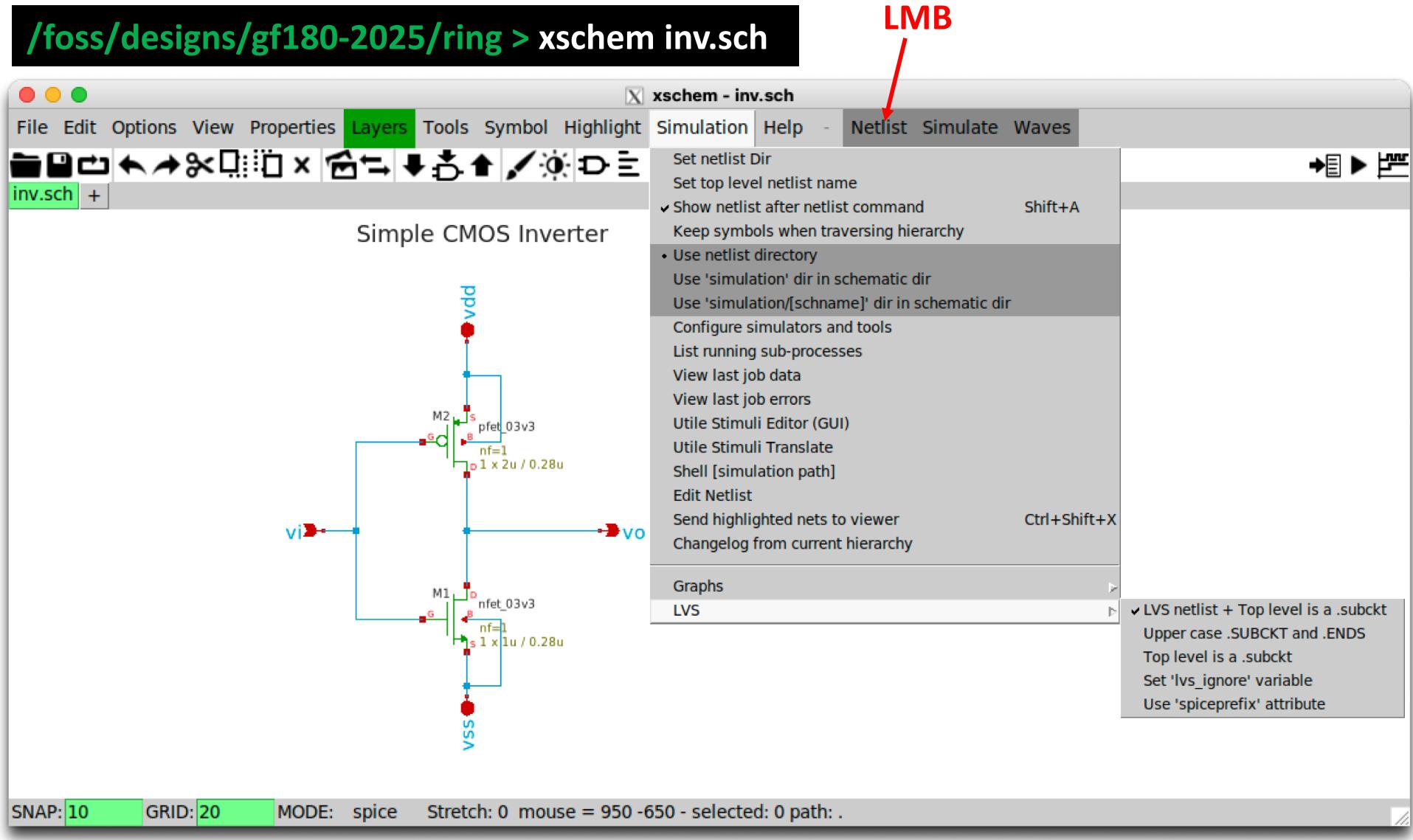


Systematic Design of Analog CMOS Circuits with LUTs using open-source tools and PDKs

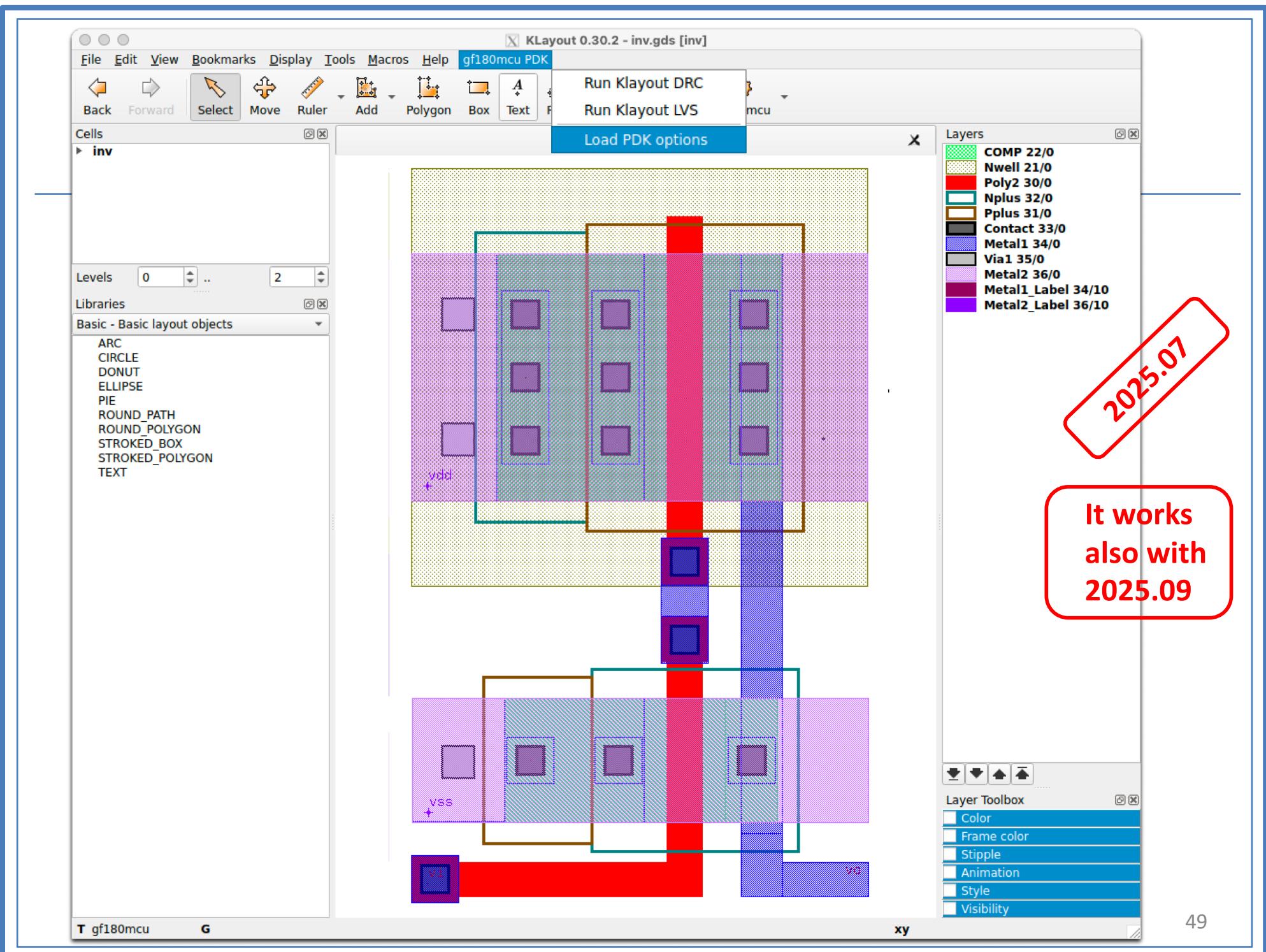
Part II (c)

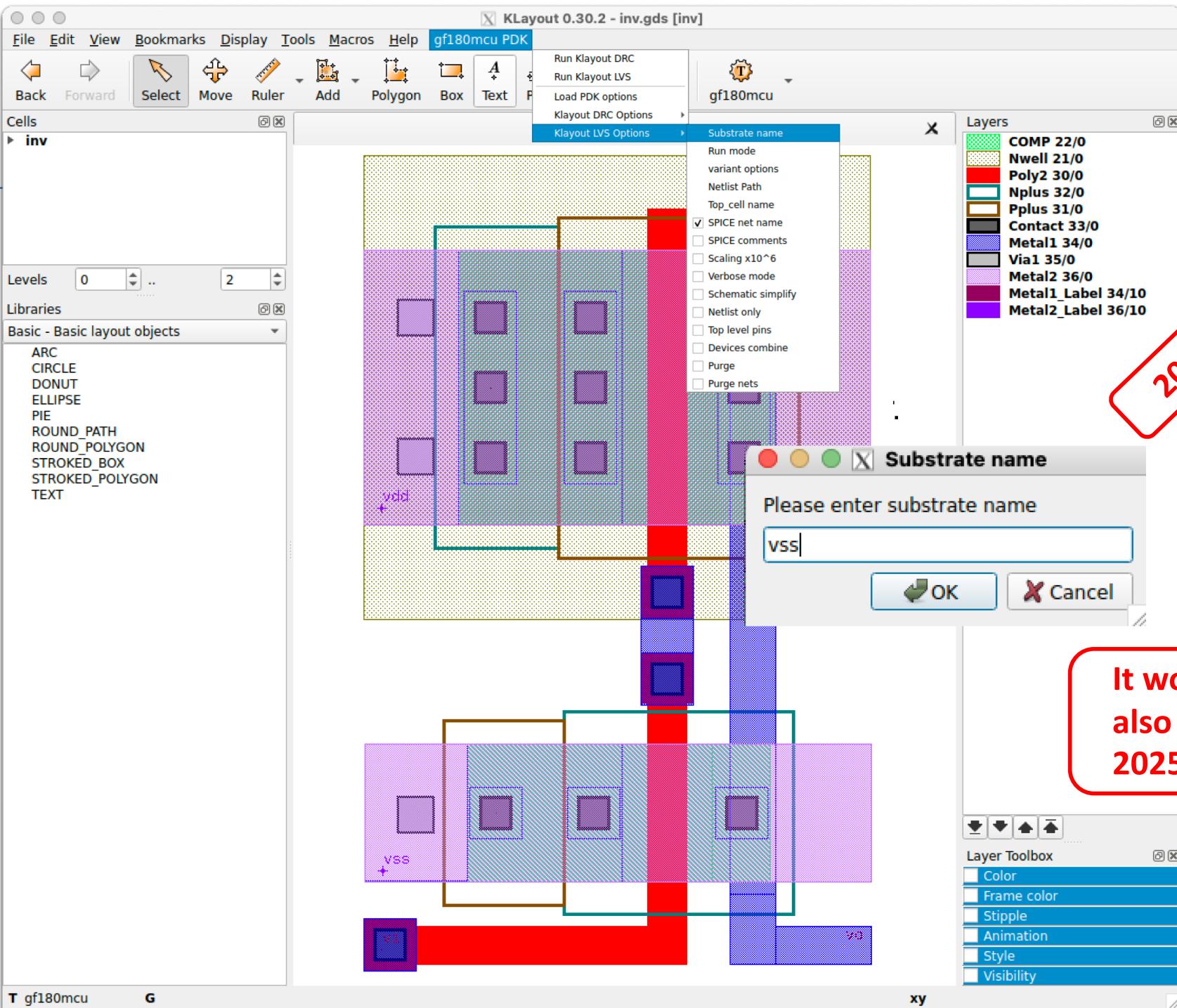
LVS with klayout

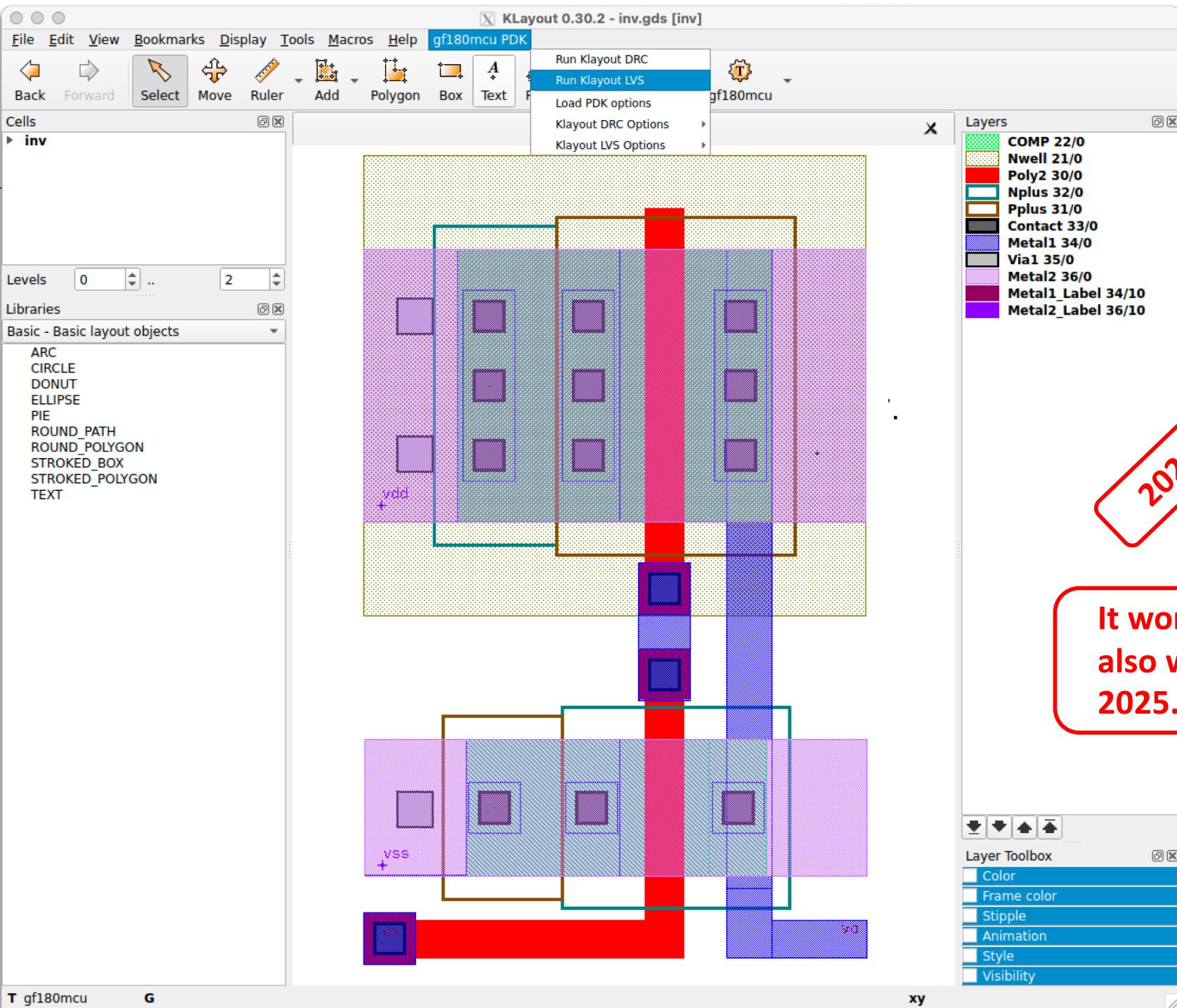


Schematic's spice netlist

```
/foss/designs/gf180-2025/ring > cat inv.spice
** sch_path: /foss/designs/gf180-2025/ring/inv.sch
.subckt inv vdd vi vo vss
*.PININFO vdd:B vss:B vi:I vo:0
M1 vo vi vss vss nfet_03v3 L=0.28u W=1u nf=1 m=1
M2 vo vi vdd vdd pfet_03v3 L=0.28u W=2u nf=1 m=1
.ends
```



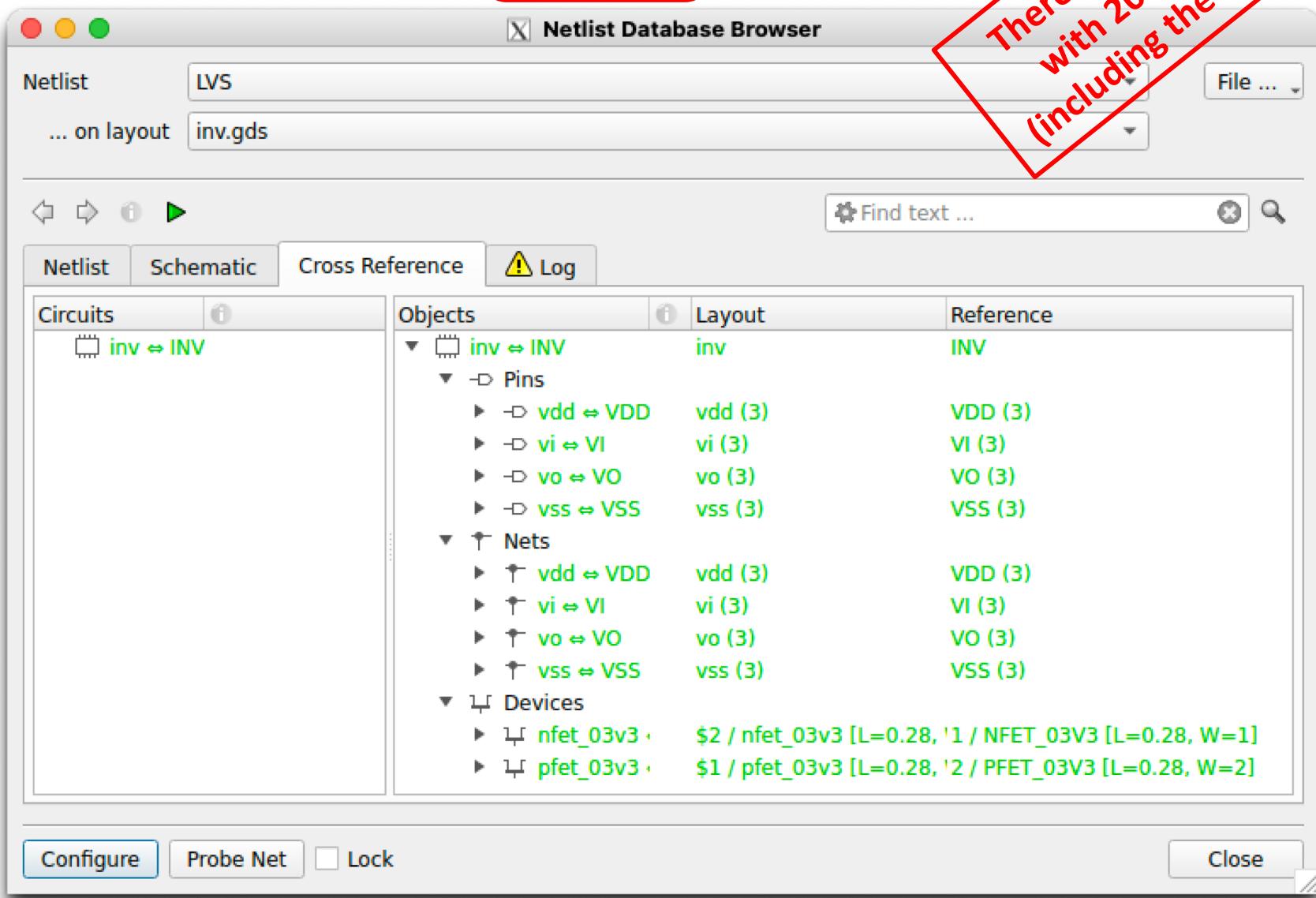




LVS with 2025.07

It works
also with
2025.09

There are issues
with 2025.11
(including the DRC)



Layout's spice netlist

- The netlist extracted from the layout using klayout is named:
`inv_extracted.cir`

2025.07

It works
also with
2025.09

```
/foss/designs/gf180-2025/ring > cat inv_extracted.cir
* Extracted by KLayout with GF180MCU LVS runset on : 15/12/2025 23:37

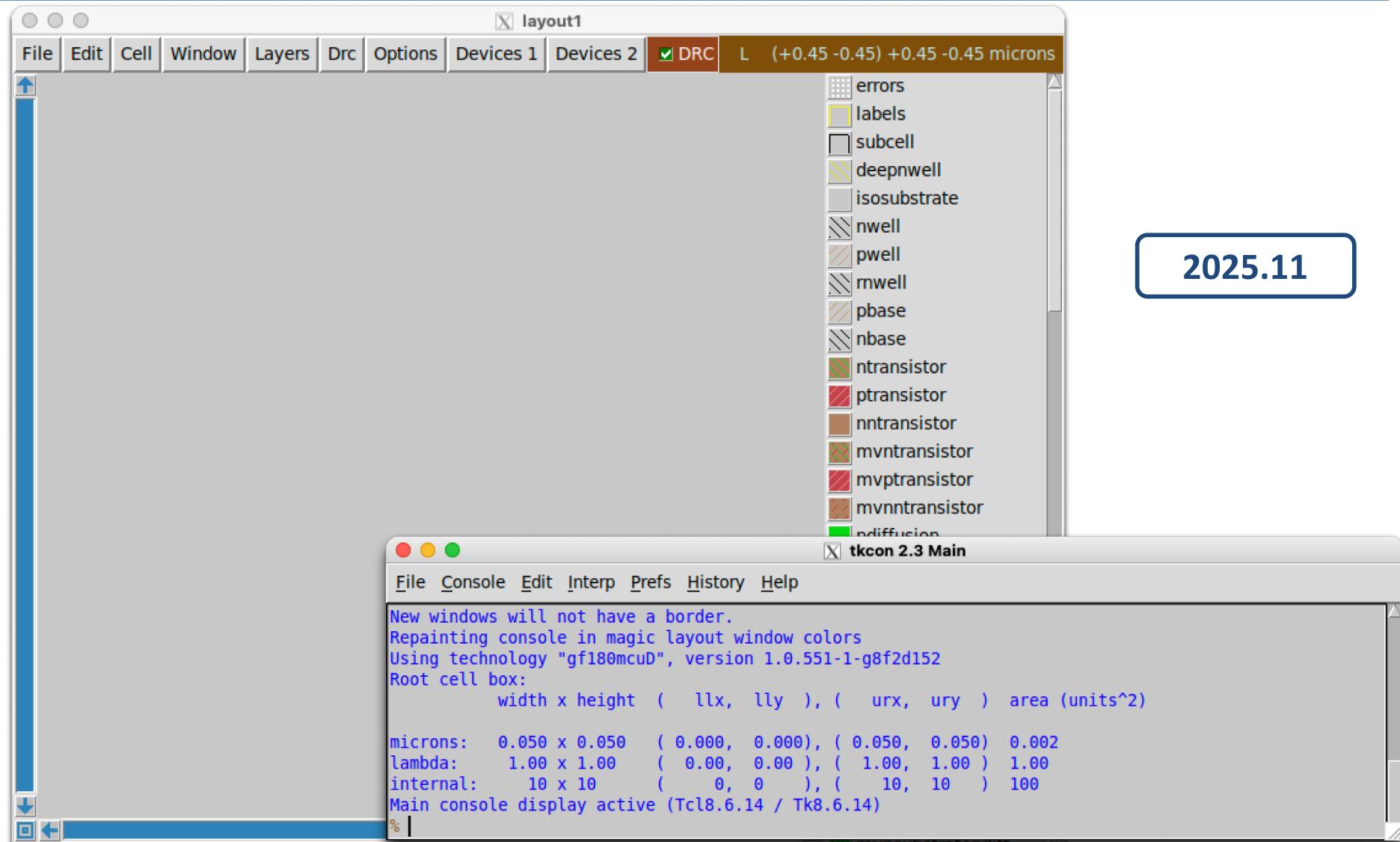
.SUBCKT inv vss vdd vo vi
M$1 vo vi vdd vdd pfet_03v3 L=0.28U W=2U AS=1.3P AD=1.3P PS=5.3U PD=5.3U
M$2 vo vi vss vss nfet_03v3 L=0.28U W=1U AS=0.61P AD=0.61P PS=3.22U PD=3.22U
.ENDS inv
```

Magic VLSI Layout Tool

<http://opencircuitdesign.com/magic/>

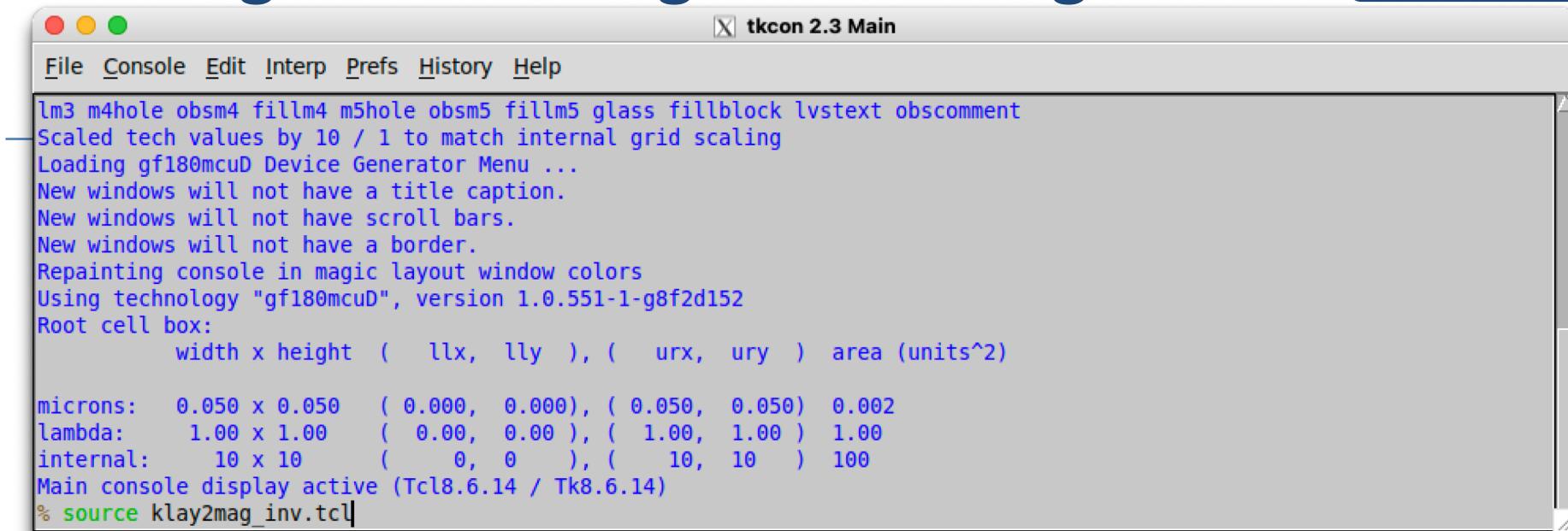
Magic VLSI Layout Tool
Current distribution version 8.3

/foss/designs/gf180-2025/ring > magic



Reading the cell inv.gds with Magic VLSI

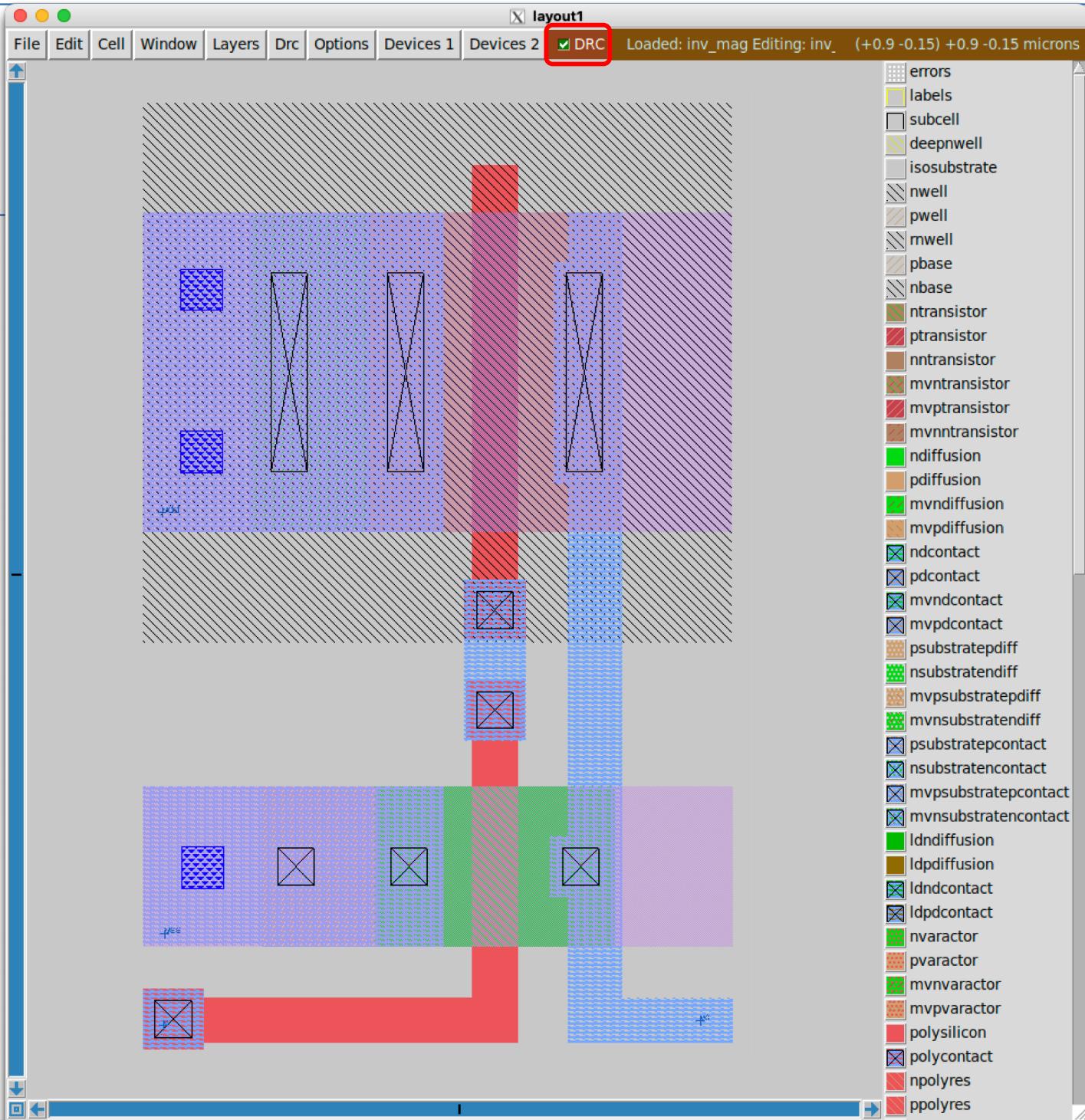
2025.11



The screenshot shows the tkcon 2.3 Main window with the following text output:

```
lm3 m4hole obsm4 fillm4 m5hole obsm5 fillm5 glass fillblock lvstext obscomment
Scaled tech values by 10 / 1 to match internal grid scaling
Loading gf180mcuD Device Generator Menu ...
New windows will not have a title caption.
New windows will not have scroll bars.
New windows will not have a border.
Repainting console in magic layout window colors
Using technology "gf180mcuD", version 1.0.551-1-g8f2d152
Root cell box:
    width x height ( llx, lly ), ( urx, ury ) area (units^2)
microns: 0.050 x 0.050 ( 0.000, 0.000 ), ( 0.050, 0.050 ) 0.002
lambda: 1.00 x 1.00 ( 0.00, 0.00 ), ( 1.00, 1.00 ) 1.00
internal: 10 x 10 ( 0, 0 ), ( 10, 10 ) 100
Main console display active (Tcl8.6.14 / Tk8.6.14)
% source klay2mag_inv.tcl
```

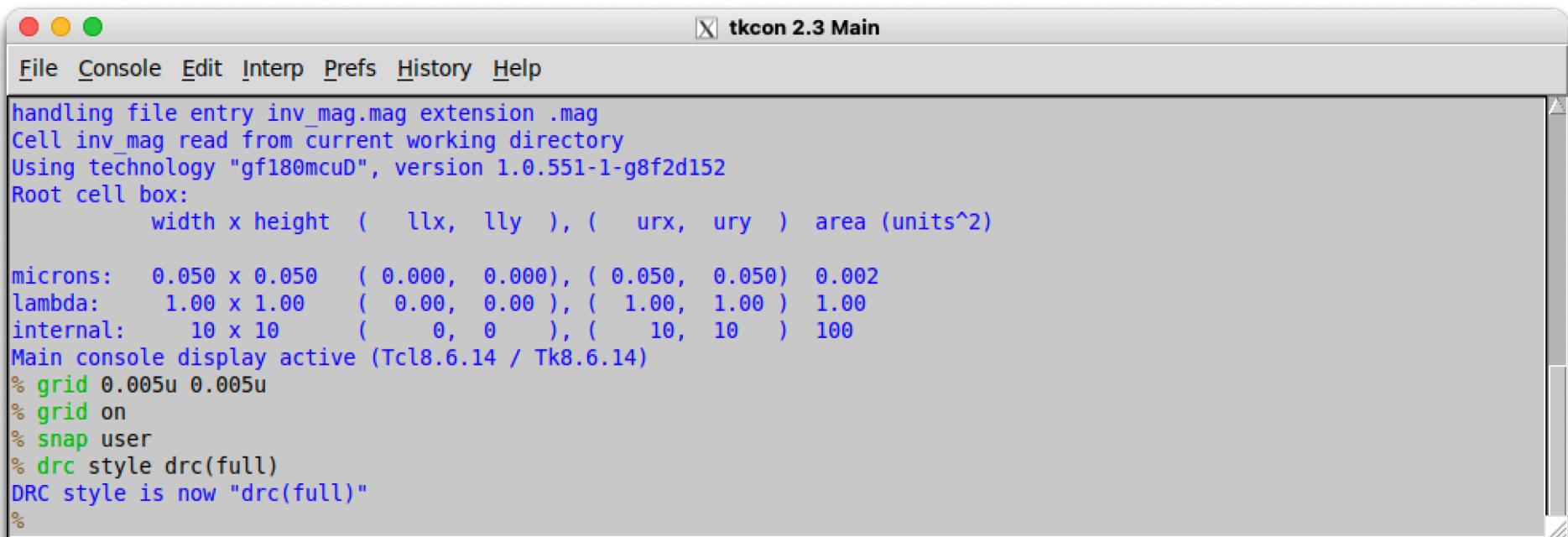
```
/foss/designs/gf180-2025/ring > cat klay2mag_inv.tcl
# klay2mag_inv.tcl
grid 0.005u 0.005u
snap user
gds read inv.gds
load inv
select top cell
expand
flatten inv_mag
load inv_mag
select top cell
cellname create inv_mag
save inv_mag.mag
quit -noprompt
```



2025.11

Design set up

2025.11



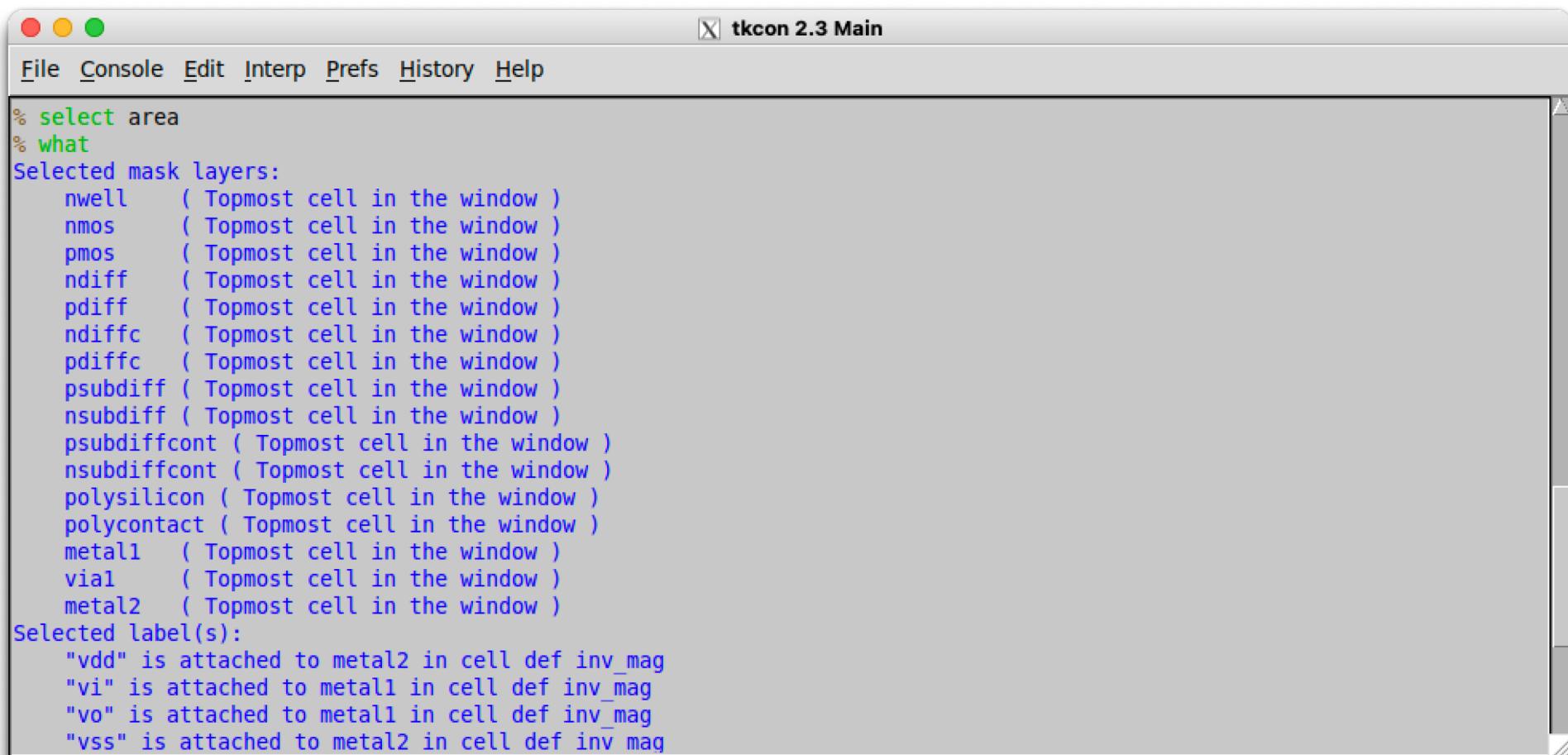
The screenshot shows a window titled "tkcon 2.3 Main". The menu bar includes "File", "Console", "Edit", "Interp", "Prefs", "History", and "Help". The main text area displays the following Tcl session:

```
handling file entry inv_mag.mag extension .mag
Cell inv_mag read from current working directory
Using technology "gf180mcuD", version 1.0.551-1-g8f2d152
Root cell box:
    width x height ( llx, lly ), ( urx, ury ) area (units^2)
microns: 0.050 x 0.050 ( 0.000, 0.000 ), ( 0.050, 0.050 ) 0.002
lambda: 1.00 x 1.00 ( 0.00, 0.00 ), ( 1.00, 1.00 ) 1.00
internal: 10 x 10 ( 0, 0 ), ( 10, 10 ) 100
Main console display active (Tcl8.6.14 / Tk8.6.14)
% grid 0.005u 0.005u
% grid on
% snap user
% drc style drc(full)
DRC style is now "drc(full)"
%
```

Dissecting the layout

2025.11

- To see all layers used in a layout, draw a box that encompass the entire layout, then use the commands:



The screenshot shows a terminal window titled "tkcon 2.3 Main". The window has a standard OS X-style title bar with red, yellow, and green buttons. The menu bar includes "File", "Console", "Edit", "Interp", "Prefs", "History", and "Help". The main text area displays the following command-line session:

```
% select area
% what
Selected mask layers:
nwell      ( Topmost cell in the window )
nmos       ( Topmost cell in the window )
pmos       ( Topmost cell in the window )
ndiff      ( Topmost cell in the window )
pdiff      ( Topmost cell in the window )
ndiffc     ( Topmost cell in the window )
pdiffc     ( Topmost cell in the window )
psubdiff   ( Topmost cell in the window )
nsubdiff   ( Topmost cell in the window )
psubdiffcont ( Topmost cell in the window )
nsubdiffcont ( Topmost cell in the window )
polysilicon ( Topmost cell in the window )
polycontact ( Topmost cell in the window )
metal1     ( Topmost cell in the window )
via1       ( Topmost cell in the window )
metal2     ( Topmost cell in the window )
Selected label(s):
"vdd" is attached to metal2 in cell def inv_mag
"vi" is attached to metal1 in cell def inv_mag
"vo" is attached to metal1 in cell def inv_mag
"vss" is attached to metal2 in cell def inv_mag
```

Dissecting the layout

2025.11

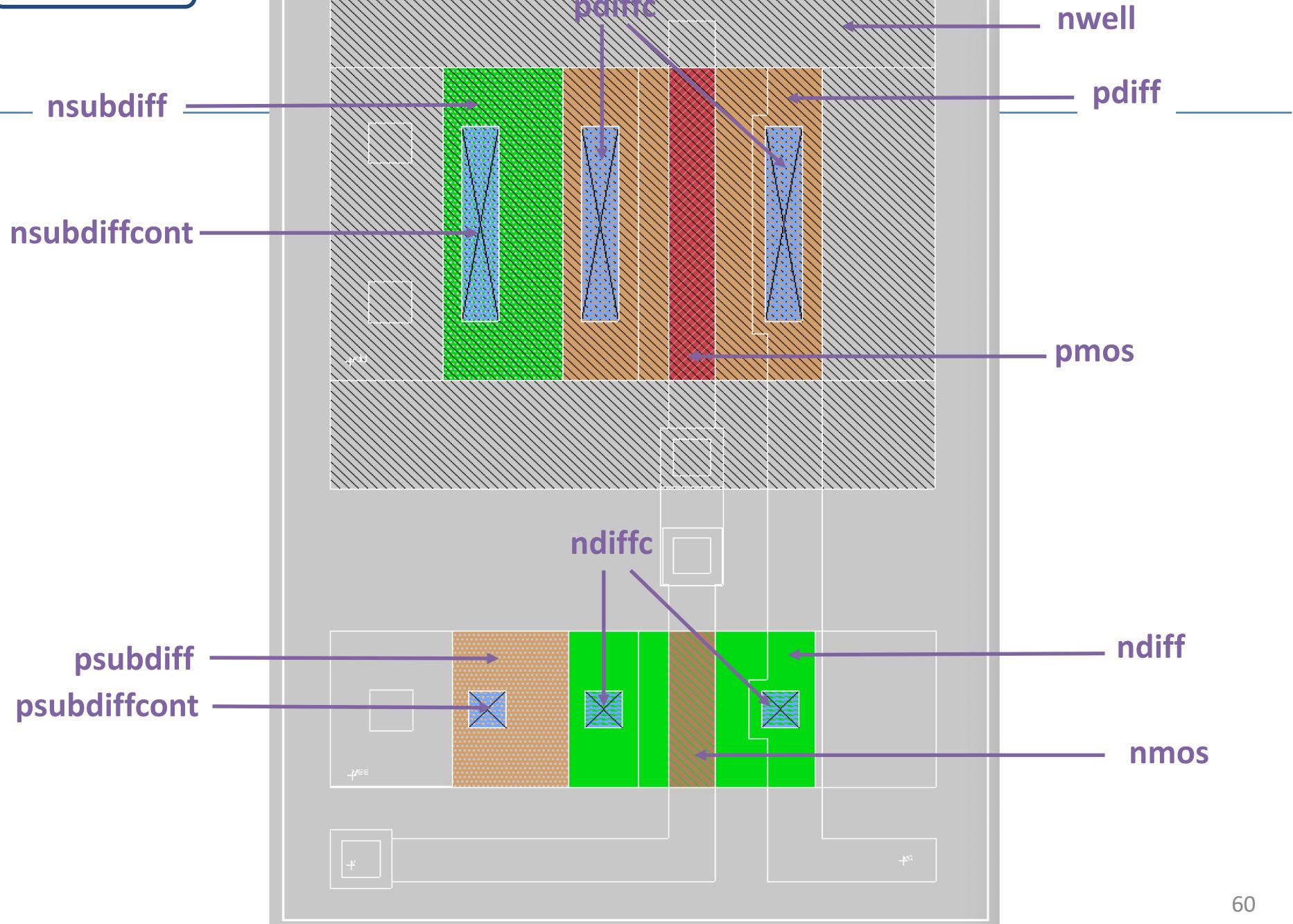
- To show/hide all layers or show a specific layer use the commands:



The screenshot shows a window titled "tkcon 2.3 Main". The menu bar includes "File", "Console", "Edit", "Interp", "Prefs", "History", and "Help". The main window displays a list of command options starting with "% see".

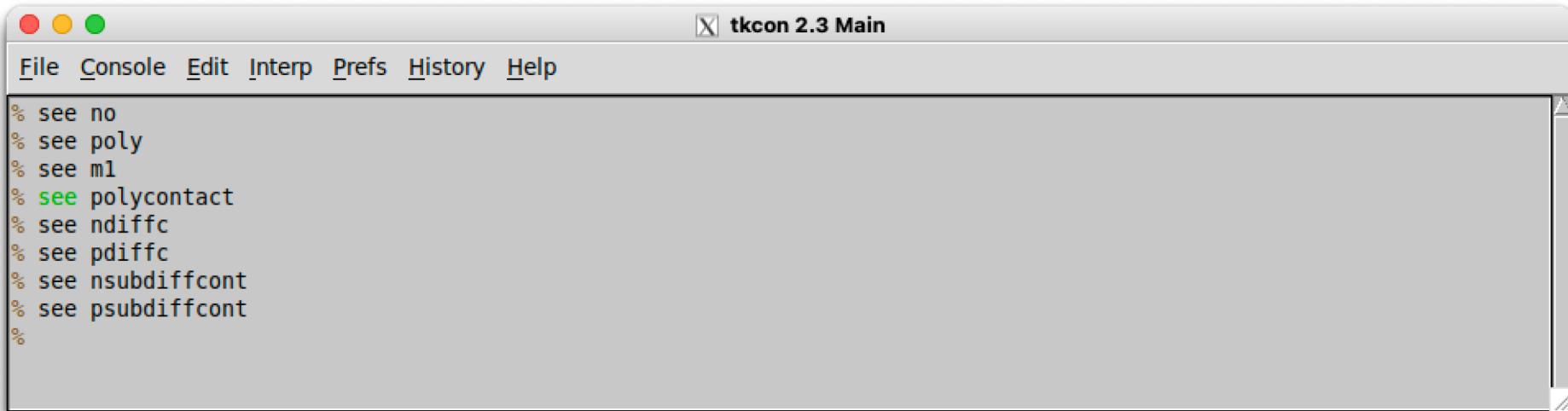
```
% see
% see no
% see ndiff
% see pdiff
% see pmos
% see nmos
% see nwell
% see ndiffc
% see pdiffc
% see psubdiff
% see nsubdiff
% see psubdiffcont
% see nsubdiffcont
%
```

2025.11



Dissecting the layout

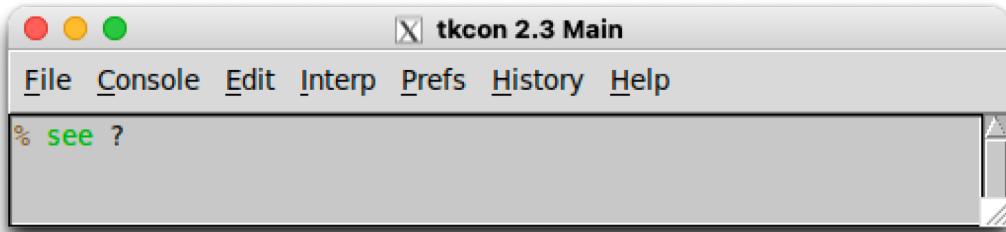
2025.11



A screenshot of the tkcon 2.3 Main window. The window title is "tkcon 2.3 Main". The menu bar includes "File", "Console", "Edit", "Interp", "Prefs", "History", and "Help". The main console area displays the following command output:

```
% see no
% see poly
% see m1
% see polycontact
% see ndiffc
% see pdiffc
% see nsubdiffcont
% see psubdiffcont
%
```

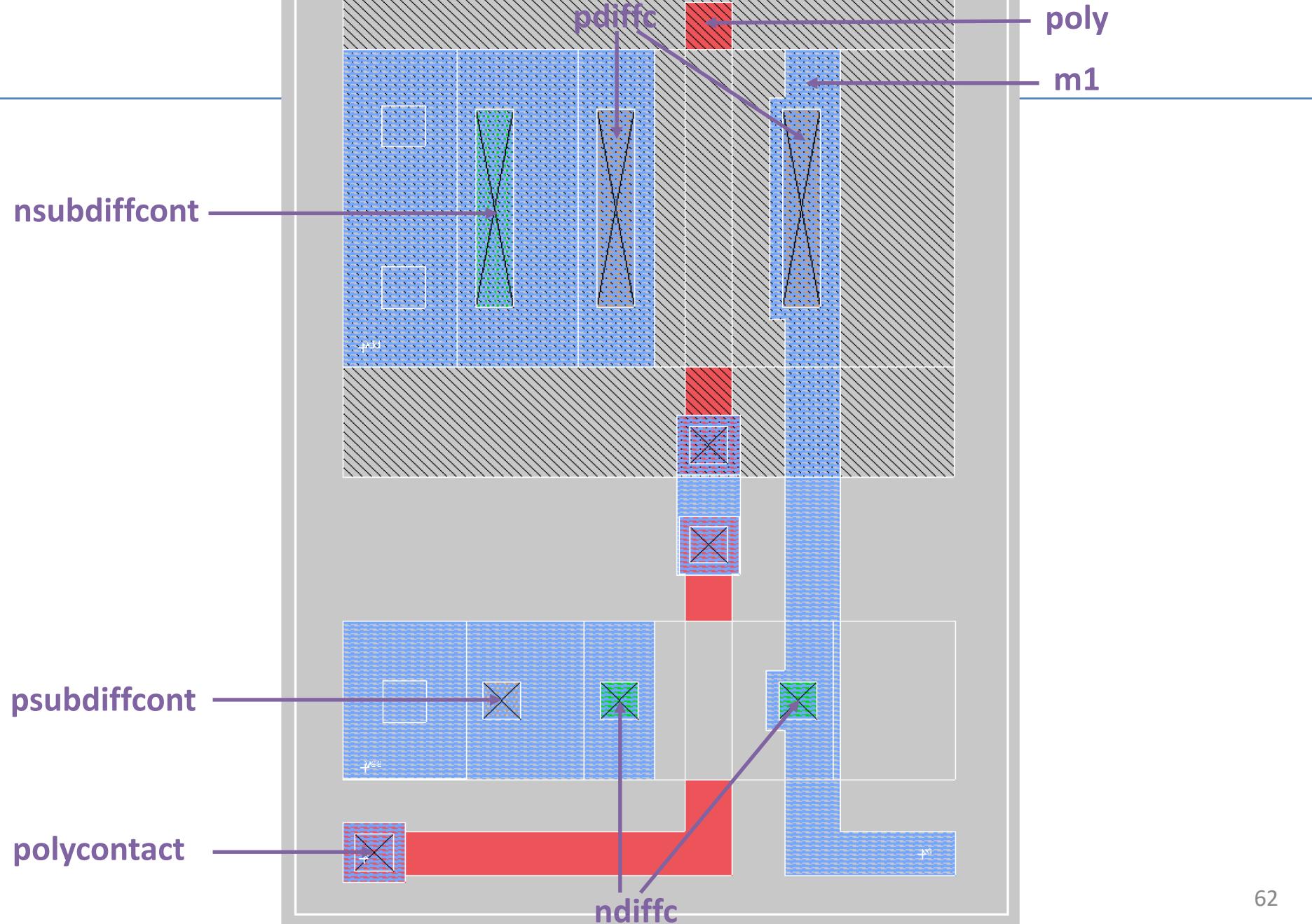
- To show all available layers use:



A screenshot of the tkcon 2.3 Main window. The window title is "tkcon 2.3 Main". The menu bar includes "File", "Console", "Edit", "Interp", "Prefs", "History", and "Help". The main console area displays the following command input:

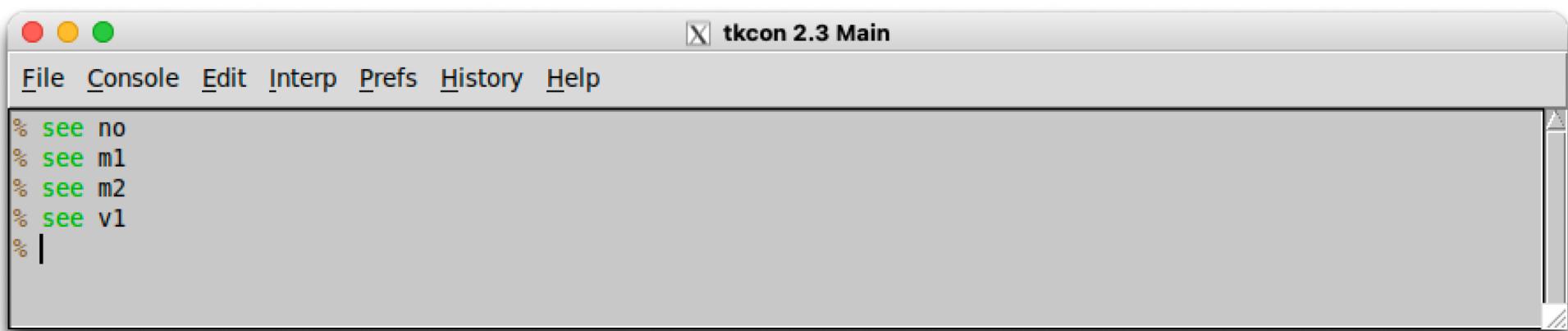
```
% see ?
```

2025.11



2025.11

Dissecting the layout

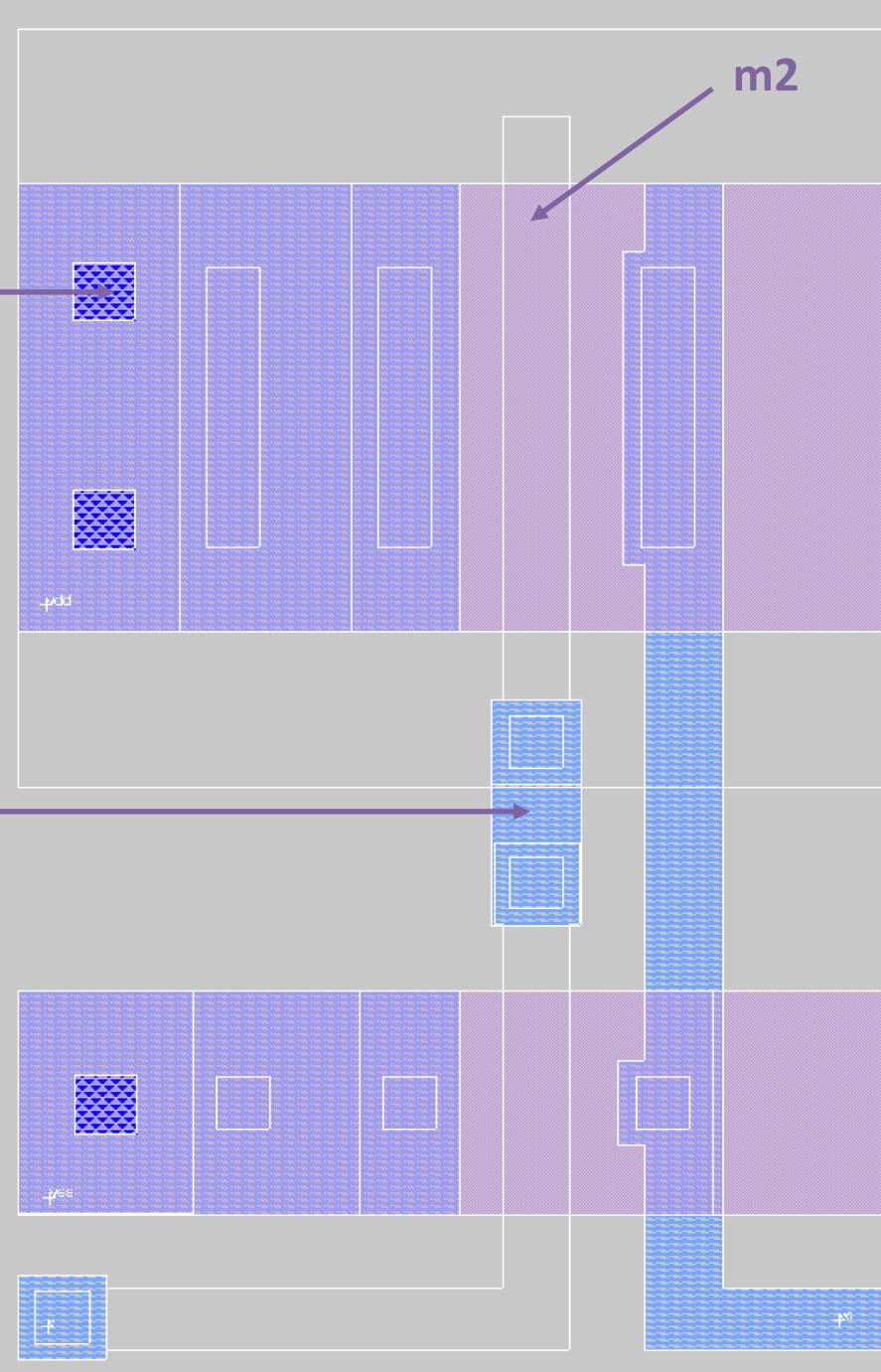


2025.11

v1

m1

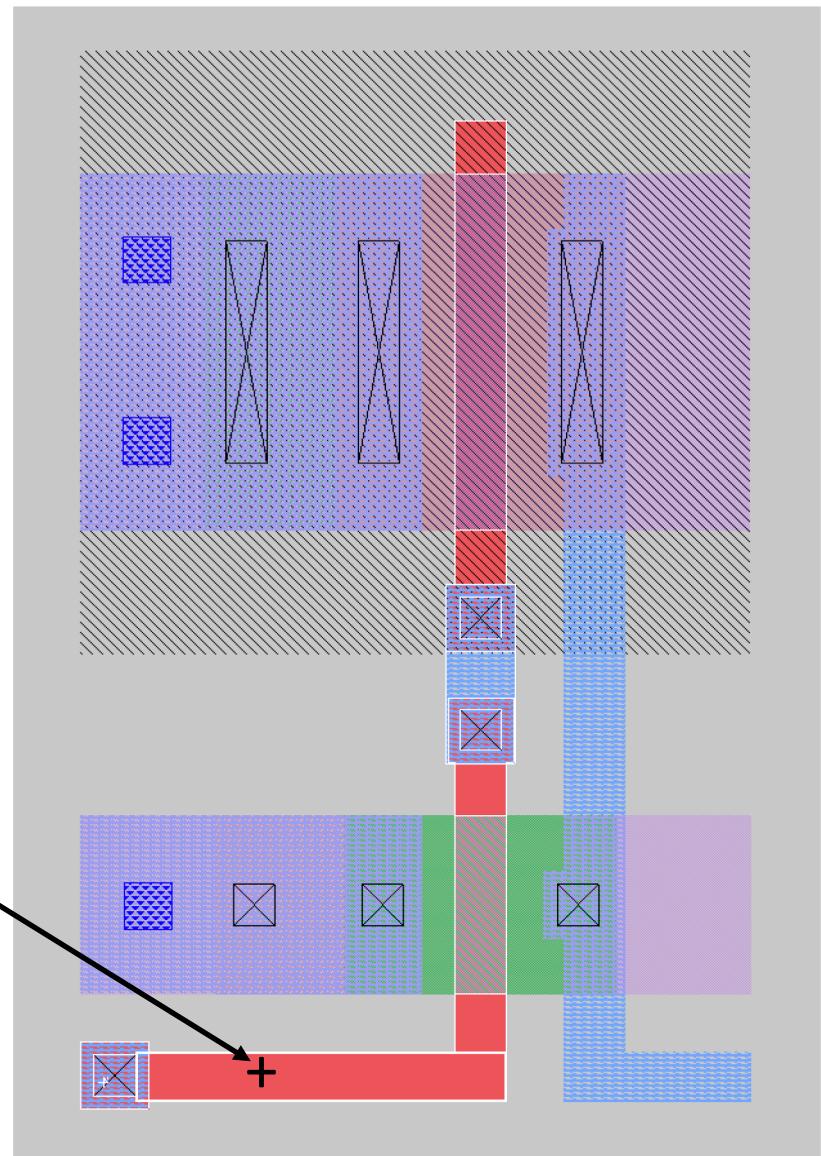
m2



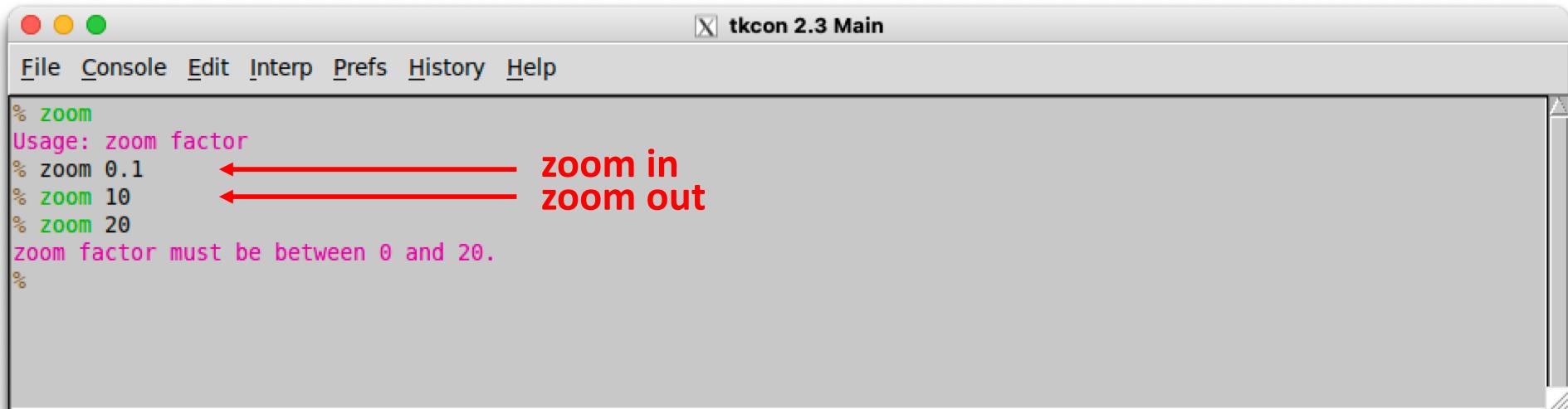
Check layers are connected correctly

- Go to the layout window and hit the shortcut v (= full zoom)
- Set the cross-hair cursor on the desired layer and hit repeatedly the shortcut s

cross-hair cursor



Zooming in and out the layout



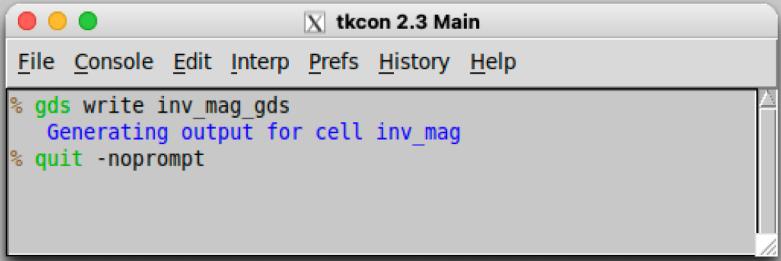
A screenshot of the tkcon 2.3 Main window, which is a terminal-like interface. The window title is "tkcon 2.3 Main". The menu bar includes "File", "Console", "Edit", "Interp", "Prefs", "History", and "Help". The command-line area shows the following interaction:

```
% zoom
Usage: zoom factor
% zoom 0.1      ← zoom in
% zoom 10      ← zoom out
% zoom 20
zoom factor must be between 0 and 20.
%
```

Two red arrows point from the text "zoom in" and "zoom out" to the respective "zoom 0.1" and "zoom 10" commands in the history.

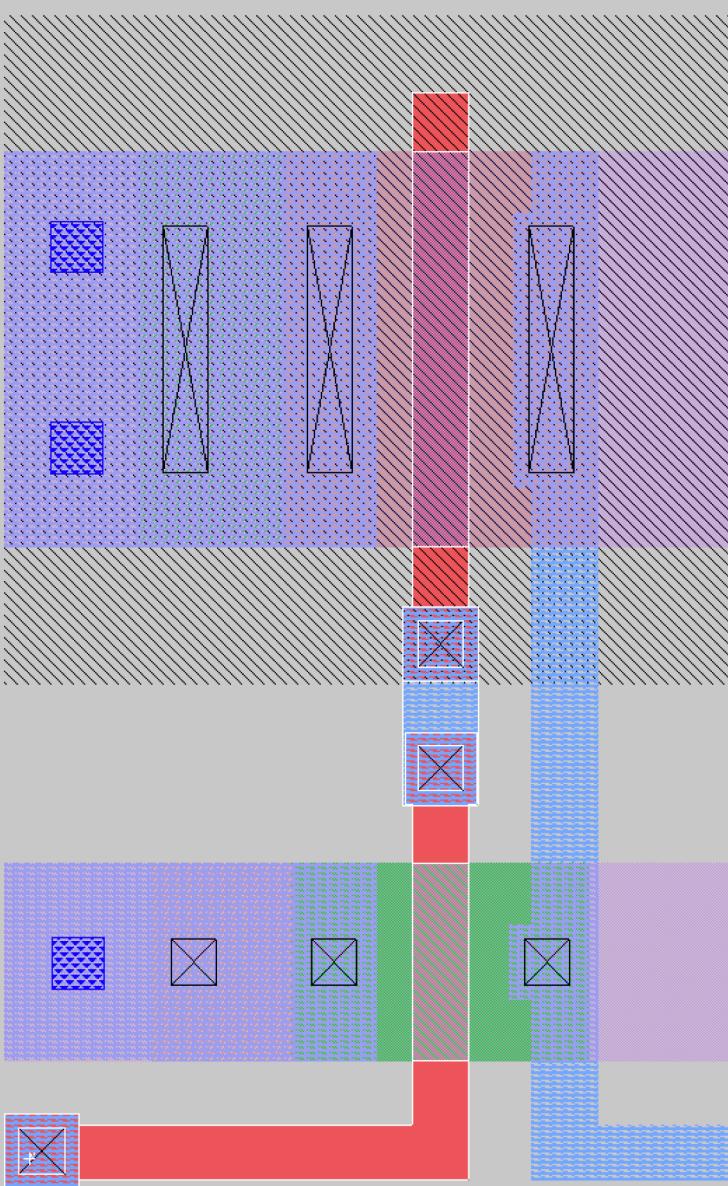
Convert from .mag to .gds

2025.11



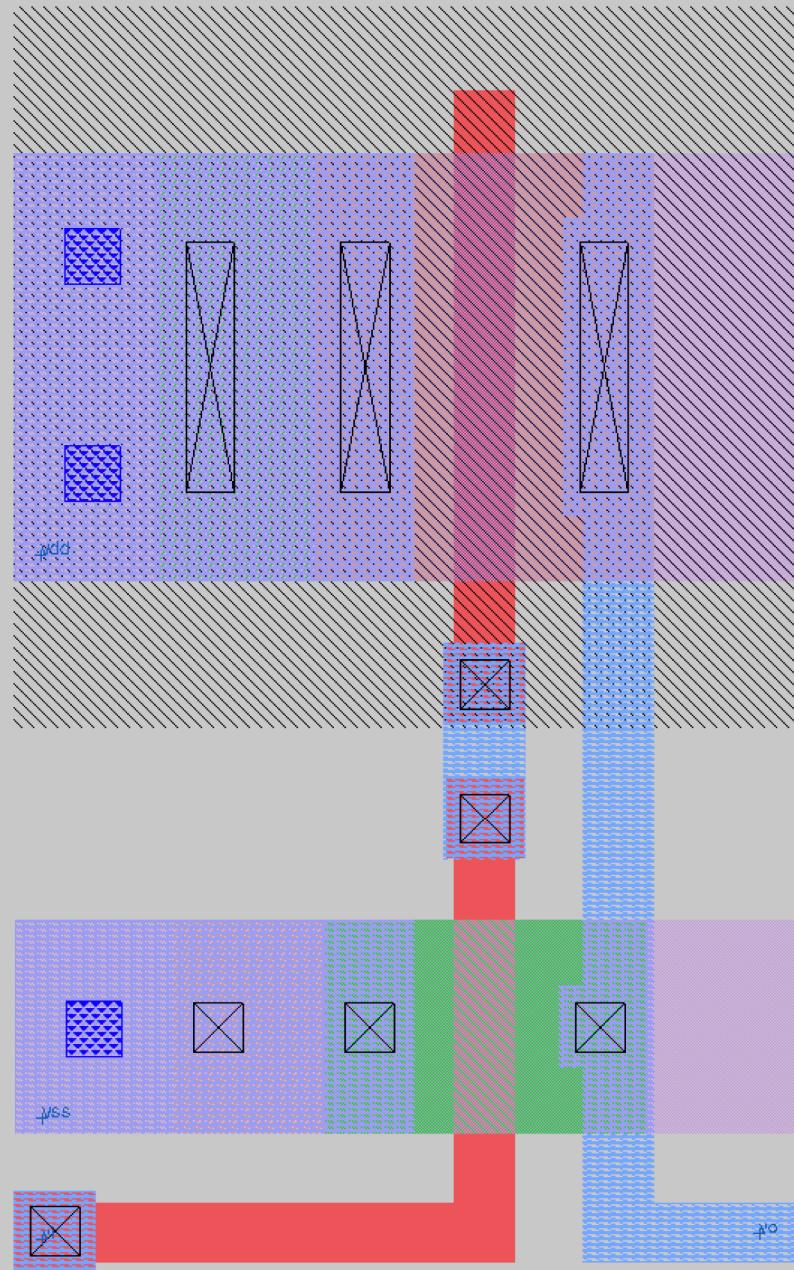
A screenshot of the tkcon 2.3 Main window, which is a terminal emulator. The window title is "tkcon 2.3 Main". The menu bar includes "File", "Console", "Edit", "Interp", "Prefs", "History", and "Help". The console area contains the following text:

```
% gds write inv_mag_gds
  Generating output for cell inv_mag
% quit -noprompt
```



/foss/designs/gf180-2025/ring > magic

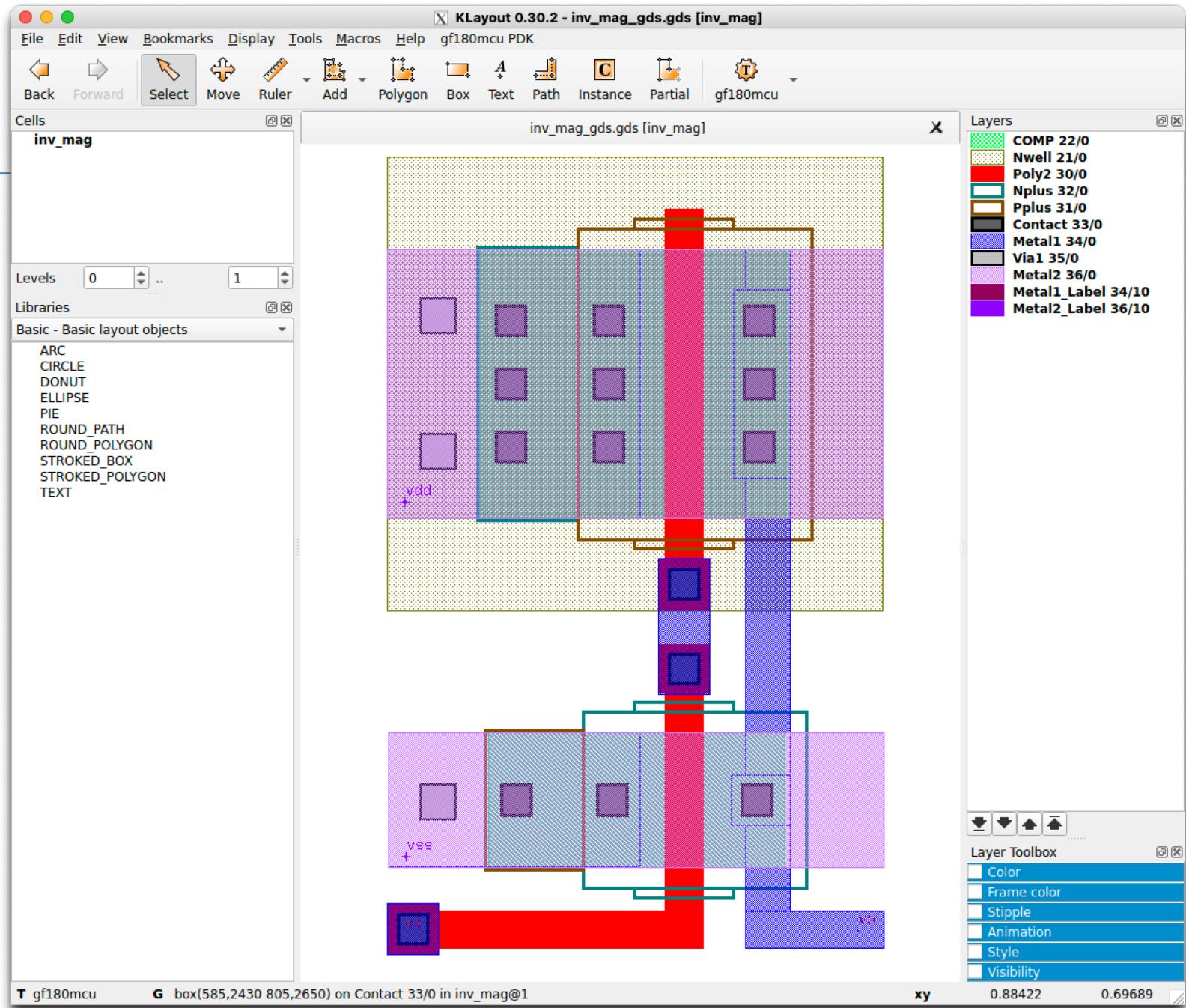
```
tkcon 2.3 Main
File Console Edit Interp Prefs History Help
% gds read inv_mag.gds
Warning: Calma reading is not undoable! I hope that's OK.
Library written using GDS-II Release 3.0
Library name: inv_mag
Reading "inv_mag".
Loading DRC CIF style.
%
```



2025.11

Reading the gds with klayout

/foss/designs/gf180-2025/ring > ke -l gf180mcu_Pk.lyp inv_mag.gds



DRC with KLayout (main.lyrdb)

2025.07

It works
also with
2025.09

