



The fabrication of the 1.3 GHz single-cell cavity utilizing the different grain size materials

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Acknowledged



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- ❖ **Introduction of KAT**
- ❖ **1.3 GHz single-cell cavity**
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Background of R&D

1.3 GHz single-cell cavity fabrication

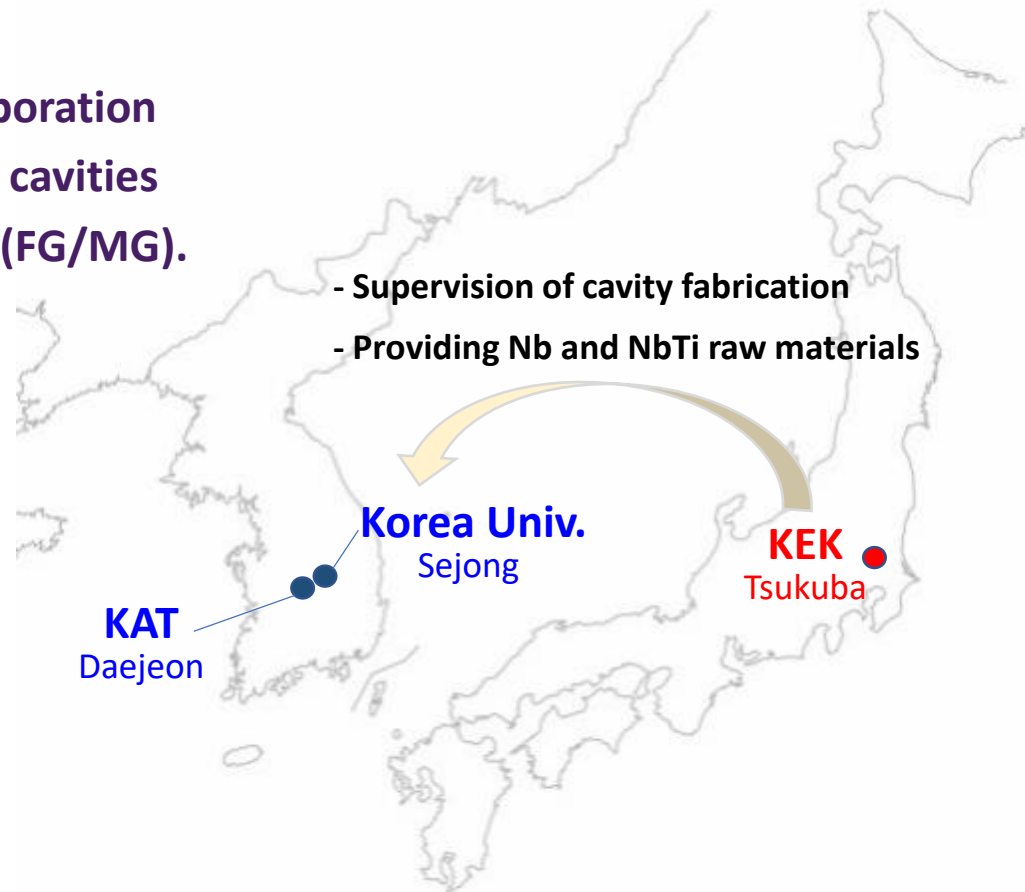
As an activity for the GLOBAL COLLABORATION for ITN,

KEK(JPN) and **Korea Univ.(KOR)** are proceeding the collaboration for the fabrication of 1.3 GHz 9-cell cavity.

KAT Co., Ltd. has participated in the collaboration for manufacturing two 1.3 GHz single-cell cavities with the different grain size Nb materials (FG/MG).

* FG : fine grain size

* MG : medium grain size



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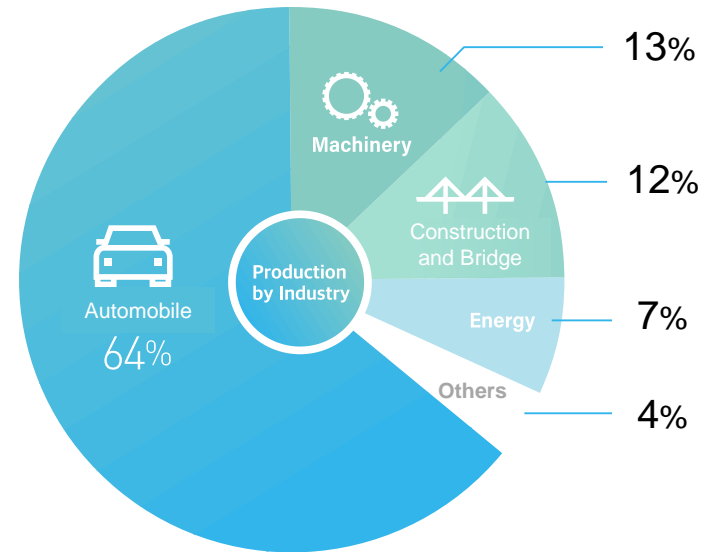
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Kiswire, Global Specialty Wire Company

Founded in 1945, Kiswire manufactures specialty steel wire products for a diverse range of industries including automotive, bridge, energy, construction and electronics. Kiswire exports to customer in over 80 countries.

Establishment	1945	Headquarters	Busan, Korea
Export countries	80	Annual total production capacity	1,200,000t
Worldwide employees	6,000	Annual sales	1.9 B USD (FY 2022)



KAT is a global leading superconducting wire company, located at Daejeon/South Korea.

Established in 2004 as a wholly owned subsidiary of Kiswire, KAT specializes in high-performance superconducting wires, including Nb₃Sn, NbTi, and MgB₂. These wires are utilized in fusion reactors such as K-STAR, ITER and DTT project.

KAT has been also developing the High-Jc Nb₃Sn wire for the FCC project in collaboration with CERN.

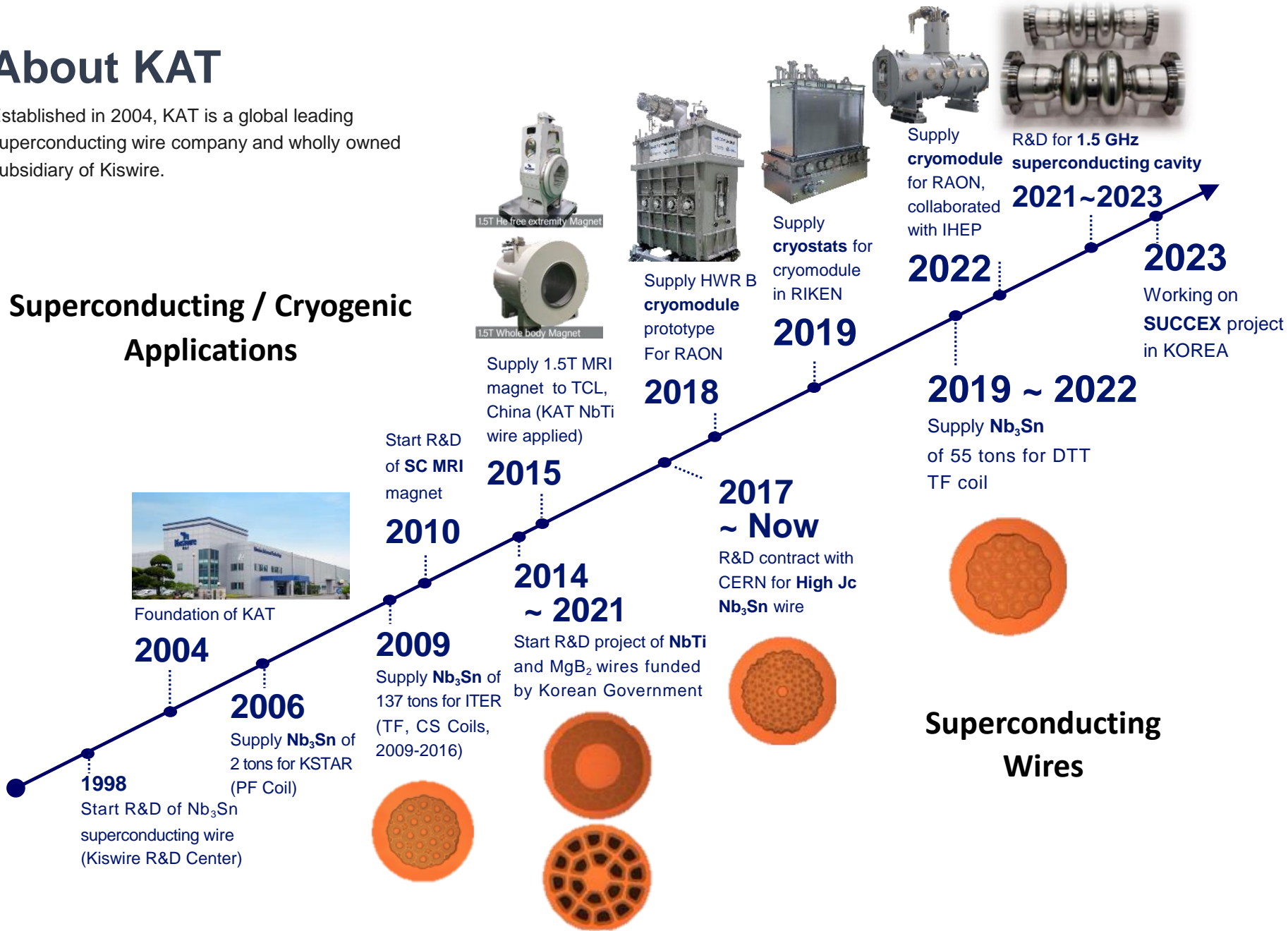
Additionally, from 2018 to 2022, KAT supplied the cryomodule prototypes and cryostats to RAON and RIKEN, respectively. From 2021 to 2023, KAT successfully fabricated and tested the 1.5 GHz 3rd harmonic superconducting cavity for new Synchrotron light source.



About KAT

Established in 2004, KAT is a global leading superconducting wire company and wholly owned subsidiary of Kiswire.

Superconducting / Cryogenic Applications



Superconducting Cryomodule



RAON HWR B Cryomodule Prototype (2018, IBS/Korea)

- Cavity, coupler, tuner were supplied by IRIS
- Cryostat design and manufacturing by KAT
- Cryomodule assembly including clean room work by KAT



Superconducting Cryomodule



RIKEN QWR Cryomodule Cryostat (2019, MHI-MS)

(vacuum vessels, thermal shields, and other parts)

- KAT has manufactured the vacuum vessels and thermal shields and the helium leak test and pressure tests according to the Japanese Industrial standard.
- Those cryostat parts have been supplied to MHI-MS and assembled as the cryomodule.
- The cool-down process has been conducted in 2020 successfully.

Superconducting Cryomodule



RAON SSR2 Cryomodule R&D Prototype Assembly (2022, RAON/Korea, Collaboration with IHEP/China)

- The cryomodule assembly work has been done by collaboration of IHEP and KAT in RAON.
- In 2024, KAT plans to participate in the SSR2 cryomodule mass production prototype in collaboration with IHEP.



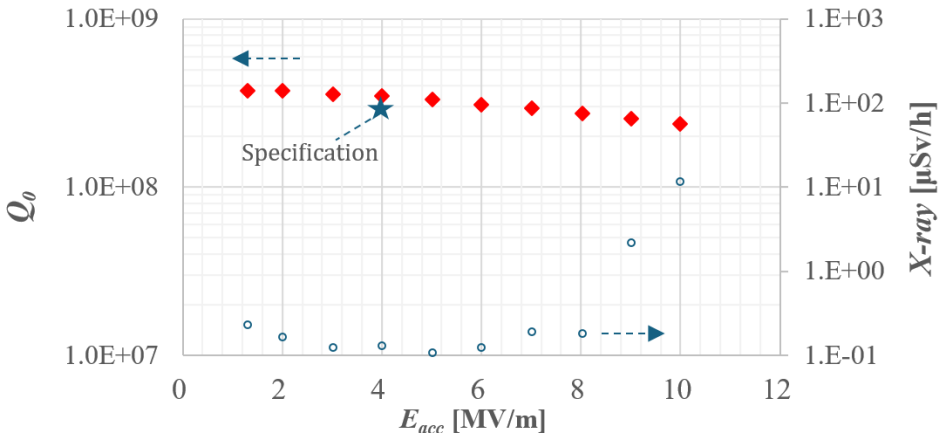
Superconducting Cavity



KPS 1.5 GHz 3rd Harmonic Cavity Prototype

(2023, Collaboration with Korea Univ.)

- The cavities have been fabricated by KAT with the technical advices by Korea University.
- The vertical test of the cavity has been conducted utilizing the infrastructure of SARI-SSRF/China, and the test results met the targeted specifications.



Vertical test results of the 1.5 GHz 2-cell 3rd harmonic cavity at 4 K

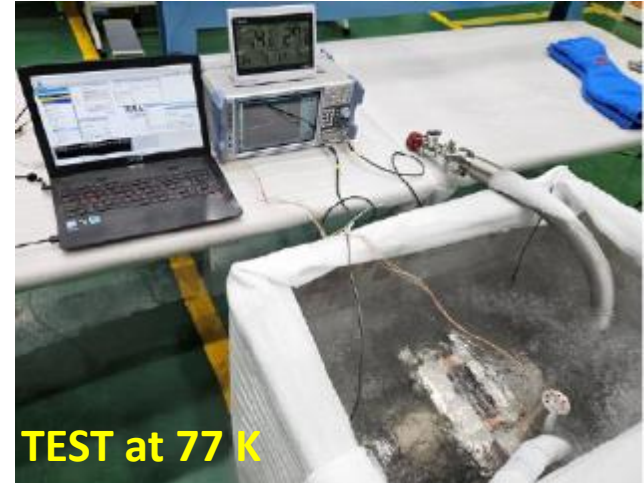
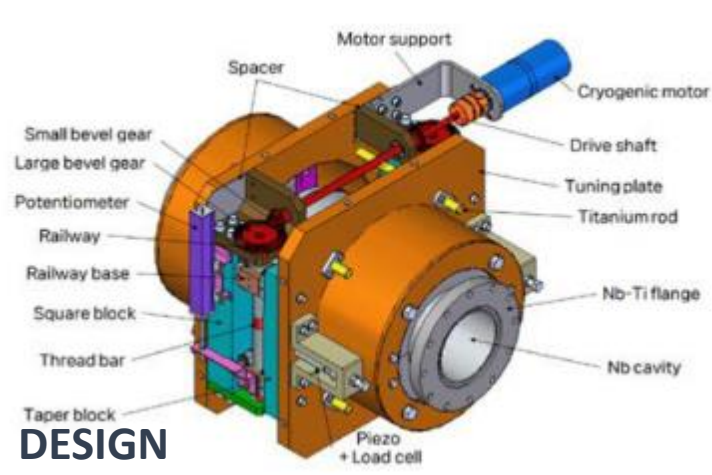
Frequency Tuner for Superconducting Cavity

Frequency Tuner for 1.5 GHz 3rd Harmonic Cavity Prototype

(2023, Collaboration with Korea Univ.)

- The tuner has been designed, manufactured, and tested by KAT with the technical advices by Korea University.
- The performance test of the tuner has been conducted at the liquid nitrogen temperature successfully.

Parameters	Unit	Required @ 77K	Measured @ 77 K
Tuning range	kHz	≥ 500	532
Tuning sensitivity	Hz/step	≤ 3.0	1.0



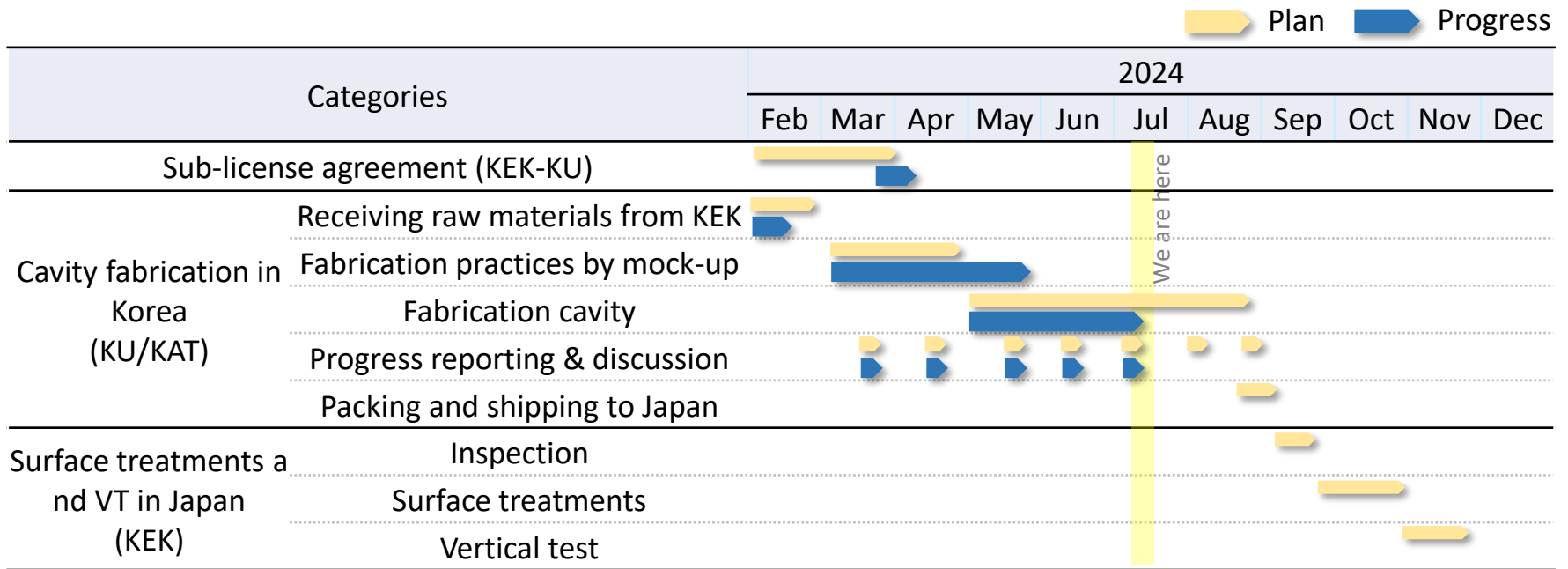
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 - Cavity Design and Raw Materials
 - Parts Fabrication
 - Electron Beam Welding
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1.3 GHz single-cell cavity

Objectives and Schedule

- Objectives
 - : Verification of cavity fabrication process in Korea by utilizing different Nb raw materials
 - Fabrication two 1.3 GHz single-cell cavities (1 FG cavity/1 MG cavity) in Korea
 - Surface treatment and vertical test of cavities by KEK in Japan
- Schedule
 - Fabrication of two 1.3 GHz single-cell cavities by Aug 2024



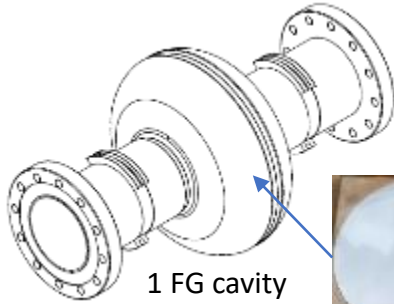
1.3 GHz single-cell cavity

Cavity Design and Raw Materials

- Cavity Design

- The typical 1.3 GHz single-cell cavity

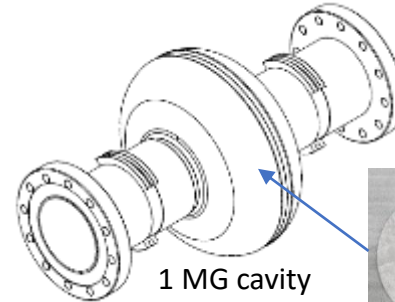
- Two cavities with same geometry, but different grain size Nb materials on the cell



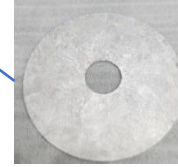
1 FG cavity



Fine grain size Nb discs are to be utilized in fabrication of half cells.

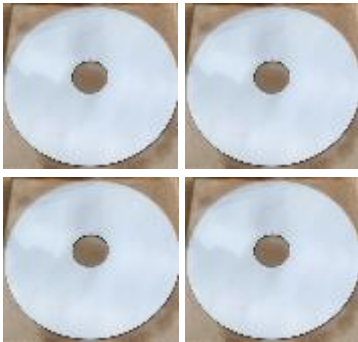


1 MG cavity



Medium grain size Nb discs are to be utilized in fabrication of half cells.

- Raw Materials



Fine grain size Nb discs
(4 pcs)



Medium grain size Nb discs
(4 pcs)



Nb tubes
(4 pcs, fine grain)



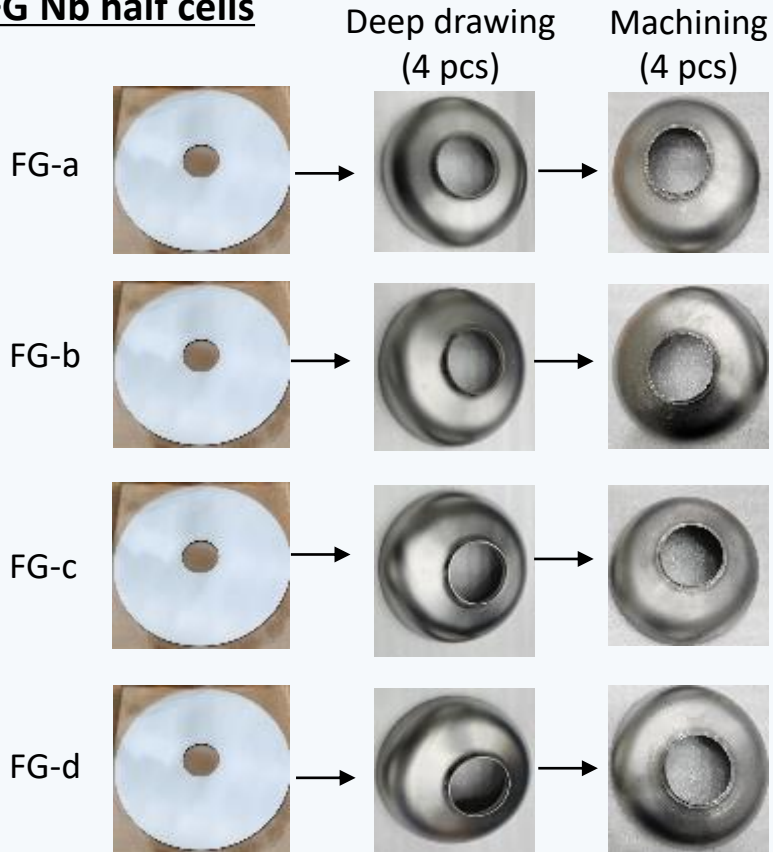
Nb billets
(2 pcs, low RRR)

1.3 GHz single-cell cavity

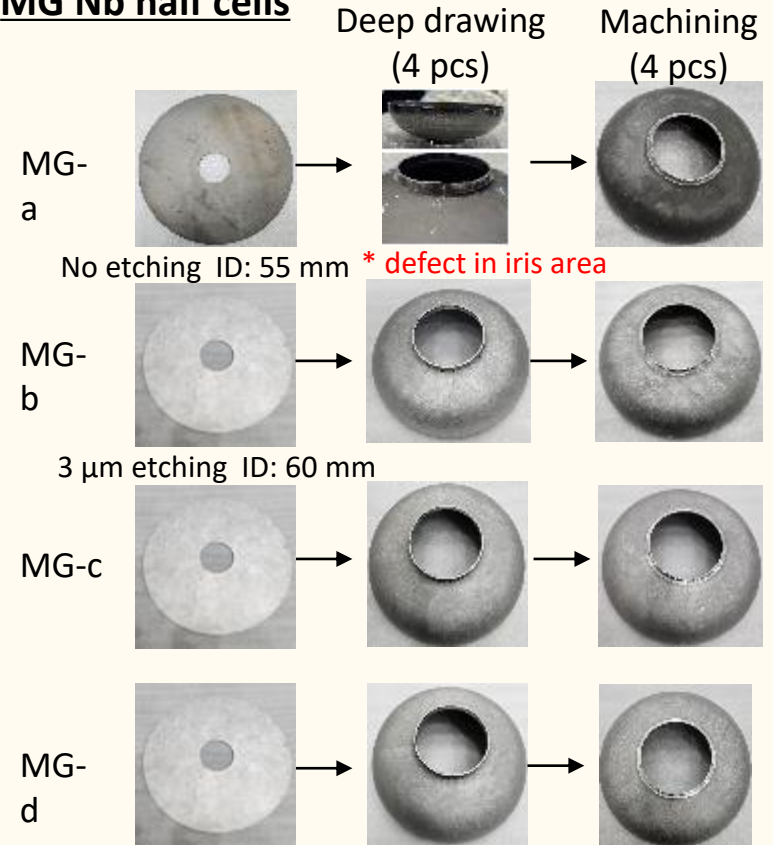
Parts Fabrication

- Half cell fabrication
 - Totally 8 half cells have been fabricated.
 - One of MG half cell had a defect at iris area during deep drawing process.

FG Nb half cells



MG Nb half cells



※ The deep drawing of half cells has been done by collaboration with KIMS (Korea Institute of Materials Science)

1.3 GHz single-cell cavity

Parts Fabrication

- Other parts fabrication
 - Tubes and fixture rings have been fabricated.

Nb Tubes



Beam tubes (4 pcs)



Beam tubes with fixture rings (4 pcs)



Nb billets



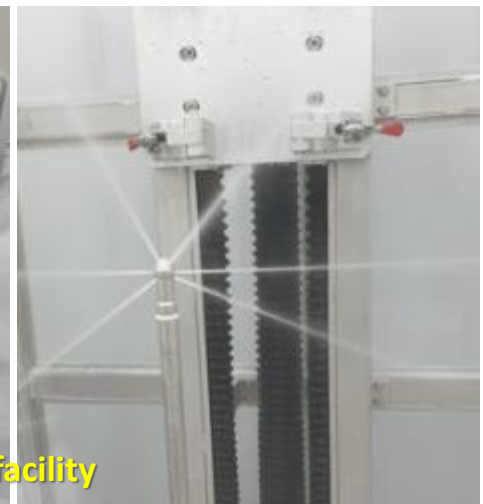
Fixture rings (8 pcs)

EBW

1.3 GHz single-cell cavity

Electron Beam Welding (EBW)

- Cavity fabrication infrastructure in KAT



1.3 GHz single-cell cavity

Electron Beam Welding (EBW)

- Before starting EBW for two 1.3 GHz single-cell cavities (1 FG cavity and 1 MG cavity) with provided Nb materials by KEK, we have practiced the EBW process to check the EBW quality.
- Around 10 Nb sheets from Tokyo Denkai/JPN have been utilized for the EBW practices.
- **The EBW of two 1.3 GHz single-cell cavities (1 FG/1 MG) will be proceeded by Aug 2024.**



Equator / Iris
EBW practices



Cells / Beam tube / Flange
EBW practices



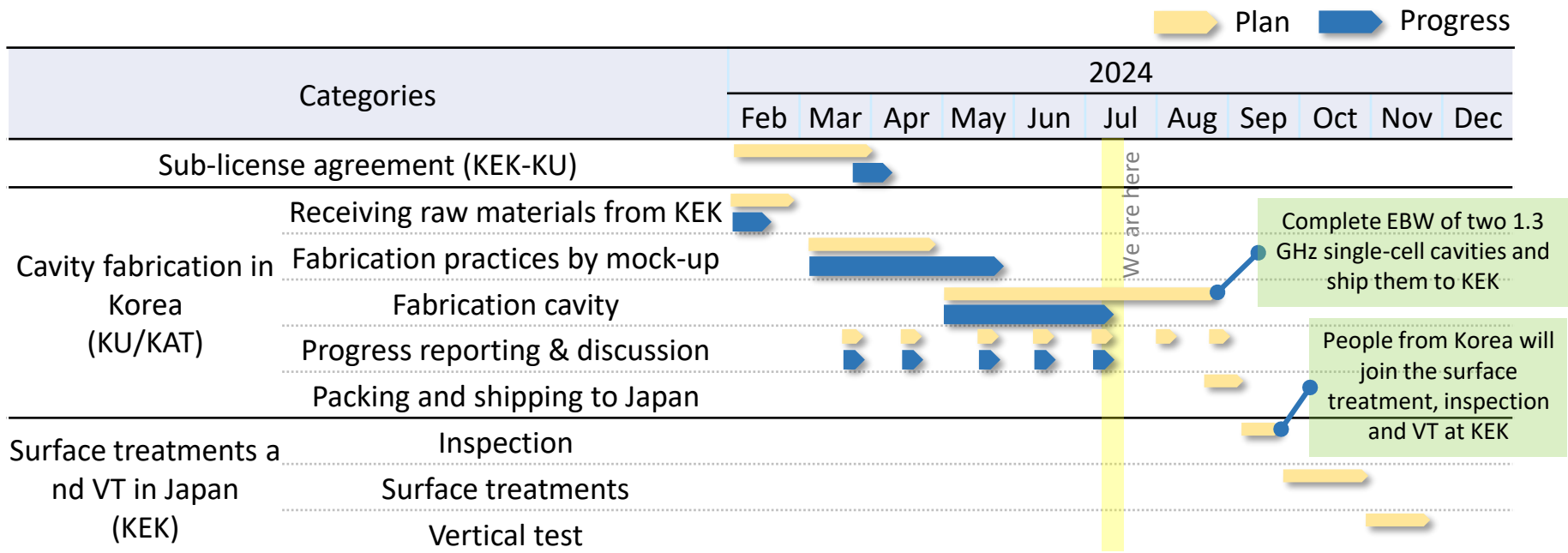
Iris
EBW practices

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Summary & Future Work

- As the activity of global collaboration for ITN, KEK/JPN and Korea Univ./KOR have started the fabrication of two 1.3 GHz single-cell cavities.
- KAT/KOR has received the Nb raw materials from KEK, and almost finished the fabrication of parts of two cavities.
- We have continued the regular technical meeting for checking progress, technical issues and so on from the Mar of 2024.
- The 1.3 GHz single-cell cavities will be shipped to Japan after EBW completed and then the surface treatments and vertical test of cavities will be conducted by KEK



End of Presentation

Thank you.