Outgassing Rate of

Highly-Pure Copper Electroplating

Applied to RF Cavities

T. Abe, T. Kageyama, Y. Saito, H. Sakai, Y. Satoh and Y. Takeuchi
High Energy Accelerator Research Organization (KEK), Japan

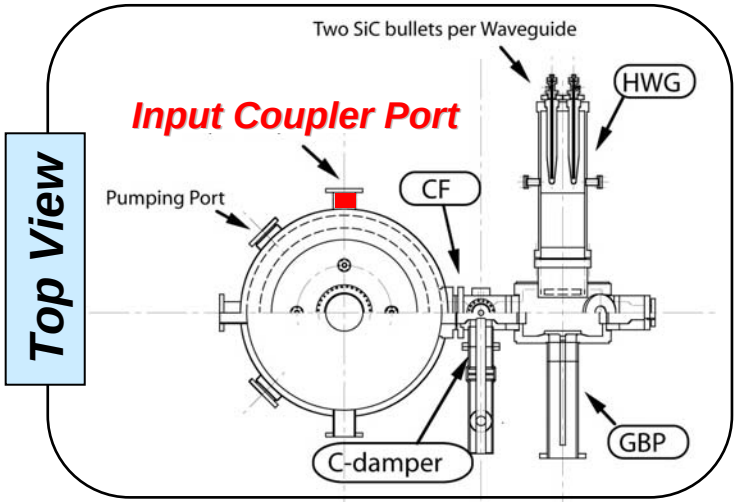
T. Nakamura, S. Nishihashi and K. Tsujimoto,
Asahi Kinzoku Kogyo Co. Ltd., Japan

K. Tajiri,
Churyo Engineering Co. Ltd., Japan

Z. Kabeya and T. Kawasumi,
Mitsubishi Heavy Industries Ltd., Japan

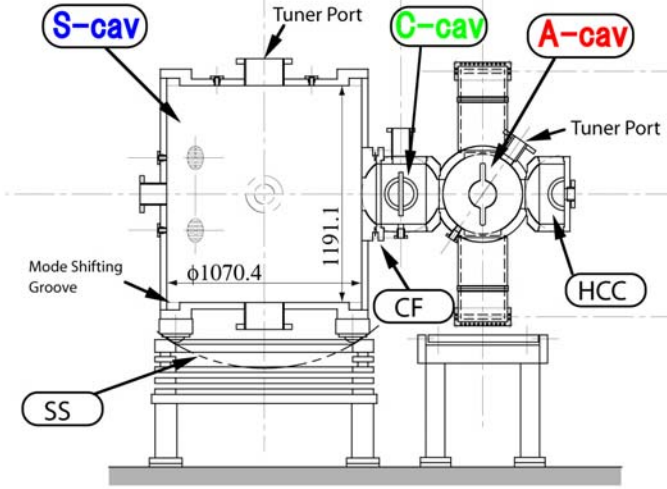
Accelerator Resonantly-coupled with Energy Storage

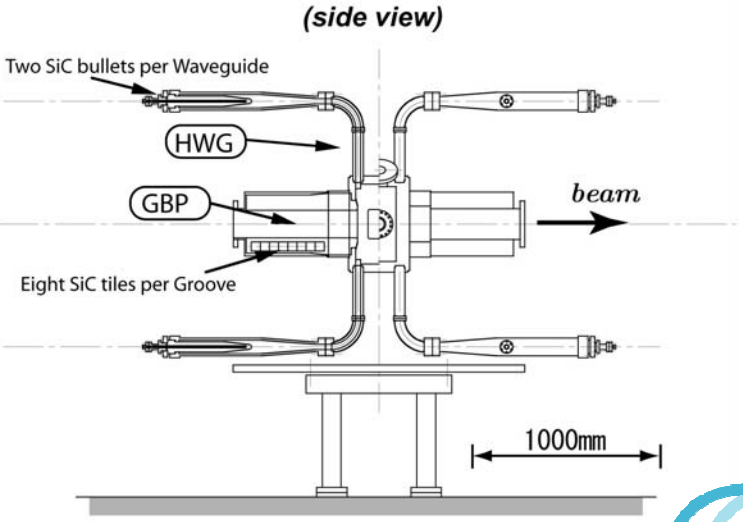
3-cavity system stabilized with the π/2-mode operation



consists of

- HOM-damped accelerating cavity (**A-cav**)
- **Energy-storage cavity** with TE_{013} (**S-cav**)
- Coupling cavity (**C-cav**) with a parasitic-mode damper





For the KEK B-factory:

KEKB uest for CPV kekb.jp

ARES S-cav's are made of Steel (SS400) with the inner surface *copper-electroplated*.

- S-cav's in KEKB --- Electroplating in a pyrophosphate bath
  - With brightener → few defects in the smooth surface
  - The facility has been retired.

- S-cav's for SuperKEKB -- New electroplating in an acid sulfate bath performed in the *periodic reverse (PR) process*

  (*H. Ino, et. al, "Advanced copper lining for accelerator components", Proc. of LAC2000, Monterey, CALIFORNIA, 1015 (2000).*)

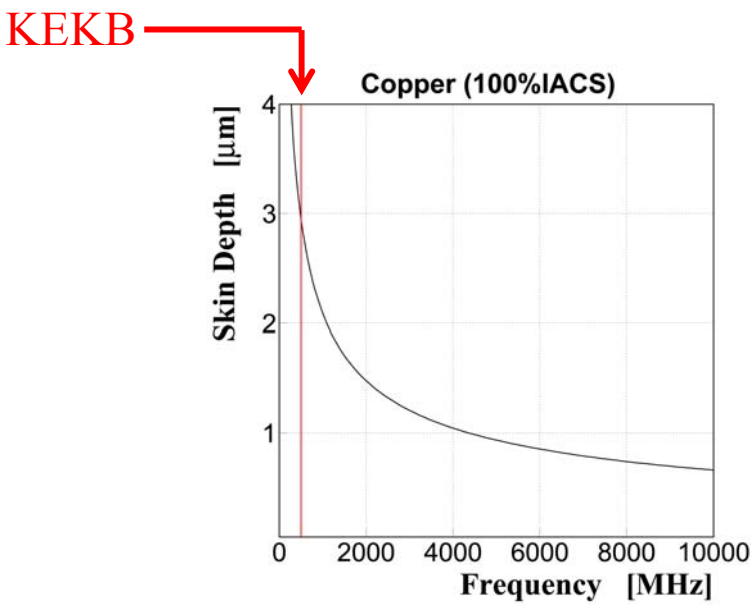
  - Without brightener → ・**High purity** (H_2:1ppm, O_2:8ppm, C:26ppm)
    ・**High electric conductivity** (102%IACS)
    ・But possible defects in the surface
  - Using the facility used for J-Parc

E.g. DTL tank

→

Differences between SuperKEKB and J-Parc Applications

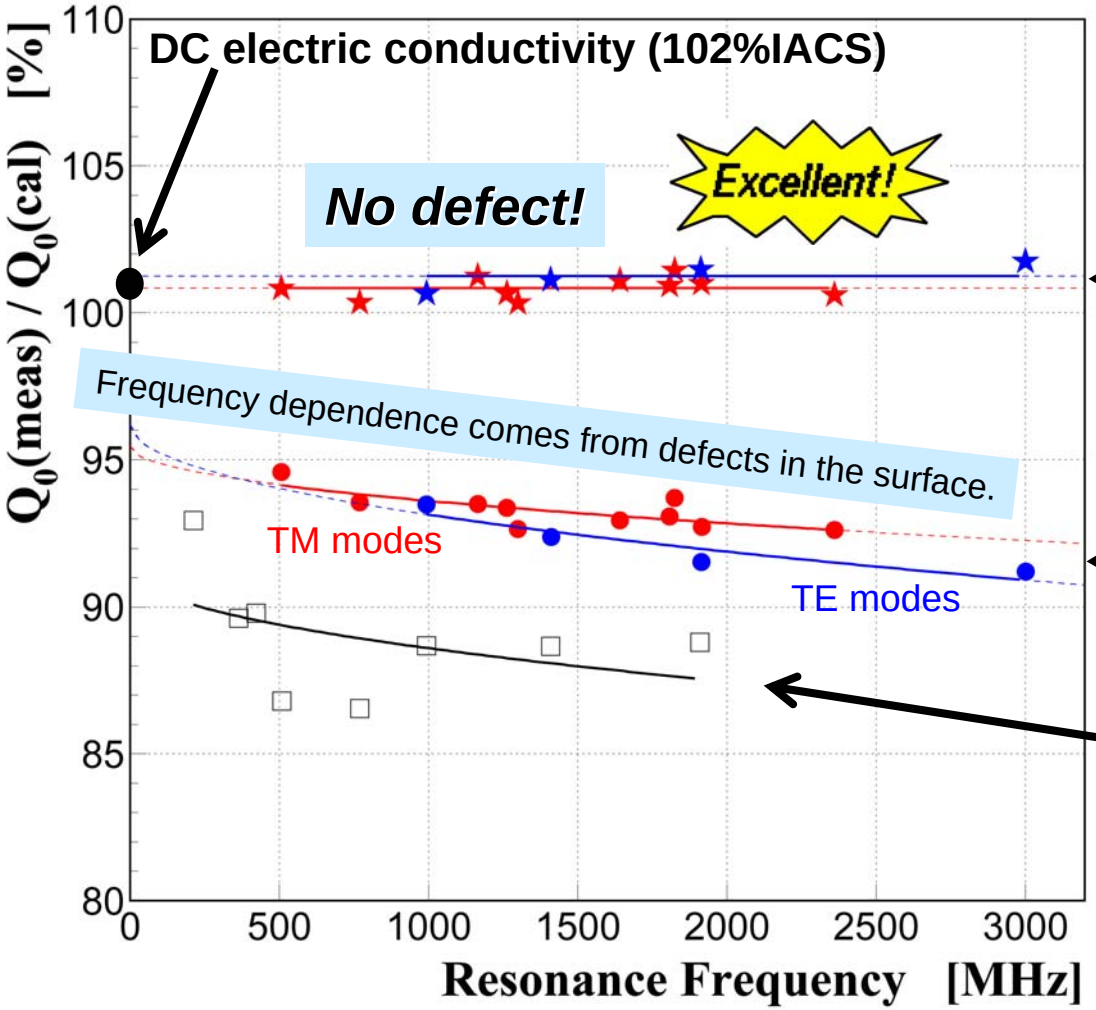
- J-Parc case
  - Thickness:~1mm → Mechanical polishing(~ 0.5mm) → Electropolishing (~ 40μm)
- SuperKEKB case
  - Thickness:~0.2mm → Electropolishing (~ 25μm)



Previous Results on the *Electric Performance*

(Presented in *PAC-2005-TPPT007*)

(1st test cavity →)



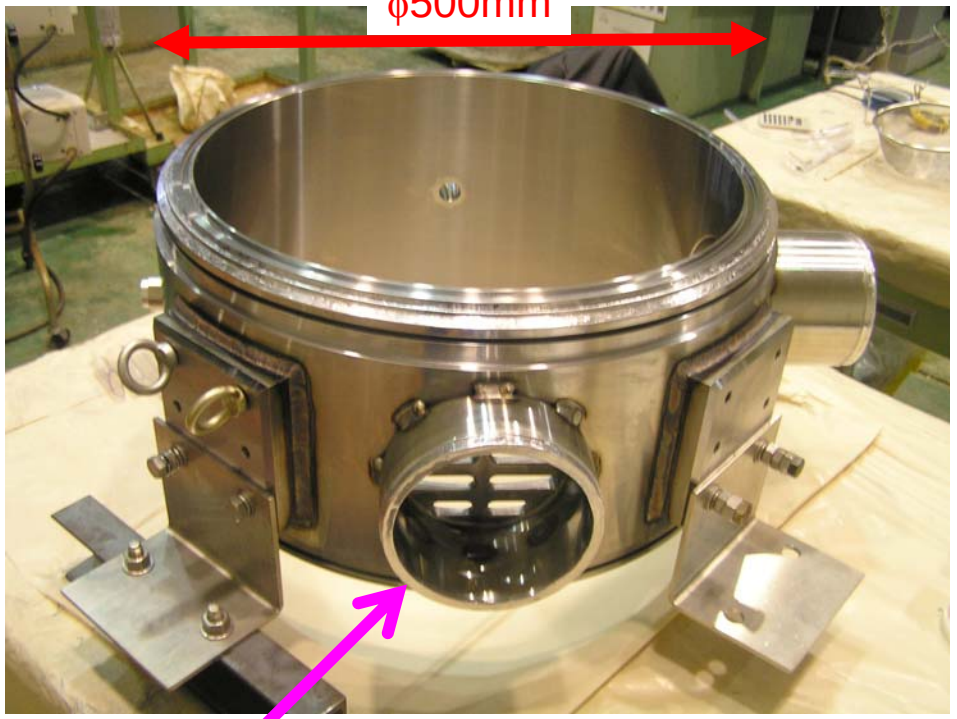
Electroplating in an **acid sulfate** bath **without brightener in PR process** **after Electropolishing** (Corrected for Q_0@20degC)

Electroplating in an **acid sulfate** bath **without brightener in PR process** before Electropolishing (Corrected for Q_0@20degC)

Electroplating in a **pyrophosphate** bath **with brightener** (applied to the present S-cav's) (no temperature correction)

2nd Test Cavity to Examine the *Vacuum Performance*

Endcap

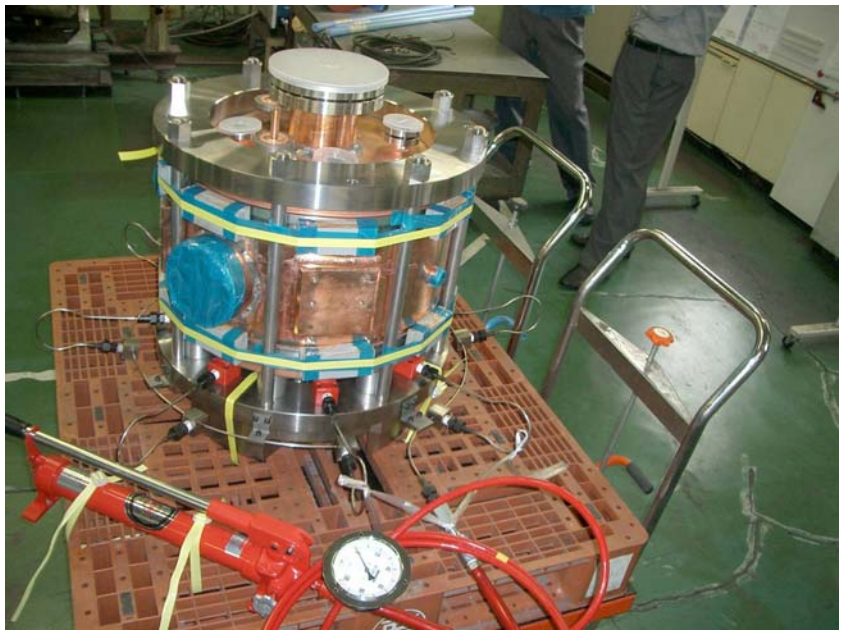


Barrel

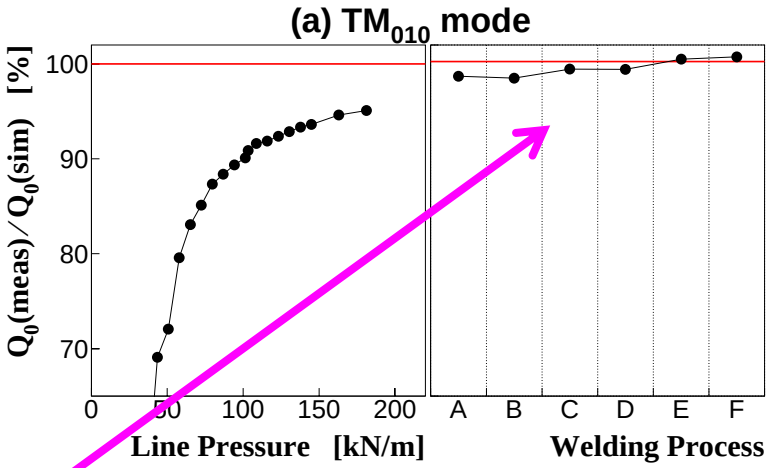
Electroplating + electropolishing were performed in the same method as applied to the 1st test cavity.

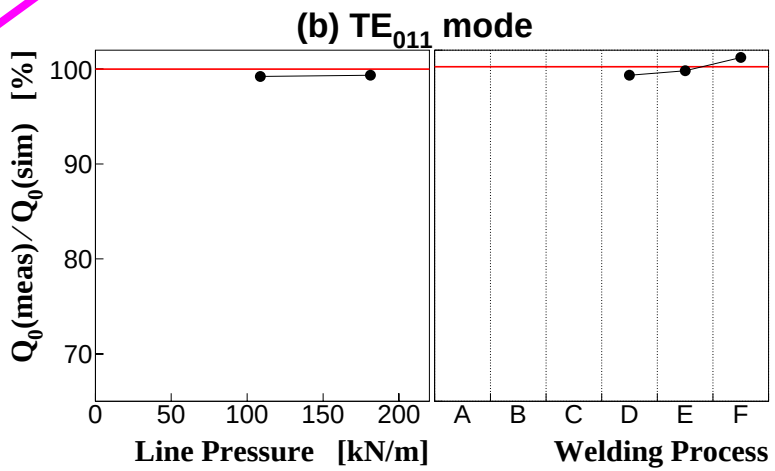
After Electroplating + Electropolishing

Pressurization using a Hydraulic Jack System



Perfect RF contact!!

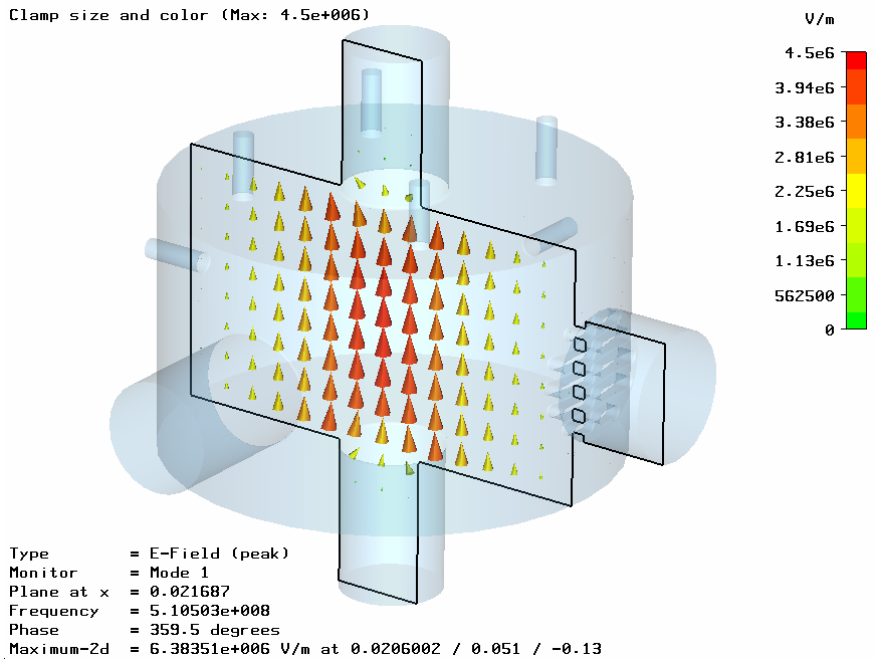




(Q0(meas): measurement)

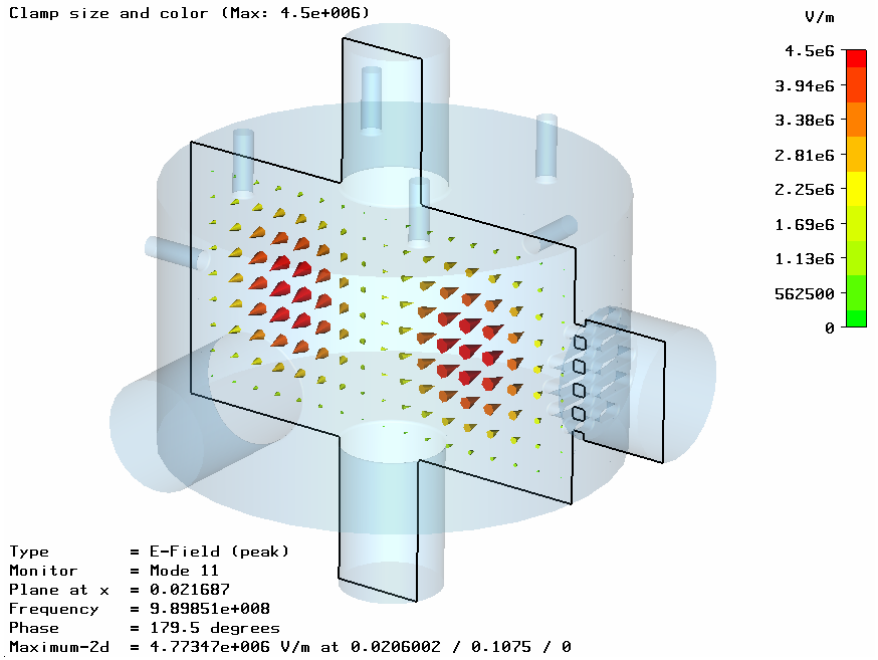
Q_0(sim)

Theoretical prediction from the 3D simulation using ***MicroWave Studio***



E-field of the TM_{010} mode

The surface current flows across the RF contact.



E-field of the TE_{011} mode

The surface current does not flow across the RF contact.

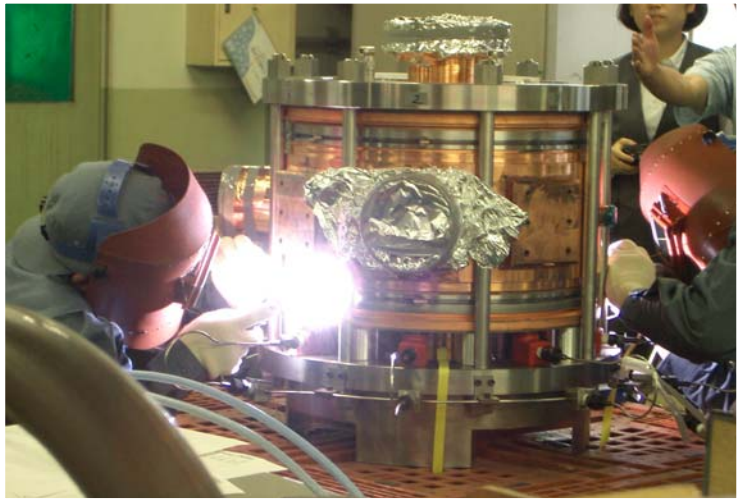
Welding

Three Steps:

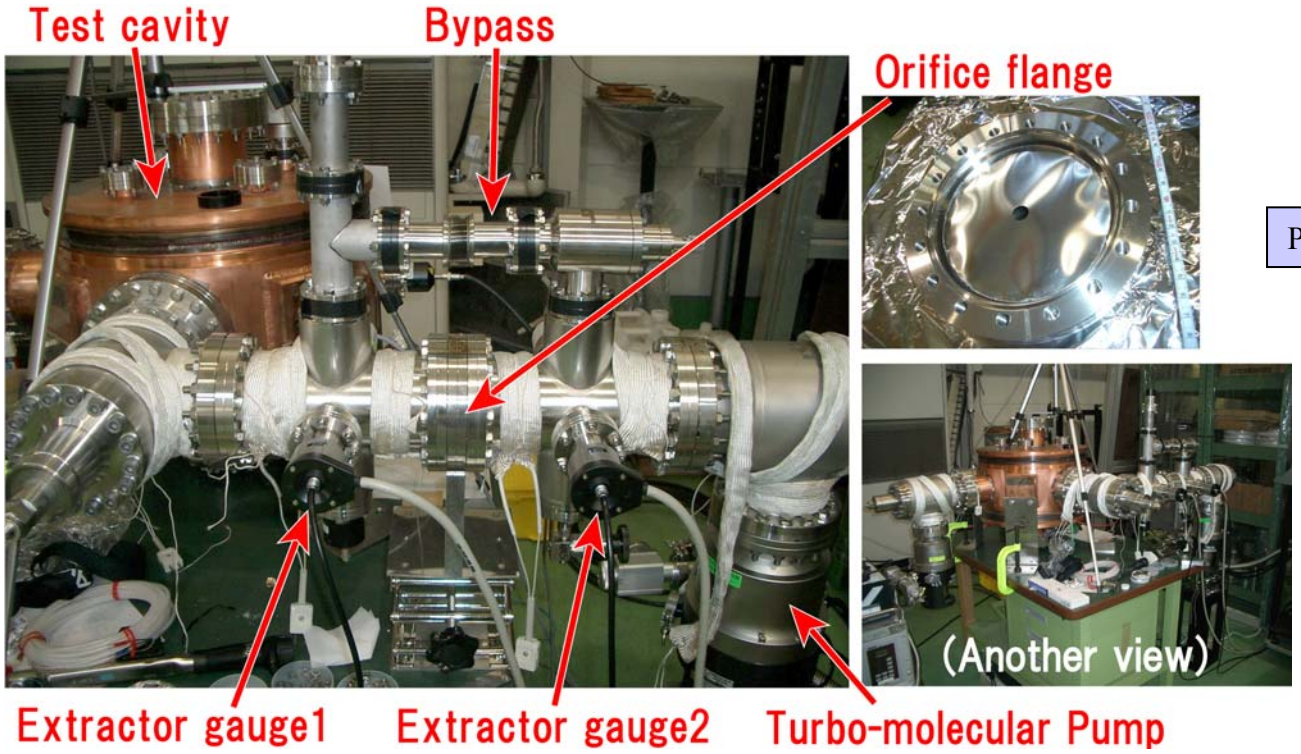
① **Tack welding**
with keeping the line pressure at the RF contact of 181[kN/m] (=185[kgf/cm])

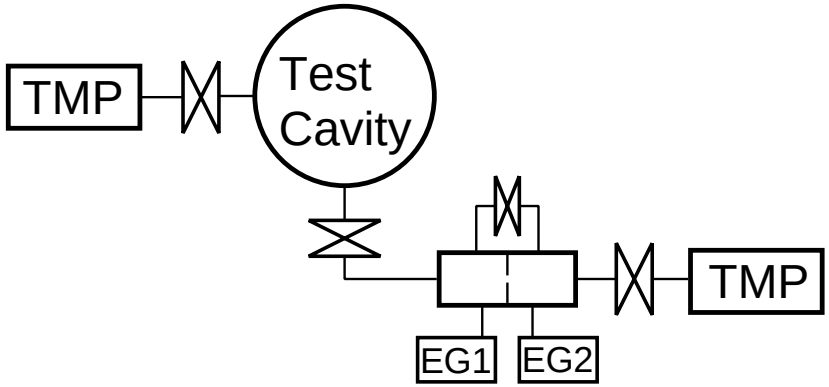
② **Intermittent welding**
with keeping the pressurization, between adjacent vertical shafts for holding the cavity

③ **Two-layer continuous welding**
on the entire circumference after the pressurization and the shafts were removed

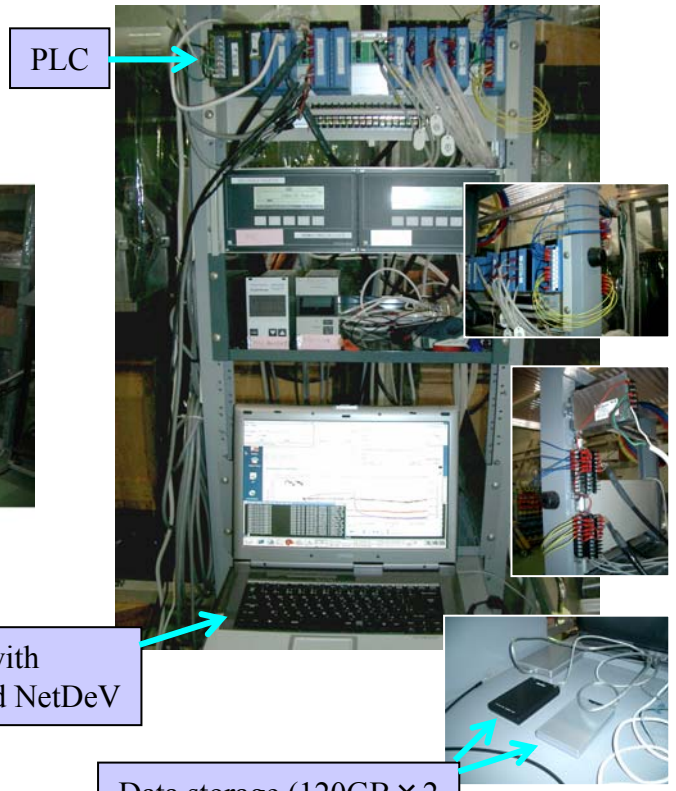


Setup for the Outgassing-Rate Measurement in the Orifice Method

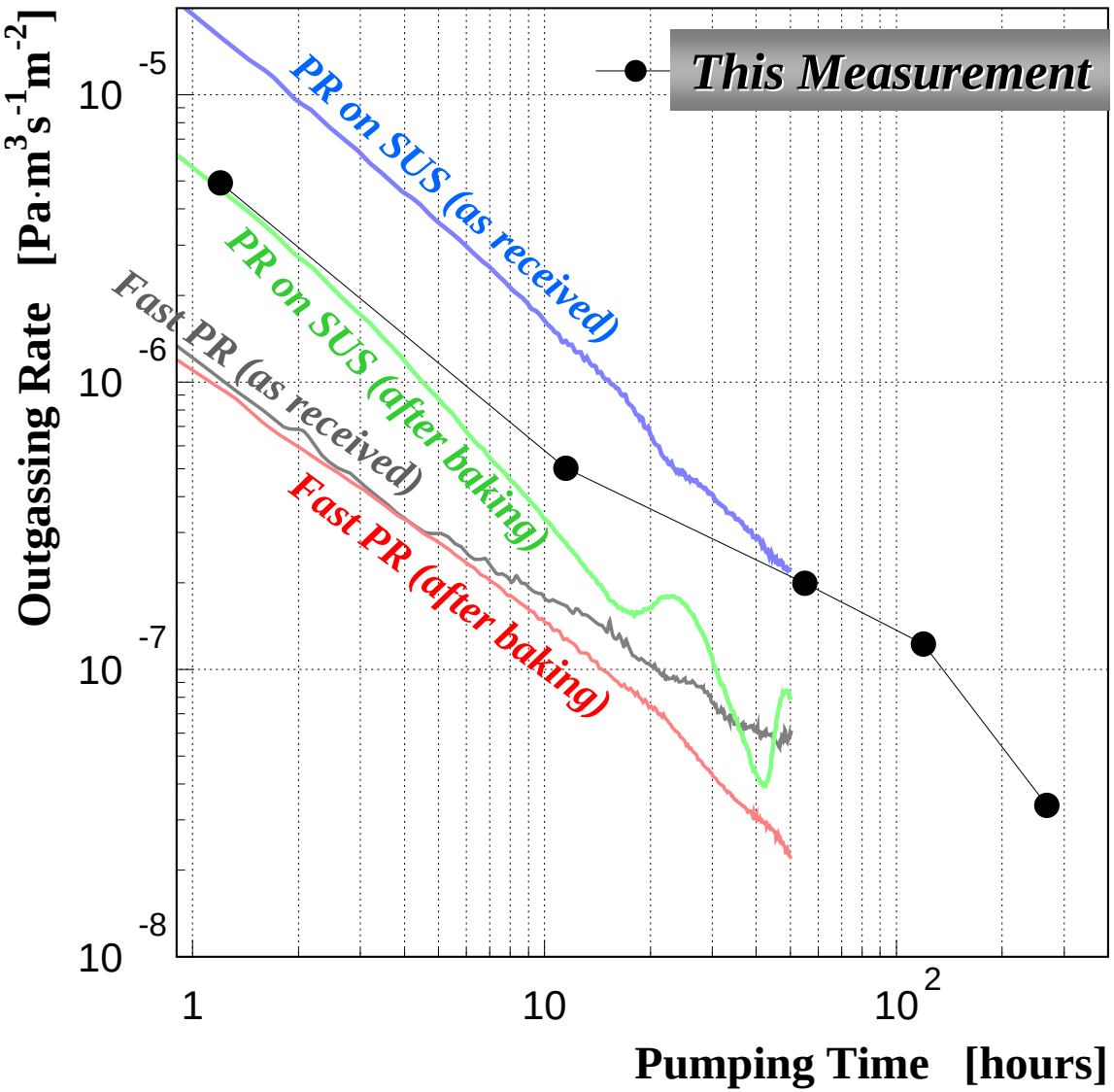




"Portable"
EPICS-based DAQ



Results



This Measurement
Electroplating + Electropolishing
Performed in the orifice method
after
① pumping for 3 months
② exposure to the air for 24 hrs

PR on SUS
Copper-electroformed on a SUS duct
in the condition for J-Parc
Measured in the ***conductance-modulation method*** (other measurement)

Fast PR
t0.3mm copper foil
electroformed in the fast PR method
Measured in the ***conductance-modulation method*** (other measurement)

Conclusions

- **Vacuum performance** examined by measuring the outgassing rate for the 2nd test cavity

  →Consistent with the other related measurements

  →Room for improvement with baking

- **Next step**: outgassing-rate measurement after baking

Acknowledgments

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