KLOE SA

HOW TO IMPORT A GDS2 FILE IN KLOE DESIGN

# TUTORIAL 1

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# Importing GDS2 file

The purpose of this tutorial is to describe the typical recommended way to import GDS/GDS2 files in KLOE DESIGN and the way to generate the corresponding files ".lwo" workable with Dilase equipment.

Here is the list of actions which will be managed in a typical conversion.

## Loading the GDSII

The file we'll take for example throughout this tutorial is a microfluidic chip presented on Fig1. This pattern is included in the example file called “TUTO-GDS.gds” associated with this tutorial.

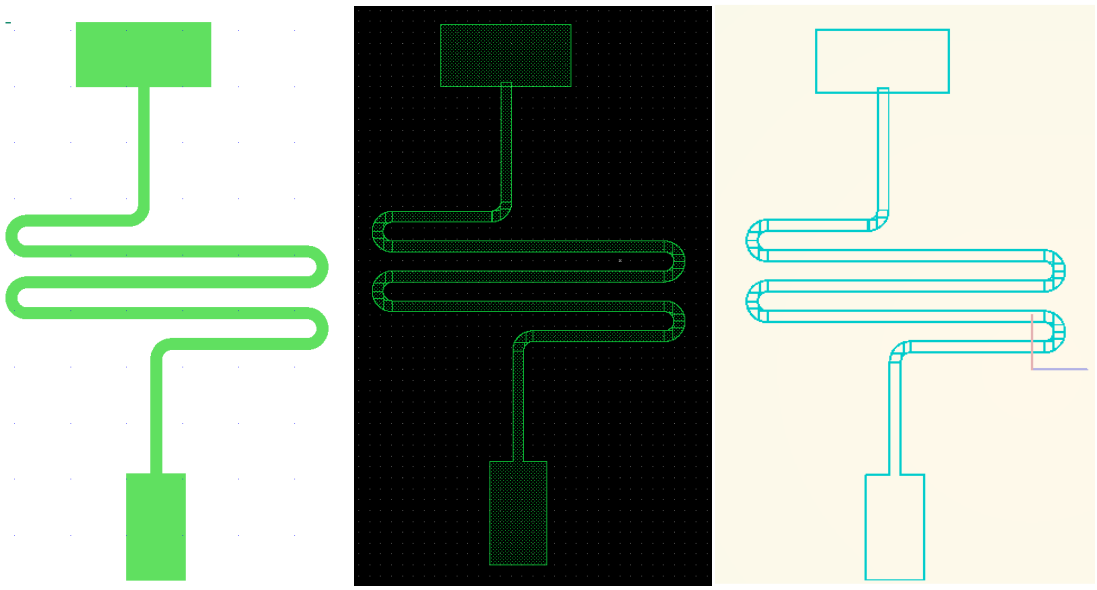


Fig 1a Fig 1b Fig 1c

**Fig 1a : Overview of the pattern expected (open with a GDSII editor with filled mode).**

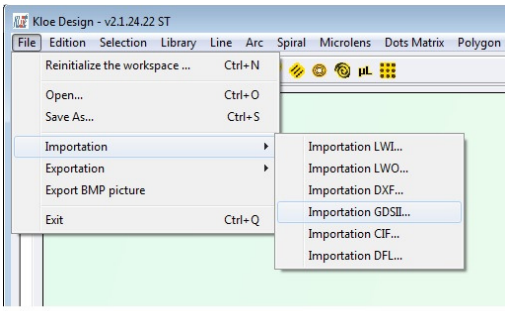
**Fig 1b : Overview of the polygon-based pattern as it is typically created (open with a GDSII editor without filled mode).**

**Fig 1c : Overview of the pattern as it appears in Kloe Design after importation.**

The pattern shown is the chip designed with a gds editor by the original designer. The chip expected to be realized is made of an area entirely exposed (green area) and marked out to shape a typical microfluidic channel. When removing the filling area (Fig 1b), it makes appear that the pattern is composed of many polygons. There can be many ways to create a gds pattern, not necessary with so many polygons to shape a channel, but each of them has a point in commun : they are made of polygons arranged together to create the pattern.

When the gds file is imported in KLOEDESIGN, all of these polygons are imported (Fig 1c) and all of them are loaded with their position and their apices.

- To import a gds file in KloeDesign, click on **“File > Importation > Importation GDSII”**




- Select the gds file to import, and then click “Open”.
- KloeDesign will display “Are you sure you want to reinitialize the workspace?”, asking if the actual graphic workspace has to be reseted before displaying the new gds pattern, or if the precedent patterns included in the workspace have to be kept. Click “Yes” or “No”. “Yes” will require Kloe Design to delete all the elements in the workspace before displaying the pattern imported.

- **Note :** As the gds is typically used in microelectronics industry, a gds file can often be made of many layers, meaning that there is many patterns organized in different overimposed levels. In order to differentiate these layers, Kloe Design will automatically match each of them with a specific display color. The color can also be selected manually by the user.

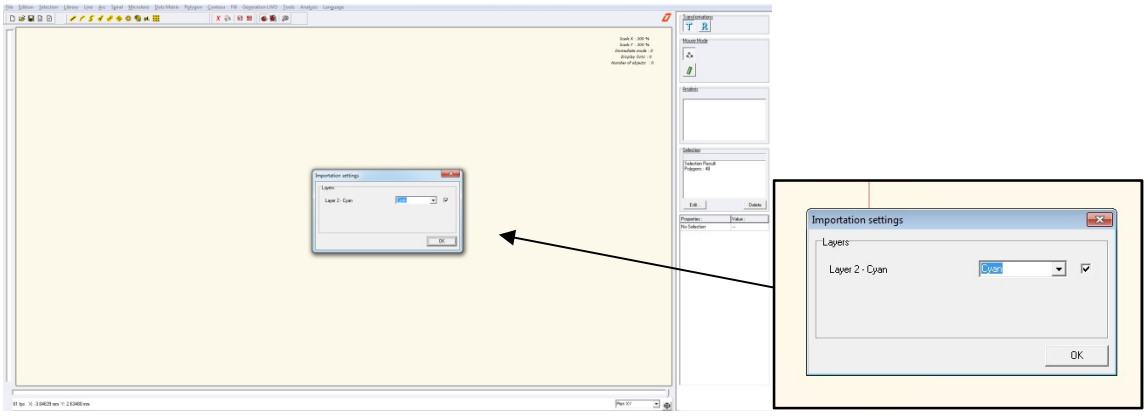



**Fig 2 : Choice for layer color**

- Then the gds pattern appears, exactly as the file has been designed, with all the polygons created in this pattern (Fig 3).

- **Note :** Dependant on the numbers of polygons, and particularly the numbers of apices, the loading time may vary and may take a few seconds or up to a couple of minutes.

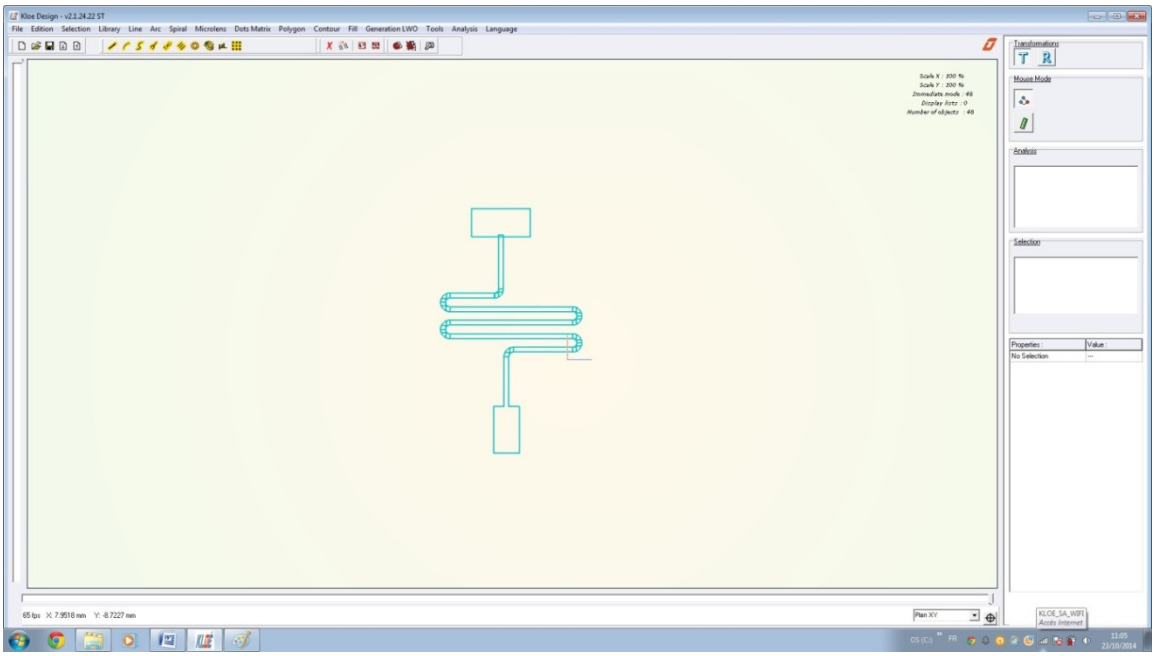


**Fig 3 : Gds pattern displayed after importation**

- Once imported and displayed, the design can be entirely processed by Kloe Design.
- From now, the user can create the “lwo” file which will be loaded and executed by the Dilase equipment (Dilase250, Dilase650, Dilase750).
- The “Generation LWO” menu is dedicated to the creation of lwo files. Click on **“Generation Lwo” > Generate the current pattern**” (Fig 4).

    - **Note :** The “**Generate the current pattern”** function is used to generate ALL the patterns displayed in the workspace. If there is some other patterns in addition to the one treated by the user, they will be generated in the same lwo file.

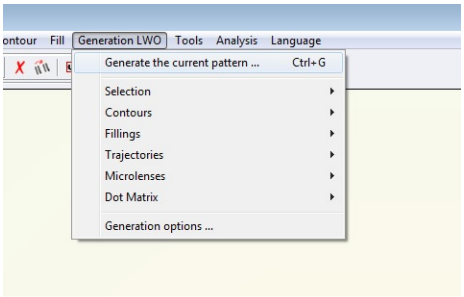



**Fig 4 : Generation of the current pattern**

- First, Kloe Design will ask for a file name and a file location and, after computing the operation, it will display the summary of the elements generated (Fig5), meaning that the generation is complete.

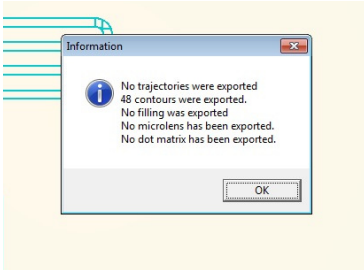



**Fig 5 : Generation summary**

- Now, the lwo file is ready to be used by the Dilase equipment. The user can load it in the software “Dilasesoft” embedded in the equipment and dedicated to manage the lithographic operations.
- A process simulation is available in KloeDesign in order to have an overview of the execution of this file by the equipment. Click on **“File > Importation > Importation LWO”**.

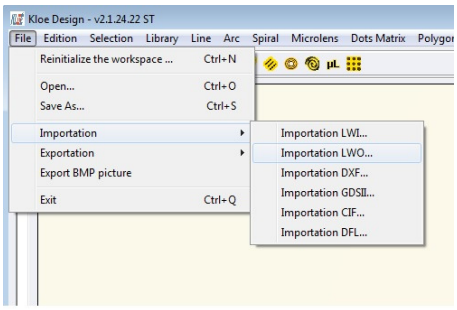



**Fig 6 : Importation LWO**

- The software will ask for a writing velocity and a repositioning velocity. Click on “Ok” to accept the default values. A green cross will move all over the graphic panel, drawing the pattern generated. This cross represents the way that the trajectories of the pattern will be written by the equipment (Fig7). The red lines represent the trajectories during which the laser is on, the green lines (if present) the ones executed by the stages but with the laser off.

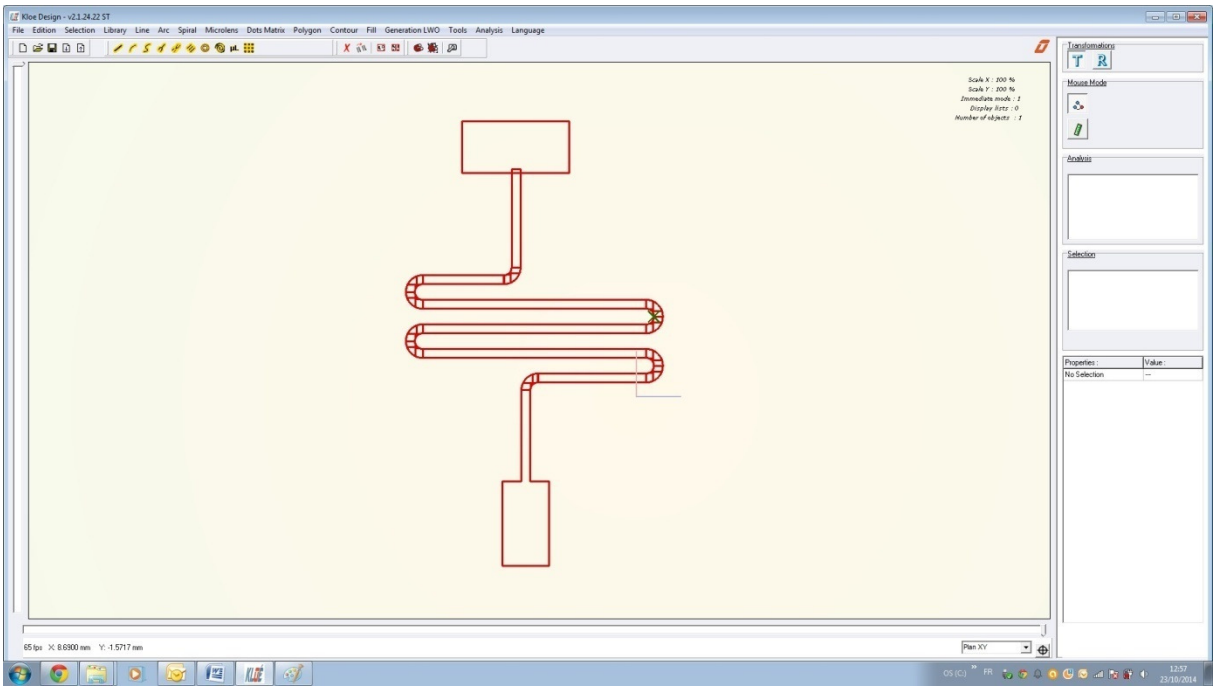


**Fig 7 : Simulation LWO**

- The lwo file is drawing exactly the pattern described by the gds file. The immediate importation doesn't require more steps to convert a gds file to a lwo file.
- The lwo file can be found in the windows explorer, cut or copy/pasted in a USB key, and copy/pasted again in the Dilase computer. See the DilaseSoft manual to know more about how to program a Dilase equipment with lwo file to schedule a lithographic process.

## Optimizing the GDSII pattern and raising lithographic quality

- Make roll the scroll wheel of the mouse to zoom in the pattern.
- Click on the red lines of the simulation pattern.
- On the right side of the interface, if the simulation pattern is correctly selected, the properties tab appears (Fig8). Click on "RAZ" to start again the simulation from the beginning, and after a few seconds of simulation, click on "Pause" to stop the simulation. The simulation will continue to go ahead by clicking on "Resume" instead of "Pause".

| Properties : | Value : |
|---|---|
| Name | test generation com |
| Color | Red |
| Position x (mm) | 0.0000 |
| Position y (mm) | 0.0000 |
| Stabilisation color | Green |
| Detection unit (ms) | 0.0000 |
| Current Index | 6035 |
| Time | 0h 0m 22s |
| Velocity write | 5 |
| Velocity replacement | 10 |
| State | Resume |
| Reloading | RAZ |

**Fig 8 : Simulation properties tab**

- The user can see the proceedings of the simulation trajectories. It appears that there is many lines written, corresponding with the border lines of the polygons. Some of them are written inside the microfluidic channel, which is wanted to be filled (Fig9).

    - **Note :** These lines are written for the only reason that they are present in the original file, but they have no utility in the final pattern which is wanted to be filled. It is possible to correct the original file (for example by removing these unwanted lines) in order to optimize the final lithographic process.

It will provide:

- Time-savings because some lines will not be written, and because the automatic writing strategy will be optimized.
- Quality-savings because some areas will not be overexposed uselessly.

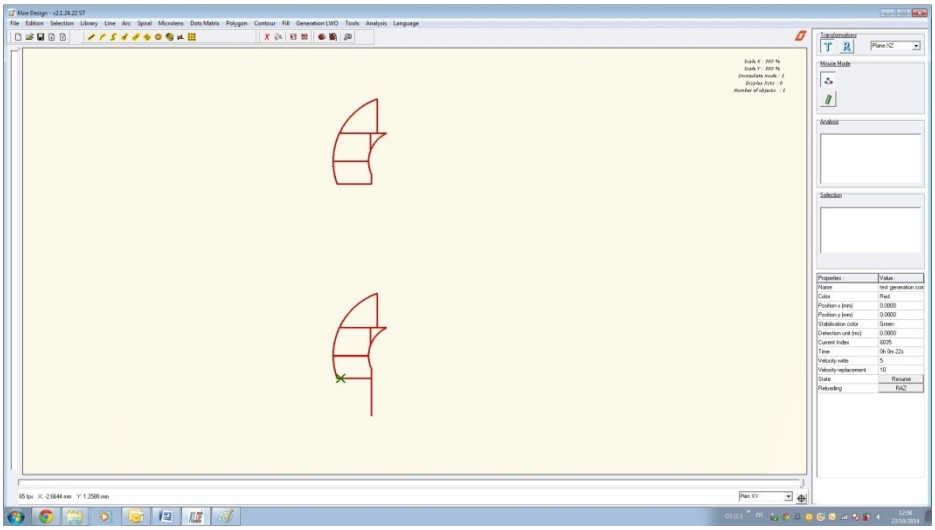


**Fig 9 : Useless lines in polygon-based pattern.**

## Dilase writing strategy

Each realization made with the Dilase technology meets a writing strategy in order to optimize the quality and the writing time.

The typical and most used writing strategy is given by the generation of a “contour pattern”, added of a “filling pattern”. The contour pattern will only include the borders of the pattern. The filling pattern will include the areas filled inside the pattern. A filling pattern can ONLY be created when associated to a contour pattern.

The optimization of a gds-based pattern (or a polygon-based pattern) starts with the contour file.

- **Note :** When a gds file is imported, the “filling pattern” is not included ! As a consequence, it is not possible to generate it without using the “Filling” menu available in Kloe Design and. The filling pattern has to be created by the user.

## Creating the contour file

The generation of the contour file will be made exactly by the same way than explained before, but some corrections will be brought before on the original pattern imported. The first corrections can be applied on the “curvature shapes”.

### Step 1 : Create arcs.

The pattern is composed of many polygons to form the curvature. In this example, the easiest way to optimize these curvature lines is to redraw them using the “arc” element in Kloe Design.

- Zoom in the wanted area displaying the elements to correct.
- Identify the useless lines to delete/move

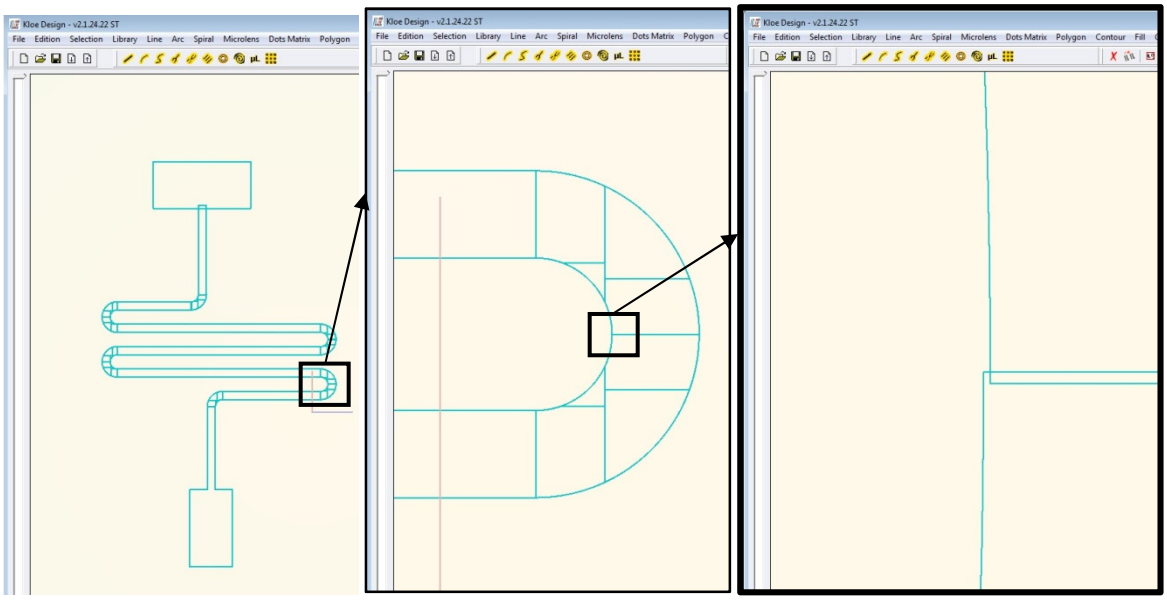


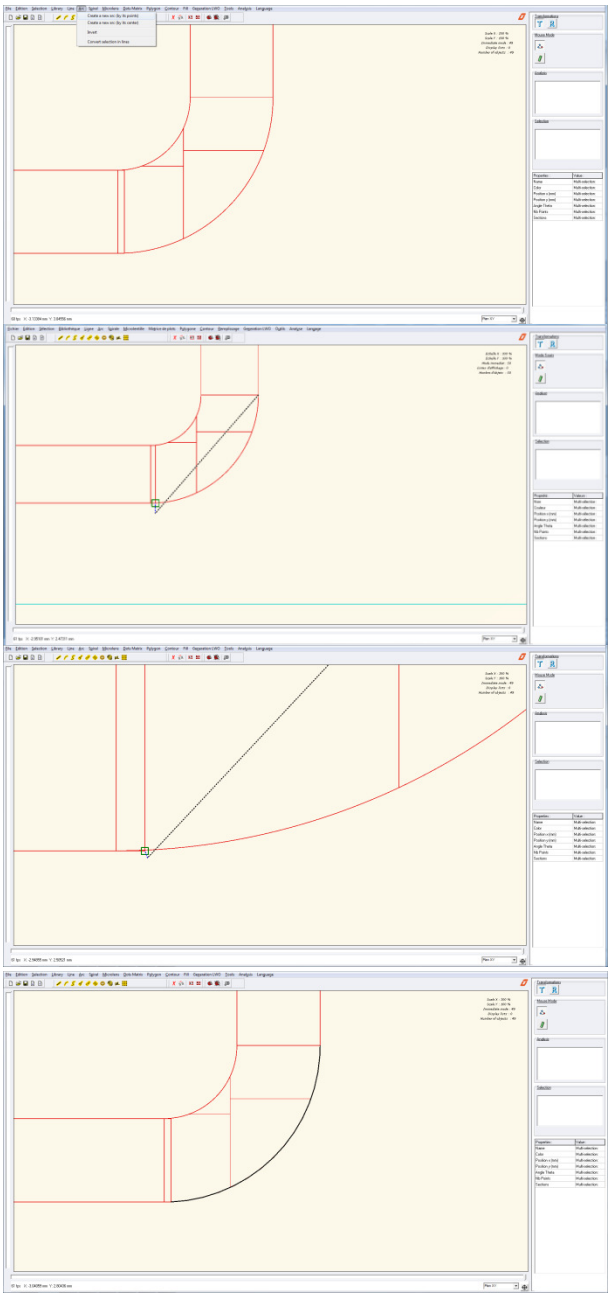
**Fig 10 : Detection of discontinuities by zooming in.**

- **Note :** By zooming in, the user can see that there are sometimes some discontinuities in the pattern, due to an inaccurate over imposition of polygons. Dependant on the resolution expected, and the effective shift between the polygons, this error can be seen on the final realization. Kloe Design provides some drawing tools to correct these errors.

- Select the elements (or polygons) to correct or to redraw.
- Click in the menu on **“Arc > Create a new arc (by its points)”**
- When the mouse arrow is getting closer of a polygon apex, a green box appears. This box is associated to a specific apex detected.
- Click Left with the mouse to create the first point of the arc.
- Move the cursor away and locate the apex (using the green box) to link the first point. The second point of the arc is created.
- A curvature line appears. Move the cursor to change and adapt the curvature of the arc to the original “curvature-like” shape.
- Click Left. The arc is created.

- See Fig11 for illustration about how to create an arc replacing a polygon

    - **Note :** this arc is a theoretical perfect arc. It is not sampled in the design file. It is only sampled for the display in the interface. When executed by a Dilase equipment, it will be sampled at the incremental step given by the stages (100nm for most of Dilase equipment).



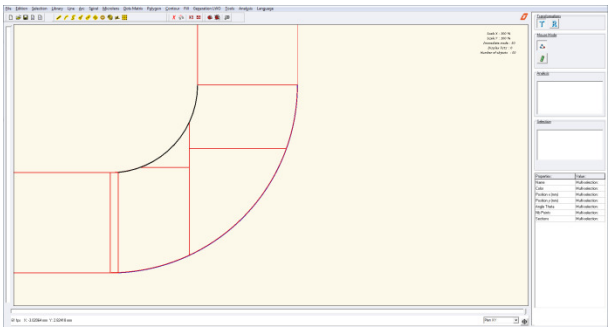
Selecting the pattern to redraw or the complete pattern to bring up points of links (Ctrl+A)

Using the tool **Arc>Create a new arc (by its points)**

Selection of the first point of the arc. Left click + move the cursor away

Selection of the second point of the arc

Adjustment of the curvature by moving the cursor and validation (left click)



Creation of the second arc and removing inner polygons.

Fig11 : replacement procedures arcs of the channel.

- Once the new shape created, delete the original polygons (see Fig12)
- Proceed as done before for the other curvatures of the pattern.

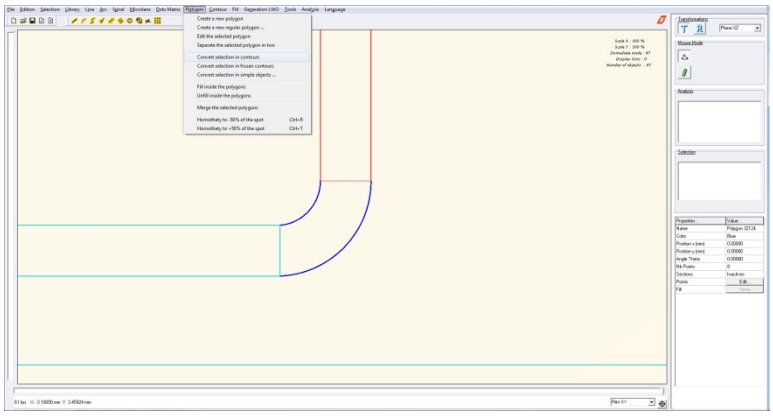


Fig12 : Remaining shape after correction

Now it can be useful to remove the border lines of the other polygons. In that exemple, the lines between the straight polygon and the arcs can be removed because they are inside the microfluidic channel.

- **Note :** the polygon element, coming from the gds file, can be modified ONLY by changing the apices (position or number). It is not possible to access to the lengths of the edges, or their orientation. KloeDesign can transform a polygon element into a “contour” element, (DXF-like element) to access to dimensional properties, and thus to more practical handling.

- Select the entire pattern by clicking on **“Selection > Select all objects”**. The pattern is becoming red, meaning that all the objects present in the graphic display are selected.
- Click on “**Polygon > Convert selection in contours"** (see Fig13). This function will convert the polygons into contours.
- Wait for the conversion process to be completed. Depending on the number of polygons and the number of apices treated, it may take several minutes.

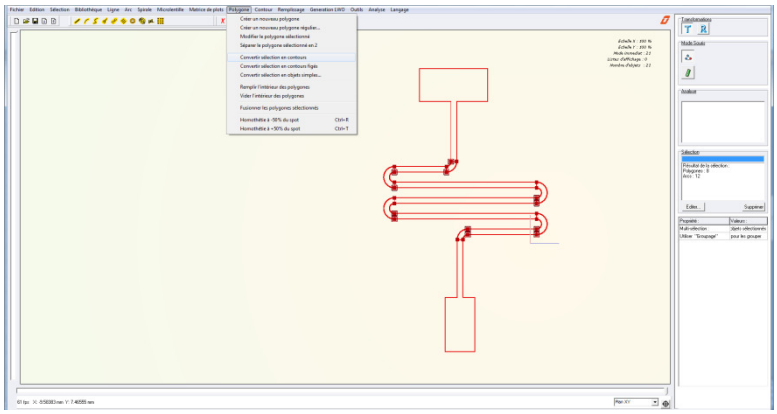


Fig13 : Conversion of the polygons into simple elements.

Once the process completed, it is possible to click on the border lines of the straight channel. Only the line handled by the mouse arrow will be selected, and not the entire polygon as seen before (see Fig14).

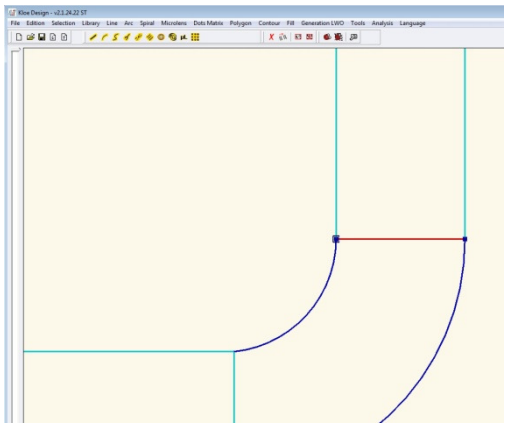


Fig14 : Selection of a line being part of a contour element.

- Remove the lines present inside the channels by pressing “Delete” key of the keyboard.

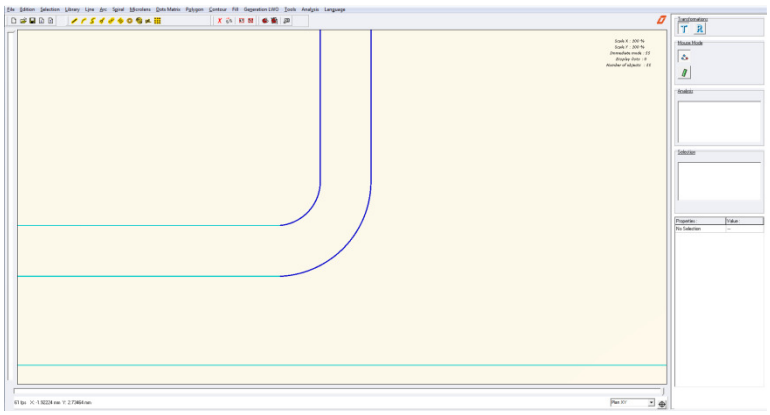


Fig15 : Pattern after deleting unwanted lines.

- Start again the operation as many times as needed.

## Step 2 : Merge polygons.

KloeDesign allows to merge two polygons together when they are overlapped. As show in Fig16, GDSII polygons are coarsely overlapped to realize the top of pattern, as it is considered as non-obstructing for the final filling of the pattern.

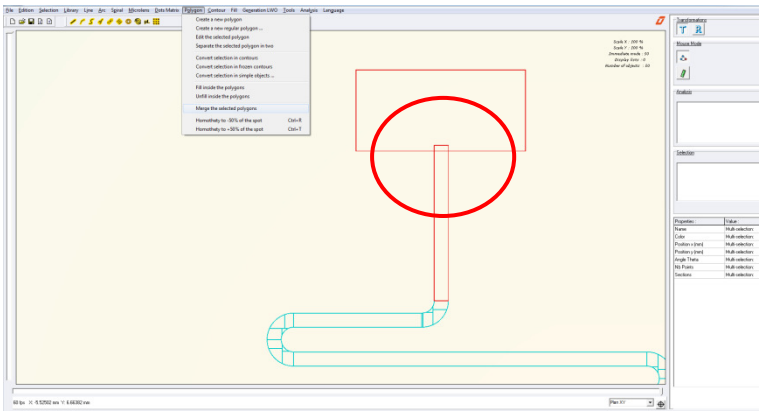


Fig16 : Merge of two polygons

- Select the two polygons to merge by clicking on them, or by dragging the mouse while left-clicking. They are becoming red colored.
- Click on "**Polygon > Merge the selected polygons"**.
- Wait for the merging process to be completed. Depending on the number of polygons and the number of apices treated, it may take several minutes.

-

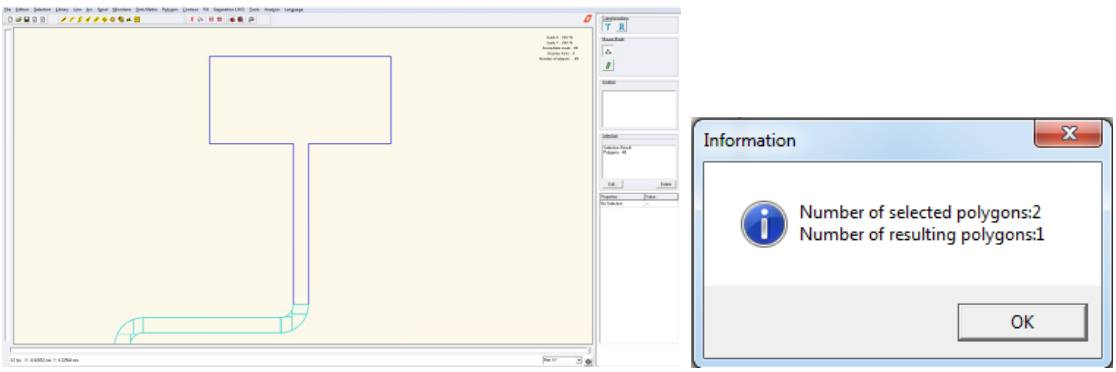



Fig17 : polygons merged

- **Note:** Two polygons having an edge in common cannot be merged.

- If all the elements have been converted in contours as described before, KloeDesign will not allow to merge the elements because they are not polygons.
- Then click on a single line of one of the 2 shapes to merge. It becomes red colored.
- Click on **"Selection > Identify the closed contour from the selection".** If the selected element is a part of a contour, each element of this contour will be selected.
- Click on **"Contour > Freeze the selected contours**". The shape remains red colored, and now all the lines are linked together.

- Click on **"Contour > Convert selection in polygons".** The contour element becomes a polygon element.
- Do the same for the second shape to merge with this precedent one.
- Now these are two polygons that can be merged.
- Please follow the first actions of this section.

## Step 3 : Lwo contour file generation.

- Once the contour pattern made and finished, it is possible to generate the lwo file corresponding to this pattern.

- Click on **"Generation lwo" menu > Generate the current pattern…".**

    - Note : The "**Generate the current pattern"** function is used to generate ALL the patterns displayed in the workspace. If there is some other patterns in addition to the one treated by the user, they will be generated in the same lwo file.

- First, Kloe Design will ask for a file name and a file location and, after computing the operation, it will display the summary of the elements generated (see Fig5 of this document), meaning that the generation is complete.

- Now, the lwo file is ready to be used by the Dilase equipment. The user can load it in the software "Dilasesoft" embedded in the equipment and dedicated to manage the lithographic operations.

## Step 4 : Taking into account the spot size

Dilase equipment will execute the trajectories computed in the lwo file, meaning that the stages will start from a point A and will go to a point B. The lwo file gives some informations to the equipment to synchronize the laser with the points A and B and eventually with other intermediate points. As the user created a lwo file based on the gds file, the border lines of the gds pattern have been directly converted in lwo trajectories at the same location. But, when the pattern will be executed by the equipment, the laser will light on the resist at this same location, converting a "software line" in a "microstructure line", giving it a "line width" according to the spot size embedded in the Dilase.

    - **Note :** Lwo file doesn't carry any informations about the spot size used by the equipment.

In order to keep the area dimensions initially given by the gds file, KloeDesign proposing some tools to the user to allow him to take into account the spot size, and then executing a lwo file in agreement with the dimensions required by the gds pattern.

- Taking into account the spot size of the beam to create an internal contour of the pattern requires to select the polygon before and to realize a homothety at 50% of the spot size.
- Click on a single element of the pattern.
- Click on **"Selection > Identify the closed contour from the selection".** If the selected element is a part of a contour, each element of this contour will be selected.

- Click on **“Contour > Freeze the selected contours**”. The shape remains red colored, and now all the lines are linked together.
- Click on **“Contour > Convert selection in polygons”.** The contour element becomes a polygon element.
- Click on “**Fill > Filling of the polygons...**". A window “Polygon Filing options” appears.
- Enter the spot size selected in the Dilase equipment in the textbox **"Spot size considered"** and then valid with "Enter" key (Fig 18). Enter **“50%”** in the textbox **“Overlap rate”** and then valid with “Enter” key (Fig18).
-

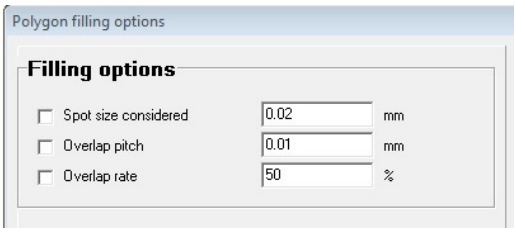



**Fig18 : Filling options**

- In the area **"Reproduce the contour by homothety"** , click on "Reduce" with the number “1” in the textbox. (Fig19).

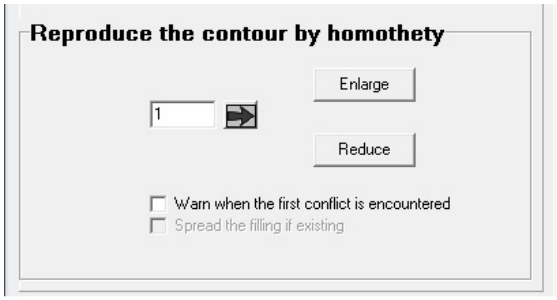



**Fig19 : Homothety options**

- One new polygon (because “1” entered) is then created, located inside the one selected (because “Reduce” clicked) and the distance between the two polygons is equal to “spot size considered” multiplied by “50%”, meaning that the distance is the half the spot size. The new polygon created is selected and red colored. The first one can be deleted if considered useless, or colored to differentiate it.

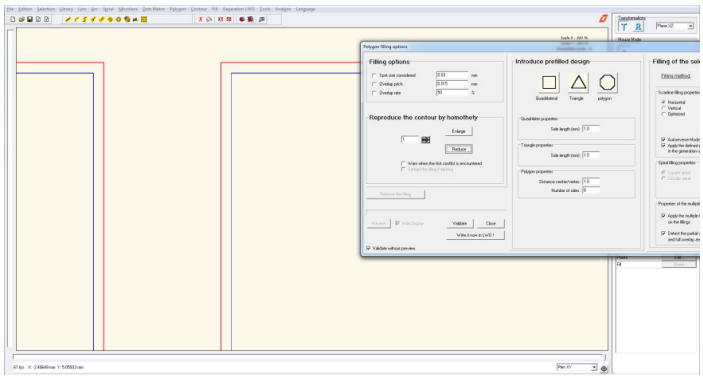


**Fig2 : Creation of an internal contour**

- For now the pattern is ready to be generated in lwo file.
- Please see Step 3 to generate the lwo file.
- The homothetic polygon created can be generated alone by selecting it, then click on **“Generation lwo > Selection > Selected patterns**…”. It will only generate the selected elements.

# Creating the filling file

## Step 1 : Creation of the filling

To generate the filling of a contour pattern, it is necessary to indicate to KloeDesign the way and the settings to use.

- **Note ;** it is absolutely necessary to associate a filling pattern to a contour pattern. The contour pattern will inform about the boundaries of the filling pattern.

- Click on the contour polygon to fill.
- Click on **“Fill > Filling of the polygons”**
- Check or enter the following settings, and valid by pressing “Enter” (see Fig21) :
  - Spot size considered = the spot size used to write the filling pattern
  - Overlap rate = 50% is default value.
  - Filling method = Scanline
  - Vertical
  - Autoreverse mode
  - Apply the multiple trigger on the fillings
  - Detect the partial overlap areas and full overlap areas.

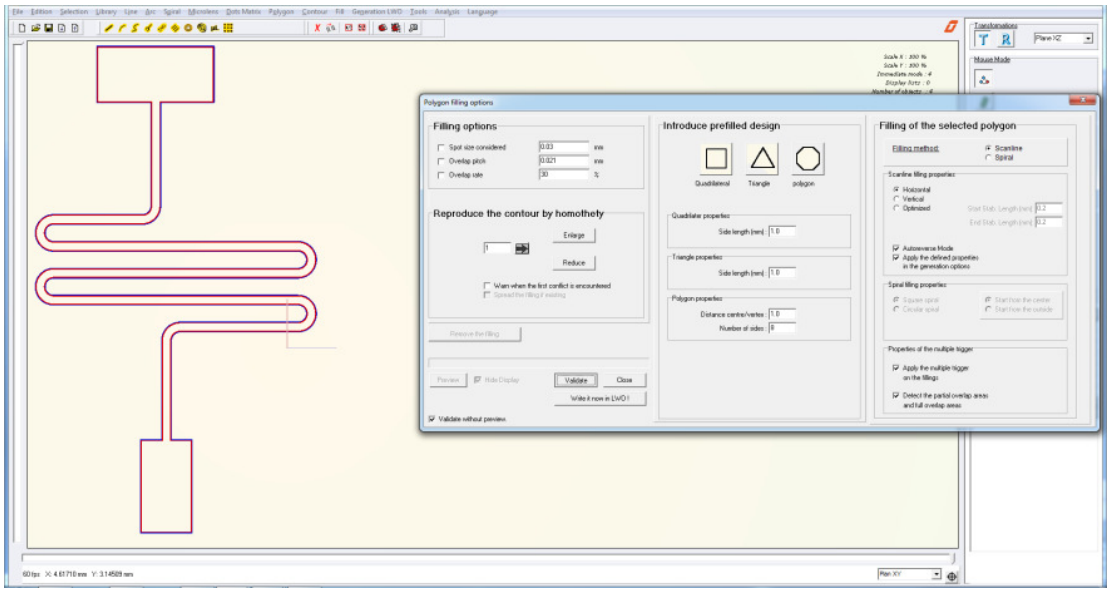



Fig21 : Polygon filling options

- Then Click on “Validate” button. The filling trajectories are calculated by the software.

    - **Note :** Dependant on the spot size considered and the surface to fill, it may take several minutes to compute.

- The graphic panel displays the computed trajectories (Fig22). The red lines represent the trajectories during which the laser is on, the green lines the ones executed by the stages but with the laser off.

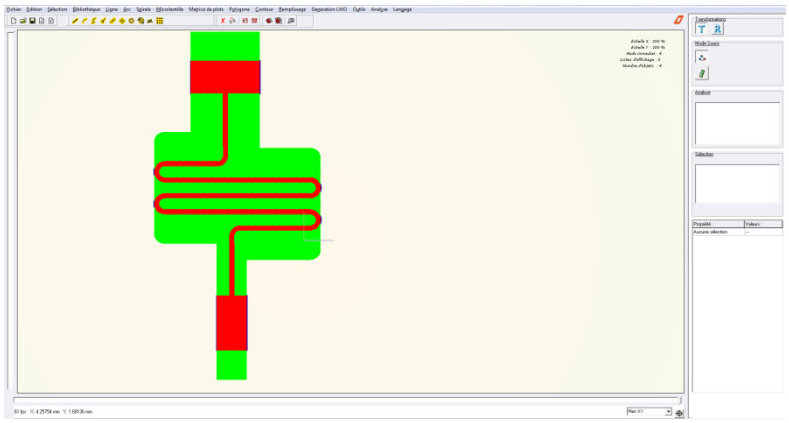


Fig22 : Displaying of the calculated filling

- Click on **“Fill > Hide all the calculated fillings”** to make disappear the filling trajectories. When hidden, a background color is applied to the contour pattern to remind that a filling has been computed for this contour.

- Click on “**Fill > View all the calculated fillings”** to make them appear**.**

## Step 2 : Generation of the filling

To generate the calculated filling as a lwo file :

- Click on **“Generation LWO > Fillings > All the fillings..."** (Fig22).

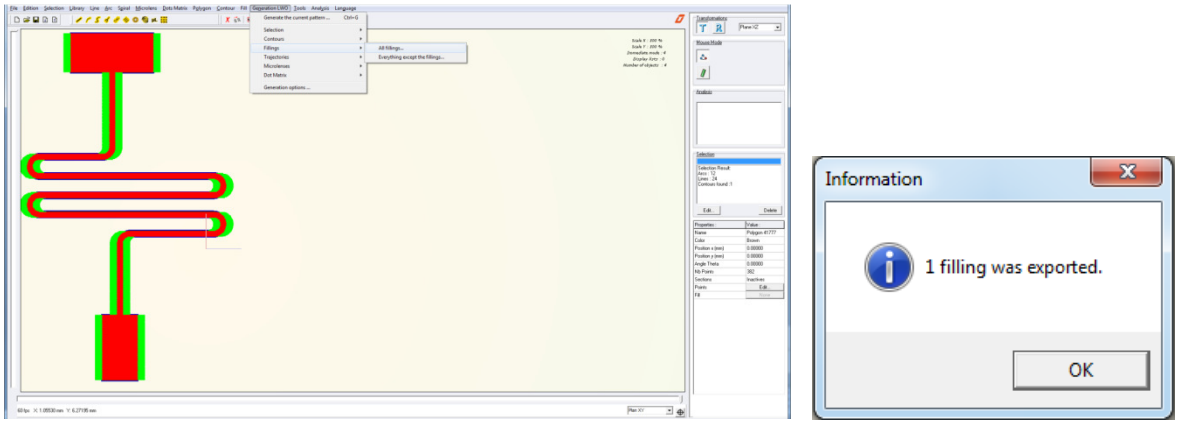



Fig22 : Generation of the filling

- **Note :** Dependant on the number of filling trajectories computed, it may take several minutes to generate.

- If the filling computed filling is not satisfying, it is possible to remove it from the contour to compute another with different settings.
- Click on the contour pattern associated to the filling wanted to be removed.
- Click on **“Fill > Filling of the polygons...”**
- Click on the “Remove the filling” button, under the “Reproduce the contour by homothety” section.

    - **Note :** If the “Remove the filling” button is not clickable, it means that there is no polygon contour selected, or the polygon contour selected has not any filling associated.

## Simulation files

Once the lwo files are generated , they are available to be used by the Dilase equipment, meaning that the user can load them in the software “Dilasesoft” embedded in the equipment and dedicated to manage the lithographic operations.

A process simulation is available in KloeDesign in order to have an overview of the execution of these files by the equipment.

- Click on **“File > Importation > Importation LWO”**.

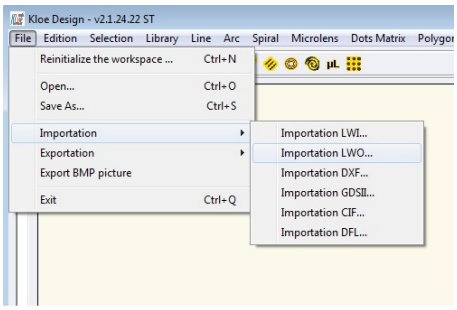
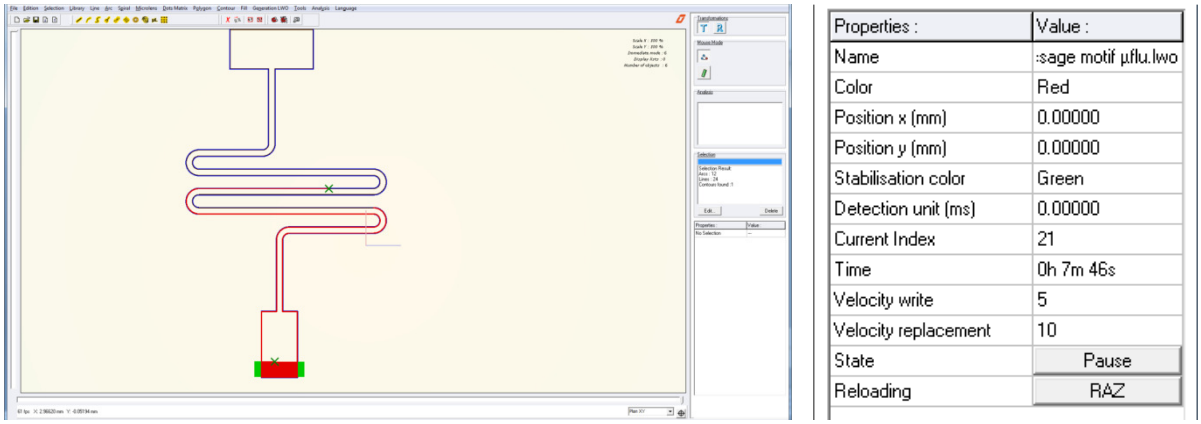



**Fig 23 : Importation LWO**

- Select the lwo file wanted to be displayed in KloeDesign.
- The software will ask for a writing velocity and a repositioning velocity. Click on “Ok” to accept the default values. A green cross will move all over the graphic panel, drawing the pattern generated. This cross represents the way that the trajectories of the pattern will be written by the equipment. The red lines represent the trajectories during which the laser is on, the green lines (if present) the ones executed by the stages but with the laser off.

The simulation starts immediately. The user can then obtain the estimated writing time of the realization made by the equipment, based on the default speed entered or set by the user.

The estimated writing time can be found by clicking on the simulation pattern, and then the properties tab at the bottom left of the interface fills with the lwo file information. The row **“Time”** indicates the estimated writing time, based on the values in the rows **“Velocity write”** and **“Velocity replacement”** (Fig24).



| Properties : | Value : |
|---|---|
| Name | :sage motif µflu.lwo |
| Color | Red |
| Position x (mm) | 0.00000 |
| Position y (mm) | 0.00000 |
| Stabilisation color | Green |
| Detection unit (ms) | 0.00000 |
| Current Index | 21 |
| Time | 0h 7m 46s |
| Velocity write | 5 |
| Velocity replacement | 10 |
| State | Pause |
| Reloading | RAZ |

**Fig24 : lwo simulation**

The time entered on the text box "Time" will be function of the writing speed and the replacement speed entered on the text box "Velocity write".

It is possible to explore different configurations by changing the **"Velocity write"** to obtain different estimations of writing time.

- **Note:** It is possible to load several times the same file into the KloeDesign interface and chose the best configuration.

The Fig25 shows the pattern created corrected on the left, the contour pattern simulation on the middle, and the filling pattern simulation on the right.

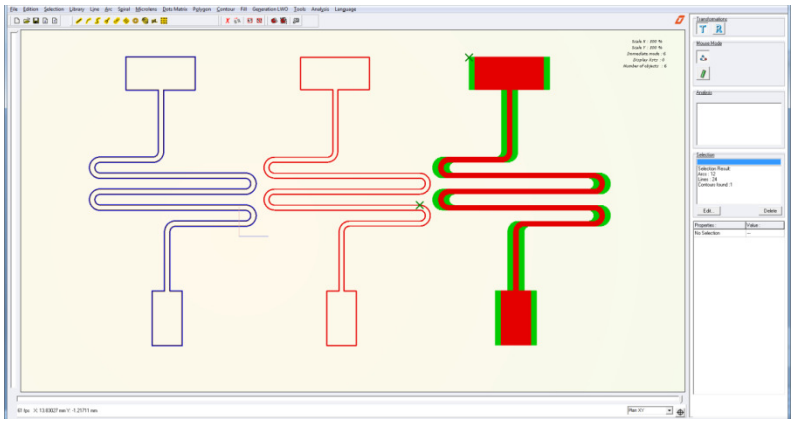


**Fig25 : Overview of the pattern, simulation pattern and filling pattern**

To match with the estimated time, the speed parameters in the Lwo simulation should be entered in the DilaseSoft interface when the lwo file will be executed.