A USER MANUAL

FOR MASKLESS MICROMODEL FABRICATION

USING HEIDELBERG (MLA-150)

1. Written by Wonjin Yun, PhD (wy30422@gmail.com)
2. Reference: Yun, W. "Advanced microfluidic framework for understanding of fluid-flow in porous media : microfabrication, imaging, and deep-learning / Appendix.3" (PhD Diss., Stanford University, 2019), 220-37. http://purl.stanford.edu/wt253cj8804
3. Ver. 4 updated on July 28 2019
4. This file is available at https://web.stanford.edu/~wyun/Heidelberg/

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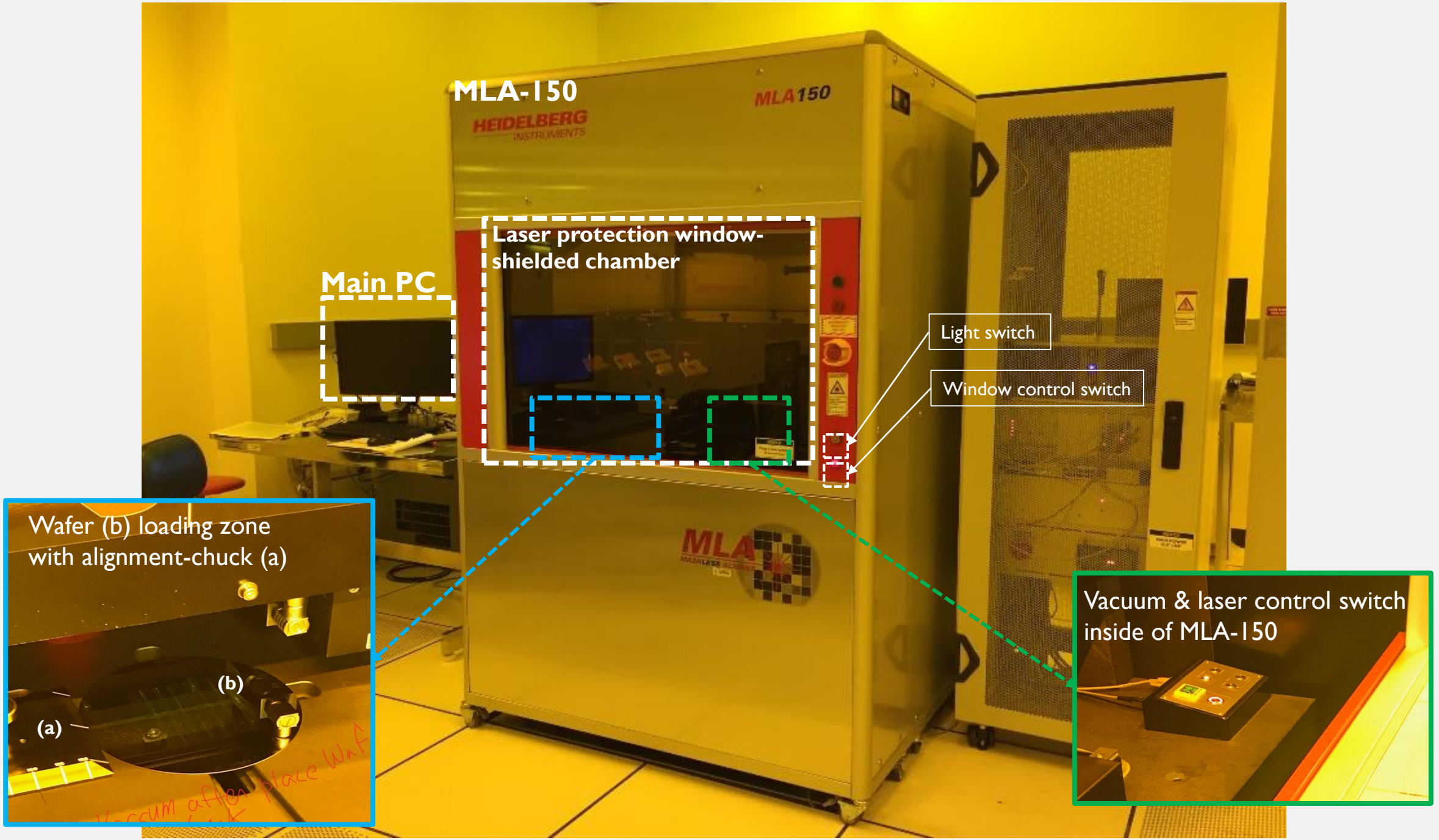
    - Step 2: Loading wafer + parameter setting
    - Step 3: Exposure + unload wafer

HEIDELBERG (MLA 150): A HIGH SPEED DIRECT WRITE LITHOGRAPHY TOOL

1) Directly expose pattern without prior fabrication of a mask resulting in a significantly shorter prototyping cycle
2) Light source at 405 nm and 375 nm
3) Allows using substrates of any size and shape
4) Exposure area upto 150 by 150 mm^2
5) Provides flexible change of pattern using drawing mode
6) Produces structures down to 600 nm
7) Alignment accuracy - as good as 500 nm
8) Automatic labeling and serialization


MLA-150
HEIDELBERG
INSTRUMENTS
MLA150
Main PC
Laser protection window-shielded chamber
Light switch
Window control switch
Wafer (b) loading zone with alignment-chuck (a)
(b)
(a)
Vacuum & laser control switch inside of MLA-150

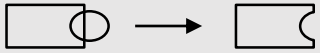
2. POINT-OF-CONTACT

- Want to become a user of MLA-150 ?
  - Swaroop Kommera / skommera@stanford.edu / 721-7546
- Any question regarding tool, file preparation, and shadowing?
  - Wonjin Yun / wyun@stanford.edu / 650-862-2190
  - https://web.stanford.edu/~wyun/Heidelberg/
- Want to read full manual ?
  - https://snf.stanford.edu/SNF/equipment/nSiL/heidelberg-mla-150
- Check training schedule ?
  - https://snf.stanford.edu/SNF/training/training-calendar

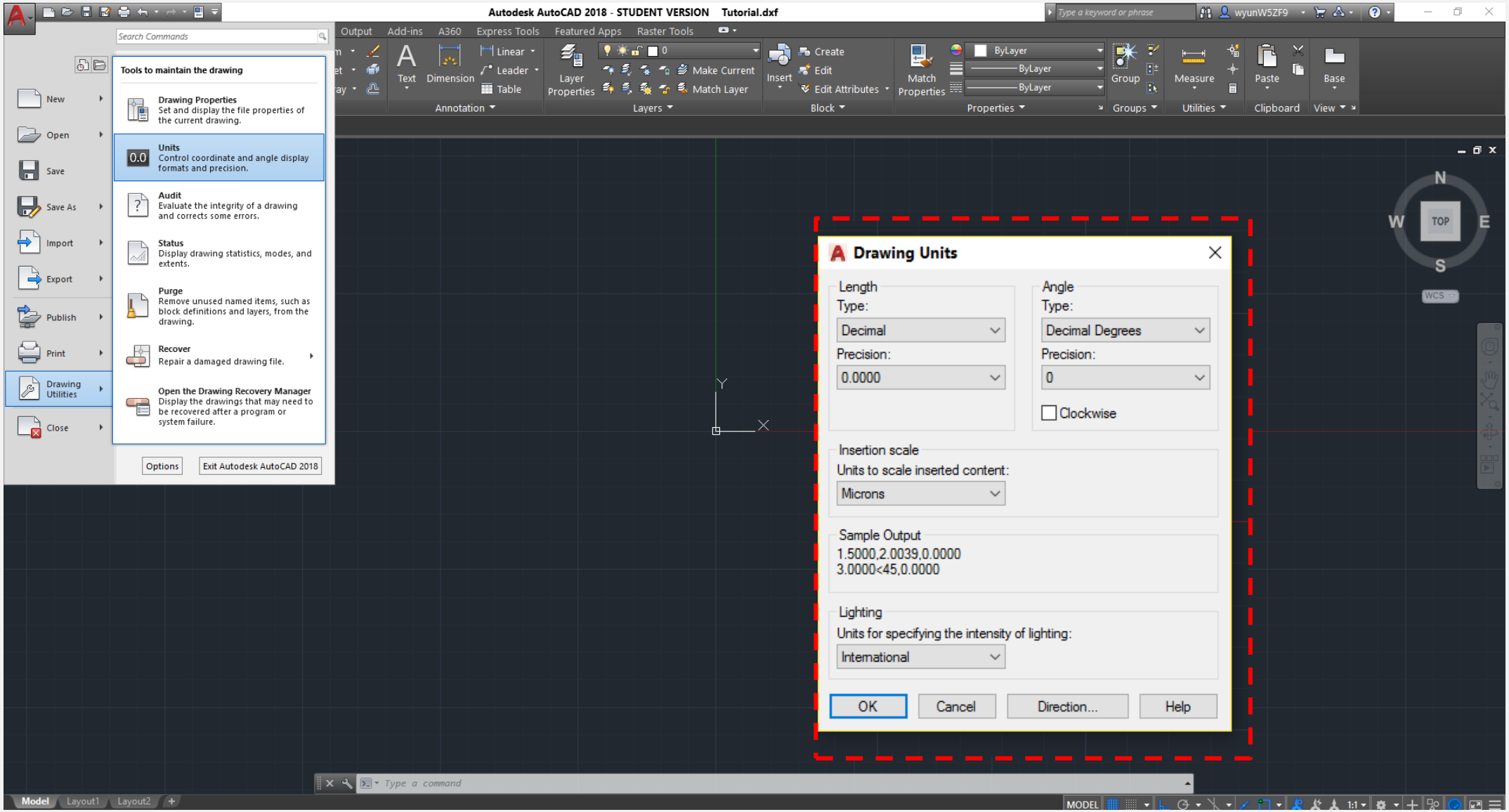
3. DESIGN YOUR MICROMODEL

1. AutoCAD-based design
2. File format conversion

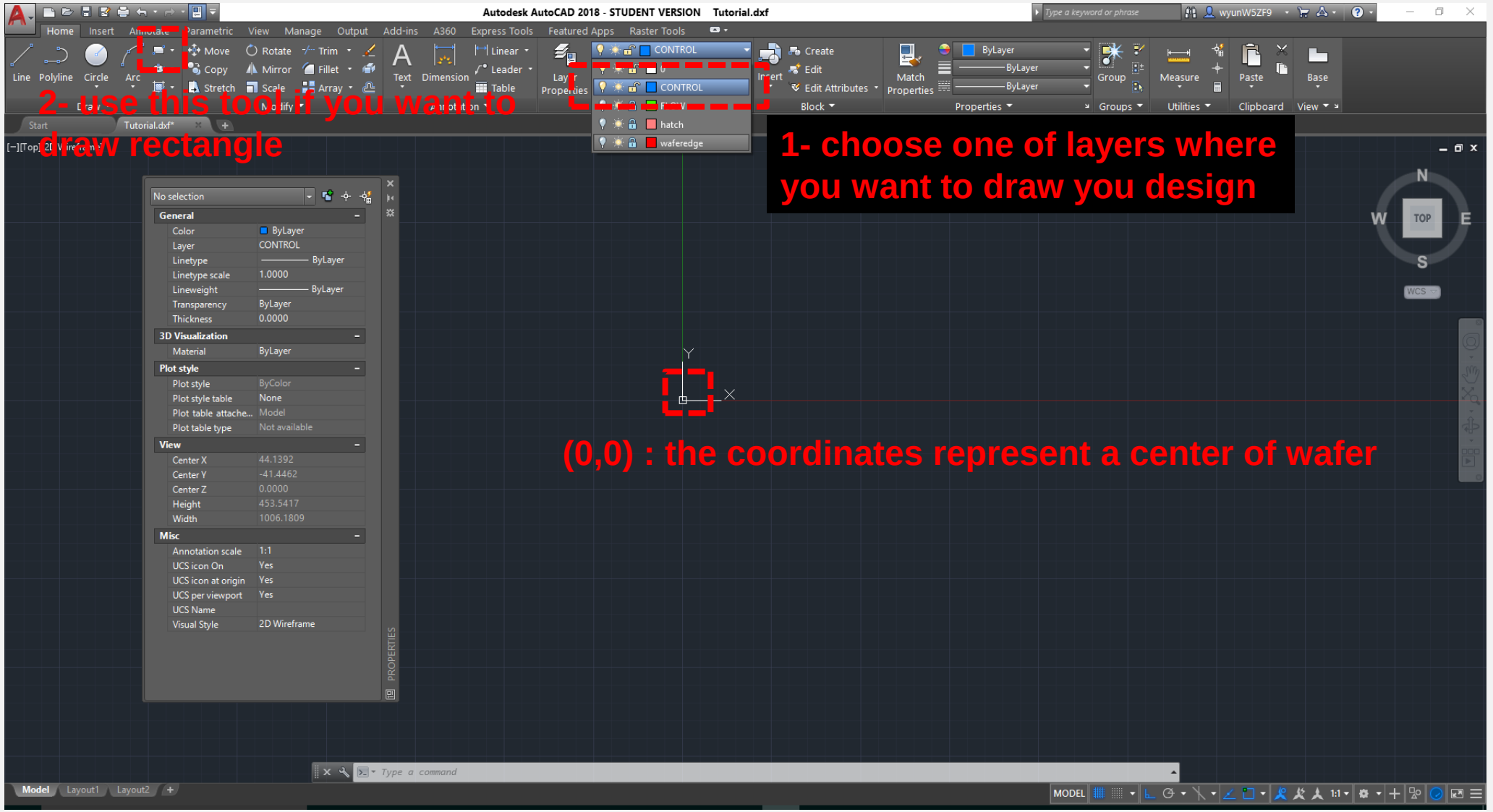
AUTOCAD-BASED DESIGN TIPS

- It will show an example of way to design channel using AutoCAD
  - You can download "tutorial.dxf" file from https://web.stanford.edu/~wyun/Heidelberg/
- Couple of useful tools will be introduced for quicker and easier design
  a. Mirror : easy to copy many objects at designated coordinates
  b. Join: Connect all polylines, arc, and lines. Prerequisite to "hatch" command.
  c. Region: redefine all object or joined object as Regions. Prerequisite to "Union" and "Subtract"
  d. Union : Combine two regions into single region 
  e. Subtract : Subtract two regions 
  f. Hatch : Fill the region or joined object 

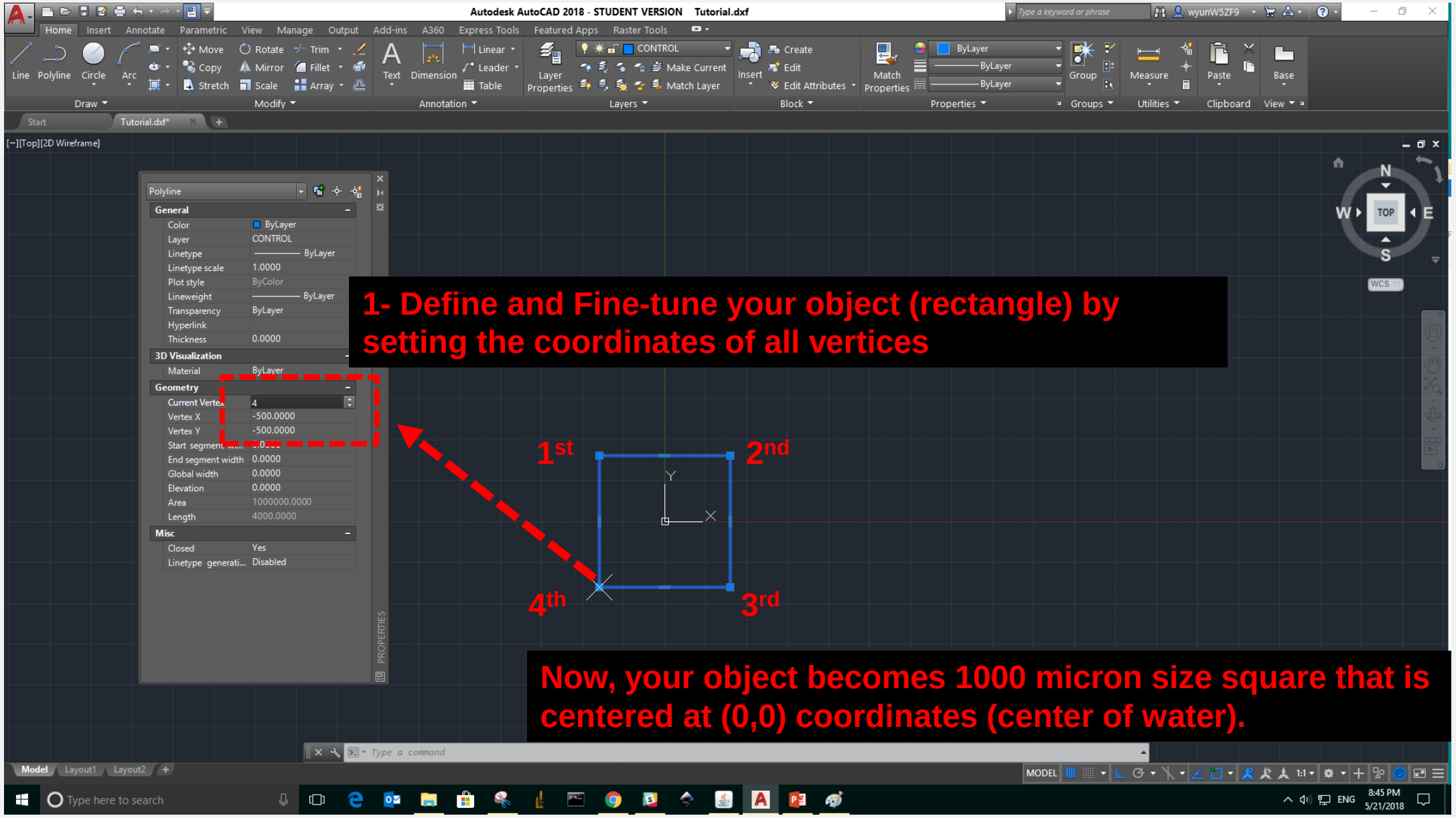
CHANGE BASE UNIT



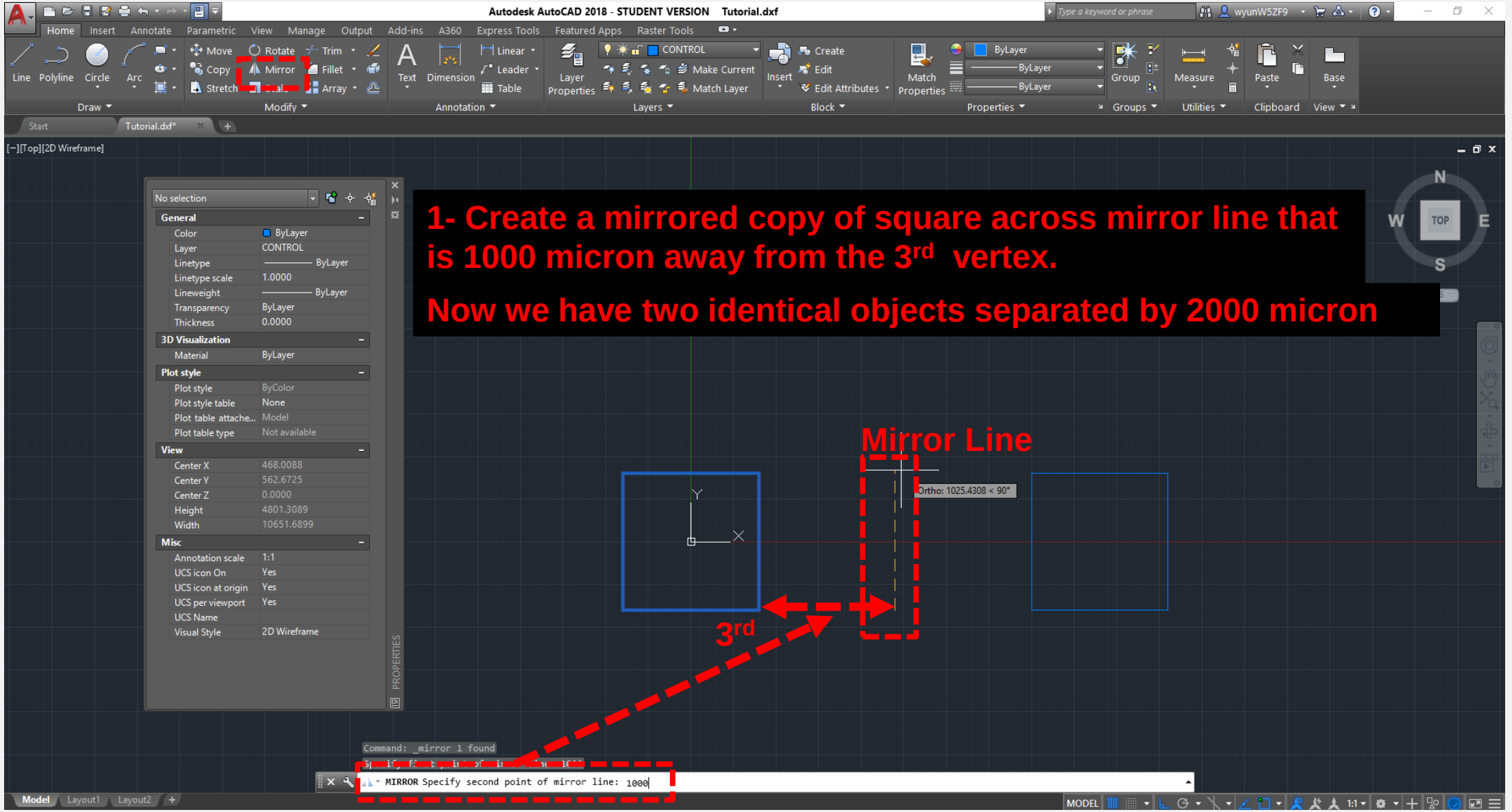
DRAW OBJECT


Autodesk AutoCAD 2018 - STUDENT VERSION Tutorial.dxf
2- use this tool if you want to draw rectangle
1- choose one of layers where you want to draw you design
(0,0) : the coordinates represent a center of wafer
CONTROL
hatch
waferedge
No selection
General
Color ByLayer
Layer CONTROL
Linetype ByLayer
Linetype scale 1.0000
Lineweight ByLayer
Transparency ByLayer
Thickness 0.0000
3D Visualization
Material ByLayer
Plot style
Plot style ByColor
Plot style table None
Plot table attache... Model
Plot table type Not available
View
Center X 44.1392
Center Y -41.4462
Center Z 0.0000
Height 453.5417
Width 1006.1809
Misc
Annotation scale 1:1
UCS icon On Yes
UCS icon at origin Yes
UCS per viewport Yes
UCS Name
Visual Style 2D Wireframe
Type a command
Model
Layout1
Layout2

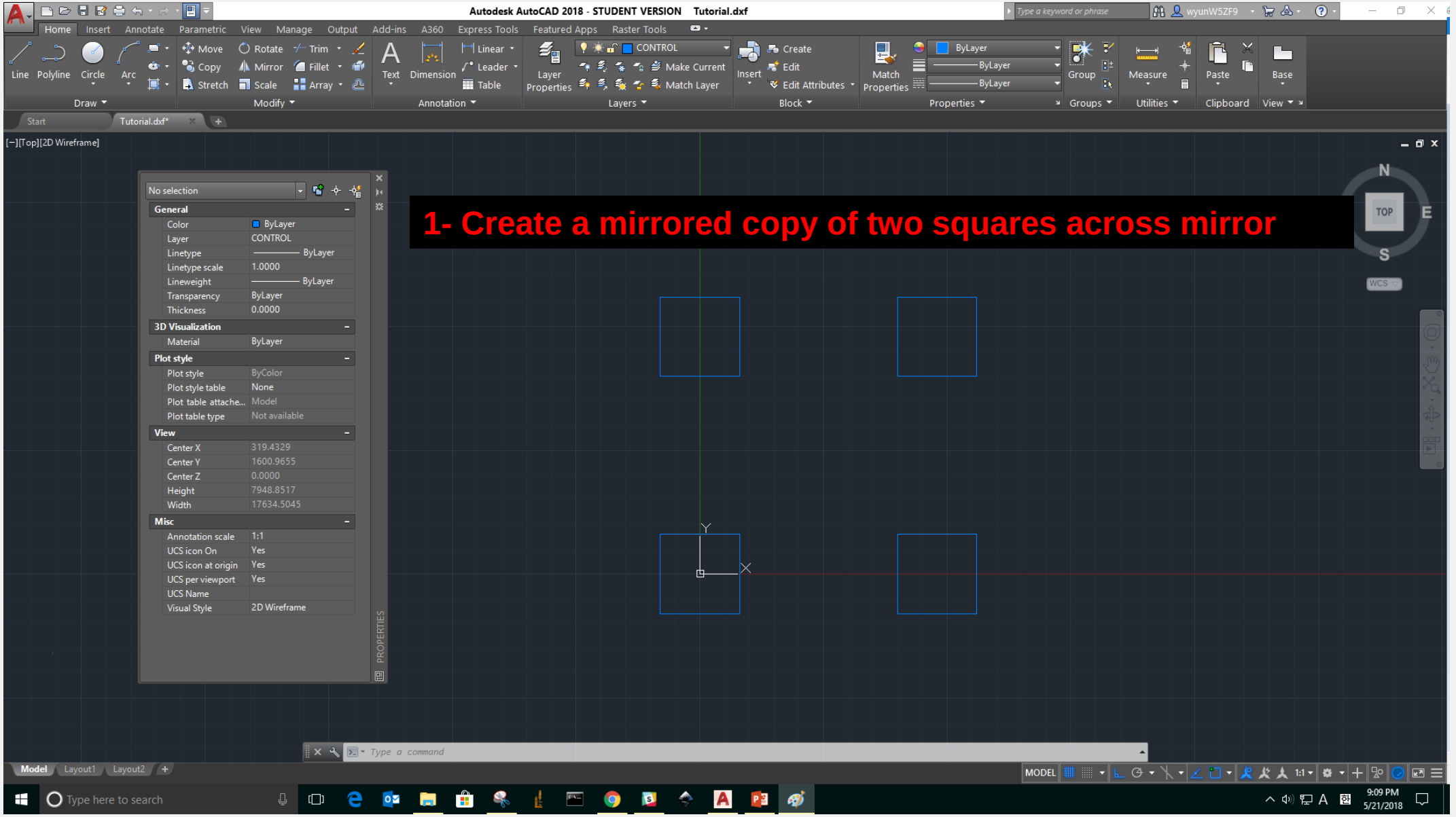
CREATE SQUARE



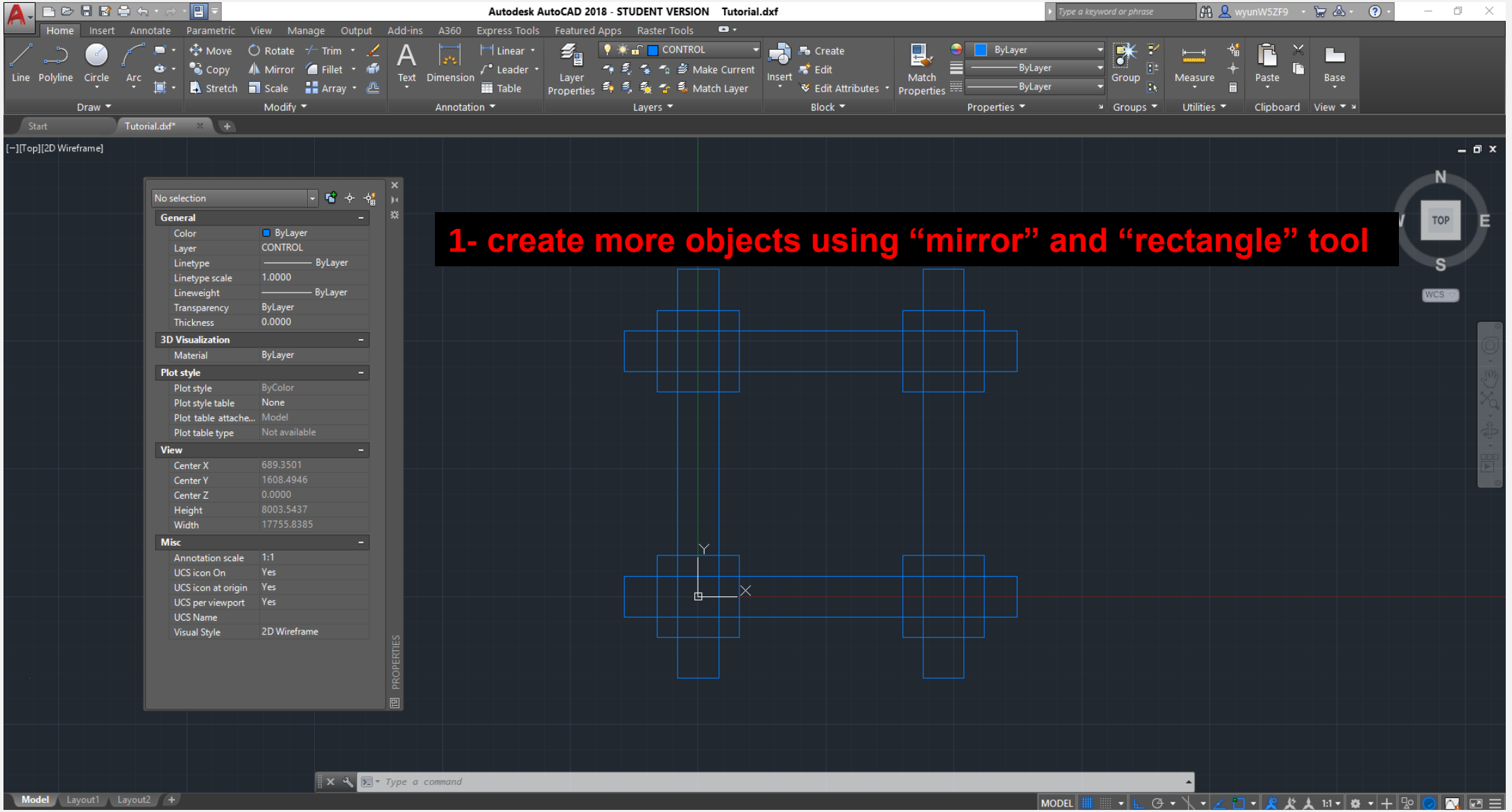
DUPLICATE SQUARE VIA MIRROR



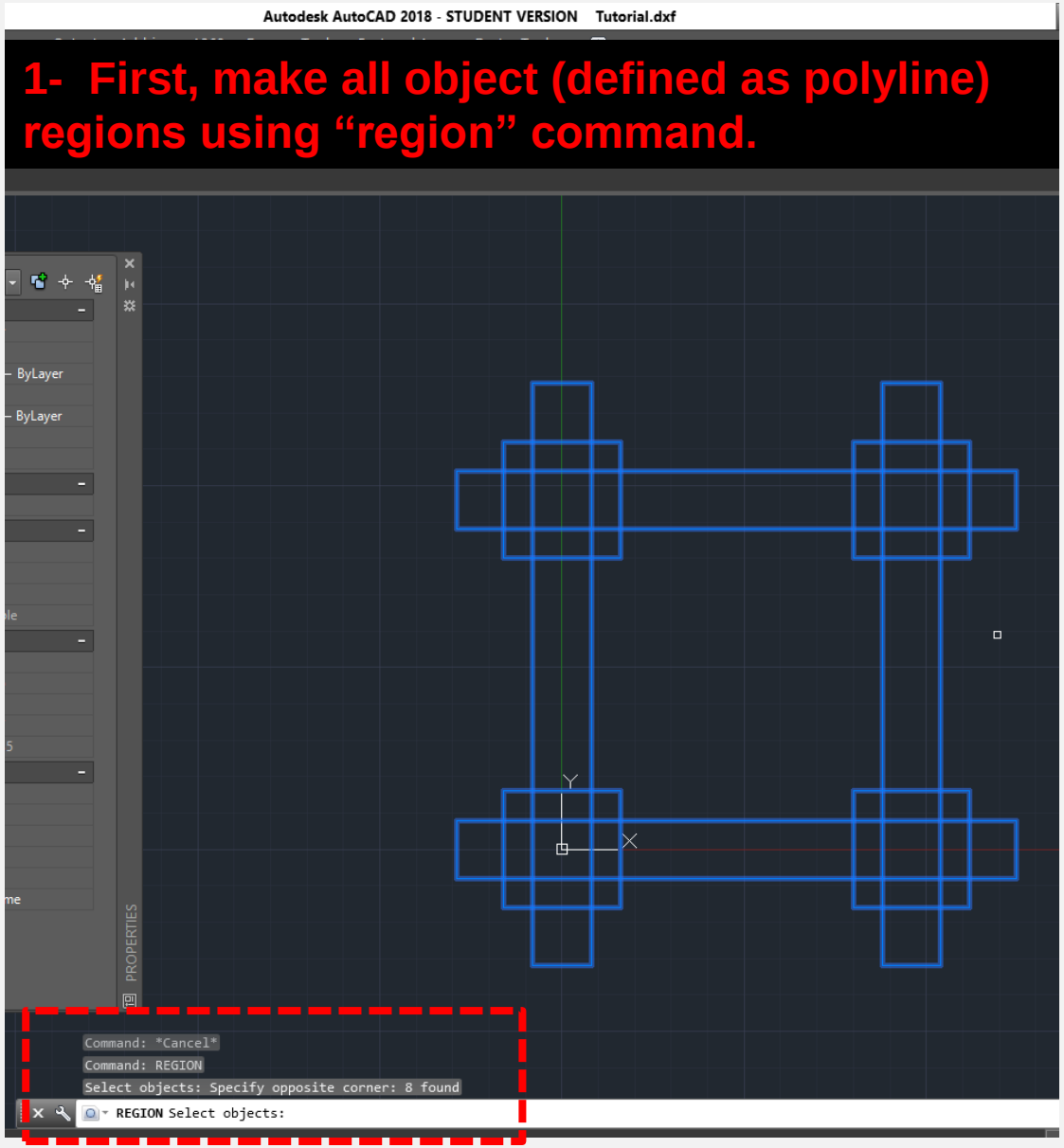
MORE COPIES

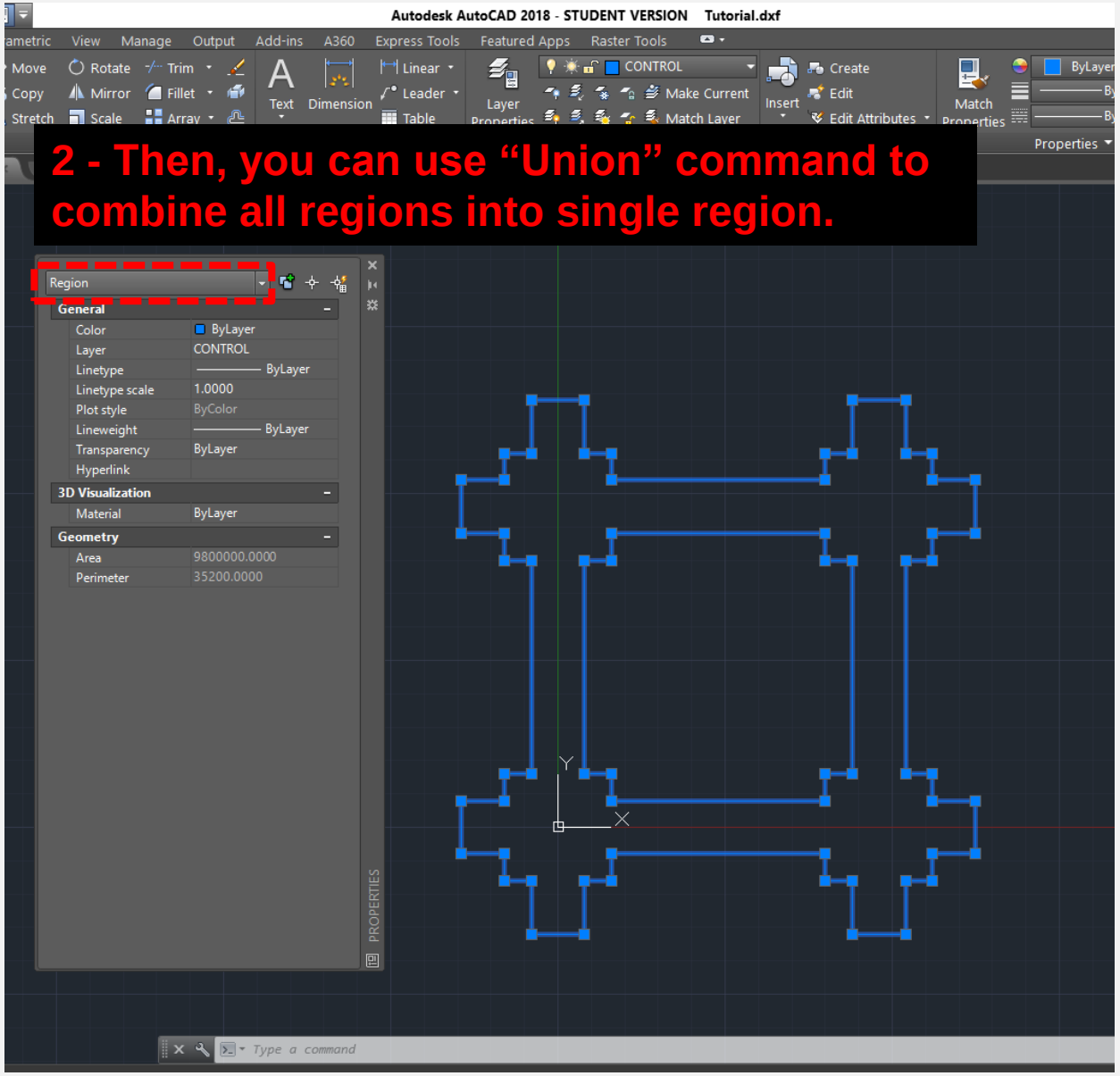

Autodesk AutoCAD 2018 - STUDENT VERSION Tutorial.dxf
1- Create a mirrored copy of two squares across mirror
[−][Top][2D Wireframe]
No selection
General
Color ByLayer
Layer CONTROL
Linetype ByLayer
Linetype scale 1.0000
Lineweight ByLayer
Transparency ByLayer
Thickness 0.0000
3D Visualization
Material ByLayer
Plot style
Plot style ByColor
Plot style table None
Plot table attache... Model
Plot table type Not available
View
Center X 319.4329
Center Y 1600.9655
Center Z 0.0000
Height 7948.8517
Width 17634.5045
Misc
Annotation scale 1:1
UCS icon On Yes
UCS icon at origin Yes
UCS per viewport Yes
UCS Name
Visual Style 2D Wireframe
PROPERTIES
Type a command
Model
Layout1
Layout2
Type here to search
9:09 PM
5/21/2018

ADD MORE OBJECTS

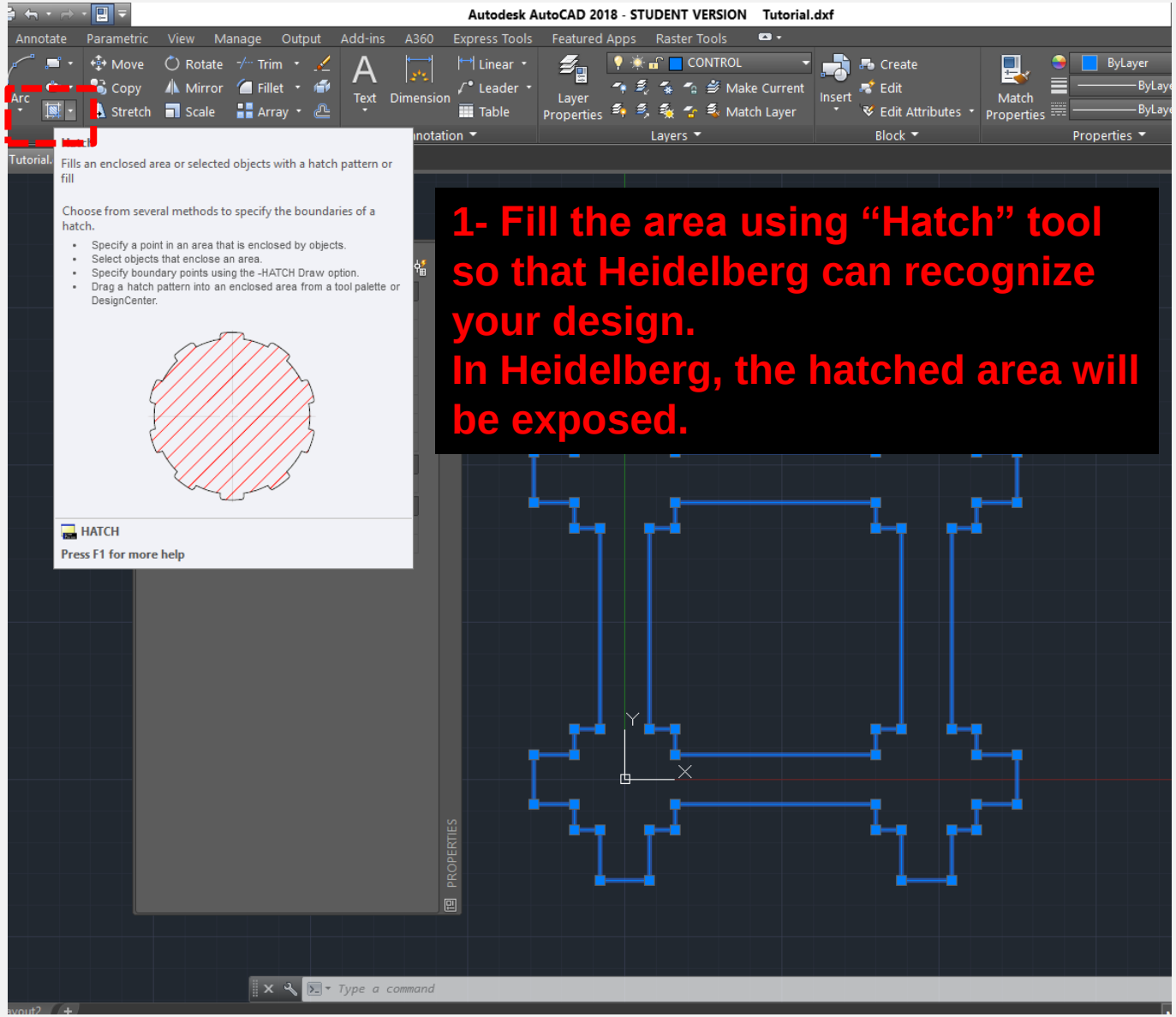


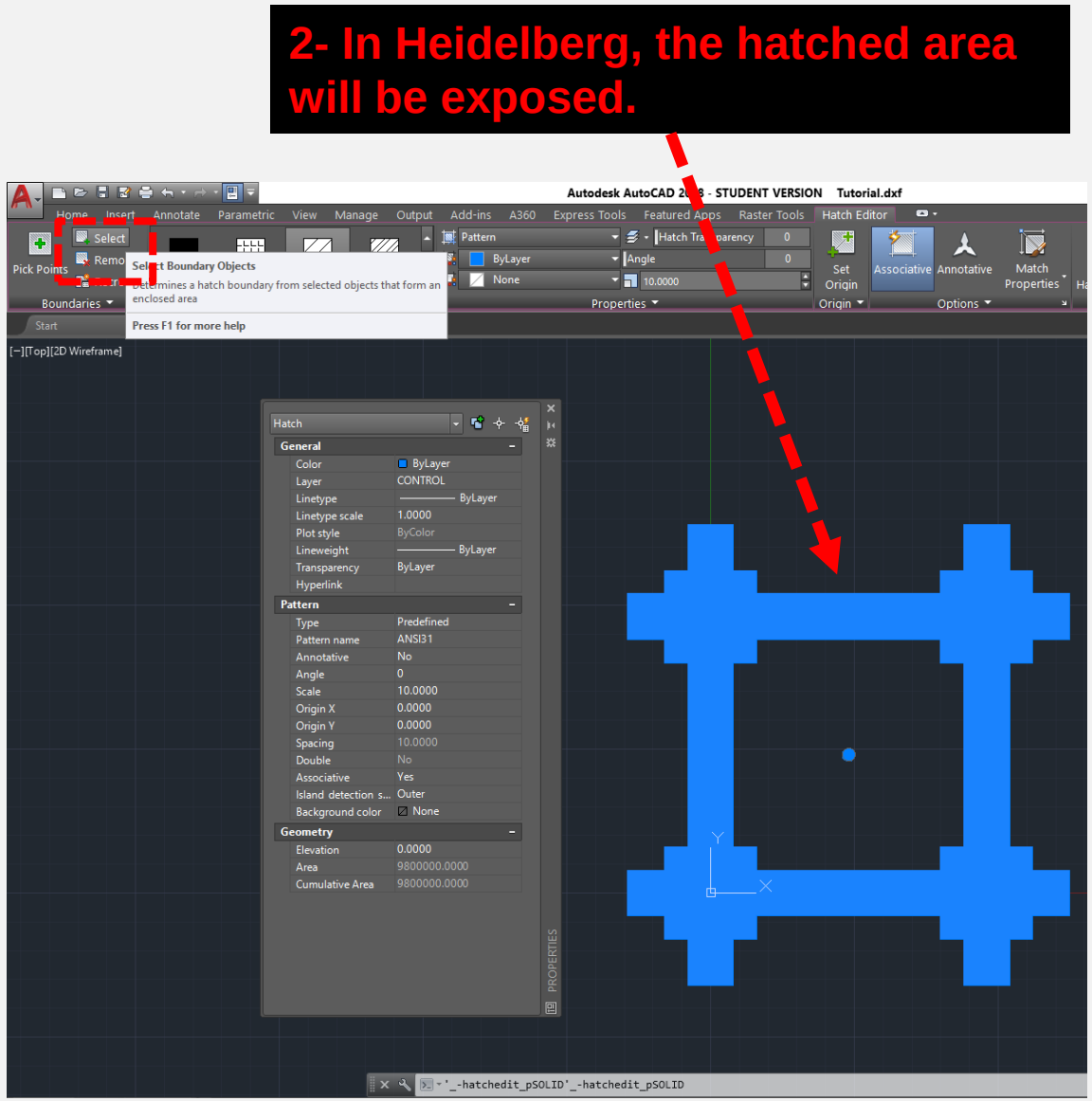
UNIFY ALL OBJECT



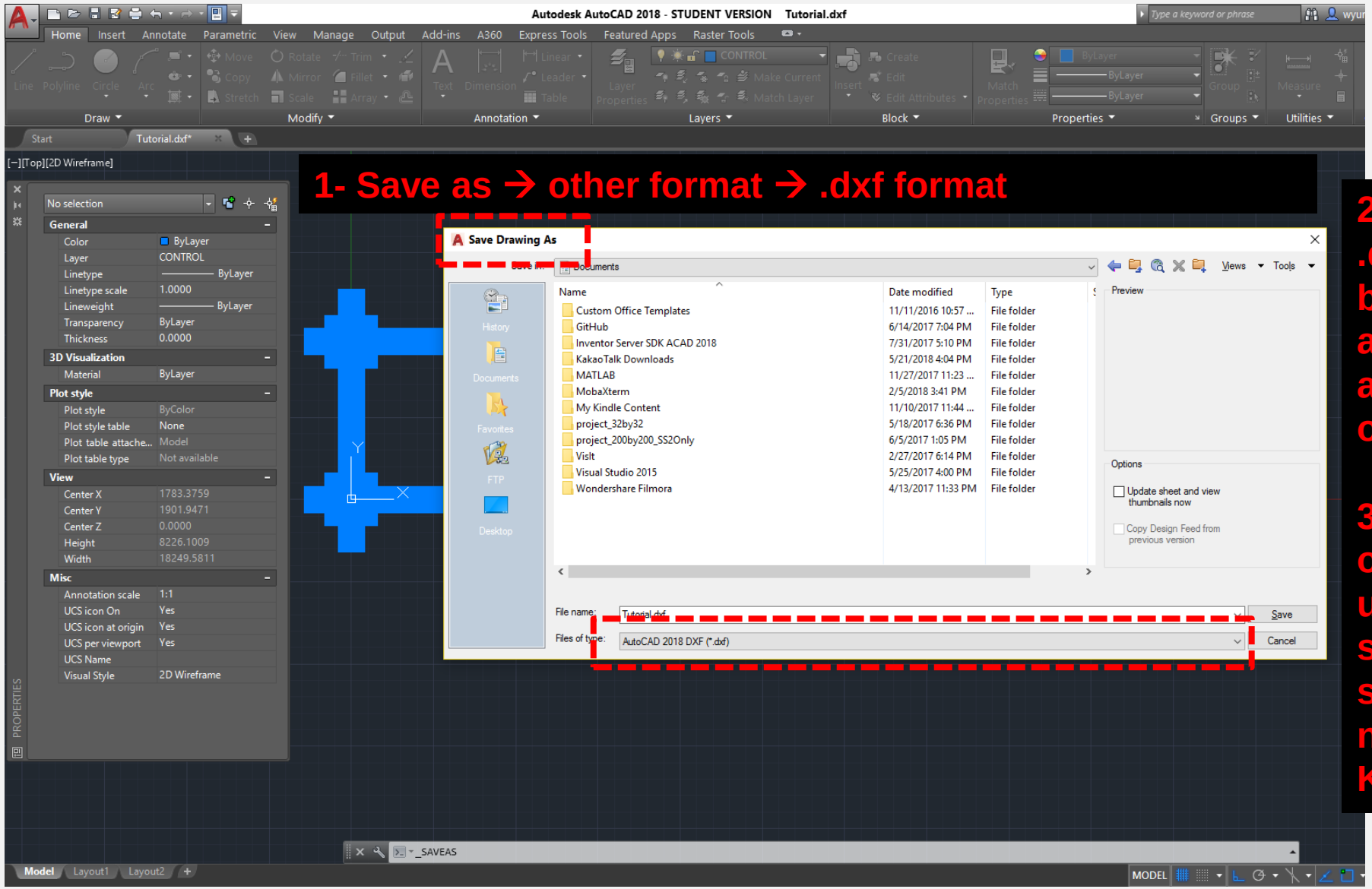


FILL THE AREA





EXPORT AS .DXF FORMAT



2 – your design is in readable .dxf format for Heidelberg, but you can keep this file as a master file for the future adjustment or modifications on different layers.

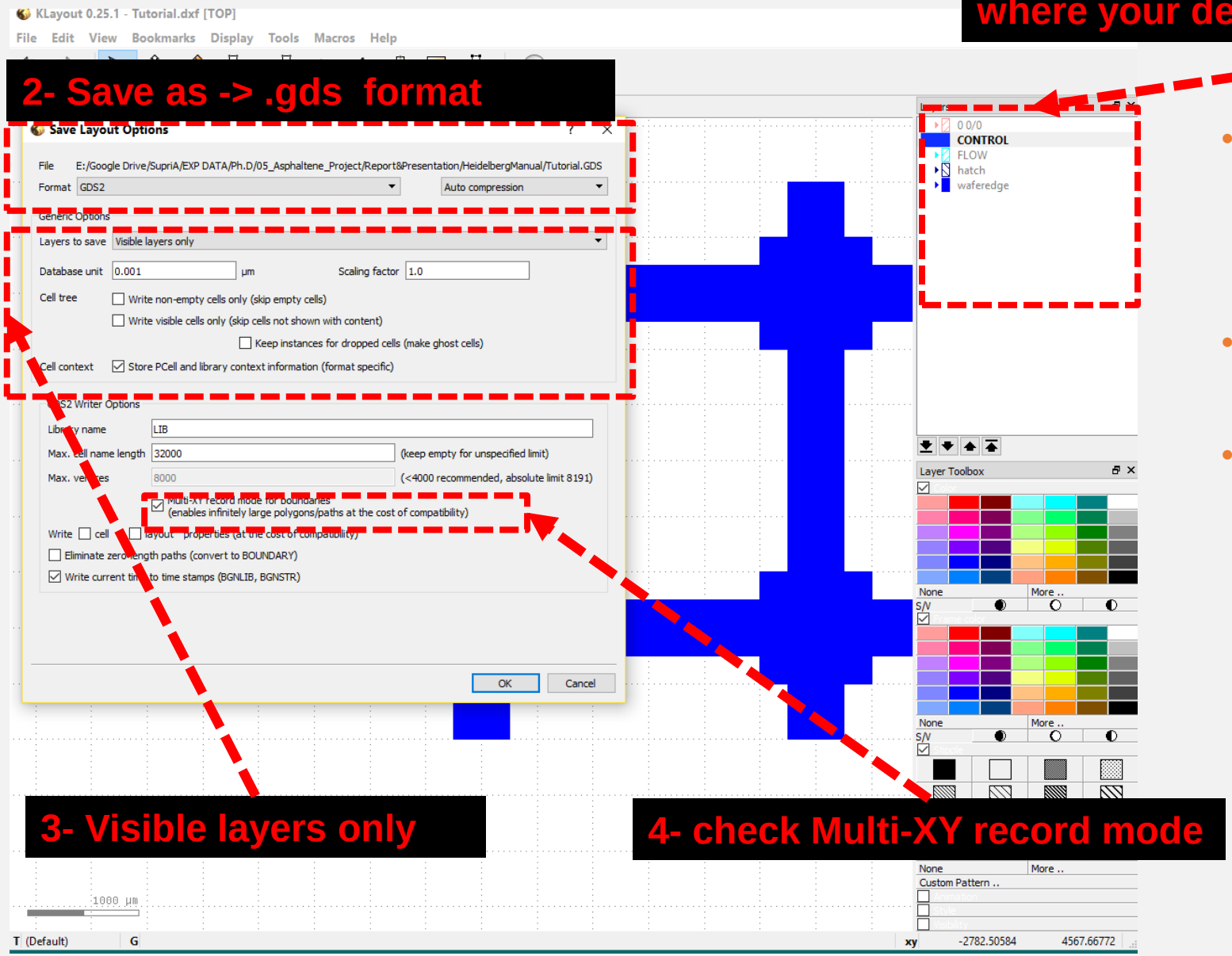
3 – If you need the design only in certain layer for your upcoming exposure, next slides show how to create separate file with the necessary layers using Klayout.

FILE FORMAT CONVERSION

- This tutorial is to simplify and select layers from AutoCAD .dxf file using Open-Source software (Klayout)
- Klayout (installed in Heidelberg main PC) is a useful tool to quick check your design beforehand and remove unnecessary layers as it is needed.

FILE CONVERSION (.gds)

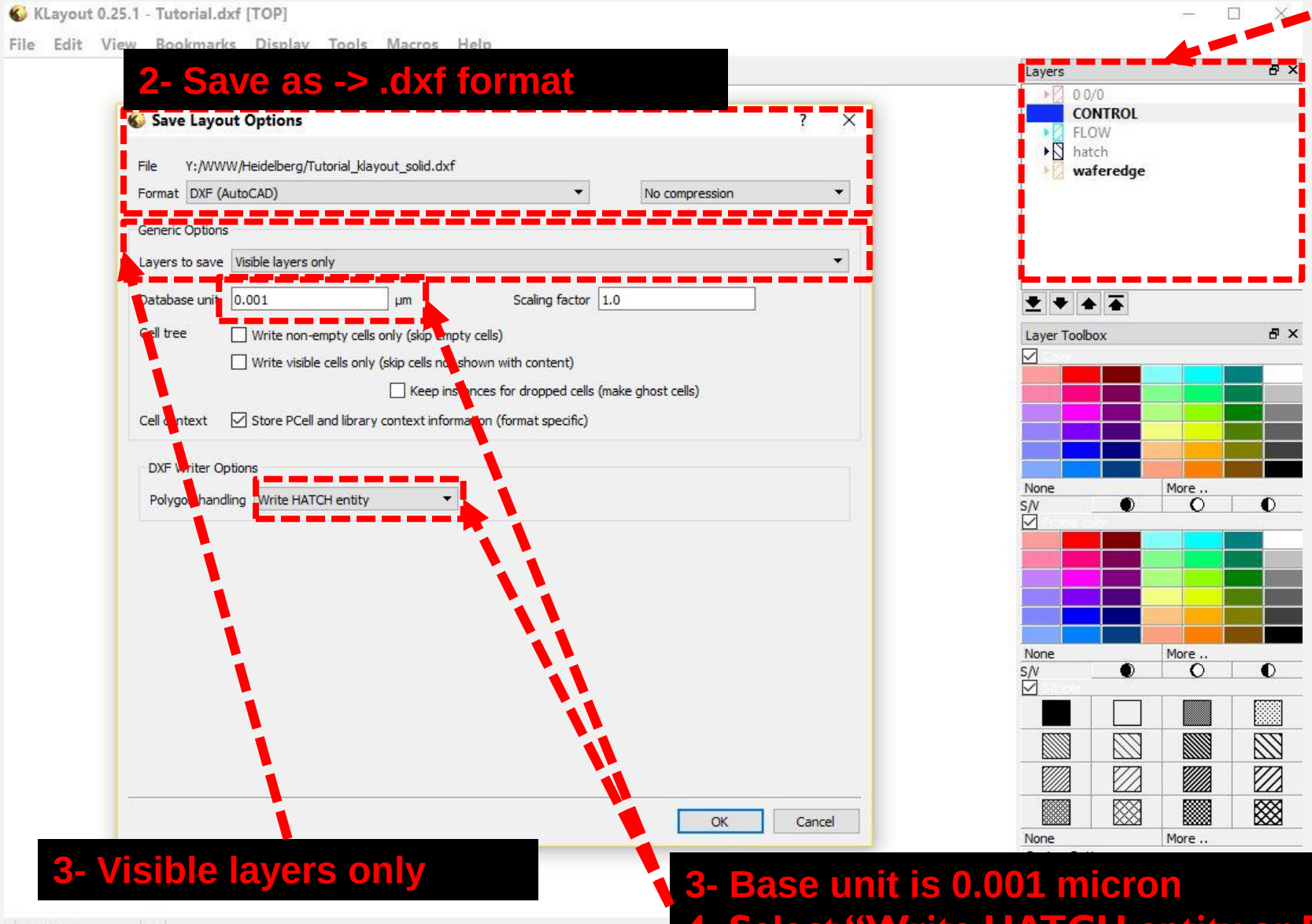
1- Drag and drop your .dxf file to open in Klayout
2- Close all unnecessary layers except “control” layer where your design is located.



- Using free software (Klayout), you can make a simple file without all unnecessary layers from AutoCAD generated .dxf format master file.
- You can install your own computer or Heidelberg main PC has it already.
- Heidelberg can read .gds format

FILE CONVERSION (.dxf)

1- Close all unnecessary layers except "control" layer where your design you want to use.



- Using free software (Klayout), you can make a simple file without all unnecessary layers from master file.
- You can install your own computer or Heidelberg main PC has it already.
- Heidelberg can read .dxf format
- .dxf format is better choice for some design that has tremendous small polylines (e.g. vectorized rock image)

4. A USER GUIDE FOR MLA-150 (MASKLESS-EXPOSURE)

Step 1: File (design) conversion

Step 2: Loading wafer + parameter setting

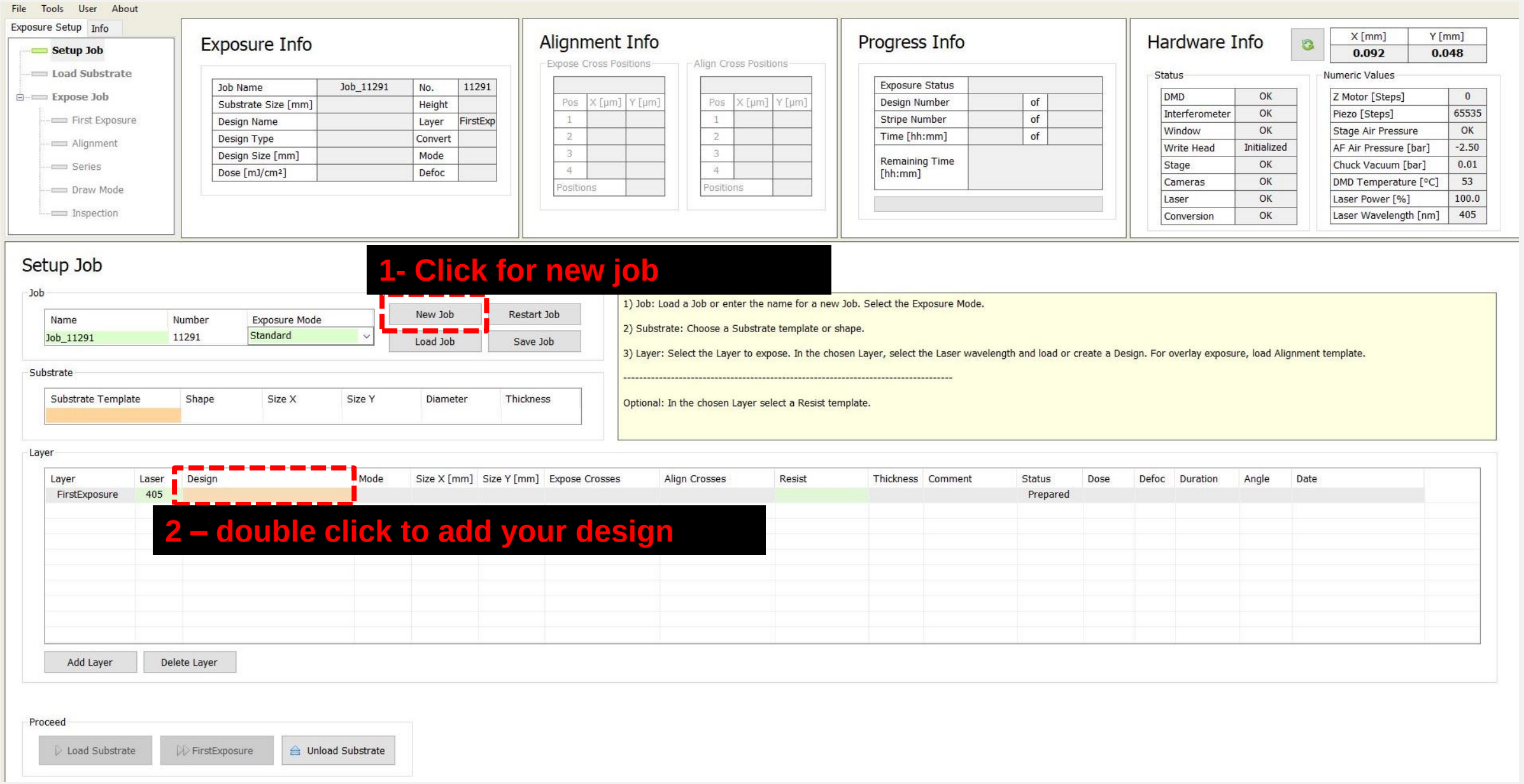
Step 3: Exposure + unload wafer

STEP 1 : FILE (DESIGN) CONVERSION

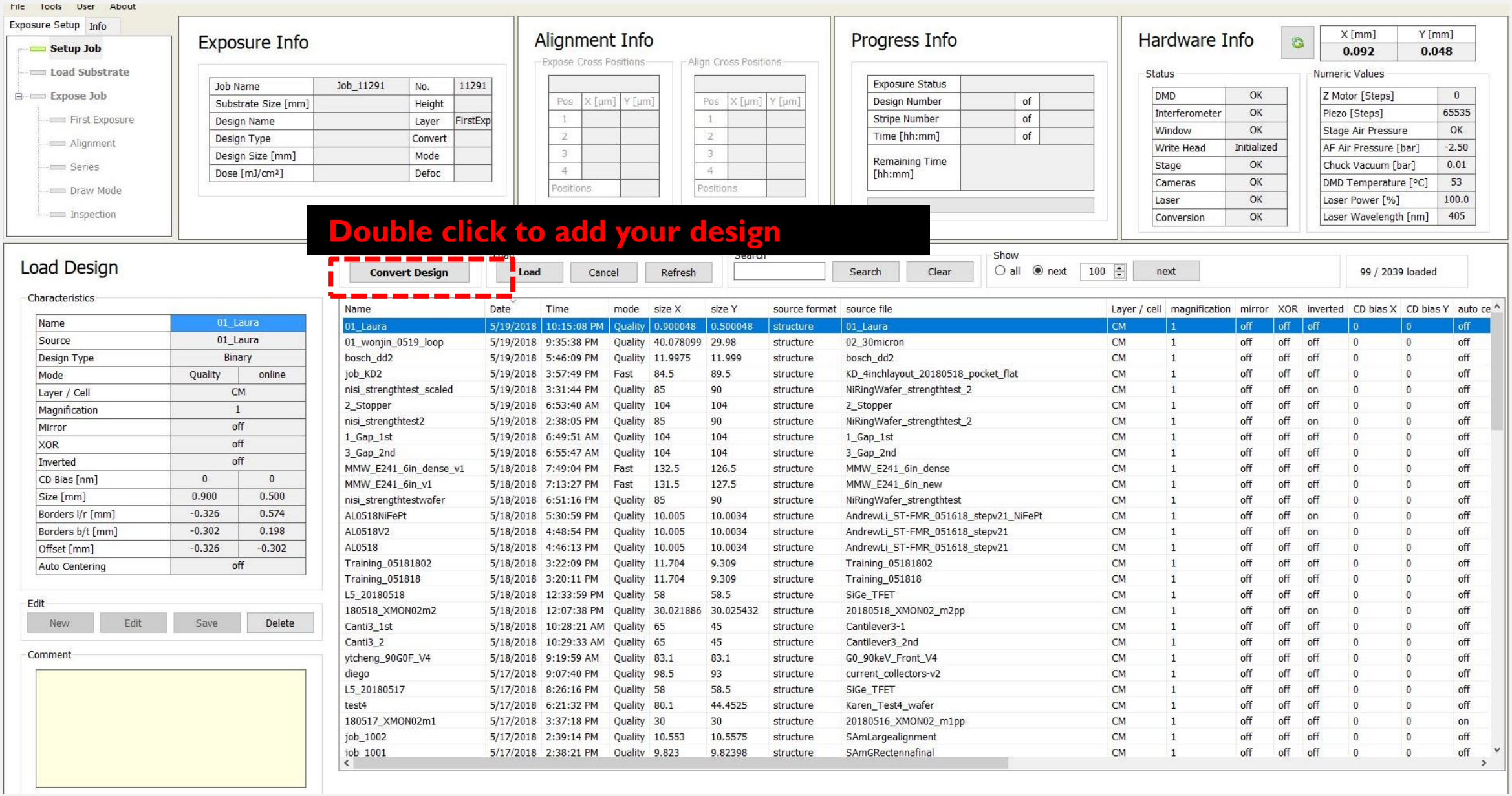
- Transfer your design from your USB to Heidelberg Main PC directory (/home/convert/gdsii/):
  - **Do not use too long file name, this causes error.**
  - **Do not transfer your design into sub-folder that you created in the directory (/home/convert/gdsii/), this causes error.**

STEP 1 : FILE (DESIGN) CONVERSION

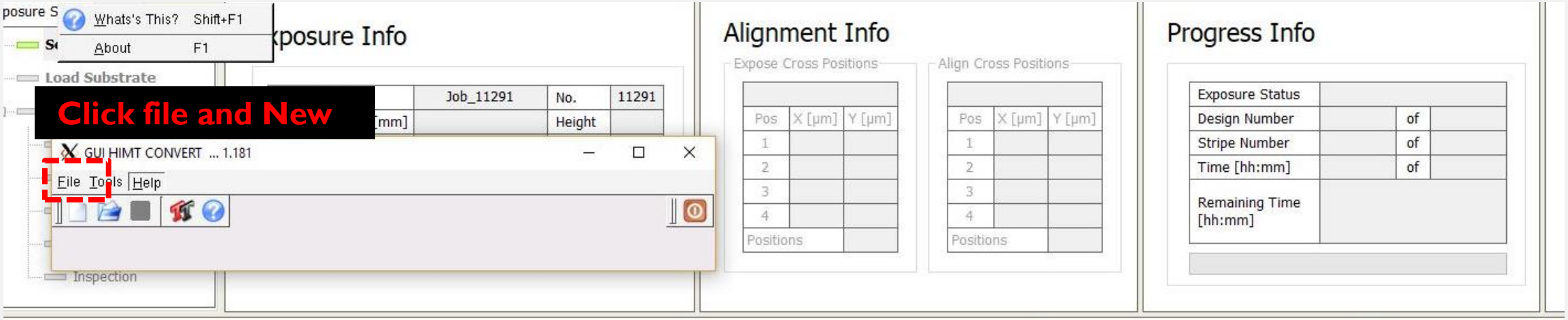
Screenshot of Main PC running MLA-150 program



STEP 1 : FILE (DESIGN) CONVERSION



STEP 1 : FILE (DESIGN) CONVERSION



Load Design

Convert Design | Load | Cancel | Refresh | Search | Clear | Show: all / next 100

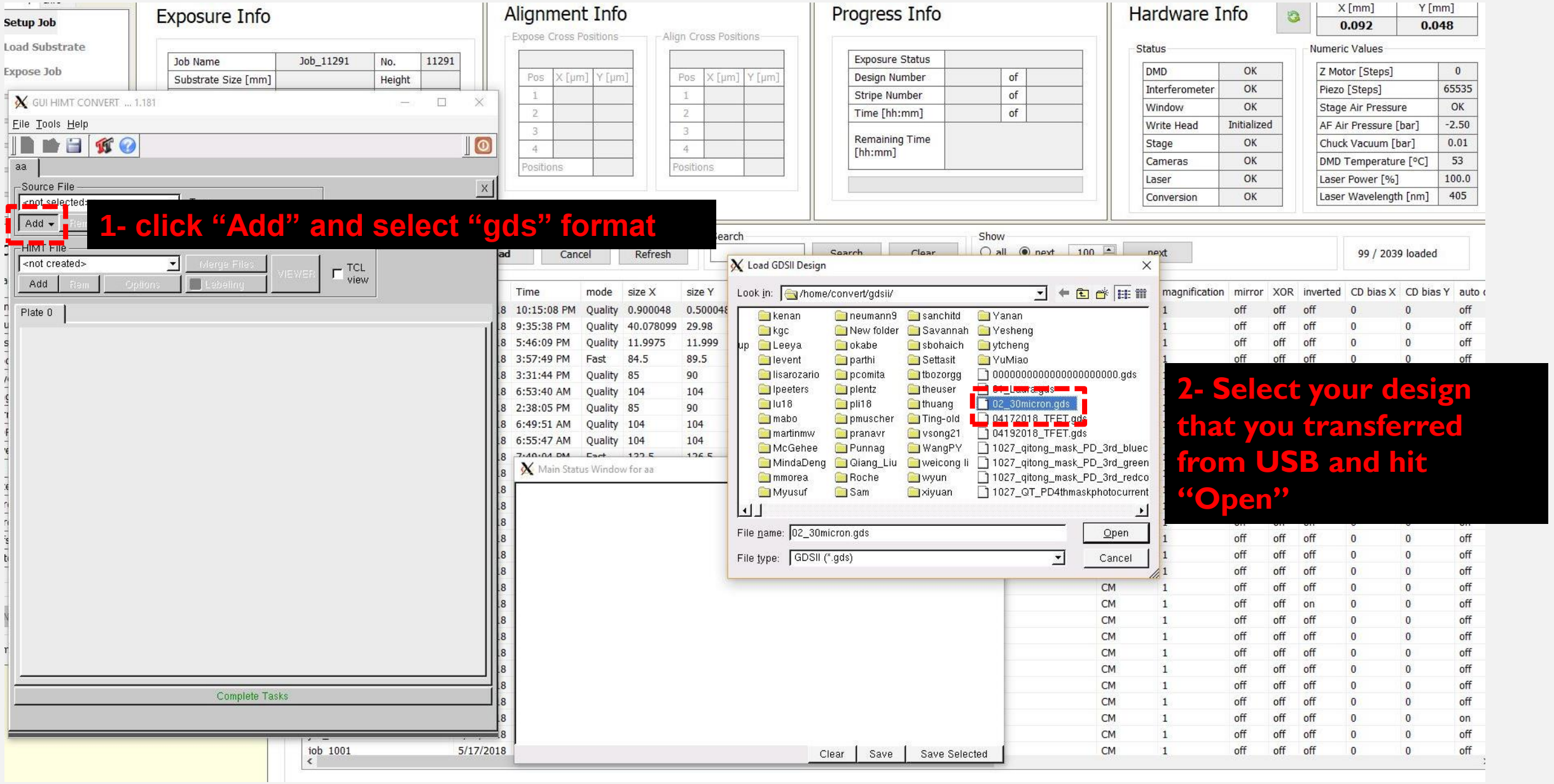
Characteristics

Name	01_Laura	
Source	01_Laura	
Design Type	Binary	
Mode	Quality	online
Layer / Cell	CM	
Magnification	1	
Mirror	off	
XOR	off	
Inverted	off	
CD Bias [nm]	0	0
Size [mm]	0.900	0.500
Borders l/r [mm]	-0.326	0.574
Borders b/t [mm]	-0.302	0.198
Offset [mm]	-0.326	-0.302
Auto Centering	off	

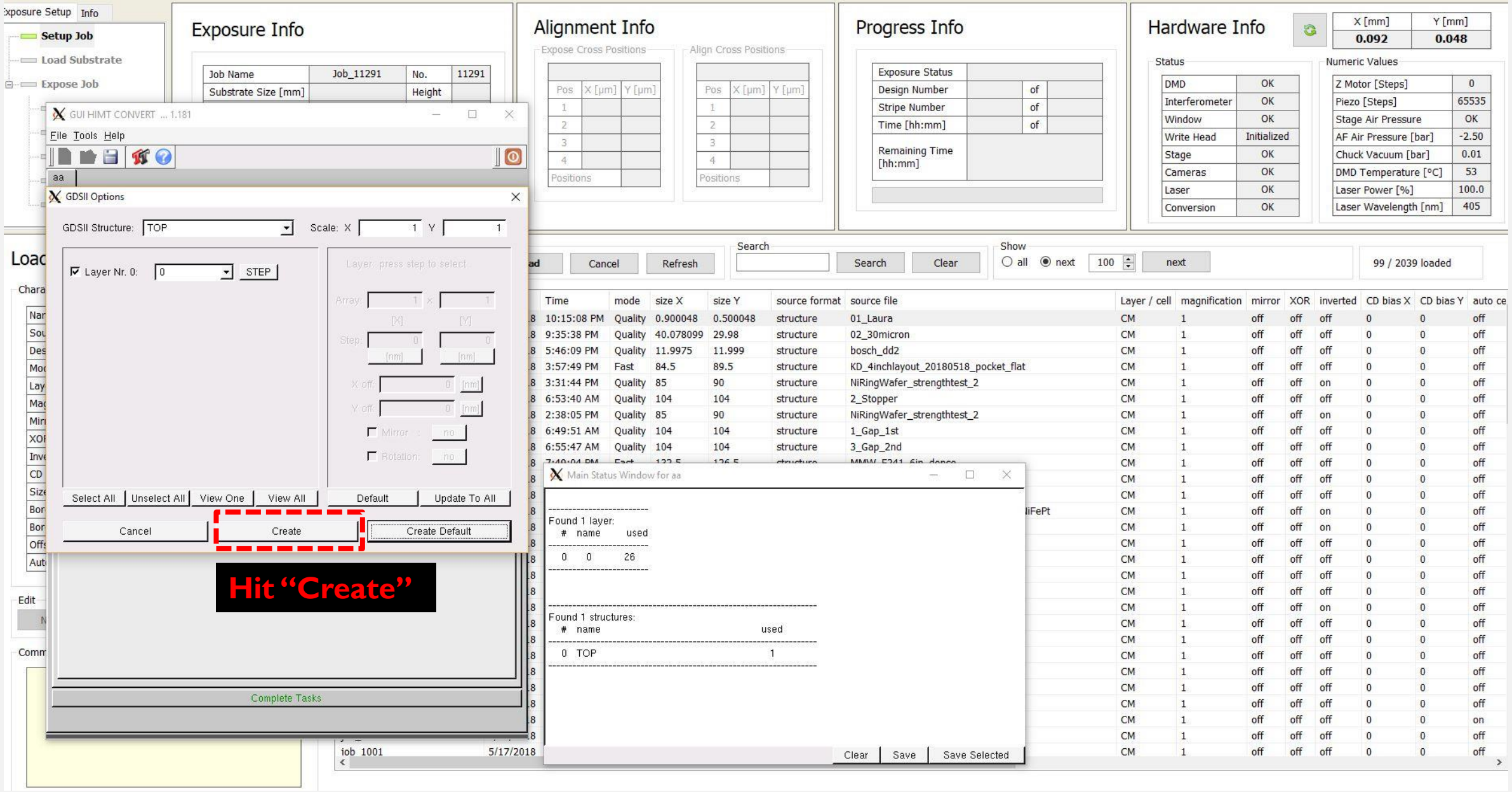
Edit

Name	Date	Time	mode	size X	size Y	source format	source file	Layer
01_Laura	5/19/2018	10:15:08 PM	Quality	0.900048	0.500048	structure	01_Laura	CM
01_wonjin_0519_loop	5/19/2018	9:35:38 PM	Quality	40.078099	29.98	structure	02_30micron	CM
bosch_dd2	5/19/2018	5:46:09 PM	Quality	11.9975	11.999	structure	bosch_dd2	CM
job_KD2	5/19/2018	3:57:49 PM	Fast	84.5	89.5	structure	KD_4inchlayout_20180518_pocket_flat	CM
nisi_strengthtest_scaled	5/19/2018	3:31:44 PM	Quality	85	90	structure	NiRingWafer_strengthtest_2	CM
2_Stopper	5/19/2018	6:53:40 AM	Quality	104	104	structure	2_Stopper	CM
nisi_strengthtest2	5/19/2018	2:38:05 PM	Quality	85	90	structure	NiRingWafer_strengthtest_2	CM
1_Gap_1st	5/19/2018	6:49:51 AM	Quality	104	104	structure	1_Gap_1st	CM
3_Gap_2nd	5/19/2018	6:55:47 AM	Quality	104	104	structure	3_Gap_2nd	CM
MMW_E241_6in_dense_v1	5/18/2018	7:49:04 PM	Fast	132.5	126.5	structure	MMW_E241_6in_dense	CM
MMW_E241_6in_v1	5/18/2018	7:13:27 PM	Fast	131.5	127.5	structure	MMW_E241_6in_new	CM
nisi_strengthtestwafer	5/18/2018	6:51:16 PM	Quality	85	90	structure	NiRingWafer_strengthtest	CM
AL0518NiFePt	5/18/2018	5:30:59 PM	Quality	10.005	10.0034	structure	AndrewLi_ST-FMR_051618_stepv21_NiFePt	CM
AL0518V2	5/18/2018	4:48:54 PM	Quality	10.005	10.0034	structure	AndrewLi_ST-FMR_051618_stepv21	CM
AL0518	5/18/2018	4:46:13 PM	Quality	10.005	10.0034	structure	AndrewLi_ST-FMR_051618_stepv21	CM
Training_05181802	5/18/2018	3:22:09 PM	Quality	11.704	9.309	structure	Training_05181802	CM
Training_051818	5/18/2018	3:20:11 PM	Quality	11.704	9.309	structure	Training_051818	CM
L5_20180518	5/18/2018	12:33:59 PM	Quality	58	58.5	structure	SiGe_TFET	CM
180518_XMON02m2	5/18/2018	12:07:38 PM	Quality	30.021886	30.025432	structure	20180518_XMON02_m2pp	CM

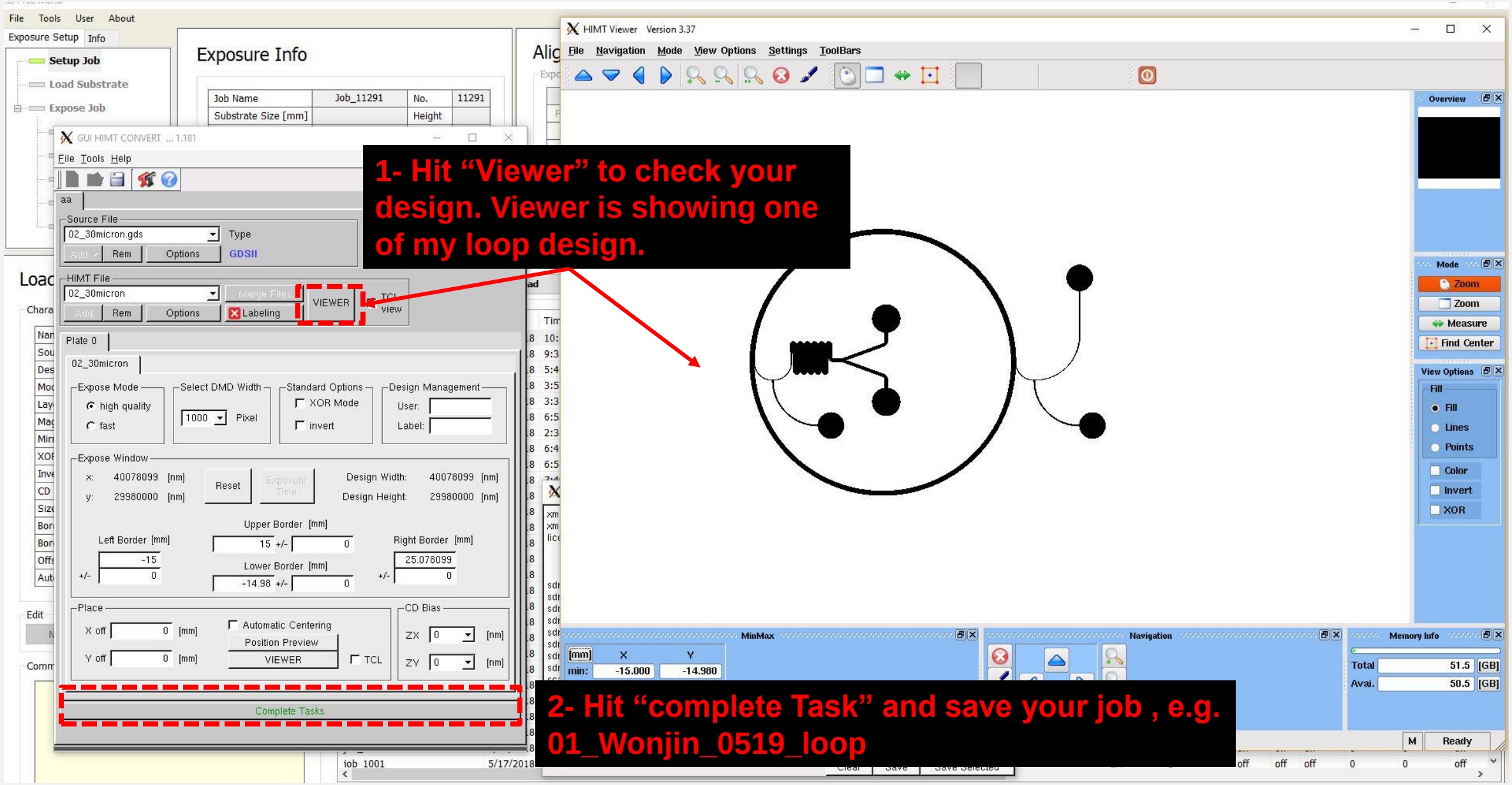
STEP 1 : FILE (DESIGN) CONVERSION



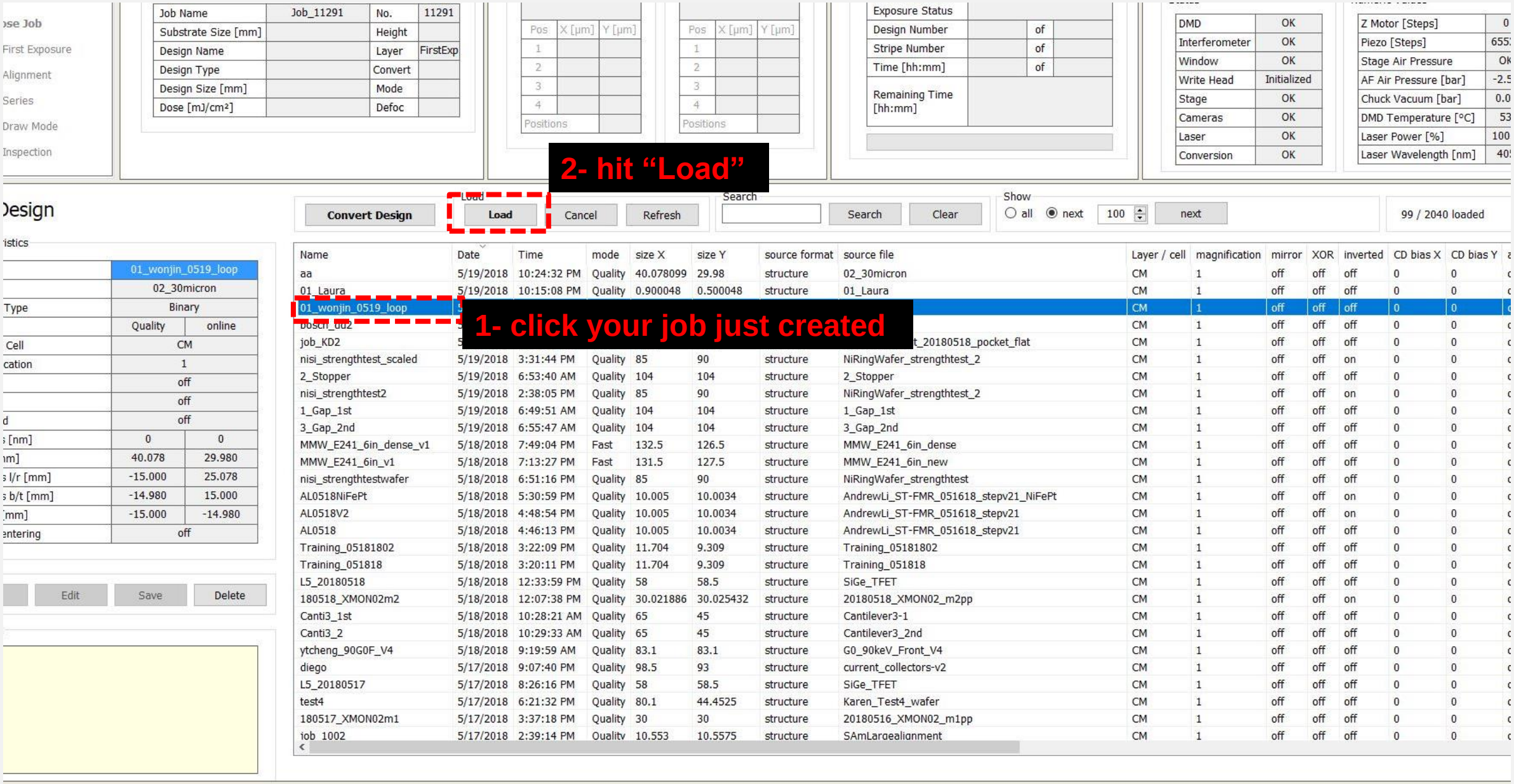
STEP 1 : FILE (DESIGN) CONVERSION



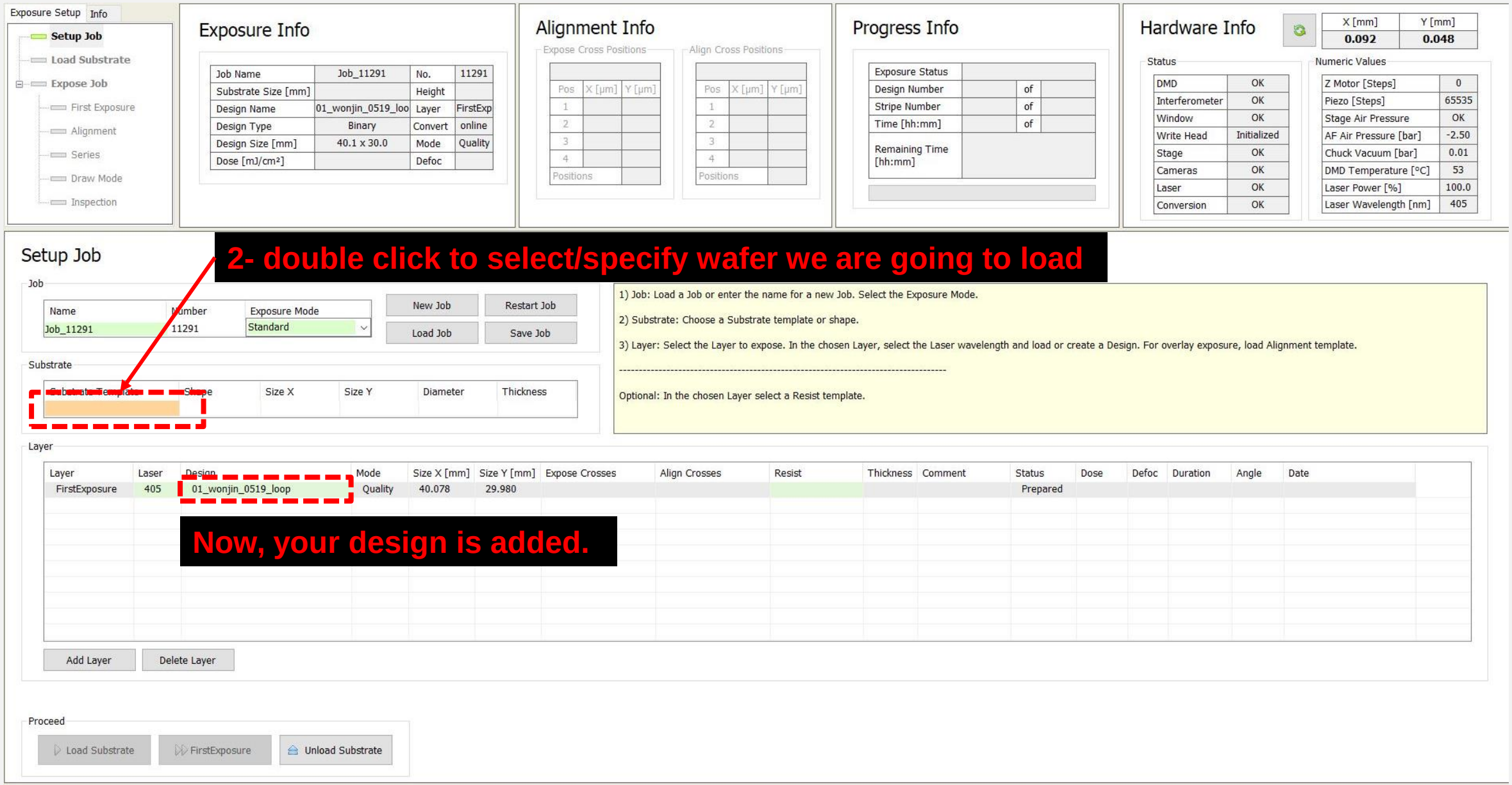
STEP 1 : FILE (DESIGN) CONVERSION



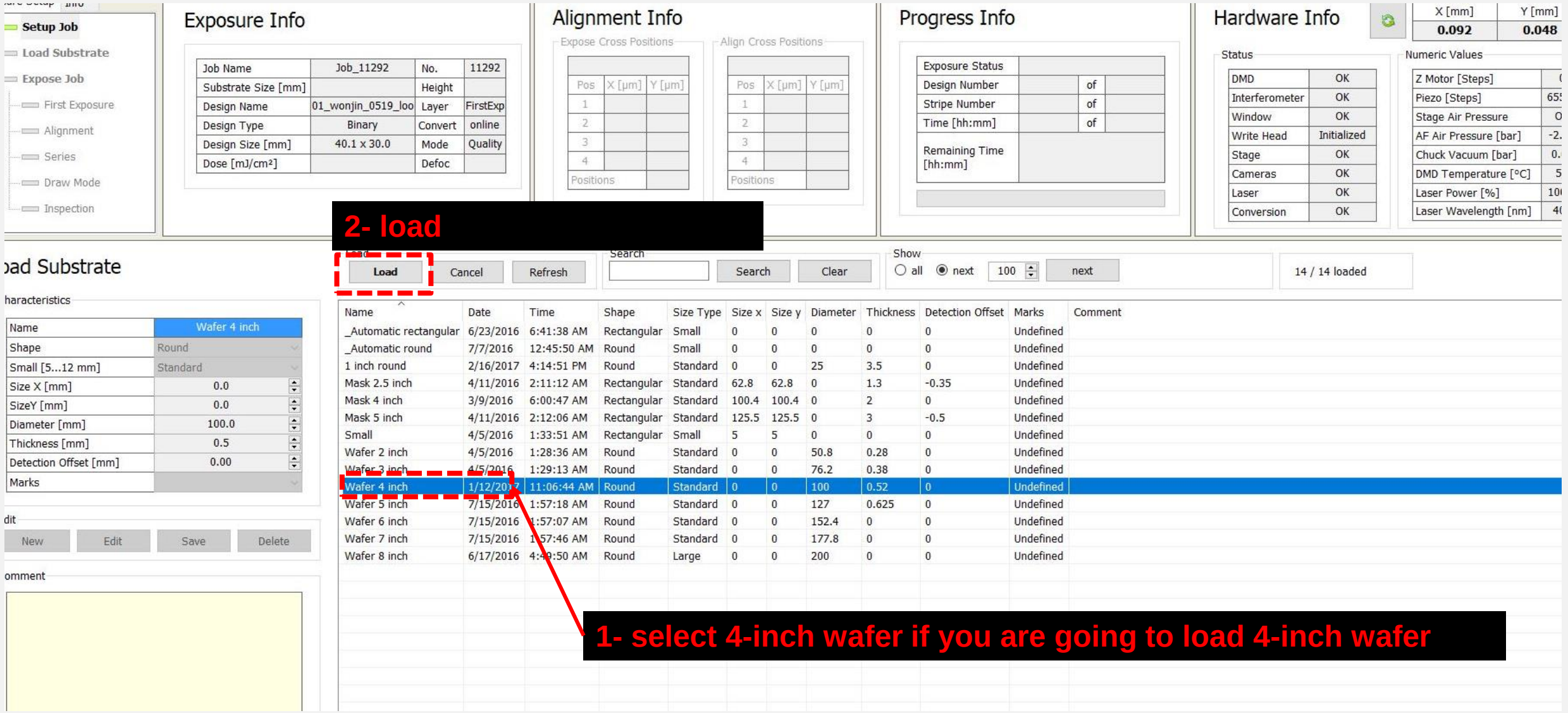
STEP 1 : FILE (DESIGN) CONVERSION



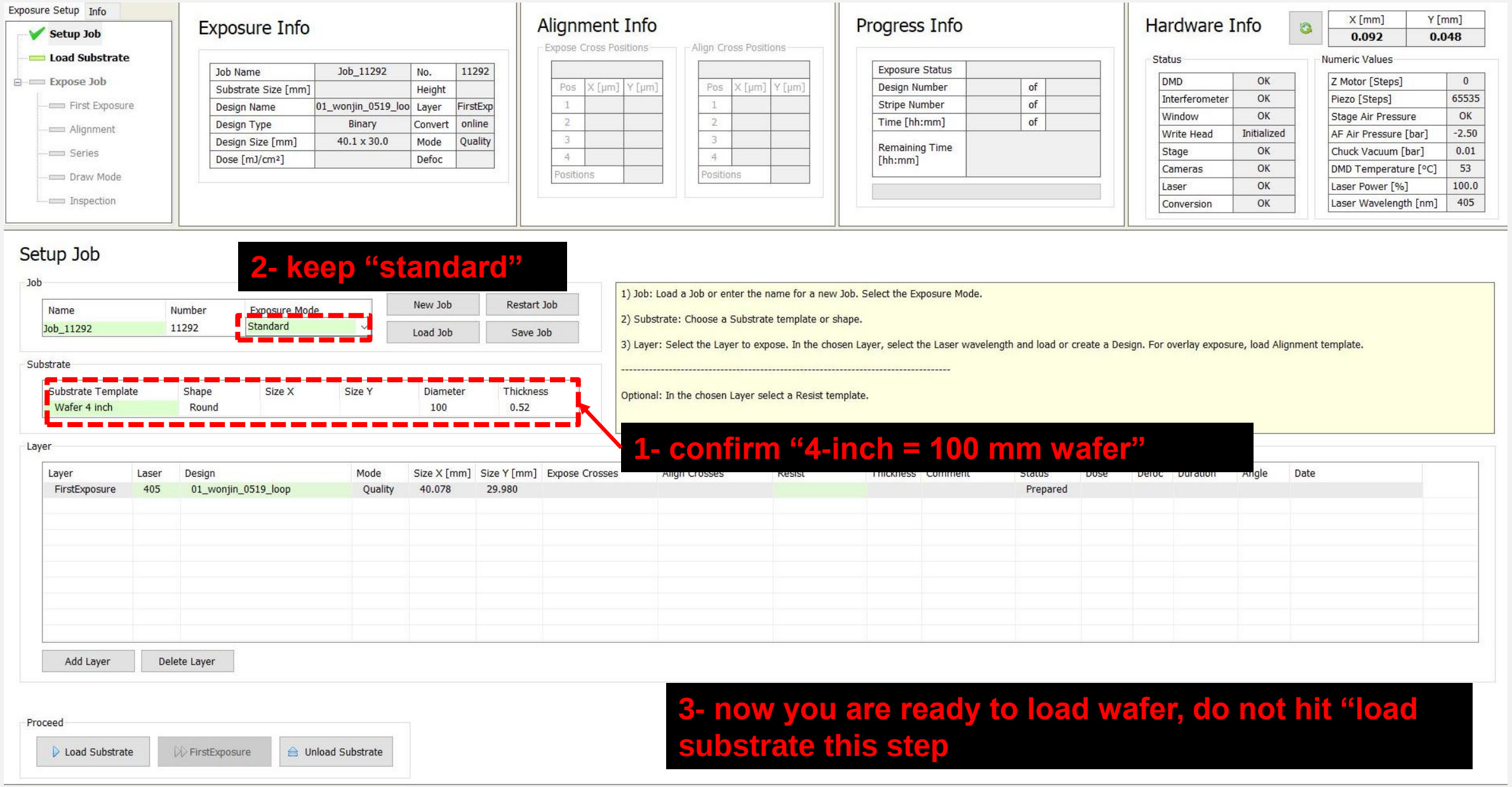
STEP 1 : FILE (DESIGN) CONVERSION



STEP 1 : FILE (DESIGN) CONVERSION



STEP 1 : FILE (DESIGN) CONVERSION



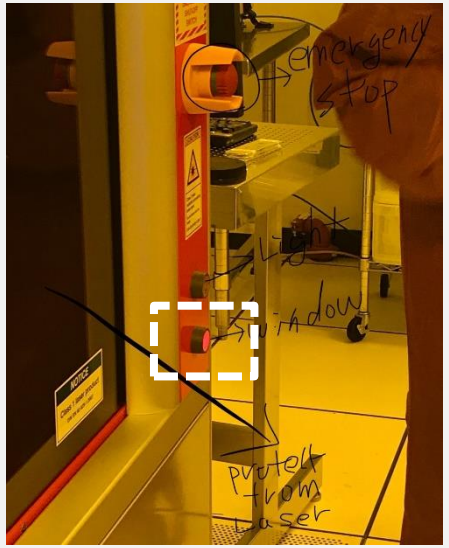
STEP 2 : LOADING WAFER + PARAMETER SETTING

- Material : 100 mm (4-inch) wafer
- Prerequisite :

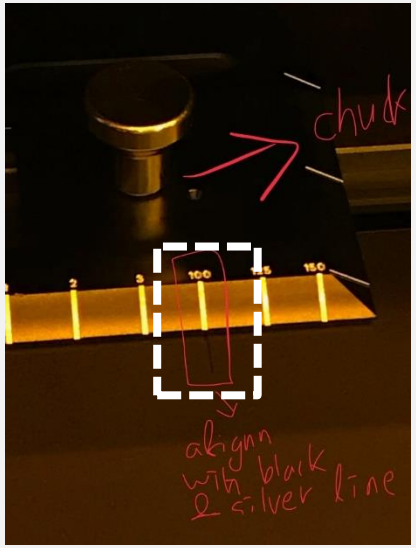
  Photoresist coating has been applied on the wafer

  2 mm EBR required

STEP 2 : LOADING WAFER + PARAMETER SETTING

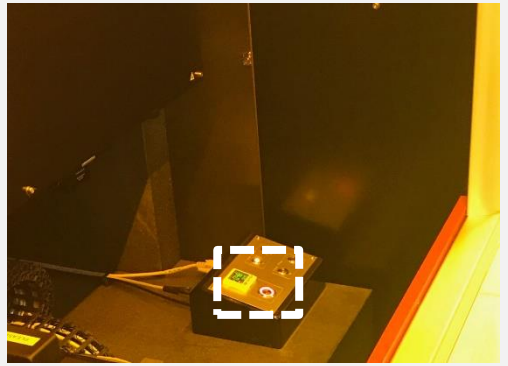


1- open window



2- place chuck (4inch = 100 mm mark aligned with mark on the stage)

3- load resist-coated wafer, flat bottom attached to the chuck , do not worried about precision of the wafer location (MLA-150 automatically detect the center of wafer)

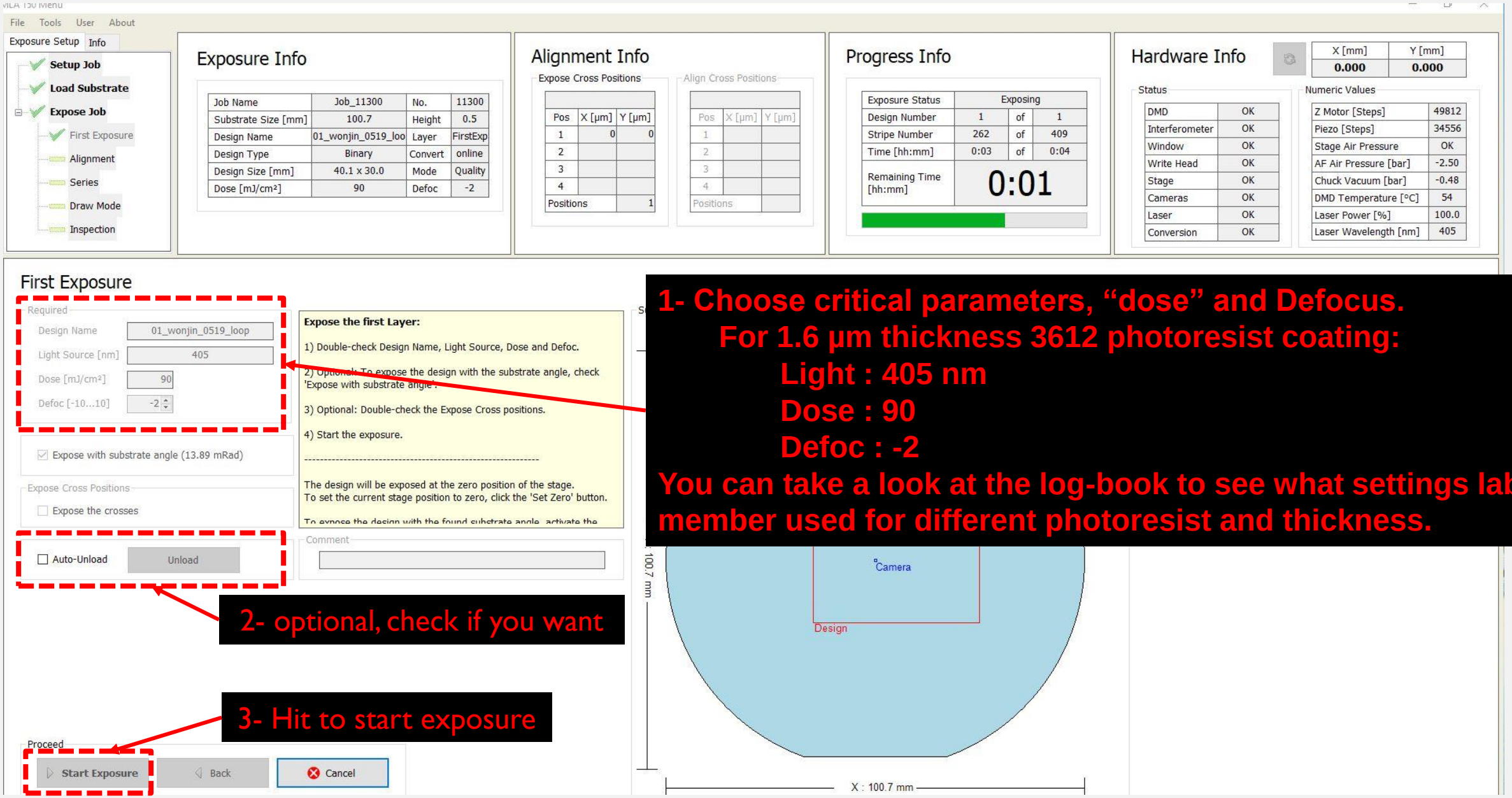


4- push vacuum button to hold wafer in position

5 - get rid of chuck
6 - Close window

6 - Hit “load substrate” and hit “continue” in following screen so that the program automatically center the wafer.

STEP 2 : LOADING WAFER + PARAMETER SETTING

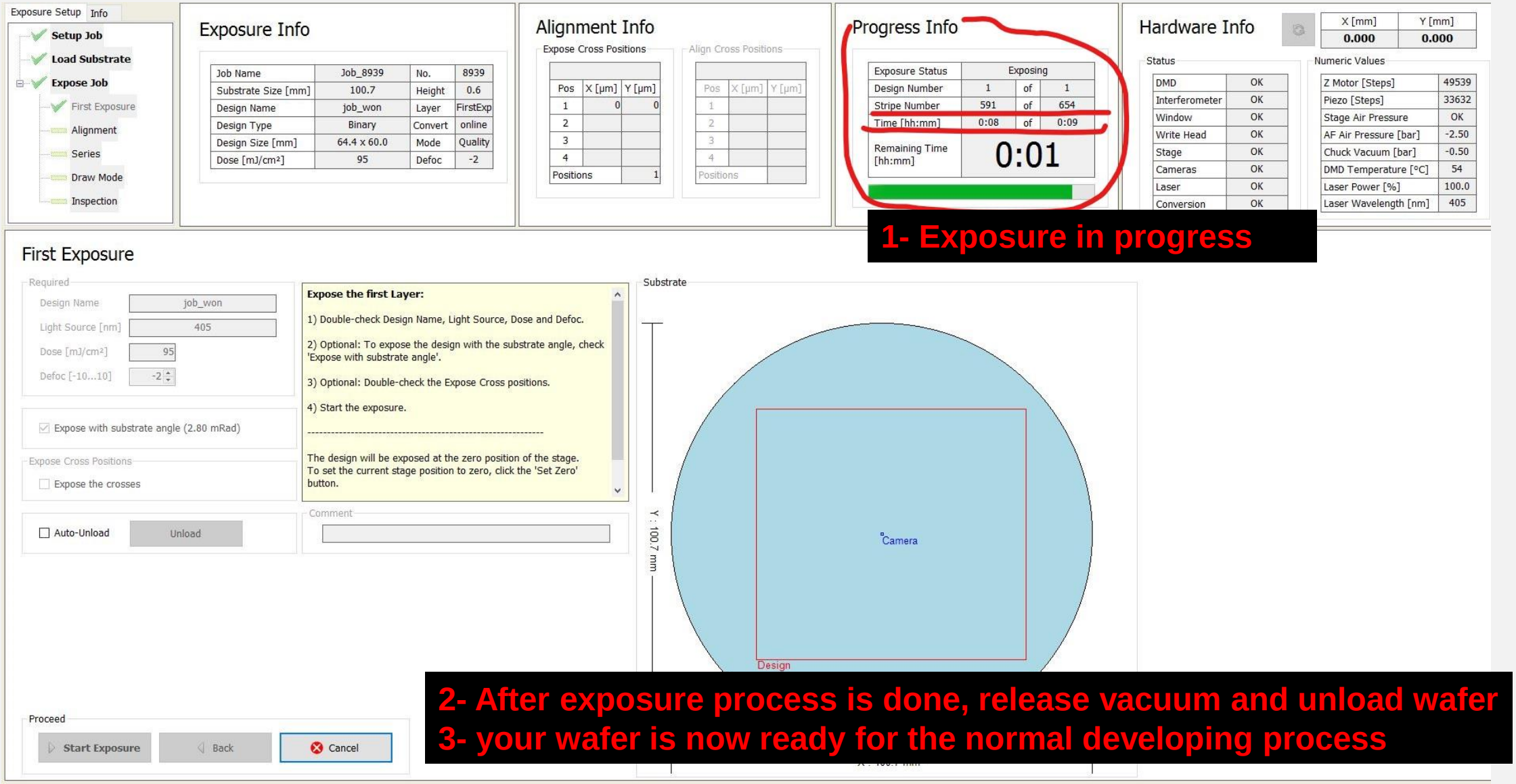


1- Choose critical parameters, “dose” and Defocus.
For 1.6 µm thickness 3612 photoresist coating:
Light : 405 nm
Dose : 90
Defoc : -2
You can take a look at the log-book to see what settings lab member used for different photoresist and thickness.

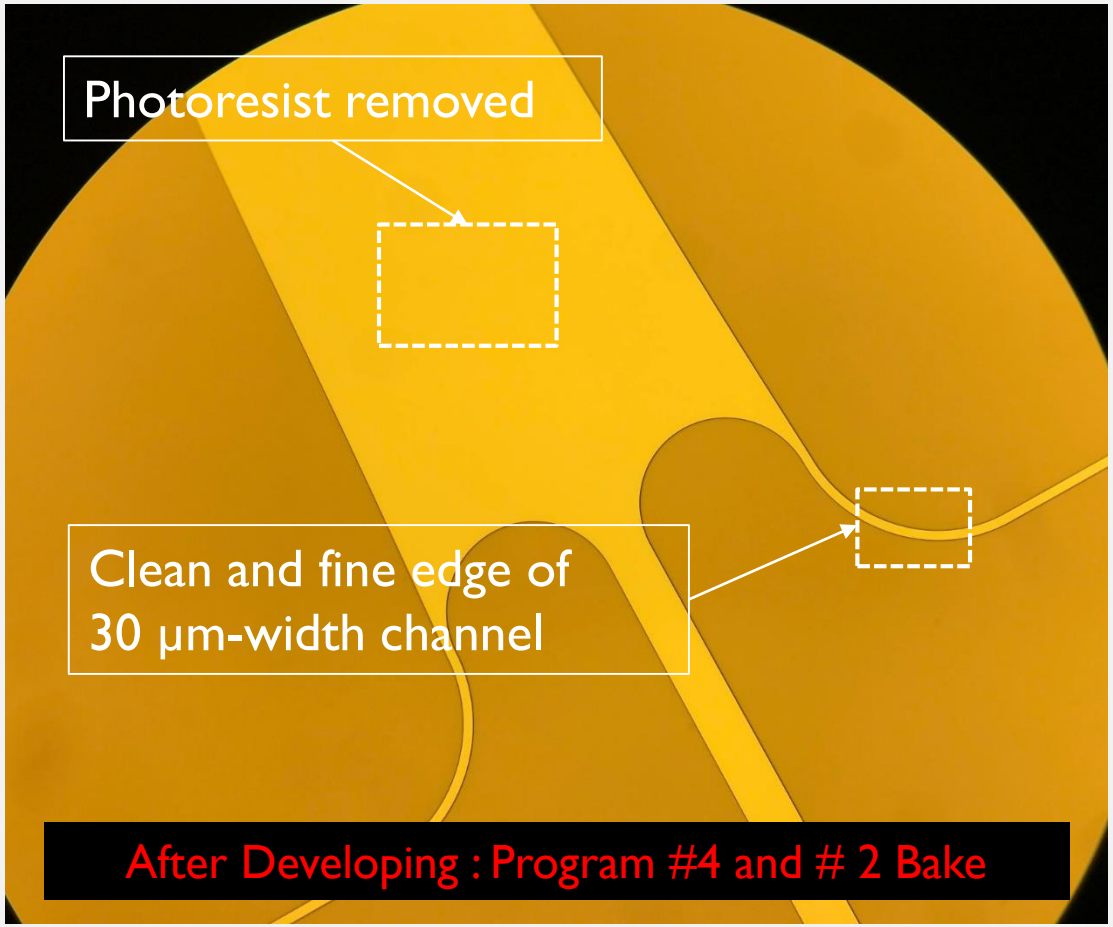
2- optional, check if you want

3- Hit to start exposure

STEP 3 : EXPOSURE + UNLOAD



QUALITY CHECK OF EXPOSURE & DEVELOPING



QUALITY CHECK OF EXPOSURE & DEVELOPING