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Decay-correlated mass spectrometry

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The use of multi-reflection time-of-flight mass spectrometry has become rather popular in the past decade. The technique provides for high mass resolving power ($m/\Delta m \sim 10^6$) and fast analysis ($t_{obs} << 100$ ms) which makes it competitive with Penning trap time-of-flight ion cyclotron resonance measurements, with the added advantage of a much greater tolerance for contaminants and the fact that each measured ion carries identical statistical weight – meaning that even one count could be a valid atomic mass determination. In order to realize such a single-ion measurement, however, it is necessary to fully exclude the possibility that the time-of-flight signal derived from noise or contaminant ions. In order to accomplish this, we have developed ion-detectors which combine a commercial dynode-based ion impact time-of-flight detector with silicon detectors to record α- and β-decay [1,2] as well as spontaneous fission and β-delayed proton emission. We are in the process, also, of developing a number of new detectors to improve the efficiency of the decay detection and extend the technique to include X-rays and γ-rays. The addition of X-rays and γ-rays will be critical to future plans for exploring the actinide and trans-actinide region by multi-nucleon transfer reaction, wherein nuclides on both sides of β-stability are produced and conjugate nuclei are often difficult to mass resolve.
I will present a detailed review of the existing detectors' performance along with some discussion of our new detector plans. Depending on the 2025 springtime accelerator schedule, first results of the new detector for X-/γ-ray correlated mass spectrometry may also be presented.

[1] T. Niwase et al., NIM A 953 (2020) 163198

[2] T. Niwase et al., PTEP Volume 2023, Issue 3 (2023) 031H01

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