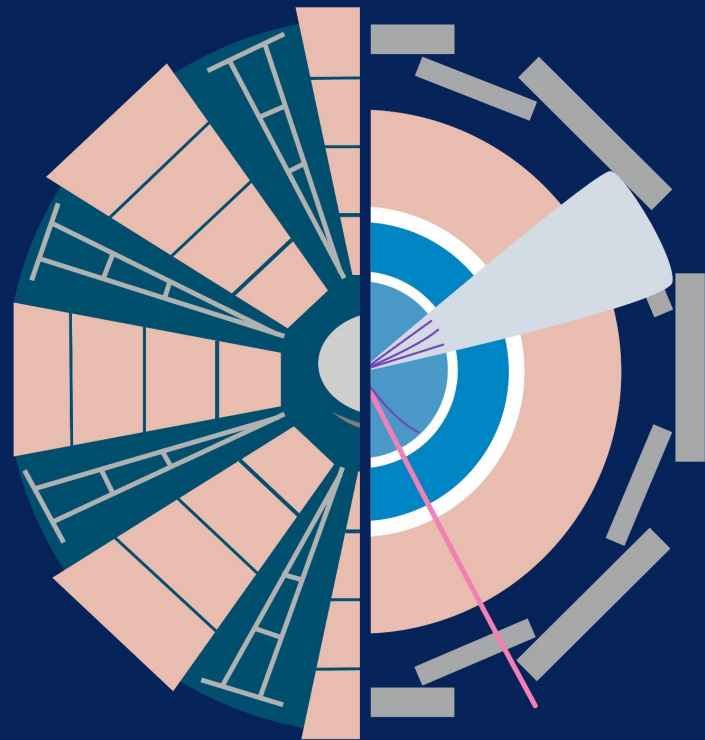# ATLAS Sweden

Summary of ongoing activities
Partikeldagarna, 24-25 November 2025
Chalmers, Göteborg

Sten Åstrand, Lund
on behalf of the ATLAS groups at
Uppsala University   **Stockholm University**
KTH   **Lund University**

ATLAS RUN 3
LARGE HADRON COLLIDER
est. 2022 at 13.6 TeV

ATLAS

General purpose particle detector

World-wide collaboration of more than 5000 people
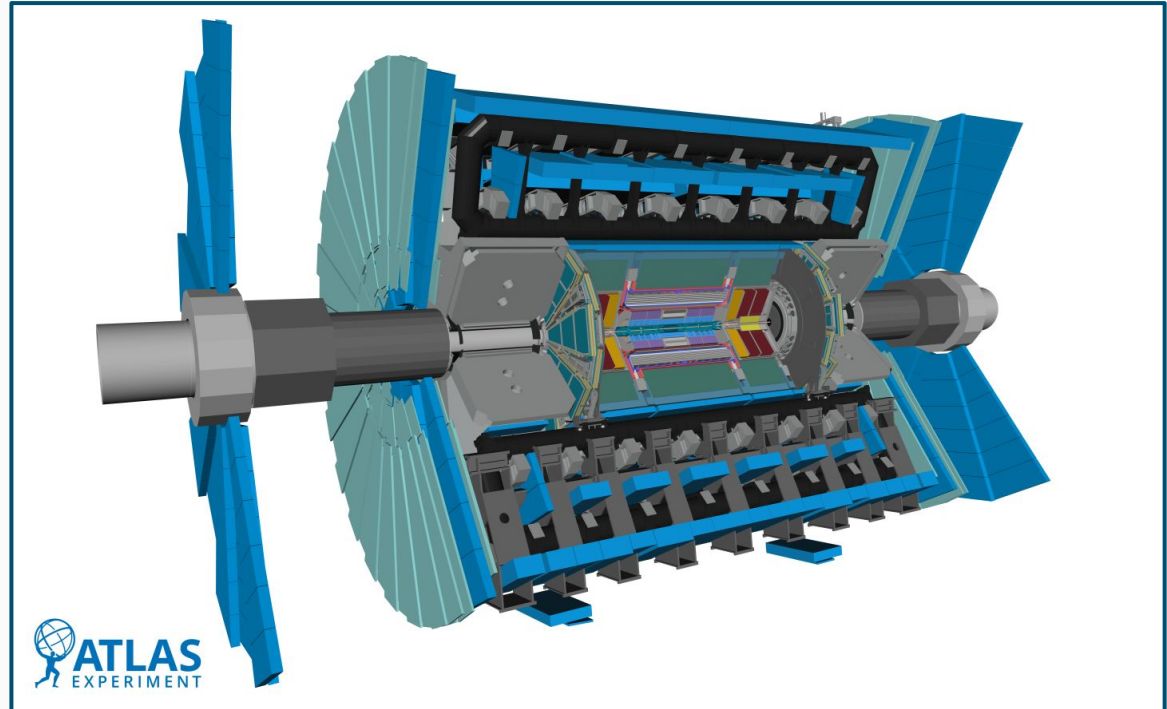
In Sweden: 39 ATLAS authors

Image credit: The ATLAS Collaboration

ATLAS

General purpose particle detector

World-wide collaboration of more than 5000 people
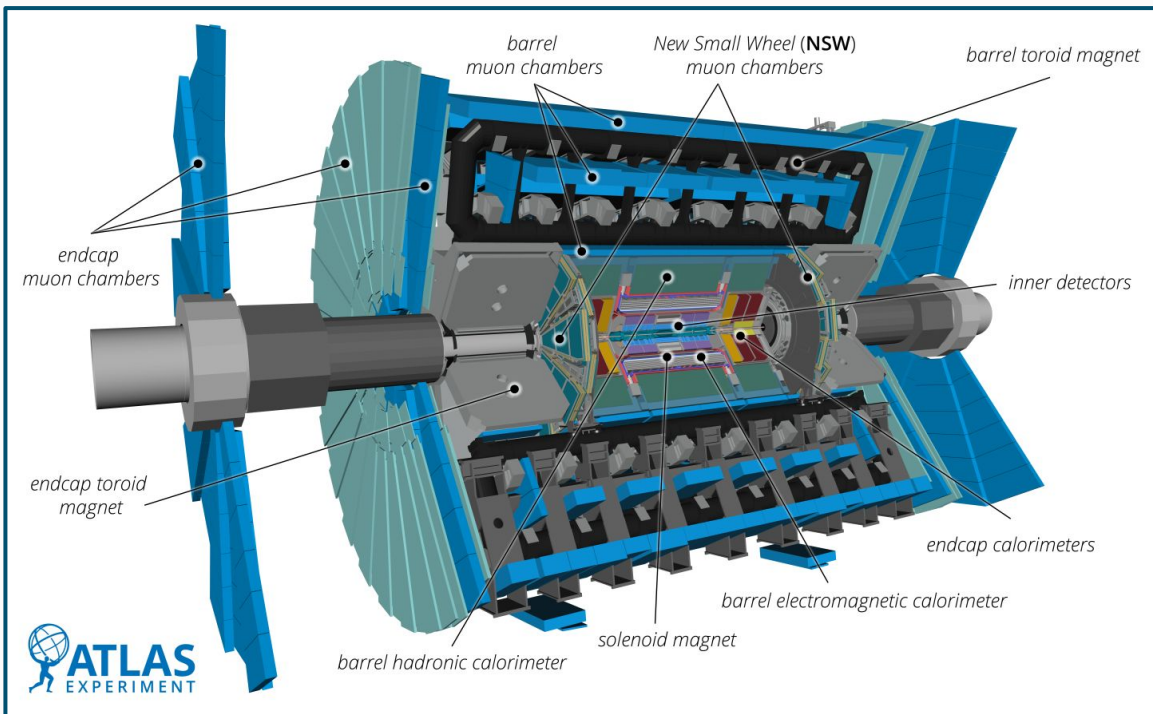
In Sweden: 39 ATLAS authors

Image credit: The ATLAS Collaboration

Outline

- Operations and performance

- Upgrade projects

- Physics analyses

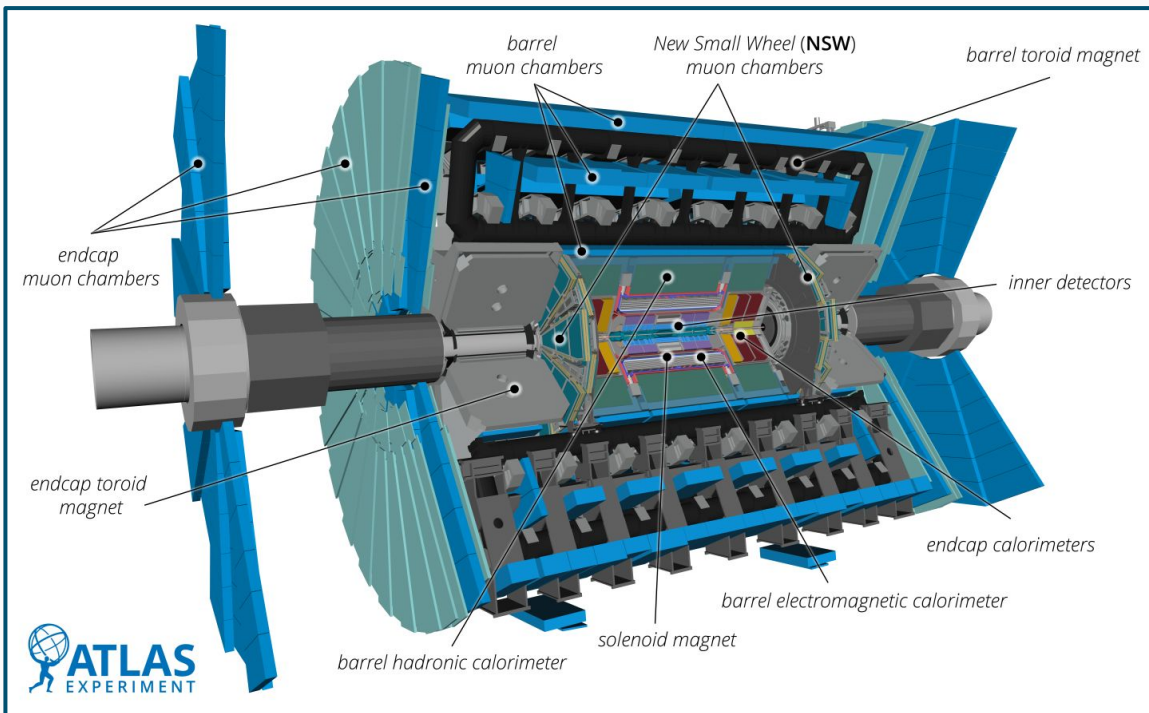Image credit: The ATLAS Collaboration

Operations and performance

ATLAS Control Room shifts

Expert on-call shifts for detector subsystems

Software

Calibrations

Data quality monitoring

Etc.

The ATLAS Control Room

Image credit: CERN

Operations and performance

ATLAS Control Room shifts

Expert on-call shifts for detector subsystems

Software

Calibrations

Data quality monitoring

Etc.

The ATLAS Control Room

Image credit: CERN

Operations and performance

Swedish involvement (bold: recently appointed)

- **Christina Dimitriadi, KTH, Online Luminosity Subgroup Convener**
- **Jonas Strandberg, KTH, Luminosity Phase-II Upgrade Convener**
- **Giulia Ripellino, Uppsala, Luminosity Convener**
- Elin Bergeås Kuutmann, Uppsala, Data Quality Convener
- **Antonia Strübig, SU, ATLAS Trigger Coordinator**
- **David Brunner, SU, Inner Tracker Alignment Subgroup Convener**
- Eduardo Valdes Santurio, SU, Tile Calorimeter Phase-II Upgrade Electronics Coordinator
- Oxana Smirnova, Lund, Nordic Tier 1 Computing Coordinator (WLCG)

Plus many contributions to operations and performance tasks

Total Swedish non-physics-analysis work 2024: 17.5 FTEs
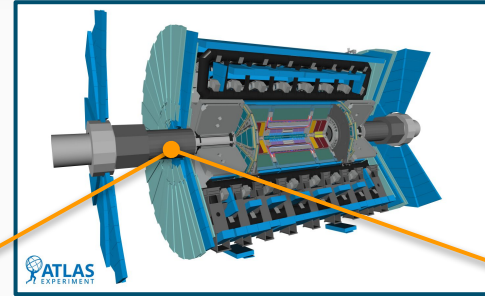
LUCID - LUminosity Cherenkov Integrating Detector

Recent tests in high-intensity beam conditions

LUCID photomultiplier tube with shielding

Image credit: Vincent Hedberg

Flavor tagging calibration using Optimal Transport, SU [ref.]

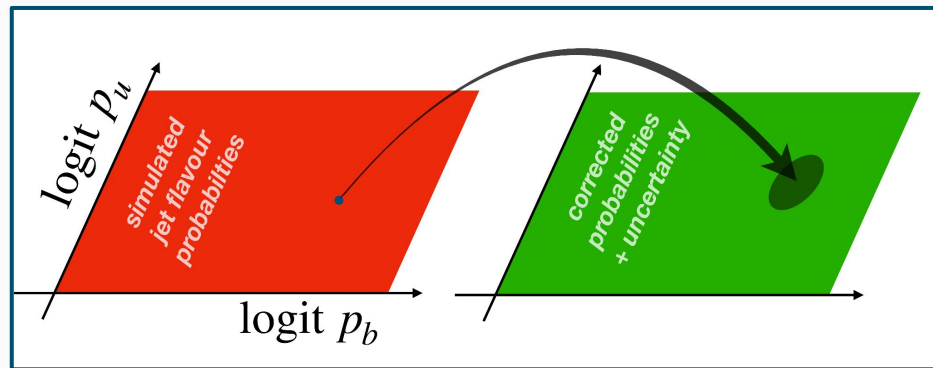- ML-based, continuous correction of quark flavor probability density in simulation vs. data

Image from [ref.]

Multi-threading in Athena (ATLAS software framework), Uppsala. Joint work with the University of Oslo.

Operations and performance

Recorded luminosity in 2025
119 fb^{-1}

Recorded in Run 2 (2015-2018)
147 fb^{-1}

2025 Higgs bosons

119 fb^{-1} · 60 pb ≈ 7.1 million
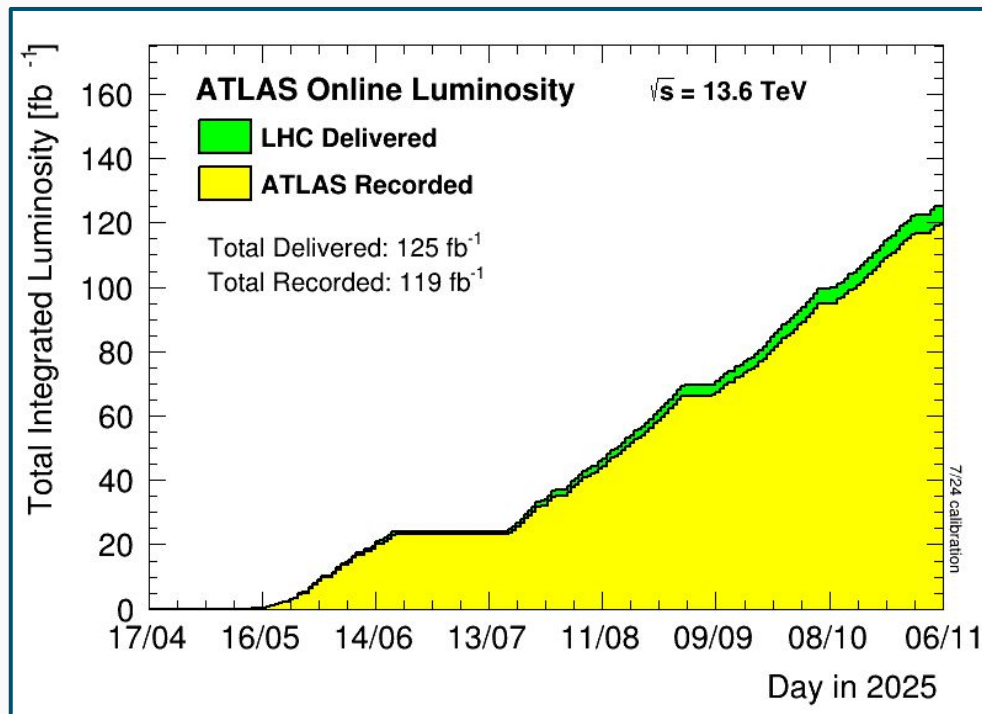
Image credit: The ATLAS Collaboration

Upgrade projects

Run 4 and the high-luminosity LHC

60 (2025)

140

Average simultaneous proton-proton collisions
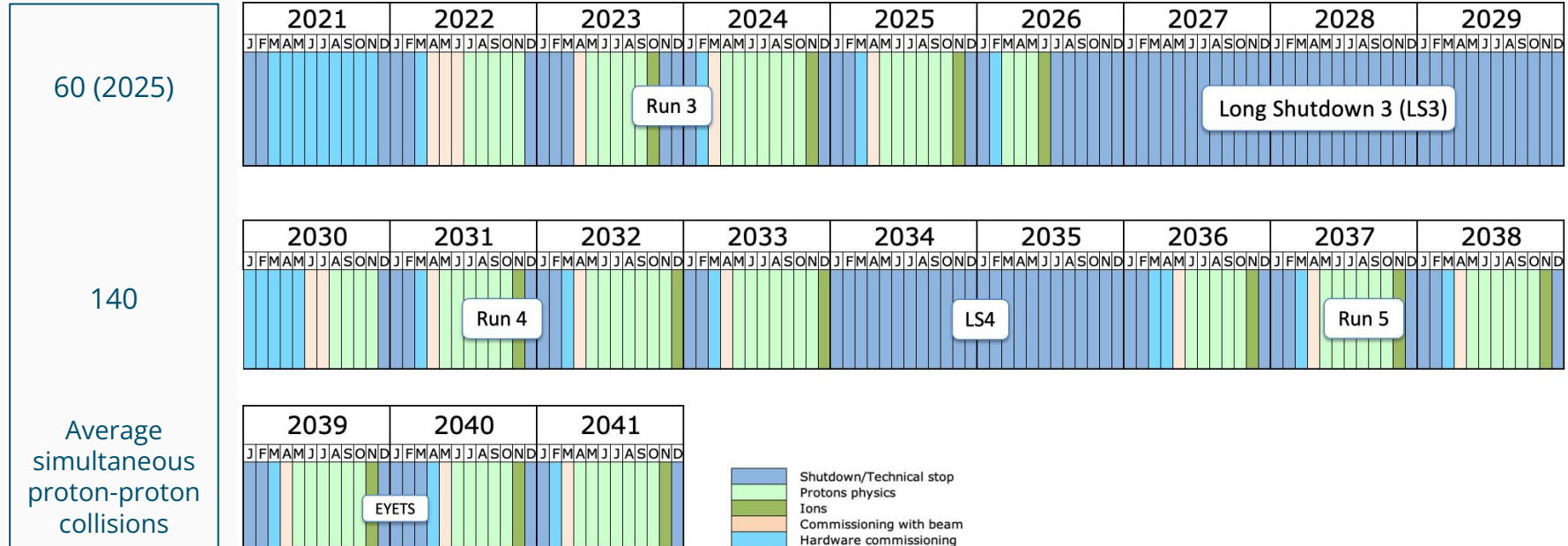
Image credit: CERN

Upgrade projects

ITk - the Inner Tracker Upgrade, Uppsala, Lund

Strip Barrel
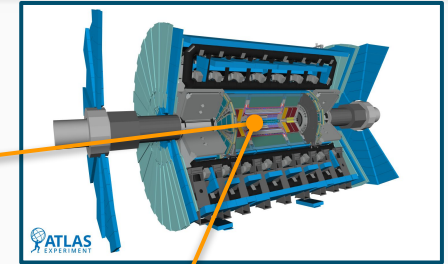
Strip Endcap

Pixel Inner Layers

Pixel Outer Barrel

Pixel Endcap

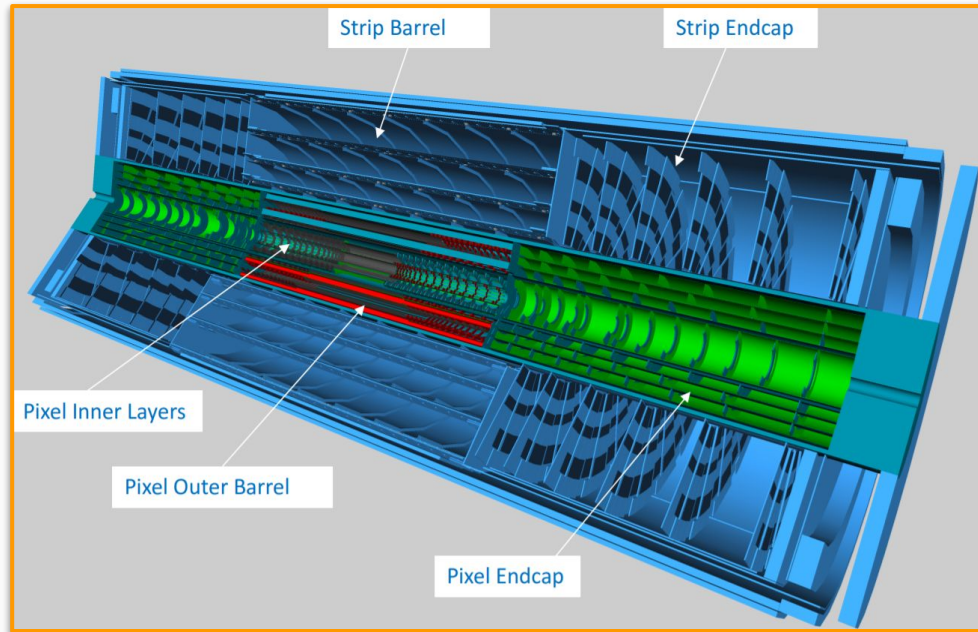Image credit: The ATLAS Collaboration

Upgrade projects

ITk - the Inner Tracker Upgrade, Uppsala, Lund

Uppsala + industrial partner
Circuit boards for strip detectors

Image credit: Geoffrey Mullier

Strip Barrel

Strip Endcap

Pixel Inner Layers

Pixel Outer Barrel

Pixel Endcap

Image credit: The ATLAS Collaboration

Upgrade projects

ITk - the Inner Tracker Upgrade, Uppsala, Lund

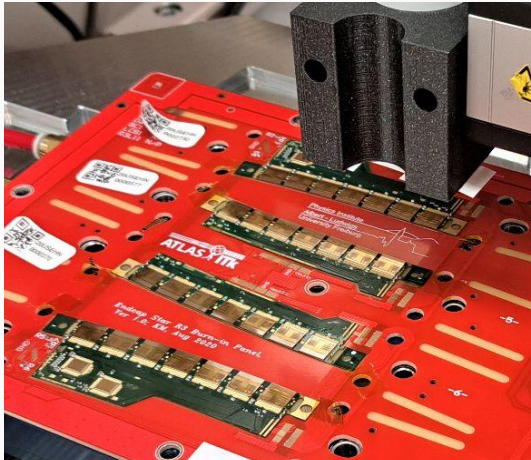**Uppsala + industrial partner**
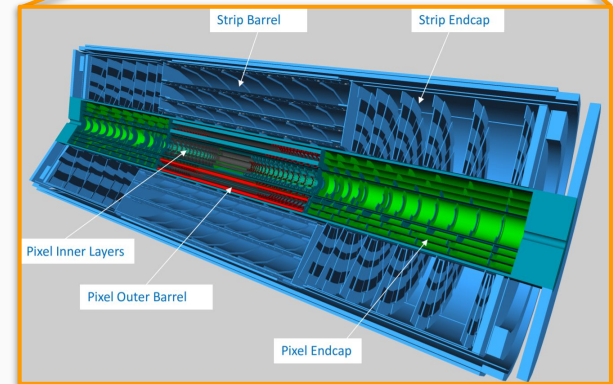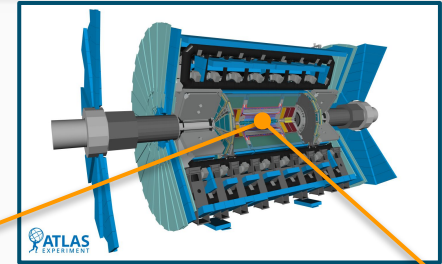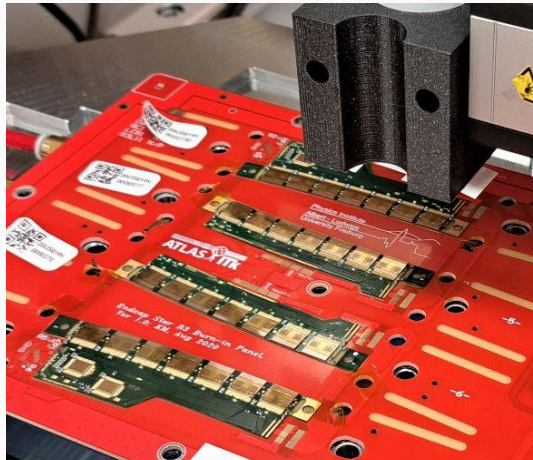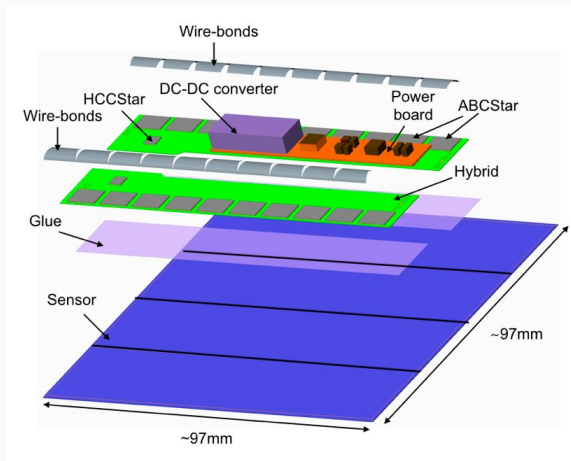Circuit boards for strip detectors

Image credit: Geoffrey Mullier

Image credit: The ATLAS Collaboration/ITk
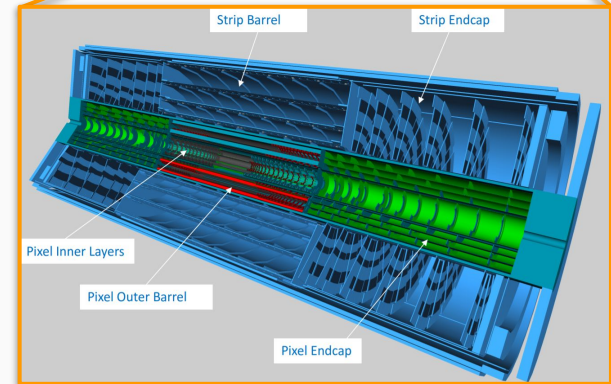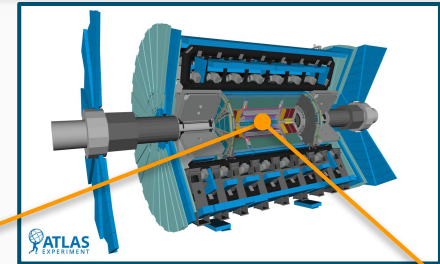
Image credit: The ATLAS Collaboration

Upgrade projects

ITk - the Inner Tracker Upgrade, Uppsala, Lund

Lund

Thermal cycling tests

Site qualification: May 2025

"Short strip" detector module

Image credit: Eduardo Torres Reoyo
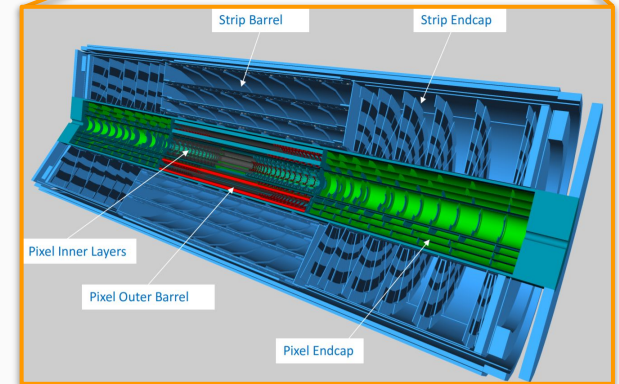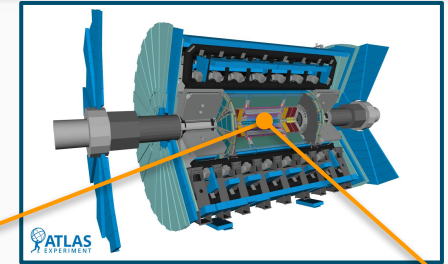
Image credit: The ATLAS Collaboration

Upgrade projects

HGTD - the High-Granularity Timing Detector, KTH

30 ps time resolution

Alternative luminometer
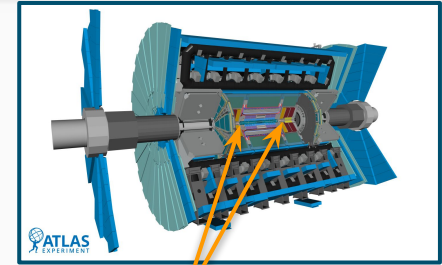
Peripheral
on-detector
Electronics

Si sensors + ASICs
$R_{in} \sim 120$ mm ; $\eta=4.0$
$R_{out}=640$ mm ; $\eta=2.4$

Image credit: ATLAS HGTD Group

Upgrade projects

HGTD - the High-Granularity Timing Detector, KTH
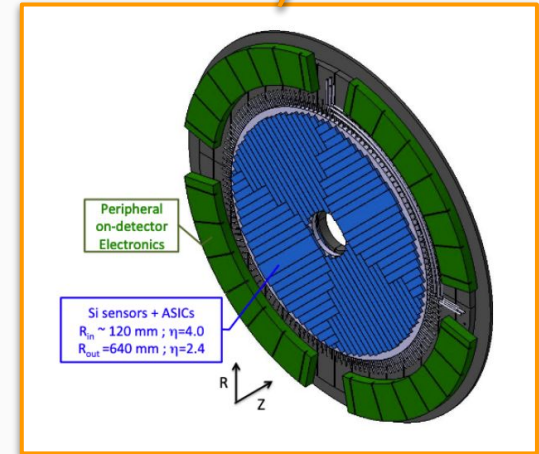
HGTD setup, SPS test beam facility, CERN, October 2025
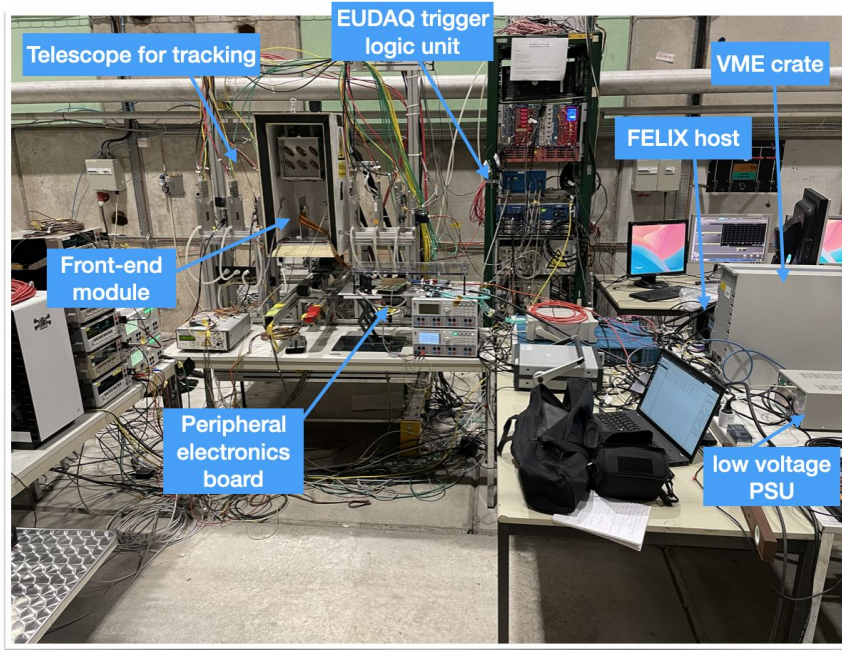
Image credit: Christian Ohm
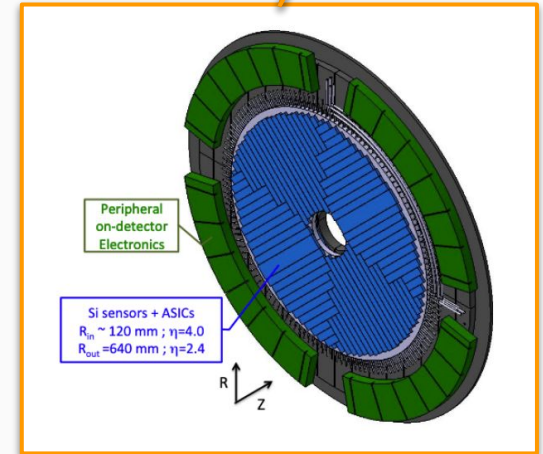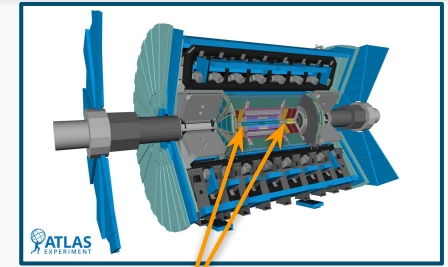
Image credit: ATLAS HGTD Group

Upgrade projects

Daughterboard - SU

Control and readout interface for the Tile Calorimeter front-end systems

Design, testing and production of 1085 Daughterboards
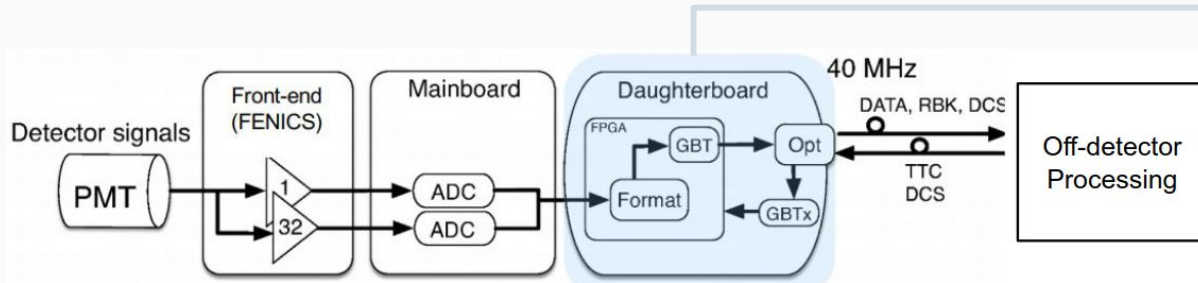
Daughterboard v6
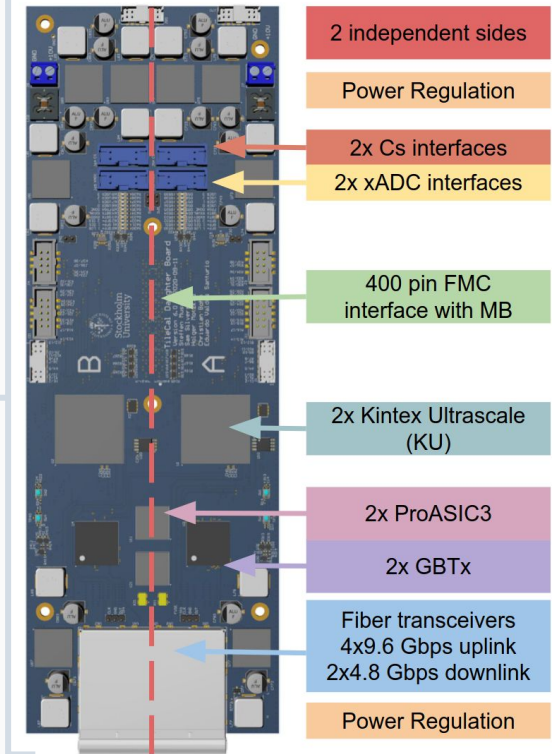
- 2 independent sides
- Power Regulation
- 2x Cs interfaces
- 2x xADC interfaces
- 400 pin FMC interface with MB
- 2x Kintex Ultrascale (KU)
- 2x ProASIC3
- 2x GBTx
- Fiber transceivers 4x9.6 Gbps uplink 2x4.8 Gbps downlink
- Power Regulation

Detector signals — PMT — Front-end (FENICS) 1 / 32 — Mainboard ADC / ADC — Daughterboard FPGA / Format / GBT / Opt / GBTx — 40 MHz — DATA, RBK, DCS — TTC DCS — Off-detector Processing

Image credits; left: ATLAS TileCal Group, right: Christophe Clement och Eduardo Valdes Santurio

Physics analyses

Uppsala University

- Composite Higgs
- Dark mesons
- Dark photons
- Higgs boson pair production, ETF interpretation
- Higgs boson pair production, $HH{\rightarrow}bb\tau\tau$

Lund University

- Anomalies in pileup
- Doubly-charged Higgs/Type-II seesaw
- Z mass measurement in $Z{\rightarrow}\mu\mu$

Prospective studies

- Heavy Neutral Leptons, ALPs, dark scalars at the FCC-ee, UU and KTH

Stockholm University

- $X{\rightarrow}SH{\rightarrow}bbyy$
- Higgs boson pair production, EFT interpretation
- SUSY *stop* search
- SUSY pMSSM interpretation
- Electroweak *ttW+jet*
- Combination $H{\rightarrow}yy$ and $HH{\rightarrow}bbyy$

KTH

- $X{\rightarrow}SH{\rightarrow}bbyy$
- Long-lived particles
- Combination $H{\rightarrow}yy$ and $HH{\rightarrow}bbyy$

Standard Model
Beyond the Standard Model

Physics analyses

Uppsala University

- Composite Higgs
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Prospective studies

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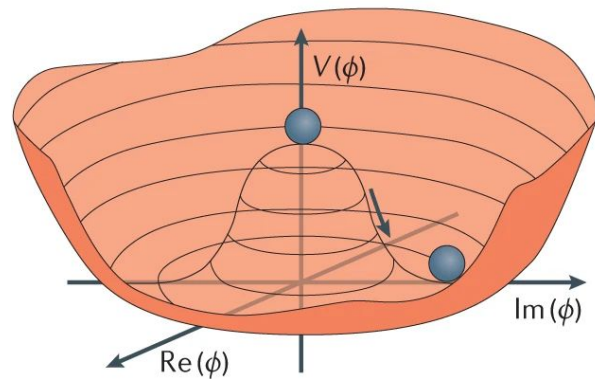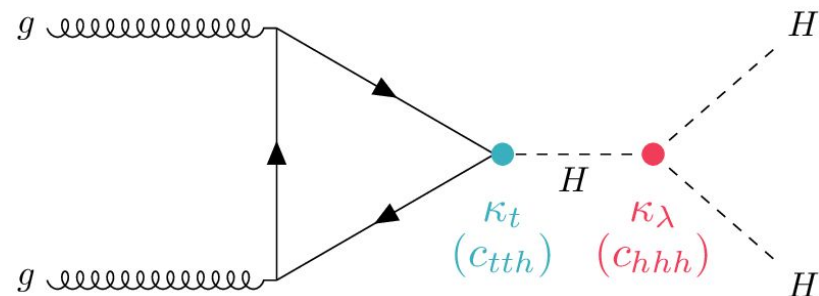
Image credit; top: [ref.], bottom: CERN

Physics analyses

Some BSM models, e.g.

- Next-to-minimal SUSY SM [ref.]
- Two-Higgs-doublet models [ref.]

predict additional

- heavy scalar boson *X*
- light scalar boson *S*
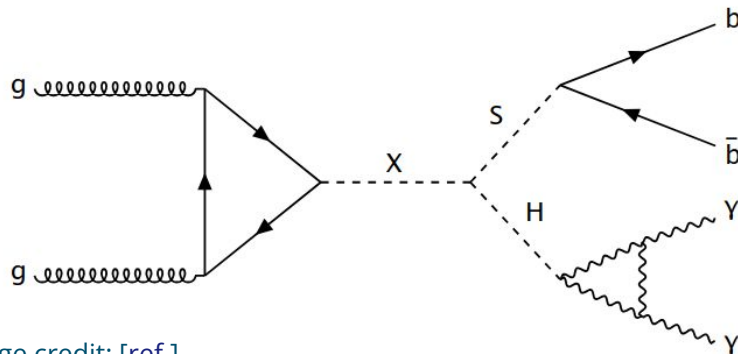
Image credit: [ref.]

Stockholm University

- ***X→SH→bbyy***
- Higgs boson pair production, EFT interpretation
- SUSY *stop* search
- SUSY pMSSM interpretation
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- Combination *H→yy* and *HH→bbyy*

KTH

- ***X→SH→bbyy***
- Long-lived particles
- Combination *H→yy* and *HH→bbyy*

> **Standard Model**
> **Beyond the Standard Model**

ATLAS Summary Summary

- ## Operations and performance
  - Control room and other shifts
  - Several coordinator and convener roles
  - 17.5 non-physics FTEs in 2024

- ## Upgrade projects
  - Inner Tracker Upgrade (Uppsala and Lund)
  - High-Granularity Timing Detector (KTH)
  - Tile Calorimeter Daughterboard (Stockholm)

- ## Physics analyses
  - 13 ongoing or recently published analyses

Backup

Physics analyses references

Uppsala University

- Composite Higgs [ref.]
- Dark mesons [ref.]
- Dark photons [ATLAS internal link]
- Higgs boson pair production, ETF interpretation [ref.]
- Higgs boson pair production, $HH{\rightarrow}bb\tau\tau$ [2024]

Lund University

- Anomalies in pileup [ref.]
- Doubly-charged Higgs/Type-II seesaw
- Z mass measurement in $Z{\rightarrow}\mu\mu$

Prospective study

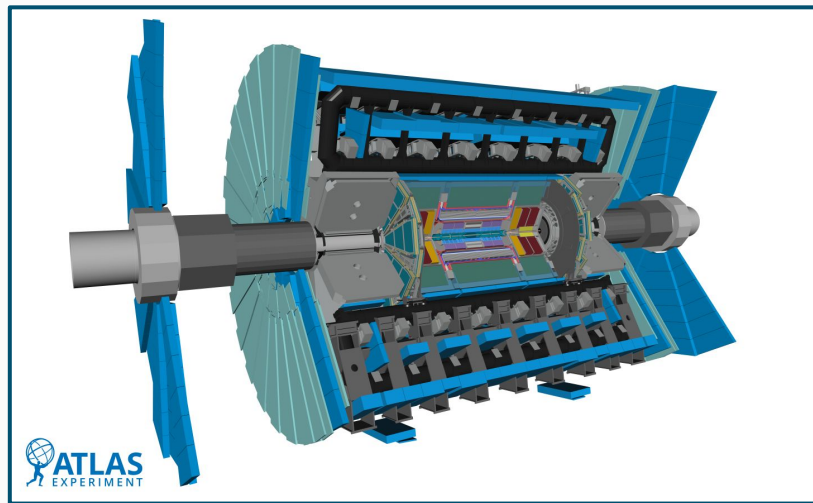- Heavy Neutral Leptons, ALPs, dark scalars at the FCC-ee, UU and KTH [ref.]

Stockholm University

- $X{\rightarrow}SH{\rightarrow}bbyy$ [ref.]
- Higgs boson pair production, EFT interpretation [ref.]
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KTH

- $X{\rightarrow}SH{\rightarrow}bbyy$ [ref.]
- Long-lived particles [ref.]
- Combination $H{\rightarrow}yy$ and $HH{\rightarrow}bbyy$

Standard Model
Beyond the Standard Model

From KTH: Operations

- Luminosity is a measure of the number of pp collisions produced by the LHC at an interaction point
- Well-monitored and accurately measured luminosity is vital for both ATLAS and the LHC
- Strong KTH presence in the ATLAS Luminosity group (Christina is the Online Luminosity Subgroup Convener since April 2025)
- Online Luminosity group responsible for:
  - Ensuring smooth and reliable real-time luminosity recording during data-taking
  - Maintaining and developing the online luminosity software
- Expert on-call shifts to continuously monitor luminosity and address issues promptly
- Control room and on-call shifts
  - Run control and trigger: Magda
  - Shift and data quality leader: Christina
  - Calorimeter + forward detectors: Emil
- Trigger: jet trigger development and data quality shifts (link)
- Magda stationed at CERN for one year, doing shifts, working on upgrades, and analyzing prototype of new luminosity detector (BMA)

From KTH: Physics analysis

Di-Higgs and search for additional scalars

- Measurement of HH provides direct evidence of the Higgs self-coupling
  - Any deviation from SM → new physics
  - Probe of the Higgs potential shape
- Search for X→SH in the bbyy final state
  - Tests extended Higgs sectors with extra scalars (X, S)
  - Strong sensitivity thanks to excellent diphoton mass resolution
  - Submitted to PLB, arXiv
- New analysis: simultaneous HH + single-Higgs measurement to constrain H→yy couplings, and increase sensitivity to the Higgs self-coupling

Beyond-SM search with challenging signatures

- Long-lived particles: displaced and delayed signatures – need special reco
- Could have been missed so far, and discovered soon
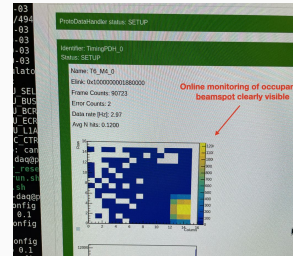- Currently leading search with delayed-jet signature (few ns)
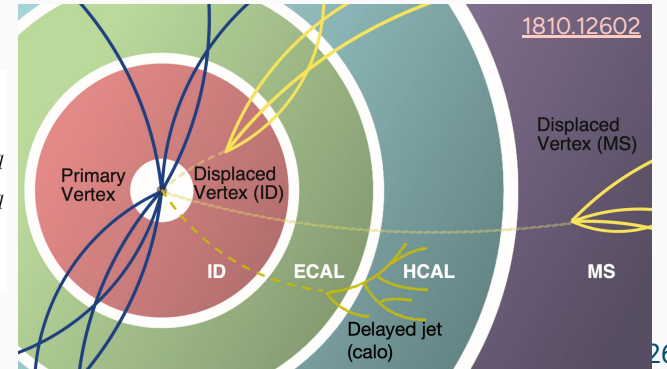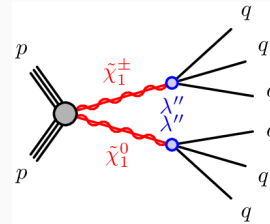
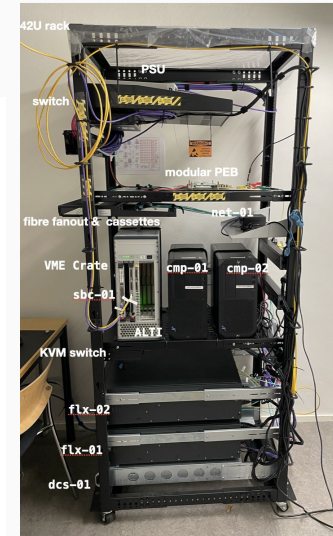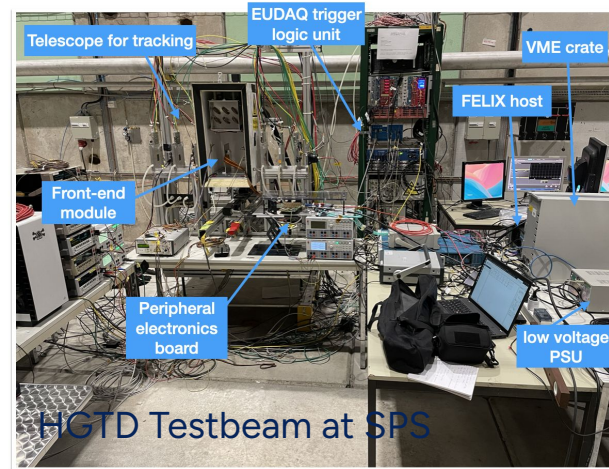# From KTH: Upgrade: High-Granularity Timing Detector

- HGTD coordinator roles: DAQ and Lumi, Software and Performance, Speakers Committee
- Photo of DAQ setup at KTH, also used by other universities as testbed.
- Testbeam at SPS in Oct, using FELIX and phase-II system for readout.
- Successful test of full readout chain: Front end (ALTIROC) -> Peripheral electronics board -> FELIX -> SW ROD, triggering via ALTI
- Coordinating new luminosity upgrade group for phase-II, under Data Preparation.

First sighting of beam with full readout chain

Development setup at KTH

Telescope for tracking
EUDAQ trigger logic unit
VME crate
FELIX host
Front-end module
Peripheral electronics board
low voltage PSU

HGTD Testbeam at SPS

42U rack
PSU
switch
modular PEB
fibre fanout & cassettes
net-01
VME Crate
cmp-01 cmp-02
sbc-01
ALTI
KVM switch
flx-02
flx-01
dcs-01

CO's photos from Oct test beam here

Trigger Online ASsistanT (TOAST)

Development by Hassane Hamdaoui. Primarily used by trigger but it is accessible to all ATLAS user. Being expanded to Run Management.

Side projects:

- Published proof-of-concept histogram density estimator, **Sparks in the Dark**:
  - SciPostPhys.18.3.080, 2404.04138
- Machine-learning based data compression, **Baler**:
  - github/baler, ICHEP2024

Combined Performance work

- Involved in the ID alignment.
  - David Brunner is Convener of the Inner Tracking Alignment subgroup.
- Have a long-standing involvement in flavour tagging.
  - Mainly work on calibrations.
    - Have worked on the mistag rate calibration for many years.
    - Recently got involved in the fully continuous calibration using Optimal Transport.

https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/FTAG-2023-06/