Update Log:

2017-11-05: Link to note " IF-Laser frequency modulation measurement with Michelson interferometer"
2017-10-17: section 1.5 added
2017-08-24: Link to note and hint to: Diode laser controller racks for Thorlabs controllers
2015-12-15: Link to note „Interference filter lasers by Andreas Jöckel (Basel)"
2014-01-27: Link to note "More output power with interference filter laser by Tobias Kampschulte" added.
Version 1.7 2013-06-13: added a picture of the mirror glued to the piezo, added a remark regarding the IF screw
Version 1.6 2013-05-27: added reference to datasheets, beam profile measurement
Version 1.5 2013-05-16: hints on collimation, filter alignment and AD590-shielding
Version 1.4 2013-02-02: internal PCB board
Version 1.3 2012-06-31: image of cable feedtrough, warning regarding the direct current modulation
Version 1.2 2012-06-08: changed interlock resistor (1kΩ -> 330Ω), added notes for peltier elements, piezo holder, and current filter
Version 1.1 2012-07-04: fixed minor errors + added additional pictures
Version 1.0 2012-07-03: uploaded the initial Version

WARNING: this manual is only a beta version. There might be things missing or simply wrong. If you spot something which you want to be changed please contact me (Carsten Robens, Robens@iap.uni-bonn.de) before changing the Evernote.

pdf-Version:

IFL_Manual.pdf
7.8 MB

The Interference Filter stabilized Laser (IFL)

The following manual is divided in sections:

---

1) Interference Laser Overview

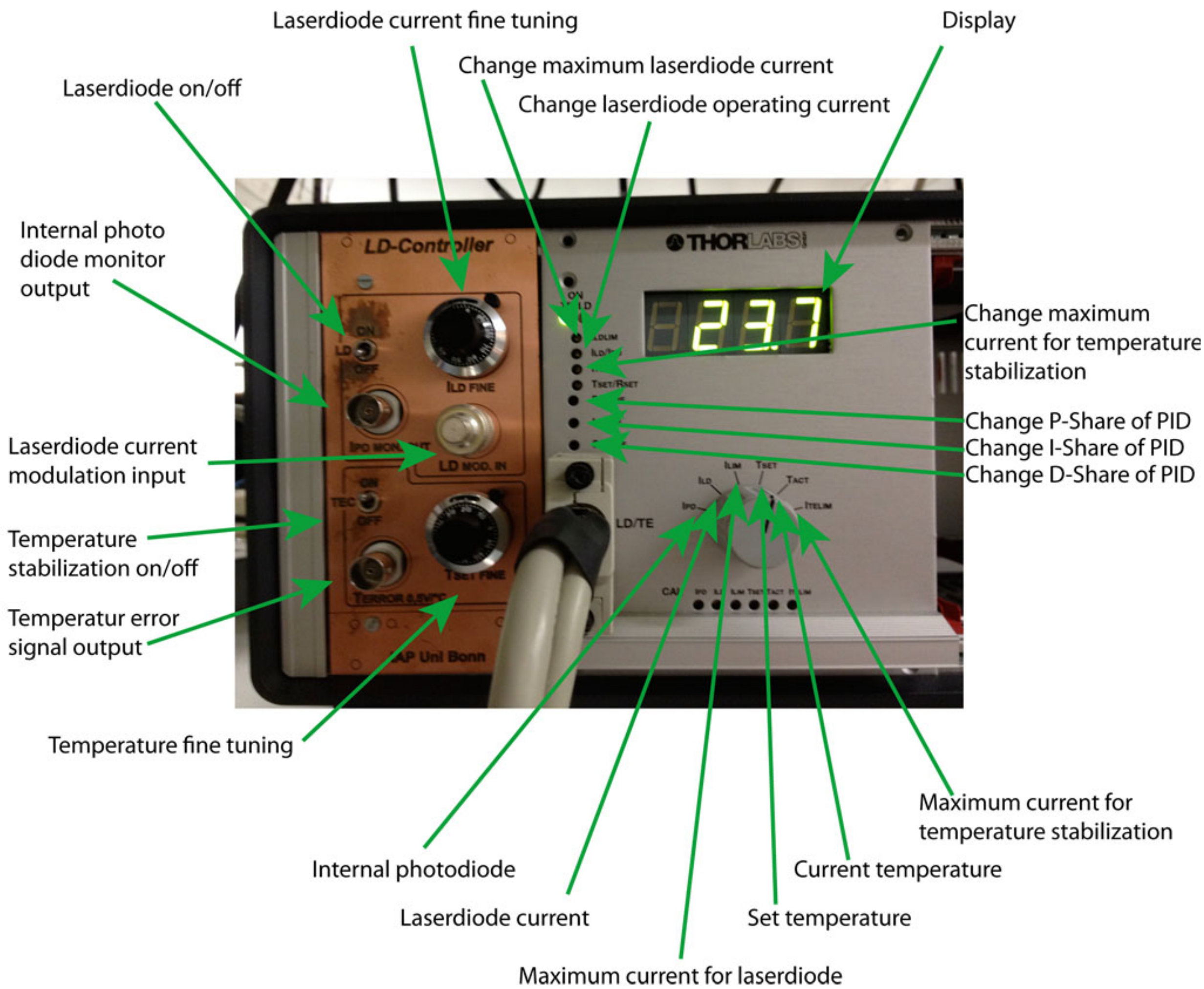
1.1 Laser Specifications

Specification	Value
Wavelength Interference Filter Lorentzian width	0.39 nm
Angular Interference Filter Lorentzian width	0.72 °
Laser-Threshold	11.3 mA
Laser-Power Gain	0.7 W/A
Modejump free Current Tuning Range	40.0 GHz
Current Tuning Slope	-1.1 +/- 0.1 GHz/mA
Current Tuning Hysteresis	≈ 2.7 mA
Modejump free Temperature Tuning Range	41.7+/- 1.3 GHz
Temperature Tuning Slope	-22.2 +/- 0.6 GHz/K
Global Temperature Slope	-3.4 +/- 0.2 GHz/K
Filter Tuning Range	[845.5 nm … 853,5 nm]
Power Fluctuation (through Filter Tuning Range)	≈ 15%

1.2 Thorlabs Lasercontroller

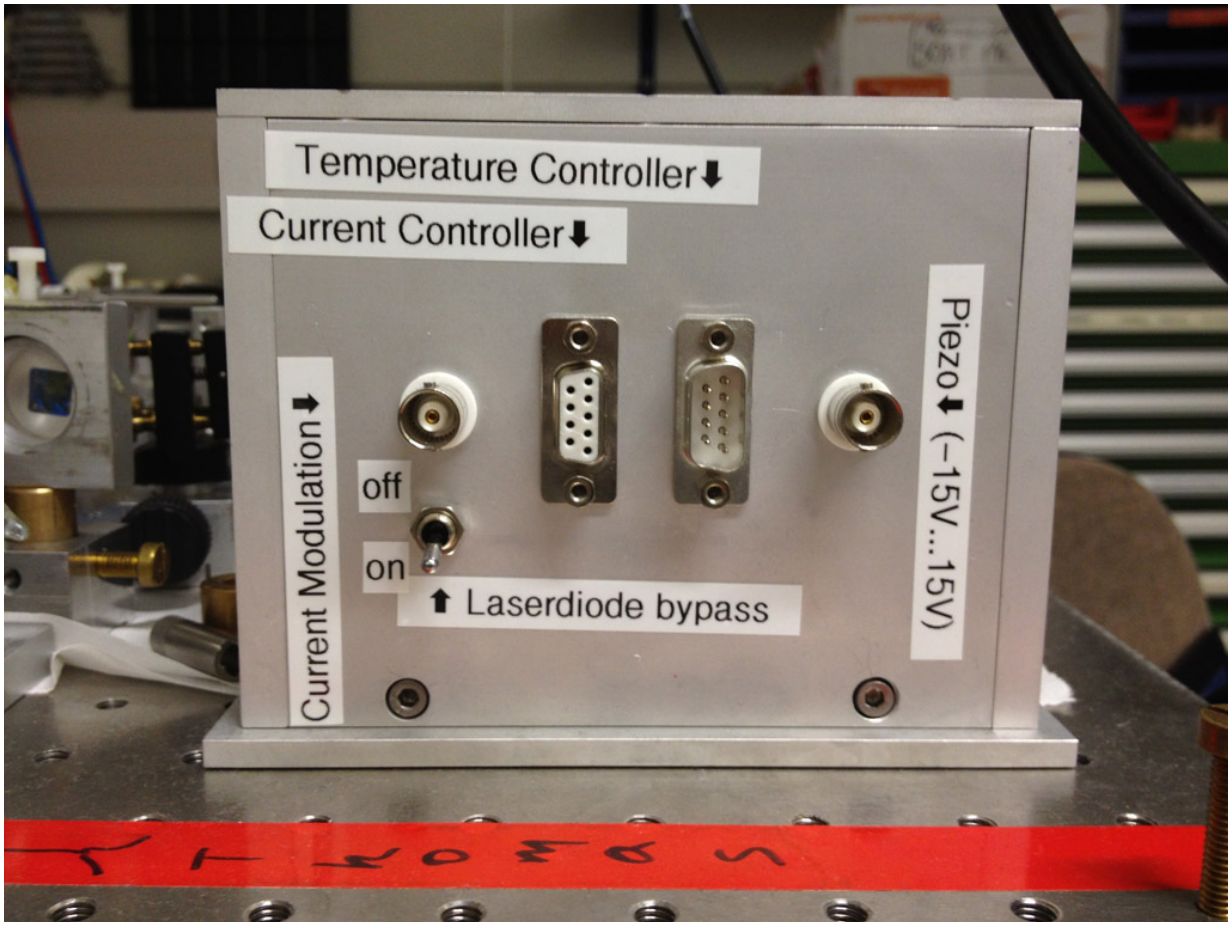
The following picture explains the functions of the thorlabs lasercontroller

Note: make sure the temperature Controller has been adopted: see: Diode laser controller racks for Thorlabs controllers



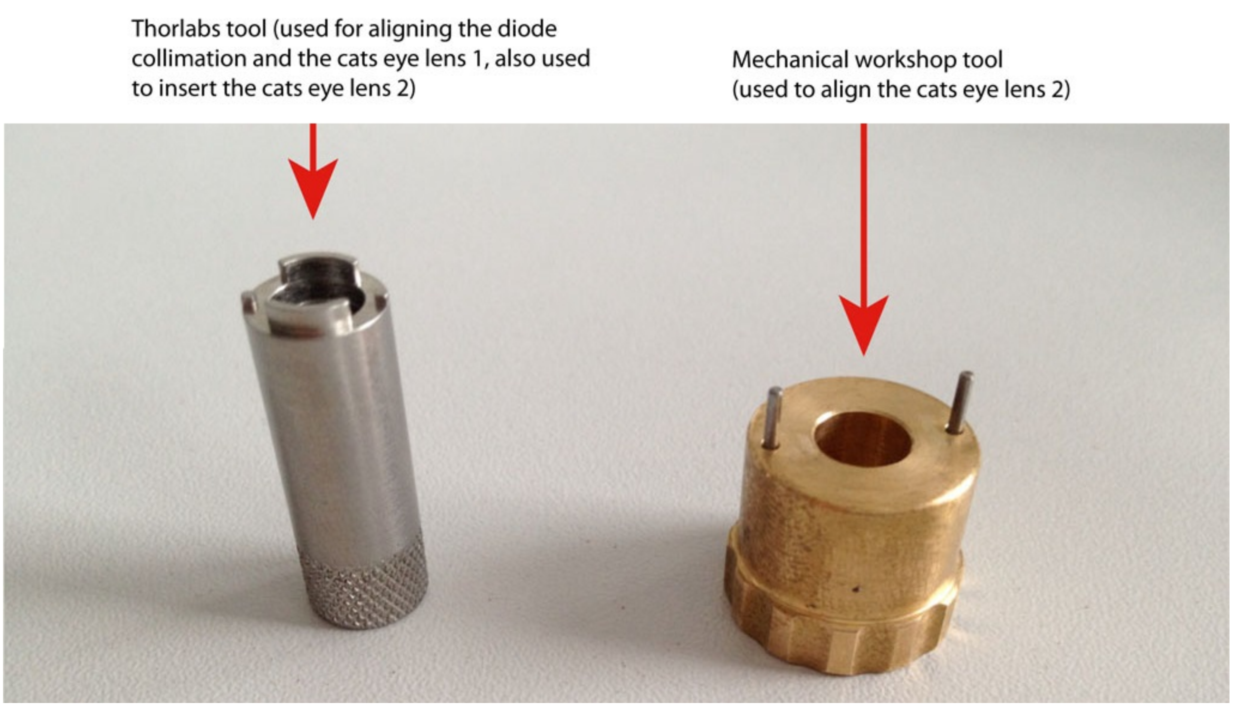
1.3 Rear-panel of the finished IFL

The following picture shows the rear-panel of a finished IFL. Please make sure to place the connectors in the same order when assembling the laser.



1.4 Thorlabs and Mechanical Workshop Tool

The following picture shows the two lens aligning tools which can be used to adjust the lenses while the laser is running.



1.5 Connecting to the Controller Rack

We are using a home-build controller rack featuring an OEM-laser-controller from Thorlabs Diode laser controller racks for Thorlabs controllers

Manual: Thorlabs ITC1xx laser diode c... 2.2 MB

Before you start, make sure you set all internal switches correctly.

Every Thorlabs controller should be modified by the electronics workshop as follows (to be sure please check)

- add an intefration capacitor of 220 µF (**bipolar** electrolytic) according to the manual p. 43
- set jumper TEC window off according to the manual p. 18
- set jumper Bias+ and Bias- disconnect according to the manual p. 18
- put the switch for constant current (CC) / constant power (CP) to constant current (CC) according to the manual p. 17
- set the decimal point of the LED display module correctly according to the manual p. 46
- calibrate the display of T_SET and T_ACT according to the manual p. 51

You (the user) have to perform the following settings:

- set the switch for the temperatue sensor (AD590/thermistor) according to the manual p. 18
- set the polarity of the laser diode according to the manual p. 17
- adjust the PID parameters of the temperature control, e.g. according to the manual p. 42
- check that the switch for the TEC integrator is on according to the manual p. 17

Note [User]:

- When turning the temperature-control on, make sure you do not exceed the current limitation of your power supply (limit TEC-current). This is of special importance, if you turn on both controllers in a Rack simultaniously.
- When turning on the temperature stabilization, keep in mind, that the capacitor of the I-share is likely to be loaded. This can lead to a very large initial response. In this case you can limit the current and wait or wait only. The settling time can easily exceed half an hour. (Time for coffee)

---

2) Laser Ingredients

Note: Many components can be found in a stock of Components in the DQSIM-Lab. Further Information can be found here: IFL Components Inventory

- Mechanics
  - Inner housing
  - Outer housing
  - a lot of different metal screws (M6, M4)
  - 4x M6 Nylon screw, approx. 20 mm long (thread)
- Laserdiode
  - 852nm uncoated 5420 Series JDSU
  - laser diode connector: Thorlabs S7060R
- Optics
  - Collimator tube (f=4.5mm)
  - Cats eye lens 1 (f=18.40mm; diameter=9.24mm)
  - Cats eye lens 2 (f=13.8Ca6mm; diameter=9.24mm)
  - Outcoupler mirror (R=30% @852nm, R=18% @770nm) (2014-01-27: see also More output power with interference filter laser by Tobias Kampschulte)
  - Interference filter (witdh_lorentz = 0.4nm @852 and 6°)
- Mounts
  - Mirror mount
    - MINI-H-U-3-3030 from Radiant Dyes
- Elektronics
  - Piezo
    - 14x HPSt150/14-10/12 from Piezomechanik
- Temperature Sensor
    - AD590
    - NTC 10K 3625K
- Standard Peltier-Element 12705 (L x B x H) 40 x 40 x 4 mm Nennspannung 15.4 V Wärme Leistung (max.) 41 W
- wires
- 1x DSUB9 male connector
- 1x DSUB9 female connector [old]
- 2x shielded BNC connector
- 1x switch
- 1x interlock resistor (330Ω) [old]
- 5mm LED (green) [new]
- 1x special circuit board [new]
- 1x DSUB9 female connector, 90° offset for board mounting [new]
- 1x interlock resistor (1kΩ) [new]
- 1x 100nF capacitor [new]
- 1x 470µF capacitor [new]
- 1x 100µH coil [new]
- header plugs [new]
- jumper [new]
- for FET current modulation (optional) [new]

- 2x diode
- 1x BF245

- for capacitive current modulation (optional) [new]
    - 1x 50Ω resistor
    - 1x capacitor (depends on your exact application)
- Other
    - thermal heatsink paste
    - thermal heatsink glue
    - 2 component glue
- Current Filter (optional) [old]
    - 1x DSUB-9 male circuit board connector
    - 1x DSUB-9 female circuit board connector
    - circuit board
    - 1x 100 nF capacitor
    - 1x 470 μF capacitor
    - 1x 100 μH coil
-

3) Cooking the laser

3.1 Pre-Assembly and Warnings

- Before starting with the assembly make sure that all mechanical components (inner housing, outer housing, and possibly the scows for the inner part) are cleaned in an ultrasonic bath.

- Make sure to always ground yourself when working with or close to the laserdiode.

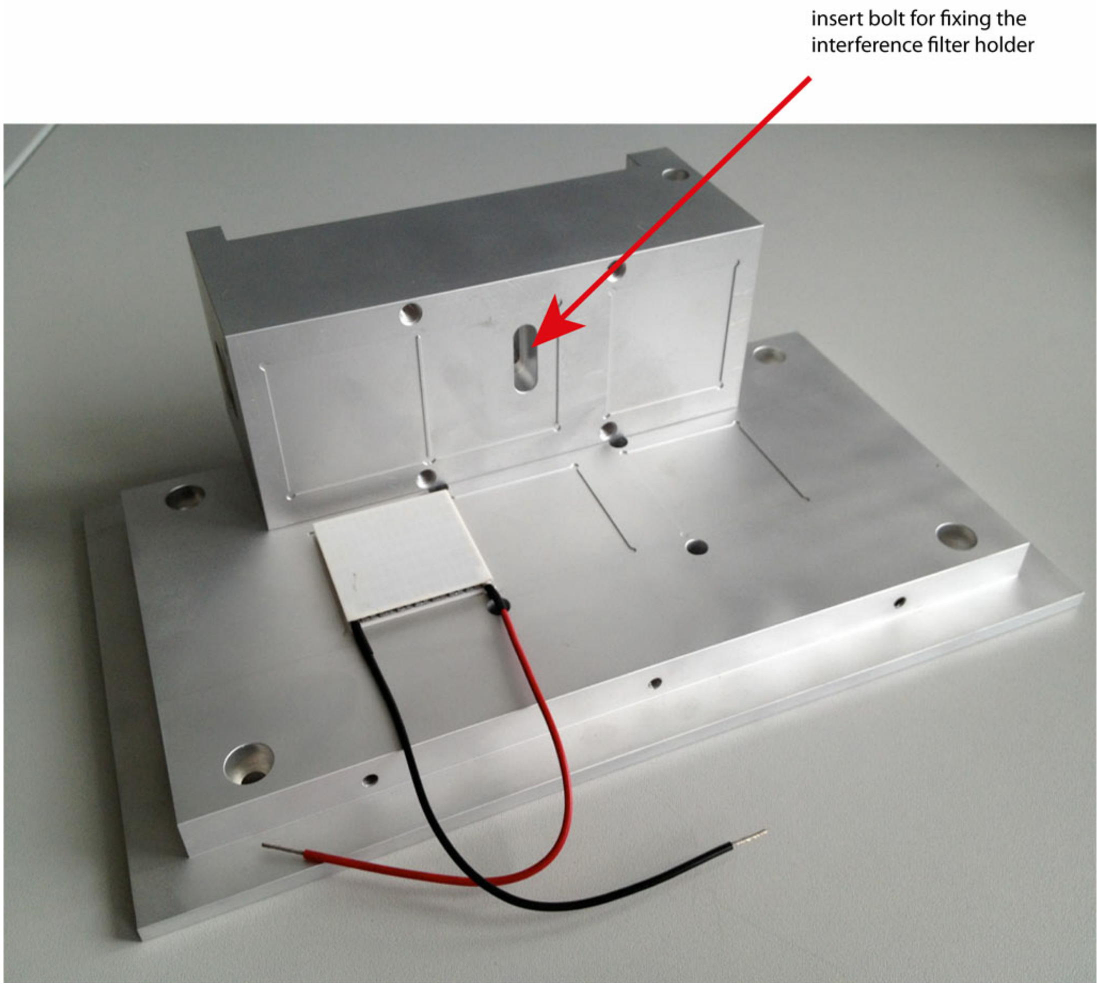
- Make sure the interference filter is as clean as possible before you insert it. Small dust grains can have huge effects on the transmitted power.

3.2 Mechanical and Electrical Assembly

The file IFL_MechanicalSetup_MrLangen.pdf shows a 3D sketch of the IFL (which can be found at the end of this note). In the following text passage I will describe as good as possible how to assemble the laser.

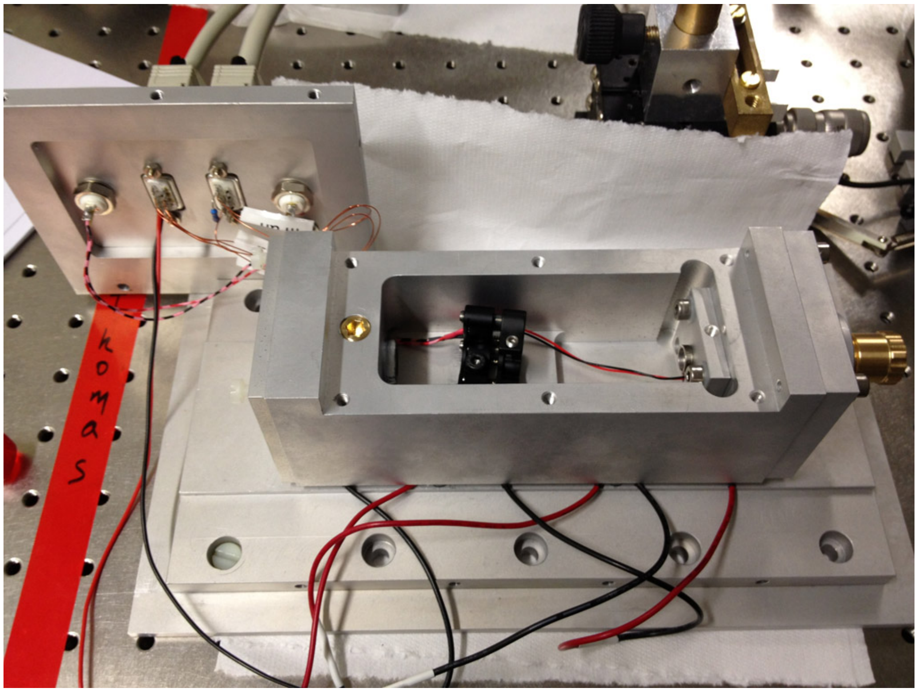
3.2.1 Peltier Elements and Temperatur Sensors
Once all mechanical parts are cleaned connect the three Peltier elements in series, then spread thermal heatsink paste on the according positions of the ground plate of the outer housing. Place the connected Peltier elements on the heatsink paste and apply another thin and even film of thermal heatsink paste on top of the Peltier-elements. The Inner housing rests on top of the heatsink paste. Due to the grinding it is possible to easily place the inner housing in the correct place. Subsequently the ground plate and the inner housing are connected by **nylon** screws. The nylon screws ensure the thermal isolation of the inner and outer housing. **Important**: make sure to place the bolt nut in the hole at the bottom of the inner housing. This bolt nut will later be used to fix the holder of the interference filter.

The following picture shows the grinding of the inner and outer housing and how to place the Peltier-elements. It also shows where the bolt nut has to be inserted.

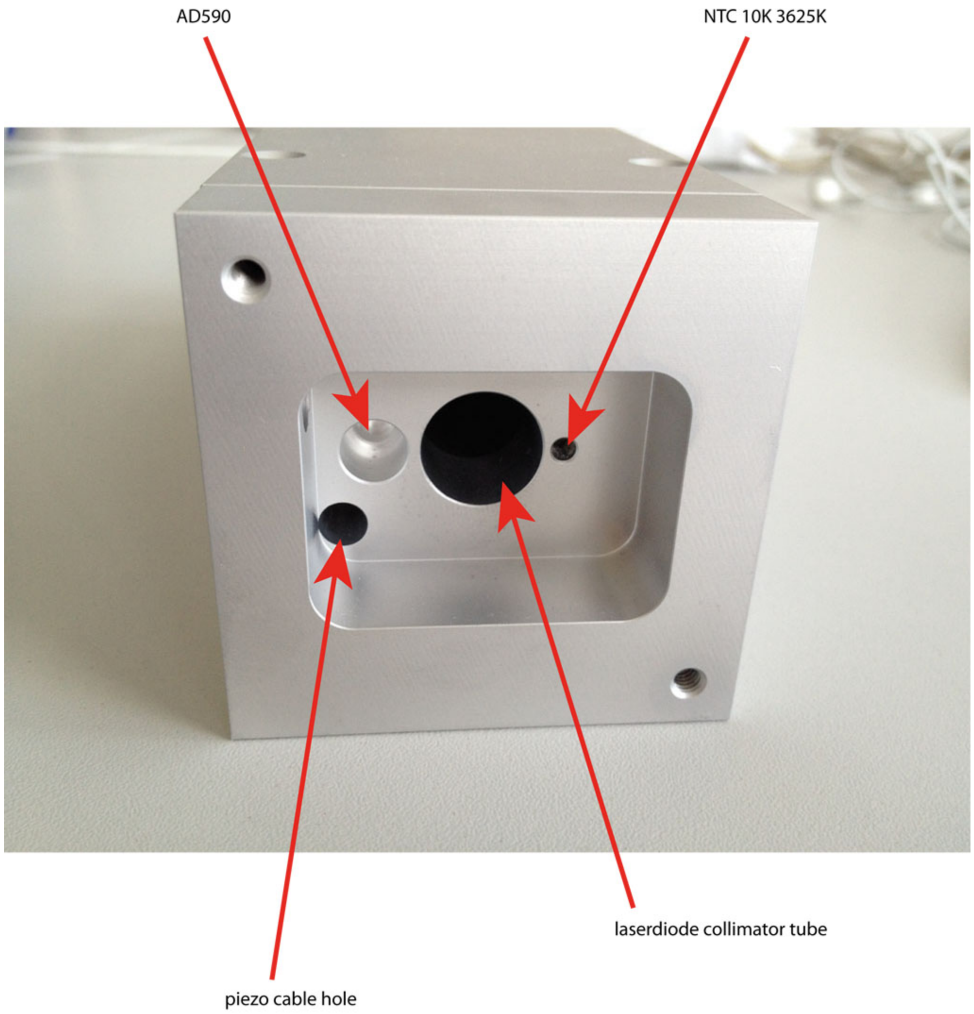


The following picture shows how the finished version with all Peltier-elements should look like (Your inner part will of course not look like this at this stage).

Note: Make sure to always connect adjacent cables in the scheme presented below. This means all Peltiers-elements should be placed in the same way (all black cables right, or all black cables left). The next step is to connect adjacent cables (always one black with one red cable) and finally to solder the outermost cables to the outgoing connector. Only if the peltier elements are placed exactly in the same way/direction as in the picture, the pin connections will match. If you place them the other way around it also works but the "hot side" and "cold side" have to be inverted so the connection polarity should be the opposite (invert the pin connections).
So: Make sure that all lasers heat/cool in the same way!



Next up is the assembly of the two temperature sensors (AD590 and NTC 10K 3625K). Connect both sensors with wires that are long enough to be connected to the DSUB-9 Connectors. Both sensors are glued in with thermal heatsink glue. The sensors are positioned in the inner housing left and right of the hole for the collimator tube. It should be clear that the AD590 only fits in the bigger hole. While gluing the sensors it is important to ensure that enough glue is inside the hole so, that the glue fully connects the housing and the sensor. However, please do not use an unnecessary amount of glue. Using a tooth pick the sensors can be easily pushed to the end of the hole.



Remark concerning the AD590

If you want to phase-modulate the current of your laser diode to imprint sidebands onto the laser output spectrum this is something you should know: The AD590 is very sensitive to RF-signals. First the RF-signal (-5 dBm might be enough) adds some rms-noise to the AD590 output signal and second the AD590 rectifies the RF signal leading to a significant change in the measured tempereature (up to 10°C, typically the measured temperature gets lower the higher the amplitude of the applied RF-signal is). To get rid of the problem the pins of the AD590 have to be shortcuted and thereby shielded in the RF domain. You do this by using capacitors. But be careful: a capacitor also always has some inductance. This inductance will isolate the pins of the AD590, which is exactly the opposite of what you want. So one needs a high capacity but a low inductance. As a rule of thumb 1 cm wire gives you about 10 nH inductance: so keep your wires short. In the end you want to keep the RF-resistance between the AD590 pins as low as possible:

$$R_\Sigma = R_C + R_L = \frac{1}{\omega C} + \omega L \quad \text{should be minimized}$$

$$\rightarrow \frac{dR_\Sigma}{d\omega} = -\frac{1}{C\omega^2} + L \stackrel{!}{=} 0$$

$$\rightarrow C = \frac{1}{\omega^2 L} \underset{\frac{\omega}{2\pi} = 50\,\text{MHz}}{=} 10\,\text{nF} \quad \text{with } L = 1\,\text{nH}$$

The rough calculation above is done for a current modulation at 50 MHz, assuming that there is an inductance of about 1 nH. So for 50 MHz modulation frequency one needs 10 nF capacitors. The last thing to remind you again is to keep the wires short. Here you can use SMD-capacitors (ask the electronics workshop) and solder them as close to the AD590 as possible. A possible result could look like this:

2 pictures of the AD590 with 3 soldered 10 nF SMD capacitors

Finally the wires from the Peltier-elements and the sensor wires will be connected to the DSUB-9 male connector, which is placed on the right (looking from the rear-side) of the laser (see image in the beginning of this manual). (TIP: for soldering the cables to the connectors it is very useful to screw the back plate with all connectors to the ground plate, as shown in the image above) The pin layout for the thorlabs laser-controller is according to table 1. Connect the Peltier-elements to TEC +/-, the AD590 to AD590 +/-, and the NTC 10K 3625K to Thermistor /GND.

table 1: pin layout

WARNING: the male and female is regarding the plug and not the connector on the laser!

15 pin male conn. Pin	Assignment Thorlabs controller	9 pin male conn. pin	Assignment Toptica current controller	9-pin female conn. pin	Assignment Toptica temperature controller
1	Interlock (<430 Ω to Interlock GND)	1	LED "LD on" (recommended: 1k Ω **in series with LED** to LED GND)		
2	Monitor diode cathode in	2	OK (same)		
3	Laser diode ground	3	OK (same)		
4	Monitor diode anode in	4	OK (same)		
5	Interlock GND	5	LED GND		
6	AD590 +			9	OK (same)
7	TEC +			4	OK (same)
8	TEC - (GND)			5	OK (same)
9	Bias - out (should be disabled by JP2)	6	Laser diode voltage sense GND		
10	Laser diode cathode out (polarity AG)	7	OK (same)		
11	Laser diode anode out (polarity CG)	8	OK (same)		
12	Bias + out (should be disabled by JP1)	9	Laser diode voltage sense		
13	AD590 -			7	OK (same)
14	Thermistor			3	OK (same)

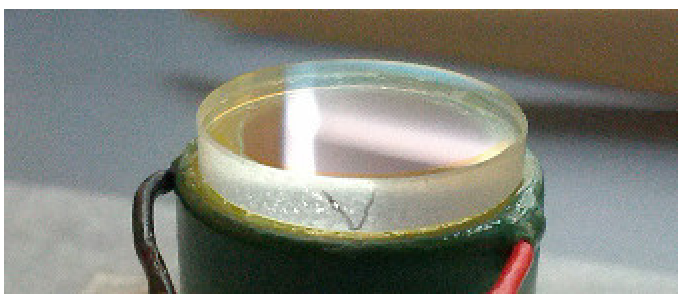
	GND				
15	Thermistor			2	OK (same)

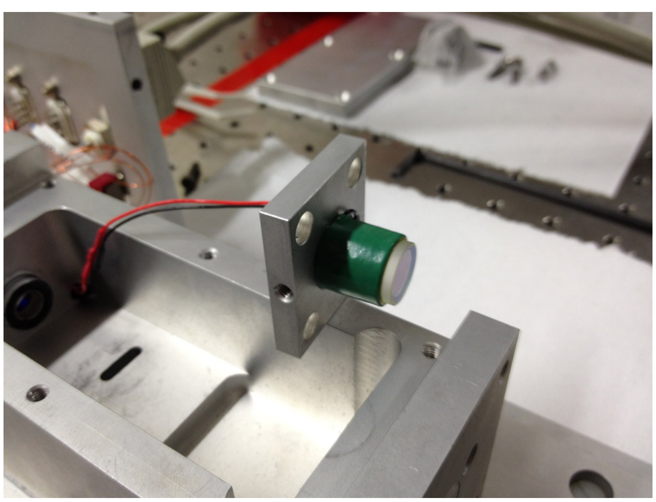
If everything is assembled correctly one can test the temperature controller. You can select either the AD590 or the NTC 10K 3625K as temperature sensor, for more information have a look at page 18 of the thorlabs manual. Usually it is more convenient to use the AD590 as it displays the temperature in °C.

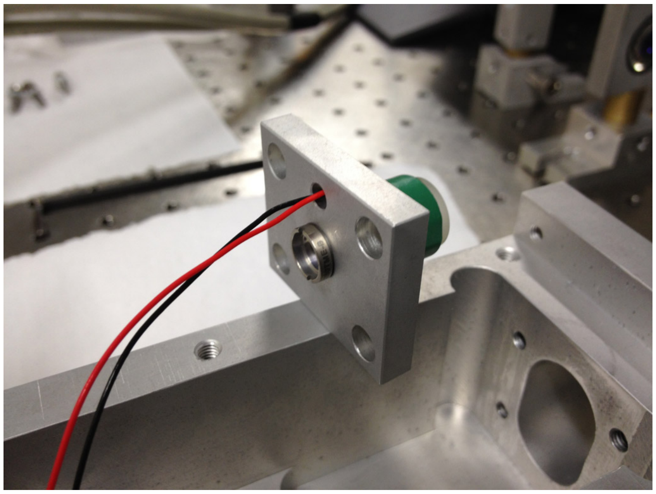
3.2.2 Piezo/Outcoupler Holder

The next step is the assembly of the piezo/outcoupler holder. We use regular two component glue to glue everything together. The following two images illustrate the finished result. Start of by gluing the piezo with a thin film of glue on the aluminum plate. It might be useful to feed the piezo cables trough the hole at the bottom before gluing. Make sure to put mild pressure on the piezo while the glue is hardening to circumvent any misplacement. Once the glue is hardened the outcoupler is glued on the piezo. Make sure the reflective side is facing the piezo before gluing. The mirror has a small arrow the side which is facing towards the reflective side, if you are not sure which side is which please contact me. Once you are sure apply a thin film of glue on the piezo and place the mirror on top. To connect the piezo to the right BNC connector (from the rear-side) the cables have to be connected to longer cables. Make sure to feed the cables trough the appropriate holes before soldering them to the BNC connector. At last "Cats eye lens 1" (f=18.40mm; diameter=9.24mm) is inserted (as shown in the second picture) using the Thorlabs tool.

Note: Be careful when gluing the piezo. The picture shows the old version of the holder with 4 instead of 2 holes. Make sure that the piezo is glued on the correct side, meaning that the screw hole on the side of the holder is facing to to top when the holder is inserted. The following picture shows the screw hole, although in this picture it faces sideways.







3.2.3 Interference Filter

Make sure the interference filter is as clean as possible. Using the normal 2 component glue, the filter is glued in the small aluminum ring. It has been proven to be useful to first position tiny drops of glue with a toothpick on the holder every 90°. Then, using tweezers, the filter can be positioned in the holder in a way that the edges of the filter are in not touching the glue. Finally by rotating the filter carefully the edges are rotated in the glue, assuring that almost no glue will be on the front or back surface of the filter. Once the glue is hardened the filter can be mounted in the MINI-H-U-3-3030 from Radiant Dyes.

The following picture shows the finished part. Please make sure to insert the filter as indicated by the red lines. The beam inside the cavity is relatively wide, the position shown below ensures the maximum usable surface for the laserbeam.

3.2.4 LaserDiode and Collimator tube

Last but not least the laserdiode will be mounted in the collimator tube according to the following datasheet from thorlabs. In the first version of the IFL a 5420 Series diode from JDSU was used. Please make sure what kind of laserdiode you have before soldering any wires! The 5420 Series has a diameter 5.6mm and will be mounted according to the lower part of the mechanical drawing. Once the collimator tube is assembled it is mounted with thermal heatsink paste in the inner housing and fixed by a screw from the top. Use thermal heatsink paste to mount the diode in the adapter, the adapter in the collimator tube, and to mount the collimator tube in the laser. The polarization axis will be set later.

0897-E0W_collimator_tube.pdf
52.9 KB

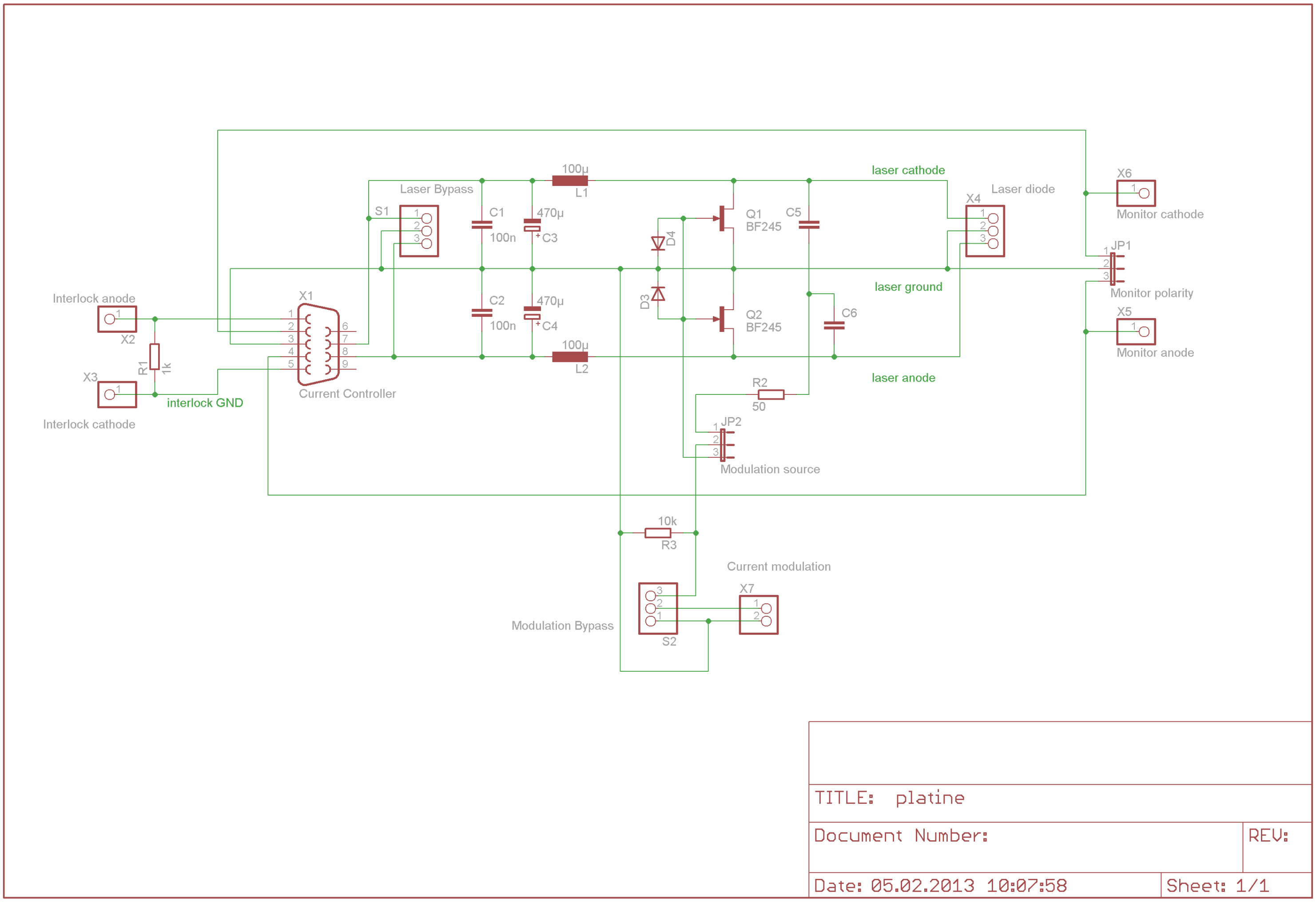
0897-E0W_collimator_tube.pdf
52.9 KB

[new - should be used for new assembly]
-In case of AG (CG) you have to connect your switch to pins 1 and 2 (2 and 3) on the Laser Bypass S1 and place capacitors C1, C3 and coil L1 (C2, C4, L2) for use as a current filter. Pin 2 of the laser diode connection X4 must always be connected to the ground of the diode whereas the cathode in case of AG (anode in case of CG) must be connected to pin 1 (pin 3). The third pin of the laser diode is used for a monitor photo diode and can either be anode or cathode depending on your diode. Connect it to X6 in case of a cathode pin or to X5 in case of an anode pin. The second monitor pin is internally connected to the diode ground. Therefore, you have to place a pinhead into JP1 and connect the diode ground via a jumper to the monitor pin of the other polarity.
-There are two possibilities (FETs or capacitors) to realize a current modulation in case you need it. Generally, this is not the case and you can go on with placing the interlock resistor as described further below.
1) FET current modulation is realized by assembling D3, D4 (yes, both of them) and Q1 for AG (Q2 for CG) and connecting pinhead 2 and 3 of JP2 via a jumper.
2) For capacitative current modulation you have to place the capacitor C5 for AG (C6 for CG), a 50 Ohms resistor R2 and a jumper between pins 1 and 2 on JP2.
Since the current modulation offers an additional way to destroy your laser diode you **must not** connect current modulation input pin 2 of JP2 directly with the current modulation BNC connector. Instead, you want to use an additional switch S2 to set any external signal to ground, e.g. when connecting a BNC cable to the BNC current modulation connector, or to the modulation input pin 2 on JP2. To prevent the need of two separate switches it is preferred to use a "double" switch, which is switching 2 lines at the same time. An additional resistor R3 reduces static electrical field further which could otherwise destroy your diode.
-Place the interlock resistor R1 and join the anode (cathode) of the green interlock LED to X2 (X3). Finally, solder the circuit board to the DSUB-9 connector. Congratulation! You have built you first Laser!

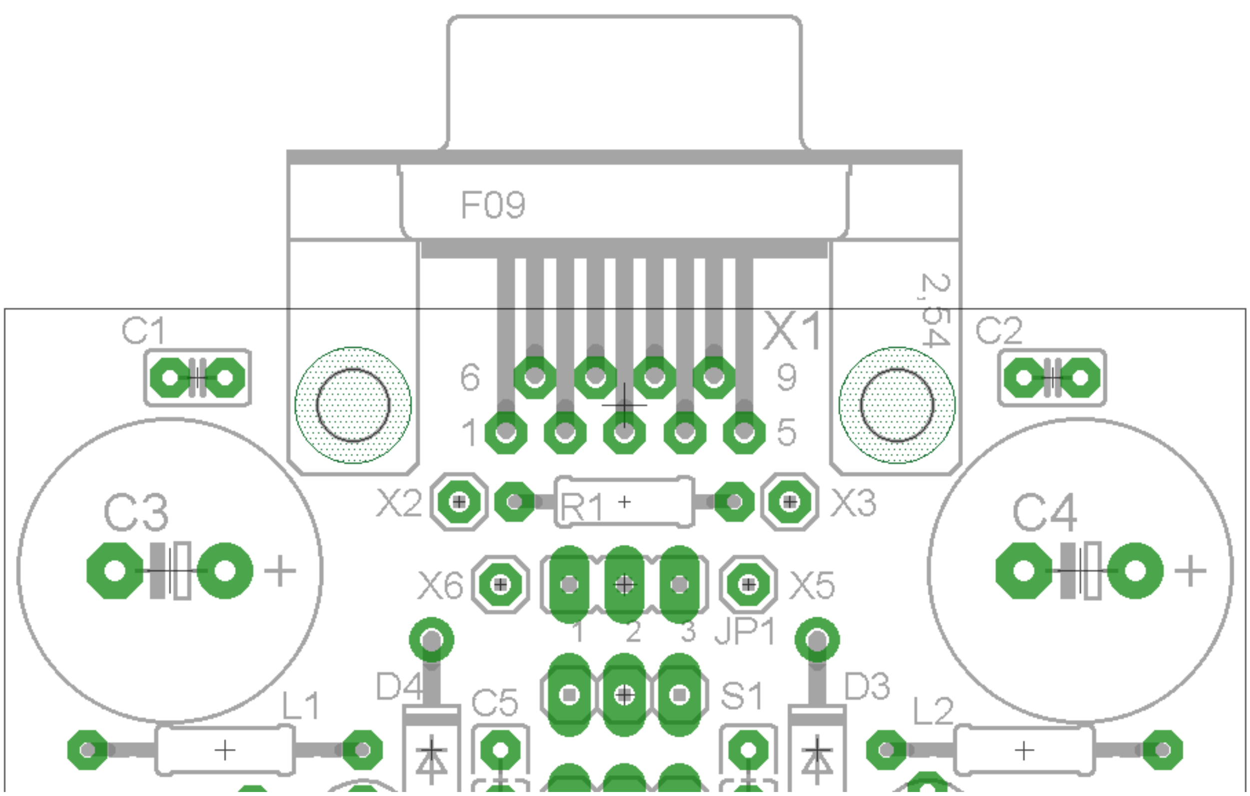
Eagle files can be found here. **(dead link? please put the file here directly, if you can find it)**

The missing description for the capacitors:

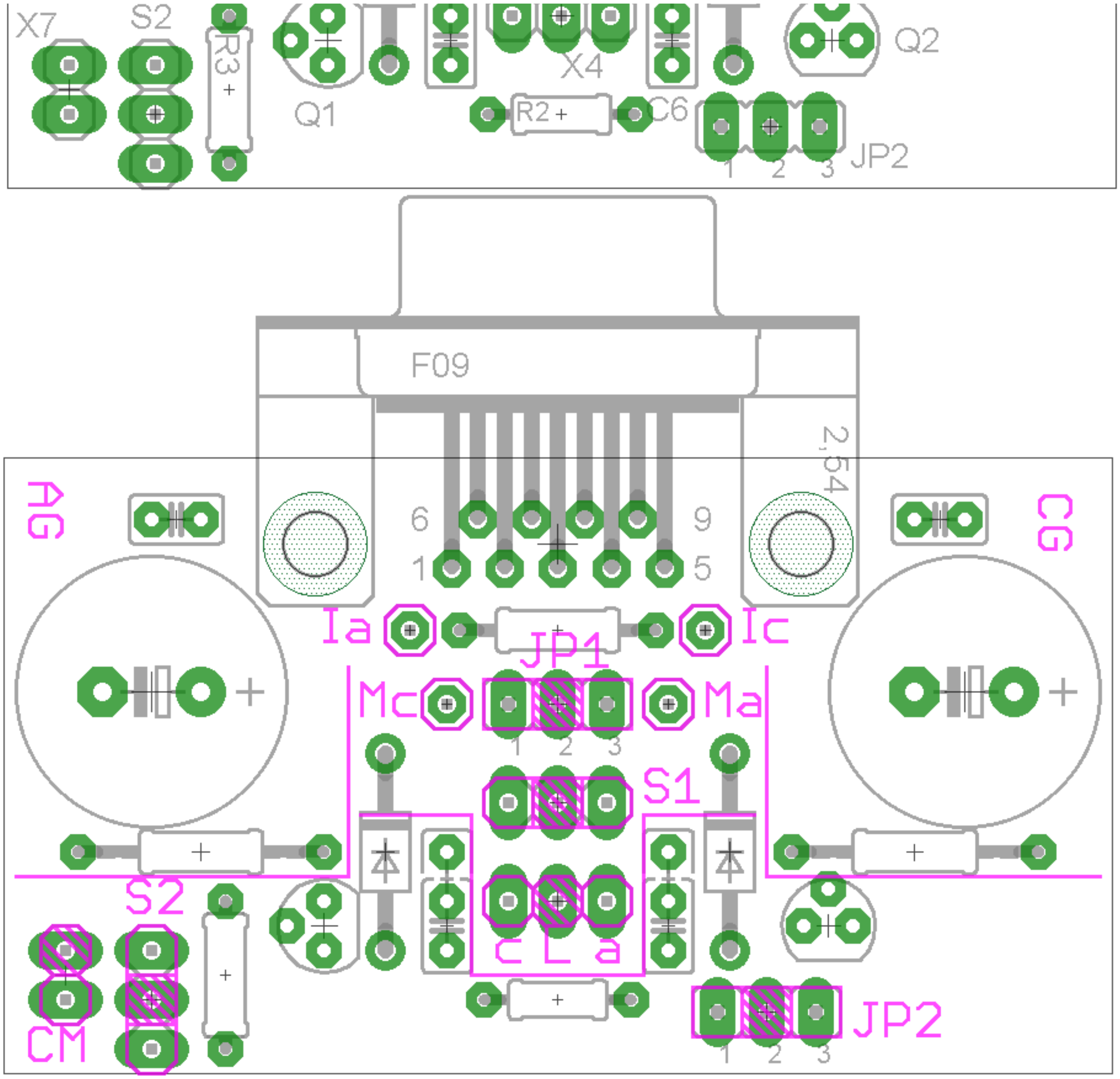
C5 = C6 = 3.3 μF, for instance, but this depends on your requirements for the capacitive current modulation.



100µ
L1
laser cathode
Laser diode
X6
Monitor cathode
Laser Bypass
S1
C1
100n
470µ
C3
Q1
BF245
C5
X4
D4
D3
JP1
Monitor polarity
laser ground
Interlock anode
X1
C2
100n
470µ
C4
Q2
BF245
C6
X5
Monitor anode
X2
R1
1k
X3
100µ
L2
laser anode
R2
50
Current Controller
interlock GND
Interlock cathode
JP2
Modulation source
10k
R3
Current modulation
X7
Modulation Bypass
S2
TITLE: platine
Document Number:
REV:
Date: 05.02.2013 10:07:58
Sheet: 1/1



F09
2,54
C1
X1
C2
6
9
1
5
C3
X2
R1
X3
C4
X6
X5
1 2 3 JP1
D4
C5
S1
D3
L1
L2

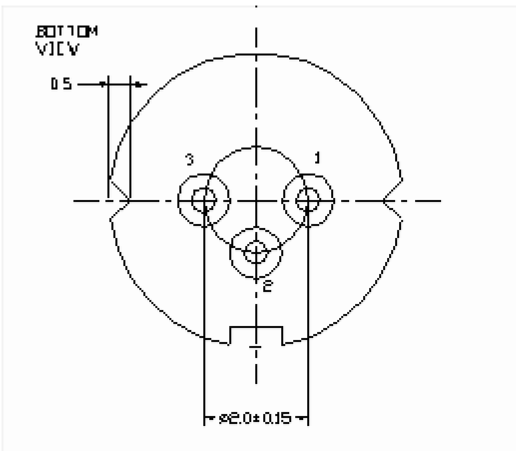


Note: the two board shown above are actually the same. The left ones shows the parts names whereas the right ones is showing magenta colored text which is engraved into the circuit board. Naming convention: Ia/Ic = Interlock anode / -cathode; MC/Ma = Monitor anode / -cathode; L = laser diode ground; a/c = laser diode anode / cathode; CM = current modulation pins; shaded regions mark ground (apart from S2). The components used in case of AG (CG) are typically placed at the bottom (top).

Pin convention for 9 mm TO-5 can

♦ELECTRICAL CONNECTION

Bottom View



Pin Configuration

A	LD cathode, PD anode (Fig. 1)
B	LD , PD anode (Fig. 2)
C	LD anode, PD cathode (Fig. 3)

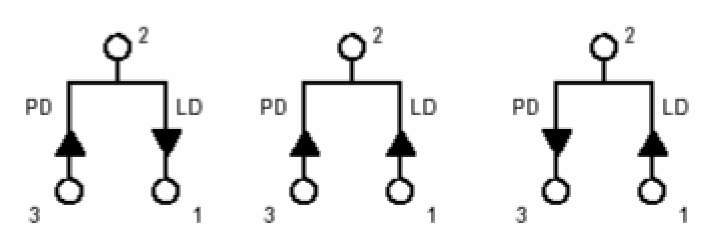
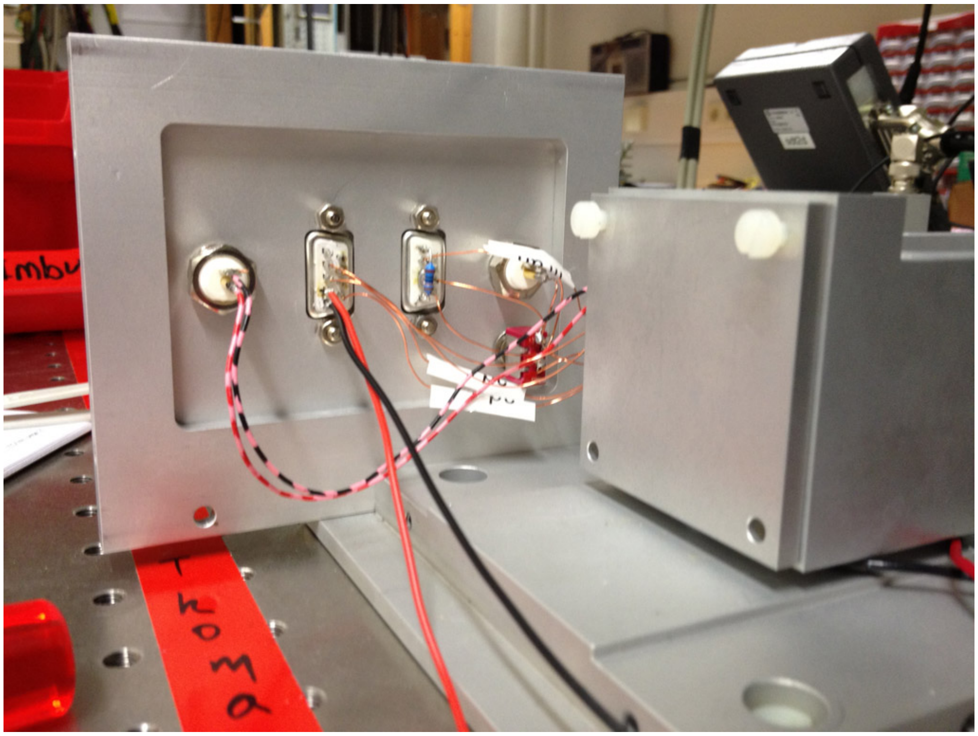


Fig. 1 QL63D4SA   Fig. 2 QL63D4SB   Fig. 3 QL63D4SC

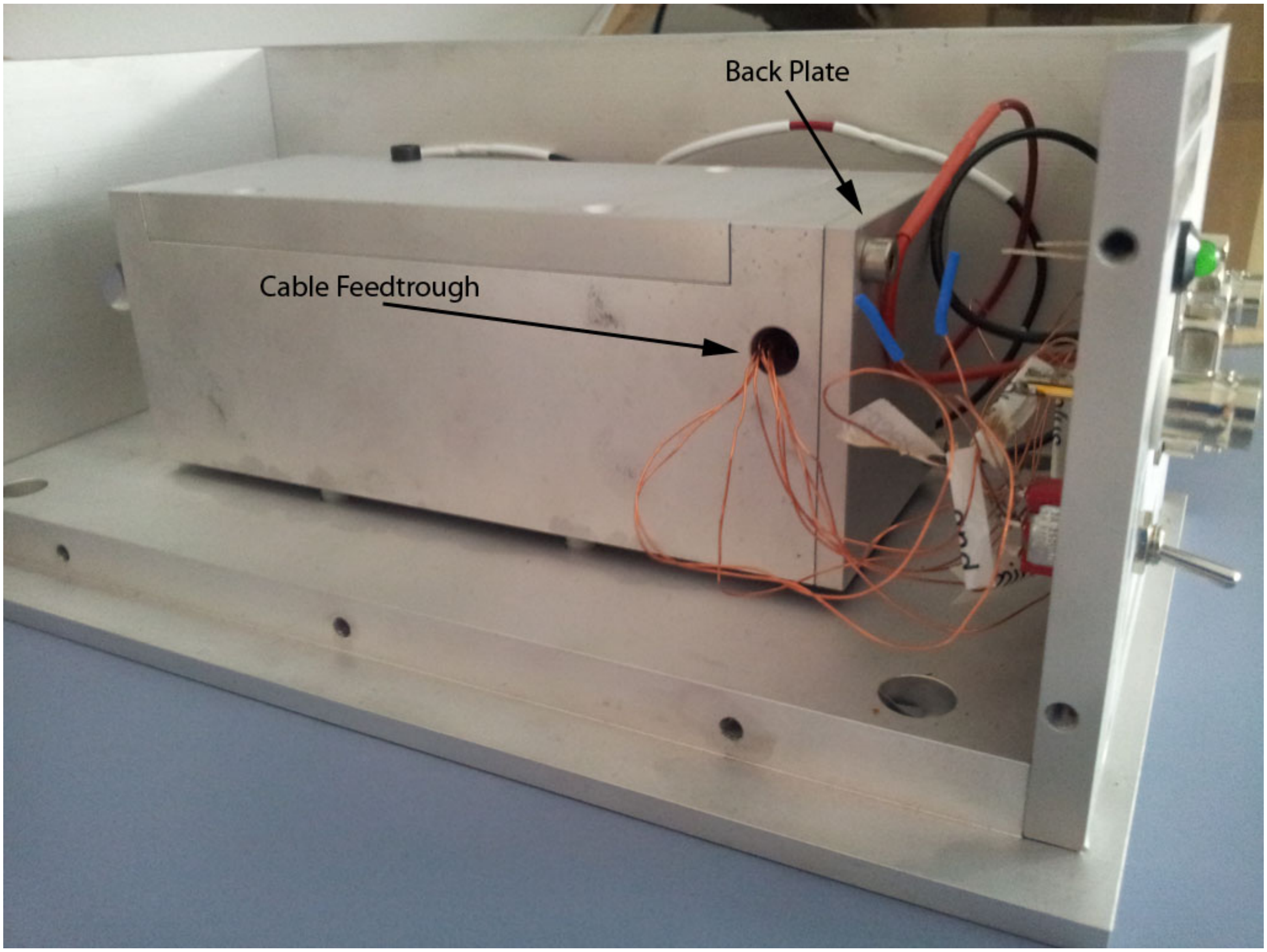
For our axcel photonics laser diode, check [here]

[old - should not be used for new assembly]

It is useful to connect the wires of the laserdiode to a laserdiode-connector instead of the diode itself. Please check the datasheet of the laserdiode for the appropriate wiring as some laserdiodes are driven by the cathode and others by the anode. To conclude the laserdiode wiring the cathode (or anode) wire from the female DSUB-9 connector (current connector, left from rear-side), the cathode (or anode) wire from the left BNC connector (used for current modulation) (**NOTE:** do not connect the BNC for current modulation unless you realy require this feature), and the cathode (or anode) wire from the diode will be connected to one pin of the switch. The same needs to be done for the three ground wires. The idea of the switch is to have an easy of bypassing the laserdiode. The laserdiode should be always bypassed when no external cables are attached to the housing. Finally all electrical wiring should look like the following images:



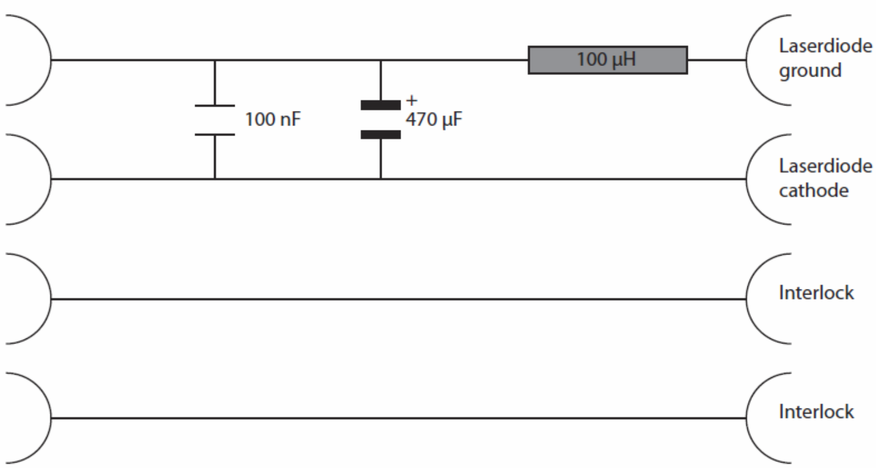
Note: Make sure that the cables are going though the feed trough before soldering them to the BNC / DSUB9 connector. Otherwise the backplate cannot be mounted as shown below. It is usefull to cover the remaining cable feedtrough hole with foam to keep the ventilation as small as possible.



3.2.5 Current filter (optional) [old]

The following circuit diagram shows the current filter. Please make sure to connect the + side of the 470 μF capacitor with the laserdiode ground (in case of a diode which is using an anode instead of a cathode the + side of the 470 μF capacitor will be connected to the anode). The finished Filter should be shielded in a housing, or at least by wrapping it in aluminum foil.

Note: although not shown in the circuit diagram, it is convenient to feedtrough the two pins for the internal photo diode of the laser diode.



CurrentFilter.pdf
232.2 KB

3.3 Laser Adjustment

3.3.0 Calibrate Temperature Controller
The Thorlabs manual page 42-43 explain the steps needed to calibrate the PID controller. The side panel of the current controller has a BNC connector which allows to display the temperature error signal on an oscilloscope.

Thorlabs ITC1xx PID Temperatu...
25.3 KB

3.3.1 Set Polarization
The polarization of a diode laser is perpendicular to the fast axis (=long axis of transversal laser beam profile). It is the group internal standard to align the fast axis parallel to the surface of the optical table.

3.3.1.1 Used Instruments
- Powermeter
- Cubeholder
- PBS

3.3.1.2 Procedure
Mount the PBS in a Cubeholder. It should now be perfectly parallel to the surface of the optical. A PBS transmits P-polarized light and reflects S-Polarized. Therefore by maximizing the reflected light, by rotating the collimator tube carefully, the resulting polarization is perpendicular to the surface of the optical table. The long axis of the transverse beam profile should be parallel to the surface of the optical table.

3.3.2 Collimate Laserdiode

3.3.2.1 Used Instruments
- 5 m of space
- laser detection card
- Shack-Hartmann wavefront camera (advanced)

3.3.2.2 Procedure1 (standard)
Use the thorlabs tool to pre-align the lens by optically controlling the collimation of the beam. Align - using the laser detection card and your eye - the collimation lens such that the beam width (only look at the long axis of the transversal laser beam profile) is constant over a distance of 5 m. You might want to use some plane mirrors to reach this 5 m free propagation distance. Again using the thorlabs tool the fine-tuning of the lens is achieved by slightly changing the distance between the lens and the laserdiode.

Once the beam is ideally collimated the lens should be glued in place by using a tiny drop of 2 component glue.

Remark: It is not always possible to collimate both transversal axis of the laser beam with a normal lens, since their waists may be at different positions in space. Therefor one should collimate the axis that is used later on for the wavelength selection via the interference filter. In our case this means that the interference filter should be always positioned perpendicular to the surface of the optical table. The angle of the filter that tunes the selected wavelength is varied by rotating the filter, but keeping its surface perpendicular to the surface of the optical table. In other words: the surface vector of the table and the one of the filter have to be perpendicular at any time.

3.3.2.3 Procedure2 (advanced)

Use the thorlabsShack-Hartmann wavefront camera to detect if the output beam of your laser is well collimated. This method has not yet been used for collimating a laser diode. If you try it you might want to write down your findings here :).

3.3.3 Laser Resonator adjustment

The following picture shows how the finished piezo/outcoupler holder with lens is installed in the cavity. The long screw will later be used to optimize the position of the lens by hand. You may also connect a translation stage to the screw.

IFL_image_05.pdf
3.2 MB

3.3.3.1 Used Instruments

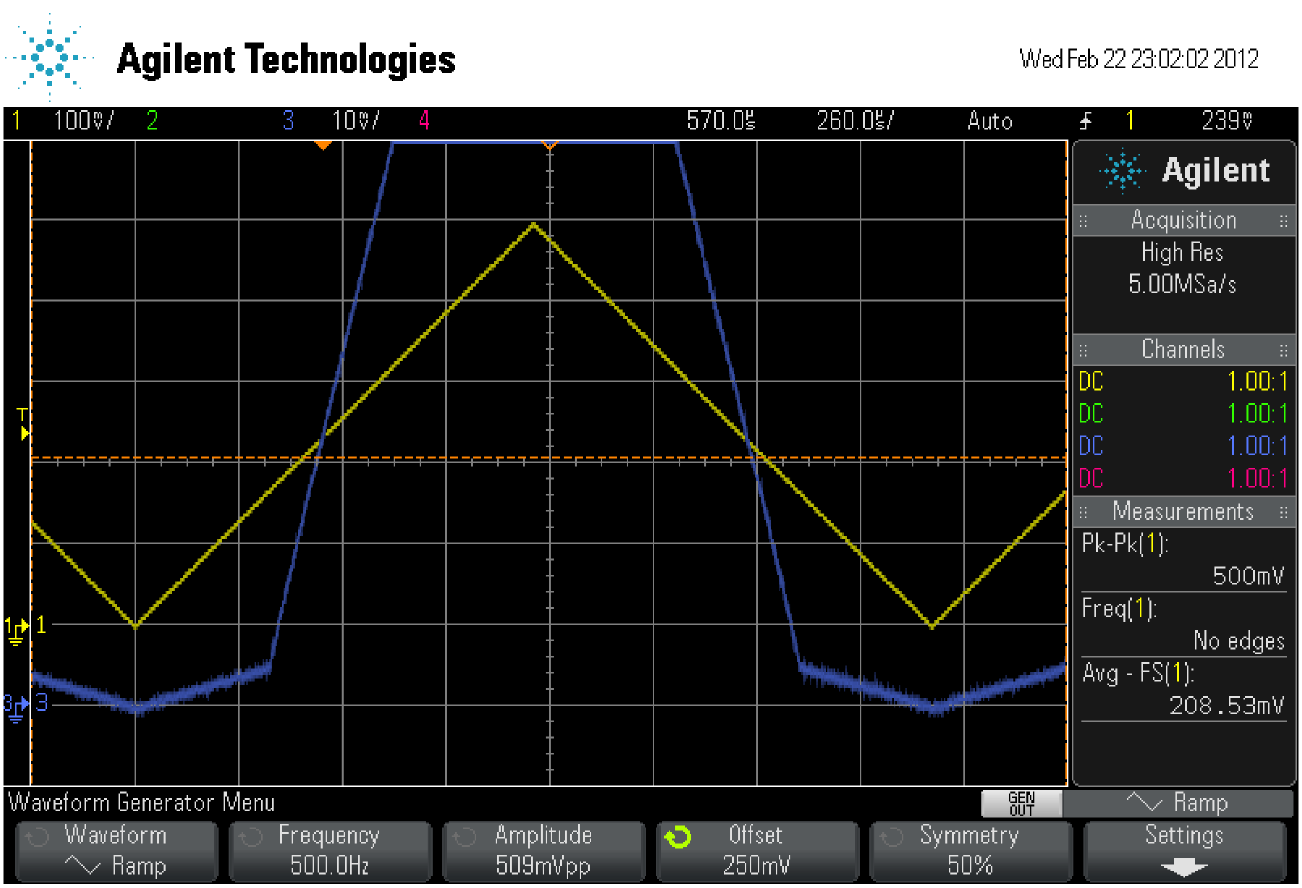
- internal photodiode
- oscilloscope ramp generator

3.3.3.2 Procedure

Use the ramp generator of the oscilloscope to produce a signal that ramps over the laser threshold. The signal needs to be connected either to the current modulation input of the controller or the current modulation input of the laser itself. The following graph shows the ramp signal (yellow curve) and the response of the internal photodiode (blue curve) of an unoptimized cavity. The red arrow shows the kink in the curve which indicates the laser threshold. By iteratively changing the distance between the lens and the outcoupler and by changing the x-y position of the lens (by slightly unscrewing the screws of the holder and moving the holder by hand) the laser threshold should be minimized (green arrow that goes to the left). The amplitude is of course also object of interest for optimization and should be maximized.

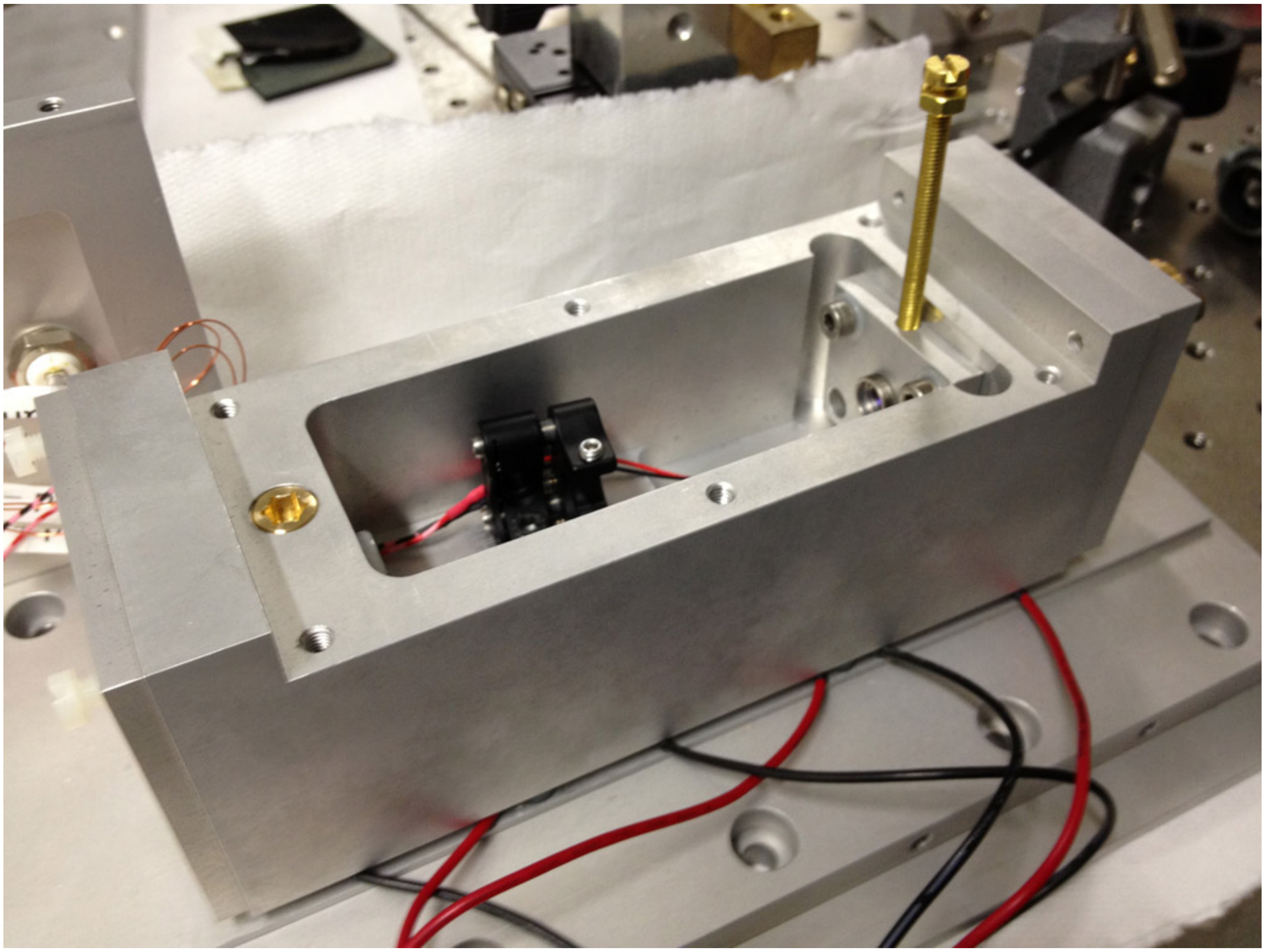
schwelle_5ma_off_2.pdf
126.1 KB

The following graph shows an optimized cavity. The comparison with the graph above clearly shows the reduction in the laser threshold and an increase in the amplitude of the internal photodiode.



3.3.4 Internal Interference Filter adjustment

Now it is time to insert the interference filter as shown below. However, in this version the holder is mounted backwards, which was necessary to avoid back reflection into the laserdiode. The new version of the IFL does not have this problem anymore.
Remark: The interference filter will be screwed to the inner housing using the slit in it and the bolt nut you put at the bottom in the **3.2.1** step. However, it is needed a custom made screw since the required length is not standard; you will be able to cut a longer screw in the student workshop.

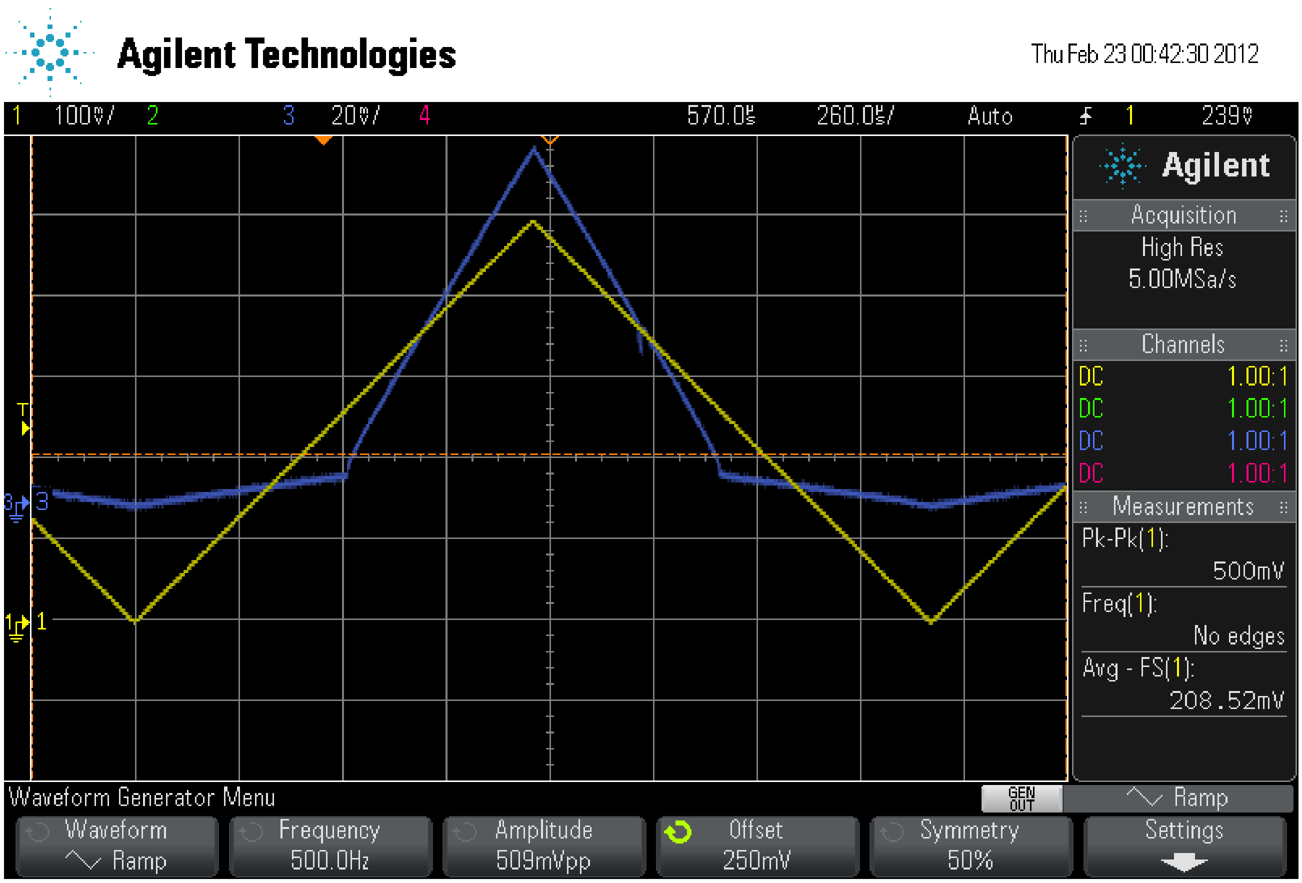


3.3.4.1 Used Instruments
- internal photodiode
- oscilloscope ramp generator
- wavemeter

3.3.4.2 Procedure
Make sure, by using the wavemeter, that the wavelength of the emitted laserlight is close to the D2 line of Cesium (351.725 718 50(11) THz). The wavelength depends on the angle of the interference filter. Keep in mind the remark under **3.3.2.2.** The interference filter introduces a slightly different optical path, which means the position of the piezo/outcoupler holder and the cats eye lens 1 have to be reoptimized for the lowest laser threshold as mentioned in the previous section.

The following graph shows that the threshold and amplitude will definitely be worse than those without the interference filter.

Once the cats eye lens is in the perfect position it should be fixed with a single drop of two component glue to.



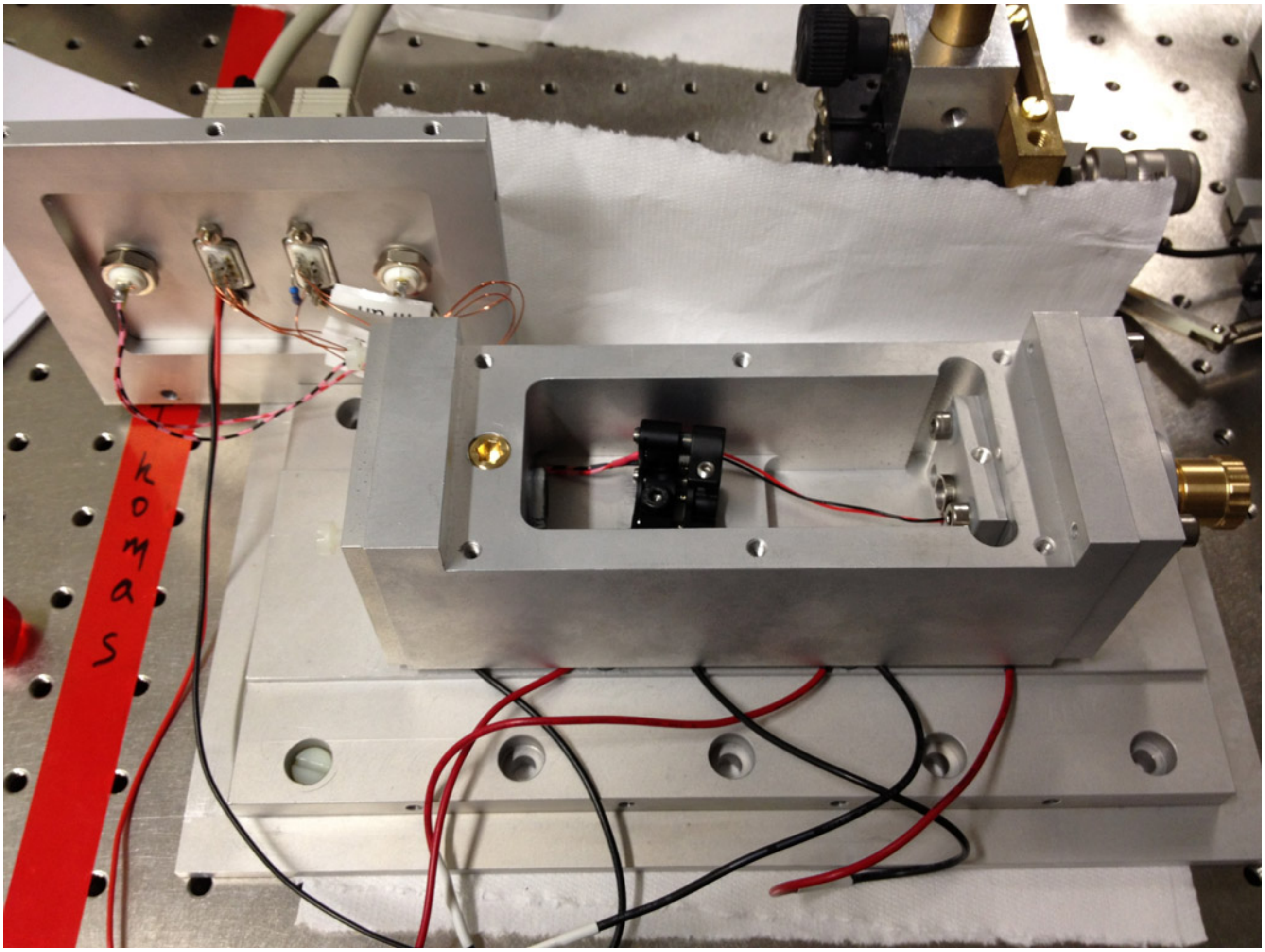
3.3.5 Cats Eye Lens 2 Adjustement

3.3.5.1 Used Instruments

- external mounted interference filter
- power meter

3.3.5.2 Procedure

The cats eye lens 2 first needs to be mounted in the brass holder produced by the mechanical workshop. The mounted lens should go all the way in. Then use the tool from the mechanical workshop (brass tool shown in the picture below on the very far right) to pre-align the holder (with lens) by optically controlling the collimation of the beam. The following procedure is the same as explained in "3.3.1 Collimate Laserdiode".



Congratulations! You now should have a working version of the IFL.
To confirm you should proceed repeating the following characterizations measurements

PLEASE: add labels to the rear-plate of the laser in the scheme as presented in the picture in the beginning.

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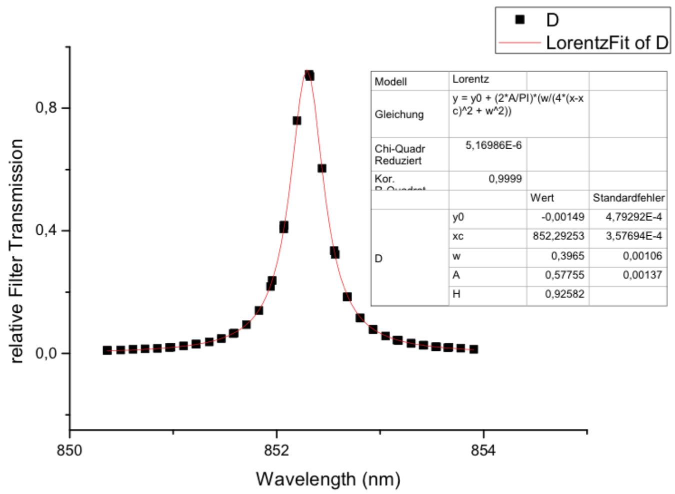
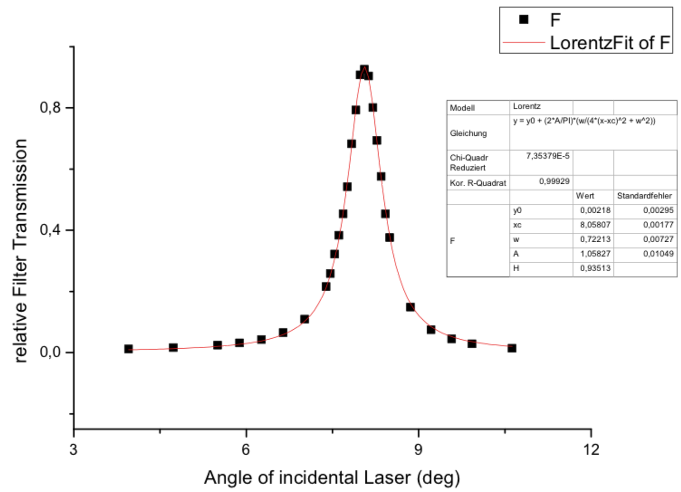
4) Characterization Measurements

4.1 Interference Filter

The following plots show the wavelength and angular dependence of the transmission of the interference filter





The corresponding Lorentzian widths are: w ≈ 0.39nm and w ≈ 0.72°.

4.2 Power-Current Characteristic

4.2.1 Used Instruments:

- Powermeter
- Attenuator

4.2.2 Comments:

The standard Powermeter sensors we use are linear up to 25mW and have a threshold of 50mW! Please make sure to use appropriate attenuators to be below 25mW when measuring the power current characteristic.

4.2.3 Results:

the following plot shows the power-current characteristic. The kinks in the slope are related to mode jumps which is verified by the current-frequency characteristic in the following section.

2012-03-03-ifl-current-power.pdf
100.7 KB

The Laser-threshold is at 11,3 mA and the output power increases by 0.7 W/A

2014-01-27: see also More output power with interference filter laser _ by Tobias Kampschulte.

4.3 Current-Frequency Characteristic

4.3.1 Used Instruments:

- Coherent Wavemeter
- Fabry Perot Cavity

4.3.2 Comments:
The Fabry Perot Cavity is used to guarantee the single mode operation of the Laser. In case the IFL is running in multimode it is usually sufficient to vary the Piezo voltage in-between 0..30V. The Fabry Perot Cavity piezo requires a ramp signal with an amplitude of 30-60V at 50Hz. It is practical to use the built in waveform generator of the digital oscilloscope to generate a ramp with an amplitude of 1V and an offset of 500mV, this signal may then be amplified to the required 30-60V.

There are two things to bare in mind when using the wavemeter: 1) make sure to use the right amount of power. The wavemeter has a little gauge at the bottom right that indicates wether the power is within the right range, as well as a tuning wheel to vary the power internally. 2) the wavemeter fibre is partially damaged which has two downsides a) please be carefully with it as a new one coasts about 800€ b) it may show the wrong wavelength. You can check this by gently touching the fibre.

4.3.3 Results:
the following plot shows the current-frequency characteristic. The kinks in the slope are related to mode jumps. The red curve shows the current-frequency for increasing currents and the blue curve shows the current-frequency for decreasing currents.

2012-03-03-ifl-current-freq.pdf
96.9 KB

The tuning range has a span of 40.0 GHz with a slope of -1.1 +/- 0.1 GHz/mA. The Hysteresis that arrises from increasing or decreasing the current has a span of 2.7 mA

4.4 Temperature-Frequency Characteristic

4.4.1 Used Instruments:
- Coherent Wavemeter
- Fabry Perot Cavity

4.4.2 Comments:
Please check the comments regarding the current-frequency characteristic for more information about the wavemeter and the Fabry Perot Cavity. It is usefull to observe the temperature error signal on the oscilloscope. This ensures temperature stabilization before taking any value.

4.4.3 Results:

the following plot shows the temperature-frequency characteristic. The kinks in the slope are related to mode jumps.

2012-03-01-ifl-temp-freq-Down...
97.7 KB

The tuning range has a span of 41.7 +/- 1.3 GHz with a slope of -22 +/- 0.1 GHz/K. The Overall slope of the curve is -3.4 +/- 0.2 GHz/K and it is most likely caused by the temperature characteristic of the interference filter.

4.5 Wavelength-Intensity Characteristic

4.5.1 Used Instruments:
- Powermeter
- Coherent Wavemeter
- Fabry Perot Cavity

4.5.2 Comments:
Please check the comments regarding the power-current characteristic for more information about the powermeter and the current-frequency characteristic for the wavemeter and the Fabry Perot Cavity.

4.5.3 Results:
The following plot shows the wavelength-intensity characteristic. To record the data presented in the plot the interference filter inside the laser was varied in its angle.

2012-04-10-Intensität-Wellenl...
8.7 KB

The IFL has a tuning range of 8nm [845.5nm - 853.5nm]. There are power fluctuations up to 15% possible while tuning. The lower limit of the wavelength is due the missing overlap of the diode gain medium and the interference filter transmission for large angles (in other words: the gainmedium can not support the wavelength which is transmitted by the filter for large angles), while the upper limit is due to back-reflection into the laserdiode.

It would be great to record this plot with a finer tuning range to observe an oscillating power.

4.6 Linewidth Measurement

4.6.1 Self Heterodyne Measurement

Pasted Graphic 5.pdf
16.5 KB

4.6.2 Optical Beating of Two Lasers

4.6.3 Fitting Tools

4.6.3.1 Seokchans Fitting Tool

Seokchan_fitting_tool.zip
821.3 KB

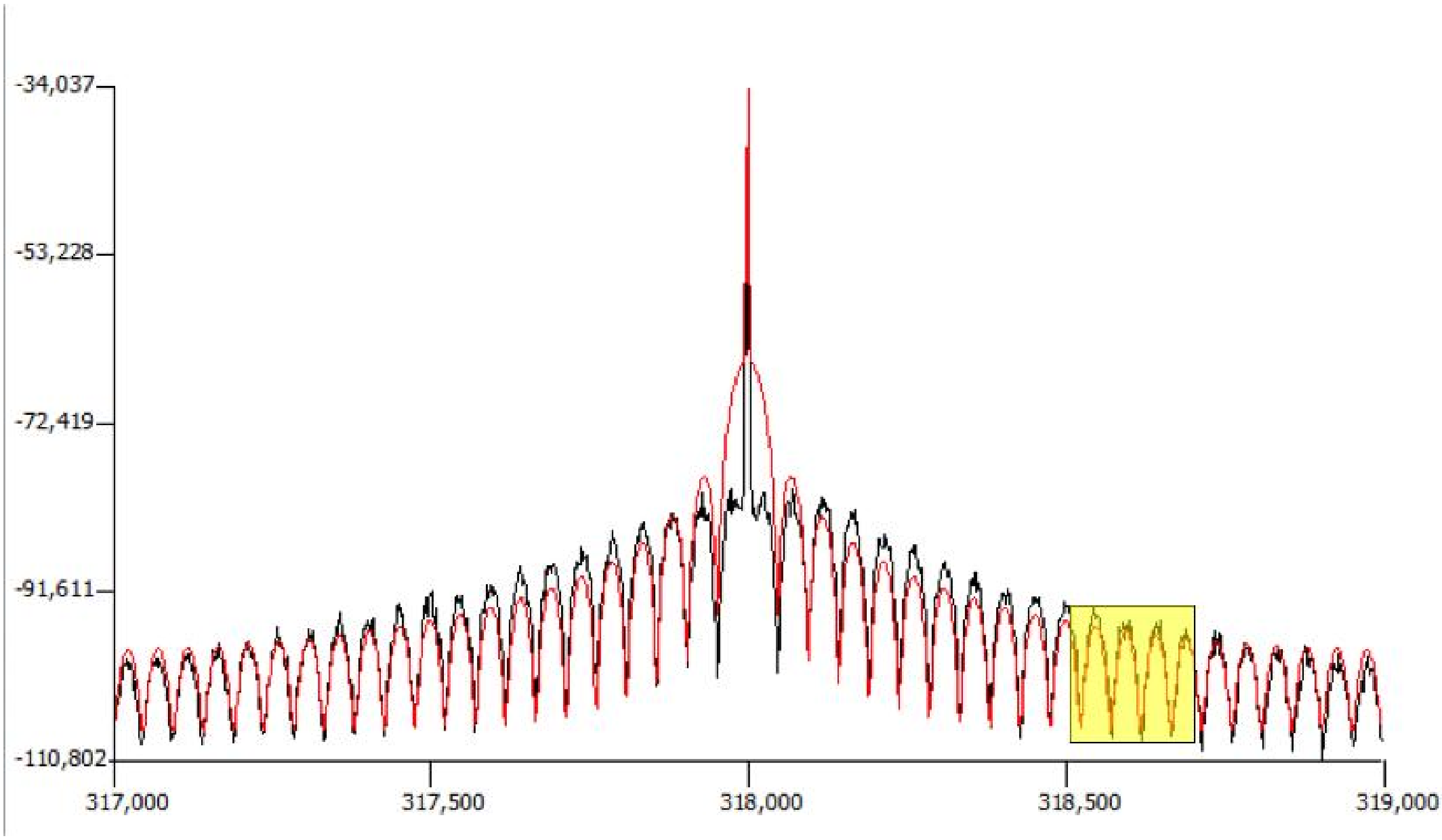
4.6.3.2 Andreas Mathematica nb

Self-delayed heterodyne measu...
338.6 KB

4.6.4 Comments

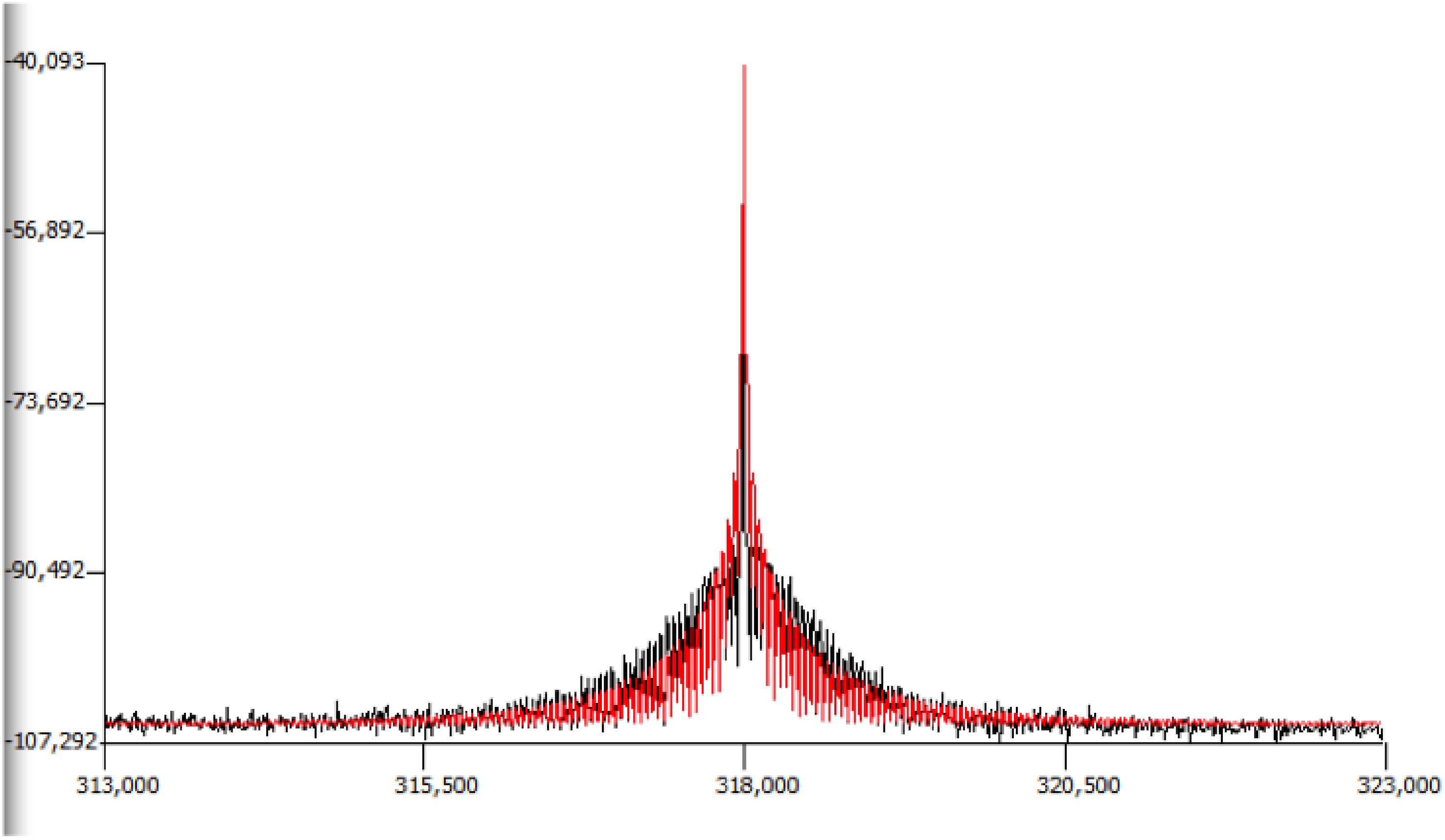
4.6.5 Results:

Span: 2MHz, Bandwidth 2 kHz



Lorentzian width = 141 Hz; Gaussuan width < 0.1 Hz

Span: 10MHz, Bandwidth 5.1kHz



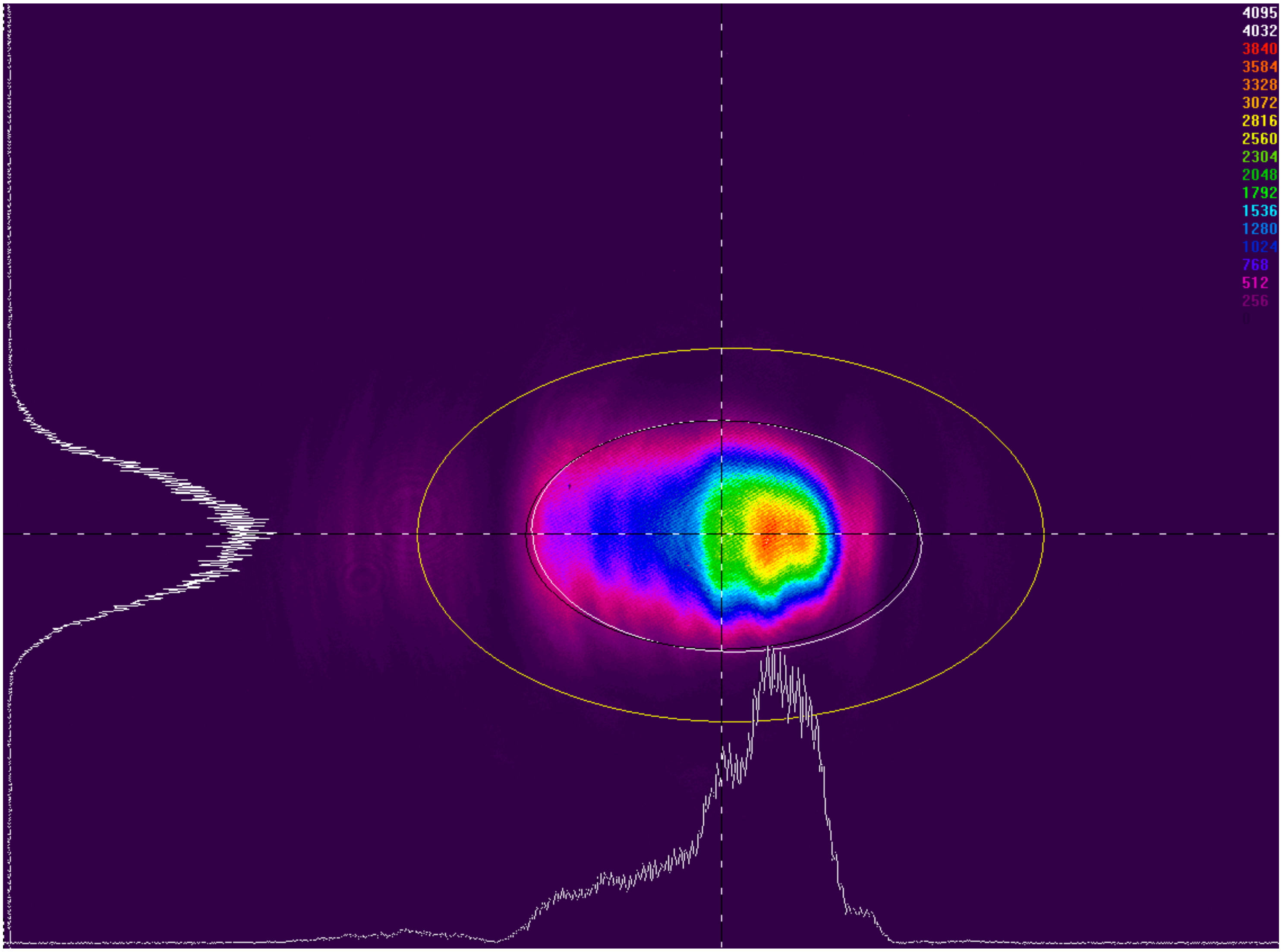
Lorentzian width = 141 Hz; Gaussuan width < 0.1 Hz

4.7 Beam Profile measurement:

4.4.1 Used Instruments:
- Beam profile camara
- Laptop

4.4.2 Comments:
-To use the beam profile camera you will need to install the spiricon driver and software. Follow the Installing Spiricon Software entry in Evernote to do it.
-To perform the measurement connect the camera to the laptop, initialize the spiricon software and click the 'start!' button. Then, make the beam of the laser hit the camera right in the center. BE CAREFUL, you must use low power and atenuation, the camera has a damage threshold and it could get broken.
-Measure the distance the beam has traveled

4.4.3 Results:
the following picture shows a beam profile taken from IFL #004.



The beam profile has a x-axis width of 2.19 mm and a y-axis width of 1.30 mm. The picture was taken at 45 cm from the IFL .

5) Datasheet

Once all characterizations are finished, you will have to create a datasheet summarizing all relevant information. To do that, just follow the IFL Datasheet Manual.

Finally, upload the datasheet to the IFL Datasheets Store

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6) Literature

IFL_MechanicalSetup_MrLangen.pdf
1.6 MB

Thorlabs ITC1xx laser diode c...
2.2 MB

54xxdiodelaser_ds_cl_ae.pdf
429.0 KB

linewidth.pdf
198.5 KB

00076663.pdf
1.6 MB

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datasheets