

Micro-Orbital Welding in ATLAS ITk upgrade

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The decision to use small diameter, thin walled Titanium tubing for the ATLAS ITk upgrade detector cooling systems has presented ATLAS engineers with many challenges.

We at the University of Sheffield have been required to orbital weld Titanium tubing as small as 2.275mm in diameter and with wall thicknesses at 160 microns. Titanium itself although being a strong and robust material is difficult to work with as it is extremely prone to oxidation which can easily contaminate the weld, so extreme cleaning steps are taken in its manufacture and we follow up with rigorous preparation throughout the welding process.

Even with these procedures in place we have done rigorous R&D to limit the porosity in these tiny welded joints by performing multiple alterations in the machine weld procedures (WPS) until we have achieved an acceptable level of result, as seen in CT scans of the sample welds we are now producing. These welds mimic the production joints we will soon be doing on mass.

In addition to these points, the need for a high yield in welding process, due to the expensive nature of the final components has led us into developing techniques and bespoke geometries (sleeves) for the parts to be welded. We have also had to consider the need for testing of sub-assemblies through the manufacture of the systems with one eye on QA & QC, and have developed specialised test fittings that can be used in conjunction with the welded sleeve terminations. These parts have been tested to hold high pressure and vacuum and to deal with various testing mediums at different sites.

The lessons learned from the R&D and pre-production work carried out so far will go forward into further work needed for integration welding work and possible repair scenarios for final joints. The information is also being shared throughout the community through regular communication and by the ATLAS ITk Welding Task Force who have produced a steering document soon to be on EDMS.

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