EPro Non-contact erosion profiling

Brief overview

Meinert, Palle

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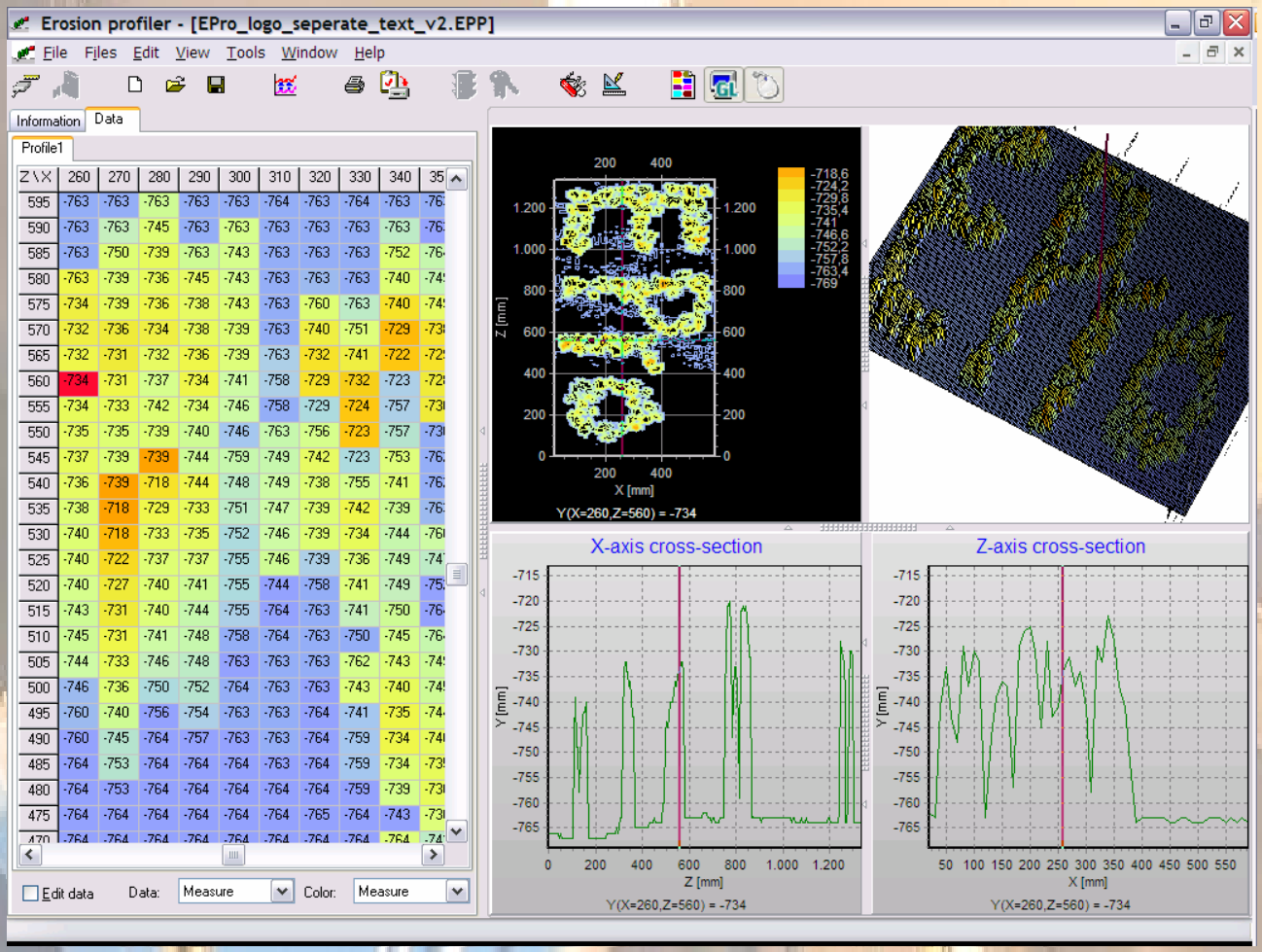

DEPARTMENT OF CIVIL ENGINEERING

AALBORG UNIVERSITY

SOHNGAARDSHOLMSVEJ 57 DK-9000 AALBORG DENMARK

TELEPHONE +45 96 35 80 80 TELEFAX +45 98 14 25 55

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SOHNGAARDSHOLMSVEJ 57 DK-9000 AALBORG DENMARK
TELEPHONE +45 96 35 80 80 TELEFAX +45 98 14 25 55

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Brief overview

By

Palle Meinert
Aalborg Universitet

Introduction

EPro is a profiling program build to measure the same surface or work piece multiple times and track changes due to erosion. It was developed during 2001 - 2002 at Aalborg University and was part of a Master of Science project dealing with stability of rubble mound breakwaters.

The goal was to automate the measuring of profiles in order to save manpower and to increase the number of possible measure points. Additional requirement was that measurements should be done in a non-contact way and that the measuring should not be hindered by the presence of water.

Profiler

The profiler was built by lab-technicians. Its measurements fits one of the flumes of the wave-lab, where it easy to mount.

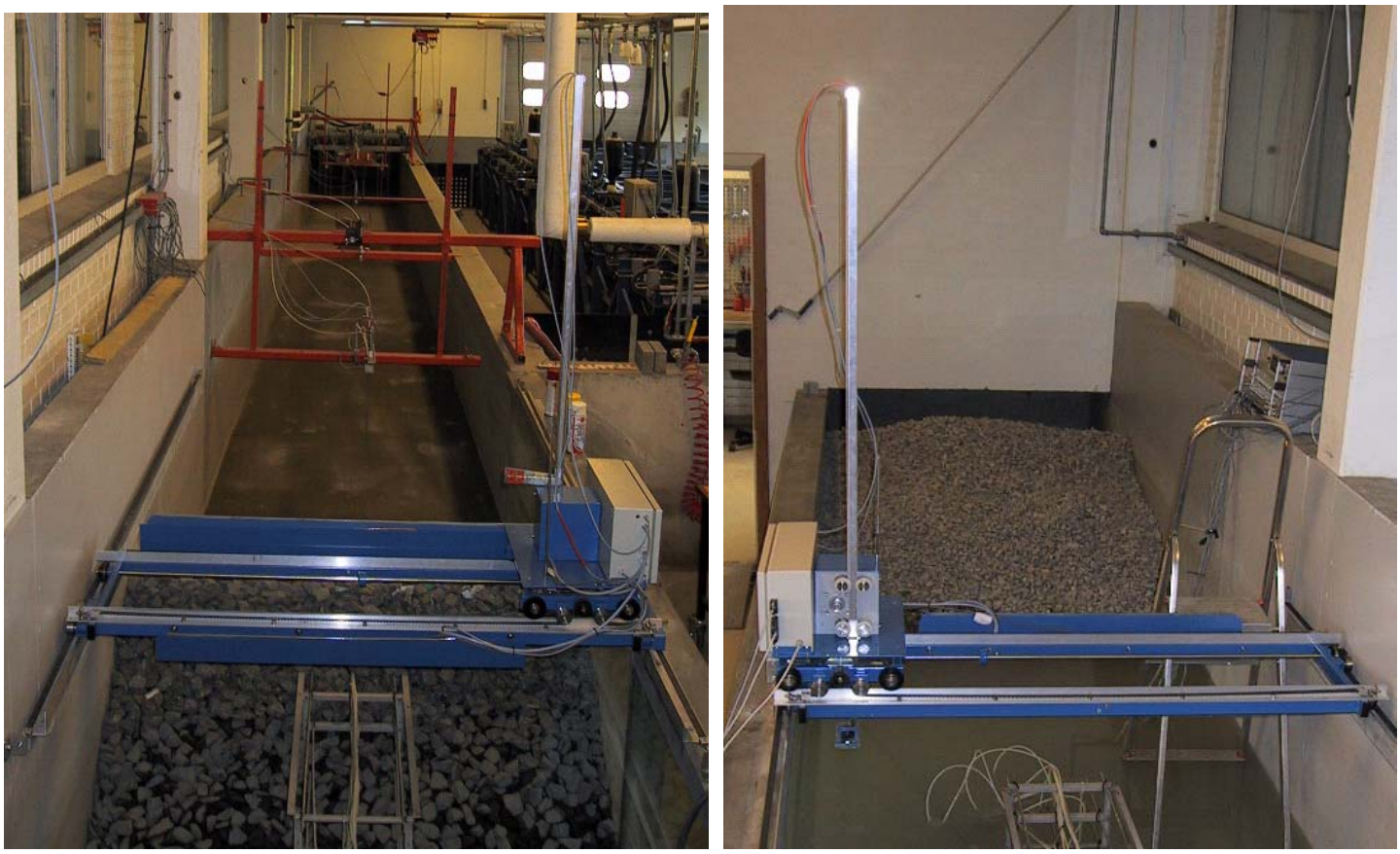

Figure 1 Photos of profiler from behind and from in front

The profiler is constructed to have three degrees of freedom:

- X - left/right
- Y - up/down
- Z - forward/backward

Each axis is controlled by high precision step-motors; depending of make, at least have a movement resolution of $\frac{1}{21}$ mm horizontal and $\frac{1}{11}$ mm vertical. Epro works with a resolution of 1mm on all axes. However, since it is a matter of calibration the program can also work in other units.

To secure stability and ease friction, horizontal movement is done on rails and vertical movement is stabilised by plastic wheels. However, in order to maintain the high precision all power transmission is done using tooth belts on all axes.

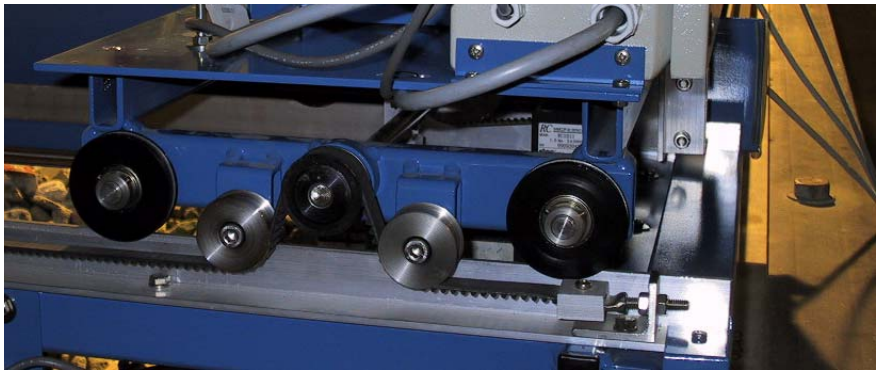

Figure 2 rail for stability and low friction, tooth belt for high precision power transmission

The non-contact measurements are carried out by a laser mounted at the end of the vertical rod. In order for the laser to get any readings, the profiler must keep it in a distance of the target, which is within the lasers working-range. Since refraction of laser light in water differs from its refraction in air, the lasers working-range also varies depending on whether the measurement is performed above or below water level. The laser currently used has the following working ranges.

- Above still water level: 55 – 256mm
- Below still water level: 76 – 343mm

The profiler can be fitted with other types of laser. However, the general rule is that the precision decreases with bigger working ranges.

With a stationary still water level and a minimum of interfering light, the laser is also capable of measurements through the water-surface. The resulting working-range will be a mixture of the above stated ranges, depending on the distance from laser to water-surface. The precision experienced was ±2 mm above and below water surface and ±5 mm when measuring through the water surface.

The profiler was connects to the controlling computer through one com-port and one USB-port. This gives the advantage that most standard pc's can be used, without having to open them and install additional hardware. The profiler can even be controlled by a notebook pc.

EPro-program

The profiler is controlled by the program EPro. This program enables multiple measurements of a well-defined target area. Afterwards the profiled surface is visually presented and the result can be inspected in detail. The program also enables easy comparison between multiple profiles and damage calculation between two profiles.

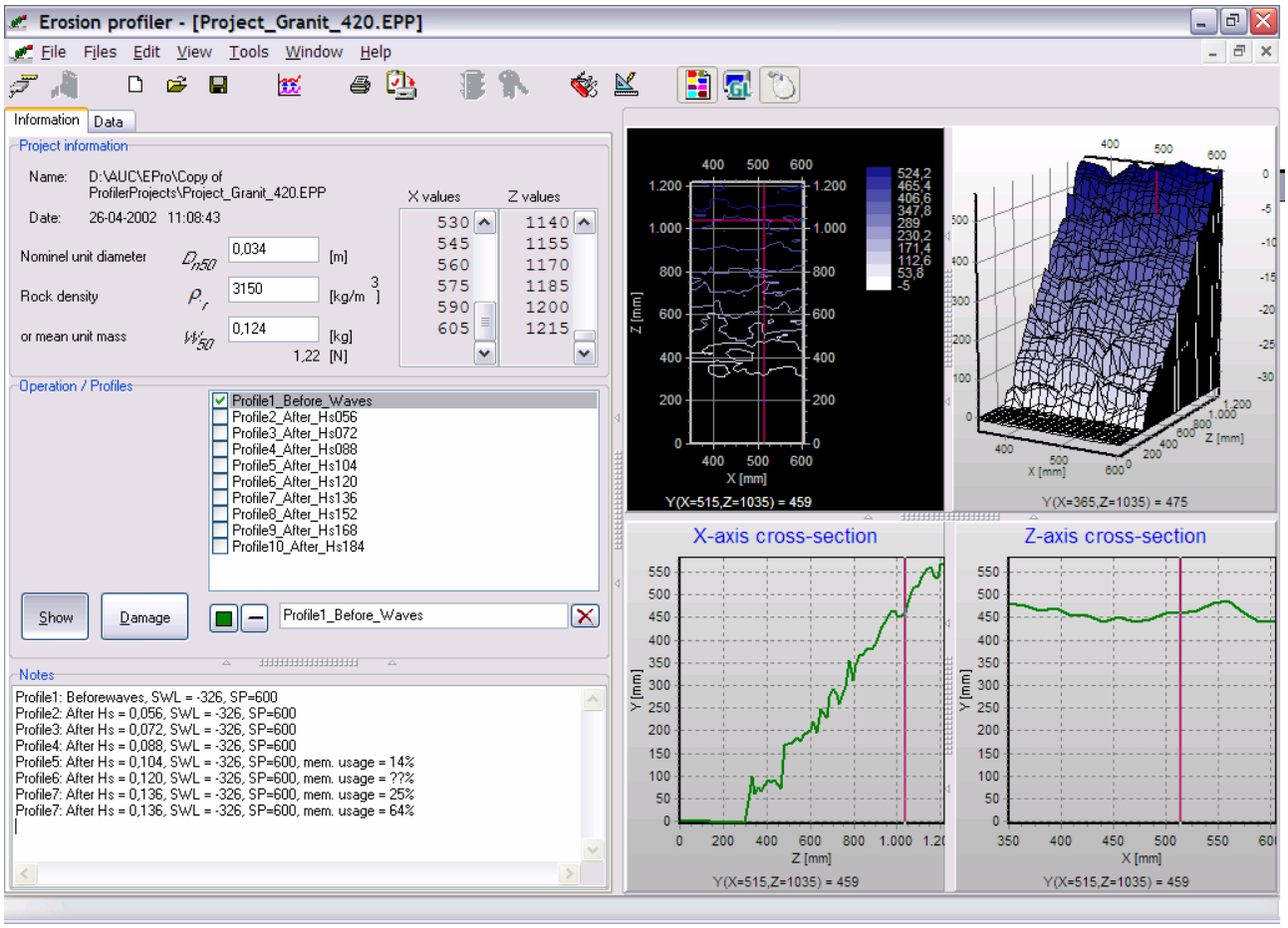

Figure 3 EPro program showing a signle profile (multiple is possible)

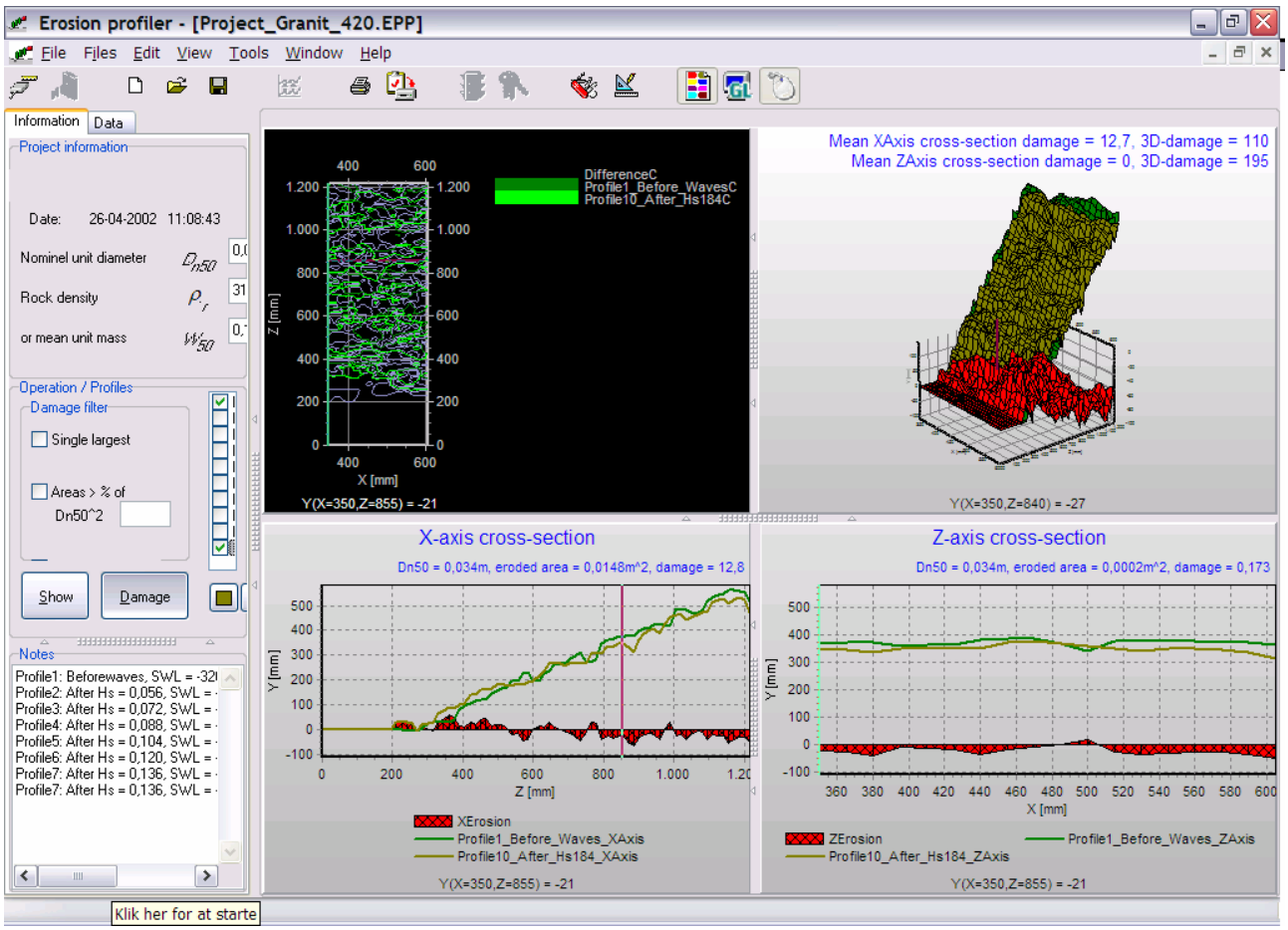

Figure 4 Example of a damage calculation in EPro

The measurements are stored in text-files, which can be easily imported in other programs for further processing. Furthermore, it is possible to print and export image and data of every chart (see Figure 6 and Figure 5).

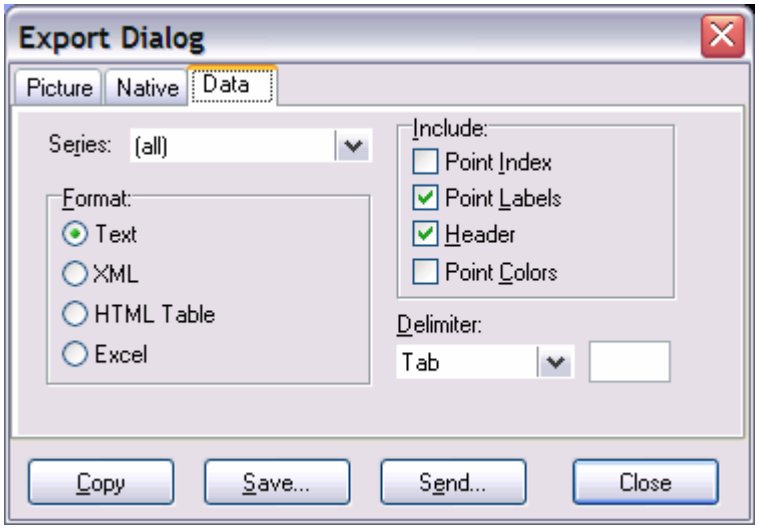

Figure 5 Example of export dialog in EPro

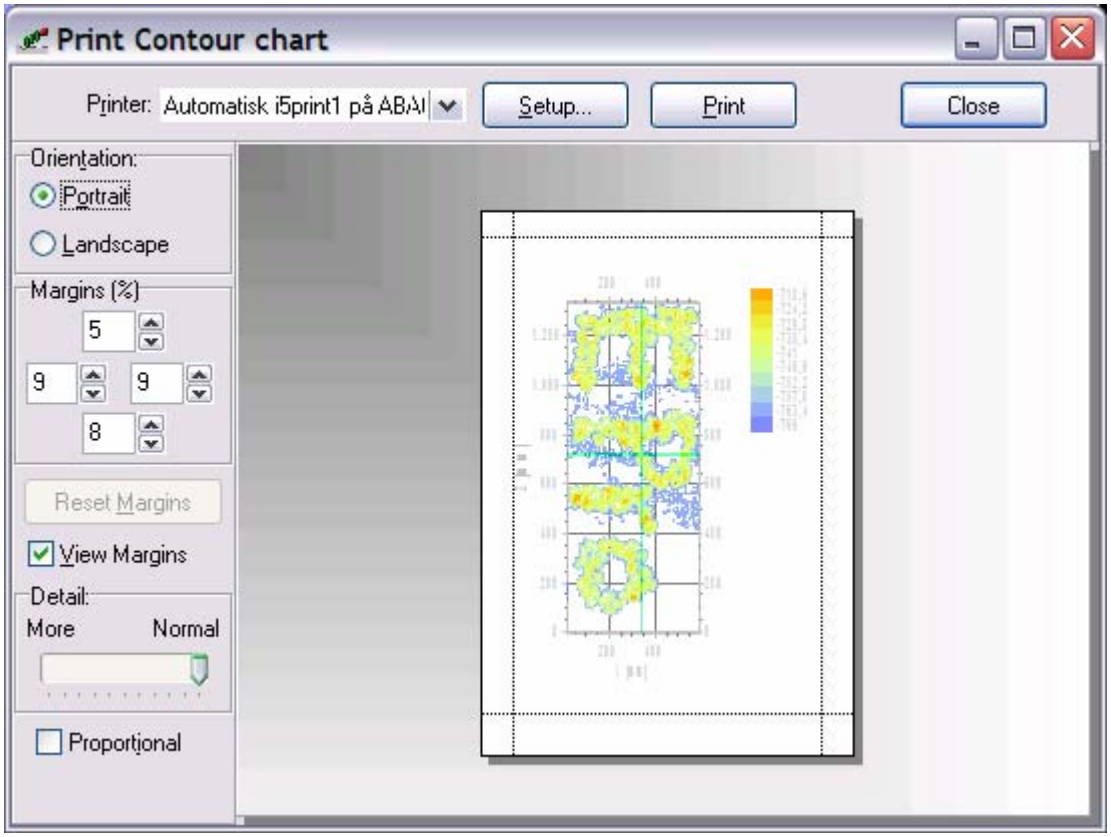

Figure 6 Example of a print dialog in EPro

When starting a new project, test area/measuring points must be defined. Therefore, the dialog in Figure 7 is displayed on creation. Example of three grids of measure-points with-in a profiling area is shown in Figure 8.

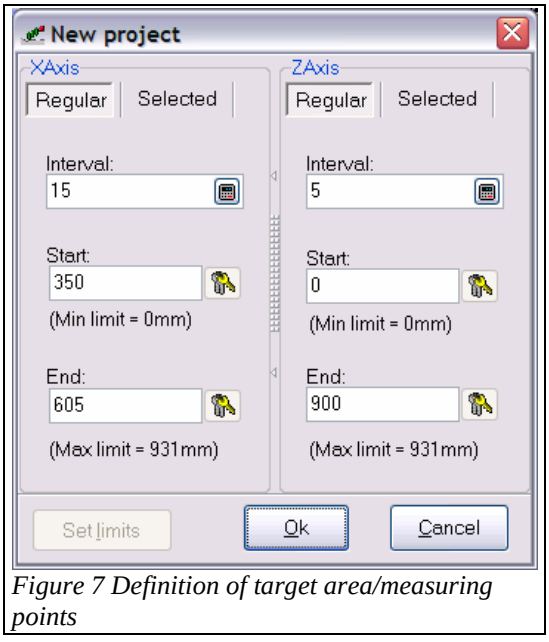

Figure 7 Definition of target area/measuring points

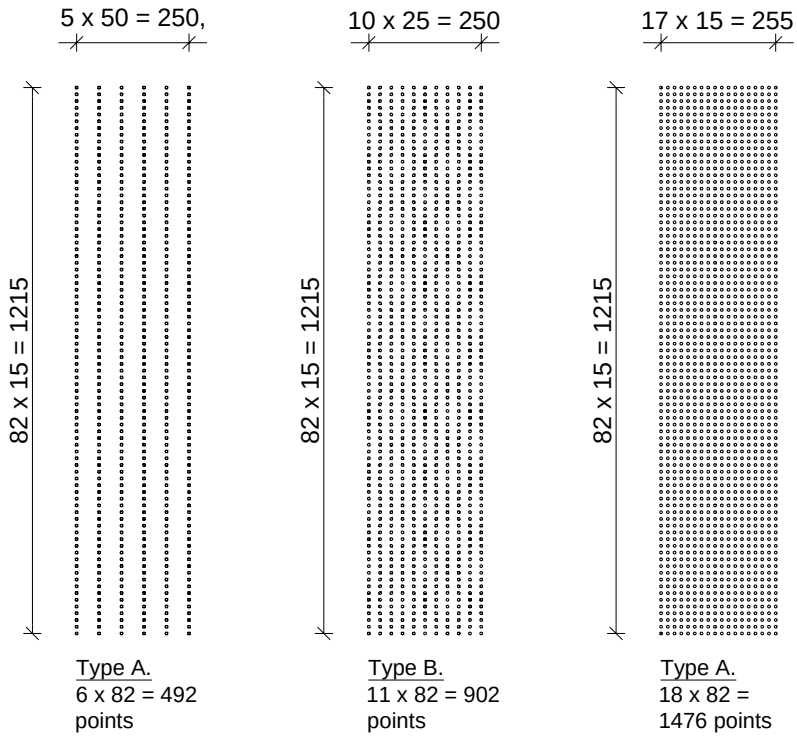

Figure 8 Number of point within the profiling area

All measure points must be within the limits defined in the set limits dialog, shown in Figure 9. This dialog will is automatic shown upon connection to the profiler.

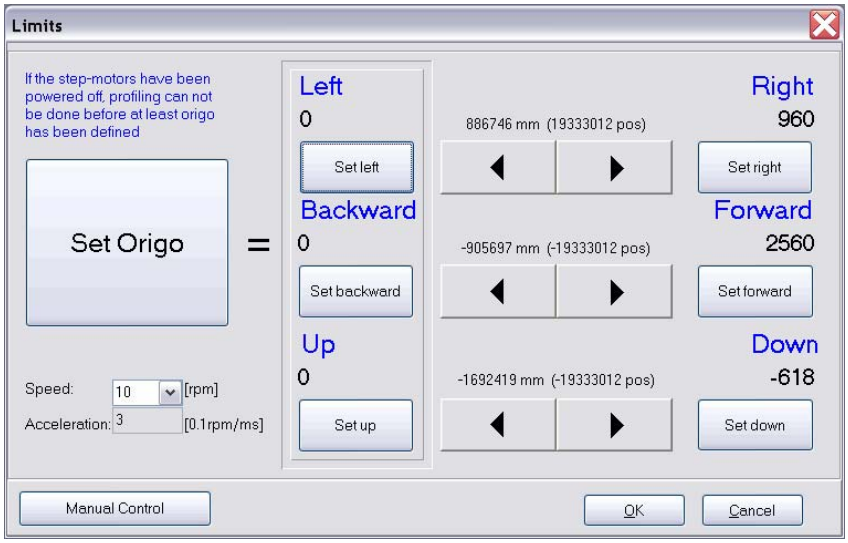

Figure 9 Definition of limits

Only in this dialog is it possible to exceed any previous defined limits. With-in the limits it is possible to manoeuvre the profiler manually by the manual-control dialog, see Figure 10 below.

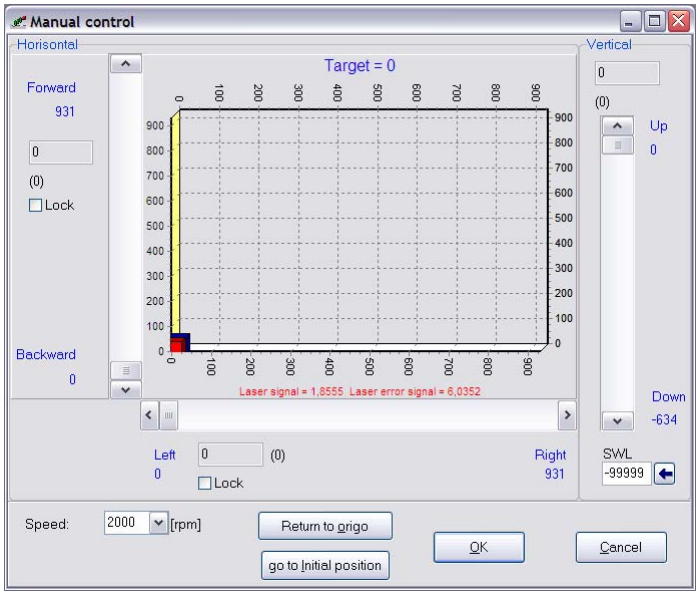

Figure 10 Manual control dialog

During profiling all the measurements are shown real time on a surface plot. Hereby, it is possible to keep track of the profiling process and to check if the measurements are conducted as expected. See Figure 11 below

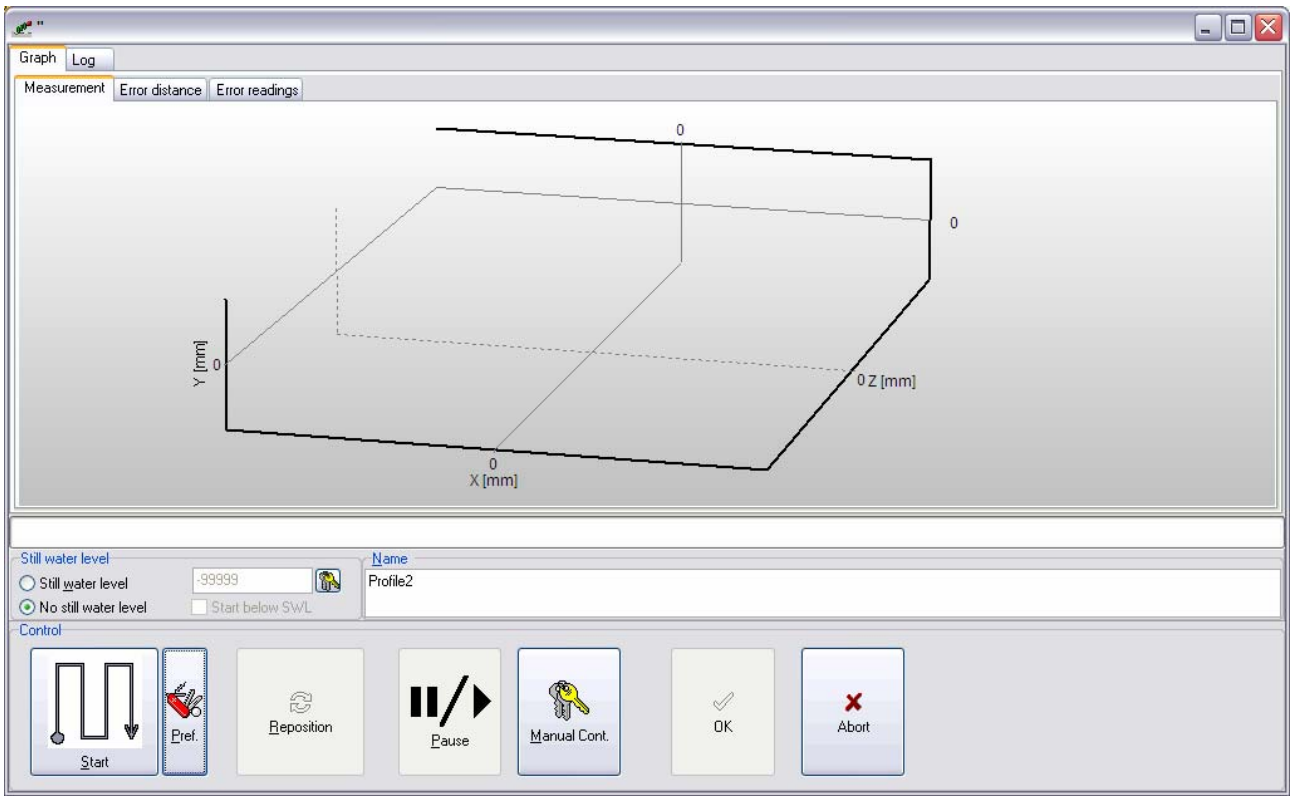

Figure 11 Profiling dialog constantly informing about the current state of the profiling

The profiling process can be paused or aborted at any time. An aborted profiling can be resumed, from the exact same location it was stopped or (by editing the log file) at any preceding location.

Program and profiling behaviour is done according to a variety of setting shown on Figure 12, Figure 13, Figure 14, Figure 15 and Figure 16.

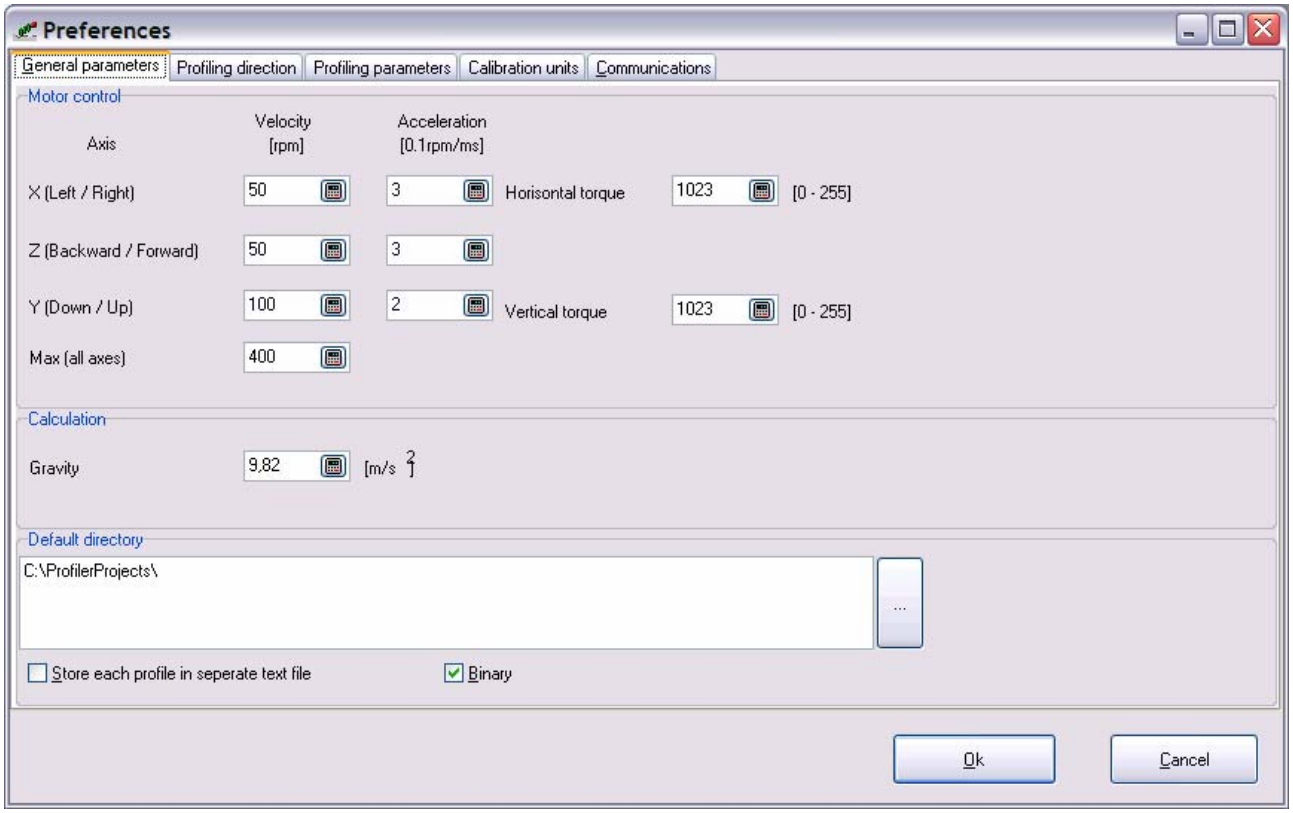

Figure 12 General profiler parameters

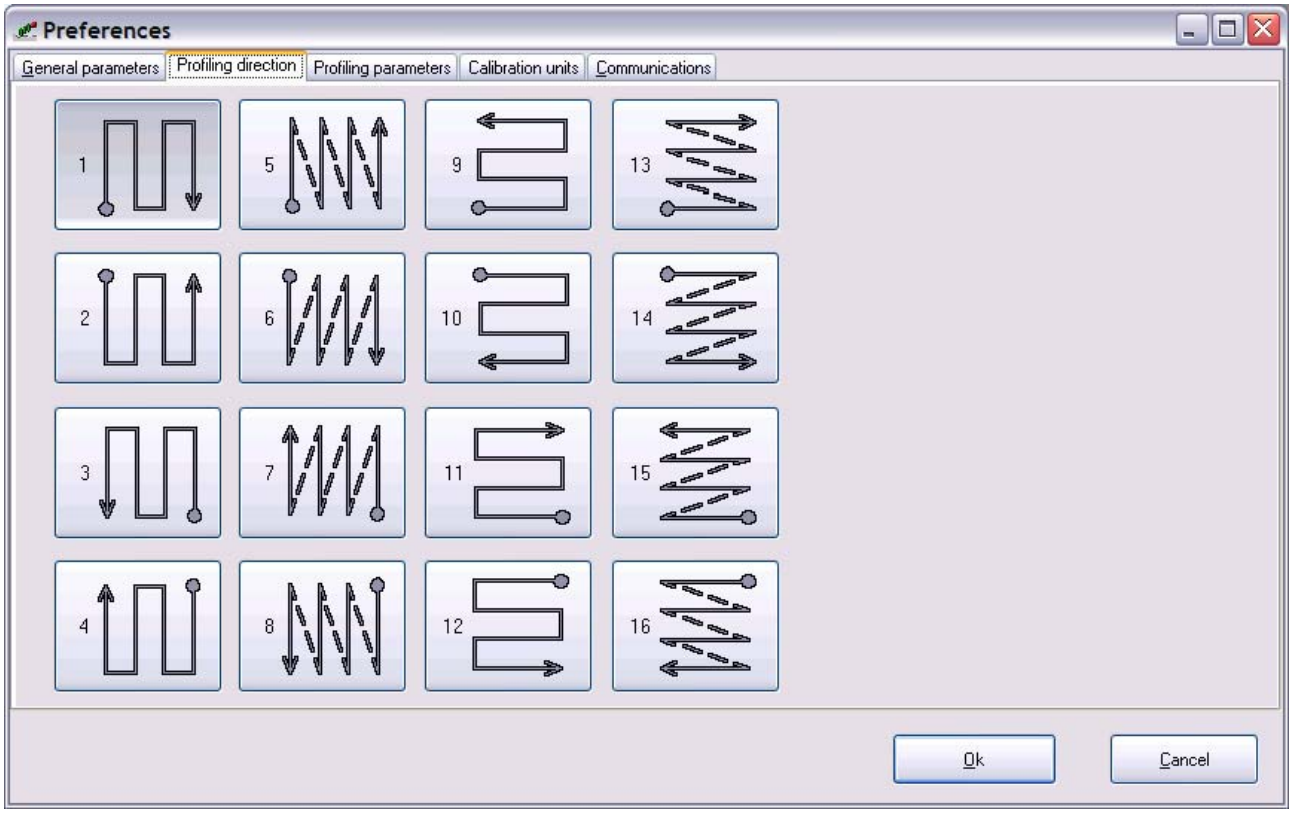

Figure 13 Possible profiling directions

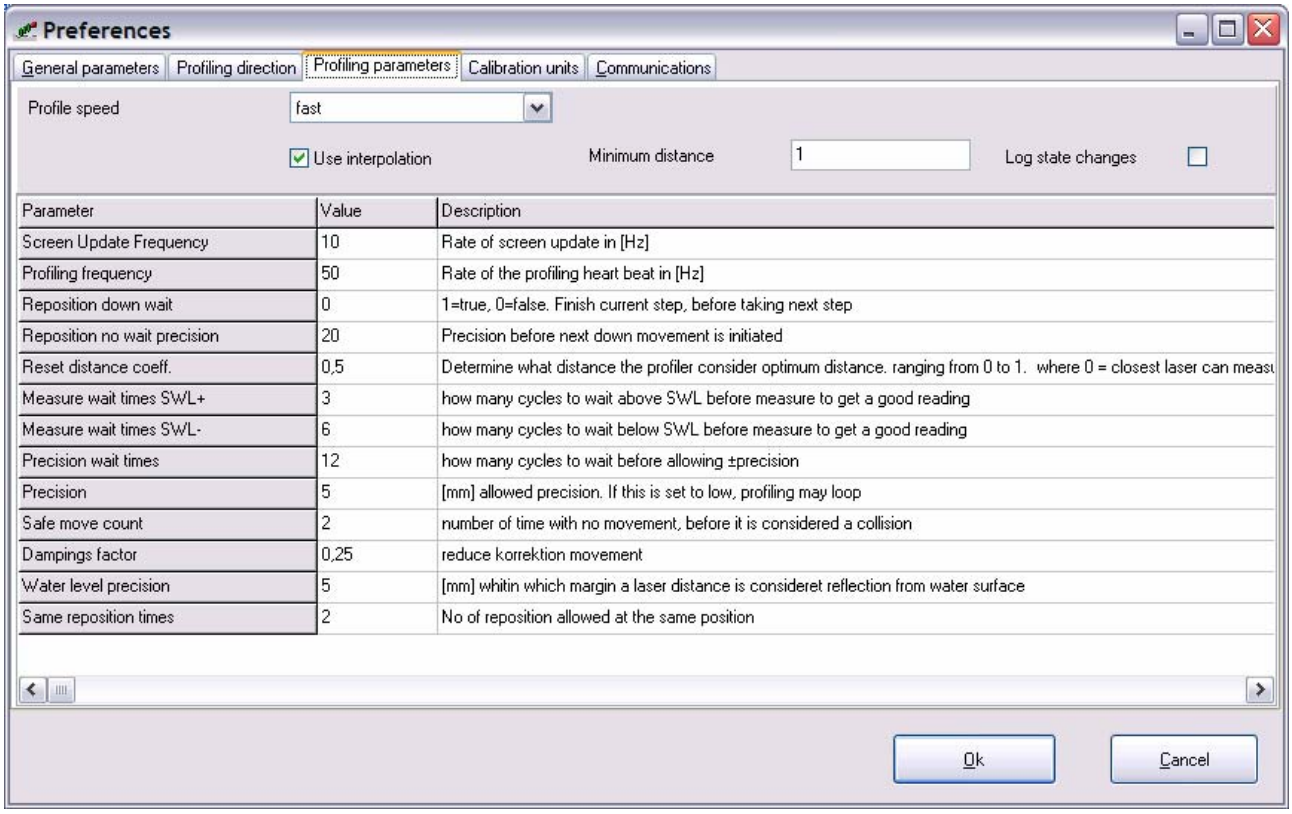

Figure 14 Advanced profiling parameters

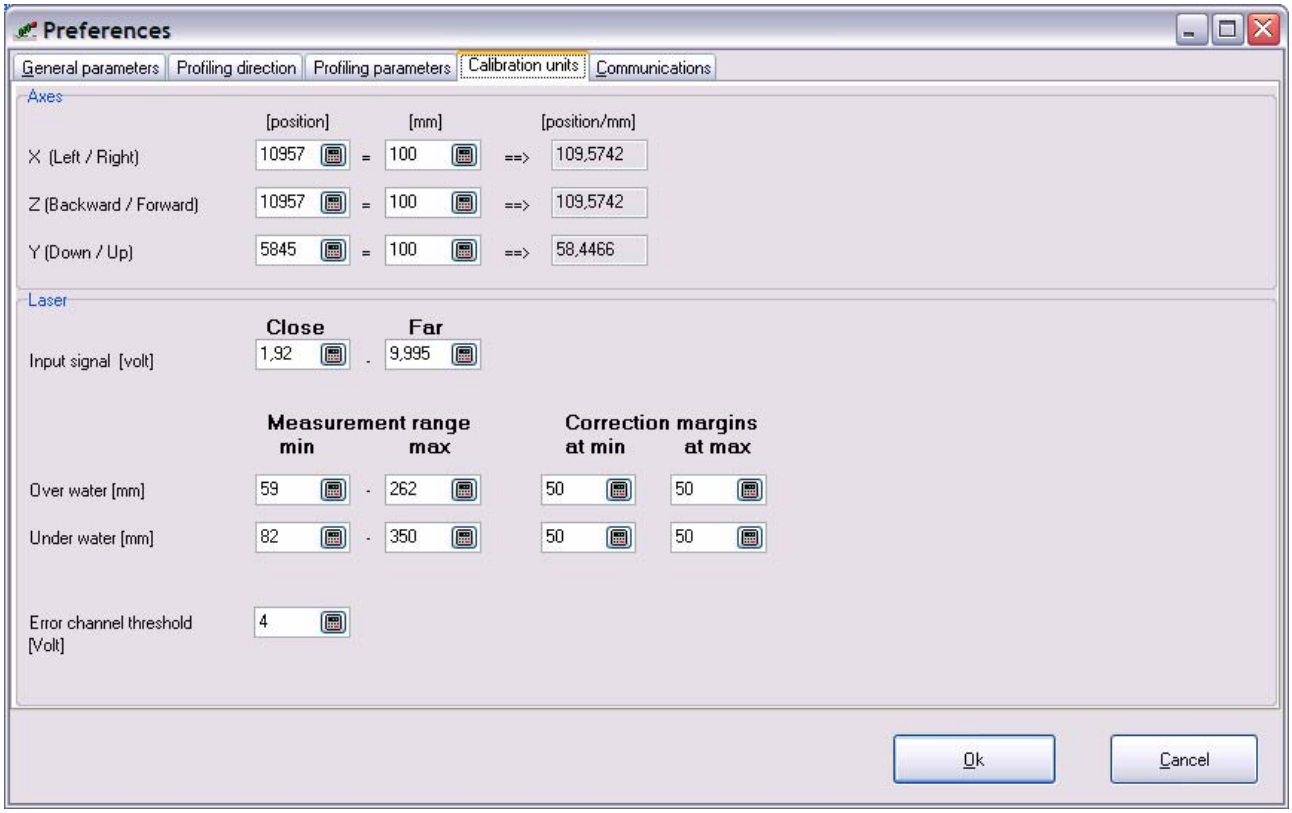

Figure 15 Calibration settings

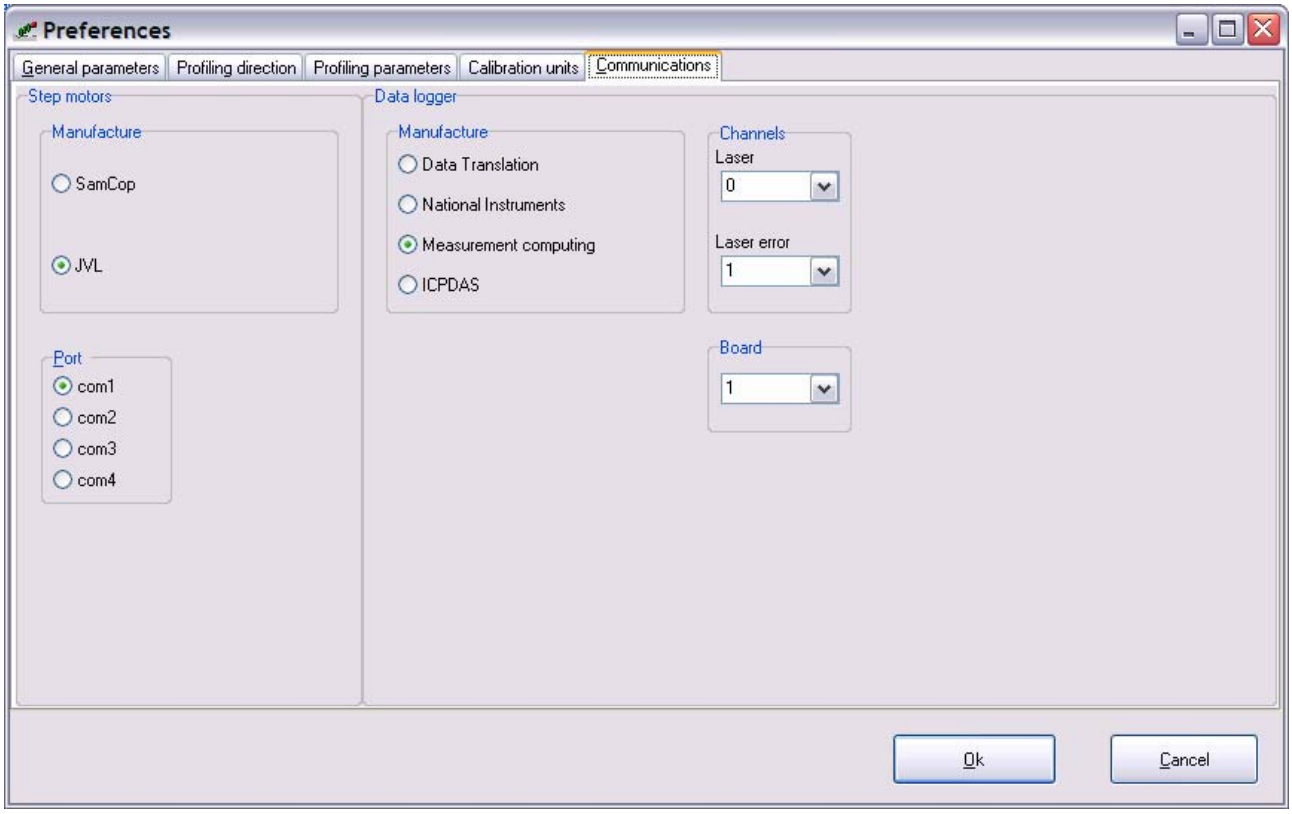

Figure 16 Communication settings