

## INTT Silicon Modules and Ladders Assembly for sPHENIX Project

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The INTermediate silicon strip Tracker (INTT) barrel is comprised of several ladders tangentially arranged in layers around the RHIC beampipe.<sup>1)</sup> Each ladder assembly has two high-density interconnects (HDI) that are epoxied to a carbon fiber stave support. The two HDIs collectively host 52 FPHX chips and 4 silicon sensors. The sensors and the chips are glued to pads on the HDIs, wire-bonded, and then encapsulated.

The assembly process consists of multiple steps (cf. Fig. 1). During the inspection step of assembly, the carbon fiber staves are measured for flatness on BNL's OGP Smartscope Flash 500. The OGP is a top-down laser optical measurement system with a potential Z accuracy of 2 microns. Qualified carbon fiber staves are placed on the assembly fixture (cf. Fig. 2) and HDIs are installed and epoxied using glue masks.

Glue masks are placed in order to accurately epoxy to the chip pads on the HDIs. Chips are then precisely located and placed with acrylic vacuum fixtures that interface with the main assembly fixture (cf. Figs. 3–5). After the chips are epoxied, they are wire-bonded to the HDIs and then electronically tested.

In the same fashion that the chips were installed, the silicon sensors are placed on epoxied locations along the HDIs using vacuum fixtures. The sensor's vacuum fixture (cf. Figs. 4 and 5) has micro adjusters allowing the sensor's position to be perfected before the epoxy cures. Small marks are referenced on the HDI and the silicon sensors using the OGP machine. These marks are used for live alignment checks while adjusting the positions of the sensors. After the epoxy is cured, a final wire-bond job is performed and the full assembly is then electrically tested.

Currently, all assembly fixtures have been designed, fabricated, and received; permitting us to begin prototype production. Additional fixtures used in transportation and wire-bonding/encapsulation are designed and being sent for fabrication. The transportation container doubles as a safe storage and testing fixture, as the electronic connectors and the cooling pipe can be accessed from outside the transportation container without putting the delicate sensors and chips at risk. Specific fixtures were necessary for the

wire-bonding and encapsulation machines so that multiple staves can be produced in the same exact manner every time, streamlining production.

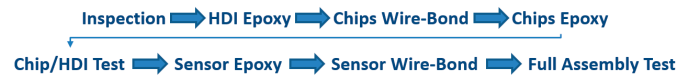


Fig. 1. Assembly Steps.

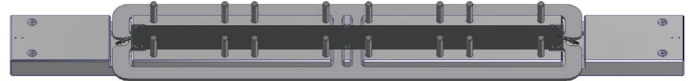


Fig. 2. Assembly Fixture.

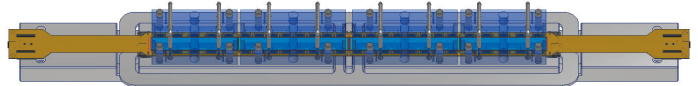


Fig. 3. Chip Placement Tools on Assembly.

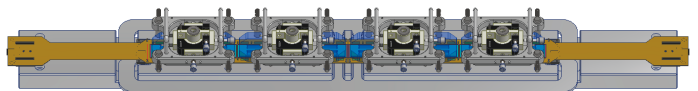


Fig. 4. Sensor Placement Tools on Assembly.

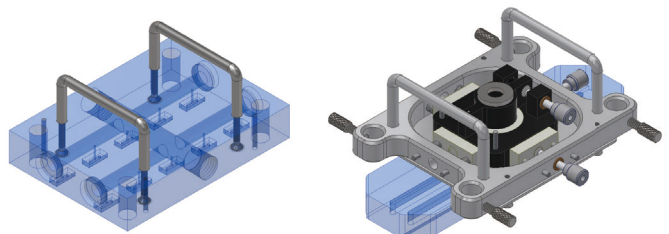


Fig. 5. Chip Placement Tool and Sensor Placement Tool

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### Reference

- 1) Conceptual Design Report of sPHENIX (2018).