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Development of LN_2 cooled permanent magnet undulators

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This work presents a novel design for a cryogenically cooled permanent magnet undulator (CPMU), advancing compact, high-field insertion devices for synchrotron light source PETRA IV at DESY. Operating at cryogenic temperatures allows significantly smaller gaps and higher fields than conventional undulators. The proposed 4 m long device, the longest of its kind, uses high-performance PrFeB magnets in a hybrid structure. The inner and outer girder design is optimized through mechanical simulations to endure strong magnetic forces while maintaining micrometer tolerances. Forces up to 35 kN are compensated using auxiliary magnets integrated into the inner girder. Adjustable link rods form the critical mechanical connection between girders, enabling fine tuning; they are undergoing cryogenic testing at 77 K to assess performance. Fluid dynamics and thermal simulations of the liquid nitrogen (LN_2) cooling system reveal temperature distributions and gradients along the undulator, crucial for ensuring magnetic field stability and optimal operation in accelerator environments.

Footnotes

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