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PhotoBench Utility

User Manual (v1.3)

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Bentham Instruments Software
Version 1.3.0

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1 PhotoBench Utility

The PhotoBench Utility version 1.1.0 has been written in conjunction with BenWin+ version 4.5.2.0 and the BPC300-C hardware system. The utility can be run by either selecting it from the Utilities menu or from the PhotoBench icon in the toolbar (Note that BenWin+ must first be initialized, see Figure 1.1).

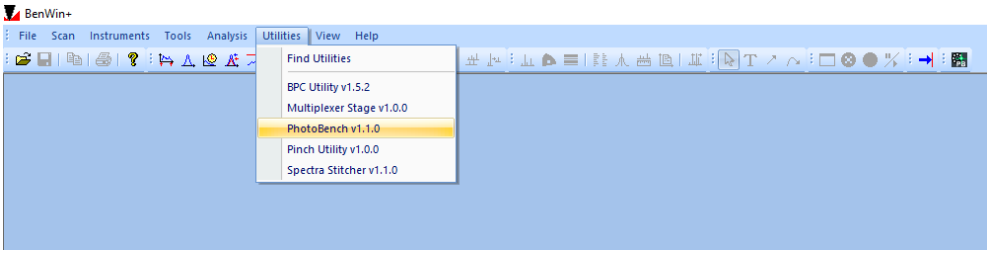


Figure 1.1

BenWin+ main screen.

2 Main Window

The PhotoBench Utility uses the concept of measurement profiles to determine the measurement process of up to six photochromic samples using the BPC300-C hardware. Once the profiles have been created, it is possible to run the whole measurement process from the main window (Figure 2.1).

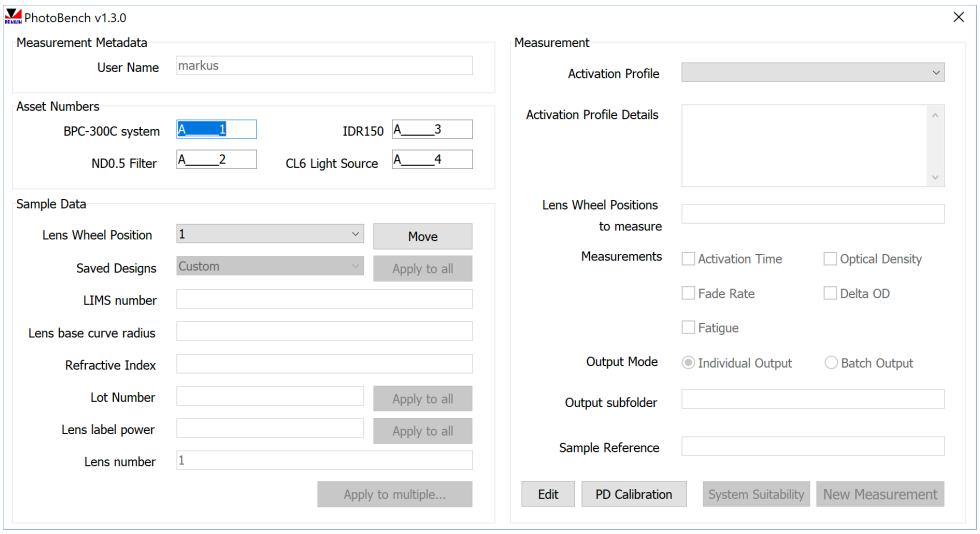


Figure 2.1

PhotoBench Utility main window.

2.1 Measurement Metadata

The User Name info box is prefilled with the BenWin+ username (Figure 2.2).

Figure 2.2

Measurement Metadata panel.

2.2 Asset Numbers

The Asset Numbers are editable according to user privileges and persist through different BenWin+ sessions. The permission to edit the System, ND Filter, IDR, CL6 are managed by BenWin+ utility permissions 1-4 respectively, managed under Accounts in the Tools menu of BenWin+.

Figure 2.3

Asset Numbers panel.

2.3 Sample Data

The user can select up to six different lens positions and fill the input information either manually or by selecting a previously saved lens design.

2.3.1 Lens Wheel Position

The *Lens Wheel Position* drop-down list allows to select one lens position from 1 to 6 (Figure 2.4). By selecting one lens position from 1 to 6, the edit boxes *Save Designs*, *LIMS number*, *Lens base curve radius*, *Refractive Index*, *Lot Number*, *Lens label power* and *Lens number* are updated with the information corresponding to the selected lens position.

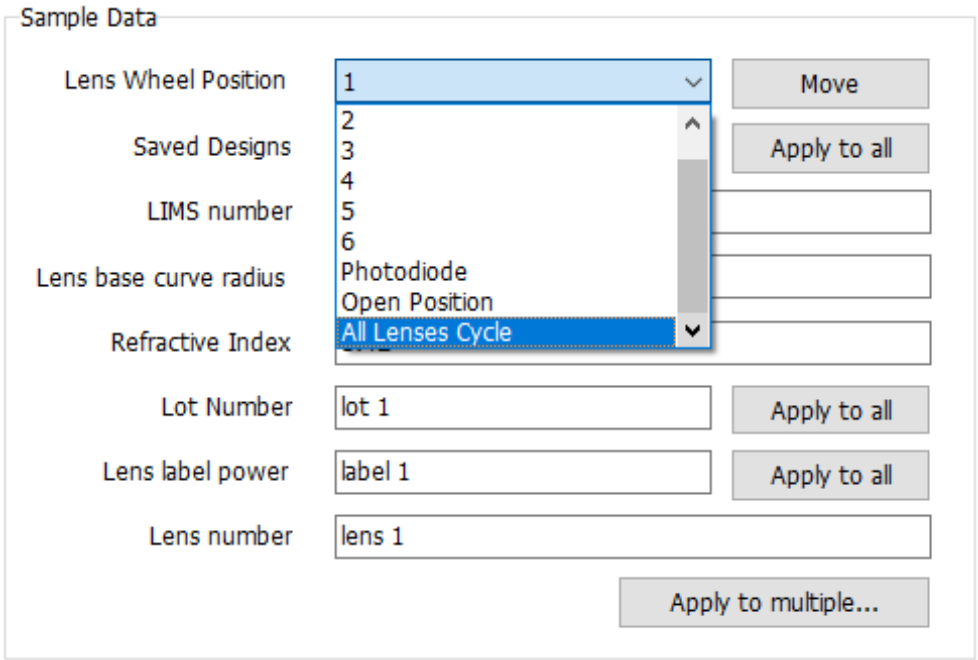


Figure 2.4

Lens Wheel Position drop-down list.

The *Lens Wheel Position* drop-down list also allows to select Photodiode, Open Position and All Lenses Cycle. The carousel can be moved to the position selected in *Lens Wheel Position* drop-down list by clicking on 'Move'. When clicking on 'Move' while All Lenses Cycle is selected, the carousel starts to move cyclically from lens position 1 to 6 (waiting 1.5 s at each lens position) and from position 6 to 1 until the user stops the operation by clicking on 'Stop' (Figure 2.5). This might be useful to remove potential bubbles before starting any measurement.

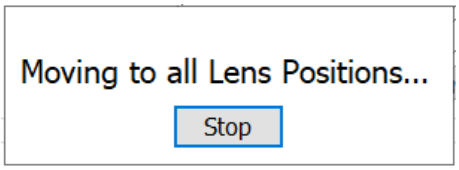


Figure 2.5

All lenses cycle dialog box.

2.3.2 Saved Designs

The *Save Designs* drop-down list allows to select between Custom and any lens design previously saved by administrator users in Settings — Saved Design Editors tab (see **3.8 Saved Design Editors** on p. 39), e.g. Lens1 (Figure 2.6a). When selecting any saved design, the edit boxes *LIMS number*, *Lens base curve radius* and *Refractive Index* are greyed out (i.e. cannot be modified) and show the information corresponding to the selected saved design (Figure 2.6b). These edit boxes can be modified again by selecting Custom in *Save Designs* drop-down list (Figure 2.6c).

When the user clicks on 'Apply to all' next to *Saved Designs* drop-down list, the current saved design is applied to all lenses (i.e. current *LIMS number*, *Lens base curve radius* and *Refractive Index* are applied to all lenses). When the user clicks on 'Apply to all' next to *Lot Number* or *Lens label power* edit boxes, the current Lot Number or the current Lens label power is applied to all lenses respectively.

The *Lens number* edit box is prefilled to match lens position. The user may change the lens number in the event of a series of more than six lenses in a lot to be measured.

The user may apply the current input measurement details to multiple lenses by clicking on 'Apply to multiple...'. A new window will be shown and the user will be prompted to enter the lens wheel positions to which the current input measurement details will be applied (Figure 2.7).

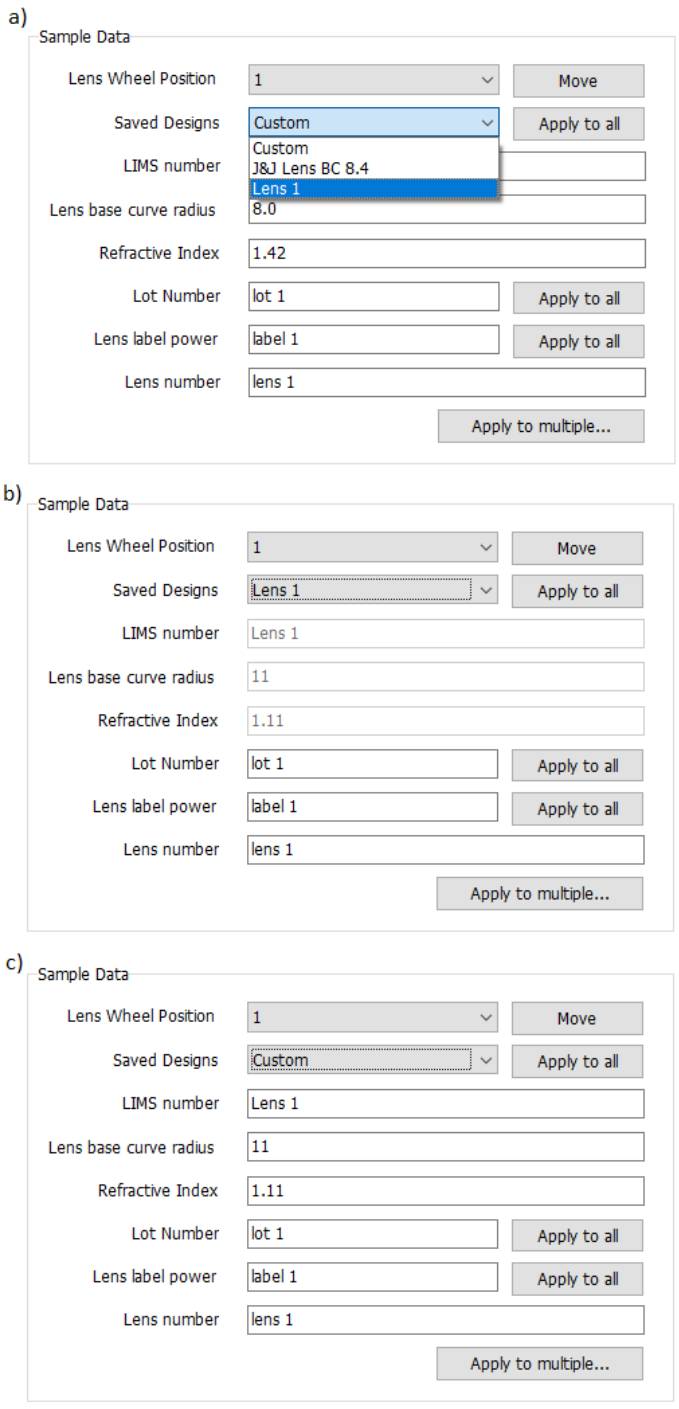


Figure 2.6

Saved Designs drop-down list.

Figure 2.7

Apply to multiple lenses dialog box.

2.4 Measurement

2.4.1 Activation Profile

The user can select different profiles from the *Activation Profile* drop-down list (Figure 2.8). The activation profiles can be edited by administrator users in Settings — Profile tab (see **3.1 Profile** on p. 18). Any profile details text added in Settings — Profile tab is shown in the *Activation Profile Details* box.

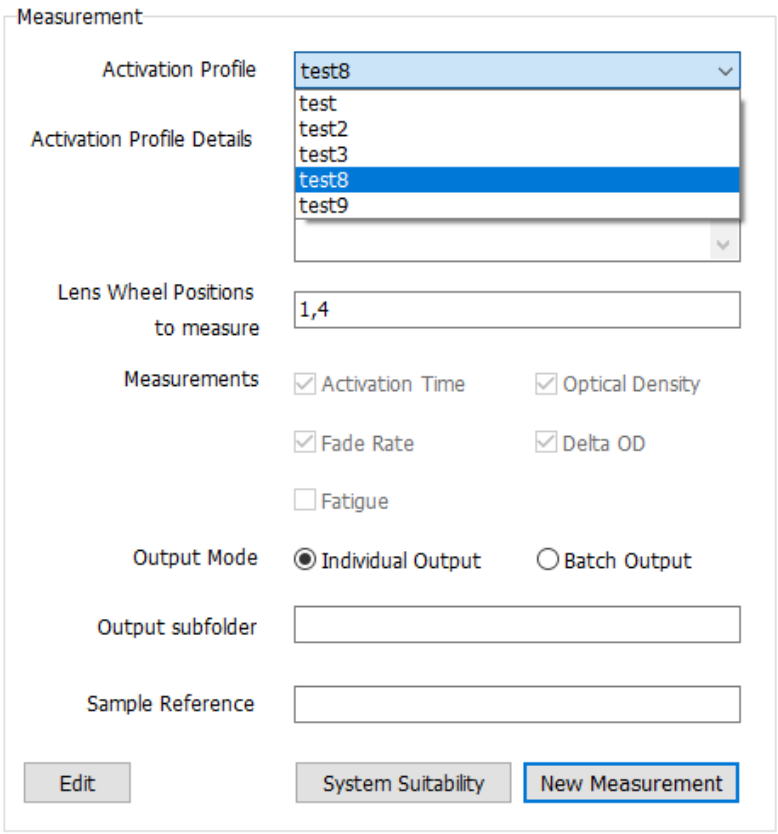


Figure 2.8

Activation Profile drop-down list.

2.4.2 Lens Wheel Positions to measure

The user can type a range of lens positions as well as individual lens positions to measure (e.g. 1-3, 5).

2.4.3 Measurements

The user may select (based on user type) different measurement options (Figure 2.8). Administrator users can enable or disable these checkboxes in Settings — Measurement Process tab (see **3.2 Measurement Process** on p. 19) so users with no administrator privileges may or may not click on them.

Table 2.1 shows the measurement processes (Reference, Faded, Darkening, Darkened, Fading) that are enabled when clicking on different Measurements options (Activation Time, Fade Rate, Optical Density, Delta OD). It is assumed that all measurement processes are initially disabled in Settings — Measurement Process tab (Figure 3.3). Note that Fatigue is an independent measurement mode from the rest of measurement options, i.e. it omits any other selected measurement option.

Table 2.1

Measurement processes enabled according to the measuremet options selected.

Measurement process						
# options selected	**Measurement/s selected**	**Reference**	**Faded**	**Darkening**	**Darkened**	**Fading**
0	No one selected	✓				
1	Activation Time	✓		✓		
	Fade Rate	✓				✓
	Optical Density	✓	✓			
	Delta OD	✓	✓	✓	✓	
2	Activation Time Fade Rate	✓		✓		✓
	Activation Time Optical Density	✓	✓	✓		
	Activation Time Delta OD	✓	✓	✓	✓	
	Fade Rate Optical Density	✓	✓			✓
	Fade Rate Delta OD	✓	✓	✓	✓	✓
	Optical Density Delta OD	✓	✓	✓	✓	
3	Activation Time Fade Rate Optical Density	✓	✓	✓		✓
	Activation Time Fade Rate Delta OD	✓	✓	✓	✓	✓
	Activation Time Optical Density	✓	✓	✓	✓	

	Delta OD					
	Fade Rate Optical Density Delta OD	✓	✓	✓	✓	✓
4	Activation Time Fade Rate Optical Density Delta OD	✓	✓	✓	✓	✓

2.4.4 Output Mode

The LIMS output data files are created according to the selected mode (Figure 2.8). Individual mode creates an output data file at the end of each lens measurement. Batch mode creates only one output data file at the end of the last lens measurement containing the data for all measured lenses. Note that the generation of LIMS output data files can be disabled in Settings — Measurement Process tab — Post Measurement Options panel (see **3.2.3 Post Measurement Options** on p. 27).

2.4.5 Output subfolder

The user can type the name of a folder (Figure 2.8) that will be created both within the output folder and the LIMS folder (see **3.6** Folder Options on p. 36).

2.4.6 Sample Reference

The sample reference is the text that will be appended to the date time as a folder name for saving the data within the output folder (Figure 2.8).

2.4.7 Edit Button

The user can open the Settings menu by clicking on 'Edit'. This button is enabled/disabled according to user privileges (Figure 2.8).

2.4.8 System Suitability

The user can measure the system suitability by clicking on 'System Suitability'. Note that at least one filter needs to be placed in a carousel position and selected in Settings — Measurement Process tab — Suitability Measurement panel (see **3.2.4 Suitability Measurement** on p. 28). A confirmation dialog box will open when clicking on 'System Suitability' (Figure 2.9).

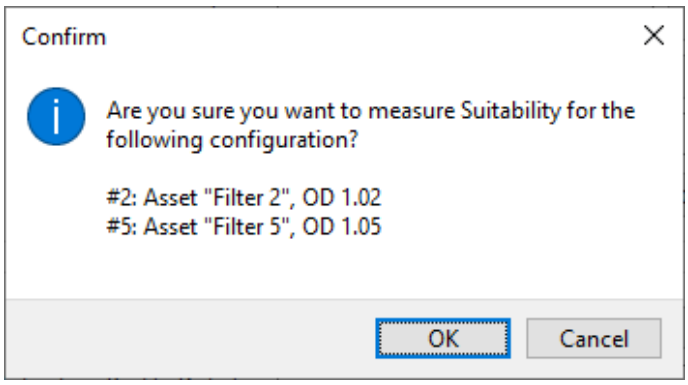


Figure 2.9

Confirmation dialog box for System Suitability.

2.4.9 New Measurement

The user can begin a new measurement process by clicking on 'New Measurement' for the selected *Activation Profile* (Figure 2.8).

2.4.10 PD Calibration

The PD Calibration button brings up the Photodiode calibration window. Permission to use this feature is managed by BenWin+ Utility Permission 5.

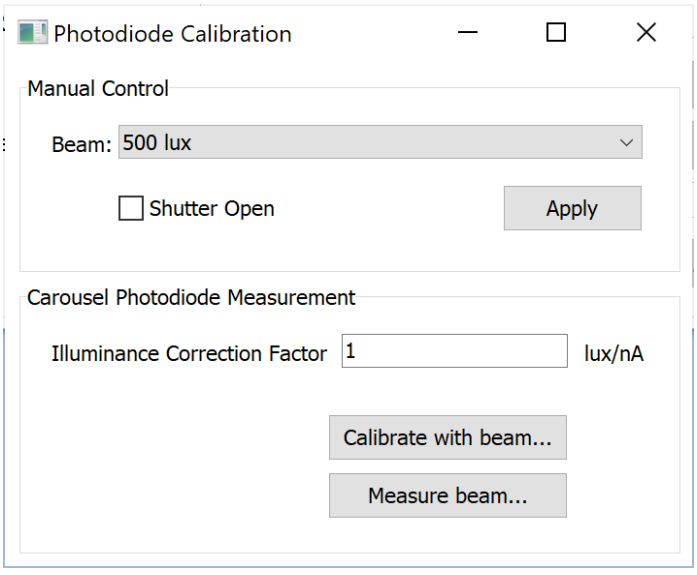


Figure 2.10

Photodiode Calibration Window

The PD Calibration button exposes a dialog where the user can calibrate the carousel photodiode, which requires knowledge of the real lux value. To this end this dialog also allows the user to manually set a predefined conditioning beam (filter and aperture combination) for the purpose of measuring the resultant spectrum. This functionality is reproduced here from similar functionality in the settings window.

3 Settings Window

The Settings Window can be opened by clicking on 'Edit' in the Main Window and entering a password (Figure 2.1). It consists of several tabs to set the measurement process and settings for a profile.

3.1 Profile

From this tab, it is possible to generate a new profile, save an existing profile, or delete a profile (Figure 3.1). The text inserted in *Profile Details* edit box for the selected profile is shown in the *Activation Profile Details* box in the Main Window.

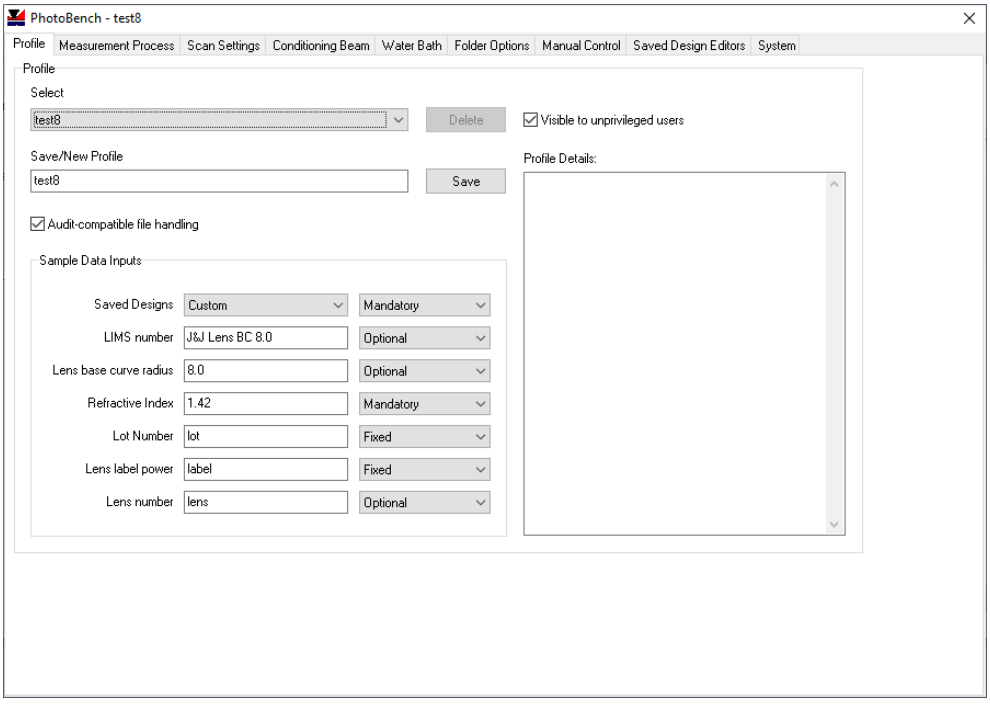


Figure 3.1

Profile tab.

3.1.1 Generate a new Profile

Enter a Name in the *Save/New Profile* edit box and click on 'Save' (Figure 3.1).

3.1.2 Save an existing Profile

Select an existing profile from the drop-down list, edit the profile as necessary and then click on 'Save' (Figure 3.1). This option is only available if *Audit-compatible file*

handling is disabled. A warning message will be displayed to confirm that the profile will be overwritten; click on 'Yes' to save the profile.

3.1.3 Delete a Profile

Only available if *Audit-compatible file handling* is disabled. Select an existing profile from the drop-down list and click on 'Delete' to permanently delete the profile (Figure 3.1). A warning message will be displayed confirming the intention to delete the profile.

3.1.4 Visible to unprivileged user

The selected profile can be shown/hidden in the *Activation Profile* drop-down list in the Main Window (Figure 2.8) by enabling/disabling *Visible to unprivileged user* (Figure 3.1).

3.1.5 Audit compatible file handling

Enabling *Audit-compatible file handling* prevents from deleting or overwriting existing profiles (Figure 3.1). If disabled, a warning message will be displayed confirming that the action will be logged in the audit log.

3.1.6 Sample Data Inputs

Sample Data Inputs prefills the fields in Sample Data (Main Window) for each lens wheel position, Each field in Sample Data Inputs has a drop-down list with the following options (Figure 3.1):

- Fixed: The field is greyed out in Main Window.
- Mandatory: The field needs to be filled in Main Window in order to start a measurement.
- Optional: The field can be empty in Main Window.

3.2 Measurement Process

The Measurement Process tab outlines all the BenWin+ measurements required for the sample under test as well as post measurement options, suitability measurement settings and a panel to set the range in which Delta OD (Delta Optical Density) is valid (Figure 3.2). Prior to all measurements (if selected), the water bath is set to a stable temperature (see **3.5 Water Bath** on p. 35).

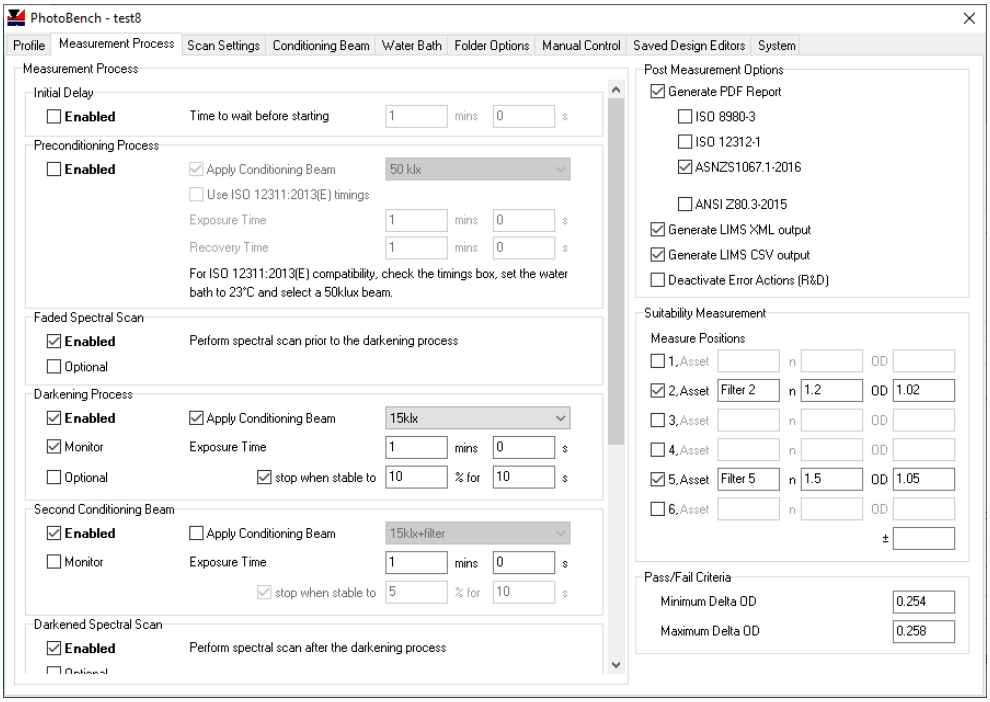


Figure 3.2

Measurement Process tab.

3.2.1 Measurement Process panel

The typical measurement process for one lens involves the following states in this order (it is assumed all processes shown in Figure 3.3 are enabled, except *Fatigue Process*):

1. Initial Delay
2. Measure pre-Lux (always performed)
3. Reference Scan (always performed)
4. Preconditioning Process
5. Faded Spectral Scan
6. Darkening
7. Second Conditioning Beam
8. Darkened Spectral Scan
9. Fading
10. Post Fading Spectral Scan
11. Measure post-Lux (always performed)

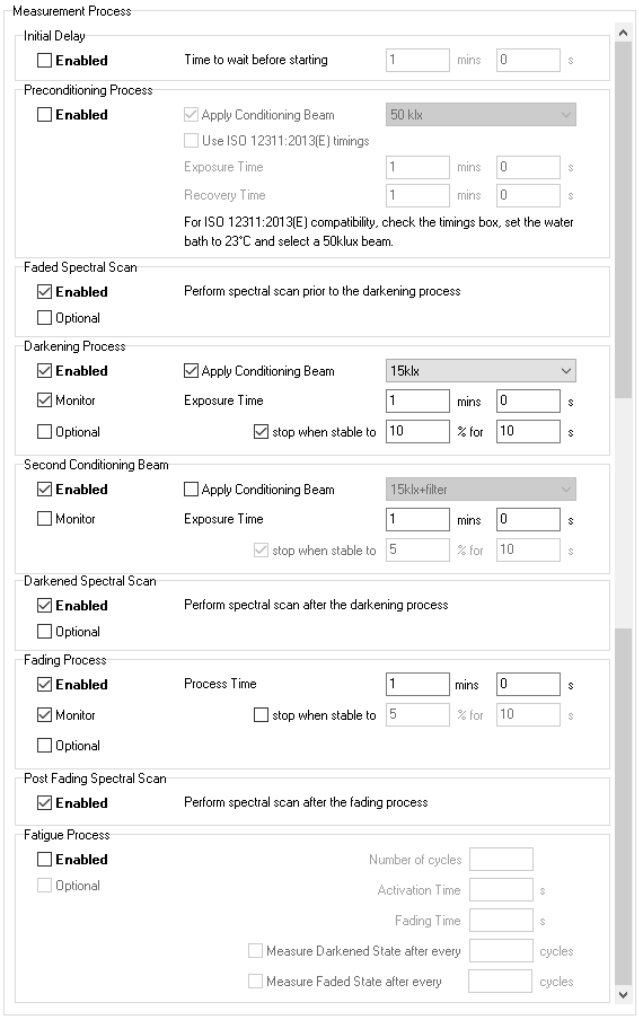


Figure 3.3

Measurement Process panel.

3.2.1.1 Initial Delay

The user can set an initial delay as a time to wait before starting any measurement (Figure 3.4).

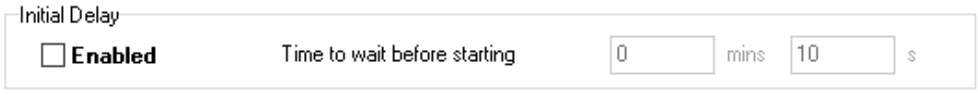


Figure 3.4

Initial Delay panel.

3.2.1.2 Preconditioning Process

The user can prepare the state of a lens before starting any measurement to e.g. ISO 12311:2013(E) standard. In order to apply the selected conditioning beam in the drop-down list, both *Enabled* and *Apply Conditioning Beam* checkboxes must be selected (Figure 3.5). The conditioning beam profiles can be set up in Settings — Conditioning Beam tab (see **3.4 Conditioning Beam** on p. 32).

Figure 3.5

Preconditioning Process panel.

3.2.1.3 Faded Spectral Scan

A spectral scan with the sample in the faded state is performed over the wavelength range selected in Settings — Scan Settings tab (see **3.3.1 Spectral Scan** on p. 29) with no conditioning beam applied (Figure 3.6).

The *Enabled* and *Optional* checkboxes affect the way a user with no administrator privileges can choose the *Optical Density* and *Delta OD* measurement options in the Main window (Table 3.1).

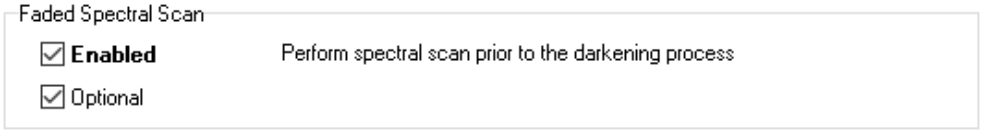


Figure 3.6

Faded Spectral Scan panel.

Faded Spectral Scan

Settings Window	Main Window
☑ Enabled ☑ Optional	☑ Optical Density ☑ Delta OD[1]
☑ Enabled ☐ Optional	☑ Optical Density ☑ Delta OD[1]
☐ Enabled ☑ Optional	☐ Optical Density ☐ Delta OD
☐ Enabled ☐ Optional	☐ Optical Density ☐ Delta OD

Table 3.1

Possible combinations of *Enabled* and *Optional* checkboxes for Faded Spectral Scan and how they affect the selection of the *Optical Density* and *Delta OD* measurement options in the Main window.

[1] *Delta OD* checkbox will be selected in the Main Window if *Enabled* checkbox is selected for both Darkening Process and Darkened Spectral Scan in Settings — Measurement Process tab (Figure 3.3).

3.2.1.4 Darkening Process

The darkening process occurs with a conditioning beam applied. In order to apply the selected conditioning beam in the drop-down list, both *Enabled* and *Apply Conditioning Beam* checkboxes must be selected (Figure 3.7). The conditioning beam profiles can be set up in Settings — Conditioning Beam tab (see **3.4 Conditioning Beam** on p. 32). The user can enter the time required for the darkening process in *Exposure Time* edit boxes (*mins* and *s*).

If *Monitor* checkbox is selected, a stationary scan is performed in BenWin+ while the darkening process occurs. The stationary scan is performed for a single wavelength chosen by the user in Settings — Scan Settings tab (see **3.3.2 Stationary Scan** on p. 30). There are two ways of monitoring the darkening process:

- Static monitoring (*stop when stable* checkbox deselected): The stationary scan is performed for the full *Exposure Time*.
- Dynamic monitoring (*stop when stable* checkbox selected): The stationary scan is analysed in real-time in order to determine whether full activation has been achieved. Full activation is defined as a signal stable when $\tau_{max} - \tau_{min} <= \Delta\tau$ (*%*) for a specific time interval Δt (*s*), where τ is the transmittance (Figure 3.7).

Figure 3.7

Darkening Process panel.

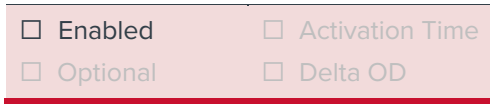
Darkening Process

Settings Window	Main Window
☑ Enabled ☑ Optional	☑ Activation Time ☑ Delta OD[2]
☑ Enabled ☐ Optional	☑ Activation Time ☑ Delta OD[2]
☐ Enabled ☑ Optional	☐ Activation Time ☐ Delta OD

Table 3.2

Possible combinations of *Enabled* and *Optional* checkboxes for Darkening Process and how they affect the selection of the *Activation Time* and *Delta OD* measurement options in the Main window.

[2] *Delta OD* checkbox will be selected in the Main Window if *Enabled* checkbox is selected for both Faded Spectral Scan and Darkened Spectral Scan in Settings — Measurement Process tab (Figure 3.3).



If *Monitor* checkbox is deselected, the *stop when stable* option is automatically disabled, and the software waits for the full *Exposure Time* before proceeding.

The *Enabled* and *Optional* checkboxes affect the way a user with no administrator privileges can choose the *Activation Time* and *Delta OD* measurement options in the Main window (Table 3.2).

3.2.1.5 Second Conditioning Beam

An optional secondary conditioning beam may be applied at this point; usually performed as part of a night driving assessment of photochromic lenses. In order to apply the selected conditioning beam in the drop-down list, both *Enabled* and *Apply Conditioning Beam* checkboxes must be selected (Figure 3.8).

This stage may be skipped entirely by deselecting the *Enabled* checkbox. The functionality of both *Monitor* and *stop when stable* checkboxes is described in section **3.2.1.4 Darkening Process** (p. 23).

Figure 3.8

Second Conditioning Beam panel.

3.2.1.6 Darkened Spectral Scan

A spectral scan with the sample in the darkened state is performed with the conditioning beam still applied (Figure 3.9). The spectral scan is performed over the wavelength range selected in Settings — Scan Settings tab (see **3.3.1 Spectral Scan** on p. 29).

The *Enabled* and *Optional* checkboxes affect the way a user with no administrator privileges can choose the *Delta OD* measurement option in the Main window (Table 3.3).

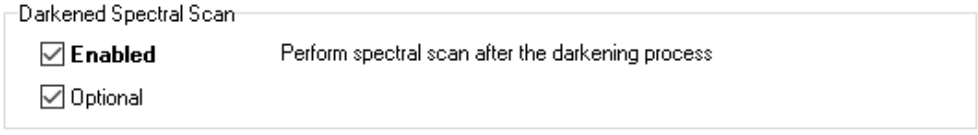


Figure 3.9

Darkened Spectral Scan panel.

Darkened Spectral Scan

Settings Window	Main Window
☑ Enabled ☑ Optional	☑ Delta OD[3]
☑ Enabled ☐ Optional	☑ Delta OD[3]
☐ Enabled ☑ Optional	☐ Delta OD
☐ Enabled ☐ Optional	☐ Delta OD

Table 3.3

Possible combinations of *Enabled* and *Optional* checkboxes for Darkened Spectral Scan and how they affect the selection of the *Delta OD* measurement option in the Main window.

3.2.1.7 Fading Process

The fading process occurs with no conditioning beam applied. The user can enter the time required for the fading process in *Process Time* edit boxes (*mins* and *s*) (Figure 3.10). The functionality of both *Monitor* and *stop when stable* checkboxes is described in section **3.2.1.4 Darkening Process** (p. 23). The *Enabled* and *Optional* checkboxes affect the way a user with no administrator privileges can choose the *Fade Rate* measurement option in the Main window (Table 3.4).

Figure 3.10

Fading Process panel.

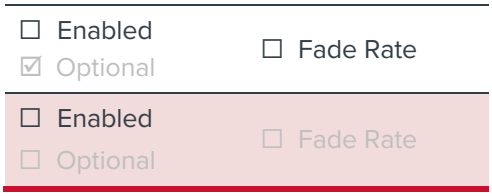
Fading Process

Settings Window	Main Window
☑ Enabled ☑ Optional	☑ Fade Rate
☑ Enabled ☐ Optional	☑ Fade Rate

Table 3.4

Possible combinations of *Enabled* and *Optional* checkboxes for Fading Process and how they affect the selection of the

[3] *Delta OD* checkbox will be selected in the Main Window if *Enabled* checkbox is selected for both Faded Spectral Scan and Darkening Process in Settings — Measurement Process tab (Figure 3.3).



Fade Rate measurement option in the Main window.

3.2.1.8 Post Fading Spectral Scan

An optional spectral scan of the sample may be performed after the fading process (Figure 3.11).

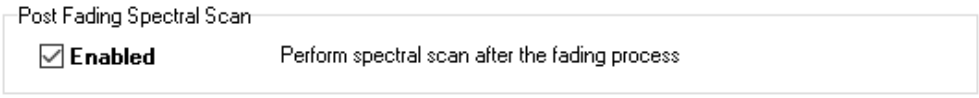


Figure 3.11

Post Fading Spectral Scan panel.

3.2.2 Fatigue Process

The *Fatigue Process* allows to study the behaviour of the lenses before, during and after a cyclic fatigue test. When *Enabled* checkbox is selected (Figure 3.12), any settings from the states described in section **3.2.1 Measurement Process panel** (p. 20) will be obviated (except for *Initial Delay*).

The fatigue process for one lens and the first cycle involves the following states:

1. Initial Delay (if required)
2. Measure pre-Lux
3. Reference Scan
4. Faded Spectral Scan
5. Darkening
6. Darkened Spectral Scan
7. Fading
8. Measure post-Lux

The following cycles involve the following states:

1. Reference Scan
2. Faded Spectral Scan (if *Measure Faded State* checkbox is selected (Figure 3.12) and the current cycle is a multiple of the cycles for measuring faded state)
3. Darkening
4. Darkened Spectral Scan (if *Measure Darkened State* checkbox is selected (Figure 3.12) and the current cycle is a multiple of the cycles for measuring darkened state)
5. Fading
6. Measure post-Lux

The last cycle involves the following states:

1. Reference Scan
2. Faded Spectral Scan
3. Darkening
4. Darkened Spectral Scan
5. Fading
6. Measure post-Lux

The *Enabled* and *Optional* checkboxes affect the way a user with no administrator privileges can choose the *Fatigue* measurement option in the Main window (Table 3.5).

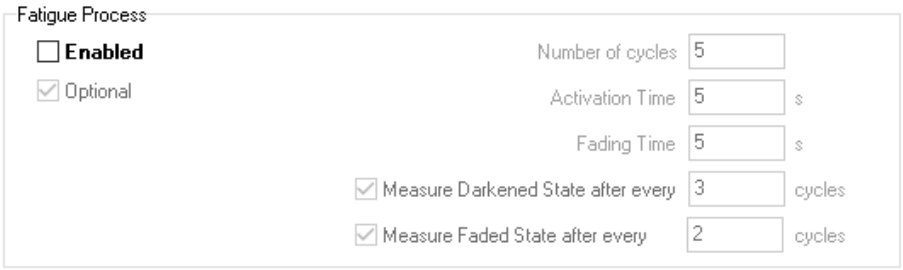


Figure 3.12

Fatigue Process panel.

Fatigue Process

Settings Window	Main Window
☑ Enabled ☑ Optional	☑ Fatigue
☑ Enabled ☐ Optional	☑ Fatigue
☐ Enabled ☑ Optional	☐ Fatigue
☐ Enabled ☐ Optional	☐ Fatigue

Table 3.5

Possible combinations of *Enabled* and *Optional* checkboxes for Fatigue Process and how they affect the selection of the *Fatigue* measurement option in the Main window.

3.2.3 Post Measurement Options

The user can enable the option of generating a PDF report by selecting the *Generate PDF Report* checkbox (Figure 3.13). After all lens measurements have been performed, the user is prompted for a location to save the report (defaults to Spectra location). The report calculates results in accordance with the selected standard (Figure 3.13). Please note that the wavelength range and step size should be set to 280 -780nm and 5nm respectively for this process to work as expected (see **3.3.1 Spectral Scan** on p. 29).

The user may choose to generate LIMS output files in .xml or .csv format by selecting *Generate LIMS XML output* or *Generate LIMS CSV output* checkboxes, respectively

(Figure 3.13). The folder for the LIMS output files can be selected in Settings — Folder Options tab (see **3.6 Folder Options** on p. 36).

The user can run the system in Debug mode when selecting the *Deactivate Error Actions (R&D)* checkbox (Figure 3.13). The R&D mode disables the error actions and reports the first occurrence of each unique error in the Results window (see **5.2 Messages** on p. 51). The measurement will continue, and the results will be saved. If a Hardware error or a Manual abort occurs the measurement will stop. See section **7 Error codes** (p. 64) for further details about error treatment. The Engineering file (see **5.5 Engineering file** on p. 54) will only save the first error occurrence in R&D mode. The R&D mode will show red borders in the Status and Results windows.

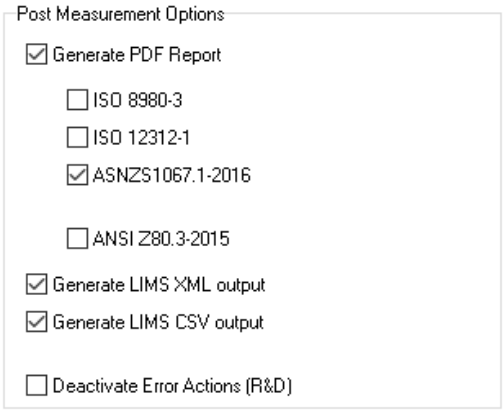


Figure 3.13

Post Measurement Options panel.

3.2.4 Suitability Measurement

The user can select the filters that will be used for a suitability measurement and enter the information by filling in the *Asset*, *n* (refractive index), *OD* (target optical density) and ± (optical density tolerance) edit boxes (Figure 3.14).

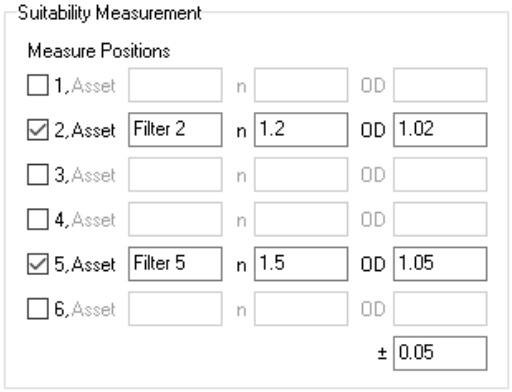


Figure 3.14

Suitability Measurement panel.

3.2.5 Pass/Fail Criteria

The user can set the minimum and maximum bounds for a successful Delta OD measurement (Figure 3.15). The outcome will be displayed in the Results window as PASS or FAIL (see **5.1 Summary** on p. 48).

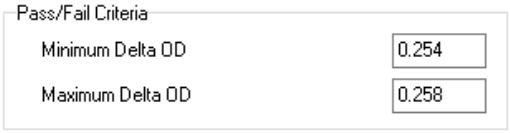


Figure 3.15

Pass/Fail Criteria panel.

3.3 Scan Settings

The Scan Settings tab allows to set different scan parameters for any spectral or stationary scans as well as error tolerances and enable the simulation mode (Figure 3.16).

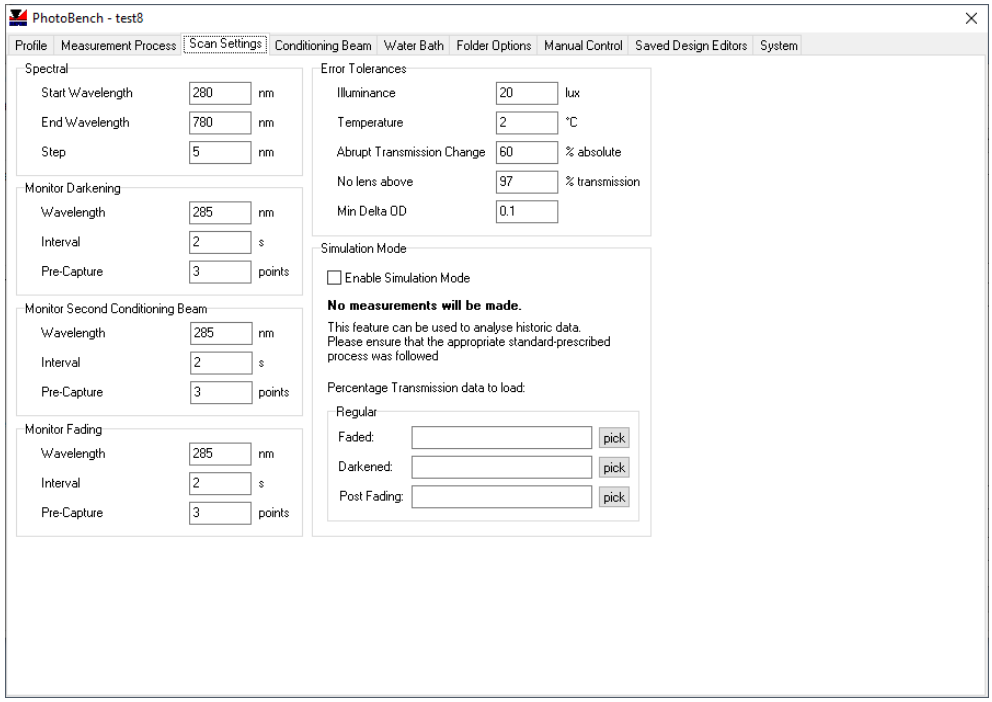


Figure 3.16

Scan Settings tab.

3.3.1 Spectral Scan

The user can set the start and end wavelength as well as the step for a spectral scan (Figure 3.17). These settings will be applied to Reference Scan, Faded Scan, Darkened Scan and Post Fading Scan. The BPC300-C is designed for the range 380 – 780nm and 5nm step. In order to generate a PDF report, the range must be set to 280 – 780nm in 5nm steps.

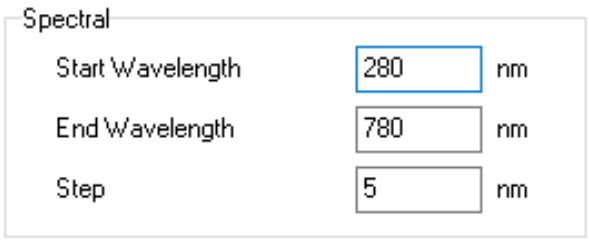


Figure 3.17

Spectral scan panel.

3.3.2 Stationary Scan

The user can enter the wavelength for which the stationary scan will be performed, the interval in seconds and the pre-capture number of points (Figure 3.18). Pre-Capture points are measured before applying a conditioning beam to the sample such that the pre-conditioning beam light level can be measured (e.g. with 3 Pre-Capture points and 2 seconds interval, 6 seconds of measurements are taken prior to the conditioning beam being applied).

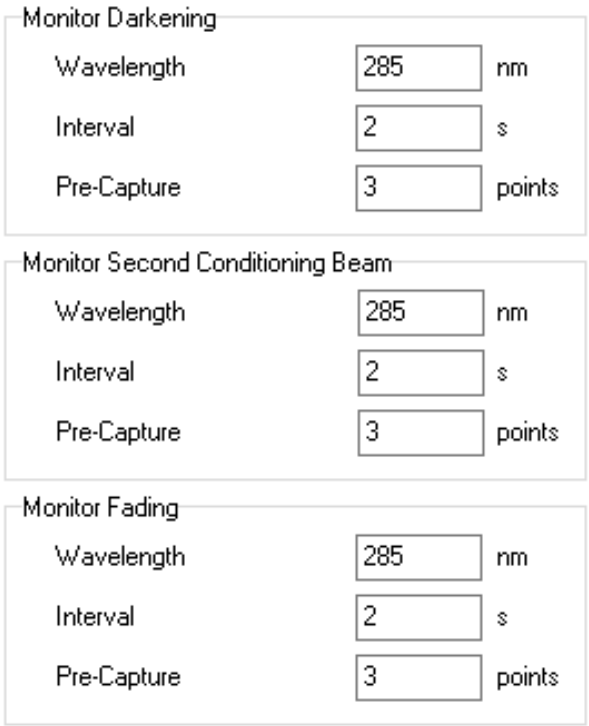


Figure 3.18

Stationary scan panels.

3.3.3 Error Tolerances

The user can set the error tolerances for the treatment of errors (Figure 3.19). The *illuminance* tolerance is used for **Lux level out of specification** error (p. 64). The *Temperature* tolerance is used for **Temperature out of specification** error (p. 64). The *Abrupt Transmission Change* tolerance is used for **Abrupt Transmission change** error (p. 64). The *No lens above* tolerance is used for **No Lens** error (p. 65). The *Min Delta OD* tolerance is used for **Measurement outside of limits** error (p. 65).

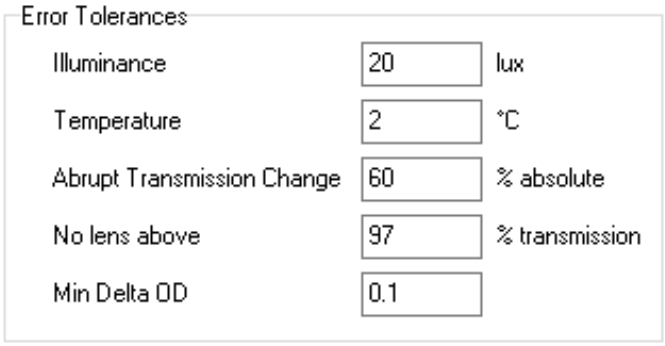


Figure 3.19

Error tolerances panel.

3.3.4 Simulation Mode

The simulation mode can be enabled by clicking on the *Enable Simulation Mode* checkbox (Figure 3.20). This mode is used to analyse previously recorded transmission data. No new data will be measured.

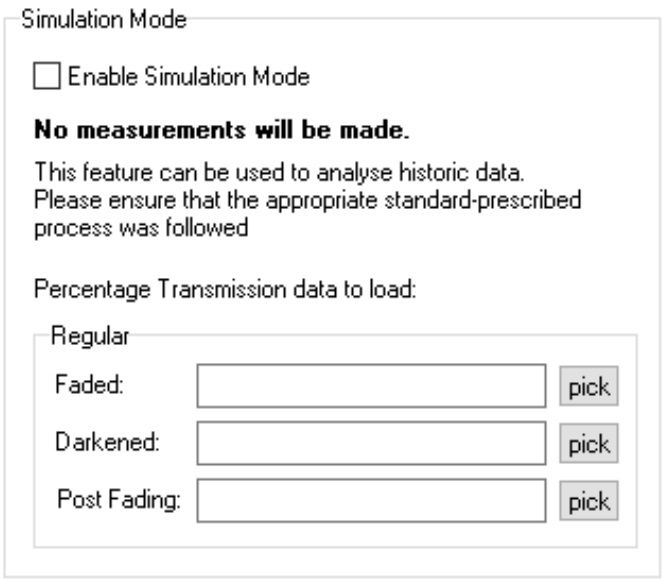


Figure 3.20

Simulation Mode panel.

3.4 Conditioning Beam

From this tab, it is possible to create a new conditioning beam profile, save an existing one, or delete it (Figure 3.21).

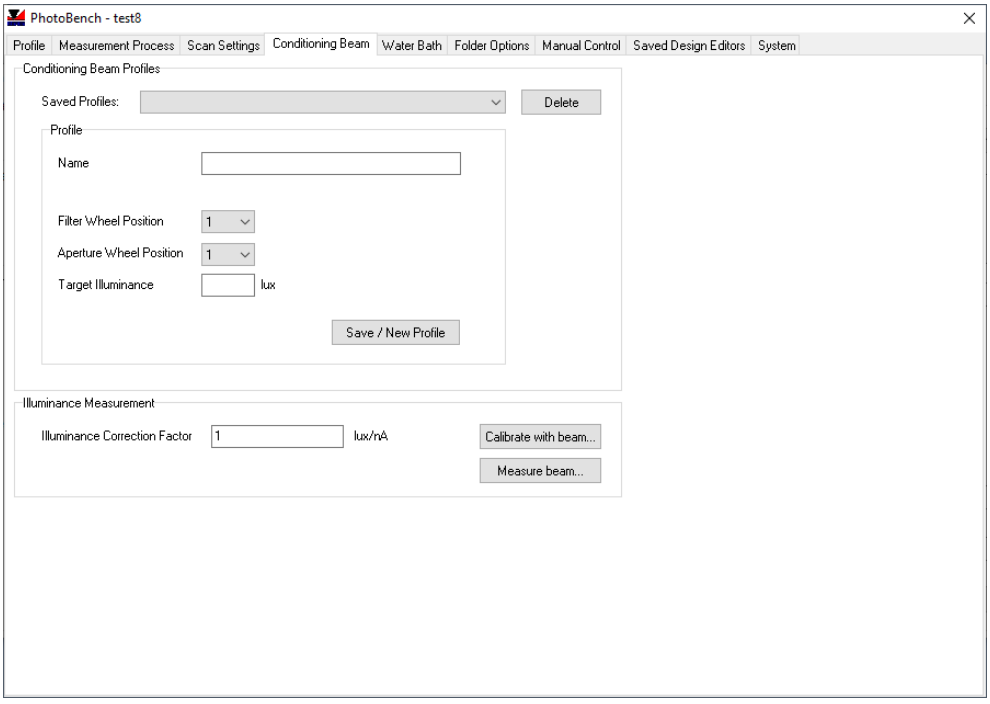


Figure 3.21

Conditioning Beam tab.

3.4.1 Conditioning Beam Profiles

After calibrating the aperture for klx (see **3.4.2.1 Calibrate with beam**

The correction factor can be computed by clicking on 'Calibrate with beam...' and selecting a conditioning beam profile. Then, type in the measured lux and click on 'OK'. The new correction factor is displayed in *Illuminance Correction Factor* edit box.

3.4.1.1 Measure beam

The measured photodiode lux after applying the correction factor can be computed by clicking on 'Measure beam...' and selecting a conditioning beam profile.

Adjusting Aperture for klx on p. 33) a new conditioning beam profile can be created following the next steps (Figure 3.22):

1. Enter a profile name in the *Name* box.
2. Pick from the *Filter Wheel Position* drop-down list a filter position from 1 to 6.
3. Pick from the *Aperture Wheel Position* drop-down list an aperture position from 1 to 4.
4. Set the target illuminance.
5. Click on 'Save/New Profile'.

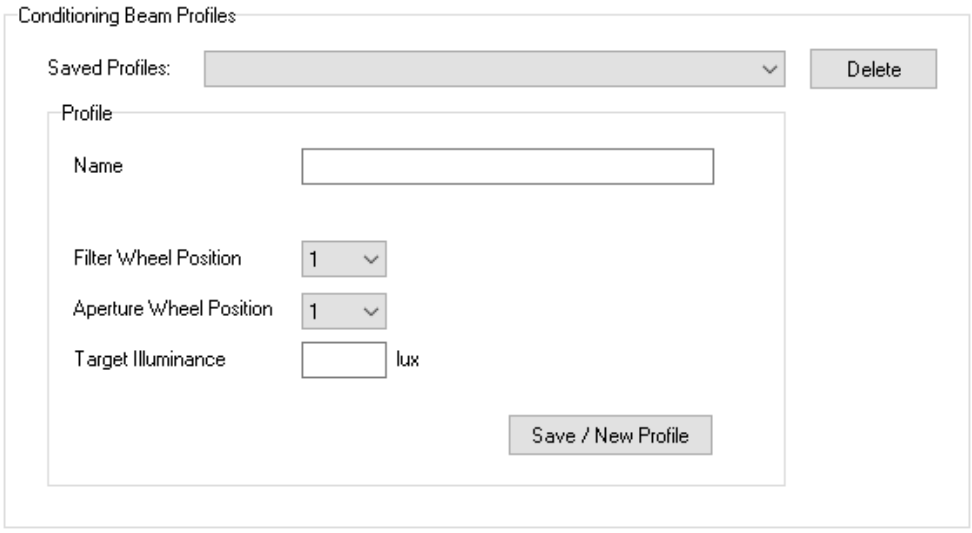


Figure 3.22

Conditioning Beam Profiles panel.

3.4.2 Illuminance Measurement

Set a calibration factor of the luxmeter by filling in the Illuminance Correction Factor edit box (Figure 3.23).

Figure 3.23

Illuminance Measurement panel.

3.4.2.1 Calibrate with beam

The correction factor can be computed by clicking on 'Calibrate with beam...' and selecting a conditioning beam profile. Then, type in the measured lux and click on 'OK'. The new correction factor is displayed in *Illuminance Correction Factor* edit box.

3.4.2.2 Measure beam

The measured photodiode lux after applying the correction factor can be computed by clicking on 'Measure beam...' and selecting a conditioning beam profile.

3.4.3 Adjusting Aperture for klx

This section describes the steps to adjust the aperture in order to set a conditioning beam:

1. Select aperture and filter location in Settings — Manual Control tab (see **3.7.1 Manual Control Settings** on p. 38) and open the shutter.
2. Remove the lid of the aperture and filter wheel box (Figure 3.24). The aperture wheel is located on the right-hand side where the activation light source originates.
3. Use a 1.5mm Allen wrench and loosen the screw at the top of the aperture that is currently directly in front of the light source. It will be the topmost aperture (Figure 3.25).
4. Gently move the Allen wrench to adjust the aperture, anticlockwise for decrease in klx, clockwise for increase in klx. Be sure to move gently as too much force can move the entire aperture wheel.
5. Once the desired klx is reached, carefully tighten the screw at the top of the aperture wheel to pin it in place. The klx may jump in the process of tightening, so be sure to monitor the lux reading.
6. Once tightened, replace the lid over the aperture and filter wheel box.
7. If this is a new setting for a certain filter-aperture combination, go to section **3.4.1 Conditioning Beam Profiles** (p. 32) and follow the steps.

a) b)

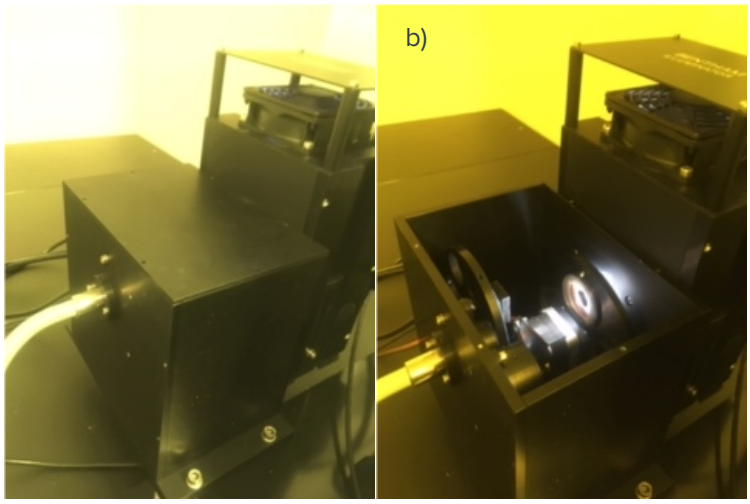


Figure 3.24

a) Aperture and filter wheel box. b) Removal of lid

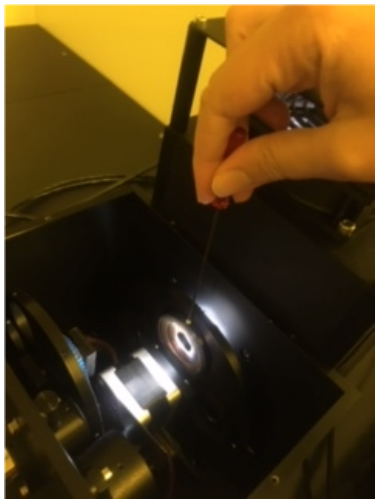


Figure 3.25

Loosening of aperture wheel.

3.5 Water Bath

The Water Bath tab allows to set a water bath temperature and monitoring the temperature (Figure 3.26).

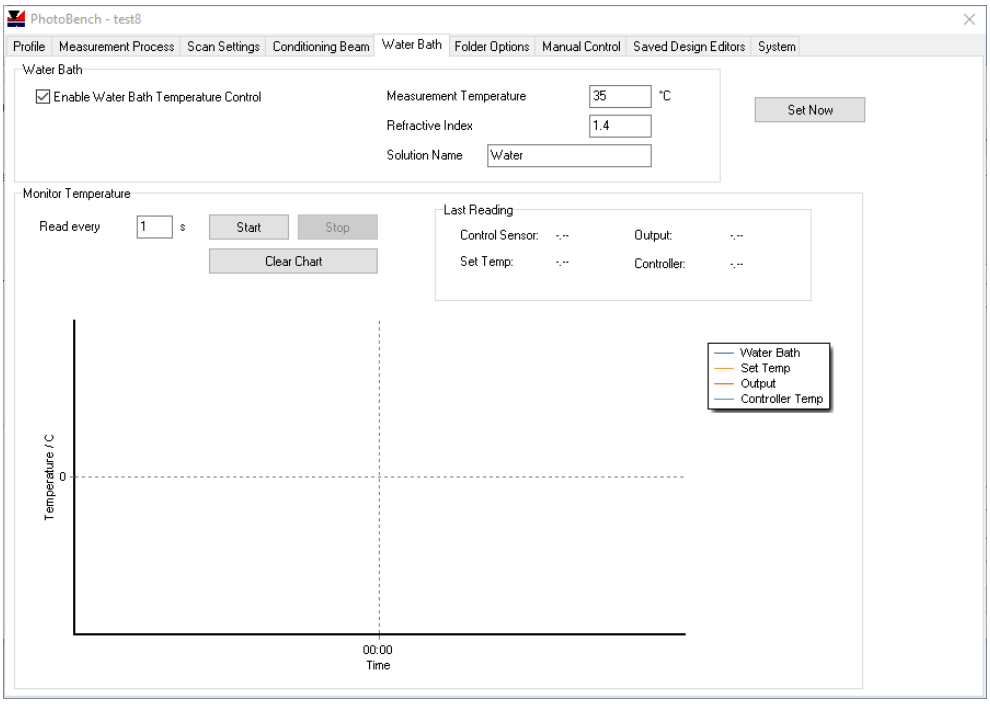


Figure 3.26

Water Bath tab.

3.5.1 Water Bath Settings

The user can set the temperature, refractive index and solution name for the water bath by filling in the *Measurement Temperature*, *Refractive Index* and *Solution Name* edit boxes, respectively (Figure 3.26).

If *Enabled Water Bath Temperature Control* checkbox is selected, the measurement process waits for the water bath to reach the selected temperature before performing any scans of the sample. Additionally, the user can manually start the process of stabilising the water temperature by clicking on 'Set Now'. Note that *Enabled Water Bath Temperature Control* checkbox must be selected.

3.5.2 Monitor Temperature

It is possible to monitor the temperature of the water bath by using the 'Start', 'Stop' and 'Clear Chart' buttons (Figure 3.26). The user can choose the frequency of the temperature readings by filling the *Read every* edit box.

3.6 Folder Options

The user can select the location of the results folder in the Folder Options panel (Figure 3.27). The Results folder is used as the base folder for all BenWin+ scans. At the beginning of the measurement process a new folder is created with the following format:

SampleReference_Time_Date

Thereafter, all measurements performed in BenWin+ are saved in this folder with a helpful name relating to the measurement being performed. For example, a fading scan performed for the lens position 4 will have the following file name:

SampleReference_Fading Process Pos 4.ben

The input file location for Profiles and Lens Designs can be selected by picking a folder in the *Profiles location* and *Lens Designs file location* edit boxes respectively, in the File Locations panel (Figure 3.27). See section **3.8 Saved Design Editors** (p. 39) for more details about Lens Designs.

The location of the LIMS and Engineering output files can be selected by picking a folder in the *LIMS output file location* and *Engineering output file location* edit boxes respectively, in the File Locations panel (Figure 3.27). See sections **5.4 LIMS output file** (p. 52) and **5.5 Engineering file** (p. 54) for further details about LIMS files and Engineering files, respectively.

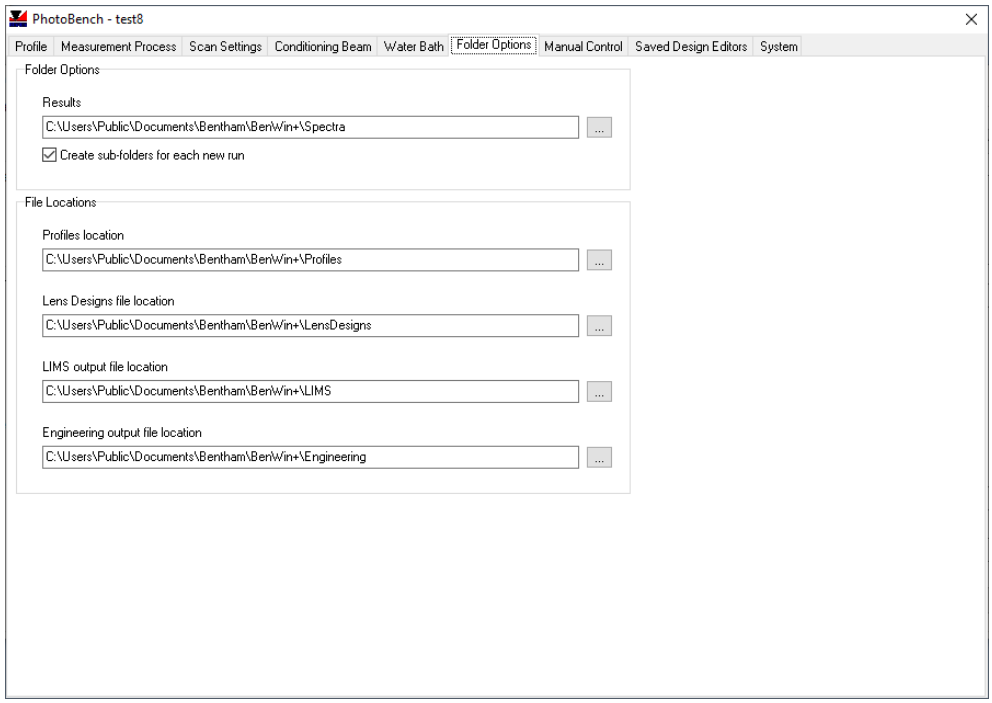


Figure 3.27

Folder Options tab.

3.7 Manual Control

The user can manually control some parts of the system in the Manual Control tab (Figure 3.28).

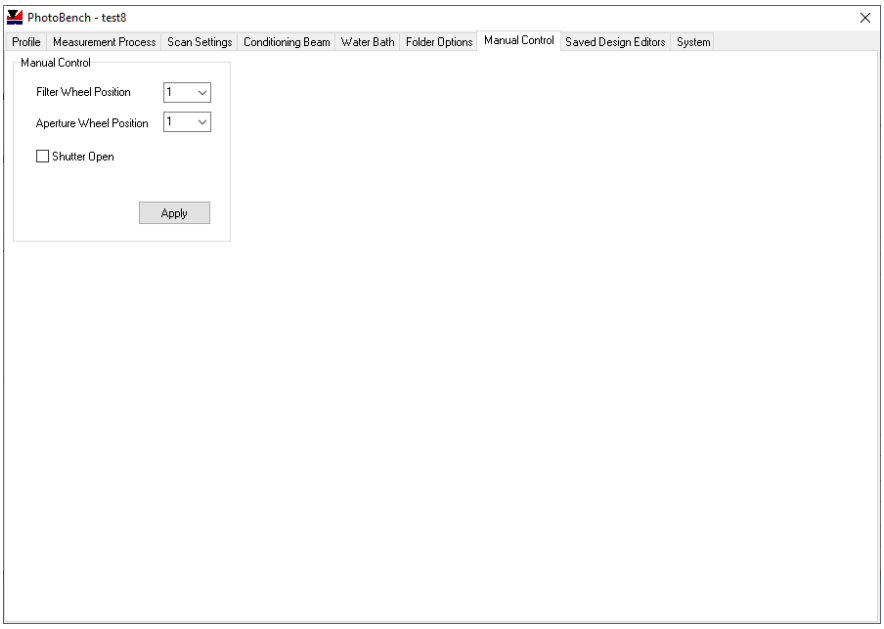


Figure 3.28

Manual Control tab.

3.7.1 Manual Control Settings

The user can control the filter wheel position, the aperture and the shutter to e.g. adjust the aperture for klx (see **3.4.2.1 Calibrate with beam**

The correction factor can be computed by clicking on 'Calibrate with beam...' and selecting a conditioning beam profile. Then, type in the measured lux and click on 'OK'. The new correction factor is displayed in *Illuminance Correction Factor* edit box.

3.7.1.1 Measure beam

The measured photodiode lux after applying the correction factor can be computed by clicking on 'Measure beam...' and selecting a conditioning beam profile.

Adjusting Aperture for klx on p. 33). The *Filter Wheel Position* drop-down list allows to select a filter position from 1 to 6. The *Aperture Wheel Position* drop-down list allows to select an aperture position from 1 to 4 (Figure 3.29).

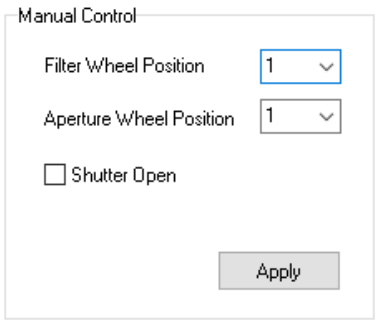


Figure 3.29

Manual Control panel.

3.8 Saved Design Editors

From this tab, it is possible to generate a new lens design, save an existing lens design, or delete a lens design (Figure 3.30). The lens designs created or modified in this tab will be available in the *Saved Designs* drop-down list of the Main window (Figure 2.6a). The saved lens designs are stored in an XML file in the selected folder for *Lens / Measurement Type* (Figure 3.27).

3.8.1 Generate a new Lens Design

Enter a *LIMS name*, *Lens base curve radius* and *Refractive Index* and click on 'Save' (Figure 3.30).

3.8.2 Save an existing Lens Design

Select an existing lens design from the drop-down list, edit *Lens base curve radius* and *Refractive Index* and then click on 'Save' (Figure 3.30). A warning message will be displayed to confirm that the lens design will be overwritten; click on 'Yes' to save the lens design.

3.8.3 Delete a Lens Design

Select an existing lens design from the drop-down list and click on 'Delete' to permanently delete the profile (Figure 3.30). A warning message will be displayed confirming the intention to delete the lens design.

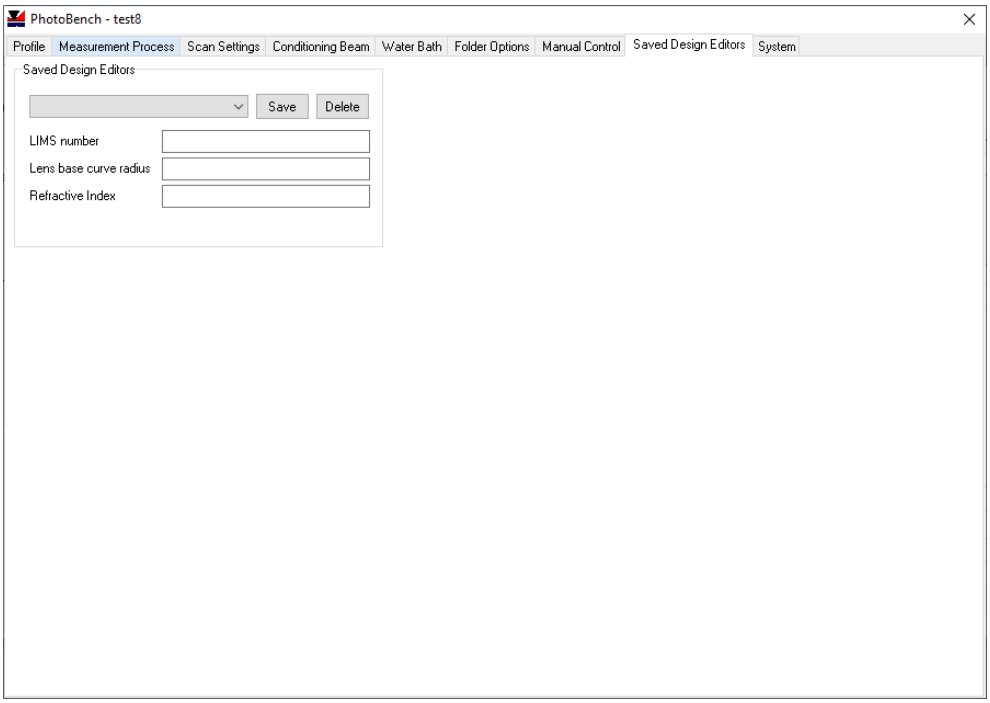


Figure 3.30

Saved Designs Editors tab.

3.9 System

The System ID can be modified in this tab (Figure 3.31).

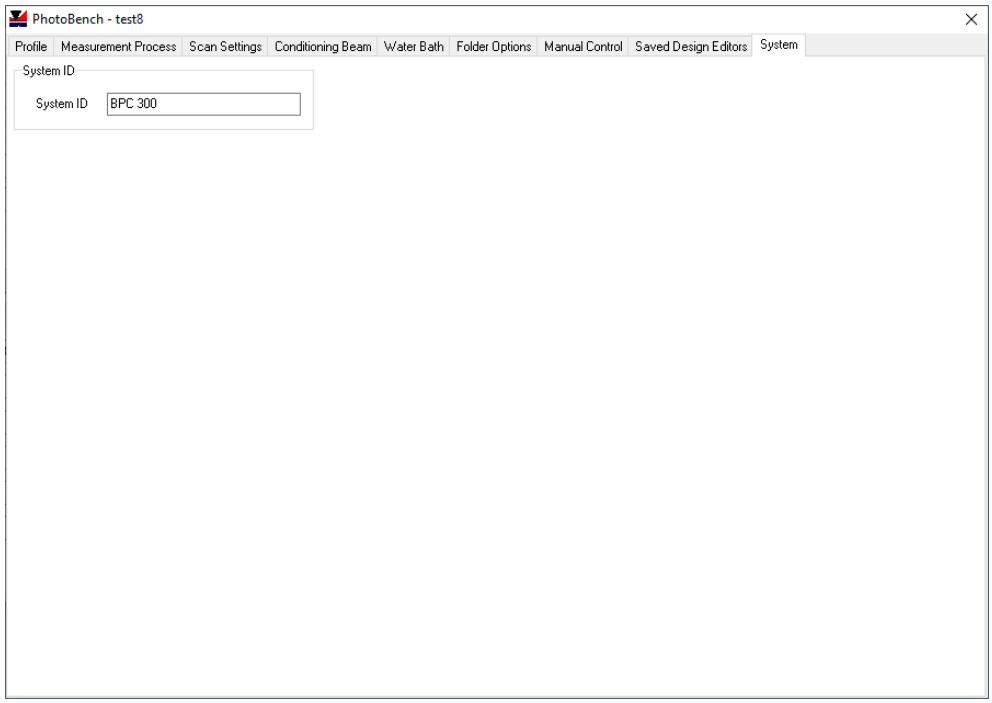


Figure 3.31

System tab.

4 Status Window

When the user clicks on 'New Measurement' or System Suitability' (Figure 2.1), the Main window closes and BenWin+ begins to make measurements. Spectral data is shown graphically (Figure 4.1) and numerically (Figure 4.2) as it arrives. The Status window displays real-time information about the lenses and the status of the measurements (Figure 4.3). When running in R&D mode (see **3.2.3 Post Measurement Options** on p. 27), the Status window appears with red borders.

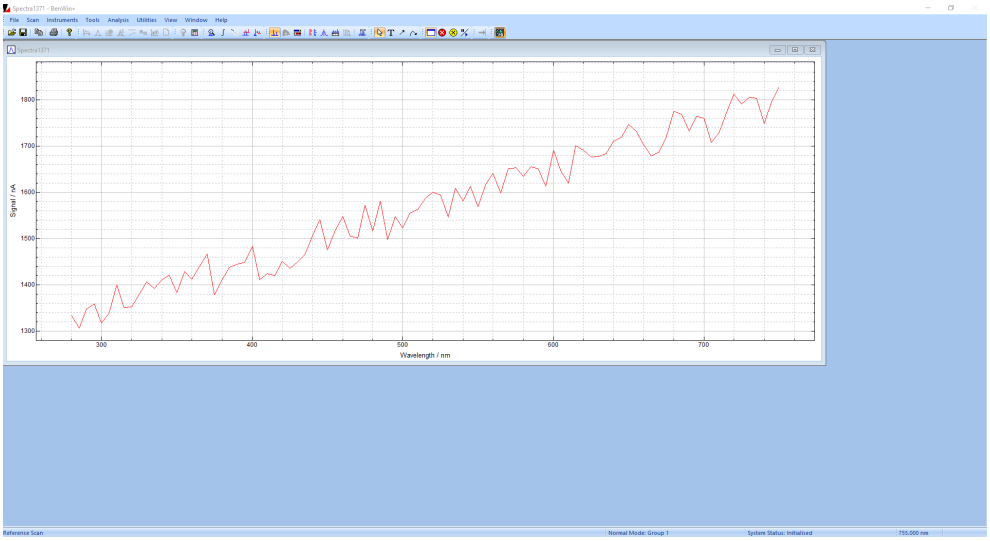


Figure 4.1

Graphical data for a spectral scan.

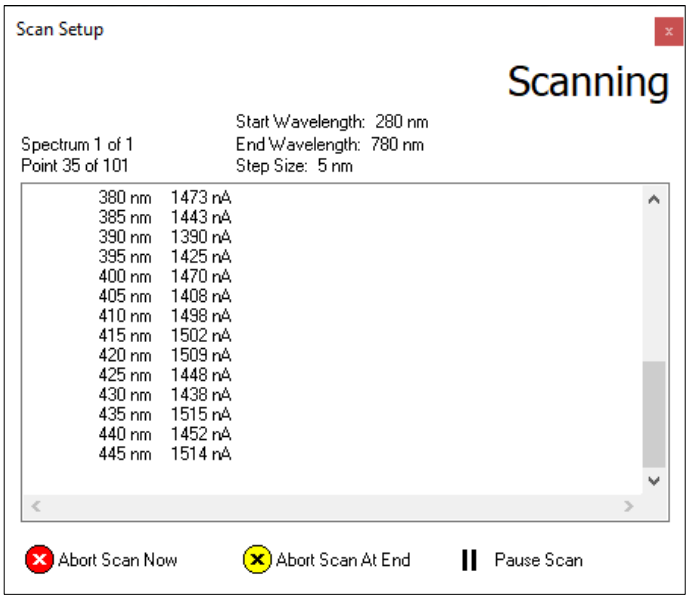


Figure 4.2

Numerical data for a spectral scan.

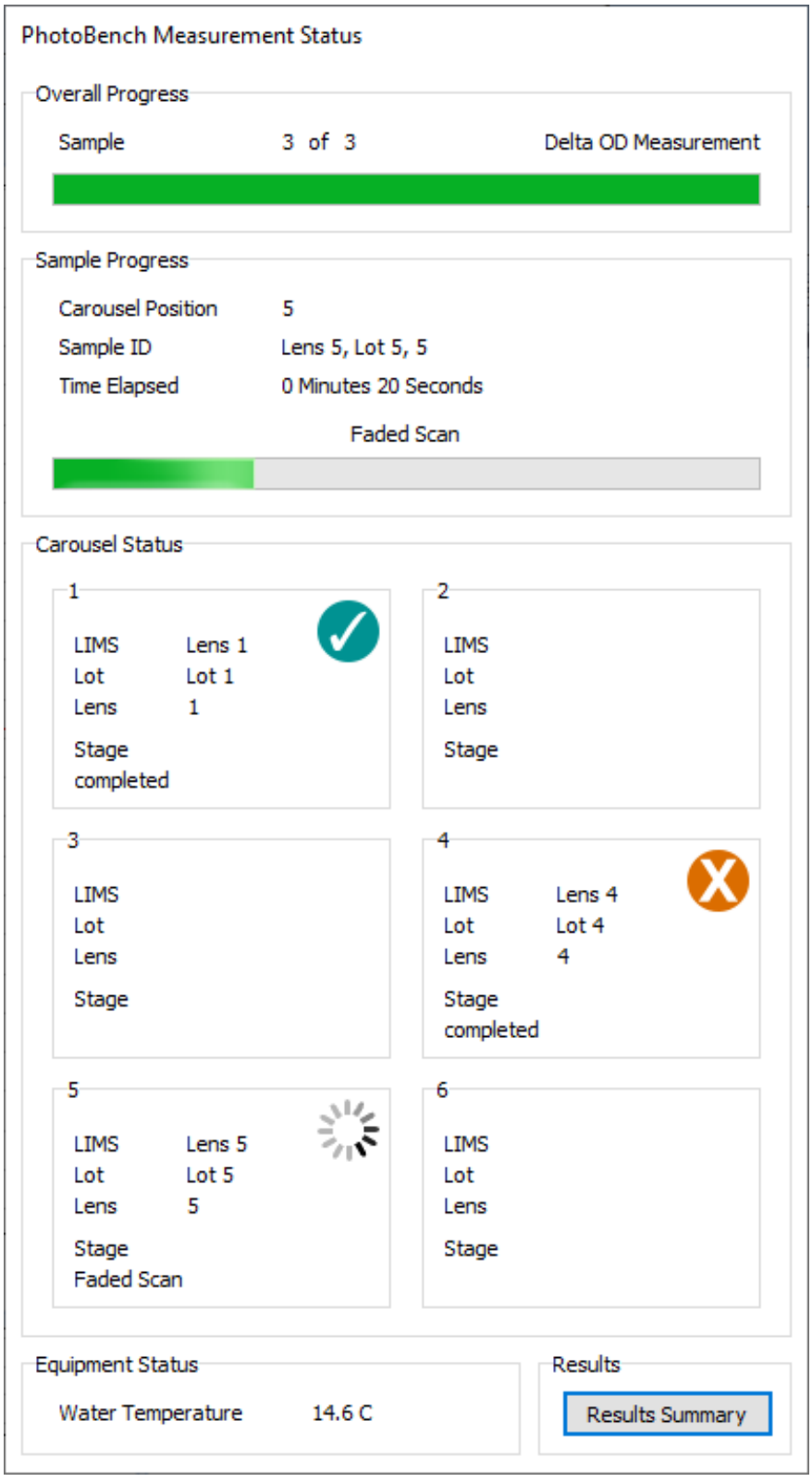


Figure 4.3

Status window.

4.1 Overall Progress

The Overall Progress panel shows a progress bar that moves according to the current sample. The information about the type of measurement being performed (Delta OD Measurement, System Suitability or Fatigue) is also displayed (Figure 4.4).

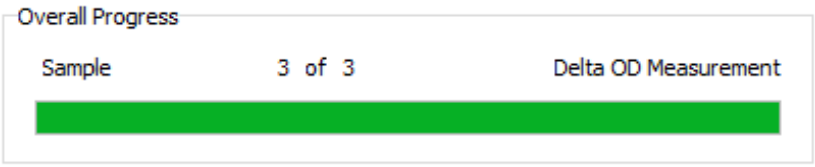


Figure 4.4

Overall Progress panel.

4.2 Sample Progress

The Sample Progress panel shows information about the current carousel position and the time elapsed for each measurement state. The information for Sample ID and progress bar changes depending on the measurement type (Table 4.1).

Sample Progress Panel

	Sample ID	Progress bar
Delta OD Measurement (Figure 4.5)	LIMS name, Lot Number and Lens Number entered in the Main window (Figure 2.1).	Moves according to the current measurement state, which is shown over the progress bar.
System Suitabilty (Figure 4.6)	Asset entered in the Settings — Measurement Process tab (Figure 3.14).	Moves according to the current measurement state, which is shown over the progress bar.
Fatigue Test (Figure 4.7)	Empty.	Moves according to the current cycle, which is show in the top right corner of the Sample Progress panel. The current measurement state is shown over the progress bar.

Table 4.1

Sample ID and Progress bar information shown in the Sample Progress panel according to the measurement type.

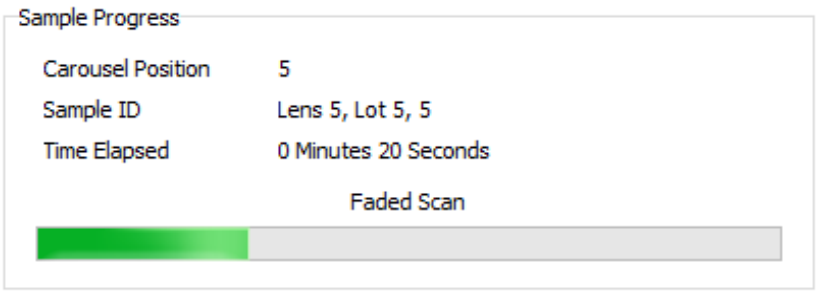


Figure 4.5

Sample Progress panel for a Delta OD Measurement.

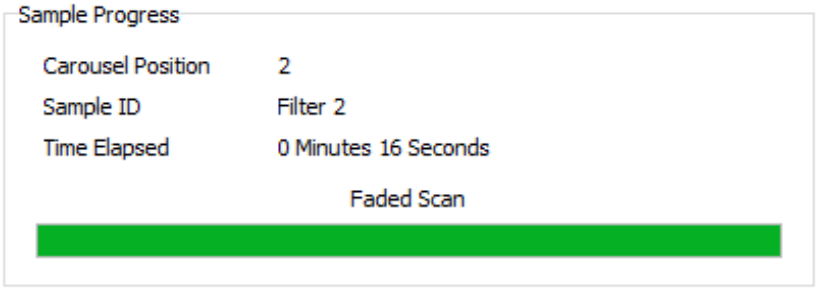


Figure 4.6

Sample Progress panel for a Suitability Measurement.

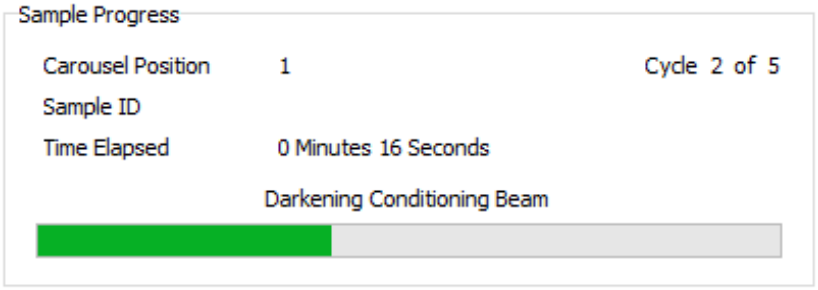


Figure 4.7

Sample Progress panel for a Fatigue Test.

4.3 Carousel Status

The Carousel Status panel shows real-time information about the status of the samples being measured. There are six subpanels, numbered from 1 to 6, each one for a different carousel position. Each subpanel shows a stage description and an icon (Figure 4.8). The relationship between stage description and icon is shown in Table 4.2.

For Delta OD Measurement and Fatigue Test, each subpanel displays information about the *LIMS name*, *Lot Number* and *Lens Number* entered in the Main window (Figure 2.1). For System Suitability Measurement, each subpanel displays the *Asset*

entered in the Settings — Measurement Process tab (Figure 3.14). The subpanels for non-measured sample positions are left empty.

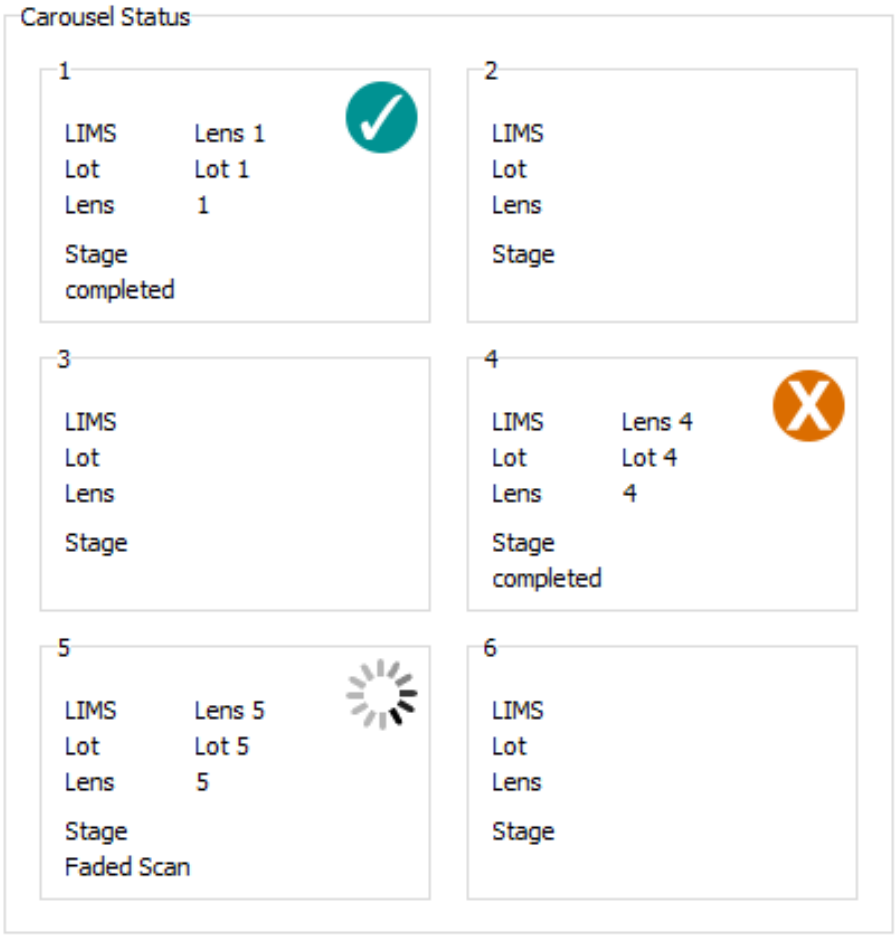


Figure 4.8

Carousel Status panel.

4.4 Equipment Status and Results

The Equipment Status panel shows the water temperature at each scan point (Figure 4.9). Note that *Enable Water Bath Temperature Control* checkbox must be selected (Figure 3.26), otherwise 'N/A' will be displayed.

The Results window (see **5 Results** on p. 48) can be hidden by clicking on 'Results Summary' (Figure 4.9). By clicking again on 'Results Summary', the Results window will be restored.

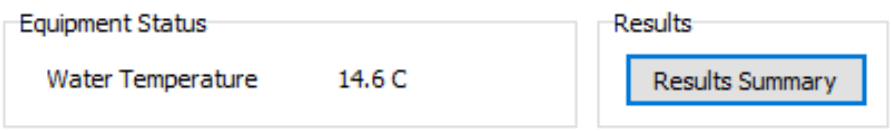


Figure 4.9

Equipment Status and Results panels.

Carousel Status

Stage description	Icon	Icon description		
Reference Scan, Faded Scan, etc.		Performing a scan		
Completed (all measurements were completed)			Delta OD Measurement Fatigue Test	System Suitability
		Pass	Delta OD is within the values entered in Settings — Measurement Process tab[4]	OD is within the tolerance provided in Settings — Measurement Process tab[5]
		Fail	Delta OD is out of the bounds entered in Settings — Measurement Process tab[4]	OD is out of the tolerance provided in Settings — Measurement Process tab[5]
Aborted		Scan aborted (see section **7 Error codes** on p. 64 for more details about potential causes of an aborted scan)		

Table 4.2

Possible combinations of stages and icons in the Carousel Status panel.

[4] See section **3.2.5 Pass/Fail Criteria** on p. 24 for further details.

[5] See section **3.2.4 Suitability Measurement** on p. 24 for further details.

5 Results

The Results window displays the results, information messages and output summary for the samples being measured once the measurements have finished (Figure 5.1). When running in R&D mode (see **3.2.3 Post Measurement Options** on p. 27), the Results window appears with red borders.

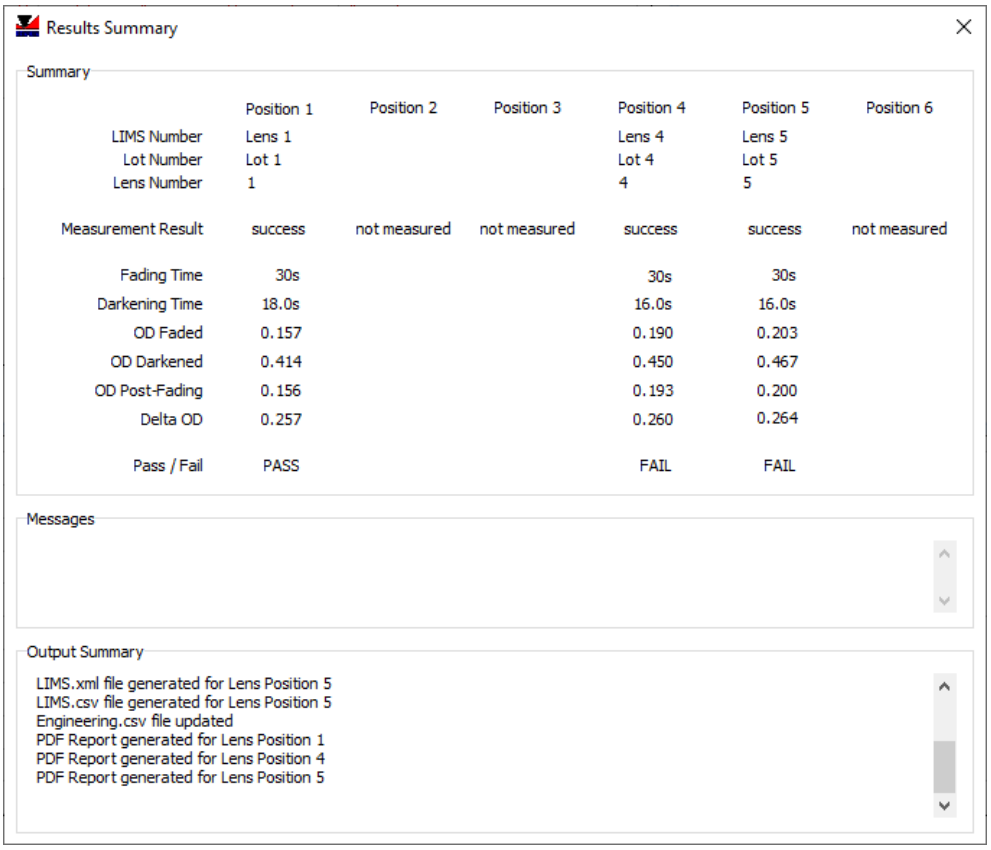


Figure 5.1

Results window.

5.1 Summary

The Summary panel shows information about the results for each measured sample (Figure 5.1). The possible results shown in the Summary panel for Delta OD Measurement, System Suitability and Fatigue Test are presented in Table 5.1, Table 5.2 and Table 5.3, respectively.

Information used to populate the Summary panel

Table 5.1

Information used to populate the Summary panel for Delta OD Measurement.

	Delta OD Measurement
LIMS number Lot number Lens number	**LIMS Number**, **Lot Number** and **Lens Number** values provided in the Main window (**Figure 2.1**).
Measurement Result	**Success**: All measurements were performed successfully. **Aborted**: An error occurred (see **7 Error codes** on p. 64). **Not Measured**: The carousel position was not selected to perform measurements. **Atypical**: The delta OD value was atypical for a photochromic lens (see 7.7 Measurement outside of limits on p. 65).
Fading Time	**Process Time** entered in the Settings — Measurement Process tab or **time when full fading is achieved** if *stop when stable* checkbox is selected (**Figure 3.10**). **N/A** if fading process or monitor stationary were disabled (**Figure 3.10**). **Empty** if an error occurred.
Darkening Time	**Exposure Time** entered in the Settings — Measurement Process tab or **time when full activation is achieved** if *stop when stable* checkbox is selected (**Figure 3.7**). **N/A** if darkening process or monitor stationary scan were disabled (**Figure 3.7**). **Empty** if an error occurred.
OD Faded	**OD Faded** computed value if faded scan was enabled. **N/A** if faded scan was disabled.
OD Darkened	**OD Darkened** computed value if darkened scan was enabled. **N/A** if darkened scan was disabled.
OD Post-Fading	**OD Post-Fading** computed value if post-fading scan was enabled. **N/A** if post-fading scan was disabled.
Delta OD	**Delta OD** computed value if faded and darkened scans were enabled. **N/A**: Delta OD could not be computed because e.g. darkened scan was not enabled. **NaN**: An error occurred (see **7 Error codes** on p. 64). **Undefined**: The tansmittance for either faded or darkened scan was 0.
Pass / Fail	**PASS** or **FAIL** depending on whether Delta OD is within the bounds provided in Settings — Measurement Process tab (see **3.2.5 Pass/Fail Criteria** on p. 28). **N/A**: Delta OD could not be computed because e.g. darkened scan was not performed or Delta OD value was atypical for a

	photochromic lens (see **7.7 Measurement outside of limits** on p. 65).

Information used to populate the Summary panel

Table 5.2

Information used to populate the Summary panel for Suitability Measurement.

	System Suitability
LIMS number Lot number Lens number	**Asset** value entered in the Settings — Measurement Process tab (**Figure 3.14**). Lot number and Lens number are left empty.
Measurement Result	**Success**: All measurements were performed successfully. **Aborted**: An error occurred (see **7 Error codes** on p. 64). **Not Measured**: The carousel position was not selected to perform measurements.
Fading Time	**N/A**: Fading process is never performed.
Darkening Time	**N/A**: Darkening process is never performed.
OD Faded	**OD Faded** computed value. Faded scan is always performed.
OD Darkened	**N/A**: Darkened scan is never performed.
OD Post-Fading	**N/A**: Post-fading scan is never performed.
Delta OD	**N/A**: Delta OD is never computed.
Pass / Fail	**PASS** or **FAIL** depending on whether OD Faded is within the tolerance provided in Settings — Measurement Process tab (see **3.2.4 Suitability Measurement** on p. 28).

Table 5.3

Information used to populate the Summary panel for Fatigue Test.

Information used to populate the Summary panel

	Fatigue Test
LIMS number Lot number Lens number	**LIMS Number**, **Lot Number** and **Lens Number** values provided in the Main window (**Figure 2.1**).
Measurement Result	**Success**: All measurements were performed successfully. **Aborted**: An error occurred (see **7 Error codes** on p. 64). **Not Measured**: The carousel position was not selected to perform measurements.
Fading Time	**Fading Time** entered in the Settings — Measurement Process tab (**Figure 3.12**).
Darkening Time	**Activation Time** entered in the Settings — Measurement Process tab (**Figure 3.12**).
OD Faded	**OD Faded** computed value corresponding to the last cycle if *Measure Faded State* checkbox is selected (**Figure 3.12**). **N/A** if *Measure Faded State* checkbox is deselected.
OD Darkened	**OD Darkened** computed value corresponding to the last cycle if *Measure Darkened State* checkbox is selected (**Figure 3.12**). **N/A** if *Measure Darkened State* checkbox is deselected.
OD Post-Fading	**N/A**: Post-fading scan is never performed.
Delta OD	**Delta OD** computed value corresponding to the last cycle if faded and darkened scans were enabled. **N/A**: Delta OD could not be computed because e.g. darkened scan was not enabled. **NaN**: An error occurred (see **7 Error codes** on p. 64). **Undefined**: The transmittance for either faded or darkened scan was 0.
Pass / Fail	**Empty**

5.2 Messages

The Messages panel (Figure 5.1) will show an error message if a condition for a valid measurement cannot be satisfied during a measurement process (see **7 Error codes** on p. 64). In R&D mode, the first occurrence of each unique error will be shown in the Messages panel (see **3.2.3 Post Measurement Options** on p. 27).

5.3 Output Summary

The Output Summary panel shows information about the generated LIMS, Engineering and PDF Report output files (Figure 5.1).

5.4 LIMS output files

The LIMS output files in .xml or .csv format can be generated after all measurements for each sample (individual output must be selected (Figure 2.8)) if *Generate LIMS XML output* or *Generate LIMS CSV output* checkboxes are selected, respectively (Figure 3.13). Note that in Fatigue mode, no LIMS files will be generated, even if they are selected.

5.4.1 LIMS XML

The LIMS output file in .xml format contains the data and the calculated results for each measured sample (Figure 5.2) if individual output mode is selected (Figure 2.8). If batch output mode is selected, the LIMS file contains data and calculated results for all measured samples. This information is also stored in the Results folder with the following format (for lens position 1): RawData_Pos1.xml.

```
<Lens>
    <Position>1</Position>
    <RefractiveIndex>1.11</RefractiveIndex>
    <ErrorCode>0</ErrorCode>
    <Temperature>15</Temperature>
    <SolutionRefractiveIndex>1.5</SolutionRefractiveIndex>
    <SolutionName>Pure Water</SolutionName>
    <Illuminance>
    <InterlockRemainedShut>-1</InterlockRemainedShut>
    <ReferenceSpectralScan>
    <FadedSpectralScan>
    <DarkeningProcess>
    <SecondConditioningBeam>
    <DarkenedSpectralScan>
    <FadingProcess>
    <PostFadingSpectralScan>
    <FadedSpectralScanPolarisationAverage>
    <DarkenedSpectralScanPolarisationAverage>
    <PostFadingSpectralScanPolarisationAverage>
    <PhotochromicResults>
        <OD_Faded>0.157</OD_Faded>
        <OD_Darkened>0.424</OD_Darkened>
        <OD_PostFading>0.155</OD_PostFading>
        <Delta_OD>0.266</Delta_OD>
        <Ratio>1.846</Ratio>
        <Result>PASS</Result>
        <Delta_OD_1067>0.266</Delta_OD_1067>
        <Ratio_1067>1.847</Ratio_1067>
        <Result_1067>PASS</Result_1067>
        <Delta_OD_within_bounds>FAIL</Delta_OD_within_bounds>
    </PhotochromicResults>
    <TemperatureAverage>15.07</TemperatureAverage>
</Lens>
```

Figure 5.2

LIMS XML file for lens position 1.

5.4.2 LIMS CSV

The LIMS output file in .csv format contains a row with the following comma separated information if individual output mode is selected (Figure 2.8):

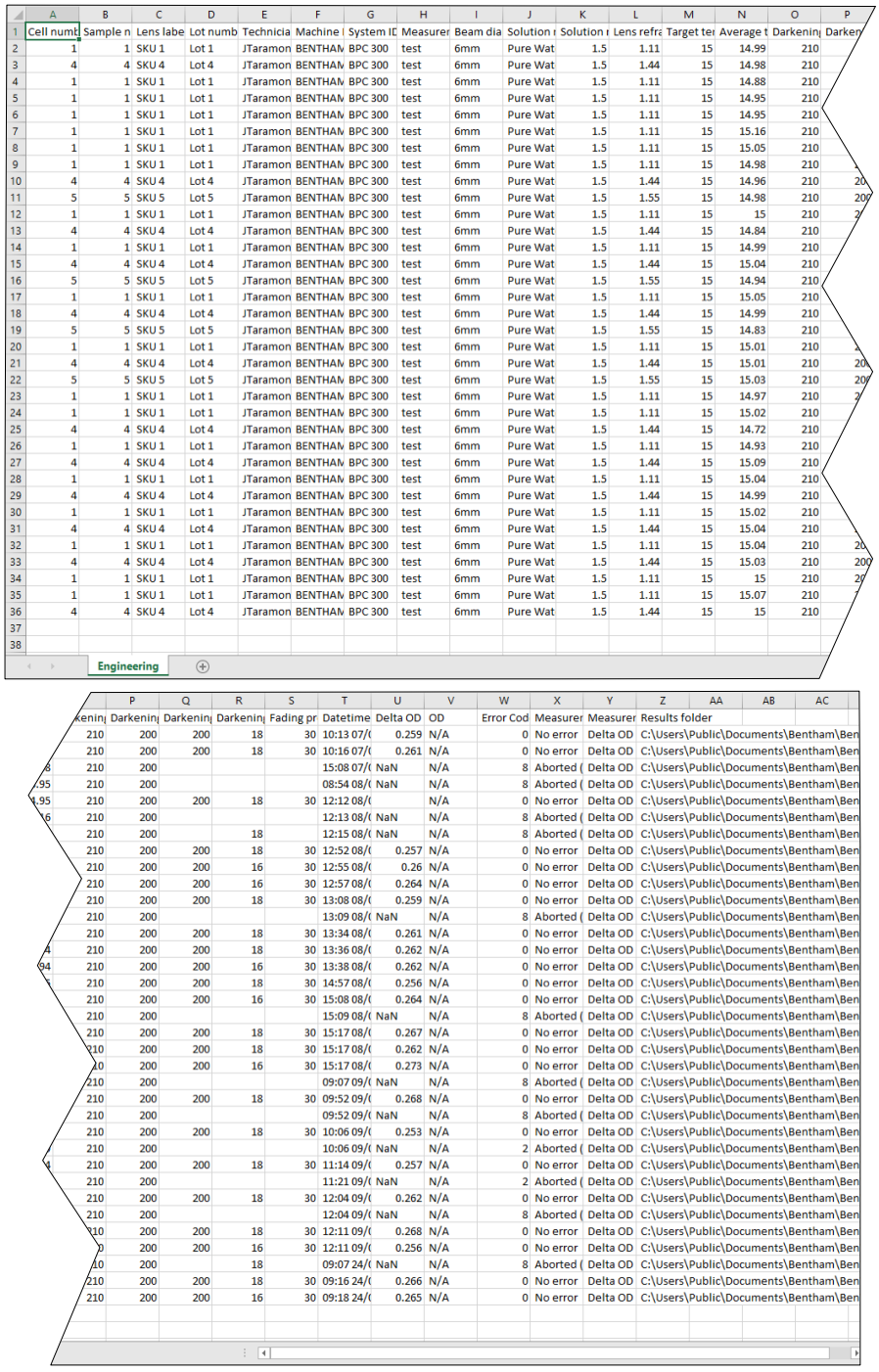
- **Cell number**: Lens Wheel Position from 1 to 6 (Figure 2.4).
- **Lens number** (Figure 2.4).
- **Lens label power** (Figure 2.4).
- **Lot number** (Figure 2.4).
- **Technician** (Figure 2.2).
- **Machine ID**: Computer Name (cannot be modified).
- **System ID** (Figure 3.31).
- **Measurement profile used**: Activation Profile (Figure 2.8).
- **Beam diameter**: Hardcoded to 6 mm.
- **Solution name** (Figure 3.26).
- **Solution refractive index** (Figure 3.26).
- **Lens refractive index** (Figure 2.1).
- **Target temperature** (Figure 3.26).
- **Average temperature**: N/A if Water Bath was disabled (Figure 3.26).
- **Darkening lux target**: Target Illuminance (Figure 3.22) corresponding to the selected Conditioning Beam for Darkening process. N/A if *Enabled* or *Apply Conditioning Beam* checkboxes were deselected (Figure 3.7).
- **Darkening pre lux**: N/A if *Enabled* or *Apply Conditioning Beam* checkboxes in Darkening Process panel were deselected (Figure 3.7).
- **Darkening post lux**: N/A if *Enabled* or *Apply Conditioning Beam* checkboxes in Darkening Process panel were deselected (Figure 3.7).
- **Darkening process time** (depending on the measurement type):
  - Delta OD Measurement: Exposure Time or time when full activation is achieved if *stop when stable* checkbox was selected (Figure 3.7). N/A if darkening process or monitor stationary scan were disabled.
  - System Suitability: N/A.
  - Fatigue Test: Activation Time (Figure 3.12).
- **Fading process time** (depending on the measurement type):
  - Delta OD Measurement: Process Time or time when full fading is achieved if *stop when stable* checkbox was selected (Figure 3.10). N/A if fading process or monitor stationary scan were disabled.
  - System Suitability: N/A.
  - Fatigue Test: Fading Time (Figure 3.12).
- **Datetime**: Datetime when the LIMS csv file is created.
- **Delta OD**: only for Delta OD Measurement, otherwise N/A.

- **OD**: only for System Suitability, otherwise N/A.
- **Error code** (see **7 Error codes** on p. 64).
- **Measurement status**: Description of the error code.
- **Measurement type**: Delta OD Measurement, System Suitability or Fatigue Test. If R&D mode was selected (Figure 3.13), “(R&D)” is added after the measurement type.
- **Results folder**: Results folder path (Figure 3.27).

If batch output mode is selected, the LIMS file contains as many rows as measured samples.

5.5 Engineering file

The Engineering file is a csv file created in the Engineering Folder (Figure 3.27) with the same columns than a LIMS csv file. After each measurement, the Engineering file is updated with the LIMS csv data (Figure 5.3), even if *Generate LIMS CSV output* checkbox is deselected (Figure 3.13).



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Cell numb	Sample n	Lens labe	Lot numb	Technicia	Machine i	System ID	Measurer	Beam dia	Solution t	Solution r	Lens refra	Target ter	Average t	Darkening	Darken
2	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	14.99	210	
3	4	4	SKU 4	Lot 4	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.44	15	14.98	210	
4	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	14.88	210	
5	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	14.95	210	
6	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	14.95	210	
7	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	15.16	210	
8	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	15.05	210	
9	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	14.98	210	
10	4	4	SKU 4	Lot 4	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.44	15	14.96	210	20
11	5	5	SKU 5	Lot 5	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.55	15	14.98	210	20
12	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	15	210	2
13	4	4	SKU 4	Lot 4	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.44	15	14.84	210	
14	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	14.99	210	
15	4	4	SKU 4	Lot 4	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.44	15	15.04	210	
16	5	5	SKU 5	Lot 5	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.55	15	14.94	210	
17	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	15.05	210	
18	4	4	SKU 4	Lot 4	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.44	15	14.99	210	
19	5	5	SKU 5	Lot 5	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.55	15	14.83	210	
20	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	15.01	210	
21	4	4	SKU 4	Lot 4	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.44	15	15.01	210	20
22	5	5	SKU 5	Lot 5	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.55	15	15.03	210	20
23	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	14.97	210	2
24	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	15.02	210	
25	4	4	SKU 4	Lot 4	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.44	15	14.72	210	
26	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	14.93	210	
27	4	4	SKU 4	Lot 4	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.44	15	15.09	210	
28	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	15.04	210	
29	4	4	SKU 4	Lot 4	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.44	15	14.99	210	
30	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	15.02	210	
31	4	4	SKU 4	Lot 4	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.44	15	15.04	210	
32	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	15.04	210	20
33	4	4	SKU 4	Lot 4	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.44	15	15.03	210	200
34	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	15	210	20
35	1	1	SKU 1	Lot 1	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.11	15	15.07	210	
36	4	4	SKU 4	Lot 4	JTaramon	BENTHAM	BPC 300	test	6mm	Pure Wat	1.5	1.44	15	15	210	
37																
38																

Engineering

	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
	kening	Darkening	Darkening	Darkening	Fading pr	Datetime	Delta OD	OD	Error Cod	Measurer	Measurer	Results folder		
	210	200	200	18	30	10:13 07/(	0.259	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	18	30	10:16 07/(	0.261	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
8	210	200				15:08 07/(	NaN	N/A	8	Aborted (	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
95	210	200				08:54 08/(	NaN	N/A	8	Aborted (	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
1.95	210	200	200	18	30	12:12 08/(		N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
16	210	200				12:13 08/(	NaN	N/A	8	Aborted (	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200		18		12:15 08/(	NaN	N/A	8	Aborted (	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	18	30	12:52 08/(	0.257	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	16	30	12:55 08/(	0.26	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	16	30	12:57 08/(	0.264	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	18	30	13:08 08/(	0.259	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200				13:09 08/(	NaN	N/A	8	Aborted (	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	18	30	13:34 08/(	0.261	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
4	210	200	200	18	30	13:36 08/(	0.262	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
94	210	200	200	16	30	13:38 08/(	0.262	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
5	210	200	200	18	30	14:57 08/(	0.256	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	16	30	15:08 08/(	0.264	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200				15:09 08/(	NaN	N/A	8	Aborted (	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	18	30	15:17 08/(	0.267	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	18	30	15:17 08/(	0.262	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	10	200	200	16	30	15:17 08/(	0.273	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200				09:07 09/(	NaN	N/A	8	Aborted (	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	18	30	09:52 09/(	0.268	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200				09:52 09/(	NaN	N/A	8	Aborted (	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	18	30	10:06 09/(	0.253	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200				10:06 09/(	NaN	N/A	2	Aborted (	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
3	210	200	200	18	30	11:14 09/(	0.257	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200				11:21 09/(	NaN	N/A	2	Aborted (	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	18	30	12:04 09/(	0.262	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200				12:04 09/(	NaN	N/A	8	Aborted (	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	18	30	12:11 09/(	0.268	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	0	200	200	16	30	12:11 09/(	0.256	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	10	200		18		09:07 24/(	NaN	N/A	8	Aborted (	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	18	30	09:16 24/(	0.266	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		
	210	200	200	16	30	09:18 24/(	0.265	N/A	0	No error	Delta OD	C:\Users\Public\Documents\Bentham\Ben		

Figure 5.3

Engineering file.

6 Running a test

This section describes the steps to run different types of tests.

6.1 Delta OD Measurement

1. Open PhotoBench utility (see **1 PhotoBench Utility** on p. 8).
2. If selecting an existing Activation Profile go to step 4.
3. Set up an Activation Profile (administrator users).
   a. Click on 'Edit' (Figure 2.1) and enter the password to open the Settings Window.
   b. Profile tab.
      Type a name for a new Activation Profile in *Save/New Profile* edit box and click on 'Save' (Figure 3.1).
   c. Saved Design Editors tab (if required saved designs do not exist).
      Fill in the *LIMS name*, *Lens base curve radius* and *Refractive Index* edit boxes with the information for the first lens and click on 'Save' (Figure 3.30). Repeat this step as many times as different lenses are going to be used in the test.
   d. Folder Options tab.
      Pick the folder locations for the results, the lens saved designs, the LIMS output files and the Engineering output file (Figure 3.27).
   e. Water Bath tab.
      Select the *Enable Water Bath Temperature Control* checkbox and fill in the *Measurement Temperature*, *Refractive Index* and *Solution Name* edit boxes (Figure 3.26). Optionally, click on 'Set Now' to start heating the water.
   f. Conditioning Beam tab.
      For setting up a conditioning beam see section **3.4 Conditioning Beam** on p. 32.
   g. Scan Settings tab.
      - Set the start wavelength, end wavelength and step for spectral scans in *Spectral* panel (Figure 3.17).
      - Set the wavelength, interval and pre-capture for Monitor Darkening and Monitor Fading panels (Figure 3.18).
      - Set Error Tolerances (Figure 3.19).
   h. Measurement Process tab.
      - Measurement Process panel (Figure 3.3).
        1. Initial Delay, if required (see **3.2.1.1 Initial Delay** on p. 21).
        2. Faded Spectral Scan (see **3.2.1.3 Faded Spectral Scan** on p. 22)
        3. Darkening Process (see **3.2.1.4 Darkening Process** on p. 23).
           Click on Apply Conditioning Beam and select a conditioning beam profile from the drop-down list.
           Set an Exposure Time.

Click on *Monitor* checkbox (if required) to perform a stationary scan while the darkening process occurs.
If *Monitor* is selected, *stop when stable* checkbox (if required) allows for a dynamic monitoring, i.e. the stationary scan is analysed in real-time in order to determine whether full activation has been achieved.

4. Darkened Spectral Scan (see **3.2.1.6 Darkened Spectral Scan** on p. 24).
5. Fading Process, if required (see **3.2.1.7 Fading Process** on p. 25).
   Set a Process Time.
   Click on *Monitor* checkbox (if required) to perform a stationary scan while the fading process occurs. The *stop when stable* checkbox (if required) works in the same way as for Darkening Process.

- Post Measurement Options panel (see **3.2.3 Post Measurement Options** on p. 27).
  Choose the required options.
- Pass/Fail Criteria panel (see **3.2.5 Pass/Fail Criteria** on p. 28).
  Set the minimum and maximum Delta OD values.

i. Return to Main Window.
   Go to Profile tab and click on 'Save', the close the window to return to the Main window. Alternatively, close the Settings window and click on 'Yes' in the confirmation window to return to the Main window.

4. Set up the lenses in the carousel (see **2.2 Asset Numbers**

The Asset Numbers are editable according to user privileges and persist through different BenWin+ sessions. The permission to edit the System, ND Filter, IDR, CL6 are managed by BenWin+ utility permissions 1-4 respectively, managed under Accounts in the Tools menu of BenWin+.

Figure 2.3

Asset Numbers panel.

5. Sample Data on p. 9).
   a. Select one lens position (1 to 6) from the *Lens Wheel Position* drop-down list, e.g. 1, and click on 'Move' to move the carousel to the lens position 1 (Figure 2.4).

   b. Introduce the lens holder containing the sample in the available position of the carousel.
   c. Select the saved design, from the *Saved Designs* drop-down list, corresponding to the selected lens in step 4a (Figure 2.6).
   d. Fill in the *Lot Number* and *Lens label power* edit boxes with information for the selected lens in step 4a.
   e. Repeat steps 4a-4d for up to six lenses in total.
6. Fill in *Lens Wheel Positions to measure* edit box with a range of lens positions or an individual lens position to measure (e.g. 1-3, 5) (Figure 2.8).
7. Measurement Options (Figure 2.8).
   a. Select *Delta OD*.
   b. Optionally select *Fade Rate*.
   c. Deselect *Activation Time*, *Optical Density* and *Fatigue*.

   See section **2.4.3 Measurements** on p. 13 for further details.
8. Select an output mode (see **2.4.4 Output Mode** on p. 15).
9. Enter a *Sample Reference* and click on 'New Measurement'.

6.2 System Suitability

1. Open PhotoBench utility (see **1 PhotoBench Utility** on p. 8).
2. If selecting an existing Activation Profile go to step 4.
3. Set up an Activation Profile (administrator users)
   a. Click on 'Edit' (Figure 2.1) and enter the password to open the Settings Window.
   b. Profile tab.
      Type a name for a new Activation Profile in *Save/New Profile* edit box and click on 'Save' (Figure 3.1).
   c. Folder Options tab.
      Pick the folder locations for the results, the LIMS output files and the Engineering output file (Figure 3.27).
   d. Water Bath tab.
      Select the *Enable Water Bath Temperature Control* checkbox and fill in the *Measurement Temperature*, *Refractive Index* and *Solution Name* edit boxes (Figure 3.26). Optionally, click on 'Set Now' to start heating the water.
   e. Scan Settings tab.
      - Set the start wavelength, end wavelength and step for spectral scans in *Spectral* panel (Figure 3.17).
      - Set Error Tolerances (Figure 3.19).
   f. Measurement Process tab.
      - Measurement Process panel (Figure 3.3).
        Enable the following actions:
        1. Initial Delay, if required (see **3.2.1.1 Initial Delay** on p. 21).
        2. Faded Spectral Scan (see **3.2.1.3 Faded Spectral Scan** on p. 22).
      - Post Measurement Options panel (see **3.2.3 Post Measurement Options** on p. 27).
        Choose the required options.
      - Suitability Measurement panel (see **3.2.4 Suitability Measurement** on p. 28).
        Select the filter position/s to measure by clicking on the checkboxes.
        Fill in the *Asset*, *n* (refractive index), *OD* (target optical density) and ± (optical density tolerance) edit boxes.
   g. Return to Main Window.
      Go to Profile tab and click on 'Save', the close the window to return to the Main window. Alternatively, close the Settings window and click on 'Yes' in the confirmation window to return to the Main window.
4. Set up the filters in the carousel.
   a. Select one filter position (1 to 6) from the *Lens Wheel Position* drop-down list, e.g. 1, and click on 'Move' to move the carousel to the filter position 1 (Figure 2.4).

b. Introduce the correct filter in the available position of the carousel according to the selected filters in Suitability Measurement panel (Figure 3.14).
c. There is no need to enter the information for *LIMS name*, *Lens base curve radius*, *Refractive Index*, *Lot Number*, *Lens label power* and *Lens number*. The software will use the information provided in Suitability Measurement panel.
d. Repeat steps 4a-4b for up to six filters in total.

5. Measurement Options (Figure 2.8).
   a. Select *Optical Density*.
   b. Deselect *Activation Time, Fade Rate*, *Delta OD* and *Fatigue*.

   See section **2.4.3 Measurements** on p. 13 for further details.
6. Select an output mode (see **2.4.4 Output Mode** on p. 15).
7. Enter a *Sample Reference* and click on 'System Suitability'. A confirmation dialog box will show the information of the filters to measure. Click on 'OK' to proceed.

6.3 Fatigue test

1. Open PhotoBench utility (see **1 PhotoBench Utility** on p. 8).
2. If selecting an existing Activation Profile go to step 4.
3. Set up an Activation Profile (administrator users).
   a. Click on 'Edit' (Figure 2.1) and enter the password to open the Settings Window.
   b. Profile tab.
      Type a name for a new Activation Profile in *Save/New Profile* edit box and click on 'Save' (Figure 3.1).
   c. Saved Design Editors tab (if required saved designs do not exist).
      Fill in the *LIMS name*, *Lens base curve radius* and *Refractive Index* edit boxes with the information for the first lens and click on 'Save' (Figure 3.30). Repeat this step as many times as different lenses are going to be used in the test.
   d. Folder Options tab.
      Pick the folder locations for the results, the lens saved designs and the Engineering output file (Figure 3.27).
   e. Water Bath tab.
      Select the *Enable Water Bath Temperature Control* checkbox and fill in the *Measurement Temperature*, *Refractive Index* and *Solution Name* edit boxes (Figure 3.26). Optionally, click on 'Set Now' to start heating the water.
   f. Conditioning Beam tab.
      For setting up a conditioning beam see section **3.4 Conditioning Beam** on p. 32.
   g. Scan Settings tab.
      - Set the start wavelength, end wavelength and step for spectral scans in *Spectral* panel (Figure 3.17).
      - Set the wavelength, interval and pre-capture for Monitor Darkening and Monitor Fading panels (Figure 3.18).
      - Set the Error Tolerances (Figure 3.19).
   h. Measurement Process tab.
      - Measurement Process panel (Figure 3.3).
      - Enable the following actions:
        1. Initial Delay, if required (see **3.2.1.1 Initial Delay** on p. 21).
        2. Darkening Process (see **3.2.1.4 Darkening Process** on p. 23).
           Click on Apply Conditioning Beam and select a conditioning beam profile from the drop-down list.
           The Exposure Time will be overwritten by the Activation Time from Fatigue Process panel (Figure 3.12).
           Click on *Monitor* checkbox (if required) to perform a stationary scan while the darkening process occurs. Note that *stop when stable* mode is not compatible with Fatigue Process.
        3. Fading Process (see **3.2.1.7 Fading Process** on p. 25)..

The Process Time will be overwritten by the Fading Time from Fatigue Process panel (Figure 3.12).
Click on *Monitor* checkbox (if required) to perform a stationary scan while the fading process occurs. Note that *stop when stable* mode is not compatible with Fatigue Process.

4. Fatigue Process (see **3.2.2 Fatigue Process** on p. 26).
Fill in the *Number of cycles*, *Activation Time* and *Fading Time* edit boxes.
If required, select *Measure Darkened State* or *Measure Faded State* checkboxes, including the number of cycles.

- Post Measurement Options panel (see **3.2.3 Post Measurement Options** on p. 27).
  1. *Generate PDF Report*.
  Note that only one report for each lens (corresponding to the last cycle) will be generated, if enabled.
  2. *Generate LIMS XML output* and *Generate LIMS CSV output*.
  Note that no LIMS files will be generated when running a Fatigue test. The output data corresponding to the last cycle of each lens will be appended to the Engineering file.

i. Return to Main Window.
Go to Profile tab and click on 'Save', the close the window to return to the Main window. Alternatively, close the Settings window and click on 'Yes' in the confirmation window to return to the Main window.

4. Set up the lenses in the carousel (see **2.2 Asset Numbers**

The Asset Numbers are editable according to user privileges and persist through different BenWin+ sessions. The permission to edit the System, ND Filter, IDR, CL6 are managed by BenWin+ utility permissions 1-4 respectively, managed under Accounts in the Tools menu of BenWin+.

Figure 2.3

Asset Numbers panel.

5. Sample Data on p. 9).
   a. Select one lens position (1 to 6) from the *Lens Wheel Position* drop-down list, e.g. 1, and click on 'Move' to move the carousel to the lens position 1 (Figure 2.4).
   b. Introduce the lens holder containing the sample in the available position of the carousel.

   c. Select the saved design, from the *Saved Designs* drop-down list, corresponding to the selected lens in step 4a (Figure 2.6).
   d. Fill in the *Lot Number* and *Lens label power* edit boxes with information for the selected lens in step 4a.
   e. Repeat steps 4a-4d for up to six lenses in total.
6. Fill in *Lens Wheel Positions to measure* edit box with a range of lens positions or an individual lens position to measure (e.g. 1-3, 5) (Figure 2.8).
7. Measurement Options (Figure 2.8).
   a. Select *Fatigue*.
   b. Deselect *Activation Time*, *Optical Density*, *Fade Rate* and *Delta OD*.

   See section **2.4.3 Measurements** on p. 13 for further details.
8. Output mode is not relevant for a Fatigue test since no LIMS files are generated.
9. Enter a *Sample Reference* and click on 'New Measurement'.

7 Error codes

During a measurement process, if a condition for a valid measurement cannot be satisfied, an error message will be shown in the Messages panel of the Results Window (Figure 5.1) and an abort icon will be shown in the Status window (Figure 4.3 and Table 4.2). This error will be reported in the LIMS output file, the Engineering file and the output raw data. Note that in R&D mode (see **3.2.3 Post Measurement Options** on p. 27) error actions will not take place except for a hardware error or a manual abort.

7.1 No error

Error code 0

If the measurement process finishes correctly, the error code 0 will appear in the LIMS output files, the Engineering file and the output raw data.

7.2 Lux level out of specification

Error code 1

If the lux level measurement taken to validate a measurement is out of specification, any subsequent lens measurements will be aborted. If this happens before starting the measurement for the first sample, no output file will be generated. If this error occurs after a lens measurement, the last measurement will be invalidated, producing an output file as normal except with NaN for delta OD and error information. An error window will be displayed with information.

7.3 Temperature out of specification

Error code 2

If the measurement temperature goes out of specification during a measurement, the last measurement will be invalidated, producing an output file as normal except with NaN for delta OD and error information. Any subsequent lens measurements will be aborted. An error window will be displayed with information.

7.4 Abrupt Transmission change

Error code 3

If the transmission measurement abruptly changes during a measurement, potentially indicating that a bubble has migrated into or out of the beam path, the current measurement will be aborted, producing an output file as normal except with NaN for

delta OD and error information. The software will proceed with any subsequent lens measurements.

7.5 Top open

Error code 4

If the lid is open during a measurement, the current measurement will be aborted, producing an output file as normal except with NaN for delta OD and error information. The software will proceed with any subsequent lens measurements once the lid is closed. A window will be displayed indicating that the lid is open.

7.6 No Lens

Error code 5

If no lens is detected in the holder during faded transmission measurement (100% transmission), the current measurement will be aborted, producing an output file as normal except with NaN for delta OD and error information. The software will proceed with any subsequent lens measurements.

7.7 Measurement outside of limits

Error code 6

If the delta OD value is atypical for a photochromic lens (this minimum atypical value can be set in Error Tolerances panel (Figure 3.19)), an output file will be produced as normal except with NaN for DOD and error information. The software will proceed with any subsequent lens measurements.

7.8 Conditioning Beam Hardware error

Error code 7

If a hardware error occurs when setting a conditioning beam, the last measurement will be invalidated, producing an output file as normal except with NaN for delta OD and error information. Any subsequent lens measurements will be aborted.

7.9 Manual abort

Error code 8

If the user aborts a scan, the last measurement will be invalidated, producing an output file as normal except with NaN for delta OD and error information. Any subsequent lens measurements will be aborted.