

Oral Poster
TUOP06&TUPO036

Vertical test results of plasma in-situ cleaning on low-beta HWR cavity

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Content

- **Carbon contamination experiments on HWR cavity**
 - Hydrocarbon adsorption at 4K
 - Carbon contaminants deposited by PECVD

- **Plasma cleaning on the carbon contaminated HWR**
 - Ar/O₂ RF plasma ignition
 - Vertical test results



Carbon contamination experiments on HWR

Binding energy between CH-contaminant and niobium surface

Weak strength

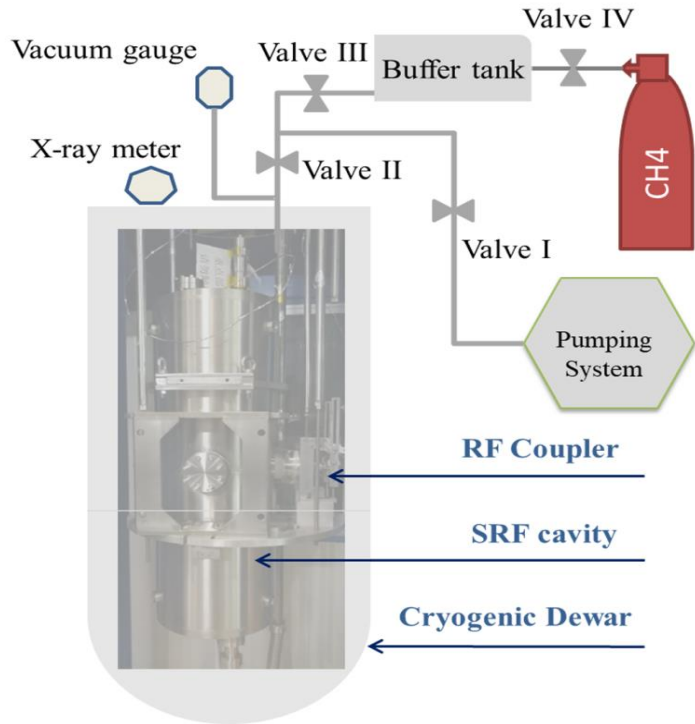
- SRF cavity is a cryogenic pump at 4K
- **Cryogenic adsorption** of residual gas and contaminants

Strong strength

- **Chemical deposited** on SRF cavity surface



Carbon contamination experiments on HWR

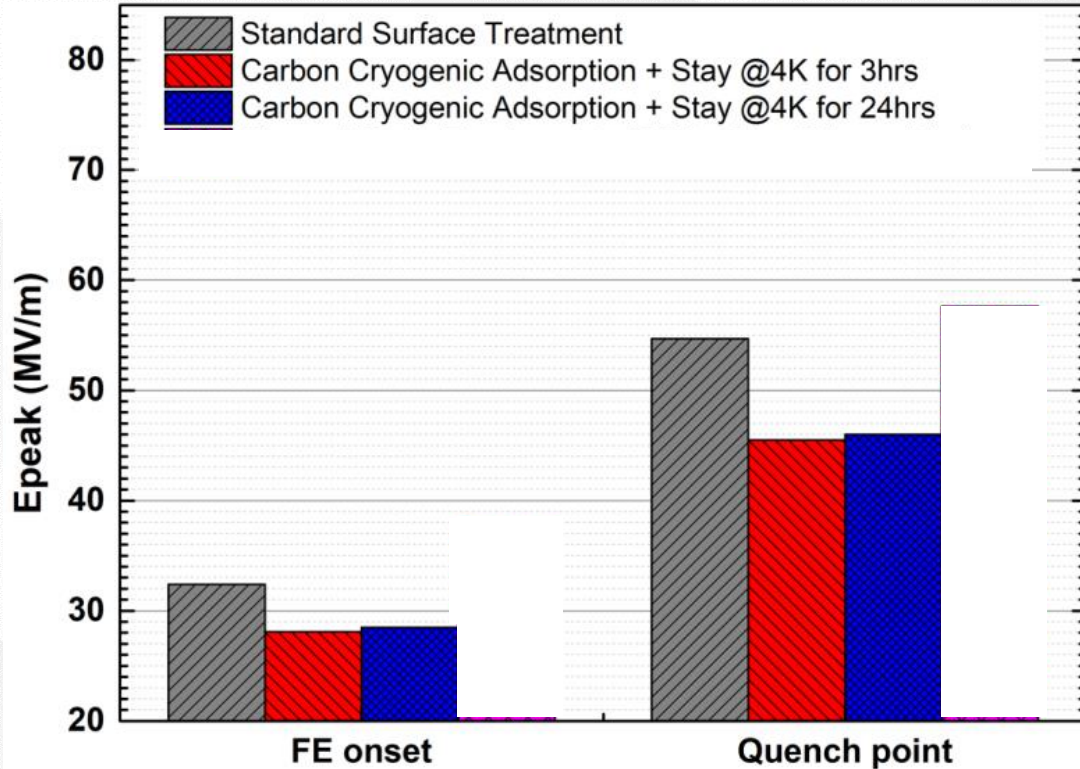


Weak strength

- Standard surface treatment as the baseline.
- CH₄ contamination by cryogenic adsorption.
- Warm up to 300K and pump CH₄ out.



Carbon contamination experiments on HWR

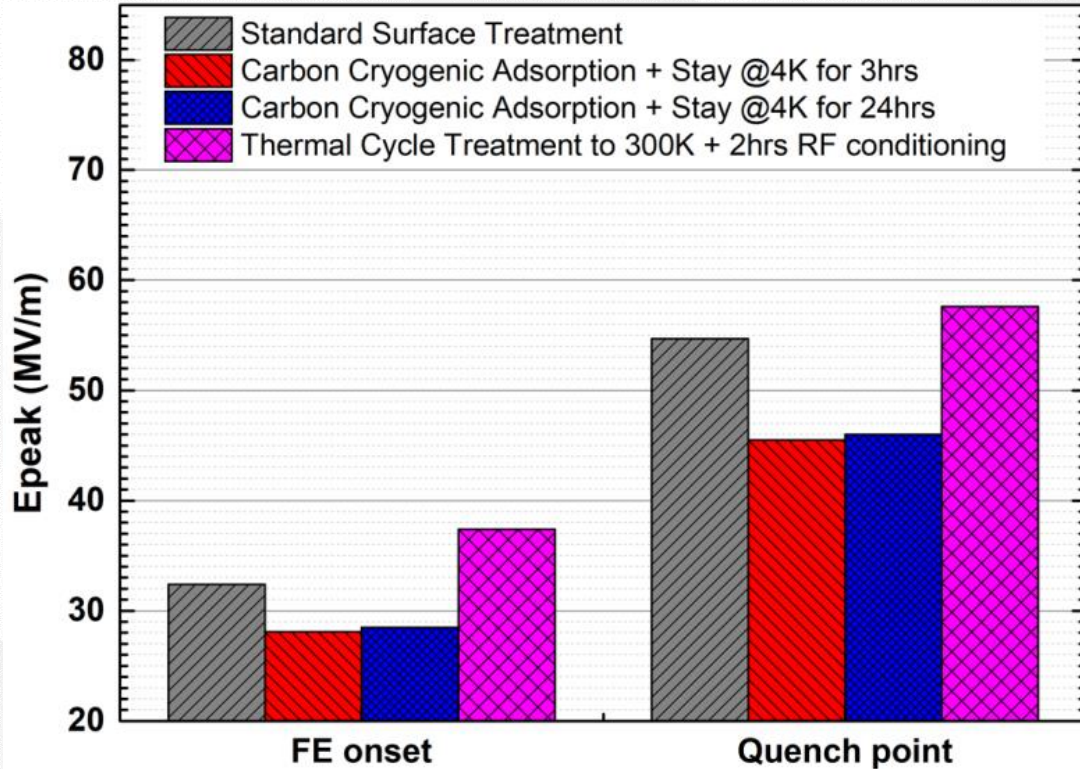


CH₄ cryogenic adsorption

- Performance degraded
- FE onset decreased by 12%.
- Quench point decreased by 18%.



Carbon contamination experiments on HWR

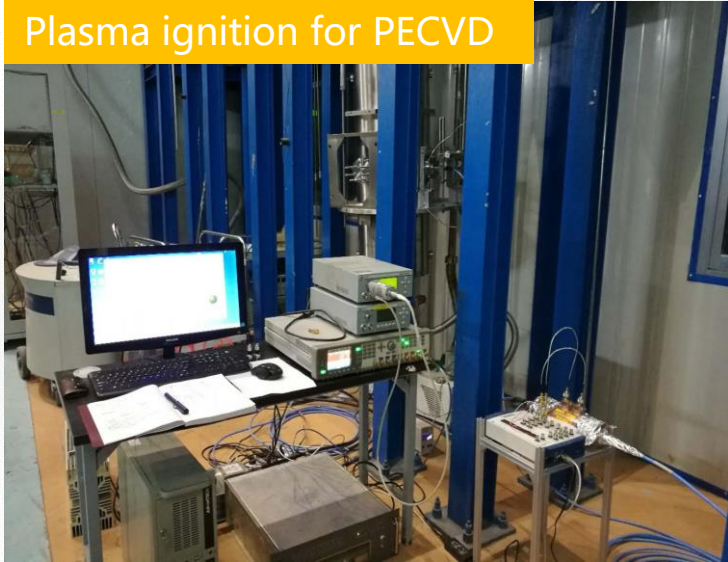


CH₄ cryogenic adsorption
-Performance degradation can be **removed** significantly by **warm up to 300K** and pumping.



Carbon contamination experiments on HWR

Plasma ignition for PECVD



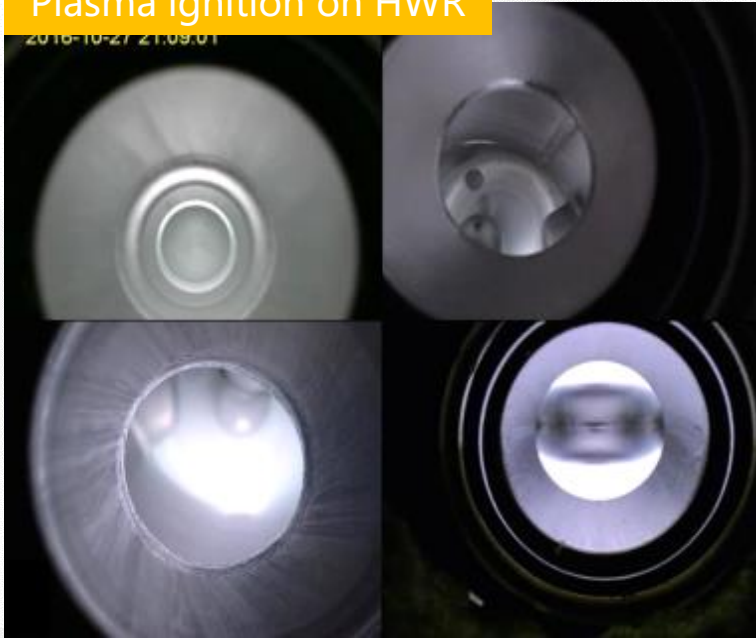
Strong strength

- Carbon contaminant deposited by PECVD.
- Ar/CH₄(3%) RF plasma was used.
- Reaction: $\text{CH}_4 \xrightarrow{\text{Plasma}} \text{CH}_3, \text{CH}, \text{C}_2\text{H}_2, \dots$



Plasma cleaning on carbon deposited HWR

Plasma ignition on HWR

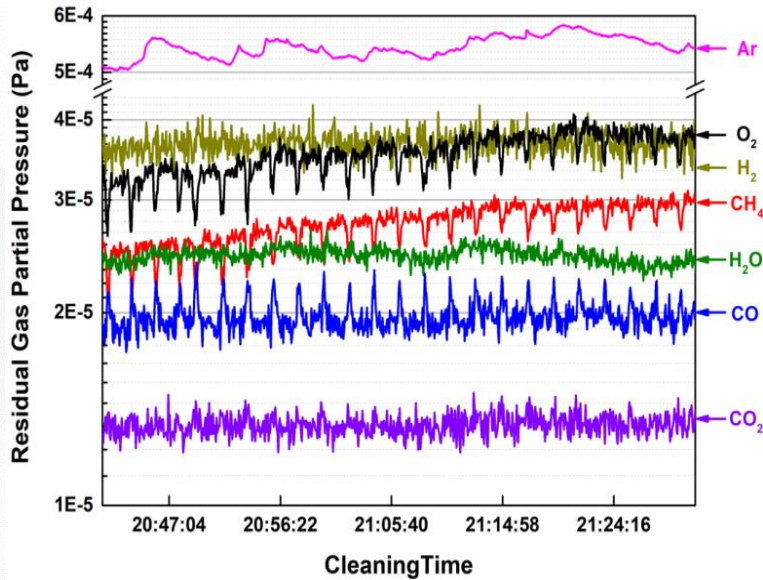


-In-situ cleaning by **Ar/O₂** RF plasma



Plasma cleaning on carbon deposited HWR

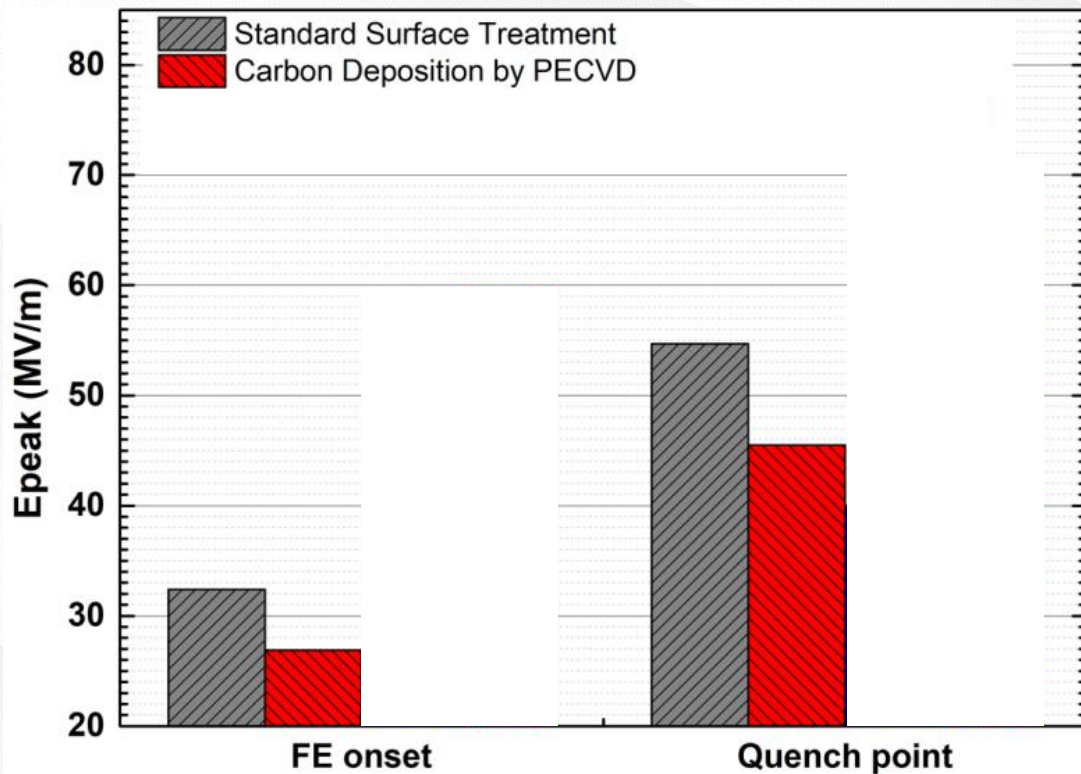
RGA data



-Residual gas analysis during cleaning of HWR



Carbon contamination experiments on HWR

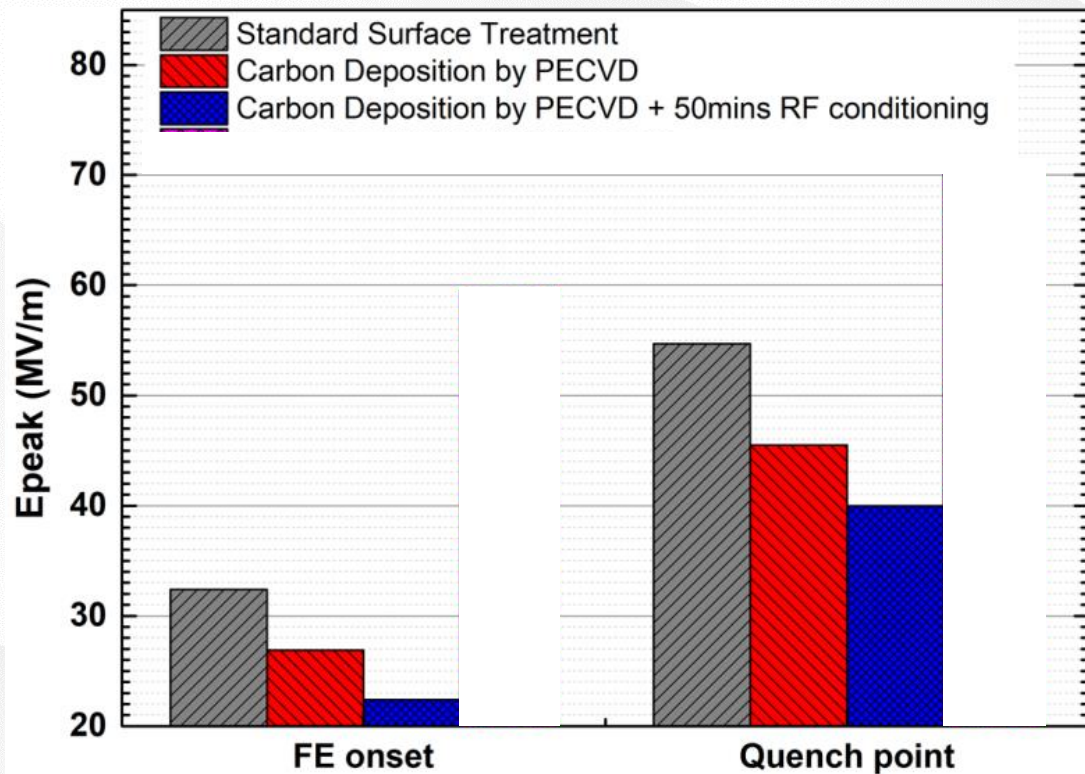


Carbon Deposition

- Performance of HWR decreased
- FE onset decreased by 15%.
- Quench point decreased by 16%.



Carbon contamination experiments on HWR

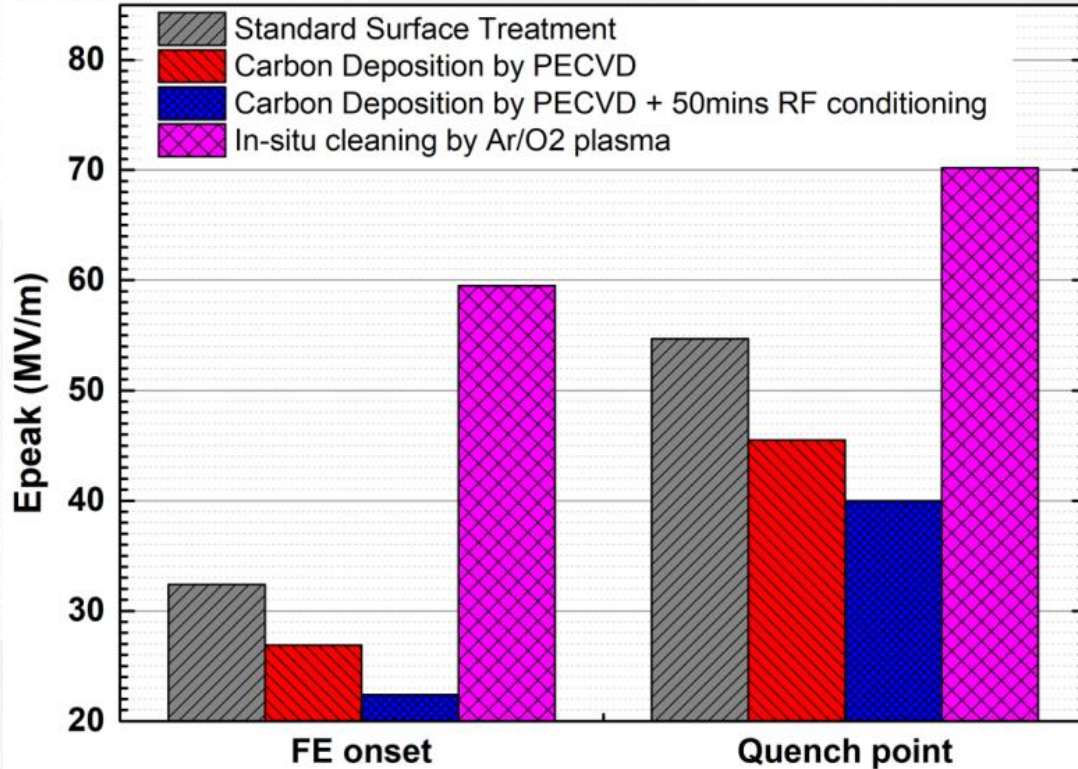


RF conditioning

-Not significantly to remove FE.



Plasma cleaning experiments on HWR



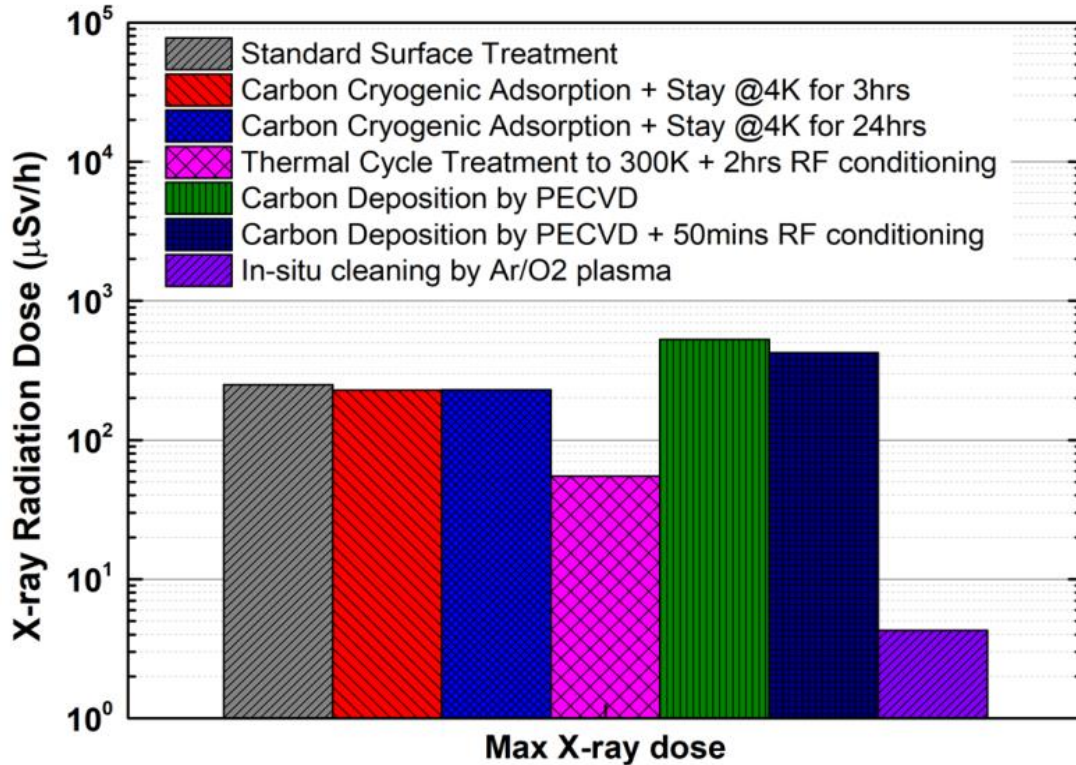
Plasma Cleaning

-Contaminants was **removed** and performance was **recovered** significantly.

-Compared with standard surface treatment, FE onset and quench point **increased by 83% and 28% respectively**.



Plasma cleaning experiments on HWR



Plasma Cleaning

-Contaminants was **removed** and performance was **recovered**.

-X-ray dose of HWR cavity was decreased from several hundred to 4.5 μSv/h significantly.



Welcome to discussion

POSTER INFORMATION

- TUPO036

- Today 16:00 – 18:00

- Conference Room 3&4

PUBLICATION

[1] A.D. Wu, S.C. Huang et al., Vertical test results of plasma in-situ cleaning on low-beta HWR cavity, TUOP036, this conference.

[2] A.D. Wu, L. Yang et al., In-situ plasma cleaning to decrease the field emission effect of half-wave superconducting radio-frequency cavities, Nuclear Inst. and Method, A 905 (2018) 61–70

[3] A.D. Wu et al., Carbon contamination mechanism and performance recovery principle for superconducting radio frequency cavities: in submitting to NIMA.



Thanks