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Multi-objective optimization of ring cyclotron RF cavity using neural network ensembles with uncertainty quantification

Wednesday 4 June 2025 16:00 (2 hours)

This study presents a multi-objective optimization scheme for ring cyclotron RF cavities, leveraging a neural network ensemble surrogate model. The cavity geometry is parameterized using Non-Uniform Rational B-Splines (NURBS), with control points and weights as design parameters. To reduce the computational cost of direct eigenmode simulations, an ensemble of neural networks trained using Ansys HFSS results is used to approximate performance metrics efficiently. The surrogate model also quantifies uncertainty, enabling Monte Carlo error propagation to account for potential manufacturing deviations. A multi-objective genetic algorithm (MOGA) explores the design space, using the surrogate model for efficient evaluations. The neural network ensemble are periodically retrained through HFSS simulations, iteratively improving the accuracy of surrogate model. This approach gives a robust and reliable RF cavity design optimization scheme.

Footnotes

Paper preparation format

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