#### MOPCAV006

# High-Q/High-G R&D at KEK using 9-cell **TESLA Shape Niobium Cavities**



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## Introduction(High-Q/High-G R&D at KEK)

- Our study on improvements in the cavity performance of three 1.3 GHz TESLA-shaped niobium superconducting radiofrequency (SRF) 9-cell cavities performed at KEK-STF from the beginning of 2019 to date is presented.
- The cavities are referred as to MT-3, MT-5 and MT-6. Theses ulletcavities are made of fine grain niobium material with RRR > 300 and the heat treatment at 900 °C for 3 h was applied at KEK.
- Baseline measurement show Q0values greater than  $2 > 10^{10}$  and the maximum accelerating gradient > 35 MV/m after applying a standard surface treatment processes developed for ILC. In this study, we applied new surface treatments in order to enhance the cavity performance reported so far.



#### Details of Treatments and Cooling used in this study

Time evolution plots of EP parameters for KEK-STD EP and KEK-cold EP are shown in the following figures.



cold-EP for MT-5



We report on the obtained results.

## Method used in this study

- We evaluated and compared the cavity performance of three SRF cavities by the vertical test at KEK to which the standard recipe developed for ILC or another recipe consisting of cold EP, 2-step baking, and original cooling procedures (KEK-fast cooling and additional cooling) are applied.
- The conditions adopted in this study are summarized in the following table.

	VT	EP	Bake	Cooling
MT3	VT4 (Baseline)	KEK-STD (20 um)	120 °C 48 h	KEK-STD
	VT5	KEK-cold (20 um)	75 °C 2h (cell1) / 75 °C 4 h (others) + 120 °C 48 h	KEK-STD
MT5	VT1 (Baseline)	KEK-STD (20 um)	120 °C 48 h	KEK-STD
	VT2	KEK-cold (20 um)	75 °C 4 h + 120 °C 48 h	KEK-STD
	VT5	KEK-cold (10 um)	75 °C 4 h + 120 °C 48 h	KEK-STD
	VT6	KEK-cold (20 um)	70 °C 4 h + 120 °C 48 h	KEK-STD w/ additional cooling
MT6	VT5 (Baseline)	KEK-STD (30 um)	120 °C 48 h	KEK-Fast w/ additional cooling
	VT6	KEK-cold (10 um)	70 °C 4 h + 120 °C 48 h	KEK-Fast w/ additional cooling





Temperature in 2-step baking as a function of time is shown in the right figure.

- Black color: Vacuum Level
- The others: Temp. at each equuator lacksquare
- There is a trouble in MT3 VT5, which result in changing the time that Cavity Temp kept 75 °C as follows:
  - 1-cell 2 h, the other cells 4 h



Temperature as a function of time for KEK-standard cooling and KEKfast cooling are shown in the following figures.



Table 1: Conditions used in this study for comparison of vertical test results

## **Experimental Status**

- Q-E curve of  $\pi$  mode obtained from the vertical tests at KEK are given in the right above figures.
  - ✓ MT-5 VT6: Both of Eacc, max and Q-value was improved.
- ✓ MT-6 VT6: Q-value was improved



400 600 800 1000 1200 1400 1600 1800 200





1400 1600 1800 2000



- $\checkmark$  Others: no improvement.
- It is noted that, at KEK, Q-value starts deteriorated when the radiation level reach ~ 2mSv/h.
- The analysis results of passband lacksquaremode analyses are summarized in the right bottom table.

#### Summary and Outlook:

- We compared the maximum accelerating gradients and the Q0 values, corresponding to the conditions summarized in Table 1.
- As a result, no improvement could be observed when only 2-step baking was applied, whereas significant improvement in the Q-value could be observed for the combination of 2-step baking with the other cooling procedure.
- Yield rate for improvement in the maximum accelerated gradient was 50% even when combining 2-step bake with the other cooling procedure.