# Scalable All-Fiber Coherent Beam Combination Using Digital Control

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We present a filled-aperture Coherent Beam Combining (CBC) system based on Locking of Optical Coherence via Single-detector Electronic-frequency Tagging (LOCSET). The sensing and control architecture is implemented using a field-programmable gate array and electro-optic phase modulators. The polarisation-maintaining all-fibre optical configuration consists of a narrow linewidth 1560 nm seed laser separated into three channels, each containing 7 W Erbium-doped fibre amplifiers and is surmised in Fig 1. The system is demonstrated experimentally, achieving a total stabilized output power of 20 W, a combination efficiency greater than 95%, and an output RMS phase stability of $\lambda/493$ as is shown in Fig 2. This architecture employs an entirely digital sensing and control scheme that is a highly scalable, wavelength agnostic and cost-effective solution for CBC [1].

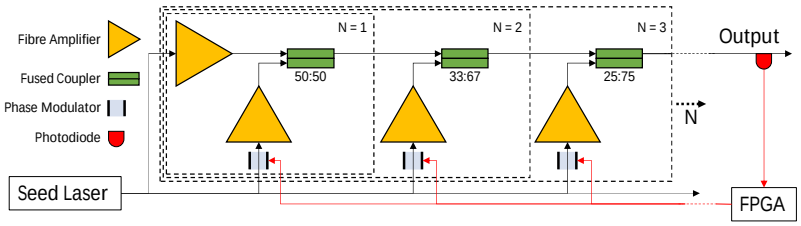


Figure 1: Simplified experimental setup, optical fibre shown in black, electrical signal shown in red. Linear chain scalability of this system is shown using $N$ Amplifier and modulators pairs with $1/(N+1)$ ratio fused fibre couplers. [1].

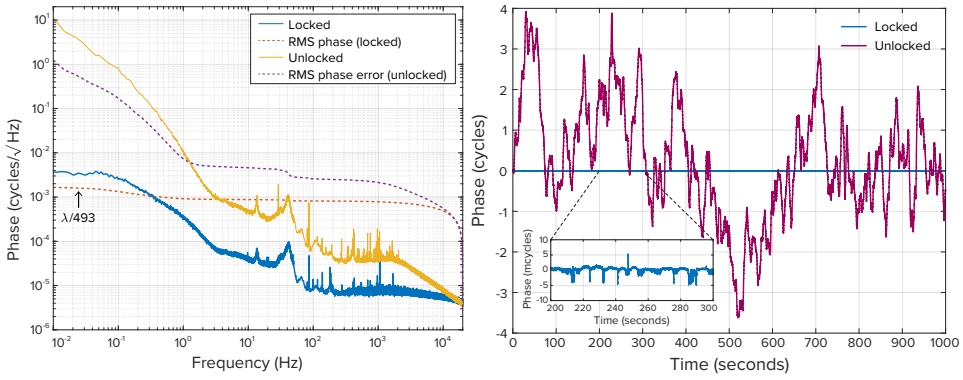


Figure 2: Measurement of unlocked and locked relative phase between two channels plotted as a power spectral density (left) and as time series data (right) [1].

[1] C. Freier, S. Legge, L. Roberts, P.B. Wigley, J.D. Close and K.S.Hardman, *Appl. Opt.* **61**, 4543-4548 (2022).