Status of the Cryogenic Storage Ring CSR

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The cryogenic electrostatic ion storage ring (CSR) \cite{1} is approaching completion at the Max Planck Institute for Nuclear Physics in Heidelberg. Relatively low ion energies of 20 to 300 keV per charge state demand extremely high vacuum ($p < 10^{-13}$ mbar RTE, i.e., equivalent gas density at room temperature) to allow research on atomic, molecular and cluster ions. This also profits from the ultra-low black-body radiation level. Using a helium refrigerator system, the walls of the vacuum system seen by the particles will be cooled down to about 10 K, sufficient to prepare clusters and molecules in or near their rovibrational ground states. At dedicated positions, 2 K will be achieved for efficient pumping by cryocondensation of hydrogen. The cryogenic principles and vacuum concepts were tested at the cryogenic test facility (CTF) constructed for this purpose. A vacuum pressure of $8 \times 10^{-14}$ mbar (equivalent gas density at room temperature) was verified allowing us to proceed within the proposed design principles for the CSR.

Consisting of three experimental straight sections and one straight section for beam diagnostics, the CSR has a quadratic shape with a circumference of ~35 m. The beam tube is housed in a large toroidal cryostat composed of rectangular boxes (cross section 1.1 m \times 1.1 m) with a stainless steel frame and aluminum cover plates. Two radiation shields at 80 and 40 K isolate the inner vacuum chamber from thermal radiation. These inner vacuum chambers are made from stainless steel wrapped in copper sheets for improved thermal conductance. They are connected via pure-copper strips to heat sinks at special pumping units, which offer large surfaces at 2 K for cryocondensation.

The assembly of the first quadrant of the CSR has been completed. The section has been cooled down for test purposes, using laser tracking to measure the displacement and tilt of the electrostatic elements in the cryogenic chambers due to thermal shrinking. Deviations of <0.1 mm, well within the requirements, were confirmed. The temperatures of the chambers were measured to <10 K and at the pumping units (5 per quadrant) 2 K temperatures were achieved. Cryogenic cool-down times were 2 weeks, with the electrostatic elements (thermally anchored via the high voltage cabling) lagging 2 days behind in thermalizing.

A large part of the structures around the ring are installed; beam diagnostic units for electric pickup signals and spatial profiles, detectors for neutral and charged fragments from interactions with the stored ions, the injection beam line, and an electron cooling device are under construction. A large electrostatic platform (300 kV) has produced first ion beams and will offer a versatile ion source area for supplying CSR ion beams.

The talk gives an overview about motivation, technical concepts and the current realization status of the CSR.

References