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ALESIA: Superconducting magnet design through multi-physics optimisation

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Designing superconducting magnets presents a challenge due to their multi-physics complexity, diverse analytical tools, and often imprecise specifications. To streamline this process, we introduce ALESIA, a novel optimisation and data management toolbox developed at CEA-IRFU.

ALESIA leverages advanced algorithms, including nonlinear programming techniques, evolutionary algorithms, active learning strategies, and surrogate modelling, to accelerate the design process. By intelligently exploring the parameter space, ALESIA enables rapid convergence towards optimal solutions while minimizing computational cost.

ALESIA's flexible architecture allows integration with any physics simulation software, encompassing magnetic field calculations (OPERA), and mechanical analysis (CAST3M), but its applicability can be broadening beyond magnet design. Crucially, ALESIA's automated optimisation loop simultaneously considers all stages - magnetism, conductor properties, mechanics, and quench behaviour - ensuring holistic and robust design solutions.

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