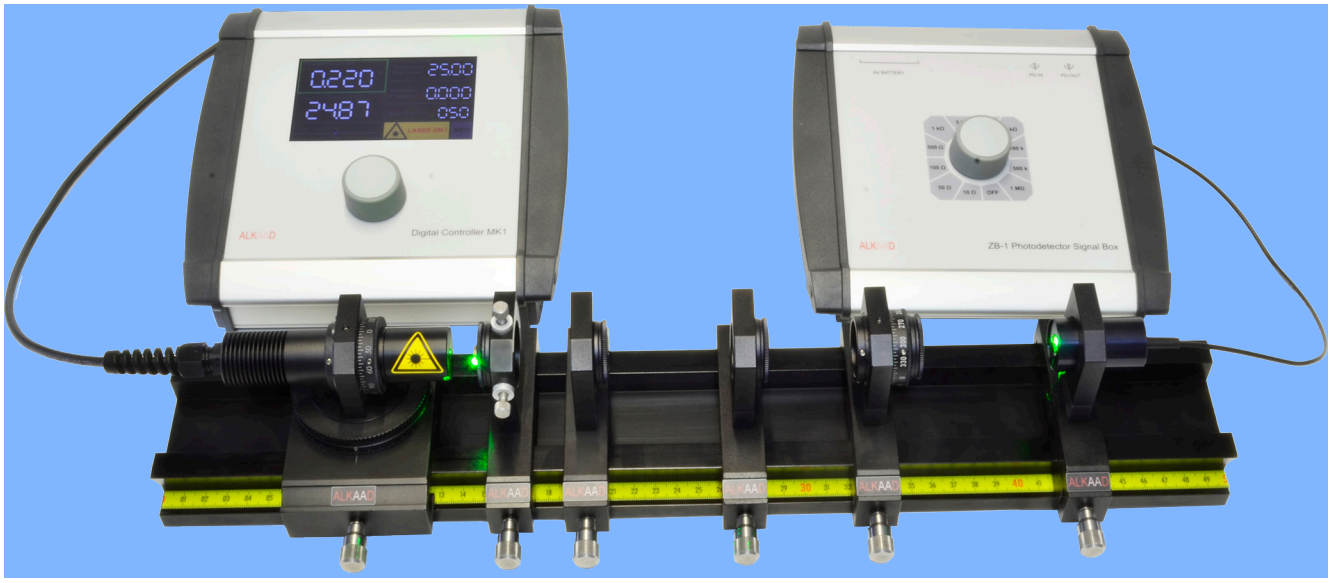
LE-0400 Diodelaser



Fermi Distribution
Green (525 nm) Laser Diode
Beam Shaping
Inversion in Semiconductors
Spatial Intensity Distribution
Polarisation Properties
Types of Laser Diodes
Spectral Properties

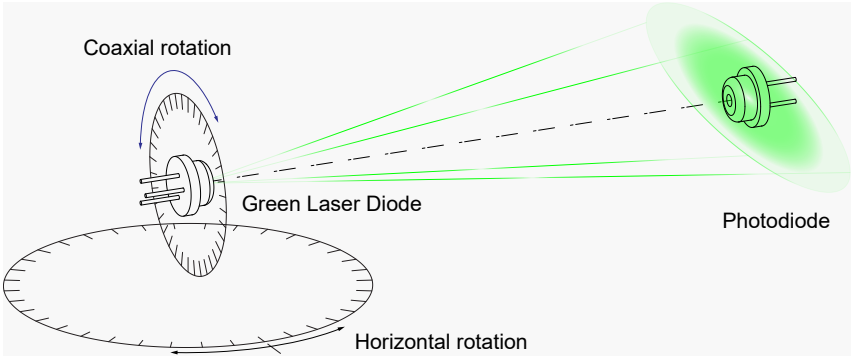
Laser diodes differ from most “classical” lasers in two distinct ways:

Firstly, they do not posses an inherently defined wavelength. Instead of two defined energy levels, the lasing transition occurs between two energy bands.

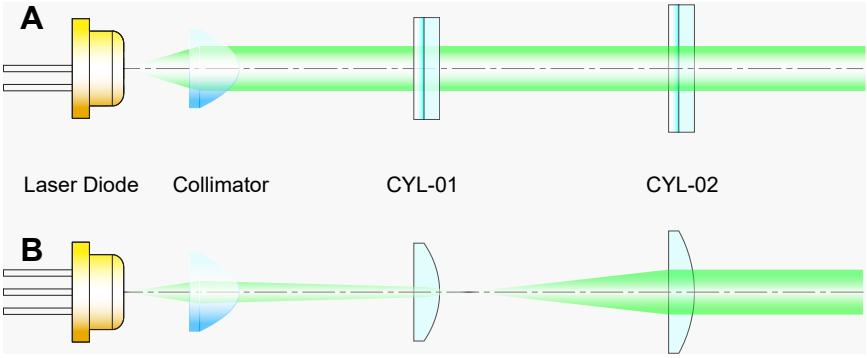
Secondly, the pn junction of the diode defines the lasing volume, instead of the resonator in a classical laser.

These experiments investigate the variation of the emitted laser wavelength versus temperature and current. The divergence and polarisation of the laser emission are examined. The set-up comprises a modern 30 mW green (525 nm) emitting laser diode, with integrated Peltier cooler, mount and driver. Collimating optics, lenses and a polarisation analyser are provided, along with a photodiode detector. A spectrum analyser is available as an option. All optical mounts and positioners are included. The laser diode is mounted in a rotational stage which allows the independent rotation around the beam propagation axis as well as perpendicular to this axis to measure the spatial distribution of the emitted laser light. The polarisation for different values of the injection current is analysed by means of a polarizer.

The spectrum analyser will be used to measure the change of wavelength by varying the temperature and injection current. The shift is app. 0.05 nm per °C. The temperature range of the diode laser controller can be varied from 10 to 60° C which results in a shift of 2.5 nm. Temperature and injection current are stabilised and displayed by the controller. The use of an oscilloscope is recommended to suppress disturbing environmental light. In this case some of the measurements are carried out with modulated diode laser light.



A laser diode emitting visible green radiation at a wavelength of 525 nm is used as probe laser. The laser diode is attached to a Peltier cooler which allows a controlled temperature change from 10-50 °C. Furthermore, the injection current can be set from zero to the maximum permissible value. The laser diode and the attached Peltier cooler are integrated into a round housing which is mounted into a twofold rotary stage for horizontal and coaxial rotation. This allows the measurement of the spatial intensity distribution of the emitted visible green light. The incident light from the laser diode is detected and measured with a fixed photodiode.



The emission of a laser diode is in general strongly divergent and asymmetric concerning the spatial propagation. The light appears to have two points of origin (astigmatic difference) and two orthogonal axes, each with different divergence. Most application however, require a round beam. To achieve this, a pair of cylindrical lenses are used as shown in the figure on the left. The case (A) shows the collimation of one direction using the collimator to create an almost parallel beam which is not affected by the cylindrical lenses. The orthogonal emission direction (B) is treated by the cylindrical lenses to obtain an almost round beam

Measurements

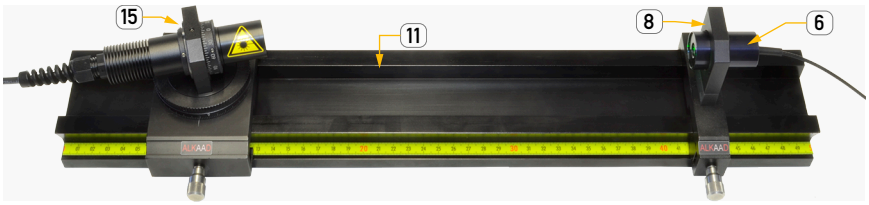


Fig. 2.25: Setup to characterise the green laser diode

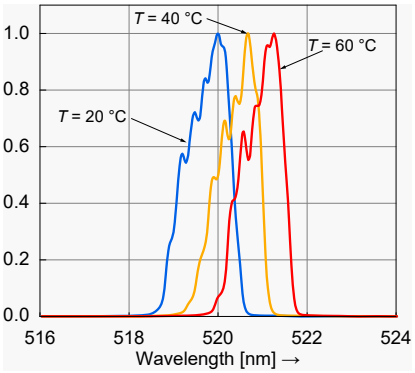


Fig. 2.26: Wavelength versus temperature

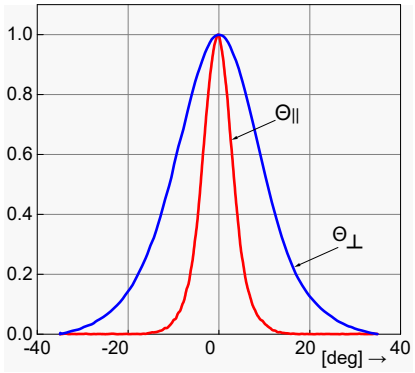


Fig. 2.27: Spatial intensity distribution

The green laser diode is mounted into the twofold rotary unit (14). It can be rotated around its horizontal as well as coaxial axis. At the beginning the horizontal angle of the laser diode is set to zero, the diode laser illuminates the photodetector (6) fully. In this arrangement the output power versus the injection current is measured with the temperature as parameter. The temperature can be set by the MK1 controller in a range from 10 to 50°C and the injection current from zero up to the maximum permissible value for the laser diode. Each laser diode contains an EEPROM in its connector where these values are stored. Once connected to the MK1 controller the values are read and the maximum current is limited to it. Even more, these values are displayed by request on the MK1 controller's touch display. In the same setup the optional spectrum analyser is applied. The fibre adapter is clicked into the mounting plate instead of the photodetector. For different temperatures the spectral curves are recorded and the wavelength change $d\lambda/dT$ determined. In addition the wavelength change $d\lambda/dI$ versus the injection current for a fixed temperature is determined.

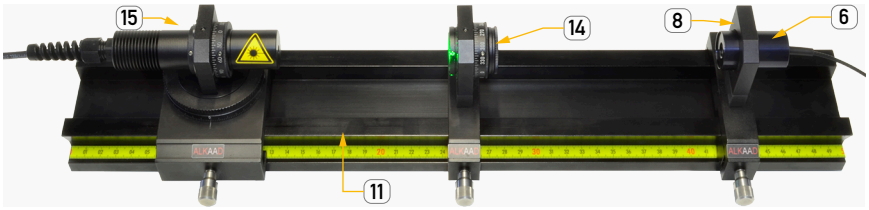


Fig. 2.28: Setup to measure the polarisation of the laser diode

The setup shown in Fig. 2.28 is used to measure the polarisation of the green laser emission. The polarisation analyser (13) is placed onto the optical bench (10) between the laser diode (14) and the photodetector (6). The detector is connected to the junction box (7) where the photocurrent is converted into a voltage and measured by the provided multimeter (3).

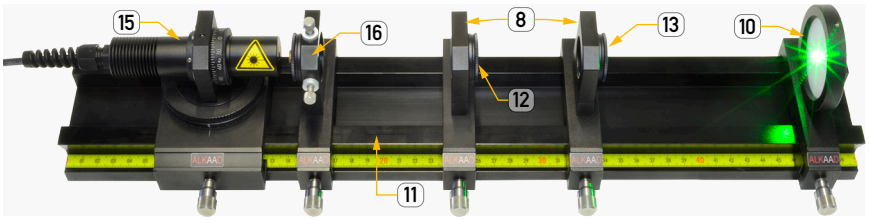


Fig. 2.29: Setup for beam collimation and shaping

The goal of this experiment is to transform the elliptical beam of the green emitting laser diode into the most perfect round shaped beam. This can be done either by just the two cylindrical lenses (12 and 13) or by the combination of the collimator (16) and the two lenses. The result can be seen on the translucent white screen. The image on the rear side can be photographed by any simple digital camera. The strategy can be either trial and error or educated guessing. In both cases, it is an exciting experience!

LE-0400 Diode laser Characterization consisting of:

Item	*Code*	*Qty.*	*Description*	*Details page*
1	CA-0060	1	Infrared display card 0.8 -1.4 µm	127 (10)
2	CA-0080	1	Optics cleaning set	127 (12)
3	CA-0220	1	Multimeter 3 1/2 digits	129 (21)
4	CA-0410	1	BNC - banana adapter cable, 1m	130 (27)
5	DC-0040	1	Diode laser controller MK1	121 (4)
6	DC-0120	1	Si-PIN Photodetector, BPX61 with connection leads	124 (21)
7	DC-0380	1	Photodetector Junction Box ZB1	125 (30)
8	MM-0020	3	Mounting plate C25 on carrier MG20	93 (1)
9	MM-0100	1	Target Cross in C25 Mount	94 (9)
10	MM-0110	1	Translucent screen on carrier MG20	94 (10)
11	MP-0150	1	Optical Bench MG-65, 500 mm	93 (8)
12	OC-0220	1	Cylindrical lens f = 20 mm in C25 mount	100 (14)
13	OC-0280	1	Cylindrical lens f=80 mm in C25 mount	100 (15)
14	OM-0400	1	Rotary Polariser / Analyser 360° on Carrier 20 mm	112 (15)
15	OM-0510	1	Diode laser head in twofold rotary mount	113 (21)
16	OM-0620	1	Collimating optics on carrier MG20	114 (30)
17	UM-LE04	1	Manual diode laser	
	Option (order separately)			
18	CA-0200	1	Oscilloscope 100 MHz digital, two channel	128 (19)
19	CA-0270	1	Fibre coupled spectrometer 200 - 1200 nm, USB	129 (26)

Highlights

Basic and advanced level ★★ experiments

Outstanding features like visible green laser diode:

- ★★ Diode laser emission
- ★★ Polarisation
- ★★ Emission spectrum
- ★★ Beam shaping

Intended institutions and users:

- Physics Laboratory
- Engineering department
- Electronic department
- Biophotonics department
- Physics education in Medicine