campus®
EDUCATIONAL LASER SYSTEMS

MAC PhotonX® powered by MICOS

V11-2007

MICOS®

EDUCATION SCIENCE RESEARCH

THE COMPANY

micos is specialized in developing, manufacturing and marketing of systems and components in the range of photonic training kits and positioning technology for education, research and industry.

Founded in 1990 **micos** is a well-established company, and employs more than 40 people: excellent physicists, engineers and staff members who are highly qualified and experienced in the field of laser technology, optics and electronics.

Development and production of **micos** products are both consolidated in one facility. But **micos** does not stop at manufacturing. As a service provider **micos** keeps close contact to customers which allows to serve their needs and demands. Therefore **micos** is a competent and reliable partner for all questions and tasks of laser education and photonics.

Since **micos** is a worldwide operating enterprise support of international customers is given by carefully selected representatives and the subsidiaries of **micos** all around the globe.

THE PRODUCTS

The use of lasers in a variety of research fields, industry, medicine and finally in many products of daily life demands a qualified education and training of students in laser technology from universities, technical high schools and vocational schools. These institutions are addressed by campus®, the series of educational laser kits from MICOS developed to support and improve practical laser training. Within this product line 27 laser training systems of the topics optics fundamentals, laser basics, laser metrology, fiber optics and telecommunications, laser material processing, and laser applications are presented.

Besides these products MICOS offers support for elaboration of suited curriculums for laser courses, design of the laboratories and advice in equipment selection with concepts for complete laser training facilities. Last but not least, training courses for all experimental systems are held at MICOS' place as well as at your site.

OPTICS FUNDAMENTALS

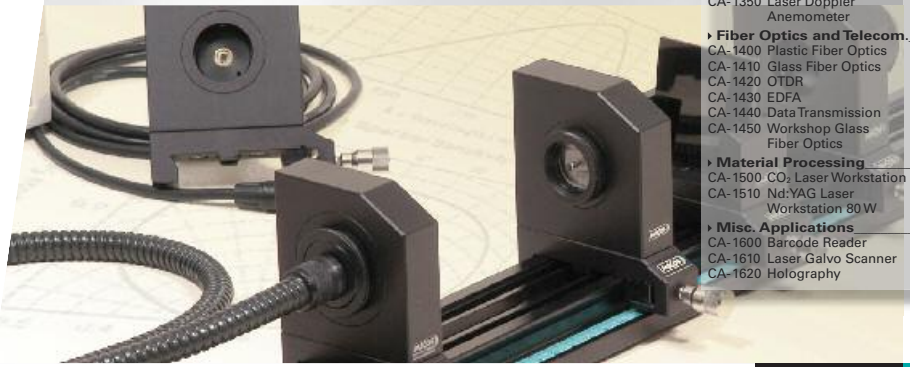
CA-1100 DETECTION AND MEASURING OF LIGHT

Educational Objectives

- Black Body Radiation
- White Light Source
- Monochromator
- Si Photodetector
- InGaAs Photodetector
- Thermoelectric Photodetector
- Photometer
- Electronic Circuits

Education in Photonics does not only apply to teaching about sundry types of light sources, but also about how to measure their light signals. Different properties like spectral sensitivity or response time of a set of photodetectors are characterized. A white light source in combination with a monochromator and a light chopper is used for simulation of cw- and pulsed light sources of various wavelengths. Additionally to the set of detectors, an electronic controller for the photodetecors allows to evaluate the effect of different types of electronic supplies and detection circuits for the photodetectors.

Order No. 4900-9-1100



CA-1110 LASER SAFETY AND CLASSIFICATION

Educational Objectives

- Laser Intensity
- Divergence of a Laser Beam
- Maximum Permissible Radiation
- Minimum Safety Distance
- Pulsed Lasers
- Damaging Effects
- Laser Classification
- Safety Goggles

This experimental kit is equipped with five laser sources of a wavelength range from blue to NIR with different powers and functions (cw- and pulsed lasers). These sources are to be classified in safety classes by power and energy measurement. Optical elements like a beam expander, filters or a scattering disc are used to modify the laser beams and hence change their safety classes. Direct laser light as well as its scattering cone profile is measured. Handling of standards like VBG and EN60825 will be introduced and trained. Effects of laser power on the human eye is simulated. MPR and MSD values are calculated and demonstrated.

Order No. 4900-9-1110

CA-1120 RADIO- AND PHOTOMETRY

Educational Objectives

- Light
- Black Body Radiator
- Thermal Light
- Cold Light
- Sensitivity of Human Eye
- Photometric Units
- Calibrated Lamp
- Lock-In Amplifier

While in Radiometry the measures for optical radiation are related to physical units like Joule or Watt, in Photometry all measurements are based on the physiological sensitivity of the human eye. Within this educational kit the basics of light and the transformation from radiometric to photometric values and vice versa are taught. The calibration with a lamp standard with certified parameters is performed. The lamp's behavior with respect to a black body radiator and its discrepancy are discussed. The Lock-In technique in combination with a light chopper to measure photometric values are examined.

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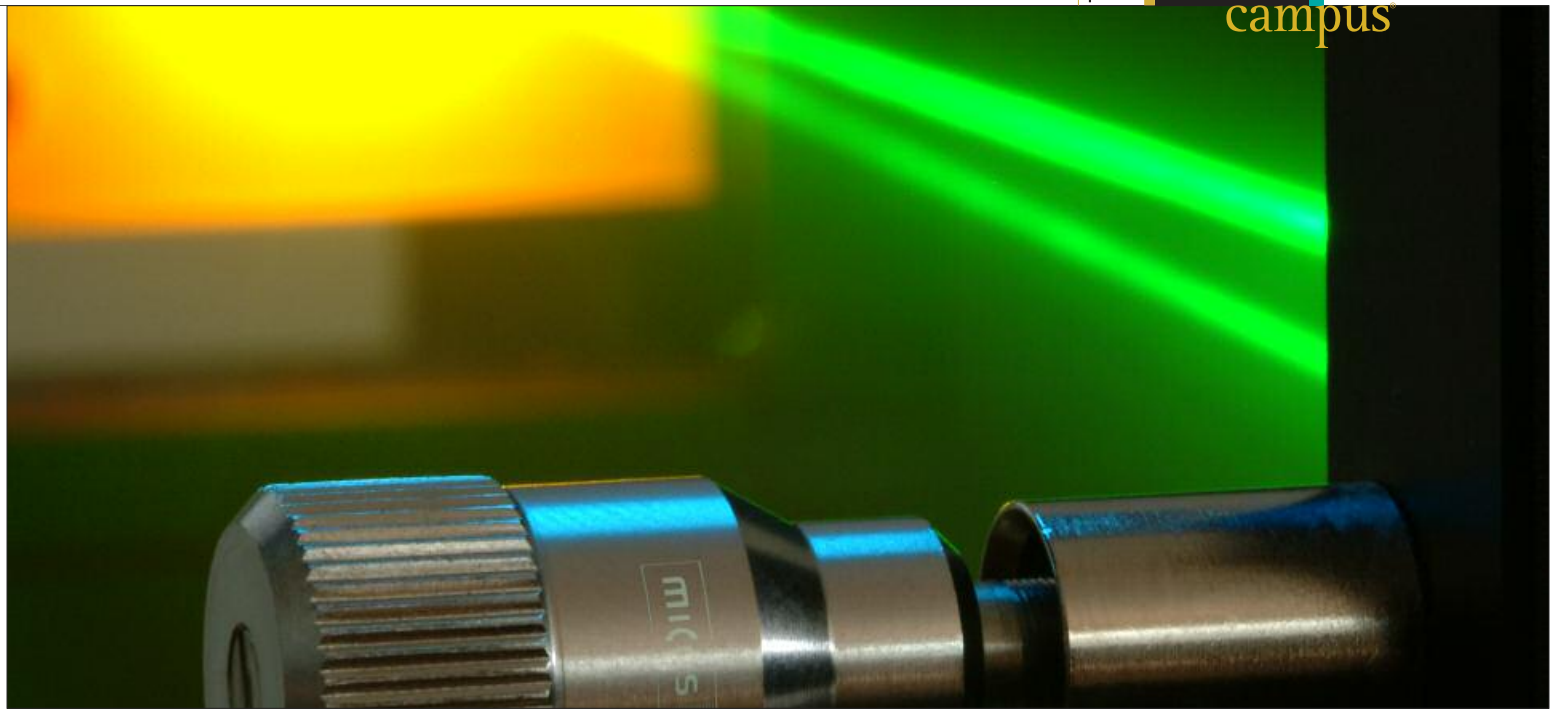

CA-1130 EMISSION AND ABSORPTION

Educational Objectives

- Einstein Coefficients
- Optical Pumping
- Diode Laser
- Absorption of Nd:YAG Crystal
- Lifetime of Excited States
- Interference Filter
- Longpass Filter

Optical pumping of an Nd:YAG crystal by the IR emission of a laser diode shows the absorption behavior of a laser medium. At a laser diode controller parameters like temperature and current of the pumping diode are set and hence its emission wavelength is defined. Therefore the spectral absorption profile of the crystal can be traced. The fluorescence of the crystal is determined by wavelength with a narrow band interference filter. The life time of the excited state is measured by a fast PIN photodiode.

Order No. 4900-9-1130

CA-1140 FABRY PEROT RESONATOR

Educational Objectives

- Two Beam Interference
- Multiple Beam Interference
- Free Spectral Range
- Finesse
- Types of Fabry Perot Resonators
- Stability Criterion
- Spectral Analysis of HeNe Laser

Aim of this experimental Fabry Perot resonator is the determination of characteristics like free spectral range and the finesse of a Fabry Perot, and the mode spectrum of a test laser (HeNe laser). One mirror of the resonator is mounted on a piezo translator resulting in a scanning Fabry Perot used as a spectrum analyzer. By variation of the resonator mirrors (the set comprises 6 mirrors) and the resonator length different types of optical resonators (confocal, concentric, hemispherical, etc.) are set up and evaluated. In case of a plane-parallel resonator a beam expander is used for enlarging the laser beam diameter.

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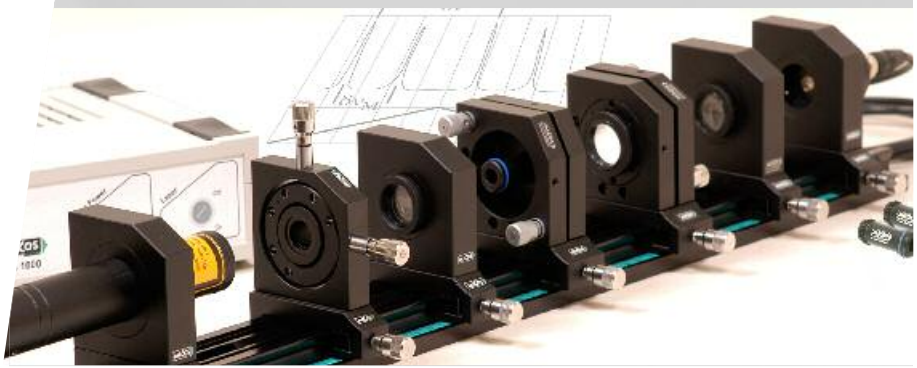


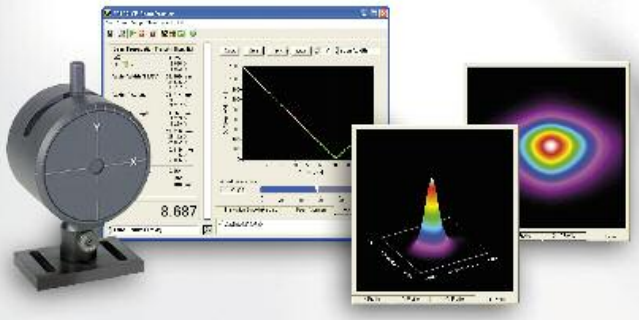
CA-1150 LASER BEAM ANALYZER

Educational Objectives

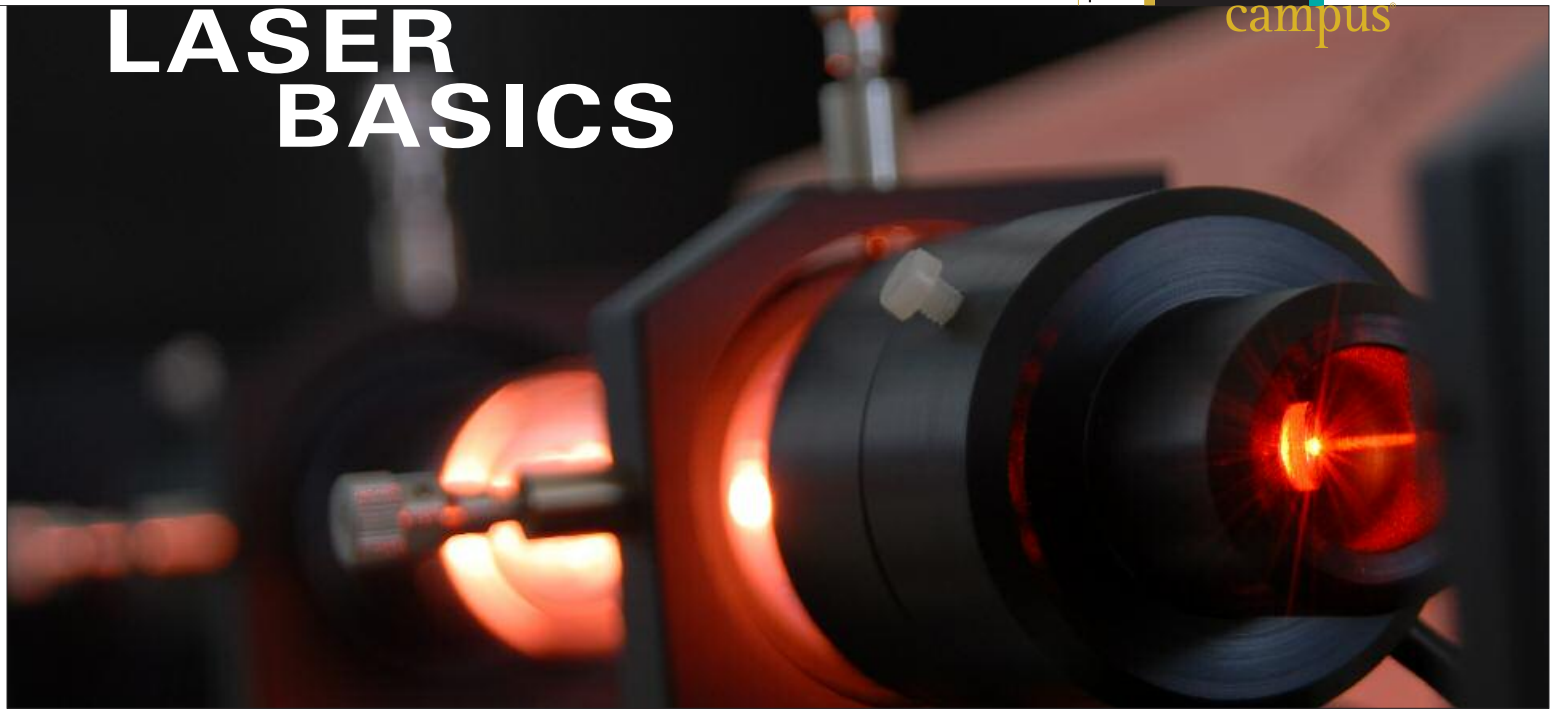
- Beam Profile
- Beam Expander
- Beam Shaping Optics
- Transversal Modes
- Beam Intensity
- Gaussian Distribution

This Laser Beam Analyzer is to understand as an add on suited for several laser kits of miCos: Nd:YAG (CA-1230),HeNe (CA-1200) and Diode Laser (CA-1220) are ideal candidates for demonstration of beam profiles, transversal mode structures or influence of beam shaping optics and telescopes on laser beams – all of them easily visualized by the Beam Analyzer. But also beam profiles after travelling through glass fibers (CA-1410, CA-1420) or interference patterns (CA-1300) are interesting objects for observation. The measured data are monitored and stored by a PC and with several software tools the intensity distribution of the laser beams can be presented.

Order No. 4900-9-1150



LASER BASICS



CA-1200 HeNe LASER

Educational Objectives

- Energy Levels of HeNe
- Emission Spectrum of HeNe
- Gain
- Longitudinal & Transversal Modes
- Mode & Line Selection
- Birefringent Filter
- Littrow Prism
- Single Mode Etalon

An open frame gas laser consisting of a HeNe tube with brewster windows and separate resonator mirrors is used for demonstration and teaching of the basics of gas lasers like stability, coherence and mode behavior. By variation of the resonator mirrors (the set comprises 4 mirrors) the resonator properties and its influences on the laser power and stability are evaluated. Wavelength selection with optical components like birefringent filter and Littrow prism is performed; mode selection is investigated using a single mode etalon.

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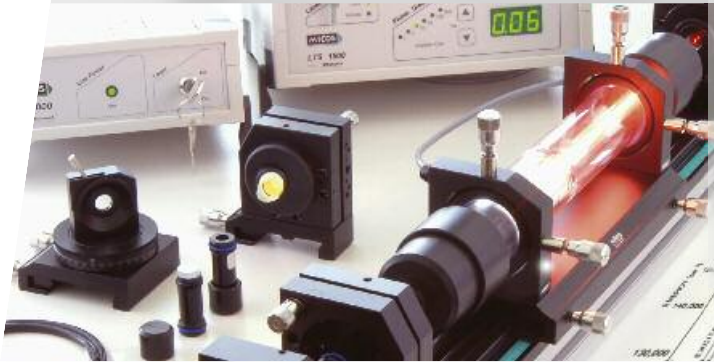


CA-1210 CO_2 LASER

Educational Objectives

- Open Frame Resonator
- Infrared Optics
- Influence of Discharge
- Influence of Gas Pressure
- Gas Handling & Gas Flow
- Thermal Interaction of Radiation
- Material Processing

The topics of experimentation on this high power gas laser are twofold: first, the alignment of the open frame resonator is trained and the influence of parameters like laser gas pressure or discharge current on the output power are determined. Second, the laser is used for evaluation of thermal interaction of radiation with matter, resulting in heating, drilling ,scribing or cutting of different types of material. The test workpieces are mounted on an XY-translation stage moved by a CAD program. The whole workspace is shielded by a thermal radiation absorbing cover allowing a safe observation of the processes.

Order No. 4900-9-1210

CA-1220 DIODE LASER

Educational Objectives

- Types of Laser Diodes
- Beam Profile
- Fast and Slow Axis
- Spectral Properties
- Laser Threshold
- Slope Efficiency
- Beam Shaping
- Polarization State

Mounted on a rotational unit the spatial distribution of laser diode emission is measured. Beam shaping optics allows to collimate the laser beam and to modify its profile. To determine threshold current and slope efficiency, the relative output power of the diode is measured as a function of the injection current. By means of absorption in an Nd:YAG crystal the dependency on the laser wavelength from the chip temperature and injection current is evaluated. The state of polarization in dependence on the diode current is probed by a polarizer. Current, temperature and modulation of the diode are adjusted on the versatile controller. **Order No.** 4900-9-1220

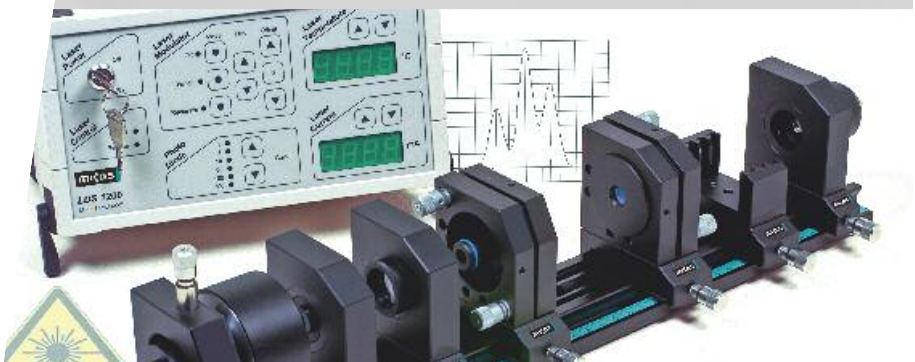
CA-1230 ND:YAG LASER

Educational Objectives

- Properties of Laser Diodes
- Optical Pumping
- Absorption of Nd:YAG Crystal
- Fluorescence Lifetime
- Static & Dynamic Behavior
- Laser Threshold & Slope Efficiency
- Resonator Properties & Stability
- Laser Spiking

As a demonstration system for a diode pumped solid state laser a fully functional Nd:YAG experimental laser is presented. Optically pumped at 808 nm absorption, spontaneous emission, lifetime of excited state, and absorption wavelengths of the Nd:YAG crystal are investigated. The relative output power of the solid state laser is measured as a function of the pump diode power to determine parameters like threshold power and slope efficiency. Properties and stability of a hemispherical resonator are examined, resonator modes are visualized. Further, a multitude of measurements for diode characterization (compare CA-1220) can be performed.

Order No. 4900-9-1230



OPTIONS FOR ND:YAG LASER

CA-1231 Frequency Doubling

- Behavior of Nonlinear Optics
- Frequency Doubling
- Power of SHG-Radiation

A KTP crystal converts the Nd:YAG emission intra-cavity to green light. For green emission above 5 mW an output coupler mirror highly transmissive at 532 nm is provided. Using an IR-absorbing filter the quadratic response of the SHG process is measured. Transverse cavity modes of the Nd:YAG laser are visualized by SHG impressively.

Order No. 4900-9-1231

CA-1232 Active Q-Switch

- Active Q-Switching
- Electro-Optical Modulator
- Q-Switching Behavior

A $LiNbO_3$-Pockels Cell changes the polarization state of the Nd:YAG emission. A brewster plate introduces losses and laser operation is suppressed. When switching the cell, the losses are minimized and a laser pulse builds up. Switching voltage and frequency are adjusted by a controller. In combination with CA-1231 intra- and extra-cavity SHG are shown.

Order No. 4900-9-1232

CA-1233 Passive Q-Switch

- Passive Q-Switching
- Saturable Absorption
- Q-Switched Radiation

A Cr:YAG crystal acts as a saturable absorber within the resonator. A train of needle like pulses are observed. The pulse frequency is influenced by the pump power and the cavity alignment. When oscillating at more than one transversal mode two or more pulse trains appear. In combination with CA-1231 intra- and extra-cavity SHG is shown.

Order No. 4900-9-1233

LASER METROLOGY

CA-1300 LASER INTERFEROMETER

Educational Objectives

- HeNe Laser
- Contrast Function
- Coherence Length
- Two Beam Interference
- Homodyne Interferometer
- Fringe Detection, Counting and Interpolation
- Definition of Length

The basic version of a Michelson interferometer is presented for training of handling, alignment and measurement of an interferometer system. Basics like properties of Gaussian beams, wave fronts and interference patterns are discussed. The spectral emission bandwidth of the laser source is introduced and its influence on the interferometer contrast is measured. The measurement of coherence length of a HeNe laser shows the students additional parameters of interferometers.

Order No. 4900-9-1300

EXTENSIONS FOR LASER INTERFEROMETER

CA-1301 Technical Extension

- Technical Interferometer
- Signal Conditioning of Sin / Cos
- Fringe Detection, Resolution, Limits
- Distance Measurement

The basic Michelson interferometer is rounded up to a technical interferometer. Length measurement with this homodyne laser interferometer is based on electronical fringe counting. The quadrature detection technique allows to determine the direction and step numbers of movement of one interferometer mirror. A comparator digitalizes the measured signals. An event counter registers the fringe numbers which are converted in measures of length.

Order No. 4900-9-1301

CA-1302 Motorized Extension

- Industrial Application
- Calibration of a Translation Stage
- Calibration Record
- Environmental Conditions

The Technical Interferometer is extended by a motorized translation stage and a controller to demonstrate the calibration of an unknown length. Via a PC a travel range is set, encoded by the controller and forwarded to the translation stage. The value measured by the interferometer is compared to the travelling distance and hence to the set value. Corrected for environmental conditions the interferometer value builds the calibration standard.

Order No. 4900-9-1302

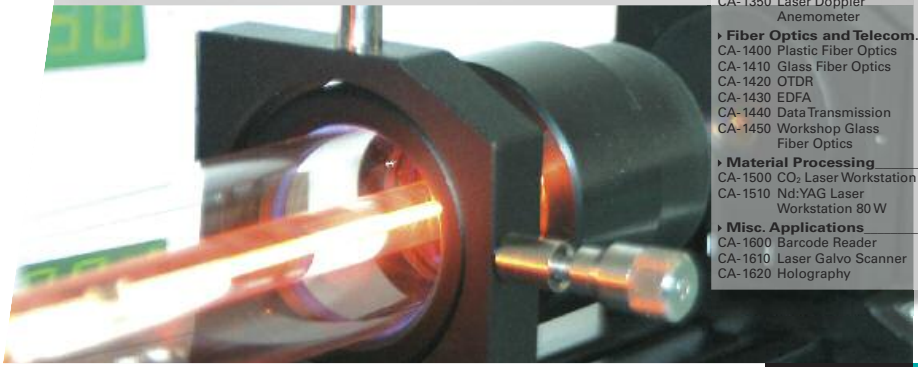
CA-1310 LASER GYROSCOPE

Educational Objectives

- HeNe Ring Laser
- Ring Laser Modes
- Interference
- Single Mode Etalon
- Doppler Effect
- Mode Lock-in
- Measurement of Rotation
- Dynamic Range

This active laser gyroscope contains a ring laser consisting of an open frame HeNe tube and a triangular resonator. The whole ring laser is set up on a rotational platform. The rotational velocity can be varied in a wide range to examine the dynamic range of the gyroscope. Counterrotating modes of the ring laser are coupled out and are superimposed. The resulting interference is detected and by electronics converted to a frequency proportional to the rotational velocity. The lock-in threshold is determined, and single mode operation is achieved by an etalon.

Order No. 4900-9-1310



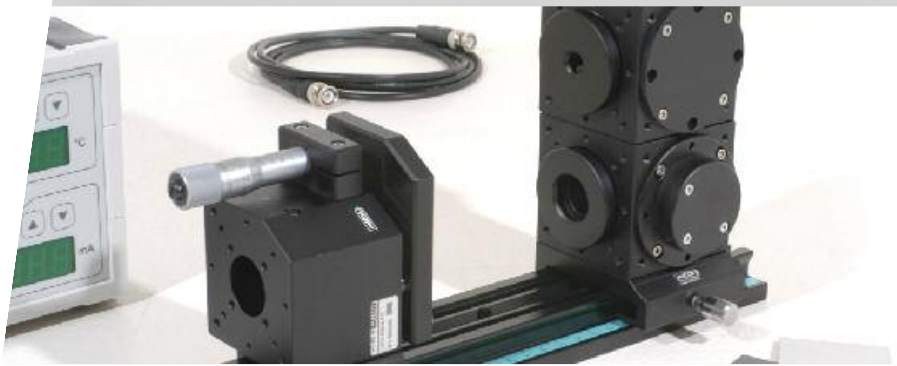
CA-1320 LASER TRIANGULATION

Educational Objectives

- Laser Diode
- Position Sensitive Detector (PSD)
- Distance Measurement
- Optical Detection of Presence
- Scattering on Surfaces
- Accuracy of Measurement

One application of triangulation in laser metrology is contactless distance measurement. Teaching and evaluation of the principles, abilities and limits of laser triangulation is the aim of this kit. A laser diode and position sensitive detector is provided in an accessible housing. Together with control electronics and translation stage for the object plates a triangulation set-up is assembled. With the translation stage displacements with 10 µm resolution are performed. Two samples with different scattering behavior simulate different surface properties.

Order No. 4900-9-1320



CA-1330 LASER LEVELING

Educational Objectives

- Laser Beam Properties
- Gaussian Beams
- Divergence
- Measurement of Distance
- Line Generation
- Floor Leveling

This educational kit teaches the basic properties of a laser beam and how to handle laser leveling systems. All typical instruments used in industry are introduced. The workshop provides a laser spirit level and a rotational laser with a penta prism which produces a horizontal and vertical leveling plane of laser light. The measurement of distances is performed by a laser range finder included in the kit. All instruments can be assembled to a solid tripod with an adjustable base.

Order No. 4900-9-1330

CA-1340 LASER RANGE FINDER

Educational Objectives

- Pulsed & CW Laser Diodes
- Beam Shaping & Bending
- Polarization
- Si PIN Detector
- Light Echoes
- Time of Flight
- Light Scattering

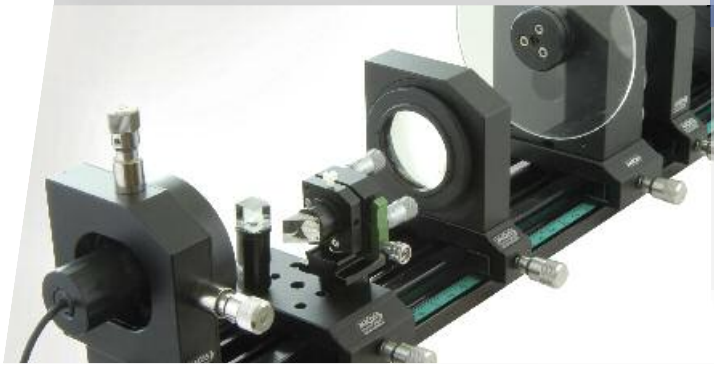
Aim of this experimental pulsed laser range finder system is to demonstrate the properties, abilities and limits of a LIDAR (LIght Detection And Ranging) system. After assembling the complete set distance measurements are performed. The pulsed laser diode in use sends short and intensive pulses in the eye safe range towards a scattering target or a corner cube reflector. A trigger signal generated by reference pulses starts the measurement and synchronizes one channel of an oscilloscope. The time of flight of the backscattered laser pulses determine the distance of the measured object. The pulse width reaches less than 50 ns and distances below 8 m can still be measured. **Order No.** 4900-9-1340

CA-1350 LASER DOPPLER ANEMOMETER

Educational Objectives

- Doppler Shift
- Beam Interference
- Scattering of Light
- Velocimetry
- Particle Size
- Fourier Transformation
- Modulation Depth
- Flow Cell

The working principle of a Laser Doppler Anemometer (LDA) is demonstrated. Two coherent laser beams are crossing each other at the measuring spot at which a rotating acrylic disc with small particles is placed. Since the two beams interfer at the intersection spot particles travelling exactly through this spot scatter the light in a periodical manner and generate an optical signal carrying a typical frequency. Scattered light is collected by a lens and focused onto a photo detector. By electronical filtering and fast Fourier transformation the frequency is extracted and the velocity of the particles can be deduced. **Order No.** 4900-9-1350



FIBER OPTICS AND TELECOMMUNICATIONS

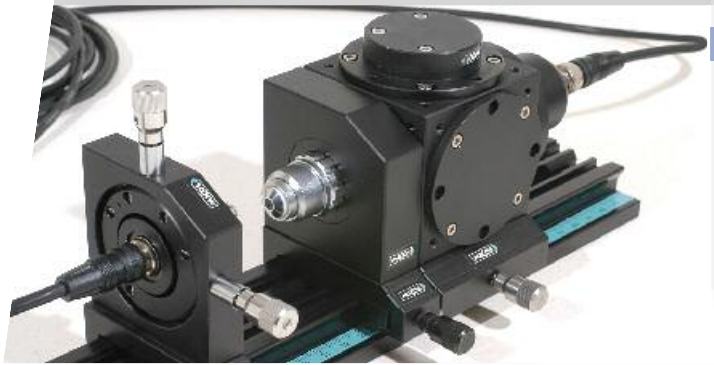
CA-1400 PLASTIC FIBER OPTICS

Educational Objectives

- LED Transmitter
- LED Modulation
- Si Photo Detector Receiver
- Dichroic Beam Splitter
- Dual Wavelength Data Transmission
- Plastic Fiber Handling
- Plastic Fiber Properties

The education on this kit starts with the preparation of a plastic fiber (POF): stripping, assembling a connector and polishing of the connector surface are trained. The losses of different length of POFs in a transmission line are measured. The set-up of a complete two channel low frequency data transmission system will be performed. All necessary components, fibers and control electronics like modulator, transmitter, receiver, demodulator and an audio amplifier with two speakers are included. Additional signal sources like a CD player can be connected to the transmitter.

Order No. 4900-9-1400



CA-1410 GLASS FIBER OPTICS

Educational Objectives

- Characterization of Fibers
- Guiding of Light in Fibers
- Single & Multimode Fibers
- Laser Diodes
- Coupling Optics
- Signal Transmission

This kit is laid out to introduce the basics of theory and handling of glass fibers. The preparation of glass fiber ends by stripping and cleaving with appropriate tools are taught and coupling laser light in a bare fiber end is trained. For this training the kit is equipped with one kilometer of single- and multimode fiber, respectively. Fiber parameters like numerical aperture, transmission speed and transmission losses are measured and determined. The light coupled in the fiber is provided by a single mode laser diode. The power and state of modulation of the diode is controlled by its electronics supply.

Order No. 4900-9-1410

CA-1420 OPTICAL TIME DOMAIN REFLECTOMETRY (OTDR)

Educational Objectives

- Laser Diode Power Modes
- Optical Fiber
- Si PIN Photodetector
- Fiber Handling and Preparation
- Coupling Light to Fiber
- Reflected Light Echoes
- Properties of Glass Fibers
- Speed of Light

After assembling the complete OTDR set reflectometry measurements are performed. Short pulses in the eye safe spectral range are coupled in a 1 km multimode fiber. The fiber ends are prepared by Miller pliers and a fiber cleaver. A trigger signal generated by reference pulses starts the measurement. The time of flight of the light backscattered by the fiber determines the length of the fiber and the position of an eventual distortion. Further, a multitude of measurements for diode characterization (compare CA-1220) and most of the measurements of the Glass Fiber Optics kit (CA-1410) can be performed. **Order No.** 4900-9-1420

CA-1430 ERBIUM DOPED FIBER AMPLIFIER (EDFA)

Educational Objectives

- Emission and Absorption
- Laser Diodes
- Coupling Light to Fiber
- Erbium Doped Fiber
- Optical Amplification
- Optical Pumping
- Fluorescence Lifetime
- ASE Signal

An open frame experimental EDFA demonstrates the principles of a fiber amplifier. A 1550 nm laser signal is coupled in an Er^{2+} doped fiber which is simultaneously pumped by a 980 nm laser diode. Amplification of the signal is measured as a function of the pump power. By changing the power of the input signal the maximum amplification value is evaluated. When pumping without additional signal input the fluorescence lifetime and the ASE-signal – both at 1550 nm – are detected. Injection current, temperature and the modulation state of the laser diodes are set by the versatile diode controllers. Further, a multitude of measurements for diode characterization (compare CA-1220) can be performed.

Order No. 4900-9-1430

CA-1440 DATA TRANSMISSION VIA OPTICAL FIBER

Educational Objectives

- Laser Diodes
- Optical Glass Fibers
- Photo Detector
- Handling of Fiber Optical Cable
- Modulation of Laser Diodes
- Video Cameras
- Video Signal Transmission
- Optical Signal Detection

The educational kit for data transmission demonstrates digital signal transmission on a 5 km optical line. A video source consisting of a color CCD camera and an audio source (CD player) is connected to the optical transmitter. Via the provided fiber the audio as well as video signals are transmitted simultaneously to the optical receiver. At the receiver's side the optical signal is transformed to an electrical signal which is passed on a TV set which displays the picture detected by the CCD camera and plays the music provided by the CD player.

Order No. 4900-9-1440

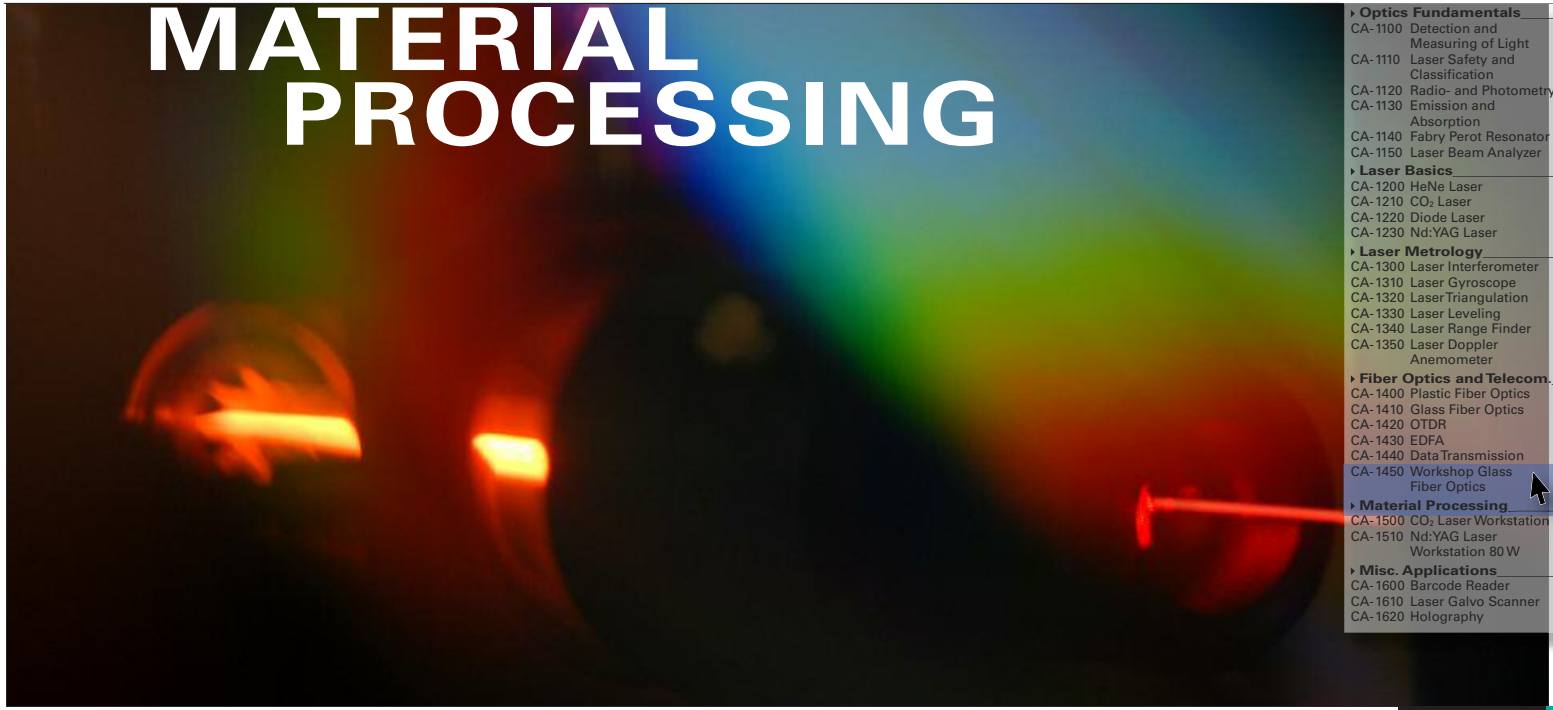
CA-1450 WORKSHOP GLASS FIBER OPTICS

Educational Objectives

- Fiber Stripping
- Fiber Breaking
- Fiber Connectors
- Polishing of Connectors
- Inspection Microscope
- Fiber Splicing
- Fiber Sleeve

This workshop teaches confectioning of a fiber connector to a bare fiber end as well as arc splicing of two fiber ends. The protection coating of the fibers is removed by a pair of Miller pliers. In a oven the fiber end is fixed to the connector by hot melt technique. For a high quality connector surface the connector tip is polished by a polishing machine. The quality of the polished surface is regarded through a handheld fiber microscope. For splicing of two fiber ends they have to be cleaved with a high performance fiber cleaver. The prepared fiber ends are fused together in a fusion splicer with display monitoring the splicing process. Finally, a protecting sleeve covers the spliced area. **Order No.** 4900-9-1450

MATERIAL PROCESSING



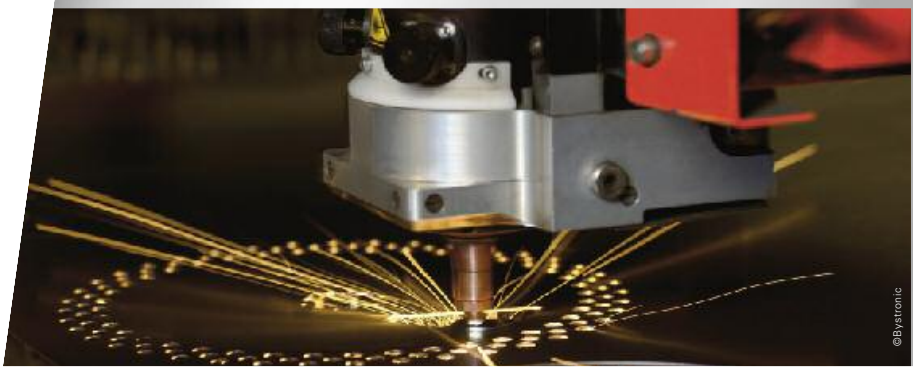
CA-1500 CO_2 LASER WORKSTATION

Educational Objectives

- CO_2 Laser Types
- Sealed-Off Design
- cw and pulsed Mode
- RF Excitation
- Material Processing
- Laser Cutting and Welding
- Laser Scribing and Drilling

Using a sealed off laser system with a power of 100 W this workstation is mainly laid out for training of material processing fundamentals and techniques. The high power laser source enables to learn welding, cutting, scribing and soldering on different materials and by variation of laser power, pulse rates, transverse velocity, process gases and focal lengths. The laser gas is RF excited and can be operated in cw- as well in pulsed mode. In the workspace the testing sample is mounted on an XY-translation stage moved by a CAD program. The whole system is driven by a provided PC. Laser safety is given by a fully closed cabinet, therefore the whole workstation represents a Class 1 laser system.

Order No. 4900-9-1500



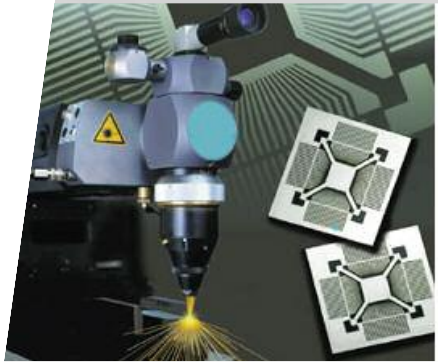
CA-1510 ND:YAG LASER WORKSTATION 80 W

Educational Objectives

- Nd:YAG Laser
- cw and pulsed Mode
- Active Q-Switch
- Laser Welding
- Laser Soldering
- Laser Drilling
- Flash Lamp Pumping

Different material processing techniques like soldering, drilling, scribing, cutting or welding can be studied with this Nd:YAG workstation. Laser power, process gas or focal length are optimized depending on the test material and the process. Equipped with a Q-switch system the laser pulses are able to evaporate material, and laser drilling can be studied. In the workspace the testing sample is mounted on an XY-translation stage moved by a CAD program. The whole system is driven by a provided PC. Laser safety is given by a fully closed cabinet, therefore the whole workstation represents a Class 1 laser system.

Order No. 4900-9-1510



MISCELLANEOUS APPLICATIONS

CA-1600 BARCODE READER

Educational Objectives

- Digital Information
- Bar Code
- Polygon Mirror
- Photo Detector
- Bar Code Detection and Algorithm
- AD Converter

The heart of a bar code reader system is a rotating polygon mirror: A laser beam is deflected at the mirror so that the laser point will describe a scanning line which probes the bar code pattern. Back scattered light is reflected to a beam splitter and focused on a photodetector. The measured signal is provided as analog signal directly via an interface or converted by an AD converter and transduced to a PC. There the signal pattern is compared with an existing database and the related item is identified. Vice versa by using a printer the students produce their own bar code labels and check the relation afterwards by using the bar code reader.

Order No. 4900-9-1600

CA-1610 LASER GALVO SCANNER

Educational Objectives

- Scanning Devices
- Galvo Scanner
- Closed Loop Circuit
- Scanner Imaging
- Laser Entertainment
- Software Handling

The setup of two crosswise arranged mirrors pivoted by galvo technique enables the scanning of a laser beam in a two dimensional field. This technology is implemented in commercial devices. The main applications of laser galvo scanners are material processing (e.g. scribing or laser printing) and entertainment like laser shows. The experimental kit consists of two galvo scanning mirrors which deflect a green laser beam towards a screen. The provided software allows the generation of various shapes and patterns for projection. Via an amplifier for the galvo signals the mirrors are addressed. Principles, abilities and limits of a galvo scanner for material processing and entertainment animation are evaluated.

Order No. 4900-9-1610

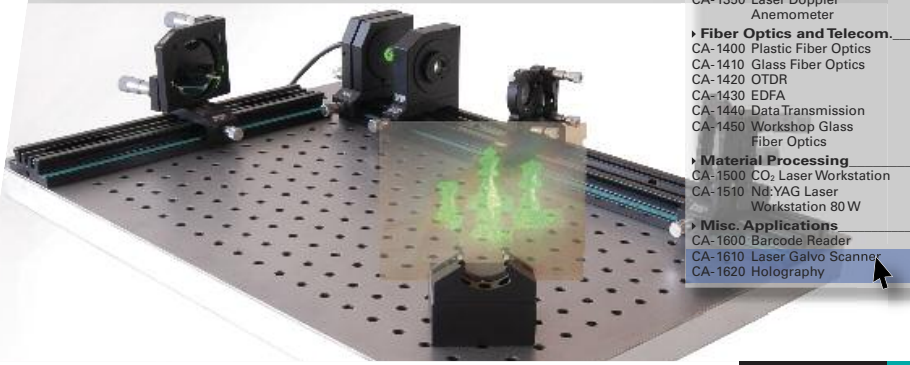
CA-1620 HOLOGRAPHY

Educational Objectives

- Transmission Hologram
- Reflection Hologram
- Interference
- Assembling of a Holo-Graphic Setup

The interference of reference beam and light scattered from the object is detected by the photo plate. Self-developing photo plates are offered making an exhausting developing procedure dispensable. Using green laser light the holograms impress by their brilliance and high contrast. **Order No.** 4900-9-1620

With the holography experimental set-up the principles of holographic recording is taught. Reflection as well as transmission holograms of objects can be taken. A beam is split into signal and reference beam and send to the object and photo plate, respectively.



EDUCATION SCIENCE RESEARCH

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