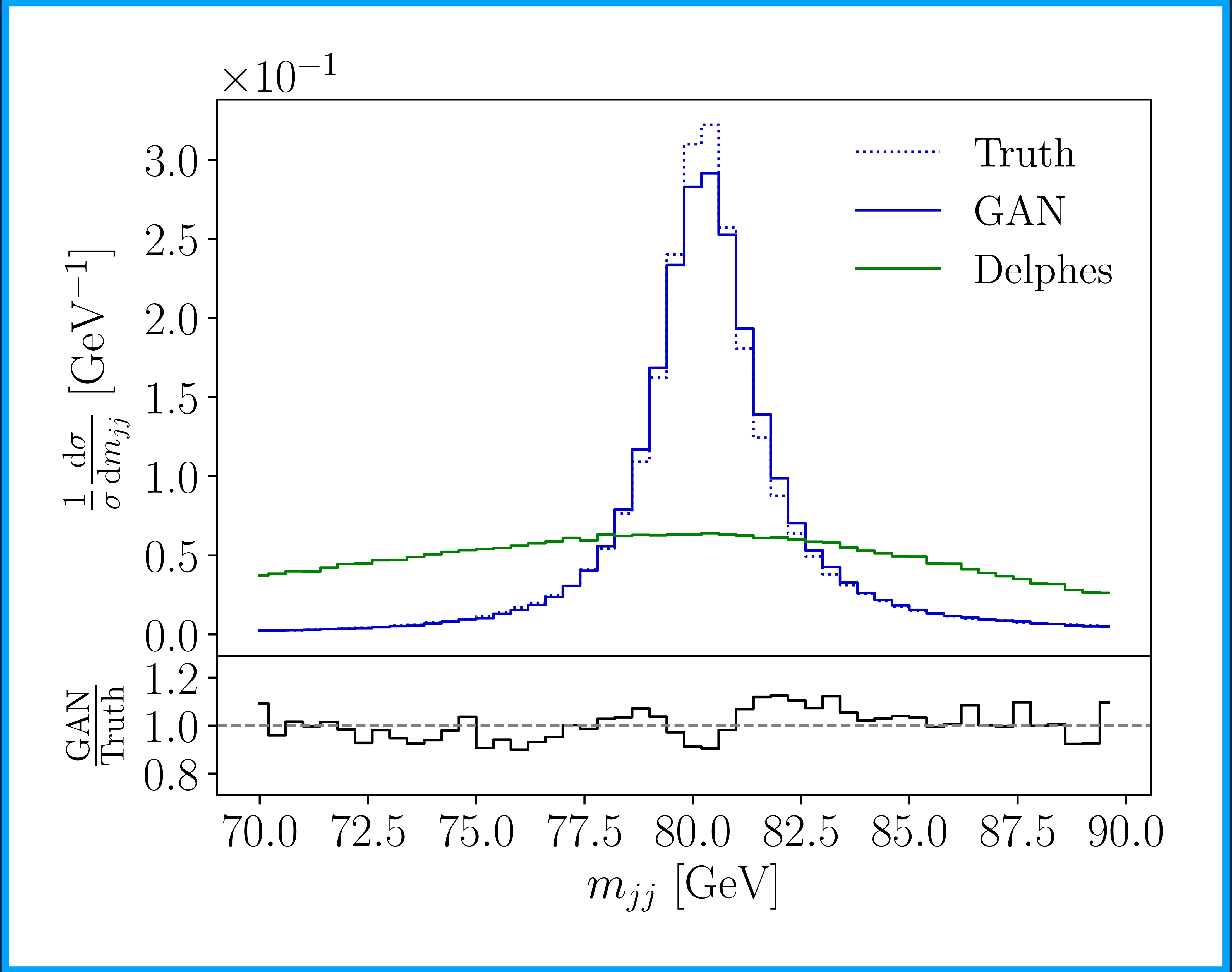
GAN Event Generation



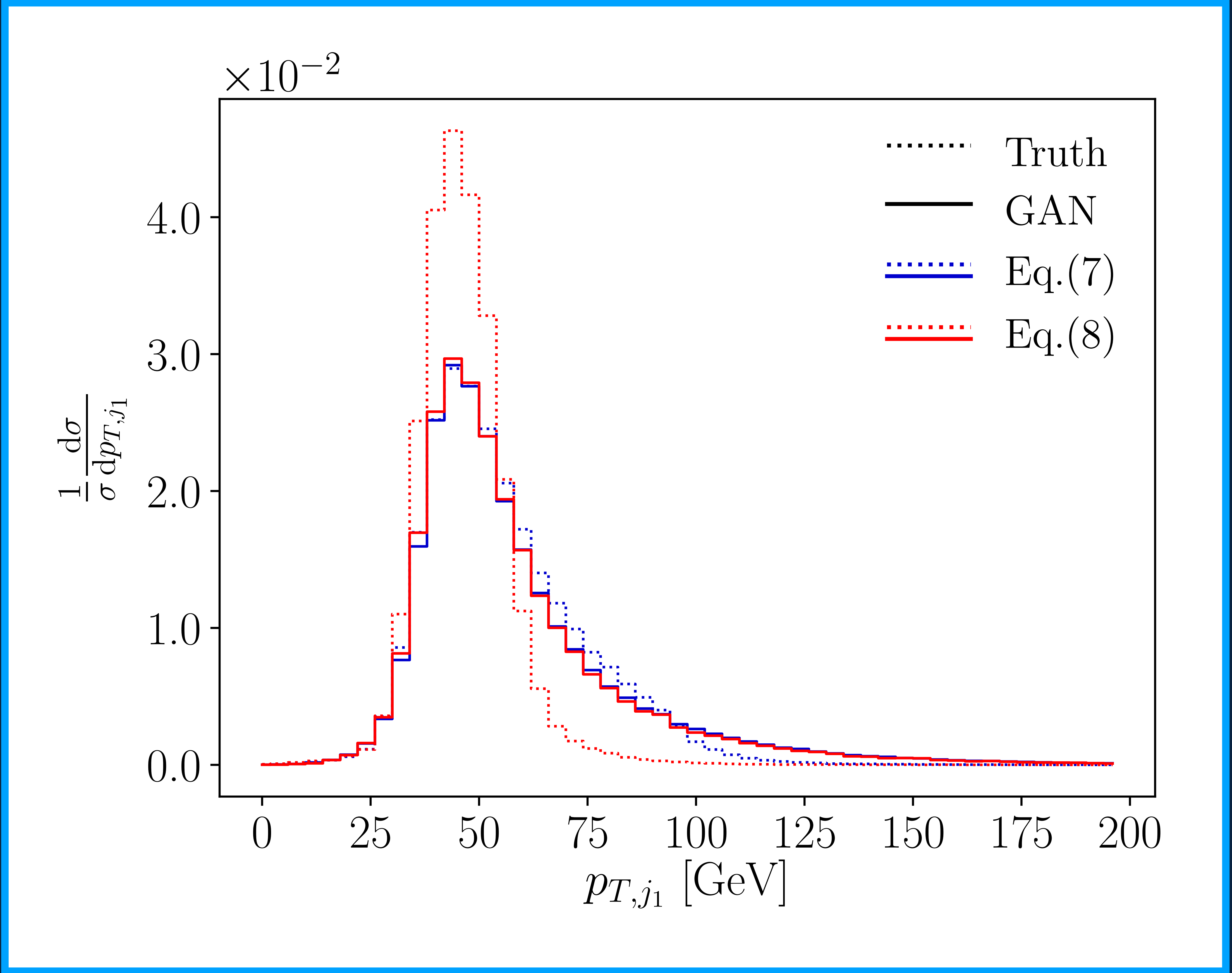


GAN Unfolding





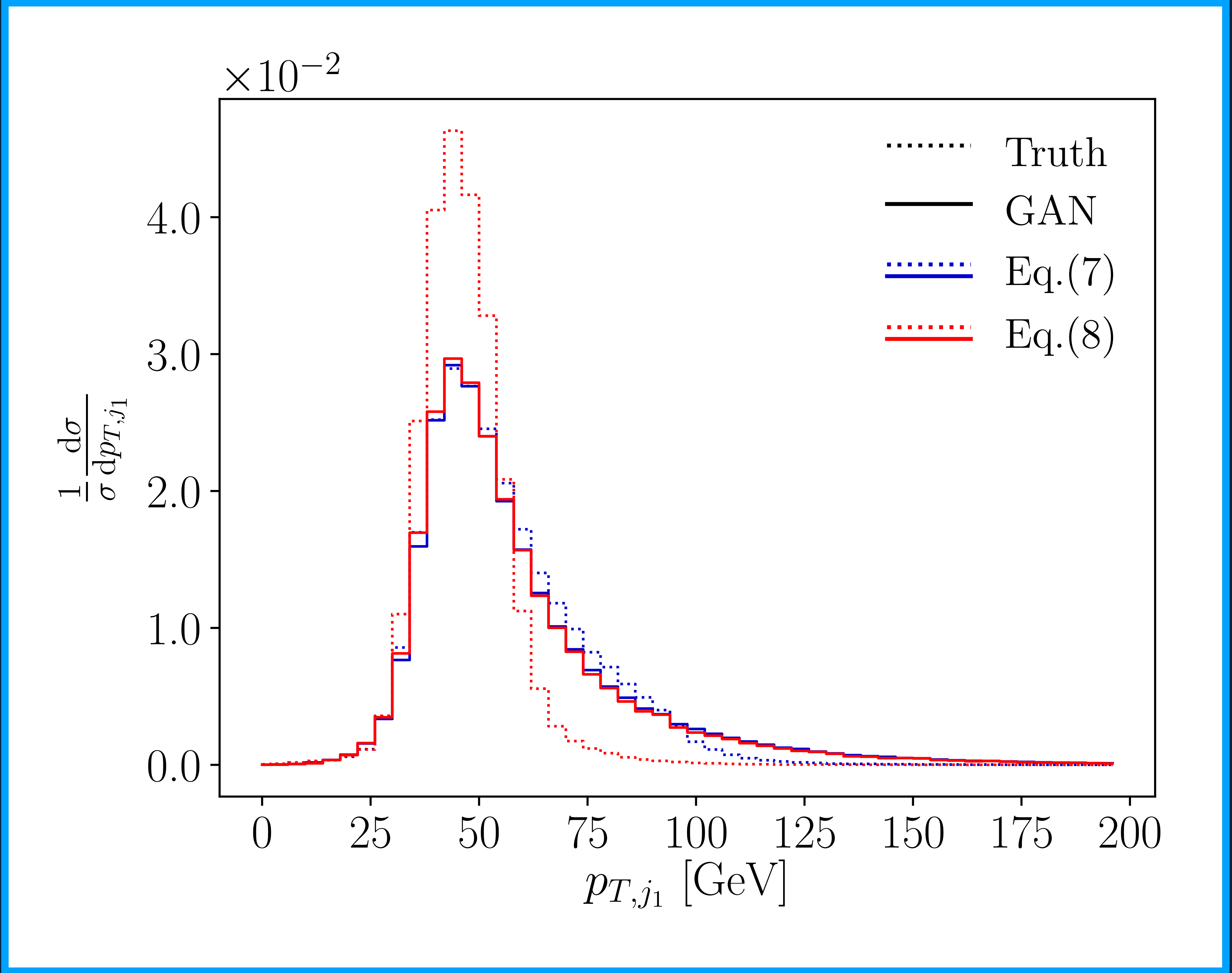
GAN Unfolding

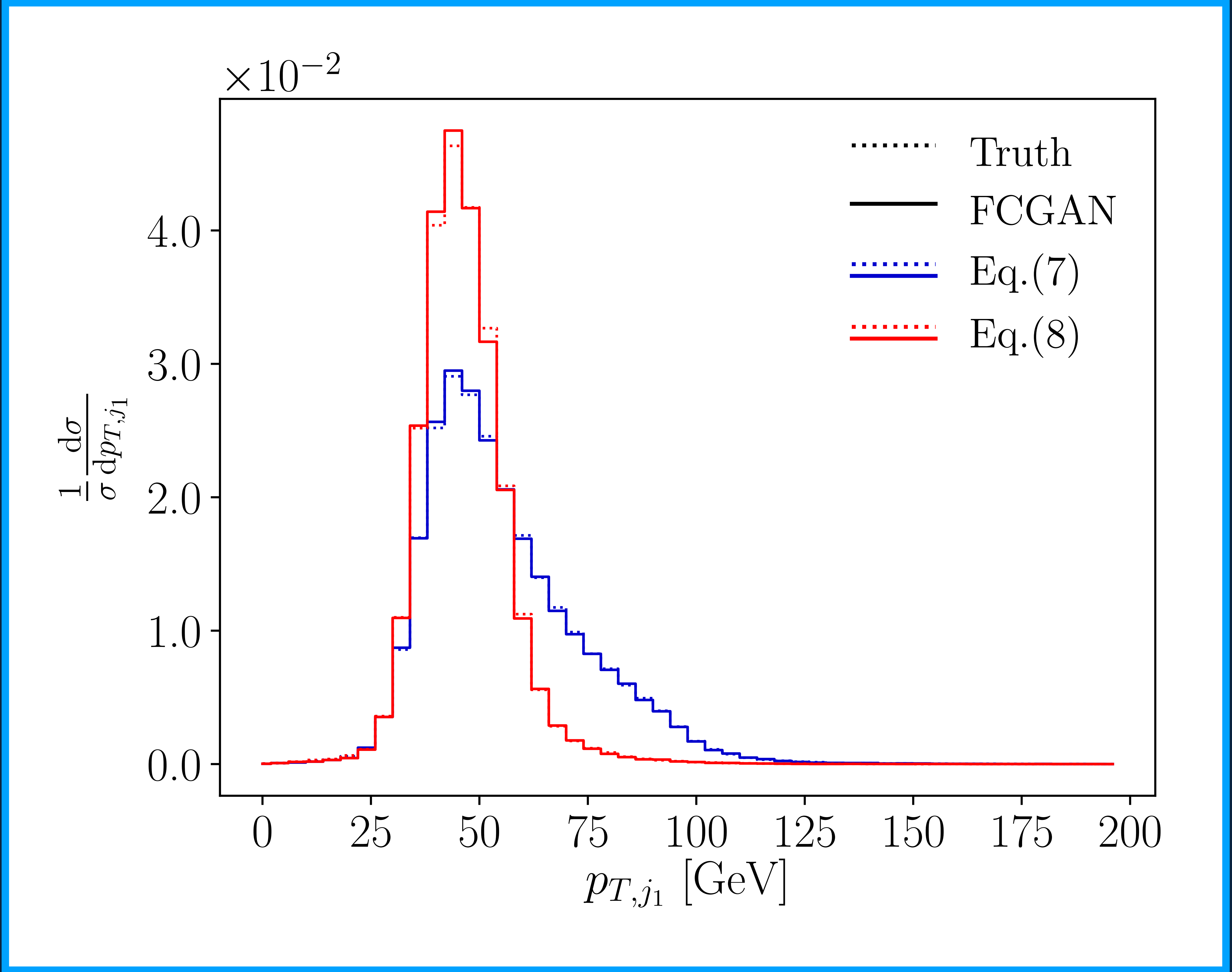


Cut I:
$30\,\text{GeV} < p_{T,j_1} < 100\,\text{GeV}$

Cut II:
$30\,\text{GeV} < p_{T,j_1} < 50\,\text{GeV}$
$30\,\text{GeV} < p_{T,j_2} < 60\,\text{GeV}$

FCGAN Unfolding



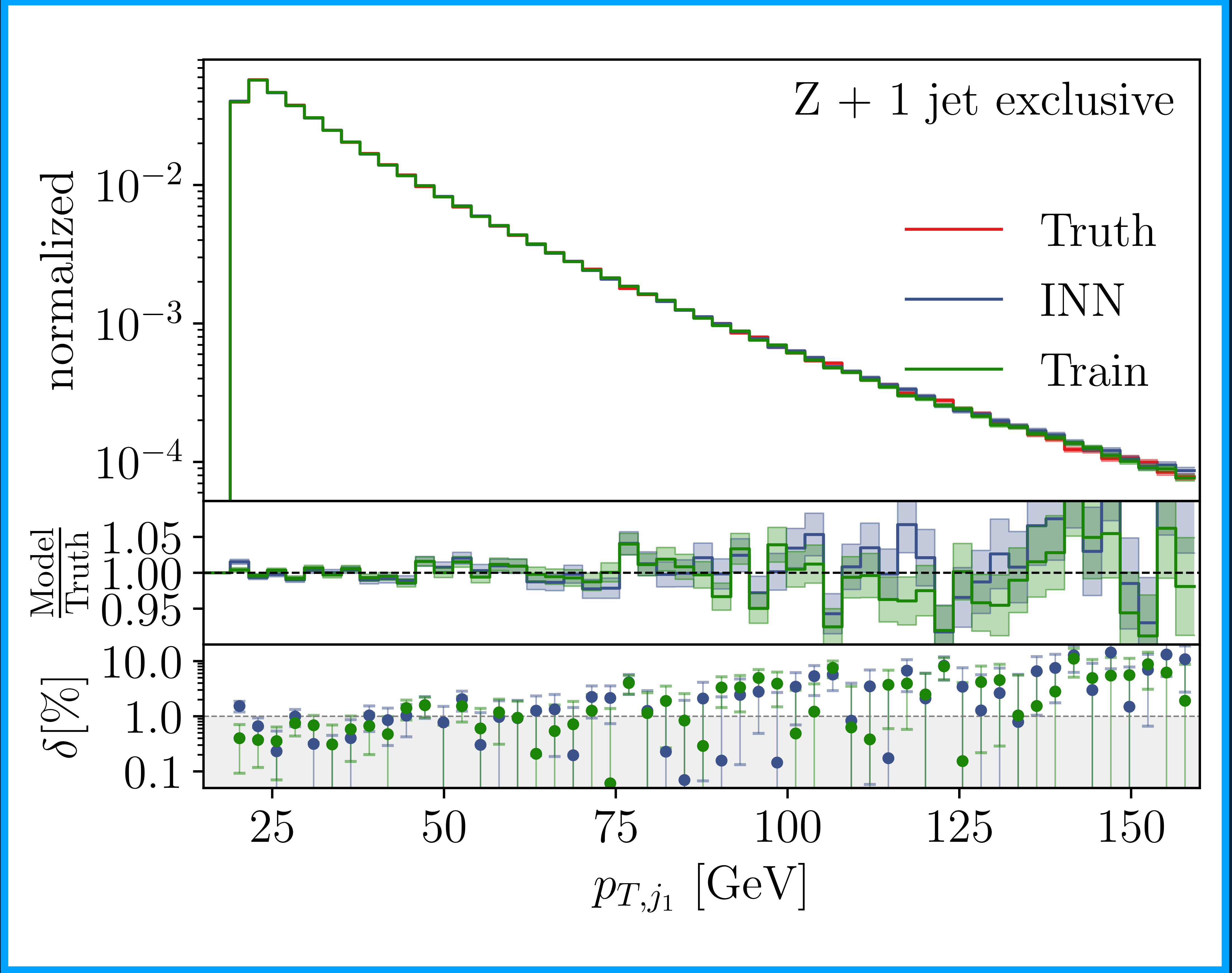


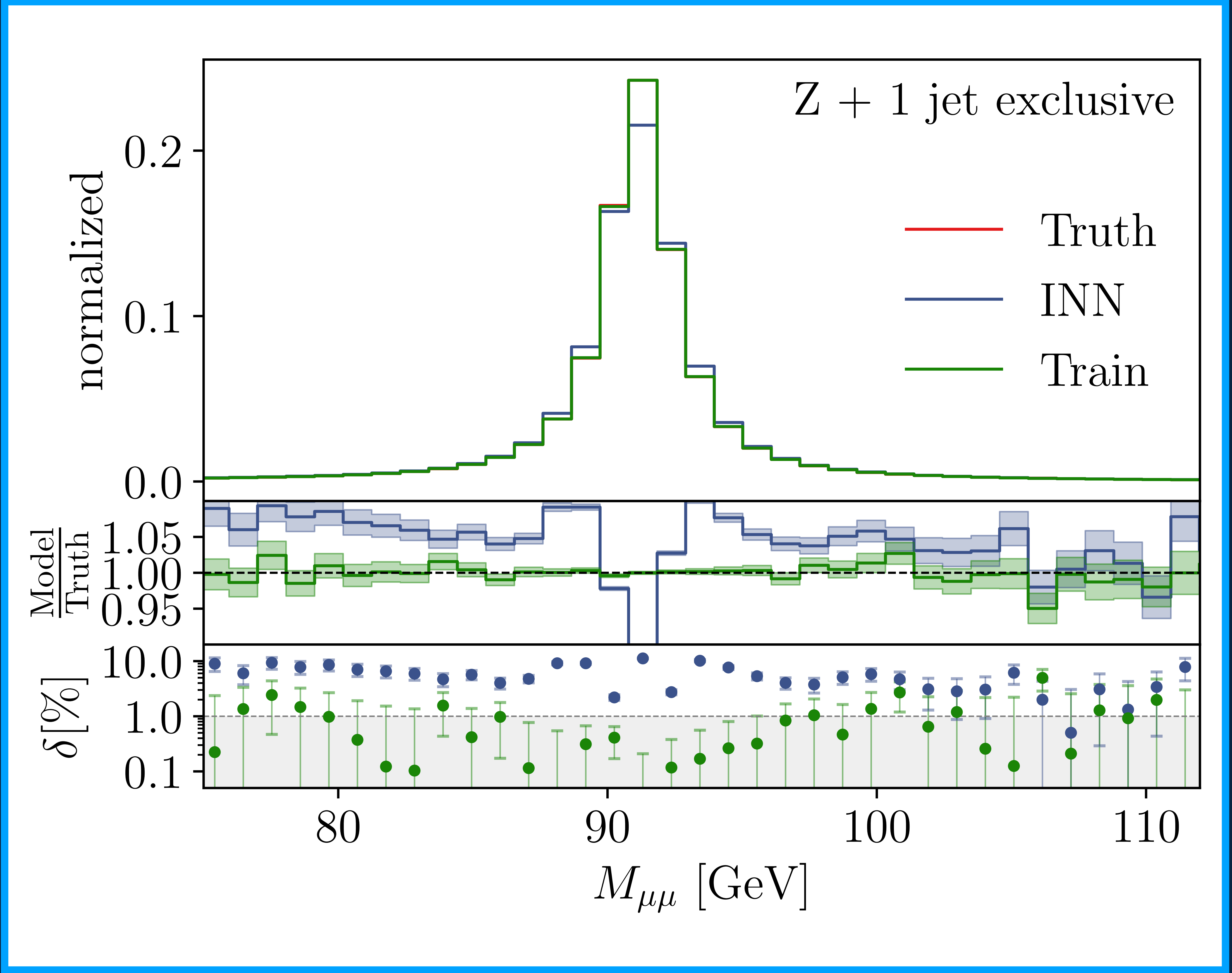
Generative Models II

Normalizing Flows

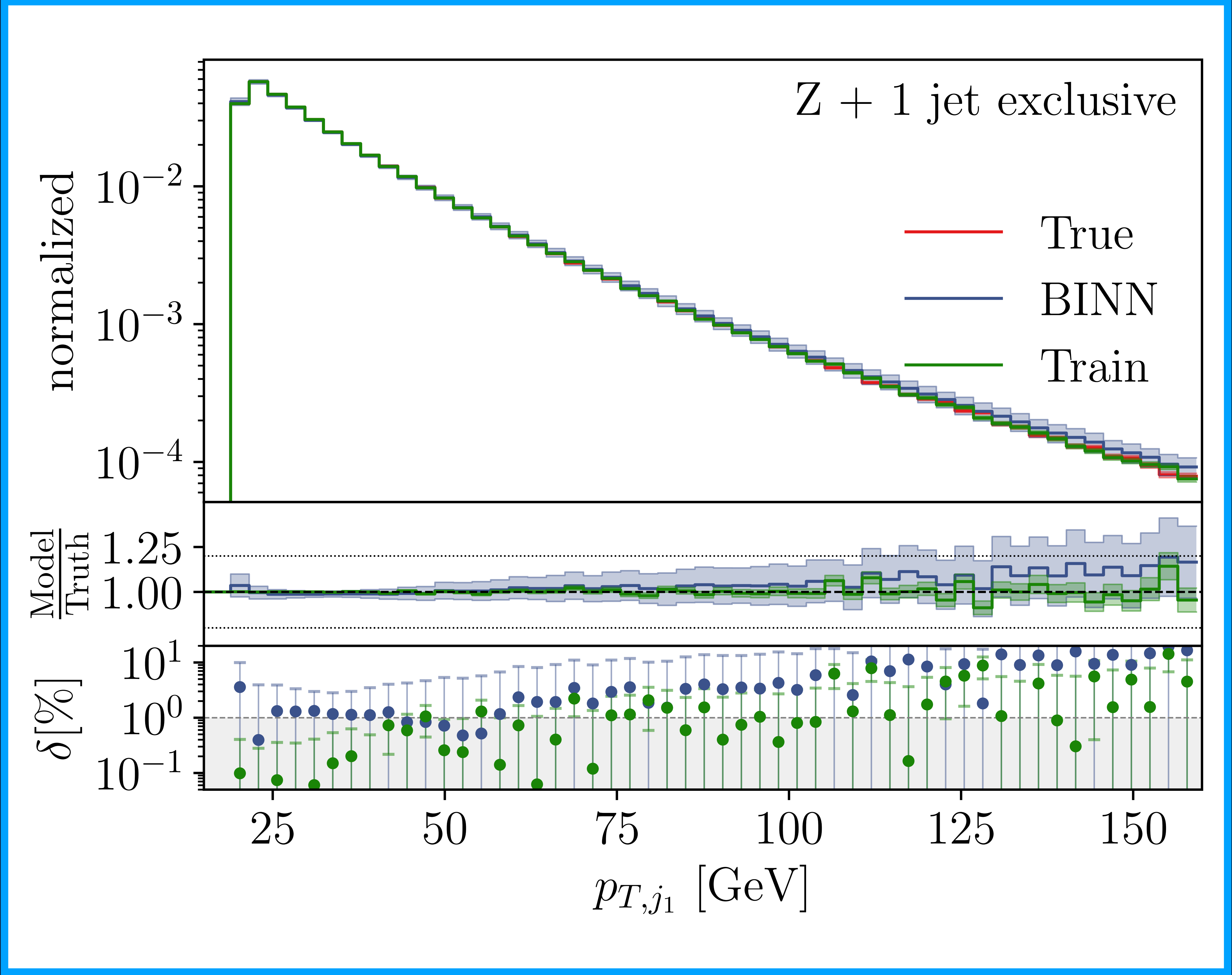
Blackboard — Session III

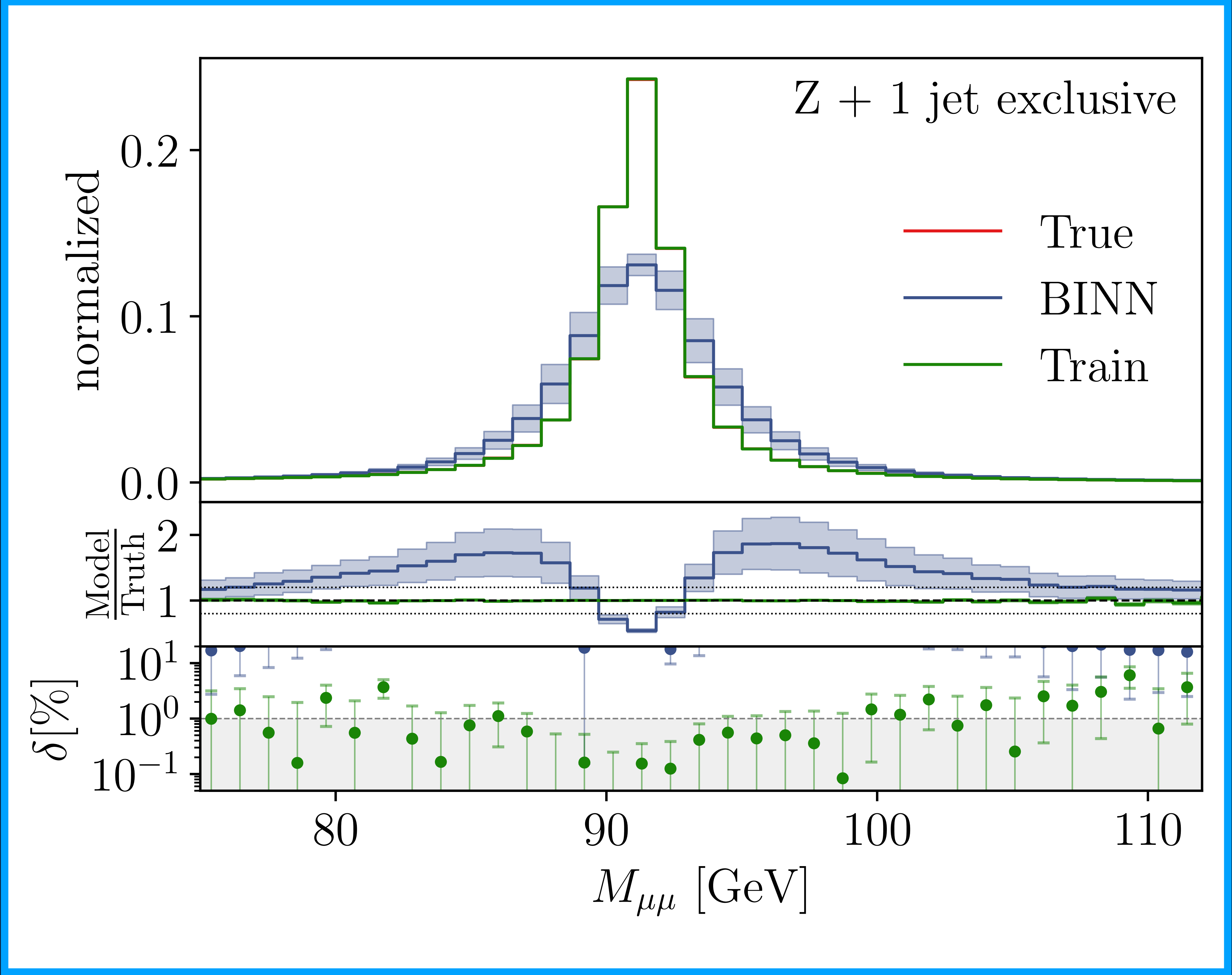
cINN Event Generation



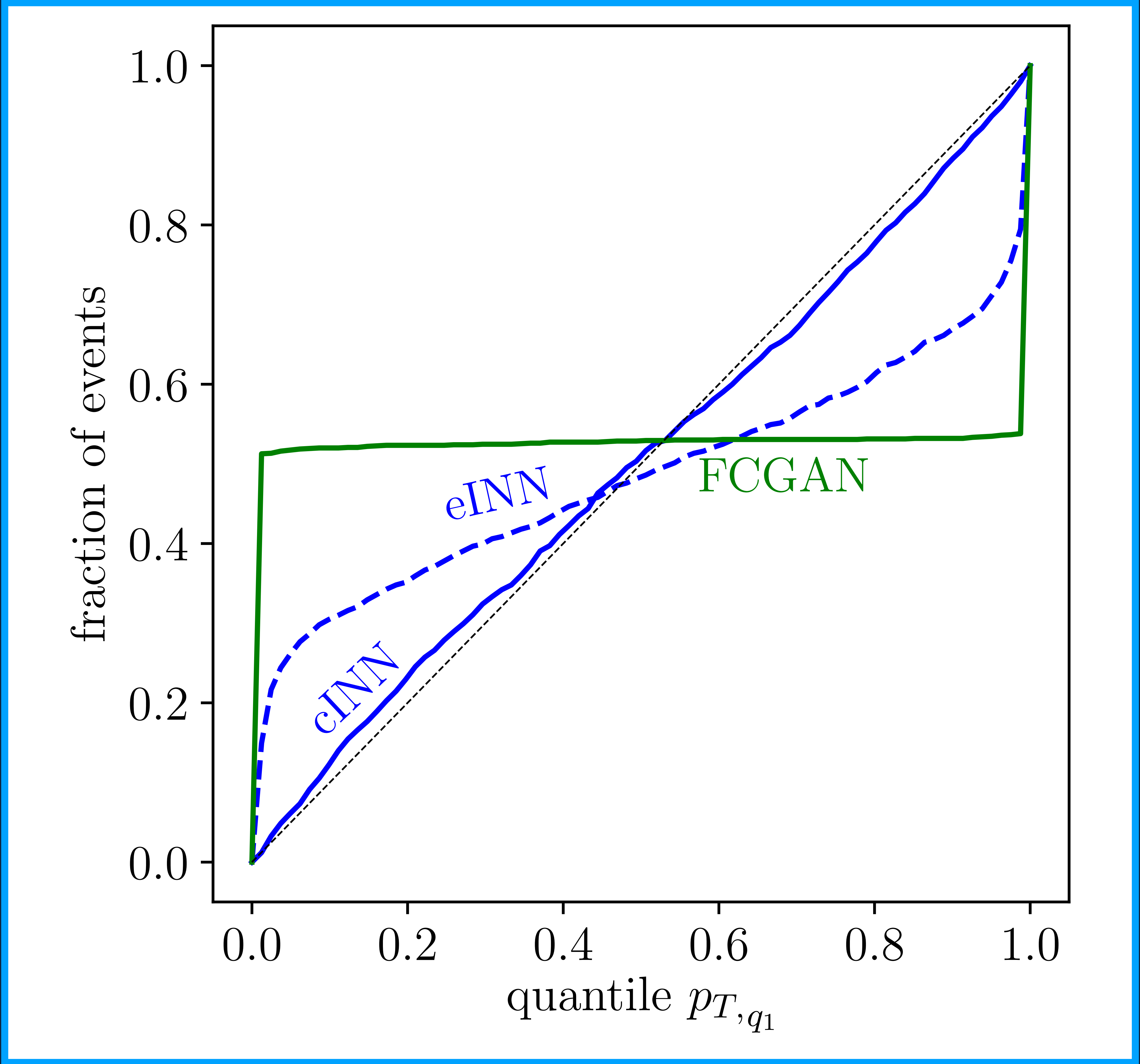


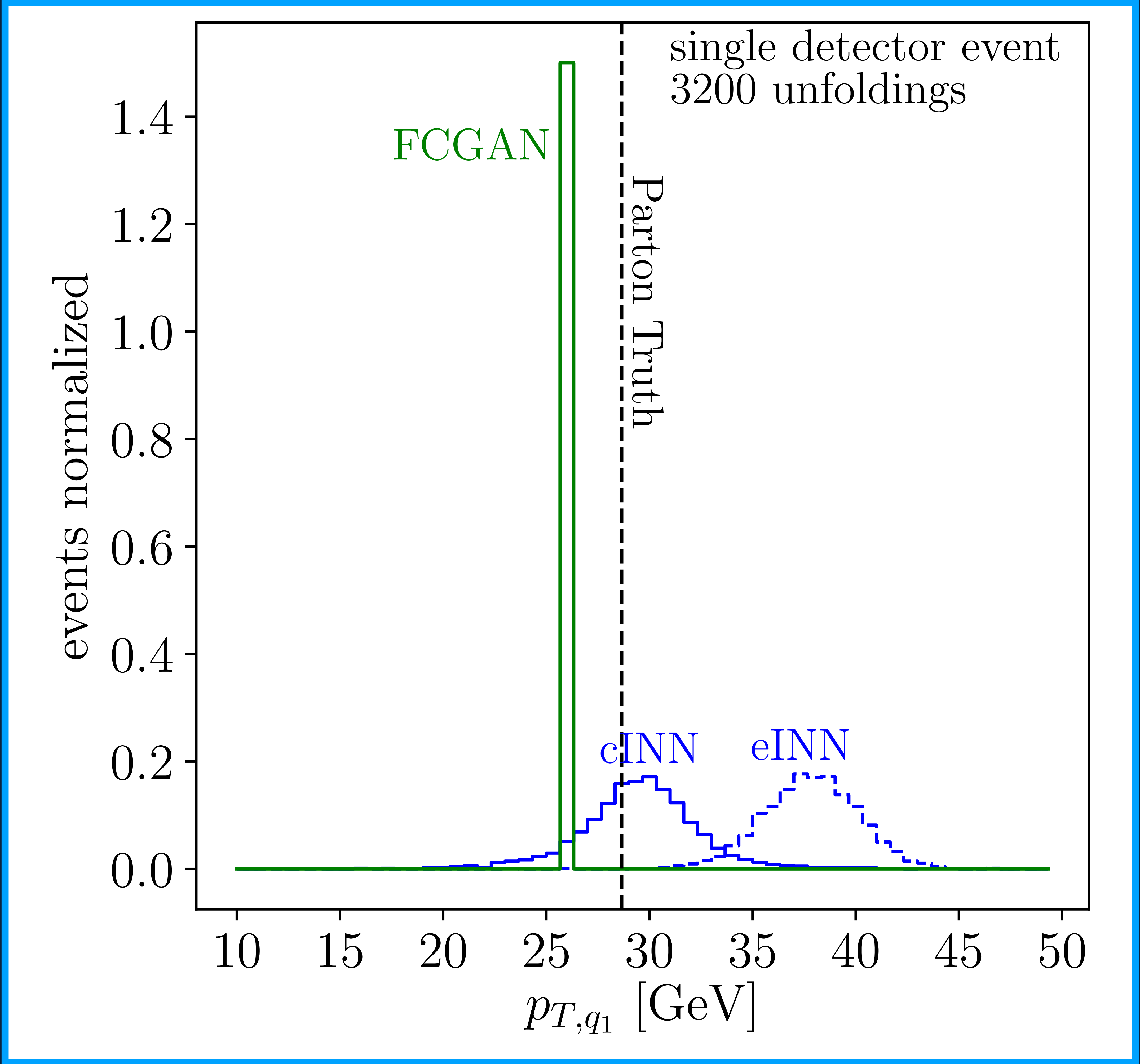
cINN Event Generation





cINN Unfolding





Anomaly Detection

Unveiling new physics at the LHC?

Blackboard — Session IV

Anomaly detection — Comparison