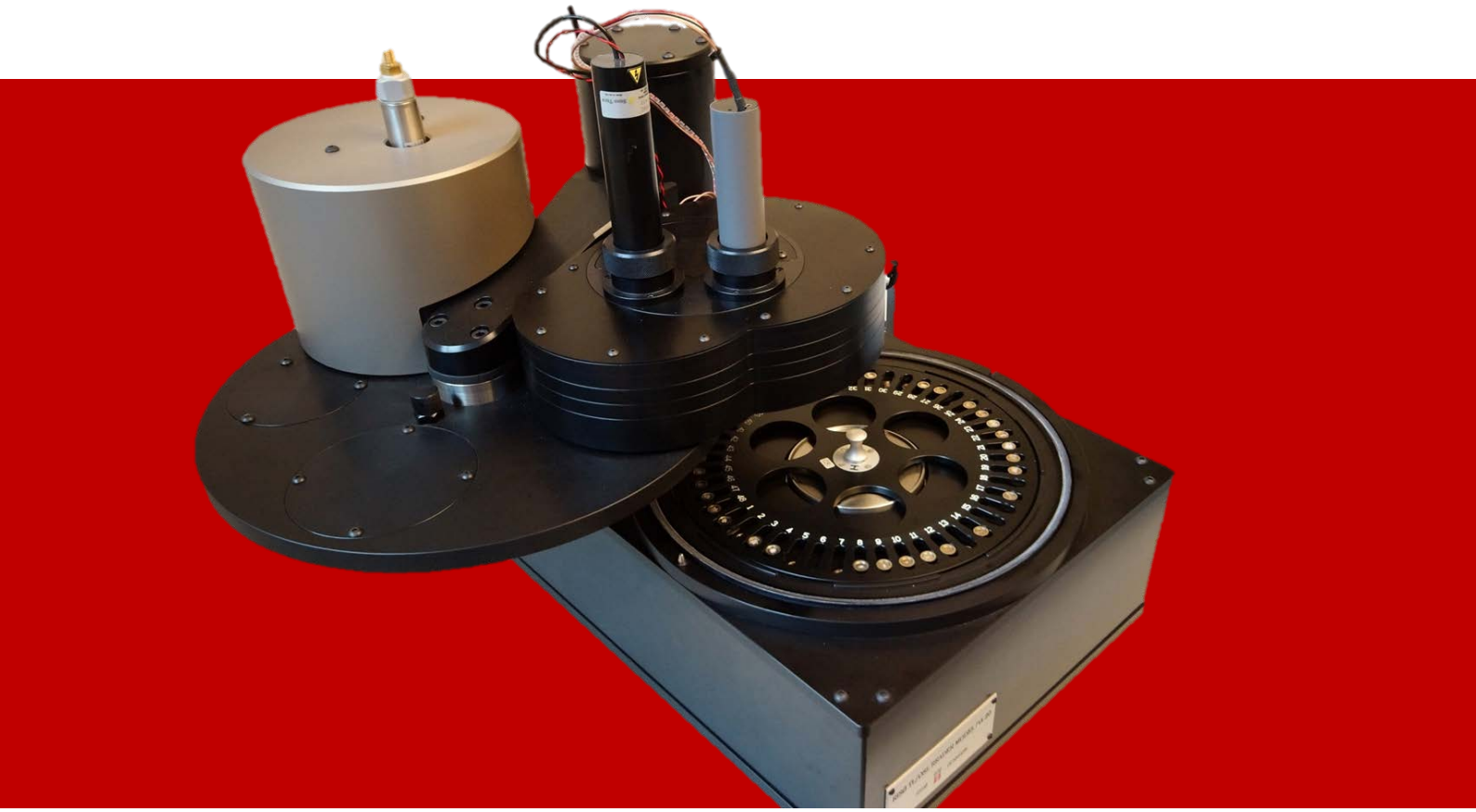
DTU Nutech
Center for Nuclear Technologies

User Manual

Automated DASH for the Risø TL/OSL Reader



November 2018

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1 Introduction

The automated Detection And Stimulation Head (DASH) for the Risø TL/OSL Reader provides easy access to new technologies, new signals and new measurement methods.

The automated DASH includes a filter changer and a detector changer (optional) that makes it possible to automatically change detection filters (4x4 filter combinations possible) and detectors (three detectors possible) during a measurement sequence.

The DASH can accommodate a variety of attachments such as the single grain attachment and the Risø spectrometer.

The automated DASH with dedicated driver electronics can be retrospectively fitted to existing Risø TL/OSL Readers and thus does not prevent the use of previously developed attachments.

2 Overall specification

Light sources:
Blue-, Green-, IR LEDs + optional external sources

Detection filter changer:
Two filter changer wheels, which each accommodate four filter baskets. Each filter basket can hold individual filters (or stack of filters) up to 7.5 mm thick with a diameter of 25 mm (1 inch)

Detector changer:
Three-position automated detector changer, e.g. two PMTs (blue and red sensitive), and an EMCCD camera

Driving electronics:
CW and pulsing, power regulation, DASH control

Compatibility:
Can be mounted on existing Risø TL/OSL readers[1]

[1] Applies to Readers manufactured after 1997 that make use of sample carrousels with a diameter of 30.5 cm.

3 Components

DASH is modularised into four layers:

- Base unit (bottom layer)
- Filter changer (middle two layers)
- Detector changer or top (top layer)

A schematic overview of the automated DASH is shown in Figure 1.

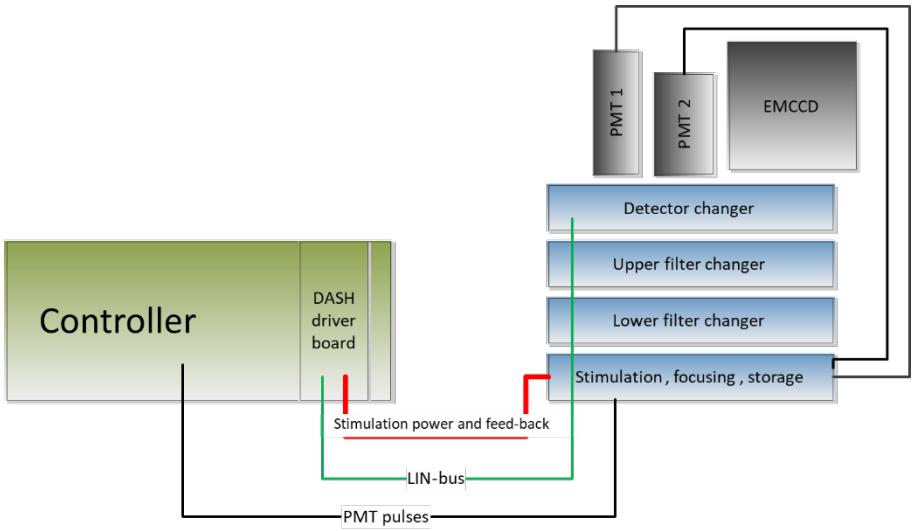


Figure 1. Schematic overview of the automated DASH and connection to the Controller. [From Lapp et al. (2015). A new luminescence detection and stimulation head for the Risø TL/OSL reader. Radiation Measurements 81, 178-184].

The filter changer, the detector changer, and focusing unit are controlled by local processors. These processors are connected via a serial bus (LIN-bus) to a Controller plug-in driver board.
The Controller plug-in board also serves as a driver board for the LEDs and regulation of power via feed-back photodiodes in the DASH.

3.1 DASH Driver Board

The DASH driver board (see Figure 2) is inserted into the back of the Controller. Some of the key features of this board are listed below:

- OSL Continuous Wave- (CW) and pulsing (POSL) boards are combined, i.e. no external wiring and no re-wiring when changing between CW and pulsing mode is required
- Increased flexibility in choice of pulsing parameters

- Auto-calibration of the optical stimulation unit
- Drives and regulates three sets of LEDs, and controls 2 external sources
- LIN-bus master which serves as controller for filter- and detector-changers, and the focussing module for the EMCCD camera

Specifications:
POSL On/Off time: > 5 µs
Gating period: freely definable within the pulse period.
Resolution: > 100 ns
Max driving voltage: 10 V
Max driving current: 1 A

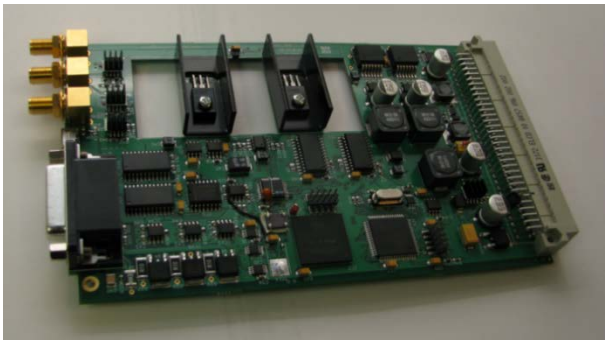


Figure 2. DASH Driver Board.

3.2 Optical stimulation unit

The optical stimulation unit is located in the bottom layer of the automated DASH (see Figure 1 and 3) and includes 7 locations for LEDs with reflectors and one empty position to enable the use of external stimulation light sources (e.g. the single-grain attachment, a violet 405 nm laser or a user-supplied stimulation source).
The standard LED configuration contains two blue (470 nm), two green (525 nm) and three (near-) infrared (850 nm) LED modules.

Standard specification:

Colour	Wavelength [nm]	Power (typical) [mW/cm^2]
Blue	470	80
Green	525	40
IR	850	300

The DASH can be configured to other light source combinations upon request. The standard system can be operated in continuous-wave (CW), linear modulated (LM) and pulsed (POSL) mode. All selections/operations are software controlled, and can be user selected during a measurement sequence.

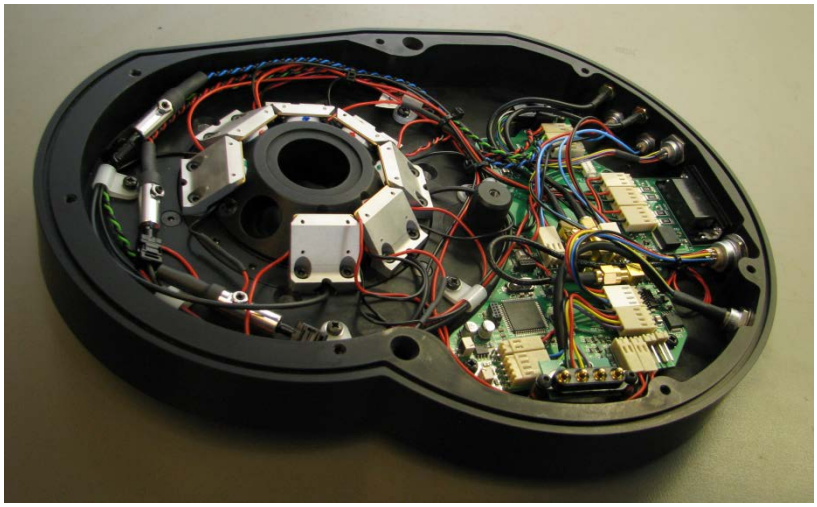


Figure 3. Bottom layer of DASH containing the optical stimulation unit and focussing for the EMCCD option.

3.3 Filter changer

The filter changer consists of two layers, each with 4 positions for standard commercially available 25 mm diameter filters. The filters can be stacked up to a thickness of 7.5 mm in each of the 8 filter holders.

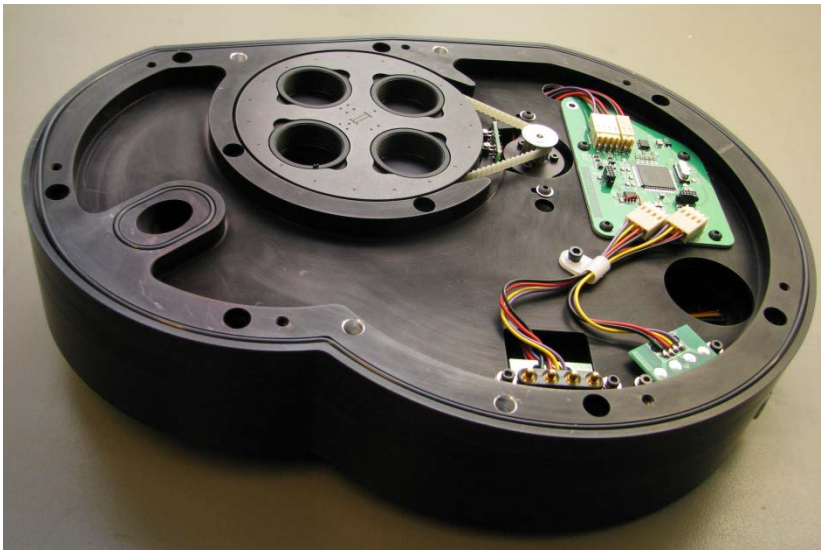


Figure 4. The top layer of the DASH has been removed such that the upper filter changer can be seen.

The standard configuration of filters is:

Layer I

- U-340 (2.5 mm)
- Blue filter pack: BG3 (3 mm) and BG39 (2 mm)

Layer II

- U-340 (5 mm)
- neutral density filter for PMT dead time measurement

Additional filters are available and users may install their own filters.

The user is able to change the DASH setup, but Figure 5 shows the default filters and their positions. In section 4.2.3 (*Detection and Stimulation Head setup*) and section 5 (*Changing detection filters in DASH*) we describe how to change filters in more detail.

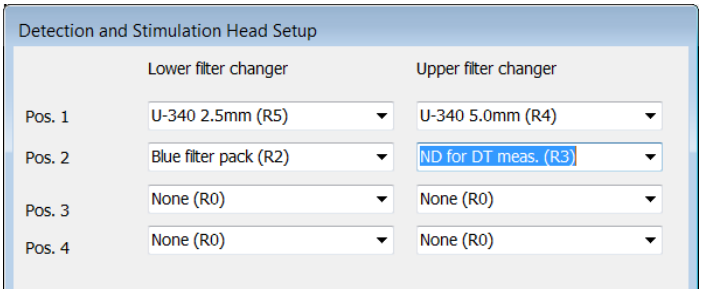


Figure 5. Default positions for the standard filters supplied with the Risø TL/OSL Reader.

3.4 Detector Changer

The detector changer can accommodate up to three detectors. DASH is fitted with collimating optics shared by all detectors. The optics are optimised for maximum transmission or, if the EMCCD camera is fitted, the best compromise between minimum non-linear distortion and maximum optical transmission.

The standard PMT is:

- Electron Tube PDM 9107Q-AP-TTL-03 (160-630 nm)

Other available detection units are:

- Hamamatsu H7421-50 (380-890 nm), cooled PMT
- Hamamatsu H7421-40 (300-720 nm), cooled PMT
- EMCCD camera (Photometrics Evolve 512) with automatically adjustable focusing optics
- Spectrometer system (Andor EMCCD camera mounted on a Kymera 193 spectrograph)

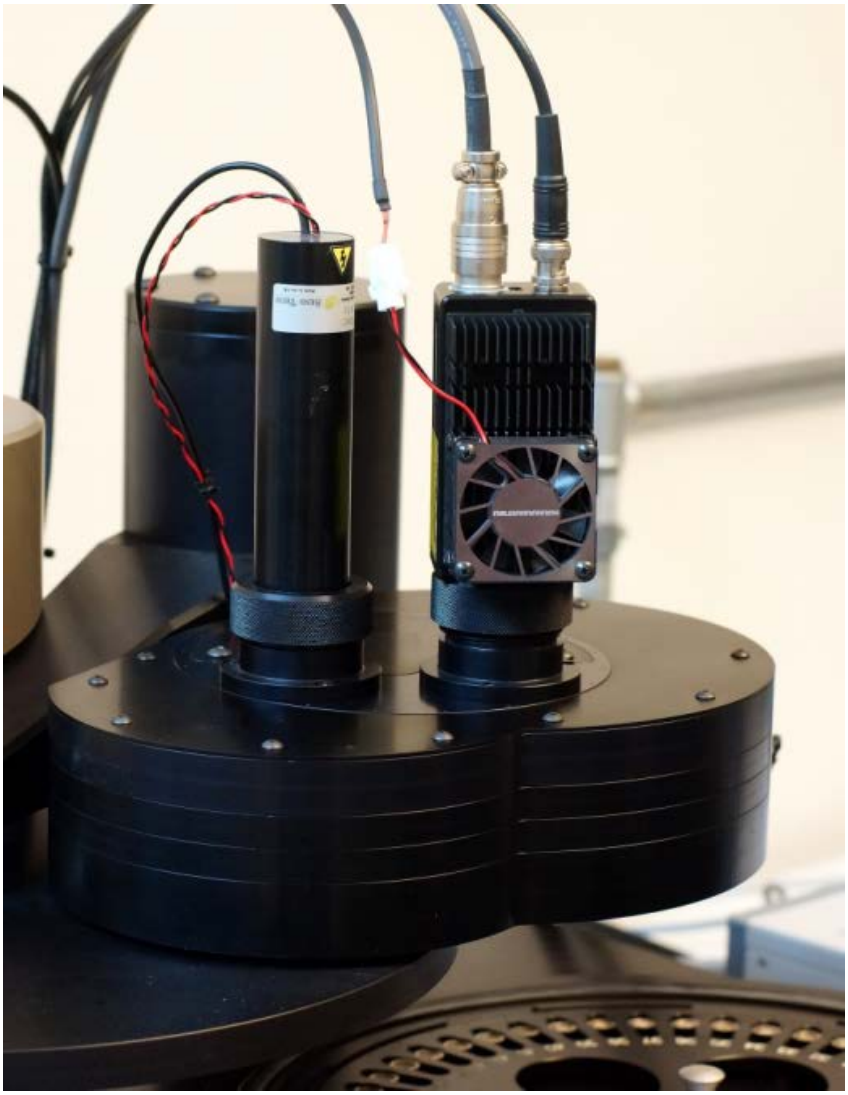


Figure 6. DASH mounted with detector changer and two PMTs.

4 Installing DASH

Installing DASH on a Risø TL/OSL Reader requires both physical mounting of the hardware (see section 4.1) as well as software setup – both using the Sequence Editor (section 4.2) and the Control program (section 4.3). The DASH driver board must be inserted into the back of the Controller (remember to switch off the power before doing so).

4.1 Mounting DASH on the Reader.

In order to mount DASH on the Reader, DASH must first be disassembled. In the following sections, we describe how to do this.
Be sure to keep the screws from individual layers separate from each other.

4.1.1 Disassembling the top layer

How to disassemble the top layer depends on whether or not a detector changer is present.

4.1.1.1 Disassembling the top layer (no detector changer)

Figure 7. Top layer without the detector changer.

Remove the seven screws indicated in Figure 7. Note that two of the screws are different from the others. Lift the top layer off. Place the top layer on a flat surface.

4.1.1.2 Disassembling the top layer (with detector changer)

Remove the eight screws indicated in Figure 8. Remove the outer part of the top layer.

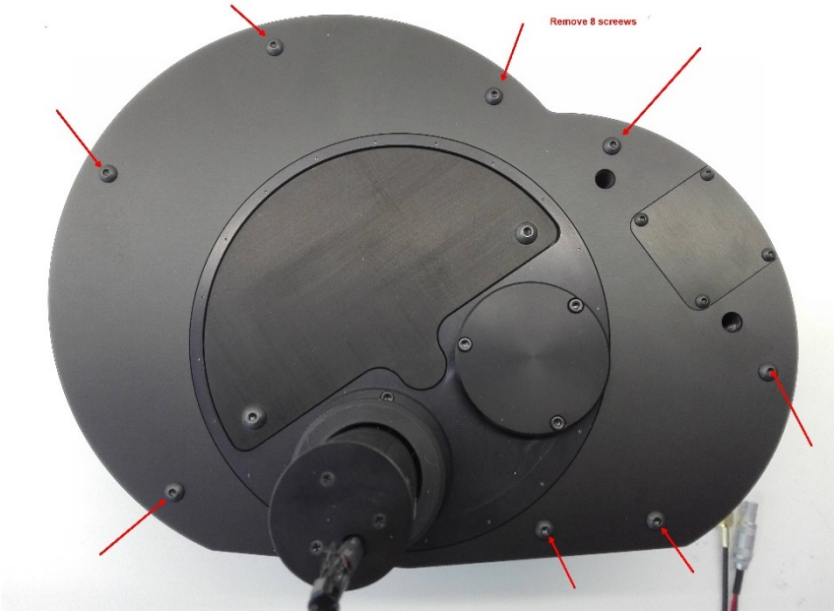


Figure 8. Top layer with detector changer.

Remove the six screws indicated in Figure 9. Lift the central part of the top layer off and place it gently on a flat surface. Be careful, as the backside is fragile.

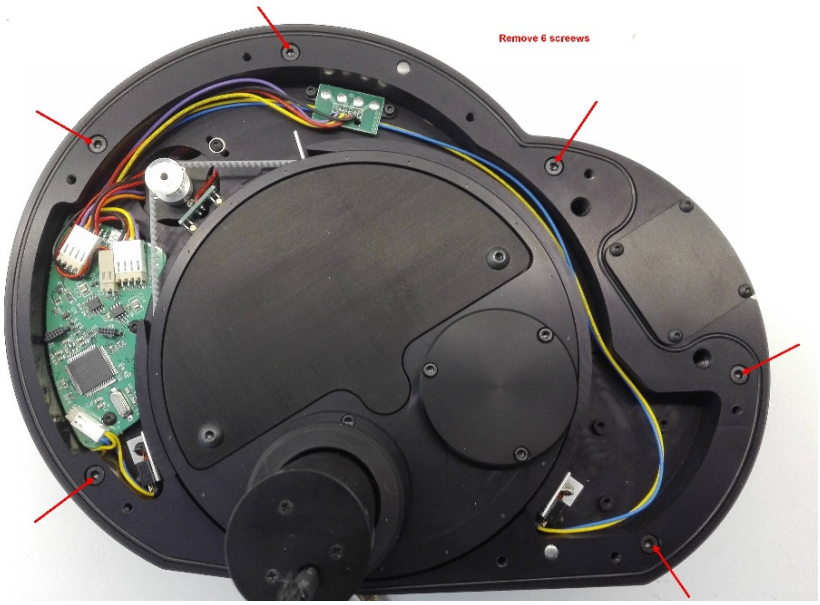


Figure 9 Top layer with detector changer after removal of the outer part of the top layer.

4.1.2 Disassembling the Upper filter changer (Layer II)

The upper filter changer located in this layer is marked as “II”. Remove the nine screws indicated in Figure 10. Lift up layer II and place it gently on a flat surface. Note that the backside is fragile.

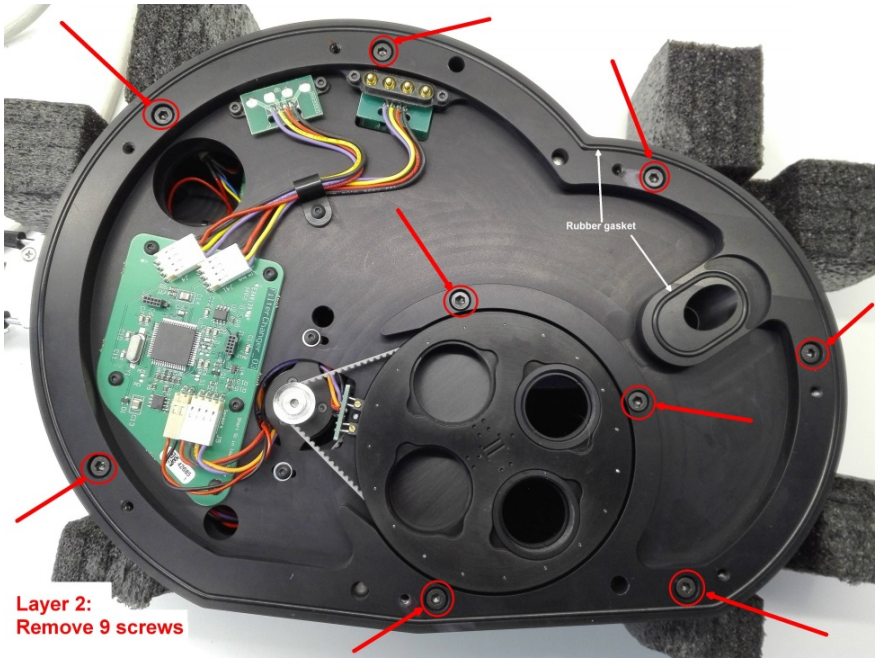


Figure 10. Upper filter changer (Layer II).

4.1.3 Disassembling the Lower filter changer (Layer I)

Figure 11 shows the layer containing the lower filter changer. The filter wheel in this layer is marked as “I”. Remove the 8 screws indicated. Note that one screw (10 mm) is shorter than the rest.

Lift layer I off and place it carefully on a flat surface. Be aware of the fragile backside.

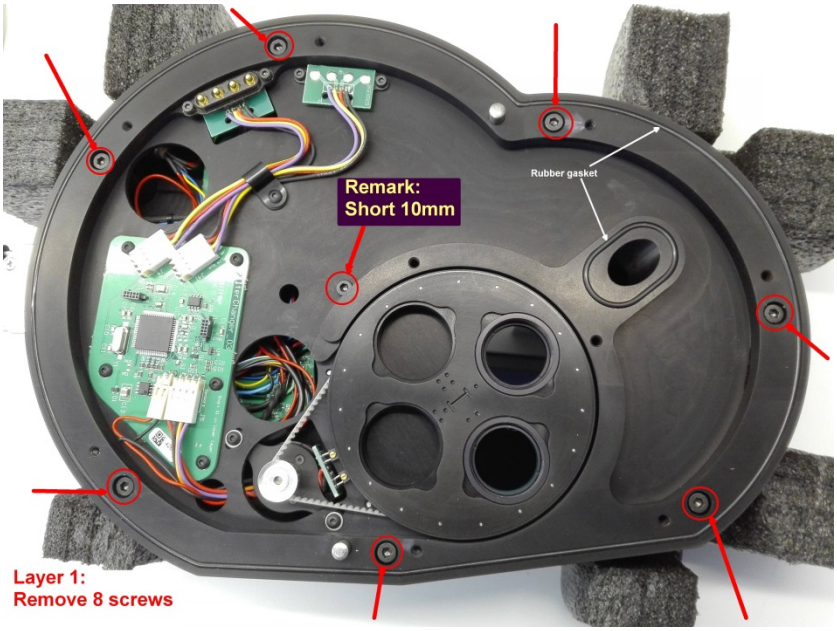


Figure 11. Lower filter changer (Layer I).

4.1.4 Mounting the base unit.

Place the base unit on the Reader. Make sure that the rubber gasket on the back is placed correctly (see Figure 12). Mount the base unit using the three countersunk screws (M5 16 mm). Be careful not to touch the thin electrical wires in the base unit (see Figure 13). Tighten the screws stepwise.

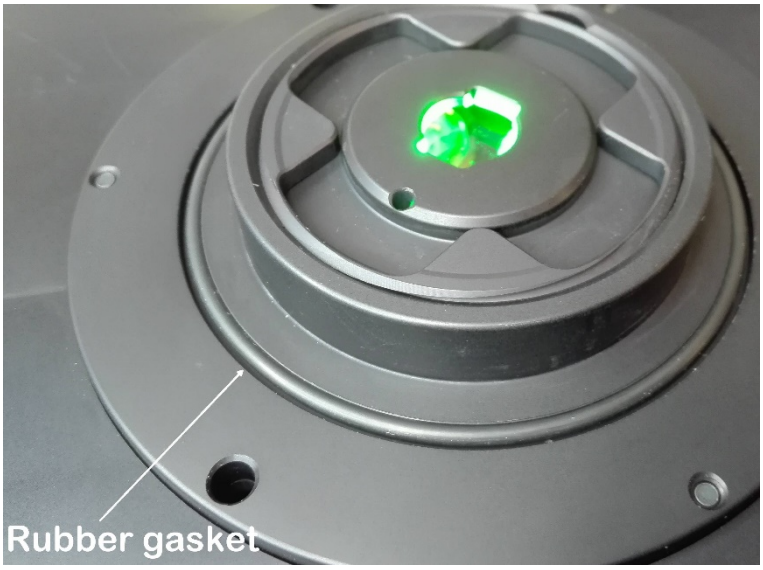


Figure 12. Enlargement of the base unit shown upside down. Ensure that the rubber gasket indicated is placed correctly.

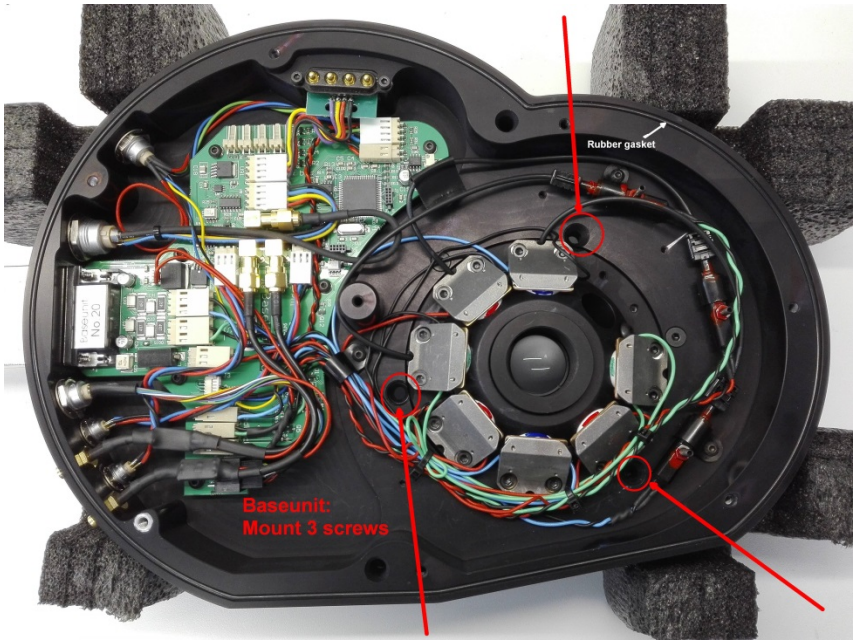


Figure 13. Base unit. Be careful not to touch the electrical wires.

4.1.5 Assembling the Lower filter changer (Layer I) on the base unit.

Check that the rubber gasket in the base unit is placed correctly (see Figure 14). Carefully place layer I on top of the base unit. The unit should be lying flat on the base. If there is any misalignment or the unit wiggles then check that the rubber gasket is in place and that no wires are caught between the layers.

Figure 14. Rubber gasket in the base unit.

Tighten the screws step by step as when changing a car tire. Note the short screw (10 mm) should be placed in the middle (see Figure 15).

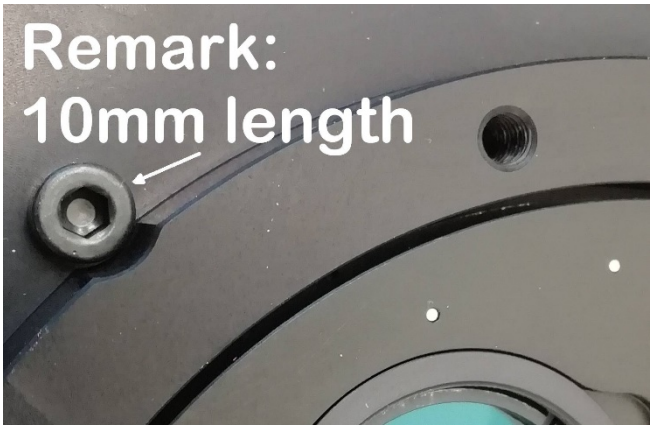


Figure 15. Short screw must be placed in the middle.

4.1.6 Reassembling the Upper filter changer (Layer II) and the Top layer

When reassembling DASH it is important to ensure that the two rubber gaskets shown in Figure 16 are placed correctly. Carefully remount layer II on top of layer I. Make sure the two layers are properly aligned. In case of any misalignment, the layers will “wiggle”. If so check that the rubber gaskets truly are in place and that no wires are caught between the two layers. Tighten the screws step by step as when changing a car tire.

Finish by remounting the top layer in the same way.

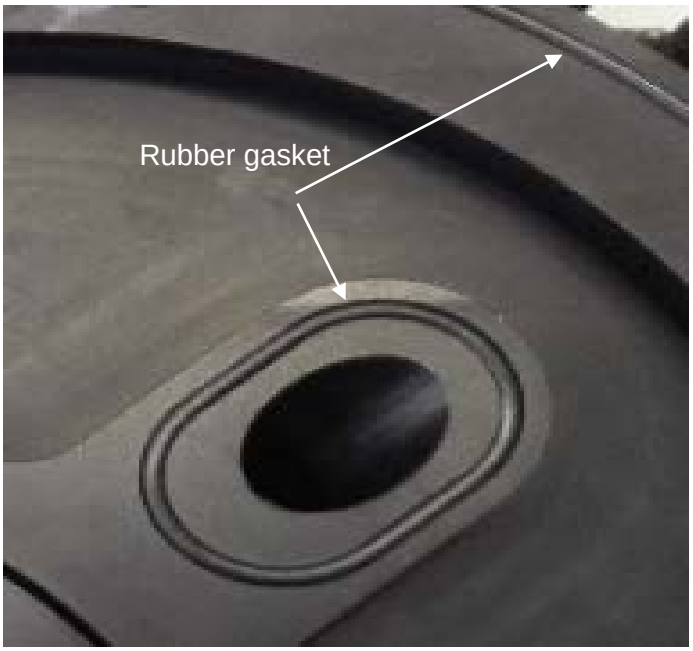
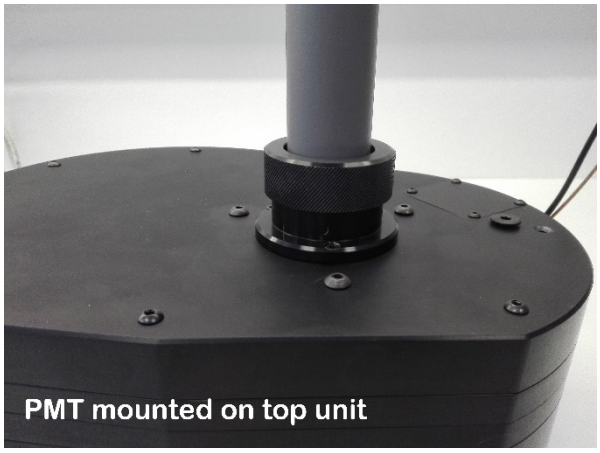


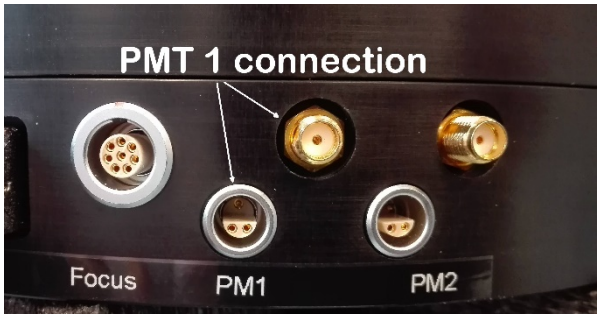
Figure 16. It is important that the rubber gaskets shown in the picture are correctly placed. These gaskets are present in both filter changer layers.

4.1.7 Mounting the PMT

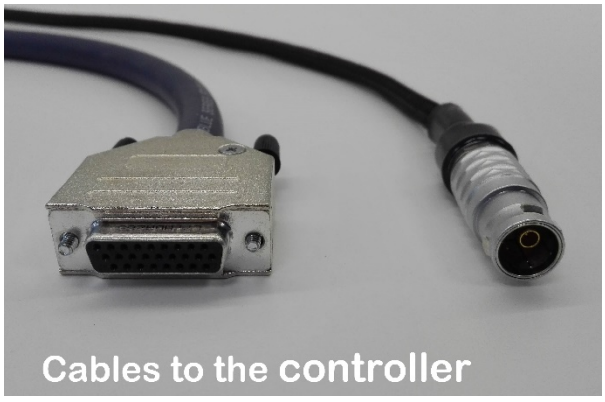
The PMT is pre-assembled in a fixture.

When mounting use the three screws supplied with the fixture. Carefully, place the PMT and fixture in the hole in the top unit. Mount it with the three screws (M3 10 mm). Tighten the screws stepwise.





Connect the PMT to DASH using the connections shown above. Connect the two cables from DASH to the controller (see below).



Now you are ready to switch on the power.

4.2 Setting up the Sequence Editor for DASH

The Sequence Editor must be setup for the Automated DASH and how to do this is described in this section. Please also see the *Sequence Editor User Manual* and the *Help* function of the Sequence Editor (you may always get context sensitive help by pressing F1)

4.2.1 System Options

In System Options, located in the Edit Menu (Edit | System Options), DASH "*Automated*" must be selected (see Figure 17).

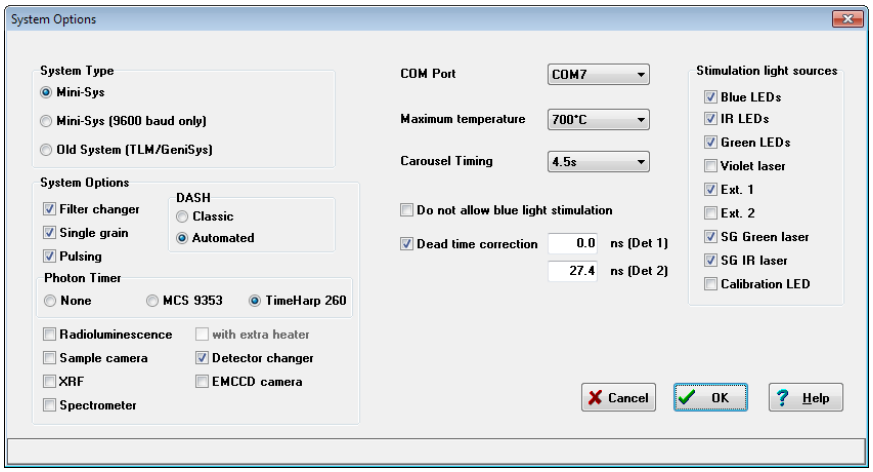


Figure 17. System Options in the Sequence Editor

When DASH "*Automated*" is selected it becomes possible to also select *Filter changer*, *Detector changer* and various *Stimulation light sources*. Check the appropriate boxes for your system.

Note that individual PMT dead times can be defined for detector 1 and detector 2 (middle panel in Figure 17).

4.2.2 Sequence Options

The "Sequence Options" (see Figure 18), located in the Edit Menu (Edit | Sequence Options), define several options which affect the overall behavior of the sequence.

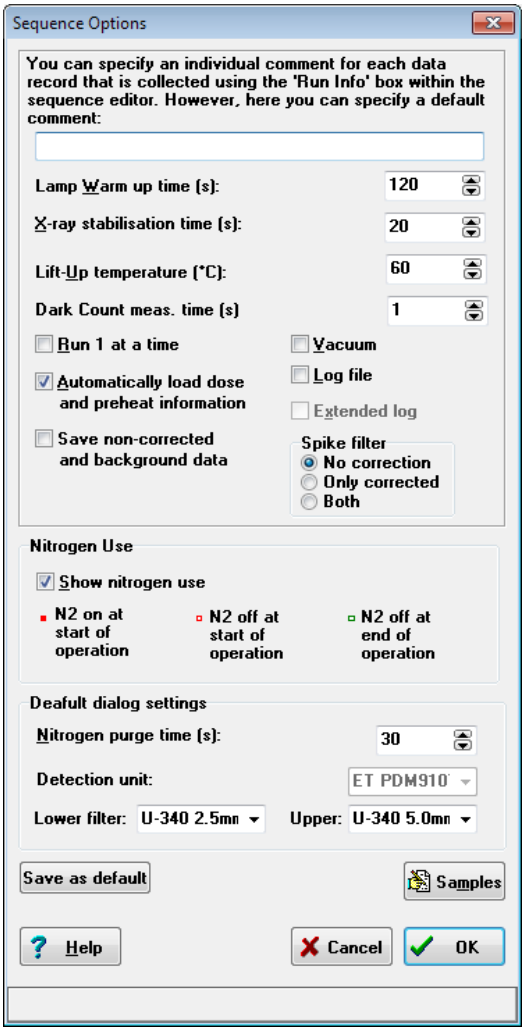


Figure 18. Sequence Options.

For TL, OSL, LM-OSL, POSL, SG-OSL and LM-SG-OSL you can specify default choices of:

- Detection unit
- Lower filter
- Upper filter

Default dialog settings:

Default nitrogen purge time:
The purge time used unless otherwise specified in individual commands.

Lower/Upper Filter:
Select the lower and upper filters that are used as a default for any commands making use of the filter changer.

Detection unit:
Select the detection unit that is used as a default for any commands making use of the detector changer.

It may also be relevant to store a default setting of the *Sequence Options*, i.e. the setting that apply when you define a sequence from scratch. The default *Sequence Options* settings is stored when pressing "*Save as default*".

Save as default:
When this button is pressed, the Sequence Options for the current sequence are stored as default settings for any new sequence defined.

4.2.3 Detection and Stimulation Head Setup

In order for the automated filter changer to work as intended, the system must know which detection filters are placed where, i.e. in which filter wheel and in which filter position. This information must be entered in the Sequence Editor using the "Detection and Stimulation Head Setup" window In the *Detection and stimulation head setup* (see Figure 19), which is located in the Edit Menu (Edit | Detection and stimulation head setup), the configuration of the automated DASH is specified.

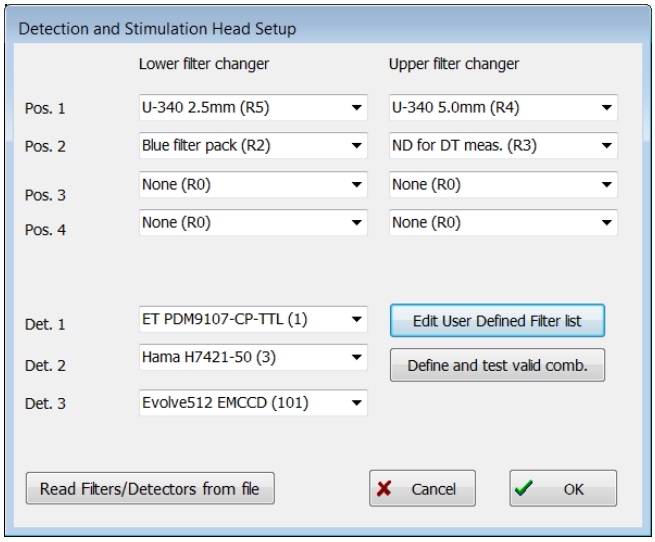


Figure 19. Detection and Stimulation Head Setup in the Sequence Editor.

The positions of the installed filters and detection units are specified in the top part of the setup screen. Filters and detectors are selected from a list that opens in the drop-down boxes.

The filters may be chosen from both standard Risø defined filters (e.g. R5) and User Defined filters (e.g. U1, see section 4.2.3.1 *Edit User Defined Filter list*).

In the setup there are three buttons:

1. Edit User Defined Filter list (see section 4.2.3.1)
2. Define and test valid comb. (see section 4.2.3.2)
3. Read Filters/Detectors from file (see section 4.2.3.3)

The functions of these are described in the following sections.

4.2.3.1 Edit User Defined Filter list

When choosing the “Edit User Defined Filter list” (see Figure 20), it is possible to define your own filters in addition to (or possibly instead of) the standard Risø filters.

Every filter is defined by a unique ID and a name.

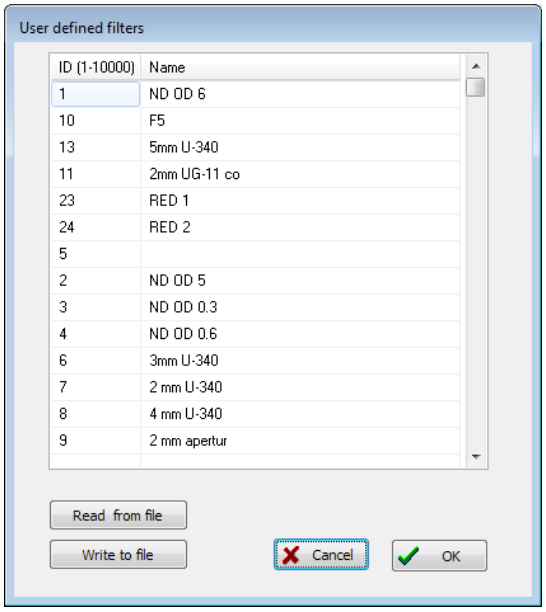


Figure 20. Example of User defined filters

When entering a new detection filter, choose an ID number (any integer between 1 and 10,000) and a filter name. Place the cursor in an empty cell, press “*Write to file*” and then “OK”.
On the “Detection and Stimulation Head Setup” screen the position of the new filter must be indicated, i.e. in which filter wheel (lower or upper) and in which position (pos. 1-4). The new filter is now available from the dropdown list.

This information is stored in the file *U_FLT.INI* in the Risø program data folder (e.g. in *C:\ProgramData\Risoe* on a standard Windows installation). If you are using a copy of the Sequence Editor on a different PC than the one used to run the Reader, then you need to copy the U_FLT.INI file to this PC.

Read from file

With this button, you may update the User defined filters and detectors specification file *U_DET.INI* with a file that has been defined on e.g. another installation of the Sequence Editor.

Write to file

With this button, you may store the User defined filters and detectors specification file *U_DET.INI as a backup or for use* on e.g. another installation of the Sequence Editor.

4.2.3.2 Define and check valid combinations

When choosing the "Define and test valid comb." button a Table appears (see Figure 21 for an example). In this table, you define which combinations of light sources, filters and detector combinations that are valid (i.e. safe to use). If a combination is defined in a sequence command that is not valid according to this table, you will get an error message when the sequence is started, and the sequence run is aborted.

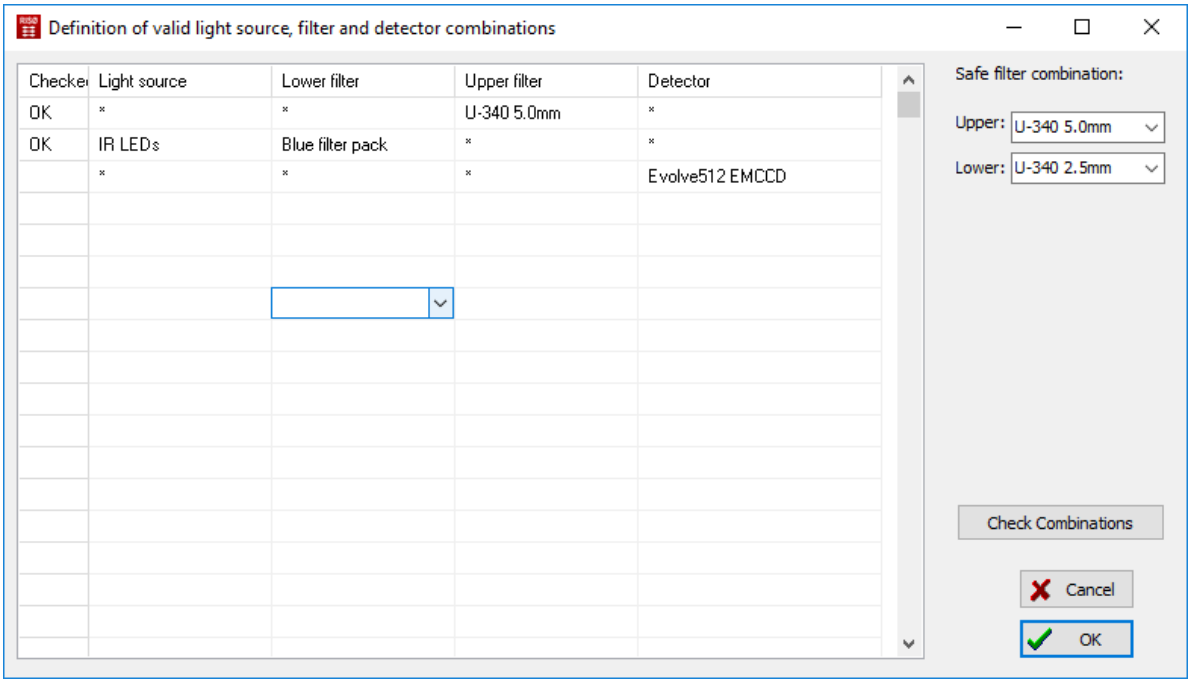


Figure 21. Definition of valid light source, filter and detector combinations.

You may use wildcards (*) in the definition of valid combinations, e.g. in the first line in the Table in Figure 21 all choices of light sources, lower filter and detector are allowed as long as the upper filer is chosen to be "5 mm U-340". You may have a greater breakthrough of the stimulation light into the detection window than otherwise possible, but you should not damage the PMT. In the second line of the Table, the rule is that one can use any filter and detector if the "IR LEDs" and the "Blue filter pack" is used. The rule in the third line is that any light source or filter combination can be used when the EMCCD is the chosen detector.
Before a defined combination is considered valid, it must have an "OK" in the "Checked" column (first column in the Table shown in Figure 21). To set the "OK" you must press the *Check Combinations*- button, and confirm each defined valid combination one by one. When pressing the "Check Combinations" button shown in Figure 21 you will be asked to verify that

all listed combinations (not previously verified) are safe to use. Figure 22 shows the popup window displayed when the “Check Combinations” button, for the example given in Figure 21, is pressed.

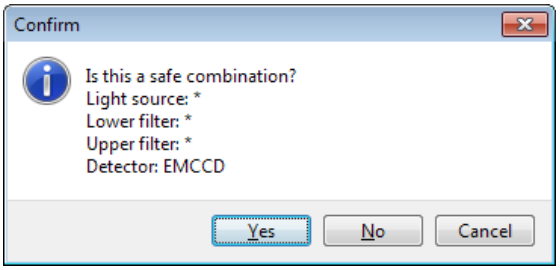


Figure 22. All combinations of light sources, filters and detectors must be validated to prevent serious damage to the detectors.

As the third line in Figure 21 has not yet been validated (it doesn’t have an “OK” in first column) you need to verify that this combination is safe to use.

In the top right corner of Figure 21, you must specify a safe filter combination to be used for operations where data are not recorded (e.g. illumination and single grain disc search). For such operations the Sequence Editor does not allow you to choose detection filters, so it is important that the e.g. the standard PMT is not exposed directly to the blue LEDs.

4.2.3.3 Read Filters/Detectors from file

With this button you may overwrite the Risø filters and detectors specification file *R_FLTDET.INI* with a possible updated file, e.g. when DTU Nutech releases a new updated file.

4.3 Setting up the Controller for DASH

The Control PC program uses the low-level commands of the Controller to operate the hardware of the Reader. It is mainly used during commissioning or troubleshooting but this program can also be useful for end-users to perform simple and isolated tests of the different parts of the reader, e.g. raising and lowering the sample lift, setting the sample wheel position, changing filter settings in the DASH and turning stimulation lights on and off (in the “Services” tab, see Figure 25). When installing DASH, you must use “Control” to change the settings in the Controller.

4.3.1 Connection tab

When you connect a Controller with a DASH driver board, you will be able to read the Driver CPLD version and the Serial Number (S/N) of the board (bottom of the middle column in Figure 23).

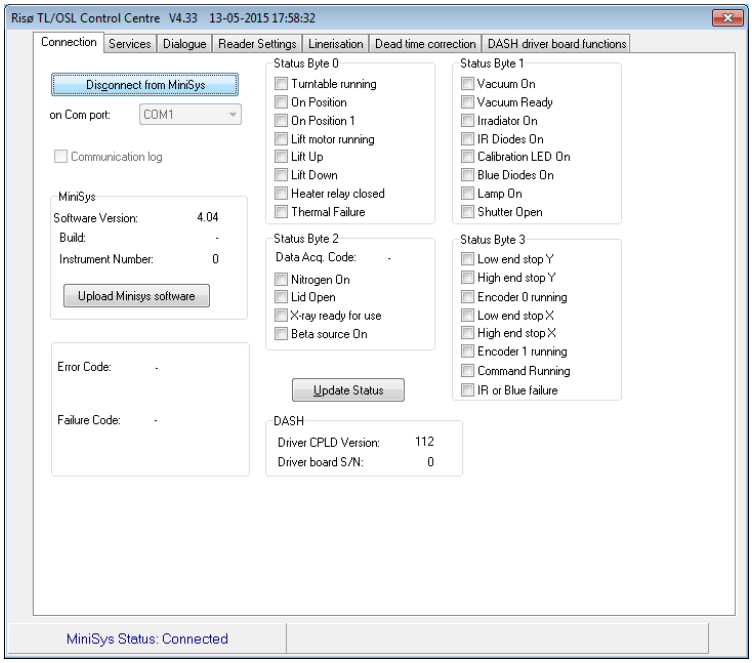


Figure 23. Screen shot of the "Connection" tab in Control

4.3.2 Reader Settings tab

If the Controller has not been set up for the automated DASH you may do this on the Reader Settings tab (see Figure 24):

1. Choose "*Automated*" under "*Stim. And Detection Head*"
2. Press "Send" to pass the information to the Controller (password: "syspass")

Now the available tabs will change to tabs relevant for the automated DASH.
You may check that the change of controller setup has been done successfully by pressing "Read" and verifying that "*Automated*" is still selected. **Note that changing any other parameters in this tab should only be done after consultation with DTU Nutech as system malfunction may otherwise occur**.

4.3.3 Services tab

When "*Automated*" DASH has successfully been selected, the "Services" tab (Figure 25) will show several new options:

- Detector position
- Focus pos. (changes the focusing plane for the EMCCD)
- Upper filter position
- Lower filter position
- Stimulation light source (shown as "Blue LEDs in Figure 25)

If pulsing mode is available, you may also set up default pulsing parameters.
Position boxes are marked with yellow background until the position has been actively set by pressing the -button.

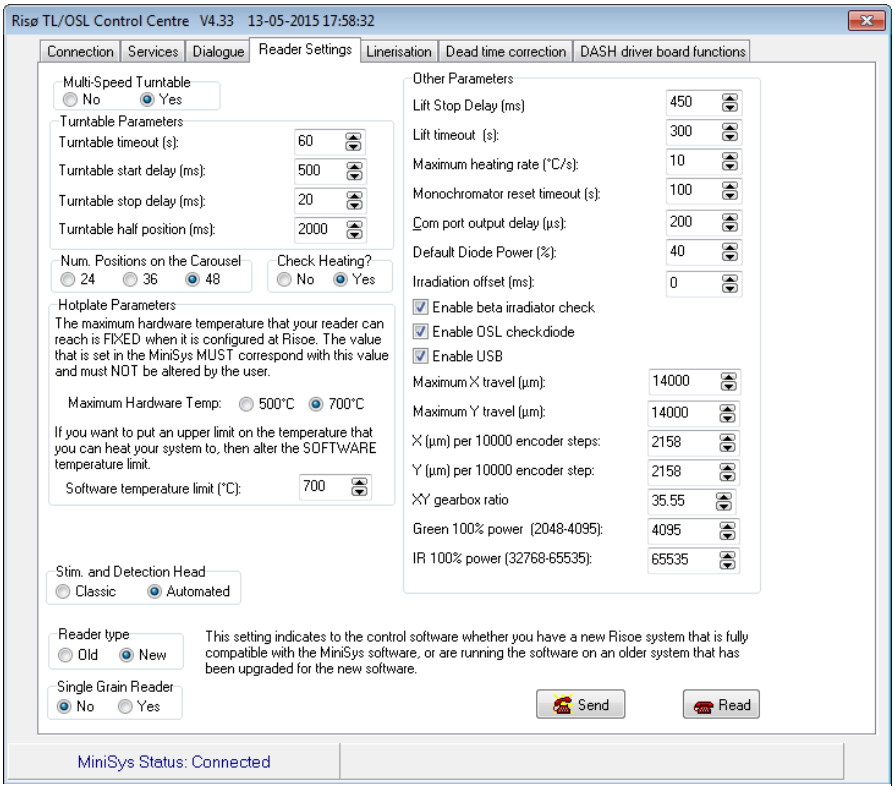


Figure 24. Screen shot of the "Reader Settings" tab in Control.

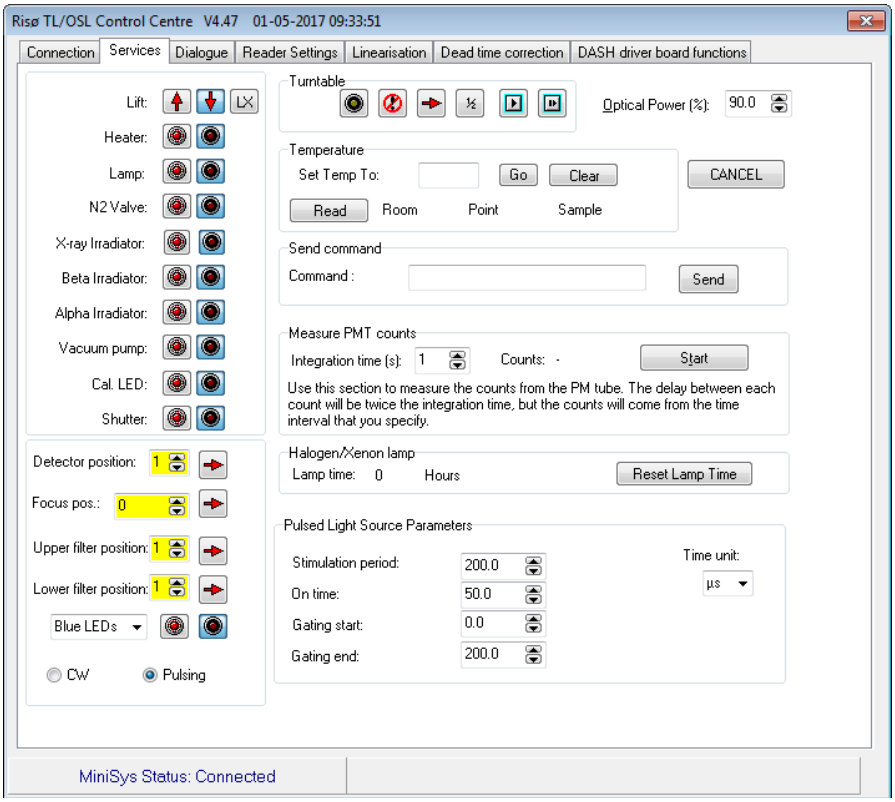


Figure 25. Screen shot of the "Services" tab in Control.

4.3.4 DASH driver board functions tab

On this tab you may perform an automated calibration of the different light sources.

The “Basic DASH driver setup” button is password protected and should only be used when directly instructed by DTU Nutech to do so.

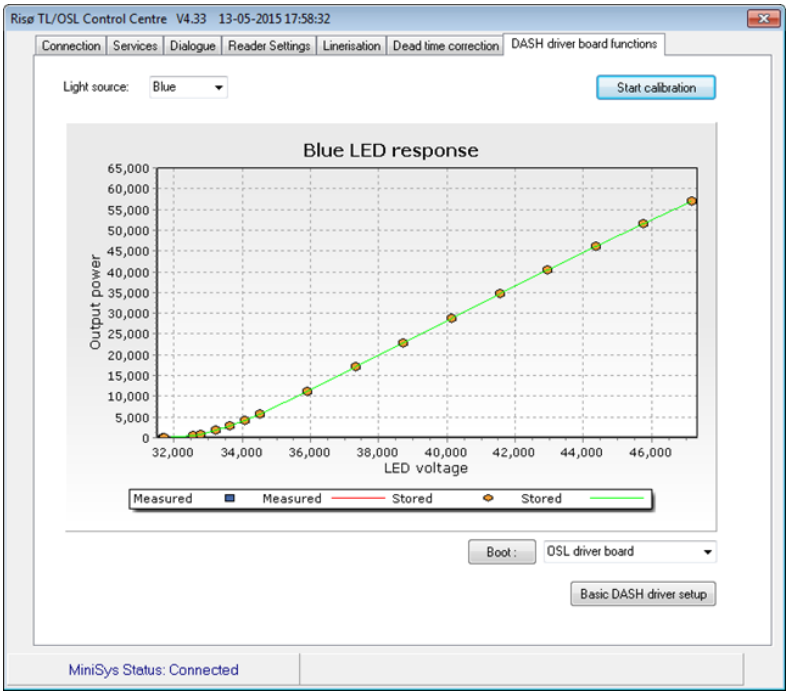


Figure 26. Screen shot of the “DASH driver board functions” tab in Control.

5 Changing detection filters in DASH

In order to change detection filters in DASH, the unit must be disassembled. First

1) Disconnect the power from the system
2) Remove the cables to the PMT(s)
3) Remove the three screws in the PMT fixture
4) Take off the fixture including the PMT and place it with the window pointing down

The additional steps in the disassembly of DASH are described in sections 4.1.1 and 4.1.2. When disassembling make sure to keep the screws from the individual layers separate from each other.

Mounting detection filters in both the lower and upper filter changer can now begin. Figure 27 shows the lower filter changer marked with “I”. Individual filter positions are marked using “dots” (1 to 4).

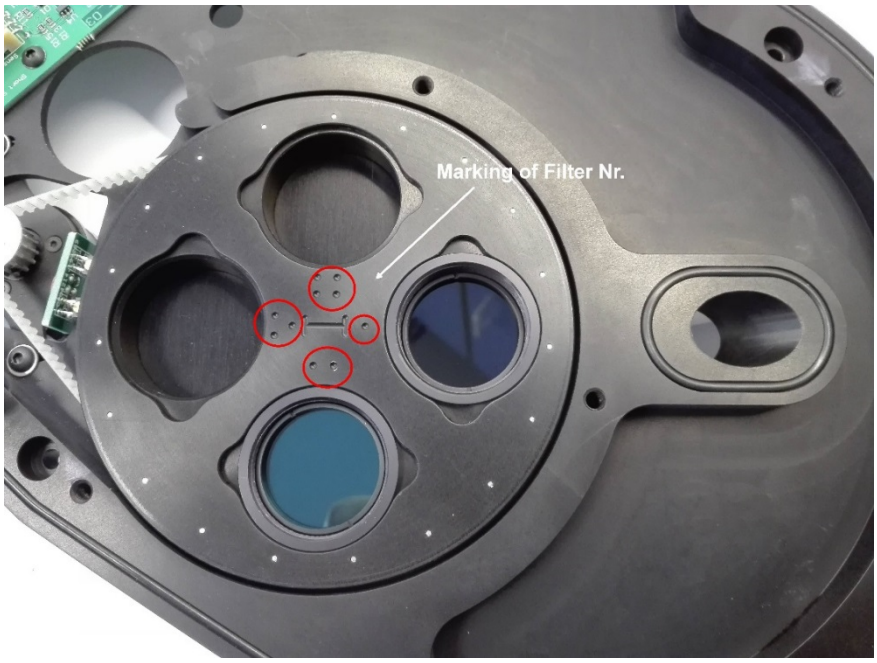


Figure 27. Lower filter changer (Layer I). Note the markings for the individual filter positions.

The detection filters are mounted in filter baskets (see Figure 28), which are easily inserted or removed from the filter wheels.

Figure 28. Individual filter baskets

The detection filter assembly consists of:

1) Filter basket.
2) O-ring size 23.5x1 mm
3) Filter 25 mm dia. Filters can be up to 7.5 mm thick. You can use more filters in the same basket, e.g. BG39+BG3. Use an o-ring between individual filters
4) Locking (retaining) ring, ThorLabs SM1RR-P10

The individual items are shown in Figure 29. When mounting detection filters, it is recommended to first place the o-ring, then the filter and finally the locking ring. If a stack of filters is mounted then place an o-ring between the individual filters.

Remember to write down the filter type and position of the filter.

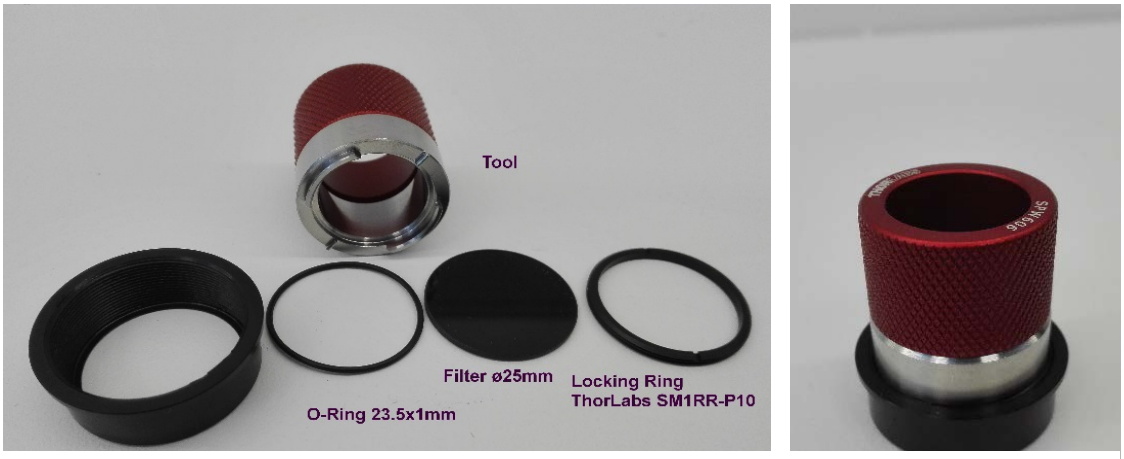


Figure 29. Individual items in the filter assembly (left) as well as the tool used for tightening the locking ring (right).

When reassembling DASH follow the instructions given in sections 4.1.5 to 4.1.7.

In order for the automated filter changer to work as intended, the system must know which detection filters are placed where, i.e. in which filter wheel and filter position. This information must be entered in the Sequence Editor using the “Detection and Stimulation Head Setup” window In the *Detection and Stimulation Head setup.* The instructions for how to do this are given in section 4.2.3.