CNF Guide to Layout BEAMER v 4.0 and SCELETON

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1. LAYOUT BEAMER OVERVIEW

Layout BEAMER provides a new innovative GUI framework for the database driven, modular design of complex layout process flows. Start Layout BEAMER by logging into korat or minx using the icons on your desktop. On Windows, also start X-Windows, either Exceed or XMing. By typing LayoutBEAMER at the prompt you will see the following main window appear:

The Layout BEAMER Graphical User Interface (GUI) consists of the left side Tool Window pane, the main Process Flow Design workspace window pane, and the lower Information Window pane. Within the Tool Window pane’s Module library under the Edit Tab, you see all available process modules in the following groups:
- Layout Process modules (Import, Export, Extract, Transform, PEC)
- Data Prep modules (Heal, NOT, Bias, P-XOR, MINUS, OR, AND, XOR)
- Modeling modules (E-Beam, Resist)
- Control modules (If, Loop, Merge, Split)

The Tool Window pane also has User Flows & Central Flow Tabs, where common user-defined process flows can be stored to build up a database for later retrieval and re-use.

Building a Process Flow is simply done by drag & drop (using the left mouse button) of the desired process modules from within the Edit Tab (Module Library) into the Process Flow Design workspace window or double click on the desired process

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Module and it will automatically be connected to the last Module added into the Process Flow Design workspace.

**Module Status**
The status of a module is shown by the module color and the icon marker located at the right side of the module. A module which has not had its parameters set is identified as an orange colored module, whereas a red color and a triangular-shaped Run To button signifies that parameters have been set but the module has not been run yet. A module which has been run and the results are ready, is shown with an overlapping-box View icon. A progress bar is shown while the process is being computed. If a module has been selected with the mouse or with the Ctrl-A command, it will have four red dots surrounding the module. Moving your mouse over a module will display the module name and any comments that have been assigned to that module.

### Single Port Modules
A port is used to connect modules. There are input and output ports. A single port module has only one port at the bottom center of the module signifying that it has only output connectivity capability. It can be connected to another module, but has no input capability within the flow. A module's ports are identified as a small, white-colored box.

### Dual Port Modules
A dual port module has a connectivity port at both the top and bottom center of the module, signifying that it has both input and output connection capability in a flow.

Dual port modules include: Extract, Filter, Transform, Grid, Heal, NOT, Bias, P-XOR, PEC, Shape-PEC, 3D PEC, FDA, Export, E-Beam and Metrology.

### Multi Port Modules
A multi port module usually has three ports with a few exceptions. The multi port modules have two input ports at the top on the module and one output port on the bottom. Some specialty modules will have one input and two output modules while others, such as Loop and Optimizer, will combine two modules as a single process,
each with input and output connectivity capability. The other exception is the new Merge and Split modules which transform into a hub with a dynamic number of ports.

Multi port modules include: OR, MINUS, AND, XOR, Split, Merge, Loop and Optimizer.
How To Connect Modules
There are three ways to connect modules. Drag and drop a module from the library onto the target module in the flow until the small white connection port turns black, then release the mouse and the modules will be connected. Modules can also be manually connected by using the right mouse button, held down, to draw a line between open ports. Finally, double clicking a module in any library will automatically send it to the Process Flow Design window, and connect it to a selected module in the flow.

Base Module Library Overview

Layout Operation:

Import  Edit
Export
Extract  Filter  Transform

Post Processing

Grid
Heal  NOT  Bias
P-XOR  Merge
OR  AND  MINUS
XOR

Process Correction

PEC  Shape-PEC  3D-PEC
FDA

Verification

E-Beam  Metrology

Control

Split
Loop  Script  Optimizer
2. Converting Patterns QUICK START

1. For short run conversions you could use a Windows machine to run LayoutBEAMER. This is accomplished by starting a session of Exceed or XMing, putty over to your korat or minx account and type **LayoutBEAMER**

   **NOTE:** Longer conversions, or any PEC related work, you must use use the SUN Rays. You can let the conversion run in the background. Log into **korat** or **minx** through a SunRay and type **LayoutBEAMER**

2. Drag & Drop the **Import** Module from the Module Library into the Process Flow Design area workspace. Navigate to a folder with your GDSII file. Either accept the default Import Layout settings (Layer Set * & Datatype Set *) which means all available layers will be imported, or choose the layers you wish to import. Execute the **Import** module by selecting **Run To** from the module option menu with a right mouse button click on the **Import** module as below. Following completion the icon dot will turn into .

3. Drag & drop the **Extract** module into the Process Flow Design area workspace, dropping it directly on top of the **In GDS** module, releasing the **Extract** module when the **In GDS** module output port turns black as shown below.

   ![In GDS and Extract modules](image)

   Choose a cell, layer and datatype range, select extents (automatic extent is default). Click **OK**. The modules appear as:

   ![In GDS and Extract modules](image)

   Right click **Extract** select **Run To**. The modules appear as:

   ![In GDS and Extract modules](image)

   To view data right click **Extract** select **View Layout**.
4. Drag & drop the Export module on top of Extract. Click Browse for other folders in the Save File window.

In the expanded Save File window, type in a file name, navigate to the correct folder, choose JEOL 52 file (*.v30), and click Save (steps 1-4 in the below figure).

For the JEOL, in the General tab make sure that the machine type is either JBX-9300FS (100kV) or JBX6300FS. Choose appropriate pattern units and shot pitch units. Fracture Mode 1 is the typical fracturing mode. Fracture Mode 2 uses the algorithm developed by Don Tennant at
Lucent that snaps ebeam pixels to pattern edges. Consequently within this mode increased number of fractured shapes are produced. When mapping layers to shot modulated clocks, within the Advanced tab, under Dose Mapping, choose Layer to Class.

Fixed main field option stacks fields in a boustrophedonic/serpentine/meander manner, whereas Floating allows placement of the main fields such that the structures are written with minimal stage movement for the areas of interest.

For the JBX63000FS: After choosing JBX-6300FS under the Machine Type settings under the General tab. Click on the Tool tab, choose:

- EOS Mode 3 4th Lens mode, 500um field size, 1nm pixels
- EOS Mode 6 5th Lens mode, 62.5um field size, 0.125nm pixels

Then go back to the General tab and modify settings.

Right click Export select Run To.

FILE TRANSFER TO JEOL6300

ftp jeol6300
user name: jeoleb
password: Jeoleb
cd pattern/user
bin
put FileName.v30

FILE TRANSFER TO JEOL9300

ftp jeol
user name: ebtest
password: EBtest
cd pattern/user
bin
put FileName.v30
Complete steps 1-3 in section 2. Drag & drop the PEC module on top of Extract.

**General** tab: With “Gaussian Approximation” enabled, enter the Beta and Eta parameters. Checking “Include Short Range Correction” enables the Alpha parameter. At 2nA or lower on the JEOL Beam FWHM[um] parameter is around 0.004.

Computing the parameters using SCELETON generated data: Choose “Numerical PSF”, click Browse and select the SCELETON xrz file (see next section on generating a SCELETON file). Set the Beam FWHM[um] to the appropriate beam diameter (at 2nA, the beam diameter is around 5nm). Within the Accuracy tab, within Dose Class Definition, default Accuracy setting: PEC will only generate the number of dose classes needed to get the defined accuracy. The default setting is 1% with the max number of 256 dose classes. This means that you will get less dose classes if the accuracy of 1% can be reached by lower number of dose classes. Choosing Fixed Number allows user defined number of dose classes, default is 64 dose classes. The isodose grid defines the grid between adjacent doses. For Manhattan geometries a minimum figure size can be specified. Click OK.

Click OK. Right click PEC select Run To. To view the proximity corrected pattern, right click PEC select View Layout. Within the Layout Viewer choose View > Color by Layer > Dose.

Export data (see Section 2 item 4). For the JEOL, exporting a v30 file will automatically generate a jdi file containing modulated doses (see below). Paste this data into the job file.

MOD001: MODULAT (( 0, 19.17 ) , ( 1, 20.00 ) , ( 2, 20.85 )
- ( 3, 21.69 ) , ( 4, 22.55 ) , ( 5, 23.41 )
- ( 6, 24.28 ) , ( 7, 25.15 ) , ( 8, 26.03 )
- ( 9, 26.91 ) , ( 10, 27.81 ) , ( 11, 28.70 )
- ( 12, 29.61 ) , ( 13, 30.52 ) , ( 14, 31.43 )
- ( 15, 32.36 ) , ( 16, 33.29 ) , ( 17, 34.22 )
- ( 18, 35.17 ) , ( 19, 36.11 ) , ( 20, 37.07 )
- ( 21, 38.03 ) , ( 22, 39.00 ) , ( 23, 39.98 )
- ( 24, 40.96 ) , ( 25, 41.95 ) , ( 26, 42.95 )
- ( 27, 43.95 ) , ( 28, 44.96 ) , ( 29, 45.98 )
- ( 30, 47.01 ) , ( 31, 48.04 ) , ( 32, 49.08 )
- ( 33, 50.13 ) , ( 34, 51.18 ) , ( 35, 52.24 )
- ( 36, 53.31 ) , ( 37, 54.39 ) , ( 38, 55.47 )
- ( 39, 56.56 ) , ( 40, 57.66 ) , ( 41, 58.77 )
- ( 42, 59.89 ) , ( 43, 61.01 ) , ( 44, 62.14 )
- ( 45, 63.28 ) , ( 46, 64.43 ) , ( 47, 65.58 )
- ( 48, 66.74 ) , ( 49, 67.92 ) , ( 50, 69.09 )
- ( 51, 70.28 ) , ( 52, 71.48 ) , ( 53, 72.68 )
- ( 54, 73.90 ) , ( 55, 75.12 ) , ( 56, 76.35 )
- ( 57, 77.58 ) , ( 58, 78.83 ) , ( 59, 80.09 )
- ( 60, 81.35 ) , ( 61, 82.63 ) , ( 62, 83.91 )
- ( 63, 85.20 ) )
4. SCELERON QUICK START

Log into korat through a SunRay NOTE: On minx sceleton command is sceleton32
Also SunRays must be used for sceleton.
Copy sceleton.mda and sceleton.rsc from ~rob.ilic/public/sceleton into a directory where
cleton will run. Typing cp ~rob.ilic/public/sceleton/sceleton.* . will copy both files into your
current working directory.

30nmHSQsoi.sip example file
#---------------------------------------------------------------
# Sceleton run for Rob (rob@cnf.cornell.edu)
# SOI - 110nm SiN on top of 1um SiO2
#
ResultFileName 30nmHSQsoi  
StackDescFileName 30nmHSQsoi
InjectionEnergy/eV 100000.0
ElectronsToTrace 3000000
Verbosity 2
IntervalInfo/s 60.0
IntervalWrite/s 600.0
#---------------------------------------------------------------

NOTE: Compiling this .sip file will read in 30nmHSQsoi.stk and generate 30nmHSQsoi.srz for
3 million 100keV electrons, it will display results every 60seconds, and write results to file every
600 sec.

30nmHSQsoi.stk example file
#----------------------------------------------------------
StackDescriptor: HSQ/SOI
NumberOfLayers: 4
#----------------------------------------------------------
MaterialDescriptor: HSQ
Thickness/nm: 30
LayFlag: 1
#----------------------------------------------------------
MaterialDescriptor: Si
Thickness/nm: 110
LayFlag: 0
#----------------------------------------------------------
MaterialDescriptor: SiO2
Thickness/nm: 3000
LayFlag: 0
#----------------------------------------------------------
MaterialDescriptor: Si
Thickness/nm: 700000
LayFlag: 0
#----------------------------------------------------------

NOTE: Layer thickness is expressed in nm. LayFlag = 1 for the resist layer.

sceleton 30nmHSQsoi.sip generates 30nmHSQsoi.srz (defined by ResultFileName)
(NOTE: on minx the command would be sceleton32 30nmHSQsoi.sip)

Extract the data half-way through the plane of the resist, in this case 15nm:
sceleton 30nmHSQsoi.srz 15 generates 30nmHSQsoi_z15.xrz
5A. LAYOUT BEAMER TONE REVERSAL QUICK START - Method 1

You should have a bounding box around your features. The bounding layer must be different than the feature layer. As an example, consider 10 x 10 array of circles (red layer) with a bounding box (green layer).

1. Drag & Drop 2 instances of the Import module and choose the same gds file (see below figure). Right click each Import and select Run To. Layout BEAMER will appear as:
2. Drag & Drop 2 instances of the Extract module over the existing Import modules. To accomplish this, drag and drop a module from the library onto the target module in the flow until the small white connection port turns black, then release the mouse and the modules will be connected.

Over the left Extract choose the bounding layer and boundary cell, over the right Extract choose your data layer and respective cell, then click OK.
Right click each Extract and select Run To. The screen should appear as:

3. Drag & Drop the left side of the Minus module over the left Extract and the right side of the Minus module over the right Extract. Right click Minus and select Run To (see left figure below). Right click Minus and choose View Layout, then View -> Fill Shapes (right figure below shows the output of the MINUS operation).

4. Drag & drop the Export module on top of Minus. Choose the file format (most likely GDS). Right click Export select Run To.
This method does not need a drawn bounding box. Pattern extents are user defined.

1. Drag & Drop an instance of the **Import** module and choose a gds file. Drag & drop an instance of the **Extract** module over the **Import** module. To accomplish this, drag and drop a module from the library onto the target module in the flow until the small white connection port turns black, then release the mouse and the modules will be connected.

Right click on **Import** and select **Run To**. Drag & drop an instance of the **Extract** module over the **Import** module. Choose the cell and layer within the **Extract** tab. Click on the **Extent** tab. Default extents are **Automatic** extents defined by your pattern. Click **User** to manually specify user extents for the Boolean operation.

2. Drag & Drop an instance of the **NOT** module on top of the **Extract** module. Right click on **NOT** and select **Run To** (see left figure below). Right click on **NOT** and select **View Layout**, then View -> Fill Shapes (right figure below displays the output of the **NOT** operation).

Drag & drop the **Export** module on top of **NOT**. Choose the file format (most likely GDS). Right click **Export** select **Run To**.