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Reducing the beamtime required for lifetime measurements with the Triple-foil Plunger for Exotic Nuclei (TPEN)

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The Recoil Distance Doppler-Shift (RDDS) technique has become a well established method of measuring the lifetimes of excited nuclear states. In the standard approach, a two-foil plunger allows excited nuclei to radiate either in flight or while stationary. This results in two gamma-ray energies associated with each transition due to Doppler shift. The relative intensity of each of these components can then be used to calculate the lifetime of the state.

The Triple-foil Plunger for Exotic Nuclei (TPEN) has recently been commissioned at the University of Jyväskylä, Finland, by studying the nuclear transitions of 156Dy through the inverse reaction 24Mg(136Xe, 4n)156Dy. TPEN consists of three foils, allowing nuclei of interest to radiate within three different velocity regimes. This results in gamma-rays of three different energies associated with each transition, one more than the standard RDDS technique. A third component can either act as a direct measurement of the differential of the decay curve, as opposed to differentiating a fitted function, or be used to probe two lifetimes of different magnitude simultaneously. The work presented demonstrates how the latter could be used to reduce the beam time required in future experiments and give access to more exotic nuclei further from stability with lower cross sections.

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