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CERTIFICATION TESTING OF PROTOTYPE SUPERCONDUCTING QUARTER-WAVE AND HALF-WAVE RESONATORS FOR HIAF*

Z. H. Liang[1,2†], M. Xu[1‡], C. L. Li[1], Q. T. Huang[3], Y. He[1,3], S. X. Zhang[1], L. B. Liu[1], G. C. Liu[1,2], J. Y. Wang[1], H. Guo[1], P. R. Xiong[1], T. C. Jiang[1], S. C. Huang[1], P. A. Xiang[3], T. Tan[1], Y. Tao[1], Z. J. Wang[1,3], F. F. Wang[1], J. C. Yang[1,3]

1.Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou 730000, China

2.University of Chinese Academy of Sciences, Beijing 100049, China

3.Advanced Energy Science and Technology Guangdong Laboratory, Huizhou 516000, China

1 Introduction

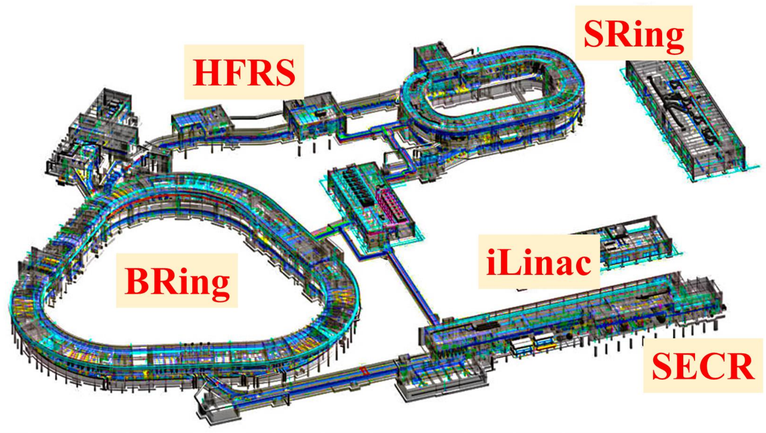

Figure 1. Layout of the HIAF.

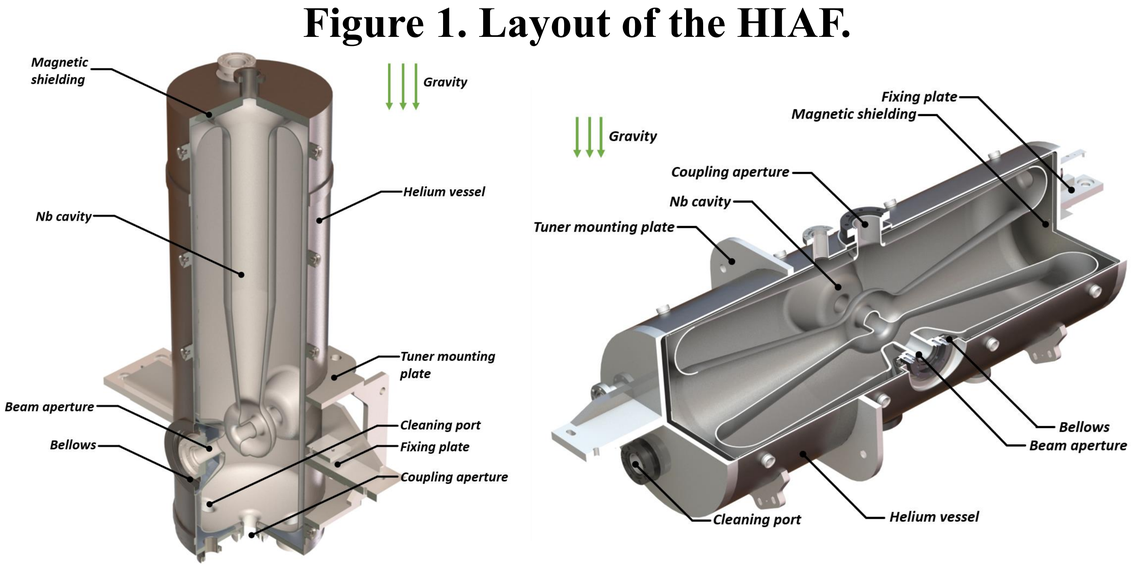

Figure 2. Schematic view of the QWR007 and the HWR015.

- Thickness of Nb = 3 mm / 5 mm
- The HIAF project requires 30 QWR007s and 66 HWR015s for its superconducting linear injector.

Table 1: RF Parameters of QWR007 and HWR015

Parameters	QWR007	HWR015
Frequency (MHz)	81.25	162.5
β_{opt}	0.07	0.15
Beam Aperture (mm)	40.0	40.0
G (ohmn)	25.9	51
R/Q (ohmn)	485.7	292
Leff (βλ mm)	258	276
Ep/Eacc	4.69	4.7
Bp/Eacc (mT/(MV/m))	8.04	6.11
Cavity Diameter (mm)	326	366
Cavity Height (mm)	1126	1014

2 Prototype Fabrication

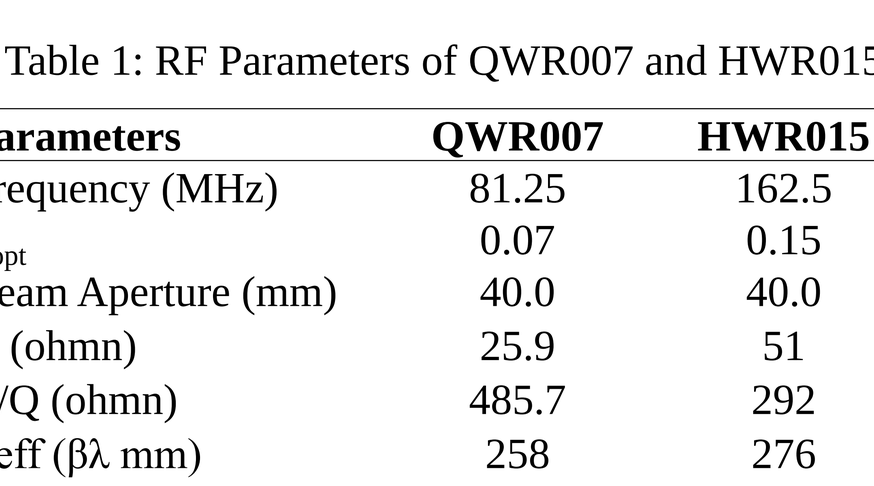

Figure 3. The first batch of QWR007 and HWR015.

The first batch of superconducting QWR007 and HWR015 cavities were fabricated by two qualified vendors (HECHAO Manufacturing Co., Ltd. and Ningxia Orient Tantalum Industrial Co., Ltd.).

3 RF Performance

- The RF performance of the bare cavities from the first batch is shown in Fig. 4. Both QWR007 cavities achieved a maximum Epk exceeding 45 MV/m, significantly surpassing the operational gradient required by the HIAF project (Epk = 28 MV/m). The two tested HWR015 cavities also met the required standards. These results indicate that the RF performance of the first batch of superconducting cavity prototypes for the HIAF project meets the operational requirements.
- The test results, shown in Fig. 4, indicate that while the welding of the helium jacket did result in a slight decrease in Q0, the tested cavities still met the HIAF project requirements under 2 K conditions, with a usable Epk exceeding 60 MV/m.

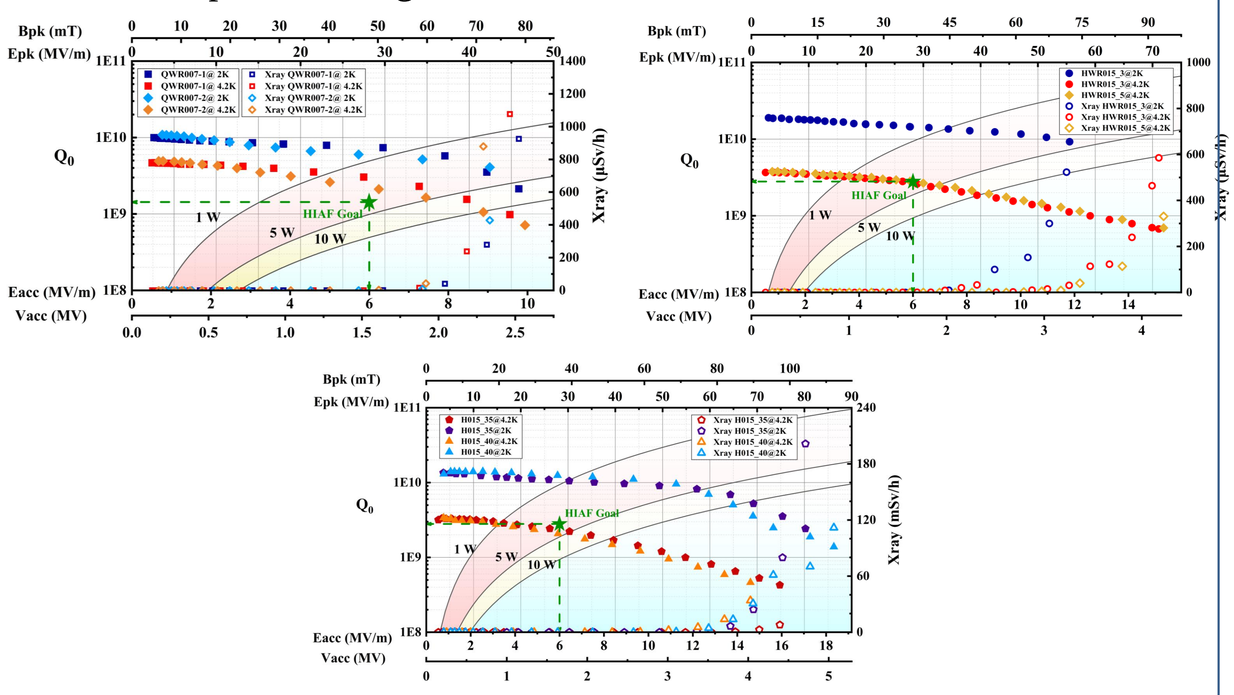

Figure 4: The Q-E curves of the QWR007, HWR015 bare cavities (up), and jacketed HWR015 (down). There are three solid black lines in each figure correspond to 1W, 5W and 10W of RF power dissipated in the cavity.

4 Mechanical Performance

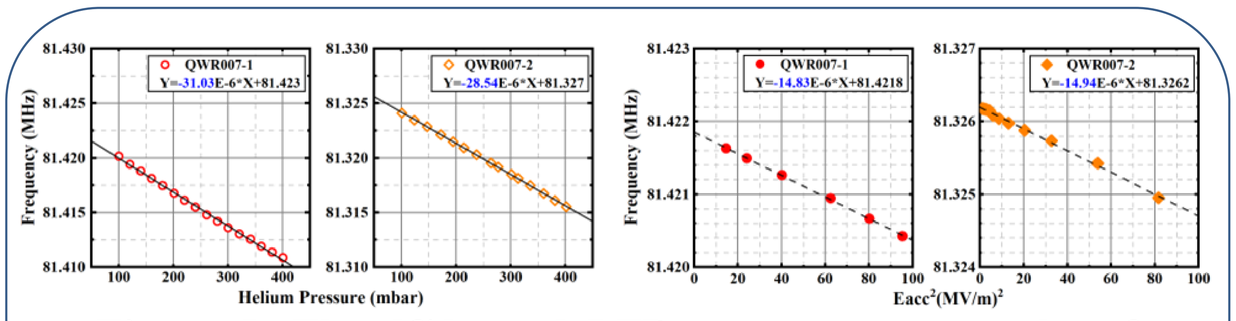

Figure 5: The df/dp and LFD measurement results of the QWR007 cavities.

Table 2: Mechanical performance of the prototype.

Cavity Number	df/dp (Hz/mbar)	LFD (Hz/(MV/m)^2)
QWR007-1	-31.03	-14.83
QWR007-2	-28.54	-14.94
HWR015-3	-6.75	-8.91
HWR015-5	-12.68	-7.54
H015-35	-6.87	-3.92
H015-40	-7.44	-5.37

Table 2 presents the mechanical performance test results for the remaining sample cavities. The HWR015 cavity exhibited minimal differences in mechanical properties before and after the helium jacket welding, demonstrating consistently robust mechanical performance.

The results indicate that due to the relatively slender inner conductor of the QWR007, it is susceptible to helium pressure fluctuations. To reduce the df/dp of the QWR007, we plan to install a damper in the inner conductor.