Status of the SuperFRS Cryogenics*

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The Cooling of the SuperFRS

In March and April, 2013, two technical review meetings with R. Pengo, cryogenic expert from INFN, Italy and P. Lebrun, cryogenic expert from CERN have been organized by the cryogenic group CSCY at GSI on the issues mainly concerning the local cryogenics for Super-FRS. The challenge of cooldown the huge mass up to 1400 tons cold iron (cooldown enthalpy: about 112 GJ from 300 K to 4.5 K) has been addressed as one of the most important features of the Super-FRS local cryogenics. In order to reach a reasonable cooldown time of 3 to 4 weeks, it turned out during the cooldown calculation that a cooling power for Super-FRS cooldown will be of similar capacity as for the large ATLAS detector at CERN, the largest particle detector ever been built in the world (with the cooldown enthalpy about 121 GJ from 300 K to 4.5 K for its 680 tons aluminium alloy cold mass) [1]. Cryogenic engineering tells that the precooling with LN2 is necessary for especially large cold mass since approximately $\approx$ 80 % of the cool down load is from 300K to 80K. The capacity of a LN2 precooler for Super-FRS cooldown is specified at around 76 kW, which is about 25 % more than the maximum capacity for ATLAS cooldown at CERN. The comparison has been done in terms of the cooldown time predicted for the Super-FRS and needed for the ATLAS detector to reach 4.5 K operation states.

CERN Magnet Testing

In the five meetings in series since May, 2013 at CERN and at GSI with regards to the Super-FRS magnet testing, the cryogenic group CSCY has provided substantial supports in the planning of the cryogenic facility for the testing at CERN in terms of magnet cooldown / warmup limitations, LN2 precooler cooling power estimation, operation conditions, interface definition, and magnet cryostat protection against over-pressure (under different worst-case scenarios, i.e., quench and insulation vacuum loss to air), and corresponding safety device sizing and set pressure choice according to European Standards as well as the testing programme about cryogenic measurement. The operation modes have been integrated into the flow scheme design of the feedboxes for different magnet groups and discussed with the experts from RIKEN in the fifth workshop on next generation Fragment Separator in Dec. 2013 in Japan. The operation experiences of the cryogenic and magnet system in the Big-RIPS at RIKEN would help us to determine certain important operation parameters both in magnet testing and in the machine commissioning phases, such as maximum allowed cooldown /warmup rates between 300 K and 100 K temperature range. The operation experience of the SAMURAI superconducting dipole at RIKEN and the design experience of the Cyclotron Gas Stopper under construction at MSU would help us to make reasonable decision for the local cryogenics of the CBM dipole to choose proper cooling technology, by a number of small cryo-coolers or over cryogenic distribution from large plant.

Local Cryogenics and Cryo Plant 1

The combination of the cryogenic distribution for low energy branch and for the high energy cave into one branch should ease the radiation protection design for the High Energy Cave construction. The updated cryogenic distribution branching into four sections over the branch box makes potential staging of the Super-FRS construction possible. The concept for the 3D engineering design of the feedboxes for all groups of magnets have been unified both for the group of 3 long multiplets located in front of the target area and the group of 3 short ones behind, and for the rest multiplet groups as well. The 3D layout of the feedbox for dipole groups has been redone in order to fulfil the constraints at the bending sections of the tunnel. The space constraint due to the limited tunnel height in front of the target area has been eased with the updated installation concept of the safety valves on the multiplet. The DMU engineering check for the feedbox concept will be continuing under the new layouts in the target region and in the tunnel. The 3D layout of the cryogenic distribution transfer line in the Super-FRS tunnel and the buildings would be one of the next major tasks for 2014. In December 2013 a technical study was placed at two suppliers for refrigerators in order to get proposals for the best plant configuration in terms of shield cooliong, 4 K cooling including liquifaction for the current leads and cool down. For this study the heat loads of the magnets and the local cryogenics were carefully rechecked and adapted to the present configuration. The output of the study is expected for April 2014 and will be the basis for the spezification of the cryo plant 1.

References

[1] R. Pengo, et al., IEEE TRANSACTIONS ON APPLIED SUPERCONDUCTIVITY, VOL. 18, NO. 2, JUNE 2008, 379 - 382

* FAIR@GSI PSP code: 2.4.12 and 2.14.8.1.1

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