Cryogenics for SIS100 Accelerator*

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Introduction

The cryogenic system for the FAIR (Facility for Antiproton and Ion Research) superconducting (SC) SIS100 synchrotron (see Figure 1) can be divided into six sections. Each of these sections will be fed from a separate Feed Box (FB) which will supply liquid helium (LHe) for magnet, vacuum chamber and bus-bar cooling as well as gaseous helium (GHe) for thermal shield cooling. Each sixth of the ring consists of one cold arc and a straight warm section with normal conducting accelerating cavities. Yet the warm section still needs to include three SC quadrupole doublets. The design progress of the cryogenic system for the SIS100 is described in the following sections.

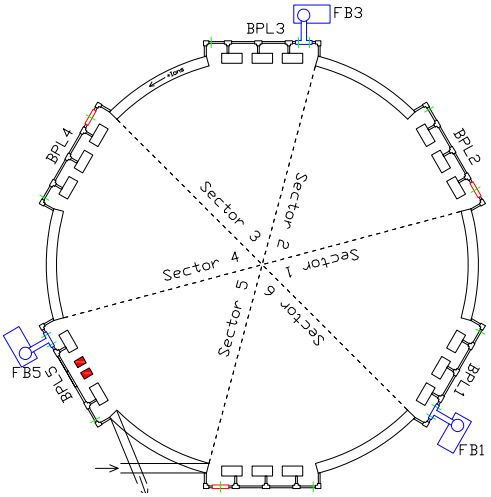

Figure 1: Schematic representation of SIS100 synchrotron showing six BPL sections.

Cryogenic System

By-pass Lines (BPLs) bypass each of the six straight warm sections of SIS100 to supply LHe and cold electrical connections to the SC quadrupole doublets within these sections. Each of the six by-pass sections is alternately equipped either with the FB or the End Box (EB) which intercepts the helium flow. The purpose of such an infrastructure is to be able to separate the ring into six sections which can be independently cooled down, warmed up and serviced. Detailed technical specification [1] concerning the BPL System was prepared and approved at GSI in 2013. Based on this, the in-kind contract was signed between FAIR and Wroclaw University of Technology (WUT). In conjunction with the cryogenic group CSCY, the WUT is currently preparing a complete technical solution of the proposed BPL System. Internal holding structure for both helium headers and bus-bars is being designed as well as new clamping solution to fix the bus-bar pairs. The most complicated components namely the connection boxes that interface BPL to quadrupole units and on both sides to the cold arcs are also being engineered. The WUT will manufacture all the components of the BPL sections according to specifications until the end of 2016.

During 2014 all technical specifications of all remaining cryogenic components for SIS100 namely the FBs, Current Lead Boxes (CLBs), Feed-in Lines (FILs) and Feed-in Boxes (FIBs) together with all the interfaces will be specified. These components will also be produced within the in-kind collaboration with WUT. First-of-series components delivered to GSI will be tested within the Serial Test Facility (STF) currently under construction. The test of the SIS100 "Mini String" (MS) will provide the opportunity to assemble and test a small scale model of SIS100 cryogenic infrastructure. It will be composed of two SC magnets representing the cold arc section joined with the small part of the BPL section. This MS will be fed from the FB joined together with the CLB to supply LHe and two pairs of cooled SC bus-bars for both magnets. The FB in question will be supplied using STF cold box manufactured by Linde Cryotechnik. The control system for the MS has to be also developed at GSI based on UNICOS platform.

Serial Test Facility for SC Magnets

In order to test the fast-ramped SC magnets for FAIR, a cryogenic test facility is designed and currently under construction at GSI. The overall capacity of the cryo plant is 1.5 kW @ 4.4 K equivalent and can be distributed to four test benches individually. In total 108 dipoles for the SIS100 will be tested at cold. The capacity of the cryogenic system is designed in a way, that one magnet can be cooled down and another magnet can be kept at cold for the measurements in the same time. The other two test benches serve for warming up and for magnet exchange, respectively. Beyond the dipoles, the high flexibility of the set-up allows also the testing of other FAIR magnets, like the SIS100 quadrupole modules or the operation of a string configuration.

References

[1] https://edms.cern.ch/document/1261140/8

* FAIR@GSI PSP code: 2.8.12 and 2.14.8.1.6