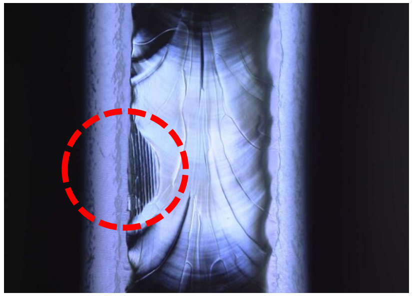
Achievement of 41MV/m by HIT-02 with KEK-HITACHI Collaboration

History of HIT-02 at STF

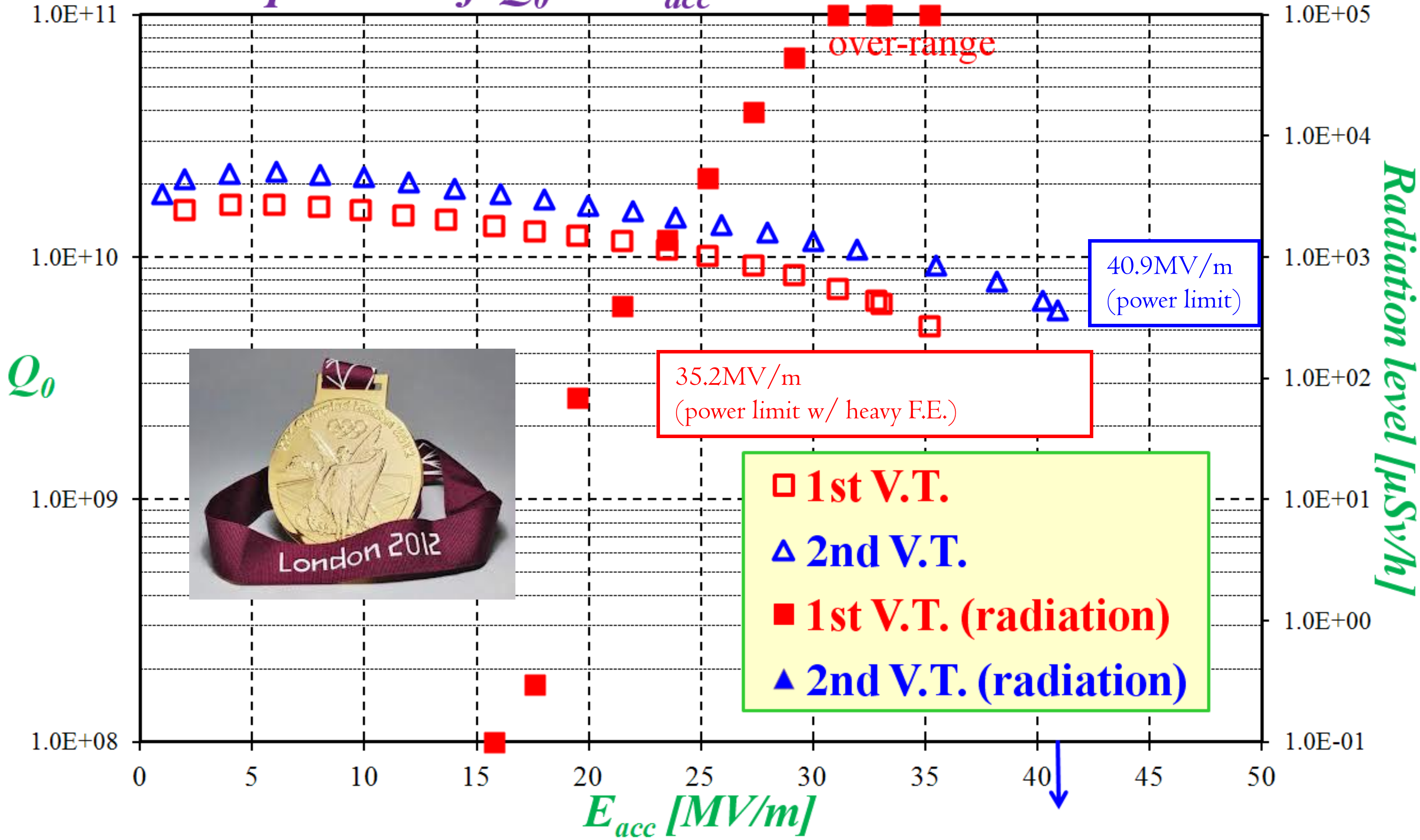
date	content	comment
8/Mar~	optical inspection	as received
14/Mar	bulk EP	100µm removal
19/Mar~	anneal	
29/Mar~	optical inspection	many marks observed
9/Apr	pre-tuning	99.1%
17/Apr	light EP	20µm removal
26/Apr	1st V.T.	35.2MV/m with heavy F.E.
9/May~	optical inspection	many marks still existed
14/May	F.F. check	99.1% → 96.5%
29/May~	**local grind**	every iris & beam pipe
15/Jun	bulk EP	50µm removal
20/Jun~	optical inspection	no mark at iris
25/Jun	pre-tuning	90.9% → 98.7%
3/Jul	light EP	20µm removal
12/Jul	2nd V.T.	**40.9MV/m with No F.E.**
18/Jul	F.F. check	98.0% → 94.7%
18/Jul~	optical inspection	



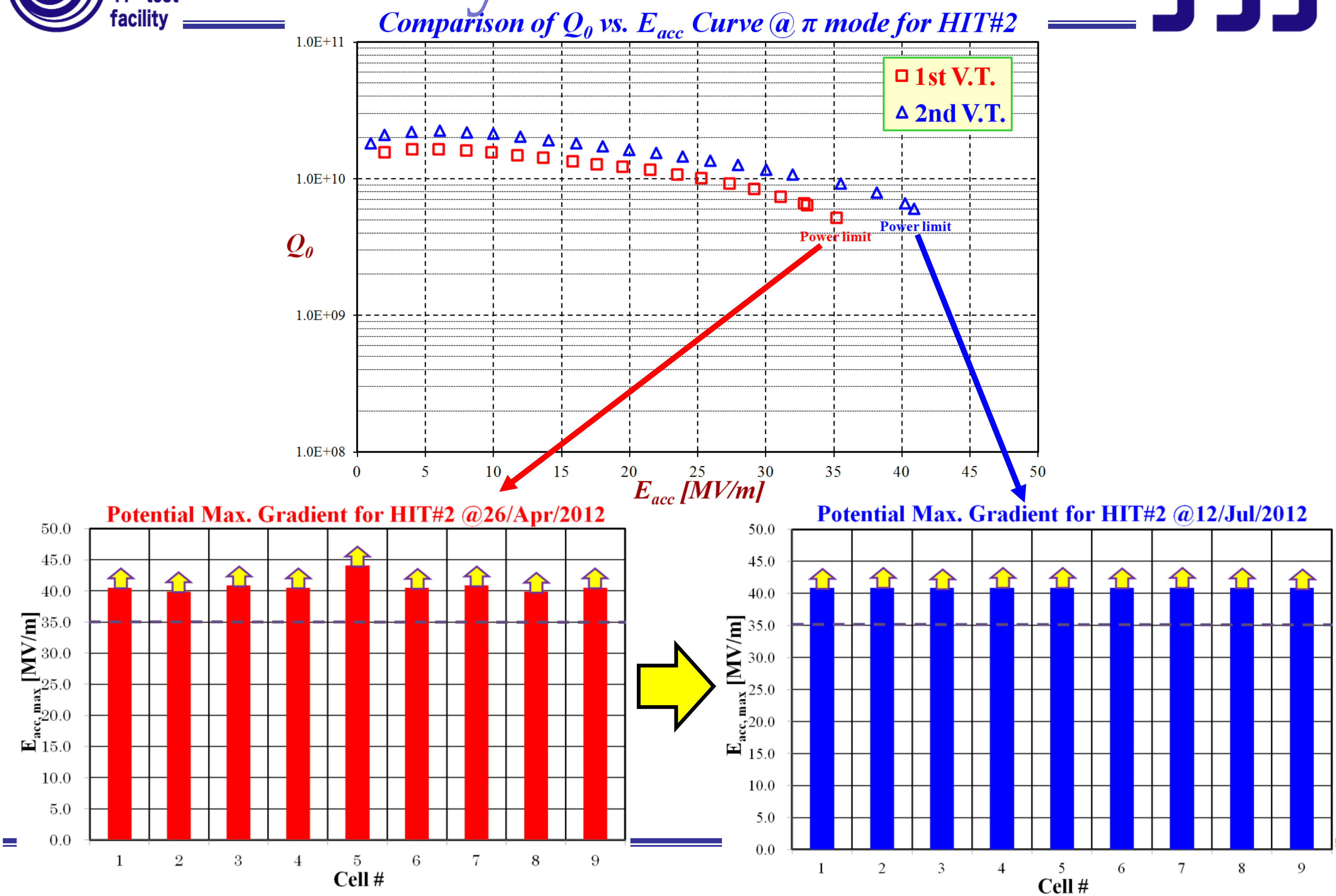
Japan Record Updated by HIT-02!

In 1st V.T., gradient reached above 35MV/m, but heavy F.E. occurred. After that, they removed many marks at every iris by their original grinding method. In 2nd V.T., this cavity achieved the ILC specification with "No F.E".
Surprisingly, they fabricated only two cavities!

Comparison of Q_0 vs. E_{acc} Curve & Radiation level

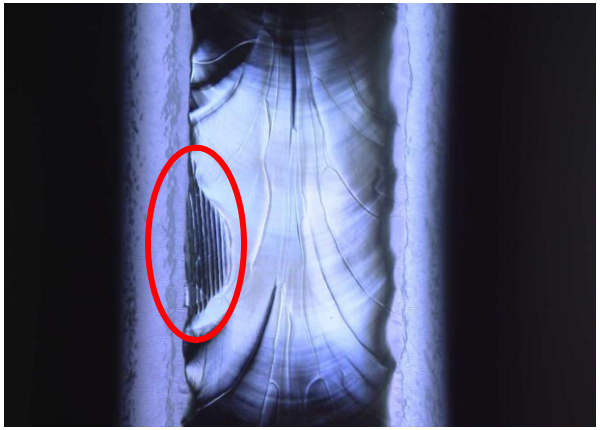
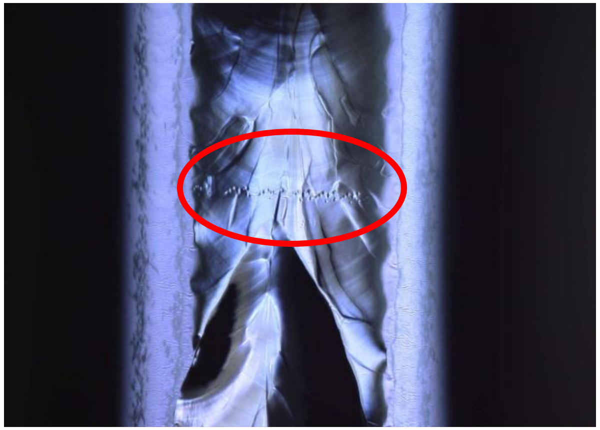
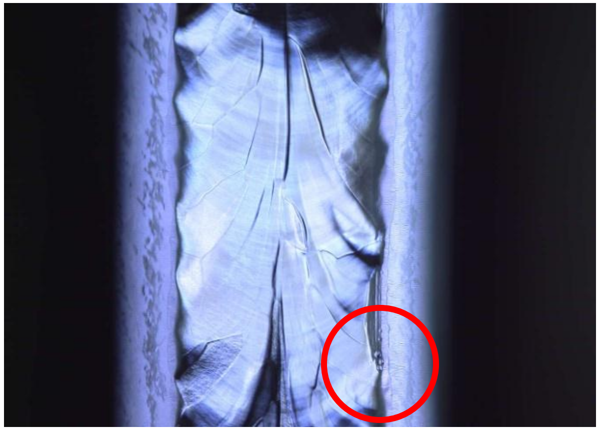


Potentially achievable Gradient

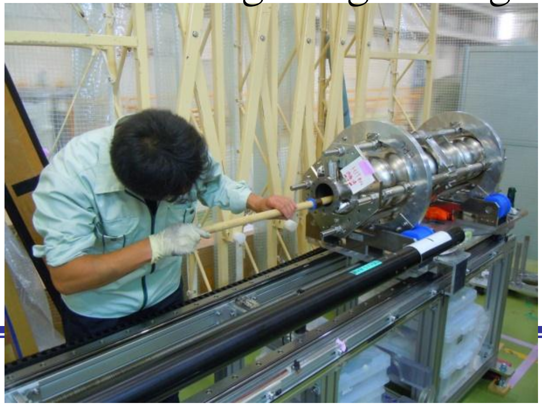


Many marks at iris observed in HIT-02

In the optical inspection before 1st V.T. of HIT-02, many marks at every iris region were observed.
Therefore, we predicted this cavity is affected by a heavy field emission, and it is actually true.
After the 1st V.T., HITACHI company persons removed every marks from every iris
by their original grinding technique.
In the 2nd V.T., this cavity experienced No field emission at 41MV/m!!

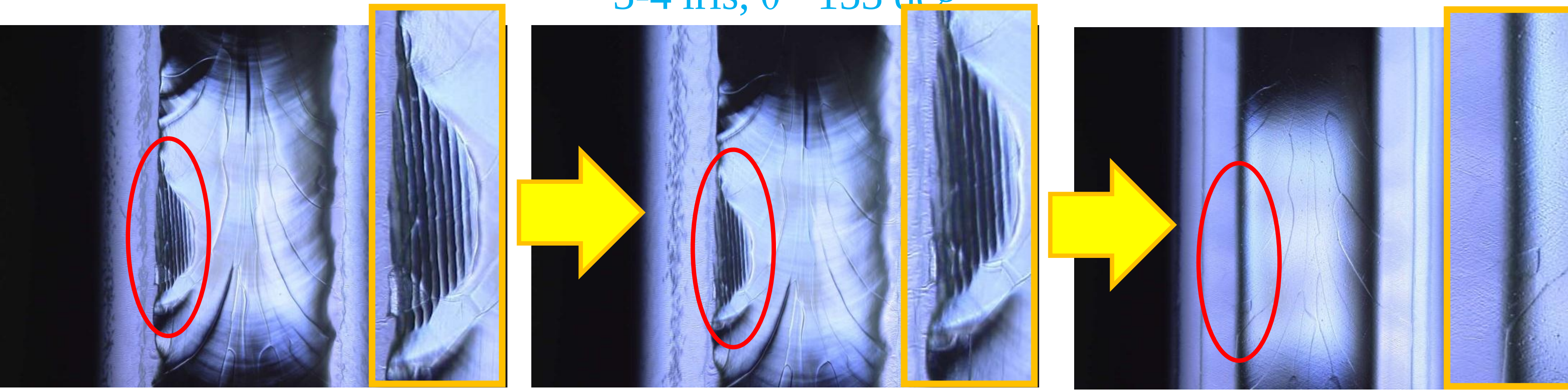




Original grinding technique by HITACHI



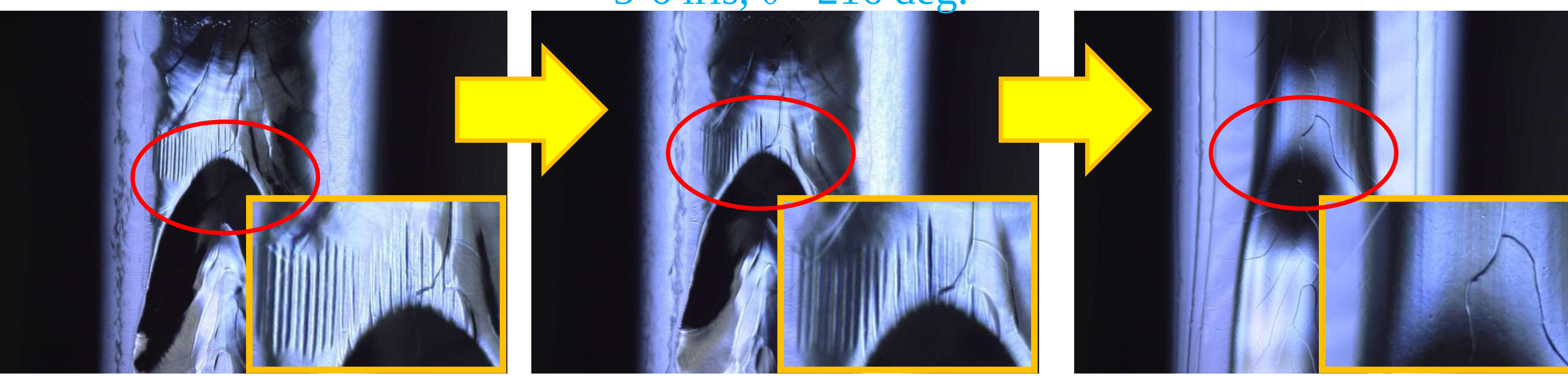

History of marks at iris ①

3-4 iris, θ =153 deg.



after bulk EP | after 1st V.T. | after local grind + bulk EP

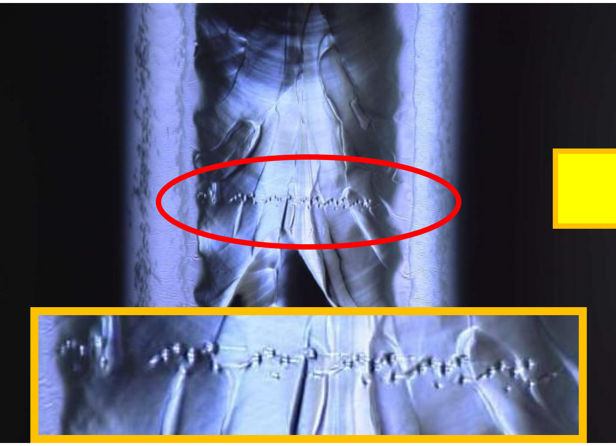
5-6 iris, θ =216 deg.



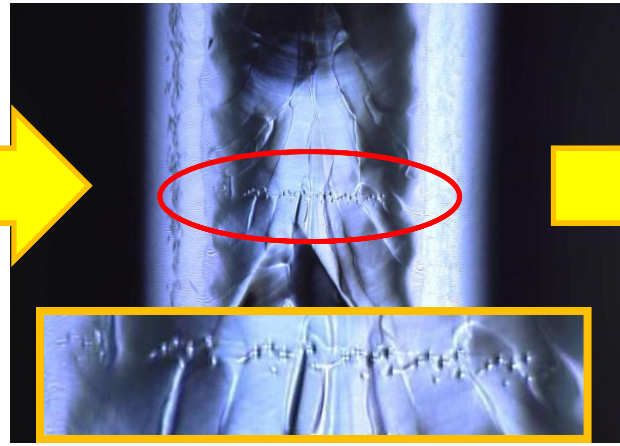
after bulk EP | after 1st V.T. | after local grind + bulk EP

History of marks at iris ②

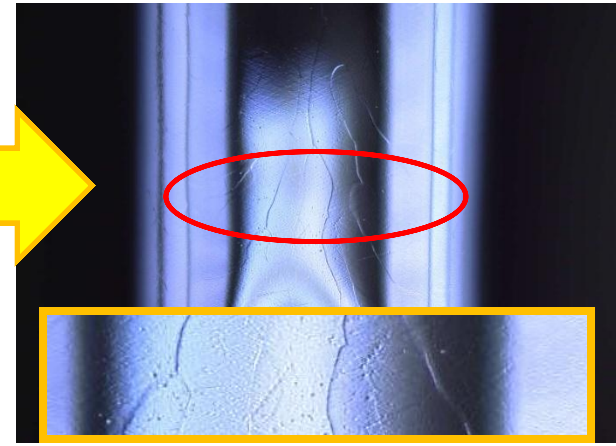
3-4 iris, θ =205 deg.



after bulk EP

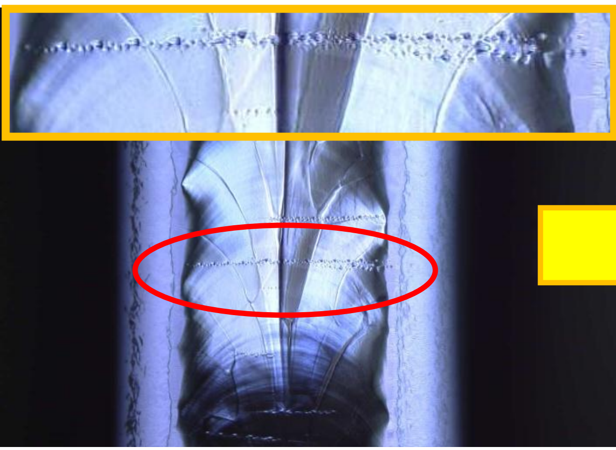


after 1st V.T.

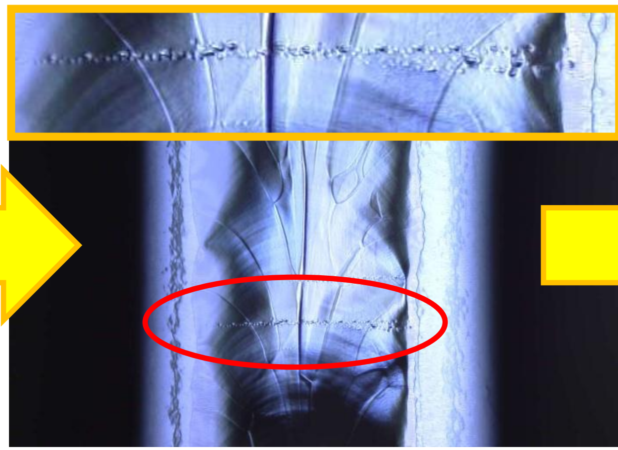


after local grind + bulk EP

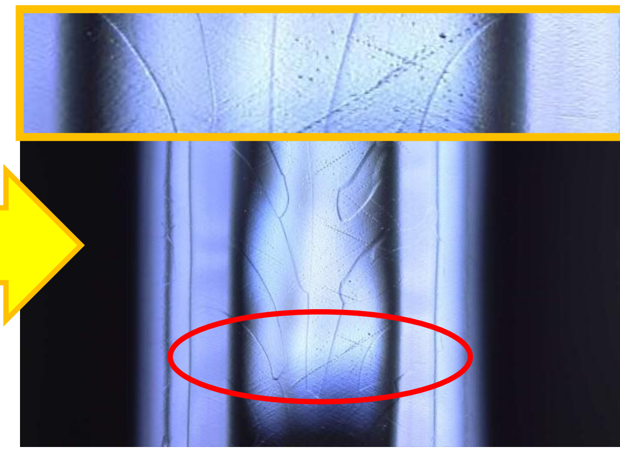
6-7 iris, θ =334 deg.



after bulk EP



after 1st V.T.



after local grind + bulk EP

Summary of Effect of Local Grind at STF

Cavity	Change of Gradient [MV/m]	Location of problematic defect	grind method	Limit cause in last V.T.
MHI#8	16 → 27 (1st → 2nd)	#2 equator (edge)	by machine	Cell #2 heating (other location)
MHI#10	26 → 20 (2nd → 3rd)	#1 & #9 equator (on bead)	by hand & machine	Cell #1 heating (other new defect)
MHI#14	13 → >37 @π (2nd → 3rd)	iris #8-#9 (edge)	by hand	Power limit
MHI#15	23 → >33 (1st → 2nd)	#2 equator (on bead)	by machine	Cell #9 heating (new defect)
	29 → >36 (2nd → 3rd)	#9 equator (on bead)	by machine	Cell #9 heating due to heavy F.E. (new defect)
	18 → >36 @π (3rd → 4th)	iris #3-#4 (edge) iris #7-#8 (edge) iris #8-#9 (edge)	by hand & by machine	Power limit
MHI#16	21 → >34	#1 equator (on bead)	by machine	HOM #2 pre-heating (transient state)

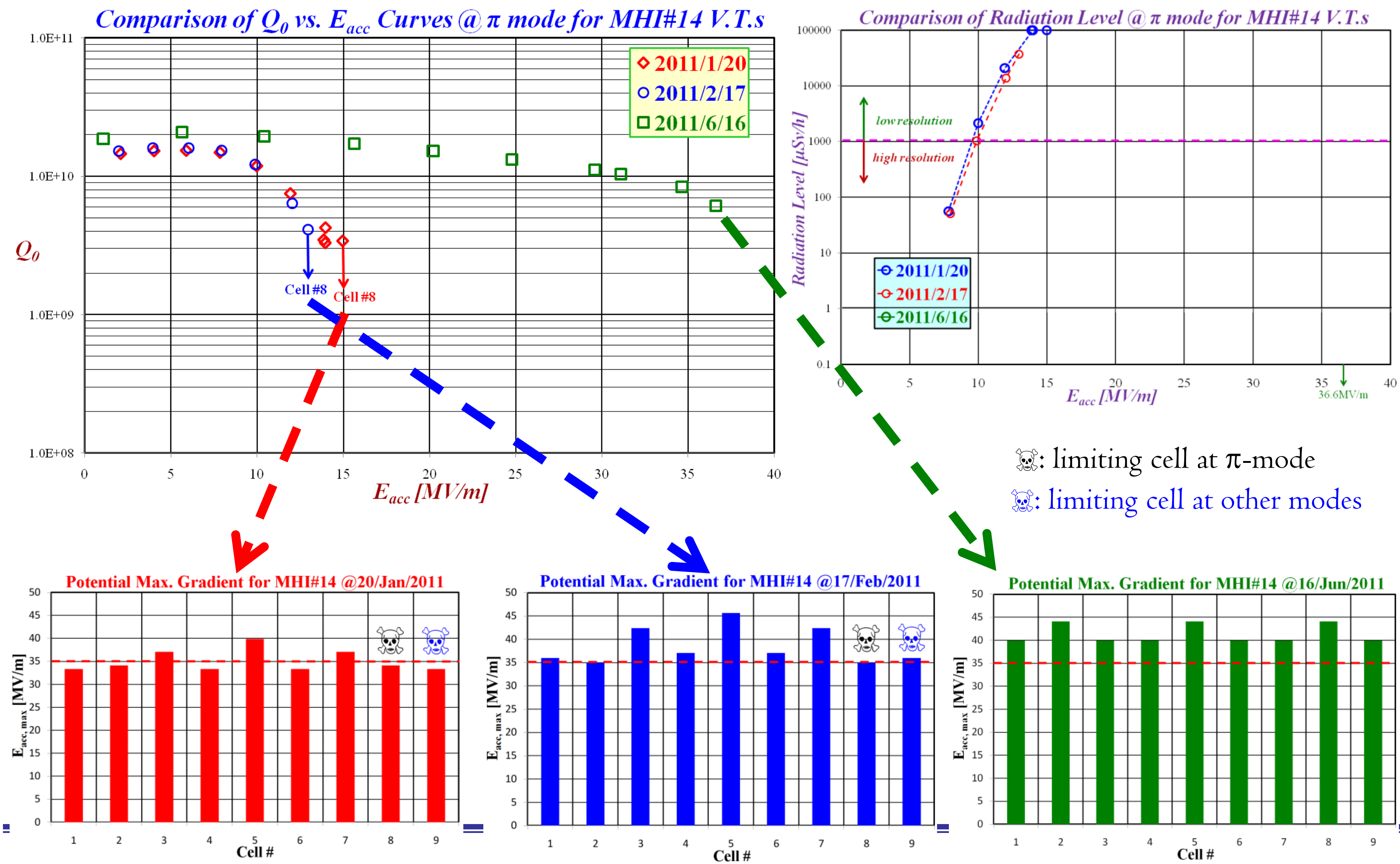
The local grinding technique is very important for the improvement of cavity performance!!

Summary of Effect of Local Grind at STF

Cavity	Change of Gradient [MV/m]	Location of problematic defect	grind method	Limit cause in last V.T.
MHI#18	31 → 10 (1st → 2nd)	beam pipes (on bead)	by machine	Cell #1 heating
MHI#18	10 → ? (2nd → 3rd)	iris #2-#3 (edge)	by machine	Cell #2, 3 heating due to heavy F.E. (new defect)
MHI#19	26 → 37 (1st → 2nd)	iris #5-#6 (edge) beam pipes (on bead)	by machine	Cell #4, 5 heating
TOS#2	31 → >38 (1st → 2nd)	#7 equator (on bead)	by machine	Cell #7 heating
TOS#2	38 → >39 (1st → 2nd)	#8 away from equator (Not on bead)	by machine	Cell #8 heating
HIT#2	>35 → >41 (1st → 2nd)	Every iris beam pipes	by hand with wood rod	Power limit with heavy field emission

The local grinding technique is very important for the improvement of cavity performance!!

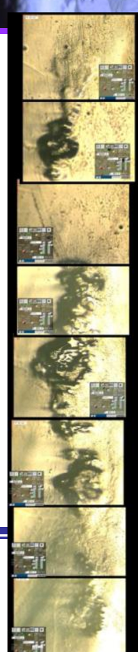
Case of MHI-14 ①



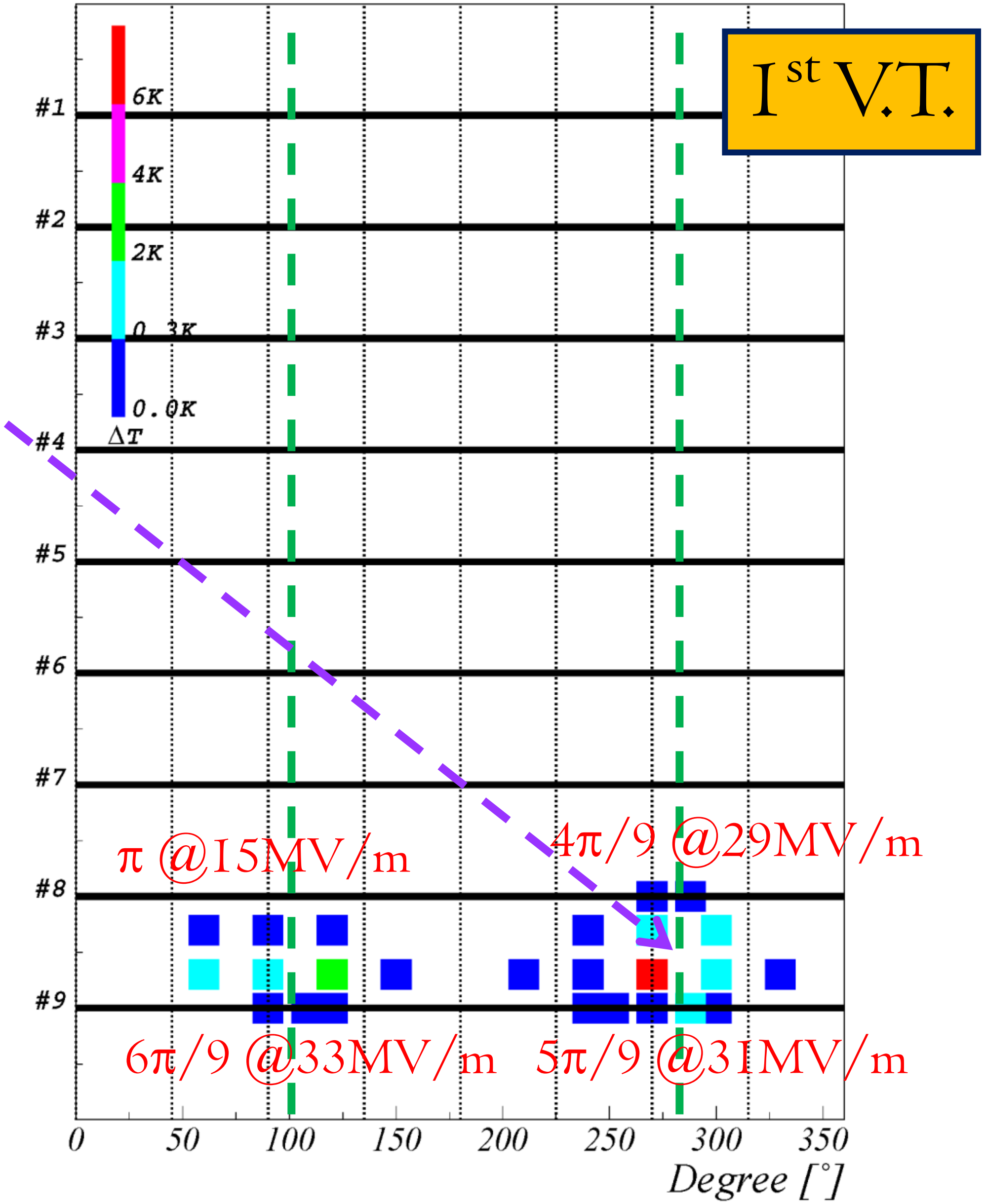
Case of MHI-14 ②

Typical case of field emission

Laser microscope



Digital microscope



Summary

- HIT-02 updated the Japan record of the Cavity performance.
- The mechanically local grinding technique is useful for the improvement of the cavity performance (at least in STF).

More detailed result will be presented in TTC meeting at J-Lab.