Raith EBPG 5150+ UCSB Operation Guide

This document is designed to guide you through the Electron Beam Lithography process when directly interacting with the Raith tool hardware and software. Specifically, this includes *sample load/unload*, *alignment microscope usage*, *column alignments*, *job programming* via cjob, and the final *exposure* of your sample.

The other important step of *pattern preparation/fracturing* using the BEAMER program is not covered here.

Some basic rules:

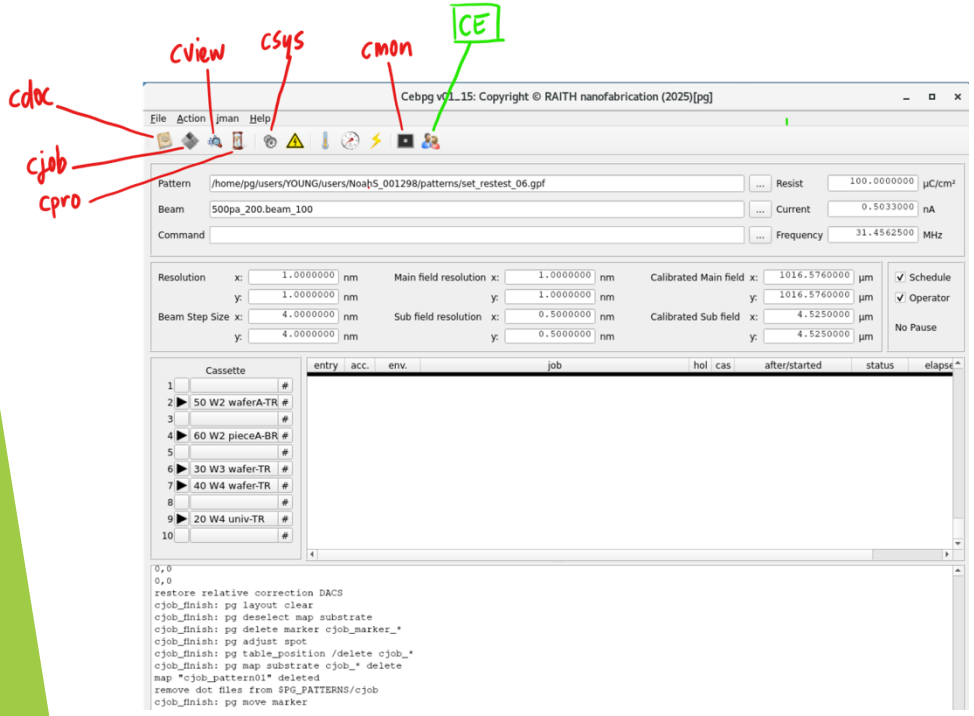
1) If you have any questions about e-beam lithography using this EBL tool, then ask before you try doing an exposure.
2) If you ever have problems while using the tool, then STOP and ask!! Do **not** try to fix it yourself.
3) It is recommended that you utilize the extensive documentation available for additional information on the system operation (either via **cdocs** or by clicking on the *HELP* button at the bottom right of any open window).

SUMMARY of Raith EBPG Operations

- **LOAD YOUR SAMPLE**
  - First confirm that the tool is **not** being used.
  - **Login** to your account using CE in cebpg window.
  - Vent the Loader.
  - **Remove** holder from Loader, **mount** your sample(s) on the correct table.
  - **Align** using the external alignment microscope – confirm substrate height using z readout relative to marker chip height and "position" (either pre-align mark or substrate center) using x,y readout relative to faraday cup.
  - **Return** holder back to the Loader and pump down.
- **PROGRAMMING AND EXPOSE**
  - Use CJOB to **program** the exposure 'job' file (the graphical display can confirm the layouts). Export to generate the executable job file.
  - Link the 'job' file to the correct holder/table in the cebpg window. In the Submit Job window that appears, enter the relative coordinates of the substrate "position" in the parameters field.
  - Start the **Exposure** by dragging Hold Line in the jobs field of the cepbpg window below your job just added to the queue.
- **FINISHING UP**
  - Vent the Loader.
  - **Remove** holder from Loader and **retrieve** your sample(s). **Return** holder back to the Loader.
  - Pump down the Loader.
  - To logout of your account, **login** to pg (admin account) using CE in cebpg window.

Background

- **OVERALL SYSTEM DETAILS**
  - **Console Desk** => contains the tool workstation and is located just outside the Tool Room.
  - **Tool Room** => contains the EBL writer, Alignment Microscope, and Stainless Steel Table (holder/table handling). It is tightly controlled for temperature, EMI, and acoustic noise.
- **WORKSTATION DETAILS**
  - System operating system is Redhat Linux 8.9 which uses the GNOME GUI.
  - The main control window for the EBPG 5150+ is **cebpg** which is always open on the LHS of the desktop.
    - Use **cebpg** to open any of the sub-control windows.



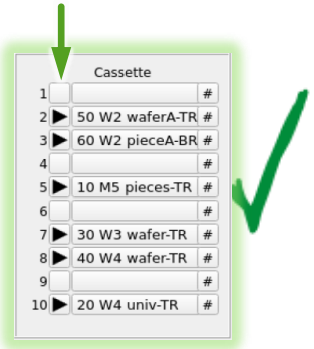
- **CE:** change environment, click on this button to log into your personal account folder before starting work on the EBL tool.
- **cjob:** a graphical user interface tool to create exposure jobs
- **cmon:** SEM monitor window with stage control (normally open on desktop)
- **cpro:** visual monitor of job progress (calibrations, exposure on the substrate)
- **cview:** used to check GPF pattern files
- **csys:** vacuum control (normally open on RHS of desktop)
- **cdoc:** user guides, system manuals. Invaluable resource! Opens in web browser

Getting started

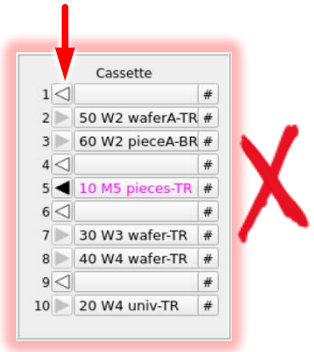
- **Is the tool being used?**

  CONSOLE DESK | Workstation | **cebpg window**

  - EMPTY STAGE: In the Cassette field, all arrows are pointing to the right in the Cassette field → and all holder labels are in black. Ok to proceed!



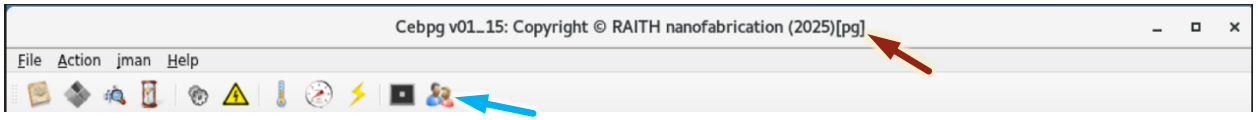
  - LOADED STAGE: In the Cassette field, the holder that is loaded is now **pink**, and the arrows → are either greyed out (labeled slots) or pointing to the left.
    STOP! Tool is being used so do NOT proceed!



- **Login to your account**

  CONSOLE DESK | Workstation | **cebpg window**

  - Click on the *Change Environment/CE* icon at the top of the window →



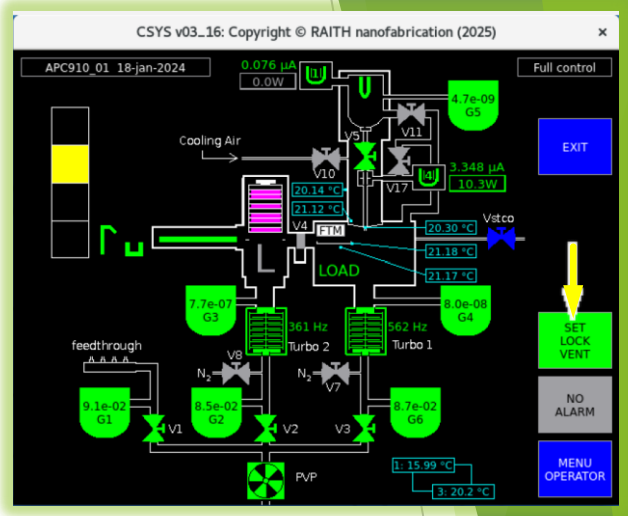
  - In the **Change Environment** window the appears, first find your group folder and then your personal subfolder and select it.
  - The title of the cebpg window will change from [pg] to [your account name] → to confirm you are logged in.

Sample Loading

Vent the Loader Unit

TOOL ROOM | **CSYS monitor screen**

- All holders are stored under vacuum in the 10-holder Loader.
- Press the green *SET LOCK VENT* button → to vent the Loader. Click *YES* to confirm the vent.

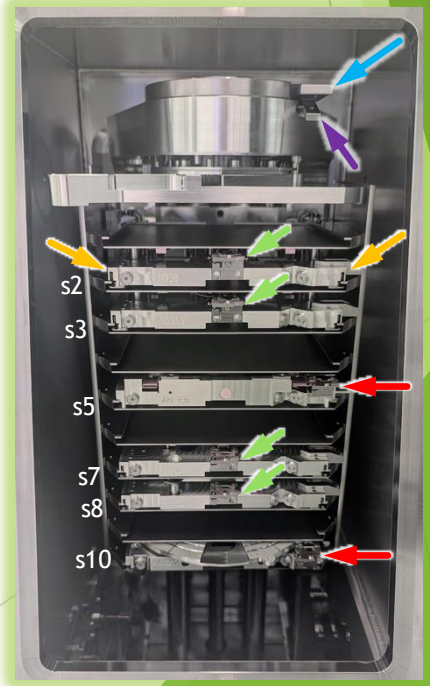


- Wait about 3-4 minutes at which point the Loader door pops open slightly and ***ATM*** (for atmosphere) appears in the csys window at the top of the Loader.

Remove the holder from Loader

TOOL ROOM | **Loader Unit**

- Make sure your gloves are clean.
- Swing the door fully upwards until it clicks.
- Release the rotation lock by pushing up on the small lever → and carefully rotate the 10 slot magazine CW by 90 degrees. Lock the magazine in place by pressing down on the large lever →
  - Grip both sides of the holder that you want to use → and slowly slide it out from its slot. CAREFUL: avoid touching the marker chip/Faraday cup (FC) area at the front/center of the holder → (note: this area on the s5: *pieces/large* and s10: *4"/6" universal* holders are on the front/right) →



Magazine shown after rotation by 90deg CW

Sample Loading

- **Load sample onto holder/table**

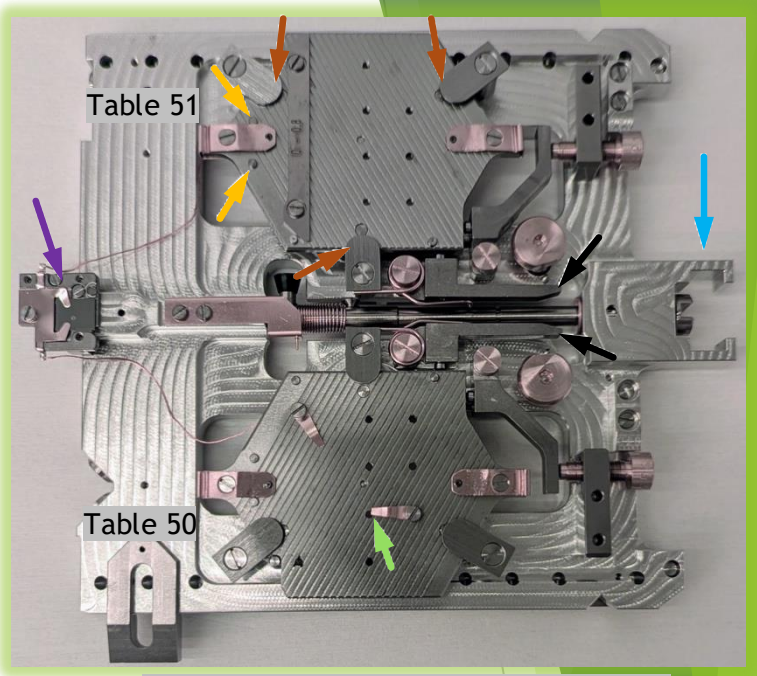
TOOL ROOM | **Stainless Steel table**

- All of the holders (except one) are top-reference (TR) holders
  - Place holder on a clean wipe with the handle to the right and the marker chip/faraday cup area to the left. This will align the XY axes with the EBL tool.

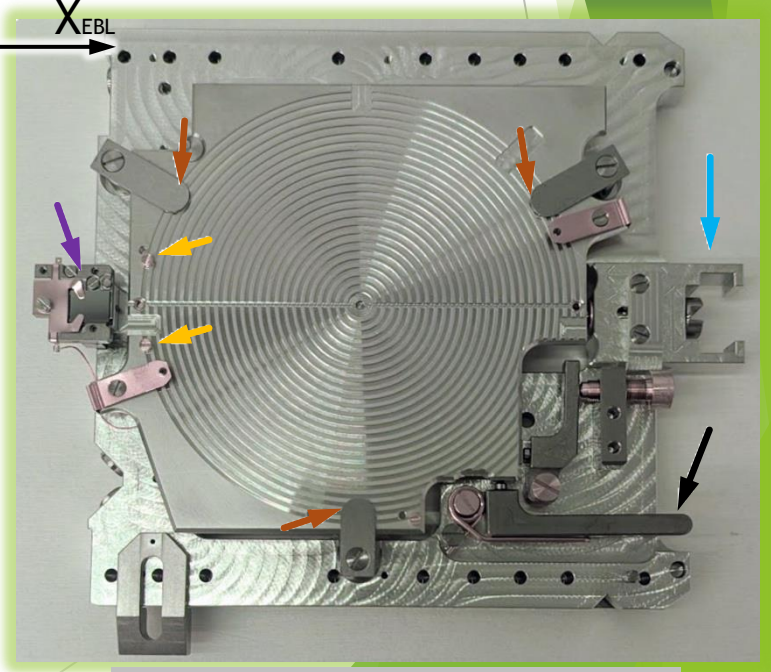
- Compress the table (for TR only)
  - Press down on the table until it clicks in place. Now the surface sits a few mm below the 3 height reference tabs
  - If you're loading a full wafer, then carefully slide the coated wafer under the height reference tabs and up against the major flat pins.
  - If you're loading a small piece, then use clips on either the bottom right or top left corner to hold the sample down*. You must place small scrap pieces from the same substrate under all 3 height reference tabs to set the correct sample height.

- Release the table
  - Push on the lever to reset the table back up to the 3 height reference tabs. Check that the sample is secure under these tabs.

* Placing the clip in those corners minimizes shadowing issues with the glancing angle laser height system.



Holder N958, slot #2 | 2 x 2" Tables, TR



Holder W955, slot #9 | 4" wafer holder, TR

Sample Loading

Sample alignment

TOOL ROOM | **External Alignment Microscope**

- Slide the holder onto the rails → of the u'scope stage
  - Turn u'scope light on. Orientation: marker chip @ back, holder hook @ front. →
  - Insert holder lock driver down into hook slot → with extended arm upwards (Fig 1), push to engage recessed flat head end with vertical locking screw slot, → then rotate 90 deg CW to lock holder (Fig 2). Remove driver.
  - 2 mags are available: 20X for fine tuning, 2.5X to find things "easier". →
- XYZ calibration check
  - Move stage to the holder marker chip. Bring a marker into focus @ 20X mag. Press Zo → (aligns Z axis with EBL tool)
  - Move stage to the FC hole (will be slightly out of focus) and center it. Press Xo,Yo → to set X,Y relative to FC.

- Sample alignment: move stage to your sample
  - Rotation:
    - Find a 'feature' (align mark or sample corner) and center in the video.
    - Move stage to find another 'feature' (different mark or an edge point). Now rotate the sample to move feature toward video center:
      Full wafer => use holder rotation control → (with table rotation driver)
      Small piece with clips => push on sample edge with graphite tweezers
    - Repeat until features remained centered in video after stage move
  - Height check/XY positioning:
    - Move around sample and confirm focus is ≤ +/-50um everywhere.
    - Move to the "characteristic" point of your sample – either a pre-alignment mark or sample center. 'Record' XY position → (relative to FC position).
- Remove holder from stage
  - Insert holder lock driver with arm to the right (Fig 2) and engage with horizontal locking screw slot. Rotate 90 deg CCW to unlock holder from the stage (Fig 1). Remove driver
  - Turn u'scope light off. Slide holder off the microscope stage and return to the loader.

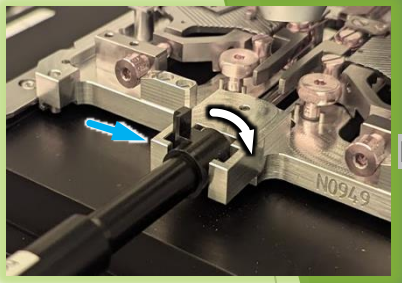
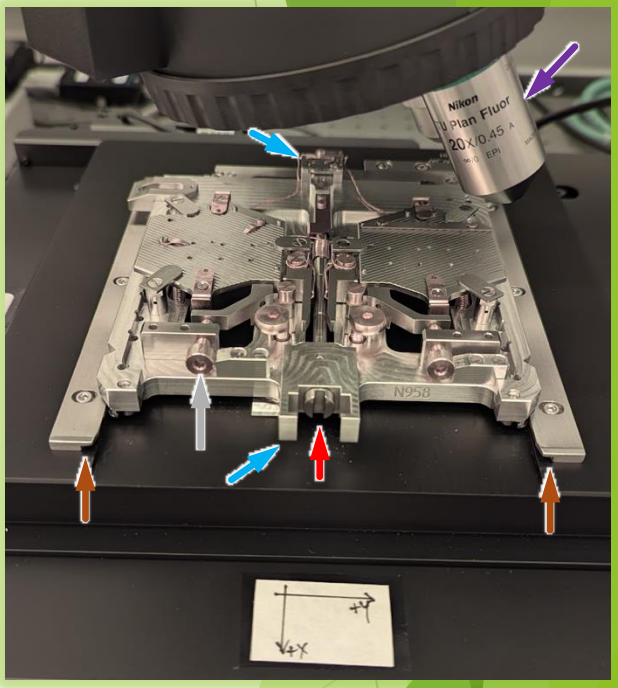


Fig 1: UNLOCKED!



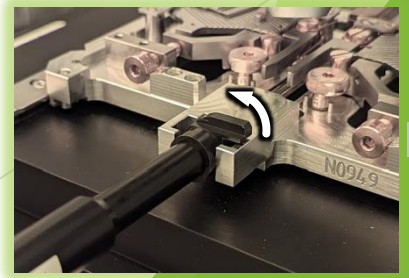


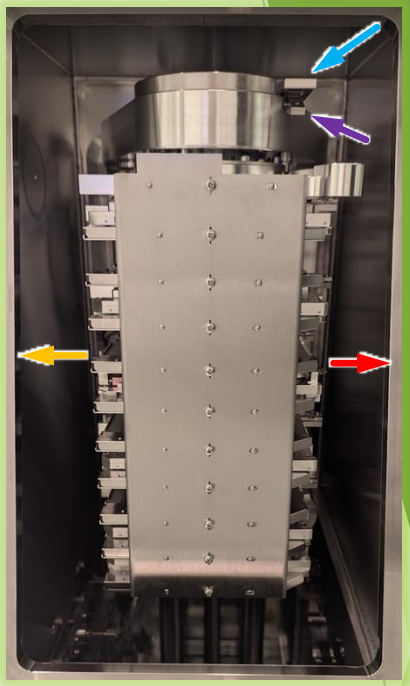
Fig 2: LOCKED!

Sample Loading

Return the holder to the Loader

TOOL ROOM | **Loader Unit**

- Reorient holder so that marker chip/FC area is facing you.
- Gripping both sides of the holder slowly slide it into the same slot you removed it from and push back till it goes no further.
- Release the rotation lock by pushing up on the small lever and carefully rotate the 10-slot magazine CCW by 90 degrees back to the 'tool loading' position. Lock the magazine in place by pressing down on the large lever
  - The holder clamps will be facing the left and the marker chip/FC areas will be facing the right

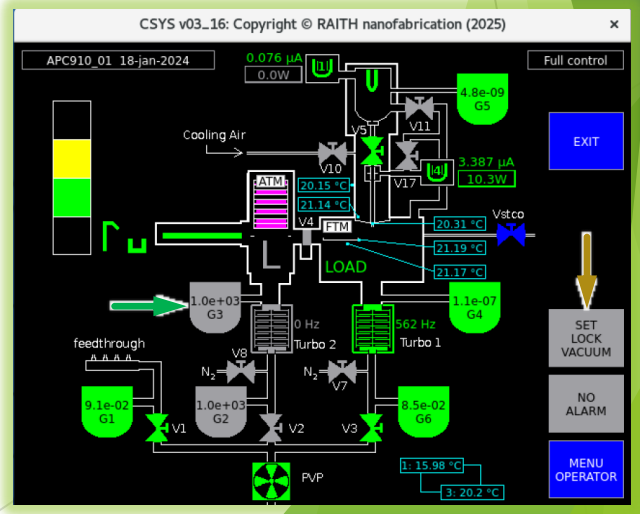


Magazine shown in "tool loading" position

Pumpdown the Loader Unit

TOOL ROOM | **CSYS monitor screen**

- Press the grey *SET LOCK VACUUM* button to pumpdown the Loader.
- Wait for the G3 indicator to turn green (@ 5.0e-5 mBar). Only then is it OK to load a holder to the stage.

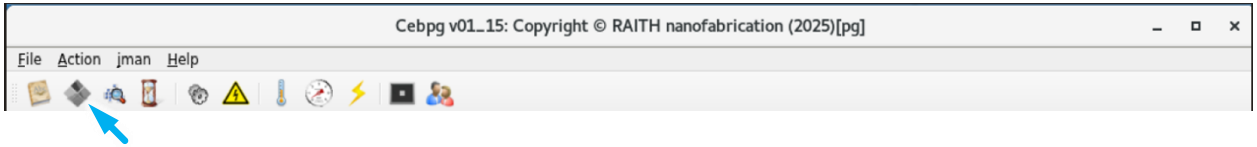


Programming via cjob

Start the cjob program

CONSOLE DESK | Workstation | **cebpg window**

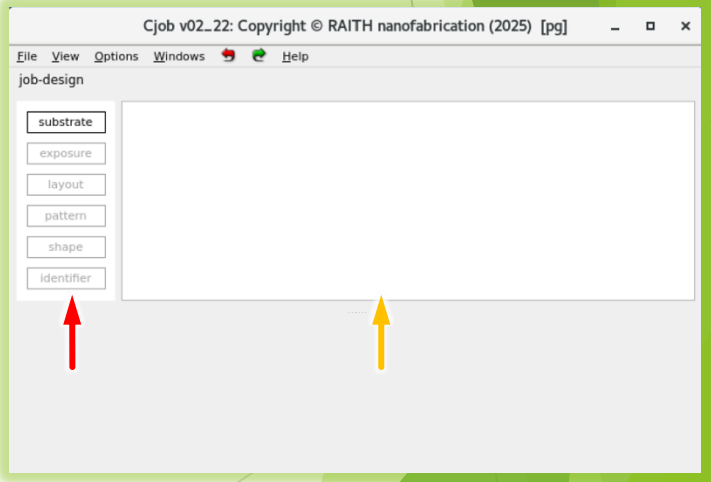
- Click on the cjob icon → at the top of the window to open it



cjob basics

CONSOLE DESK | Workstation | **cjob window**

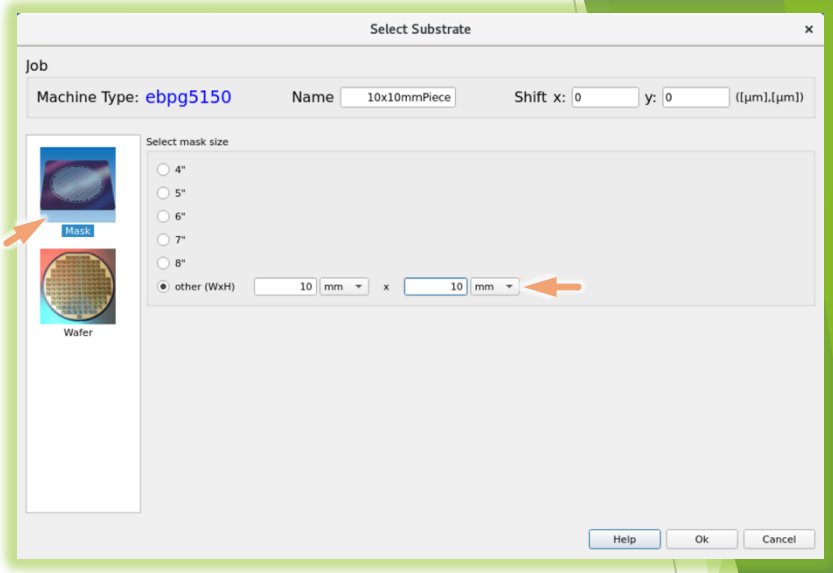
- cjob is a GUI used to create (and display) exposure layouts for the 5150+ EBL tool
  - It brings together pattern information from GPF files and tool info such as beam settings, markers, base doses, etc to create an executable job file (via EXPORT)
  - cjob uses drag and drop of the base modules → into the design panel → (an editable window opens)* to create the exposure job structure
- Base Modules for cjob
  - **SUBSTRATE:** enter the details of the sample to be patterned. Small pieces? use **Mask:** *other option*. Full wafers? select **Wafer**.
  - **EXPOSURE:** this is the module that defines the executable exposure job; defines beam voltage (100kV always), pre-exposure checks, global mark details.
  - **LAYOUT:** defines arrays for pattern positioning via repetitions; can apply base dose modulations within the array.
  - **PATTERN:** selects GPF file for the exposure; sets the beam condition and base dose; define the local mark details.
  - **SHAPE:** can add pre-defined shapes (rectangle, cross, etc) to the job without a GPF file
  - **IDENTIFIER:** Text labels can be included with the exposure (including doses when modulating dose in the LAYOUT module)



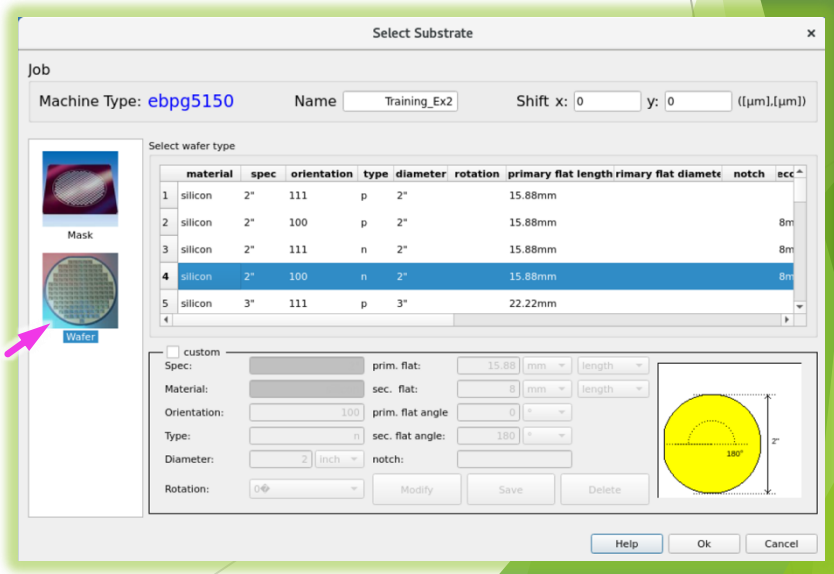
*click on the HELP button in the BRH corner of any window for more information

Programming via cjob

- **Setup an exposure**
  - **substrate** module
    - For small pieces, select MASK, *other options* ➔ and set the X,Y dimensions of the sample piece (10mm x 10mm in example shown).



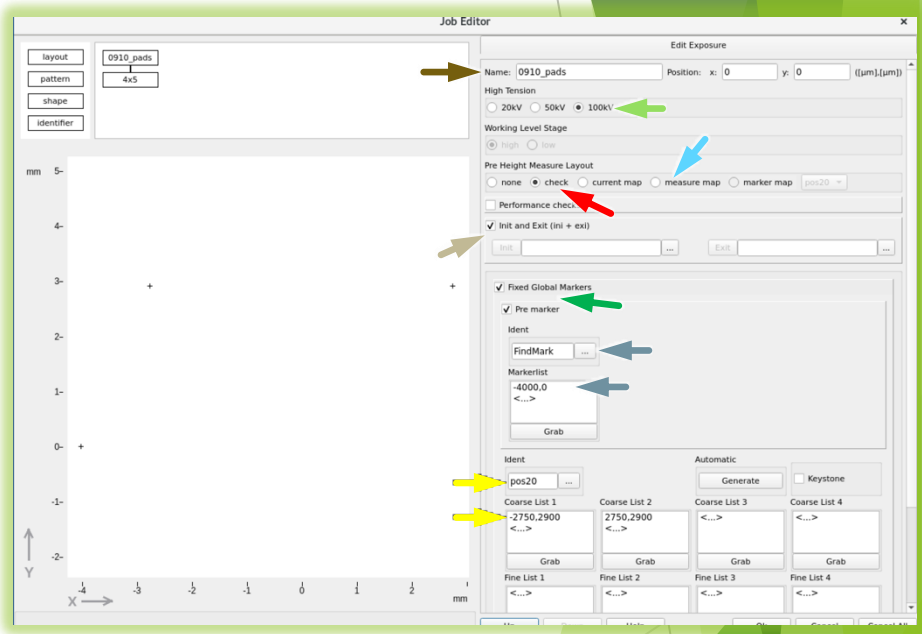
    - For full wafers, select WAFER ➔ and choose the wafer size from the (extensive!) menu that pops up (here a 2" wafer is selected).



Programming via cjob

Setup an exposure

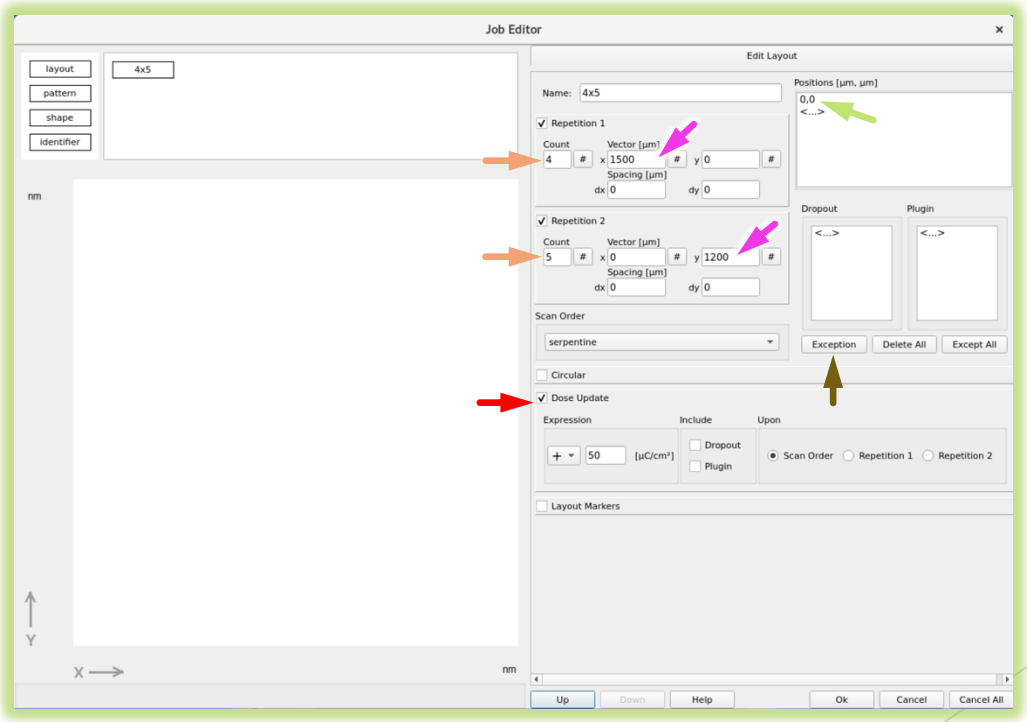
- **Exposure** module: the structure defined within this module defines the executable job file for your exposure. Allows you to store many exposure jobs within one cjob file.
  - Name → defines the executable job name (using the date here is good practice)
  - 100kV must always be selected →
  - Pre Height Measure Layout: height measurements are an intrinsic part of the Raith EBL experience and need to be accounted for properly
    - "standard" substrate size => select *check* → for a 3x3 initial height test (failure is not an option!)*; will use height measurements during exposure if OK.
    - smaller pieces => select *measure map* → ; measures a 10x10 array of heights defining a height "polynomial" that will instead be used during exposure, failure OK!
  - initialization files: → modifies std behavior during operation; to be active, the ini file needs to be in your jobs directory*
  - Global marks definition for an aligned write: always select *Fixed Global Marks* with *Pre-Marker on* → - and every marker must have an identifier (defining cross/rect?, pos/neg?, size?)
    - Pre-align mark →: identifier = FindMark to use SEM/joystick mode to position the marker.
    - Global marks →: Use 2 coarse marks minimum for wafer rotation check (must be ≤ 0.2 deg*)



***template.ini** on the desktop contains 3 options to modify standard behavior: (1) allow > 1 failure during initial *check*, (2) increase wafer rotation limit above 0.2 degrees, (3) no height detection at markers. Copy to your jobs folder and comment out the options you do not want (using # symbol at start of line).

Programming via cjob

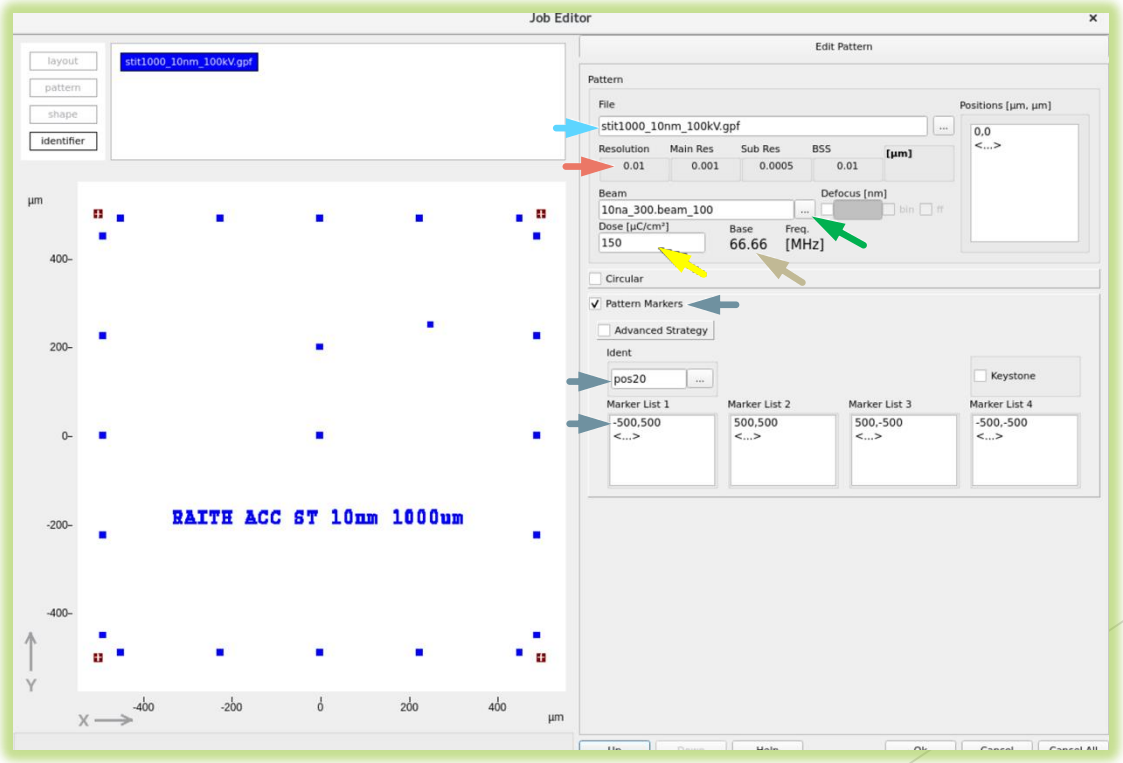
- **Setup an exposure (cont)**
  - **layout** module
    - Use repetition 1 and repetition 2 to setup a 2D array layout
      - Count : number of columns and rows in the array (4C x 5R as shown).
      - Vector : pitch between columns and rows (shown as 1500 and 1200um, respectively)
      - Positions : reposition the array center from sample center default; note that multiple entries => nested arrays! (shown as 0,0 here)
    - Exceptions : Drop-out (removes array elements) and/or plug-in (adds array elements with different properties, e.g., GPF file, dose, or beam condition) using CTRL-click.
    - Dose Update : Automated dose array generator for the 2D array layout (in the example here, this adds 50uC/cm2 to each array element)



Programming via cjob

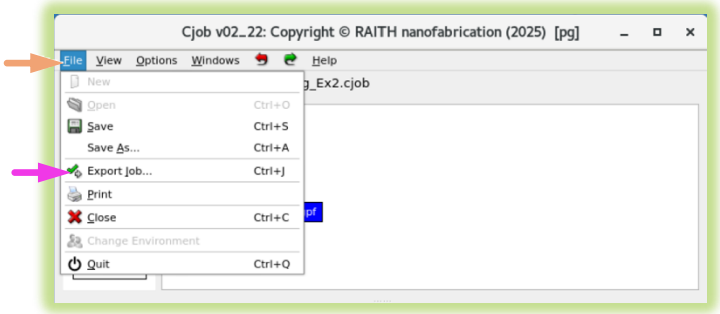
- **Setup an exposure (cont)**
  - **pattern** module: linking the external GPF file(s) generated in BEAMER to the exposure job.
    - note that the GPF already sets the Beam Step Size (BSS) for the exposure and is not a variable here.
    - Select the pattern to be exposed from the list in your patterns sub-directory*
      - The MF, SF, and BSS resolutions used to define the pattern are printed out below
    - Then select the beam condition (from the drop-down menu) and the desired base dose to expose the pattern. A frequency check will confirm, or otherwise, that the 125MHz speed limit is not violated
    - For an aligned write with local die markers, select Pattern Markers and set the identifier and mark positions (wrt die center)

* need to use the nanofiles server along with *nf_sync* command to transfer your GPF files from BEAMER PC to the EBL workstation.

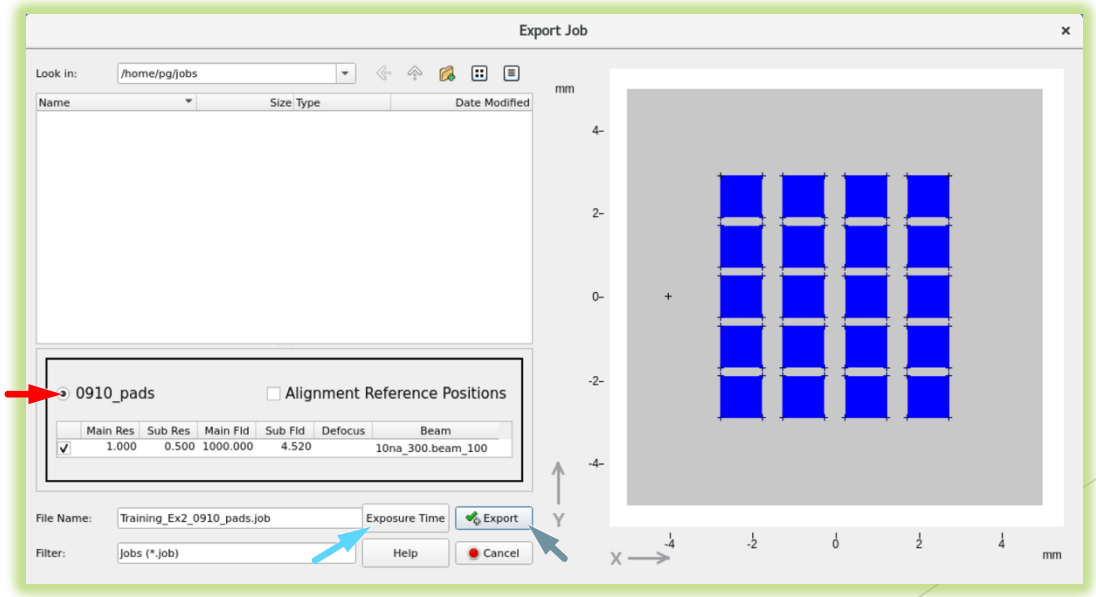


Programming via cjob

- **Setup an exposure (cont)**
  - **export the job**: creating the executable job file
    - In the cjob window, click on File → in the Main menu, then select Export job… → in the drop-down menu



    - In the Export Job window that appears, select the job you want to compile from your cjob file → (0910_pads shown here) and click the Export button →
      - Note that you can get an exposure time estimate by clicking here →

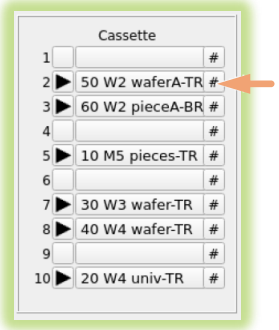


Exposing your sample

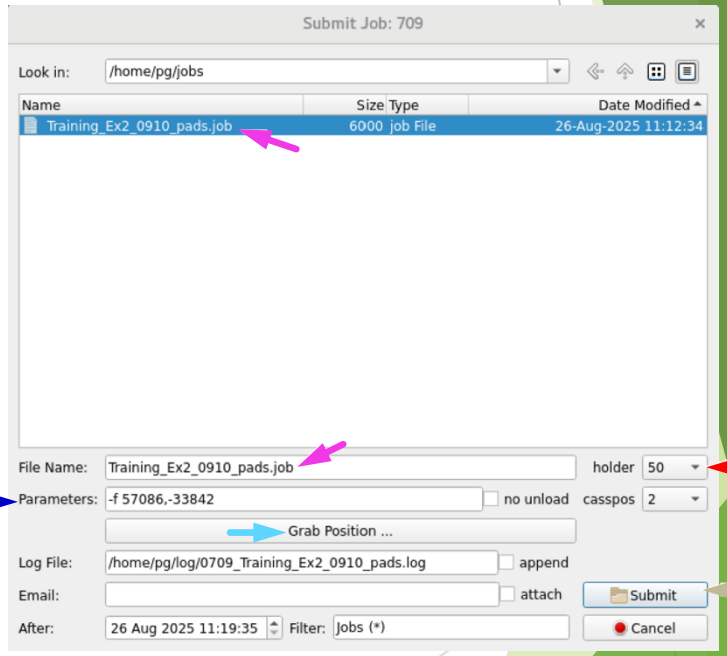
- **Send Job file to the queue**

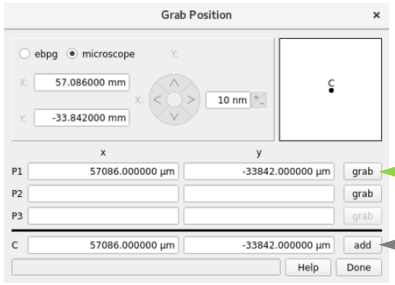
  CONSOLE DESK | Workstation | **cebpg window**

  - Link your job file to the correct holder/table
    - In the *Cassette* field of the cebpg window, click the # button to the right of the holder to be used for the exposure (here, the top reference (TR), 2 x 2” holder in slot 2 is selected)



  - In the **Submit Job** window that appears:
    - Choose the .job file you want to expose
    - IMPORTANT! You need to convert from ideal coords in cjob to the actual coords with your sample on a holder/table on the stage.
    - Parameters field: Use -f command along with the readout of the alignment microscope (wrt FC position) representing the ‘characteristic’ position of your sample (align mark, sample center?)*
    - Multi-table holder in slot 2 or 3? Click on the *holder* button to choose the appropriate table if needed (50 or 51 for TR, 60 or 61 for BR)
    - Click *Submit* button to add to the job queue





*Note if you leave the microscope stage at the relevant position of your sample, then clicking on the *Grab Position* button to open the **Grab Position** window, then *Grab* and *Add* will automatically add the stage position to the Parameters field

Exposing your sample

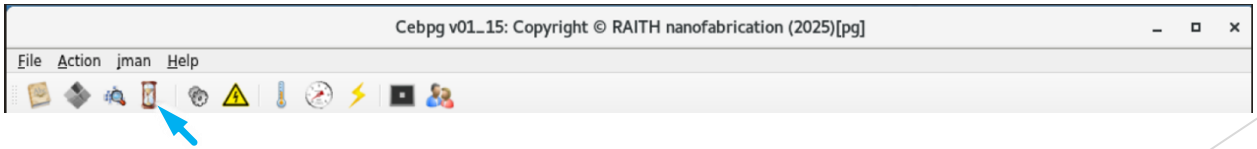
- **Time to expose**

  CONSOLE DESK | Workstation | **cebpg window**

  - The *Jobs Queue* field of the cebpg window shows previously exposed jobs → as well as the job that was just added → – each separated by the HOLD line →
    - To start the exposure, simply click and drag down ↓ the HOLD line → below the job just added →

entry	acc.	env.	job	hol	cas	after/started	status	elapsed
695	pg	YOUNG NoahS_001298	jobs/set-restest-11_right_sets.job -f 56144,-33772	50	1	22-Aug-2025 16:39:18	FINISHED	06:01
696	pg	YOUNG NoahS_001298	jobs/set-restest-11_right_sets.job -f 63972,-51435	50	1	22-Aug-2025 16:45:19	FINISHED	05:22
699	pg	YOUNG WillQW_001830	jobs/SideWall_1.job -f 52935,-40507	50	1	24-Aug-2025 12:45:06	FINISHED	02:45
700	pg	YOUNG WillQW_001830	jobs/SideWall_1.job -f 54651,-41819	50	1	24-Aug-2025 12:48:31	FINISHED	03:01
701	pg	YOUNG NoahS_001298	jobs/set-restest-11_left_sets.job -f 55573,-36690	50	1	24-Aug-2025 15:18:16	FINISHED	05:36
702	pg	YOUNG NoahS_001298	jobs/set-restest-11_left_sets.job -f 63818,-51591	50	1	24-Aug-2025 15:23:52	FINISHED	05:39
703	pg	MISHRA BoyuW_001389	jobs/PRSD8a_Rijo_Tgate.job -f 52860,44189	50	2	24-Aug-2025 15:57:02	FINISHED	08:21
704	pg	MONDEWirelessInc HenryC_0...	jobs/mh06_03_W016_0825.job -f 34818,-32968	40	8	25-Aug-2025 10:29:00	FINISHED	14:36
705	pg	STEMMER ArmanR_001269	jobs/Arman_TJ_asym1.job -f 56997,-52550	60	3	25-Aug-2025 12:53:41	FINISHED	05:08
706	pg	STEMMER ArmanR_001269	jobs/Jiashu_PN1.job -B -f 63009,-28233	60	3	25-Aug-2025 12:58:50	FINISHED	03:38
707	pg	YOUNG LiamC_012066	jobs/main-job_LCFPI022_contact_patch.job -f 55767,-35643	50	2	25-Aug-2025 15:04:44	FINISHED	06:14
708	pg	YOUNG MarcoV_001878	jobs/CL_CP_10_fingers.job -f 56695,-35704	50	2	25-Aug-2025 15:32:14	FINISHED	05:36
709	pg		jobs/Training_Ex2_0910_pads.job -f 57086,-33842	50	2	26-Aug-2025 11:21:30	HOLD.L...	

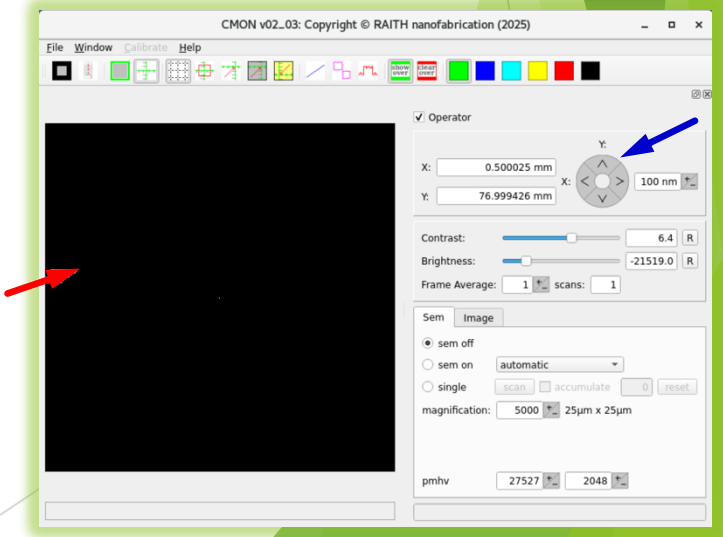
  - Open **cpro** to observe the calibrations and exposure in real time on the screen →



Exposing your sample

- **What happens during exposure?**
  - Sample is loaded onto the stage, followed immediately by a pre-exposure height check (as specified in the **Exposure** module) – *check* versus *measure map*?
  - Set beam condition to programmed setting in cjob
  - Automated objective aperture alignment (including aperture switch if needed)
  - Then standard column calibration: **"*pg adjust ebpg*"**
    - ***pg move marker***: move to pre-defined holder mark on marker chip and detect it
    - ***pg adj table coords***: resets current stage position to stored marker position
    - ***pg adj height comp***: measure height at marker and adjust focus/deflector gains.
    - ***pg adj pull-in***: adjusts DAC's used for repositioning field center after a stage move.
    - ***pg adj focus auto***: correction of focus and stigmation using the holder marker
    - ***pg adj main comp***: adjust main deflector gains to set 1000um field size (moves marker around field)
    - ***pg adj trap comp***: adjust subfield deflector gains to set 4.5um subfield size
    - ***pg measure current***: confirm beam current
    - ***pg adj frequency***: calculates and sets the subfield scanner speed based on dose, current, and BSS

- If no alignment marks, then the exposure immediately proceeds.
- If alignment marks are defined however, then the mark detection routines will run during exposure. Note if *FindMark* is used as a mark identifier, then you will need to use the SEM viewer ➔ and stage joystick ➔ in the **cmon** window to position the mark by centering in the video.

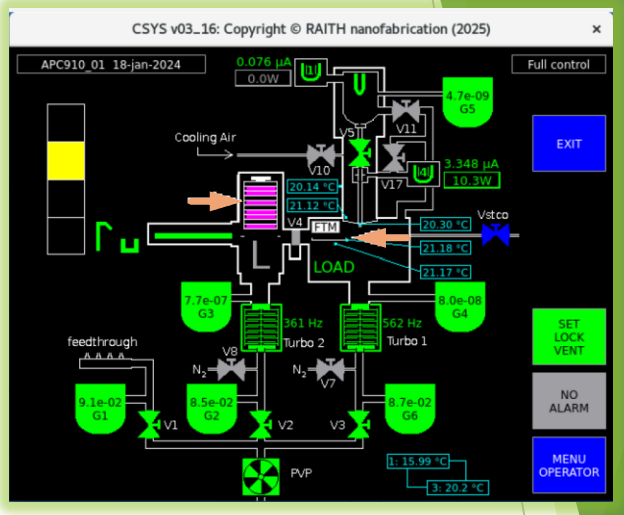


Finishing Up

- **Unload sample**

  TOOL ROOM| **Loader Unit** + **CSYS monitor screen**

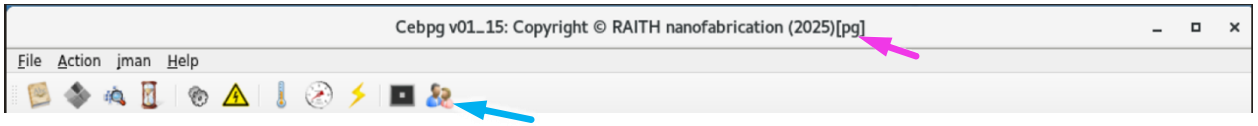
  - First confirm that the holder has returned to the Loader after exposure was completed - empty stage and magazine full
    - Follow the same procedure for “Loading Sample” detailed earlier: *Vent the loader -> Remove holder from Loader -> Remove sample from Holder -> Return holder to Loader -> Pump-down the Loader*



- **End session -> Log out!**

  CONSOLE DESK | Workstation | **cebpg window**

  - Click on the *Change Environment/CE* icon at the top of the window



  - In the **Change Environment** window the appears, select pg and hit *Enter*
  - The title of the cebpg window will change from [your account name] to [pg]. You are logged out!
  - Close **cjob** and **cpro** windows if you haven’t already.

Other stuff to know!

- **Available beam conditions/currents at UCSB**

- Naming convention:
  - 1st term = beam current (pA, nA)
  - 2nd term = objective aperture size (um)
  - 3rd term = *.beam_100* => 100kV operations

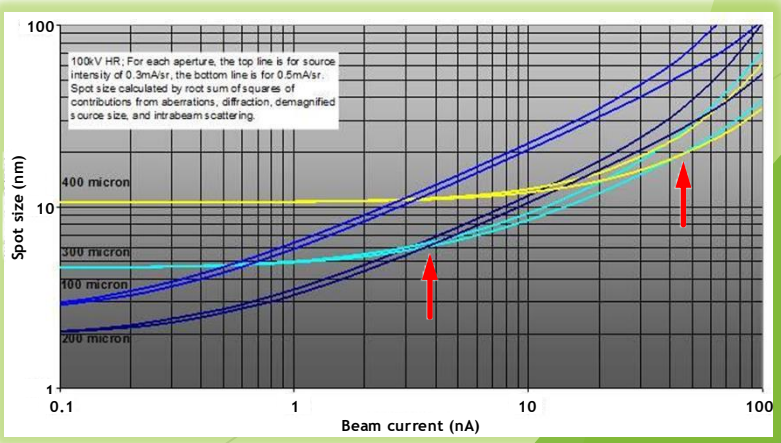
```
[pg@b100 pg]~> pg info archive beam

Mode information                Date         H.T.   Apert. Spots.     Beamc.    Beampar
                                                                                          
50pa_200.beam_100               05-JUN-2025 100 kV  200 um 0.043 um     0.05 nA     60.0 s
100pa_200.beam_100              05-JUN-2025 100 kV  200 um 0.035 um     0.10 nA     60.0 s
150pa_200.beam_100              05-JUN-2025 100 kV  200 um 0.029 um     0.15 nA     60.0 s
200pa_200.beam_100              05-JUN-2025 100 kV  200 um 0.025 um     0.20 nA     60.0 s
500pa_200.beam_100              22-AUG-2025 100 kV  200 um 0.034 um     0.50 nA     60.0 s
1na_200.beam_100                06-AUG-2025 100 kV  200 um 0.034 um     1.00 nA     60.0 s
2na_200.beam_100                24-AUG-2025 100 kV  200 um 0.038 um     2.00 nA     60.0 s
4na_300.beam_100                05-JUN-2025 100 kV  300 um 0.025 um     4.00 nA     60.0 s
5na_300.beam_100                06-AUG-2025 100 kV  300 um 0.022 um     4.99 nA     60.0 s
8na_300.beam_100                05-AUG-2025 100 kV  300 um 0.035 um     8.05 nA     60.0 s
10na_300.beam_100               05-JUN-2025 100 kV  300 um 0.025 um    10.00 nA     60.0 s
15na_300.beam_100               05-JUN-2025 100 kV  300 um 0.028 um    15.04 nA     60.0 s
20na_300.beam_100               05-JUN-2025 100 kV  300 um 0.029 um    20.01 nA     60.0 s
30na_300.beam_100               05-JUN-2025 100 kV  300 um 0.033 um    29.91 nA     60.0 s
40na_300.beam_100               05-JUN-2025 100 kV  300 um 0.035 um    39.62 nA     60.0 s
50na_400.beam_100               05-JUN-2025 100 kV  400 um 0.034 um    49.63 nA     60.0 s
80na_400.beam_100               05-JUN-2025 100 kV  400 um 0.043 um    79.53 nA     60.0 s
100na_400.beam_100              05-JUN-2025 100 kV  400 um 0.050 um   100.23 nA     60.0 s
150na_400.beam_100              05-JUN-2025 100 kV  400 um 0.068 um   150.65 nA     60.0 s
200na_400.beam_100              05-JUN-2025 100 kV  400 um 0.090 um   199.70 nA     60.0 s
250na_400.beam_100              05-JUN-2025 100 kV  400 um 0.116 um   250.30 nA     60.0 s
300na_400.beam_100              05-JUN-2025 100 kV  400 um 0.150 um   299.00 nA     60.0 s
350na_400.beam_100              05-JUN-2025 100 kV  400 um 0.195 um   350.70 nA     60.0 s
```

200um

300um

400um

- Predicted beam diameter versus current, I_B (as a function of aperture size):
  - $I_B < 3.7nA$: use 200um aperture
  - $3.7nA < I_B < 45.0nA$: use 300um aperture
  - $45.0nA < I_B$: use 400um aperture



Other stuff to know!

- **Holder/table details**
  - Unless otherwise stated, all tables have:
    - Wafer Major Flat on the left-side (euro style)
    - Full table rotation control
    - Top reference (TR) substrate height alignment (using 3 height tabs at table edge)

Look in: /home/pg/archive/archive.holders

				marker [mm]			cup [mm]			centre [mm]		
ID	Type	Size	Name	x	y	z	x	y	z	x	y	z
10	pieces-TR	5"	AH936	13.130	13.912	0.000	14.458	21.096	0.000	105.000	105.000	0.000
20	univ-TR	4"	AA0212	11.536	15.115	0.000	14.416	22.501	0.000	72.000	75.000	0.000
30	wafer-TR	3"	W954	11.058	74.551	0.000	14.428	81.929	0.000	75.000	75.000	0.000
40	wafer-TR	4"	W955	11.517	74.510	0.000	14.457	81.846	0.000	75.000	75.000	0.000
50	waferA-TR	2"	N958	11.215	74.499	0.000	14.407	81.881	0.000	72.000	35.000	0.000
51	waferB-TR	2"	N958	11.054	74.498	0.000	14.407	81.881	0.000	72.000	115.000	0.000
60	pieceA-BR	2"	N949	11.703	75.061	0.000	14.438	81.950	0.000	72.000	35.000	0.000
61	pieceB-BR	2"	N949	11.703	75.061	0.000	14.438	81.950	0.000	72.000	115.000	0.000

- 10 | pieces-TR | 5” square table (#AH396)
  - Slot 5: used for substrate pieces of <u>all</u> sizes, held in place by clips; no table rotation control
- 20 | univ-TR | 4”/6” wafer table (#AA0212)
  - Slot 10: ‘universal’ holder for 4” or 6” wafers => currently setup for 4” wafers.
- 30 | wafer-TR | 3” wafer table (#W954)
  - Slot 7: used for 3” wafers
- 40 | wafer-TR | 4” wafer table (#W955)
  - Slot 8: used for 4” wafers
- 50/51 | waferA/B-TR | Dual 2” wafer tables (#N958)
  - Slot 2: used for 2” wafers or smaller substrate pieces (held by clips); table A @ bottom, table B @ top
- 60/61 | pieceA/B-TR | Dual 2” piece tables (#N949)
  - Slot 3: for smaller substrate pieces (held by clips) only; table A @ bottom, table B @ top.
    Bottom reference tables => substrate height manually corrected by the fine adjustment set screws in the 3 height tabs (0.090” allen wrenches are provided for this)

Other stuff to know!

- **Useful commands**
  - Refresh/update table coordinates
    - **[pg@b100 pg]~>** mvm *# move to holder mark and measure position*
    - **[pg@b100 pg]~>** mpg tab *# gives current stage coords (relative to home position)*
    - **[pg@b100 pg]~>** atc *# updates table coordinate system to stored holder mark position*
  - Refresh/update current for any beam condition
    - **[pg@b100 pg]~>** pg info archive beam *# lists all beam condition filenames for 100kV*
    - **[pg@b100 pg]~>** arcr be 1na_200.beam100 *# restores condition file; here we restore 1nA beam, 200um aperture*
    - **[pg@b100 pg]~>** mcur *# measure current; if it has drifted, then continue*
    - **[pg@b100 pg]~>** adjust_beam 1.0 *# reset current to 1 nA (nominally)*
    - **[pg@b100 pg]~>** mcur *# confirm new current ~ 1nA*
    - **[pg@b100 pg]~>** arcs be 1na_200.beam100 *# save new settings into the beam condition file*
  - Various
    - **[pg@b100 pg]~>** mpgm height *# measures height @ current position*
    - **[pg@b100 pg]~>** pg info adj ebpg *# prints out the data from the last calibration (adjust ebpg)*
    - **[pg@b100 pg]~>** mcur *# measure current*

Other stuff to know!

- **Markers**
  - Refresh/update table coordinates
    - **[pg@b100 pg]~>** mvm *# move to holder mark and measure position*
    - **[pg@b100 pg]~>** mpg tab *# gives current stage coords (relative to home position)*
    - **[pg@b100 pg]~>** atc *# updates table coordinate system to stored holder mark position*