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Non-insulated ReBCO coils for the confinement of Electron-Positron Pair Plasmas

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The APEX Collaboration endeavours to magnetically confine electron-positron pair plasmas. The operational APEX-LD experiment is at the initial stage of electron plasma experiments, and concurrently, the EPOS Stellarator is in design phase. A key technology in both experiments is REBCO (Rare-earth Barium Copper Oxide) high-temperature superconductors.

REBCO presents itself as a promising technology for compact magnetic traps with moderate field strengths (0.5 - 2 T) due to its higher operating temperature (approximately 20 K) and superior performance within a magnetic field in contrast to low-temperature superconductors such as Nb₃Sn and NbTi. The non-insulated coil design, devoid of turn-to-turn insulation between the ReBCO windings, offers enhanced stability and robustness, and provides passive quench protection.

For EPOS, the non-planar coils require careful optimization of the winding pack orientation to prevent damage to the ReBCO tape. We've optimized, constructed and tested several test coils to validate the strain optimization process. Furthermore, we've built a number of compact, double pancake coils that not only emulate the winding pack conditions of the EPOS stellarator but also serve as a potential test platform for the injection of Rydberg positronium into magnetic fields.

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