CRYOMODULE DEVELOPMENT FOR ERL MAIN LINAC SUPERCONDUCTING CAVITY

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Abstract

In order to obtain the technology needed for ERL main linac, a great deal of effort had been put into development of critical components of ERL main linac cryomodule, such as cavity, input coupler, HOM absorber. In this paper, the recent progresses of cryomodule development are shown in this fiscal year.

9-CELL SUPERCONDUCTING CAVITY

At last year, we fabricated #1 9cell superconducting cavity prototype for ERL main linac to investigate the designed cell shape and the eccentric fluted beampipe structure and could reach the 25MV/m at vertical test, which satisfied our requirements of 20MV/m accelerating field [1]. In this year, we fabricated the cavity #2 9cell cavity prototype, which is considered to be installed into a cryomodule, with satisfying Japanese high pressure low. As shown in Figure 1, He jacket end plates and stiffener rings are manufactured. Niobium thickness is increased for both half of end cells. For vacuum sealing, Helicoflex is applied. Figure 2 shows vertical test results for cavity #2. For all measurements, field reached to more than 20 MV/m. We noted that in 2nd vertical test, X-ray burst was occurred and resulted in the Q-degradation especially in the lower field than 15MV/m. Nevertheless after a warming-up, the quality factor was recovered at 3rd vertical test. This cavity also satisfied the requirements for ERL main linac. For cryomodule assembly of cERL in 2012, two more 9-cell cavities were already fabricated.

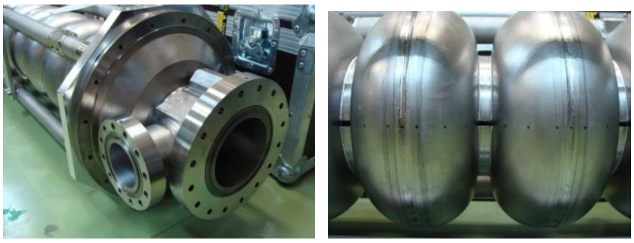

Figure 1: 9-cell cavity #2. (left) titunium end plate for He jacket and flanges and (right) stiffener rings.

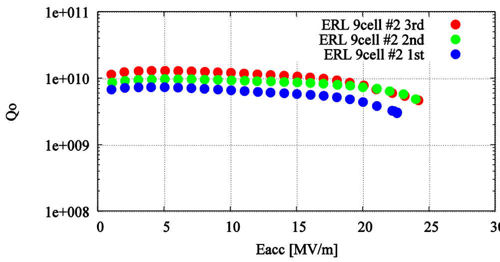

Figure 2: Vertical test results for prototype main linac 9-cell cavity #2.

INPUT COUPLER

A coaxial type power coupler with double ceramics was designed for ERL main linac input coupler [2]. Assuming maximum of 50 Hz detuning and external Q to be 2 x 10^7, maximum of 20 kW RF power is required to keep cavity field stable. A prototype input coupler was fabricated, to check its performance. High power test stand was constructed at ERL Test Facility in KEK. Setup is shown in Figure 3. In order to simulate the condition inside cryomodule, the input coupler was installed into vacuum chamber and the cold window was cooled by liquid nitrogen. RF power was fed by a 30 kW IOT and pass through the coupler, then reflected by an end plate. The coupler was processed with the condition of standing wave. After eight hours pulse processing, RF power reached to 25 kW. Then, RF power had been kept to be 20 kW. Figure 4 shows that RF power had been successfully kept during 16 hours. During this test, the input coupler was enough stable, except that the arc sensor worked three times by noise. Measured temperature rise was adequate. From this high power test, it is realized that the input coupler satisfied the specification of ERL main linac.

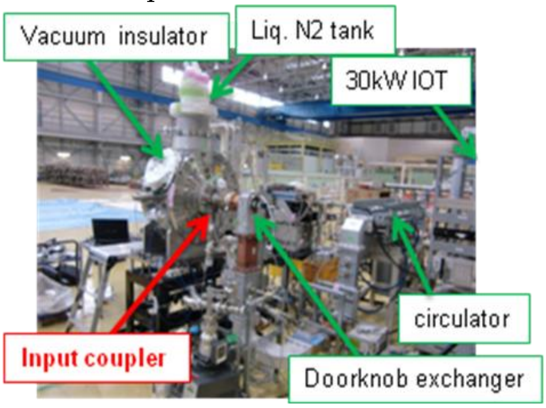

Figure 3 : Setup for high power test for input coupler, under 80K temperature

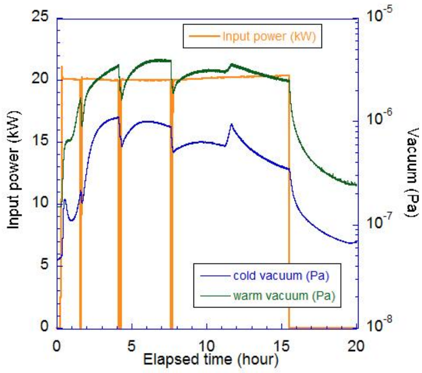

Figure 4 : Results of high power test. RF power had been kept to be 20 kW.

HOM ABSORBER

Beampipe HOM absorber is applied for efficient HOM damping. The HOM absorber will be installed into a cryomodule, and located under 80 K condition. After investigating the RF characteristics at low temperature, one ferrite was selected as the material for HOM absorption [3]. In this year, the prototype HOM absorber model with HIP ferrite were fabricated as shown in Figure 5. HIPped ferrite is attached on the inner surface of copper base. This model has used to HOM absorption measurements and thermal cycle tests. The right of Figure 5 shows setup for HOM measurement. The HOM absorber model with HIP ferrite was mounted on the LBP part of the prototype cavity #2. HOM characteristics were measured with and without the HOM absorber model with HIP ferrite, at room temperature. The results of measurements are shown in Figure 6. The Q values of both monopole and dipole modes were sufficiently damped. Thermal cycle tests of prototype HOM absorber were applied and now under analysis.

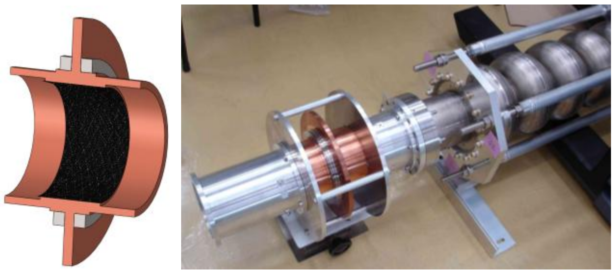

Figure 5 : (left) Schematic view of the HOM absorber model with HIP ferrite. (right) The HOM absorber model mounted on the cavity #2 for HOM measurement.

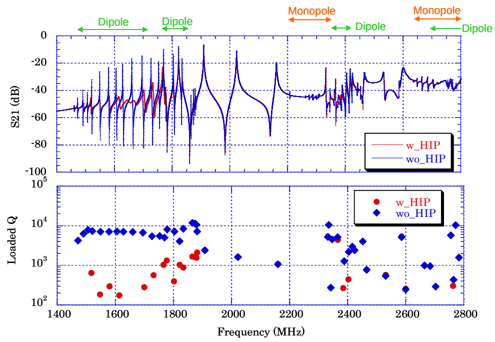

Figure 6 : (top) HOM spectrum and (bottom) loaded Q values for with (red) and without (blue) HOM absorber model with HIP ferrite.

REFERENCES

[1] K. Umemori et al., "Results of vertical tests for KEK-ERL 9-cell superconducting cavity", IPAC'10, Kyoto, Japan, May 2010, p2956
[2] H. Sakai et al., "Power coupler development for ERL main linac in Japan", IPAC'10, Kyoto, Japan, May 2010, p2953
[3] M. Sawamura et al., "Cooling test of ERL HOM absorber", IPAC'10, Kyoto, Japan, May 2010, p2344