

ML4HEP

Modern ML for particle physics



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

Ramon Winterhalder — UC Louvain

ML4HEP Review

HEP ML Living Review

Home Recent About Contribute Resources Cite Us

Search

GitHub 246 78

A Living Review of Machine Learning for Particle Physics

Modern machine learning techniques, including deep learning, is rapidly being applied, adapted, and developed for high energy physics. The goal of this document is to provide a nearly comprehensive list of citations for those developing and applying these approaches to experimental, phenomenological, or theoretical analyses. As a living document, it will be updated as often as possible to incorporate the latest developments. A list of proper (unchanging) reviews can be found within. Papers are grouped into a small set of topics to be as useful as possible. Suggestions are most welcome.

download review GitHub

Expand all sections Collapse all sections

Reviews

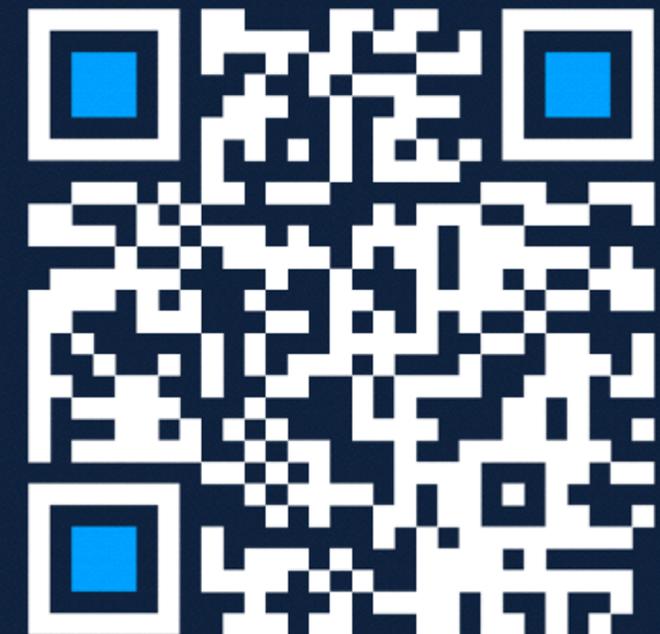
- Modern reviews
- Specialized reviews
- Classical papers
- Datasets

Table of contents

- Reviews
 - Modern reviews
 - Specialized reviews
 - Classical papers
 - Datasets
- Classification
 - Parameterized classifiers
 - Representations
 - Targets
 - Learning strategies
 - Fast inference / deployment
- Regression
 - Pileup
 - Calibration
 - Recasting
 - Matrix elements
 - Parameter estimation
 - Parton Distribution Functions (and related)
 - Lattice Gauge Theory
 - Function Approximation
 - Symbolic Regression
- Equivariant networks.

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

HEPML-Review



Plan of attack

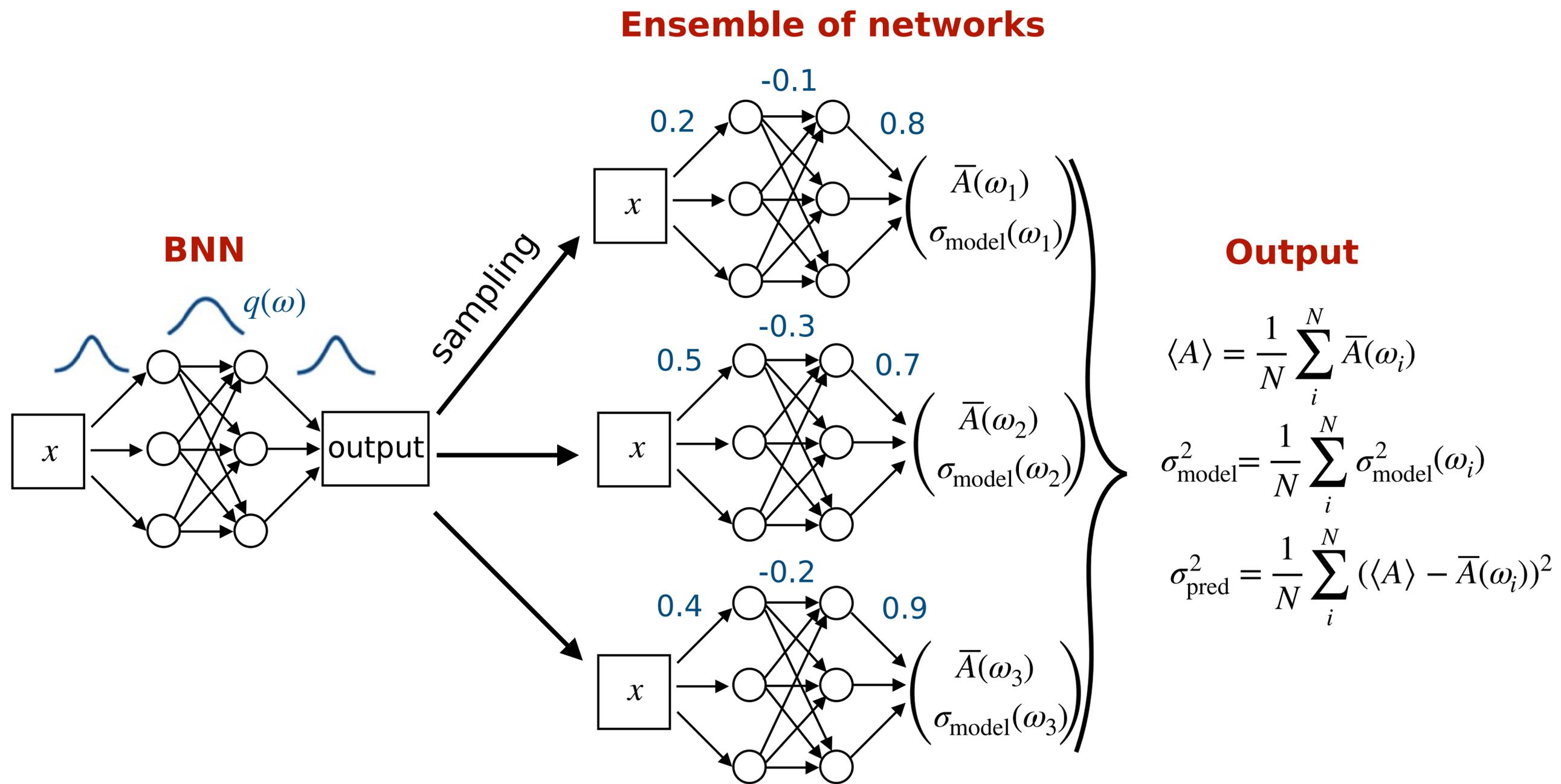
1. Bayesian Neural Networks
2. Generative Models I — GAN and VAE
3. Generative Models II — Normalizing Flows
4. Anomaly Detection

Bayesian Neural Networks

Errors and regularization

Blackboard — Session I

Bayesian Networks — Overview

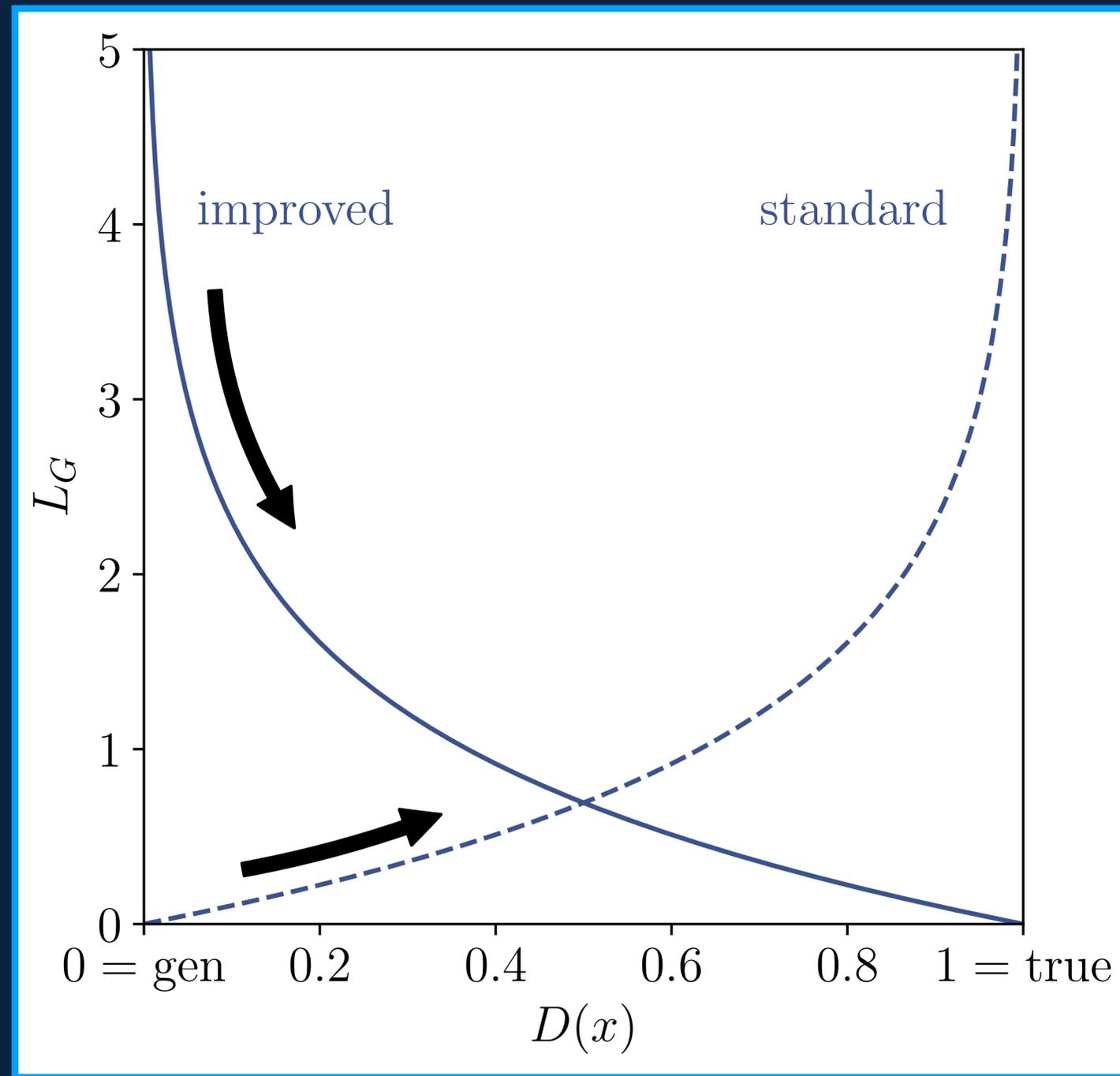
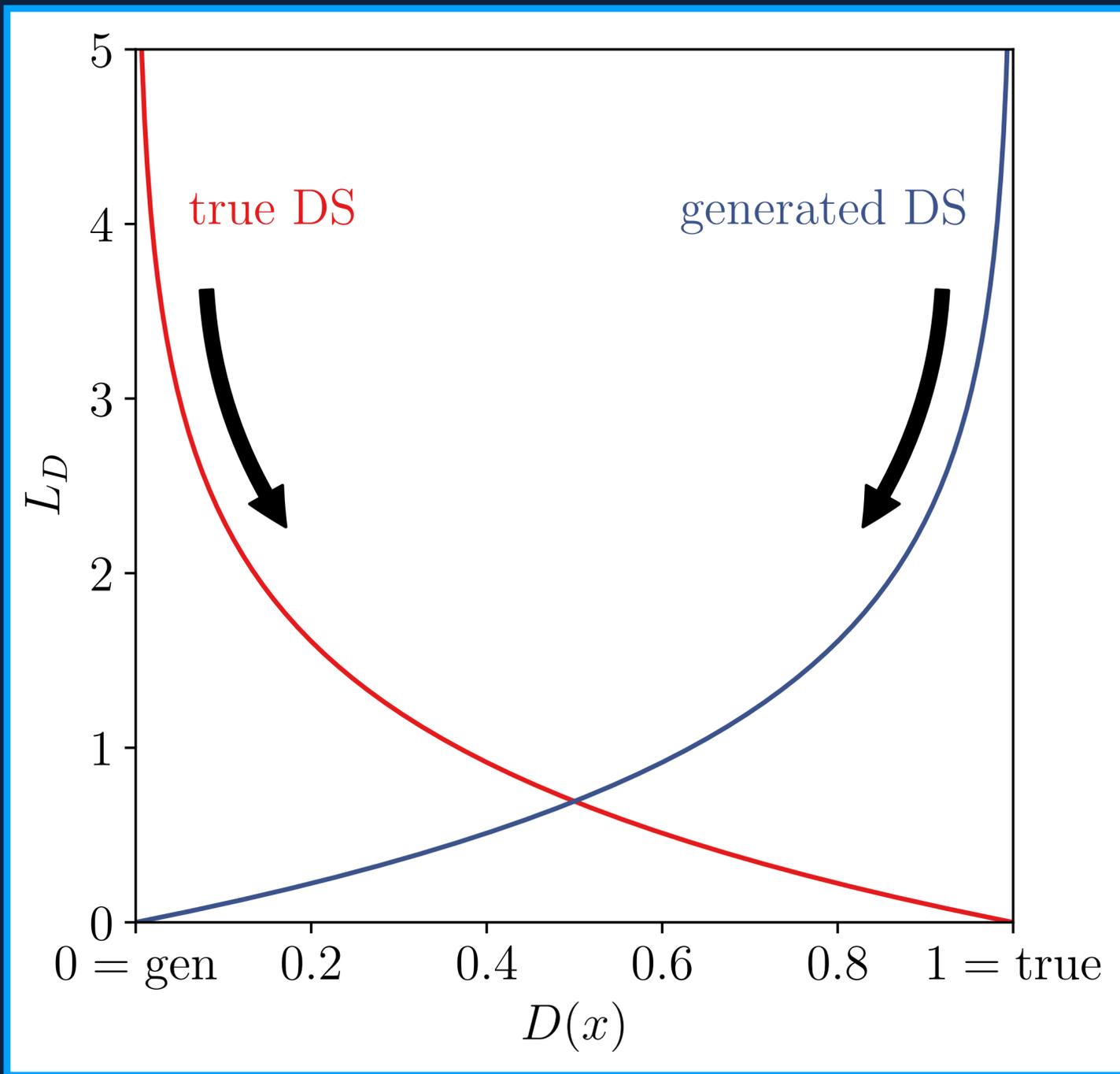


Generative Models I

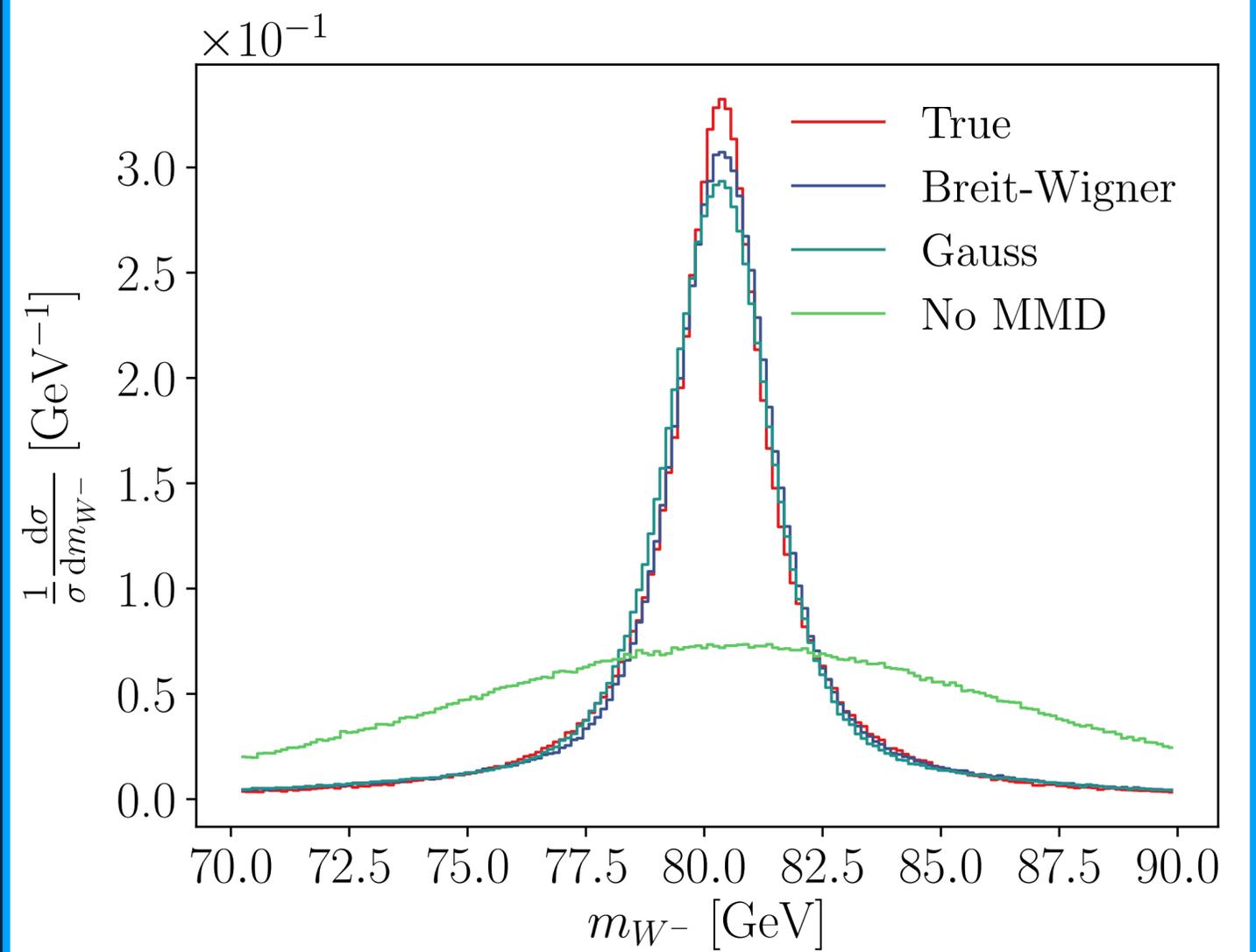
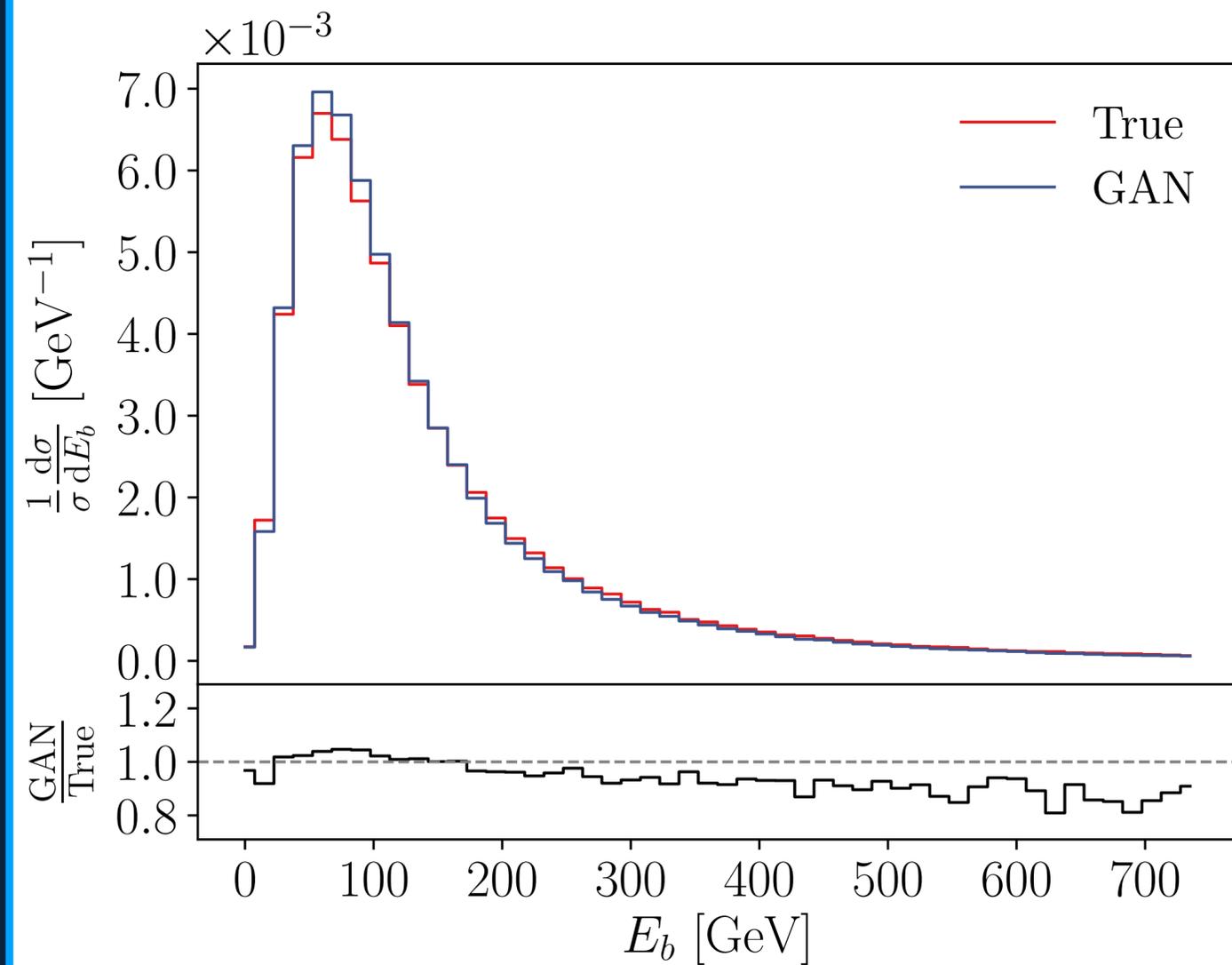
GANs and VAEs

Blackboard — Session II

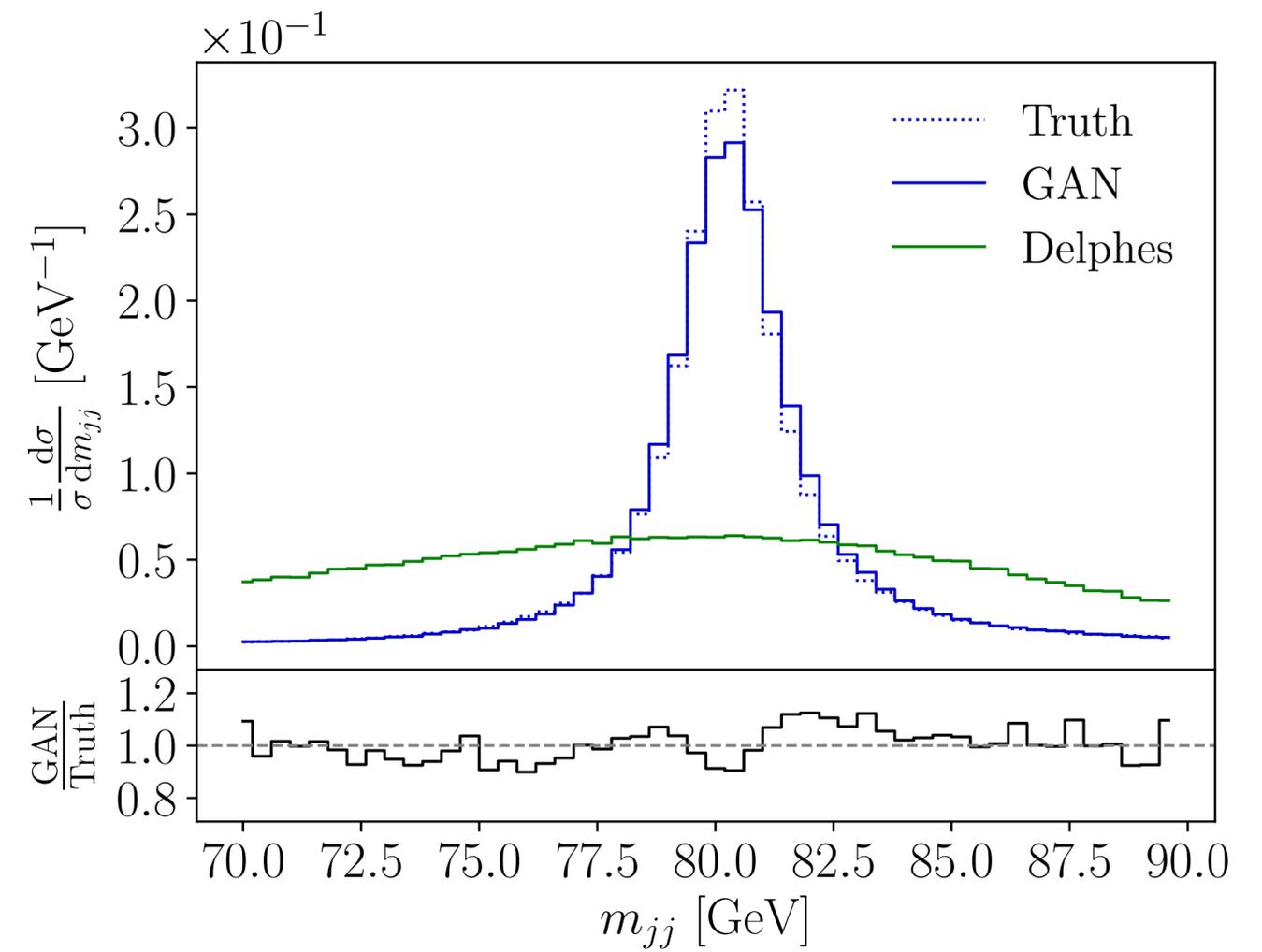
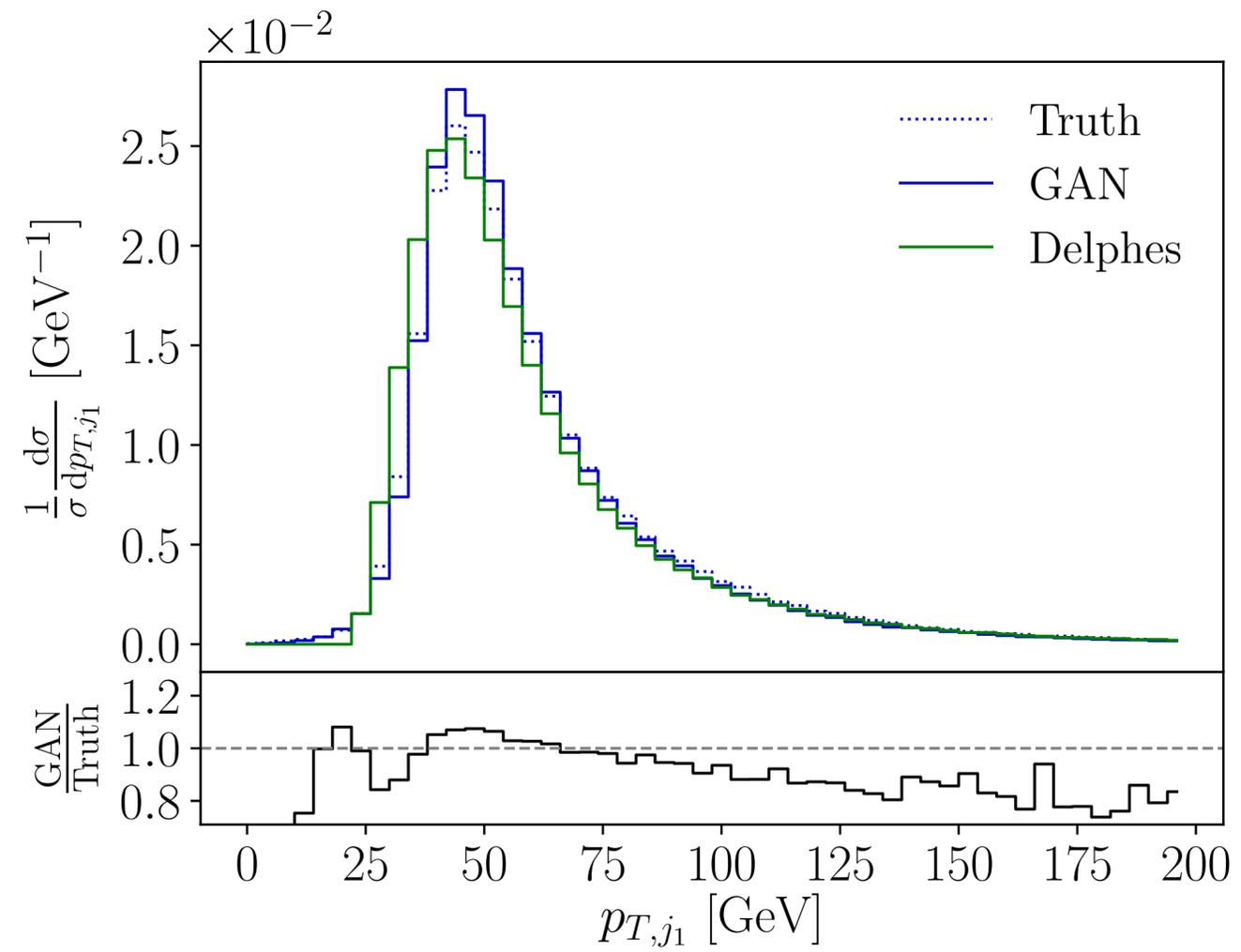
GAN Loss



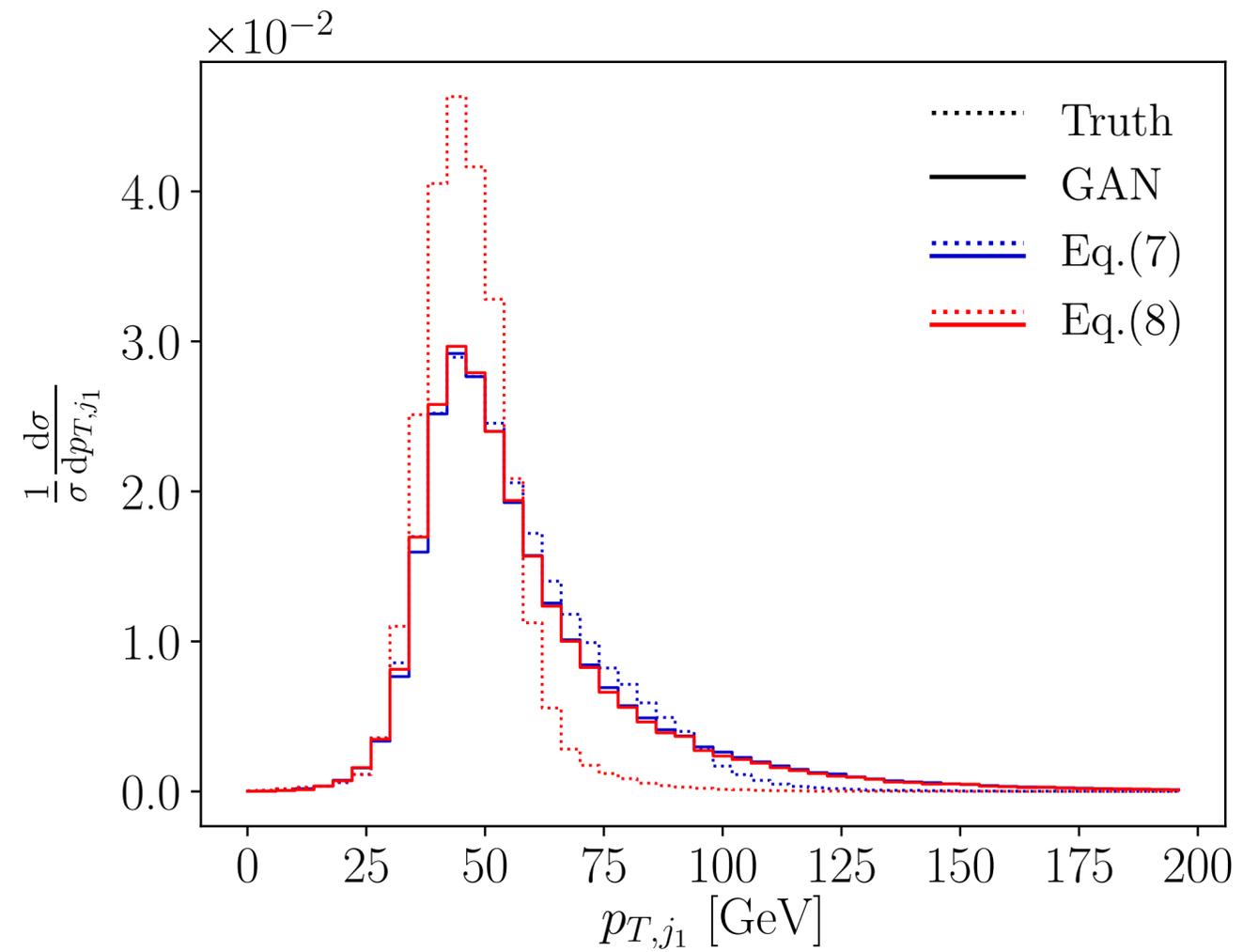
GAN Event Generation



GAN Unfolding



GAN Unfolding



Cut I:

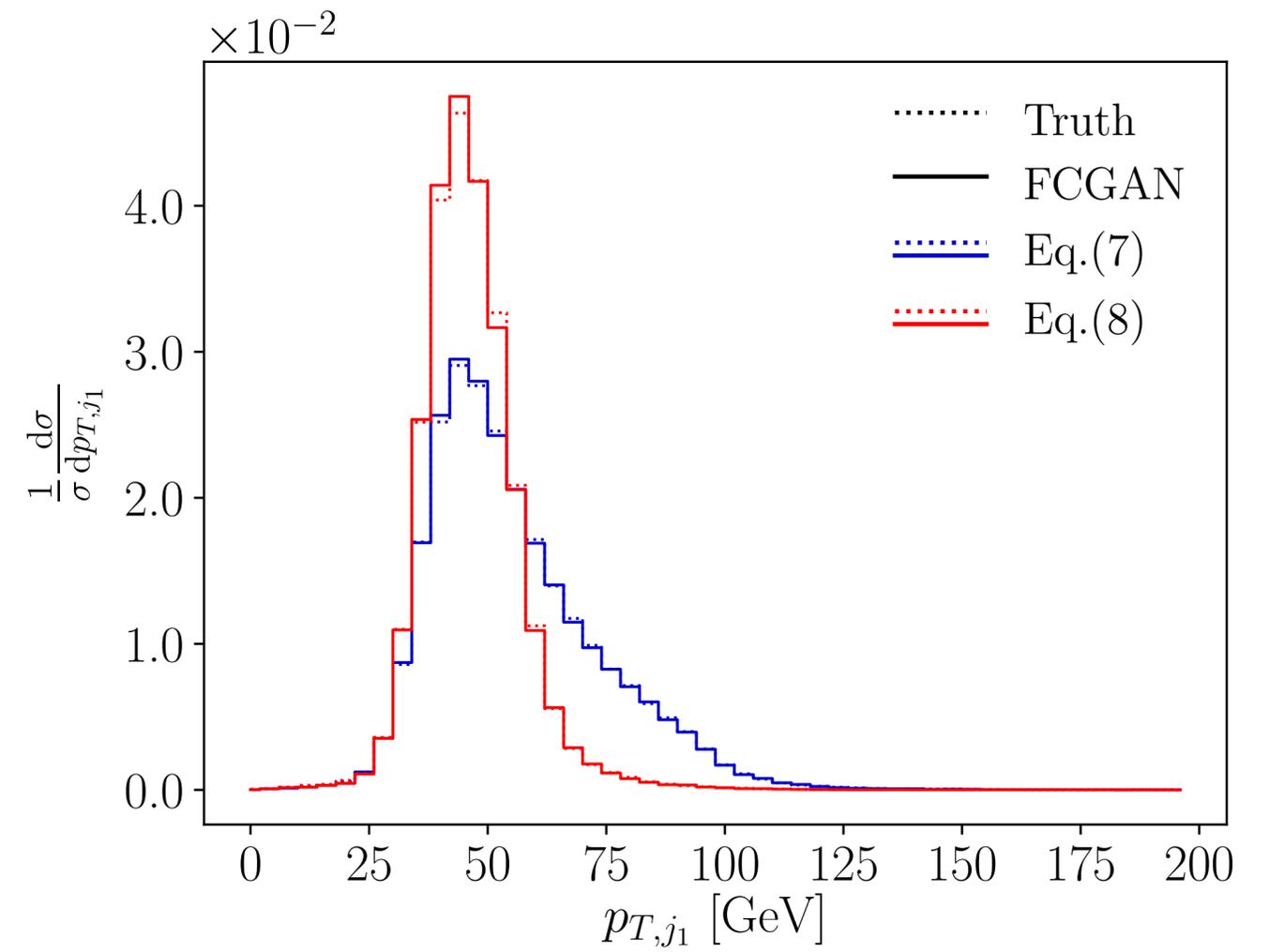
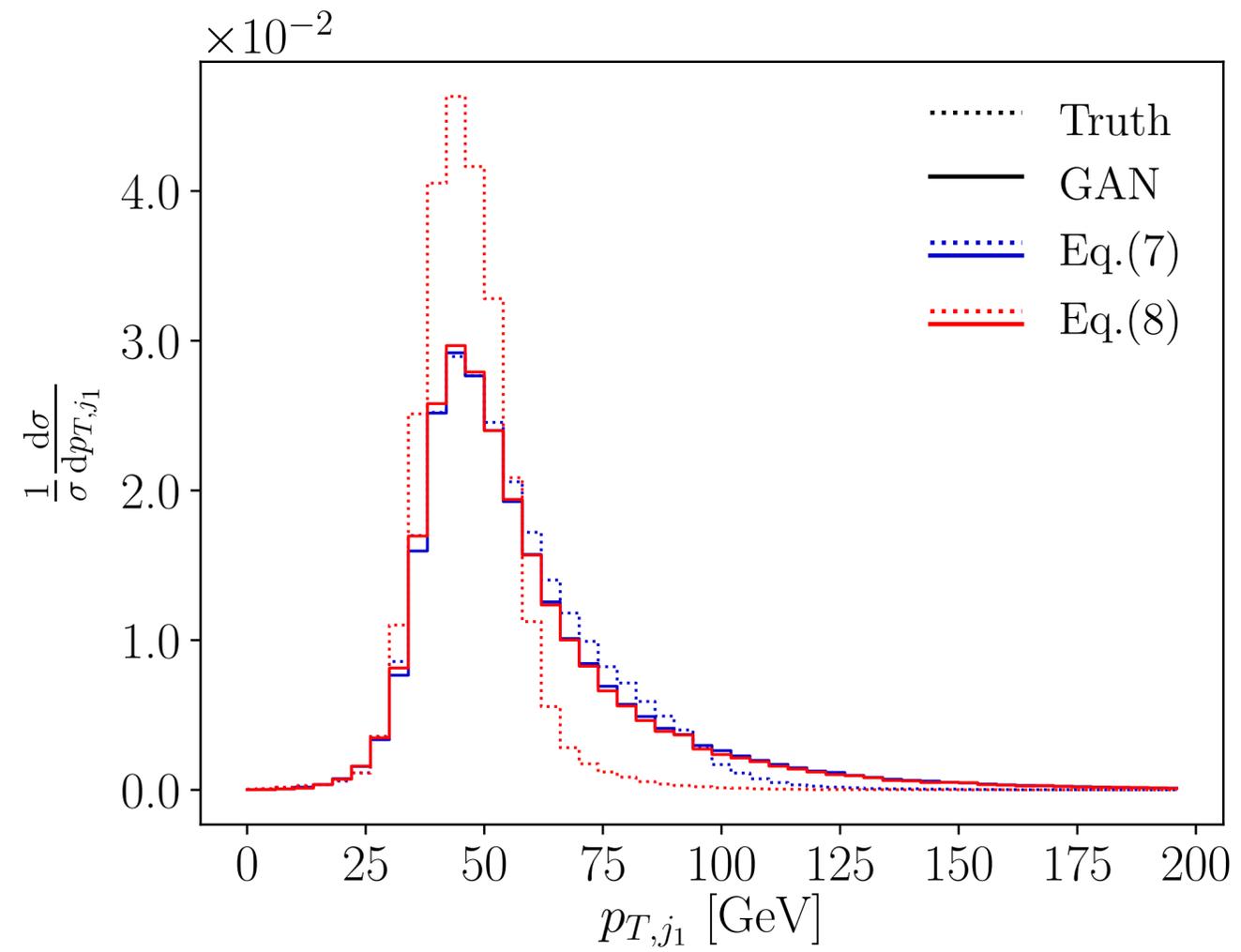
$$30 \text{ GeV} < p_{T,j_1} < 100 \text{ GeV}$$

Cut II:

$$30 \text{ GeV} < p_{T,j_1} < 50 \text{ GeV}$$

$$30 \text{ GeV} < p_{T,j_2} < 60 \text{ GeV}$$

FCGAN Unfolding

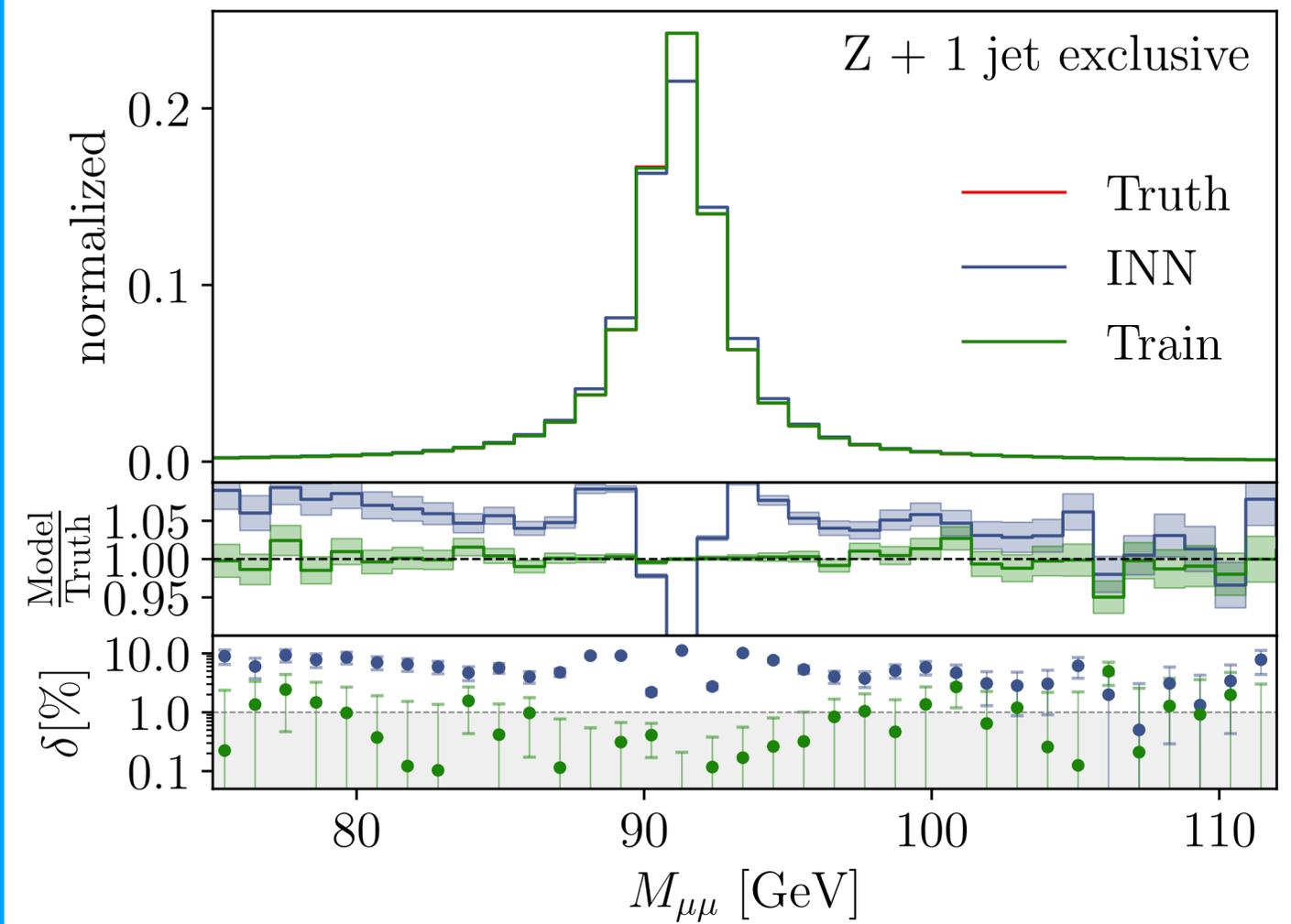
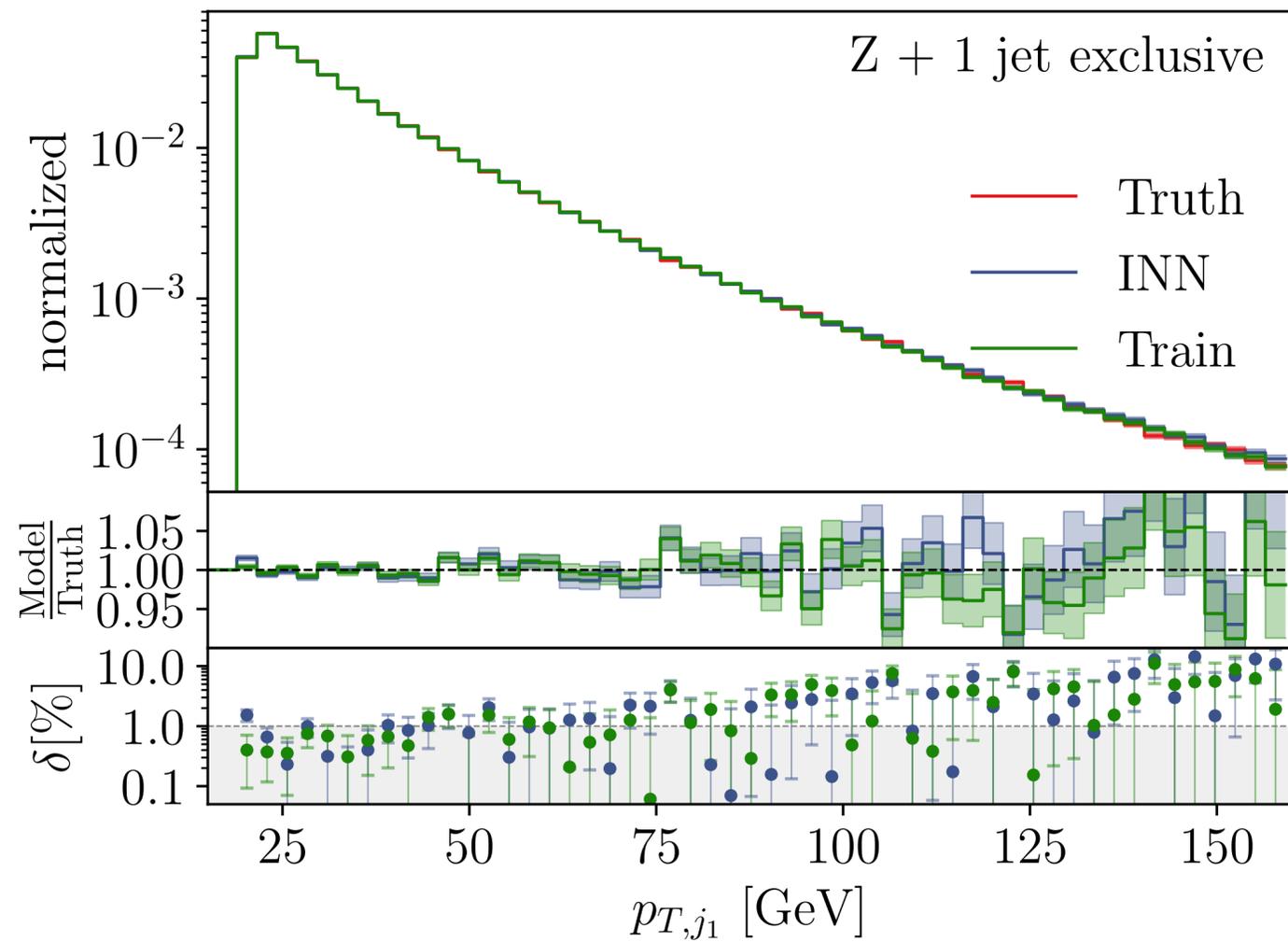


Generative Models II

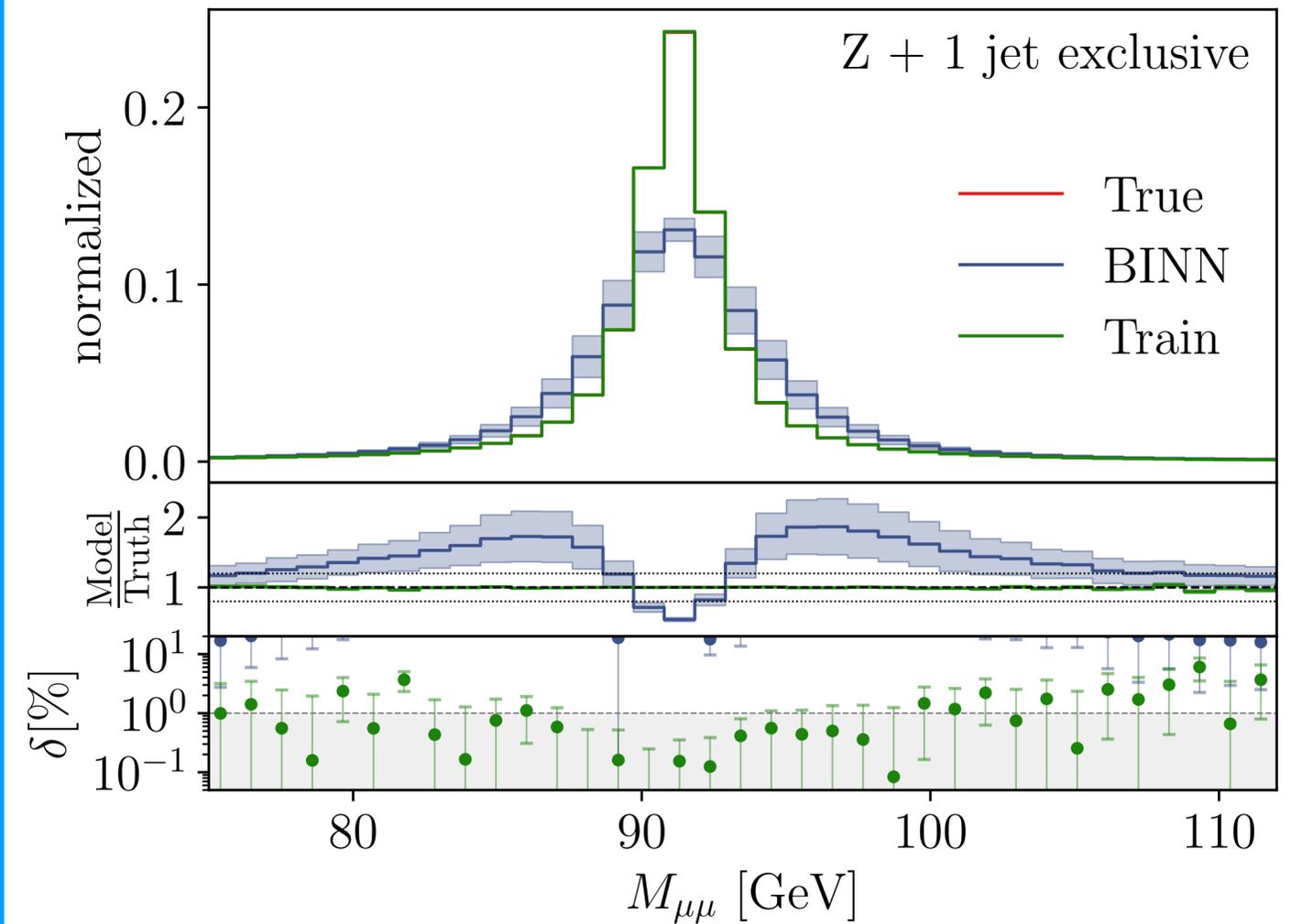
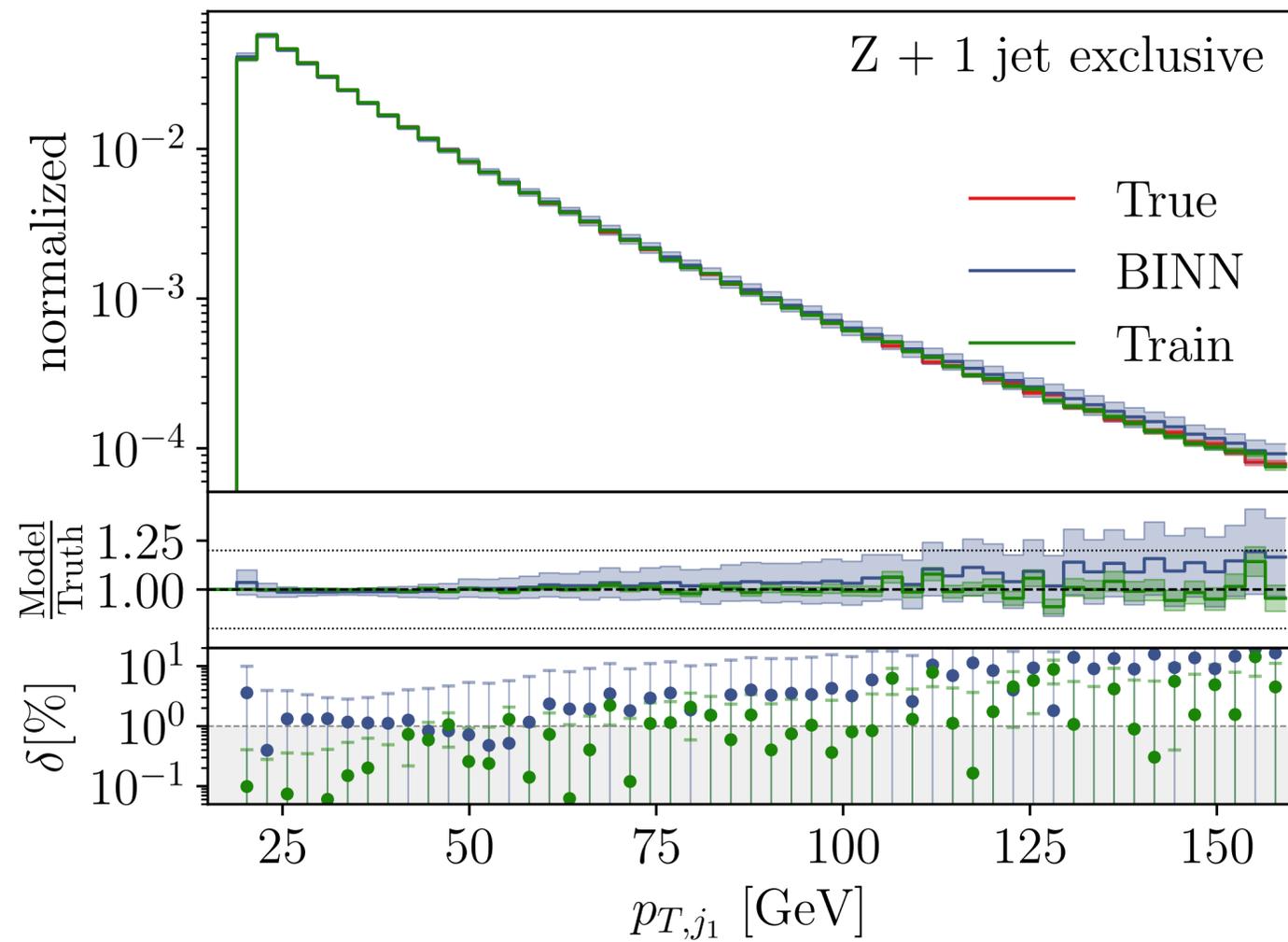
Normalizing Flows

Blackboard — Session III

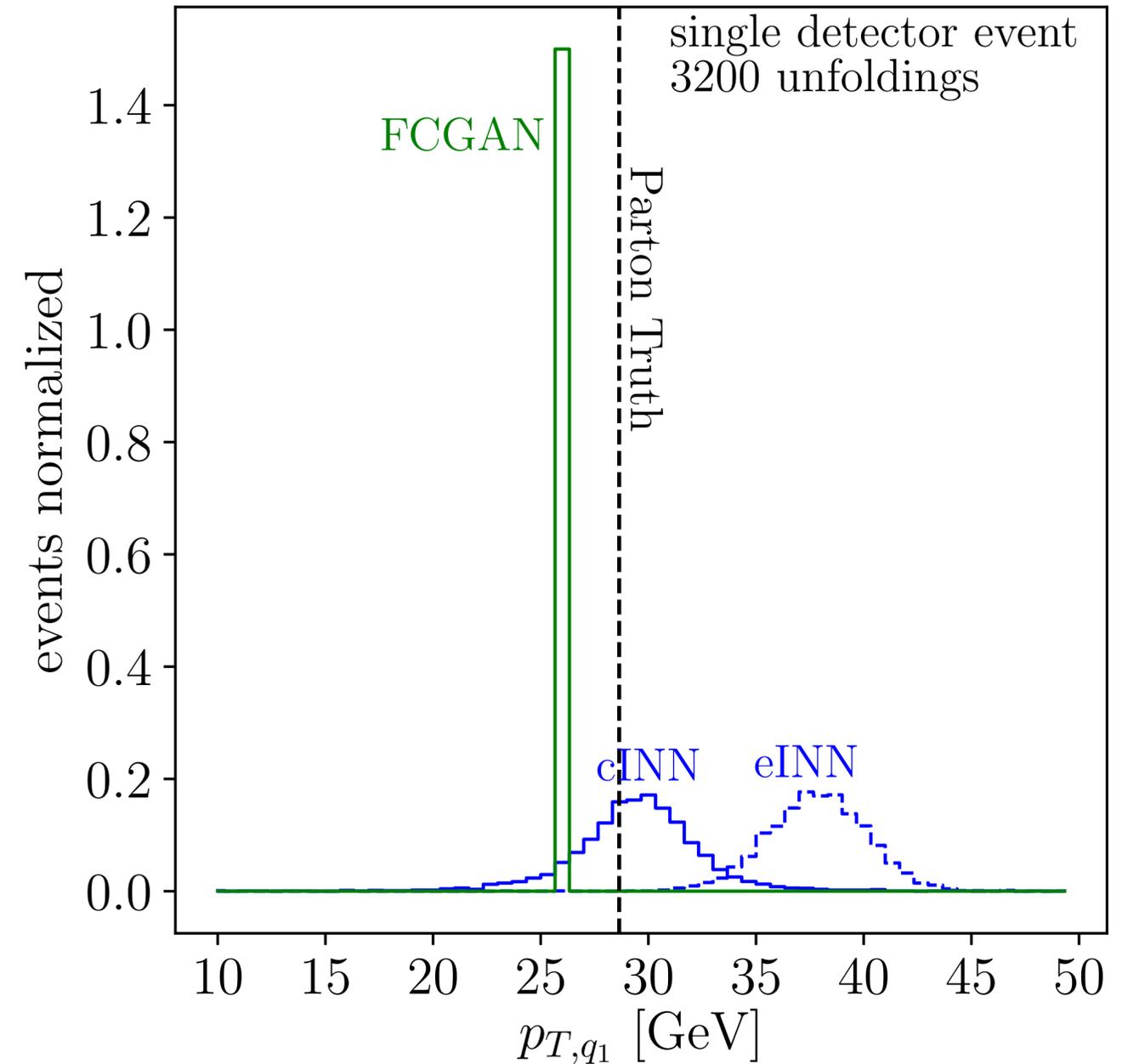
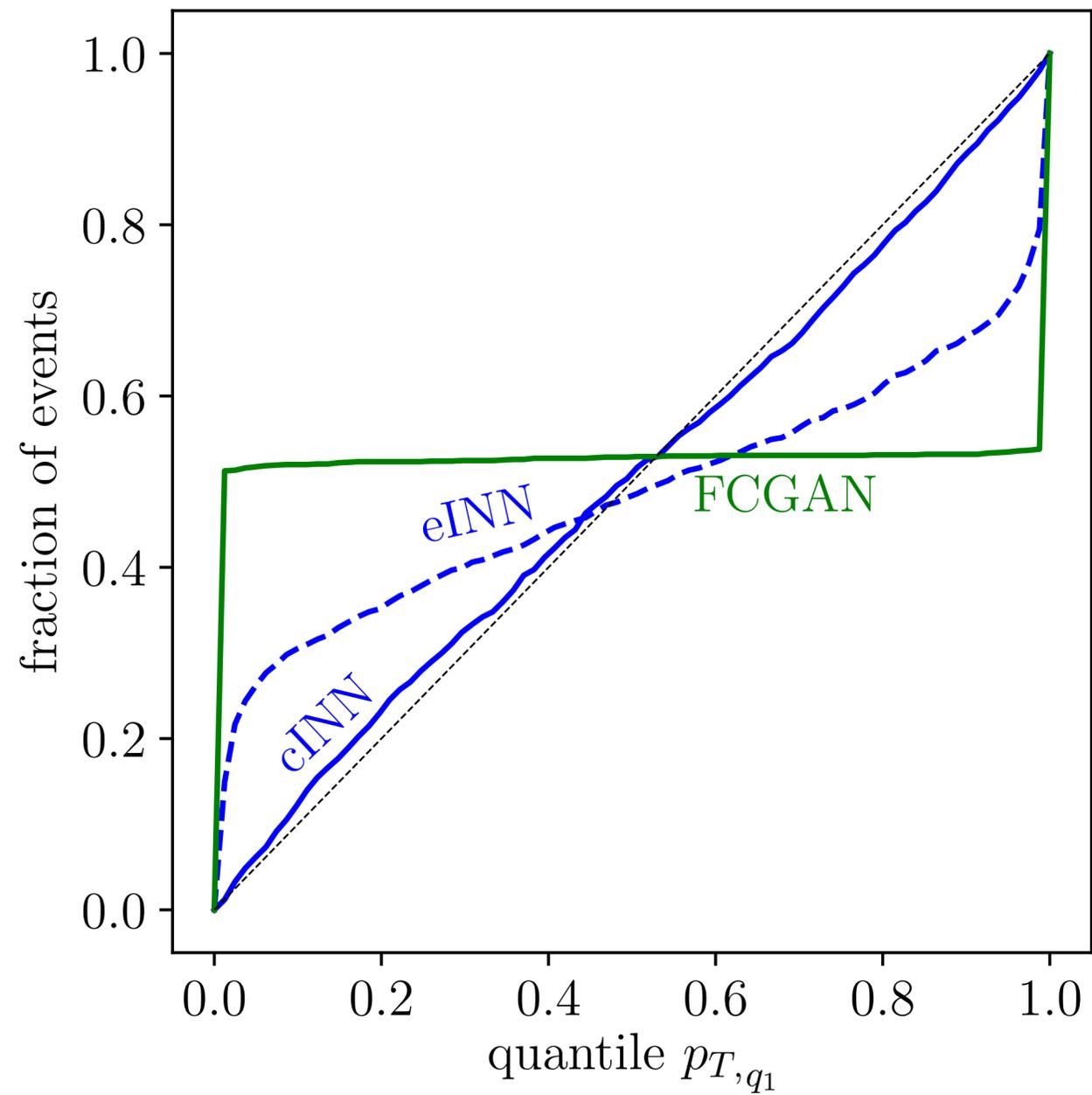
cINN Event Generation



cINN Event Generation



cINN Unfolding



Anomaly Detection

Unveiling new physics at the LHC?

Blackboard — Session IV

Anomaly detection — Comparison

