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Mass Measurements with the Canadian Penning Trap at CARIBU[1]

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Roughly half of the elements heavier than iron are thought to be produced through the astrophysical r process of nucleosynthesis. Despite its large influence in explaining the observed abundance of heavy elements, much of the r process is still poorly understood. A more thorough library of nuclear data of neutron-rich nuclei is needed to improve the accuracy and progression of r-process calculations. In particular, accurate mass measurements are in demand due to the strong coupling between mass and other nuclear properties such as β-decay and neutron-capture rates. For nearly three decades, direct mass measurements conducted by Penning trap mass spectrometers have proven to be an accurate method of determining masses to a precision suitable for r-process calculations ($\Delta m/m < 10^{-7}$). The Canadian Penning trap mass spectrometer (CPT) is 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. Since moving into CARIBU the CPT has successfully measured the masses of more than 110 isotopes to a typical precision of 15 keV/c^2. In order to push measurements to nuclides further from stability which may play a part in the r process, a number of upgrades to both the CPT and CARIBU have been made. A Multi-Reflection Time-Of-Flight (MR-TOF) mass separator has been added to the CARIBU beamline providing cleaner beams to low-energy experiments, and at the CPT a position-sensitive multichannel plate detector has been installed to facilitate a contemporary phase-imaging mass measurement technique. This technique allows for faster measurements with fewer ions and provides more than an order of magnitude improvement in mass resolving power without loss in precision. These upgrades, alongside recent measurements of neutron-rich rare-earth isotopes will be discussed.

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