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The Mechanical Design and Simulation of a Scaled H⁻ Penning Ion Source

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The ISIS cesiated Penning compact surface plasma source (CSPS) used at Rutherford Appleton Laboratory, whilst a reliable and well proven design, is unable to produce the beam parameter requirements for the upcoming Front End Test Stand (FETS) experiment. To this end a larger, scaled ion source is being developed which crucially features a plasma volume eight times larger than the ISIS source.

This new source should deliver a substantially higher beam current at the same 50Hz repetition rate, whilst at the same time providing a longer lifetime due to the use of optimised electrode cooling and pre-operational heating, designed to reduce reliance on the use of destructive DC discharge to achieve operational temperatures.

This paper describes the mechanical design changes required to accommodate the 8 fold increase in plasma volume whilst maintaining similar overall external dimensions to the ISIS source. Both the optimized cooling systems and the cathode pre-heating design are shown, including the linked fluid dynamic and steady-state thermal analyses.