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# DEVELOPMENT OF VERTICAL ELECTROPOLISHING FACILITY FOR NB 9-CELL CAVITY (3)

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*Abstract*

The 1st report was delivered in May, 2018 at the IPAC 18 in Vancouver, Canada. The 2nd report was delivered in September, 2018 at the LINAC 18 in Beijing, China. We will make our 3rd report in July, 2019 at the SRF-19 in Dresden, Germany. There will be two main points this time. The first is that by using our improved Ninja Electrode Premium, we can out-perform our number one and number two competitors in terms of uniform electropolishing of the interior of the 9-cell cavity. The second point is that we can remove hydrogen gas, reacted during electropolishing, from the cavity chambers in a manner that has not been successfully achieved by 1st report, May 2018 and 2nd report, September 2018. We will report our 9-cell vertical polishing revolver-type unit that solves the above two problems.

## INTRODUCTION

The 1st report was delivered in May, 2018 at the IPAC 18 in Vancouver, Canada [1]. Following that, after improvements were made for its practical use, production, and installation, the 2nd report was made on September, 2018 at the LINAC 18 [2].

Our 3rd report this time concerns improvements made to the 9-cell VEP for mass-production3.

## FACILITY DEVELOPMENT OVERVIEW

With our #1 machine, our goal was to achieve a uniform internal surface in the cavity with the ninja electrode by inverting the flow and outflow of the EP solution, but we saw a 1:6 scattering. With our #2 machine, our goal was to use automatic valves to control the inflow and outflow of the EP solution to achieve a uniform polishing with the ninja cathodes, but saw a 1:4 scattering. With our #3 machine, we aimed for mass production and worked to achieve an EP polishing scattering of 1:2 on the inner surface of the cavity, but we achieved 1:15. The main points of #3 machine are that we set the ninja cathode inside the 9-cell cavity and rotated it 180° while the EP solution was inside. Figure 1 shows photos of 1st – 3rd machine.

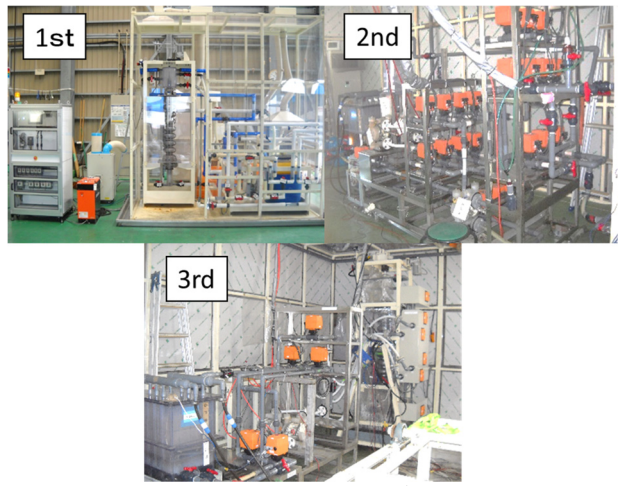

Figure 1: Photos of 1st – 3rd machine.

## PREVIOUS PROBLEMS

Problems arose in trying to achieve uniform EP inside the 9-cell cavity. We surmise that the reason was the creation of hydrogen gas during EP that resulted in the hydrogen bubbles adhering to the inner cavity surface. Why do they adhere? The two reasons are as follow.

① Rotation speed of the ninja cathode

② EP solution flow speed

To solve these 2 problems, we improved the rotation device on the #3 machine, but a problem arose.

1. EP solution leak
2. Changing electrodes
3. Cooling system during electropolishing
4. Control of EP solution flow with solenoid valves
5. EP solution leakage from rotating part when ninja electrode rotating part was rotated
6. Total removal of hydrogen gas produced during EP

To solve these problems,

- EP solution doesn't leak even when Ninja electrode rotates
- Supply, electricity, coolant water doesn't disperse
- Power source, water, disposal of EP solution

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## DISCUSSION AND CONTENT OF IMPLEMENTATION

In the normal position, hydrogen gas is removed from the upper part along with the EP solution. But part of the hydrogen gas still adheres to the upper portion of the cavity.

We surmise that hydrogen gas in the upper part sticks to the adhesion layer, and results in lack of uniform polishing. As a solution, we inverted the position so that bubbles adhering to the upper part are now on the bottom and can then be removed from the top.

When reversing, there is some concern the EP solution may leak from the lower portion of the rotating part. We solved the problem of EP solution leakage from the rotating part by constructing a seal like one shown in the separate diagram. We confirmed there was no leakage during 10-hour, 30 minute inversion. Figure 2 shows photos of cavity rotation. Currently, during rotation, there is no EP leakage during electropolishing. The seal on the rotating part is replaced with each usage.

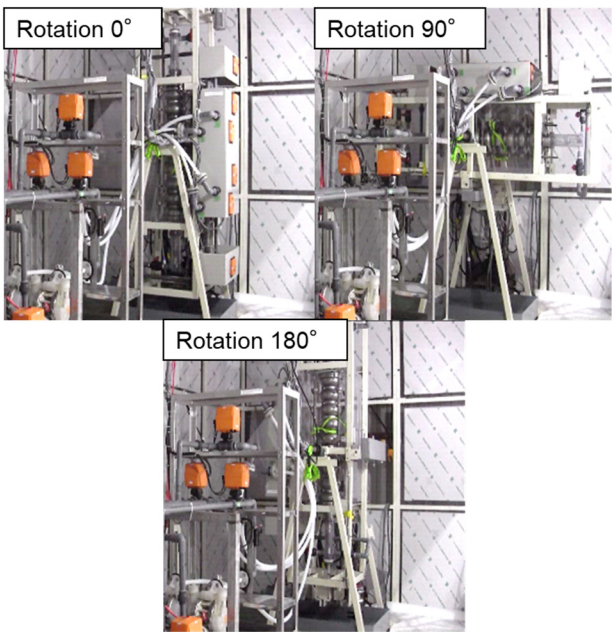


Figure 3: Photos of the touch panel screen and auto valves.

## FUTURE PLAN

Using the above method, we will next proceed with mass-production. Although electropolishing uniformity has been improved, we will investigate ninja electrode masking, and rotation speed in order to further reduce EP scattering from the equator part and the iris part, in order to achieve more uniform polishing of the inner surface of the 9-cell cavity.

## REFERENCES

[1] Y. Ida *et al*., "Development of Vertical Electropolishing Facility for Nb 9-cell Cavity" in *Proc. 9th International Particle Accelerator Conf. (IPAC'18)*, Vancouver, Canada, April-May 2018, paper THPAL031, pp. 3699−3701.

[2] Y. Ida *et al.,* "Development of Vertical Electropolishing Facility for Nb 9-cell Cavity (2)" in *Proc. 29th Linear Accelerator Conf. (LINAC'18)*, Beijing, China, September 2018, paper TUPO069, pp. 494−495.