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Comparison of cryogenic process control strategies using simulation software and applied to a superconducting magnet test bench at CERN.

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Industrial process controllers for cryogenic systems used in test facilities for superconducting magnets are typically PIDs, tuned by operational expertise according to users requirements (covering cryogenic transients and associated thermo-mechanical constraints). In this paper, an alternative fully-automatic solution, equally based on PID controllers, is proposed. Following comparison of the operational expertise and alternative fully-automatic approaches, a new process control configuration, based on an estimated multiple-input/multiple-output (MIMO) model is proposed. The new MIMO model-based approach fulfils the required operational constraints while improving performance compared to existing solutions.
The analysis and design work is carried out using both theoretical and numerical tools and is validated on the case study of the High Field Magnet (HFM) cryogenic test bench running at the SM18 test facility located at CERN. The proposed solution was validated by simulation using the CERN ECOSIMPRO software tools using the cryogenic library (CRYOLIB) developed at CERN.

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