

A 10 W narrow-linewidth thulium fibre master oscillator power amplifier

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Single-frequency thulium-doped silica fibre (TDF) master-oscillator-power-amplifier (MOPA) systems have generated much interest due to their broad tunability and applications in atmospheric sensing, defence, optical communications, and next-generation gravitational wave (GW) detectors. Goodno et al. [1] have demonstrated a 608 W thulium MOPA using a distributed feedback (DFB) 3 mW laser diode as a master oscillator, yielding a linewidth <5 MHz, approximately that of the seed source. Narrower linewidth seeds can be achieved using a core-pumped short distributed Bragg reflector (DBR) cavity and highly-doped TDF [2, 3]. Geng et al. [2] have demonstrated 40 mW output with a 20% slope efficiency and a linewidth of ca. 3 kHz, while Zhang et al. [3] produced 580 mW single-frequency output with a slope efficiency of 13%.

The schematic in Figure 1 shows our TDF MOPA, for use in GW detectors. The seed laser features high environmental acoustic and thermal isolation and a linear polarization to achieve the required <1 kHz linewidth. The TDF DBR master oscillator consists of a 25 mm long, highly doped TDF spliced between two 30 mm long fibre Bragg gratings (FBGs) written in single mode (SM) and polarization maintaining (PM) passive germanium-doped fibre [4]. The FBGs are spectrally aligned using a two-stage temperature-controlled mount that also provides environmental isolation. This configuration enables single polarization and single longitudinal mode operation[5].

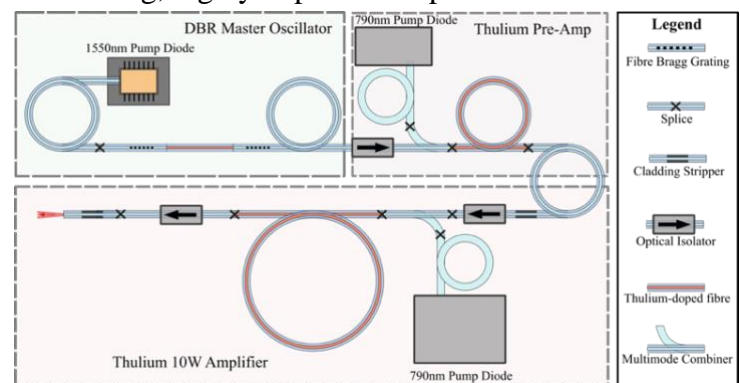


Figure 1. Schematic of the 10 W TDF MOPA

The output of the DBR master oscillator is first amplified to ~ 1 W using a PM TDF pre-amplifier, and then to 10 W using a higher-power PM TDF amplifier, maintaining the low noise performance of the seed. We shall present the characterization of a TDF DBR master oscillator and its amplification to 10W for wavelengths between 1900 nm and 2050 nm, demonstrating, to the best of our knowledge, the narrowest linewidth thulium MOPA system between 1900 nm and 2050nm at these power levels.

[1] G. Goodno et al., *Opt. Lett.* **34** 1204 (2008)

[2] J. Geng et al., *Opt. Lett.* **34** 3493 (2009)

[3] Z. Zhang et al., *IEEE Photon. Technol. Lett.* **23** 417 (2011)

[4] D. Stepanov and L. Corena, *Opt. Express* **22** 27309 (2014)

[5] M. Oermann et al., *Australian Institute of Physics Congress*, paper 7G.4 (2012)