

# Design of higher order mode damped cavity for electron-beam stabilization in SR2

Y. Maeda<sup>\*1</sup> and M. Wakasugi<sup>\*2,\*3</sup>

Electron scattering off online-produced radioactive isotope has been successfully conducted at the self-confining RI ion target (SCRIT) facility.<sup>1)</sup> In the SCRIT method, unstable nuclear ions are trapped on the orbital path of the electrons circulating in a SCRIT equipped RIKEN electron storage ring (SR2). For improved performance of SCRIT devices, stabilizing the electron beam is essential. However, the beam stability problem of SR2 leads to issues such as reducing ion trapping lifetime and luminosity. The beam instability is caused by the higher order modes (HOM) induced by the beam in the accelerating cavity. Therefore, recently we have been developing an accelerating cavity equipped with an HOM damping mechanism to resolve this beam instability.

The slot-type HOM damping cavity adopted here was originally developed at Spring-8<sup>2)</sup> and has a simple structure that efficiently damps HOMs other than those in the acceleration mode. The TM020 mode with a resonance frequency of 956 MHz was used as the accelerating mode. The slot was located at the node position of the magnetic field of the TM020 mode. The ferrite chip placed there absorbs HOMs other than TM020, thereby reducing the Q value.

First, in investigating the cavity shape using SUPERFISH, a reverse triangular cavity shape offered higher Q values and shunt impedance than the conventional pillbox-shaped cavity. The results of the 3D electromagnetic field calculations introducing the HOM damping mechanism using CST Studio Suite are shown in Fig. 1. While the Q value of the TM020 mode remained almost unchanged, those of the other modes were significantly reduced.

Additionally, to suppress the decrease in the Q value of the accelerating mode when attaching auxiliary equipment such as couplers, a structure called the field correction tuner (FCT) was introduced. These attachments reduce the Q value because they distort the magnetic field along the slot, as shown in Fig. 2. The FCT is a fixed cylindrical metal piece designed to efficiently correct this magnetic field distortion as indicated by the red line in Fig. 2. As a result, the reduction in Q value was minimal at only 0.73%.

Figure 3 shows the 3D model of the cavity that was ultimately created. In this model, the performance of the accelerating mode was found to be  $f = 956.220$  MHz,  $Q = 52904.6$ ,  $R_{SH} = 3.27$  M $\Omega$ . Moving forward, we plan to proceed with the fabrication of the actual device.

<sup>\*1</sup> Department of Physics, Kyoto University

<sup>\*2</sup> Institute for Chemical Research, Kyoto University

<sup>\*3</sup> RIKEN Nishina Center

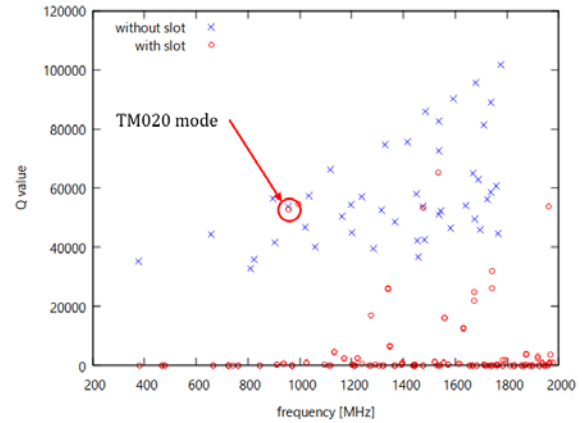


Fig. 1. Q value of the HOM with the HOM damped mechanism (red circle) and without it (blue factor).

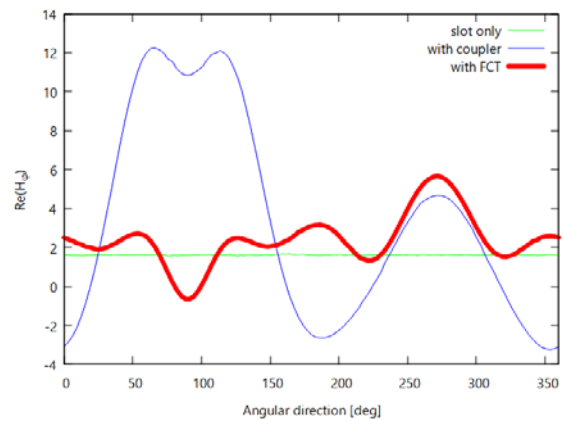


Fig. 2. Distortion of magnetic field in TM020 mode along slot position. Uniform in the absence of slots (green line), but the introduction of couplers distorts the magnetic field (blue line). The introduction of FCT has reduced the distortion (red line).

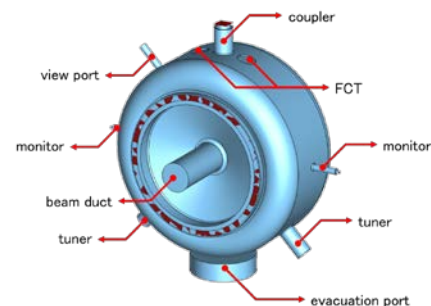


Fig. 3. Created 3D model.

## References

- 1) K. Tsukada *et al.*, Phys. Rev. Lett. **131**, 092502 (2023).
- 2) H. Ego *et al.*, Proc. the 11th Annual Meeting of Particle Accelerator Society of Japan, (Aomori, Aug. 9–11, 2014), pp. 237–241.