L.8: Generation of UV beam by frequency summing of outputs of Copper-HBr laser

Copper-HBr laser (Cu-HBrL), a low temperature (~500 ^{o}C) & high pulse repetition rate (PRR: 15-20 kHz) variant of atomic copper laser, emits coherent radiations at (λ) = 510.6 nm (G) & 578.2 nm (Y) with excellent beam characteristics. The high PRR sum frequency radiation (λ = 271.2 nm) based on the Cu-HBrL is highly useful for fast & precision material processing, high PRR pumping of cerium-doped crystals for tunable UV generation, UV spectroscopy, biomedical studies and many more applications. In view of this, in LSED, an UV source at λ = 271.2 nm of 1.5 W average power and 18 kHz PRR is generated based on an in-house developed Cu-HBrL. A type-I, critically phase matched β-BBO crystal is used as the UV generator.

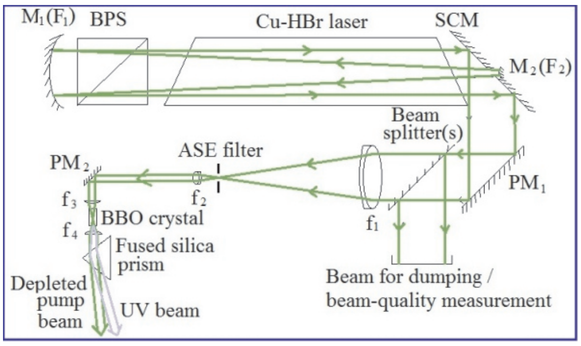

Fig. L.8.1: Schematic of the experimental set up

Figure L.8.1 shows the schematic of the experimental set up. The Cu-HBrL was fitted with a positive branch confocal unstable resonator of magnification 50 (F_1 = 250 cm & F_2 = -5 cm), with an intra-cavity cube polarizer (BPS). The polarized output beam of dia. 25 mm [with following parameters for green and yellow beams, line-widths Δv_G = 4 GHz & Δv_Y = 6.5 GHz, beam divergences θ_G= 120 μrad & θ_Y = 95, and pointing instabilities of δ_G= ± 19 μrad & δ_Y= ±15 μrad], is taken out as the reflection off a scraper mirror (SCM). Amplified spontaneous emission was filtered from the beam and it was reduced to 2.5 mm diameter, using an achromatic telescopic lens pair (f_1, f_2 = 100,10 cm) and an aperture of dia. 0.5 mm placed at the common focal plane. The collimated beam was line focused, by a cylindrical lens (f_3) of focal length 4 cm, on the BBO crystal (6 x 4 x 10 mm^3,cut angle = 47°) which was tilted about 0.7° for the type-I phase matching angle of 46.3°. The crystal was mounted on a 5-axis micro-positioner. The depleted visible and generated UV beams were then collimated using a fused silica cylindrical lens (f_4=10 cm), which were separated using a fused silica prism. The incident average pump power on the crystal, was varied using a suitable combination of beam splitters. The maximum pump fundamental power (P_{G+Y}) was limited to about 12 W to prevent the detrimental thermal effects & crystal damage. The pump & generated UV radiations were monitored using a spectro-photometer (Avantes) (Fig. L.8.2). The pump laser power, UV radiations power and temporal profiles were suitably monitored to analyze the efficacy of the UV conversion process.

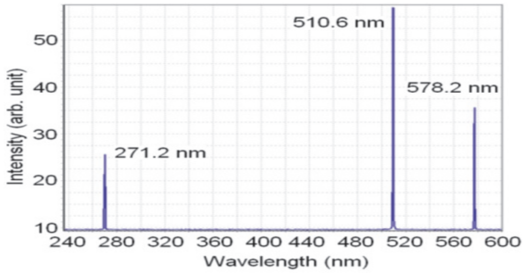

Fig. L.8.2:Spectro-photometer trace of the pump & generated UV radiations

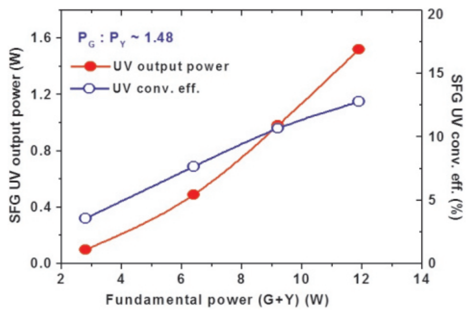

Fig. L.8.3: Variation of the UV average power & conversion efficiency with pump average power

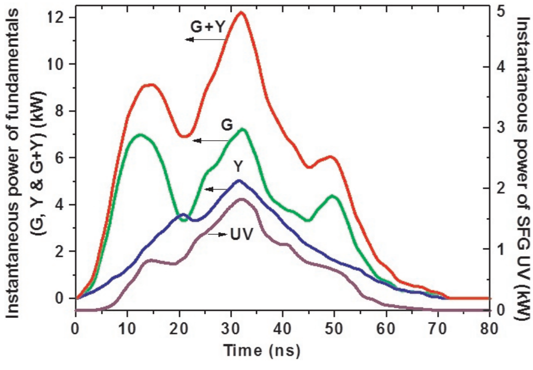

Fig. L.8.4: Variation of instantaneous power of the pump & generated UV radiations

Maximum average UV output power of about 1.52 W was obtained at about 13% average (Fig. L.8.3) and 16% peak (Fig. L.8.4) conversion efficiency. The experimental results were analyzed and discussed in terms of degree of spatial, spectral and temporal matching behavior of the pump G & Y radiations. For more details please refer to *R. Biswal et al., Applied Optics 54(32), 9613-21 (2015).*

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