RAON CRYOMODULE DESIGN FOR QWR, HWR, SSR1 AND SSR2*

Woo Kang Kim#, Heetae Kim, Min Ki Lee, Young Kwon Kim, Gunn-Tae Park and Hyung Jin Kim

Rare Isotope Science Project, Institute for Basic Science, Daejeon 305-811, Republic of Korea

Abstract

The accelerator called RAON which will be built in Korea has four kinds of superconducting cavities such as QWR, HWR, SSR1 and SSR2, operating at 2 K and 4.5 K. The current status of design for the QWR, HWR, SSR1 and SSR2 cryomodules are reported. The issues included in the paper are thermal and structural design results of the components such as support and thermal shield in the cryomodules. The cryomodule hosts the superconducting cavities in high vacuum and thermally insulated environment in order to maintain the operating temperature of superconducting cavities. It also keeps the cavities in a good alignment to the beam line. It has an interface for supplying RF power to cavities between cold and warm components. The whole configuration of the integrated system is also presented. This paper presents the detailed design of the cryomodule.

INTRODUCTION

The superconducting driver linac accelerates the beam up to 200 MeV/u [1]. The driver linac hosts low energy superconducting linac (SCL1) and high energy superconducting linac (SCL2). The SCL1 accelerates beam up to 18 MeV/u. The SCL1 uses the two different cryomodules such as QWR and HWR which have superconducting cavity. The SCL2 has SSR1 and SSR2 cryomodule, which accelerates beam up to 200 MeV/u

In this report, we show the cryomodule design for QWR, HWR, SSR1, and SSR2. The deformation simulation for SSR1 and SSR2 is performed.

CRYOMODULE DESIGN

The parameters and requirement for the superconducting driver linac are shown in Table 1. Table 1 summarizes the design parameter of cryomodules. In order to construct SCL1 and SCL2, we need to make 22 QWR, 13 HWR1, 19 HWR2, 23 SSR1, and 23 SSR2. The drive frequencies for cavity in QWR, HWR, and SSR are 81.25 MHz, 162.5 MHz, and 325 MHz, respectively. Fig. 1 represents the components of SSR2 cryomodule. The SSR2 cryomodule consists of vacuum chamber, magnetic shield, thermal shield, cryogenic pipe lines, and support. The cryogenic pipe lines are located inside of the thermal shield. The thermal shield is installed inside of magnetic shield. The magnetic shield is installed in the vacuum chamber.

Table 1: Design parameters of cryomodules

Note	No	Frequency
QWR	22	81.25 MHz
HWR1	13	162.5 MHz
HWR2	19	162.5 MHz
SSR1	23	325 MHz
SSR2	23	325 MHz

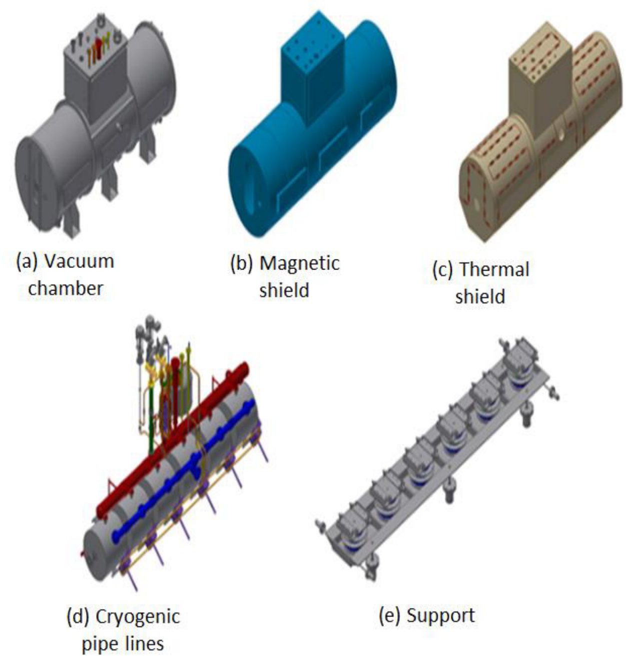

Figure 1: Components of SSR2 cryomodule

Thermal Shields

In order to reduce the radiation heat from room temperature to the 2 K cold mass, the copper thermal shields cooled by liquid helium are adopted between the cold mass assembly and the vacuum chamber. The thickness of the shields is 3 mm. The shields comprise two end plates and two side plates with liquid helium cooling pipe soldered onto them. The shields are designed to assemble and disassemble easily for the purpose of changing the cavities.

*Work supported by the Rare Isotope Science Project of Institute for Basic Science funded by the Ministry of Science, ICT and Future Planning (MSIP) and the National Research Foundation (NRF) of the Republic of Korea under Contract 2013M7A1A1075764.
kwko11045@ibs.re.kr

Vacuum Chamber

The material of the cryomodule for vacuum is made of STS316L stainless steel and composed of top cover plate and bottom plate. The thickness of the top cover plate and the bottom plate for QWR, HWR, and SSR are 15, 25 and 30 mm, respectively. The reinforcement rods are applied to reduce its deformation. A layer of u-metal is attached onto its inner side for magnetic shielding [2].

Cooling Support

The cold mass support assembly is to support the 2 K and 4.5 K cold mass. It is mainly composed of one support frame, rod, and frame. The frame is made of the same material as the liquid helium vessel of cavity in order to reduce thermal stress which is imposed on the cavity [3].

Detail Cryomodule Design of HWR2, SSR1 and SSR2

Fig. 2 shows the drawing and 3D design of HWR2 cryomodule. The HWR2 has four cavities which are operated at the temperature of 2 K and the frequency of 162.5 MHz. Fig. 3 shows the drawing and 3D design of SSR1 cryomodule. The SSR1 has three cavities which are operated at 2 K and the frequency of 325 MHz. Fig. 4 show the drawing and 3D design of SSR2 cryomodule. The SSR2 has six cavities which are operated at the temperature of 2 K and the frequency of 325 MHz.

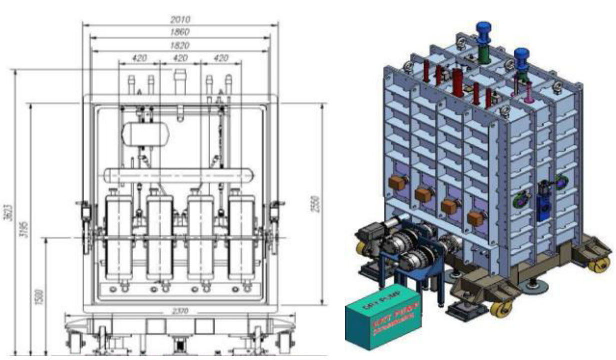

Figure 2: Drawing (the left) and 3D design (the right) of HWR2 cryomodule

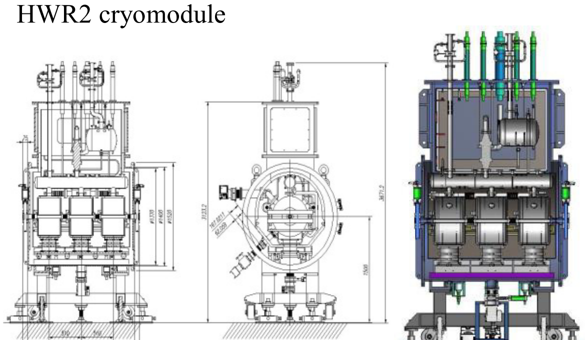

Figure 3: Drawing (the left) and 3D design (the right) of SSR1 cryomodule

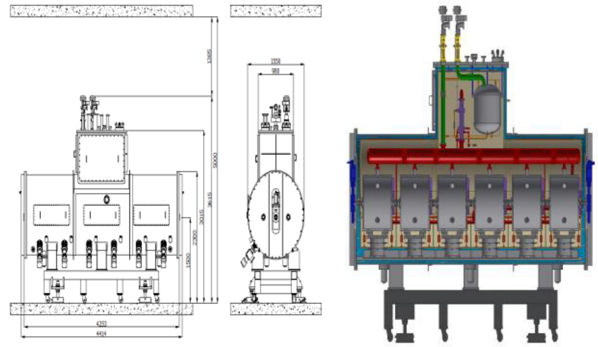

Figure 4: Drawing (the left) and 3D design (the right) of SSR2 cryomodule

Fig. 5 shows the deformation simulation of SSR1 cryomodule. This deformation simulation shows the estimated deformation when the SSR1 cryomodule is fully operated at 2 K environment. The maximum deformation is 0.73, which is acceptable in our design value. The deformation changes the beam alignment. So, this deformation simulation is important to know the beam alignment at low temperature environment. Fig. 6 shows the deformation simulation of SSR2 cryomodule.

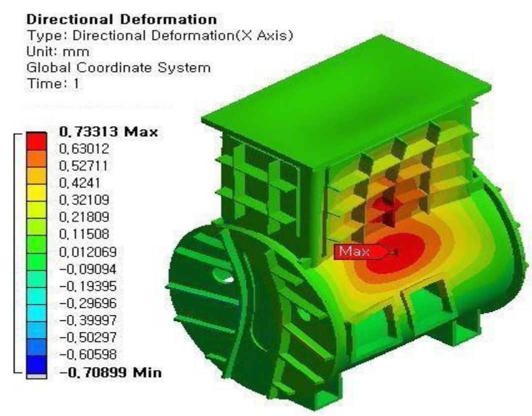

Figure 5: Deformation simulation of SSR1 cryomodule

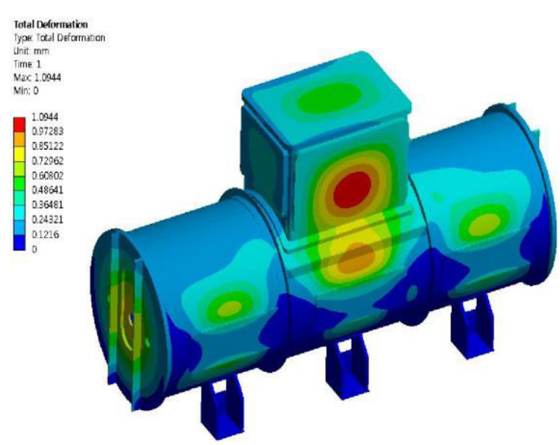

Figure 6: Deformation simulation of SSR2 cryomodule

ISBN 978-3-95450-142-7

CONCLUSION

We have shown the schematic design of crymodule for RAON accelerator system. In order to construct SCL1 and SCL2, we need to make 22 QWR, 13 HWR1, 19 HWR2, 23 SSR1, and 23 SSR2. The detailed design for HWR2, SSR1, and SSR2 cryomodule were shown. The deformation simulation for SSR1 and SSR2 were performed at low temperature environment. The fabrication of the cryomodule has almost been done. The cryomodule will be assembled and cold test will be performed in near future.

ACKNOWLEDGMENT

This work was supported by the Rare Isotope Science Project of Institute for Basic Science funded by the Ministry of Science, ICT and Future Planning (MSIP) and the National Research Foundation (NRF) of the Republic of Korea under Contract 2013M7A1A1075764.

REFERENCES

[1] Sun Kee Kim et al, Baseline Design Summary, http://risp.ibs.re.kr/orginfo/info_blds.do.
[2] R. Ferdinand et al., Proc. of LINAC Conference 2010, p. 16, Tsukuba, Japan (2010).
[3] M.A. Gusarova et al, Proc. of LINAC Conference 2008, p. 266, Victoria, BC, Canada (2008).