ISBN: 978-3-95450-211-0 doi:10.18429/JACoW-SRF2019-TUP011

QWR085 DESIGN FOR BISOL POST ACCELERATOR SCL2*

Meng Chen, Shengwen Quan†, Feng Zhu‡, Kexin Liu, Jiankui Hao, Shu Chen, Anqi Cheng, Yunqi Liu, Dongming Ouyang, Peking University, 100871 Beijing, China,
Zhaohua Peng, China Institute of Atomic Energy (CIAE), 102413 Beijing, China

Abstract

BISOL (Beijing Isotope-Separation-On-Line Neutron-Rich Beam Facility) is a new generation radioactive ion beam(RIB) facility. It consists a CARR nuclear reactor, a high intensity deuteron accelerator and a post accelerator. QWR085 cavity is supposed to be used in SCL2 of post accelerator. This paper mainly talks about the electromagnetic design, mechanical design and vibration damper design of QWR085.

INTRODUCTION

BISOL[1] post accelerator is a secondary beam accelerator, to accelerate radioactive beams from CARR nuclear reactor or high intensity deuteron accelerator facility. It will contain LEBT, RFQ, four superconducting accelerating sections, a 180° bending section, a charge stripping section and some matching sections, to boost RIBs from 3 keV/u to 150 MeV/u. For the SCL2 section, 96 quarter wave resonators with frequency of 81.25 MHz and β=0.085 will be used to accelerate ions from 1.8 MeV/u to 18 MeV/u.

RF DESIGN

Tapered shape inner conductor and cylinder shape outer conductor are adopted for the QWR085 design to enhance its RF performance. Cavity optimization is done with CST Microwave Studio [2] to minimize E_{pk}/E_{acc}, B_{pk}/E_{acc} and increase G and R_{sh}/Q. The final parameters have been presented in Table 1, and the RF field distributions have been shown in Fig. 1.

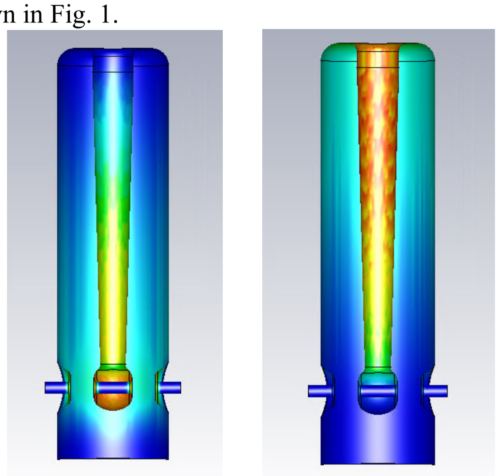

Figure 1: Electric field (left) and magnetic field (right) of BISOL QWR085.

Table 1: RF Parameters of BISOL QWR085

Parameter	Value	Unit
Frequency	81.25	MHz
β_{opt}	0.085	
E_{pk}/E_{acc}	5.6	
B_{pk}/E_{acc}	9.5	mT/(MV/m)^2
G	22	Ω
R_{sh}/Q	614	Ω

MECHANICAL DESIGN

To ease the difficulty of post processing like HPR and BCP, a demountable bottom flange and tuning plate design of BISOL QWR085 is adopted. The mechanical design used FRIB QWR085 as reference [3]. The tuning plate is made of niobium with a thickness of 1.2 mm, it is sandwiched by indium seals between the cavity bottom flanges, as is shown in Fig. 2. The bottom flanges are made of titanium to enhance the mechanical performance of bottom side of the cavity. Two liquid helium channel are also added to the bottom flange to ensure effective cooling of tuning plate.

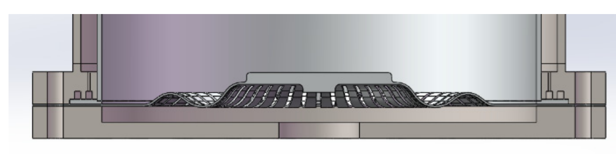

Figure 2: Bottom flange and tuning plate design scheme.

The multi-physics analysis is done with COMSOL Multiphyics [4]. Results show that it has a tuning sensitivity of 5.7 kHz/mm. To control the cavity frequency within ±20 kHz, the tuning plate need a ±3.5 mm displacement range, the maximum stress is about 155 MPa at 3.5 mm displacement.

RF heating simulation was also done to estimate temperature rise of tuning plate at a relative high accelerating gradient. Results show that the highest temperature of tuning plate may reach to 5.65 K at accelerating gradient of 8.5 MV/m, as shown in Fig. 3.

Simulation of frequency change during cavity cooling shows that the frequency will rise about 118 kHz at 4.2 K, as shown in Fig. 4.

Some other mechanical simulation results are listed in Table 2.

*Work supported by China National Nuclear Corporation (FA18000201)
† qsw@pku.edu.cn
‡ zhufeng7726@pku.edu.cn

ISBN: 978-3-95450-211-0 doi:10.18429/JACoW-SRF2019-TUP011

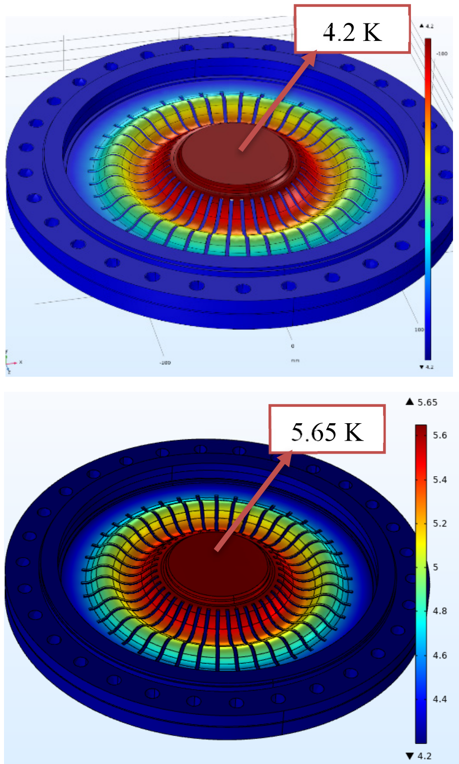

Figure 3: Temperature distribution of tuning plate at 0.085 MV/m(top) and 8.5 MV/m(bottom).

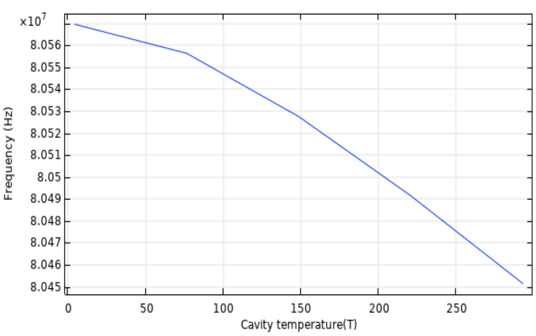

Figure 4: Frequency change during cavity cooling down.

Table 2: Mechanical Parameters of Naked QWR085

Parameter	Value	Unit
Frequency	81.25	MHz
EP/BCP	70	Hz/μm
Cool down	410	Hz/K
df/dp	-13.1	Hz/mbar
LFD	-2.257	Hz/(MV/m)^2

VIBRATION DAMPER

Microphonics analysis of inner conductor shows that the vibration frequency of inner conductor is about 67 Hz. To depress microphonics excited by vibrations from environment and vacuum pumps [5], a mechanical damper is added inside the inner conduct. Design of the mechanical damper is presented in Fig. 5. Three figures are used to contact inner conductor surface and stainless steel cone, so that the vibrations of inner conductor can be transferred to the cone, becoming damper's sliding on the bottom of cylinder base. The optimization of this damper to depress microphonics is under research.

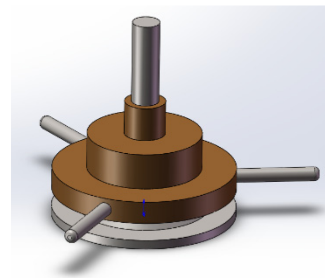

Figure 5: Mechanical damper.

CONCLUSION

This paper mainly presents electromagnetic and mechanical design of BISOL QWR085. We have adopted a demountable bottom flange and tuning plate design for the convenience of post processing. Simulation results show that it has a good RF and mechanical performance. A mechanical damper was added inside the inner conductor to depress microphonics.

REFERENCES

[1] B. Q. Cui *et al.*, "The Beijing ISOL Initial Conceptual Design Report", *Nuclear Instruments and Methods in Physics Research B*, vol. 317, pp. 257-262, Dec. 2013. doi: 10.1016/j.nimb.2013.07.059

[2] CST, http://www.cst.com

[3] K. Saito *et al.*, "Superconducting RF development for FRIB at MSU", in *Proc. 27th Linear Accelerator Conf. (LINAC'14)*, Geneva, Switzerland, Aug.-Sep. 2014, paper THPSC18, pp. 790-794.

[4] COMSOL, http://cn.comsol.com

[5] I.I.Petrushina *et al.*, "Suppression of mechanical oscillations in Quarter Wave 106 MHz Resonator", in *Proc. XXIV Russian Particle Accelerator Conf. (RuPAC2014)*, Obninsk, Russia, Oct. 2014, paper THIOA02, pp. 359-361