Contribution ID: **31** Type: **Instruments**

A position sensitive Schottky cavity doublet for use in the Rare RI Ring.

Monday, 22 August 2022 14:00 (15 minutes)

Despite being proposed over half a century ago, various aspects of the r-process synthesis of heavy elements remain unknown¹. One such mystery is that of the true astrophysical site. Intense neutron flux is required to set sufficient conditions for synthesis. In order to clarify the conditions of the r-process, mass measurements of neutron rich isotopes involved in the r-process chain are crucial to constrain mass models thereby improving accuracy of simulations which rely on extrapolated values ². The Rare Radio-Isotope storage ring (R3) at RIKEN, Japan currently carries out isochronous mass spectrometry via a time-of-flight (tof) measurement over multiple revolutions. Due to low production rates, reliable beam diagnostics are essential to achieving the high yield necessary to create sufficient statistics. Currently no sophisticated beam monitor is permanently installed, therefore a novel position-sensitive Schottky cavity doublet has been developed at GSI, Darmstadt to be tested at R3. With design based on the existing successful cavities at GSI, it can additionally perform mass determination via frequency measurement; this method has been proven to provide excellent resolution³. This would remove the need to reliably extract particles to complete a tof measurement, increasing the potential yield. Position sensitivity enhances the precision of this method by correcting for velocity spread of particles offset from the isochronous condition. Moreover, it could enable measurement of the magnetic rigidity inside the ring which is used for mass determination and recorded with a thick gas based detector upstream. Removing the need for this detector would greatly reduce energy loss and increase precision. In this work, the theory and operation of the novel Schottky cavity doublet is presented.

[1] E. M. Burbidge, G. R. Burbidge, W. A. Fowler, and F. Hoyle, 'Synthesis of the Elements in Stars', Rev. Mod. Phys., vol. 29, no. 4, pp. 547–650, Oct. 1957, doi: 10.1103/RevModPhys.29.547.

[2] J. J. Cowan et al., 'Origin of the heaviest elements: The rapid neutron-capture process', Rev. Mod. Phys., vol. 93, no. 1, p. 015002, Feb. 2021, doi: 10.1103/RevModPhys.93.015002.

[3] P. Kienle et al., 'High-resolution measurement of the time-modulated orbital electron capture and of the β+ decay of hydrogen-like 142Pm60+ ions', Physics Letters B, vol. 726, no. 4, pp. 638–645, Nov. 2013, doi: 10.1016/j.physletb.2013.09.033.

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Session Classification: Young Scientist Session 2