Installation and offline tests of a position-sensitive Schottky cavity doublet

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The Rare-RI Ring (R3) is one of three storage rings at the forefront of mass measurement of short-lived neutron rich isotopes alongside ESR, Germany[1)] and CSRe, China.[2)] It is a dispersive ring that operates in the isochronous mode which causes particles to circulate independent of their velocity, separating them in the time domain by their mass to charge ratios. Their mass can then be calculated by their time-of-flight (ToF) relative to a reference particle. The isochronous condition can only be fulfilled for one species causing a momentum spread for other isotopes, increasing the uncertainty in the mass measurement. This is corrected at R3 using the relationship between the ToF and momentum measured upstream from the ring at the dispersive focal plane in BigRIPS.[3)] This correction assumes that the momentum is unchanged from that focal plane to the ring. Moreover, it requires detectors which add small amounts of energy straggling and causes significant charge exchange with high Z beams which are planned for the future.

A position-sensitive Schottky Cavity Doublet (SCD) has been developed[4)] to remedy this by measuring the position non-destructively inside R3, removing the need for beam line detectors. The SCD has two cavities, as shown in Fig. 1, which are excited by the induced current of a charged beam. The elliptical cavity has an offset beam-pipe which creates a position dependence on the signal power. The cylindrical cavity is used as a reference. Normalisation reveals the final position information which is used to correct the mass measurement. The detector was paid for by the Max Planck Institute for Nuclear Physics and constructed by GSI, Germany. Recently, it was transported to RIKEN and installed in R3. Offline tests have shown that the detector is ready for testing with a heavy ion beam.

Offline measurements were made using a signal generator. We measured the resonant frequency of each cavity along the range of the tuning plungers which matched the designed values. The magnetic couplers that extract the signal were measured with a network analyser and we found that connection to the ring marginally changed the impedance leading to a slight over-coupling. This can be corrected for during analysis. Finally, a signal generator was input into the elliptical cavity which excited the cylindrical cavity via crosstalk, as shown in Fig. 1B. From the offline tests we evaluate that components are working as expected and the SCD is ready for a test with a heavy ion beam.

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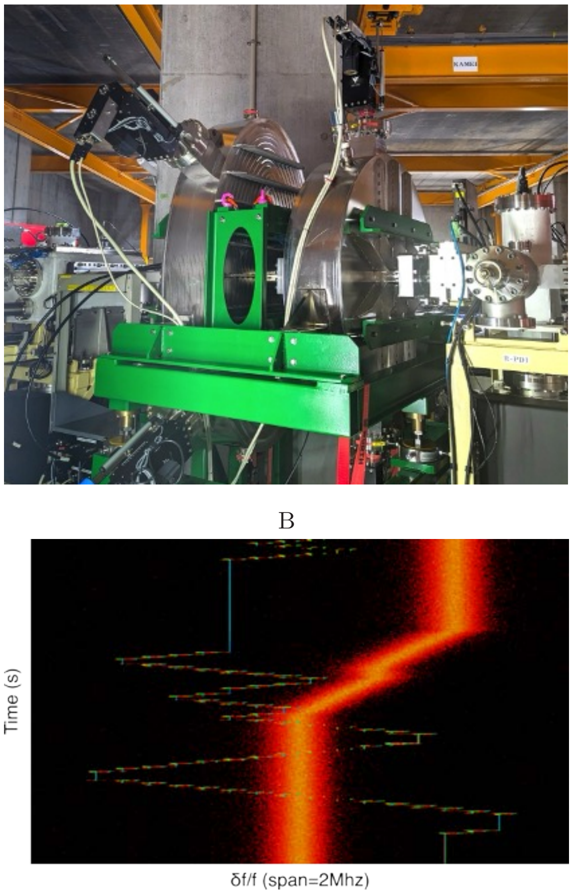

Fig. 1. A shows the installed SCD. B shows the cylindrical cavity spectrogram when excited by a signal generator input into the elliptical cavity. The thermal noise about the resonant frequency, f_r (thick signal), and the signal generator's frequency (thin signal) can be seen. Adjustment of f_r was made with the tuning plungers and the signal generator's frequency was changed manually to mimic an erratic signal. The time axis duration is 25 s.

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