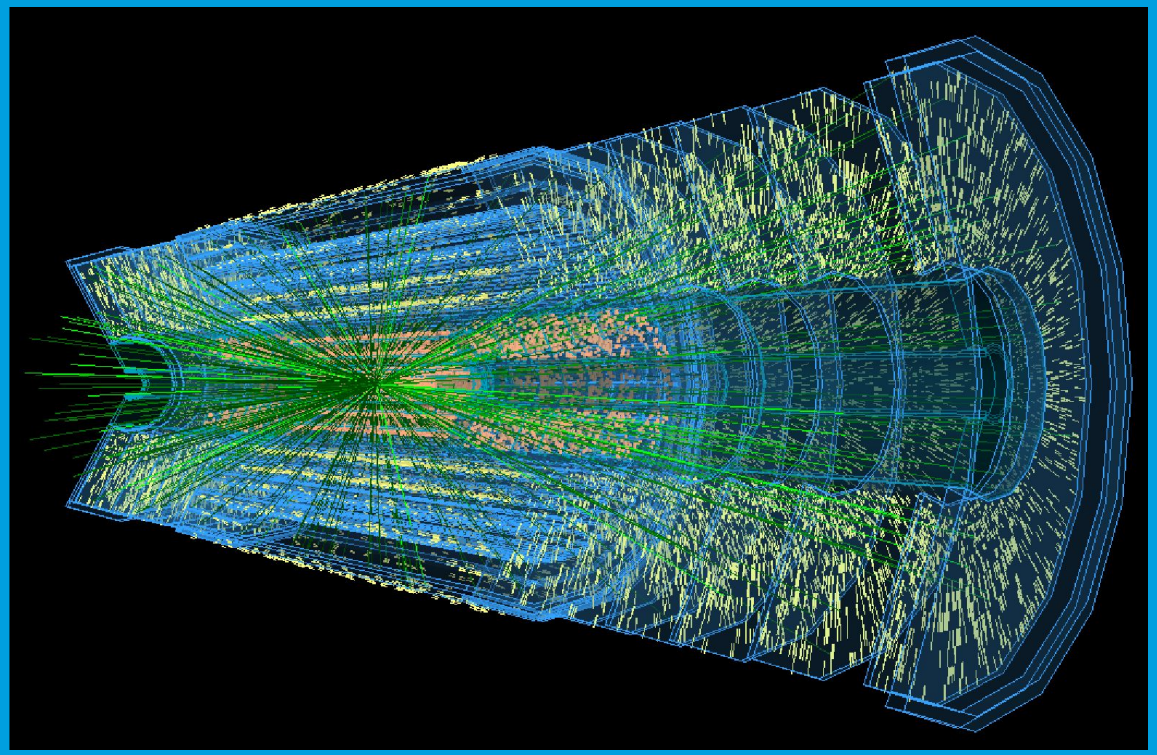
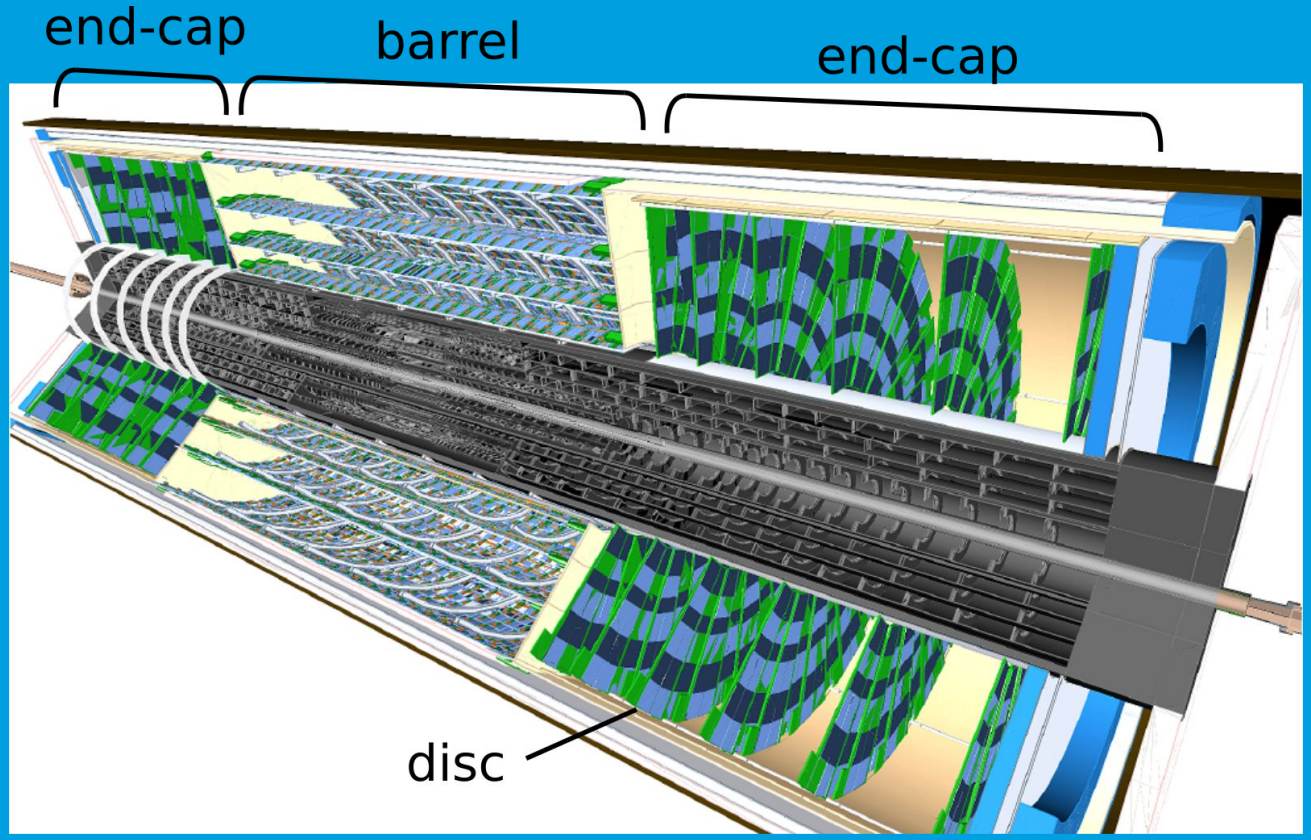
ATLAS Upgrade

Liebenberg Retreat 2024





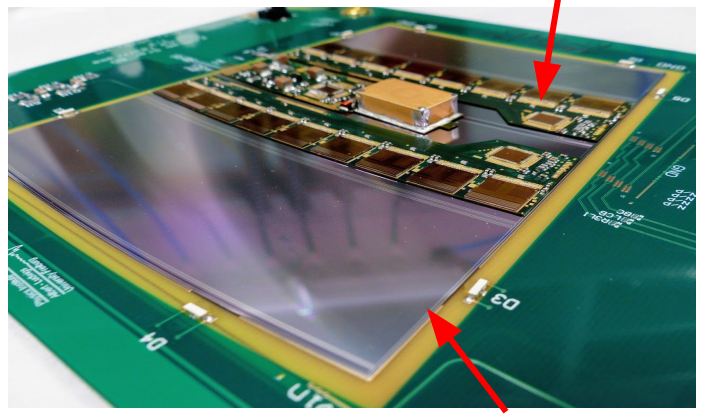
ATLAS ITk Strip Tracker Upgrade

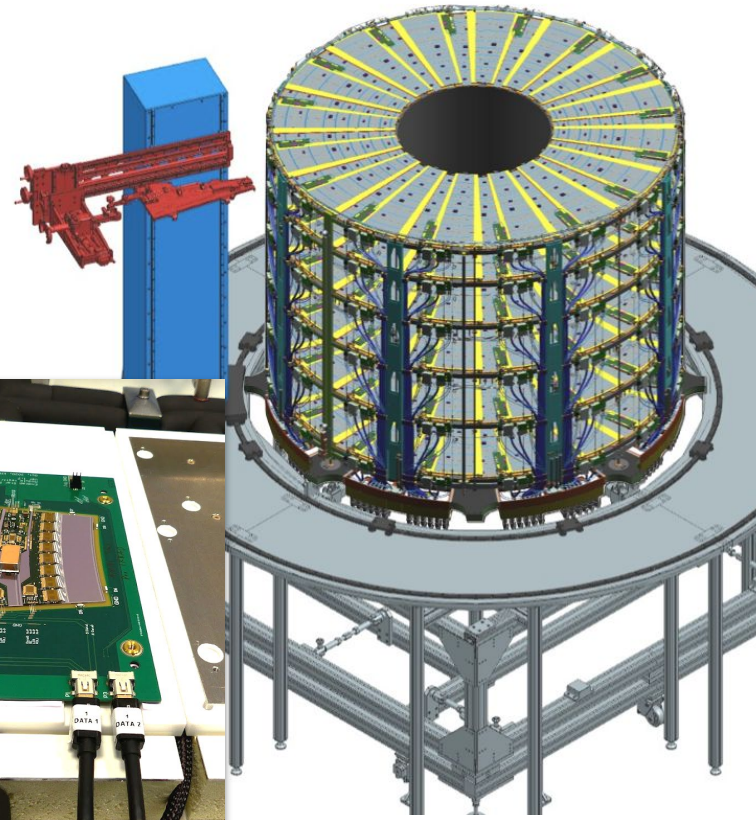
Micro-Intro: why ATLAS upgrade @ DESY

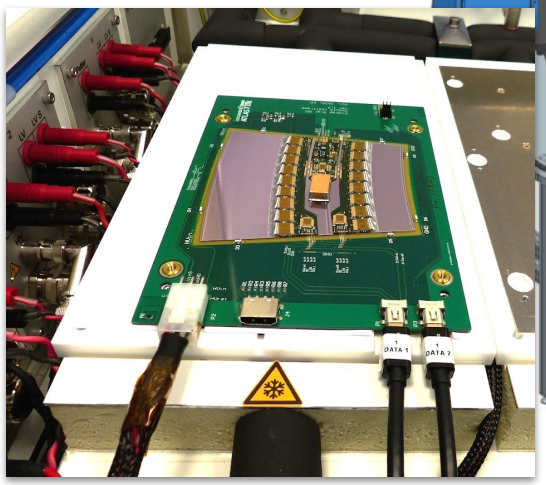
- LHC: higher luminosity with “HL-LHC” Upgrade
- at HL-LHC, current ATLAS tracking detector will not
  - withstand radiation nor
  - be able to separate dense tracks in time and space
- ATLAS needs new tracker
  - higher radiation hardness and
  - higher granularity and
  - faster readout (and new trigger) capabilities

- DESY joined ATLAS late, without contributing to orig. ATLAS construction
  - required that large labs do this, to be accepted into collaboration
  - we fulfill this “dept” retroactively with contribution to tracker upgrade

- DESY-Z contributed significantly to dev of new tracker
- will also build modules for ~60% of one endcap
  - currently concluding pre-production and production prep
  - ITk Strips module production was scheduled Q4-2023
    - delayed by two significant issues
    - now planned to start Q1-2025 :(



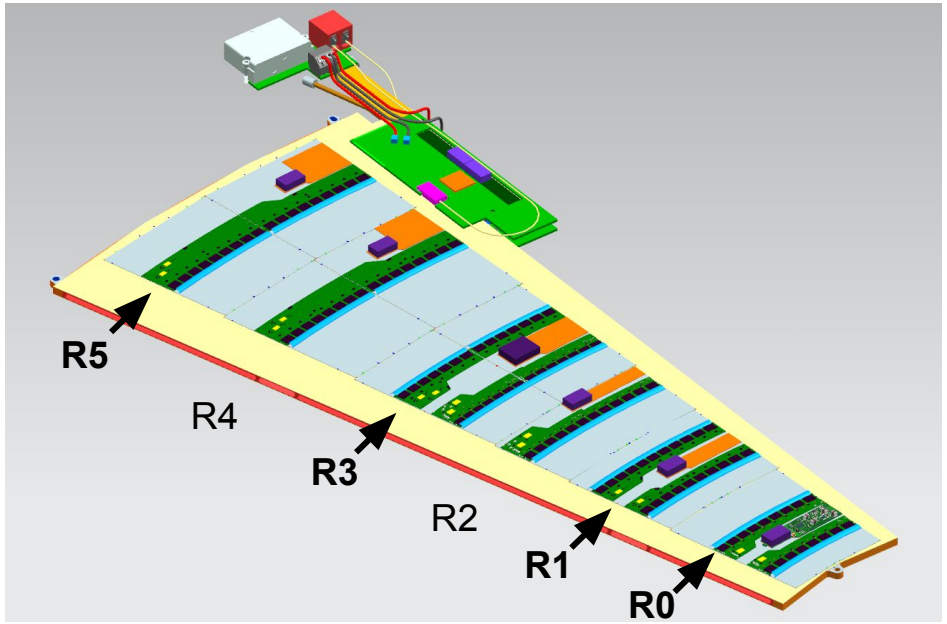


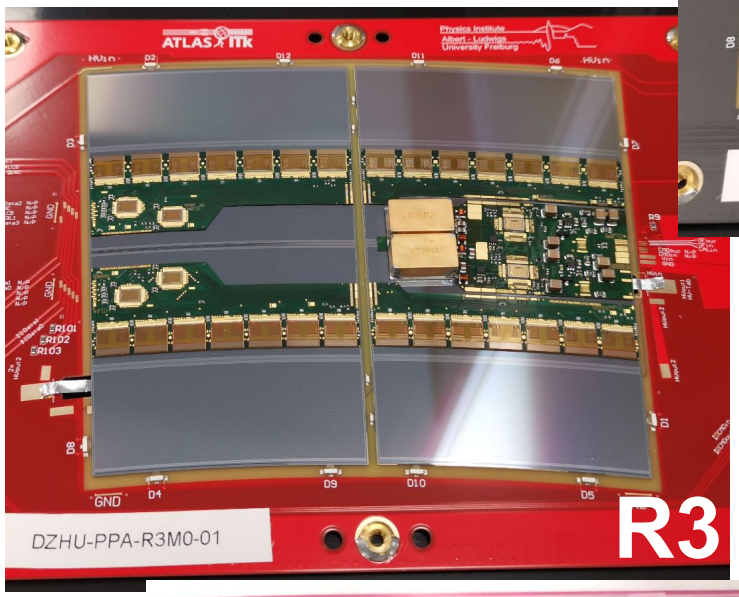


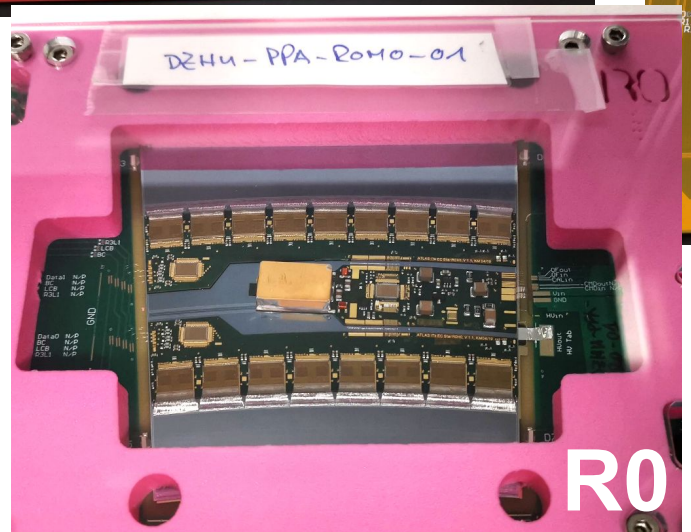
ATLAS ITk Strip Tracker Upgrade

Module types produced at Zeuthen

- Building 4 Types







ATLAS ITk Strip Tracker Upgrade

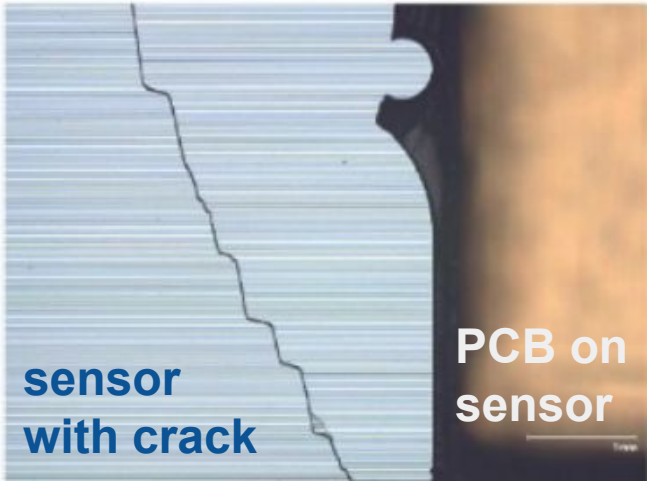
The (main) cause for the severe delay: Sensor cracking and Cold Noise

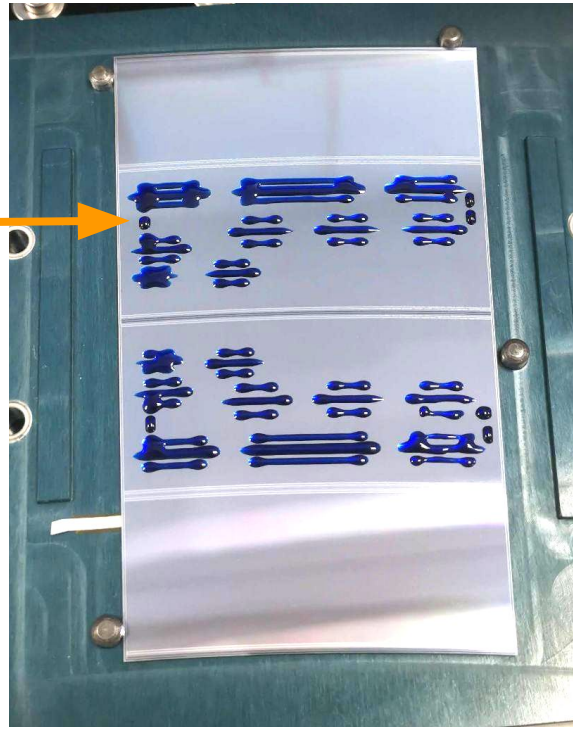
- Cold Noise luckily only seen in module types that are not built in Zeuthen

- Sensor cracking however is bad luck

  - with glue glass transition at 40°C
    (not at >100°C as advertised by vendor)
    - stress by differences in thermal expansion is relieved at 40°C in glass transition (soft glue)
    - leads to excessive stress in sensor below - 40°C
    - can pull the sensor apart locally

  - and with “glue support dots”
    - leading to high local stress on sensor





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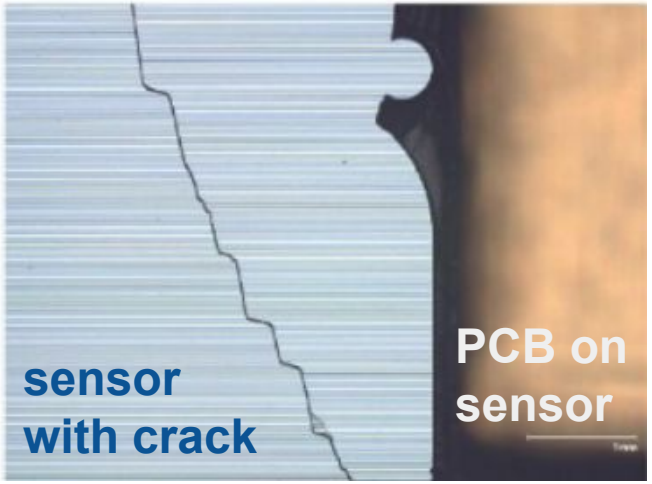
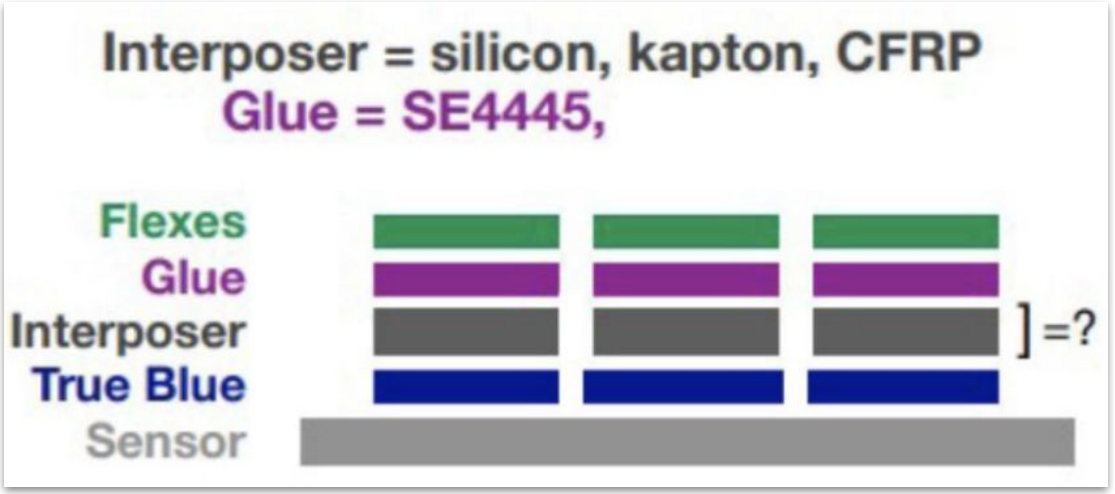


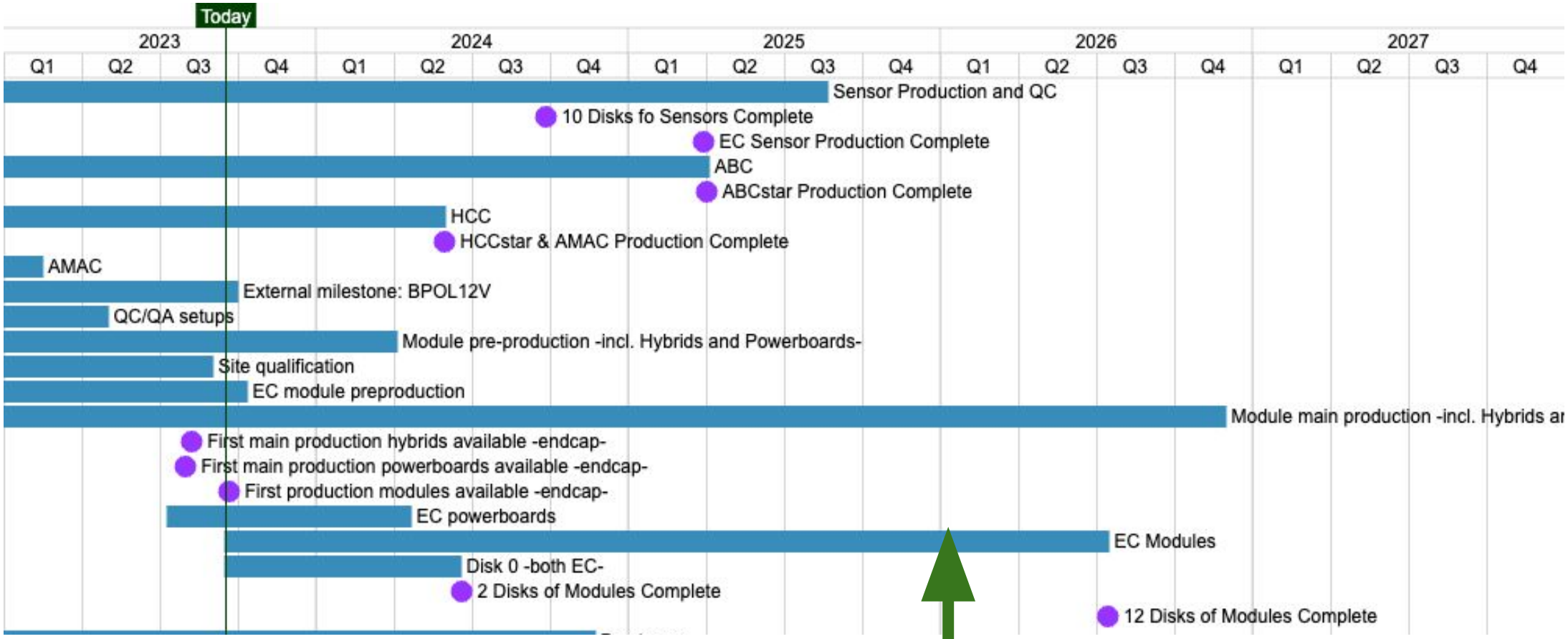
- Cracking solutions: Two known options
  - 1) drop glue support dots and keep below 35°C
  - 2) add flexible layer at back of PCBs as stress relief (design change!)

- Solution 2) is preferred for barrel type modules but poses severe personpower issues in endcap
  - we are trying to show that solution 1) is ok for endcap
  - also have to test solution 2)
  - this is central for the whole project and hinges on personpower being available NOW in Zeuthen to build modules in this way



ATLAS ITk Schedule – status Sep 2023

we thought this was unlucky…

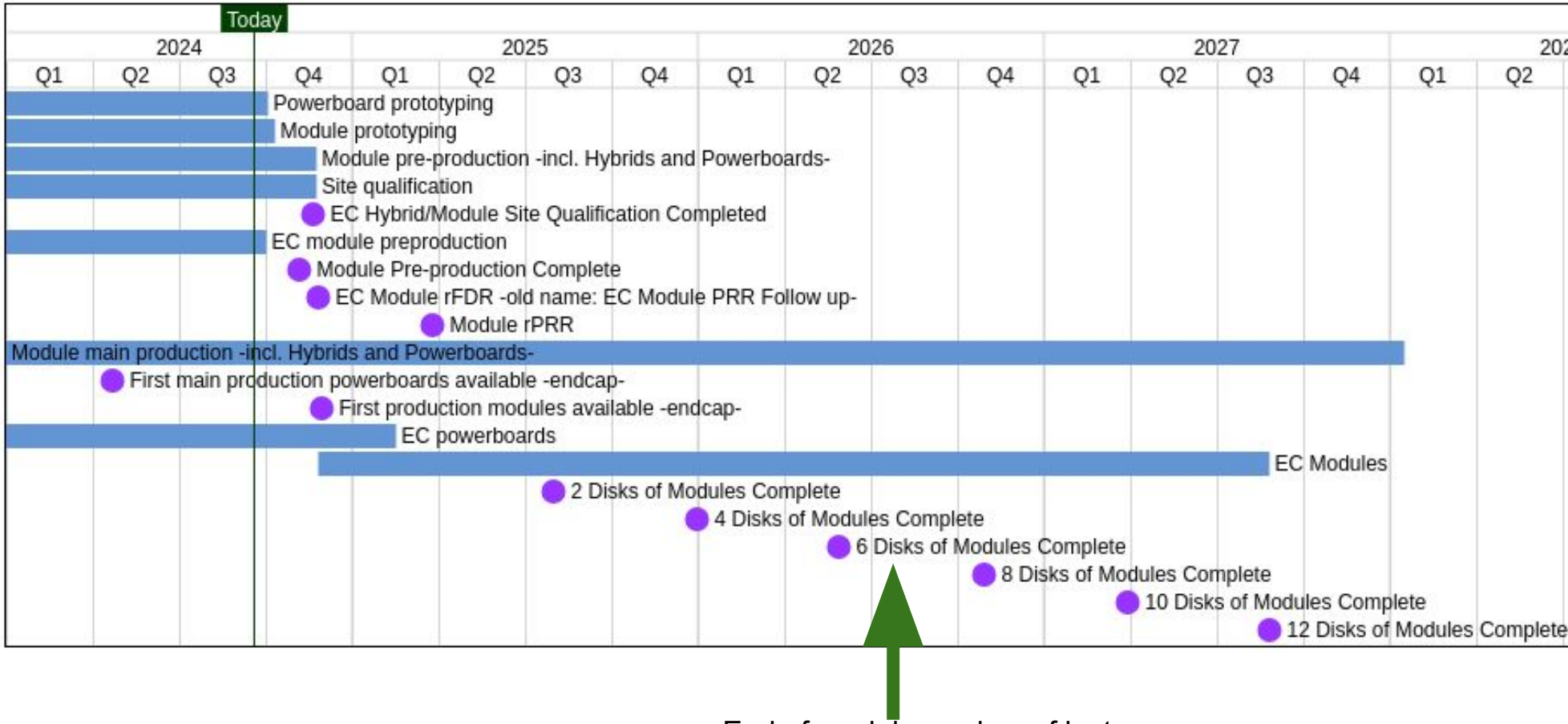


End of module prod as of last year

- End of module production moved from Jan 2026 to Mid 2026 due to
  a. Issues with modules: Cold Noise (mostly solved), HV breakdown (indications for solution), EC module noise (solved)
  b. Russian war on Ukraine
  c. Global supply chain crisis

ATLAS ITk Schedule – status Sep 2024

Effect od current delays in theory (not all delays might yet have been captured)



End of module prod as of last year

- End of EC module production moved from Mid 2026 to Mid 2027 due to
  a. Mainly sensor cracking (and cold noise)
  b. as well as part availability in EC and personpower

ATLAS ITk Strip Tracker Upgrade

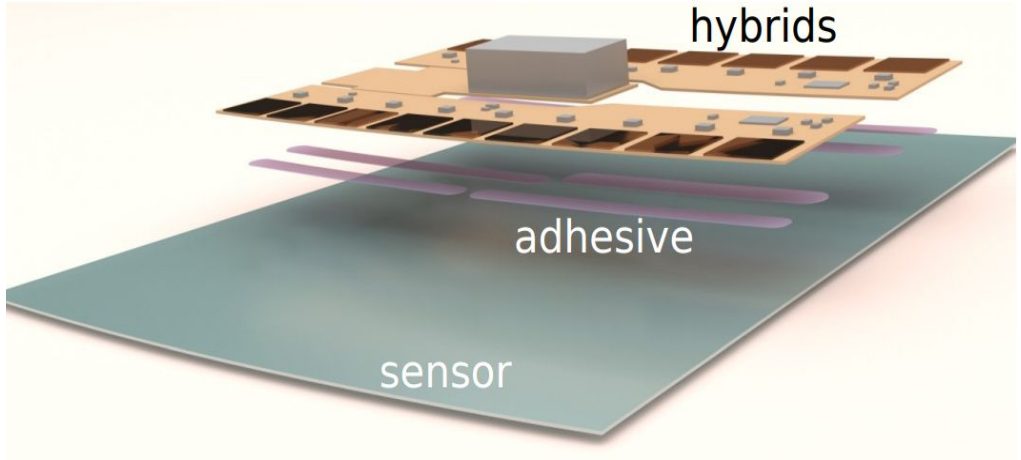
Team and Status

- **Technicians**
  - Martin Renzmann [Bonding expert]
  - Carl Beichert (HU) [setups expert, carer]
  - Mandy Radicke [Gluing and QC expert]
  - Oliver Schäde [Glue focus]
  - Maik Daniels (HU) [Glue focus, still learning]
- **Scientists**
  - Ben Bruers [parental leave till 2025, s/w and h/w developer]
  - Alavaro Lopez [part time Postdoc, till Dec 2024, sensor QC]
  - Hagen Moebius [SHK, 10 hours a week, sensor QC]
  - Christian Scharf [very part time Postdoc, HU, inventory]
  - Thorsten Kuhl [sensor QC, module QC, PCB QC]
  - Ingo Bloch [something of everything]

- **2 of 5 technicians currently re-assigned to other projects**
  - severely slowing our progress
  - Mandy especially cannot be replaced

- **Status - end of pre-production**
  - building modules to help finding solutions for sensor cracking issue
    - high pressure from collaboration
  - in parallel preparing production
    - automation and QC setup streamlining
    - optimisation of glue- and bonding programs
    - first production steps: preparation of sensors and PCBs for use in modules

Backup slides…

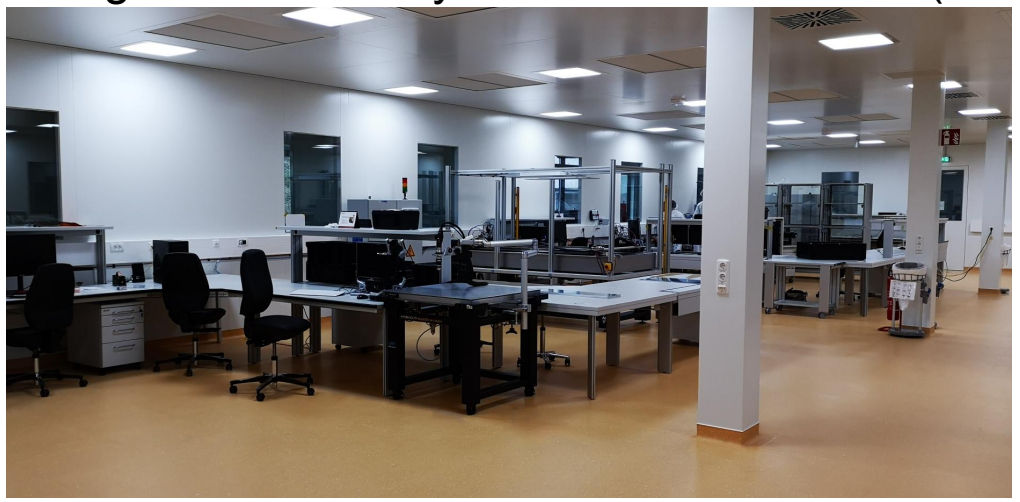


ATLAS ITk Strip Tracker Upgrade

DESY wide laboratories and clean rooms operational – images as of last year, now less unused looking

Zeuthen ATLAS upgrade production lab (ISO-6)

Hamburg DAF assembly and QC Clean Room (ISO-7)



Hamburg DAF module/petal building Clean Room (ISO-6)

Hamburg DAF Integration Clean Room (ISO-7)

DESY Deliverables

Need to deliver more than 4600 parts ….

- **Petal cores (400)**
  - Planning based on delivering parts for all cores for BOTH end-caps
    - Co-cured facings, Titanium pipes with welded insulating breaks, smaller parts
  - Main process of building the petals taken over by company AVS (Spain)

Zeuthen focus

- **Endcap modules (2000 + 500)**
  - Split into 3/4 in Zeuthen and 1/4 in Hamburg
  - 500 modules for the HU delivery
  - Backup for each other

~20% of all EC modules produced in Zeuthen

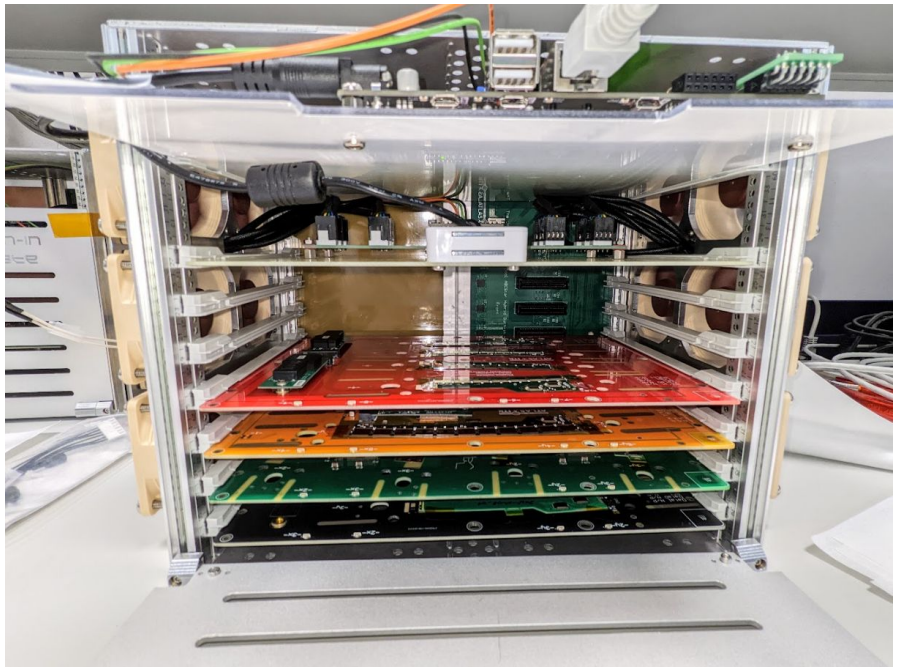
- **End of Substructure (EoS) cards (1630)**
  - Custom board to be produced in industry
  - Test of every single EoS board for both end-caps and the barrel
  - FE group strongly involved

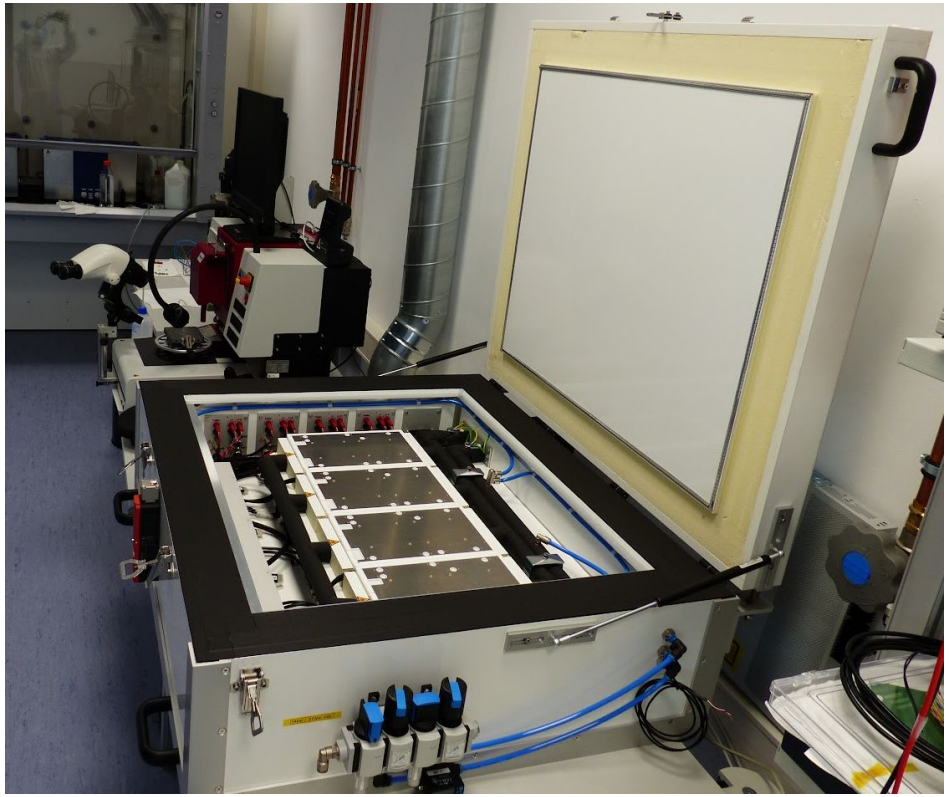
- **Fully instrumented petals (100-125)**
  - ~ 50% of an end-cap
- **End-cap integration structure (1)**
  - Structure will be built at NIKHEF
    - DESY involved in overall design and producing some of the carbon fiber components (service trays)
- **Fully instrumented end-cap (1)**
  - In close collaboration with Berlin, Dortmund and Freiburg

ATLAS ITk Strip Tracker Upgrade

at DESY - Zeuthen Campus

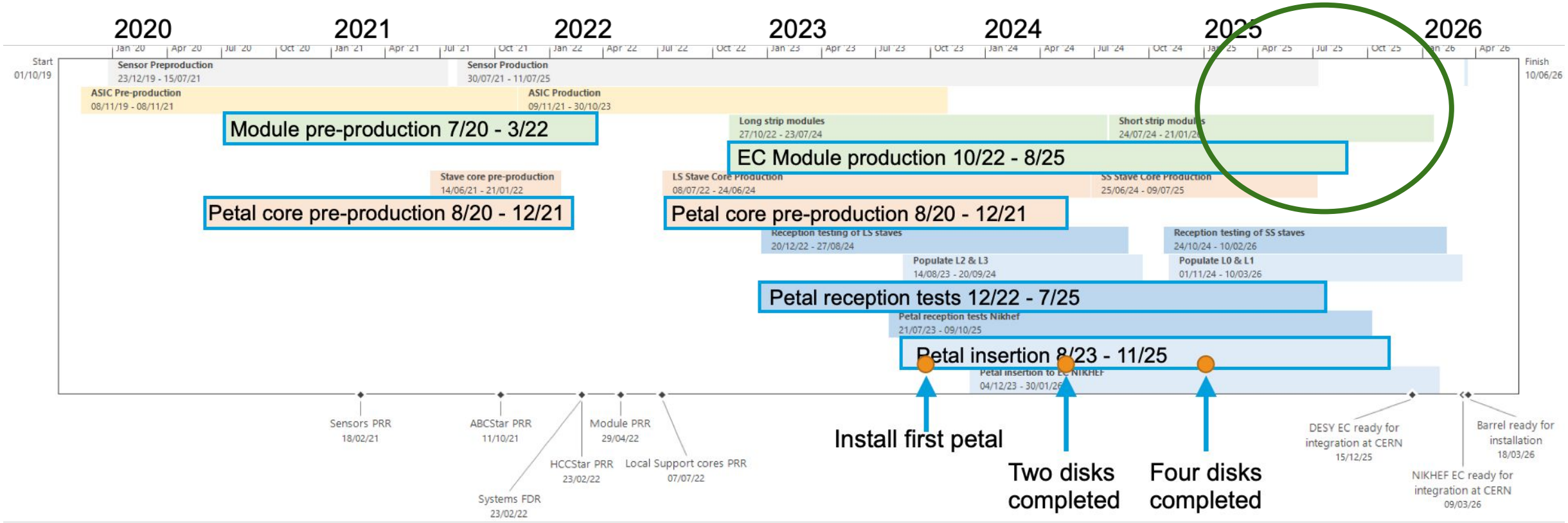
- **Quality test infrastructure**
  - hybrid burn in crate
  - module thermal cycling and testing box
    - cycles between -35°C and +40°C (now reduced to +20°C)
    - cycling and testing fully automated to run over night





ATLAS ITk Schedule – status Sep 2022

Highlighted on DESY Deliverables (Status: PRC - May 2022)



- Overall - strong impact due to Covid-19 - many delays in all areas
- Hard to disentangle “normal” delays and Covid-delays, but estimates assume at least 70% of delays due to lockdowns etc.
- Running with 50% top speed compared to “normal” times
- Many reviews ongoing