NT342 series

Tunable Nd:YAG-Laser System

Servicing Manual

NT342 Rev. 1606

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Chapter 2 PREFACE

Competence Disclaimer

Optical parametric generator system and its components are complicated and sensitive equipment, therefore the procedures described in this manual should only be performed by Ekspla engineers or personnel that were trained by Ekspla engineers. Any unauthorized interference with the system might result in a void warranty.

This manual was designed by Ekspla service primarily for Ekspla service engineers but can also be used by properly trained personnel. If you are not certain about your ability to use the procedures described in this manual, please contact Ekspla service for further assistance.

Legal Disclaimer

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Chapter 2 Safety

Please consult the *NT342* user manual for information about the labelling, safety features, potential hazards and safe handling.

> ***Caution:***
> ***Use of controls and adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.***

2.1. Competence Disclaimer

> ***Attention***
> ***However, it is assumed that procedures, described in this manual, are performed by the properly trained personnel who are able to handle safety issues in a potentially dangerous environment where some routine operation safety requirements are ignored, like working with cover(s) removed, safety interlocks defeated, high voltage circuits exposed etc.***

DO NOT perform service procedures if you are not properly trained and do not possess the required competence.

2.2. Safety Class

This laser is a **Class 4** laser product according to the IEC60825:2007 standard, and, by definition, relates to certain safety and fire hazards.

1. General Safety Guide
2. Set up controlled access areas for laser operation.
3. Limit access to the laser to personnel whose presence is not necessary.
4. Never look directly into the laser beam.
5. Survey the area where the laser beam traverses and block all unnecessary specular reflections and scattering.
6. Terminate the laser beam.
7. Avoid blocking the output beams or their reflections with any part of your body.
8. Operate the laser at the lowest beam intensity possible for a given application.
9. Wear safety goggles; choose a model consistent with use conditions and visual function required.
10. Expand the laser beam whenever possible to reduce beam intensity.
11. Absorb secondary reflections with energy-absorbing filters.
12. Work in high ambient illumination when possible. This keeps the eye's pupil constricted, thus reducing the possibility of eye damage.

13. Place any external optical components with a flat or negative curved surface looking toward the laser, so that reflections are not focused back or are directed into an energy trap.
14. Double check that the laser is turned off. Use a positive check method such as an IR card or energy detector.
15. Follow the instructions in this manual.
16. Unplug the laser power cord and short internal components when working on the power supply.
17. Only attempt electrical service if you are experienced in high voltage/current circuits and understand the circuitry and related hazards.
18. Be especially careful when working with IR or UV radiation. Although you cannot see it, this radiation can focus on the retina and cause damage.
19. Never look directly into the end of a connected fiber optic cable when the laser is in operation.

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Failure Diagnostics Flowchart

If you experience issues with your NT342 system, first step should be trying to identify your problem by following these three flowcharts:

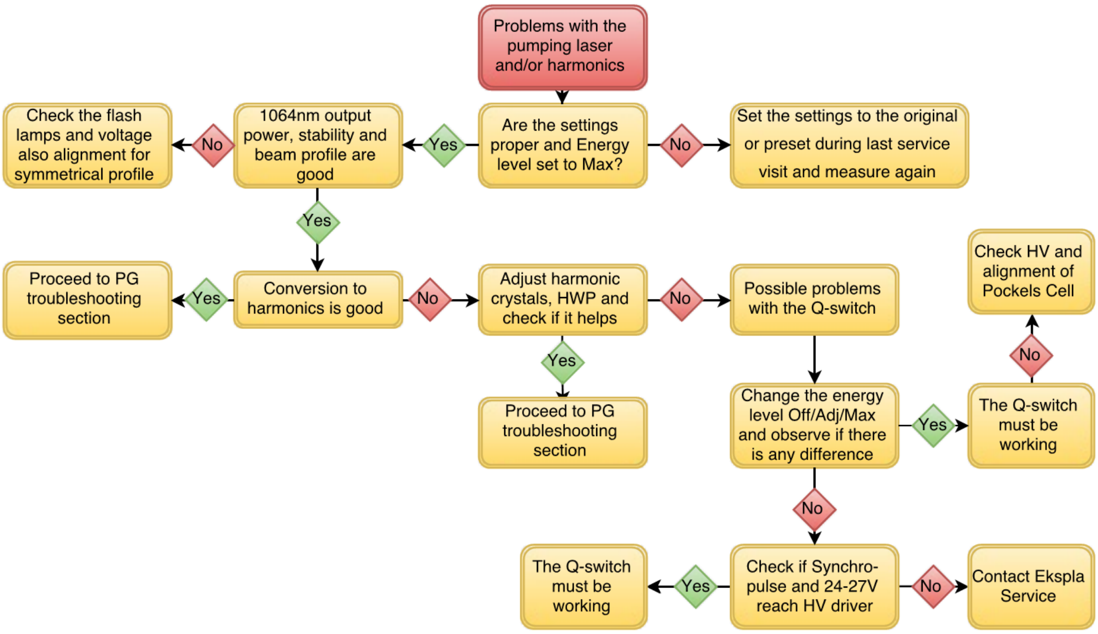

Figure 1 Problems with pumping laser and/or harmonics

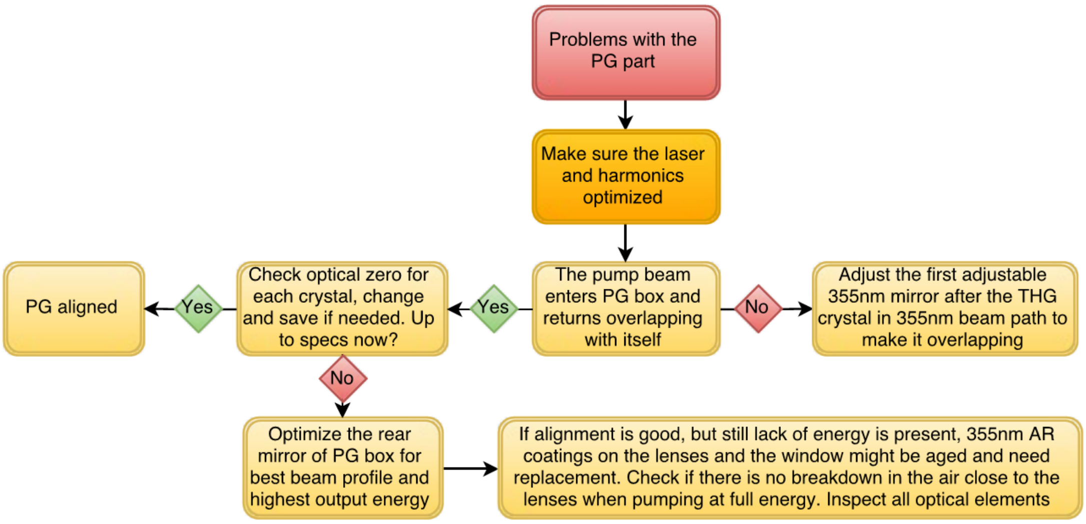

Figure 2 Problems with PG stage

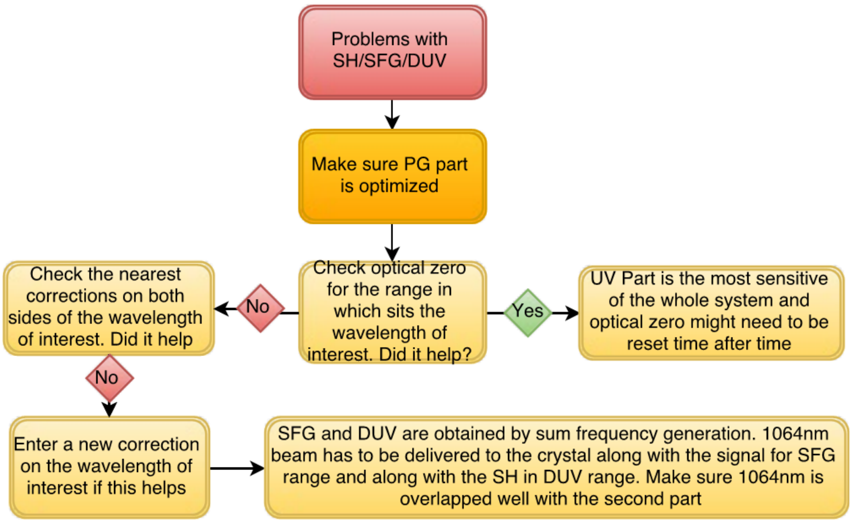

Figure 3 Problems with SH/SFG/DUV modules

General Rules for the Laser Adjustment

Here are some basic rules about laser adjustment that you should know and use before continuing to use this manual further:

1. Do not adjust the laser if it works under specification.
2. Do not adjust the laser if you have already done it and you think you can make it slightly better.
3. Always adjust the screws one by one. If the performance drops after adjusting the component, set the adjusting screw exactly back. Work on the same adjusting screw until the performance is restored. Do not attempt to restore the performance with another component or another adjustment screw.
4. Never adjust the optical components randomly, always have a reference point. For example, if the oscillator is not generating any detectable energy, do not try to find alignment randomly. The probability to align optics randomly in perfect alignment is just too low to take chances. There are special procedures of cavity alignment from scratch.
5. General mirror replacement rule: this rule applies to the optical components from which the laser beam is reflected. Before replacing the mirror, place a target in a diastase (target, paper stick, etc.) from the mirror marking the exact spot of reflected beam. The greater the distance, the more accurate is the result of the replacement. Remove the optical element, leaving the holder intact. Put the new optical component and fix it. The reflection from the replaced component might not hit the target exactly. Adjust the holder by adjusting screws to guide the beam to the center of the target.
6. Replace optical components one by one. Never dismount more than one mirror, if you are not aware of alignment procedure from the scratch.

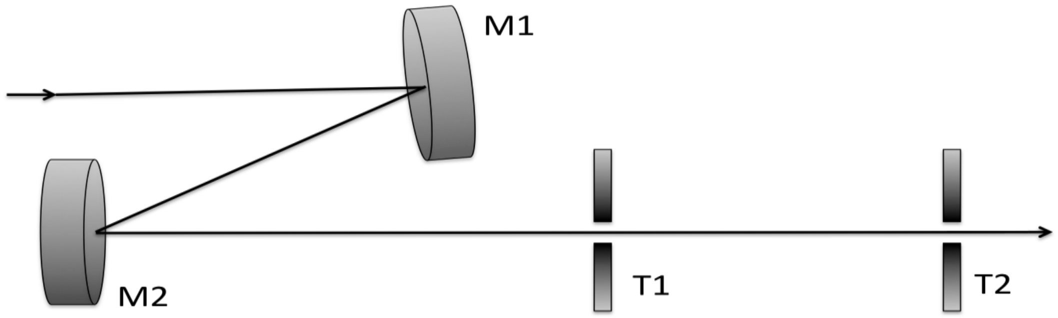

Figure 4 Two mirrors and two targets

The classic laser adjustment task is to guide the beam through 2 pinholes or targets. This situation is illustrated in Figure 4. To accomplish this task, adjust the M1 to guide the beam to T1. Then adjust M2 to guide the beam to T2. Go back to M1 and again adjust it to guide the beam to T1. Repeat these steps multiple times until the beam hits the center of both targets. The number of iterations depend on the distance between elements.

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Chapter 2 NL300 OSCILLATOR

NL300 oscillator is Nd:YAG based laser which is the base of NT342 system. It acts as a pump source for IIH and IIIH radiation (which further is used for OPO pumping). This oscillator is also used in NT341 systems as a pump source and in NL30X lasers as stand-alone laser.

Principle of Operation of the NL300 Laser

The NL300 laser head (see Figure 5) comprises of:

- Laser rod;
- Flash lamp;
- Pockels cell PC;
- Cavity mirrors RM & OC;
- Polarizer P.

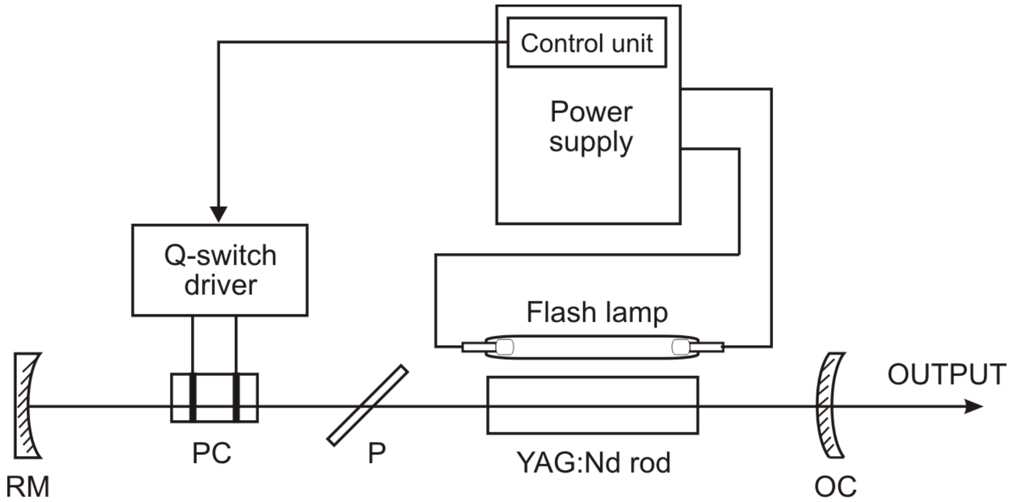


Figure 5 Optical/electrical scheme of NL300 series laser head

The laser operates in resonator quality modulation mode (also referred to as resonator losses' modulation). The laser geometry is an unstable resonator comprising of a concave rear mirror RM (99% reflection) and a convex output coupler OC – variable reflectivity mirror. Divergence of the output beam depends on the radius of curvature of the rear mirror and the thermo-induced lens in the laser rod. Thermo-induced lensing is proportional to pump power. In order to get a properly collimated output beam, the pumping level must not exceed the level preset at the factory (see User manual for specific values).

The Pockels cell PC together with a proprietary driver induces considerable steady losses in the resonator. While PC high voltage is present, generation is not possible (Q-switch is closed). When a high voltage is off, losses in the resonator are minimized and laser pulse is generated (Q-switch is opened). Laser timing diagrams are presented in Figure 6.

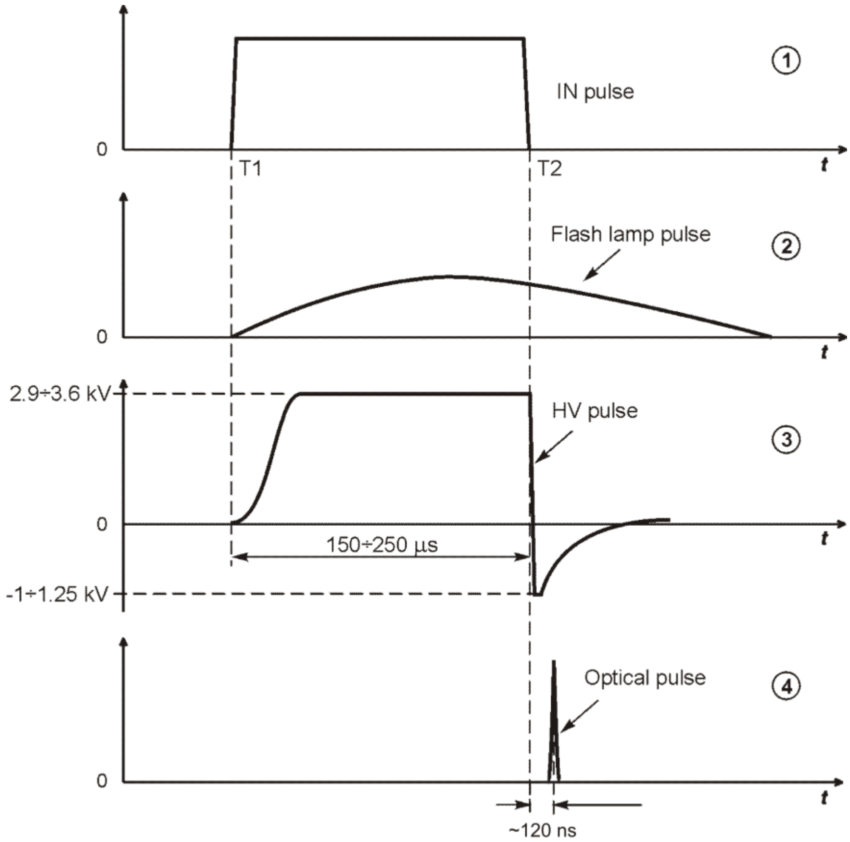


Figure 6 NL300 timing charts

The external triggering pulse applied to the input *IN* on power supply or triggering pulse generated by the internal control unit (chart ①) at T1 starts the discharge of power supply capacitors through the flash lamp (chart ②) and closes the Q-switch (chart ③), inducing high resonator losses. The Q-switch remains closed until maximum inversion in the Nd:YAG rod is achieved. At this moment Q-switch opens (chart ③), losses in the resonator are minimized, and a very short and powerful optical pulse is generated (chart ④).

The delay between the firing flash lamp and opening of Q-switch is determined by duration of the triggering pulse (chart ①) and is adjusted at the factory for each laser individually. Delay can be further adjusted using the remote control pad (see User manual).

Elimination of the Free Running

Free running is one of the main problems when dealing with NL300 type oscillators. This term is used to describe the lasing while the q-switch is closed (*EO OFF* mode). This effect can be extremely damaging to all the optics inside the laser head because of very high peak power generated. Usually the free lasing looks like shown in Figure 7.

Figure 7 Laser free running in EO OFF mode

Following are the three general examples of passive free-running occurrence.

1. Misalignment: if polarization optics, especially the Pockels cell, are misaligned, then the polarization within the laser cavity becomes slightly randomized: i.e., the dielectric polarizer does not receive linearly polarized light. As a consequence, when the polarizer should reject energy light from the cavity, a certain amount 'leaks' through. That 'leakage' energy then builds up and becomes lasing. Since this lasing occurs before the Q-switch is opened, it is called free-running.
2. Increased pump: if flash lamp voltage is increased, the oscillator will reach a level at which it begins to lapse due to the increased gain. This once again occurs because the polarization optics cannot reject enough energy out of the cavity.
3. Optical feedback: optical feedback from amplifiers, or any reflective surface, can increase the amount of energy in the laser cavity. This increased energy, just as in the previous case of increased pump, can exceed the polarization optics ability to reject enough energy from the cavity.

To eliminate the free running Pockels cell position or voltage (or both) have to be changed. For better results the laser must warm up. Run the laser for at least 1 hour in *EO OFF* mode before adjusting the Pockels cell. Turn the laser to *EO OFF* mode and start the laser by pressing button *RUN*. With an IR card, check for free-running generation presence. If detected, try to eliminate it by adjusting the PC voltage in CANBrowser (*HV40W → Set Voltage*), or adjusting potentiometer on PC driver in older systems. Try changing the voltage by ± 50 V. If that doesn’t eliminate the free running, then set back the original voltage and try to adjust the position of the Pockels cell.

To adjust the position of the Pockels cell, release the two fixing screws ([3] in Figure 8) to permit rotating the PC holder around its horizontal axis, using a 5 mm Allen hex key [4]. Adjust the PC holder in vertical plane with 5 mm Allen hex key to a position where the free running intensity is lowest (preferably, no free running is present at all). To adjust the PC in a horizontal plane, use a 1.5 mm Allen hex key ([5] in Figure 8). Adjust the PC position to eliminate free running. If necessary, do horizontal and vertical adjustments in iterations.

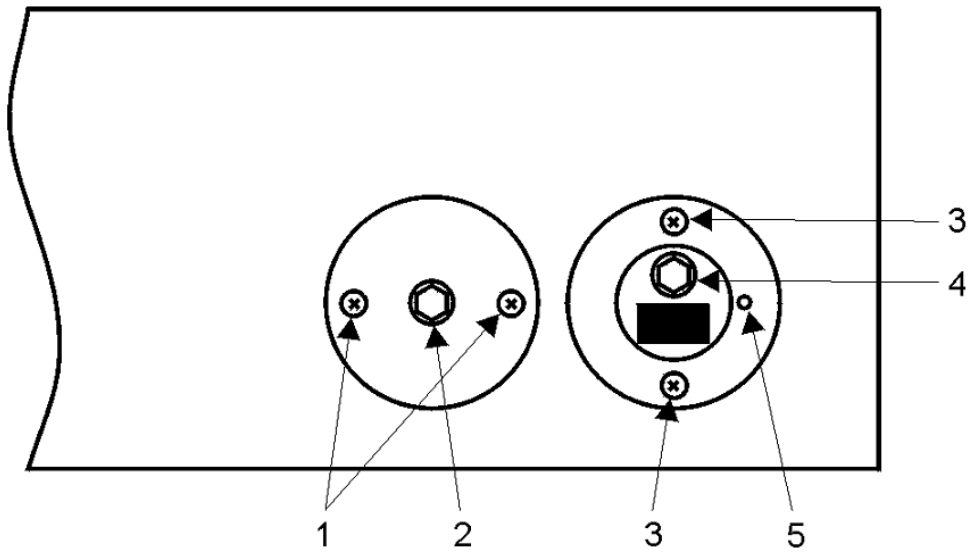


Figure 8 Side view of polarizer and Pockels cell holders

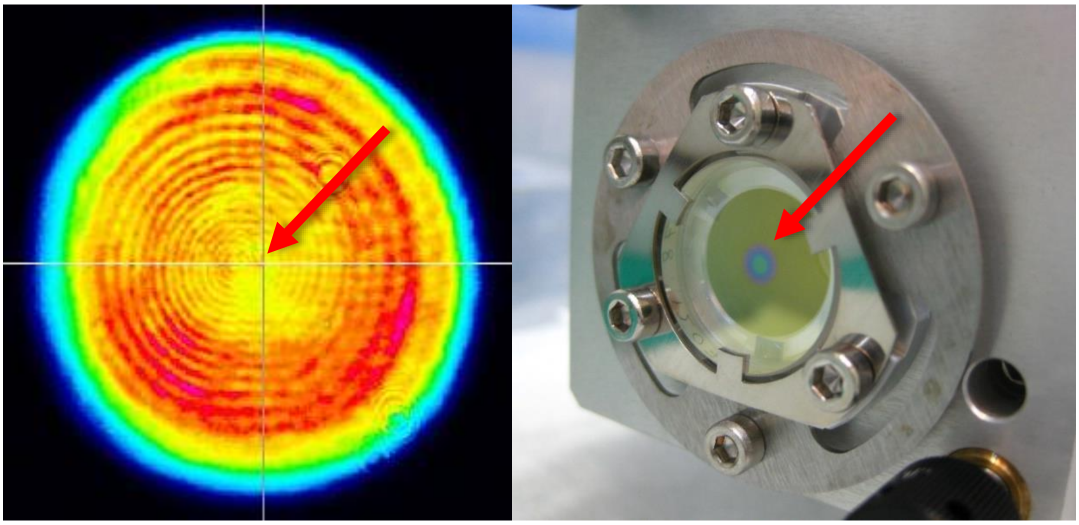
When free-running disappears, raise the pump voltage (using the potentiometer *VOLTAGE* on a power supply) up to 100 V above the nominal value (i.e., that at which the specified output energy is obtained). If free-running appears, adjust the PC voltage and position once again. Do not run the laser with higher pumping in *MAX* or Adj mode. Once you have finally eliminated free-running, lower the pump voltage down to nominal.

Any movement of the Pockels cell may cause oscillator misalignment, which might require readjustment of cavity mirrors. After completing the free running elimination procedure run the laser in the adjustment mode and re-check the spatial distribution of the beam with a high resolution IR card and photo-paper. Adjust the cavity mirrors if necessary (see 0 Optimization of the Profile).

Optimization of the Profile

Switch on the laser. Make sure there is no free lasing in *EO OFF* mode. Check spatial distribution using an IR card with high spatial resolution (white ceramic card for instance). Adjust the end mirror angle to get a circular spot (Figure 9, *a*) that is spatially limited within the aperture of the laser rod.

Usually it is enough to adjust the end mirror to restore laser cavity alignment but if oscillator's output coupler was misaligned or changed it might be necessary to adjust it. The beam has a slight minimum of intensity (Figure 9, *a* - arrow) where it passes the output coupler spot of maximum reflectivity (at the geometrical center of the output coupler). When the beam position is correct this minimum must be at the center of the beam distribution. Adjust both mirrors in order to get the correct beam position (centered in the rod / circular, and minimum centered in the beam).



a *b*

Figure 9 Typical NL300 oscillator beam profile a) with OC center shown; b) OC of NL300 with center shown

First, make sure that output coupler is positioned correctly (section 0 Output Coupler). After you are sure that OC is in a correct position, adjust the back mirror (RM) to get the round profile, then adjust the front mirror (OC) to misalign it and compensate with RM to get the round profile again. If you see that center of OC is getting further from geometrical center of the profile, adjust OC in another direction (misalign the profile with OC while turning adjustment screw to the other direction). Repeat the procedure for both coordinates. Usually it takes quite a few iterations to get correct profile.

2.1. Replacement of the Oscillator Elements

Before replacing any of the NL300 oscillator's elements make sure there is no free running (see 0 Elimination of the Free Running) and optimize the beam profile (see 0 Optimization of the Profile). Even if oscillator is generating lower energies, or the beam is distorted due to some damaged optics, still try to achieve as best performance as you can. It is much easier to adjust one element after replacement that to realign the whole resonator. If, however, oscillator is not generating anything due to damaged element, replace the element and proceed with the instructions in section 0 Oscillator Adjustment when no Generation is Present.

2.1.1. Flash lamp

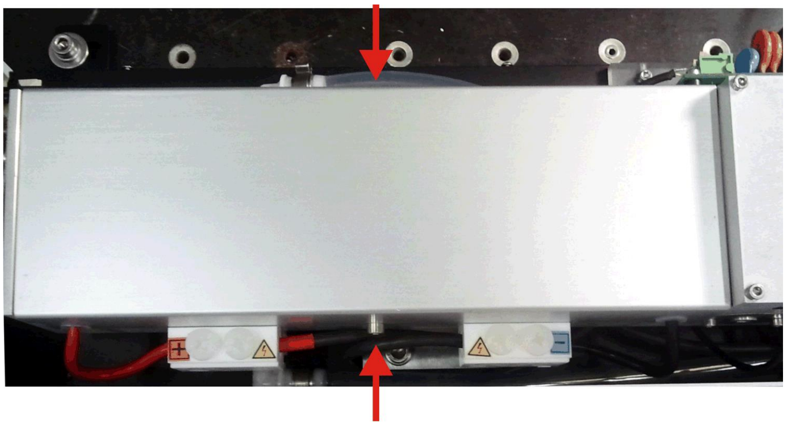
If you notice that oscillator output is lower than it should be, even if oscillator is aligned properly and no contamination observed, it means that flash lamp pumping energy has decreased. This is normal effect due to flash lamp ageing. To compensate for energy loss, you can increase flash lamp voltage with potentiometer *VOLTAGE* on the power supply. However, if voltage increase for more than 10 % above the factory pre-set voltage, it is time to replace the flash lamp. Usually one flash lamp last for > 20 million shots (actual number of shots depends on factory voltage, repetition rate, etc.). Replacement of the flash lamp must be performed only when cabinet is isolated from the mains. To replace the flash lamp, follow these steps:

<u>Warning!</u>
<u>Failure to follow this procedure may lead to injury and severe equipment damage. Always wear safety goggles to protect the eyes from flying debris—the flash lamp can potentially explode.</u>

<u>This procedure must be performed only with cabinet isolated from mains.</u>

<u>Pockels cells and harmonics crystals are highly hygroscopic. Take special care to keep the moisture away from them when replacing flash lamps.</u>

1. Make sure the laser system is switched off and isolated from mains supply.
2. Allow at least two minutes to elapse since disconnecting mains.
3. Open laser head cover.
4. Release the fast connector on a coolant supply hose. Since the cooling unit pump is off, the water will drain down the lines quickly if cooling unit is placed below the laser head. If not, ensure that the water will not spill on optics and electronics. Apply the connector back.
5. Unscrew two fixing screws on the sides and remove the laser chamber compartment cover.



<u>Figure 10 Laser chamber compartment cover</u>

6. Unscrew six screws fixing the upper part of the laser chamber (pointed by green arrows in Figure 11. Do not release the four screws holding the underlying plate, pointed by red arrows!)

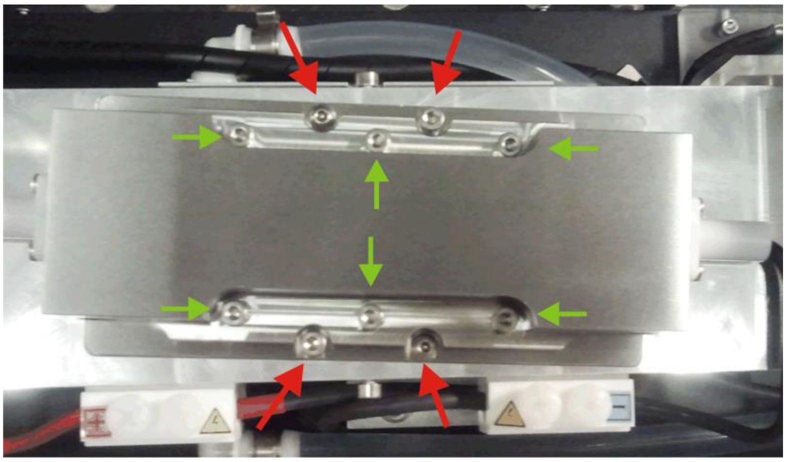


Figure 11 Screws fixing the upper chamber part

7. Remove the outer plastic bolts covering electrodes fixing screws (Figure 12). Release screws fixing the electrodes of the flash lamp. Disconnect electrodes.

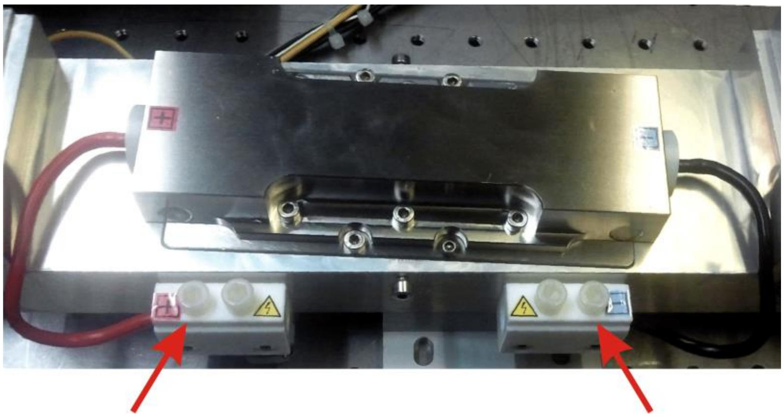


Figure 12 Disconnecting the electrodes

8. Lift the upper part of the laser chamber and put it on clean solid surface upside down. Rinse the residual moisture, if needed.

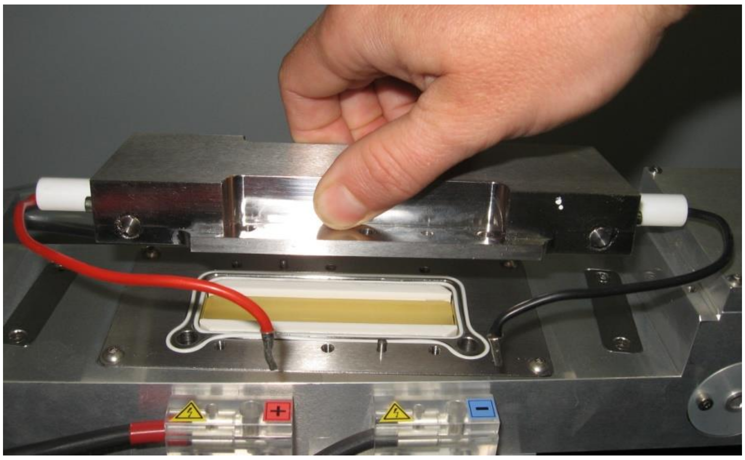


Figure 13 Lifting the upper part of the laser chamber

9. Release the screws fixing the lamp end caps, see Figure 14.

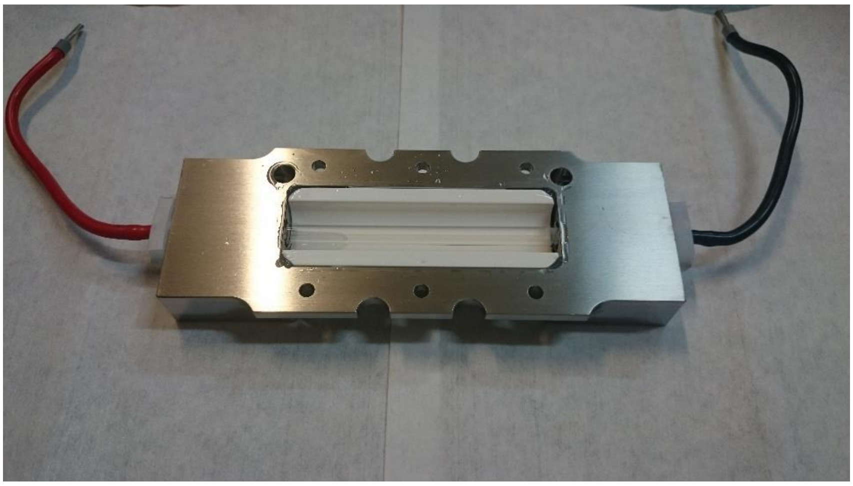


Figure 14 Removing lamp end caps

10. Carefully pull the lamp out; see Figure 15 . If necessary, gently work it to make the silicon seals release. Be careful to avoid any bending force that may break the lamp.

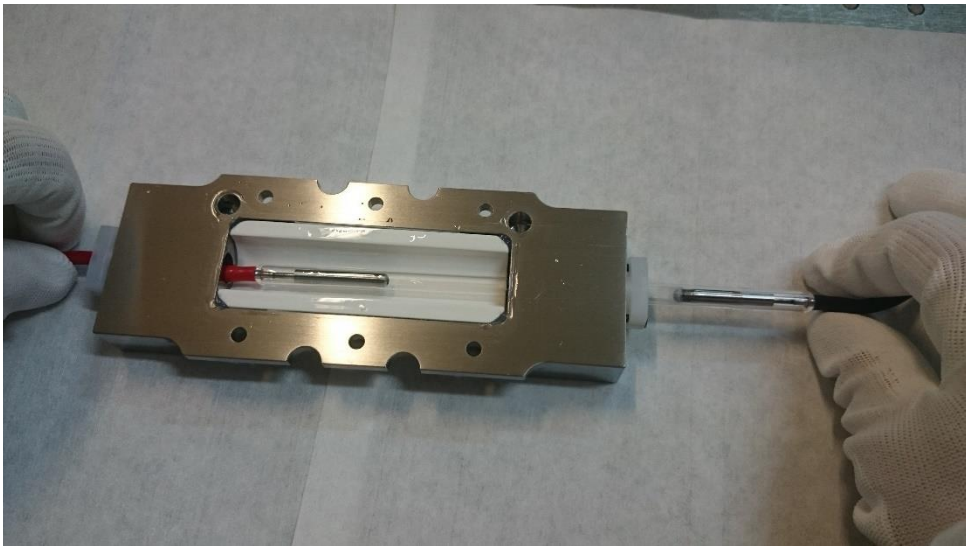
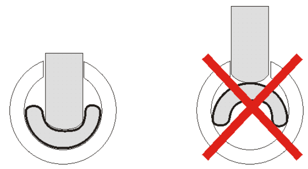


Figure 15 Pulling the lamp out

11. Cleanse a new flash lamp with methanol or acetone and insert it into pump chamber. Take care to ensure correct polarity: red painted end is positive.
12. Tighten lamp caps properly with same force, do not over-tighten.
13. Make sure that silicon seal is properly placed in its channel.
14. Return the upper part of the chamber to its place and fix by screws. Make sure that seal channel position matches on both upper and lower parts.

15. Reconnect the electrodes. Put back the plastic bolts.

    Attention:
    Ensure that a contact layer inside is facing outwards from electrode. Otherwise electrodes may burn out because of a resulting small contact area.



16. Connect the power supply to mains and wait for ~10 min for crystals to warm up.
17. Switch on the power supply, press button *Service* on the power supply. For some power supplies you may need to press RUN to start water pump. Once pump started press Stop to stop the laser firing. Watch 1…2 min for water leakage to appear at the lamp plates. If leakage detected, switch the power supply unit off and eliminate the reason of leakage.
18. Place back the laser chamber cover; secure it with the screws.
19. As a precaution measure, decrease the lamp pump voltage to ~50V below the factory setup (see User manual, chapter *Factory Settings*) in order to prevent the optics damage in case the laser is over-pumped by the new flash lamp, which emits more light than the old one. If the setup value is unknown at the time of replacement, decrease voltage to ~200V below the last used. Start operating and increase flash lamp voltage until you obtain specified output energy.

Rod replacement

To inspect the laser row you have to ignite flash lamp's simmer glowing. To ignite the simmer, turn the key switch *POWER* to position *ON* and press *RUN* → *STOP* on the control pad. There should be a light glow from the rod, but **the laser should not be firing!** The surfaces of the output mirror and rod will be readily seen through the laser RM mirror.

If you see any dots on the rod surface, it is necessary to take the rod out and clean it (or if the rod is damaged - replace it). To access the rod, follow these steps:

1. Make sure the laser system is switched off and isolated from mains supply.
2. Allow at least two minutes to elapse after disconnecting mains, or capacitors to discharge.
3. Open laser head cover.
4. Unscrew two fixing screws and remove the laser chamber compartment cover (see Figure 10, marked with red arrows).
5. Release six screws (pointed by green arrows in Figure 11) fixing the upper part of the laser chamber. That should be done to let water out of the laser head. Make sure water leaked out. Then tighten the released screws back again.
6. Release the fixing electrodes of the flash lamps and disconnect electrodes.
7. Unscrew four screws fixing the laser head (pointed by red arrows in Figure 11).
8. Carefully pull the laser head out.

To clean the rod surfaces, try to blow any detected dust particle(s) away using pressurized gas (filtered dry nitrogen). If not available, attempt cleaning the surface with a lint-free cotton swab moistened with a few droplets of pure acetone or ethanol. Use cotton swabs only with wooden or plastic stems. In case the contaminants endure, the drag method of cleaning can be used. That is, slowly drag a lens tissue or cotton swab saturated with isopropyl alcohol or ethanol across the surface. If done correctly, the solvent will evaporate uniformly without leaving any streaks or spots. To make the rod surfaces easily visible, illumine one end of the rod and look through the other at a dark background, as shown in Figure 16.

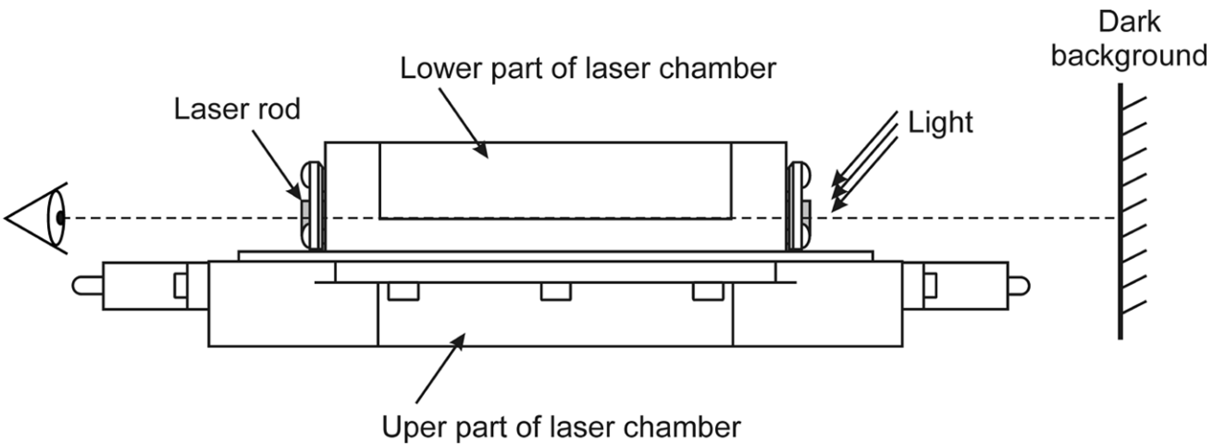


Figure 16 Inspection of the rod's surfaces

If all attempts to clean it result in failure, or if the surface is damaged, the laser rod needs to be replaced. As the rod ends are cut at an angle, the laser chamber must be orientated not parallel to the resonator axis, but so that the rods end surfaces are vertical. For proper orientation, it is convenient to use an auxiliary visible-light (VIS) laser as shown in Figure 17 (top view). Access to the laser rod as described above and then follow these steps:

1. Place the head on a flat surface (with the old rod) and fix it so that it won't move.
2. Guide the auxiliary VIS laser beam through the center of the rod.
3. Mark the position of the reflected beam (the further the better).

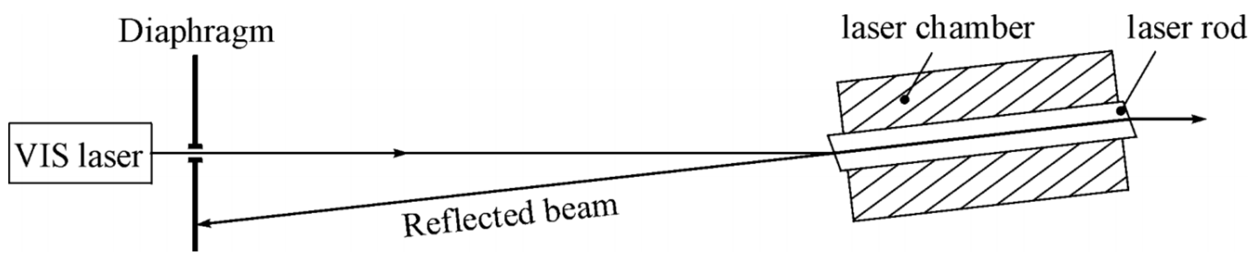


Figure 17 Laser rod orientation

4. Pull the rod out and replace it with the new one. The rod ends must be equally placed from both sides of the pump chamber. Do not touch the rod ends with your fingers.

Finger-prints left on the rod ends will cause bad laser operation, and lead to rod surface damage.

5. Pull silicon O-rings onto the rod ends.
6. Replace the rod pressure plates and screws, but do not tighten.
7. Turn the laser rod around its axis until the reflected beam travels at the same height as with the old rod. Horizontal position of reflected beam might differ a bit due to slightly different cut angles.
8. Tighten the screws of the rod pressure plates at both ends of the laser chamber. Alternately tighten the screws one turn at a time, to evenly compress the silicon O-rings.
9. Place the laser head into the oscillator and fix all the screws.
10. Connect the water pipes to the laser chamber.
11. Switch on the power supply in *SERVICE* mode (cooling unit is on, but voltage of the flash lamps is off). For 1-2 min, watch for leakage to appear at the rod pressure plates. If leakage detected, switch the cooling unit off. Remove the leaking pressure plate. Examine the O-ring for any damage. If defective, repair or replace with a new one. Check for leakage once again.
12. Put the laser head cover and secure it with the screws.

Replacing the laser rod may cause misalignment requiring readjustment of cavity mirrors and Pockels cell. After completing laser rod replacement, it is very important to check adjustment of the laser cavity and confirm that there is no presence of free-running generation. Perform the procedures described in 0 Elimination of the Free Running and 0 Optimization of the Profile, if necessary.

Polarizer

Replacement of a polarizer is quite straightforward and easy. You may find optimal position by finding maximum output power in a free running mode or by a minimum generation threshold. Adjusting by a maximum energy is easier, but adjusting by a minimum generation threshold is more precise. To replace the polarizer, proceed as follows:

1. Disconnect Q-switch synchronization cable (*1* in Figure 18).
2. Unscrew polarizer holder screws (*2* in Figure 18).
3. Remove the polarizer holder from another side of the oscillator.
4. While heating with a hot air fan set to 150 ^{o}C, gently remove the polarizer. Try not to move the ND filters near the polarizer.
5. Clean all the glue from polarizer holder.
6. Install new polarizer using the two-component epoxy glue.
7. Put the holder back to the oscillator and slightly tighten the screws.

8. Turn on the laser.

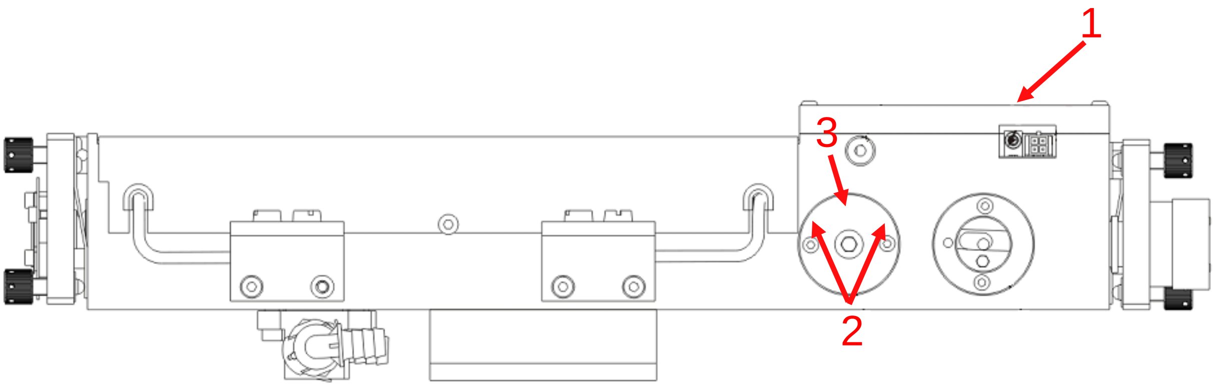


Figure 18 Side view of the NL300 oscillator

9. If you are adjusting by a maximum power: slightly tuning polarizer with an Allen hex key (*3* in Figure 18) find the position for maximum output power (use power or energy meter).
10. Tighten the screws (*2* in Figure 18).
11. Adjust the rear mirror for optimal beam profile.
12. If you are adjusting by minimum generation threshold: reduce the pumping voltage so that free running generation from the laser would be barely visible on sensitive IR card.
13. Adjust the position of polarizer (*3* in Figure 18) so that laser generation would be strongest.
14. Reduce pumping voltage again and repeat step 10. Repeat this procedure until you find best polarizer position.
15. Return pumping voltage to its original value.
16. Adjust the rear mirror for optimal profile.
17. Turn off the laser.
18. Plug the Q-switch synchronization cable back to the oscillator (1 in Figure 18) and check the energy of the oscillator.

After replacing the polarizer, it might be necessary to optimize the beam profile and eliminate free running. Perform the procedures described in 0 Elimination of the Free Running and 0 Optimization of the Profile, if necessary.

Pockels Cell

If it is necessary to replace Pockels cell, remove its holder (Figure 19), like polarizer holder in chapter 0 Polarizer, and put a new Pockels cell on the holder. Install new Pockels cell onto its holder and put it in an oscillator along with washers and tightening plate. One washer goes between Pockels cell heater and oscillator frame and another one goes between oscillator frame and tightening plate.

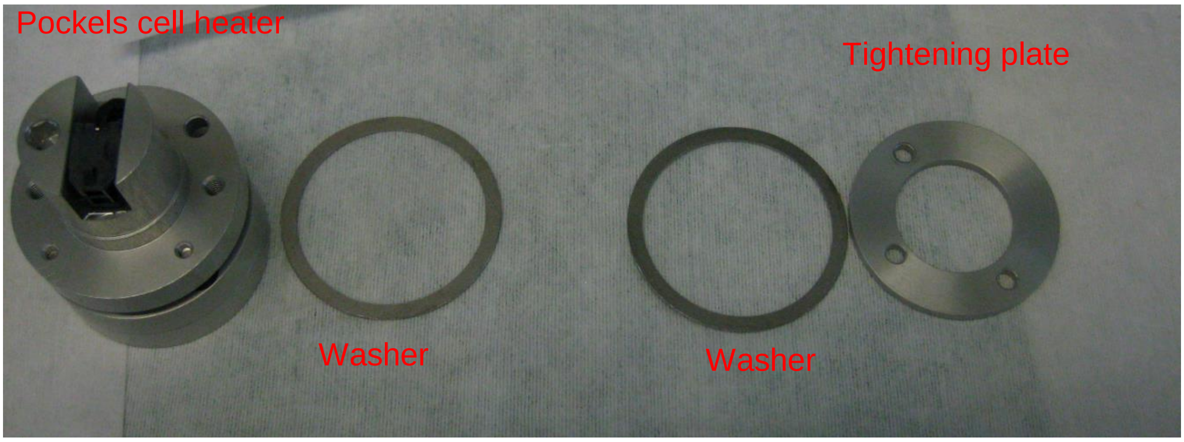


Figure 19 Pockels cell holder (heater) with washers and tightening plate

Turn the PC vertically with a 5 mm Allen key (*4* in Figure 8) in order to see the maximum aperture of the crystal in the vertical direction. Release the screws fixing the PC to the holder, move the crystal up or down to see it vertically centered with respect to the laser rod (Figure 20). Tighten the fixing screws. If it's necessary to move PC holder horizontally to align it horizontally centered with respect to the laser rod, you have to remove Pockels cell with its heater and add or remove washers placed between the aluminum body and the PC holder.

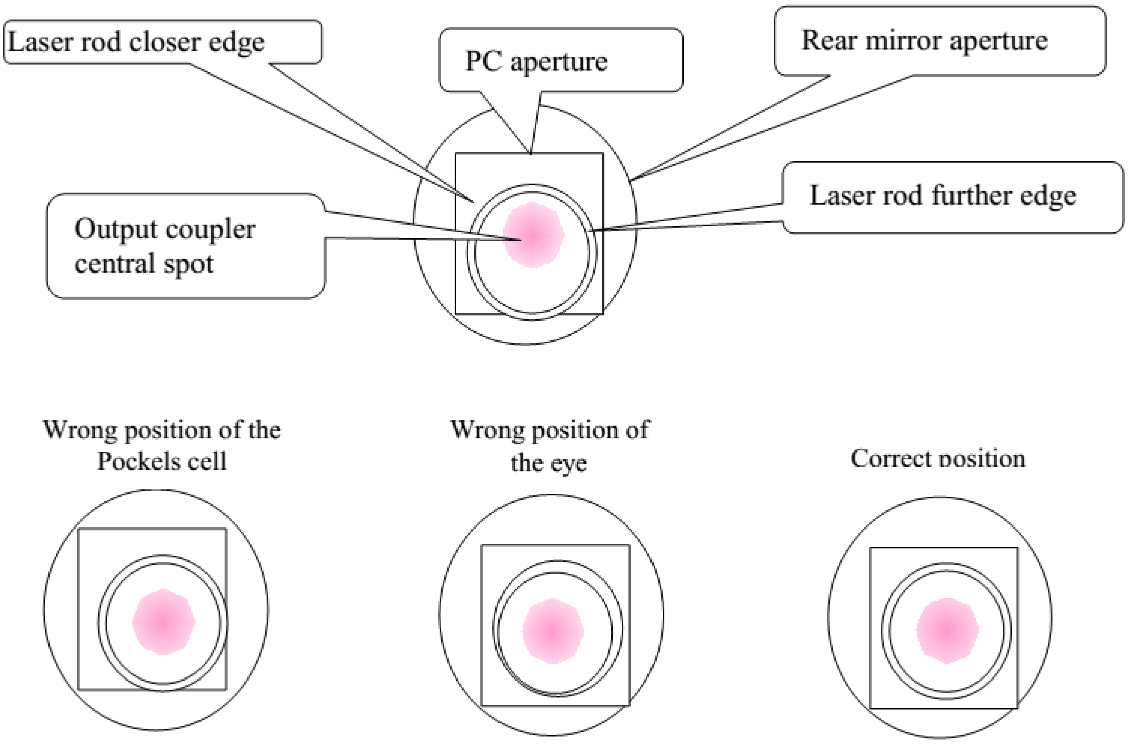


Figure 20 Positioning of Pockels cell

After the Pockels cell has been replaced, or after the laser cavity has been adjusted, it needs to be adjusted. For a coarse adjustment please follow these steps:

1. Release the fixing screws (*3* in Figure 8) so that you could turn the PC holder around the horizontal axis using a hex key (*4* Figure 8).
2. Put one thin film polarizer between polarizer (*P* in Figure 5) and Pockels Cell (*PC* in Figure 5) and another film polarizer between Pockels cell and rear mirror (*RM* in Figure 5). Polarizers should be crossed.
3. Switch on the laser and ignite the flash lamp simmer by pressing *RUN* → *STOP* on a control pad. Flash lamp should be simmering but the **laser should not be running!**
4. Look through the rear mirror (RM) of the laser. You should see a dark cross like in Figure 21. If you see an illuminated cross instead, rotate one thin film polarizer by 90 degrees.

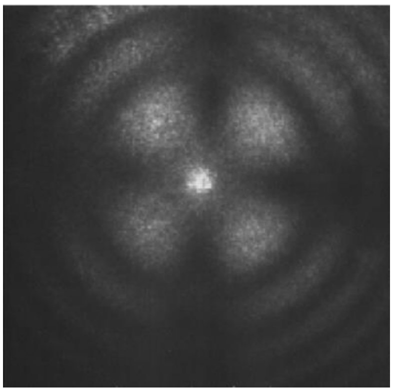


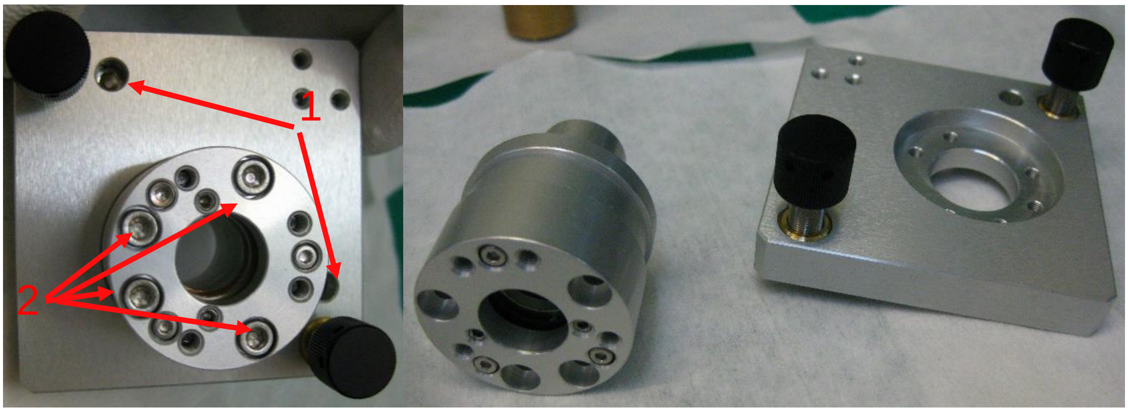
Figure 21 Depolarized 'cross'

5. Move the Pockels cell holder vertically (*4* in Figure 8) and horizontally (*5* in Figure 8) to get the 'cross' to the center of laser rod. Make sure your eye position is correct (Figure 20).

After completing PC adjustment, it is very important to recheck the laser cavity alignment (see section 0 Optimization of the Profile). Any movement of the Pockels cell may cause misalignment requiring readjustment of the cavity rear mirror. For fine Pockels cell adjustment follow instructions in section 0 Elimination of the Free Running.

Rear Mirror

To replace the rear mirror you have to remove its holder from the oscillator. Remove four bolts (*2* in Figure 22, *a*) that holds the inner part of RM holder and take it out (Figure 22, *b*).



a *b*

Figure 22 Rear mirror (RM). a) holder; b) its disassembly

After the inner part of RM holder is removed unscrew four screws (3 in Figure 22, *b*) and remove tightening cap. Now you have access to RM. Simply remove the old mirror and put new one in. Curved surface of the mirror (marked with an arrow on the edge of the mirror) should face towards the oscillator. Now assemble RM holder back and put it on the oscillator. Don't forget to put 3 mm metal ball back to its place.

After the new mirror is installed it will be necessary to optimize the profile, for this follow instructions in section 0 Optimization of the Profile. If the beam became elliptical after RM replacement it is necessary to compensate thermo-induced astigmatism with RM. For this follow these steps:

1. Turn on the laser in adjustment mode.
2. Check spatial distribution at a 3…5 m distance from the laser, using high resolution IR card and photo-paper.
3. Using 1.5 mm Allen hex key, adjust both of two screws on the rear mirror holder (Figure 23) in order to get spatial distribution as close as possible to circular.

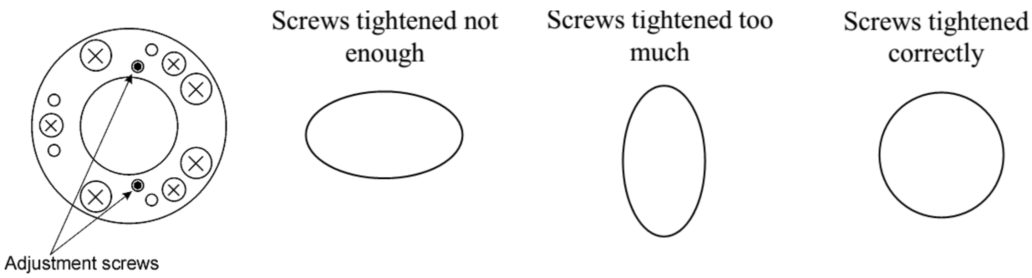


Figure 23 Compensation of thermo-induced astigmatism

Output Coupler

Replacement of output coupler is a bit more difficult than RM. This is due to that OC has variable reflection across its aperture. In the center reflection is maximum (Figure 9, *b*) while in the corners reflectance is lower. Before replacing the OC please make sure that oscillator is optimized for best performance (chapters 4.2. and 4.3.). To replace the OC follow these instructions:

1. Unscrew two screws that on the OC holder (1 in Figure 24).
2. Remove OC holder from the oscillator (be careful not to lose 3 mm metal ball).

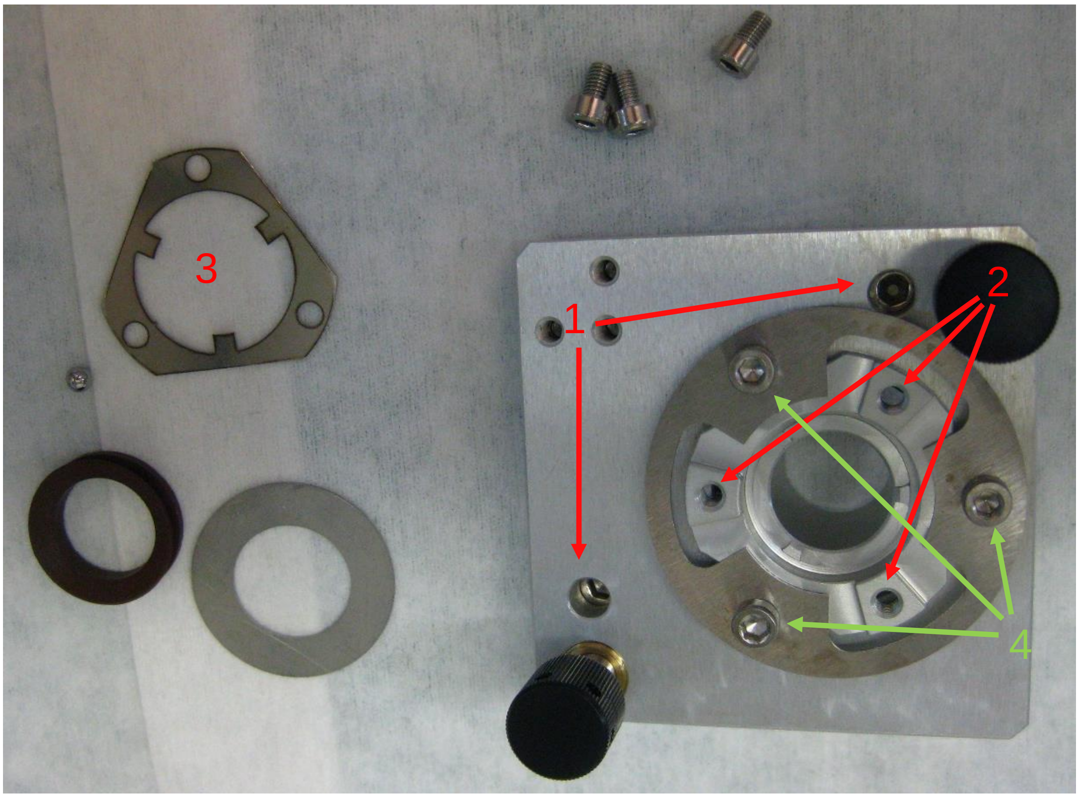


Figure 24 OC holder disassembled

3. Remove three screws that are holding metal spring (*2* in Figure 24) and remove the spring (*3* in Figure 24).
4. Remove the OC and put a new one.
5. Assemble OC holder and put it back to the oscillator.

Now we need to adjust OC position so that the geometrical center of OC would be in the same position as laser rod.

6. Switch flash lamp simmer on by turning the key switch to ON position and pressing *RUN* → *STOP* on the control pad. The lamp should be on but the laser should be not firing.
7. Illuminate output coupler by table-top lamp straight through a diffuser (a piece of white tissue is suitable) as shown in Figure 25.

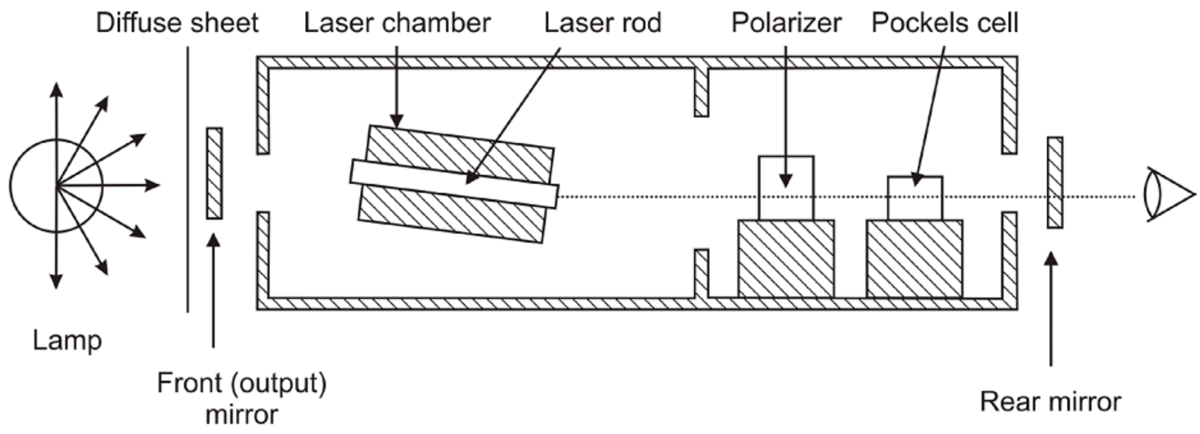
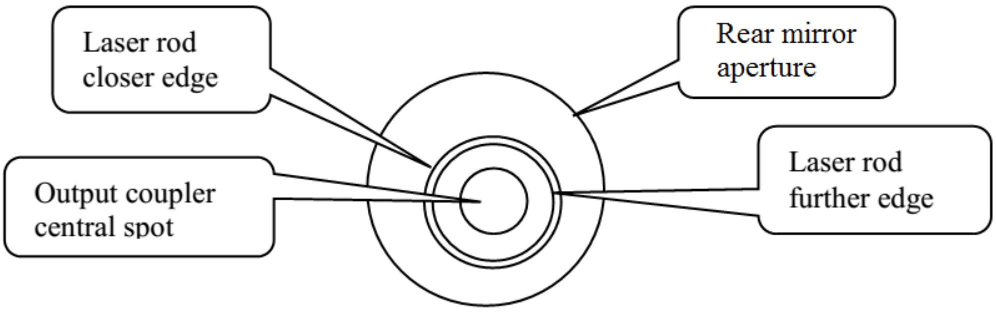
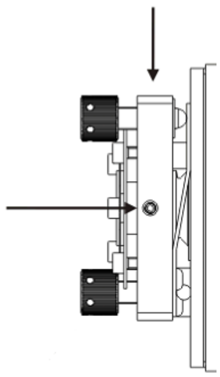


Figure 25 Illumination of the output coupler

8. Look through the rear mirror. You should see something as in Figure 26, *a*.



a



b

Figure 26 a) View through the RM, b) top view of OC holder with adjustment screws marked

9. Release three screws (*4* in Figure 24) to loosen OC holder just enough for the holder to move.

10. While observing the view through RM (Figure 26, *a*), adjust the position of OC with adjustment screws ((Figure 26, *b*).

11. Adjust the position of OC so that the center of OC would be in the center of laser rod (Figure 27).

12. Tighten three screws (*4* in Figure 24) back and check the position of OC again.
13. If position of OC has shifted repeat the procedure.

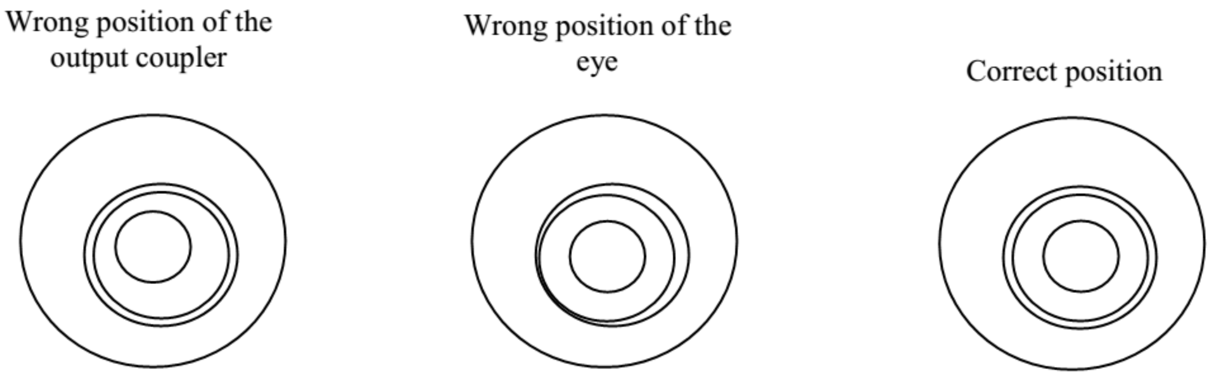


Figure 27 Adjustment of the output coupler

Oscillator Adjustment when no Generation is Present

Usually NL300 oscillator does not misalign to the extent where it won't generate at all. However, if after replacing one (or both) of the cavity mirrors you don't observe any radiation from the laser, it becomes quite problematic to restore the laser operation. You will have to realign the cavity completely. To do so, please follow these steps:

1. Remove the Pockels cell and polarizer from the cavity (it is not necessary to remove the polarizer if it is already aligned).
2. Direct an auxiliary visible (VIS) laser beam into the laser cavity through the output mirror, as shown in Figure 28.

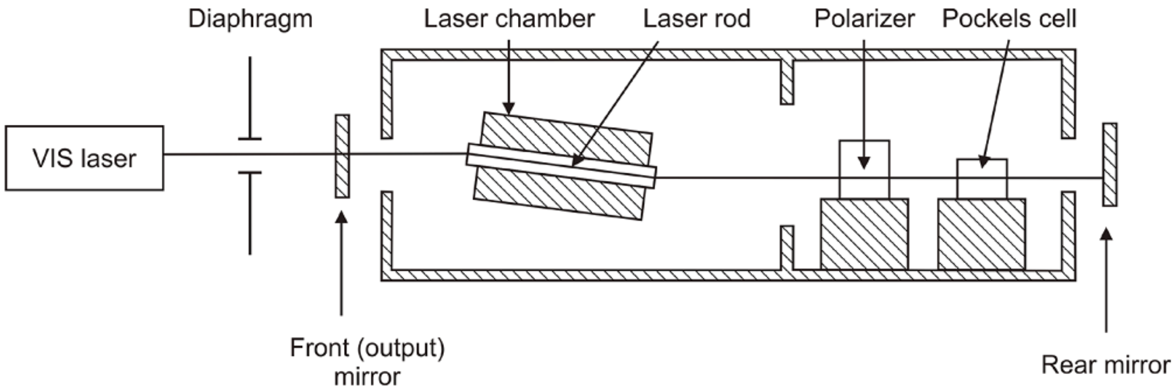


Figure 28 Beam position alignment

3. Near the VIS laser, place a diaphragm with an aperture of ~1.5…2 mm.
4. Direct a visible laser beam approximately through the center of the laser rod.
5. Adjust the rear mirror and output coupler (turn the adjustment screws of their holders) to make the reflections from them hit back into the diaphragm's aperture.

After cavity mirrors have been adjusted to the generation axis, the laser should generate the free running. If it still does not generate anything, increase the pump voltage by 100 V (but no more than 20 % above the factory set value, consult the User manual). When you get the laser generating free running, optimize the profile (section 0 Optimization of the Profile); then, if you have removed the polarizer, install it back (section 0 Polarizer), install Pockels cell (section 0 Pockels Cell) and perform the fine adjustment of the PC (section 0 Elimination of the Free Running).

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SH AND TH GENERATION, OPO GUIDING OPTICS

NT342 Optical Layout

Optical layout of the NT342 system is presented in the picture below. The numbering of optical elements in this picture further is used as a reference.

> *Note*
> *Please note, that actual numbering in some systems may differ. The functional purpose and placement of optical elements, however, should still corespond to the Figure 29.*

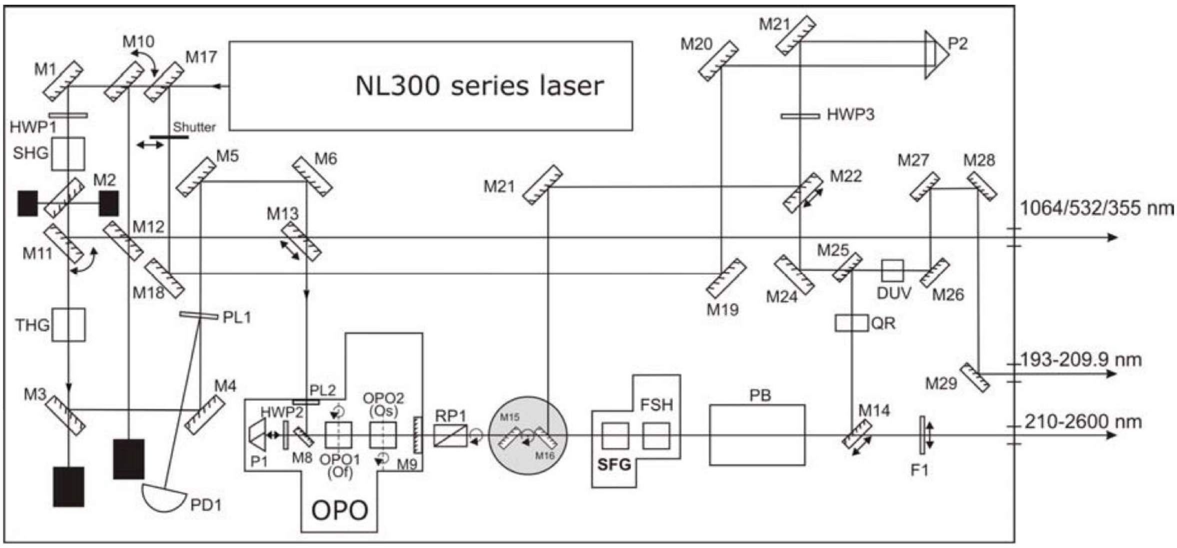


Figure 29 Standard optical layout of NT342 system. Full version is shown; 1H/2H, SH-SFG and DUV options

HWP1 Replacement and Alignment

HWP1 (Half wave plate) allows to adjust the beam polarization from vertical to horizontal. This is needed for optimizing the THG efficiency.

Optimize the SHG (Second Harmonic Generator) and HWP1 while maximizing the pulse energy of 532nm. THG (Third Harmonic Generator) must be removed during this procedure.

After the SHG crystal is aligned, do not attempt to adjust it again. Place the THG in the holder. Adjust the THG and HWP1 while maximizing the pulse energy of 355nm. After adjustment, tighten the HWP1 holder.

When HWP1 is adjusted to maximize the output of 532nm, the output of THG (355nm) will be very poor. This is because too much of 1064nm photons are converted to 532nm and the intensity of 1064nm is too low for THG. Misaligning the SHG would partly restore the intensity of 1064nm and as a result the intensity of THG 355nm but the pulse to pulse stability will be lower. This is because the SHG crystal is misaligned and works on the slope of efficiency. For the stable operation, it is essential that both SHG and THG would be adjusted on the peak of efficiency.

SHG/THG Crystal Replacement and Alignment

1. Pay attention to the arrow on the SHG holder. The crystal must be oriented so that the arrow would point to the direction of the laser beam.
2. Connect the heater.

   Attention
   The Molex connector is not symmetrical and polarity is critically important!

3. The red LED must switch on if connected properly. Wait several minutes until the LED starts blinking, which means the temperature is elevated and stable.
4. Use the dedicated 532nm output to measure the pulse energy of SHG.
5. Adjust the alignment screw while searching for maximum pulse energy of SHG.

   Attention
   There are multiple maximums of harmonic efficiency. You have to find the center highest maximum. The advice is to try to adjust the crystal to both directions searching for the peak of maximum efficiency.

The holder of SHG or THG could get stuck and will not adjust the angle of crystal while turning the adjustment screw. This could happen when the adjustment screw reaches the end and the pellet gets trapped inside the mount. This situation can be recognized if the output of 532nm does not change in full range of adjustment screw.

Plugging the power connector by force in opposite way will result in reverse polarity and the heater will get damaged. After connecting the heater to DC supply the LED must turn on. If the LED is not on, inspect the Molex connector. Both pins should be same level in depth and you should get 12V on Molex connector pins. Otherwise, contact Ekspla service department.

THG replacement or alignment is the same as SHG replacement or alignment. The only difference is that THG adjusted in vertical axis while SHG adjusted in horizontal axis.

M3, M4, M5, M6 Replacement and Alignment

Note
Please also refer to the section 0 General Rules for the Laser Adjustment.

Before dismounting the mirror, place the target to mark the position of the beam in a distance. The greater the distance of the target from the mirror – the more accurate the result of adjustment.

Dismount the mirror leaving the holder without any adjustment.

Place the new mirror. If needed, adjust the holder in order to hit the center of the target.

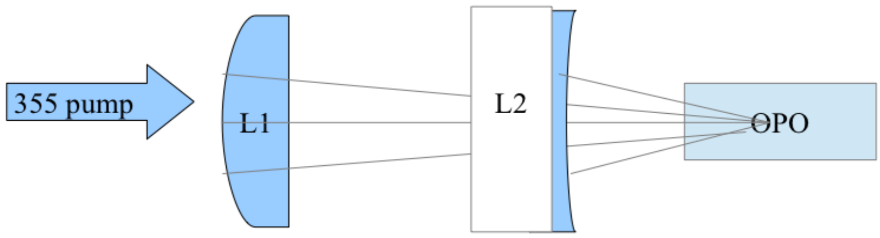
L1, L2 Replacement and Alignment

L1 and L2 together makes the telescope, which usually decreases the beam spot size by 25%. The difficulties of aligning the L1 and L2 are:

- The orientation of the lens must be taken into account in order to protect the OPO crystals.
- The 355nm pump beam must enter through the center of both lenses.

The distance between the lenses must be set very precisely for perfect beam collimation.

INCORRECT WAY



CORRECT WAY

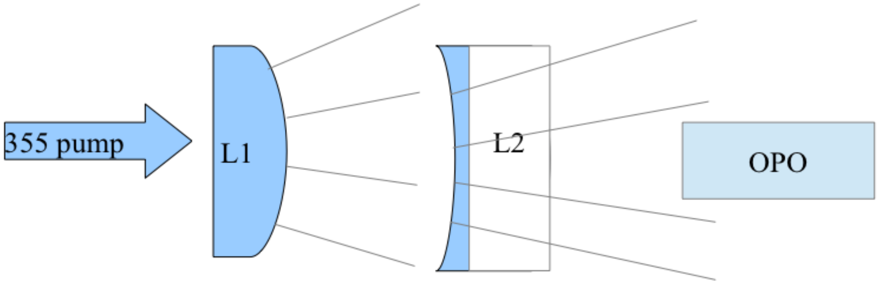


Figure 30 L1, L2 orientation

For the proper L1, L2 replacement remove the whole OPO box from the laser base. Mark the position of OBO box before removing it. Also, remove the side cover of the laser case. As a result - the beam reflected from M6 will leave the laser housing. Place a proper beam dump and be aware of the laser safety!

Do not unplug the cable of the step motor while the PG unit is ON. Switch off the laser and only then unplug the step motor cable.

Proper placing the lenses in the holder is very important. Usually L1 and L2 lenses have one flat surface and one curved surface. The danger of curved surface is that it might work like concave mirror. The surfaces of lenses are anti-reflected, but 0.01% reflectivity might still be enough to damage the OPO crystals. As a solution – the lenses must be oriented in a way that the reflection to the OPO crystal will be diverging as shown in Figure 30.

After lens replacement it is necessary to collimate and align the pump beam. To do this follow these steps:

- Mark the positions of L1 and L2 holders. After L1, L2 replacement the holder positions will be very similar. Markers will help to estimate the position and distance between L1 and L2.
- Remove L1 and L2 holders from the rail.
- Run the laser in ADJ mode with low energy output.

- Mark the 355nm spot outside the laser housing (big sheet of white paper works the best). Do not place the target too far. Approximately one meter is a proper distance.
- Insert the L2. The spot on the target will be expanded (it should be easily seen on a white paper sheet). Adjust the lens horizontally and vertically to make the big spot centered on the target. Fix the lens position in the holder. Fix the holder to the rail.
- Set laser to the *OFF* mode. Insert the L1 holder. Set the distance between lenses to be similar as before replacement. Run laser in ADJ mode.
- Adjust L1 horizontally and vertically in order that 355nm would hit the center of the target. Fix the lens in the holder.
- Adjust the distance between lenses with L1 so that the 355nm beam would be collimated (beam size must be the same in various distances). Fix the L1 holder to the rail.

Place the OPO box back to the laser. The 355nm pump beam must go through the center of the OPO crystals. Also it must go through the centers of SFG and FSH crystals. Remove RP1 (This allows for the 355nm beam leaked through M9 to go further to the SFG and FSH crystals.)

After this procedure the OPO is aligned very roughly and most probably OPO will not provide the full pulse energy. Please refer to 0 Optical Parametric Oscillator Unit (OPO) for the further actions.

Pump beam (THG) alignment

1. Set Adj mode. Use low energy pulses and set the wavelength at 500 nm for this procedure.
2. Place the target (you should have it from Ekspla with a pinhole at 50 mm height. One side is IR visualizer of a yellow color; another side is white) after the M3, so that the 355 nm UV would hit the center of the yellow side of the target.
3. In an ideal case, the reflection from M9 goes exactly back to the pinhole of the target and cannot be seen. Please check the UV at the beam dumps near M2 (refer to Figure 29).
4. If there is a spot of UV near the correct dump and there is no visible spot of UV on the white side of the target the alignment is correct.
5. If there is a UV spot on the target – adjust the last mirror before telescope (L1, L2) in order to guide the spot to the center of pinhole. This mirror should be M6 or M7.

Setting the OPO Optical Zero

There are two OPO crystals in the parametric generator. They function together at the same time so it is essential to have them properly aligned to each other. They are referenced as ‘crystal 1’and ‘crystal 2’ further.

1. Set wavelength of Optical Zero to 532.1nm.
2. Use *ADJ* mode and low energy pulses.
3. Rotate crystal 1 out of the phase matching angle. This might be done through UniPG software (2 degrees) or control pad (500 steps) depending on the model.
4. Fine tune crystal 2 in order to detect the green light generation.
5. It is important to set correct pump energy. If the green light generation cannot be found, increase the pumping a bit. If the green light generation occurs in a wide range of steps, reduce the pumping. If the OPO generates even more wavelengths than green, reduce the pumping until only green light is generated.
6. While tuning the crystal 2, one maximum of green light generation should be found. Don't worry of its instability. It should be not stable and randomly blinking as the pump is on the threshold of OPO generation.
7. Set the crystal to the maximum of generation and write down the step motor position of crystal 2.
8. Set both OPO motors to the initial values.
9. Now the same procedure should be done for another OPO crystal.
10. Rotate crystal 2 500 steps (for control pad adjustment) or 2 degrees (for UniPG adjustment).
11. Fine tune crystal 1 in order to detect the green light generation.

12. Set the crystal to the maximum of generation and write down the step motor position of crystal 1.
13. Enter found positions for both motors and measure the output energy at full pumping power.
14. Compare the energy to the previously measured. If the energy is higher, save the adjustment.

While fine tuning the crystal it is possible to accidentally align it with another crystal which is turned 500 steps away. In such situation OPO will start to generate the output which can be mistaken for the optical zero. But the generated wavelength will not be similar to 532.1nm (it will be other color). This situation can occur when both crystals are set ~500 steps from Optical Zero simultaneously. This can be recognized by the OPO output color.

OPO1 and OPO2 replacement

There is an arrow marked on the OPO crystal. The arrow must point to the output of the OPO. Crystal side with the arrow mark must be orientated towards to the step motor.

Do not rotate the OPO holder for a full rotation. A heater wire is near the axes of the motor and rotating OPO holder for a full circle might damage the wire.

SECOND HARMONIC MODULE

In NT342 systems second harmonic unit (Figure 32) converts the OPO-emitted light (from 420 nm to > 2000 nm) to the second harmonic and extends the adjustable wavelength range down to 210 nm. There are two nonlinear crystals in SH module; each crystal works separately and is responsible for approximately half of the conversion range. When conversion occurs in one crystal the other one is acting just as a compensator to compensate beam walk off in the first crystal. Crystals are labeled as FSH (First Second Harmonic crystal) and SSH (Second Second harmonic crystal). Conversion in SH module is quite straightforward and strongly depends on OPO energy output. If OPO output is lower, then the SH output will decrease even more.

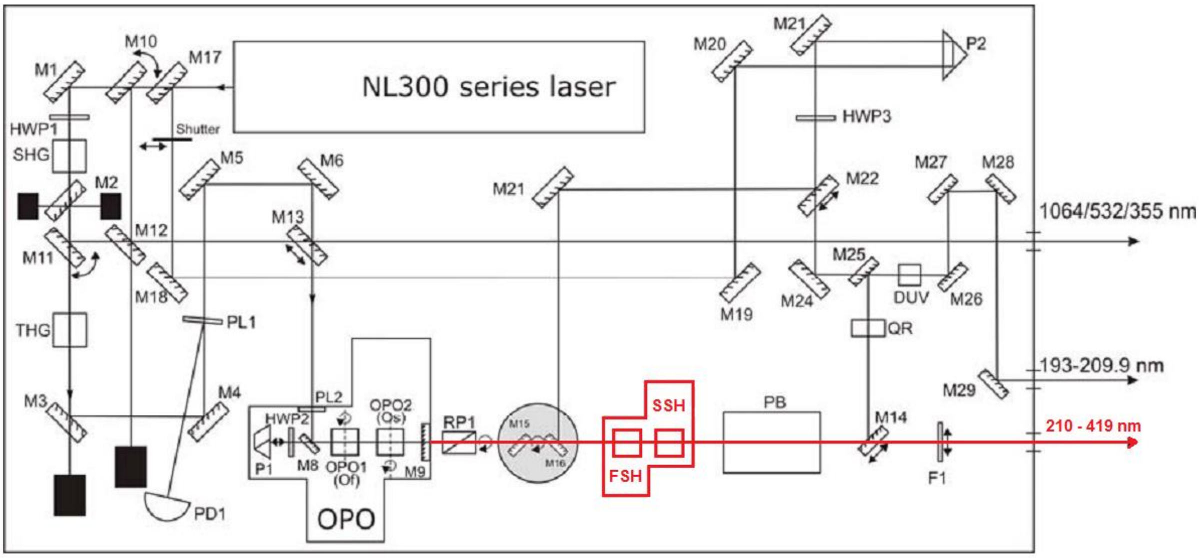


Figure 31 Optical layout of the system with SH module marked red

To ensure proper SH module functionality a few conditions should be met:

1. OPO energies should meet the specified values
2. Crystals should be clean and free of defects (section 0 Crystal Replacement below).
3. OPO beam should pass the crystals without clipping the holders and should be 50 mm high from the laser base (section 0 Guiding the Beam Through the Crystals).
4. Adjustment of the SH crystal angles should be correct for every wavelength (section 0 Adding Corrections).

To ensure that all three conditions are met, read the following chapters.

Crystal Replacement

To access the SH crystal remove the lid marked in Figure 31. Do this while the laser is switched off. After you’ve accessed the crystals rotate the holders using a tooth pick and inspect the crystals with a torchlight. If you see any dusts or contamination try to clean it with pure ethyl acetate.

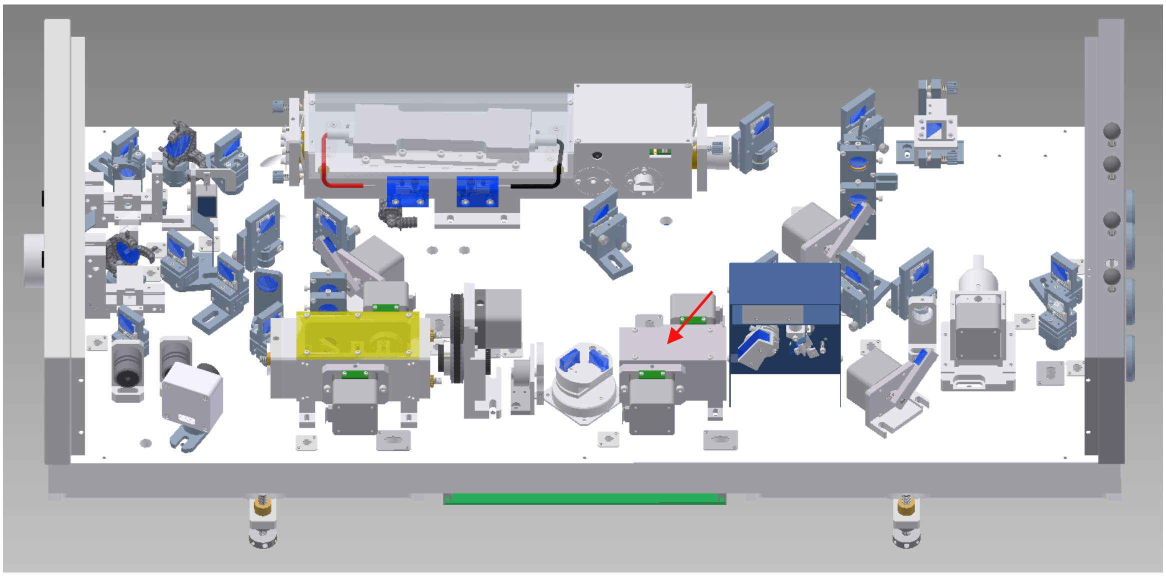


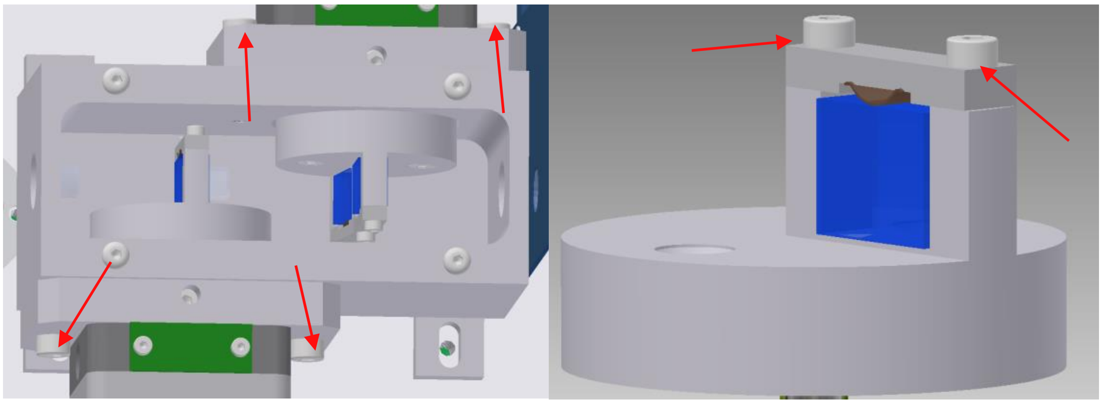
Figure 32 View of SH module within the NT342 system

Before replacing SH crystal it would be a good idea to take some photos of how they were fixed and what was the position/direction of the crystals. To replace SH crystal, remove crystal holders with motor from SH module first.

1. Release the fixing screws that hold SH crystal motor (Figure 33, a).
2. Take the motor out of SH module and place on a clean flat surface.
3. Remove the top of the crystal holder (Figure 33, b).
4. Carefully remove the crystal (replace one crystal at a time and note the position of arrow, or a dash on the crystal).
5. Put a new crystal to the holder (make sure that arrow, or a dash, on the crystal is in the same position as it was on the old crystal, as in Figure 34).
6. Put motor back to the SH module.

Same procedure works for the second crystal.

Please note that in NT342-SH models only two crystals are present in SHG module, but in NT342-SH/SFG lasers there may be three crystals. Two are for SHG and one for SFG. The SFG crystal is on the bottom of the second holder (when the laser set to SH wavelength range, e.g. 250 nm).



a b

Figure 33 a) Motor fixing screws marked by red arrow, b) SHG crystal holder

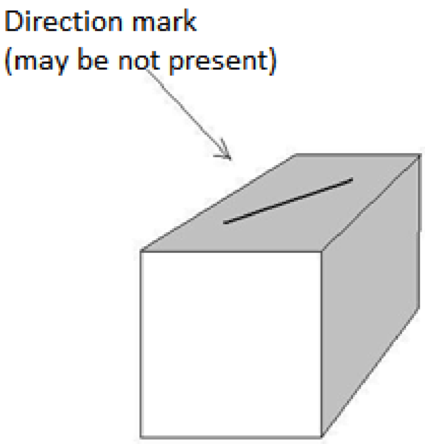


Figure 34 Direction mark on the SH crystal (may be not present in some systems)

After crystal replacement it is necessary to make sure that the beam passes though the crystals without clipping the holders (section 0 Guiding the Beam Through the Crystals). Also it might be necessary to correct Optical Zero position and add some corrections (section 0 Adding Corrections). To ensure the proper functioning of SH module, read those chapters and follow the instructions there.

Guiding the Beam Through the Crystals

Sometimes after OPO realignment or after SH crystal replacement the beam might not pass through the crystals without clipping. This occurs due to different OPO alignment. Even if you see that SH energies are within specified values clipping the holders is still dangerous since OPO beam will ablate the metal and debris will deposit on the crystals. This will result in premature crystal damage.

There might be two different misalignments – vertical and horizontal. If misalignment is vertical you have to realign OPO to get the beam to travel in 50 mm height (since SH crystals can move only in horizontal direction). However, SH crystals are clipped in horizontal direction, it might be possible to adjust the position of SH module for a beam to pass the crystals without clipping the holders.

Before continuing, make sure that OPO generation is optimized and beam divergence is within specifications.

To guide the beam through SH crystals follow these steps:

1. Remove the lid from SH module (Figure 32).
2. Set the wavelength to SH range (~250 nm) and lower the pump energy until you get low energy but stable OPO generation at ~500 nm (energy should be low enough not to ablate the plain paper).
3. Put a thin piece of paper between the first and second SH crystals (Figure 33, *a*).
4. Observe how the profile looks like. Normally ~90…95 % of the profile should pass the crystals and only the ‘cross’ tails should be clipped. The center of OPO beam should pass though the center of the SH crystal.
5. Put a thin piece of paper after second SH crystal and observe the profile again.
6. If OPO beam is not passing though the center of SH crystals or it is clipped by SH crystal holders, it is necessary to adjust the crystal position.
7. Before moving SH crystals, mark the position of SH module on the laser frame with a pencil. In a case of failure, SH module could be restored to its original position.
8. Release the four fixing screws holding the SH module.
9. Move the SH module while continuously checking where the low energy OPO beam passes through the crystals.
10. When a position where OPO beam passes through the center of SH crystals is found, fix the SH module back to laser frame.
11. Check the position of OPO beam again (SH module might shift a bit while tightening the screws).
12. Repeat the procedure if necessary.

This alignment procedure is for NT342 models where both SH crystals are positioned in one module (similar to OPO module). If SH crystals are on separate holders in your system, the alignment procedure is similar and only difference is that both SH crystals are aligned separately.

After completing OPO beam guidance though SH crystals it might be necessary to enter new optical zero positions and a few corrections (section 0 Adding Corrections).

Adding Corrections

If you experience an energy drop in some parts of NT342 wavelength range (or all of it), it might mean that phase matching condition in OPO and SH modules has changed. This can occur due to the changed position of the pump beam, misalignment in OPO resonator, or improper crystal mounting (e.g. crystals are fitted into holders not tight enough and change their position when scanning through the wavelength).

Before adding new corrections to the SH module or altering the old ones, please make sure that OPO is aligned properly and gives specified energies through all the range. Also, OPO beam should pass through the SH crystals without clipping them.

First thing to check is to scan through the wavelengths of SH range (210…419 nm) and find where the energy is lower than specified. If energy is down through all the range it would be good to start by changing optical zeroes of the SH range. There are two optical zeros for SH range, one for FSH and another for SSH crystal. On control pad select MENU/NEXT/GO to “0”. PG controller will set the wavelength of optical zero of the selected range. To change the angle of optical zero, adjust the angle of the crystal to get maximum energy, and then save it as optical zero (NEXT/SAVE “0”). Same procedure works for SSH crystal.

After optimizing the angle of SH optical zeros, scan though SH wavelength range again and check if the energy improved. If it is still low in some ranges, you can try altering existing corrections. Go to a correction where energy is low and try to change the angle of it. If you see any improvement save the correction, do this for all corrections in SH wavelength range.

If the output energy at the wavelengths between the inserted correction points still drops below specified, add new correction points. For this select the wavelength where energy drops the most and change the angle of the corresponding SH crystal to maximize the energy. Save a new correction here. NOTE, do not enter or save corrections on optical zeros!

If guiding the beam through SH crystals, changing optical zero position, altering existing corrections and adding new corrections do not help to get the specified energies, it means that either OPO is not functioning properly or there is some problem in SH optics. Inspect the performance of OPO and condition of OPO/SH optics.

SUM FREQUENCY GENERATOR MODULE (SFG)

Sum frequency generation (SFG) covers the same wavelength range as SH module (303 nm…419 nm) and is implemented only if higher energies are desired. The main SFG difference from the SH is that only OPO beam is used to pump SH, while for the SFG pumping OPO beam is mixed with a portion of 1st harmonic 1064 nm (Figure 35). Due to this mixture higher energies in 303 nm…419 nm wavelength range can be achieved.

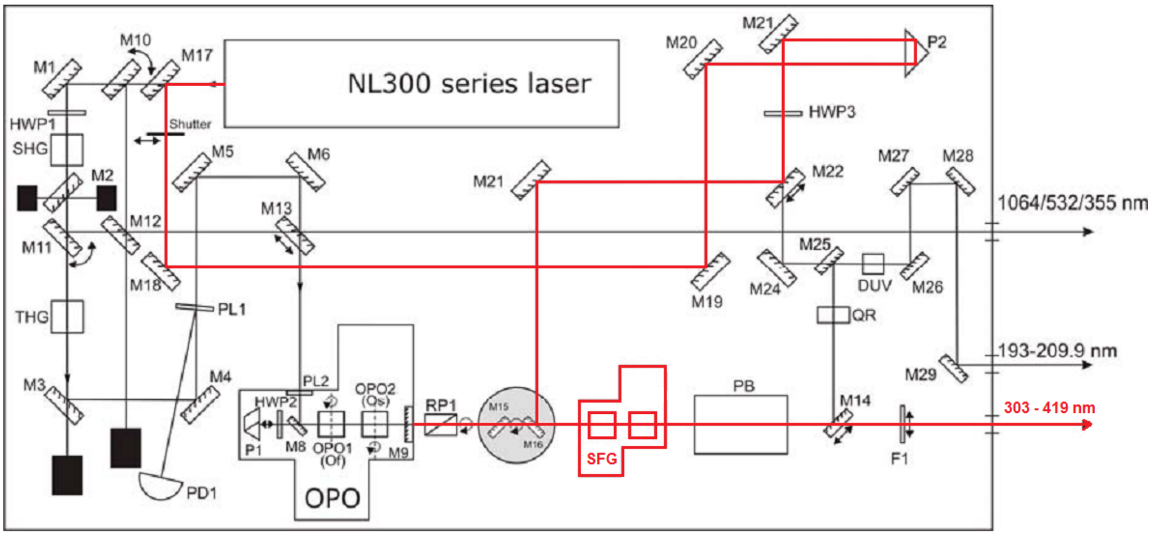


Figure 35 Optical layout of the system with SH/SFG module and 1st harmonic pump beam path marked red

Replacement of the Crystals

Replacement of the SFG crystal is very similar to the replacement of the SH crystal. The only difference is that there's only one SFG crystal. To change the SFG crystal, follow the procedure described in section 0 Crystal Replacement. (Figure 36).

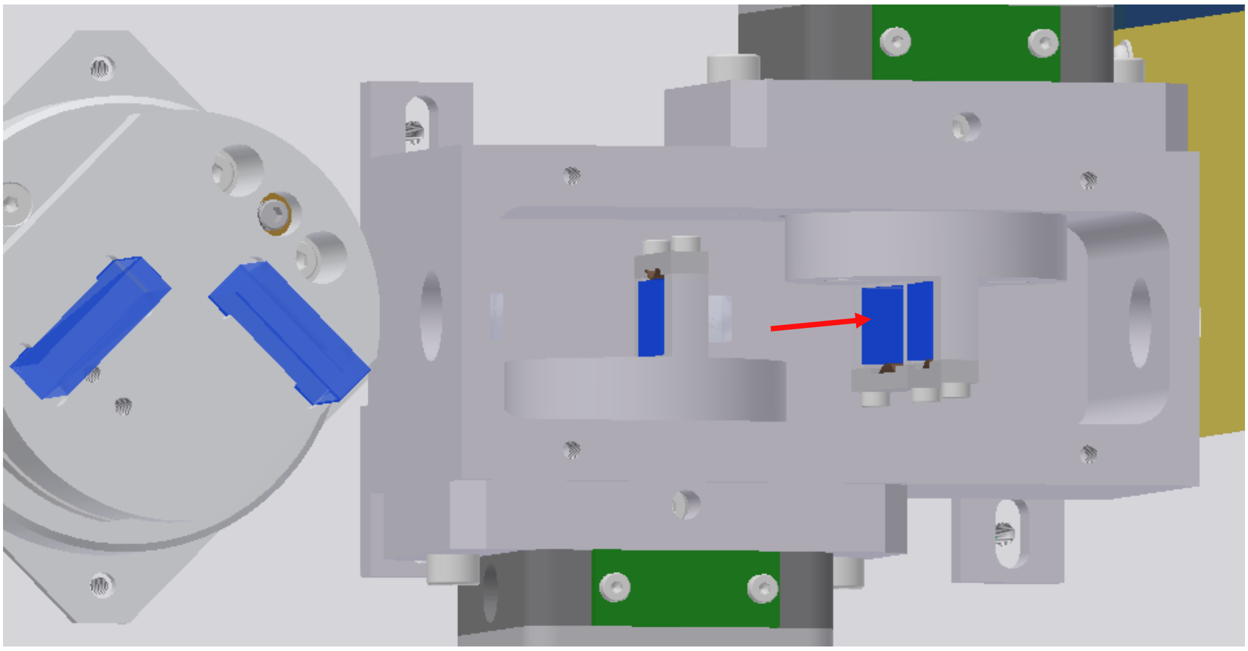


Figure 36 Position of the SFG crystal

Adjusting IH and OPO beams

For optimal SFG module operation both pump beams (1st harmonic and OPO) have to overlap in time and space. Since it's quite hard to change the position of the OPO beam, usually 1st harmonic beam is adjusted to match the OPO. Spatial and time overlap has to be checked in iterations.

To check the spatial overlap:

1. Put a 50 mm target just before SH module (if a 50 mm target doesn't fit there, put an IR detection card).
2. Set the wavelength to SFG range (~ 400 nm).
3. Set the laser to *ADJ* mode and run the laser.
4. If OPO is generating, blocks the beam just outside the OPO.
5. Now you should see the 1st harmonic beam going to SFG module.
6. Note the position of the 1st harmonic beam.
7. Block the 1st harmonic beam and unblock OPO beam.
8. If there is no OPO generation, increase the laser energy (by *Q-SW delay*) until weak generation from the OPO is observed.
9. Note the position of the OPO beam.
10. Block OPO beam again and unblock 1st harmonic (if you increased the energy for the OPO generation, don't forget to lower it again).

11. Adjust M21 (Figure 35) so that 1st harmonic beam hits the same spot as OPO beam.
12. Now put the target (or IR detection card) after SFG module just before PB prisms (Figure 35).
13. Repeat the steps 2 to 11 only now adjust M16. It is done by entering corrections in *SFG_Sw* field using UniPG software (consult the User manual). If you are using an older laser, corrections are added via control pad.
14. Repeat the adjustment of M21 and M16 so that OPO and 1st harmonic beams overlap completely in SFG module.

After OPO and 1st harmonic beams are aligned visually, start the system in a *MAX* mode and check the energies in SFG range. Select the wavelength which gives the most energy and adjust M21 and M16 to get the maximum energy. It might be necessary to adjust M21 and M16 in iterations to get the best possible result.

Guiding the Beam Through the Crystals

This procedure is the same as for SH crystals in section 0 Guiding the Beam Through the Crystals. The only difference is that you have to guide not only the OPO beam, but also the 1st harmonic beam. If both beams overlap properly (section 0 Adjusting IH and SH/SFG Beams) there should be no problem guiding them both through SFG crystal. However, if OPO beam is passing correctly and 1st harmonic beam is clipping a holder (or vice versa), it is necessary to improve the overlap of both beams. For this refer to section 0 Adjusting IH and SH/SFG Beams.

Adding corrections

Adding corrections to SFG range is the same as adding corrections to SH region.

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DEEP ULTRA VIOLET MODULE (DUV)

Deep UV unit (DUV) extends the wavelength range of NT342 system to 193 nm (Figure 37). This is done by generating the sum frequency radiation from SH/SFG radiation (210 nm...409 nm) and 1st harmonic (1064 nm). Operation principle and adjustment are very similar to that of SFG.

DUV energy is very sensitive to OPO and SH/SFG alignment (since we are using SH/SFG beam for pumping) so before adjusting DUV crystal or 1st harmonic pump, make sure that OPO and SH/SFG are functioning properly and produce specified energies.

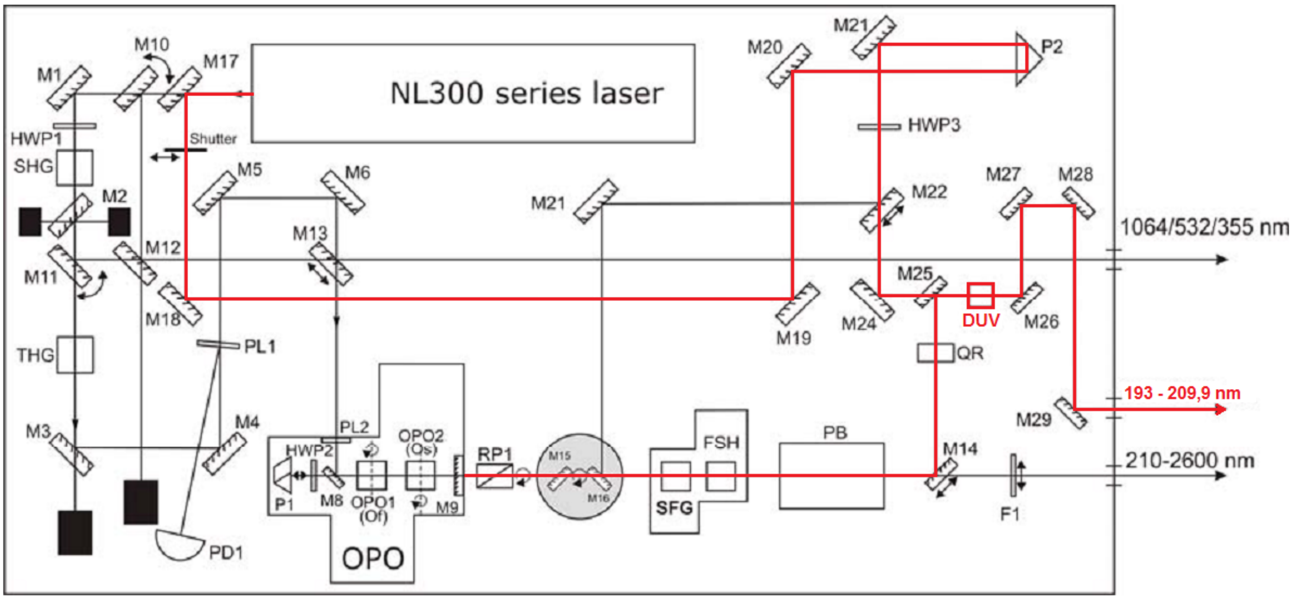

Figure 37 Optical layout of the system with DUV module. The DUV module and 1st harmonic pump beam path for DUV are marked red

Replacement of the crystals

1. DUV unit crystal removal is the same as for SH/SFG crystals. Only difference is that DUV crystal is not in a module but rather simply as a standalone optical element (Figure 38). To change the crystal, follow these steps:
2. Remove the crystal holder release two fixing screws (Figure 38, red arrows) and carefully take out the crystal holder.
3. Place the holder on a flat clean surface remove top of the holder (Figure 38, green arrows) to access the crystal.
4. Now carefully remove the crystal (note the position of crystal marking as in Figure 34).
5. Put the new crystal in (crystal marking facing the same direction).

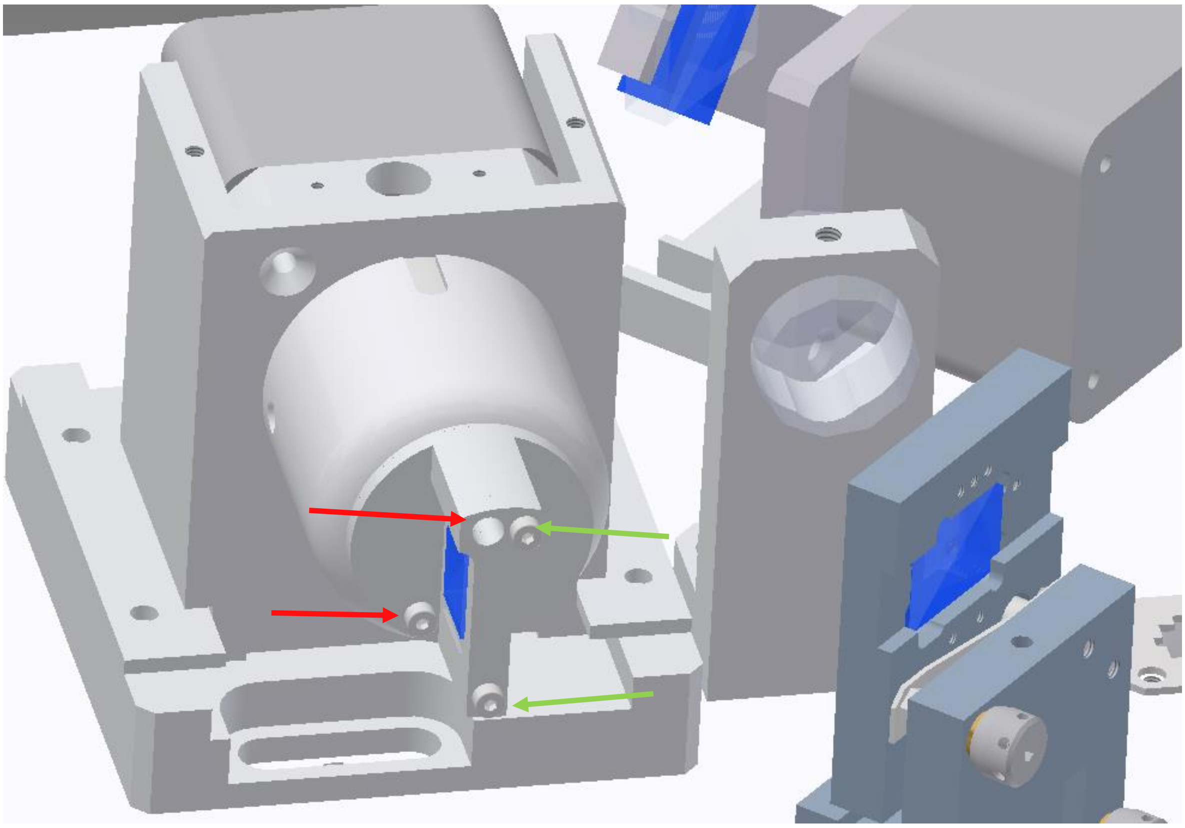

Figure 38 DUV unit with crystal holder screws marked

Adjusting IH and SH/SFG Beams

Since DUV unit also generates sum frequency 1st harmonic and SH/SFG beams have to overlap in time and space same as for SFG overlapping procedure is same as for SFG (section 0 Adjusting IH and SH/SFG Beams). Only difference is that in a DUV unit it is possible to adjust both pump beams, whereas in SFG unit it is possible to adjust 1st harmonic pump only.

In DUV case put a target (or IR detection card) just after M25 and just before M26. Do not adjust M21 and the mirrors before it (Figure 37), they are already adjusted for beam overlapping in SFG module. To adjust for 1st harmonic beam proper overlapping use only mirror M24 (Figure 37) and to align SH/SFG beam coming to DUV unit you can adjust mirror M25.

Guiding through the crystals

This procedure works the same as for SH/SFG crystals, except that there is only one crystal. Also in a DUV there is a possibility to adjust the beam in vertical direction, so if pump beams are clipping the crystal on the top or bottom, change the direction of 1st harmonic and SH/SFG pump beams by adjusting M24 and M25 respectively.

Adding Corrections

Adding corrections to DUV unit works the same as for SH/SFG unit. Don’t worry about the wavelength, it is already defined by pump beams used. Changing the angle of DUV crystal will only affect the energy of generated signal.

Since energies from DUV unit are quite low, a sensitive energy meter capable of measuring ~100 µJ should be used.

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SYSTEM CONTROLS AND POSSIBLE FAILURES

NT342 series system can be controlled either from control pad or by a computer. Computer control is performed using either RS232 connection by sending/receiving string commands or through the CAN protocol (also called USB-CAN or CAN-bus protocol). Please refer to user manual of the system for the information of which type of control is used. There are different control pads used in NT34X and NL3xx laser, it depends on system firmware. Note, that dedicated control pad should be used, otherwise malfunction or damage of control pad can occur.

Typical failures result inability to control the laser and/or read any parameters from it.

Control pad failure

Most probable reason of failure is a damaged wiring. In this case control pad screen usually becomes blank. Try to operate the system from computer and, if unsuccessful, then CPU does not operate properly and further troubleshooting will be necessary.

If operation from computer is successful, then CPU is operating properly and problem is related to communication between CPU and control pad. Check control pad cable. If possible, try to replace cable or re-solder contacts. If that does not help – Control pad must be replaced or repaired.

Computer control failure

Please check if system can be operated from control pad. If system cannot be controlled by control pad, then the CPU does not operate properly and further troubleshooting will be necessary.

Please check the cables connecting laser power supply RS232 connector to computer RS232 connector. If possible, try to replace cable or re-solder contacts.

Failure of RS232 Control

If your system uses RS232 based communication and you suspect its failure, please perform the steps below:

1. Check the cable connecting computer to laser system and replace/repair if necessary.
2. Check RS232 port settings in Windows *Device manager*. Correct settings are:
   baud rate: 19200
   data bits: 8
   parity: none
   stop bits: 1
3. Use hardware RS232 port on computer motherboard, or, if unavailable, use the USB-RS232 adapter supplied by EKSPLA. It is known that some other USB-RS232 adapters cause problems.

4. Set the COM port from 1 to 5. Communication via COM port usually fails if COM port is higher than COM 6.

Communication test is done by sending command [SAY] via RS232. System should reply with string indicating system status (usually *READY*). Sending commands could be done using any RS232 communication software (on older Windows computers it is possible to use included *Hyper Terminal* software).

Failure of a CAN Control

Please ensure that the connection type is set to RS232 (COM port) and respective RS232 port is selected through the CANBrowser Options menu option. If other software is used, please ensure that following files are present in the program directory:

REMOTECONTROL.dll

REMOTECONTROL.CSV

CANRS232.dll

USBCAND.dll

Set COM port from 1 to 5. Communication via COM port usually fails if COM port is higher than COM 6.

If all of above does not solve the problem – contact EKSPLA service team for further support.

Table 1 List of the CAN bus registers in a system, as shown in .CSV file

CONTROLLER	***REGISTER***	***DESCRIPTION***
UCP	Firmware	Control pad firmware version
NL30X	State	Status of the laser (RUN, STOP or FAULT in case of failure)
NL30X	Output level	Current state of pumping laser (OFF, Adj or Max)
NL30X	Output enable	Enables output (control is done by enabling Pockels cell operation)
NL30X	Continuous/Burst mode/ Burst trig	Continuous – operation at designed frequency Burst mode – burst mode enabled, waiting for trigger Burst trig – burst mode enable, trigger sent (must be changed to burst mode and back to burs trig to send another trigger)
NL30X	Burst length, pulses	Number of pulses in a burst. Value is used when burst mode is enabled.
NL30X	Synchronization->Sync mode	Synchronization mode of the laser. Internal or External. If external mode is used, trigger pulses must be supplied to the SyncIn BNC connector on the front of power supply
NL30X	Synchronization->SyncOut delay	Delay for the SyncOut BNC connector on the front of power supply
NL30X	Synchronization->Divider, every Nth pulse	Frequency divider setting. Output enabled on every Nth shot of the flash lamp. Flash lamp is firing at design frequency; frequency dividing is done by controlling Pockel cell.
NL30X	PS5062 Controls->Pump voltage	Pumping laser flash lamp voltage. Normally should be adjusted during service or flash lamp replacement. Too high value can cause optics damage.
NL30X	PS5062 Controls->Read cooling temperature	Internal cooling water loop temperature readout.
NL30X	PS5062 Controls->Set cooling temperature	Internal cooling water loop temperature setting. Too high value can cause pump chamber overheat and components damage. Maximum safe value is about 34 deg. C. Typical value is 28°C for water-water cooling, 32 °C for air-water cooling.
NL30X	PS5062 Controls->12V supply current	12V output current readout
NL30X	PS5062 Controls->Control unit supply voltage	Voltage for the laser control board
NL30X	PS5062 Controls->Lamp pulse counter	Number of flash lamp shots fired by the power supply
NL30X	Setup->Repetition Rate	Repetition rate (frequency) of the laser. This value should not be changed.

NL30X	Setup->Repetition Rate low limit	Lowest allowed repetition rate. Must be equal to laser frequency.
NL30X	Setup->Repetition Rate high limit	Highest allowed repetition rate. Must be equal to laser frequency.
NL30X	Setup->Minimum EO delay	Minimum Q-switch delay. Sets the minimum allowed Q-switch delay. Value should not be changed.
NL30X	Setup->Best EO delay	Q-switch delay for “Max” mode
NL30X	Setup->Adjustment EO delay	Q-switch delay for “Adj” mode
NL30X	Setup->Thermolens time	Number of seconds until the output is allowed (number of seconds until thermal lens in Nd:YAG rod stabilizes after laser was started)
NL30X	Setup->Options	Indicates the power supply type used (MR9 or PS5062). Usually PS5062.
NL30X	Setup->Power electronics on/off	Turns on and off power electronics portion of power supply
NL30X	Setup->Safety mod	Normal or service. Equal to pressing “Service” button on the front of power supply.
NL30X	Firmware	Firmware version
NT342 (OR PG_CAN)	Wavelength	Wavelength of OPO. This
NT342 (OR PG_CAN)	Status	OPO status readout (Initiation, Tuning, Ok, etc.)
NT342 (OR PG_CAN)	Backlash compensation	Enables or disables motors backlash compensation to prevent hysteresis, when turning in different directions.
NT342 (OR PG_CAN)	Laser off	Sets if laser must be turned off for example when changing wavelength ranges
NT342 (OR PG_CAN)	Correction Points No.	Number of correction points in the memory
NT342 (OR PG_CAN)	Motors Positions Rel.	Reference point for calculating motors position
NT342 (OR PG_CAN)	Motors Positions ->…	Respective motor position
NT342 (OR PG_CAN)	Optical Zeroes->…	Respective motor optical zero
NT342 (OR PG_CAN)	Offsets->	Respective motor position (used for motors with two positions)
NT342 (OR PG_CAN)	Energy Meters->UV Gain	Coefficient for internal UV energy monitoring photodiode
NT342 (OR PG_CAN)	Energy Meters->Delay	Delay for internal energy detector. Typically 80 microseconds.
NT342 (OR PG_CAN)	Max Energy->UV OPO	Maximum pumping energy for OPO. If higher value is detected by internal energy monitor, sound alarm will beep
NT342 (OR PG_CAN)	Energy->UV OPO	Internal energy detector value (value of last measured pulse).
NT342 (PG_CAN	Type	System type, for example NT342SFG, NT342DUV, etc.
NT342 (OR PG_CAN)	Serial Nm.	Serial number of the system
HV40W	Power switch	Turns Q-switch module off and on.
HV40W	Set HV voltage	Q-switch voltage setting. Value can be optimized after Pockels cell adjustment (new value is usually within ±50V from factory level). Value also should be optimized after Pockels cell replacement.

HV40W	HV voltage	Q-switch voltage readout. Should be the same as setting (within few volts measurement accuracy).
HV40W	HV current	Q-switch current readout. High current may indicate HV module failure. Typical values are about 0.1-0.2mA
HV40W	HV supply enabled	Enables HV signal output
HV40W	Power circuit status	OFF, when laser output disabled, ON when continuous laser output is enabled, BURST when burst of pulses is sent
HV40W	Current limit status	Indicates if controller is operating normally or current limit mode is enabled (failure).
HV40W	Calibrate->Current limit	Current limit setting. If higher current is detected, module will enter current limit mode prevent damage.
HV40W	Calibrate->Calibrate HV voltage	Calibration coefficient for HV voltage setting
HV40W	Calibrate->Calibrate display HV voltage	Calibration coefficient for HV voltage readout
HV40W	Calibrate->Current sensor constant	Calibration coefficient for HV module current sensor
HV40W	Calibrate->High voltage limit	Sets limit for HV module. This is used to prevent module damage, when accidentally too high voltage value is set. Usually about 4000V.
HV40W	Version HV40W	Firmware version of HV40W module

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PS5062 and Cooling Unit Problems, Errors, Diagnostic and Solutions

Possible NT342 (and NL300) system series displayed error messages and their available solutions:

WRONGF “20H” - Wrong Ext. Trigger Frequency.

External laser trigger frequency is out of the range. PS accepts repetition rate with frequency deviation of ±10%. I.e. if laser repetition rate is 10 Hz, the correct external frequency input will be between 9...11 Hz. Ekspla recommendation is to keep the external triggering frequency as close to the middle value as possible for correct laser system operation.

SHUTTER “10H” - Shutter Interlock.

Sometimes laser system is equipped with shutters which have interlock. They usually work with harmonic (which energy is high) guiding mirrors. These interlocks prevent laser operation when shutter is closed to prevent any damage to the shutter.

Shutter must be opened for correct operation if some of the harmonic guiding mirrors are up. Please consult user manual for each specific system regarding correct shutter + mirror positions.

FLASH 8H - Flash Lamp Error

First, the flash lamp should be taken out and inspected, especially if the lamp has many tens of million shots under its belt.

Check the flash lamp wiring. Firstly, connectors in power supply has to be properly fixed, and the polarity has to be correct. Then check continuity of the power wires (resistance at the ends should be <1 Ohm). Check if wiring is well fixed in the laser head and pump chamber.

COOLING 4H – Cooling Error

This error appears when internal flow sensor fails to detect the water flow in the inner cooling loop. Check if there is enough water in a cooling water tank. Restart the system few times and check if the water pump forces air to go out from the tubes. If it fails, use a large syringe and fill one of the laser tubes with deionized or distilled water up to the top. This will help to start the cooling loop smoother.

Sometimes if the system was unused for prolonged time period, it may happen that internal cooling loop flow rate really drops. Low flow rate does not lift flow sensor so it shows flow error. It may seem that it is a sensor fault, but in fact it is a low flow problem. Usually reduced flow rate leads to hotter pump chambers. If there are more pump chambers with their separate cooling units, compare their temperature by thermometer or by hand (with a caution).

In this case particle filter and cooling water has to be replaced. That should the fix flow error.

OVERHEAT 2H - Overheat

If the water temperature exceeds the set temperature by 1.5…2.0 °C it stops the system and this error message will appear. If cooling type is water – water check if cooling water valves are opened.

If the cooling type is water-air, check if air intake holes are open. Ensure proper room conditioning. Room temperature should be at least 5…7 °C lower than water temperature to prevent overheating of the cooling unit.

EMISSION 1H PS - No Emission

Unsuccessful attempt to fire the simmer. Flash lamp, power wiring, power supply failure, insulation breakdown.

Firstly, this error can appear if *SERVICE* button is pressed and illuminated. It prevents firing the simmer and turning the lamp on during the various actions performed by the service. I.e. when the cooling water is replaced, it is safer to freshly run cooling loop without flash lamps on. It reduces a risk of overheating the pump chamber.

If the *SERVICE* button is not pressed it does not defeat firing the simmer. But if water flow is somehow restricted or there is an air trapped in tubes, combination of *Emission 1H*, *Cooling 4H* and *Flash lamp 8H* errors can appear. Because of failure to detect the water flow, power supply restricts firing up the simmer.

If water is running and there are no other errors, only *1H,* check the flash lamp wiring. Firstly, connectors in power supply has to be properly fixed, polarity has to be correct. Then check continuity of power wires (resistance at the ends should be <1Ohm). Last, check if the wiring is well fixed in the laser head and pump chamber.

PS5062 Water and Filter Replacement Procedures

PS5062 has a deionizing filter. It does not have a particle filter. DI filter has to be replaced every 5 years. For replacement please follow these steps:

1. Use pump to remove water from the cooling unit water tank. It does not have a special drain port.
2. Disconnect one of the cooling loop hoses and, using the compressed air, force the water to gather in a water tank.
3. Fill the water tank with DI or distilled water.
4. Turn on power supply with a key, press *Service* button to prevent the simmer from turning on. Press *Run* button on a control pad, it will start water pump.
5. If you get *Cooling* error, try to restart the power supply with a key few times. If you do not see water flowing through the loop, follow the next step. When the pump is dry, it is really hard to get it running and pumping water. If the water is running well, skip the next step.

6. Take a large syringe (more than 20 ml volume). Fill it with DI or distilled water. Disconnect the water input tube from pump chamber. Fill the tube with water using the syringe. Fill it up to the connector and connect the tube back to the pump chamber. Restart the power supply and repeat if necessary.
7. Fill the water tank almost full. De-press the *Service* button and use the system.

Failure to Start the Power Supply

There could be numerous reasons why power supply does not turn on after turning the key switch to *ON* position.

1. Check if power supply is connected to outlet power. In this case "Power" LED light should be on, even when the key switch is in off position.
2. If it is off – check fuses mounted in the back of power supply.
3. Check if "Break" BNC connector is connected. If it is connected to external break circuit, make sure that it is intact.
4. Check if red mushroom button is depressed. If it is pressed laser is not going to turn on.
5. Check is cover interlock is on or overridden if laser cover is taken off.

If points above are checked, but the power supply stays off, contact Ekspla service for further assistance.

High EM Noise from Power Supply, Wiring and Flash Lamps

It is normal for power supply to emit EM noise and it exceeds standards by 7dB. If you suspect that noise is higher than normal there are few things to check:

1. Flash lamps age. While flash lamp gets older, emitted noise tends to increase. So if the flash lamp was replaced long time ago it means that it is time to replace it with a new one.
2. If flash lamp is newly replaced but it emits a lot of EM noise, it is possible that a polarity of the flash lamp is mixed. So check the polarity and make sure it is installed correctly.

Caution
Installing flash lamp in reverse polarity makes it to degrade very fast. Usually using it for one day it looks like it was used for tens of millions shots. If flash lamp was installed incorrectly it should be replaced with a new one.

PS5062 Umbilical Connection Procedure

1. Remove the front panel of PS5062 first. After that remove the side covers.
2. Detach controller board plug from the umbilical cord (Figure 3942).
3. Put all the cables and hoses through the hole in the back panel of PS5062 frame.

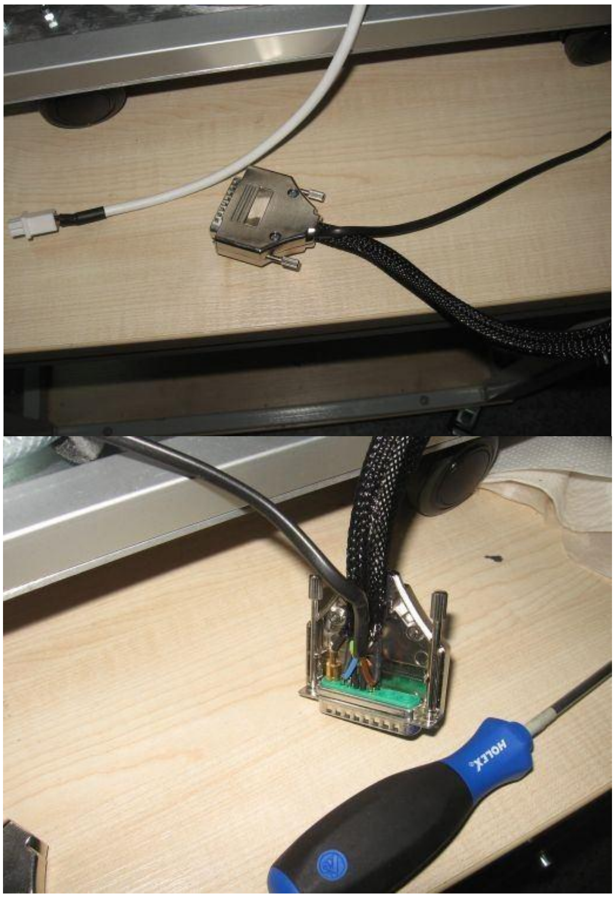
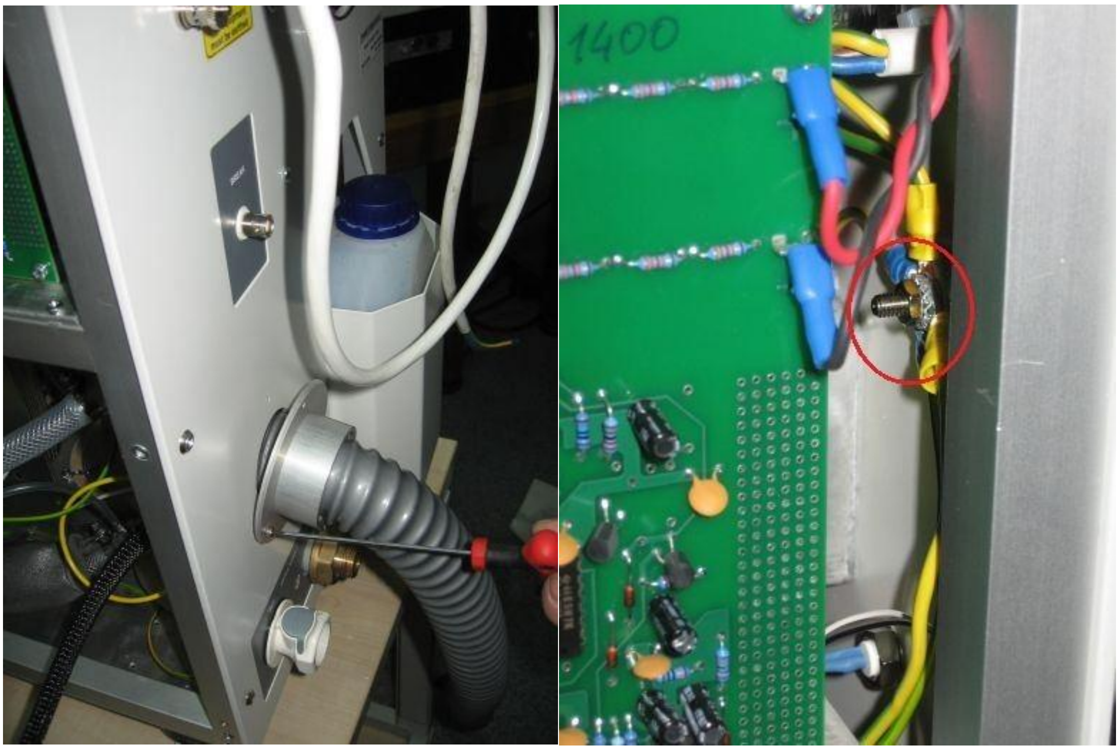


Figure 39 Controller board plug

4. Fix the cap from umbilical cord to the back panel of PS5062 frame (Figure 40, *a*).
5. Assemble back the controller plug (opposite to step 2).
6. Tighten the ground cable to the wall on the PS frame (Figure 40, *b*).
7. Connect the power cable (Figure 41, *a*).



a) b)

Figure 40 a) Cap of the umbilical cord, b) ground cable connection point

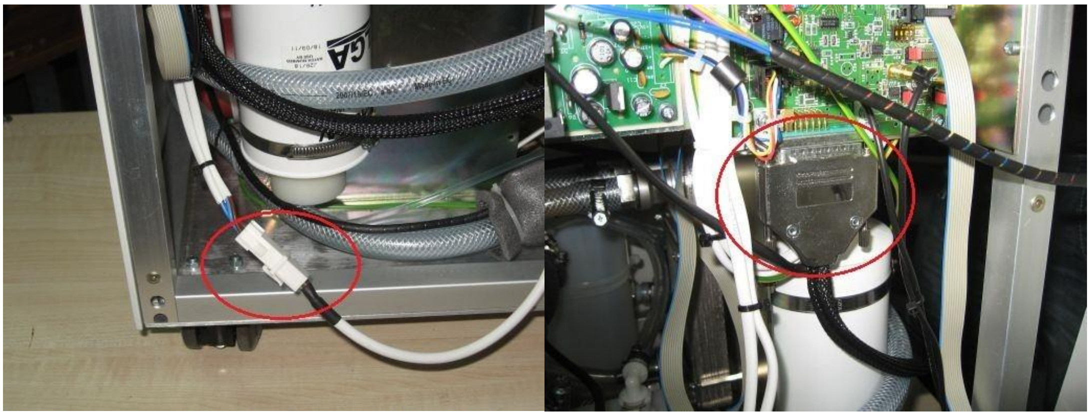
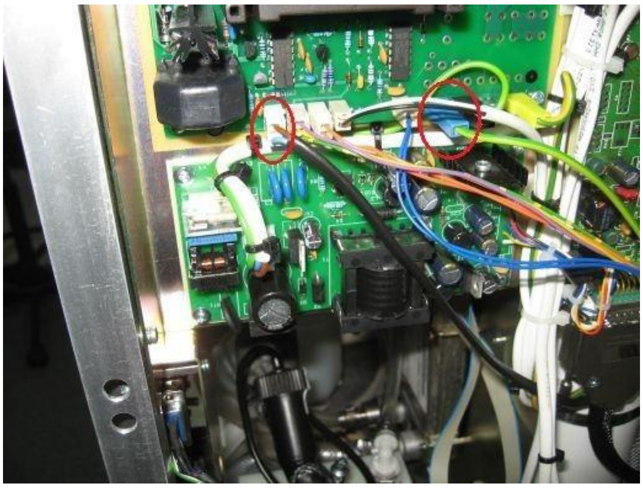
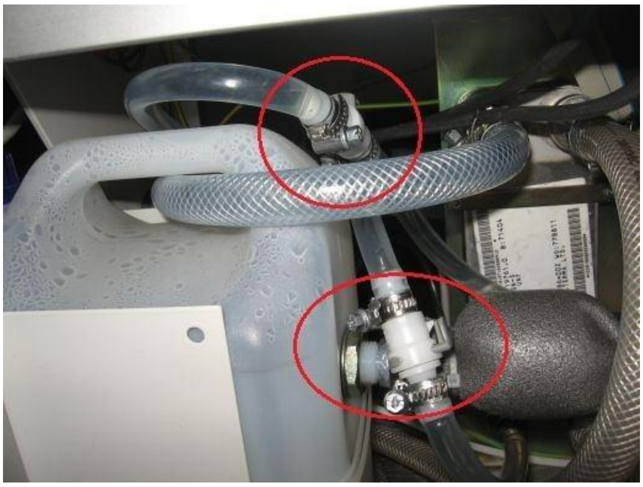


Figure 41 a) Power cable connection, b) controller board plug

8. Connect the plug to controller board (Figure 41, *b*).
9. Connect heater plug and ground cable (Figure 42, *a*).
10. Connect cooling hoses to appropriate connectors (Figure 42, *b*).
11. Connect High Voltage cables and tighten the nuts (Figure 43). The red cable represents positive ‘+’ terminal, and the black cable – negative ‘-‘.



a)



b)

Figure 42 a) Heater and ground plugs, b) cooling water hoses

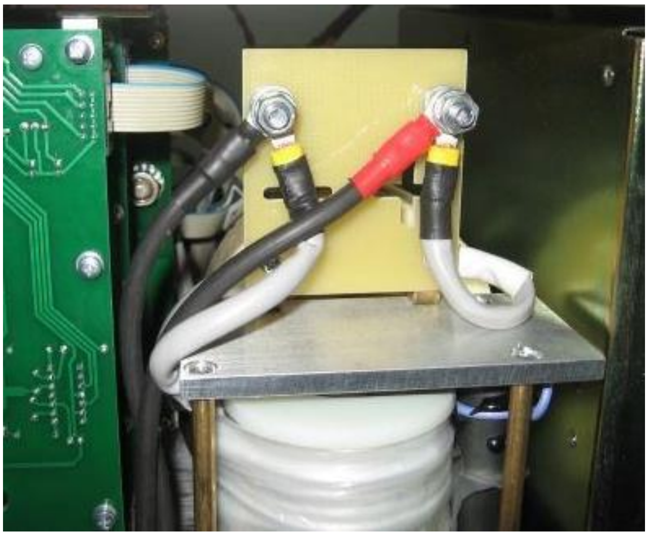


Figure 43 High voltage cables

PS5050 ‘0200’ Error, Possible Flash Lamp Failure

Error *0200* appears when the power supply channel fails to ignite the simmer in flash lamps. If you experience this error, please check the system according to the steps bellow:

1. Remove and inspect the flash lamp. It could be broken or aged. Replace with a new one if necessary. Proceed to next step if error remains.
2. Turn the power supply off. Take off protective flash lamp lead cover from PS. Use multi-meter continuity test function and test wire continuity (resistance) from leads on power supply to the leads which come to flash lamp. It should be < 1.0 Ohm. If it passes this test proceed further. If not, replace broken wires or make sure that all contacts are good.
3. Inspect boards visually for any burn marks or smell. For older make power supplies diodes VD2, VD4, VD6 and VD8 in LM06 board tend to break.

If the problem persists, follow the next steps. These instructions work with PS5050 (one channel power supply) too. These instructions help to find problem source. Follow these steps:

1. Remove power supply from the rack.
2. Put it near power supply rack, to have possibility to connect flash lamp wires.
3. Unscrew and remove the power supply lid.
4. Prepare a multimeter, capable to measure 1000V. Most suitable is an analog voltage meter resistant to EM noise. Please choose measurement wires which holds 1000V.
5. Measure *OSC (CH1)* channel if *Ignition* voltage exists (Figure 44 and Figure 45).

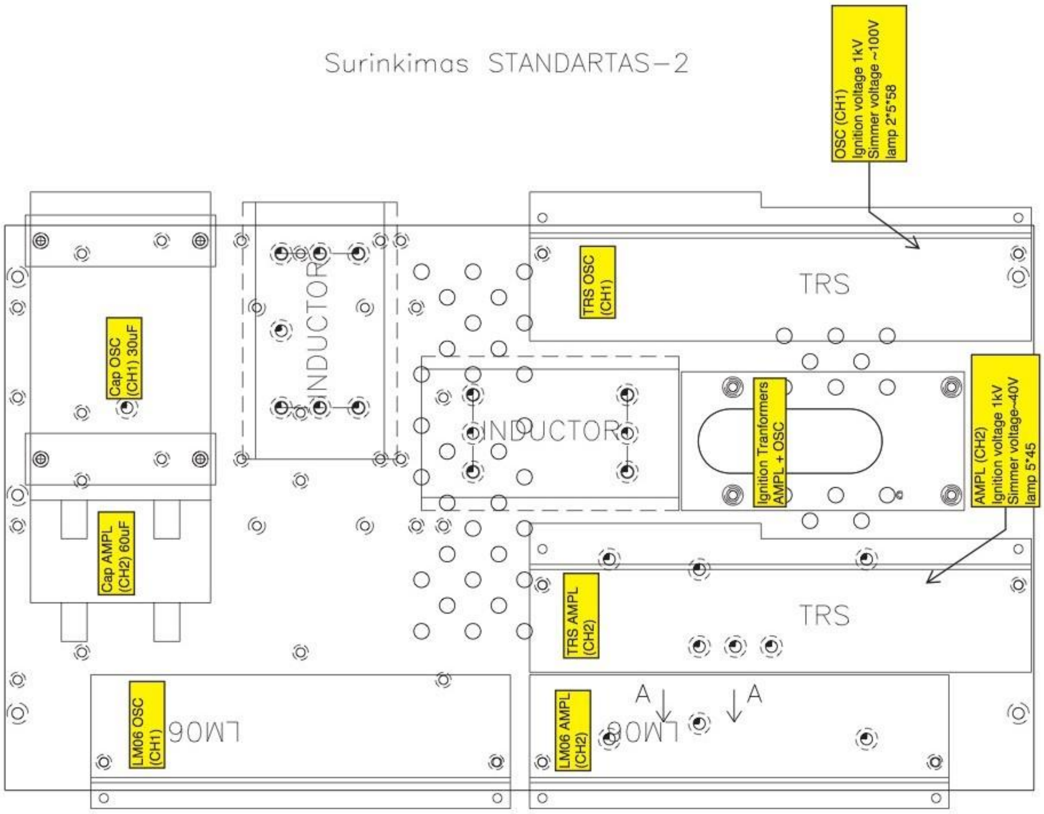


Figure 44 PS5050 board layout

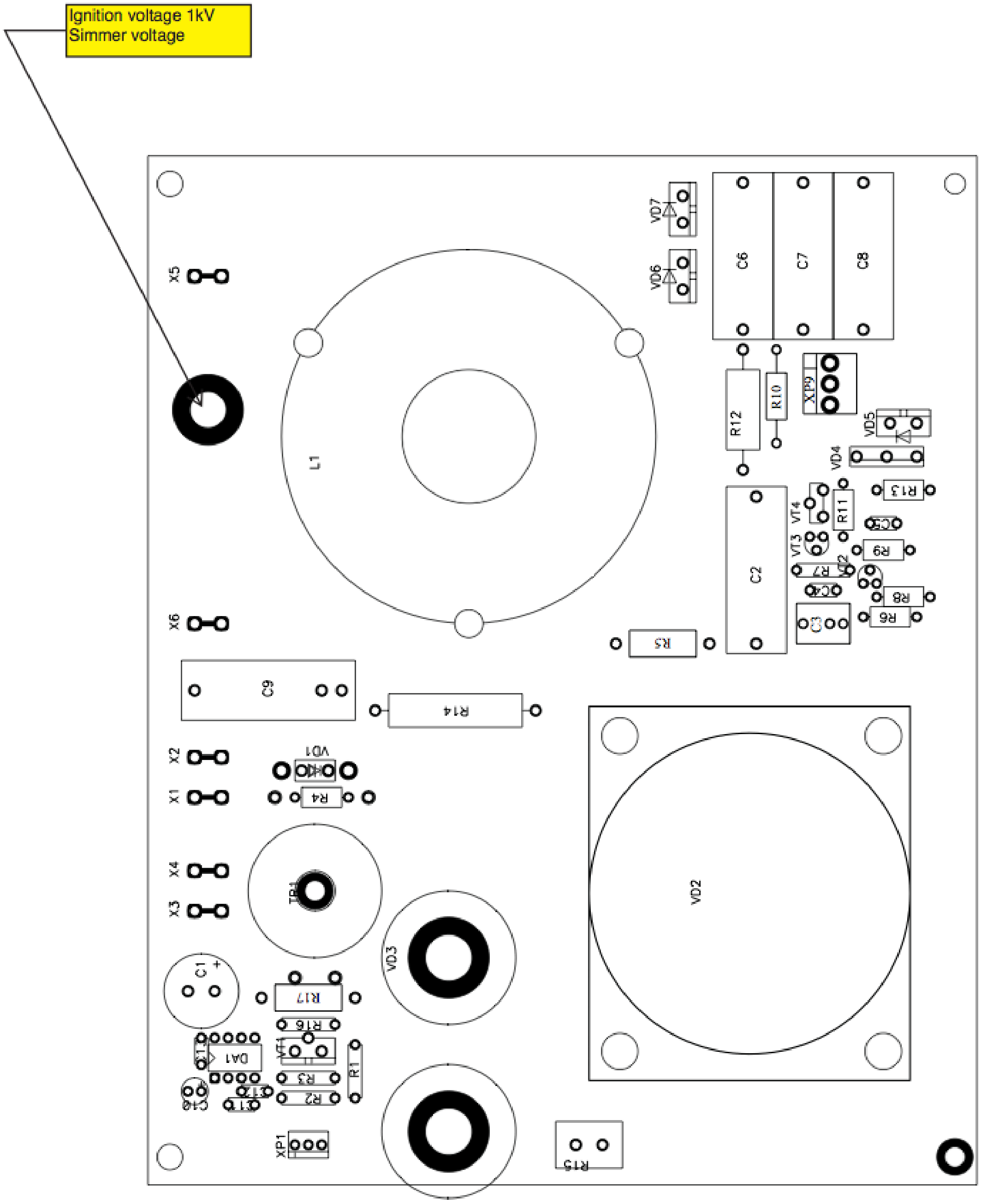


Figure 45 TRS-3 board

6. Disconnect OSC lamp wires from power supply.
7. Turn off both channels using switches on PS panel.
8. Connect Volt-meter (700…1000V) between '+' on the frame and '-' on the point *Ignition voltage* (M6 screw on the TRS board, Figure 45).
9. Turn on the power supply (both channels are off); after ~5 seconds turn on *OSC (CH1)* switch and check what is the voltage at the indicated point. If measured voltage is 0V, LM06 board is broken. Additional measurements have to be done, measure supply and control voltages.

10. Measure if 300V supply is present (Figure 46), measure it between X1 and X2. If this voltage is not present, check the 24V power supply board.
11. Measure control signal - when switching power supply on, on XP1 connector (10 pin flat cable) on 6 pin voltage must change from +15V to ~0V (Figure 46). If the voltage does not change, check the cable and PS5053CPU board (instructions below).

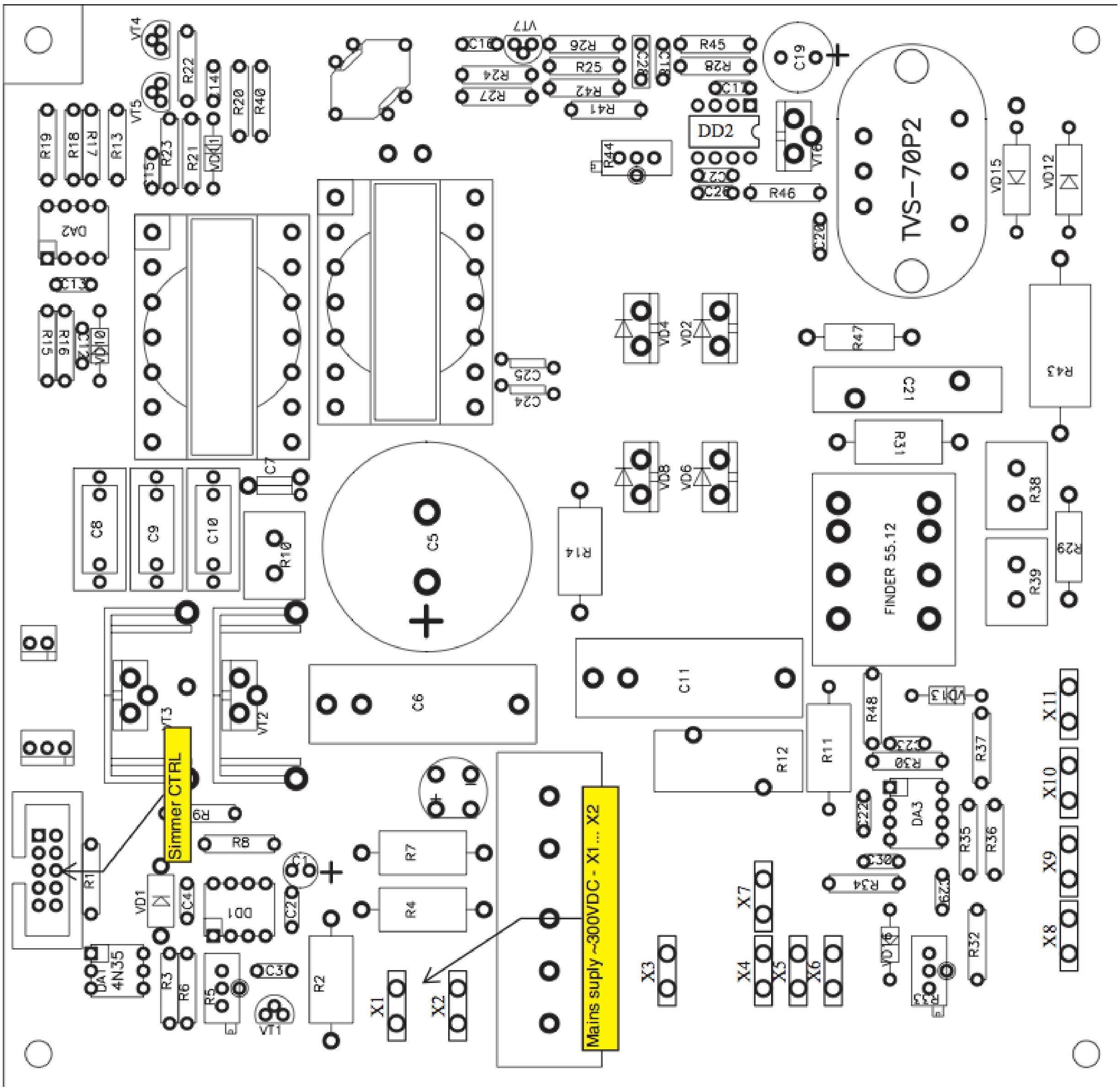


Figure 46 LM06 board

12. If measured voltage is ~50…200 V, the TRS board is broken. It could happen due to thyristor VD4 on the TRS board break down. It shorts the circuit or gives large current leak. Due to construction features, it is almost impossible to check that without removing the module from power supply.

13. If measured voltage is 800…1000V, the TRS ignition circuit is broken. (Broken one of the VT2-4 of VD4). We recommend to replace whole TRS board, because it is faster solution, than looking for broken components and replacing them 1 by 1.

14. If control signal is missing, then PS5053CPU board has to be checked. Measure if the OSC simmer control signal exist on PS5053CPU board (Figure 48). If it exists - when channel is switched on, voltage changes from +15V to ~0V (using oscilloscope is more convenient). Then it means that control cable is broken somewhere. If signal does not exist - something is broken in PS5053CPU board. In this case power supply has to be shipped to EKSPLA. CPU board replacement is not straightforward; it requires whole power supply re-tuning.

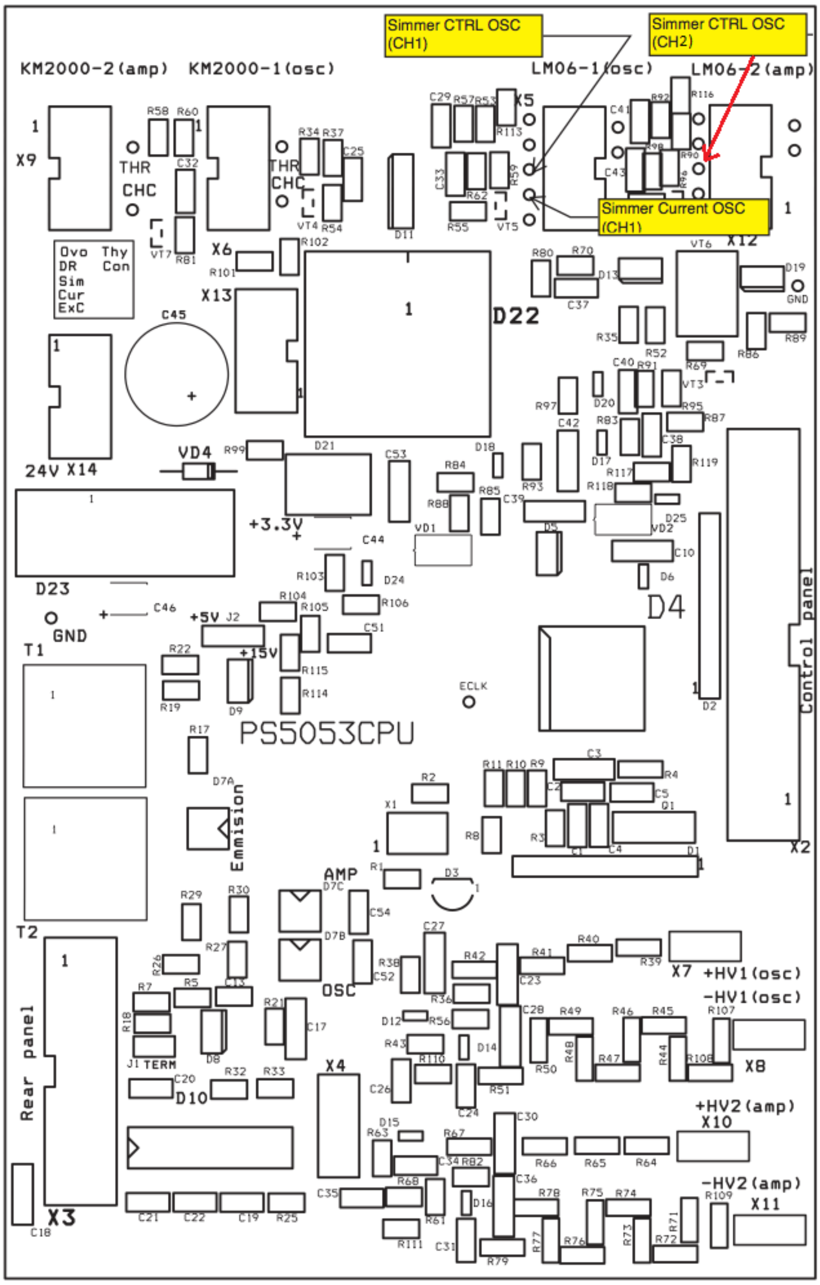


Figure 47 PS5053CPU board

Another possible but rare source of problem - LM06 board current measuring part does not work, or LM06 gives too low current to a flash lamp. To check LM06 performance follow these steps:

1. If it is possible to see if flash lamp simmer light up, check if it starts to light up. In this case flash lamp wires have to be connected to power supply. It is possible that flash lamp will simmer only for 0.5…1.0 s so this test is better performed by two persons. One observes, while the other switches on the power supply. If lamp simmers for 0.5…1.0 seconds (visually observable), then check the current control part, or current to the flash lamps (if it is lower than 0.1 A, LM06 power part is broken, if current is 0.5…0,8 A, it is current measurement control or cable failure).
2. If lamp simmers for short time, probably it is problem indicated above. Use the two channel oscilloscope to measure if the current signal appears after turning on the power supply. Check PS5053CPU board *Simmer CTRL* and *Simmer Current* signals. (Figure 47). When the *Simmer CTRL* goes to low level, after a few milliseconds *Simmer Current* signal should appear (goes to high level). If this does not happen, send the power supply to EKSPLA. If *Simmer Current* signal appears after *Simmer CTRL*, but power supply does not work as supposed, it has to be sent to EKSPLA. As mentioned earlier, it is very hard to adjust CPU board on customer site.

Thyristor Replacement

The main issue about this procedure is to connect all the cables back the same way as they are before replacement. Make few pictures of inside view at different angles (you should see all the connections).

First of all, disconnect and remove the power supply drawer out of the rack. Put it on the table. Remove the cover. Remove the metal stripe, which comes across the power supply, above the LM and TRS boards. Two more bolts secure this board to the back side stripe.

Disconnect the wires. It would be the best to disconnect HV cables from LMs. HV cables are with silicon isolation.

HV (-) is a blue one. It is closer to the front side panel.

HV (+) is a red one. It is closer to the back side panel.

When disconnecting such connections, **do not** pull the wires, but use a thin (-) screwdriver, otherwise you can break the wire. Put the screwdriver between the contact and the board, then just push it.

Then disconnect the control cables from CPU board and power cable of mains disconnect from the 24V board. There is more space and after that you will not confuse these cables.

The more complicated task is to disconnect the cables for HV measurement. They are connected to the CPU board at its bottom part. You will need to put your hand inside there. Shades of *Osc (CH1)* cables are green. The cable *CH1 (+)* is red and the cable *CH1 (-)* is black. Shades of *Amp (CH2*) cables are yellow. The cable *CH2 (+)* is red and the cable *CH2 (-)* is black. Here is the reminder for connecting them back (looking from the bottom side they are connected in this manner: two yellow *CH2 (-)*; *CH2 (+)*; then two green *CH1 (-); CH1 (+)*. Also refer to Figure 47.

Place the power supply unit on its side that simmering unit would be at the bottom. You need to unscrew 6 bolts, which hold the duralumin base plate. The best is to start unscrewing the lower ones. Two lower screws at the front, then two lower ones at the back. Then release two upper screws, but before removing them totally you need to hold the whole simmering unit. You may grab ignition transformers or baffle. Only when you hold it firmly, you may unscrew the two upper bolts totally. Otherwise the heavy unit will bend the bolts and damage thread. (The other way: at the beginning remove all these screws from the bottom. Then the simmering unit will be held only on boards. After that turn it back and unscrew the bolts securing the boards to the housing). When all the 6 bolts are removed, put the power supply unit again upside up (original position).

HV 'log' (metal piece) must be pushed to the outside by fingers. It is not fixed anyhow, just is placed on four small stages. Usually you need to force it a bit, but sometimes it falls out by itself. Push the HV log outside, then turn it and put it through the hole back inside. If it is impossible because of wires, then you need to do this procedure at the same time, when removing the whole Simmering unit.

> *Note:*
> *Be careful while lifting the unit out of the housing, it may break one o elements on the board of CPU. When taking it out, hold firmly for ignition transformers, baffle or main capacitors. You may need someone's help, while doing this. One can lift the unit and at the same time the other can put through the hole that HV log, which is originally outside. Before doing this, you may shift a bit the whole simmering unit towards front panel, then there will be more space for HV log. When lifting, all the time the base plate of the simmering unit must be parallel to the bottom plane. Otherwise it will clip something.*

After the simmering unit is removed from power supply, put on the table, remove the TRS board of oscillator channel (2 bolts at the bottom). You may not have the good access there still, because the wires of the thyristor are thick. The easiest way to remove the old thyristor is just to bend few times to one and the other direction until three pins of it will break. Then use a soldering tool and tweezers for removing the rest of these pins – just to leave clean holes. After that solder the new one thyristor there. Be careful not to overheat the board – the tracks may start peeling.

Assemble everything back just in opposite direction:

Fix the TRS board to the simmering unit. Place it back inside the power supply unit at the same time you need to put through the hole that HV log. Be careful again not to break any element on CPU board, while doing this procedure. Secure the bolts to the bottom of the power supply and connect the cables the same way as they were connected:

Yellow shades – *Amp (CH2*) at the bottom; green shades – *Osc (CH1)* at the top. Minus wires of both pairs are black and must be connected lower, whereas the plus wires are red and must be connected above. Connect HV cables of charging units: *Blue HV-* (they could be black sometimes) X8-X11 closer to the backside panel. Red *HV+* closer to the front panel X4-X7. It is described in a such detailed way because the **connection order must not be confused** in any way. Otherwise the whole power supply will get burned and you will need to replace most of the parts.

If control cables or power cables to the simmering unit will be not connected, nothing should happen, because some interlocks will save the unit. In any case it is better to connect these cables also.

Before turning on the power supply unit, set the switches *CH1 (OSC)* and *CH2 (Amp)* to the *OFF* positions. Set the voltages to 0V and turn on the power supply unit. Then turn on one of the channels. If the simmering is present, then it is fine, you may try to increase the voltage to few hundreds of volts and set triggering mode internal (on the power supply), then start shooting. After that do the same with the other channel. If you do not see anything strange and it looks fine, just set the voltages, which were set before removing it and you may start the laser working. Do not forget to *set External triggering* mode.

PS5050 Error Codes and Solutions

PS5050 :22 PowerDown 10H – Power voltage dip is detected. Power supply may be simply switched off.

PS5050 :22 OvervoltCh1 20H – Power supply shutdown due voltage on capacitors exceeded critical value.

PS5050 :22 ThermoCh1 80H – Charger 1 overheat. Let cool down before restarting the power supply, check ambient temperature, ventilation openings.

PS5050 :22 CurrentCh1 200H – No simmer current, possible flash lamp failure.

PS5050 :22 InterlockCh1 800H – Cooling unit fails to cool properly flash lamp head.

PS5050 :22 Connector 1000H – HV connectors cover is not fixed properly.

PS5050 :22 NoChargeCh1 2000H – Power supply hardware failure.

PS5050 :22 InterlockCh2 8000H – Safety interlock circuit break.

Sometimes error 2000 appears together with error 200. Error 2200 is result of two errors: no charge and flash lamps.

The name *24V board* is misleading as this is an obsolete leftover name since the older makes. There's no 24 volts there since year 2000 (only 15V). If there's no 300 volts in *24V board* then the problem lies there. Most likely rectifier VD1 is blown (KBPC2510). Probably I don't need to explain, how to test a rectifier.

At the same time check if the resistor R1 (COR-5 220ohm) is not burned, also contacts of relays K1 and K2 have to be checked for them not to be stuck together. There's also a chance that a ‘transfer’ hole close to VD1 is burned (Figure 49). This should be visible. If not, continuity can be checked once rectifier is removed.

One of simplest ways for repairs would be getting a replacement *24V board*. In recent versions rectifiers are more powerful and problem with ‘transfer hole’ burning out is solved. Take the old board out and put new one in. New board is very similar to old one, size and major contacts/connectors are at the same places. The name of a new board is 15V2K1F1.

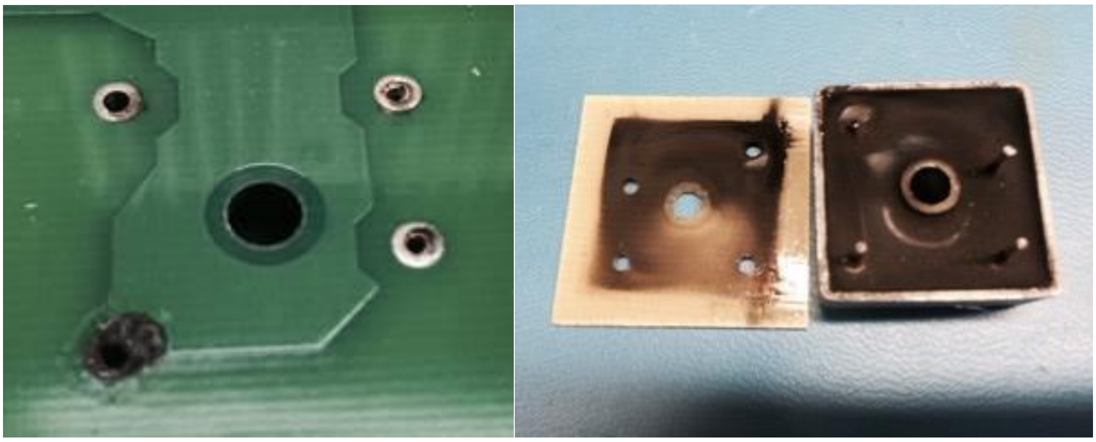


Figure 48 ‘Transfer’ hole burnt

PS1222CO Water and Filter (Particle + Di) Replacement

For this procedure you will need:

- New cartridge filter (every 5 years or when *Purity low* LED is on);
- New particle filter;
- 5 liters of distilled or de-ionized water;
- Screwdriver.

The procedure:

1. Disconnect system from the mains.
2. Remove the cooling unit from the rack.
3. Open the *DRAINPORT* (14 in Figure 49) and remove water from the cooling unit. Close the *DRAINPORT*.
4. Rotate blue cap of particle filter in order to remove it (Figure 50).
5. Particle filter will be loose in the cap. (Figure 51, *a*) Just remove old one and put new filter in the same manner.
6. Fix blue cap gently back in its position.

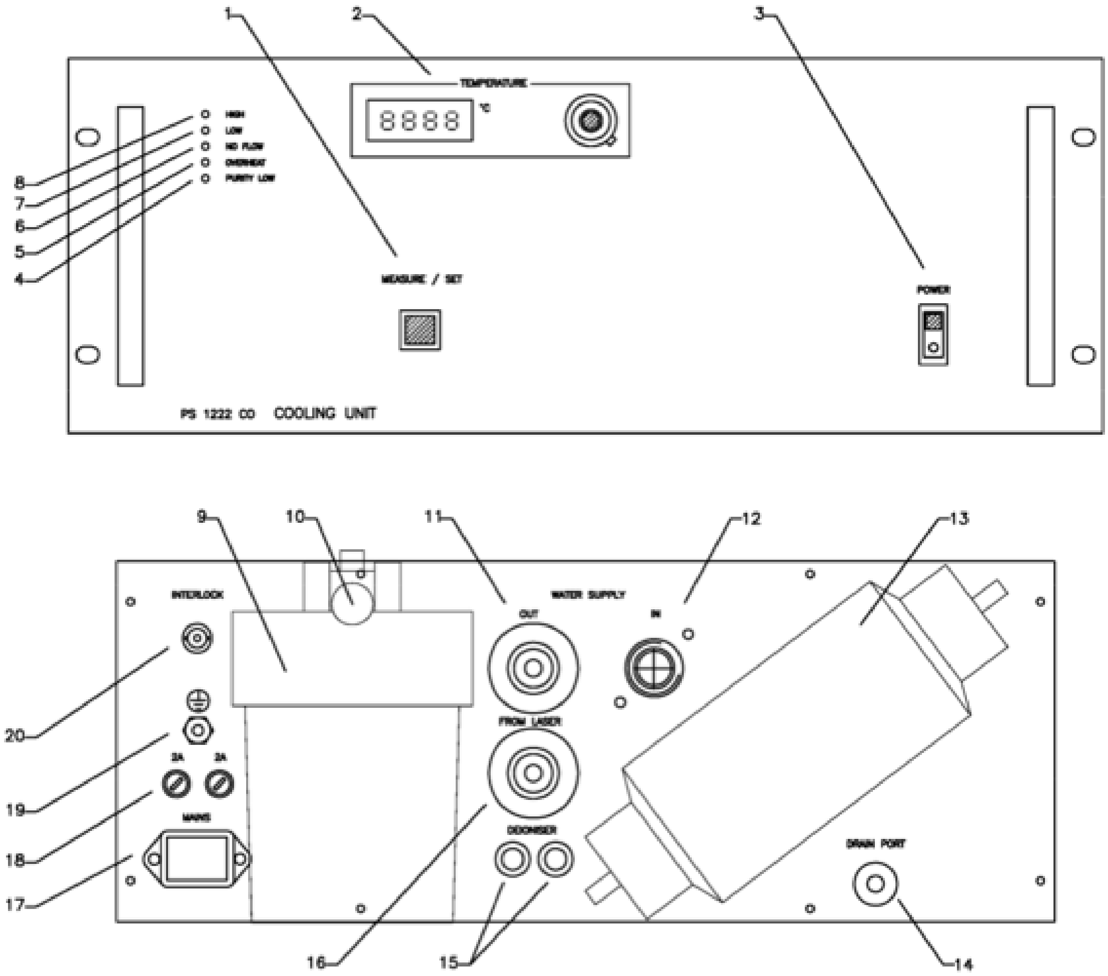


Figure 49 Cooling unit front and back panels

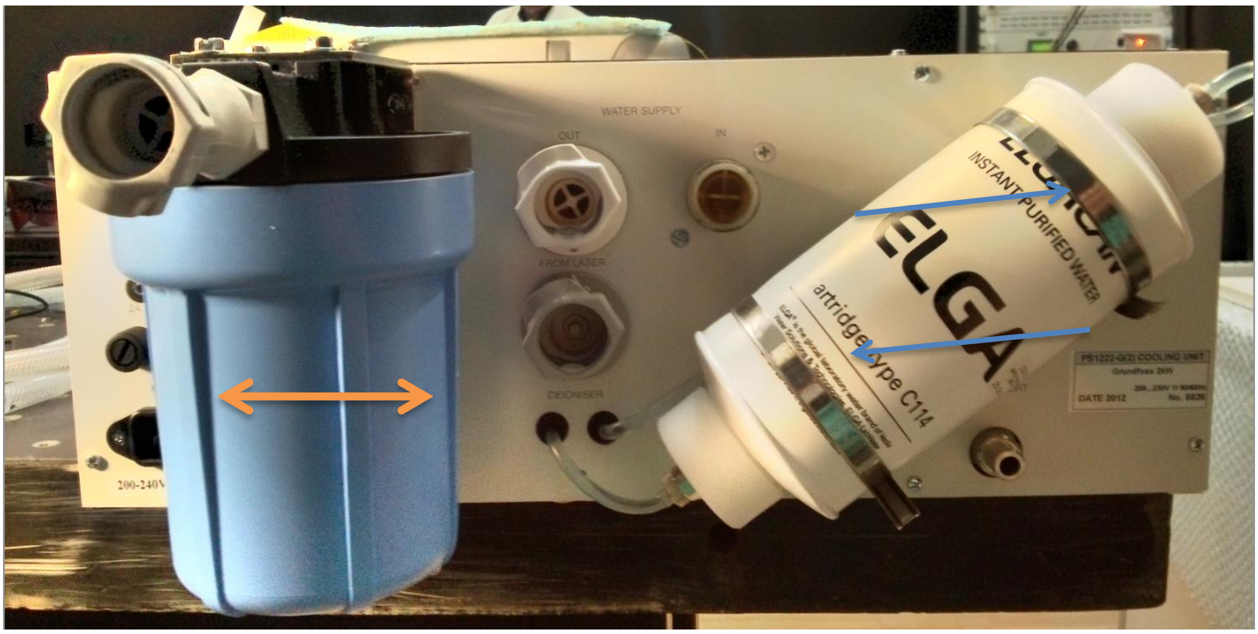


Figure 50 Back view of the cooling unit

a) *b)*

Figure 51 a) Particle filter, b) DI filter

7. Release two screws to untighten the cartridge DI filter (Figure 50, right)
8. Move metal bracers close to each other.
9. In this step the cartridge filter will be loose, so just unscrew both plastic endings of the filter (Figure 51, b) and the filter is removed.
10. Fix new filter in the same manner. Do not over tighten braces because filter housing will break.
11. Please note, that while tightening the white plastic ending of filter the pipe will get twisted clockwise. This position is not correct. So, before tightening the white cap just rotate it anticlockwise in advance.
12. If the water is not changed regularly and contamination is visible, please remove water from the hoses of all laser system as well. Put the cooling unit back in the rack and connect cables. Fill the unit with distilled water and connect it to the mains.
13. After plugging laser to the mains do not use laser for about 10 minutes, wait for the crystals to warm up.

PS1222CO Overheat Error

This error could be caused by no external water flow or to less pressure difference. It also could be caused by external water valve (Figure 52, *a*) contamination and blocked water flow. Through this external valve the water goes IN the cooling unit. If you unplug the pipe, you will see the protective net inside (Figure 52, *b*). If you see any contamination, try cleaning it by spraying water with pressure.

a) *b)*

Figure 52 a) External water valve, b) protective net inside the valve

PS1222 Flow and Water Level Sensor Checkup

In order to check the sensors, it is needed to measure resistance or ‘to ring’ the pins of the main connector on TBC board (Figure 53).

Pin numbers of the sensors:

- pins 1 to 17– flow sensor.
- pins 19 to 21– water high level
- pins 19 to 18– mid level
- pins 7 to 19– low water level sensor.

When the system is started and when the sensor is manually triggered, there should be short circuit between described pins. In order to manually trigger level sensor, it is needed to lift the float with some plastic (**not metal, important**) stick. Measure the resistance between the pins.

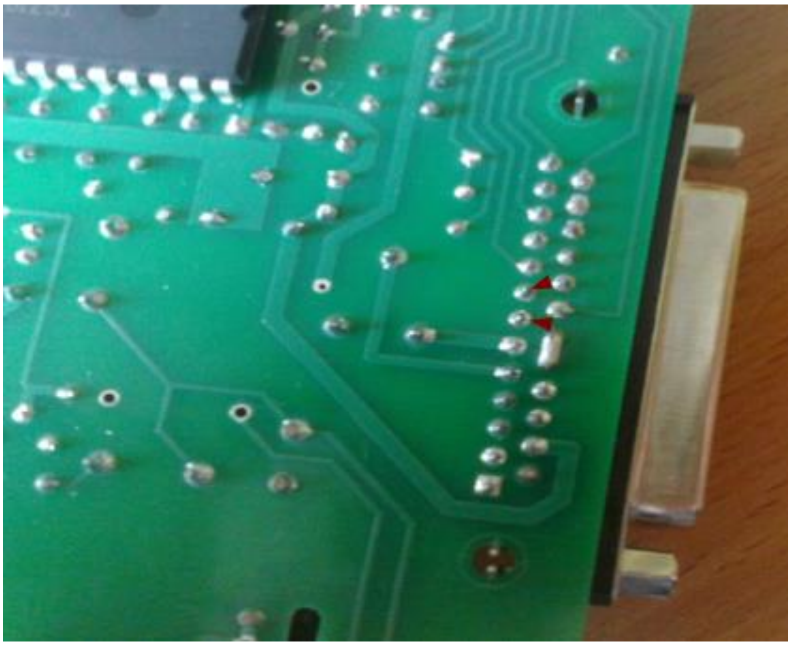


Figure 53 Main connector on TBC board

PS1222 “Speck” Water Pump Checkup

If 220V is available for the pump, but pump fails to run, check the following things:

1. Check connections on connection brick (Figure 54). If connection is good proceed to the next step.
2. Could be that Start-Up capacitor failed. Please measure its capacitance. It has to be around 6.8 µF. If capacitance is different, replace the capacitor and try to run the pump again.
3. The last thing could fail are motor windings. Open connection brick (Figure 54) to reveal contacts and measure resistance between windings. Resistance between the two edge contacts should be 47 Ω, between the edge and center contact – 68 Ω (21 Ω). If resistances are different, replace the pump.

Figure 54 Water pump connection brick

Appendix – Manual Change History

Rev1606

Base version.