

Thermal effects in a single-frequency, fiber laser pumped, nested cavity optical parametric oscillator

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Abstract: We investigate thermal effects in a Nested-Cavity doubly resonant optical parametric oscillator (NesCOPO), pumped by a high repetition rate fiber laser, and the consequences on its spectral characteristics.

Monitoring the emanations of multiple chemical species on urban or industrial sites is of prime interest for environmental or security applications. In this context, optical parametric sources (OPOs), thanks to their broad spectral tunability, are a promising solution for the development of local or remote sensing instruments. Such measurements were performed with a configuration of doubly resonant Nested Cavity OPO, as already demonstrated by our group [1]. However, at high mean pump power, thermal effects can occur and disturb the spectral properties of the parametric source [2,3]. In this article, we focus on the thermal behavior of the NesCOPO, pumped by a one Watt level ns pulsed fiber laser, and especially investigate the effects of cavity length tuning.

The OPO mirrors are mounted on piezoelectric ceramics (PZT), in order to control the cavities length (Fig.1.a), and the PPLN crystal is heated with a temperature stability within a few mK. Thermal effects due to the idler absorption in the PPLN at 3.3 μm were observed by slowly modulating the PZT transducer of the idler mirror (M_i) resulting in mode-hopping of the OPO inside the parametric gain bandwidth. However, as shown in Fig.1.b, the power and spectral behavior of the source is not equivalent when the idler cavity is either reduced or expanded during the M_1 mirror position sweeping.

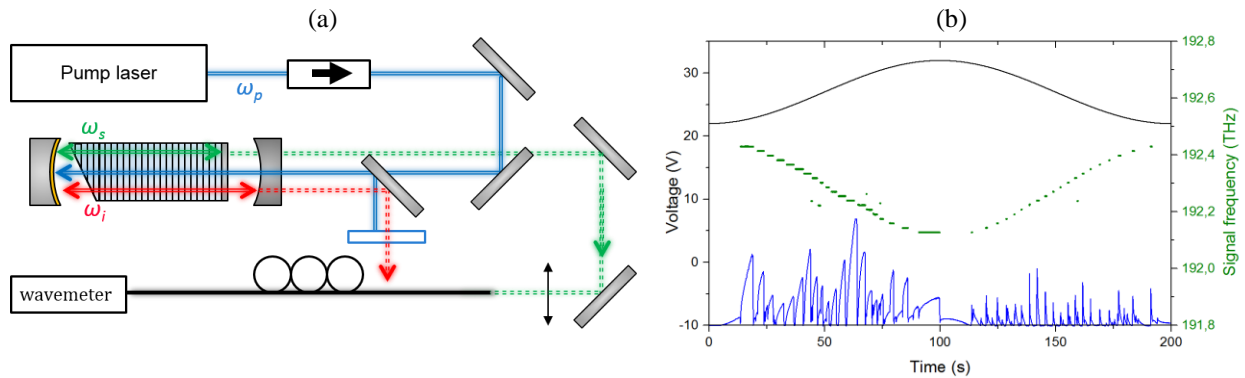


Fig. 1 (a) Scheme of the experiment. (b) Voltage applied to the PZT (black), signal wave frequency (green) and mode power in arbitrary unit (blue).

We observe that, while increase the idler cavity length (i.e. increasing the PZT voltage), temporal steps between two modes hops are longer, than while reducing the idler cavity. Indeed, the idler cavity length rise using the PZT tends to compensate for the thermal expansion of the optical cavity lengths due to idler absorption. Calculations, and experimental study with different idler output coupler, show that this behavior can be partially compensated with a lower cavity finesse.

References

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