Metallurgical and crystallographic aspects of the Einstein Telescope design

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Abstract

Gravitational wave detection, based on extremely accurate laser interferometry, is an entirely new method to observe the universe, complementary to conventional observations based on electromagnetic radiation. The Einstein Telescope, the largest and most accurate gravitational wave detector to date, is scheduled to be built in Europe by 2035. To achieve the required accuracy its laser beams should extend over very long distances and be contained in ultra-high vacuum (_˜10ˆ(-10) torr). Hence, the main structural component of the telescope should be a 120 km-long 1 m-diameter ultra-high vacuum pipeline, which intends to become the largest ultra-high vacuum system ever built. Traditionally, austenitic stainless steel is used for such pipelines, but given the scale of the project, alternative materials must be considered to reduce the cost. Ferritic stainless steel (FSS) is a good alternative but presents challenges when it comes to welding. An overview of a joint research program between Ghent University and CERN is presented in this contribution. The work includes modelling of weld heating cycles, weld zone microstructure, mechanical properties characterization, and failure analysis. Phase transformations and crystallographic aspects of straining in the weld zone of several FSS grades are discussed, and preliminary conclusions concerning FSS applicability in the Einstein Telescope project are drawn.

Keywords: Einstein Telescope, Ferritic Stainless Steel, Beam Pipeline, Welding, Mechanical Properties

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