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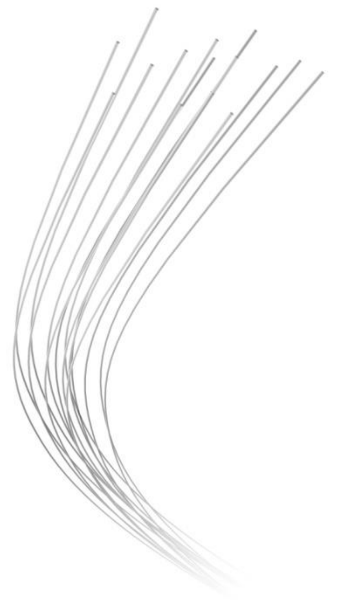
# DILASE TUTORIAL

## Focalisation Test



*DilaseSoft - TUTORIAL 6 – Automatic Line Switching*

*V1.2 on 2019/04/16 by RC-CC*

## INTRODUCTION

Focusing height is essential for the use of DILASE equipment. Its adjustment and control ensure the conformity and reproducibility of a lithographed pattern to the expected specifications.

The purpose of this tutorial is to describe the step-by-step procedure to perform a focus test with a Dilase (KLOE.SA) equipment.

## RELATED DOCUMENTATION

KLOE SA provide several further manuals, tutorials and instructions related to its equipment and its operation. Please refer to these following documentations to help you in this tutorial:

***- DILASE 250 Manual.pdf***

***- DilaseSoft 250 Manual.pdf***

***- Tutorial – Dose Test.pdf***

## CONVENTIONS

**NOTE** : Information to follow the steps

**IMPORTANT** : Information to follow absolutely

**PRUDENCE** : Information to not damage the equipment

**ATTENTION** : Information to avoid injury

## SYMPTOMS AND VISIBLE SIGNS OF FAILURE

- Poor writing quality
- the writing dimensions are not reached

## When did you need to set a focalisation test?

1/ You did not know the focusing height on your sample.

2/ Writing quality is poor

3/ You are working on a new substrate with a new photoresist and your usual parameters did not works.

4/ Writing dimensions are not reached

## REQUIREMENT:

- Dilase 250/650/750
- Silicon substrate or glass substrate coated with 0.5µm thick positive photoresist
- Spin-coater
- Hot plate

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## PRINCIPLE:

The focus test allows, as on a microscope, to find the operating point that will give the best lithographic conditions.
This parameter once obtained will be repeatable and will provide the best resolution of the equipment on a specific substrate thickness and a specific coating.
This test will have to be reproduce if any changes in terms of resolution is observed.
The step-by-step procedure of the focusing test consists of several steps:

- Coating a thin layer of photoresist on a substrate
- Files creation
- Execution into piloting software (DilasSoft)
- Development and analyse.

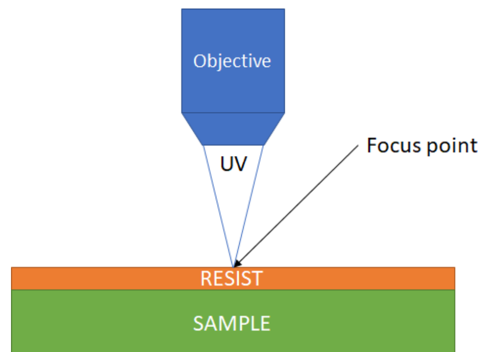


**Figure 1: Principal of the focal distance**

> **NOTE:**
>
> UV focus is always different from the visible focus.
>
> On standard equipment, this shift between UV and visible, called Delta Focus (ΔFocus), is in most of case always deeper from the visible focus, see Figure 2.
>
> If this is not the case, please refer to the manufacturer's documentation supplied with the delivery of the equipment

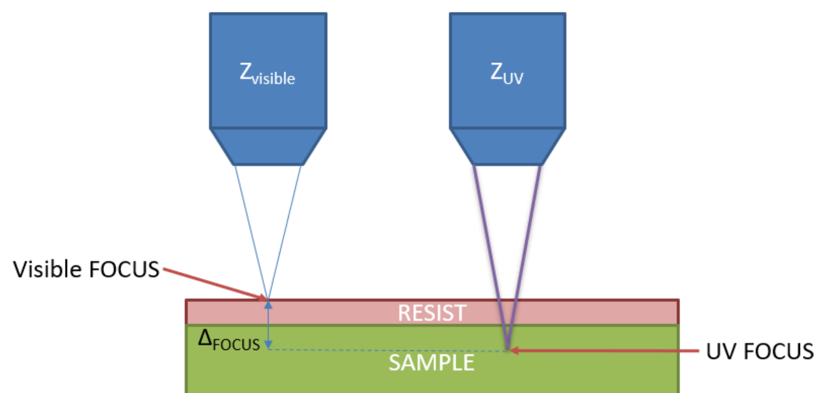


**Figure 2: Principle of the focus**

**NOTE:**

UV Focus will have to be found by testing the values of focus around the "**Visible Focus**" also called **"Zvisible"** (Focus that allows to have a clear image of the substrate on the camera).

Figure 3 shows the principle of the focusing test.

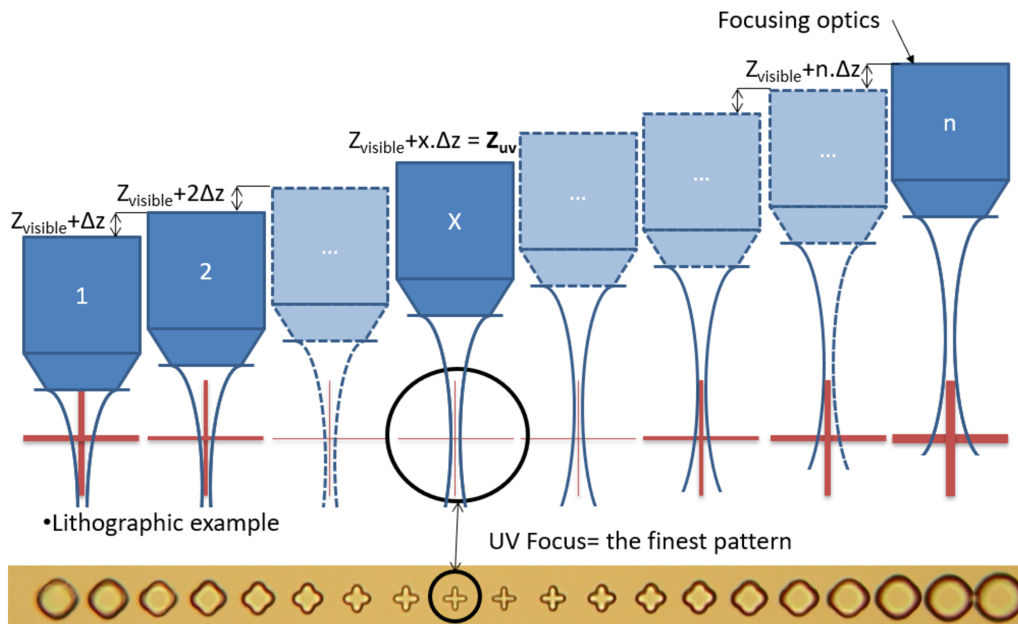


**Figure 3: Focusing test**

A variation of the focal position will be applied around the visible focus.

The lithographic result will show a blurred realisation going to a clear pattern until it becomes blurred again.

The ΔFocus will have to be calculated and can be applied again from the visible focus for new realizations.

$\Delta Focus = Z_{visible} - Z_{UV}$

# STEP-BY-STEP PROCEDURE – Focalisation Test:

## Substrate coating

During this step, a substrate and a photosensitive resin will be used as examples. The same procedure may be followed on other types of substrates and other types of resins in accordance with the technical specifications of the materials used.

- Choose a substrate
- Measure its thickness with a micrometer
- Choose a resin and follow the deposit process indicated by the datasheet to obtain a required thickness.

**Example below :**

| Substrate | Silicon wafer 4 inches / 530µm thick |
|---|---|
| Resin | Shipley 1805 /0.5µm thcik deposit |

Spin coater settings:

| Speed | 4000 rpm |
|---|---|
| Acceleration | 1000 r/s |
| Process time | 30 sec |

Hot plate settings:

| Temperature | 100°C |
|---|---|
| Duration | 1 minute |

- Clean the wafer (isopropanol +optical wypes)
- Start the deposit
- Take back the wafer and clean the back side
- Place the wafer on hot plate at 110°C during 1 minut
- Store into a UV protective box

**IMPORTANT :**

Photosensitive resin deposits must be made and must be stored away from all sources of UV radiation.

# STEP-BY-STEP PROCEDURE – Focalisation Test:

## Setting up the equipment

One considers a Dilase configuration including a motorised focusing stage.

- Switch ON the DILASE
  - Switch ON the computer and the monitor
  - Release the E-Stop switch and turn ON the Starting Key from the equipment's console.
- Starting up the DILASE

**CAUTION:**

**Before continuing, make sure that the chuck (substrate holder) is free from any elements (covers, substrates, etc...) and the focusing device is free from any protection.**

  - Open DilaseSoft (Shortcut Icon available on the desktop)
  - Initialise the equipment (See Figure 4)

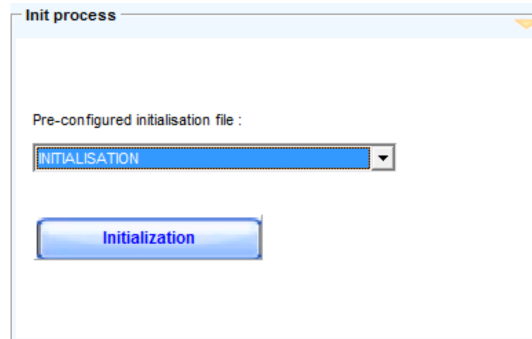


Figure 4: Initialisation button

**NOTE:**

Please wait during initialisation, the system will automatically proceed by checking the limit switches of all the stages embedded in the equipment. The system is ready to use when the information window "**Initialisation in progress**" disappears.

- Put a sample with a thin film of positive resist on the chuck (example: Silicon wafer + Shipley 1805 - 0.5µm)
  - Cover all the holes on the chuck to avoid vacuum leakage
  - Click on **"Vacuum"** and be sure the vacuum is **"OK"**

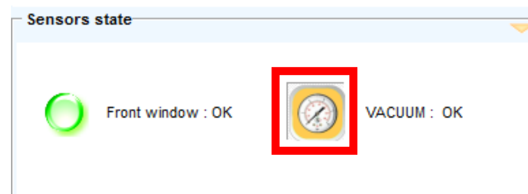


Figure 5: Vacuum button present

## STEP-BY-STEP PROCEDURE – Focalisation Test:

### File creation

The following procedure will describe step by step, how to create a focusing test using simple design as lines.

<u>With **"KloeDesign":**</u>

- Generate a 5mm line
  - Add a new line
    - Length: 5 mm
    - Angle: 0°
    - X position: 0 mm
    - Y position: 0 mm

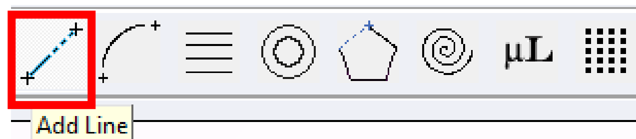


Figure 6: Creation of a line

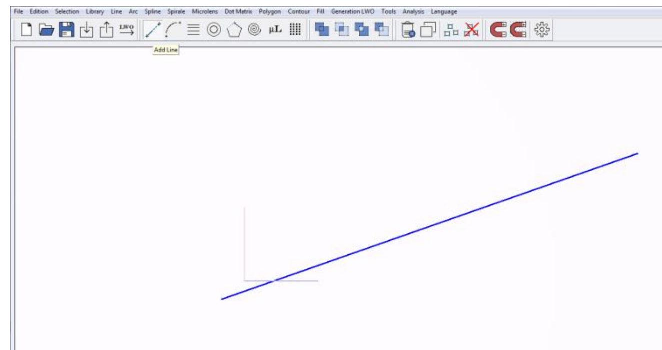

Figure 7: Creation of a line

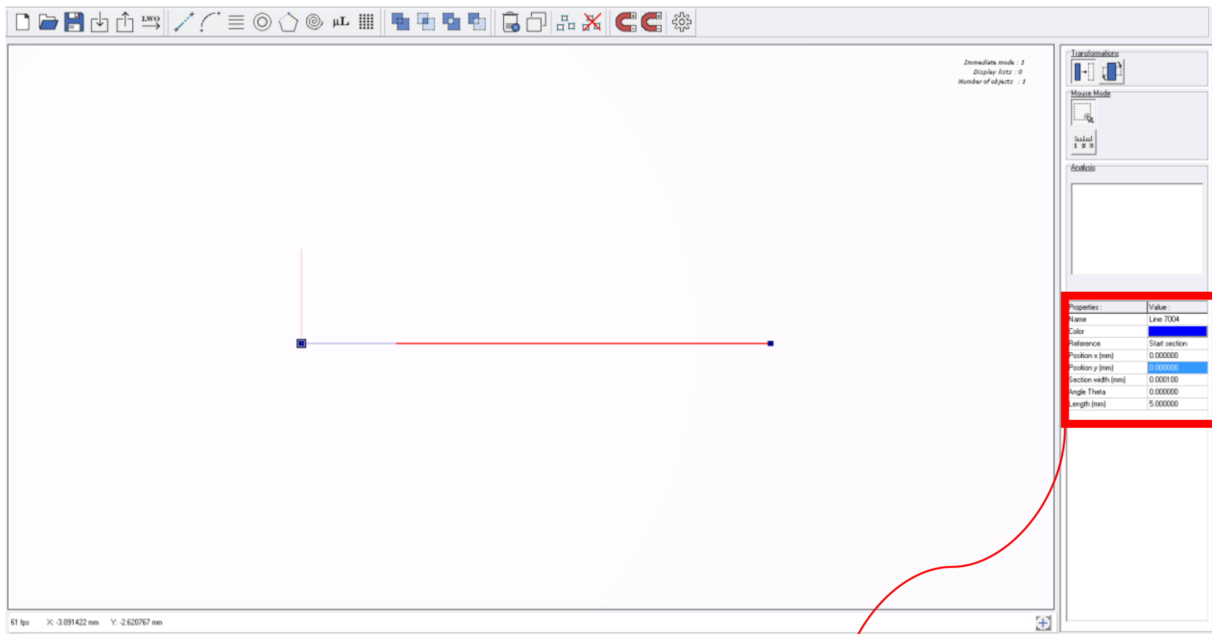

Figure 8: Creation of a line of 5mm

| Properties : | Value : |
|---|---|
| Name | Line 7007 |
| Color | |
| Reference | Start section |
| Position x (mm) | 0.000000 |
| Position y (mm) | 0.000000 |
| Section width (mm) | 0.000100 |
| Angle Theta | 0.000000 |
| Length (mm) | 5.000000 |

Figure 9: Detail of the settings area

- Click on "**Generation lwo => Generate the current pattern**"

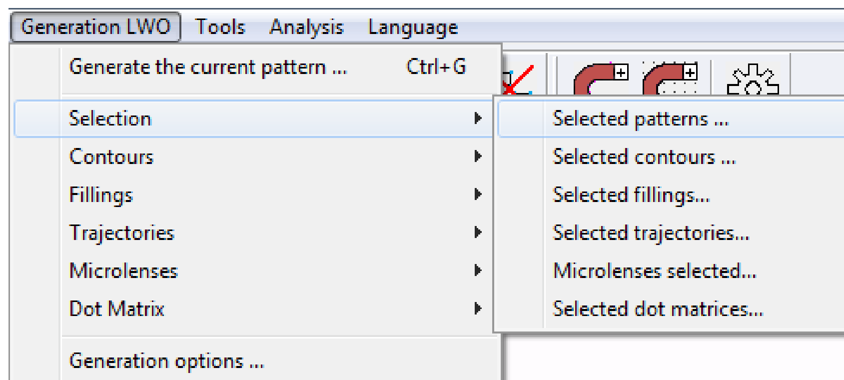


Figure 10: Generate a line in LOW

- Save as **"line5mm on X.lwo"**

## STEP-BY-STEP PROCEDURE – Focalisation Test:

### How to set the focusing test

This steps will allows to estimate the range of focal length to be tested.

With **"DilaseSoft":**

- Switch on the light by clicking on **“Turn ON light”**

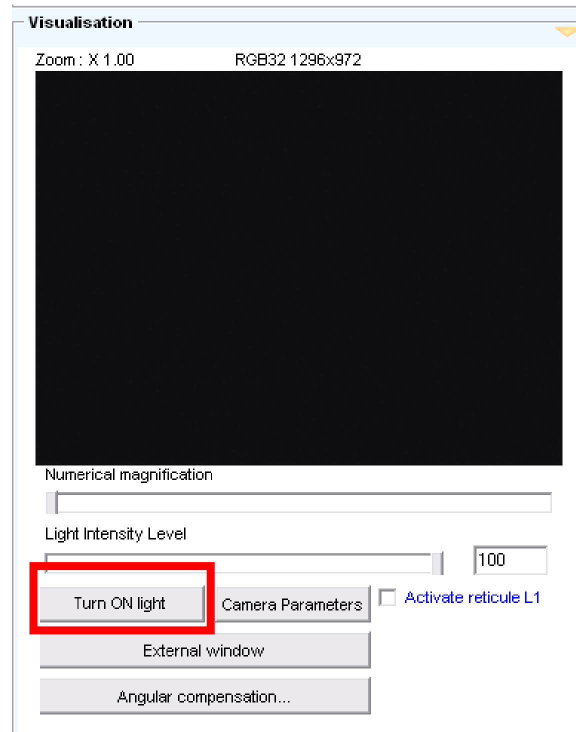


Figure 11: Turn ON light

- Move the stages to reach a corner of the substrate using the arrow on the **“Engine control panel”**.

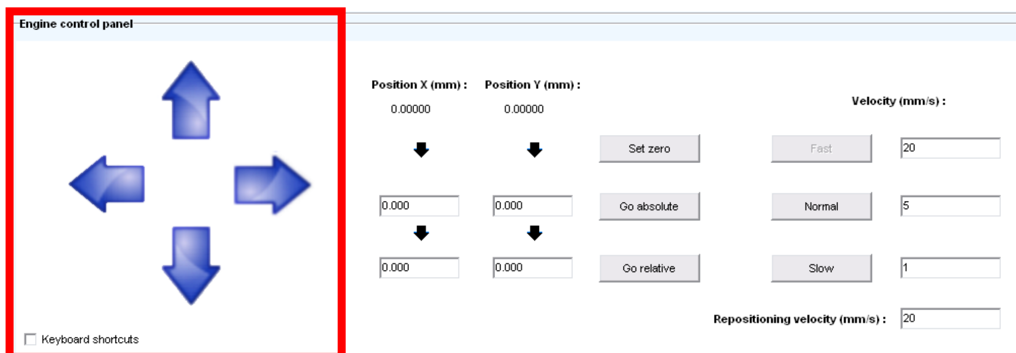


Figure 12: Engine control panel

- Move the motorised focus up and down, using the arrows into **"Focusing Stage"** panel, untill to obtain a clear image of the substrate see Figure 13 & Figure 14.

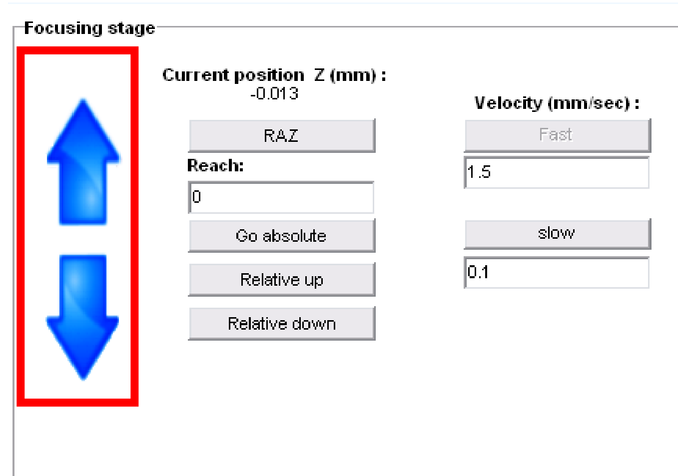


Figure 13: Focal command button

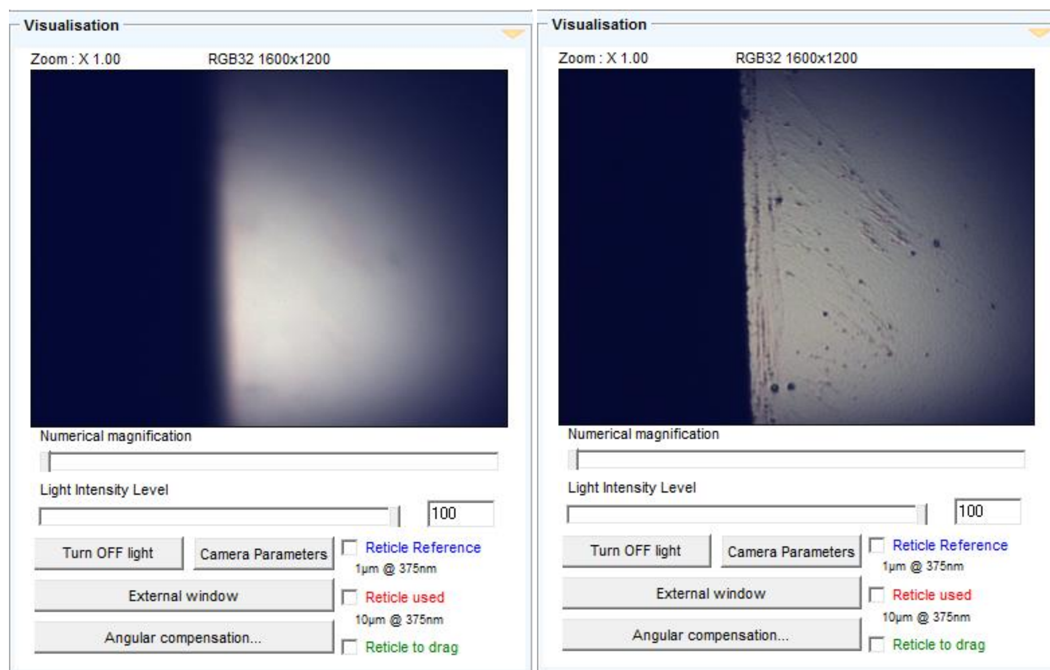


Figure 14: Blurred image (left) – clear image (right)

- Note the value indicated below **"current position Z (mm)"** into the **"Focalisation panel"**.

**NOTE:**

This value will be called **"Visible Focus"**

- Load the LWO **"line5mm on X.lwo"** into the file list by clicking on **« Add »**.

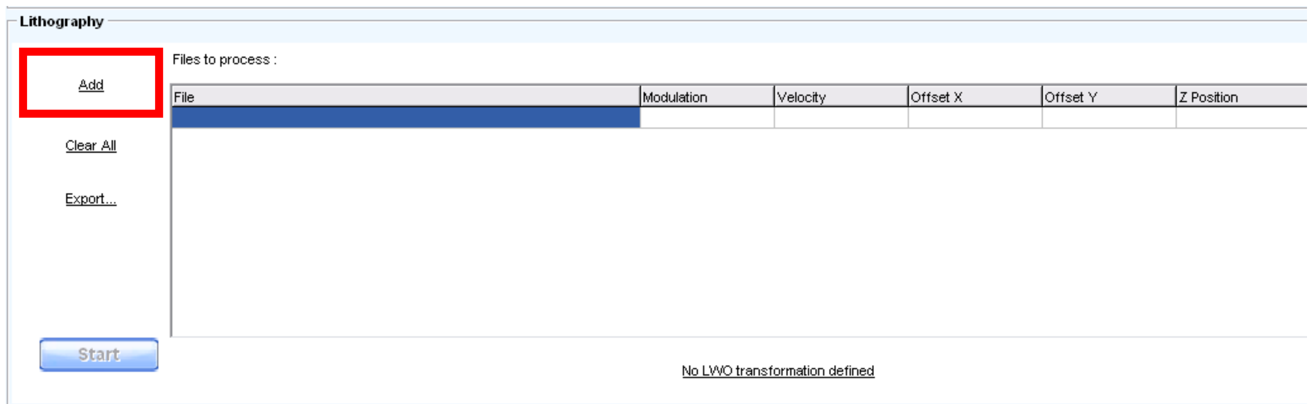


Figure 15: Add LWO file button

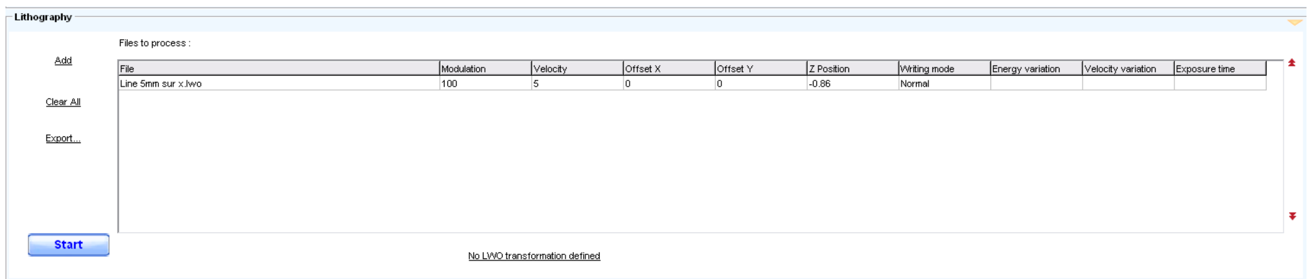


Figure 16 : Window of files to process

- Repeat the previous step 20 times

- Change the parameters of the first file, by filling in the boxes :
  - Speed at 5mm/s
  - Modulation at 100%
  - Position x to 0
  - Position y from 0 to 2mm every 100µm with a difference of 200µm between the 1st and 2nd to be able to recognize the beginning of the test

**NOTE:**

Right-click on the modulation and speed column and click on **"apply the selection to the whole column"** to fill the entiere column with the parameter selected see Figure 17.

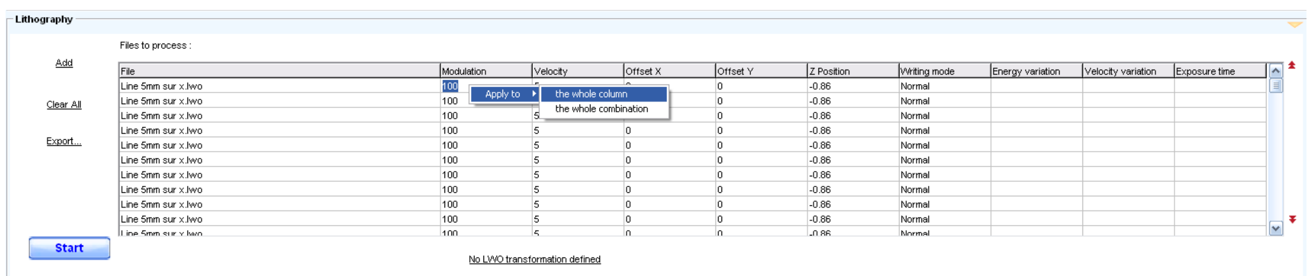


Figure 17: Application to the whole column

- Fill Z position column with values surrounding the Visible Focus in 5µm steps.

Lithography

Add

Clear All

Export...

Files to process :

| File | Modulation | Velocity | Offset X | Offset Y | Z Position | Writing mode | Energy variation | Velocity variation | Exposure time |
|---|---|---|---|---|---|---|---|---|---|
| Line 5mm sur x.lwo | 100 | 5 | 0 | 0 | -0.8 | Normal | | | |
| Line 5mm sur x.lwo | 100 | 5 | 0 | 0.2 | -0.805 | Normal | | | |
| Line 5mm sur x.lwo | 100 | 5 | 0 | 0.3 | -0.81 | Normal | | | |
| Line 5mm sur x.lwo | 100 | 5 | 0 | 0.4 | -0.815 | Normal | | | |
| Line 5mm sur x.lwo | 100 | 5 | 0 | 0.5 | -0.82 | Normal | | | |
| Line 5mm sur x.lwo | 100 | 5 | 0 | 0.6 | -0.825 | Normal | | | |
| Line 5mm sur x.lwo | 100 | 5 | 0 | 0.7 | -0.83 | Normal | | | |
| Line 5mm sur x.lwo | 100 | 5 | 0 | 0.8 | -0.835 | Normal | | | |
| Line 5mm sur x.lwo | 100 | 5 | 0 | 0.9 | -0.84 | Normal | | | |
| Line 5mm sur x.lwo | 100 | 5 | 0 | 1 | -0.845 | Normal | | | |
| Line 5mm sur x.lwo | 100 | 5 | 0 | 1.1 | -0.85 | Normal | | | |

Start

No LWO transformation defined

**Figure 18: Final file list**

**<u>NOTE:</u>**

If the "Visible focus" value found is **"-0.845"** the focusing test will start with **"-0.8"** and finish with **"-0.895"**.

**<u>NOTE:</u>**

Focus shift value recommended is:

- **20µm** for rough test
- **10-5µm** for standard test
- **2µm** for fine test

- Click on **« Export »** to save the file list into DFL named « Focusing test ».
- Click on **« START »** to begin the lithography.
- Develop the sample once the writing is finished with appropriate developer.

**<u>NOTE:</u>**

For the example : Shipley 1805 is revealed with MF319 developer during 15sec then rinsed with water.

- Observe the results and identify the finest and best defined line see Figure 19.
  - Count the number of lines to get the UV focus and compare with the file list.

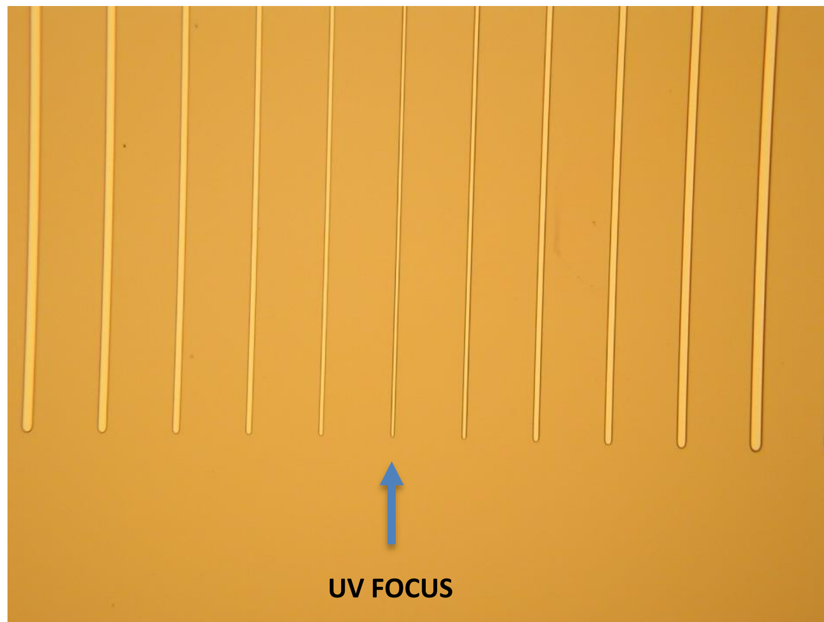


Figure 19: Results

- Calculate the Delta focus between UV Focus and Visible focus, this value will be use for the next lithography.

**TROOBLE SHOOTING:**

- ❖ Lines do not become smaller then larger again.

=> Increase the shift between each Z position

- ❖ Lines are overexposed and do not allow to identify the focus clearly

=> Reduce the modulation for each line.

- ❖ Lines are not visible

=> If there is no filter to remove from the optical path, Increase the modulation. If the modulation is at the maximum, reduce the speed.

# END OF TUTORIAL