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Frequency Comb-based Seed Source for Spectral Beam Combining with Enhanced Brillouin Suppressing Properties

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Beam combining of multiple lasers is done to increase the output power levels beyond the achievable power from a single laser. There are two broad methods of beam combining, coherent beam combining (CBC) and spectral beam combining (SBC) [1]. In CBC, the optical phase of all the combining beams needs to be controlled [2]. SBC has advantages over CBC such as not requiring precise phase control of individual beams [3] and graceful degradation of system output power if individual units fail. However, in SBC, each laser needs current and temperature controller and line broadener, making the system uneconomical and complex. This problem can be solved if multiple lasers in SBC are extracted from a single laser. In this work, we demonstrate a frequency comb-based seed source that uses one laser wavelength to generate multiple wavelengths with tunable repetition rate and central wavelength. We use a demultiplexer to extract 200GHz separated carriers in distinct fiber ports. We further experimentally demonstrate that our system enables superior stimulated Brillouin scattering (SBS) suppression through line-shaping the spectrum. In fiber amplifiers, SBS is enhanced due to seeding by back-reflected component of laser spectra. Here we mitigate it by making the spectrum asymmetric by utilizing the suppression band of demultiplexer, which reduces power at Stokes wavelength. With tailored line-shape, the SBS threshold of the system increases by 58%. As a proof of concept, we have demonstrated the proposed architecture in C-band, but the same system can be replicated in other wavelengths (e.g. 1µm) where SBC applications are more important.

Fig.1(a) shows the system schematic. A narrow linewidth laser (~100kHz) is used to generate optical carriers using sinusoidal phase modulation along with white noise phase modulation. A pulse shaper controls the spectral phase prior to nonlinear broadening in highly nonlinear fiber (HNLF). The broadened comb is sent to demultiplexing unit to get carriers in distinct fiber ports as shown in Fig.1(b). Here the carriers are 200GHz separated to make beam combining easier. Fig.1(c) shows a comparison of line-shape and SBS spectral overlap for two cases: noise modulation only and noise modulation along with modified line-shape. With modified line-shape, there is a sharper roll-off with significantly lower power in the Stokes wavelength. Fig.1(d) shows average backward propagating power with coupled output power. It is evident that the slope of backward power increases

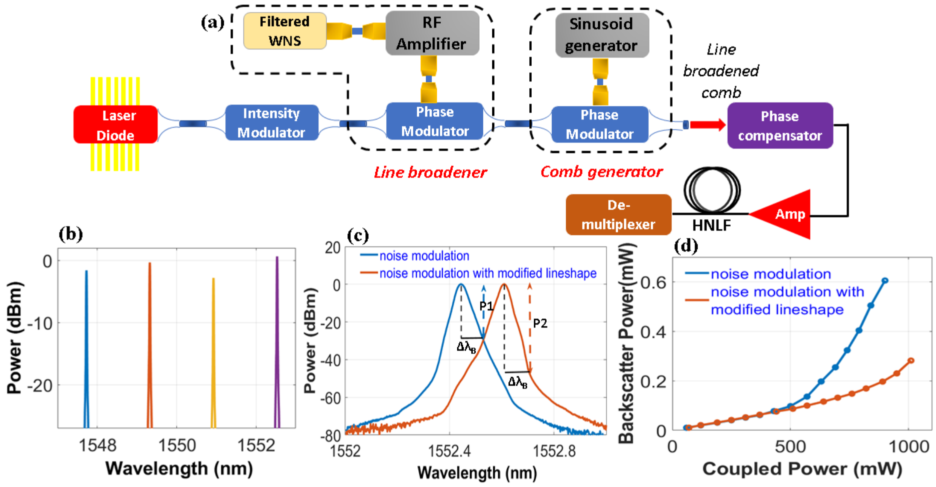

Fig. 1 (a) Architecture of spectrally broadened electro-optic frequency comb generator (b) De-multiplexed carriers from the line broadened comb (c) Line-shape modification through de-interleaver (d) Comparison plot of output power vs average backward power for noise modulation and noise modulation with altered line-shape case.

sharply in noise broadened case compared to noise broadened with modified line-shape case. Thus, the proposed system allows for enhanced SBS suppression, and hence power scaling. Proposed architecture can be readily implemented in SBC systems to achieve higher output power from a single laser source.

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