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13. ABSTRACT *(Maximum 200 words)*

A titanium sapphire ultrafast laser system was procured and merged with a high repetition rate pulsed valve to produce higher harmonic light output in a rare gas jet. The ultrafast laser system consists of a seed laser, a regenerative amplifier, and a two-pass power amplifier. The system operates at 2.8 mJ energy per pulse, 75 fs pulse duration, and 1000 Hz repetition rate. Higher harmonics up to 20 eV have been observed at the 1000 Hz repetition rate by focusing the output of the laser into an argon jet. The energy of the higher harmonics is sufficient to produce excellent signals when ionizing NO.

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Report

Equipment procured from Spectra-Physics, 1344 Terra Bella Avenue, Mountain View, CA 94039-7013, in conjunction with Positive Light (Merlins and Spitfire)

one	Millennia-P diode-pumped solid state cw laser 5W at 532 nm
one	Model 3941-M2S-USP (Tsunami) Mode-locked Ti:sapphire laser with sub 50 fs pulse duration at 800 nm
two	Merlin - Nd:YLF intra-cavity doubled kHz pump lasers for spitfire amplifier
one	spitfire-F-1K, one kHz regenerative amplifier, 0.75 mJ/pulse, <80 fs at 800 nm
one	NSI-2449 multipass amplifier extension for spitfire, >2.5 mJ/pulse, <80 fs at 800 nm

List price - $355,100

Final price with discounts - $288,100

Funding Sources:

AFOSR DURIP	$142,000
University matching	$25,000
NIST lab reserve match	$86,000
NSF grant	$35,100

The laser system procured required more funds than were available from the DURIP alone. It was decided to procure a system for high repetition rate (1000 Hz) whereas the original proposal indicated a 10 Hz laser. This would give higher data acquisition rates, which was deemed necessary. Calculations indicated that 1.5-3 mJ pulse in 80 fs would be adequate to generate the higher harmonics as proposed. Therefore additional sources of funding were obtained through the University of Colorado and NIST matches. In addition, a sizable price reduction was negotiated. In addition, Spectra-Physics and Positive Light had to be pushed to the limit on power amplification. As a result, they designed and added a state-of-the-art two-pass linear power amplifier to the regenerative amplifier system.

The laser system was installed in August and September of 1997 and a 1000 Hz pulsed valve was made operational in the fall of 1997. The first higher harmonics were observed in January of 1998. Using a simple vacuum ultraviolet monochromator, which cuts off at 20 eV, the higher harmonics up to the 15th of 800 nm are observed in 1st or 2nd order of the monochromator by focusing the laser into the argon jet. Even though the grating and mirror system of this monochromator was very lossy, the light output of all the higher harmonics was sufficient to ionize NO and detect the ions with excellent signal-to-noise.

A complete new apparatus has been constructed which incorporates high vacuum, oil-free beam transport from the pulsed valve to a grazing incidence grating, to an interaction region where the VUV or soft x-ray beam can be crossed with a sample and electrons detected with a magnetic bottle time-of-flight spectrometer. This apparatus will be operational soon, permitting harmonics up to 100 eV to be used for core level spectroscopy and dynamics. The first planned experiment will detect the core level shifts of Al and Br in aluminum bromide compounds.