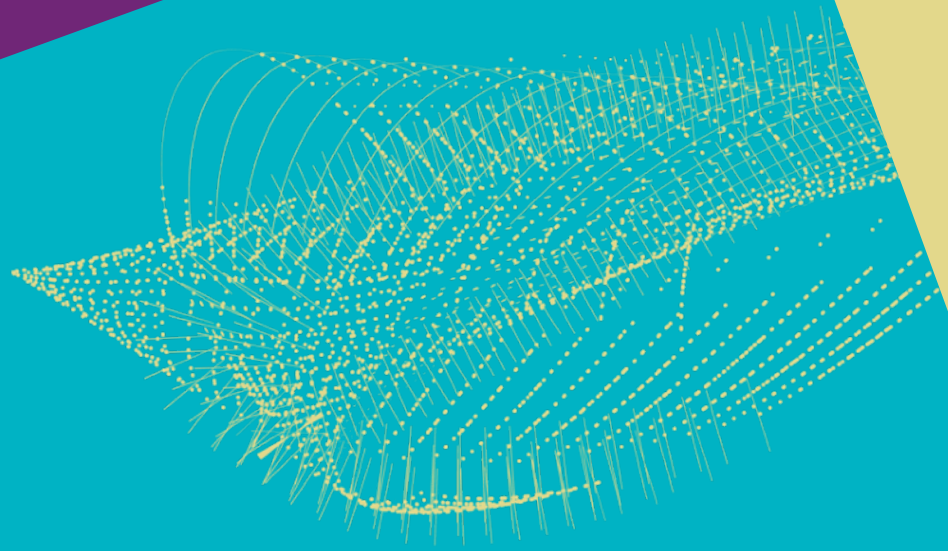
Nikhef



12/May/2026

Tracking @ ATLAS (@ Nikhef)

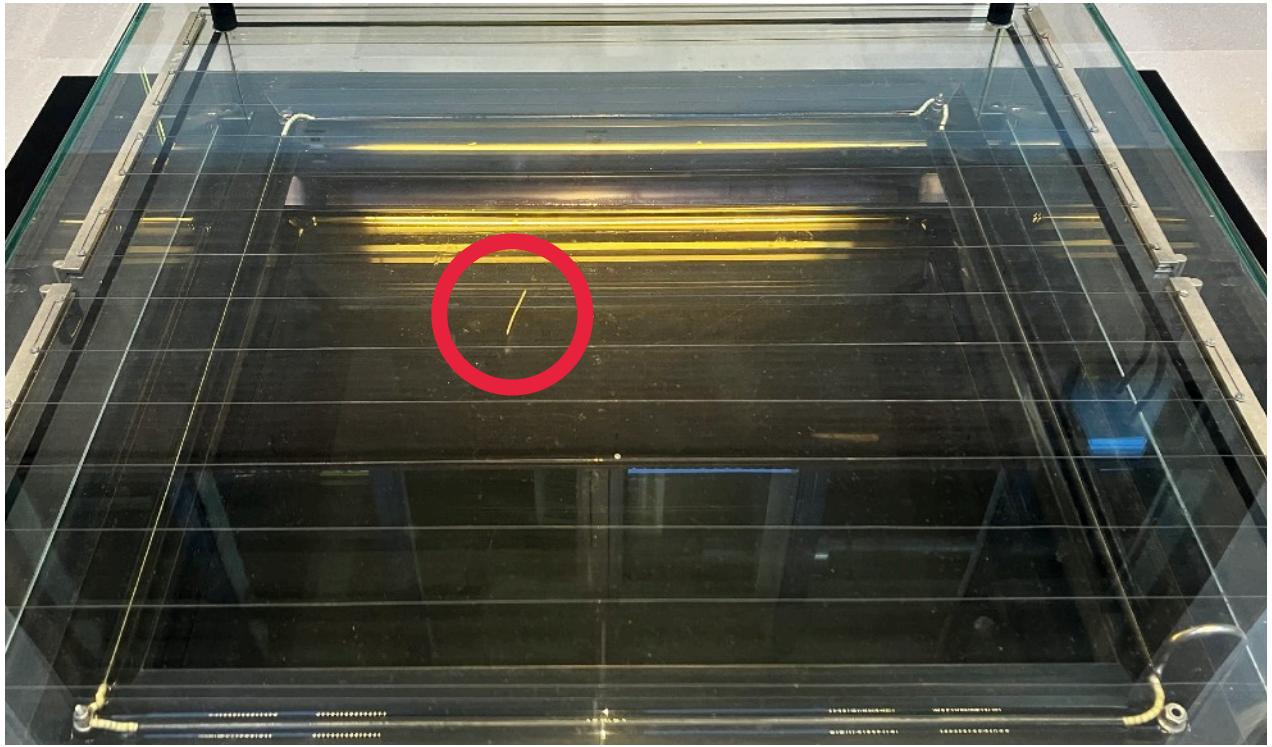
Siang-Yuan Lin

Tracking?

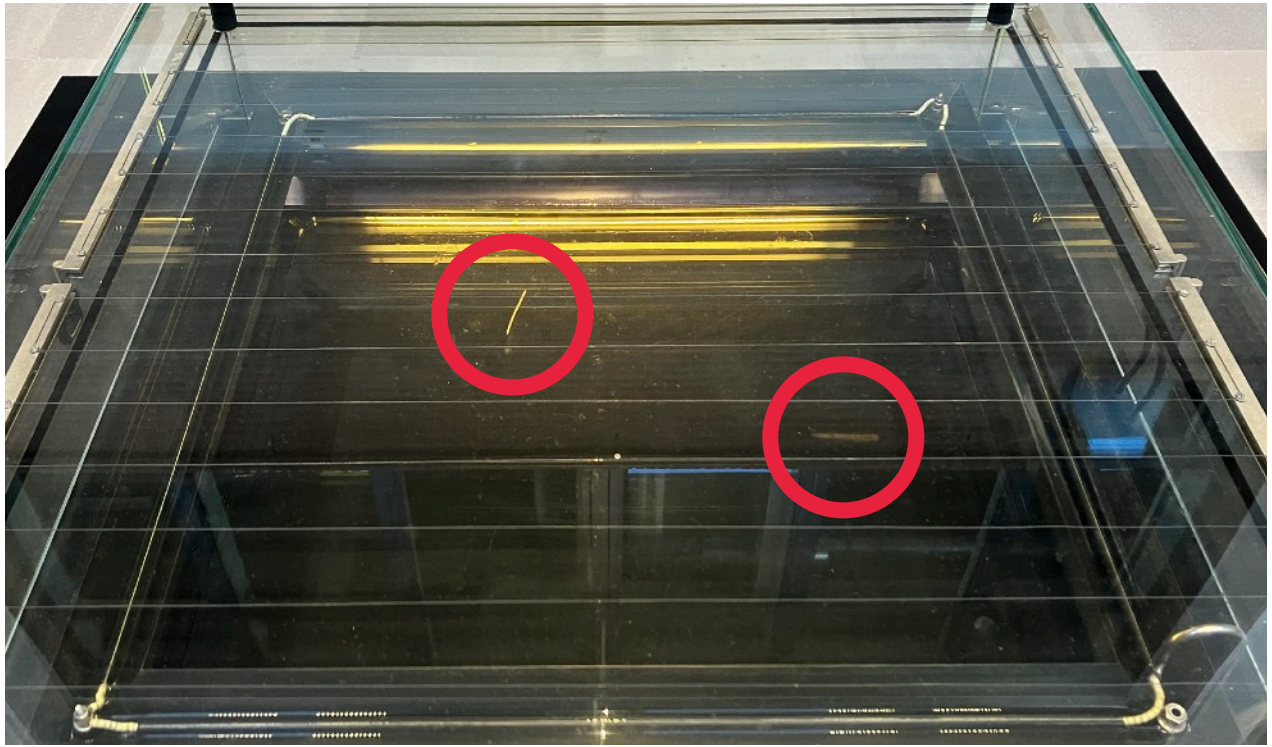
https://en.wikipedia.org/wiki/Tracking_(hunting)

Cloud chamber

Cloud chamber

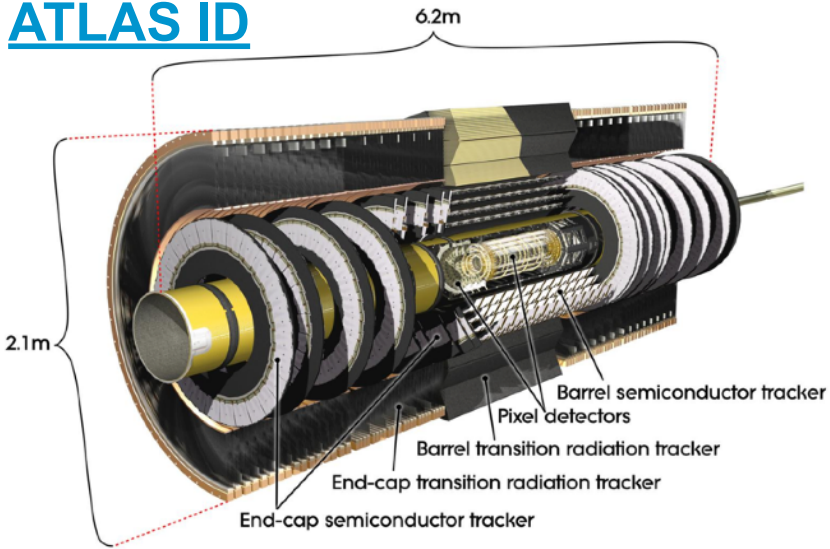


Cloud chamber



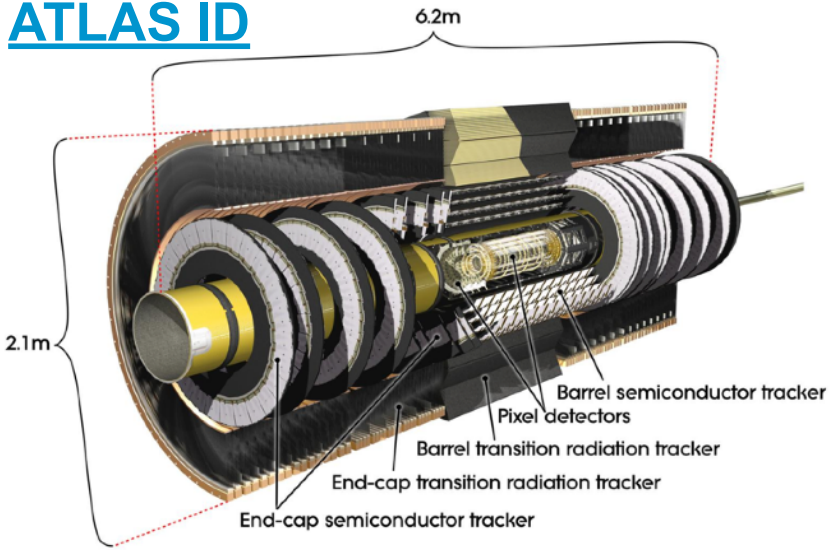
Hardware - leaps and strides

ATLAS ID

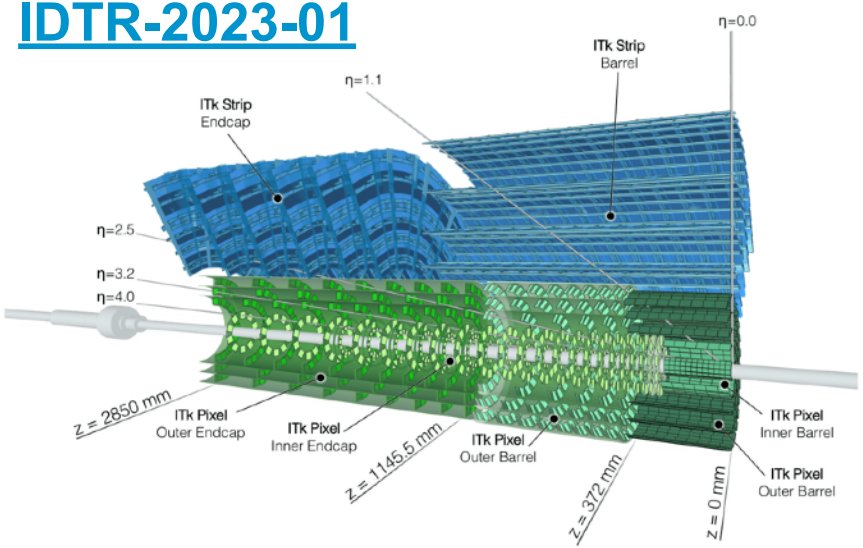


Hardware - leaps and strides

ATLAS ID



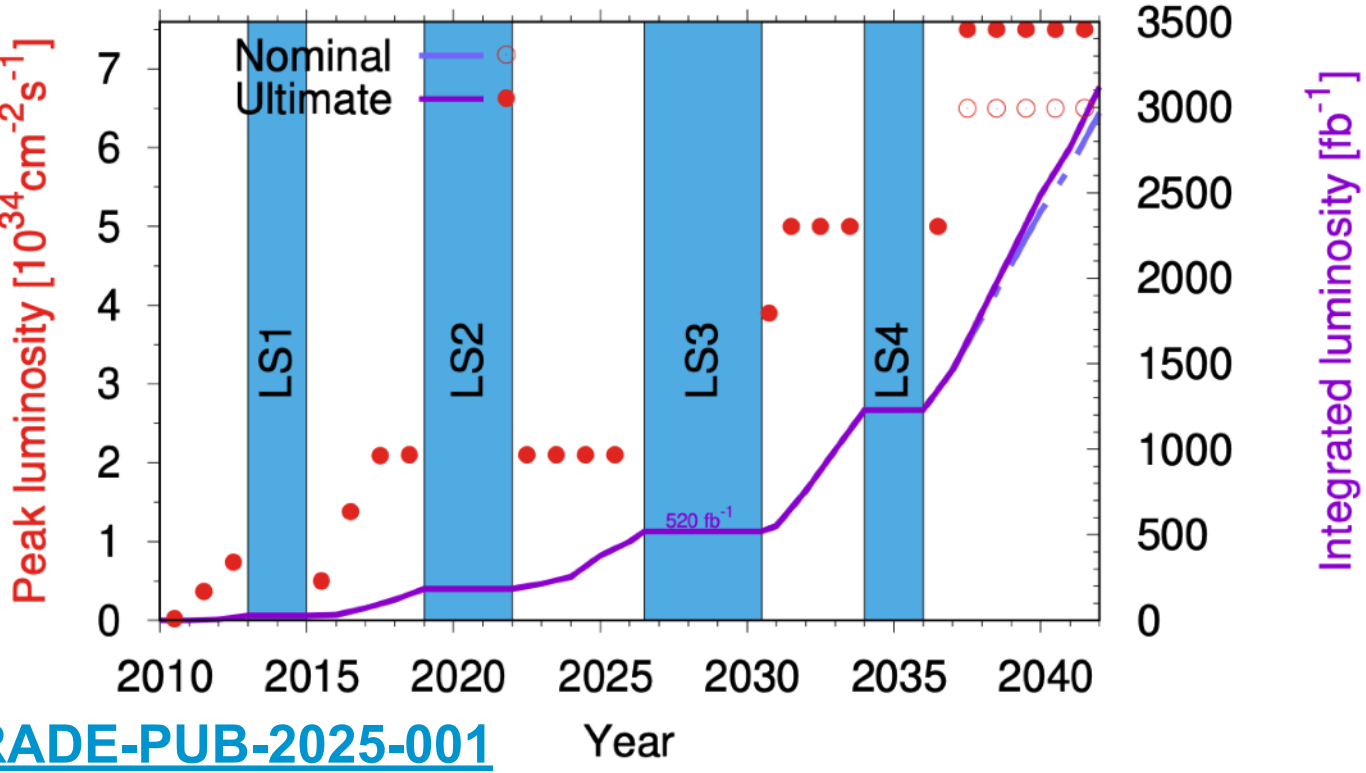
IDTR-2023-01



Wider $|\eta|$ coverage 2.5 → 4.0

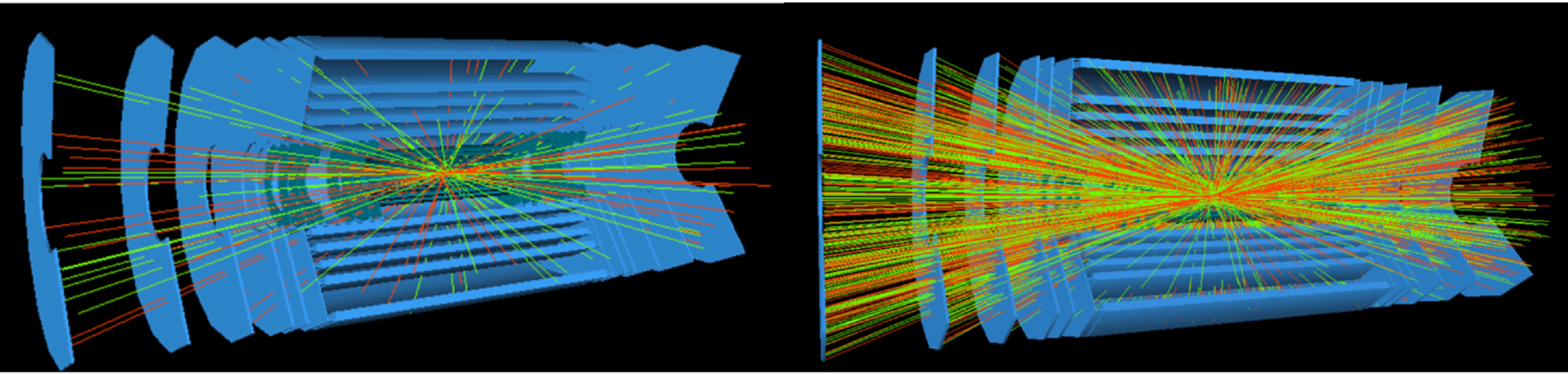
More readout channels: ~10^8 → ~5×10^9

Challenges in the High Luminosity LHC era



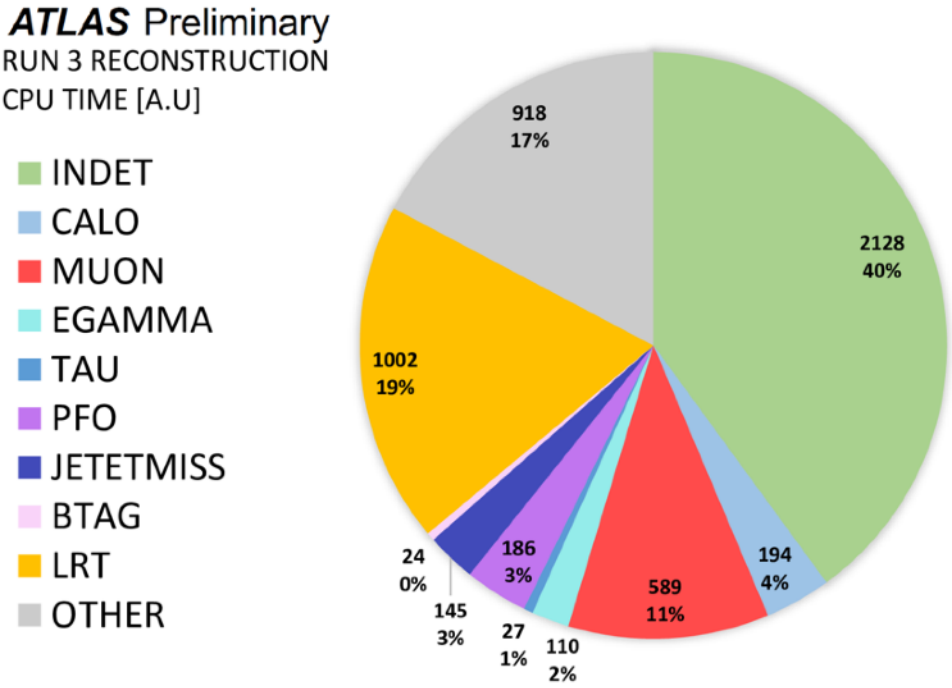
ATL-UPGRADE-PUB-2025-001

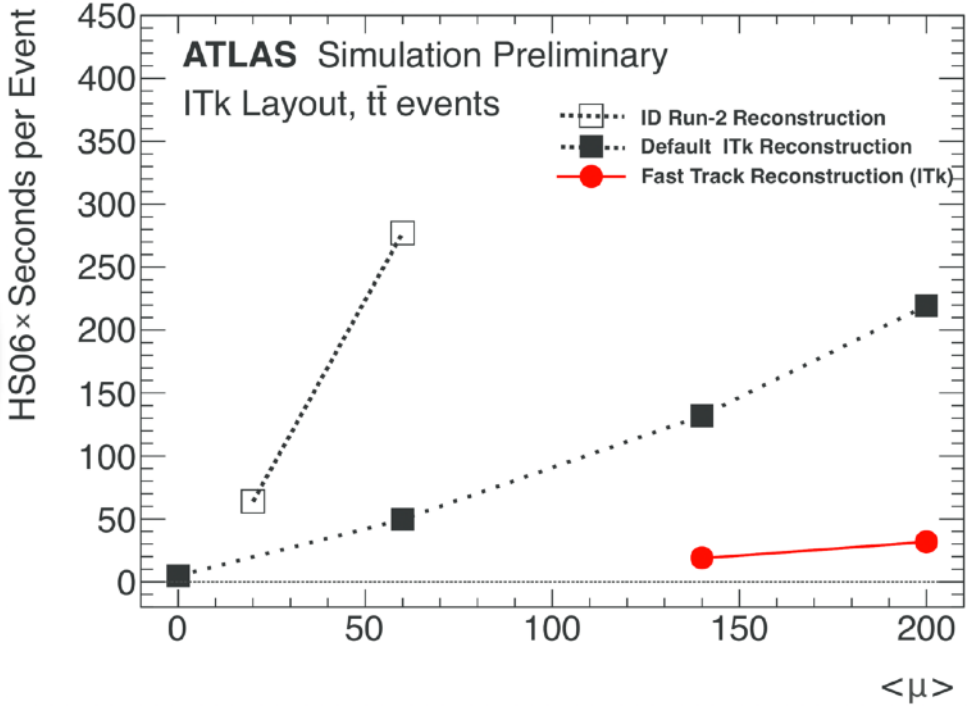
Challenges in the High Luminosity LHC era



Pile-up = 23 arxiv:1201.5469 Pile-up = 230

Challenges in the High Luminosity LHC era

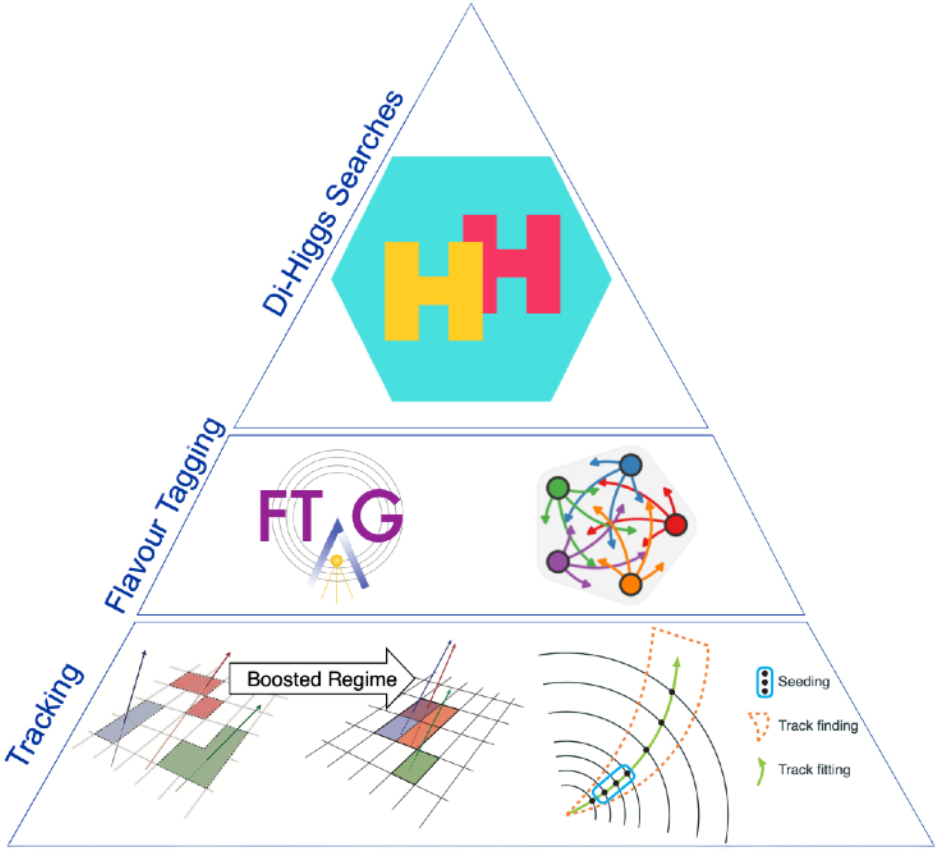




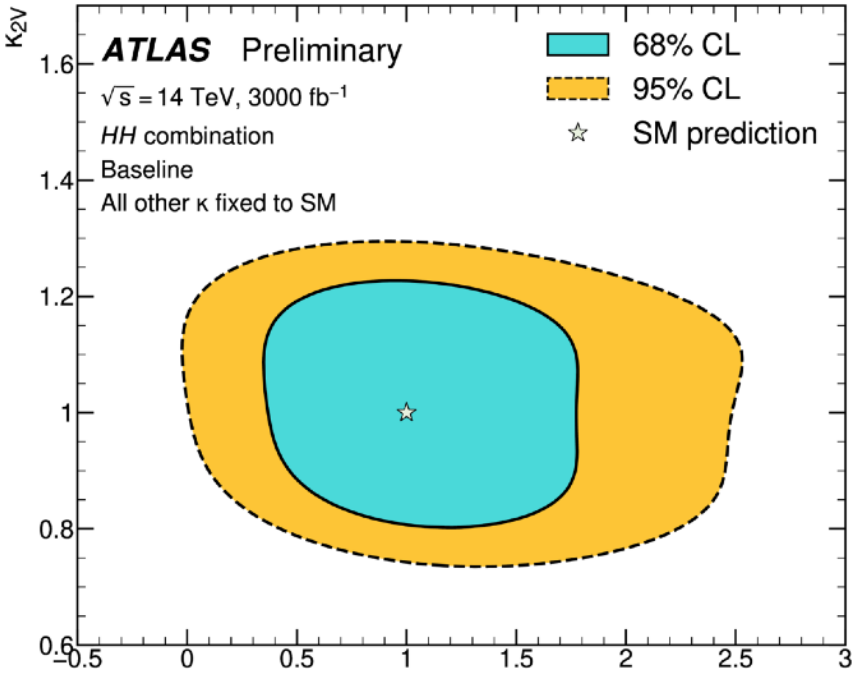
[ATL-PHYS-PUB-2021-012]

[ATL-PHYS-PUB-2019-041]

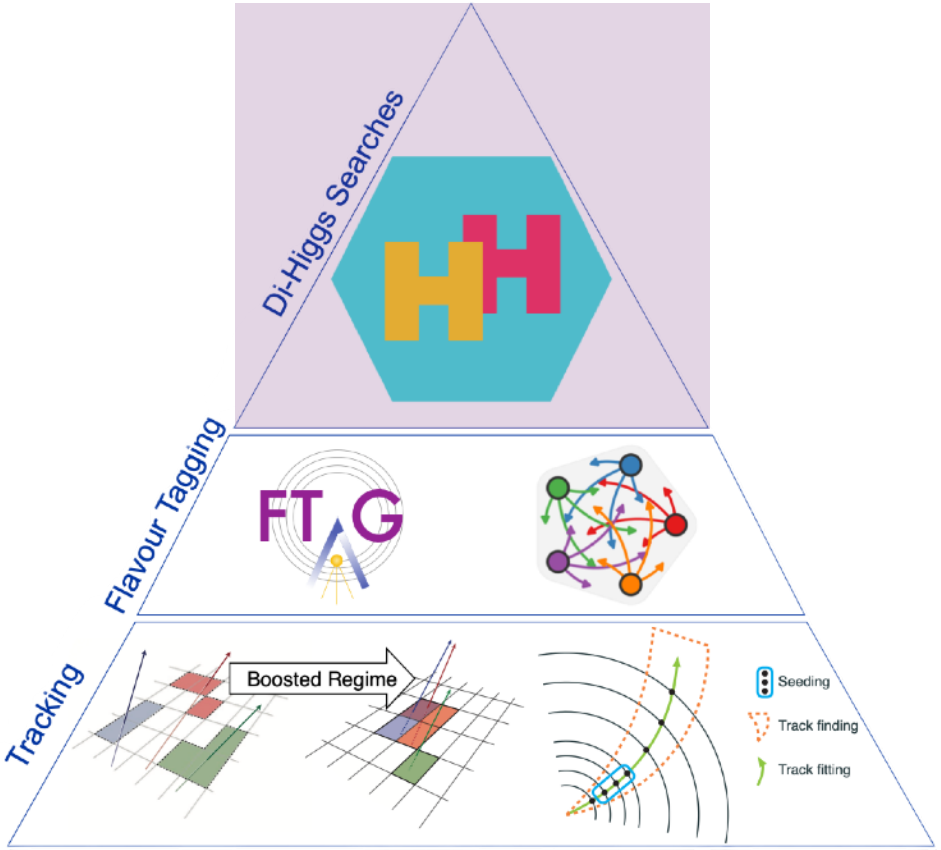
ATLAS *Physics*



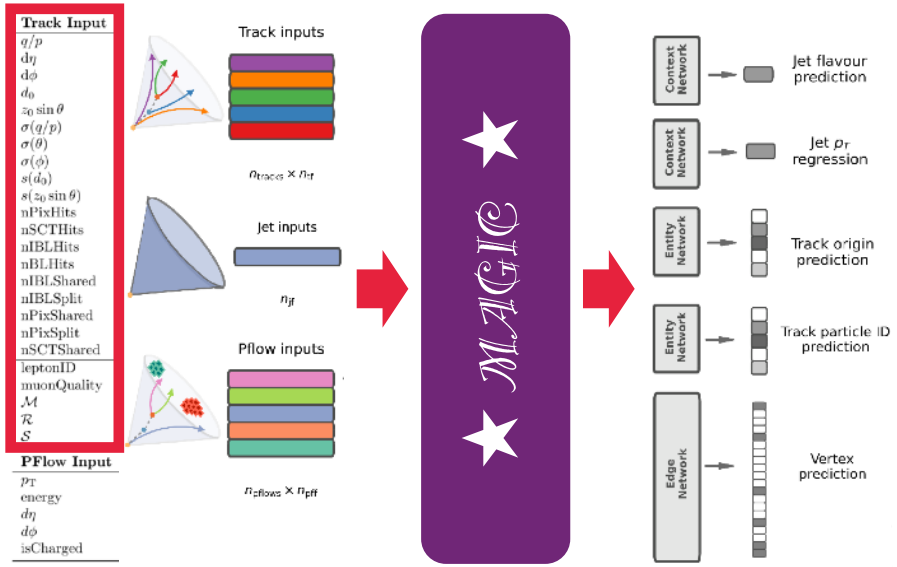
ATLAS *Physics*

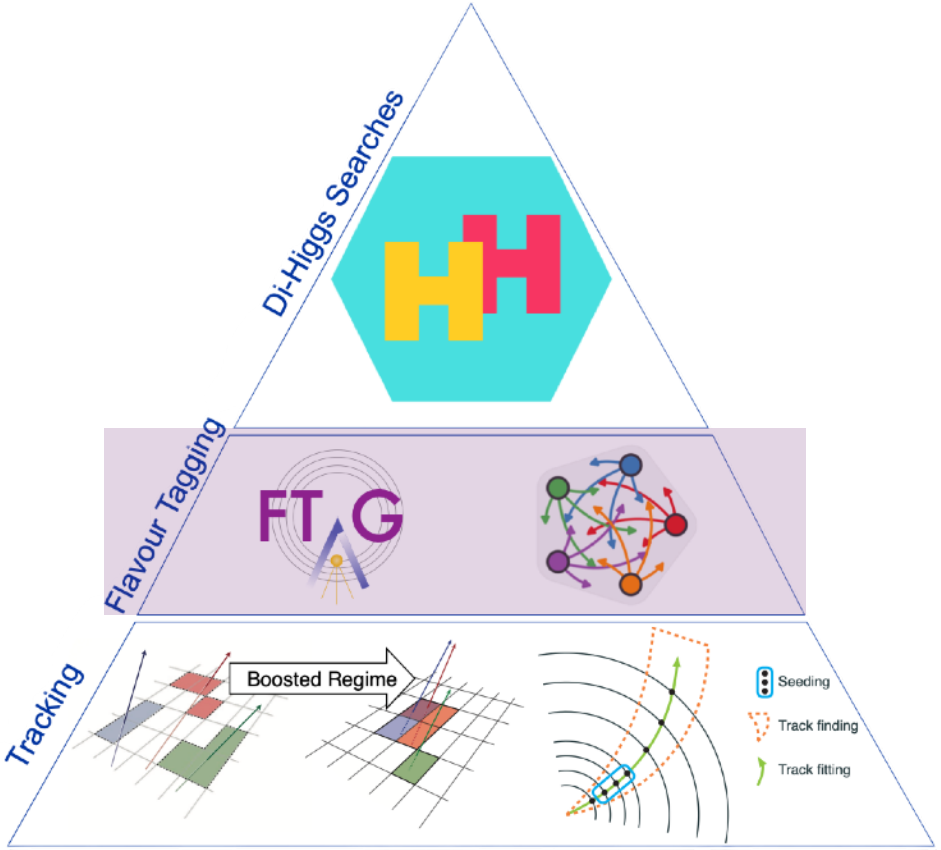


[ATL-PHYS-PUB-2025-006]



ATLAS *Physics*





[ATL-PHYS-PUB-2026-001]

ATLAS *Physics*

Space point formation
Clustering

↓

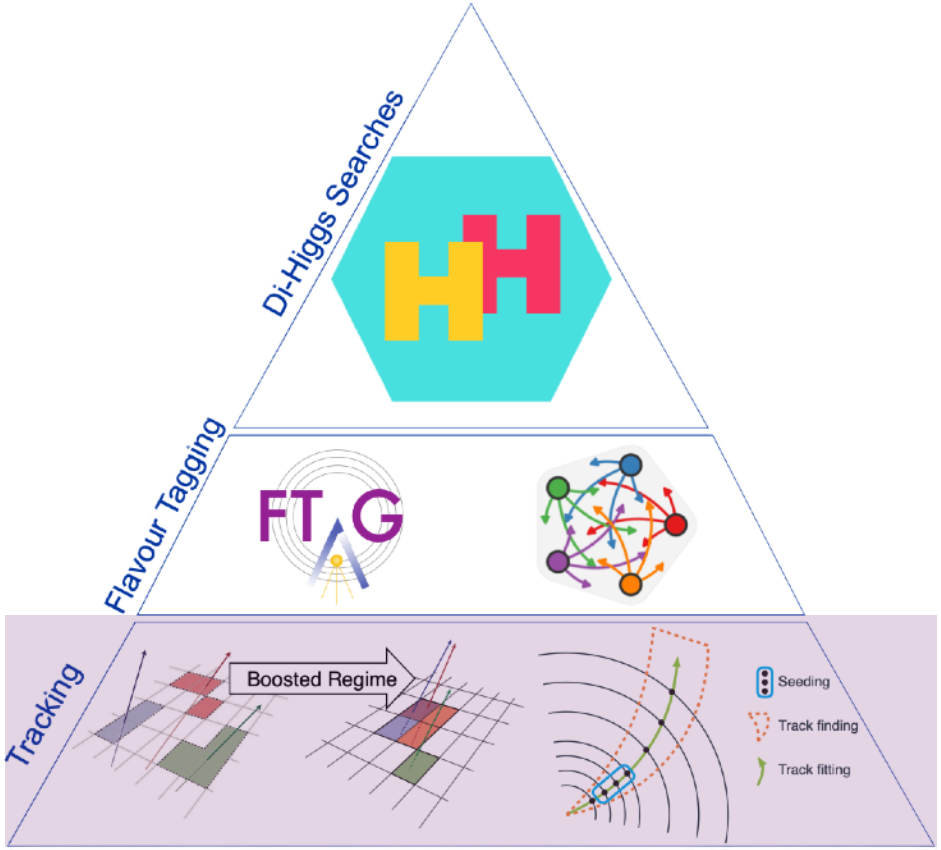
Track Seeding

↓

Track Finding &
Fitting

↓

Ambiguity Solving



ATLAS Tracking

Space point formation
Clustering

↓

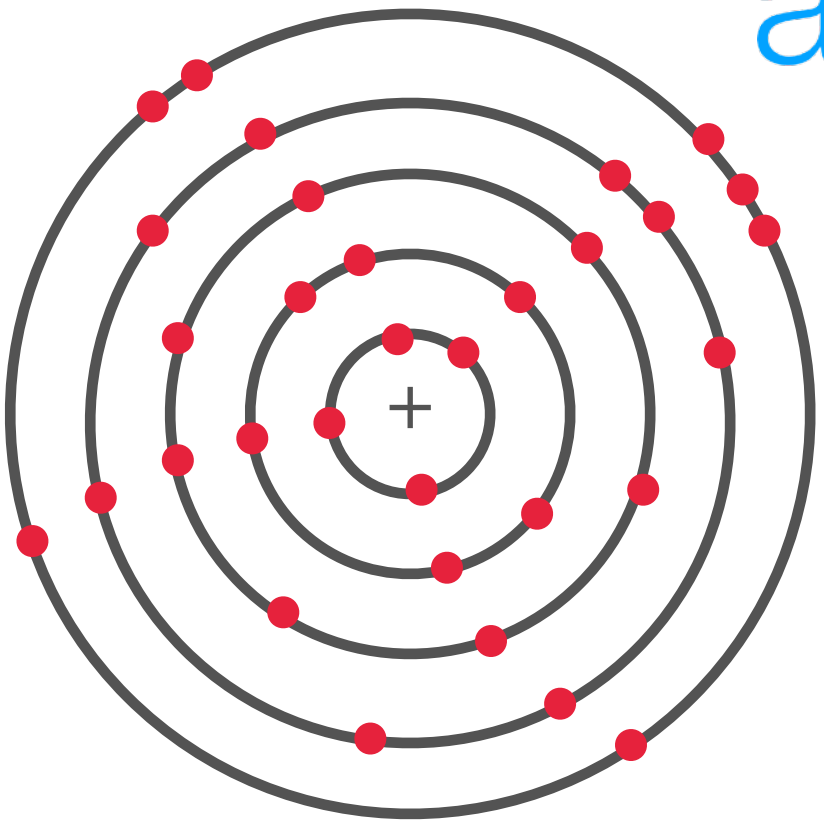
Track Seeding

↓

Track Finding & Fitting

↓

Ambiguity Solving



ATLAS Tracking

Space point formation
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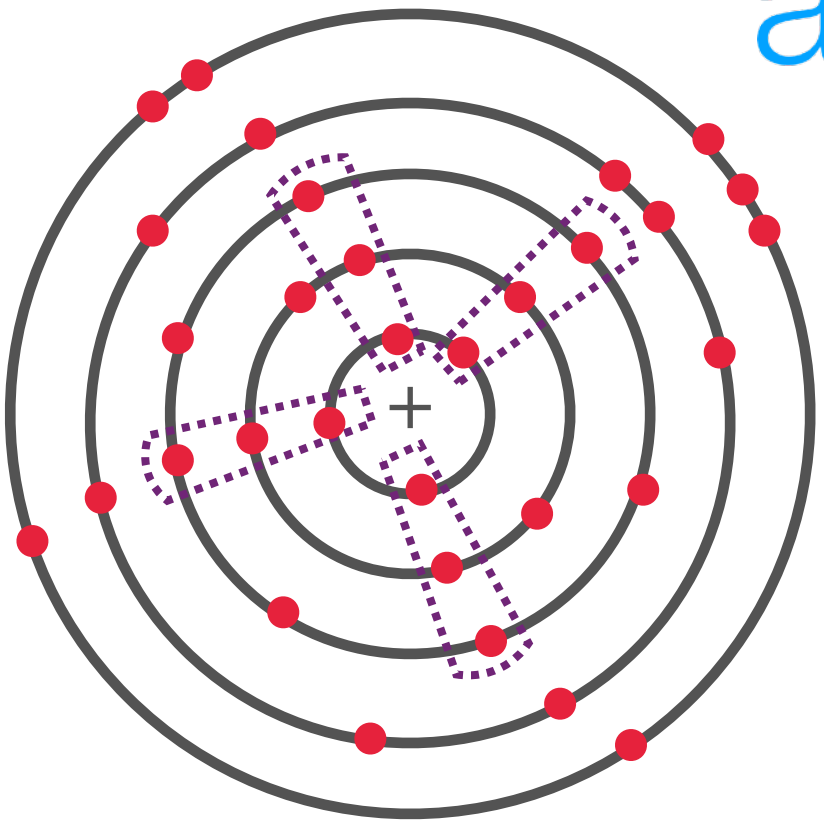

ATLAS Tracking

Space point formation
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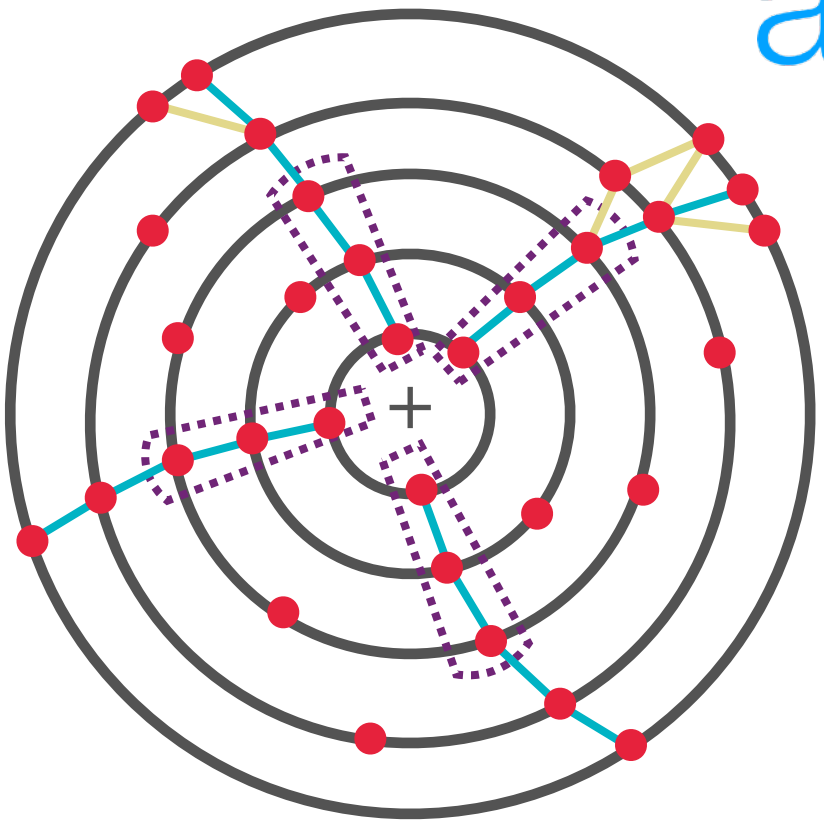
Ambiguity Solving



ATLAS Tracking

Space point formation
Clustering

↓

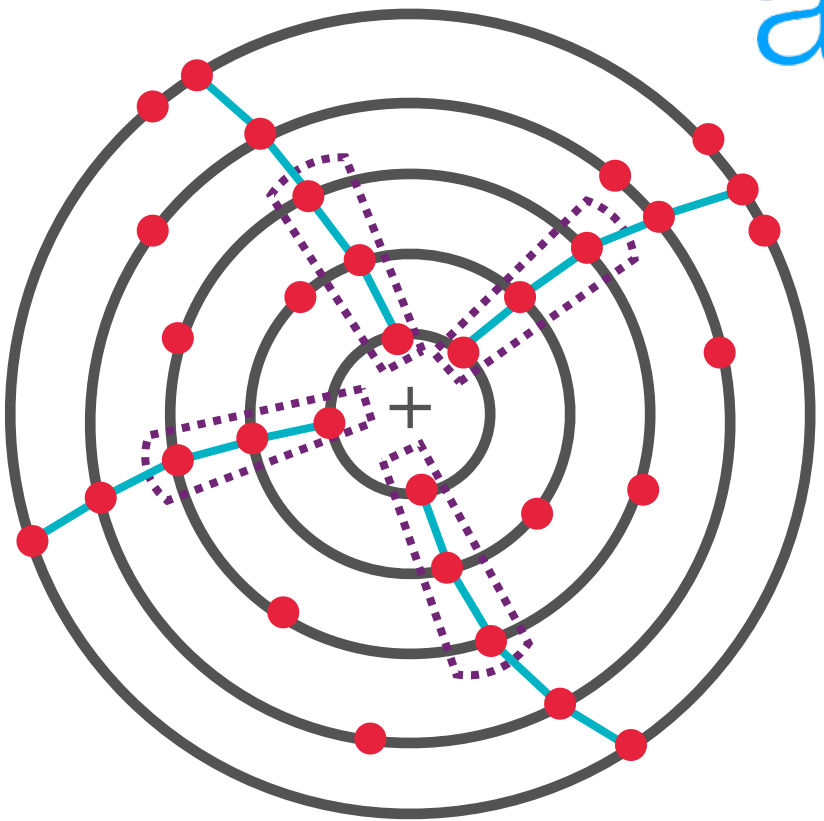
Track Seeding

↓

Track Finding &
Fitting

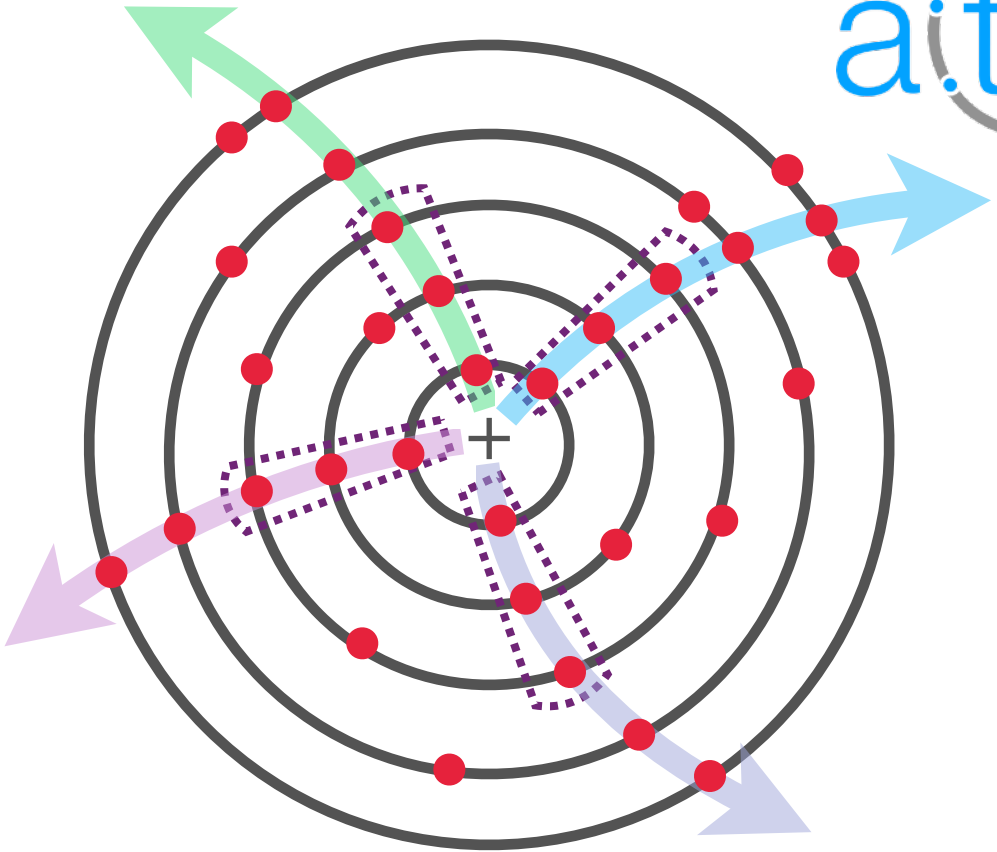
↓

Ambiguity Solving



ATLAS Tracking

- Space point formation
  Clustering
- Track Seeding
- Track Finding &
  Fitting
- **Ambiguity Solving**

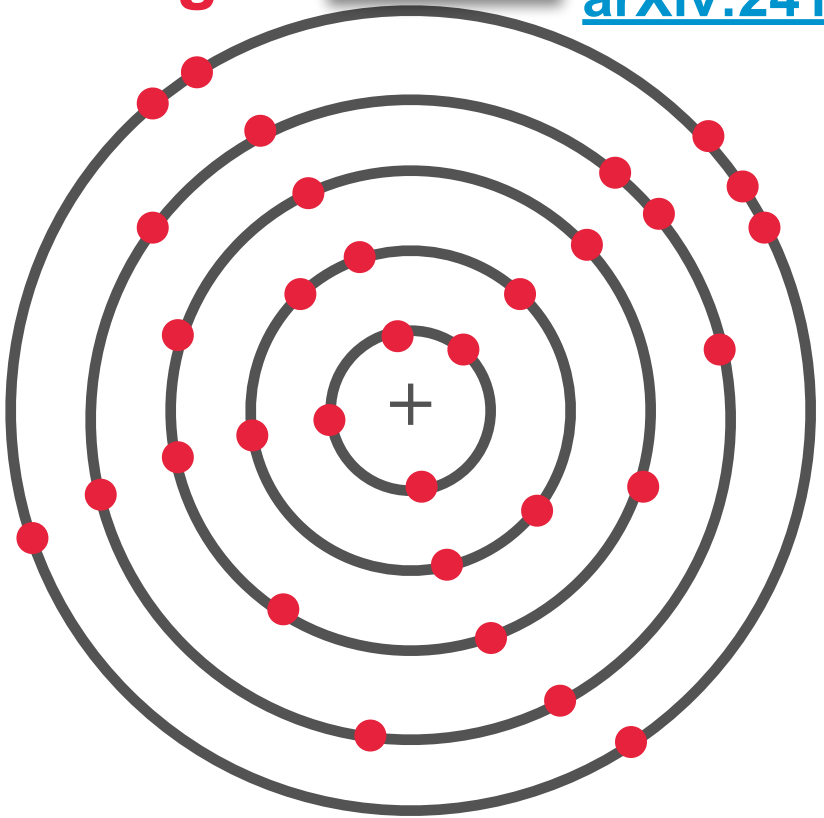


Tracking with machine learning

arXiv:2304.02643
arXiv:2411.07149

Space point formation
Clustering

Inference



Tracking with machine learning

arXiv:2304.02643
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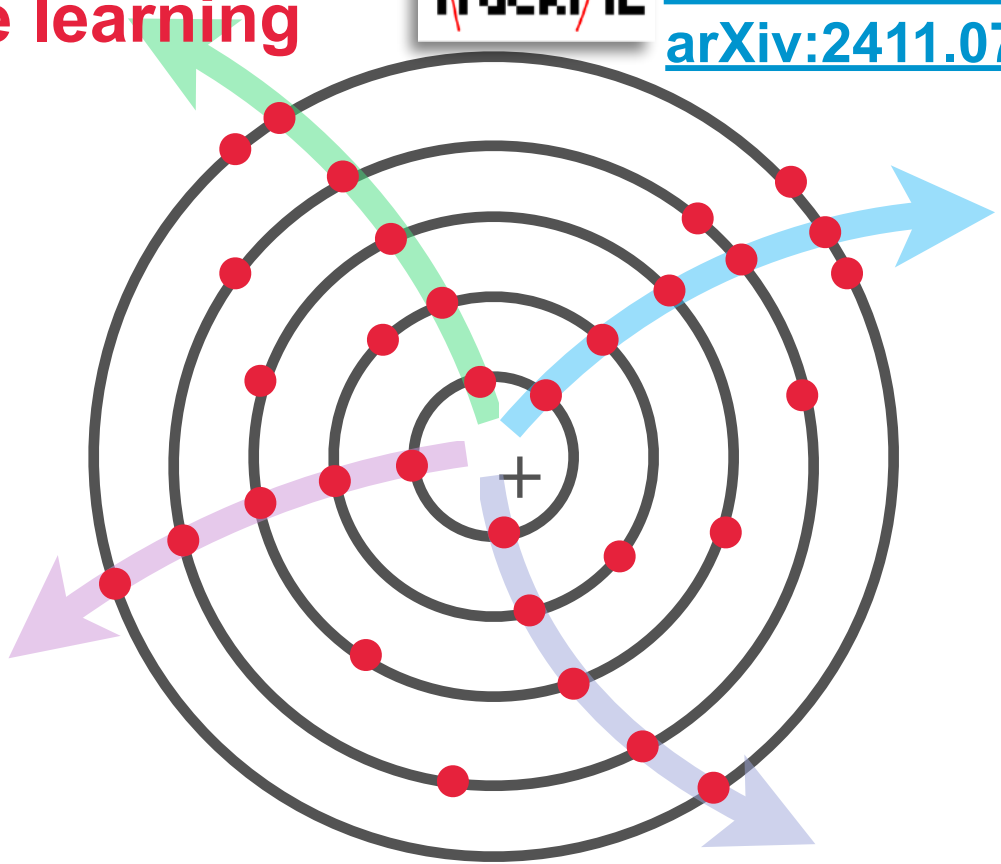
Space point formation
Clustering

Inference



Tracking with machine learning

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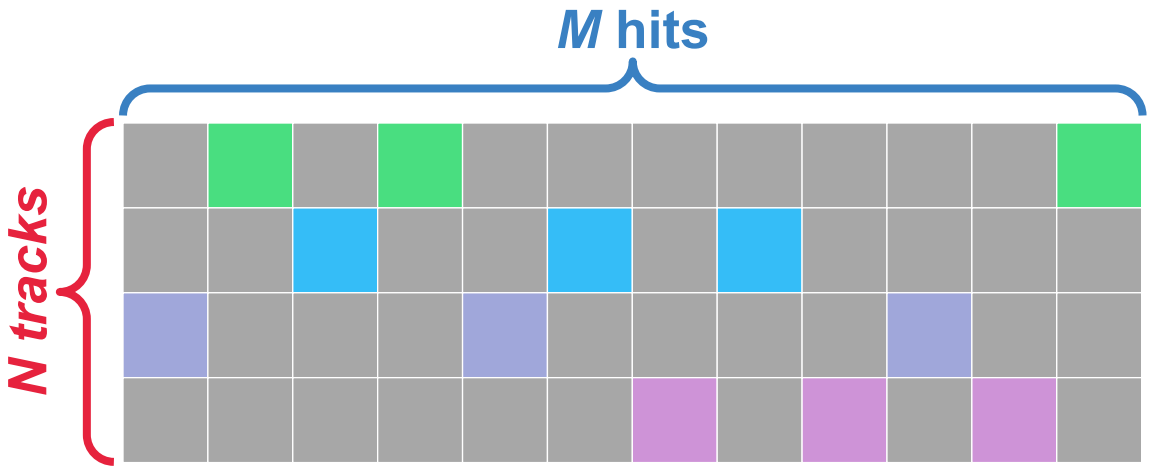
Space point formation
Clustering

Inference



Tracking with machine learning

arXiv:2304.02643
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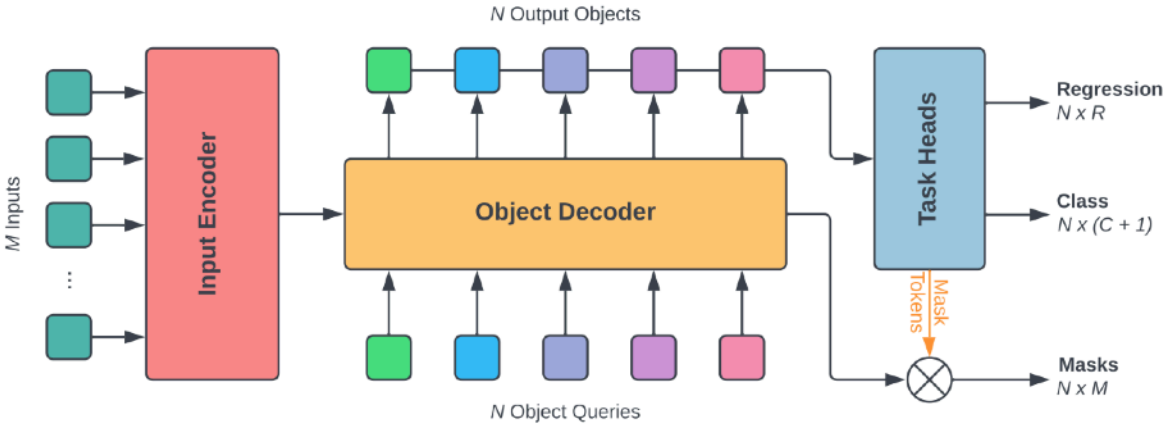

Tracking with machine learning

arXiv:2304.02643
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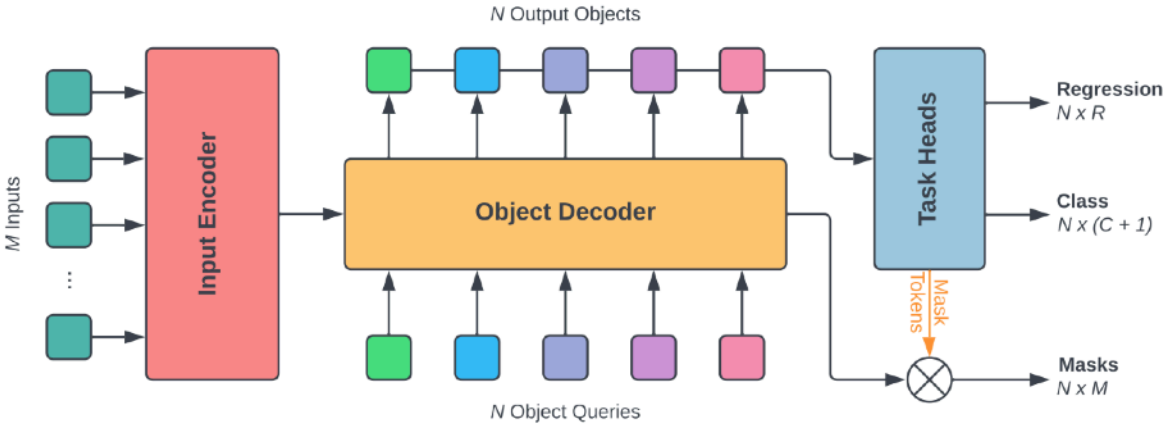
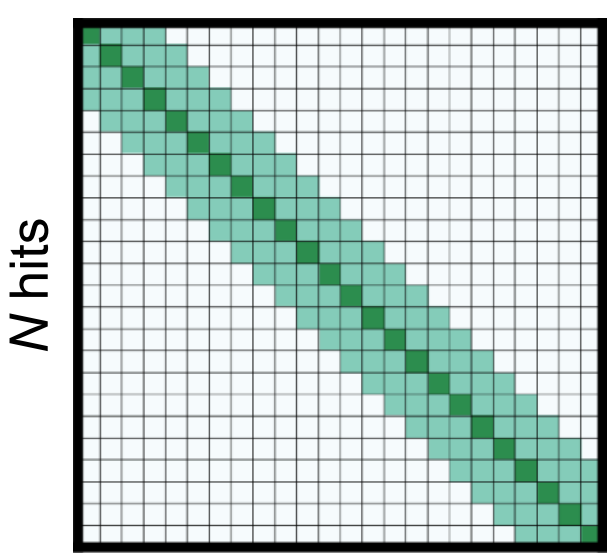
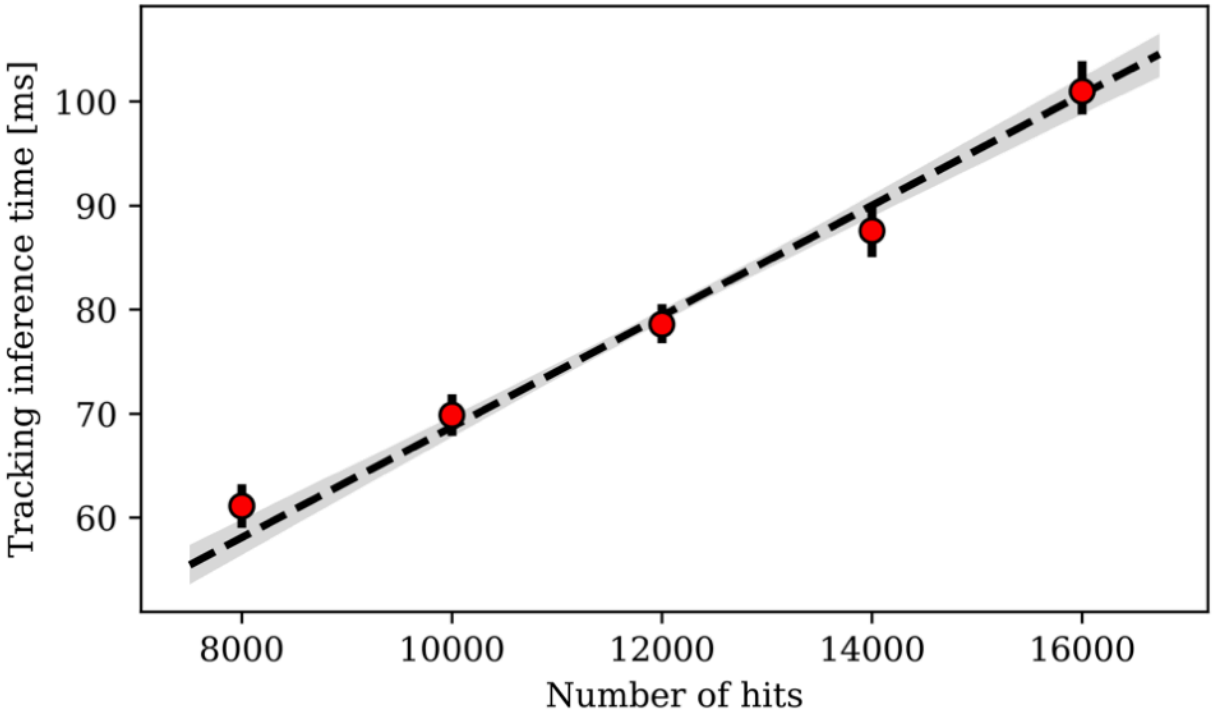




Sliding window attention

Tracking with machine learning

arXiv:2304.02643
arXiv:2411.07149



Tracking with machine learning

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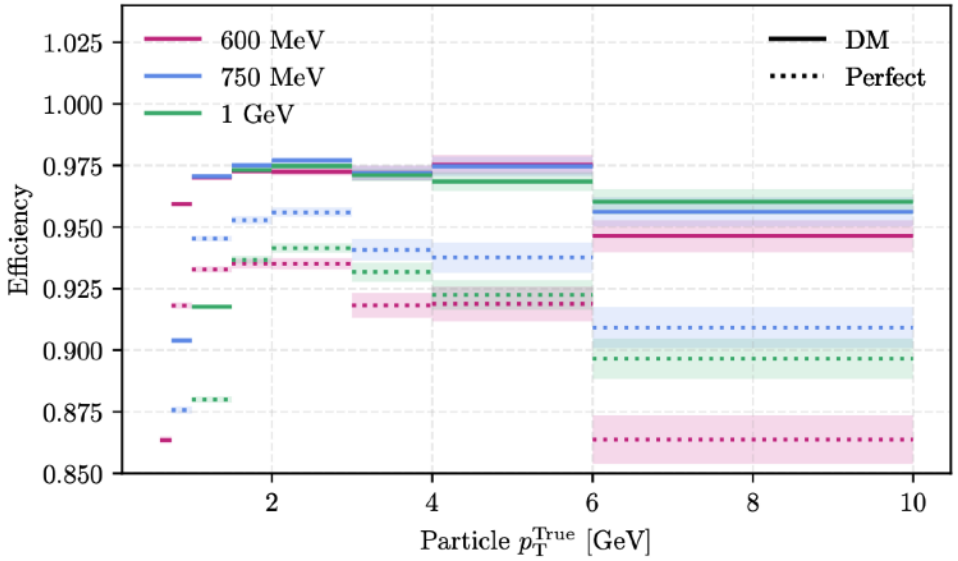
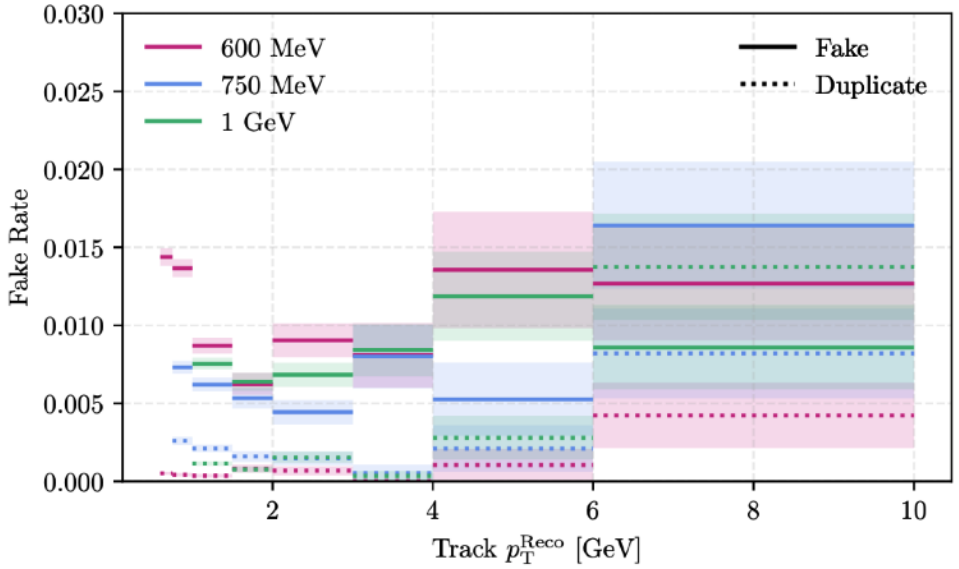
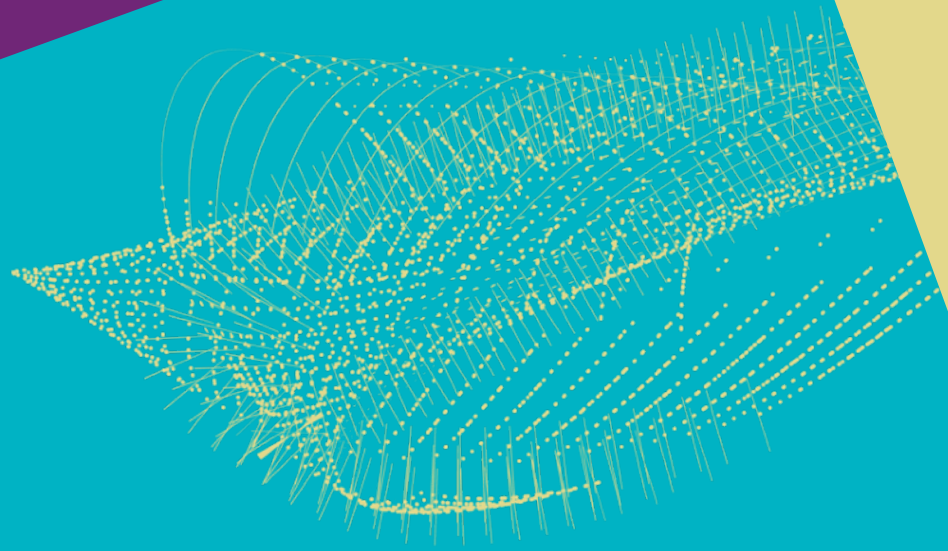




Summary

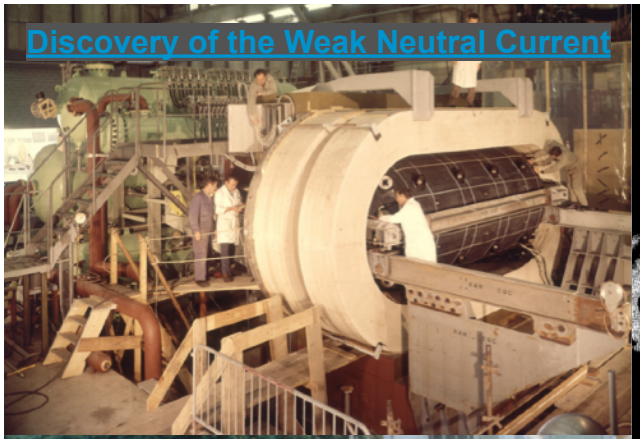
- Tracks → objects → analysis → discovery / measurement
- HL-LHC era → more data → computationally challenging
- Tracking ~ iterative (mostly analytical) process of spatial pattern recognition
  - Opportunity for SOTA image segmentation techniques (scalable)
- [Not covered today] Muon tracking (geometry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

Nikhef



Thank you!

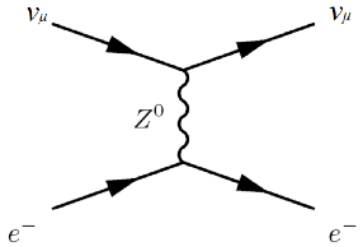
Bubble chamber


Discovery of the Weak Neutral Current


Gargamelle, Léon Van Hove sq., CERN

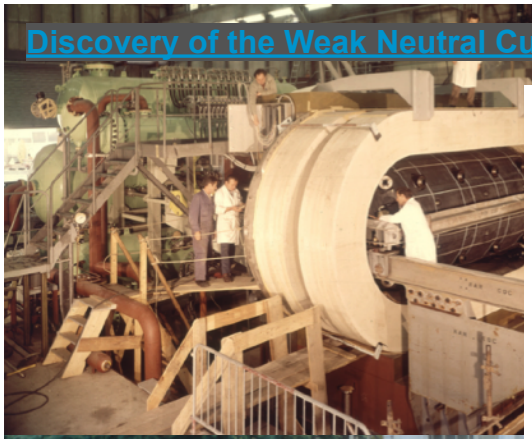
Search for elastic ν_μ - e scattering


Scanner, Madeleine Znoy (BEBC 1976)

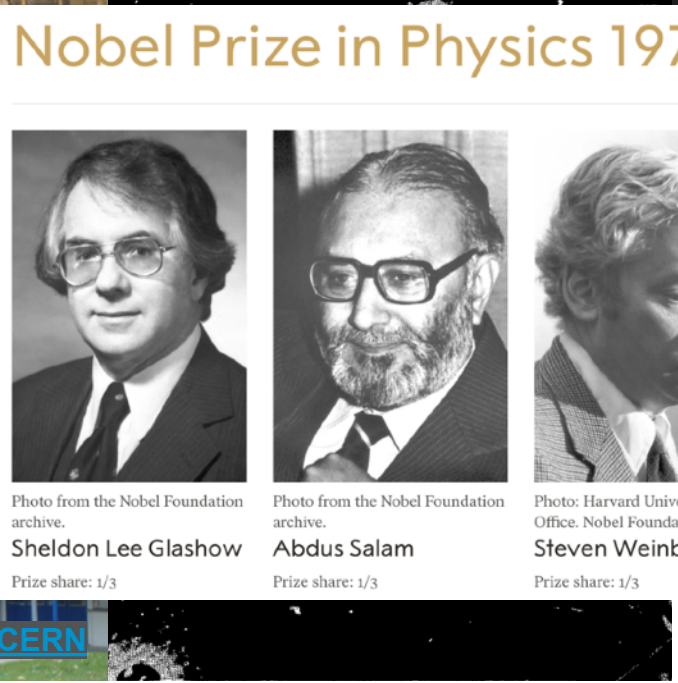


Bubble chamber

Discovery of the Weak Neutral Current

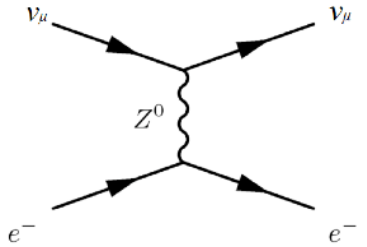


Search for elastic ν_μ - e scattering



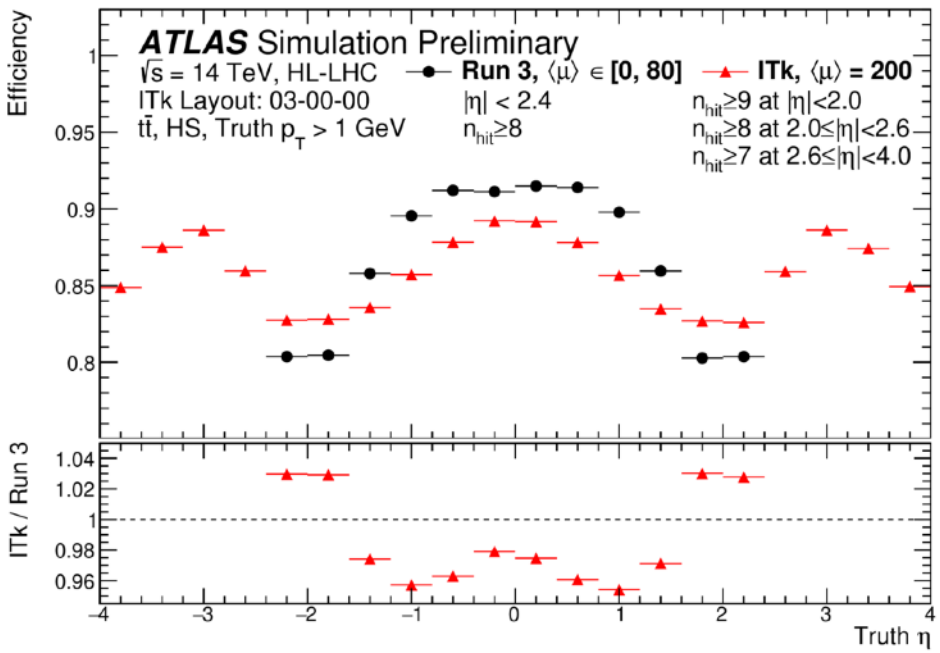
er, Madeleine Znoy (BEBC 1976)

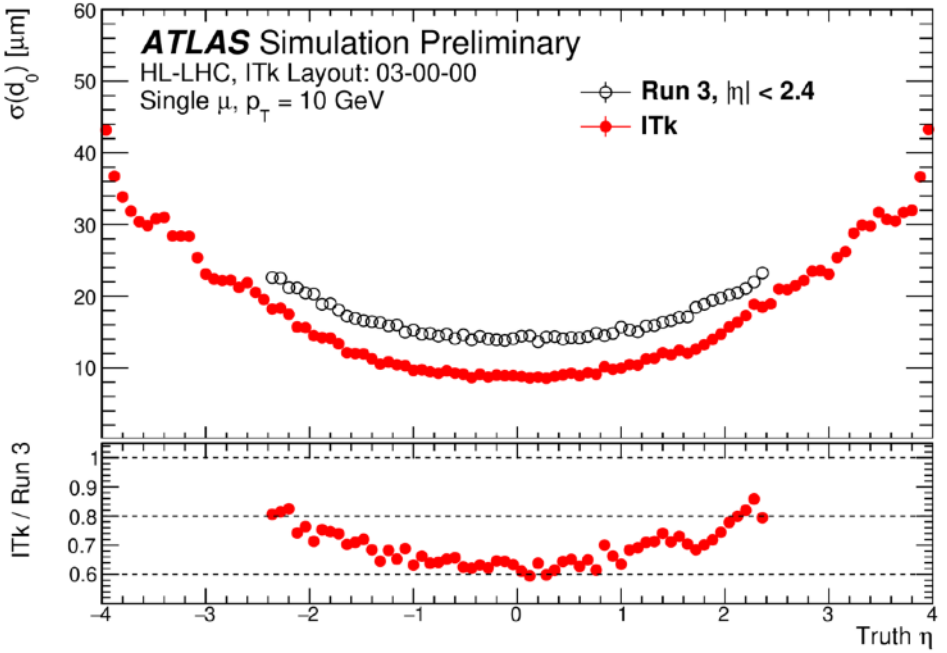
Gargamelle, Léon Van Hove sq., CERN



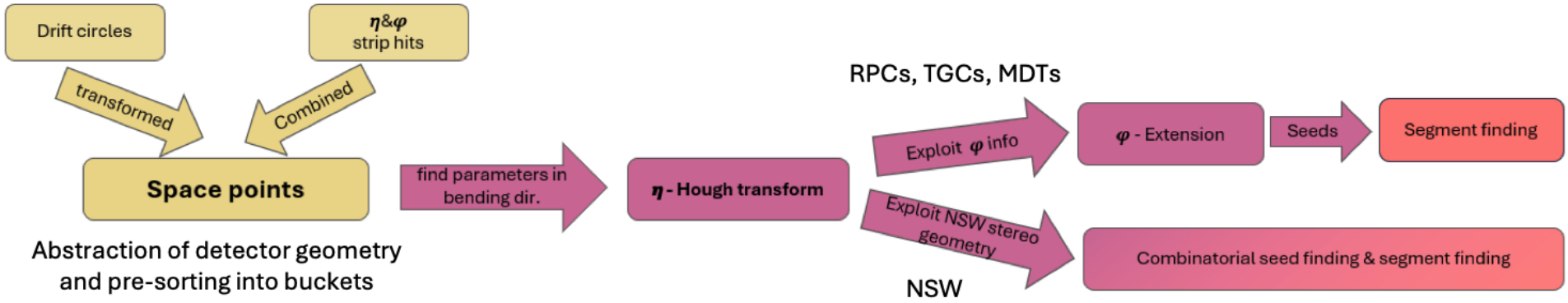
Expected tracking performance of ITk upgrade

IDTR-2023-05



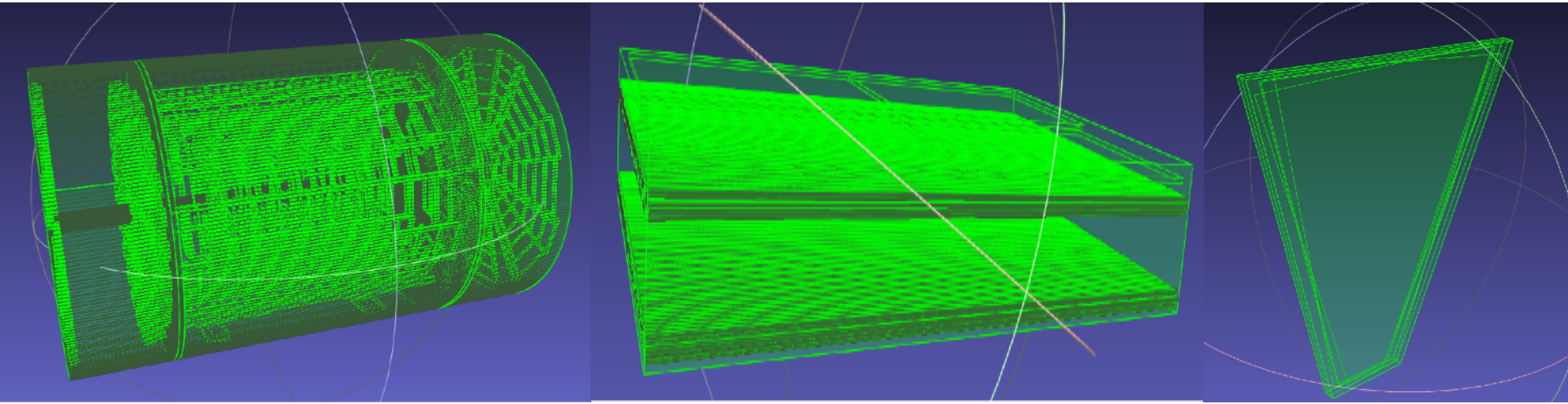


ACTS integration for muon tracking



[ID tracking WS: Phase II Muon tracking]

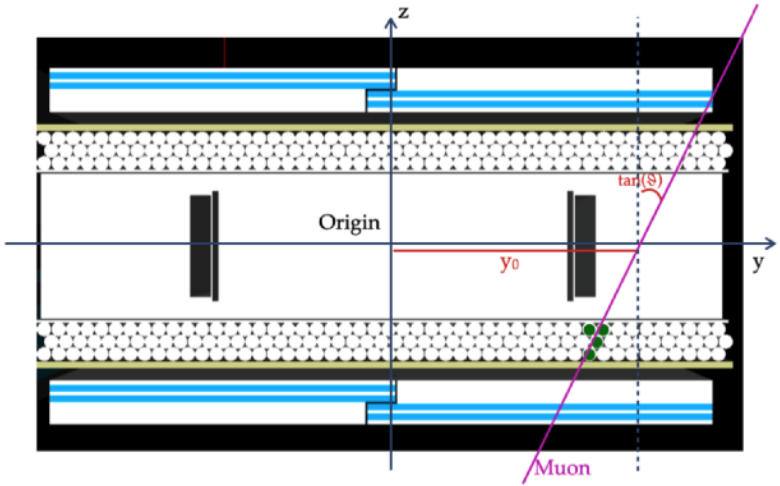
ACTS integration for muon tracking

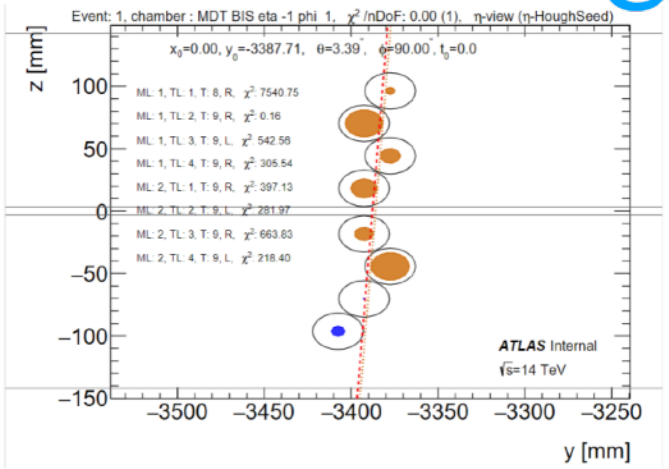


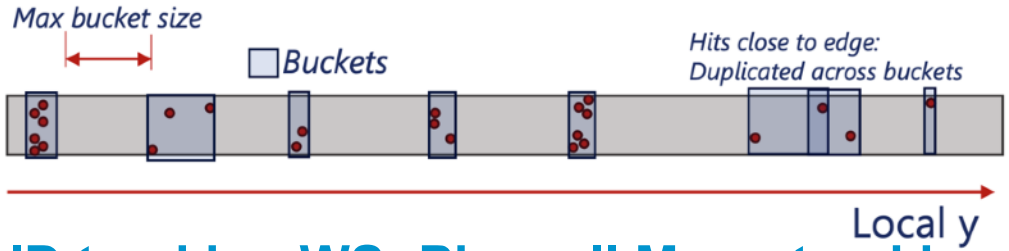
[Muon week, Feb. 2026]

[ID tracking WS: Phase II Muon tracking]

ACTS integration for muon tracking

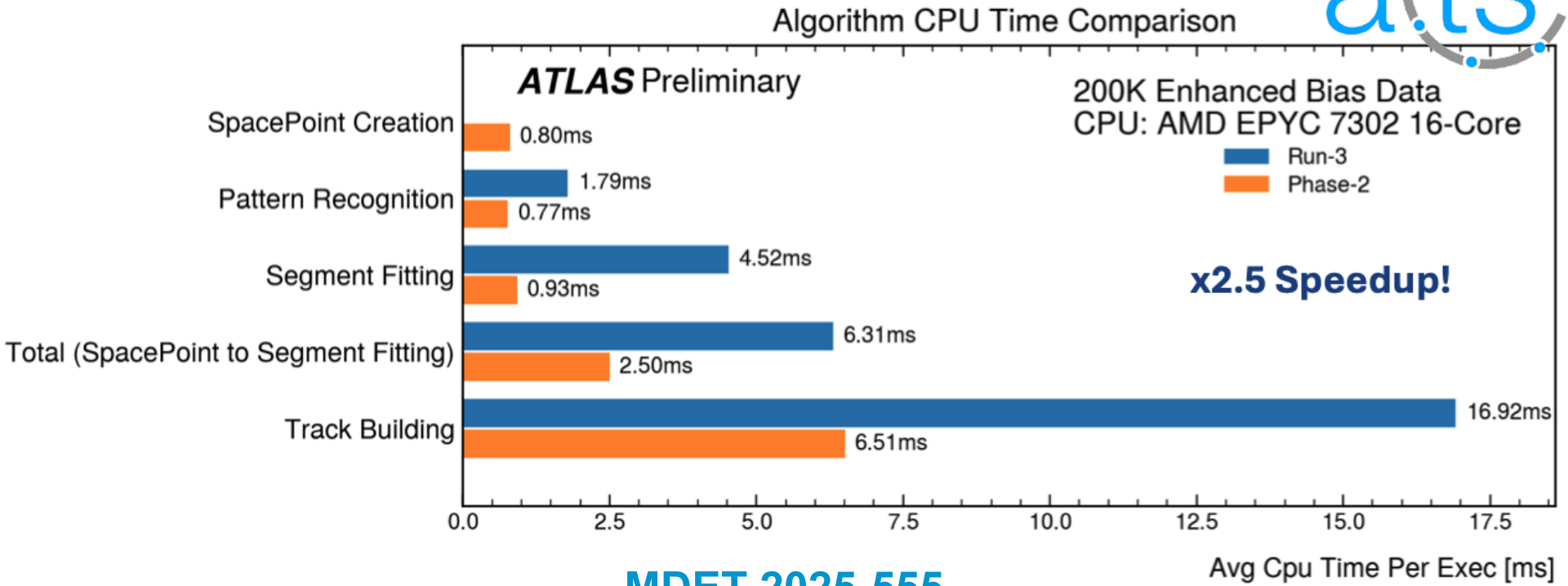






[ID tracking WS: Phase II Muon tracking]

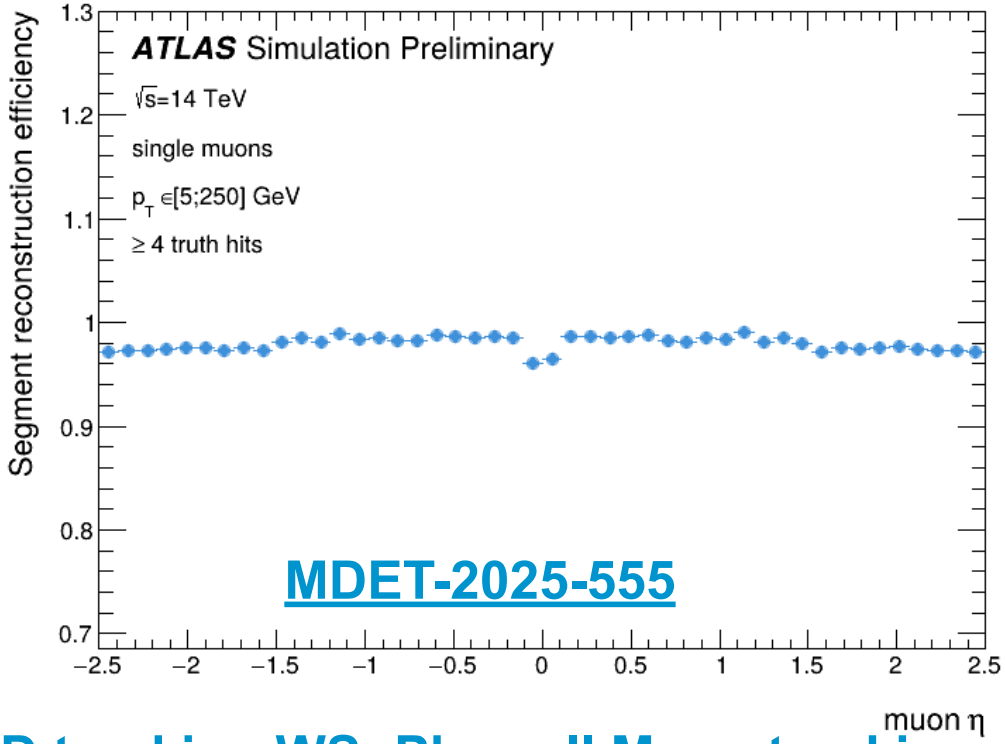
ACTS integration for muon tracking



[MDET-2025-555]

[ID tracking WS: Phase II Muon tracking]

ACTS integration for muon tracking



MDET-2025-555

ID tracking WS: Phase II Muon tracking