Flavour Tagging with Graph Neural Networks with the ATLAS experiment

Waltteri Leinonen on behalf of the ATLAS Collaboration

Radboud Universiteit

EuCAIF conference 2024

Physics-informed GNN

Flavour Tagging with Graph Neural Networks with the ATLAS experiment

GN1 and GN2 are ATLAS's state-of-the-art low-level ***b*-tagging** and **boosted Higgs tagging** architectures.

- Physics inspired tagging with **auxiliary tasks** : $L_{total} = L_{jet} + \alpha L_{vertex} + \beta L_{track}$
  - Interpretable model outputs through **vertexing** and **track tagging**
- Massive performance upgrade
  - Many-fold higher background rejection → **Higher tagging efficiency**
- Flexible architecture, suitable for general tagging tasks
  - **Boosted Higgs →** $b\bar{b}/c\bar{c}$ **tagging** used in **precision measurements**
    - Top tagging folded into the same architecture
  - Unique challenges in producing mass-decorrelated tagger

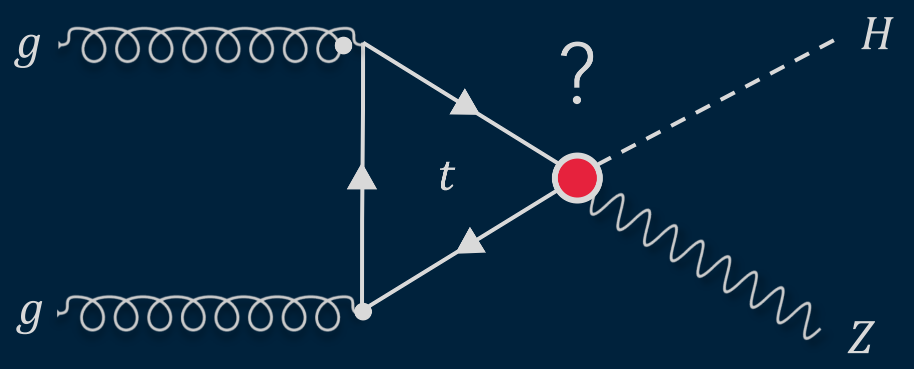
Amsterdam, The Netherlands, April 30 - May 3, 2024

EUROPEAN AI FOR FUNDAMENTAL PHYSICS CONFERENCE EuCAIFCon 2024

Towards the First Time Measurement of $gg \to ZH$ at the LHC Using Transformer Networks

Geoffrey Gilles, Wouter Verkerke, Marcel Vreeswijk

Extract New Physics Contributions from the Challenging $gg \to ZH$ process

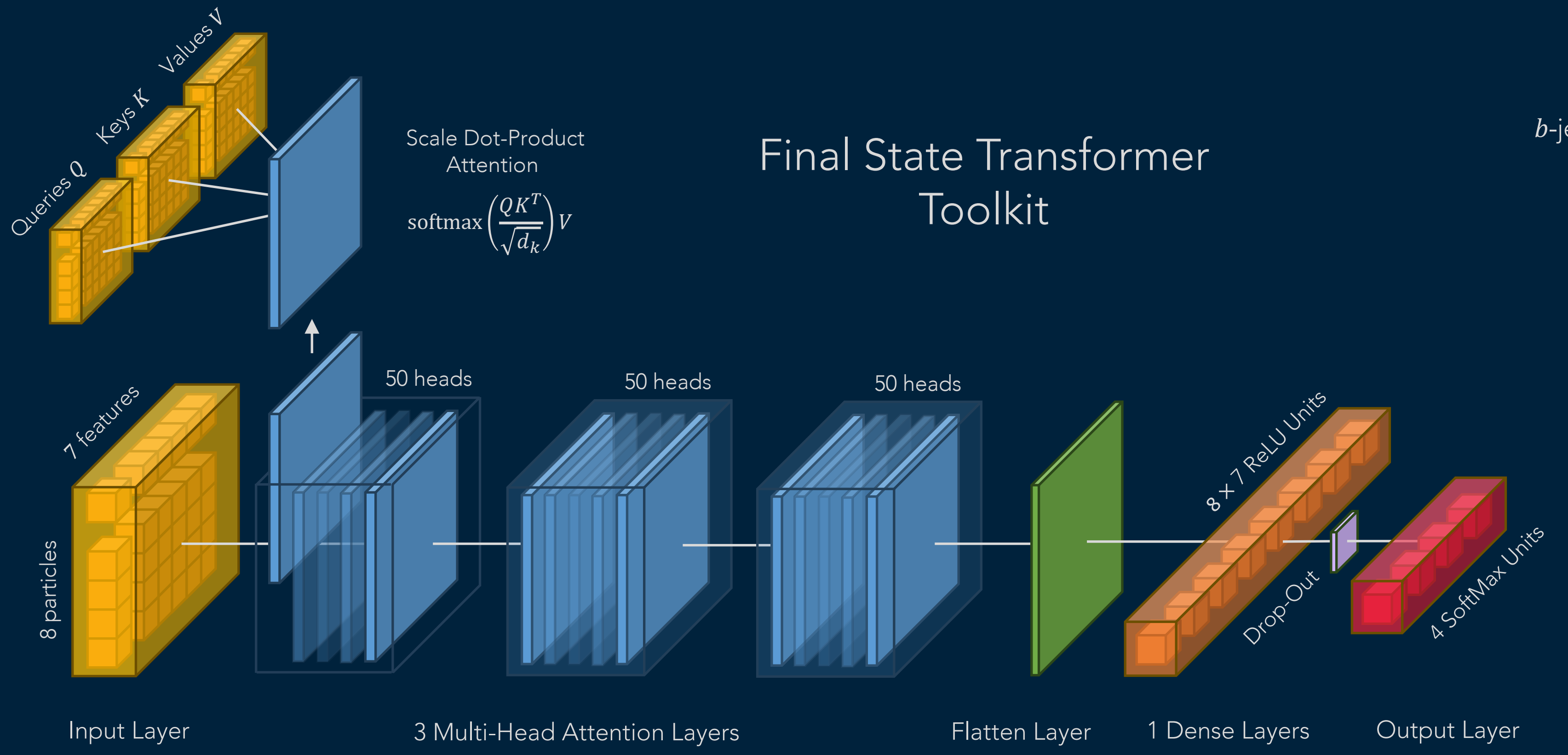


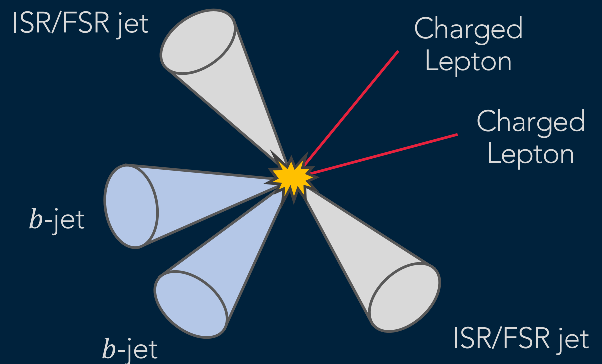
Simulation Based Inference empowered by Transformer network

Towards the First Time Measurement of $gg \to ZH$ at the LHC Using Transformer Networks

Learning from Particle Collision Event Final State

Final State Transformer Toolkit



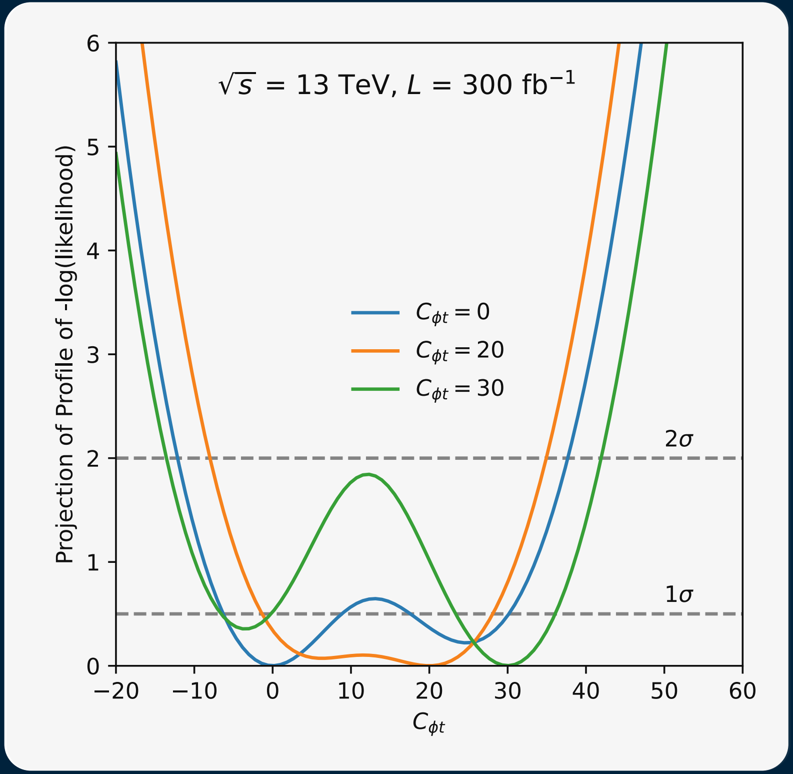


Discriminate signal from background
&
Assess new physics contributions

Exploring Simulation Based Inference

Construct likelihood function based on Transformer output probabilities

$$\begin{aligned}\mathcal{L} = & P_{obs}^{SM} \\ & + c_{\phi t} \cdot P_{obs}^{INT} \\ & + c_{\phi t}^2 \cdot P_{obs}^{QUA} \\ & + \mu_{BKG} \cdot P_{obs}^{BKG}\end{aligned}$$



Capture intricacies of new physics interaction and detector responses in unprecedented details

Want to see the full story?

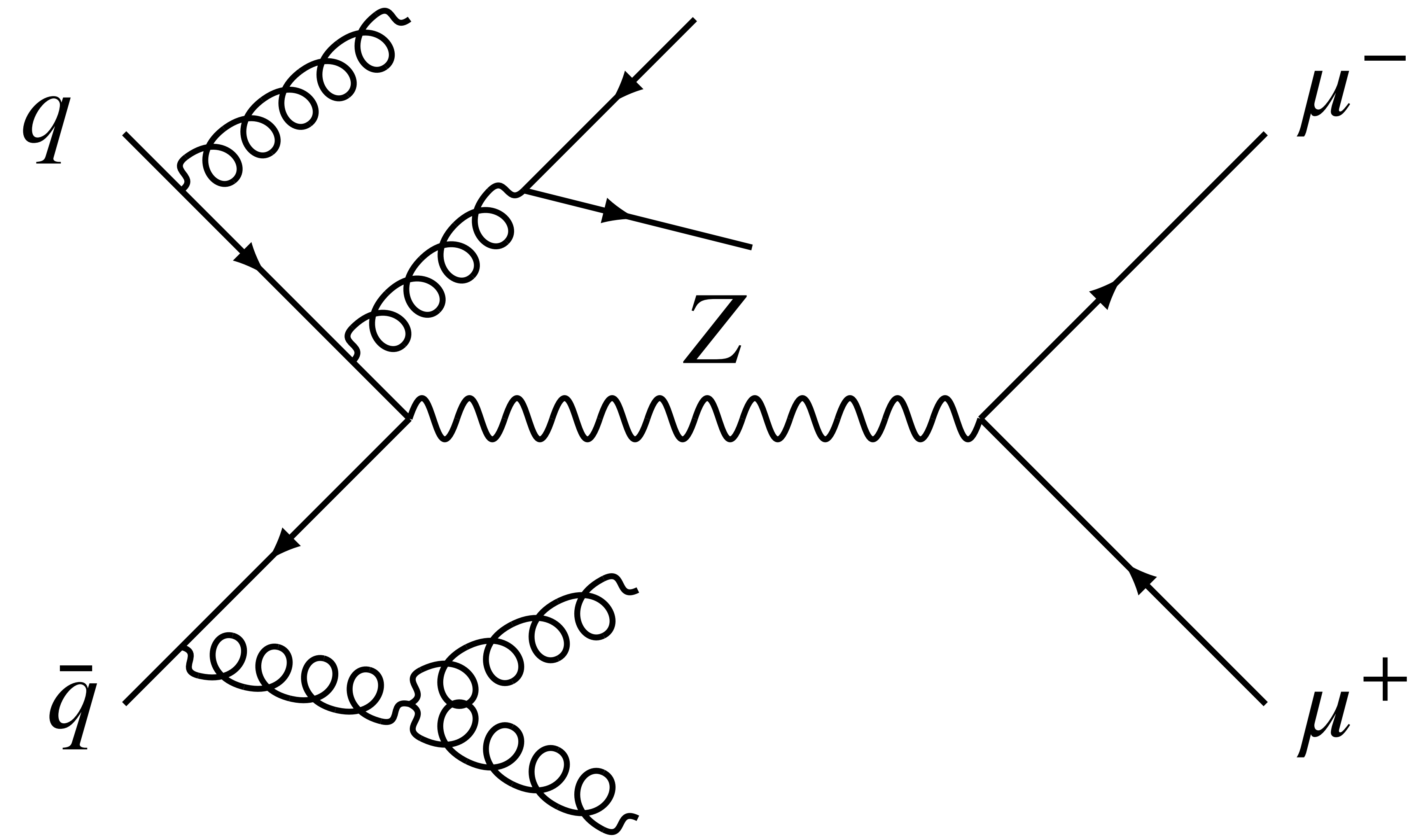
Visit my poster for in-depth findings and analysis!

LHC Event Generation with JetGPT

Anja Butter, Nathan Hütsch, Sofia Palacios Schweitzer, Tilman Plehn, Peter Sorrenson, Jonas Spinner, Nathanael Ediger, Maeve Madigan
Heidelberg University

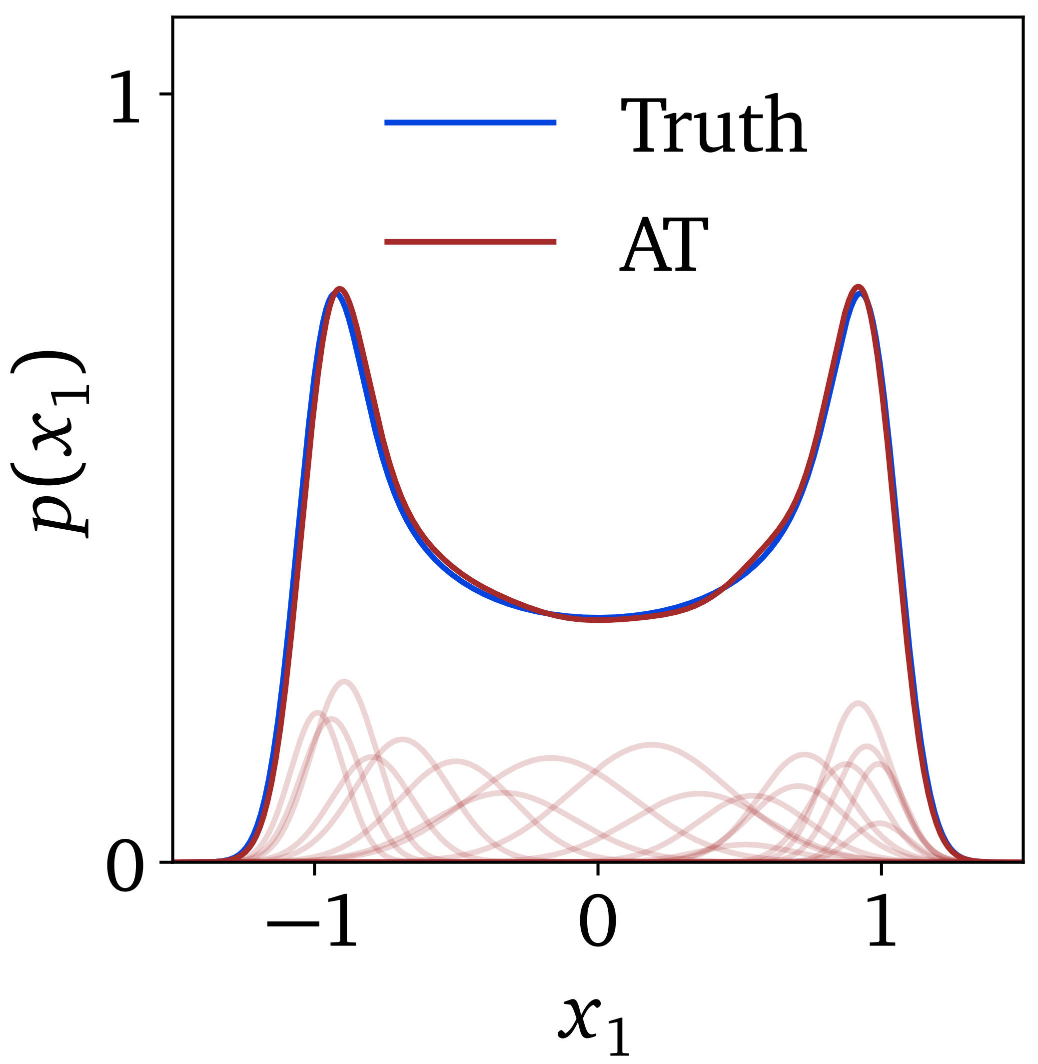
Physics problem

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



ML solution

- Autoregressive **transformer**
- **Gaussian Mixture Model** likelihood
- **Neural classifier** to locate and reweight remaining discrepancies



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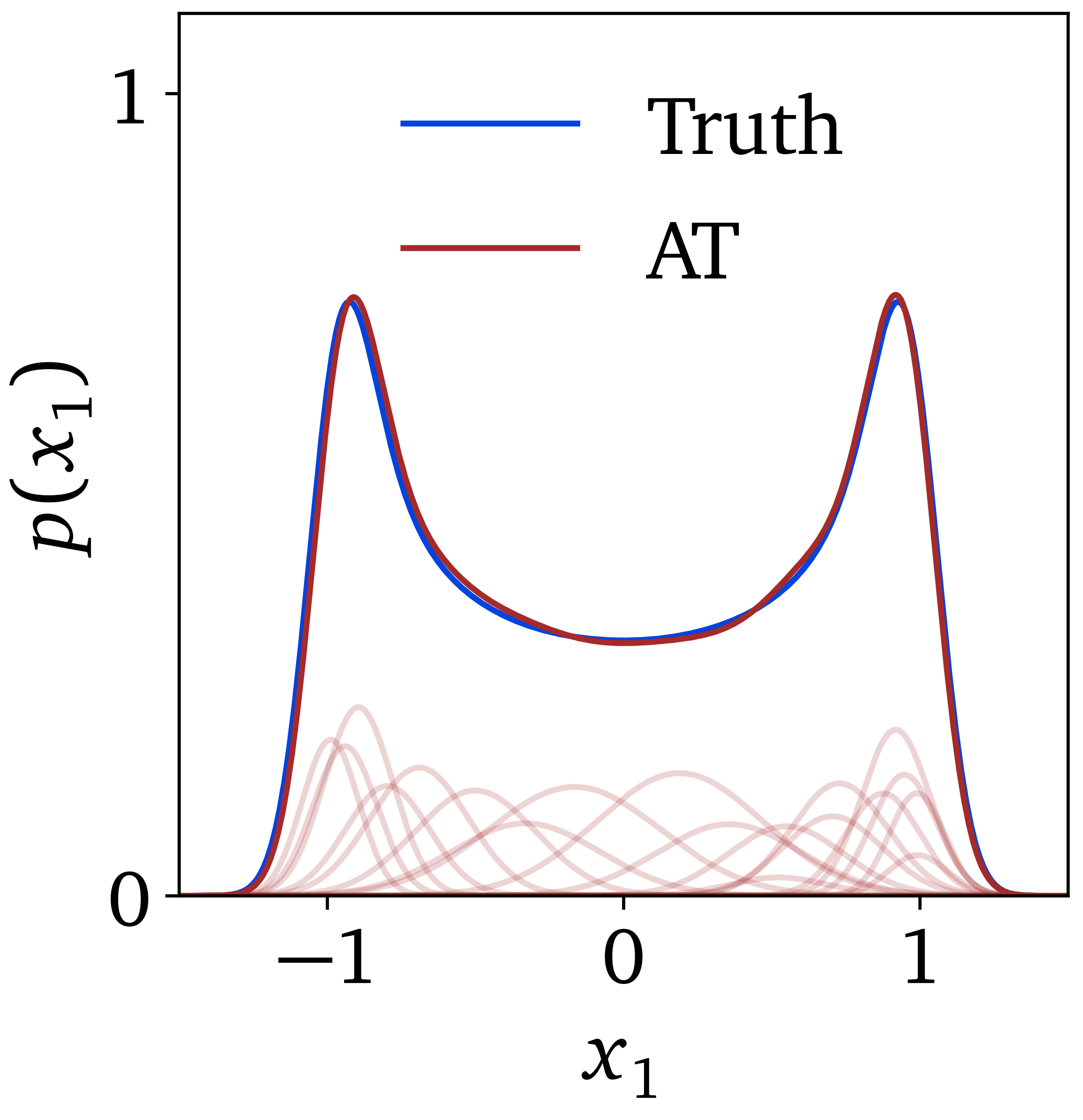

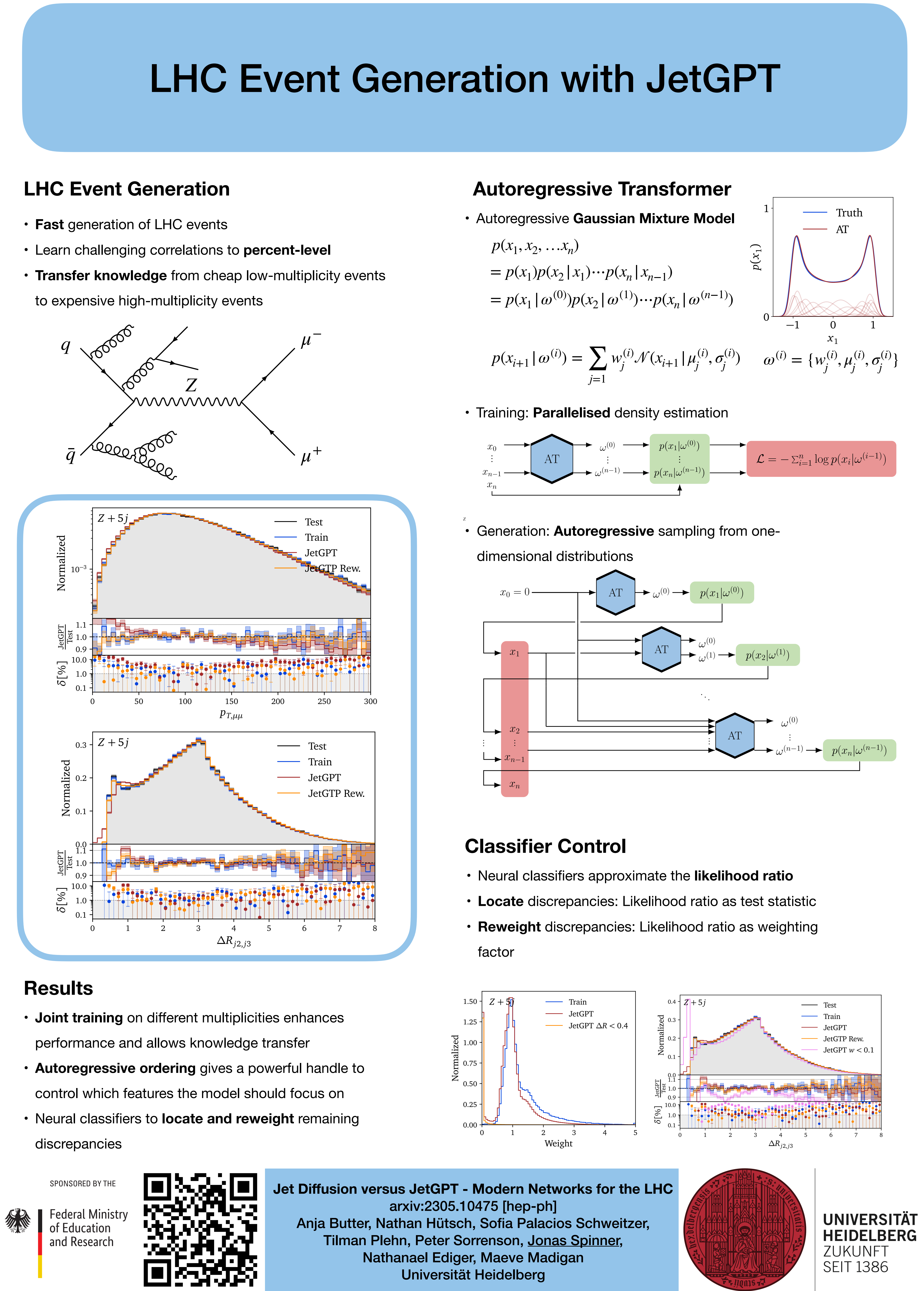

ATLAS EXPERIMENT

Abstract #126; poster Thur #95

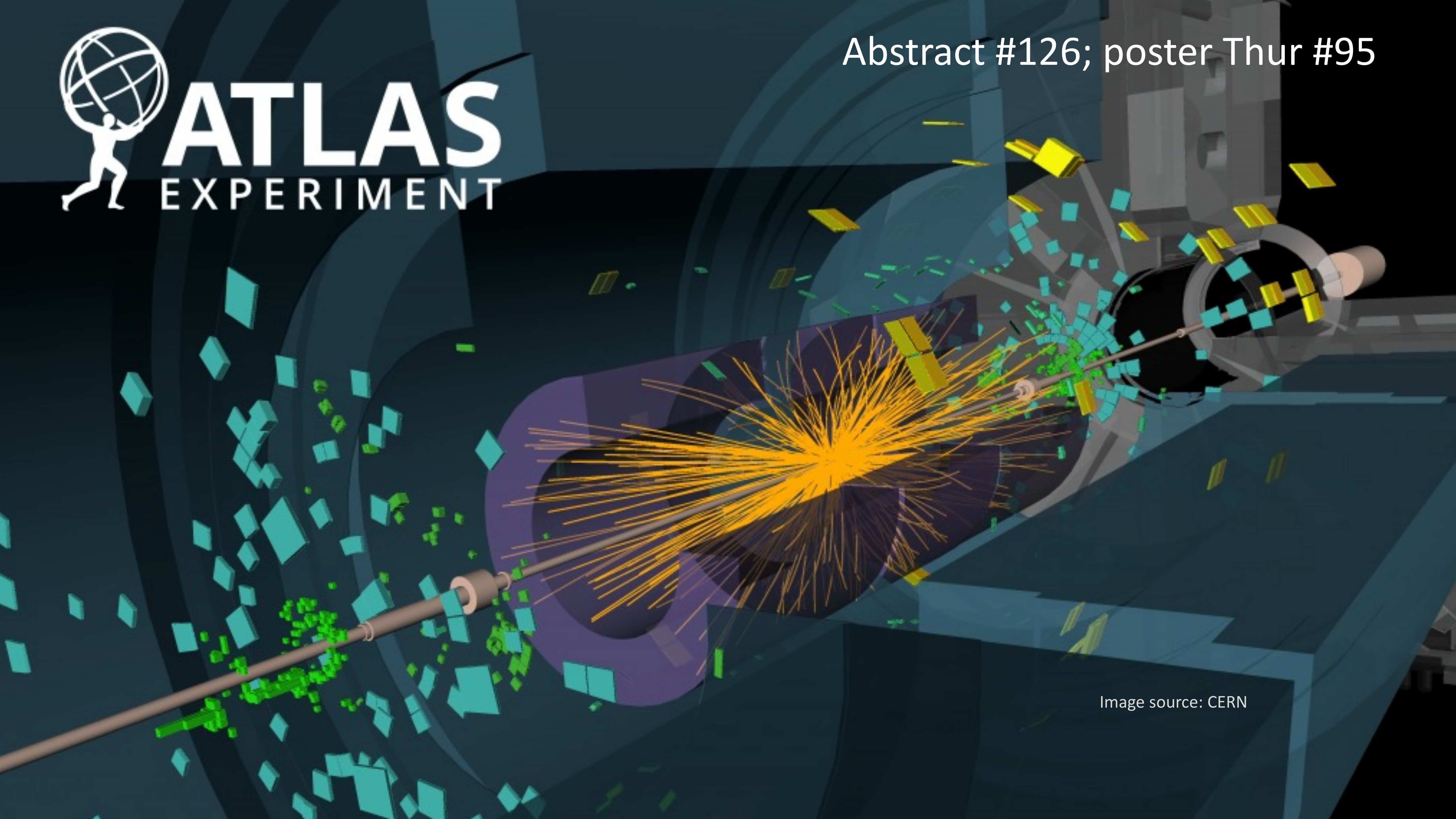

Image source: CERN

Abstract #126; poster Thur #95

Task: Reconstruct tracks from 3D point cloud

Abstract #126; poster Thur #95
Task:
Reconstruct tracks
from 3D point cloud
Approach:
Transformer-inspired models

Abstract #126; poster Thur #95

Transformer-inspired ML models for particle track reconstruction

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