Suppressing Stimulated Brillouin Scattering in Multimode Fibers with High Output Beam Quality

Kabish Wisal[1,*], Chun-Wei Chen[2], Stephen C. Warrensmith[3], Peyman Ahmadi[4], Hui Cao[2], A. Douglas Stone[2]

Department of Physics[1], Department of Applied Physics[2], Yale University, New Haven, CT 06520, USA

Future Industries Institute[3], University of South Australia, Mawson Lakes, SA 5095, Australia

Coherent[4], 1280 Blue Hills Ave., Bloomfield, CT 06002, USA

Stimulated Brillouin Scattering (SBS) is one of several nonlinear effects that limit the power scaling in high power delivery fibers and fiber amplifiers[1]. We demonstrate experimentally that by controlling the input mode excitation in a multimode fiber (MMF), significant increase in the SBS threshold can be achieved, while maintaining a high beam quality. We used a spatial light modulator (SLM), to shape the incident wavefront of a laser beam launched into a MMF such that the output is focused to a diffraction-limited spot (see schematic in Fig.1a), which can be collimated using a lens. The SBS threshold for this excitation (Fig.1b) was 3.8 W, higher than that for fundamental-mode-only excitation (2.4 W) by 1.5 times. This increase in SBS threshold upon multimode excitation is a result of reduced intermodal SBS gain[2]. An even higher (2.3x) SBS threshold (5.6 W) was obtained when the focused spot was offset from the fiber axis by 5 μm (Fig. 1c), a result of increased excitation of higher order modes due to axial symmetry breaking. We calculated the SBS threshold for various offset distances using our newly developed multimode SBS theory[2]. The SBS threshold increases monotonically with the offset distance (see Fig.1d) and the experimental data agree well with the theory predictions. Our results strongly suggest that wavefront shaping of signals in MMFs provide an efficient path for SBS suppression, while preserving the spatial coherence of light for a narrowband seed.

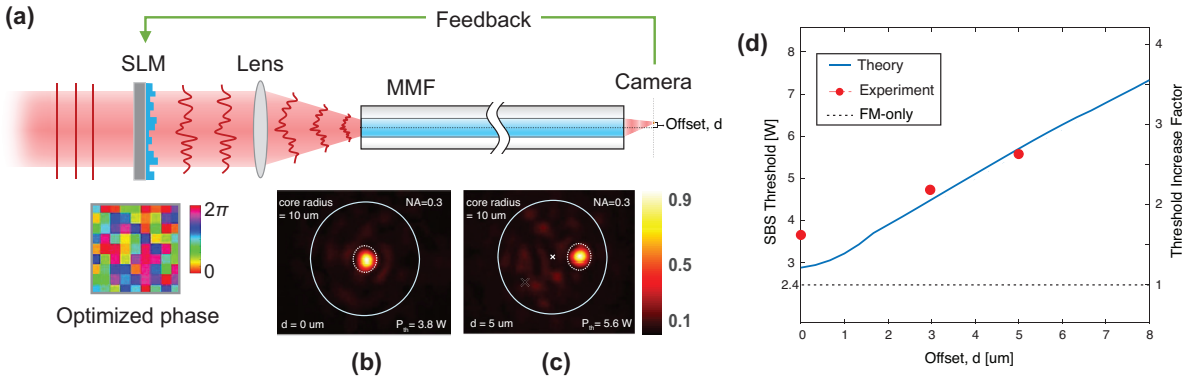

Figure 1: (a) Schematic for obtaining a focused spot (with possible axial offset, d) at the output of a MMF. The experimental results for (b) on axis and (c) off-axis focusing show increased SBS thresholds. (d) Theoretical prediction of SBS threshold compared to experimental data for various offset distances

[1] A. Kobyakov, M. Sauer, D. Chowdhury, *Adv. Opt. Photonics 2, 1–59 (2010).*

[2] K. Wisal, S. Warrensmith, C-W. Chen, R. Behunin, H. Cao, AD Stone, *Proc. SPIE PC1199504 (2022)*

We thank Ori Henderson-Sapir, Linh Viet Nguyen, Erik P. Schartner, Heike Ebendorff-Heidepriem, and David Ottaway at University of Adelaide, Australia, for fruitful discussions. This work is funded by AFOSR: FA9550-20-1-0129.