EPJ Web of Conferences **307**, 04058 (2024)
EUROPHOTON 2024
https://doi.org/10.1051/epjconf/202430704058

Study of ppLN crystals for sum frequency generation of CW laser demonstrating 20 nm tunability in the visible range from 616 to 636 nm, through temperature tuning

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Abstract: This work presents the study of custom-made nonlinear ppLN crystals enabling the generation of CW laser around 626 nm demonstrating over 500mW over a 20 nm tunability range using temperature tuning, through SFG of tunable 1 and 1.5µm lasers.

1. Introduction

There are very few widely tunable continuous-wave laser systems in the visible range around 626 nm, apart from dye lasers. Such lasers are useful for conducting molecular spectroscopy experiments in the visible spectrum and can also serve as a fundamental building block for the development of tunable continuous-wave sources in the UV range, which are useful for UV spectroscopy experiments on ozone or probing Rydberg states of Sr atoms, considered as qubit sources for quantum processors.

2. Description

There are currently no widely tunable high-power laser sources in the red-orange range around 626 nm, apart from dye lasers, which are no longer maintained by their suppliers. We propose to address this by developing a new laser source based on nonlinear generation of visible light from two high-power (up to 10 W) infrared sources, widely tunable around 1 and 1.5 µm. We have conducted initial demonstrations using a commercial ppMgOLN crystal, where we were limited in terms of tunability range by the crystal [1]. We are now investigating a more compact geometry for frequency summation to make the system easily transportable and usable without manual translation of the crystal. To achieve this, the Femto Institute has prototyped and produced crystals with a succession of channels of different poling steps along the crystal axis, which expands the accessible phase-matching range by solely adjusting the crystal's temperature.

3. Results

Using the architecture depicted in Figure 1, we compared the performance of crystals with 2 and 3 periods in terms of total generated power as well as mode shape.

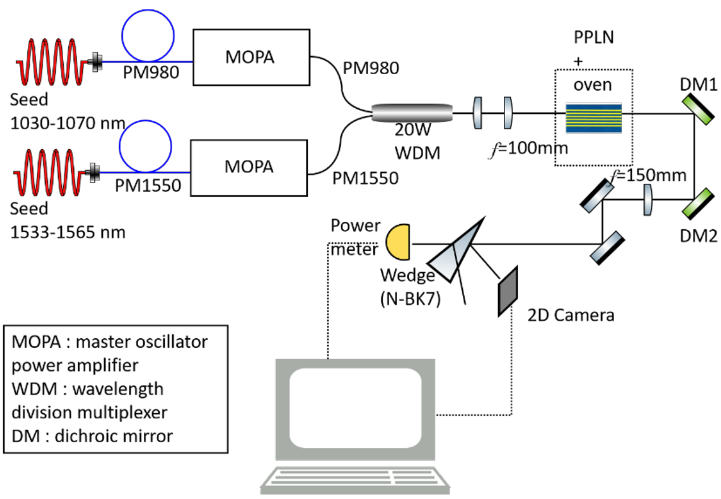

Figure 1: Laser architecture for testing the nonlinear crystals

We verified that the phase-matching temperatures were consistent with predictions, and we were able to demonstrate the generation of over 300 mW across the entire spectral range for 3 channels crystals, achieved by simply adjusting the crystal temperature, as shown in Figure 2, and could even attain 500mW with a two channels crystal, as shown in Figure 3.

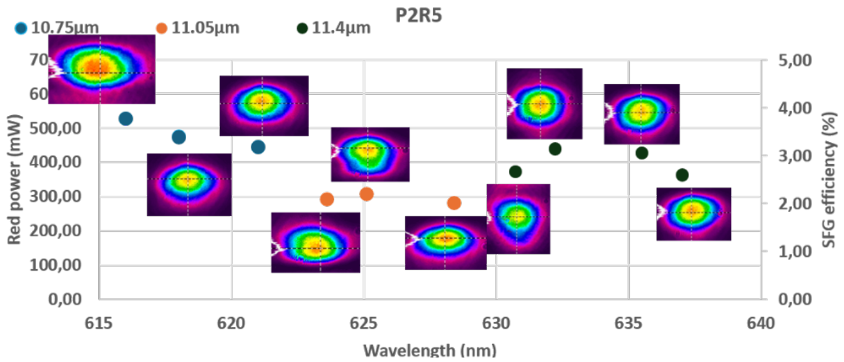

Figure 2: Power and optical mode obtained as a function of wavelength for a crystal with 3 successive channels

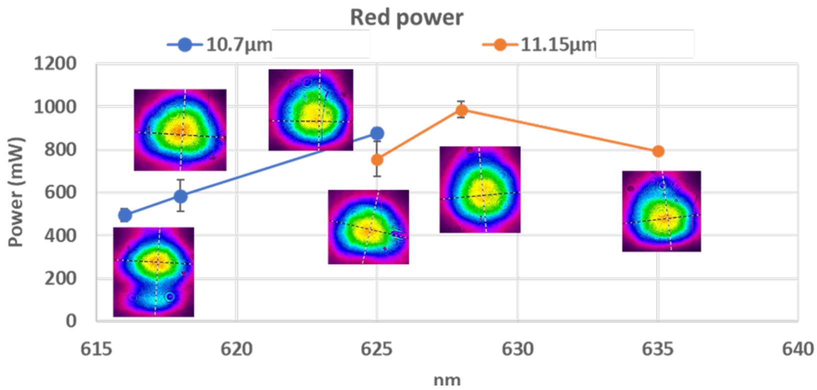

Figure 3: Power and optical mode obtained as a function of wavelength for a crystal with 2 successive channels

[1] D. Darwich, R Prakash, C. Dixneuf ,Y.-V. Bardin, M. Goeppner, G.Guiraud, N. Traynor, G. Santarelli and A. Hilico, "High power ultralow-intensity noise continuous wave laser tunable from orange to red," Opt. Express 30, 12867