ATLAS Phase II Upgrade for High Luminosity
Stave Core Production at Yale

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Overview

The ATLAS experiment is an important element of the CERN physics program. A major upgrade of the detector is planned for commissioning during CY2025. Included in the upgrade is a new central tracker consisting of silicon pixel (inner) and strip (outer) detectors. The silicon strip detector is comprised of three major subsystems, including two endcaps and a barrel.

The barrel section consists of four concentric cylinders of staves. Each stave has 28 silicon detectors (14 +26 mrad, 14 -26 mrad) and is 1.4 meters in length. The stave core provides both mechanical support and thermal management for the detectors and associated electronics.

The Yale University ATLAS Group is responsible for the production and quality assurance for one-half of the total barrel stave core complement (248 out of a total of 496 including spares). Our collaborators in the UK (Oxford, Liverpool, Queen Mary and Sheffield are responsible for the other half). Brookhaven National Laboratory will then mount silicon modules on each Yale-produced stave and test the final assembly. The completed staves will be shipped to CERN for installation in the barrel support structure.

Production will be occurring from FY2020 through FY2022. Pre-production is scheduled for FY2018 through FY2019. We are currently in prototype mode through FY2017.

Prototype Stave Core Assembly

Stave Core Assembly Flow

Honeycomb First Facing Second Facing Carbon Foam Ends Carbon Foam Straights Side Closeouts Locking Points

PEEK End Closeout (Isolator Strain Relief)

Stave Core Thermal Imaging QA at Iowa State & Yale Wright Lab

• Principle
  • Stave coolant circulates at low temperature (expected default ~40°C, ambient at room temperature)
  • IR camera takes thermal image of stave to visualize cooling path
  • Delaminations from pipe to foam to facing show up as hot spots

• Cooling system
  • Recirculating chiller (SP Scientific RCZ1180)
  • T range -80°C → +75°C
  • Booster pump to ensure required pressure (Liquiflo, 180 psi @ -60°C)
  • "Coolant" 3M Novec HFE-7100

• FLIR A655sc thermal camera chosen as optimal match to QA

• Thermal image of a full-size stave
  • Single image taken with an 80° wide-angle lens at 0.9 m camera-stave distance; coolant at ~55°C

Delaminations are identified as bumps and dips in the temperature profile; for now we look at small regions over centers of cooling pipes

Expect to see blue (maybe also purple) defects as bumps

Don’t know—looks very small

No Hysol around half of tube circumference (shows up more on top side)

OK

Carbon foam/titanium tube assembly

Axial co-cured facing on vacuum fixture

Foam/tube, end closeouts glued to facing

C-channel closeouts in assembly jig

Installing locking point housings

Carbon fiber honeycomb in Hysol/graphite bath

Honeycomb installed in stave core

Grinding core to uniform thickness Stereo co-cured facing on vacuum fixture

Preparing 0.5 mm deep Hysol/graphite bath

Dipping core in bath Gluing core to stereo facing Locking point fixture

Detailed view of locking point fixture