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Rapid light manipulation techniques for collinear laser spectroscopy in application for neutron-deficient francium

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Collinear laser spectroscopy has been the workhorse at radioactive beam facilities to study nuclear spins, electromagnetic moments and changes in mean-squared charge radii for decades. With the quest of proceeding towards the study of more exotic isotopes, rapid light manipulation techniques for narrow-linewidth lasers have been developed in order to reduce the hyperfine pumping associated with fluorescence studies of atomic species. Firstly, the laser intensity supplied to the spectroscopy setup is modulated by means of an electro-optical modulator acting as a fast-switching half-waveplate [1]. Generating individual photon pulses and thus effectively achieving an "on/off" effect for the laser light, the observed intensities for the weaker hyperfine transitions are dramatically increased. The reduction of hyperfine pumping effects has aided in nuclear structure studies of francium [1] and rubidium [2] isotopes and isomers. Secondly, the intensity modulation technique has been taken further by implementing rapid frequency switching using a double-pass, acousto-optical modulator [3]. The synchronisation of the two modulators allows short photon bursts at variable frequencies to be delivered to the light collection region allowing for an increase of the total laser/atom interaction time whilst maintaining minimal hyperfine pumping. In this contribution, a detailed description of the new developed techniques and results from the experiment at TRIUMF-ISAC on neutron-deficient francium isotopes and isomers will be presented.

[1] A. Voss et al., Phys. Rev. Lett. 111, 122501 (2013).
[2] T.J. Procter et al., Eur. Phys. J. A 51, 23 (2015).
[3] A. Voss et al., accepted in Phys. Rev. C.

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