# OMEGA EP System Operations Manual Volume VII–System Description

# Chapter 2: Laser Sources

# Chapter 2
# Laser Sources

## 2.1 INTRODUCTION

The laser sources subsystem generates the shaped input pulses for the four beamlines. The first floor of the OMEGA EP Facility has an ~4500 ft$^2$, Class 1000 clean room located directly below the Laser Bay dedicated to the laser sources. Figure 2.1 provides an illustration of this arrangement. An injection periscope conveys the laser sources output pulse to the infrared alignment table (IRAT), located in the Laser Bay, where it is coaligned with the alignment laser. From the IRAT, the main pulse is transported to the injection table and injected into the beamline spatial filters and proceeds on to the amplifiers. The Laser Sources Bay contains all the equipment needed to create the laser beam that travels through the beamline amplifiers and to the target. Many of the critical beam characteristics are determined by the laser sources subsystems, including temporal, spatial, and spectral pulse shaping and energy. The pulse also meets the system wavefront, centering, and pointing budgets.

There are independent laser sources for each of the four beamlines (Fig. 2.2). Sources for Beamlines 1 and 2 produce both short (1- to 1000-ps) and long (1- to 10-ns) pulses (shown schematically in Fig. 2.3). Sources for Beamlines 3 and 4 provide only long-pulse beams and have similar but more-simple configurations (shown in Fig. 2.4). Short-pulse operations originate in a mode-locked oscillator that produces 200-fs pulses with a large spectral bandwidth. These pulses are stretched in time (chirped) and amplified using optical parametric chirped-pulse amplification (OPCPA).[1,2] Long pulses from all laser sources beams originate in a single-frequency fiber laser and are amplified in a regenerative amplifier

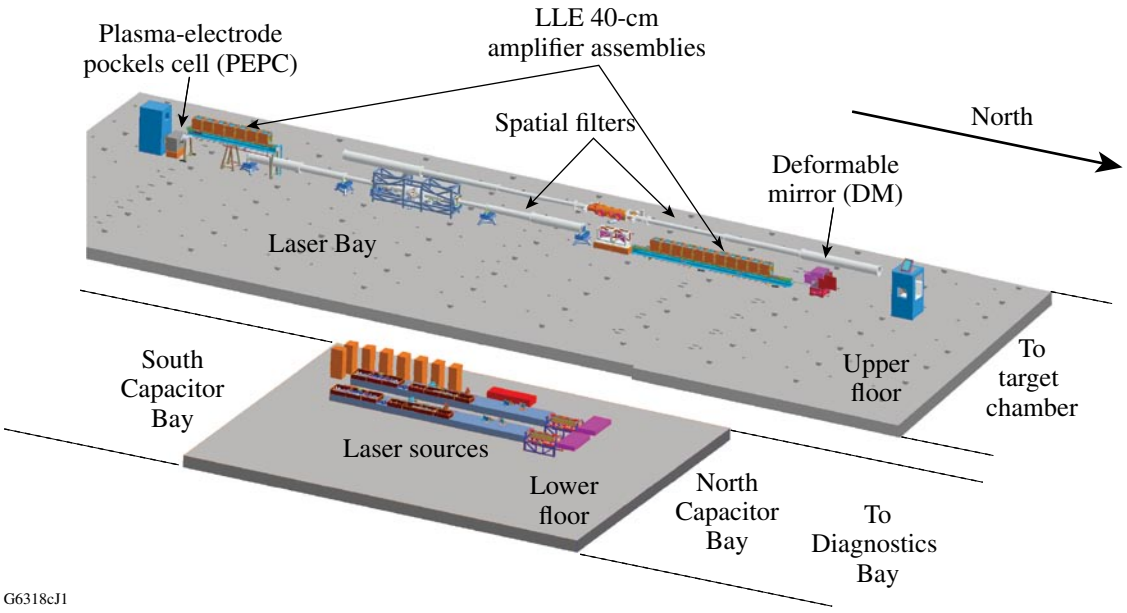


Figure 2.1
Laser sources are located in a clean room directly below the Laser Bay between the South and North Capacitor Bays. Only one Laser Bay beamline and two laser sources are shown for clarity.

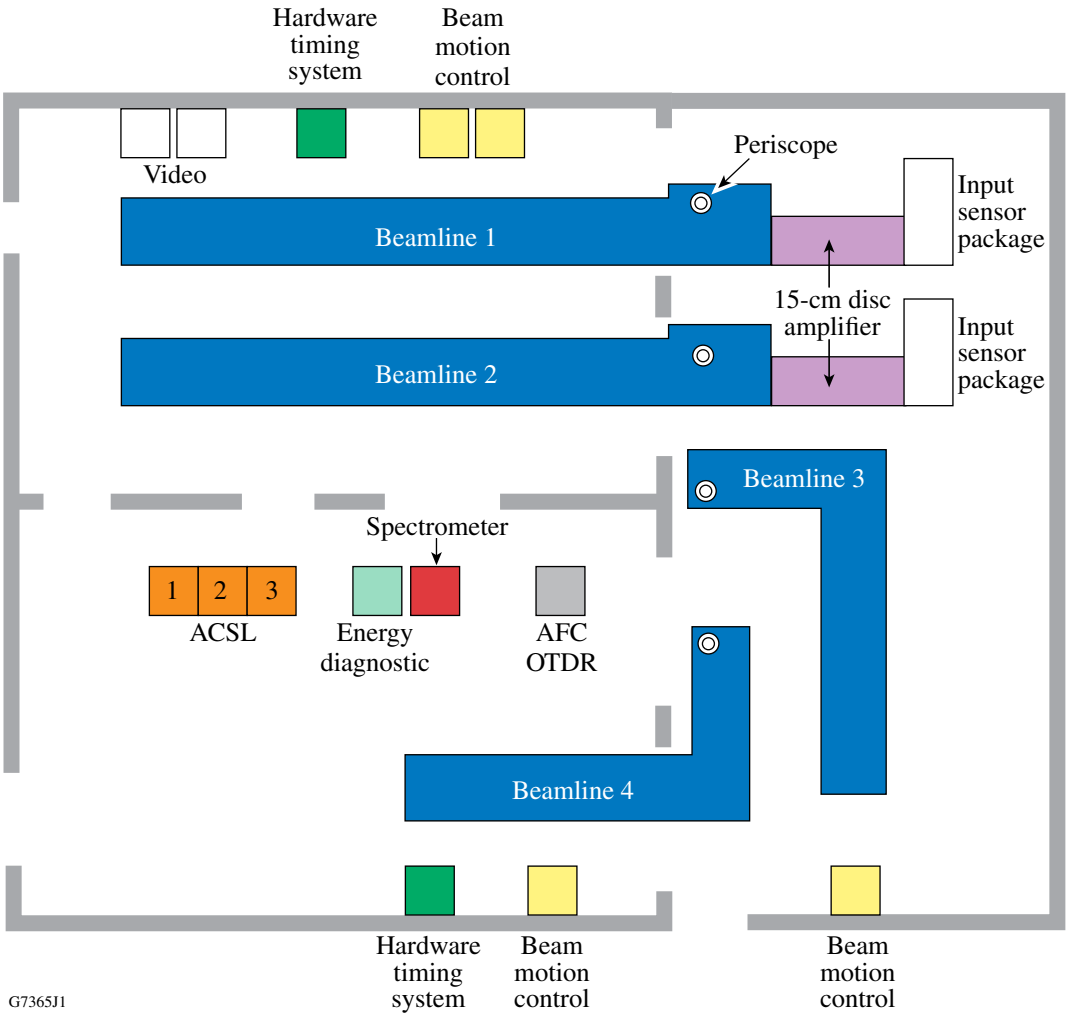


Figure 2.2
Simplified Laser Sources floor plan. Each of the four beamlines is supported by an independent source (blue). The 15-cm disc amplifiers and input sensor package positions are shown for Beamlines 1 and 2. The locations of other supporting diagnostic and control equipment are also shown.

(regen) after temporal shaping. The long-pulse regen pulse "on beams 1 or 2" requires an additional double-pass preamplifier stage to raise the energy to the levels required for sharing the remaining path of the laser sources chain with the short OPCPA pulses. Either pulse is then passed through a glass amplifier (Fig. 2.4) that boosts the energy to the required levels for the beamline amplification stages. Each type of pulse must satisfy different sets of design requirements for its spatial intensity distribution, temporal pulse shape, and spectral composition.

The top-level source requirements are presented in Sec. 2.2, followed by a more detailed discussion of the short-pulse and long-pulse front ends (Secs. 2.3 and 2.4, respectively) and subsystems common to both front-end configurations (Sec. 2.5). Many of the subsystem components are based on technologies currently in use on the OMEGA system. Examples include single-frequency fiber lasers, aperture-coupled strip line (ACSL) pulse-shaping systems,[3] diode-pumped regenerative amplifiers,[4] and bulk electro-optic phase modulators[5] that apply a frequency-modulated (FM) bandwidth to the laser pulses. Finally, Sec. 2.6 provides an overview of the diagnostics required to monitor the performance of the laser sources.

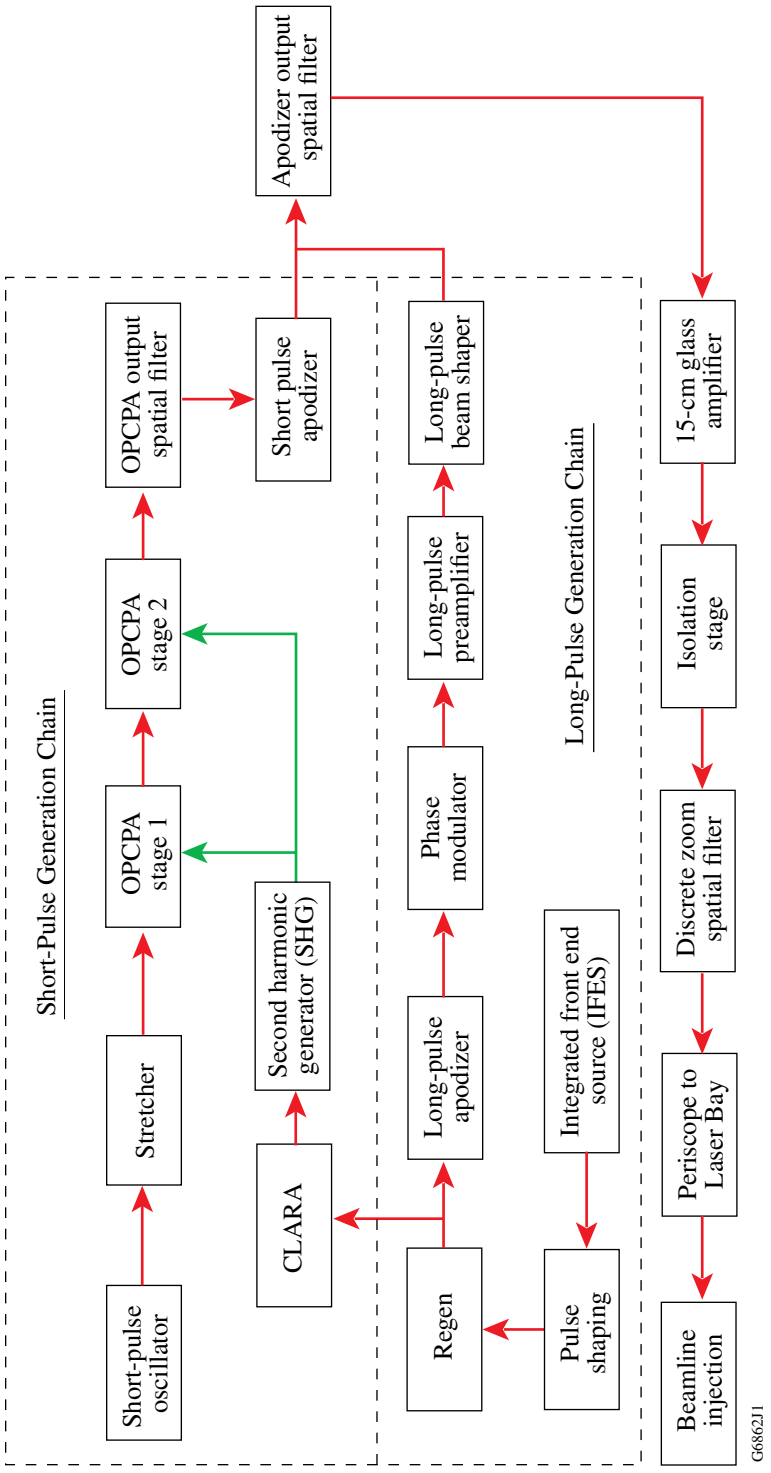


Figure 2.3
Schematic diagram of the Laser Sources subsystem design for Sources 1 and 2. These sources support both short-pulse (1 to 100 ps) and long-pulse (1 to 10 ns) operation. The "green" coloration from the CLARA SHG indicates $2\omega$. Beamlines 3 and 4 do not have short-pulse capability and therefore have a different configuration.