RECENT RESULTS OF 1.3 GHZ 9-CELL SUPERCONDUCING CAVITIES IN KEK-STF

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Abstract

MHI#10 and #11 cavities were measured in KEK-STF as the s0 plan for ILC. After these vertical tests, they will be sent to J-Lab and tested at least once there. Recently, two new cavities without HOM coupler were fabricated and measured in STF, which were made by two new vendors (HITACHI and TOSHIBA). As the international collaboration, one cavity from IHEP in Beijing was sent to KEK, optical inspected, high pressure rinsed and vertical tested. In this report, the results of the vertical test for these cavities will be presented in detail.

INTRODUCTION

In the fabrication of MHI#10 and #11 (4th batch) in 2009-2010, the procedure of the electron beam welding (EBW) was changed. Specifically, the centring location at the dumbbell connection was introduced for the first time. This technology is already used in some foreign companies. Due to this change, the condition of EBW had also changed. However, the parameters of EBW were same as before, not changed. There is not any other changing condition for these cavities at the stage of the fabrication, compared to the old ones.

Two new Japanese vendors joined in the fabrication of the 1.3GHz superconducting cavity from 2009. This trial was successful and their first prototype cavities were completed. After the normal process, including the optical inspection, EP, annealing and pre-tuning, they were vertical-tested at STF.

KEK-IHEP collaboration started from 2008 for the superconducting cavity technology. The first prototype, which shape is the Low-Loss type, was completed at IHEP in 2010 and sent to STF for the vertical testing after the final surface treatment.

RESULT OF S0 PLAN

Figure 1 shows the result of MHI#10 and #11 cavity. The vertical tests were done totally three times for each cavity. However, any cavity could not reach ILC specification, which is 0.8×10^{10} at 35MV/m.

The condition of EP was same for every vertical test. However, the rinsing process was different at every surface treatment. For example, LIQUINOX was used before the second vertical test, and scrubbing around the both beam pipes with HOM couplers by a special clean cloth was tried before the third vertical test for the MHI#10 cavity. The EP acid was exchanged to new one between the second and third vertical test of MHI#10. After the third vertical test, many brown stains were observed inside the MHI#10 cavity again [1]. Moreover, the radiation level measured at the top flange of the cryostat was much higher at the third test, as shown in Fig. 2.

Figure 3 shows the T-mapping results for the both cavities. In MHI#10 cavity, the heating location was not changed among these vertical tests, although the local

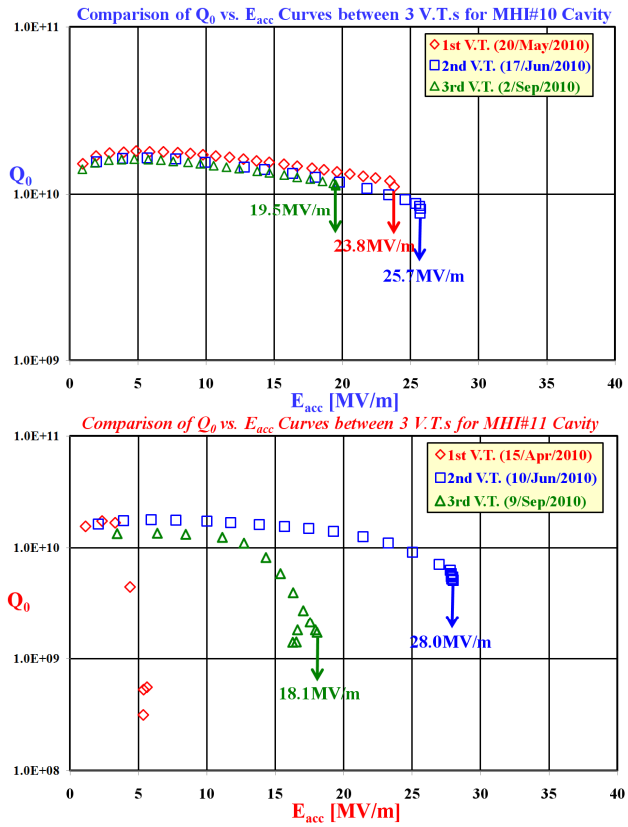

Figure 1: Q_0-E_{acc} curves for MHI#10 (up) and #11 (down) cavities.

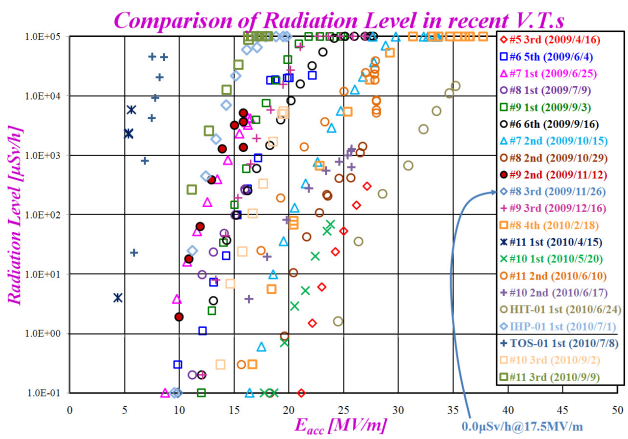

Figure 2: Radiation level measured at the top flange of the cryostat.

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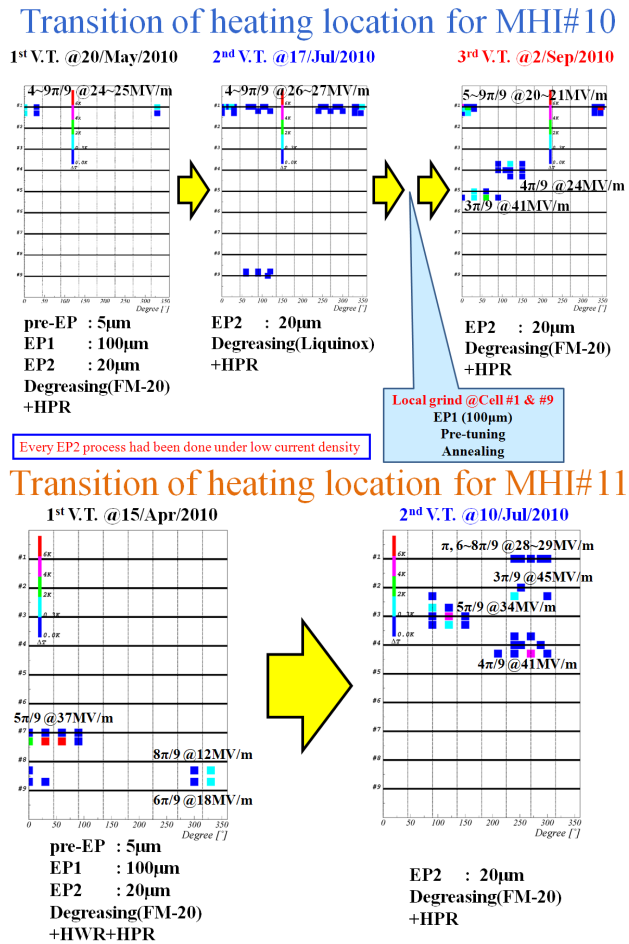

Figure 3: T-mapping results for MHI#10 and #11 cavities.

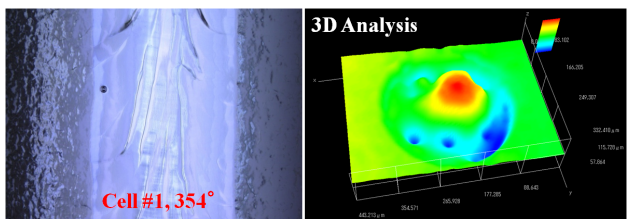

Figure 4: Defect at cell #1 (left) and the profile by 3D analysis (right) for the MHI#10 cavity.

grinding for the heating location at cell #1 was done between the second and third vertical test. After receiving this cavity from a vendor, several defects on the seam of EBW at cell #1 and #9 were observed. Normally, a defect is observed on the heat affected zone away from a seam of EBW for the other MHI cavities. However, for this cavity, these defects were "on" the seam of the EBW, and the profile was complicated like a caldera as shown in Fig. 4. The case of MHI#10 cavity was the first time. Presumably, the condition of EBW was not optimized for the centring location of the equator region. Any EP treatment and the local grinding were not effective.

RESULTS OF NEW VENDORS AND INTERNATIONAL COLLABORATION

HITACHI and TOSHIBA completed the first cavity as a prototype without HOM coupler, which name is HIT#1 and TOS#1. In STF, these cavities were optical-inspected, pre-tuned, surface-processed and vertical-tested. In the stage of the first optical inspection, it was found that the quality of TOS#1 is not acceptable, because it has numerous defects, rough seam of electron beam welding and irregularities on every seam. On the other hand, HIT#1 has a satisfactory quality and a satisfying result was expected. Figure 5 shows the results for the both cavities. HIT#1 reached around 35MV/m with the least radiation level at STF. The cause of the low Q_0 value was due to the RF loss at the both end flanges of stainless steel.

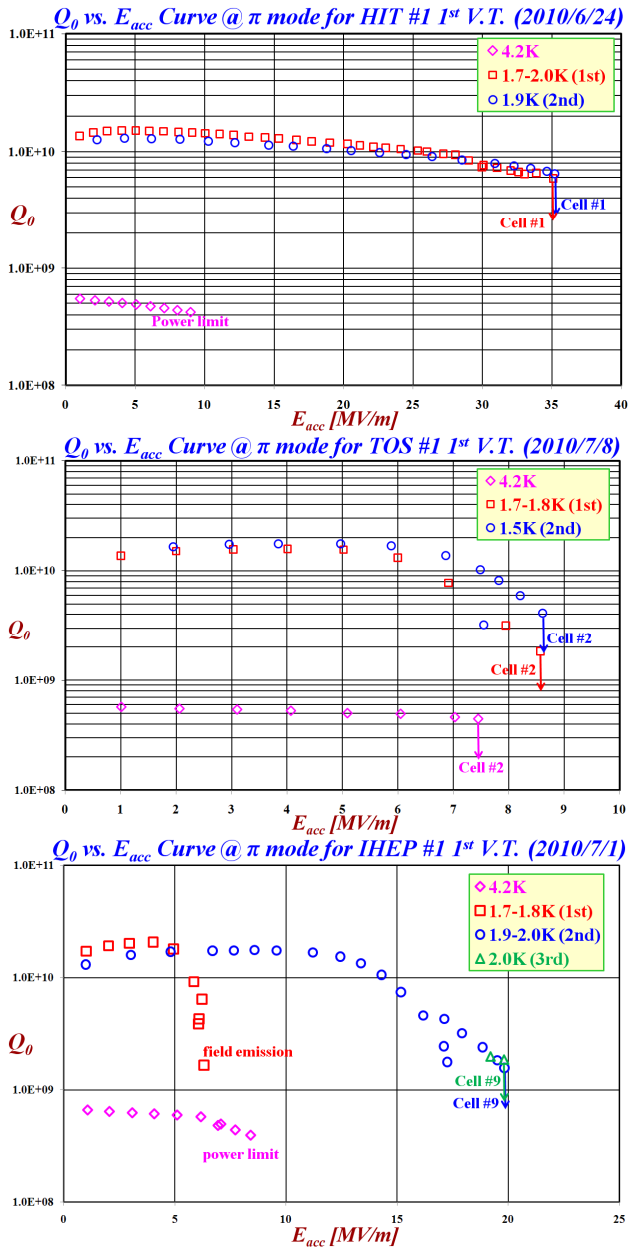

Figure 5: Q_0-E_{acc} curves for HIT#1 (up), TOS#1 (middle) and IHEP#1 (down).

TOS#1 was the almost worst result at STF with much higher radiation level, as shown in Fig. 2.

IHEP#1 had several low quality EBW seams, which were observed by an optical camera at IHEP. This cavity has experienced many barrel polishing, a few chemical polishing, pre-tuning and low-pressure rinsing at IHEP. After these processes, it was sent to STF, and experienced high-pressure rinsing, assembly working in the clean room and vertical testing, including the optical inspection by Kyoto camera after the vertical testing. The result of the vertical test was shown in Fig. 5. Although the field emission was somewhat heavy, the achievable gradient was almost 20MV/m. This result was sufficiently satisfactory.

Figure 6 shows the result of T-mapping for these new cavities. At the vertical test of HIT#1 cavity, the "pre-heating" phenomenon was observed at cell #3, and the problematic seam was observed at the heating location of cell #1. Several bump-type defects were observed at the heating location of cell #1 for TOS#1 cavity. This location was about 30mm away from the equator. The imperfect EBW seam was observed at the heating location at cell #9 for IHEP#1 cavity.

SUMMARY AND FUTURE PLAN

The vertical tests were carried out for MHI#10, MHI#11, HIT#1, TOS#1 and IHEP#1 cavities at STF. Although the both MHI cavities could not reach the ILC specification, HIT#1 cavity brought the sufficiently satisfactory result. On the other hand, it is necessary for TOS#1 cavity to do many things for the EBW technology. The KEK-IHEP collaboration was successful at the first stage of the plan. The second stage will be carried out by using a new cavity (IHEP#2) in 2011. STF is the active facility of the superconducting cavity for ILC or the other projects. Figure 7 shows the summary of the best vertical test result and the history of the achievable gradient for every cavity measured at STF.

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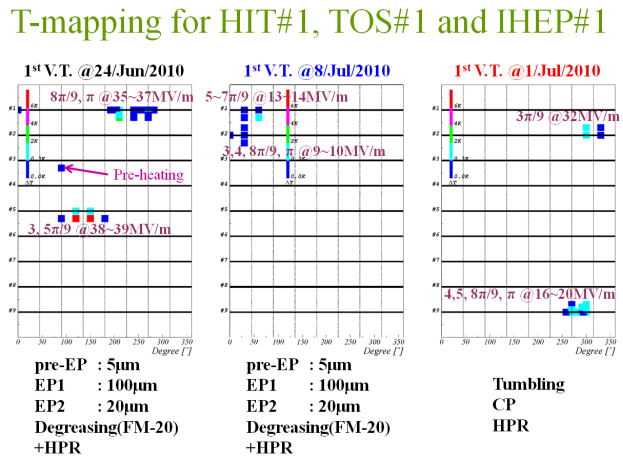

Figure 6: T-mapping result of HIT#1 (left), TOS#1 (middle) and IHEP#1 (right).

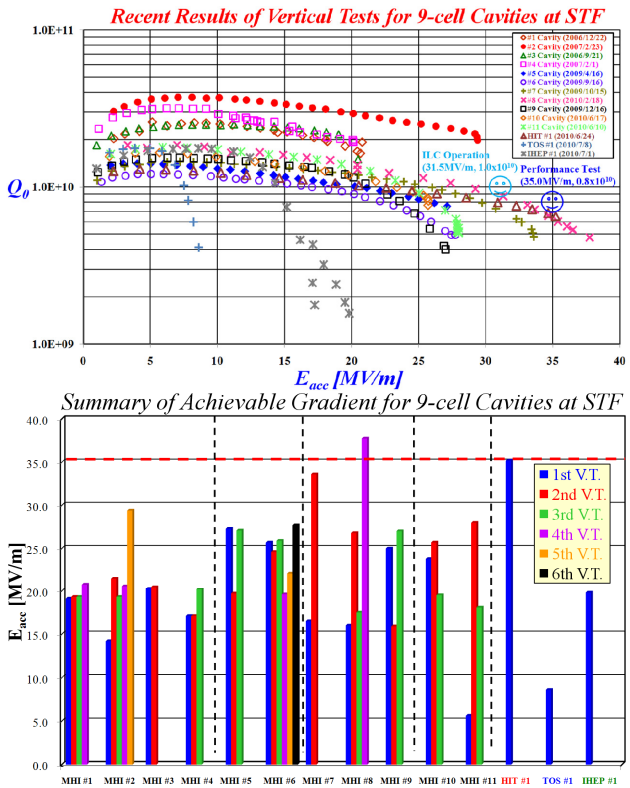

Figure 7: Summary of the best vertical test and the history of achievable gradient for every cavity measured at STF.

REFERENCES

[1] T. Saeki, et al., TTC meeting 2010, FNAL, U.S. "http://indico.fnal.gov/conferenceDisplay.py?confId=3000".