L.2: Development and commissioning of 100W CVL-MOPA system operated from IGBT based pulse power supply

A Copper Vapor Laser (CVL) master oscillator power amplifier (MOPA) system of 1 oscillator and 3 amplifiers, delivering an average output power of more than 100 W at a pulse repetition rate 6 kHz and operating from a solid state switch (IGBT) based pulse power supply was developed and commissioned at Laser System Engineering Section (LSES). Operating in the visible region (510 and 578 nm), the output of CVL was in pulsed mode with short pulses of about 40 ns duration at a pulse repetition rate of 6 kHz.

The oscillator and amplifier units of CVL were based on identical laser tubes of diameter 47 mm, length 1.5 m. Working temperature of the laser tube was around 1500 C. The laser head assemblies and power supplies, developed earlier, were upgraded to deploy reliable and efficient CVL-MOPA system for the users.

Each CVL of the MOPA system was operated by IGBT pulse power supply, which generated high voltage (~15 kV) pulses of fast rise-time of less than 70 ns across the laser load at average power level of around 5 kW. Magnetic pulse compressors (MPC) were used in the pulse power supply to handle high peak current (~800 A) of the laser load. Precision synchronization of laser pulse power supplies with jitter of less than ±5 ns was required for efficient operation of CVL-MOPA system. Normally large timing jitter (+/-20 ns) used to be present in the MPC based pulse power supplies due to many factors like dc voltage regulation, ripple voltage, jitter of IGBT driver, reflected voltage and other temperature dependent parameters. Thus realization of efficient CVL-MOPA is a challenging task with MPC based pulse power supplies.

The IGBT based power supplies for 6 kHz CVL system, developed earlier, were also upgraded. The ripple voltage at switch mode power supply (DC) feeding the pulse generator was reduced to < 0.5% using external L-C filter. Trigger system of the high voltage pulse power supplies was improved to achieve desired timing performance. Thus the timing jitter of less than ±4 ns could be achieved for the high voltage pulse power supplies within the typical operating range of the CVL.

The oil cooling system for pulse power supply was modified from centralized cooling to local cooling and thus working pressure of the pulse generator chambers was reduced from ~ 5 Bar to less than 1.3 Bar. The modified local oil cooling system improved system reliability of the CVL pulse power supplies. A programmable delay generator having variable delay range from 0-255 ns in step of 1ns was used to precisely synchronize the CVL power supplies.

The oscillator of the CVL-MOPA system was configured with unstable resonator of magnification of 30 (concave mirror f=3 m and convex mirror f=10 cm). The three CVL amplifiers were aligned to obtain maximum power amplification. Average output power of 105 W was achieved at the output stage of third amplifier. The average output powers, delivered by the oscillator and the three amplifiers in the CVL-MOPA system, were 16, 50, 70, and 105 W respectively. The CVL-MOPA system in operation is shown in Fig. L.2.1.

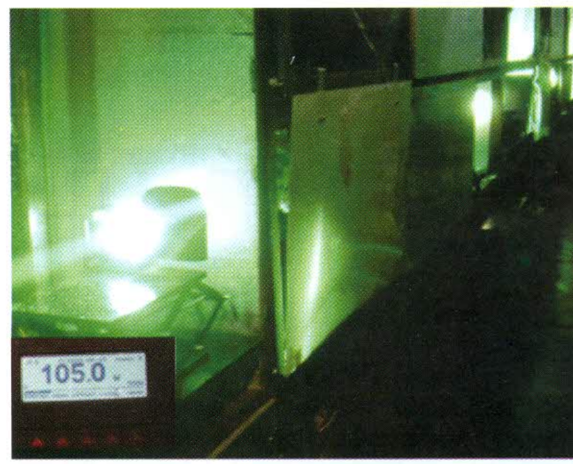

Fig. L.2.1: Copper vapor laser MOPA system

The jitter histogram for laser output pulse (blue) with respect to trigger input pulse to the CVL pulse generator is shown in Fig. L.2.2. The jitter is spread within +/- 3 ns for 1000 samples. The improved jitter and timing performances makes it possible in future to commission the CVL-MOPA system of 4 lasers.

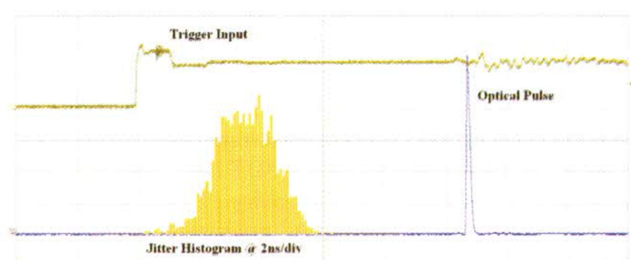

Fig.L.2.2: Jitter Histogram of Laser optical pulse

The CVL- MOPA system, based on IGBT based power supplies was operated for various users, working in the diverse areas of dye laser, non-linear physics and laser spectroscopy.

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