

# Documentation



**LASERTEC**

---

Pfronten GmbH

---

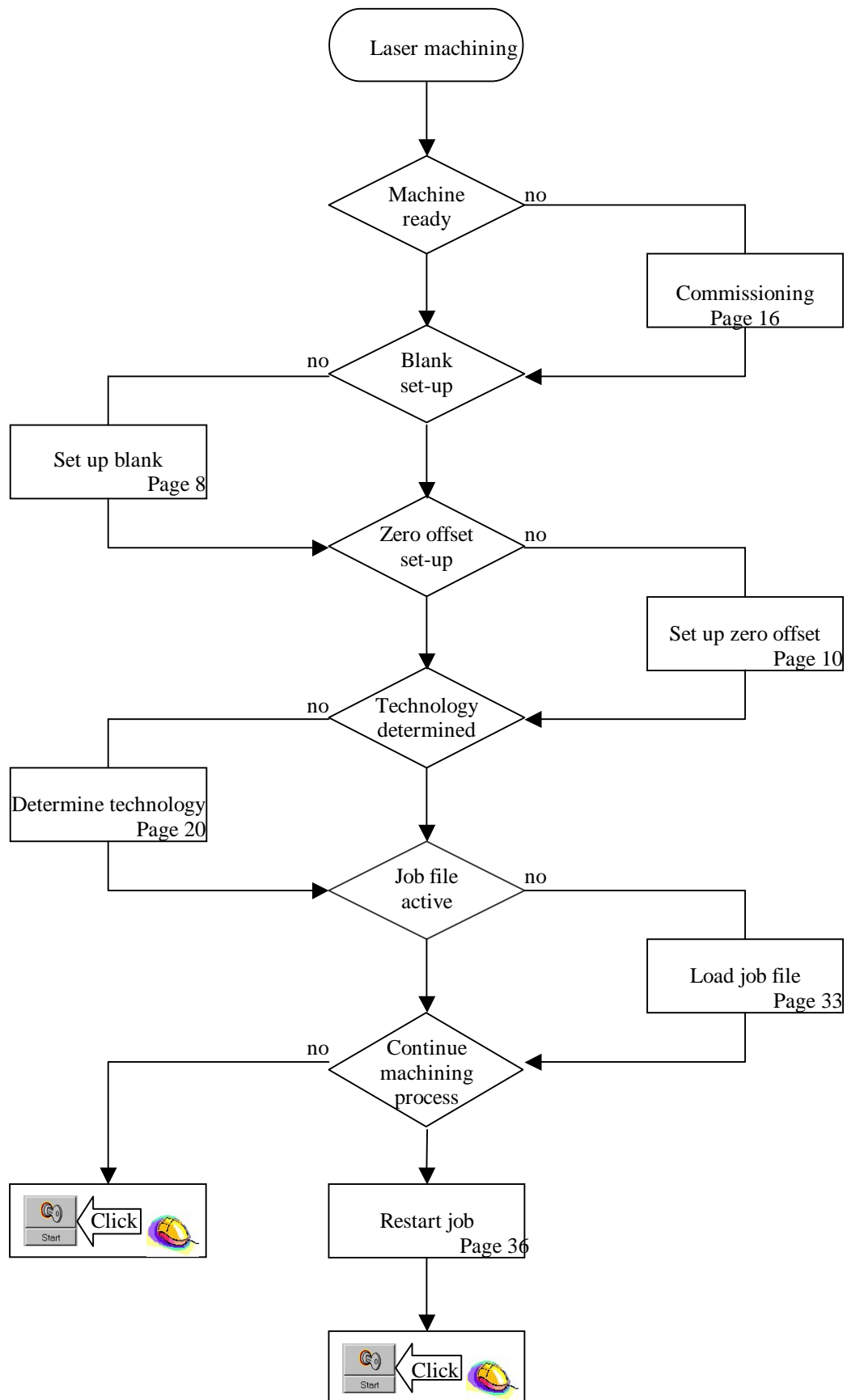
Release: 2420134\_LaserSoft3D\_99802-04\_GB.pdf

## Contents

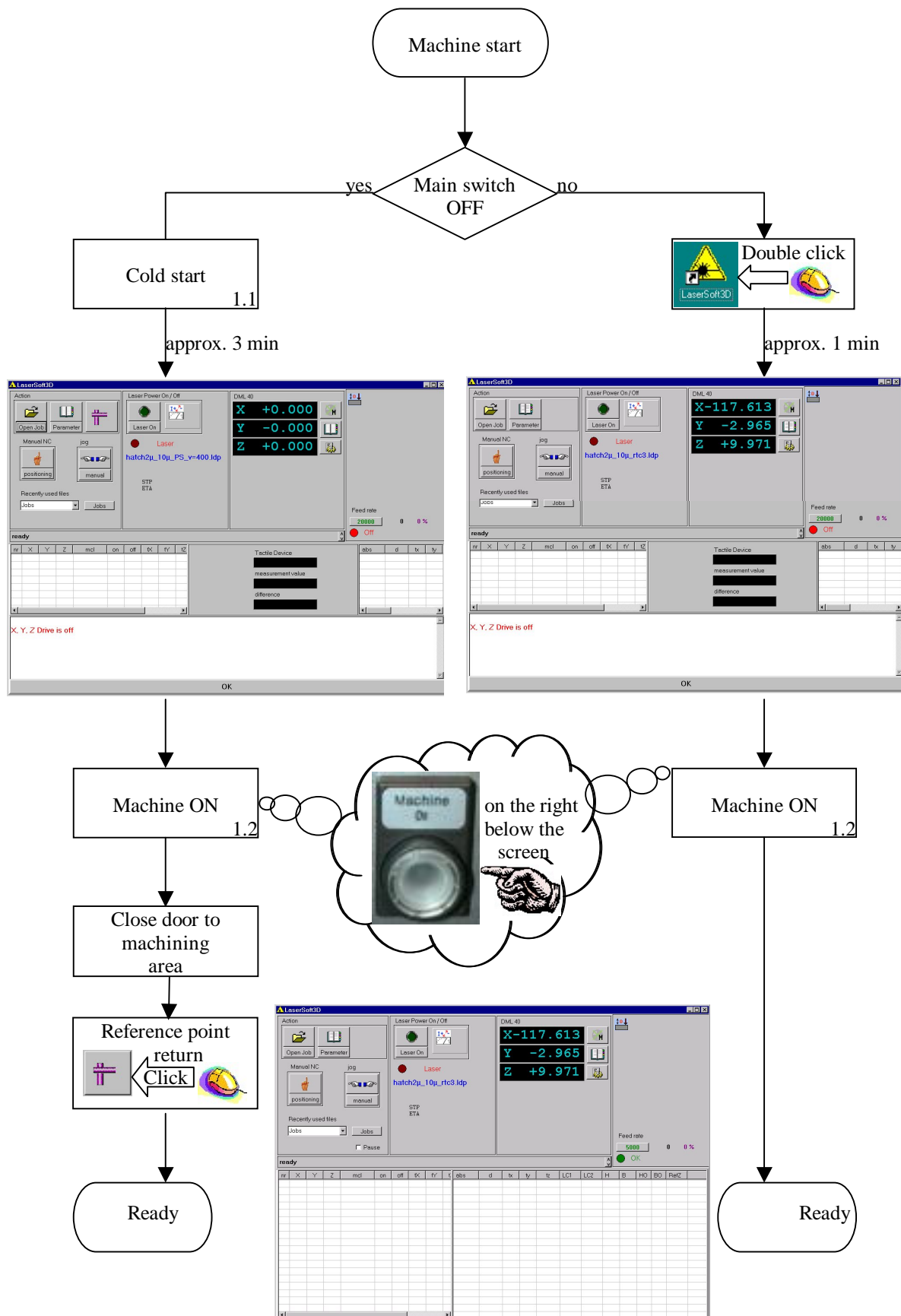
1	Machine start.....	6
1.1	Cold start:.....	6
1.2	Machine ON: .....	6
1.3	Machine reference point return.....	6
2	Set up blank:.....	8
2.1	Chuck blank:.....	8
2.2	Determining the set-up height on the compound table .....	8
2.3	Entering a preliminary zero offset: .....	9
3	Set up zero offsets .....	10
3.1	Definitions:.....	10
3.2	Setting up the blank zero offset: .....	11
3.2.1	Defining the blank zero offset by a fixed point: .....	12
3.2.2	Defining the blank zero offset by averaging between two auxiliary points .....	12
3.2.3	Defining a point by the intersection of two edges .....	13
3.3	Setting up the part zero offset.....	14
3.3.1	Defining the part zero offset in X and Y:.....	14
3.3.2	Setting up the part zero offset in Z :.....	15
3.3.2.1	Presetting the part zero offset in Z .....	15
3.3.2.2	Probe at zero (reference probing):.....	16
3.3.2.3	Adjusting the set zero offset to the actual probing value: .....	17
4	Machining technology .....	18
4.1	Technology parameters: .....	18
4.1.1	Function principle of the Q switch :.....	18
4.1.2	Lamp current:.....	19
4.1.3	First pulse problems: .....	19
4.1.4	Function principle of the mechanical first pulse killer:.....	19
4.1.5	Function principle of the mode aperture: .....	19
4.1.6	Material or part-dependent technology parameters : .....	19
4.2	Defining the machining technology.....	20
4.2.1	Closing frequency and opening time of the Q switch: .....	21
4.2.2	Engraving speed:.....	21
4.2.3	Mode aperture:.....	21
4.2.4	Transmission of the technology parameters to Lasersoft3D .....	22
4.2.4.1	Input group „Scanner Laser“ .....	22
4.2.4.2	Machine-specific parameters, input group „Timing“:.....	23
4.2.5	Determining the lamp current:.....	24
4.2.5.1	Procedure for generating the test cavity: .....	24
4.2.5.2	Opening the technology window: .....	24
4.2.5.3	Layer thickness and track distance.....	24
4.2.5.4	Pocket size .....	25
4.2.5.5	Scan location.....	25
4.2.5.6	First pulse killer .....	25
4.2.5.7	Hatching.....	26
4.2.5.8	Use the tactile device:.....	27
4.2.5.9	Experimental determination of the lamp current .....	27
4.2.5.9.1	Principle procedure.....	27
4.2.5.9.2	Practical procedure: .....	28

4.2.6	Setting the software-supported first pulse killer .....	29
4.2.6.1	Function principle .....	29
4.2.6.2	Parameters of the software-supported first pulse killer function .....	29
4.2.6.3	Optimization of the software-supported first pulse killer function: .....	30
4.2.6.4	Mechanical first pulse killer function: .....	31
4.3	Storing technologies: .....	32
5	Machining start.....	33
5.1	Open job files for machining:.....	33
5.2	Current control:.....	34
5.2.1	Tactile device-controlled current control .....	34
5.2.1.1	Reference point .....	34
5.2.2	Sensor-controlled current control .....	35
5.2.2.1	Sensor-controlled current control - free running.....	35
5.2.2.2	Sensor control with adjustment over the entire cavity depth (by probe).....	35
5.2.2.3	Sensor control with adjustment up to a given depth (by probe until Z) .....	35
5.3	Restarting an interrupted machining process .....	36
5.4	Switching to another technology parameter set.....	36
5.5	Start machining process .....	36
6	Auxiliary functions .....	37
6.1	Move axes: .....	37
6.1.1	Programmed axis travel, „Manual NC“: .....	37
6.1.2	Move axes with jog keys: .....	38
6.2	Microscope camera: .....	39
6.2.1	Open camera panel: .....	39
6.2.2	Compensate for camera offset: .....	40
6.3	Notebook .....	41
7	Short keys : .....	42

## Workflow of laser machining



## Machine start



## 1 Machine start

Before starting the machine, fully turn the feed potentiometer to the left up to the stop.

Principally, no objects may be left in the area below the compound table, neither clamping devices nor workpieces may protrude from the clamping plates.

No loose objects may be located on the clamping plate.

Workpieces must be chucked using claws or by means of a machine vice.

The clamping devices used must safely be screwed down on the clamping plate.

Only the factory-set processor configuration guarantees a trouble-free machine operation.

The laser machine is ready after the control software Lasersoft3D is activated and the machine is referenced.

### 1.1 Cold start:

After switching on the main switch installed on the right of the machine, Windows NT and Lasersoft3D will start-up automatically.

After approx. two to three minutes, the Lasersoft Main Window is opened.



### 1.2 Machine ON:

Switching on the laser machine requires Lasersoft3D to be active. By pressing the Power On push-button on the right below the display, the machine is activated and the indicator light of the bottom lights up.



### 1.3 Machine reference point return

For executing a reference point return, keep the <Ctrl> key pressed and click on the button in the main window provided for this purpose (see figure on the right).

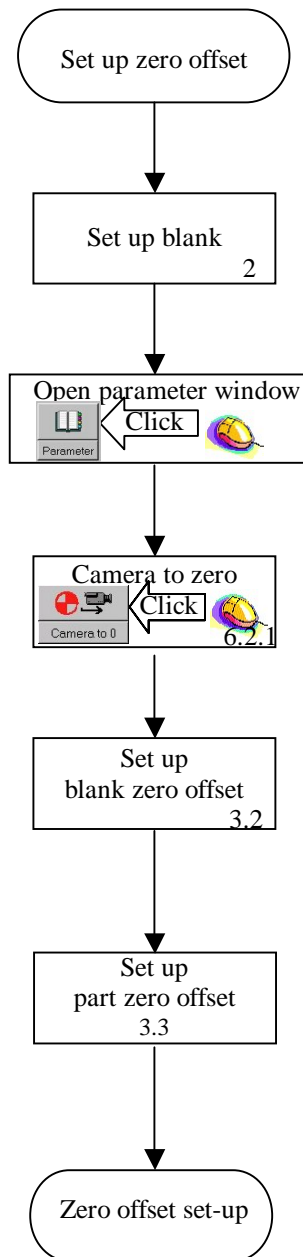
Slowly turn the feed potentiometer to the right.

A reference point return must be executed after each cold start of the machine.



Shutting down the Lasersoft3D will automatically switch off the machine.

## Set up zero offset



## 2 Set up blank:

### 2.1 Chuck blank:

Fix the blank on the clamping plate using a clamping device (compare fig. below 2.2).

**The total weight of blank and clamping device must not exceed 50 kilograms.**

Safely screw down the clamping device on the plate.


### Risk of interference.

Next to the clamping device with the clamped part, no other objects may be located on the table.

The area below the compound table must also be kept free from any objects.

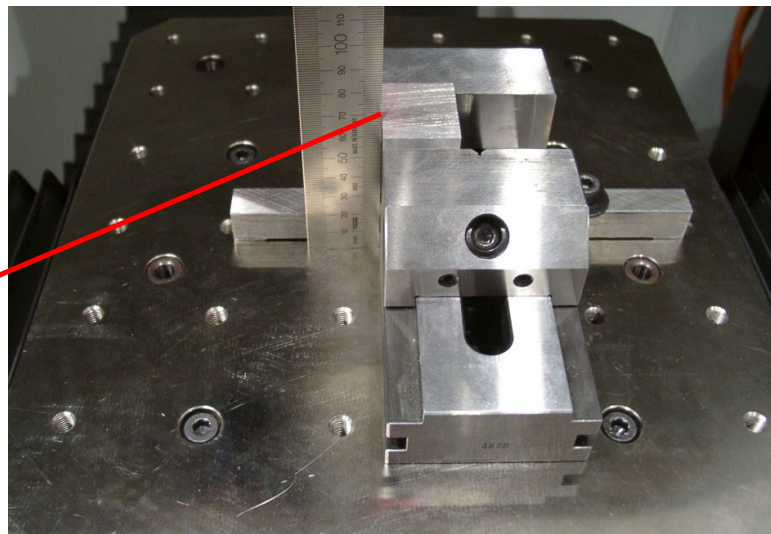
No object or parts thereof may protrude from the circumference of the clamping plate.

### 2.2 Determining the set-up height on the compound table

Open the parameter window with , either from the interactive option „Move Axis with Jog Keys“ or from the main window.

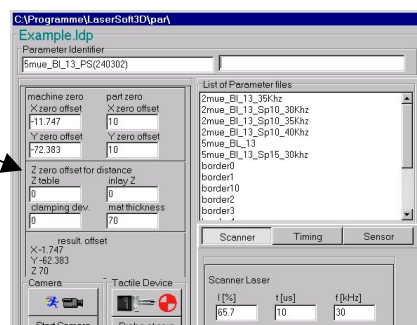
Measure the total height of component and clamping device above the clamping plate. (See figure on the right)

Enter the measured height in millimeters in the field „mat thickness“ in the parameter input dialogues.



Z zero offset for distance	inlay Z
Z table	0
clamping dev.	mat thickness
0	70

The input fields „Z table“, „inlay Z“ and „clamping dev.“ must be reset to zero.



**If the input of the material thickness is omitted or if a wrong thickness value is entered, interferences are unavoidable.**



## 2.3 Entering a preliminary zero offset:

**Condition:** The blank is clamped in accordance with 2.0.  
The total height of the structure composed of clamping device and blank was entered in the dialogue „mat thickness“ of the parameter dialogue.

The subsequent „probing to Z process“ serves the precise determination of the Z coordinate of the blank surface.

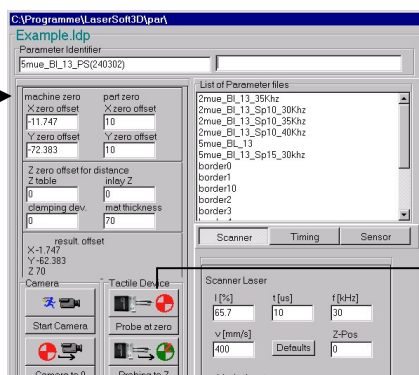
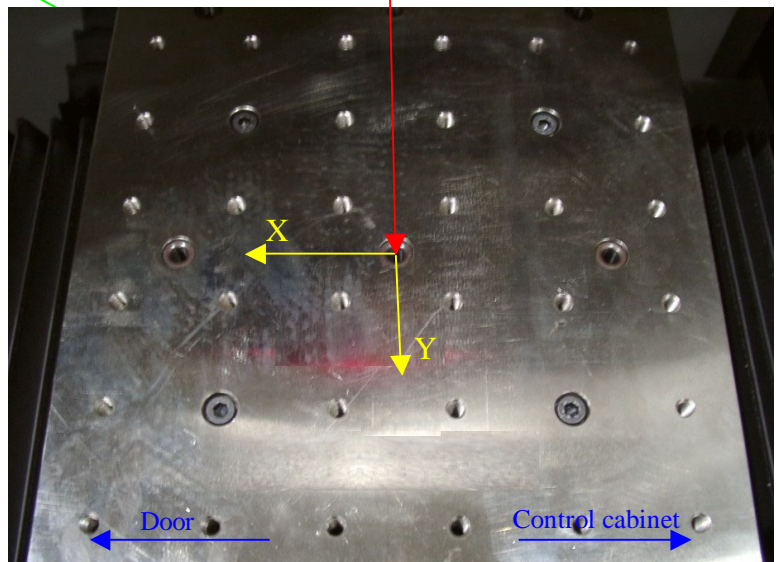
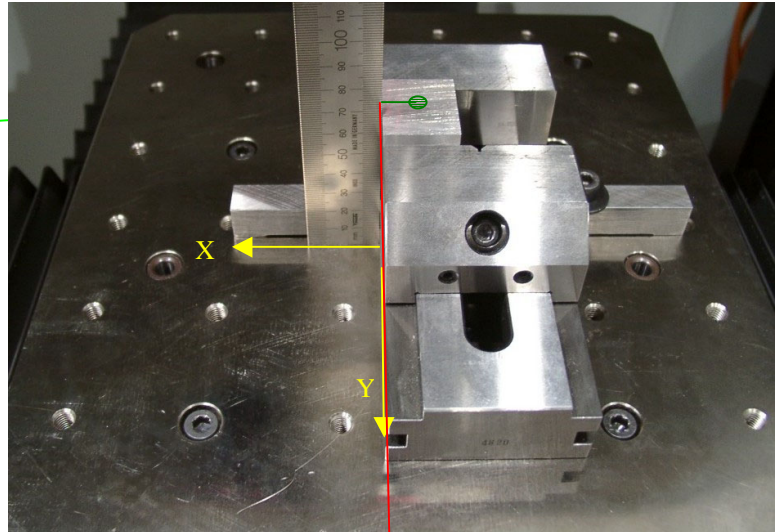
For this purpose, enter a preliminary and arbitrary reference point on the blank surface in the parameter field.

The sleeve centered on the clamping plate marks the machine-internal zero offset (see figure on the right) and may thus serve as reference for determining the preliminary blank zero offset.


The offset in x and y between the selected reference point and the machine zero offset is roughly measured, the measured values are entered in the parameter field below „machine zero“ with the correct sign.

machine zero	part zero
X zero offset	X zero offset
<input type="text" value="X"/>	<input type="text" value="0"/>
Y zero offset	Y zero offset
<input type="text" value="Y"/>	<input type="text" value="0"/>

The value for „part zero“ must be reset to zero.

Fully turn the feed potentiometer to the left up to the stop.

Press  to activate the probe. (3.3.2.2)

Slowly turn the feed potentiometer to the right. After completing the probing process, the material thickness is updated using the Z coordinate by clicking on the



button. (3.3.2.3)

### 3 Set up zero offsets

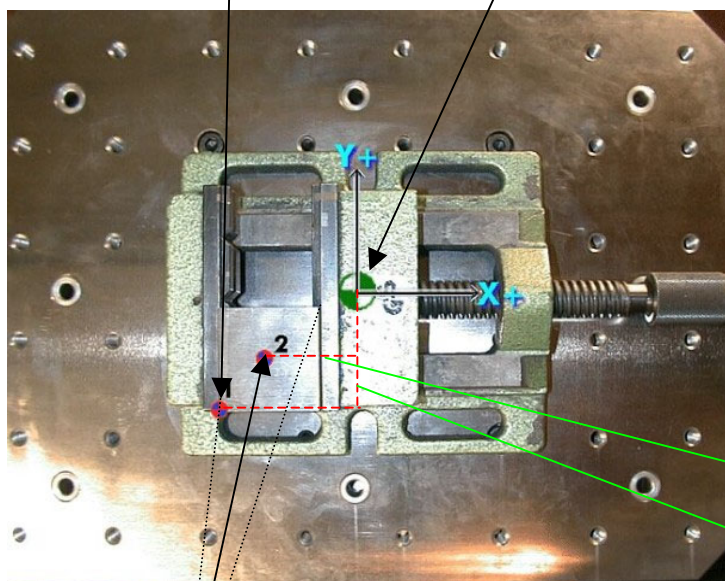
#### 3.1 Definitions:

Three zero offsets must be distinguished:

1. The machine zero offset is system-specific and may not be changed.
2. The part zero offset marks an arbitrary reference point to be set on the part blank. This reference point will be fixed by the setter using the microscope camera.
3. The resulting part zero offset is then determined by the part zero offset and a zero offset value to be entered by the setter in the parameter field of Lasersoft.

Blank zero offset  
at exposed position  
or at intersection between two edges

Machine zero offset in x/y,  
the machine zero offset in z  
is located at the height of the laser spot.

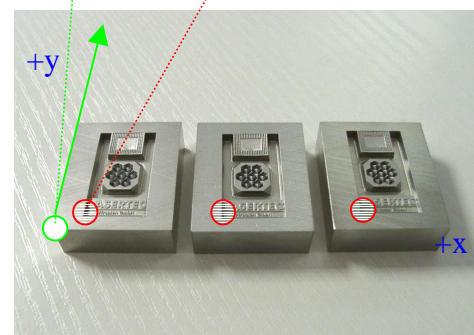


Blank zero offset:  
centered between  
two edges

Shift workpiece  
with reference to blank

machine zero	part zero
X zero offset	X zero offset
-11.747	10
Y zero offset	Y zero offset
-72.383	10

The part may be shifted with reference to the blank zero offset for instance to center it on the blank or to produce several workpieces on a blank. The desired shift of the workpiece with reference to the blank zero offset is entered in the parameter input field.



### 3.2 Setting up the blank zero offset:

#### Conditions:

The blank was set up in accordance with chapter 2.

The feed potentiometer is fully turned to the left up to the stop. (Check without fail!)

From the interactive parameter dialogue, the camera is activated by clicking on the <Camera to 0> button.

This opens up the camera window and the interactive input fields for the manual positioning of the axes (Fig. 3.2.2).

Slightly turn the feed potentiometer to the right; the machine will automatically move the blank below the camera using the zero offset entered in 2.3.



#### **Positioning the blank below the camera:**

By manually moving the table 6.1.2, the blank clamped on the compound table is positioned at a point where the area with the provided reference point is located below the camera and the surface of the part is clearly displayed in the camera window. As orientation help, you may use the reflection of the camera beam on the part (Fig. 1). The center of the illuminated area is shown in the camera window.

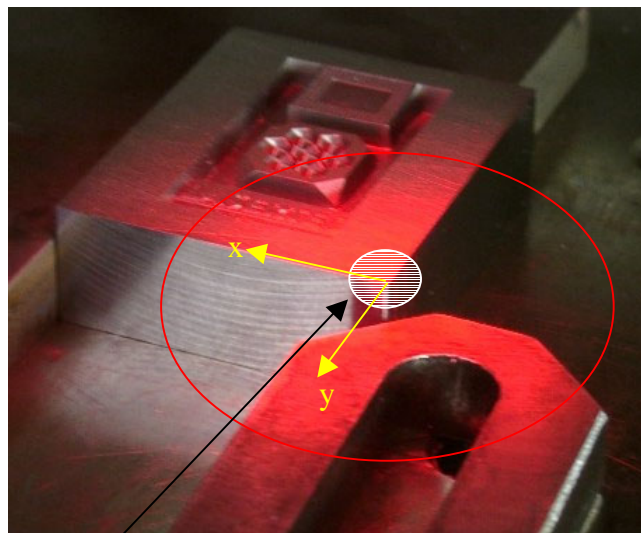
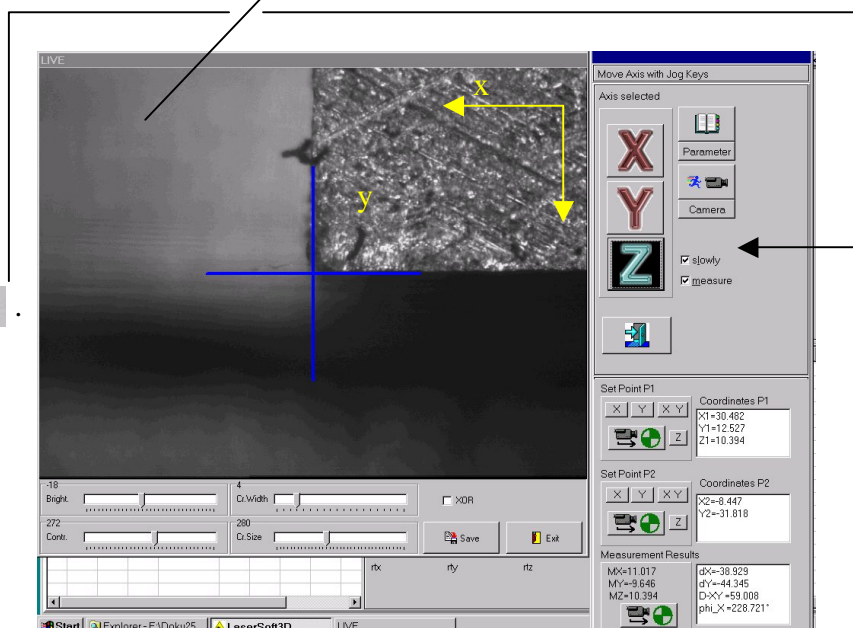


Fig. 1

The preliminary reference point must then precisely be positioned below the cross wire. For a fine positioning, it is recommended to activate the

option ☒ slowly .


The camera application shows a detail of approx. three times three mm, one pixel roughly corresponds to 4  $\mu\text{m}$ .






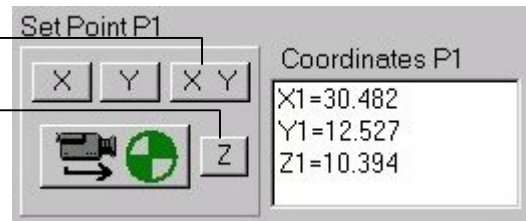
### 3.2.1 Defining the blank zero offset by a fixed point:

After having positioned the reference point below the cross wire of the camera in accordance with section 3.2, this point can be entered into the parameter field as blank zero offset.

The coordinates of the horizontal are stored and displayed by clicking on the  button.

Surfaces located at the height of the laser spot, i.e. at the machine zero offset in Z, are clearly displayed in the camera window.


By clicking on the  button, the Z coordinate of the displayed surface is determined in relation to the upper edge of the clamping plate, i.e. the height of the clamped assembly composed of clamping device and blank.



Set Point P1

Coordinates P1

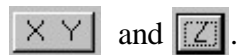
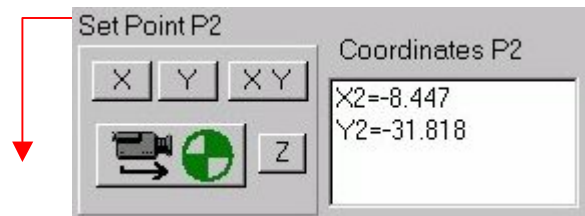
X1=30.482  
Y1=12.527  
Z1=10.394

From the set point defined in this way, plus a second set point, a reference point may be formed by averaging, or the set point may be entered in the parameter input field as zero offset by clicking on the  button.

### 3.2.2 Defining the blank zero offset by averaging between two auxiliary points

In accordance with 3.2.1, one set point has already been defined.

In accordance with the procedure y.y, a second fixed point is now brought below the cross wire and entered in the **second** point memory by clicking on the buttons

Set Point P2

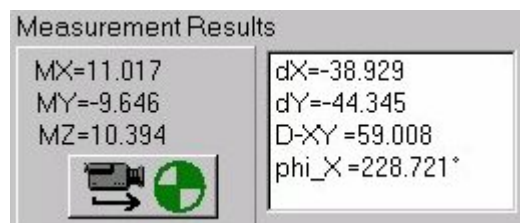
Coordinates P2

X2=-8.447  
Y2=-31.818

The mean result is displayed as follows.

Calculated zero offset:

$$\begin{aligned} MX &= \frac{1}{2} dX \\ MY &= \frac{1}{2} dY \\ MZ &= \frac{1}{2} (Z_2 - Z_1) \end{aligned}$$



Measurement Results

MX=11.017  
MY=-9.646  
MZ=10.394


dX=-38.929  
dY=-44.345  
D-XY=59.008  
phi\_X=228.721°

$$dX = X_2 - X_1$$

$$dY = Y_2 - Y_1$$

$$D-XY = \sqrt{dX^2 + dY^2}$$

$$\phi_X = \arctan \frac{dY}{dX}$$

By pressing the  button, the calculated point is stored as zero offset.

This option may be used to position the zero offset precisely in the center of a part or an edge.

### 3.2.3 Defining a point by the intersection of two edges

Points may also be defined as intersecting point of two edges.

The edges the intersection of which is to be determined must fulfil the following requirements:

1. one edge runs in parallel to the machine-internal X axis
2. the other edge is in parallel with the machine-internal Y axis
3. from the above conditions, the following results:  
The edges form a right angle.

**Procedure for defining a point from the intersection of two edges:**

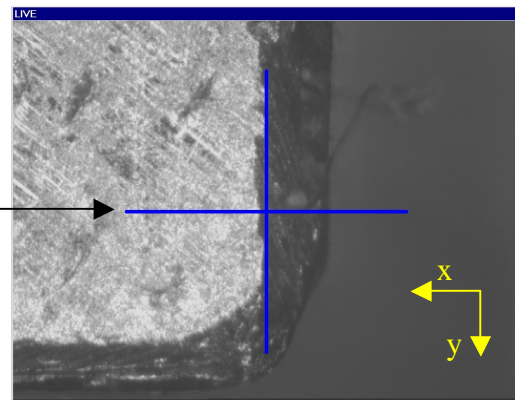
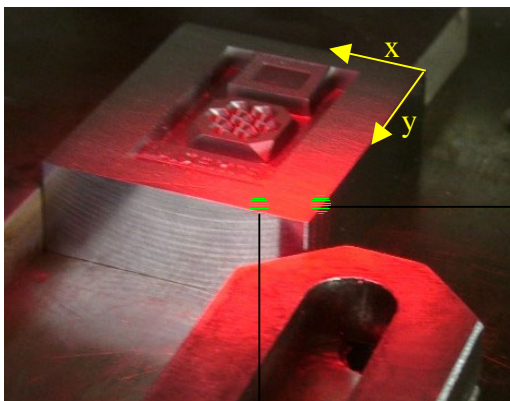


Fig. 2

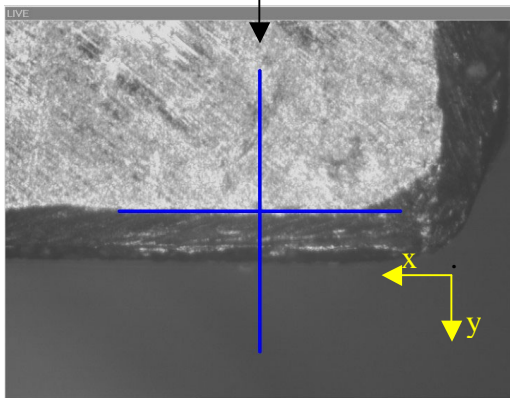

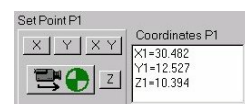



Fig. 3

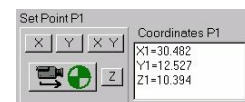
1. An arbitrary point located on the edge which is in parallel to the Y axis is positioned below the camera (Fig. 2).

By clicking on the  button, the Y coordinate is stored in the point memory.



2. An arbitrary point on the edge which is in parallel to the X axis is located below the camera (Fig. 3).

By clicking on the  button, the X coordinate is stored in the point memory.

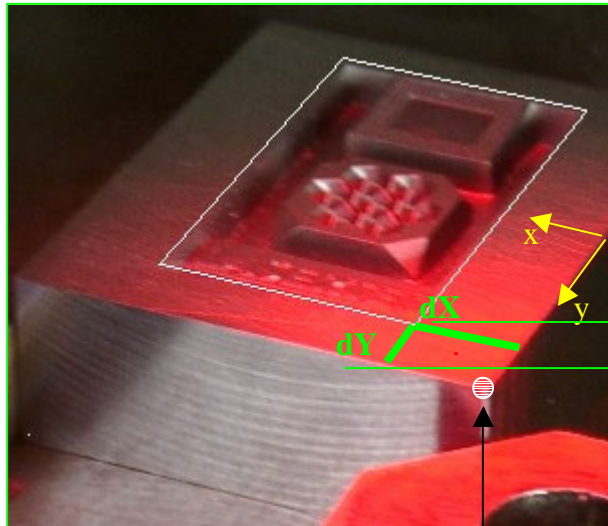


1 and 2 may also be carried out in reverse order.

### 3.3 Setting up the part zero offset

#### 3.3.1 Defining the part zero offset in X and Y:

If blank and part zero offset are not identical, you must enter the shift of the part zero offset with reference to the blank zero offset in the parameter field (see figure below).



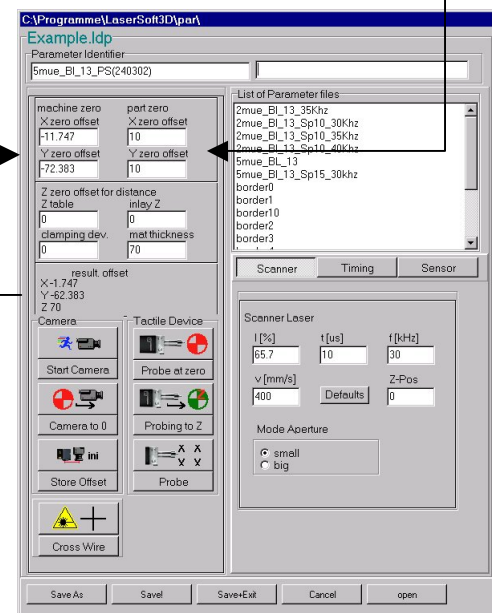
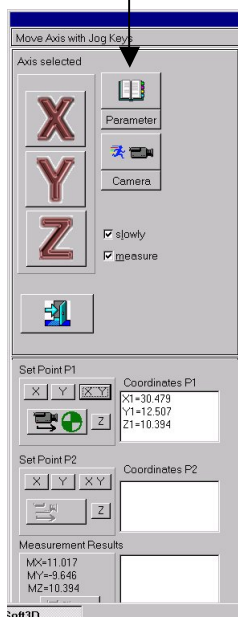
machine zero	part zero
X zero offset	X zero offset
11.017	dX
Y zero offset	Y zero offset
-9.646	dY

Part zero offset

Open the parameter window by clicking on the



button in the interactive field „Move Axis with Jog Keys“, or - if this has already been closed - in the main window.



result. offset
X -1.747
Y -62.383
Z 70

The part zero offset defined from the blank zero offset and zero offset shift is displayed in the parameter window as resulting zero offset.

### 3.3.2 Setting up the part zero offset in Z:

**The zero offset in Z must be defined precisely and carefully - wrong or missing data will inevitably lead to interferences.**

#### **Conditions:**

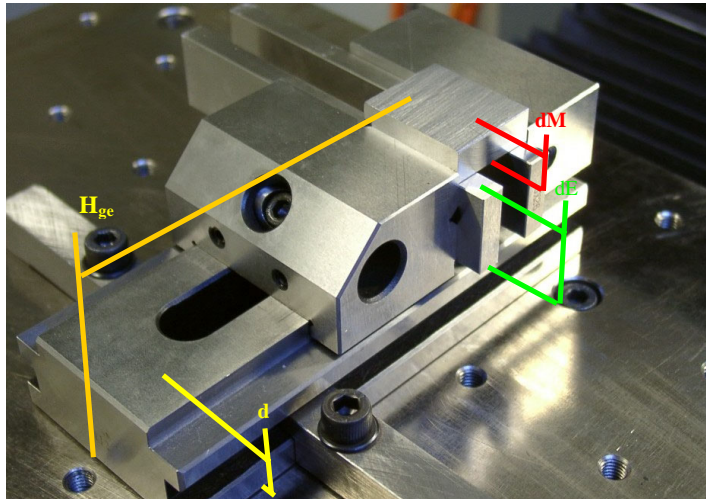
The blank has been set up in accordance with 2.

The blank zero offset was set up in X and Y in accordance with 3.2.

#### 3.3.2.1 Presetting the part zero offset in Z

The part zero offset in Z lies on the unmachined surface of the blank and is defined by the height of the blank upper edge above the surface of the compound table ( $H_{tot}$ ).

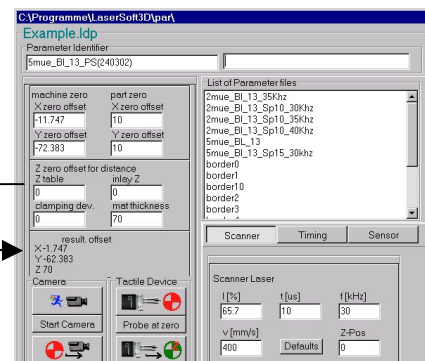
The sum from the material thickness  $dM$ , the thickness of the inlay in the clamping device  $dE$  and the height of the part support surface of the clamping device  $dS$  results in the total height  $H_{tot}$ .



For determining  $H_{tot}$ , three constants are available in the parameter input field: „Z table“, „clamping dev.“ and „inlay Z“ as well as the variable „mat thickness“.

The constant „Z table“ serves for defining an assembly permanently installed on the clamping plate, e.g. magnet or vacuum table.

Z zero offset for distance Z table	inlay Z
0	dE
clamping dev.	mat thickness
dS	dM



The part zero offset resulting from the above settings is displayed in the field „result. offset“ of the parameter input area there the resulting Z value is calculated as sum from the values of the input field „Z zero offset for distance“.

result. offset  
X-1.747  
Y-62.383  
Z 70

To check the result, the total height of the assembly installed on the clamping plate should be measured and compared to the displayed Z value.

**The displayed Z value must be bigger than or equal to the measured value; otherwise, there is the risk of interference.**

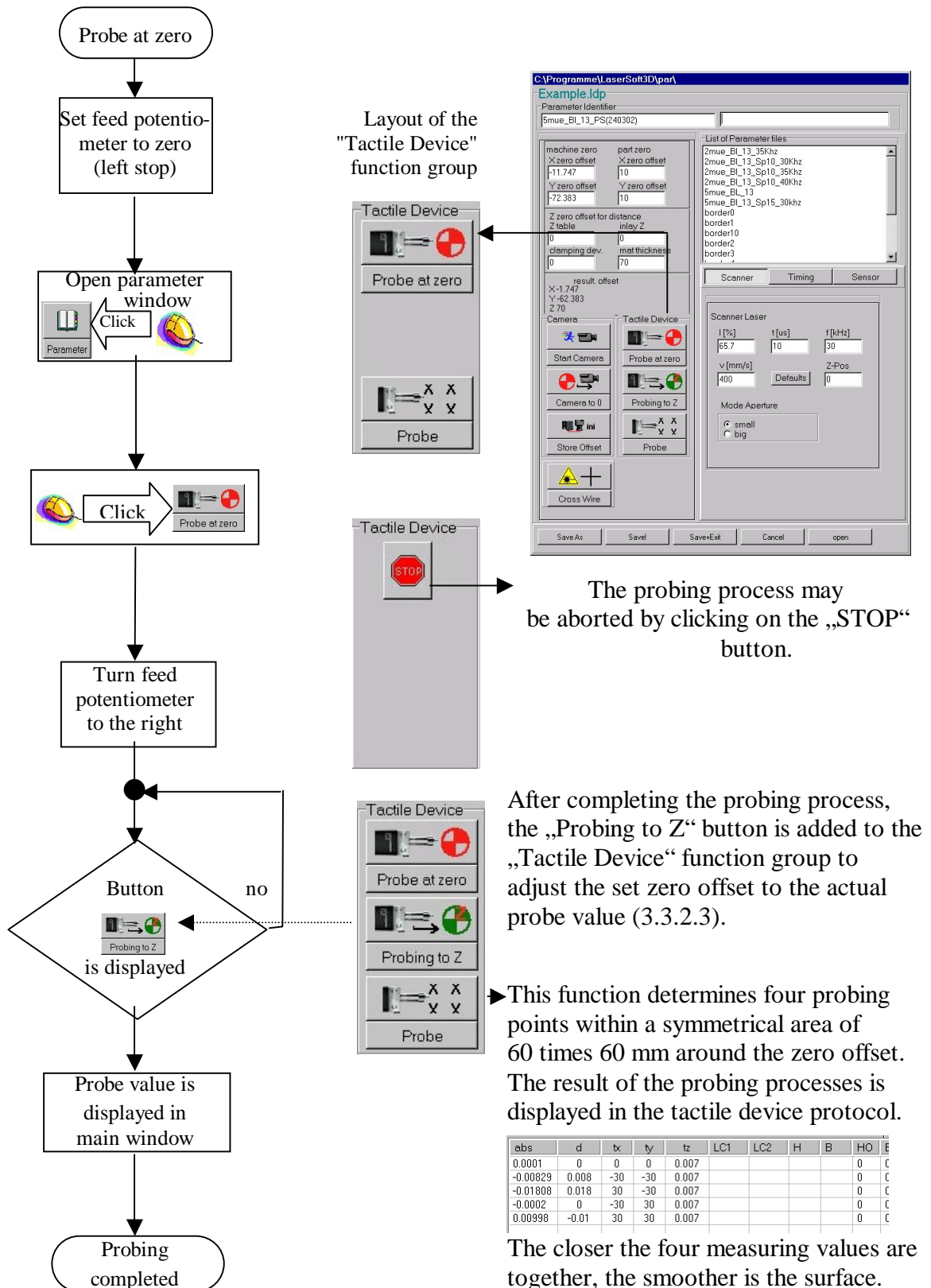
The precise part zero offset in Z must be determined using the probe („probe at zero“).



### 3.3.2.2 Probe at zero (reference probing) :

#### Condition:

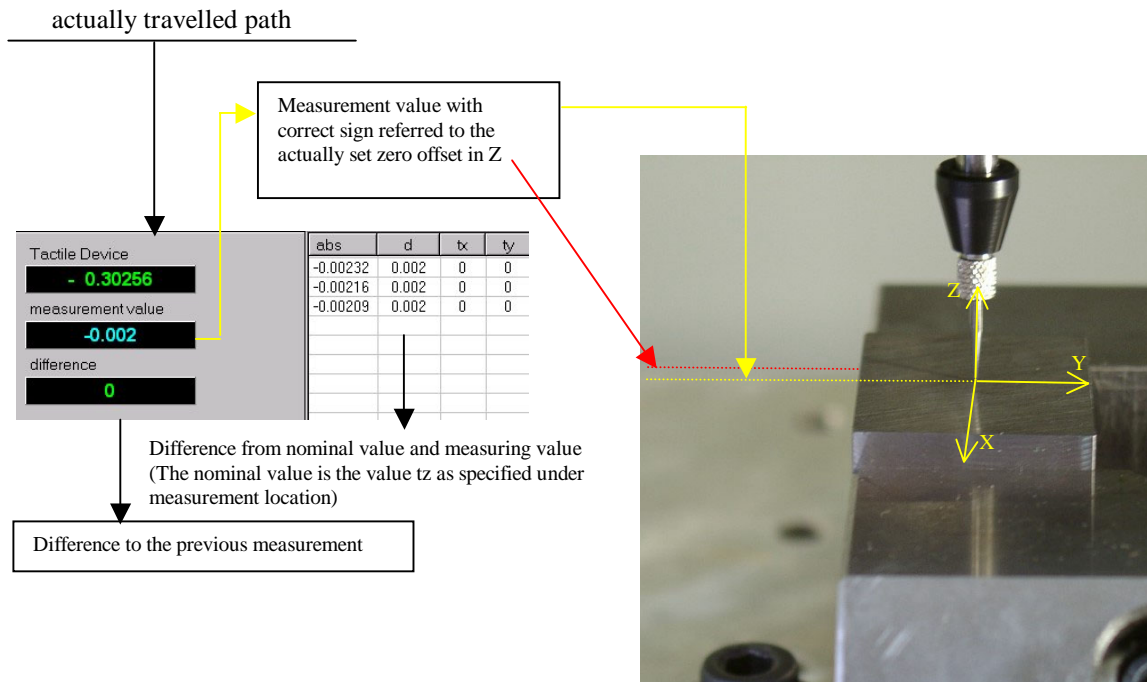
The part zero offset in Z must have been preset in accordance with Fehler!  
Verweisquelle konnte nicht gefunden werden. .





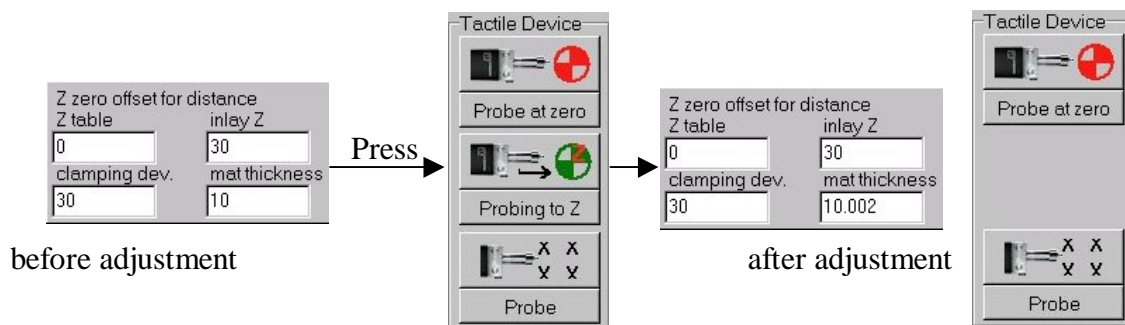
### 3.3.2.3 Adjusting the set zero offset to the actual probing value:

The result of the reference probing is displayed in the main window as shown in the following figure.



The actual measurement revealed a positive value, i.e. the part was specified slightly too high (compare above figure).

The material thickness entered in the parameter dialogue must be adjusted to the actual measuring value by clicking on the „Probing to Z“ button.



Only the material thickness is compensated for, whereas „Z table“, „Clamping dev.“ and „inlay Z“ remain unchanged.

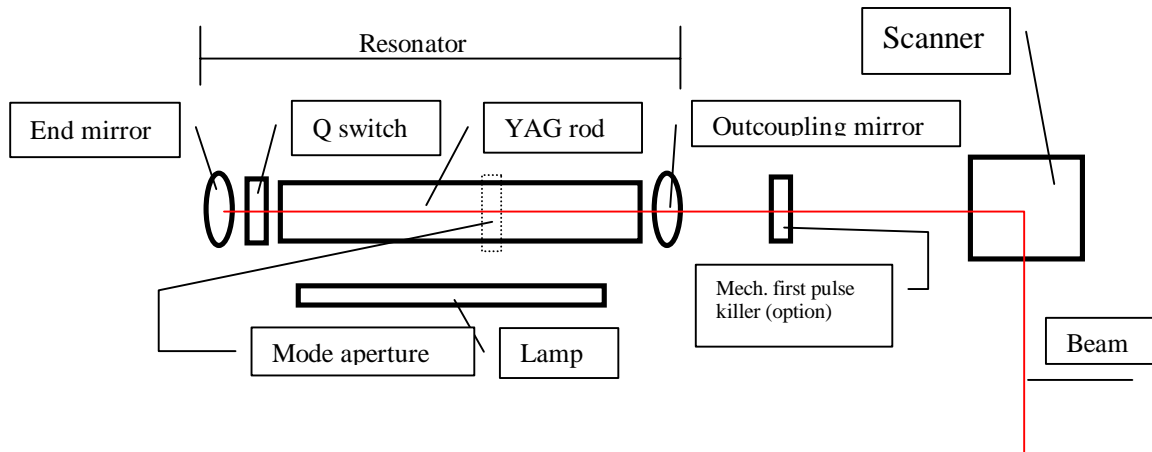
After the adjustment, the „Probing to Z“ button is hidden again.

The part is now set up completely under the condition that steps 2 up to and including 3.3.2.3 were carried out.

## 4 Machining technology

### 4.1 Technology parameters:

The following figure shows a diagram of the most important components for beam generation and beam switching.



Inside the resonator, stationary light waves are formed through radiation on the YAG rod (laser-active medium) where the energy of these light waves are led out of the resonator as laser beam through the outcoupling mirror by approx. 40 %.

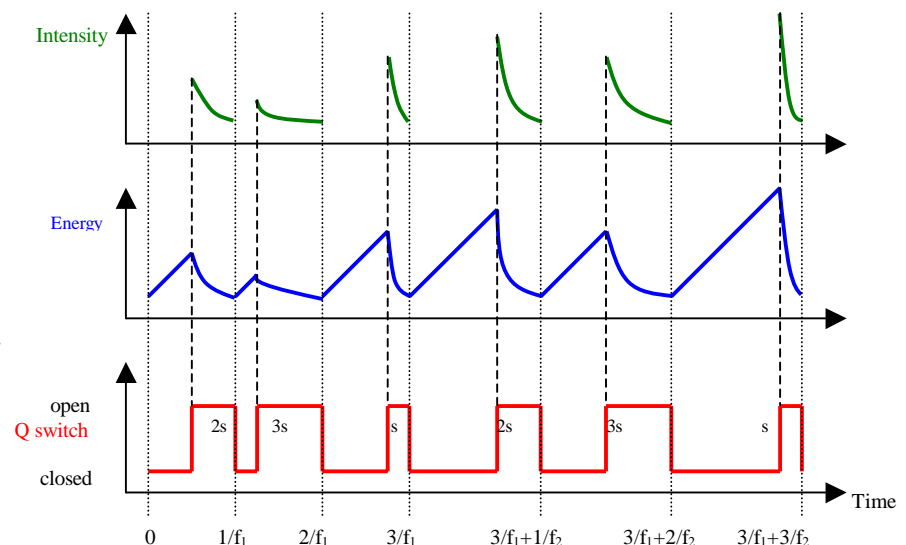
#### 4.1.1 Function principle of the Q switch:

With the Q switch closed, the ray trajectory in the resonator is interrupted, no stationary waves may form so that no laser beam is generated; this means that no energy is withdrawn from the YAG rod so that it accumulates the radiated energy.

The amplitude of the stationary waves formed with the Q switch open and thus the intensity of the laser beam produced is the higher the longer the laser active medium was radiated with the Q switch closed, i.e. the more energy has accumulated in the YAG rod.

By opening and closing the Q switch periodically, laser pulses are generated the intensity of which depends on the closing frequency and opening time of the Q switch. The following figure explains this interrelation.

In case of a constant closing frequency ( $f_1$  or  $f_2$ , where  $f_1 > f_2$ ), shortening the open time  $s$  generates laser pulses of higher intensity, reducing the closing frequency increases the intensity level altogether.



#### **4.1.2 Lamp current:**

The intensity level of the laser beam may not only be raised by variation of the closing frequency of the Q switch but also by increasing the lamp current, or can be reduced by lowering the lamp current.

#### **4.1.3 First pulse problems:**

At the end of an engraving track, the laser beam is switched off by closing the Q switch.

The scanner is positioned at the starting point of the next track.

This process requires a multiple of the period time of the closing frequency of the Q switch.

In other words - the YAG rod is charged with much more energy during the positioning of the scanner mirror and during the engraving process.

When opening the Q switch, pulses of high intensity are thus generated.

The high intensity laser pulses produced after a prolonged closing period of the Q switch cause craters at the beginning of the laser track.

Lasersoft3D offers the option of suppressing the first pulses (software-supported first pulse killer).

#### **4.1.4 Function principle of the mechanical first pulse killer:**

The laser beam may be interrupted mechanically outside the resonator; therefore, it is not necessary to switch off the beam during the positioning process so that the first pulse problem does not occur at all.

#### **4.1.5 Function principle of the mode aperture:**

In the resonator, stationary light waves are formed between the mirrors with one oscillation node at each mirror.

A stationary wave with no further nodes inside the resonator is called a wave with the mode zero.

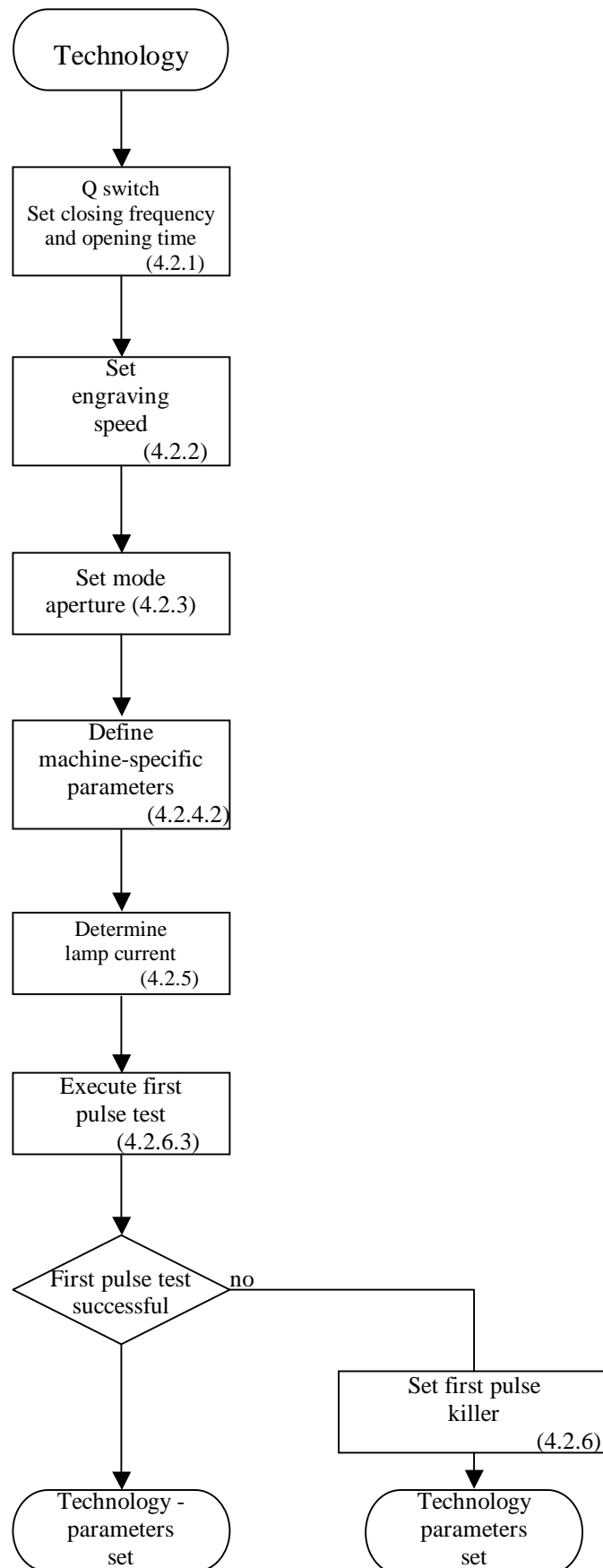
If a stationary wave disposes of further oscillation nodes inside the resonator, this is called a stationary wave with a higher degree mode.

A big mode aperture allows for these waves to be generated, a small mode aperture prevents their occurrence. If waves of higher modes are stopped down, this leads to an improved focussing of the laser beam, i.e. to a smaller laser spot; on the other hand, it equally causes less cutting due to the lower energy density inside the spot.

#### **4.1.6 Material or part-dependent technology parameters:**

The engraving speed, the setting of the first pulse killer, of the Q switch, of the lamp current and of the mode aperture directly affect the quality of the part surface after the machining and vary depending on material and condition of the part.

## 4.2 Defining the machining technology



#### 4.2.1 Closing frequency and opening time of the Q switch:

The closing frequency of the Q switch depends on the material to be machined.

You may use the values in the following table as reference.

Material	Frequency range	Comment
<b>Steels</b>	<b>25 – 45 kHz</b>	<b>Feed depending on contour between 150-600 mm/sec</b>
<b>1.2311</b>	<b>35 kHz</b>	
<b>Aluminium F38</b>	<b>10 – 25 kHz</b>	
<b>Brass</b>	<b>10 – 25 kHz</b>	<b>Low frequencies at high scanning rates</b>
<b>Copper</b>	<b>10 – 25 kHz</b>	<b>Low frequencies at high scanning rates</b>
<b>Titan</b>	<b>35 – 40 kHz</b>	
<b>Hard metals</b>	<b>15 – 19 kHz</b>	<b>Select low feeds (150 – 250 mm/sec)</b>
<b>Silicon carbide</b>	<b>30 – 35 kHz</b>	
<b>Silicon nitride</b>	<b>30 – 35 kHz</b>	
<b>Oxide ceramics</b>	<b>5 – 10 kHz</b>	<b>Select layer thickness of 4 – 5 µm</b>
<b>CBN</b>	<b>20 – 25 kHz</b>	
<b>PKD</b>	<b>30 – 35 kHz</b>	
<b>Graphite</b>	<b>30 – 50 kHz</b>	

As opening time of the Q switch, a constant value of 10 µs has proven to be appropriate.

#### 4.2.2 Engraving speed:

The feedrate depends on the set Q switch closing frequency.

As reference value, use the following formula:

The speed in mm/sec results from the Q switch closing frequency in kHz multiplied by ten.

If for instance steel is to be machined with a closing frequency of 40 kHz, the feedrate is calculated as follows:

$$40 * 10 = 400 \text{ mm/sec.}$$

Depending on the condition of the cavity, the speed must be corrected around the reference value, i.e. smaller parts or parts with filigree structures are machined at lower feedrates, bigger parts may be engraved faster particularly in view of reducing the machining time.


#### 4.2.3 Mode aperture:


A small mode aperture leads to a smaller laser spot (Ø approx. 30 µm) and is particularly suited for components with high demands on the surface quality, for smaller parts or parts with filigree structure.

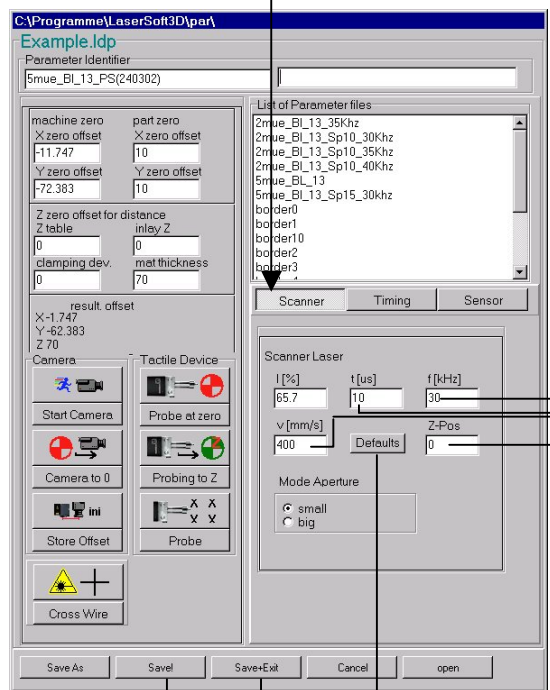
A big mode aperture with a focus diameter of approx. 80 µm - 100 µm is recommended if particularly high cutting rates are required and a high surface quality is not of priority.

## 4.2.4 Transmission of the technology parameters to Lasersoft3D

### 4.2.4.1 Input group „Scanner Laser“

The parameter panel is activated from the main window by clicking on the  button.

The defined values are transferred to the „Scanner Laser“ input group which is called by pressing the  button.



**Input fields for technology parameters**

- f [kHz]** 35: Q switch closing frequency
- t [us]** 10: Q switch opening time (should remain set to 10 µsec)
- v [mm/s]** 200: Engraving speed
- Z-Pos** 0: Defocussing of the laser beam when executing cleaning technologies



Button for the automatic updating of machine-related technology parameters.

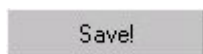
**Each time after changing the engraving speed, the machine-specific parameters must be updated.**



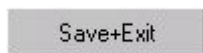
Ø of the laser spot approx. 30 µm

Ø of the laser spot approx. 80 µm - 100 µm

**Any changes to the settings in the parameter dialogue will only become effective for Lasersoft after explicitly storing the values.**



Store all parameters

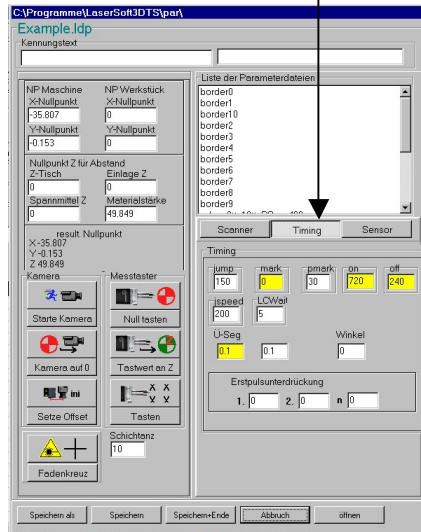


Parameters are stored followed by closing the parameter dialogue.


#### 4.2.4.2 Machine-specific parameters, input group „Timing“:

The machine-specific parameters are time constants and compensation paths (overtravel segments) required for the high-precision positioning of the scanner mirrors and which depend on the desired engraving speed.

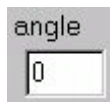
These settings in the parameter panel are accessible by clicking on the  button.



The parameters Jump, mark, pmark, on, off and LCWait are time constants, jspeed is a positioning speed, Ü-Seg are compensation paths (overtravel segments).

The settings are stored in tabular format in the "Timing.ini" file in Lasersoft3D and must be updated each time after changing the engraving speed by clicking on the  button in the input group „Scanner“.

The values suggested here should only be changed in exceptional cases if an optimization is required.



Using this input field, the alignment of the part coordinate system may be adjusted by up to three degrees in positive or negative rotating direction in X and Y with relation to the machine coordinate system.

#### 4.2.5 Determining the lamp current:

For determining the lamp current, a square pocket is generated.

During this process, the cut-off depth is continuously measured; depending on the deviation from the nominal depth, the lamp current must manually be increased or reduced by the setter.

##### 4.2.5.1 Procedure for generating the test cavity:

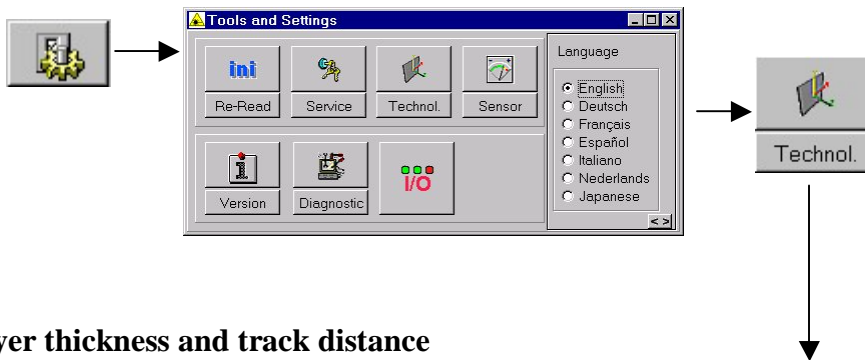
###### Conditions:

A blank consisting of the material from which the part is to be produced must be clamped, the part zero offset must be set.

##### 4.2.5.2 Opening the technology window:

The „Tools and Settings“ window is opened from the main window by clicking on

the button



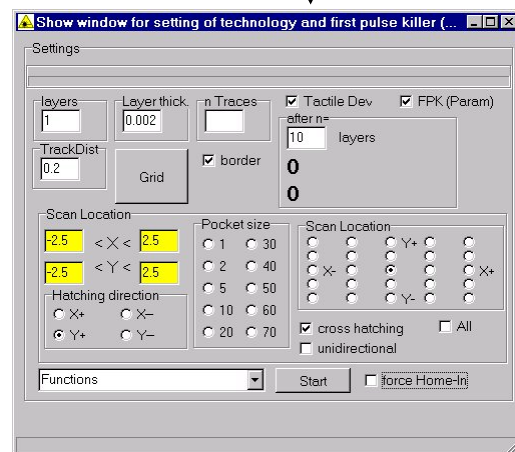
##### 4.2.5.3 Layer thickness and track distance

Before producing the pocket, the offset between the laser tracks (track distance) and the layer thickness must be specified.

The track distance is entered into the input field



The track distance should always equal the distance between two laser pulses and is calculated from the quotient of the feedrate and the Q switch opening frequency.



$$\text{Track distance} = \frac{\text{Feedrate}}{\text{Q switch opening frequency}}$$

The layer thickness depends on the required geometry and the desired machining rate. In general, a layer thickness of 2 µm produces good results.

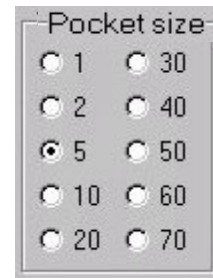


#### 4.2.5.4 Pocket size

The data in the field „Pocket size“ refers to the edge length of the square test pocket. Selecting < 1 > produces a square test cavity with 1 mm edge length, selecting < 2 > produces such a cavity with 2 mm edge length etc.

The pocket size to be adjusted depends on the geometry of the part to be produced.

In case of little structured bigger parts, an edge length starting from 5 mm must be selected, for smaller parts or parts with filigree surface details, the edge length must be set to a value smaller 5 mm.

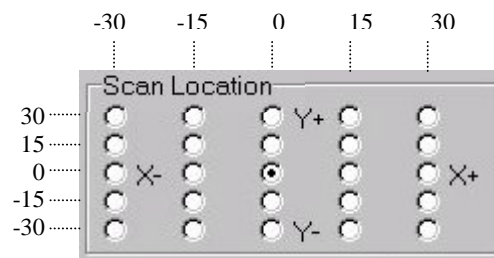


#### 4.2.5.5 Scan location

The scanner is able to scan a square of 60 mm edge length, where the test cavity is produced in the center of the square.

Using the input field „Scan Location“, the pocket may be positioned in X and Y direction in 15 mm steps.

Shifting the technology pocket away from the center of the scan field is for instance useful for determining separate border cutting technologies.

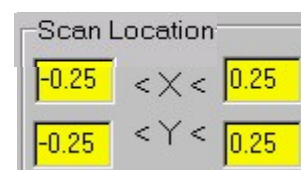


The position of the pocket with reference to the set part zero offset is displayed.

The field shown on the right also serves to describe a pocket with an edge length deviating from the value specified in the input field „Pocket Size“.



If for instance a pocket with an edge length of 0.5 mm is to be generated and centered in the scan field, enter the data as shown on the right. Any desired shift in the scan field must be added to these values.



#### 4.2.5.6 First pulse killer

The parameters of the software-supported first pulse killer must be specified as described in 4.2.5.

Then, activate the option ☒ FPK (Param) .

### 4.2.5.7 Hatching

The following hatching types may be set:

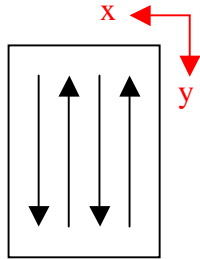
☐ cross hatching  
☐ unidirectional

☐ cross hatching  
☒ unidirectional

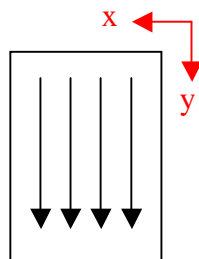
☒ cross hatching  
☐ unidirectional

☒ cross hatching  
☒ unidirectional

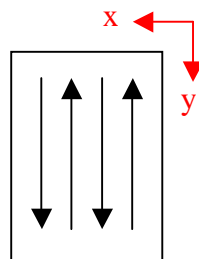
Layer <n>



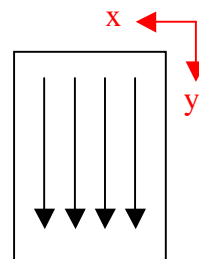
Layer <n>



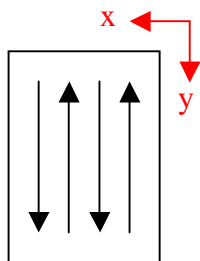
Layer <n>



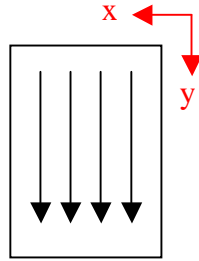
Layer <n>



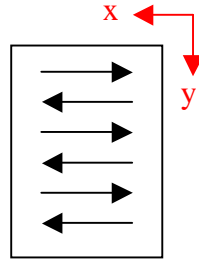
Layer <n+1>



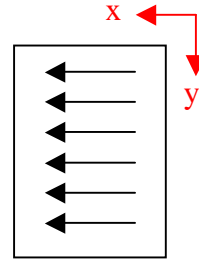
Layer <n+1>



Layer <n+1>



Layer <n+1>



The orientation of the hatching depends on the setting in the input field „Hatching direction“.

Hatching direction  
☐ X+ ☐ X-  
☒ Y+ ☐ Y-

Both <Y+> and <Y-> cause the hatching to be produced in Y direction; in the same way, <X+> and <X-> cause the hatching to be produced in X direction.

The orientation of the hatching depends on the setting in the input field „Hatching direction“.

Hatching direction  
☐ X+ ☐ X-  
☒ Y+ ☐ Y-

The hatching is produced in the set direction following the set sign.

The hatching used for producing the technology must be identical to the hatching used in LPSWin for programming the related part.

#### 4.2.5.8 Using the tactile device:

The cutting depth is measured using the tactile device; for this purpose, activate the option

☒ Tactile Dev .

You must enter the number of layers after the cutting of which the actual depth of the cavity is to be measured. A high value (number of layers) delays the sensitivity to current changes; in praxis, a value or four to ten layers has proven to be appropriate.



#### 4.2.5.9 Experimental determination of the lamp current

##### 4.2.5.9.1 Principle procedure

Starting from an initial current of I0 which ranges between 35 and 45 % of the maximum lamp current **depending on the required** cutting depth, the machining of the test cavity is started.

After each probing, the **cut amount** and the **difference between nominal and actual cutting amount** must be checked.

The **number of layers cut** is displayed in the technology window.



The nominal cutting value is calculated from the number of layers multiplied by the layer thickness. Insufficient cutting is signaled by blue values, excessive cutting by red values.

The **difference between nominal and actual cutting amount** can be taken

from the tactile device protocol in the main window. If the difference is higher than **0.05 mm**, the machined surface is no longer at the height of the laser focus; in this case, abort and repeat the setting of the technology. If the difference remains constant, a good technology is obtained.

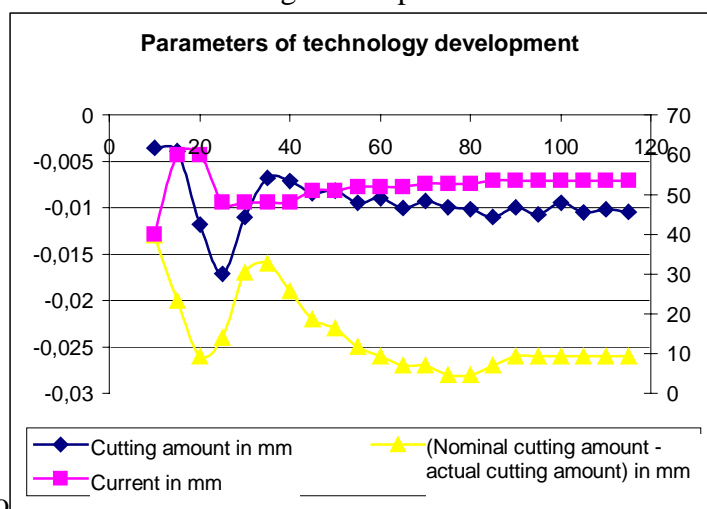
abs	d	tx	ty	tz
-0.13039	-0.028	0	0	-0.158
-0.14054	-0.027	0	0	-0.168
-0.15154	-0.026	0	0	-0.178
-0.16152	-0.026	0	0	-0.188
-0.17223	-0.026	0	0	-0.198
-0.18167	-0.026	0	0	-0.208
-0.19216	-0.026	0	0	-0.218
-0.20233	-0.026	0	0	-0.228

The following diagram explains the procedure for determining the lamp current.

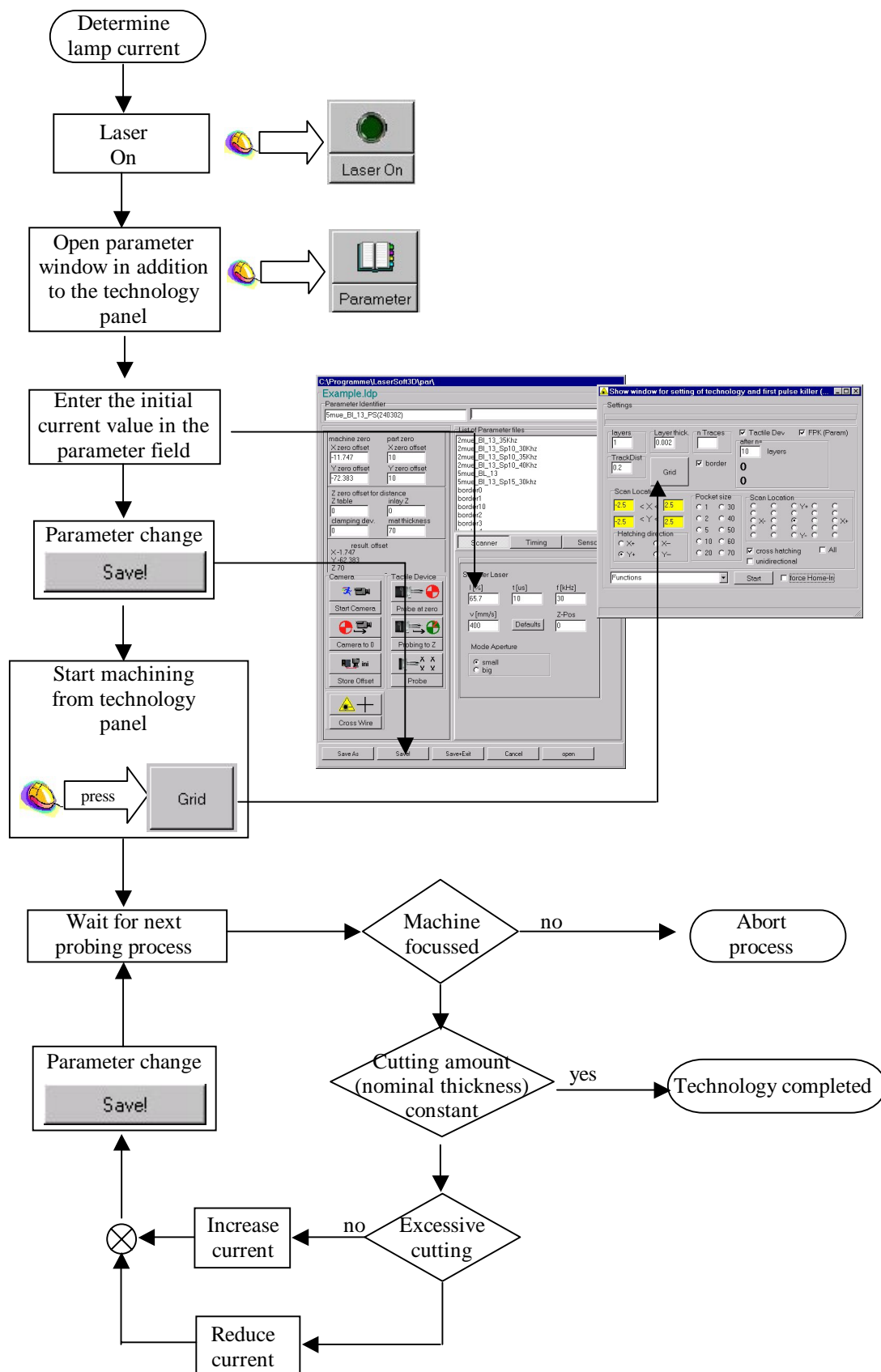
In the example, the required cutting amount is calculated from

$$5 \text{ layers} * 2 \mu\text{m} = 10 \mu\text{m}$$

Starting at 40 % lamp current and a resulting cutting amount of 5  $\mu\text{m}$ , the current was increased which led to excessive cutting. By reducing or increasing the current in ever smaller steps, 53.3 % were determined as lamp current granting a constant cutting amount. The difference from nominal during the entire process, i.e. the machining was constantly carried out at the height of the laser focal point.



#### 4.2.5.9.2 Practical procedure:



## 4.2.6 Setting the software-supported first pulse killer

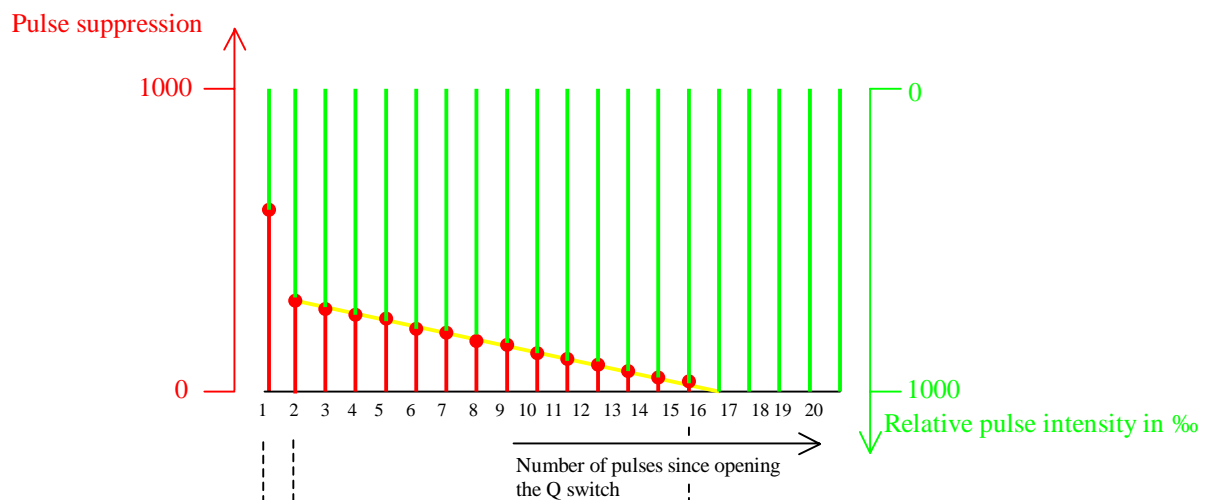
### 4.2.6.1 Function principle

The laser pulses generated at the start of an engraving track dispose of a considerably higher intensity than inside the track.

In order to avoid the production of craters at the transitions between laser tracks, Lasersoft offers the first pulse killer function.

This function purposefully reduces the intensity of an adjustable number of pulses following the opening of the Q switch.

### 4.2.6.2 Parameters of the software-supported first pulse killer function



The parameters for the software-supported first pulse killer function are entered in the parameter field below

Suppression (killing) of the first laser pulse following the opening of the Q switch

Definition of the ramp after which the relative intensity of the laser pulses are increased to 1000 % step by step

First pulse Killer

1. 500 2. 300 n 15

C:\Programme\LaserSoft3D\part

Example.lbp

Parameter Identifier

Smue\_BI\_13\_FS(240302)

machine zero port zero

X zero offset X zero offset

Y zero offset Y zero offset

Z zero offset for distance

Z table inlay Z

clamping dev. mat thickness

result offset

X-1.747

Y-42.383

Z 270

Camera Tactile Device

Start Camera Probe at zero

Camera to 0 Probe

Store Offset

Close Wire

Save As Save Save-Exit Cancel open

List of Parameter files

2muse\_BI\_13\_35khz

2muse\_BI\_13\_Sp10\_30khz

2muse\_BI\_13\_Sp10\_35khz

2muse\_BI\_13\_Sp10\_40khz

5muse\_BI\_13

5muse\_BI\_13\_Sp15\_30khz

border0

border1

border10

border2

border3

Scanner Timing Sensor

Timing

jump mark pmark LCWait

150 0 60 5

speed on off

400 400 120

O-Seg angle

0.15 0.2 0

First pulse Killer

1. 2. n

### 1. Parameter < 1 > :

This parameter defines the intensity reduction of the first pulse produced after opening the Q switch.

A value of 500 has proven to be appropriate as initial value for this parameter.

### 2. Parameter < 2 > :

This parameter sets the maximum value of the falling ramp with which the first pulse killer decays.

This value must be lower by 200 compared to parameter < 1 > .

### 3. Parameter < n > :

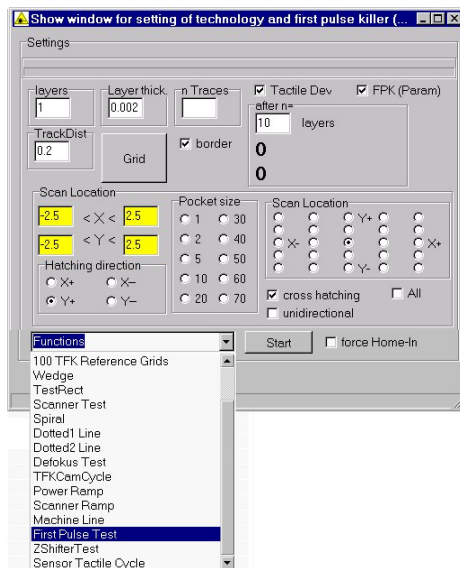
The Q switch opening frequency is used as reference point for the parameter n, i.e. for the number of pulses after which the full intensity is reached.

<n> must be set to half of the frequency in kilohertz but may not be smaller than 15.

For a Q switch opening frequency of 40 KHz , < n > is set to 20, for a frequency of 20 KHz, <n> remains set to 15.

## 4.2.6.3 Optimization of the software-supported first pulse filler function:

The settings of the software-supported first pulse killer function may be optimized with the function „First Pulse Test“ in the technology window.



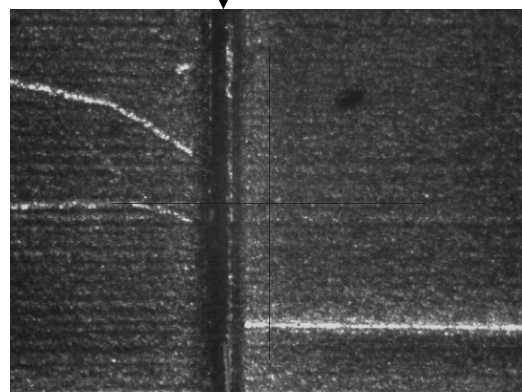
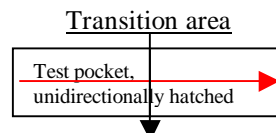
### Executing the first pulse test:

A blank must be clamped and the part zero offset must be set.

Infed, track distance and lamp current must correspond to the provided machining technology.

Then select the „First Pulse Test“ function from the list in the technology window.

After clicking on the **Start** button, two pockets of a size of two times four mm lying edge-to-edge are produced on the blank. Depending on the setting of the first pulse killer function, hills or craters are generated at the transitions.



After producing the double pocket, the camera is moved to zero (6.2.1).

The figure on the right shows the transition area between both pockets; the first pulse killer setting is too strong as you can see from the clearly visible hill.



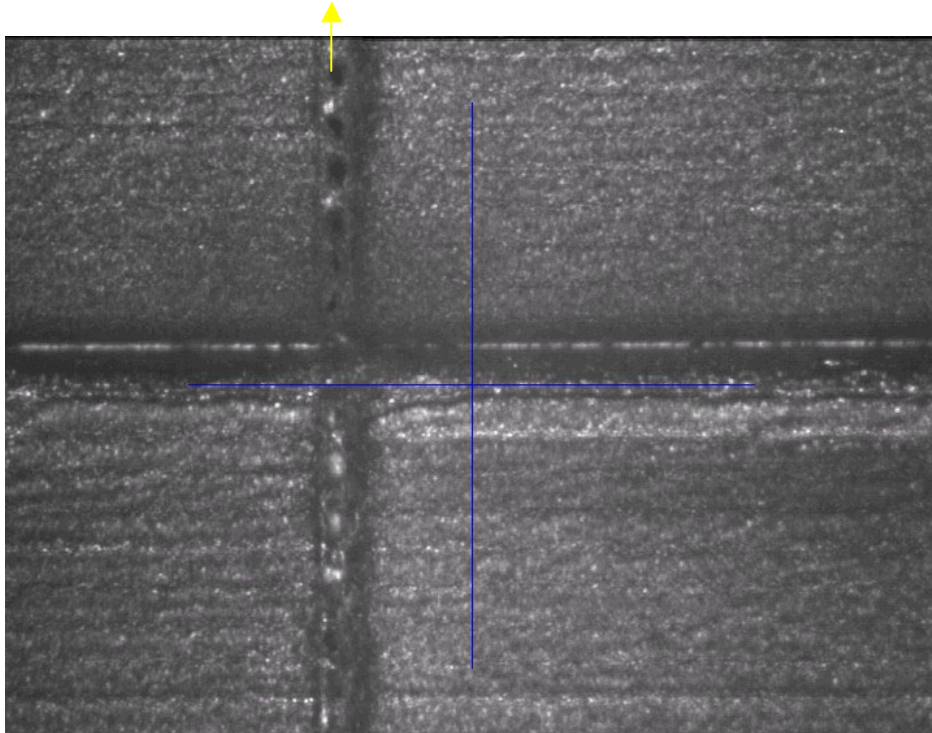
The following figure shows the transition area of two pockets positioned directly next to each other.

The double pocket visible in the upper half of the figure was produced using the following first pulse parameters:

Suppression of the first pulse : 300  
Maximum ramp value : 100  
Number of pulses until full intensity is reached : 15

The first pulse killer value is too low.

This becomes appearance by the dot-shaped burn-ins inside a ditch.



To produce the pocket as shown in the lower half of the figure, the level of the first pulse killer was raised by 200.

Suppression of the first pulse : 500  
Maximum ramp value : 300  
Number of pulses until full intensity is reached : 15

The dot-shaped burn-ins are clearly reduced, the ditch produced is less deep.

The optimum settings for the first pulse killer function must newly be defined by way of try and error after altering the feedrate or the Q switch opening frequency.

#### 4.2.6.4 Mechanical first pulse killer function:

The (optional) mechanical first pulse killer replaces the software-supported pulse suppression.

### 4.3 Storing technologies:

It is recommended to store successfully used parameter sets for later use.

For this purpose, the parameter panel offers the  function.

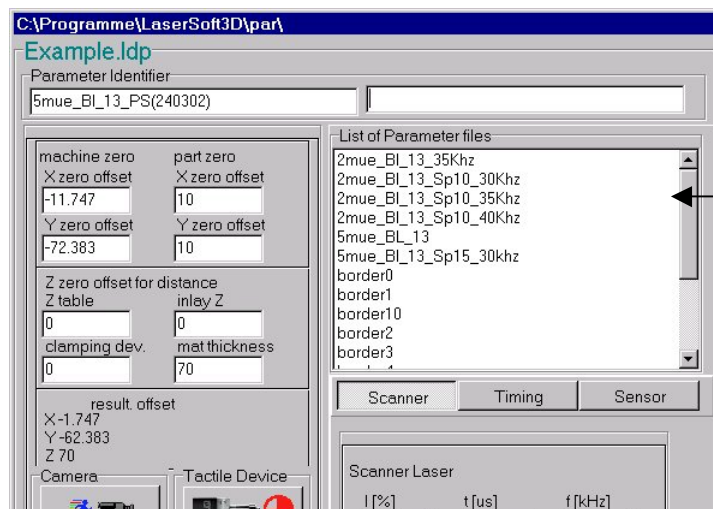
Press



As standard, Lasersoft3D opens the directory „par“ which is factory-set under c:\programme\lasersoft3d for parameter files; using the standard windows dialogue, you may create any number of new directories or switch between the existing ones.

If the parameter set to be stored is backed up in a new directory, Lasersoft will use this directory as actual parameter directory.

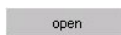
### Opening an existing parameter file:



The technology sets stored in the active directory are displayed in the parameter dialogue.



Activate the desired parameter set with a mouse click.

The  function allows for selecting a parameter file from another than the actual directory.

The newly open directory remains the preset parameter directory until the directory is changed with „Store as“ or „Open“.



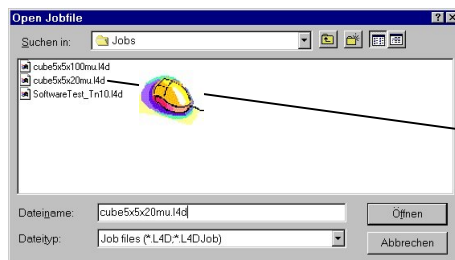
## 5 Machining start

### 5.1 Open job files for machining:


The programming system LPSWin calculates the engraving traces required for generating the cavity from the geometry data and stores the traces in a machining file (L4D file).

You may open a machining file from the main window by clicking on the open

job button



The desired file may be selected from the standard dialogue field, for instance

 cube5x5x20mu.l4d

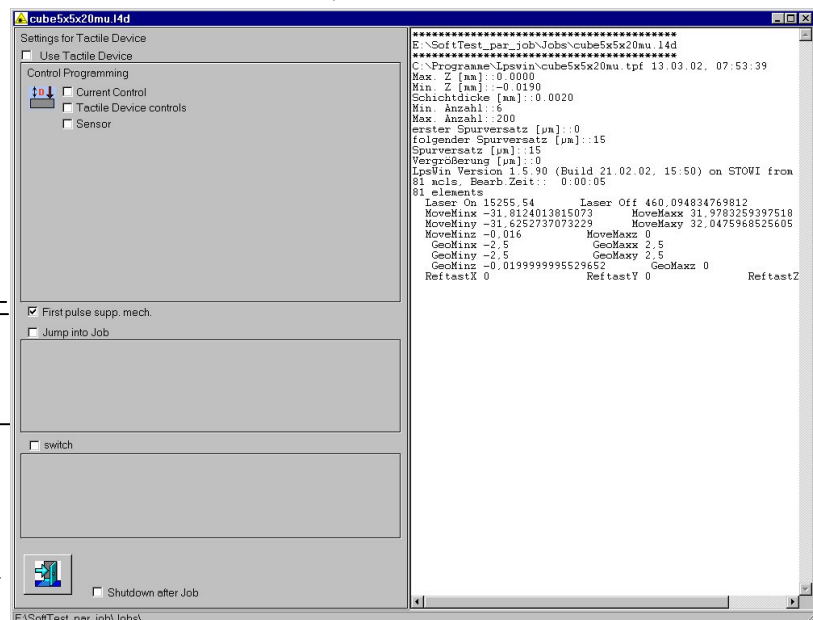
Settings for tactile device

and current control

Selection of the mechanical first pulse killer

Restarting an interrupted machining process

Switching the technologies during the machining process

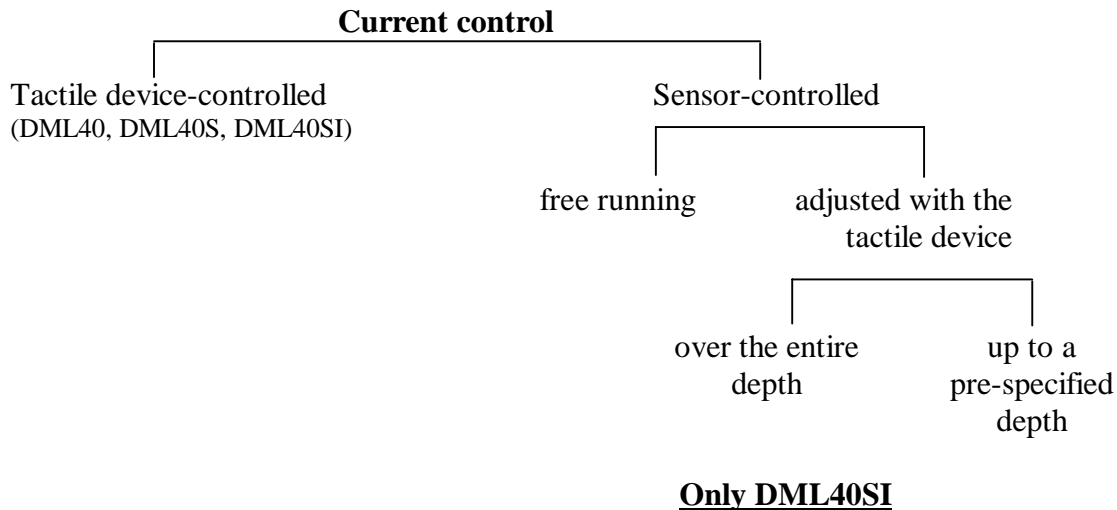


## 5.2 Current control:

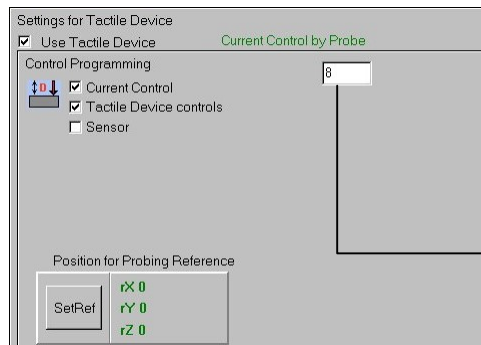
### Condition:

A measuring point was fixed when programming the part.

The machine types DML40 and DML40S only dispose of the option of a probe-supported control, the machine types DML40SI are additionally equipped with an optical sensor for in-process control.



### 5.2.1 Tactile device-controlled current control




During the machining of the part, the depth of the cavity is measured using the tactile device after a pre-specified number of layers. Depending on the deviation from the nominal depth, the current for the subsequent layers is increased or reduced.

Enter the number of layers after the machining of which the control is to be started in the input field.

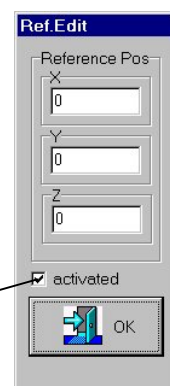
#### 5.2.1.1 Reference position

After activating the tactile device, a reference point may be defined on the surface of the blank outside the part.

Before every measurement, the depth is measured at this position and the measuring value is used for calibrating the tactile device.

For entering the probing reference point, click on the  button.

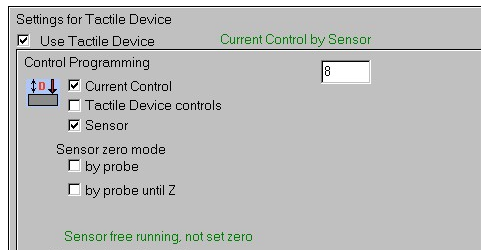
Enter the reference position on the panel as shown on the right and activate the referencing process.



## 5.2.2 Sensor-controlled current control

The sensor-controlled current control is only available for the machine type DML40SI.

### 5.2.2.1 Sensor-controlled current control - free running

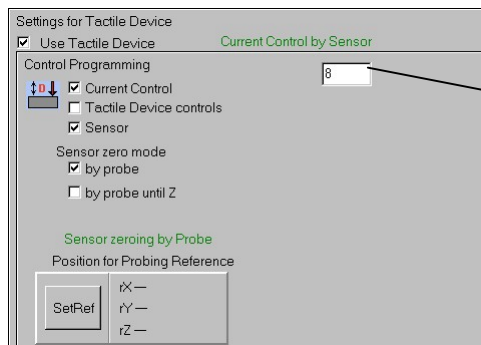


For determining the actual depth, only the measuring values of the optical sensor are used. If a measuring point was defined when programming the component, the tactile device may additionally be activated, the measured values are logged in the tactile device protocol of the main window but do not affect the control.

### 5.2.2.2 Sensor control with adjustment over the entire cavity depth (by probe)

#### Condition:

A measuring point was defined when programming the part

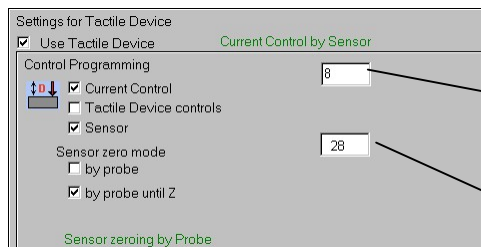


For determining the actual depth, only the measuring values of the sensor are used. After a pre-defined number of layers, the sensor is adjusted to the tactile device.

### 5.2.2.3 Sensor control with adjustment up to a given depth (by probe until Z)

#### Condition:

A measuring point was defined when programming the part.

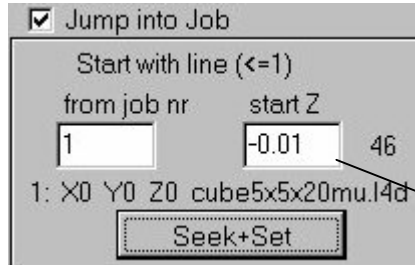


For determining the actual depth, only the measuring values of the sensor are used. After a pre-defined number of layers, the sensor is adjusted to the tactile device. The adjustment is only made up to the set number of layers.

### 5.3 Restarting an interrupted machining process

#### Condition:

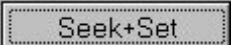
The Z coordinate at the point of time of the interruption is known, the part is clamped and the part zero offset was entered.





Open the machining file and enter the setting values for the current control.

Activate the ☒ Jump into Job option.

The Z coordinate of the position at which the machining process was interrupted must be specified here.

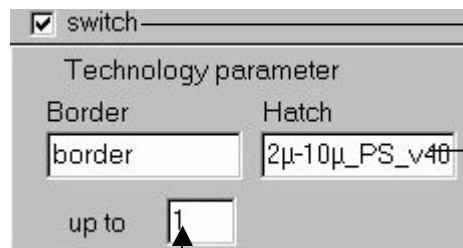
Click on the  button. The data set related to the Z coordinate is searched.

Quit the selection window with , then start the machining by clicking on the  button in the main window.

### 5.4 Switching to another technology parameter set

#### Condition:

The border cutting technologies (Border0..Border<n>) must exist.





Activate this option.

Name of the hatching technology

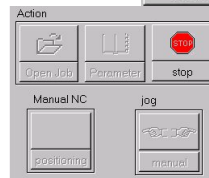
Number of border cutting technologies.

### 5.5 Start machining process

After closing the job selection window by clicking on the  button, the part machining may be started in the main window by clicking on the  button.

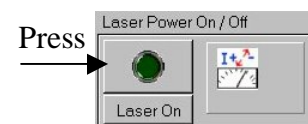


Press



Machining process can be aborted.


**Attention:** Switch on the laser before starting the machining process.




## 6 Auxiliary functions

### 6.1 Move axes:

For moving the axes, two functions to be called from the main window are available:

1. „Manual NC“, accessible by clicking on the  button in the main window.

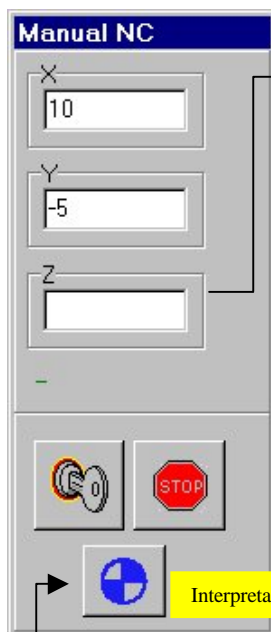
2. „Jog“, to be called from the main window by clicking on the  button.

#### 6.1.1 Programmed axis travel, „Manual NC“:

**Before executing this function, always reset the feed potentiometer to the zero position (fully turn to the left up to the stop).**

#### **Increased risk of interferences**

The X, Y and Z coordinates of the target point are entered in the appropriate input fields on the panel shown to the left.



→ Axes, for which no coordinates were entered, are not moved.

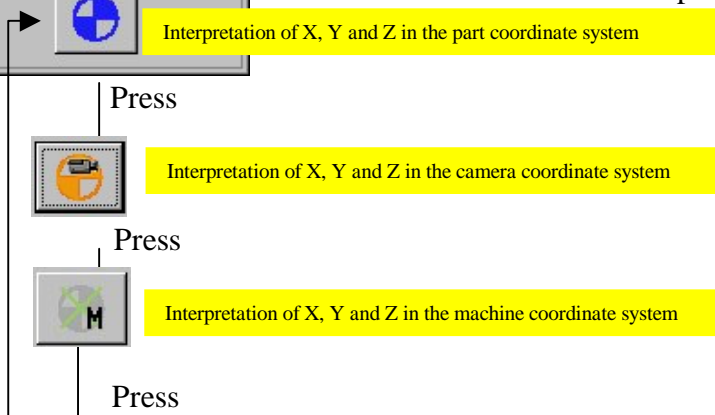


By clicking on the button with the key symbol, the process is started.  
Slowly turn the feed potentiometer to the right.

#### **Principally, the following must be observed:**

**While moving the axes, always observe the compound table - imminent interferences may often be avoided by quickly pressing the emergency STOP button.**

Before using this function, select the reference system in which the coordinates are to be interpreted.

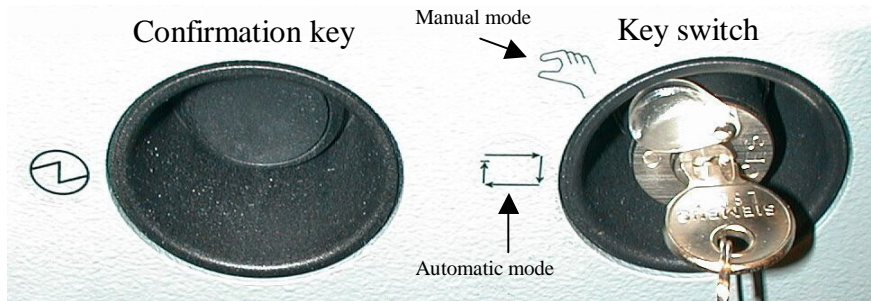


**This function can only be carried out with the doors to the machining area closed and locked.**

## 6.1.2 Move axes with jog keys:

This function may be executed with the door to the machining area closed and locked and the key switch at the front of the control unit set to „Automatic“ mode.

If axes must be moved with the door open, turn the key switch to the „Manual mode“ position; for moving an axis, the confirmation key must be kept pressed.



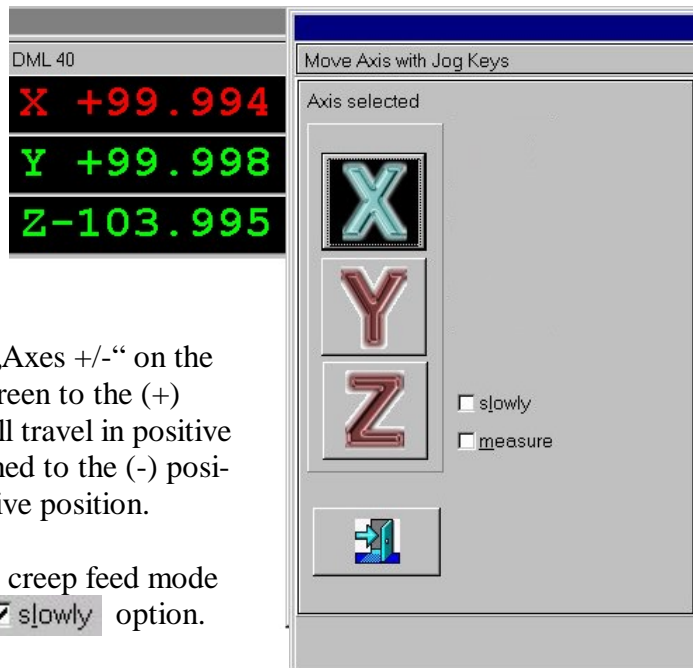
Confirmation mode and key switch

Activate the dialogue „Move Axis with Jog Keys“ by clicking on the




button in the

Select the axis to be moved by clicking on **X**, **Y** or **Z**. The colour of the position values displayed for this axis in the main window changes to red, and the appropriate button under „Axis selected“ is marked accordingly.



Through turning the switch „Axes +/-“ on the operating panel below the screen to the (+) position, the selected axis will travel in positive direction; if the switch is turned to the (-) position, the axis moves in negative position.

For a higher positioning accuracy, the creep feed mode may be activated by clicking on the ☒ slowly option.

You may quit this function by clicking on the  button.

**For safety reasons, the feed potentiometer may be opened (turned to the right) by half at maximum if axes are moved manually.**





## 6.2 Microscope camera:

The microscope camera serves the high-accuracy positioning of the parts in the X/Y plane. The resolution of the camera amounts to 4  $\mu\text{m}$ .

### 6.2.1 Open camera panel:

The parameter panel offers the "camera" function group.

The  function opens the camera window and simultaneously the input field for manually moving the machine axes, supplemented by the "Store Offset" and "Camera to 0" options (see figure on the right).

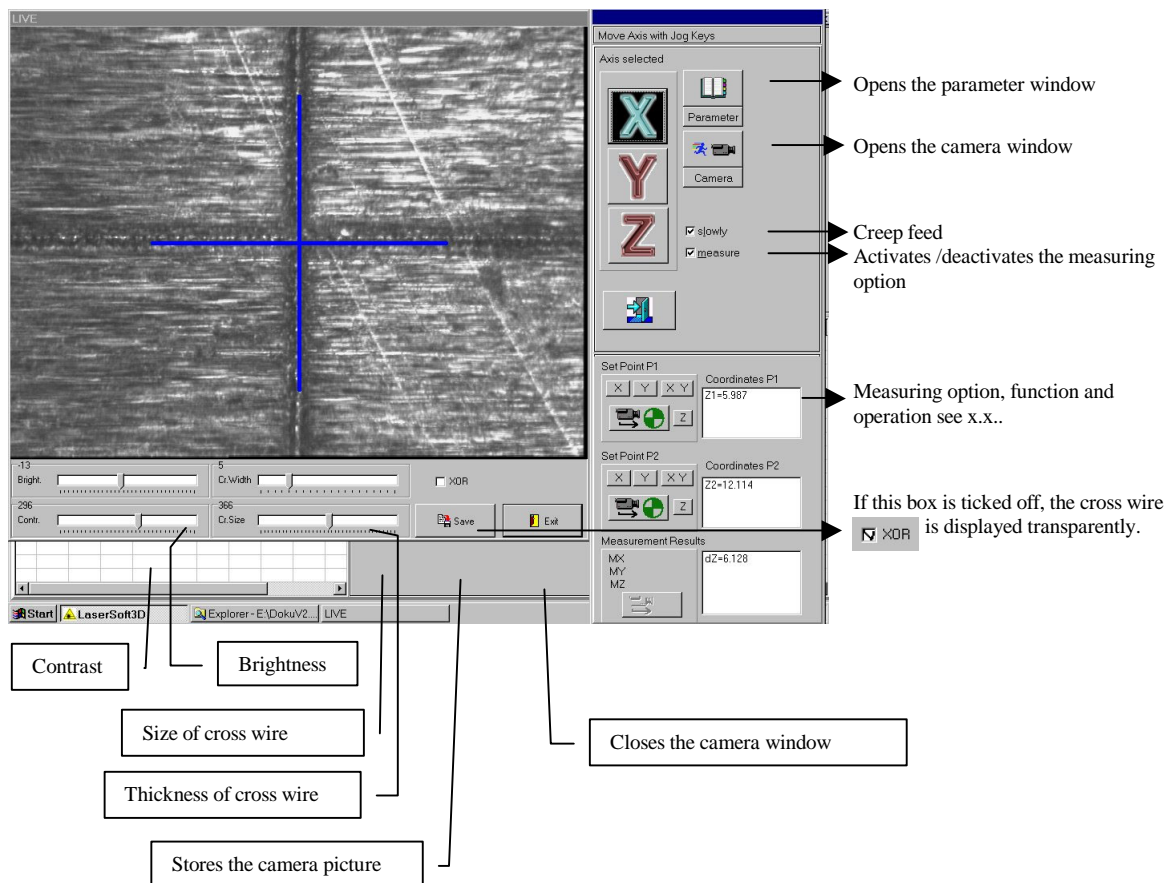
 This option functions in the same way as "Start Camera", however, simultaneously the compound table is moved to the set zero offset below the camera. For this purpose, a valid zero offset must have been set up beforehand (compare chapter 3).



### If no zero offset has been set up, there is the risk of interference.

For safety reasons, the feed potentiometer should be reset to zero (fully turn to the left up to the stop) before activating this function.

This function can only be executed with the door closed and locked. If the positioning is to be done with the door open after the zero offset return, turn the key switch to the manual position; this unlocks the door, and you may position the axes manually with the confirmation key kept pressed.



### 6.2.2 Compensate for camera offset:


For constructive reasons, the camera is installed offset from the machine origin. The offset between camera zero offset and machine zero offset is stored in Lasersoft. After prolonged operation of the machine, it is recommended to compensate for the camera offset.

#### Conditions:

A blank, preferably with anodized surface, has completely been set up with zero offset. The laser is switched on.

For compensating the camera offset, proceed as follows:

Reset the feed potentiometer to zero (fully turn to the left up to the stop).

Click on the  button in the parameter dialogue.

Slowly open the feed potentiometer.

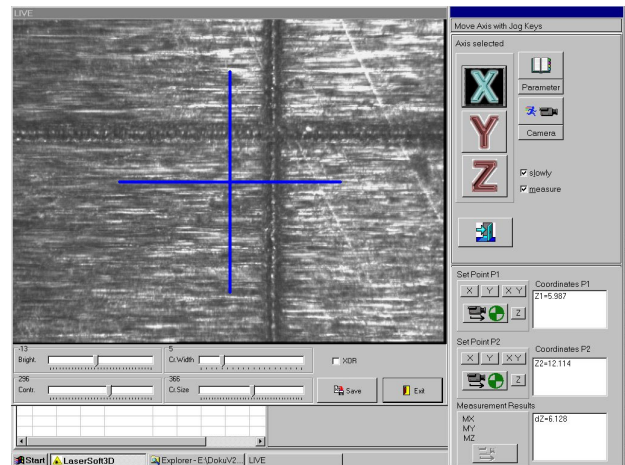
A cross wire is engraved on the part at the zero offset.

Click on the  button.

If the camera offset is correct, the engraved cross wire and the cross wire of the camera must precisely be congruent (compare figure in 6.2.1).

If this is not the case (compare figure to the right), the cross wire of the camera must be made congruent with the engraved one by manually moving the axes (6.1.2).

Save the new camera offset value by clicking on the  button.



**This process should be carried out before each precision machining process.**

### 6.3 Notebook

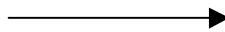
A notebook is integrated in Lasersoft.

You may call this notebook from the main window

by clicking on the



button.



You may now enter any text you wish in the window via the keyboard.

**With the parameter window simultaneously open, four zero offset memories (P1 – P4) are active.**

#### Storing a zero offset:

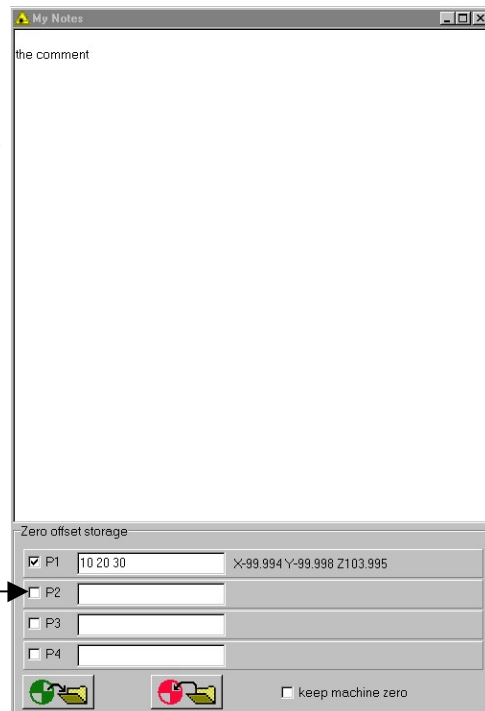
First, activate the point memory in which the actual zero offset is to be stored.

By clicking on the



button, the actual

resulting zero offset is saved in the memory.



#### Restoring a saved zero offset:

First, activate the point memory including the zero offset to be restored.

By clicking on the



button, the contents of the zero offset memory

is transferred to the parameter field.

#### Restoring a saved zero offset while keeping the actual blank zero offset:

Activate the ☒ keep machine zero option, then restore the zero offset as described above.

The stored zero offset is split up into blank zero offset and part zero offset and transferred to the parameter field.

## 7 Short keys:

The following shortcuts are integrated in LaserSoft3D:

### LaserSoft3D Main Window

Ctrl-Alt-S	Same function as the <b>Tools</b> button in the Machine Window
Ctrl -H	Button <b>Move</b> or <b>Manual NC</b>
Ctrl -M	Button <b>Manual</b> Move Axis with Jog Keys
Ctrl -N	Button <b>Notebook</b>
Ctrl -O	Button <b>Open Jobfile</b>
Ctrl -P	Button <b>Parameter</b>
Strg -S	<b>Stop</b> button to stop the running machining process
Esc	Closes the error message window, if open

### Dialogue Manual NC

Input key	Enters a value in the X or Y field and jumps to the Y or Z field. In the Z field, the entry is completed and the move is started.
1-8	Sets the feedrate override to a value between 1 % and 125 %
Esc	Same function as <b>Cancel</b>

### Dialogue Manual Move Axis with Jog Keys

X	X axis ON/OFF button
Y	Y axis ON/OFF button
Z	Z axis ON/OFF button
1-8	Sets the feedrate override to a value between 1 % and 125 %
L	Switches the feedrate between normal and slow
Esc	Same function as <b>Cancel</b>

### Dialog Parameter

Esc	Same function as <b>Abort</b>
F7	Same function as <b>Store</b>
F8	Same function as <b>Store+End</b>
F9	Same function as <b>Store as</b>

### Dialog Tools and Settings

Esc	Same function as <b>Close</b>
Ctrl -N	NC program
Ctrl -I	IO inputs/outputs

### All dialogues

F1	Online-Html Help
----	------------------