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Phase-imaging mass measurements with the Canadian Penning trap mass spectrometer

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There is a severe lack of nuclear data, including masses, on the neutron-rich side of the valley of stability forcing r-process models and calculations to utilize predictive models or rely on masses obtained from extrapolation. With a number of rare isotope beam facilities turning on worldwide, there are many experiments probing the nuclear landscape further from stability than ever before. One such experiment is the Canadian Penning trap mass spectrometer (CPT), currently located in the CARIBU facility at Argonne National Laboratory where intense radioactive beams of neutron-rich nuclei are produced from the spontaneous fission of ^{252}Cf. Historically, Penning trap mass spectrometers have been wildly successful in accurately measuring the masses of trapped ions using a time-of-flight ion-cyclotron-resonance method (TOF-ICR), capable of determining masses with sub-keV precision. However, attempts at measuring the masses of short-lived, weakly produced isotopes quickly exposes the weaknesses of TOF-ICR. To probe the masses of such rare isotopes far from stability a modern phase-imaging ion-cyclotron-resonance technique (PI-ICR) has been implemented at the CPT. PI-ICR is intrinsically more efficient than TOF-ICR and provides more than an order of magnitude improvement in resolving power. The experimental setup at CARIBU will be discussed and the advantages of PI-ICR will be demonstrated by the recent measurement of neutron-rich rare-earth isotopes approaching the r-process path.

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