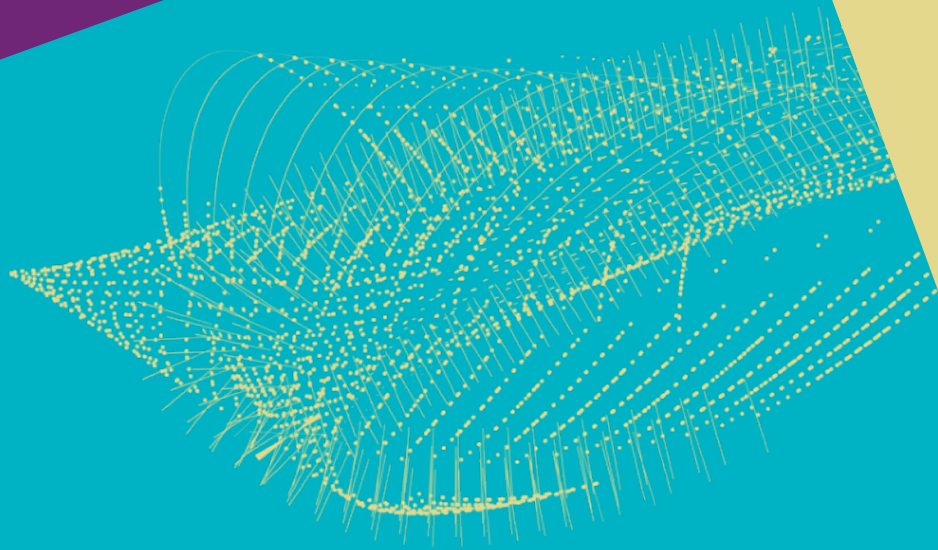




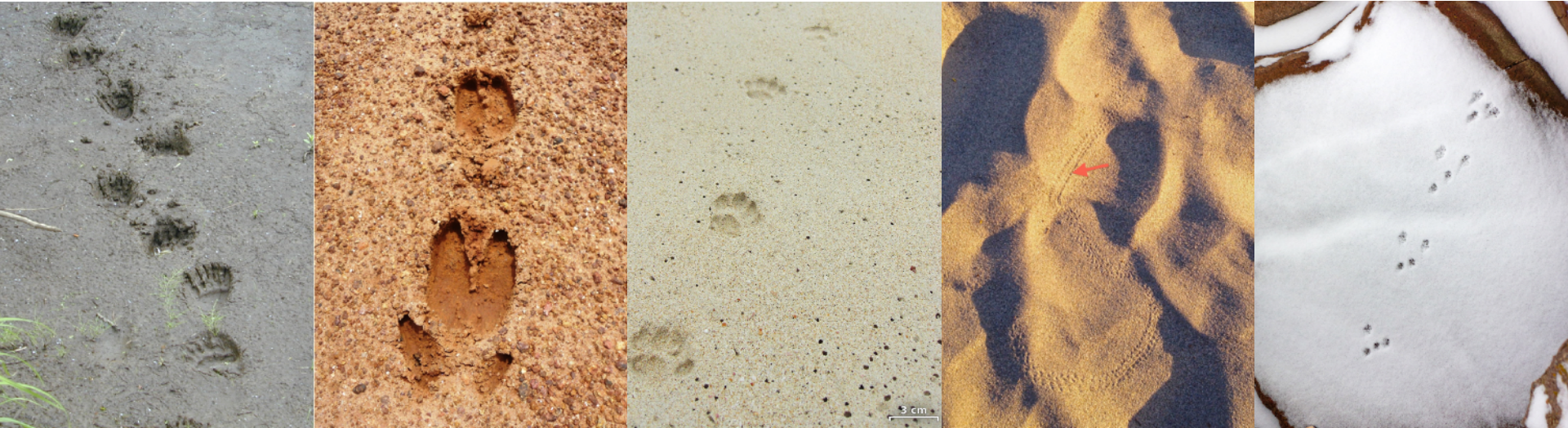
12/May/2026

Tracking @ ATLAS (@ Nikhef)

Siang-Yuan Lin



Tracking?

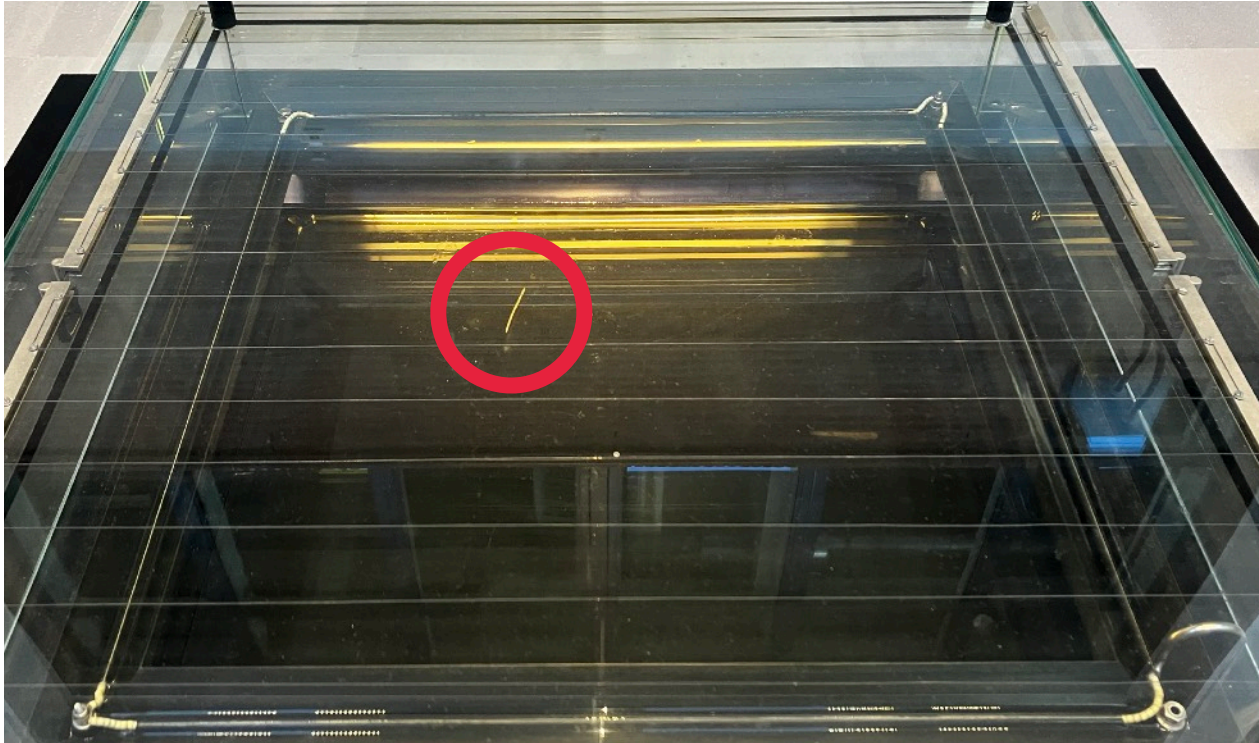


[https://en.wikipedia.org/wiki/Tracking_\(hunting\)](https://en.wikipedia.org/wiki/Tracking_(hunting))

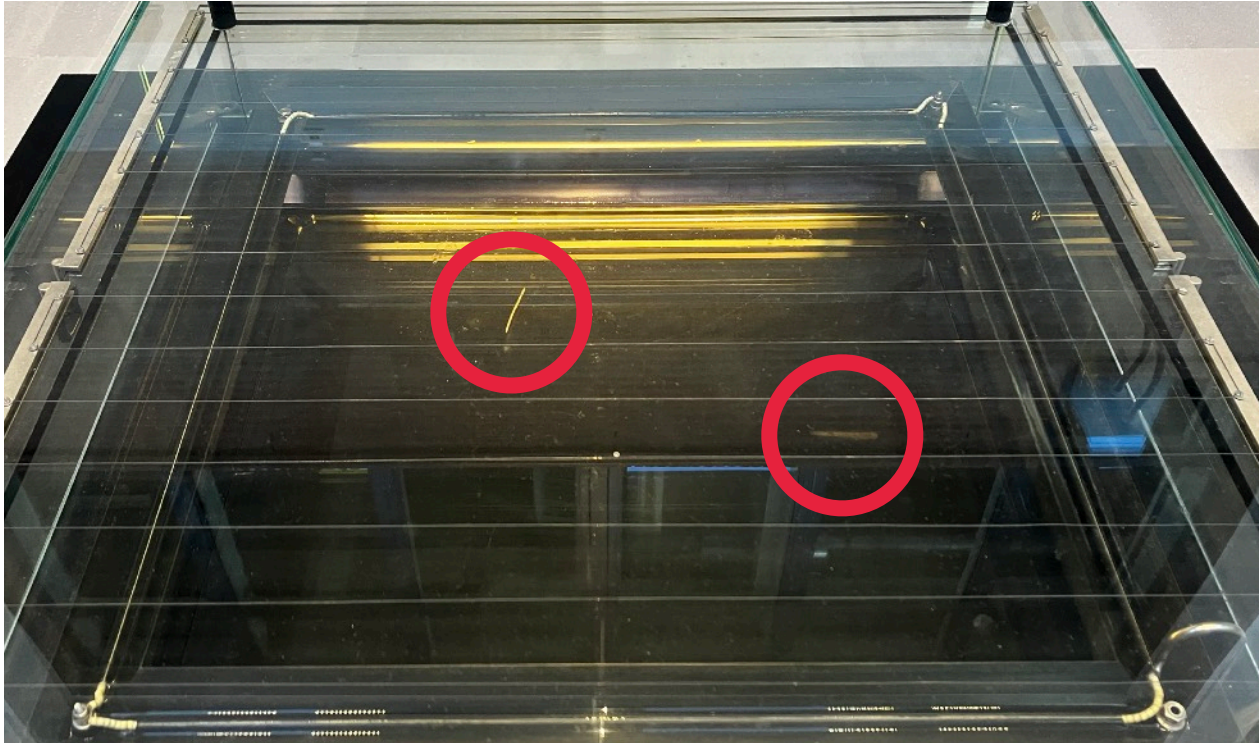
Cloud chamber



Cloud chamber

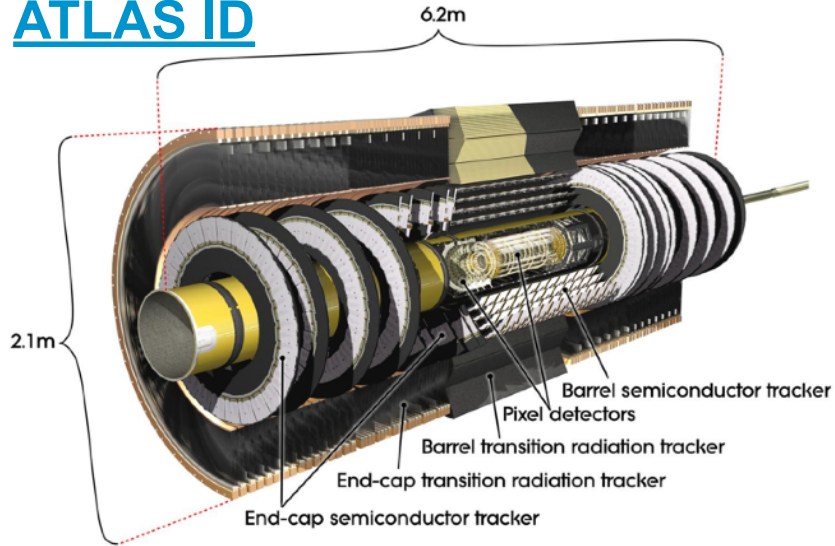


Cloud chamber



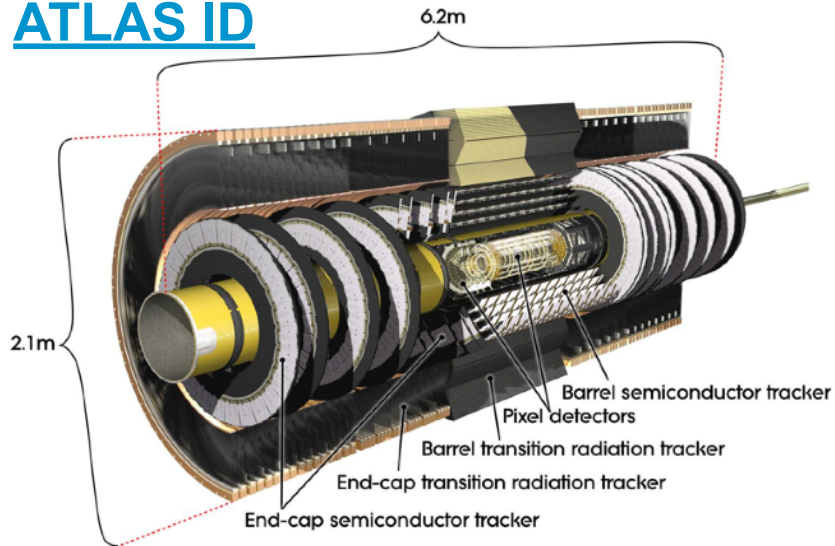
Hardware - leaps and strides

ATLAS ID

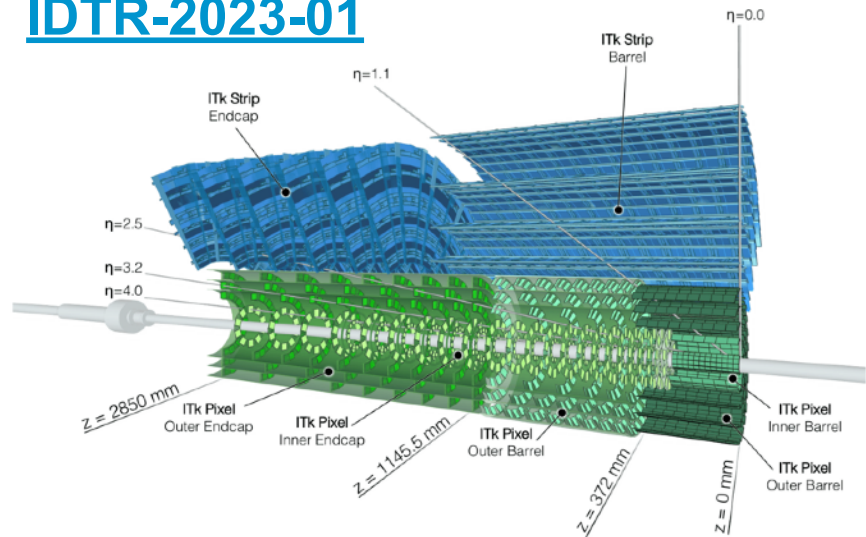


Hardware - leaps and strides

ATLAS ID



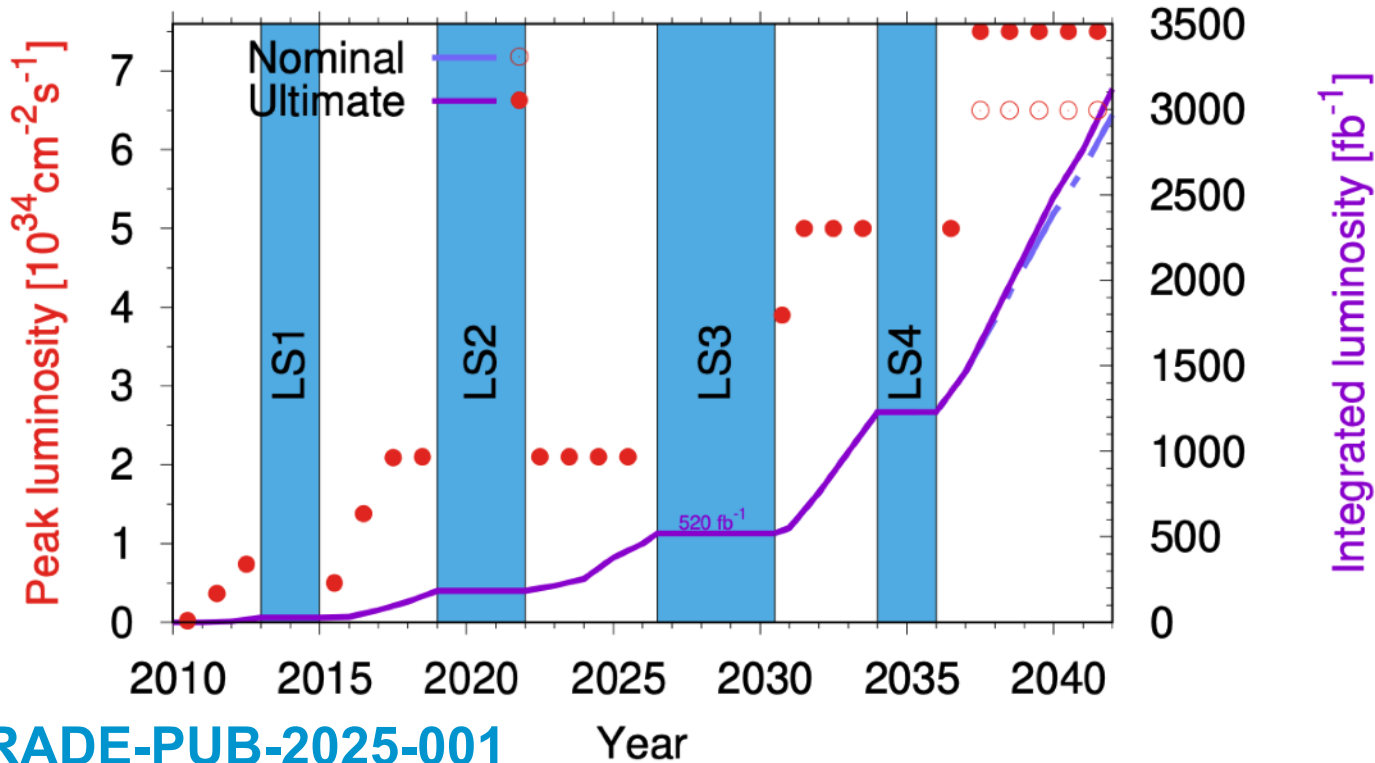
IDTR-2023-01



Wider $|\eta|$ coverage $2.5 \rightarrow 4.0$

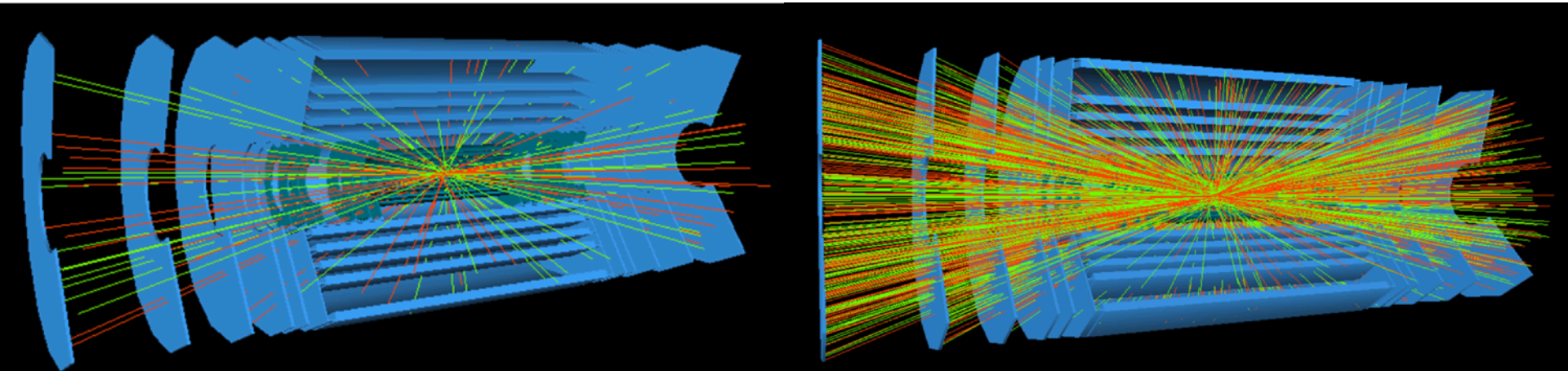
More readout channels: $\sim 10^8 \rightarrow \sim 5 \times 10^9$

Challenges in the High Luminosity LHC era



[ATL-UPGRADE-PUB-2025-001](#)

Challenges in the High Luminosity LHC era



Pile-up = 23

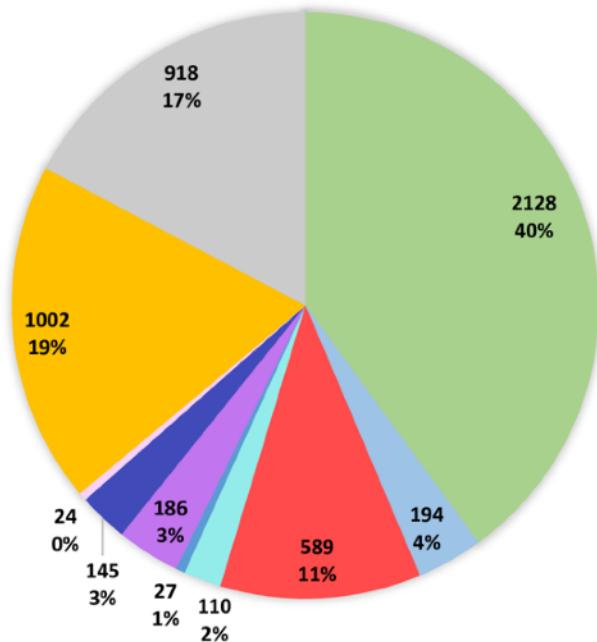
[arxiv:1201.5469](https://arxiv.org/abs/1201.5469)

Pile-up = 230

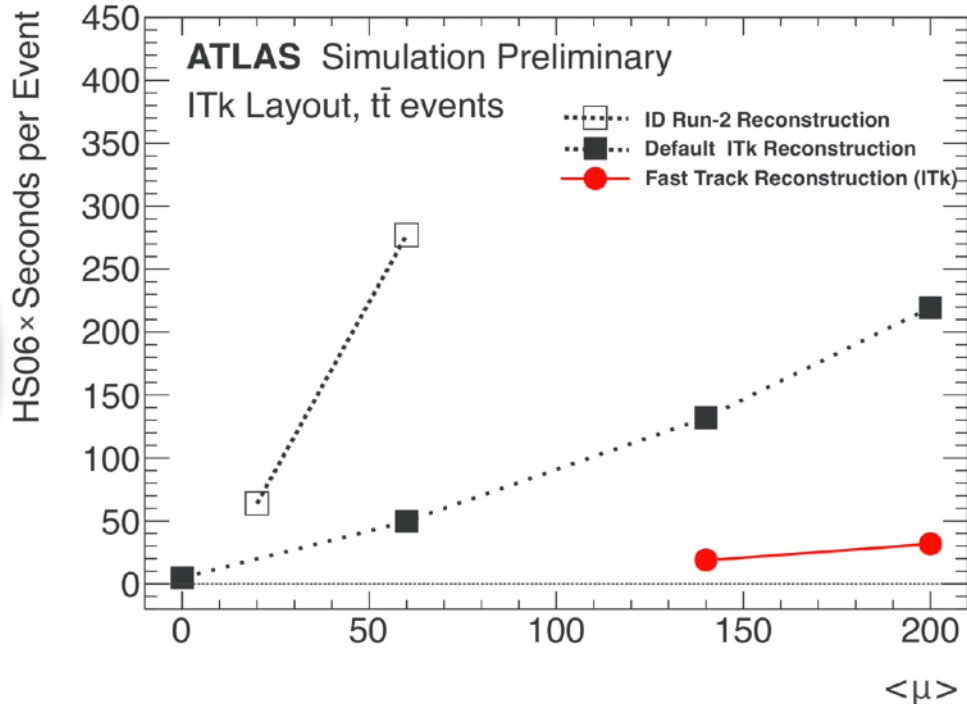
Challenges in the High Luminosity LHC era

ATLAS Preliminary
 RUN 3 RECONSTRUCTION
 CPU TIME [A.U]

- INDET
- CALO
- MUON
- EGAMMA
- TAU
- PFO
- JETETMISS
- BTAG
- LRT
- OTHER

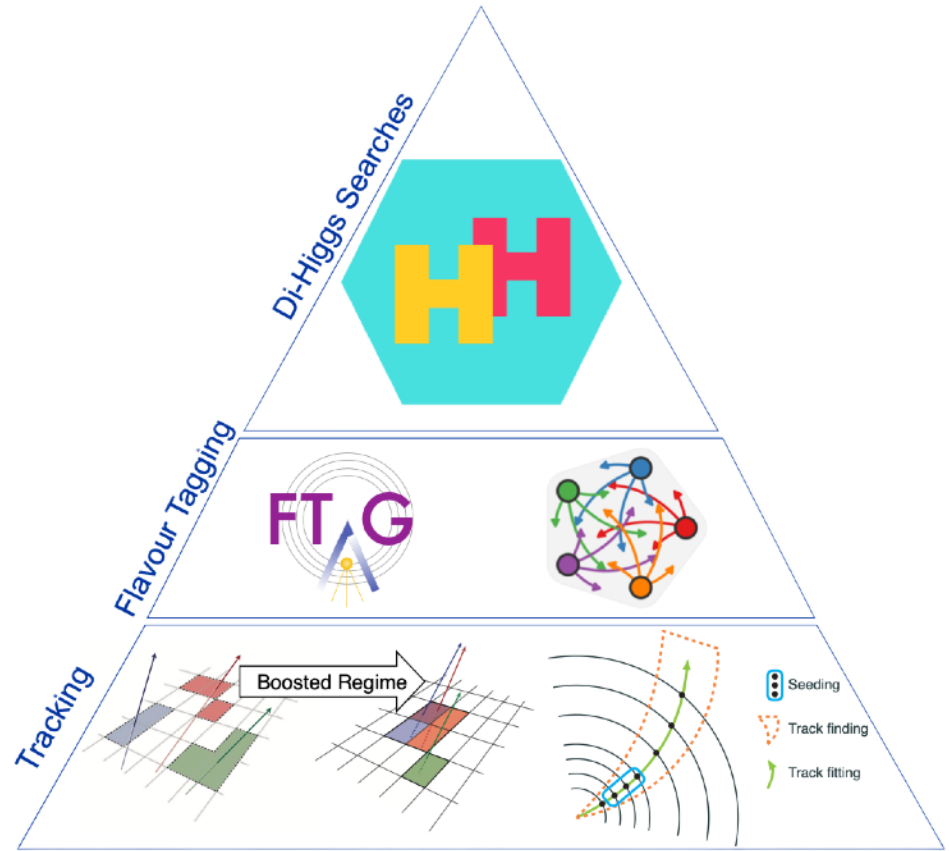


[ATL-PHYS-PUB-2021-012](#)

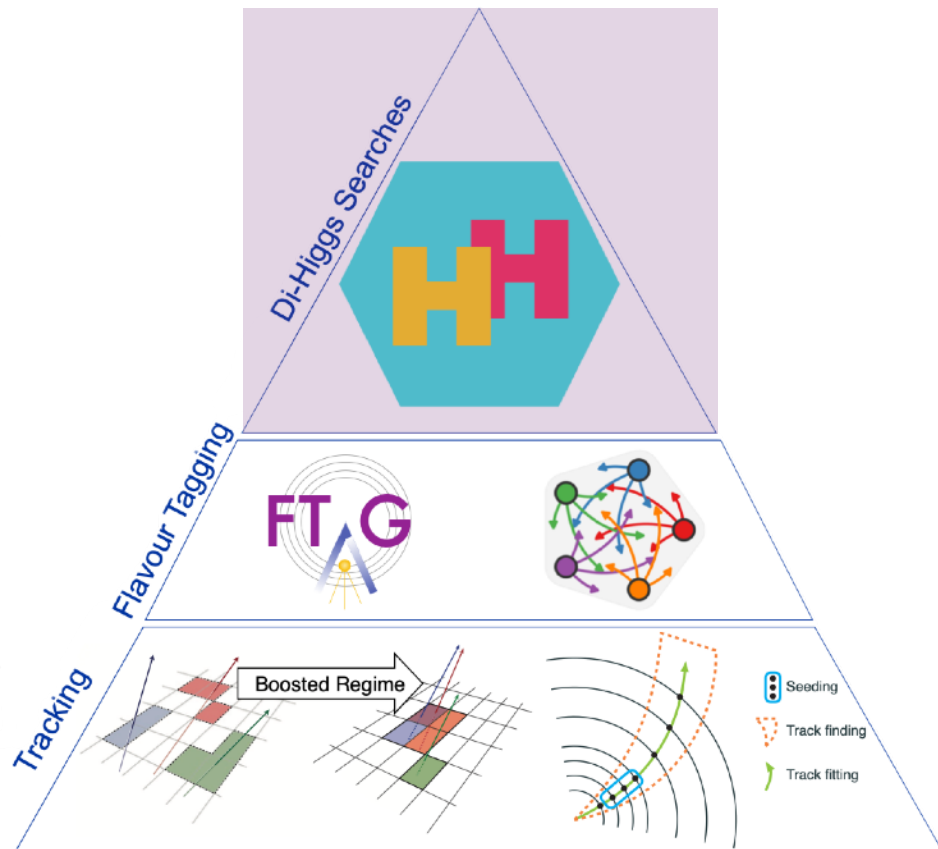
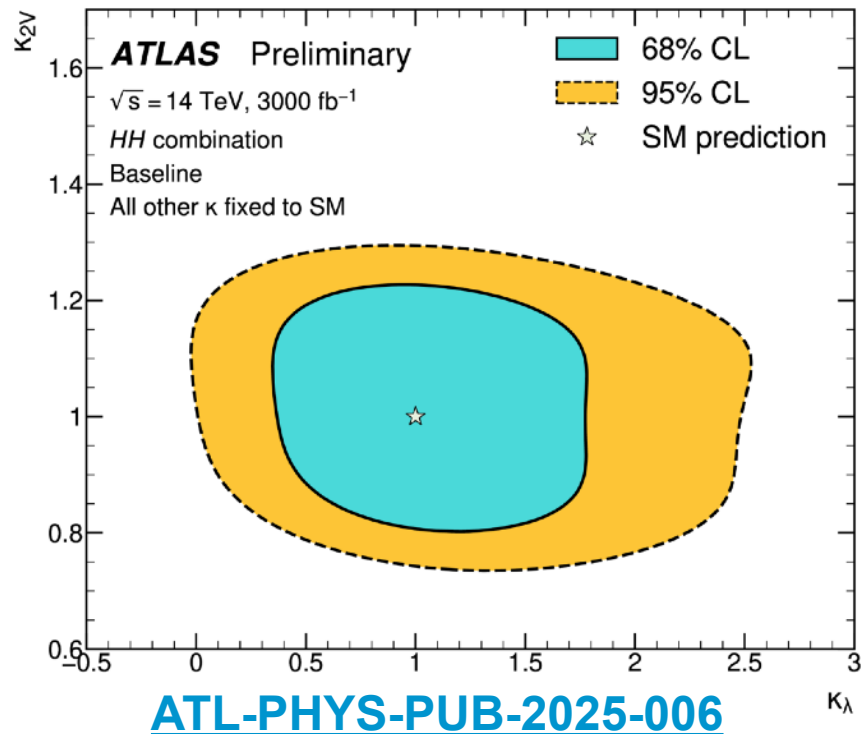


[ATL-PHYS-PUB-2019-041](#)

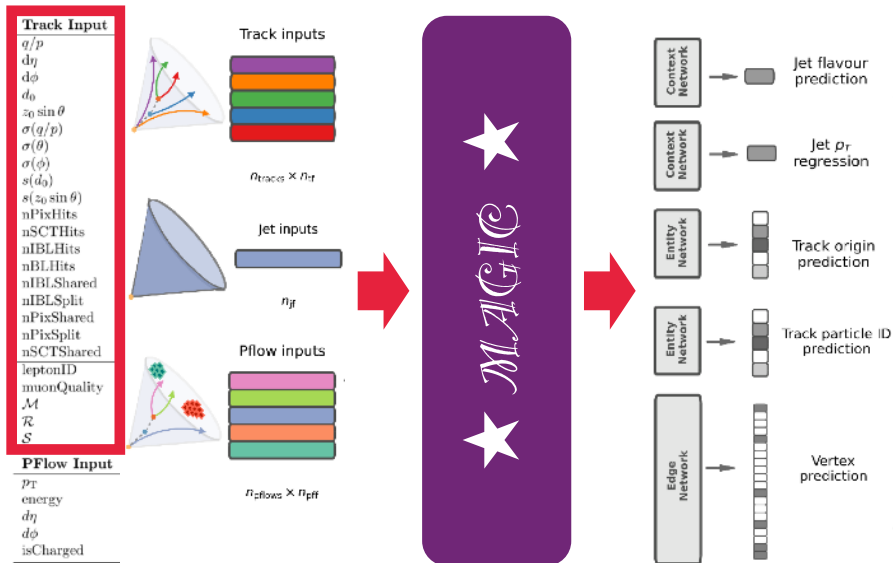
ATLAS Physics



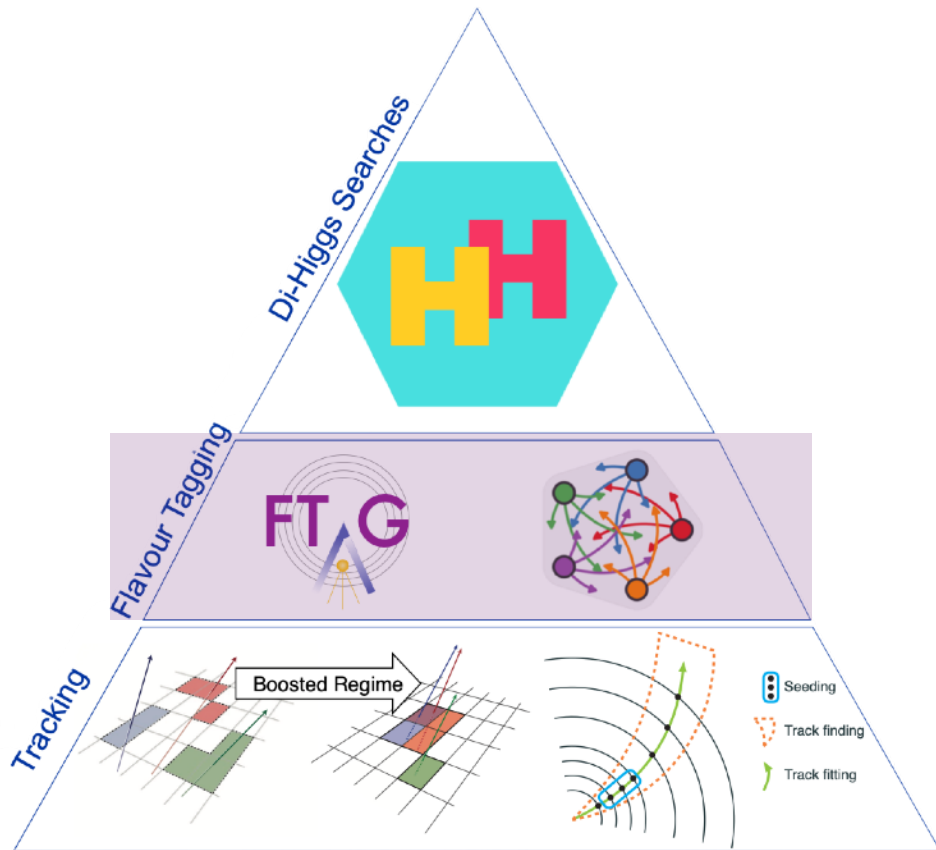
ATLAS Physics



ATLAS Physics



[ATL-PHYS-PUB-2026-001](#)



ATLAS Physics

Space point formation
Clustering



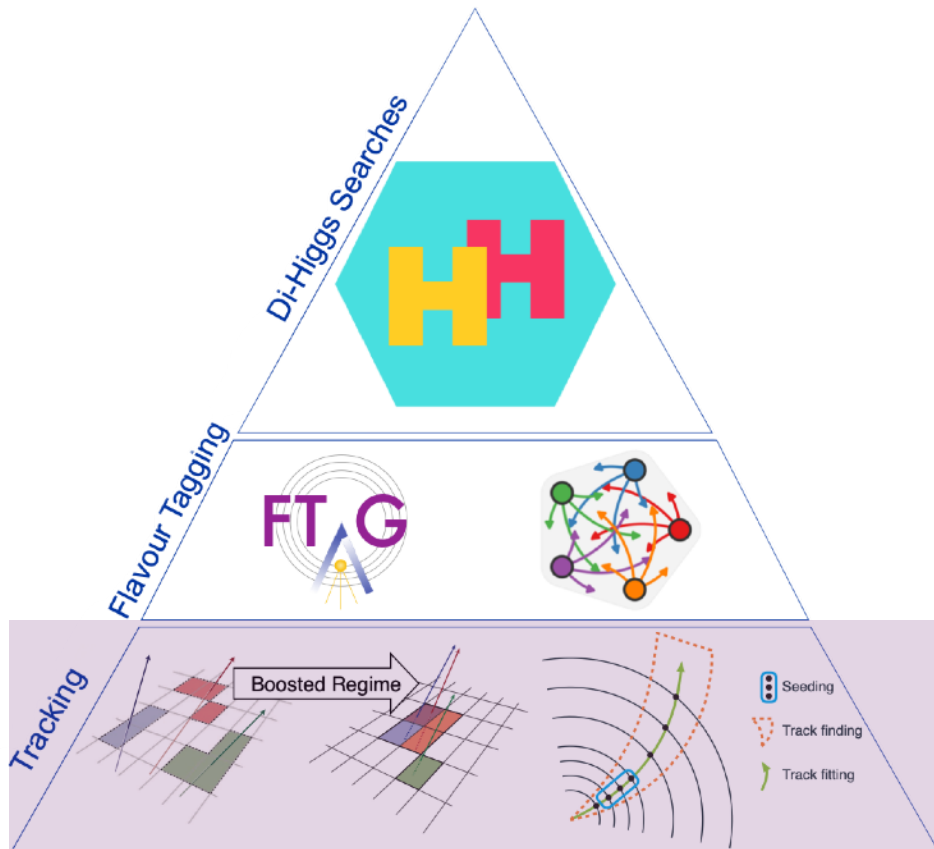
Track Seeding



Track Finding & Fitting



Ambiguity Solving



ATLAS Tracking



Space point formation
Clustering



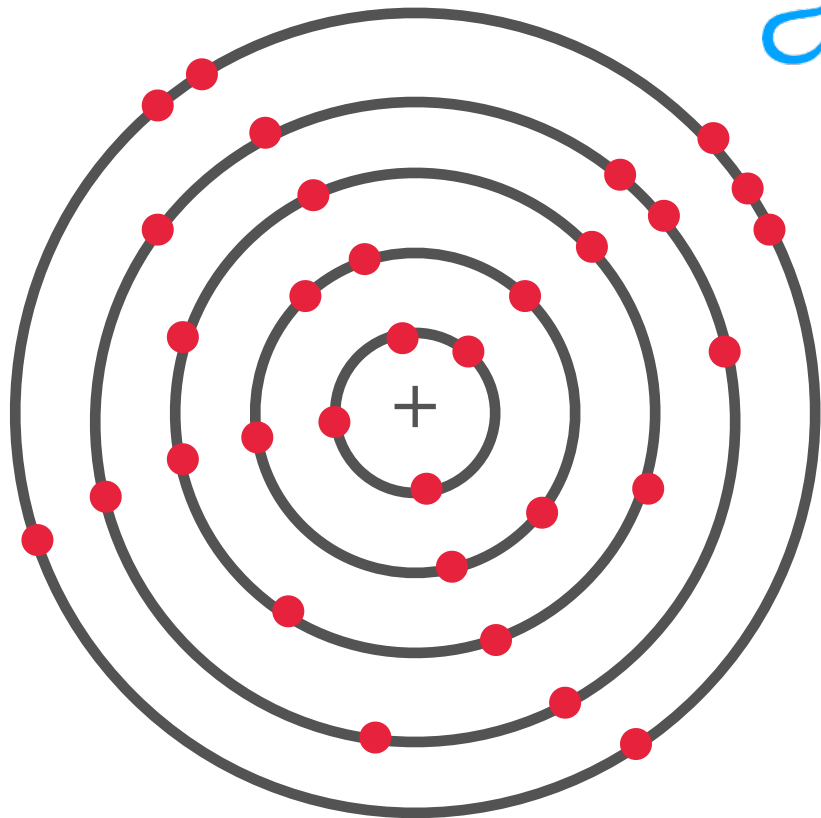
Track Seeding



Track Finding &
Fitting



Ambiguity Solving



ATLAS Tracking



Space point formation
Clustering



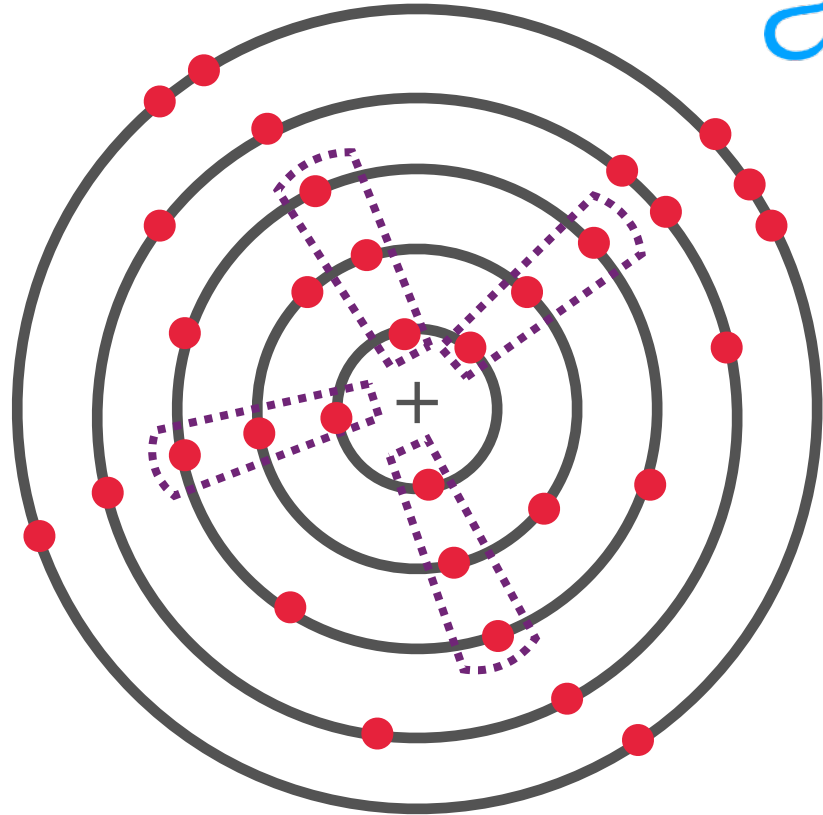
Track Seeding



Track Finding &
Fitting



Ambiguity Solving



ATLAS Tracking



Space point formation
Clustering



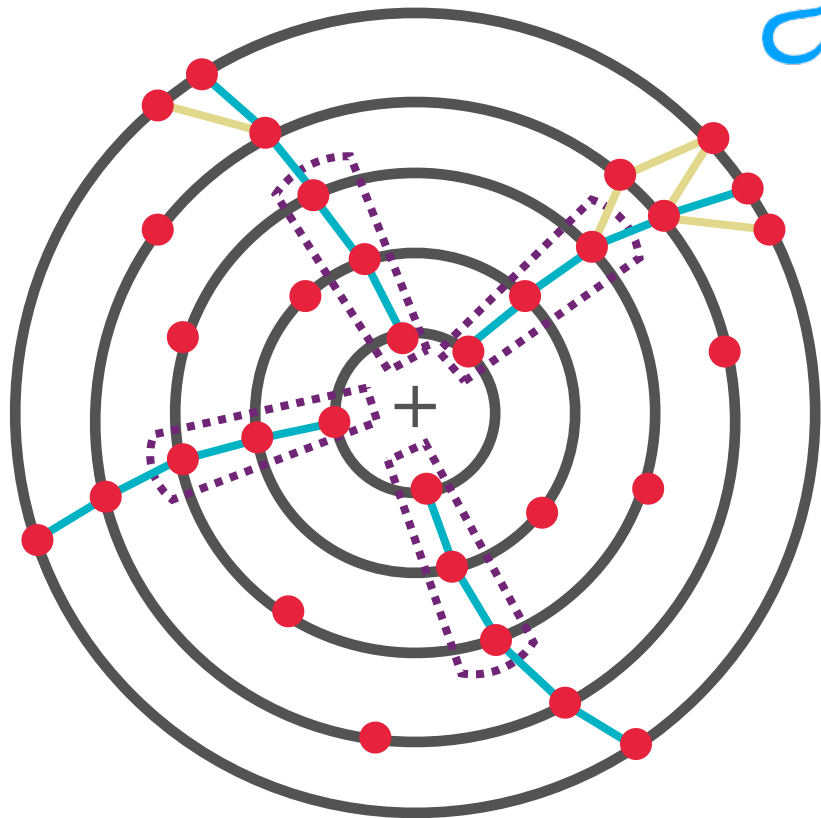
Track Seeding



Track Finding &
Fitting



Ambiguity Solving



ATLAS Tracking

Space point formation
Clustering



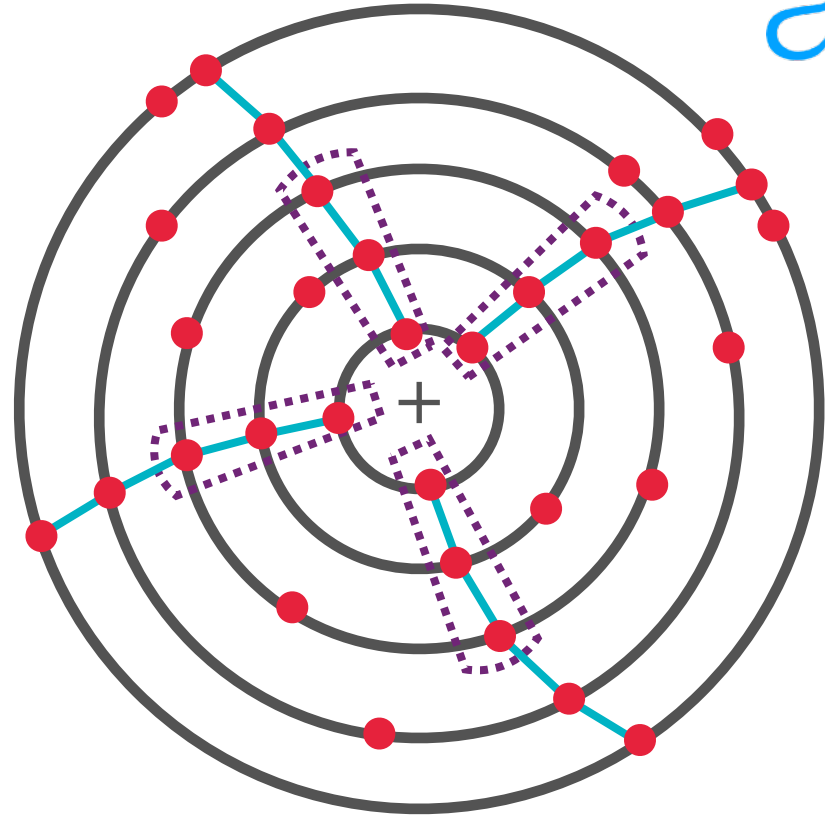
Track Seeding



Track Finding &
Fitting



Ambiguity Solving



ATLAS Tracking

Space point formation
Clustering



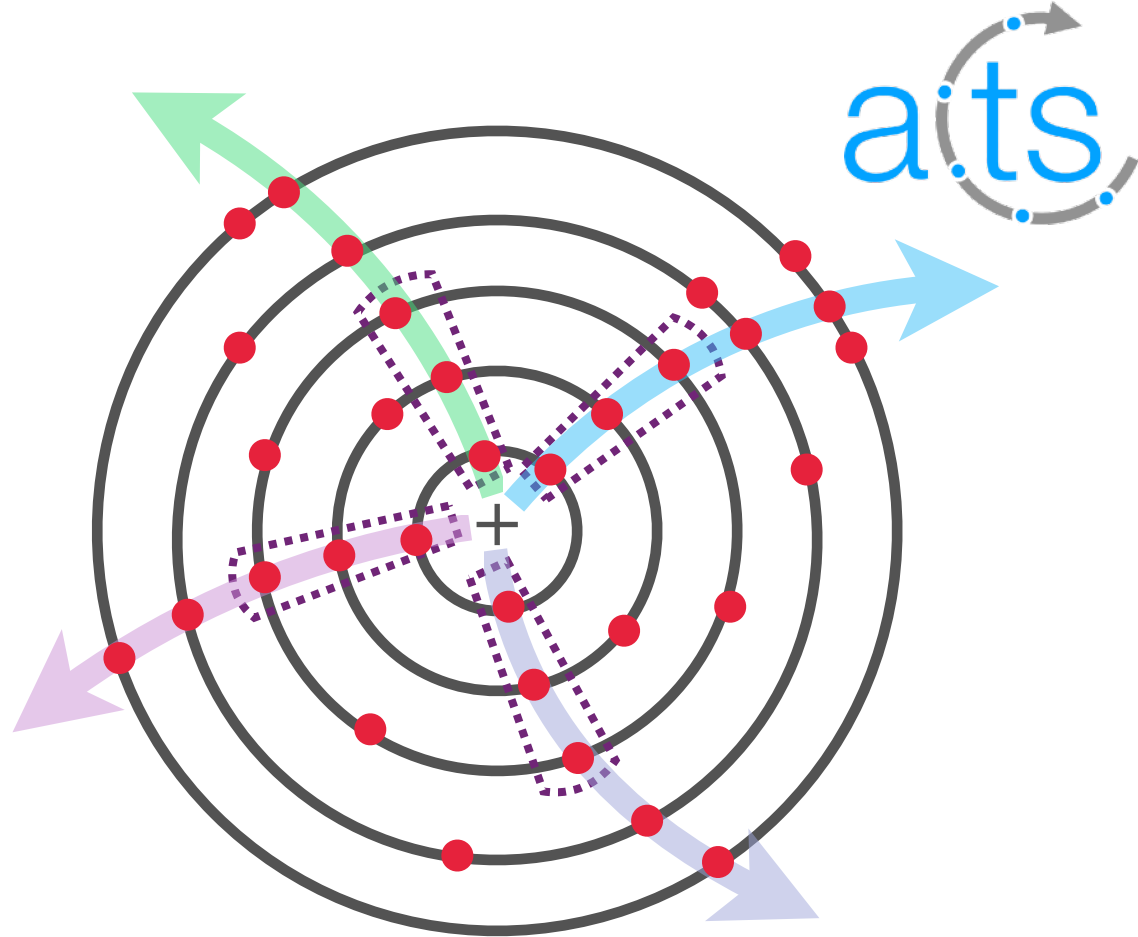
Track Seeding



Track Finding &
Fitting



Ambiguity Solving



Tracking with machine learning

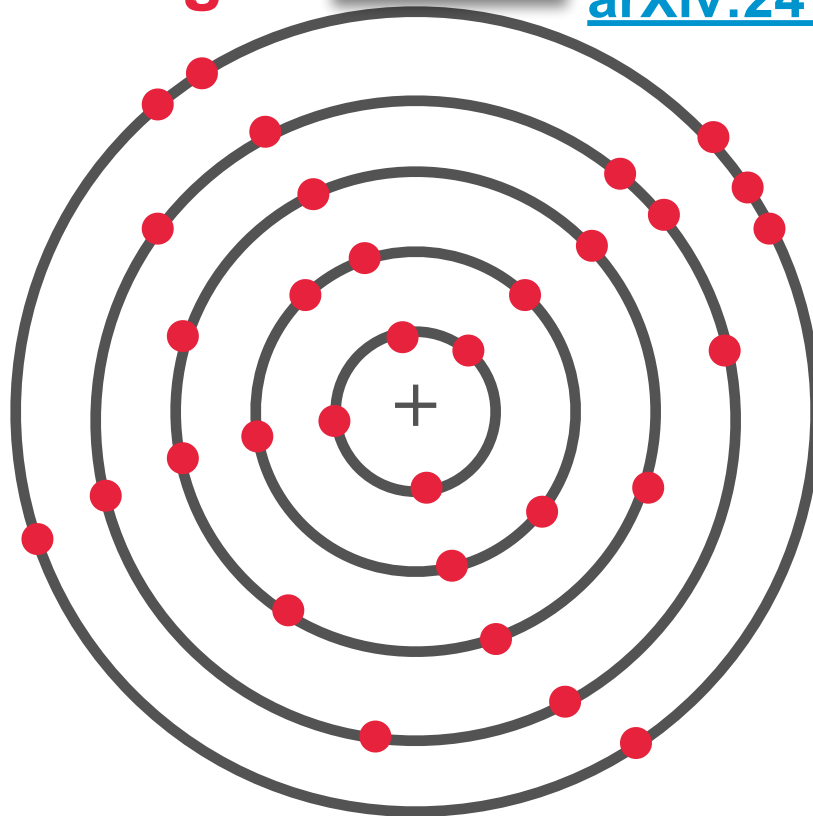


[arXiv:2304.02643](https://arxiv.org/abs/2304.02643)
[arXiv:2411.07149](https://arxiv.org/abs/2411.07149)

Space point formation
Clustering



Inference



Tracking with machine learning

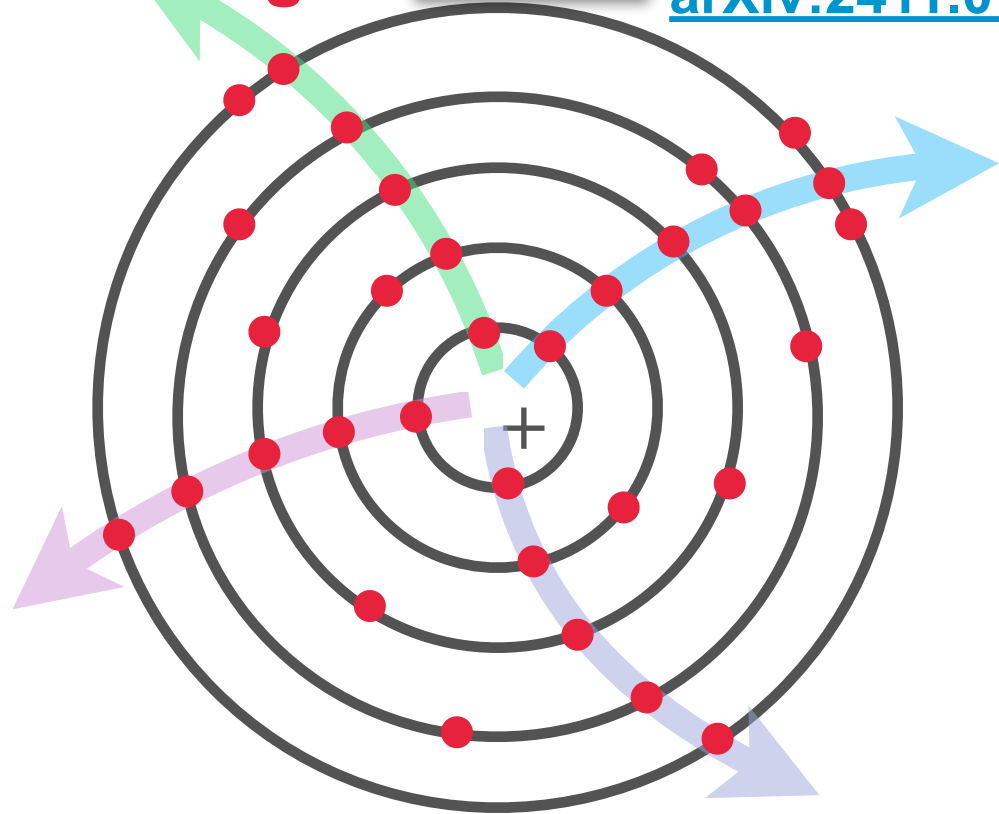


[arXiv:2304.02643](https://arxiv.org/abs/2304.02643)
[arXiv:2411.07149](https://arxiv.org/abs/2411.07149)

Space point formation
Clustering



Inference



Tracking with machine learning



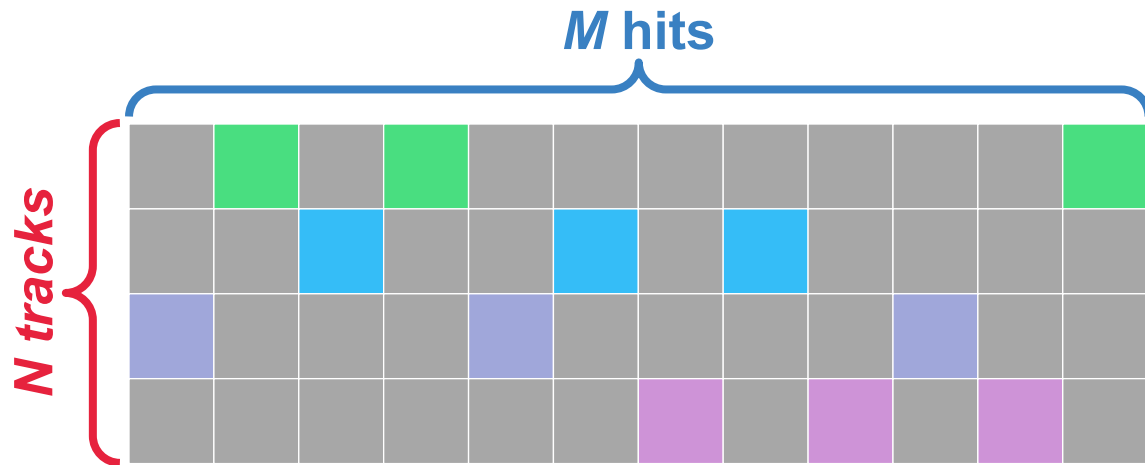
[arXiv:2304.02643](https://arxiv.org/abs/2304.02643)

[arXiv:2411.07149](https://arxiv.org/abs/2411.07149)

Space point formation
Clustering



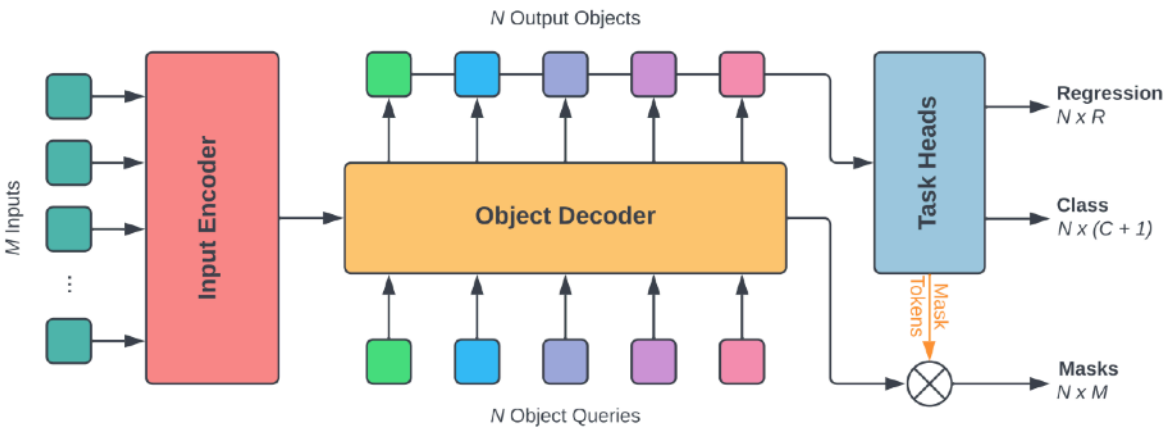
Inference



Tracking with machine learning



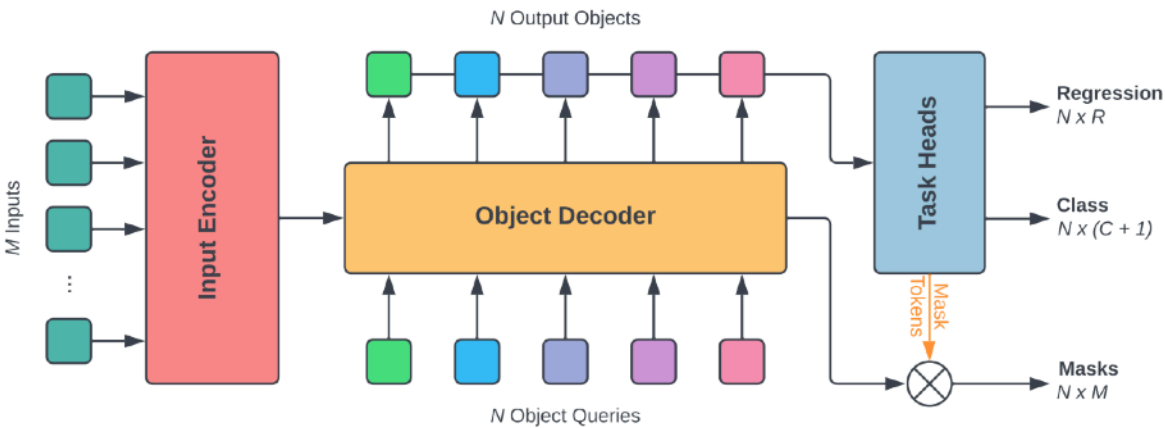
[arXiv:2304.02643](https://arxiv.org/abs/2304.02643)
[arXiv:2411.07149](https://arxiv.org/abs/2411.07149)



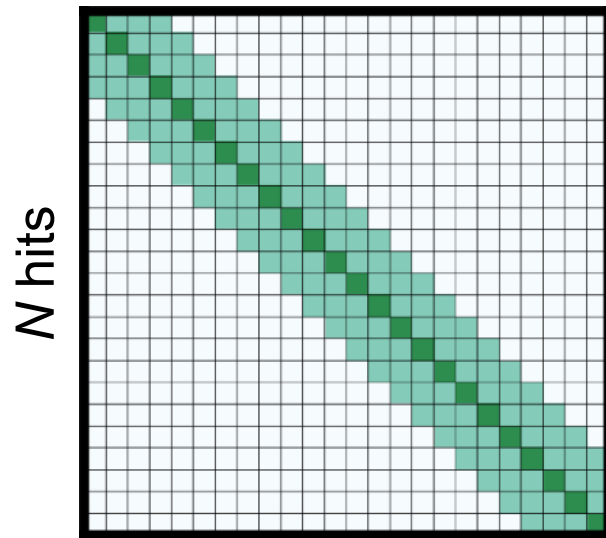
Tracking with machine learning



[arXiv:2304.02643](https://arxiv.org/abs/2304.02643)
[arXiv:2411.07149](https://arxiv.org/abs/2411.07149)



N hits

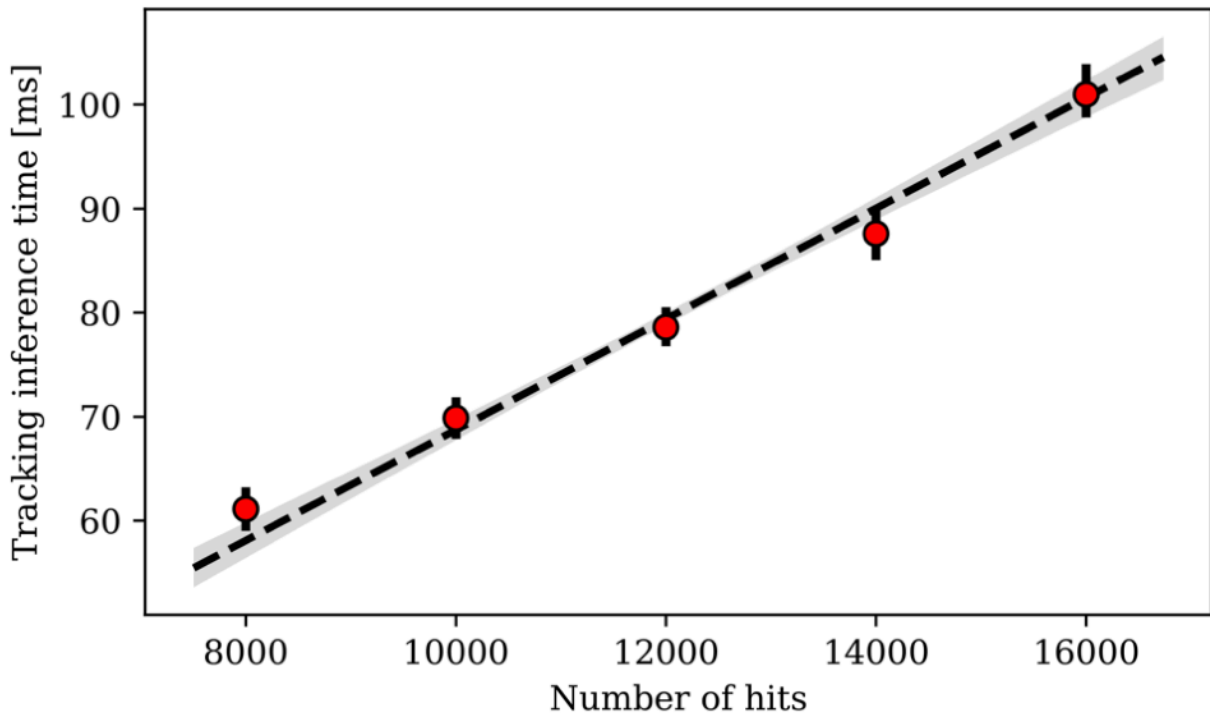


Sliding window attention

Tracking with machine learning



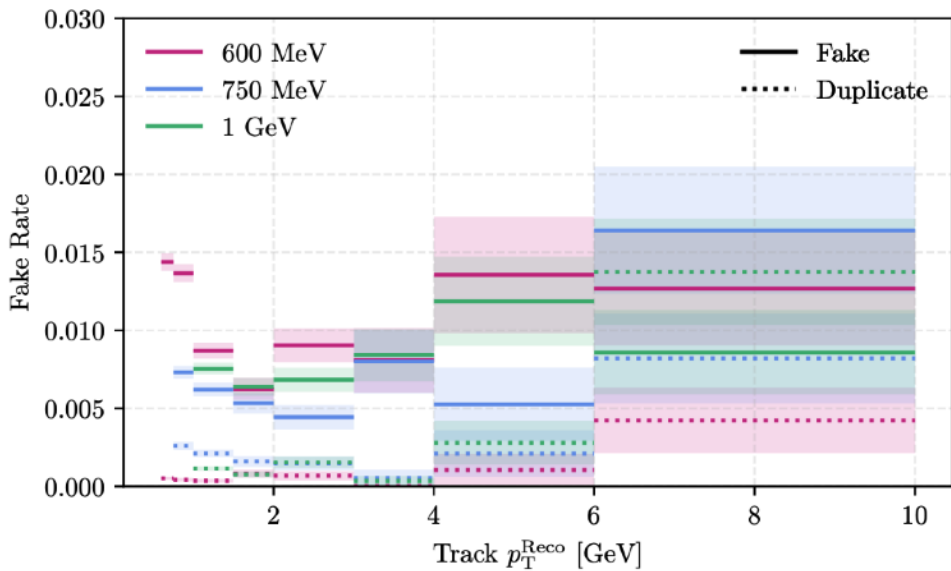
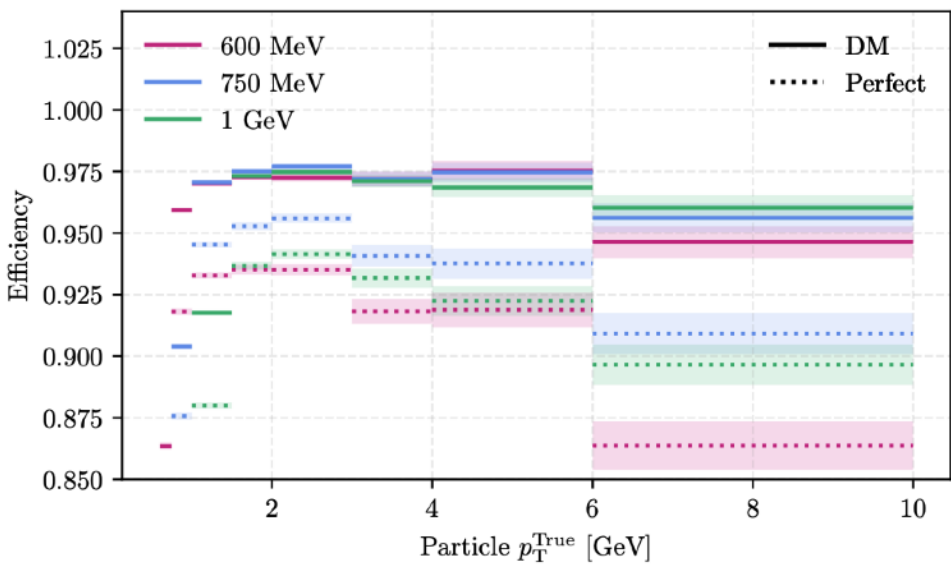
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[arXiv:2411.07149](https://arxiv.org/abs/2411.07149)



Tracking with machine learning



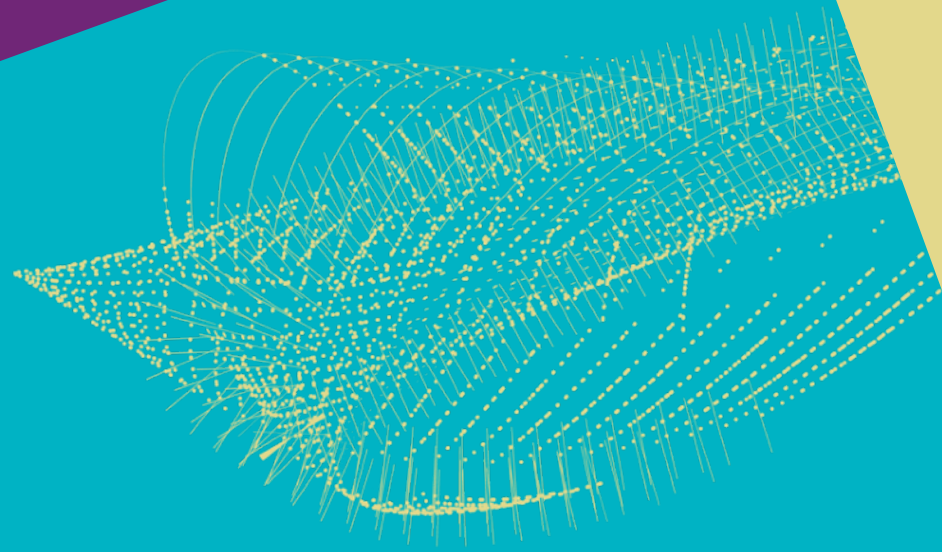
[arXiv:2304.02643](https://arxiv.org/abs/2304.02643)
[arXiv:2411.07149](https://arxiv.org/abs/2411.07149)



Summary

- Tracks → objects → analysis → discovery / measurement
- HL-LHC era → more data → computationally challenging
- Tracking ~ iterative (mostly analytical) process of **spatial pattern recognition**
 - Opportunity for SOTA image segmentation techniques (scalable)
- [Not covered today] Muon tracking (geometry modeling, ac t s integration)

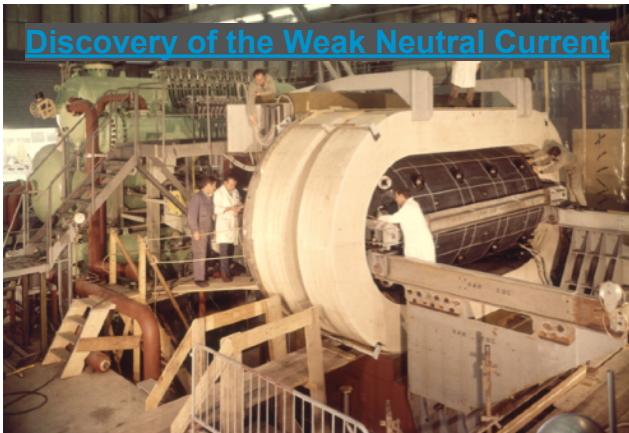
Nikhef



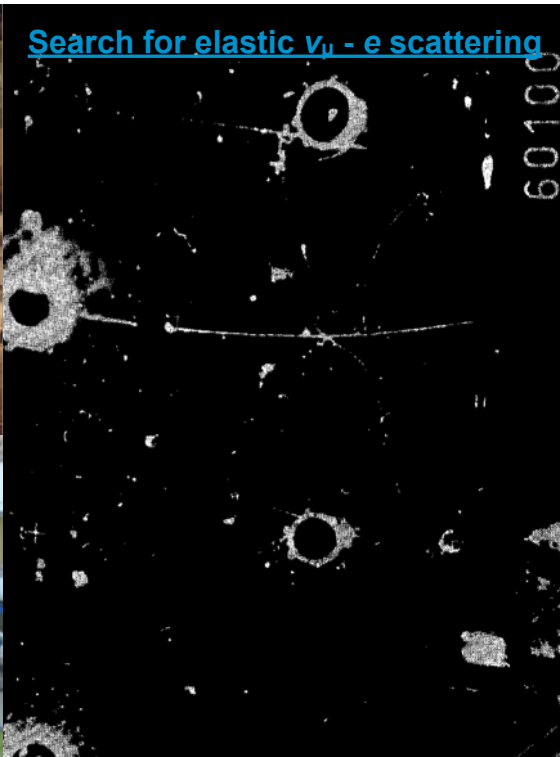
Thank you!

Bubble chamber

Discovery of the Weak Neutral Current



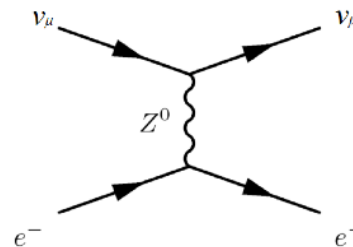
Search for elastic $\nu_\mu - e$ scattering



Scanner, Madeleine Znoj (BEBC 1976)



Gargamelle, Léon Van Hove sq., CERN



Bubble chamber

Discovery of the Weak Neutral Current

Search for elastic $\nu_\mu - e$ scattering

Nobel Prize in Physics 1979



Photo from the Nobel Foundation archive.

Sheldon Lee Glashow

Prize share: 1/3



Photo from the Nobel Foundation archive.

Abdus Salam

Prize share: 1/3



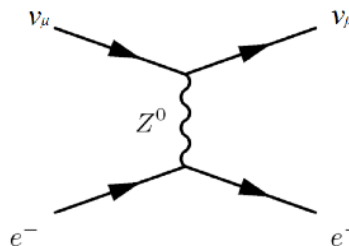
Photo: Harvard University News Office. Nobel Foundation archive

Steven Weinberg

Prize share: 1/3



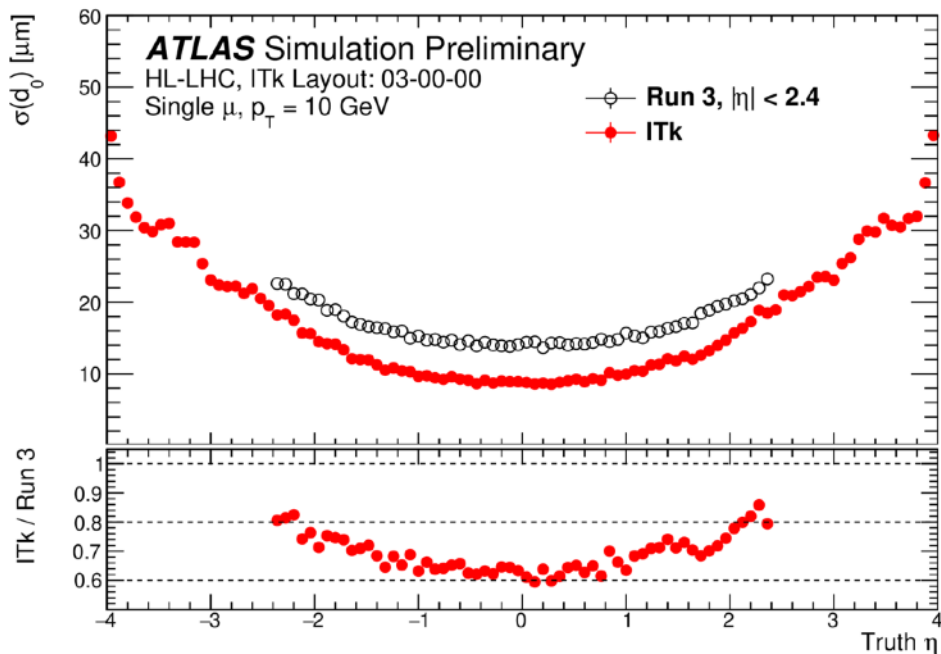
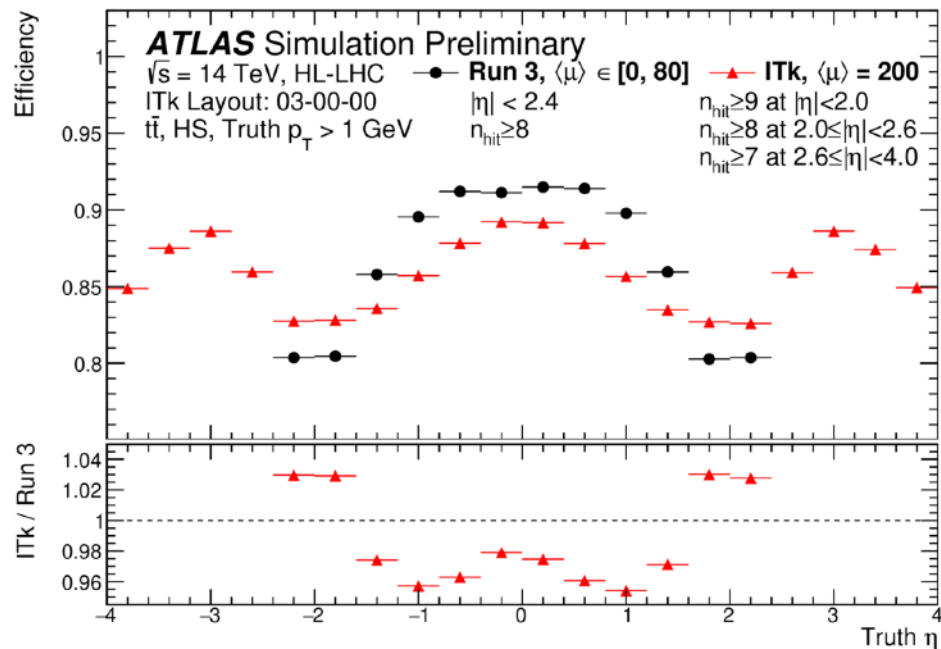
er. Madeleine Znoj (BEBC 1976)



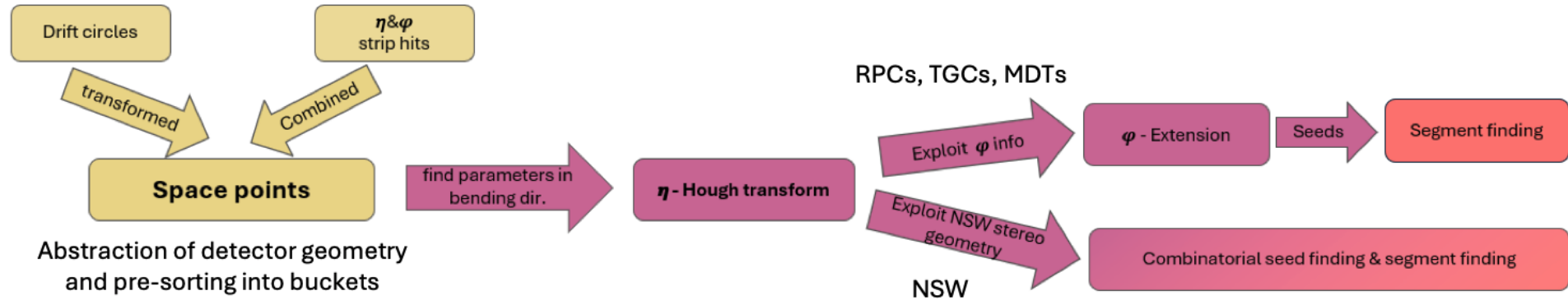
Gargamelle, Léon Van Hove sq., CERN

Expected tracking performance of ITk upgrade

IDTR-2023-05

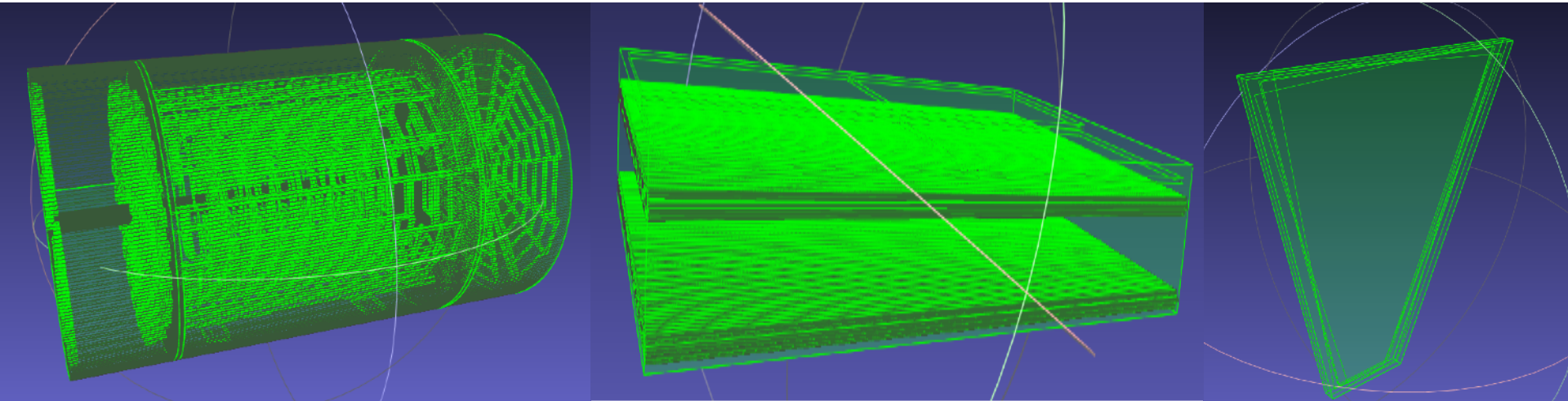


ACTS integration for muon tracking



ID tracking WS: Phase II Muon tracking

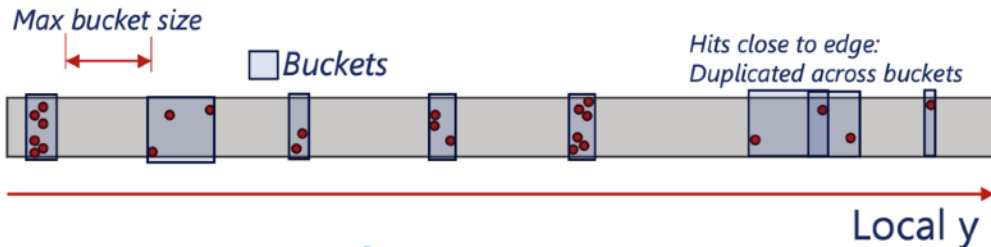
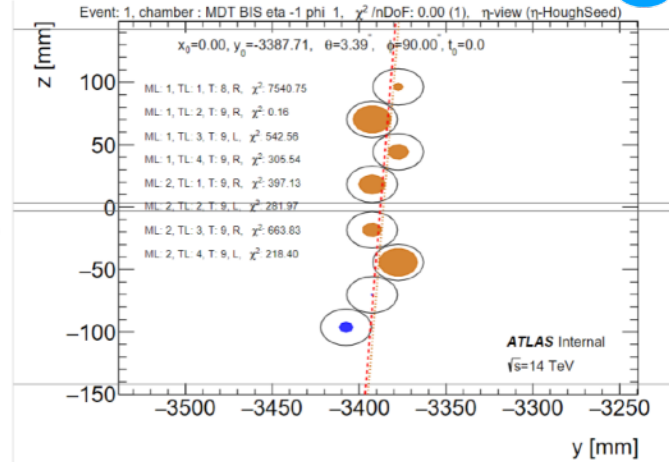
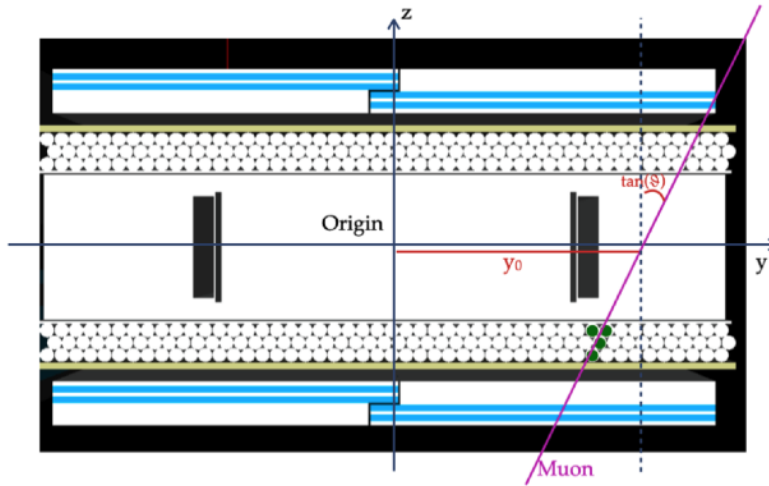
ACTS integration for muon tracking



Muon week, Feb. 2026

ID tracking WS: Phase II Muon tracking

ACTS integration for muon tracking

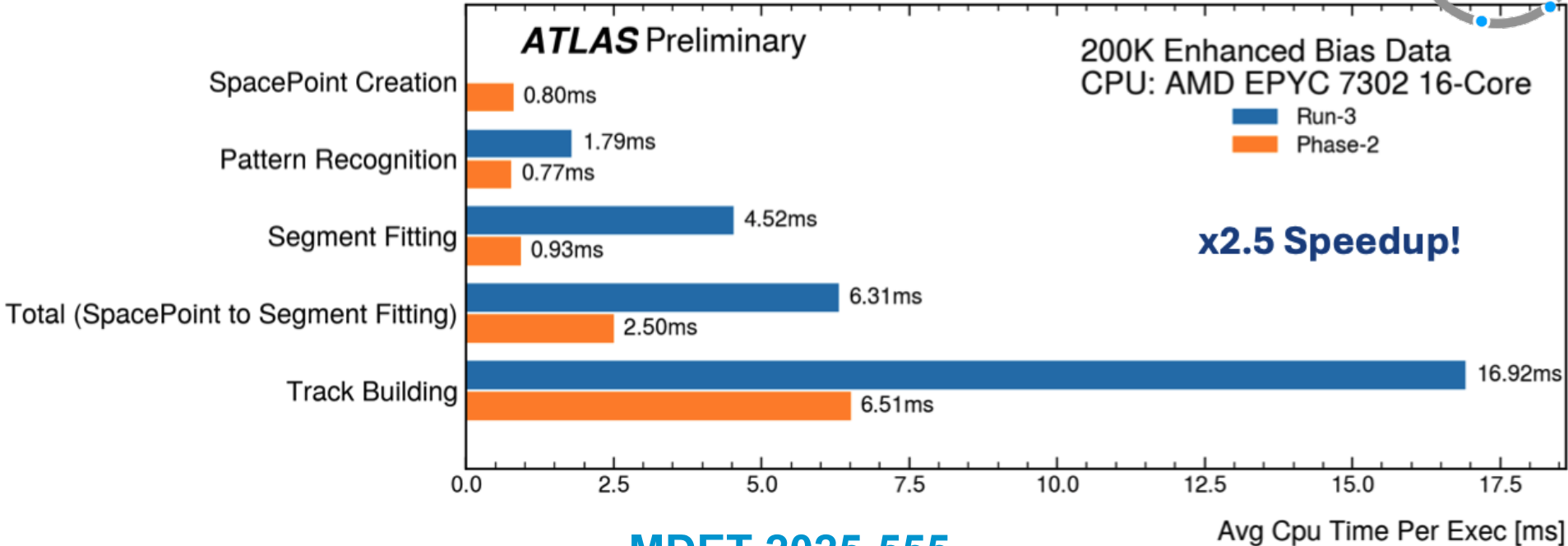


ID tracking WS: Phase II Muon tracking

ACTS integration for muon tracking



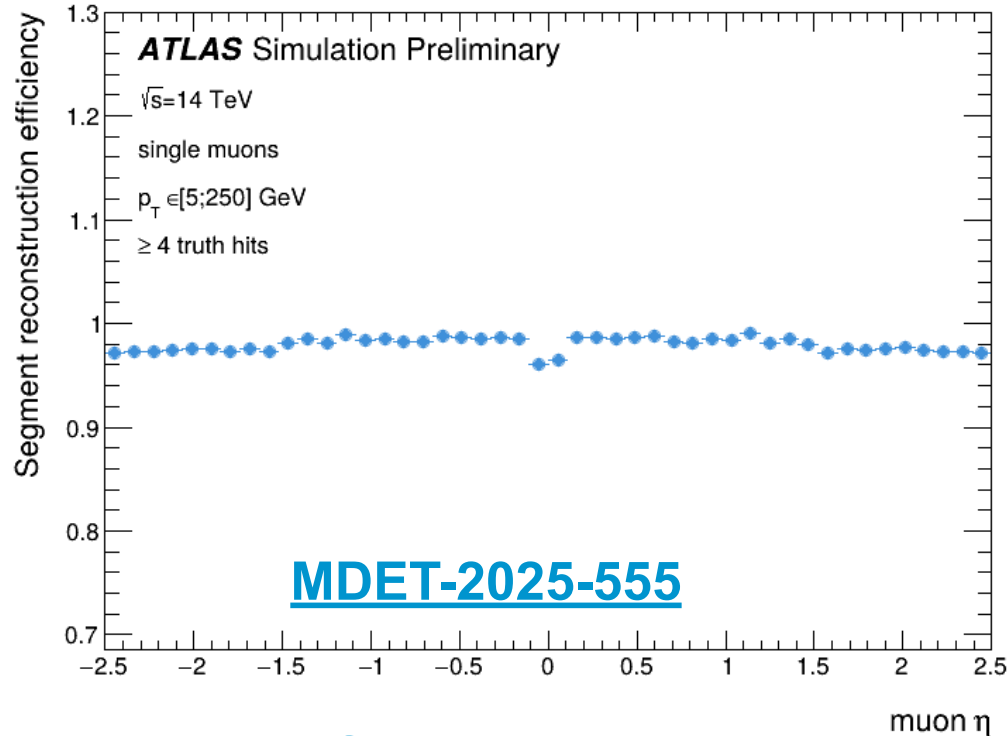
Algorithm CPU Time Comparison



[MDET-2025-555](#)

[ID tracking WS: Phase II Muon tracking](#)

ACTS integration for muon tracking



ID tracking WS: Phase II Muon tracking