

Coherence Measurements of Microstructure Fiber Supercontinuum

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Broadband supercontinuum (SC) generation in microstructure fiber has now been reported under a variety of experimental conditions. Although SC generation is complex, theoretical and numerical studies are beginning to understand the spectral broadening mechanisms and the stability (or the lack thereof) of SC. Numerical simulations, in particular, have shown that SC generation can exhibit extreme sensitivity to input pulse noise, leading to shot-to-shot intensity fluctuations that can wash out spectral fine structure when averaged over many shots, and shot-to-shot phase fluctuations that degrade the SC coherence. Previously, we confirmed these predictions by FROG and single-shot spectral measurements. (These fluctuations have also been studied at NIST using RF noise spectra.)

The SC coherence properties can also be quantified using a Young's two-source type experiment. This technique was first reported by Bellini and Hansch in the context of SC generation in bulk materials. We have now applied this technique to the characterization of the coherence of microstructure fiber SC by interfering together two SC independently generated in different fiber segments. An analysis of the resulting interferogram allows the wavelength dependence of the mutual degree of coherence between the SC to be determined, and a comparison with stochastic nonlinear Schrödinger equation simulations shows that the observed coherence degradation in our experiments is consistent with technical fluctuations in the injected peak power.

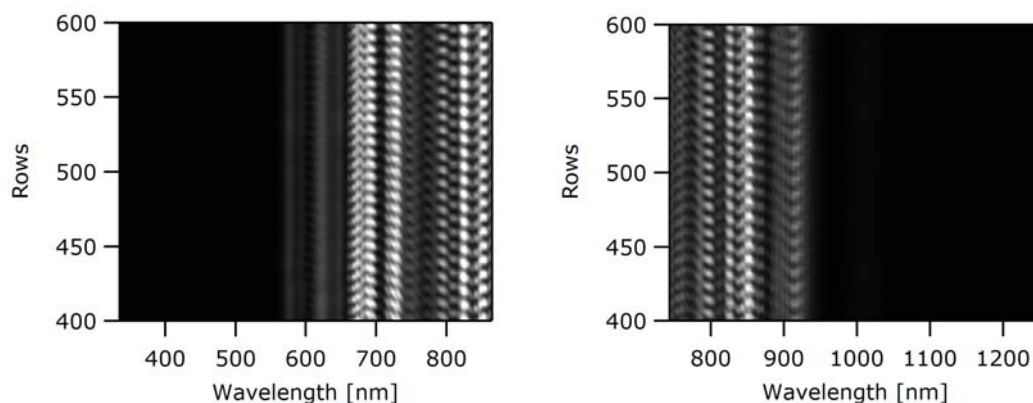


Fig. 1. Interference fringes observed between two independently generated SC.

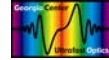


Figure 1 shows the results from our Young's two-source interference experiment. Distinct fringes are observed in the overlapped region between the two SC beams, showing that some coherence is maintained in the SC generation process. Fringe visibility and the degree of coherence can be further extracted from the interference pattern, and the results are in very good agreement with numerical simulations assuming 2% variation in the injected peak power (see Fig. 2).

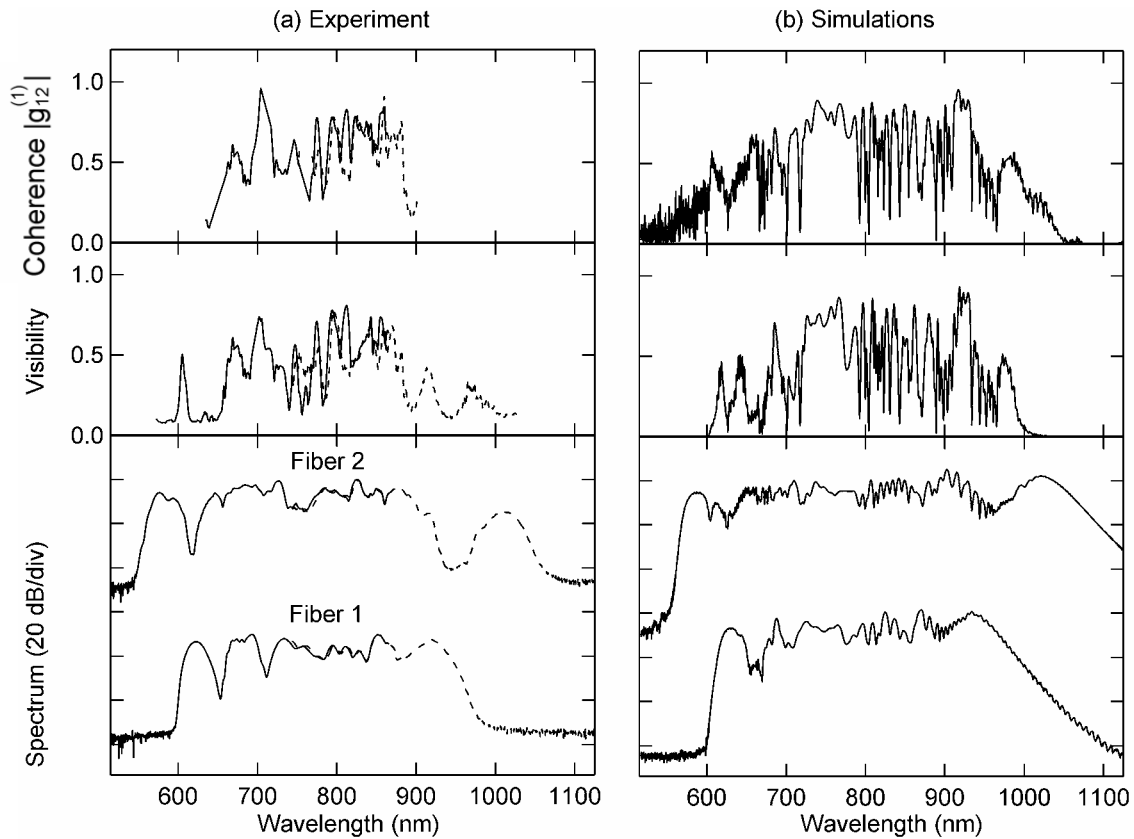


Fig. 2. (a): experimentally measured SC spectra from each fiber (bottom), the visibility extracted from the interferogram between the two SC (middle) and the corresponding calculated degree of coherence (top). (b): corresponding results from simulations.

These results suggest that the generation of coherent SC will require particular care in the stabilization of the pump laser and the mechanical fiber injection conditions.