

Cavity fabrication status in KEK/CFF

KEK

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Current status of Cavity Fabrication Facility (CFF)

Cavity Fabrication Facility (CFF) is working for ILC;

- Study for cost reduction in cavity fabrication
 - ✓ Try new materials (large grain Nb)
 - ✓ Mass production techniques
- Pass the Japanese helium vessel code (high pressure gas safety act.)
 - ✓ Tensile test in cryogenic temperature
 - ✓ Buckling simulation
 - ✓ Welding Procedure Specification
- Investigation on tuner
- Cooperation with companies
- Hydroforming cavity



Main equipments in CFF



Electron beam welding machine
(SST, Germany)
Max. beam voltage: 150 kV



Microscope
(Surface inspection)



Servo press machine
(AMADA, Japan)
Max. applying force:
1500 kN

A cavity can be fabricated
in KEK site combined with
machine tools at MEC

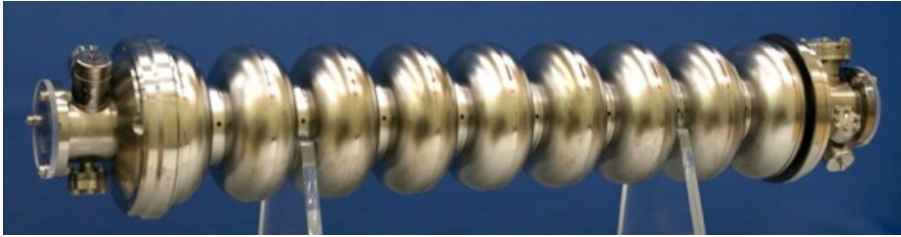


Chemical polishing



CNC vertical lathe
(Moriseiki, Japan)

History of CFF



5 × **9**-cell cavities, 5 × **3**-cell cavity, 10 × **1**-cell cavities
(& some seamless cavities)

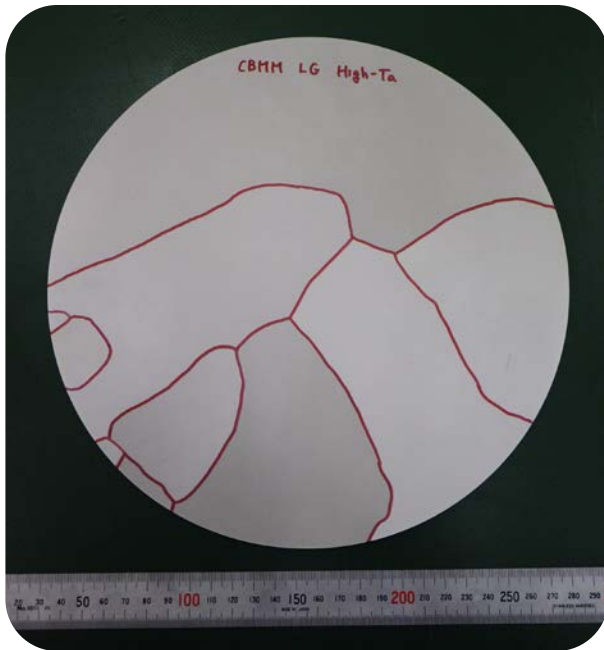
Large Grain Nb

Large grain (LG) niobium for cost reduction

CBMM LG: RRR = 242-298, High-Ta contained (1034ppm)

※High-Ta contained Nb is cheaper than low-Ta contained Nb

CBMM $\phi 260$



Completed
in 2017

Extend to 9-cell

1.3GHz Tesla shape



Completed
in 2019



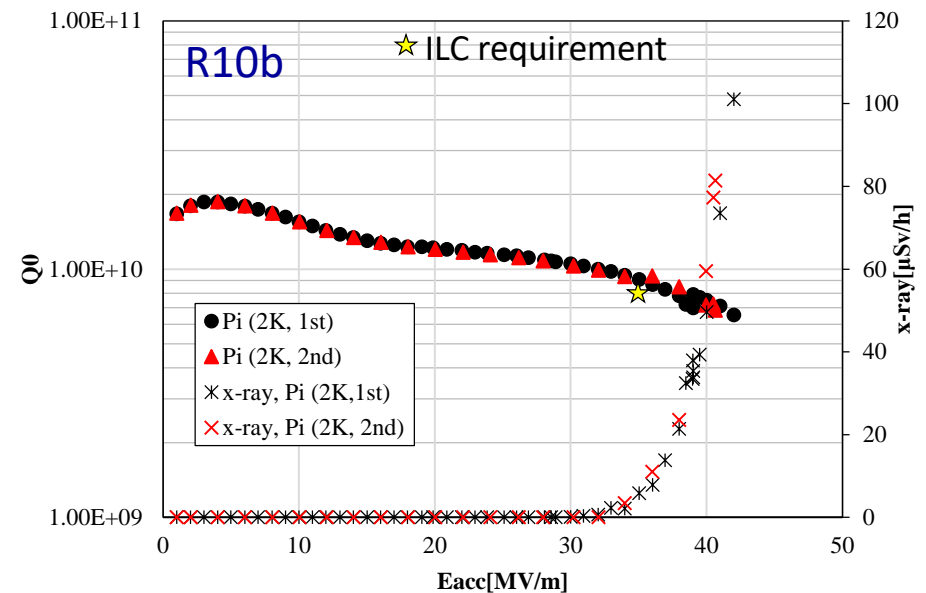
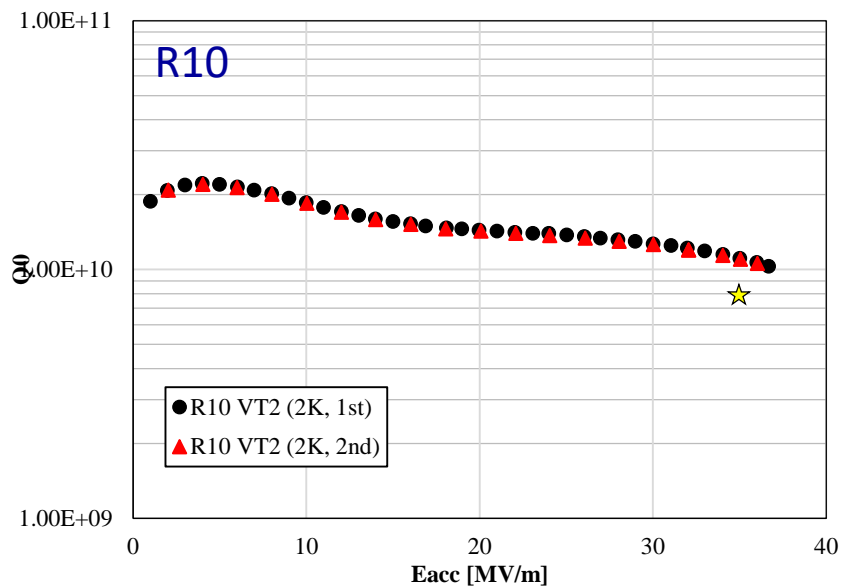
CBMM LG: 3-cell cavity (reminder)

Two 3-cell cavities were fabricated.

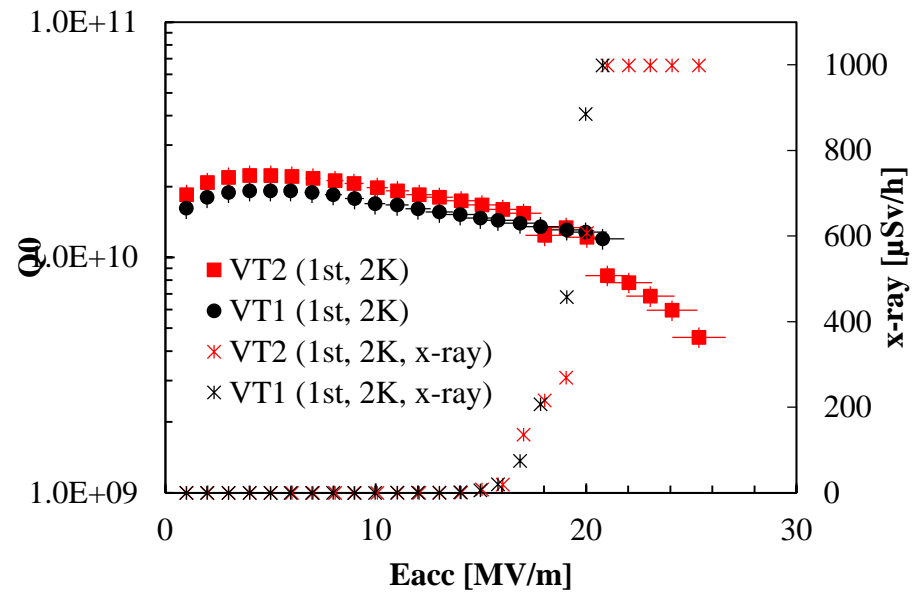
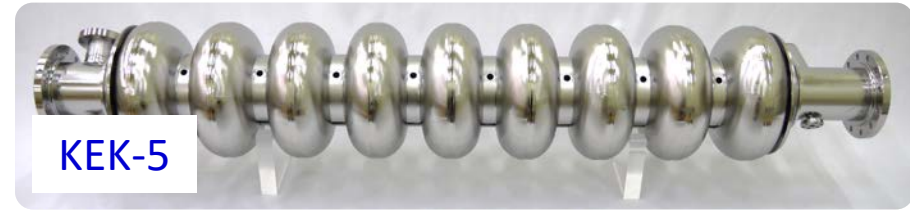
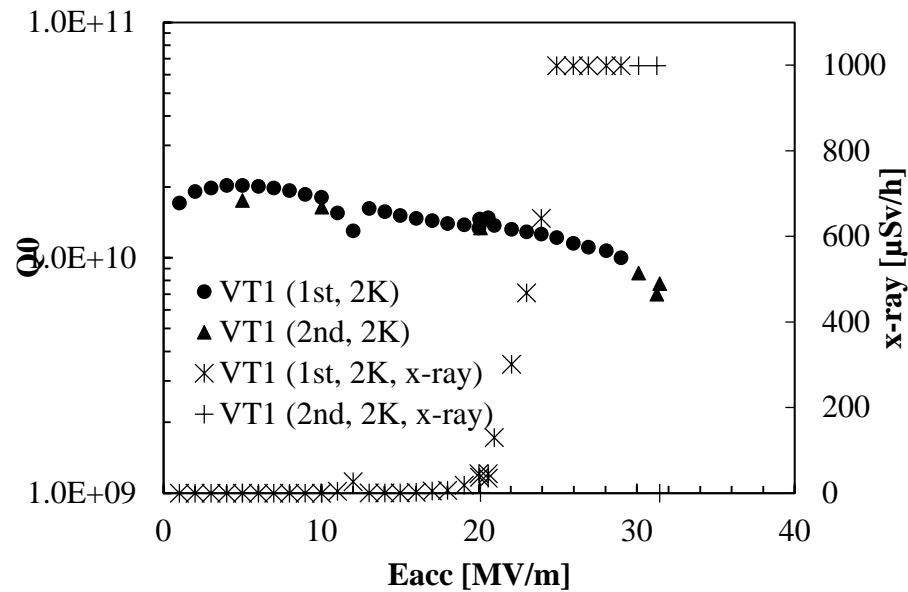
Surface treatment (standard ILC recipe)

1. EP1 (100 μ m)
2. Annealing (750deg \times 3hrs)
3. Tuning
4. EP2 (20 \sim 30 μ m)
5. Assembly
6. Baking (120deg \times 48hrs)

R10/R10b



CBMM LG: 9-cell cavity

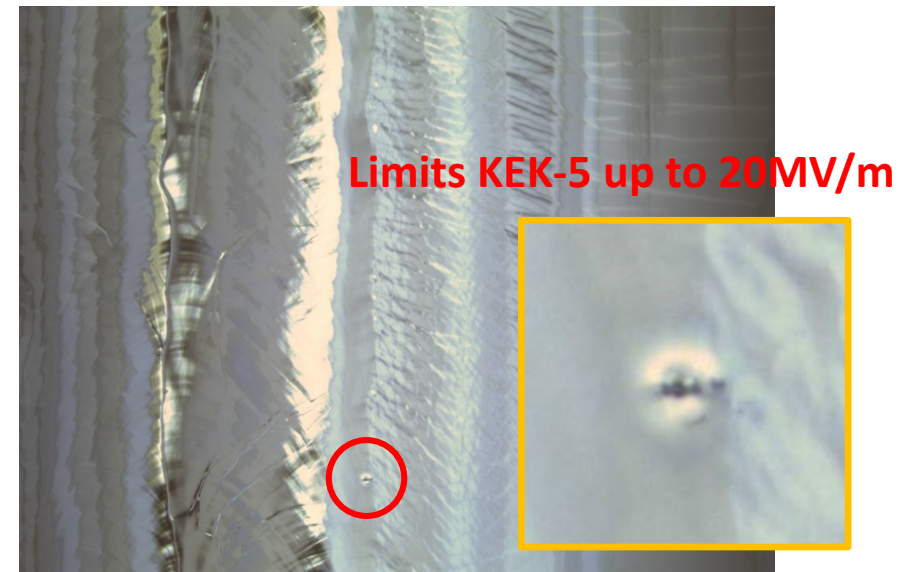
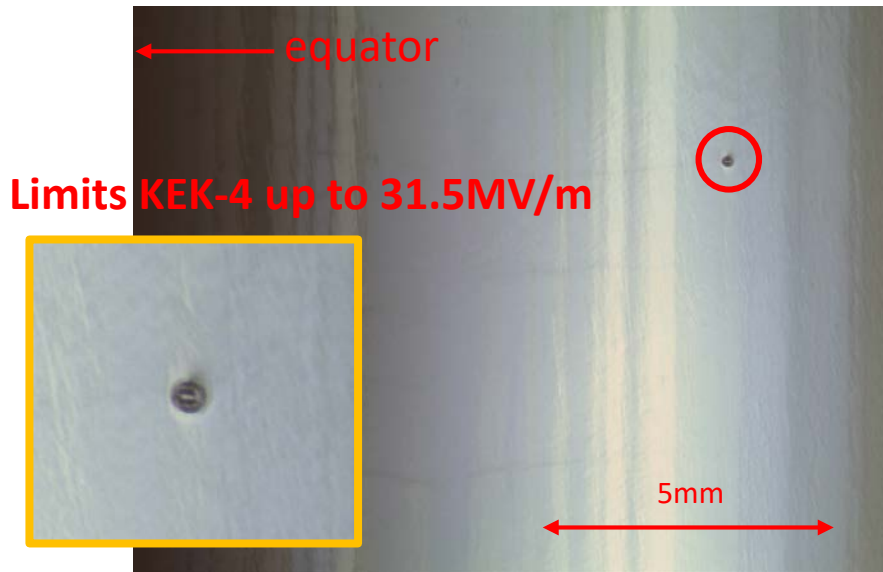


Maximum gradients

	Cell1	Cell2	Cell3	Cell4	Cell5	Cell6	Cell7	Cell8	Cell9
KEK-4	40.0	40.9	>31.5	>31.5	>40.9	31.5	31.5	>40.9	>40.0
KEK-5	>34.4	32.9	30.3	33.4	35.9	>33.4	>30.3	>32.9	>34.4

→To be measured again

Found defects



- ✓ Need to reconsider our fabrication process;
 - Welding procedure
 - Grinding procedure
- ✓ Observe material itself
 - Inner mechanical/thermal stress
 - Contamination

Increase yield ratio
→ Most effective cost reduction

Helium vessel code

High pressure gas safety act. (Helium vessel code)

Aiming to pass the high pressure gas safety act. by KEK.

- Current goal: FG cavity
- Future plan: LG cavity

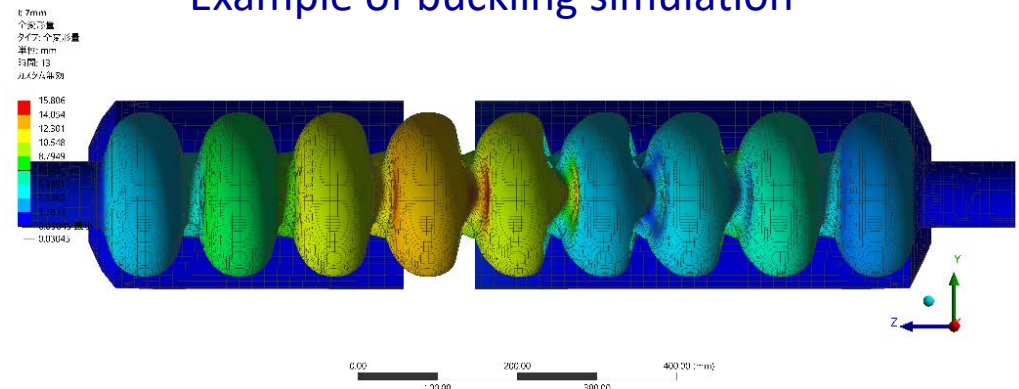
Several items are necessary;

- Buckling/stress simulation
- Welding procedure specification (WPS)
- **Mechanical properties of materials**

Example of WPS

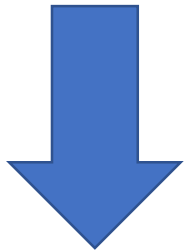


Example of buckling simulation

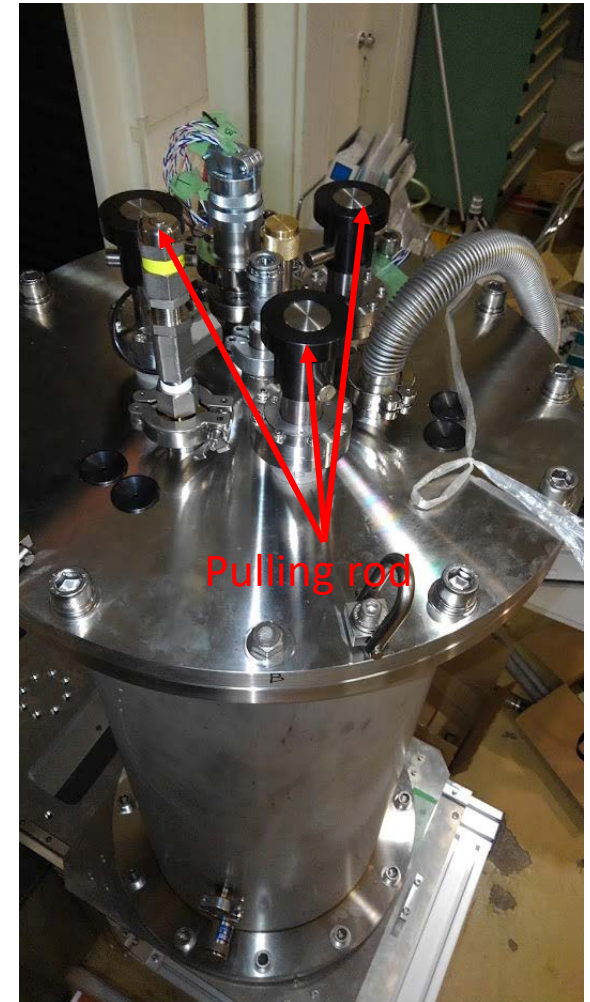


Tensile test at cryogenic temperature

Measuring mechanical properties of LG is necessary to pass the helium vessel code.



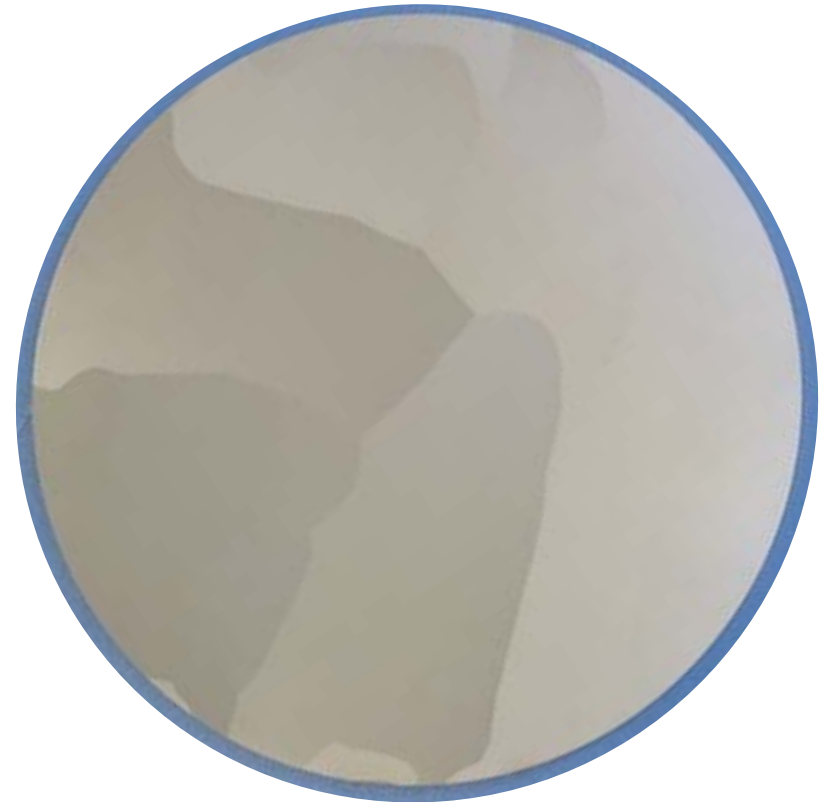
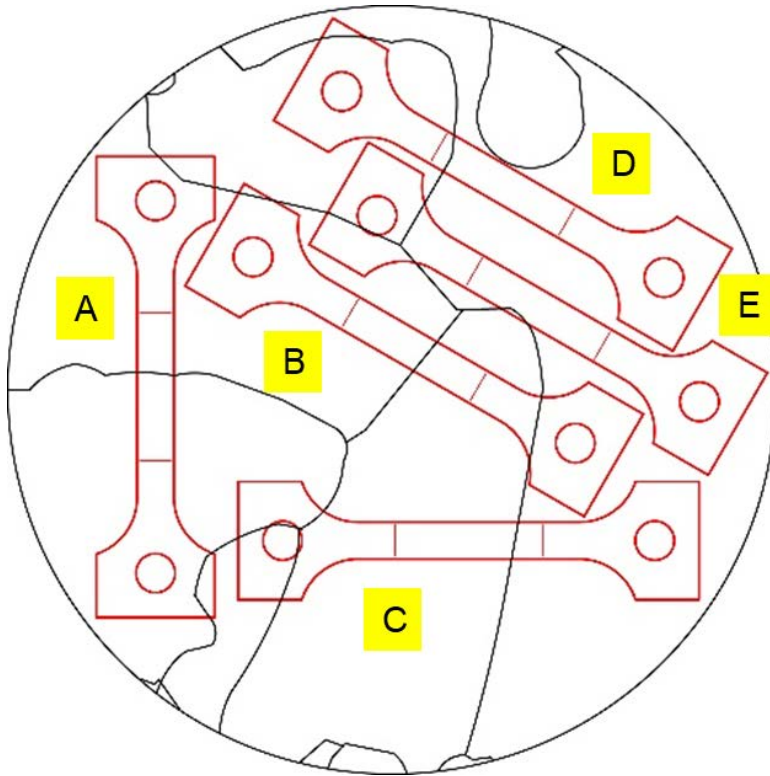
We are currently investigating tensile test system at cryogenic temperature.



Investigated by K. Enami

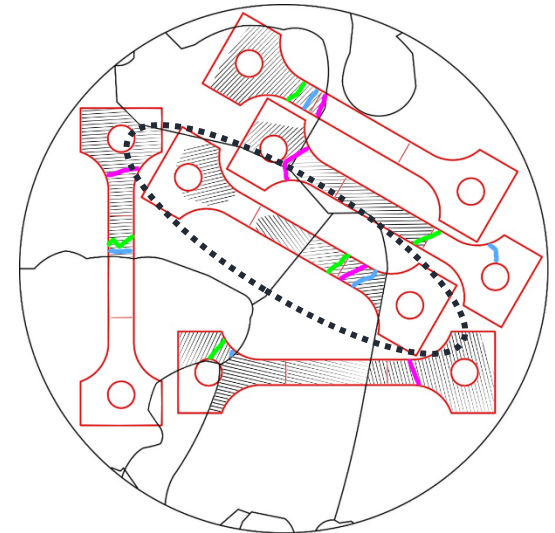
Tensile test of LG slices at cryogenic temperature

3 discs which has similar grain alignment were used for the test.
→Samples were cut considering grain alignment.

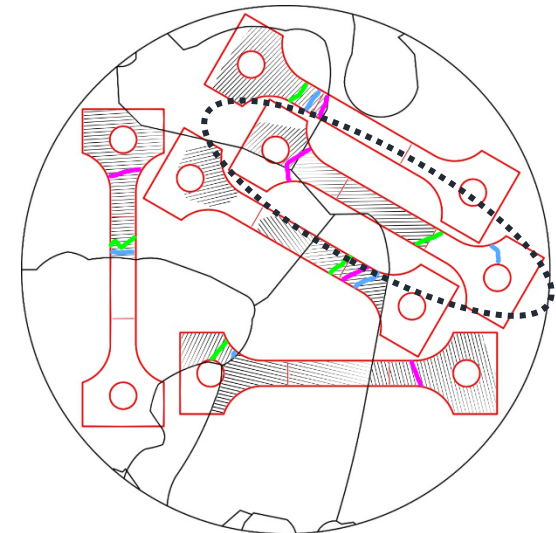


Examples of tensile test results of LG

Broken at similar positions



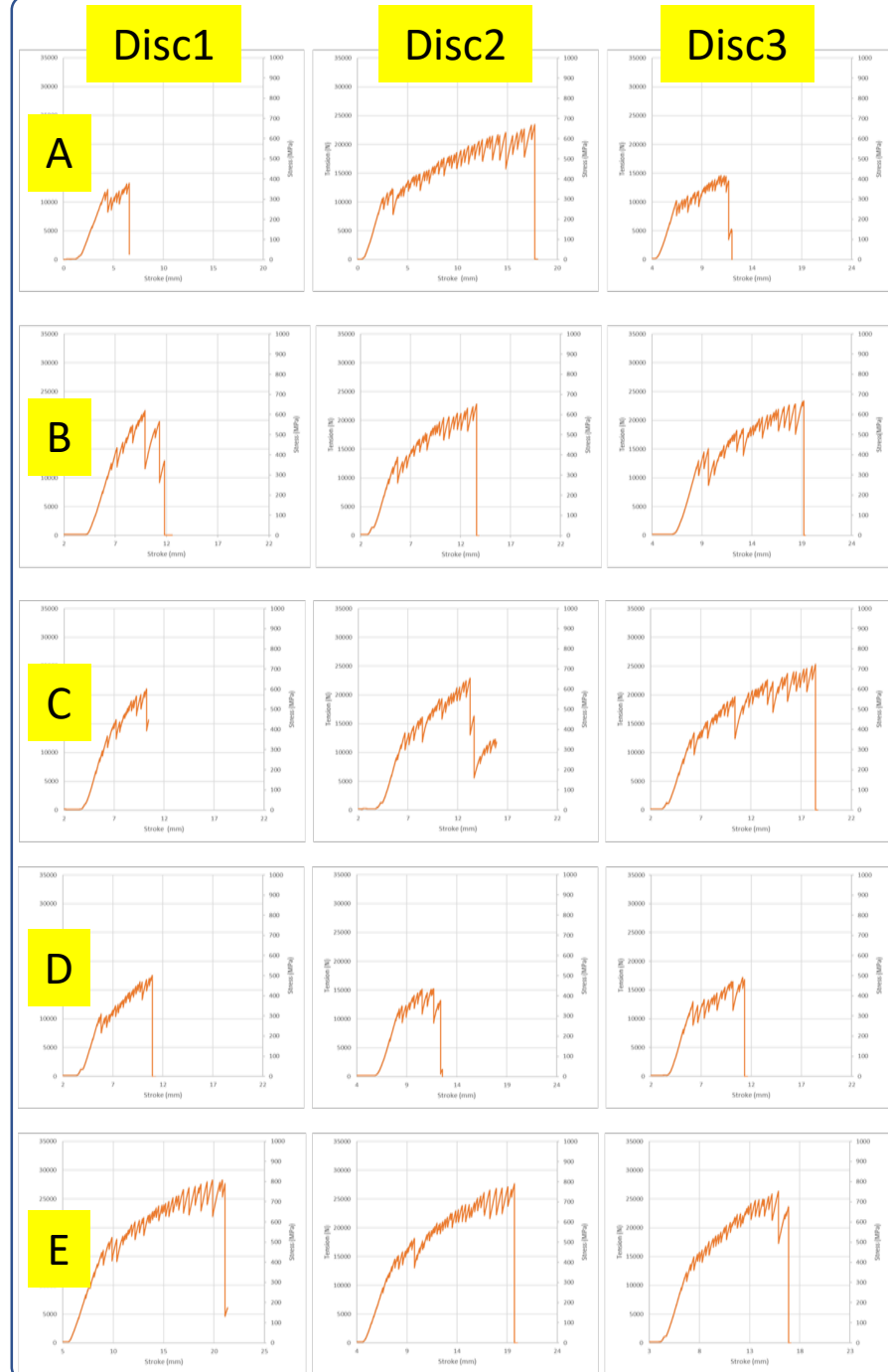
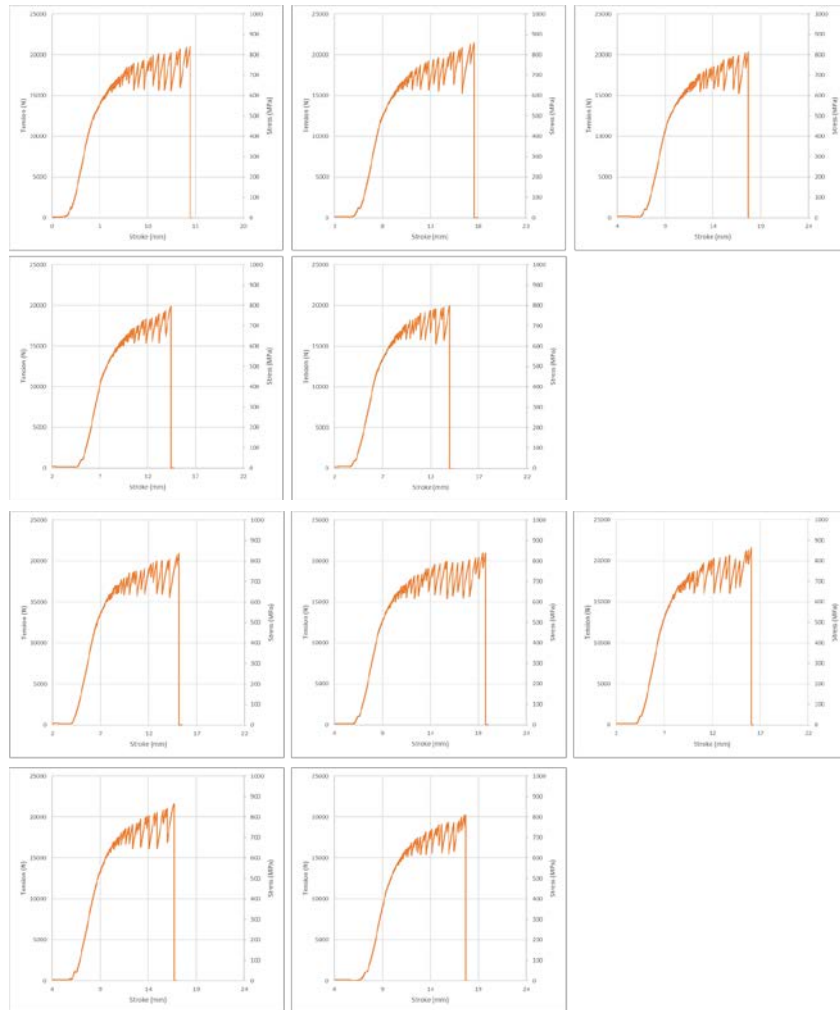
Broken at totally different positions



LG and FG comparison

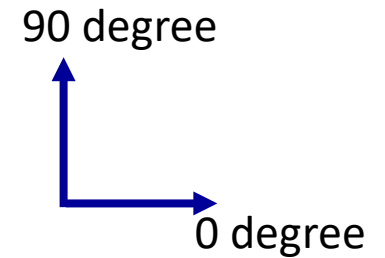
LG

FG



Trend analysis

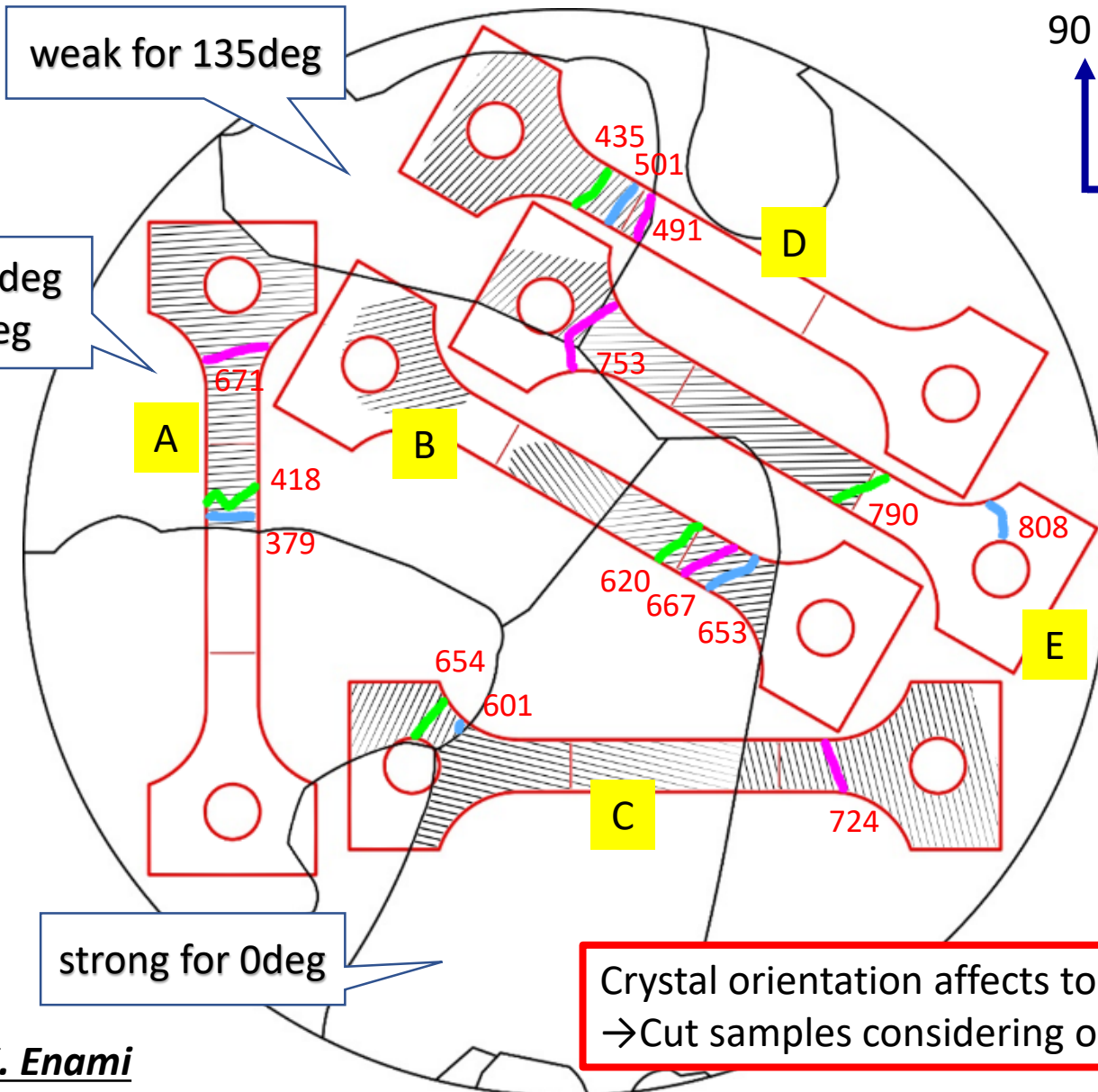
*red number represents
broken tension



weak for 135deg

strong for 135deg
weak for 90 deg

strong for 0deg



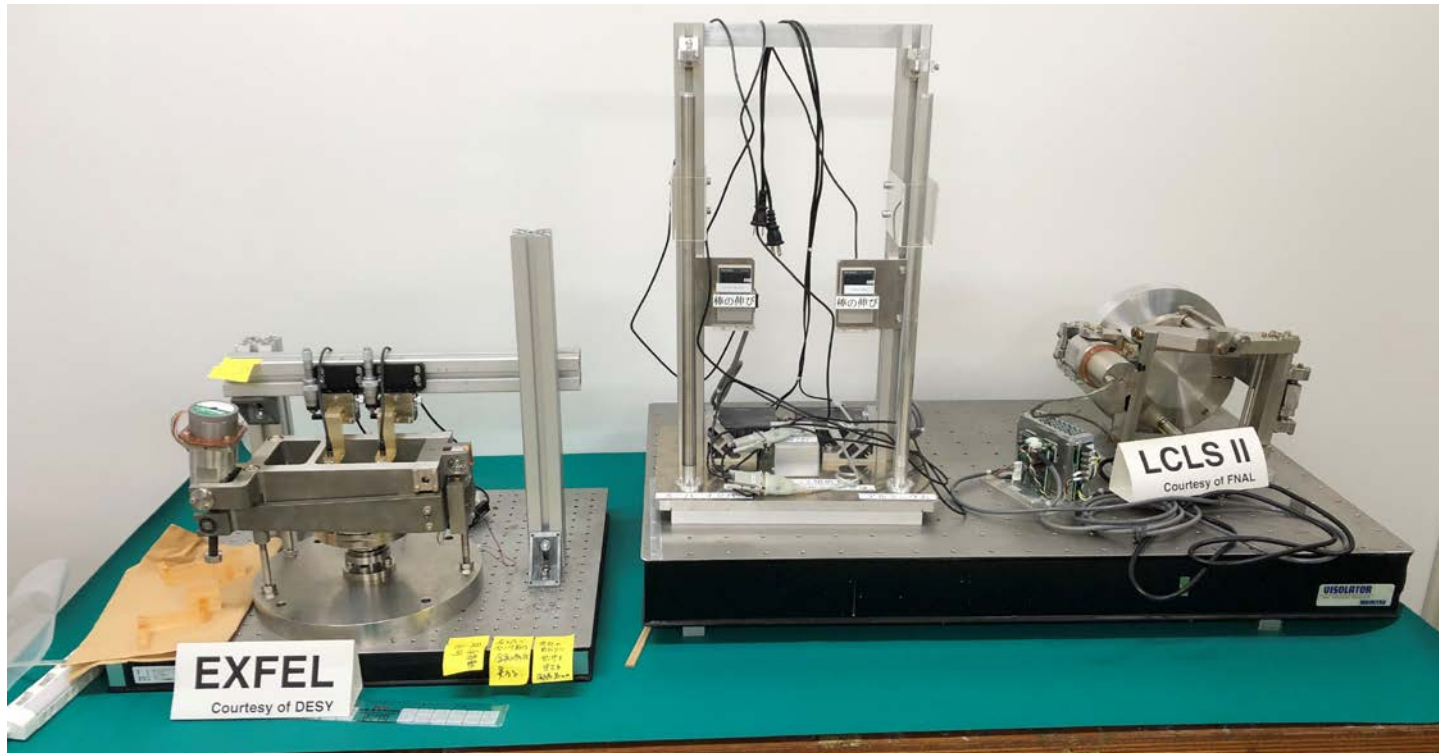
Crystal orientation affects to tensile strength
→ Cut samples considering orientation

Investigation on tuner

Investigation on tuner

Many thanks to DESY and FNAL, we had just re- started our investigation on tuner.

- Validating (playing) two tuners.
- Investigating suitable tuner for ILC
→ Use the best of both tuner
- Finding new actuator



Investigated by M. Yamanaka

Collaboration with companies

Collaboration with company

Collaboration is ongoing with several companies.

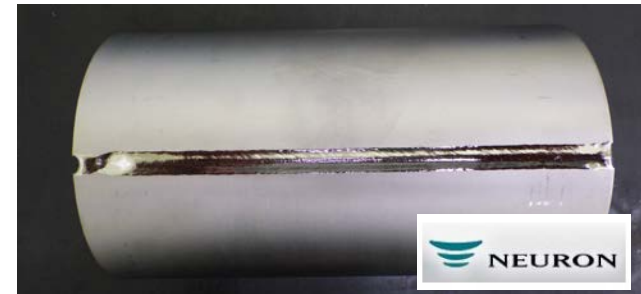


HOM housing production



ULVAC

Beam tube mass production

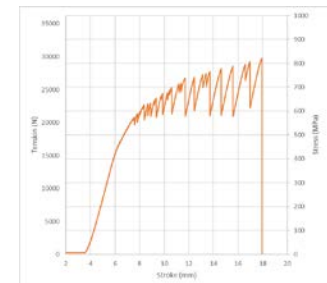


Cavity fabrication



Cryogenic tensile test of Nb production

ULVAC



Similar values as Tokyo Denkai were measured.

Summary

Summary

- Cost reduction investigation on material
 - Two 9-cell cavities were fabricated using CBMM LG
 - ✓ Insufficient results were obtained
 - To be measured again
 - ✓ Some defects were found
 - Reconsider fabrication process
 - Observation of material itself
- Helium vessel code
 - ✓ Aiming to pass with FG cavity (on going)
 - ✓ Planning to pass with LG cavity
 - Measurement of mechanical property is necessary
 - Tensile test system in cryogenic temperature was investigated
 - further strategy will be necessary for the measurement
- Investigation on tuner
 - Just started
- Cooperation with companies