Impact of Input Power on CEP Stabilization in Femtosecond and Attosecond Lasers: A Review

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Abstract:
Carrier-envelope phase (CEP) stabilization is essential for femtosecond and attosecond pulsed lasers. This review examines Randy Lemons et al. (2019) and aims to qualitatively assess the impact of input power on CEP.

Introduction:
In recent years carrier-envelope phase (CEP) stabilization has become an increasingly vital performance parameter in the development of femtosecond and attosecond pulsed lasers systems. Ultrafast laser systems have demonstrated significant impact in the fields of material processing [2], as well as spectroscopy and sensing [3].

The Feed-Forward method of CEP stabilization as presented in [1] may be improved upon by varying the doping concentration of the Er:Yb Co-doped fiber amplifier. This increase in output power will further increase the effects of spectral spanning via self-phase modulation [1], a reduced full-width half maximum (FWHM) [4] and reduction in phase noise [5].

METHODS
Developed by Dan T Nguyen and published in [6], the MATLAB based analysis models the propagation of light in Er:Yb co-doped phosphate fibers. Although it is unknown what type of fiber was doped in the paper under review, it is reasonable to assume phosphate fiber for the purpose of this analysis due to their ability to be doped with high concentrations of impurities [6]. Further assumptions in the analysis include a pump power of 100w at 980 nm, input signal power of 140 mW at 1550 nm and background loss of 3 dB/m.

The analysis was performed for various concentrations of Erbium and Ytterbium. Three concentration combinations will be considered as part of the review and are as follows: 3% Er / 3% Yb, 6% Er / 8% Yb, and 8% Er / 6% Yb. Tabulated results for each are presented in Table 1, and Pump Power, Absorption, and Signal power are presented in Figure 1.

Table 1: Tabulated Results of Analysis

Parameter	3% Er / 3% Yb	6% Er / 8% Yb	8% Er / 6% Yb
Sat. Length (cm)	11.7	7.7	8.9
Pump Power (%)	1.29	2.68	1.19
Absorb. Power (%)	10.35	27.15	30.89
Signal Power (%)	3.75	9.45	10.81

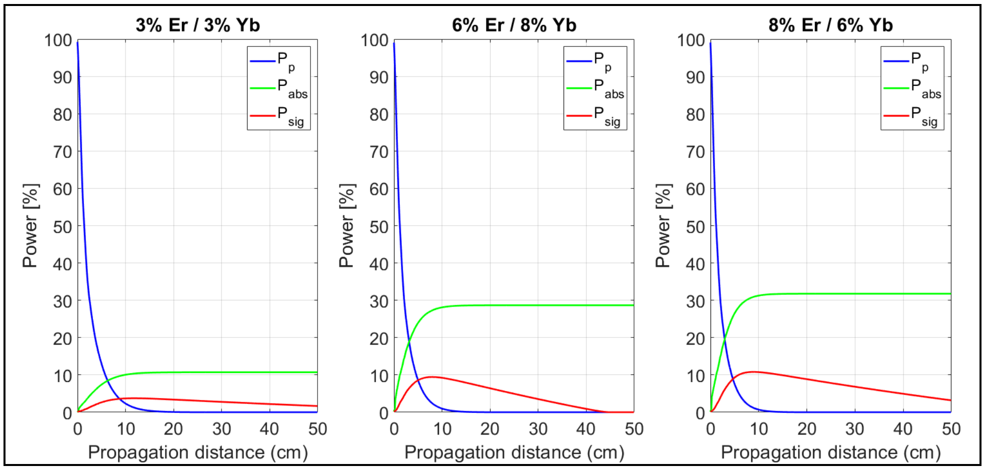

Figure 1: Pump Power, Absorption, and Signal power vs Fiber Length

RESULTS AND INTERPRETATION

By varying the doping concentration of the Er:Yb doped fiber amplifier it is possible to increase signal strength. Using The results of the 3% Er / 3% Yb doped fiber as a baseline, increasing doping concentrations to 8% Er / 6% Yb yields an increase in signal strength of ≈ 7% and a reduction of required fiber of 2.8 cm. The results present imply that CEP stabilization can further be improved by tuning the doping concentration of Er:Yb doped fiber to increase signal strength and inturn improve SNR resulting in less ASE induced phase noise [5].

CONCLUSIONS

Tuning of the doping concentration of Er:Yb fibers can improve signal strength and improve CEP. Future work will further investigate the possibility of using silica fibers in place of phosphate, the influence of pump power on CEP, and examine higher doping concentrations than those considered here.

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