

# Connecting to Sentaurus

EE232 Discussion

2/2/2015

# Connection Options

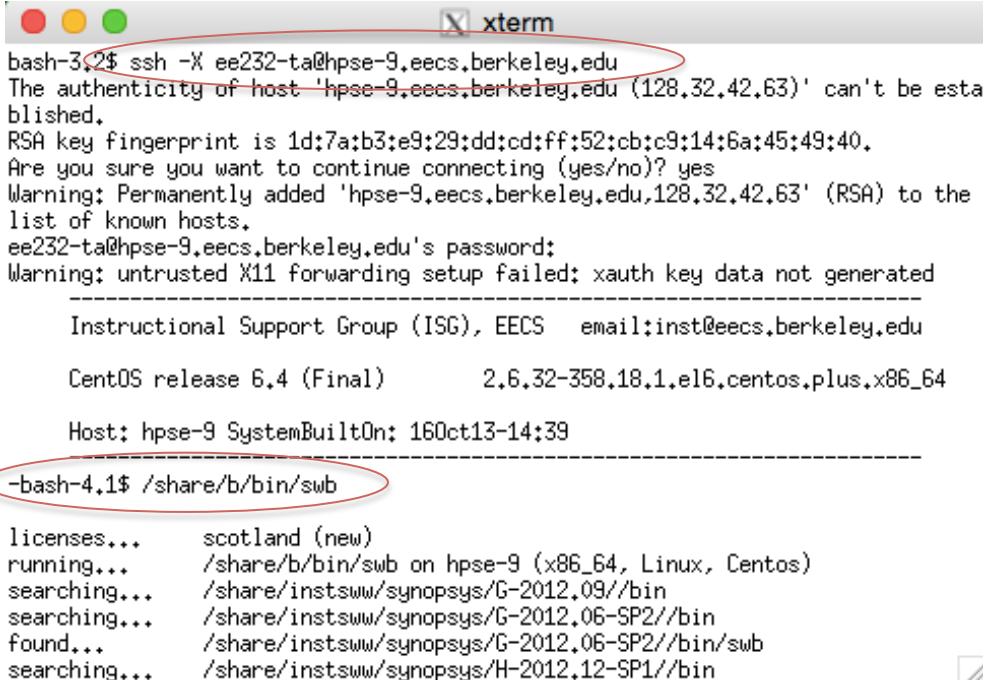
- Class Account (a bit slow):
  - hpse-9.eecs, hpse-10.eecs, hpse-11.eecs, ... ,  
hpse-15.eecs
- Device group members have access to their own servers. Ask a member of your group.
- Install on your workstation at your desk (must have linux installed).

# EECS Instructional Connection

- Connection via X11 (graphical SSH)
- Install the following software on your computer first:
  - Windows: MobaXterm  
<http://mobaxterm.mobatek.net/download.html>
  - Mac: Xquartz  
<http://xquartz.macosforge.org/landing/>

# Connect to server

- `ssh -X username@hpse-9.eecs.berkeley.edu`
- Launch Sentaurus workbench:
  - Type `‘/share/b/bin/swb’`



```
bash-3.2$ ssh -X ee232-ta@hpse-9.eecs.berkeley.edu
The authenticity of host 'hpse-9.eecs.berkeley.edu (128.32.42.63)' can't be established.
RSA key fingerprint is 1d:7a:b3:e9:29:dd:cd:ff:52:cb:c9:14:6a:45:49:40.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added 'hpse-9.eecs.berkeley.edu,128.32.42.63' (RSA) to the list of known hosts.
ee232-ta@hpse-9.eecs.berkeley.edu's password:
Warning: untrusted X11 forwarding setup failed: xauth key data not generated

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Instructional Support Group (ISG), EECS    email:inst@eecs.berkeley.edu

CentOS release 6.4 (Final)                2.6.32-358.18.1.el6.centos.plus.x86_64

Host: hpse-9 SystemBuiltOn: 160ct13-14:39
-----
-bash-4.1$ /share/b/bin/swb

licenses...    scotland (new)
running...    /share/b/bin/swb on hpse-9 (x86_64, Linux, Centos)
searching...  /share/instdsw/synopsys/G-2012.09//bin
searching...  /share/instdsw/synopsys/G-2012.06-SP2//bin
found...     /share/instdsw/synopsys/G-2012.06-SP2//bin/swb
searching...  /share/instdsw/synopsys/H-2012.12-SP1//bin
```

# Some Notes about connecting

- Each time swb is run, you must select the folder where your sentaurus projects reside (STDB). This can be your home directory or a folder you create.
- Sentaurus will only run while you stay connected. If you lose your connects the program (and your simulations) will stop.
- If your connection is spotty, consider remote desktop to a windows server on campus and doing your remote X11 session from that computer.
- For more details, see inst website (<http://inst.eecs.berkeley.edu/cgi-bin/pub.cgi?file=synopsys.help>)

# Getting Started

- Copy 'EEL-1D' example to your directory
- Edit device structure with sde
- Edit device simulation with sdevice
- Add a parameter to your device simulation
- Edit your data analysis in svisual
- Save and pre-process
- Run your simulation
- View your device structure with svisual
- View your simulation results with svisual

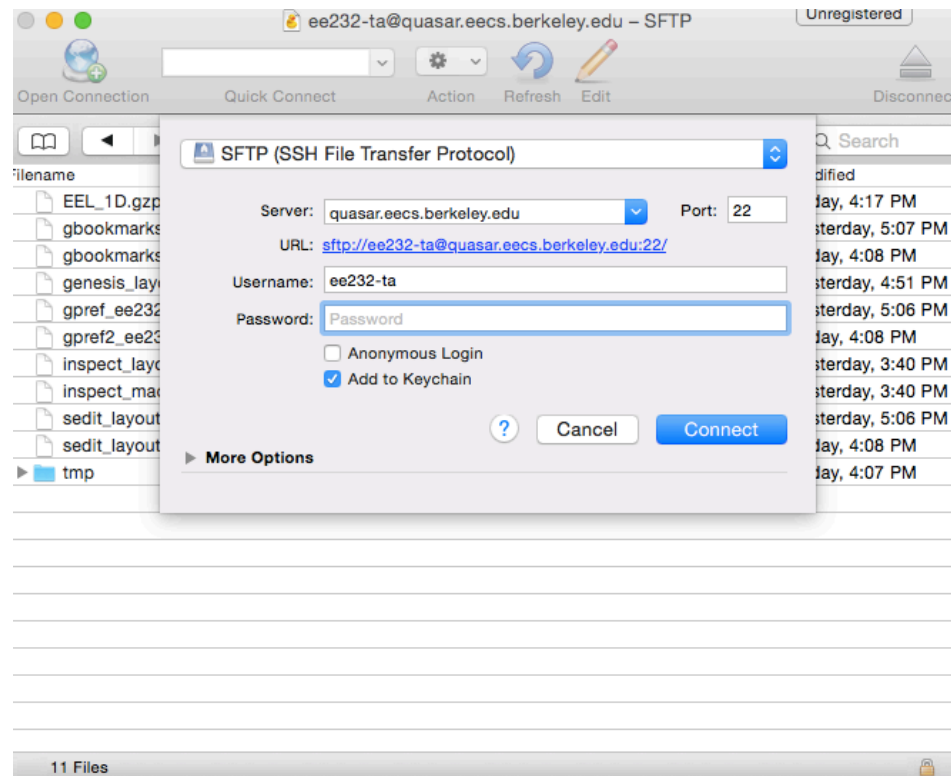
# Copy Example to your directory

Using SFTP copy the example (EEL\_1D.gzp) to your project directory.

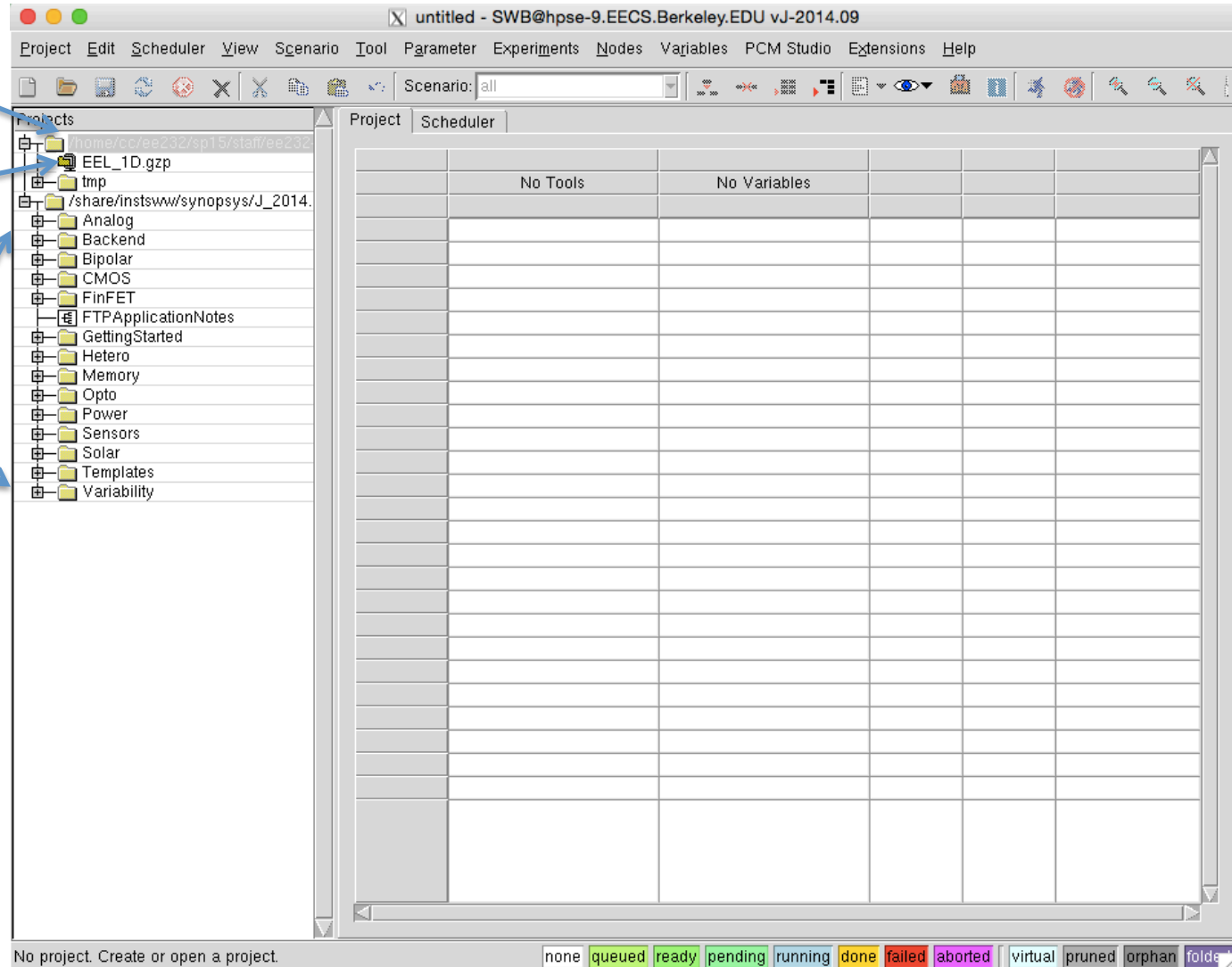
Mac: cyberduck (<https://cyberduck.io/?l=en>)

Window: WinSCP (<http://winscp.net/eng/index.php>)

Connect to quasar.eecs.berkeley.edu for SFTP



# Open Sentaurus



Your project directory

Example project

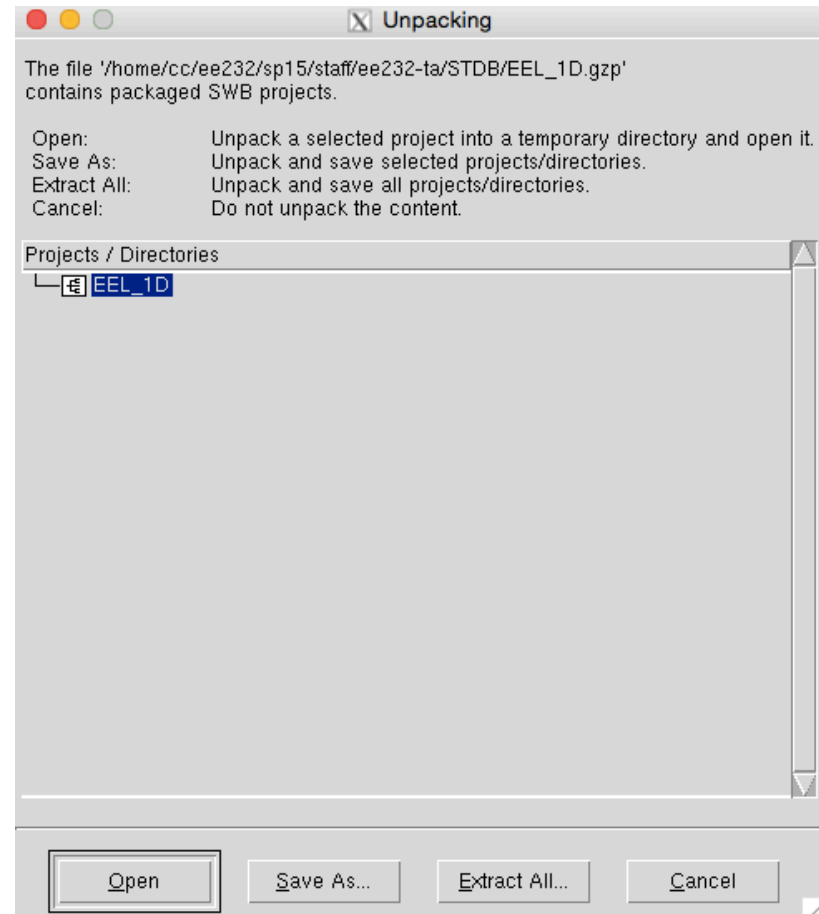
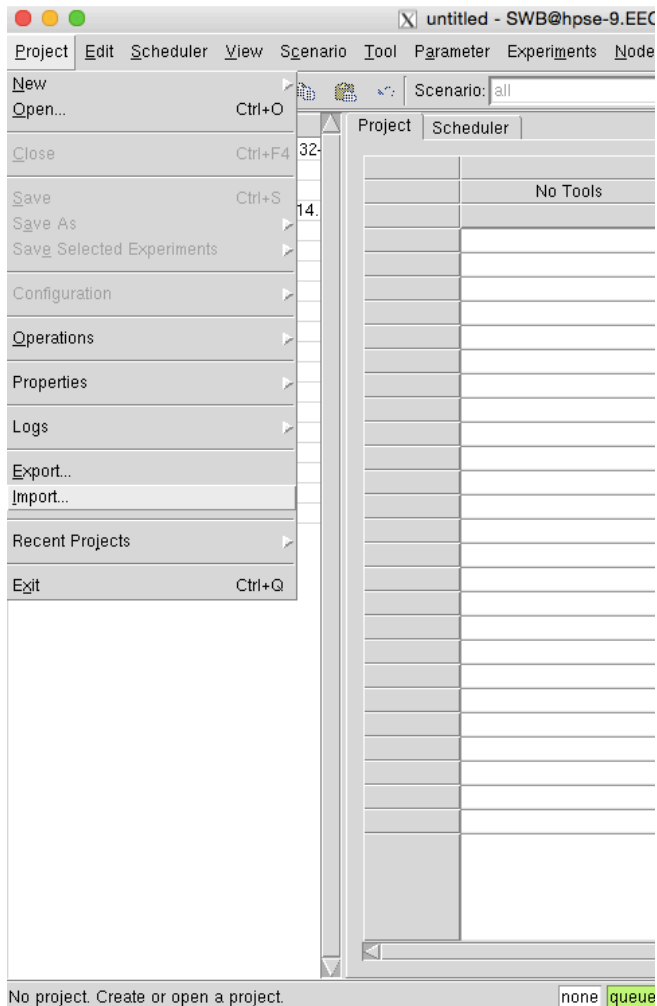
Other Examples:  
Can copy these  
to your project  
directory.

No project. Create or open a project.

none queued ready pending running done failed aborted virtual pruned orphan folder



# Import zipped example



- Go to 'Project -> Import...'
- Select the EEL-1D project and click 'Save As...' or 'Extract All..' to save to your project directory.

Simulation tool

# Layout of SWB

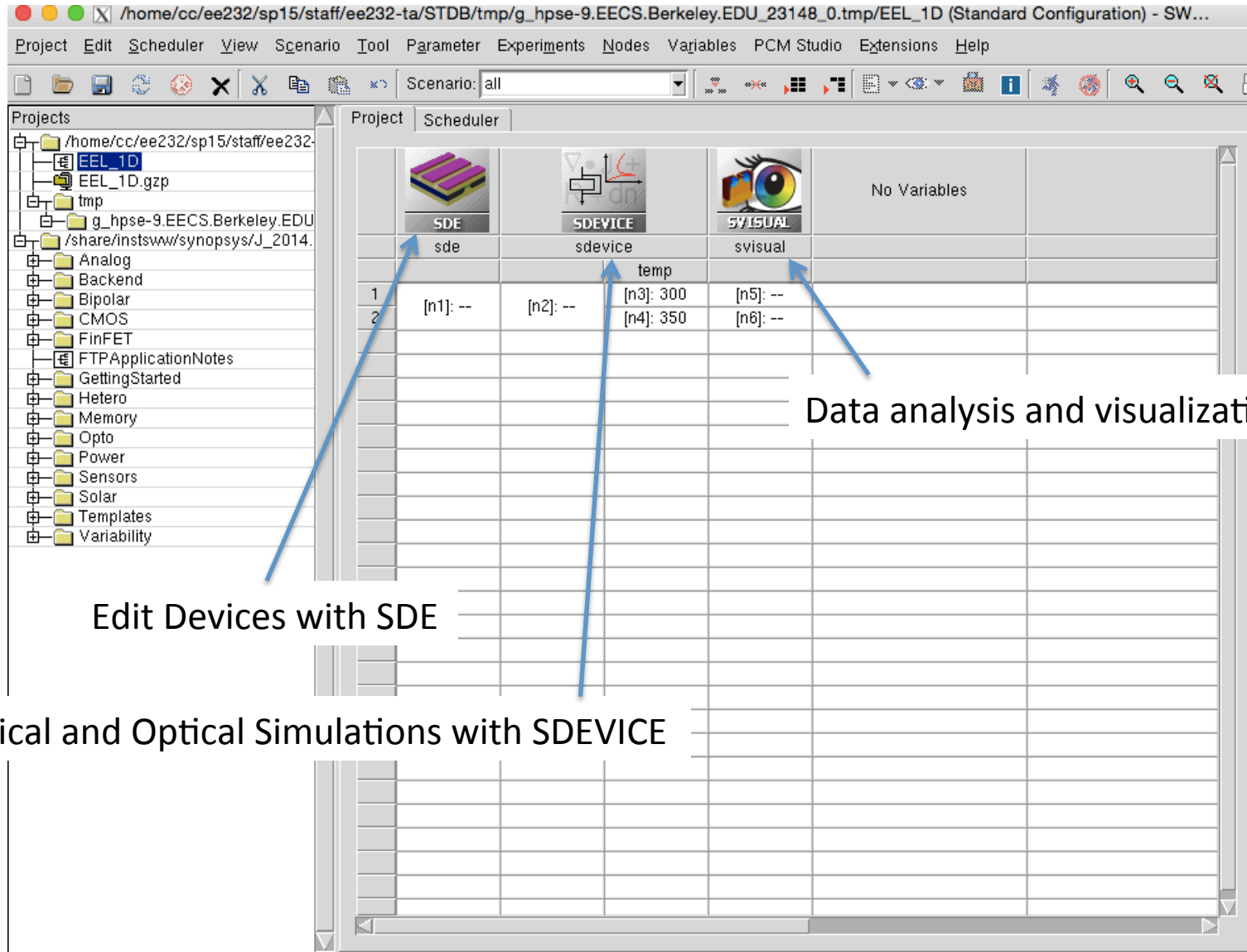
Parameter for simulation

The screenshot shows the Synopsys Workbench (SWB) interface. On the left is a project tree with folders like 'EEL\_1D', 'tmp', and 'g\_hpse-9.EECS.Berkeley.EDU'. The main window displays a 'Scheduler' view with a table of simulation nodes. The table has columns for simulation nodes and parameters. A blue circle highlights the cells '[n5]: --' and '[n6]: --' in the second row. Blue arrows point from external text to the 'SDE' icon and the highlighted cells.

	SDE	SDEVICE	temp	SVISUAL	No Variables
1	[n1]: --	[n2]: --	[n3]: 300	[n5]: --	
2			[n4]: 350	[n6]: --	

Individual Simulation Node

# Layout of SWB

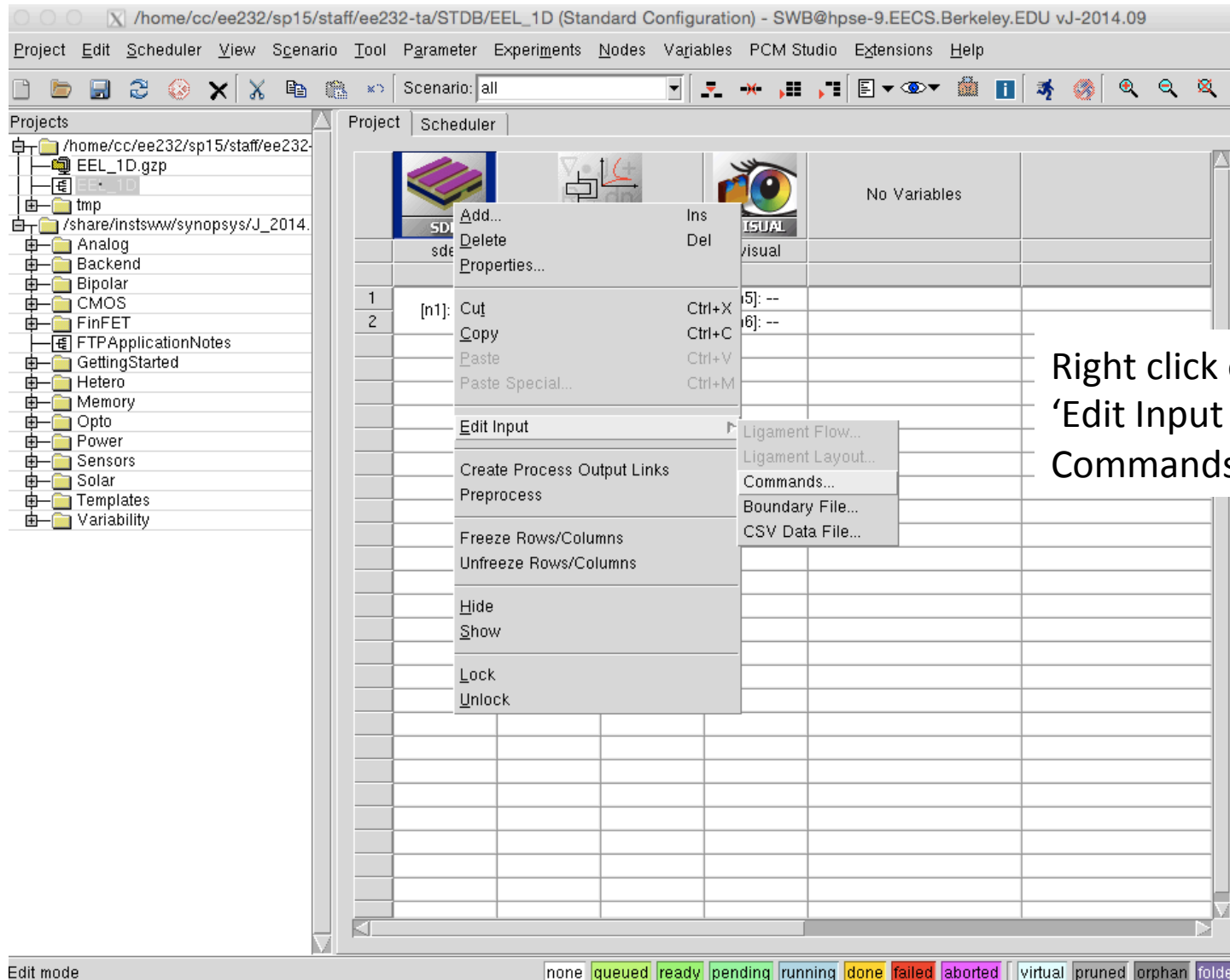


Edit Devices with SDE

Electrical and Optical Simulations with SDEVICE

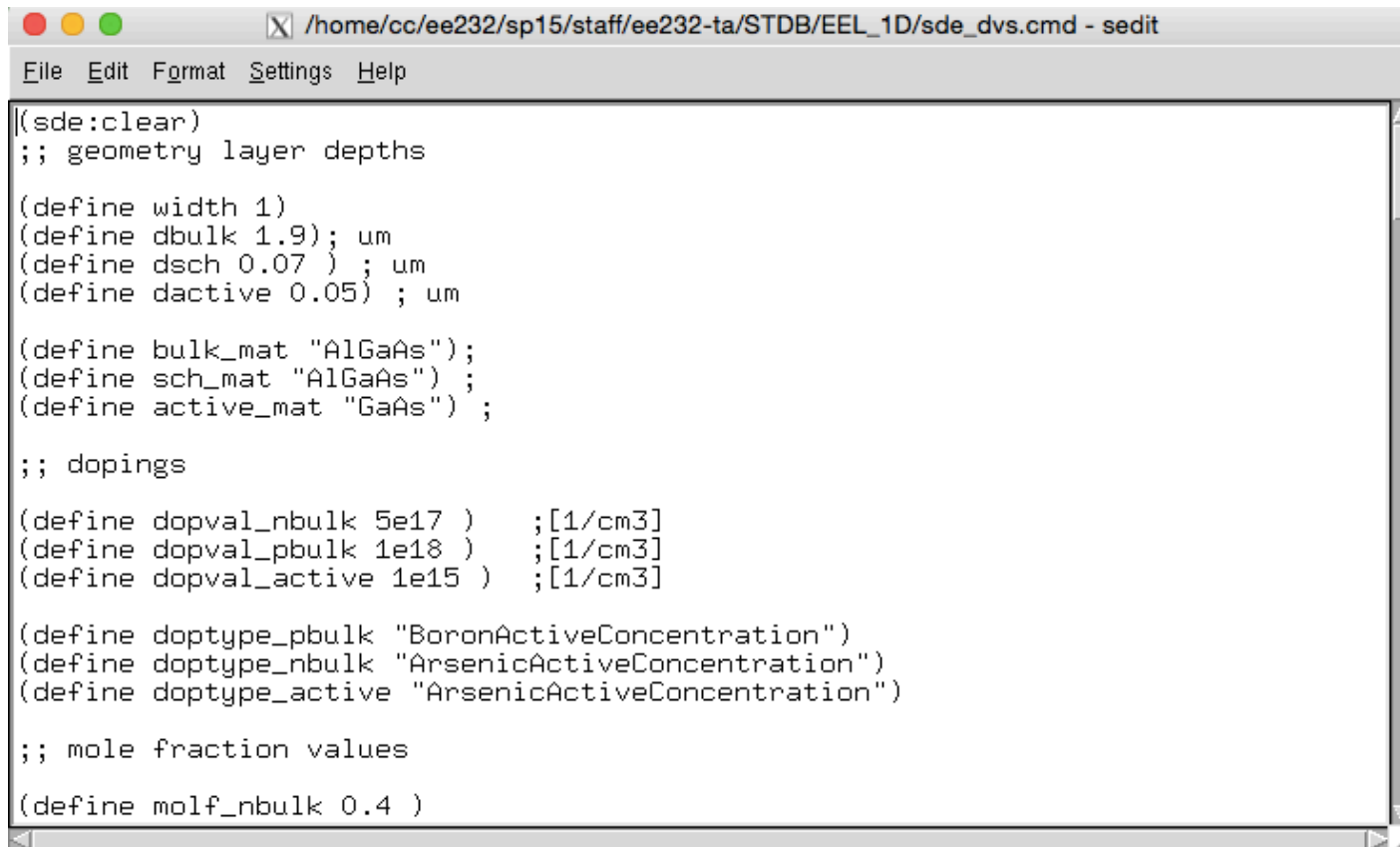
Data analysis and visualization with s

# Edit Structure with SDE



Right click on SDE tool,  
'Edit Input ->  
Commands...'

# Edit Structure with SDE (2)



```
/(sde:clear)
;; geometry layer depths

(define width 1)
(define dbulk 1.9); um
(define dsch 0.07 ) ; um
(define dactive 0.05) ; um

(define bulk_mat "AlGaAs");
(define sch_mat "AlGaAs");
(define active_mat "GaAs");

;; dopings

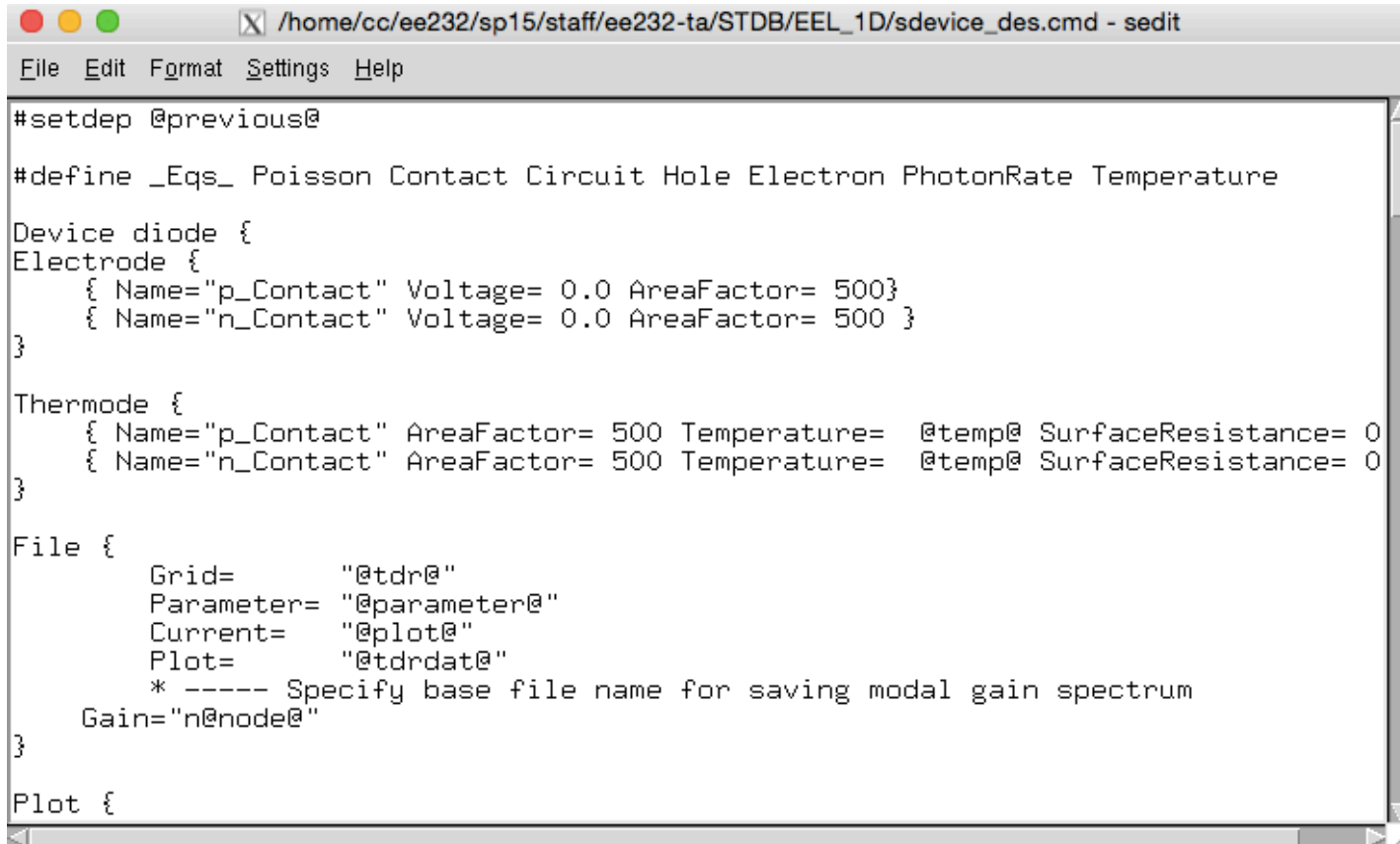
(define dopval_nbulk 5e17 ) ;[1/cm3]
(define dopval_pbulk 1e18 ) ;[1/cm3]
(define dopval_active 1e15 ) ;[1/cm3]

(define doctype_pbulk "BoronActiveConcentration")
(define doctype_nbulk "ArsenicActiveConcentration")
(define doctype_active "ArsenicActiveConcentration")

;; mole fraction values
(define molf_nbulk 0.4 )
```

- Everything defined with text file. Need to define materials, geometry, doping level, mole fraction, and contact placement.
- The simulation mesh is also defined here. Commands can be found in the SDE manual.

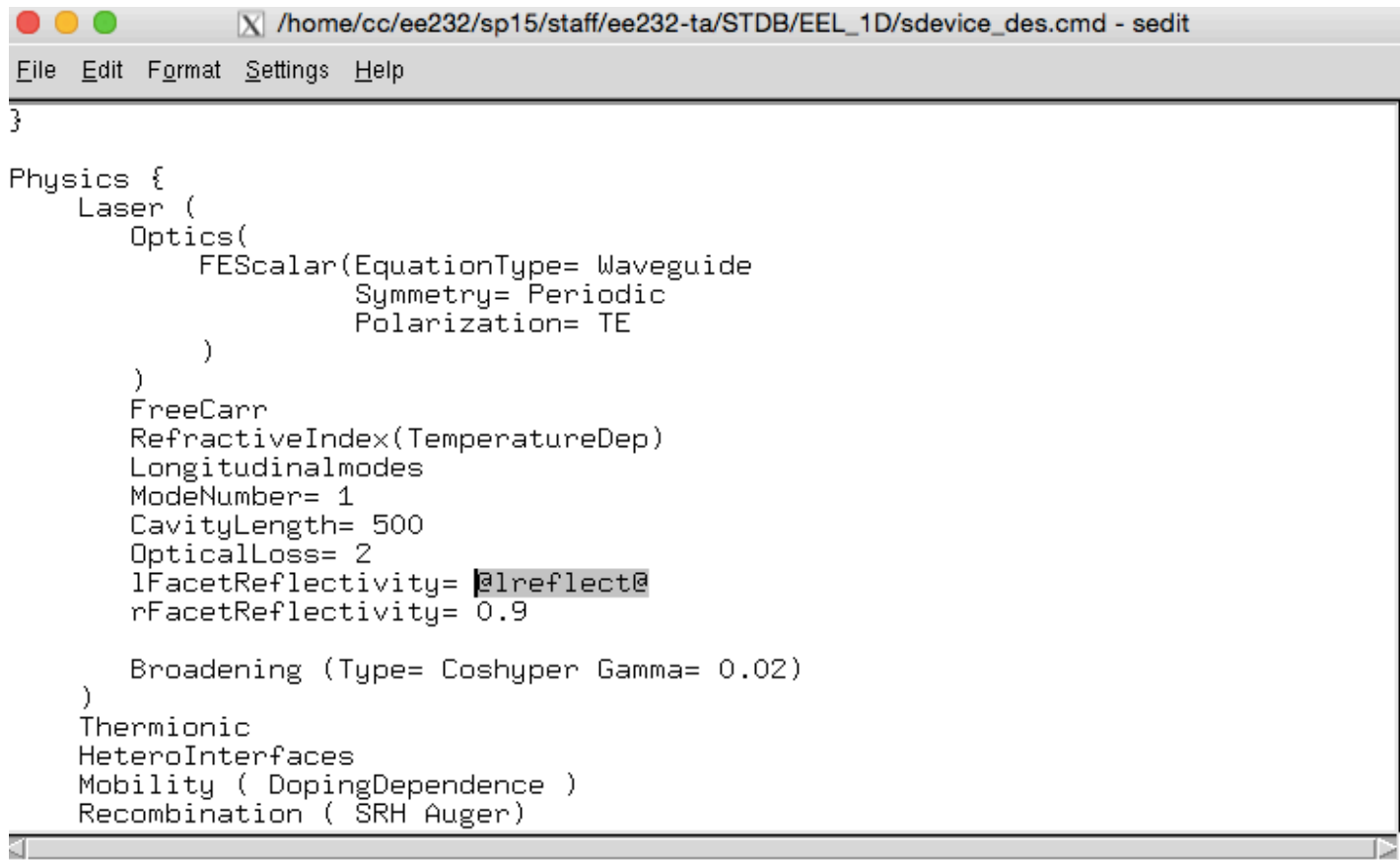
# Edit Device Simulation with SDEVICE



```
#setdep @previous@
#define _Eqs_ Poisson Contact Circuit Hole Electron PhotonRate Temperature
Device diode {
Electrode {
    { Name="p_Contact" Voltage= 0.0 AreaFactor= 500}
    { Name="n_Contact" Voltage= 0.0 AreaFactor= 500 }
}
Thermode {
    { Name="p_Contact" AreaFactor= 500 Temperature= @temp@ SurfaceResistance= 0
    { Name="n_Contact" AreaFactor= 500 Temperature= @temp@ SurfaceResistance= 0
}
File {
    Grid=      "@tdr@"
    Parameter= "@parameter@"
    Current=   "@plot@"
    Plot=      "@tdrdat@"
    * ----- Specify base file name for saving modal gain spectrum
    Gain="n@node@"
}
Plot {
```

- Similarly right click on sdevice to edit the command file.
- Syntax is different here. Need to define input/output files, electrodes, thermodes (if doing thermal simulation), all physics models used, and the actual voltages, currents to sweep.

# Add Parameter to simulation

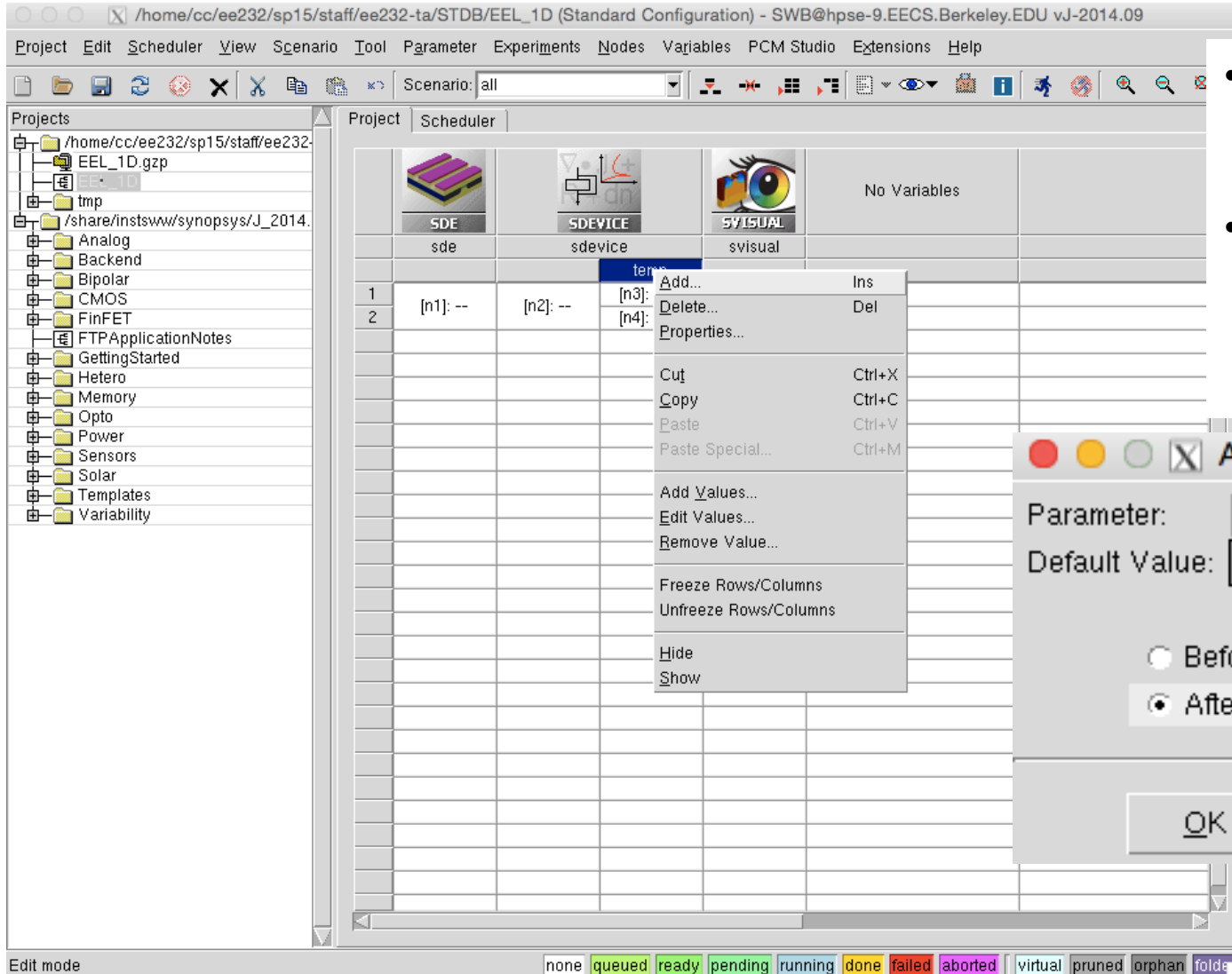


```
/home/cc/ee232/sp15/staff/ee232-ta/STDB/EEL_1D/sdevice_des.cmd - sedit
File Edit Format Settings Help
}
Physics {
  Laser (
    Optics(
      FEScalar(EquationType= Waveguide
              Symmetry= Periodic
              Polarization= TE
            )
    )
    FreeCarr
    RefractiveIndex(TemperatureDep)
    Longitudinalmodes
    ModeNumber= 1
    CavityLength= 500
    OpticalLoss= 2
    lFacetReflectivity= @lreflect@
    rFacetReflectivity= 0.9

    Broadening (Type= Coshyper Gamma= 0.02)
  )
  Thermionic
  HeteroInterfaces
  Mobility ( DopingDependence )
  Recombination ( SRH Auger)
```

- We can make one of the mirror reflectivities in the laser a parameter in the workbench.
- In the sdevice command file, change the lFacetReflectivity from 0.07 to @lreflect@
- The @..@ indicates a parameter and any name can be used.

# Add Parameter to workbench



- Right click under sdevice and select Add...
- Type parameter name and default value



# Add more values

- Right click on 'Ireflect'
- Type parameter value
- Can add multiple values
- New simulation nodes are automatically created

The screenshot shows the Synopsys PCM Studio interface. The main window displays a table with columns for parameters and their values. A context menu is open over the 'Ireflect' parameter in the second row. The 'Add Values...' option is selected, which has opened the 'Add Parameter Values' dialog box.

	sde	sdevice	temp	Ireflect	
1			[n7]: 300	[n3]: (	Ins
2	[n1]: --	[n2]: --	[n8]: 350	[n4]: (	Del

**Add Parameter Values**

Scenario: all  
Parameter: Ireflect

Min. Value: 0.14  
Step: 1  
Number of Values: 1  
 Lin  Log  
Format: [dropdown]  
 Add Values to Selected Experiments Only

OK Apply Cancel

none queued ready pending running done failed aborted virtual prune

# Save and Preprocess

The screenshot shows a software interface with a menu bar (Project, Edit, Scheduler, View, Scenario, Tool, Parameter, Experiments, Nodes, Variables, PCM Studio, Extensions, Help) and a toolbar. The left pane shows a project tree with a context menu open over the 'EEL\_1D.gzp' project. The main area displays a 'Scheduler' table with columns for 'sde', 'sdevice', and 'svisual'. The 'sdevice' column is further divided into 'temp' and 'lreflect' sub-columns. The table contains four rows of data.

	sde	sdevice	svisual
		temp	lreflect
1		[n7]: 300	[n3]: 0.07
2	[n1]: --	[n2]: --	[n9]: 0.14
3		[n8]: 350	[n4]: 0.07
4			[n11]: 0.14

- Right click on project, 'Project->Preprocess'

# Run Simulation

The screenshot shows the Synopsys EDA software interface. The title bar indicates the project path: `/home/cc/ee232/sp15/staff/ee232-ta/STDB/EEL_1D (Standard Configuration) - SWB@hpse-9.EECS.Berkeley.EDU vJ-2014.09`. The menu bar includes Project, Edit, Scheduler, View, Scenario, Tool, Parameter, Experiments, Nodes, Variables, PCM Studio, Extensions, and Help. The toolbar contains various icons, with the 'Run selected nodes' icon (a blue play button) circled in red.

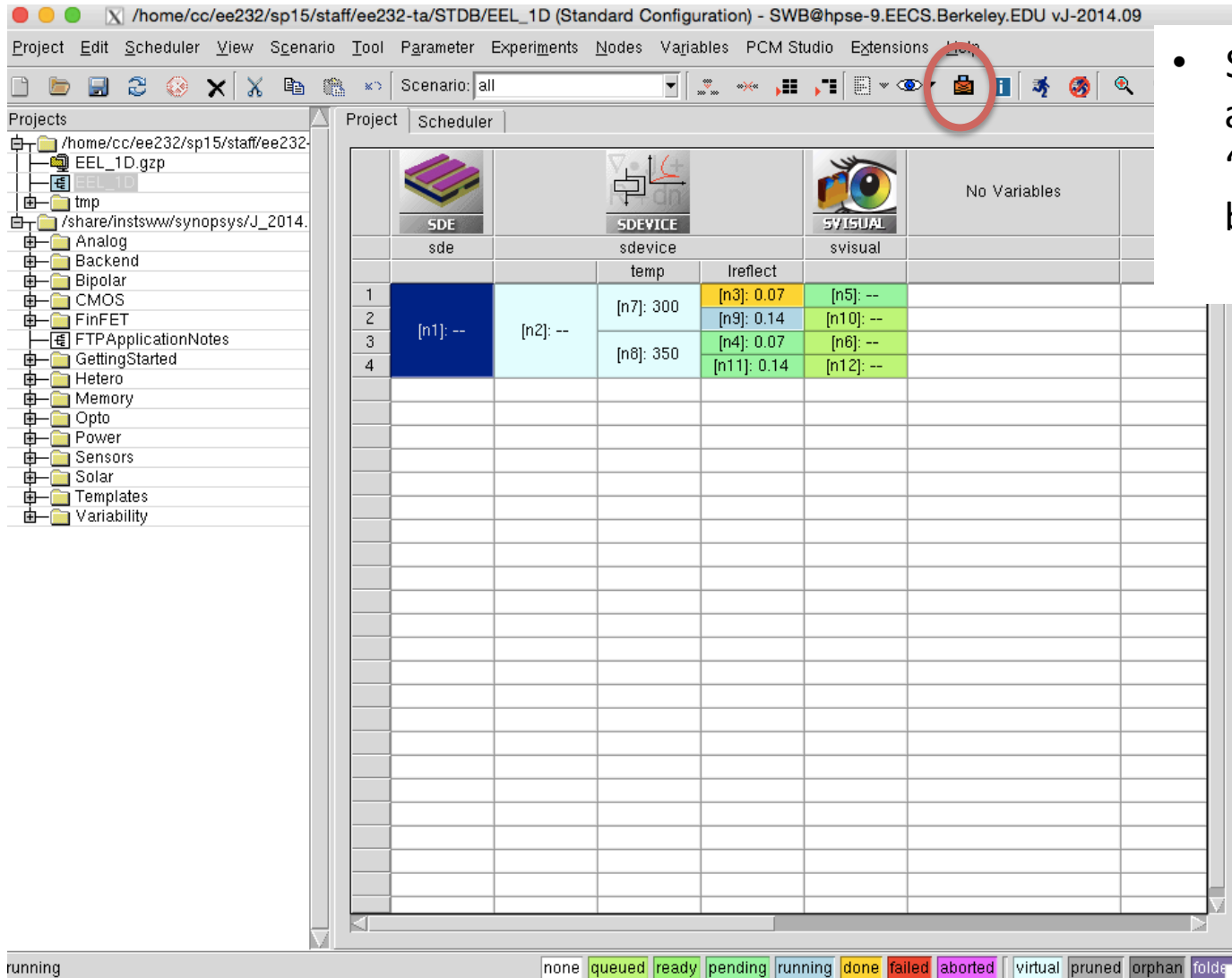
The 'Projects' pane on the left shows a tree view of the project structure, including folders like `/home/cc/ee232/sp15/staff/ee232-ta/EEL_1D` and `/share/instswww/synopsys/J_2014`.

The main workspace displays a 'Scheduler' view with a table of simulation nodes. The table has columns for SDE, SDEVICE, and SVISUAL. The 'SDEVICE' column is further divided into 'temp' and 'ireflect' sub-columns. The 'SVISUAL' column is labeled 'No Variables'. The table contains four rows of data, with the second and third rows highlighted in light blue.

	SDE	SDEVICE	SVISUAL
	sde	sdevice	svisual
		temp	ireflect
1	[n1]: --	[n2]: --	[n3]: 0.07
2		[n7]: 300	[n9]: 0.14
3		[n8]: 350	[n4]: 0.07
4			[n11]: 0.14

The status bar at the bottom shows the current mode as 'Edit mode' and a list of node statuses: none, queued, ready, pending, running, done, failed, aborted, virtual, pruned, orphan, folder.

# View Structure with Svisual

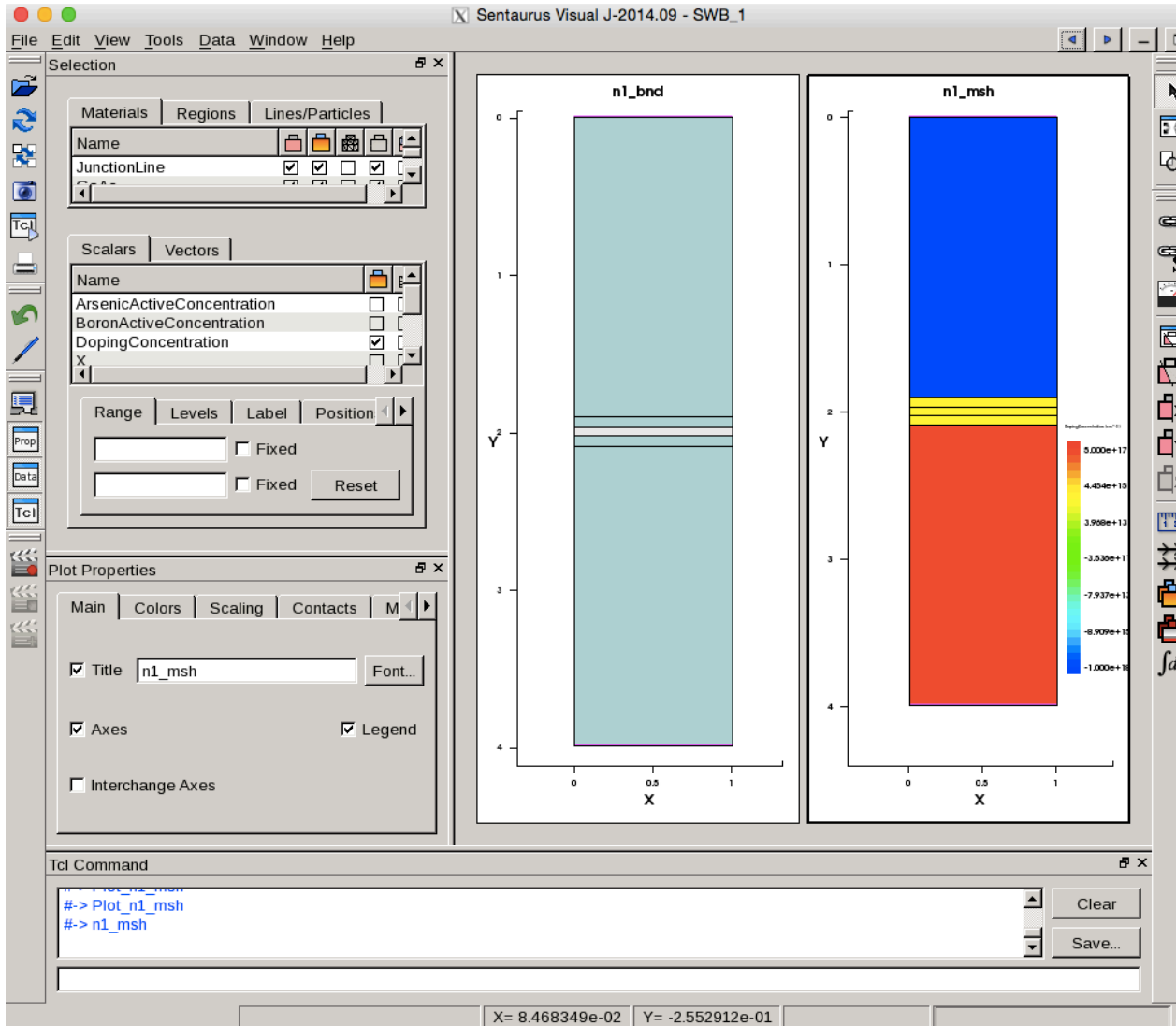


The screenshot shows the Synopsys IDE interface. The top toolbar contains several icons, with the 'Svisual' icon (an eye) circled in red. The main window displays a table of simulation results for the 'svisual' node. The table has columns for 'SDE', 'SDEVICE', and 'Svisual'. The 'SDE' column contains '[n1]: --'. The 'SDEVICE' column contains '[n2]: --'. The 'Svisual' column contains values for 'temp' and 'lreflect'.

	SDE	SDEVICE	Svisual
	sde	sdevice	No Variables
		temp	lreflect
1	[n1]: --	[n7]: 300	[n3]: 0.07 [n5]: --
2		[n8]: 350	[n9]: 0.14 [n10]: --
3			[n4]: 0.07 [n6]: --
4			[n11]: 0.14 [n12]: --

- Select SDE node and click the 'Quick Visualize' button

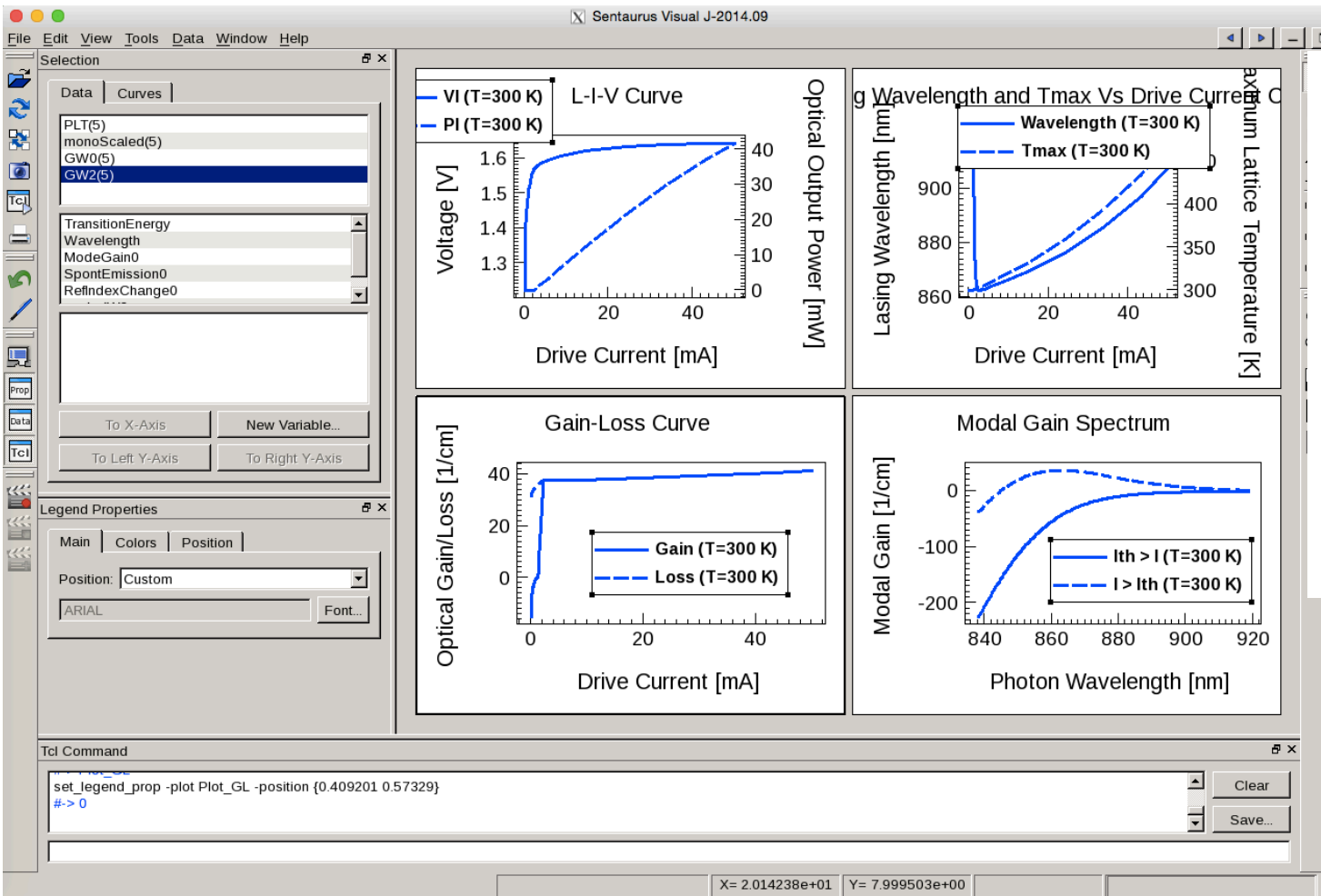
# Structure in svisual



Can see many aspects of structure including dimensions, doping level, contacts, etc.

# Data Analysis with svisual

- Click on svisual node and click run. Svisual script will analyze results and create graphs.
- You can edit the svisual command file to view script commands or add new analyses.



# Svisual analysis will extract values visible in the workbench

The screenshot shows the Synopsys workbench interface. The main window displays a table with columns for 'sde', 'sdevice', 'svisual', 'lop', 'lth', and 'dPth'. The 'svisual' column is highlighted with a red circle, indicating the focus of the analysis. The table contains four rows of data, with the first three rows having values in the 'lop', 'lth', and 'dPth' columns.

	sde	sdevice	temp	lreflect	svisual	lop	lth	dPth
1			[n7]: 300	[n3]: 0.07	[n5]: --	49.93	1.957	1.007
2	[n1]: --	[n2]: --		[n9]: 0.14	[n10]: --	49.93	1.803	0.9274
3			[n8]: 350	[n4]: 0.07	[n6]: --	49.94	2.233	0.9554
4				[n11]: 0.14	[n12]: --	49.94	2.07	0.8745

This is useful for quick analysis or large parameter sweeps.

# Sentaurus Manuals

- Manuals for the basic sentaurus tools are posted on piazza for the class.
- They can be found on the server here:  
*/share/instsww/synopsys/J\_2014.09/tcad/J-2014.09/manuals/PDFManual/data*
- Don't post or share the manuals publicly as part of the license agreement Berkeley has with synopsis.