QUENCH FIELD AND LOCATION IN VERTICAL TESTS AT KEK-STF

Y. Yamamoto#, E. Kako, T. Shishido, KEK, Tsukuba, Japan

Abstract

Many vertical tests have been done for the ILC (International Linear Collider) and ERL (Energy Recovery Linac) at KEK-STF since 2008. T-mapping system (fixed type) was equipped every vertical test, and quench location was identified completely. Every quench location at quench field will be presented in this paper.

INTRODUCTION

Many 9-cell cavities have been fabricated, measured and assembled for the use of STF-1 (Phase-1) [1], S1-Global [2], Quantum Beam Project [3] and STF-2 (Phase-2) including R&D program for the cavity performance. T-mapping/X-ray-mapping system [4] is usually equipped every vertical test at STF. Once cavity has a quench, the quench location is identified certainly by T-mapping system. Before and after every vertical test, the cavity inner surface is inspected by the Kyoto camera [5], and

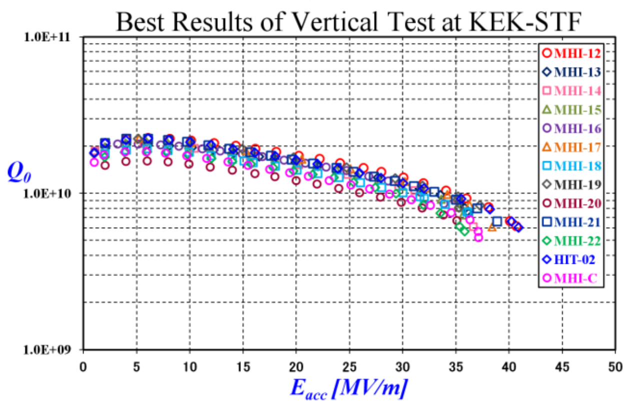

Figure 1: Best Q_0 vs. E_{acc} curves of the vertical tests for MHI-12–MHI-22, MHI-C and HIT-02 cavities.

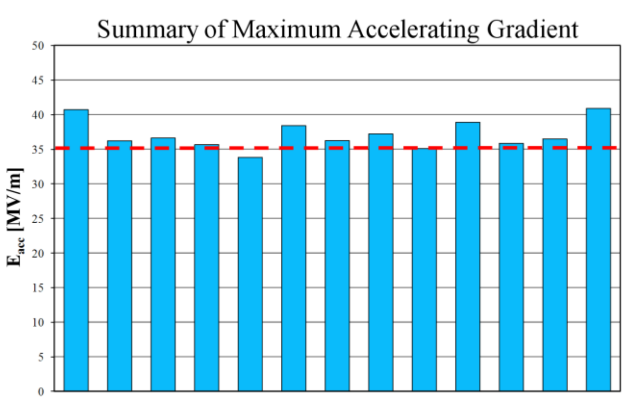

Figure 2: Maximum accelerating gradient in vertical tests of MHI-12–MHI-22, MHI-C and HIT-02 cavities. Instead of MHI-16, every other cavity achieved above 35 MV/m.

#yasuchika.yamamoto@kek.jp

problematic defect is typically observed. After the removal of the defect by local grinding, the cavity performance is drastically improved in the next vertical test. This is a typical situation at KEK-STF.

Recently, vertical test for MHI-23–MHI-26 starts for CM-2a (half size cryomodule) in STF-2. It will complete by the end of this year. They will be assembled into CM-2a before next summer. From autumn, STF-2 will start.

VERTICAL TEST RESULT

Figure 1 shows the recent result of the vertical tests for 9-cell cavities (MHI-12–MHI-22, MHI-C and HIT-02). Except for MHI-16, the other cavities attain above 35 MV/m as the ILC specification [6]. Figure 1 shows the Q_0 vs. E_{acc} curves for the best result of the vertical test. Figure 2 shows the maximum accelerating gradient for these cavities. Table 1 shows the summary of the best result in the vertical test. More detail information for these results is described in [7].

MHI-C is a prototype cavity fabricated for a study of mass production using a new technology [8]. This cavity attained above 35 MV/m in the first vertical test. HIT-02, which was fabricated by a new vendor, also attained above 35 MV/m in the first vertical test, however, the field emission was heavy. After the local grinding for the iris region, this cavity attained 41 MV/m without field emission in the second vertical test. Vertical test for these cavities will be continued as R&D for high performance in future.

Table 1: Summary of the Best Result in V.T.s at STF

Cavity	Max. E_{acc} [MV/m]	Q_0 at Max. E_{acc}	Q_0 at 35MV/m	No. of V.T.
MHI-12	40.7	6.2×10^9	9.3×10^9	2
MHI-13	36.2	7.5×10^9	8.6×10^9	2
MHI-14	36.6	6.1×10^9	8.4×10^9	3
MHI-15	35.7	7.3×10^9	8.1×10^9	4
MHI-16	33.8	8.6×10^9	-	2
MHI-17	38.4	6.1×10^9	8.5×10^9	1
MHI-18	36.2	7.5×10^9	8.0×10^9	4
MHI-19	37.2	8.4×10^9	9.6×10^9	2
MHI-20	35.1	6.7×10^9	6.7×10^9	3
MHI-21	38.9	6.6×10^9	9.1×10^9	1
MHI-22	35.8	5.7×10^9	6.2×10^9	2
MHI-C	37.1	5.2×10^9	7.5×10^9	4
HIT-02	40.9	6.1×10^9	9.3×10^9	2

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QUENCH FIELD AND LOCATION

T-mapping system combined with X-ray-mapping has been used every vertical test at STF since 2008. Once cavity has a quench, this system identifies the quench location certainly. At present, totally 51 quench events in π mode were observed for 28 9-cell cavities. Figure 3 shows the quenching cell for those data. Every cell has an equal probability for quench in π mode. However, there is a bias in cells #1, #2 and #9. This means RF performance is different between centre cell and end cell (end cell has a beampipe). It is interesting that DESY's result has a same trend as KEK-STF [9].

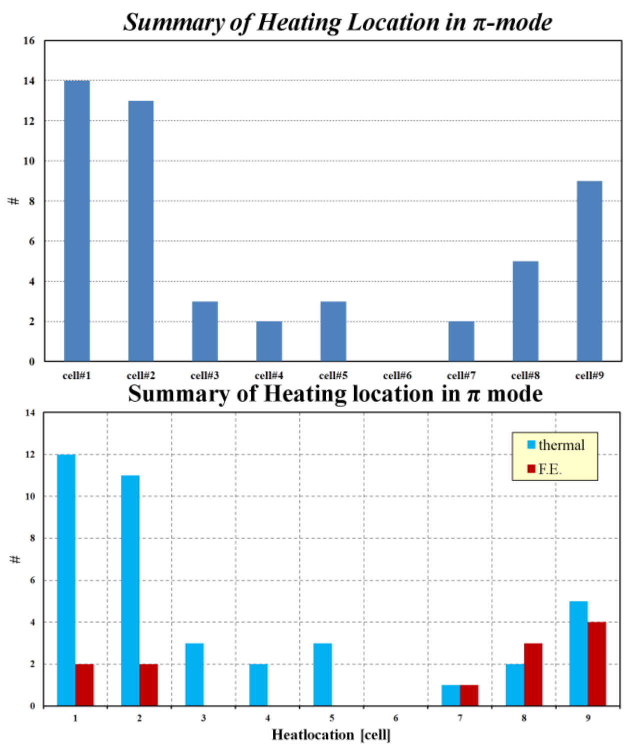


Figure 3: Quenching cell for π mode in vertical test at KEK-STF (top). After separation into two limiting cause, the same histogram is re-displayed separately (bottom).

Figure 4 shows the quench location mapping for π mode in vertical test at KEK-STF. Figure 5 shows the histogram for each angular region. In the angular distribution of quench location, there is no excess compared to Figure 3. Figure 6 shows the correlation between quench cell and field for π mode. Events with lower quench field (<20 MV/m) concentrate on the both end cells and neighbouring cells. Probably, this trend is due to the speciality of end cell.

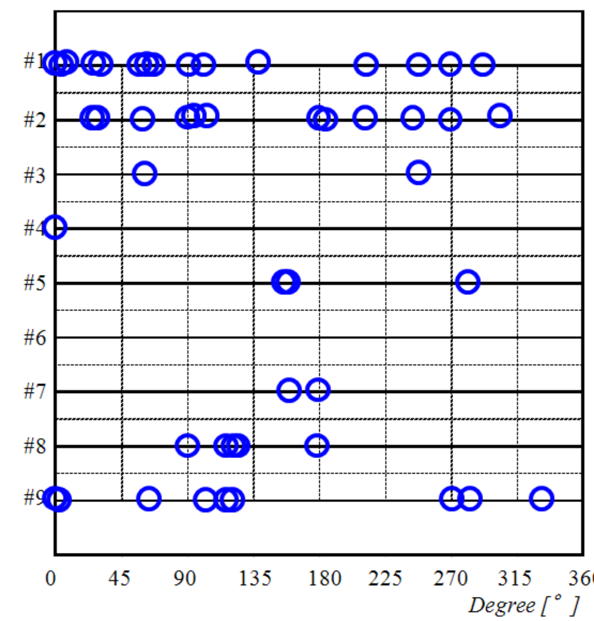


Figure 4: Quench location mapping for π mode in vertical test at KEK-STF. The horizontal axis is the clockwise angle viewing from the input coupler side (0º is the position of the input coupler), and the vertical axis is the cell location from cell #1 (top) to cell #9 (bottom). The black horizontal lines show the equator region of the cell, and dotted lines show the iris.

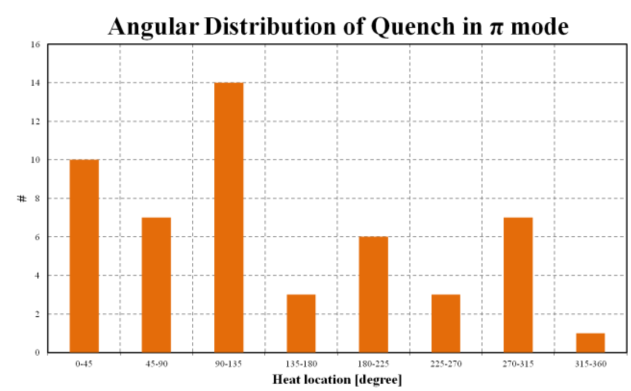


Figure 5: Angular distribution of quenching location for π mode in vertical test at KEK-STF (histogram).

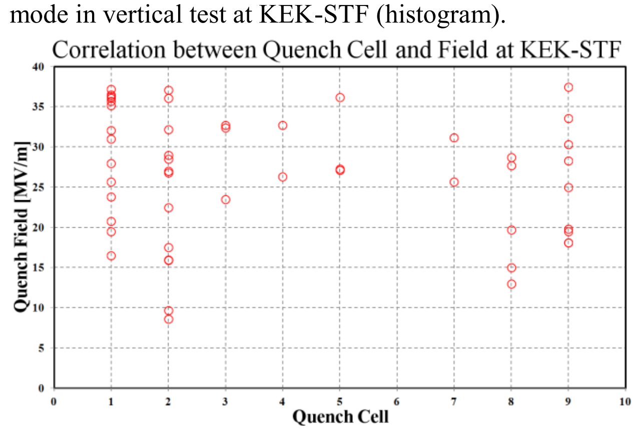
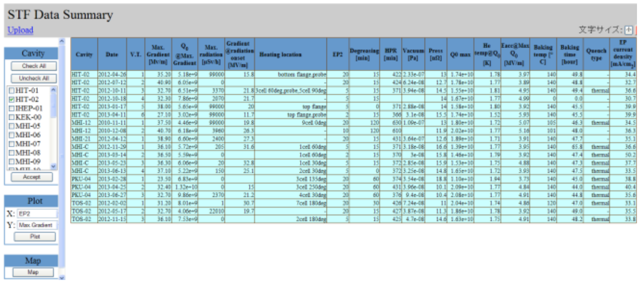


Figure 6: Correlation between quench cell and field at KEK-STF.

DEVELOPMENT OF DATA BASE

Recently, data base for result of vertical test at KEK-STF is under development. In addition to cavity performance, EP and rinsing parameter, and T-mapping results are included in this data base. Figure 7 shows the data base at present.



Cavity	Date	V.T.	Max. Gradient [MV/m]	Q_0 @Max. Gradient	Max. radiation [μSv/h]	Gradient @radiation onset [MV/m]	Heating location	EP2	Degreasing [min]	HPR [min]	Vacuum [Pa]	Press [nΩ]	Q0 max	He temp@Q_0 [K]	Eacc@Max Q_0 [MV/m]	Baking temp [°C]	Baking time [hour]	Quench type	EP current density [mA/cm$_2$]
HIT-02	2012-04-26	1	35.20	5.18e+9	99000	15.8	bottom flange,probe	20	15	422	2.33e-07	13	1.74e+10	1.78	3.97	140	49.8	-	34.4
HIT-02	2012-07-12	2	40.90	6.05e+9	0		-	20	15	424	6.24e-08	12.7	1.78e+10	1.77	3.89	140	48.8	-	32.7
HIT-02	2012-10-11	3	32.70	6.51e+9	3370	21.8	3cell 60deg,probe,5cell 90deg	5	15	371	3.94e-08	14.5	1.55e+10	1.81	4.95	140	49.4	thermal	36.6
HIT-02	2012-10-18	4	32.30	7.86e+9	2070	21.7	-	5	15			14	1.67e+10	1.77	4.99	0	0.0	-	30.7
HIT-02	2013-01-17	5	38.00	5.65e+9	99000	20	top flange	5	0	371	2.88e-08	14	1.58e+10	1.80	3.92	140	45.5	-	39.9
HIT-02	2013-04-11	6	27.10	3.02e+9	99000	11.7	top flange,probe	2	15	366	3.1e-08	15.5	1.74e+10	1.52	5.93	140	45.5	-	39.9
MHI-12	2010-11-11	1	37.50	4.46e+9	99000	19.8	9cell 0deg	20	120	630	1.09e-07	13	1.80e+10	1.72	5.07	105	46.3	thermal	34.5
MHI-12	2010-12-08	2	40.70	6.18e+9	3960	26.3	-	10	120	610		11.9	2.02e+10	1.77	5.16	101	48.0	-	36.3
MHI-21	2012-04-12	1	38.90	6.60e+9	2400	27.3	-	20	15	431	3.64e-07	12.6	1.89e+10	1.71	3.91	140	47.7	-	35.1
MHI-C	2012-11-29	1	36.10	5.72e+9	205	31.6	1cell 60deg	5	15	371	3.18e-08	16.6	1.39e+10	1.77	3.95	140	65.8	thermal	36.6
MHI-C	2013-03-14	2	36.50	5.59e+9	0		1cell 60deg	2	15	370	3e-08	15.8	1.48e+10	1.79	3.92	140	47.4	thermal	50.2
MHI-C	2013-05-23	3	36.30	6.06e+9	20	32.8	1cell 30deg	5	15	372	2.85e-08	15.9	1.53e+10	1.75	4.88	140	47.3	thermal	37.7
MHI-C	2013-06-13	4	37.10	5.22e+9	150	25.1	2cell 30deg	5	0	372	3.25e-08	14.8	1.65e+10	1.72	3.93	140	47.5	thermal	33.5
PKU-04	2013-02-28	1	23.50	6.83e+9	0		3cell 135deg	20	60	374	3.54e-08	18.8	1.10e+10	1.94	3.73	140	45.0	thermal	38.8
PKU-04	2013-04-25	2	32.40	1.32e+10	0	15	3cell 250deg	20	60	431	3.96e-08	10.1	2.09e+10	1.77	4.84	140	44.0	thermal	40.4
PKU-04	2013-06-27	3	32.70	9.86e+9	2370	21.2	4cell 30deg	20	60	376	9.4e-08	10.4	2.08e+10	1.77	4.91	140	44.8	thermal	35.6
TOS-02	2012-02-02	1	31.20	8.01e+9	1	30.7	7cell 180deg	20	30	426	7.24e-08	11	2.04e+10	1.74	4.86	120	47.0	thermal	33.1
TOS-02	2012-05-17	2	32.70	4.06e+9	22010	19.7	-	20	15	427	3.87e-08	11.3	1.86e+10	1.78	3.92	140	49.0	-	35.5
TOS-02	2012-11-15	3	36.10	7.53e+9	0		2cell 180deg	5	15	425	4.7e-08	14.6	1.63e+10	1.75	4.91	140	48.2	thermal	33.8

Figure 7: Data base of cavity performance, EP and other parameters at KEK-STF.

SUMMARY

In STF, many vertical tests have been carried out since 2008. It is not difficult to achieve the ILC specification at present.

There is the excess in the quenching cell at vertical test. Cell with lower quench field concentrates on the end cells and neighbouring cells. On the other hand, the angular distribution of quench location has no bias.

Recently, data base of cavity performance, EP and the other parameters is under development, and will be public in future.

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