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Design and validation of a micrometric and adaptable calibration bench for frequency scanning interferometry sensors

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The High-Luminosity Large Hadron Collider (HL-LHC) project at CERN aims to enhance the LHC's performance and increase its discovery potential. As part of this upgrade, new components will be installed and must be aligned with an accuracy of 0.17 mm vertically and 0.33 mm radially (1σ) over a length of 420 m.
To achieve such requirements in harsh conditions, CERN has developed a range of new sensors using Fourier analysis-based Frequency Scanning Interferometry (FSI), capable of absolute distance measurements on multiple targets within a few micrometers'uncertainty. More than 600 of these FSI sensors will be deployed for the project, necessitating an accurate, fast, adaptative and cost-effective calibration of these sensors. To do so, a specialized calibration bench has been developed.
This paper details the design, benchmarking, and final validation of this calibration bench, which enables rapid calibration of a wide range of FSI sensors to an accuracy below 10 µm (1σ). Additionally, it presents the first intense use of this bench in the frame of the Inner Triplet String test, a facility representing one complete section of new focusing regions of the HL-LHC upgrade project.

Footnotes

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