Measurement of isochronism using α-source for the Rare RI Ring

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The Rare RI Ring was constructed at the RIBF to measure the masses of nuclei pertinent to the r-process.[1)] We performed an offline machine study using α-source (^{241}Am). The α-source was placed in the ring on the central orbit at the R-MD1 area after the first sector as shown in Fig. 1. First, we tried transporting the α particle in the ring and succeeded. Next, to confirm the isochronous field of the ring, we measured TOF after one revolution using two detectors. One was a carbon foil detector like a circulation detector of this ring,[2)] and the other was a plastic scintillator. The carbon foil detector consisted of thin carbon foil (60 μg/cm^2 thickness) and three wired plates. A schematic view of these detectors is shown in Fig. 1. The carbon foil detector was placed in front of the source, whereas the plastic scintillator was placed behind the source to detect the α particle after one revolution. A delayed signal from the carbon foil detector was used as a stop signal of TOF, and a signal from the plastic scintillator was used as a start signal.

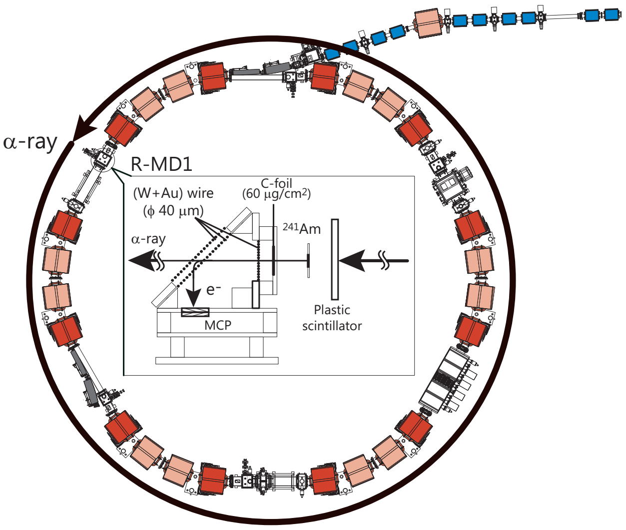

Fig. 1. Setup of α-source and detectors. The carbon foil detector was placed in front of the α-source, whereas the plastic scintillator was placed behind.

The obtained TOF was 4643.5(6) ns which corresponds to an α particle with 0.87 MeV/nucleon. This energy is equivalent to the value calculated from energy loss by the cover of the source and the carbon foil. In addtion we measured TOF while changing the radial gradient of the magnetic field using 10 trim coils.

Figure 2 shows the results of measurement and simulation by MOCADI.[3)] To evaluate the optimum gradient value, we fitted the results with a parabolic function. The obtained mean value of 0.207(2) is in very good agreement with the simulation result of 0.205. This shows that our isochronous field calculation was correct and an isochronous field is formed using trim coils. The final observed width had 0.61 ns standard deviation. However, the width was limited by the timing resolution of the detectors. Therefore, the achieved isochronism of the ring was less than 1.3×10^{-4}.

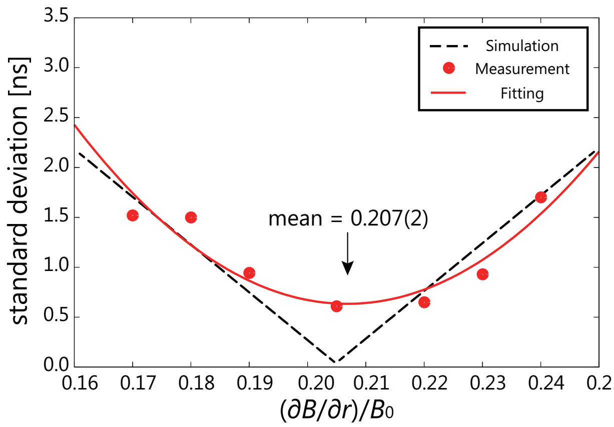

Fig. 2. Results of measurement (closed circles) and comparison with simulation (dashed line). The solid line is the result of fitting with a parabolic function.

It is seen from our results in Fig. 2 that the standard deviation was saturated. This saturation was caused by the limitation of timing resolution of the detectors.

Currently, we are testing an injection system to store the α particle from the source for several revolutions. If we can measure the TOF after several revolutions, we would be able to confirm the isochronism with higher order even though the timing resolution of the detectors is limited. Furthermore we will perform a machine study using a heavy-ion beam in the next fiscal year.

References
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