

## Fee-based activities performed by the RI Application Research Group

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This article summarizes the fee-based activities performed by the RI Application Research Group in 2021, which include the distribution of radioisotopes (RIs) and utilization of heavy-ion beams in the industry.

Since 2007, RIKEN has distributed RIs to users in Japan for a fee in collaboration with the Japan Radioisotope Association<sup>1)</sup> (JRIA). The nuclides include  $^{65}\text{Zn}$  ( $T_{1/2} = 244$  days),  $^{109}\text{Cd}$  ( $T_{1/2} = 463$  days),  $^{88}\text{Y}$  ( $T_{1/2} = 107$  days),  $^{85}\text{Sr}$  ( $T_{1/2} = 65$  days), and  $^{67}\text{Cu}$  ( $T_{1/2} = 61.8$  hours) produced in the RIKEN AVF cyclotron by the Nuclear Chemistry Research Team of the RI Application Research Group.

According to a material transfer agreement (MTA) drawn between the JRIA and RIKEN, JRIA mediates the transaction of RIs and distributes them to users.  $^{65}\text{Zn}$  and  $^{109}\text{Cd}$  are delivered approximately two weeks after the acceptance of an order.

$^{85}\text{Sr}$ ,  $^{88}\text{Y}$ , and  $^{67}\text{Cu}$ , which have short half-lives, are not stocked like  $^{65}\text{Zn}$  and  $^{109}\text{Cd}$ ; instead, they are produced in a scheduled beamtime after an order is accepted. Therefore, they are delivered after two or more months.

Details regarding RIKEN RIs can be found on the online ordering system, J-RAM,<sup>2)</sup> of JRIA.

In 2021, we delivered 4, 2, and 10 shipments of  $^{65}\text{Zn}$ ,  $^{88}\text{Y}$ , and  $^{85}\text{Sr}$  with a total activity of 31, 2, and 36.4 MBq, respectively, and no shipment of  $^{67}\text{Cu}$  and  $^{109}\text{Cd}$ . The final recipients of RIs included 11 universities, two research institutes, one private company, and one medical research center.

Figure 1 shows the yearly trends in the number of orders and amount of distributed RIs.

Compared with 2020, the amount of distributed  $^{65}\text{Zn}$  and  $^{85}\text{Sr}$  increased, that of  $^{109}\text{Cd}$  decreased, and that of  $^{88}\text{Y}$  remained the same. The amount of  $^{85}\text{Sr}$  distributed in 2021 was the highest since the beginning of its distribution. The number of orders for  $^{65}\text{Zn}$  in 2021 was the highest in the last seven years; however, it was significantly less than that in 2010.

The Industrial Application Research Team of the RI Application Research Group promotes the utilization of heavy-ion beams in the industry. The RIKEN Nishina Center allows the use of the AVF cyclotron, RILAC, and RIKEN Ring Cyclotron (RRC) by private companies in Japan for a fee.<sup>3)</sup> Currently, the main users include semiconductor companies that irradiate space-use semiconductor devices with  $^{40}\text{Ar}$ ,  $^{84}\text{Kr}$ , or  $^{136}\text{Xe}$  ions from the RRC to simulate single-event effects due to the heavy-ion components of cosmic radiation.

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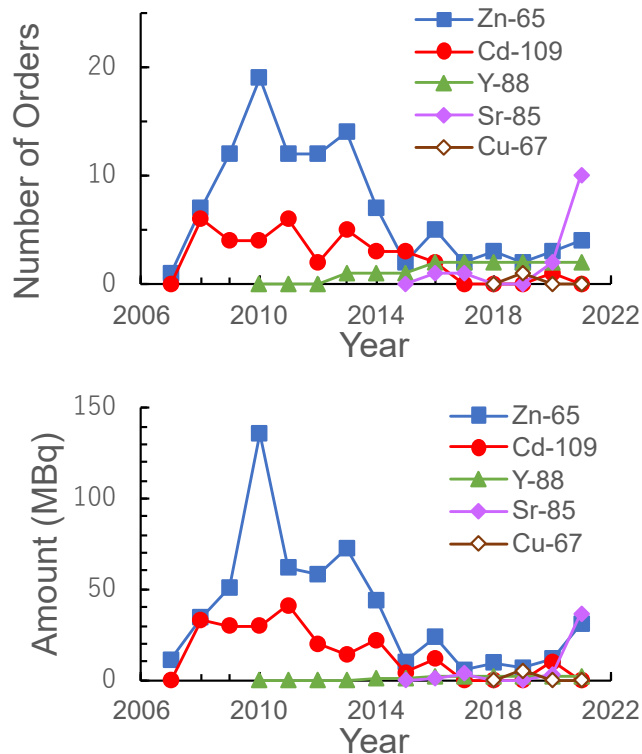


Fig. 1. Number of orders (upper) and amount (lower) of RIs distributed yearly from 2007 to 2021. The distribution of  $^{88}\text{Y}$ ,  $^{85}\text{Sr}$ , and  $^{67}\text{Cu}$  started in 2010, 2015, and 2018, respectively.

The proposals for beam utilization are reviewed by a program advisory committee dedicated to industrial use (InPAC).

In January 2021, In-PAC reviewed and approved three proposals via e-mail. In July, In-PAC held its 17th meeting, where it reviewed and approved seven proposals, including two new proposals.

In 2021, four companies executed 13 fee-based beam-times, nine of which used a  $^{84}\text{Kr}$  beam with a total beamtime of 161 h and four utilized an  $^{40}\text{Ar}$  beam with a total beamtime of 48 h. In response to user demand, we are prepared to supply  $^{12}\text{C}$  beam; further details are provided elsewhere in this progress report.

### References

- 1) <http://www.jrias.or.jp/> (Japanese), <http://www.jrias.or.jp/e/> (English).
- 2) <https://j-ram.org/> (Japanese).
- 3) <http://ribf.riken.jp/sisetu-kyoyo/> (Japanese).