General advice on how to handle the TCTControl box

The TCTControl boxes are available in 4 or 6 axes option. Both versions come with stepper motor outputs and: 1x USB client, 1x USB host, 1x 10/100 ethernet, 1x E-stop input, 6x Signal input (i.e. for limit switches), 1x spindel control ouput, 2x relais output, 1x UniPrint3D port and 1x Power supply connector (AC adapter included in delivery).

Note the following:

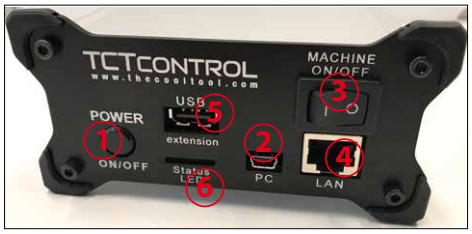
1) Never use the TCTControl box without the 24 V power supply. (24 V, 5A power adapter include)

2) Never plug or unplug the step motors during operation. The "MACHINE" [3] must be switched off first. This also applies to all other inputs and outputs on the rear panel.

3) Use the box in a dry environment. The ambient temperature should be between -10 and +35 degrees celsius (14 and 95 degrees Fahrenheit).

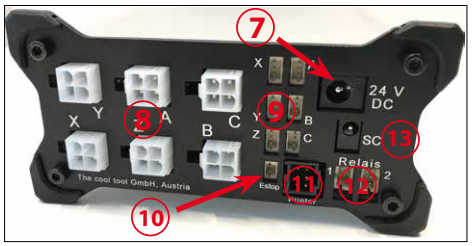
4) Only use the step motors supplied by us.

5) Turn on "MACHINE" only after the control software machinekit® (Cetus/machineface®) has been started. To simulate projects on the screen turn off "MACHINE".



1 ... boot/shut down button (software part)
2 ... connection to the PC (USB)
3 ... ON/OFF (stepper motor driver part)
The stepper motor drivers part is independent from the software part and must be switched on/off separately.
4 ... network connection
5 ... USB port to connect WLan adapter, flash drives, ...
6 ... status LEDs:

Blue LED shine
TCTControl software part is running
Blue and red LED shine
CNC application is running
software status -> machine power on
(ON/OFF button without function)



7 .... power connector (24 V / 5 A adapter)
8 .... machine axes (stepper motor)
9 .... input eg. reference switches
10 ... E-stop (art.no. 164 425 CNC)
11 ... connection to UniPrint3D
12 ... relais outputs 1 + 2 (signal 24 V)
13 ... spindle control output (0 - 10 V)

Connect the 24 V power supply to the TCTControl.
Use the supplied USB cable to connect TCTControl to a free USB port.

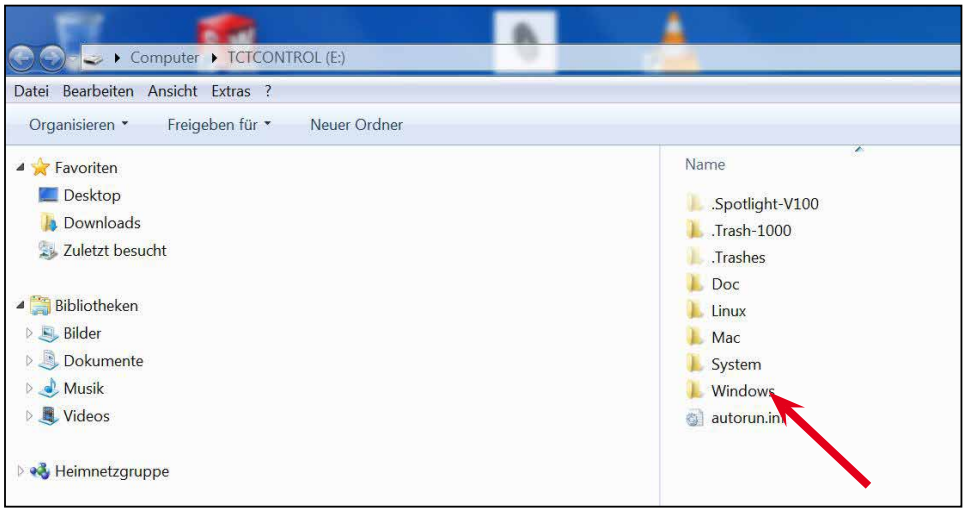
Wait until it shows under Windows.

(PC with Windows 7 or higher)

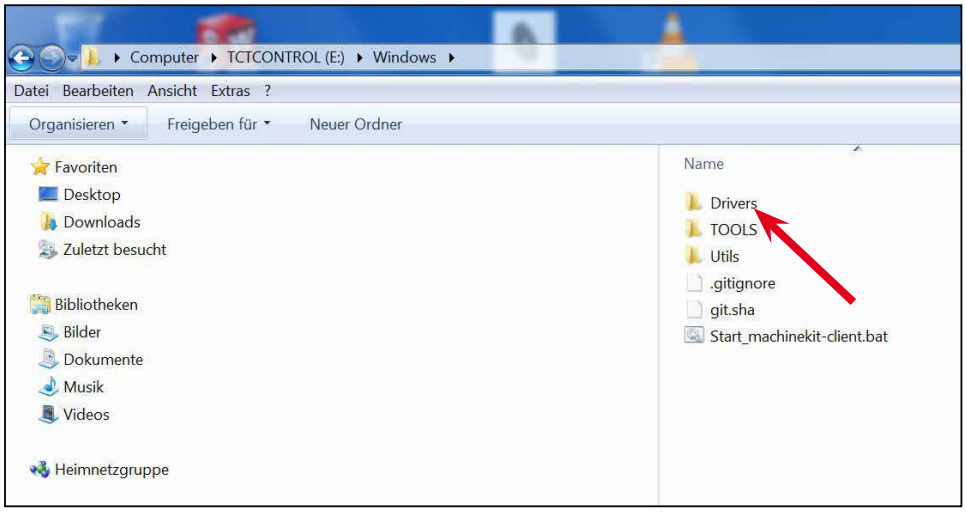
For Win8 and Win10 user:

a) disable the driver signature verification before you continue.
You can find many tutorials on the internet.
or
b) follow the video **https://youtu.be/y-rFVQplUWs**
(In this case, continue with „**Start CNC application 4.2.2**“.)

open folder „Windows“
on TCTControl

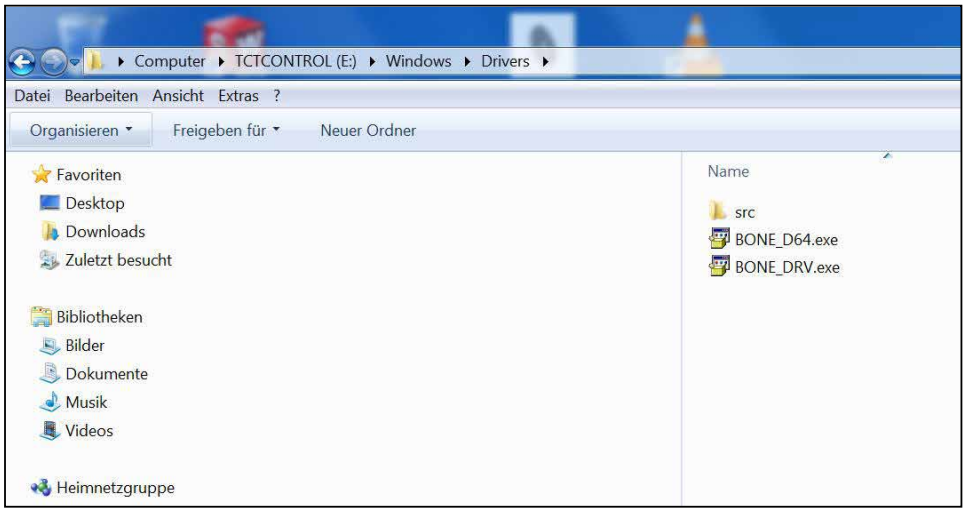


go to „Drivers“



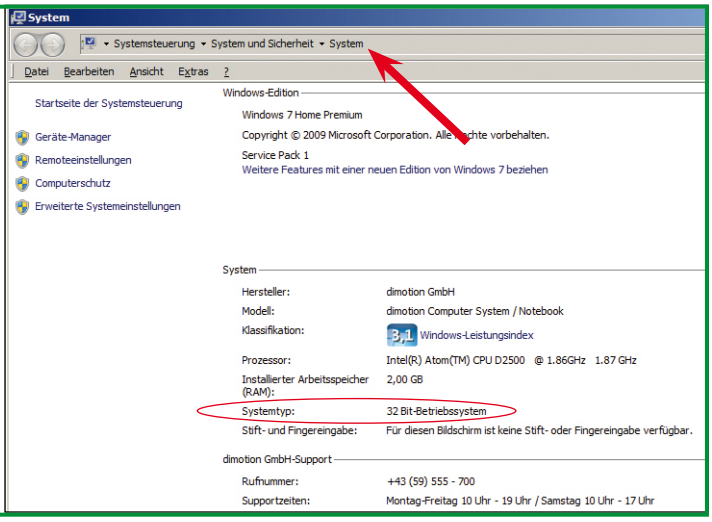
start „BONE_DRV“ for 32bit OS

start „BONE_D64“ for 64bit OS

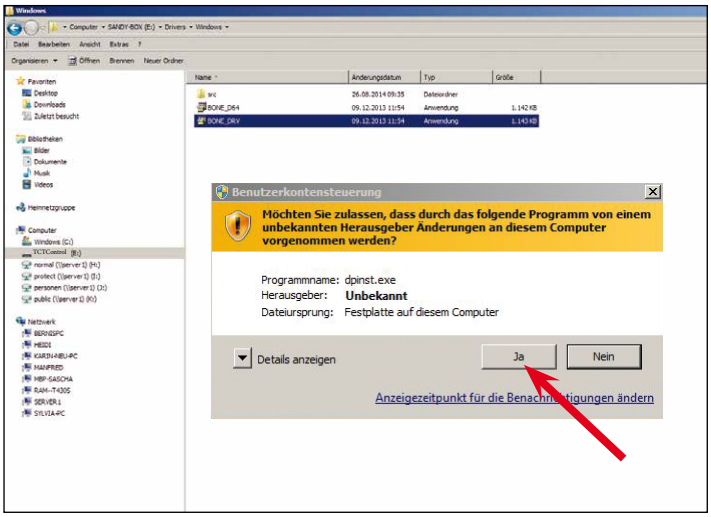


OPTIONAL

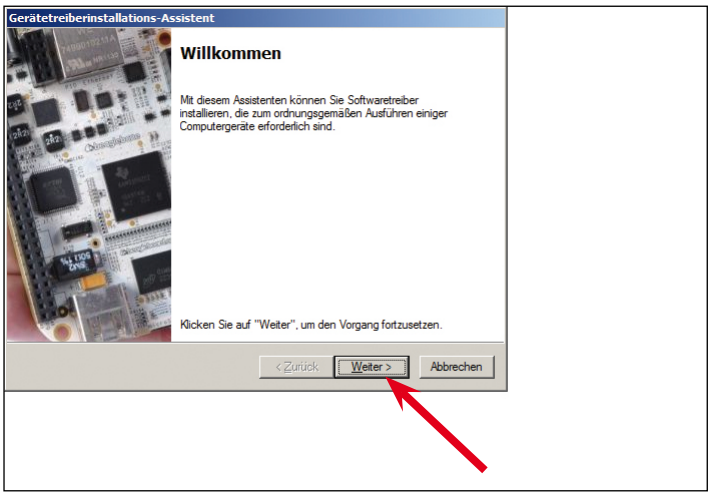
Under „Systeminformation“ you can find the information.



click YES



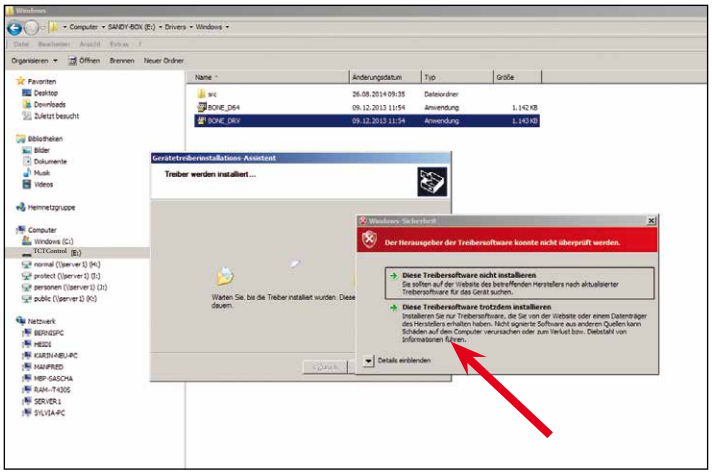
click CONTINUE



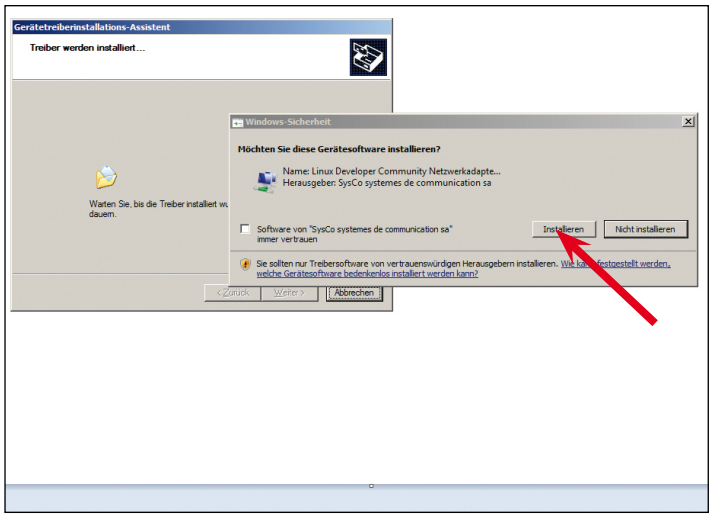
YES install this driver!

(This needs to be continued several times.)

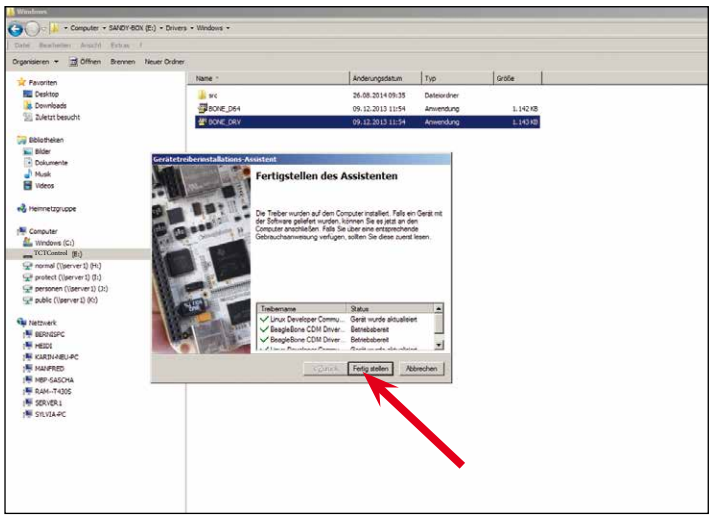
Also confirm all firewall and virus scanner messages concerning TCTControl.



click INSTALL

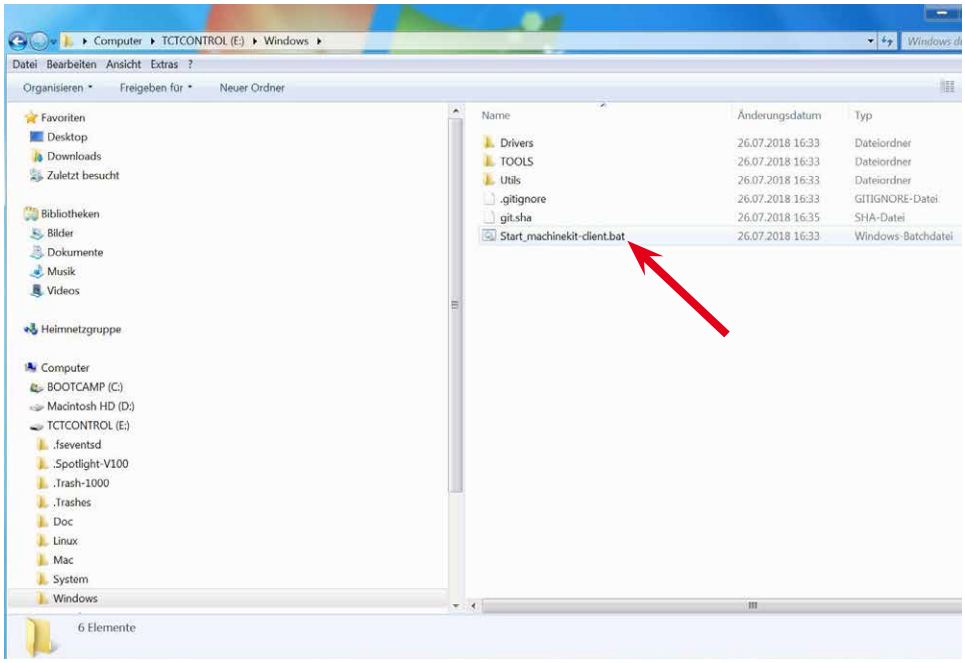


click COMPLETE

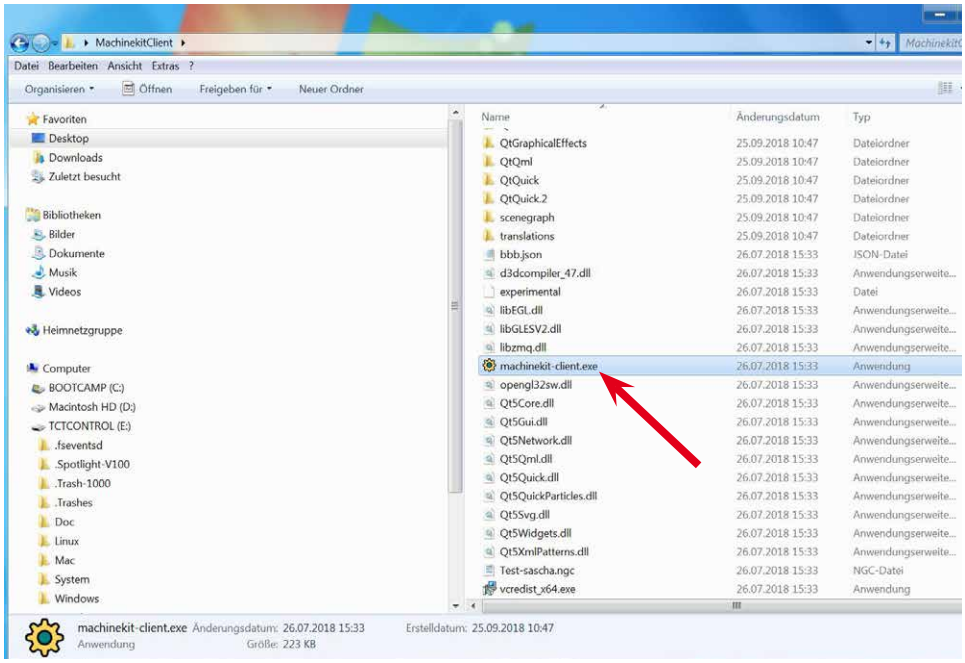


Start CNC application

Variant A:
Run the machinekit-client directly from TCTControl.
Go to
TCTControl\Windows\
start “Start_machinekit-client.bat”

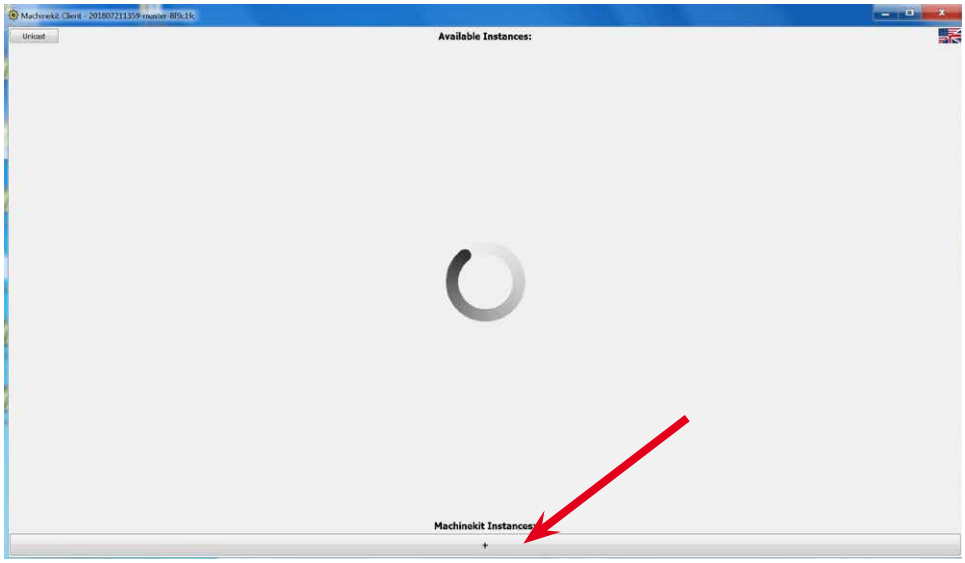


Variant B:
Run the machinekit-client from your Windows system.
Go to
TCTControl\Windows\Utils\
copy the folder “MachinekitClient “ to you system (eg.: to the Desktop),
Open the folder and start “machinekit-client.exe”



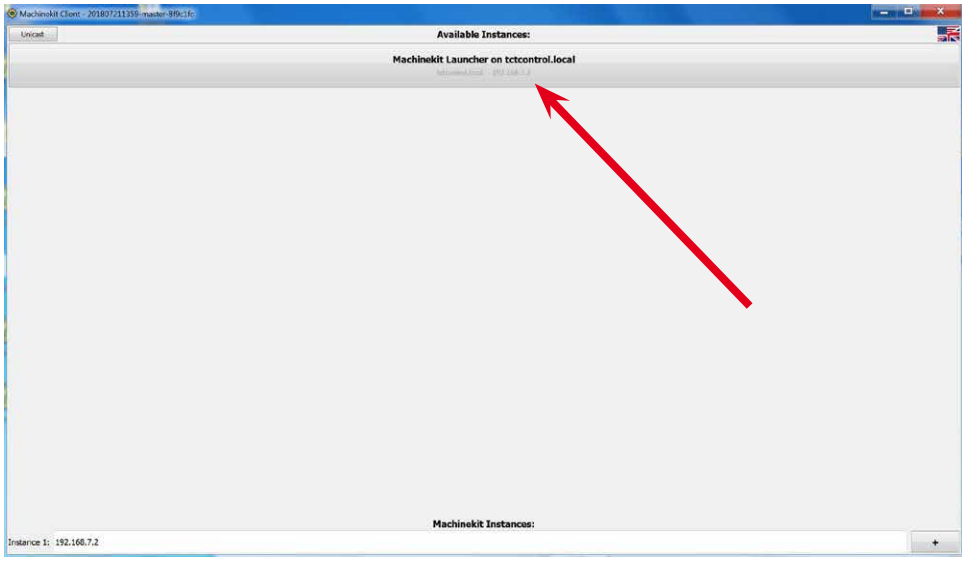
Machinekit-client starts

If you used variant B, than you must enter the IP of the TCTControl, at the first start.
Click at “+”



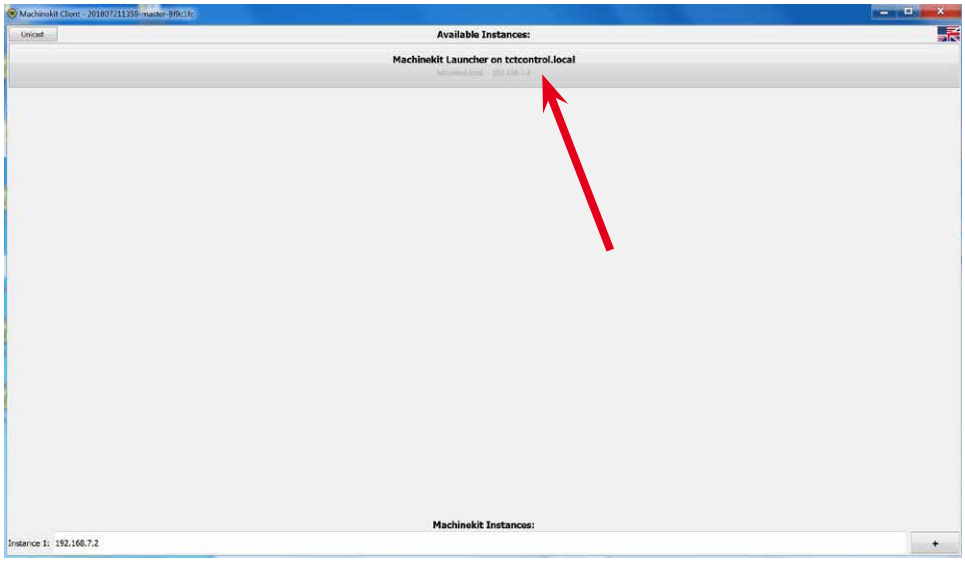
The standard IP of the TCTControl is: **192.168.7.2**

Few seconds later, the machinekit-client shows the connected TCTControl.

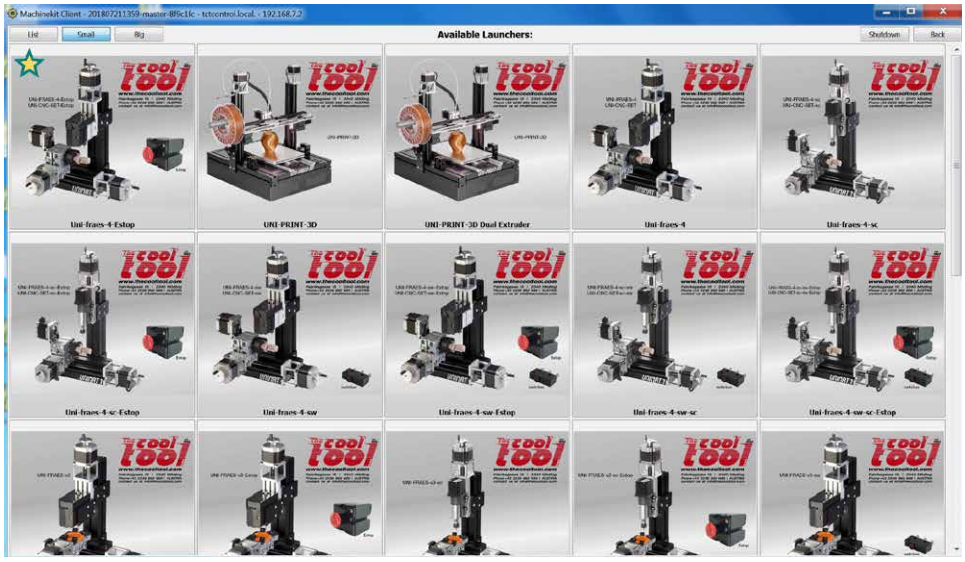


To change the language, click on the flag and select your preferred language.

Go to the machine menu.
Click on
“Machinekit Launcher .....”

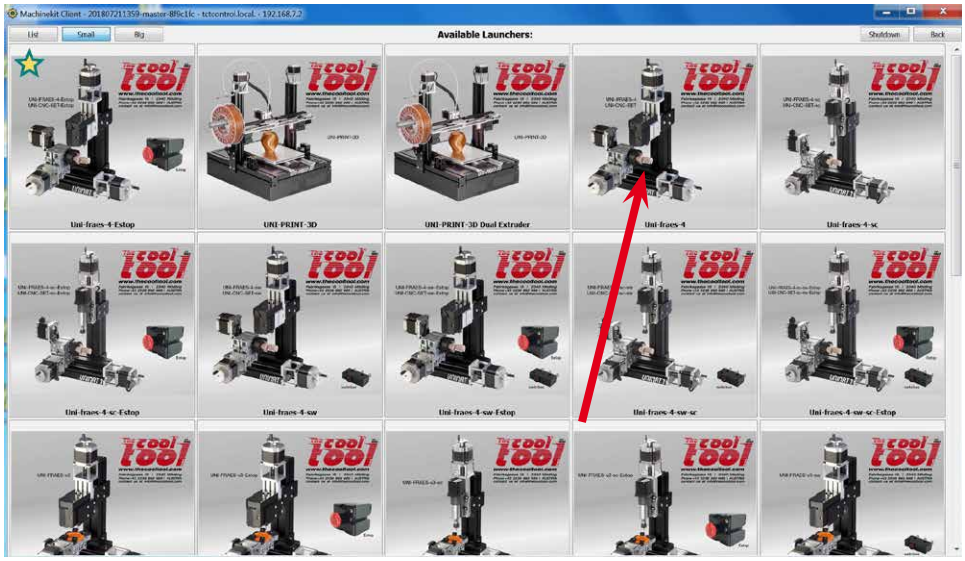


All available machine configurations are now being displayed.

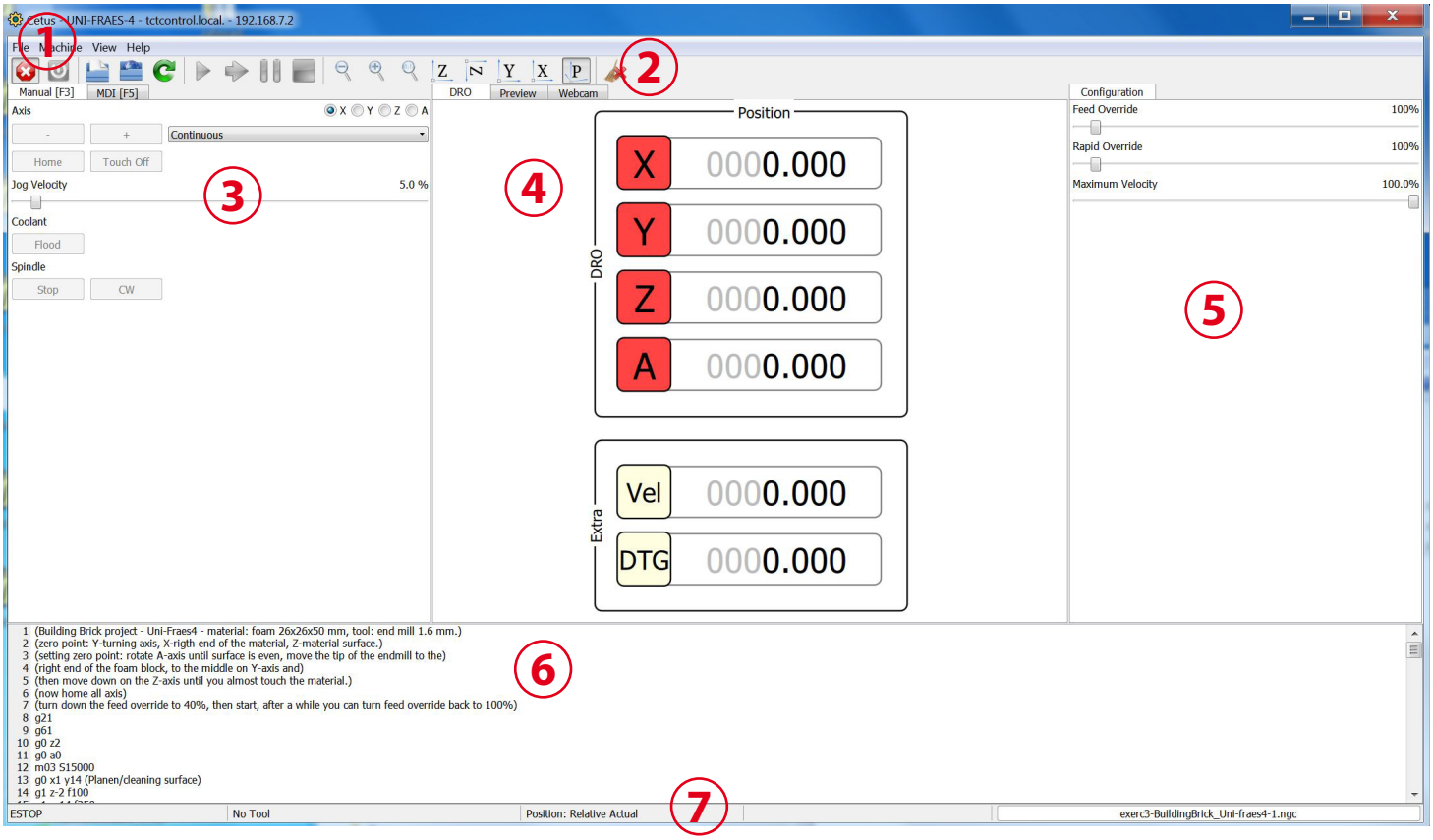


Use the STAR to rank machines up.

To start a machine configuration click on it.



The starting process takes some seconds.



1 .... menu bar

A1) File -> Open File --- To open file from PC or network and upload it to the TCTControl

A2) File -> Open File from Machine ---- To open file that already stored on TCTControl

A3) File -> Edit File with System Editor --- To edit the currently loaded G-Code file.

A4) File -> Reopen file --- After editing an open file, reopen it to update.

A5) File -> Edit Tool Table --- Add and remove tools.

A6) File-> Disconnect from Session --- Go back to the Launcher, without shutting down the running machine configuration.

A7) File-> Shutdown Session --- Shut down the machine configuration and go back to launcher.

A8) File-> Exit User Interface --- Closes the machinekit-client application, the machine configuration remains running.

B) Machine --- For more details take a look at point 2 „icon bar“

C) View --- Setup the user interface

2 .... icon bar

 E-Stop ON/OFF

 machine ON/OFF

 open file from PC

 open file from TCTControl

 reload open file

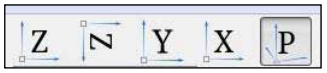
 start working process

 process only next line

 working process pause

 stop working process

 zoom function for preview



change preview view

 reset live plot

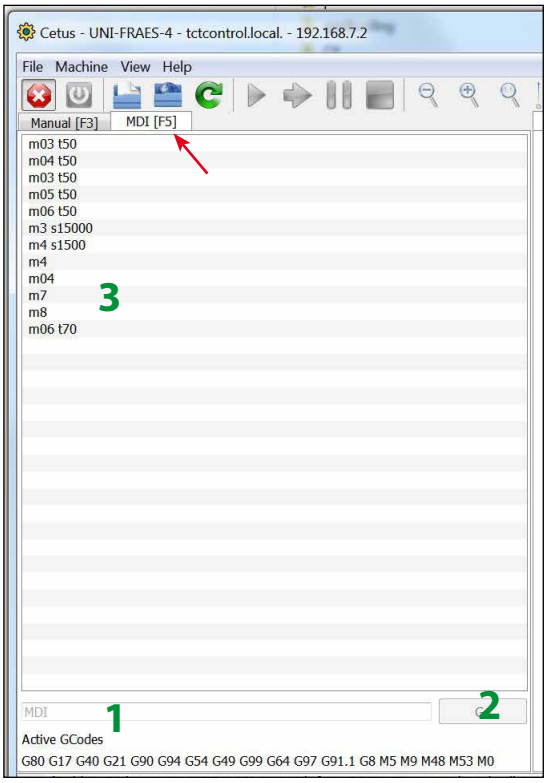
3 .... control area

Can only be used if E-Stop is OFF and machine is ON.

A) Manual

May slightly vary depending on the machine configuration.

1 ..... axis selection
2 ..... direction of movement
3 ..... distance of movement (0.001 up to continuous)
4 ..... referencing the axis (e.g. set zero point, ...)
5 ..... speed of the movement (feed rate)
6 ..... relais (cooling, dust extraction, ...)
7 ..... headspindel (ON/OFF, rpm, direction of rotation
available functions depend on the motor used.



B) MDI (manual data input)

Can only be used if all axes are referenced.

1 ..... enter one command line (e.g. G0 X10 y10)
2 ..... to execute inputted command, click here
3 ..... history of entered command lines

If you click on a line in the history, the line will be entered again (1).

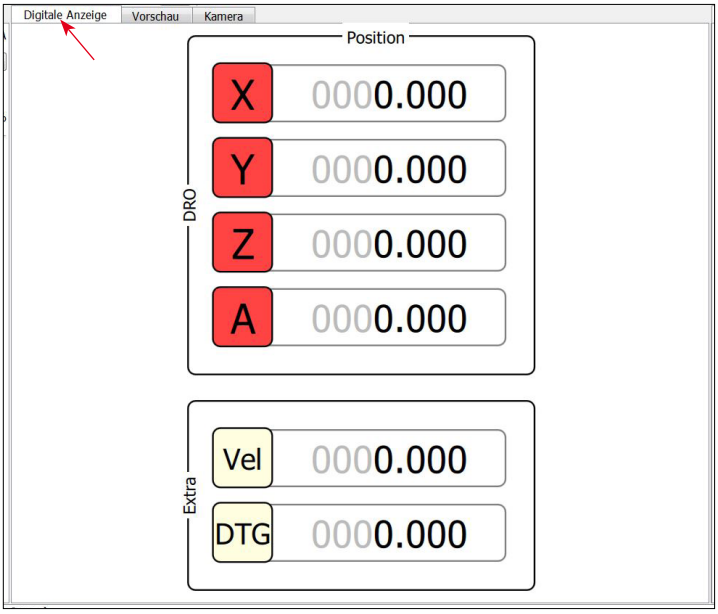
4 .... information area

DRO (digital readout)

X, Y, ... (depends on the machine used) show the actual positions of the axes. If the background is red, the axis is not referenced (homed). If the background is green, the axis is homed.

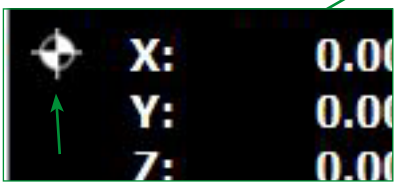
Vel .... actual speed of the machine movement.

DTG .... distance to go

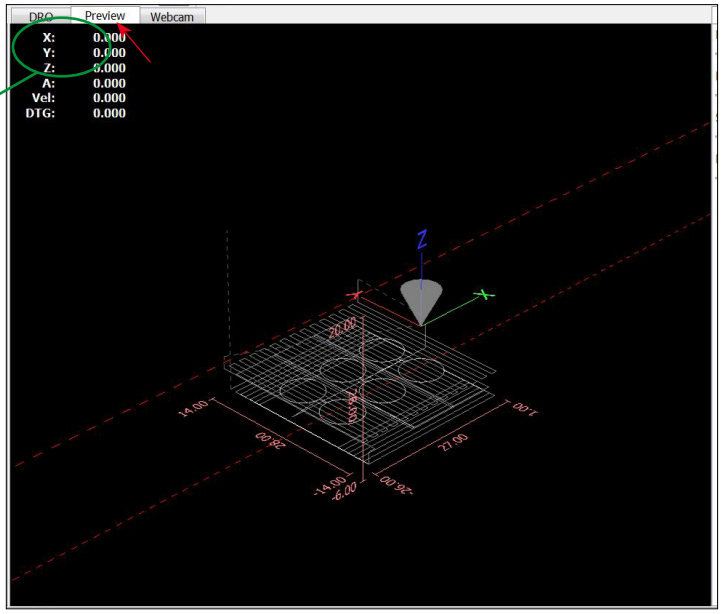


Preview

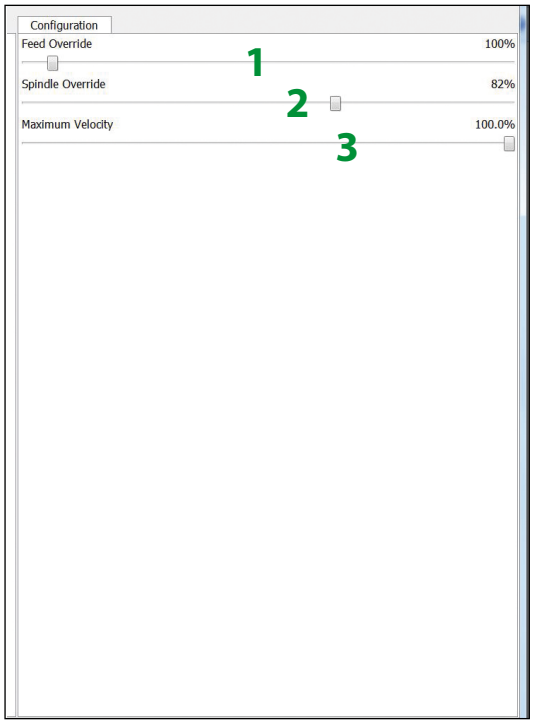
shows additionally all tool paths of the open G-Code files



marks referenced (homed) axis.

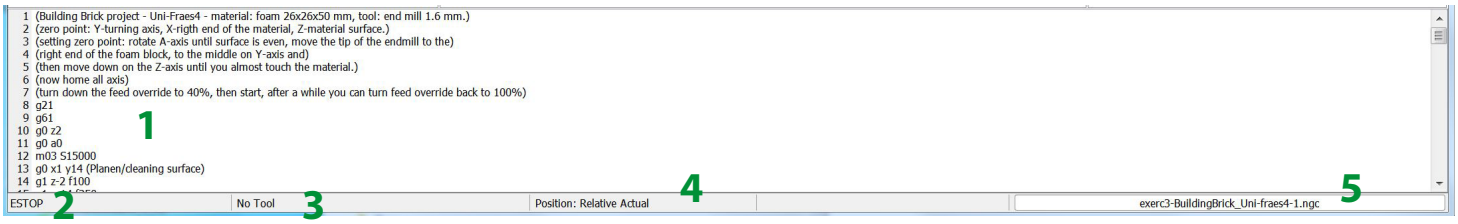


5 .... Configuration area



1 ..... Feed Override (override programmed feed rate [F] of loaded G-Code file)
2 ..... Spindle Override (override programmed spindle speed [S])
3 ..... Maximum Velocity (override the maximal speed of the machine)

6 .... loaded G-Code file and 7 .... info line

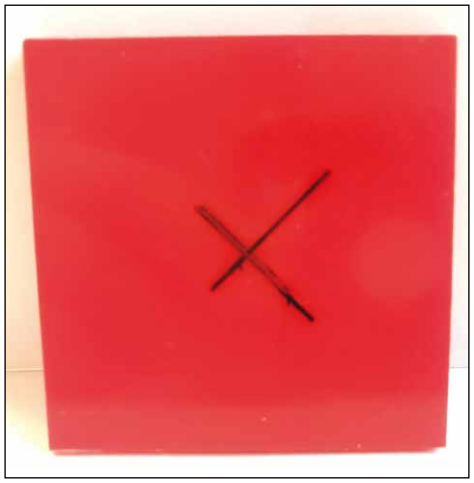


1 ..... Currently loaded G-Code file
2 ..... Machine status ON/OFF
3 ..... Currently loaded tool
4 ..... Position mode
5 ..... File name of the currently loaded G-Code file.

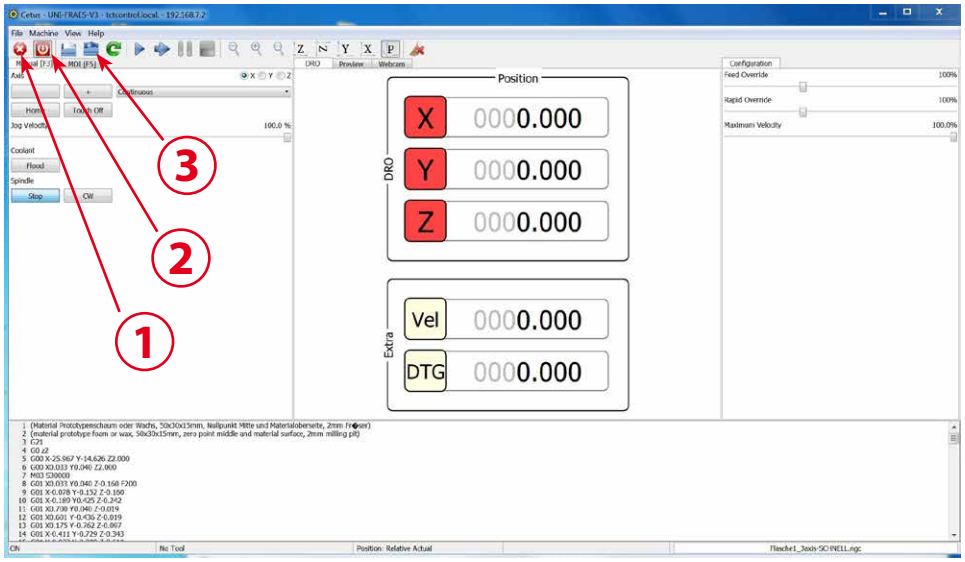
Cetus - start a sample file
[milling • cutting • turning]

Machine: UNI-FRAES-V3
File: Sample_M1.ngc
Raw material: Special colored Acrylic, 50x50x3 mm[art.no.: 166PLEXS]
Tool: 1.6 mm end mill

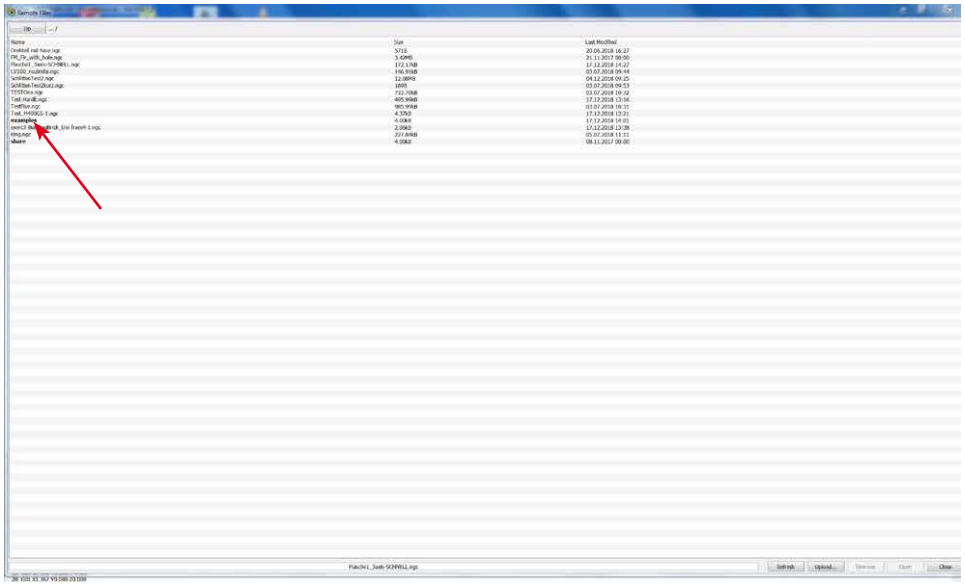
•) Mark the center of the square (raw material)
•) Use the clamping jaws to fix the raw material. Protect the machine table by placing a second plate (plywood or acrylic, thickness min. 3 mm) beneath the raw material.



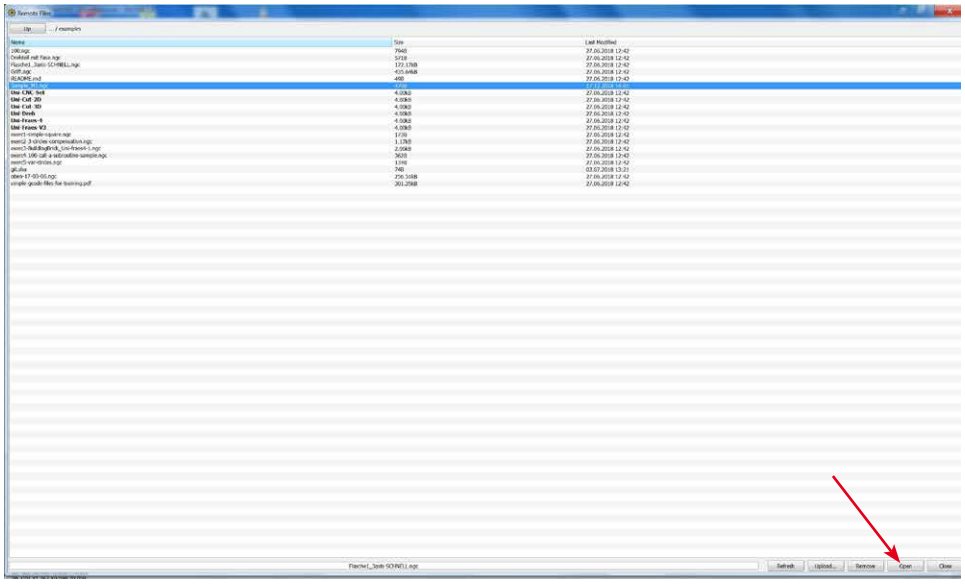
•) Start UNI-FRAES-V3 (machinekit-client)
1) Deactivate the E-Stop
2) Machine power ON
3) Open G-Code file stored on machine



double click on EXAMPLES



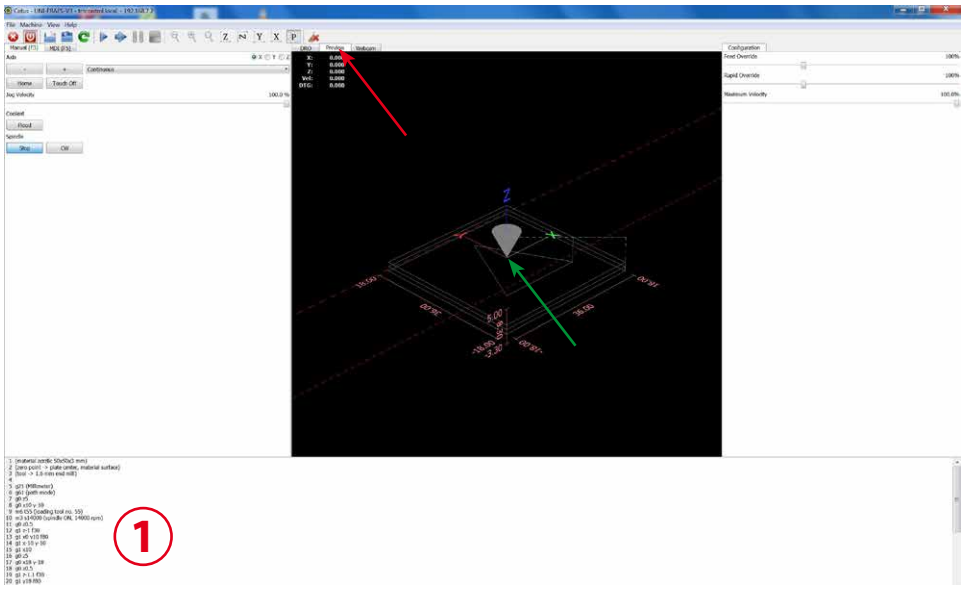
1) select the sample file [Sample_M1.ngc]
2) click on OPEN



switch to PREVIEW

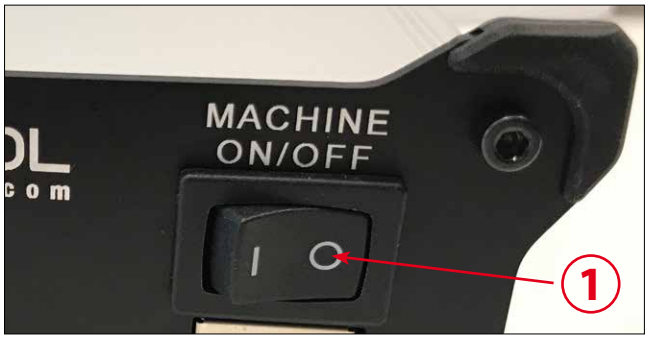
Origin of the coordinate system = workpiece zero point

1 ... Currently loaded G-Code
Comments can be written in brackets ().



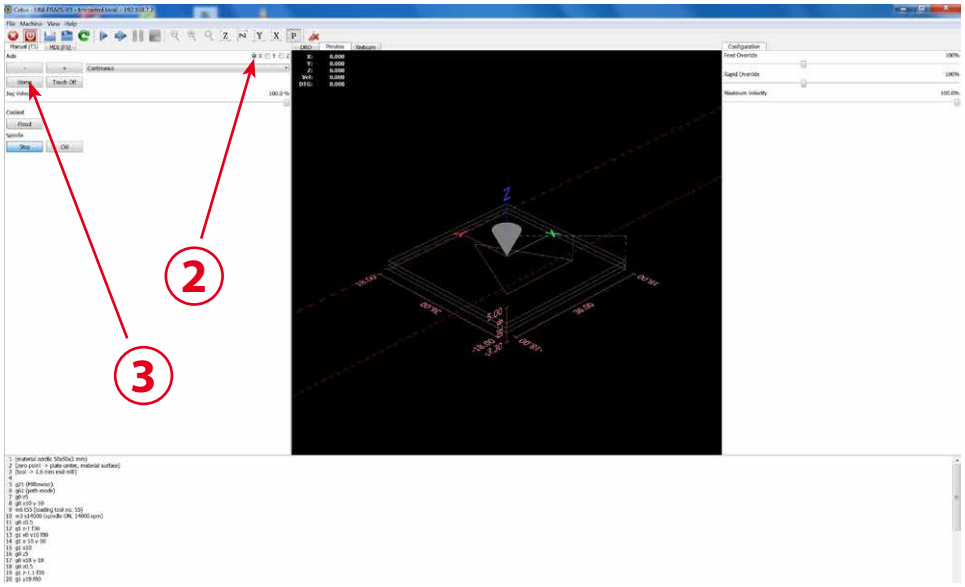
•) Simulate the G-Code

1 ... Turn MACHINE OFF!
2 ... Select the X axis
3 ... click HOME



Repeat the process with Y and Z axis.

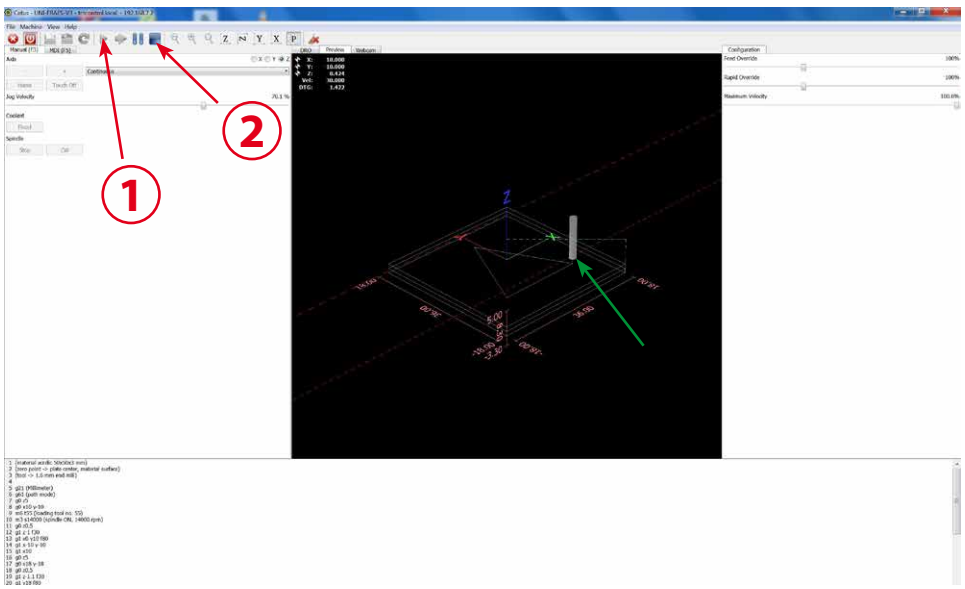
Now all 3 axes are homed.



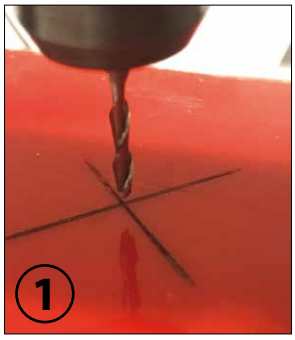
1) click on „PLAY“

The simulation is running.

2) click on „STOP“ to stop the simulation



•) Run the G-Code at the milling machine



1 ... move the milling head (X/Y axis) to the zero position at the raw material.
2 ... put a thin paper between raw material end milling head. Go down with the Z axis and stop if the paper get stuck.
3 ... now the milling head stay at the zero position.

For that work you can move the axes manual (using the hand wheels - MACHINE at the TCTControl must be OFF!
or
Use the Cetus software interface to move the axes - MACHINE at the TCTControl must be ON!

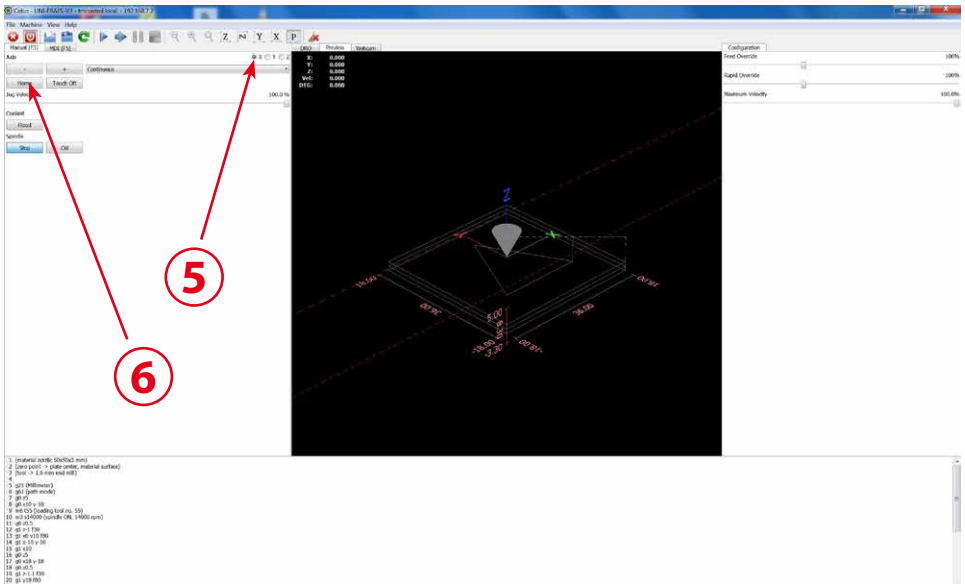
4 ... turn MACHINE ON at the TCTControl

5 ... select the X axis
6 ... click HOME

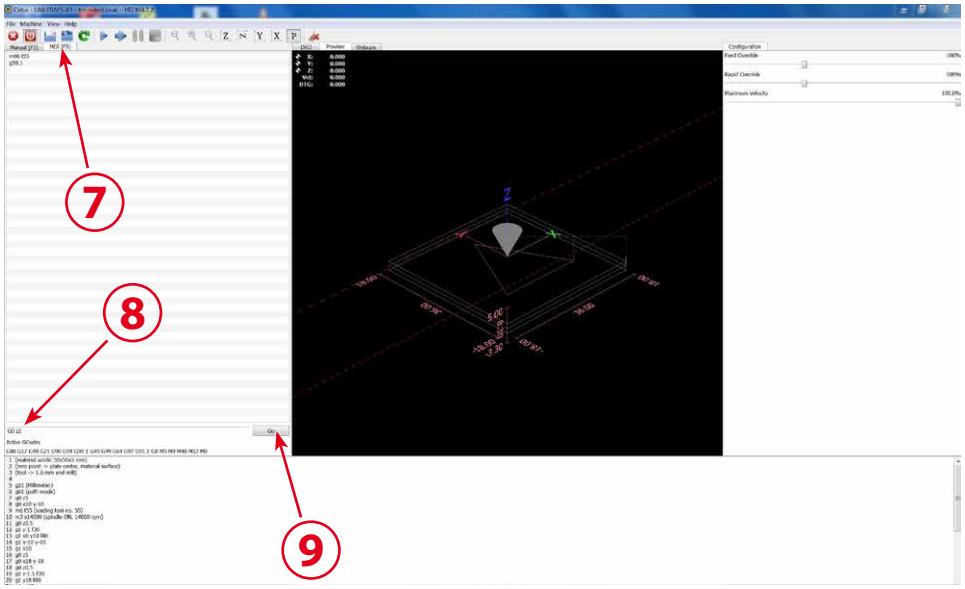
Repeat the process with Y and Z axis.

Now all 3 axes are homed.

If a axis is already homed, no problem, home it again.



7 ... switch to MDI
8 ... enter: G0 z2
9 ... click GO

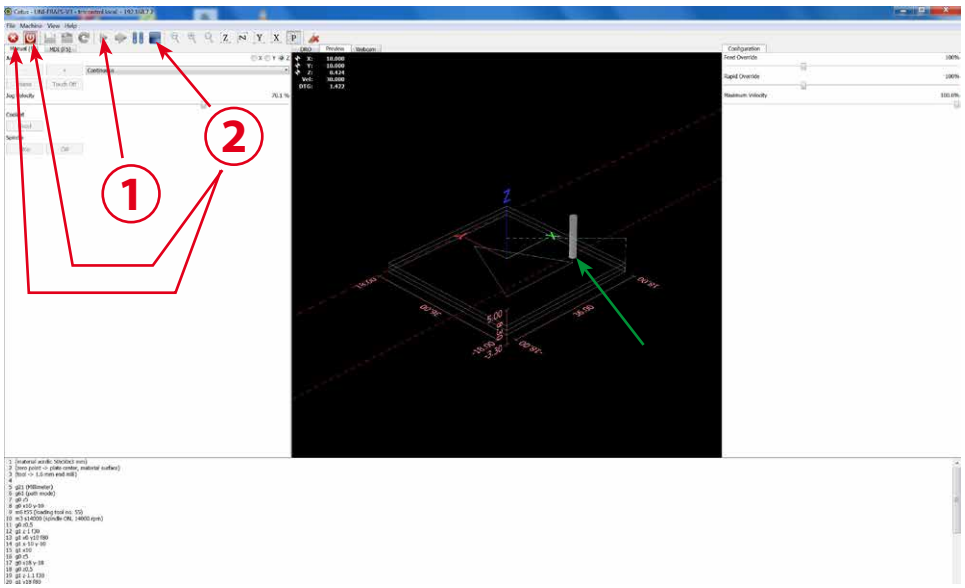


10 ... turn the milling motor ON

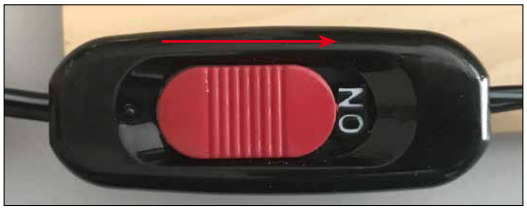
1) click on „PLAY“

The milling process starts.

2) to stop the machine (milling process) click on one of the three icons
a) E-stop
b) Machine power
c) Stop



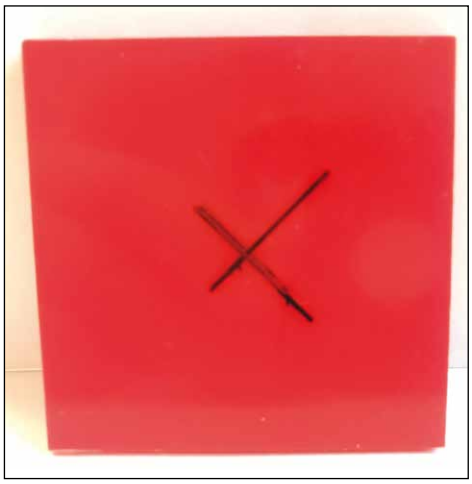
When the milling operation is finished turn the milling motor OFF!



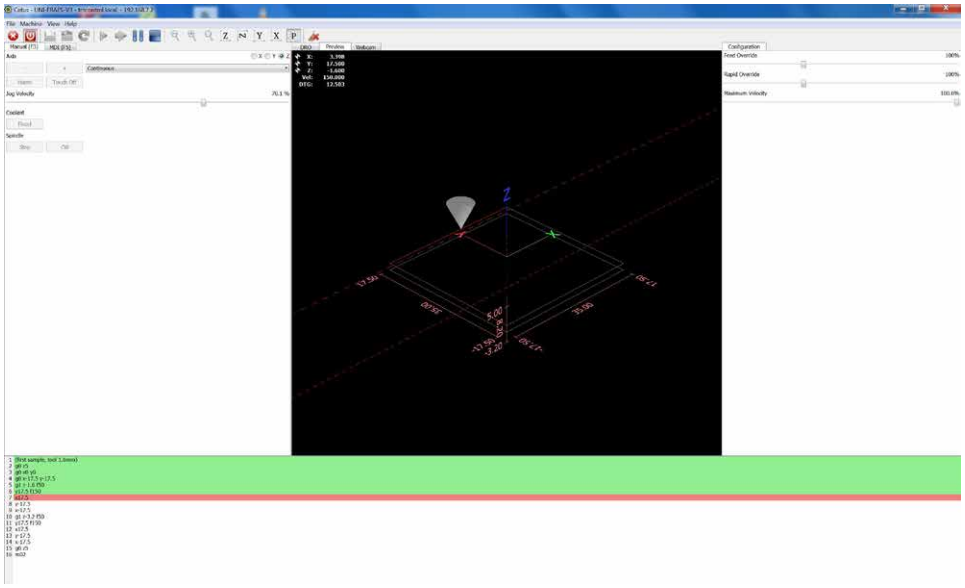
Exercise 1

Machine: UNI-FRAES-V3
File: .../examples/exerc1-simple-square.ngc
Raw material: Special colored Acrylic, 50x50x3 mm[art.no.: 166PLEXS]
Tool: 1.6 mm end mill

•) Mark the center of the square (raw material)
•) Use the clamping jaws to fix the raw material. Protect the machine table by placing a second plate (plywood or acrylic, thickness min. 3 mm) beneath the raw material.



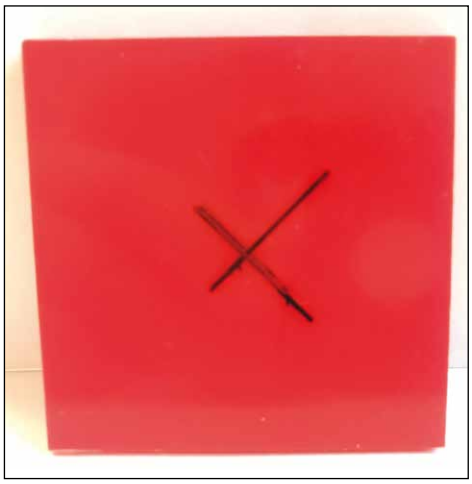
It is similar to the Sample_M1.ngc file



Exercise 2

Machine: UNI-FRAES-V3
File: .../examples/exerc2-3circlrs-g41_g42.ngc
Raw material: Special colored Acrylic, 50x50x3 mm[art.no.: 166PLEXS]
Tool: 1.6 mm end mill

•) Mark the center of the square (raw material)
•) Use the clamping jaws to fix the raw material. Protect the machine table by placing a second plate (plywood or acrylic, thickness min. 3 mm) beneath the raw material.

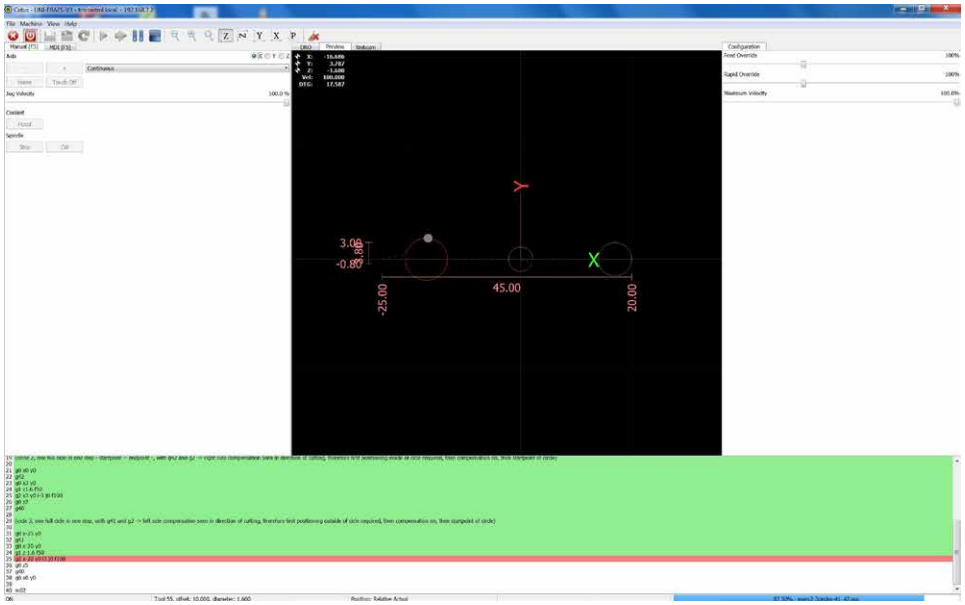


Programmed diameter of the circles is 6 mm.

1st circle (on right possition):
It is without tool diameter compensation. The diameter of the cut out part is 6 - 1.6 = 4.4 mm
The diameter of the cuted hole at the raw material is 6 + 1.6 = 7.6 mm

2nd circle (in the middle):
With tool diameter compensation. The diameter of the cut out part is 6 - 1.6 - 1.6 = 2.8 mm
The diameter of the cut hole in the material is 6 mm

3rd circle (on the left possition):
It is with tool diameter compensation. **The diameter of the cut out part is 6 mm.**
The diameter of the cut hole in the material is 6 + 1.6 + 1.6 = 9.2 mm

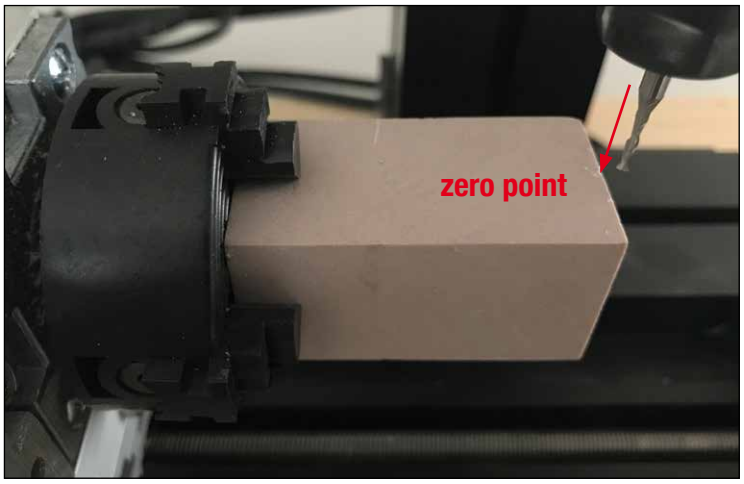


Experiment
Now replace the milling head at your milling machine - use for example a 1.2 mm end mill.
For tool number take a look at your tool table (t50 = 1.2 mm end mill)
Now „File =>Edit file with System Editor“, change the tool number from T55 to T50
Save as => exerc2-3circlrs-g41_g42-A.ngc ==> on the Desktop ==> open the new files in CETUS
Use a new raw material and cut the circles again (don't forget to update the zero point).
The diameters of the cuted hole (circle 2) and the cut out part (circle 3) will be also 6 mm.
It was only one small change at the G-Code file necessary!

Exercise 3

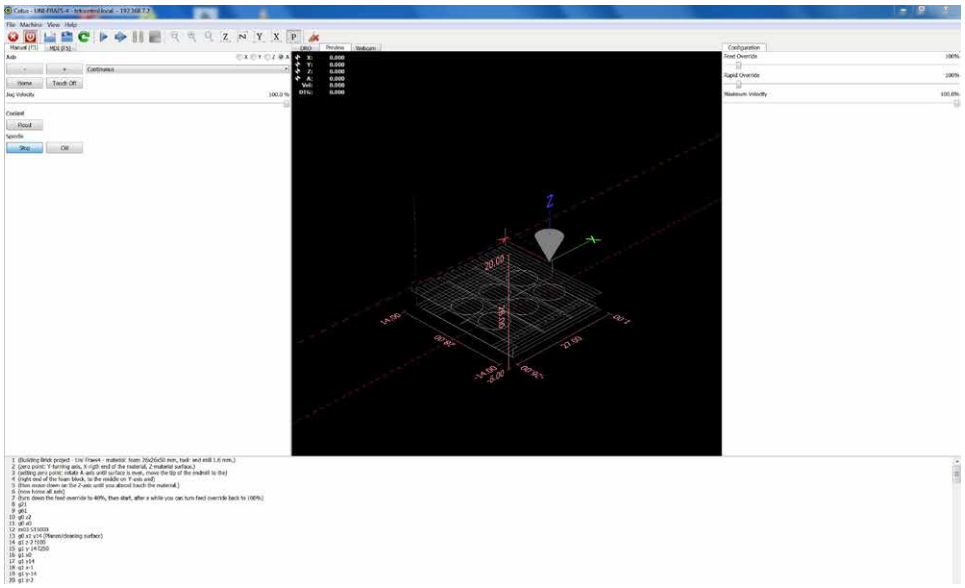
Machine: UNI-FRAES-4
File: .../examples/exerc3-BuildingBrick_Uni-fraes4-1.ngc
Raw material: Special milling foam, 50x25x25 mm[art.no.: 166FOAM S]
Tool: 1.6 mm end mill

•) Mark the zero point (raw material)
•) Use the 4 jaw chuck to fix the raw material.



After successfully milling this project the first time, try the following:

a) Go to „MDI“
b) Enter
G0 a180 => „GO“
c) Go to „MANUAL“
d) Home A axis again!
e) Now you can start the milling file again.

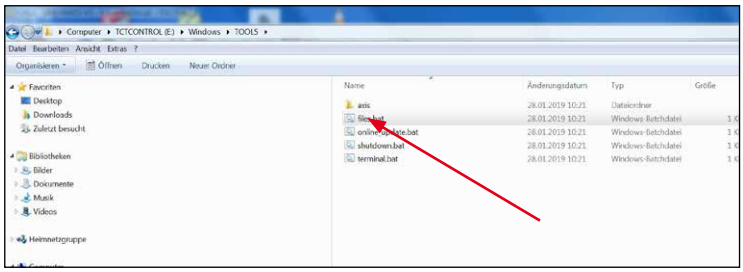


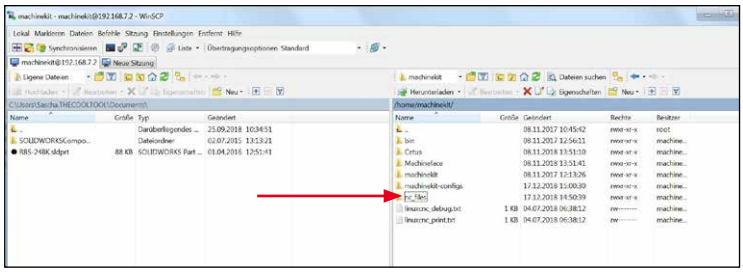
Exercise 4

Machine: UNI-FRAES-V3
File: .../examples/exerc4-100-call-a-subroutine-sample.ngc
Raw material: plywood or acrylic, dimensions depending on the selected parameters
Tool: 1.6 mm end mill

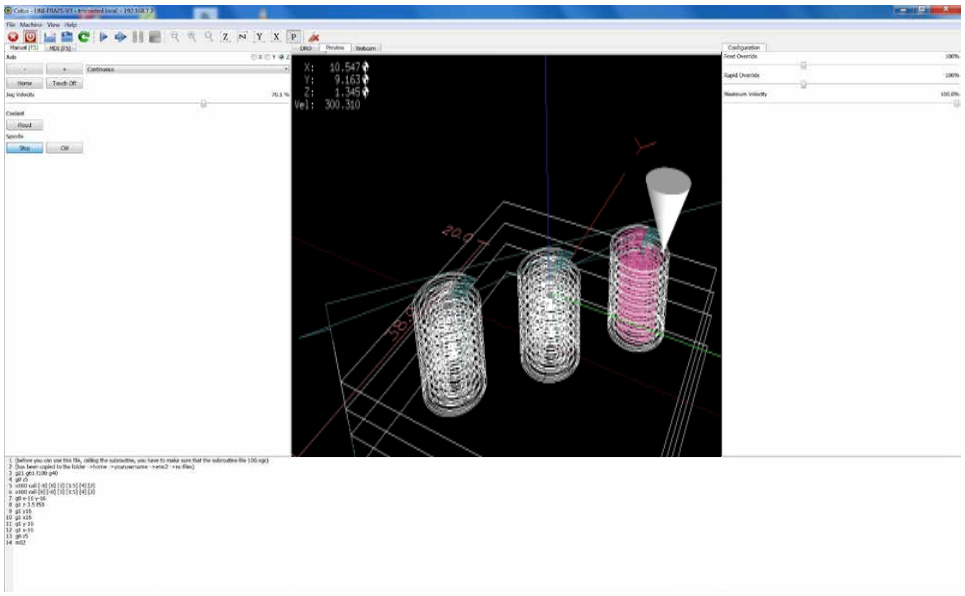
Preparation

•) Start the files.bat file at TCTControl/Windows/ TOOLS/
•) When asked for a password use: machinekit
The left part of the „WinSCP“ window is the file system of your PC. The right part is the file system of the TCTControl.
•) Go to nc_files/examples
•) Copy following files to the folder nc_files:
100.ngc
exerc4-100-call-a-subroutine-sample.ngc





•) Open the exerc4-100-call-a-subroutine-sample.ngc file in CETUS



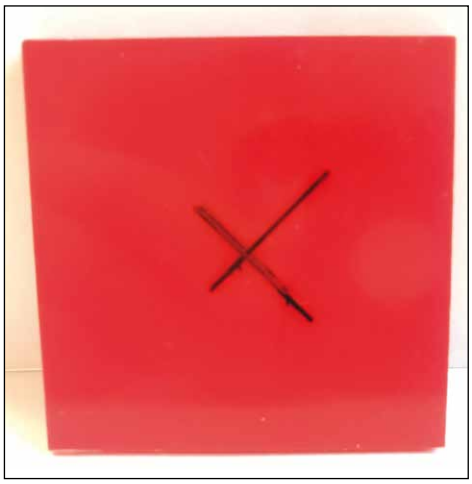
See comments in file exerc4-100-call-a-subroutine-sample.ngc !!!
To learn what the parameters like [-8] [8] [3] [3.5] [4] [2] mean, please read the comments in 100.ngc.

Experiment with different parameters.

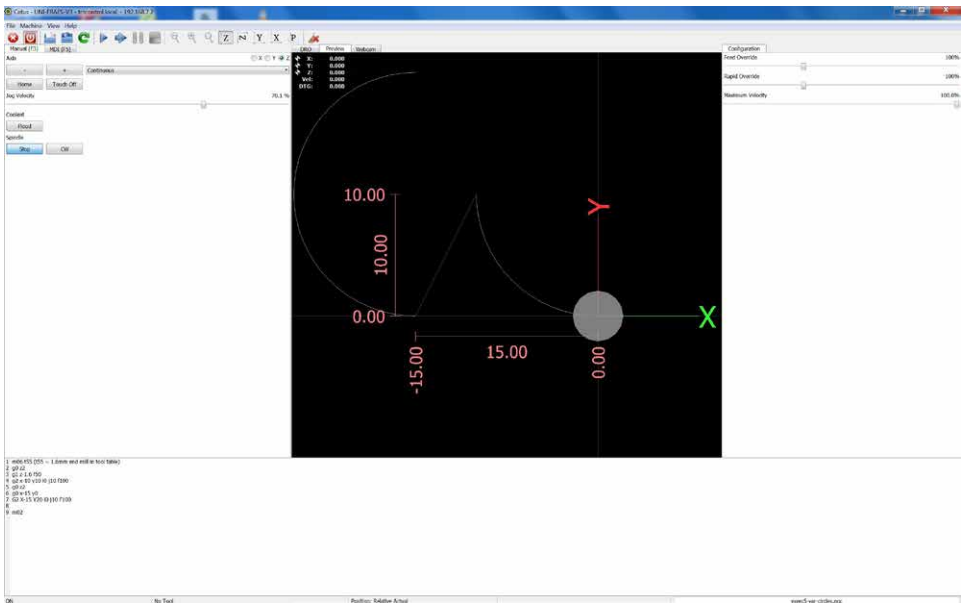
Exercise 5

Machine: UNI-FRAES-V3
File: .../examples/exerc5-var-cicles.ngc
Raw material: Special colored Acrylic, 50x50x3 mm[art.no.: 166PLEXS]
Tool: 1.6 mm end mill

•) Mark the center of the square (raw material)
•) Use the clamping jaws to fix the raw material. Protect the machine table by placing a second plate (plywood or acrylic, thickness min. 3 mm) beneath the raw material.



Showing circle segments with G2.



Required hardware

Unimat CNC 3-axis vertical milling machine, CNC-rotating axis [164300 CNC], clamping device (e.g.: collet, 3-jaw chuck, ...), TCTControl [TCTCONT4 or TCTCONT6]

Requirements for the workpiece

The area to be engraved must have a consistent diameter.

1) Calculating the "SCALE" for the machine configuration (.ini file)

•) CNC-rotation axis [164300CNC]: 1 (micro) Step ≙ 17,7°
•) cylinder diameter ø ..... D [mm]
circumference ..... U [mm] (U ≙ 360°)
π 3,14159

$$U = D \times \pi$$

$$1\ mm \triangleq 360 / U = S$$

$$SCALE\ [step/mm] = 17{,}7° \times S$$

1.1) Example of a cylinder with ø 14 mm

U = 14 x 3,14159 = 43,98226
S = 360 / 43,98226 = 8,18512
SCALE = 17,7 x 8,18512 = 144,87662

2) Customize the machine configuration file (e.g.: Uni-fraes-v3v2.ini)

•) Start files.bat
[TCTCONTROL\Windows\TOOLS\files.bat]
In the right area is the Linux file system of the TCTControl
•) The machine configurations files folder is
/home/machinekit/machinekit-configs/

•) Mark the configuration to be edited -> right mouse click -> Edit
•) Scroll to „#Second axis“

```
# Second axis
[AXIS_1]

TYPE =                          LINEAR
HOME =                          0.000
MAX_VELOCITY =                  5.0
MAX_ACCELERATION =              20.0
STEPGEN_MAX_VEL =               6.0
STEPGEN_MAX_ACC =               22.0
STEPGEN_MIN_VEL =               0.001
BACKLASH =                      0.000
SCALE =                         -3200
MIN_LIMIT =                     -50.0
MAX_LIMIT =                     50.0
FERROR =                        0.500
```

•) Comment out the line „SCALE -3200“ with #

```
STEPGEN_MIN_VEL =               0.001
BACKLASH =                      0.000
# SCALE =                         -3200
MIN_LIMIT =                     -50.0
MAX_LIMIT =                     50.0
```

•) Add the following lines and save the file

```
STEPGEN_MIN_VEL =               0.001
BACKLASH =                      0.000
# ORIGINAL - cross slide Y-axis
# SCALE =                         -3200
# diameter 14 mm
SCALE =                         144.87662
MIN_LIMIT =                     -50.0
MAX_LIMIT =                     50.0
```

•) Open Machinekit client and start machine configuration

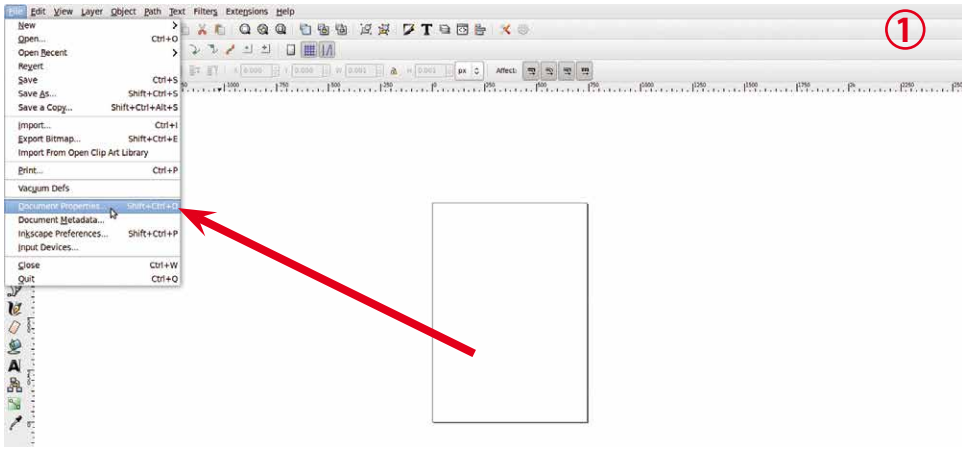
3) Connect the Unimat CNC-rotating axis [164300CNC] to the Y-axis of the TCTControl

4) It is now possible to engrave a design (G code / X, Y, Z values) on the cylinder surface.

Sample 1 - engraving into acrylic

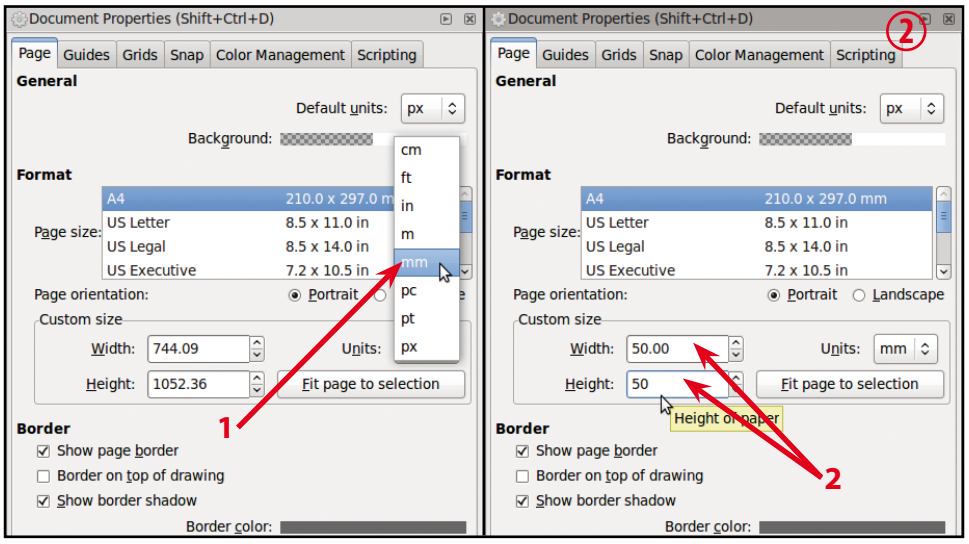
raw material: acrylic plate ~ 50 x 50 x 3 mm
tool: end mill ø1.0 mm
optional: end mill ø1.6 mm

1) open "Inkscape®" then click on "File" --> "Document Properties...".

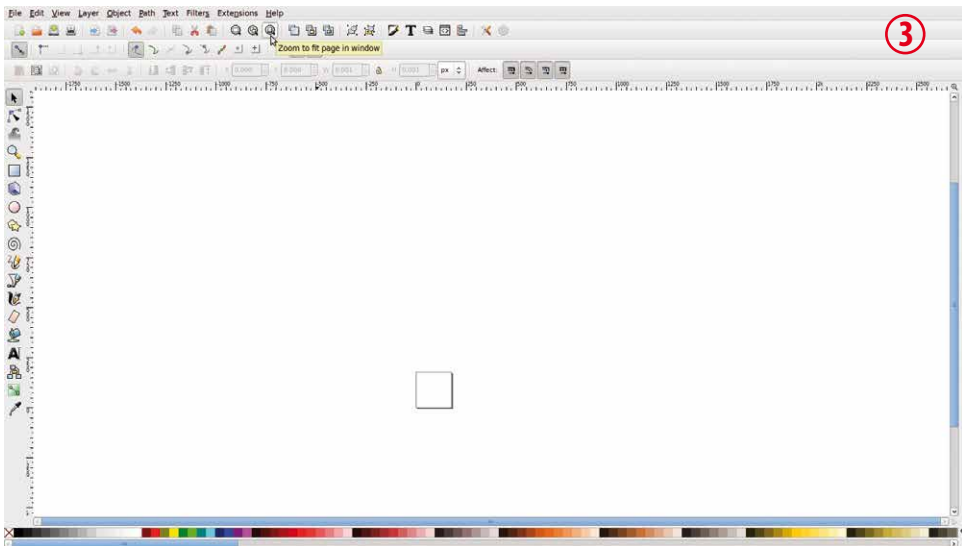


2) select at "Custom size" --> "Units" --> "mm".

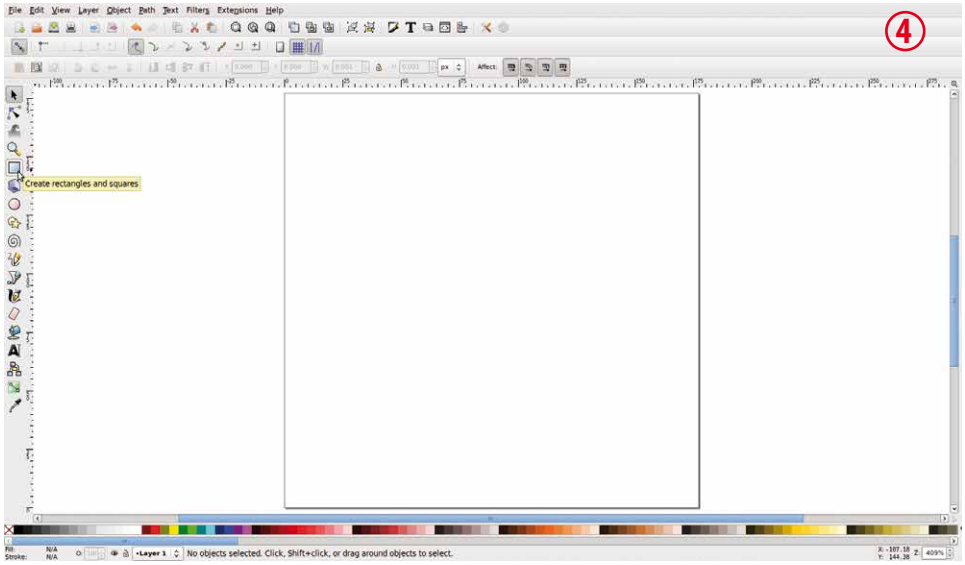
enter for both "Width" and "Height" 50 after that close the window.



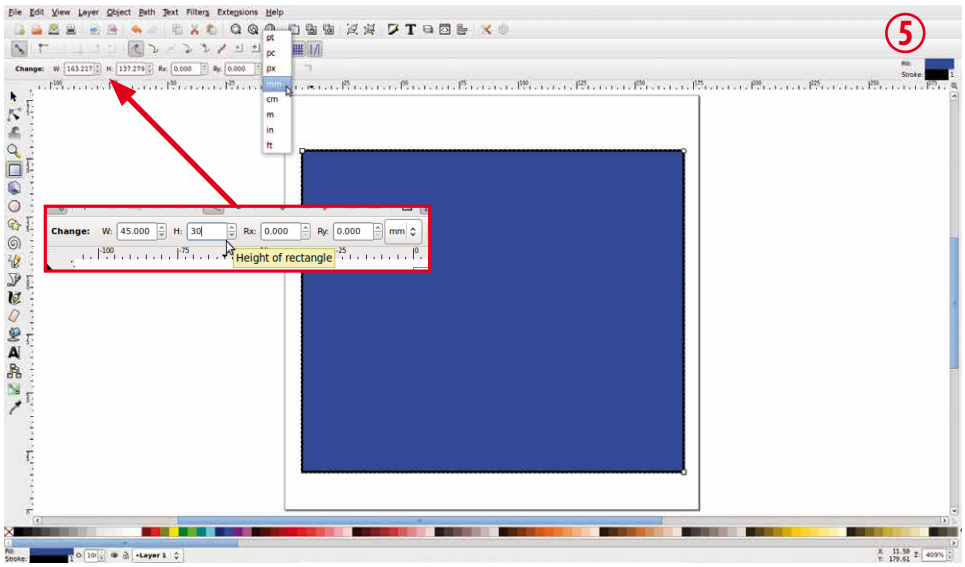
3) click on the magnifier icon "Zoom to fit page in window".



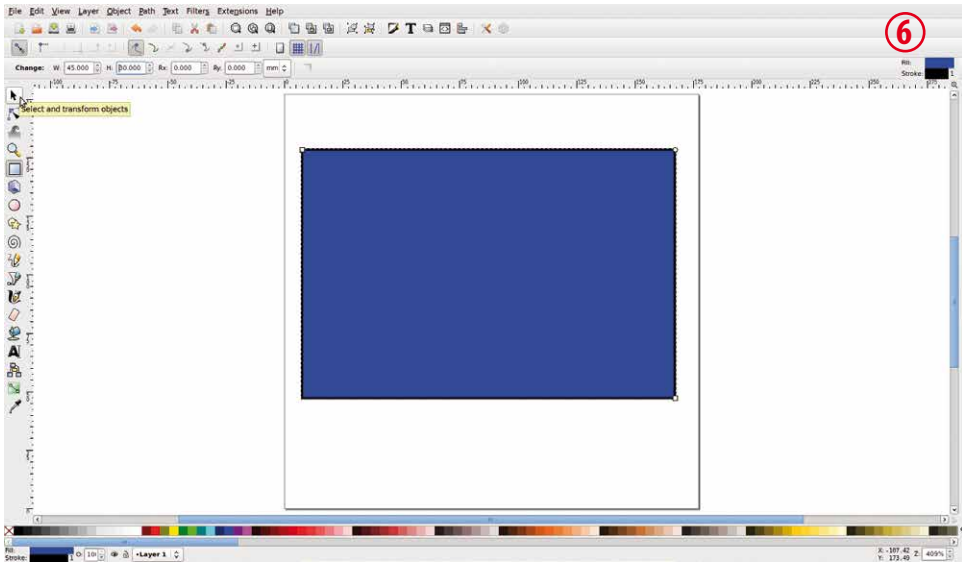
4) click on the square icon "Create rectangles and squares".



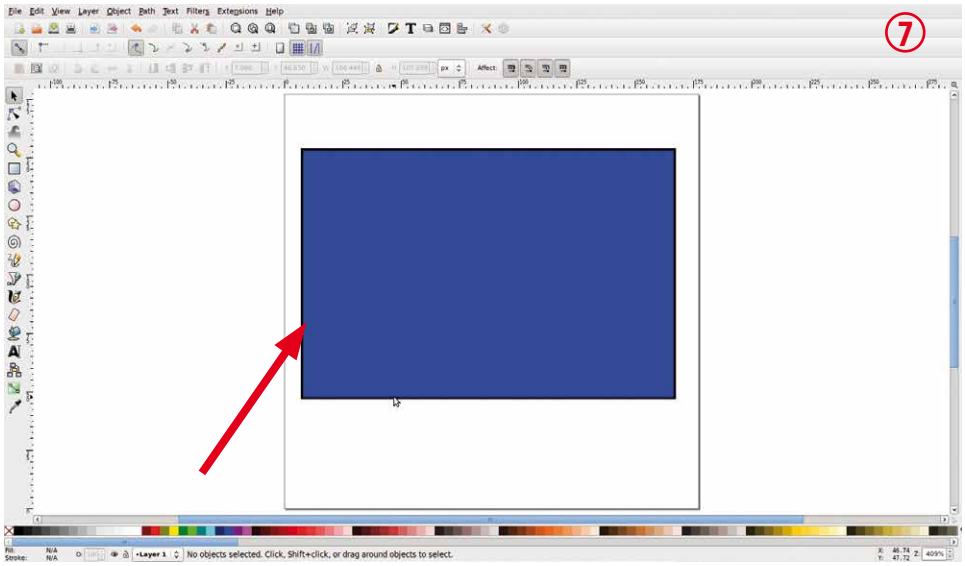
5) at "Change" select "mm" then enter for "W" (width) 45 and for "H" (height) 30.



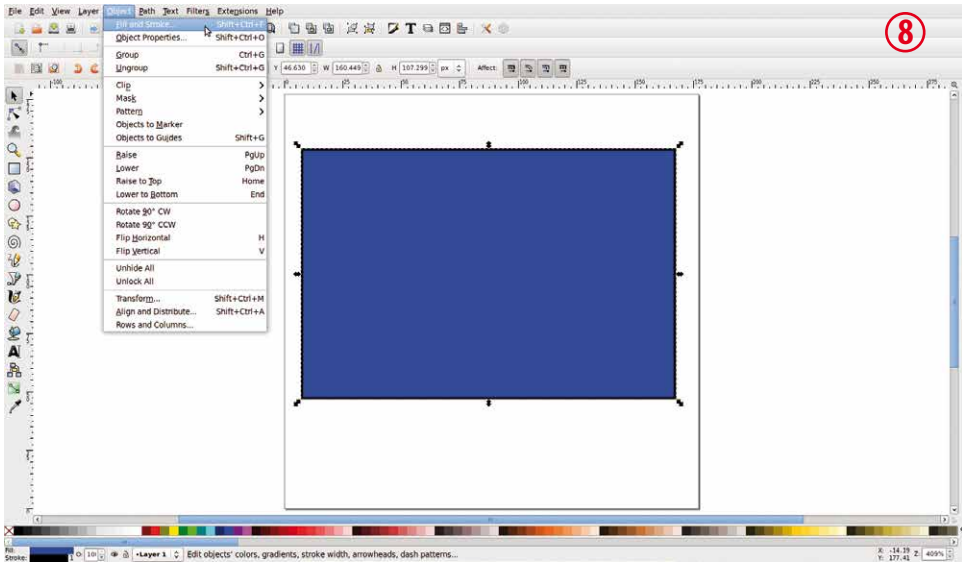
6) click on the arrow "Select and transform objects".



7) select the rectangle (click on it).

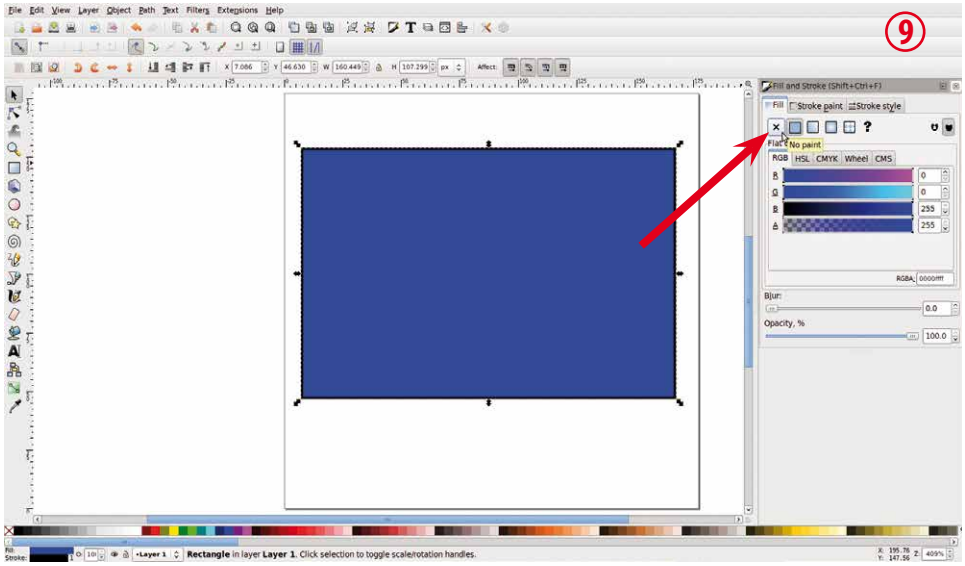


8) Now that the rectangle is marked click on "Object" --> "Fill and Stroke".



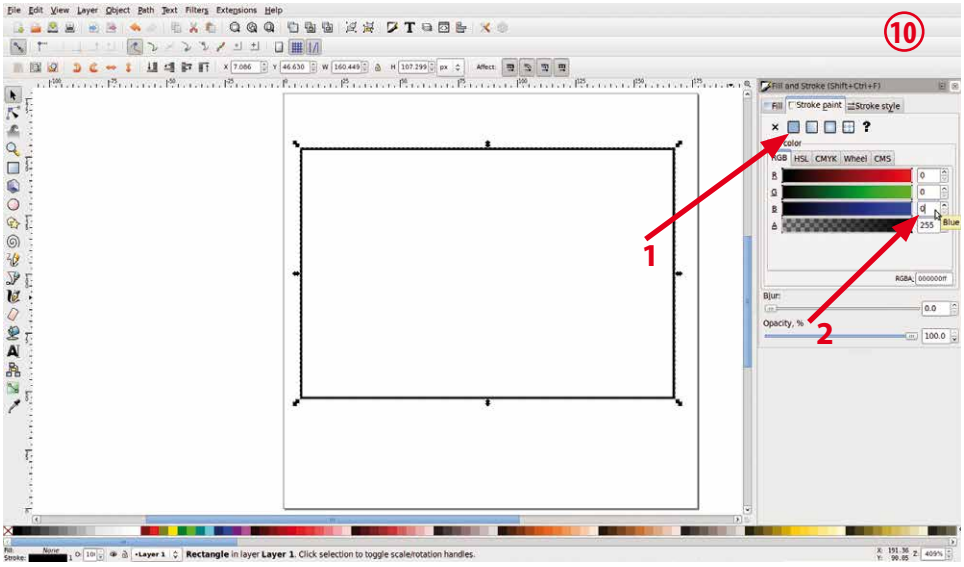
9) in the window "Fill and Stroke" select "Fill" and click on "X" (No paint).

Attention:
The rectangle must be selected (marked).



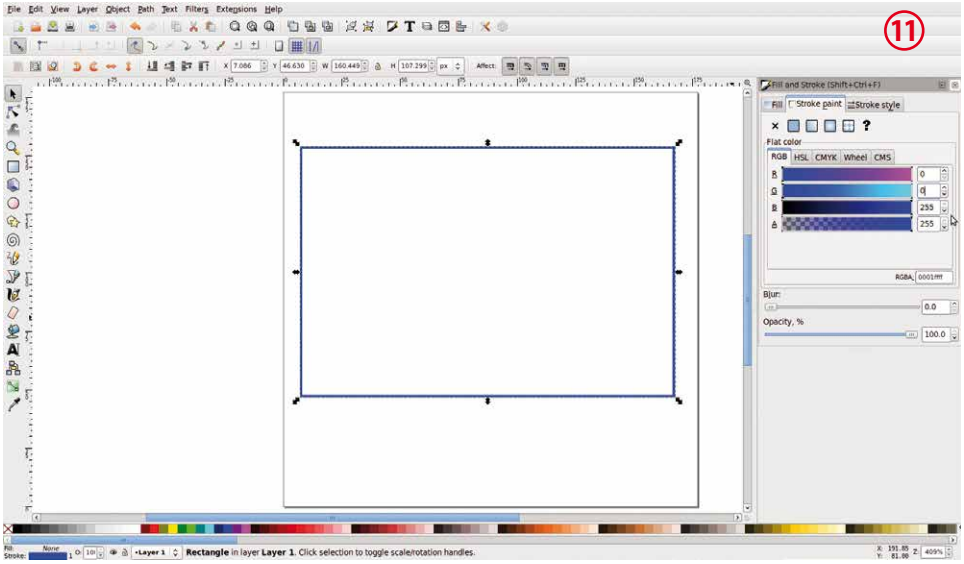
10) switch to “Stroke paint” and click on “Flat color” (1), then click “Blue” (2).

Attention:
The rectangle must be selected (marked).



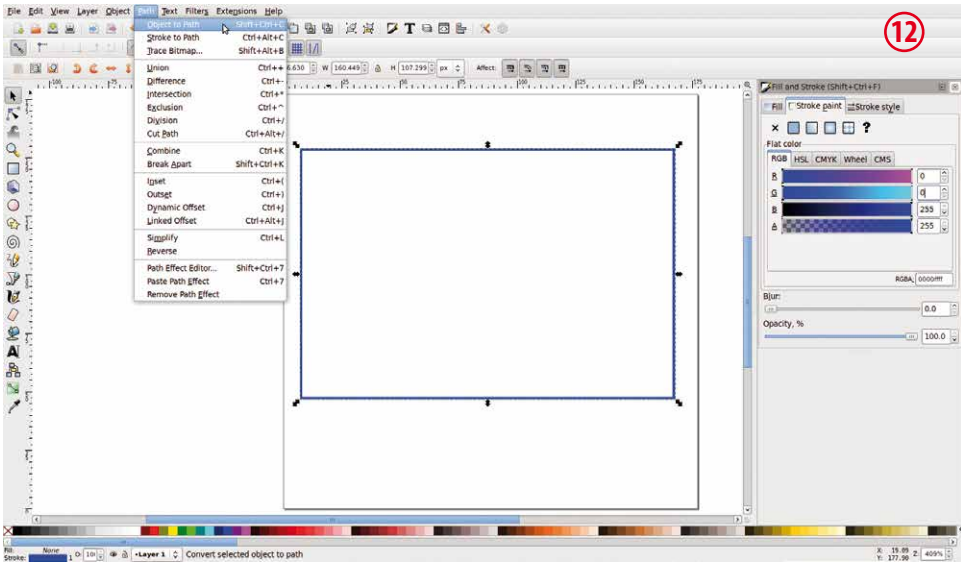
11) write “255” and press “Enter”. The contour color of the rectangle is now blue.

Attention:
The rectangle must be selected (marked).



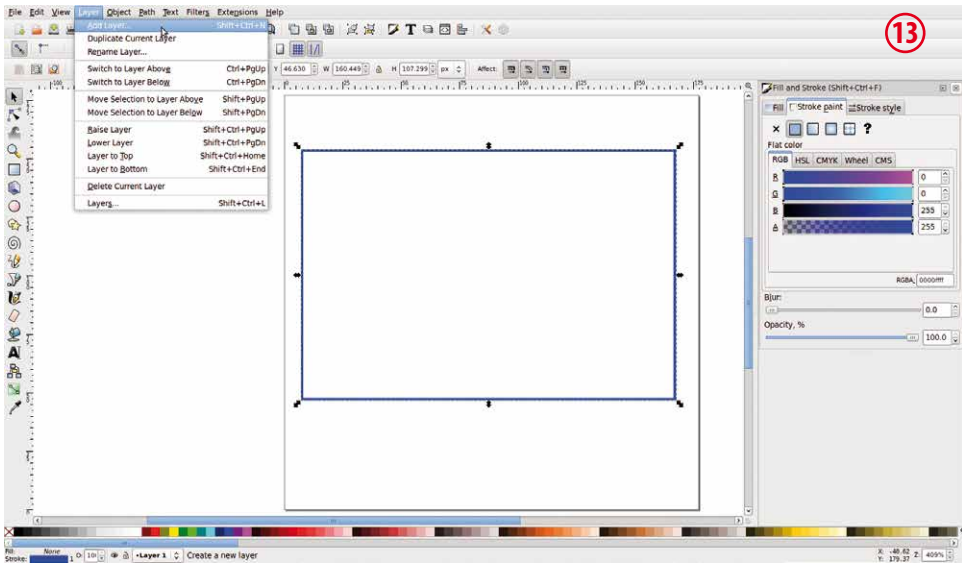
12) click on “Path” --> “Object to Path” (vector). Now the rectangle is a vector graphic.

Attention:
The rectangle must be selected (marked).

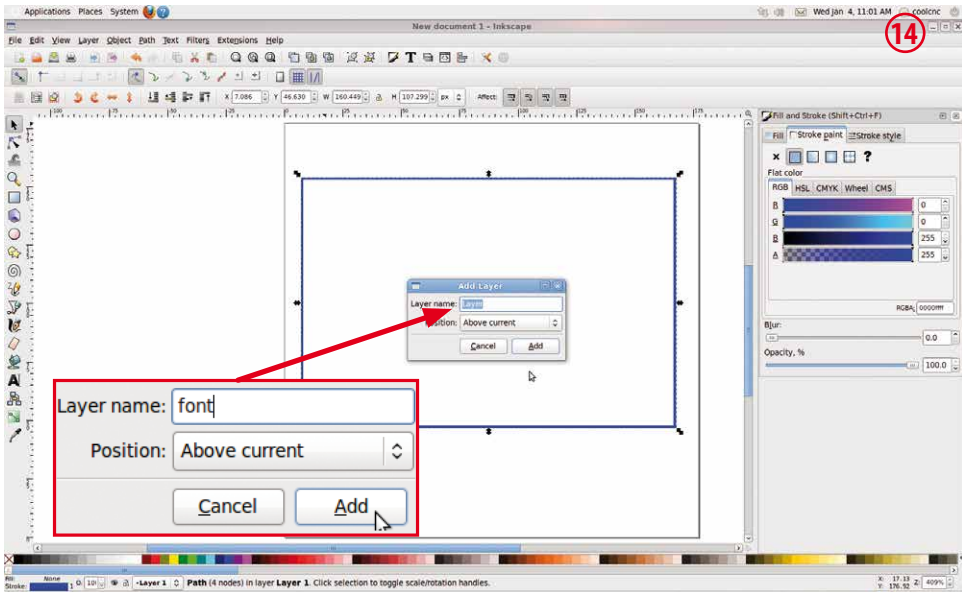


Create a new layer for the labeling:

13) click on “Layer” --> “Add Layer”.

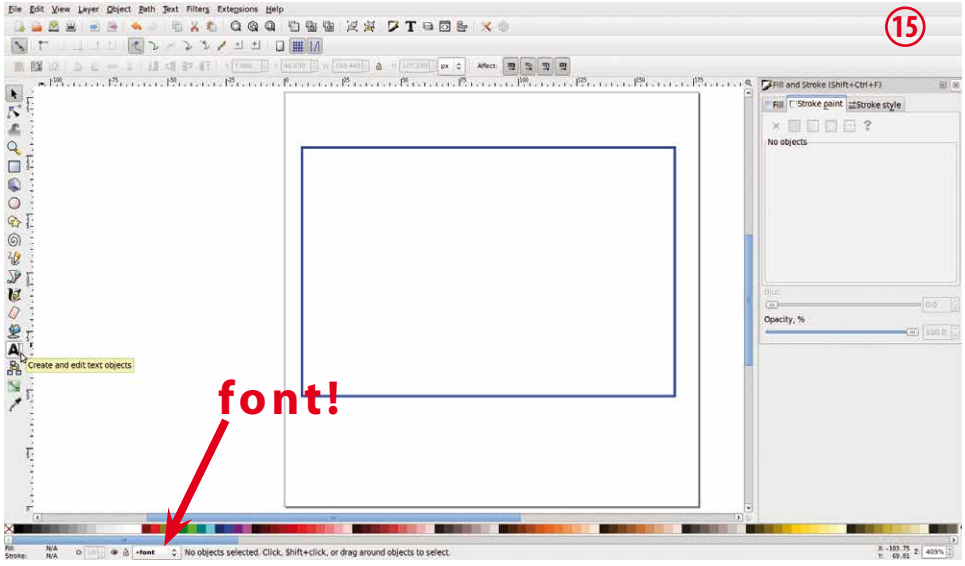


14) enter following name for the layer “font”, then click on “Add”.



15) click on “A” icon “Create and edit text objects”.

Attention:
Layer “font” must be activated.

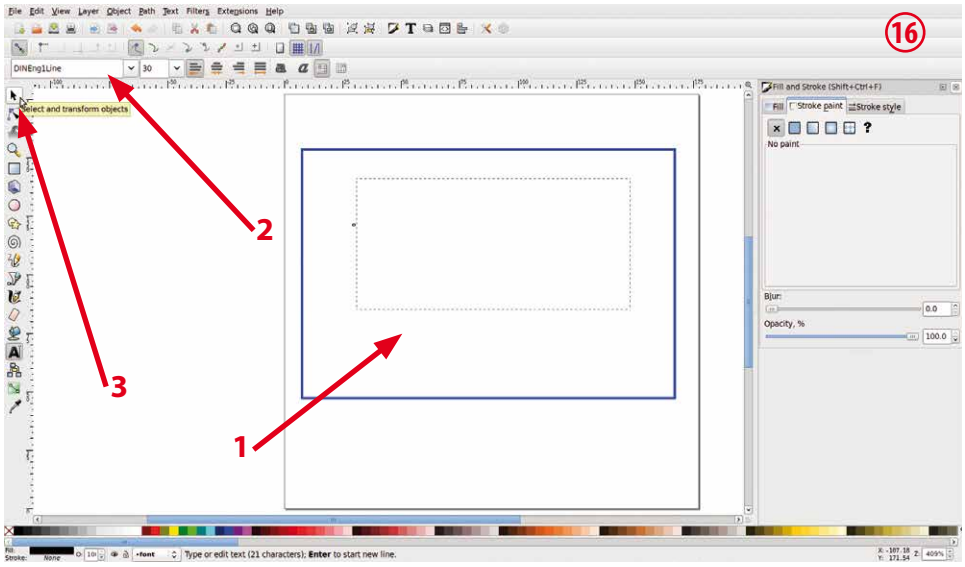


16) click into the blue rectangle, then select a (Single Line Fonts) - for example "DINEng1Line". Write your text - for example:

The Cool Tool

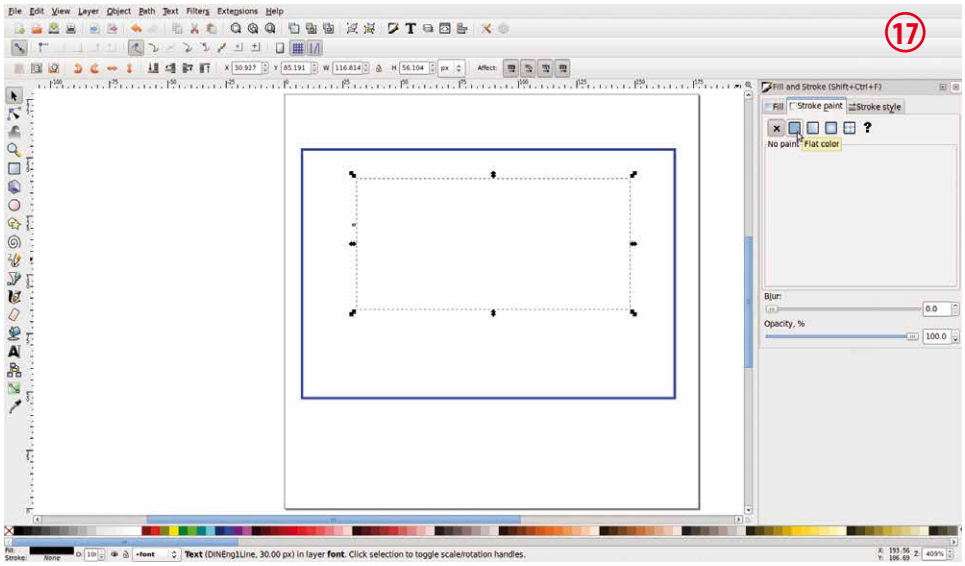
CoolCNC

After that click on the arrow icon "Select and transform objects".

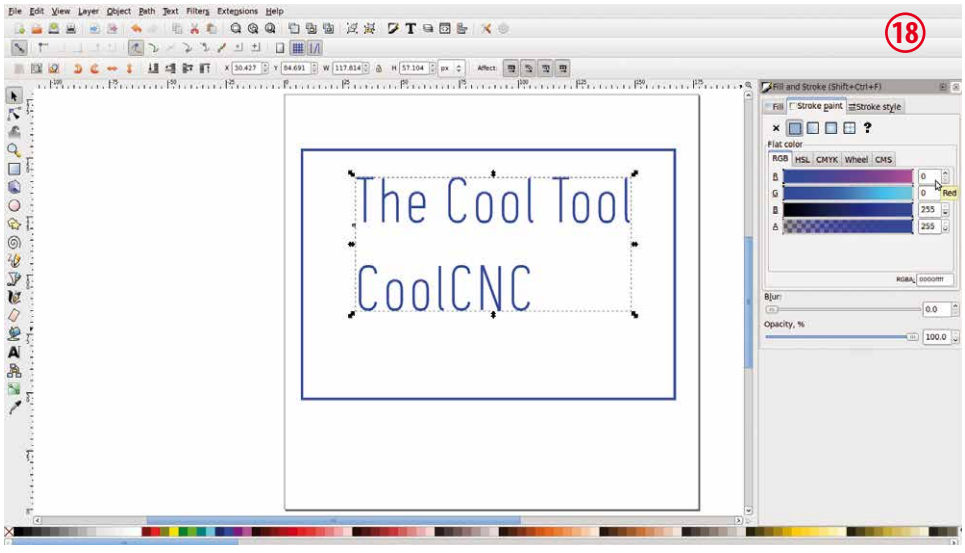


17) click on "Stroke paint" --> "Flat color".

Attention:
The text field must be activated (marked).

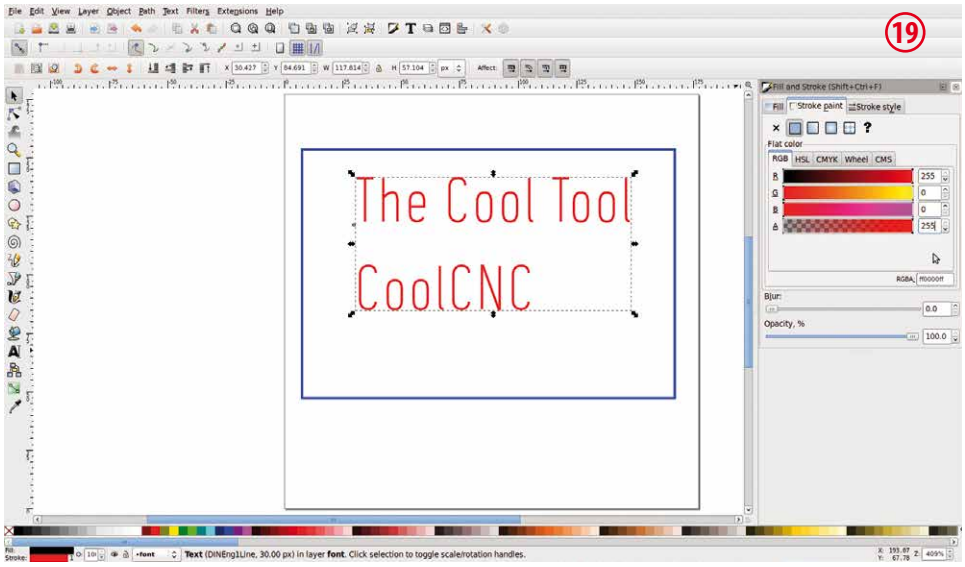


18) click on "red"



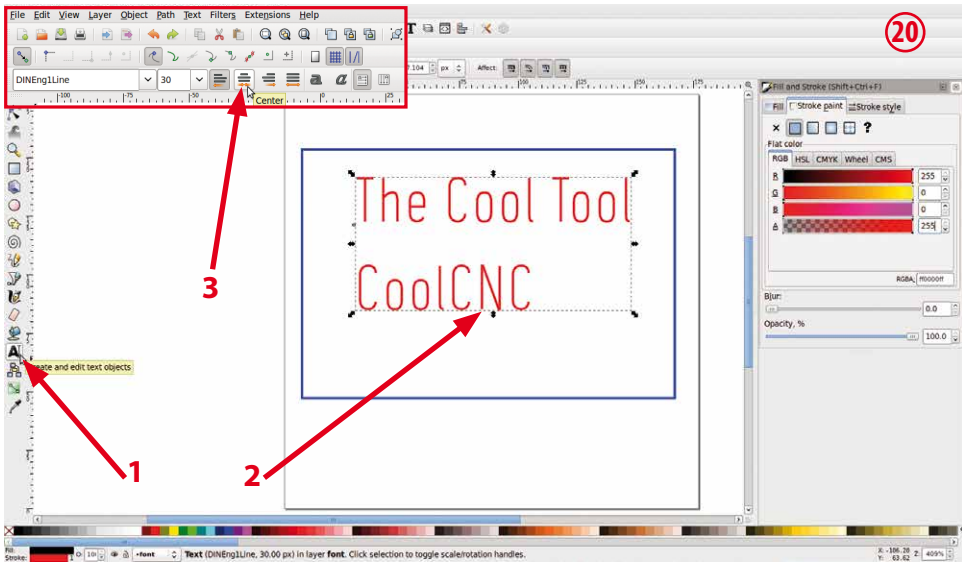
19) enter "255" then click on "blue" and change value to "0" and press "Enter".

Attention:
The text field must be activated (marked).

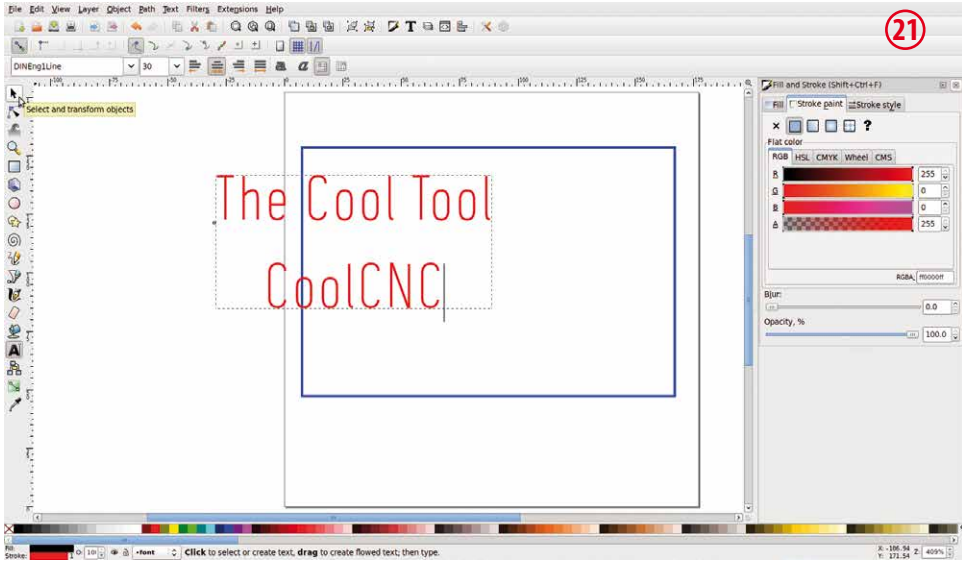


20) click on "A" icon "Create and edit text objects", then click into the text field (The Cool Tool ....).

After that click on "Center".

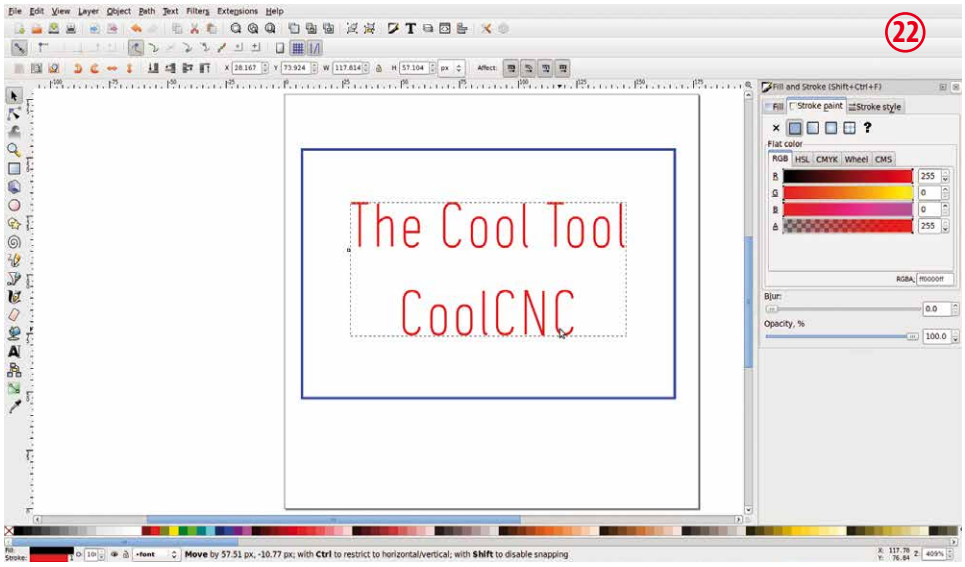


21) click on the arrow icon "Select and transform objects".



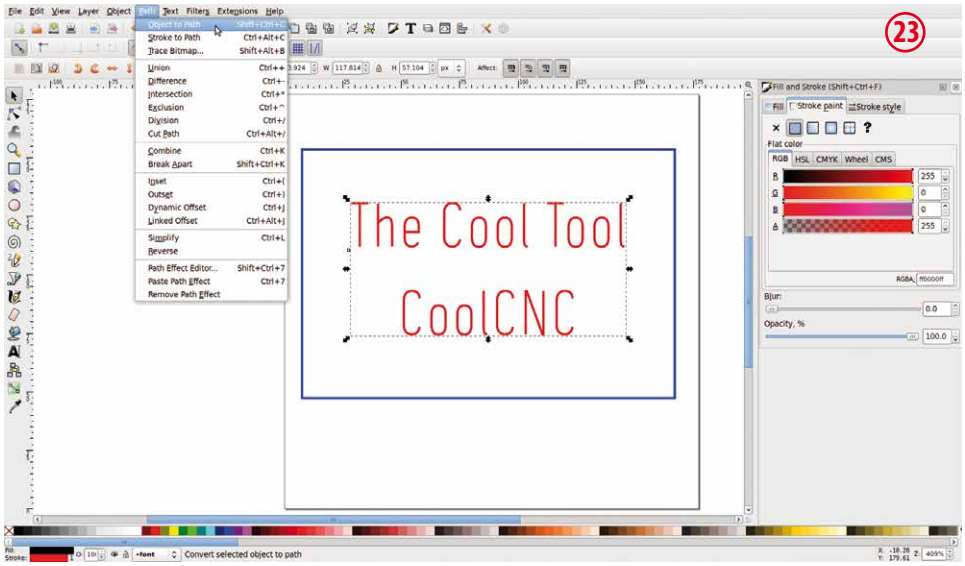
22) select the text field and place it in the middle of the blue rectangle.

Attention:
Please take care that the blue rectangle is at the center of the raw material. If it is not at the center, select the blue rectangle and the text field and place it again.



23) click on "Path" --> "Object to Path" (vector). Now the font is converted to a vector graphic.

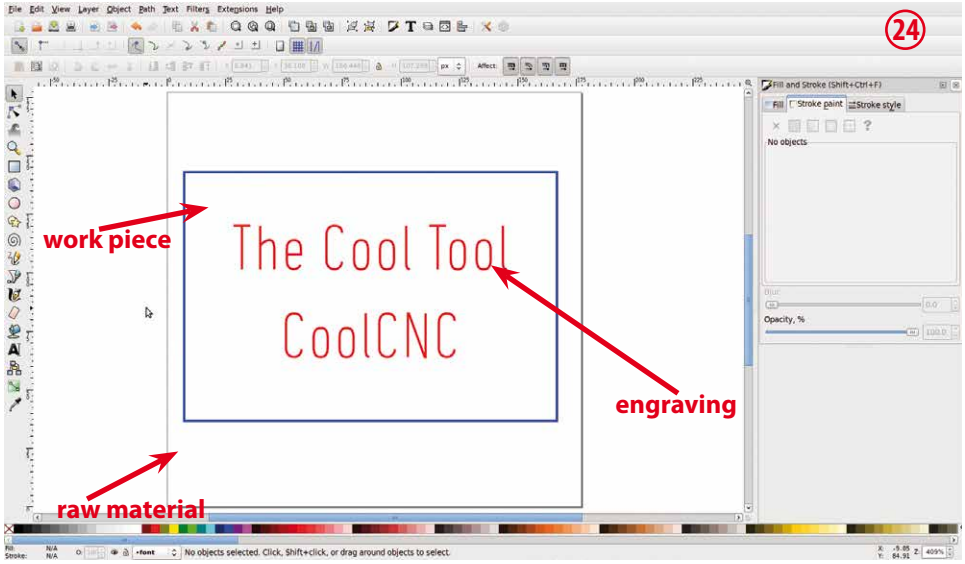
Attention:
The text field must be activated (marked).



24) Why two layers?
For each cutting depth you need a separate layer. Here we have two different depths:

1) red text: 1.0 mm (engraving)

2) blue rectangle: 4.5 mm
(raw material 4.0 mm - acrylic)

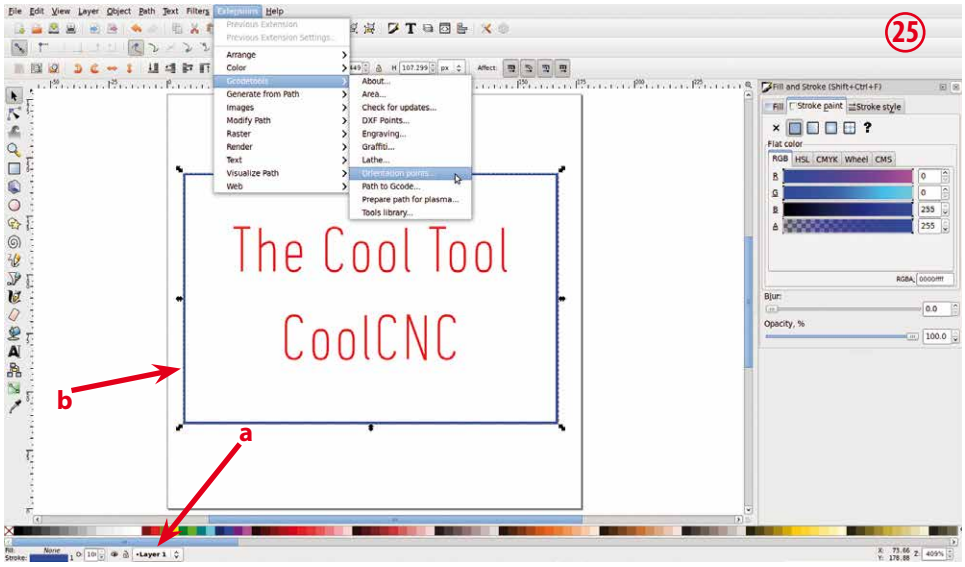


Gcode Tools®

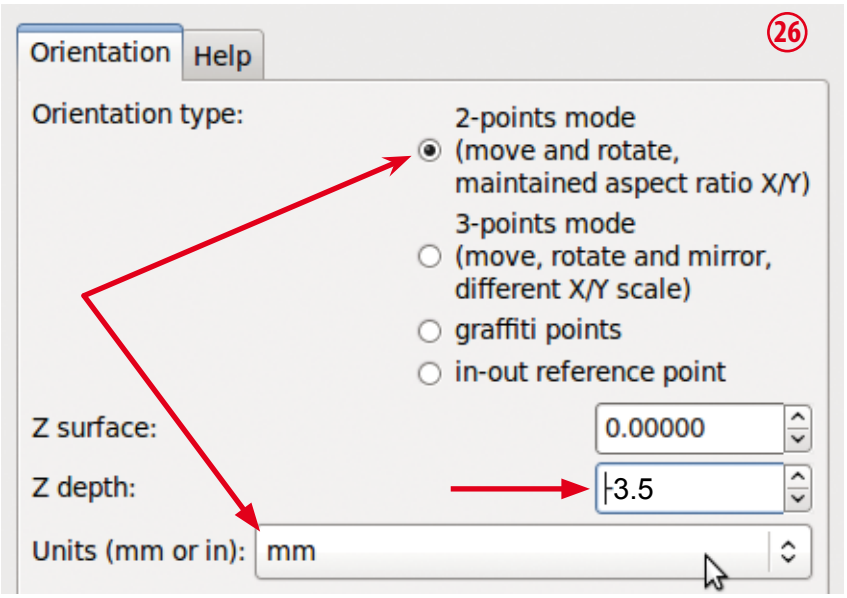
25) Orientation points
(zero point for the blue rectangle)

click on “Extensions” --> “Gco-detools” --> “Orientation points ...”

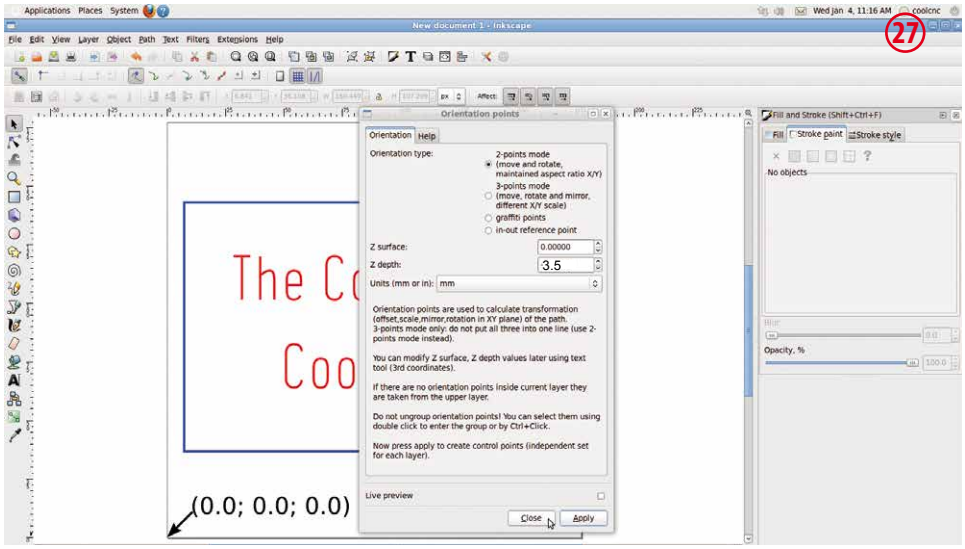
Attention:
a) layer “Layer 1” must be activated.
b) blue rectangle must be selected.



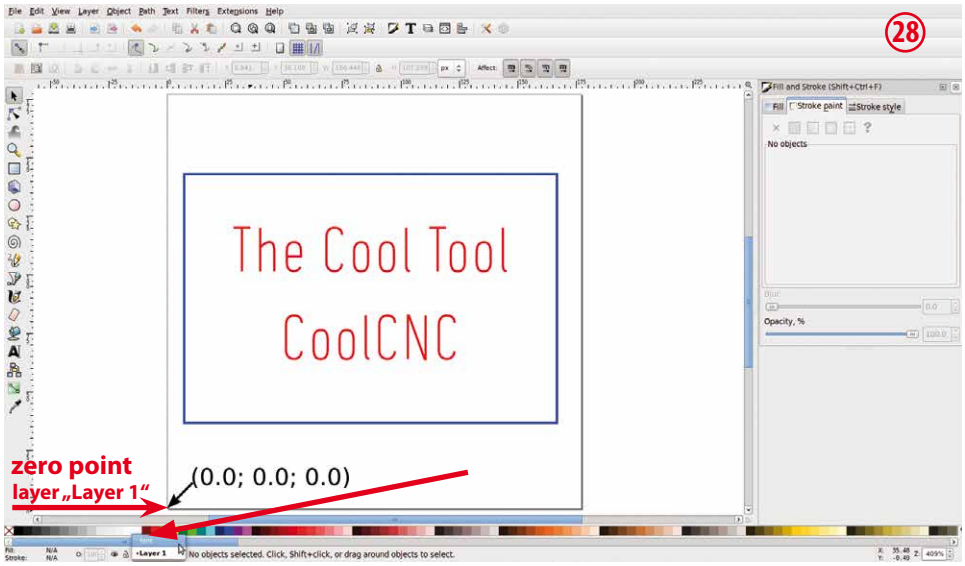
26) select “2-points mode” and “mm”. enter at “z depth” “-3.5”.
Attention:
“z surface” remains “0.0”.



27) click on “Apply” and then “Close”



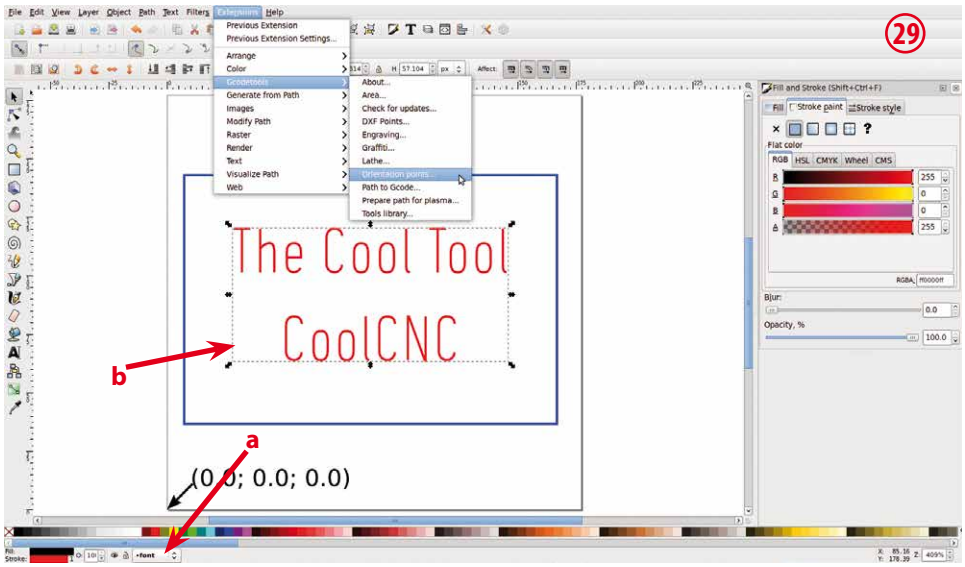
28) select the layer "font"



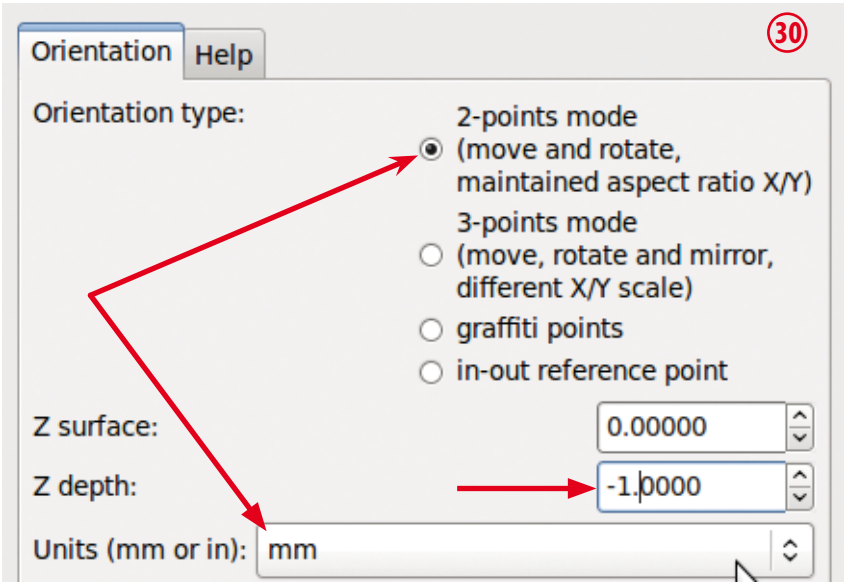
29) Orientation points
(zero point for the red text)

click on "Extensions" --> "Gcodetools" --> "Orientation points ..."

Attention:
a) layer "font" must be activated.
b) red text must be selected.

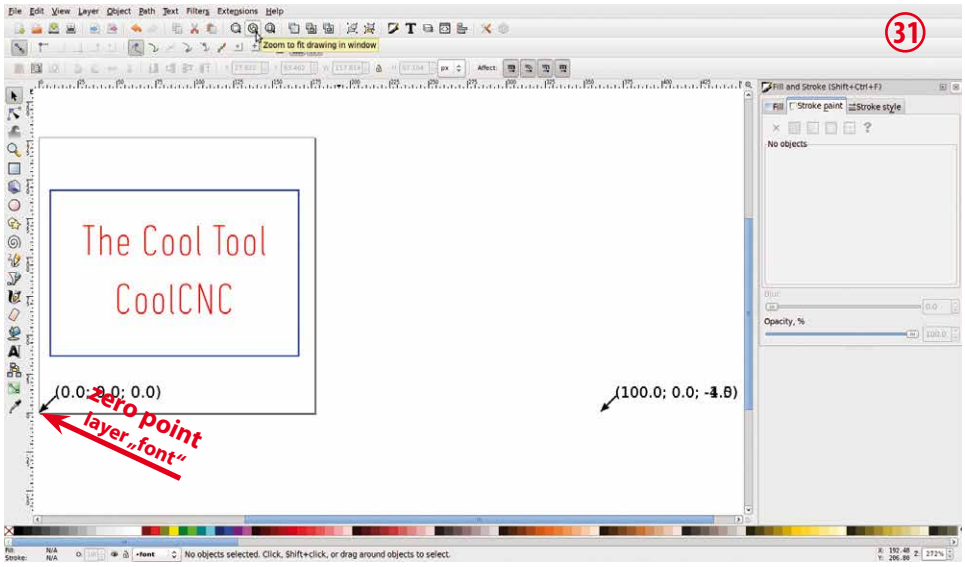


30) select "2-points mode" and "mm". enter at "z depth" "-1.0".
Attention:
"z surface" remains "0.0".

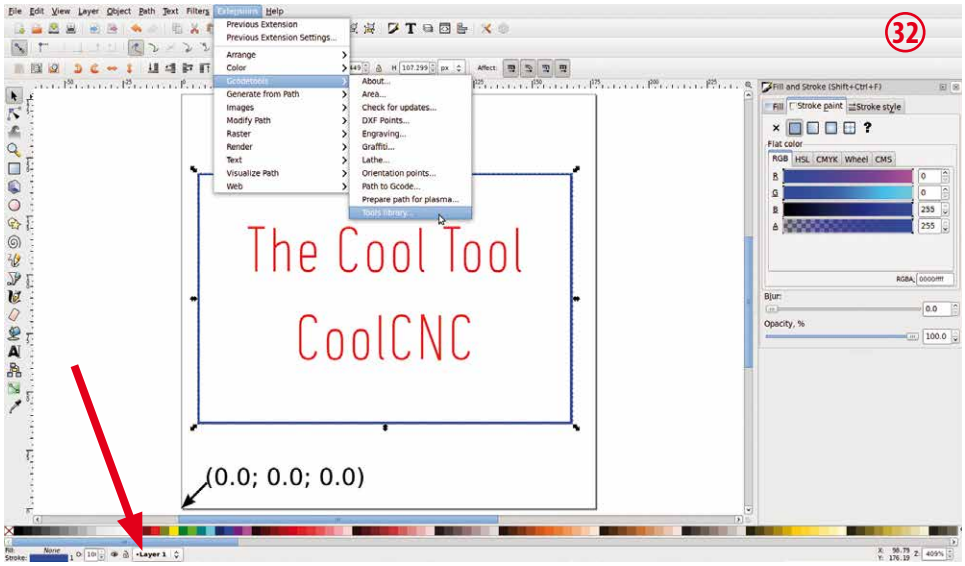


31) The position of the zero point for layer "Layer 1" and layer "font" is the same (congruent).

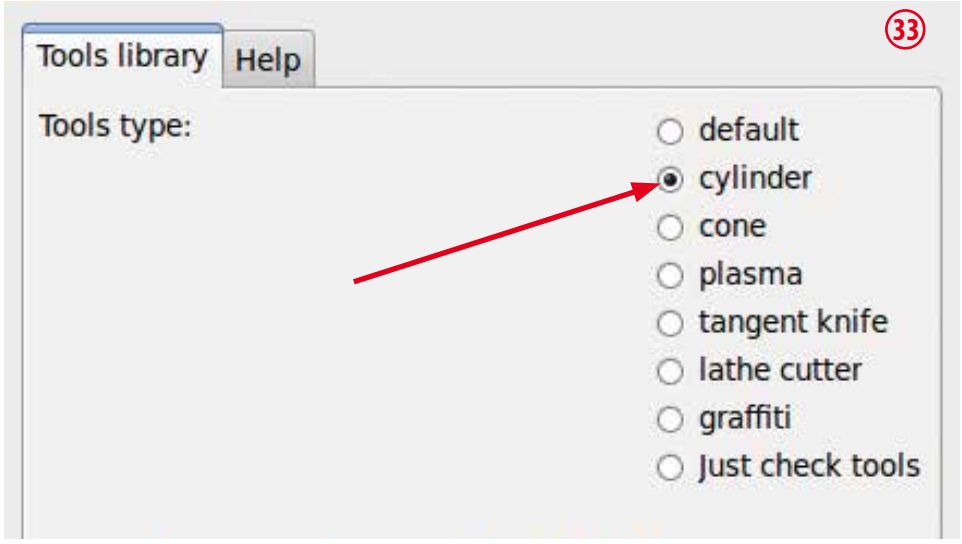
Attention:
Do not move this point!



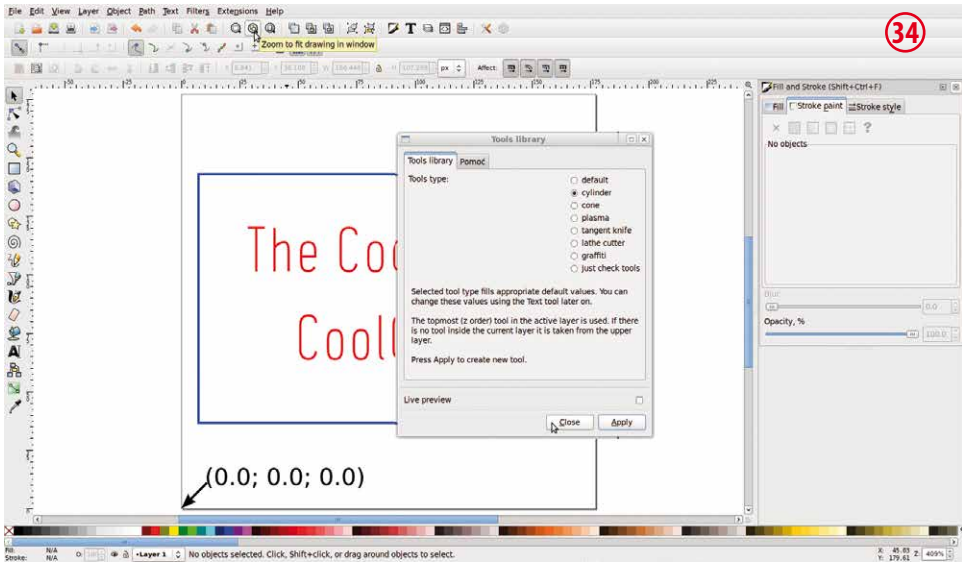
32) Tools library
activate "Layer 1" and select the blue rectangle (marked), then click on "Extensions" --> "Gcodetools" --> "Tools library"



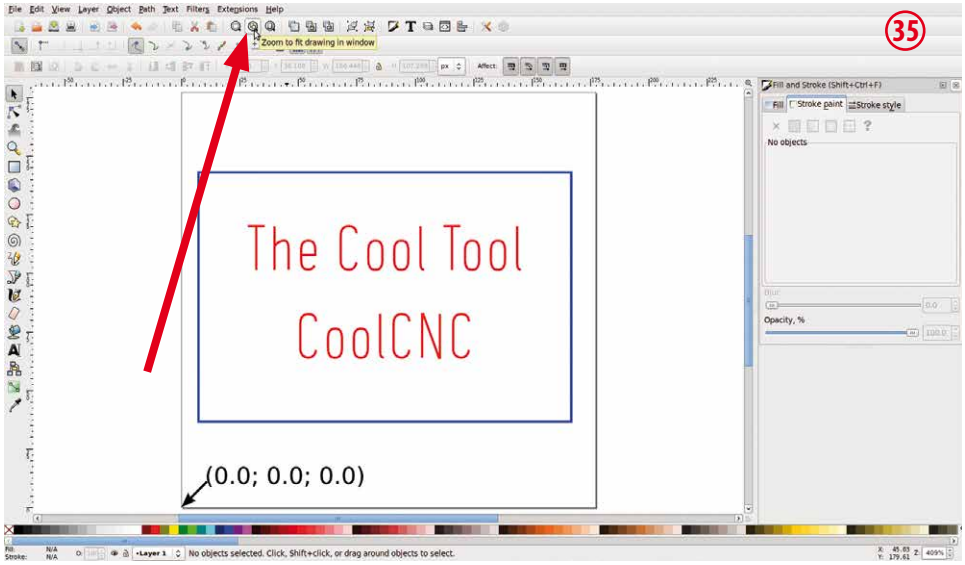
33) select "cylinder"



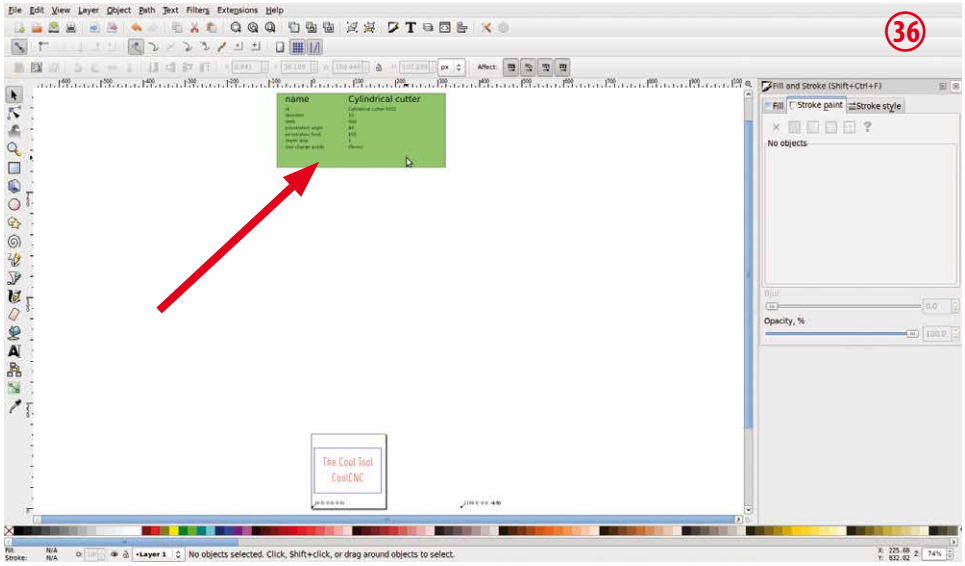
4) click on “Apply” then close the window - click on “Close”



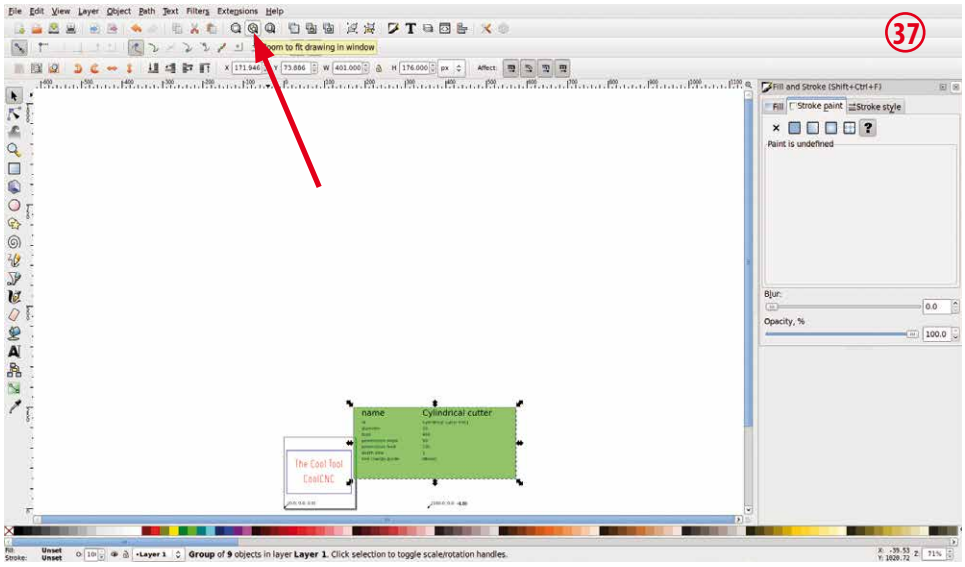
2) click on the magnifier icon “Zoom to fit drawing in window”



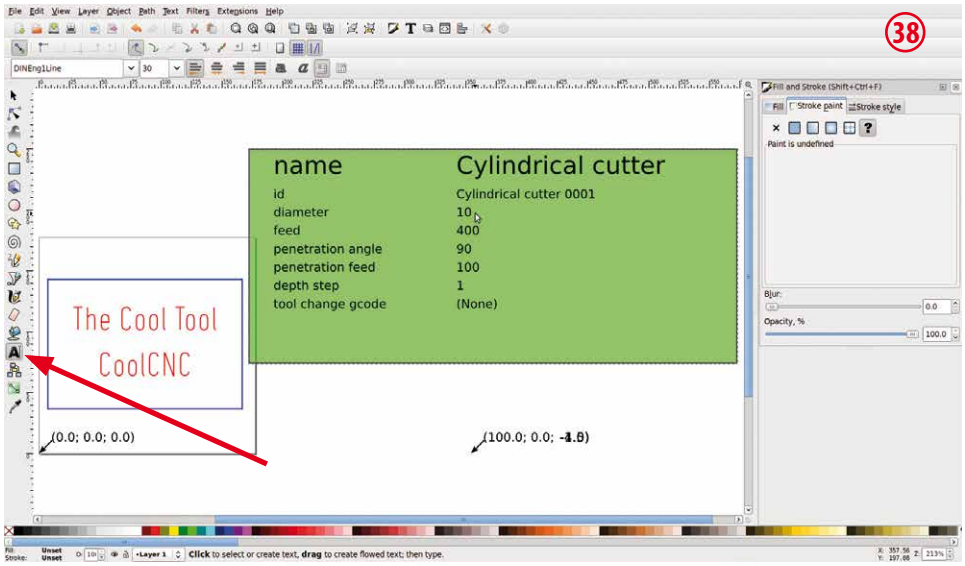
36) now you can see the “Tool window“ for “Layer 1”.



37) place the "Tool window" near the blue rectangle, then click on the magnifier icon (Zoom to fit drawing in window).

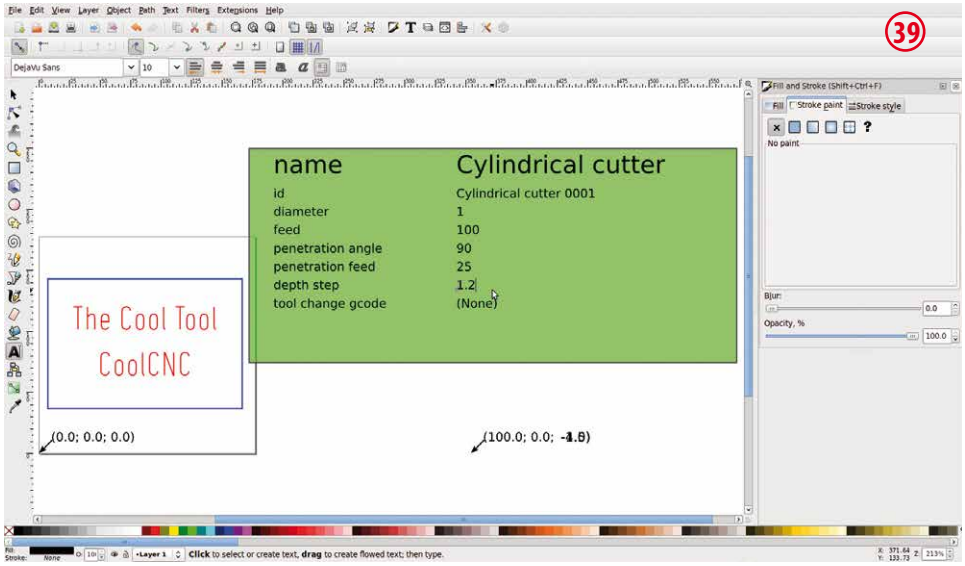


38) click on the "A" icon (Create and edit text objects)

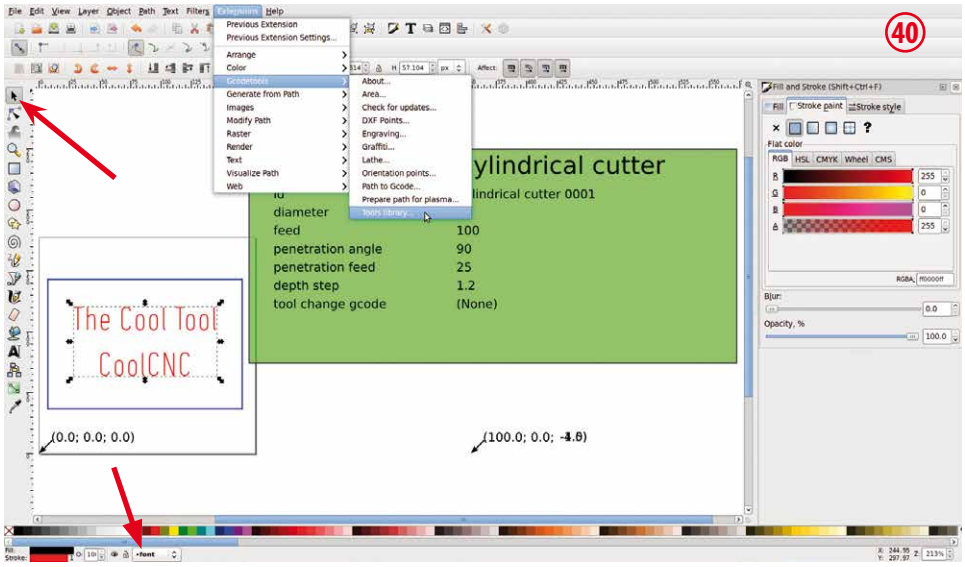


39) edit the following parameters in the "tool window:

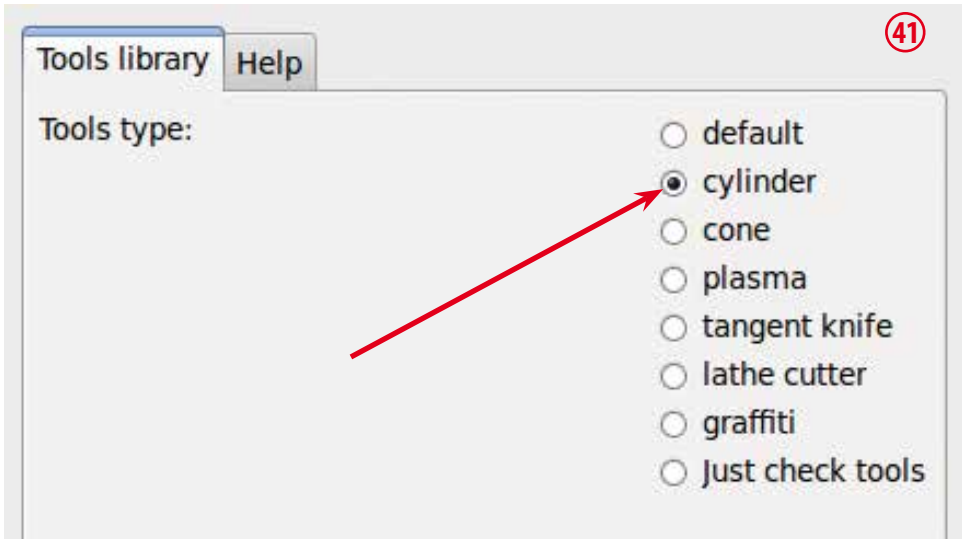
diameter = 1
feed = 100
penetration feed = 25
depth step = 1.2



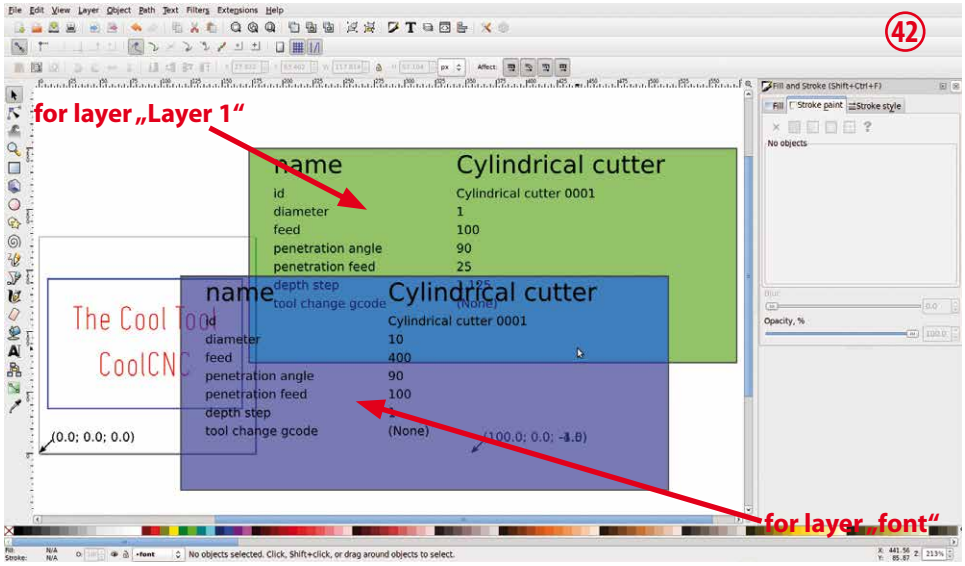
40) activate layer "font" and select the red text (marked), then click on "Extensions" --> "Gcodetools" --> "Tools library"



41) select "cylinder" and click on "Apply" then close the window - click on "Close".

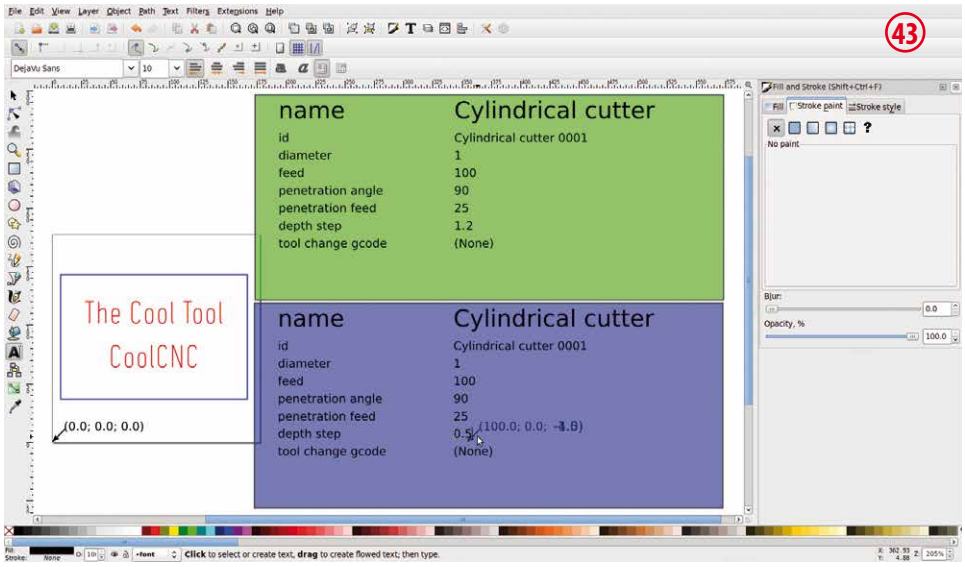


42) the new "Tool window" (window for layer "font") is magenta.

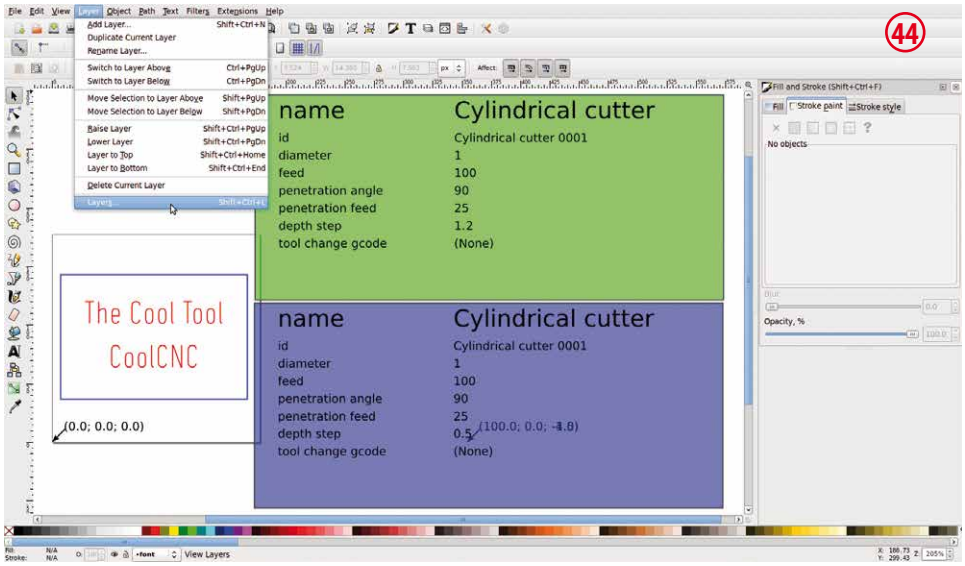


43) click on the "A" icon (Create and edit text objects) and edit following parameters:

diameter = 1
feed = 100
penetration feed = 25
depth step = 0.5

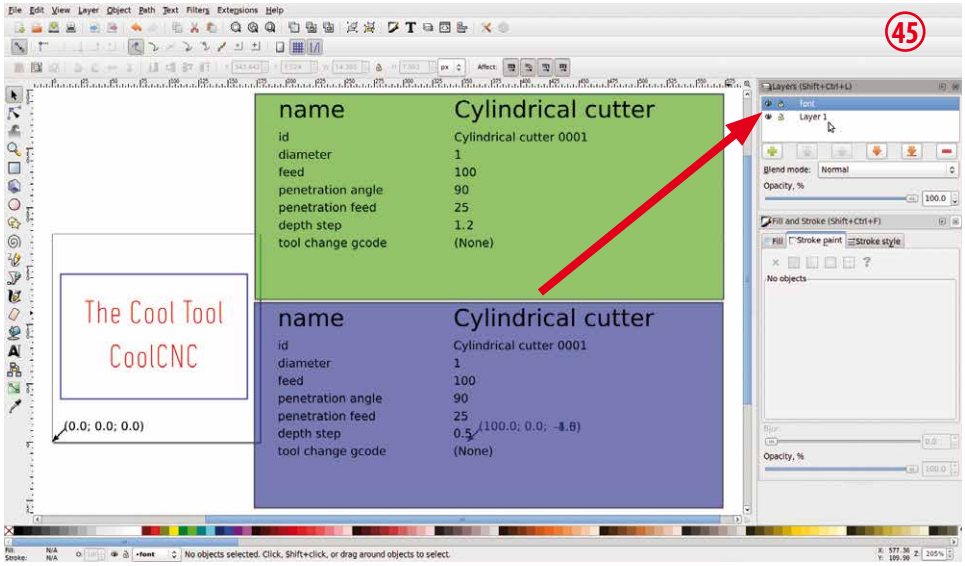


44) check the order of the layers. click on "Layer" --> "Layers ...".

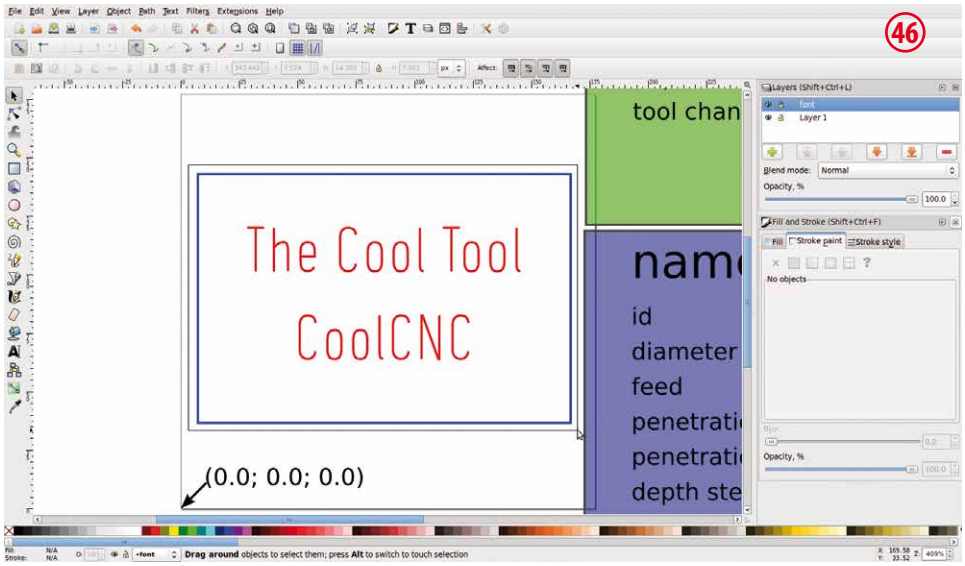


45) correct order: 1) font
2) Layer 1

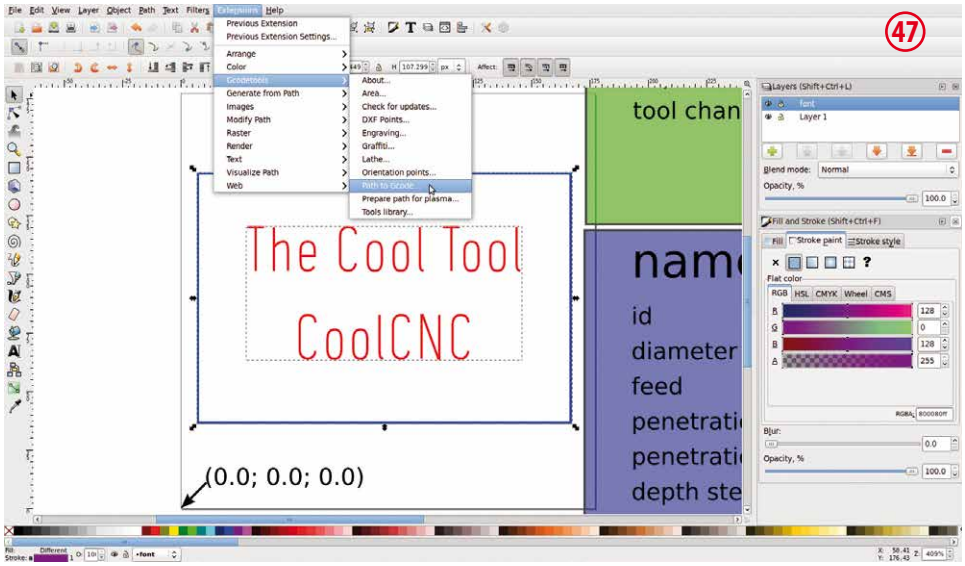
If the order isn't correct, you can change the order. Select one of the two layers and then move it (with the arrows) up or down.



46) click on the arrow icon "Select and transform objects", then select the engraving (red text) and the work piece (blue rectangle).



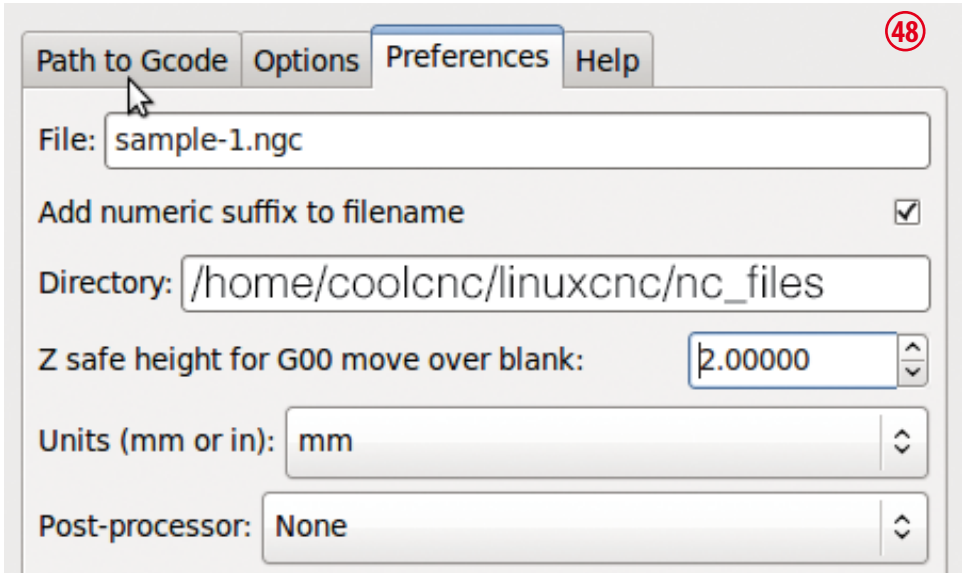
47) click on "Extensions" --> "Gcodetools" --> "Path to Gcode ...".



48) click on "Preferences" and enter following parameters:

File: **sample-1.ngc**
Add numeric..... **"activate"** ☑
Directory: **/home/cool-cnc/linuxcnc/nc_files**
("coolcnc" = username)
Z safe height **2.00**
Units **mm**
Post-processor **None**

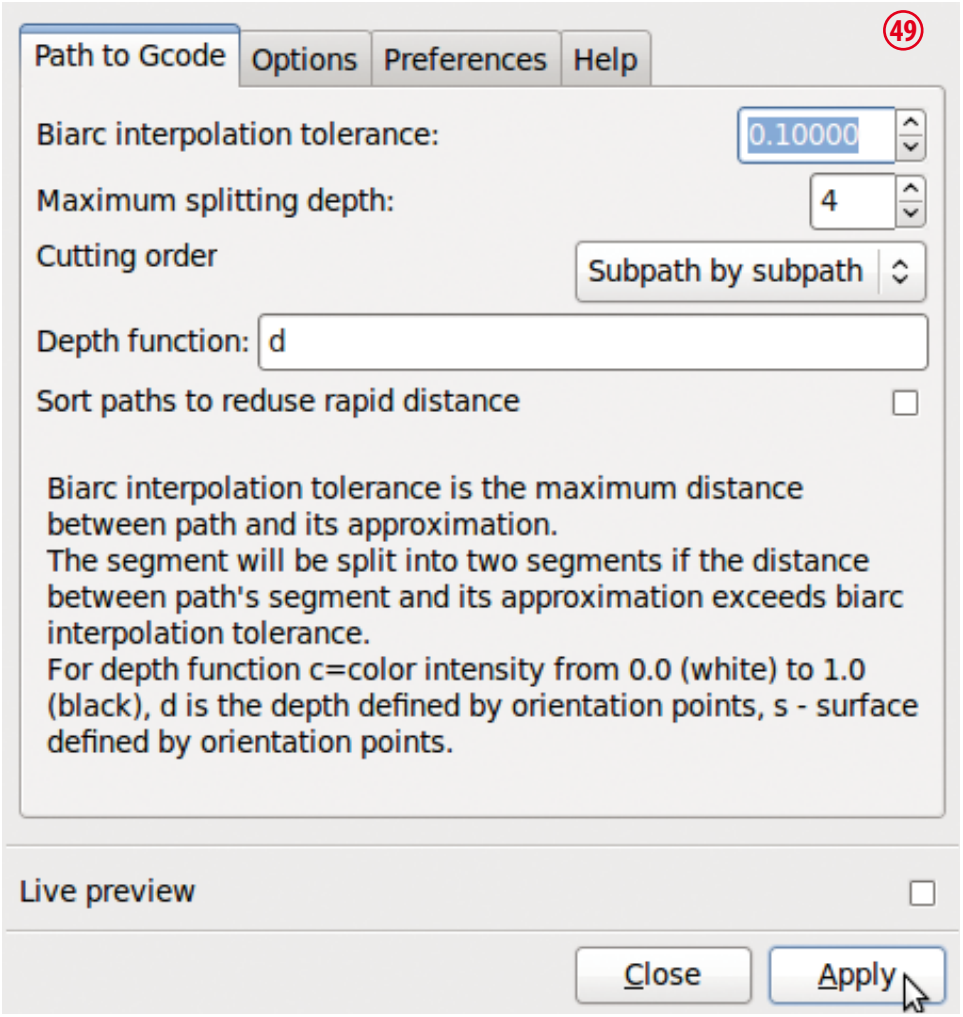
click on "Path to Gcode"!



49) check the parameters:

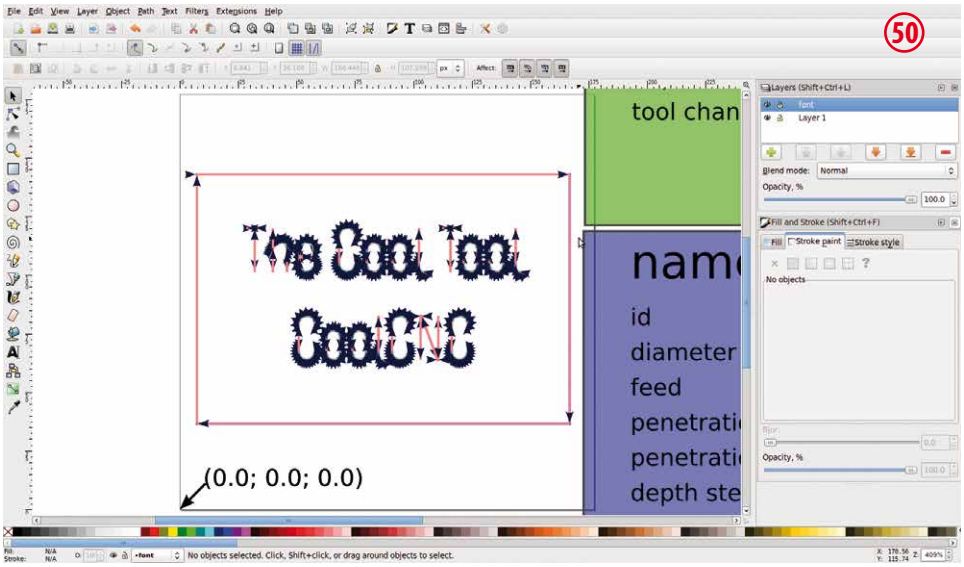
Biarc inter..... **0.100**
Maximum splitting **4**
Cutting order
subpath by subpath
Depth funktion: **d**

click on “Apply” and then close the window- click on “Close”!



50) finished!

Now you can save the Inkscape file (click on “File” --> “Save”) , after that you can close Inkscape®.



51) Open the generated G-Code file in CETUS (UNI-FRAES-V3).

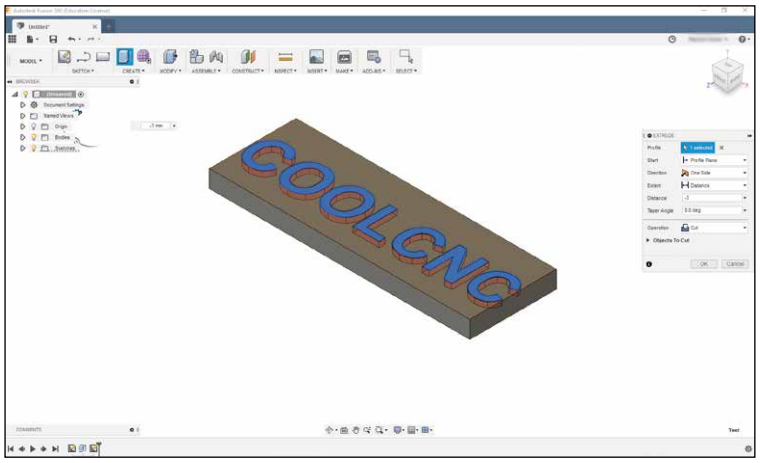
Working with Autodesk® Fusion 360®

https://www.autodesk.com/products/fusion-360/students-teachers-educators

Fusion 360 is a professional 3D CAD/CAM software for which AUTODESK offers free licenses for education.

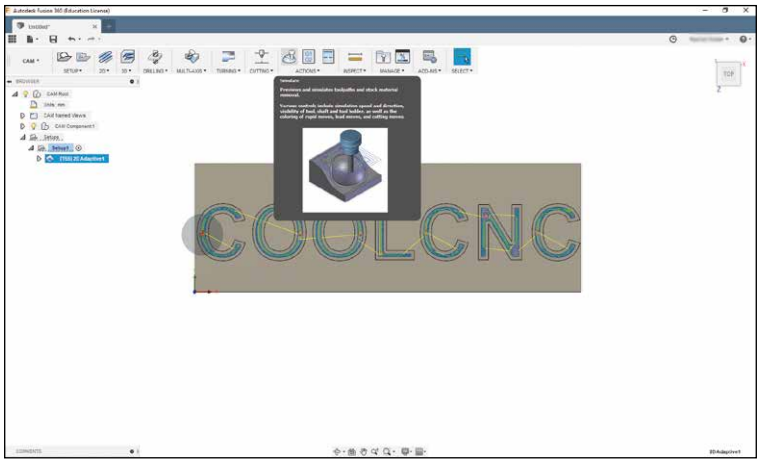
Advanced designs, 2.5D drawings or 3D models can be constructed, the CAM functionality allows for generating G-code files.

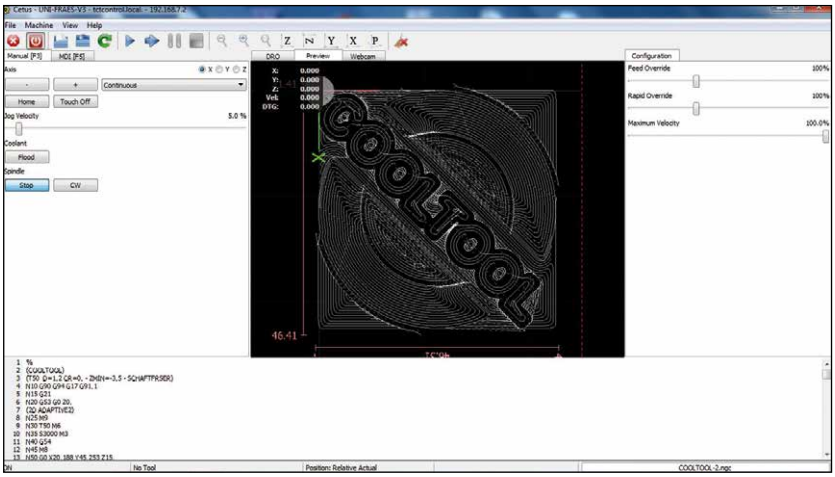
Suitable post-processors and tool-tables make it compatible to the Machinekit CNC software.



Fusion 360 - CAD
(design process)

Fusion 360 - CAM
(set machining parameters)





Cetus - machinekit
(loaded G-Code)

Autodesk® Inventor® can also be used.

Education

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