Femtosecond Pulses in 375 nm - 405 nm Region by Chirped Sum Frequency

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Abstract: Tunable femtosecond pulses have been obtained from nJ pulse energies of the oscillator by sum frequency between the fundamental and the chirped pulse. The pulse has been characterized by the same set up.
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1. Introduction to the style guide, formatting of main text, and page layout

Tunable femtosecond (fs) pulses in near UV region have applications in several areas viz., time-resolved spectroscopy, waveguide fabrication, bio-photonics, bio-medicine and in nanotechnology. Such pulses can be generated by second, third and fourth harmonic generation of the fundamental wavelength of the Ti: Sapphire laser. Sum frequency generation process has also been used to generate pulses in UV region by changing the chirp of the input pulses[1]. However, the obtained wavelength range in these is limited by the tunability of the fundamental beam.

Earlier, broadly tunable parametric line emission from β-barium borate on pumping with picosecond pulses was reported by us[2]. In this report, we present the generation of tunable fs pulses in near UV range by using the sum frequency of the chirped and the main pulse of Ti: Sapphire oscillator by using a simple experimental geometry. Further, with a small modification of this set up into the spectral phase interferrometry for direct electric filed reconstruction (SPIDER) technique[3], we have characterized the fundamental pulses to estimate the properties of the obtained UV pulses.

2. Experimental

The schematic setup used in the experiment is shown in Fig. 1. A Ti: Sapphire oscillator (TISSA 100) with ~100 fs duration pulses (energy of 2 nJ) at 775 nm at a repetition rate of 82 MHz was used in the experiments. The pulses from the oscillator were divided into two replica pulses by using a 50/50 beam splitter. One part of the beam was used to generate chirped pulses by passing through the SF 57 glass slab of 60 mm length. The chirped pulse along with its replica was focused with two focusing mirrors of 200 mm focal length. The sum frequency was generated

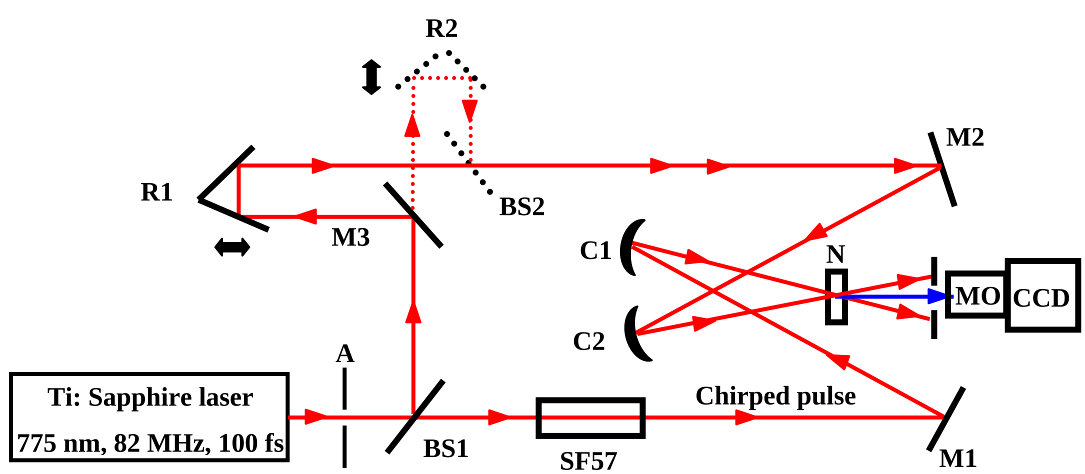

Fig. 1. Experimental set up for chirped sum -frequency generation scheme: BS1, BS2 - Beam splitters, A-Aperture, SF57-Glass block, M1, M2, M3-Plane mirrors, R1, R2-Retro reflectors, C1, C2 -Concave mirrors, N-Nonlinear crystal (BBO), MO-Monochromator, CCD-Charge-coupled device. The dotted part of the optical set up is used in for characterization of the pulse. The double arrows (↔) indicate the time delay in fs.

by overlapping spatially and temporally the two portions on a 2 mm β-barium borate (BBO) crystal (Castech) cut at an angle of 29^0. The spectra of the generated signals were measured by using the spectrometer (Spectra Pro-2150i) and air - cooled CCD (PIXIS: 100). The pulse duration was obtained by using a lab built all-reflective autocorrelator interfaced with LabVIEW code.

3. Results and discussion

Fig. 2 shows the experimentally recorded spectra (normalized to unity) of the generated pulses. The two interacting pulses exhibits Type I (o+o→e) phase matching interaction. Therefore, the generated frequencies are orthogonally polarized with respect to the input pulses. The phase matching angle[4] varies from 31.2^0 to 28.8^0 for tuning the sum frequency signal from 375 nm to 405 nm.

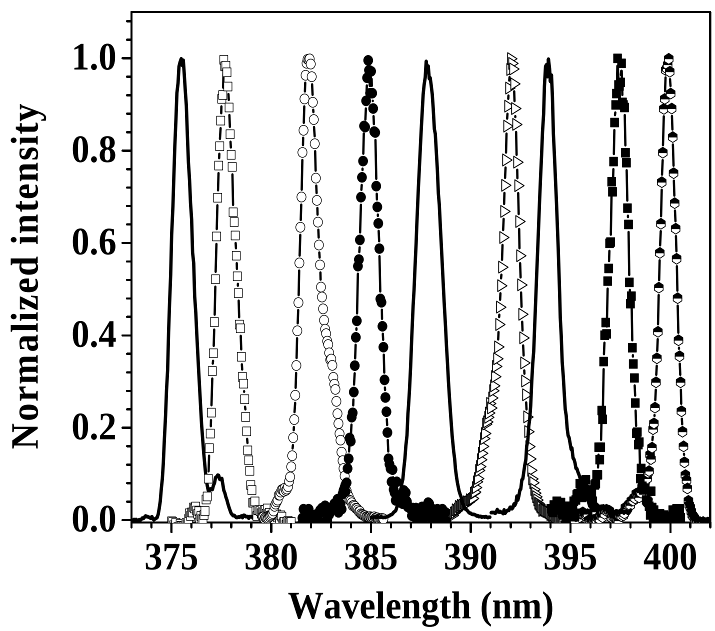

Fig. 2. Experimentally recorded sum frequency signals for various phase matching angles from 31^0 to 28^0. For brevity, several measured spectra have been omitted between every two spectra presented here.

The maximum power is obtained for the wavelength of 383-392 nm (with an efficiency of 2%) while for other wavelengths it decreases gradually. From 375 nm to 380 nm and from 395 nm to 400 nm, the output power is small because of lower intensities at the wings of chirped and fundamental pulses.

4. Conclusions

Generation of tunable fs pulses in near UV region has been demonstrated directly from nJ pulse energies of Ti: Sapphire oscillator at a fixed pump wavelength. The fs pulses can be tuned continuously with the steps of about 1 nm. The characterization of the output in UV has been done based on the estimates from the measurements of the fundamental pulse. We believe that this technique will be useful with higher energy pulses from the amplifiers.

5. References

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