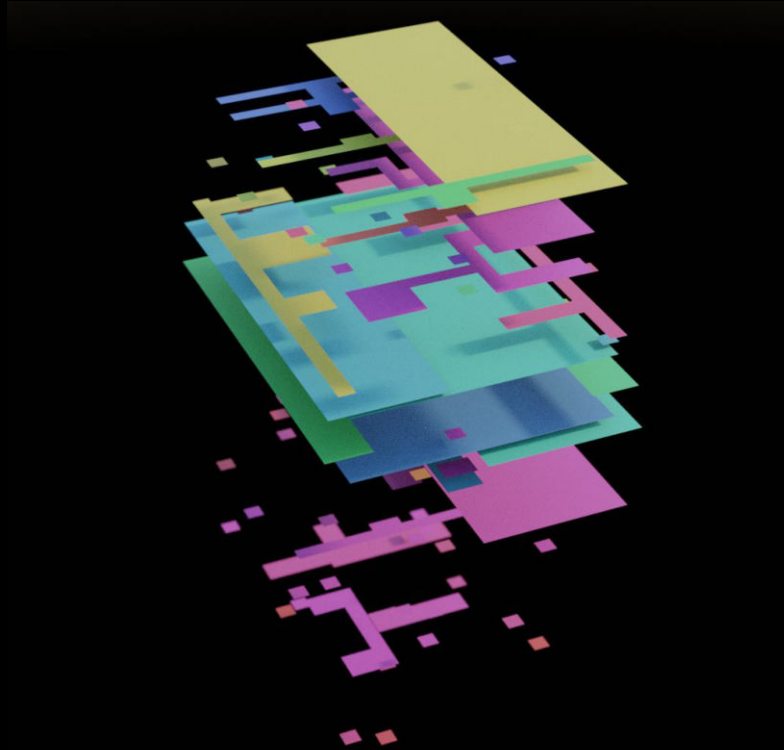


# Open Source ASIC tooling



@matthewvonn [bit.ly/riscv-japan-2022](https://bit.ly/riscv-japan-2022)

# ***ChipFlow***

Helping product companies  
make their own chips

<https://www.chipflow.io/>



Learn to design your own  
ASIC and get it fabricated!

<https://zerotoasiccourse.com/>



The home for Yosys and related  
Open Source EDA projects

<https://www.yosyshq.com/>

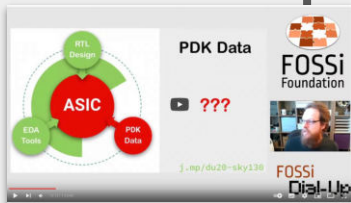


**Quick overview...**

# 2020

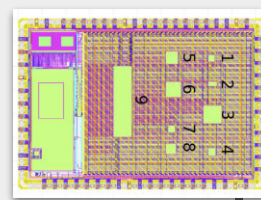
June

Tim Ansell announces Sky130 PDK  
and free shuttle opportunity



November

Zero to ASIC demo for remoticon



July

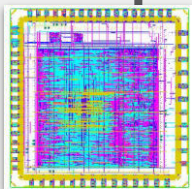
VGA clock GDS with OpenLane

December

MPW1 tapeout with Efabless

# 2021

March  
Strive bringup



**Rapid IC Prototyping Solution**

- Rapid design implementation leveraging a full cover chip ASIC (Gatelet)
- Low cost 8MPH shuttle fabrication for the ASIC open flow
- No open source requirement
- \$9750 per project

**Includes:**

- Complete design flow based on OpenLane & MPW
- Advanced physical implementation for digital design
- Required commercial EDA system as well as the required package and evaluation board
- 2D user design area
- 3D programmable I/O supporting digital and analog
- 100 packaged parts / chiplets, 800K 1.5 fabrication board area

**Schedule based on demand:**

- Earliest tapeout: June 15, 2021
- Latest shipment: August 20, 2021

Project shuttle capacity: 2000 minimum, 4000 maximum

• 1200 maximum flow study (availability of resources on project not met)

**efabliss!**

**efabliss.com**

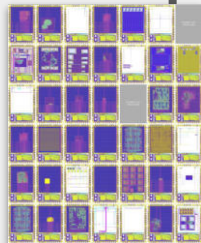
**\$9750 per project**

MPW  
New Design Area

A small image of a microchip with a green label that says "MPW".

May  
Chiplgnite - commercial version

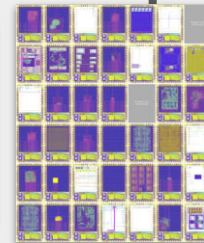
June  
MPW2 tapeout



October  
MPW1 silicon arrived!



November/December  
MPW3/4 tapeout



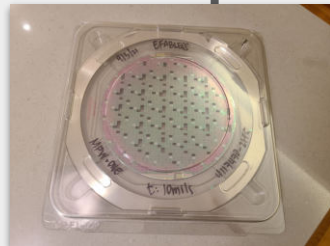
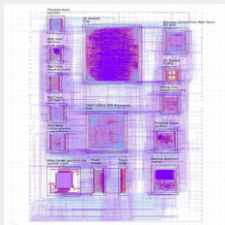
November  
Remoticon 2021

# 2022

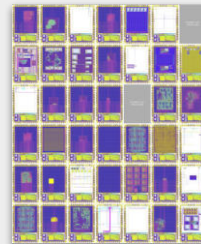
Jan/Feb  
MPW1 bringup



April  
MPW2 wafers out of fab



Rest of 2022  
2 more tapeouts, more fabs, PDKs



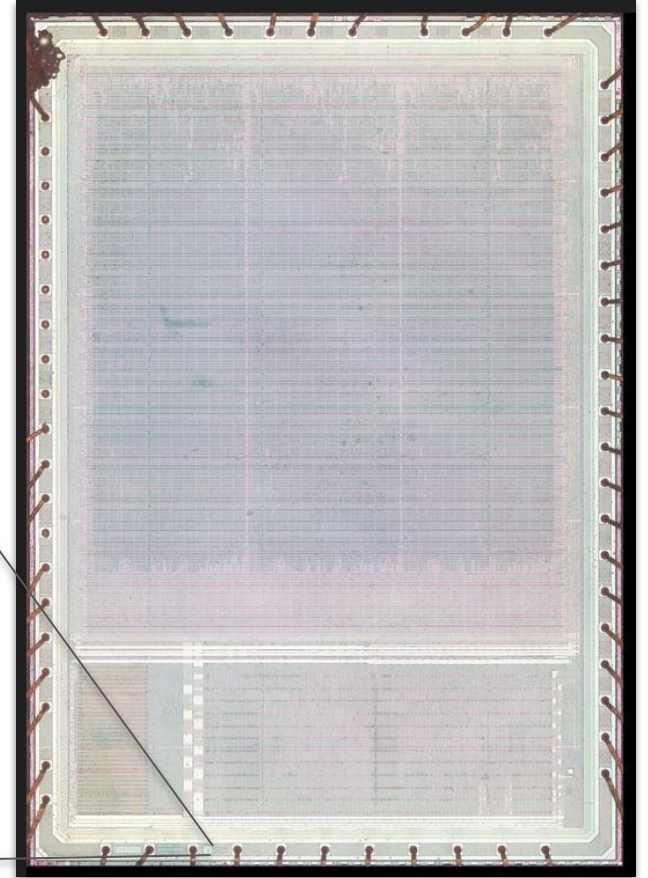
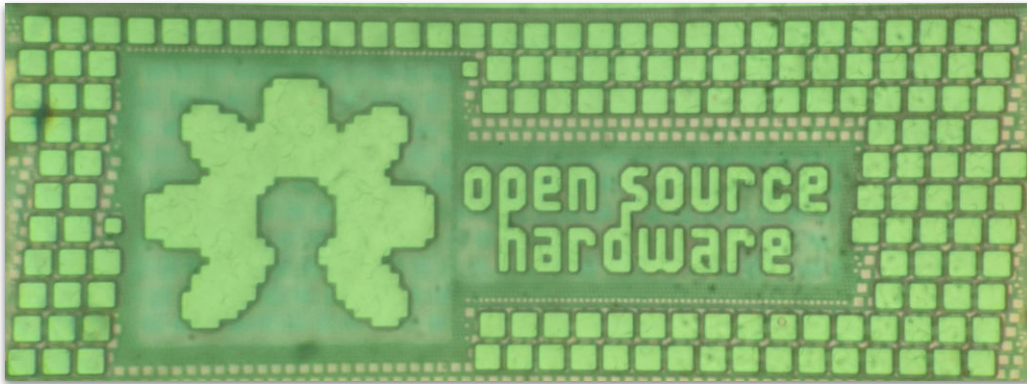
March  
MPW5 tapeout

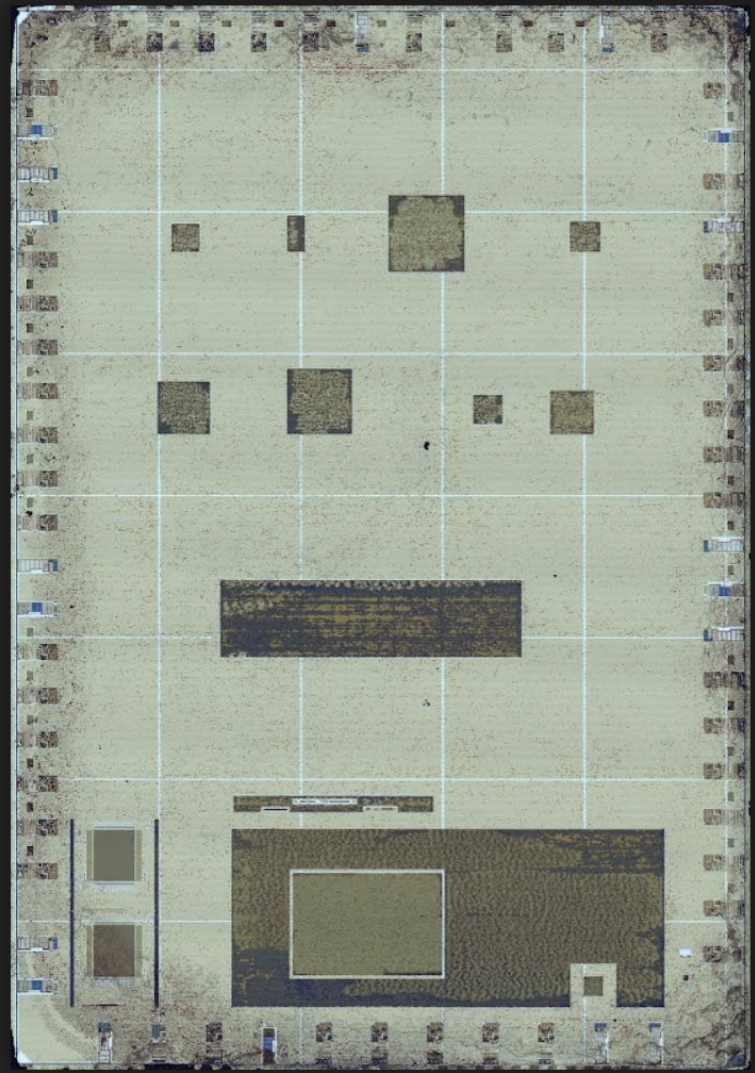
June  
MPW6 tapeout



# MPW1

- Die imaged by [John McMaster](#)
- [Zoomable image](#)
- [OpenTapeOut talk](#)





**seven-segment-seconds**  
shows seconds on a seven segment LED display  
*Matt Venn*

**ws2812**  
ws2812 LED interface for 8 addressable LEDs  
*Matt Venn*

**spinet**  
SPI-connected network hub  
*Richard Miller*

**multi project harness**  
The multiplexer that connects each project in turn to the inputs and outputs  
*Matt Venn*

**Storage Area**  
2KB DFFRAM  
*Efabless*

**Management Area**  
Pico RV-32 based SoC  
*Efabless*

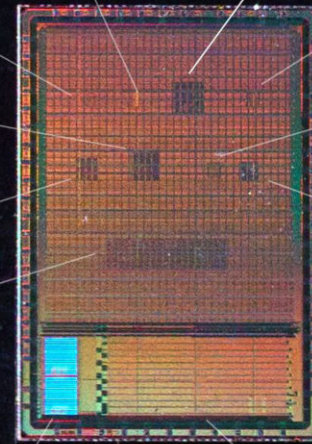
**mm2hdmi**  
HDMI driver  
*Aleksandar Pajkanovic*

**asicfreq**  
Frequency counter  
*Michael Betz & Vamsi Vytla*

**TPM2137**  
Reverse Engineering challenge  
Q3K

**ASIC\_watch**  
4 digit 7 segment clock  
*Louis Ledoux & Guillem Cabo*

**vga-clock**  
show the time on a VGA panel  
*Matt Venn*

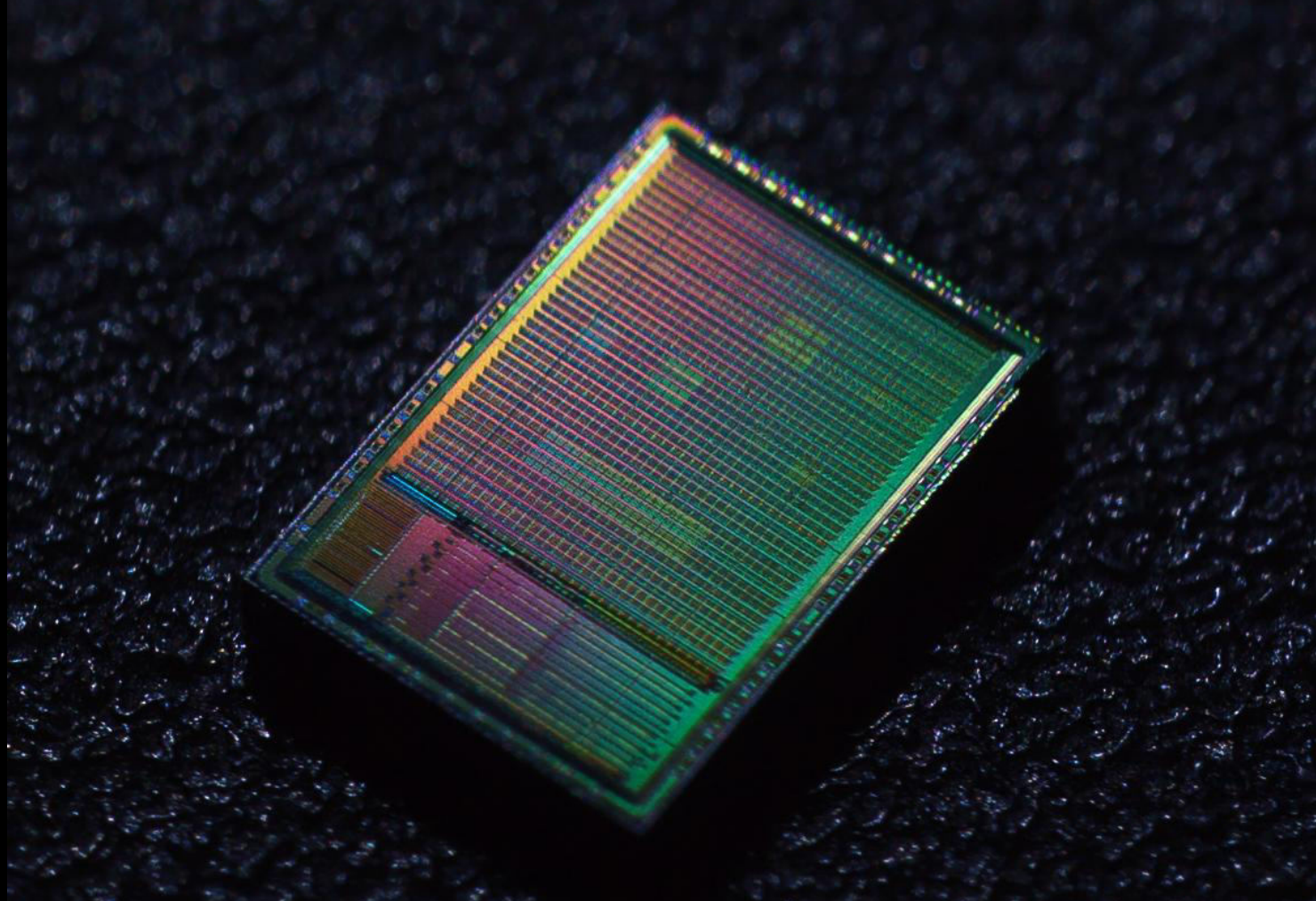


Photos by [Maxiborga](#)

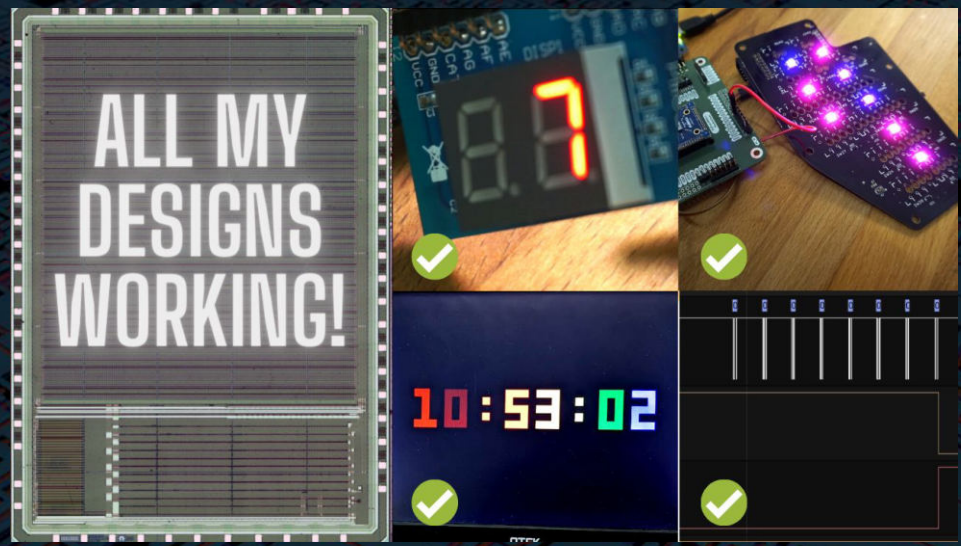
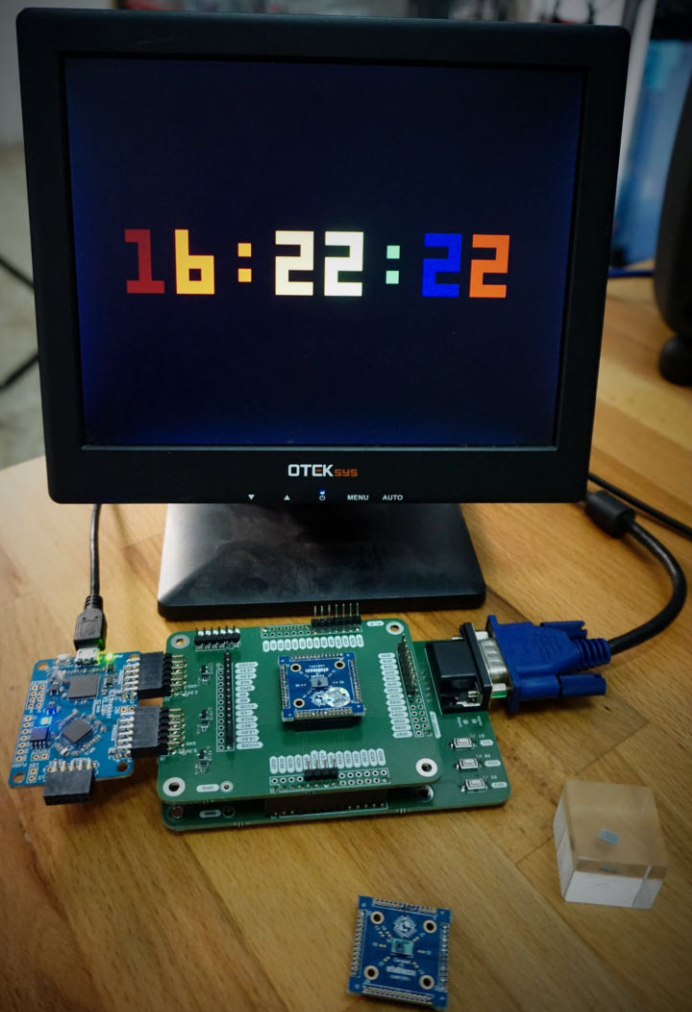
Die images by <https://www.explained.com/>

Lots more info <https://bit.ly/mpw1-samples>





[Image by Maxiborga](#)



<https://zerotoasiccourse.com/post/mpw1-is-alive/>

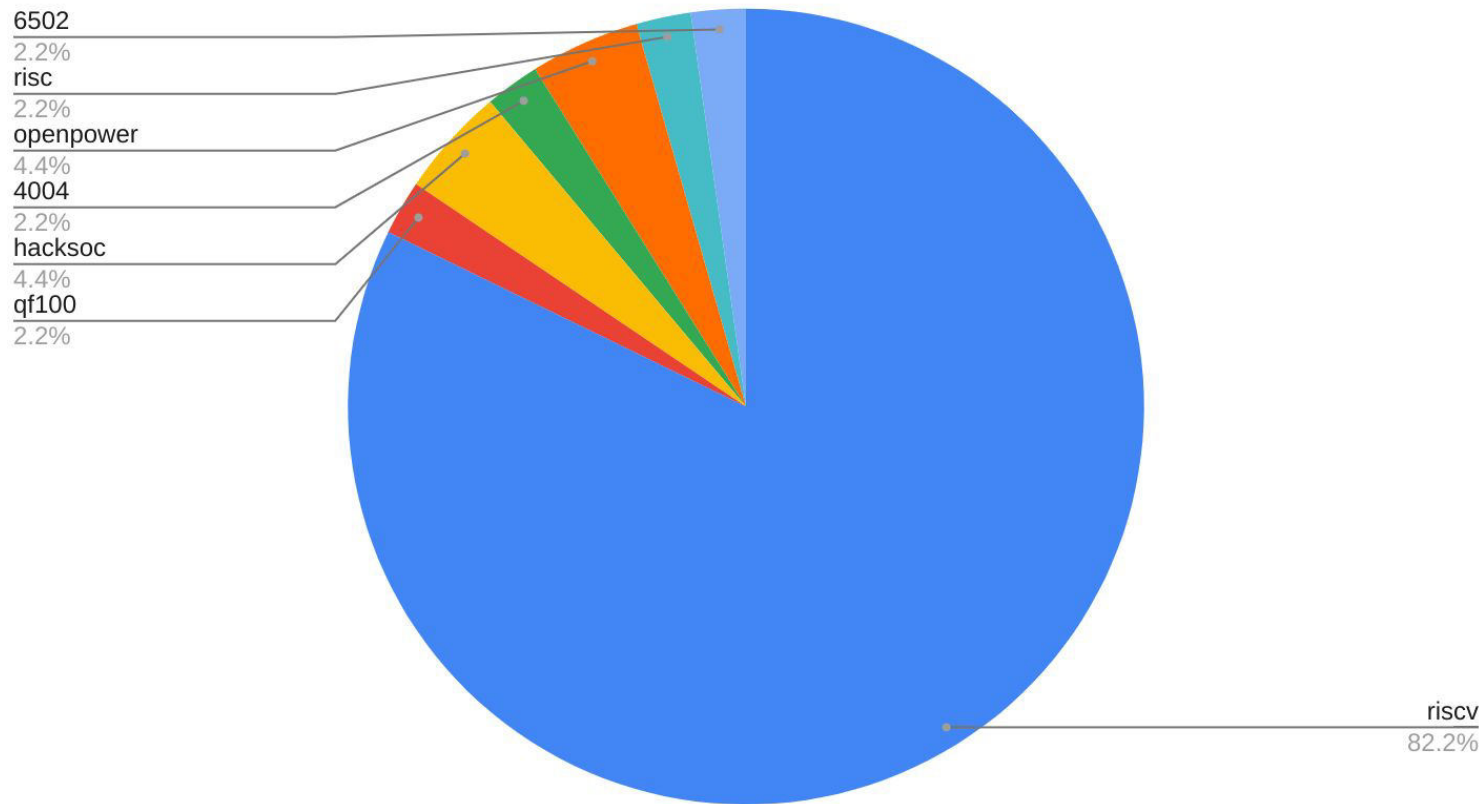


# RISCV on the shuttles

- One 'free' RISCV CPU on each chip:  $40 * 5 = 200$ 
  - MPW1 40 PicoRV32
  - MPW2 to 5 160 VexRISC
- Of the 200 applications, 45 were SoC or CPUs
- 37 of which were RISCV variants
- In total **237 RISCV CPUs** across all shuttles so far

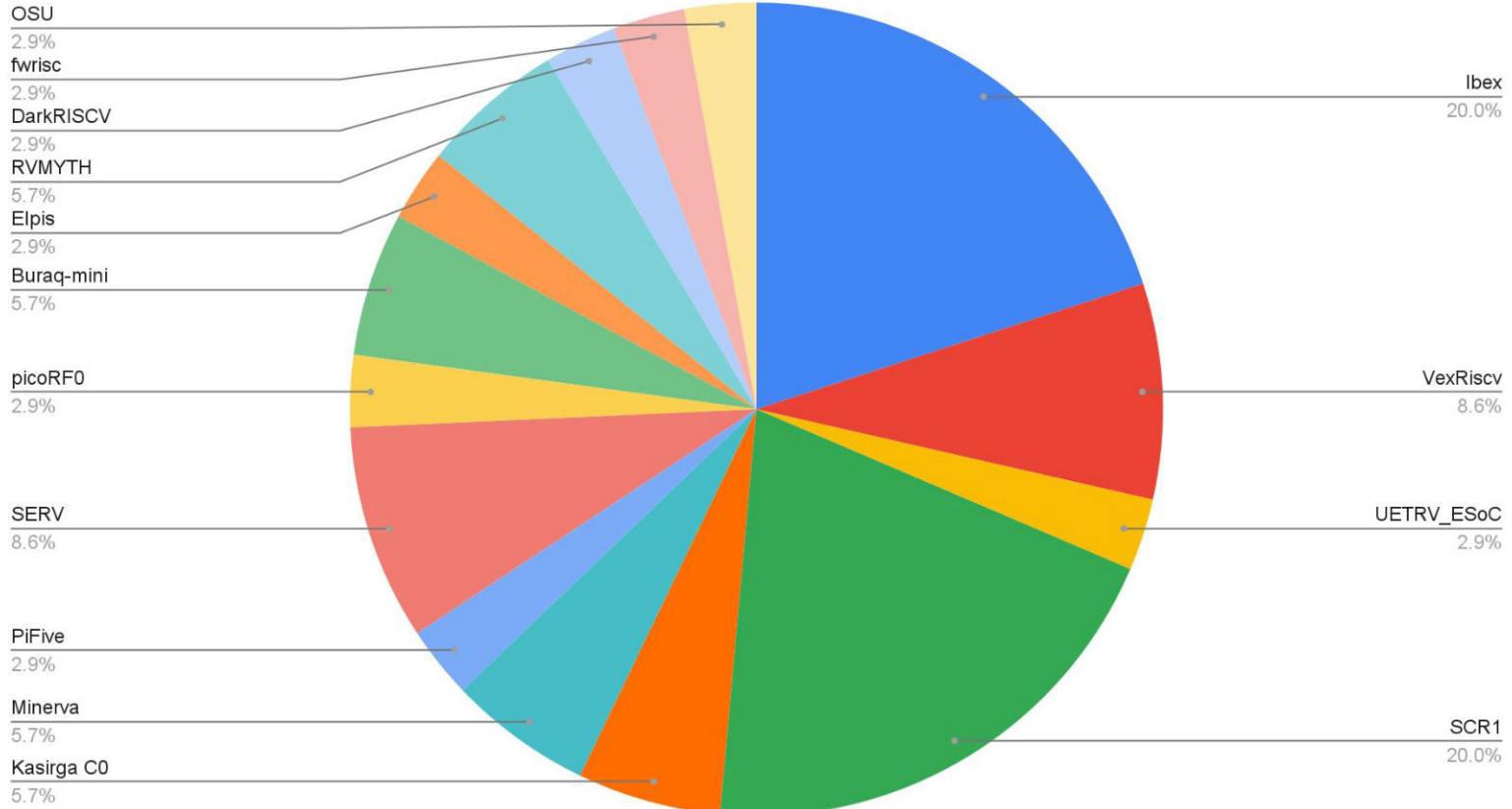


## 45 CPUs were submitted to Google MPW shuttles 1 to 5

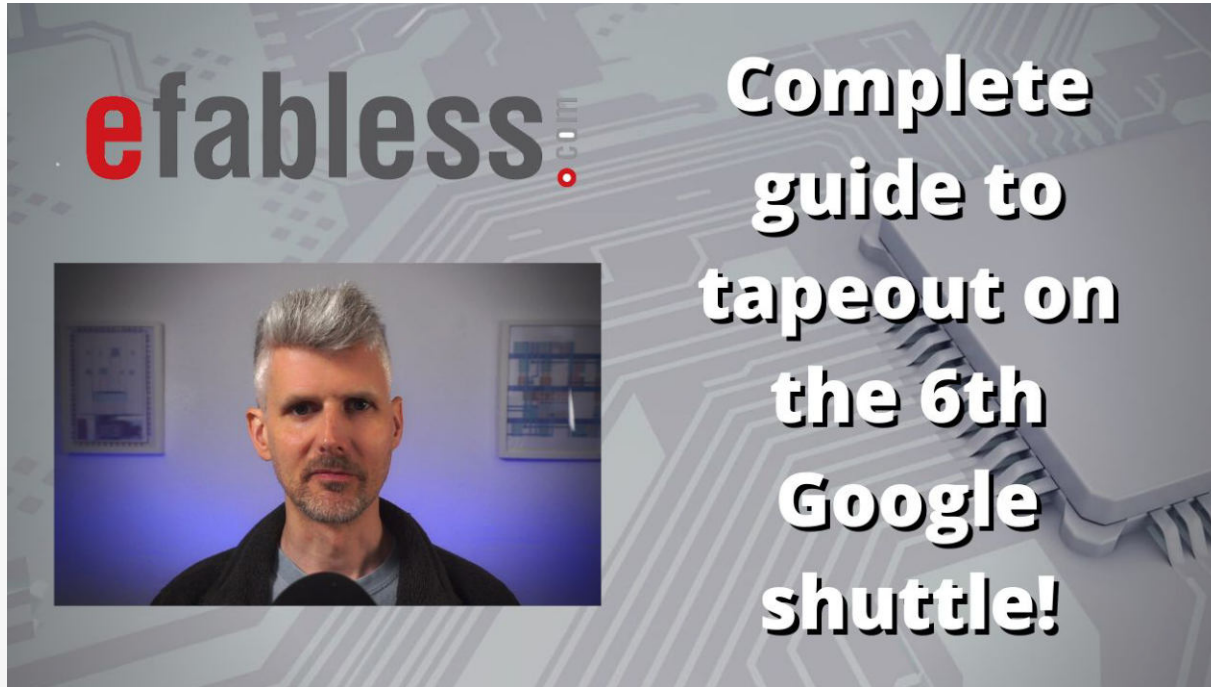




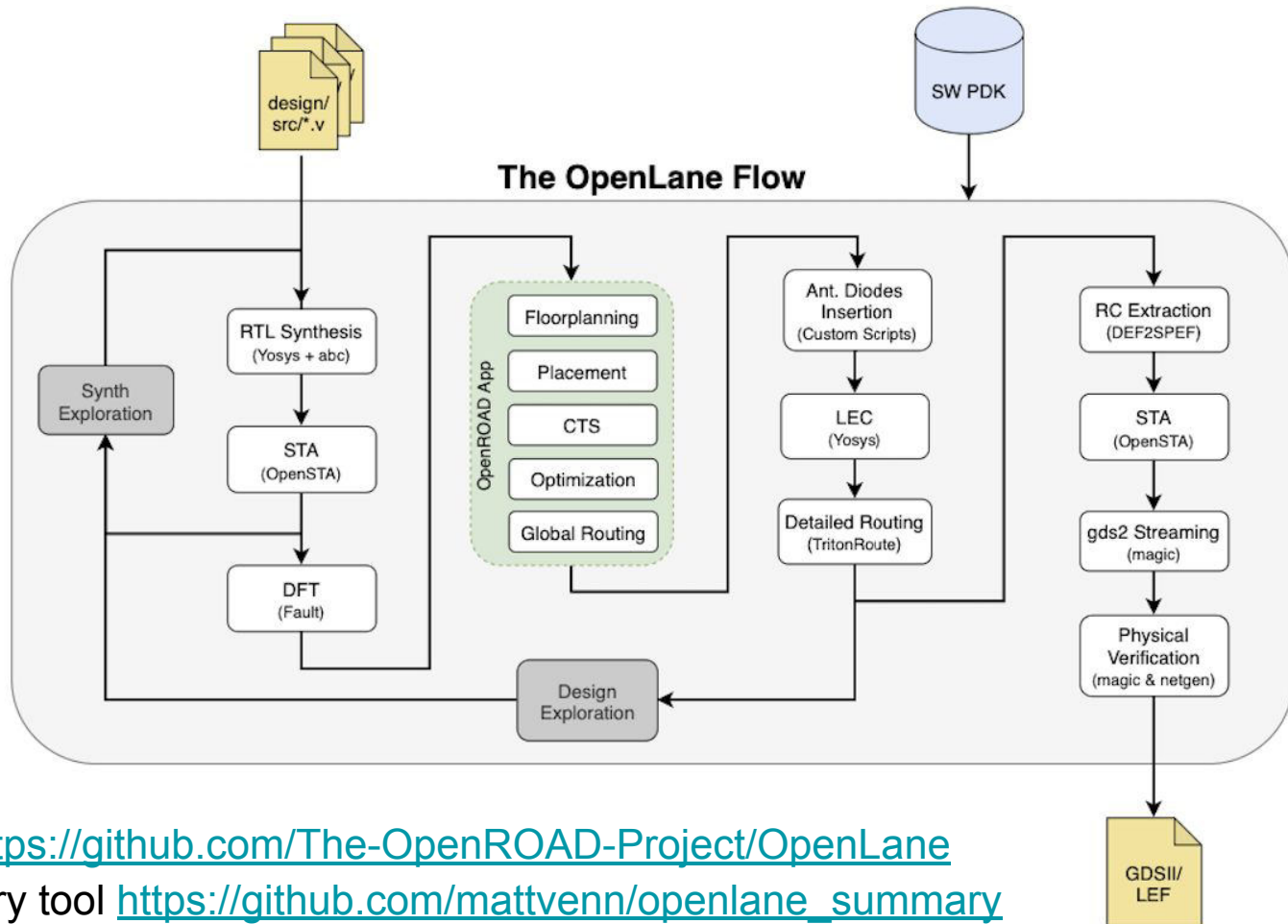
# RISCV by base (excluding PicoRV32)



# How to get your CPU onto silicon - **demo**

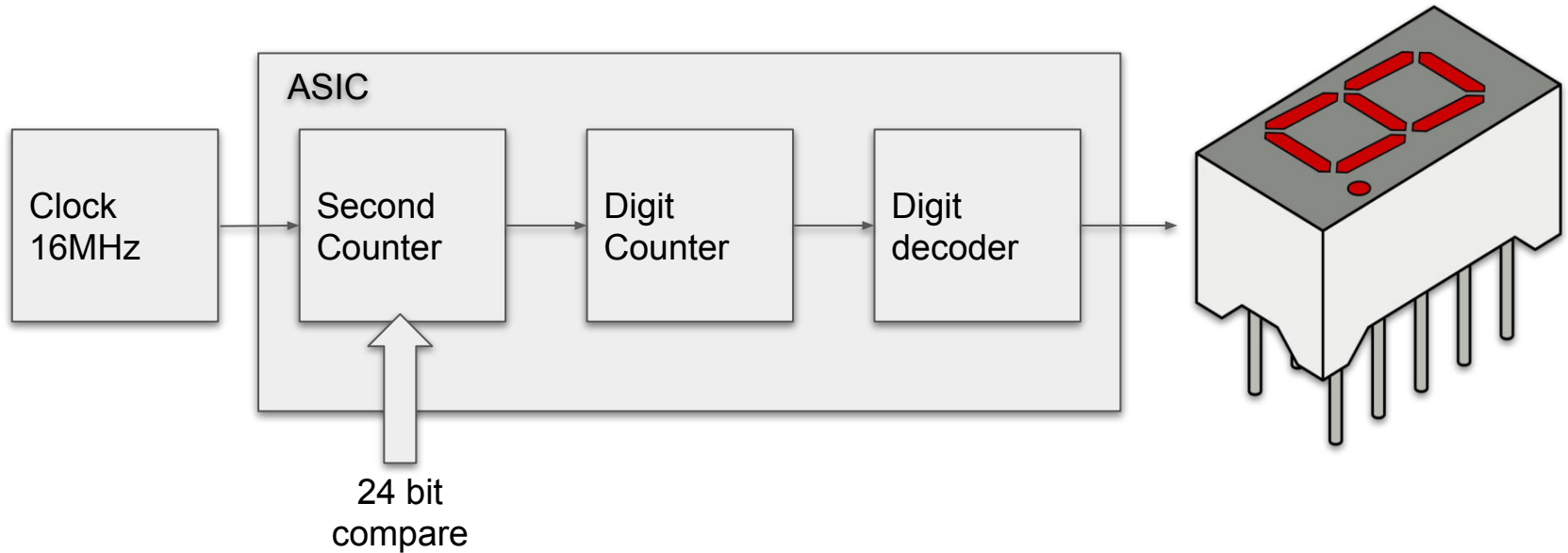


[https://www.youtube.com/watch?v=MNuoYz\\_MM-c](https://www.youtube.com/watch?v=MNuoYz_MM-c)



repo <https://github.com/The-OpenROAD-Project/OpenLane>  
 summary tool [https://github.com/mattvenn/openlane\\_summary](https://github.com/mattvenn/openlane_summary)

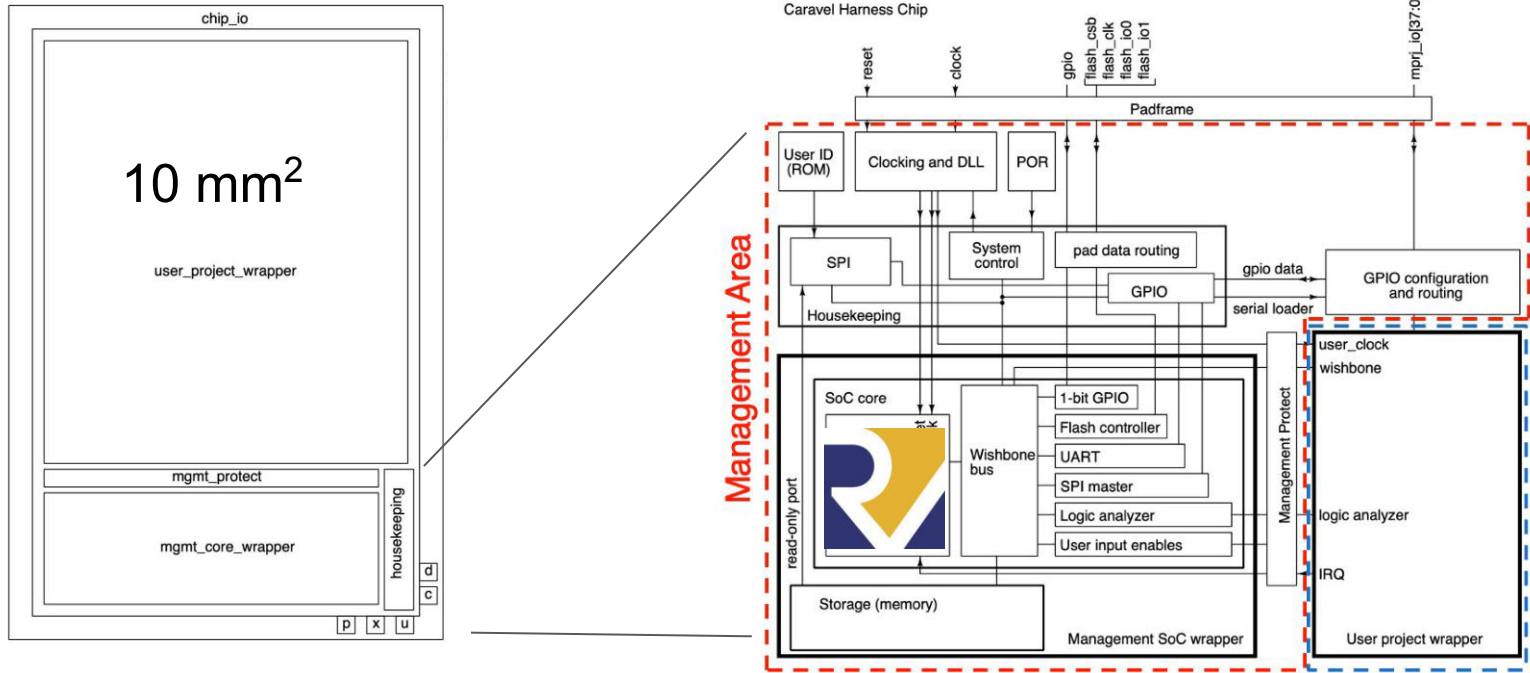
# Demo design - 7 segment seconds



- repo [https://github.com/mattvenn/seven\\_segment\\_seconds](https://github.com/mattvenn/seven_segment_seconds)
- blog post on the working ASIC <https://www.zerotoasiccourse.com/post/mpw1-bringup/>



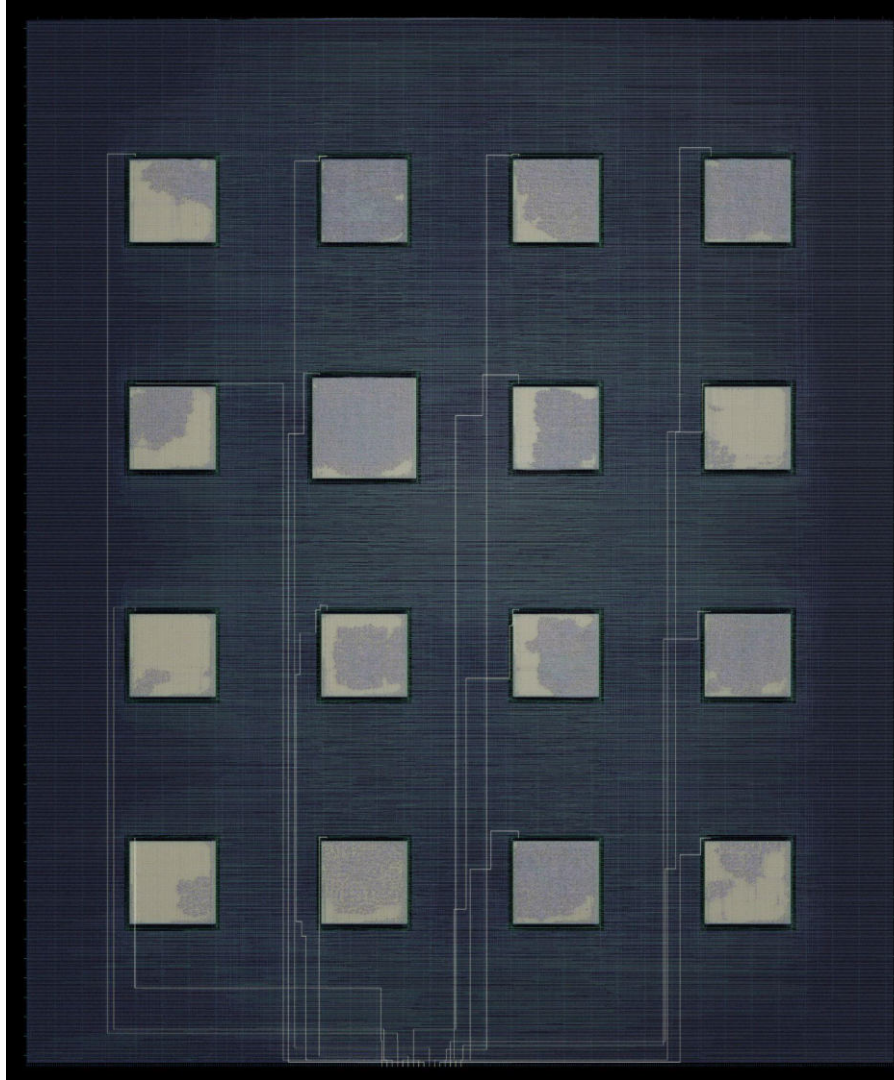
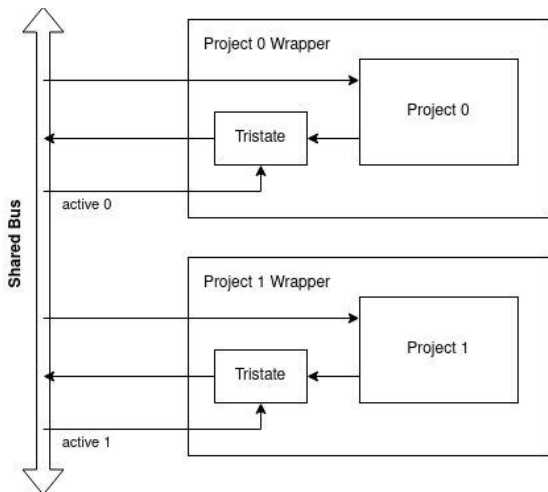
# Making a submission to [Efabless](https://efabless.com)



<https://caravel-harness.readthedocs.io/en/latest/>

# Multi Project Tools

- [https://github.com/mattvonn/multi\\_project\\_tools](https://github.com/mattvonn/multi_project_tools)
- Project outputs isolated with tristate buffers
- Projects are activated by firmware
- Each project has around 300 x 300 um
- Used to submit 70 designs by 35 people across 5 shuttle runs

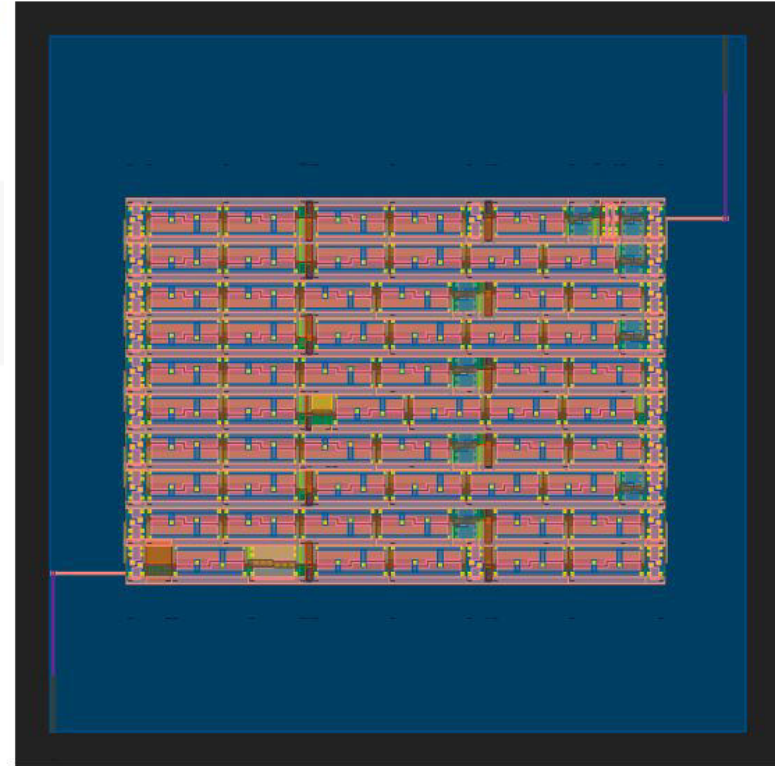


# ASIC tools in the cloud

- [CMOS simulation](#)
- [OpenLane](#)
- Follow [Proppy on twitter](#)

```
import pathlib
import gdstk
import IPython.display
```

```
gdss = sorted(pathlib.Path('/content/runs').glob('*/*results/final/gdss')).pop()
library = gdstk.read_gds(gdss[-1])
top_cells = library.top_level()
top_cells[0].write_svg('inverter.svg')
IPython.display.SVG('inverter.svg')
```



```
import matplotlib.pyplot as plt
```

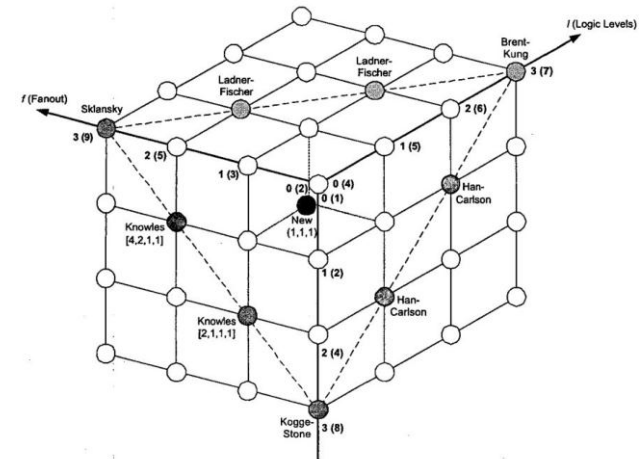
```
fig, ax = plt.subplots(figsize=(20, 10))
ax.set_title('sky130_fd_sc_hd_nand2_1')
ax.set_xlabel('time in 1e-14s')
ax.set_ylabel('voltage in V')
ax.plot(analysis.A)
ax.plot(analysis.B)
ax.plot(analysis.Y)
ax.legend(('A', 'B', 'Y'))
plt.tight_layout()
plt.show()
```

sky130\_fd\_sc\_hd\_nand2\_1



# Optimising hardware adders

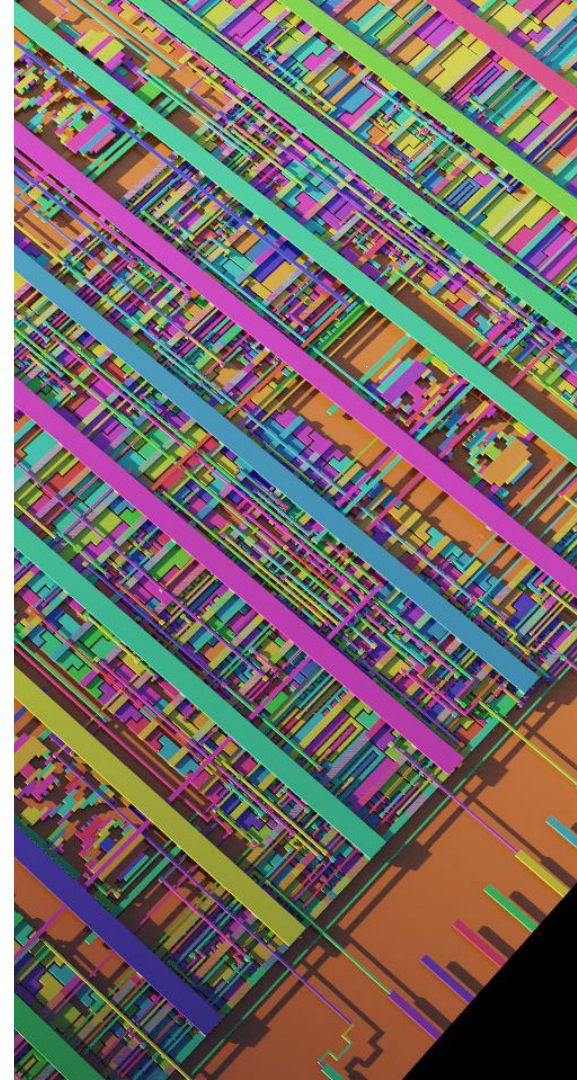
- When a RISC-V processor boots into Linux, [65% to 72% of instructions use addition](#)
- Teo's work allows us to create specific adders targeting a specific PPA
- We are [instrumenting the adders](#) and taping out on MPW6
- Follow [Teo on twitter](#)





# Community growth

- 3k Skywater slack members on 120 channels
- Join <https://join.skywater.tools/>
- 450 stars on OpenLane github repo
- 2k stars on Skywater PDK repo
- 450 public projects with design/GDS on [Efabless website for MPW 1 to 5](#)



# Get involved!

- Documentation
- Contribute to EDA software
- Next tapeout is MPW6 in June, 7 & 8 later this year

# Connect with me!

- Slides <https://bit.ly/riscv-japan-2022>
- Newsletter  
<https://www.zerotoasiccourse.com/newsletter/>
- Twitter [@matthewvnn](https://twitter.com/matthewvnn)
- Linked.in <https://www.linkedin.com/in/matt-venn/>

