



# Horizontal Test Results of Large Grain 9-cell cavity

**The 11<sup>th</sup> IHEP-KEK SRF collaboration meeting**

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# Motivation



- **Obtain the technology needed for the horizontal test of Large Grain TESLA 9-cell cavity**
- First trial of horizontal test for large grain 9-cell cavity
- First trial of horizontal test for TESLA cavity
  
- **There are several challenge!**
- First welding of He jacket to TESLA 9-cell cavity
  - Can cavity performance be maintained during jacket welding?
- First trial of HPR for dressed 9-cell cavity
  - Effective to suppress field emission?
- Firstly designed the magnetic shield for TESLA 9-cell cavity
  - How is flux trapping for horizontal test? How is Q-value?

# Procedure to Horizontal Test of KEK-7



Month	Procedure	Place
2022/June	Vertical test	STF
July	Ar purge & flange exchange	STF cleanroom
July ~ August	He jacket welding	CFF
August ~ Sept.	Pressure test	CFF
Oct. ~ Nov.	Disassembly HPR & Assembly for Jacketed cavity	COI cleanroom
Dec. ~ January	Preparation for HT	AR East
2023/January	HT	AR East

# Flange exchange for jacket welding

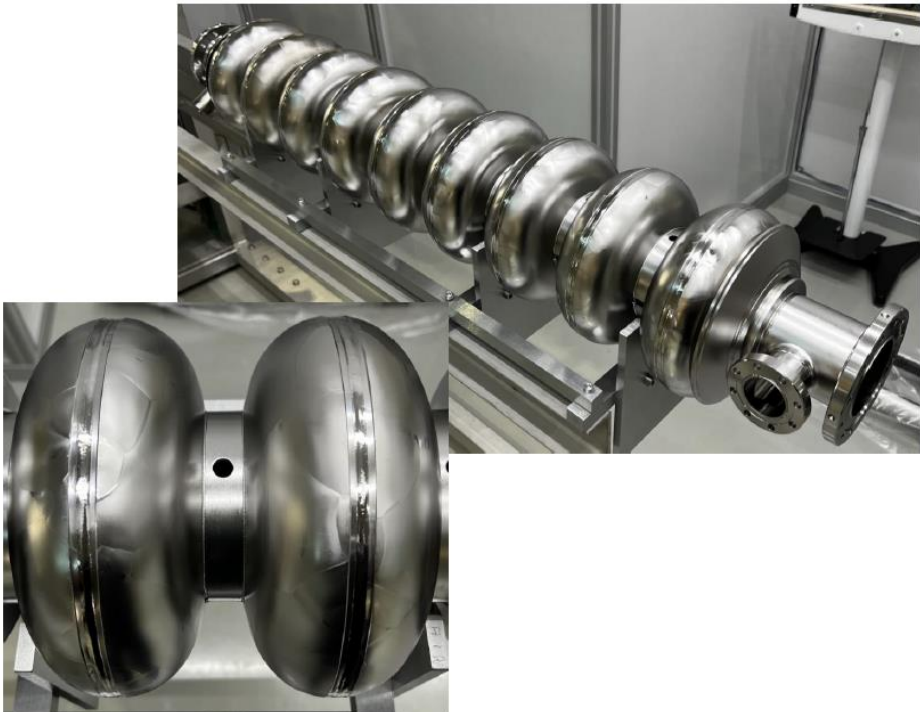


- Cavity flange was exchanged for jacket welding, under Ar flow.
- Slow pump/purge system was used for the pumping and purge.



## Large grain cavity

- TESLA shape 9-cell cavity
- Large grain Nb cavity
  - High RRR, high Ta content
- Manufactured at KEK CFF



Name, 2022/00/00

## Surface treatment

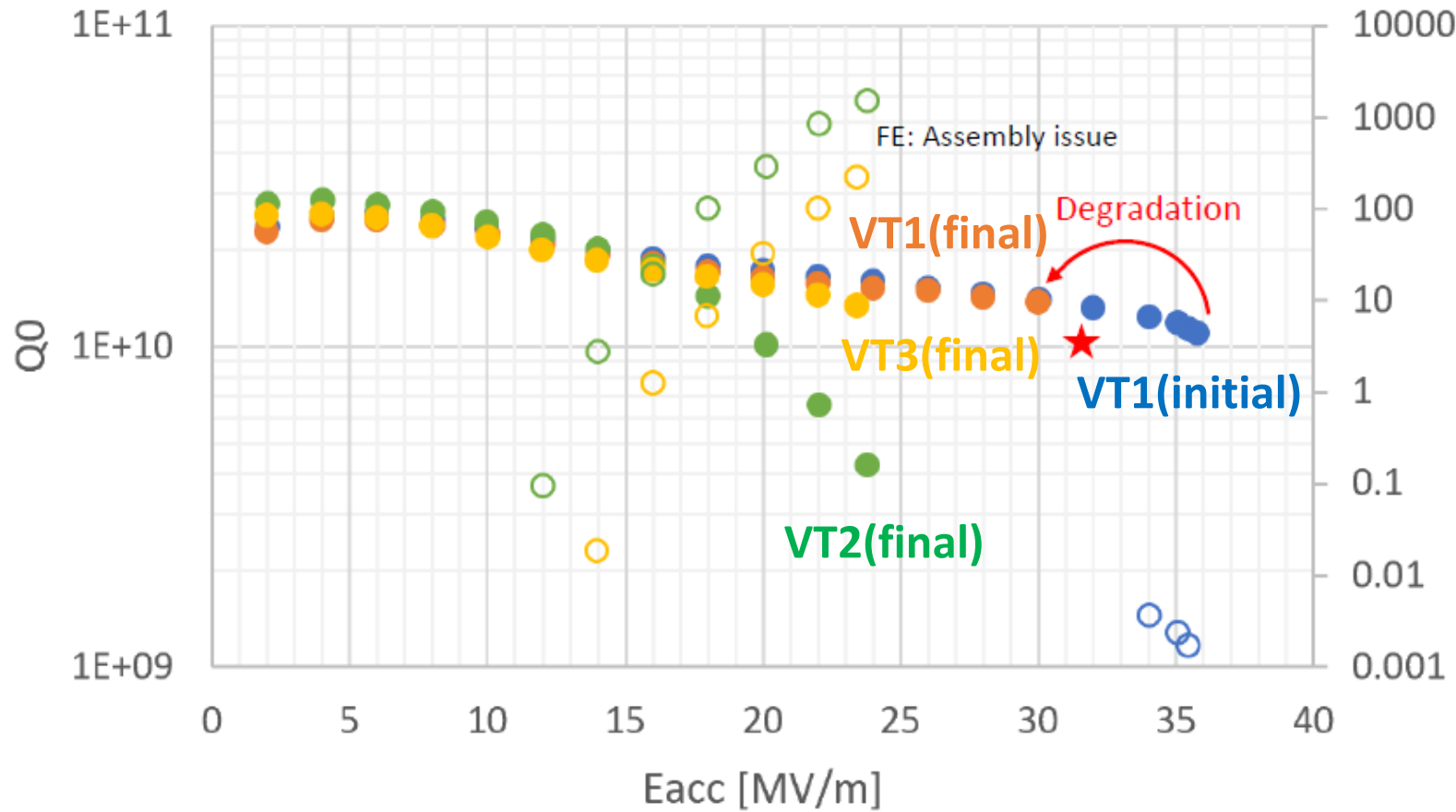


- Local grinding
- Pre-EP (5  $\mu\text{m}$ ) + EP-1(100  $\mu\text{m}$ )
- Heat treatment (900 C, 3h)
- EP-2 (20  $\mu\text{m}$ )
- HPR & Assembly
- Baking (120C, 48h)  $\Rightarrow$  VT1
- HPR & Assembly  $\Rightarrow$  VT2
- HPR & Assembly  $\Rightarrow$  VT3

### Standard recipe

(EP+120C baking) was applied on the cavity

# Vertical test results



- 1<sup>st</sup> VT showed degradation after quench.
- 2<sup>nd</sup> and 3<sup>rd</sup> VT was suffered from F.E.

Final VT results before HT was 24 MV/m.

VT1: 36MV/m (initial) -> 30 MV/m (after quench)

VT2: 24 MV/m with field emission

VT3: 24 MV/m with field emission

# He jacket welding

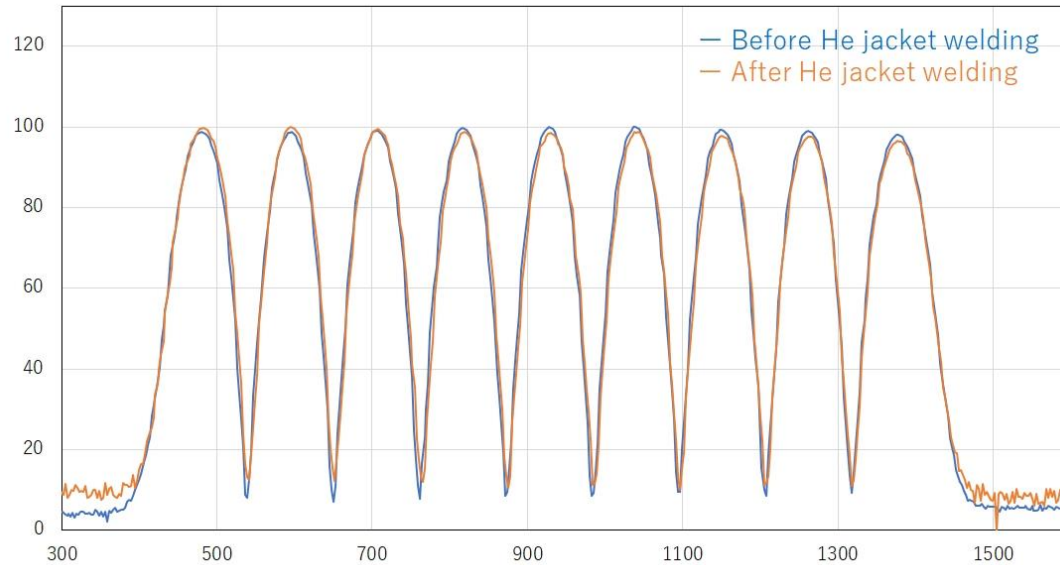


- It was first time to weld TESLA (Euro-XFEL) type Helium jacket to the cavity at KEK.
- He jacket welding was successfully carried out.





# Frequency/flatness during jacket welding



Field flatness was compared before/after jacket welding

- Before welding 98%
- After welding 97 %
- Almost no change.

- During jacket welding procedure, cavity frequency is observed using antenna.
- Frequency change before/after jacket welding was 24 kHz



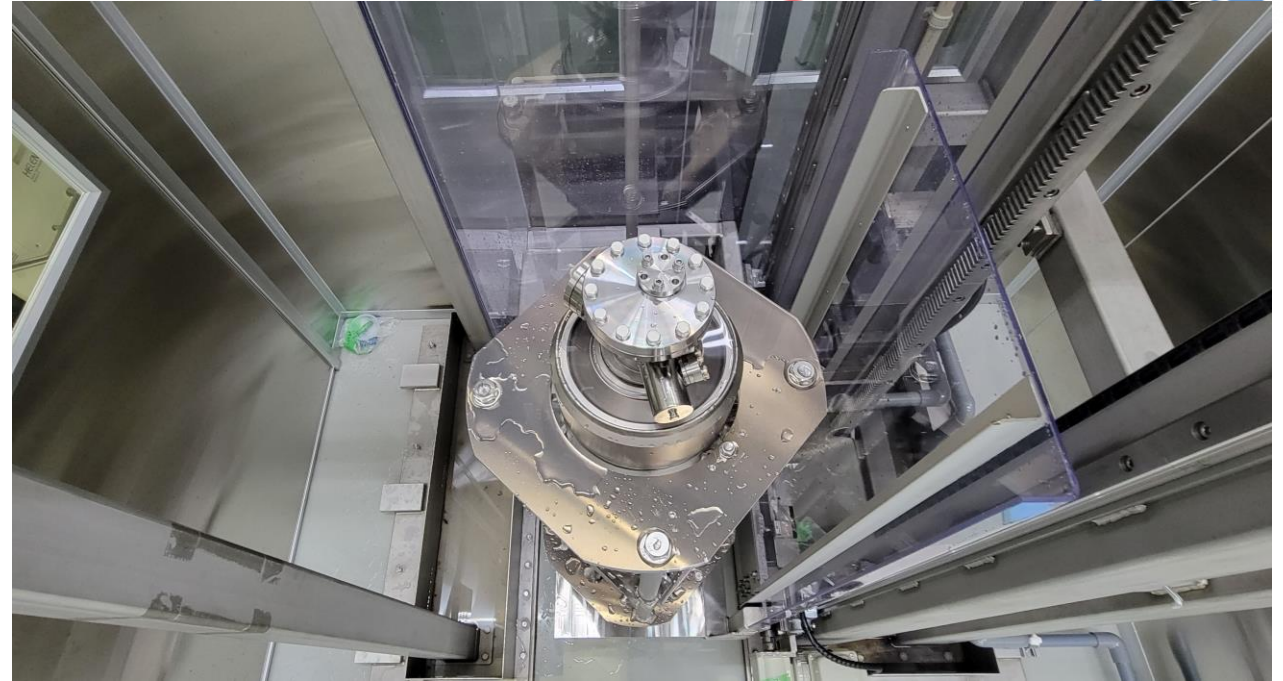
He jacket welding was successfully carried out.



# HPR for dressed cavity



- It was first trial to apply HPR to the cavity with He jacket at KEK.



- New HPR stand at KEK-COI building was used for HPR of dressed cavity.
- Cavity assembly was carried out at COI clean room.

# Clean room assembly after HPR

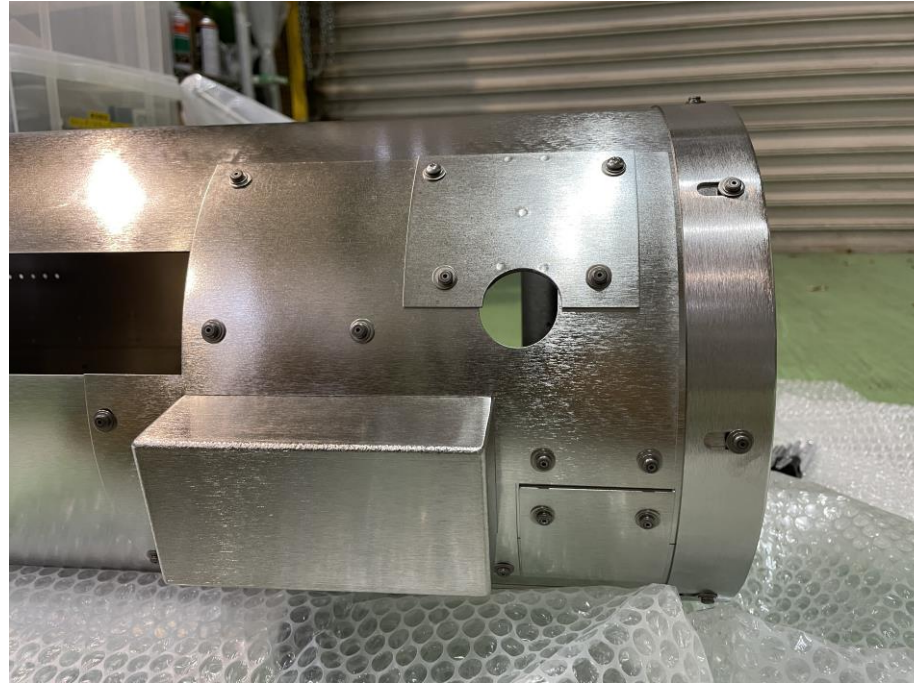
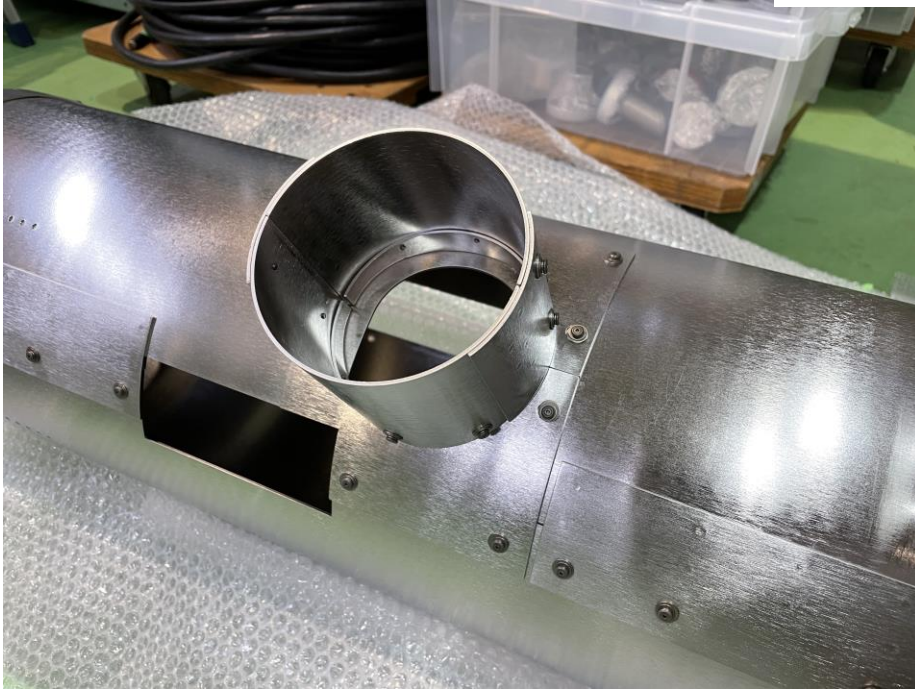
- HPR and assembly works were successfully carried out.
- As later show, source of field emission at VT3 was removed and cavity performance was improved at Horizontal test.





# Magnetic shield

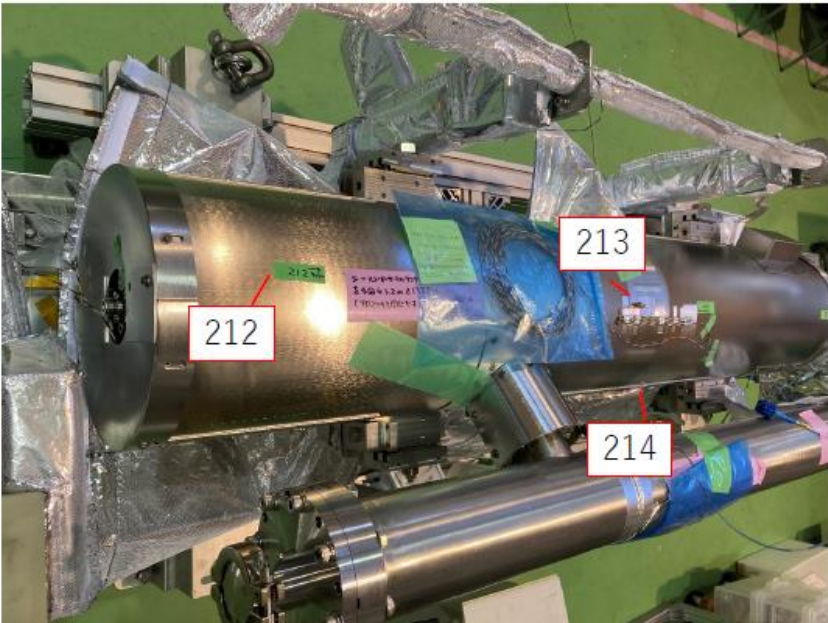
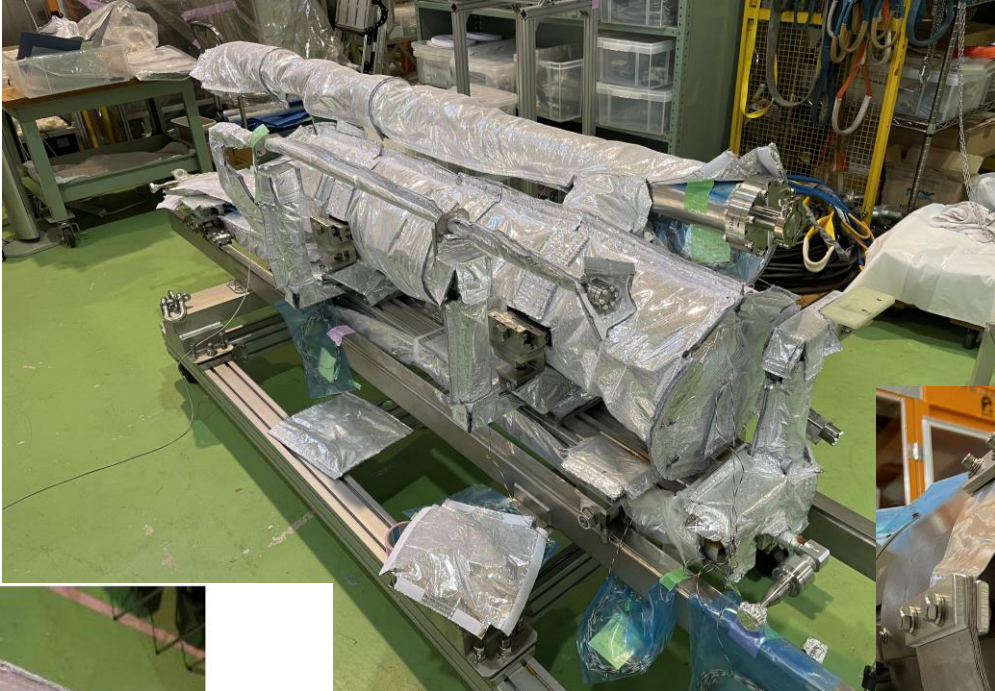
It was first time to design and fabricate magnetic shield for TESLA (Euro-XFEL) type cavity at KEK.



- Separated to upper and bottom parts and both sides of cap.
- Additional magnetic shields (patches and boxes) to prevent halls.



# Preparation for Horizontal Test



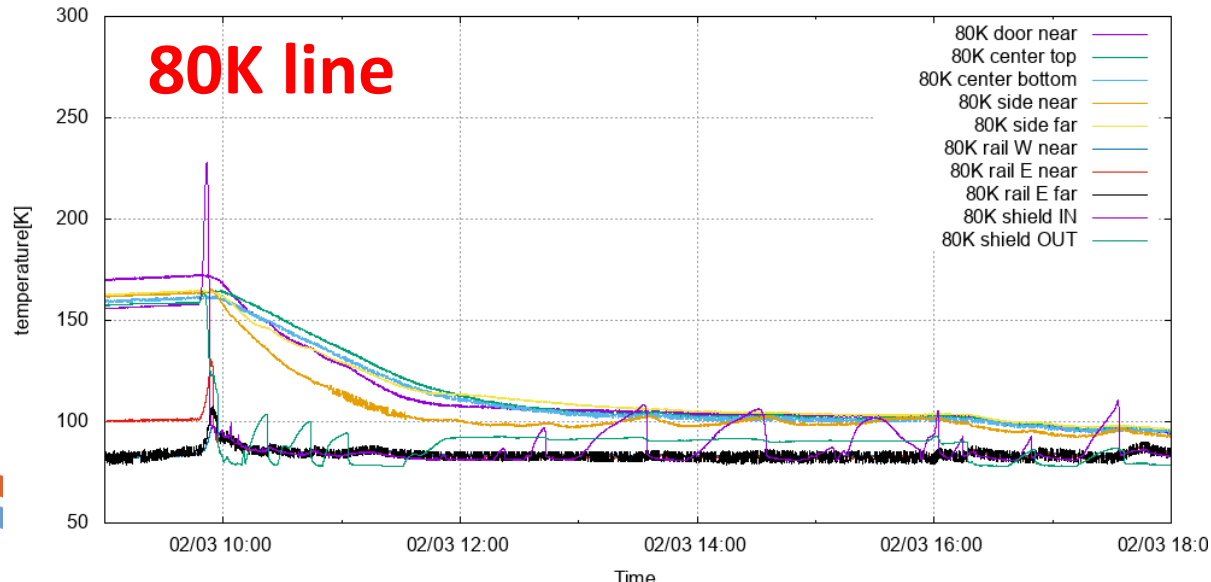
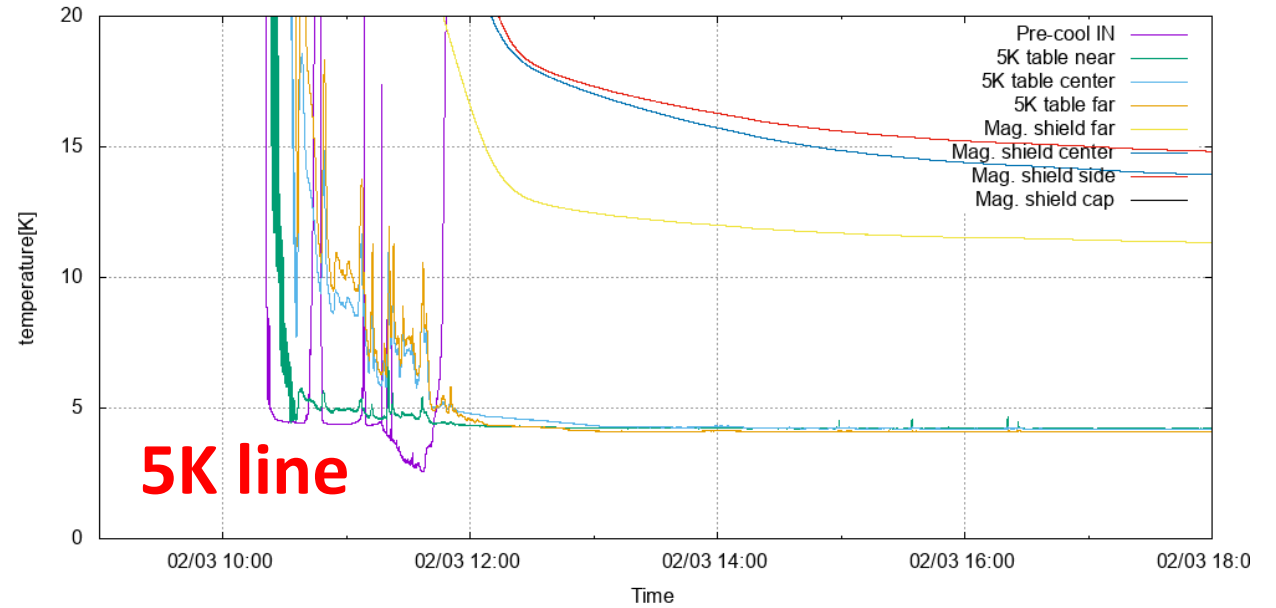
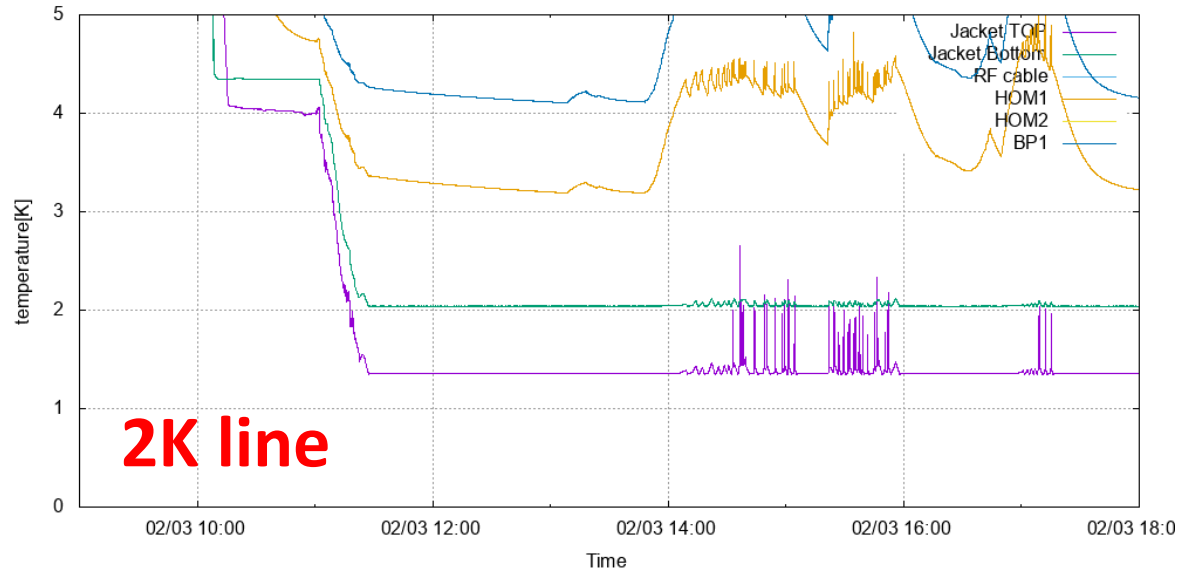
215



Title of talk



# Cool down of Horizontal Cryostat

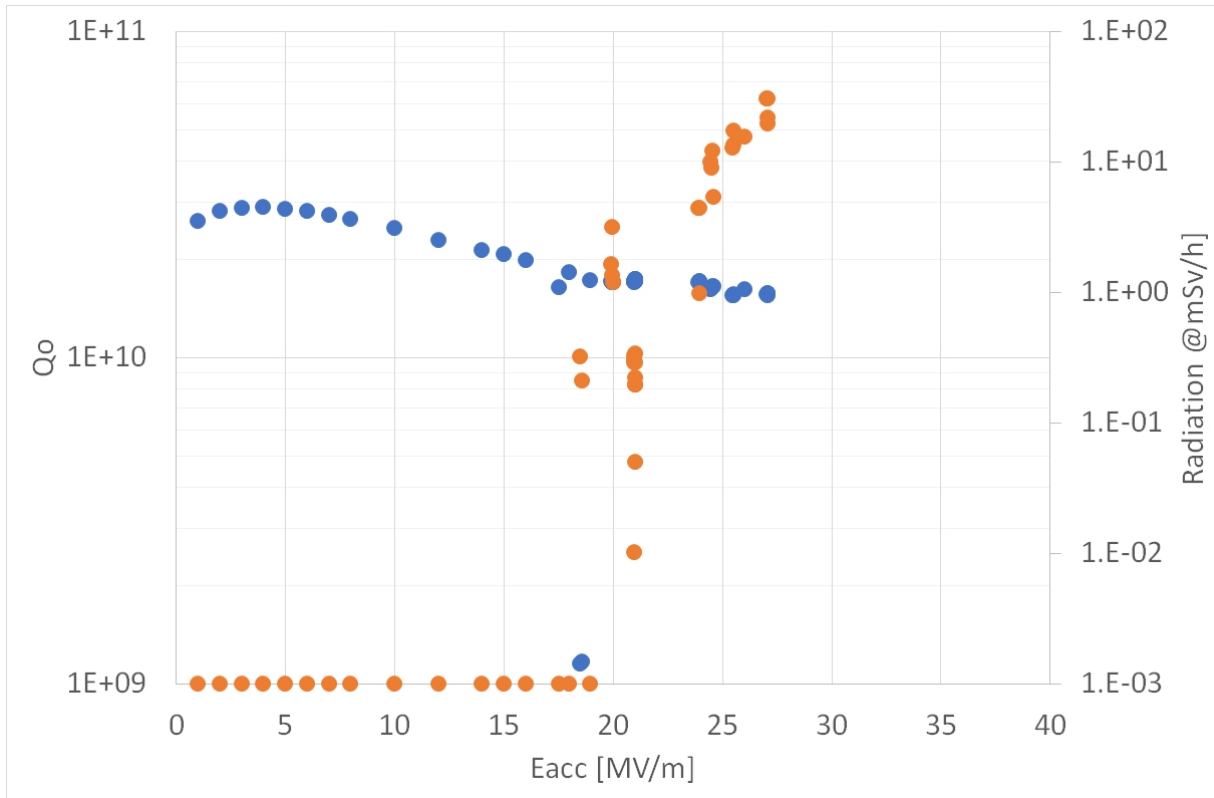


He jacket: cooled 2K  
HOM, beampipe: cooled to 3~6 K  
5K rail: cooled to 4 K  
Magnetic shield: 12~15 K, end cap < 50 K  
80K rail: cooled to 80 K  
80K shield: cooled to less than 100 K

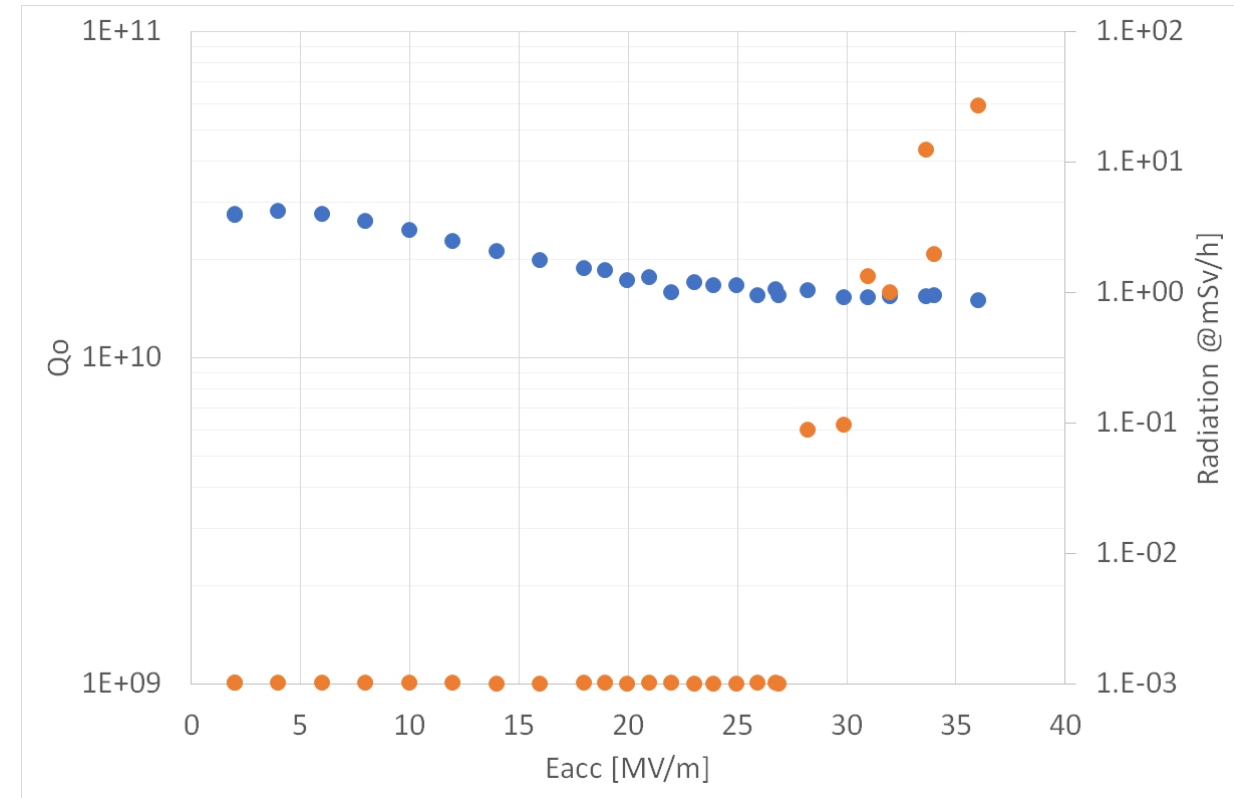
# Horizontal test results



## 1st day of HT



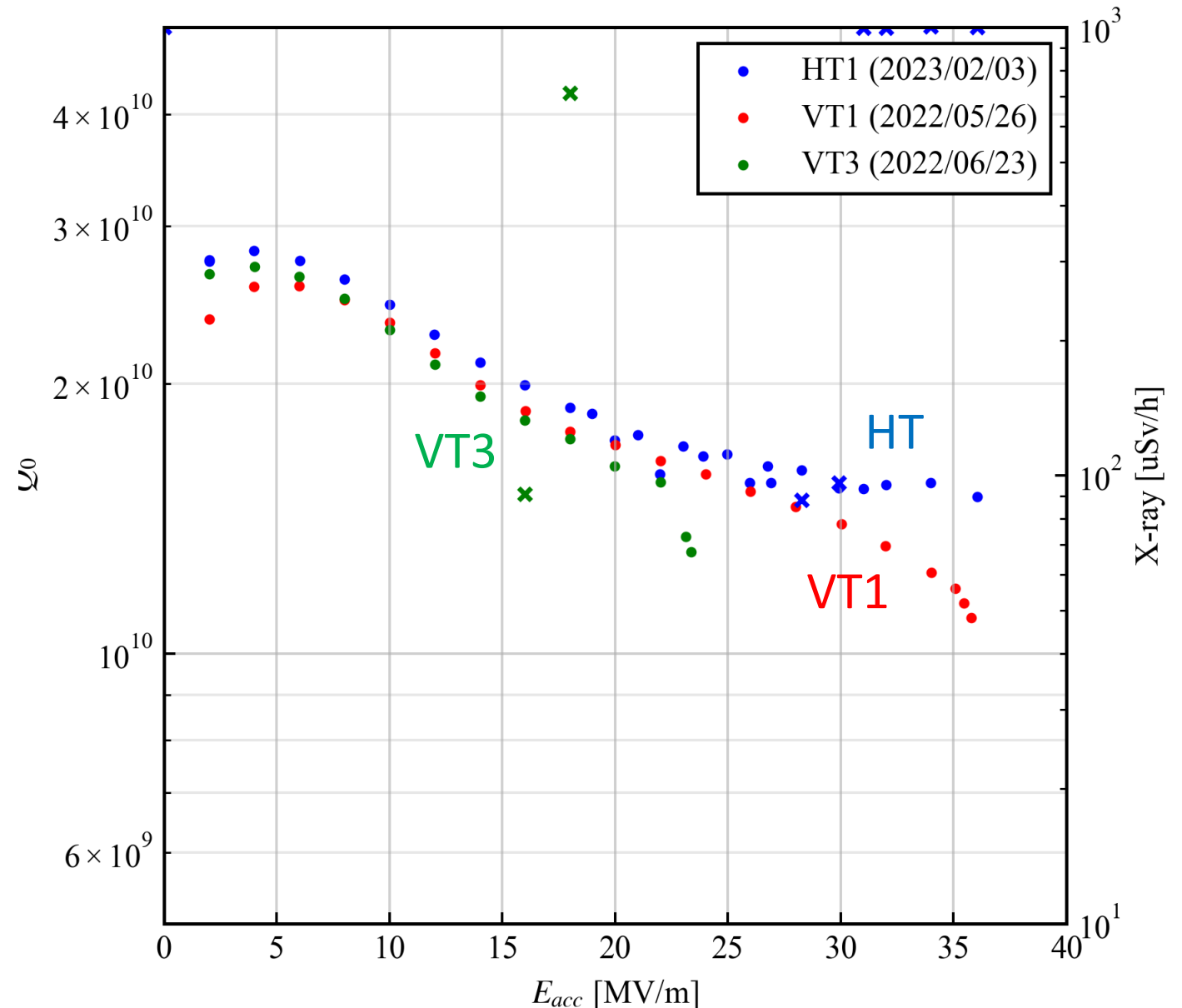
## 2nd day of HT



- 1<sup>st</sup> day's results were limited by F.E. But it was processed.
- Eacc = 36 MV/m with  $Q_0 > 1e10$  was obtained.
- Above  $P_0 = \sim 20$  W, field can not keep, because of increase of He temperature.
- The data points on high field were taken by short pulse-like mode.

# Comparison with VT

- Surface treatment: EP & 120C, 48h baking
- Q-value was very good.
  - Magnetic shield works well?
  - Flux was effectively expelled??
- Little bit better than VT.
- Q-value of high-field is excellent,  $1.5 \times 10^{10}$  @ 36MV/m. (Because of short pulse??)



# Summary



- TESLA-type 9-cell large grain cavity was fabricated at KEK-CFF.
- After surface treatment and vertical test, the He jacket was successfully welded on the cavity. The dressed cavity was cleaned by HPR and re-assembled.
- Magnetic shield, thermal anchor and so on were prepared and mounted on the cavity, which was installed into the horizontal cryostat at KEK-AR-East.
- Cooldown process was smoothly carried out and temperature of cavity was reached to 2K.
- Field emission existed at the initial stage was processed and the cavity performance of  $E_{acc} = 36 \text{ MV/m}$  and  $Q_0 > 1e10$  was obtained. LLC specification was satisfied.