SYSTEM 2000

Lasers for Holography

JK LASERS

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Holography with pulsed lasers

In the past the majority of holograms have been taken with continuous wave gas lasers, because it is relatively easy to produce gas lasers having the required coherence properties. However, such holograms require an exposure time of about a second and this means that the whole system – laser, object, optics and holographic plate – has to remain stable to better than an eighth of a wavelength of light over the exposure time. This involves the use of massive stabilised tables, and it also precludes the possibility of taking holograms of moving objects.

A pulsed laser can produce sufficient energy to take a hologram within a pulse duration of 25 nanoseconds, a timescale in which all motion is essentially frozen, so that the use of stabilized equipment can be avoided. This allows holograms to be taken on the factory floor or the ordinary laboratory bench, and even of moving objects. In addition by using two such pulses from a laser separated in time by a known amount, it is possible to superimpose two holograms so that any motion of the object between the two pulses can be observed as a series of interference fringes, which are 'frozen' into the holographic plate. In practice the time separation has to be carefully selected, in order to have neither too few nor too many interference fringes. This technique allows detailed studies of stress and vibration to be made on engineering objects, e.g. defects in the bonding of honeycomb panels used in the aircraft industry can be observed.

JK Lasers have developed complete laser systems specifically for pulsed holography utilizing standard equipment from the SYSTEM 2000 range. As a result of these developments it is now possible, for the first time, to take pulsed holograms reliably and repeatably with qualities and contour free depths comparable to those obtained with gas lasers. The particular features incorporated by JK Lasers are:

Transverse Coherence

All SYSTEM 2000 holographic lasers use selected ruby laser rods of the highest quality. This ensures reliable operation in the TEMoo mode with the highest output energies thus giving clear and evenly illuminated holograms.

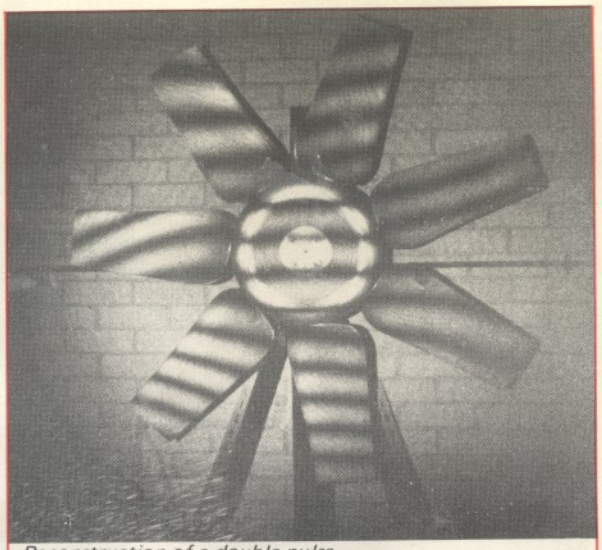
Temporal Coherence

Long coherence length is achieved in SYSTEM 2000 holographic lasers by a combination of a reflecting and a transmitting etalon. Each of these specially designed etalons is housed in an independently temperature controlled oven. The temperature of each oven is sensed by a platinum resistance thermometer and the controllers allow repeatable setting to 0.1°C. The temperature of the ruby laser rod is independent of the etalons, being controlled by a separate water cooling unit. This system allows clear holograms to be taken with scene depths of 2 metres or more, and with contour free depths of at least one metre.

For applications not requiring long coherence, such as in-line transmission holography of droplets or particles, the transmitting etalon may be omitted with economic advantage.

Double Pulse Operation

The SYSTEM 2000 holographic laser can be supplied for either single pulse or double pulse operation. In either case Q-switching is achieved with an electronically controlled SYSTEM 2000 Pockels cell Q-switch unit. In double pulse operation, the pulse separation is adjustable using calibrated delay controls from 1 to 800 microseconds.



Reconstruction of a double pulse hologram showing the rotation of a one metre diameter propeller taken with SYSTEM 2000

Output Energies

The SYSTEM 2000 holographic laser oscillator has a conservatively rated output energy of 30 millijoules in TEMoo mode. By the addition of amplifier stages the output can be increased up to 10 joules without destroying the coherence properties of the basic oscillator. All SYSTEM 2000 ruby amplifiers use 8" long rods giving single pass gains of up to 20 for input energy densities of 100 millijoules per cm^2. Different diameter rods are used depending on the required output energy.

Power Supplies

These holographic laser systems use standard SYSTEM 2000 power supplies of proven reliability. Units are normally supplied for operation at up to 6 ppm but versions giving repetition rates up to 60 ppm can be supplied. The SYSTEM 2000 format of a main console and separate control units allows for easy modification of systems from single to double pulse operation or for increased coherence at a later date.

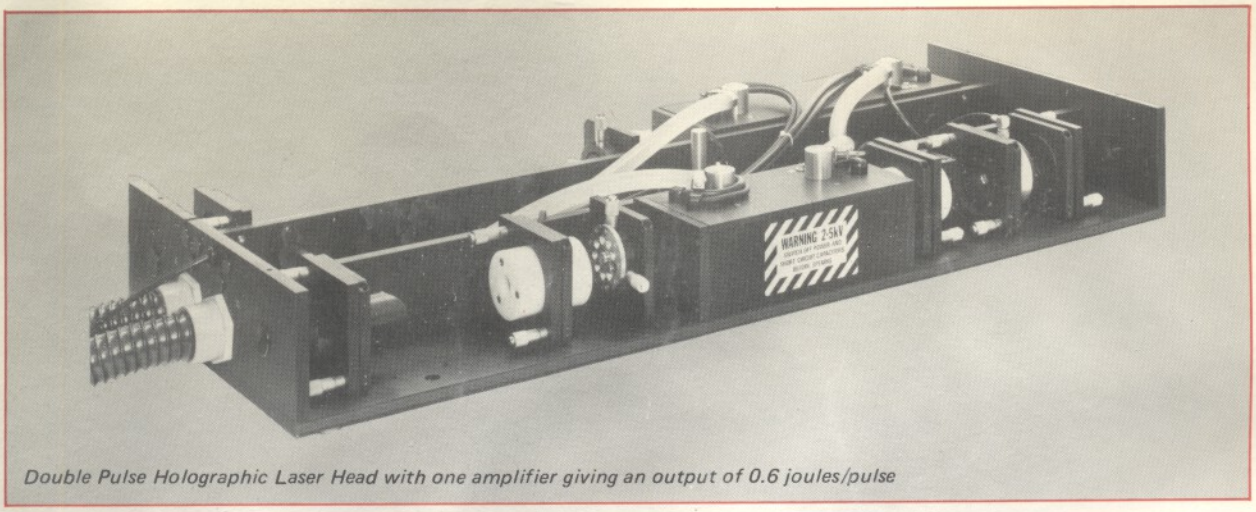
Cooling System

The laser rod, flashtubes and pumping chamber are water cooled with a temperature controlled closed circuit cooling system located in the bottom of the power supply console. The system is constructed from carefully chosen materials and includes a stainless steel water to water heat exchanger requiring a mains water supply for primary cooling. In the event of a mains supply not being available a closed circuit refrigerated system can be provided.

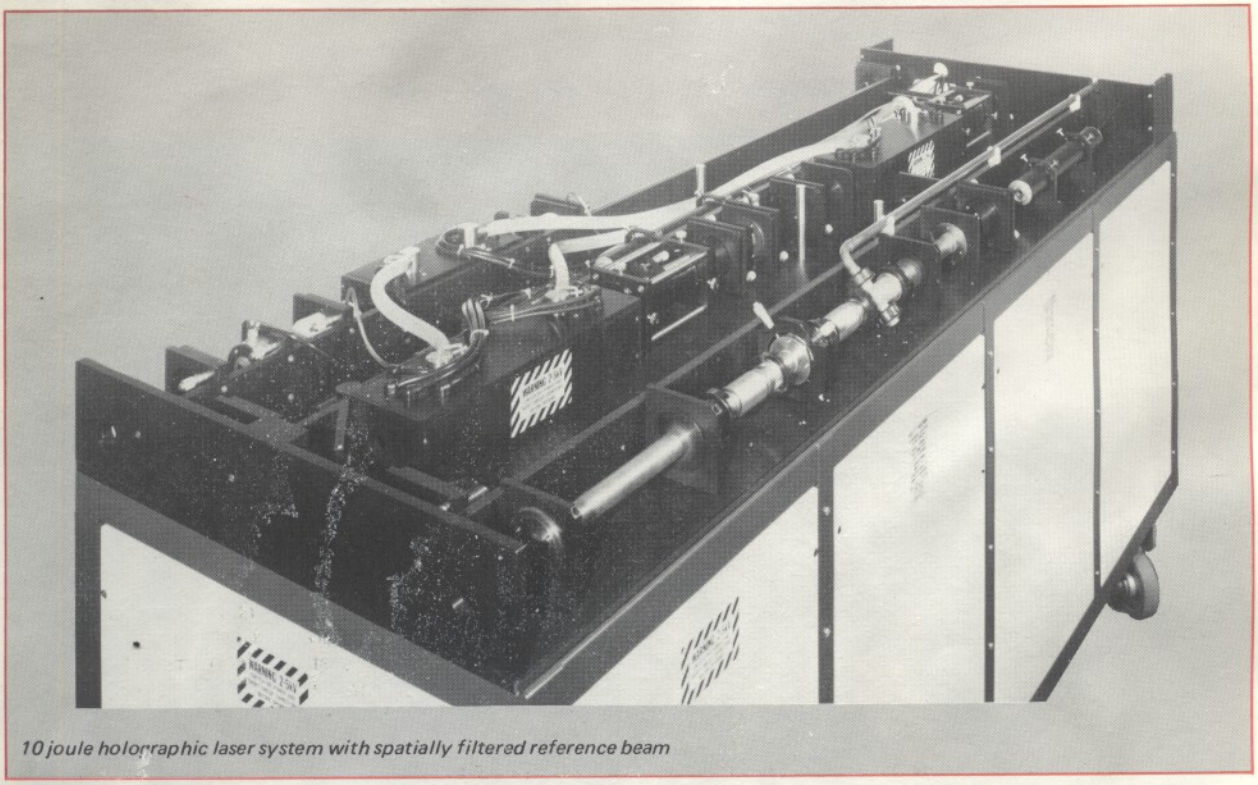
Holokits

JK Lasers has gained a wide experience in using pulsed lasers to take holograms in a variety of practical situations. As a result a set of components have been developed to facilitate taking holograms in conjunction with the SYSTEM 2000 holographic laser. These include beam splitters, beam expanding lenses, plane mirrors of various apertures, plate or film holders, and all fit standard SYSTEM 2000 optical mounts for simple alignment. The optics have been specially designed to withstand the high power densities of pulsed lasers, since optics developed for use with gas lasers are generally unsuitable. The optical mounts can be supplied with switchable magnetic bases for use on a steel table, to allow rapid re-alignment of the system.

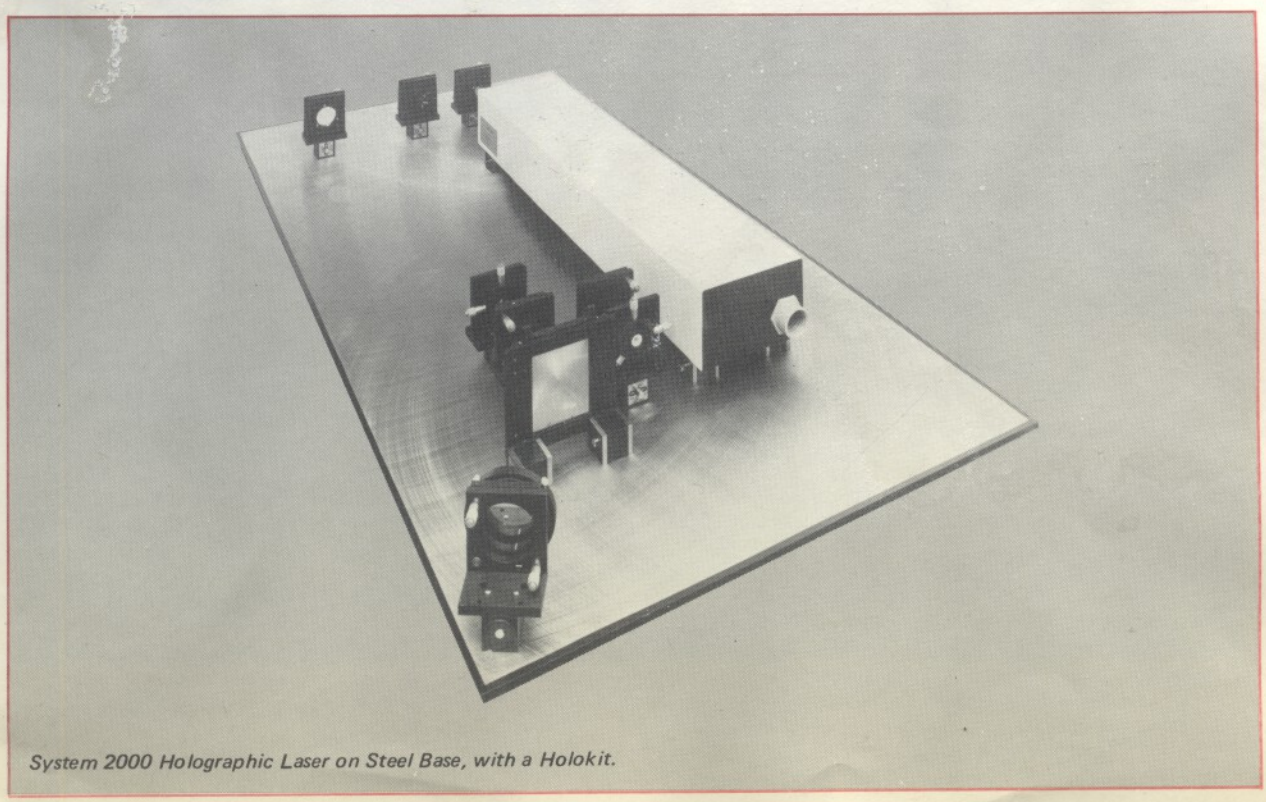
JK Lasers experts are pleased to advise on the most suitable kit of parts for any given situation. This approach effectively allows the user to have a custom built holocamera at a very competitive price.



Double Pulse Holographic Laser Head with one amplifier giving an output of 0.6 joules/pulse



10 joule holographic laser system with spatially filtered reference beam



System 2000 Holographic Laser on Steel Base, with a Holokit.

System Specification

Cat. No.	Systems	Total Output Energy
HS1	Oscillator only	0.03 Joules
HS2	Oscillator plus 1/4" diameter amplifier	0.60 Joules
HS3	Oscillator plus 3/8" diameter amplifier	1.20 Joules
HS4	Oscillator plus 3/8" and 5/8" diameter amplifier	10 Joules

Notes:

1. Oscillators are normally produced on 1 metre optical rails.
2. Oscillator/Amplifier combinations are normally produced on twin 1, 1.4 or 2 metre optical rails.

Common Specifications

		Option Ref.
Transverse mode	TEMoo	
Coherence length	~ 10 cm > 1 metre	S L
Pulse duration	~ 25 nanoseconds	
Single pulse operation		1
Double pulse separation	1-800 μ secs	2
Repetition rate	up to 6 ppm up to 60 ppm	6 60*
Input power	220/240V single phase 13 amps	
Cooling water required	up to 4 litres/min at $\leqslant 15^{\circ}C$ Pressure 5 psi	

* Only available on HS1 and HS2 but maximum coherence length may be reduced at 60 ppm.

Complete system can be specified by adding the option references to the system catalogue no. e.g. HS2/L/2/6

Holographic reconstructions by courtesy of Dept. of Mechanical Engineering, Loughborough University of Technology, Leicestershire

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Publication LH–1

Designed and Produced by Lisle Design Studio Limited
Printed in England by George Over Limited