

Heidelberg DWL66 Laser Writer

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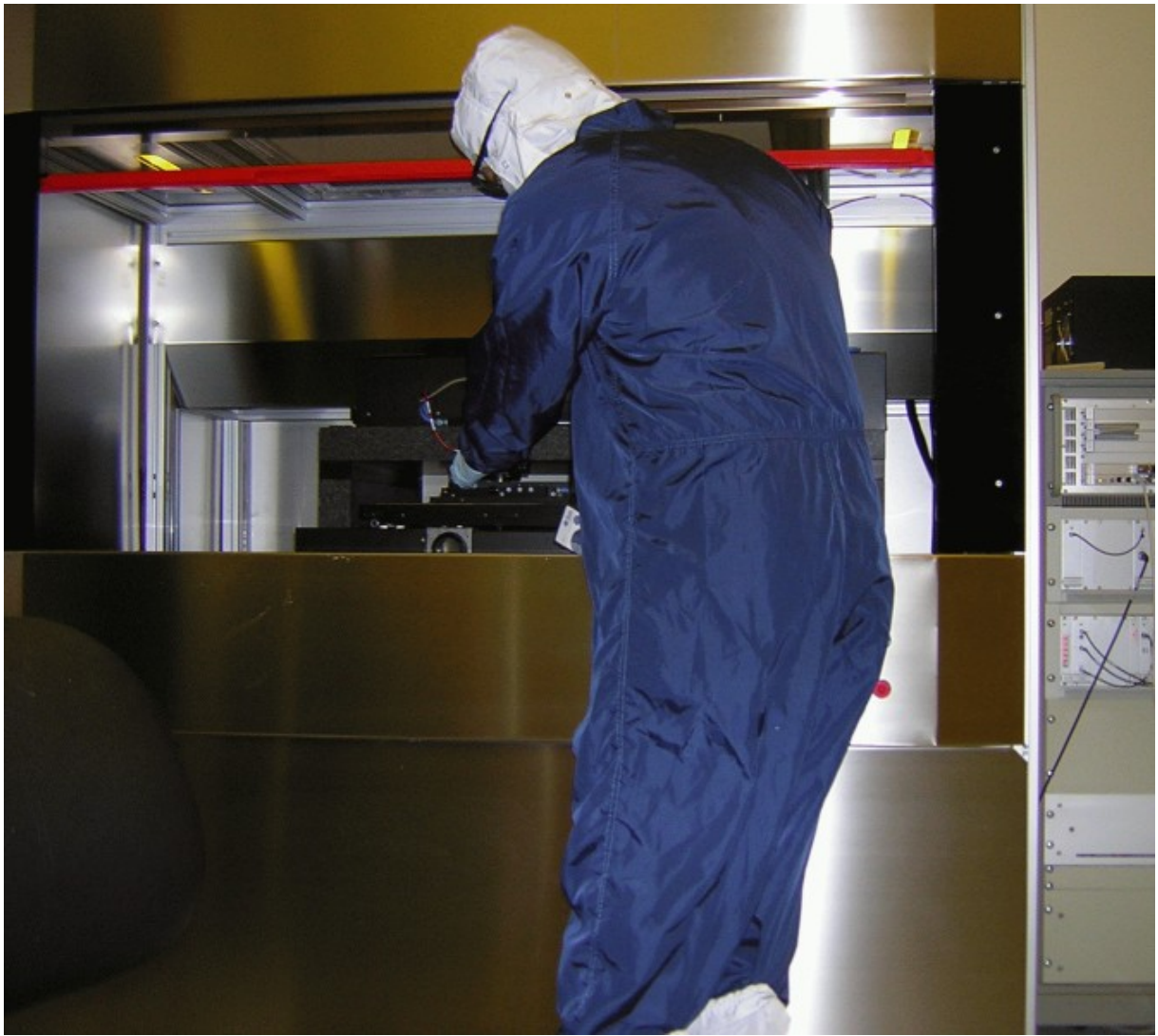


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1. Overview of the Laser Writer

1.1. DWL66 capabilities and features

- Expose small parts samples up through 8" wafers, including masks
- Accepts design files in the formats: CIF, DXF, GDSII, GERBER, HPGL and HMT
- Minimum feature size is about 0.6 μm
- Front side and backside alignment
- Metrology:
 - ❖ Overlay – measures relative position of two features on two different lithography levels
 - ❖ Distance -- measure the distance between two features
 - ❖ Positions – measures the die-to-die distances to check system linearity and orthogonality
 - ❖ Line width – measures the width of lines (critical dimension measurement)
 - ❖ Pitch, Stitching, Edge roughness
- Grayscale exposure
- 442nm HeCd laser source
- A large set of write head objectives to optimize exposures
- 40 nm address grid

Table 1-1: Feature size versus write head

Minimum features size/distance between features	Write Head Size (focal length)	Focus Depth	Relative write speed versus 10mm head (approx)
~0.6 μm	2 mm	~1.0 μm	20 times slower than 10mm
0.8 μm	4 mm	~1.8 μm	7 times slower than 10mm
2 μm	10 mm	~8 μm	
4 μm	20 mm	~50 μm	2 times faster than 10mm
8 μm	40 mm	~200 μm	>2 times faster than 10mm



Figure 1-1: DWL 66 Main system environmental chamber contains laser optics, stage, and camera systems

1.2. Subsystems

There are several subsystems to the DWL 66:

- Exposure system which includes laser, laser optics, stage, and camera systems. See Figure 1-1
- Exposure control industrial computer gives low level system commands to the exposure system. See Figure 1-2.
- User interface PC for exposures running Microsoft Windows and the DWL MENU software. See Figure 1-3
- Conversion PC running Susie Linux to convert user designs (GDS, DXF, GERBER, etc) into a format that can be read by the exposure control computer. See Figure 1-3.
- A single workstation for operating both PC's. See Figure 1-4.



Figure 1-2: Exposure Control Computer rack



MS Window PC
For DWL MENU

Linux PC for
Convert software

Figure 1-3: User PCs



Figure 1-4: User Computer Work Station

1.3. Designs, and Masks

Typically Users will bring designs on a memory stick or transfer the design file over the network via secure file transfer.

Users can purchase mask blanks from the Nanofab that are individually packaged and ready for exposure. The following are pricing and availability of masks as of 1/22/2005. The price in the Portal are the official prices.. Prices and availability can change without notice to reflect changes in our costs and availability from our suppliers.

Table 1-2: Masks blanks available for purchase

<i>Size (l x w x thickness)</i>	<i>Material</i>	<i>Availability</i>	<i>Cost per blank</i>
4" x 4" x 0.090"	Soda Lime Glass	Stocked	\$ 27
4" x 4" x 0.090"	Quartz	Stocked	\$ 94
5" x 5" x 0.090"	Soda Lime Glass	Stocked	\$ 36
5" x 5" x 0.090"	Quartz	Stocked	\$ 94
7" x 7" x 0.120"	Soda Lime Glass	Stocked	\$ 110
7" x 7" x 0.120"	Quartz	Upon request	\$ 485

This remainder of the manual is divided up into sections on setup, mask writing and direct wafer exposure (no alignment), exposure with front side alignment, exposure with backside alignment, metrology, and grey scale exposure.

2. User Setup

2.1. Note Well!

- The DWL66 uses a 442nm HeCd laser. The laser beam path is covered and users must never remove any of the covers. To ensure that users are not exposed to the laser light a shutter is interlocked with the front sash such that if it is opened a shutter is closed on the laser.
- Opening the front sash not only closes the laser shutter it also disables the drive for the stage. If the sash is opened during an exposure the exposure will stop and will not be able to be restarted.
- The stage position is measured using a laser interferometer system. Do not touch any of the mirrors (see Figure 2-1) or interrupt the beam. Touching a mirror will likely destroy it and interrupting the laser beam will require the system to be reset.

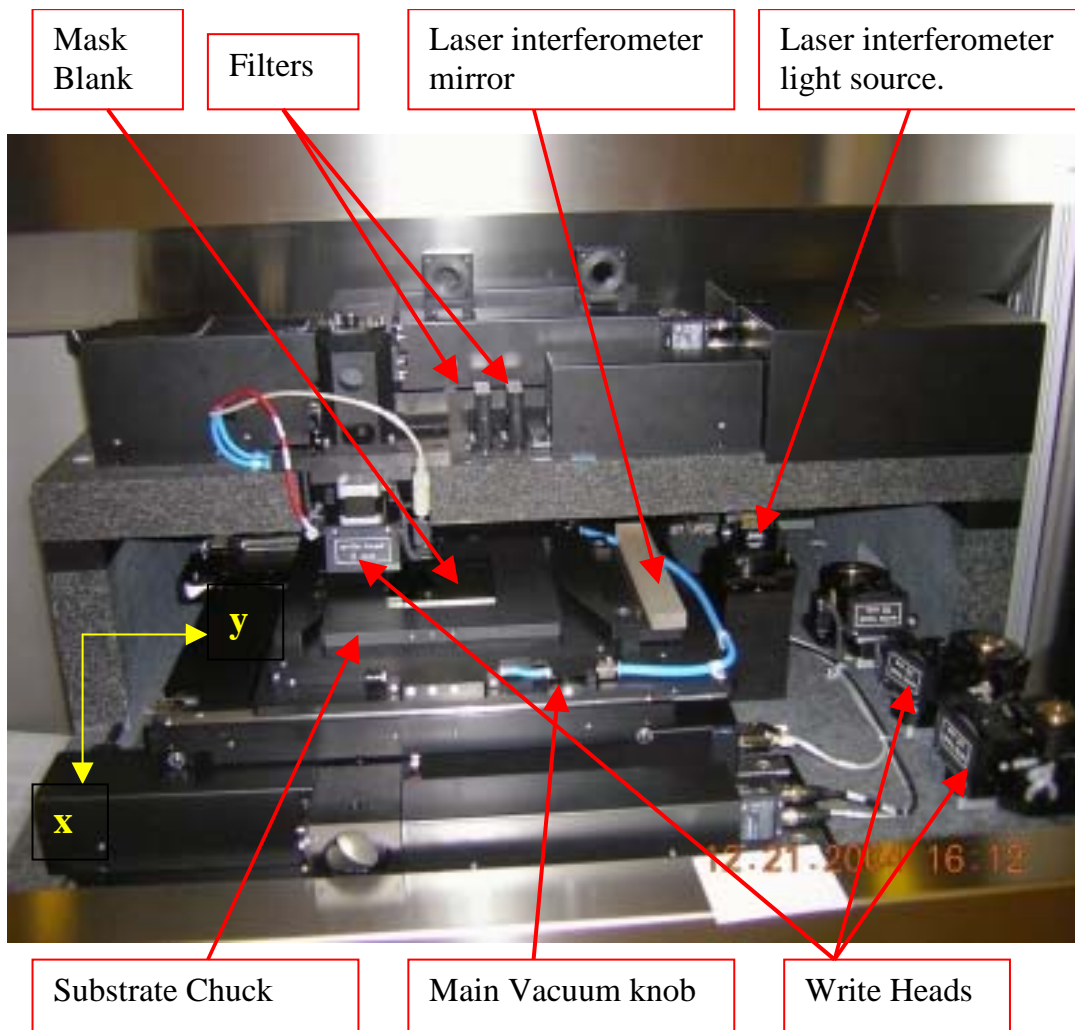


Figure 2-1: DWL 66 Stage and optics

- The laser life is limited and to keep expenses down the laser must be shutoff via the user interface once an exposure is finished. There is an interlock system that prevents the laser from being turned back on for 20 minutes. Once the laser is turned on you must wait 20 minutes for it to stabilize before starting your exposure.
- **Warning:** The height meter uses puffs of air to measure the distance from the substrate to the lens. Due to its design the smallest substrate should be 1" in diameter.

2.2. System Setup

- Press the button on the KVM (Figure 2-2) if needed to switch to the DWL MENU PC.
- Log into or unlock the control PC by pressing Ctrl-Alt-Delete
User: dwl66
Password: Laser442nm (watch the case!)
Domain: DWL66



Figure 2-2: User Workstation KVM switch

- Start up the DWL MENU user interface if not started by clicking on the 😊 icon on the MS windows quick launch bar.
- **Trouble shooting:** If a window pops up with the message “*DWL Does Not Respond*” go to the troubleshooting section of this manual at the end of the book and see the section on “**Startup.**”
- During startup the system will sit there as it loads the write head information into the exposure computer. After more than a minute the DWL MENU window will appear (figure 2-3).
- Click **OK** on the DWL MENU window See Figure 2-3.

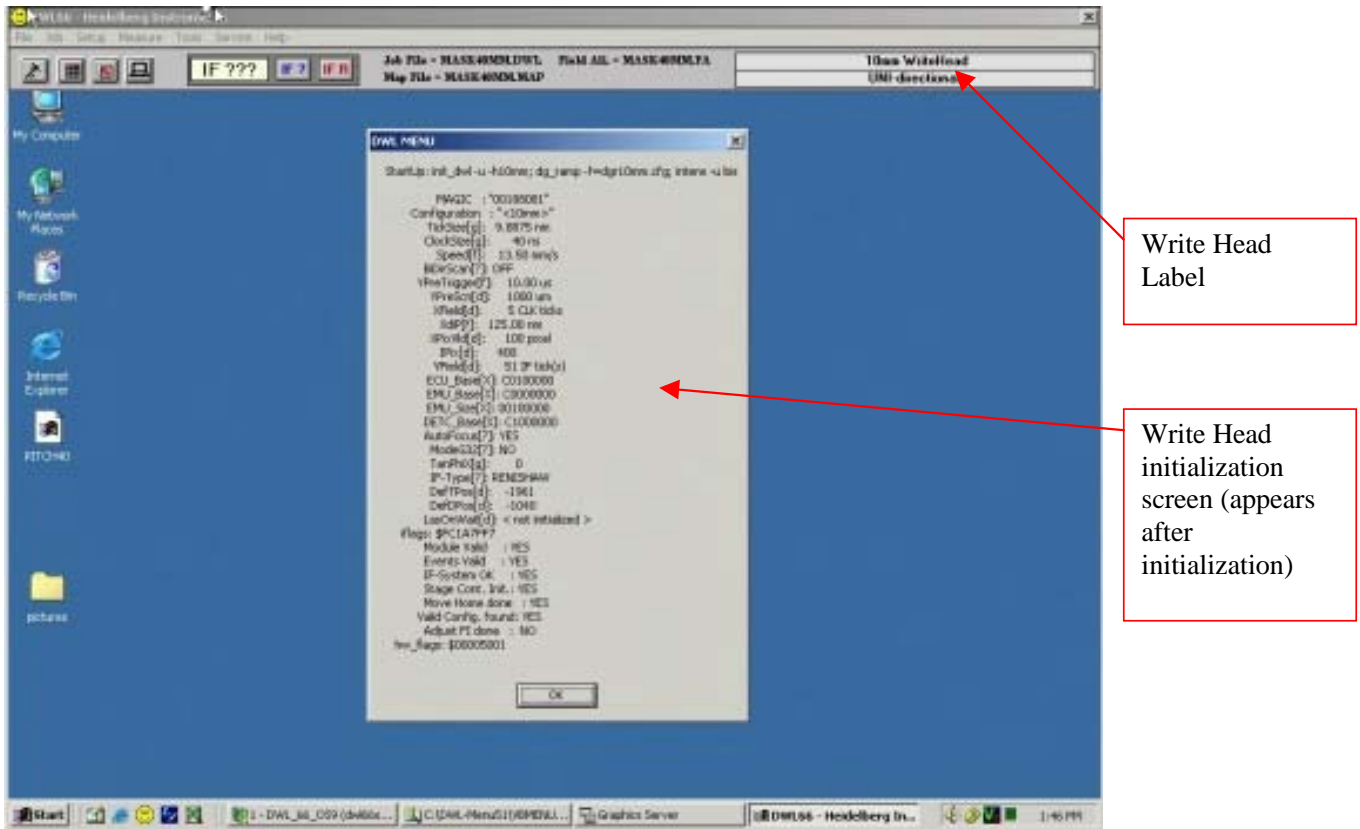


Figure 2-3: DWL MENU startup

2.2.1. Check and laser startup

- ❖ Check that the environmental system is working and both the set temperature and measured temperature are 21.5°C (See Figure 2-4). If it is off press the green on button.

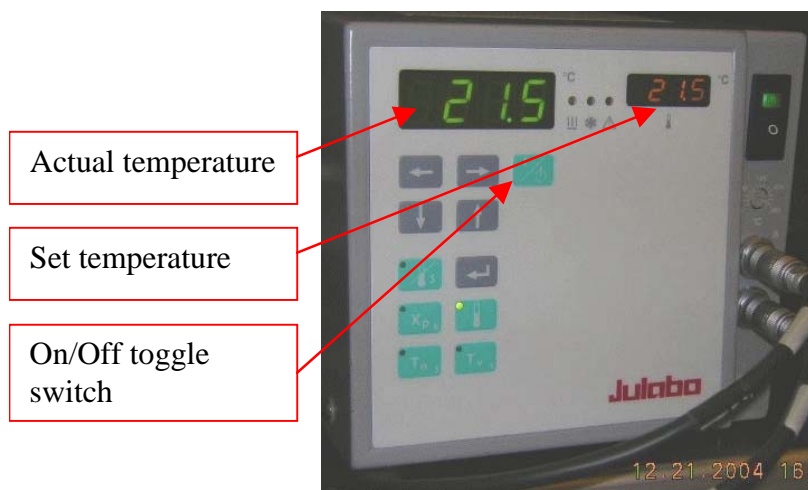


Figure 2-4: Environmental chamber temp controller

- ❖ The laser is needed for all exposures but is not necessary for metrology. Turn on the laser if you need it by:

- DWL MENU: Navigate to Job-->Run Job
- DWL MENU Expose: In the Expose window click on the *LaserCtrl* button which will bring up the laser control window
- DWL MENU LaserCtr: Click the *Command ON* button (figure 2-5). Note: The laser will not be able to turn on if 1) it was turned off less than 20 minutes ago or 2) the PC was powered off less than 20 minutes ago.
- DWL MENU LaserCtr: Close the LaserCtr window.

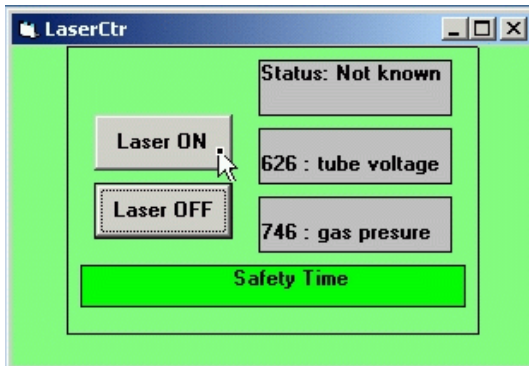




Figure 2-5: Laser control window

2.2.2. Changing write heads

- ❖ DWL MENU: Open the Control Panel by clicking on .
- ❖ DWL MENU Control Panel: Click on the unload icon . See Figure 2-6 for details on this control.

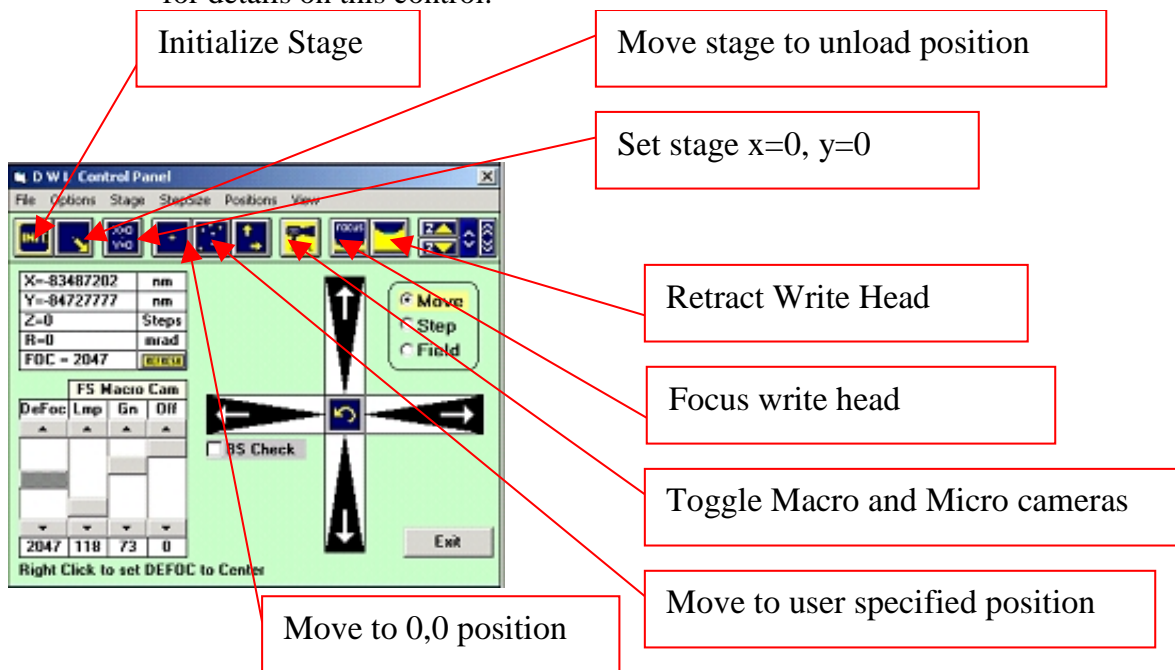


Figure 2-6: DWL Control Panel

- ❖ System: Open the sash by flipping the toggle switch to the left.

- ❖ **System:** Take off the serial cable (figure 2-7) and let it dangle to the left of the write head. **Note that only the screw closest to the front is tight.**



Figure 2-7: Removing write head serial cable

- ❖ **System:** Take off red coax cable by squeezing sides of pulling out (figure 2-8) and letting it dangle to the left of the write head.



Figure 2-8: Releasing write head red coax cable by squeezing the connector

- ❖ **System:** Let cables dangle to the *left* of the write head.
- ❖ **System:** Loosen 3 screws holding write head with the 3 mm “T” hex wrench (figures 2-9 and 2-10) while supporting the write head with your hand.

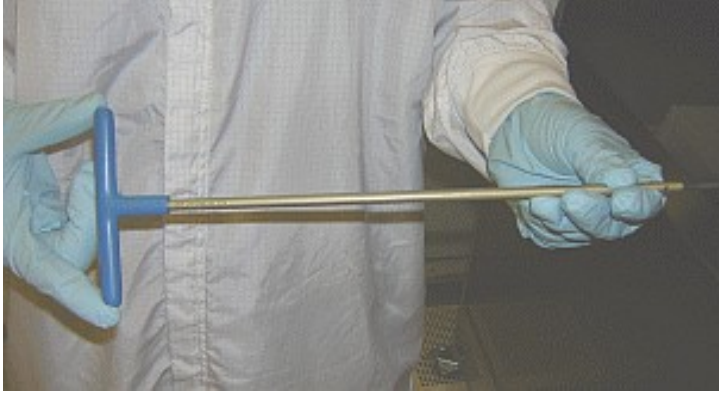


Figure 2-9: "T" hex or Allen wrench

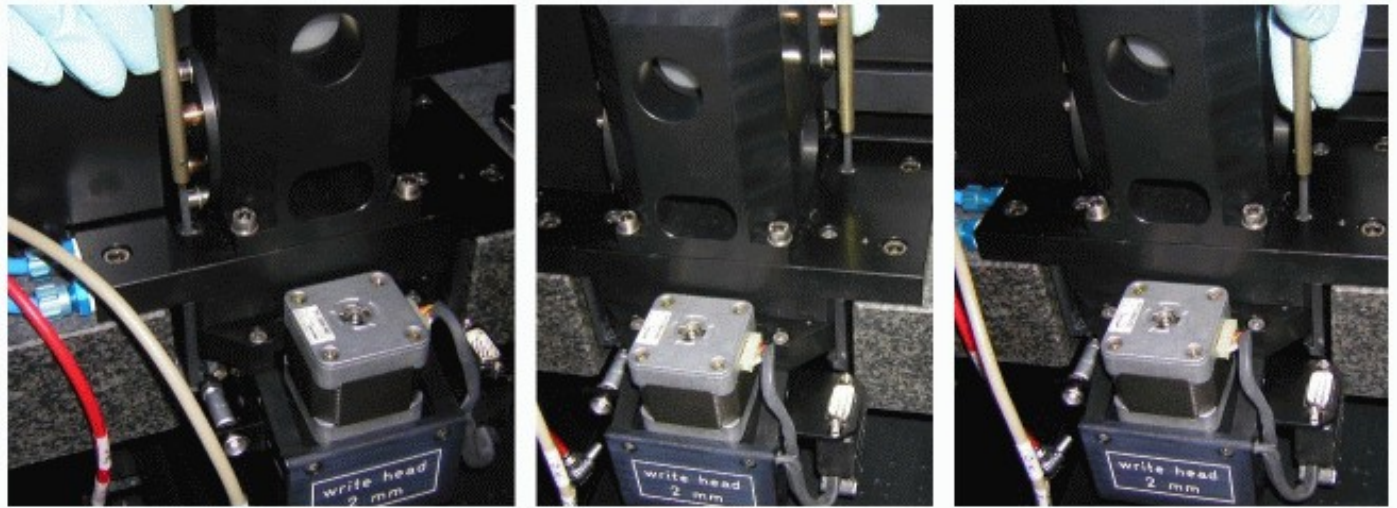


Figure 2-10: Removing write head screws

- ❖ **System:** Let go of write head and put down hex wrench.
- ❖ **Warning:** Do not touch the lens area of the write head because this will knock it out of calibration and may cause permanent damage.
- ❖ **System:** Slide out the write head lifting the whole time so that it does not drop onto the chuck (Figure 2-11)
- ❖ **System:** Place the write head upside down on the granite block (Figure 2-11).



Figure 2-11: Sliding write head off of rails



Figure 2-12: Write head stored upside down

- ❖ **System:** Slide new write head onto the rails.
- ❖ **System:** While supporting the head tighten the 3 screws. **Warning:** Use only TWO fingers to tighten screws (figure 2-13)!



Figure 2-13: Tighten with two fingers

- ❖ **System:** Replace the serial and coax cables. Be sure that the screw nearest the front on the serial cable is tight.
- ❖ **DWL USER PC:** Look up the filters needed for the write head in the “*Write Head Info.doc*” file on the desktop of the User PC.
- ❖ **Warning:** Do not touch the filter glass.
- ❖ **System:** Using the 2.5mm Allen wrench remove any filters in the optical path and place them on top of the covers (figure 2-14).



Figure 2-14: Installing filters

- ❖ **System:** Place the filters needed for the write head in the optical path and tighten down the setscrew. **Warning:** Use only TWO fingers to tighten the setscrew!
- ❖ **Check:** Make sure that the filters cannot be moved side-to-side. If they can then tighten them a little more.
- ❖ **System:** Close the sash by flipping the toggle switch to the right position.
- ❖ **DWL MENU:** Change the write head by double clicking on the write head label in the DWL MENU upper right hand corner (See Figure 2-3).
- ❖ **DWL MENU Choose Configuration:** Choose the file name that corresponds to the write head installed (figure 2-15).
- ❖ **DWL MENU Choose Configuration:** Click on “*UNI-directional*” (typical) for normal exposure or “*Grayscale*” for gray scale lithography exposures (figure 2-15).
- ❖ **DWL MENU Choose Configuration:** Click the “*Load It!*” button (figure 2-15).

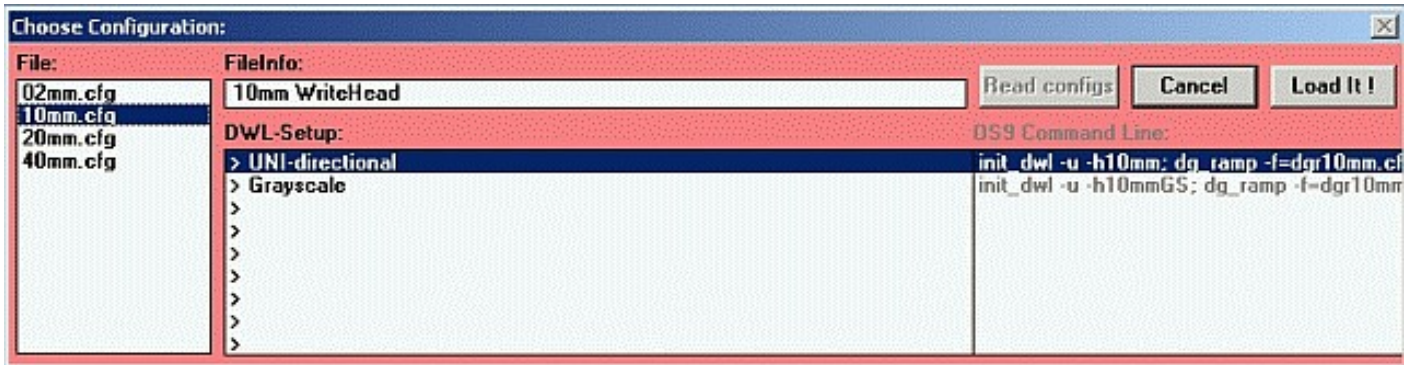

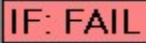




Figure 2-15: Choose Write Head Configuration

- ❖ **Wait:** It will take about one minute for the parameters to load and display the informational screen (figure 2-3). Click “OK” when prompted.
- ❖ **DWL MENU:** Click on the  icon to update the interferometer information. If you see  then go to *Trouble Shooting* section.

2.2.3. Changing substrate chucks

- ❖ If the sash is not open and the stage is not in the unload position:
 - DWL MENU: Open the Control Panel by clicking on .
 - DWL MENU Control Panel: Click on the unload icon .
 - System: Open the sash by flipping the toggle switch to the left to open
- ❖ **System:** **Check** that main vacuum valve off (in the vertical position) (figure 2-16).

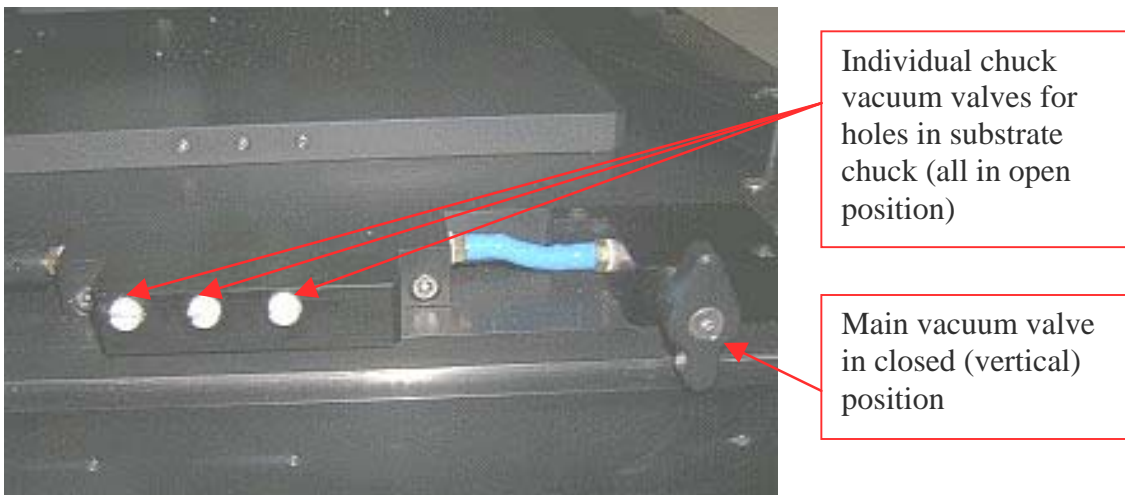


Figure 2-16: Chuck vacuum controls

- ❖ **System:** Lift and slide out the chuck (figure 2-17). **Warning:** Do not bump the chuck into the write head when sliding it out.

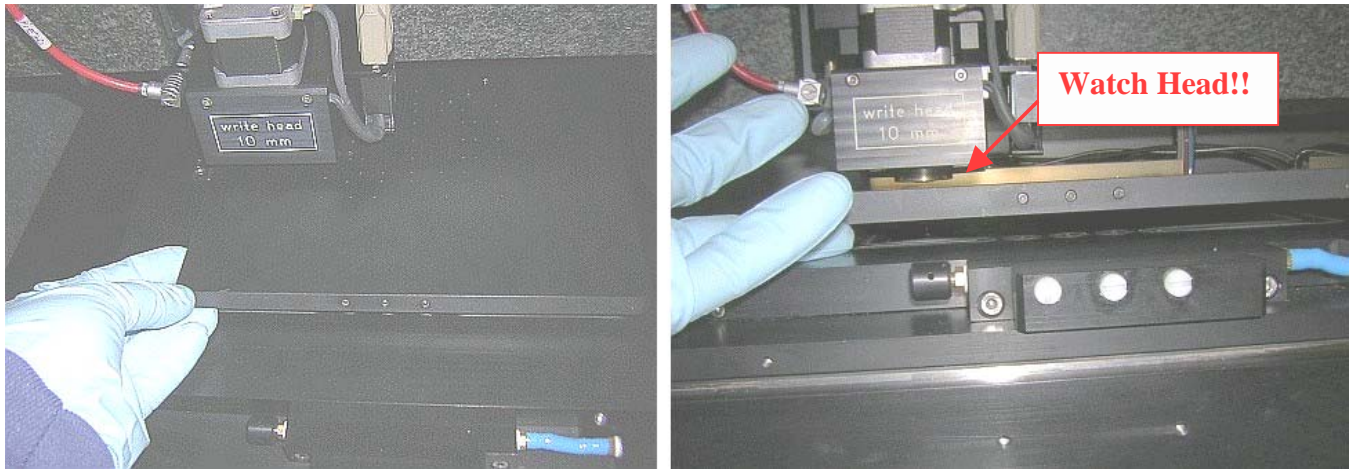


Figure 2-17: Carefully lift and slide out chuck

- ❖ **System:** Slide in the new chuck such that the three holes in the chuck align with the three holes in the stage (figure 2-18).

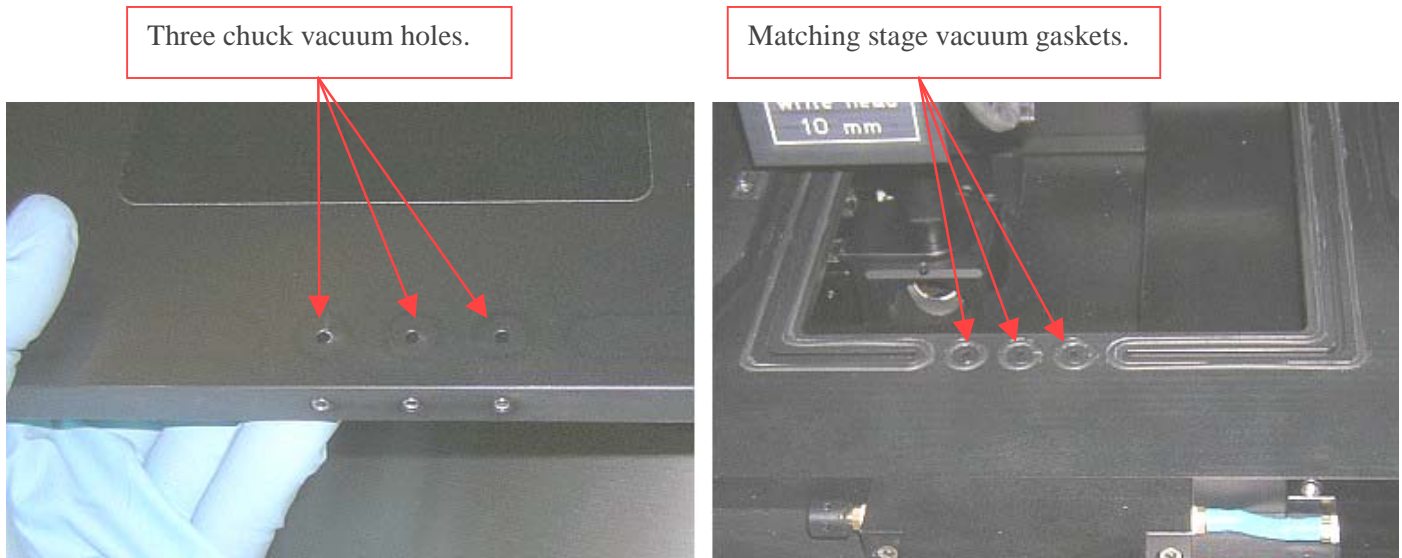


Figure 2-18: Chuck and stage vacuum holes



- ❖ **System:** To check that the chuck is seated against the rubber gaskets close all chuck valves by turning them to a vertical position.
- ❖ **System:** Turn on the main vacuum valve by turning it to a horizontal position
- ❖ **System:** The chuck should not move when lifting it gently. If it does reposition it and try again.
- ❖ **System:** Once the chuck is properly positioned turn off the main vacuum valve by rotating it into a vertical position.
- ❖ **System:** The chuck valves should be positioned according to table 2-1. See figure 2-14 for reference to the valves.

Table 2-1: Substrate chuck vacuum valve positions

Chuck	Left Valve	Middle Valve	Right Valve
-------	------------	--------------	-------------

Chuck	Left Valve	Middle Valve	Right Valve
4" / 5 " Mask	Vertical	Horizontal	Horizontal
7" Mask	Vertical	Horizontal	Horizontal
2"/3"/4" wafer	Vert. for 4"	Vert. for 3"	Vert. for 2"
6" wafer for backside align			
3" wafer for backside align (can be used with 4" wafers)			
2" wafer for backside align			

2.2.4. Loading and unloading substrates

- ❖ If the sash is not open and the stage is not in the unload position:
 - DWL MENU: Open the Control Panel by clicking on . See Figure 2-1 for details on this control
 - DWL MENU Control Panel: **Click on the unload icon** 
 - System: Open the sash by flipping the toggle switch to the left to open
- ❖ **System:** Turn main vacuum valve off by turning the vacuum knob to the vertical position (Figure 2-14)
- ❖ **Check:** The chuck vacuum valves are in the correct positions. (See the table 2-1)
- ❖ **System:** Place the substrate on the chuck placing it against the "stop" pins (figure 2-19).

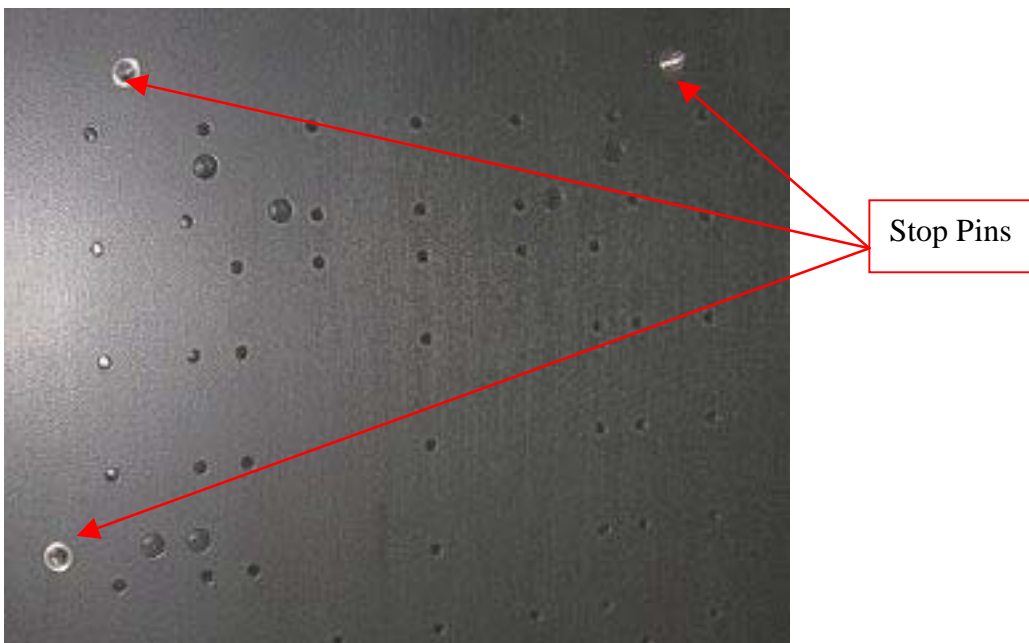




Figure 2-19: Close up of "stop" pins for 4"/5" mask chuck

- ❖ **System:** Turn on the main vacuum valve by rotating it to a horizontal position.
- ❖ **Check:** The substrate should not move if gently pushed.
- ❖ **System:** Close the sash

- ❖ **DWL MENU Control Panel:** Click on the init icon . If the state does not move, get help from the staff.
- ❖ **Warning:** The substrate **MUST BE UNDER THE WRITE HEAD before focusing**. If not reposition the stage by using the large arrows on the DWL Menu Control Panel.
- ❖ **DWL MENU Control Panel:** Click on the focus icon  and click on the “yes” button when prompted.
- ❖ **DWL MENU Control Panel:** Click on the *Exit* button.

2.3. Converting designs



The purpose of this software package is to convert source files from GERBER, DXF, CIF, GDSII, HPGL or HIMIT -structure format into LIC format. The LIC format can (unlike the other input data formats) be converted real-time into the final pixel data set. The advantage of the LIC format, compared to the final pixel data set, is that its file size is much smaller due to a highly optimized compression scheme.

Note: If you are making a mask for the 5x Nikon stepper, your CAD should not contain Nikon alignment fiducials. They are already provided for you in the stepper mask job templates discussed later in this manual. If you have these marks in your CAD, remove them before continuing.

We recommend the GDSII format (also know as just GDS). Design files may be transferred to the PC via secure file transfer protocol (sftp) or a USB memory stick.

The following steps will work for most cases. Please see the conversion software manual for additional details.

- **Workstation:** Press the button on the KVM switch (Figure 2-2) if needed to switch to the Convert PC.
- Log into or unlock the Convert PC:
User: convert
Password: Laser442nm (watch the case!)
- **Convert PC:** Transfer the file to the PC by one of the two methods:
 - ❖ **NOTE:** put the GDSII design file in the directory “gdsii” in the convert home directory
 - ❖ USB Memory Stick:
 - **Convert PC:** Put the USB Memory stick in the USB slot at the bottom front of the Convert PC.
 - **Convert PC:** Follow the on screen menu to get access to your design file or open **My Computer** (on the desktop) and navigate to the USB drive. **NOTE: If the USB drive does not show up under My Computer or it cannot be opened please reboot the computer..**
 - **Convert PC:** Right click on your design file and choose copy.

- **Convert PC:** Open the home directory by single clicking on the home icon .
- **Convert PC home:** Find and open the gdsii directory.
- **Convert PC gdsii:** Point to an empty spot in the directory, right click and choose paste to copy your file to the gdsii directory
- ❖ Secure File Transfer Protocol (sftp)
 - **Your PC:** Using sftp software (SSH Secure Shell at www.ssh.com is a popular version) open a connection to `dwl66convert.nanofab.psu.edu` enter the user name “convert” and the password given above.
 - **NOTE:** Make certain that you are transferring the file in binary mode.
- **Convert PC:** Start the conversion software by single clicking on the icon .
- **Convert PC: NOTE that there can be no spaces in the filenames (input or output) for the Convert program. There must also be no dashes “-“ in the output (lic directory name).**
- **Convert PC:** Setup the Standard Menu (See Figure 2-20)
 - ❖ Choose the correct write lense by clicking on the *Write Lens* text at the top of the menu. Note that the “GS” at the end of a lens name stands for Gray Scale and should only be used for grayscale exposures.
 - ❖ Set the *Format* to be **gdsii** if you are using GDS input files. Note that this is setting the default directory where you have stored your design file.
 - ❖ Set *Source file* by clicking on the “>” and choosing your design file from the list
 - ❖ Set the *Magnification factor* to **1.0** unless you are writing a stepper reticule in which case it should be set to 5.0
 - ❖ Set the *rotation* to **0** unless you want to rotate you design
 - ❖ The *X-Offset [nm]* and *Y-Offset [nm]* should typically both be set to **0**.
 - ❖ *Mirroring at x axis* is usually set to “**no**”
 - ❖ *Mirroring at y axis* is often set to “yes” when writing masks. The reason to mirror about the y-axis is that during lithography the mask is flipped over so that the chrome side faces the sample effectively mirroring the design. The easiest way to visualize this is to draw an “L” on the CAD. Then mirror the CAD design about the y-axis so that the “L” is written backwards on the mask. Then when the mask is flipped chrome side down to expose the photo resist on the *sample* the “L” will be readable.
 - ❖ *Left border [nm]*, etc. are usually left in “**automatic**”. Regarding the borders settings, they are utilized in conjunction with the exposure mode. To avoid difficulties, leave them in the automatic mode. If you would like to manually set the borders be sure to set all four boards manually. Automatic and manual border setting cannot be mixed.
 - ❖ *Exposure mode* can set to “**inverted**” or “**noninverted**”. Non-inverted is standard and will result in all the features in the CAD to be exposed. Inverted does just the opposite – exposing everything within the borders except the features drawn in the CAD.
 - ❖ *Frame size [nm]* is usually **0**. Setting it to a positive integer will result in a frame being exposed around the design of that thickness in nanometers. Note

that the size should be at least the size of the minimum feature that can be written with the write lens (head) that is being used. (See table 1-1.)

- ❖ *Insert text* must be **off**.
- ❖ *Lic directory* must always be set to “**Other value**” in which case the **directory name should be chosen with the format *YYMMsomename*** where **YY** is the two digit year and **MM** is the two digit month (Example: 0603wang1). This makes it easier to cleanup old files on the OS9 computer. **Note:** If you are converting multiple layers from a single cell/structure in a GDSII file to write multiple masks, you must choose a different lic directory name for each layer. . Each conversion must have a unique **lic directory** name and the name **MUST NOT CONTAIN SPACES, DASHES “-“, OR OTHER SYMBOLS (UNDERSCORE “_” IS OK)**.. The software will not warn you if you use one of these names but you will likely not be able to find your design once it is transferred to the OS9 computer.

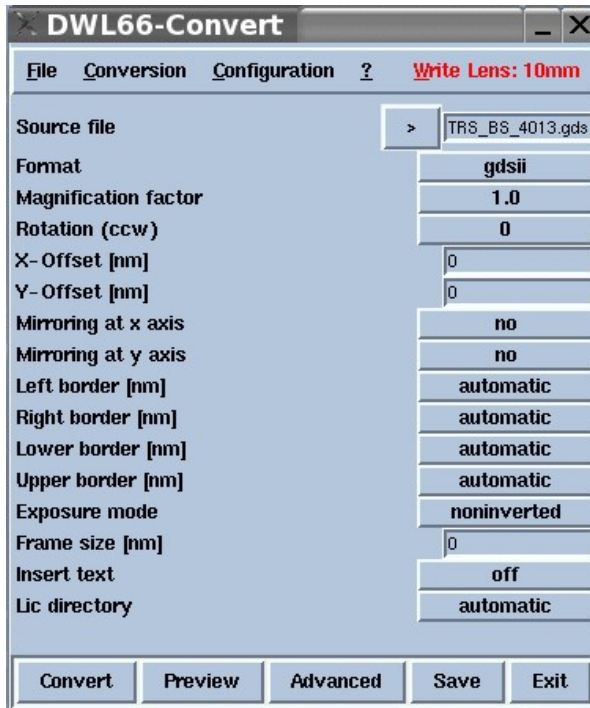


Figure 2-20: Convert Standard Menu

- **Convert PC:** To select your cell/structure, layer(s), and function to merge different layers together, you must navigate to *Configuration* → *GDSII* → *Create merge configuration*.
- **Convert PC merge configuration:** Select the top-level cell/structure by clicking on the “**Select...**” button (figure 2-21). Then click on the cell you wish to convert and click the “**Ok**” button.

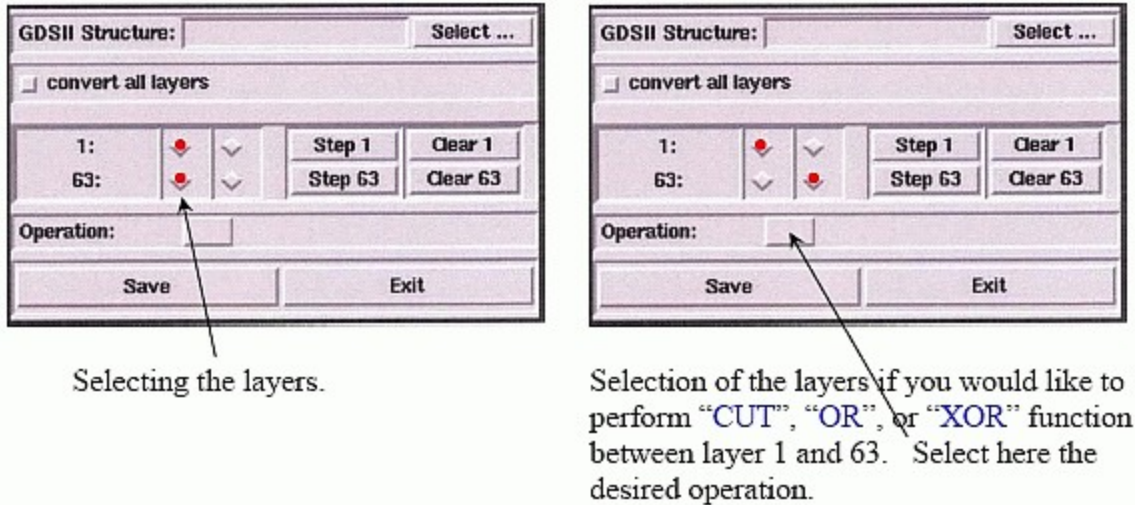


Figure 2-21: Convert GDSII merge layer information

- **Convert PC merge configuration:** Next choose the layer(s) to convert and any operation(s) to apply to the layers. Selecting layers is different if a operation is used versus just choosing layers without applying any operations.
 - ❖ **Convert PC merge configuration *NO Operations*:** This means that choosing multiple layers results in an "OR" being applied. Choose just the *left most red buttons*. See the left part of figure 2-21.
 - ❖ **Convert PC merge configuration *OPERATIONS*:** The operations "or", "cut", and "xor" can be applied between the layers. Choose the operation to be applied from the list by clicking on the blank button (right part of figure 2-21). See figure 2-22 for an illustration of each function. **Note:** The left-to-right order of the selected affect which layer is chosen first for the operation. **Warning:** there should only be one red button chosen in each *column*. Choosing more than one red button in the same horizontal position will have *unpredictable results*.
- **Convert PC merge configuration:** Click the "Save" button and then the "Exit" button.

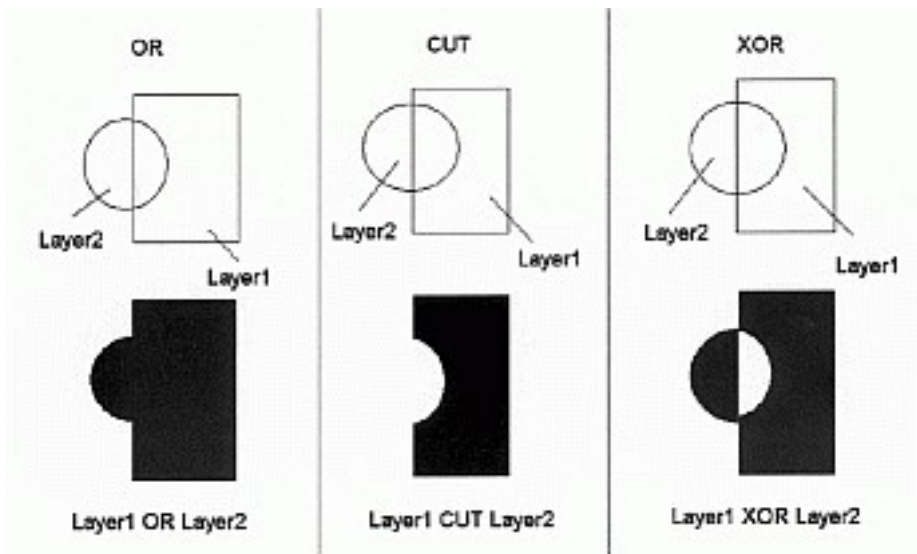


Figure 2-22: Merge Functions

- **Convert PC advanced menu:** Click on the “*Advanced*” button to get the the advanced menu. In general there is very little that needs to be changed in the advanced menu with the exception of the *extra pixel*. See the next few steps for details (figure 2-23)
 - ❖ *Strip width [pixel]:* Leave it set to the **default**.
 - ❖ *Pixel size [nm]:* Leave it set to the **default**.
 - ❖ *Arcres [degree]:* Leave it set to the **default** unless converting Autocad dxf files. See Convert manual for details.
 - ❖ *Dxf units [nm]:* Leave it set to the **default** unless converting AutoCAD dxf files in which case this is the scale that the AutoCAD was drawn and is often 1, 1000, or 1000000. See Convert manual for details
 - ❖ *Additional pixel [pixel]:* This is dependent on the write head and can be specified in 0.25 pixel increments. The normal range is from 0 to 5. See: **DWL MENU PC:** Look up the number of additional pixels needed for the write head in the “Write Head Info.doc” file on the desktop of the User PC. Then switch back to the Convert PC.
 - ❖ *Xor mode:* Set it to “**off**”.
 - ❖ Calculate exposed area: Set it to “**on**”
 - ❖ Automatic centering: Set it to “**on**”
 - ❖ *Spot size correction x [nm]:* Leave it set to the **default**.
 - ❖ *Spot size correction y [nm]:* Leave it set to the **default**.
 - ❖ *Scale factor x:* Leave it set to the **default**.
 - ❖ *Scale factor y:* Leave it set to the **default**.
 - ❖ *Left optic path:* Set it to “**off**”.
 - ❖ *Scale offset:* Set it to “**off**”.
 - ❖ Invert spotsize correction: Set it to “**off**”

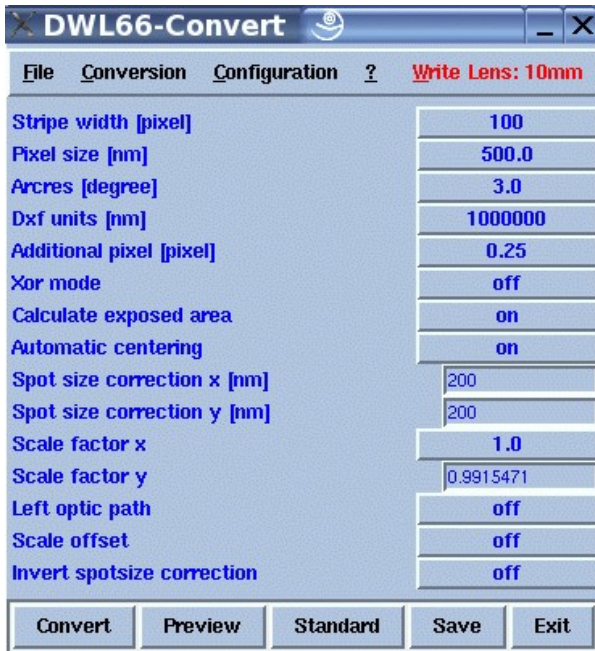


Figure 2-23: DWL66 Convert Advanced Menu

- **Convert PC:** Click on the “Save” button.
- **Convert PC:** Click “Preview” button to view the fractured data. **Note:** You must create the merged configuration prior previewing! **It is best if you click on the “Fill” button in the Preview window so you see how you features are interpreted by the software.**
- **Convert PC:** Exit Preview by navigating to “File → Exit.”
- **Convert PC:** If you want to find out the size of the design navigate to “Conversion → Determine Design Borders.” It will list out the borders of your design in nm.
- **Convert PC:** Click on the “Convert” button. A box will pop up asking you to confirm the settings for your conversion. If you are satisfied with the information displayed click, the “Yes” button.
- **Convert PC:** Following a successful conversion, navigate to “File → Transfer Lic files.” This will copy the lic files from the LINUX Convert PC to the exposure control computer. When this operation is complete, close the transfer window.
- **Convert PC:** Click on the “Exit” button.
- **Convert PC:** Clean up your files. It is recommended that you keep a copy of the files in your lic directory. The easiest way of doing this is to copy to a memory stick or use sftp. **Note:** Files are not backed up and may be deleted without warning to make more room on the computer.
- **Reminder:** Don’t forget your memory stick!

3. Exposures without alignment (Masks)

This section explain how to do a basic exposure without any alignment to a previous lithography level. The procedure below has mask making in mind but can also be used for directly exposing samples.

- **KVM Switch:** Press the button on the KVM (Figure 2-2) if needed to switch to the DWL MENU PC.
- **DWL Menu PC:** Log into or unlock the control PC by pressing Ctrl-Alt-Delete
User: dwl66
Password: Laser442nm (watch the case!)
Domain: DWL66
- **DWL Menu PC:** Start up the DWL MENU user interface if not started by clicking on the 😊 icon on the MS windows quick launch bar. Note it will take about 1 minute for the application to appear.
- **DWL MENU:** Open the Control Panel by clicking on the 🛠 icon (figure 3-1).

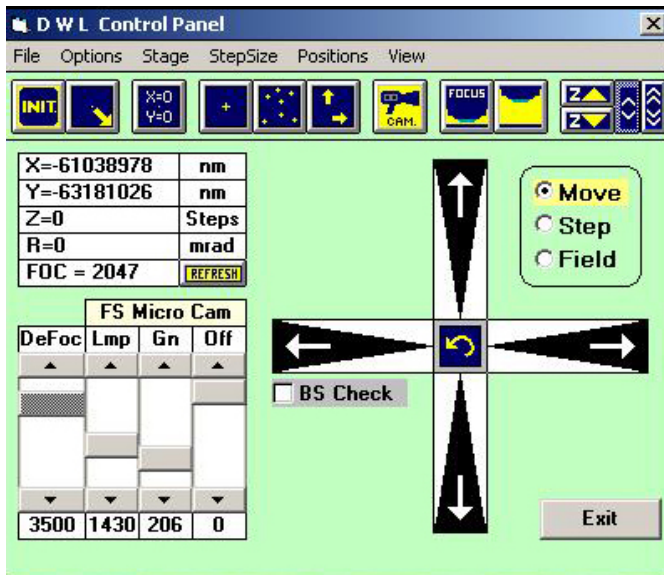


Figure 3-1: DWL Menu control panel

- **DWL MENU:** From the main menu, choose “Setup → New”. A *New Exposure Map* window will open similar to the one displayed below:

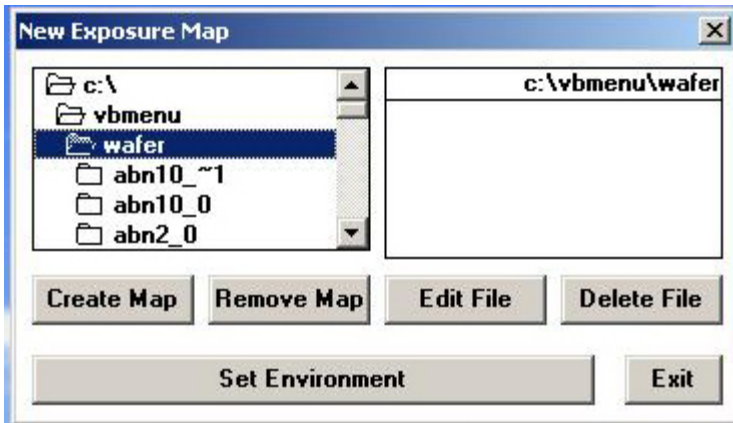


Figure 3-2: Selecting or creating a new exposure map

3.1. Setting up the Map File

- **DWL MENU New Exposure Map:** Click on the “**Create Map**” button and enter a *Map Name* which must be less than 8 characters. Do not use special characters, only letters and numbers.
- **DWL MENU New Exposure Map:** Click the **OK** button. Then Click the **YES** button when prompted to set the *Environment* to the *Map Name*. Then click **Exit**.
- **Note:** If you are making a stepper mask, do not create a new map. Please use the templates step10mm for 10 mm write head jobs or step2mm for 2 mm write head jobs. More information on these templates will be provided in the following section.
- **DWL MENU:** From the main menu navigate to “*Setup* → *Exposure Map*”. The Exposure Map Design window will appear similar to the one in figure 3-3.

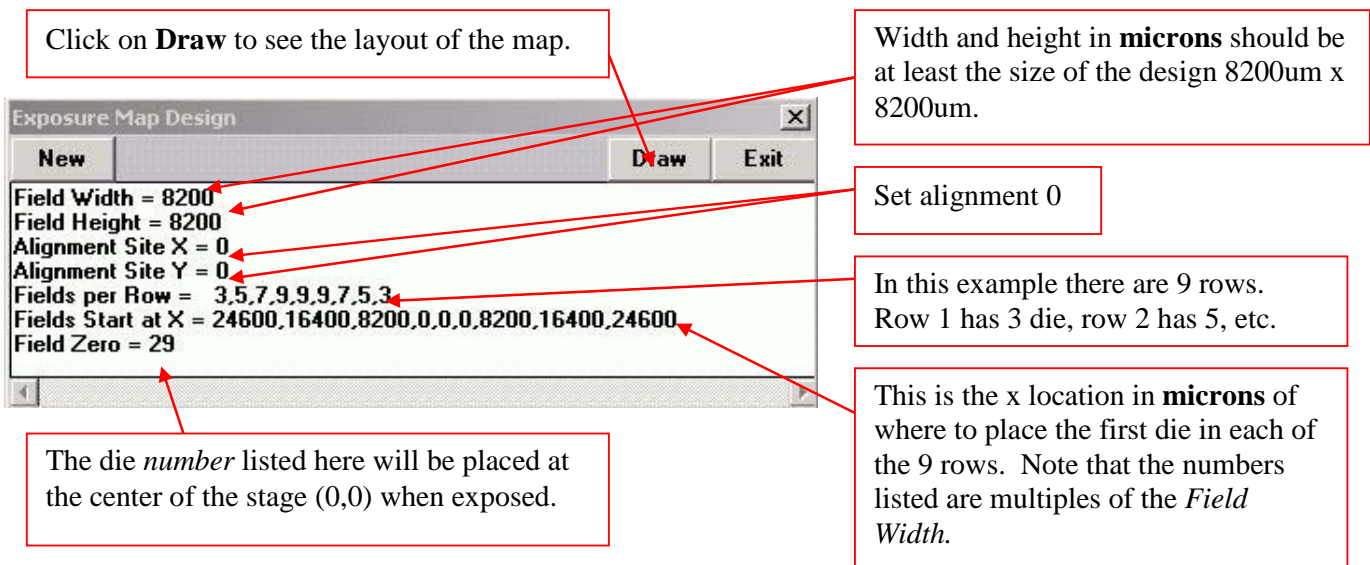


Figure 3-3: Example exposure map

- **DWL MENU Exposure Map Design:** For the example given in figure 3-3 the field (design) size was 8200um x 8200um (*Field Width* and *Field Height*). A layout of die in the shape of a 4" wafer was wanted so that there were a different number of fields in each row (*Fields per Row*). The first field in the first 3 and last three rows needed to be started the distance of several fields from 0um in the x direction (*Fields Start a X*). Note that the distances given in figure 3-3 are multiples of the *Field Width*. The field at the center of the layout was chosen to be field 29 (*Field Zero*). Note that the *Field Zero* will be exposed at the defined center position of the stage (0,0).
- **DWL MENU Exposure Map Design:** Click on the “**Draw**” button to see the layout of the map (figure 3-4).

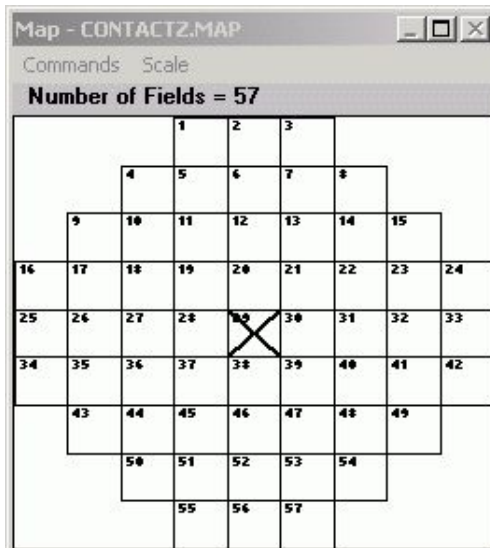


Figure 3-4: Exposure map layout

- **DWL MENU Exposure Map Design:** Click the **Exit** button on the exposure map design and then click the **Yes** button to overwrite the file.

3.2. Editing the DWL Job File

- **DWL MENU:** Navigate to *Job* → *Make Job*. Also from the main menu, choose *File* → *Designs*. The screen should look like figure 3-5

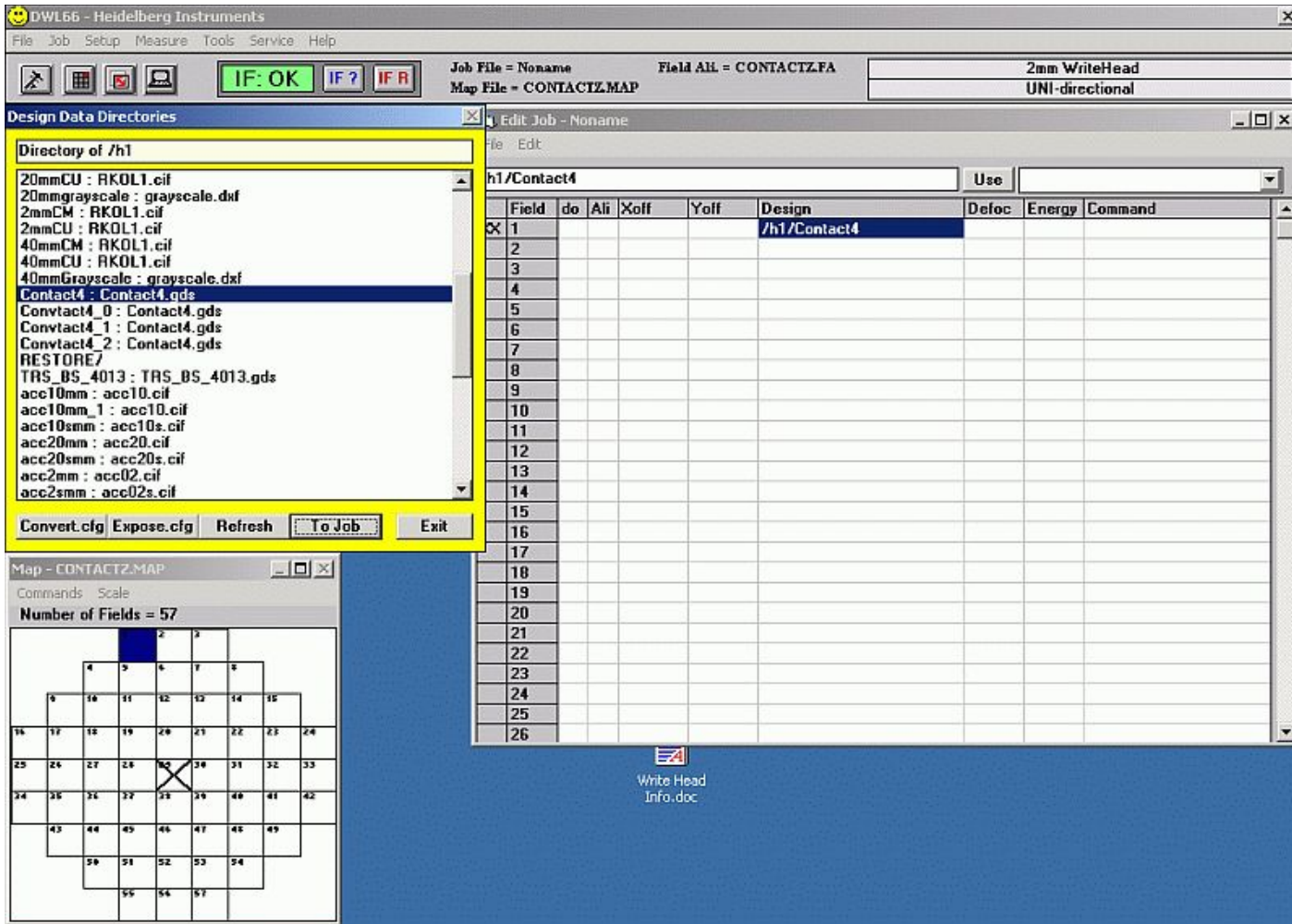


Figure 3-5: Window for making a job

- **DWL Menu Edit Job:** Click on the cell in row 1 under column “do”. Enter a “-1” in the cell. **Note:** The “-1” means “true” or “do the exposure.” Any cell you don’t want written do not place a -1 in the do column of that row.
- **DWL Menu Edit Job:** You may enter *Xoff* and *Yoff* (x and y offset values in microns) to offset the exposure of your design. Most of the time these fields are left blank.
- **DWL Menu Edit Job:** Click on the cell in row 1 under column “Design”.
- **DWL Menu Design Data Directories:** Under the design data directories, your pattern should appear, look for your cell/GDS file name. If you do not see your file and the file transfer has completed successfully, click the **Refresh** button. Click on your design to highlight it.
- **DWL Menu Design Data Directories:** Transfer the design name to the Edit Job window by clicking on the **To Job** button.
- **DWL Menu Edit Job:** Click on the cell in row 1 under the column “Defoc”. Enter the defocus value found in the “*Write head info.doc*” file on the desktop. Valid values are from 0 to 4095 by 1 and each step is about 5nm

- **DWL Menu Edit Job:** Click on the cell in row 1 under the column “*Energy*”. Enter the energy value found in the “*Write head info.doc*” file on the desktop. Valid values are from 20 to 100 by steps of 10.
- **Note:** The **Defoc** and **Energy** values may have to be configure by running a dose and focus matrix, particularly if the 2mm or 4mm write head is being used. A dose and .focus matrix must be used if exposing a substrate other than the mask blanks supplied by the Nanofab.
- **DWL Menu Edit Job:** An example of the first complete row can be seen in figure 3-6.

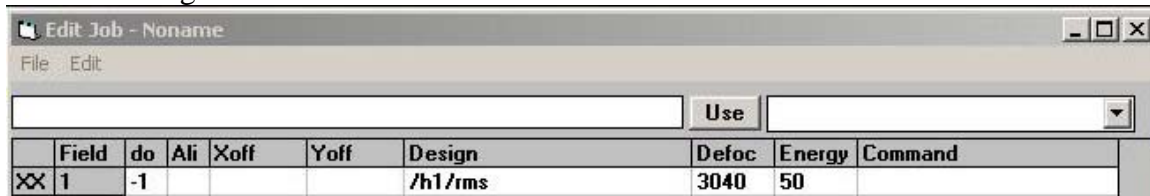


Figure 3-6: Example of first row filled out in Edit job window

- **DWL Menu Edit Job:** Using the mouse highlight all the cells on all the rows and then press the keys **Ctrl** and **d** to copy all of the first row to all the rows.
- **DWL Menu Edit Job:** Navigate to *File* → *Exit*. Then click **Yes** or **Ok** to save
- **DWL Menu Design Data Directories:** Click the **Exit** button on the **Design Data Directories** window.

3.3. Exposing the substrate

- **System:** Now is a good time to check that the laser is working by looking at the power supply on top of the OS9 computer. The gauge should read something other than zero. If the gauge reads zero then the laser is off and you should go to the laser control panel on the DWL Menu. If that does not work then see the staff.
- **DWL Menu:** From the main menu navigate to *Job* → *Run Job*.

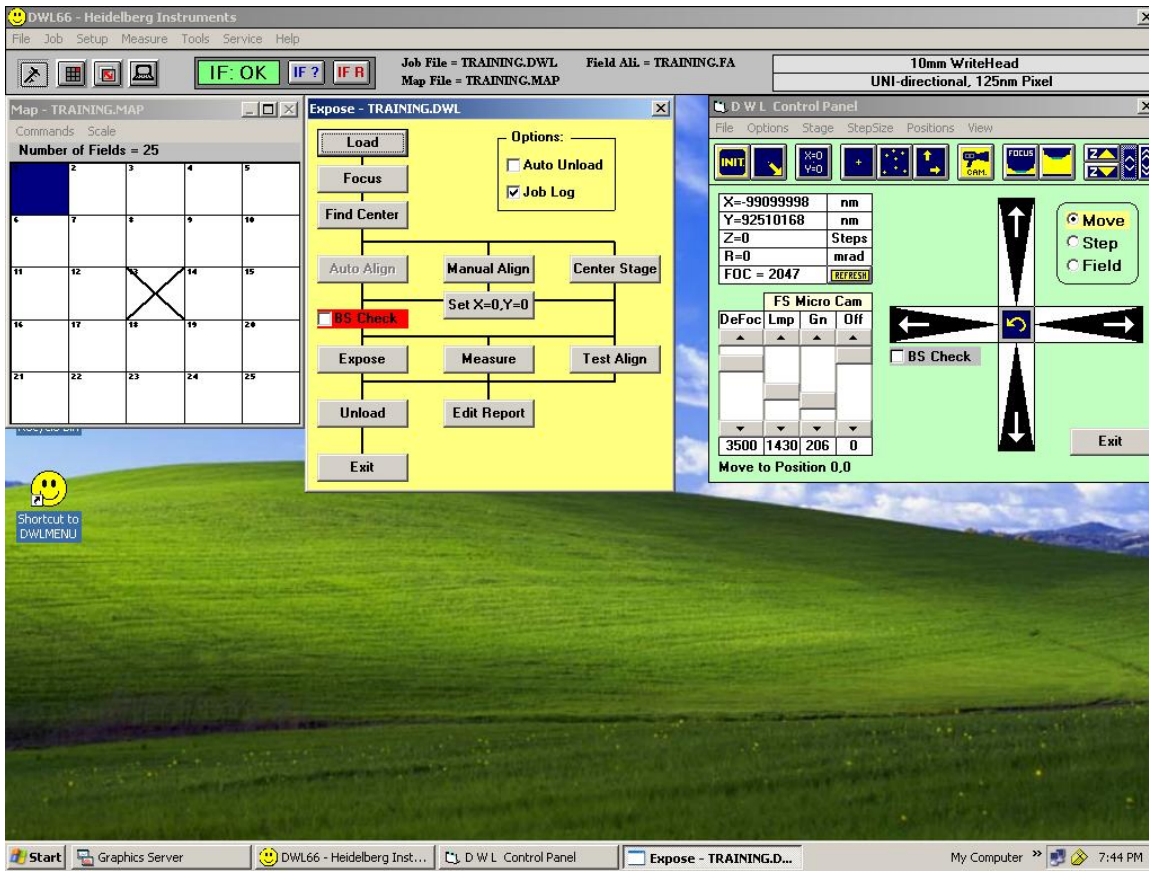


Figure 3-7: Run Job windows

- **DWL Menu Expose:** Make sure that the objective is hovering above the sample and then click Focus and answer **Yes** when prompted. **It is extremely important that the substrate is underneath the objective, if you try to focus on the anodized stage you will DESTROY the objective.** The Z level in the *Control Panel* window will read a value other than 0, this will be the focal plane of the optics.
- **DWL Menu Expose:** Click on the **Find Center** button and then click the **Start** button. This routine will determine the center of your wafer or mask. Make certain that the value it reports is reasonable.
- **DWL Menu Expose:** Then Click on the **Yes** button when prompted to set the new center. If you feel like the numbers are in error, repeat the Find Center operation.
- **DWL Menu Expose:** Click on the **Exposure** button to run the job and expose the wafer. If a window pops up stating that the write head specified does not match the write head of the design then there is a problem, one of three things is the cause. See the sections on converting your design and changing the write head for more information.
 - Converted the design with the wrong write head
 - The wrong write head is in the system
 - Did not specify that the write head was changed to the DWL Menu
- **DWL Menu:** The pattern should start writing. An estimation of the total write time will be displayed based on the exposure of the first pattern in the map that

you are writing. If you are writing an array of different patterns, this estimate is meaningless. Write time on this system is strictly dependent on the extent of the patterned data, not the exposed area. To get a rough estimate of the write time, use the following information:

- 10 mm head writes a 1 in² area in ~22 minutes.
- 2 mm head writes a 1 in² area in ~2 hours.
- **DWL Menu PC:** **Lock the PC** to prevent someone accidentally interrupting the job by pressing the keys **Ctrl – Alt – Delete** on the key board and choosing the **Lock Computer** button.

3.4. Finishing Up

- **DWL Menu:** When finished, acknowledge that the job is complete by clicking OK in the exposure finished window. Click Unload to unload your substrate, open the front panel window and remove the substrate and close the front panel. Again, Unload is interlocked and will not work if the front panel is open. Do not attempt to unload your sample without clicking Unload.
- **Warning: Turn off the laser because it has a limited life.**
 - ❖ **DWL MENU Expose:** In the Expose window click on the **LaserCtrl** button which will bring up the laser control window
 - ❖ **DWL MENU LaserCtr:** Click the **Command ON** button (figure 2-5) and *then* then the **Command OFF** button.
 - ❖ **DWL MENU LaserCtr:** Close the LaserCtr window.
- **DWL Menu Expose:** Click on the **Exit** button on both the *Expose* and *Control Panel* windows.

4. Exposures with Front Side Alignment

In order to work with the more advanced features, such as metrology, direct writing with alignment and front/back side alignment, you should be proficient with running the DWL 66 independently. The instructions below are intended as a supplement to additional staff training on front side alignment

4.1. General Setup

You will need to do at least one test exposure to measure any misalignments and correct for these. Please see the staff for help with the corrections.

The system uses crosses for alignment and the size of the cross is dependent on the write head. See table 4 below for information on the size of the crosses. The crosses should be placed towards the corner of the field.

Table 2: Size of Alignment Cross for each write head

WRITE HEAD	EXPECTED OVERLAY	LINE WIDTH	LENGTH OF CROSS
2mm		5um	40um
4mm		10um	100um
10mm	<1um	25um	200um
20mm		50um	400um
40mm		100um	800um

These instructions assume that you have already had the write head and chuck in the system and that the sample has been loaded on the chuck and the write head focused on it. Also it is assumed that the design file has been converted and transferred. Please follow the instructions in sections 2 and 3 to setup the system and convert your design file.

4.2. Setting up the Map File

You will setup the map file much as before, but the “Alignment Site ...” rows will need to be filled in. See section 3.1 for how to do the basic setup. See below for how to setup the map file for alignment

1. **DWL Menu- Exposure Map Design:** The syntax for the alignment is to list out the positions of the center of the crosses relative to the center of the pattern. The units are in micros and the syntax is:
Alignment Site X = X1, X2, X3, etc...
Alignment Site Y = Y1, Y2, Y3, etc...
where the coordinates for the crosses are (X1, Y1), (X2, Y2), (X3, Y3), etc.
2. **DWL Menu- Exposure Map Design:** Fill in the coordinates and “Exit” and save the Exposure Map. See Figure 4-1 for an example.

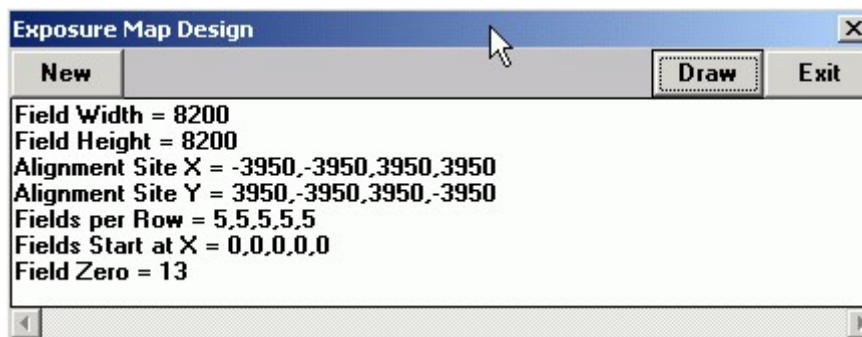




Figure 4-1: Exposure Map with alignment

4.3. Global Alignment

The substrate global alignment adjusts for any rotation of the substrate. Then the center of “Field Zero” is found and defined as the origin (0,0) of the stage.

1. You need two identical features at opposite edges of the patterned area of the substrate to correct for rotation of the substrate.
2. **DWL Menu- Control Panel:** Find mark or feature at the one edge of the patterned area using the stage control and macro and micro cameras. You should use the micro camera for fine location of the feature.

3. **DWL Menu:** Click on the  button to bring up the Manual Global Alignment panel.
4. **DWL Menu- Manual Global Alignment:** Choose “Align along X-Axis” or “Align along Y-axis” depending on how your two features are oriented. This will cause a panel labeled “Point to 1st Site” will appear and on the video screen thin green cross hairs will appear
5. **DWL Menu- Point to 1st Site:** Use the mouse to move the cursor in the panel to move the cursor on the other screen. Point to a corner or other sharp features. Then click on “OK”. The system will move the point you chose to the center of the screen and then present a new panel called “Point to 2nd Site”.
6. **DWL Menu- Point to 2nd Site:** Click on the “Panel” button to bring up the Control Panel. Use the control panel to move the same feature on the opposite side of the patterned area. Then *exit* from the Control Panel.
7. **DWL Menu- Point to 2nd Site:** Again use the mouse to move the cross hairs on the same corner of the 2nd feature and then click “OK”.
8. **REPEAT:** Now the system will move the stage back to the 1st point and report to you the angle off the axis and distance to the two points. Click “OK” then you should repeat steps 5 and 7 above angle found is less than 0.02 mrad. (You can skip step 6 because the system will automatically move between the 1st and 2nd points.). Then click on the “Cancel” button on the “Point to 1st Site” panel. Click on “Exit” in the Manual Global Alignment window.
9. **Verify:** You can verify the global correction by using the control panel to move around the patterned area. You should see no angular translation of the features.
10. **Control Panel:** Use the Control Panel to move to center of “Field Zero” as defined in the Map file and define this to be 0,0 by clicking on the zero button (.

4.4. Finding a Cross and Field Alignment File

You must help the system find the first cross and test that the system can repeatedly find the cross.

4.4.1. Define a Cross

- 1) **DWL Menu- Control Panel:** Use the control panel to move a cross to the center of the video screen and turn on the micro camera
- 2) **DWL Menu:** Navigate to Setup → Simple Cross Alignment → Using FindXY which will bring up a panel to point to opposite *inside* corners of the cross.
- 3) **DWL Menu – First Corner:** Use the cursor to point to the first inside corner of the cross and click “OK”.
- 4) **DWL Menu – Second Corner:** Use the cursor to point to the *second* inside corner of the cross and click “Ok”. When prompted save the file as the default filename
- 5) **DWL Menu:** Navigate to Setup → Field Alignment Method which will bring up a panel to test the ability of the DWL to find the cross.
- 6) **DWL Menu- Field Alignment Macros:** Click on the “Execute Site” button and after several seconds the cross should move to the center of the screen. Record the x & y positions on a scrap of paper
- 7) **DWL Menu- Field Alignment Macros:** Repeat clicking on the “Execute Site” button and record the x & y positions again. Repeat at least one more time. The variation in the location should not vary by more than a few tenths of a micron for the 10mm write head. If it varies by more, then please see the staff for help.
- 8) **DWL Menu- Field Alignment Macros:** If the alignment is repeatable then click “Exit” and save the file.

4.4.2. Test alignment

You can test the alignment using all your markers and test the repeatability of this too. This step is not necessary but is recommended when you are setting up a new design for the first time.

- 1) **DWL Menu:** Navigate to Setup → Test Field Alignment
- 2) **DWL Menu – Test Field Alignment:** Make sure you are at position of first cross.
- 3) **DWL Menu – Test Field Alignment:** Click on “Test Here”. The cross should move to the center of the screen. If it move off-center, then it did not find the cross and you will have to change the alignment parameters. See staff for help.

4) **DWL Menu – Test Field Alignment:** Instead of “Nominal Position” in the drop down menu choose “Repeatability”. Then click “Test Here”. The detail in each x, y position is reported for each marker. You should see a repeatability of less than 0.5um for the 10mm write head. This will get better with the smaller write heads and worse with larger ones.

5) **DWL Menu – Test Field Alignment:** Click exit.

4.5. Editing the DWL Job File

You should first setup the DWL Job file as instructed in section 3.2. There is only one simple change to add in the alignment.

1. **DWL Menu- Edit Job:** Under the “Ali” column put in the number 4 (for four alignment sites) for each field you want to use alignment.
2. **DWL Menu- Edit Job:** Close the Edit Job panel and save the DWL Job file.

4.6. Exposing the Substrate

Exposure is exactly the same as with a mask

4.7. Finishing Up

Same as normal.

5. Exposures with Backside Alignment

In order to work with the more advanced features, such as metrology, direct writing with alignment and front/back side alignment, you should be proficient with running the DWL 66 independently. Consult the user guide manuals and work with staff.

6. Metrology

In order to work with the more advanced features, such as metrology, direct writing with alignment and front/back side alignment, you should be proficient with running the DWL 66 independently. Consult the user guide manuals and work with staff.

7. Grey Scale exposure

In order to work with the more advanced features, such as metrology, direct writing with alignment and front/back side alignment, you should be proficient with running the DWL 66 independently. Consult the user guide manuals and work with staff.

8. Trouble shooting



This section lists some of the most common problems users may experience and steps the user can take to correct them

8.1. Startup Problems

Most problems during startup occur with DWL Menu not being able to communicate with the ECC computer. The following instructions will walk you through re-establishing communication and manually initializing the stage.


8.1.1. “DWL Does Not Respond”


A window with the message “DWL Does Not Respond” typically occurs only the first time the DWL Menu is started after the PC has been rebooted. Follow the instructions below to initialize communication with the DWL exposure control computer.

- ❖ **DWL Menu:** Click on the mini terminal icon .
- ❖ **DWL Menu mini terminal:** Press enter TWO times.
- ❖ **DWL Menu mini terminal:** At the login prompt enter:
User: dwl
Password: dwl
- ❖ **DWL Menu mini terminal:** Close the mini terminal window. **Note:** It takes about ½ minute for the window to close
- ❖ **DWL Menu:** Click on interferometer check icon . If “IF: Fail” appears then follow the instructions in the next section.

8.1.2. “IF: Fail”

If “IF: Fail” is showing on the DWL Menu, this means that the interferometer subsystem is not initialized. The best way to initialize it is to telnet directly to the exposure computer and reset it at the command line by following the instructions below.

- ❖ **MS Windows:** Click on the Host Explorer icon  on the MS Windows quick launch bar.
- ❖ **Host Explorer:** Choose **DWL_66_OS9** and click on the *connect* button.
- ❖ **Host Explorer:** Login:
User: dwl
Password: dwl
- ❖ **Host Explorer:** Type “*init_stage*” at the command prompt. The stage should move to its limits and a large amount of diagnostic information will be displayed on the screen.

- ❖ **Host Explorer:** Run the “*init_stage*” command one more time to be sure the stage is initialized
- ❖ **Host Explorer:** Minimize the Host Explorer DWL window
- ❖ **DWL Menu:** Click on the check interferometer icon . **Note:** If “IF: Fail” still is showing seek staff assistance and report a trouble call on the Portal

8.2. DWL Menu Crashes

Occasionally the DWL Menu software will crash. Most of the time you can simply restart it. Then follow 8.1.1 and 8.1.2 above to make sure everything is ok. If it is not then please see the staff.

9. Final Check List

NOTE: Users are responsible for cleaning up after themselves.

10. Training Check List

- Overview of the system
- Venting system
- Loading samples
- Loading sources (including adding metal to e-gun crucibles)
- Evacuating the chamber
- Evaporating using the e-gun source (including melting in new metal)
- Evaporating using the thermal source
- Changing the thickness monitoring crystal
- Cleanup!
- Add to List on Portal

