PIC Design Tutorial

We decided to design our PIC with python using a package called 'gdspy'.

We then import it to Virtuoso, possibly add some stuff to the design, then run DRC using the relevant Tower PDK.

1. Installing python + gdspy (courtesy of Matan)
   Download Anaconda from https://www.anaconda.com
   After installation, open "Anaconda Prompt" terminal (similar to cmd - just write it in the search bar).
   In this terminal type: `conda install -c conda-forge gdspy` - this will install the gds library we are using.
   You can also use the library called **nazca** by following the installation guide https://nazca-design.org/installation
   After the installation is finished, open **Spyder** enviorment (you should have it if you installed Anaconda).
   If you don't have Spyder download from https://www.spyder-ide.org

2. Write your PIC in python:

   Full documentation of gdspy: https://gdspy.readthedocs.io/en/stable/

   Some points to emphasize:

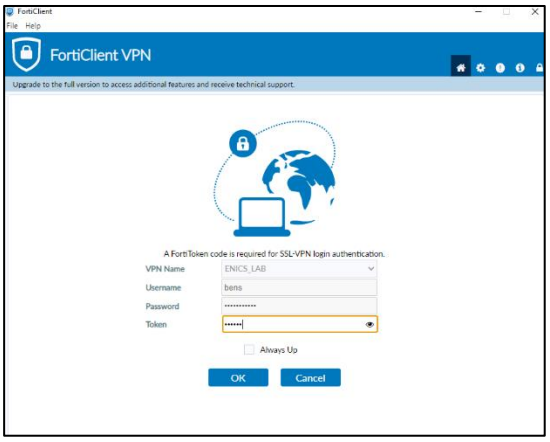
   - 'Import gdspy' at the top
   - Write at the beginning of the code the following:
     lib = gdspy.GdsLibrary()
     cell = lib.new_cell('*#cell_name_here#*')
     CAREFUL! The cell name you choose here will automatically be the name of the cell in Virtuoso after importing. If you import a gds with a cell name that already exists in your Virtuoso environment, the existing one will be overridden.
   - You can create your waveguides and other elements directly in the correct layers of the specific PDK. For example:

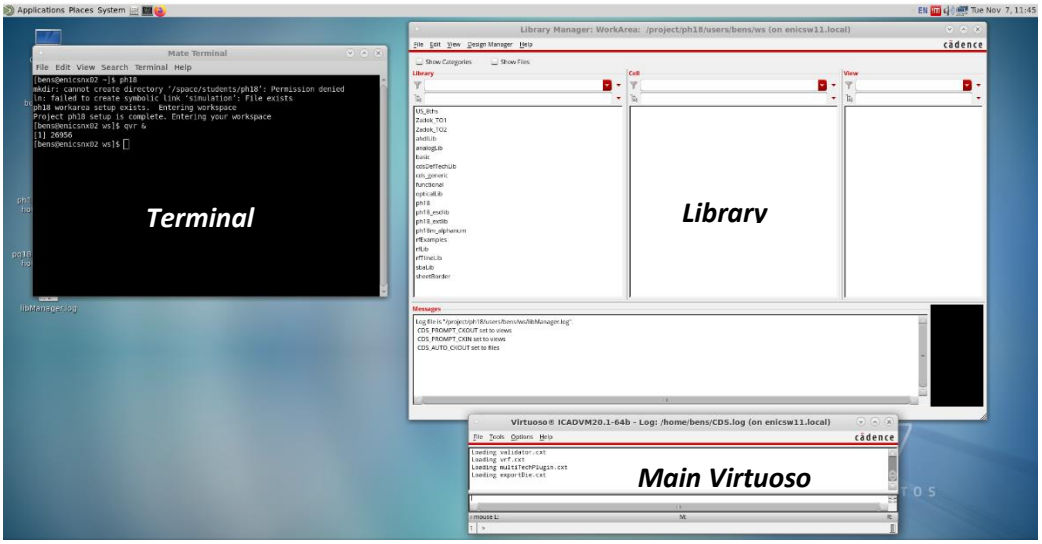
     ```
     ld_NWG          = {"layer": 174,    "datatype": 0}
     ld_Silox        = {"layer": 9,      "datatype": 0}
     ld_taperMark    = {"layer": 118,    "datatype": 120}
     ld_GC           = {"layer": 118,    "datatype": 121}
     ld_SUS          = {"layer": 195,    "datatype": 0}
     ld_VG1          = {"layer": 192,    "datatype": 0}
     ld_TNR          = {"layer": 26,     "datatype": 0}
     ld_Contact      = {"layer": 7,      "datatype": 0}
     ld_VIA1         = {"layer": 17,     "datatype": 0}
     ld_METAL1       = {"layer": 8,      "datatype": 0}
     ld_METAL2       = {"layer": 18,     "datatype": 0}
     ```

     You will find the layers numbers in the PDK book (hotcode).

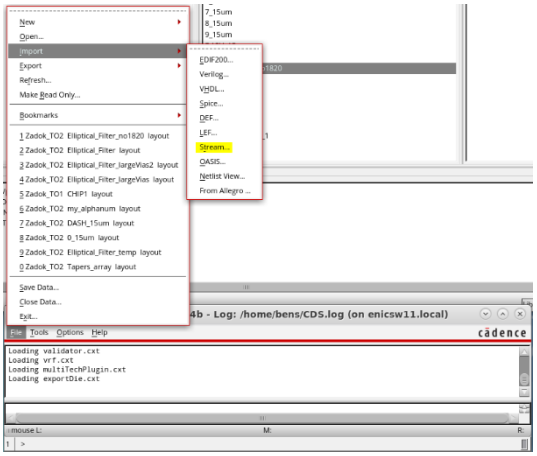
- Some common commands in gdspy:
    - path1 = gdspy.Path(width, (x,y))
      Start a path with the specified width at location (x,y)
    - path1.segment(length, "+x", **ld_NWG)
      Create a section at the specified length of the created path. “+x” represents the direction of the path, it can be “+x”,”-x”,”+y”,”-y”. The last argument is the layer in which the path is drawn.
    - path1.turn(radius, "l", **ld_NWG)
      Create a turn with the specified bend radius. “l” is the direction of turn, it can be “l”, “ll”, “r”, “rr”. The last argument is the layer in which the path is drawn.
    - x_save = path1.x
      y_save = path1.y
      You can save a specific point, for example if this is a point you would like to come back to later, to start a new path there.
    - rect1 = gdspy.Rectangle((x1,y1), (x2,y2), **ld_METAL2)
      Draw a rectangle with corners at points (x1,y1), (x2,y2) at layer METAL2.
    - cell.add(path1) or cell.add(rect1)
      add the created shape to the cell.
- Optional: ‘gdspy.LayoutViewer(lib)’ to view the layout
- Optional: ‘lib.write_gds("*#gds_name_here#*.gds")’ to save as GDS.
- Recommended: ‘gdspy.current_library = gdspy.GdsLibrary()’ so you can run the code again without starting a new console.

3. Open Virtuoso (Relevant for Zadok group)
   If this is your first time – you should ask ENICS guys to open a new user for you (ask Mirit, also need Avi’s approval).
   If this is not your first time logging in, a reminder of the process:
   - Start ‘FortiClient’ VPN
   - Type username + password
   - Connect to the FortiClient app on your smartphone and type the code
   - Open NoMachine
   - Open the relevant machine (for me it’s “enics_no_machine bens, Linux”)
   - Click “create a new virtual desktop”
   - You might need to type your NoMachine password here
   - In the linux environment, open the terminal by clicking the black screen logo
   - Type “ph18”
   - Type “qvr &”
   - You should end up with the following screen:

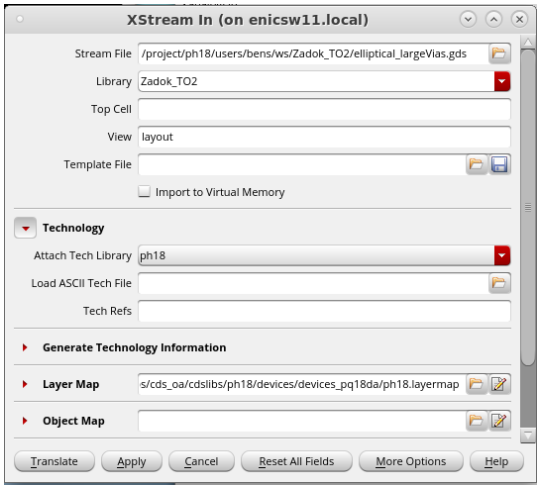




4. Import GDS to Virtuoso



- In the main virtuoso panel, click:
  File -> Import -> Stream
- In the window opened click the file logo at the first line (Stream file), then find the GDS you want to import (recommended: drag from your windows environment to NoMachine, then place inside the project's folder)
- In the "Library" line, choose the library in which you want the GDS to appear, for instance "Zadok_TO2".
- Attach tech file: ph18
- Layermap: choose the layermap of the correct PDK. For instance, mine is placed at: '/project/ph18/users/bens/ws/HOTCODE_2/amslibs/cds_oa/cdslibs/ph18/devices/devices_pq18da/ph18.layermap'



  The import window should look like in the attached screenshot, then click "Apply" and close the window. **CAREFUL!** You should always make sure that you are not overriding an existing layout. See previous "CAREFUL" comment.

5. Working in Virtuoso

   Some useful shortcut keys:

   F – fit to screen

   M – move an object

   C – copy object

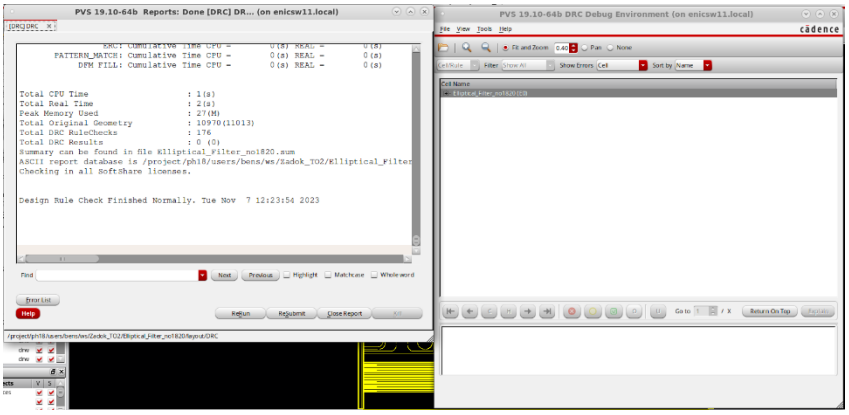
   Q – edit parameters of an object

   F3 – also edit parameters of an object

   U – undo

K – add ruler
Shift+K – erase all rulers
R – add a rectangle

6. Run DRC
While working on the layout: PVS -> Run DRC…
Then in the new window:
   - In “Run Data” choose the run directory: I usually open a directory called “DRC” inside the “layout” directory of the current cell (see screenshot)
   - In “Rules” click “add” in the lower panel, then choose the rules file of the relevant PDK (inside the hotcode folder). Notice that by default, files of type “rules” are not visible. You should switch to “any file” in the “files of type” bar.
   - Click “Submit” and wait. In a few seconds you will see a full report of all the violations, if exist. A clean DRC run looks like in the attached screenshot



7. Final Actions
In the DRC folder you opened, you will find a file named “*#your_cell_name#*.gds”. This is the file you want to submit to Tower.
I don’t know of a simple way to transfer files from Linux to Windows (the other way is simple – just drag), so I open Mozilla firefox in the linux environment and send the gds to myself via email.