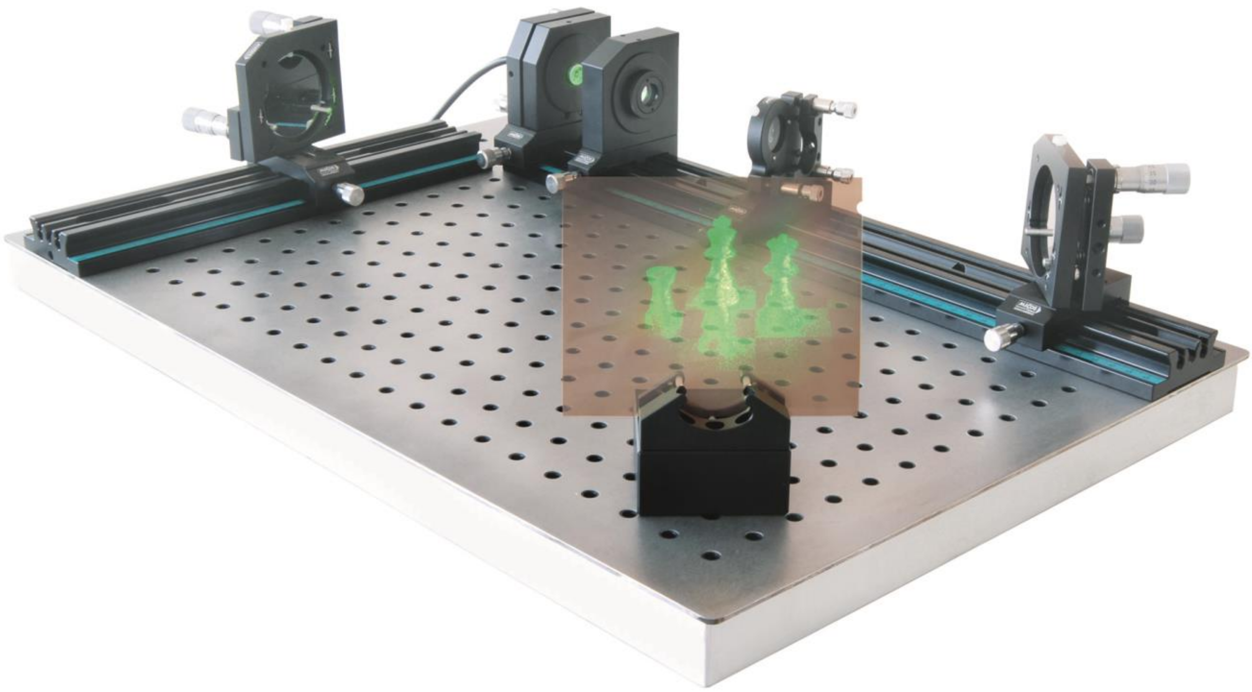
Holography (CA-1620)



Holography is known as a method for capturing fascinating 3D images of objects and people. For many years, however, holography has also been studied as a technique for optical data storage. In the 1980s and 1990s, intensive research was done on materials for spectral multiplex holography (spectral hole burning) and temporal transient techniques (time domain holography). Current research in holographic data storage research is DVD-like media with a capacity that is up to a hundred times higher than that of regular DVDs. This is accomplished by storing holograms in layers within the disk volume rather than on the surface as in conventional optical storage systems

eLas' holography setup teaches the basics of holographic recording: storing three-dimensional information, handling of a coherent light source, adjusting object and reference beams, storing the amplitude and phase of the light waves in a photosensitive film, developing the exposed film footage, reconstruction of the recorded hologram.

Reflection and transmission holograms of objects can be recorded. A solid base plate on air cushions ensures stability and enough free space for the holographic setup. Lasers, lenses and mirrors in stable, opto-mechanical components from eLas can be easily and quickly positioned and shifted on rails. Students do not only get to know and record different types of holograms, but also learn their development and fixing. The necessary equipment is included in the set. By recording and reading with 532 nm laser light, the holograms impress with their brilliance and high contrast.

Educational Objectives of Investigation

- Transmission, Reflection and Denisyuk holograms
- Amplitude and phase holograms
- Reference and object beam
- Virtual and real image
- Coherence, diffraction and interference
- Developing and fixing of holograms

Applied Experiments

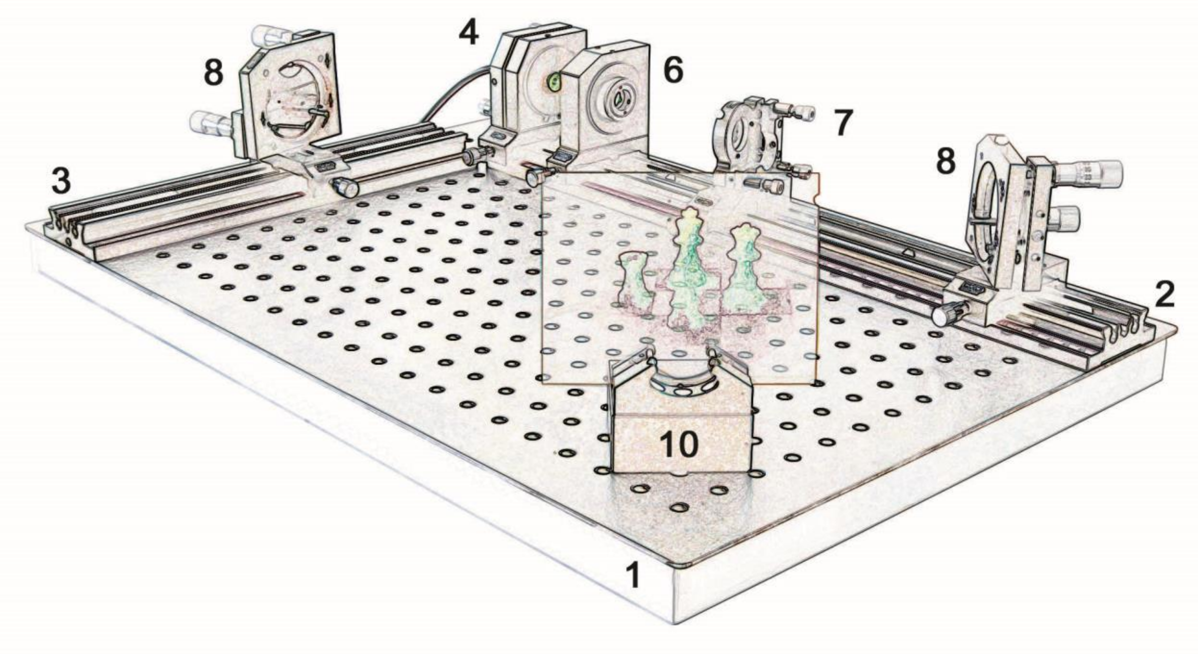
- Designing a holographic setup
- Working with a coherent light source
- Beam shaping and deflection by means of lenses and mirrors
- Geometrical arrangement of the object and reference beam
- Illumination of the object
- Estimate and calculate exposure times
- Interference of two light beams
- Storage of three-dimensional information in amplitude and phase
- Exposure of photosensitive plates
- Developing and bleaching of exposed film footages
- Reconstruction of the recorded hologram

Ordering Information

For ordering the Holography experimental kit (CA-1620)

use ordering number 4900-9-1620

Setup and Components



1 Optical breadboard 600 x 400 mm, approx. 18 kg, with two air cushions incl. pump for vibration damping

2 Flat rail 500 mm with mm scale

3 Flat rail 300 mm with mm scale

4 Green laser (532 nm, 5mW) in θ,φ fine adjustment holder on carrier

5 Laser supply LSC 2000 with remote button as shutter function (not shown)

6 Beam expansion unit with two interchangeable biconcave lenses (f = -5 mm and f = -10 mm) in holder on carrier

7 Beam splitter unit with two interchangeable beam splitter plates (50:50 and 30:70) in θ,φ fine adjustment holder on carrier

8 Two large circular flat mirrors (50 mm) for beam deflection in θ,φ fine adjustment holders on sliding carriers

9 Set of 30 pieces of holographic films on glass slides, 63x63 mm, green sensitive (not shown)

10 Holder for holographic plate

11 Object on pedestal with magnets (not shown)

12 Mini photodetector with multimeter for measuring illumination (not shown)

13 Developer chemicals (sodium hydroxide, phenidone, ascorbic acid, sodium phosphate; not shown)

14 Fixer chemicals (sodium persulfate, citric acid, copper bromide, potassium bromide, amidol; not shown)

15 Development materials: photo trays, tweezers, wide neck bottles, developer safety goggles (not shown)

16 Sample hologram (not shown)

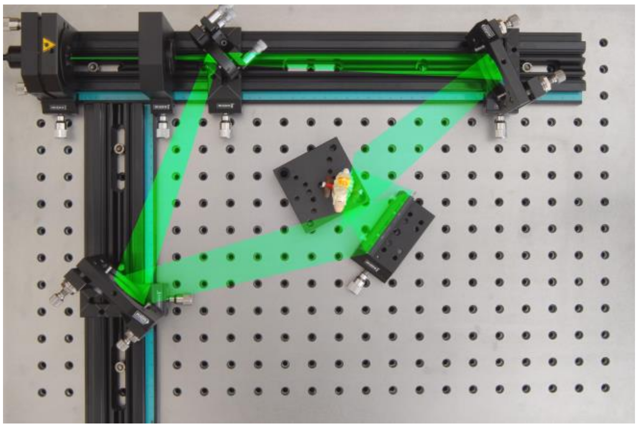
17 Instruction manual (not shown)

Examples of possible holographic setups

- **Direct beam transmission holograms**

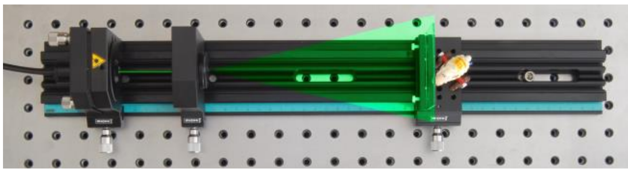
To record a transmission hologram with relatively little effort, a direct beam structure is offered, as shown in the picture. Object and reference beams are formed by one divergent laser beam. The structure is therefore compact, it requires few optical elements and the adjustment effort is limited. As a result, variation options are few only.

- **Two-beam transmission holograms**



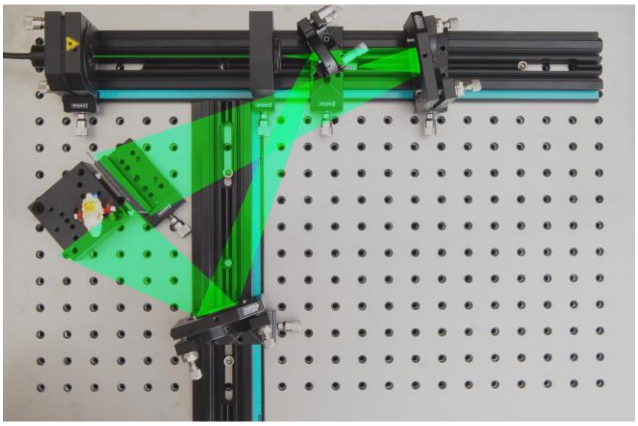
Compared to direct-beam holography, a two-beam design allows more freedom in the arrangement of object and photographic plate. Here, the laser beam is already divided into two parts in advance. A better illumination of object and photo plate is possible. So not only the illumination of object and plate can be adjusted, but also the intensity ratio of the two beams can be varied. In the setup, the division into object and reference beam can be clearly seen. Both beams hit the photographic plate from the same side in transmission hologram.

- **Direct beam reflection holograms (Denisyuk holograms)**



When recording a reflection hologram, the reference beam and the object beam illuminate the photo plate from opposite sides. The Denisyuk arrangement represents the simplest structure: the expanded laser beam hits the photo plate as a reference beam. Unabsorbed light passes through and illuminates the object located directly behind the plate. Light scattered by the object hits the photographic plate from the back as an object beam.

- **Two-beam reflection holograms**



Reflection holograms are also possible in the two-beam setup. As a result of exposure of the photographic plate from different sides, the interference fringes are on the order of half the wavelength of the laser light used. Therefore, on the one hand, the resolution of the film emulsion must be very high. On the other hand, the images require more power than a transmission hologram. Therefore, longer exposure times and a very stable optical arrangement are necessary. The latter is made possible by stable opto-mechanics on a heavy base plate mounted on air cushions.

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