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Fri-Af-Po.10-01: End-Field Analysis and Phase Tuning of a Segmented Superconducting Undulator Prototype

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This paper presents the end-field analysis and phase optimization of a segmented superconducting undulator prototype (SC-AGU). This prototype consists of multiple segments, each requiring precise alignment and phase tuning to ensure optimal magnetic field performance and synchrotron radiation output. This segmented undulator design enables each segment to have distinct magnetic gaps, deflection parameters (K), and period lengths (λu), while ensuring a constant resonant fundamental photon energy across all segments, as permitted by the constraints of electron beam dynamics. This paper presents the methodology for end-field analysis, which includes detailed simulations to characterize the magnetic field distribution at the ends of each magnetic array. Special attention is given to the impact of field quality at the segment junctions and on radiation properties, maximizing on-axis spontaneous emission while retaining the electron beam's 'stay-clear'area and reducing the impedance constraints imposed by the undulator magnet structure along the entire straight section.

Furthermore, the phase tuning process is investigated by optimizing the phase shift between the superconducting segments. This optimization aims to minimize magnetic field deviations at segment junctions, ensuring smooth transitions and consistent field profiles. By preserving the desired radiation properties and enabling efficient, high-quality beam performance, this approach significantly enhances the device's overall performance.

Author: Dr MUSARDO, Marco

Co-authors: TANABE, Toshiya (Brookhaven National Laboratory); RANK, James (Brookhaven National Laboratory); BROOKBANK, Thomas (Brookhaven National Laboratory); EIPPER, Brian (Brookhaven National Laboratory); HIDAS, Dean (Brookhaven National Laboratory); HOLLAND, Bryan (Brookhaven National Laboratory); MIGLIORINO, Daniel (Brookhaven National Laboratory)

Presenter: Dr MUSARDO, Marco

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