Contribution ID: **11**

Type: **not specified**

Spectral linewidth control of broadly tunable high repetition solid state lasers

Thursday 21 February 2013 17:10 (20 minutes)

Resonance ionization is the key for the efficient production of highly pure beams produced with laser ion sources at Isotope Separator On-Line (ISOL) facilities. The high element selectivity is achieved by applying a multi-step resonant excitation and ionization scheme via optical transitions unique for every element. To ensure access to a maximum number of elements wide-range tunable laser systems like Ti:sapphire or dye lasers are required. The frequency selection of the Ti:sapphire lasers operated at the leading on-line laser ion source facilities worldwide (i.e. ISOLDE-RILIS at CERN, ISAC-TRILIS at TRIUMF and few others) is based on a combination of a birefringent filter and a thin etalon which limits the spectral line width to typically 6 GHz, which almost perfectly matches the Doppler width of the thermal atom ensemble inside a hot cavity. For applications like direct in-source laser spectroscopy addressing hyperfine structure and isotope shift investigations as well as isomer selection a further considerable reduction of the experimental line width is required. This is achieved by utilization of a second, thick etalon within the laser resonator implying simultaneous control. The resulting laser line width well below 1 GHz expands the applications of this solid state laser system and enhances generation of higher harmonics to access the blue and ultra-violet spectral range. The operation principle, wavelength selection, line width reduction and automated wavelength control of the dual-etalon laser are discussed in this presentation. The actual performance at Mainz as well as at the CERN ISOLDE/RILIS is analyzed and the steps towards a reliably tunable, fully automated narrow band width Ti:sapphire laser are given.

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