Variational inference for pile-up removal at hadron colliders with diffusion models

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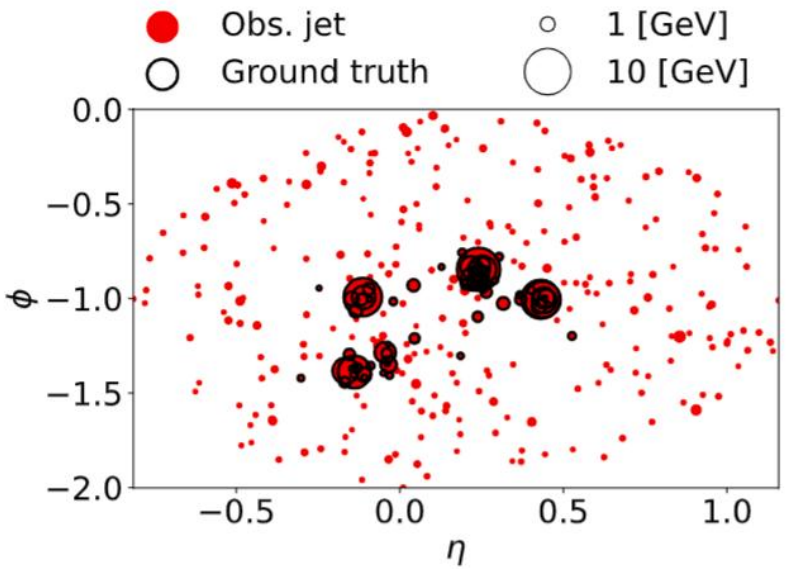
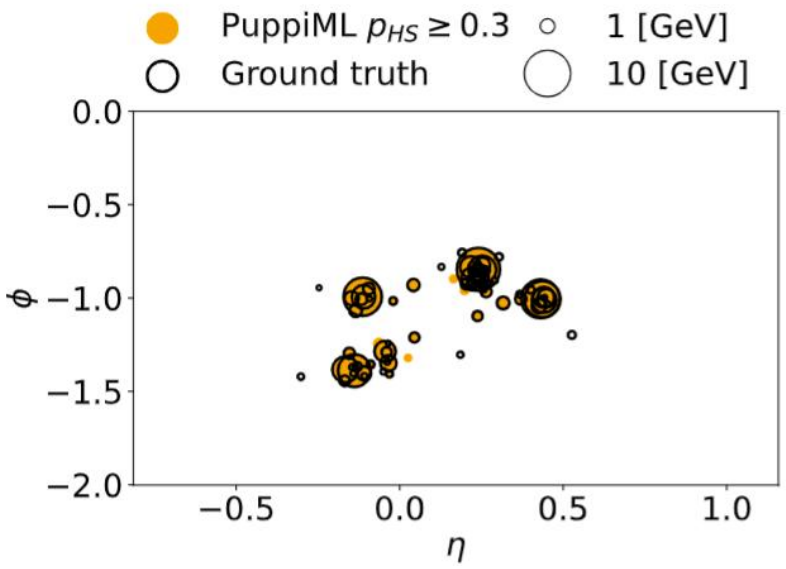
Noisy environment of ATLAS

- Most experiments works in a noisy environment
  - ATLAS => pile-up
  - Classifier based removal is common (0: pile-up particle, 1: true particle)
- Using variational inference to generate the clean event
  - Like super-resolution for image generation

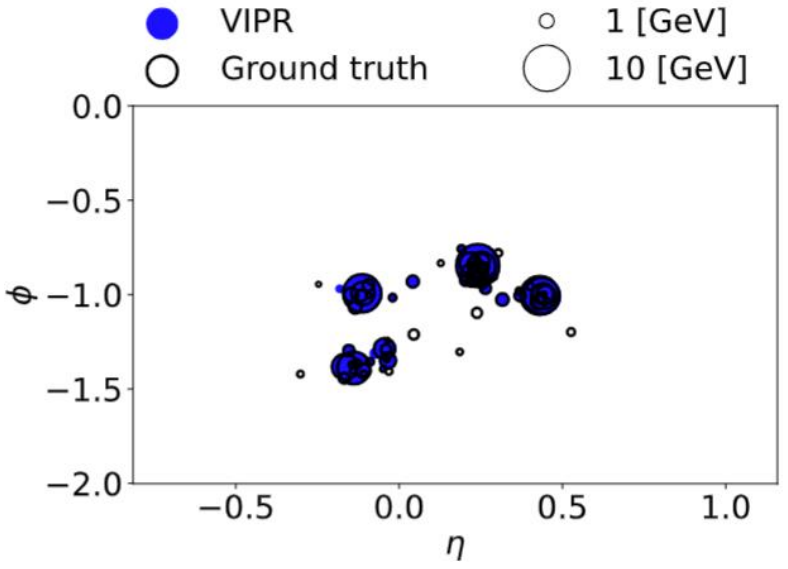
Observed event



Classifier removal

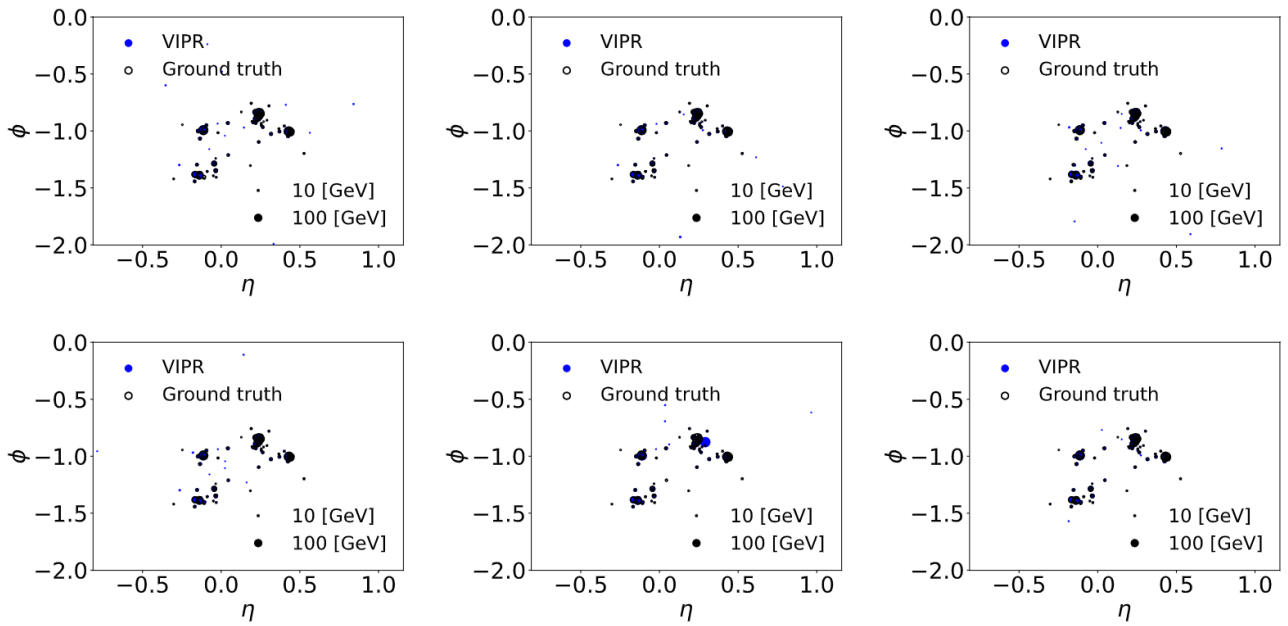


Variational inference removal

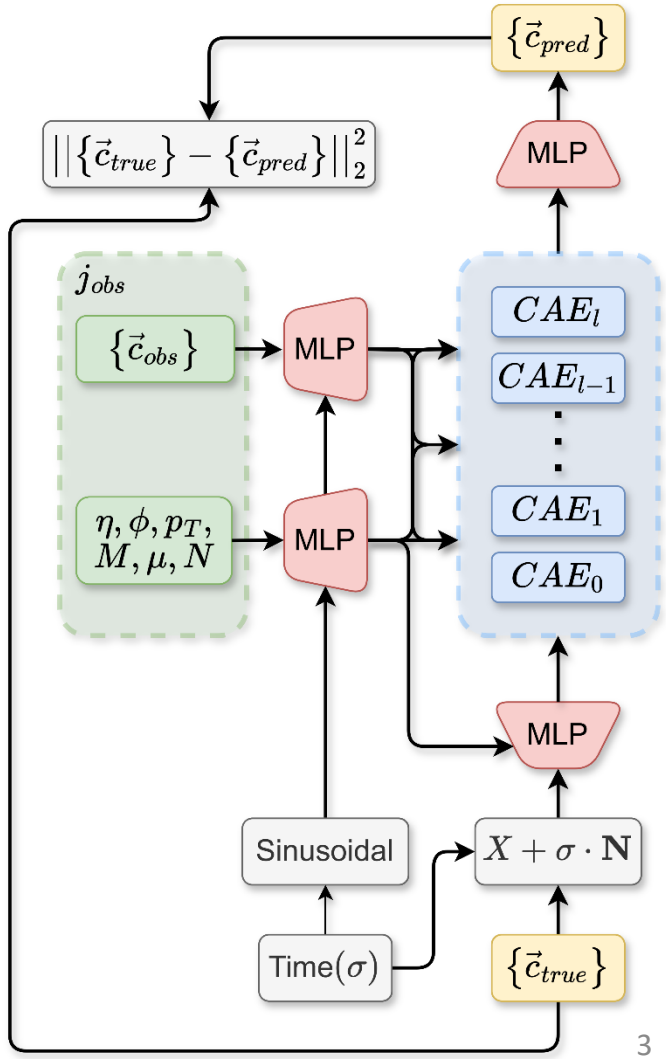


Variational Inference using diffusion

1. Can overcome in-efficiencies (based on simulation)
    - Detector limitation
    - Reconstruction inaccuracies
2. Full posterior estimation
    - Generate multiple solution from the posterior



Set-to-set diffusion



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Not limited to The ATLAS Experiment

If classifier-based noise removal is used,

variational inference can usually also be used

Other items we can talk about:

- **Diffusion models**
- **Transformers**
- **Optimal transport**
  - **Domain adaptation**
  - **Decorrelation**