SSDLTR Formatting Template & Guide

Title (Arial Bold 14 pts)

Authors (Arial 10pt)

Contact information of authors

General Guidelines

- Papers should be between 2-5 pages in length, including photographs, tables, schematics, plots and references.
- Documents should be ONLY in Arial and symbol Font.
- Graphics/ Charts / Photographs MUST be converted to GREyscale.
- Main text should be in 10 point Arial type  Title should be 14 pt Arial Bold Font
- Text should be left justified.
- Single column format
- **One inch margin** top, bottom and sides. **Note this is not the MS Word default.**
- The footer should have the papers' session name and the principle author's name (ie. Plenary - Smith) centered, .3” from the bottom in 10 pt Arial. Authors will be informed of their sessions before the paper deadline.
- Imported graphics should be .bmp, .gif or .jpg only.
- Make graphics, equations, tables etc. in-line on their own line. (Choose “in-line with text” in the formatting options.) Convert all graphics to grayscale.

Things to avoid

- No page numbers.
- No color graphics. (For charts, choose shades of grey that will stand out in B&W)
- No Company LOGOS
- No cross-links, hyperlinks, linked footnotes etc.
- Turn change tracking OFF.
- No floating graphics elements.
- No text boxes or graphics boxes (MS Word).

Electronic submission requirements

- Papers must be submitted electronically as word documents in a single file to ssdltr@hotmail.com.
- File size must be less than 10 MB.
- Electronic submissions must have the file titled Lastname.doc. (ie. Smith.doc)
- Electronic submissions must be in Microsoft Word.

The following paper is included as a sample of correct formatting
Power Scaling a Self-Fourier Laser Array Using Different Laser Sources

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In this paper, coherent laser combination using a Self-Fourier (SF) cavity is described using four different sources or configurations: (1) a multicore fiber laser with 21 independent cores, (2) a 21-element array of independent fiber lasers, (3) a five-element array of independent fiber lasers, and (4) a three-element array of independent diode lasers. The operation of the SF cavity has been previously described [1–3] and has been demonstrated to coherently combine an array of seven unpolarized fiber lasers with high coherence (> 0.8).

In a Phase II Small Business Innovation Research (SBIR) program currently being performed for the U.S. Army Space and Missile Defense Command (SMDC), a multicore fiber laser coupled to a SF cavity is in the process of being built and demonstrated [4]. This array will consist of a single fiber with 21 independent cores in a rectilinear pattern coupled to a SF cavity in a monolithic structure by fusion-splicing a short end cap with a curved output facet to the multicore fiber.

![Multicore fiber laser coupled to SF cavity in monolithic structure.](image)

**Figure 1.** Multicore fiber laser coupled to SF cavity in monolithic structure. The outputs of the 21 independent cores are coupled together using the curved output facet that performs the lensing function on the reflected light necessary to effect the spatial Fourier transform for the feedback to the array. The 21-element core pattern shown at the right.

One key engineering issue associated with demonstration of this coherent array at the 300-W output power is creating a low loss and rugged fusion splice between the multicore fiber and the stub lens which would have significantly different outer diameters such as 0.600 mm (MCF) and 1.50 mm.

![Photograph of large end cap successfully fused to single-mode fiber laser](image)

**Figure 2.** Photograph of large end cap successfully fused to single-mode fiber laser (looking through end cap to focus on the core of the fiber).
In another Phase II SBIR program currently being performed for the Naval Surface Warfare Center (NSWC) (Crane), a 21-element array of independent fiber lasers is being built to demonstrate the power and number scaling of the SF cavity [5].

**Figure 3.** SF cavity designed to demonstrate the coherent coupling of 21 independent fiber lasers (using ~ 10-W laser elements) as well as the coherent combination of 5 fiber lasers at 150 W each to yield 750 W total output power.

The initial demonstration will be a 21-element array using 10-W laser elements for a total output power equal to ~ 200 W. We will then limit the array size to the central five elements and use 150-W lasers in these positions to scale the total output power of the array to 750 W. With a simple change of pump diodes, the array will have the capacity to scale up to 3 kW total output power.

**Figure 4.** 10-W fiber laser module with integrated driver and temperature controller designed for use in 21-element coherent fiber laser array.

In an independent project performed in collaboration with Raytheon Missile Systems and IPG Photonics, an array of five independent fiber lasers was coherently coupled using a SF cavity and successfully scaled from 1 W per element to 10 W per element. This fiber laser module is presented in Fig. 5.
Figure 5. IPG Fiber Laser Module. Unit contains seven independent fiber lasers with 10 W output power capability each.

The far-field interference fringes of this array are presented in Fig. 6. These fringes demonstrate a visibility equal to 0.84.

![Graph showing interference fringes](image)

Figure 6. High-visibility interference fringes of three independent fiber lasers at varying total output levels.

One significant result of this program was demonstrated by the fact that this particular SF cavity operated coherently and without damage with a total output power equal to 10X the level at which it was designed for and that the coherence remained the same. The results of this program also confirm that unpolarized fiber lasers can be coherently coupled with high coherence. This can be explained by the supposition that each of the two polarization states in each fiber laser coherently combines with the same polarization state in each of the other fiber lasers, but the two polarization states do not couple with each other, as expected. This results in an unpolarized output from the coherent array.

In a program being performed with the Naval Undersea Warfare Center (NUWC) (Newport), an array of three diode lasers was coherently combined using a SF cavity [6]. Due to budgetary constraints, these diodes were independently mounted and coupled to the cavity using passive optical fibers. Due to the fact that the diode lasers are intrinsically polarized (TE), polarization-controlled fibers were used to perform the optical coupling.
Figure 7. Array of independent diode lasers fiber coupled in external SF cavity.

The results of this project are presented in Fig. 8, which shows the high visibility far field interference fringes of the diode array. These fringes demonstrate a coherence equal to 0.89.

Figure 8. Far-field interference fringes of coherent diode array in SF cavity.

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REFERENCES


