Generation of multimillijoule redshifted beams for stimulated Raman scattering*

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Introduction

Stimulated Raman backscattering (SRBS) is a possible candidate to overcome scaling limitations of state of the art chirped pulse laser amplifiers [1]. SRBS describes a three wave interaction in laser plasmas in which a plasma wave is generated due to the ponderomotive force of a beatwave originating from two counter-propagating and frequency shifted laser pulses. The frequency shift difference defines the optimal plasma frequency. To achieve an efficient energy transfer between the counter-propagating pulses a frequency difference between $5-10\%$ ($500-1500cm^{-1}$, 50-100 nm for typical CPA systems) is necessary [2].

Redshift with stimulated Raman scattering

The necessary parameters for a seed beam are: i) a well-defined redshift which must be independent of the energy available; ii) a single spatial mode beam and iii) a pulse duration much shorter than the pump pulse. The introduced Group Velocity Mismatch (GVM) it is suitable to partially recompress the pulse and forego further recompression techniques. To support a high total energy output gases are ideally suited for this application. SF_6 provides a 100 nm redshift at 1053 nm ($775cm^{-1}$).

Experimental results

The presented data [3] were collected in the XRay Lab at the PHELIX Laser facility. The laser provides up to 200 J in 500 fs at 1053 nm every 90 minutes. Figure 1 shows the aquired spectra. To generate the seed beam the energy was reduced to 0.1-0.4 J at the axicon every 3 minutes.

Conclusion

We characterized a simple but reliable method for the generation of redshifted seed beams for SRBS. The results show that with minimal alignment, fitting for few shot systems like PHELIX it is possible to generate customized high quality beams. The redshift is not energy dependent and tunable by the Raman medium and the order of the process used. Results show further a high absolute energy of the seed beam suitable to be used in the nonlinear Raman regime. With these seed source we are now in the favourable situation to complete our SRBS experiment at PHELIX, which will be a major step forward to realize a hight power pulse light source for studying the interaction of intense pulses with heavy ions, or dense plasmas generated with heavy ions, as available at FAIR.

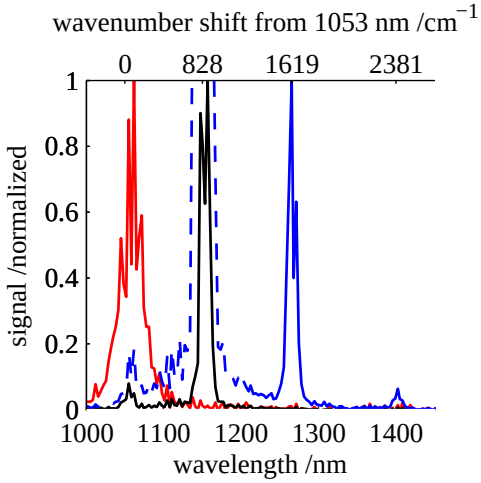

Figure 1: Spectral evolution of Raman shifted pulses using SF_6 with short (black line), long (blue dotted) caustic length, and Ar with significant spectral broadening for fundamental pulses at 1053 nm.

References

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* Work supported by GSI(PHELIX)/HI Jena/HGShire/European Regional Development Fund (EFRE)/state of Thuringia (TMBWK) under Grant No. B 715-08008/TR 18/US Air Force Office of Scientific Research through grants No. FA9550-12-1-0143 and No. FA9550-12-1-0482/US Defense Threat Reduction Agency through grant No. HDTRA 1-14-1-0009