



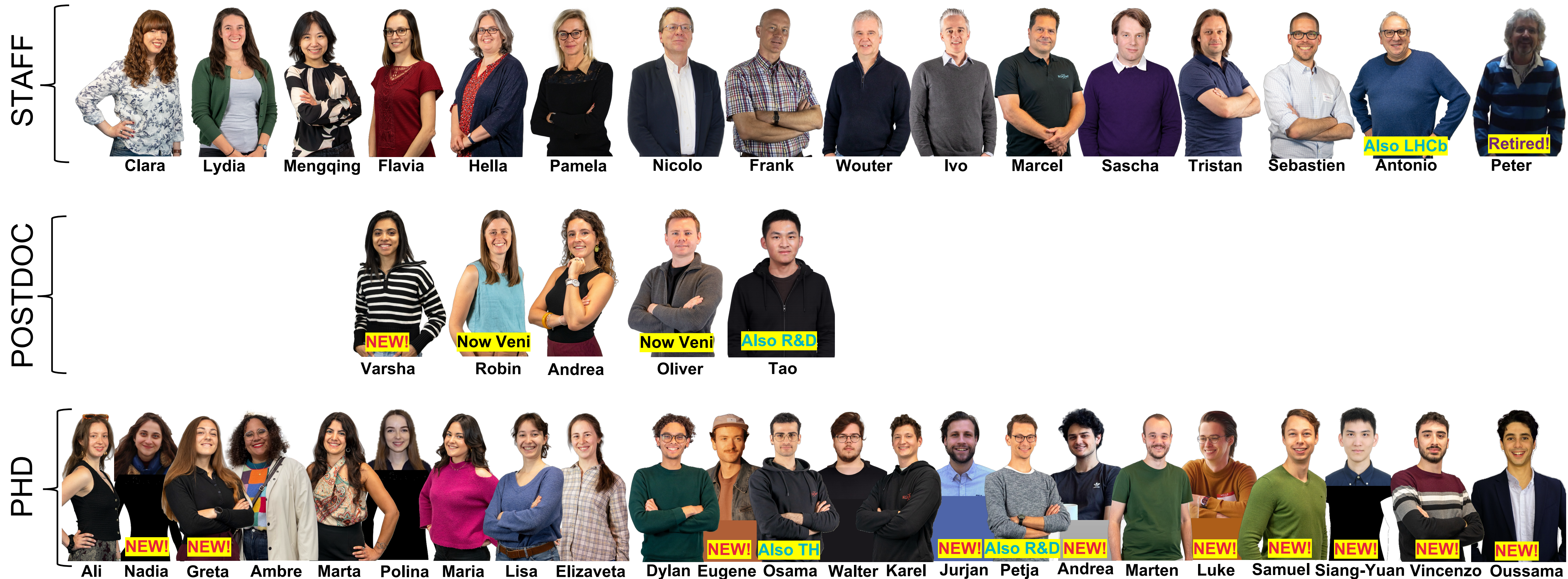
ATLAS GROUP OVERVIEW

NIKHEF JAMBOREE 2026

Flavia de Almeida Dias



NIKHEF ATLAS GROUP



+ 10 master students and 7 bachelor students

ROLES IN THE ATLAS COLLABORATION 2025-2026

Since last Jamboree

Physics & data processing

- **Statistics** Committee Chair: Lydia Brenner
- **Derivation** Coordinator: Flavia de Almeida Dias
- **Derivation** Production Manager: Flavia de Almeida Dias



Detector & Reconstruction Software

- **HGTD** Institutional Board Chair: Frank Filthaut
- **HGTD** Electronics Coordinator: Frank Filthaut
- **ITK** Strip Global Mechanics Coordinator: Marcel Vreeswijk
- **DAQ** Readout Firmware Coordinator: Frans Schreuder
- **Muon** Software Coordinator: Peter Kluit



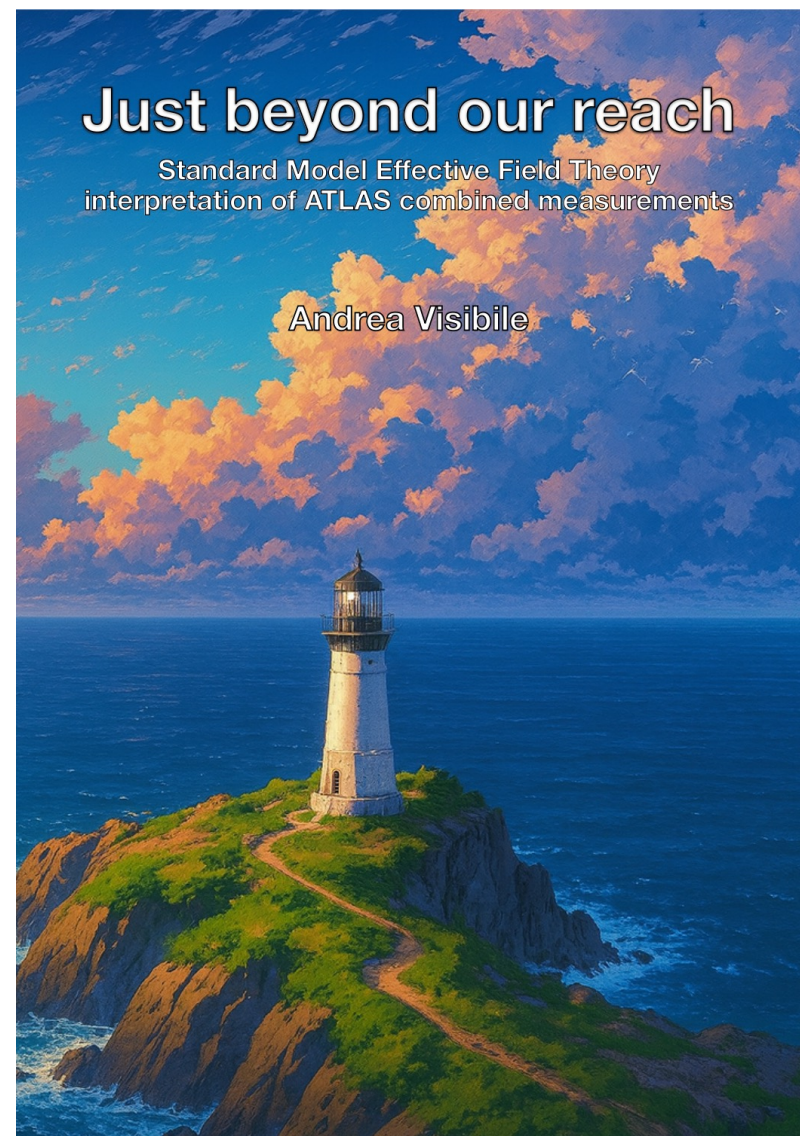
Collaboration & Organization

- **CB** Chair Advisory Group Member: Frank Filthaut
- **Early Career** Scientist Board: Robin Hayes
- **Equity, Diversity and Inclusion** Coordinator: Flavia de Almeida Dias

PHD THESES COMPLETED 2025-2026

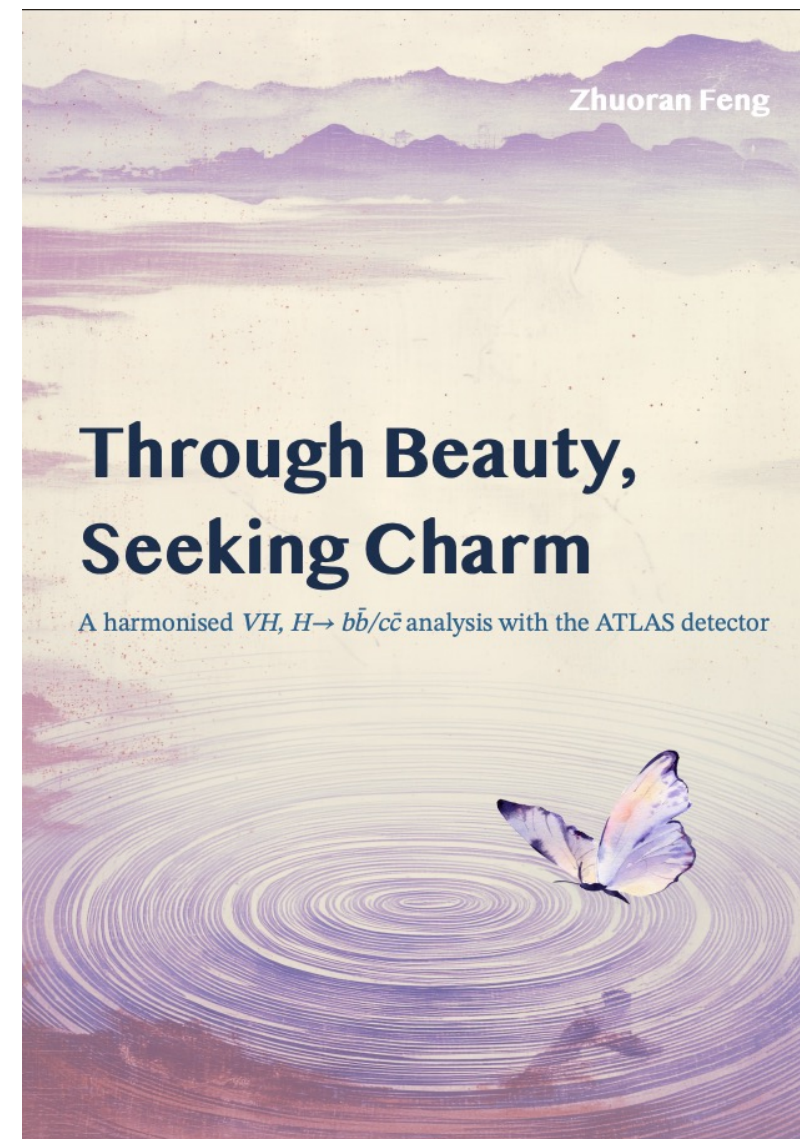
Since last Jamboree

Andrea Visibile



20 Feb 2026

Zhuoran Feng



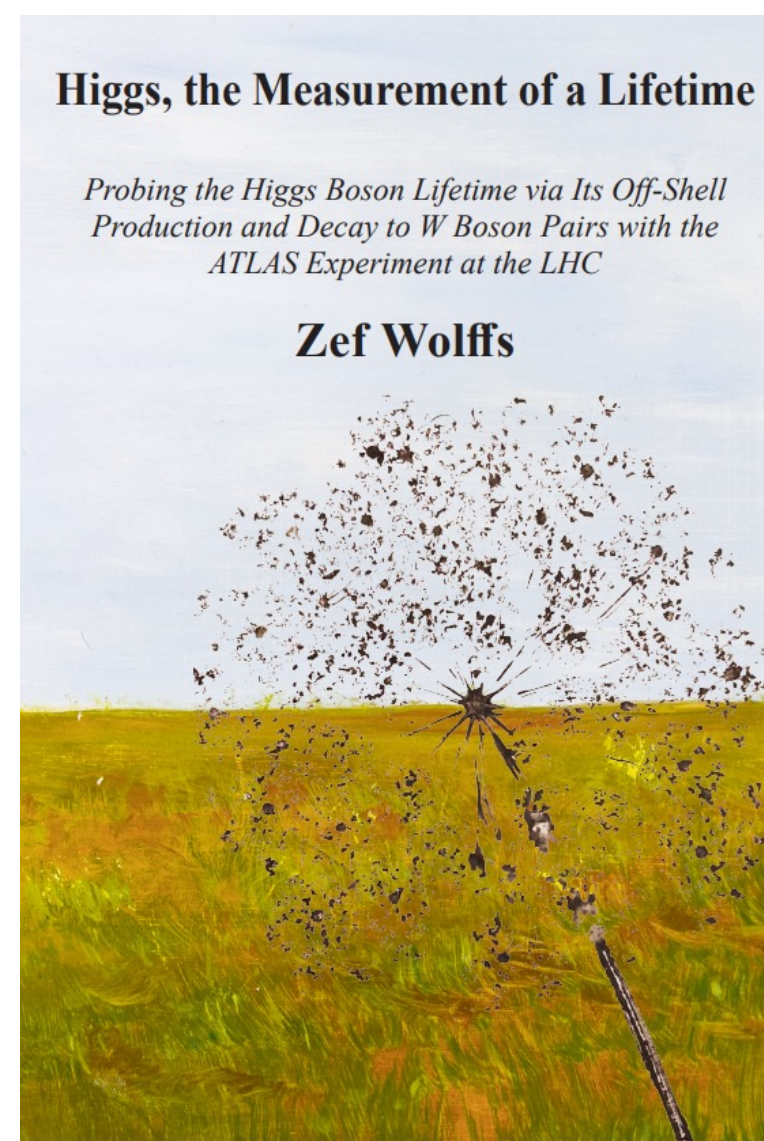
24 Nov 2025

Bryan Kortman



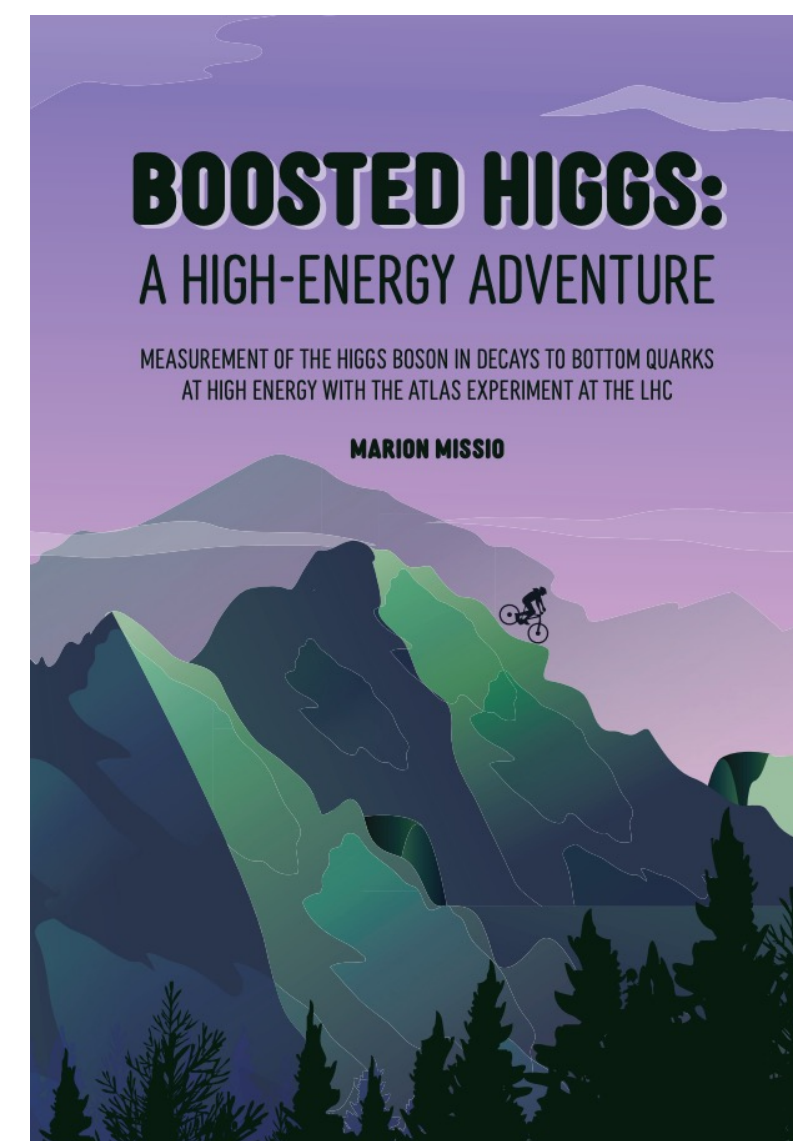
3 Oct 2025

Zef Wolffs



11 Feb 2026

Marion Missio



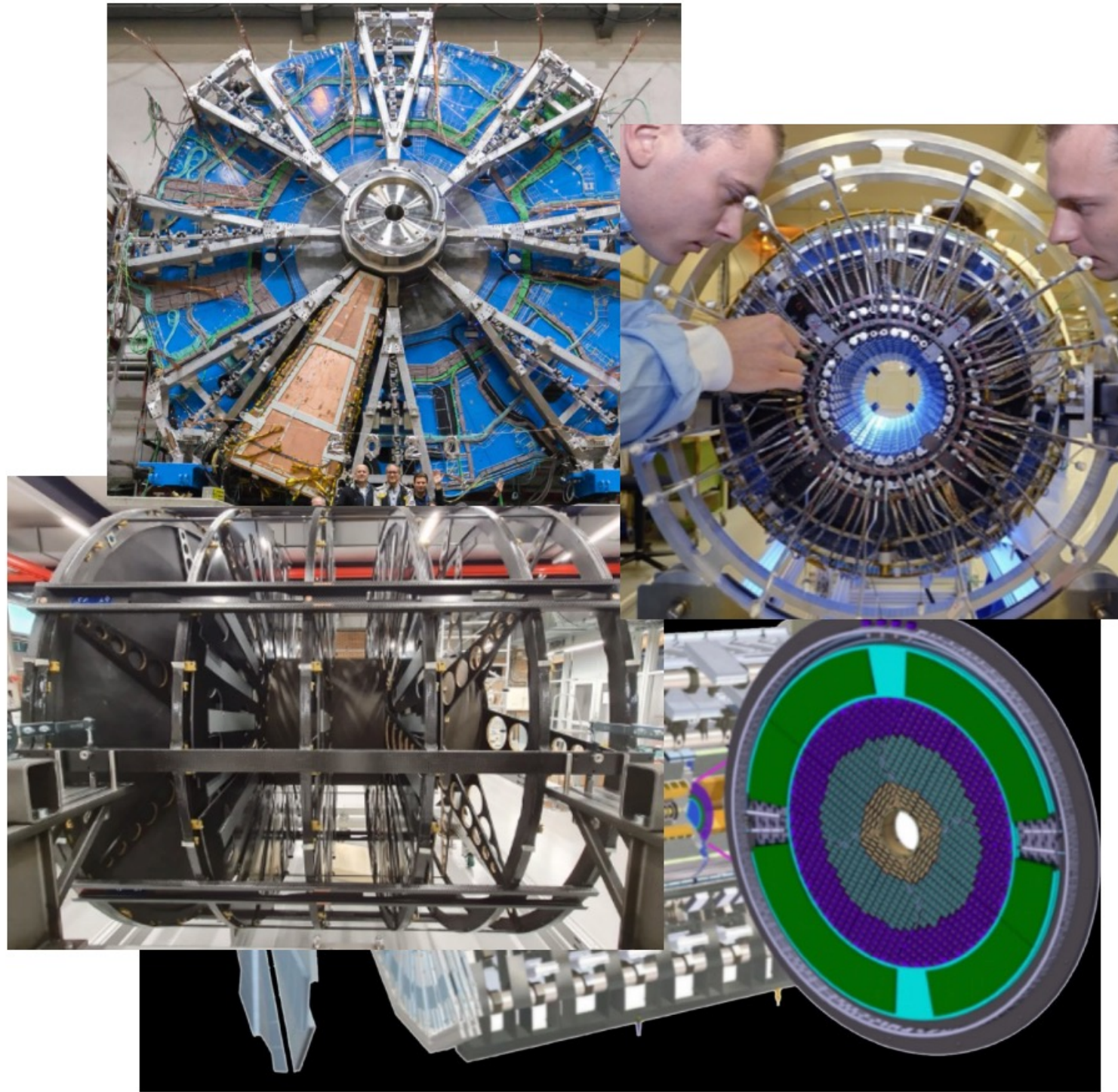
23 Oct 2025

Diana Pyatiizbyantseva



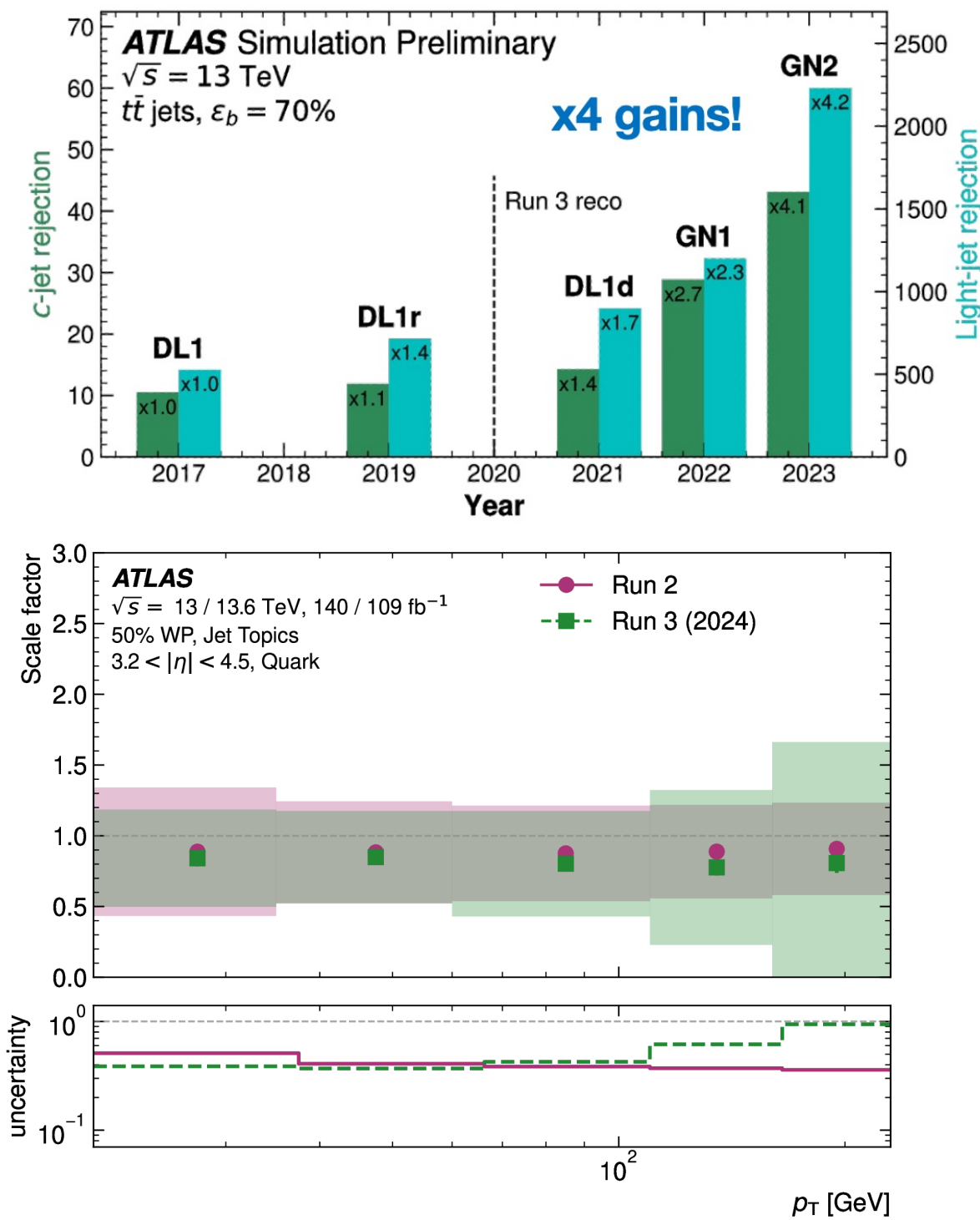
23 Sept 2025

FROM DETECTOR TO PHYSICS



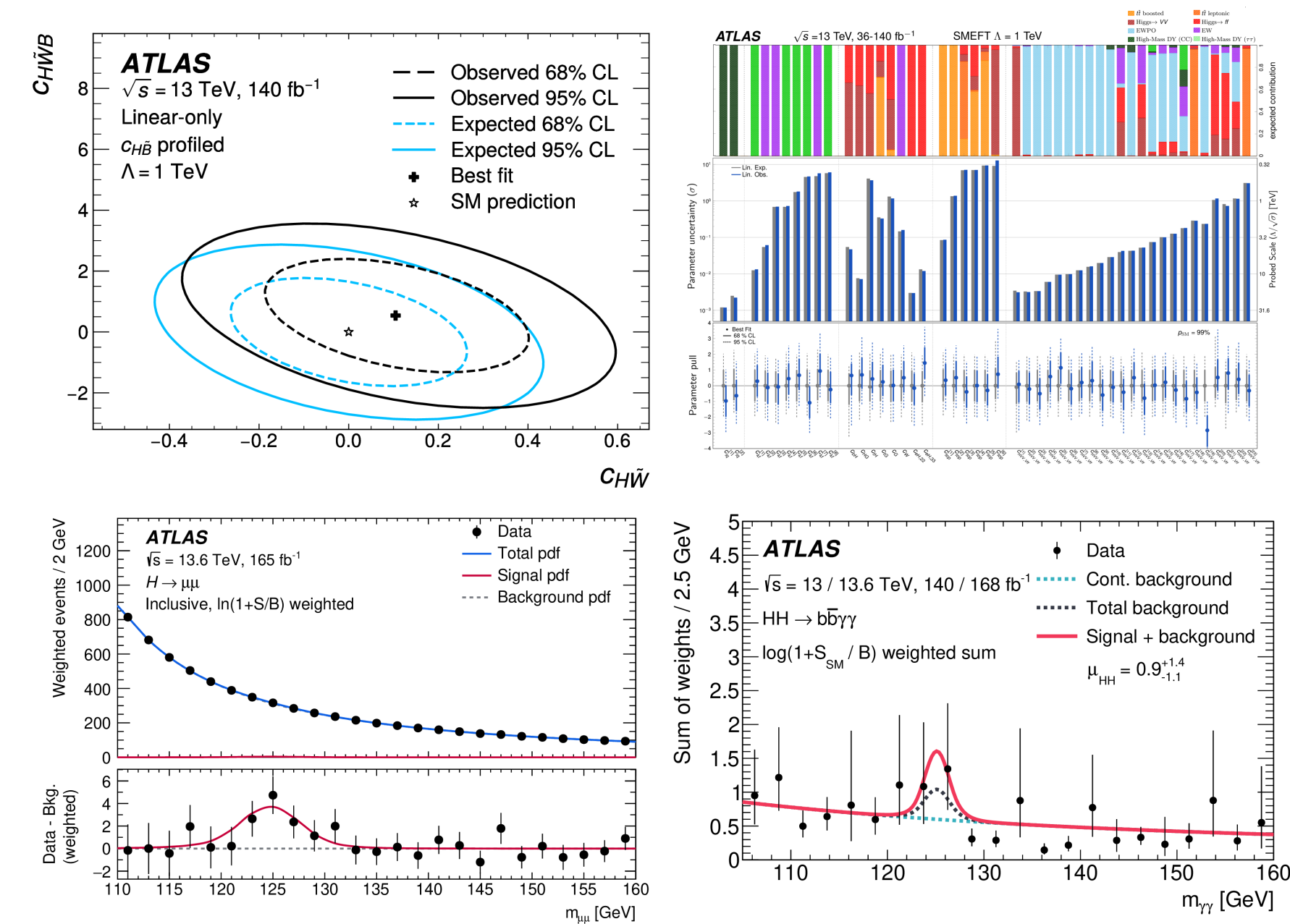
Detector building & commissioning

Tristan's talk



Algorithms & performance

Siang-Yuan's talk



Data analyses

Robin's talk

NIKHEF ATLAS PHYSICS OVERVIEW

Exploring TeV scale physics at the LHC



Electroweak symmetry breaking

h-V interaction

h-h interaction

*Origin of
fermion masses*

h-f interaction



V-V scattering

3V, 4V couplings



Couplings

rare and anomalous



*New particles
& interactions*

*resonance searches
effective field theory*

Synergistic to: tracking, jet tagging, ML/AI, statistics, SMEFT

NIKHEF ATLAS GROUP



ATLAS UPGRADE



Tristan du Pree
Nikhef Jamboree
12 May 2026

ATLAS UPGRADE

Royal Palace @ Dam Square, 1 May 2026

ATLAS @ Amsterdam

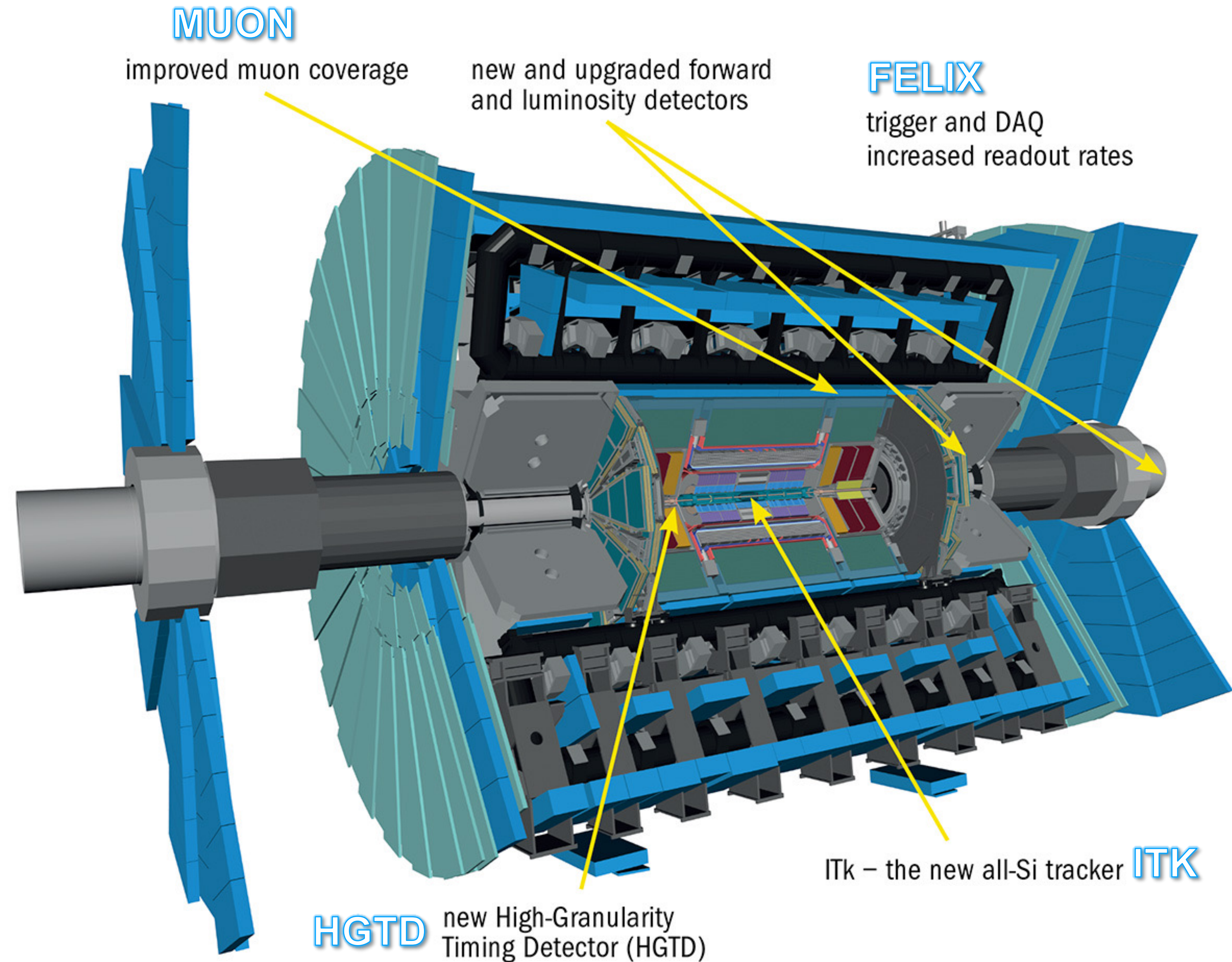
- Recently renovated
 - 350 years
 - Dirty air
 - Ageing



ATLAS UPGRADE

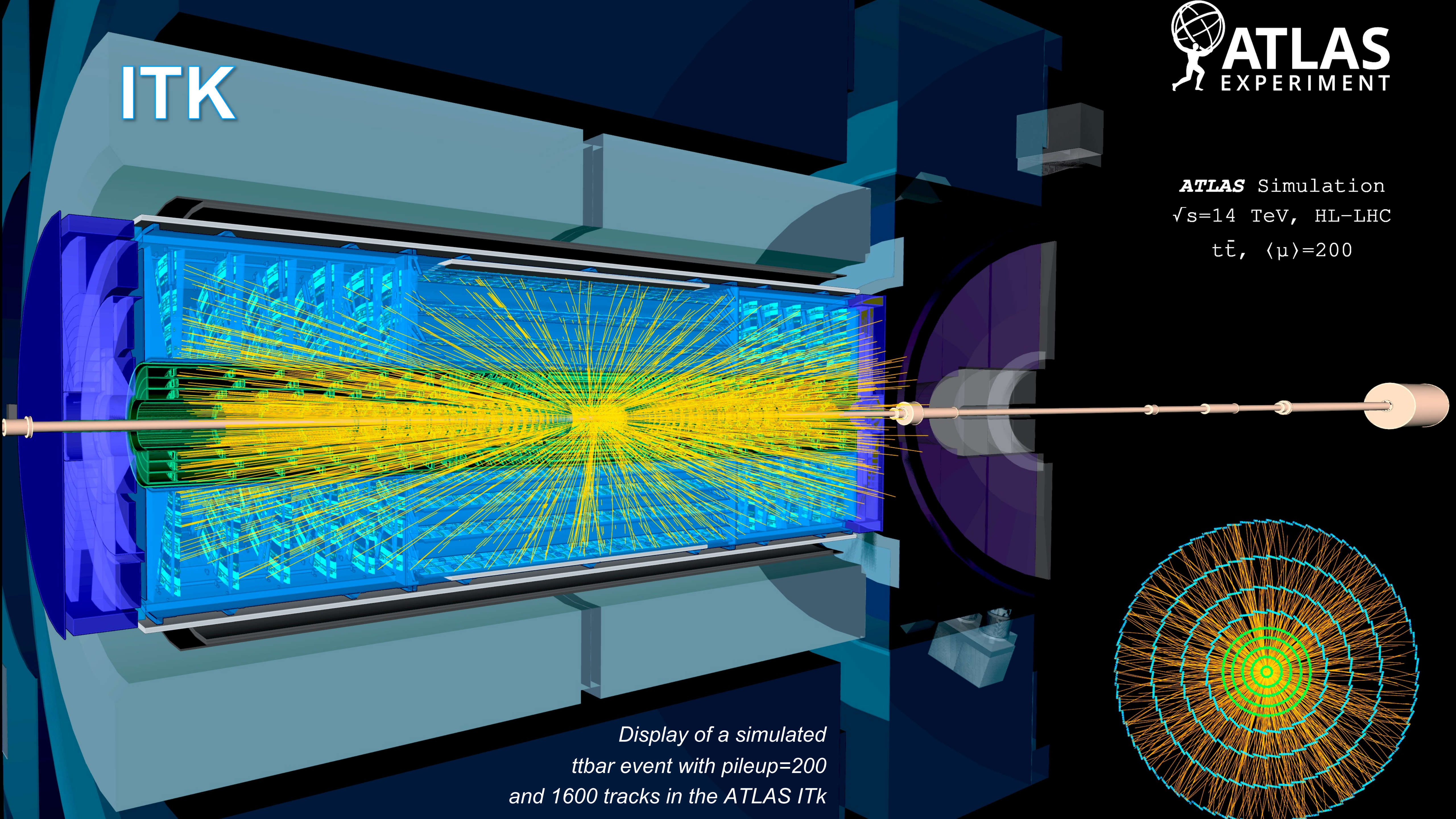
ATLAS @ CERN

- To be upgraded
 - >15 years
 - Radiation
 - Ageing



ITK

ATLAS Simulation
 $\sqrt{s}=14$ TeV, HL-LHC
 $t\bar{t}$, $\langle\mu\rangle=200$



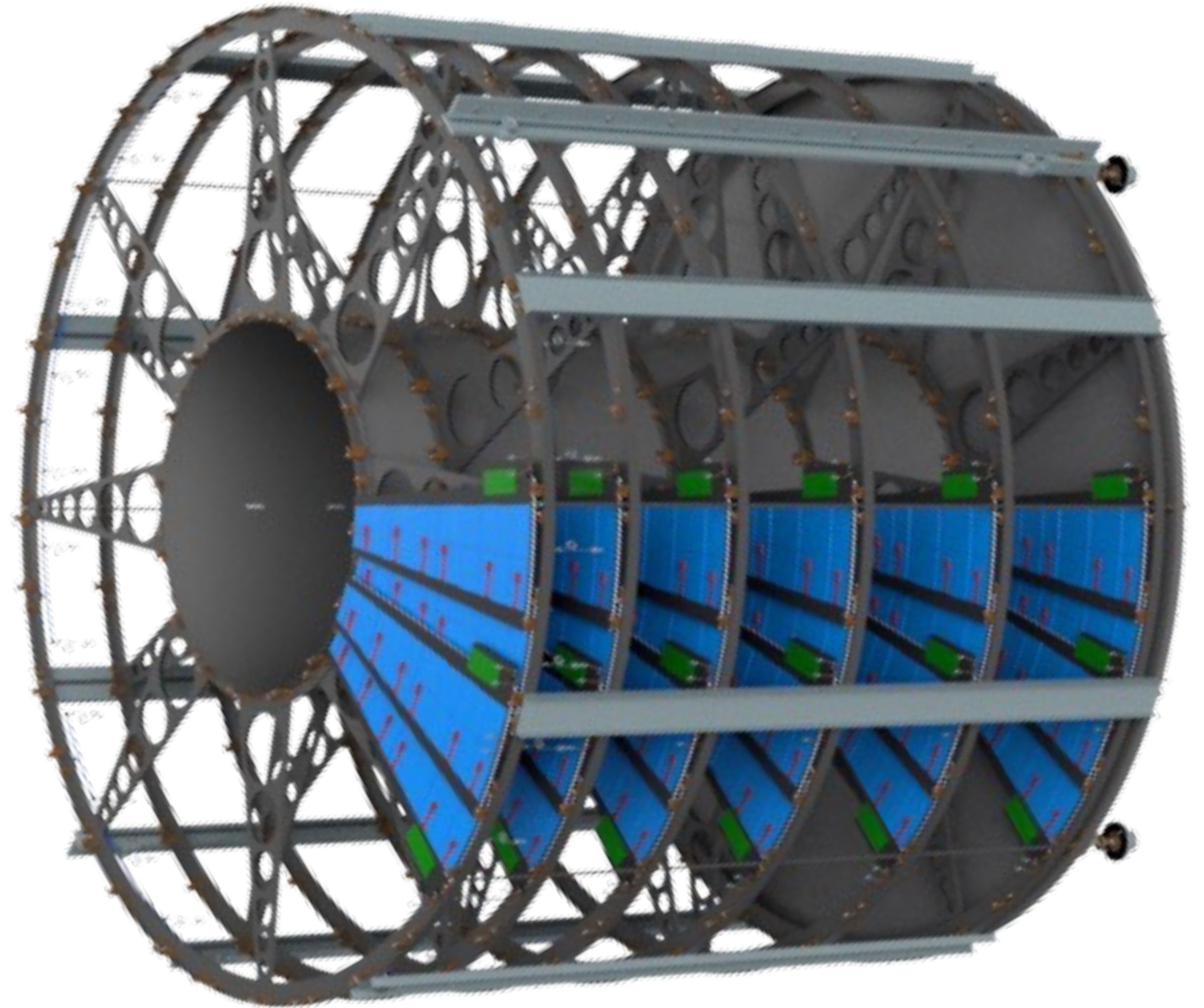
*Display of a simulated
ttbar event with pileup=200
and 1600 tracks in the ATLAS ITk*

ITK: ENDCAP STRUCTURES

Made at Nikhef

- Both ITk endcaps
- 1 shipped to DESY

Large+Light+Precise+Stable

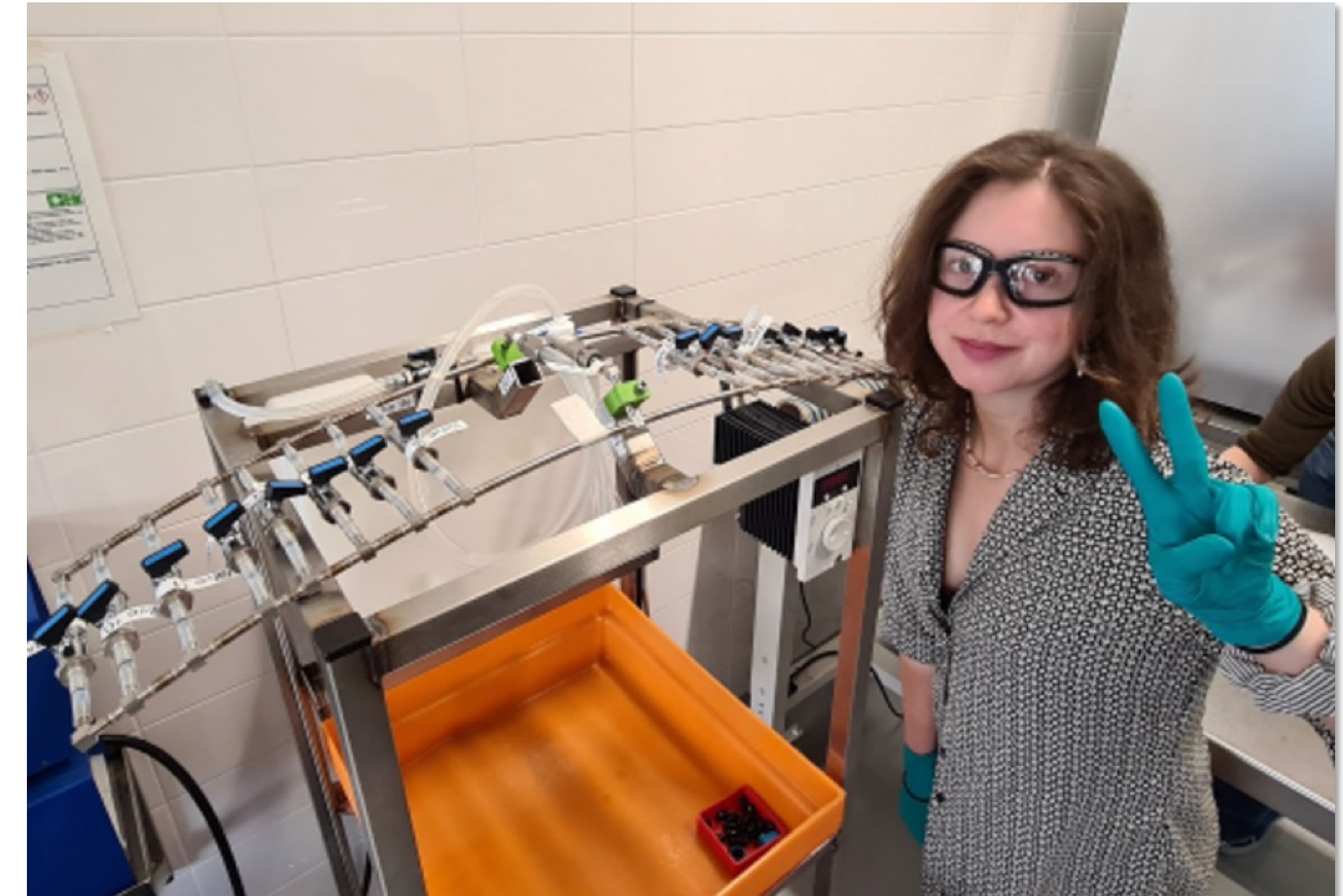


ITK: ACTIVITIES

PhD student

Workshop & cleanroom activities

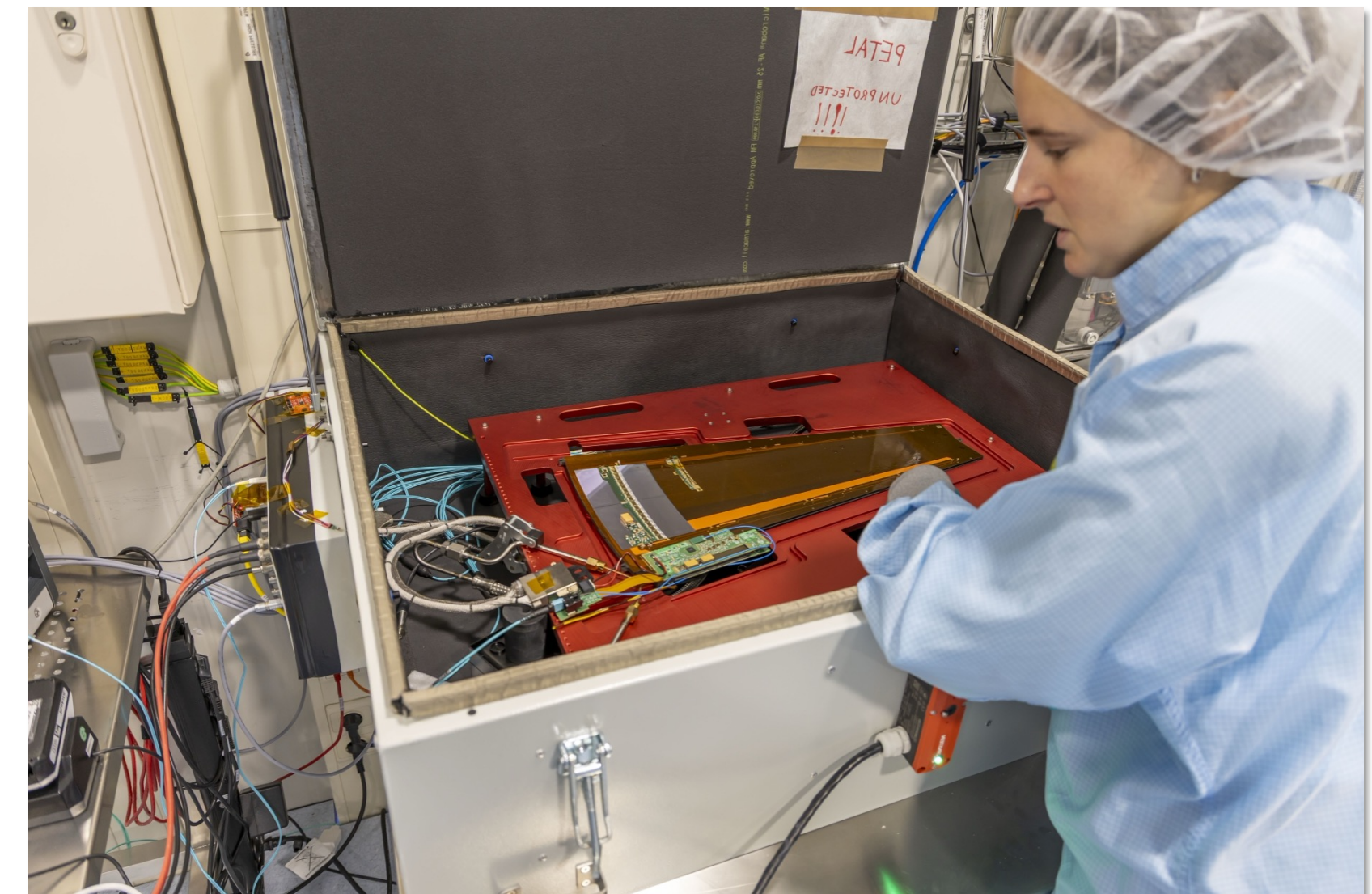
- Cooling, welding, etc
- Prepare for petal shifts
- Insertion, commissioning, tests



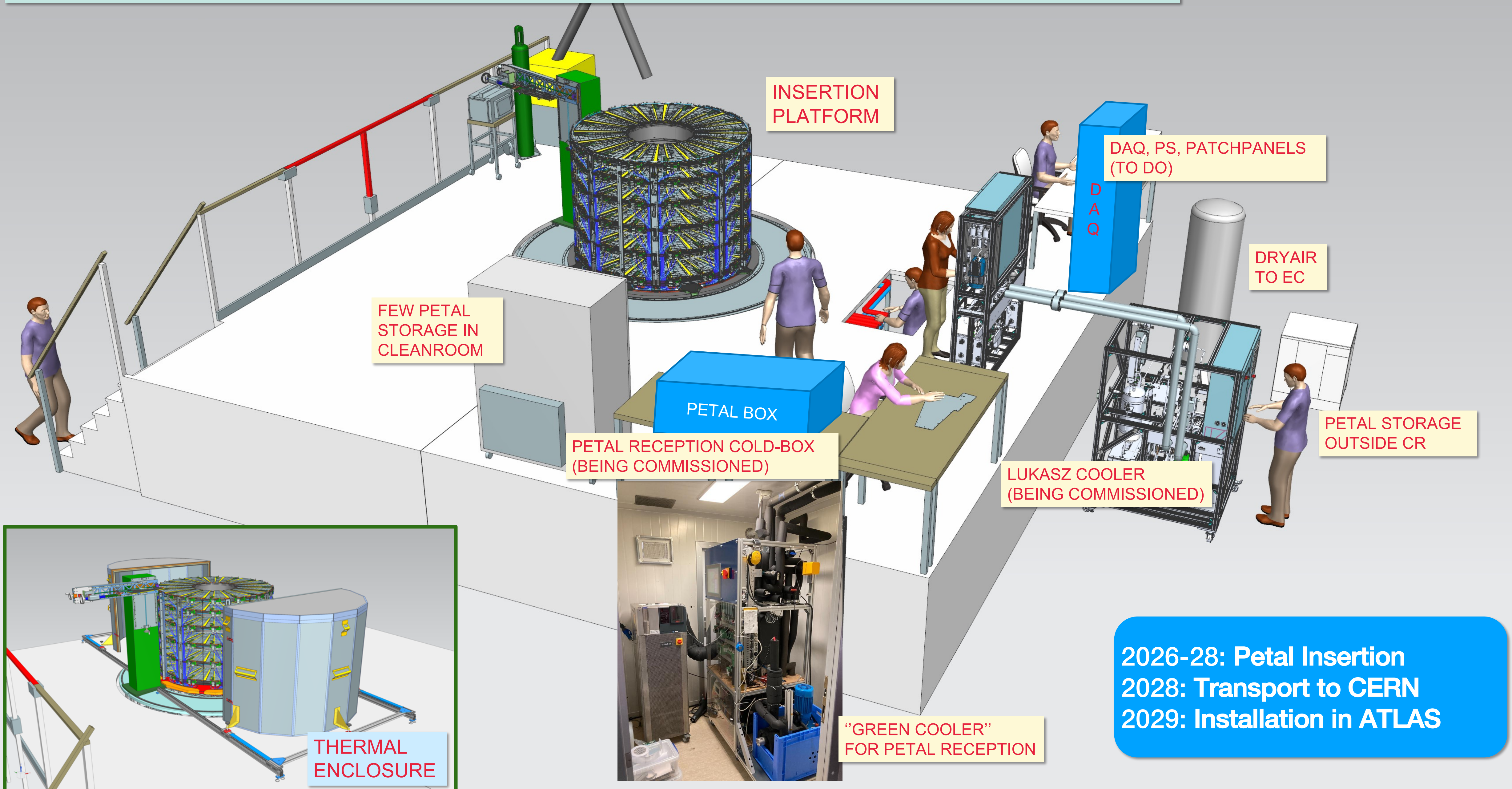
Technicians



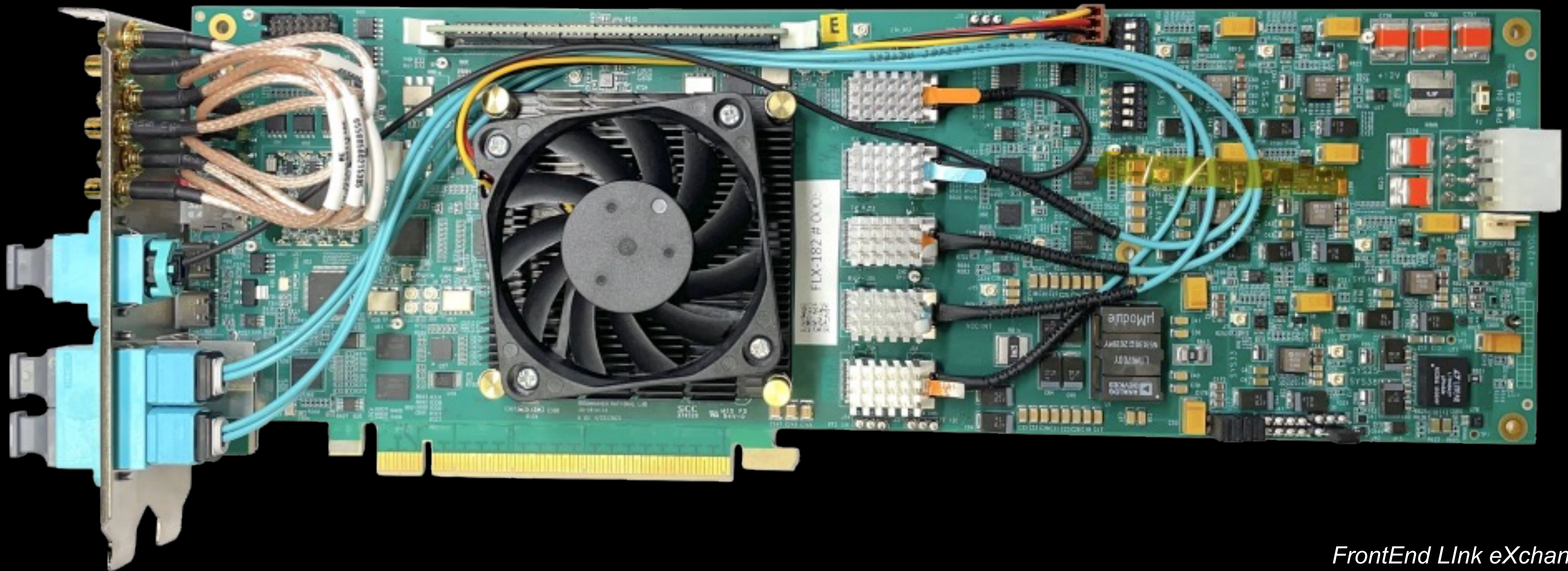
Postdoc



TARGET SUMMMER 2026: READY FOR PETALIZATION



FELIX



*FrontEnd Link eXchange
Readout system of the ATLAS experiment*

FELIX INTRO

HL-LHC: more data

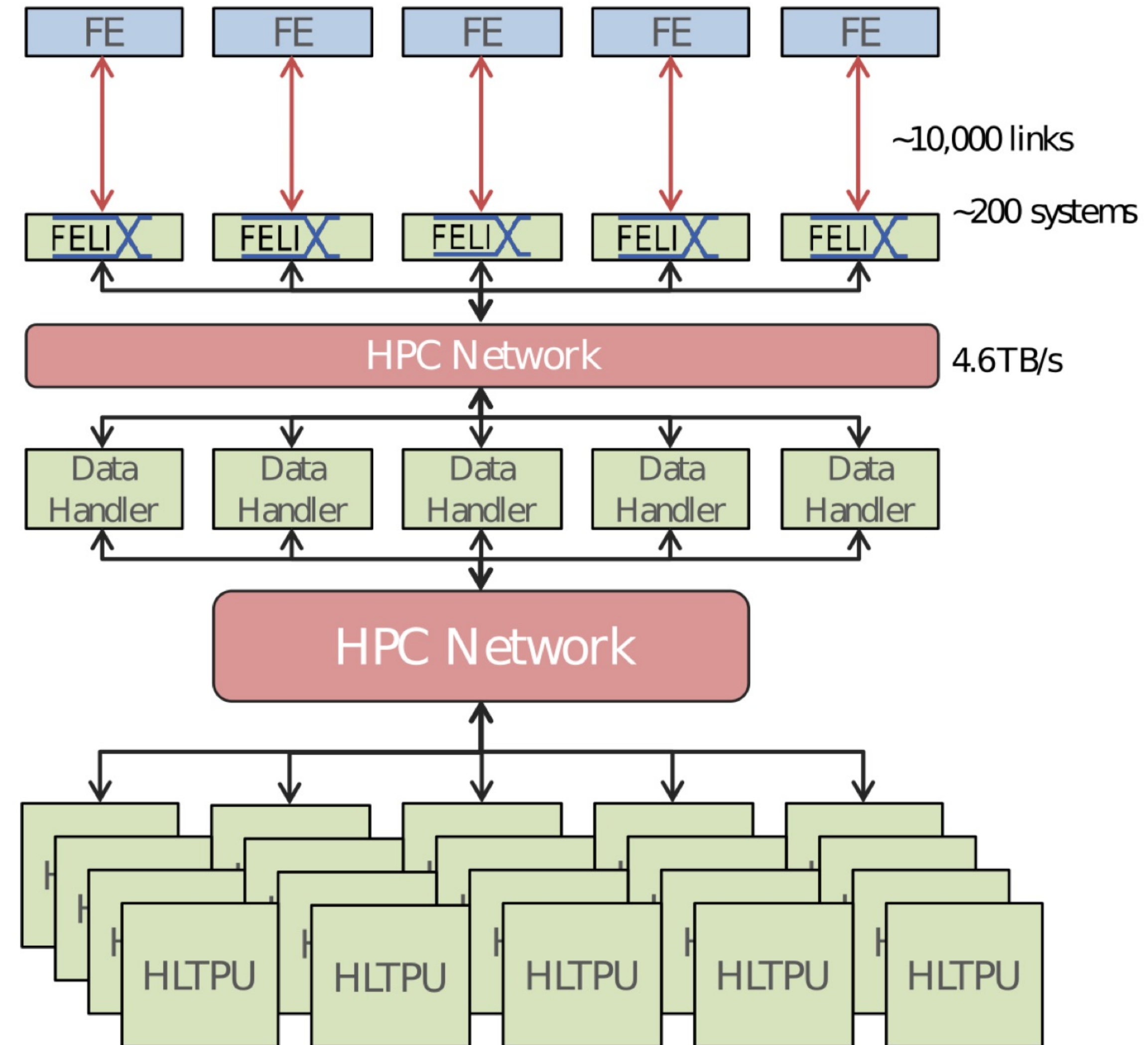
- x10 trigger rate
 - 1MHz
- x3 interactions
 - 200 pileup
- x20 readout rate
 - 4.6 TB/s

New readout chain

- Trigger, clock, data acquisition



Felix & Frans @ CERN



FELIX STATUS

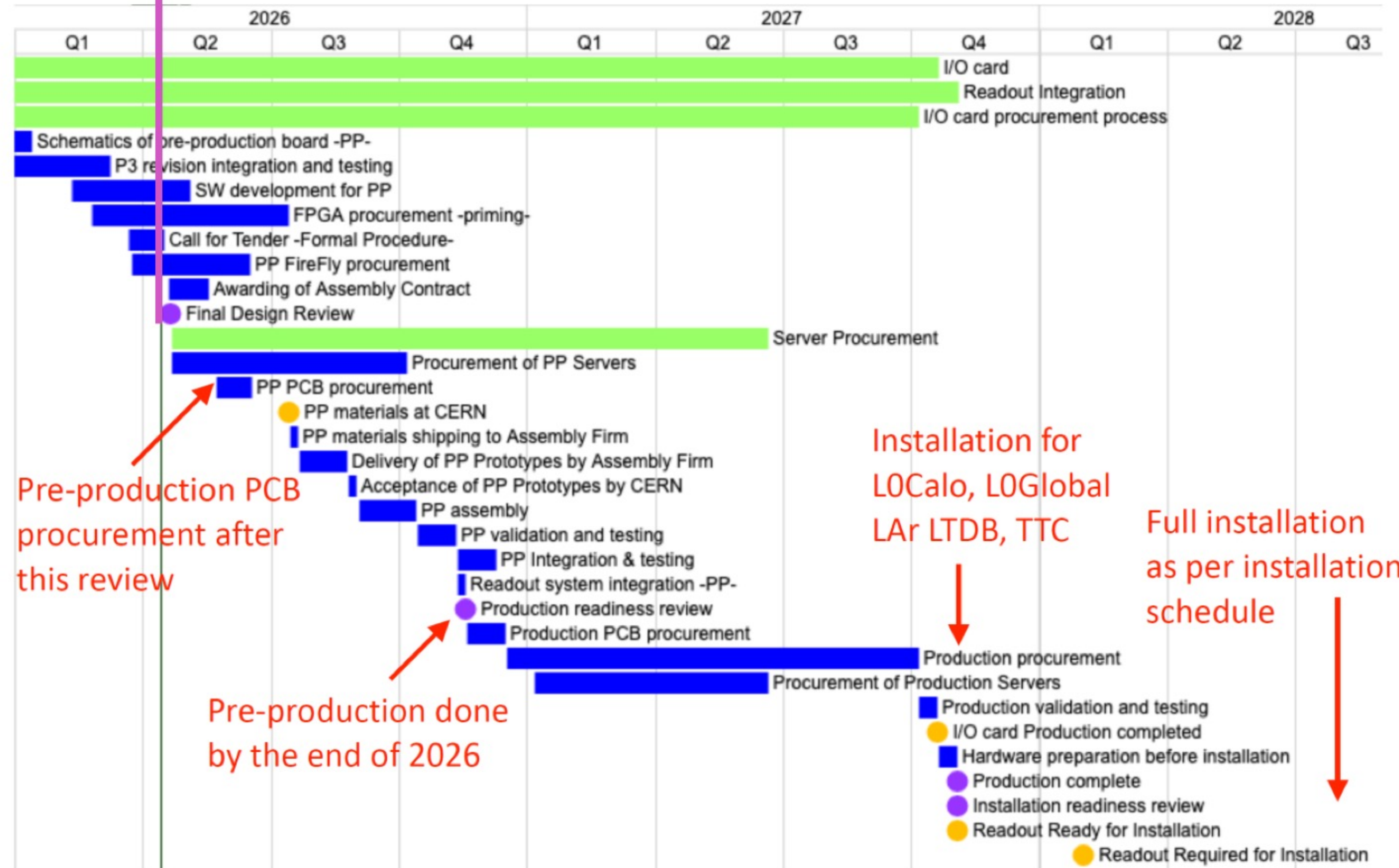
Timeline

- 22 April
- **FDR!**
- 2026
- **Pre-production**
- 2027-2028
- **Full installation**

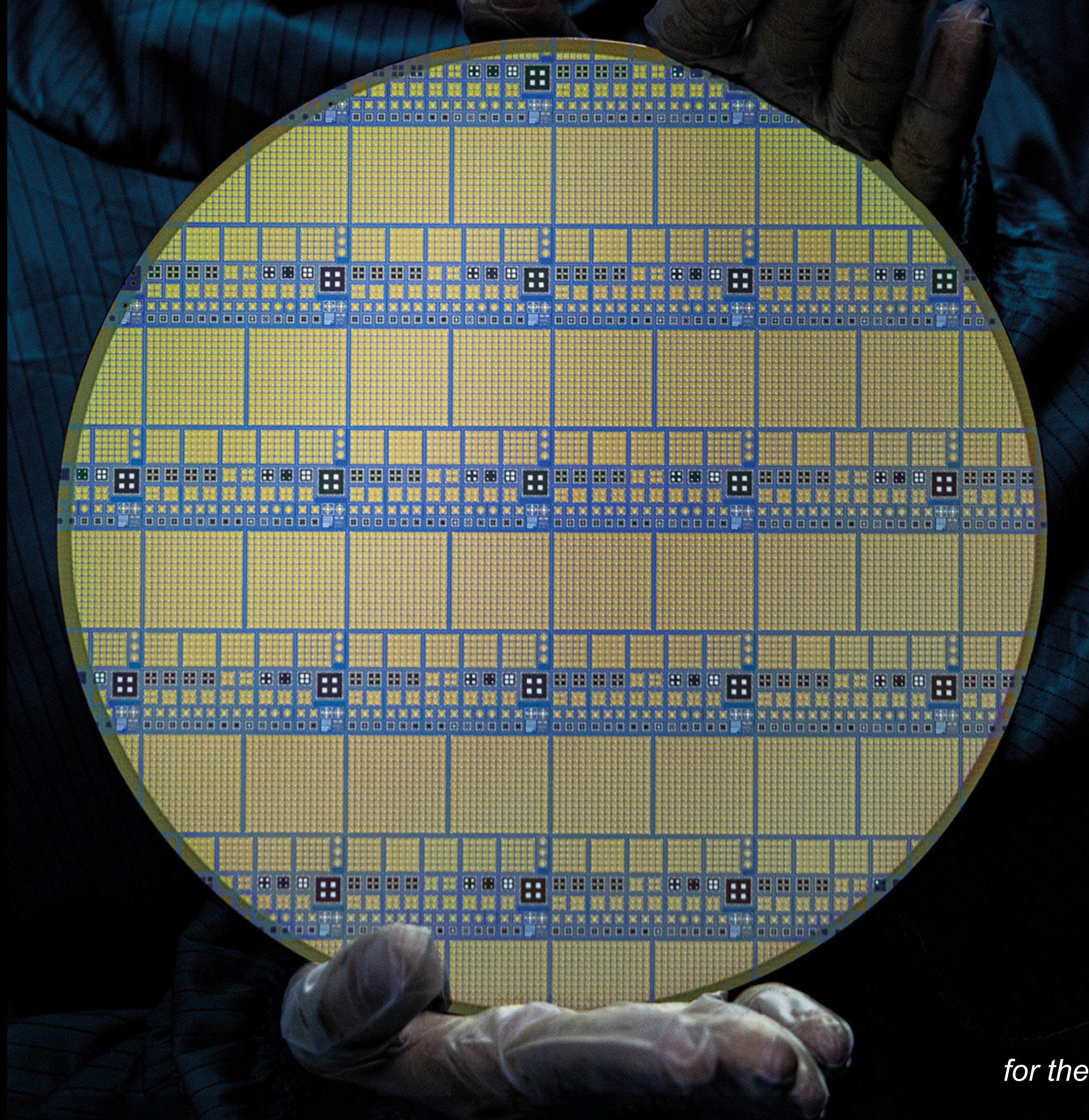
Procurement ongoing

- **FPGA, FireFly, PCB**
- **Assembly & Servers**

Crucial Milestone was on April 22 2026: Final Design Review!



HGTD



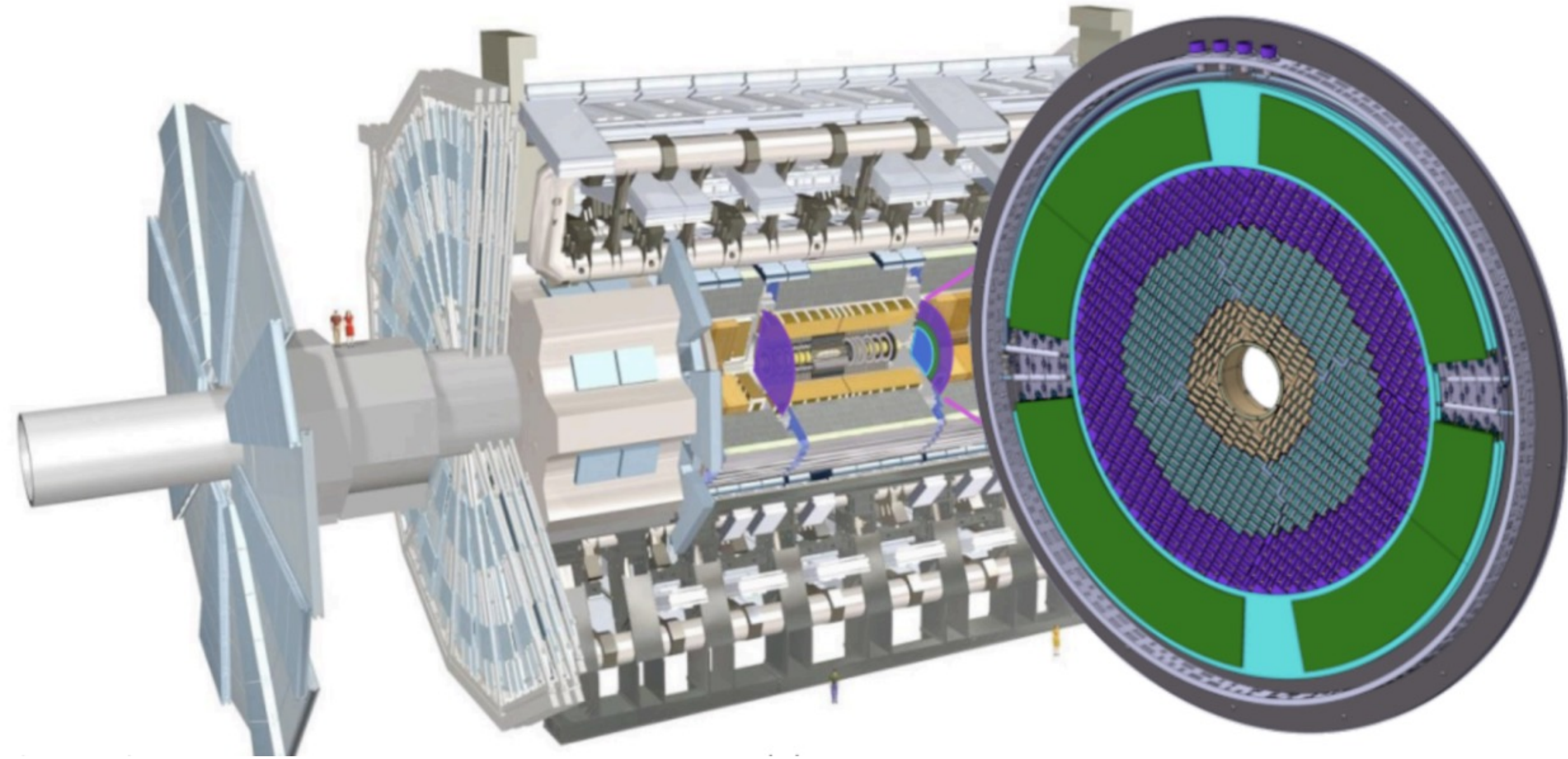
*8-inch prototype wafer
of low-gain avalanche diodes
for the High-Granularity Timing Detector*

HGTD INTRO

High Granularity Timing Detector

- Forward region
 - $2.4 < |\eta| < 4$
- Timing information
 - 30-50 ps

Handle pileup=200 in HL-LHC!



Nikhef 'Fastrack'



HGTD STATUS

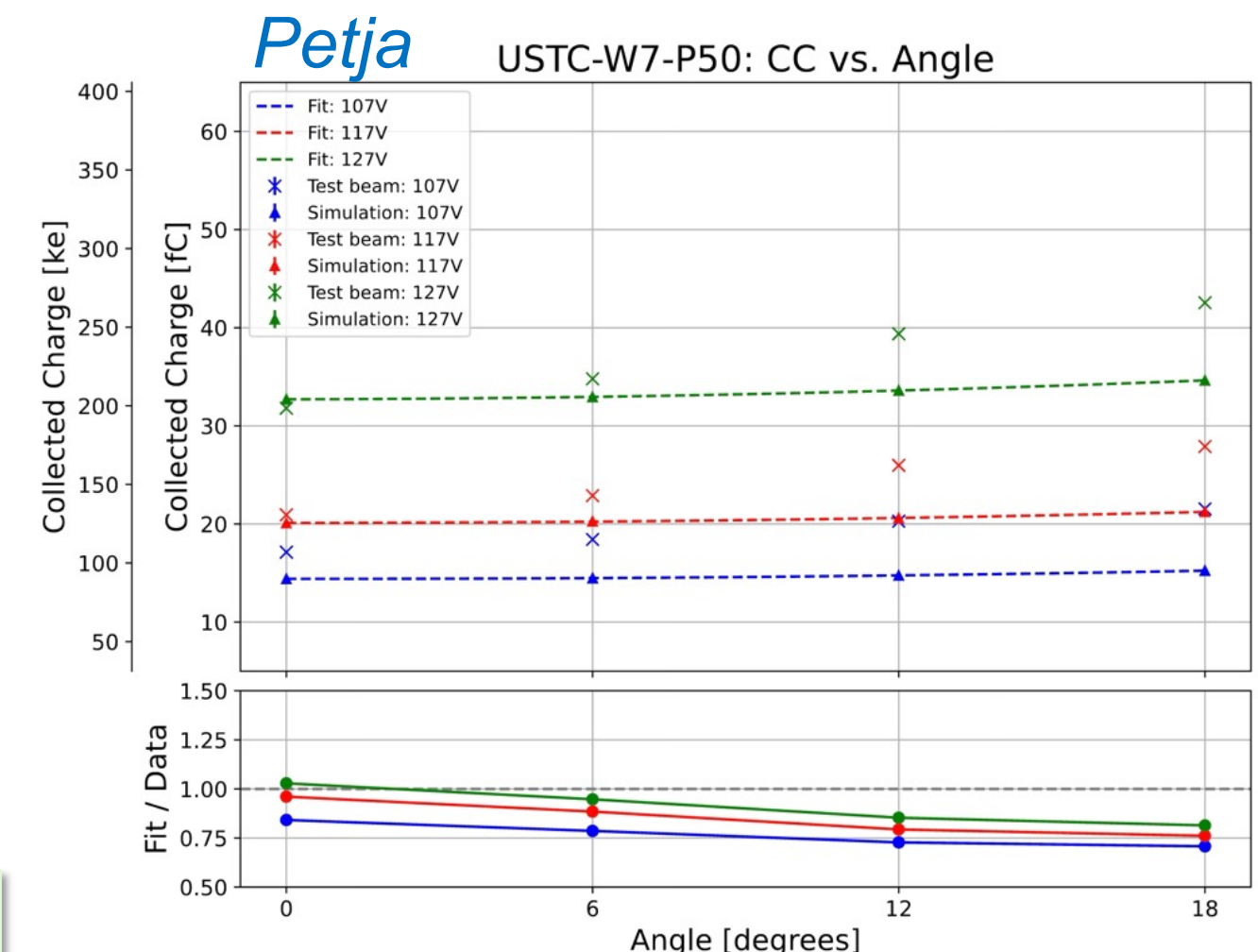
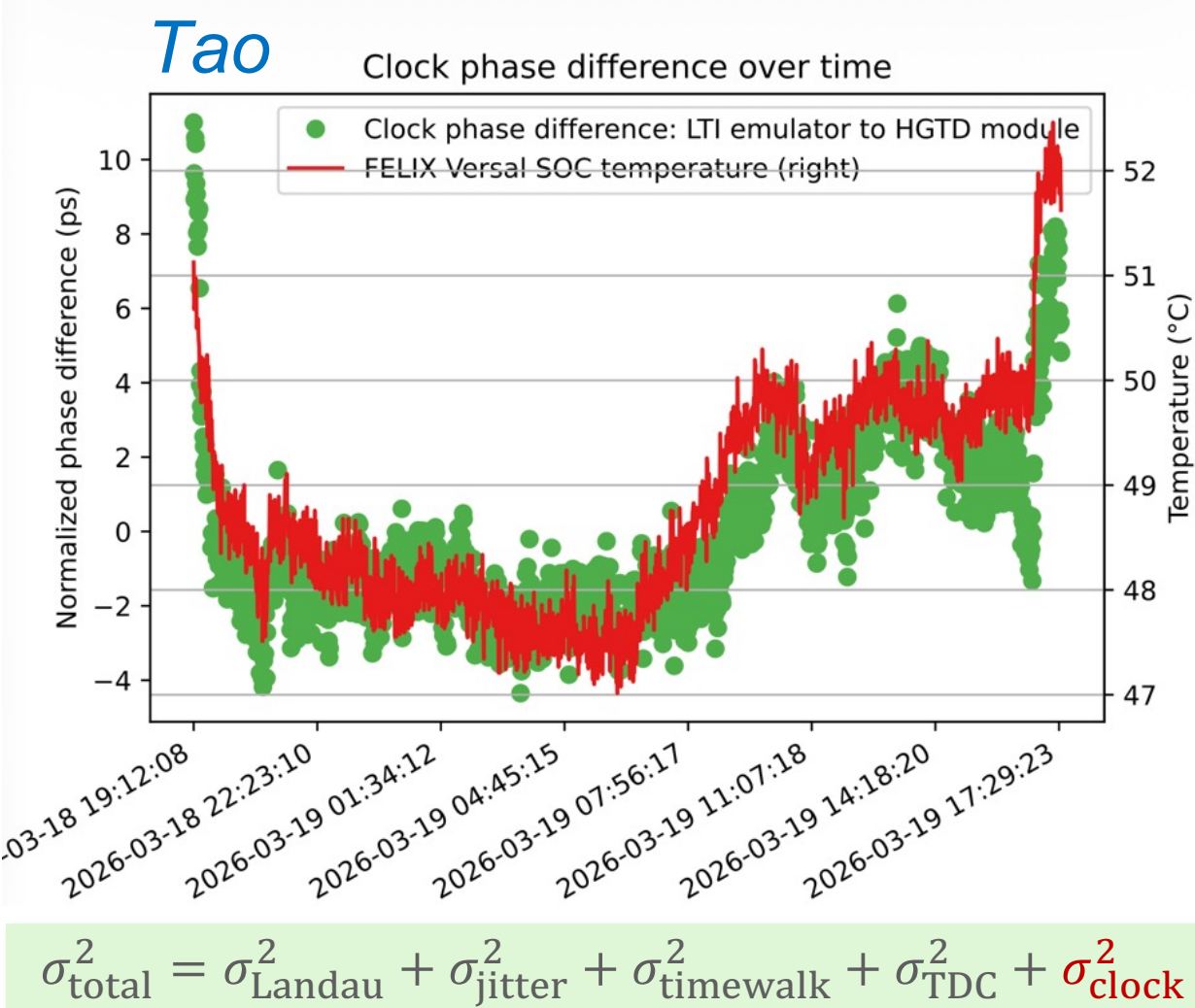
Testbeam with Nikhef PhD students

Simulate sensor response

- Compare with testbeam

Characterize clock contributions

- Effect on timing resolution
- Interplay with FELIX



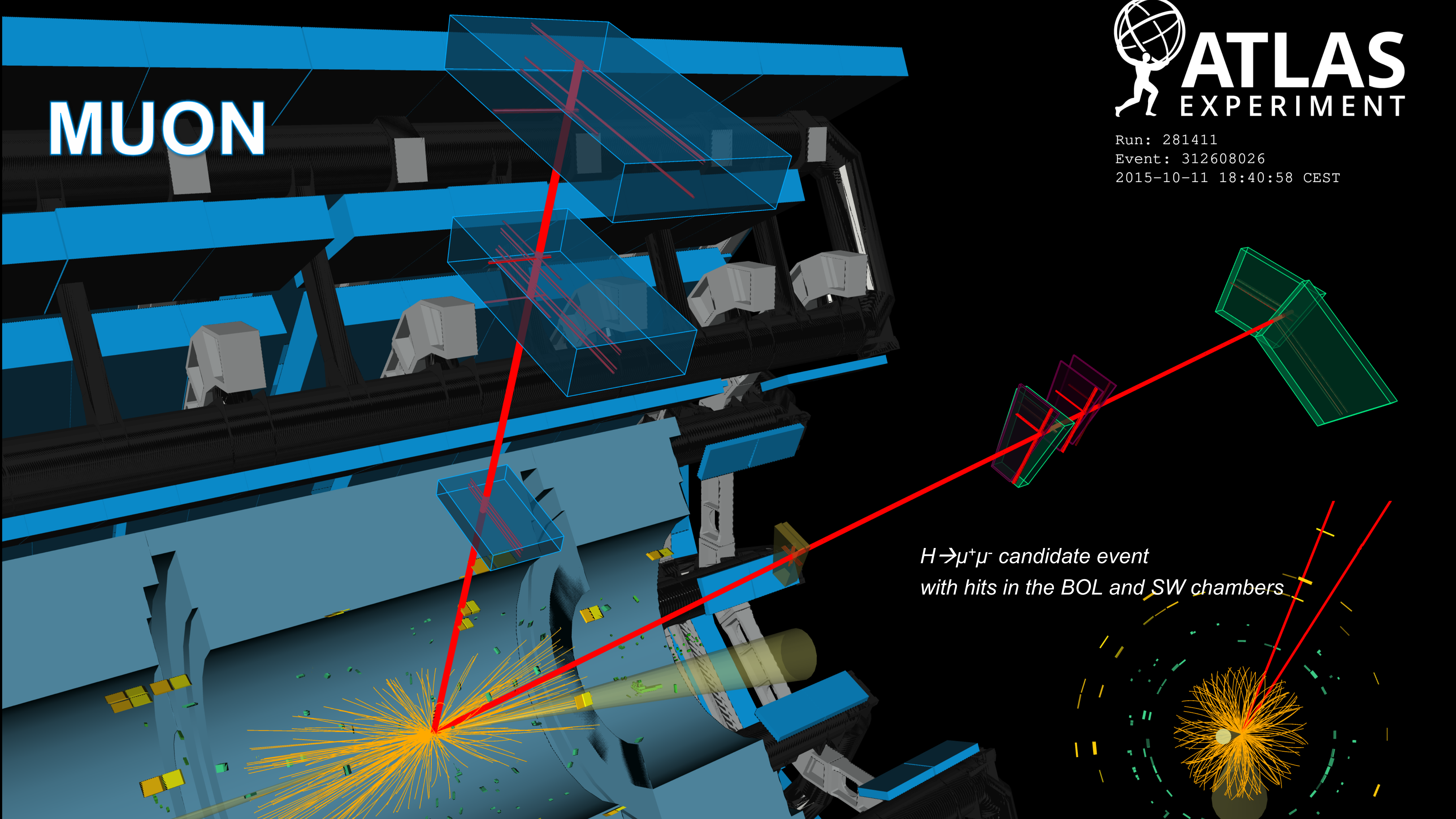
MUON

Run: 281411

Event: 312608026

2015-10-11 18:40:58 CEST

*$H \rightarrow \mu^+ \mu^-$ candidate event
with hits in the BOL and SW chambers*



MUON DETECTOR

Completed BIS production

New barrel BIS chambers

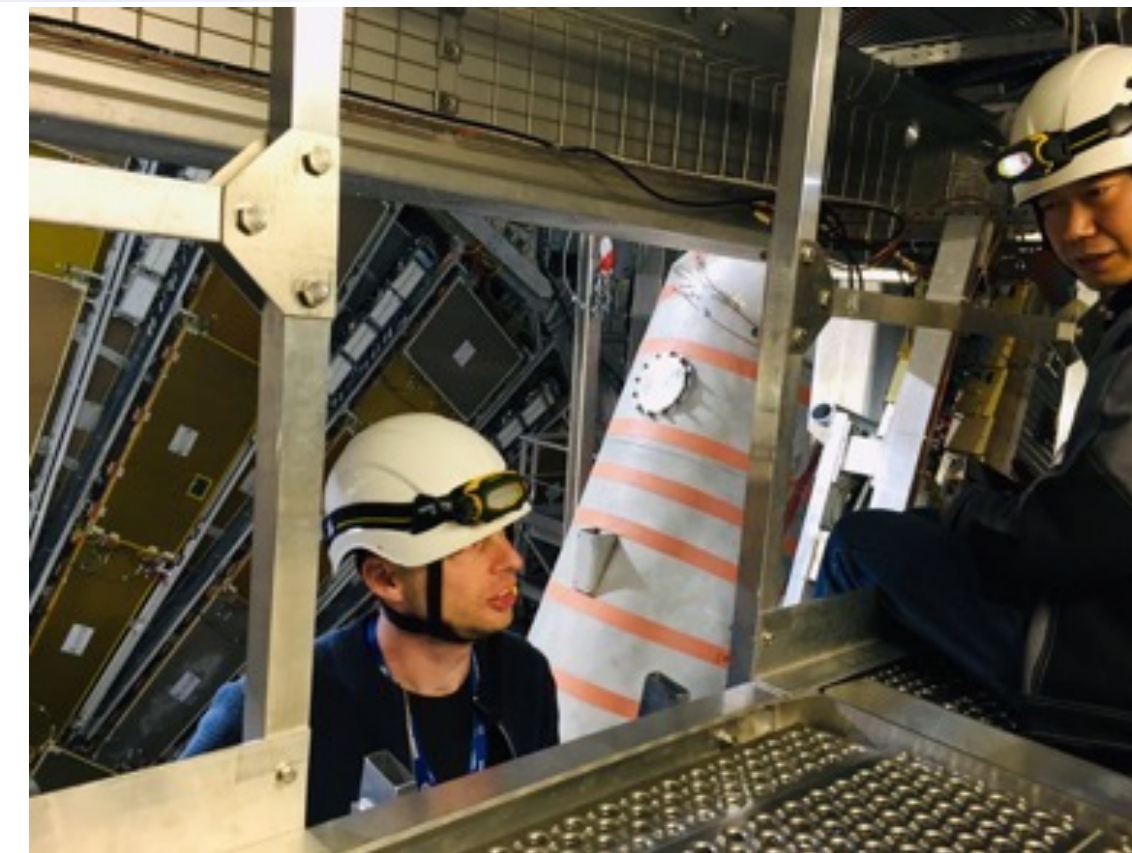
- Granularity + Trigger
 - ~100 chambers to be installed



DCS & Services

- Cabling
- Alignment
- Electronics
 - ~1000 chambers

DCS replacement for LS3

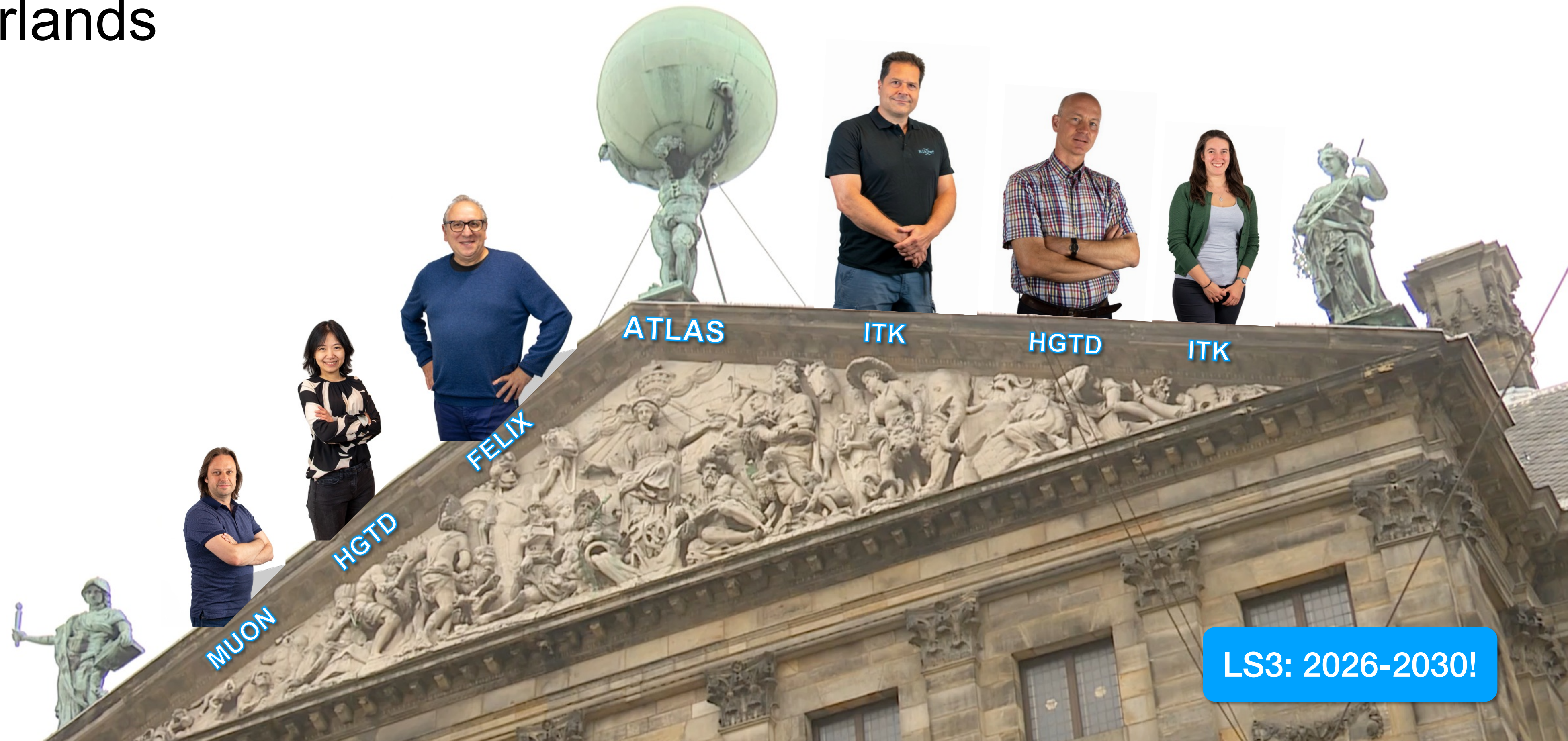


THE ATLAS UPGRADE FOR HL-LHC

Institute-wide effort
from technicians,
engineers, students,
postdocs, and staff

Major ATLAS activity at CERN
and in the Netherlands

- MUON
- HGTD
- FELIX
- ITK



LS3: 2026-2030!

THE FUTURE OF ATLAS AT HL-LHC IS BRIGHT

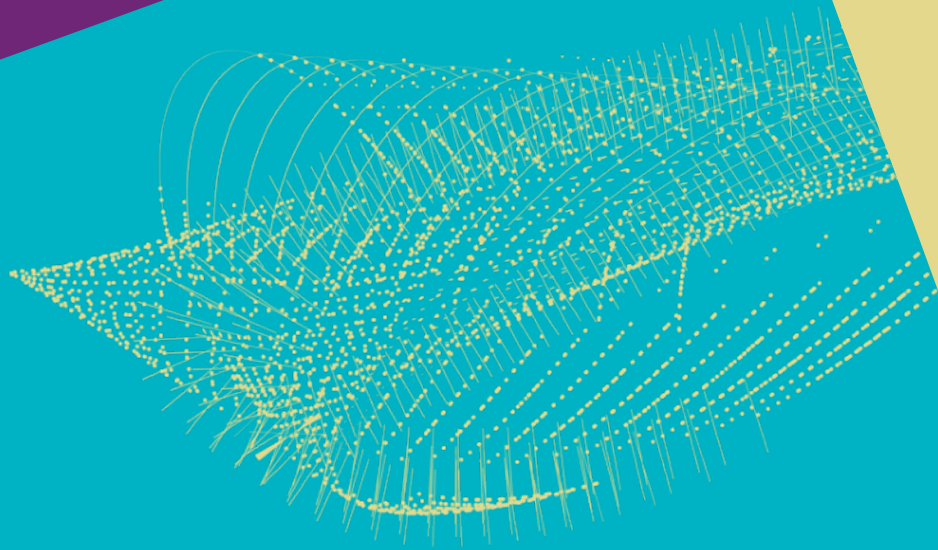




12/May/2026

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

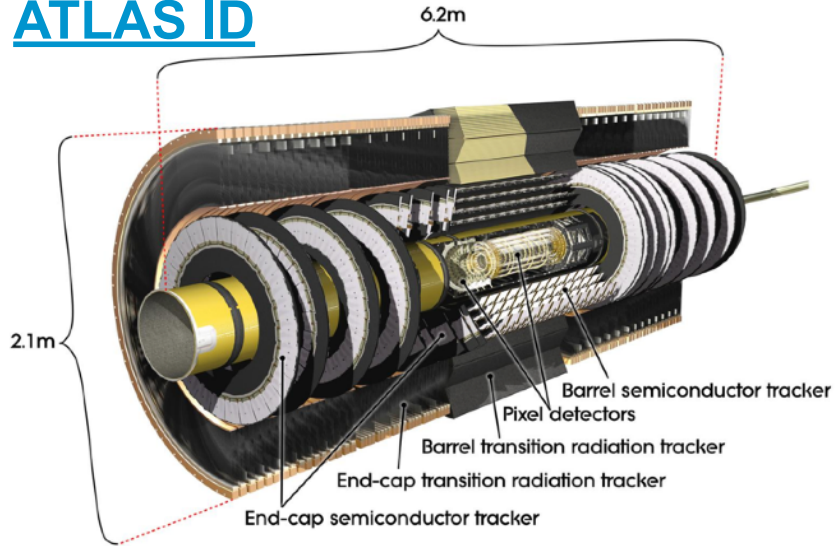


Cloud chamber



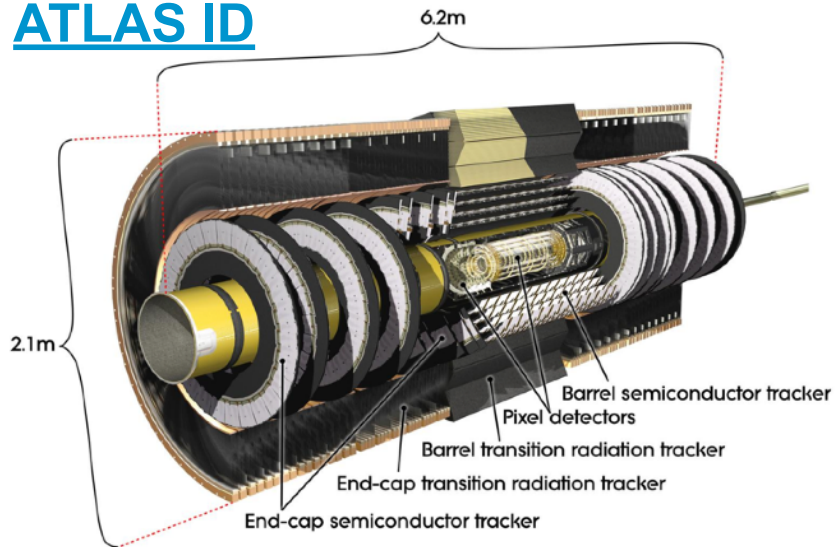
Hardware - leaps and strides

ATLAS ID

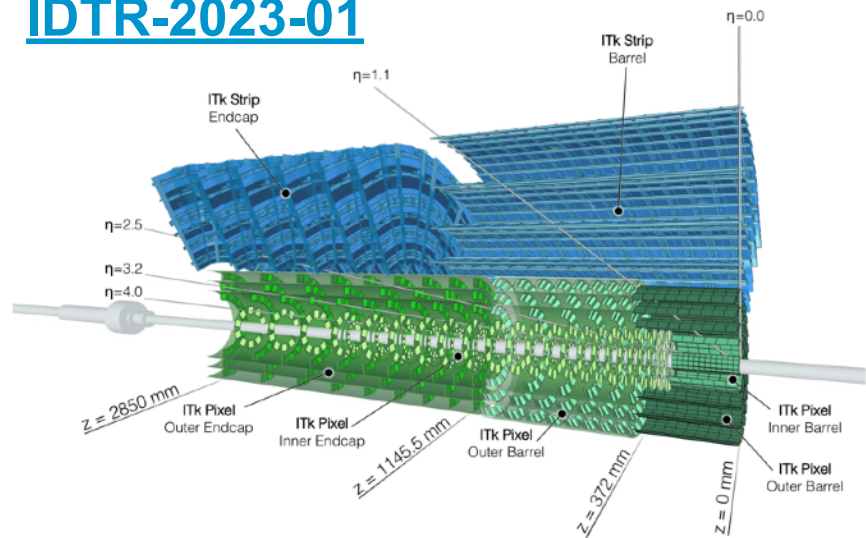


Hardware - leaps and strides

ATLAS ID



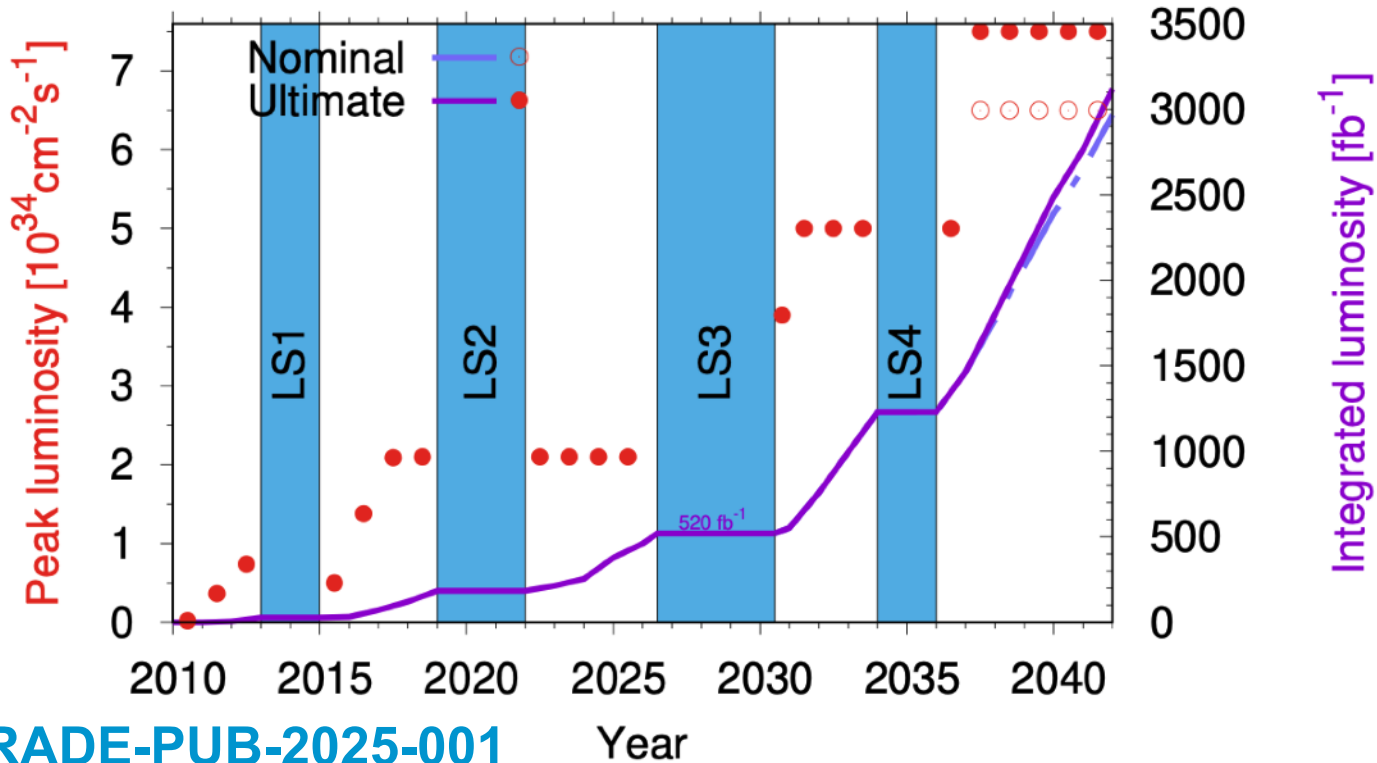
IDTR-2023-01



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

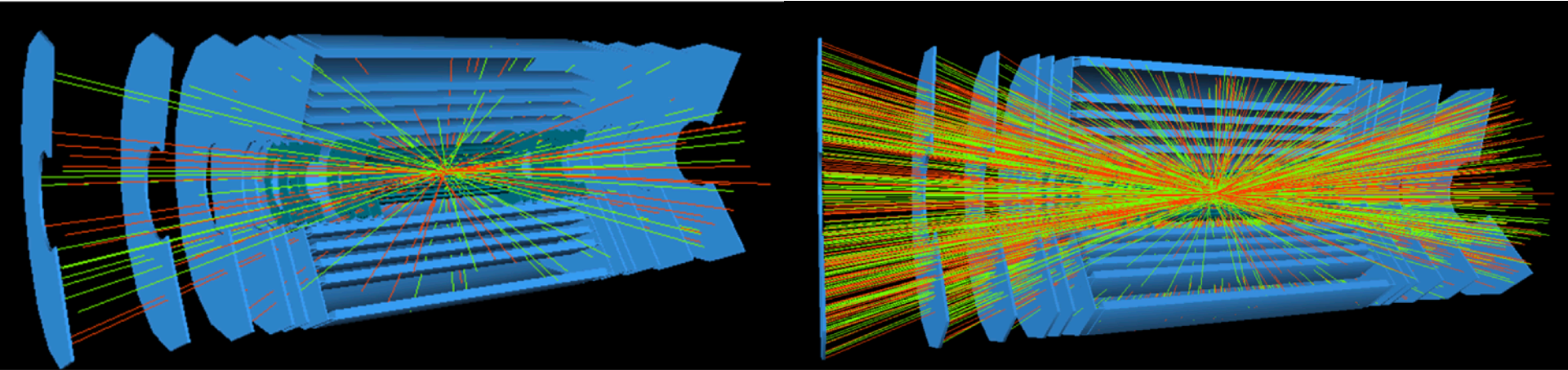
More readout channels: $\sim 10^8 \rightarrow \sim 5 \times 10^9$

Challenges in the High Luminosity LHC era



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

Challenges in the High Luminosity LHC era



Pile-up = 23

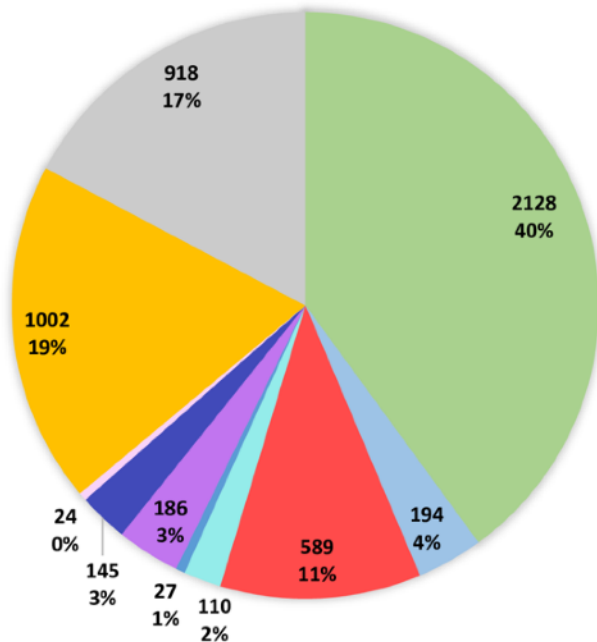
[arxiv:1201.5469](https://arxiv.org/abs/1201.5469)

Pile-up = 230

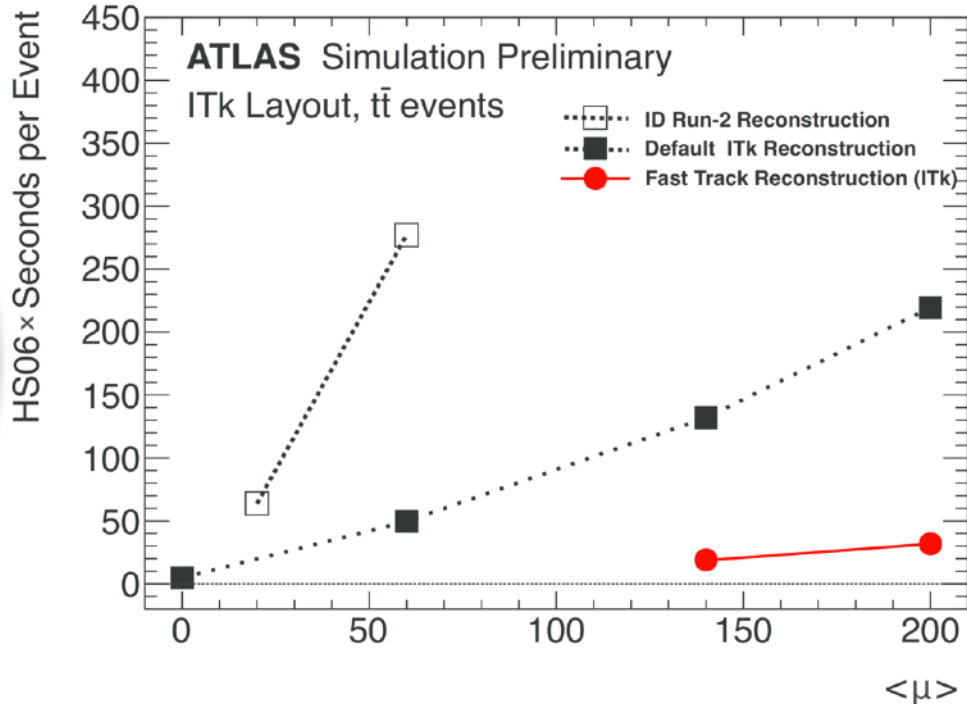
Challenges in the High Luminosity LHC era

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

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

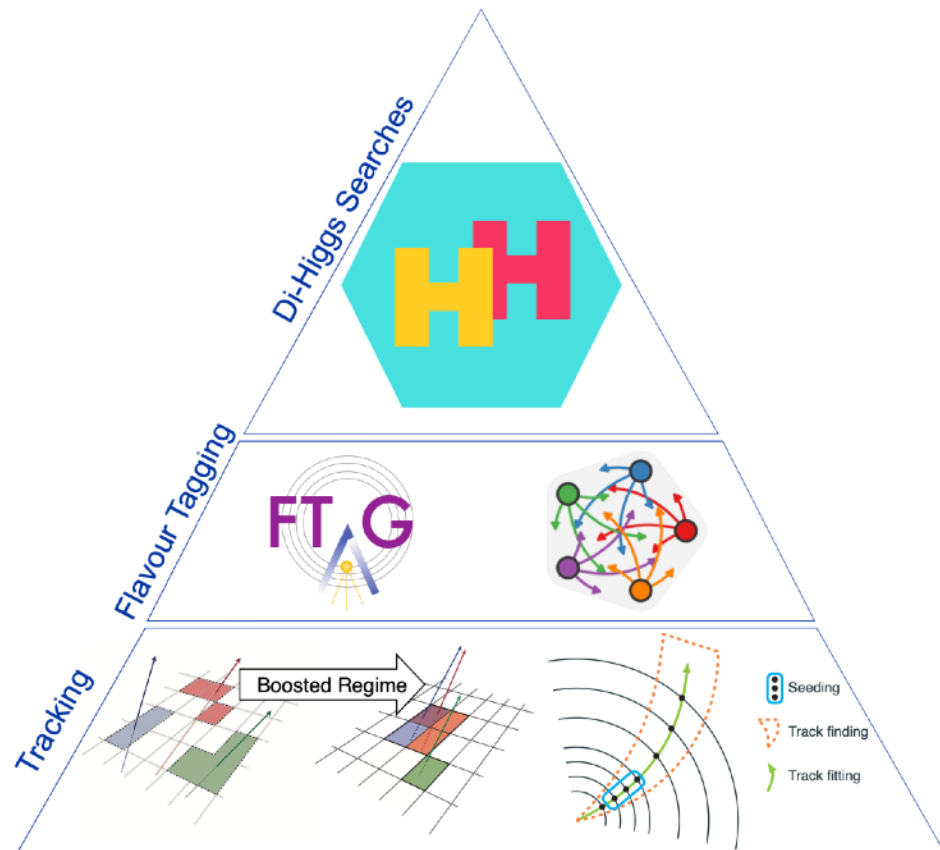


[ATL-PHYS-PUB-2021-012](#)

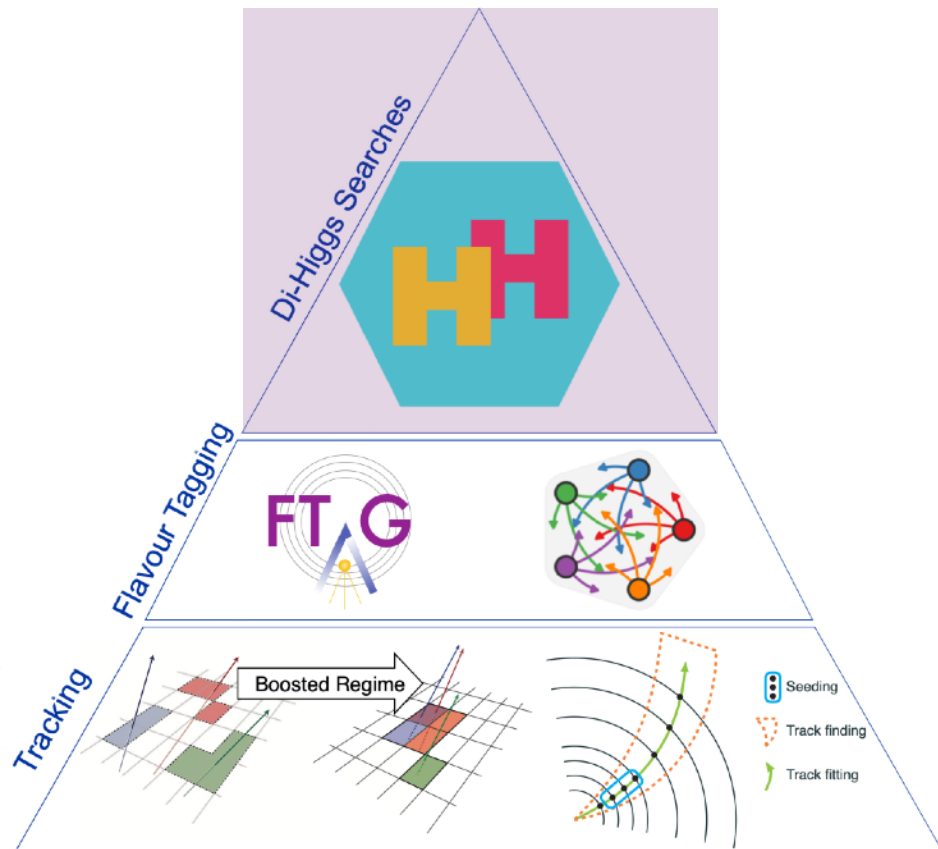
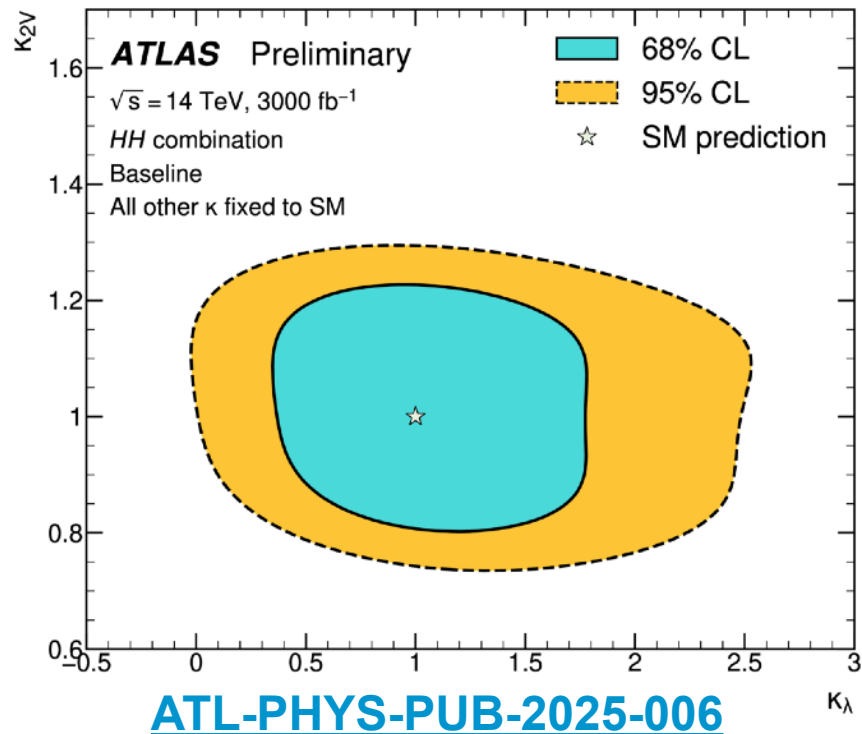


[ATL-PHYS-PUB-2019-041](#)

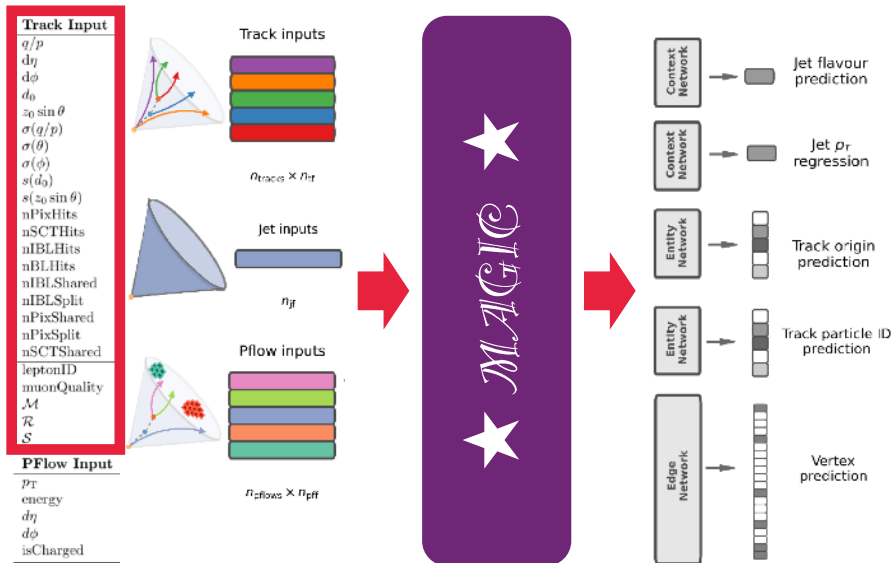
ATLAS Physics



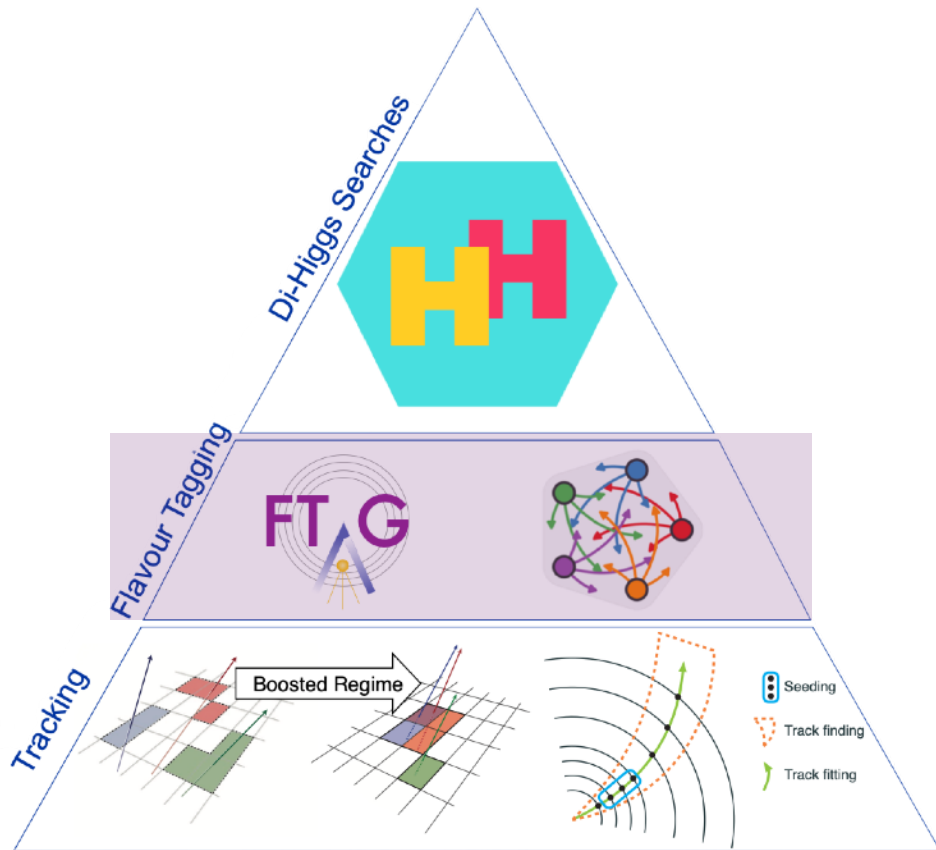
ATLAS Physics



ATLAS Physics



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



ATLAS Physics

Space point formation
Clustering



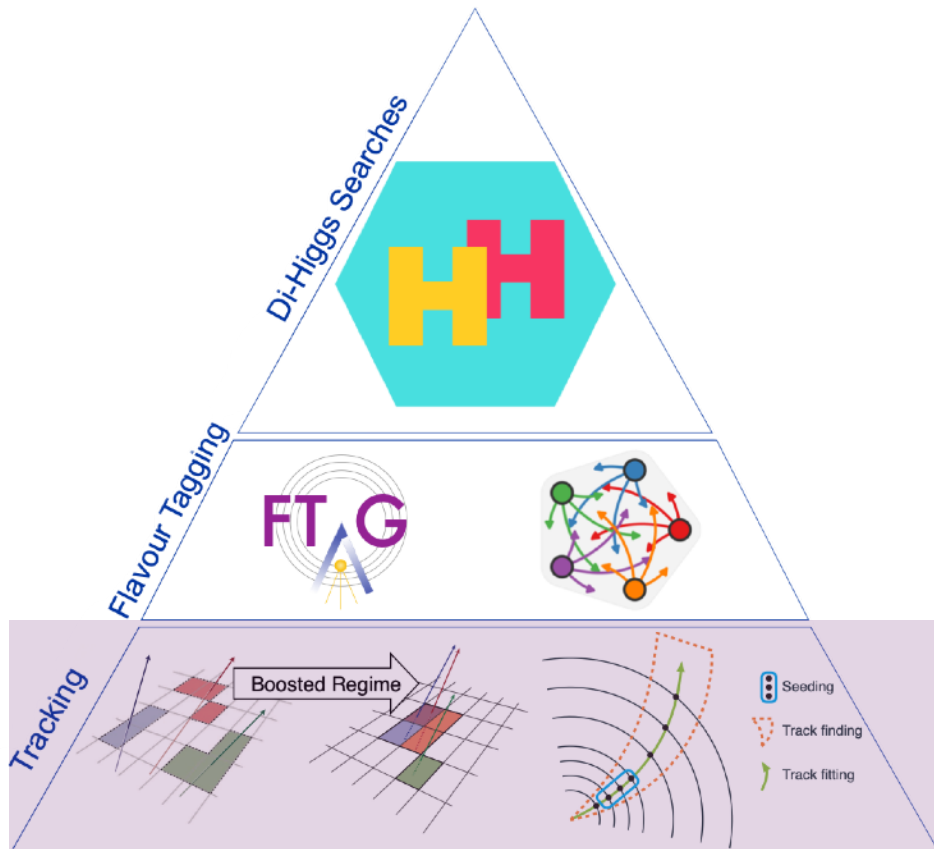
Track Seeding



Track Finding &
Fitting



Ambiguity Solving



ATLAS Tracking



Space point formation
Clustering



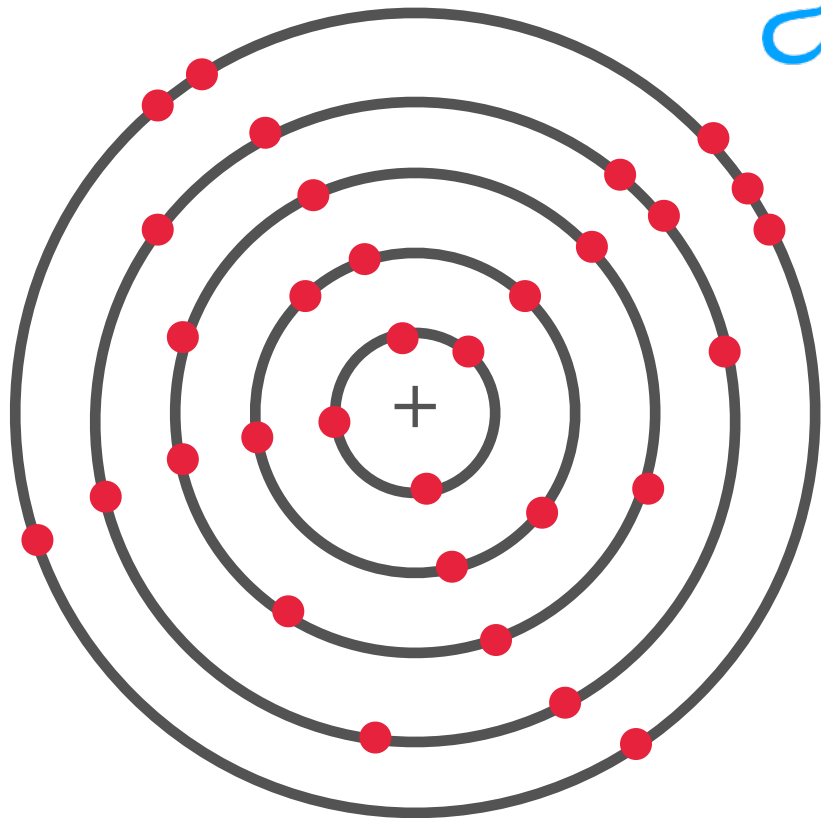
Track Seeding



Track Finding &
Fitting



Ambiguity Solving



ATLAS Tracking



Space point formation
Clustering



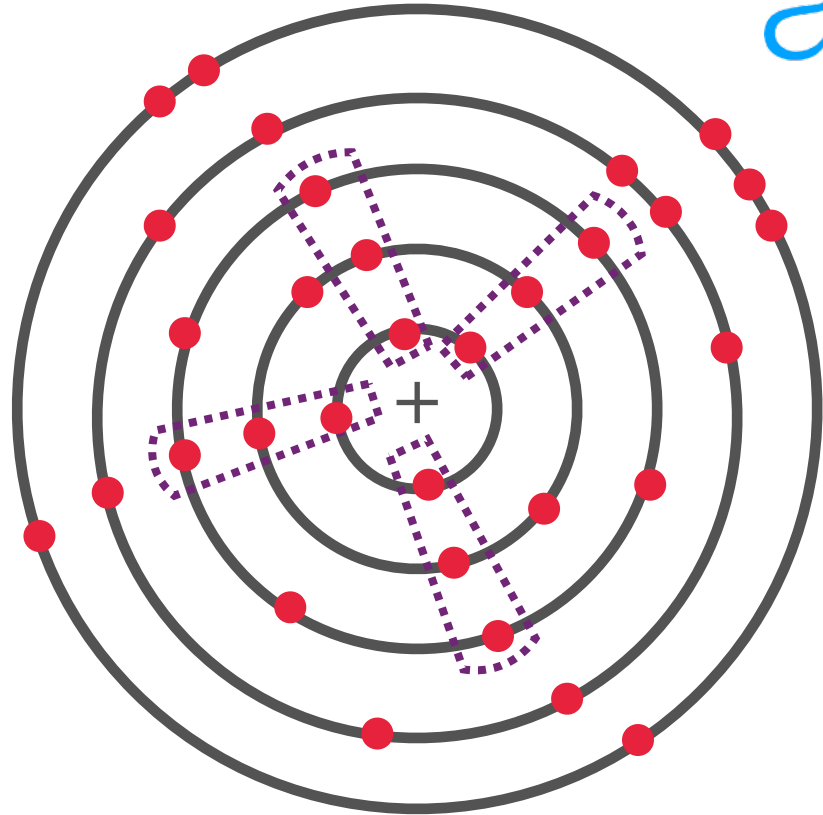
Track Seeding



Track Finding &
Fitting



Ambiguity Solving



ATLAS Tracking



Space point formation
Clustering



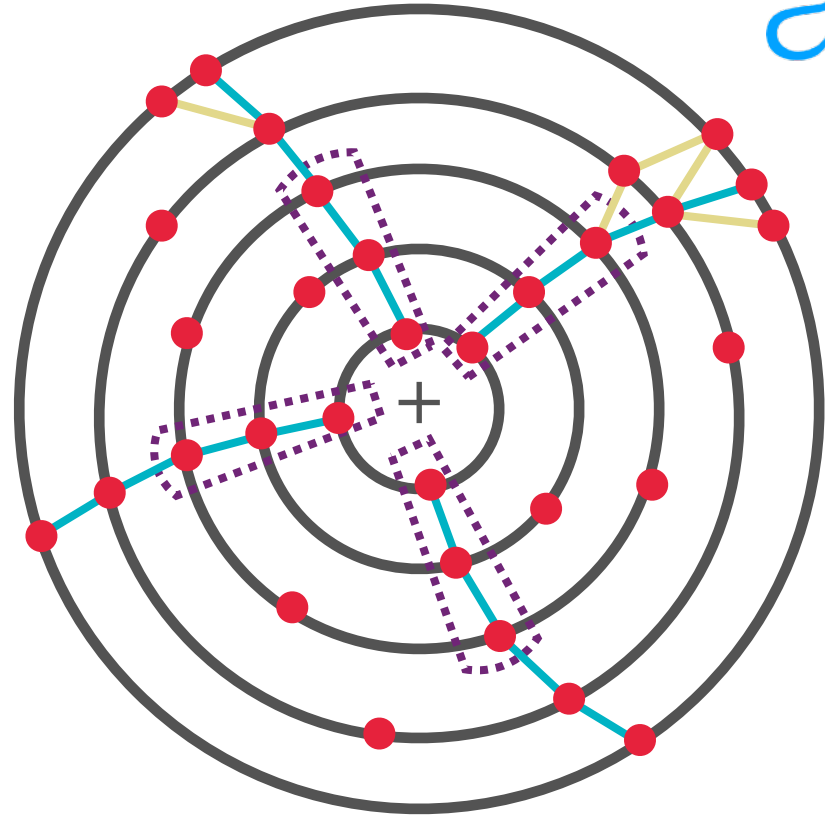
Track Seeding



Track Finding &
Fitting



Ambiguity Solving



ATLAS Tracking



Space point formation
Clustering



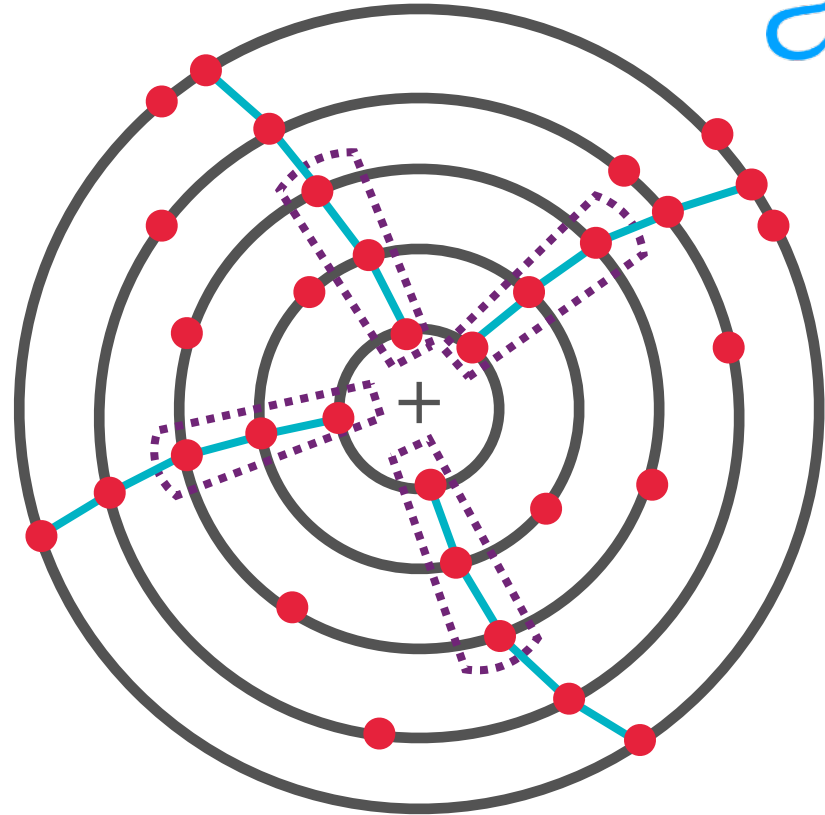
Track Seeding



Track Finding &
Fitting



Ambiguity Solving



ATLAS Tracking

Space point formation
Clustering



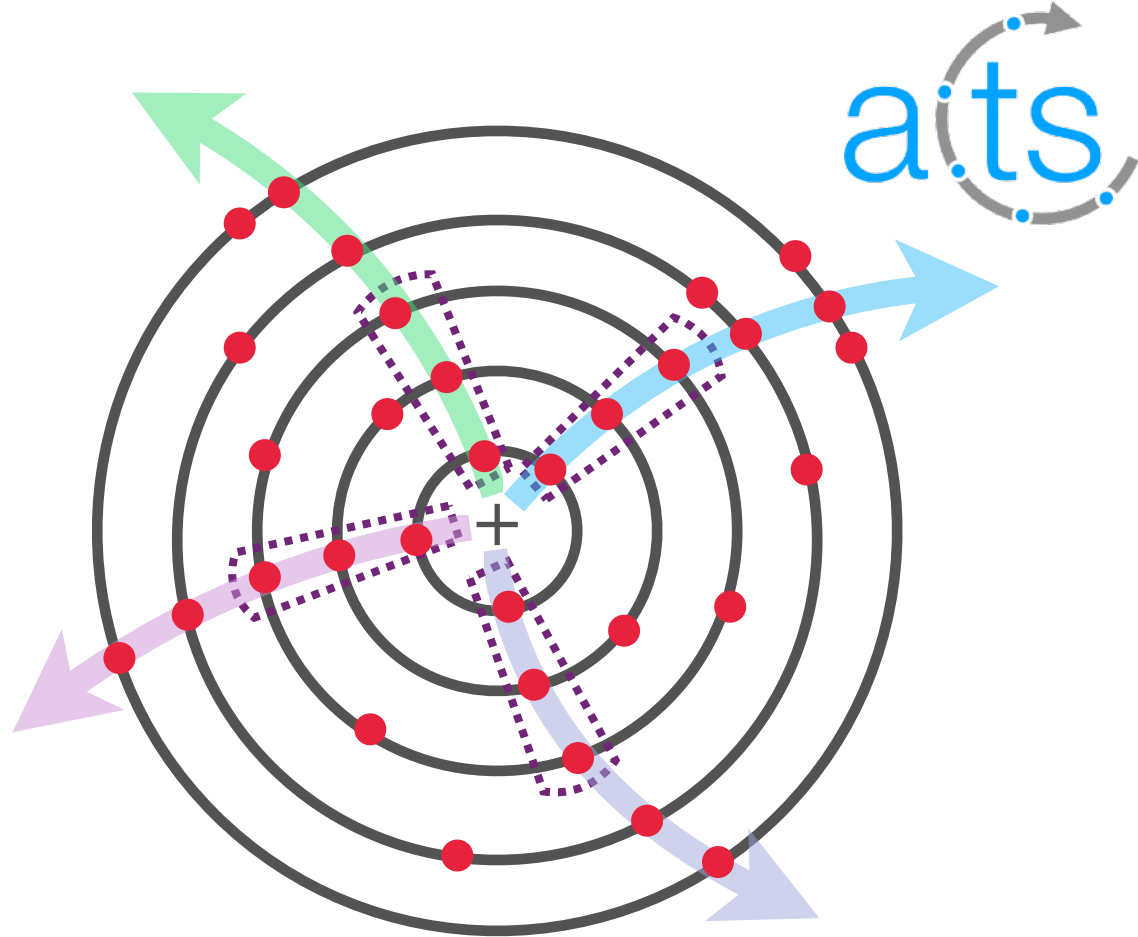
Track Seeding



Track Finding &
Fitting



Ambiguity Solving



Tracking with machine learning

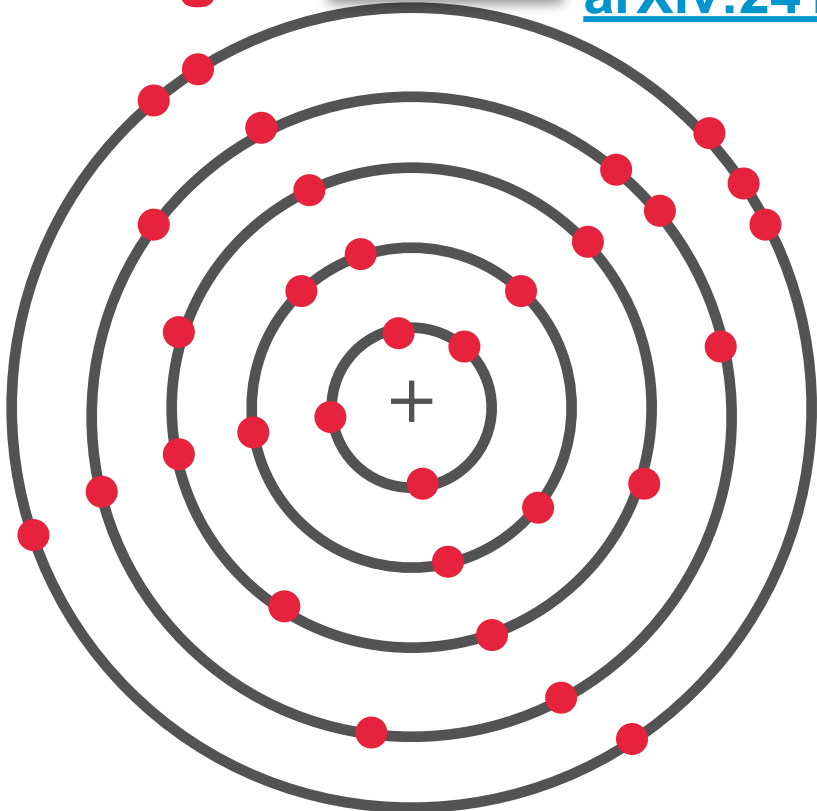


[arXiv:2304.02643](https://arxiv.org/abs/2304.02643)
[arXiv:2411.07149](https://arxiv.org/abs/2411.07149)

Space point formation
Clustering



Inference



Tracking with machine learning



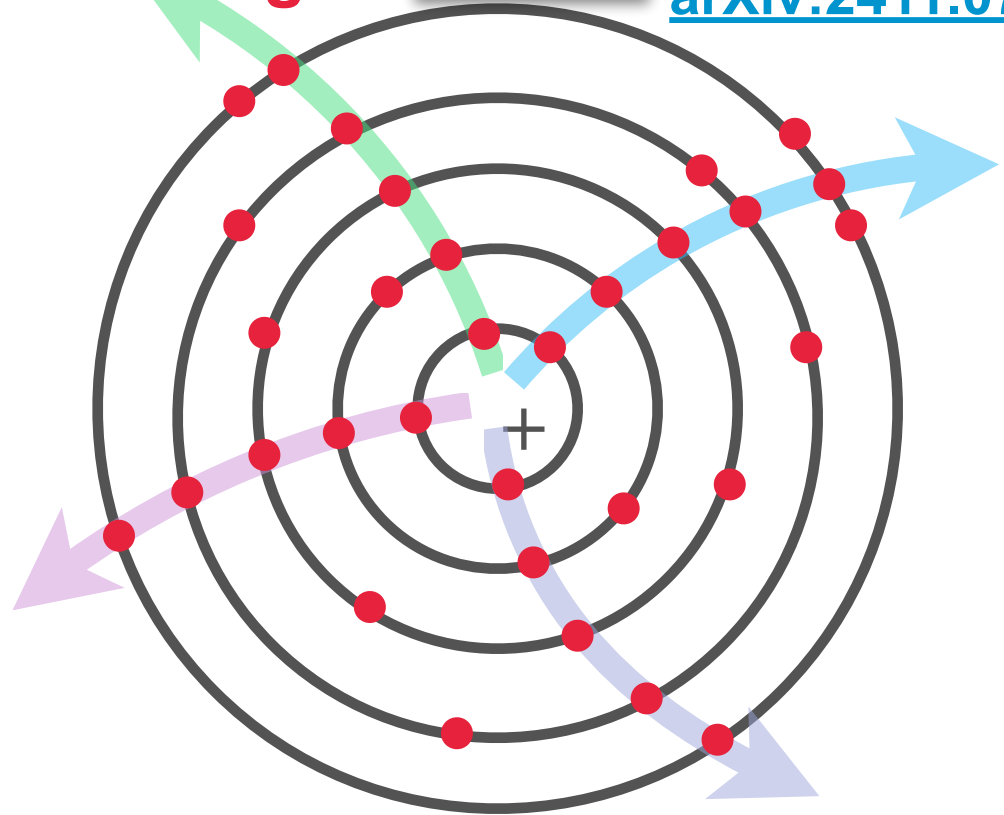
[arXiv:2304.02643](https://arxiv.org/abs/2304.02643)

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

Space point formation
Clustering



Inference



Tracking with machine learning



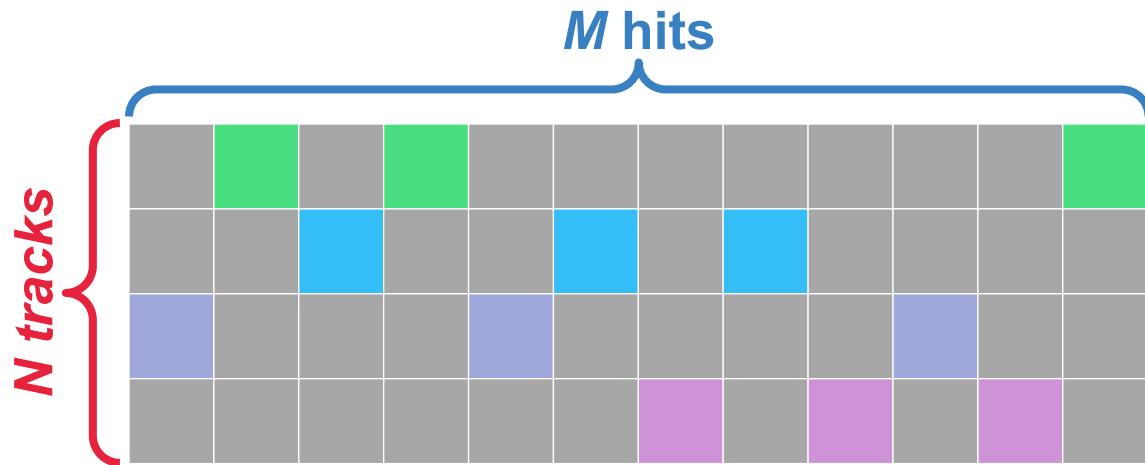
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[arXiv:2411.07149](https://arxiv.org/abs/2411.07149)

Space point formation
Clustering



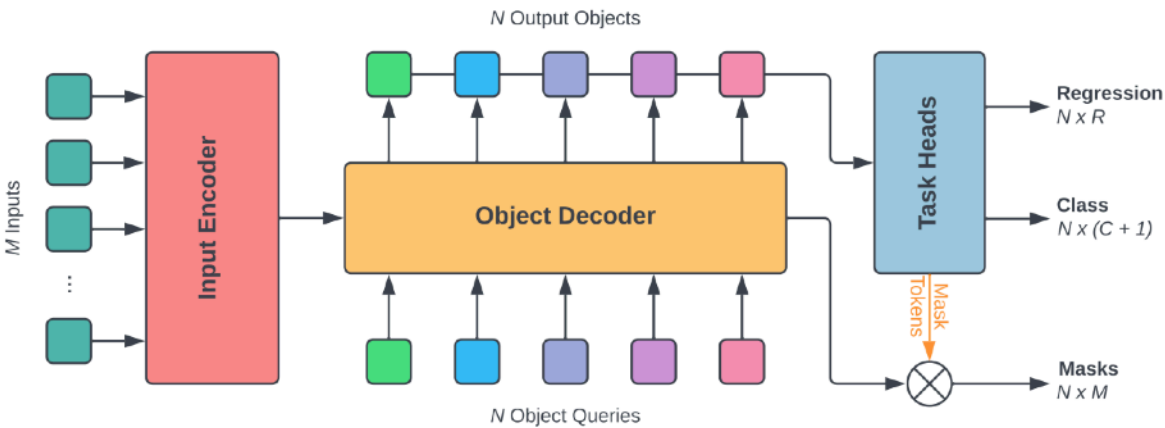
Inference



Tracking with machine learning



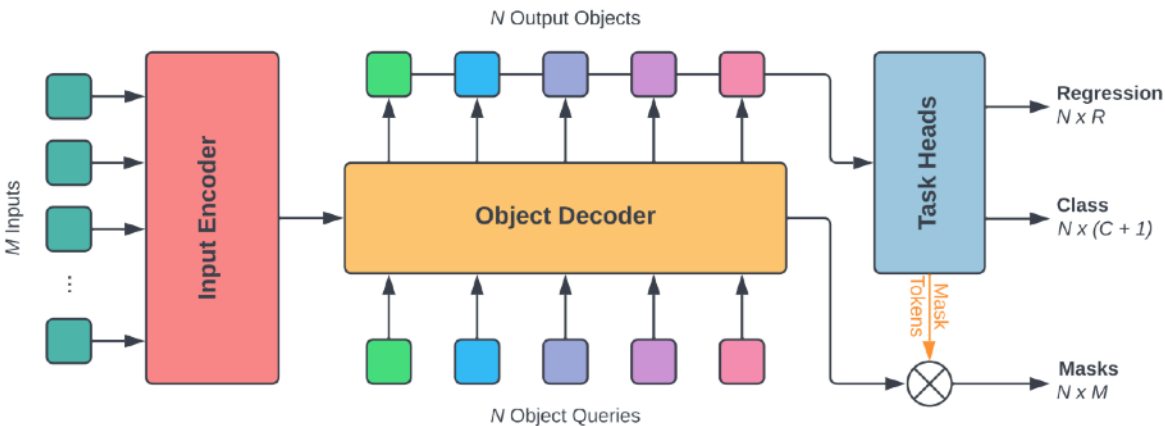
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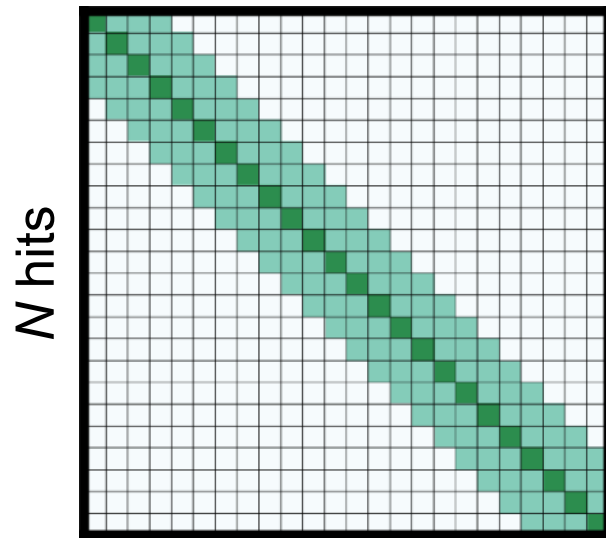
Tracking with machine learning



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



N hits

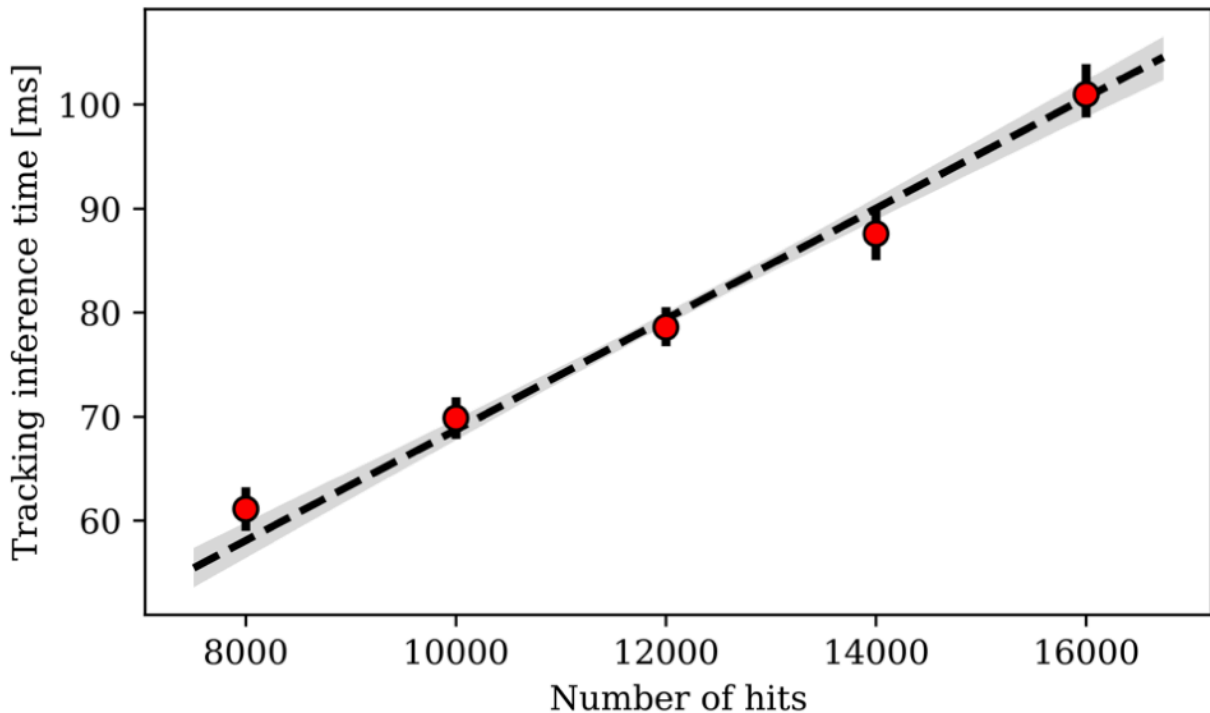


Sliding window attention

Tracking with machine learning



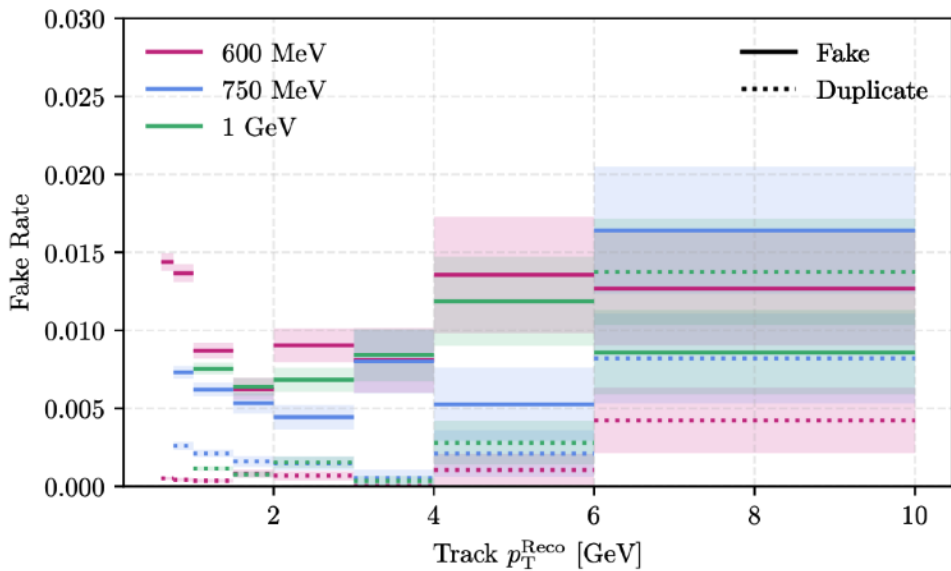
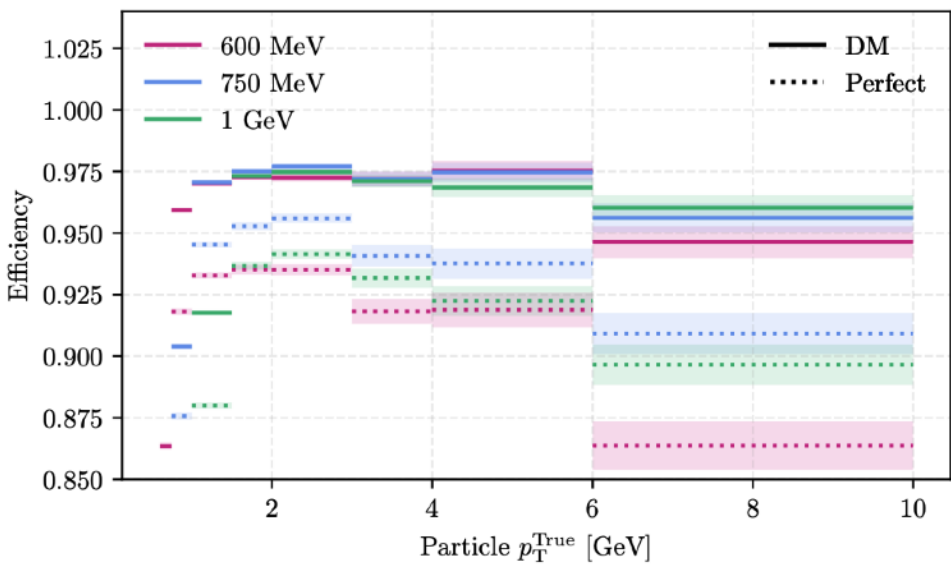
[arXiv:2304.02643](https://arxiv.org/abs/2304.02643)
[arXiv:2411.07149](https://arxiv.org/abs/2411.07149)



Tracking with machine learning



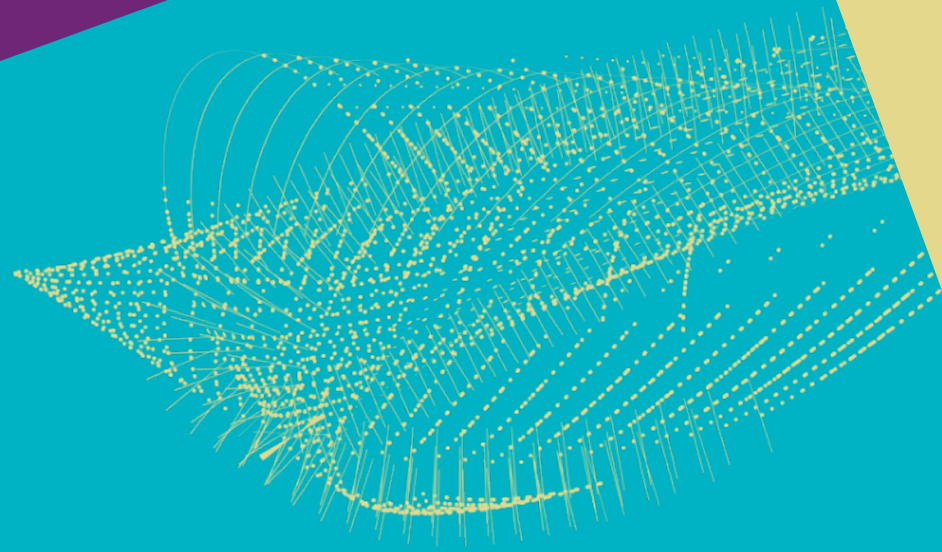
[arXiv:2304.02643](https://arxiv.org/abs/2304.02643)
[arXiv:2411.07149](https://arxiv.org/abs/2411.07149)



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!

Nikhef



THE HIGGS BOSON AND THE MYSTERY OF MATTER- ANTIMATTER ASYMMETRY

Robin Hayes for the ATLAS group

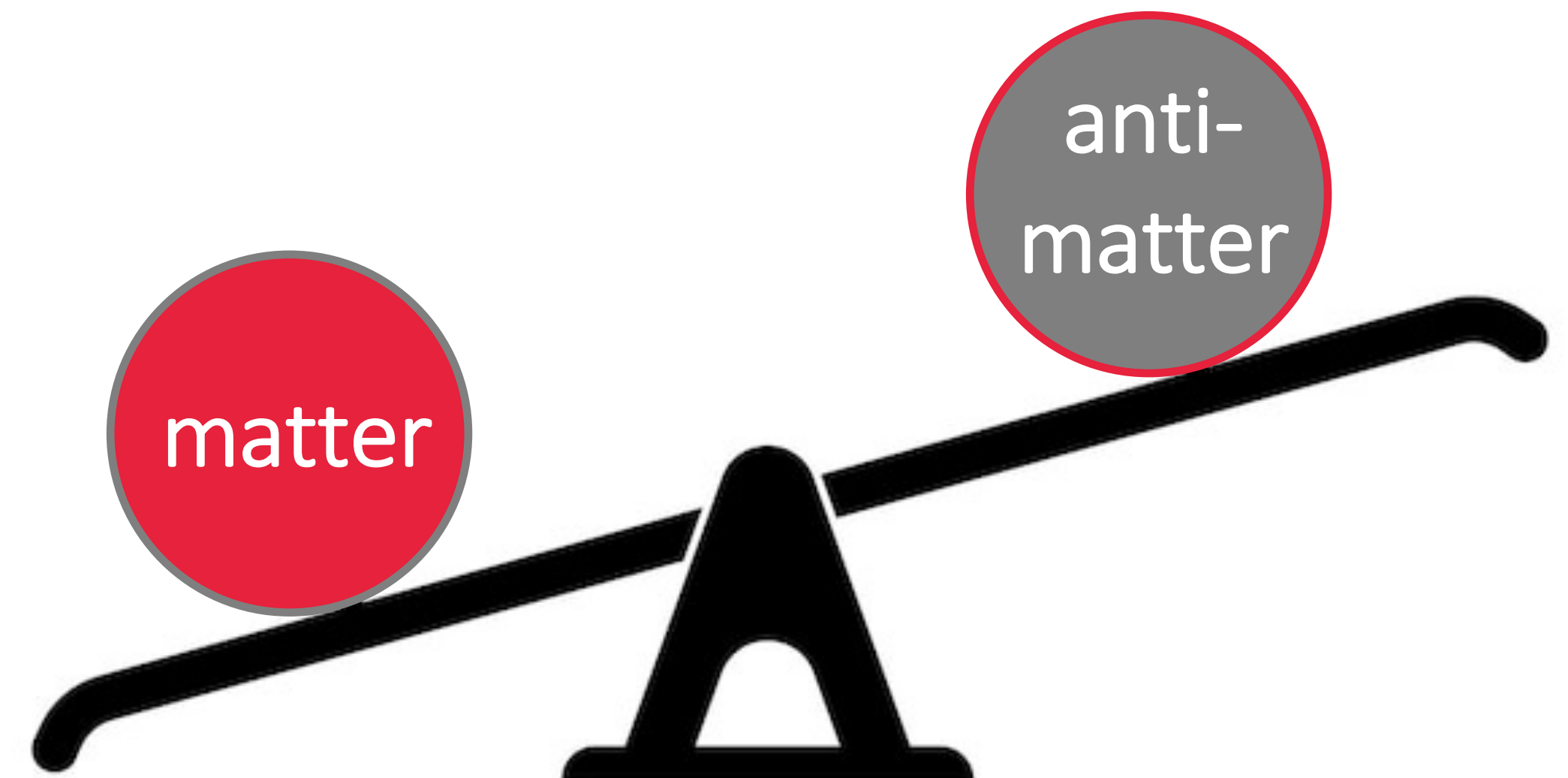
Nikhef Jamboree (May 11-12 2026)

Why is the Universe Mostly Matter?

Following the Big Bang:
for every **10^8 matter particles**, there
were **$10^8 - 1$** anti-matter particles.

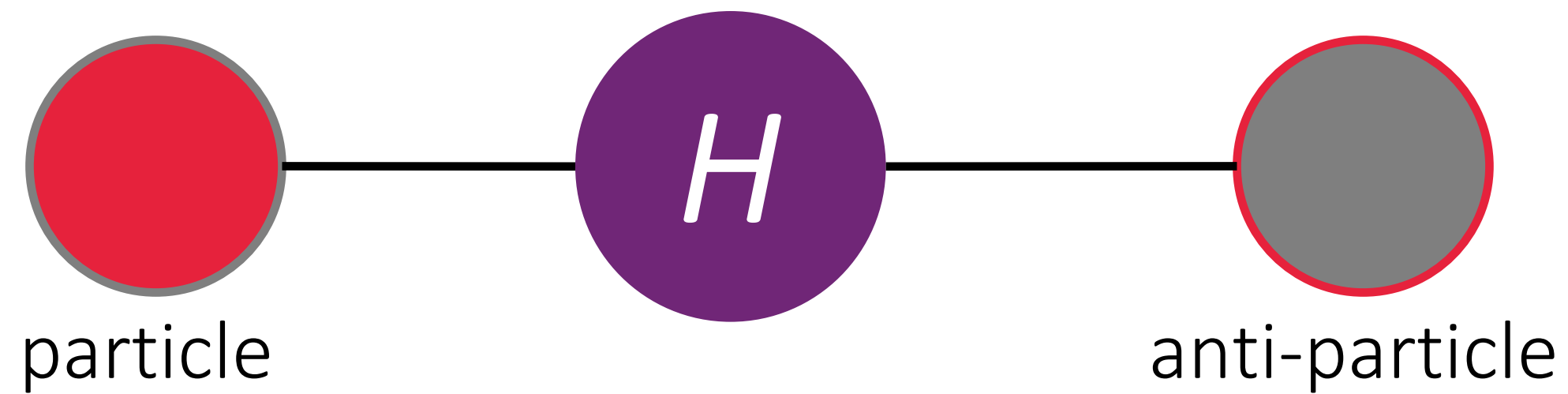
The Standard Model (SM) can't
account for this asymmetry!

For answers: the Higgs
boson?



For Answers: the Higgs Boson?

Predicted by the SM:

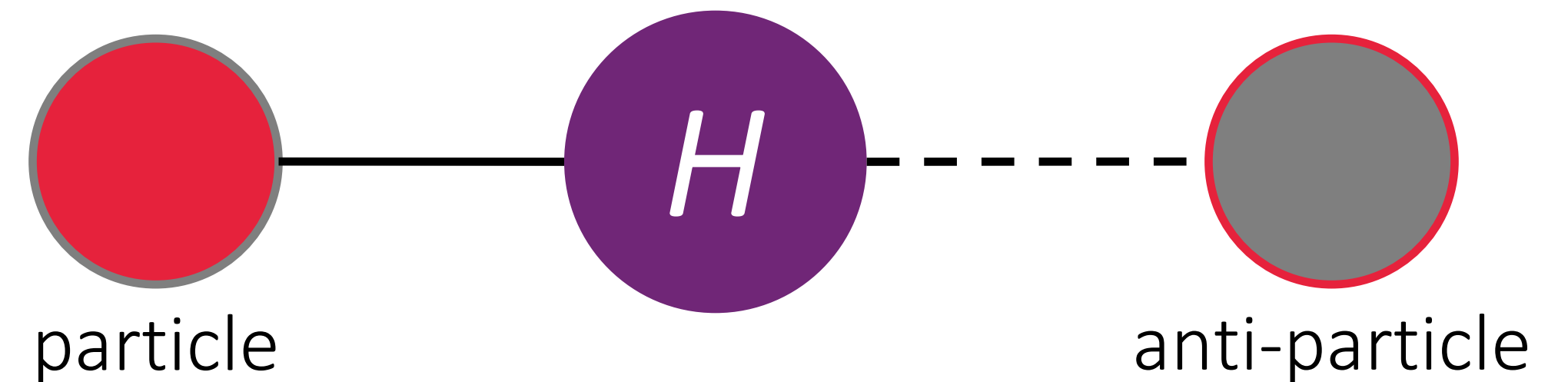


- Higgs interacts identically with particles and antiparticles

No matter-antimatter asymmetry*

*actually just very small

Predicted by alternate theories:



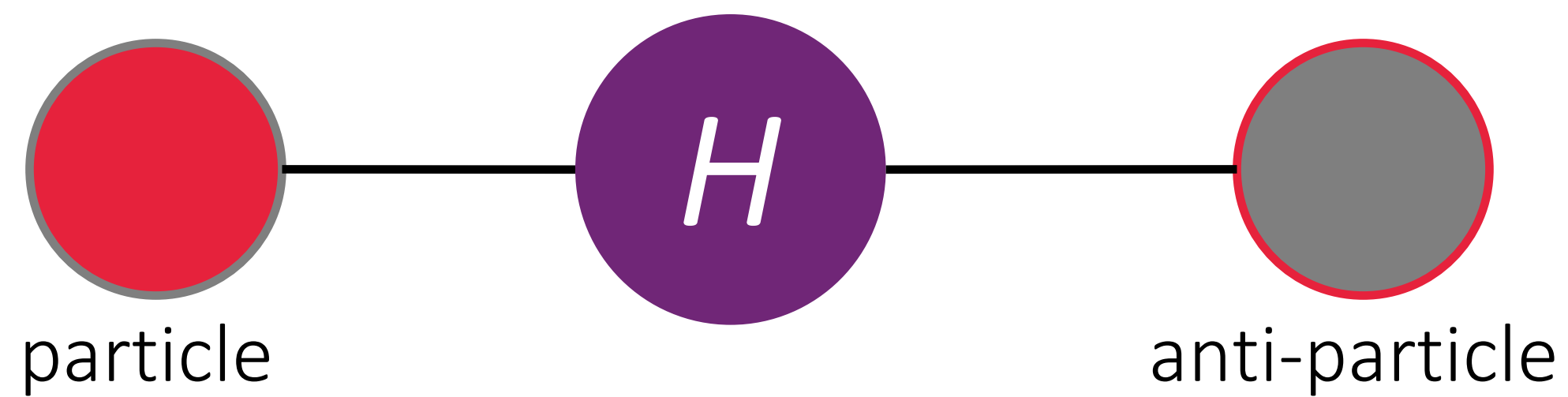
- Higgs interacts differently with particles and antiparticles

Matter-antimatter asymmetry*

*if some other conditions are also satisfied

For Answers: the Higgs Boson?

Predicted by the SM:

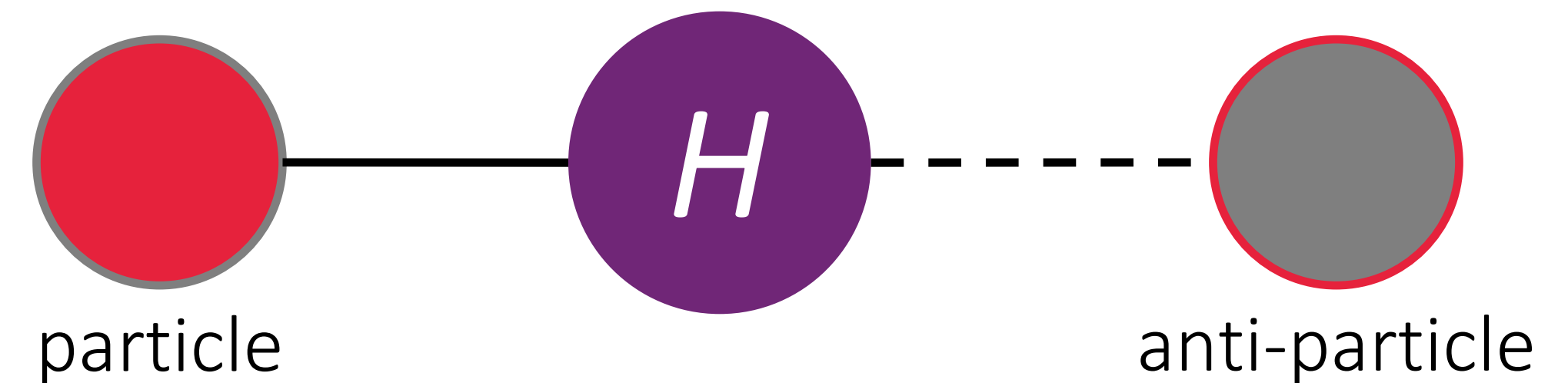


- Higgs interacts identically with particles and antiparticles

No matter-antimatter asymmetry*

*actually just very small

Predicted by alternate theories:



- Higgs interacts differently with particles and antiparticles

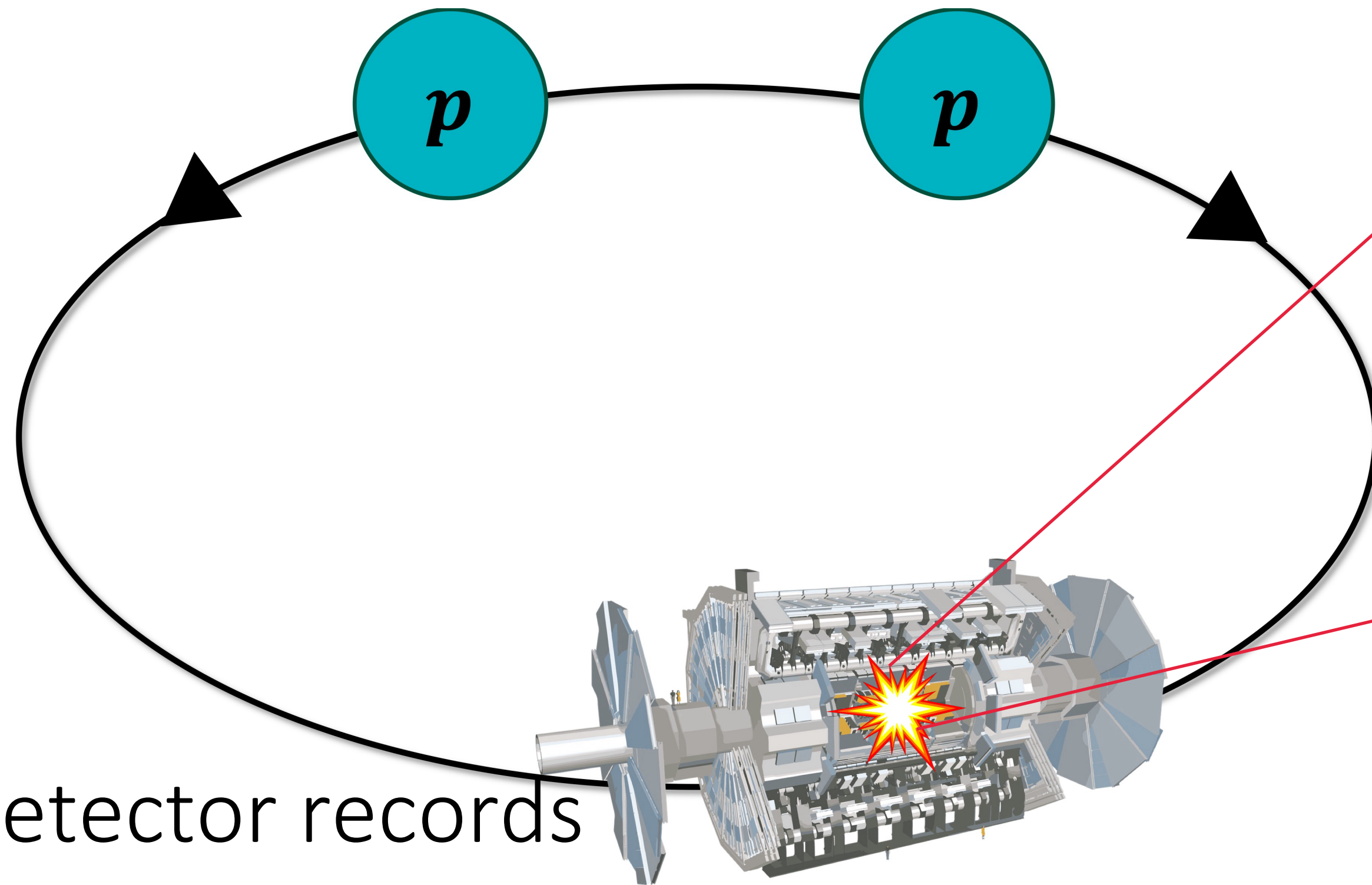
Matter-antimatter asymmetry*

*if some other conditions are also satisfied

Charge-parity (CP) violation

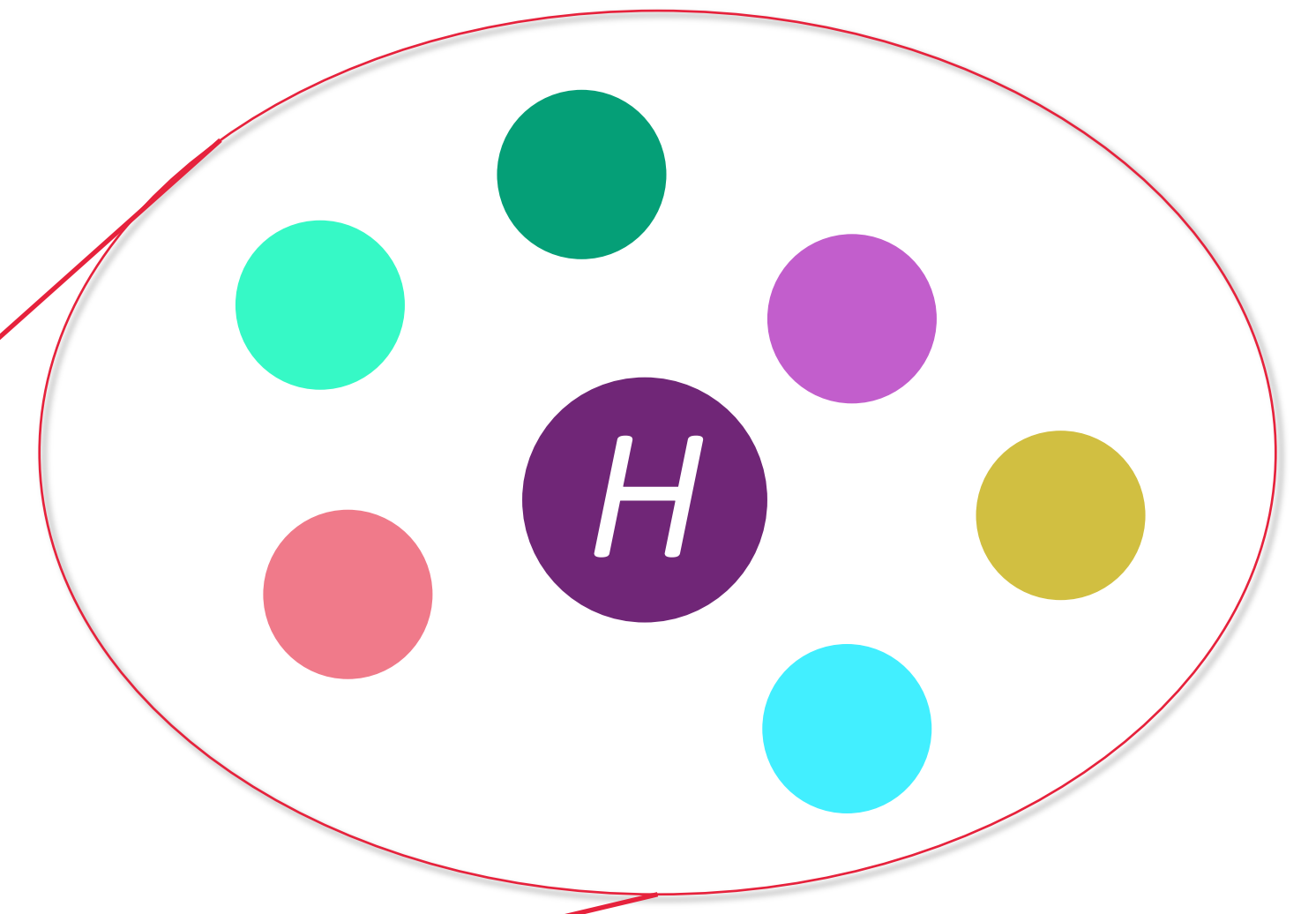
Looking for CP Violation at the Large Hadron Collider

1. High-energy proton beams accelerated at the LHC.



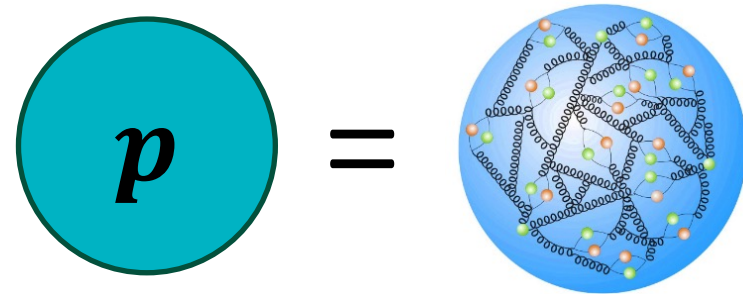
2. ATLAS detector records collision products.

3. Proton collisions produce new particles... including Higgs bosons!



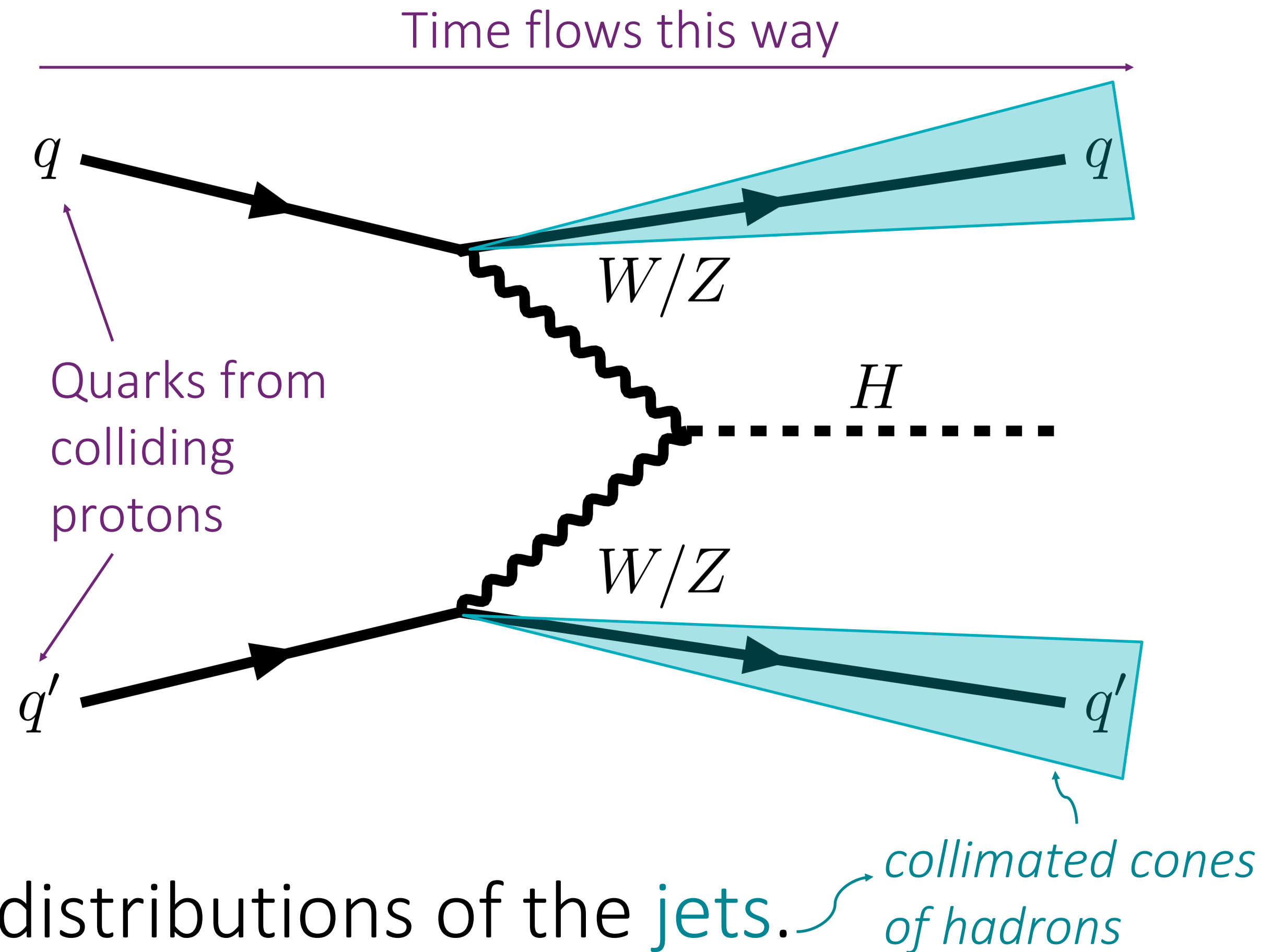
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Higgs produced by interaction of quarks and gluons in the proton.



One mechanism:
vector boson fusion (VBF).

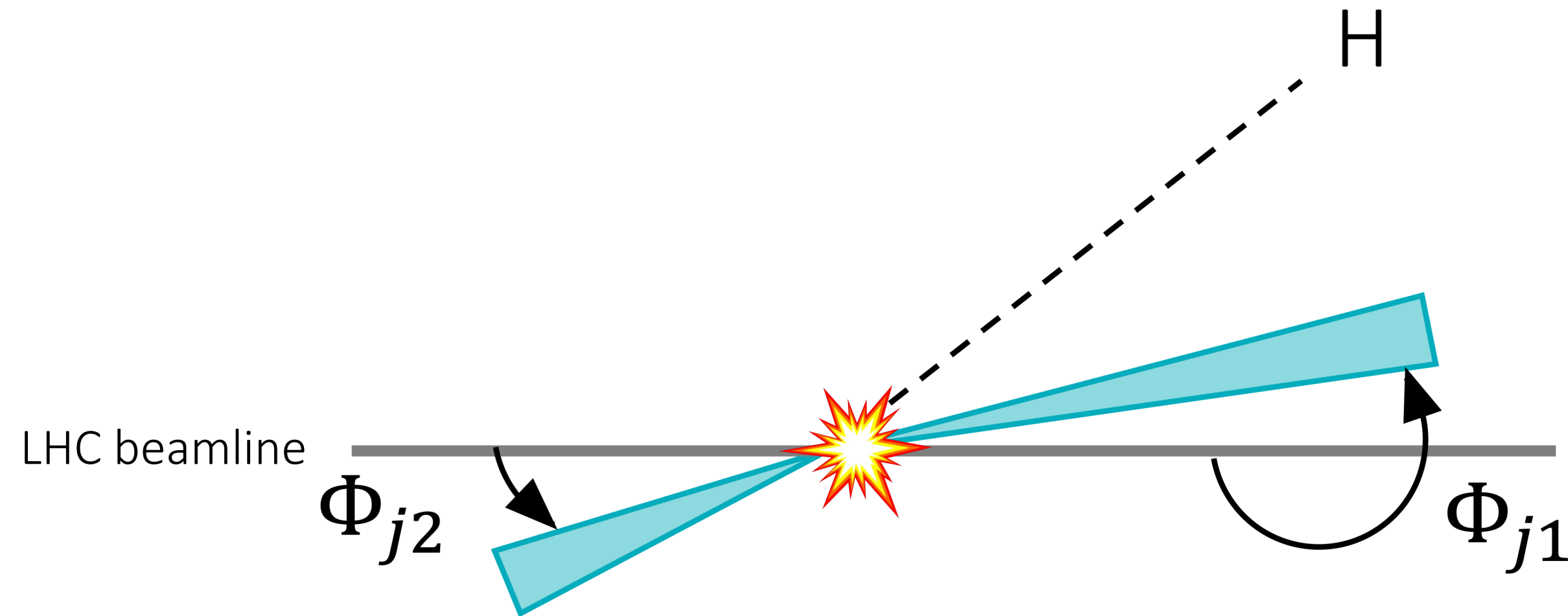
CP violation would change angular distributions of the **jets**.



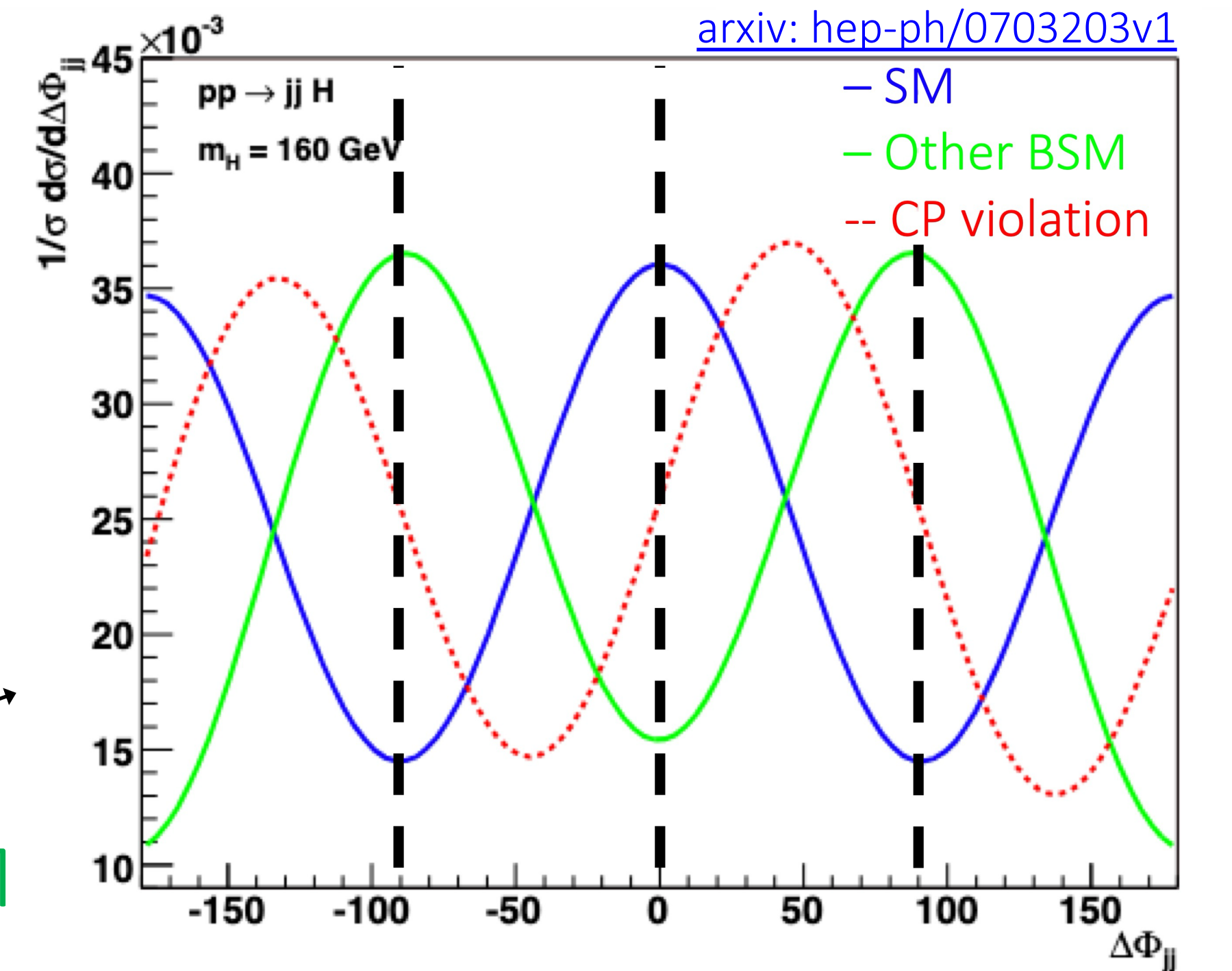
CP Violation in Vector Boson Fusion

Variable sensitive to CP violation: $\Delta\Phi_{jj}$.

- Azimuthal angle difference b/w the two jets, ordered by their angle wrt the beamline.

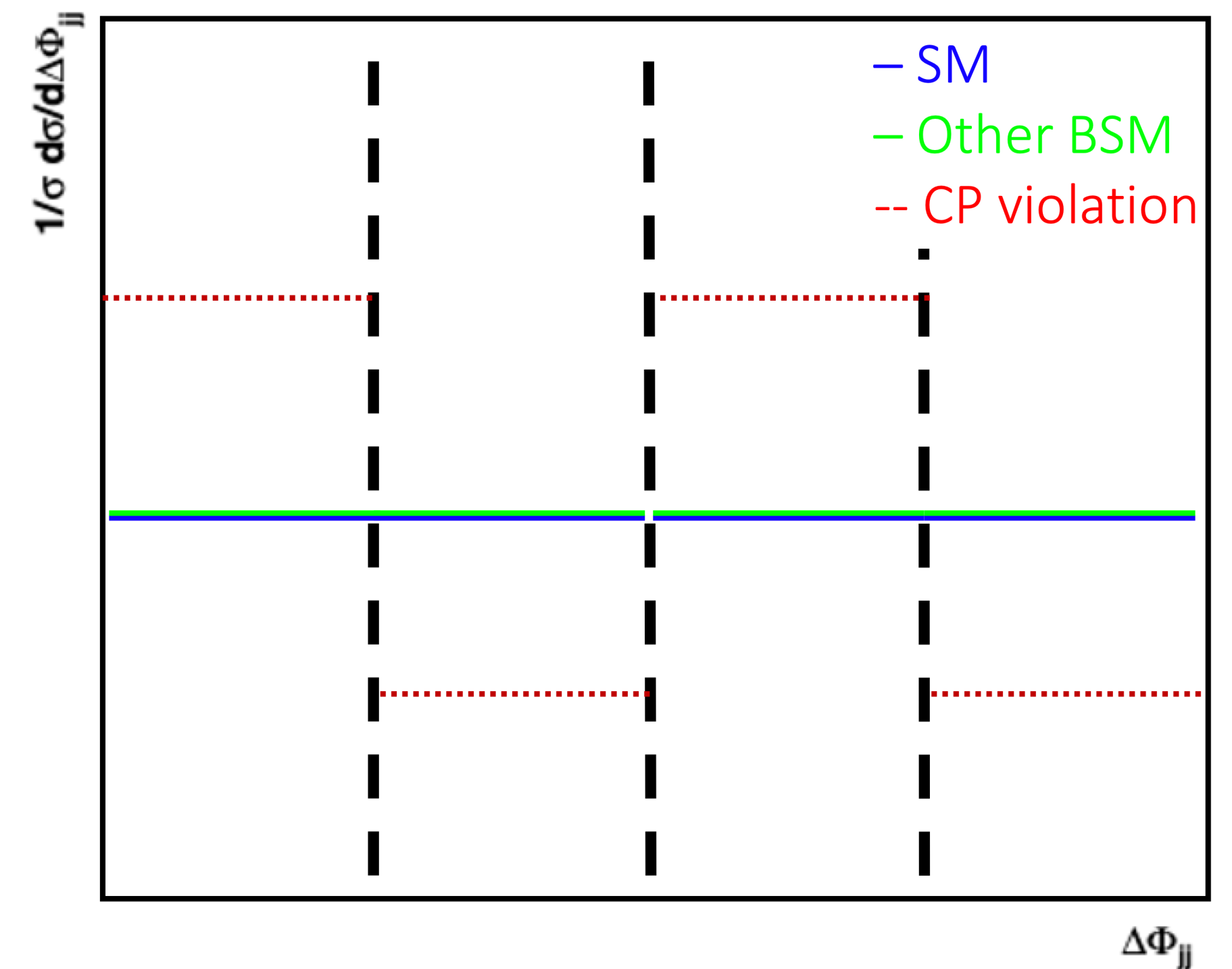
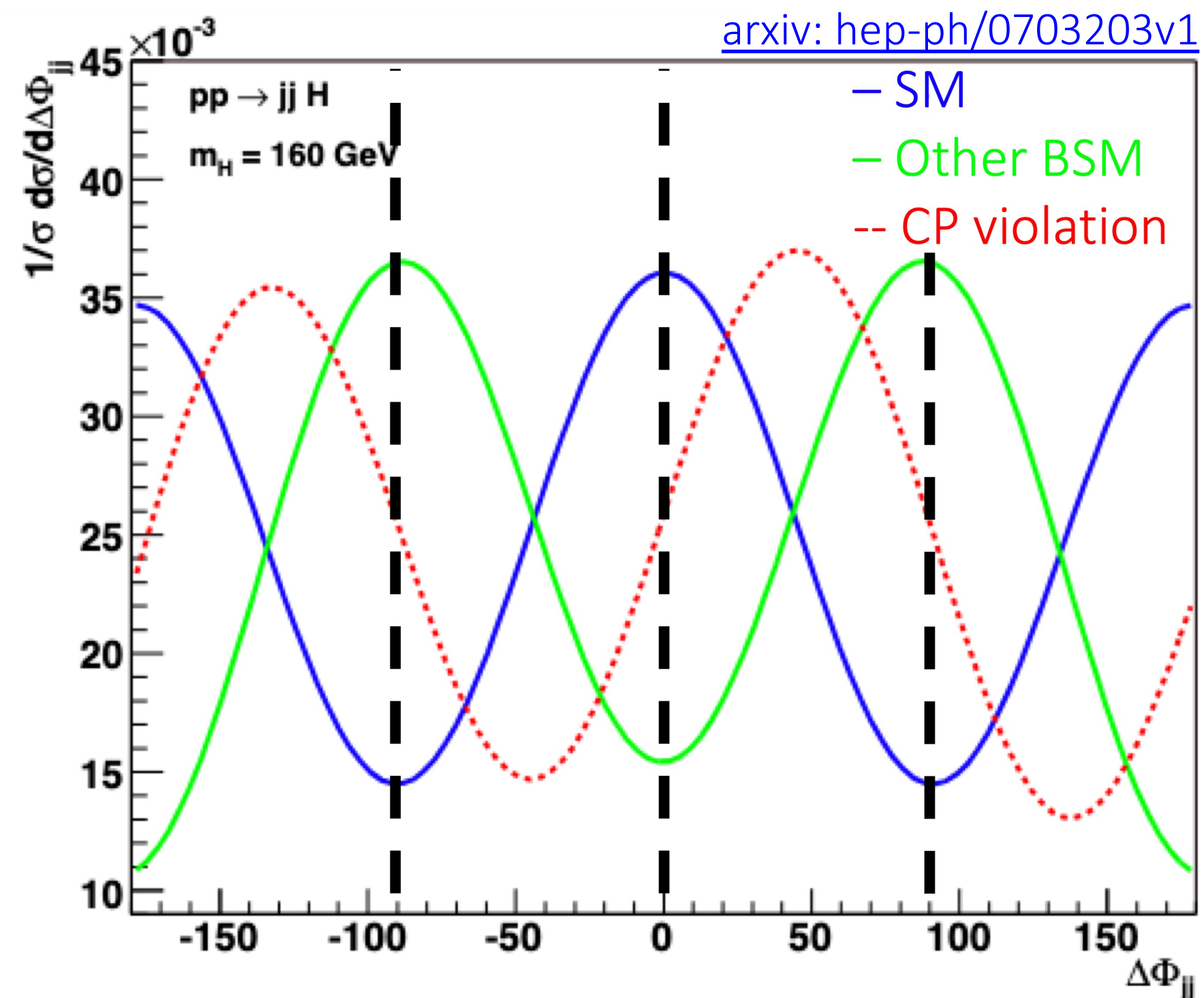


$\Delta\Phi_{jj}$ is: symmetric for SM
symmetric for non-CP-violating beyond SM
asymmetric for CP violation



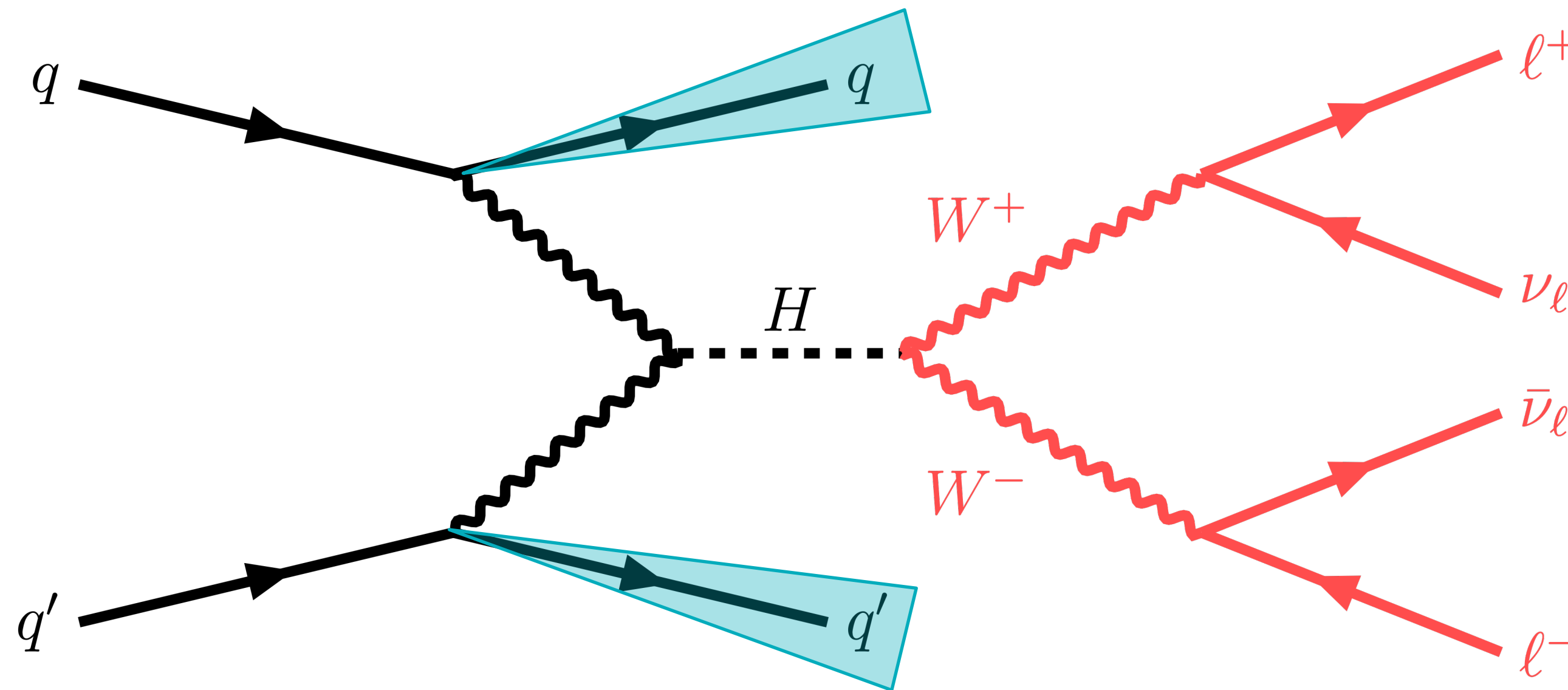
Measurement Strategy

- Four distinct bins capture the major shape effects.



Measurement Strategy

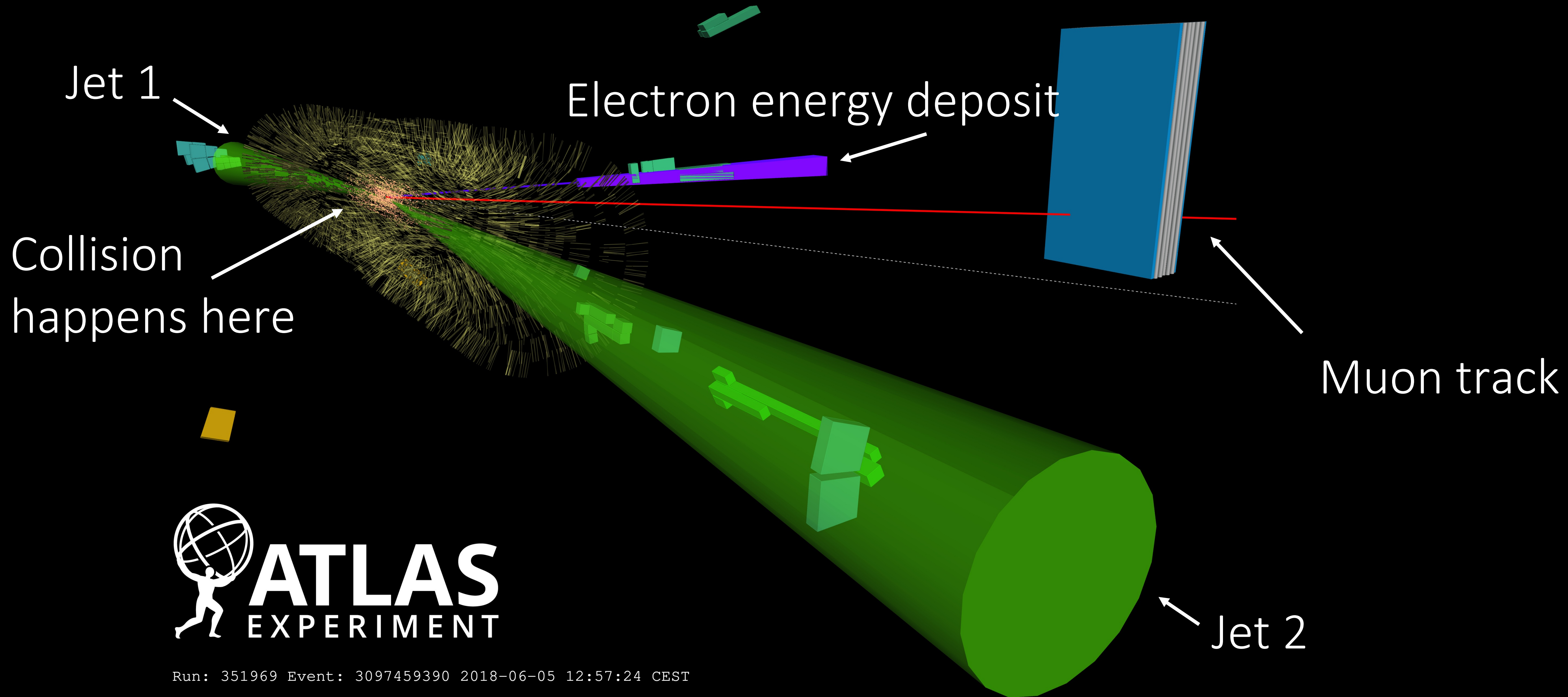
- The Higgs boson lives for 10^{-22} s \rightarrow look for its decay to W bosons, then to leptons (e/μ) and neutrinos.



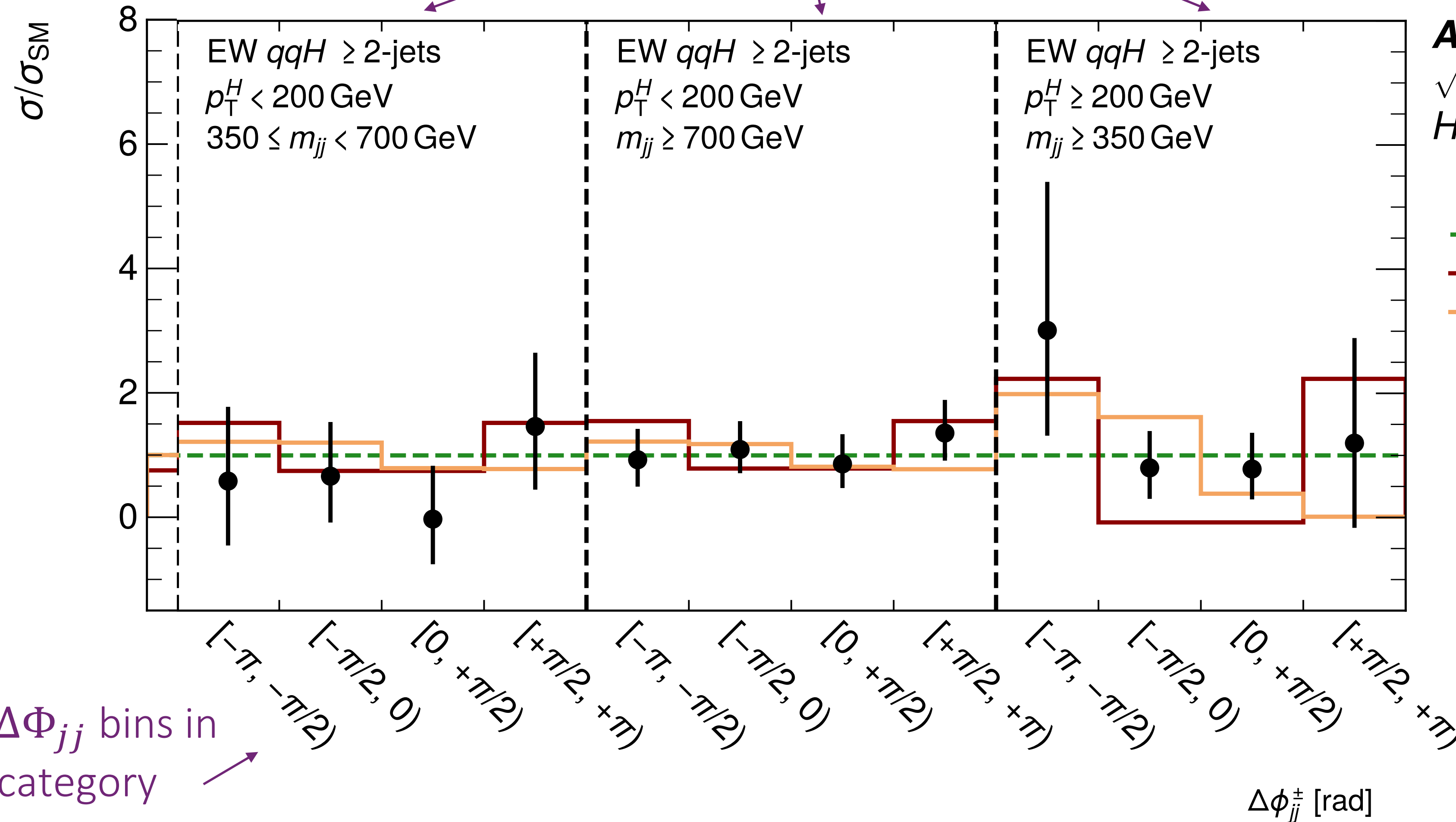
Detect:

- 2 jets
- two leptons (e/μ)
- missing energy from neutrinos

Typical event in the ATLAS detector:



Three main categories for sensitivity



ATLAS

$\sqrt{s} = 13$ TeV, 140 fb^{-1}
 $H \rightarrow WW^* \rightarrow \ell\nu\ell\nu$

Four $\Delta\Phi_{jj}$ bins in each category

Measurement is symmetric in $\Delta\Phi_{jj} \rightarrow$ no CP violation ☹️

Conclusion

- First time probing CP violation in VBF $H \rightarrow WW^*$.
- Measurement strategy enables combination with others for stronger results [[arXiv:2603.20117](https://arxiv.org/abs/2603.20117)].
- No sign of CP violation here yet!

