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# VISUALIZING MICROCHIPS

All Open Source

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## SOME CELLS



# A BOOTSTRAP PROBLEM

## IN OUR DEPARTMENT...

**Disclaimer:** i am a computer scientist (CS), not an electrical engineer (EE)!

You want to build microchips, but

- No prior knowledge about digital design
- No funding / minor support
- No students to help
- No suitable curriculum (computer science!)
- No encouragement by colleagues

**Question:** How to bootstrap the process to build hardware?

**Answer:** Open Source helps a lot (NDAs, License costs, ease of installing).



# WHEN ALL YOU HAVE IS ...

## Secret ingredient

If you want to build a ship, don't drum up the men to gather wood, divide the work, and give orders. Instead, teach them to yearn for the vast and endless sea.

(Antoine de Saint-Exupéry)

**Question:** How to light a spark for digital design and building microchips?

- Make it attractive.
- Lower the entrance barriers.
- Demystify it.
- Make use of the skills of Non-EE people (CS for example).

**Today's talk:** Visualizing

SINGLE CELLS

## GET THE CELLS

### Step 1:

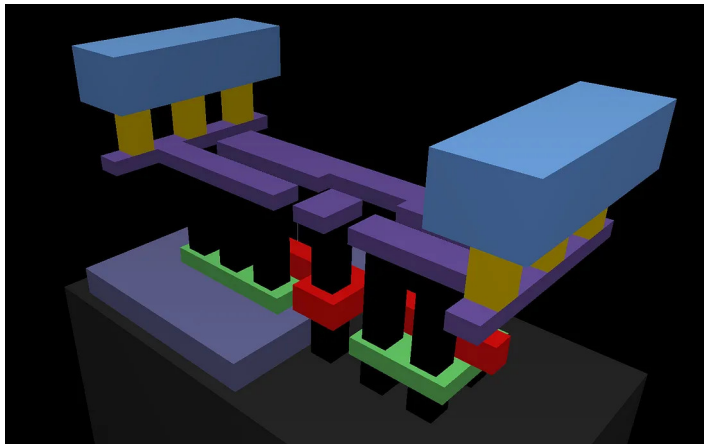
Grab your favourite Open Source PDK: SKY130, IHP130, GF180

### Step 2:

Find the GDS files in the PDK library. If there is only a single GDS library: Extract the single cells as GDS with Python (gdspy).

## VIEW THE CELLS

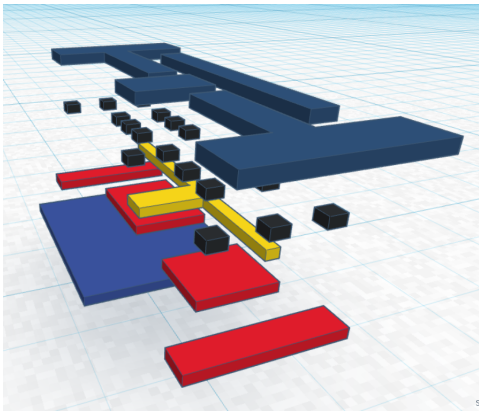
**Step 3:** Inspect the GDS of the cell with a viewer (GDS3D):



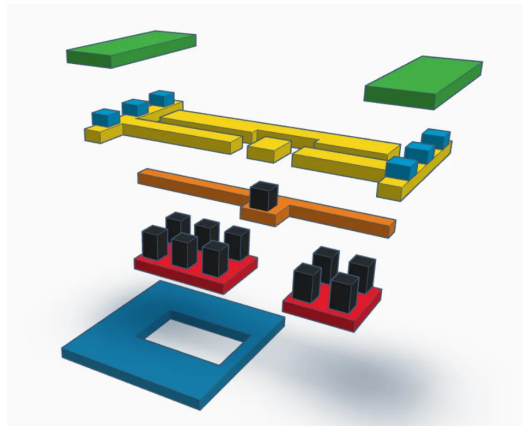
GDS rendering of a SKY130 Inverter with GDS3D

# CONVERT THE GDS TO STL

**Step 4:** Convert the cells GDS to STL files (GDSiiSTL):



STL layers of an IHP130 Inverter, done with GDSiiSTL



STL layers of an SKY130 Inverter, done with GDSiiSTL

## 3D PRINT THE STL LAYERS

### Step 5: Print the STL files



Prints of a IHP130 Inverter, sadly they are wrong.

# GLUE THE PRINTS TOGETHER

Scale:  
40000 : 1  
4cm : 1um



IHP130 Inverter with false power rails

## SIDESTORY

Insert side story about my "learnings" with IHP130 Inverter here.

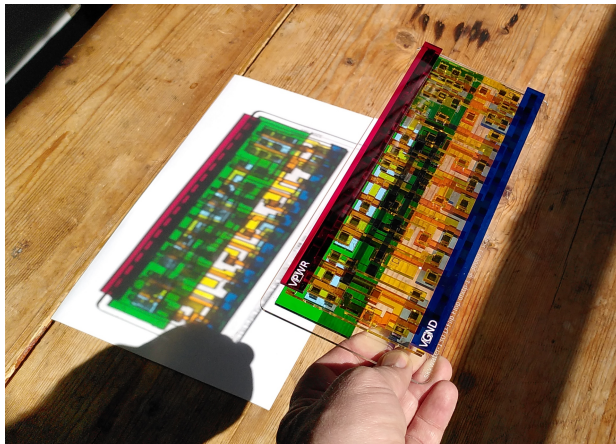


IHP130 Inverter with false power rails



## OTHER PEOPLES WORK

A laser cutted model, done by Hennes Zeller:

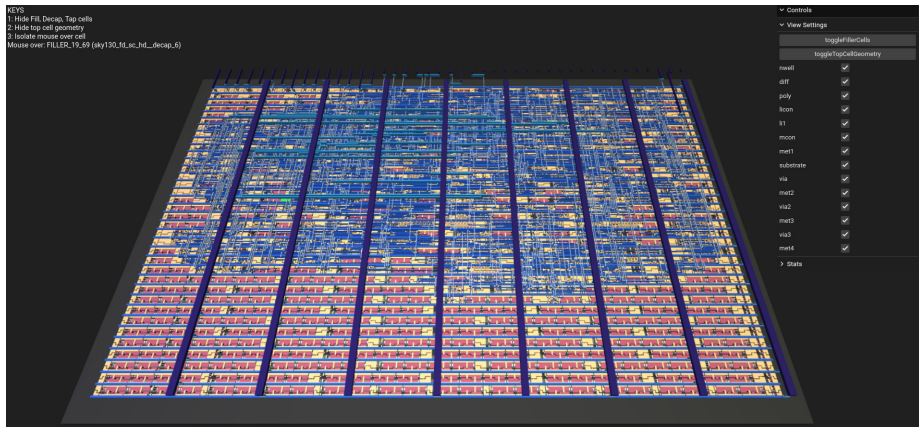


Hennes Zeller Tweet: <https://twitter.com/HennerZeller/status/1507849442363265024/photo/1>

FULL DESIGNS

# TINYTAPEOUT WEBVIEWER: ZOOMED OUT

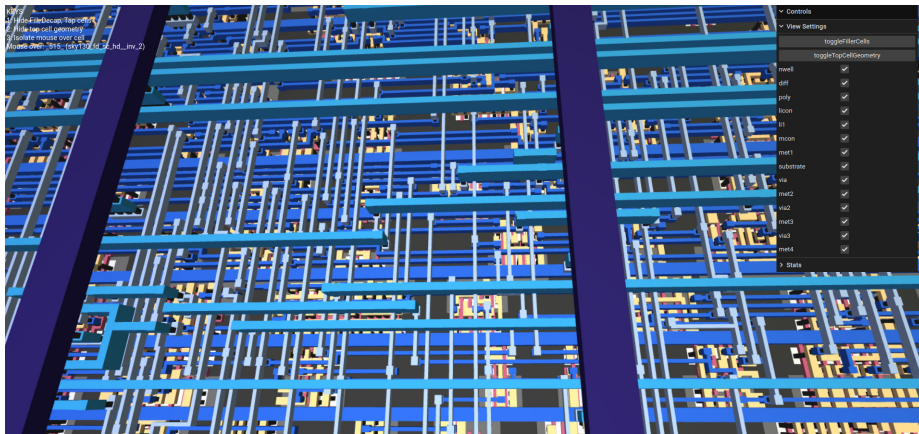
With every TinyTapeOut design comes a 3D explorable Webview of the design:



vgallock design made for TinyTapeOut

# TINYTAPEOUT WEBVIEWER ZOOMED IN

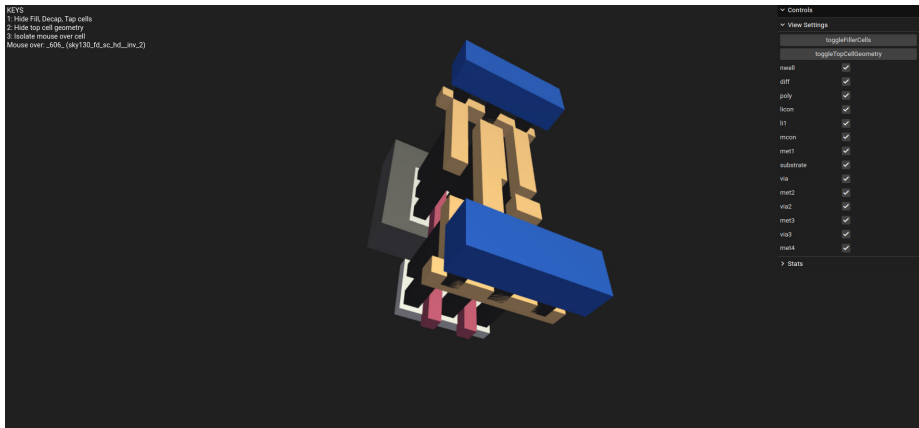
With every TinyTapeOut design comes a 3D explorable Webview of the design:



vgalock design made for TinyTapeOut

# TINYTAPEOUT WEBVIEWER: SINGLE CELL

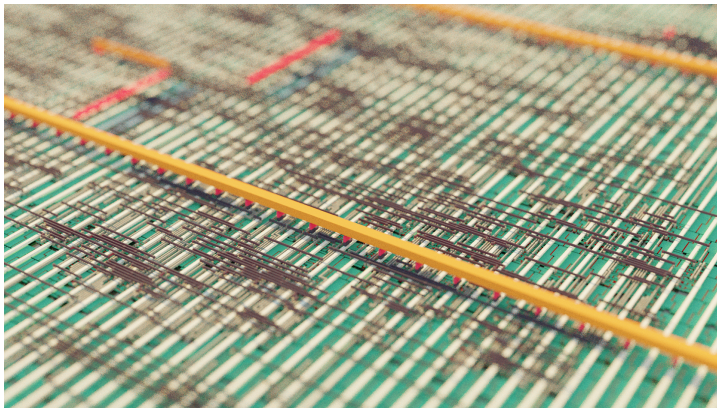
With every TinyTapeOut design comes a 3D explorable Webview of the design:



vgalock design made for TinyTapeOut

# MAXIMO BALESTRINI: RENDERINGS 1

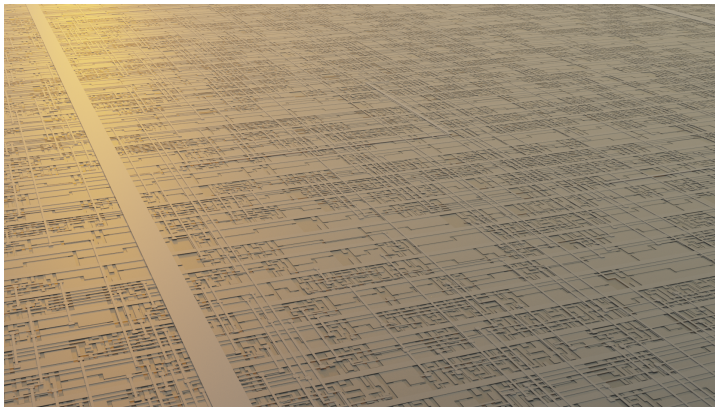
Maximo Balestrini does some amazing renderings of chip designs with Blender. And he has a youtube tutorial about it.



Rendering by Maximo Balestrini [https://github.com/mbalestrini/sky130\\_blender\\_renders\\_tutorial](https://github.com/mbalestrini/sky130_blender_renders_tutorial)

# MAXIMO BALESTRINI: RENDERINGS 2

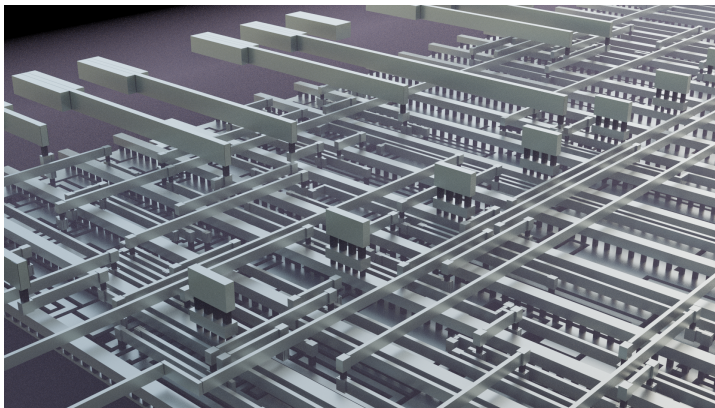
Maximo Balestrini Rendering:



Rendering by Maximo Balestrini [https://github.com/mbalestrini/sky130\\_blender\\_renders\\_tutorial](https://github.com/mbalestrini/sky130_blender_renders_tutorial)

# MAXIMO BALESTRINI: RENDERINGS 3

Maximo Balestrini Rendering:



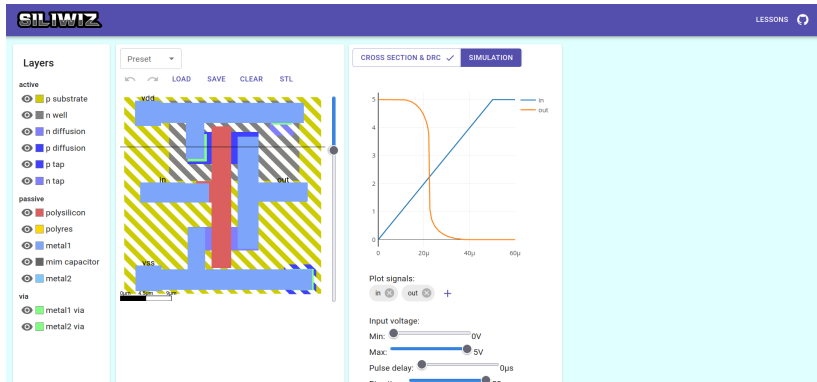
Rendering by Maximo Balestrini [https://github.com/mbalestrini/sky130\\_blender\\_renders\\_tutorial](https://github.com/mbalestrini/sky130_blender_renders_tutorial)



## OTHER WORKS

# SILIWIZ: EXPLORATION AND LEARNING

Siliwiz:



<https://app.siliwiz.com/>

LINKS

# LINKS



Picture by Thorsten Knoll

My 'How-to' blog post: <https://medium.com/@thorstenknoll/open-source-ic-cells-as-3d-prints-a-rough-how-to-guide-90a8bc8b3b57>

# LINKS

## Step 1:

Open Source PDKs:

- Sky130 <https://github.com/google/skywater-pdk>
- IHP130 <https://github.com/IHP-GmbH/IHP-Open-PDK>
- GF180 <https://github.com/google/gf180mcu-pdk>

Example for a single cell as GDS (SKY130 Inverter):

[https://github.com/google/skywater-pdk-libs-sky130\\_fd\\_sc\\_hd/blob/ac7fb61f06e6470b94e8afdf7c25268f62fbd7b1/cells/inv/sky130\\_fd\\_sc\\_hd\\_inv\\_1.gds](https://github.com/google/skywater-pdk-libs-sky130_fd_sc_hd/blob/ac7fb61f06e6470b94e8afdf7c25268f62fbd7b1/cells/inv/sky130_fd_sc_hd_inv_1.gds)

# LINKS

## Step 2:

Python GDSPY:

**<https://pypi.org/project/gdspy/>**

Example Python code for extraction of cells (modify to your need):

**<https://gist.github.com/ThorKn/6414844b3a355e928619dfa2abdba3f3>**

## Step 3:

GDS3D (including adaption for SKY130):

**<https://github.com/trilomix/GDS3D>**

# LINKS

## Step 4:

Adaption of gdsiistl for SKY130 PDK: <https://github.com/mbalestrini/gdsiistl>

Adaption of gdsiistl for IHP130 PDK: <https://github.com/ThorKn/gdsiistl>

## Step 5:

This step depends on what software you want to use with your 3D printer. I am using

TinkerCAD from Autodesk (Not Open Source!)

CURA Software for slicing (Not Open Source!)

But there is a ton of Open Source Software for printers available. Pick yours.

## 3D laser cutted cell by Hennes Zeller:

<https://twitter.com/HennerZeller/status/1507849442363265024/photo/1>

# LINKS

## **TinyTapeOut design exploration Webviewer:**

Example of a full design with the TinyTapeOut 3D Webviewer:

**<https://thorkn.github.io/tt03p5-vgaclock-02/>**

Github Actions of TinyTapeOut 05 (incl. the Webviewer):

**<https://github.com/TinyTapeout/tinytapeout-05/actions>**

TinyTapeOut Website: **<https://tinytapeout.com/>**



## LINKS

### **Visualizing and exploring full designs with Maximo Balestrinis rendering works:**

Blender Tutorial Github:

**[https://github.com/mbalestrini/sky130\\_blender\\_renders\\_tutorial](https://github.com/mbalestrini/sky130_blender_renders_tutorial)**

Blender Tutorial Youtube:

**<https://www.youtube.com/watch?v=gBjQI3GrBHU>**

Maximos Twitter (X) with a lot of other showcases:

**<https://twitter.com/maxiborga>**

## Q AND A

I have a few printed 3D cells with me and i don't want to carry them back home :)  
Open-source is sharing!

Thank you.

Questions?

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