HHH Workshop
(July 15th 2023, Dubrovnik)

Flavour Tagging In ATLAS

Bingxuan Liu
Simon Fraser University

On behalf of the ATLAS Flavour Tagging Group

ATLAS EXPERIMENT

Contact info: bingxuan.liu@cern.ch
Skype: prbbing

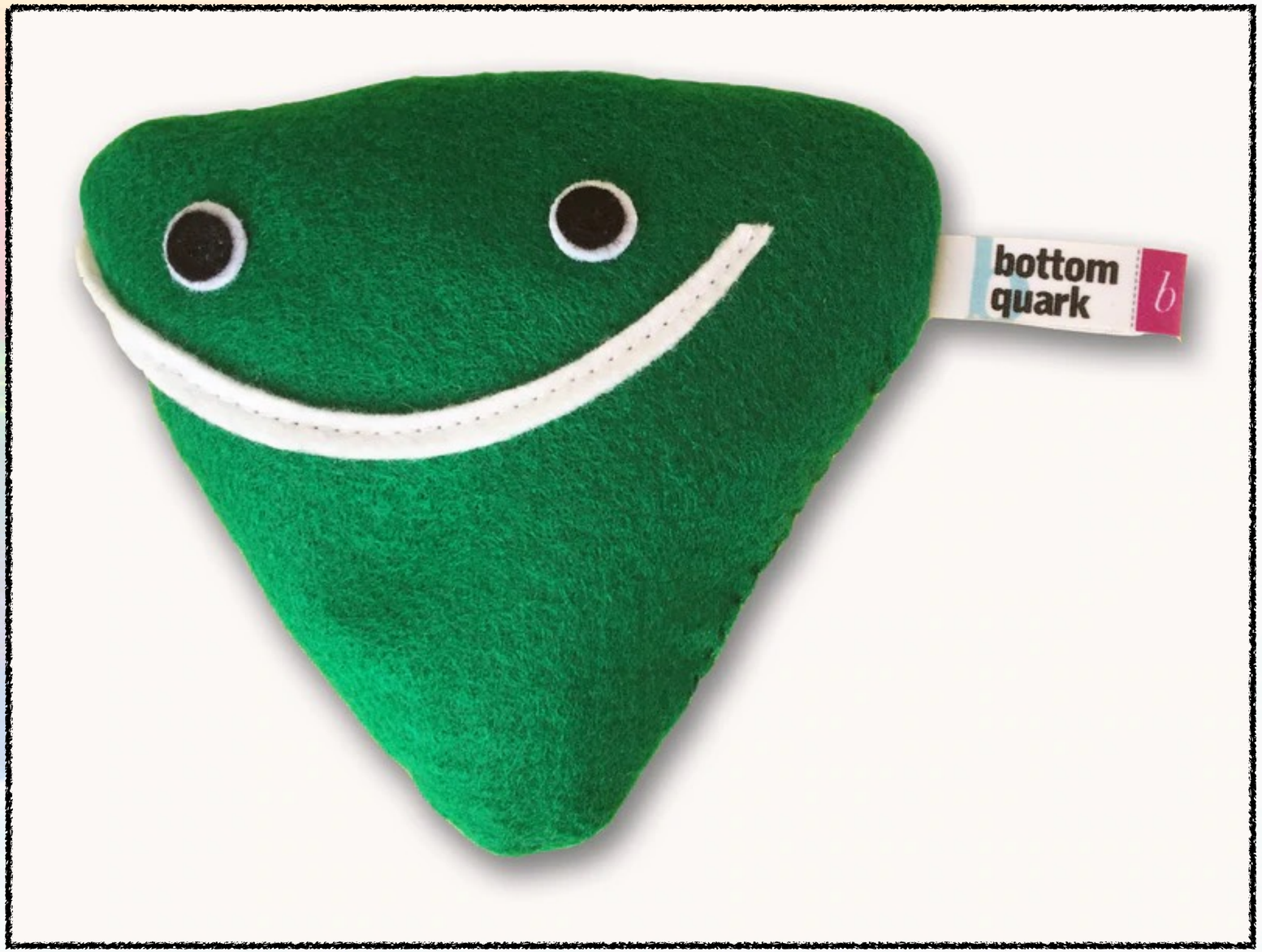
SFU SIMON FRASER UNIVERSITY

Aims to determine……

Whether a jet contains
specific particles

Aims to determine……

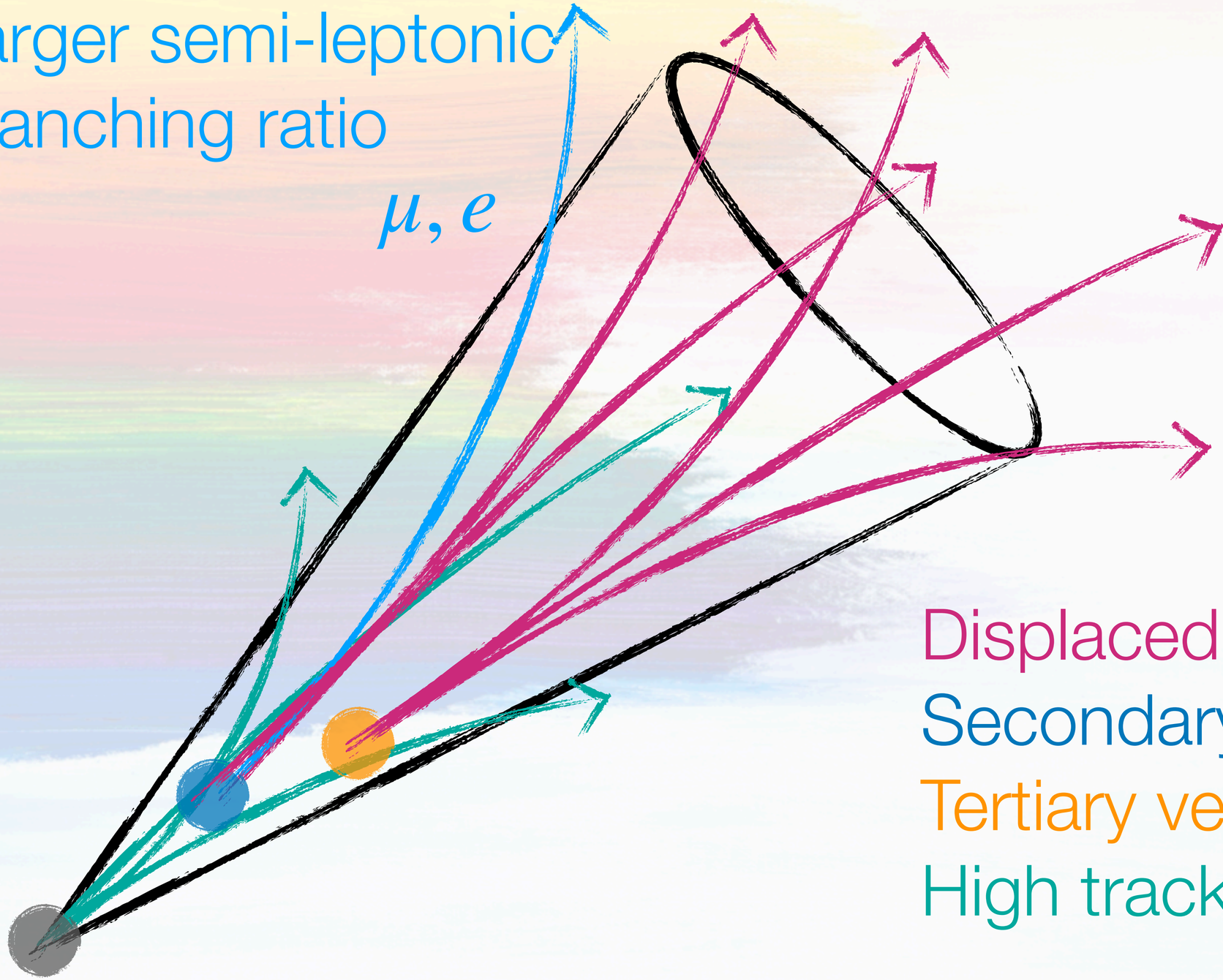
So that we know what flavour it has



Lifetime: ~ps
Mass: ~5 GeV
Decays to charm

Larger semi-leptonic branching ratio

μ, e



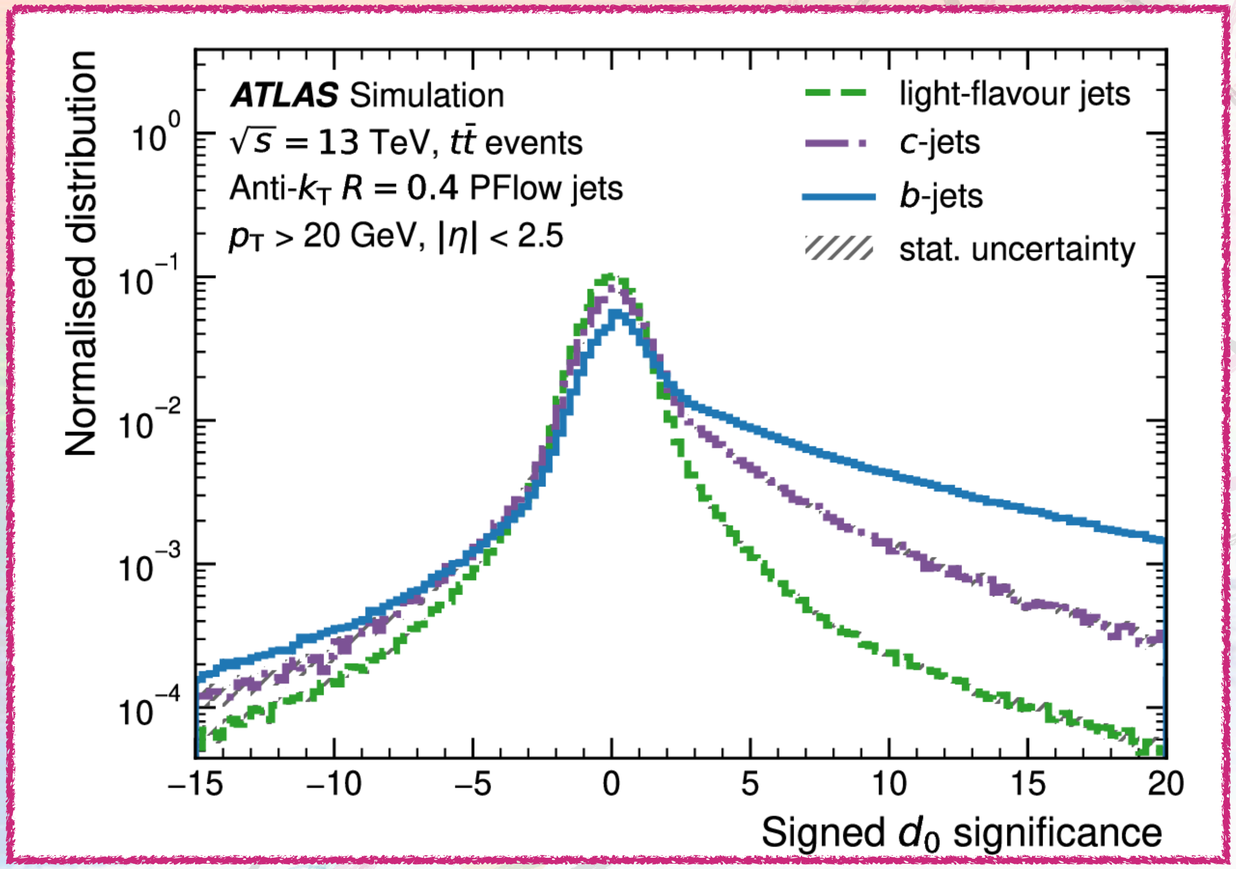
Displaced tracks

Secondary vertex

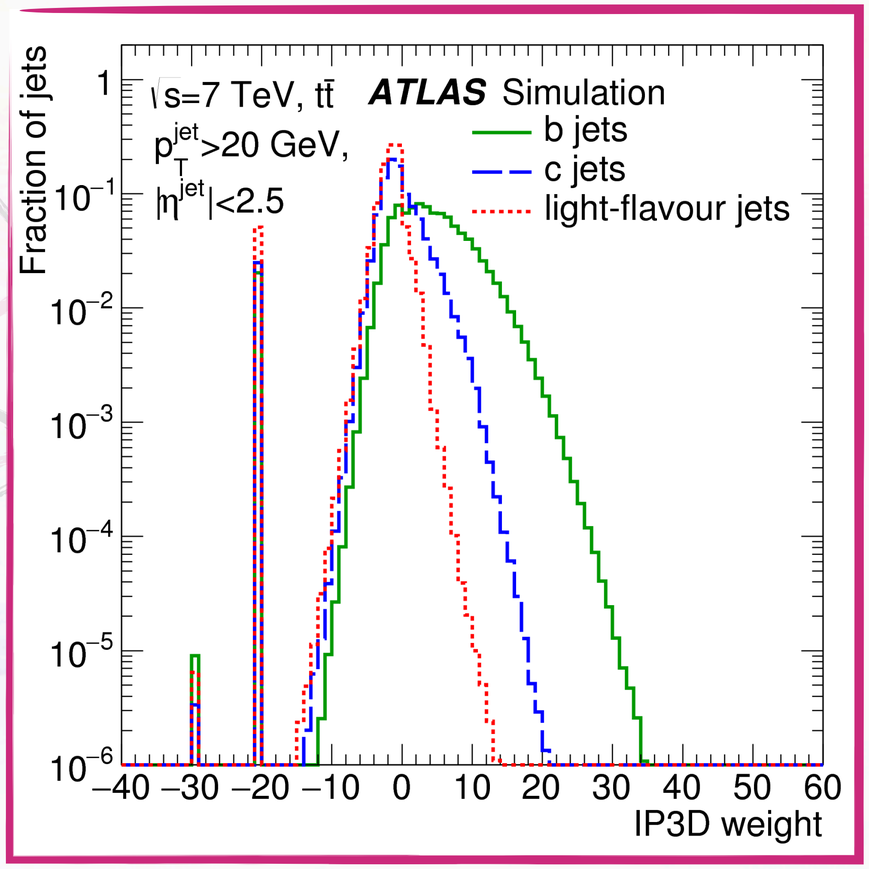
Tertiary vertex

High track multiplicity

JINST 11 (2016) P04008



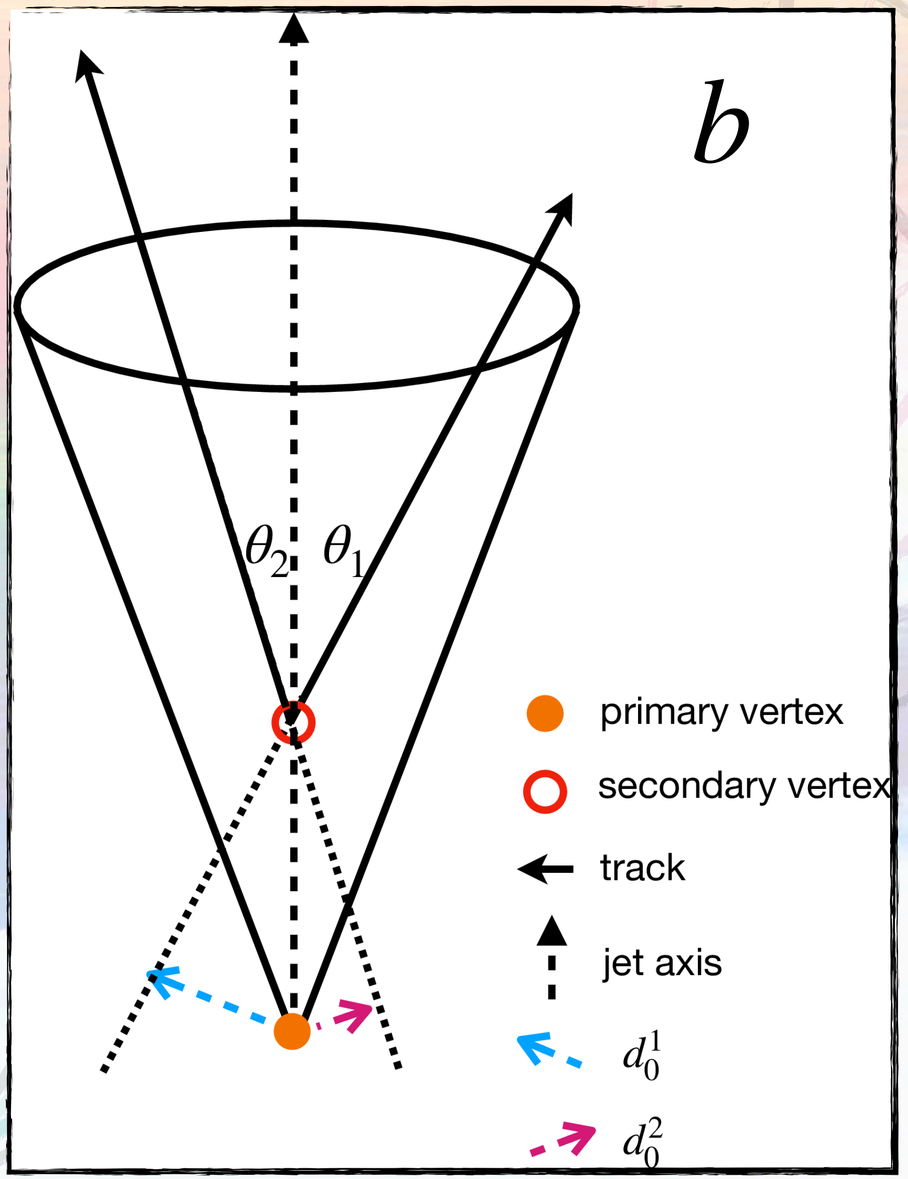
CERN-EP-2022-226

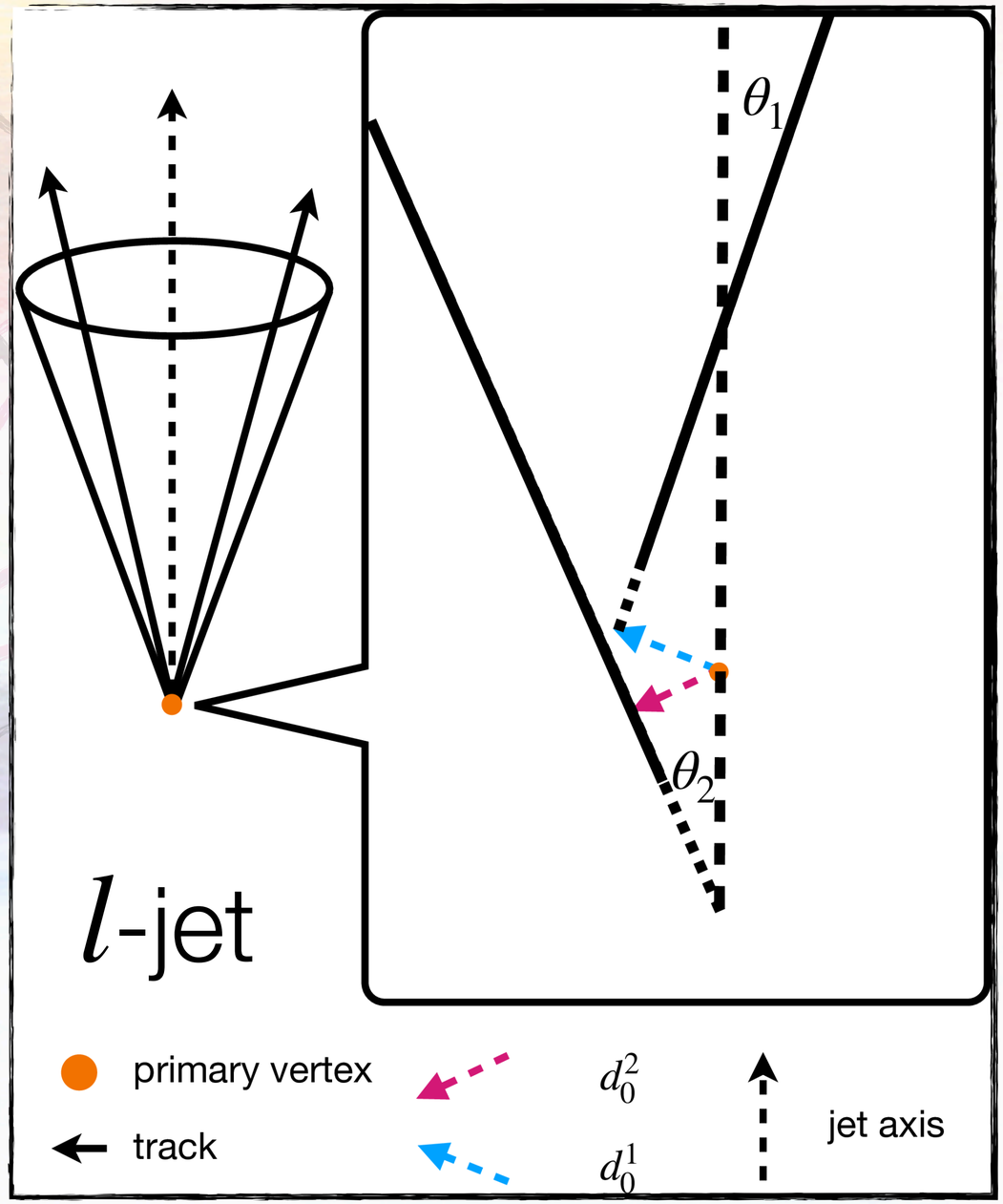


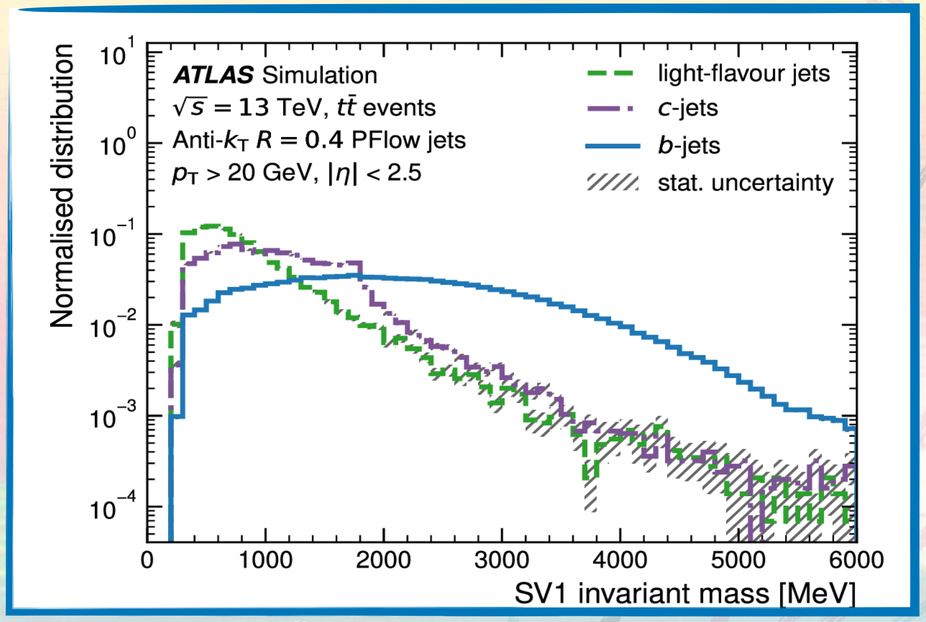
Displaced tracks

IP2D and **IP3D** algorithms

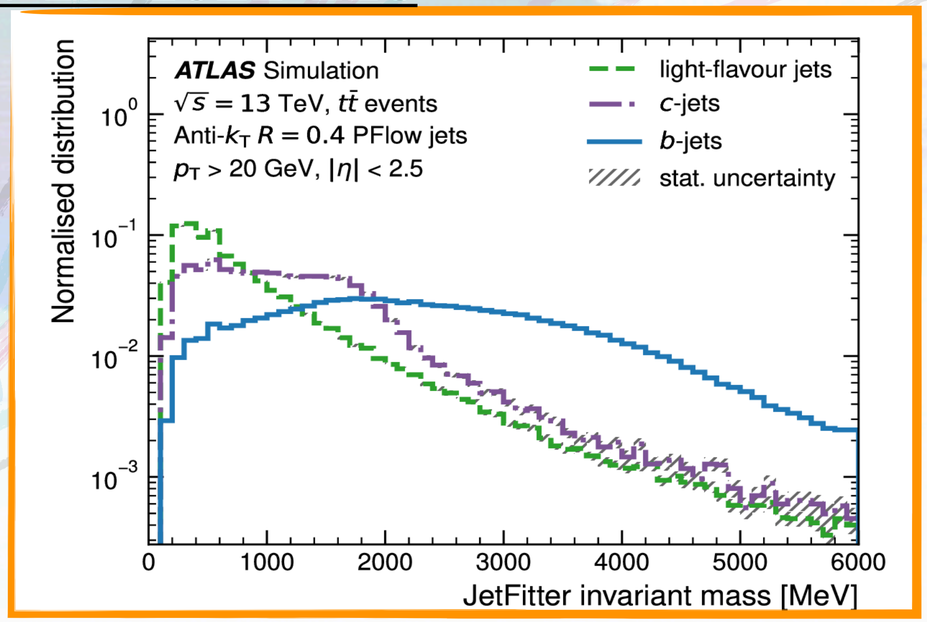
ATL-PHYS-PUB-2022-010





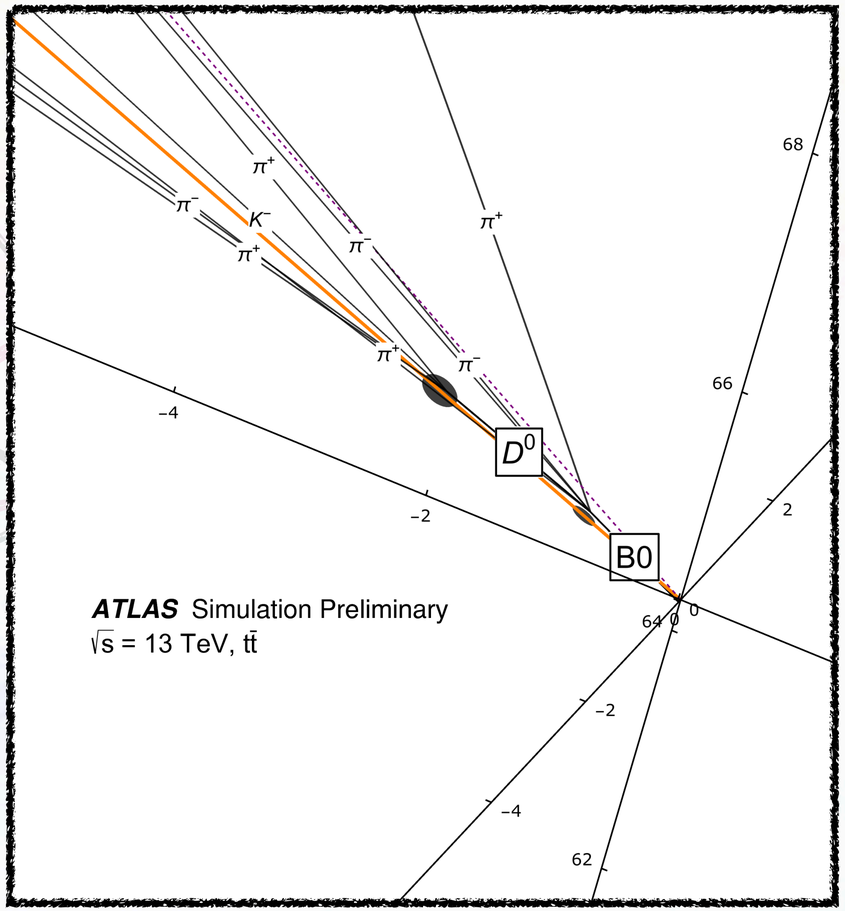


CERN-EP-2022-226



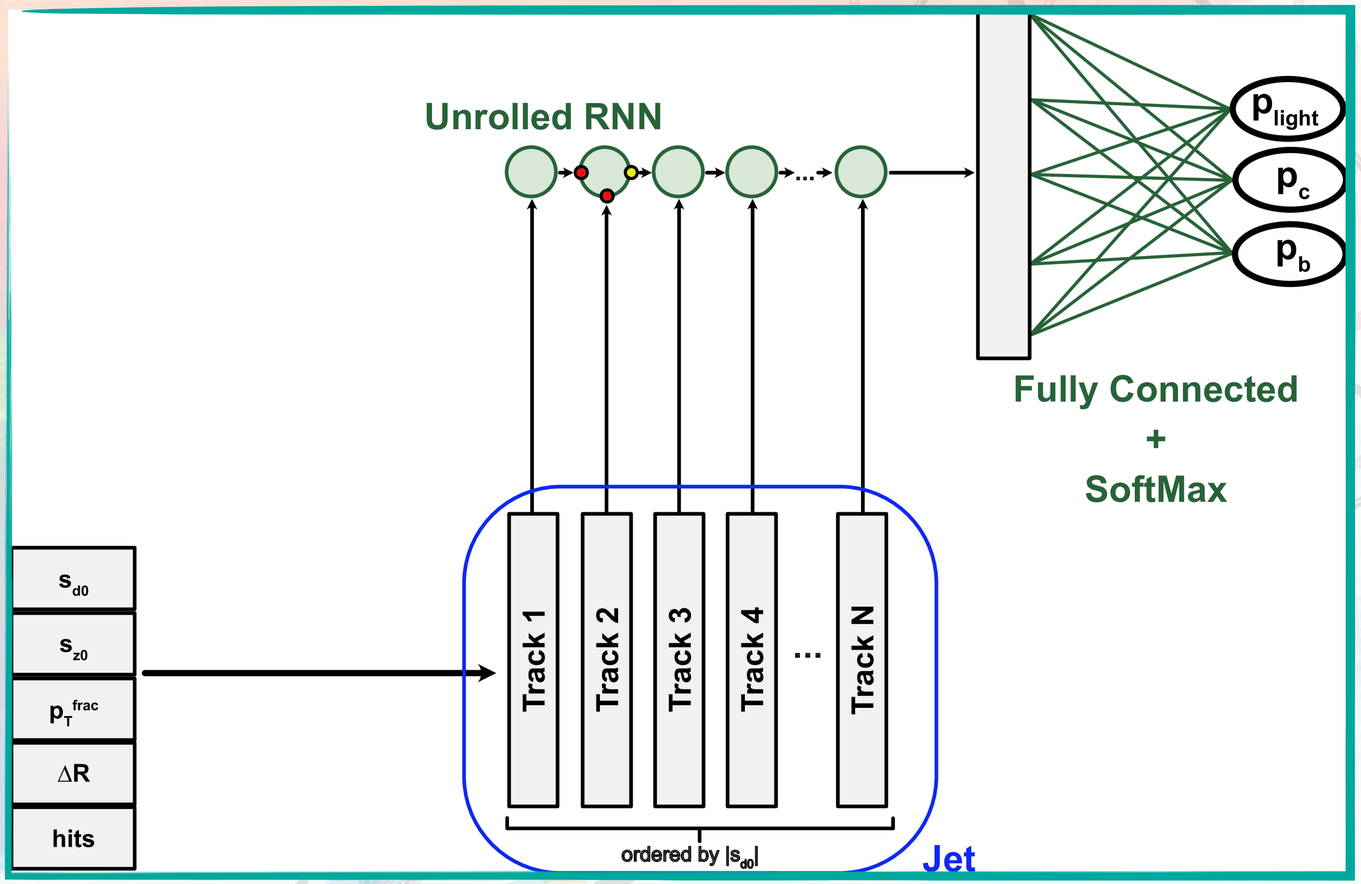
SV1 and
JetFitter

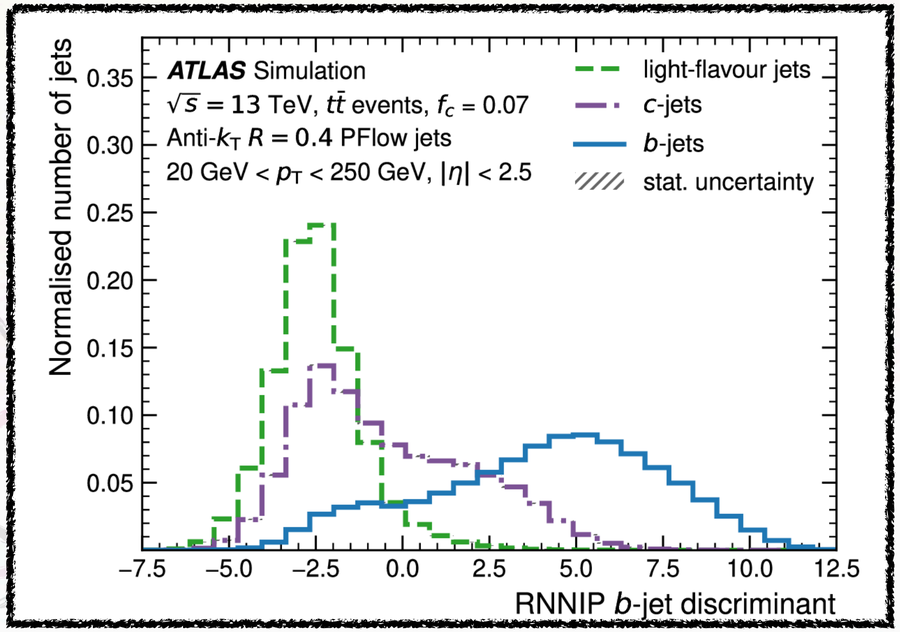
FTAG-2017-004



Secondary vertex

Tertiary vertex



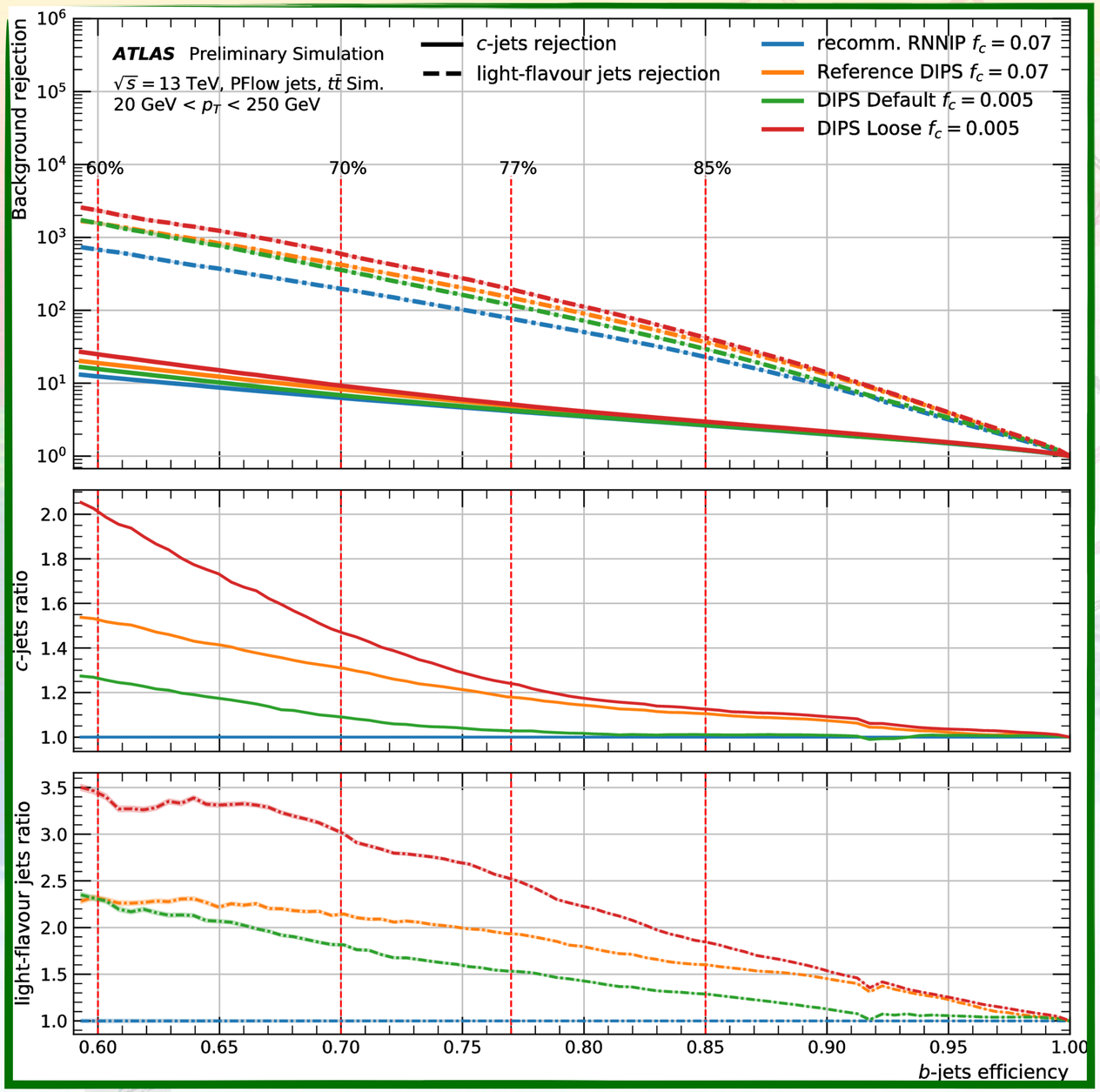


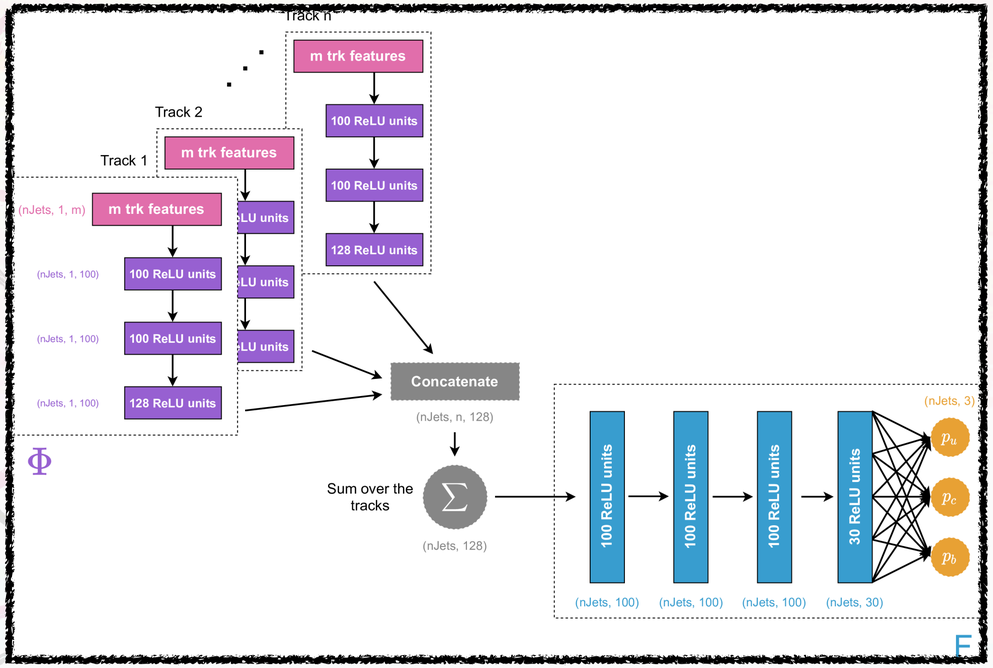
A Recurrent Neural Network (**RNNIP**) that explores correlations between tracks

CERN-EP-2022-226

Displaced tracks

High track multiplicity



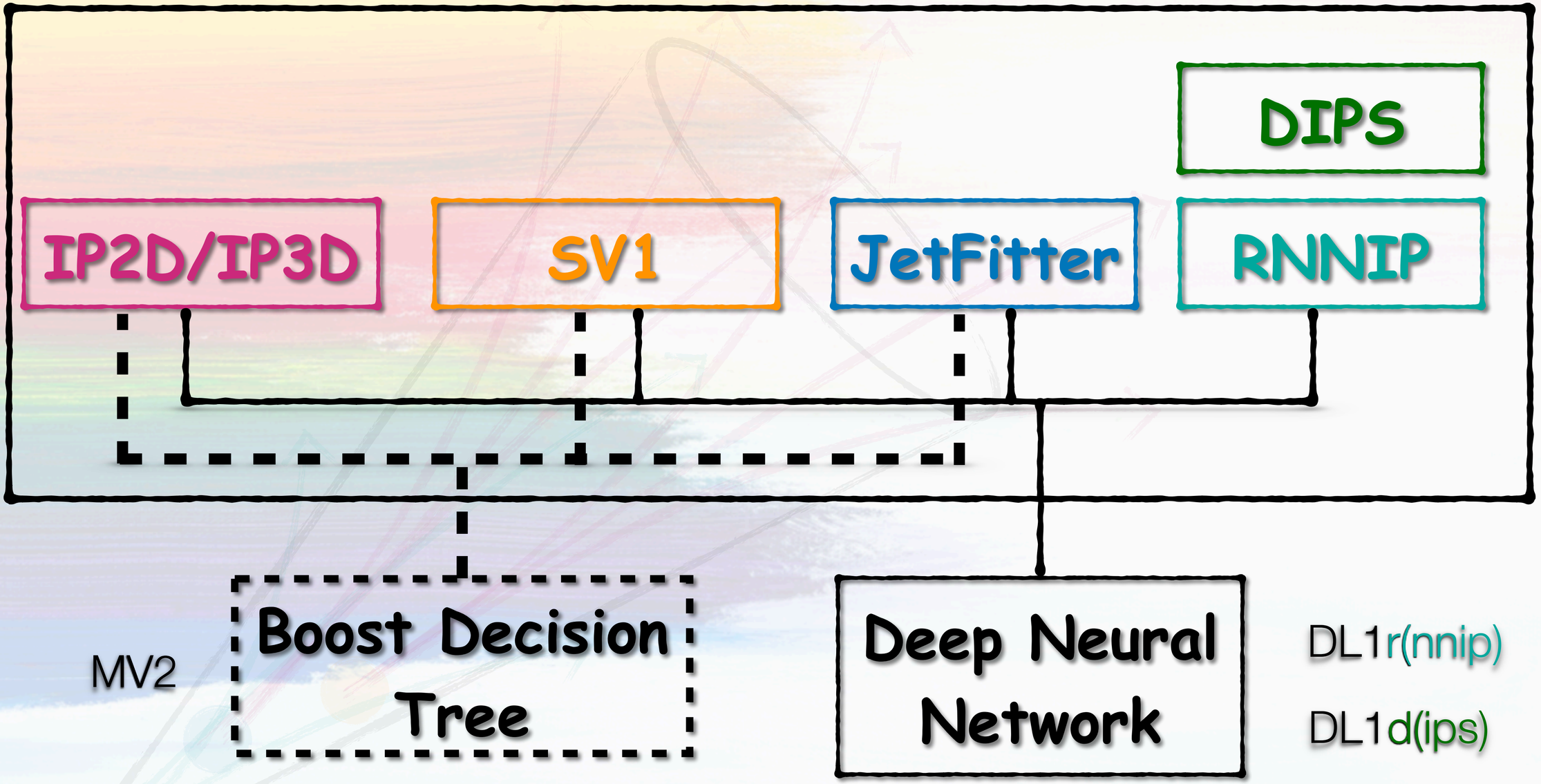


A Deep Impact Parameter Set (**DIPS**) that is permutation invariant, compared to RNNIP

ATL-PHYS-PUB-2020-014

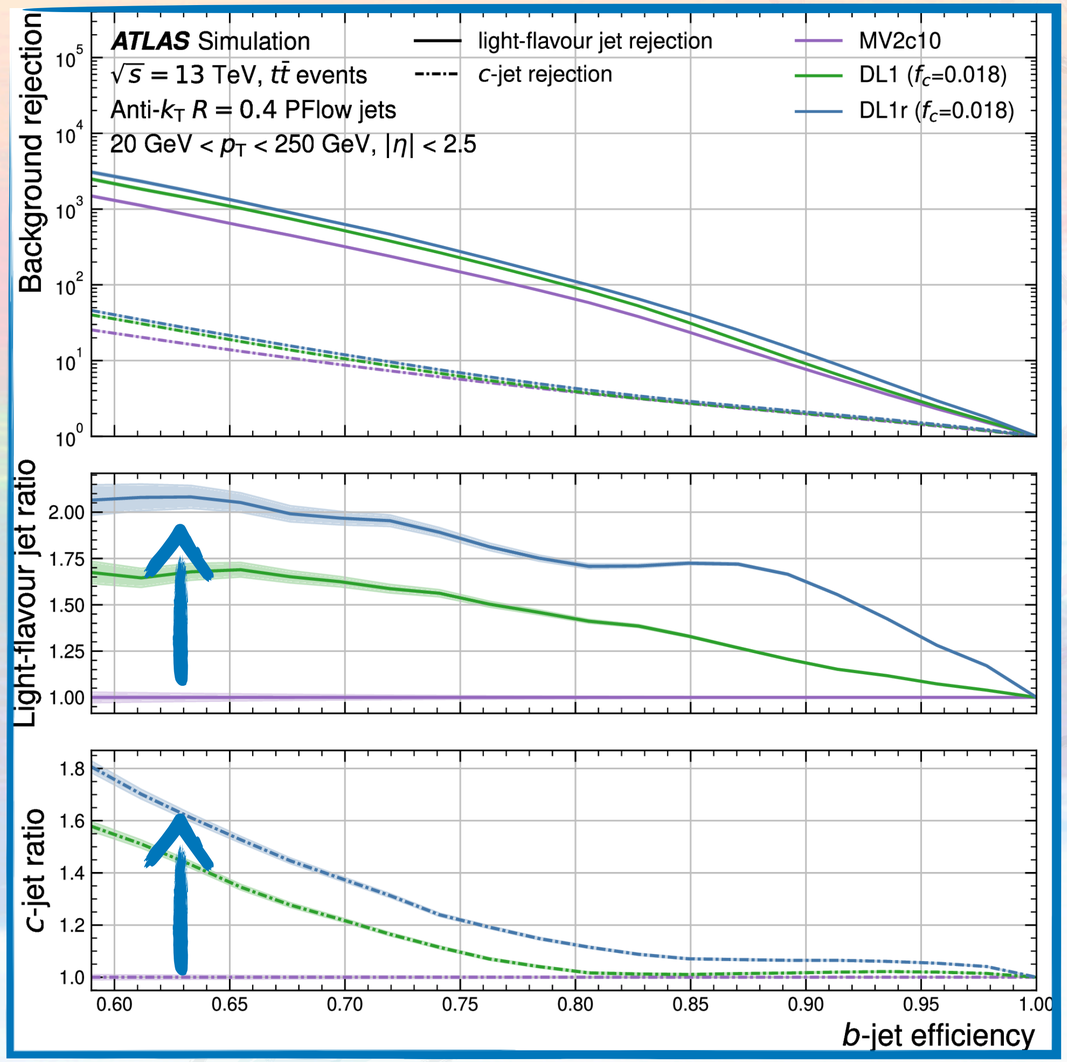
Displaced tracks

High track multiplicity

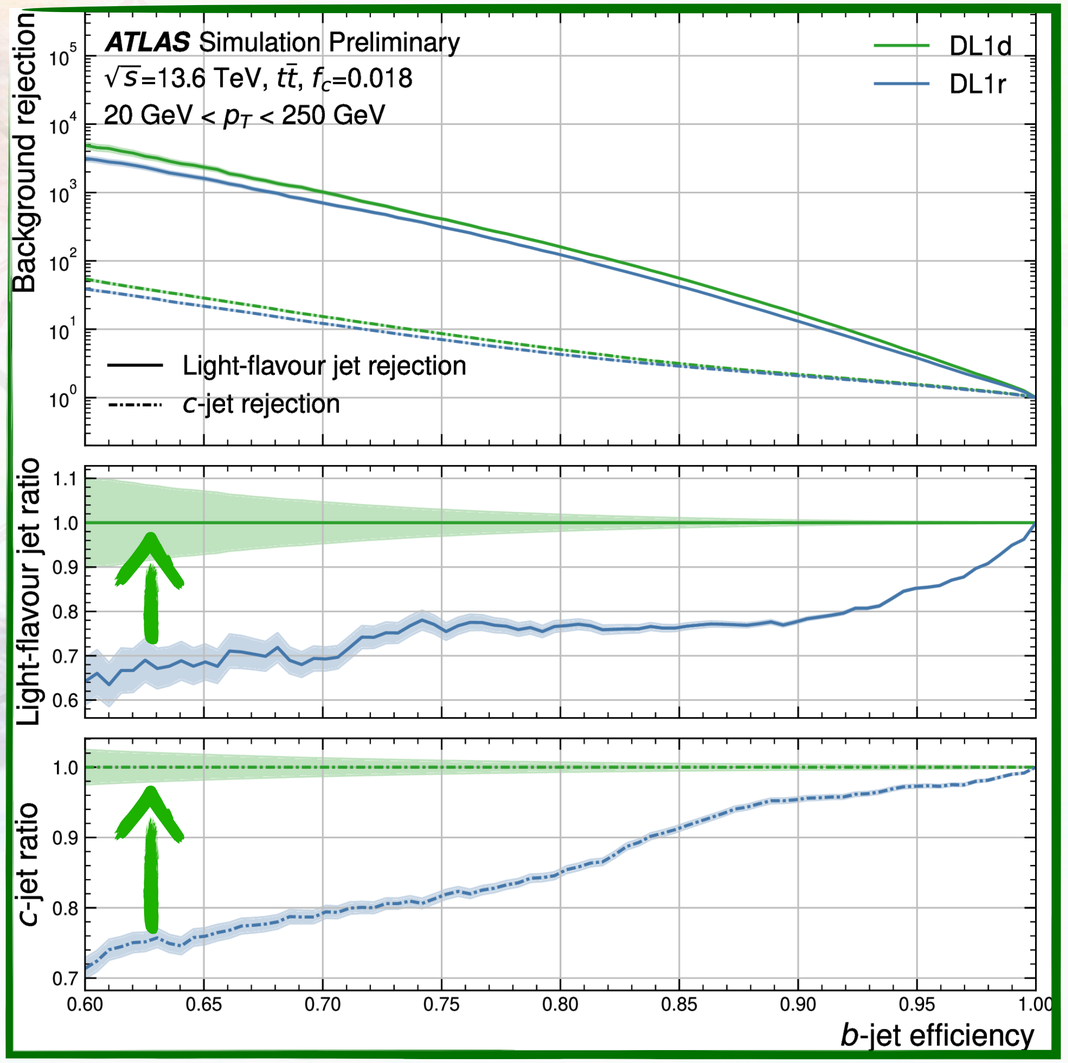


CERN-EP-2022-226

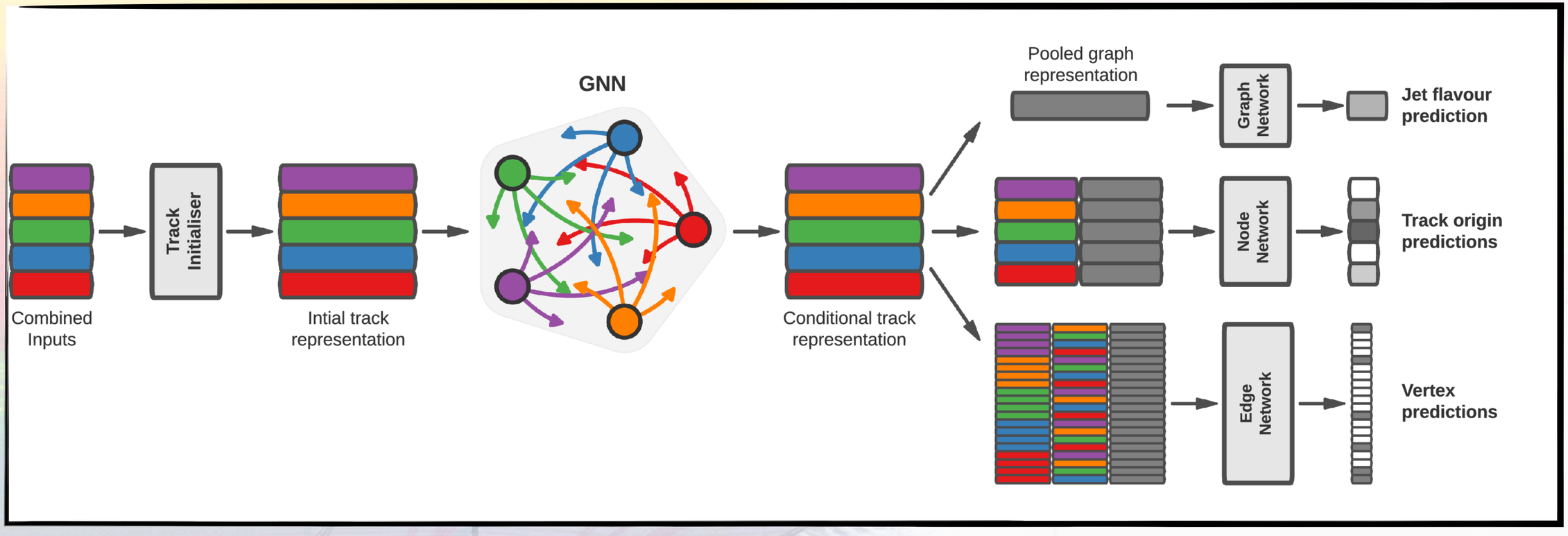
CERN-EP-2022-226

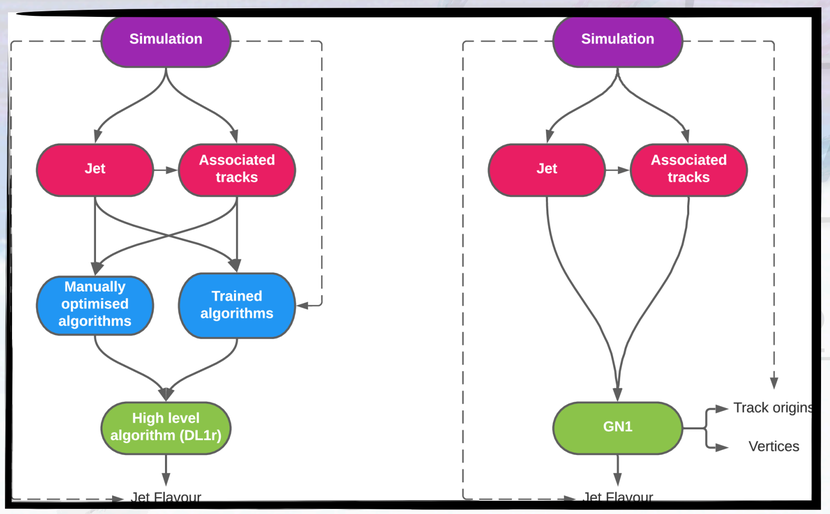


FTAG-2022-004



Early Run 2 → Run 2 → Early Run 3

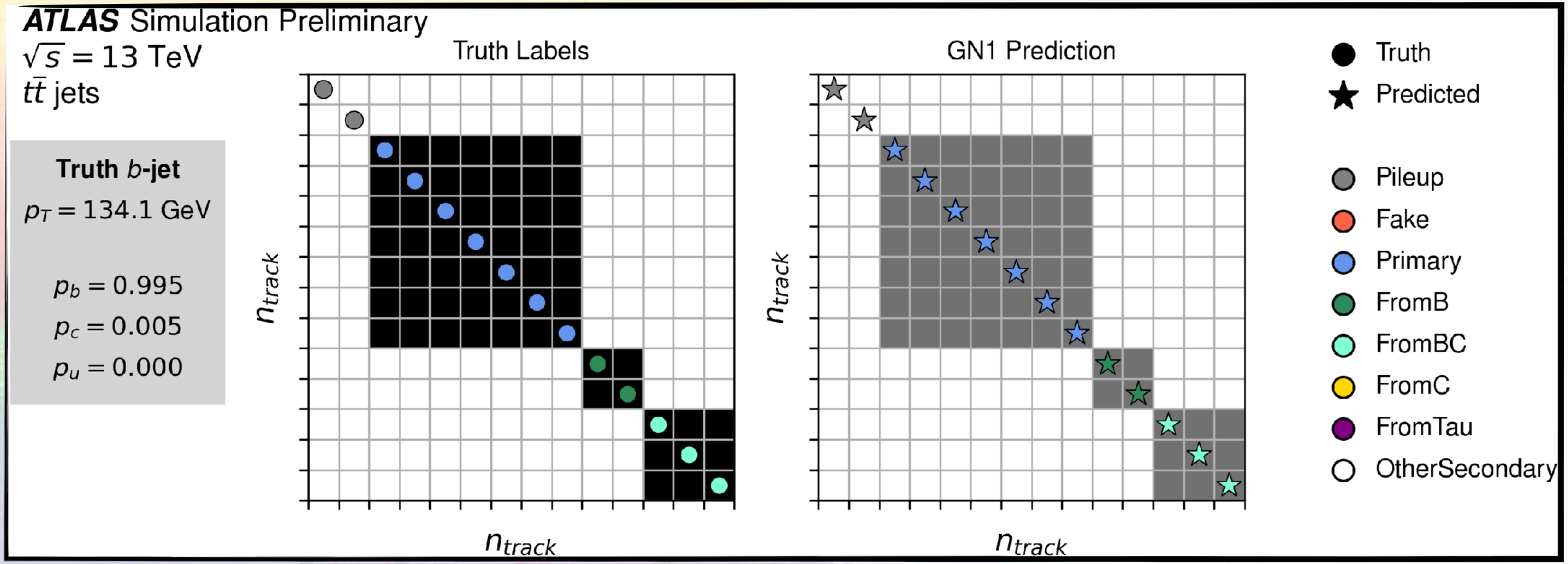




End-to-end Graph Neural Network (GNN) approach

Do not rely on those manually crafted algorithms any more

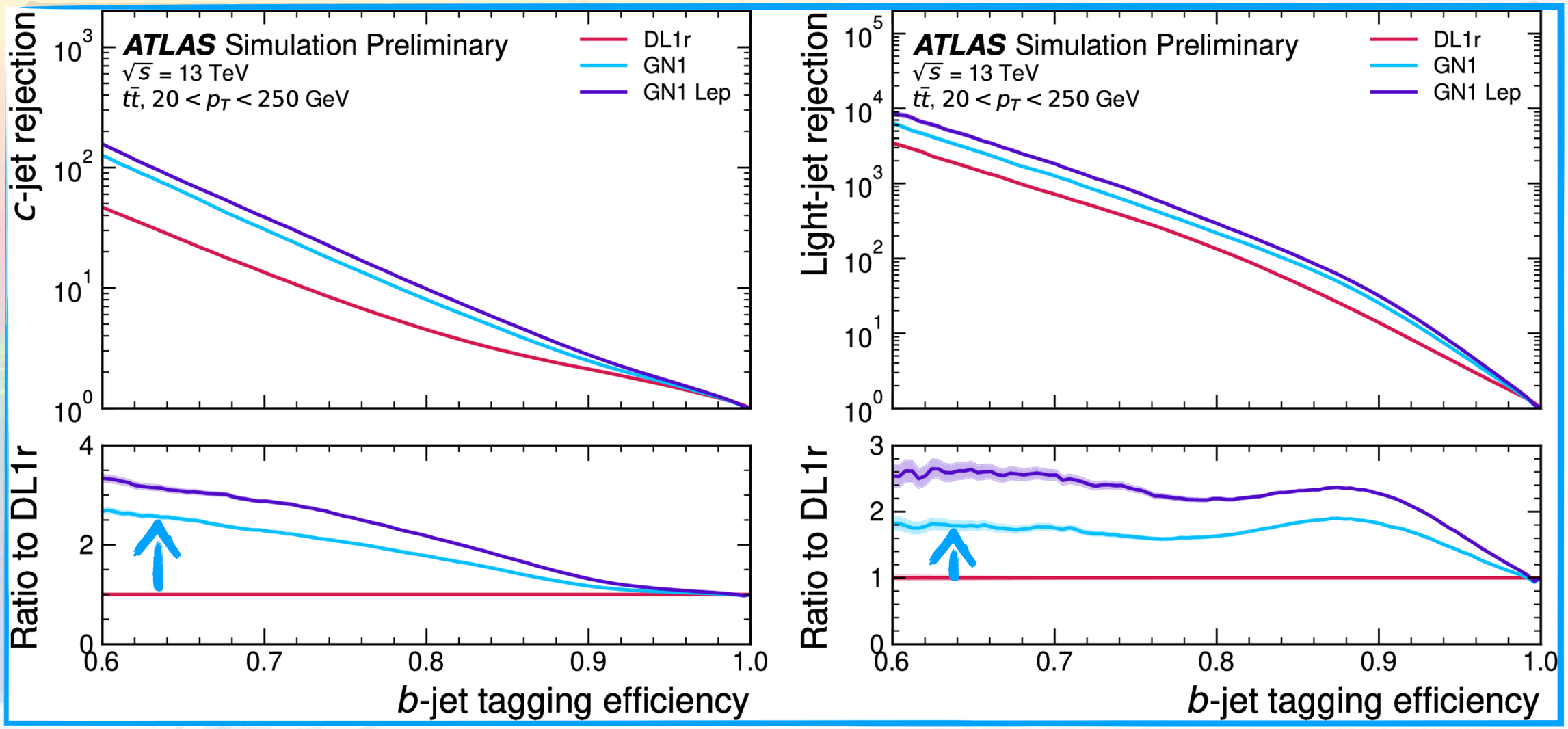
ATL-PHYS-PUB-2022-027



FTAG-2023-01

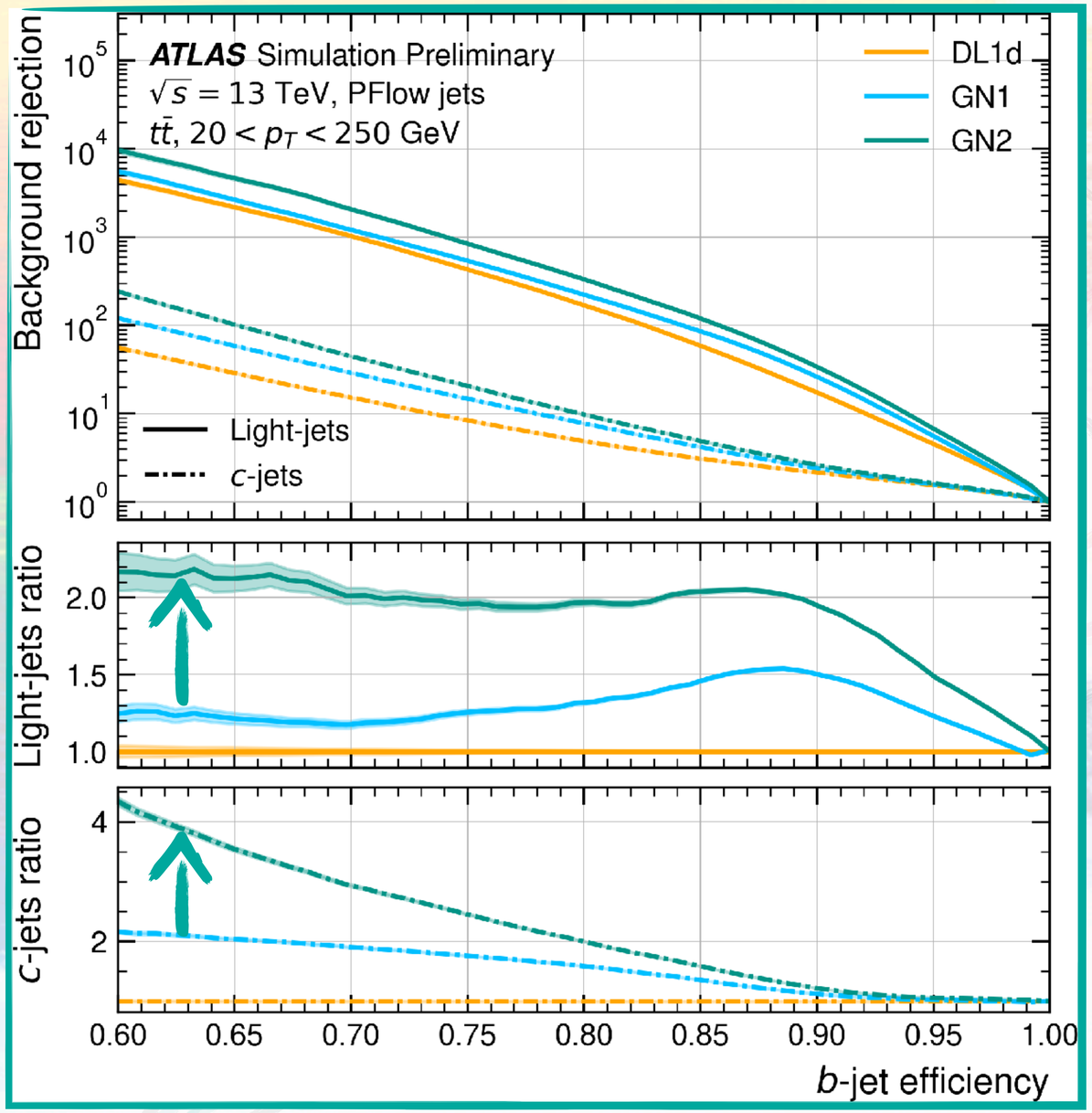
ATL-PHYS-PUB-2022-027

Intuitive to interpret



ATL-PHYS-PUB-2022-027

Early Run 2 → Run 2 → Early Run 3 → Fall 2022

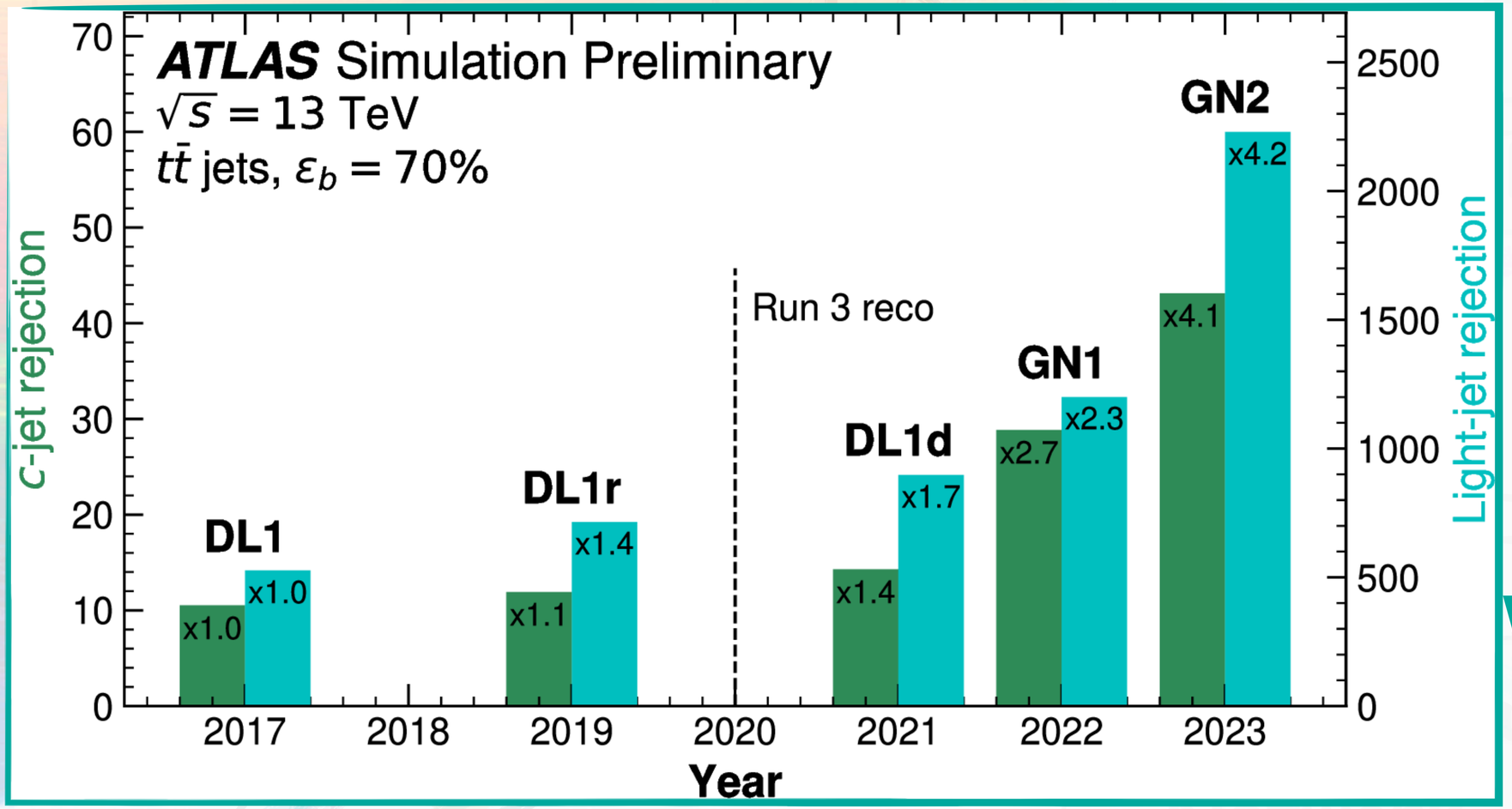


FTAG-2023-01

Update version of GN1 with the transformer architecture adopted achieves the best performance!

NOW!

Early Run 2 → Run 2 → Early Run 3 → Fall 2022



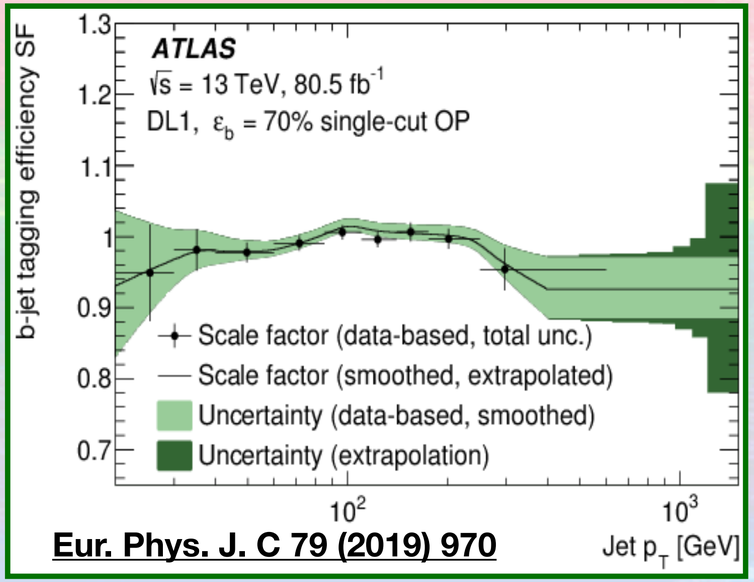
FTAG-2023-01

WOW!

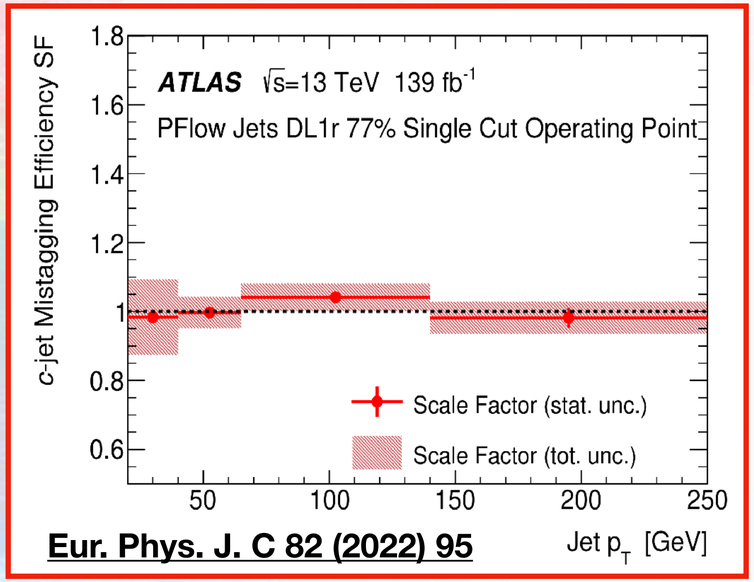
Early Run 2 → Run 2 → Early Run 3 → Fall 2022

Taggers are developed using simulation

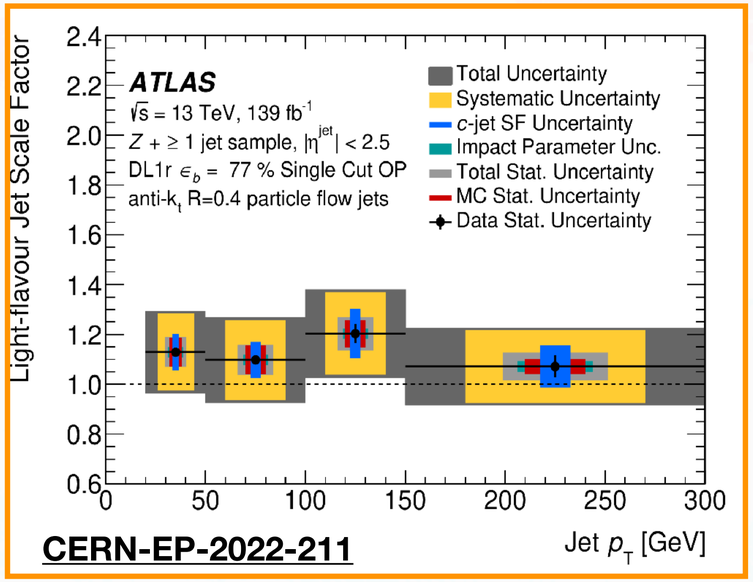
Do the work well in data?



Eur. Phys. J. C 79 (2019) 970



Eur. Phys. J. C 82 (2022) 95

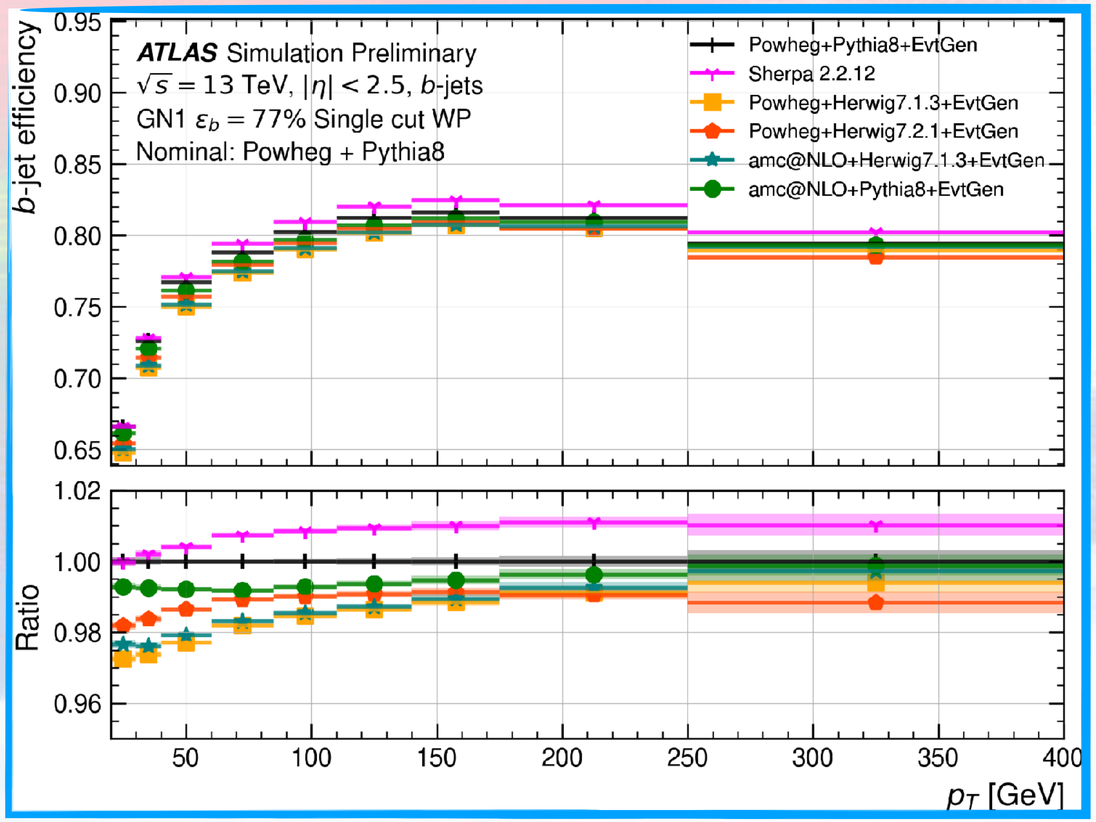


CERN-EP-2022-211

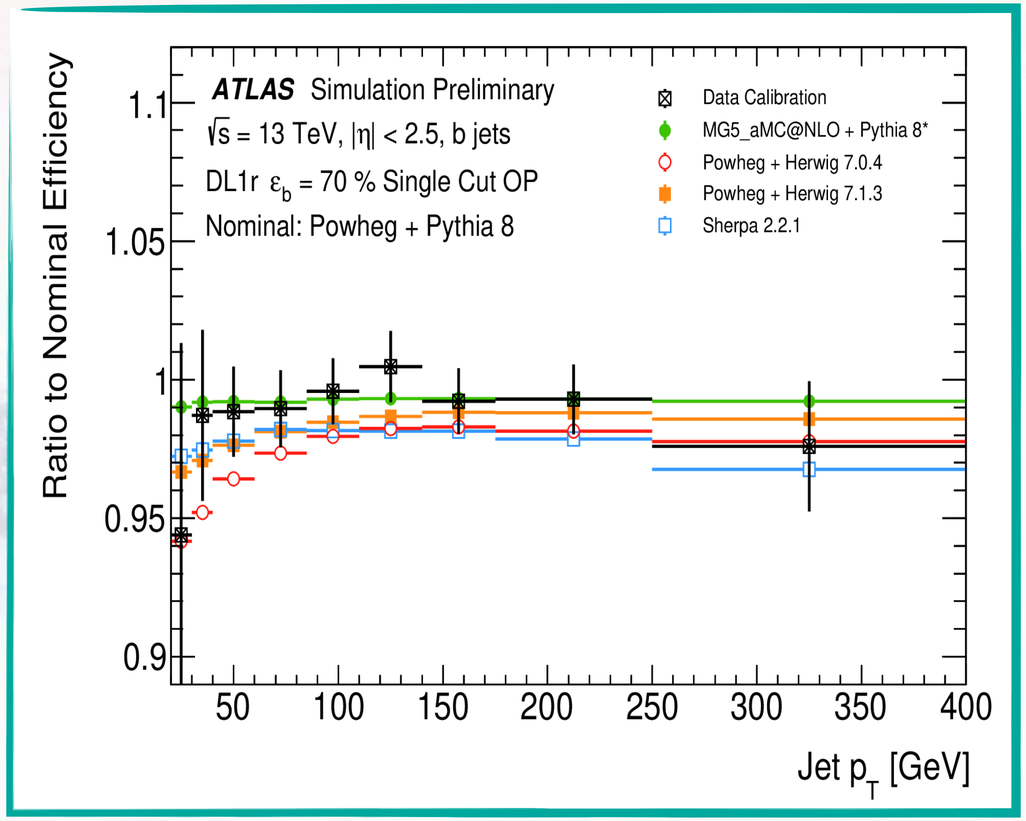
Efficiencies in data are measured for b-, c- and light-jet

Taggers are developed using simulation

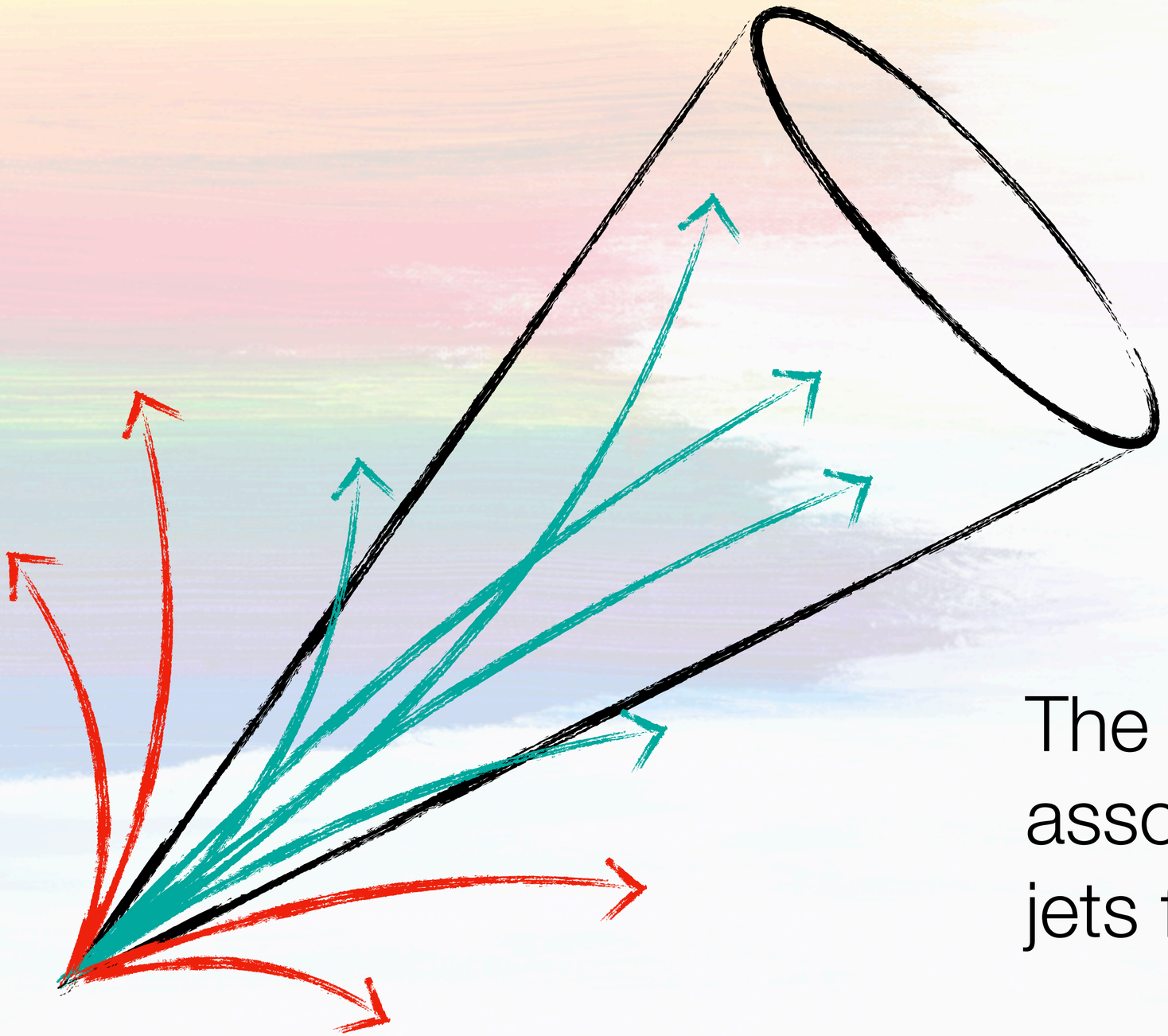
Do they work well for all generators?



ATL-PHYS-PUB-2021-003

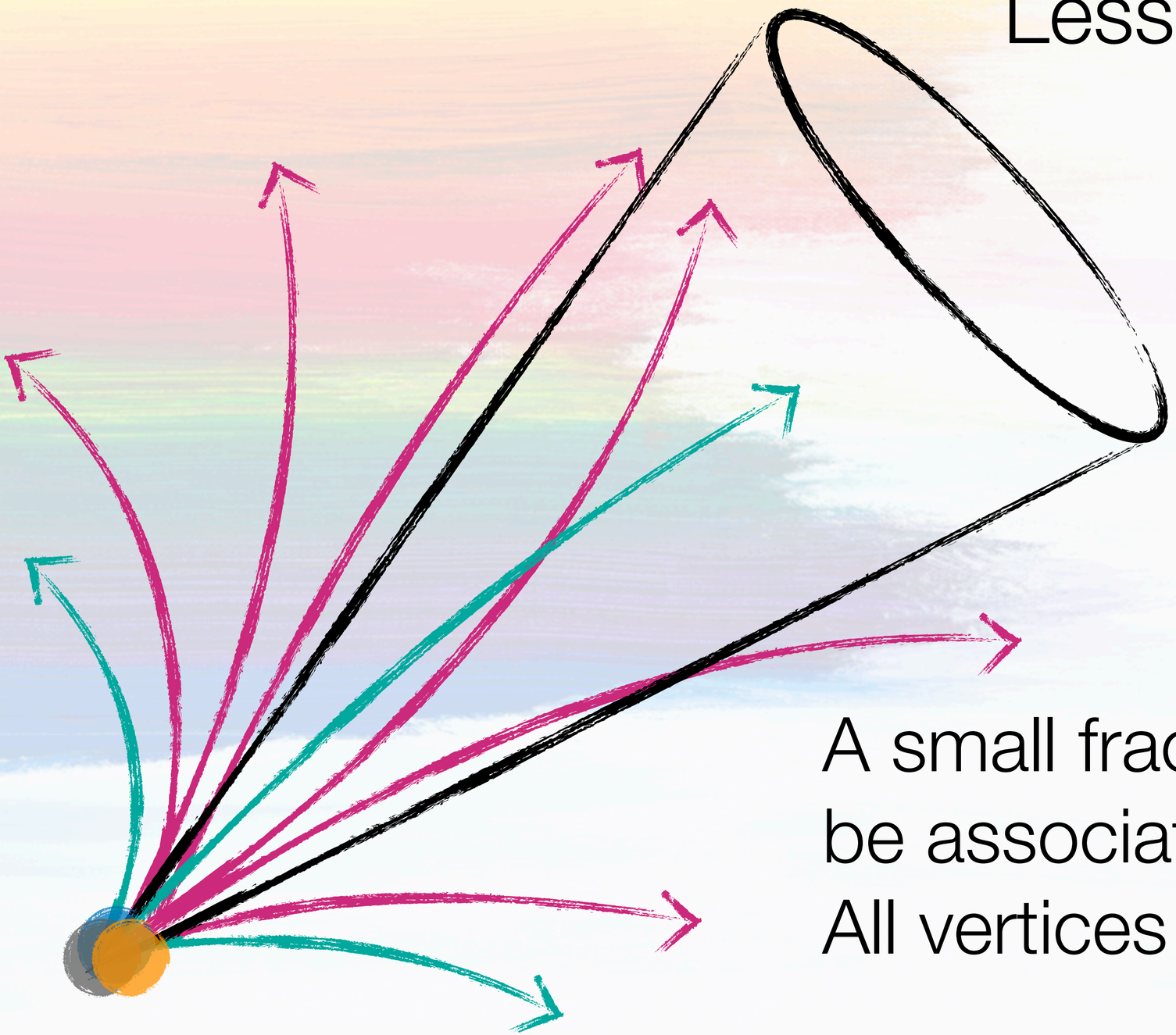


FTAG-2023-01



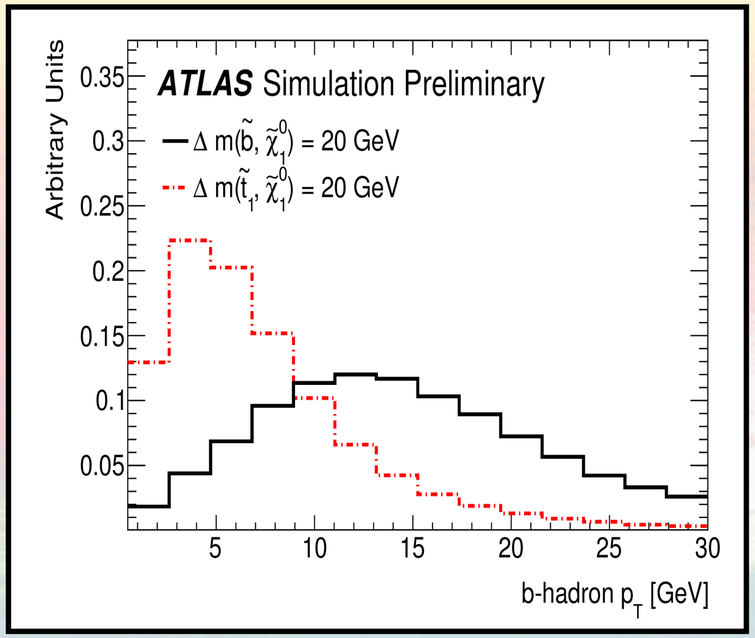
The ATLAS approach associates tracks with jets first

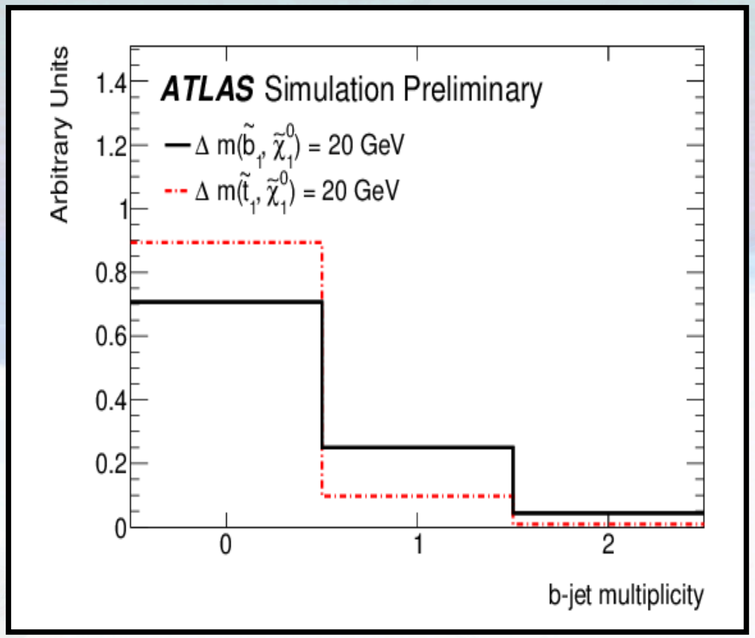
Less optimal at low p_T

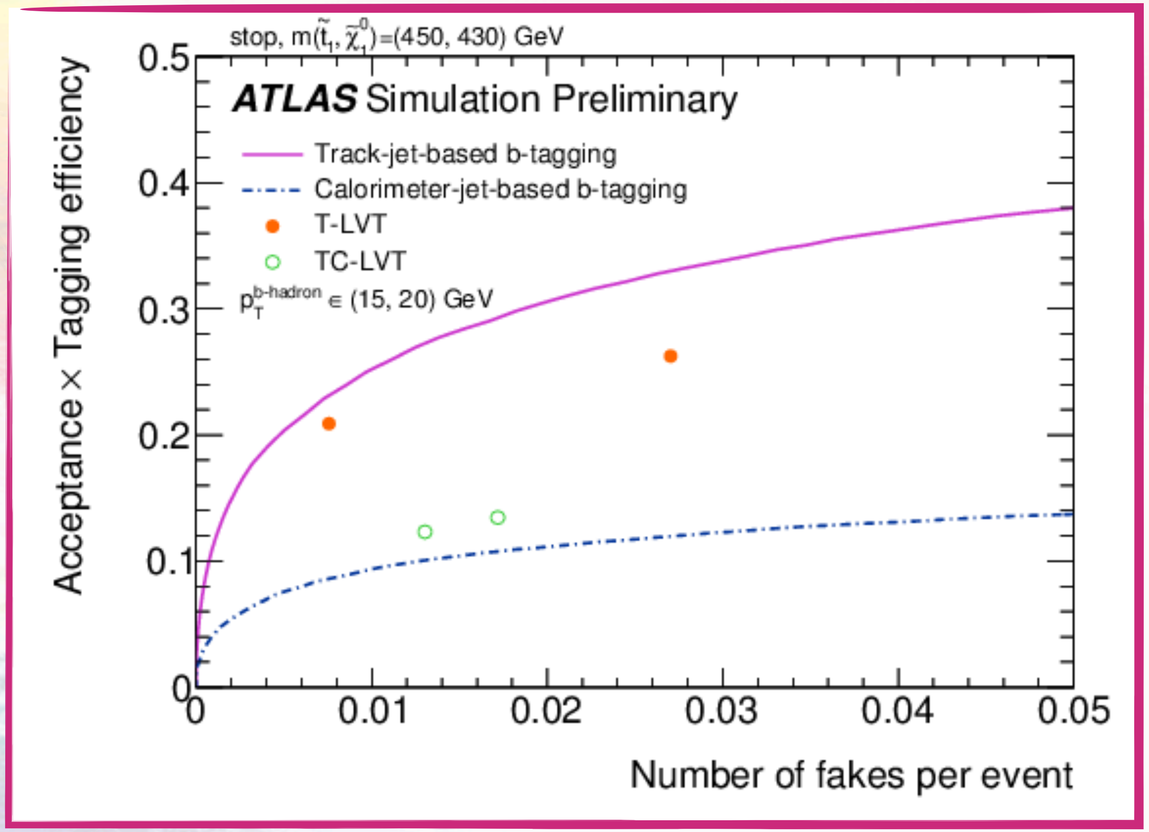


A small fraction of tracks can be associated

All vertices start overlapping



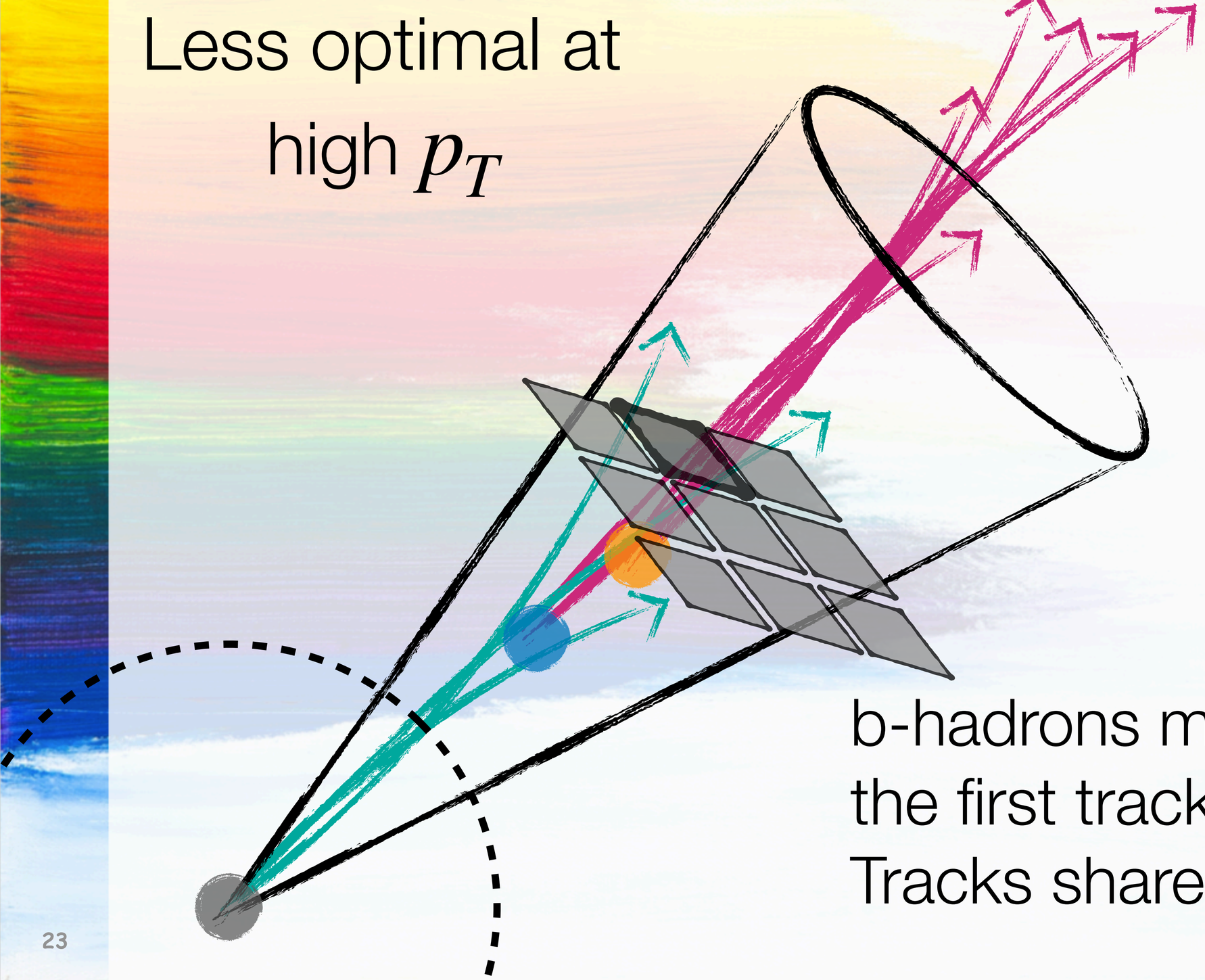




ATLAS-CONF-2019-027

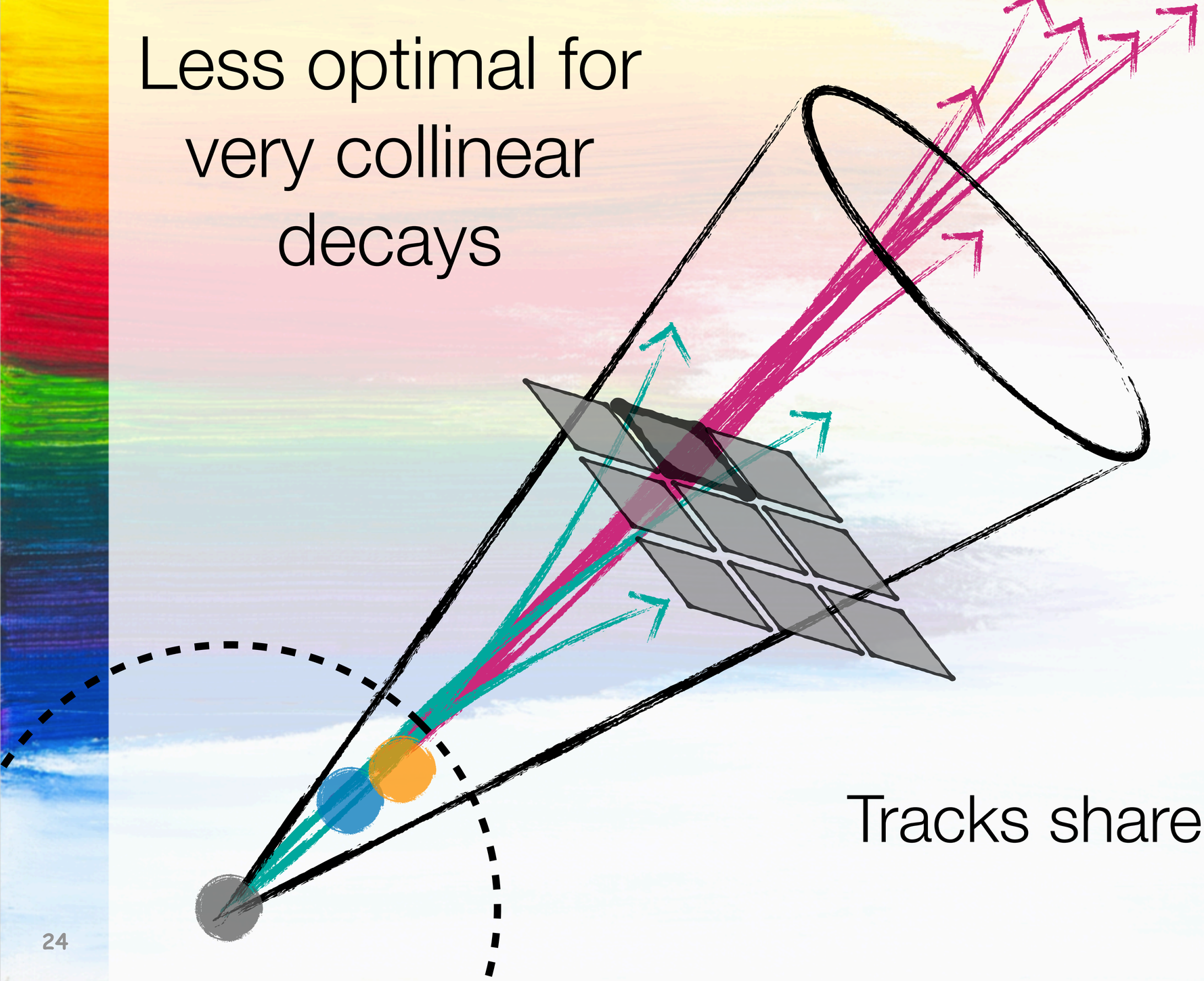
A special soft b-hadron identification algorithm that does not rely on jets

Less optimal at high p_T



b-hadrons may decay after the first tracker layer
Tracks share modules more

Less optimal for very collinear decays



Tracks share modules more

b-jet τ-jet g-jet

They all share similar characteristics. Technologies available a decade ago prevented us from having all-in-one approach

Flavour tagging is a fun, and fast advancing area

New end-to-end GNN approach is very flexible and portable

A lot of possibilities for the HHH program

Why HHH?


YES
WAY
ENVY
SPICED IPA

Dubrovnik is an amazing place to do CATegorization


I have no back up, for now


Thank You!