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Super-MuSR scientific design: Progress towards a step-change in muon capabilities at ISIS

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Super-MuSR is a major project to upgrade the MuSR instrument at ISIS that aims to provide an order of magnitude increase in resolution and counting rate in separate modes of operation. This now forms an early part of the ISIS-wide Endeavour programme, an estimated £90m investment in new and upgraded instruments, which we are aiming to start in the 23/24 financial year.

Experiments using the current MuSR instrument generally focus on magnetism and superconductivity, particularly those situations where weak relaxation rates are observed. To extend these capabilities a new detector array will increase the data collection rate by more than fifteen times. This will also enable detailed studies of quantum coherent muon states and in-operando diffusion measurements of battery cells. The present instrument is limited in the frequency range it can study by the intrinsic muon pulse width at ISIS. This issue will be overcome using a pulse slicer to remove both ends of the incoming pulse and increase the time resolution approximately ten-fold, albeit reducing the muon flux. Complementing this will be spin rotators to allow transverse field measurements over 0.1T. These will increase the range of magnetic and superconducting samples that can be studied. A new cruciform will permit either fly-past measurements for smaller samples with lower backgrounds or quick changes between cold dilution fridges for high experiment throughput for larger samples as now.

We have now completed the scientific design of the instrument and are now prototyping individual beamline and spectrometer components. Here we report the progress made with the scientific design of the beamline and instrument to realise our scientific goals, with likely performance evidenced through simulations.

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