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PEFP SRF Prototype Cavity Fabrication and Vertical Test

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1. Introduction

A superconducting radio frequency (SRF) cavity with a geometrical beta of 0.42 has been designed to accelerate a proton beam after 100 MeV for an extension of Proton Engineering Frontier Project (PEFP) [1-2]. The designed cavity shape is an elliptical and the resonant frequency is 700 MHz. In order to confirm the RF and mechanical properties of the cavity and check the fabrication procedure, we are developing two prototypes of niobium cavities. One is two-cell cavity and the other is five-cell cavity. The two-cell cavity is for finalizing the niobium cavity production procedure and testing the cavity RF properties at a low temperature and moderate power level as well as for the surface treatment study. The five-cell cavity is mainly for checking the production quality and testing vertical test system. For a vertical test of the niobium cavities, test equipment such as a cryostat, RF amplifier and LLRF control system is under preparation.

2. Niobium Cavity Design

The major parameters of the PEFP SRF cavity are like followings [3].

- Frequency:	700 MHz
- Operating mode:	TM010 pi mode
- Cavity type:	Elliptical
- Geometrical beta:	0.42
- Number of cells:	5 per cavity
- Accelerating gradient:	8 MV/m
- Epeak/Eacc:	3.71
- Bpeak/Eacc:	7.47 mT/(MV/m)
- R/Q:	102.3 ohm
- Epeak:	29.68 MV/m
- Field flatness:	1.56 %
- Cell to cell coupling:	1.41 %
- Geometrical factor:	121.68 ohm
- Cavity wall thickness:	4.3 mm
- Lorentz force detuning:	0.4 Hz/(MV/m)^2
- Stiffening structure:	Double ring
- Effective length:	0.45 m
- External Q of FPC:	8.0E5 ±20 %
- HOM load:	less than 2 W
- HOM Qext requirement:	less than 3.0E5

For quick prototyping, we designed a two-cell cavity which can be considered to be composed of three parts; the center cells, fundamental power coupler (FPC) beam tube and field probe beam tube. We chose to attach double-stiffening ring around dumbbell in center cells to reduce Lorentz detuning. The diameter of the cavity is 379.02 mm and the total length including the NbTi flange is 528.78 mm. The drawing for the two-cell cavity is shown in Fig. 1.

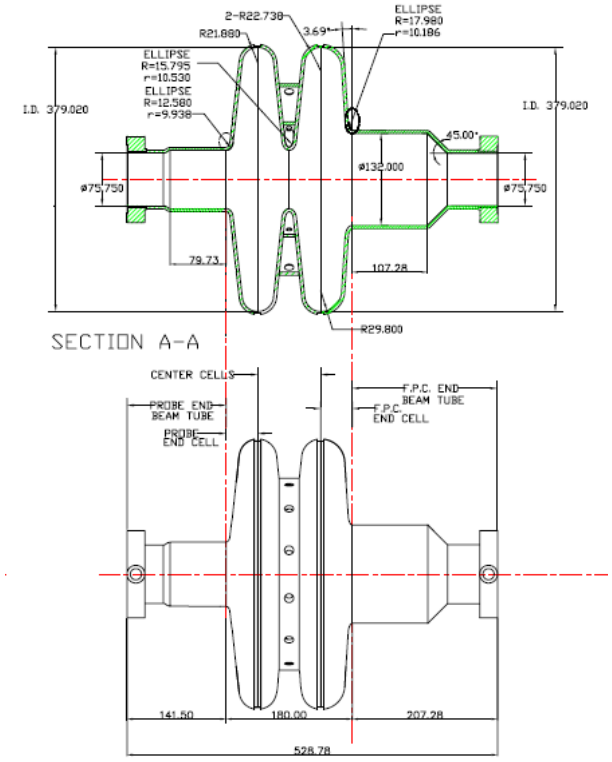

Figure 1. Drawing for the two-cell cavity.

3. Niobium Cavity Fabrication

We made the half cells with deep drawing process. When we stamped the first half-cell, the raw half-cell was broken at iris part. This phenomenon was not observed during copper test and this means that the mechanical properties of the niobium are not the same as those of copper. A possible cause of this breaking is small size of the central hole. We increased the central hole size and obtained the ideal half-cell as shown in Fig. 2. The beam pipe transition parts were also fabricated by using drawing process.

Two half cells are joined to make a dumbbell by the electron beam welding as shown in Fig. 3. The FPC beam tube and the field probe beam tube are also assembled with an end cell by the electron beam welding. The fabricated FPC beam tube and the field

probe beam tube are shown in Fig. 4 Three sub-assemblies are joined by the electron beam welding.

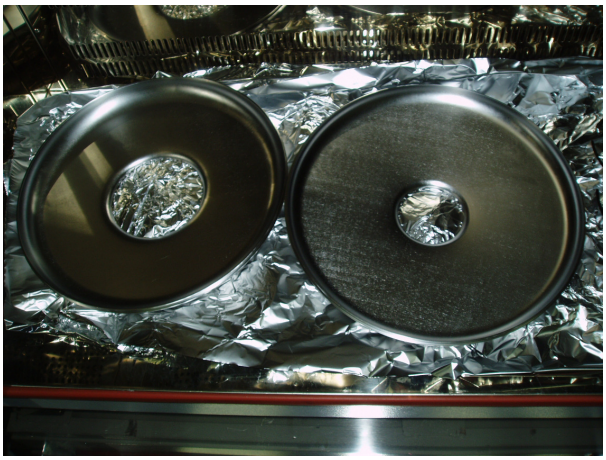

Figure 2. Fabricated half cells through deep drawing method. The picture of the half cells shown were taken after trimming and cleaning.

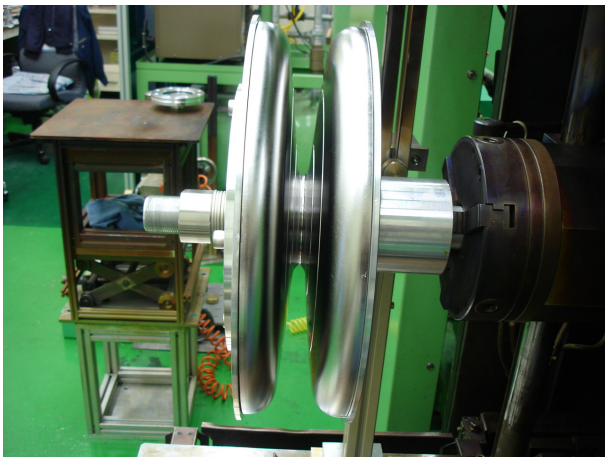

Figure 3. Dumbbell fabrication by joining two half cells by using the electron beam welding.

Figure 4. End cell sub assembly.
Left: FPC beam tube. Right: Field probe beam tube.

4. Vertical Test Preparation

The schematic drawing for the vertical test of the SRF cavity is shown in Fig. 5. The cryostat includes the vacuum jacket with 40 layers of the superinsulation and equipped with LHe level meter and the temperature sensors. The static heat loss is estimated to be about 5.4 W and the dynamic heat loss to be about 3.2 W under the condition of 17 ms RF pulse with 1 Hz repetition rate. With these estimation, the available test time is expected to be about 6 hours.

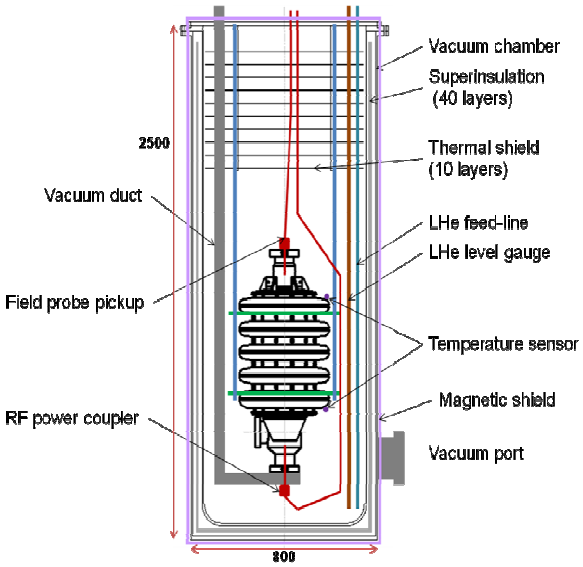

Figure 5. Schematic of the vertical test cryostat.

5. Conclusions

Prototype niobium cavity is under development. Two-cell cavity for quick prototyping has been designed and fabricated by using a deep drawing method and the electron beam welding. Cryostat for the vertical test has been designed and under fabrication. The vertical test will be performed in near future.

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REFERENCES

[1] Sun An, Y. S. Cho and B. H. Choi, “Design of the PEFP Low-beta Cryomodule”, Proc. of APAC07, p564, Indore, 2007.
[2] Sun An, Gao Changyi, Zhang Liping, Tang Yazhe, Li Yingmin, Han-Sung Kim, Yong-Sub Cho and Byung-Ho Choi, “RF Superconductivity Activities of PEFP”, Proc. of SRF 2007, Beijing, 2007.
[3] Sun An, Y. S. Cho and B. H. Choi, “PEFP Low-beta SRF Cavity Design”, Proc. of PAC07, p2164, Albuquerque, 2007.