Recent inspection results by Kyoto-camera

Ken Watanabe （KEK）

TTC meeting at New Delhi

October 20-23, 2008

Outline

1) History of Kyoto camera system

2) Correction of the shape analysis (Comparison with the Kyoto camera and Laser microscope of Keyence VK-8500 by using sample plate)

3) Example of the inner surface on the hot spots
(Z110 #8 cell, Z111 #6 cell and AES001 #3 cell etc...)

4) Inspection of the STF Baseline cavities : #5 and #6
(Survey a spots, marking a spot location for V.T.)

5) Summary

1) History of Kyoto camera system

The high-resolution camera system is developed to search the defects and measure the shape of them for better yield of accelerating gradient of SC 9-cell cavities.

2006 : Development started in Kyoto university. (Iwashita, Hayano, Tajima)

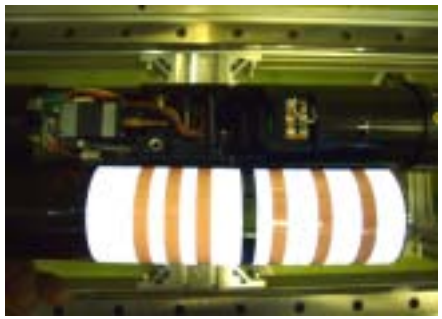
2008/3 : A prototype model was completed and moved to KEK.

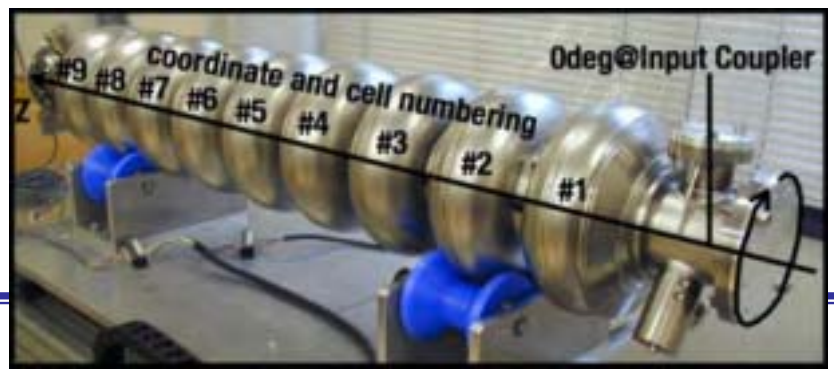
2008/7 : A mass production model was completed and moved to DESY.

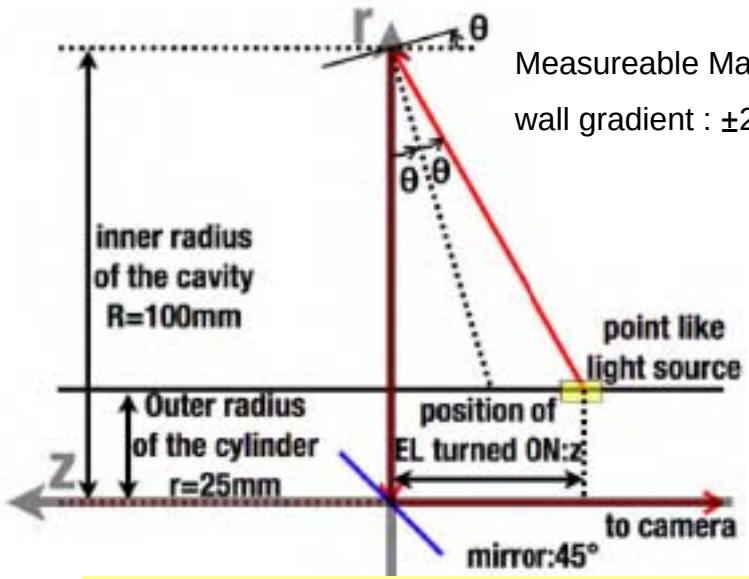
The Cavities observed to October 2008, are shown in the following,

* AC71, AC74, AC80
* Z84, Z110 (T-map), Z111 (T-map)
* AES#001 (T-map)
* STF Baseline #5 and #6, ERL cavities (9-cell, 2-cell and single cell) by MHI
* Some samples (Plates, Dambels, etc…)

About the Kyoto camera system (Mass production model)







Measureable Maximum wall gradient : ±20 degree.

Schematic drawing of the wall gradient measurement

Characteristic of Kyoto camera system

* The High resolution images can be taken.
* The wall gradients of inner surface can be measured to use the Strip line EL illuminator. (Judge -> Pit or Boss ?)
* The heights or depths can be also estimated by measured wall gradients for some well-conditioned defects.

2) Correction of the shape analysis of Kyoto camera system

Method,

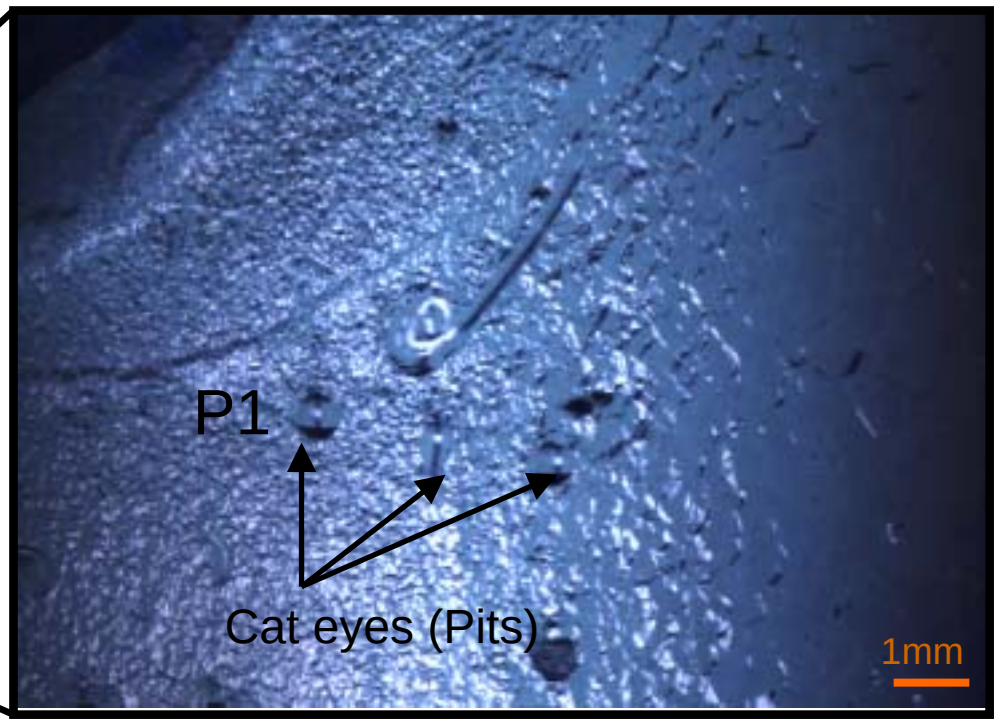
(1) Make a pits on the Niobium plate (Finished EP) by using a stainless ball (Diameter is 2.44 mm)

(2) The shape analysis of these pits made as following methods,

: Kyoto camera system (Tajima method)

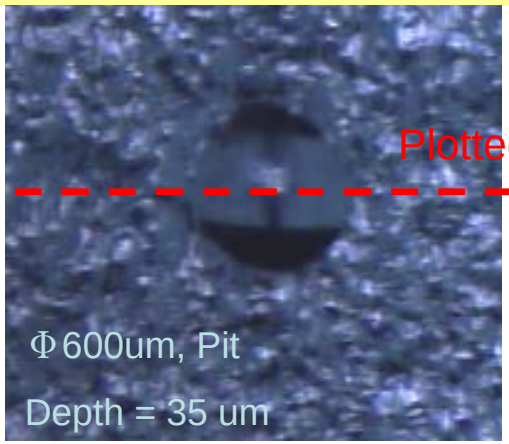
: Laser microscope (Keyence VK-8500)

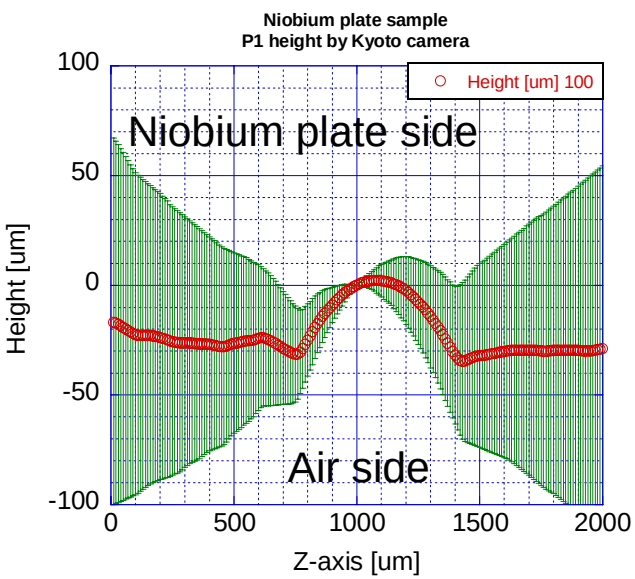
Niobium sample plate



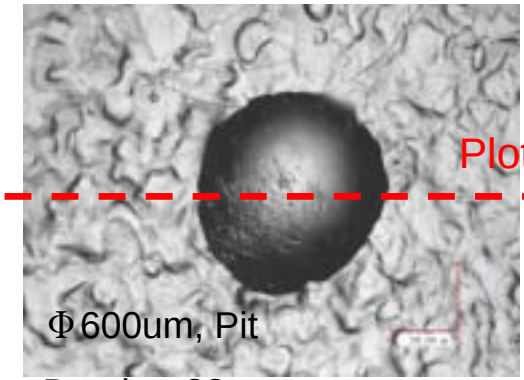
Result of Shape analysis : P1

Kyoto camera : Tajima method

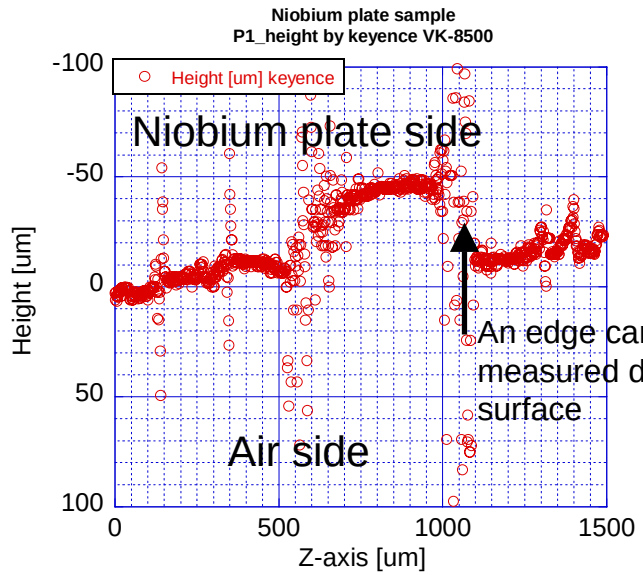




Laser microscope: VK-8500



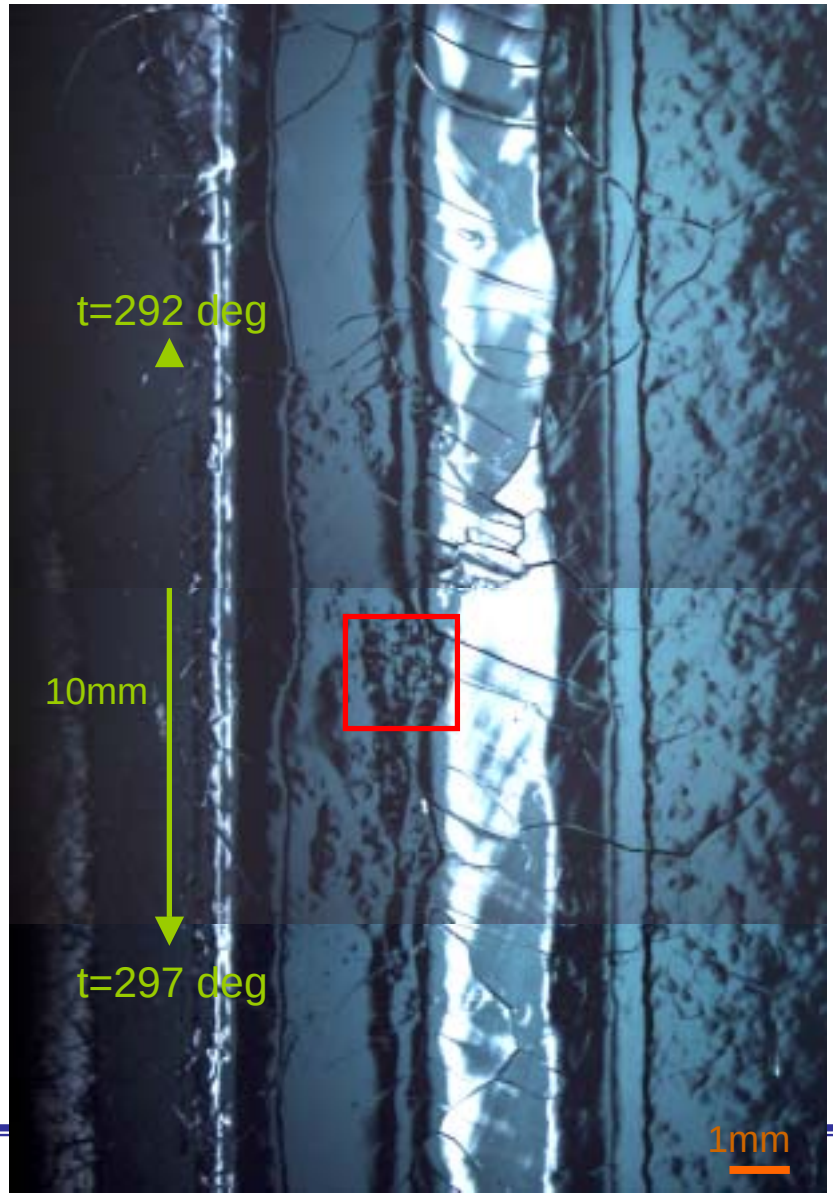
Depth = 38 um



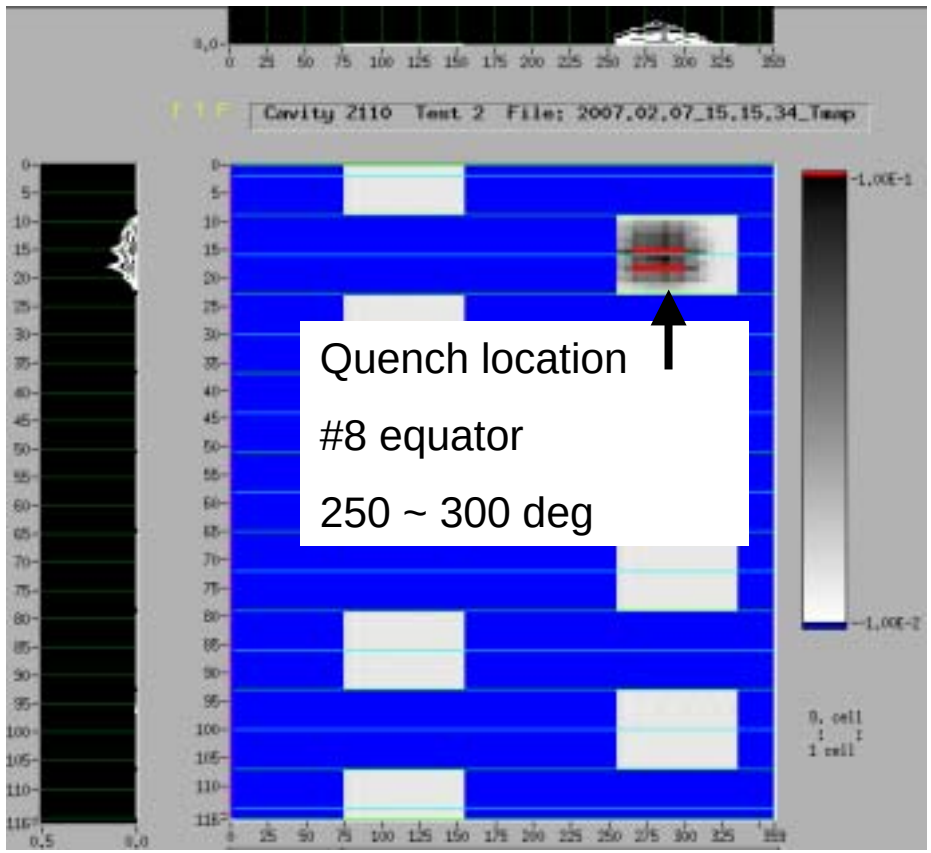
The results of depth value are almost same.

3) Example of the inner surface on the hot spot : Z110 #8 cell equator

#8 equator, t=288 ~ 299 deg

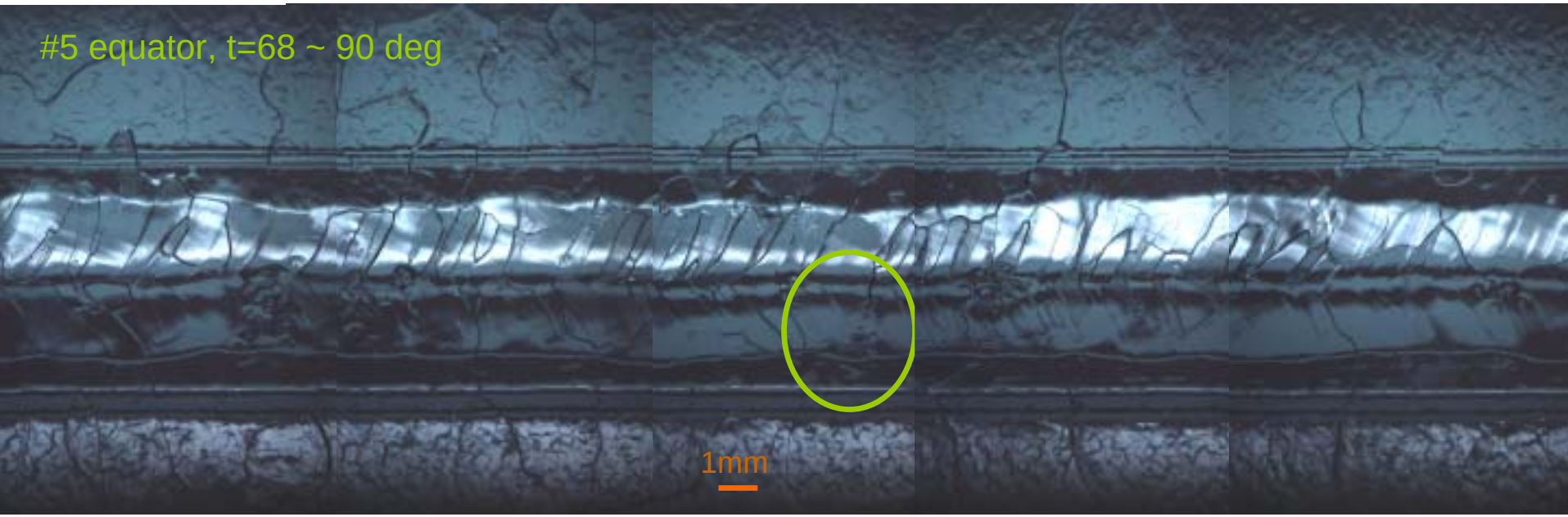


T-map data in test 2, 14.2 MV/m



Group of spots with 10mm wide on the EBW seam were observed.
Similar spots group were also observed in several places. See following slides.

Z110: group of spots (1)



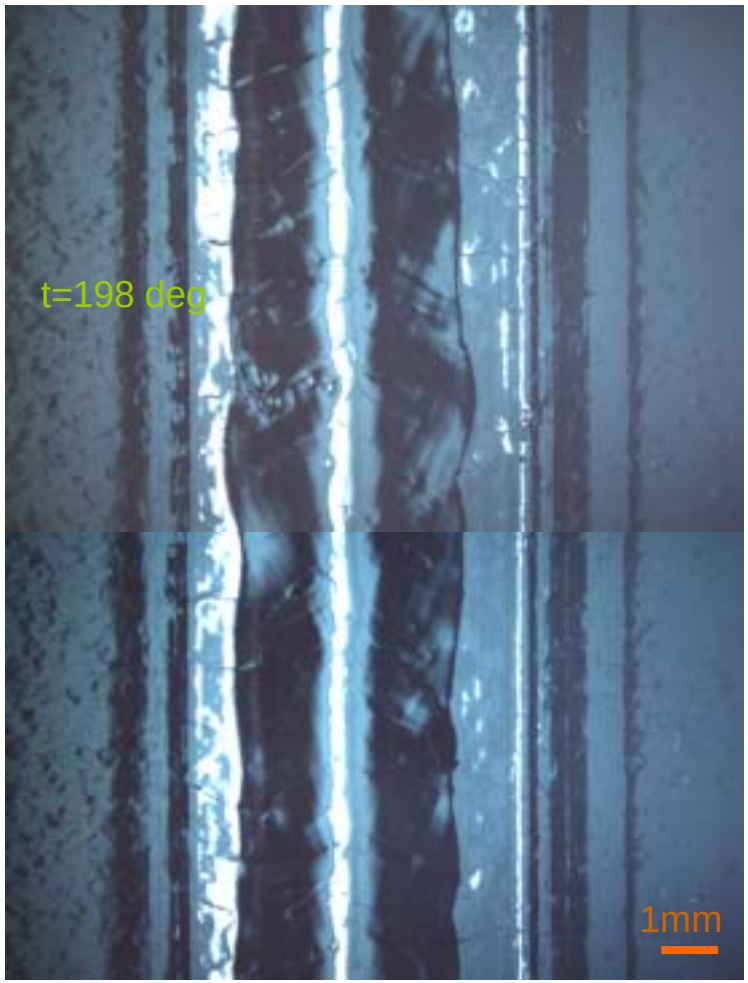
68 deg — 40mm — 90 deg

Five group of the spots has during 22 degree on the EBW seam.

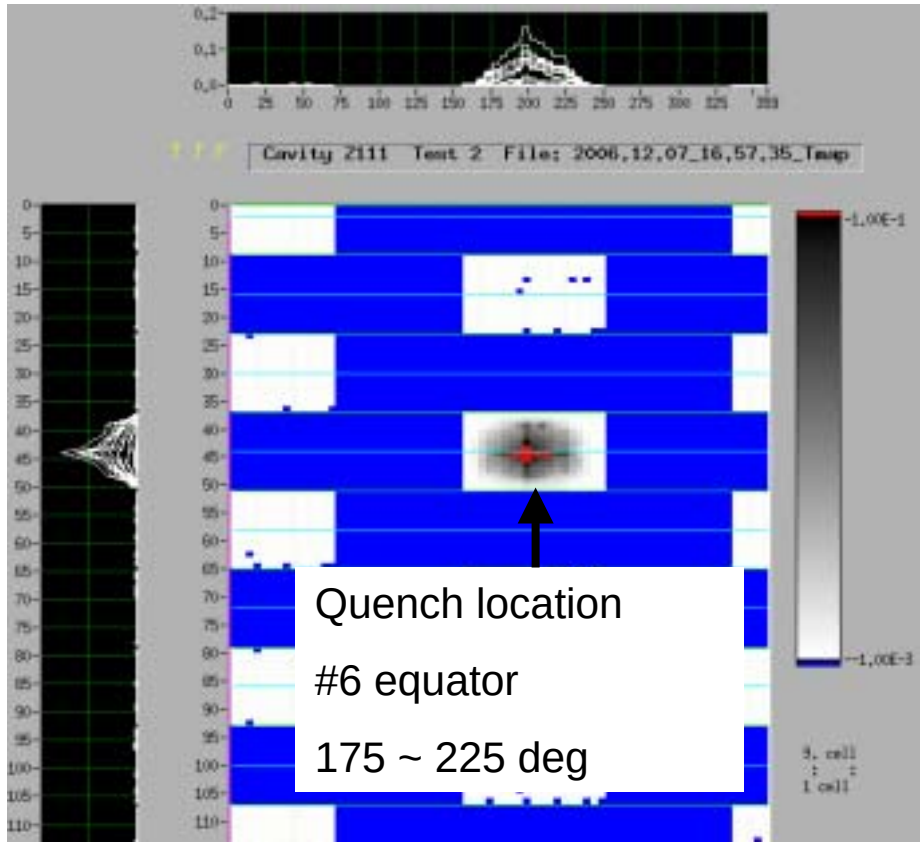
Z110: group of spots (2)

3) Example of the inner surface on the hot spot : Z111 #6 cell equator

#6 equator, t=193 ~ 204 deg



T-map data in test 2, 16.0 MV/m



Group of spots with 1.5mm wide on the EBW seam were observed. Similar spots group were also observed in several places.

Two kind of spots in Z111

Type-1; clear bump spots or single spot.

ex) Z111 #4 equator, t=296 deg, group of spot

Type-2; faint bump spots or single spot.

ex) Z111 #5 equator, t=43 deg, group of spot

There was almost no type-2 spot in Z110.
Material removal difference?

Summary: Location of the group of spots on equators (Z110 and Z111)

Z110 (total 31 points)

#1 equator : 123 deg.

#2 equator : 68, 121, 152, 178, 334, 356 deg.

#3 equator : 138, 264, 268 deg.

#4 equator : 269 deg.

#5 equator : 40, 48, 70, 74, 79, 84, 88, 128, 213, 276 deg.

#6 equator : 162, 185 deg.

#7 equator : 94 deg.

#8 equator : 236, 254, 274, 291, 294, 296, 301 deg.

(heat location by T-map : 250 ~ 300 deg.)

#9 equator : Nothing.

(There were single spots on along equator of every cell.)

#1,#9 = 17 MV/m, #2,#8 = 15 MV/m, #3,#7 = 19 MV/m

#4,#6 = 14 MV/m, #5 = 20 MV/m

fewer clear spot in the cell exceeding 20 MV/m.

Z111 (total 43 spots)

#1 equator : 0, 9, 13, 42, 154, 184, 192, 326, 339, 347 deg.

#2 equator : 4, 8, 17, 21, 39, 57, 168, 224, 229, 234, 251, 268, 272, 304 deg.

#3 equator : 18, 27, 40, 53, 71, 137, 189, 229, 234, 243, 252, 260, 264, 273, 281, 295, 300, 309, 322, 336 deg.

#4 equator : 0, 14, 18, 23, 27, 40, 54, 156, 160, 182, 208, 235, 239, 248, 256, 265, 273, 296, 340, 349 deg.

#5 equator : 0, 34, 39, 43, 83,118, 149, 188, 214, 343 deg.

#6 equator : 0, 20, 34, 80, 172, 190, 198, 234, 286, 295, 304, 318, 322, 348 deg.

(heat location by T-map : 175 ~ 225 deg.)

#7 equator : 0, 6, 66, 87, 142, 185, 225, 243, 264, 277, 300 deg.

#8 equator : 19, 53, 120, 143, 173, 186, 265, 305, 340 deg.

#9 equator : 18, 35, 52, 101, 122, 140, 150, 176, 233, 322, 356 deg.

RED: group of faint spots

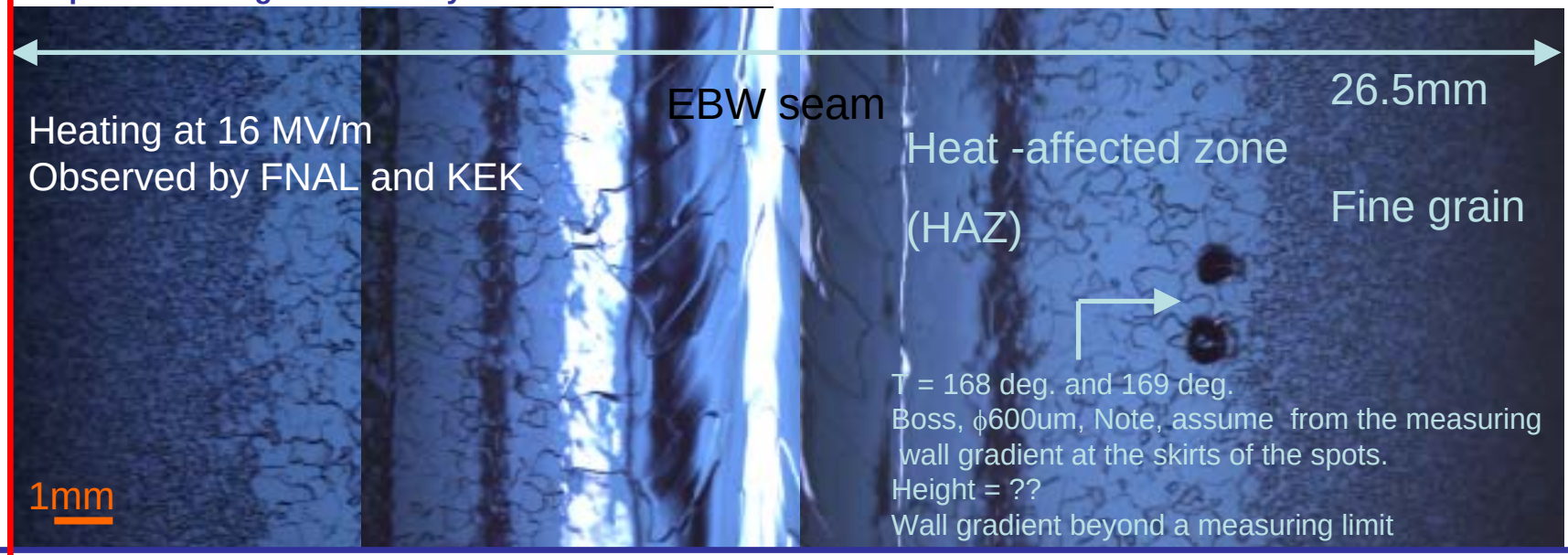
(There were single spots on along equator of every cell.)

#1,#9 = 26 MV/m, #2,#8 = 23 MV/m, #3,#7 = 17 MV/m

#4,#6 = 16 MV/m, #5 = 23 MV/m

Many spots observed. All spots were observed on the EBW seams.

3) Example of the inner surface on the hot spot : AES#001 #3 cell equator



Rotate angle

Twin spots were observed on the heat-affected zone (HAZ).
EBW seams were very smooth at all cells equator.

Other spots position : #3 cell equator, t = 181 deg on the HAZ.
(Boss, diameter = 400, height = 42 um)

#7 cell equator, t = 325 deg on the HAZ.
(Pit, diameter = 500 um, depth = 28 um)
Max Eacc = 16 MV/m, But no heating.

4) Inspection of the STF Baseline cavities (#5, #6)

2008/6 : STF Baseline cavities #5 and #6 were fabricated by MHI.

First inspection by using Kyoto camera was done after fabrication.

2008/7 : Pre-EP (5 um) and EP-1 (20 um),

Total removed about 25 um.

Second inspection by using Kyoto camera was done after Pre-EP and EP-1

2008/8 : EP-1 (100 um), Total removed about 25 um + 100 um.

Third inspection by using Kyoto camera was done after 2nd-EP-1(100um).

Measurement and Analysis of the cat eyes for STF Baseline cavities #5 and #6.

2008/9~10: Anneal process

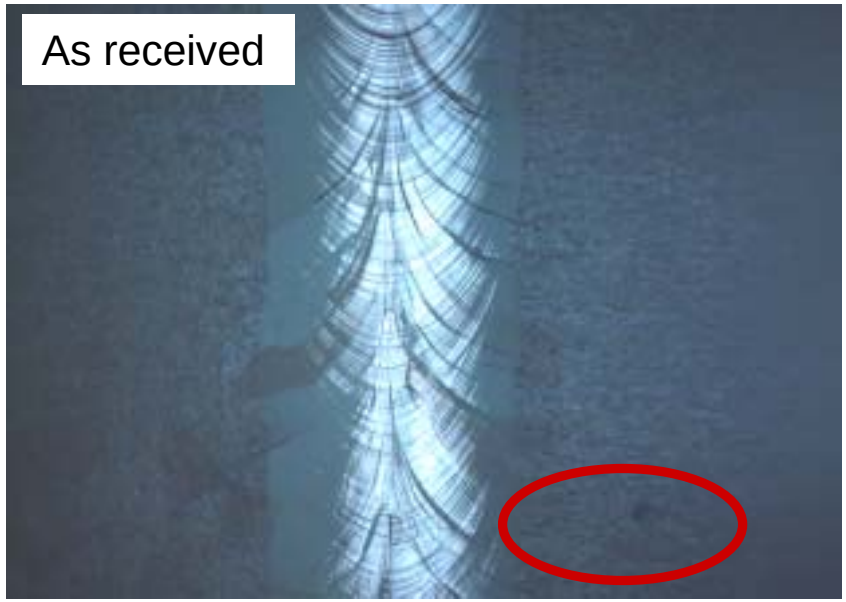
Fourth inspection by using Kyoto camera was done after Anneal process.

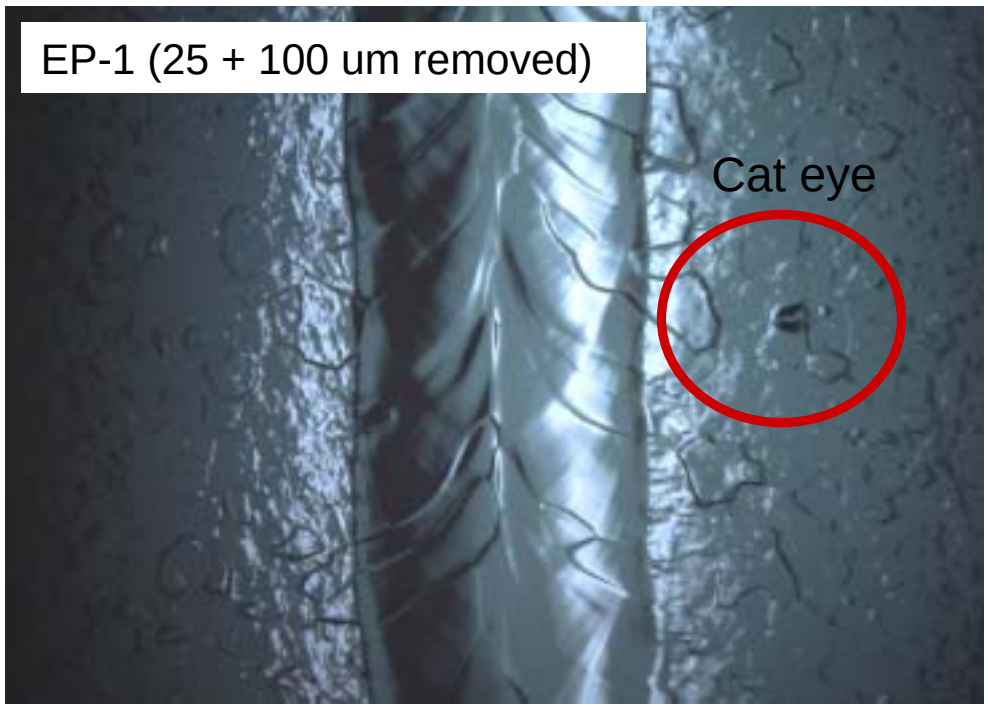
Marking the spots location for Vertical test.

2008/11~12 : Pre-tuning and First Vertical Test with T-map.

Comparison with each treatment, STF BL cavity #5 : #4 cell equator

The cat eye can find after EP-1 process (25 + 100 um removed) , and can measure the shape of the spot.





4) summary of spots location

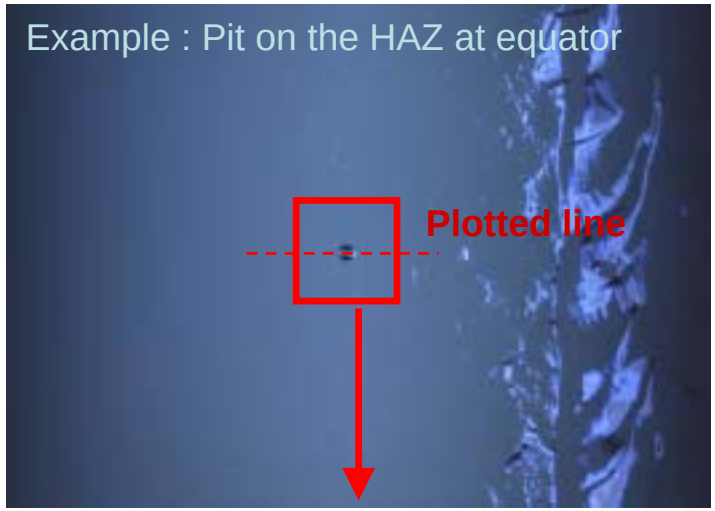
Two type of spots were observed on the STF Baseline cavities.

1) Boss on the HAZ at equator (diameter: > ϕ300 um)

2) Pit on the HAZ at equator (diameter: > ϕ300 um)

EBW seams were smooth.

(No spots and single spot on the EBW seams)



Result of inspection of the STF Baseline cavities.

STF Baseline cavity #5 has,

One boss on the HAZ (#1 cell equator),

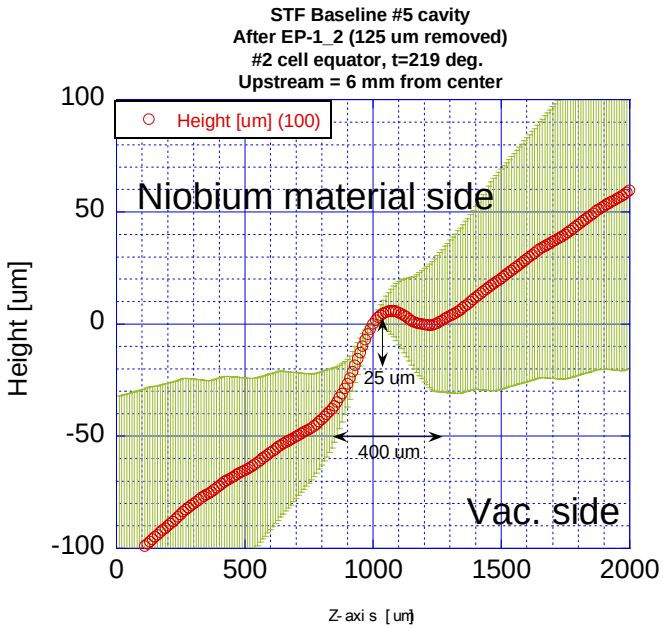
Fourteen pits on the HAZ (#1, #2, #3, #4, #5, #6, #7, #9).

STF Baseline cavity #6 has,

No boss on the HAZ,

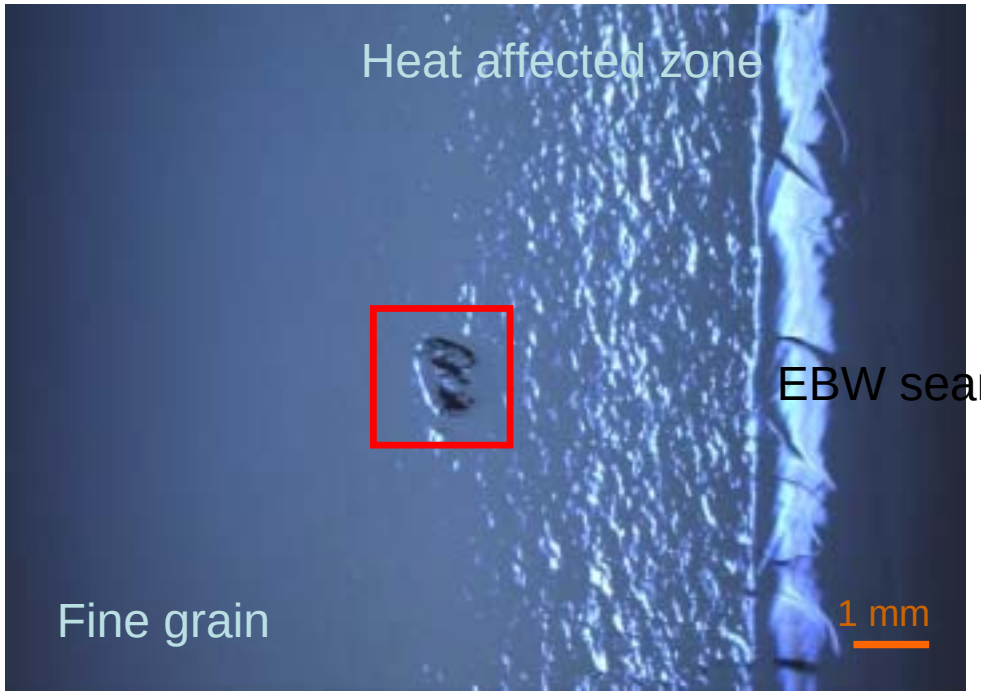
Fifteen pits on the HAZ (#2, #3, #4, #5, #6, #7, #8).

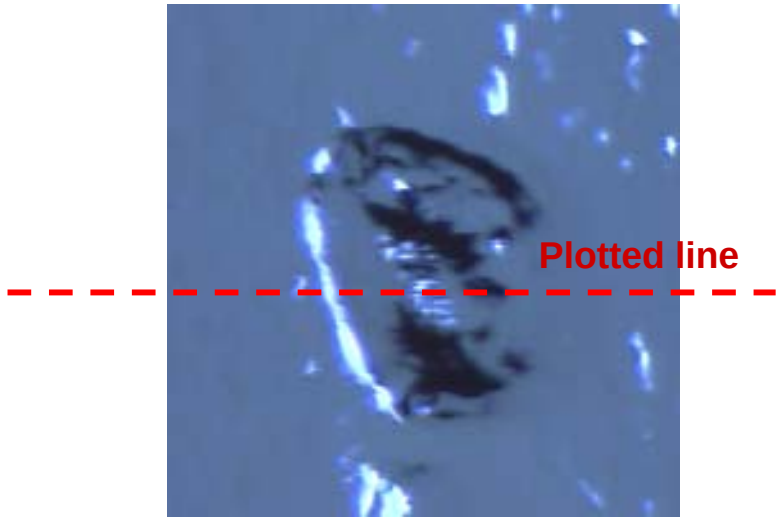
At vertical test, thermometer will equip on the these spots.

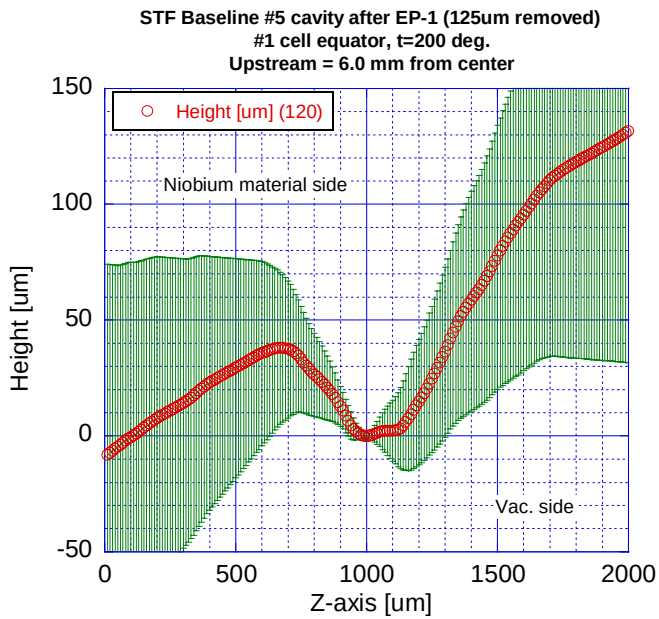


Boss on the HAZ at STF Baseline cavity #5

#1 cell equator end group side, t=200deg.







This boss is very big.

Diameter = 800 um,

Height = 50 um

Summary

The inspection of cavity surface was started by using Kyoto camera system from March 2008.

The collection of shape analysis of Kyoto camera system was done.

The inspection of the hot spots location of Z110, Z111 and AES#001 was done.

(The spots were observed at the hot spots.)

The inspection of the STF Baseline cavities (#5, #6) were done at each process to trace the condition of inner surface.

(As received, after Pre-EP and EP-1, after anneal process, etc…)

The survey and marking of the spots to study the hot spot were done before 1st Vertical Test.

The thermometers will equip the spot locations to study the hot spot and will measure 1st Vertical Test of STF Baseline cavities #5 and #6 at December 2008.

Thank you your attention