



Optical Inspection update at KEK

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- 1) History of Kyoto camera system

- 2) Inspection of the STF Baseline cavities
(Spot survey, marking for V.T.)

- 3) AES#001 cavity inspection before and after EP 20um
and V.T.

- 4) 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.

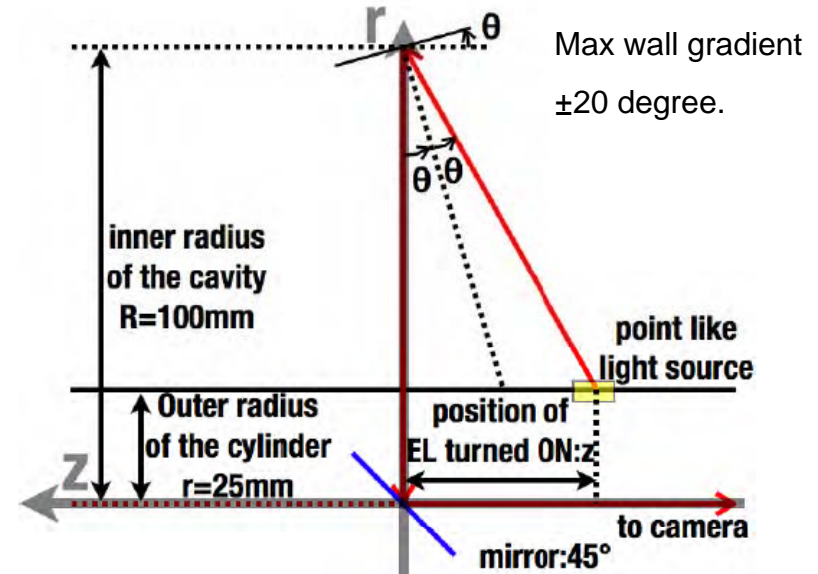
2008/7 : A mass-production model was completed and rent out to DESY.

The inspected cavities until November 2008 are shown in the followings,

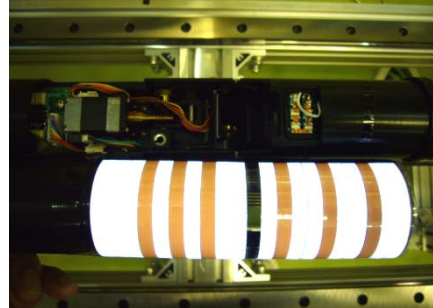
- * AC71, AC74, AC80
- * Z84, Z110 (T-map), Z111 (T-map)
- * AES#001 (T-map, Before and after EP process at KEK)
- * STF Baseline #5 and #6, KEK-ERL cavities (9-cell, 2-cell and single cell)
- * Some samples (Plates, Dambbels, etc...)

The inspection of the STF Baseline cavities (#5, #6) were done in each process.

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

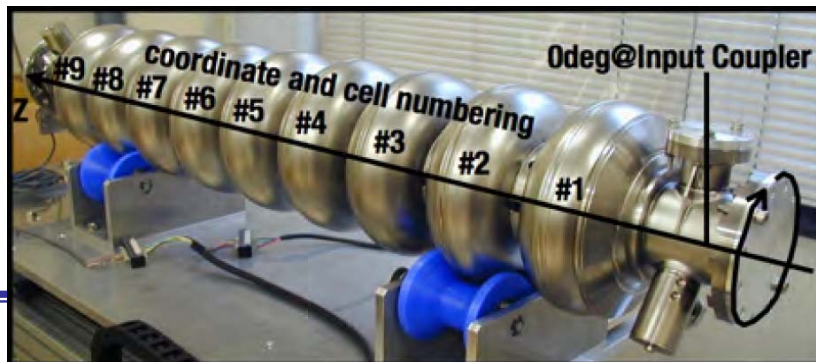


Schematic drawing of the wall gradient measurement



Characteristic of Kyoto camera system

- * The high resolution image can be taken.
- * The wall gradients of inner surface can be measured to use the Strip line EL illuminator. (Judgment of Pit or Bump is possible)
- * The heights or depths can be estimated by measured wall gradients for some well-conditioned defects.





STF Baseline cavity #5, #6



2) Result of inspection of the STF Baseline cavities (#5, #6)



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

The first inspection by using Kyoto camera was done after fabrication.

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

Total removed about 25 μm .

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

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

The third inspection by using Kyoto camera was done after 2nd-EP-1(100 μm).

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

2008/9~10: Anneal process

The 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.





2) Result of inspection of the STF Baseline cavities (#5, #6) Spots type



Two type of spots were observed in the STF Baseline cavity #5, #6

- 1) Bump on the HAZ at equator (diameter: > 300 μm)
- 2) Pit on the HAZ at equator (diameter: > 300 μm)

EBW seams were smooth. (No group and single of spots)

Result of spots of the STF Baseline cavities.

(The shape analysis were carried out after EP process 125 μm)

STF Baseline cavity #5 has,

One bump at the HAZ (#1 cell equator),

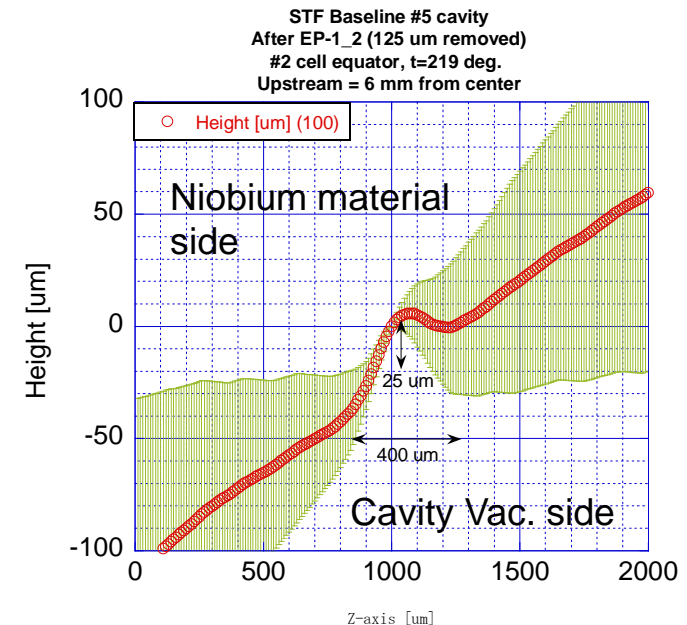
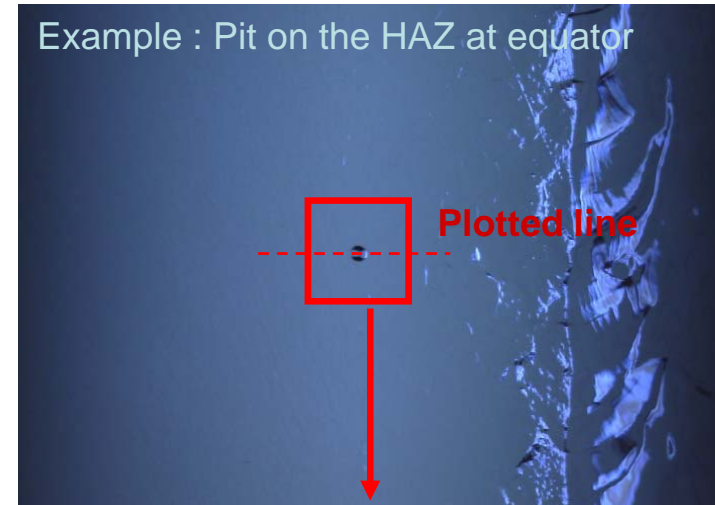
Fourteen pits at the HAZ (#1, #2, #3, #4, #5, #6, #7, #9).

STF Baseline cavity #6 has,

No Bump at the HAZ,

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

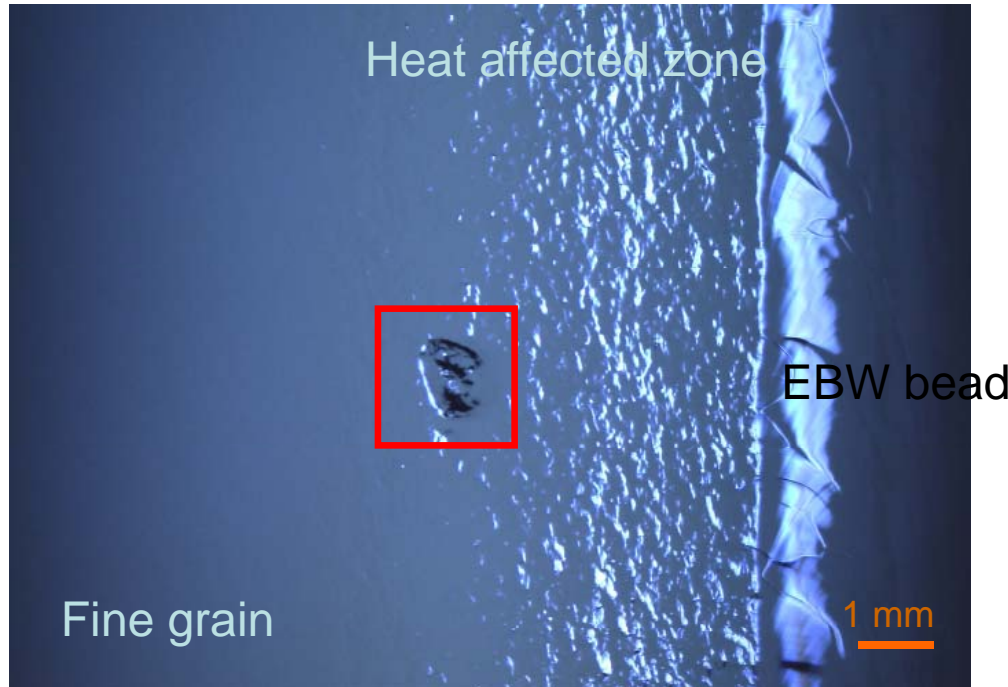
At vertical test, thermometer will equip on the these spots.





2) Bump on the HAZ at STF Baseline cavity #5

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

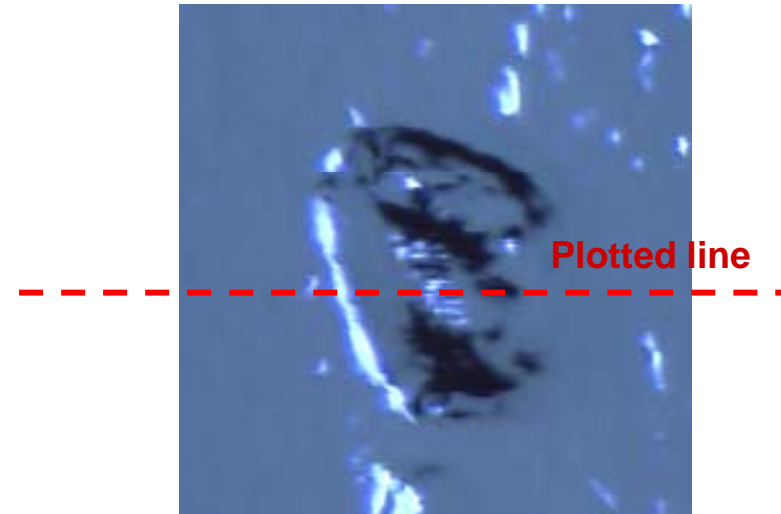


This spot is big bump.

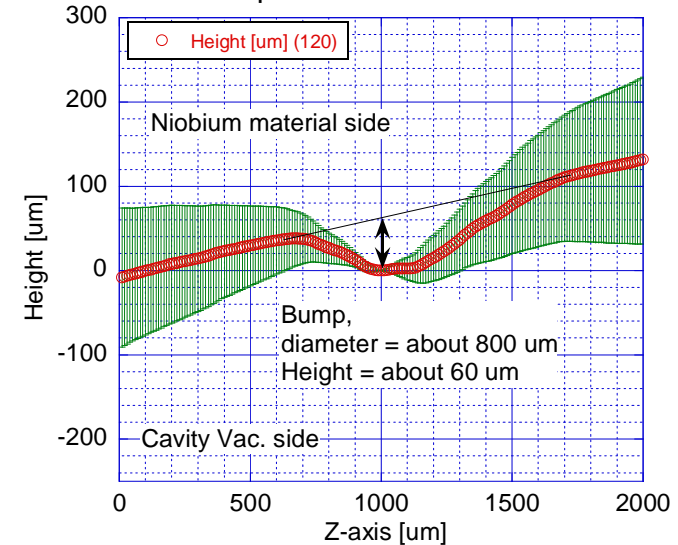
Diameter = 800 μm ,

Height = about 60 μm

Vertical test of this cavity will be done in the first week of Dec 2008.



STF Baseline #5 cavity after EP-1 (125 μm removed)
 #1 cell equator, t=200 deg.
 Upstream = 6.0 mm from center



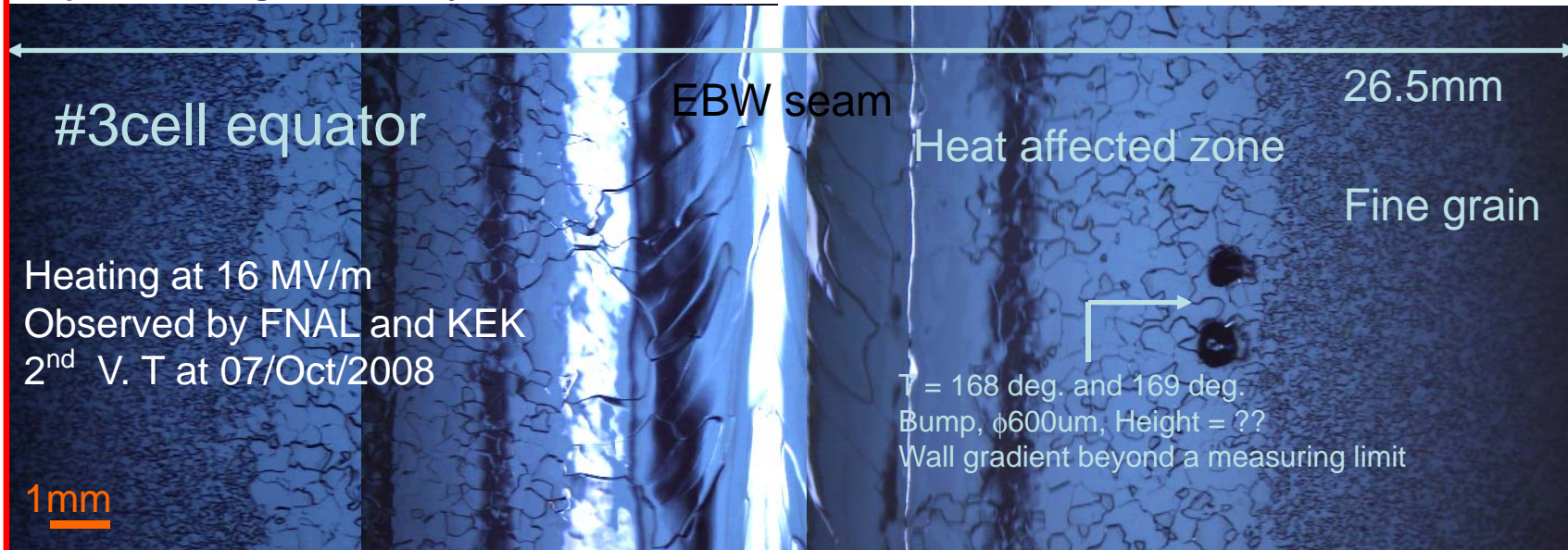


AES#001 cavity



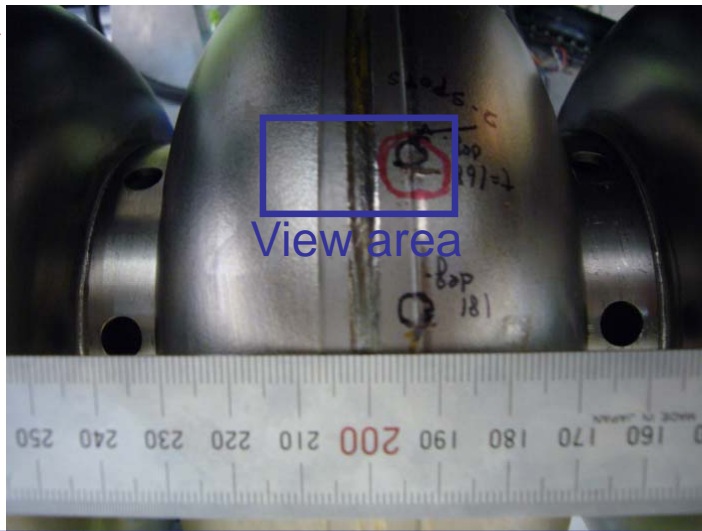
3) AES#001 inspection on the HOT SPOTS after 2nd Vertical Test

superconducting rf test facility



Z-axis

Rotate angle



Z-axis

Twin spots were observed on the heat affected zone (HAZ). EBW seams were very smooth at all cell equators.

Other spots position : #3 cell equator, t = 181 deg on the HAZ.
(Bump, 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.

After this inspection, EP 20um process and Vertical test was done.

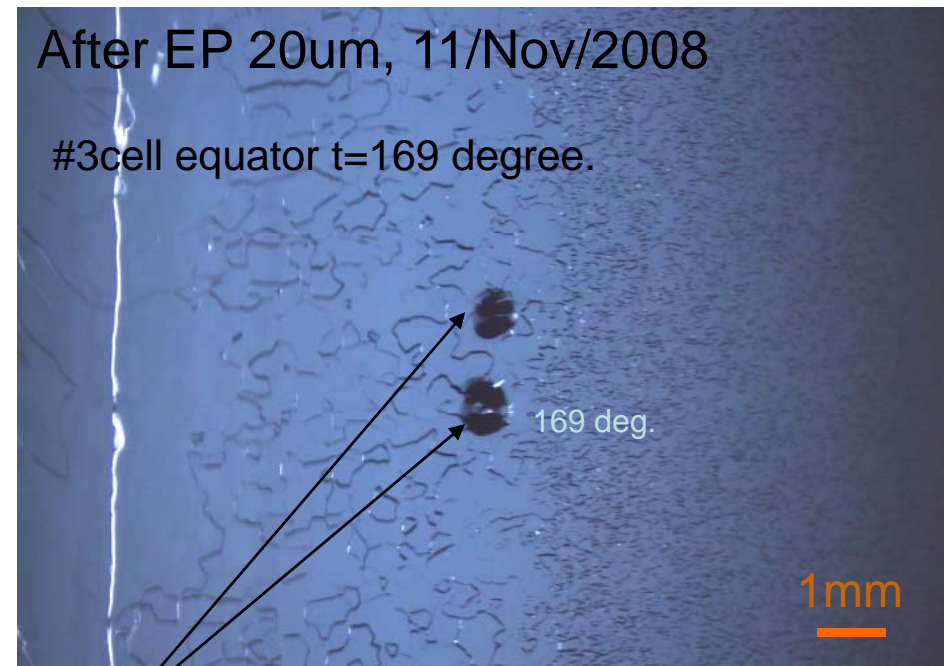
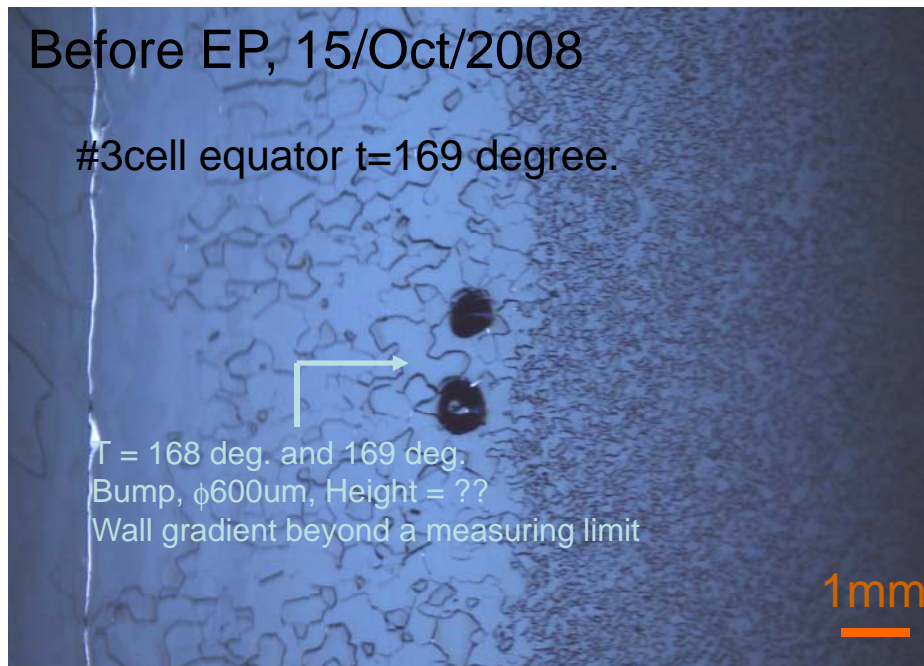


Treatment : EP 20um, HOT rinse, HPR and Baking at STF.

T-map type: 9-cell Fixed (Fish bone type)

Heating at 22 MV/m on the #3cell equator t=169 degree.

Eacc was improvement from 15.8 MV/m to 22.1 MV/m (however HOT spot was same location.)



After EP 20um, the edge of the spots became bright. It shows that it become gentle wall gradient due to EP process (Maybe). The spot of 169 deg is possible to measure a wall gradient.

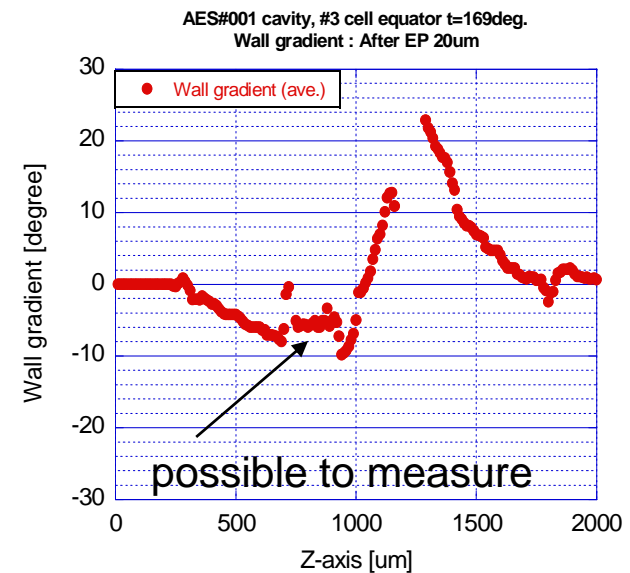
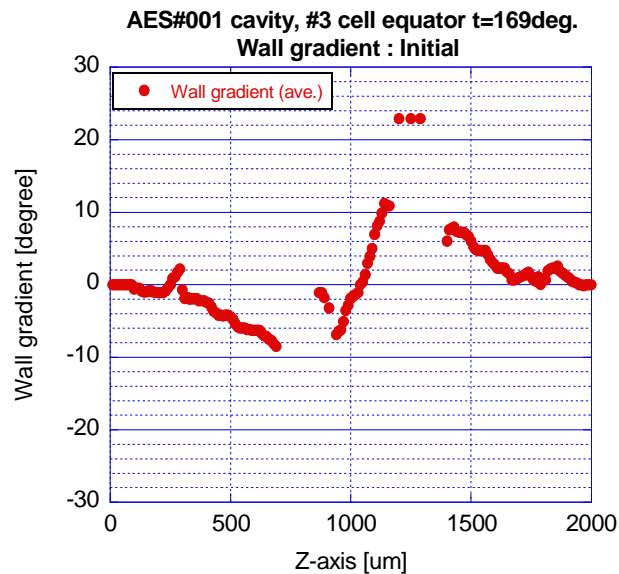
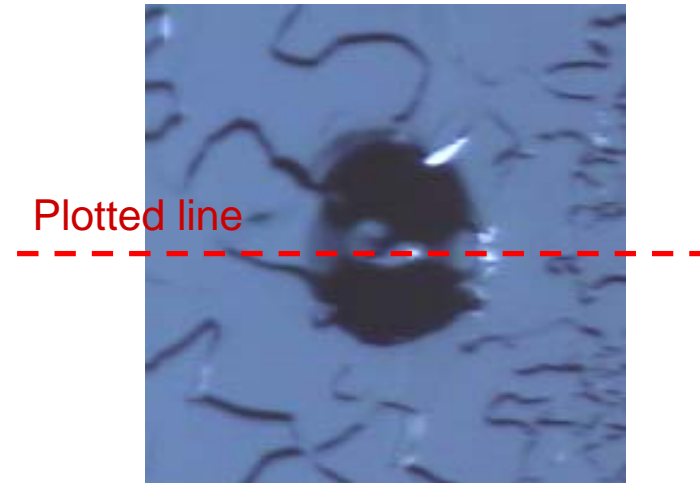
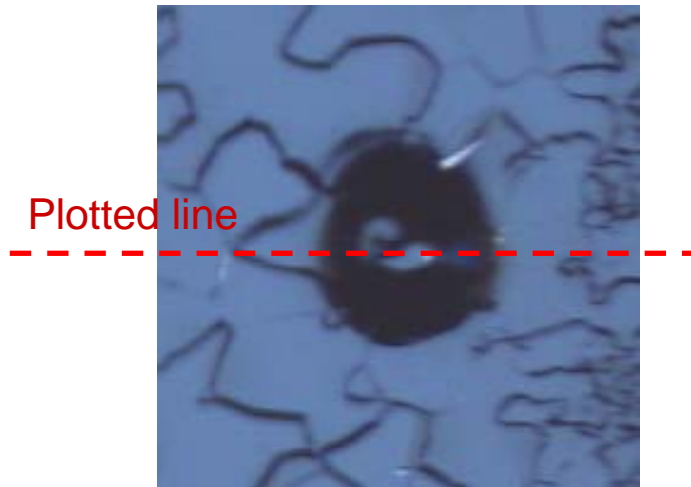


Comparison of wall gradients before and after EP



Before EP, #3cell T=169deg.

After EP 20um, #3cell T=169deg.

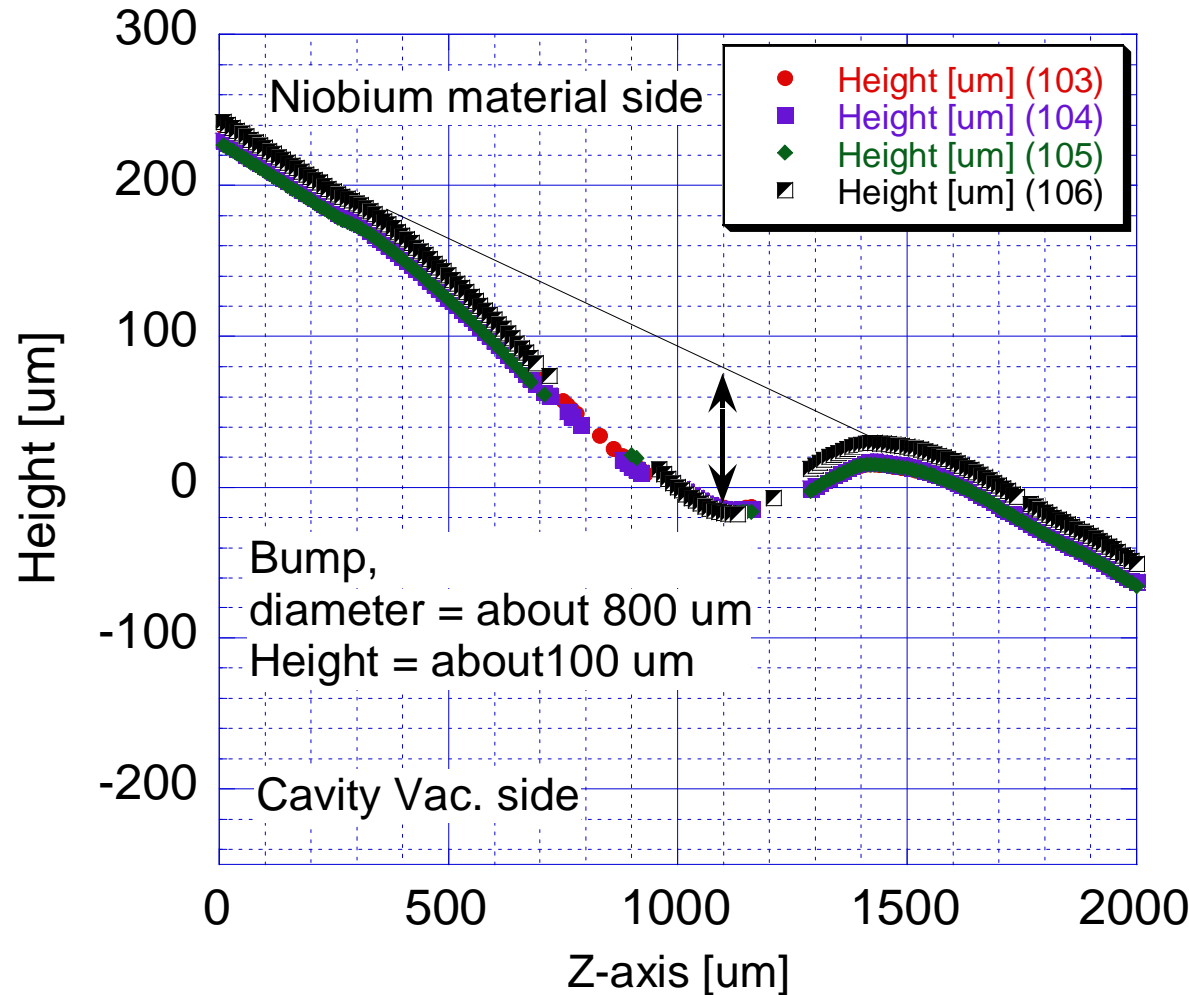




Estimated Bump shape at #3cell t=169deg.



AES#001 Cavity : #3 cell Equator, t=169deg.
After EP-2 (20um removed) and Vertical test
2008/11/7 at STF



Very big
Bump.

Quench field is
22.1 MV/m.



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

The inspection of the STF Baseline cavities (#5, #6) were carried out in each process to trace the change of inner surface.

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

The thermometers will be equipped at the spots location to study the hot spot and will measure 1st Vertical Test of STF Baseline cavity #5 in the first week of December 2008. (*#6 cavity will be measured in the third week of December 2008)

AES#001 cavity of Eacc improved from 15.8 MV/m to 22.1 MV/m in EP process.

The Shape of HOT spot was estimated. The spot was Bump (Diameter = about 800 um, Height = about 100 um).



Thank you your attention