



**DWL 66FS**

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*Doc. No.: DWL-HI-023  
Revision: 1 (Juli 2007)*

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# Preface

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This Manual is a reference manual for the more complex functions of the DWL 66's User Menu.

The chapters are sorted by menus, and sections are defined by the functions in those menus. Each function occurring in a menu is described in its functionality as well as in the context of possible applications.

## *Related Documentation*

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**HEIDELBERG INSTRUMENTS** offers several further Manuals related to the machine and its operation. If you did not get one of these or need an update, please contact **HEIDELBERG INSTRUMENTS**, Germany.

***Preinstallation Guide***

System requirements, sizes and weights of components etc.

***Conversion Software Manual***

Manual for the HIMT conversion software used for data preparation and fractioning

***User Guide, Part I***

Step by step instructions for general system usage and standard applications

## *Conventions used*

---

Throughout this manual there are safety warnings. To classify the degree of danger in each of these situations, the following notation is used:

**CAUTION:** Advises that you risk damaging your equipment if you do not heed instructions.

**WARNING:** Advises that you risk danger to personal health if you do not follow instructions carefully.

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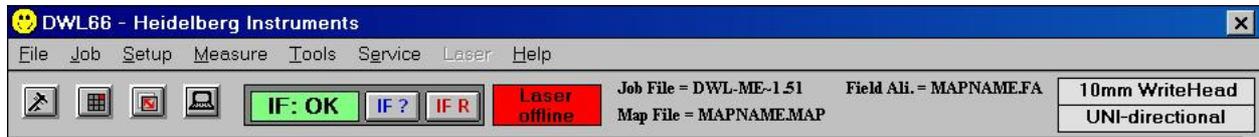
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# CHAPTER 1 - GENERAL FUNCTIONS



The DWL User Menu provides instant access to main functions via the control toolbar. It also shows the files of the currently active environment and important system status information.

## TOOLBAR BUTTONS AND STATUS LABELS



Opens Control Panel (see *Chapter 7, Control Panel*)



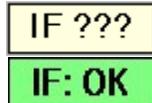
Opens current Exposure Map (see below)



Starts Manual Global Alignment Sequence, a predefined alignment procedure (see below, and User Guide 1)



Opens Mini-terminal window for login; file transfer and limited communication with the OS9-system (see below)



Interferometer status label, updated only when **IF ?** is clicked. ??? means that no interferometer status request has been issued since the last menu restart.



Requests Interferometer status

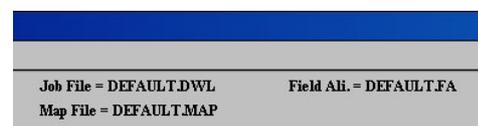


Resets Interferometer

**NOTE:** **IF R** also forces a stage reset! Coordinate settings and rotational alignment will be lost!

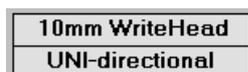


Laser status label. *Only available in systems with externally controllable laser.*



Current environment label

Shows currently loaded environment files (see *Chapter 2, Environment Files*).



Configuration file in use; double-click to change configuration (see **User Guide I**)

## MENU GROUPS

The main menu bar offers a number of logical menus:

- **File:**

Drops a list of commands used for the transfer of prepared designs and for help on environment files that determine both position and alignment of features onto a substrate. Shows also which files are currently loaded.

- **Job:**

Gives access to the necessary functions to set up and run exposure jobs in the currently loaded environment.

- **Setup:**

Offers commands that can be used to prepare numerous automatic or semi-automatic sequences for alignment, to set up and load exposure job environments, and for capturing image templates to be used for alignment processes.

- **Measure:**

Access to available measurement functions for control of exposure quality.

- **Tools:**

Contains presentation methods for measurement and job results.

- **Service:**

Offers a number of programs for testing and calibrating the DWL system.

- **Laser (*only available in systems with externally controllable laser*)**

Gives direct access to some control functions of the laser:

- On / Off - switch laser on / off
- Disable - set laser to minimum current for lasing (power saving mode)
- Enable - return to full power from 'disabled' state

- **Help:**

Gives access to an alphabetical help subject index and software information (version, history)

## EXPOSURE MAPS

### EXPOSURE MAP DISPLAY

**Window 2** shows a graphical interpretation of the current **Map** file. If a design being exposed is to be stepped several times on a substrate, or if various patterns must be written onto numerous fields, the **Window 2** map represents the order in which the fields are arranged on a substrate according to the current **Map** file. During an exposure, the **Window 2 Map** will display which field is being exposed. The zero field, marked with a cross, is used as the coordinate origin.

| Map - DEFAULT.MAP     |       |    |    |    |
|-----------------------|-------|----|----|----|
| Commands              | Scale |    |    |    |
| Number of Fields = 25 |       |    |    |    |
| 1                     | 2     | 3  | 4  | 5  |
| 6                     | 7     | 8  | 9  | 10 |
| 11                    | 12    | 13 | 14 | 15 |
| 16                    | 17    | 18 | 19 | 20 |
| 21                    | 22    | 23 | 24 | 25 |

Window 2

### MAP - COMMANDS

- **Select Fields:**

Highlights fields in the **Exposure Map** that will automatically set marks on corresponding rows in the **Make Job** window and allows the operator to mark several fields at once (e.g., program a selected row of fields to have the same focus offset aided by the **Make Job** submenu). The *zero* field, marked with a cross, is used as a coordinate reference.

- **Clear Fields:**

Removes selected flags and row marks in the **Make Job** program.

- **Show Positions:**

Normally displays absolute coordinates in microns in reference to a selected field.

- **Jump Positions:**

If the interferometer coordinate system is set and aligned to a substrate, the **J**ump **P**ositions command may be used for leaping to a selected field. When the **J**ump **P**ositions command is highlighted, a warning window will appear. The **J**ump **P**ositions command is only to be used *after* substrate is aligned and its respective coordinates are set to the **Map** correctly; otherwise, the stage may leave the auto-focus regime, and moving it back may damage the nozzle.

## **MAP - SCALE COMMANDS**

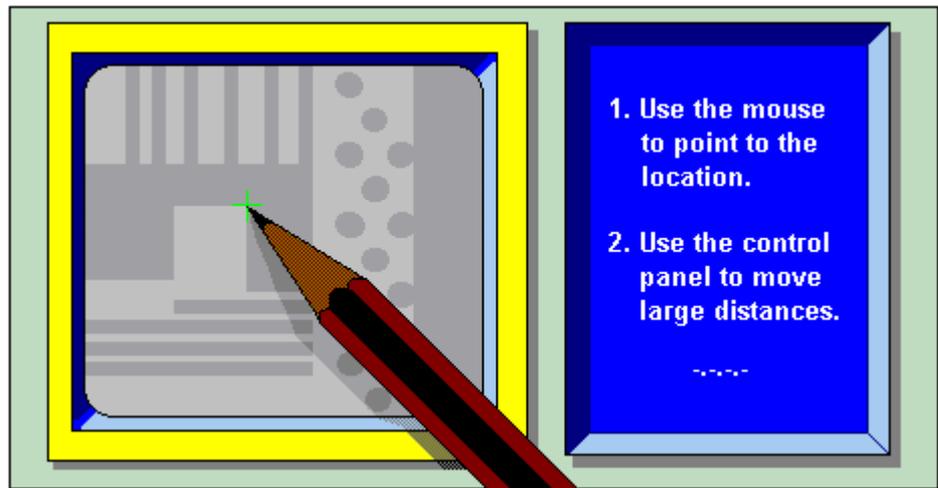
Select any of the *absolute scale displays*. All entries show the size of the entire **Map** area.

- **Automatic:**

Both the X and Y-axis are independently normalized and will show a distorted view of field distribution.

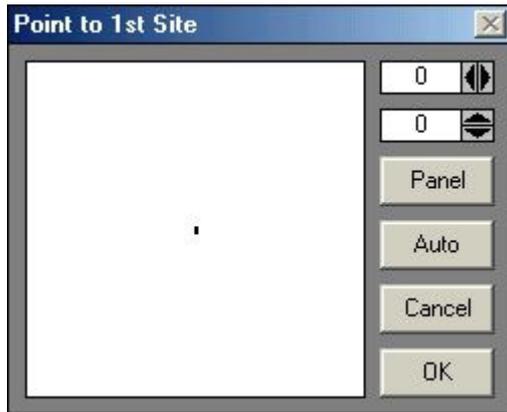
## ***FIND MANUAL***

---



### **INTRODUCTION**

The **Find Manual Method** is a much used service routine to determine the exact interferometric position of any structure within the current camera image by pointing to the location of interest. The results are best near the center of the camera image and are automatically adjusted for the camera selected. Good results can only be expected if every camera has been calibrated. This **Method** is not directly accessible to an operator and will only appear when it is necessary to determine the exact location of a specific feature (**Window 11**), which can be done by pointing a cursor. The **Find Manual Method** is used in alignment procedures as well as some measurement methods.



**Window 11**

## **FIND MANUAL WINDOW**

Whenever a procedure requires the manual determination of a structure position, the **Find Manual** window (**Window 11**) will open and an instruction on which feature to point to may appear in the title bar.

- **Mouse and Fine Adjust:**

Rough adjustment of the cursor cross on the monitor is done by moving the cursor in the left field of **Window 11** (*hold down left button of mouse to move cursor*). The two adjustment boxes on the upper-right hand side of **Window 11** show the current position of the cursor in camera pixels, where **0,0** is the center of the camera image. For fine adjustment, the pixel values may be changed with the arrow buttons.

- **Panel:**

(Invokes the **Control Panel**) If the region of interest is outside the camera field, or changing camera settings is necessary, the **Control Panel** must be activated with this button, since all other methods of starting the control panel will not work in such a situation.

- **Auto:**

Current field alignment will be used to determine the structure position.

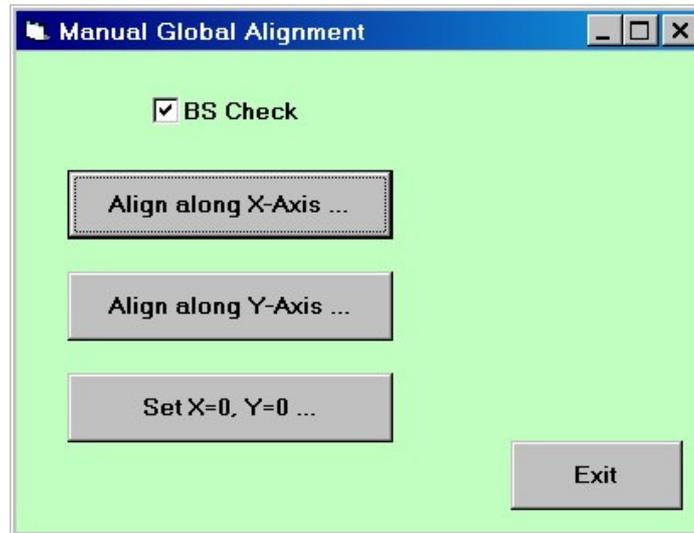
- **Cancel:**

Closes the **Window 11** and causes an error signal to return to the calling program (as if the template was not found).

- **OK:**

Quits **Window 11** and returns the final absolute position of the cursor in the interferometer coordinate system to the calling program for further processing.

## Manual Global Alignment



The Manual Global Alignment is used to correct for angular loading errors. It also offers one possible way of setting the plate origin if it is defined by a preexposed structure.

- **BS Check (systems with Backside Alignment only):**  
If this checkbox is activated, the alignment will be done with the backside camera system.
- **Align along X-Axis ...**  
A sequence is started during which the operator is asked to point to two alignment points that have the same horizontal position. These can be two parts of the same horizontal plate edge as well as two preexposed structures on the plate. The pointing is done using the **Find Manual** function explained above.
- **Align along Y-Axis ...**  
A sequence is started during which the operator is asked to point to two alignment points that have the same vertical position. These can be two parts of the same vertical plate edge as well as two preexposed structures on the plate. The pointing is done using the **Find Manual** function explained above.
- **Set X=0, Y=0 ...**  
A Find Manual window opens asking the operator to point to the position on the plate that should be used as origin. This can be a plate corner as well as a predefined structure on the plate.

## **MINI TERMINAL**

---

The Mini Terminal establishes a direct terminal connection to the main OS9 system. The main application of this feature is the log on to the OS9 system after system start. In addition, the Mini Terminal can be used to transfer files from and to the OS9 system. Advanced operators can also use it to manually send OS9 commands or to temporarily change system parameters. However it can not be used to edit files directly on OS9, or to run monitor programs with a continuous data flow.

### **LOGIN FUNCTION**

To login, hit "Enter" twice until the "User:" prompt appears. Enter user name and password, then close the Mini Terminal. A message box shows details about the configuration loaded (see *Chapter 7, View OS9 Configuration*).

### **FILE TRANSFER MENU ("FILE")**

The **File** transfer menu can be used to transfer small text files from the OS9 system to the User PC or vice versa. It can not be used for large text files, formatted files, ordinary files.

- **File to Windows from OS9**

When this function is activated, the user is prompted for the name of the source file on OS9. If the file is not in the home directory, the name should be entered as an absolute path (/h0/user/dwlii/...). The contents of the source file will be listed into the temporary memory and can then be saved on the User PC. A window will open where a location and name for the file on the User PC can be chosen.

- **File from Windows to OS9**

When this function is activated, a file selection window opens where the file to be transferred has to be selected. Next, the user is prompted for the name the file should have on OS9. If the file should be transferred to a directory other than the home directory, the full absolute path should be used (/h0/user/dwlii/...). After this, file transfer starts.

### **OS9 COMMANDS**

If the MaskWrite system is connected and the PC is logged on, detailed information on every **OS9** command may be obtained by opening the **Mini Terminal** window and typing in commands with the **-?** option. The most common commands can be found under *Chapter 7, Small Talk Comm Debug and OS9 Commands*.

## CHAPTER 2 - FILE MENU

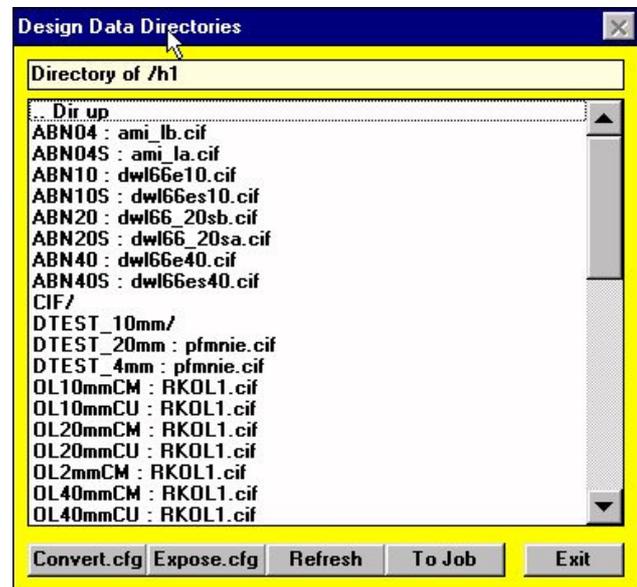
### DESIGN DATA

#### INTRODUCTION

A DWL can only write data in the machine's internal format, called LIC. This data is normally prepared either on a separate partition of the User PC, or on an off-line workstation, where the program **XCONVERT** is installed. The **XCONVERT** program fractures original data and generates a file for every stripe to be written. Then, through the **atrans** program, these files (plus multiple control files) are transferred to the machine via ethernet using the FTP protocol.

The amount of designs that can be stored in a machine depends solely on the size of the data partitions on the hard disk. A number of test designs are permanently stored in the system partition.

The **File** menu command **Designs** opens the **Design Data Directories** window (**Window 1**), which displays all the currently present design directories in the default design path given in the configuration file.



Window 1

## DESIGN DATA DIRECTORIES BUTTONS

- **Convert.cfg:**

Shows the parameter file that was used during the conversion of the design to LIC data files.

- **Expose.cfg:**

Shows the file **expose.cfg** for the specific design, which controls the exposure, and is generated by the conversion software. A design converted for a particular machine configuration usually cannot be used again when fundamental machine properties such as stripe width, or address grid have been changed; therefore, the working design must be re-processed and loaded.

- **Refresh:**

The transfer of the list of converted designs to the Operator PC requires some time and will only be done the first time **Window 1** is loaded. If design data is added in the meantime, this function will re-read the list of design directories.

- **To Job:**

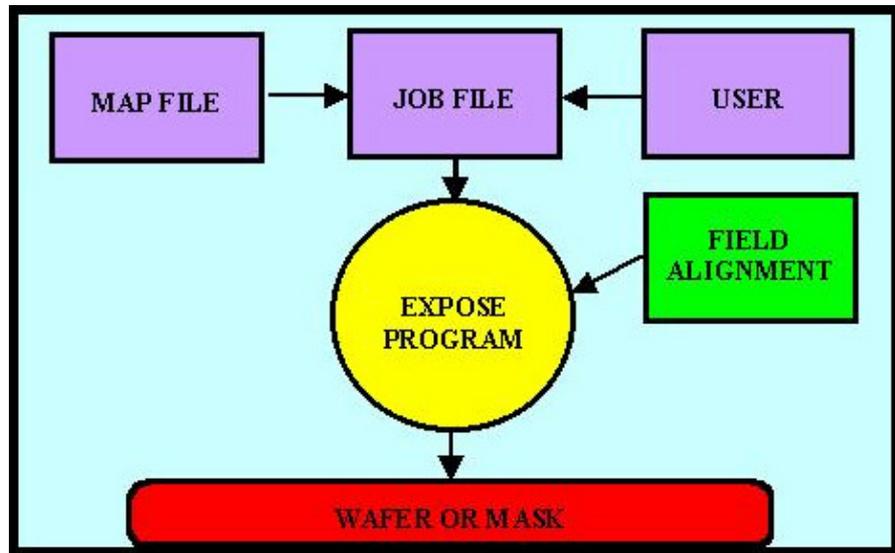
Directly transfers the data location of a design from the list to the Job file. Highlighting **Make Job** under **J**ob in the main menu opens the Job file. Highlight the Design cells where the design name should be transferred to and then highlight the design name in the list and press **To Job**.

- **Cancel:**

Closes **Design Data Directories** window (**Window 1**), or closes the viewer after pressing **Expose.cfg** or **Convert.cfg**.

## **ENVIRONMENT FILES**

---



### **INTRODUCTION**

Multiple sub programs in the DWL menu require special job-dependent data files, which can be connected to a specific job as to avoid loading these files all the time. In many cases, entries within the files are altered automatically. If the DWL system is not running properly it may be caused by a changed entry into its environment and can be fixed by re-loading the original desired file. Not all three files are necessary to run all applications, the only exception being the direct writing of substrates featuring alignment marks.

Which set of environment files is loaded can be seen in the main menu bar, or in the **File** menu drop down list. The functions of the files are:

**Job File:**

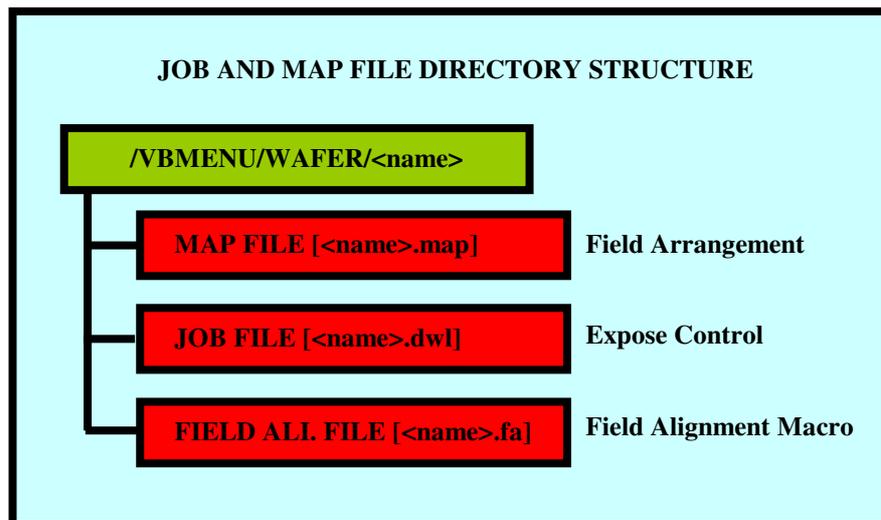
Contains information for the system on what data is written in which field of the Exposure Map and under what conditions.

**Map File:**

Contains geographic information on the location of the sub fields on the substrate (Exposure Map).

**Field Alignment:**

Describes the procedure used to determine field positions on a substrate by detecting alignment structures. The file has a specific format and is written in a special macro-language.



---

## **CHAPTER 3 – JOB CONTROL**

---

### **INTRODUCTION**

After environment and setup procedures are prepared, highlighting Make Job enables an operator to adjust exposure parameters, such as Lic data selection, Defocus and Energy. Highlighting the Run Job panel allows for the final steps of an exposure to be performed.

*For the following submenu options, the “**Exposure Map**” window will be opened beside the current window. See Chapter 1, Exposure Map for details on available options.*

### **JOB COMMANDS**

- **Make Job:**  
Opens job files in the **Edit Job** spreadsheet for setup and editing.
- **Run Job:**  
Loads the **Expose** window that contains controls for each step of an exposure or measurement procedure.

## EDIT JOB

Which Data Set must be written where and under what conditions.

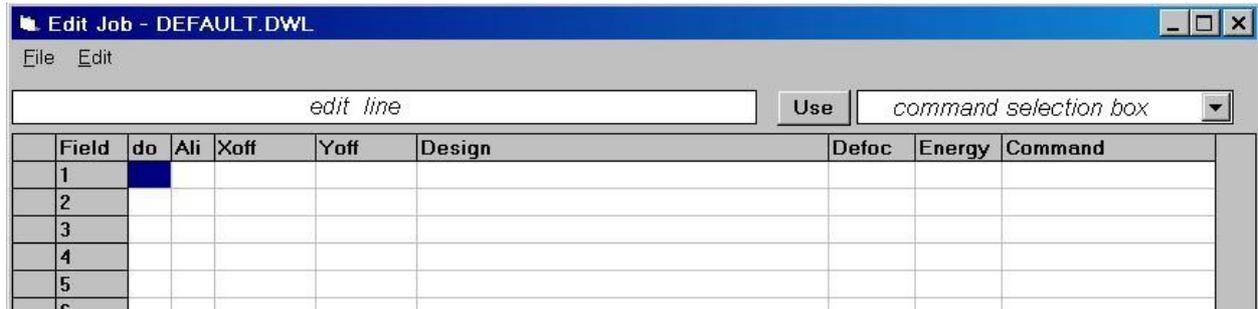
| Field | Co | All | Map? | Val? | Utiliser | DeNo | Expos | Command |
|-------|----|-----|------|------|----------|------|-------|---------|
| 1     |    |     |      |      |          |      |       |         |
| 2     | -1 |     |      | 3    | -50      | 60   |       |         |
| 3     | -1 |     |      | 3    | -50      | 60   |       |         |
| 4     | -1 |     |      | 2    | -50      | 70   |       |         |
| 5     | -1 |     |      | 2    | -50      | 80   |       |         |
| 6     | -1 |     |      | 3    | -50      | 90   |       |         |
| 7     | -1 |     |      | 3    | -10      | 100  |       |         |
| 8     | -1 |     |      | 3    | -10      | 60   |       |         |
| 9     | -1 |     |      | 2    | -10      | 80   |       |         |
| 10    | -1 |     |      | 2    | -10      | 70   |       |         |
| 11    | -1 |     |      | 3    | -10      | 60   |       |         |
| 12    | -1 |     |      | 3    | -10      | 60   |       |         |
| 13    | -1 |     |      | 3    | 0        | 100  |       |         |
| 14    | -1 |     |      | 2    | 0        | 80   |       |         |
| 15    | -1 |     |      | 2    | 0        | 80   |       |         |
| 16    | -1 |     |      | 3    | 0        | 70   |       |         |
| 17    | -1 |     |      | 3    | 0        | 60   |       |         |
| 18    | -1 |     |      | 2    | 10       | 100  |       |         |
| 19    | -1 |     |      | 2    | 10       | 80   |       |         |

### INTRODUCTION

With the **Edit Job** spreadsheet (**M**ake **J**ob command in the **J**ob menu), the **J**ob menu offers a tool to edit the **J**ob **F**ile, which controls design positions according to the fields defined in the Exposure **M**ap and the conditions of each exposure on the substrate.

A **J**ob **F**ile can also be edited using any editor or spreadsheet program (i.e., **M**icrosoft **E**xcel), as long as the format description is being obeyed.

## FORMAT OF THE JOB FILE



**Window 3**

A DWL **Job File** controls the entire exposure sequence and its organization is similar to a spreadsheet. Advanced work can be done using, e.g., **Microsoft Excel**.

A **Job File** consists of 9 *columns*, but the *number of rows* is equal to the *amount of fields* in the active **Map**. In the case of a simple **Map** featuring only one field, the spreadsheet will only contain one row.

Editing of the cells is done by highlighting them and then working on the contents in the edit line at the top of the sheet.

## COLUMNS

- **Field:**

Contains a number referring directly to the field in the wafer map, which is viewed simultaneously with this spreadsheet. The order of the rows is generally synonymous with the field numbers, but is not essential. The fields will be exposed *in the order of their positions on the spreadsheet, not the field number*. Fields cannot be moved within the **Edit Job** spreadsheet; instead, use **Microsoft Excel**.

- **do:**

Contains a flag, which will determine if the field corresponding to the row is going to be written. If the value entered in this column is  $-1$  then the flag is true for this row and the corresponding field in the **Map** will be exposed. If the value in the row is 0, or it is empty, the field will be skipped.

- **Ali:**

For overlay exposures or measurements, a field alignment procedure can be prepared that detects the position of a specific unambiguous structure. If the same structure appears several times in the same field, it can be used in several positions to improve alignment accuracy and increase the number of alignment parameters that can be set using the measurement results. The maximum number of alignment marks is 4. Each measurement result is compared to the nominal coordinates given in the map file for the respective alignment structure, and any deviations are used to optimize the coordinate matching of the system to the substrate. The parameters calculated from the measurement results are:

- 1 site: field origin offset
- 2 or 3 sites: correction of linear distortions in one axis / two axes
- 4 sites: rotational correction (on top of global alignment)

The necessary entries to activate a field alignment procedure are:

|               |                      |
|---------------|----------------------|
| <b>ALI=:</b>  | No Alignment         |
| <b>ALI=0:</b> | No Alignment         |
| <b>ALI=1:</b> | One Site Alignment   |
| <b>ALI=2:</b> | Two-Site Alignment   |
| <b>ALI=3:</b> | Three-Site Alignment |
| <b>ALI=4:</b> | Four-Site Alignment  |

- **Xoff:**

Entering a value in microns will shift the final position of where this field will be written in X. The value can be signed and can have a decimal point. The **X-Shift** in this column will always be added to the position provided by the **Map**, meaning that a positive number will shift the written design to the right.

- **Yoff:**

Entering a value in microns will shift the final position where this field will be written in Y. The value can be signed and can have a decimal point. The **Y-Shift** in this column will always be added to the position provided by the **Map**, meaning that a positive number will shift the written design up.

- **Design:**

The **Design** cell must contain the name of the directory where the converted design data (Lic files) is stored.

**Exposures:**

It is possible to expose more than one design in the same field by entering more design data locations separated by a semicolon. Entering the same design several times will lead to multiple exposures of this design in the same position. This can be used e.g. if laser power has dropped too low to achieve a good exposure in one run. However, exposure quality decreases with this technique. For multilayer exposures, it is more recommendable to do overlay exposures that allow an alignment to a previously written structure, to compensate any drift effects.

**Measurements:**

To do an automatic measurement, the name of the measurement file must be entered preceded by "**M:**" (i.e., **M:test.msr**). If several measurements are to be executed in the same field, the file names must be separated by a semicolon. Measurement files are created using the functions of the **Measurement** menu.

- **Defoc:**

Enter a value between 0 and 4095 as a focus offset. A value of 2048 means no defocus. Calibration is usually such that one unit is 5nm. Before a final exposure is made, a series of fields with the same pattern at various defocus levels should be used to find the best focus offset for an exposure. This is the only correct defocus procedure for substrates with relatively thick resists. If the cell in the **Defoc** column is empty, no defocus is made.

| WRITE LENS | FOCUS DEPTH |
|------------|-------------|
| 2mm        | ~ 1.0µm     |
| 4mm        | ~ 1.8µm     |
| 10mm       | ~ 8µm       |
| 20mm       | ~ 50µm      |
| 40mm       | ~ 200µm     |

- **Energy:**

The name of an intensity correction file is entered in the **Energy** column. Such a name consists of a number only. The file 100 sets the energy to 100% and the file 70 to 70%, etc. Normally not all values are available. Similarly to finding the best focus, the **Energy** column is used for finding the best energy by varying the energy across an array of fields

- **Command:**

Executes multiple commands before and after an exposure, or measurement. A list of available commands will drop by clicking on the ▼ scroll arrow located on the right hand corner of the **Use** box, shown in **Window 3**. Select any of the available commands and enter a numeric, or string value, if required. All commands executed before an exposure or measurement must be preceded by highlighting, "**BEFORE:**" Commands executed after an exposure or measurement must be preceded by highlighting, "**AFTER:**" Both selections must only appear once, but can be followed by any number of commands. A semicolon must separate each command. Any command chosen from the table will be automatically added to the current command sequence by pressing the **Use** button. See below at **LISTS AND BUTTONS** for explanations of the available commands.

## **EDIT JOB - FILE COMMANDS**

- **New:**

Creates a fresh sheet with the number of rows corresponding to the number of fields by the current **Map** file. The new Job file will be called "**NONAME.DWL**" until it is being stored under a different name.

- **New Map:**

Used to load a different **Map** from the **\VBMENU\WAFER\** directory or create a new map. The newly loaded **Map** will appear, and in case of a new map, the name of the new environment will be used to create a new environment (see **CHAPTER 2: ENVIRONMENT FILES**).

**NOTE:** Not all corresponding environment files will necessarily be loaded together with a map. Check in the list of current environment files (on the main toolbar) before executing a new **Job** file.

- **Open:**

Opens an existing **Job** file from the **\VBMENU\WAFER\** directory together with the corresponding environment files, if these are not yet loaded.

- **Save:**

Saves the current **Job** file. An overwrite warning will appear if a file of this name already exists.

- **Save As..:**

Saves the current **Job** file under a new name.

- **Exit:**

Exits **Edit Job** window.

## **EDIT JOB – EDIT COMMANDS**

### **Terminology of Markings:**

- A highlighted cell (left-click on cell) is called “*focused*”. Its contents are displayed in the edit line and can be worked on.
- The row corresponding to a *focused* cell is automatically *selected* and can be seen by the two crosses displayed in the leftmost cell of the row. In the **Exposure Map** window, the field corresponding to the marked row turns **blue**.
- If several cells are to be selected at the same time (i.e., a row or column), they can be *marked*. This can be done by click-and-drag with the left mouse button over a region of cells, by clicking on the column/row heading to mark a whole column/row, or by using the corresponding option in the **Edit** menu of the **Edit Job** window to mark several rows that are not connected. If regions are marked with the mouse, only the first row within this region is shown as selected.

### **Commands:**

- **Cut, Copy, Paste:**

Used for data transfer to (**Copy**) and from (**Paste**) the **Windows Clipboard**, which can be used as an intermediate storage for transfer to other positions or other applications. **Cut** will copy and clear the contents of the marked cell(s).

- **Fill Down:**

Copies the content of the uppermost cell, or cells, of the marked area, into all marked cells below.

- **Formula Fill Marked:**

Generates a sequence of numbers, which may be combined with both a leading and trailing string. In the first dialogue box, enter the starting value, followed by the step size, separating the two values with a comma. In the following dialogue box, enter the preceding and trailing strings separated by a comma. If a string is not necessary, only enter a comma, or nothing. **Remark:** *works only on continuous regions of marked cells*

- **Replace:**

Searches for a specific string in the marked area, *not in the whole file*, and will replace it with a new string.

- **Set Marks:**

If the **Set Marks** command is selected, then all rows corresponding to the cells clicked on will remain marked until the marking is removed. Once set, the corresponding option in the **Map** window (**Commands - Select Fields**) is set automatically. Stays active until selected again here, or disabled in the **Map** window.

- **Set Marks Conditionally:**

Will mark all rows where selected cells contain the string entered as marking condition in a dialog box.

- **Remove Marks:**

Clears all marks previously set. Can also be done by highlighting the **Clear Fields** command on the **Map**.

## **LISTS AND BUTTONS:**

- **Use:**

Places a selected command into the spreadsheet. A command is selected by opening the commands list (click arrow on the right-hand side of the text box) and highlighting the command. A selected command will be transferred into the command selection text box. Whenever the **Use** button is pressed, the command in the command selection box will be transferred to the "command" cell that has the focus. If the focus is not on a "command" cell, a warning will be issued. The processing of commands starts after the stage has moved to the field.

- **Commands List:**

**AFTER: / BEFORE:**

These keywords can be used to define the time at which a command or set of commands should be executed. If no keyword is used, all commands are executed before the stage moves toward the field (unless stated otherwise in the specific command).

**DTEST**

Service command for deflector parameter setup test. *Redundant in fast scan systems.*

**Focus**

Stage moves to the center of the field, and write head is being focused here.

**INIT:<command line parameter>**

Used to reinitialize the configuration with different parameter settings.

**Lamp (value)**

Sets illumination of the camera system to the value stated.

**MovReIX( $\mu$ ) / MovReIY( $\mu$ )**

*Not functional.*

**MovZ(Steps)**

Moves up the write head by the number of steps given (1 step = 1.25 $\mu$ m)

**OS9:<command\$>**

After this keyword, any OS9 command can be entered for execution before an exposure. Can not be combined with the keywords **BEFORE** and **AFTER**.

**PT(value)**

*Not usable in fast scan systems.*

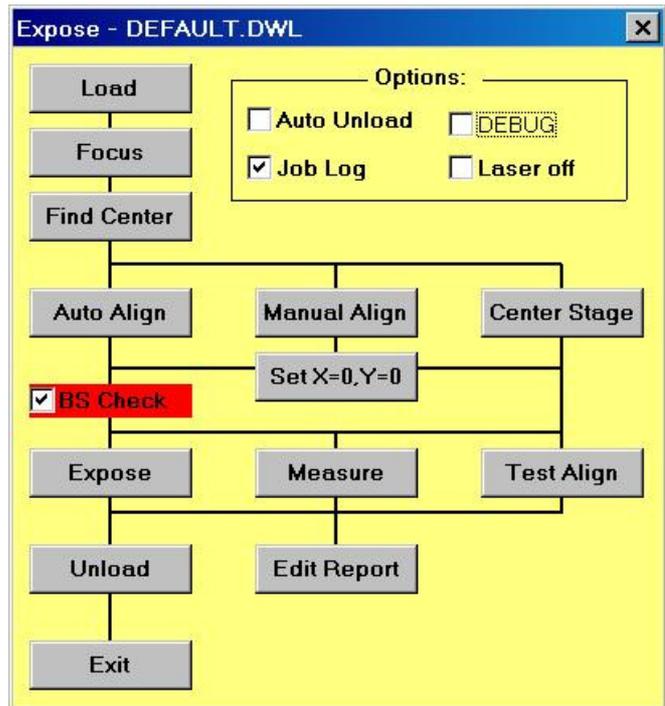
**ToFieldStart**

*Not functional.*

# EXPOSE

## INTRODUCTION

Highlighting **Run Job** under **Job** in the main menu opens the **Expose** window (**Window 4**), which is kept as simple as possible and may be used to routinely run pre-defined jobs. The environment must be modified first before changing designs, then multiple functions can be used in a logical sequence as shown in **Window 4** below.



**Window 4**

## EXPOSE - BUTTONS

- **Load:**  
 Moves up the writehead, performs a stage initialization- if necessary, and moves the stage to the load position.
- **Focus:**  
 Focuses on a substrate.  
 After a substrate is manually loaded and focused upon, a number of alignment methods are available:
- **Find Center:**  
 Starts the **Find Center ()** procedure, which detects the edges of a plate using the auto-focus sensor and calculates the plate center from the results. Once the routine

is finished, the stage moves to the position detected and requests if the stage coordinate system origin should be set there.

- **Manual Align:**

This preprogrammed sequence interactively aligns a substrate along the X-axis, or along the Y-axis.

- **Center Stage:**

Moves the stage to the center of the interferometer field.

- In situations where it is not necessary to make an alignment, this position may be used as a reference point.

- **Auto Align:**

This option is deactivated, as the corresponding functions are as of now, incomplete.

- **Set X=0, Y=0:**

Sets the origin of the coordinate system to the current position.

- If none of the above commands are used, the control panel is necessary for moving to a specific position, i.e., *a point with a certain distance from the plate center or to a corner of the substrate.*

**NOTE:** Highlight **Make Job** under the **J** menu to re-inspect or make last minute changes in the Job file.

- **Expose:**

Exposes a plate exactly as instructed by the **Edit Job** file, including a possible multi-site field alignment. The **Map (Window 2)** is continuously updated during an exposure. While exposing one field, the User PC is simply waiting and displays how many stripes must still be written for the field. In case of an emergency, clicking on the **BREAK** button in the “**Scanning...**” window will interrupt a current exposure, where all other controls will be deemed invalid during this time. After **BREAK** is clicked the current stripe will be completed but all processes necessary for the exposure will be stopped.

- **Measure:**

Starts a measurement sequence for jobs containing *measurement references* in the **Lic Buffer** column. Measurements results are entered into the **Report** file, which can be analyzed for a variety of properties using some of the functions under the **Tools** menu. Clicking on the **Measure** button a second time will interrupt a measurement sequence.

- **Test Align:**

Performs all functions of an exposure exactly as the real expose sequence would, only the **Expodie** command will not be given to the OS9 System. *A test exposure* is

extremely important for debugging complete alignment sequences, while a report will be made containing all details about the alignment results etc. Use with caution, this sequence cannot be interrupted.

- **Unload:**

Moves up writehead and moves stage to the unload position.

- **Edit Report:**

Allows operator to view a report about the (test) exposure and save it under a different name (optional).

- **Exit:**

Closes **Expose** window (**Window 4**).

### Example of a Report File

A **Report** file for a multi-field exposure / alignment opens with a header, containing the job file name, the date, and the starting time of exposure. Relevant information pertaining to the job file is repeated and followed by the alignment results in each field. If automatic measurements were taken, the results would be listed after each alignment.

**HEADER:** Exposure of Job=PERF207.DWL

: Date=01-21-1995  
: Start Time=17:38:44

**FIELD1:** Alignment Field #=1 Number Of Sites=1

: Site=1 X=-250 Y=1020  
: Site=1 DeltaX=-75 DevX=0 DeltaY=127 DevY=0  
: 1 sites used, Xshift=74.9 Yshift=-127.0 Xsize=1 Ysize=1 Xrot=0 Yrot=0  
: Start Field # 1 at t=12:15:12  
: 1 -1 /h0/USER/DWLII/lic/acc10 SCAN:AOD0=2029 -97 120  
OS9:dg\_ramp -f=7494  
: Expodie /h0/USER/DWLII/lic/acc10 SCAN:AOD0=2029 dieX=-3210208 dieY=-59  
SCAN: TSX=9.89032570238 SCAN: TSY=9.89032570238

**FIELD2:** Alignment Field #=2 Number Of Sites=1

: Site=1 DeltaX=-67 DevX=0 DeltaY=115 DevY=0  
: Xshift=66.5 Yshift=-115.0 Xsize=1 Ysize=1 Xrot=0 Yrot=0  
: Expodie /h0/USER/DWLII/lic/acc10 SCAN:AOD0=2029 dieX=-25277 dieY=-59  
SCAN: TSX=9.89032570238 SCAN: TSY=9.89032570238

**FIELD3:** Alignment Field #=3 Number Of Sites=1

: Site=1 DeltaX=-65 DevX=0 DeltaY=114 DevY=0  
: Xshift=64.8 Yshift=-114.0 Xsize=1 Ysize=1 Xrot=0 Yrot=0  
: Expodie /h0/USER/DWLII/lic/acc10 SCAN:AOD0=2029 dieX=-3260761 dieY=-59  
SCAN: TSX=9.89032570238 SCAN: TSY=9.89032570238

**TAIL:** Exposure Finished at 09.21.2001 t=17:46:47

## CHECKBOX OPTIONS:

- **Auto Unload:**

If checked, the **Unload** function will be executed after the exposure is finished.

- **Job Log:**

If checked, the name of an exposure / measurement control file is entered into a list, followed by the first **Design-** or **Measurement (M:) file** name encountered. Next, both start time and date as well as stop time and date are listed, and this information is entered into the file, "**JOBLOG.TXT**", which can be found under **VBMENU\WINDWL**.

- **DEBUG:**

Activates a set of debug options and creates extended reports and logs. Need a lot of disk space and **SHOULD ONLY BE USED BY ADVICE OF HIMT SERVICE**.

- **Laser off:**

*Available only in systems with externally controllable laser.* If this option is checked, the laser will be switched off after completion of the exposure job.

- **BS Check:**

*Only available in systems with backside alignment configuration.* Set to use backside alignment system for field alignment.

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## **CHAPTER 4 - JOB SETUP**

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### **SETUP COMMANDS**

A large number of submenu commands are available for the preparation of complex exposure jobs, including procedures for field alignment. In addition, the Setup submenu contains commands for preparing a fresh exposure map.

- **New:**

Installs a new environment directory and necessary root files for further customization.

- **Exposure Map:**

Creates and displays new exposure maps and defines the relative coordinates of alignment sites.

- **Simple Cross Alignment:**

Offers two ways of automatically preparing simple field alignment procedures for alignment to crosses.

- **Field Alignment Method:**

Develops and tests automatic field alignment methods for field-by-field exposures.

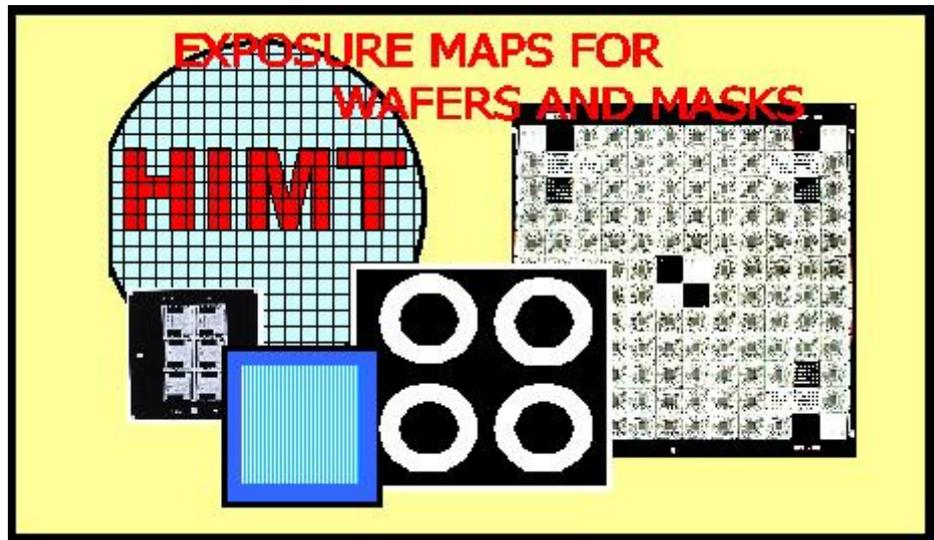
- **Test Field Alignment:**

A multiple site alignment testing method, used to find and test suitable alignment sites.

- **Define Template:**

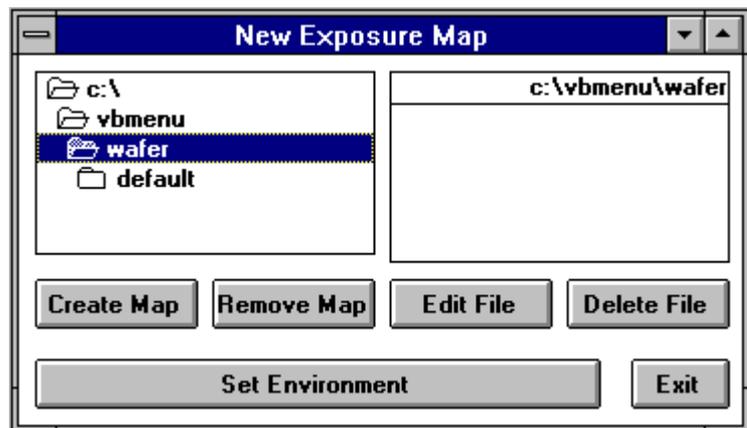
Used to teach the system specific, clear-cut image features that can be recalled and used as an alignment template.

## **NEW EXPOSURE MAP**



### **INTRODUCTION**

All files for one project are located in the same directory along with report files for a certain job. In the **New Exposure Map** window (**Window 5**), an existing environment may be loaded or a new environment directory can be created.



**Window 5**

## NEW EXPOSURE MAP BUTTONS

- **Create Map:**

Upon starting a new project, set the main directory to **\VBMENU\WAFER** using the directory select box and then click on the **Create Map** button. A name of maximal 8 characters is requested, used as a project name. A directory is created and will be filled with three root files, which are copied from the **VBMENU\WINDWL\default.map**, **default.wa**, and **default.fa**.

- **Remove Map:**

Completely removes the directory and all files selected out of the directory box after a confirmation.

**Note:** Directory may not be the current environment.

- **Edit File:**

Loads the file selected in the right file box (of **Window 5**) into a small editor and may be used to view a file or to make minor changes.

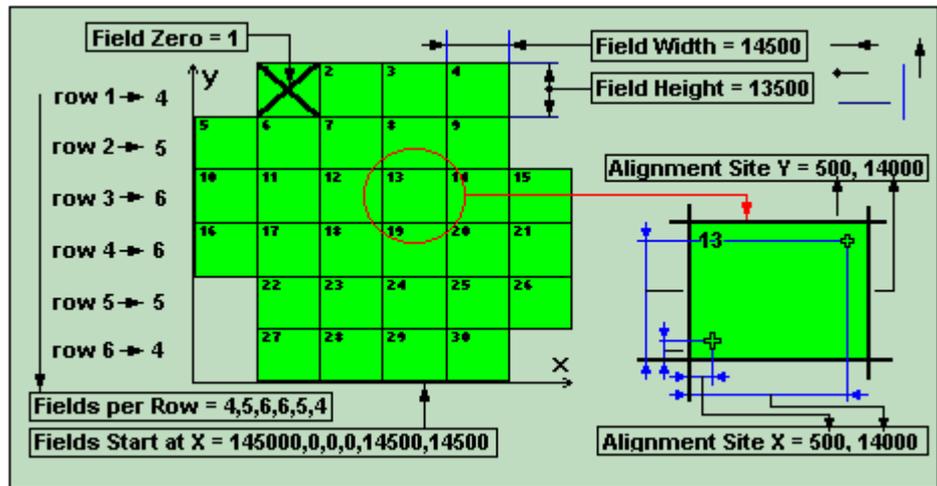
- **Delete File:**

Deletes a selected file from the file box after confirmation.

- **Set Environment:**

Upon selection of a **Map** file from the file box, the complete environment can be set to this project. This button will display which project has been selected. Click on the button to load.

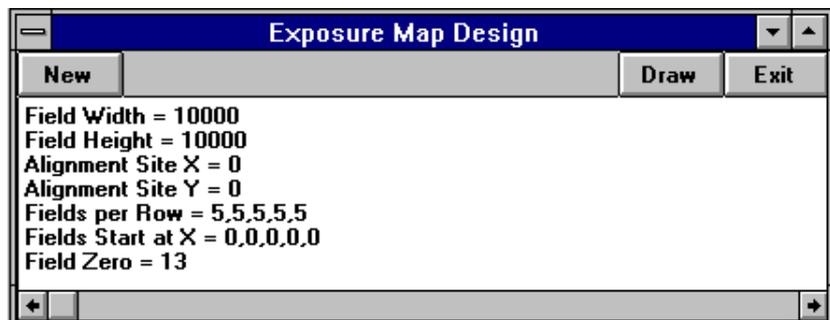
## EXPOSURE MAP DESIGN



### INTRODUCTION

Described in the **Map** file, the **Exposure Map** has a very specific format as shown in the example below:

- Line 1:** Field Width = 14500 (in  $\mu\text{m}$ )
- Line 2:** Field Height = 13500 (in  $\mu\text{m}$ )
- Line 3:** Alignment Site X = 500, 14000 (in  $\mu\text{m}$ )
- Line 4:** Alignment Site Y = 500, 14000 (in  $\mu\text{m}$ )
- Line 5:** Fields per Row = 4,5,6,6,5,4
- Line 6:** Fields Start at X = 14500,0,0,0,14500,14500 (in  $\mu\text{m}$ )
- Line 7:** Field Zero = 1



Window 6

**NOTE:** Spaces are not important, but upper- or lower-case of the characters are. Meanings of various entries are shown in the figure at beginning of sub-chapter. Upon starting the **Exposure Map Design** window, data from the current map is loaded. All positions and sizes are to be entered in micrometers. *In lines 5 and 6, a value must be entered for each row.*

## **EXPOSURE MAP DESIGN BUTTONS**

- **New:**

If a new map is loaded the map description will default, where all prepared numbers will disappear.

- **Draw:**

Will cause a map as described by the current text to be shown in a separate window.

- **Exit:**

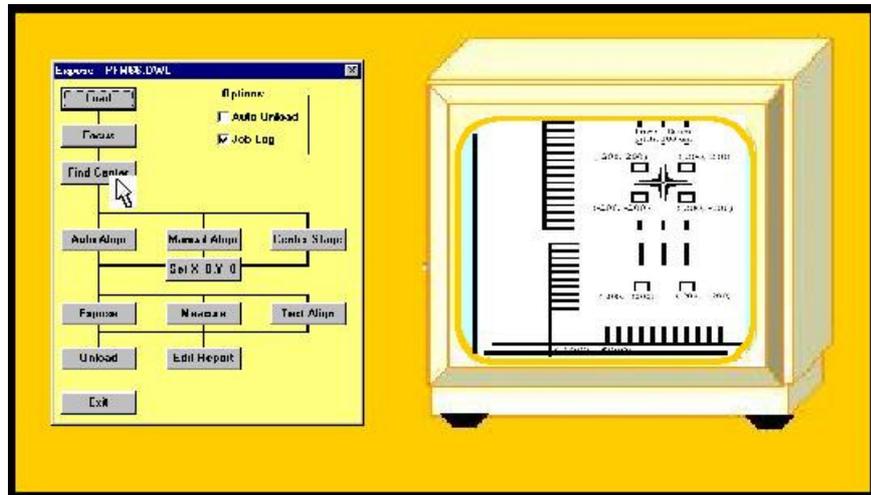
Exits **Window 6**.

### **NOTE**

In the case of a single layer, single field Mask exposure, **Window 6** must be modified as shown below:

Field Width = 100000  
Field Height = 100000  
Alignment Site X = 0  
Alignment Site Y = 0  
→ Fields per Row = 1  
→ Fields Start at X = 0  
→ Field Zero = 1

## **SIMPLE CROSS ALIGNMENT**

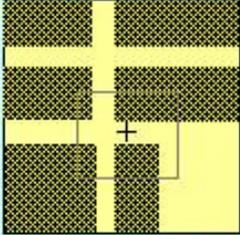
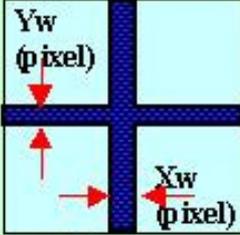
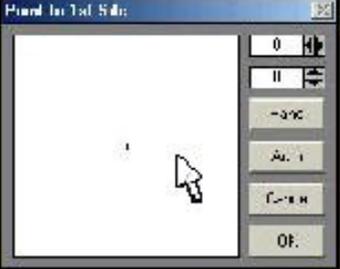


The **Simple Cross Alignment** command offers two modes of automatically generating a field alignment method if the alignment mark to be used is a cross. These two modes are:

- **Using Find XY:** Detects a cross by its borders
- **Using Pos XY:** Detects a cross by detecting the centers of its lines

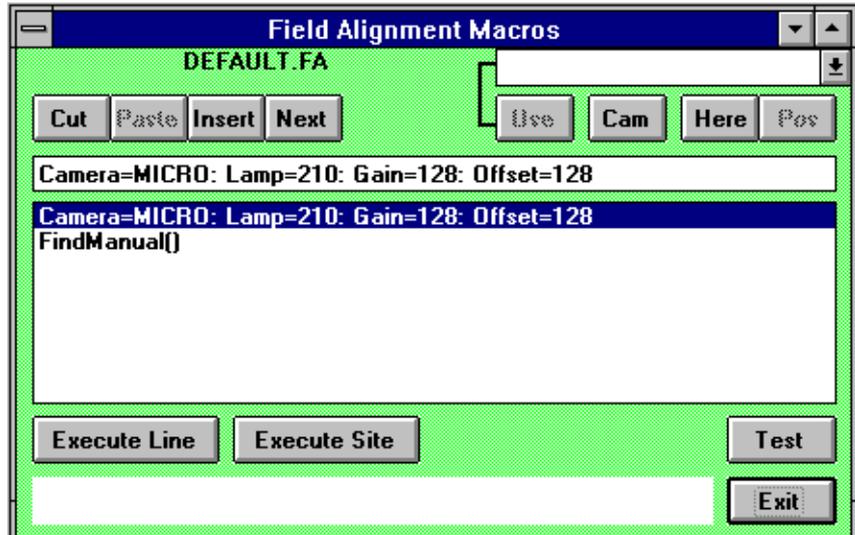
The camera settings must be optimized for best contrast. After calling the procedure, the operator has to indicate the dimensions of the cross by clicking on certain parts of the pattern (as requested in the **Point to...** window heading, details depend on the procedure chosen). After that, a standard field alignment procedure is automatically created using the method chosen and the values gained.

## FIELD ALIGNMENT METHODS

| METHOD 1   | METHOD 2  | METHOD 3  |
|--|---|---|
| <p>Template [name, #]</p>  <p>System searches for a pre-defined template in current image</p> | <ul style="list-style-type: none"> <li>- FindXY(Xw, Yw, Model)</li> <li>- FindX (Xw, Model)</li> <li>- Find Y(Yw, Model)</li> </ul>  <p>System finds center of a line or cross or a set of lines (Model)</p> |  <p>Find Manual()</p> <p>User points to object using the mouse</p> |

### INTRODUCTION

Field alignment of an object must be done specifically to some structure on a pre-exposed layer and can be very different for many substrates. Therefore, numerous methods are available for many applications. The field alignment procedure at a certain site may be the outcome of various steps and altering sequences. However, the **Field Alignment Method**, developed using **Field Alignment Macros (Window 8)**, applies to one site only. For multi-site alignment, the full sequence is determined by the relative positions of the sites as is given in the **Map** file, and by the selection of the number of alignment sites to be used, which is done in the **Edit Job** spreadsheet (**Ali** column). The DWL menu contains a special macro-language for the purpose of field alignment. This macro language allows for the development of special alignment procedures, which are optimized for the application they are used for.



Window 8

## FIELD ALIGNMENT PROCESS

The **Field Alignment Method** must be stored in a file with the extension ".fa". After generating a **New Exposure Map**, a directory is generated containing a "name.map" file and two alignment files, "name.wa" and "name.fa". The **Field Alignment Method** stored in "name.fa" is executed by means of the **Expose** program (depending on the instructions previously fed into in the **Job** menu), which accepts only a specific format of the method.

## MACRO LANGUAGE FUNCTIONS

### Image Settings:

- **Camera:**

[Camera= Macro / Micro] Selects the Macro or the Micro Camera

- **Focus Offset:**

[Focus=#] Sets the focus offset to a value. The range is between 0 and 4095. Normal value = 0.

- **Camera Gain:**

[Gain=#] Sets the video amplifier gain to a value. The range is between 0 and 255. Normal value = 128.

- **Lamp Intensity:**

[Lamp=#] Sets the camera illumination intensity to a value. Range is between 0 and 255.

- **Camera Offset:**

[OffSet=#] Sets the video amplifier offset to a value. Range is between 0 and 255.

- **Delay:**

[Delay=#] Will wait for the designated number of seconds necessary for the stage to relax after a move. If a camera image is captured too soon after a move, stage position will not be correct.

**Movements:**

- **Absolute Movements:**

[MovToX(Xvalue)] / [MovToY(Yvalue)] / [MovToXY(Xvalue, Yvalue)] Moves to the absolute positions Xvalue / Yvalue. Values can be represented in microns by including a "U" in the number; Otherwise, the values are interpreted as interferometer ticks.

- **Relative Movements:**

[MovX( Xvalue)] / [MovY(Yvalue)] / [MovXY(Xvalue ,Yvalue )] Moves relative to the current position over the distance Xvalue and/or Yvalue. Values can be represented in microns by including a "U" in the number; otherwise, values are interpreted as interferometer ticks.

**Alignment Procedures:**

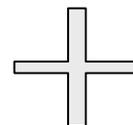
- **Manual Alignment:**

[FindManual()] Activates a target cross in the video image. The cross can be positioned on a specific part of a structure. The target cross position is then used to obtain the position information (see section *Find Manual* in Chapter 1).

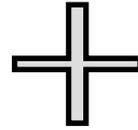
- **Alignment to a Cross by Outline:**

[(FindXY(Xwidth,Ywidth,Model))] Determines the center of a cross with two lines in the video image, where the Value Xwidth must be the width of the vertical line in camera pixels, and the Value Ywidth must be the width of the horizontal line in camera pixels. The model parameter selects the algorithm where for simple crosses the numbers 0... 2 should be used. The different models are:

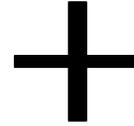
0 – for a cross with a clear, thin outline:



1 – for a cross for a clear thick outline:



2 – for a cross with sharp defined edges:



- **Alignment to a Vertical Line:**

[**FindX(Xwidth, Model)**] Determines the center of a vertical line in the video image, where the Value Xwidth must be the width of the vertical line in camera pixels. The model parameter selects the algorithm (See **Alignment to a Cross by Outline** for example).

- **Alignment to a Horizontal Line:**

[**FindY(Ywidth, Model)**] Determines the center of a horizontal line in the video image. The Value Ywidth must be the width of this line in camera pixels. The model parameter selects the algorithm (See **Alignment to a Cross by Outline** for example).

- **Alignment to a cross by Video Profiles:**

[**PosXY(Xwidth,Ywidth,Dist)**] Determines the center of a cross by defining the centers of the video profiles of the bars on both sides of the center. Measurement boxes of the size given will appear right, left, above and below the center of the monitor image in the distance from the center obtained.

- **Alignment Using A Template:**

[**Template(Name, #)**] Determines the position of a template, stored with both the name, "**Name**," and the number, "**#**".

**Example Using Macro Language Functions:**

*An alignment to a cross is done where the cross is larger than the camera field. The stage is slightly moved to step across a substrate obtaining as much data as possible.*

**Line 1:** Camera=MICRO: Lamp=210: Gain=128: Offset=128

**Line 2:** FindXY(45,45,2)

**Line 3:** MovX(-30U): FindY(45,2)

**Line 4:** MovX(60U): FindY(45,2)

**Line 5:** MovXY(-30U,-30U): FindX(45,2)

**Line 6:** MovY(60U): FindX(45,2)

**Line 7:** MovY(-30U)

**Line 8:** FindXY(45,45,2)

*In this case, the reactions are:*

**Line 1:** Set Camera to MICRO and choose Lamp, Intensity, Camera, Gain and Offset

**Line 2:** Search for a cross of about 45 pixels in width in X and in Y applying model 2

**Line 3:** Move stage in X by 30 microns and find the center of a horizontal line with a width of 45 pixels.

**Line 4:** Move stage in X by -60 microns and find the center of a horizontal line with a width of 45 pixels.

**Line 5:** Move stage in X by 30 microns and in Y by 30 microns. Find the center of a vertical line with a width of 45 pixels.

**Line 6:** Move stage in Y by -60 microns and find the center of a vertical line with a width of 45 pixels.

**Line 7:** Move stage in Y by 30 microns.

**Line 8:** Search for a cross of about 45 pixels in width in X and in Y applying Model 2

*The DWL system will analyze the position of a large cross by stepping along the cross in all directions, obtaining accurate results. The values of each alignment are averaged producing a result, unless an alignment is non-successful, in which case this particular measurement will be ignored.*

## EDIT BUTTONS

The Command buttons in the **Field Alignment Macros** window (**Window 8**) are made so that the **Field Alignment Method** can be developed, tested, and saved upon **Exit**. The **Field Alignment Method** is loaded upon opening **Window 8**. The box in the center of **Window 8** consists of a list of commands. Use the cursor keys or mouse to highlight a line. The content of the selected line is copied into the text-line above the list so that the text may be edited. While pressing the Carriage Return Key, the edited line is checked for syntax and other errors, and unless there is a problem the line is copied onto the list. In order to aid in the development of new lines, an entire program vocabulary is available to scroll down through from a list box on the upper-right corner of **Window 8**. Any command highlighted from the program vocabulary is then shown in the text-line.

- **Cut:**

Removes the highlighted line from the list and places it in an intermediate store. Please note that **Windows Clipboard** is not used here.

- **Paste:**

Will insert a line in front of the currently selected line to be loaded with the content of the intermediate store.

- **Insert:**

Inserts an empty line in front of the currently selected line.

- **Next:**

Hangs an empty line on the end of the list.

- **Use:**

Copies the text in the select box onto the edit-line.  
Normally entering values for the parameters is necessary.

- **Cam:**

Loads all necessary commands to set both the current camera conditions and lamp intensity in the edit-line.

- **Here:**

Saves current absolute position as reference position for relative positions calculated using the **Pos** button.

- **Pos:**

Loads a relative **Mov** command to the current stage position respectively to the position marked with the "**Here**" button.

## TEST BUTTONS

Test functions are not useful and can even be dangerous if the stage is not initialized. Test functions can therefore not be used until a stage initialization has been done.

- **Execute Line:**

Executes a highlighted line from the list. If an alignment statement is included in the line, the result of this alignment is shown in the lower area of **Window 8**. If an alignment could not be done, an illogical value will be shown instead.

- **Execute Site:**

Will execute the entire procedure, meaning all lines will be executed. In such a case, the average result of all alignment statements will be displayed.

- **Test:**

Tests entire **Field Alignment Method**, just as it would run during normal execution.

- **Exit:**

Will overwrite the current field alignment file with the developed method after a confirmation and then close **Field Alignment Macros** window (**Window 8**).

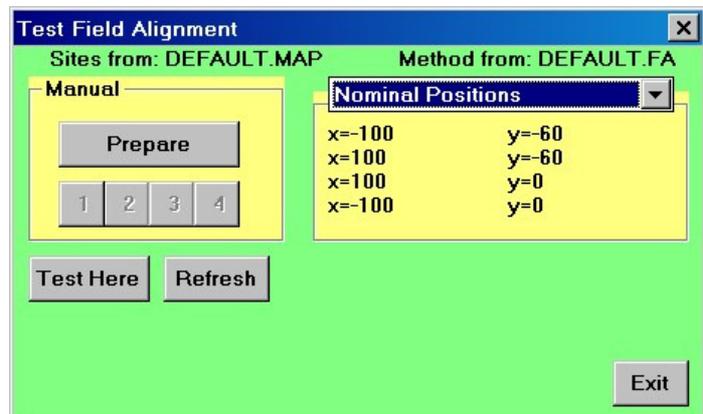
## TEST FIELD ALIGNMENT

1. The positions of each Site are defined in the MAP file.
2. At each Site the same field alignment sequence is done.
3. The sequence is always from Site 1 to 2 to 3 to 4.

The results of the sequence are:  
 Average Displacement  
 Size distortion in X and Y  
 X-angle error  
 Y-angle error

### INTRODUCTION

The **Test Field Alignment** window (**Window 9**) utilizes the current **Map** file and **Field Alignment** file. **Site 1** has a special function when testing as it is used as a reference, meaning that if a test is started, **site 1** must be within the view of the camera being used for the **Field Alignment Method**.



**Window 9**

Upon starting the testing process, nominal positions of the alignment sites will be displayed in the right box (**Window 9**). If only one alignment position is defined in the **Map** file then only one alignment position will be seen, etc. In some cases, exact alignment positions are not known and must be measured using **MANUAL MODE**.

## MANUAL MODE

Before **MANUAL MODE** can begin, use the **Control Panel** to move the stage to a position where the first alignment site is in clear view of the camera.

- **Prepare:**

Will start the manual process of getting nominal positions (up to four) for the alignment sites. After an alignment site has been accepted, move to the next site, or click on the **Cancel** button in the **Manual Alignment** window (**Window 11**, defined in more detail under **FIND MANUAL**). Nominal positions will appear after alignment sites have been defined.

- **1,2,3,4:**

Causes the system to move to the positions of these pre-defined alignment sites.

- **Test Here:**

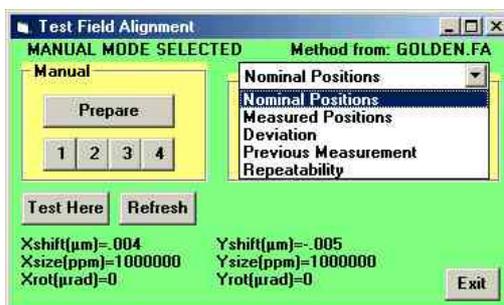
Once a camera has moved into position of the first site, the **Test Here** command will begin an automatic multi-site alignment test. Depending on the number of available sites, the results for up to six parameters will then be displayed in the lower part of **Window 9**:

Xshift( $\mu\text{m}$ )= Yshift( $\mu\text{m}$ )= (1 site)  
Xsize(ppm)= Ysize(ppm)= (2 sites)  
Xrot( $\mu\text{rad}$ )= Yrot( $\mu\text{rad}$ )= (4 sites)

The same results will be used in a multi-site alignment and correction procedure during an exposure.

- **Refresh:**

Used after editing an alignment procedure or selecting new **Environment** files. Clicking the **Refresh** button will cause **Window 9** to reload the aforementioned files.



## RESULT ANALYSIS OPTIONS

The commands in the following list determine which set of parameters is being shown in the text box underneath it.

- **Nominal Positions:**

Alignment positions from the **Map** file, or those manually measured.

- **Measured Positions:**

Results from the last full alignment sequence.

- **Deviation:**

Deviation between the latest measurement and the nominal values.

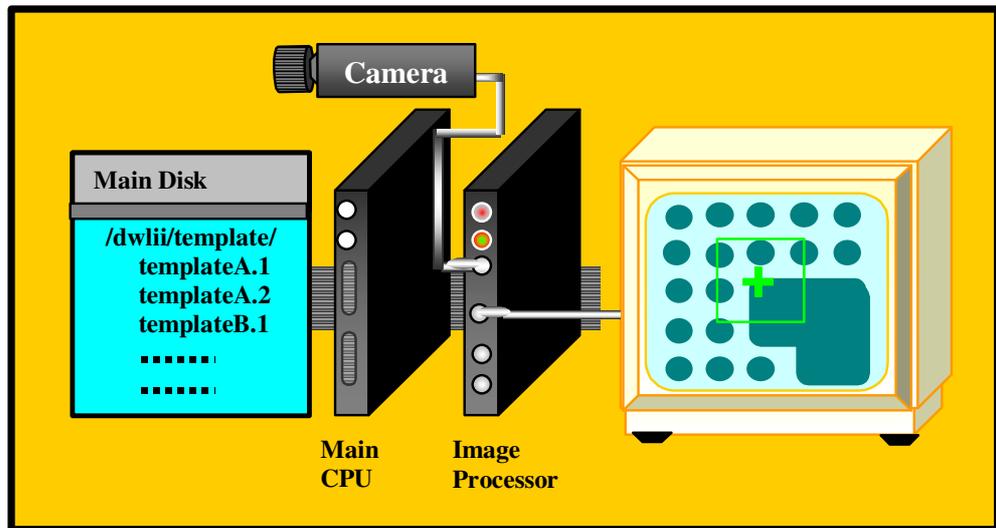
- **Previous Measurement:**

Results of the measurement taken before the last full alignment sequence.

- **Repeatability:**

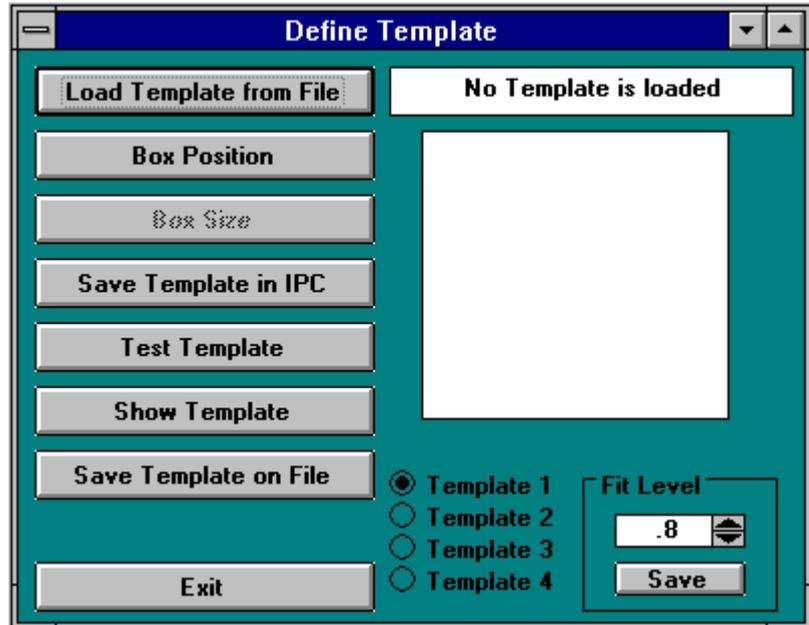
Deviation between the latest measurement results and measurement results from the previous measurement.

## DEFINE TEMPLATE



### INTRODUCTION

This procedure is made for an interactive template definition. Before the program can begin, a substrate from which a template will be made must be on the stage and in-focus, and the camera with which the template will be processed, must be selected in the **Control Panel**. Contrast and illumination should be as well as possible. For more information on the image alignment by means of a template search, see **Field Alignment**. The multiple sub-commands in this program are logically arranged and will normally be executed from top to bottom.



Window 10

## DEFINE TEMPLATE BUTTONS

- **Load Template from File:**

Shows the already defined templates that can now be selected. Be aware of the way in which templates are stored on the main system hard disk **/USER/DWLII/TEMPLATE** directory. Templates are stored under a name and a number as an extension. The image processor only knows templates by their number. For example, the **Os9** directory will show files in a manner as such:

```
Calibr.1
Calibr.2
Calibr.3
XLD5050r.1
XLS5050x.1
```

After selection of a file - Calibr.1, Calibr.2, or Calibr.3, all templates stating Calibr will be loaded to the template locations represented by the corresponding number in the extension. If only one template is defined, only one template will be loaded; thus, selecting XLS5050.1 - for example, will cause a template to be loaded in template register number 1.

- **Box Position:**

First step of a template definition sequence after the camera has been selected and the object area where a template is to be defined is visible and not too close to the edge of the monitor image. After selection, the image is frozen and a cross appears in the center of the screen, which can be moved while holding down the left button of

the mouse in the white square. Fine adjustment can be done using the arrows at the side of the square.

- **Box Size:**

After definition of template position, its size is set using the slides that appear. The best template is relatively small, yet contains unique information for both axes.

- **Save Template in IPC:**

Saves the defined template in the RAM of the image processor card IC40 under the number previously set with the template # checkbox.

- **Test Template:**

Tests a defined template on the current image. The result is printed below the cursor block in means of the following format:

```
FOUND TEMPLATE AT:  
  R-Fit = 0.7  
Xabs=-914-325  
Yabs= 644 230
```

The R-Fit value gives the reliability of the result; an R-Fit of 1 is a perfect match. For each axis' the absolute template position in tics is shown, followed by the template position in camera pixels.

If a template is not found an error message will appear. As a remedy, optimize contrast, uniqueness, or lower **Fit Level**.

- **Show Template:**

Templates are stored in the IC40 as a series representation at various pixel resolutions. The first search is done with a very course template image where 16x16 pixels are combined, followed by the next image with 8x8 pixels, etc. The **Show Template** command is used to ensure that the information in a course image still contains unique features so that a template may be found unambiguously. Particularly if there is too much detail in a template, the low-resolution image may contain only a blur and is then impossible to find unambiguously.

- **Save Template on File:**

All templates defined and stored in the IC40 under the numbers 1 through 4 can be stored under a common name. After a [name] has been entered into the dialogue box, the templates are stored under the names: <name>.1 through <name>.4 in the **Os9** directory **/USER/DWLII/TEMPLATE**.

- **Template #:**

Selects, which image processor template register, is used for storing and loading.

- **Fit Level:**

Using the arrows, the current fit level given in the box can be changed. The new fit level will only be used for template testing unless it is being transferred to the configuration file using the **Fit Level Save** button. The **Fit Level** decides the reliability, that a result from a template search procedure that must have to be accepted as O.K. Usually set to 0.8 (= 80% reliability); should never be lower than 0.6.

- **Fit Level Save:**

Causes the currently entered fit level to be stored into the configuration file, where the value will be used for all future alignments - *be careful when changing the **Fit Level**.*

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## CHAPTER 5 - METROLOGY

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### **METROLOGY COMMANDS**

A number of measurement procedures to quantify exposures are listed under **Measure** in the main menu. Some of these commands are specifically developed to aid with the measurement of parameters important for system specific adjustments and calibrations. Most metrology commands require top illumination, which will lower quality measurement of emulsion plates if using the high magnification objectives with 4mm and 10mm focal lengths.

- **Overlay:**

Measures the relative positioning accuracy of two overlaid exposures on a single plate by utilizing a number of models, such as box-in-box structures, etc.

- **Distance:**

Offers both an automatic and a manual metrology method for measuring the distances between two features on a substrate.

- **Positions:**

Measures die-to-die alignment of a feature in order to ensure that the machine coordinate system is linear and orthogonal.

- **Linewidth:**

Measures and analyzes the line width of a feature based on its video profile.

- **Pitch, Stitching, Edge:**

Measures the distance between two identical features by associating video profiles of the images and then searching for the maximum in the correlation function.

## OVERLAY MEASUREMENTS

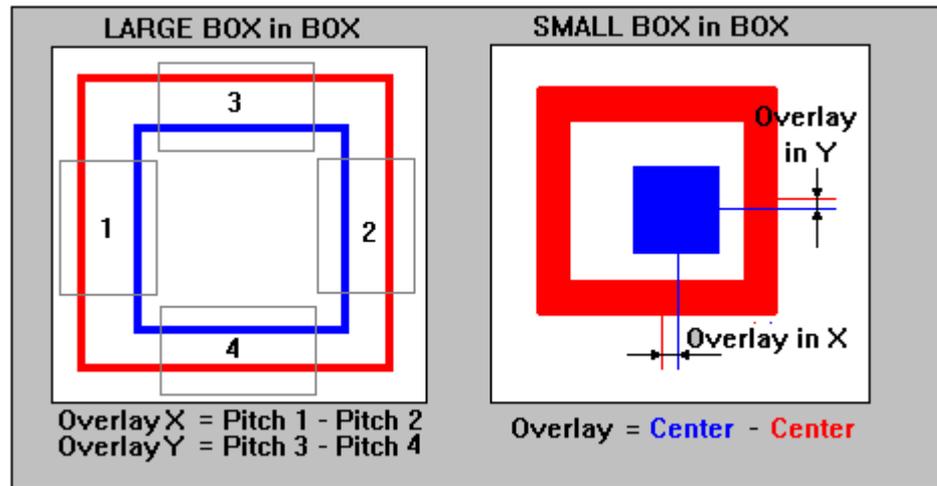


Figure 5

### INTRODUCTION

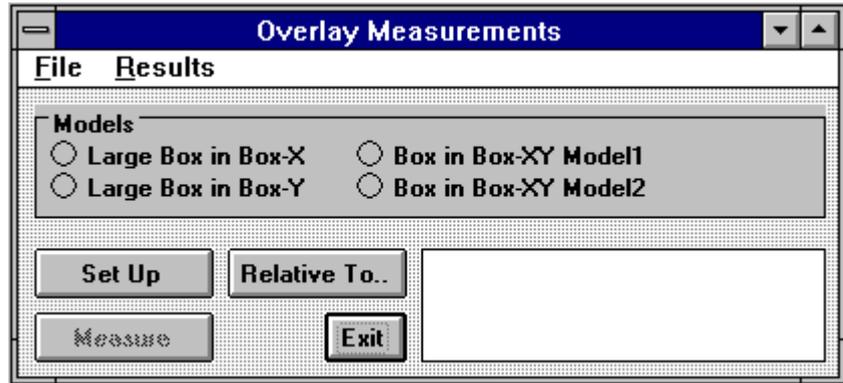
The purpose of overlay measurements is to determine the position shift between two printed layers. To use the measurement methods offered under this command, specific structures must be written as shown in **Figure 5**, where the **red** structures are written in one layer, while the **blue** structures are part of the other layer. *Overlay measurements* are designed to measure the registration between these two layers. There are two different models:

- **LARGE BOX in BOX METHOD:**

Two lines of equal thickness are written on two layers. For the measurement, boxes must be defined over these lines, two for -X and two for -Y. Within each of these boxes the pitch, or distance between the two lines is measured. Overlay is calculated by the difference between pitches. The **Large Box in Box** structure is usually greater than the micro-camera field so the stage will move to each measuring box before doing a pitch measurement.

- **SMALL BOX in BOX METHOD:**

The **Small Box in Box** structure consists of two box shaped areas placed within each other. Measuring symmetry axes and comparing the differences will determine the overlay.



Window 12

## OVERLAY MEASUREMENTS - FILE COMMANDS

- **Load:**

Loads an already existing measurement file, which must have the extension ".msr", and is normally found in the directory **\MEASURE**. Upon loading, a model option is read from the file and is automatically switched on. After loading, a window will appear requesting that the operator, "**Point to the reference site**," to which all recorded measurement positions will correspond. If the measurement method is executed automatically through a **Job** file, the chosen reference site can also be the alignment site of the respective field.

- **Save Measurement:**

Saves the current measurement method under a requested file name. This measurement method can then be reloaded later or used within an automatic measurement procedure. If a reference site was not previously marked, a window will appear requesting to "**choose a reference site**".

- **Exit:**

Closes the **Overlay Measurements** window (**Window 12**).

## OVERLAY MEASUREMENTS - RESULTS COMMANDS

After a measurement series has been made, results may be inspected and saved using the **Results** commands.

- **View and Save:**

Loads an editor with the current measurement results. The file can then be saved as a text file within the editor.

- **To Excel:**

Copies the measurement results to the Clipboard. These can now be copied into another application by pressing **Control-V**, or highlighting the **Paste** Function. In this

way, data can e.g. be displayed and further processed using **Microsoft Excel** or any other spreadsheet application.

## MODELS

The result of an overlay measurement depends on the contrast of structures, which in many cases is far from ideal; therefore, a number of measurement strategies have been developed, where two fundamentally different principles are being used: *Pitch Measurement* -determines the distance between two similar structures, and *Center Measurement* -determines the main symmetry axis of a structure.

- **Large Box in Box-X:**

A **Large Box in Box** structure will consist of two frames with similar thickness', each written on a separate layer (as shown on the left-side in **Figure 5**). Upon set up, a window will request the placement of a measurement box over two vertical lines at one location **(1)**. The distance between these lines will now be measured using the *pitch method*. Next, the same box must be placed over the corresponding right side of the alignment structure **(2)**. The overlay is determined by the difference between these distances. The stage will always move the location where the measurement box has been placed to the center of the screen before a measurement is started.

- **Large Box in Box-Y:**

A **Large Box in Box** structure will consist of two frames with similar thickness', each written on a separate layer. Upon set up, a window will request the placement of a measurement box over two horizontal lines at one location **(3)**. The distance between these lines will now be measured using the *pitch method*. Next, the same box must be placed over the corresponding lower part of the alignment structure **(4)**. The overlay is determined by the difference between these distances. The stage will always move the location where the measurement box has been placed to the center of the screen before a measurement is started.

- **Box in Box-XY Model1:**

A **Small Box in Box** structure consists of a filled block, framed by a relatively thick line. Comparing the symmetry axis of the small block with the symmetry axis of the frame does a measurement. The size of the whole structure is typically between 10 to 20-microns.

- **Box in Box-XY Model2:**

**Box in Box-XY Model2** is applied if there is a rather weak contrast, or if a structure is covered with a layer of resist and only the edges of the structure are detectable. Overlay is measured in a similar way as with the **Large Box in Box** structure, but without moving the stage to the measurement positions.

## OVERLAY MEASUREMENTS BUTTONS

- **Set Up:**

Before a measurement can be executed it must be pre-programmed with the **Set Up** model. Depending on which method has been selected, measurement boxes are required to be placed over the structures, and then a series of measurements can be made by continuation. Cancel **Set Up** model if sufficient measurements have been made. Once **Set Up** is complete, the whole measurement process can be saved and viewed in **View Measurement Method** under the **Tools** menu.

- **Relative To..:**

Before a measurement can be saved a reference position must be selected. If no reference position is selected, then the current stage position will be used as a reference position. For a local series of measurements the location of the first structure is normally used as a reference point. If the measurement method is ready to be used for automatic measurements in the **Job** file, the field alignment sight may be used.

- **Measure:**

Starts the currently active measurement sequence.

- **Results (Text Box):**

The **results text box**, located on the lower right-hand side of **Window 12**, posts the actual overlay results and at the end of the measurement averages appear. The complete results can be viewed using the **View and Save** command.

- **Exit**

Closes the **Overlay Measurements** window (**Window 12**).

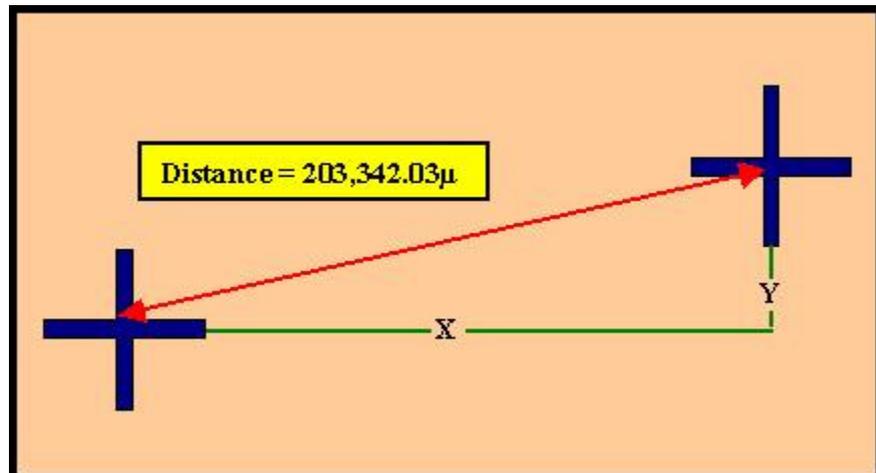
### Example of an Overlay Measurement Method

*A typical program should follow the format of the model below:*

```
Method=Small Box in Box-XY
Camera=Macro
InnerBox-X=100
InnerBox-Y=100
OuterBox-X=200
OuterBox-Y=200
Reference=Center of First Structure
{
    'Indicates start
0,0      'X,Y of 1. site
100,0    'X,Y of 2. site
200,0    'X,Y of 3. site
300,0    'X,Y of 4. site
400,0    'X,Y of 5. site
500,0    'X,Y of 6. site
}
'End of series
```

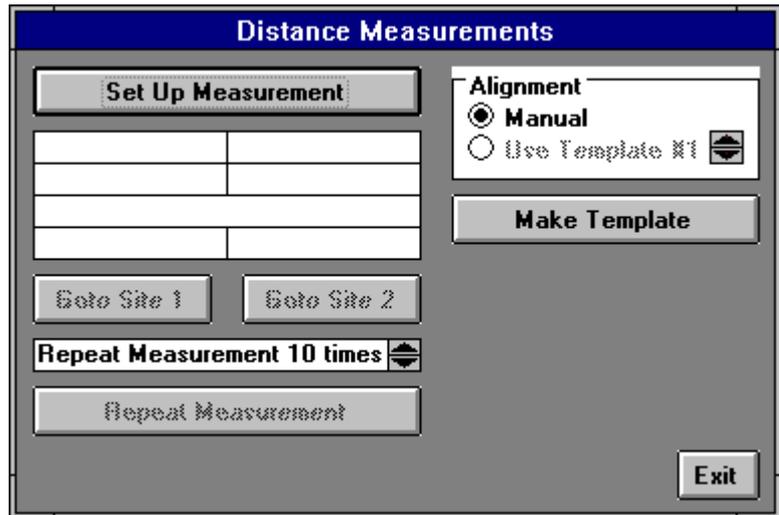
## ***DISTANCE MEASUREMENTS***

---



### **INTRODUCTION**

The measurement of distances on a substrate can be small as to fall within a camera image, or large as to encompass the entire stage travel range. Precision of measurement is enhanced by repeating several times and will result in additional statistical information. The best values are obtained if automatic template recognition is used for the real measurement.



Window 13

## DISTANCE MEASUREMENT BUTTONS

- **Set Up Measurement:**

Before a distance measurement can be made, the two points to be measured must be defined. A window will request the operator “**to point to the first site**” with the cursor by means of the mouse, then repeat for the second site. Use the **Control Panel** to move over large distances, for switching between cameras, and for the adjustment of contrast, etc. Once the measurement has been setup, the distance between the two points (or, sites) will be shown in microns.

- **Goto Site 1:**

Moves stage to the site of the first measurement point.

- **Goto Site 2:**

Moves stage to the site of the second measurement point.

- **Repeat Measurement # times**

**Repeat measurement** should be set to at least **5 times** for a satisfactory measurement accuracy.

- **Repeat Measurement:**

Starts a measurement series.

- **Exit:**

Closes **Distance Measurements** window (**Window 13**).

## **ALIGNMENT**

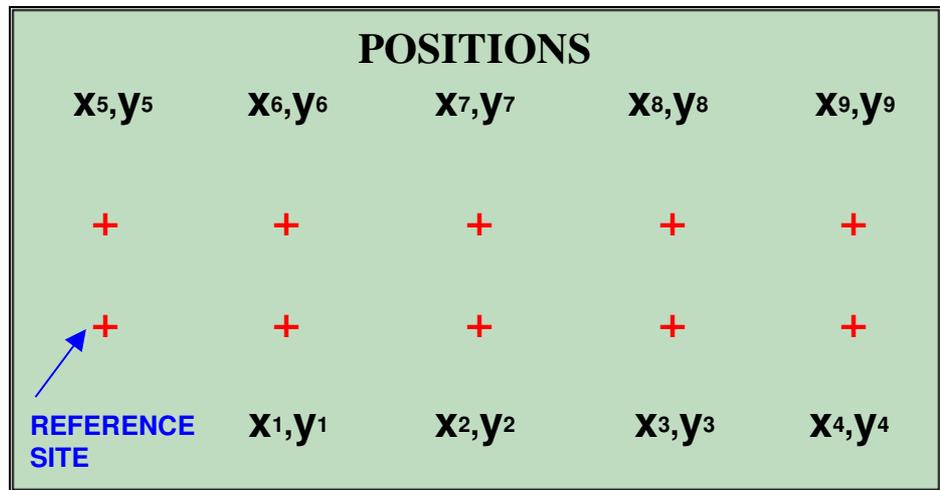
Select either **Manual** mode, which is also used for **Set Up**, or the **Use Template** mode. A template must be defined, before the **Use Template** mode may be chosen.

- **Make Template:**

Opens **Define Template** window. If the template defined here will only be used for the current distance measurement, it would be sufficient to store the template in one of the four buffers of the IPC module.

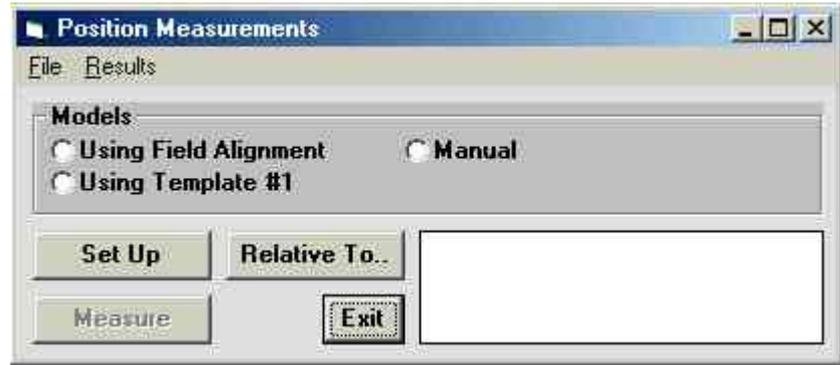
## **POSITION MEASUREMENTS**

---



### **INTRODUCTION**

Position measurements provide information, not only about distances, but angular distortions or non-linearity over a substrate as well. Position measurements are therefore an important tool for initial system calibration and exposure quality control.



Window 14

## POSITION MEASUREMENTS - FILE COMMANDS

- **Load:**

Loads an already existing measurement file, which must have the extension ".msr", and is normally found in the directory **MEASURE**. Upon loading, a model option is read from the file and is automatically switched on. After loading, a window will appear requesting that the operator, "**Point to the reference site,**" to which all recorded measurement positions will correspond. If the measurement method is executed automatically through a **Job** file, the chosen reference site can also be the alignment site of the respective field.

- **Save Measurement:**

Saves the current measurement method under a requested file name. This measurement method can then be reloaded later or used within an automatic measurement procedure. If a reference site was not previously marked a window will appear requesting to "**choose a reference site**".

- **Exit:**

Closes the **Position Measurements** window (**Window 14**).

## POSITION MEASUREMENTS - RESULTS COMMANDS

After a measurement series has been made, results may be inspected and saved using the **Results** commands.

- **View and Save:**

**Loads an editor with the current measurement results.** The file can then be saved as a text file within the editor.

- **To Excel:**

Copies the measurement results to the Clipboard. These can now be copied into another application by pressing **Control-V**, or highlighting the **Paste** Function. In this

way, data can e.g. be displayed and further processed using **Microsoft Excel** or any other spreadsheet application.

## **MODELS**

If the distribution of identical structures on a substrate should be measured, a template or – if the structure is e.g., a cross – a field alignment method can be used. If the positions of several different structures should be measured, this must be done either manually or with several separate measurements relating to the same point of reference.

- **Using Field Alignment:**

Uses current field alignment for position detection. Highlight **Field Alignment Method** under **S**etup in the Main Menu.

- **Using Template #1:**

This method uses the template currently stored in buffer #1 of the IPC for the detection of structure positions. To define a new template, highlight **Define Template** under **S**etup in the Main Menu.

- **Manual:**

In manual mode, the operator is prompted to “**Point to the Site to be Measured**” for each structure position measurement, similar to the setup procedure.

## **POSITION MEASUREMENT BUTTONS:**

- **Set Up:**

Before a Position Measurement may be done, the stage positions at which the structures to be measured are well within the camera field must be determined to program the measurement procedure. When the **Set Up** function is started the operator is prompted to “**Point to First Site**” to be measured using the mouse and, if necessary, the **Control Panel**. This has to be repeated for each structure to be measured. Finish the measurement setup by choosing **Cancel** in the **Define Measurement** dialogue box. Now the measurement method can be saved and viewed in **View Measurement Method** under **T**ools in the Main Menu.

- **Relative To...:**

Before a measurement can be saved a reference position must be selected. If no reference position is selected, then the current stage position will be used as a reference position. For a local series of measurements the location of the first structure is normally used as a reference point. If the measurement method is ready to be used for automatic measurements in the **J**ob file, the field alignment sight may be used.

- **Measure:**

Starts the currently active measurement sequence.

- **Results (Text Box):**

The **results text box**, located on the lower right-hand side of **Window 14**, posts the actual measurement result. The complete results can be viewed using the **View and **S**ave** command.

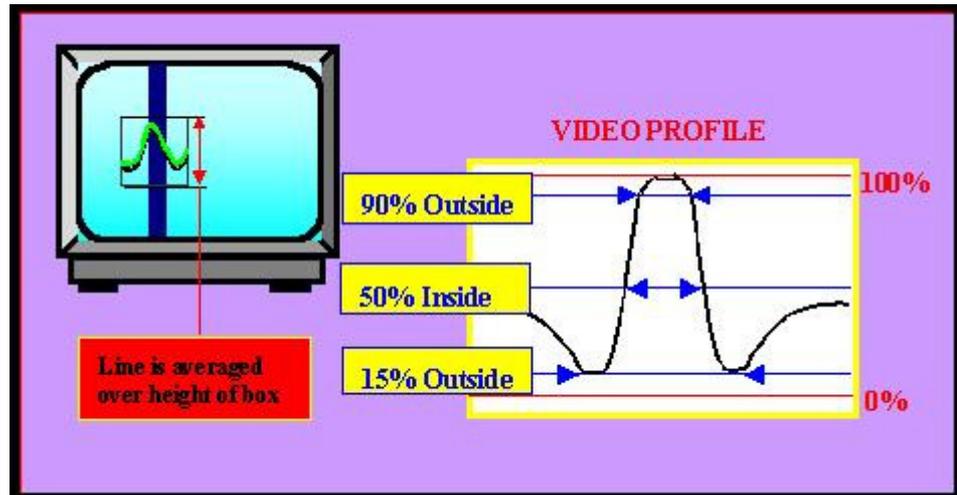
- **Exit**

Closes the **Position Measurements** Window (**Window 14**).

### **Example of a Position Measurement Method**

*A typical program should follow the format of the model below:*

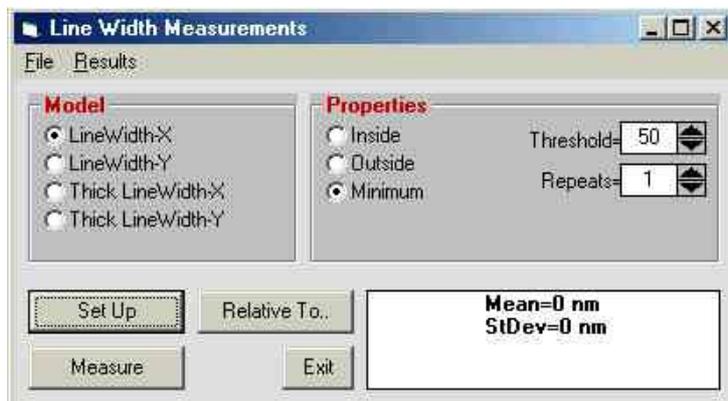
```
Method=      Using Template #1
Camera=      Micro
Box Width=   0
Box Height=  0
Reference=   Lower Left Corner of Pattern
{
  'Indicates start
0,0         'X,Y of 1. site
100,0      'X,Y of 2. site
200,0      'X,Y of 3. site
300,0      'X,Y of 4. site
400,0      'X,Y of 5. site
500,0      'X,Y of 6. site
}
'End of series
```



## LINE WIDTH MEASUREMENTS

### INTRODUCTION

**Linewidth** measurements are done through the camera system where the video camera must show the line structure to be measured either in X or in Y. Measuring the diameter of a circle is possible by either lowering the box height, or tightening the width of the box. The contrast should be clear, and if contrast is not clear, modify **Lamp**, **Gain** and **Offset** of the camera to improve the contrast. Two of the available analysis models are based on a linear fit to a small range of video signals around a requested threshold value, followed by a determination of the intersection between the horizontal threshold line and the fitted lines. Thereby, values are considerably more accurate than just the camera pixel size. The third model determines the positions of the two signal minima using a parabolic fit.



Window 15

## **LINEWIDTH MEASUREMENTS - FILE COMMANDS**

- **Load:**

Loads an already existing measurement file, which must have the extension ".msr", and is normally found in the directory \MEASURE. Upon loading, a model option is read from the file and is automatically switched on. After loading, a window will appear requesting that the operator, "**Point to the reference site,**" to which all recorded measurement positions will correspond. If the measurement method is executed automatically through a **Job** file, the chosen reference site can also be the alignment site of the respective field.

- **Save Measurement:**

Saves the current measurement method under a requested file name. This measurement method can then be reloaded later or used within an automatic measurement procedure. If a reference site was not previously marked a window will appear requesting to "**choose a reference site**".

- **Exit:**

Closes the **Line Width Measurements** window (**Window 15**).

## **LINEWIDTH MEASUREMENTS - RESULTS COMMANDS**

After a measurement series has been made, results may be inspected and saved under **Results** commands.

- **View and Save:**

Loads an editor with the current measurement results. The file can then be saved as a text file within the editor.

- **To Excel:**

Copies the measurement results to the Clipboard. These can now be copied into another application by pressing **Control-V**, or highlighting the **Paste** Function. In this way, data can e.g. be displayed and further processed using **Microsoft Excel** or any other spreadsheet application.

## **MODELS**

- **LineWidth-X**

Select the X method for vertical lines.

- **LineWidth-Y**

Select the Y method for horizontal lines.

- **Thick LineWidth-X:**

Selects the measurement method for thick vertical lines (larger than 1/2 monitor image).

- **Thick LineWidth-Y:**

Selects the measurement method for thick horizontal lines (larger than 1/2 monitor image).

## **PROPERTIES**

- **Inside:**

Analysis is done by looking for the intersection between the video profile and the threshold level, starting from the center of the box.

- **Outside:**

Analysis is done by looking for the intersection between the video profile and the threshold level, starting from the two edges of the measurement box.

- **Minimum:**

Beginning at the center of the measurement frame, searches for the two extremes. The location of extremes is found by locally fitting a parable.

- **Threshold=**

Enter a value between 0 and 100% of the amplitude of the video profile. For most purposes the value should be between 25% and 50%.

- **Repeats=**

The measurement method averages over all the video lines within the height, or width of a box before making threshold analysis. In addition, the whole measurement can be repeated and averaged a number of times by entering the desired number of repeats in this box. However, no statistical information is deduced from this type of averaging.

## **LINewidth MEASUREMENTS BUTTONS**

- **Set Up:**

Before a measurement can be executed it must be pre-programmed with the **Set Up** model. Depending on which method has been selected, measurement boxes are required to be placed over the structures, and then a series of measurements can be made by continuation. Cancel **Set Up** model if sufficient measurements have been made. Once **Set Up** is complete, it can be saved and viewed in **View Measurement Method** under the **Tools** menu.

- **Relative To..:**

Before a measurement can be saved a reference position must be selected. If a current reference position is not manually selected, then an arbitrary location may automatically select the current position. For a local series of measurements the location of the first structure is normally applied. If a method for including a fully automatic program is pre-prepared, the alignment site can be employed.

- **Measure:**

Starts the currently active measurement sequence.

- **Results (Text Box):**

The **results (text box)**, located on the lower right-hand side of **Window 15**, posts the actual measurement results and at the end of the measurement averages appear. The complete results can be viewed using the **View and Save** command.

- **Exit:**

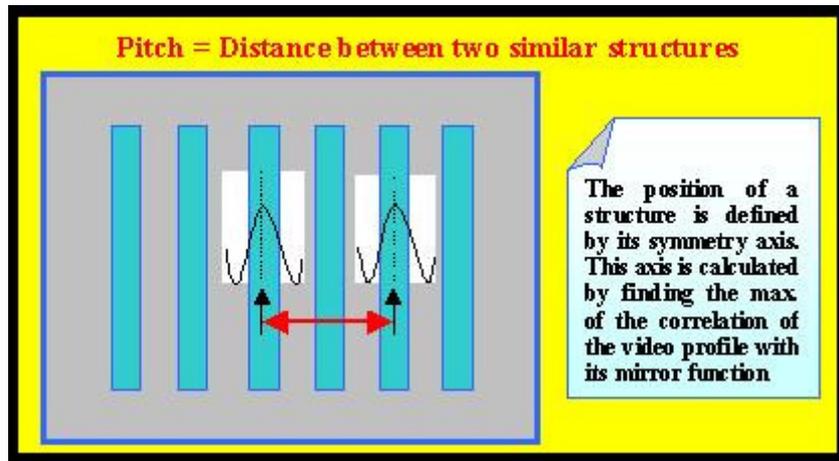
Closes the **Linewidth Measurements** window (**Window 15**).

### Example of a Linewidth Measurement Method

*A typical program should follow the format of the model below:*

```
Method=LineWidth-X
Camera=Micro
BoxWidth=100
BoxHeight=84
Model=Inside
Threshold=50
Repeats=1
Reference=Low Left Corner PFM Pattern
{
    'Indicates start
0,0      'X,Y of 1. site
100,0    'X,Y of 2. site
200,0    'X,Y of 3. site
300,0    'X,Y of 4. site
400,0    'X,Y of 5. site
500,0    'X,Y of 6. site
}
'End of series
```

## **PITCH MEASUREMENTS**



### **INTRODUCTION**

In many cases it is important to measure the distance between two structures, located relatively near to each other. If such structures are identical in appearance, the distance being measured is uniquely defined by a numerical comparison of the two video profiles of each structure. A cross correlation will yield the distance with an extremely high repeatability.

- **PITCH MEASUREMENTS:**

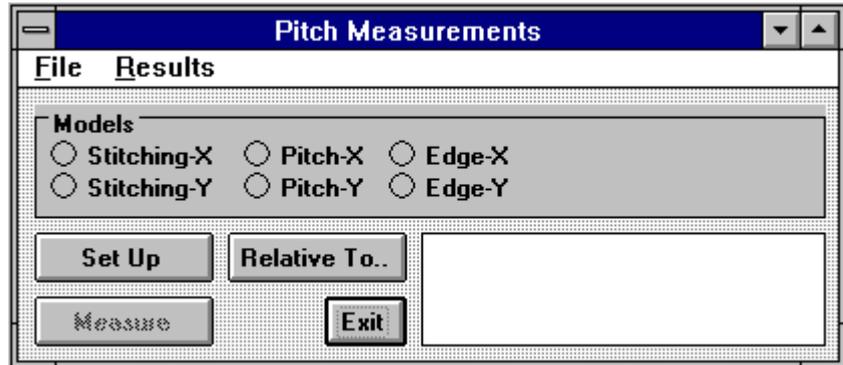
The pitch measuring method is applied for finding the horizontal distance of pairs of vertical lines or for finding the vertical distance of pairs of horizontal lines. This method may be extended to measure whole sets of equidistant lines.

- **STITCHING MEASUREMENTS:**

Determines the vertical position of two horizontal lines or the horizontal distance of two vertical lines. This method and is designed to run DWL stitching performance measurements in both X and in Y, using the system test pattern.

- **EDGE MEASUREMENTS:**

The measurement of edge roughness in an exposed structure. The average position of a vertical line is measured at a number of positions. Each position is determined by the location of the maximum in the cross-correlation function of the local video profile through its mirror image. The RMS deviation of a fit through these position measurement results will determine edge roughness.



Window 16

## PITCH MEASUREMENTS - FILE COMMANDS

- **Load:**

Loads an already existing measurement file, which must have the extension ".msr", and is normally found in the directory **MEASURE**. Upon loading, a model option is read from the file and is automatically switched on. After loading, a window will appear requesting that the operator, "**Point to the reference site,**" to which all recorded measurement positions will correspond. If the measurement method is executed automatically through a **Job** file, the chosen reference site can also be the alignment site of the respective field.

- **Save Measurement:**

Saves the current measurement method under a requested file name. This measurement method can then be reloaded later or used within an automatic measurement procedure. If a reference site was not previously marked, a window will appear requesting to "**choose a reference site**".

- **Exit:**

Closes the **Pitch Measurements** window (**Window 16**).

## PITCH MEASUREMENTS - RESULTS COMMANDS

After a measurement series has been made, results may be inspected and saved using the **Results** commands.

- **View and Save:**

Loads an editor with the current measurement results. The file can then be saved as a text file within the editor.

- **To Excel:**

Copies the measurement results to the Clipboard. These can now be copied into another application by pressing **Control-V**, or highlighting the **Paste** Function. In this

way, data can e.g. be displayed and further processed using **Microsoft Excel** or any other spreadsheet application.

## MODELS

- **Stitching-X:**

Measures the distance between two vertical lines, on both left and right sides of a stripe border, and will repeat the measurement in other locations on the substrate, if required. The RMS deviation of the results from the resulting average will determine stitching quality in -X.

- **Stitching-Y:**

Measures the vertical distance between the sections of two horizontal lines, on both left and right sides of a stripe border, and will repeat the measurement in other locations on the substrate, if required. The RMS deviation of the results from the resulting average will determine stitching quality in -Y. This value depends on the stage velocity and therefore must be minimized by optical adjustment for each configuration individually.

- **Pitch-X:**

Compares the distance between two vertical lines or a row of equidistant lines over a programmed area.

- **Pitch-Y:**

Compares the distance between two horizontal lines or a row of equidistant lines over a programmed area.

- **Edge-X:**

Determines the roughness of a vertical edge due to position fluctuations, but can only be applied to a comparatively thin vertical line. The result is insensitive for line width fluctuations.

- **Edge-Y:**

Determines the roughness of a horizontal edge due to position fluctuations, but can only be applied to a comparatively thin horizontal line. The result is insensitive for line width fluctuations.

## PITCH MEASUREMENTS BUTTONS

- **Set Up:**

Before a measurement may be executed it must be pre-programmed with the **Set Up** model. Depending on which method has been selected, measurement frames are required to be placed over the structures, and then a series of measurements can be made by continuation. Cancel **Set Up** model if sufficient measurements have been

made. Once **Set Up** is complete, the method programmed may be saved and viewed in **View Measurement Method** under **T**ools in the Main Menu.

### Example of a Pitch Measurement Method

*A typical program should follow the format of the model below:*

```
Method=Pitch-X
Camera=Micro
BoxWidth=100
BoxHeight=275
BoxDistance-X=201.44098189792
Reference=Lower Left Corner of PFM Pattern
{
    'Indicates start
0,0      'X,Y of 1. site
100,0    'X,Y of 2. site
200,0    'X,Y of 3. site
300,0    'X,Y of 4. site
400,0    'X,Y of 5. site
500,0    'X,Y of 6. site
}      'End of series
```

- **Relative To..:**

Before a measurement can be saved a reference position must be selected. If no reference position is selected, then the current stage position will be used as a reference position. For a local series of measurements the location of the first structure is normally used as a reference point. If the measurement method is ready to be used for automatic measurements in the Job file, the field alignment sight may be used.

- **Measure:**

Starts the currently active measurement sequence.

- **Results (Text Box):**

The **results text box**, located on the lower right-hand side of **Window 16**, posts the actual measurement result. The complete results can be viewed using the **View and Save** command.

- **Exit:**

Closes the **Pitch Measurements** window (**Window 16**).

## CHAPTER 6 - TOOLS

---

### TOOLS

A number of tools have been prepared for the further processing and display of collected data.

- **Analyse Report for Alignment:**

Extracts relevant alignment information from a job report file, where the data can then be sent to a spreadsheet for further evaluation.

- **Analyse Report for Measurement Results:**

Extracts relevant measurement information from a job report file, where the data can then be sent to a spreadsheet for further evaluation.

- **View Job Log:**

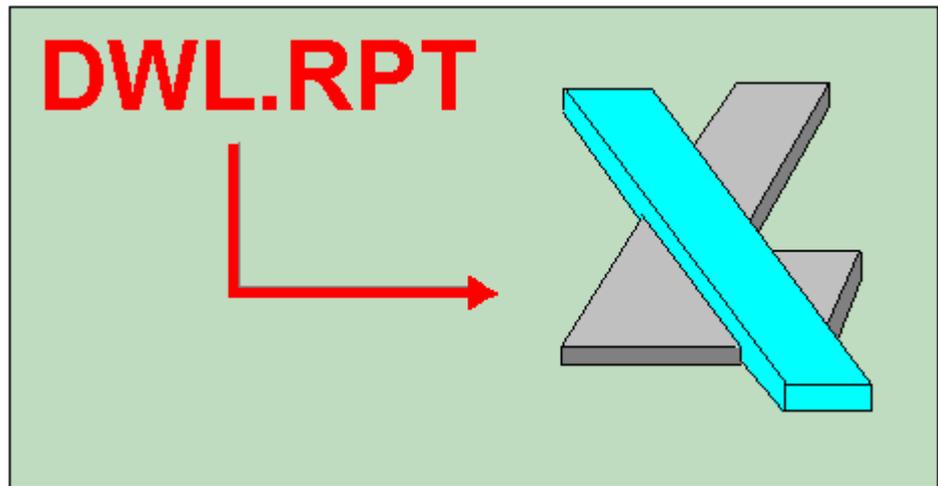
Displays content of the Job Log File.

- **View Measurement Method:**

Displays present measurement method and will enable an operator to edit the method (i.e., to manually add more measurement points).

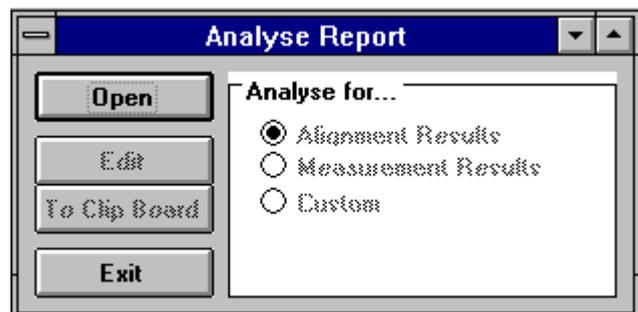
## **ANALYSE REPORT**

---



### **INTRODUCTION**

After each exposure and measurement procedure, a **Report** file is produced containing information regarding the inspection and qualification of an exposure. Since all the various information stored in a **Report** file are printed in a sequential order, extracting specific data may be necessary before further evaluation may be done. This data extraction may be done either manually or automatically using the **Analyse Report** window (**Window 17**).



**Window 17**

## **ANALYSE FOR... FUNCTIONS**

- **Alignment Results:**

Extracts and groups all relevant alignment data into a table to be processed in **Microsoft Excel**.

- **Measurement Results:**

Extracts and groups all measurement results into a table to be processed in **Microsoft Excel**. The **M** Measurement menu is followed by all stage positions and current measurement results used to produce a plot of measurement results as a function of the location on the substrate.

- **Analyse For... (Text Frame):**

Displays which option for report file data extraction is currently active.

## **ANALYSE REPORT BUTTONS**

- **Open:**

Directly after an exposure, or measurement, the last report made is loaded by default and it is not necessary to open a file. The **O** Open command will analyze a previously written report. All report files have the extension **.rpt** and are normally recorded in their corresponding Job directory.

- **Edit:**

Loads the requested data under a different name into an editor where it may be inspected and saved.

- **To Clip Board:**

Writes extracted data to the **C** Clipboard. It can then be pasted into an editor or spreadsheet program (i.e., **Microsoft Excel**) for inspection and further analysis. Without exiting the DWL menu, start the other application and press **C** Control-V, or use the **P** Paste command available within the application. The data will be loaded onto the current spreadsheet.

- **Exit:**

Closes the **Analyze Report** window (**Window 17**).

## ***VIEW JOB LOG FILE***

---

### **VIEW JOB LOG**

If **Job Log** is highlighted in the **Run Job** submenu, then the name of the current job, start time, and stop time for each exposure or automatic measurement is entered in the file "C:\VBMENU\WINDWL\JOBLOG.TXT". The **View Job Log** function loads this file into the **Windows Notepad** where it can be inspected, altered, printed or saved under another name, or on another medium. The content of the **Job Log** is useful for accounting purposes.

## ***VIEW MEASUREMENT METHOD***

---

### **VIEW MEASUREMENT METHOD**

Opens the **Windows Default Editor** (usually Notepad) for inspecting, editing, saving, and printing measurement method files. Once a specific measurement method is created, the list of measurement locations can be extended using the editor, which is easier than having to prepare each individual measurement point manually. To construct a measurement location table for an extremely large number of measurements, a spreadsheet program like e.g. **Microsoft Excel** can be used, but be careful to use the correct format when transferring the coordinate sets to the measurement method.

## CHAPTER 7 - SERVICE

---

### **SERVICE COMMANDS**

- **Debug Window:**

Monitors communication between the User PC and the DWL Main CPU. This function is only to be used during a test, since it will considerably slow down the performance of the entire DWL system.

- **View OS9 Config:**

Shows current machine configuration parameters.

- **DWL Control Panel (F9):**

Opens window with manual controls for most system functions, particularly stage initialization and focus.

- **Edit Configuration File:**

Opens editor to check and edit current system configuration. Provides access to the **Configuration Change** window as well as the **windwl.ini** menu startup file for viewing.

- **Video Calibration**

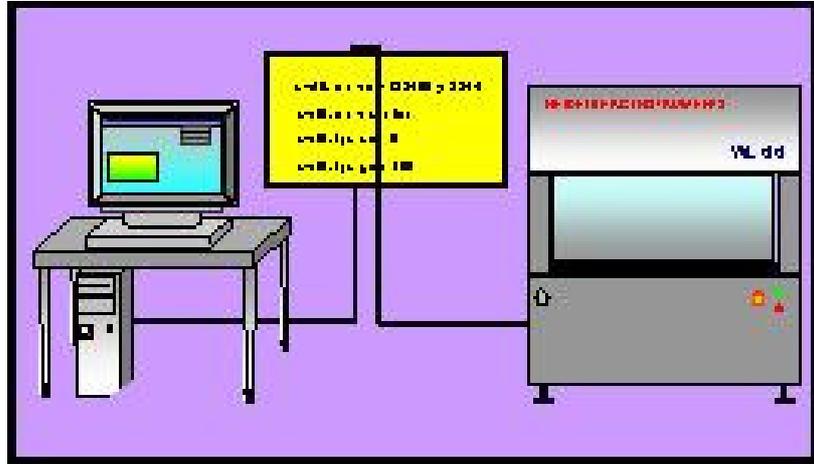
Calibrates the micro- and macro-camera position against the interferometer. This procedure must be repeated whenever modifications to the optics system have been made.

- **Reset Stage:**

Initializes the stage after confirmation from the operator by moving it back into the Home position and resetting the interferometer coordinate system. Same function as the **Stage → Reset** Option in the **Control Panel** menu.

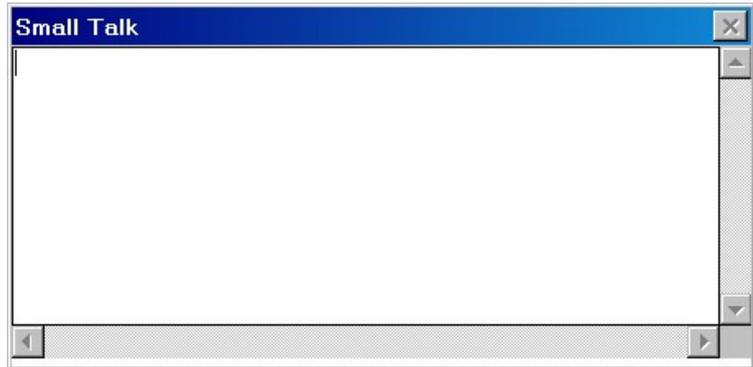
## ***SMALL TALK COMM DEBUG AND OS9 COMMANDS***

---



### **INTRODUCTION**

The DWL main system is controlled by a number of programs running concurrently. The User PC simply generates command strings in a useful sequence where decisions depend on a response from the main system. Communication usually runs along one serial COM port, and before the system can be operated, the PC port must be logged in as a user for the OS9 operating system, by clicking on the **Mini Terminal** icon  located below the main menu toolbar. User name and password are factory preset to: "dwlii". If the PC is not logged in or there is no connection to the system, opening the **Debug Window** will display commands that would have been sent by the PC to the DWL system.



**Window 18**

## OS9 COMMANDS

This is only an excerpt of the most common functions. If the DWL system is connected and the PC is logged on, detailed information on every **OS9** command may be obtained by opening the **Mini Terminal** window and typing in commands with the **-?** option.

- **General Commands:**

### *adjust\_fi*

*Function:* download / create frequency & intensity data for ECU  
*Syntax:* adjust\_fi {[<opts>] <filename>} [<opts>]  
 Options of interest:

- c Create new frequency-intensity database file
- u Update from existing database
- p adjust Intensity Profile
- l Init with default values
- s[=][<fac>] Scale Int.Profile to <fac>%
- t[=][<range>] Defl.Area Test (+/-<range>%)  
 <range> 0-100 (%)
- d[=]<hex> debug flag:  
 \$0800 program variables  
 \$0400 Parser

### *expodie*

*Function:* Exposure Control Program  
*Syntax:* expodie [<opts>] {<design> [<opts>]}  
 Options of interest:

- i[=]<value> Exposure Intensity (0-100)[%]
- s[=]<name> list of stripes
- x[=]<value> X position (nm)
- y[=]<value> Y position (nm)
- k keep SDist from expose.cfg
- d[=]<hex> debug flag:  
 \$0800 program variables  
 \$0400 Parser

\$0100 Messages  
\$0004 calculated values

**hw**

*Function:* User Interface for DWL hardware

*Syntax:* hw [<opts>] [<cmds>]

*Commands:*

|                     |                                   |
|---------------------|-----------------------------------|
| ifstat              | check status of IF-System         |
| ifreset             | reset IF-System                   |
| hecd[+ / -]         | open / close HeCD shutter         |
| afix[+ / -]         | fix / release Auto Focus          |
| movz                | display actual <zpos>             |
| movz=<zpos>         | move write head to <zpos>         |
| movz[+ -]<zsteps>   | move write head +/- <zsteps>      |
| movz:=<zpos>        | set write head position to <zpos> |
| adc.<cname>         | read value from ADC <cname>       |
|                     | hilo (CH4)                        |
|                     | piezo (CH5)                       |
|                     | intens (CH7)                      |
|                     | IN_0 (CH0)                        |
|                     | IN_1 (CH1)                        |
|                     | IN_2 (CH2)                        |
|                     | IN_3 (CH3)                        |
|                     | IN_4 (CH6)                        |
| dac.<cname>=<value> | set <value> for DAC <cname>       |
|                     | lamp...(CH_A)                     |
|                     | defoc...(CH_D)                    |
|                     | OUT_0...(CH_B)                    |
|                     | OUT_1...(CH_C)                    |

*Options of interest:*

|            |  |
|------------|--|
| -d[=]<hex> | debug flag:<br>\$0800 program variables<br>\$0400 Parser |
|------------|--|

**init\_dwl**

*Function:* initialize DWL data structures

*Syntax:* init\_dwl [<opts>]

*Options of interest:*

|             |  |
|-------------|--|
| -f[=]<file> | configuration file (default: dwl.cfg)                    |
| -u          | force update with conf. file                             |
| -r[e u]     | remove installed memory modules & events                 |
|             | e remove only events                                     |
|             | u unlock all events                                      |
| -d[=]<hex>  | debug flag:<br>\$0800 program variables<br>\$0400 Parser |

\$0100 Messages

**mov**

*Function:* Interface to stage control  
*Syntax:* mov [<opts>]  
*Options of interest:*

|                  |                                       |
|------------------|---------------------------------------|
| home             | move stage to home position           |
| -u               | force move home                       |
| [x/y].           | show x/y position in nm               |
| [x/y]:=<num>     | set x/y abs. position to <num> nm     |
| [x/y]:[+/-]<num> | set x/y pos. to actual [+/-]<num> nm  |
| [x/y][+/-]<num>  | move x/y [+/-]<num> nm from act. pos. |
| [x/y]=[+/-]<num> | move x/y to pos. [+/-]<num> nm        |
| -d[=]<hex>       | debug flag:                           |
|                  | \$0800 program variables              |
|                  | \$0400 Parser                         |
|                  | \$0100 Messages                       |
|                  | \$0080 Communication                  |
|                  | \$0008 Events                         |

• **Image Processing Commands:**

**ipc**

*Function:* execute image processor commands  
*Syntax:* ipc <command>  
*Commands:*

|                      |   |
|----------------------|---|
| dc <xpix> <ypix>     | activate cursor at position <xpix>,<ypix> enter -1 to deactivate cursor, unit is monitor pixels |
| db <xwidth> <ywidth> | set box size to <xwidth>x<ywidth> (unit pixels)   |
| offset <val>         | set camera intensity offset to <val> (range 0...255)  |
| gain <val>           | set camera gain to <val> (range 0...255)  |
| snap                 | freeze image  |
| live                 | start continuous image grabbing   |
| cam [0 / 1]          | switch to macro / micro camera  |

**width**

*Function:* Measure width of video profile  
*Syntax:* width <parameter> <parameter> ...  
*Parameters:*

|                |  |
|----------------|--|
| axis [x/y]     | measurement orientation, can be 'x' or 'y' |
| xpos [pixel]   | left border of measurement box (0..639)    |
| ypos [pixel]   | upper border of measurement box (0..511)   |
| xwidth [pixel] | width of measurement box (0..320)          |

|                     |  |
|---------------------|--|
| ywidth [pixel]      | height of measurement box (0..256)   |
| repeat [count]      | number of accumulations (>1)   |
| model [to ti m]     | measurement algorithm, can be to (threshold outside), or ti (threshold inside) |
| epsilon [pixel]     | interpolation range (0..7), usually 2 gives best results                       |
| threshold [percent] | threshold (0..100)   |

**center**

*Function:* Measure position of symmetry axis of video profile

*Syntax:* center <parameter> <parameter> ...

*Parameters:*

|                |  |
|----------------|--|
| axis [x y]     | measurement orientation, can be 'x' or 'y' |
| xpos [pixel]   | left border of measurement box (0..639)    |
| ypos [pixel]   | upper border of measurement box (0..511)   |
| width [pixel]  | width of measurement box (0..320)          |
| height [pixel] | height of measurement box (0..256)         |
| repeat [count] | number of accumulations (>1)               |
| grfx [0/1]     | switch off / on graphics                   |

*Remark:* The program generates a debug file named result.wks; this file contains intermediate results and the graphs of the intensity profile, the correlation function and the square fit function

**pitch**

*Function:* Measure distance between two similar video profiles

*Syntax:* center <parameter> <parameter> ...

*Parameters:*

|                  |  |
|------------------|--|
| axis [x y]       | measurement orientation, can be 'x' or 'y' |
| xpos [pixel]     | left border of measurement box (0..639)    |
| ypos [pixel]     | upper border of measurement box (0..511)   |
| width [pixel]    | width of measurement box (0..320)          |
| height [pixel]   | height of measurement box (0..256)         |
| repeat [count]   | number of accumulations (>1)               |
| estimate [pixel] | nominal or estimated pitch                 |

**tload**

*Function:* Load templates from disk to ipc

*Syntax:* tload -p=<path> -w=<file>

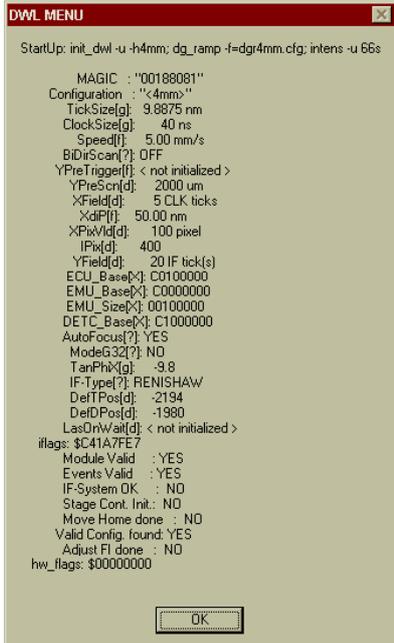
**tsave**

*Function:* Save templates to disk

*Syntax:* tsave -p=<path> -tn=<template#> -w=<file>

## VIEW OS9 CONFIGURATION

This option uploads some of the machine configuration parameters currently loaded on the DWL66 and display them in a text box. In addition, it performs some status checks on OS9 as well as within the menu and displays the results. The function started by this menu option is automatically executed whenever the menu is started or the configuration is changed. On OS9, the parameter and status check resulting in the displayed values is executed by using the OS9 command `init_dw1 -v`. This is a very helpful tool for troubleshooting.



```

DWL MENU
StartUp: init_dw1 -u -h4mm; dg_ramp -f=dgr4mm.cfg; intens -u 66s
MAGIC : "00188081"
Configuration : "4mm"
TickSize[g]: 9.8875 nm
ClockSize[g]: 40 ns
Speed[f]: 5.00 mm/s
BDiScan[?]: OFF
YPreTrigge[f]: < not initialized >
YPreScn[d]: 2000 um
XField[d]: 5 CLK ticks
XdiP[f]: 50.00 nm
XPixVid[d]: 100 pixel
IFix[d]: 400
YField[d]: 20 IF tick(s)
ECU_Base[x]: C0100000
EMU_Base[x]: C0000000
EMU_Size[x]: 00100000
DETC_Base[x]: C1000000
AutoFocus[?]: YES
ModeG32[?]: NO
TanPhi[x]: -9.8
IF-Type[?]: RENISHAW
DeITPos[d]: -2194
DeIDPos[d]: -1980
LasOrtVal[d]: < not initialized >
iflags: $C41A7FE7
Module Valid : YES
Events Valid : YES
IF-System OK : NO
Stage Cont. Init.: NO
Move Home done : NO
Valid Config. found: YES
Adjust FI done : NO
hw_flags: $00000000
    
```

### OS9 PARAMETERS

The character in square brackets shown behind some of the parameters denotes the data type of the parameter for consistency check against the value (g - double, f - float, ? - boolean, d - decimal, x - hexadecimal).

- MAGIC**  
 Internal parameter denoting the structure of the main data module DWL\_inimod for consistency check with program versions. If versions don't match, the error message here would be: "init\_dw1: Can't accept DWL\_inimod"
- Configuration**  
 Currently active configuration.

- **TickSize**  
Length unit of the interferometer system in nm. Standard value is 9.8875nm.
- **ClockSize**  
System clock period in ns. Standard 40ns (= 25 MHz).
- **Speed**  
Stage speed during exposures in mm/s. Scales with write head and depends on exposure mode.
- **BiDirScan**  
Flag for activation of bidirectional writing. Values OFF (no bidirectional functionality) / ON (bidirectional writing configured).
- **YPreTrigger**  
Trigger delay/advance in ns for the backward written stripes during bidirectional writing. If the system is not configured for this mode, the parameter is noted as "not initialized".
- **YPreScn**  
Acceleration distance during exposures, in  $\mu\text{m}$ . Scales with write head.
- **XField**  
Pixel period in x in system clock ticks (= period of data clock). Standard value is 5 clock ticks, which usually means a pixel period of  $5 \cdot 40\text{ns} = 200\text{ns}$ , corresponding to a data clock frequency of 5 MHz.
- **XdiP**  
Distance between interpolated pixels (see IPix) on the substrate, in nm. Scales with write head and depends on write mode.
- **XPixVld**  
Scan width in pixels. Standard is 100 pixel, leading to a scan time of  $200\text{ns} \cdot 100 = 20\mu\text{s}$ . When calculating the scan rate, a dead time of 5 $\mu\text{s}$  for data loading and ramp restart has to be added to this value.
- **IPix**  
Interpolated subpixels per scan. Each pixel is in x divided into several ( $\text{XPixVld}/\text{IPix}$ ) subpixels to determine the value on the interpolation scale for the pixel. Standard value is 400.

- **YField**

y-distance between scans in interferometer ticks. Configuration dependent. During an exposure, while the stage is moving continuously, a scan is triggered every YField ticks.

- **ECU\_Base / EMU\_Base / DETC\_Base**

Base addresses and address room regions set for communication with the related system hardware components.

- **EMU\_Size**

Memory size of the Exposure Memory Unit.

- **AutoFocus**

Flag denoting whether an autofocus system is configured. Possible values: YES / NO

- **ModeG32**

Flag denoting whether grascaling is configured. Possible values YES / NO.

- **TanPhiX**

Tangens of the orthogonality correction angle. Corrects for the angular misalignment between the interferometer mirrors with respect to a perfectly orthogonal setup.

- **IF-Type**

Interferometer type installed (denoted by manufacturer name). Possible values: RENISHAW / ZYGO / HP

- **DefTPos**

Default focus position of the backside camera system lens in motor steps relative to retracted position. Negative number.

- **DefDPos**

Default tilt position of deflector mount during exposures. Configuration dependent.

- **LasOnWait**

Configuration of wait time in seconds before the laser can be switched on again after a software controlled switch off. Only usable for lasers connected to the OS9 system. Usually not used (entry "not initialized").

## SYSTEM STATUS

- **iflags**

Internal flags for interferometer initialization values

- **Module Valid**

Checks if the main data module DWL\_inimod is OK. Possible values: YES / NO

- **Events Valid**

Shows whether event initialization has taken place since the last system startup (prevents double call of the same routine by different programs).

- **IF-System OK**

Interferometer system status check. Possible values: YES / NO. In case of problems, please consult the troubleshooting section of **User Guide I**.

- **Stage Cont. Init.**

Flag denoting whether the stage controller was initialized since the last system startup.

- **Move Home done**

Flag denoting whether a homing procedure has been performed since the last system startup.

- **Valid Config. found**

Shows if the requested configuration file was found and is valid. Possible values: YES / NO.

- **Adjust FI done**

Denotes whether the data imaging frequency-intensity table for the current configuration was loaded successfully. Possible values: YES / NO.

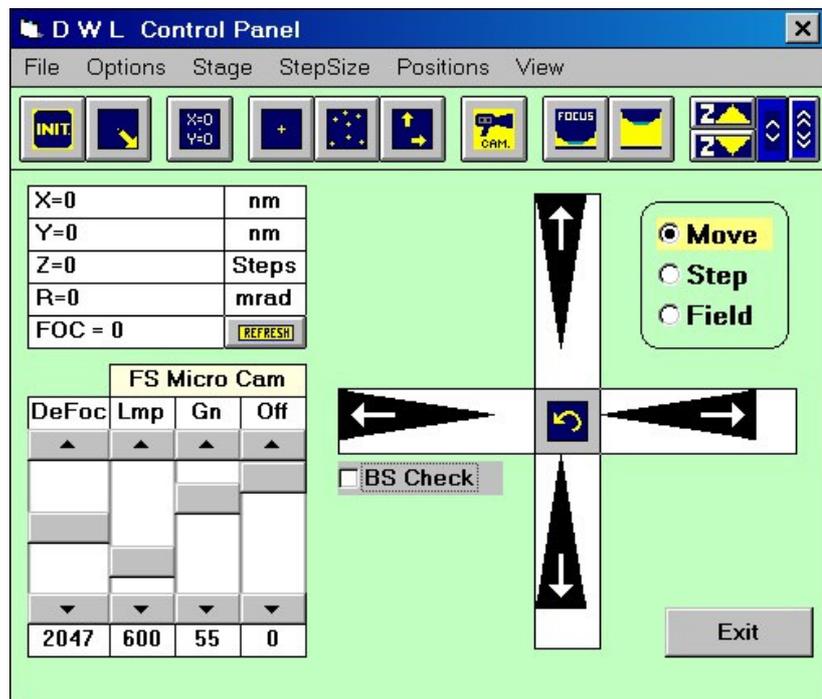
- **hw\_flags**

Internal flags for state of system hardware.

## DWL CONTROL PANEL

### INTRODUCTION

The most important commands for direct, interactive operation are made available through the **DWL Control Panel (Window 19)**, featuring options for stage control, focusing, simple measurement capabilities, camera adjustments, etc. The **DWL Control Panel** can be opened by clicking on the **Control Panel** icon  located below the main menu toolbar, or by highlighting the **DWL Control Panel F9** submenu under the **Service** heading.



Window 19

## STAGE BUTTONS

- **Initialize**



Initializes stage coordinates, where the *writehead* moves until it reaches its upper endswitch and the *XY stage* moves to the home position. After setting the X and Y position registers to zero, the stage moves to the center position.

- **Load Position:**



This function performs a stage initialization as described above and then moves the stage to the load position.

- **Set X=0, Y=0:**



Sets both X and Y coordinates to zero at the current position.

- **Move To 0, 0:**



Moves stage to the latest set 0,0 position

- **Move To..:**



Moves stage to an absolute X / Y position, where the required position is entered in microns.

- **Move...:**



Moves stage to a relative X / Y position, where the required position is entered in microns.

## CAMERA BUTTONS

- **Camera:**



Selects micro- or macro-camera and correspondingly, adjusts the video values for the selected camera to the latest values that were used.

## WRITEHEAD BUTTONS

- **Focus:**



Moves down the writehead until it reaches the airflow auto-focus position while continuously displaying the current Z-stage position. Pressing the **Cancel** button will abort the **Focus** command if there are any doubts regarding the correct position of the airflow auto-focus. *The nozzle can be permanently damaged if the stage moves while performing the **Focus** function, or if focusing is done on the edge of a substrate.*

- **Lens Up:**



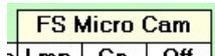
Moves the writehead into its upper end position. Use if there are doubts about the surface flatness of the substrate and a test focusing on different locations and comparing the z-values must be done.

- **Move Z:**



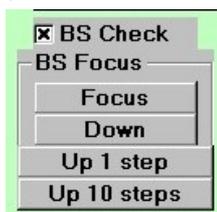
The writehead moves up or down while one of the z-buttons is pressed. Using the arrow buttons, choose between slow or fast movement. It is not possible to move below the airflow focus position.

## CAMERA SELECTION / BACKSIDE FOCUSING



The camera label shows which camera is currently selected. To change between the low resolution macro- and the high resolution micro-camera, click on the label.

*Systems equipped with backside alignment:* If the **BS check** box is checked, the label can be used to select the macro- or micro-camera of the backside alignment system. In addition, buttons for backside focussing appear:



**Focus** - moves the backside lens to the preset position for backside imaging.

**Down** - the lens is moved down into the retracted position

**Up 1 step / 10 steps** - these buttons can be used to manually move the backside lens towards the substrate and check for the optimum focussing position.

## SCROLL SLIDES

- **DeFoc (Defocus):**

Slide to set a certain offset between the airflow focus position and the required optical focus. Value range is 0 to 4095. (200 units are approximately 1µm).

- **Lmp (Lamp):**  
Slide to choose lamp intensity. Value range is 0 to 4095.
- **Gn and Off (Gain and Offset):**  
Control gain and offset of the image processing system and are normally set to 128. Only slide to a different setting if it is necessary to increase contrast.

### MENU BAR

- **File:**
  - **Load / Save Panel Status:**  
Will refresh **Configuration File** with new values- or reload previous values.
  - **Quit:**  
Closes **Control Panel (Window 19)**.
- **Options:**
  - **Microns / nm/steps:**  
Check desired metric representation of the stage (microns/nm) and write lens (microns/steps) position. The **Result Panel** displays selected metrology.
  - **Relative / Absolute**  
Check desired representation of the stage position. The **Result Panel** displays selected representation. If **Relative** representation is marked then a  $^{u0^a}$  button will appear and the stage position window is reset. Marking **Absolute** will return the display to absolute stage position coordinates. This feature can be used for rough distance measurements.
- **Stage:**
  - **Initialize:**  
Initializes stage coordinates, where the *writehead* moves until it reaches its upper endswitch and the *XY stage* moves to the home position. After setting the X and Y position registers to zero, the stage moves to the center position.
  - **Load Position:**  
This function performs a stage initialization as described above and then moves the stage to the load position.
  - **Test Init Quality:**  
Checks on offsets in the stage coordinate system. This function is automatically performed every time a stage initialization is done. There, if the result is above a limit set in the configuration, the stage is re-initialized until the offset is within the limit.
  - **Reset:**  
Initializes the stage after confirmation from the operator by moving it back into the Home position and resetting the interferometer coordinate system.
  - **Motor ON / OFF:**  
Switches linear motors on or off.

- **Move...:**  
Moves stage to a relative X / Y position, where the required position is entered in microns.
  - **Move to...:**  
Moves stage to an absolute X / Y position, where the required position is entered in microns.
  - **Move to 0, 0:**  
Moves stage to the latest set 0,0 position
  - **Set X=0 Y=0:**  
Sets both X and Y coordinate values of current position to the values given.
  - **Set X=\_, Y=\_:**  
Sets coordinate values of current position to the values given.
  - **Set rot = 0:**  
Resets rotation angle to 0 (including any rotational correction).
  - **Find Plate Center:**  
Starts an automatic sequence that detects the positions of the plate edges and calculates the plate center position from that. Write lens should be focused at approximate center before starting this sequence.
- **StepSize:**  
Shows field size, as extracted from the current Map file, which will be used for the fieldwise stage move function. Also shows current stepsize for stepwise motions, which can be changed by clicking on the numbers.
  - **Positions:**  
Offers the possibility to memorize a position, or move directly to one of the memorized positions by highlighting them in the list. Up to 8 positions can be stored in the list. To memorize a position, move the stage to it, click on "Set Position", and choose the list place for the position. The current coordinates will then show up in the list at the position that was indicated.  
*Note:* The coordinates are stored in the user coordinate system, so if the origin changes, the stored position will also be in a different place on the stage.
  - **View:**
    - **Standard / Advanced:**  
Selecting Advanced gives access to some more advanced controls.  
**CAUTION:** These functions should only be used by experienced users, as wrong usage may cause severe damage to the system, e.g. through nozzle crash.

## MOVEMENT OPTIONS

- **Move:**  
Stage movement with arrows is done in steps that depend on the distance from the center in which the arrow is clicked on. The farther out the click position is, the larger

the step will be, up to a maximum of about one camera picture. The distance value of the maximum stepsize is calculated from the camera calibration value of the current writehead configuration for the active camera.

- **Step:**

Jumps the stage over preset steps independent of click-position. Set the stepsize with the **StepSize** Menu function.

- **Field:**

Jump from field to field as defined in the exposure map.

## **X-Y STAGE**

- **ARROWS:**

With each left-click on one of the arrow fields the stage moves according to the mode chosen in the **Movement Options** frame. A right-click moves in the opposite direction.

- **CENTER ARROW:**

Moves the stage back to the previous position.

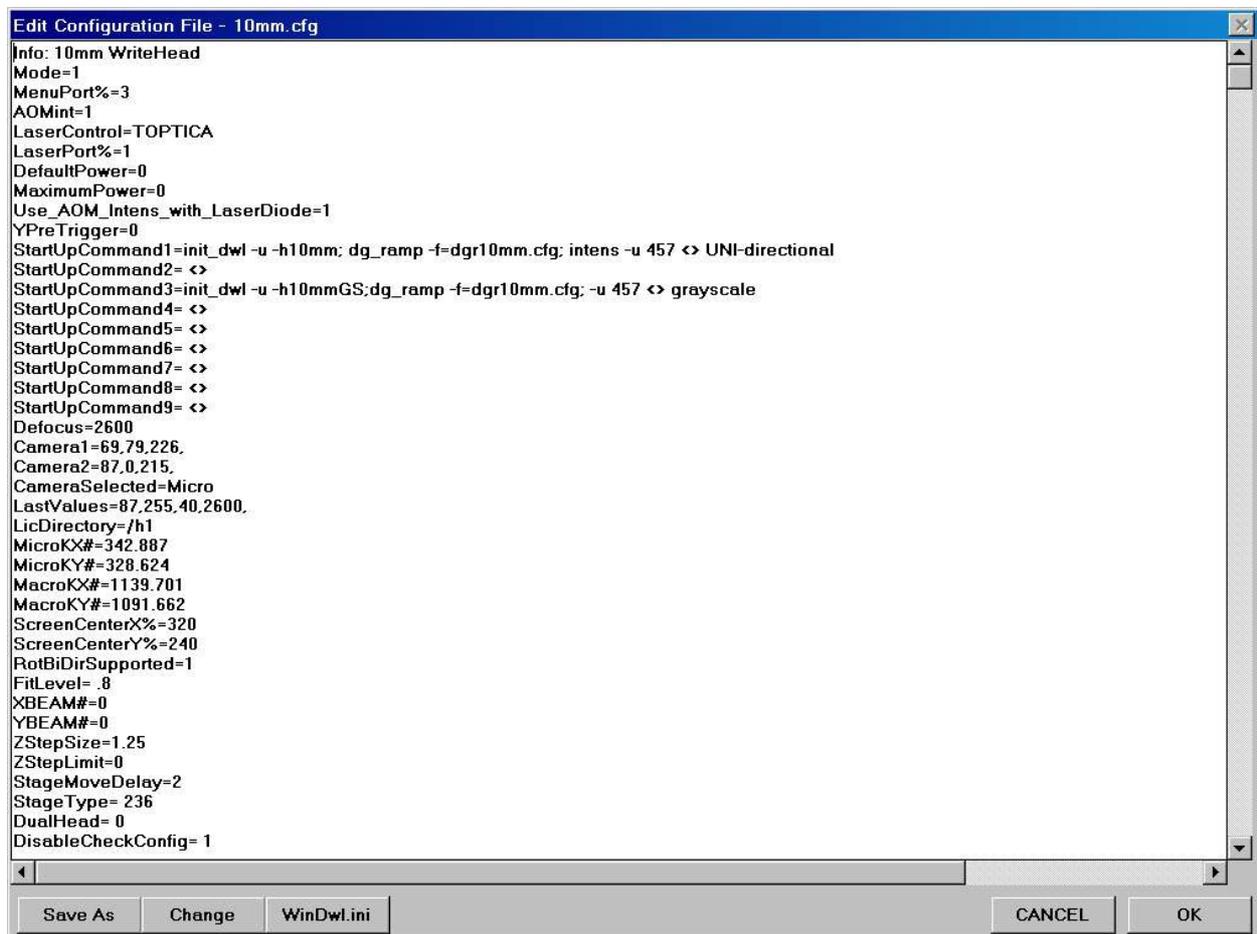
## **EDIT CONFIGURATION FILE**

### **INTRODUCTION**

There's at least one configuration file for each writehead located in the directory **VBMENU/WINDWL**. These contain important parameters about the system hardware, general menu settings, exposure settings etc.

**NOTE:** Some entries are set manually during setup and calibration, while others are continuously modified by the menu to memorize settings etc..

Highlighting **Edit Configuration File** under **Service** in the main menu will open the current configuration file in the **Edit Configuration File** window (**Window 20**):



**Window 20**

This window can be used for viewing as well as editing the parameter values.

**CAUTION:** Only advanced users should modify these settings, as some of them could cause damage to the system if set incorrectly!

## EDIT CONFIGURATION FILE BUTTONS

- **Save As:**

Saves current configuration file under a new name.

- **Change:**

Opens the **Choose Configuration** window (also accessible from configuration information box in the main menu toolbar), in which a new configuration file can be loaded.



In the **Choose Configuration** window, the left text box shows which write head configurations are available. Once a write head has been chosen, the right text box displays the write modes available for the chosen write head.

- **Cancel:**

Closes **Choose Configuration** window and returns to the main menu.

- **Load it!:**

Menu will restart with the new configuration.

- **WinDwl.ini**

The **WinDwl.ini** button opens the file **WinDwl.ini**, which only consists of two lines and sets the configuration file for the menu, which will be loaded at the menu startup. This file is automatically created whenever the configuration file is changed. The first line shows, which write head configuration was loaded, last.

The configuration should not be changed manually. There is a different configuration file available for each writehead, i.e., the file **04mm.cfg** is the configuration file for a **4mm** writehead, the file **20mm.cfg** for a **20mm** writehead. The second line shows which of the available write modes were chosen for the chosen write head.

- **CANCEL**

Closes **Edit Configuration File** window (**Window 20**) without testing for changes or updating the system.

- **OK**

Accepts modifications, saves changed configuration file, and resets all system parameters accordingly.

## **PARAMETERS**

Relevant menu parameters and their functions are:

- **Info:**

This parameter determines the **File Info** line shown in **Choose Configuration** window if the file is highlighted.

- **Mode=**

Mode=0 means DWL is available  
Mode=1 can be used to test most functions

- **MenuPort=**

Indicates which COM port is being used for communication between the menu and the system

- **AOMint=**

Type of intensity setting technique, which depends on a machine's hardware  
Usually set to 1 for newer machines

- **LaserControl=**

In systems with externally controllable lasers, this parameter sets the type of control used

- **LaserPort%=**

In systems with externally controllable lasers, COM port of the User PC used for laser control

- **DefaultPower=**

In systems with externally controllable lasers, laser power is set to this value while no exposure is running. *Dysfunctional in newer versions.*

- **MaximumPower=**

Maximum usable power of installed laser. Used to check laser during startup.  
*Dysfunctional in newer versions.*

- **Use\_AOM\_Intens\_with\_LaserDiode=**

Determines whether the intensity of a laser diode is controlled directly from the menu or using an acousto-optic deflector.

- **YPreTrigger=**

*Only needed in bidirectional configurations. Trigger adjustment to match positions of backward written stripes to the forward written ones. This parameter is part of the menu configuration file only for information, exposures use the value given on OS9.*

- **StartUpCommand#=**

Initialization commands on OS9 to be executed during menu start, or when the configuration is changed. Separated by <>, this line also contains the information under which the different initialization sequences for this write head configuration show up in the **Choose Configuration** window. See also **Choose Configuration** above.

- **Defocus=**

Last selected offset to the airgauge focus point

- **Camera1/2=**

Last used values for lamp (Imp), offset (off) and gain (gn) for macro-/micro-camera

- **Camera3/4=**

Last used values for lamp (Imp), offset (off) and gain (gn) for macro-/micro-camera of the backside imaging system

- **CameraSelected=**

Indicates which camera has been selected (macro or micro)

- **LastValues=**

Last values for lamp (Imp), offset (off), gain (gn), and defocus (defoc) used in the Control Panel

- **LIC Directory=**

Default path for design data on machine

- **MicroKX/Y#= / MacroKX/Y#=**

Camera calibration value in X / Y direction for macro / micro camera, unit is ticks per pixel

- **MicroKX/YBS#= / MacroKX/YBS#=**

Camera calibration value in X / Y direction for macro / micro camera of the backside imaging system, unit is ticks per pixel

- **ScreenCenterX/Y%=**

Center pixel of the frame grabber in X / Y

- **RotBiDirSupported=**

Set to 0 if system does not support coordinate system rotation for bi-directional writing; set to 1 if system does support it

- **FitLevel=**

The correlation level that must be achieved so that a template is considered "found". Standard value is 0.8, but may be set to a lower value if contrast is poor

- **X/YBEAM#=**

Distance between the center of the micro-camera image and the position of the write beam in X / Y, measured in micrometers

Typically, the value should be roughly half the scan width

Important for multi layer exposures

See **Overlay Exposure Instruction** in **User Guide: PART I** for information on how to set these parameter

- **X/YBEAMBS#=**

Distance between the center of the backside micro-camera image and the position of the write beam in X / Y, measured in micrometers

Important for multi layer exposures with backside alignment

See **Using Backside Alignment** instruction in **User Guide: PART I** for information on how to set these parameter

- **ZStepSize=**

Step size in micrometers for coarse write head motion

- **ZStepLimit=**

Limits the distance the write head may move toward the chuck to prevent nozzle crash. If after the given number of steps the focus is not reached, a warning will be issued, and the write head moves up again. To disable this function, set the value to 0.

- **StageMoveDelay=**

Depending on the size of the stage a certain delay is necessary after the stage is stopped and a camera frame is frozen

The value can only be entered as an integer in seconds

- **StageType=**

Certain menu functions are changed depending on what stage is built into a system

Stage types of the DWL 66 are: "206" for a DWL 66 without camera system, "236" for a DWL 66 with camera system, and "246" for a stage with backside alignment capability.

- **DualHead=**

Set 1 for systems with dual head configuration (separate camera and exposure heads).

- **DisableCheckConfig=**

At loading, usually each configuration file is crosschecked for validity. Set this parameter to 1 to disable checking. Use only for tests!

- **TestInitLimit%=**

Tolerance limit for coordinate offset during initialization. If set to 0, no automatic check on initialization quality is performed.

- **StageLoad=**

The plate load position of the stage in nm. The format is x=<value> y=<value> z=<value>. Z is usually set to 20000; X and Y depend on the stage size.

- **Options=**

Contains a list of menu options which stay selected when the menu is restarted.

All menu options for which the corresponding keyword is present in the configuration file are activated upon startup.

The keywords are separated by "," i.e., *AutoUnload, JobLog*, will cause the system to move to the unload position upon termination of the exposure and to make a record of all expose jobs.

- **JobFile=**

Name and Path of the current **Job** File

- **MapFile=**

Name and Path of the current **Map** File

- **WaferAliFile=**

Name and Path of the current **Global Alignment** File (*Not used*)

- **FieldAliFile=**

Name and Path of the current **Field Alignment** File

- **Positions=**

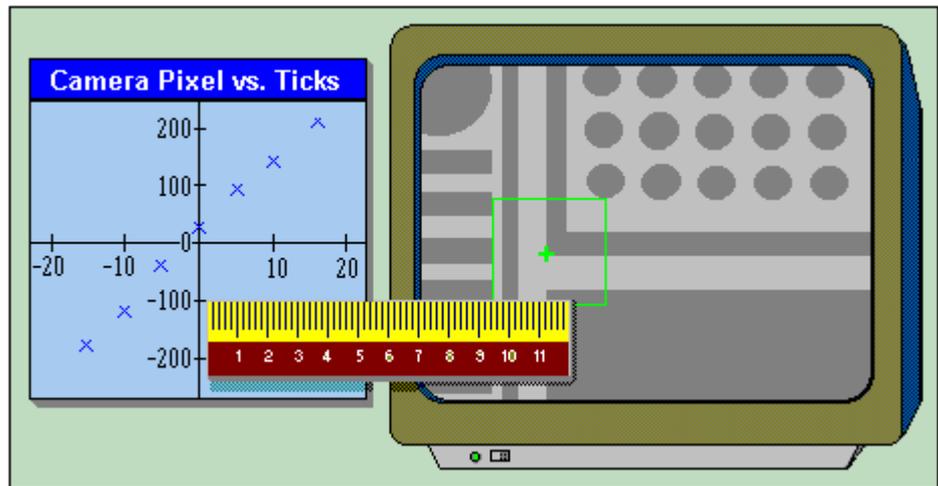
A record of the 8 stage positions, which can be programmed by the user in the **Control Panel**

The format is: x=value y=value(TAB)x=value y=value(TAB).....

- **StepMove=**

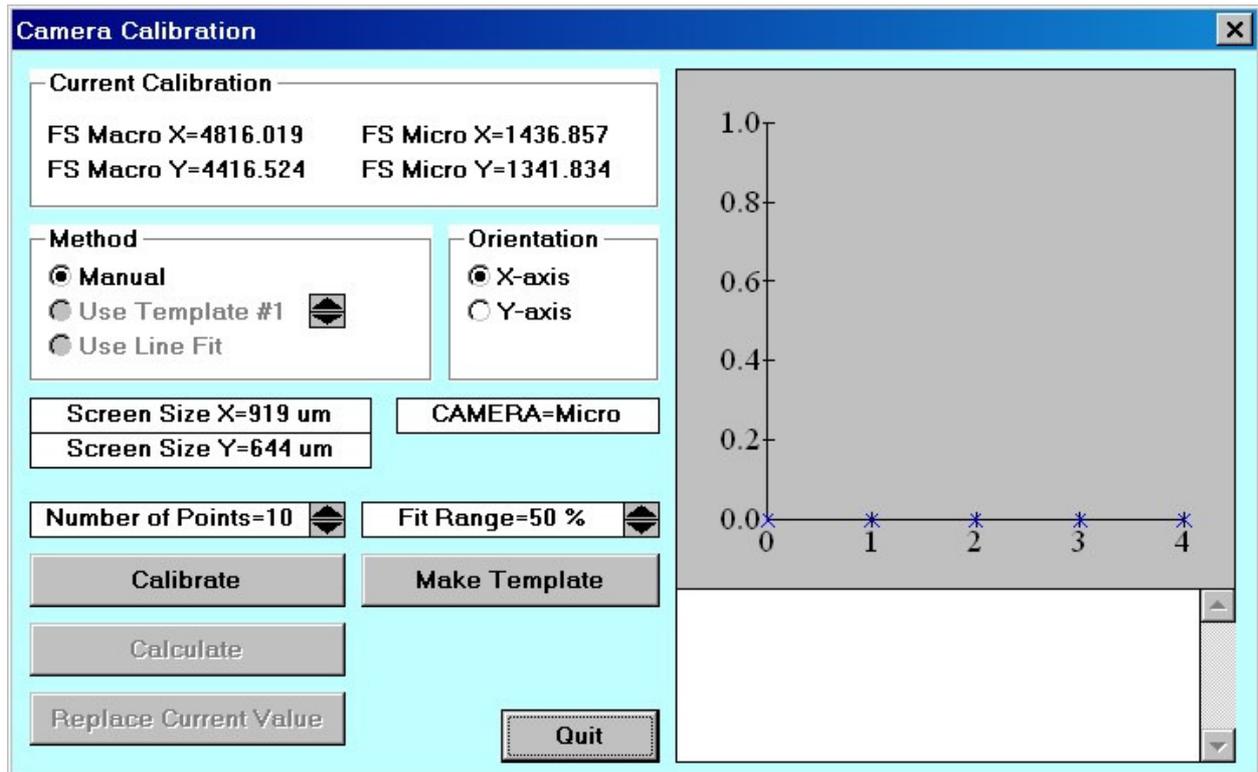
Last selected step size for stepwise stage movements, in microns

## **CAMERA CALIBRATION**



### **INTRODUCTION**

The relation between camera pixels and interferometer ticks has to be measured for applications such as alignment, measurements, and calibration. Camera calibration must be done after any modifications to the optical system, particularly if the camera systems are affected. A program will calibrate the cameras automatically aided by the image processor if a substrate with sufficient image contrast is available.



**Window 21**

A step by step instruction for the execution of a **CAMERA CALIBRATION** is available in **User Guide: PART I**.

## **CURRENT CALIBRATION AND CAMERA TEXT BOX**

The current calibration values for the active camera system (FS - front side, BS - back side) are shown in the **Current Calibration** frame. Below the **Orientation** frame, there is also noted for which camera the calibration will be done. To swap the system or the active camera, close the **Camera Calibration** window (Window 21), use the control panel to choose the other system / camera, then reopen the **Camera Calibration** window.

## **METHOD**

- **Manual:**

Use if no reliable template could be defined. Calibration will be done by manually positioning a target cross on the observed structure.

- **Use Template:**

Uses last template defined and stored in the IPC template buffer chosen with the arrow buttons. Only active after **Make Template** button has been used.

- **Use Line Fit**

*Not yet implemented*

## **ORIENTATION**

- **X-axis / Y-axis:**

Selects the axis to be calibrated.

## **PARAMETERS**

- **Number of Points=:**

Sets number of positions used for calibration measurement.

- **Fit Range= \_\_%:**

Determines the range of the camera field over which the calibration will be done.  
*Maximum number is 90%.*

## **CAMERA CALIBRATION BUTTONS**

- **Calibrate:**

Starts the automatic calibration procedure for the active camera (change cameras in the **Control Panel**). The data points are shown in graph during measurement.

- **Make Template:**

Opens the make template program, where saving the template, although not forbidden, is not necessary. Storing template in the IPC module is sufficient by using any of the four buffers, primarily buffer 1.

- **Calculate:**

Performs a linear regression analysis of measured curve, where the slope will be the new calibration factor. *Results and reliability of the regression fit are shown in the text box below the graph.*

- **Replace Current Value:**

Replaces the current calibration factor, shown on top of the form, with the latest calibration factor measurement.

- **Quit:**

Closes the **Camera Calibration** window (**Window 21**).

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## CHAPTER 8 - HELP SYSTEM

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### HELP MENU COMMANDS

- **Main Subject Index**

Opens an alphabetical list of subjects. Highlight and double-click on an entry to display help text.

- **Read Me**

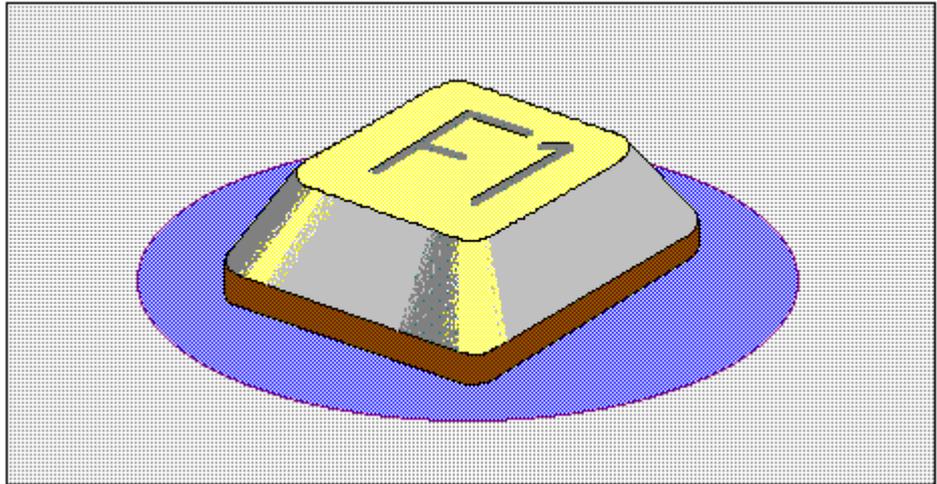
Opens editor with **Read Me** file informing about the latest menu modifications and the history of previous changes.

- **About**

Displays originator and version of the Menu. Please have this information ready when contacting HIMT in regarding any questions or concerns.

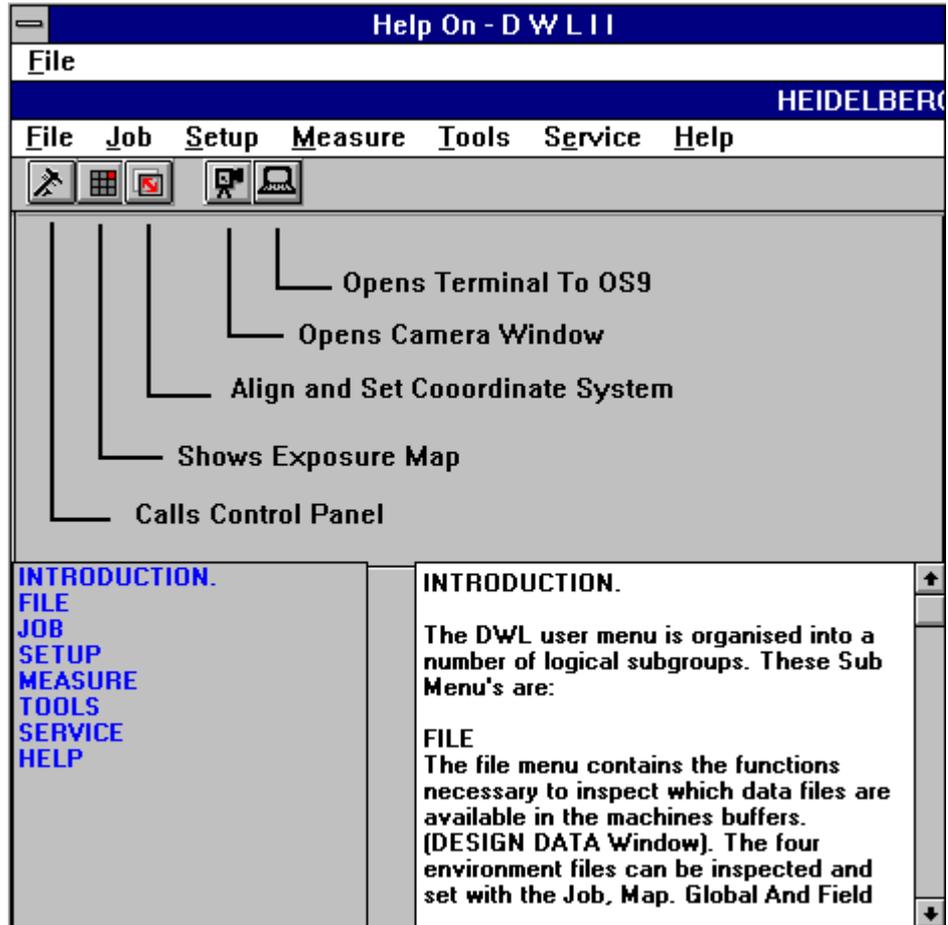
## **ON-LINE HELP SYSTEM**

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### **INTRODUCTION**

The On-Line DWL Help System extracts current information and hints on using the DWL menu and the direct write laser system. Pressing "**F1**" will always show information regarding the currently active application in a window similar to **Window 22** below. Press "**Esc**" to return to active applications.



Window 22

## KEYWORDS

By highlighting one of the *keywords* in the list on the left side of the **Help Index**, text scrolls automatically to show the text related to the chosen keyword. Keywords are always (sub) paragraph titles.

## HOW TO ADD "HELP TEXT"

To make notes on items or clarify a help entry, either type in or change the text in the help entry. Entering a paragraph title on a separate line and typing the entire word in capitals will create a paragraph; for example, to add a paragraph on a checklist before an exposure, type the following remarks in the help text under the "**Run Job**" window:

### Example of Adding Text into the **Help On** Window

A check list for exposures is added as a help text. The formatting of the text should be as follows:

```
:      CHECK LIST (use only capitals in the help text and the word will be entered as a
keyword)
:      1. Load Plate
:      2. Move Stage to Center
:      3. Focus
:      4. Find plate center
:      5. Set XY coordinate system to X=0.5*Pattern size and Y=0.5*Pattern size
:      6. Use Job Hello.dwl
:      7. Enter current job in Lic Buffer column
:      8. Start
:      9. Etc,..
:     10. Etc,..
```

Highlight **S**ave (*to save new entry*) under the **F**ile menu, or press ESC and accept the suggestion of system to update the file. Pictures cannot be altered.

**Note:** *When installing an update for the menu, all new entries will be overwritten.*

### HELP ON – **F**ILE COMMANDS

- **Save:**

Overwrites current file with the changed help text.

- **Save As:**

Saves current file with changed help text under a new name (*as requested*).

- **Exit:**

Closes **Help On** window (**Window 22**) and returns to current active application window.