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Calculation of interstrand coupling losses in superconducting Rutherford cables with a continuum model

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Rutherford cables for particle accelerator magnets can be subjected to time-varying magnetic fields during the typical accelerator operating cycle, which in turn induce coupling currents flowing in the loops formed at the contacts between different strands. A proper analysis of the losses generated by these currents must be carried out for the design of the cryogenic system.
The models reported in the literature exhibit some limits related to computational burden when applied to the analysis of interstrand coupling currents for real cable geometries. To solve this problem, a continuum model with non-uniform contact conductances between the strands was developed. The model allows one to attain the required level of detail in the description of the interstrand currents. The model is validated by comparison with analytical results available in the literature for simplified case studies with uniform magnetic field applied orthogonal to the cable. Examples of current and loss distributions are presented in the paper, to prove the potential of the model to analyze Rutherford cables of any configuration. Finally, a study regarding the proper choice of the boundary conditions of the problem is presented, which opens the path towards new experimental investigations on the actual current distribution and losses in real long Rutherford cables for accelerator magnets.

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