



## **Review of optical inspection methods and results**

K. Watanabe (KEK)

SRF 2009, September 22, 2009



\* The high-resolution camera system is developed to search defects and measure the shape of them for better yield of accelerating gradient of SC 1.3 GHz 9-cell cavities at labs around the world.

\* The goal of the study is to have reference to estimate a cavity performance by inspection.

\*The high resolution camera system is important for industrialization of cavity fabrication to make a suitable production control.

Surface inspection of material EBW inspection

Surface treatment inspection etc.



understand field limitation.

## The World Map of the Inspection Camera





## Inspections during cavity test (in KEK-STF)

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### \* 1<sup>st</sup> inspection at "As received".

Check the EBW seam and Outside of Weld Area at equator and iris.

\* 2<sup>nd</sup> inspection after bulk EP, then shape analysis and marking of the suspicious spots.

\* 3<sup>rd</sup> inspection after Vertical test with Tmap result.

(In case of bad cavity performance and Tmap detected a heating location.)

\* Counter-measure for next test.

\*Molding of defect, \*Local Grinding etc.

\*Rinsing method (Degreaser, Ethanol etc.)



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## Inspection before vertical test (Example: MHI-08)

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and cavity inspection at "Every" Vertical test and treatment.





superconducting rf test facility MHI-05 #3-cell, Un-MHI-05 #6-cell, Un-MHI-06 #5-cell, Un-1HI-01 #3-cell, Pit MHI-08 #2-cell, Pit uniform EBW seam uniform EBW seam uniform EBW seam 2 MV/m (KEK) 17 MV/m (KEK) 25.6 MV/m (KEK) 32.9 MV/m (KEK) 39.9 MV/m (KEK) Constraint Constraint in the 2mm x 2mm 2mm x 2mm MHI-05 #5-cell, Un-MHI-03 #5-cell, Pit uniform EBW seam No clear defect 21.3 MV/m (KEK) 29.2 MV/m (KEK) 2mm x 2mm MHI-04 #1-cell, Pit 21.5 MV/m (KEK) 2mm x 2mm AES-01 #3-cell, bump AES-01 #3-cell, Note: There are some case of no defect found by Kyoto camera at 22.4 MV/m (KEK) bump 15.8 MV/m around a heating location with low field quenches. (KEK), Additional EP 20µm (A cause of the field limitation will be other reason.) Send Lab Sample : MHI-01 ~ MHI-09, AES-01 : 10 cavities. Number of thermo-sensor: MHI-01 ~ MHI-04: 4 sensors per cell. MHI-05 ~ MHI-09 and AES-01: 36 sensors per cell. 2mm x 3mm mm x 3n 25 30 35 40 15 20 Gradient at heating cell [MV/m]



### Correlation of spot size and heating (Rough estimation)

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ftl

1. High resolution camera systems are used in labs world wide to make better yield of high gradient.

Summary

2. Correlation of defects size and quench field is under collecting by combination of inspection and T-map.

3. Larger, deeper (or higher) pits (or bumps) seem to cause quenches. However, not all of the optically observed defects lead to problems.

4. High resolution camera systems can be used for the quality control of cavity fabrication. The feedback to manufacturing of cavity lead to better production yield.





# Thank you for your attention!

Appreciation to the people who gave me materials. (Rong-Li Geng, Camille Ginsburg, Dmitri A. Sergatskov, Sebastian Aderhold, Tsuyoshi Tajima, Zachary Conway, Matthias Liepe)

Poster and Talk for cavity inspection and T-mapping system in this conference,

- Y. Yamamoto, TUPPO 038, TUPPO 057.
- W-D. Moeller, TUOAAU04
- Rong-Li. Geng, TUPPO059
- S. Aderhold, TUPPO035.
- T. Tajima, TUPPO010.
- D. A. Sergatskov, TUPPO037.

- Y. Iwashita, TUPPO040
- Z. A. Conway, TUOAAU05
- etc.....