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EPro user manual

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Publication date:
2006

Document Version
Publisher's PDF, also known as Version of record

Link to publication from Aalborg University

Citation for published version (APA):
Meinert, P. (2006). *EPro user manual*. Department of Civil Engineering, Aalborg University. Hydraulics and Coastal Engineering No. 39

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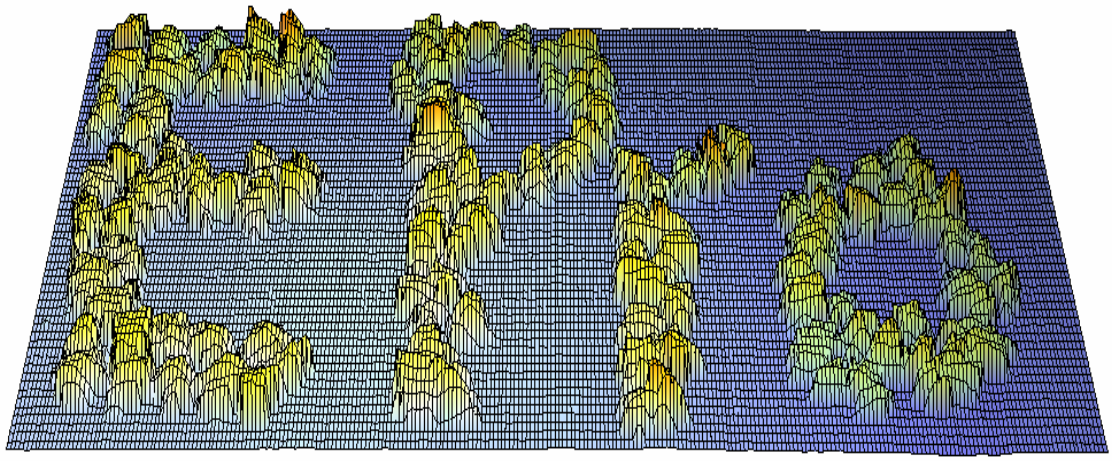

EPro
user manual

april, 2006

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Hydraulics and Coastal Engineering No. 39

ISSN 1603-9874

april 2006

EPro
user manual

By

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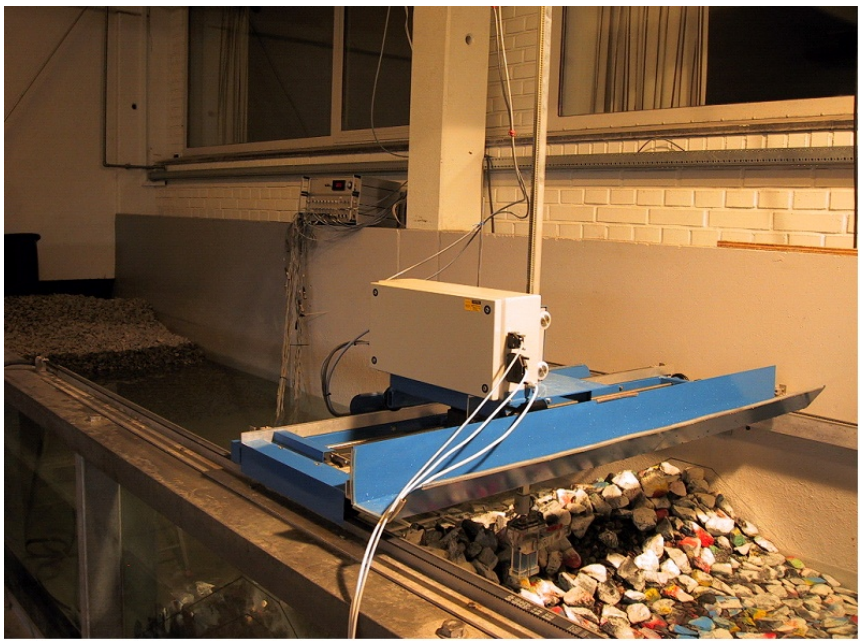
EPro 1.0

Non-contact erosion profiling

by Palle Meinert

EPro is an Erosion PROfiling program, which was original, developed for the Hydraulics and Coastal Engineering group at Aalborg University. Its purpose was/is to make non-contact 3D-measurements of breakwaters, seabed etc. in order to determine erosion. The distances are measured by laser.

All measured profiles are grouped into projects. After measurement, the results are graphically presented and can be examined in details.



EPro Help Document

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Table of Contents

Part I Main window 2

1 Connect / disconnect profiler 3
2 Set limits 3
3 Manual control 4
4 Reset motors 5
5 Create new project 6

Part II Project window 8

1 Information / data 9
2 Grahical representation 11
3 Offset profiles 12
4 Smooth profile 13

Part III Profiling 16

1 Control 17
2 Status information 18

Part IV Preferences 22

1 General parameters 22
2 Profiling direction 24
3 Profiling parameters 26
4 Calibration units 28
5 Communication 29
6 Through water 30

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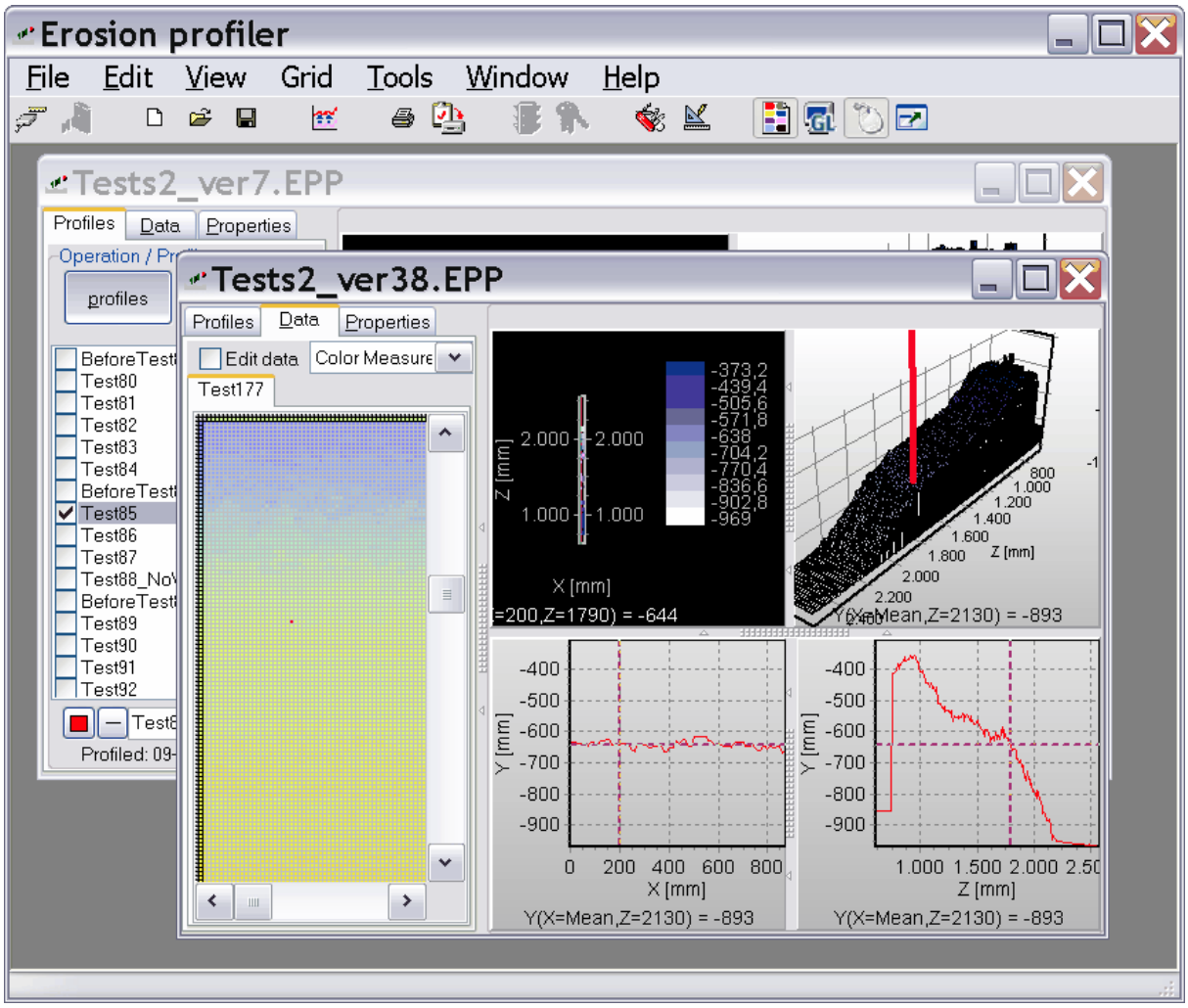
Part 1. Main window

EPro is a so-called MDI-application, which can have multiple projects open at the same time.



In top of the window, a toolbar is giving quick access to the most common operations. From left to right these are:

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16.

No. *Function*

1. Connect/disconnect profiler
2. New profile
3. New project
4. Open project
5. Save project
6. Offset profiles
7. Print charts
8. Export data
9. Set limits for working area
10. Manual control the profiler
11. Open Preferences dialog
12. Edit advanced properties for charts
13. Toggle between range and palette coloring
14. Toggle OpenGL
15. Toggle display of current position on charts
16. Toggle fullscreen

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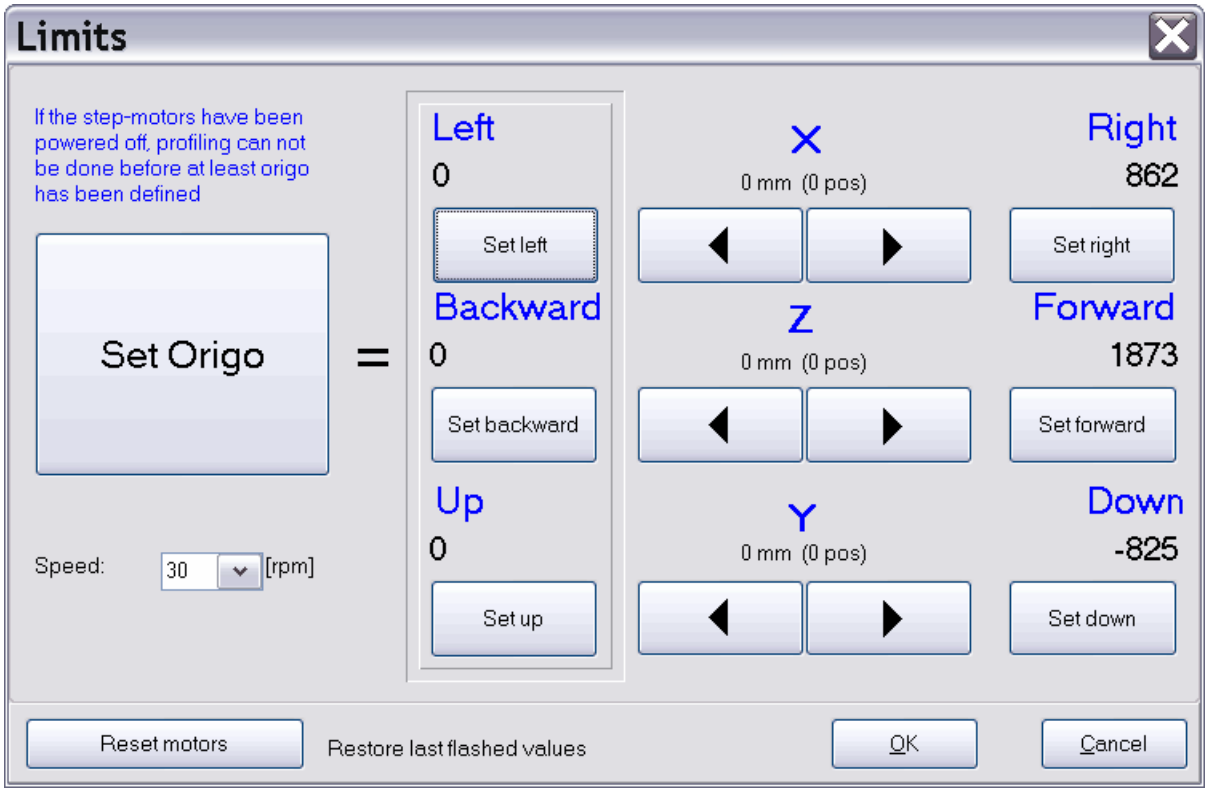
1.1 Connect / disconnect profiler

This will connect/disconnect to the profiler using the communication parameter set up in preferences. If everything is right and connection is successful the set limits dialog will be displayed allowing the position of origo to be defined. This is needed if the motors have been off; otherwise, absolute movement is not possible.

1.2 Set limits



The set limits dialog serve three purposes:

1. Definition of origo
Except in this dialog, all movements are done using absolute coordinates. However, this is only possible when the motors know their position. Therefore, definition of origo is required.

Origo = left-limit + backward-limit + up-limit

2. Define movement boundaries
Setting the boundary of movement, defines the profiler's working space. However, in this dialog, it is possible to move the profiler beyond the limits. When creating a new project, it is checked that, the profiling-area does not exceed these limits.

Axis movement is done by pressing the arrows-buttons. For increased precision, the speed can be adjusted. The recommended order to perform a full limit definition is:

1. define up-limit
2. define down-limit
3. move to upper position to avoid possible collision before horizontal movement
4. define left limit
5. define backward-limit
6. define right limit
7. define forward limit

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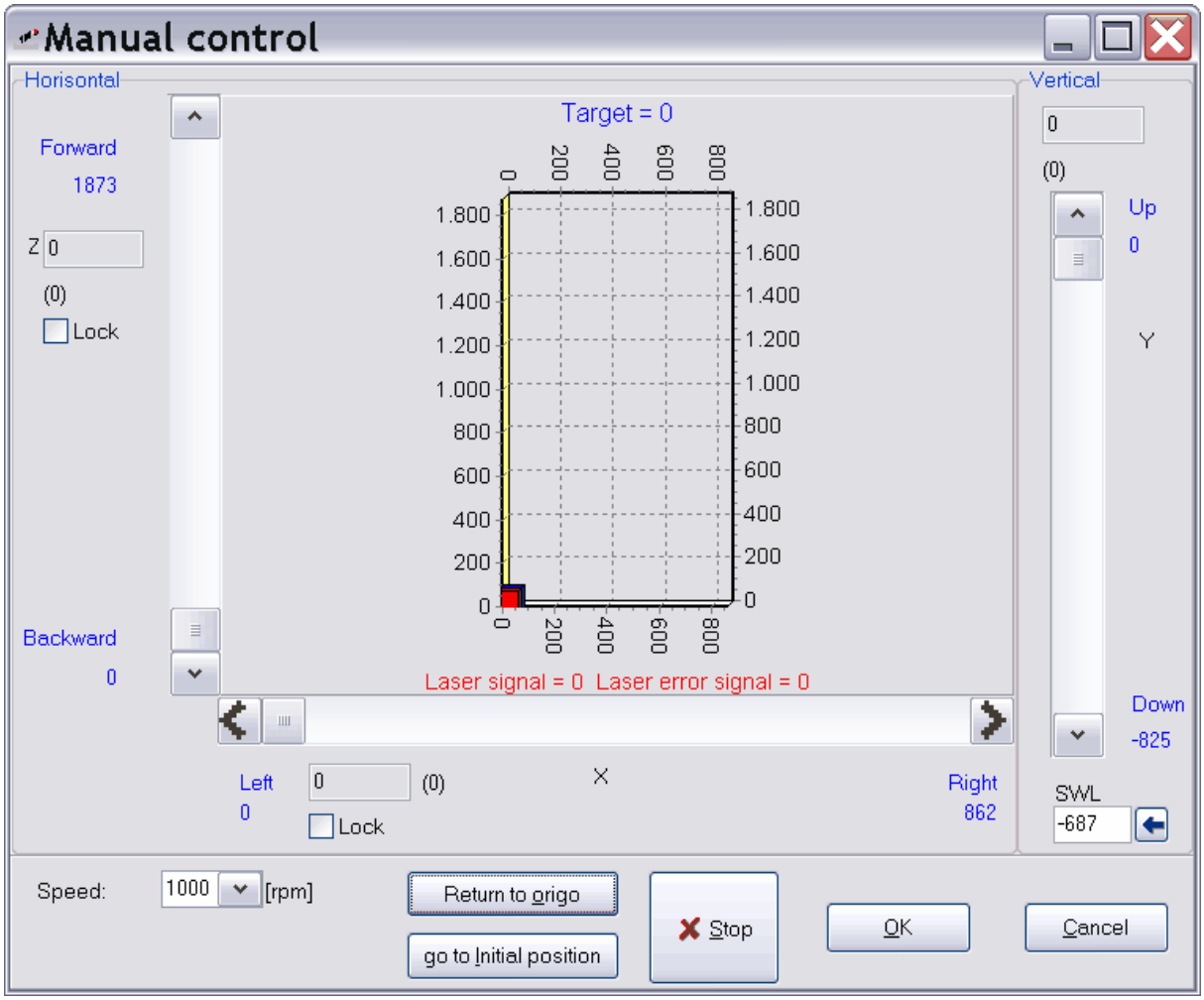
The limits can be tested int the Manual control dialog.

3. Determine and verify position/mm ratio
Since this dialog shows the internal position-count of each motor, it can be used to determine the conversion-ratio between [positions] and [mm] (see Calibration units).

Reset motors
See Reset motors.

1.3 Manual control



In this dialog, the profiler can be moved manually. Movement is done using absolute coordinates, if no movement happens it is most likely because, origo has not been defined, in the set limits dialog.

Each axis is presented with a slider. Any change on these slider results in instant movement of the profiler.

Horizontal movement can also be done by dragging the green marker to a desired position. The red marker indicates the profilers actually position and is constantly keeping up with the green marker on any horizontal position change. If the mouse is equipped with a scroll button, it will control vertical movement.

The profiler can also be controlled by keyboard using the cursor-keys for horizontal movement and page-up/down for vertical movement. If combined with the CTRL-key increments will be 1mm else 10mm.

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Each of the horizontal axes can be locked at a certain position, by checking its lock-checkbox.

Control		*Description*
Speed	:	Speed of all movement. Speed cannot exceed the maximum allowed speed set up in preferences.
Return to origo	:	Moves the profiler to origo.
Go to initial position	:	Just like return to origo, except the backward/forward-axis is moved to maximum forward. This is useful for parking the profiler during tests.
Stop	:	Emergency stop button, to stop all movement immediately.
SWL	:	SWL used for calculating target

This dialog is also useful for calibrating the laser, since it displays raw voltage output from the laser together with the calculated position of the target. To obtain reliable results please make sure to set the SWL (still water level) if water is present.

1.4 Reset motors

If the motors have been overloaded, they sometimes raise an internal error-flag and cease to operate until this flag has been cleared. Pressing the reset-button will clear the motors and restore the last flashed values. If the motors still refuse to operate, try switching off and on the power. This operation will also clear any position memory in the motors and a new definition of origo is required, see Set limits.

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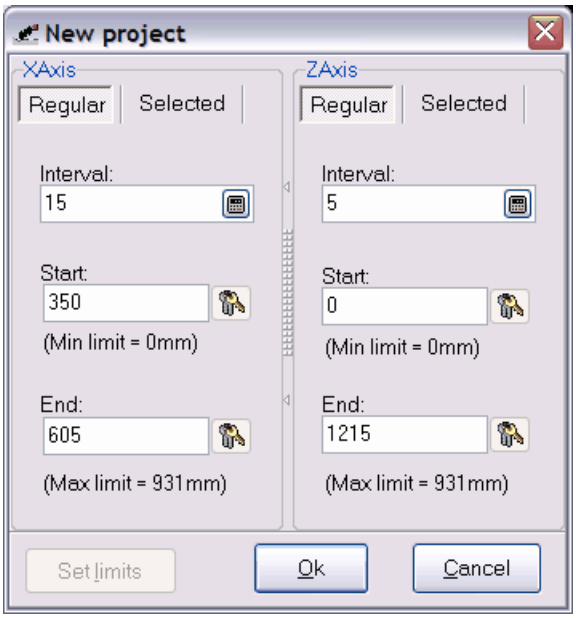
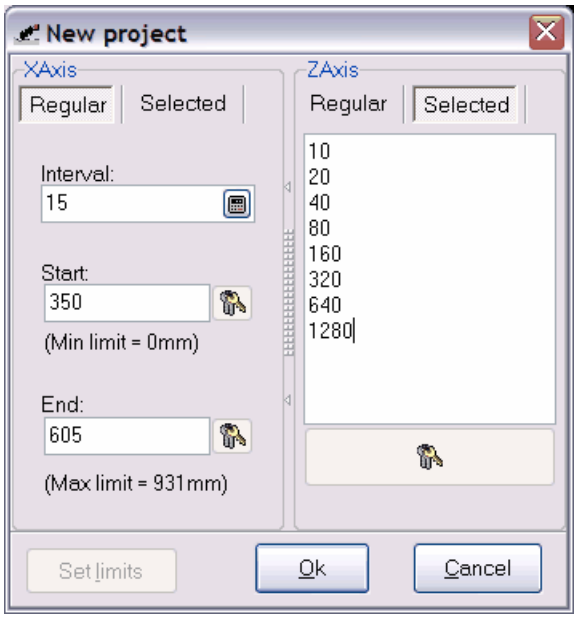
1.5 Create new project

A project is a compilation of uniform profiles. In this context, uniform means, profiles with identical profiling area.

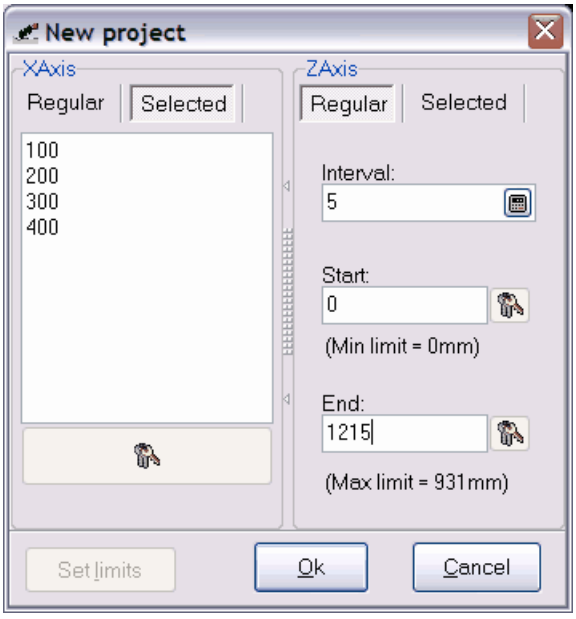
When selecting new-project a dialog appear where these points must be defined. These points can be entered as an array with start, stop and interval or as custom points. This can be done individually for the X- and Z-axis. Examples of all four combinations are shown below.



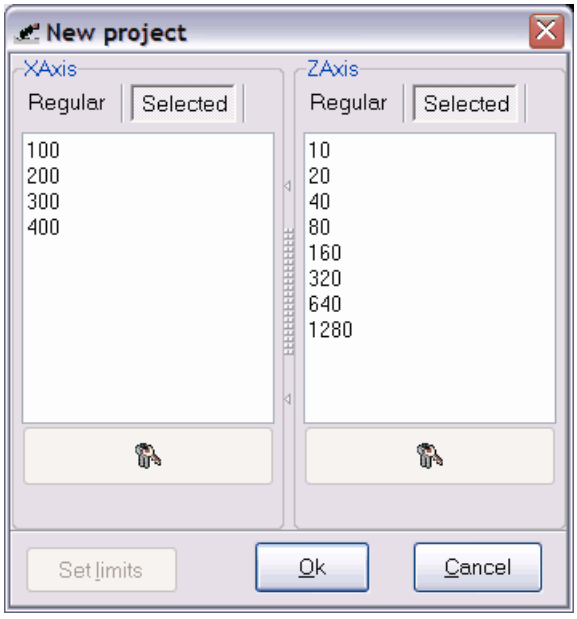
or



or



or



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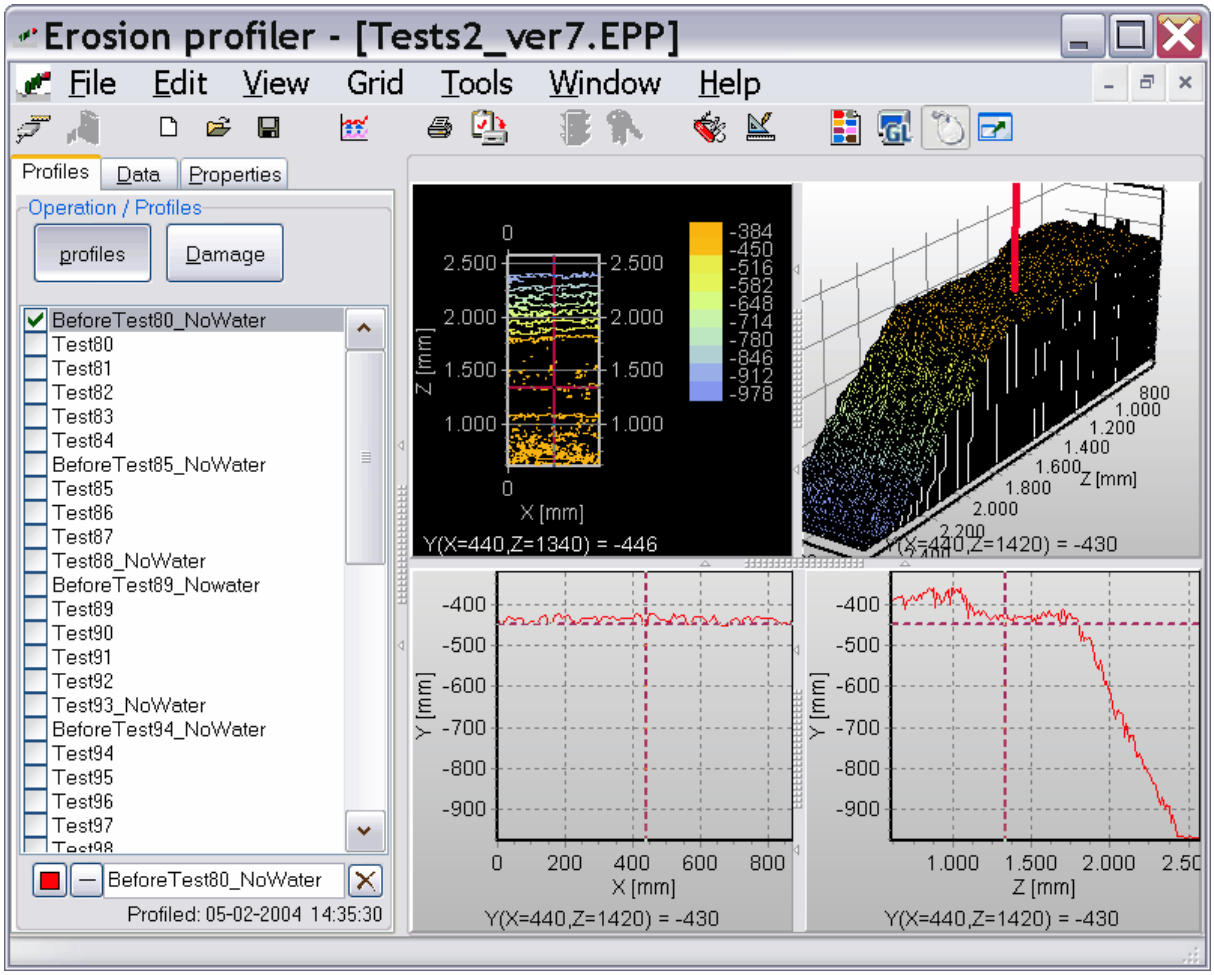
Part 2. Project window



The project window is split into two parts.

1. data and information tabs
2. graphical presentation of the measurements

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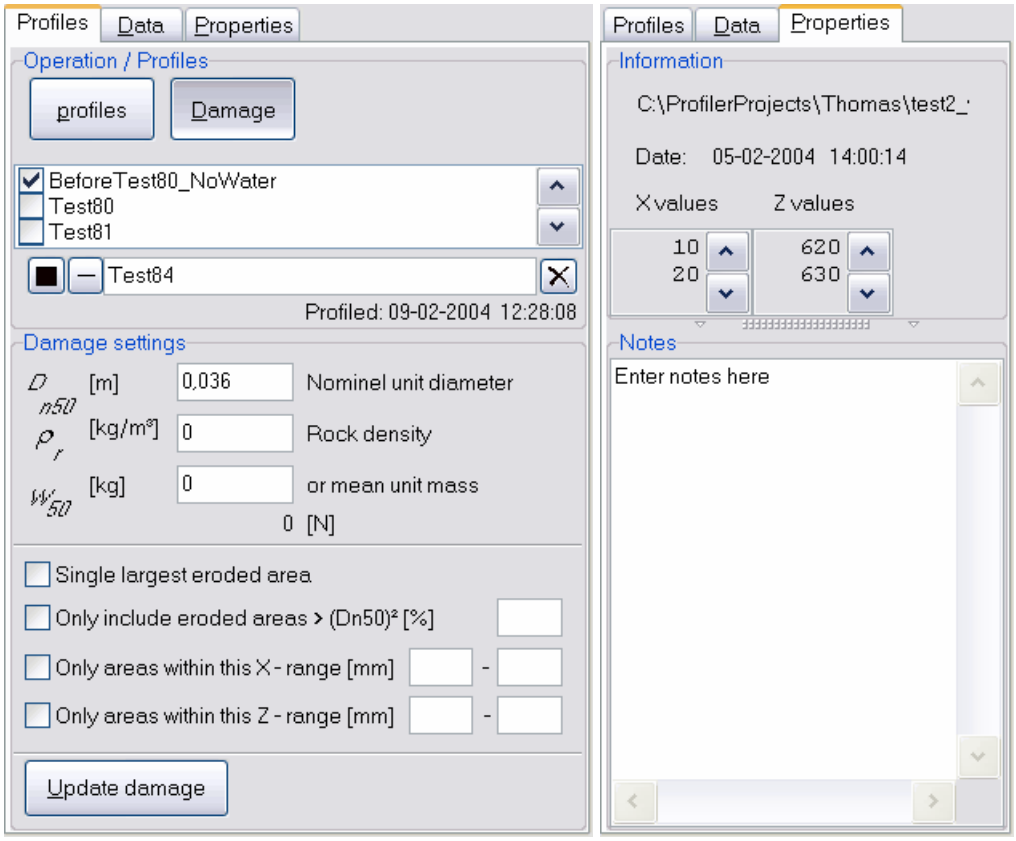
2.1 Information / data

The information/data is used to manage the measured data.



ProfilesThis tab controls the profiles. Profiles can be enabled and disabled individually. When two profiles is selected, it is possible to make a damage calculation. The damage calculation will determine the eroded area between two profiles and calculate a damage value, which tell how many of elements with a nominal unit diameter of Dn5o would fit into the eroded area. The area considered during a damage calculation, can be reduced by applying some filters.

Properties
This tab will display the properties of the project. It is also possible to write additional notes.

Data
This tab show all the measurements (and error values) in tabular form. The data can be colored either by magnitude or by error. When a cell is selected, it position is indicated on the charts. A double click on the grid will move the profiler to the location of the measurement. Selecting the grid menu or clicking with the right mouse button will bring up the following menu, giving access to various editing

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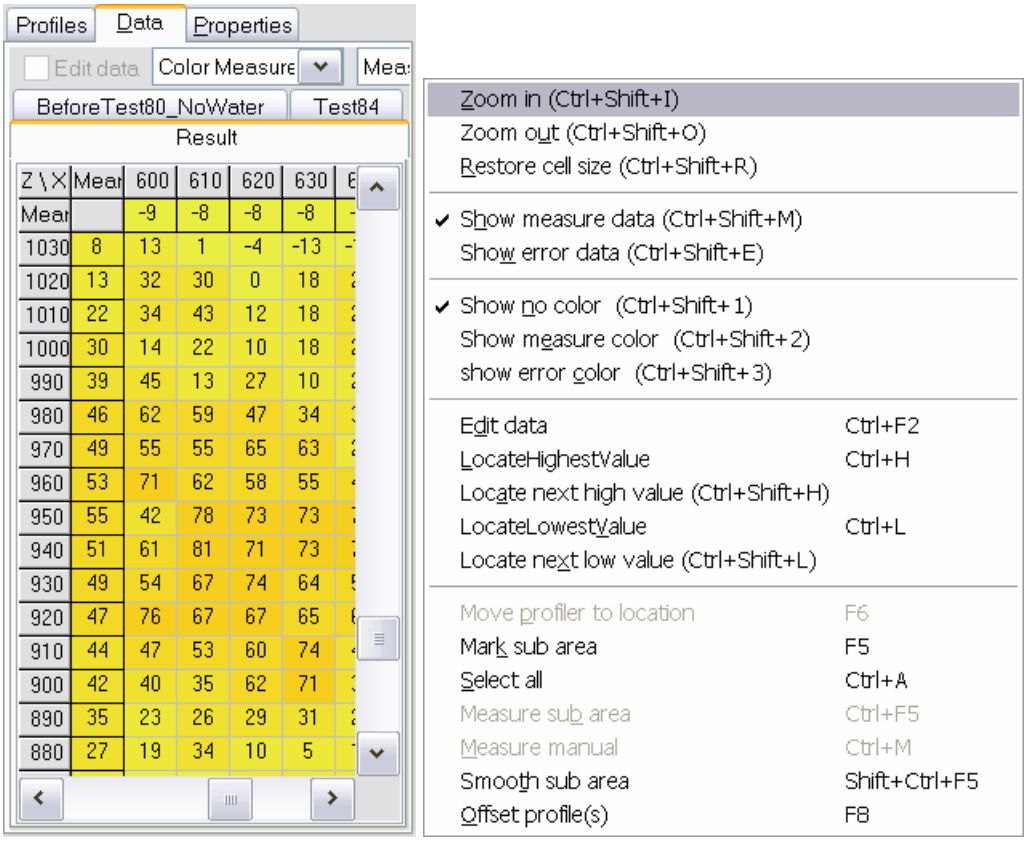
and navigation possibilities.



Z \ X	Mean	600	610	620	630
Mean		-9	-8	-8	-8
1030	8	13	1	-4	-13
1020	13	32	30	0	18
1010	22	34	43	12	18
1000	30	14	22	10	18
990	39	45	13	27	10
980	46	62	59	47	34
970	49	55	55	65	63
960	53	71	62	58	55
950	55	42	78	73	73
940	51	61	81	71	73
930	49	54	67	74	64
920	47	76	67	67	65
910	44	47	53	60	74
900	42	40	35	62	71
890	35	23	26	29	31
880	27	19	34	10	5

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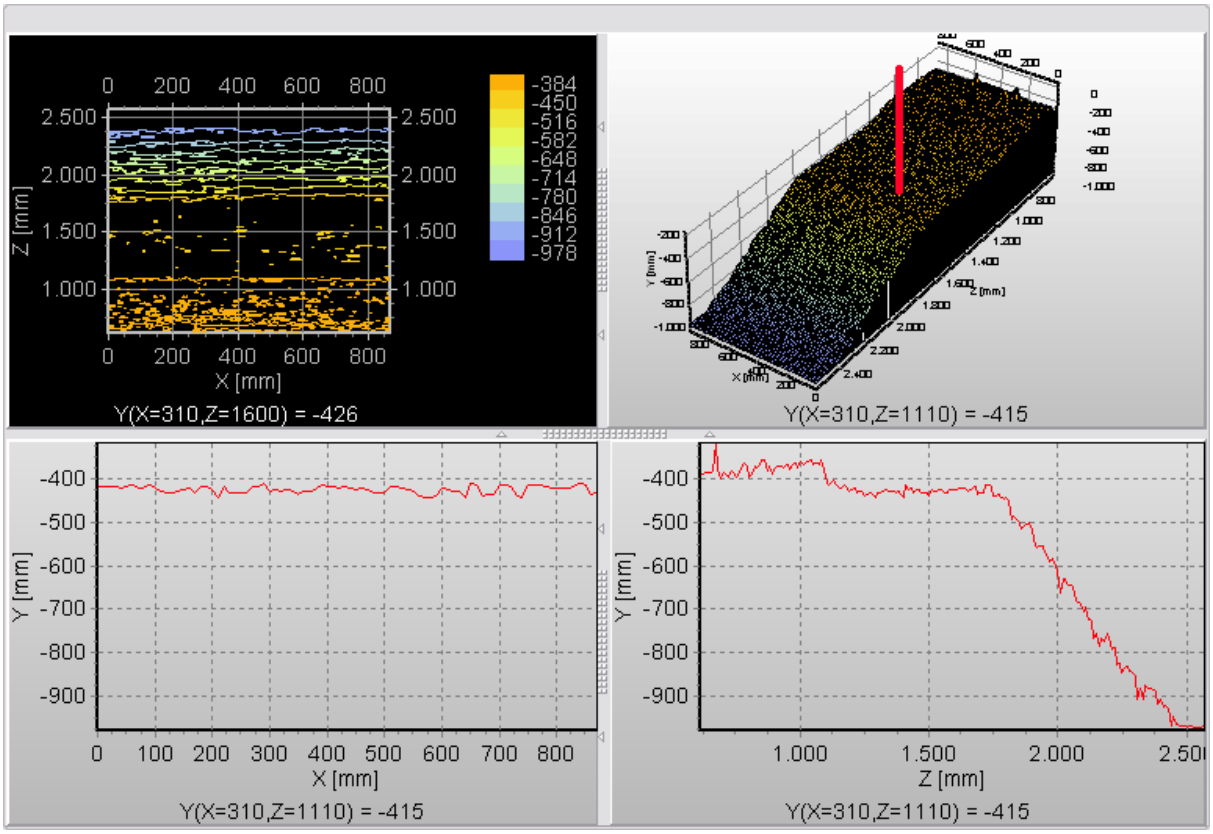
2.2 Grahical representation



There are four charts used to display the measurements graphically.

1. Contour chart
2. Surface chart
3. y-z cross-section
4. y-x cross-section

All charts can be printed or exported as either graphic or data. This is either done from the right click popup menu or from the file menu.

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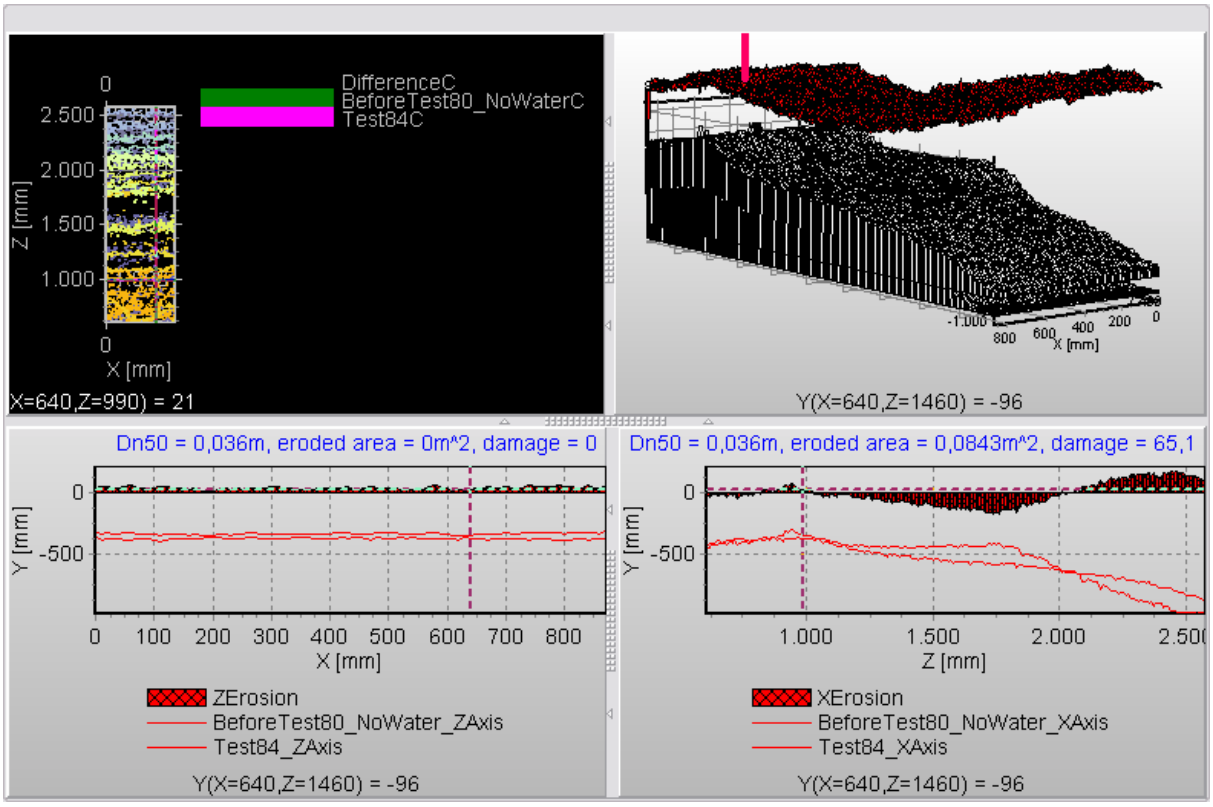
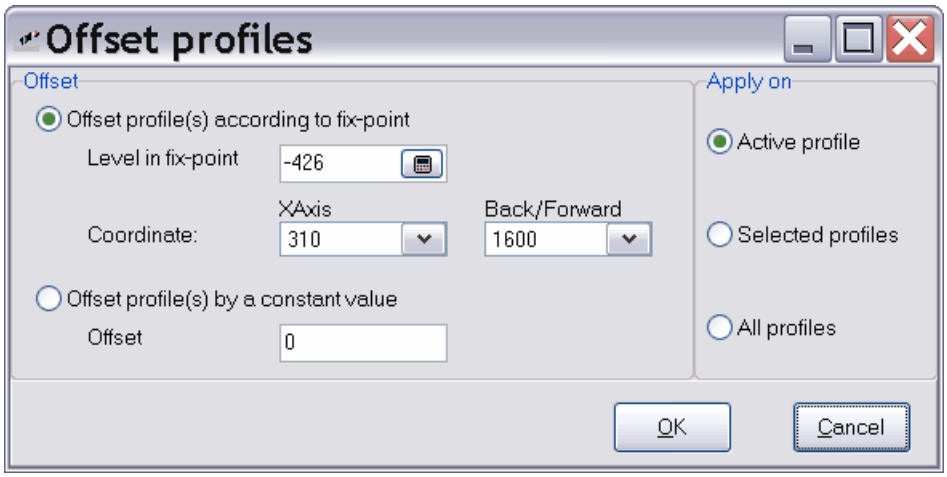


Damage calculation will also show the size of the eroded area.

2.3 Offset profiles



When comparing profiles it is important, that origo is the same. However, it can happen that the offset of the profiles differs. This dialog can change the offset of the profiles. The can be done in two ways.

1. Offset according to fix-point
It is recommended to include a non-eroding area in the measurement area. This could for example be a part of the concrete floor. Then all profiles can aligned to have a stated value in stated fix-point.

2. Offset by constant value
Offset profiles by constant value.

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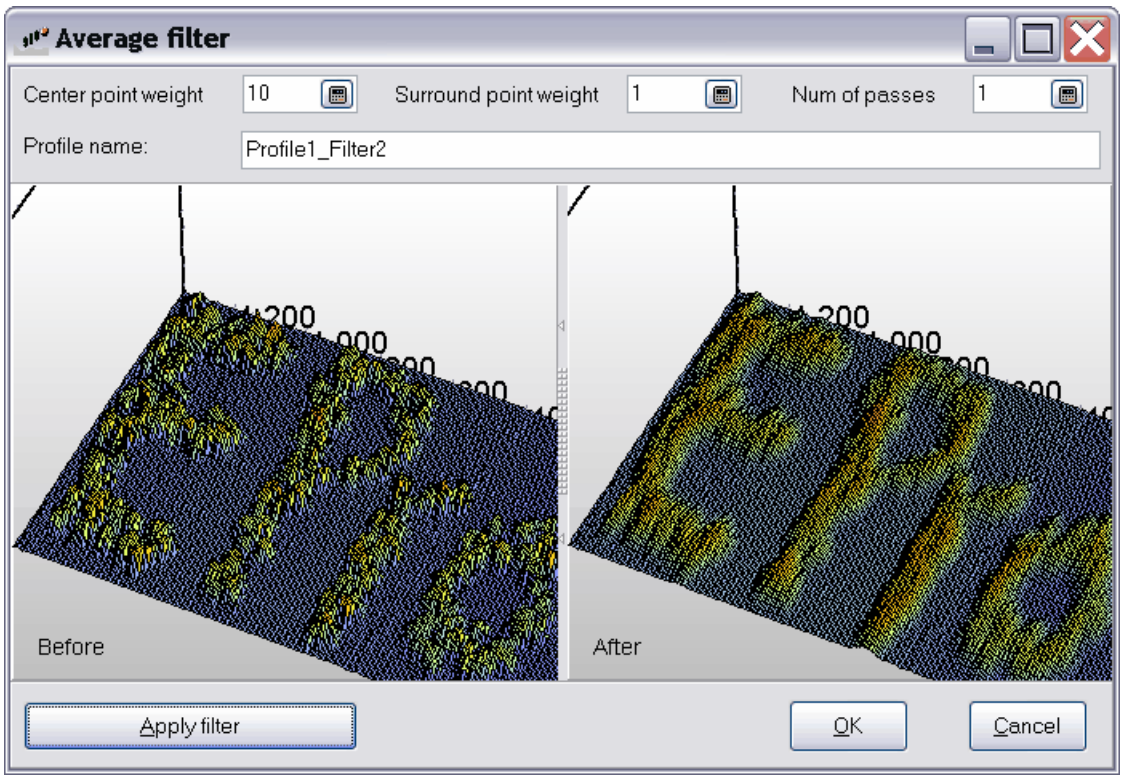
2.4 Smooth profile



The smooth profile dialog will apply a average filter on the profile or selected sub-area. The result will be stored as a new profile, so the old measurements are preserved. The dialog shows the original profile together with the new profiler for comparison. The average filter covers a square of nine measure points of which it will calculate the mean. This value will be assigned to the center measure-point.

Parameter		*Description*
Center point weight	:	How many times the value of the center point it self should count.
Surround point weight	:	How many times the value of each of the surround 8 values should count.
Num of passes	:	how many time the average filter should be repeated.

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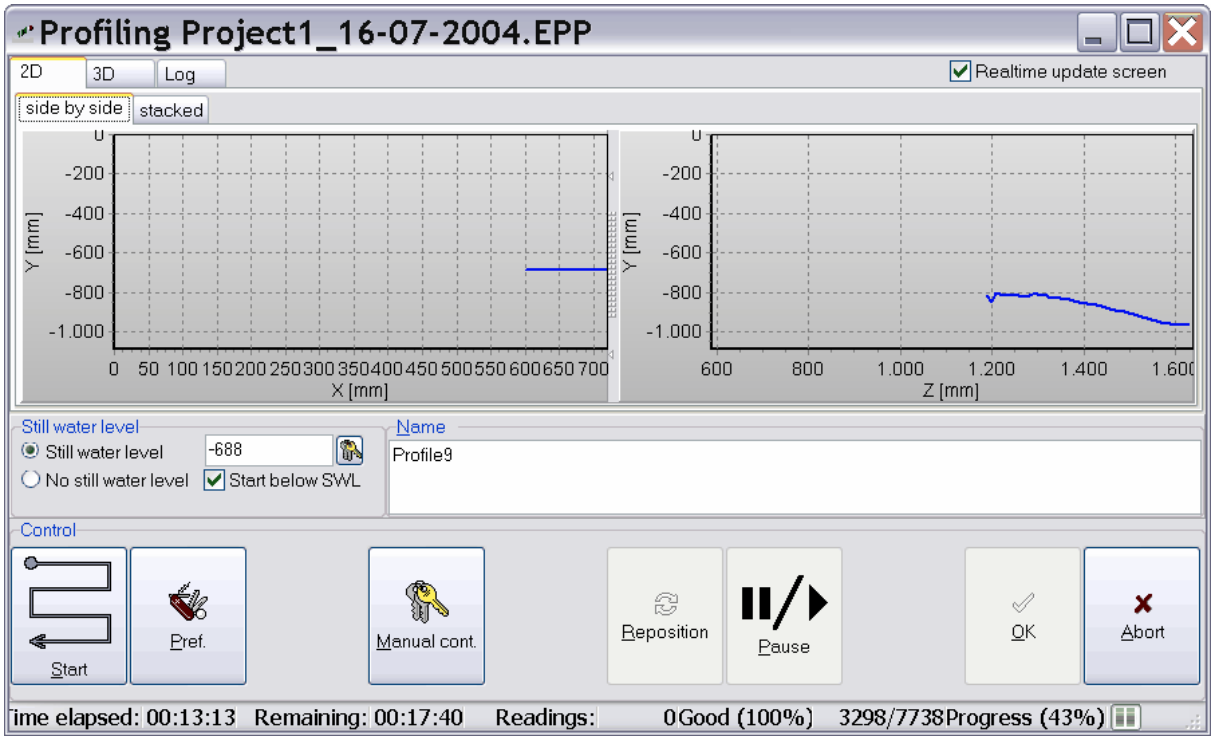
Part 3. Profiling



Profiling is done according to the speed, acceleration, direction and parameters chosen under preferences. It is important to fit those settings to the current project.

Most important is, that the vertical velocity and acceleration together with profiling frequency is set sufficiently high compared to the horizontal velocity in order for the profiler to react and avoid obstacles.

The profiling algorithm has some built in mechanism to avoid collision. This mechanism compares the current laser reading with the last valid reading and has some built in rules about how big a deviation is allowed before a reposition is requested. The size of the accepted deviation is based on the laser working range and its vertical position in relation to a possible water surface.

If the anti collision mechanism is preventing the profiler from reaching the target, proper operation can be resumed by forcing a reposition. However, I might be better to abort the profiling, manually remove the faulty measurements in the restart file, and resume profiling.

Since no previous target exist at start, anti collision mechanism is not active and is important that the laser get a reading of the first measure point to avoid collision. Under a forced reposition, anti collision is also disabled and the same conditions apply.

If collision happens, it will be detected and the collision position will be considered a measurement.

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3.1 Control

Profiling is started by selecting "new profile" in the file menu or hitting on the tool-bar. However, the following condition must be satisfied before profiling can start:

- Program has established connection to profiler and origo is defined
- A project is active

If an incomplete profiling exists for the current project, the program will ask whether to continue this profiling or start from the beginning.

Before starting the profiling, the program must know the still water level if water is present. This is needed to proper translate the laser signal into a distance.

Field		*Description*
Still water level	:	Check if water is present in the profiling area. If water is present, the level must be entered. The level required is the vertical-position of the laser when touching the water surface with the glass in front of the laser. This value can be detected manually by pressing the attached button on the right of the input field.
Start below SWL	:	Check if first measure point is located deeper than the lasers under-water-minimum below water surface. This prevent the profiler from measuring the water surface as an target.
No still water level	:	Check if no water is present within the profiling area.
Name	:	The name of the profile. This can be modified later on. Note that only the following characters are valid a-z, A-Z, 0-9 and "_".

In the control-section a few buttons is located which interact with the profiler and the profiling algorithm.

Button		*Description*
Start	:	Start the profiling. Will first be enabled when a valid still water level and show point has been entered
Pref.	:	Short cut to the Profiling direction tab under preferences. This gives the possibility to change various profiling parameters. E.g. direction and speed. Some parameters changed while profiling is running will not be active until next time profiling is started.
Reposition	:	Forces the profiler to move up and make a new search for target. This is very useful to get the profiler back on track.
Pause/Continue	:	Pauses or continue profiling
Manual control	:	Display the manual control dialog and allow moving the profiler. On continue the profiler automatic moves back to the right position. However, if any obstacles are present it is better to do a manual return. Notice! If the vertical position is changed during manual movement and the dialog is exited with Ok, the new vertical position will be used by the profiling algorithm. If the dialog is exited with cancel, the old vertical profiling position is restored.

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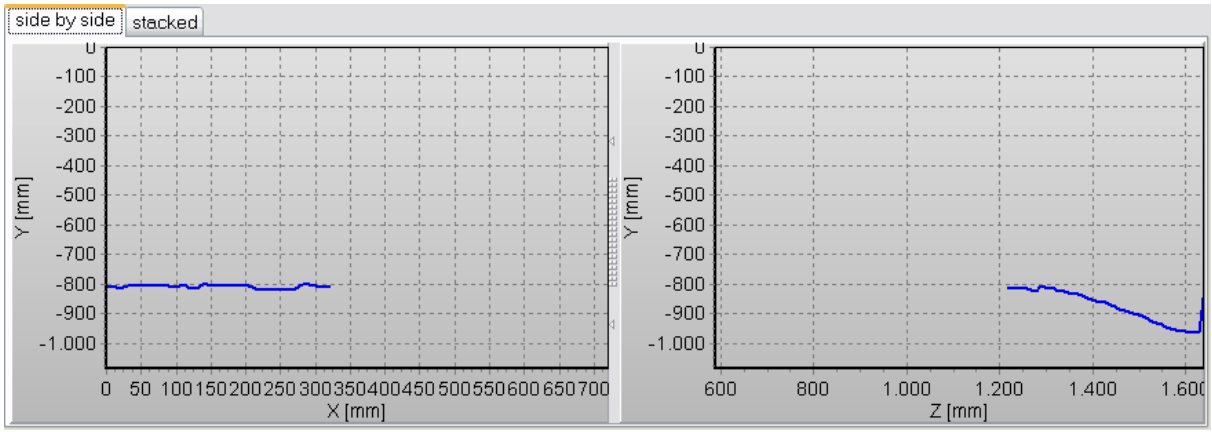
Abort : When profiling is aborted, the user will be prompted for whether the measurements should be stored as a new profile. If yes, it will be possible to measure missing by using sub-area measurements. If no, it will be possible to restart the measurement again when selecting new profile. The measurements can be rolled-back, by opening the restart file in a text-editor and remove the faulty measurements from the end of the file.

Ok : When profiling has finished successfully, the Ok-button will be enabled. Pressing the Ok-button will save the profile and return to the project window.

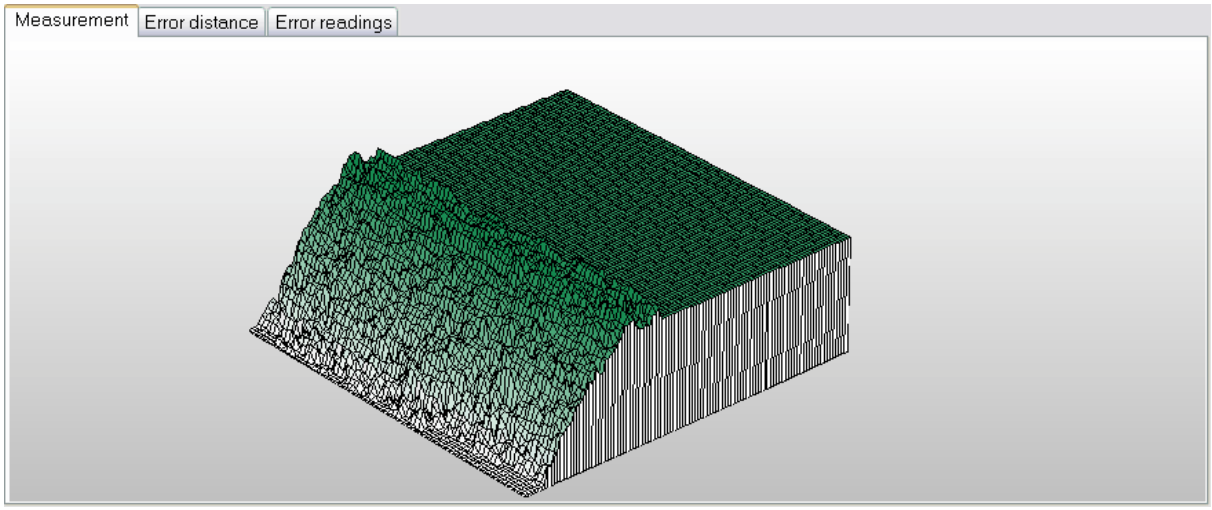
3.2 Status information

Cross-sections



2D Cross-section is the default and recommended way of tracking the profiling progress, since it is very readable and do not stress the computer much.

Measurements



This is a surface plot all measurements. Initially all measure points are given the value of the down limit. Every time a point has been measured, the surface plot is updated.

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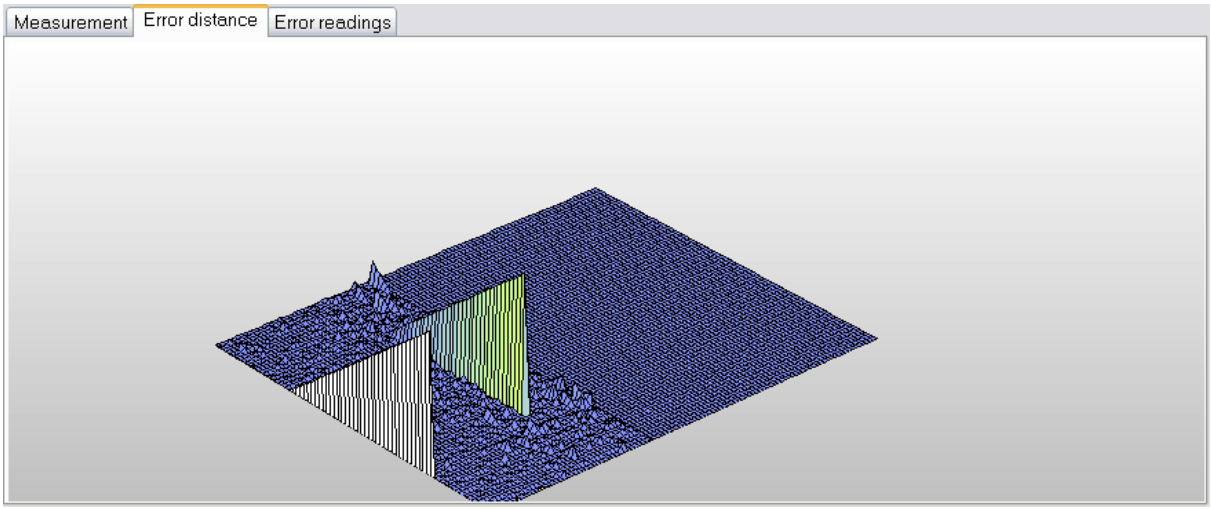
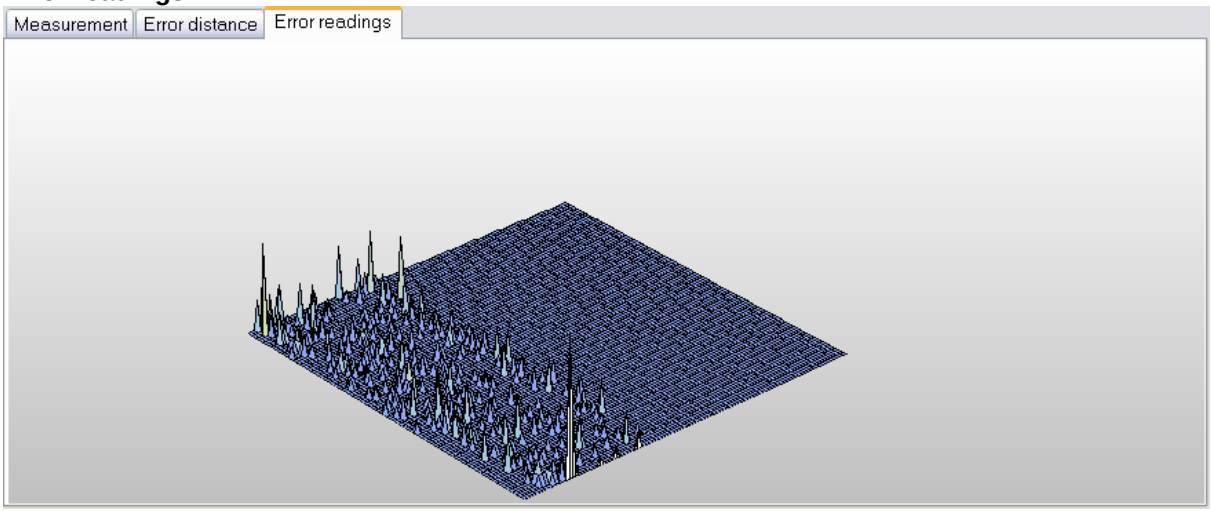
Error Distance



When profiling in fast modes, the profiler does not stop at each measure point. Instead it continuously sample laser readings while moving smoothly through all measure-points. Each measure point will be assigned the measurement closest to its position. This chart show the distance between the measure-point and the position where actual position of the measurement assigned to it was done.

This information is stored together with the measurements and is very valuable indicator for the validity of the measurements.

Error readings



If memory usage is enabled under profiling parameters this plot displays the amount of error-readings located at each measure-point. Many error-readings indicate poor readings and thereby less reliable results. In the lower right corner, the usage of memory readings is compared to the total amount of laser readings.

This information is NOT stored and the information is lost when the profiling dialog is closed. However, if needed there is a work around to store this information manually:

1. Wait for profiling to finish
2. Accept the message-dialog displaying "Profiling finished"
3. DON'T close the profiling window
4. Double click on graph to enter chart-properties
5. Choosing the export page allows storage of both data and graph in a variety of formats
6. When done exporting, exit chart properties
7. now the information has been stored and the profiling dialog can be closed

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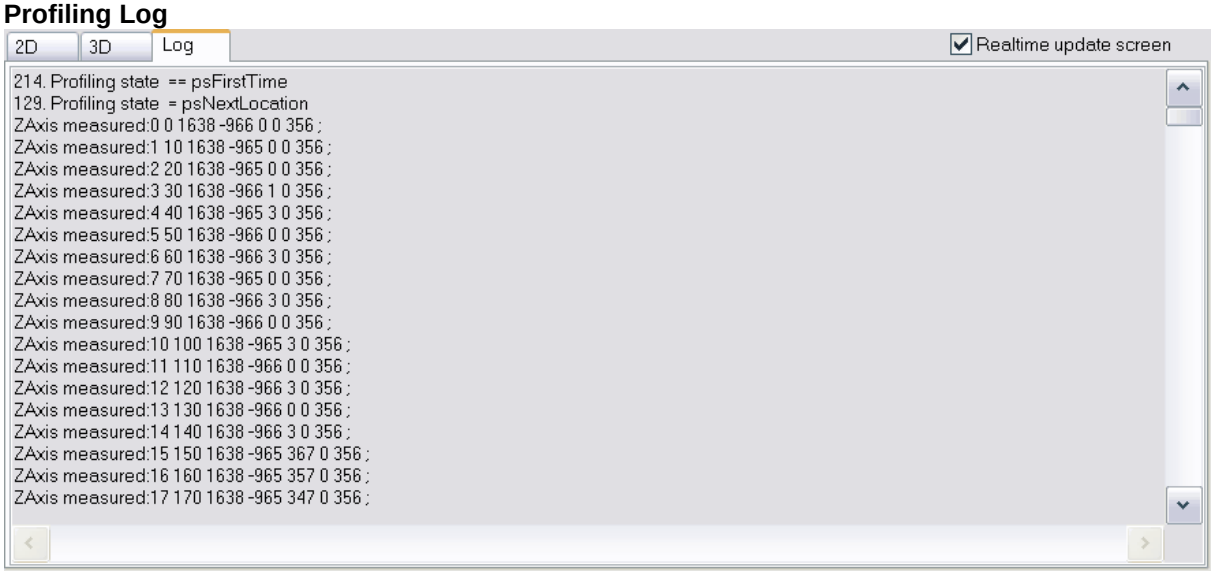
Profiling Log



The log page contains a large text-field, where all measurements are logged. For debugging purposes, extended logging can be enabled be checking "log state changes" under Profiling parameters. If necessary, the log information can be saved by copying it to an empty text-file.

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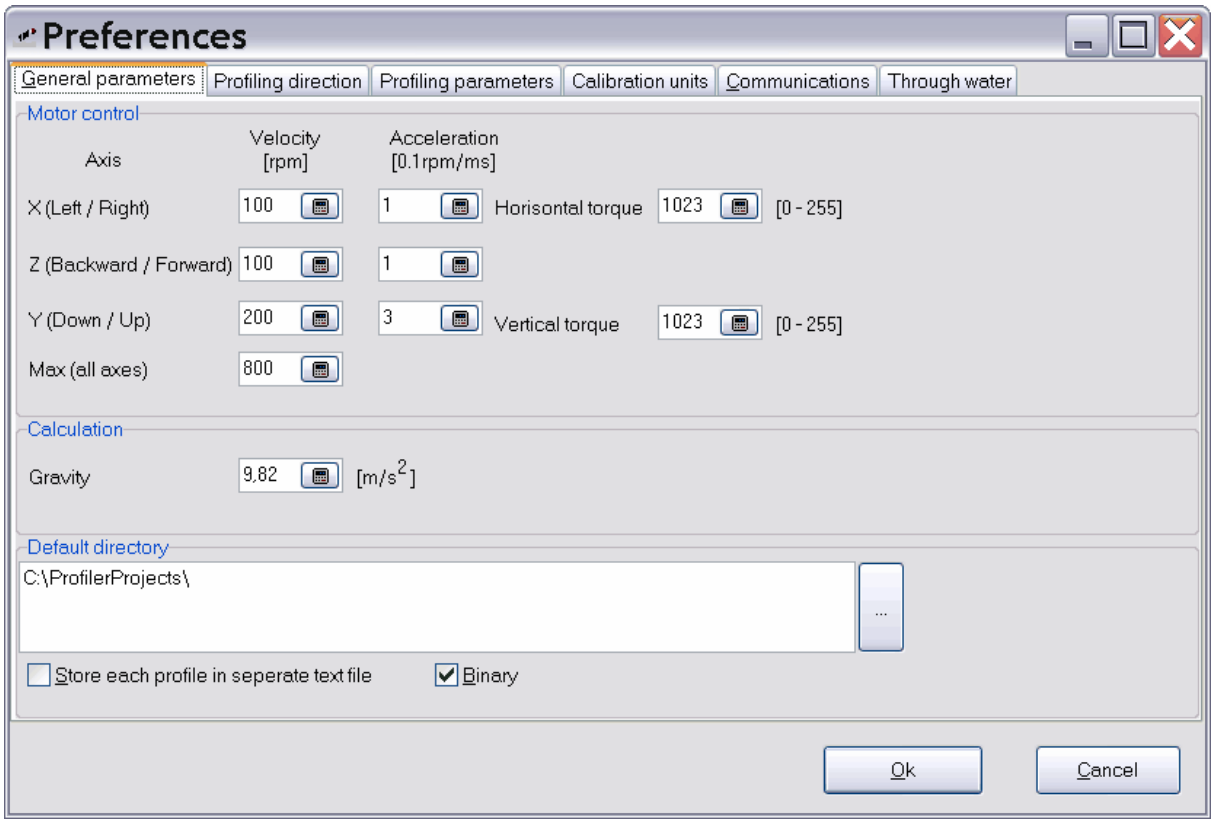
Part 4. Preferences

The behaviour of EPro is configured in preferences. The various settings are split into the following tabs:

General parameters
Profiling direction
Profiling parameters
Calibration units
Communication
Through water

4.1 General parameters



This page is divided into three sections, described below.

Motor control

Field		*Description*
Max velocity	:	The maximum allowed velocity.
Velocity	:	The velocity used for each axis during profiling
Acceleration	:	The acceleration used for each axis during profiling
Vertical and Horizontal torque	:	Adjustment of the current supplied to the motors. A setting of 255 is Maximum and default value. If set to low, the motor may come to a hold.

Calculation

Field		*Description*
Gravity	:	Gravity acceleration in m/s2 used to calculate W50 in Newton

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Default directory

Field	:	*Description*
Default location of project files	:	Default location of profiler projects
Store each profile in separate text file	:	If selected each profile will be stored in separate text-files. This makes it easy to import direct into third-party software for further processing, without running export. Separate profile files are slower to load into EPro and consume more diskspace. If not selected, all profiles are stored in a native chart-format.
Binary	:	Store the profile information as binary native chart format. This is smaller and faster to load than native format in text. However the content cannot be checked with a text editor. This option is only valid if profiles are not stored in separate text files.

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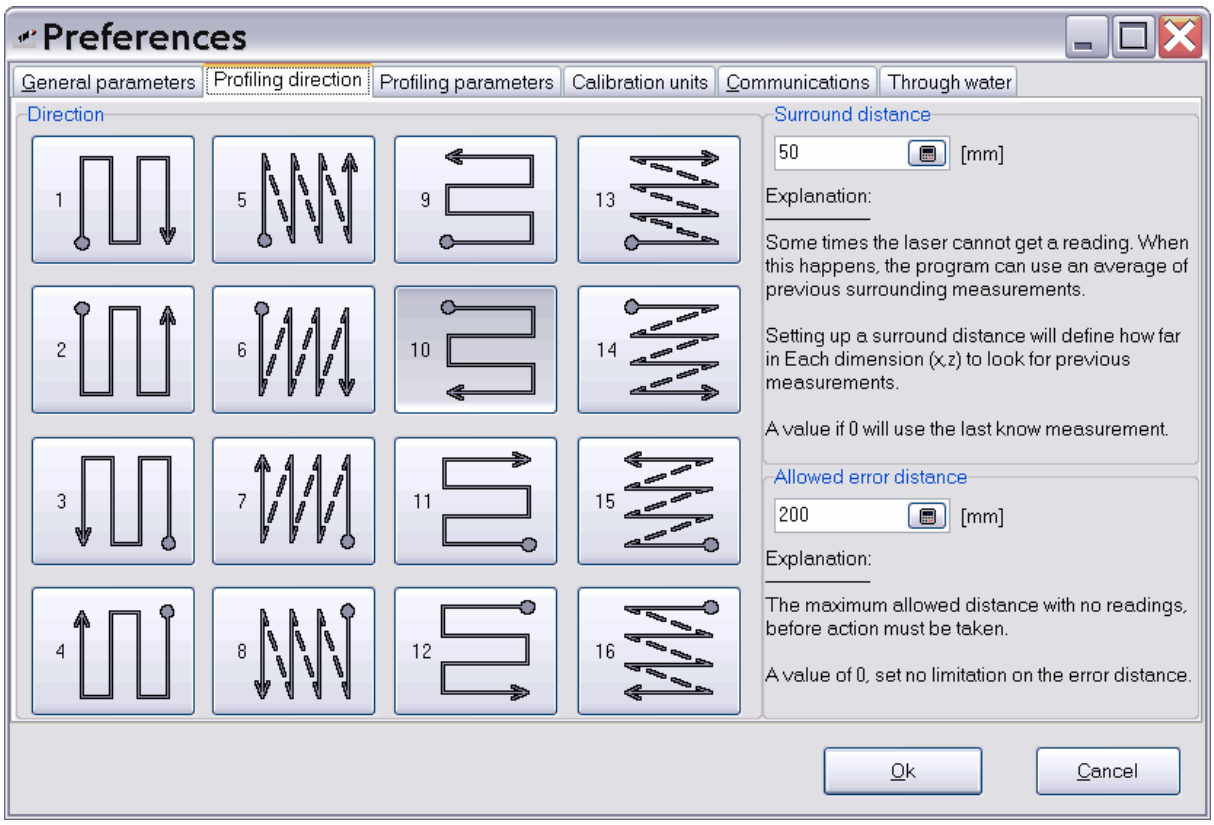
4.2 Profiling direction



Direction
On this page, the profiling direction is chosen. Depending on the target the optimum route, between measurements points vary.
Some of the considerations to make, when choosing the profiling direction is:

1. Possible danger for collision
If the route is chosen in a way, where very steep rises occurs the possible danger of collision, due to loss of track, is high. A route in only one direction should be considered (route with dash-lines).

2. Possible light interference
If start is above water, there is a great risk of the water surface being detected as target due to interfering light. The profiling algorithm is constructed to minimize this risc. However, if it prove to be a problem, it can be avoided, by starting under water. This however introduce a new risc to the credibility of the results. When raising through the water surface water drops can consentrate on the laser and act like a prism disturbing the measurements.

3. Required amount of vertical adjustment
In order to make the profiling running smooth a minimum of vertical adjustment is desirable. It will also reduce the profiling time. Choose a route where minimal vertical adjustment is needed.

Surround distance
Some times the laser cannot get a reading. When this happens, the program can use an average of previous surrounding measurements. Setting up a surround distance will define how far in Each

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dimension (x,z) to look for previous measurements. A value if 0 will use the last know measurement.

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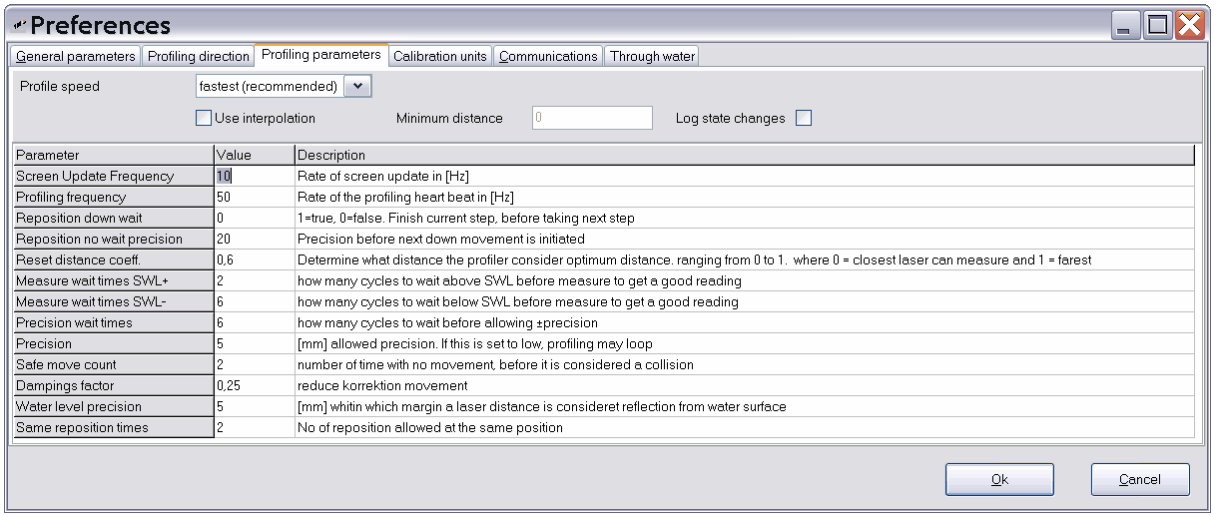
Allowed error distance
The maximum allowed distance with no readings, before action must be taken. A value of 0, set no limitation on the error distance.

4.3 Profiling parameters



Parameter		*Description*
Profile speed	:	The profiler can operate four different modes, varying from slow and safe to fast and less safe. Slow (safe mode): The profiler only makes horizontal movements when the laser is in upper most position. This makes operation extremely slow. Normal: The profiler stops at each measure point and wait for all vibrations to settle down before making a measurement and continue. If the connection between the computer and the profiler is disturbed the motors will immediately stop. Fast: Unlike the normal mode the profiler don't stop at the measure points. Instead, it move softly and collect measurements continuously. For every laser reading, the motors are requested to report their position. If the profiler does not make a reading at the exact measure point, a value will be extrapolated from the surrounding readings. This possible inaccuracy compared to the previous two modes is often more than compensated by the increase of readings. Fastest. Just like fast mode except for every laser reading, the program will only request the moving motors for their position. This reduces communication and increases the possible number of readings.
Use signal memory (Normal mode only)	:	1=true, 0=false. Not used in turbo-mode. If true and a measurement is invalid, the profiling can use the last valid measurement. If set to false, this is not allowed on a measure-point.
Use interpolation	:	Use interpolation to obtain a fitted measurement in the exact measure point.
Minimum distance (Fast and fastest mode only)	:	Interpolation is only activated if the distance between the actual measure-point and the reading the located closest exceed the minimum distance.
Log state changes	:	For debugging purposes. The profiling algorithm is using state flags to control its operation. If log state changes are checked, all state changed are written to the log-screen while profiling.

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Screen update frequency	:	Desired screen update frequency. Screen update during profiling can be very CPU intensive and has been separated from the profiling movement control.
Profiling frequency		Desired frequency of the profiling movement control. It is recommended to set this frequency sufficiently high and let the speed of the motors / data-logger determine the actual frequency. Warning, if this frequency is to low the profiler may not be able to react fast enough to avoid collision.
Reposition down wait	:	1=true, 0=false. Finish current step, before taking next step. When set to false, a new step replaces the old, before it has finished, as long as target is not within sight. This make reposition and start running smoother.
Reposition no wait precision	:	If "reposition down wait" is false, the next step is taking soon as the vertical position is this precision of its previous destination.
Reset distance coefficient	:	When the measured laser-signal is with correction margin, this coefficient determines the correction. Valid range is from 0 to 1. Where 0 = closest laser can measure and 1 = most remote. A value of 0.5 is recommended, which equals centre of working range.
Measure wait times SWL+ (Normal mode only)	:	Determine how many cycles to wait above Still water level before measuring a point. This is introduced to minimize disturbance from mechanical vibration. At least 1/10 [s] is recommended (see timer frequency under Profiling parameters, to determine length of a cycle)
Measure wait times SWL- (Normal mode only)	:	Determine how many cycles to wait below Still water level before measuring a point. This is introduced to minimize disturbance from mechanical vibration. At least 1/2 [s] is recommended (see timer frequency under Profiling parameters, to determine length of a cycle)
Precision wait times	:	Some times the motors do not reach the desired position within 1[mm] precision. Precision wait times, is the number of cycles to wait, before lowering the precision from exact to approx ±precision (see next field)
Precision	:	If exact precision is not possible, this value determines the tolerance in [mm]. At least 2 [mm] are recommended. If set to low, profiling may come to a hold.
Safe move count	:	If vertical position does not change although desired position is not reached, it is considered a collision. Safe move count, determine the amount of cycles the position does not change before it is considered a collision and a safe move is made (move with laser up)
Damping factor	:	This factor reduces the correction movement to a fraction of the calculated correction. This makes corrections less nervous. A value of approx 0.25 is recommended.
Water level precision	:	When testing or moving to still water level during profiling
Same reposition times:		Maximum number of repositions allowed at the same positions. To prevent a "Dead loop".

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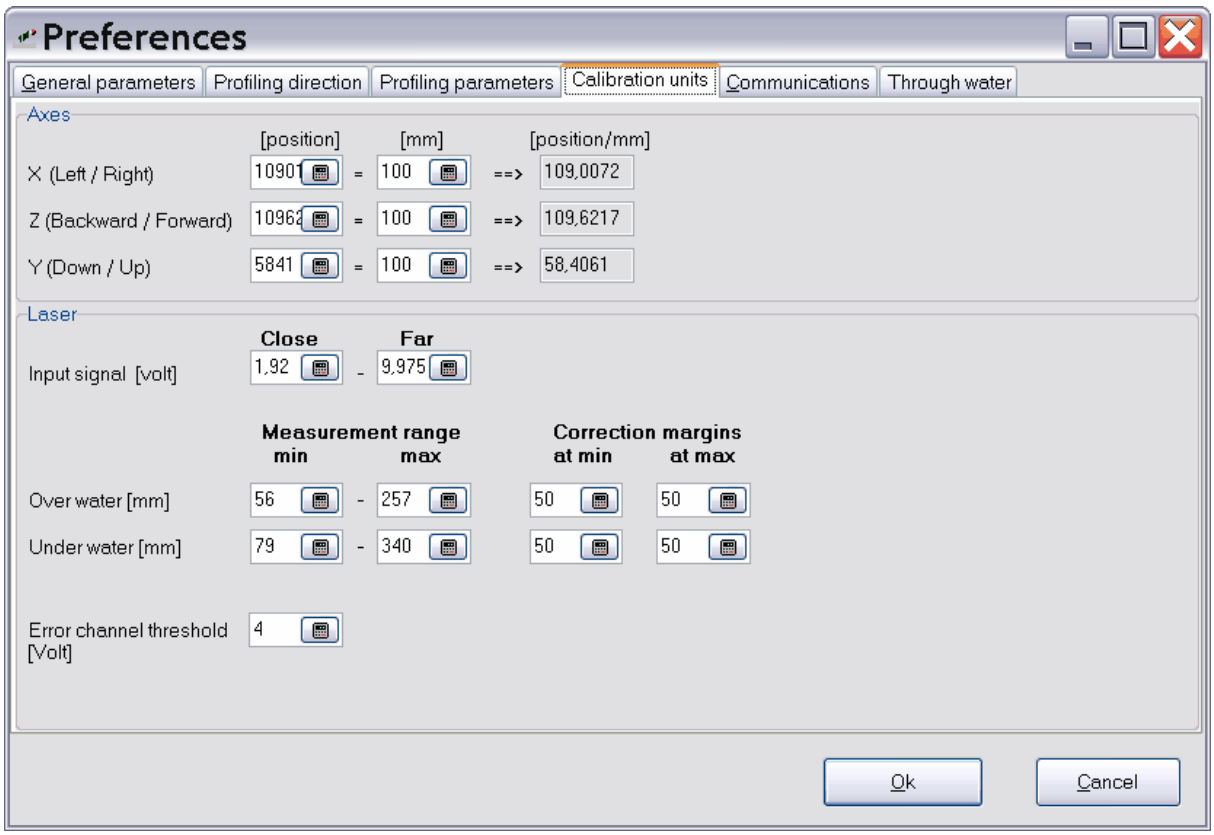
4.4 Calibration units



In order to make all measurements in mm, the program needs to how to convert from the motors position-count and the lasers Volt signal. These setting may need to be changed, if the gearing is changed on an axis or the laser is changed.

Axes
Each step-motor keep tracks of it position, however a ratio must be defined to convert the motors internal position into mm. The set limits dialog can be used to get this information.

Laser
The lasers return their measurements as a voltage signal. This section defines the ratio to convert [Volt] into [mm]. If the laser has, a separate error-signal it is possible to define the threshold, before an error should be considered.

Since refraction of light differ between air and water, the conversion relationship between [Volt] and [mm] must be entered for both. The Manual control dialog can be used for this, since it display the laser reading in volt.

Field		*Description*
Input signal Close [Volt]	:	Outer volt-signal for close target
Input Signal Far [Volt]	:	Outer volt-signal for remote target
Under water min [mm]	:	Smallest possible measurement under water
Under water max [mm]	:	Largest possible measurement under water
Under correction margin at min [mm]	:	Vertical adjustment is done to keep the measurement above min-distance + margin
Under correction margin at max [mm]	:	Vertical adjustment is done to keep measurement below max-distance - margin
Over water min [mm]	:	Same as under water min, but in air
Over water max [mm]	:	Same as under water max, but in air
Over correction margin at min: [mm]		Same as under water correction margin at min, but in air

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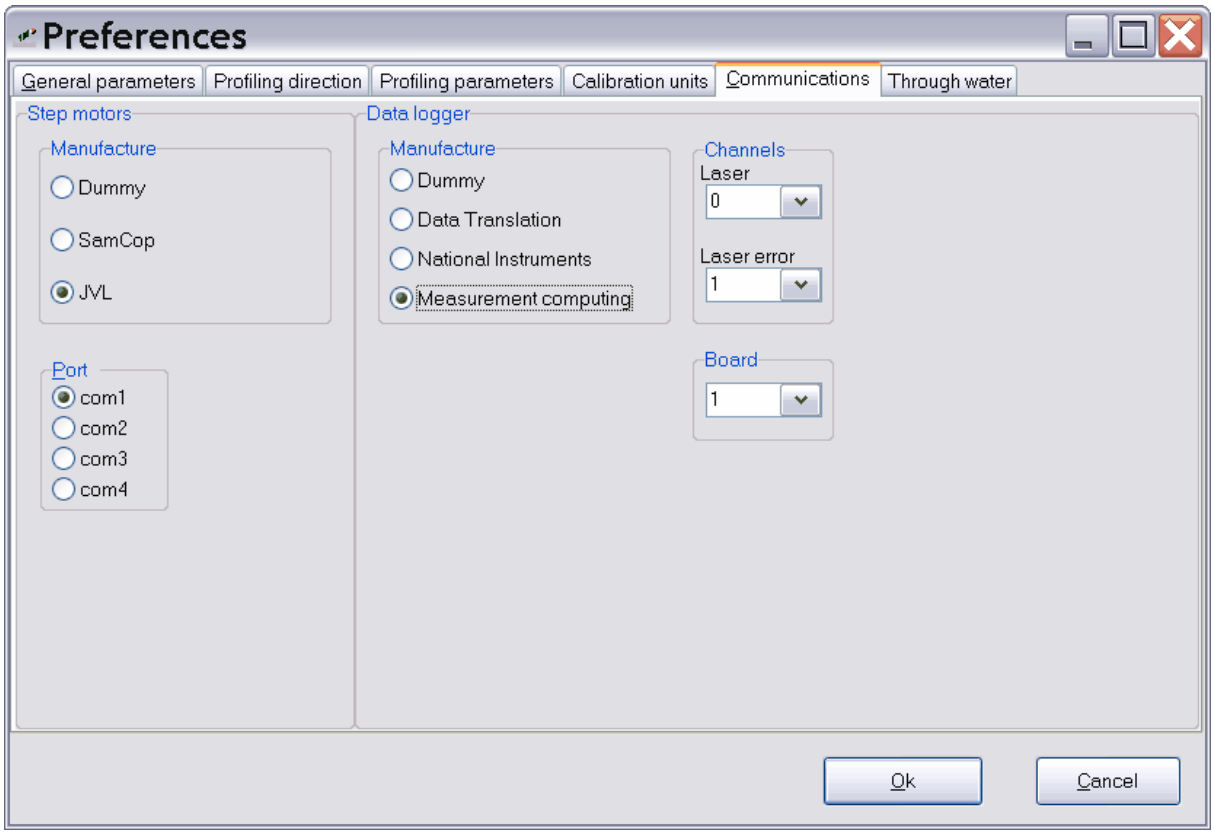
Over correction margin at max [mm] : Same as under water correction margin at min, but in air

Error Channel threshold [Volt] : Threshold value before error should be considered, if separate error-channel is present

4.5 Communication



On this page, the data communication parameters to the step-motors and data logger are maintained. In addition to Port and Speed, the channels for the laser and water sensor can also be configured.

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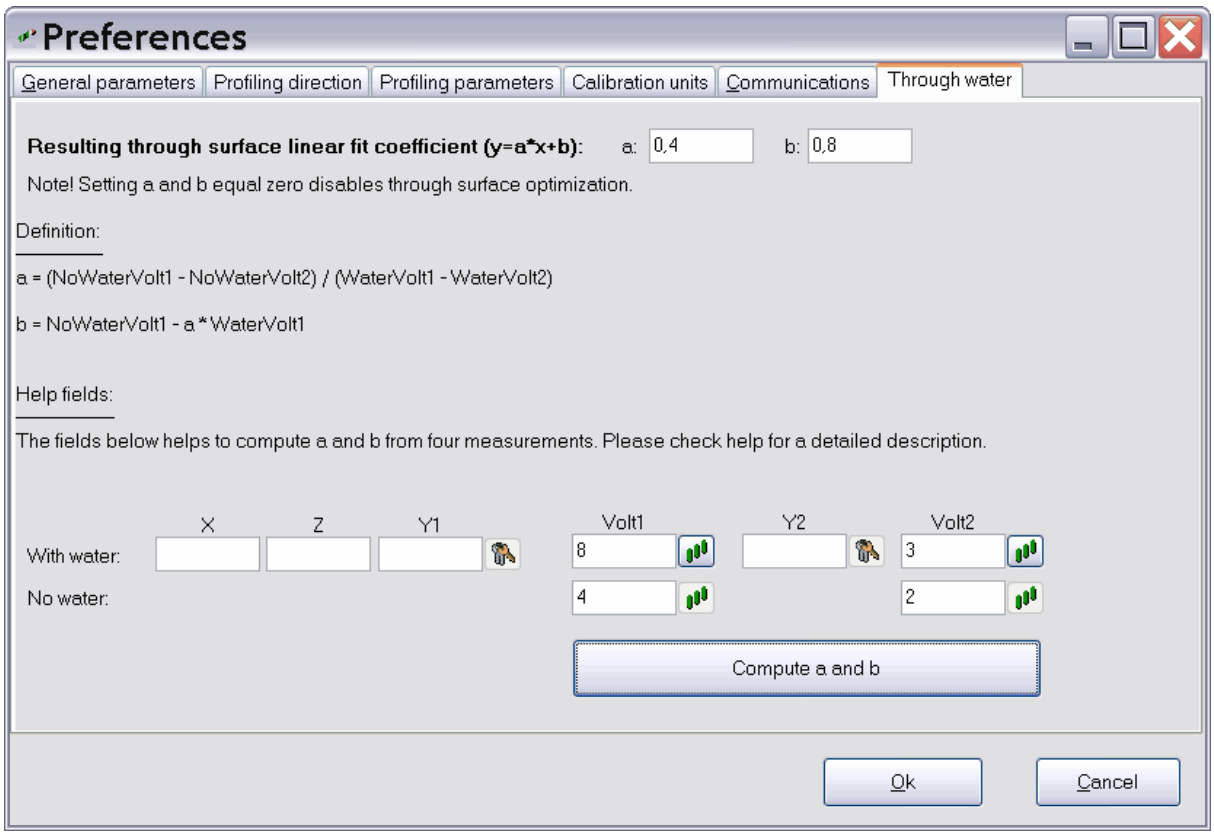
4.6 Through water



Experimental!
The greatest weakness of the profiler is measuring of target through the water surface. Measuring fully below water and fully above water is no problem. Test has shown that the precision of through surface measurements can be greatly improved by applying a linear fitting function. However this fitting function may depend on the target material.

This function will be applied when the laser is more than the laser minimum working distance above the SWL and the target is below the SWL. At precisely minimum working distance above SWL tests has revealed the problem does not exist and the profiler is programmed to rise to this position when it breaks through the water surface.

The coefficients of the fitting function can be determined by using the help fields and following these steps:

1. Press the key-button attached to the Y1-field, to manually locate a position.
2. locate a position where
   a. there is water
   b. the water depth is to small for the laser to work below the SWL
3. Select a vertical position, which is near the maximum working range of the laser. Make sure that it is a valid reading (Volt value fluctuate and the error-volt is below its threshold).
4. make a reading of the Voltage 1 with water by pressing the button attached to the Volt1 field and accept by pressing ok in the manual control dialog
5. locate a new vertical position, which is lower than position 1 but still above the laser minimum working range above SWL (check calibration tab for this value)
6. make a reading of Voltage 2 with water by pressing the button attached to the Volt2 field
7. remove the water and make new readings of Volt1 and Volt2 at the same positions with no water
8. Finally press compute a and b to calculate the coefficients. Note the help fields are not stored, when leaving this dialog.

If more convenient, the measurements without water can also be carried out first. However, the positions must still be higher than the minimum working distance above the SWL when water is added.

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