Two-Color Induced Super Continuum Generation

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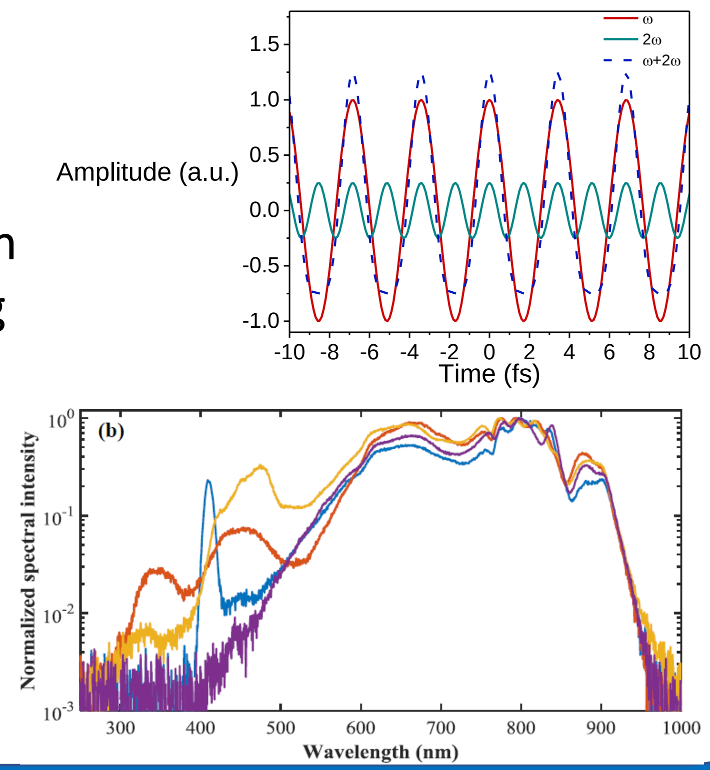
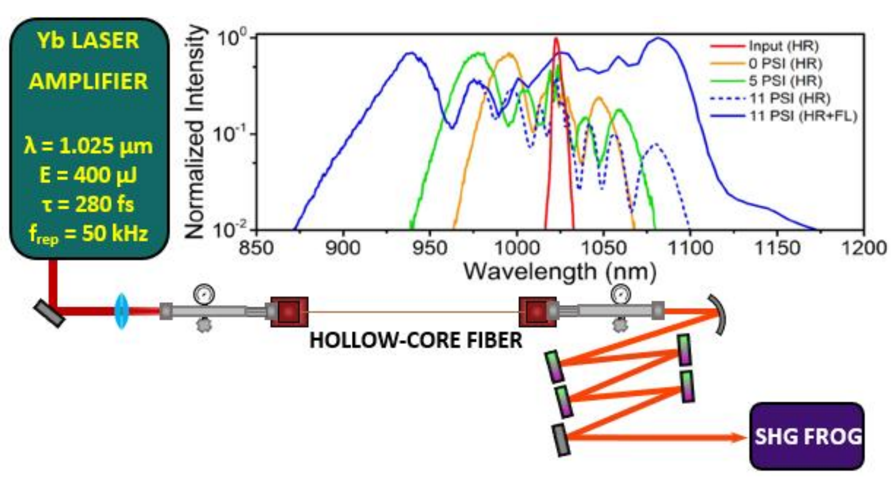
Motivation

- Short pulses require broad spectrum
- Non-linear propagation can be enhanced using a two-color field
- We want to use a two-color field to improve SCG in gases

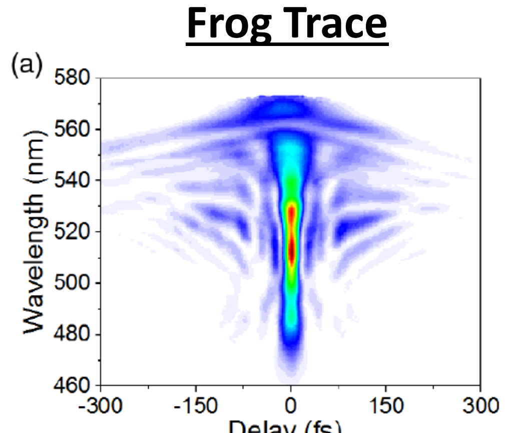


Previous Results

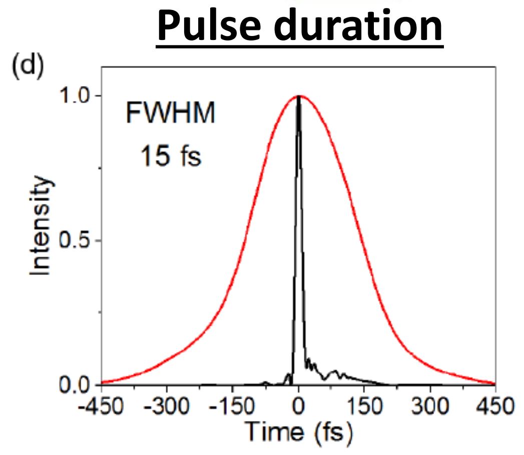
Experimental setup with spectrum



Frog Trace



Pulse duration



Laser source Specifications

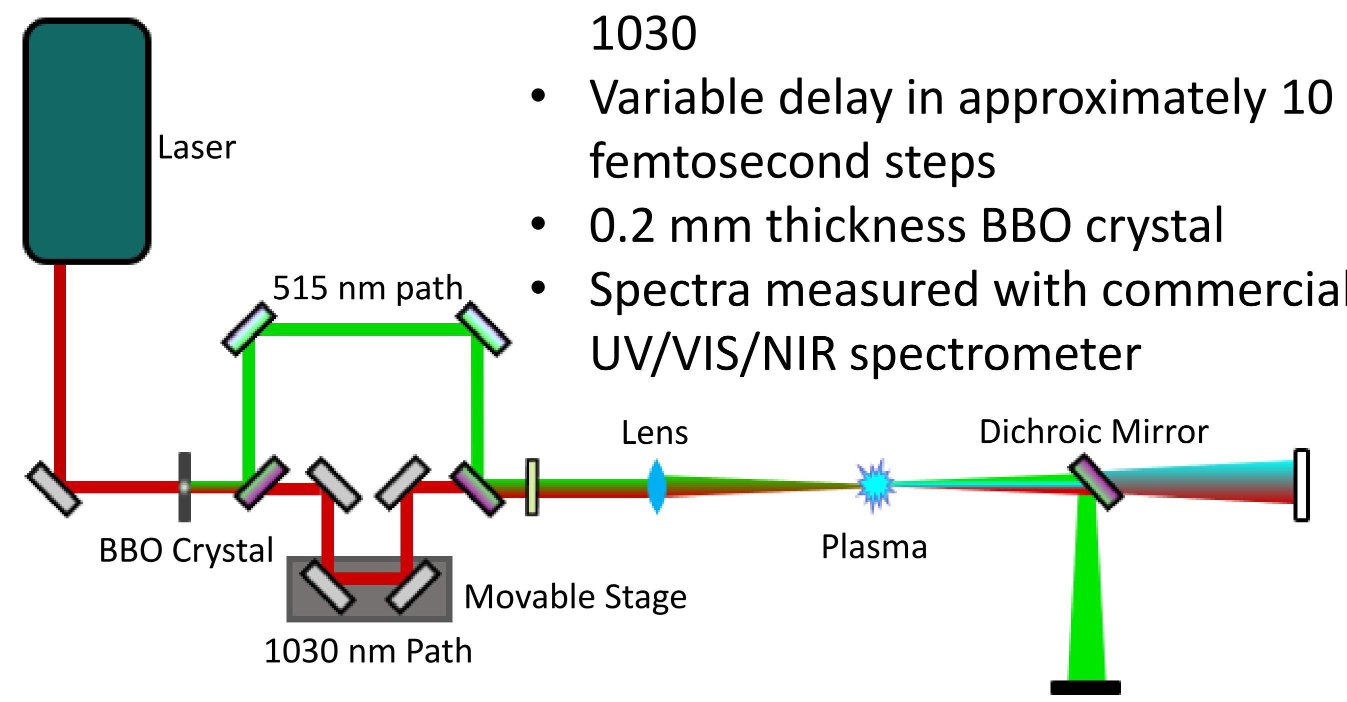
This experiment uses a Yb:KGW solid state laser with:

- Wavelength: 1030 nm
- Average Power: 20 Watts
- Max Pulse Energy: 0.4 mJ
- Pulse Duration: 280 fs
- Repetition Rate: 50 kHz

Experimental Setup

This experiment was conducted by using a 1030nm driving laser pulse, which passed through a BBO crystal for second harmonic generation and later focused through a lens in air for the generation of a broader spectrum

- Equal optical path lengths for 515 and 1030
- Variable delay in approximately 10 femtosecond steps
- 0.2 mm thickness BBO crystal
- Spectra measured with commercial UV/VIS/NIR spectrometer



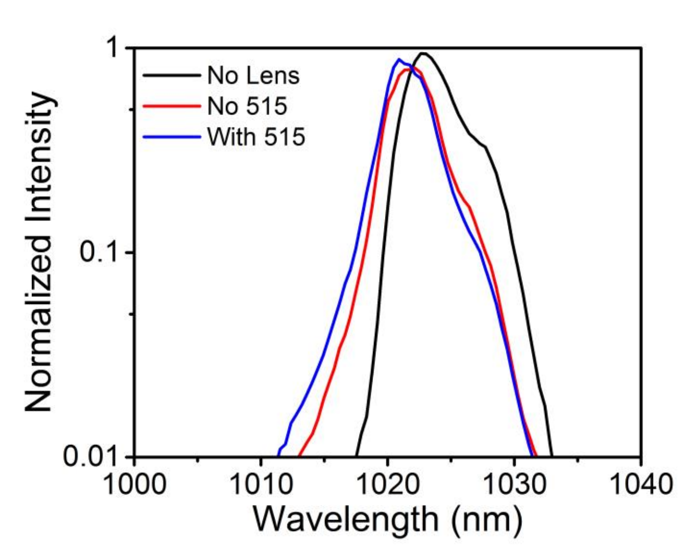
Two-Color Interferometer Spectrum

BBO Crystal Power Conversion

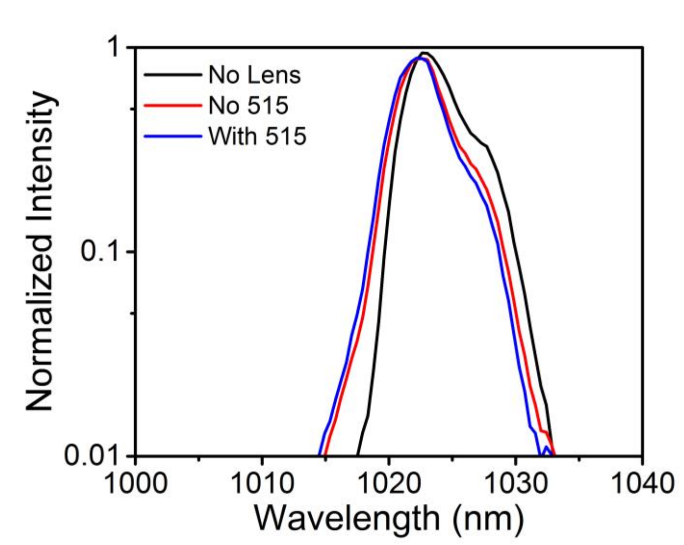
Angle (degrees)	515 Path Power (W)	1030 Path Power (W)
0	0.026	0.213
45	0.005	0.250
68	0.001	0.244
90	0	0.234

- Once the 1030 and 515 wavelengths are spatially and temporally aligned, they created a broader spectrum
- We can see a stronger spectrum enhancement when using the 50mm lens

50mm Lens



88mm Lens



Delay Dependence of Interferometer

Sum Frequency Generation

$\omega_3 = \omega_1 + \omega_2$

$\omega_1 = \omega_o$ (fundamental)

$\omega_2 = 2\omega_o$ (second harmonic)

$\omega_3 = \omega_o + 2\omega_o = 3\omega_o$

Delay Dependent Signal

$$I_{\omega_3} = \int_{-\infty}^{\infty} \left(I_{\omega_1}(t) I_{\omega_2}(t-\tau) \right) d\tau$$

- Sum frequency signal is only present when the two pulses are overlapped

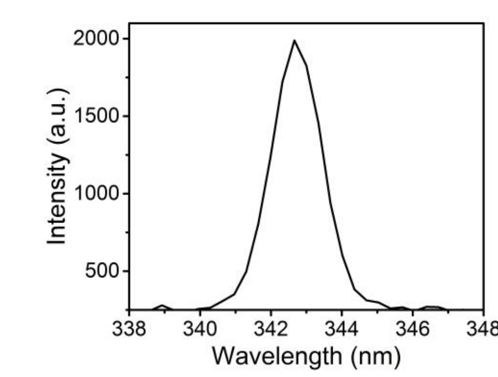
Cross Correlation Duration

$$\sigma_{\omega_3} = \sqrt{\sigma_{\omega_1}{}^2 + \sigma_{\omega_2}{}^2} \cong 300\,\text{fs}$$

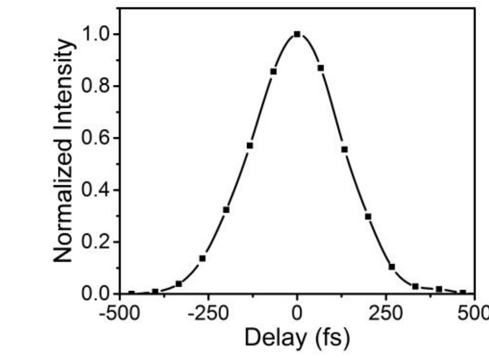
Second Harmonic Pulse Duration

$$\sigma_{\omega_2} = \sqrt{\sigma_{\omega_3}{}^2 - \sigma_{\omega_1}{}^2} \cong 100\,\text{fs}$$

Sum Frequency Signal



Cross-correlation



Conclusion and Future Steps

- Using the Interferometer we were able to generate a sum frequency signal in plasma
- We also determined that depending on how the phase of the 515 and 1030 wavelengths align will affect the intensity of our sum frequency signal and ultimately the broadening effect of our fundamental wavelength
- My future plans is to combine the interferometer with our hollow-core fiber to conduct super continuum generation. Our goal is to obtain an even broader spectrum that can't be obtain through super continuum generation alone

References

[1] J. Beetar, et al., Hollow-core fiber compression of a commercial Yb:KGW laser amplifier, J. Optical Society of America B, 2019.
[2] Y. Yang, et al., A robust two-color-field driven hollow-core fiber compressor, CLEO, 2018.

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