Developments for the CR Stochastic Cooling System

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The large-acceptance Collector Ring (CR) is designed to provide fast stochastic cooling (SC) of antiproton and rare isotope beams. A detailed specification document [1] describing the complete CR SC system in the frequency bandwidth 1-2 GHz has been released. Intensive in-house engineering activities, preparation of the technical infrastructure taking into consideration electrical and mechanical safety issues as well as critical procurements of system components have taken place during 2013.

Electrodes and pick-up tanks, Simulations of the system performance

The layout and testing challenges of the prototype pick-up tank are explained in [1]. The new water-cooled linear motor drive units have been tested at room temperature with different acceleration profiles set by a control software. The linear motor drives fulfill the following specifications: (i) their maximum range of plunging is 70 mm following the shrinking beam size during stochastic cooling and (ii) at the end of the cycle, they move back out to their maximum aperture within 200 ms, before a new beam is injected. Their synchronous operation remains to be tested after re-assembly in the tank.

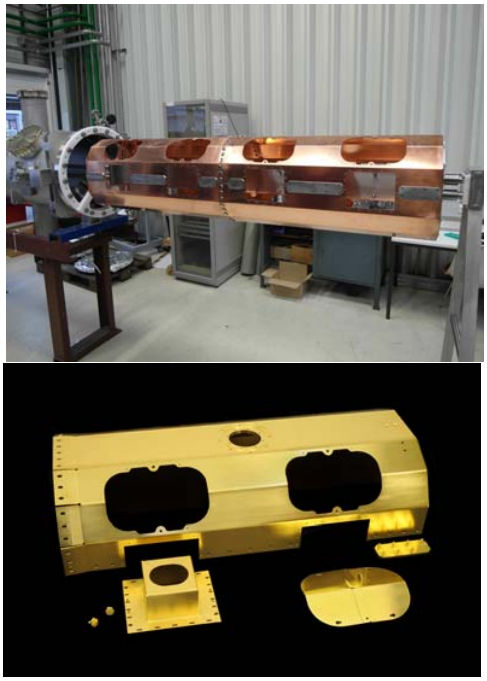

Figure 1: Up: Copper cryoshield before mounting in the prototype tank. Down: Cryoshield parts after gold plating.

The intermediate cryoshield, which will be held at 80 K inside the pick-up tank, was successfully inserted into the prototype tank at room temperature. It consists of 4 half-shells, each 1 m long, and bears holes for the motor drives and for assembling, it is made of oxygen-free copper (Fig. 1, up). Afterwards, its pieces were polished and galvanically gold plated (Fig. 1, down), so as to reach very low thermal emissivity. The preparation of the cryoshield was a complex interdisciplinary task completed at GSI.

Simulations with the HFSS code have converged to possible designs of the Faltin-type electrodes of the Palmer pick-up [2]. The Palmer cooling performance in the CR has been calculated using a Fokker-Planck approach, modified for this purpose, and implementing the properties of the suggested electrodes. With the confidence thus gained, engineering work on electrode prototypes could start.

In parallel, a numerical model for simulating the Palmer stochastic cooling of ions in the time domain has been written, cross-checked against analytical formulae, and subsequently applied to the CR case as well as to experimental data from ESR operation.

RF signal processing and operation codes

The RF block diagram of the complete SC system and its integration into the building has been refined [3] so as to save electrical length, since the flight time of the quasi-relativistic particles from pickup to kicker is very short.

After releasing the technical specification of the very demanding 1-2 GHz power amplifiers, the procurement procedure was launched. It has led to a first round of intensive technical negotiations with potential providers, aiming at awarding the contract beginning of 2014.

The design of the notch filters was optimized and their measured RF properties lie within the specifications. The mechanical assembly, including the thermally stabilized delay line, has been finalized.

Conformal to the defined standards of the FAIR control system, a new operation program covering all cooling branches of the ESR SC system has been developed and implemented to the existing RF hardware. This is a major step towards the preparation of such operation codes for the CR system.

References

[1] Doc F-DS-BC-01-SC-CR-v1.0.pdf, GSI EDMS Doc. 1316650/1; CR Technical Design Report 2014.

[2] D. Barker et al., JACoW Proc. COOL'13, WEPPO21.

[3] C. Peschke et al., JACoW Proc. COOL'13, WEPPO20.

 doi:10.15120/GR-2014-1-FG-CR-02