Track reconstruction with ACTS in modern high-energy physics experiments

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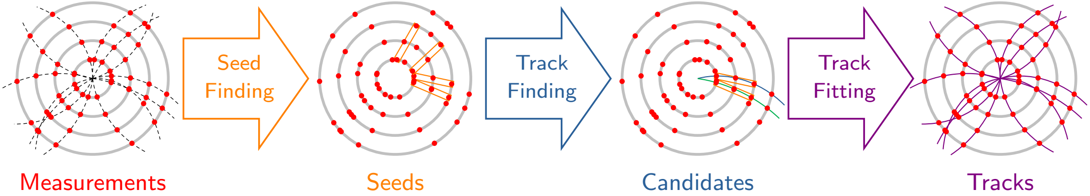
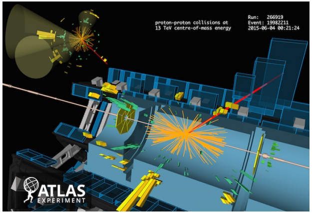
22nd of September 2026

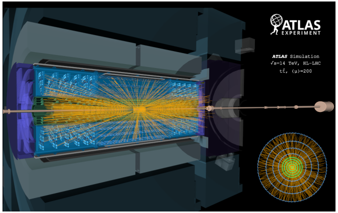
From Measurements to Tracks

- Which hits belong together?
- Which candidates describe the same particle?
- How many possibilities can we afford to test?





[1]



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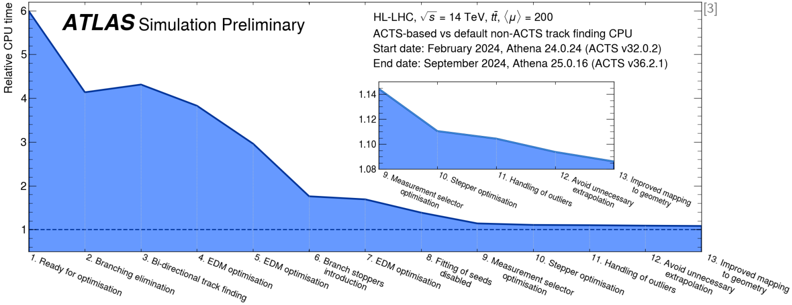


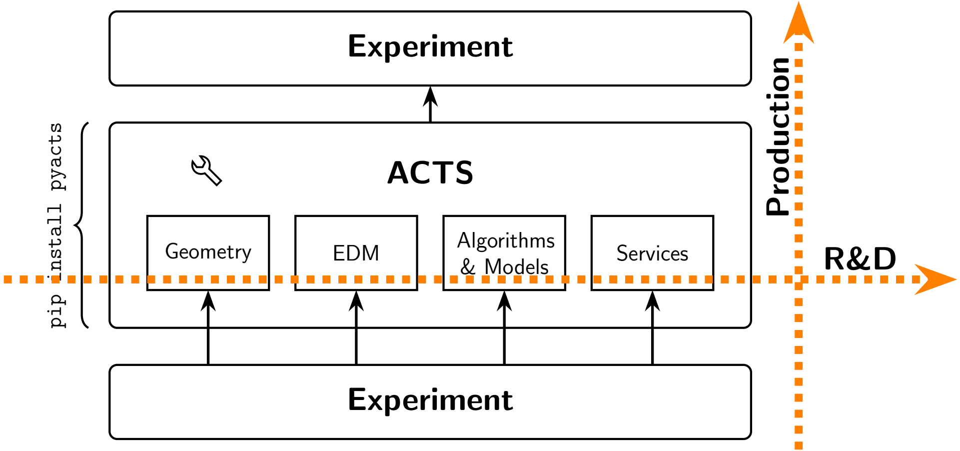
[3]

- Denser collisions
- Larger data volumes
- More combinations
- Natively single-threaded
- New tracker
- Redesign while ATLAS keeps running

2016: ACTS starts as a standalone tracking toolkit.

[1] ATLAS Collaboration
[2] ATLAS Collaboration
[3] ATL-PHYS-PUB-2024-017

ACTS – A Common Tracking Software

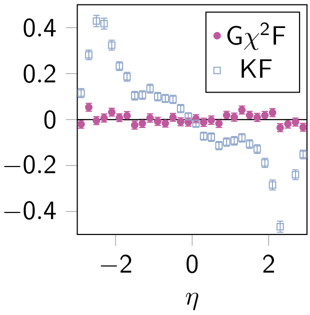


https://github.com/acts-project/acts/

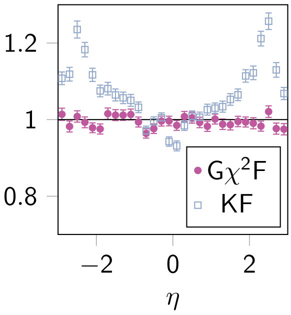
Austrian contribution: Global χ^2 Fitter in ACTS

- Open Data Detector (ODD)
- 10^5 events, $|\eta| \leq 3$, $\phi \in [0, 2\pi)$
- $pT \in [1, 100]$ GeV/c, randomised charge (to reduce biases)

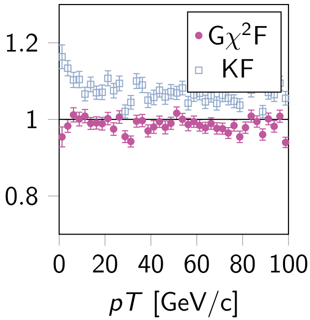
Pull mean: θ over η



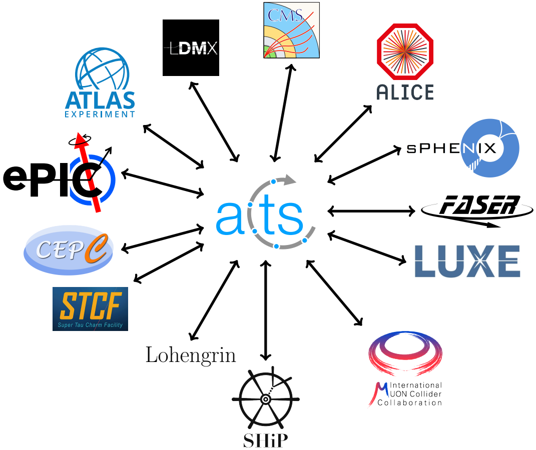
Pull width: θ over η



Pull width: θ over pT

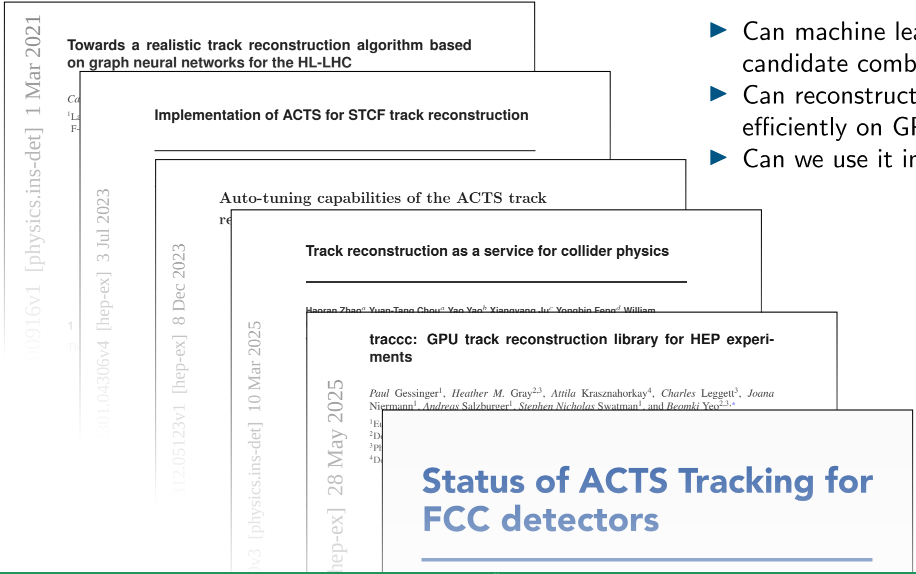


ACTS Across Detector Contexts – What Sharing Changes



- Fix issues once, benefit across experiments
- Different detectors expose hidden assumptions
- Share development and maintenance

An R&D platform for future tracking



Towards a realistic track reconstruction algorithm based on graph neural networks for the HL-LHC

Implementation of ACTS for STCF track reconstruction

Auto-tuning capabilities of the ACTS track

Track reconstruction as a service for collider physics

traccc: GPU track reconstruction library for HEP experiments

Paul Gessinger[1], *Heather M.* Gray[2,3], *Attila* Krasznahorkay[4], *Charles* Leggett[3], *Joana* Niermann[1], *Andreas* Salzburger[1], *Stephen Nicholas* Swatman[1], and *Beomki* Yeo[2,3,*]

Status of ACTS Tracking for FCC detectors

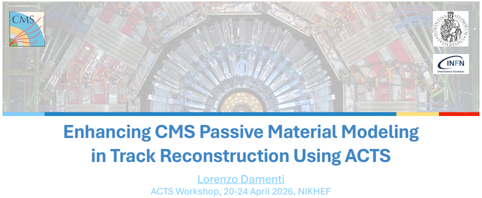
- Can machine learning reduce candidate combinations?
- Can reconstruction run efficiently on GPUs?
- Can we use it in the future?

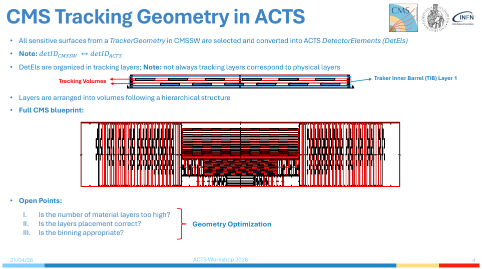
Take-Home Message

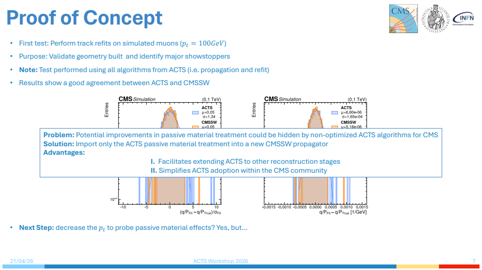
- ACTS is ATLAS run-4 standard and deployed
- International community – Austria contributes too
- R&D: machine learning, GPU tracking, future detectors, . . .

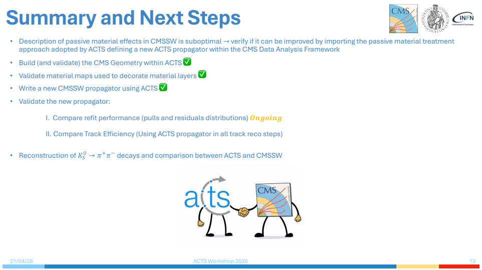
Extra Slides

CMS Tracking with ACTS



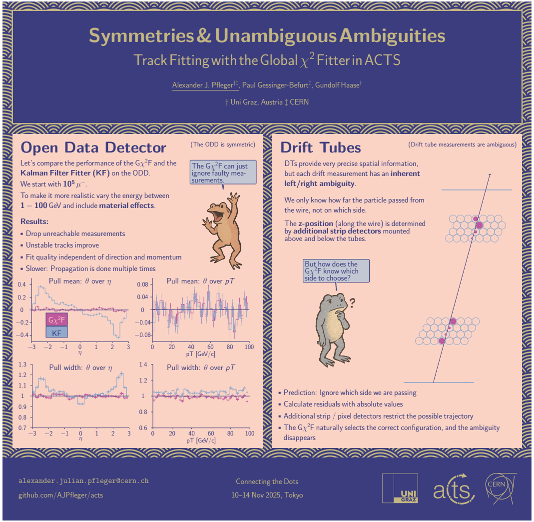






https://indico.cern.ch/event/1577742/contributions/7005748/

- Full algorithm
- Already explored by experiments
- Austrian Doctoral Student Programme
- PhD at Uni Graz at CERN



https://indico.cern.ch/event/1499357/contributions/6628643/