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A Novel Next-Generation Cryogenic Stopping Cell for the Low-Energy Branch of the Super-FRS

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The next-generation cryogenic stopping cell (CSC) for the Low-Energy Branch (LEB) of the Super-FRS is based on our experience of advanced stopping cell techniques. The stopping cell is operated at cryogenic temperatures to ensure a high purity of the stopping gas and high density operation enabled using an RF carpet with a small electrode structure size. These techniques have been implemented in the first version of the cryogenic stopping cell for the LEB, which has recently been commissioned in FRS experiments with a primary beam of 238U ions at 1000MeV/u [1].

The next generation CSC consists of two main vacuum chambers, an outer chamber that provides the insulation vacuum for the inner chamber, which is operated at cryogenic temperatures (~ 70 K). The system will incorporated several novel concepts (i) the inner chamber is divided into a high-density stopping region and a low-density extraction region, (ii) ion extraction is done in vertical direction with respect to the incident fragment beam, (iii) multiple parallel extractions nozzles are used between the high and low pressure region and (iv) a dual-layer rectangular RF carpet (structure size: > 6 electrodes / mm) with electrode lines that overlap at right angles is used.

Compared to conventional stopping cells, these new design features lead to numerous advantages: (i) extremely short extraction times (~5ms), (ii) higher rate capability, (iii) minimized power dissipation, which is crucial for cryo-operation, (iv) increased areal density without compromising extraction times, efficiencies or rate capability, (v) precise measurement of the range of the ions and (vii) improved cleanliness of the CSC.

The stopping volume has a width of 25 cm, a height of 10 cm and a length of 2 m corresponding to an areal density of 40 mg/cm^2, an increase by a factor of 8 from the areal density of the present CSC. In combination with the momentum compression provided by the energy buncher of the Super-FRS, stopping efficiencies close to unity are expected for all but very light nuclei. The extraction time of the ions will be about 5 ms, shorted by a factor of 5 compared to the present CSC.
The novel CSC will thus significantly improve the performance of present stopping cells and give access to very exotic and short-lived nuclei available at the Super-FRS.

[1] S. Purushothaman et al, (2013) EPL 104 42001

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