# FASTTRACK DAQ and ALICE

## in The Netherlands


ALICE

Nikhef


# A common DAQ group

# netFELIX: An international collaboration for a Common DAQ

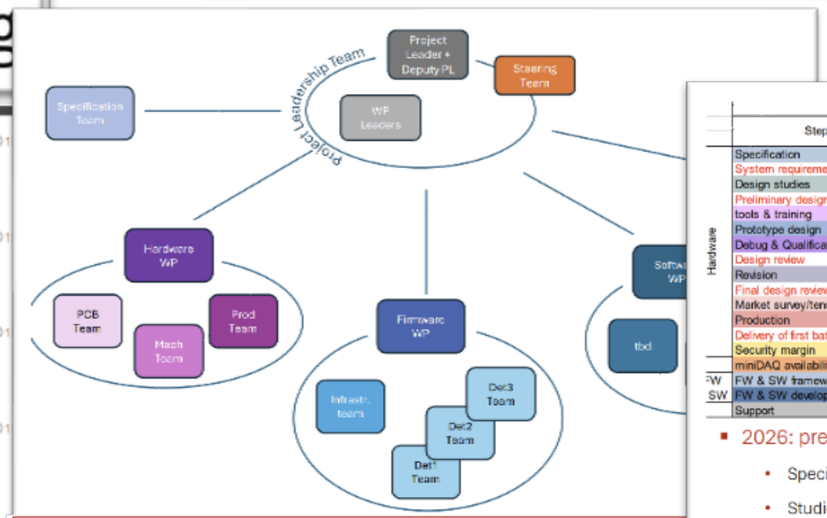
**Building a common readout platform was in the air for quite some time**

***Many discussions took place:***

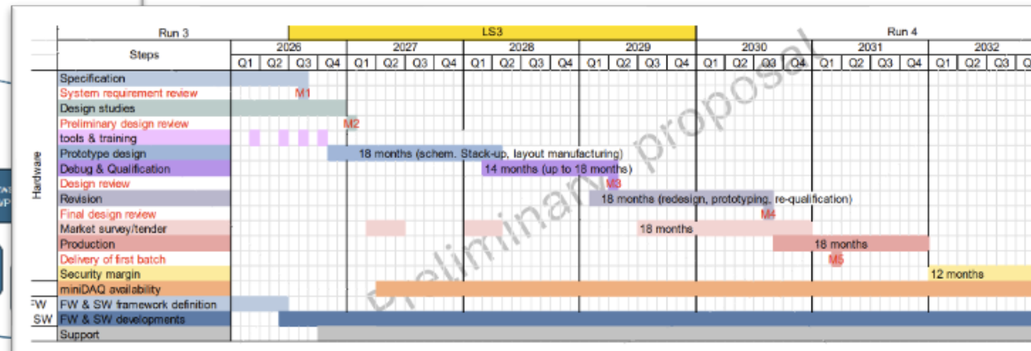
- ***BNL, IN2P3, Nikhef***
- ***CERN EP ESE, DT&Head Office***
- ***ALICE, ATLAS, LHCb, SHiP, SME***
- ***R&D : DRD 7.1,7.3,7.5 ; CERN EP RnD WP6&9***

**Finally, planets were aligned!**

A common Readout Platform for future Experiments designed as an evolution of the ATLAS FLX-155 card, optimized for timing, targeting 400 GbE links to DAQ, future-proof form factor, compatible with lpGBT and Silicon Photonics Front End links.

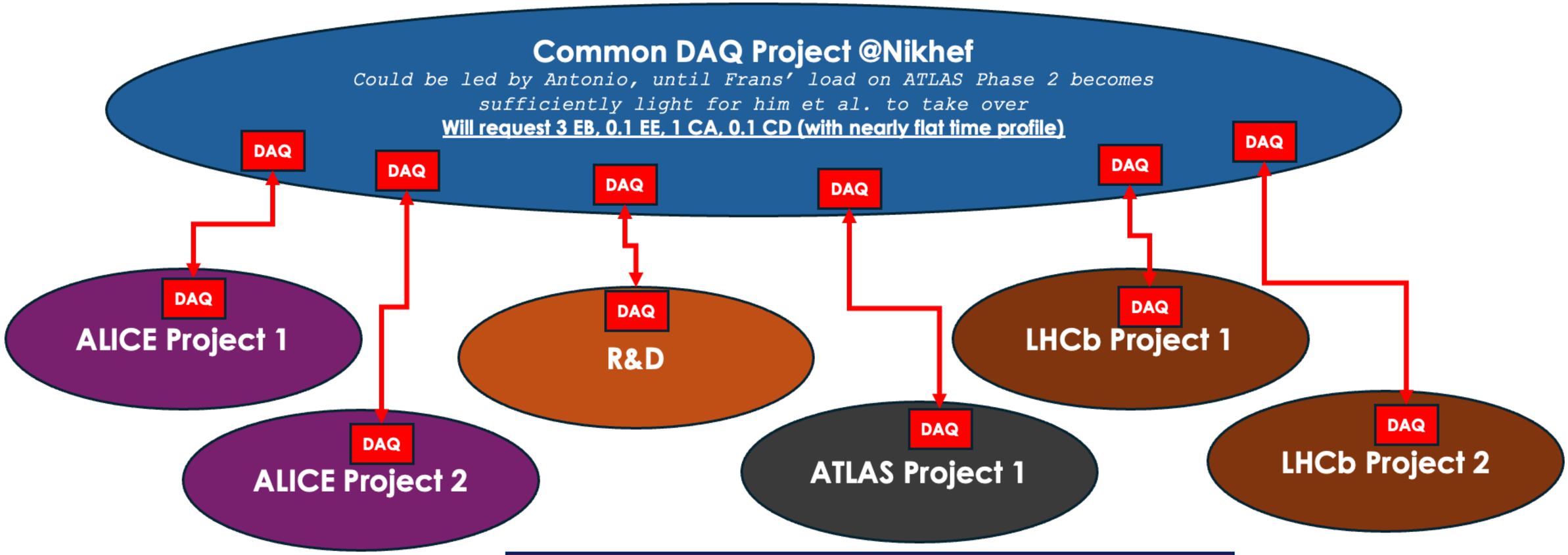




- PROPOSAL
  - Paschalis Vichoudis / CERN , as Project Leader + HW Team membe
  - Frans Schreuder / Nikhef, as Deputy Project Leader + FW Team mer
  - Project Assistant* (documentation, meeting organization, planning)




- 2026: preparatory work
  - Specification stage
  - Studies to validate technical choices
  - FW & SW Frameworks preparation
- Important Milestones along the way
- Support to start as soon as miniDAQs available
- Component procurement to start after M2
  - Especially for critical ones (DDRs, FPGAs..)
- Contingency
  - 18 months foreseen for a redesign if needed
  - added 2032 as full year of contingency

# Partecipate in netFELIX and organise FASTTRACk DAQ as:




***N.B. beside the personpower for common DAQ, also some "uncommon" (i.e. project-dependent) DAQ requests, e.g.:***

- ***0.x EA (adapter boards, chip carrier boards, etc.)***
- ***0.x EB (detector specific firmware etc.)***
- ***0.x EE (test setup cabling etc.)***
- ***0.x CA (detector-specific embedded software etc.)***
- ***0.Y CB (control software etc. – this has to be significant)***
- ***0.x CC (simulation? Not sure what Ruud meant by CC…)***

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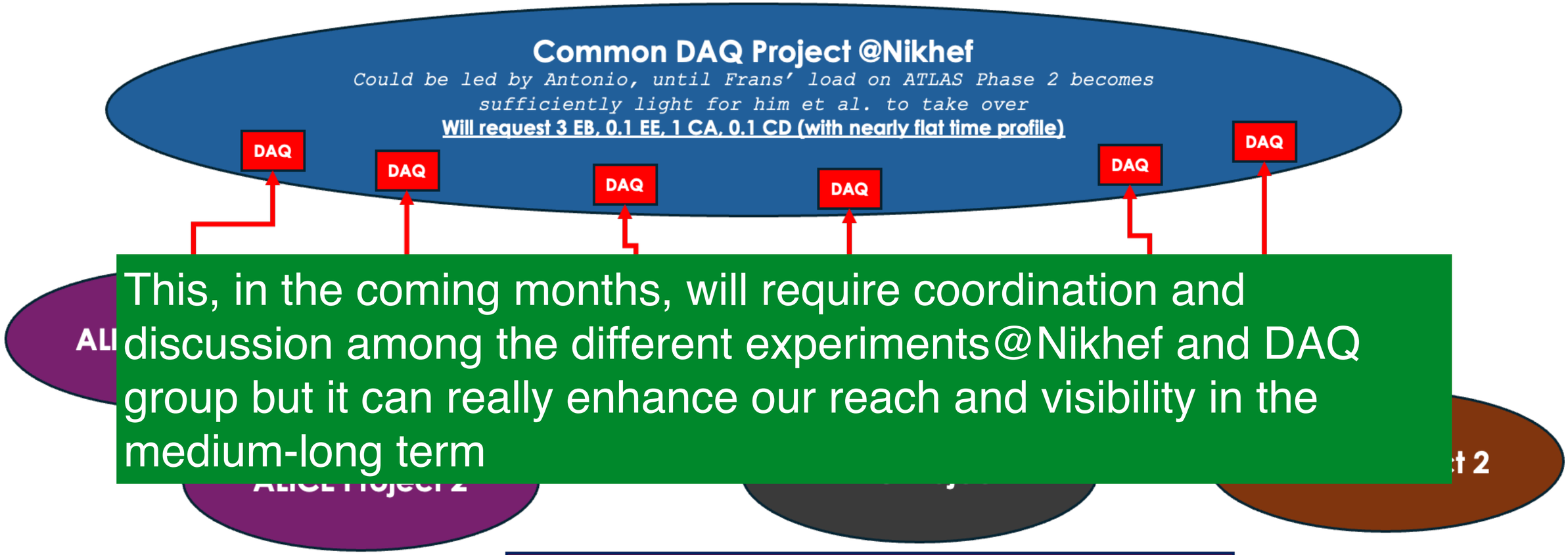


This, in the coming months, will require coordination and discussion among the different experiments@Nikhef and DAQ group but it can really enhance our reach and visibility in the medium-long term

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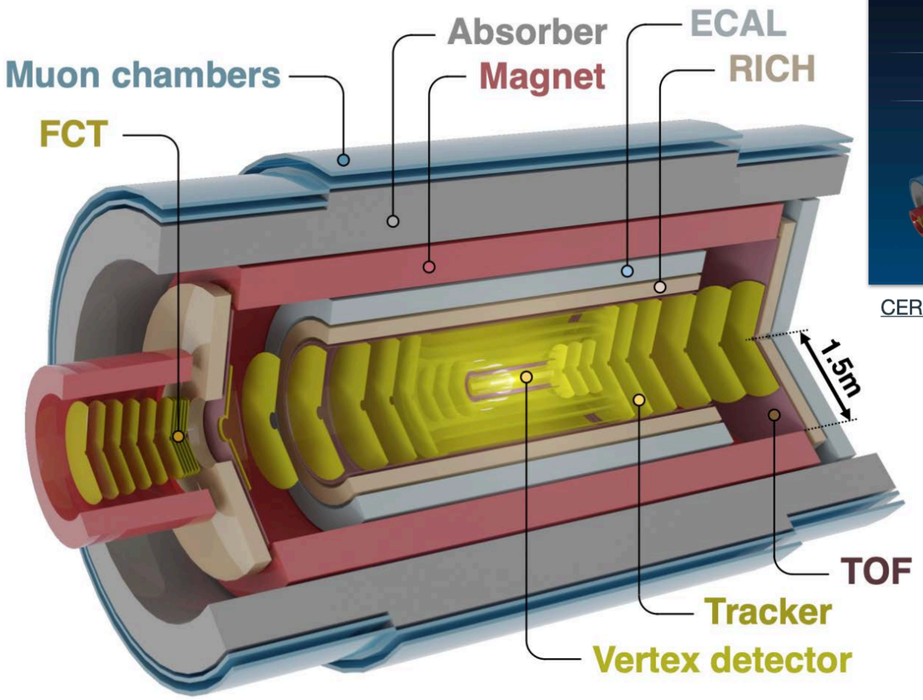
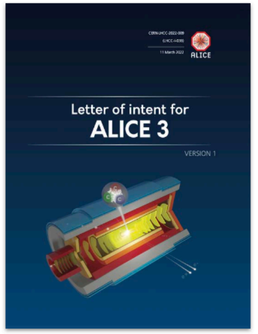
# ALICE3 project(s)

# ALICE 3 (2036- )

- Completely new experiment
  - Material budget: 0.1% $X_0$ iris layer (other layers < 1% $X_0$)
  - Rapidity coverage: up to 8 rapidity units
  - Go as close to the beam as possible
    - Improved Velo like solutions
  - Time measurements: outer layer ~ 20 ps
    - More timing layers and different silicon pixel technologies considered

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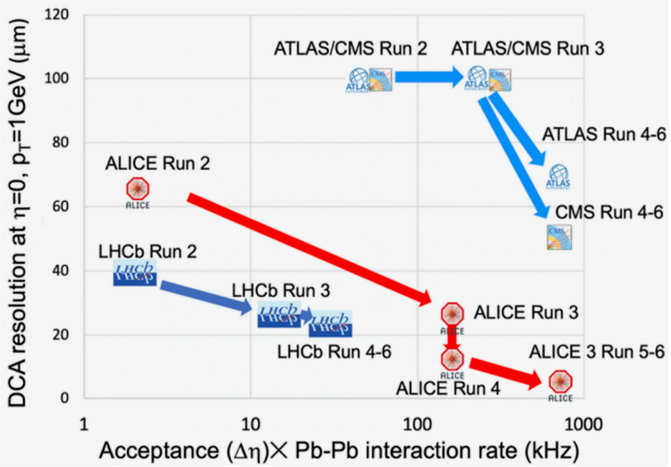
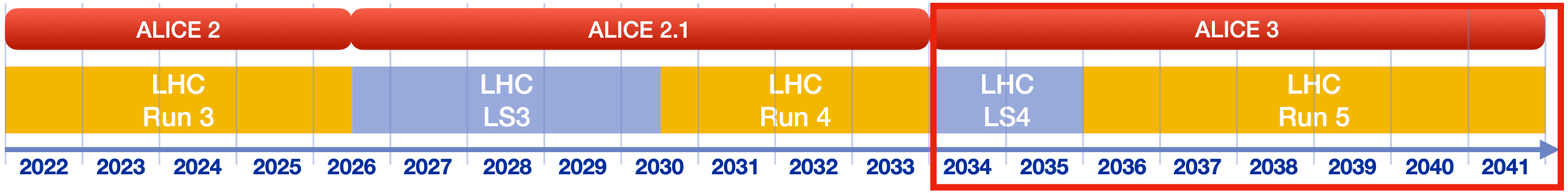
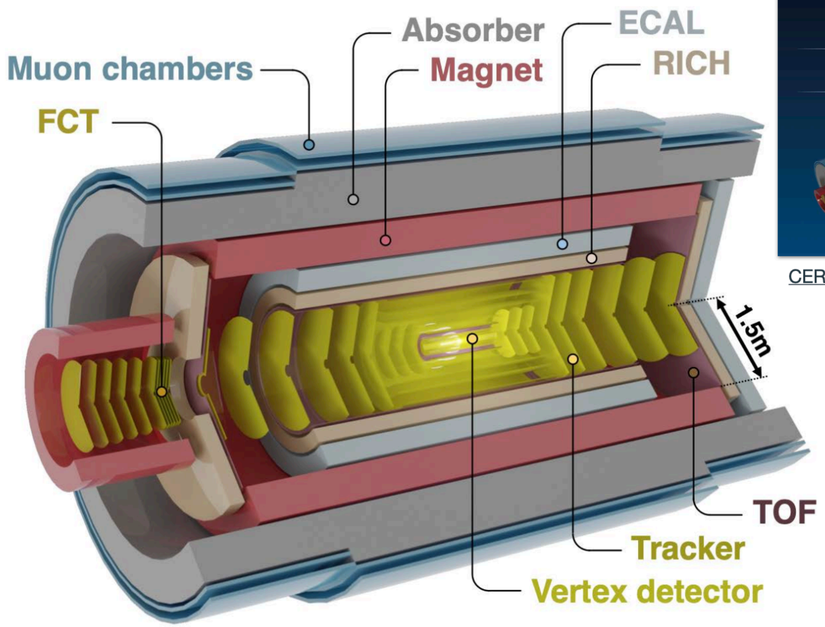


# ALICE 3 (2026-2036): Detector





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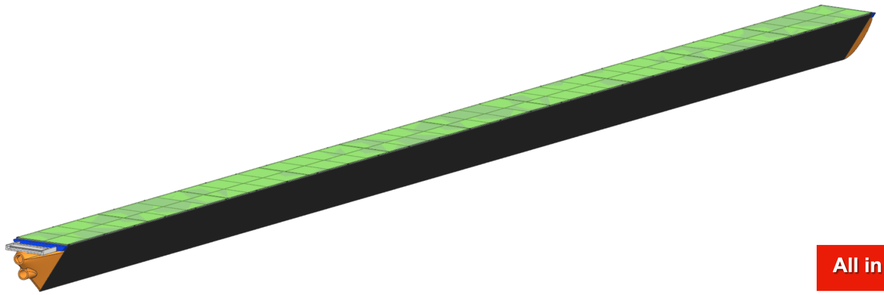
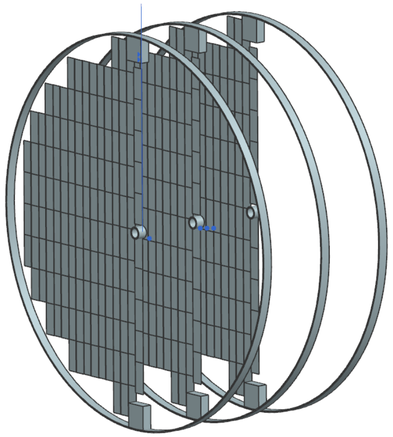
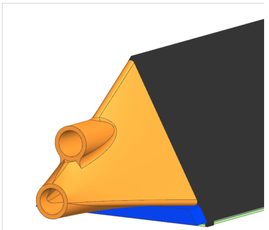
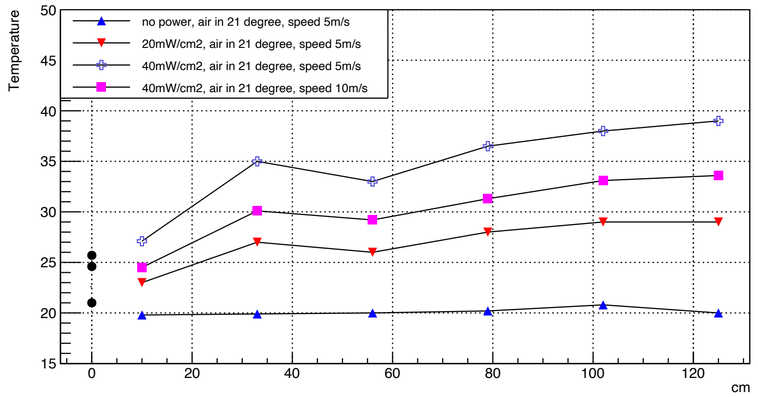
## What we do:

Major responsibility on the tracker forward disks
Main stakeholders in the project besides us: *Germany, Korea, France and Austria(?)*










**All in all, concluding**

- **My job is to put the minimum physics requirement and that is a pointing resolution of 3-4mum at pT = 1 GeV, and a momentum resolution at 1% or better, this translates in mechanical structures + cooling < 1% $X_0$**
- **You are completely free to tell me how (even because I have no idea :))**

38 ALICE MT

# ALICE 3 (2026-2036) Tracking

## Develop algorithms for low-$p_T$ tracking in dense environment driven by physics requirements

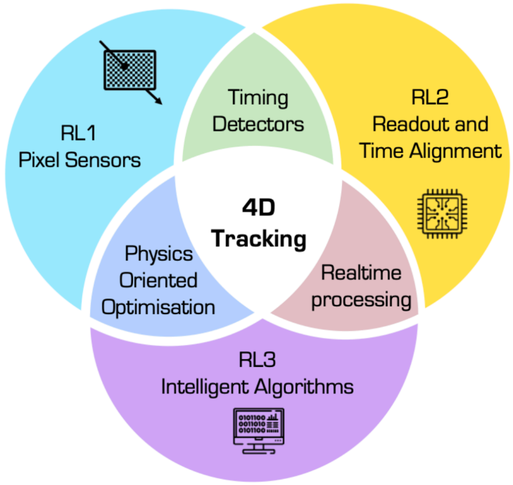
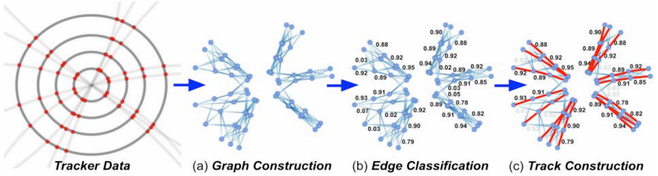
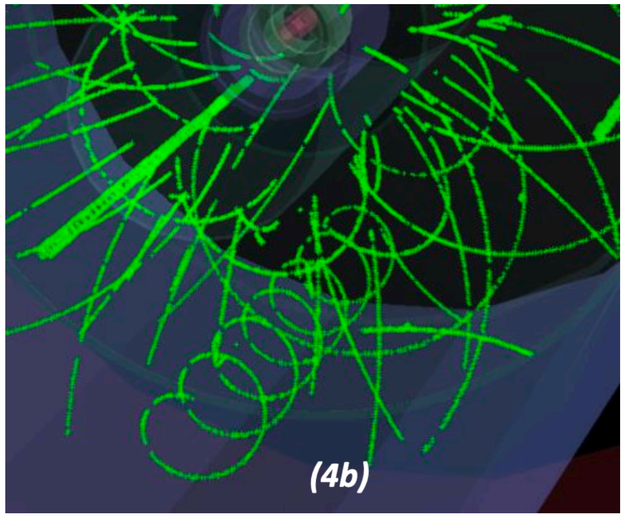
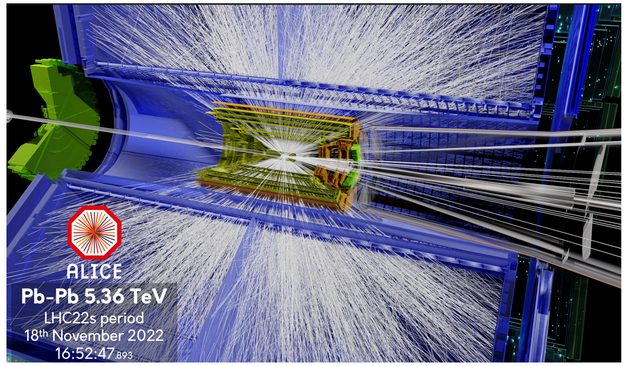



Figure 5: Interplay between the research lines.

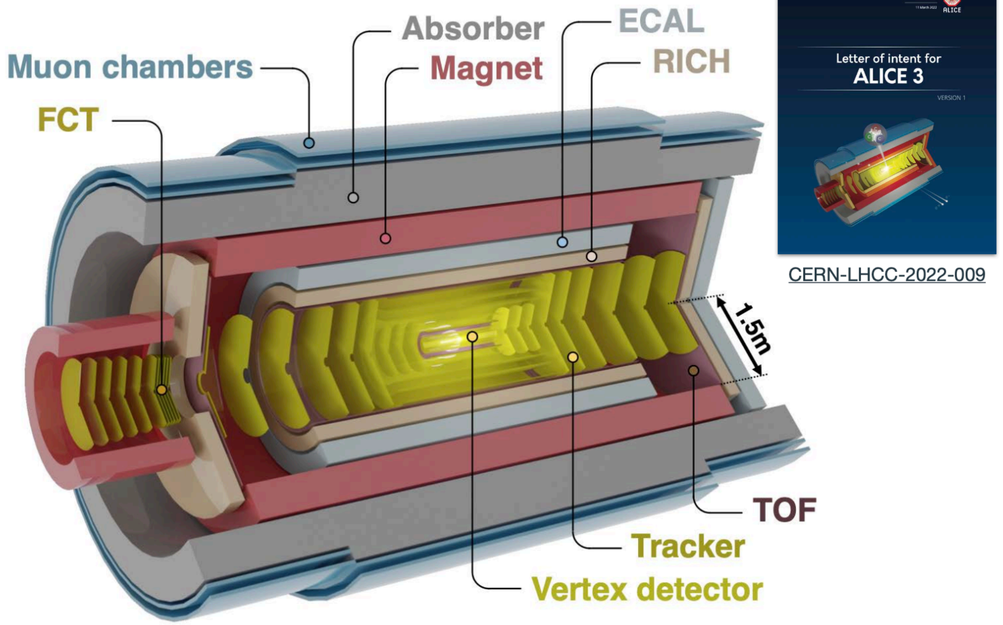
- Development of ACTS-based track reconstruction framework for ALICE 3
  - ➡ Evaluation and optimization of physics and computing performance
  - ➡ Investigate ML-based approaches for track reconstruction
  - ➡ 4D tracking and vertexing
- Tracking software leading role
  - ➡ Strengthen links with CERN tracking and computing experts
  - ➡ Hosting ACTS-related meetings (April first one at Nikhef)
- HPC & accelerated tracking
  - ➡ GPUs (consumer grade and data-center class)
  - ➡ FPGAs for low-latency or energy-efficient parts



# ALICE 3 (2026-2036): a bird's-eye view







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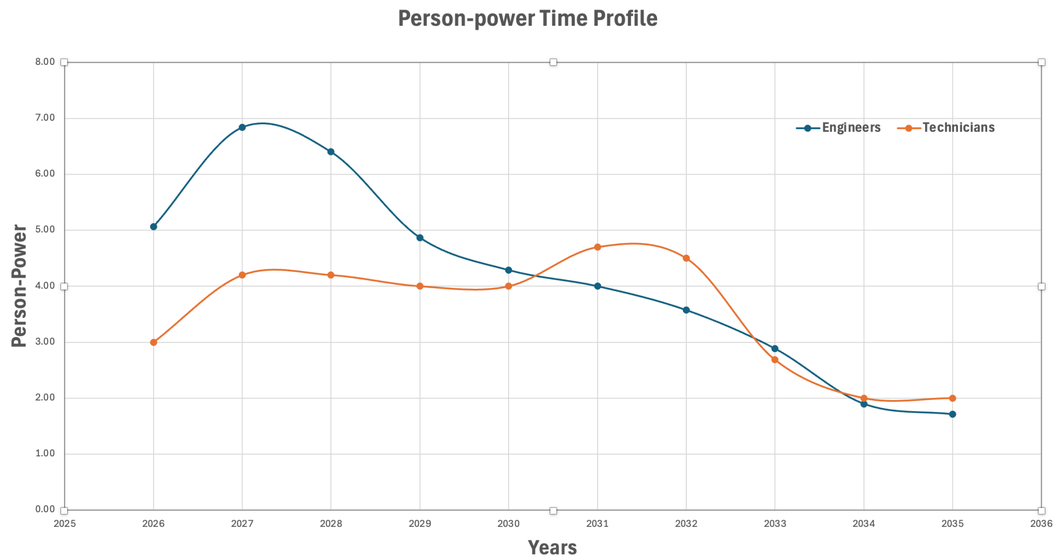
**High level milestones:**

- Mechanics: stave-like structures with integrated cooling and ring support - R&D, Design toward TDR and, later, (part of) production - *key partners: France, Germany, Korea, Austria*
- Sensor design/characterisation and powering (responsible of TDR chapter on powering) *key partners: CERN, France*
- Readout/DAQ: ALICE specific firmware for FELIX, setups *key partners: CERN, France, Germany*
- Commissioning and installation *key partners: CERN, France, Germany*
- Tracking: Integration of ACTS in ALICE, 4D tracking, AI tracking *key partners: CERN, ALICE Coll, ….*

# FASTTRACK: Personpower

| | | | WP1 Sensors | | | | | | WP2 ASICs | | | | WP3 Readout | | | | WP3 Mechanics & Cooling | | | | | | WP5 IT Infrastructure, Data & Software | | | | Partial Totals Material | Partial Totals Personnel | Total Material | Total Personnel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | WP1.1 3D Hybrids Material | WP1.1 3D Hybrids Personnel | WP1.3 LGAD Hybrids Material | WP1.3 LGAD Hybrids Personnel | WP1.2 Monolithic Material | WP1.2 Monolithic Personnel | WP2.2 Monolithic Material | WP2.2 Monolithic Personnel | WP2.1 Hybrid ASICs Material | WP2.1 Hybrid ASICs Personnel | WP3.1 High-Speed Transmission Material | WP3.1 High-Speed Transmission Personnel | WP3.2 Data Acquisition Material | WP3.2 Data Acquisition Personnel | WP4.1 Module Construction Material | WP4.1 Module Construction Personnel | WP4.2 Cooling Material | WP4.2 Cooling Personnel | WP4.3 Mechanics & Infrastructure Material | WP4.3 Mechanics & Infrastructure Personnel | WP5.1 Accelerators Material | WP5.1 Accelerators Personnel | WP5.2 Algorithms Material | WP5.2 Algorithms Personnel | | | | |
| ALICE | Detector | Sensor | | | | | 0.3 | | | | | | | | | | | | | | | | | | | | | | | |
| | | Mechanics | | | | | | | | | | | 0.2 | 1 | | | 0.3 | 1 | 0.3 | 1 | 1.2 | 3 | | | | | | | | |
| | | Module Assembly | | | | | | | | | | | | | | | 0 | 0 | | 0 | 0.2 | | | | | | 3.8 | 8 | | |
| | | Cooling | | | | | | | | | | | | | | | | | 0.3 | | | | | | | | | | | |
| | | Readout | | | | | | | | | | | 0.3 | 1 | 0.7 | 1 | | | | | | | | | | | | | | |
| | | Power | | | | | | | | | | | | | | | | | | | 0 | | | | | | | | 8.1 | 9 |
| | Common Funds | Common Funds | | | | | 0.5 | | | | | | | | 0.5 | | | | | | 0.25 | | | | 0.25 | | 1.5 | 0 | | |
| | R&D | Sensor Submission Costs | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| | | Characterisation | | | | | 0.4 | | 0.4 | | | | | | | | | | | | | | | | | | 2.3 | 0 | | |
| | | R&D | | | | | | | | | | | | | 0.1 | | 0.2 | | | | 0.2 | | | | | | | | | |
| | Computing | Computing | | | | | | | | | | | | | | | | | | | | | 0.25 | | 0.25 | 1 | 0.5 | 1 | | |
| | | | | 0 | | 0 | | 0 | | 0 | | 0 | | 2 | | 1 | | 1 | | 1 | | 3 | | 0 | | 1 | | | | |

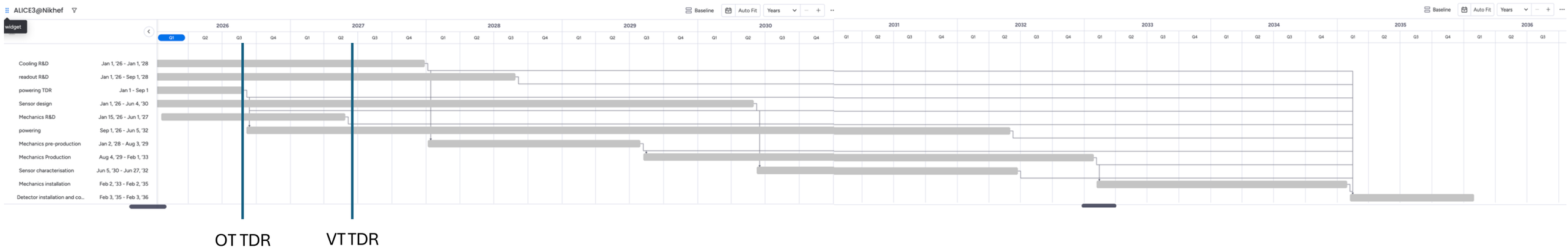




To contribute our share to building this detector requires a significant investment

# ALICE 3 (2026-2034): Personpower

| Deliverable Type | FASTTRACK WP | Optional Cost (MEUR) | | Q2/2026-Q1/2027 | Q2/2027-Q1/2028 | Q2/2028-Q1/2029 | Q2/2029-Q1/2030 | Q2/2030-Q1/2031 | Q2/2031-Q1/2032 | Q2/2032-Q1/2033 | Q2/2033-Q1/2034 | Q2/2034-Q1/2035 | Q2/2035-Q1/2036 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MoU | WP1.2 Monolithic | 0.300 | | | | | | | | | | | |
| MoU | WP3.1 High-Speed Transmission | 0.200 | | | | | | | | | | | |
| MoU | WP4.1 Module Construction | 0.300 | | | | | | | | | | | |
| MoU | WP4.2 Cooling | 0.300 | | | | | | | | | | | |
| MoU | WP4.3 Mechanics & Infrastructure | 1.200 | | | | | 0.5MT.E+2MT.D | 0.3MT.E+2MT.D+0.3MT.F | 0.2MT.E+2MT.D+0.5MT.F | 2MT.D+0.2MT.E+1MT.F | 1.5MT.D+1MT.F | 1MT.D+0.5MT.F | 1MT.D |
| MoU | WP4.1 Module Construction | 0.200 | | | | | | | | | | | |
| MoU | WP4.2 Cooling | 0.300 | 5.300 | | | | | | | | | | |
| MoU | WP2.2 Monolithic | 0.000 | | | | | | | | | | | |
| MoU | WP3.1 High-Speed Transmission | 0.300 | | | | | | | | | | | |
| MoU | WP3.2 Data Acquisition | 0.700 | | | | | | | | | | | |
| MoU-CF | WP1.2 Monolithic | 0.500 | | | | | 1ET.E | 1ET.E+0.5ET.A | 1ET.E+0.5ET.A | 1ET.E | 1ET.E | 1ET.E | 1ET.E |
| MoU-CF | WP3.2 Data Acquisition | 0.500 | | | | | | | | | | | |
| MoU-CF | WP4.3 Mechanics & Infrastructure | 0.250 | | | | | | | | | | | |
| MoU-CF | WP5.2 Algorithms | 0.250 | | | | | | | | | | | |
| R&D | WP1.2 Monolithic | 1.000 | | 0.5ET.E+0.5ET.A | 0.5ET.A+0.7ET.E | 0.5ET.A+1ET.E+0.2ET.B | | | | | | | |
| R&D | WP1.2 Monolithic | 0.400 | | 0.1MT.G | 0.2MT.G | 0.3MT.G | 0.2MT.G | 0.3MT.G | 0.3MT.G | 0.3MT.G | 0.1MT.G | 0.1MT.G | 0.1MT.G |
| R&D | WP2.2 Monolithic | 0.400 | | | | | | | | | | | |
| R&D | WP1.2 Monolithic,WP2.2 Monolithic | 0.000 | 2.800 | 0.7ET.C + 0.3ET.D | 1ET.C+0.5ET.D | 0.5ET.C+0.5ET.D | 0.3ET.C+0.4ET.D | | | | | | |
| R&D | WP3.2 Data Acquisition | 0.100 | | | | | | | | | | | |
| R&D | WP4.1 Module Construction | 0.200 | | | | | | | | | | | |
| R&D | WP4.3 Mechanics & Infrastructure | 0.200 | | 1MT.E+0.5MT.A/B+1MT.D | 1MT.E+1MT.A/B+1MT.D | 1MT.E+1MT.A/B+1.5MT.D | | | | | | | |
| R&D | WP5.1 Accelerators ,WP5.2 Algorithms | 0.500 | | | | 0.5CT.C | 0.5CT.C | 0.5CT.C | 0.5CT.C | 0.5CT.C | 0.5CT.C | | |
| Contingency | All WP's | 0.530 | 1.060 | | | | | | | | | | |
| Contingency | All WP's | 0.530 | | | | | | | | | | | |
| | | 8.100 | | | | | | | | | | | |
| | | | | 4.6 | 5.9 | 7.0 | 4.9 | 4.9 | 5.0 | 5.0 | 4.1 | 2.6 | 2.1 |
| | From proposal | | | 8 | 11 | 10 | 9 | 8 | 9 | 8 | 6 | 4 | 4 |

| | |
|---|---|
| MT.A | Simulation studies |
| MT.B | Studies of Thermodynamics & Heat Transfer |
| MT.C | Materials Science & Engineering |
| MT.D | Manufacturing & Production |
| MT.E | Design & Drafting |
| MT.F | Control Systems & Mechatronics |
| MT.F | Control Systems & Mechatronics |
| ET.A | Analog electronics design (frontends, RF, advanced PCB's) |
| ET.B | Digital electronics design (DAQ) |
| ET.C | Analog IC design |
| ET.D | Digital IC design |
| ET.E | Technical support (cables/mechatronics/integration etc) |
| CT.A | Software engineering for embedded or data acquisition |
| CT.B | Software engineering for control systems (SCADA) |
| CT.C | Software engineering for analysis frameworks /simulations |
| CT.D | System administration and network administration support |



# Project or Projects?

- Historically ALICE has been treated, OPP and Nikhef wise, as a single project, independently from the size of it.

- This time it is probably better, for OPP and management purposes, to separate ALICE3 in **two sub-projects**: “Mechanics” and “Electronic and design”

***May be 2+1 adding (4D/AI) low-pt tracking (around 2029) as a standalone project***

- Keep in mind ITS3 is still running so it would mean 3 projects and relative codes for ALICE@OPP

# Concluding: The idea in a slide

1) Detector

- Focus efforts that are coherent with Nikhef vision and that grant maximum visibility with > 2036 in mind

2) Tracking

- Focus on ALICE unique capability, I.e (4D/AI) tracking down to tenth of MeV
  -> Complementary physics reach with respect CMS and ATALS

3) Physics exploitation (>2036)

- Leverage on 1) and 2) for strong positioning in heavy-flavour physics, electromagnetic probes with an eye on beyond standard model possibilities