Empirically Trained Hadronic Event Regenerator

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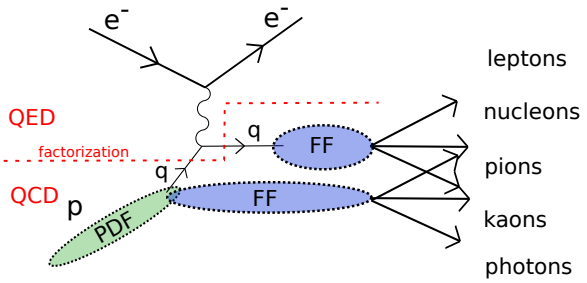
Hadronic Event Generators

- PYTHIA
- HERWIG
- ISAJET
- Sherpa

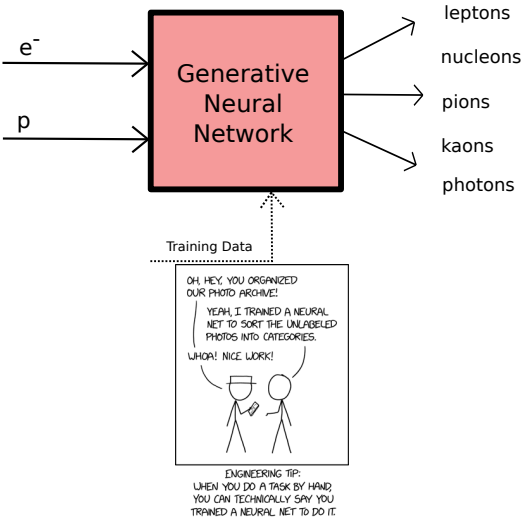
- Inputs:
  - PDFs (QCD)
  - FFs (QCD)
  - Factorization
  - QED
  - Tune to match experiment...



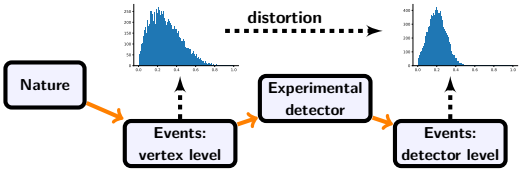
ETHER: An Agnostic Event Generator

- No theory input on vertex interactions
- Generative Adversarial Networks (GANs)
- Inputs: electron and proton
- Outputs: long-lived (detectable) particles
- Train generator against existing data

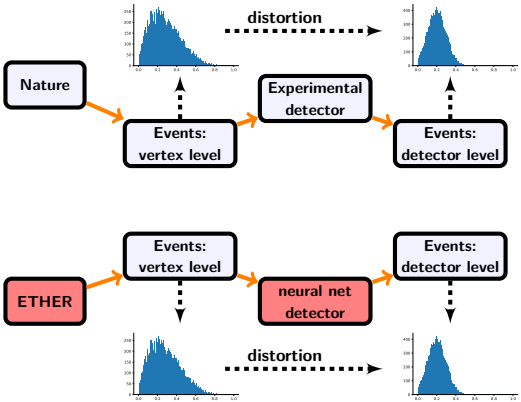
- Leverage recent major advances in Generative Machine Learning



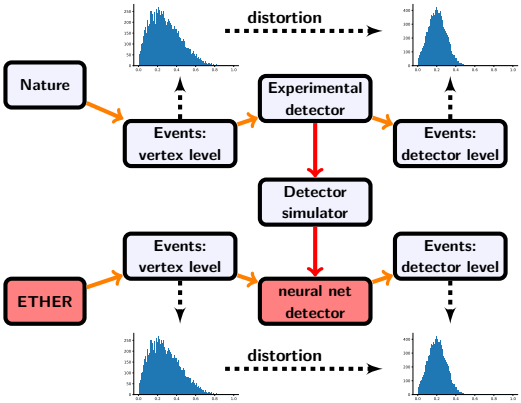
ETHER Flowchart



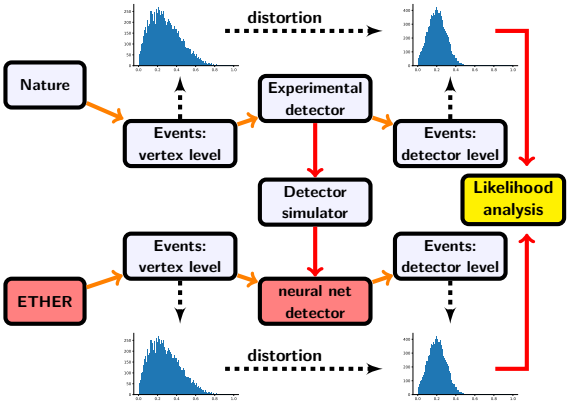
ETHER Flowchart



ETHER Flowchart



ETHER Flowchart



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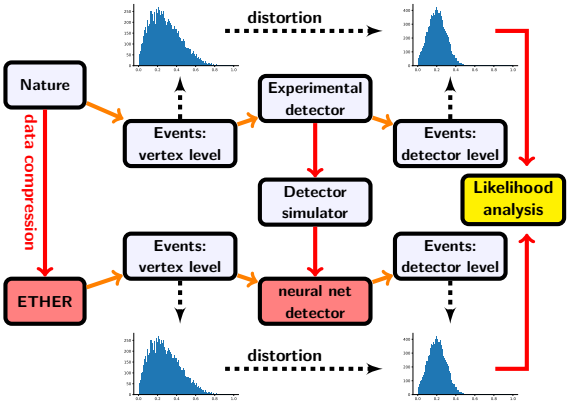


ETHER Collaboration

Old Dominion University

- Yaohang Li
- Yasir Awadh Alanzi

Davidson College

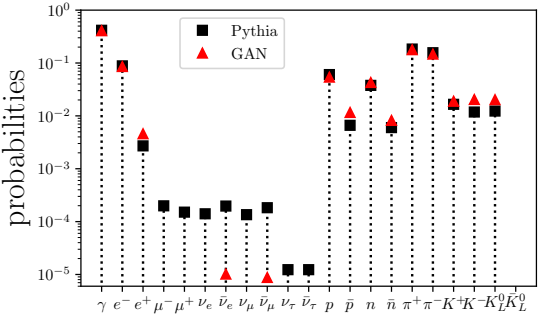
- Michelle Kuchera
- Raghuram Ramanujan
- Ryan Strauss
- Evan Pritchard
- Michael Robertson

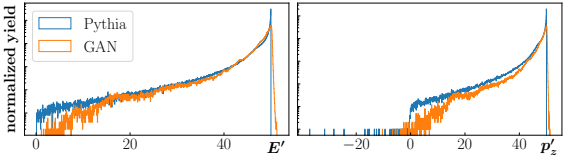
Jefferson Lab

Nobuo Sato Wally Melnitchouk Tianbo Liu Evan McClellan Luisa Velasco

Progress

Dual GAN





Outlook

Full Exclusive Event

- R&D on data representation and GAN architecture for full exclusive events
- R&D: make generators *conditional* on $\sqrt{s}$
- **Challenges:**
  - Variable number of particles
  - Discrete (PID) and continuous (4-vector) variables

Simpler, Inclusive Final States

- Develop inclusive GANs for specific reactions
- One GAN per final state:
  - $p(e, e')X$
  - $p(e, e'\pi^+)X$
  - $p(e, e'\pi^+\pi^-)X$
  - ...
- R&D: make generators *conditional* on $\sqrt{s}$