Laser micro-machining system instalation and user manual

Reconfigurable Robotic Laboratory

October 18, 2012

Preface

This manual is a first draft prepared by a student (not the producer company). So most names and expressions that are used are not correct scientifically and the procedures explained are prone to error. So be careful with carrying out the procedures and always check with the person in charge (If you are the one in charge, well; good luck!). This manual is available on lab's webpage where you can leave comments please provide us with your feedback so we can improve it. Also more detailed user manuals for components of the system and supporting software can be downloaded from that page.

After installation and before first use

Alignment procedure

After each movement of the machine, the optical system should get rearranged to put the laser beam in the middle of the input cavity on the scanner body and completely perpendicular to it. In what follows the procedure for alignment is presented briefly.

1- If you fill like it put on gloves. Finger prints on optical surfaces apparently don't increase performance!
2- Remove the black caps on the optical systems presented in Figure 1.
3- Remove the beam expander
4- Adjust mirrors (1) and (2) so that the beam would pass from the middle of the both diaphragms. The mirrors have 1 translational DOF, and two tilt motions. Remember to first open the fixing screw on the mirrors. And after adjusting to close it.

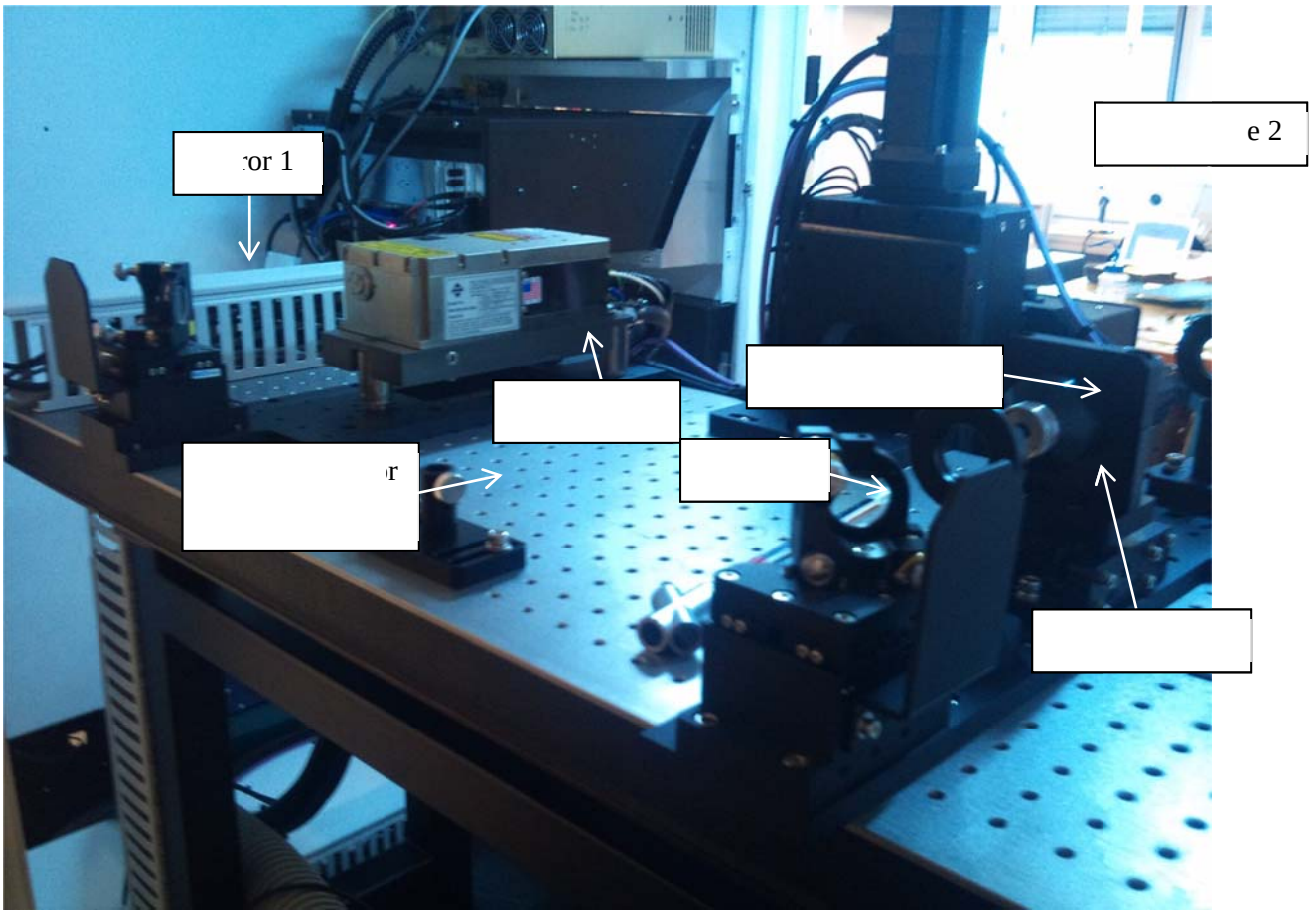

Figure 1: optical system 1st half

5- Adjust mirrors (3) and (4) so that the beam becomes perpendicular to the scanner face Figure 2. In this stage don't use translational degree of freedom and do it with tilting the mirror. To do this first place the mirror on hold (1) you should check the arrow on the side of mirror it doesn't work on both sides. Now adjust mirror (3) so that the reflected beam concur with the incoming beam (Wait! It sounds wrong! Well you are right. I read somewhere in laser head manual that you should never send back the beam to the laser head but that is the way the installers did it. At least try to get over with this process fast). What you should do in this

stage is you take a piece of paper put a hole in it and take it in laser's path and then adjust the mirror so that the reflection concurs with the position of hole and the incoming beam.

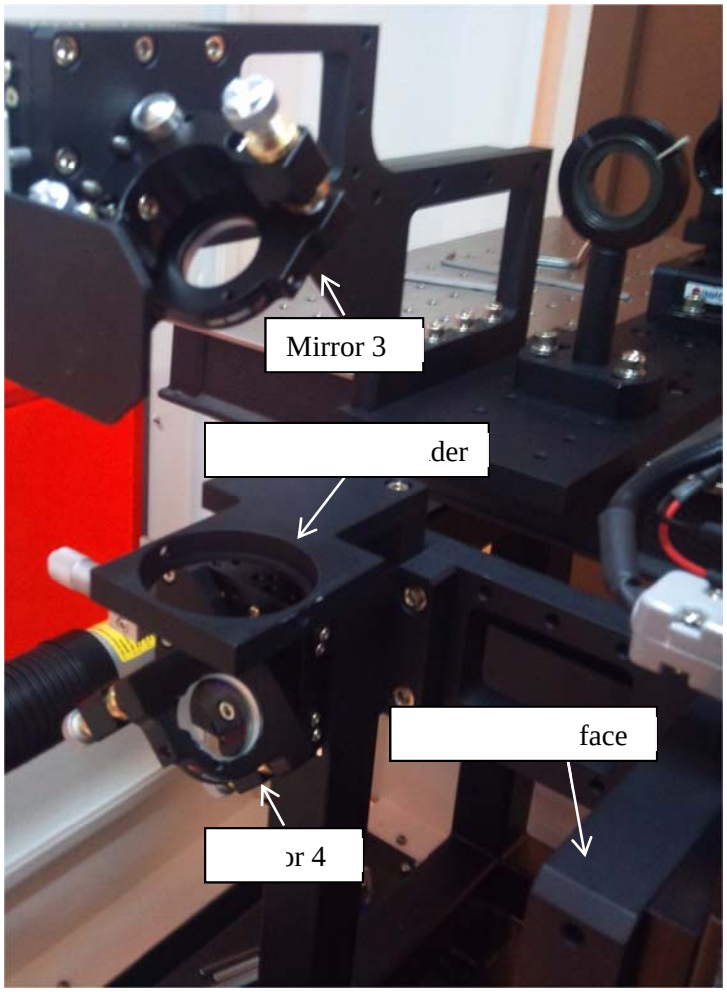

Figure 2: optical system 2nf half

6- Put the mirror on the side of the scanner and check for perpendicularity and if needed adjust using mirror 4.
7- Now using translational DOFs position the beam in center of the scanner. (you should do the steps 5,6 and 7 couple of times to reach the desired result)
8- Put back the beam expander in its place using the 4 screws on the expander holder, center the beam and make it perpendicular to the scanner face.
9- Now that you have done the best you can you should do the final adjustment. Put the power sensor in its holder shown in Figure 1. Using computer program, make a step output (current around 28 and power percentage of 95) and measure the power (Write it down if you like). Now remove the power sensor and put it under the scanner. Do the power measurement again. You should reach power efficiency available in the accompanying excel file(what it was at the time of installation)
10- Now you need to make the chart for laser power in each pulse. We need it so we don't have to make all the recipes for cutting different material again. Knowing what pulse energy we need we can simply choose from the chart instead of doing it all over again. The parameters are frequency (constant at 20kHz), current and pulse energy. Power efficiency and pulse energy of the laser system after first installation are presented in Figure 3 and Figure 4. 1- maximum at 95% 2-very nonlinear

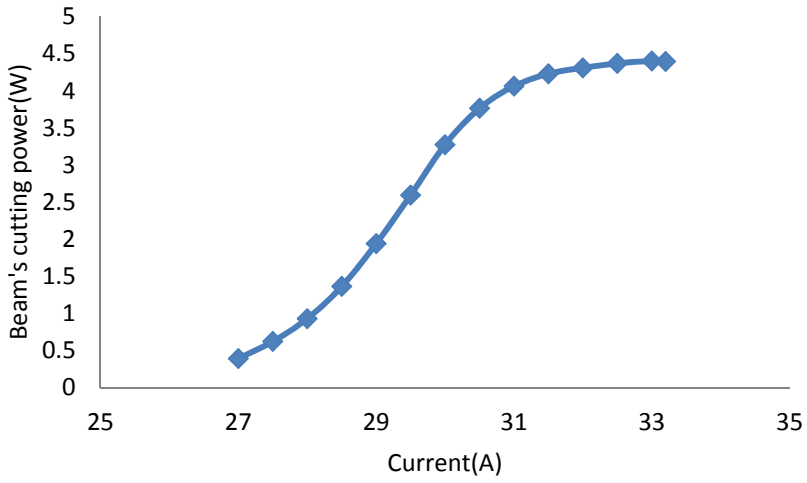

Figure 3 Power as function of current

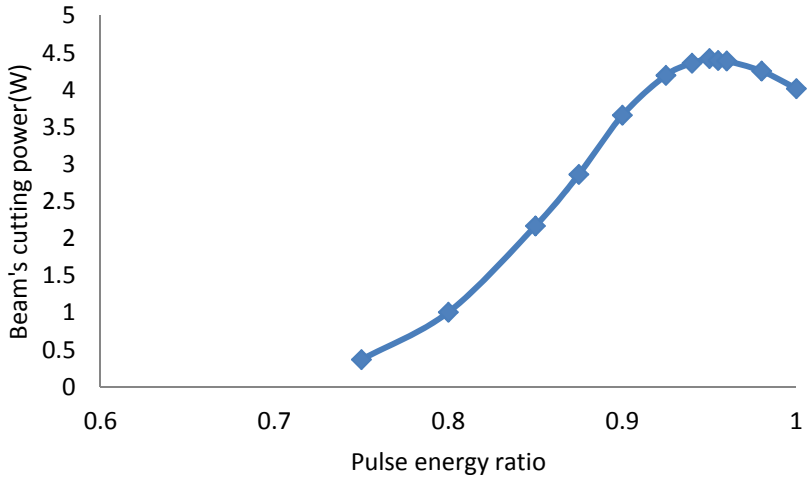

Figure 4 Power as function of pulse energy ratio

Finding the focal plane

After each alignment of the laser the operator have to find the focal plane for the laser. The procedure we use (It is not the best) is:

we put a thin glass (0.5mm it was a special glass cause Lim told me even they cannot buy it anymore!) on two pillars (these are left by installer for us and the heights are determined) what we do is to start making lines on the glass while changing the position of scanner in z direction. The laser starts to make marks somewhere and somewhere it stops making marks we choose the middle one as our focal place position (the best way is to make marks on special material and check for the narrowest and cleanest cut).

In this stage the cuts are made with: 33.2A current, 85% pulse energy, 0.5m/s marking speed

Making the correction file

A bachelor student can write us an image processing program to do this and we can even sell it back to Inno6.

In this stage, the scanner makes slightly curved lines instead of straight ones. So a correction is needed. First in the file defaults.txt you should change the correction file to the file named correction1to1.txt which is in the same folder (). This is the file for marking without any correction. Go to correction window in the program. For this machine 7 by 7 mesh is enough. After marking using the order button in this page you should start filling up the table in this page. You make the cross mark to concur with the point and then double click on the corresponding element in the table.

Be careful since the axis of the stage and the scanner are not the same you should move between points and fill up the table as presented in Figure 5.

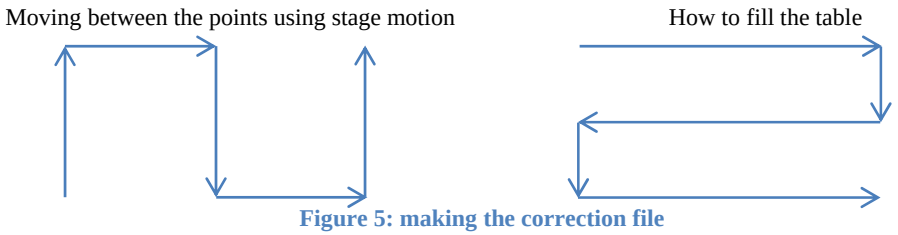

Figure 5: making the correction file

After completing the table save the data, open it with excel, clear the empty rows, save it as *.pm, copy the .exe and .dat into the folder, copy .pm into .dat. run the .exe. load and create. Now you you should have a correction file with .CBT extension. Copy it in the mfi/ini folder and change the file name in defaults to the file you have created.

In case of problem with laser head

If there ever was a problem with laser head (first of all, well done!!) you should pack it as presented in Figure 6 before returning it to Korea (Inno6) or US (Photonics). As I am sure you have figured it out you should first ask which one!

Figure 6: laser packaging

General Information for using the laser

Regular maintenance:

The beams position on the stage in regard to camera changes over time (Don't know why?). So the relative distance between the scanner and the camera should get corrected every now and then. To do so, make mark with scanner press go to camera button. If the cross wasn't in the middle of the mark, you should change the distances.

Every now and then the Inno6 comes up with upgrades for their software. In that case you should go to the folder and replace the mfl200.exe. Always keep the file you are replacing as back up.

General use

There are 3 parameters for controlling the cut:

1- Pulse energy (current and PEP)
2- Overlap (Marking speed & repetition). For glass and brittle material there should be no overlap (marking speed 0.1m/s). While for material like metal there should be large overlap (marking speed 0.05m/s).
3- Z position: for materials like glass (brittle) it is better to have the focal plane slightly above the surface of specimen.

Before making a cut ALWAYS check:

1- Have you put the correct thickness for your sample (in case of a transparent material the wrong thickness can cause damage to the stage)
2- Be sure to click for scan so the stage moves under the scanner
3- Be sure to click for scan. Since the focal plane of camera and the scanner are not the same forgetting to do this can damage the stage
4- Always make sure to have the right setting file chosen.

Movement in z direction

Only use slow or at most the medium velocity for changing the position in z direction. Using fast motion would result it stepper motor skipping some steps. Since we don't have a feedback on position in this direction unlike x and y direction, where linear encoder provides feedback, Using high speed causes in the problems. If this happens (in case you cannot make cut or cannot see the object which means focal plane is not where the computer program expects) just click "stage homing"

Aligning the mark for multi-layer fabrication

There is an auto alignment window in the program. As it turned out we cannot use this in our machine since the marks our machine makes are not clear enough. What we should do instead is to align the cross mark with the aligning mark manually and keep the rotation from here on and save the position as one of the memories.

AutoCAD and cncCAD:

Each element in AutoCAD corresponds to 2 elements in the laser program. The maximum number of lines possible for laser program to compile is 7000 which means in AutoCAD we should break the design to files with up to 3500 elements.

Type co→copy, right (enter), and simply read the instruction.

F_8 for making the lines along the grid.

Trim easy.

Move

You should have the files in the middle of each section, but in cncCAD the origin is automatically put on the lowest most left element. So first we compile the file (closed contour open contour) then we change the color of the two lines on the corner and change (To white) the position of origin. The lines we changed colors would not get cut. Now make the NC code. There are two times in the process you should check cut without beam size compensation.

Miscellaneous

There is this program for changing laser parameters. It has come with the laser. We are not going to use it. The name, user name and password are all the same: PII. The port you should select is com2

<Cold start>

- Turn on the chiller for 30min at 26C
- Power plug in (crystal starts to get heated) wait 30min
- Turn on the power switch (red toggle switch) wait 5min
- Press the shutter button (now ON)
- Turn the enable key (now ON)
- Turn on the LDD (now ON)
- Change the current to 20A. Wait 5min.
- Change the current to 33.2A.
- Now ready.

<Cold off>

- Change the current to 0A
- Press LDD (now OFF)
- Turn the enable key (now OFF)
- Press the shutter button (now OFF)
- Power toggle switch off
- Unplug the power cord
- Chiller off

<Warm off>

- Change the current to 0A
- Press LDD (Now OFF)
- Press the shutter key (now OFF)
- Power toggle switch off
- Chiller (can stay on or off)

<Warm Start>

- Chiller on if it was off
- Power switch on
- Press Shutter key on
- Press LDD (Now ON)
- Change the current to 20A. Wait 5min.
- Change the current to 33.2A.