SRF2025 TOKYO

22ND INTERNATIONAL CONFERENCE ON RF SUPERCONDUCTIVITY

September 21-26, 2025

Contribution ID: **46** Contribution code: **THB03** Type: **Invited Oral Presentation**

Cavity surface inspection: automated defect detection using a short focus imaging system

Thursday 25 September 2025 11:40 (20 minutes)

The performance of SRF cavities is critically dependent on the integrity of their inner surfaces. However, traditional inspection methods are limited by the geometry of these cavities. To overcome this challenge, a novel automated defect detection system has been developed at CERN. This system utilizes a short-focus imaging system mounted on a scanning robotic arm, enabling comprehensive and high-resolution inspection of the entire cavity surface. By combining overlapping image coverage with optical anomaly analysis, surface irregularities can be precisely identified and cataloged. Advanced algorithms, including both rule-based and machine learning models, are employed to classify defects such as scratches, inclusions, pits, and weld artifacts. This approach has been successfully tested on 1.3 GHz and 400 MHz cavities fabricated from both bare niobium and copper substrates, as well as niobium-coated cavities. Full cavity scans typically require between 3 to 20 hours, depending on cavity size, and are performed by acquiring a series of overlapping images each 10 x 15 mm. Subsequent defect detection and analysis are carried out offline as part of the automated image processing chain. This facilitates the creation of a standardized catalogue of surface defects, with images taken under consistent imaging conditions. The systematic analysis of defects can be used to develop predictive insights into defect impact on cavity performance, ultimately advancing SRF technology.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: MATHEWS, Sonia (European Organization for Nuclear Research)

Co-authors: MACPHERSON, Alick (European Organization for Nuclear Research); STAPLEY, Niall (European Organization for Nuclear Research)

Presenter: MATHEWS, Sonia (European Organization for Nuclear Research)

Session Classification: Thursday Oral Session: B

Track Classification: MC4: SRF Technologies