# 1.2 W, Tunable, Continuous-Wave, Single-Frequency, Solid-State Blue Source

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Continuous-wave (cw) solid-state blue sources are of interest for optical data storage, laser displays, spectroscopy, and medical diagnostics. Frequency doubling of Ti:sapphire can in principle can provide coverage in the 400-500 nm range, but at relatively high cost and complexity. Here, we describe a novel approach to the generation of cw blue radiation based on intracavity SHG of a cw singly-resonant OPO (SRO) with MgO:sPPLT as the nonlinear crystal [1,2]. The source offers wide tuning range, watt-level output power, and single-frequency performance, in a simple, compact, all-solid-state design.

Figure 1 shows the schematic of the experimental setup. The SRO ring cavity comprises two concave reflectors, $M_1$ and $M_2$, ($r$=100 mm) and two plane mirrors, $M_3$ and $M_4$. All mirrors are highly reflecting *(R*>99.9%) for the resonant signal (840-1000 nm) and highly transmitting ($T$=85-90%) for the idler (1100-1400 nm), thus ensuring SRO operation. $M_4$ also has high transmission ($T$=85-90%) over 425-500 nm. The nonlinear crystal is 30-mm long MgO:sPPLT ($d_{eff}$~10 pm/V) with a single grating (Λ=7.97 µm). The SRO is pumped in the green by a frequency-doubled, cw, single-frequency Nd:$YVO_4$ laser. For internal SHG, we used a 5-mm long BIBO as the nonlinear crystal located at the second cavity waist between $M_3$ and $M_4$. The crystal is cut for type I interaction *(ee→o*) in the *yz*-plane ($\varphi=90^o$) at an internal angle $\theta=160^o$ at normal incidence ($d_{eff}$~3.4 pm/V). The crystal faces are AR-coated for the resonant signal ($R$<0.5%) and for the SHG wavelengths ($R$<0.8%). For stable single-frequency operation, a 500-µm-thick fused silica etalon (FSR =206 GHz, finesse ~0.6) is used internal to the SRO cavity. The total optical length of the cavity is 690 mm, corresponding to a FSR~434 MHz.

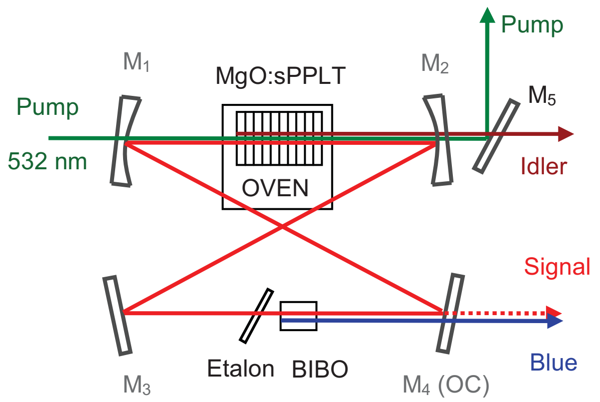


**Fig. 1.** Schematic of the intracavity frequency-doubled MgO:sPPLT cw SRO for watt-level blue generation.

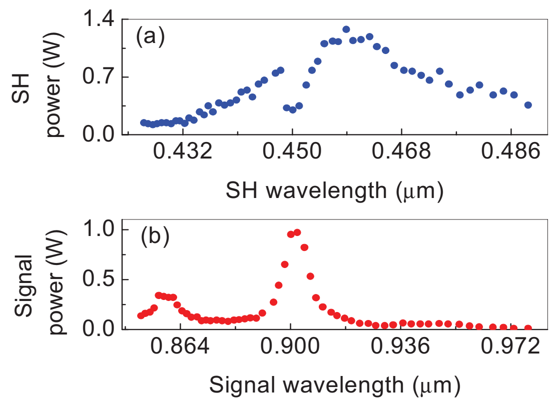


**Fig. 2.** (a) Generated blue power versus wavelength, and (b) Out-coupled signal power across the tuning range.

By varying the MgO:sPPLT crystal temperature from 71 °C to 240 °C, the signal could be tuned from 978 to 850 nm [1,2]. The corresponding SHG wavelengths, from 489 to 425 nm, are generated by varying the BIBO crystal angle from 163.8° to 155.2°. The measured blue power (Fig. 2(a)) varies from 145 mW at 425 nm to 360 mW at 489 nm, with as much 1.27 W available at 459 nm with a green-to-blue conversion efficiency in excess of 14% at crystal temperature 128°C. We extracted >500 mW of blue power over 58% of the tuning range and >250 mW over 84% of the tuning range. The sudden fall in the blue power near 450 nm is due to the rise in signal coupling loss through mirror $M_4$, Fig. 2(b), which results in reduced intracavity signal power and thus lower SHG conversion efficiency. As such, the use of a more optimized coating for $M_4$ with minimum transmission loss across the signal tuning range will readily overcome the dip in SHG power. The passive frequency-stability of the blue, with an instantaneous linewidth of ~8.5 MHz, is better than 280 MHz (limited by the wavemeter resolution) over a time-scale of 340 seconds. The far-field energy distribution of blue radiation measured using a beam profiler confirming a $TEM_{00}$ spatial profile. Comprehensive results of these measurements will be presented.

**References**

1. G. K. Samanta, G. R. Fayaz, Z. Sun, and M. Ebrahim-Zadeh, *Opt. Lett.* **32**, 400 (2007).
2. G. K. Samanta, G. R. Fayaz, and M. Ebrahim-Zadeh, *Opt. Lett.* **32**, 2623 (2007).

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