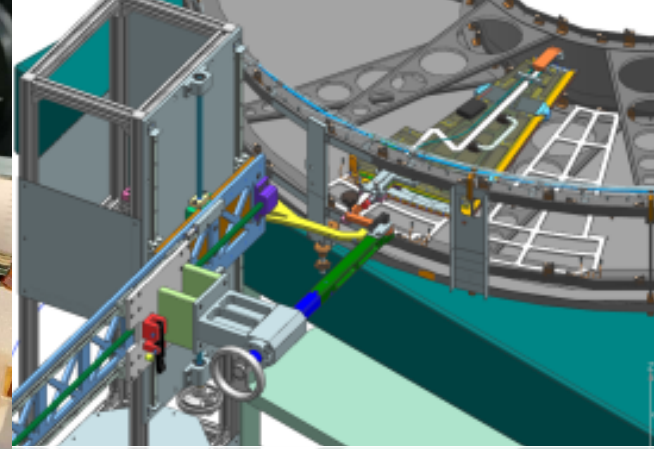
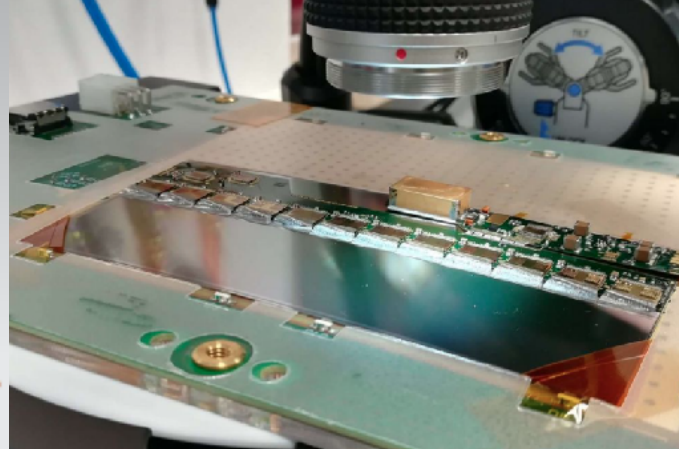
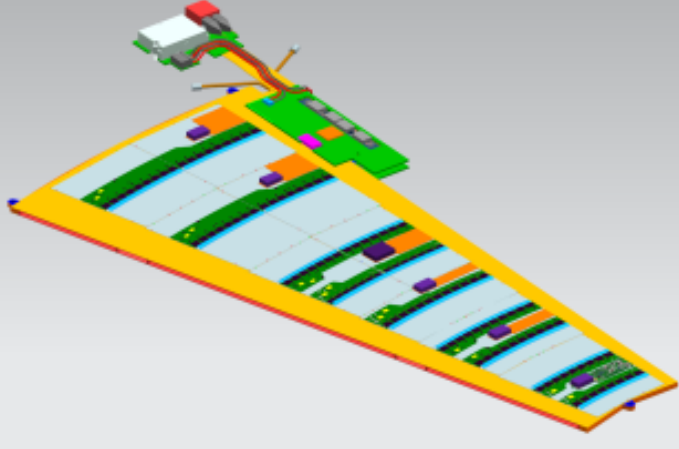


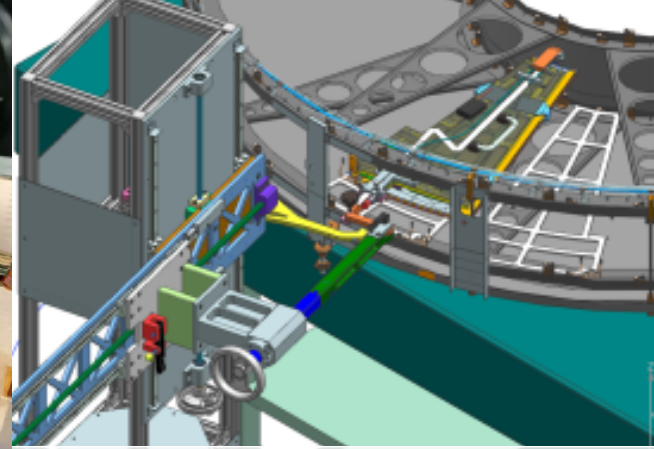
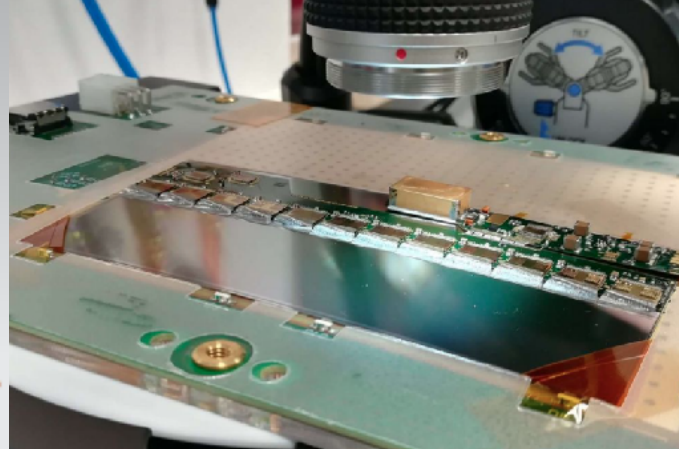
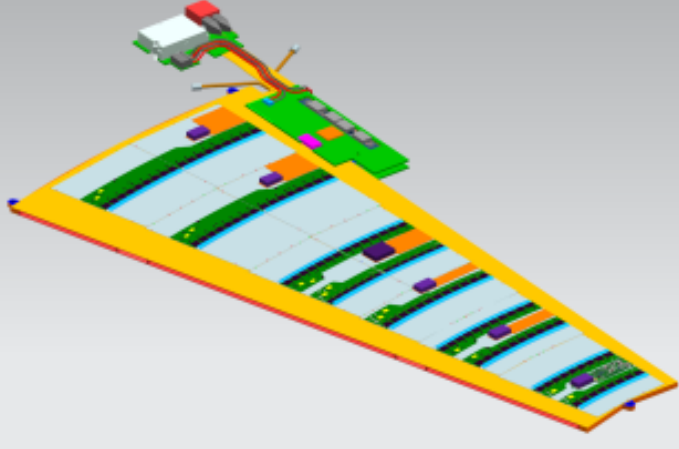


DESY ATLAS ITk “Dive In”

Ingrid-Maria Gregor

For the **DESY ATLAS Group**





DESY ATLAS ITk “Dive In”

Ingrid-Maria Gregor

For the **DESY ATLAS Group**



Reminder: DESY ATLAS is one group in two sites!!



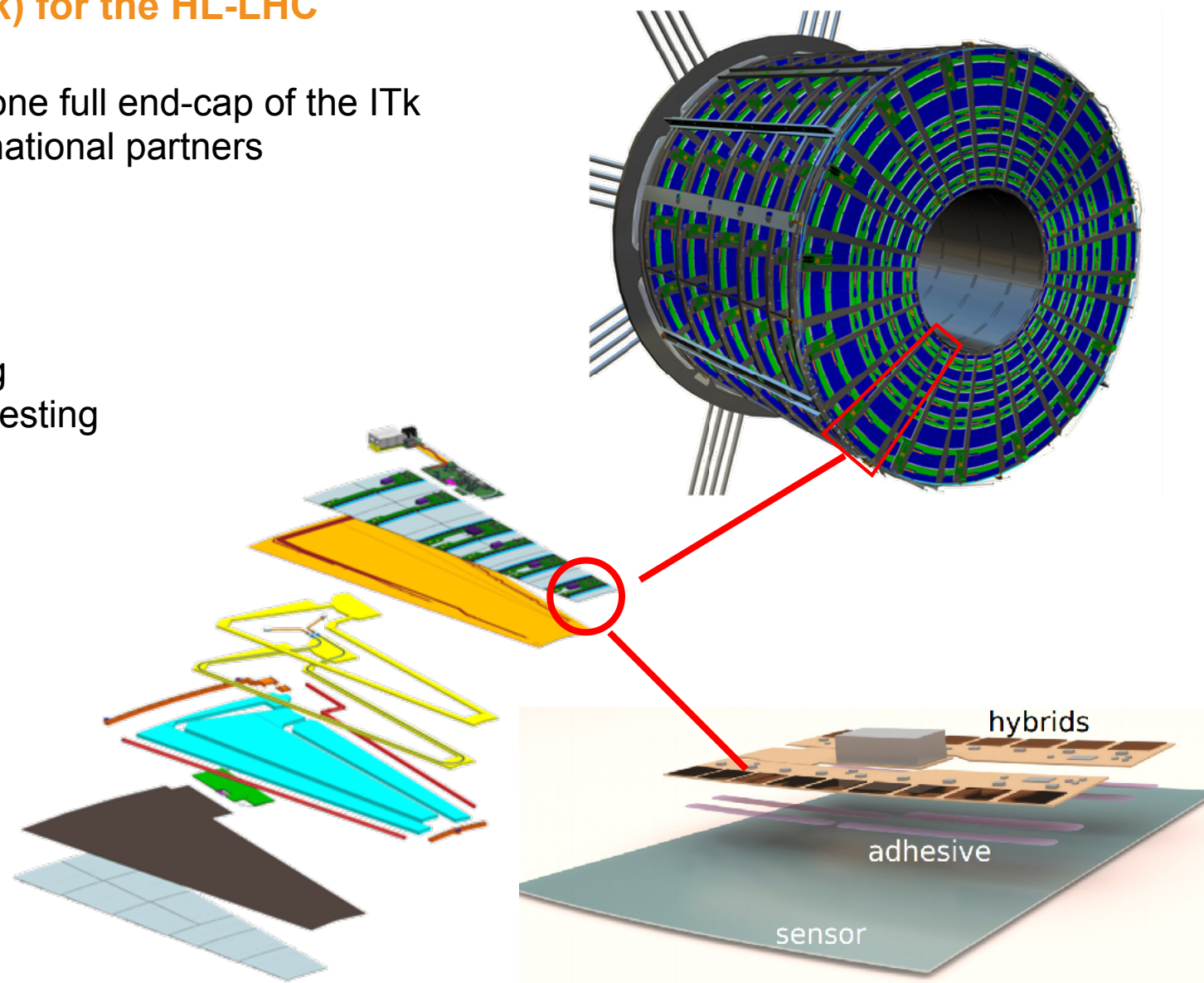
Overview of DESY activities

ATLAS Detector Upgrade - Inner Tracker (ITk) for the HL-LHC

- DESY ATLAS is working on the realisation of one full end-cap of the ITk
- In strong collaboration with German and international partners

- **Activities:**

- Sensor studies and quality control testing
- Hybrid quality control
- Module development, building and testing
- Petal core development, production and testing
- Module loading onto petal cores
- End of substructure (EoS) card
- Endcap integration at DESY and CERN
- CO₂ cooling
- And many other tasks...



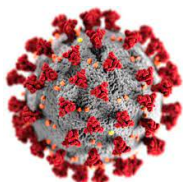
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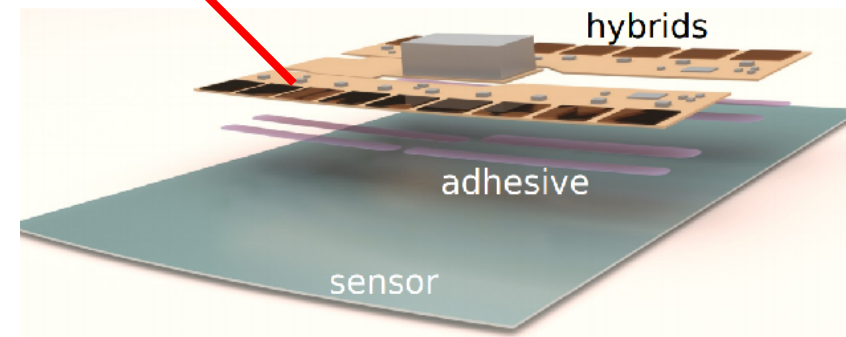
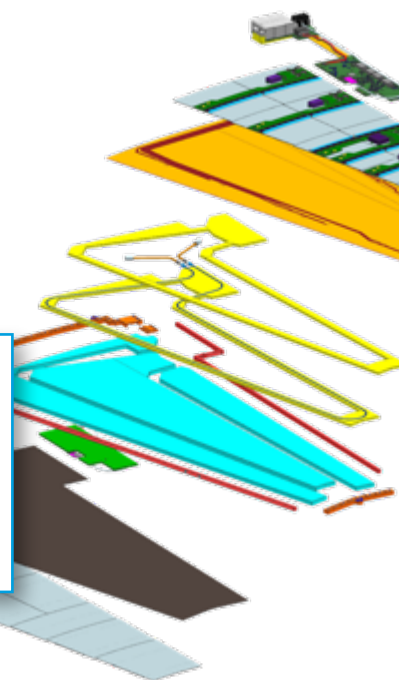
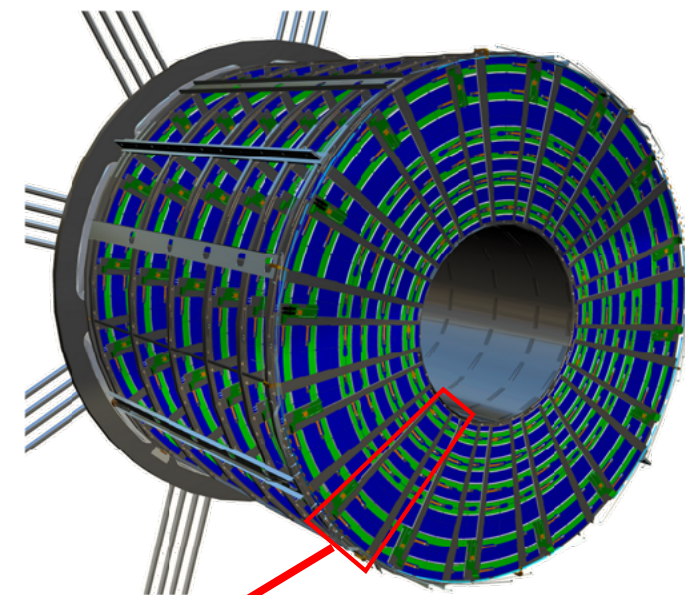
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We were able to have the labs running for most of the time, but of course are also experiencing many Corona related delays. Will concentrate on what was beyond ...



ATLAS Deliverables for ITk Strips End-cap

Need to deliver more than 4600 parts



- **Petal cores (400)**
 - Delivering parts for all cores for BOTH end-caps
 - Co-cured facings, Titanium pipes with weldings, smaller parts
 - Main process will be taken over by company
- **Endcap modules (2000 +500)**
 - Split into 3/4 in Zeuthen and 1/4 in Hamburg
 - **500 modules for the HU delivery**
- **End of Substructure (EoS) boards (1630)**
 - Custom board to be produced in industry, populated at DESY
 - Test of every single EoS board for both end-caps and the barrel
- **Fully instrumented petals (100)**
 - 50% of one end-cap
- **Service trays for end-cap structure (16)**
 - All service trays for both end-caps produced at DESY
- **Fully instrumented end-cap (1)**
 - Assembly in close collaboration with Humboldt University, University Dortmund and University Freiburg,

First delivery complete!

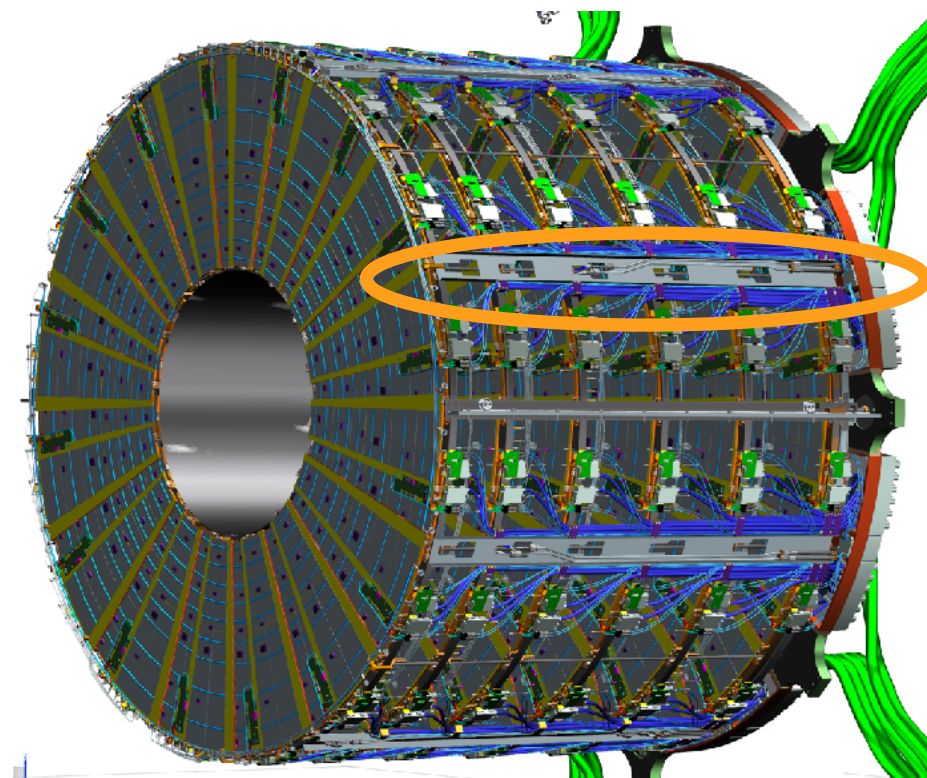
DESY proudly presents the service trays



- Host cooling and electrical services along the EC, add structural stiffness to EC structure
- Electric link between each EC wheel and bulkhead via tray + cooling service
- Full production of 16 service trays completed and delivered to Nikhef

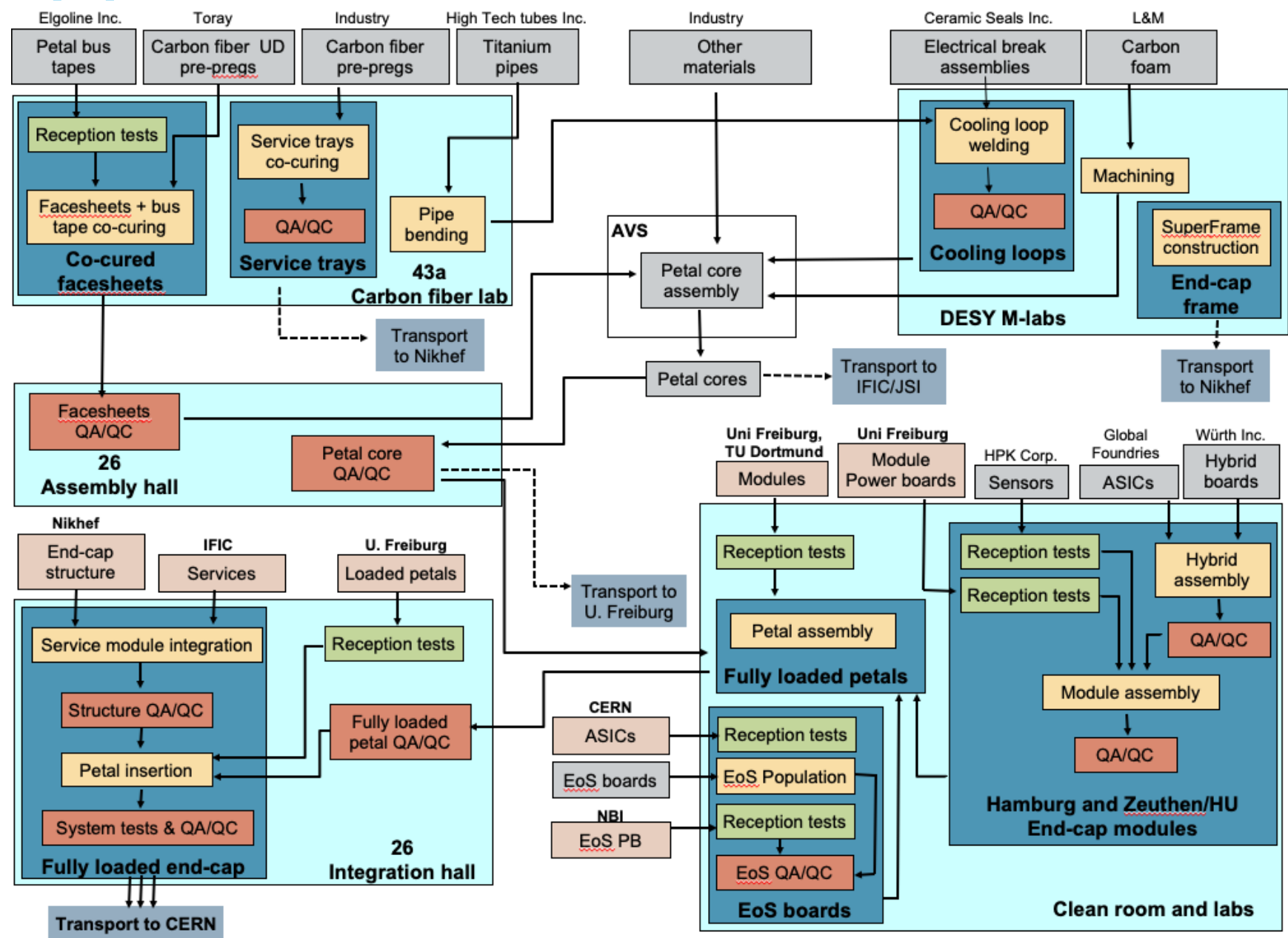


Finished trays after machining



Earlier prototype

End-cap production workflow at DESY



DESY facility

Reception test at DESY facilities

Activity at DESY facility

QA/QC evaluation at DESY facility

DESY deliverable

Transport to another ITk institute

Name of the company if known

Industry Deliverable

Name of the institute

Deliverable from another ITk institute

New lab space for ITk project

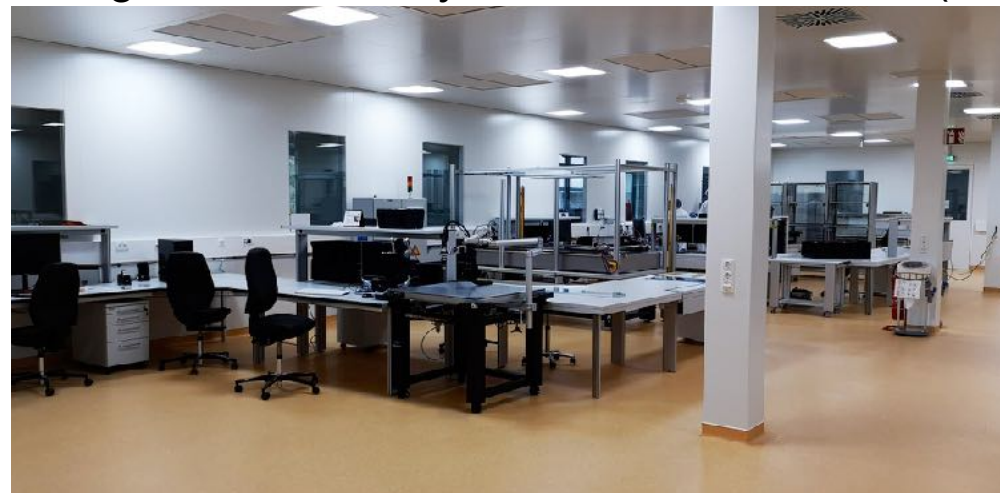
All laboratories and clean rooms operational, gearing up for site qualification

Zeuthen ATLAS upgrade production lab (ISO-6)



+ carbon fibre lab !

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)



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Detector Assembly Facility

Important infrastructure for the assembly of the end-cap

- Large multipurpose hall - Hall inside large hall
- Clean room installed inside
- Shared with DESY CMS



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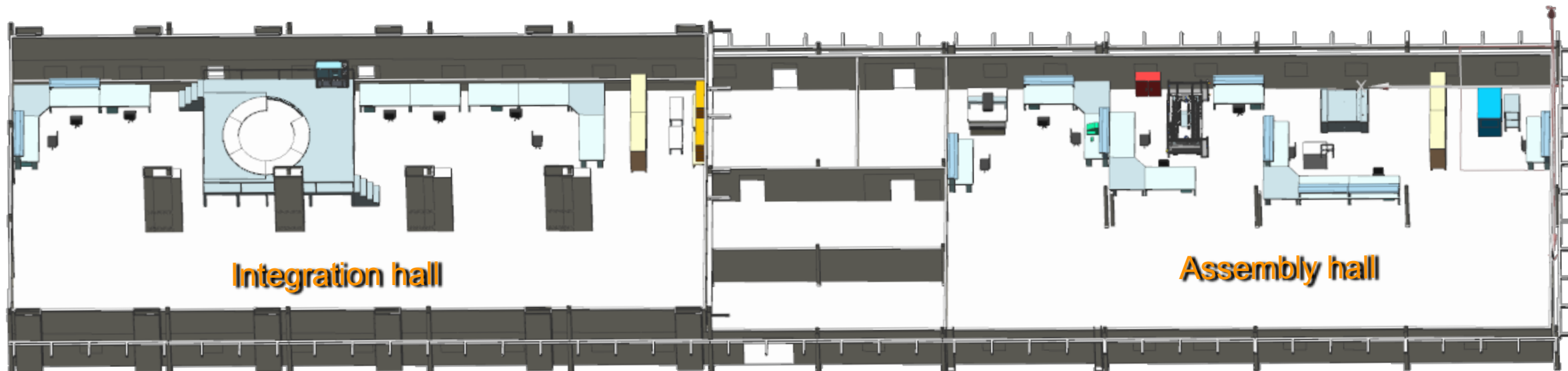
Entrance



Detector Assembly Facility

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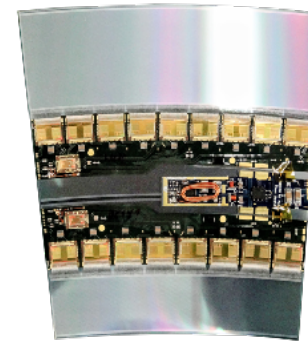
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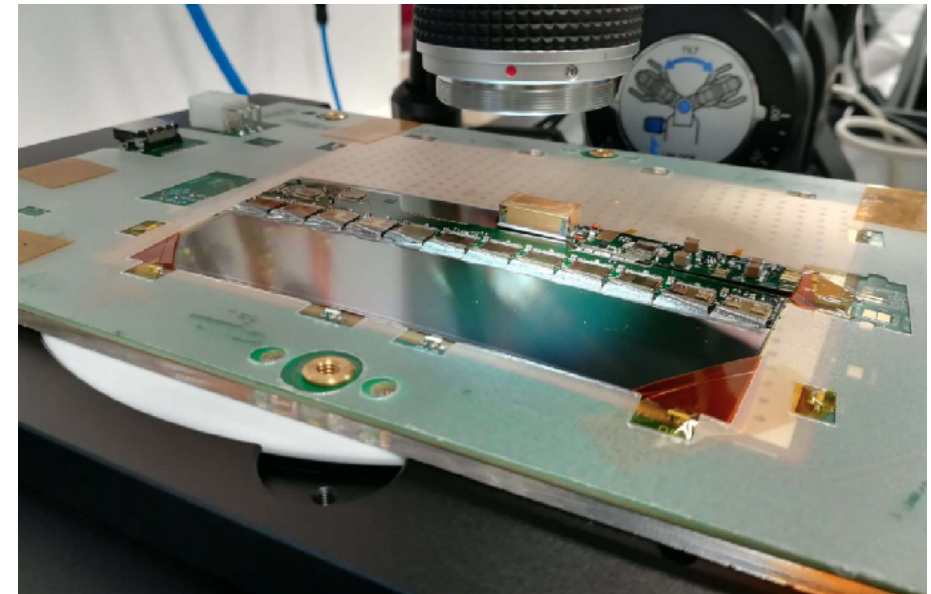
The building blocks: modules

Delivery: 1500 Zeuthen + 500 HU + 500 HH

- All six types of modules to be produced at DESY
 - Zeuthen: combination of DESY and HU infrastructure to build together 2000 modules
 - Hamburg: building R0 and R2 modules with Canadian hybrids
- Involved in all R&D phases gearing towards production
 - Qualification of glueing processes
 - Optimisation of module design
 - Pioneers in the use of gluing robots
 - Precision tools for module building
 -



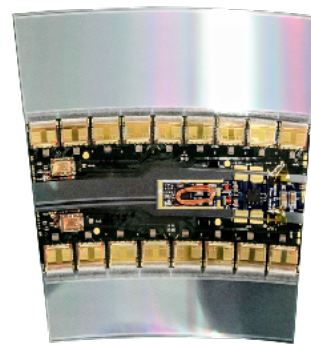
Glue application with robot



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Glue application with robot



Production readiness

- ~95% in terms of material and methods
- ~75% in terms of peer-reviewed site qualification

Problems encountered:

- Production of R2 tools took much longer than anticipated

Production rates

- Zeuthen+HU: 18.24 modules/week
- Hamburg: 6.1 modules/week

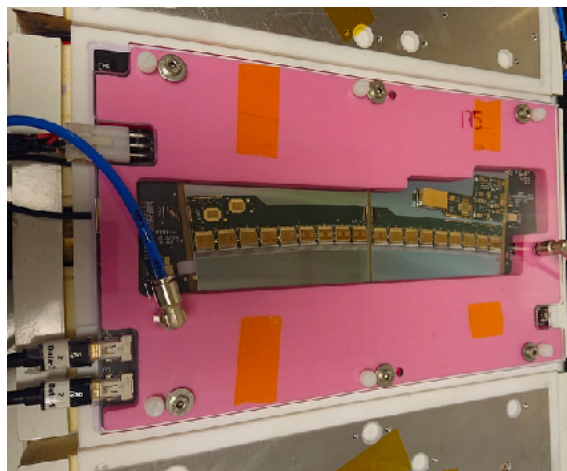
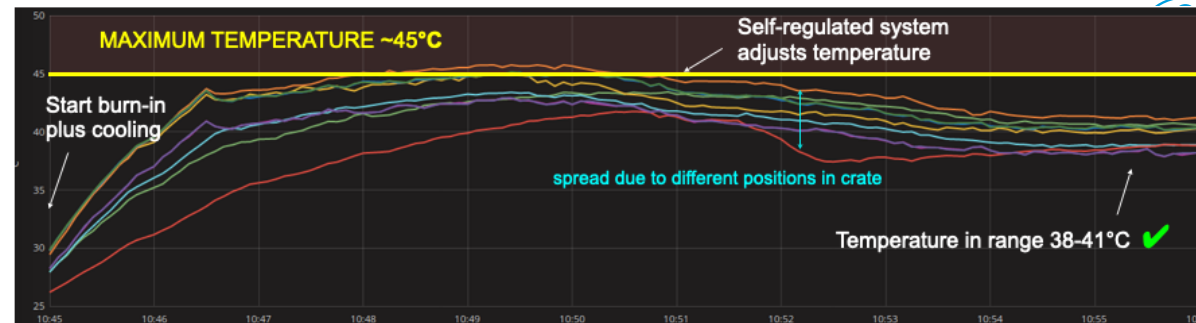
Risks

- ALL known module production risks ...
- Hard to keep specialised technicians due to low payment in German public service

Module Testing

Invested significantly into QA/QC infrastructure

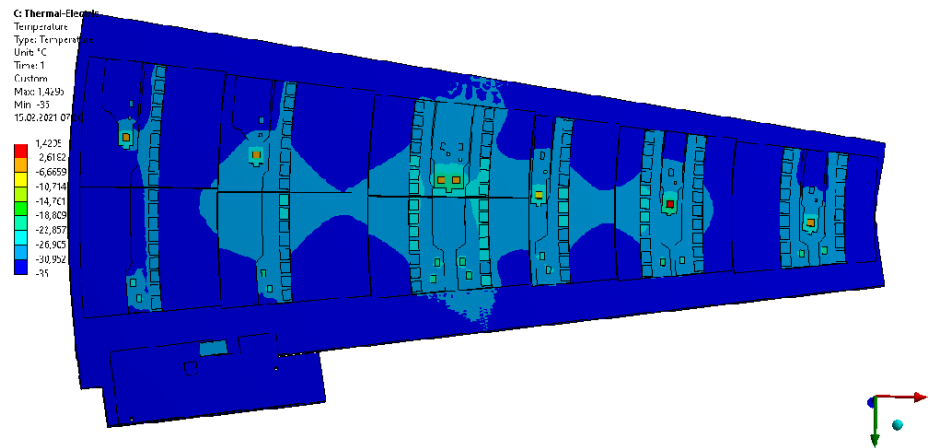
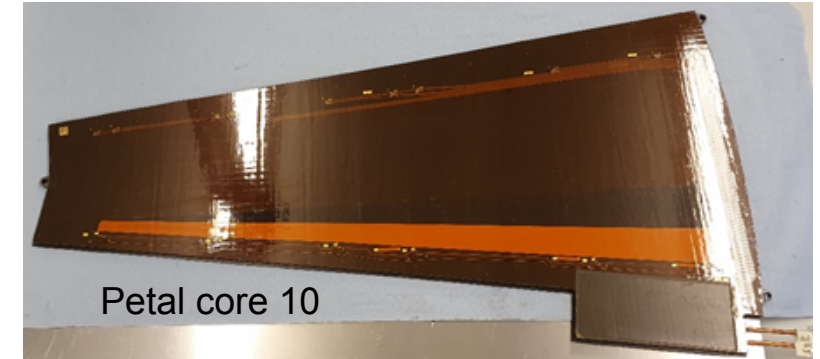
- Took on two test stand developments and construction for collaboration:
 - hybrid burn in crate cooling / slow control system (incl. user GUI)
 - module thermal cycling box
- Both required extensive workshop and engineering time (~5FTE in 2021)



Petal Core Production

Working with industry

- Petal production for both end-caps pioneered at DESY
- First ~10 petals produced in-house using our carbon-fibre lab
- Due to amount of petal -> found Spanish company AVS for full production
- DESY providing petal parts :
 - Cooling loop with electrical insulation breaks
 - Bus tape co-cured with Carbon Fiber pre-preg = “facesheets”
 - Thermal “Allcomp” foam
- Full QA/QC being done for 50% of the petals at DESY



Production readiness

- June 2022

Problems encountered:

- Items not being delivered when expected (e.g. carbon foam)

Test rates

- full QC for one petal/week

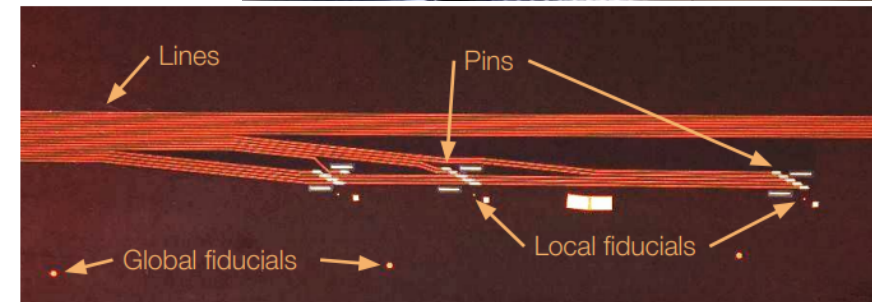
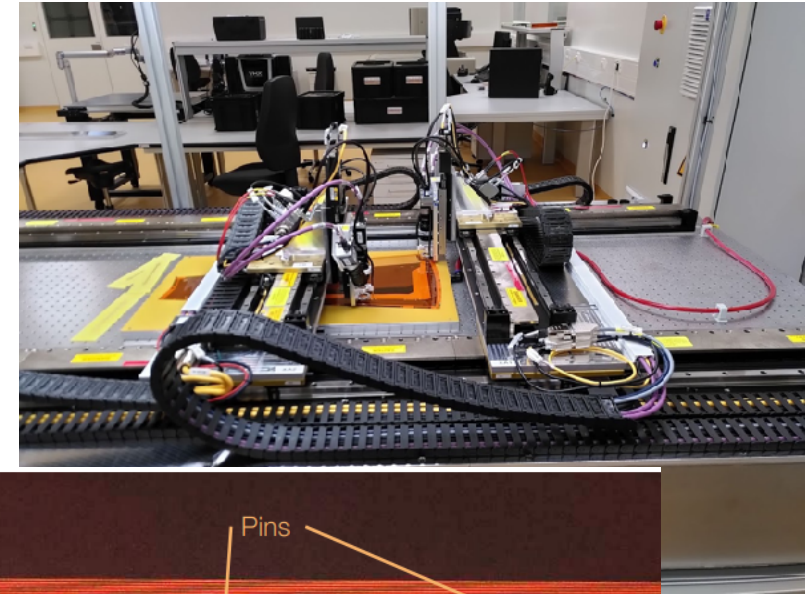
Risks

- Company not able to deliver in time

BusTape Testing and Module Loading

Using robots to get the job done

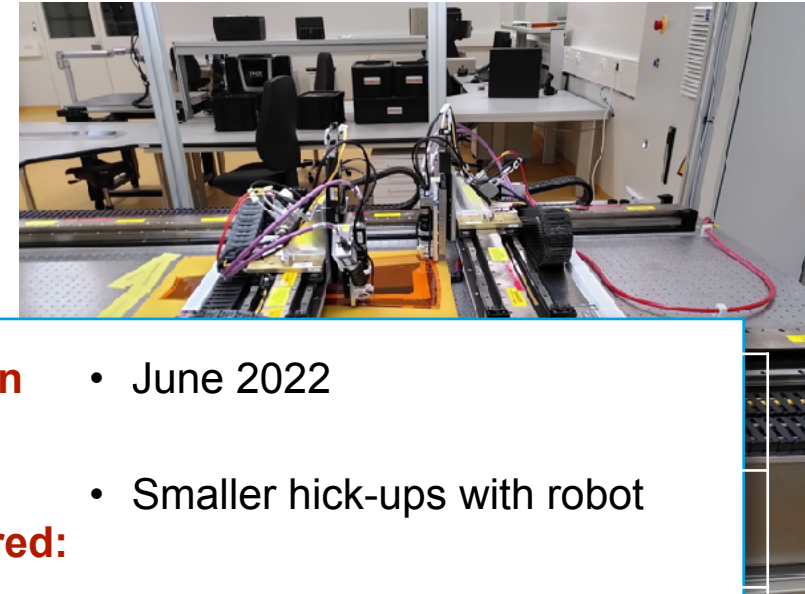
- Testing the bus-tapes before, after co-curing and on core
- Self-assembled robot based on development from Oxford
- Pre-production bus tapes **all** tested before co-curing
- Ongoing: retesting after co-curing



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Production readiness

- June 2022

Problems encountered:

- Smaller hick-ups with robot

Test rates

- rate driven by production rate

Risks

- Company not able to deliver in time

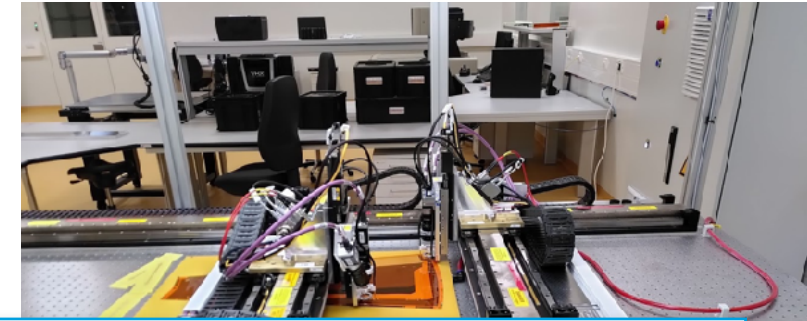
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Find better picture with petal on robot



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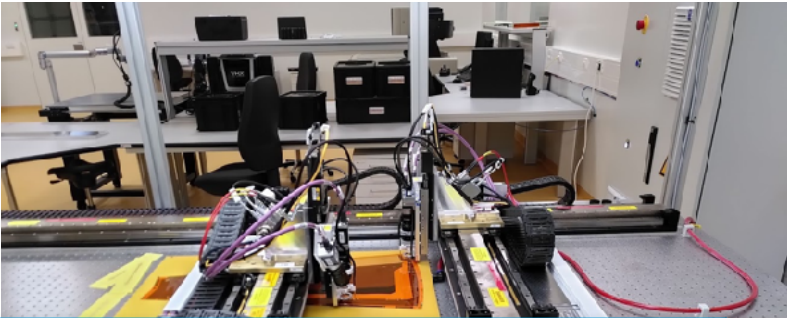
- Company not able to deliver in time

- Robotic gantry development within end-cap community
- Fully automated technique for three tasks in one: glue, pick-and-place, post-mounting metrology
- Routine for module placement optimised to achieve the placement requirements

BusTape Testing and Module Loading

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Production readiness	• June 2022
Problems encountered:	• Smaller hick-ups with robot
Test rates	• rate driven by production rate
Risks	• Company not able to deliver in time

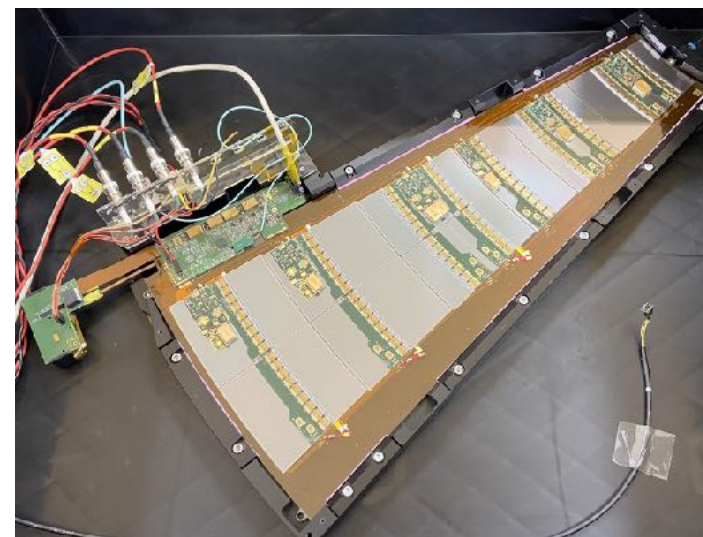
- Robotic gantry development with community
- Fully automated technique for one: glue, pick-and-place, position metrology
- Routine for module placement achieve the placement require

Production readiness	• June 2022
Problems encountered:	• none ?
Test rates	• one per week
Risks	• Problems with gantry

End of Substructure (EoS) Card

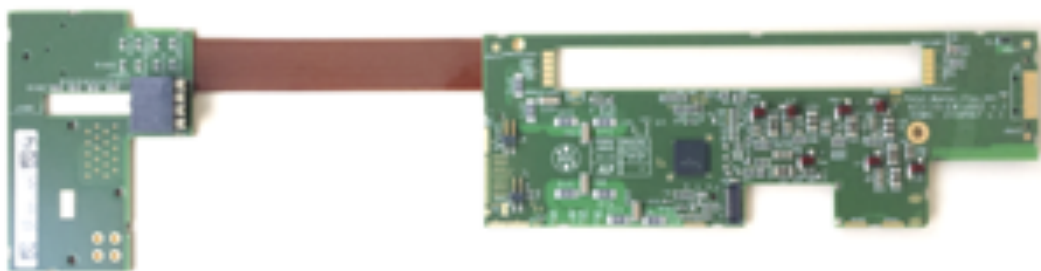
Gateway between on- and off-detector with 10 Gbit/s links

- Production of EoS cards for ITk strip tracker at DESY (~2000 cards for **both barrel and end-cap**)
- At DESY: full infrastructure for designing and developing EoS cards, approval process, and production with short turnaround
- Stave EoS Cards successfully used at strip barrel institutes
- Petal master EoS card successfully used to readout data from populated petal core from Freiburg
- **PCB boards produced in external company; electrical components in hand; population and QA/QC testing at DESY**



EoS integration

Petal loaded with modules and EoS master @DESY



EoS card
Prototype petal master

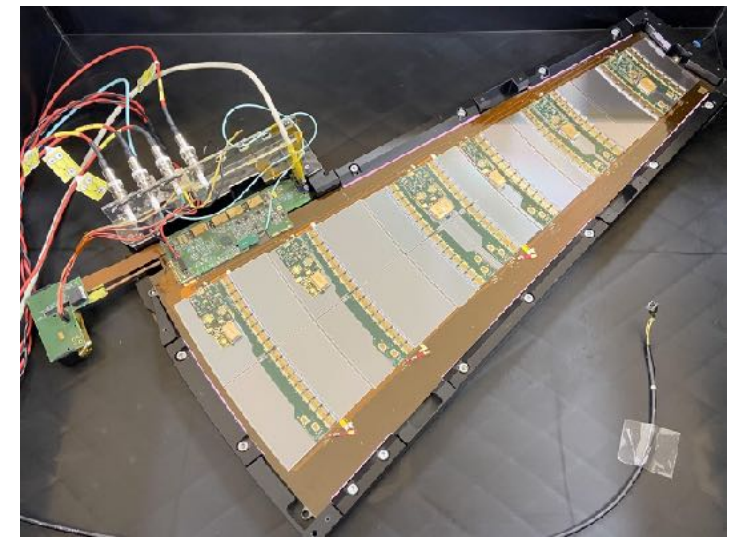


Needle-probe test-stand
at DESY

End of Substructure (EoS) Card

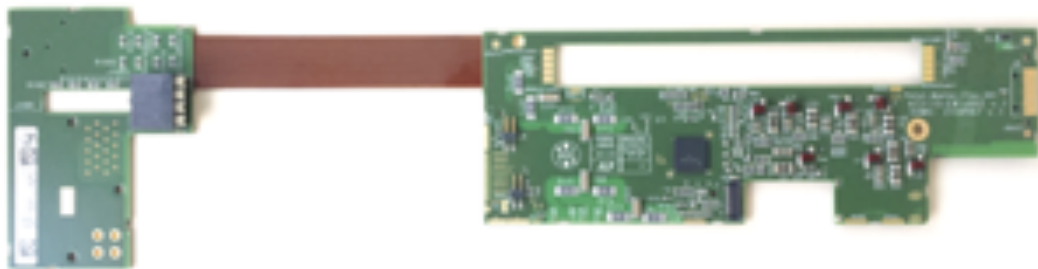
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Production readiness

Problems encountered:

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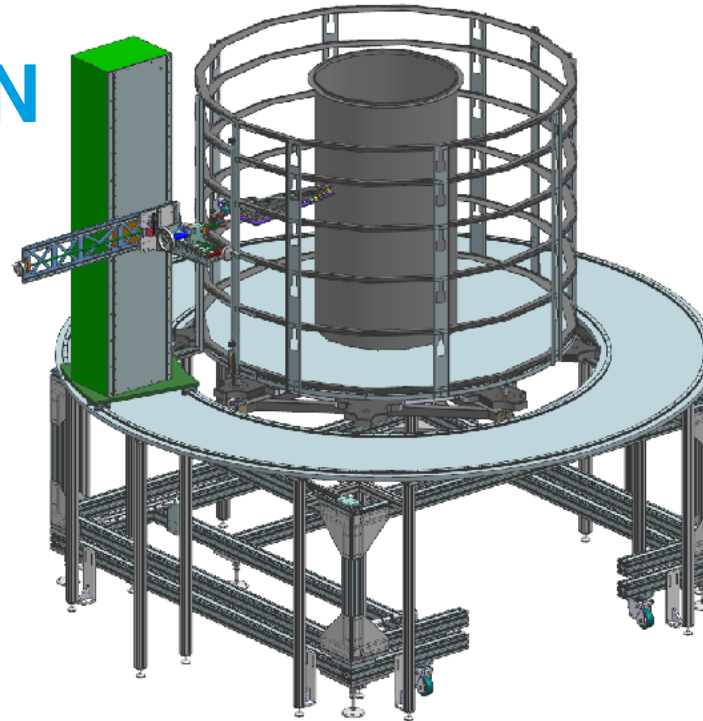
Risks

- After PRR (August 2022)
- Last minute changes communicated badly
- 120 boards/week
- Company delivering PCB boards

Integration@DESY and CERN

Getting tools ready for end-cap

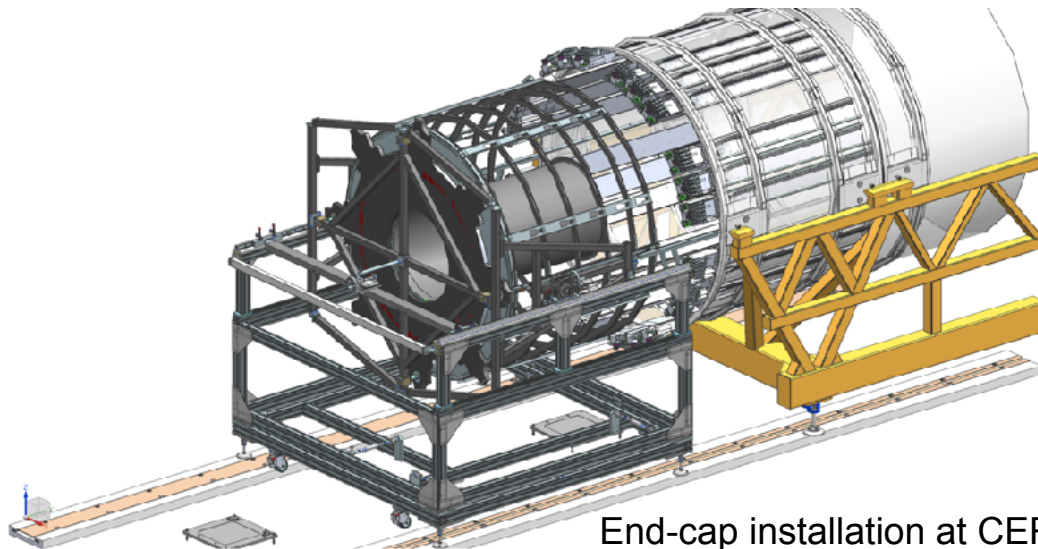
- Number of tools, frames and platforms needed for integration
- Super-frame currently in production
- Petal insertion successfully demonstrated
- Four LUCASZ CO2 plants built and commissioned (one at CERN)



Petal insertion at DESY using insertion tool and super-frame (simplified end-cap)



Petal insertion procedure tested with end-cap mock-up



End-cap installation at CERN using super-frame (simplified end-cap)

Two out of
plants for C
DESY and

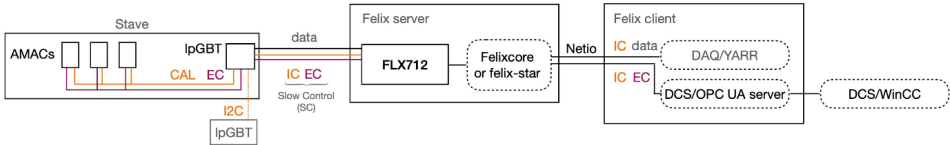
Production readiness

Risks

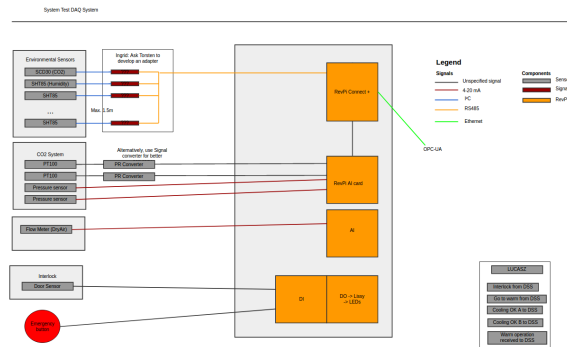
- No production items - only tools: start building now
- Integrity of (expensive) petals during insertion
- Transport of fully instrumented endcap to CERN!!!

Test Beam and System Test

Collaborative effort as final check



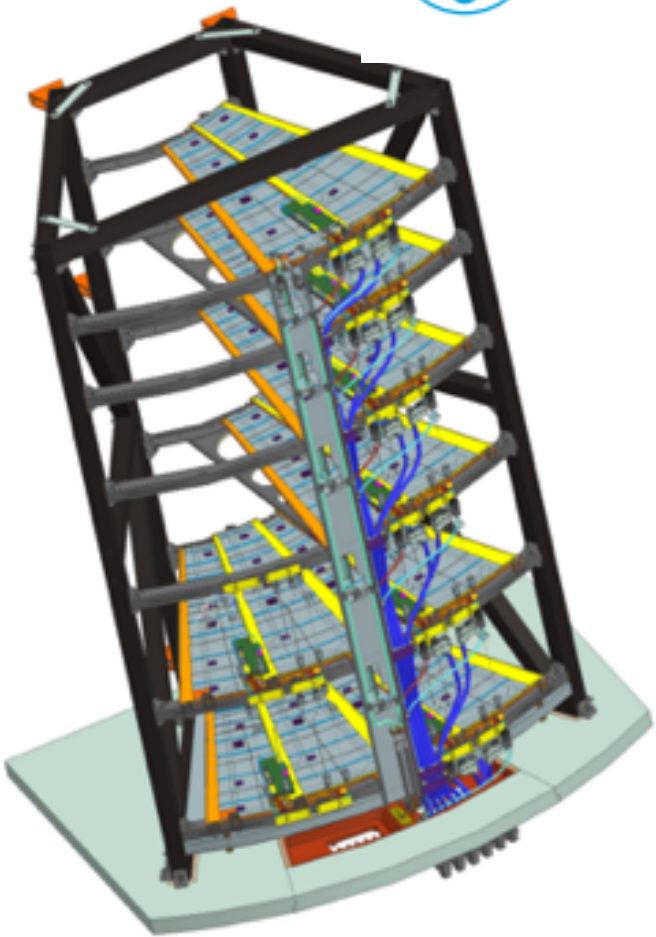
DAQ preparation and testing



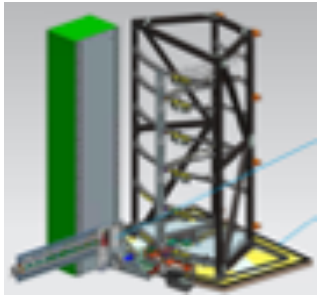
DCS development



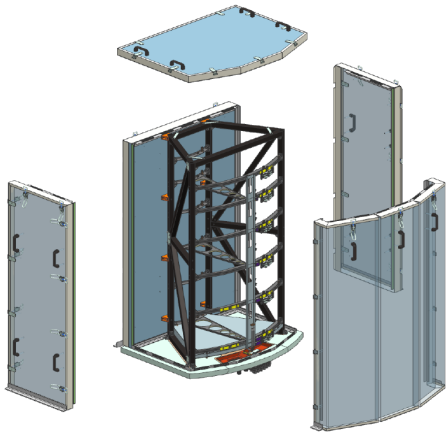
LUCASZ CO2 cooling



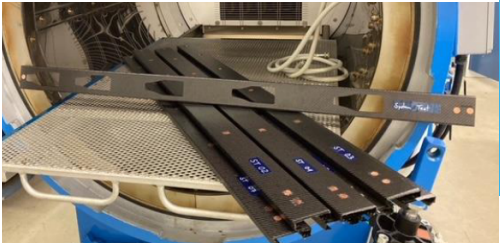
1/8th slice of the EC, populated with a total of 12 petals, built with real mechanical components and prototype parts (services)
→ **important input for system test FDR and start of ITk production**



Infrastructure at DESY



Design and fabrication



Production of service trays

The Team

From Master students to senior staff scientists - all hands on deck !



The Team

From Master students to senior staff scientists - all hands on deck !



Very young and diverse team !

Opportunity: give people chance to be involved in detector work while working on data analysis

Recent years: many young postdocs getting involved and progressed well

Conclusions

state again that delays due to external problems (items not being delivered, people suddenly not in lab,...) are very hard to plan for

You be no news