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Exercise 3:
A First Layout

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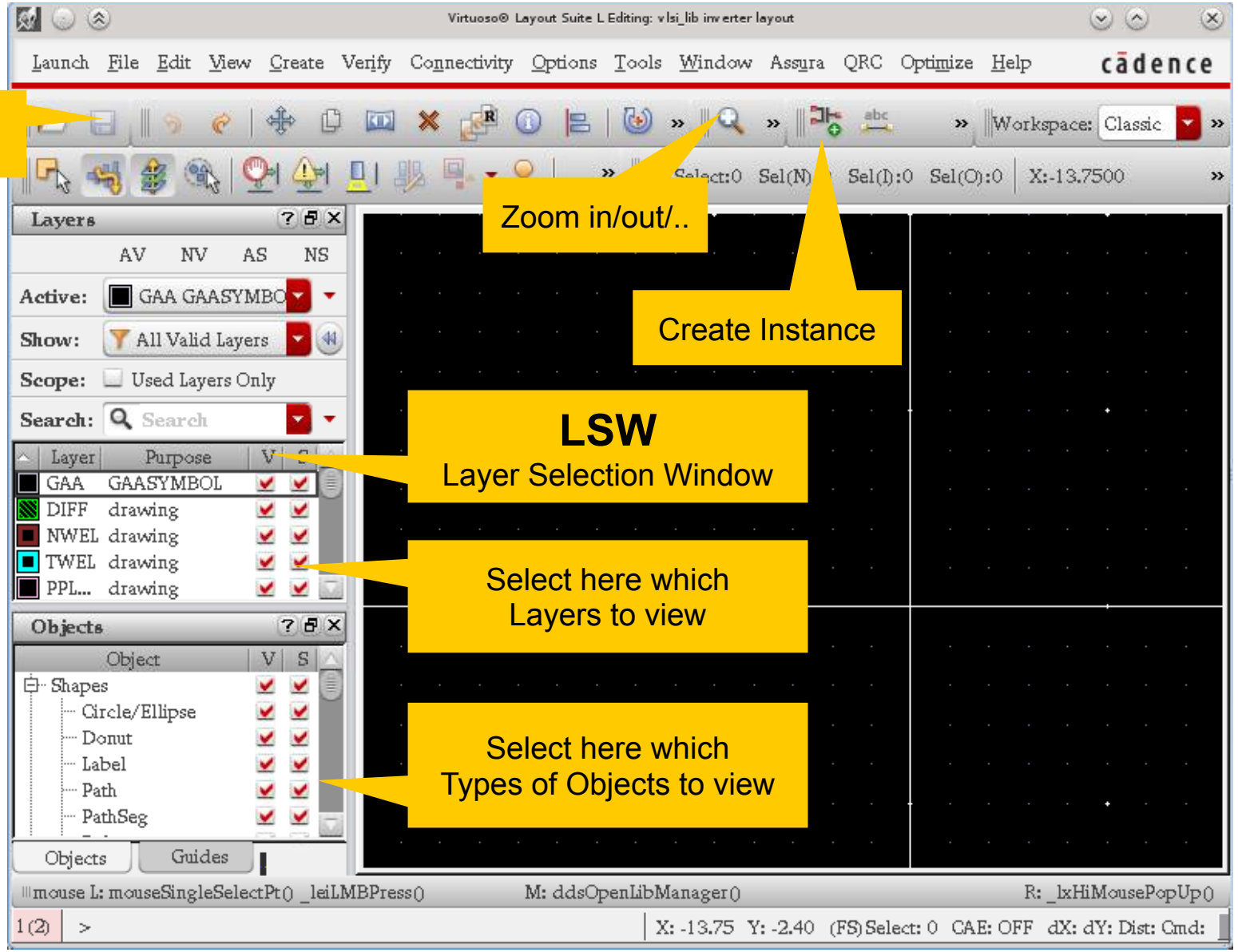
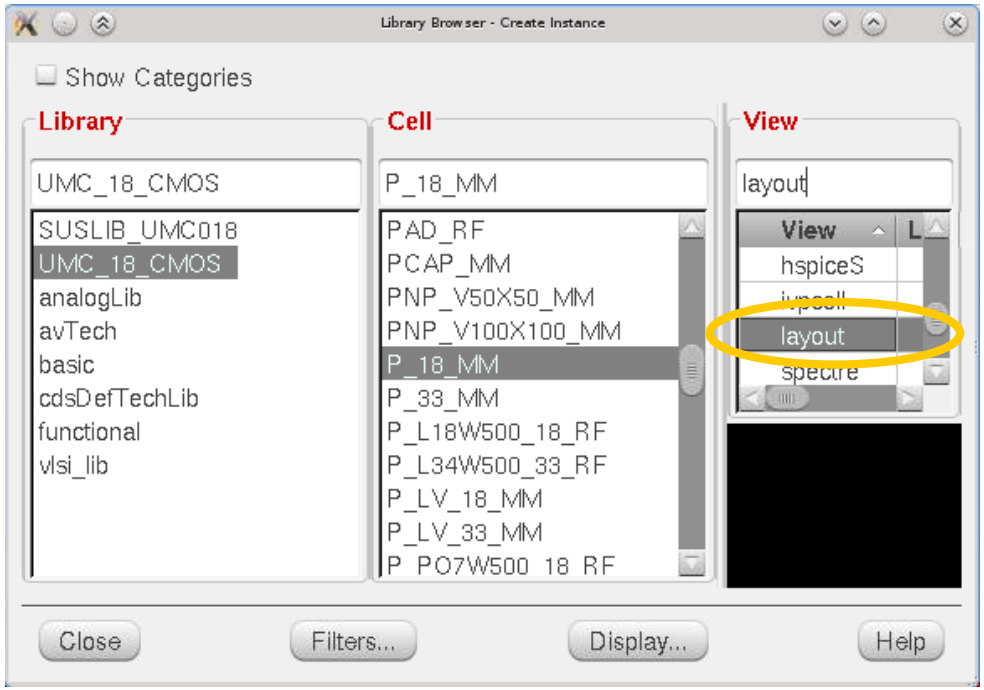
The (Layout) Editor Window



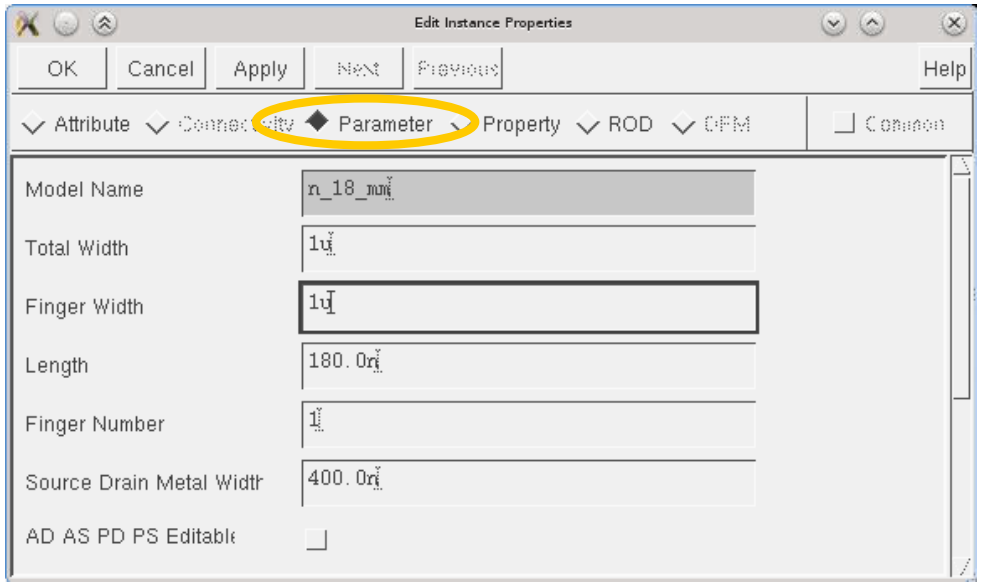
Adding a Transistor

- To add a component ('instance') to a layout:
  - Press the 'Create Instance' button  or
  - select Create → Instance or
  - press 'i'
- Browse to the UMC_18_CMOS library
- Choose N_18_MM or P_18_MM, view layout



Changing Component Parameters

- To change *parameters* of an instance
  - Press the 'Edit Properties' button  or
  - select Create → Properties → Object or
  - press 'q' or
  - use the Property Editor Panel
- Chose the 'Parameter' tab



- Observe how the layout of the part changes!

Intermezzo: Executing Commands

- Two possibilities for most commands:

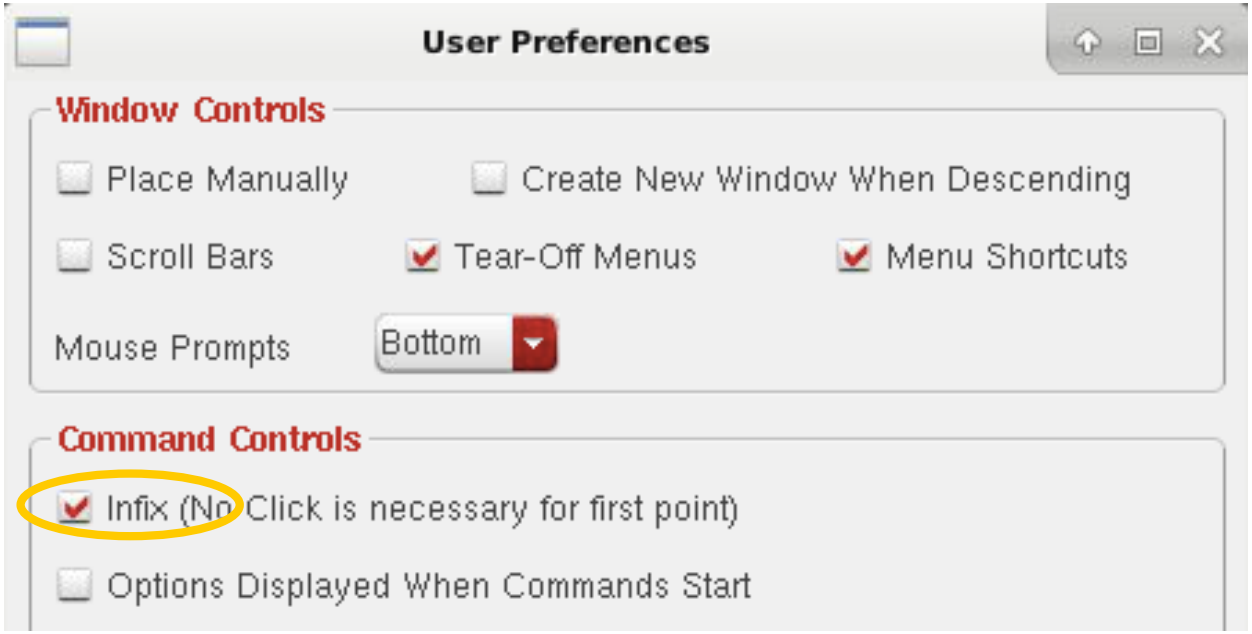
1. Execute command **once**:
   - Select objects(s)
   - Press command key
   - Execute command (once)

2. **Multiple** execution:
   - Press command key → switch to command mode (new cursor)
   - Select objects to execute commands on them
   - Press ESC = escape to end

- Example:
   - Select – delete — delete one instance
   - Delete – click – click … - click – escape — delete multiple

Changing User Preferences

- You can change the behaviour somewhat under CIW → Options → User Preferences
  - 'InFix' can be selected so that commands take action immediately, without extra mouse-click

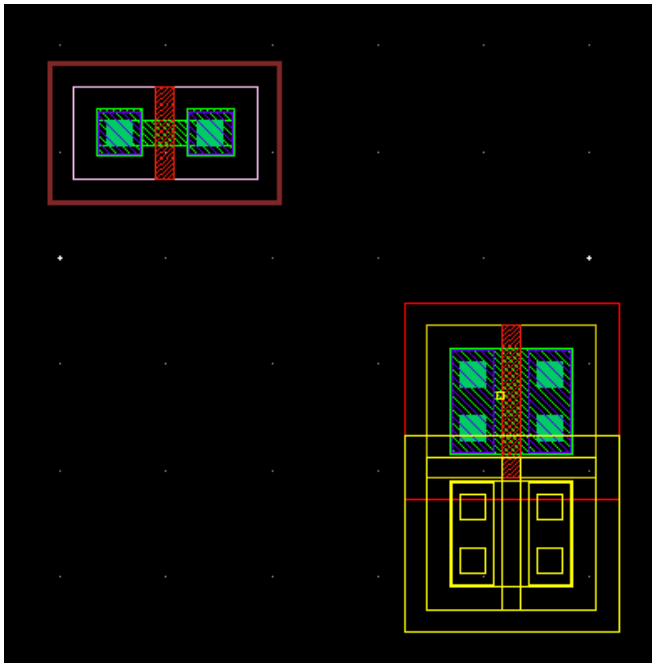


Intermezzo: Getting more Command Options

- In general, pressing F3 while executing a command opens a window with more options.
  - rotate, flip
  - allowed routing angles
  - colors
  - …
- Sometimes need to press F3 **twice**

Moving an Instance

- **Select** the instance with the mouse
  - leftclick — to select individual instances
  - shift – leftclick — to **add** instances to selection
  - ctrl – leftclick — to **remove** instances from selection
  - drag rectangle — select instances in area
- To **move**
  - Press ‘Move’ button  or
  - select Edit → Move or
  - press ‘m’
- Alternative:
  - First press ‘m’
  - select – move – drop, …ESC
- Alternative:
  - click – drag – drop
- For options (**snap mode**, rotate, flip,..): F3



Setting User Mode Details

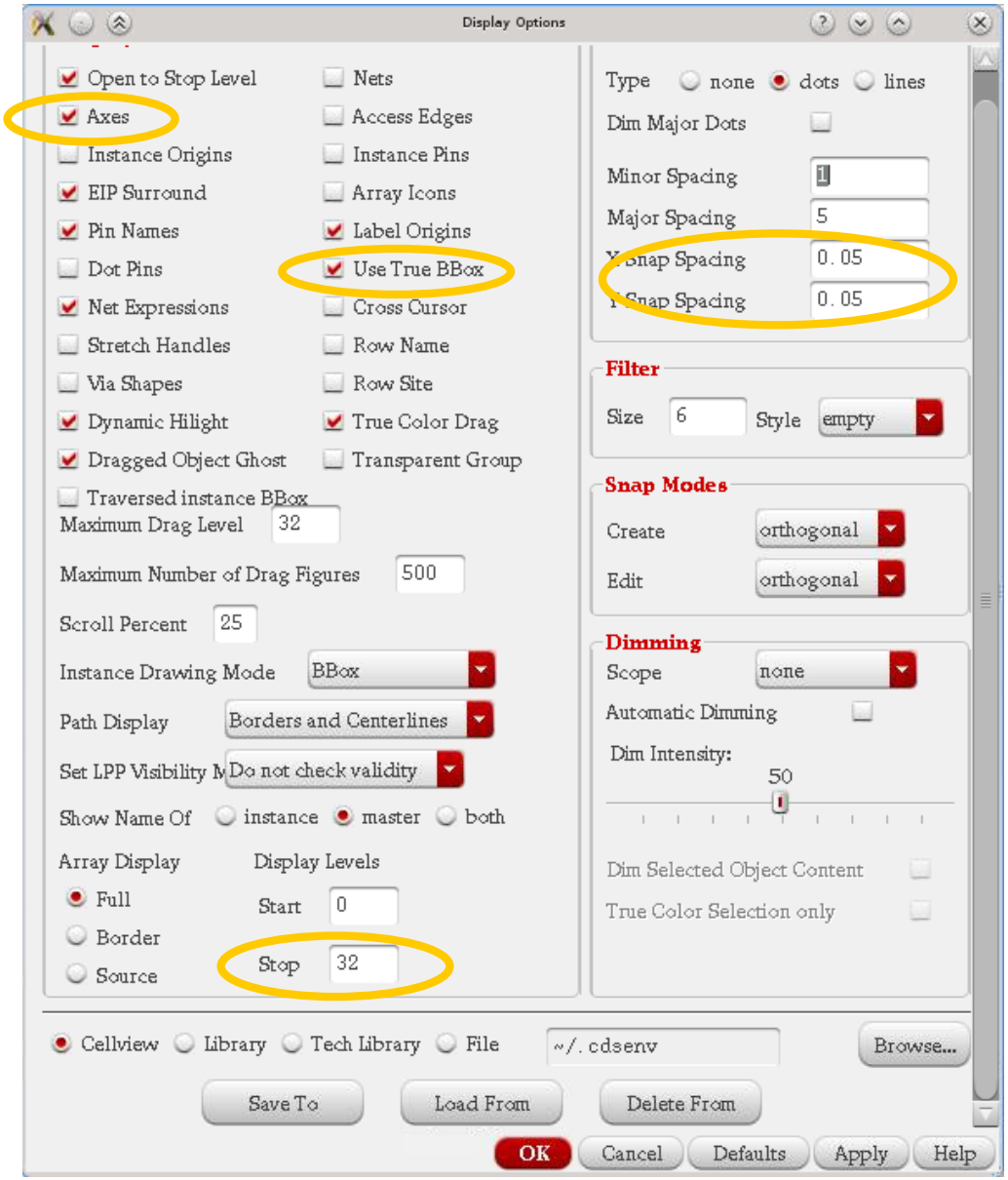
- By pressing 'g', the 'gravity' mode can be toggled. With gravity on, the cursor 'snaps' to 'interesting' locations.
  - You see the new gravity state in the CIW
  - For now, keep gravity off

- **Important:** F4 () toggles between
  - full select - a shape is always *completely* selected
  - Partial select - can select *parts* of a shape

- The Origin can be moved via Edit → Advanced → Move Origin (+ click with new position of origin)
  - This is a dangerous command if you have already used the cell in other places: The cell will shift *everywhere*!

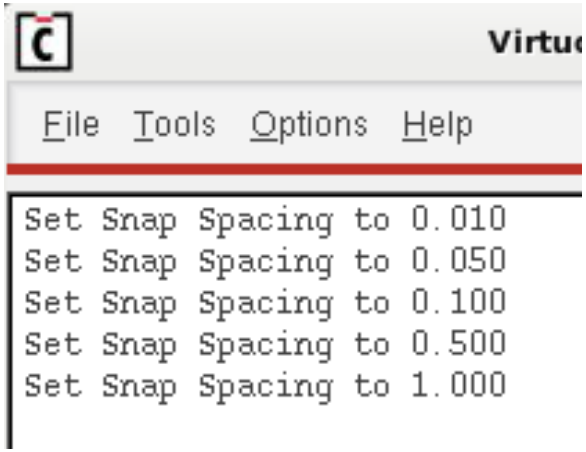
The Display Options Window

- Pressing ‘e‘ brings up the Display Options Window
- It allows to set many things:
  - Axis on off
  - Dot Grid
  - **SNAP GRID**
  - Display Levels
  - ...



Additional Bind Keys for SNAP - Grid

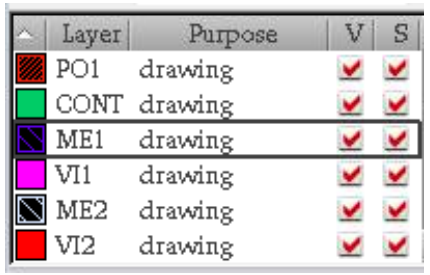
- Changing the grid to the largest reasonable value is useful
- We have therefore created some extra short cuts to do this:
  - Keys 1, 2, 3, … change the grid to increasingly coarse values
  - The value is displayed in the CIW:



- You will learn how these keys are defined in the SKILL part

Adding Shapes

- Before drawing a shape, select the layer in the Layer Selection Window (LSW)
  - Start with Metal 1 = ME1

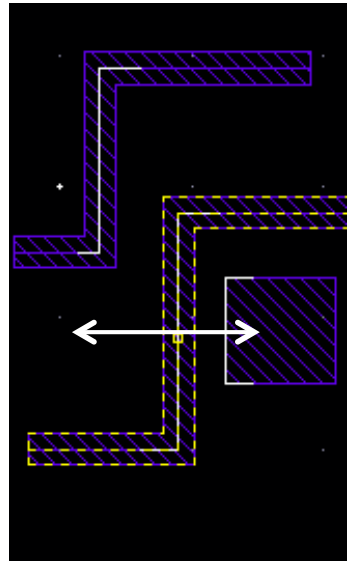


- There are 3 different shape types
  - Rectangles Create → Shape → Rectangle or 'r'
  - Polygons Create → Shape → Polygon or 'Shift-P' (double click to finish)
  - Paths Create → Shape → Path or 'p' (double click to finish)

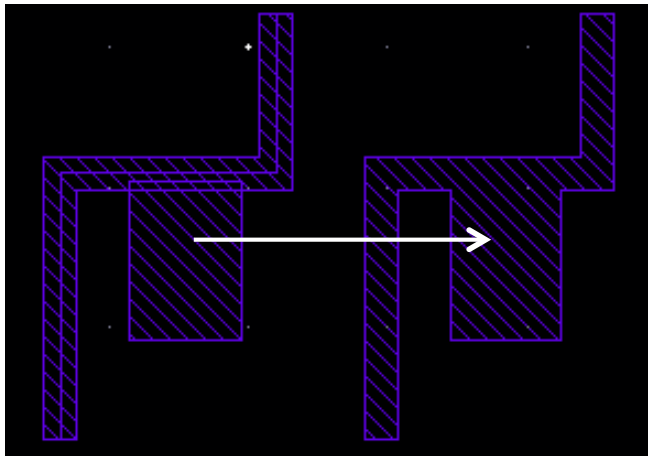
- **Paths** have a *width* which can be changed by F3.

Modifying Shapes

- When partial selection is enabled (F4), a part of a shape can be selected and stretched or deleted
- Multiple segments can be selected
  - This is very powerful in Virtuoso!!



- Several selected shapes can be *merged* with 'Shift-M'



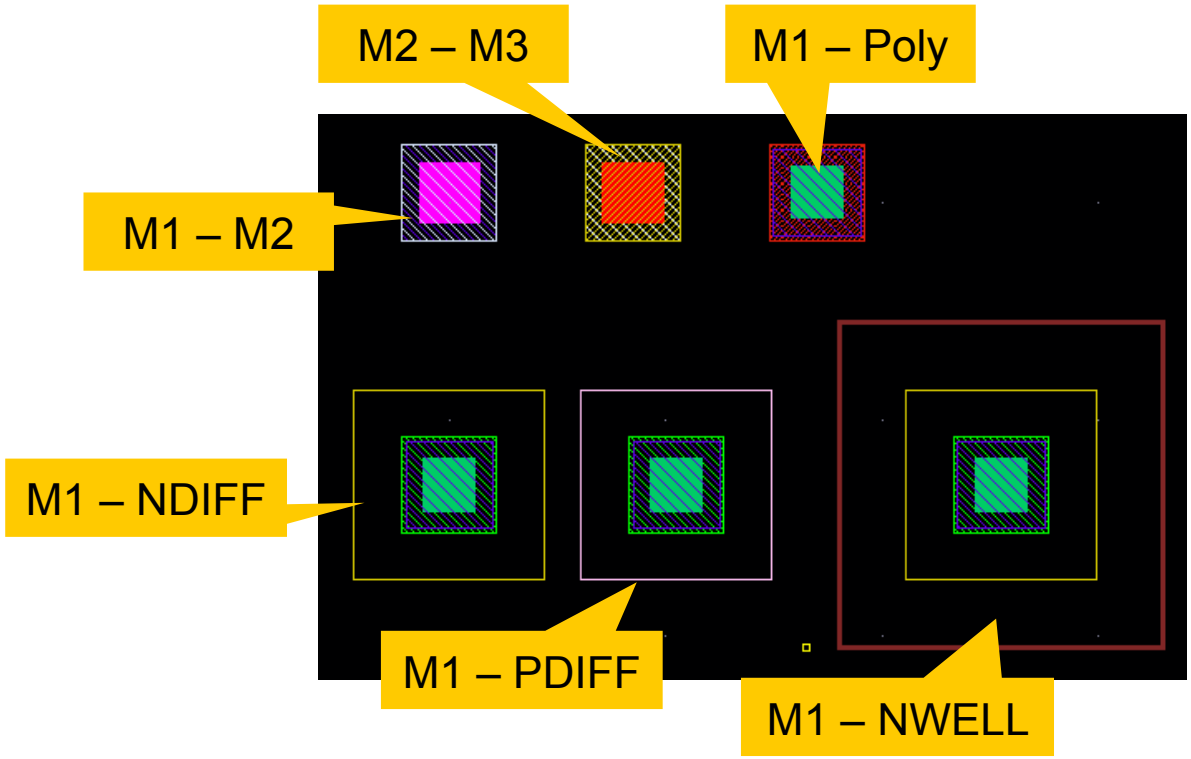
- Shapes can be *chopped* (cut) with 'Shift-C' (+ cut shape)
- Shapes can be converted to Polygons with Edit → Convert → to Polygon

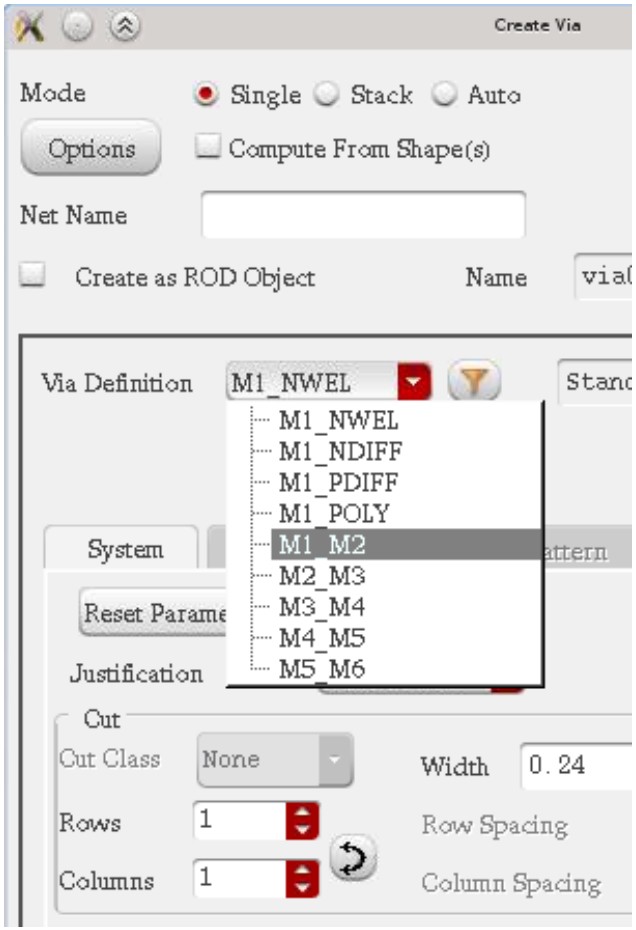
Flatten

- All objects in an instance can be moved to the active cell view using the Flatten command.
  - The instance does not exist any more after this command, it is replaced by its content
- In fact, *everything* is 'pulled up' by one level in the hierarchy
- More than one level can be flattened at once
- When PCELLs are flattened, there are often several shapes on one layer. These can be MERGEd.
  - Also, special (symbolic, vendor, ...) information may be present and should be removed.
- The reverse functionality is to make a layout cell from a selected set of shapes: Edit → Hierarchy→ Make Cell

Adding Vias and Contacts

- **Vias** are connections between adjacent *metal* layers
- **Contacts** go to active devices (M1 – Poly or M1 – Implant)
- Press 'o' to add a via
  - Select the correct layer pair



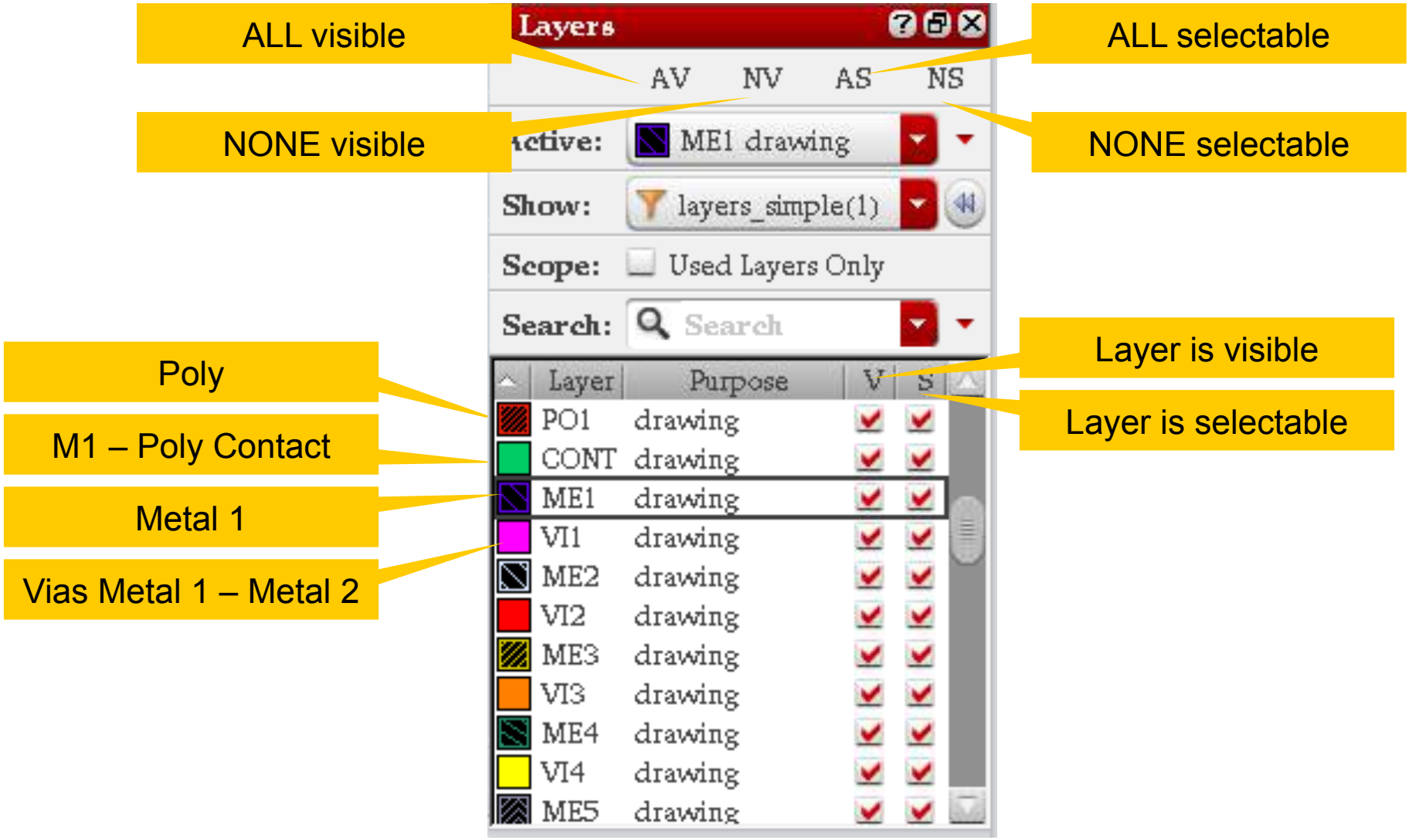


Zooming …

- show everything: ‘f’ (fit)
- scroll: arrow keys
- zoom in: ctrl-z or]
- zoom out: shift-z or [
- zoom area: right mouse – drag
- pan selection: tab
- last view: w
- top/bottom/..: ctrl - arrow

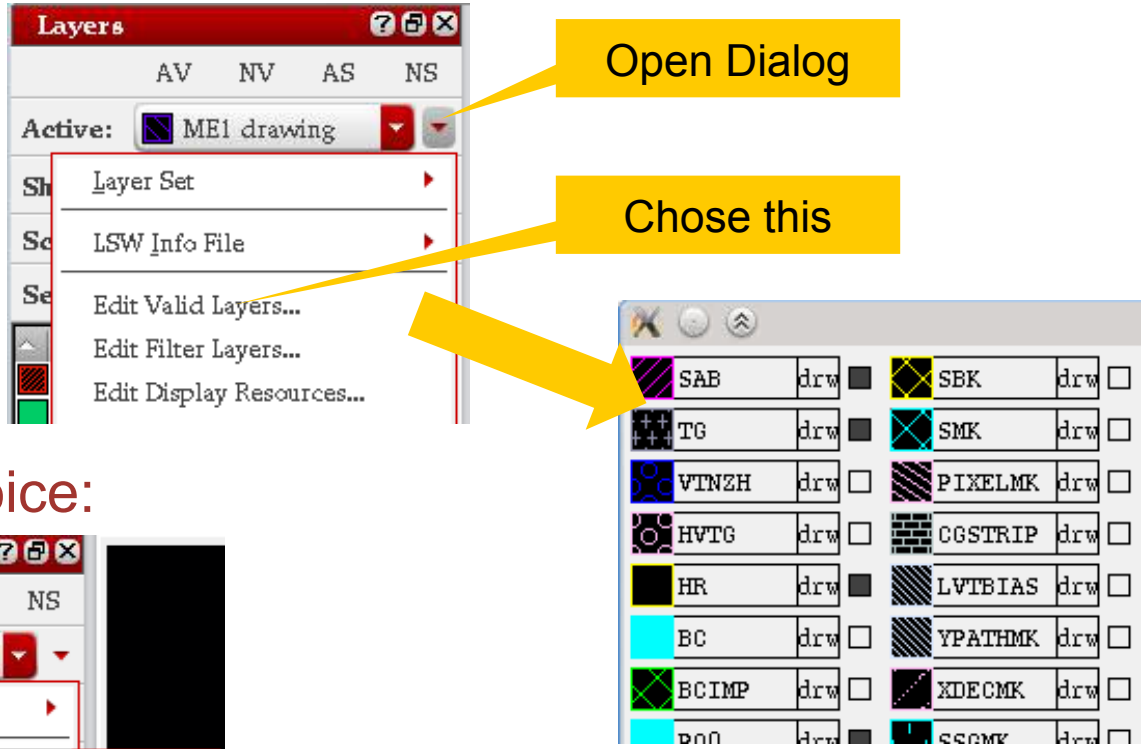
- See menu View→ …

The Routing Layers / The LSW

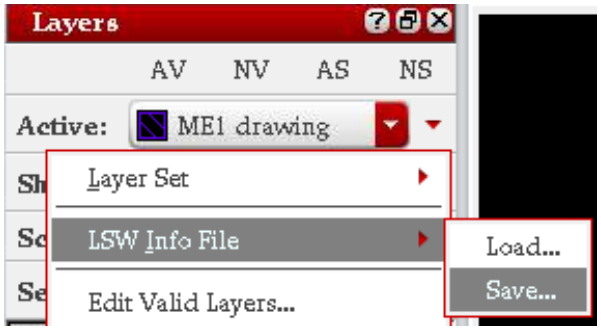


Modifying & Saving a Layer Map

- It is convenient to show only some layers in the LSW
- Chose your layers in the *Edit Layers* Dialog



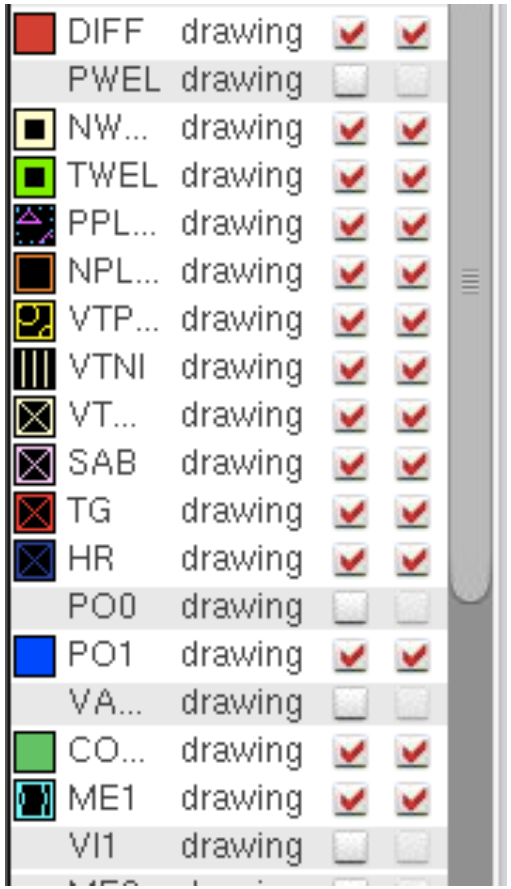
- Save your choice:

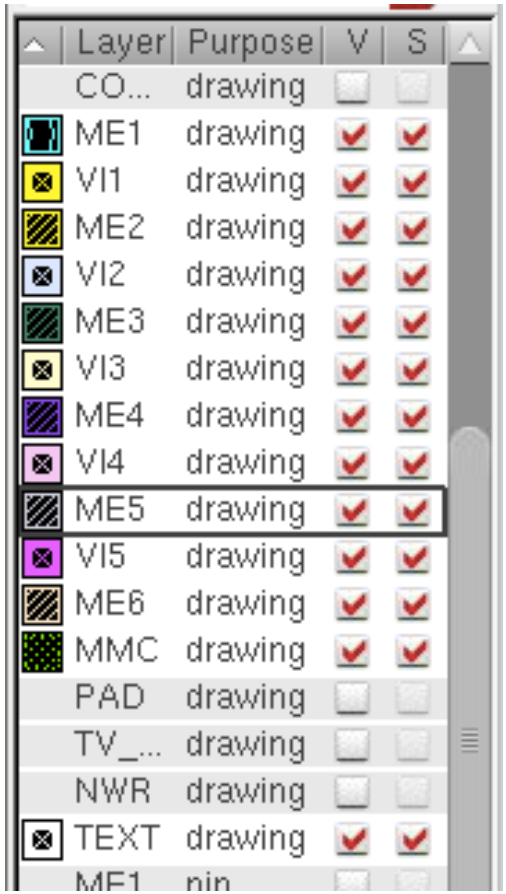


- Load a LSW Info file from there

Pre-Defined Layer Sets

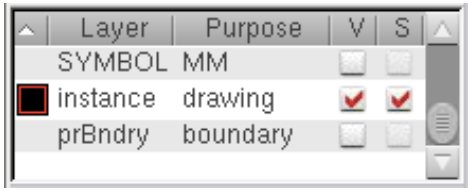
- We have pre-defined two layer sets
  - Use keys 8 ('transistors') and 9 ('routing')



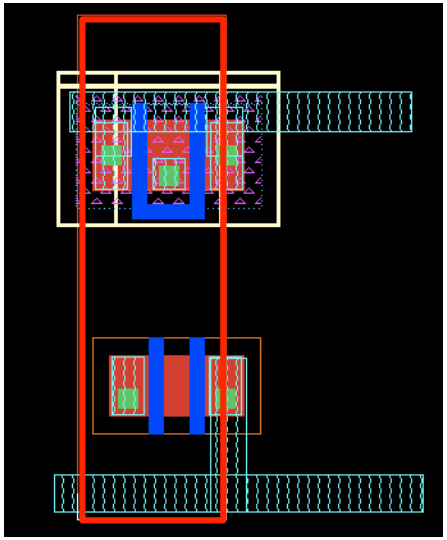


The 'Bounding-Box' and Display Level

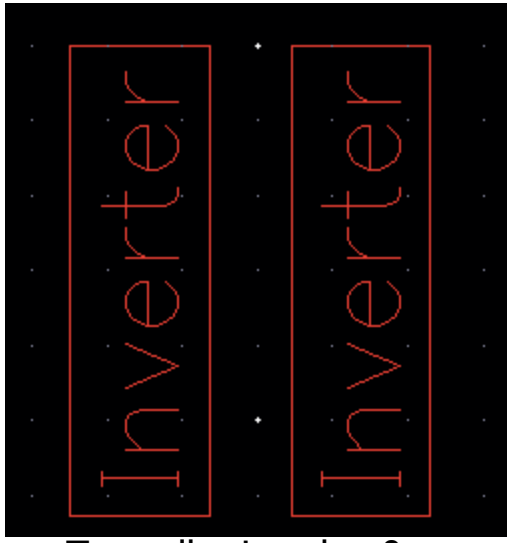
- Similar to the *selection box* of a symbol, a layout can have a '*Bounding Box*' which will be displayed in the next hierarchy level (above) when display level is decreased.
  - It is drawn on layer 'instance – drawing'
  - You may need to turn the layer on (see prev.)



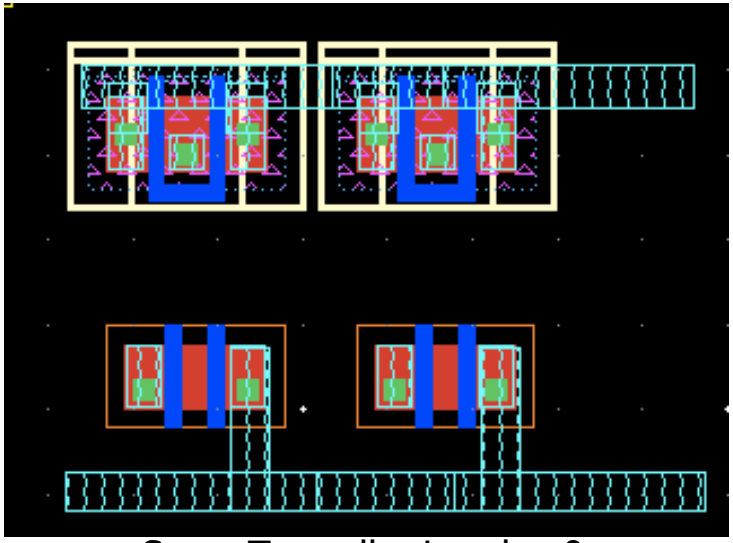
- If you instantiate the cell (layout):
  - you see only the bounding box if display level = 0 (Ctrl-F)
  - you see 'into' the cell for level > 0 (Shift-F sets level to 20)



Inverter - Layout



Top cell – Level = 0



Same Top cell – Level > 0

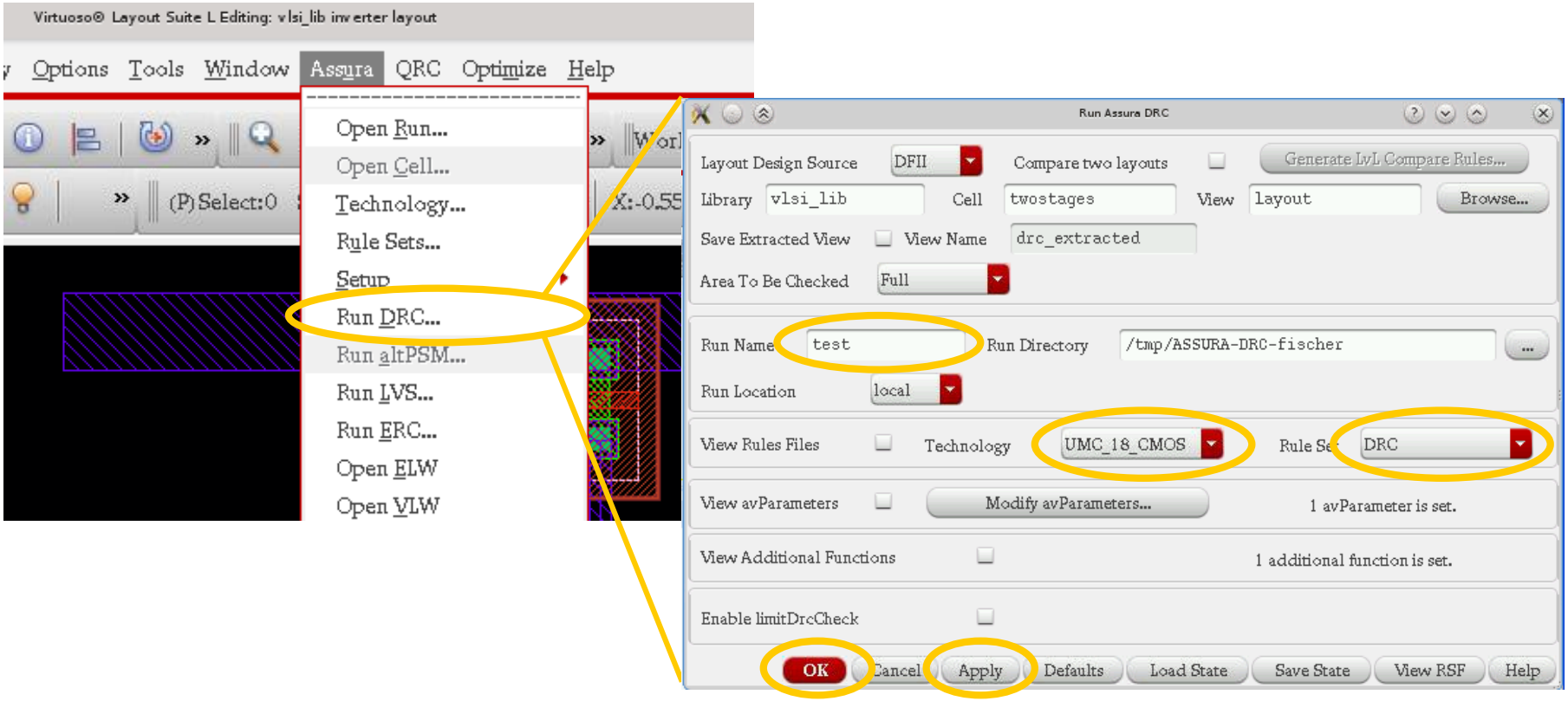
EXERCISE

Warmup

- Play around with the layout editor:
  - Get a PMOS and an NMOS
  - Turn on and off layers
  - Draw some metal traces, use Rectangles and Paths
  - Shift things around
  - Modify the paths
  - Get some contacts

Run a DRC for your Layout Tests

- Select from the top menu Assura → Run DRC…
  - Make sure *Rule Set DRC* is selected
  - Make sure you have set a *run name*
  - *OK* closes the window, *APPLY* keeps it



Inverter and NAND3

- Produce the layout of an inverter
  - Have the PMOS 3 times as wide as the NMOS
  - Put the PMOS at the top, the NMOS at the bottom
  - Put the input on the left side on ME1, the output right on ME2
  - Run power / ground horizontally at top/bottom
  - Connect also the NWELL and the substrate

- Try the layout of a NAND3
  - Try to make the inverter and the layout the same 'height' so that the power connects automatically when placing two cells side-by-side (see next slide)

Layouts

- Do the layout such that multiple gates can be easily placed side by side.
  - Power/ground should run horizontal at bottom and top
  - Find good distances of power traces, wells, …