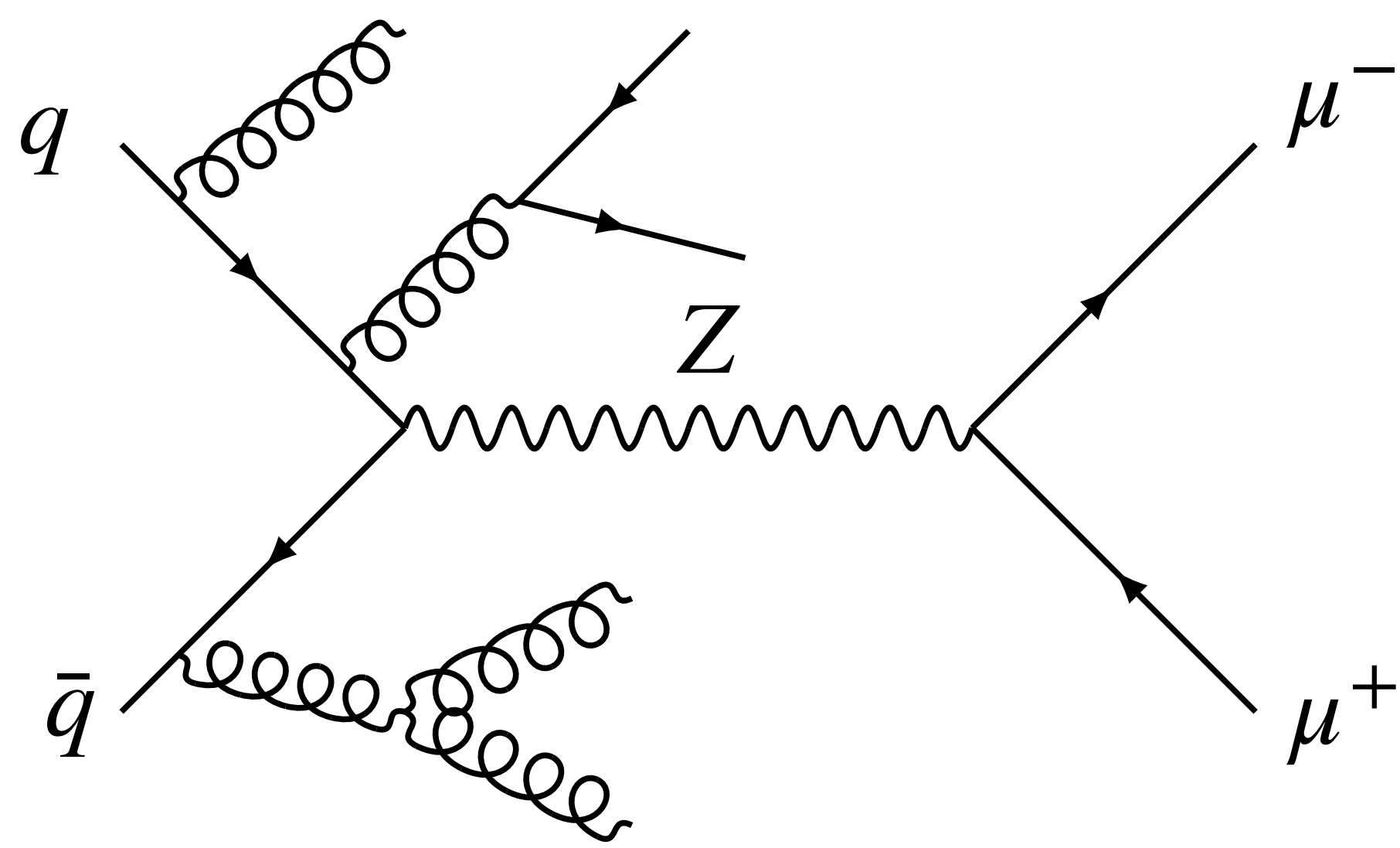


LHC Event Generation with JetGPT

LHC Event Generation

- **Fast** generation of LHC events
- Learn challenging correlations to **percent-level**
- **Transfer knowledge** from cheap low-multiplicity events to expensive high-multiplicity events

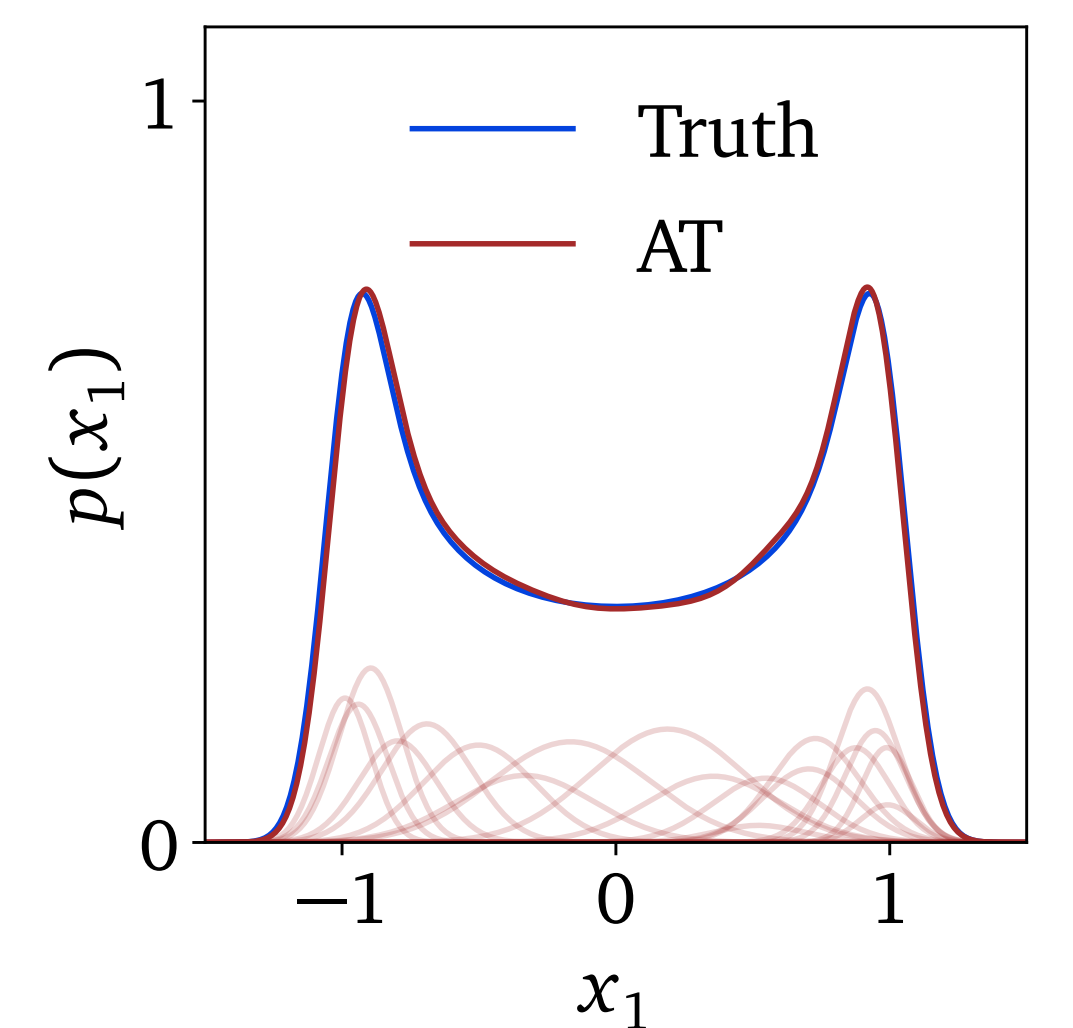


Autoregressive Transformer

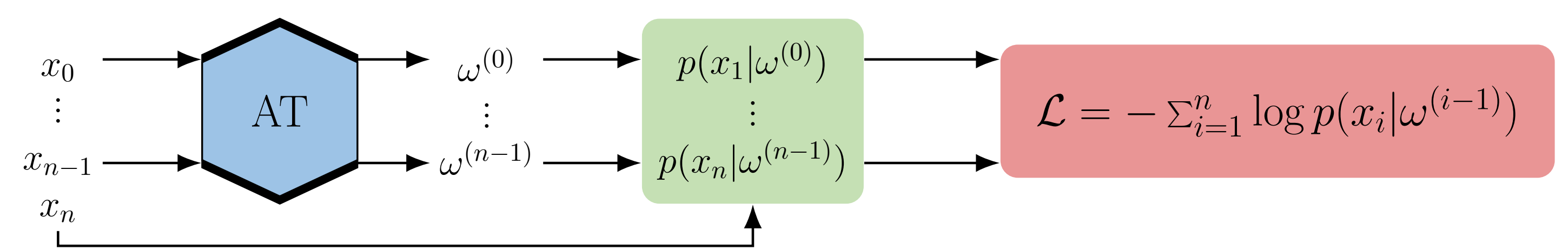
- Autoregressive **Gaussian Mixture Model**

$$\begin{aligned}
 p(x_1, x_2, \dots, x_n) &= p(x_1)p(x_2|x_1)\dots p(x_n|x_{n-1}) \\
 &= p(x_1|\omega^{(0)})p(x_2|\omega^{(1)})\dots p(x_n|\omega^{(n-1)})
 \end{aligned}$$

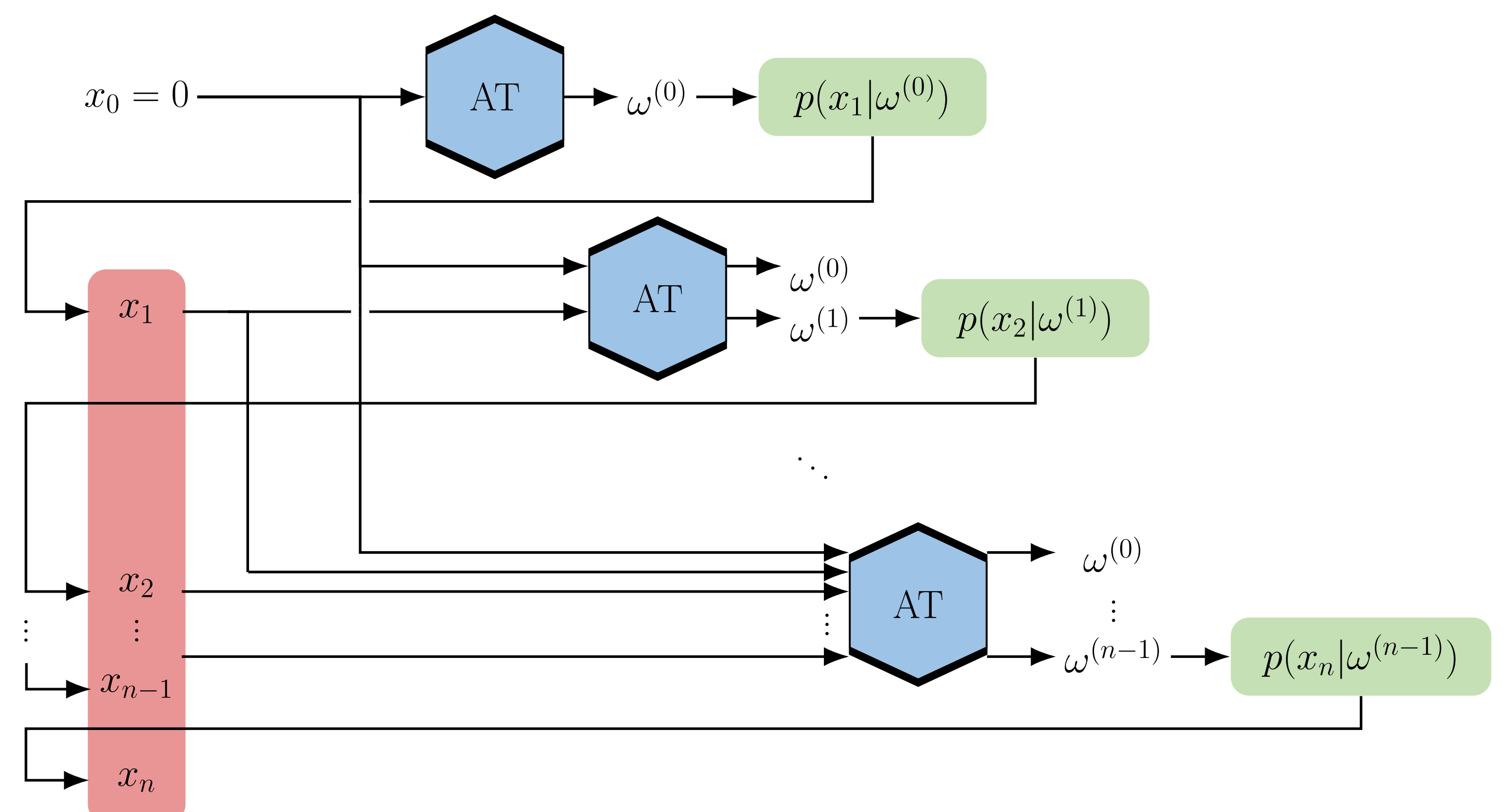
$$p(x_{i+1}|\omega^{(i)}) = \sum_{j=1} w_j^{(i)} \mathcal{N}(x_{i+1}|\mu_j^{(i)}, \sigma_j^{(i)}) \quad \omega^{(i)} = \{w_j^{(i)}, \mu_j^{(i)}, \sigma_j^{(i)}\}$$



- Training: **Parallelised** density estimation

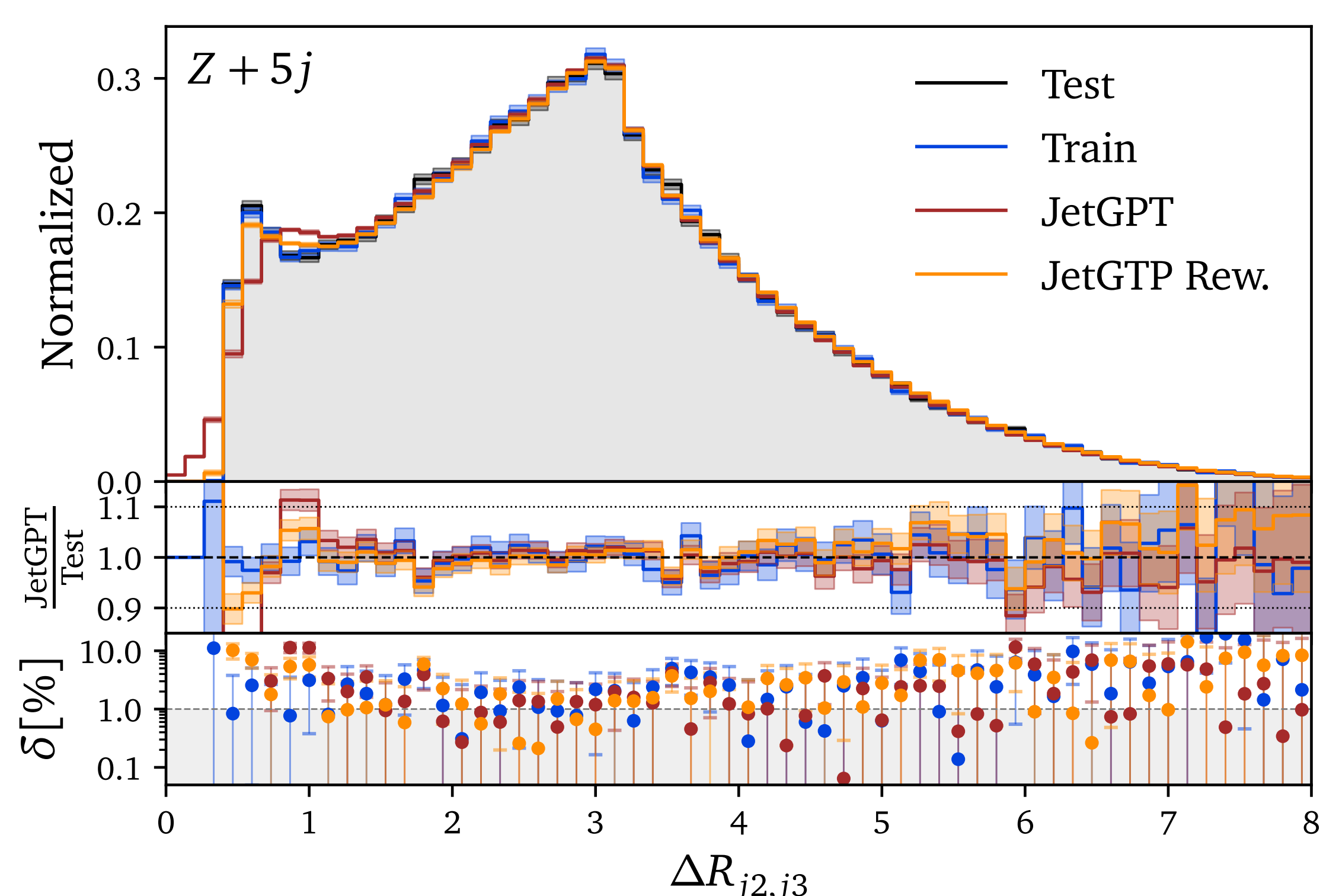
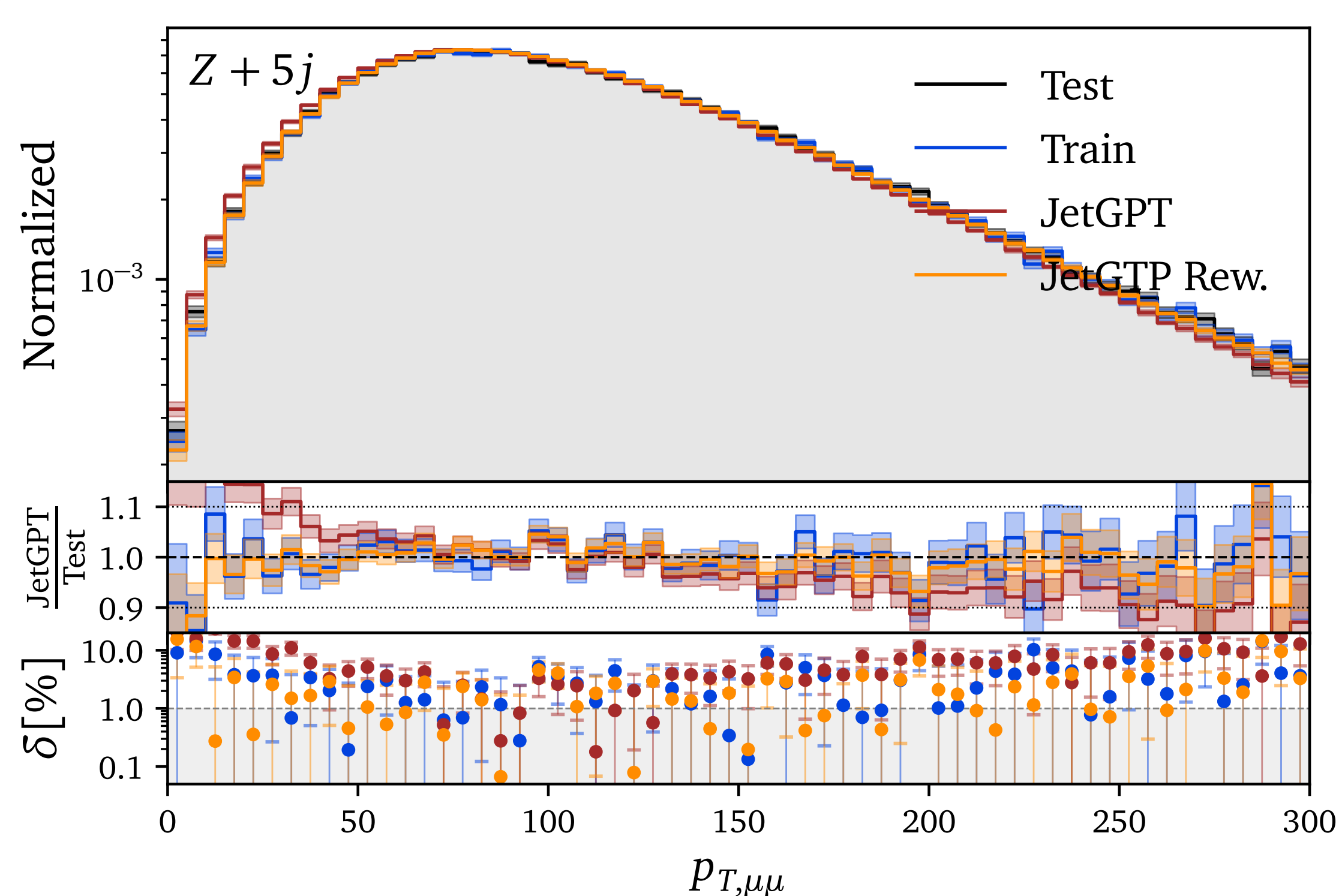


- Generation: **Autoregressive** sampling from one-dimensional distributions



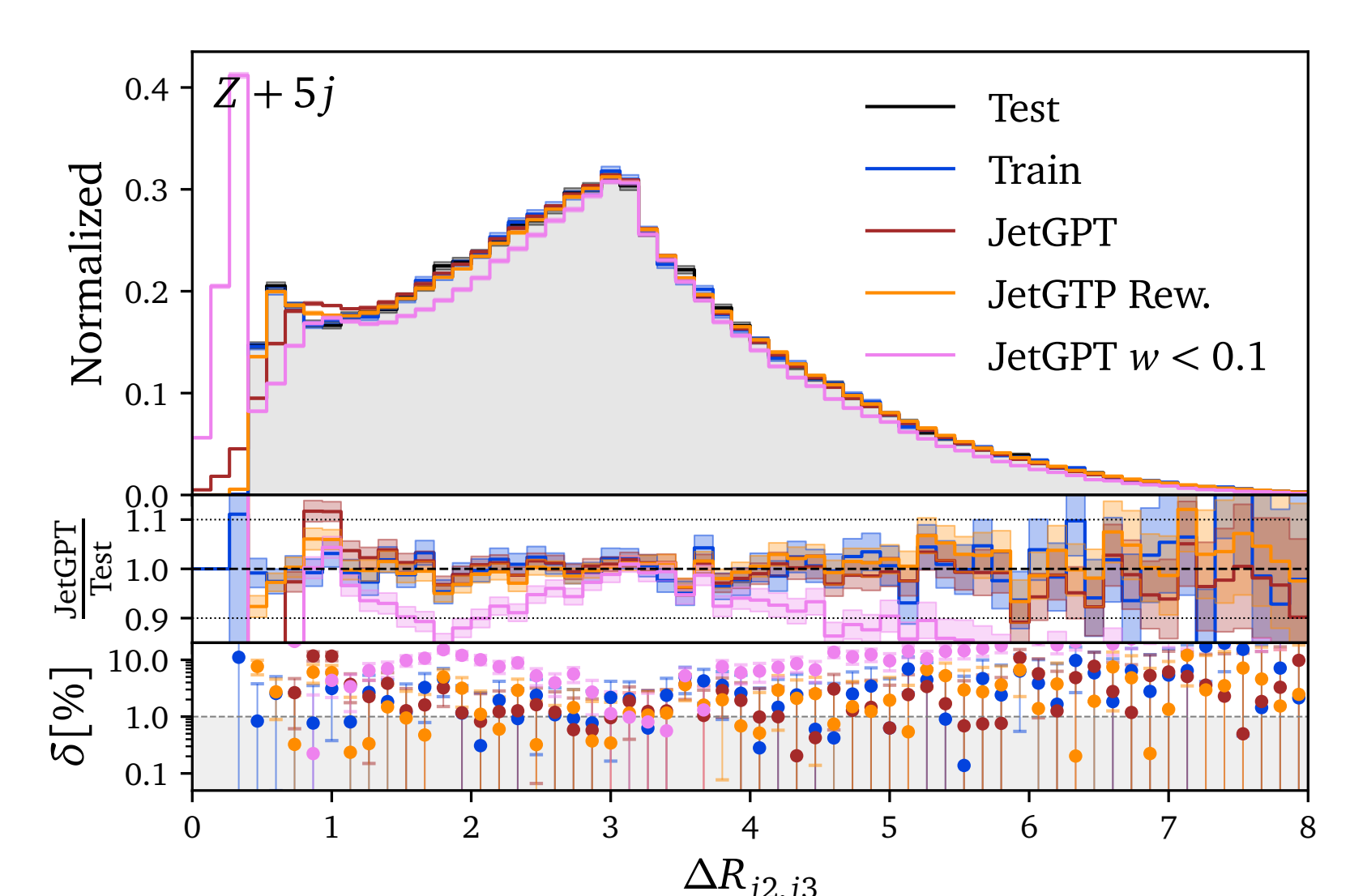
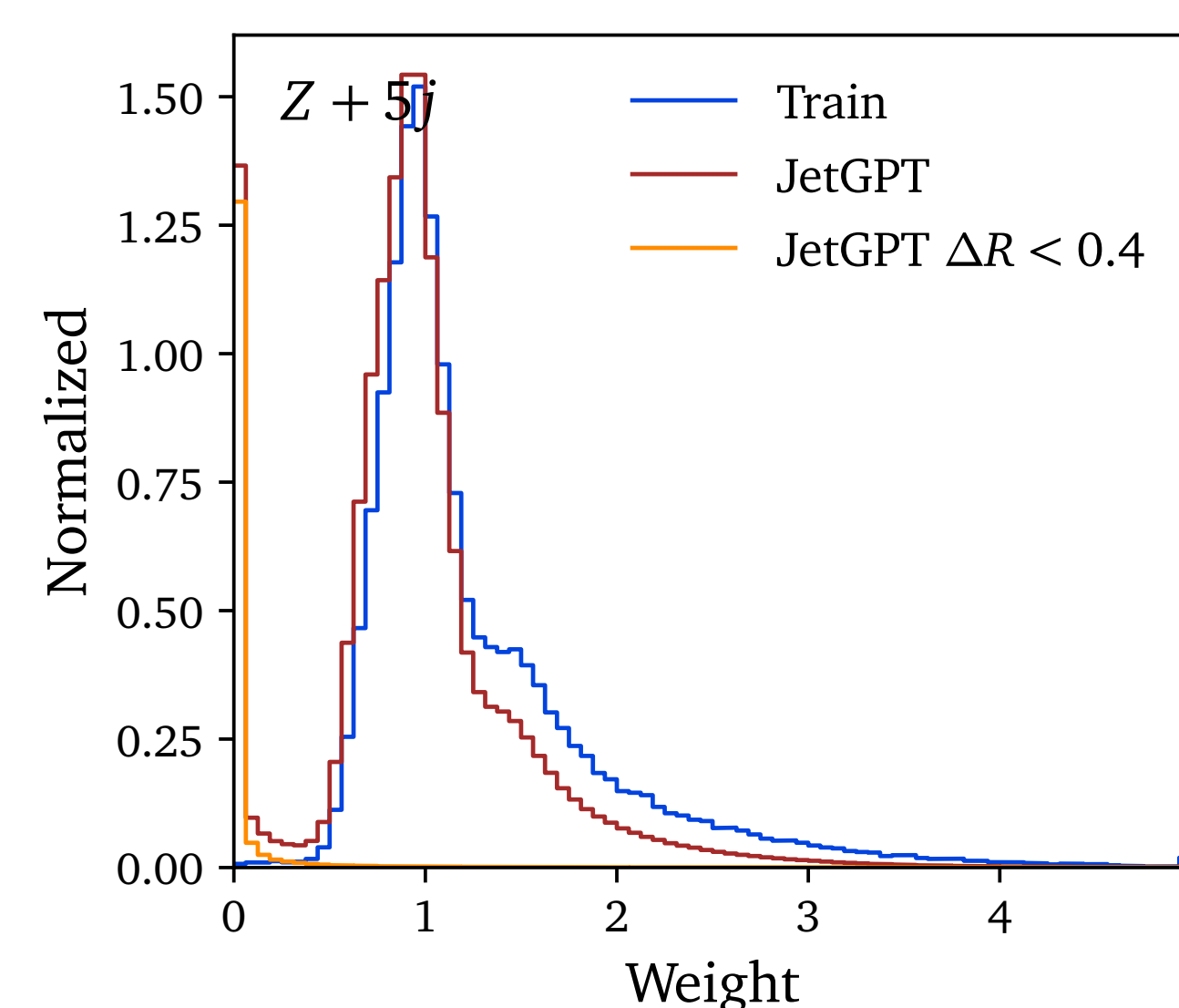
Classifier Control

- Neural classifiers approximate the **likelihood ratio**
- **Locate** discrepancies: Likelihood ratio as test statistic
- **Reweight** discrepancies: Likelihood ratio as weighting factor



Results

- **Joint training** on different multiplicities enhances performance and allows knowledge transfer
- **Autoregressive ordering** gives a powerful handle to control which features the model should focus on
- Neural classifiers to **locate and reweight** remaining discrepancies



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arxiv:2305.10475 [hep-ph]

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