Rio planex laser diode characterisation

The laser diode is set up like described in the other wiki articles concerning it:

- Laserdiode
- Laserdiode Mount
- Laser driver
- Pin assignment/Cables
- Temperature Controller
- Laser Housing

This characterisation is at many points compared to a

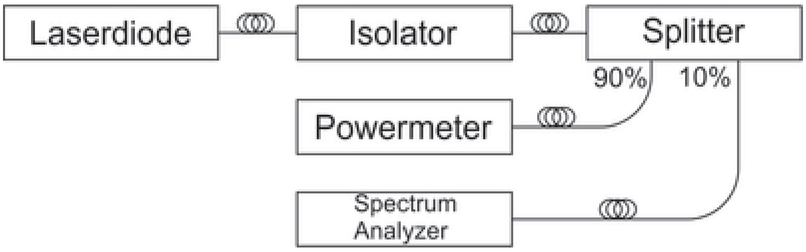
report
by rio on the factory test of the diode. The graphs taken from the factory test report use thick blue lines, the others use fine black dots.

Characterisation overview

<fc #ff0000>characterisation.pdf</fc>

Measurement setup

The Measurement setup is as shown in the picture below:



These are the components used:

- **Isolator:** NoTail Isolator, model NISO-D-15-PP2-FC/APC
- **Splitter:** Thorlabs PN1550R2A1
- **Powermeter:** Thorlabs PM100AT
- **Spectrum Analyser:** ADVANTEST Q8384 Optical Spectrum Analyser

Characterisation of measurement setup

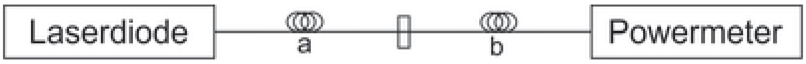
Measurements

Laser driver display: 35 mA, Temperature of laser diode stabilised to 17.5°C ± 0.5mK

A

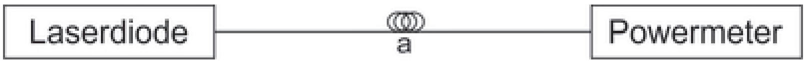
Measured Power: 1.27 mW

B



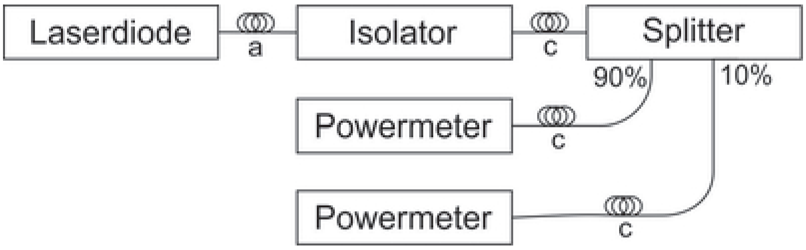
Measured Power: 1.67 mW

C



Measured Power: 1.70 mW

D



Measured Power:
at 90% of splitter: 1.070 mW
at 10% of splitter: 0.1279 mW

Results

Component	Efficiency
Fiber b	0.982
Isolator	0.760
90% of Splitter	0.828
10% of Splitter	0.0989

The Measurements were evaluated using mathematica:

Mathematica File

Spectrum

Direct Comparison

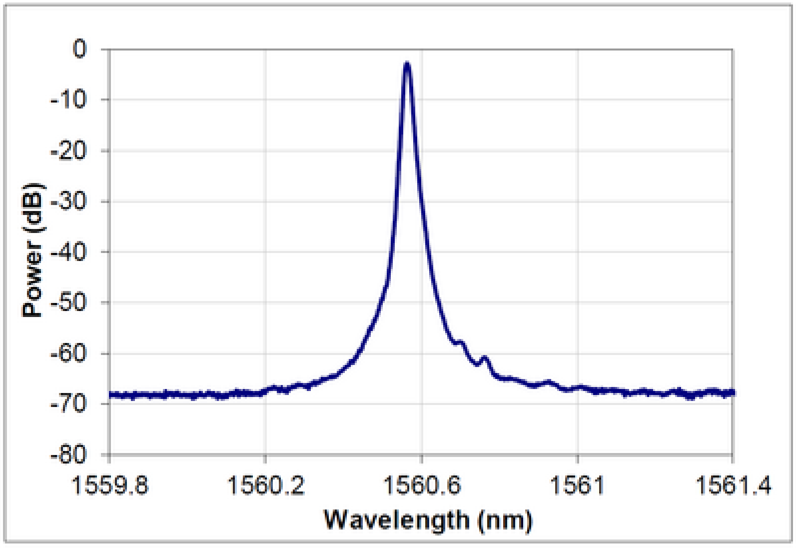
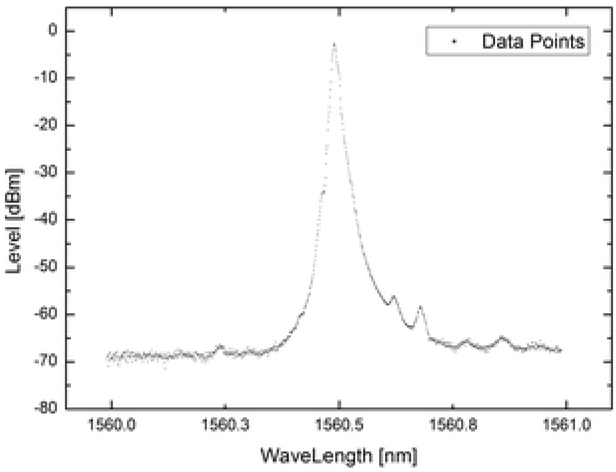
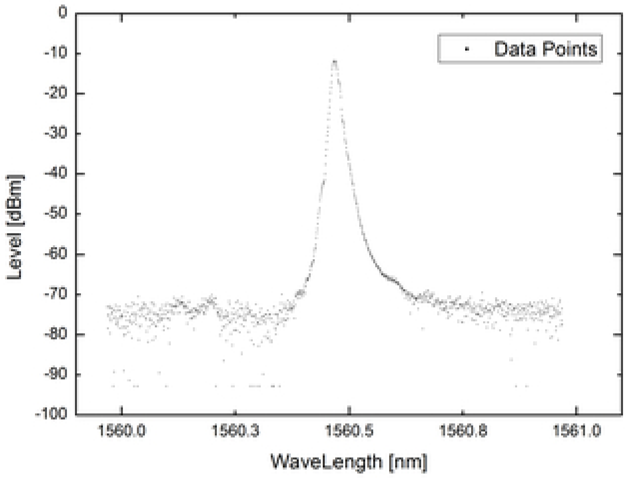


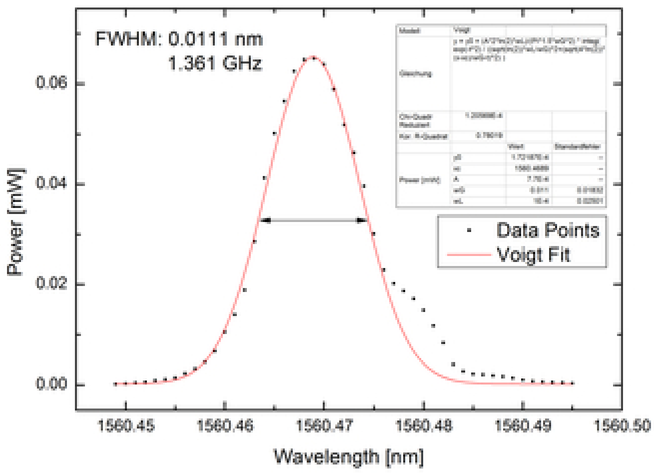
Fig.4: Spectrum (CW, Tset, Ibias)



Test report (Left): 124mA, 17.5°C
Characterisation (Right): 123.5mA, 17.5°C

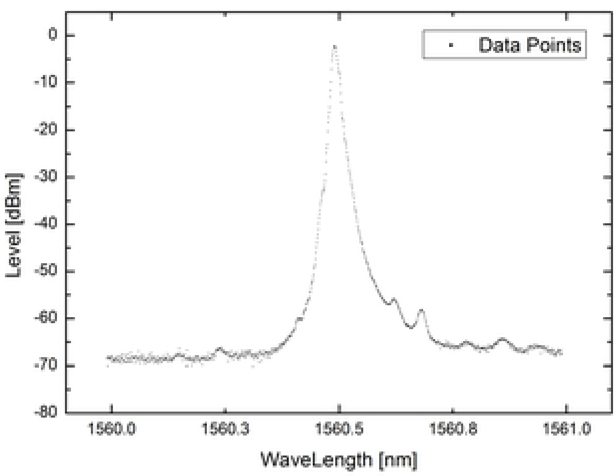
Further Data

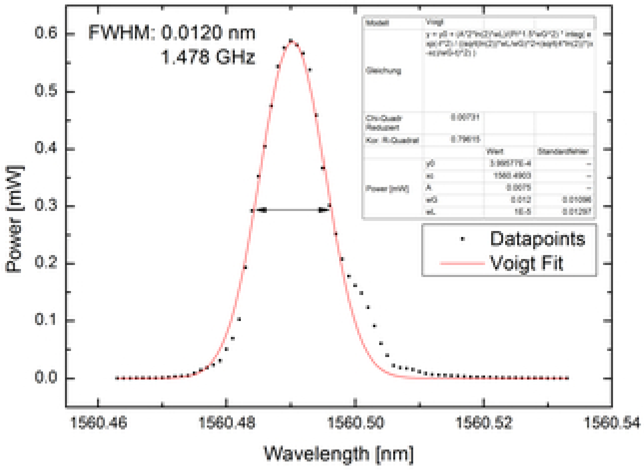




Measured at 40.5 mA, 17.5°C. Raw Data:

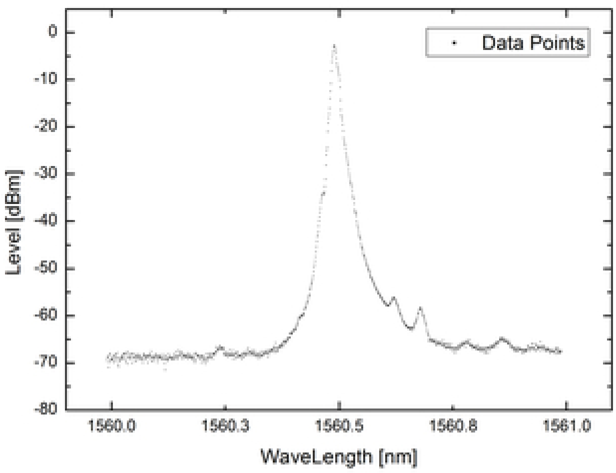
CSV-File

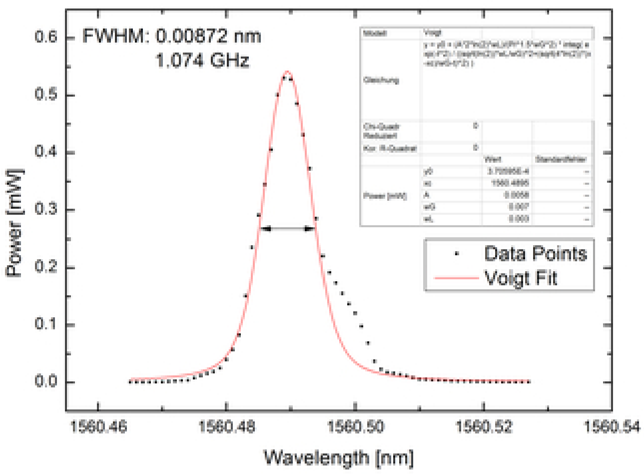




Measured at 119.7 mA, 17.5°C. Raw Data:

CSV-File





Measured at 123.5 mA, 17.5°C. Raw Data:

CSV-File

FWHM calculated using this script:

Mathematica file

Results

The spectrum of a laser under ideal circumstances is described by a lorentzian. As the center frequency of a laser isn't stable, it shifts many times during the measurement of a spectrum. The center frequency underlies a normal distribution, making the graph of the measurement looking more like a gaussian curve. Using a Voigt curve to fit to the measurement accounts for both factors as it is a convolution of a lorentzian and a gaussian.

In all three spectrum measurements above, the gaussian term of the Voigt fit dominates the lorentzian term. This shows that the linewidth (FWHM) in the measurements above is mainly determined by the shift of center frequency, leading to a much higher linewidth than the lorentzian FWHM of 1.3 KHz described in the test report.

Temperature dependency

Meerstetter target temperature changed stepwise, measurement when temperature stabilized to ca. ±0.5mK around target temperature. Current set to 123.5 mA.

Wavelength vs Temperature

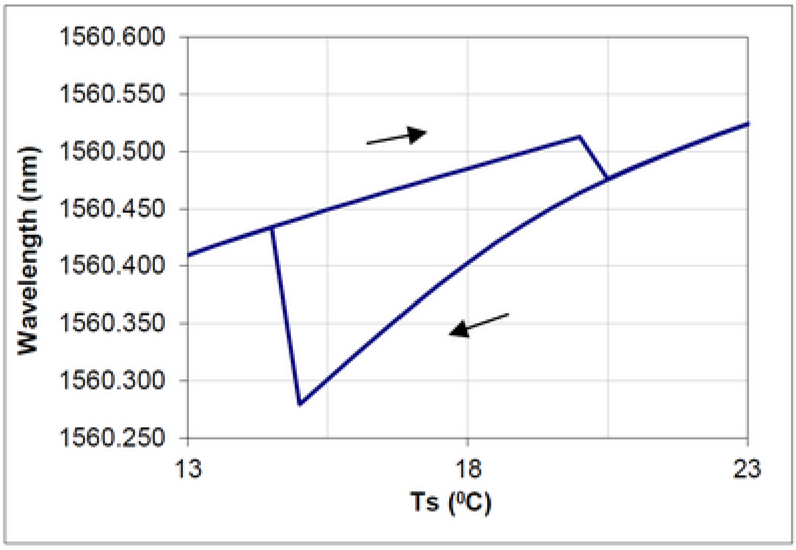
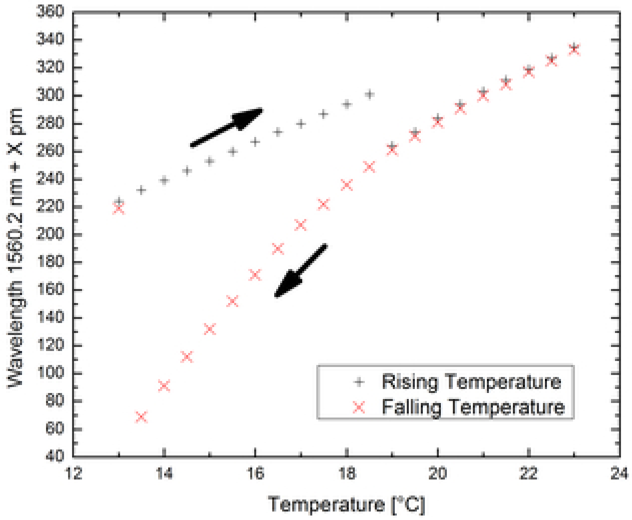


Fig.2: Wavelength vs. Tset at Ibias



Both graphs match up quite well, except for a shift in temperature. It seems as if the characterisation graph is the almost the same as the one from the test protocol but shifted by 1.5°C to the left.

Power vs Temperature

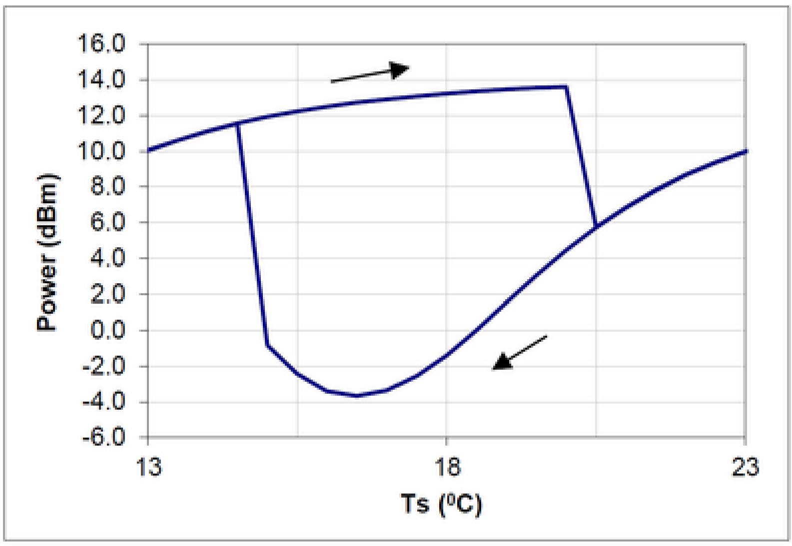
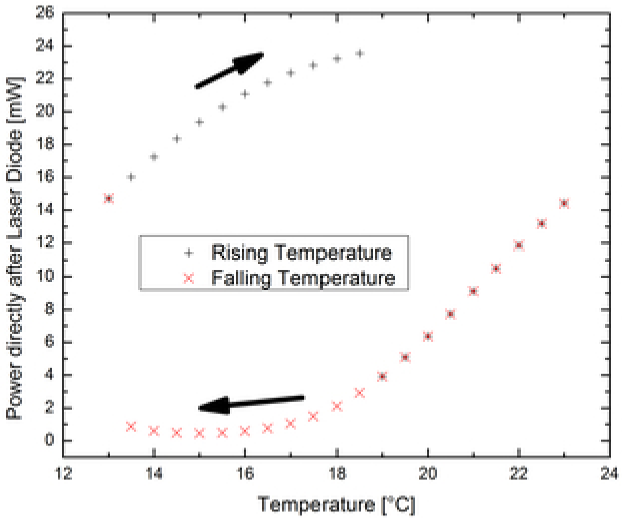


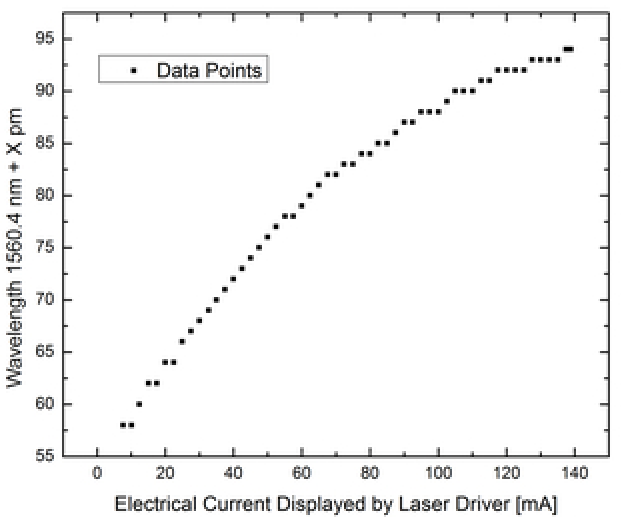
Fig.3: Power vs. Tset at Ibias



Current dependency

Wavelength vs Current

Laser driver display as reference for electrical current. Temperature stabilised to 17.5°C.



Power vs Current

Laser driver display as reference for electrical current, post-corrected using characterisation of laserdriver. Temperature stabilised to 17.5°C.

Comparison

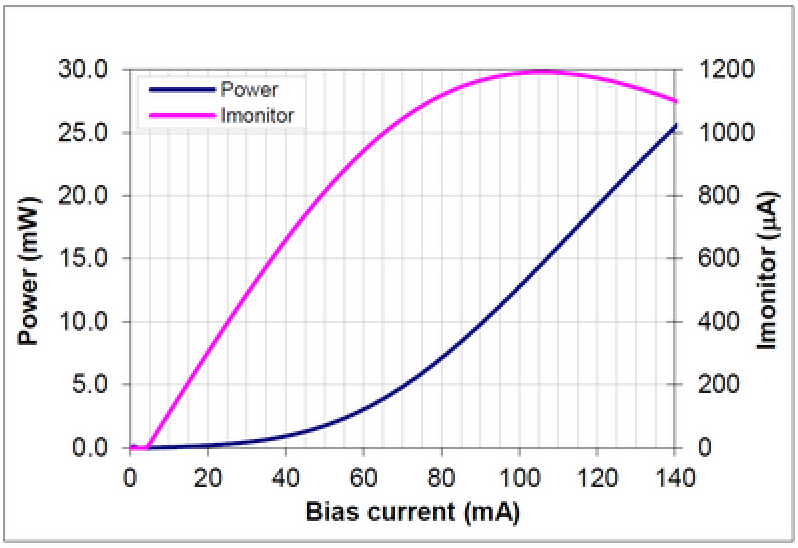
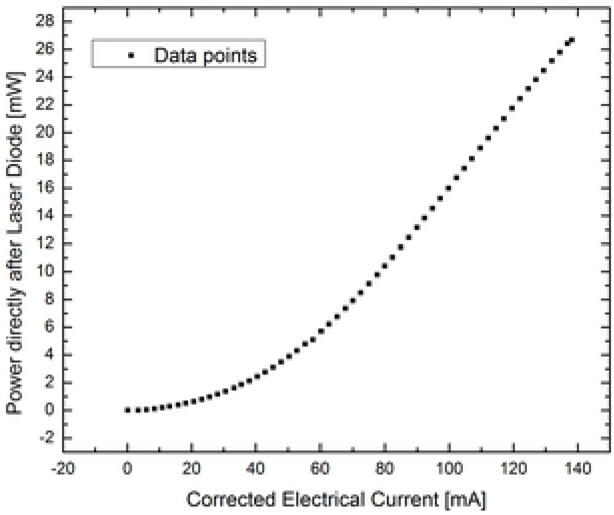
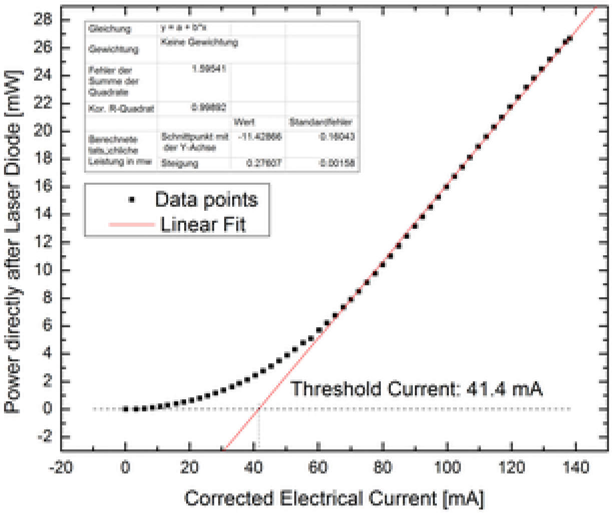


Fig.5: Laser Output Power and Imonitor vs. Bias Current at Tset



Characteristic Curve



The threshold current is 41.4 mA. Below this current the light emitted is mostly through spontaneous emission, above it most of the light is emitted through stimulated emission.

The equation for the linear fit is:

$$P = 0.27607 \, \frac{W}{A} \: I -11.42866 \, mW$$

P: Optical power of the laser, I: Electrical current flowing through the laser

Long term stability

<fc #ff00ff>Bisl Theorie zu Allan-deviation</fc>

Data logging with python

For doing long term data logging, a python script was written. This script automatically logs the power measured by the Thorlabs powermeter and the temperature measured by the Meerstetter temperature controller. These values are logged in a single log file together with the time elapsed in seconds as well as statusses of the connection to the powermeter and the temperature controller, to have a reliable way of telling which values are valid and can be used in the evaluation.

The script is based on scripts by E. Wodey and jfk.

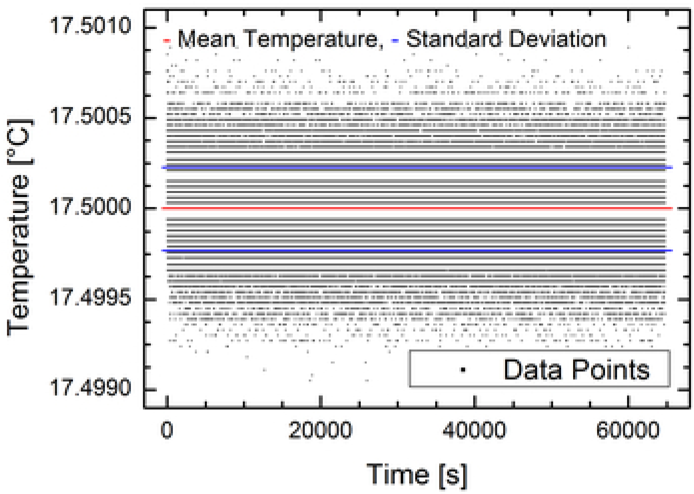
Python scripts:

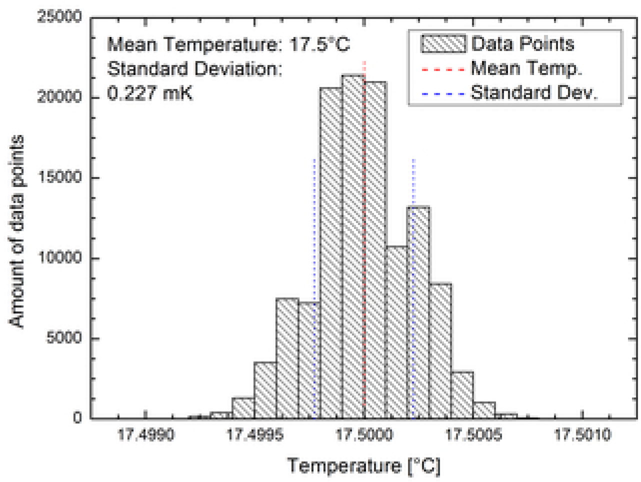
ZIP file

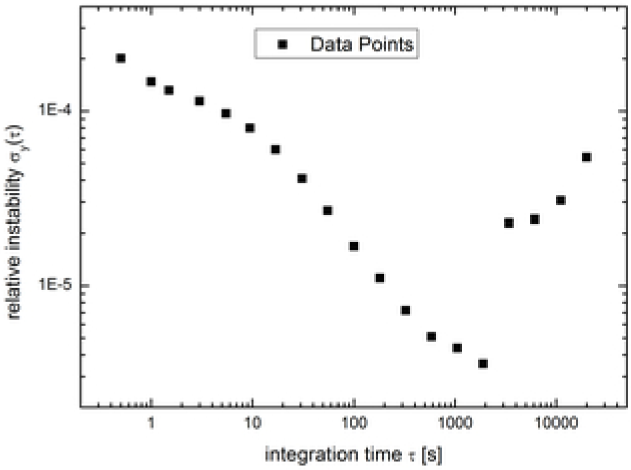
Measurement 1

Current set to 123.5 mA. Meerstetter set to stabilise to 17.5°C

Temperature stability



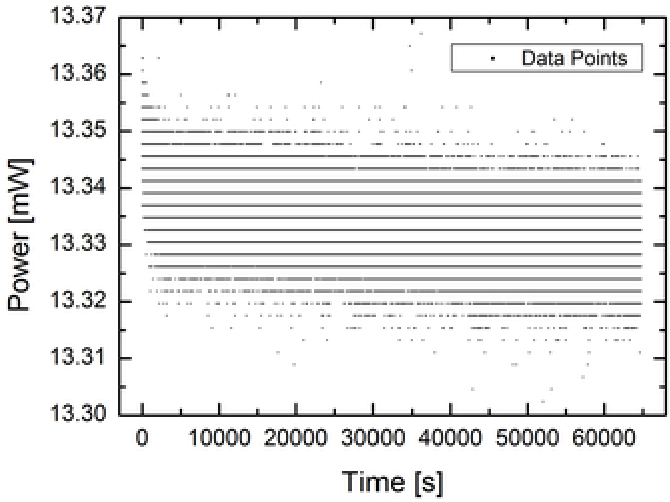


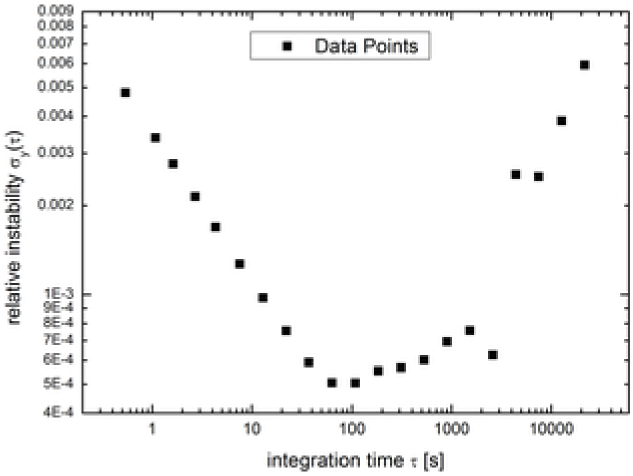


The mean temperature is 17.5°C. The laser diode is stabilised to this temperature with a standard deviation of 0.227 mK. The temperature stabilisation didn't experience any visible drifts. The instability of the temperature is lowest on a timescale of approximately 2000 s with a relative instability of ca. $4 * 10^{-6}$.

The allan deviation was calculated using the AllenLive script. This can be found in the AFS under `AFS\.iqo.uni-hannover\projects\magnesium\Mathematica\allan\Allan-Live 1.2.nb`. The script assumes temporally evenly spaced measurement data. The data used isn't perfectly evenly spaced, its mean time difference is 0.540612s with a standard deviation of 0.0111856. The script was still used as an approximation.

Power stability



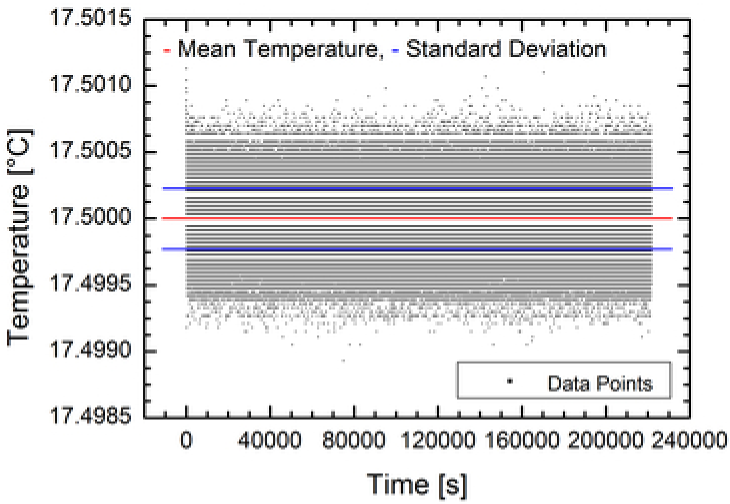


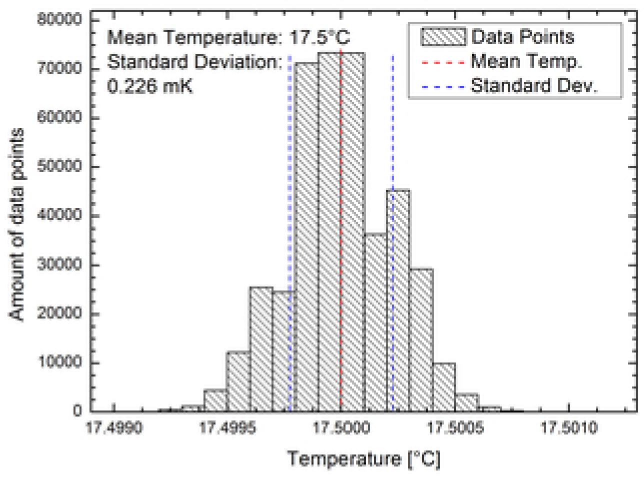
The power experiences a visible drift in the measurement time. The instability of the laser is lowest on a timescale of approximately 100 s with a relative instability of ca. $5 * 10^{-4}$. The allen deviation is calculated as above. The power is measured after isolator and splitter, it is not corrected.

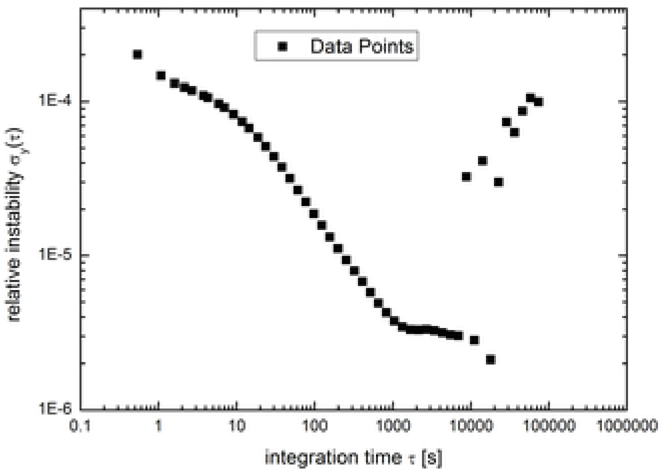
Measurement 2

This measurement was done for a longer period of time than measurement 1. Current set to 123.5 mA. Meerstetter set to stabilise to 17.5°C. The power was measured directly after the isolator, meaning not using the splitter, leading to higher measured powers than in measurement 1.

Temperature stability

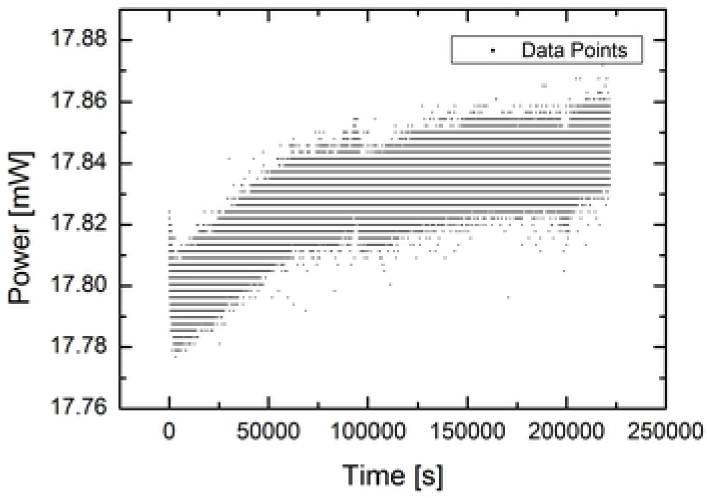


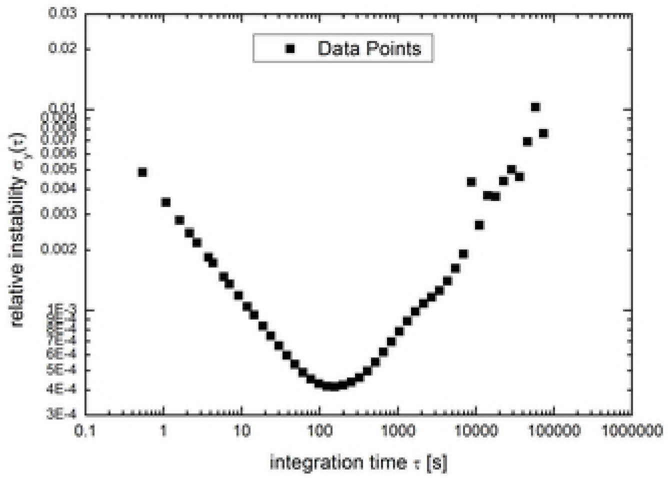




The mean temperature of 17.5°C is the same as in measurement 1. The standard deviation of 0.226mK is very similar to the 0.227mK of the first measurement. Also there was no visible drift on the longer timescale. The allen deviation shows similar results to measurement 1 as well with the lowest relative instability being about $3*10^{-6}$ on the timescale of multiple thousand seconds.

Power stability





The allen deviation shows similar characteristics as for measurement 1. The lowest relative instability is approximately $4.5*10^{-4}$ for a timescale of about 100s. The power seems to underly noise on a short timescale, dominated by a drift on the larger timescale. This drift seems to be rather random comparing the graphs plotting power vs time of measurement 1 and 2.