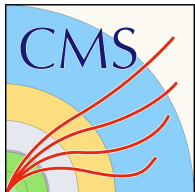# FlashSim: End-to-End simulation with flow matching
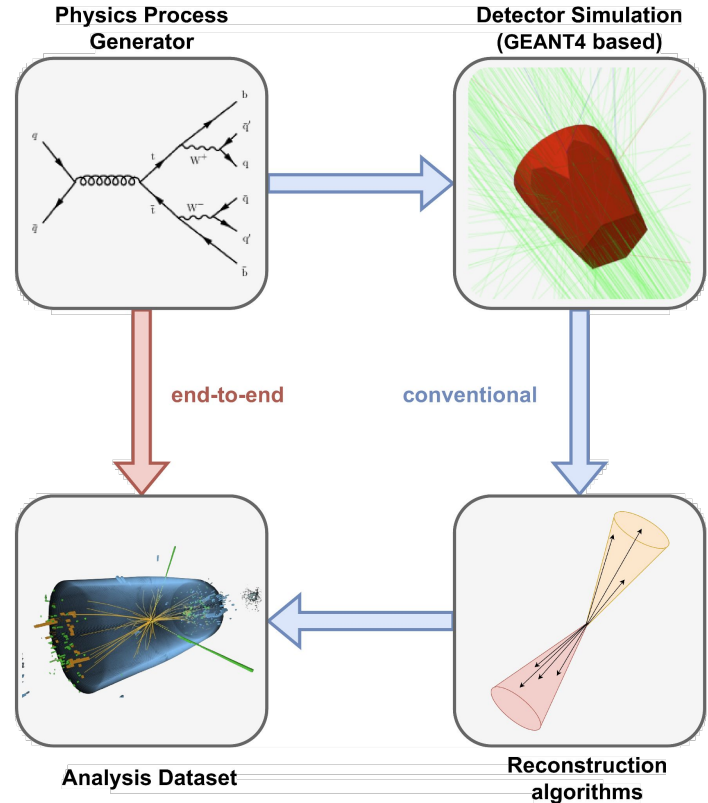
Francesco Vaselli on behalf of the CMS Collaboration
francesco.vaselli@cern.ch

We propose an *end-to-end* approach for faster simulations

Main idea: going directly from the generator output objects to the high level analysis objects (jets, muons …)!

We want something:

- Fast(er): reached ~kHz!
- Not analysis specific
- Depending on Gen (not just a generic event but the event)

Physics Process Generator

Detector Simulation (GEANT4 based)

end-to-end

conventional

Analysis Dataset

Reconstruction algorithms

2

Continuous Normalizing Flows are the backbone of our approach!

We learn an invertible transformation, taking us from data x to noise z

Once f has been found we can invert it, start from noise and sample new data from the unknown PDF!
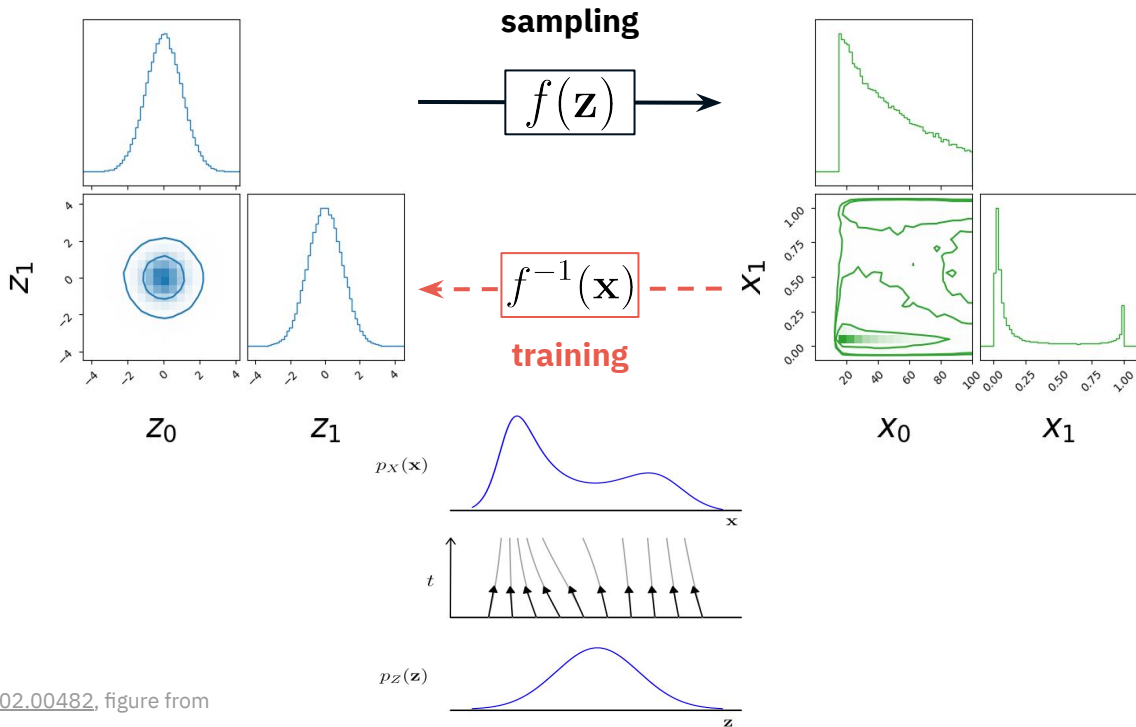
Results are convincing

Simulation speed per object is around 10 kHz.

Our results accurately reproduce the Full Simulation data of the CMS Experiment, on both training and unseen processes, for:

- 1-d distributions;
- correlations between the variables;
- different physical processes;
- analysis-level plots.

For more:
Poster Session B, Thursday, Loc 70
contact: francesco.vaselli@cern.ch

CMS *Simulation Preliminary*

- - - FullSim
— FlashSim

btagCMVA btagCSVV2 btagDeepB btagDeepC btagDeepFlavB

refs: https://cds.cern.ch/record/2858890, and
https://arxiv.org/abs/2402.13684

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