

Nikhef

ATLAS

Pamela Ferrari



THE ATLAS GROUP

Staff



Mengqing Hella Flavia Pamela Lydia Clara



Tristan Ivo Frank Wouter Nicolo Marcel Sascha Peter Antonio
(also LHCb)

15

Postdoc



Andrea Robin



Oliver Geoffrey Matous Carlo Luca Edwin Tommaso
(also theory)

9

PhD



Polina Diana Elizaveta Zhuoran Evelin Ash Ambre Ali Marion



Dylan Zef Andrea Marten Osama Jordy Bryan Walter Petja
(also R&D)

18

+ 9 MSc Students: Duncan, Karel, Jasper, Dorian, Peter, Marcello, Saskia, Bram, Sacha.

ATLAS ROLES IN 2023-2024

PHYSICS

Physics coordinator: P. Ferrari

(ended 10/2023)

Exotics group convener: F. Dias

(ended 10/2023)

Top-quark mass/properties convener: C. Nellist

(ended 03/2024)

H→WW convener: R. Hayes

Statistics committee: L. Brenner (Chair), W. Verkerke

COLLABORATION

CB Chair Advisory Group: W. Verkerke (12/23), F. Filthaut

Early Career Scientist Board: H. Arnold

Diversity and Inclusion committee: F. Dias

DETECTOR

ITk Strip Global Structure Activity Coordinator: M. Vreeswijk

(ended 03/2024)

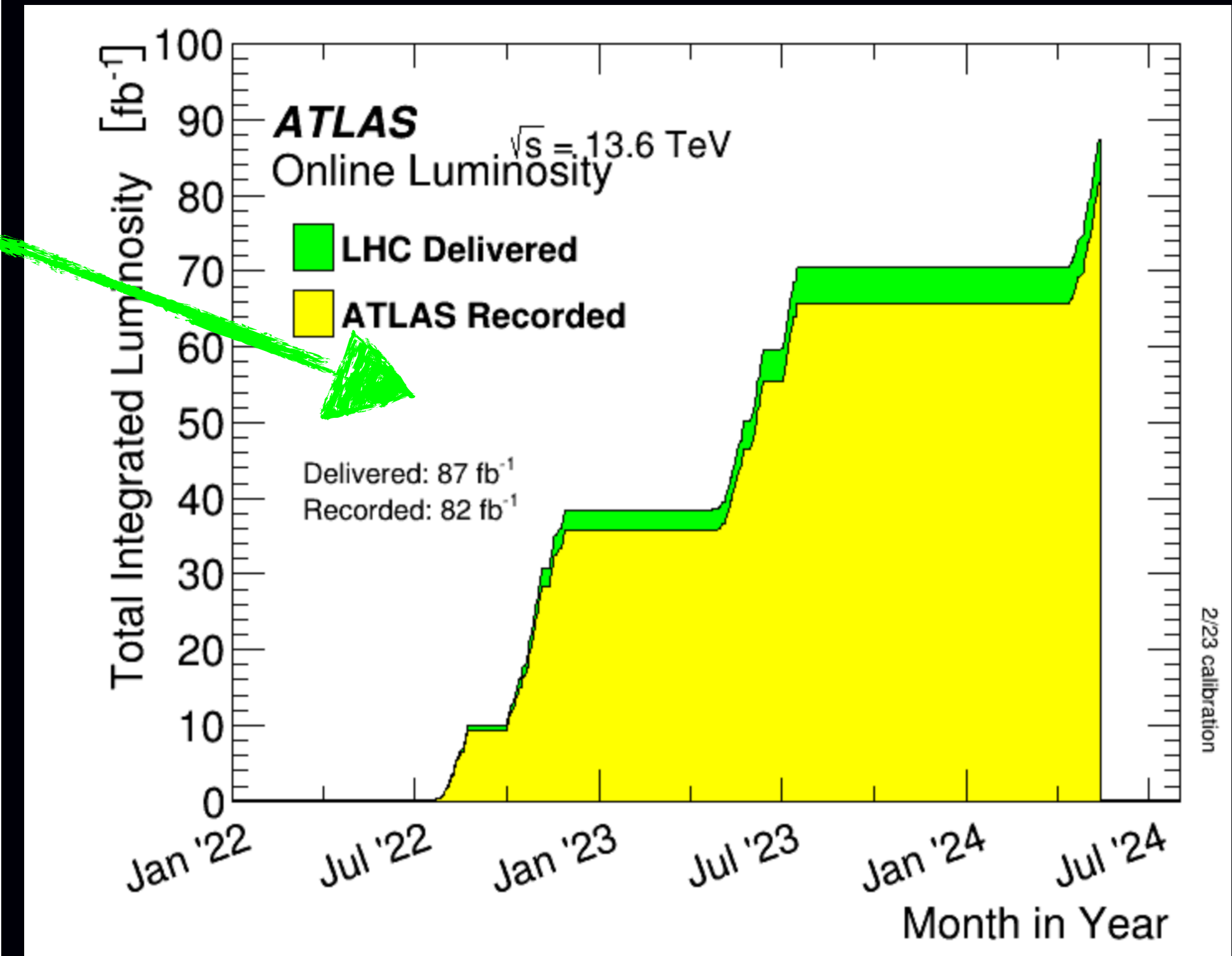
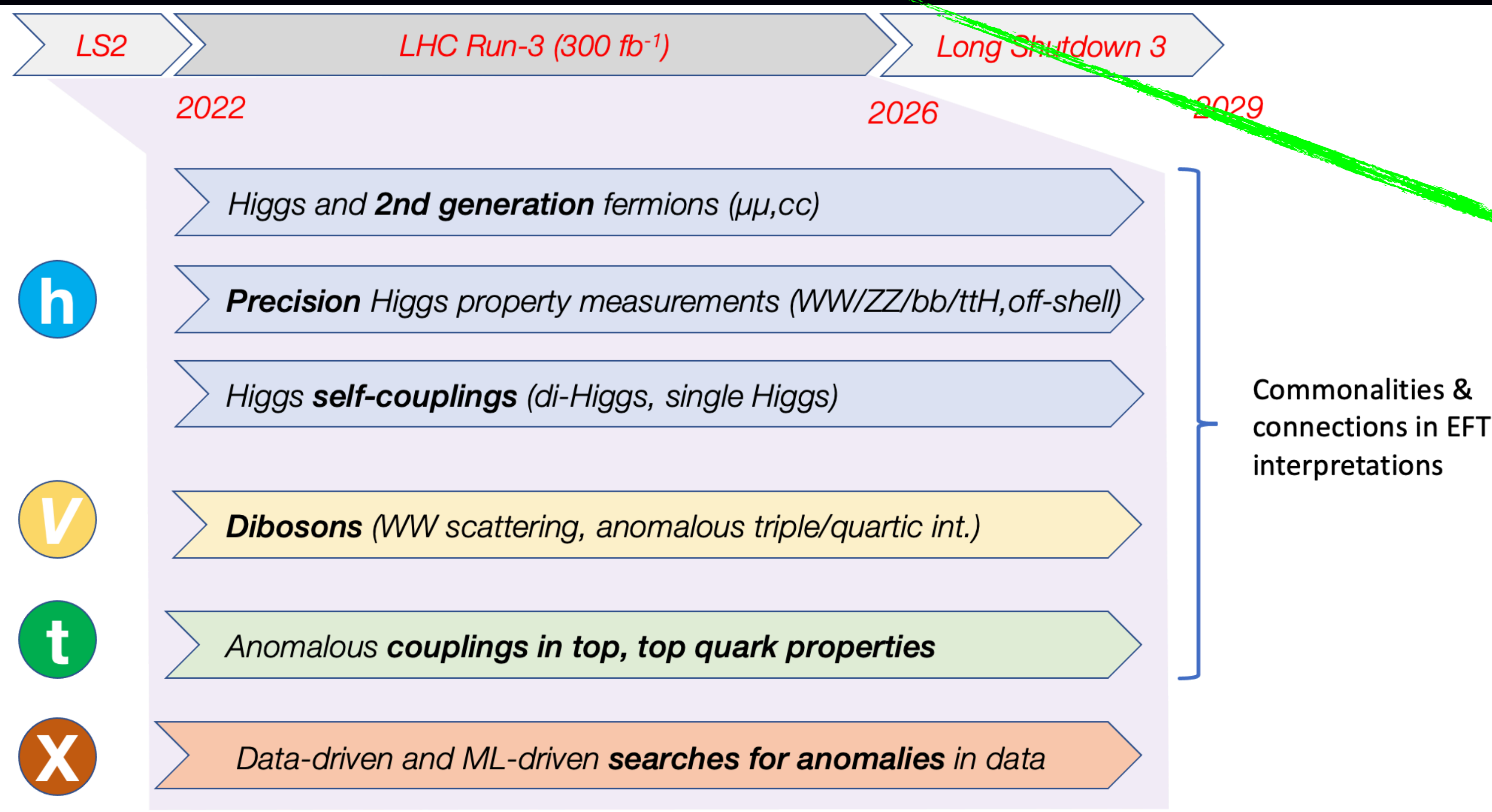
ITk Strip Project Engineer: M. Vreeswijk

HGTD Institute Board chair+Electronics Coord.: F. Filthaut

HGTD DAQ coordinator: M. Wu

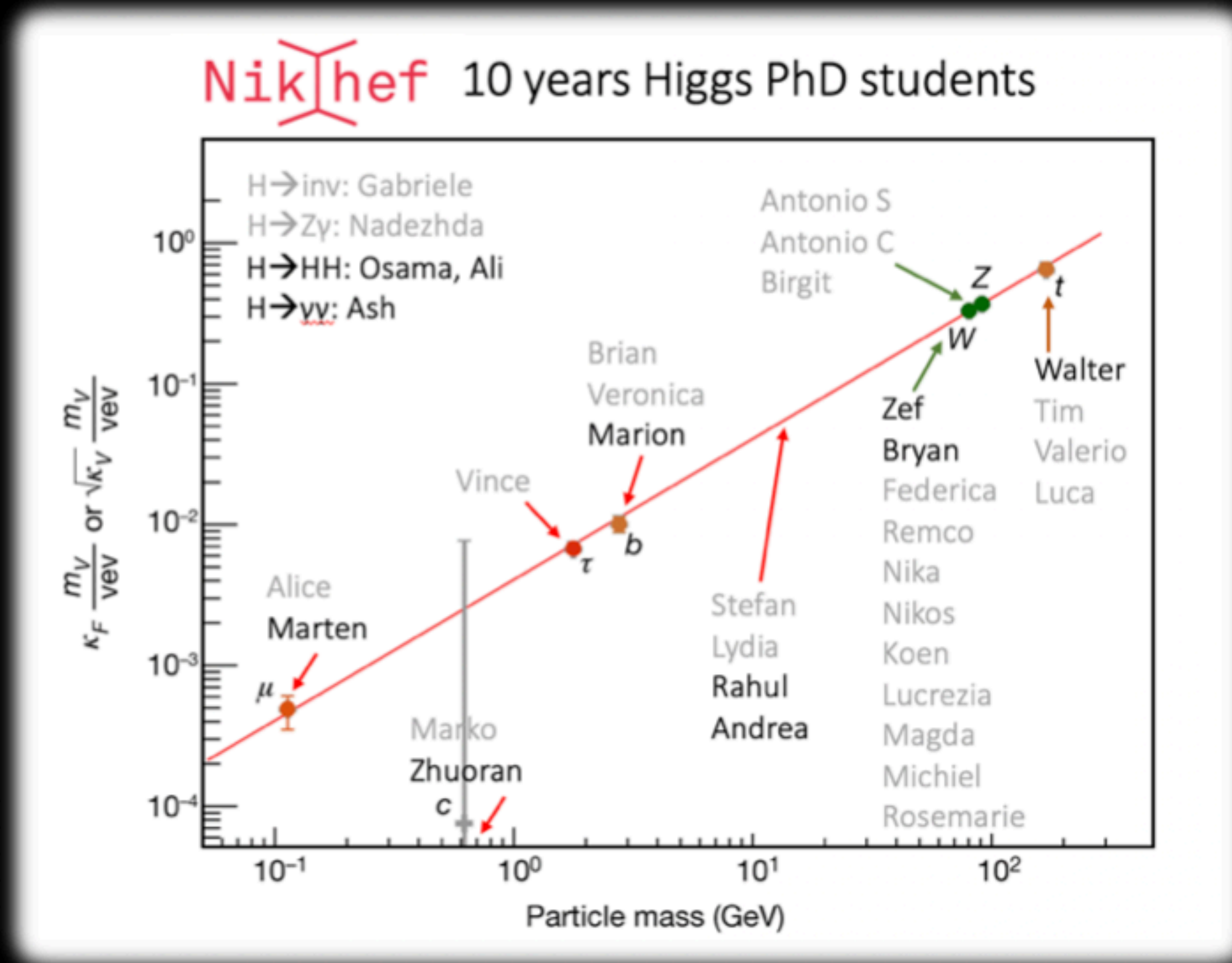
NIKHEF ATLAS PHYSICS AMBITIONS

LHC Run 3 successfully ongoing

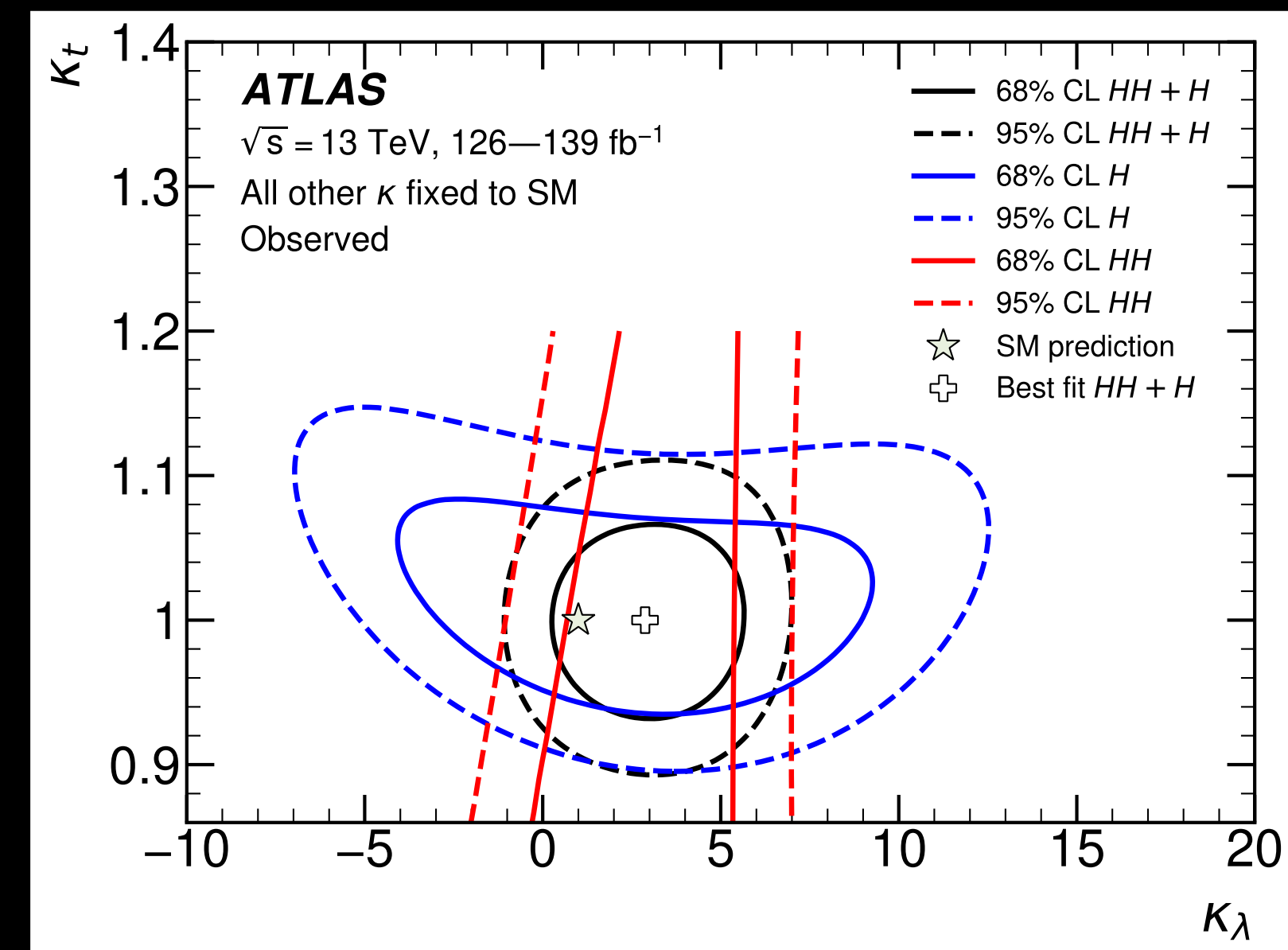


HIGGS PHYSICS

Huge involvement of Nikhef group in almost all aspects of Higgs physics, many leading contributions

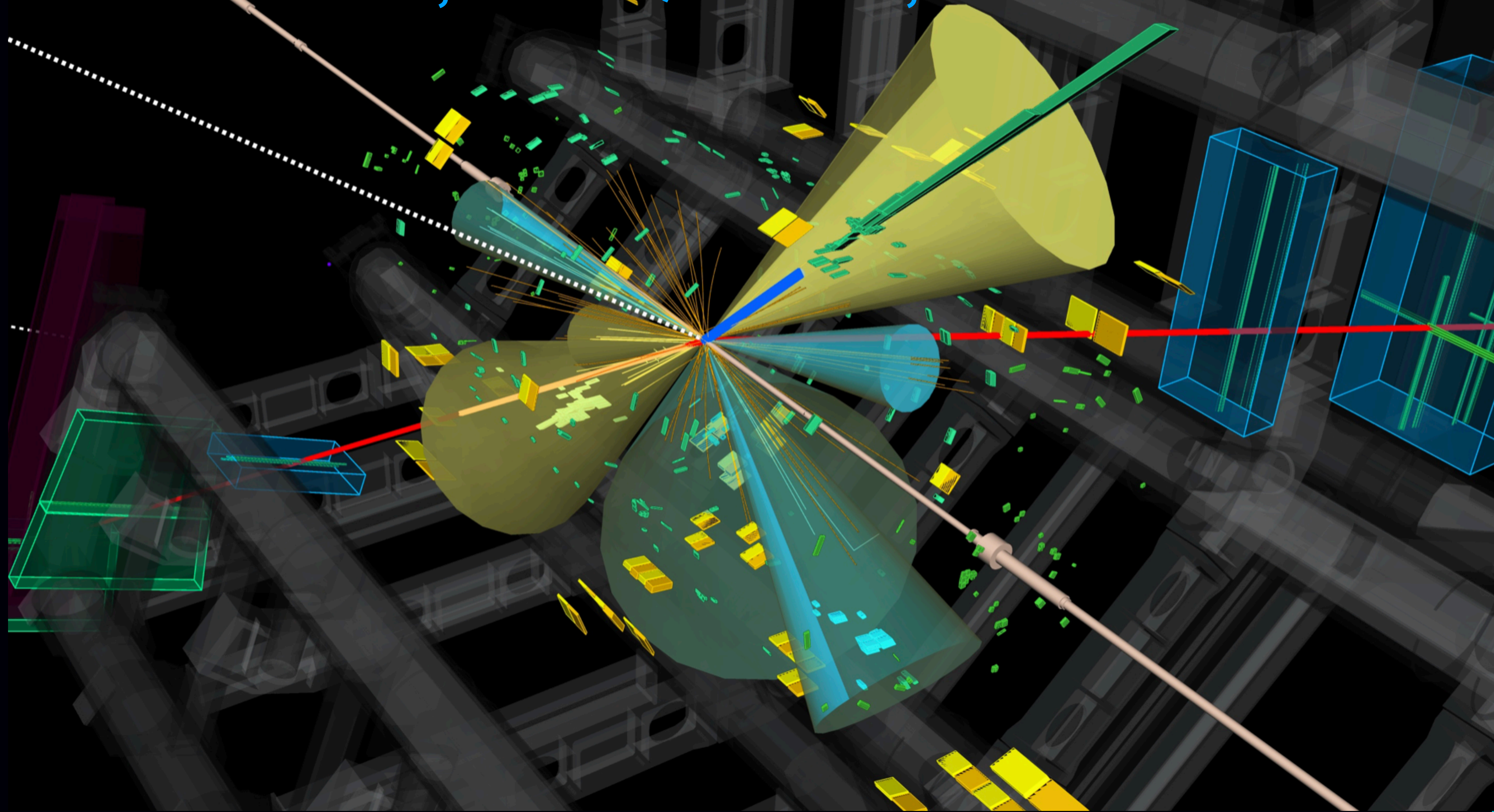


κ_t =Higgs boson couplings to top quarks
 κ_λ =Higgs Self coupling



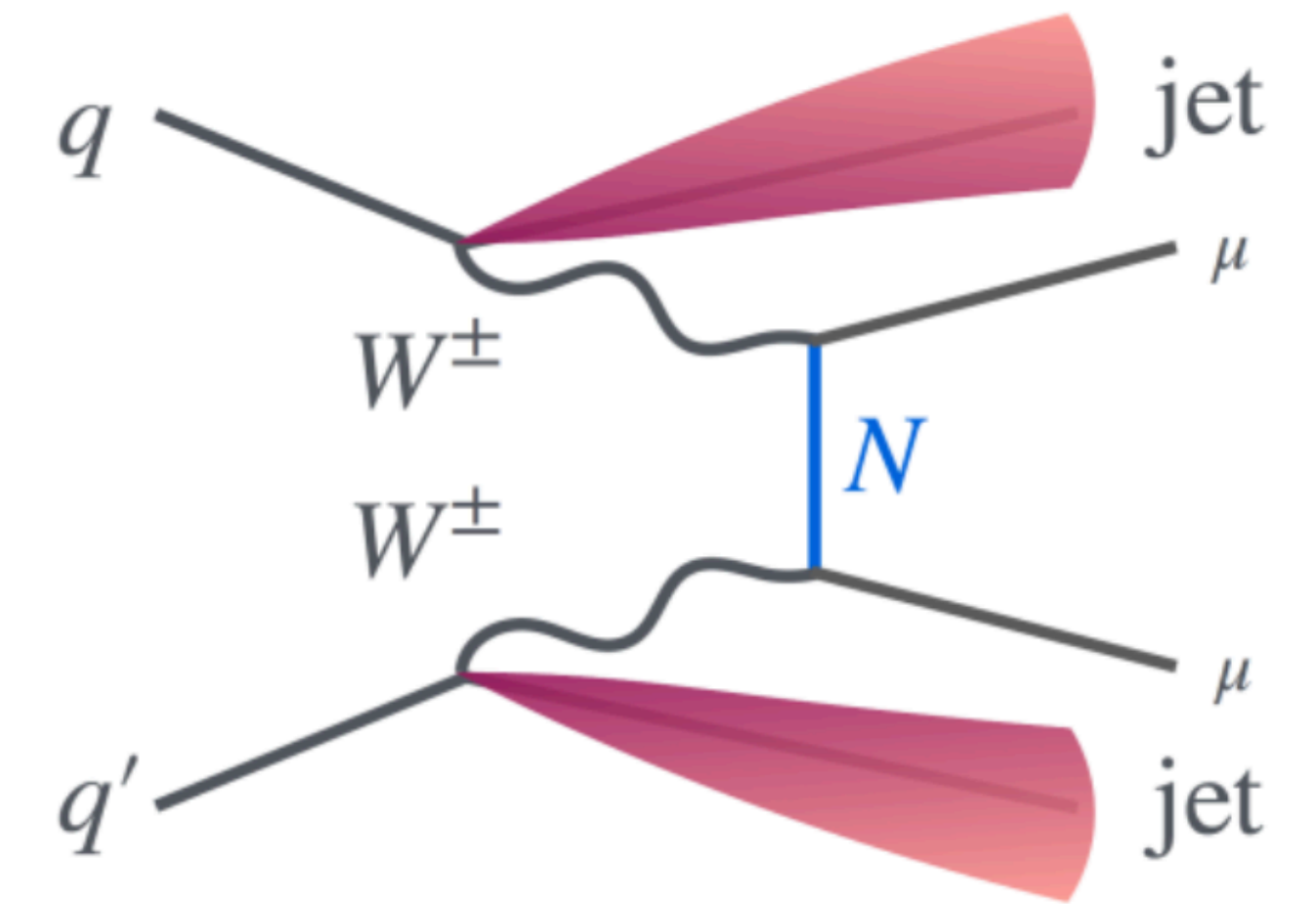
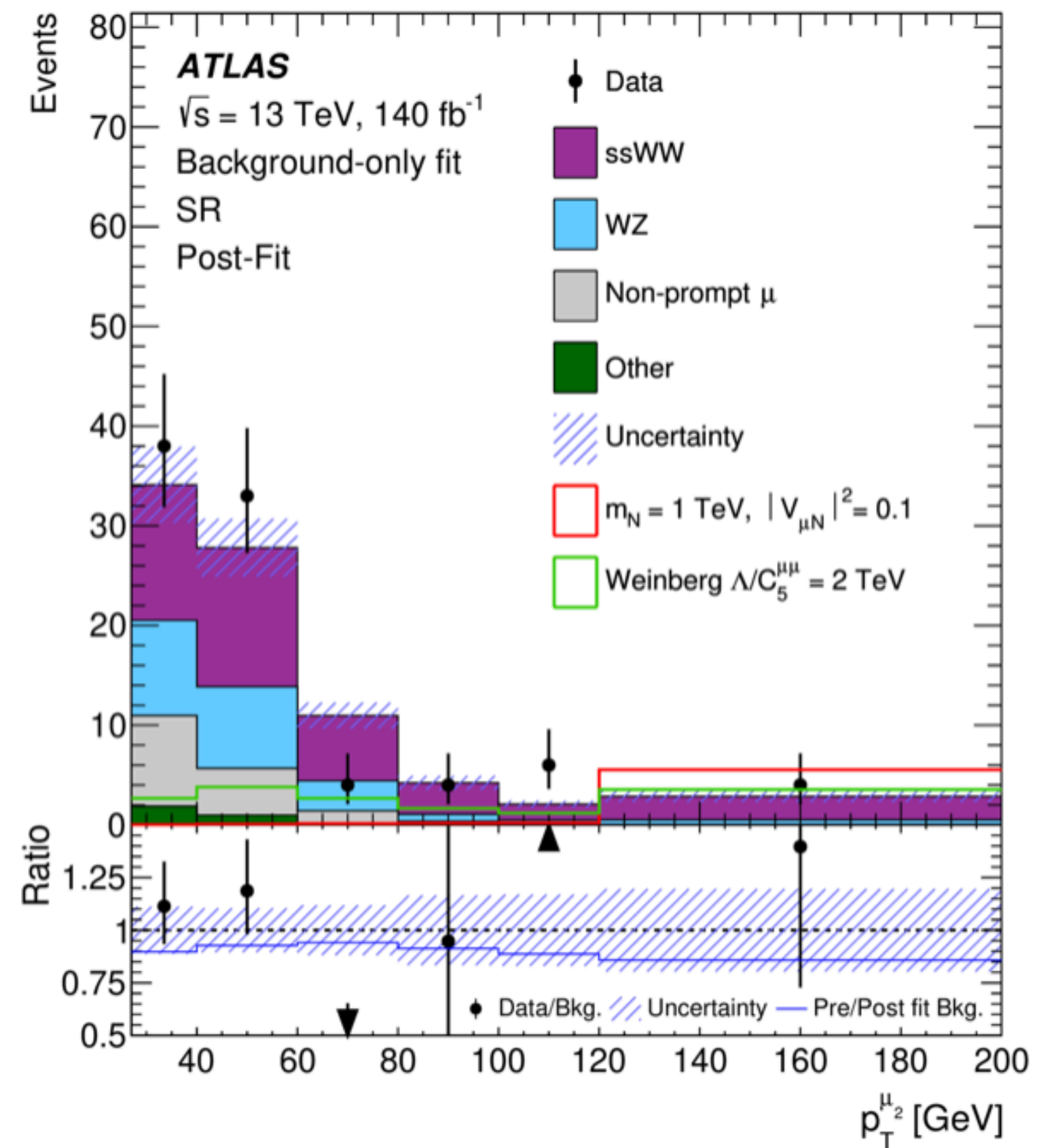
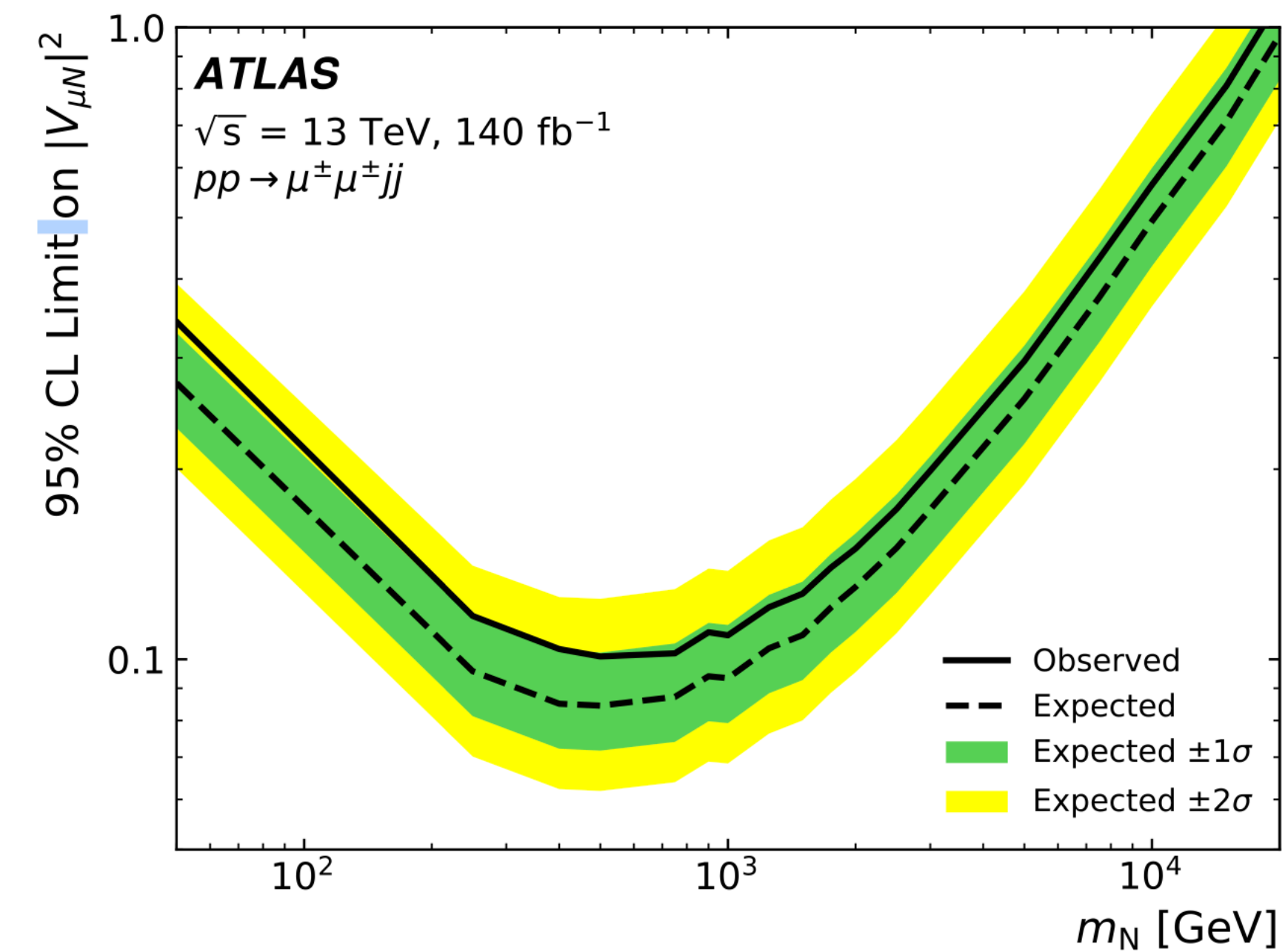
Higgs boson self-coupling constraints from single and double-Higgs production

VECTOR BOSONS, TOP QUARKS, SEARCHES



VECTOR BOSONS, TOP QUARKS, SEARCHES

Heavy Majorana Neutrino search

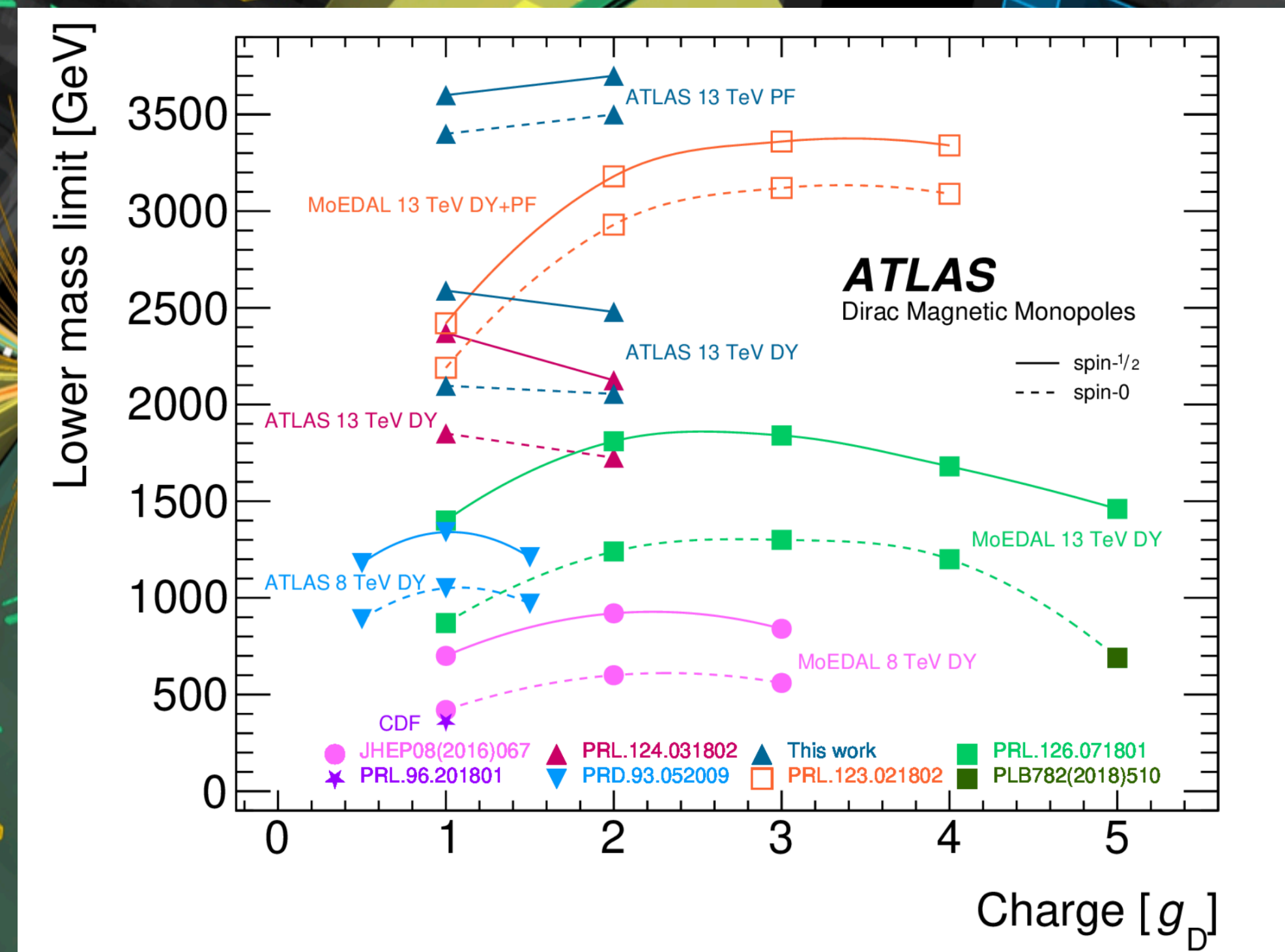
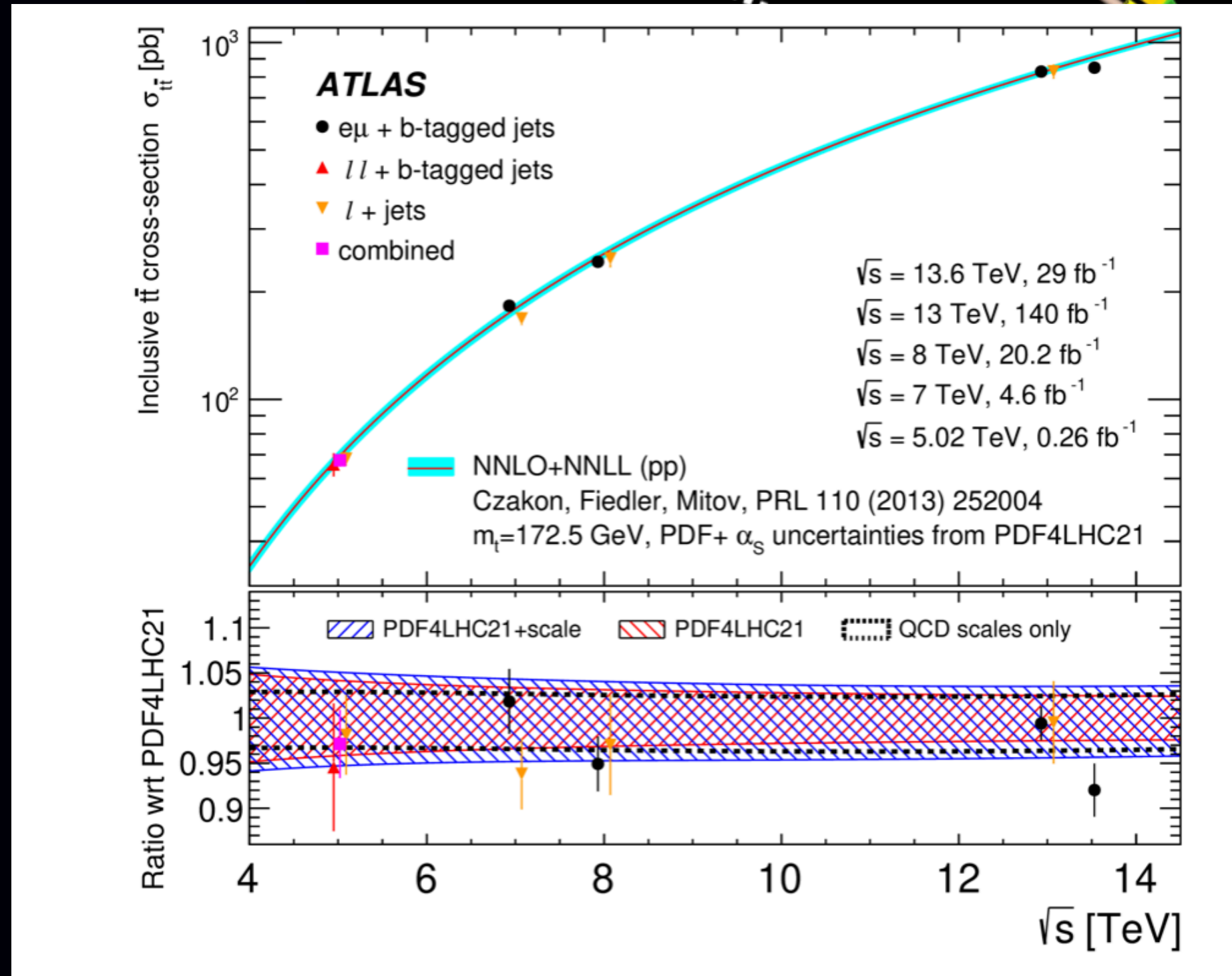


Previous limits only up to 1 TeV

VECTOR BOSONS, TOP QUARKS, SEARCHES

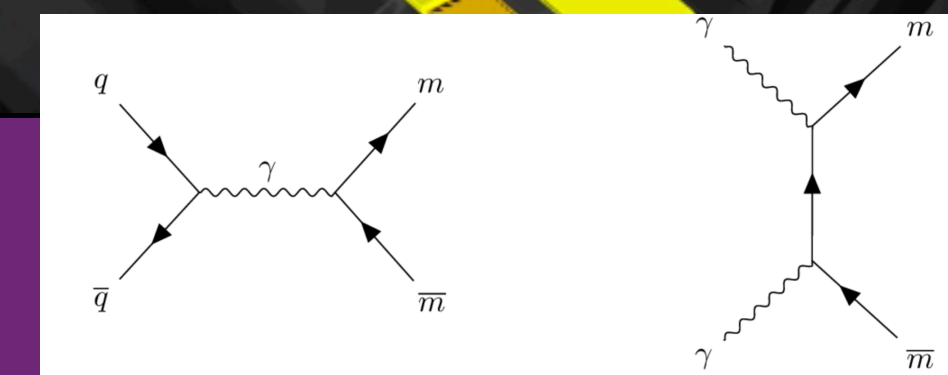
Run 3 ttbar x-section

Magnetic Monopoles: "one of the safest bets about physics not yet seen" (Polchinski)



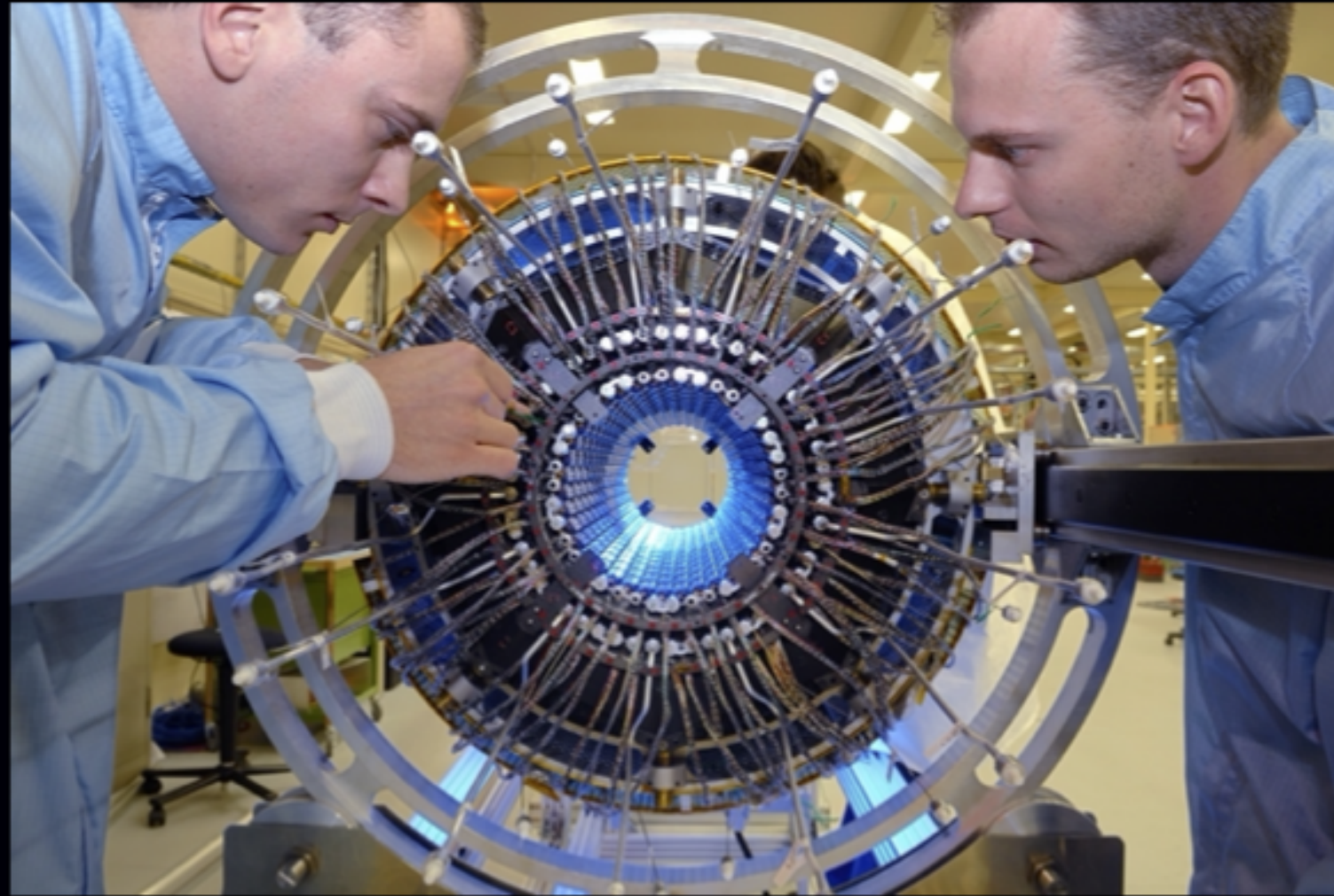
test of Performances: b-tagging

One of tightest limits yet on their production rate

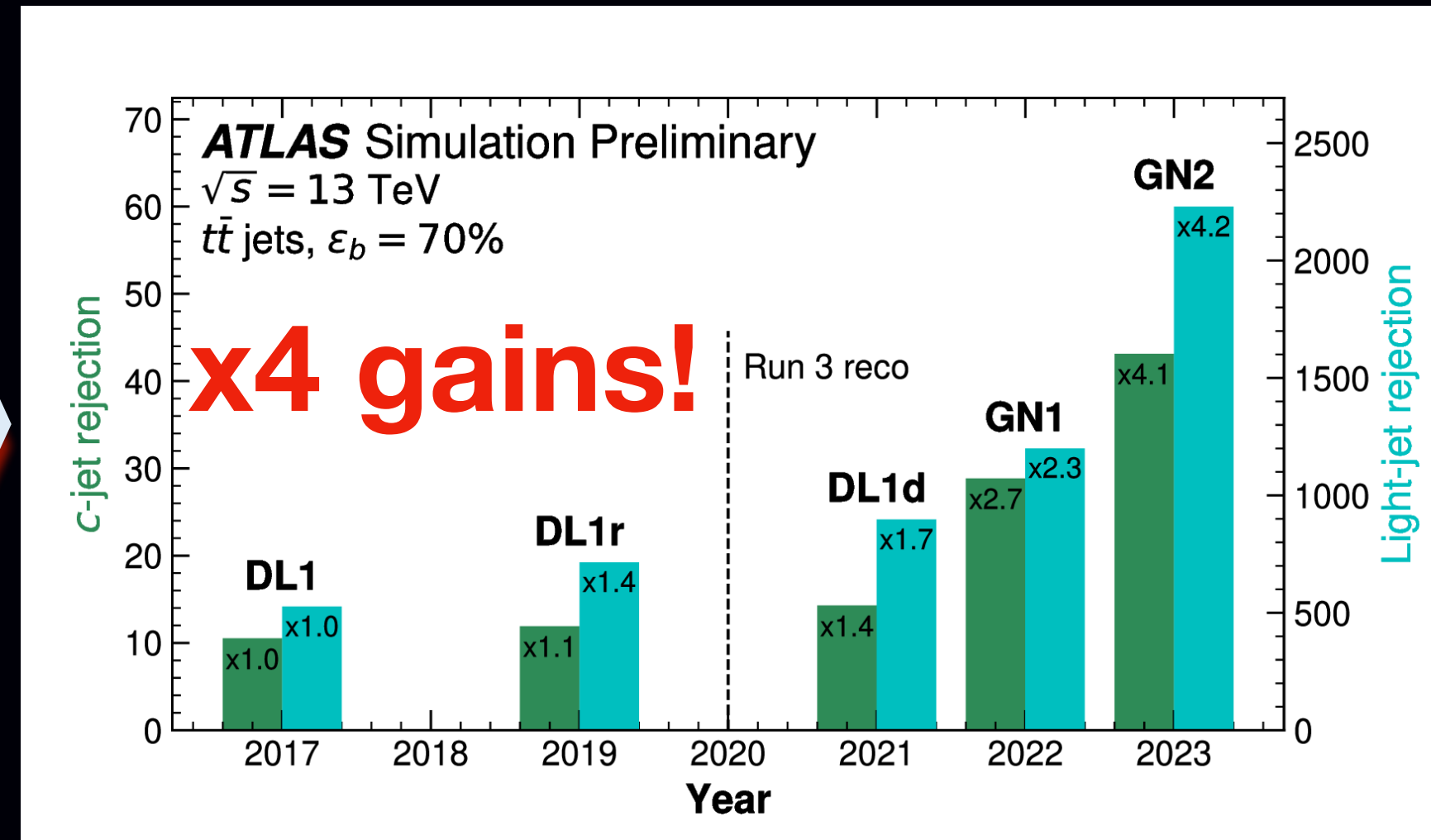


NIKHEF: FULL-CHAIN INVOLVEMENT, FROM DETECTOR TO PHYSICS

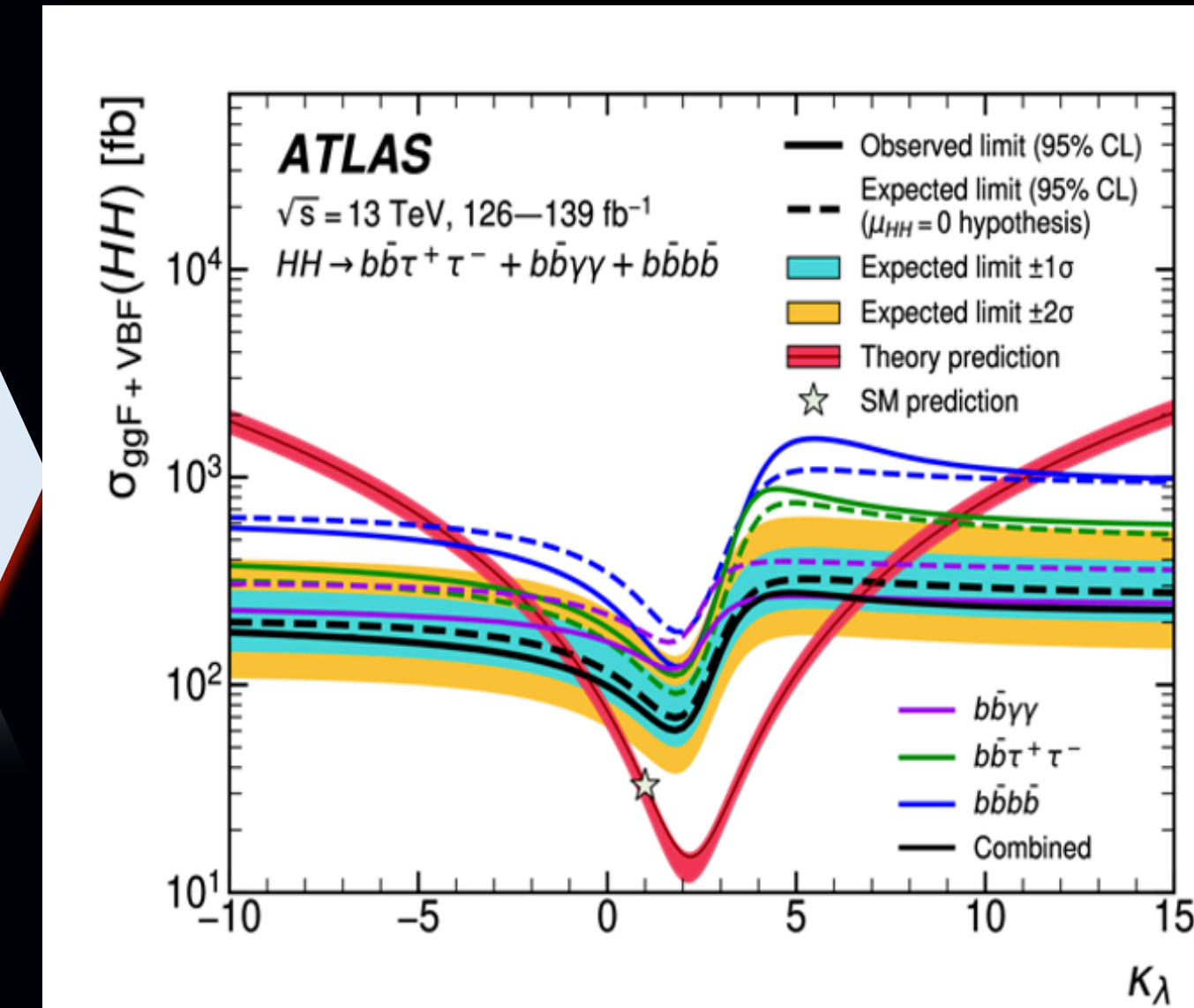
IBL detector (crucial for b-jet ID)



b-jet identification algorithms



$H(H) \rightarrow bb(bb/\tau\tau/\gamma\gamma)$ analysis



CO2 cooling

Front-end readout chips

Nikhef

Boosted Higgs tagger taskforce

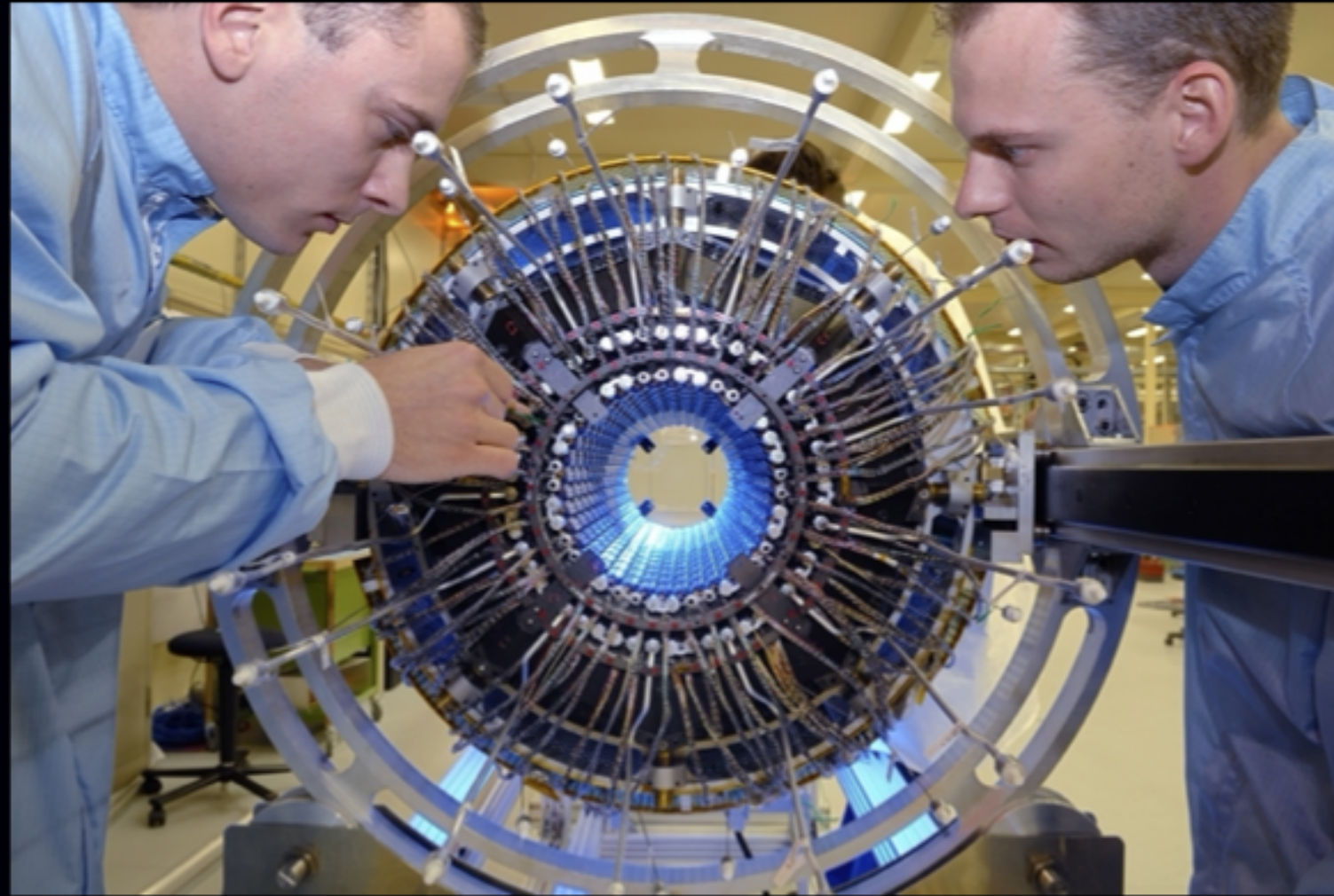
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Most stringent limits on di-Higgs
production rates to date

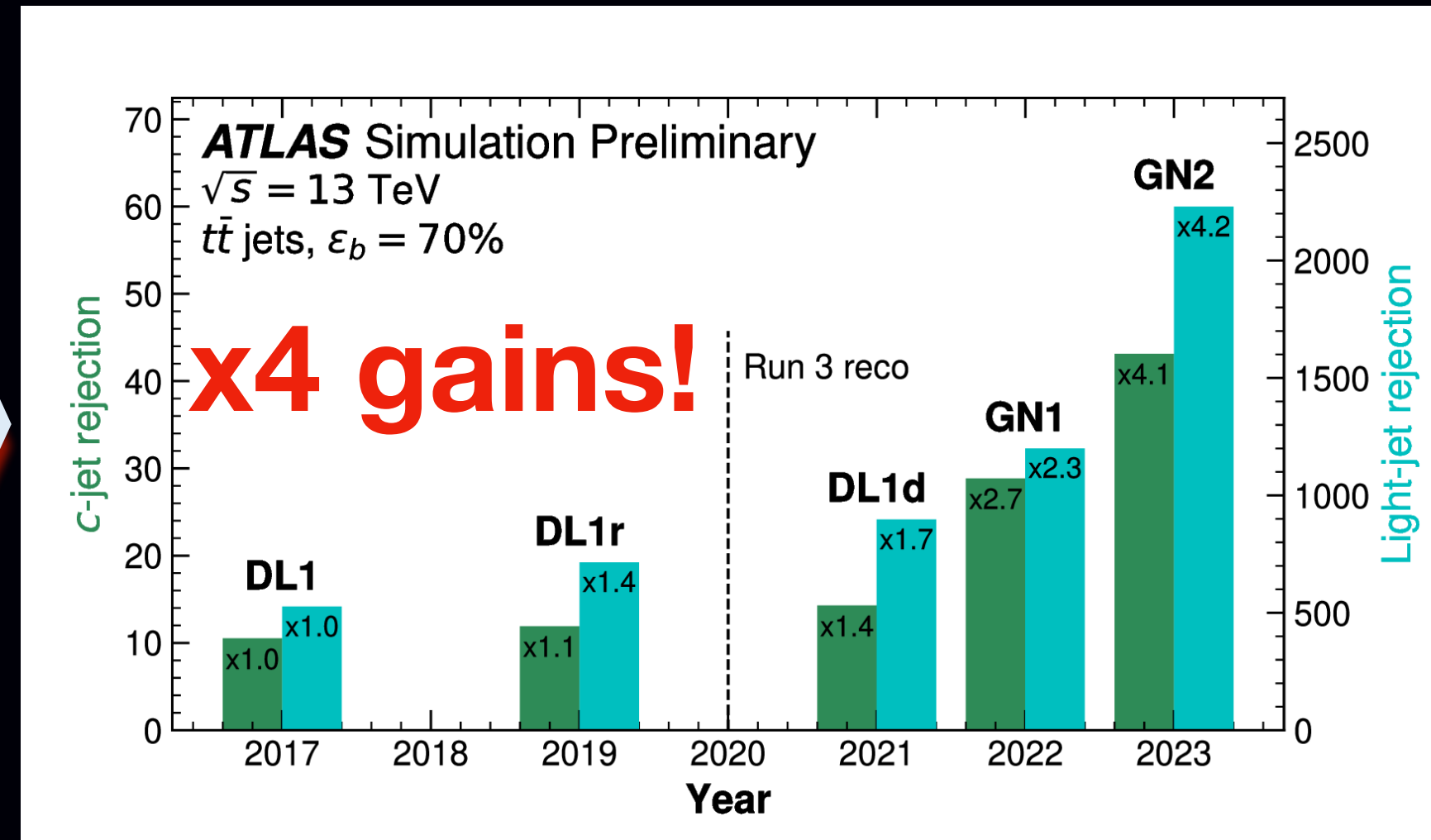
Nikhef

NIKHEF: FULL-CHAIN INVOLVEMENT, FROM DETECTOR TO PHYSICS

IBL detector (crucial for b-jet ID)



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Nikhef

Boosted Higgs tagger taskforce

Nikhef

Most stringent limits on di-Higgs
production rates to date

Nikhef

RUN 3: COMMISSIONING

Muon **New Small Wheels**, new for Run-3



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Alignment & track reconstruction

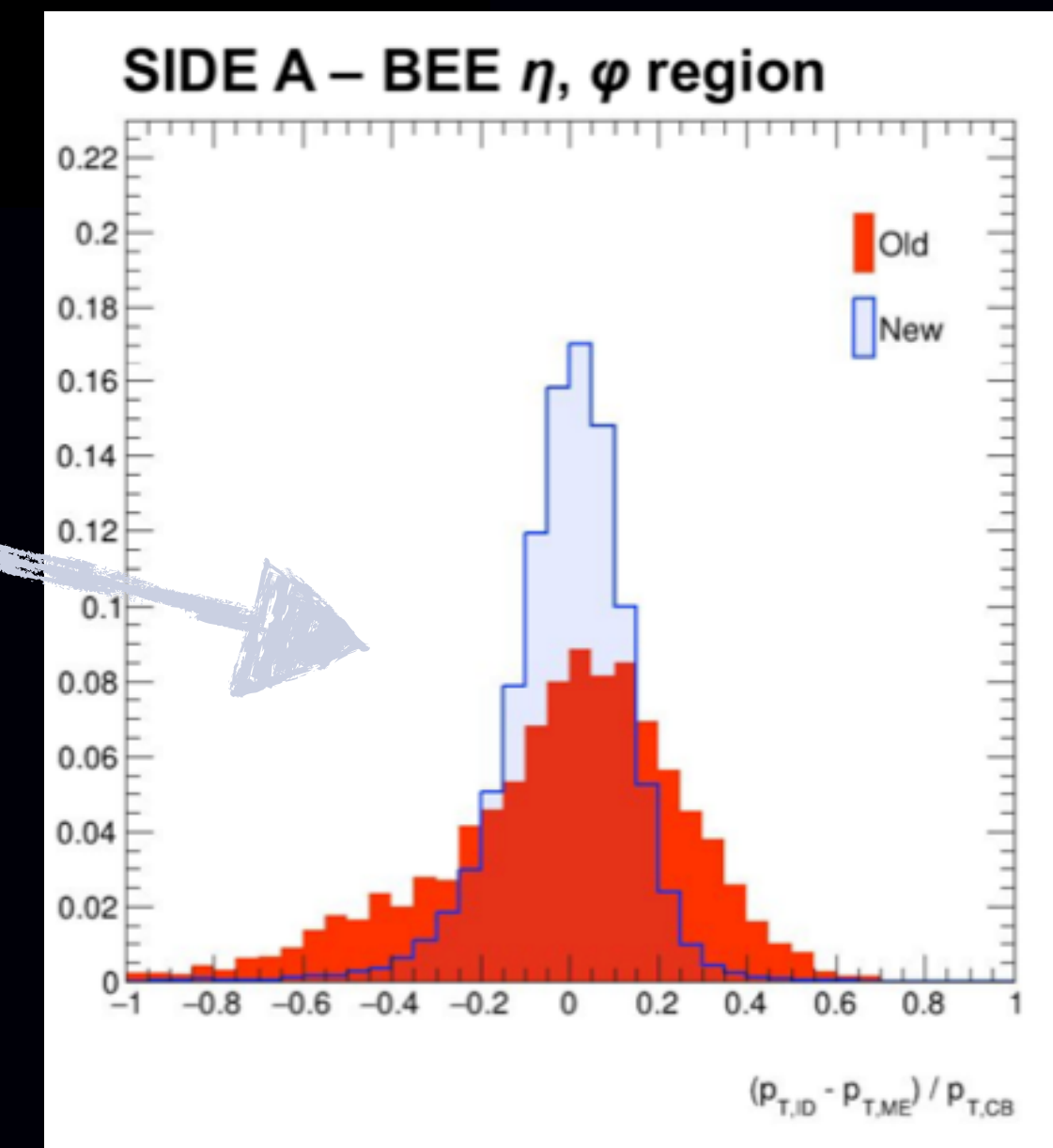
Phase-1 FELIX Trigger & **DAQ system** for NSW, L1Calo



Nikhef

progress with aligning muon spectrometer for Run 3!
(NSW & MDT)

strong bias in run 3
alignment corrected
to be now comparable
to run 2



MDT DCS WORK

MDT Detector Control System:
ELMBs inside MDMs are not radiation-hard enough for Run4
eYETS23/24: Replaced 135/1170 ELMBs



All need to be replaced until
the end of LS3



Tristan du Pree
Project Leader



Henk



Jochem



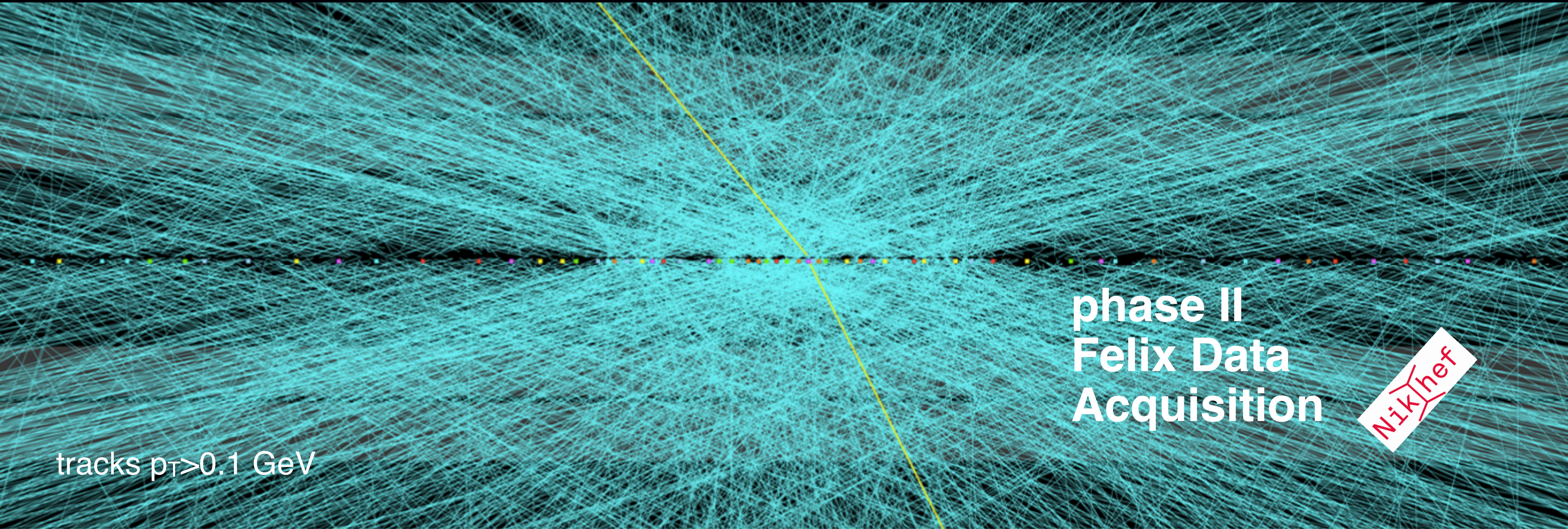
Gino



Karol

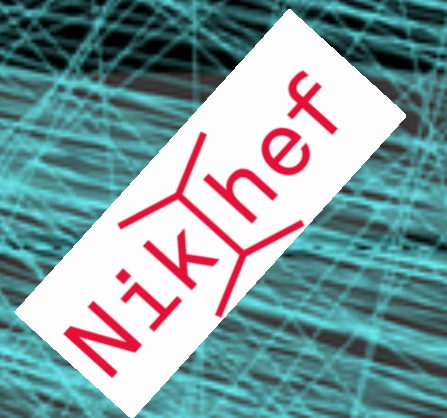
THE HIGH LUMINOSITY ERA

High-Lumi era: **10x more data** than Run1+2+3, delivered at **5x the rate**
Need **new detectors & DAQ** that can cope with track density & radiation



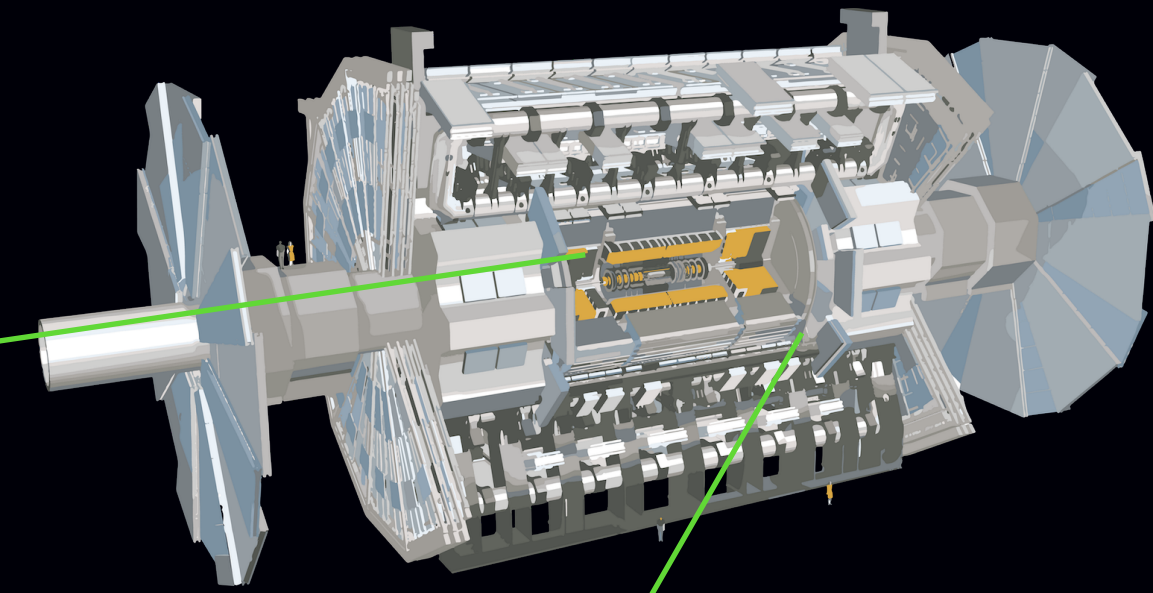
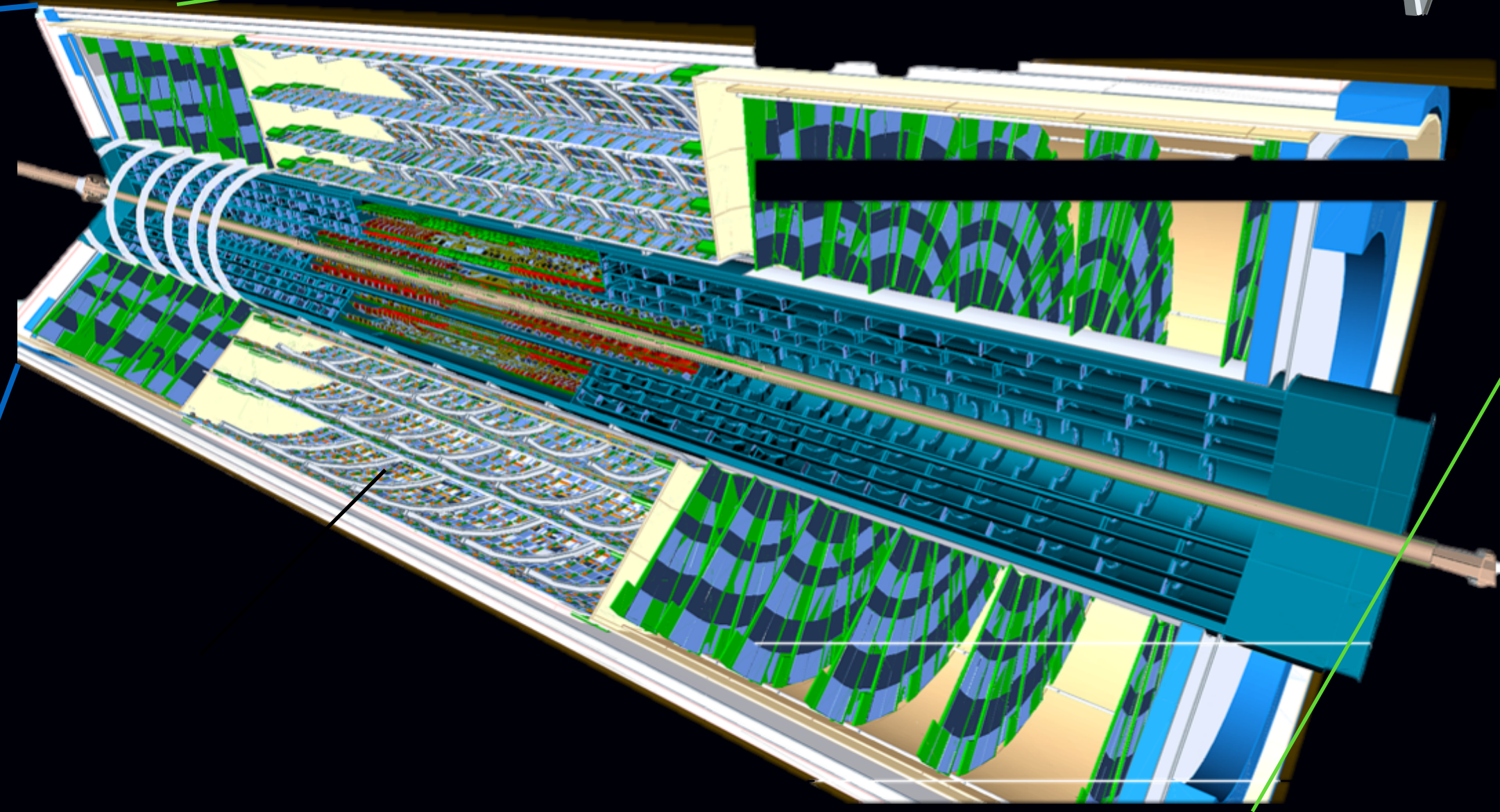
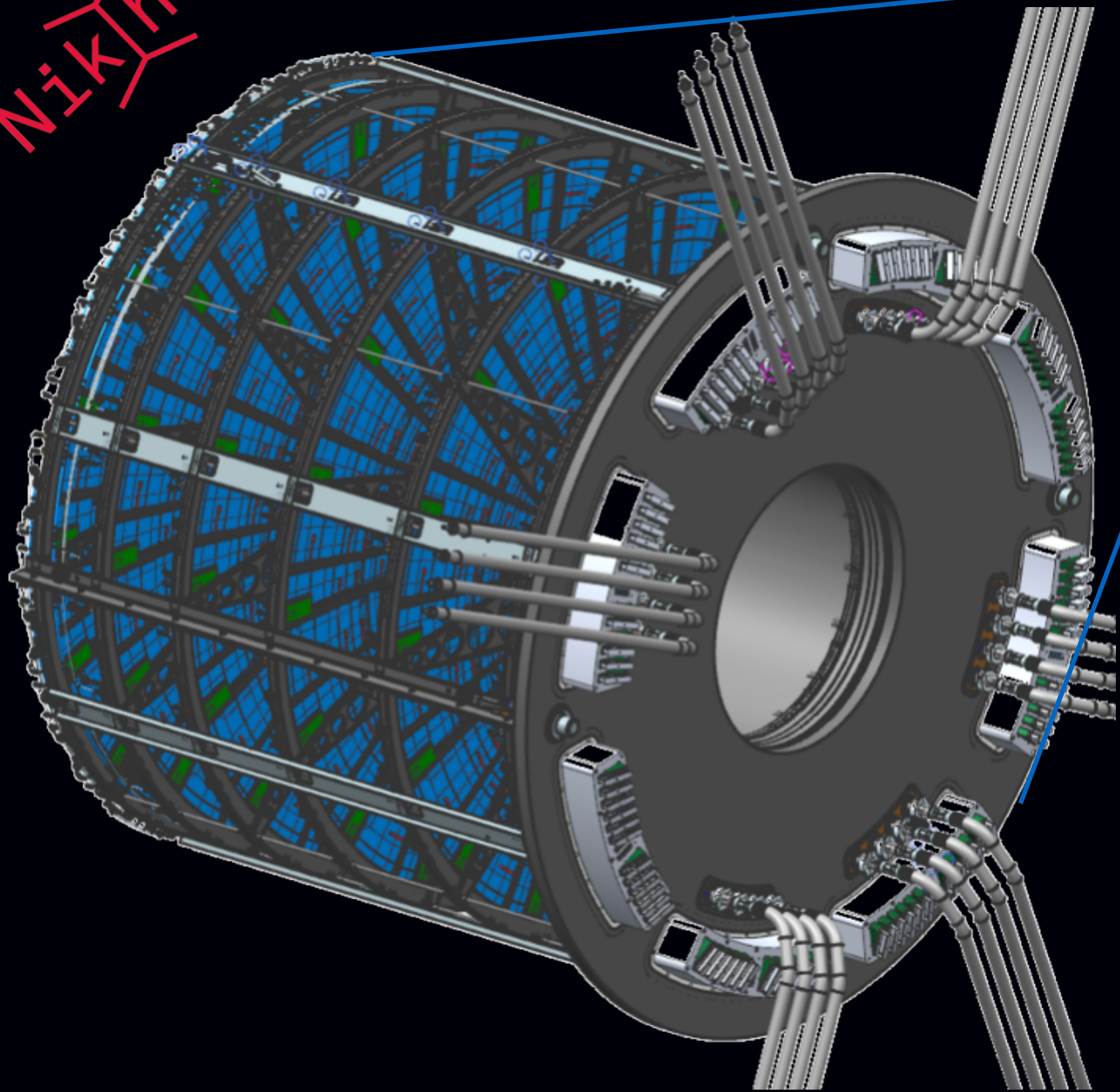
tracks $p_T > 0.1$ GeV

phase II
Felix Data
Acquisition



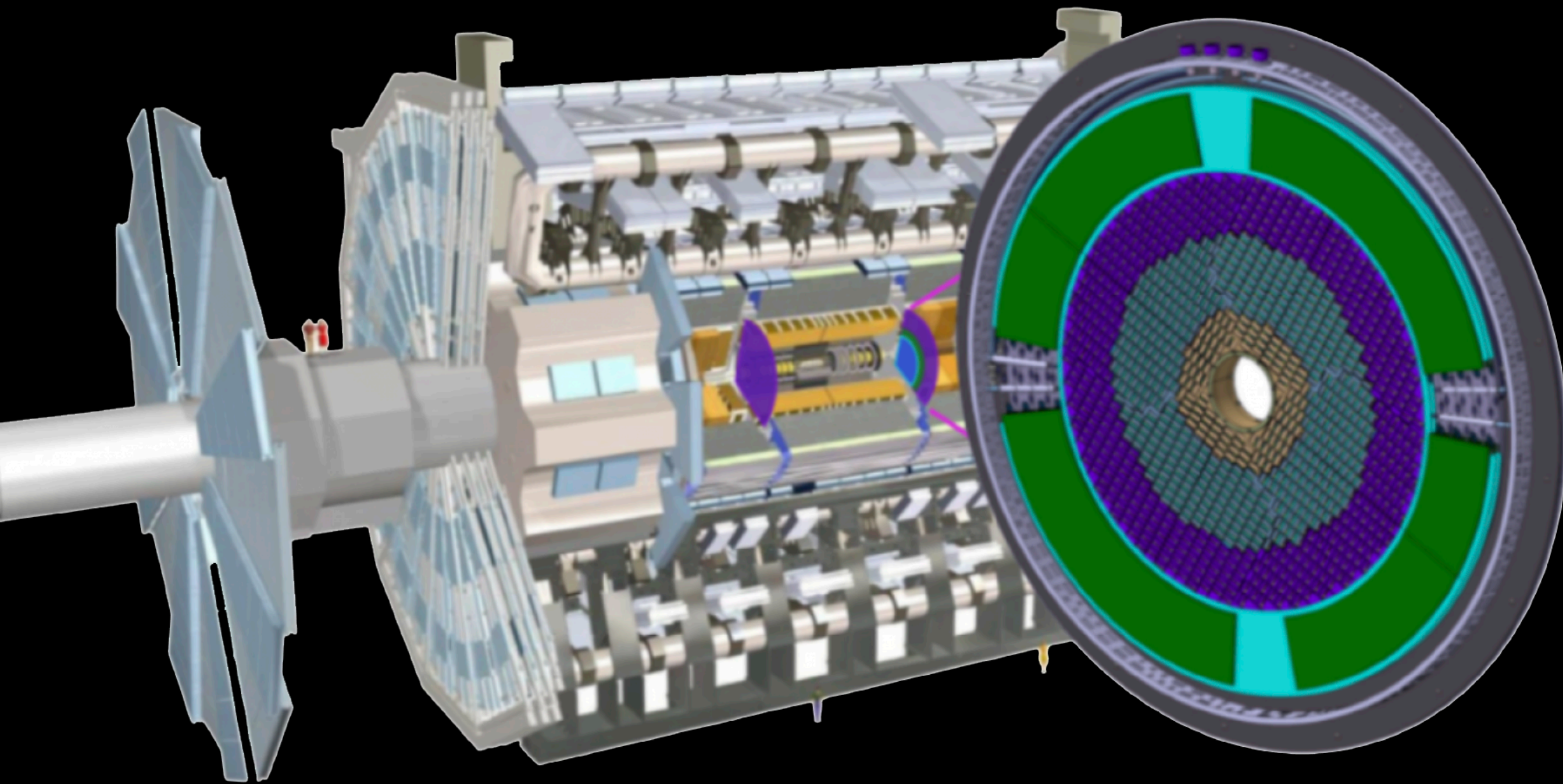
HL-LHC: WE NEED NEW DETECTORS

Nikhef



ITK: all-new **all-silicon** detector (2028)
Much improved **forward coverage** ($|\eta| < 4$)
Very **high resolution** (50x more channels)

HL-LHC: WE NEED NEW DETECTORS (2028-2034)

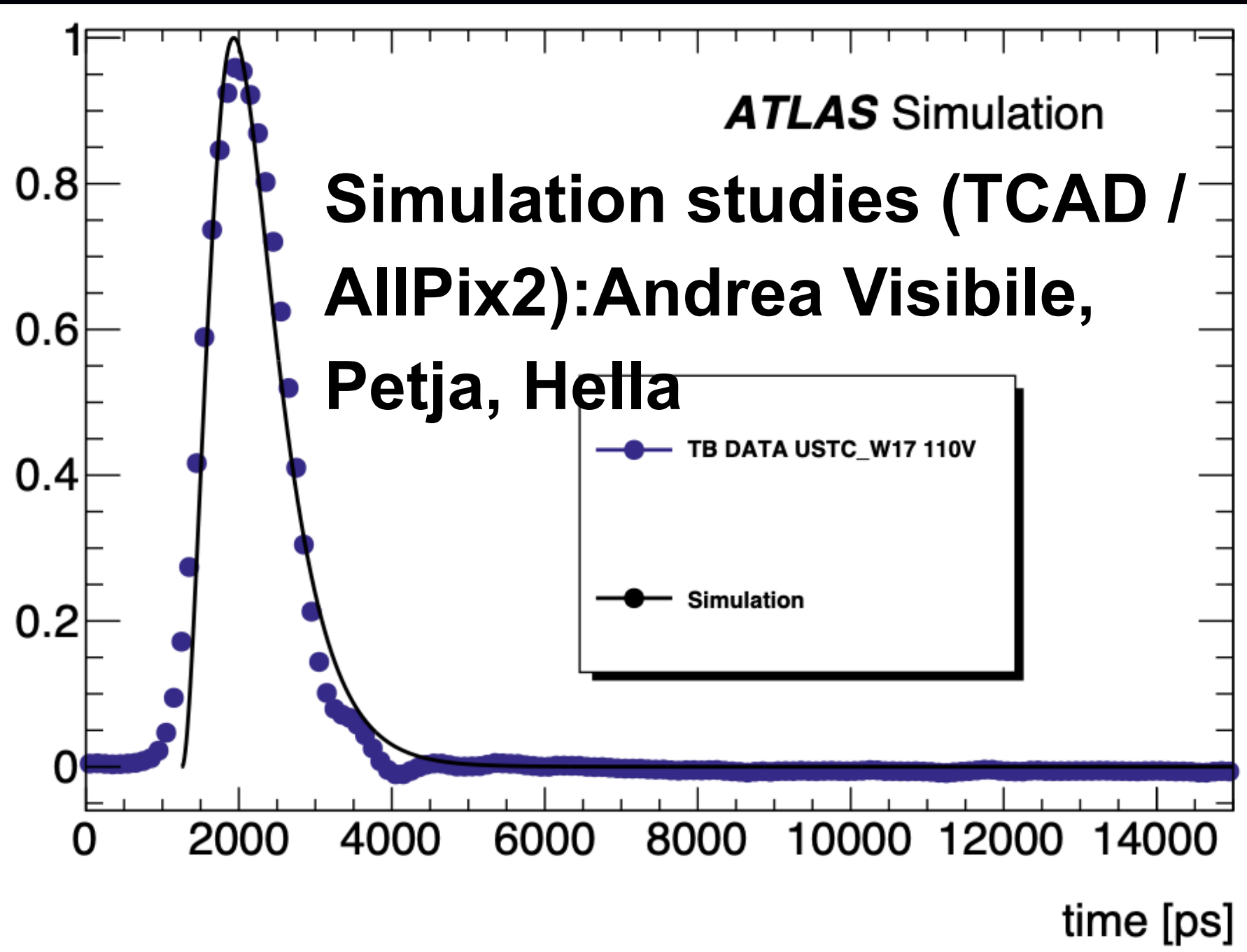


New forward detector $2.4 < |\eta| < 4.0$
High Granularity **Timing** detector:
Ultra-precise timing measurement reduces 'pile-up' tracks by an order of magnitude

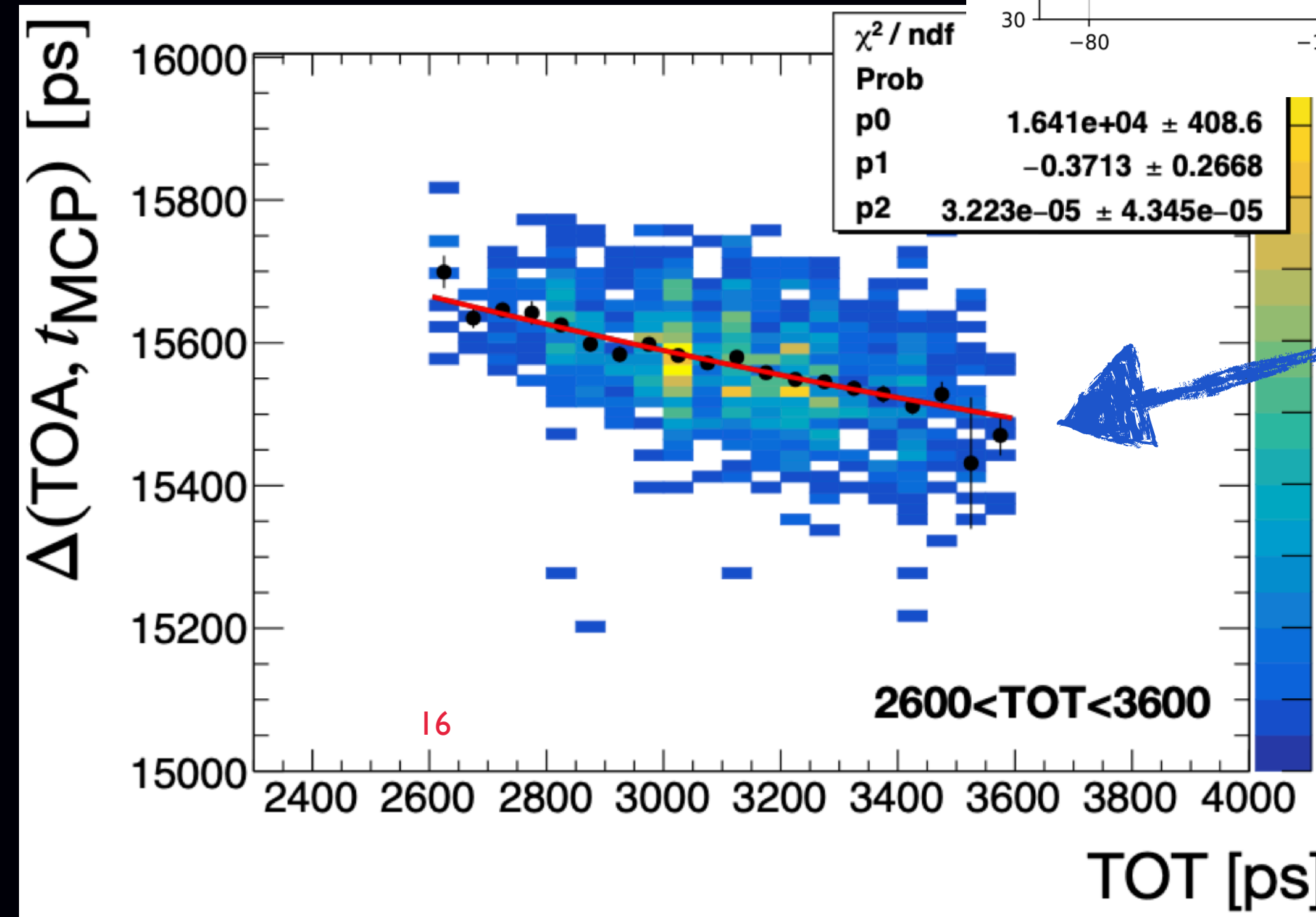
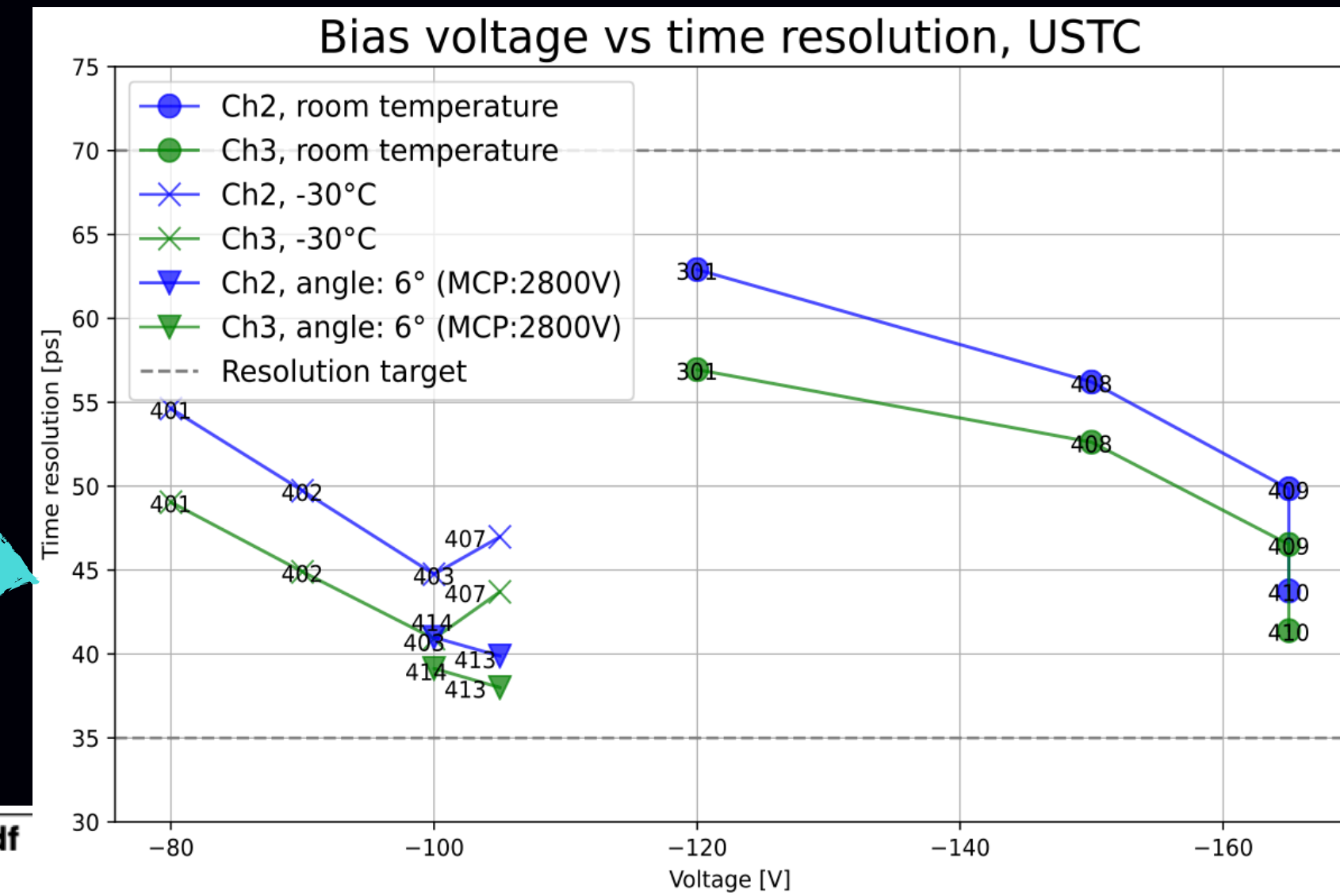
Nikhef

Initial version installed in 2028
Partial upgrades in 2034 & beyond

HGTD Nikhef contributions

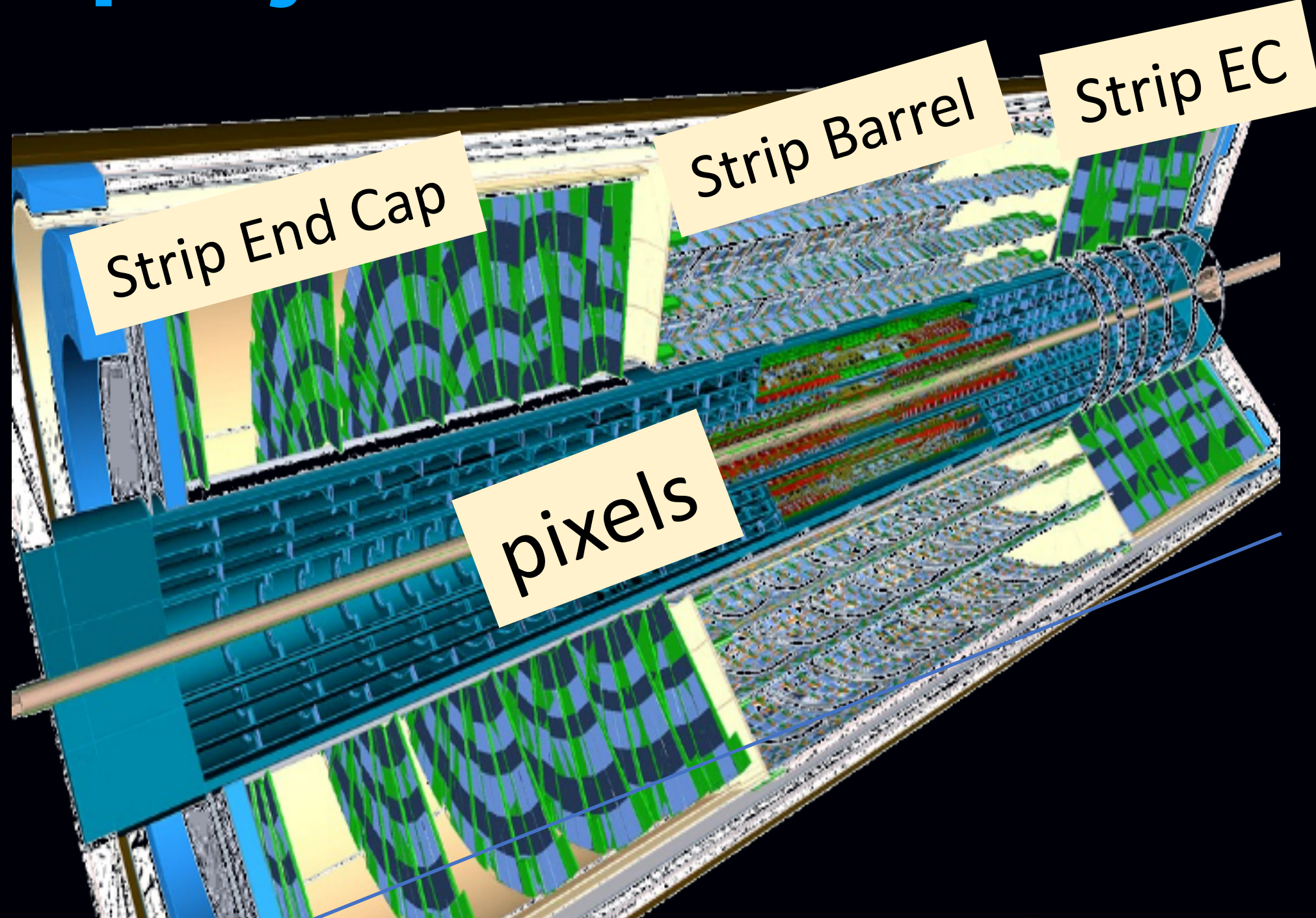


Low Gain Avalanche Detectors (LGAD): sensor test-beam data analysis: Marcello Pozzessere, Mengqing

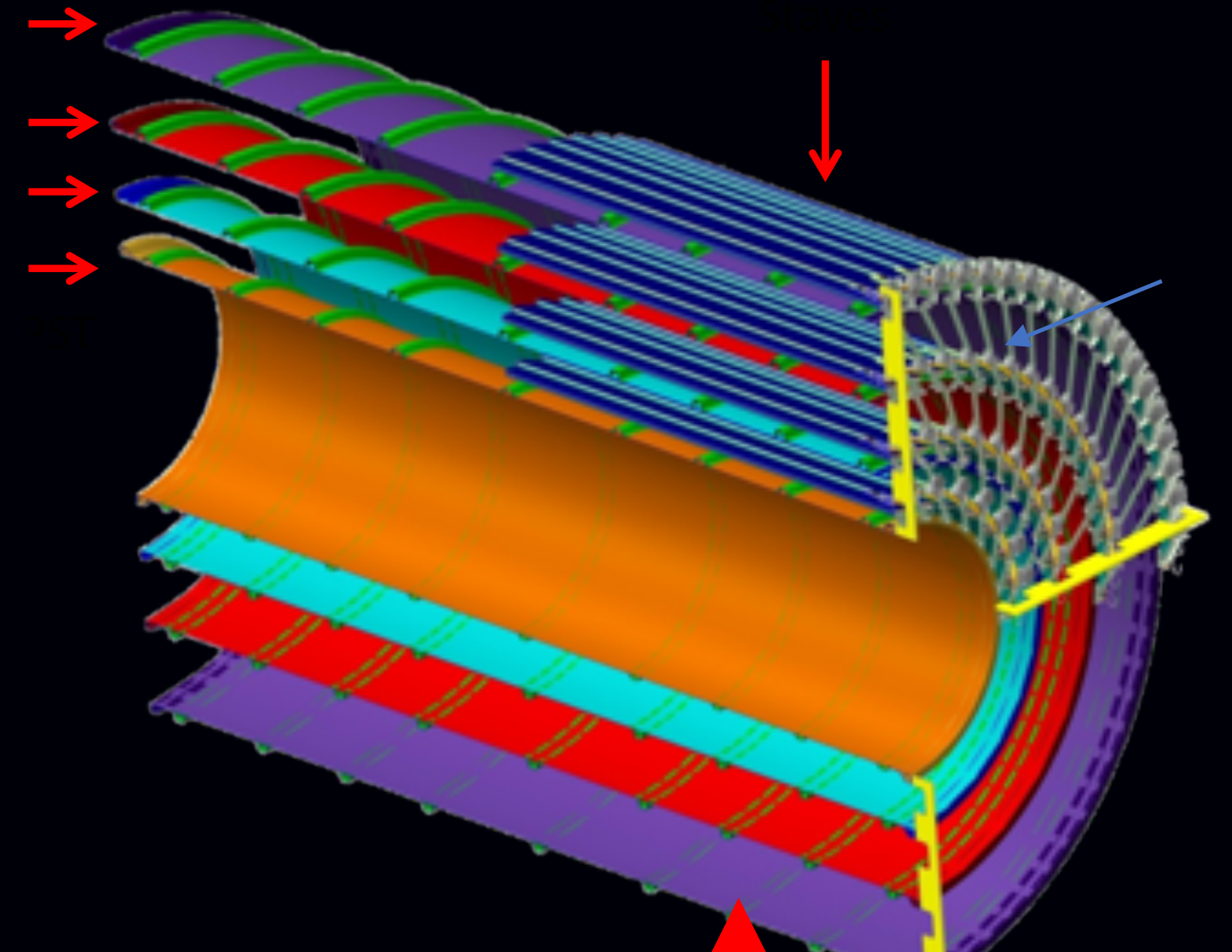


Sensor+ASIC test-beam setup & preliminary data analysis: Marion

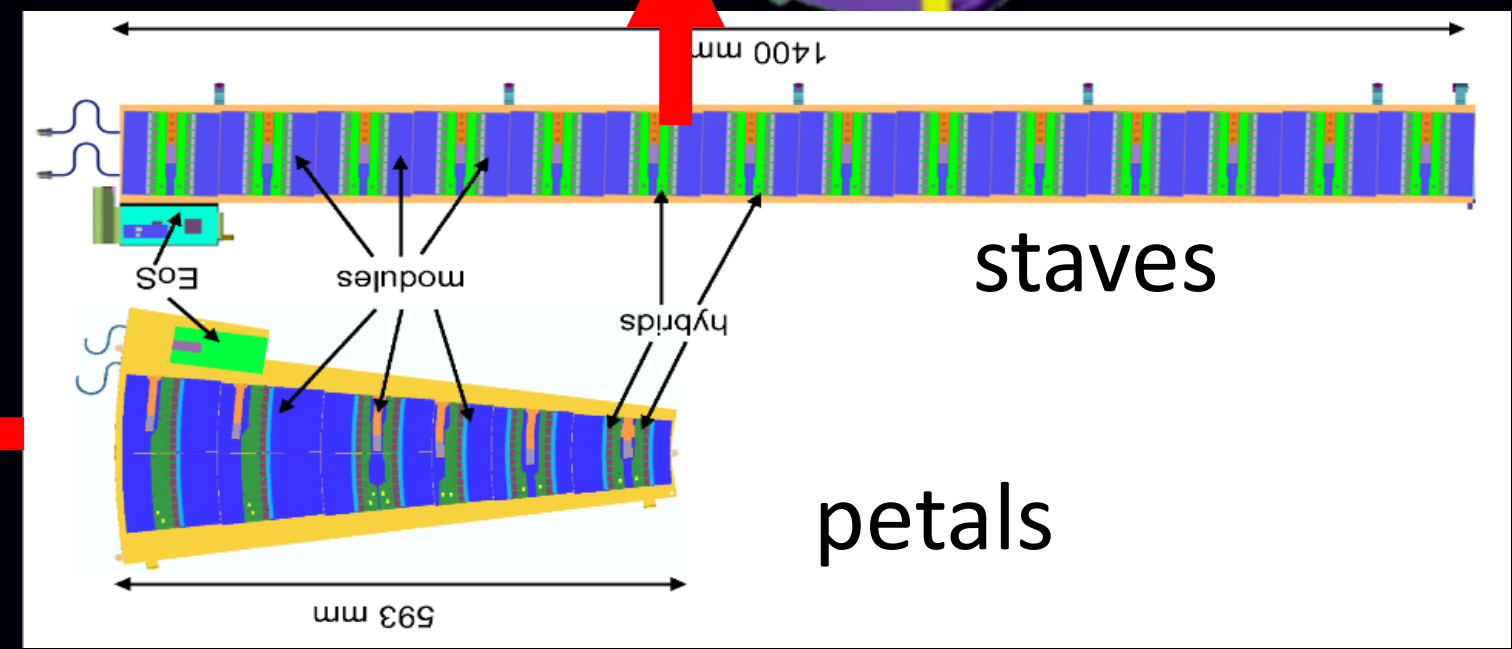
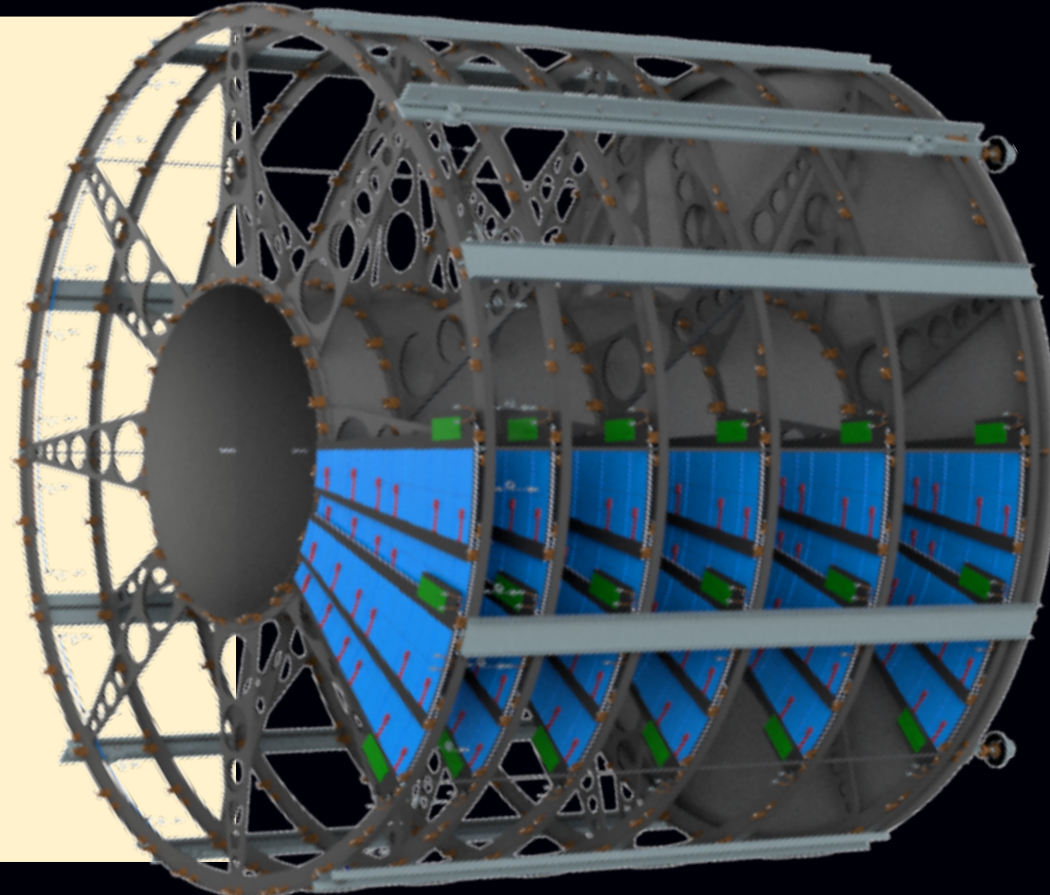
ATLAS-ITk project overview



Barrel 2.2.7.1:
4 cylinders with brackets for staves



@Nikhef:
make two EndCap (EC) structures
→ Insert petals to one EC
Other EC to DESY (soon)
→ Both ECs to CERN in 2026.



Newest timeline for EC macro-assembly

EC2 for Nikhef

@Nikhef

EC1 for DESY

@Desy

@Cern

2) Combine structure in superframe and perform rotation tests.

4) Transport CERN

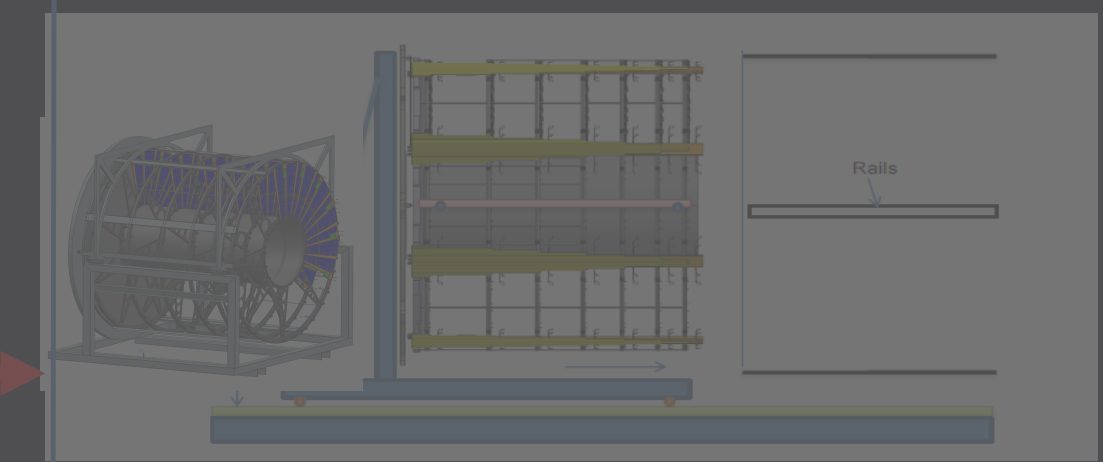
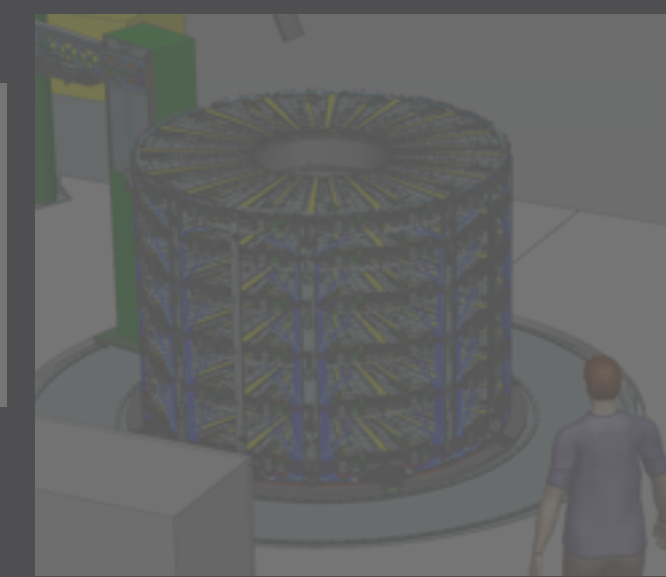
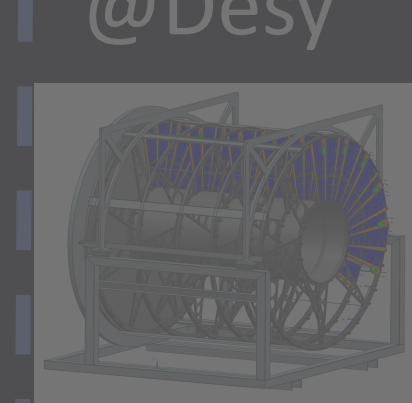
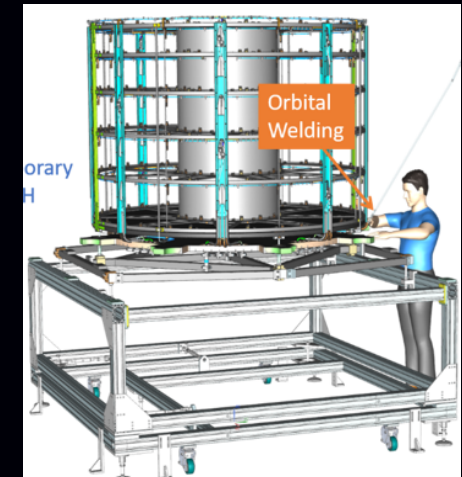
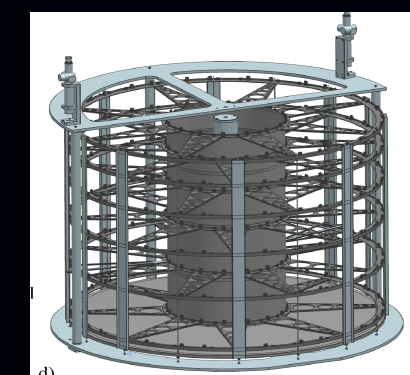
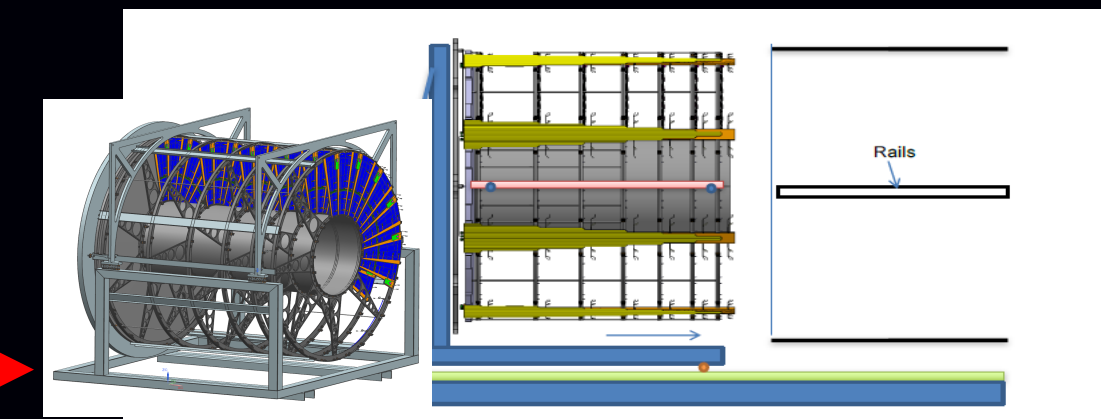
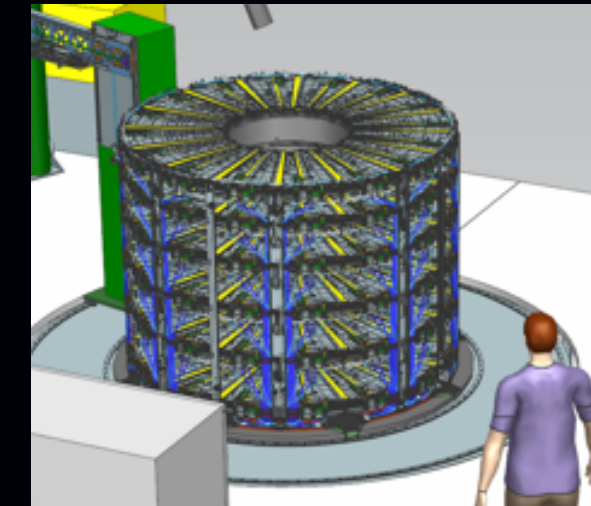
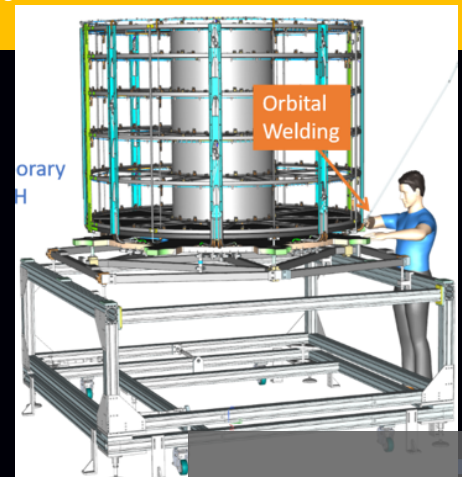
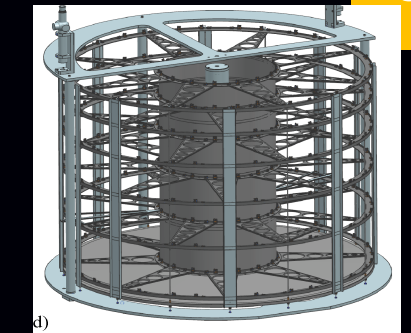
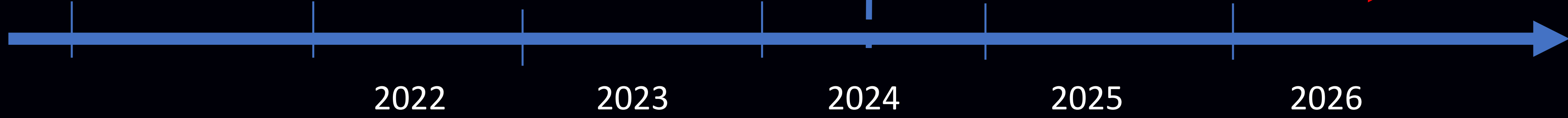
5) CERN test and installation

1) Assembly 2x

Petal Reception

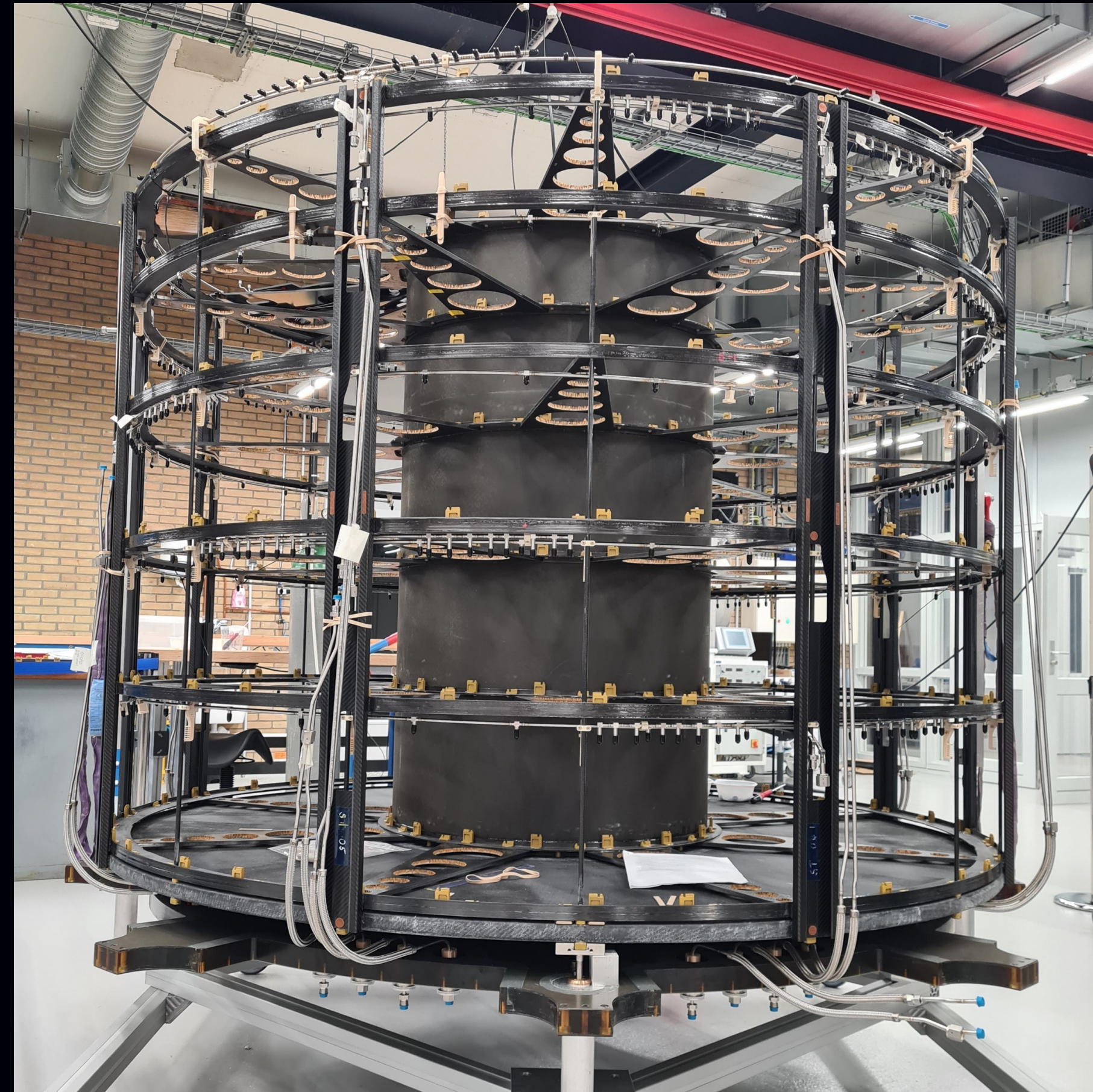
3) Petal Insertion

Transport to DESY



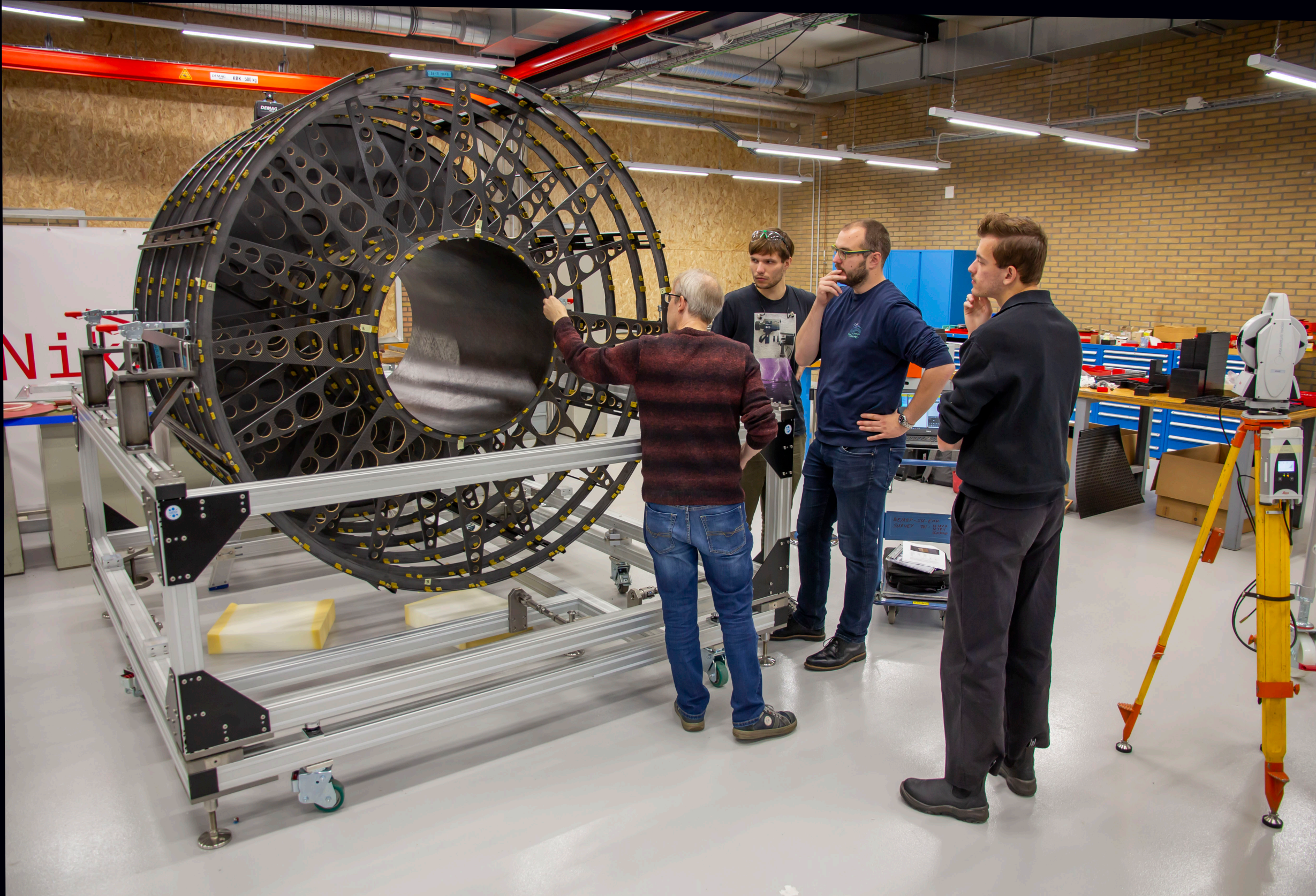
NIKHEF TODAY

- Finished production BOTH Carbon Fibre End-Cap (EC) structures.
- Cooling services produced@nikhef and mostly installed + tested



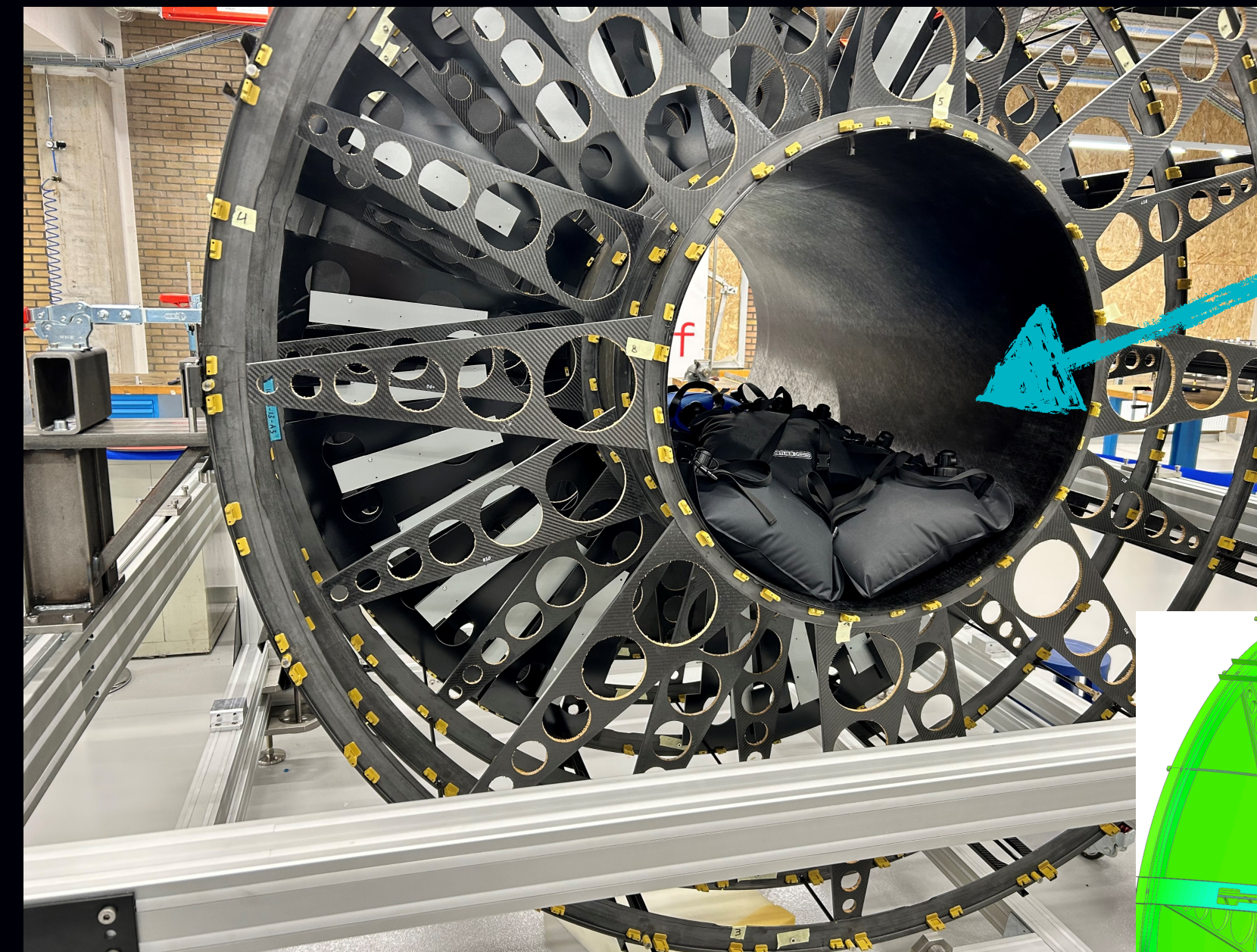
Quality Assurance and Control: 3D LASER MEASUREMENT

3D laser measurements

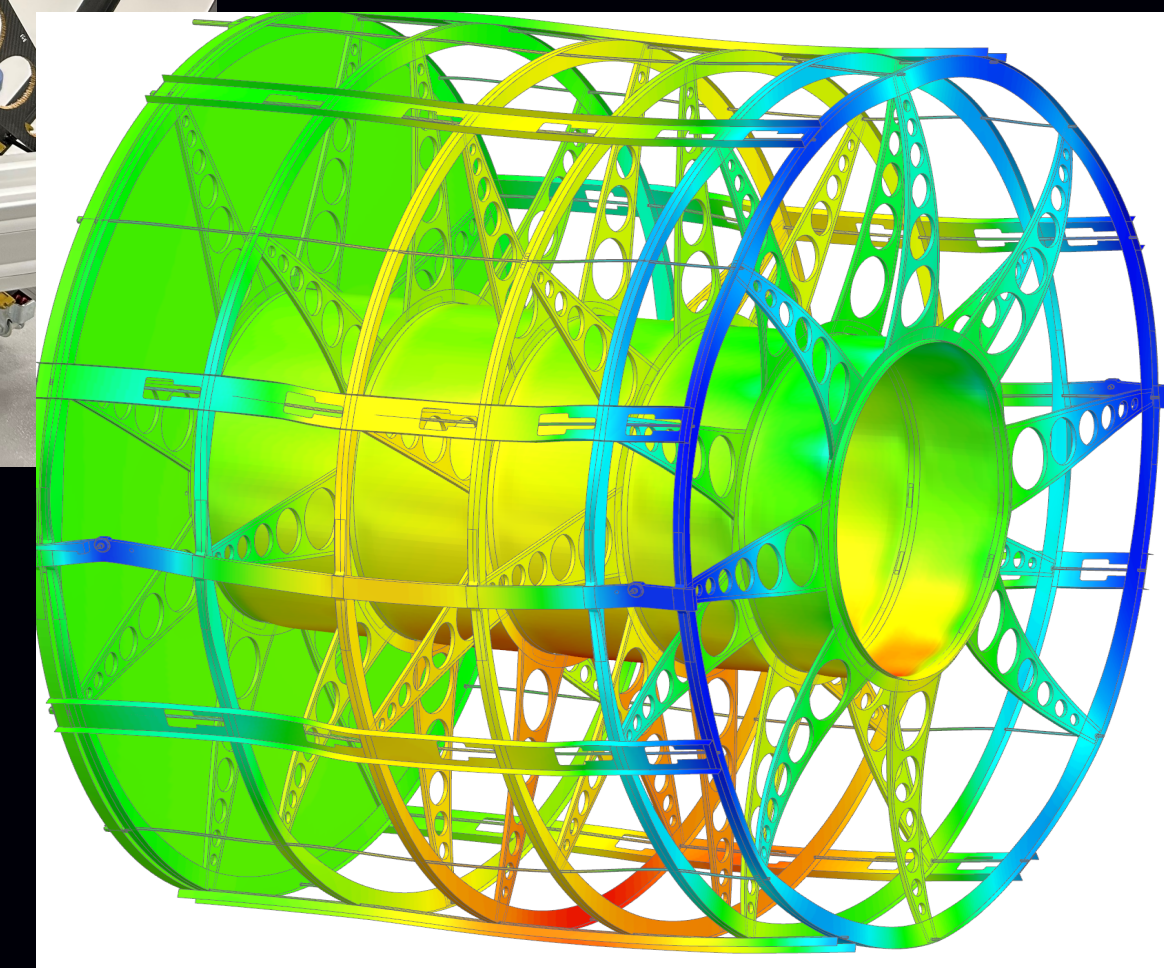


Global accuracy < 100um (target)

measurement under load 2x nominal =250 kg



waterbags



deformation <100 um: Stiffer than what required.

Target for 2nd half 2024: cleanroom (CR) ready for petalization

Thermal Enclosure around EC for coldtest –shown below-- (in production)

- Cooling tubes under platform
- Dryair+ interface to EC

Coming months

Insertion Tower DESY delivered

Petal storage in CR Q3 2024 Being designed

Lukasz cooler Arrives Q2 2024

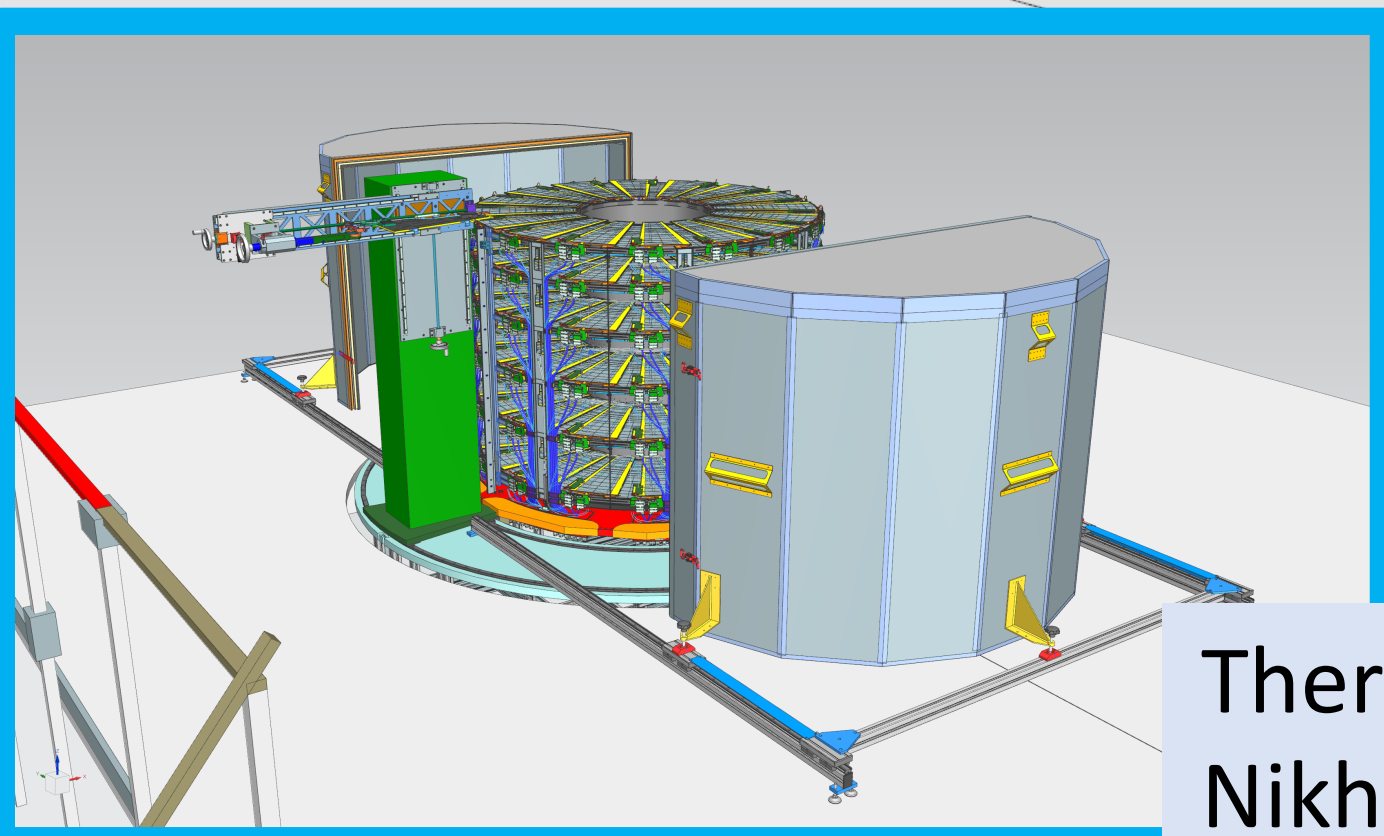
Platform just got installed

Petal box

Petal pipe bender 2024 Q2 Optimization takes time

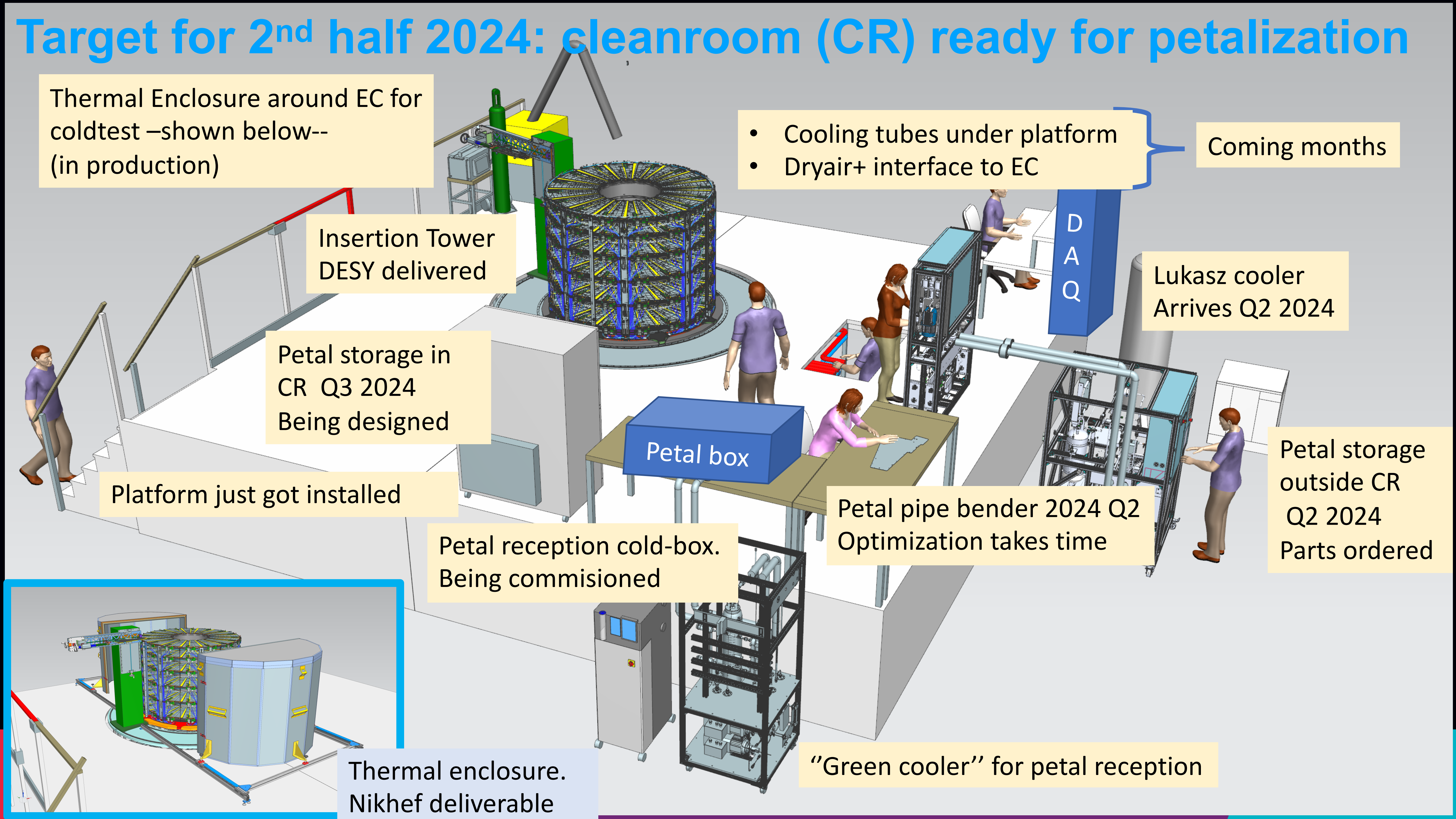
Petal storage outside CR Q2 2024 Parts ordered

Petal reception cold-box. Being commissioned



Thermal enclosure. Nikhef deliverable

“Green cooler” for petal reception



Target for 2nd half 2024: cleanroom (CR) ready for petalization

Thermal Enclosure around EC for coldtest –shown below-- (in production)

Coming months

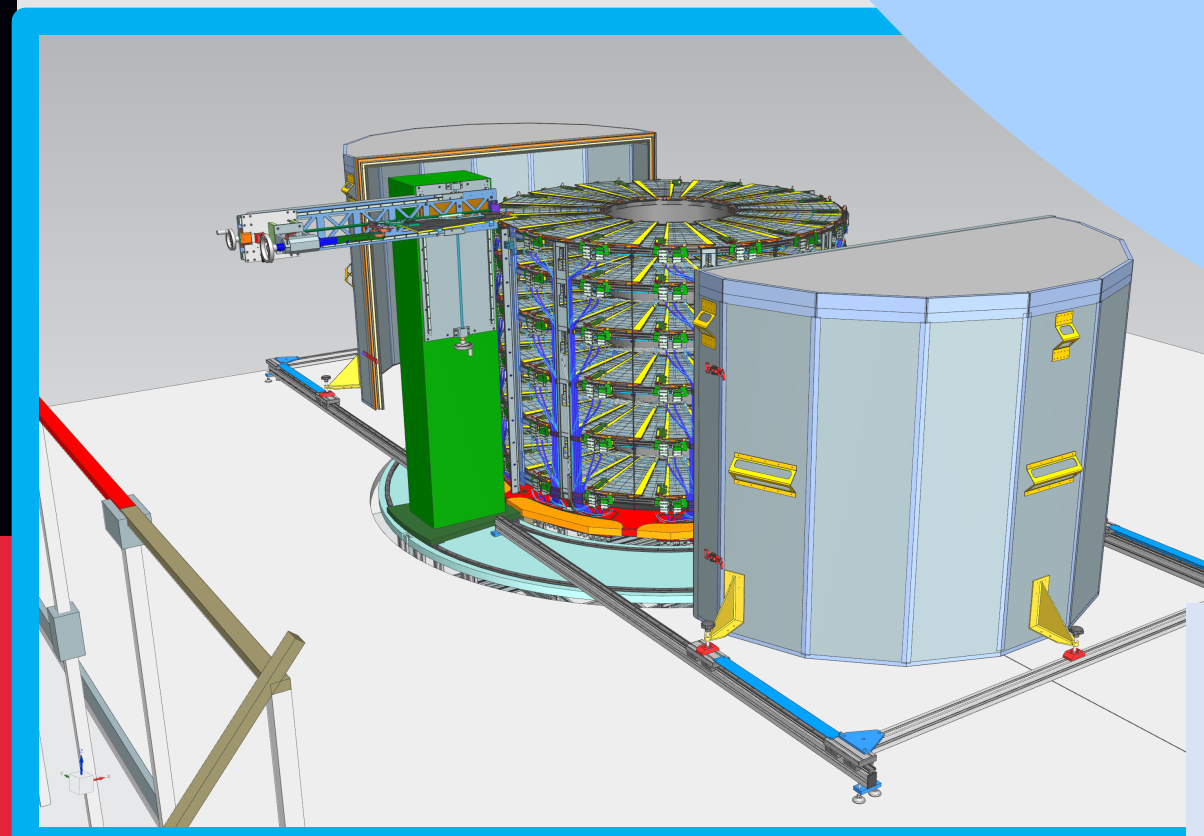


Platform

all parts of cleanroom are being delivered, designed or commissioned !

4

storage
de CR
2024
arts ordered



Thermal enclosure. Nikhef deliverable

“Green cooler” for petal reception

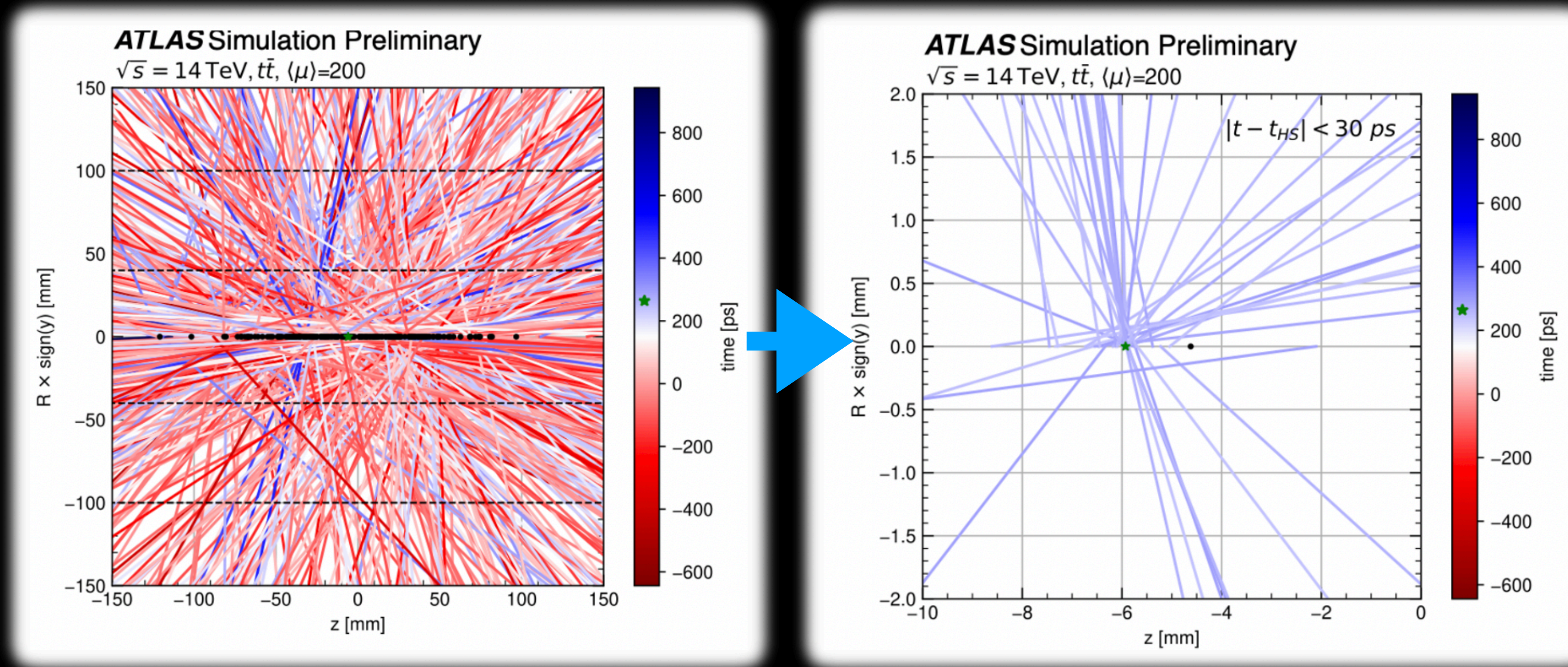
- **Vibrant physics program**, focused on forefront research ready to explore the wide physics territory ahead of us.
- **Heavily involved** in Muons software and in muon and b-jet performance
- Working at **Full steam** on HL-LHC detectors



Back-up

HL-LHC: WE NEED DETECTOR R&D

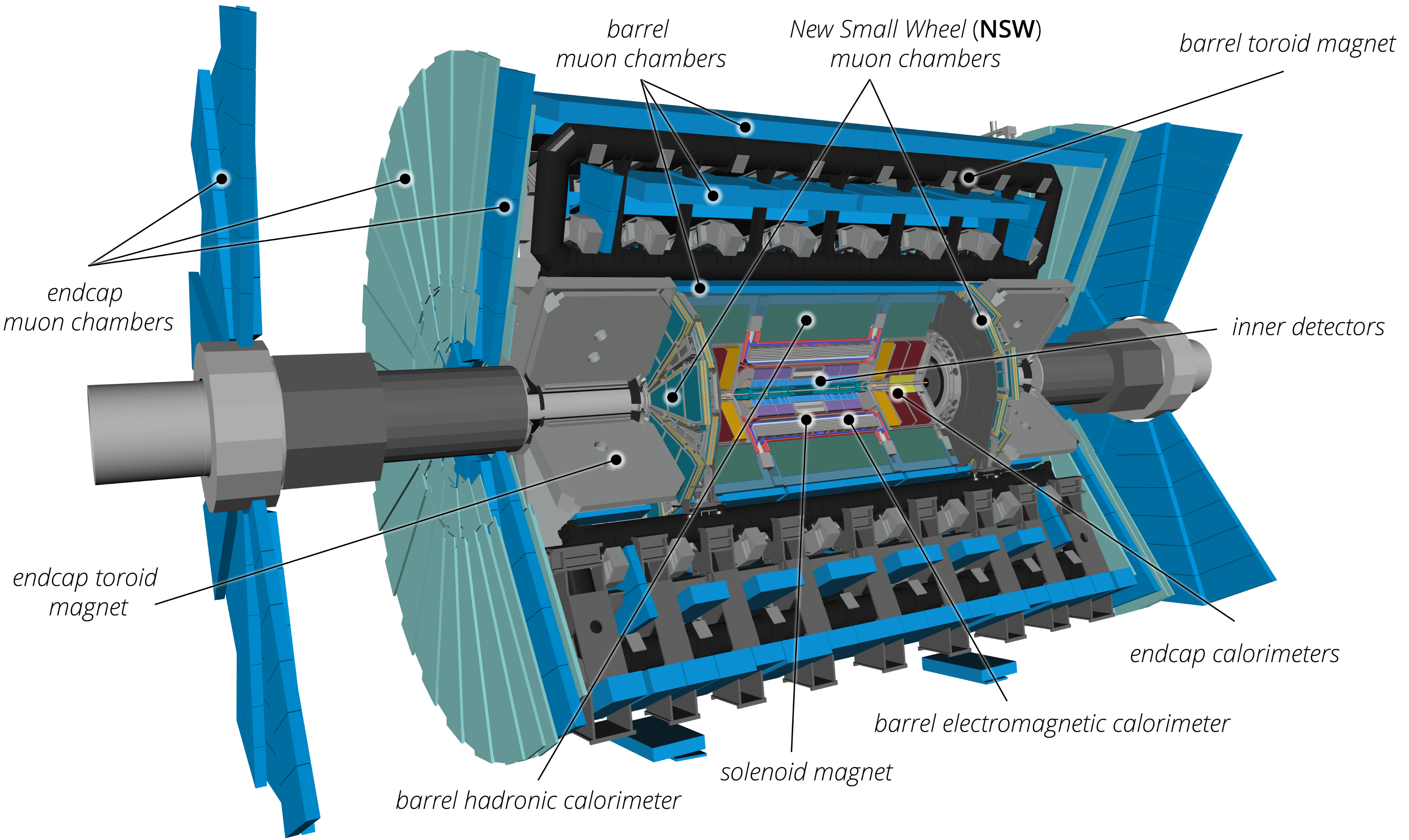
Possibility to replace inner layer of ITk barrel pixel **after 2035**:
Opportunity to add fast-timing detector layer



Technologically *very challenging*, no suitable existing technology,
R&D also useful towards future collider detectors

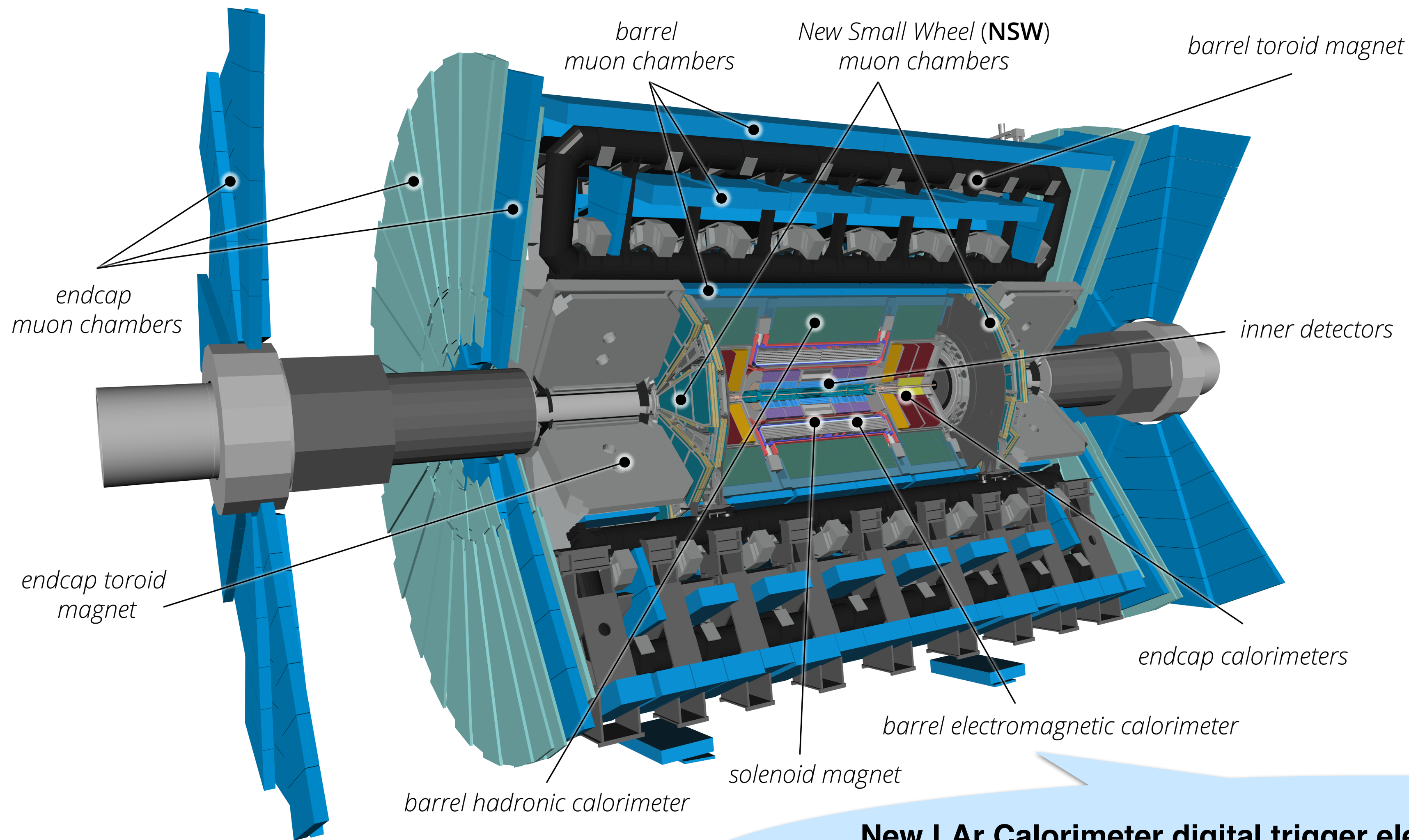
RUN 3 DETECTOR EVOLU FOR HL-LHC

[arXiv:2305.16623](https://arxiv.org/abs/2305.16623)



RUN 3 DETECTOR EVOLU FOR HL-LHC

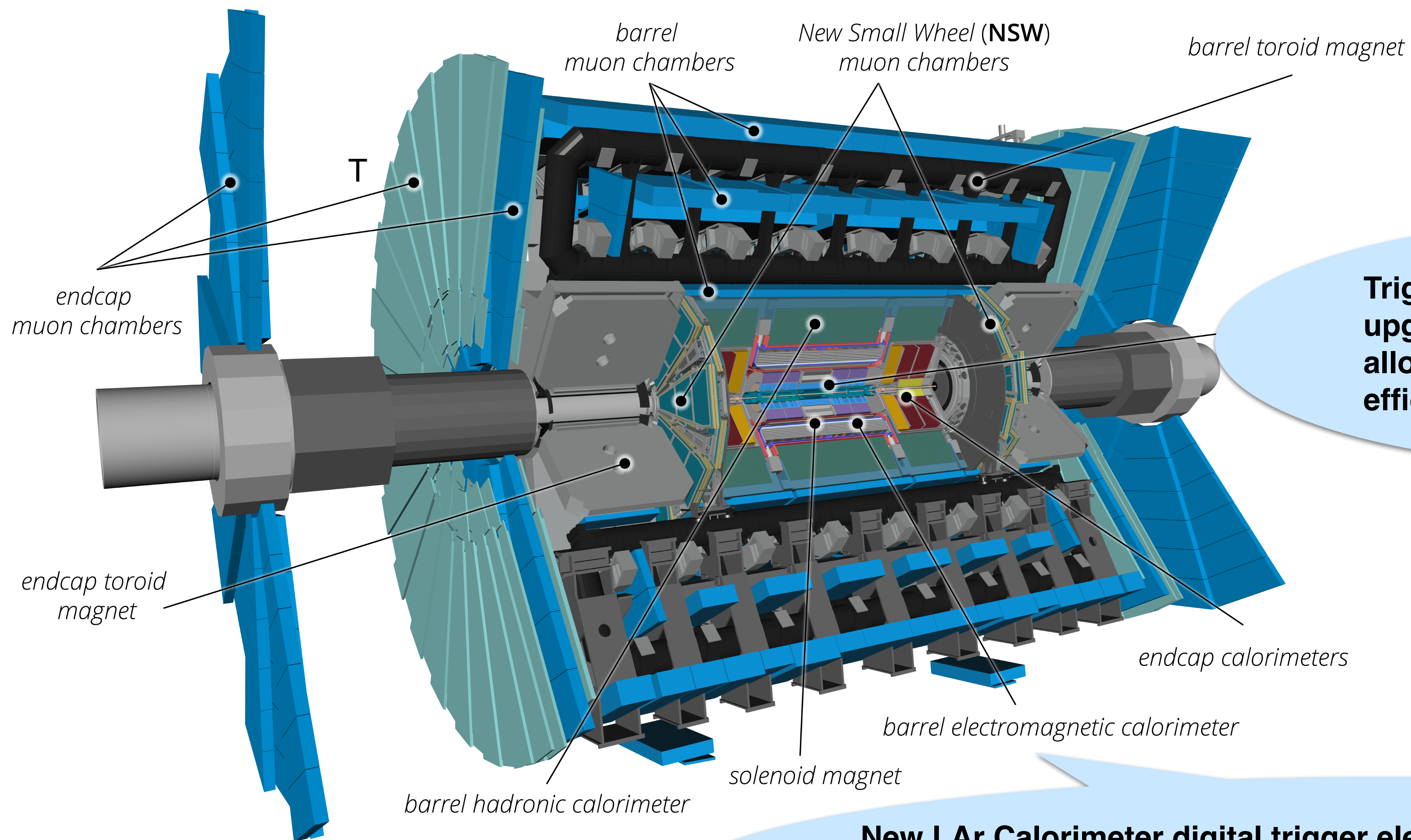
[arXiv:2305.16623](https://arxiv.org/abs/2305.16623)



**New LAr Calorimeter digital trigger electronic boards:
improved first level trigger granularity!
towards HL-LHC runs to deal with high background rates**

RUN 3 DETECTOR EVOLU FOR HL-LHC

[arXiv:2305.16623](https://arxiv.org/abs/2305.16623)

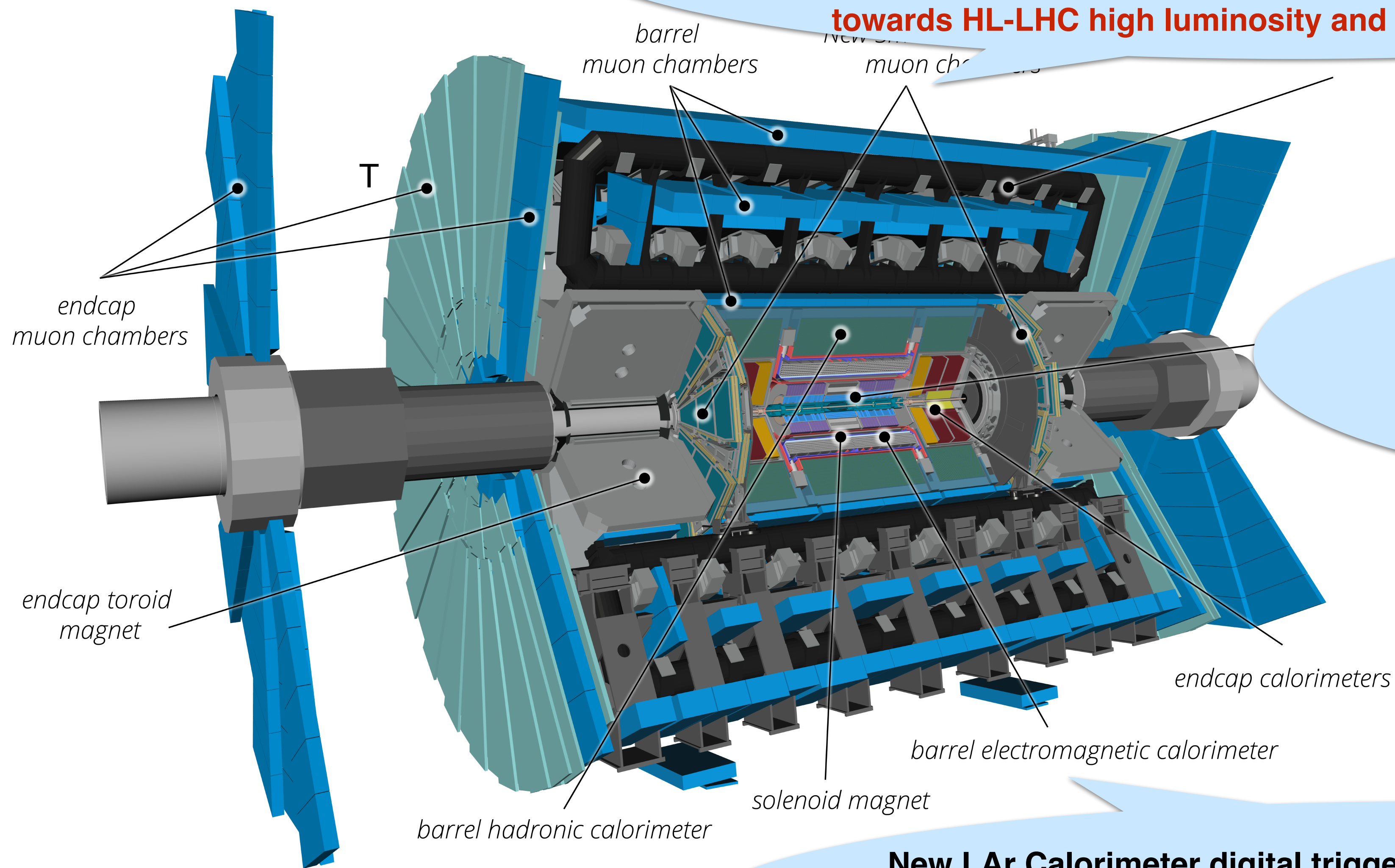


Trigger & data acquisition have upgraded hardware & software allowing the trigger to select events more efficiently & reduce background rates

**New LAr Calorimeter digital trigger electronic boards:
improved trigger granularity!
towards HL-LHC runs to deal with high background rates**

[arXiv:2305.16623](https://arxiv.org/abs/2305.16623)

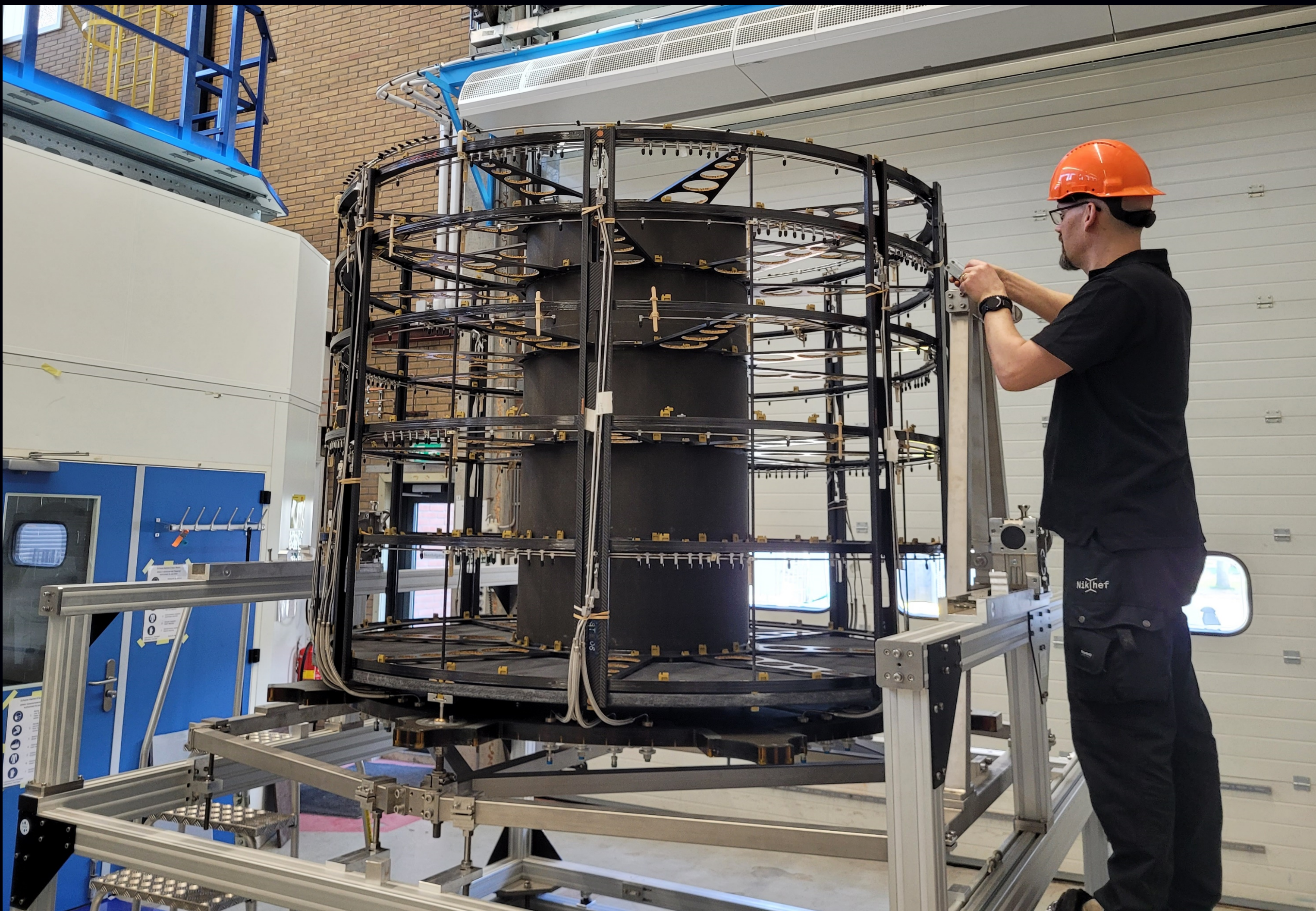
Muon New Small Wheels to replace innermost forward Muon station to
1) improve Level 1 trigger
2) maintain good tracking in end-cap region
towards HL-LHC high luminosity and high background rates



Trigger And data acquisition systems have upgraded hardware ad software allowing the trigger to spot a wide range of collision events (with same acceptance)

New LAr Calorimeter digital trigger electronic boards: improved trigger granularity!
towards HL-LHC high luminosity and high background rates

Preparation to ship EC1 to DESY ongoing



Special “Superframe” designed by DESY used for petal insertion (EC vertical) and transport (EC horizontal).

This transport is the test-case final transport (fake petals and weight to mimic cable are added)

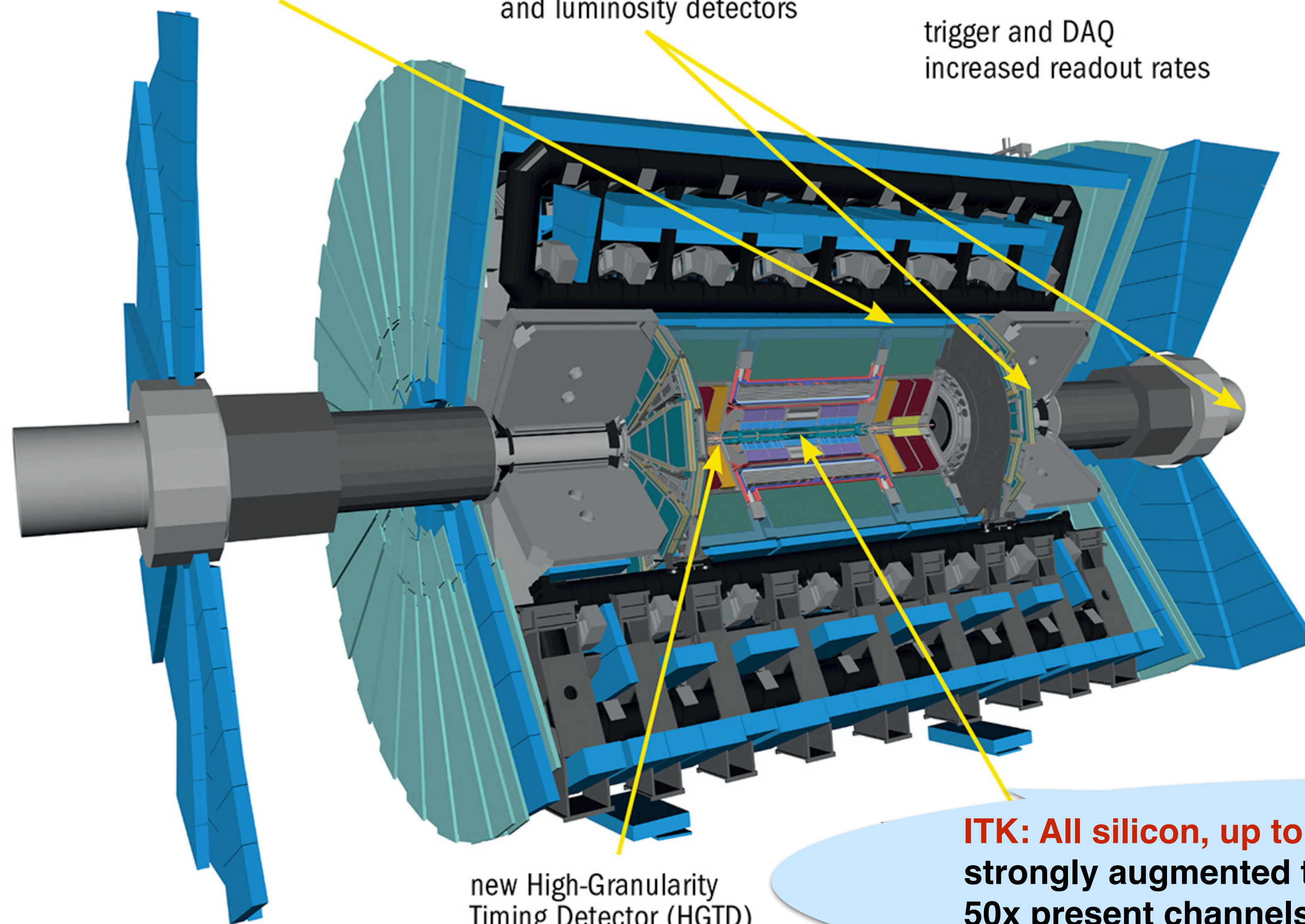
Nikhef performs FEA of EC structure during transport.

HL-LHC UPGRADE

improved muon coverage

new and upgraded forward and luminosity detectors

trigger and DAQ
increased readout rates



new High-Granularity
Timing Detector (HGTD)

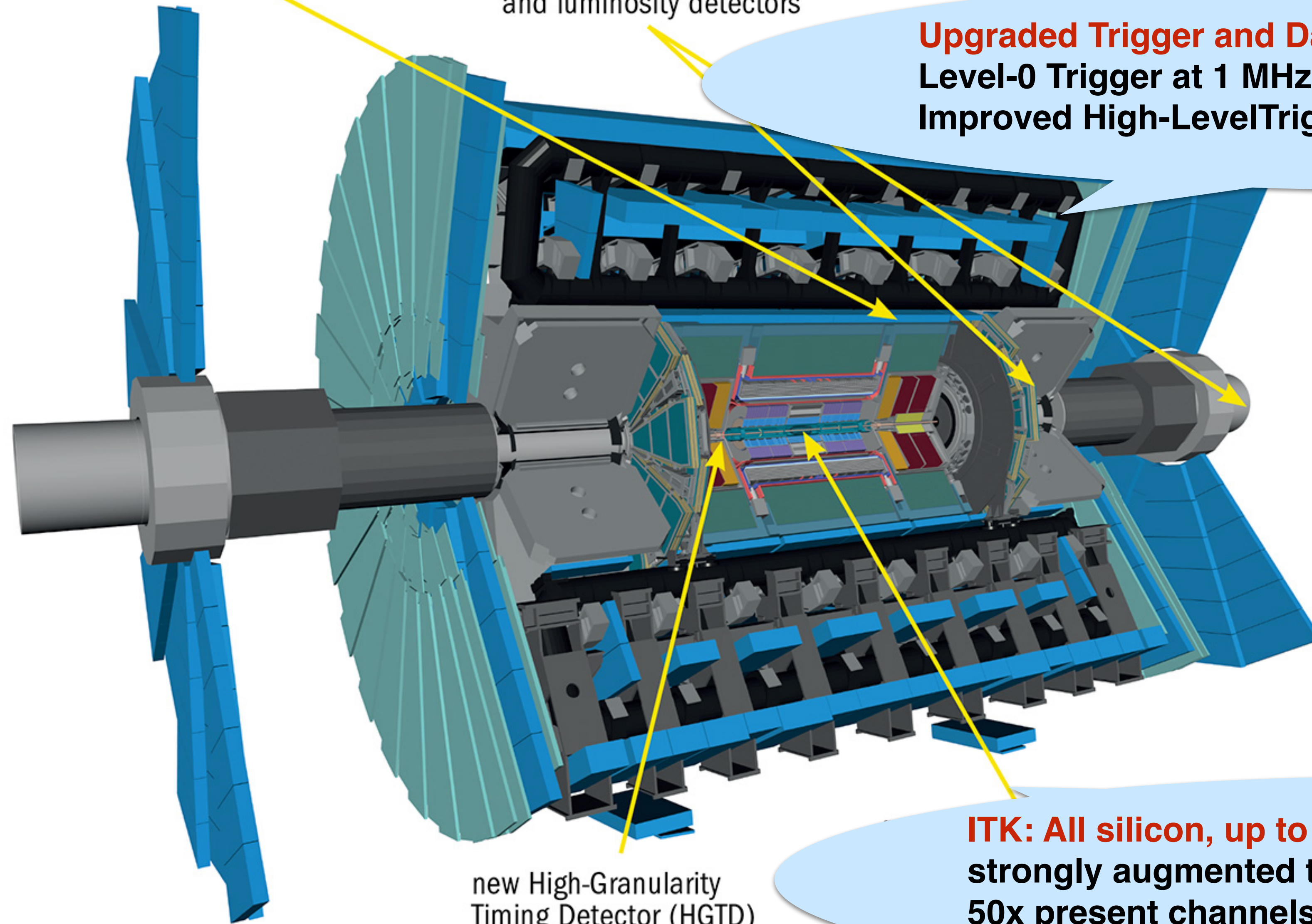
**ITK: All silicon, up to $|\eta| = 4$
strongly augmented tracking acceptance,
50x present channels → to cope with high occupancy**

HL-LHC UPGRADE

improved muon coverage

new and upgraded forward
and luminosity detectors

Upgraded Trigger and Data Acquisition system
Level-0 Trigger at 1 MHz, Full-feature global trigger
Improved High-Level Trigger (150 kHz full-scan tracking)



new High-Granularity
Timing Detector (HGTD)

ITK: All silicon, up to $|\eta| = 4$
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Improved High-Level Trigger (150 kHz full-scan tracking)

Electronics Upgrades

- LAr Calorimeter
- Tile Calorimeter
- Muon system

new High-Granularity Timing Detector (HGTD)

ITK: All silicon, up to $|η| = 4$
strongly augmented tracking acceptance,
50x present channels → to cope with high occupancy

HL-LHC UPGRADE

New Muon Chambers

Inner barrel region with new RPC and sMDT detectors

new and upgraded forward and luminosity detectors

Upgraded Trigger and Data Acquisition system

Level-0 Trigger at 1 MHz, Full-feature global trigger
Improved High-Level Trigger (150 kHz full-scan tracking)

Electronics Upgrades

- LAr Calorimeter
- Tile Calorimeter
- Muon system

new High-Granularity Timing Detector (HGTD)

ITK: All silicon, up to $|\eta| = 4$

strongly augmented tracking acceptance, 50x present channels → for pile-up rejection

HL-LHC UPGRADE

New Muon Chambers

Inner barrel region with new RPC and sMDT detectors

new and upgraded forward and luminosity detectors

Upgraded Trigger and Data Acquisition system

Level-0 Trigger at 1 MHz, Full-feature global trigger
Improved High-Level Trigger (150 kHz full-scan tracking)

Electronics Upgrades

- LAr Calorimeter
- Tile Calorimeter
- Muon system

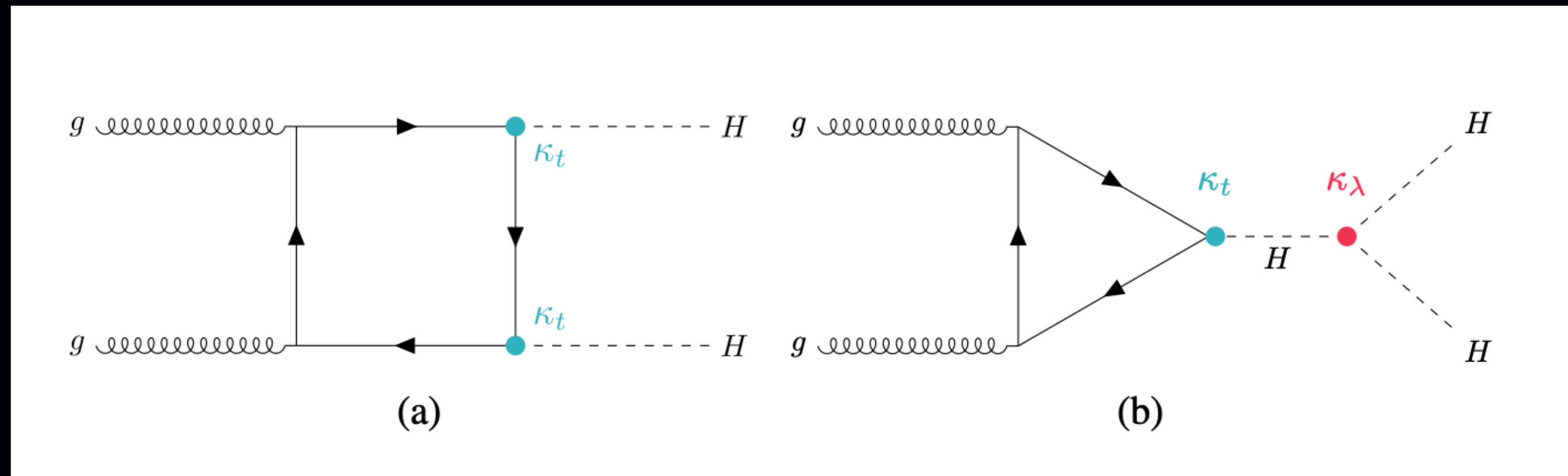
High Granularity Timing Detector (HGTD)

Forward region
($2.4 < |\eta| < 4.0$)

ITK: All silicon, up to $|\eta| = 4$

strongly augmented tracking acceptance,
50x present channels → to cope with high occupancy

ADDITIONAL MATERIAL



Grants awarded 2017-2022

ATLAS group

- EU Marie Curie Innovative Training Network INSIGHTS (Verkerke, e400k)
- FOM Projectruimte (van Eijk/Ferrari, e500k)
- NWO ENW-GROOT Higgs (Verkerke, e3000k)
- NWO VENI (Arnold, e300k)
- NWO VIDI (de Almeida Dias, e800k)
- OCW NWA (Caron, e130k)

Together with other Nikhef groups

- NWO ENW-M2 Higgs (Rojo/Verkerke, e700k) – ATLAS share ~25%
- NOW XL Faster (Snoek, e3000k) – ATLAS share ~15%

Total amount awarded 2017-2022 e5.6m

HANDS ON ITK !

Assembly of ITk strip endcap at Nikhef

