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Development and Tests of a Full-Size Additive Manufactured Radio Frequency Quadrupole Module

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Based on an initial proof-of-concept, a full-size single-piece pure-copper Radio Frequency Quadrupole (RFQ) prototype module was for the first time designed and additively manufactured (AM), as a result of a multi-disciplinary collaborative effort and of the deployment of state-of-art AM technology. The 39-cm long prototype with modulated electrodes replicates, with several improvements allowed by AM, the design of the CERN high-frequency (750 MHz) RFQ that has already found applications in proton therapy of cancer and ion beam analysis.
Thanks to its unique features, AM technology is unlocking great potential for the optimisation of a complex accelerating cavity like the RFQ. The RFQ geometry can be improved based only on accelerator physics and functional requirements without considering limiting factors (e.g. tolerances, shape, size and configuration) imposed by the conventional manufacturing techniques. Additionally, cooling channels and connection flanges can be integrated in the overall structure, with a gain in installation and operation flexibility.
In-depth geometrical accuracy and surface roughness measurements were performed on the proof-of-concept prior and after the surface treatment operations. The results are fully in line with the standard RFQ requirements. Vacuum, RF and water tightness tests are being performed on the full prototype. The paper will discuss in detail the technological process, the measurements and the test results.

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Footnotes

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