

ATLAS current Silicon Strip Tracker and requirements on precision for the Upgrade

WP 4: Automated Precision Assembly Procedures

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ATLAS current tracker: assembly and precision

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- Manual assembly at 14 different sites, which had to proof their ability before
- Use of precision tools, optical alignment and fiducials
- **Precision of endcap modules 17 μm in the $r\text{-}\phi$ coordinate and 580 μm in the z -coordinate from the correlation obtained through fitting**
- Mechanical tolerance for positioning sensors within the back-to back pair better than 8 μm transverse to the strip direction. **Manual production allows precision with tolerance of 5 μm .**
- Precision of barrel modules, partially assembled with with module mounting robot for module-to-disk assembly
 - Mechanical alignment tolerance Back-to-back:
 - < 8 μm (in-plane lateral, X),
 - < 20 μm (in-plane longitudinal, Y),
 - < 70 μm (out-of plane, Z, deviation from the average profile)

ATLAS current tracker: assembly and precision c'td

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- **2-year period of series production including 15% spares**
- Of the total module production, about 3% are out of xy tolerance and about 2.6% are out of z tolerance
 - 2582 barrel modules were built, required 2122 modules → 90.5% yield
 - 2196 endcap modules were built within specifications, 1976 required → 93% yield
- Problems (from Steve McMahon's slides in internal meeting)
 - Alignment with offline track-based alignment uses a global chi-squared technique that minimizes the residuals to samples fitted tracks -> high accuracy but there are deformations of larger sectors, so called “weak modes”.
- General comments (from Tim Jones and Steve McMahon's slides in Mainz)
 - Keep in mind several failure modes
 - Try to see the overall picture
 - Problems mainly from cooling system (leak tightness), cables

Challenges:

- Achieve at least same precision as current SCT
- Alignment of sensors on frontside and backside of core structure with dimension of up to 1 m length
- Alignment of different sensor sizes
- Gluing/Co-curing height of core, bus tape and sensor
- Bus tape connection between frontside and backside

Important for Alignment:

- Have survey during and after assembly

Freiburg plans:

- Investigate on metrology tools
- Plan/build assembly tools
- Build prototype of two-sided petalet
- Investigate on stability: temp, RH, vibration, power variations ...

- Assembly:

Methods/tools for alignment during assembly, use of fiducials etc., consecutive steps of assembly, availability and reliability for mass/automated production (assembly speed)

- Metrology:

Measurements tools, tools for determination of precision of two-sided objects and of large objects (~ 1m length of Petal)

Market survey about possible tools for alignment

- Change in precision due to environments (temperature, humidity), resulting necessity of stability, stiffness

- Gluing procedures, choice of glue, co-curing ?

- Survey on possible rework procedures ?

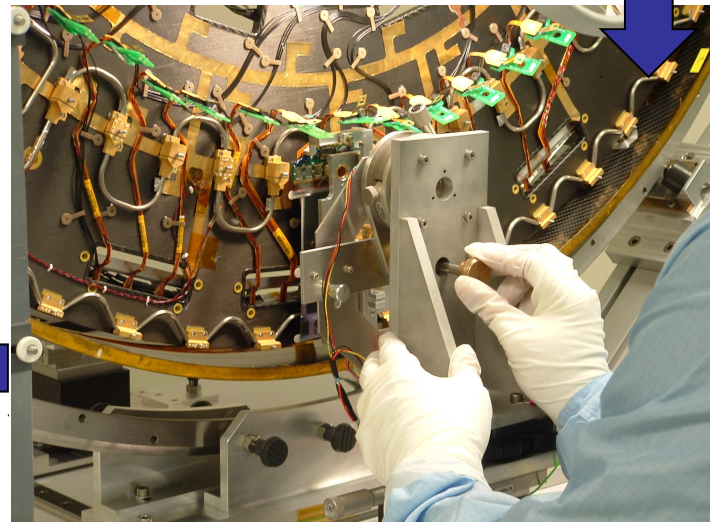
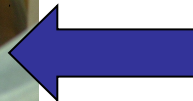
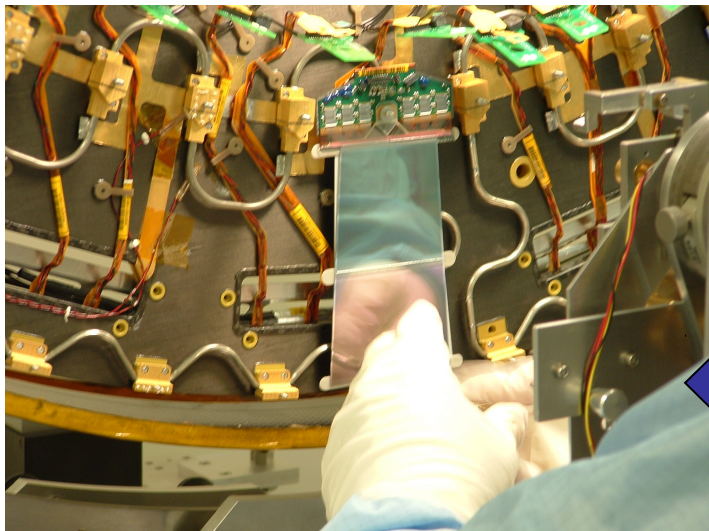
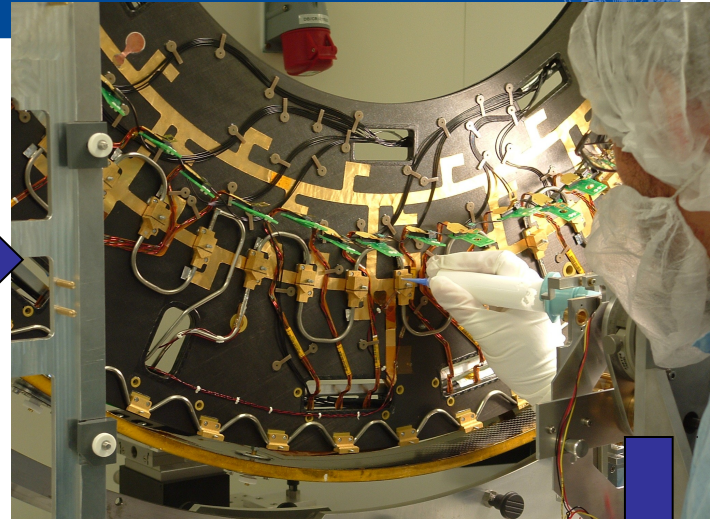
- Logistics in large scale production ?

Spares



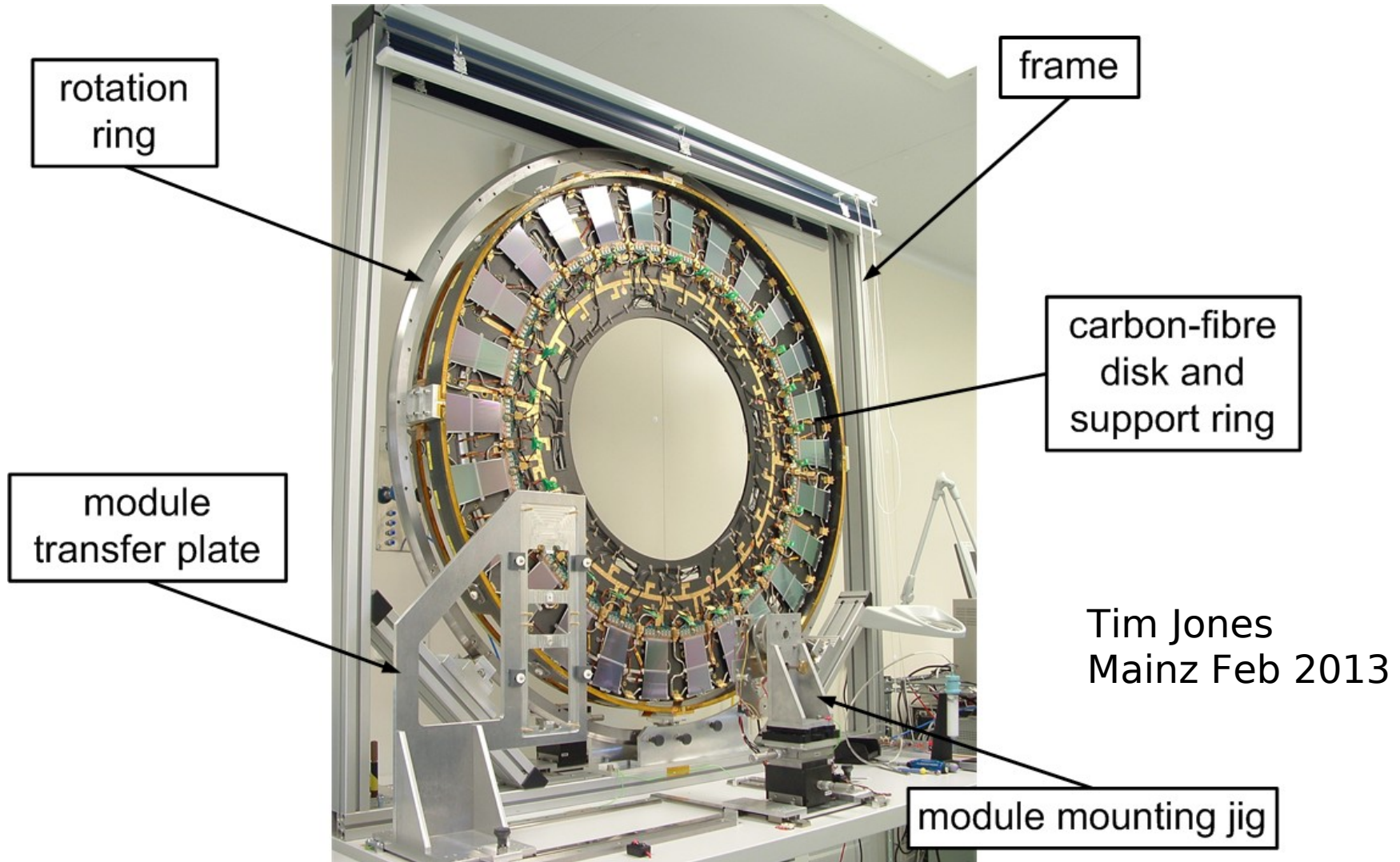
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From Module to Detector

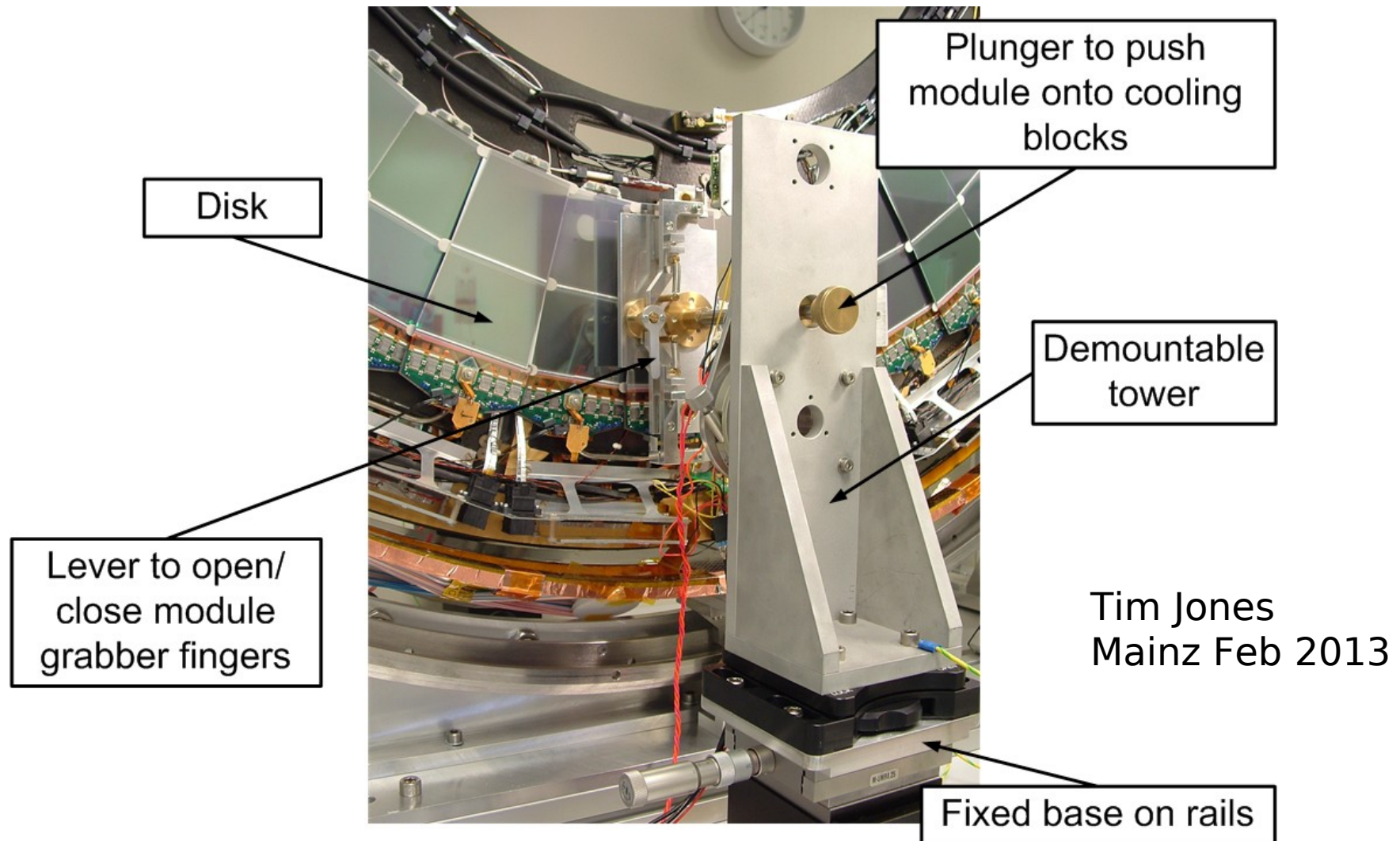


Manual assembly using precision tools

Module Mounting Tooling



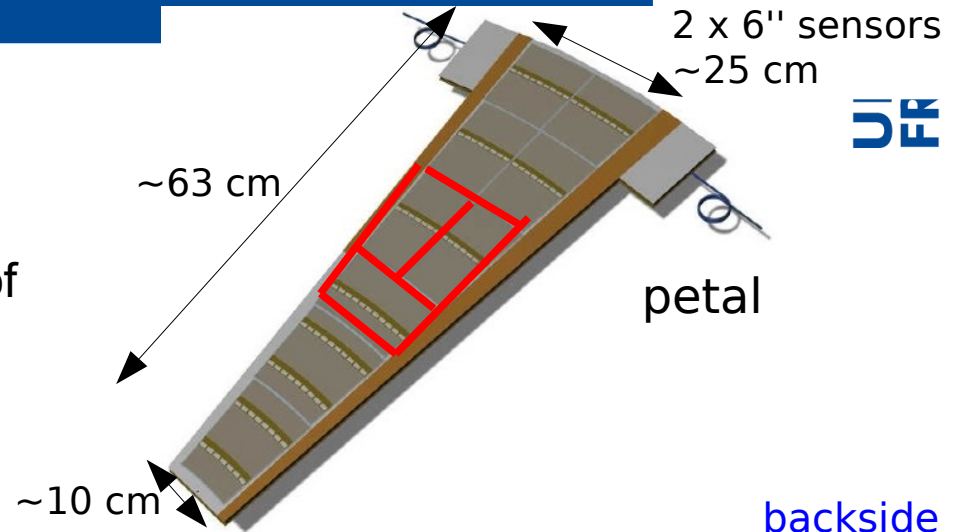
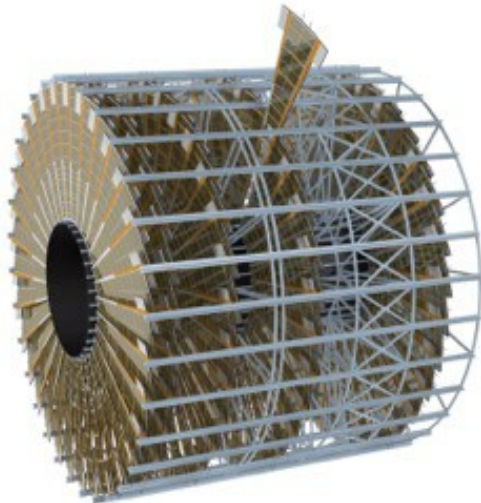
Module Manipulator



Concept for the Endcap Strip Modules: Petal

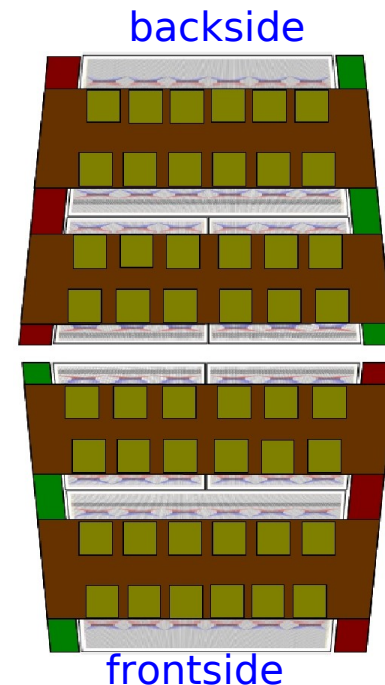
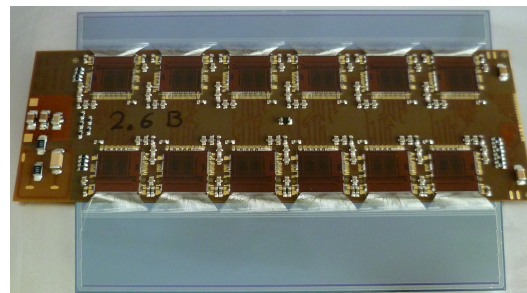
Endcaps follow stave concept

- 7 disks per endcap with 32 petals each
- 6 rings of sensors with radial strips of different length
- Sensors glued on cores from both sides endcap



Prototyping in **Petalet** program:

- Test assembly and hybrid design/production on innermost radius with smallest strip pitch and region where petal splits in 2 sensor columns



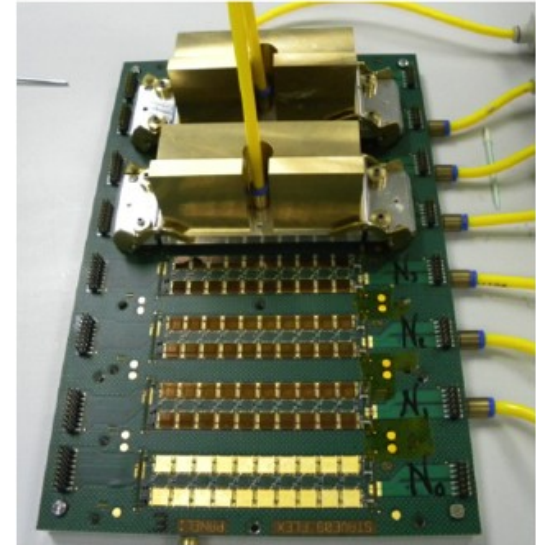
Stave Prototype production



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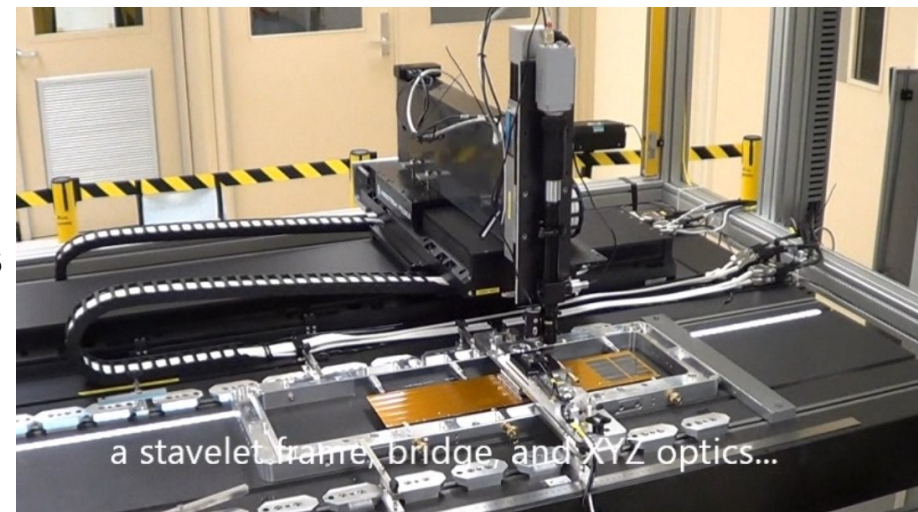
Stavelet production:

- Prototyping of single-sided staves and double-sided ones with fewer modules to test construction and powering
- Focus on mass-production
 - Hybrid on panels for population
 - Testing on panels
 - Use of simple vacuum pick-up tools with fine thread screws
 - 8 production sites



Assembly of Staves:

- Manual and use of gantry at RAL
- Driven by Labview
- Alignment with laser optics using fiducials on detector and frame, robust vacuum jigs
- Foreseen precision: $\pm 5 \mu\text{m}$ perpend. to strips, $\pm 50 \mu\text{m}$ along strips



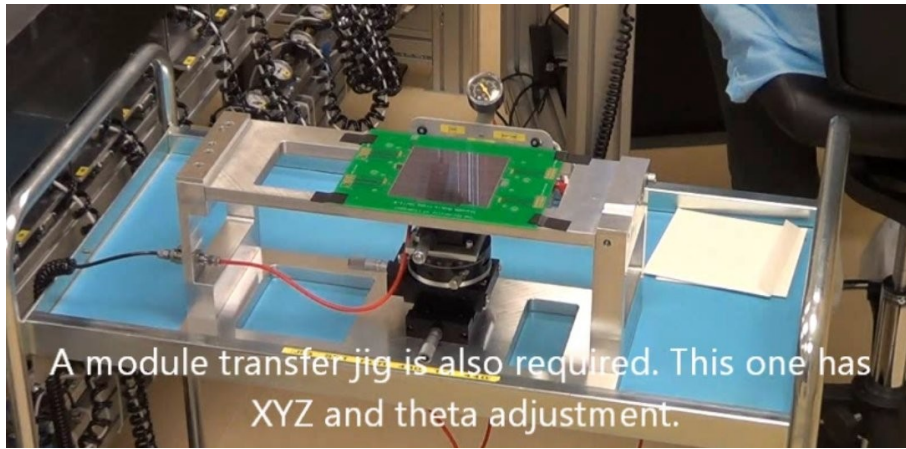
More photos in spare slides

Thanks to Martin Gibson

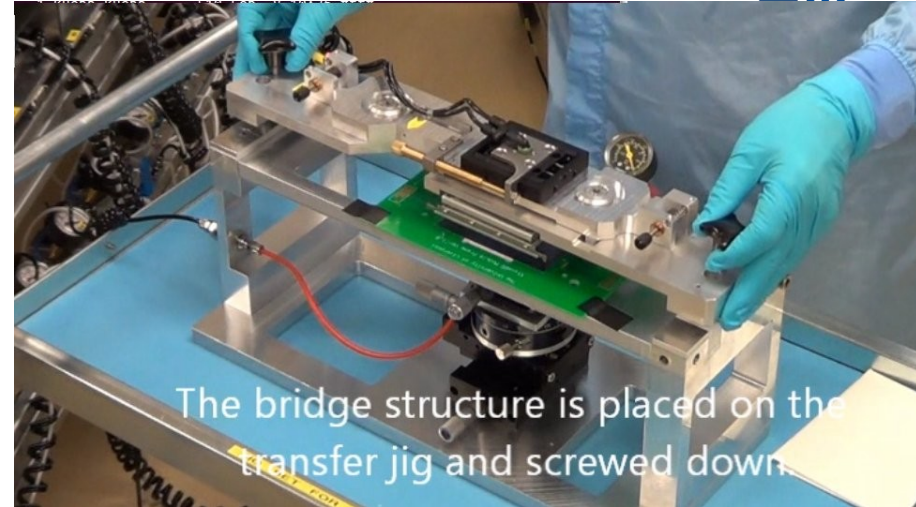
Stave Prototype production



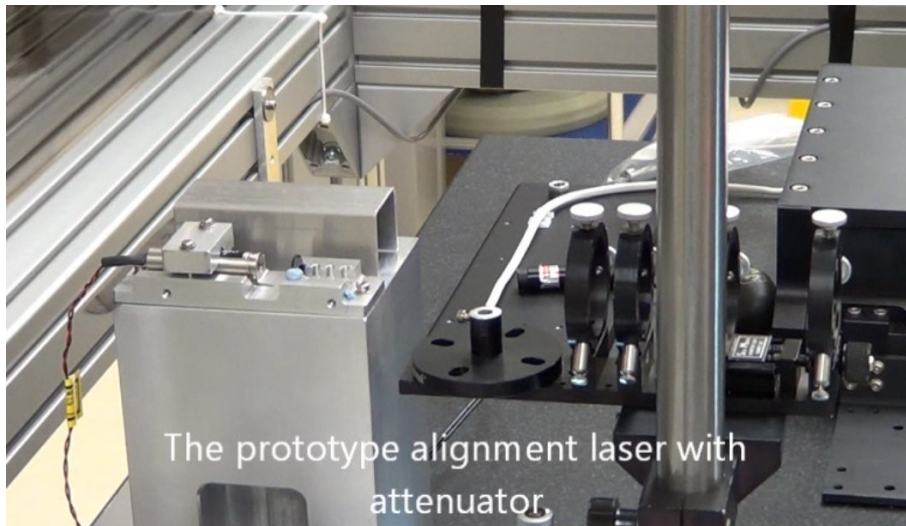
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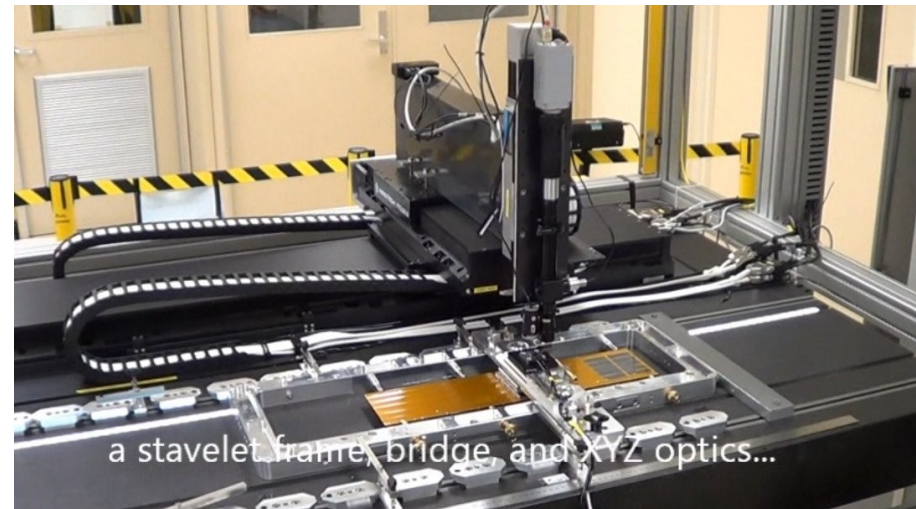
A module transfer jig is also required. This one has XYZ and theta adjustment.



The bridge structure is placed on the transfer jig and screwed down.



The prototype alignment laser with attenuator.



a stavelet frame, bridge, and XYZ optics...

Thanks to Martin Gibson