CNC and 3D printing: open source all the way!

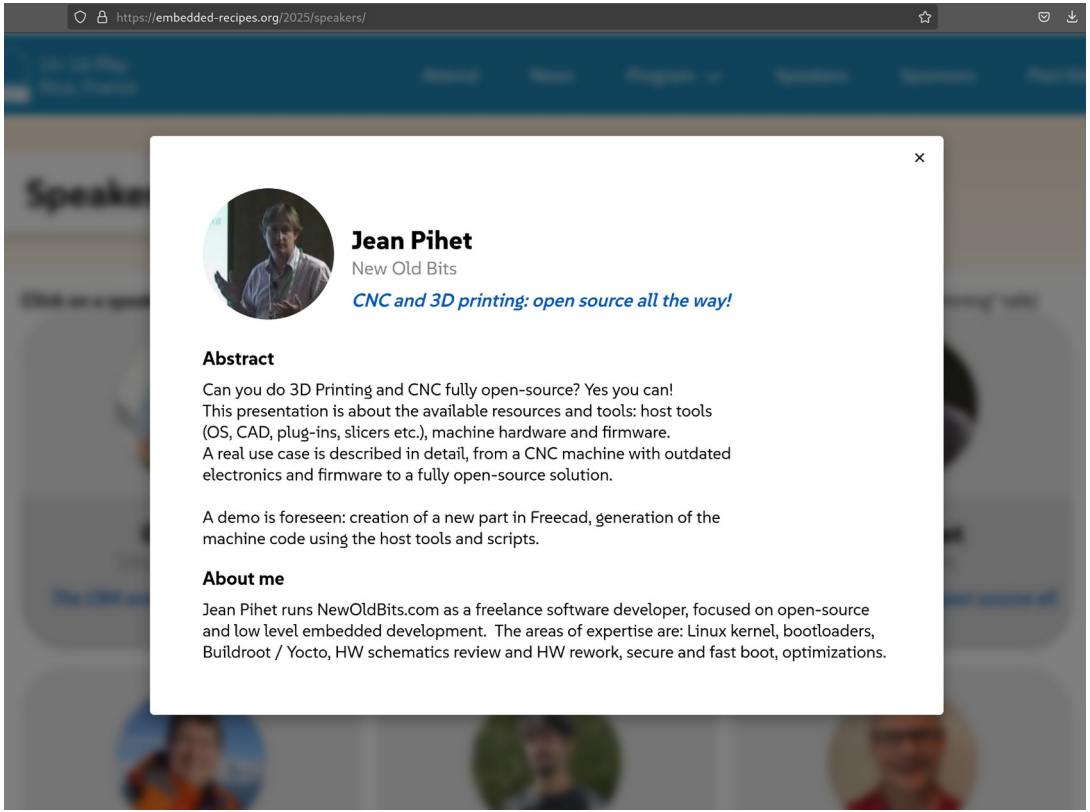
Jean Pihet

NewOldBits.com Consulting

mind an open source of wisdom

ToC

- Introduction
- 3D printing
- CNC
- Host tools
  - Overview
  - FreeCAD
- Demo host tools for CNC
  - FreeCAD and scripts



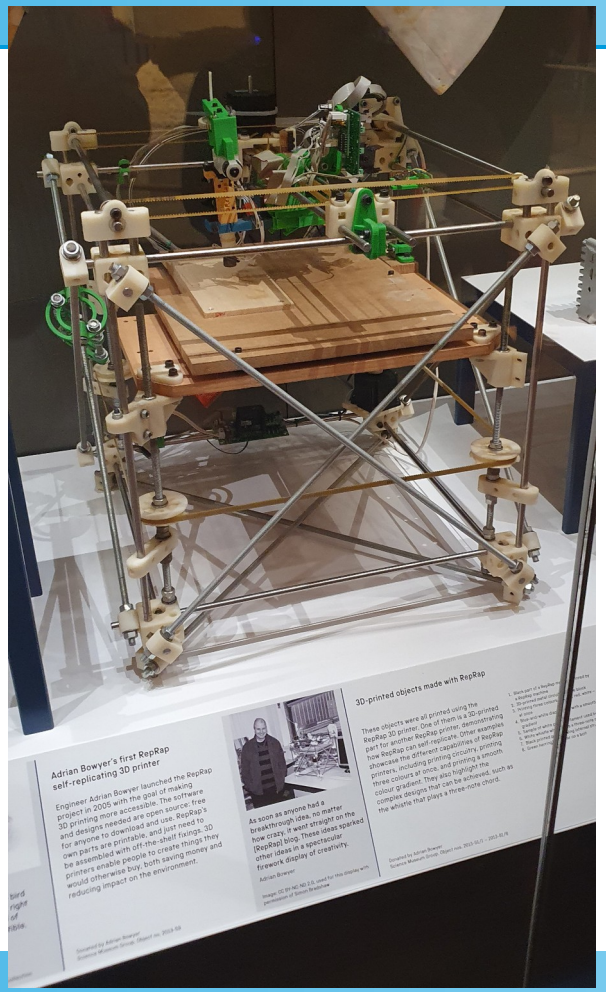
Introduction

- Needs for 3D and CNC
  - FDM 3D printer, multi material, fast, 24/7
  - Light CNC: 3 axes, manual tool change and oiling
- Starting point
- Tools
- FreeCAD oriented

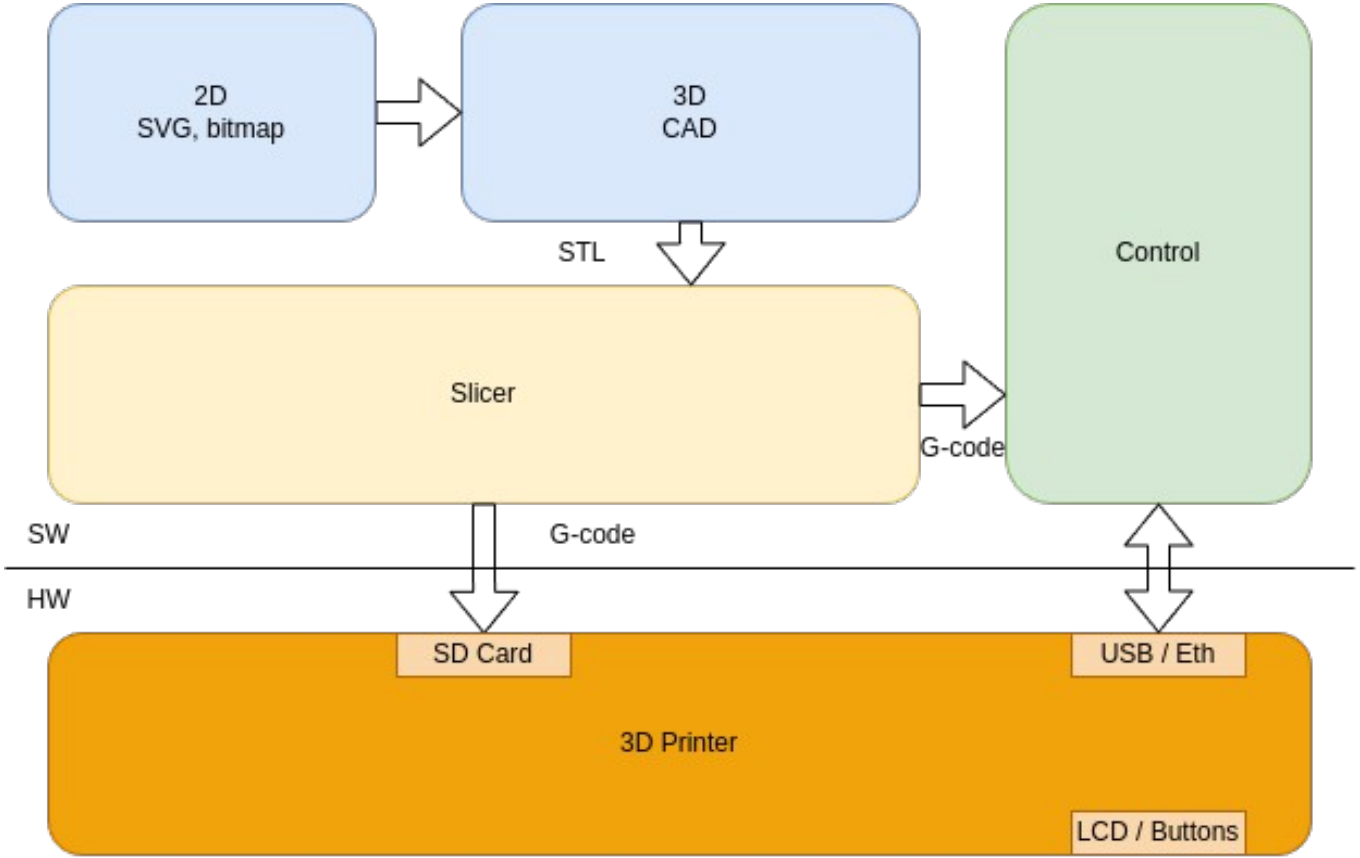
3D printing - History

- 2005 Reprap: self replicating
- 2010 1st Prusa Mendel
- 2011 Ultimaker
- 2011 Marlin FW
- 2015 Prusa i3, printing farm

- Open source
  - FW: Sprinter, grbl, Marlin. Klipper
  - Electronics & HW: main board, extruder, heat & level bed
  - Host tools: Slic3r, PrusaSlicer, Ultimaker Cura. OctoPrint
  - Models: Printables.com, Thingiverse

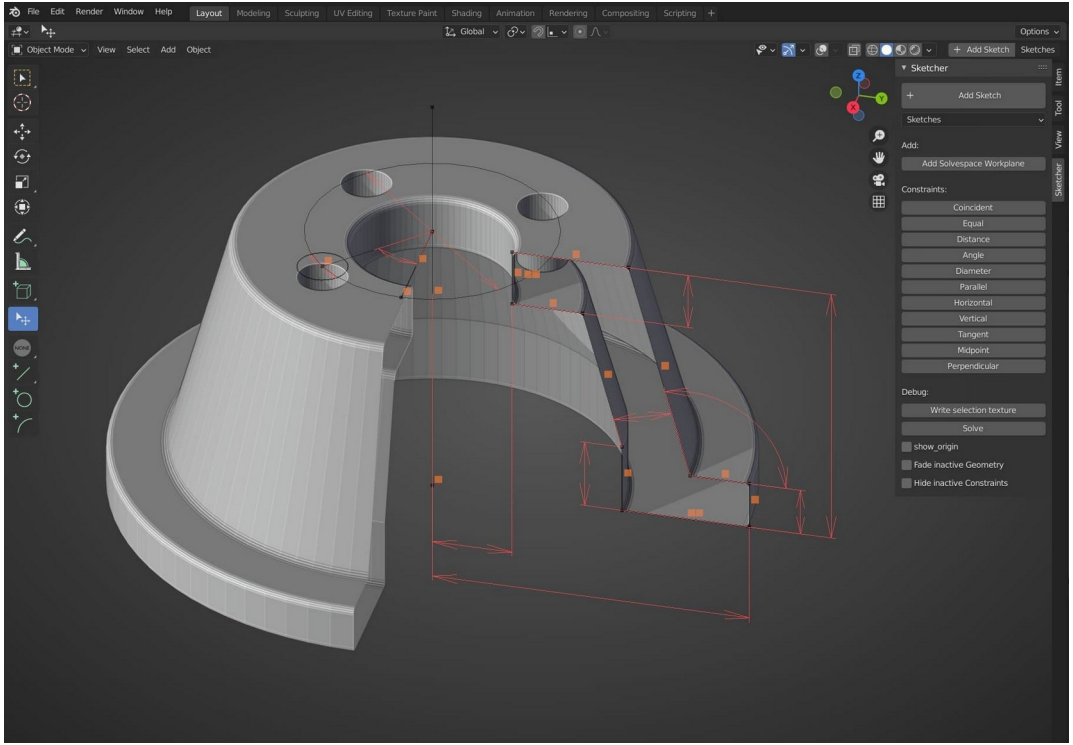


3D printing – Host tools



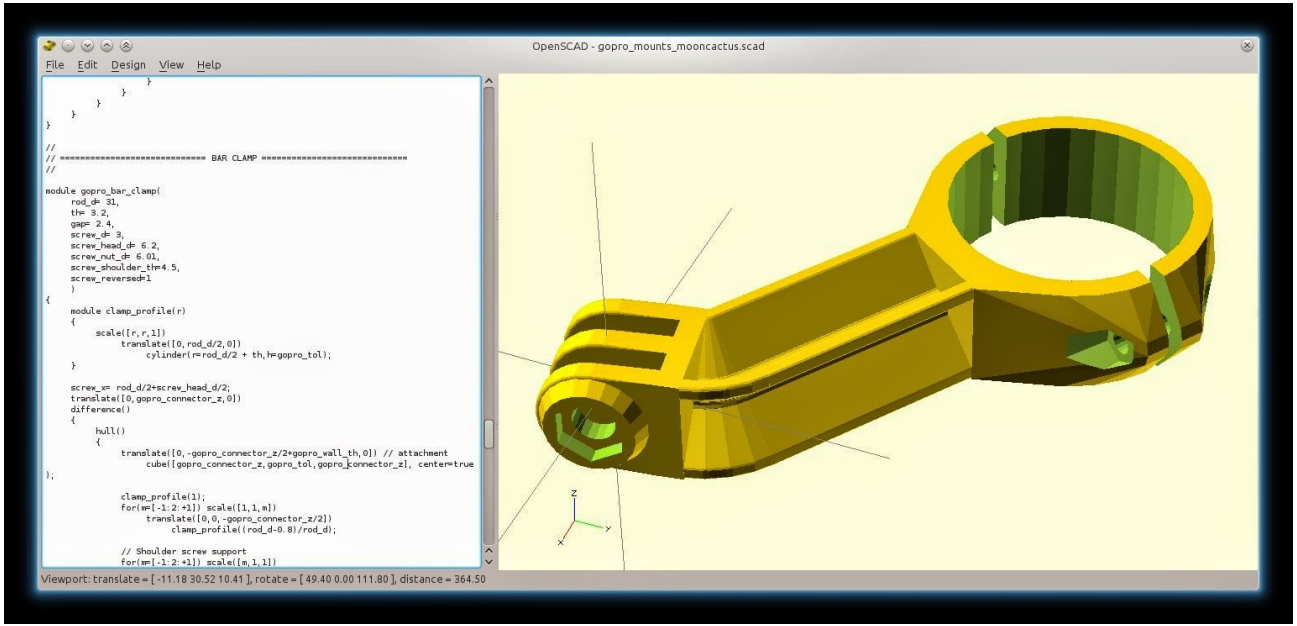
3D printing – Host tools

- 2D
  - Gimp, Inkscape: vectorize bitmap, drawing
- CAD: Blender
  - Originally for artwork and animation but useful for CAD
  - Lots of features
  - Destructive vs non-destructive modelling



3D printing – Host tools

- CAD: OpenSCAD
  - script based
  - parametric
  - DXF, STL, OFF
  - Libraries available



3D printing – Host tools

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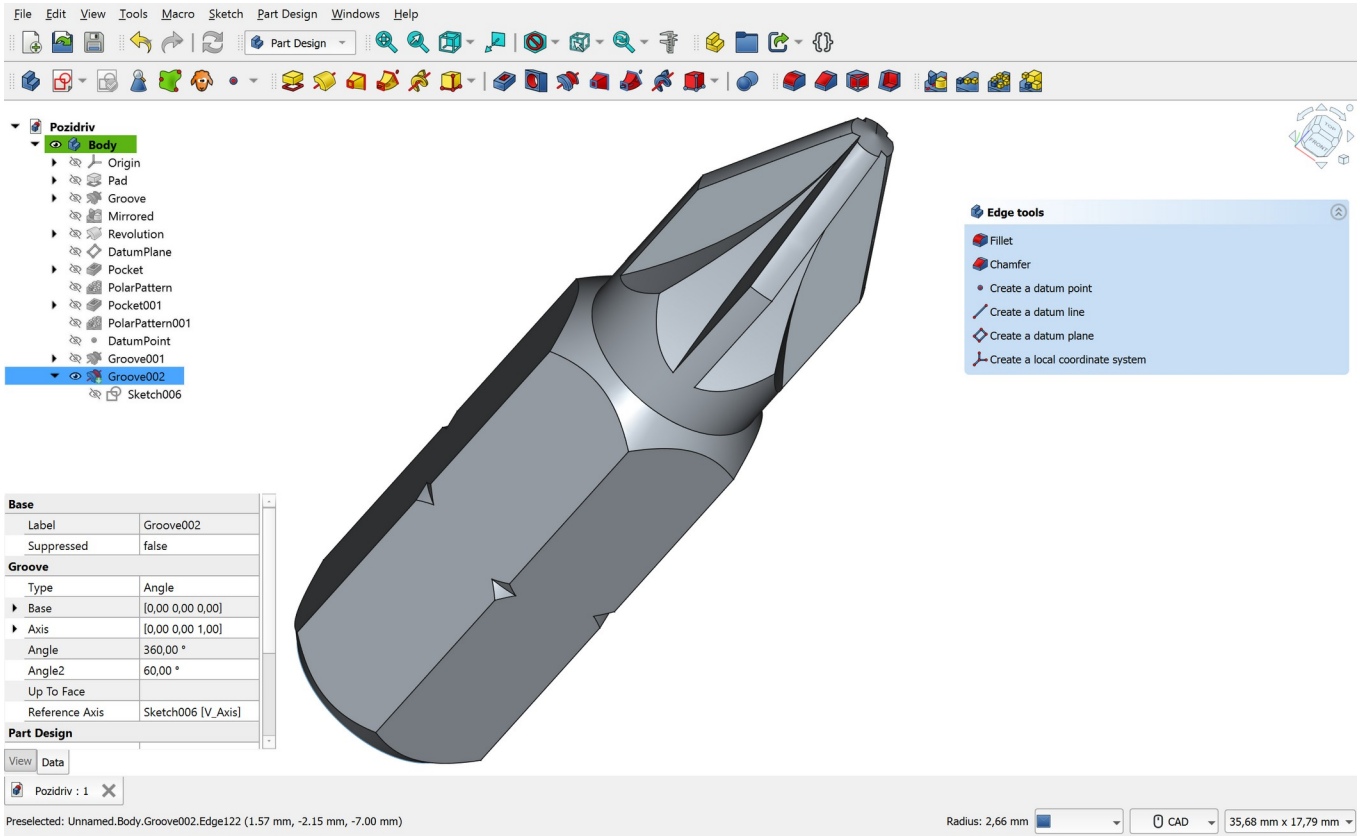
- CAD: FreeCAD
  - One-stop shop
  - Modules
    - Sketch
    - Model
    - Part
    - Assembly
    - CAM (→ CNC)
    - Workbench
  - Python API
  - Mature 0.19 - 1.0



3D printing – Host tools

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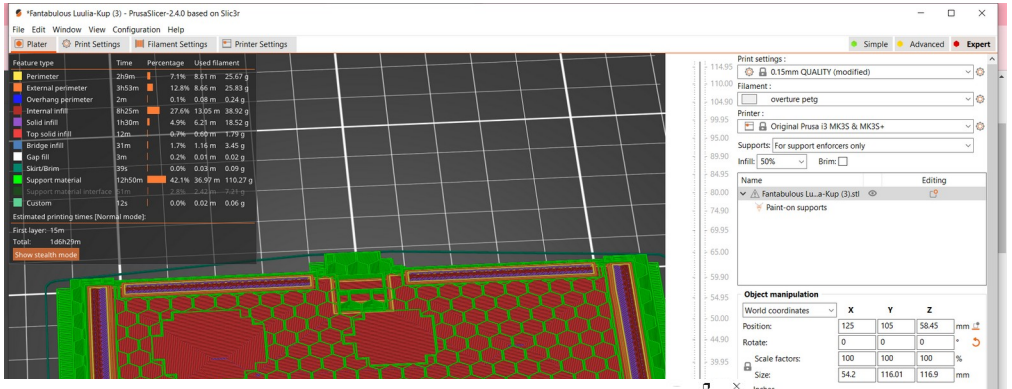
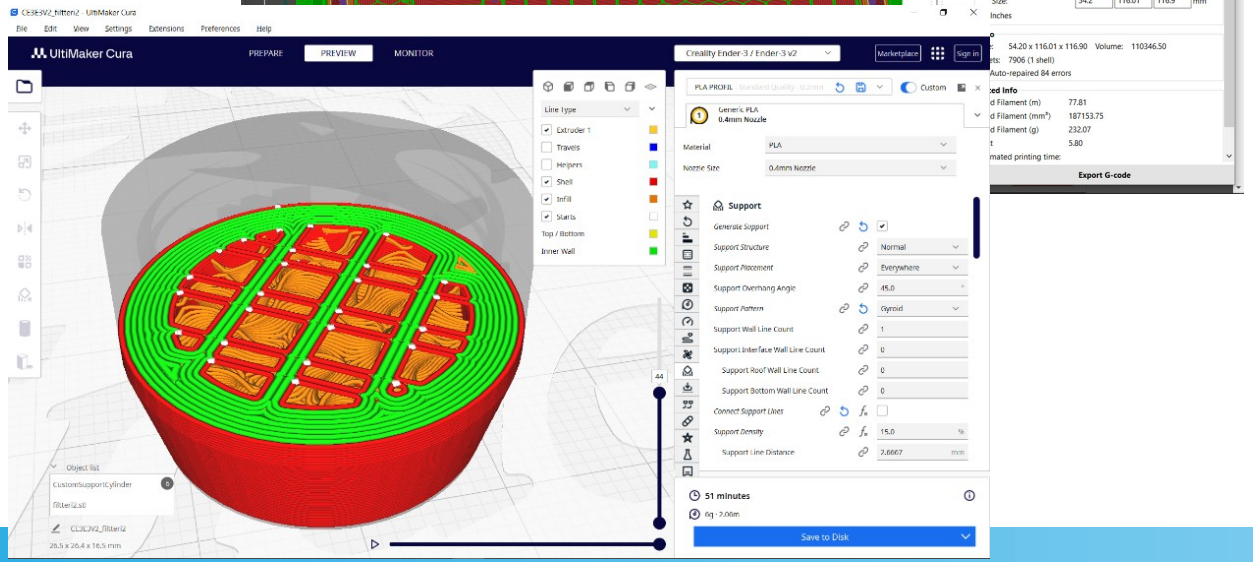
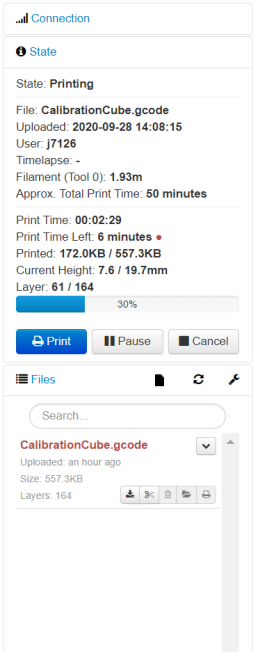
- Slicer: 3D → G-code
  - PrusaSlicer
  - Ultimaker Cura
  - Exotic slicers: S4_slicer, Infinite Z

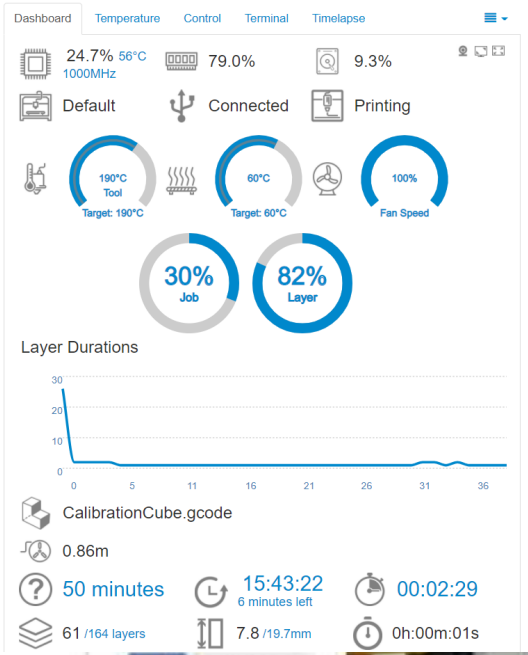


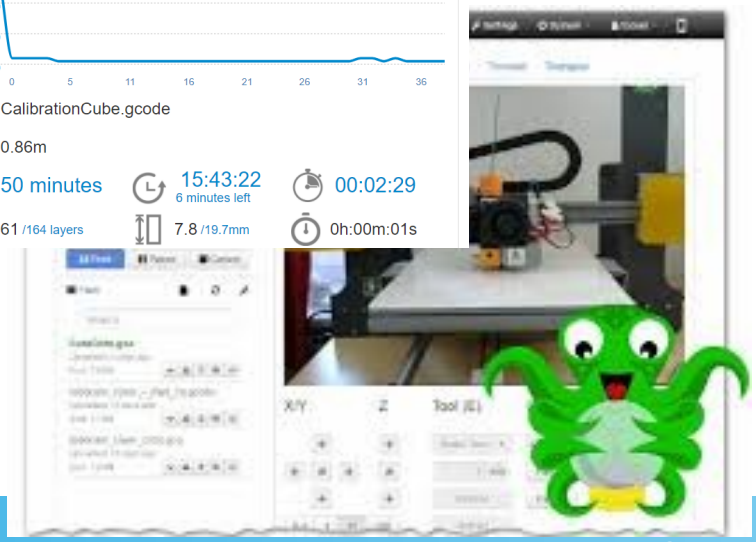


3D printing – Host tools

- Control
  - Setup and maintenance
  - Monitoring, logging
  - Image and videos, timelapse
  - Advanced features via plug-ins
  - Web server, manage files
  - Firmware / Control
    - Marlin / OctoPrint

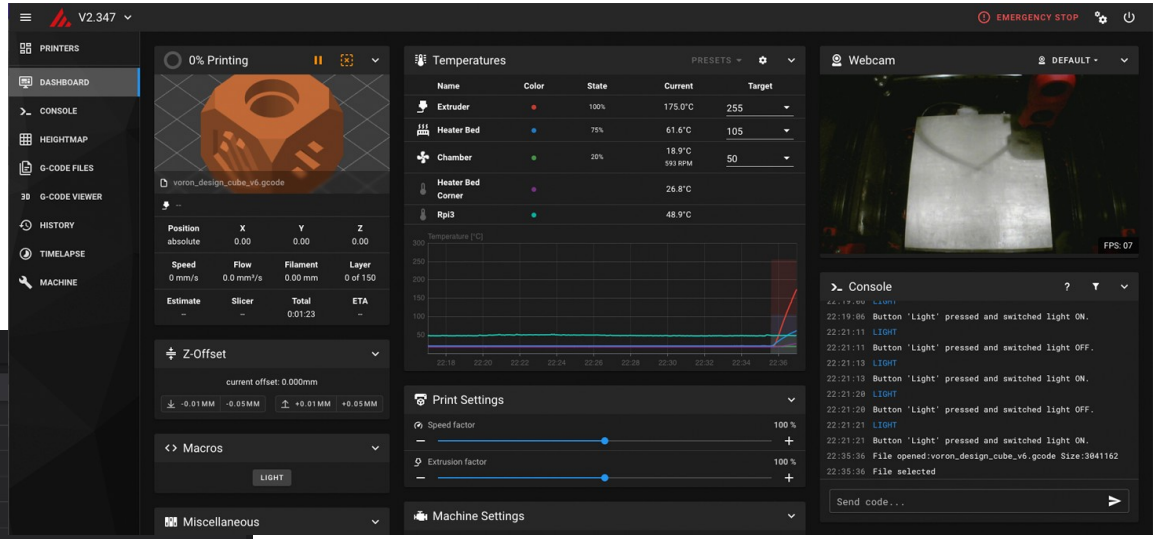


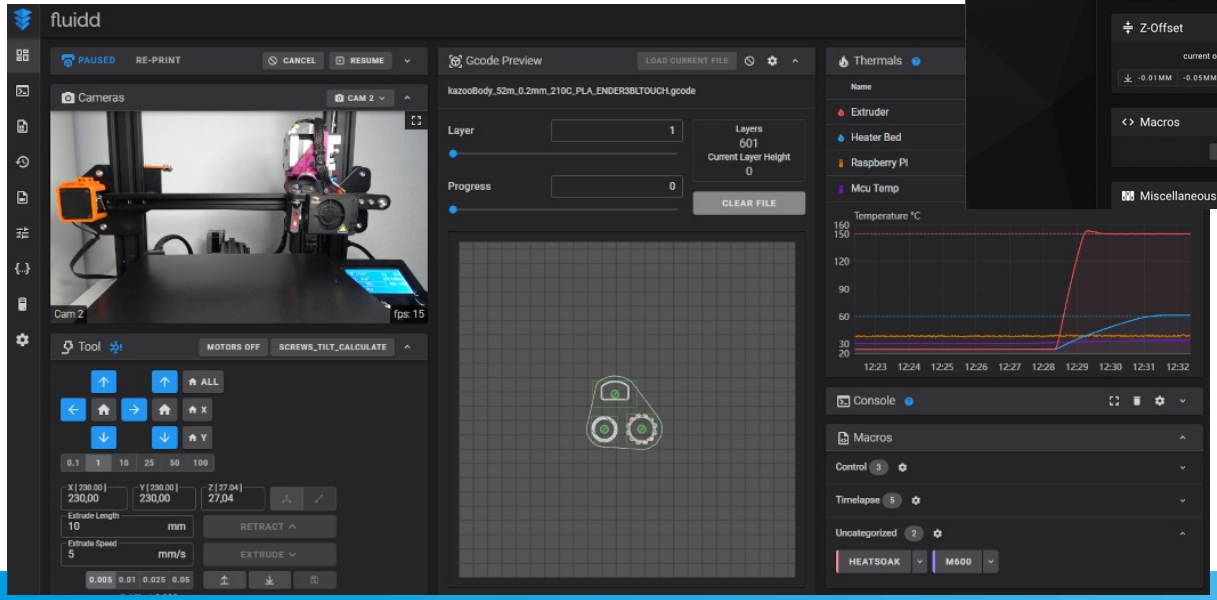




3D printing – Host tools

- Control
  - Firmware / Control
    - Klipper / Mainsail - Fluidd

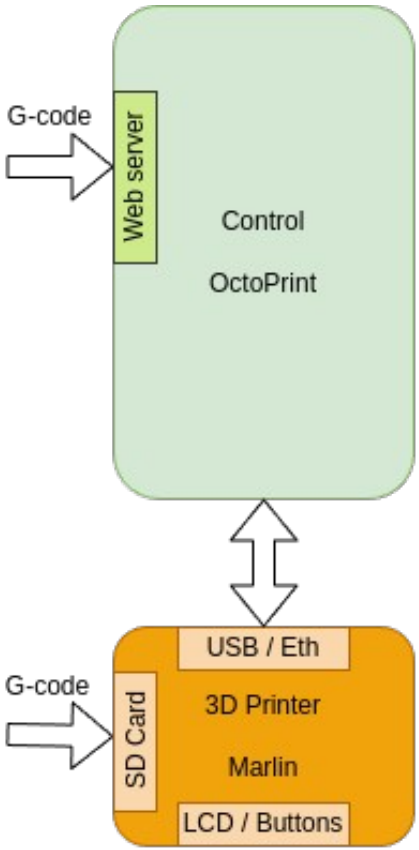




3D printing – Firmware

- Marlin
  - G-code handling: perform computation, run UI & RT tasks
  - Simple to configure (.h), build and install
  - Well supported
- Klipper
  - Separates computation and UI (RPI) from RT tasks (printer board)
  - Requires RPI
  - More efficient: faster, precise
  - More advanced features, multi-printer
  - Easy to configure without re-install

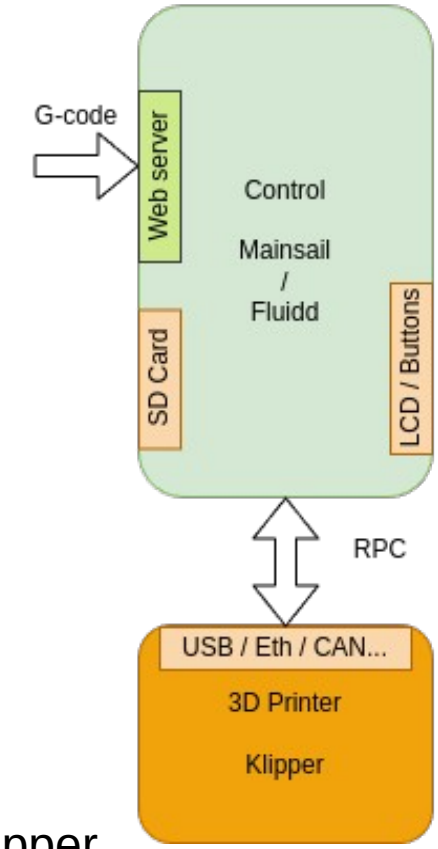
3D printing – Firmware



- Webserver
  - G-code
  - control
  - Images & video
- G-code to printer

- G-code handling
- RT tasks
- UI via LCD / Butttons

Marlin



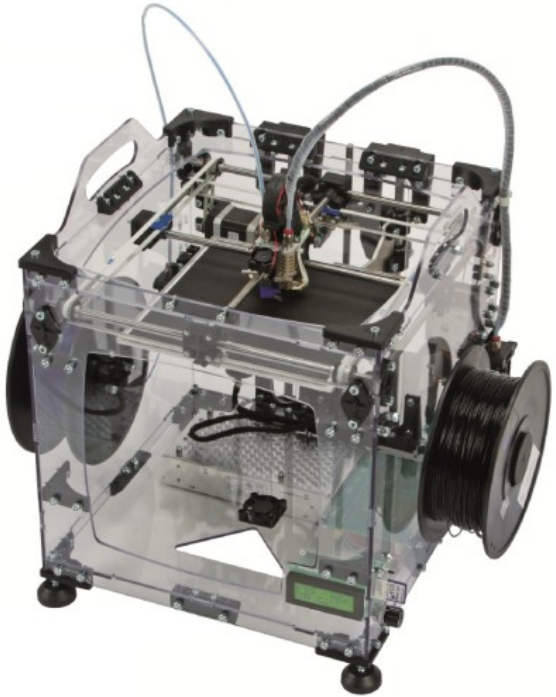
- Webserver
  - G-code
  - control
  - Images & video
- G-code handling
  - Computation
  - Optimization
- G-code generation (slicer)
- RPC to printer
- UI via LCD / Butttons

- RT tasks

Klipper

3D printing – Machine

- Lots of ‘open-source’ printers
- Velleman K8400

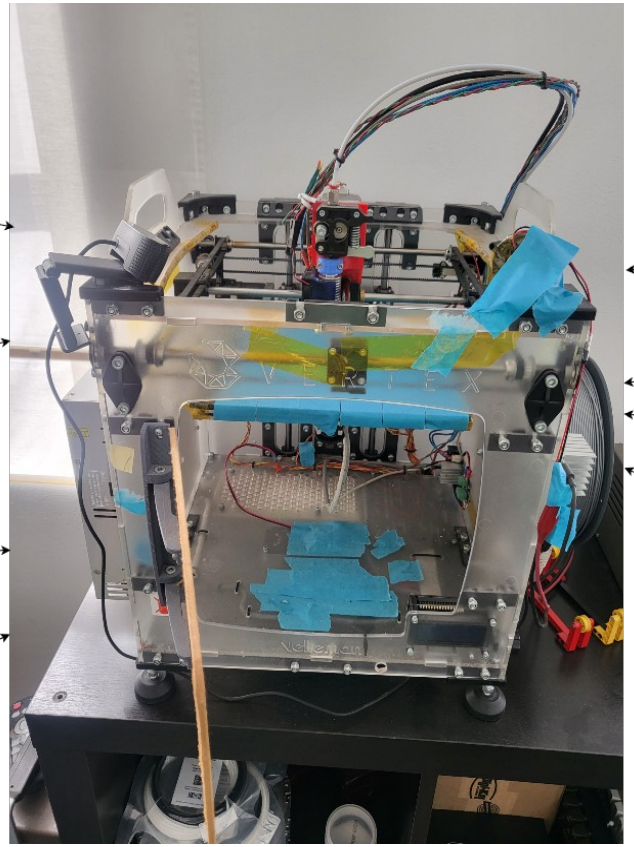


Re-designed head
- E3Dv6
- On-board extruder motor
- High-perf heater
- Thermocouple

Camera

Highly optimized heat flow

4 power supplies



Bed fan

Heated bed 24V

Optmized Z axis

RPI / OctoPrint

3D printing – Machine

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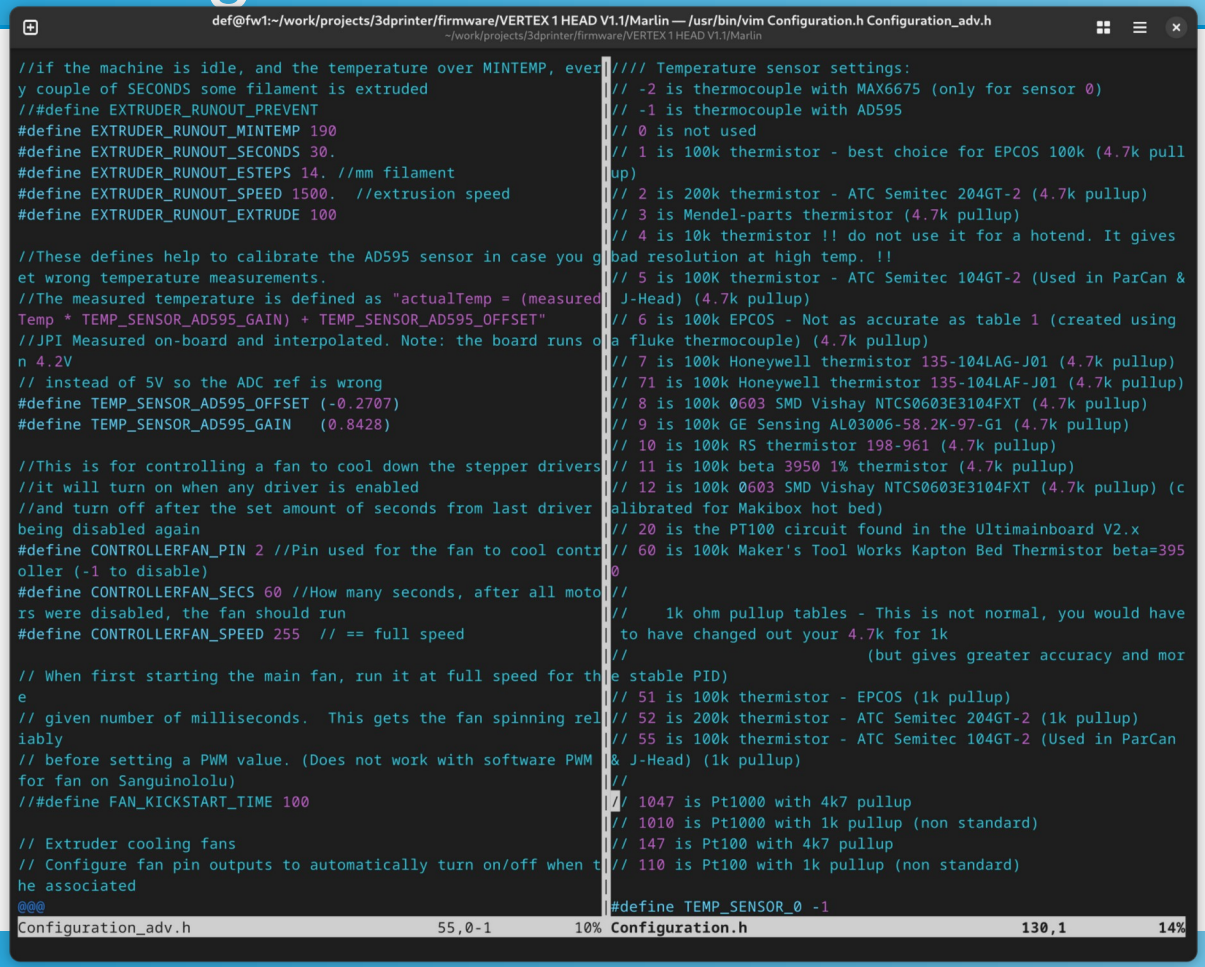
- Hacked for:
  - Robustness
  - Print speed
  - Print size
  - High Temp, multi mat.
  - Better control, remote
- Patch on Marlin
  - 40 LOC ;-)



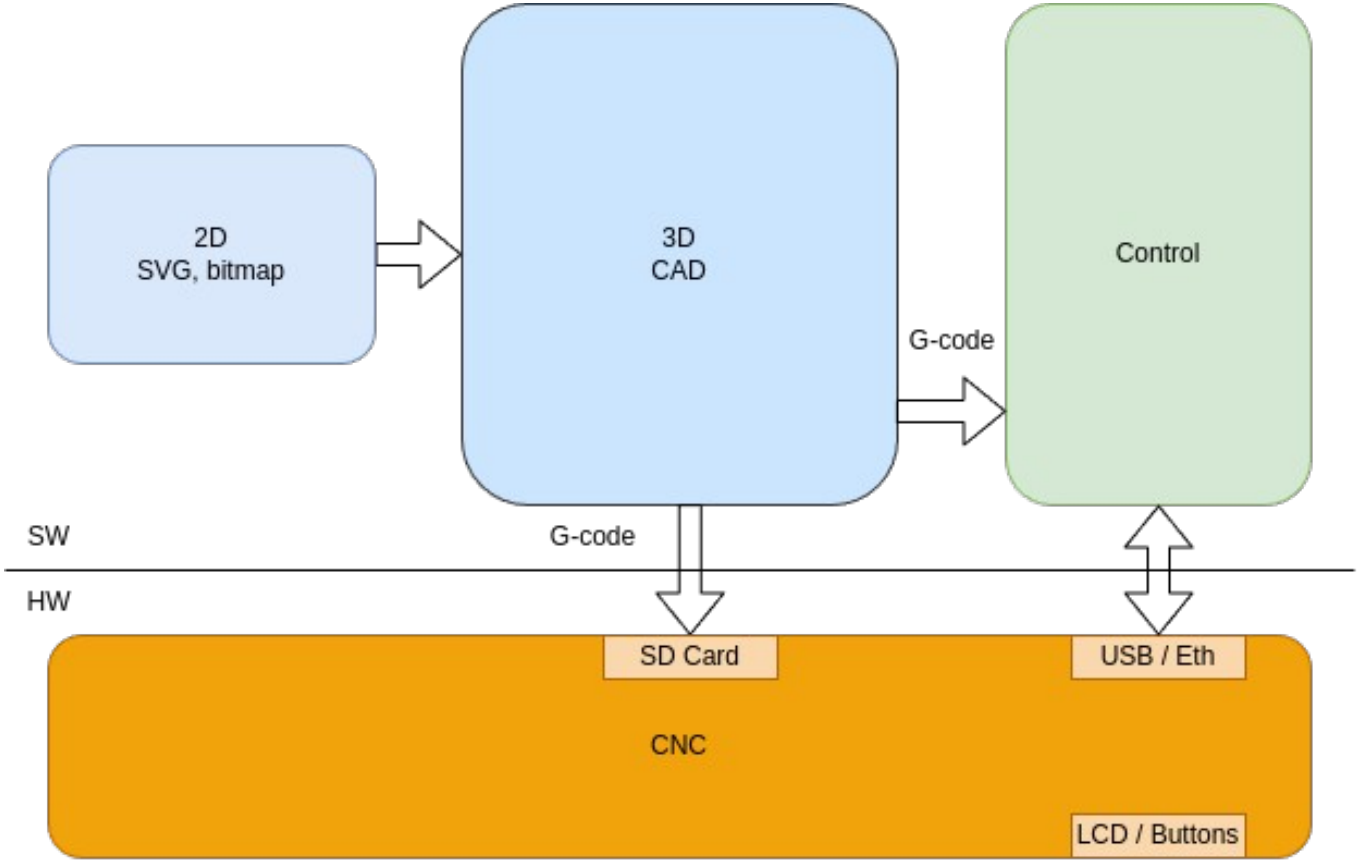
CNC

Differs from 3D Printing

- Less common
- Host tools CNC / CAM
- ‘Slicer’
- Interaction with model
- Start reference point

Similar to 3D Printing

- G-code export
- Control



CNC – Host tools

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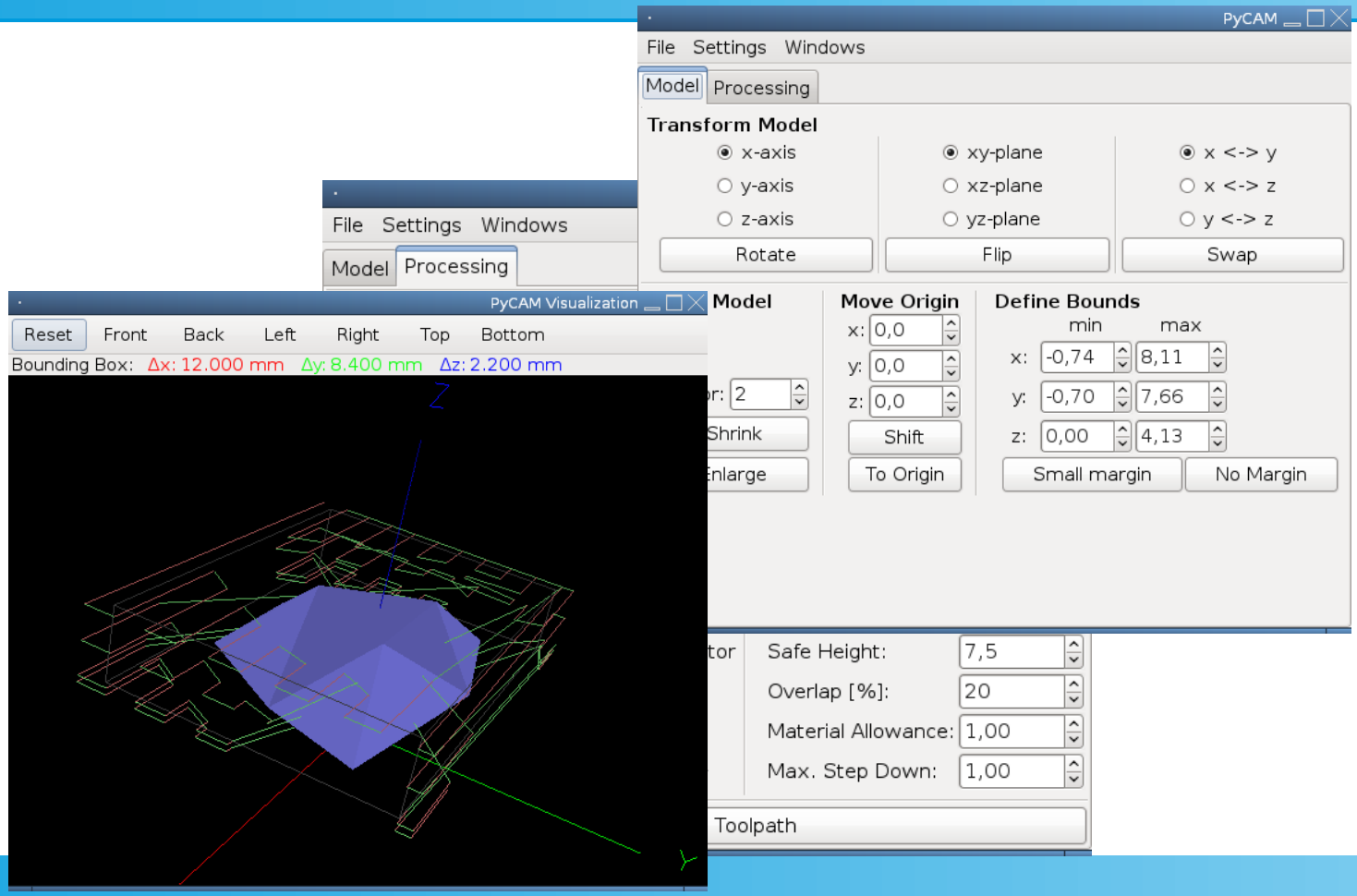
PyCAM

- Python app
- Basic CNC, text...
- Not maintained

Linux CNC dist.

CNC Toolkit

- Multi axis



CNC – Host tools

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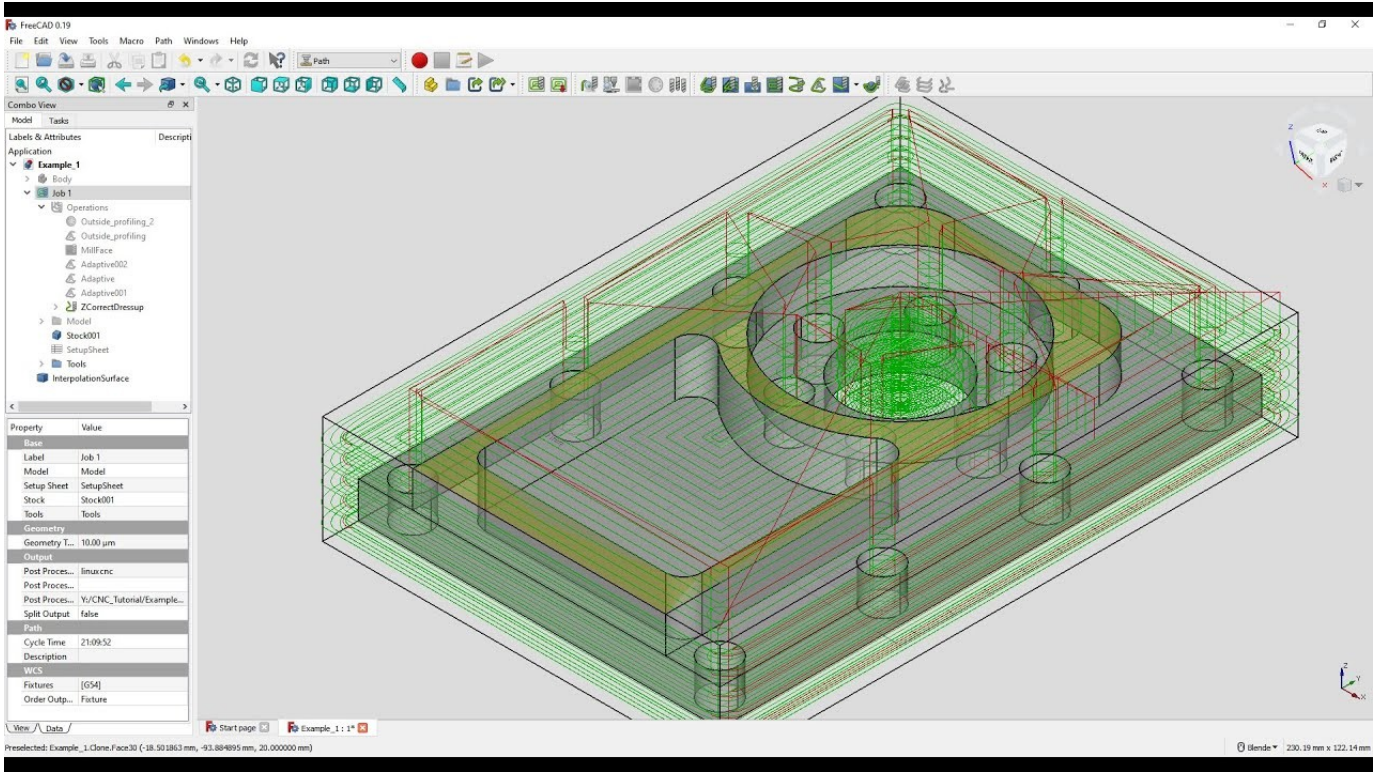
FreeCAD

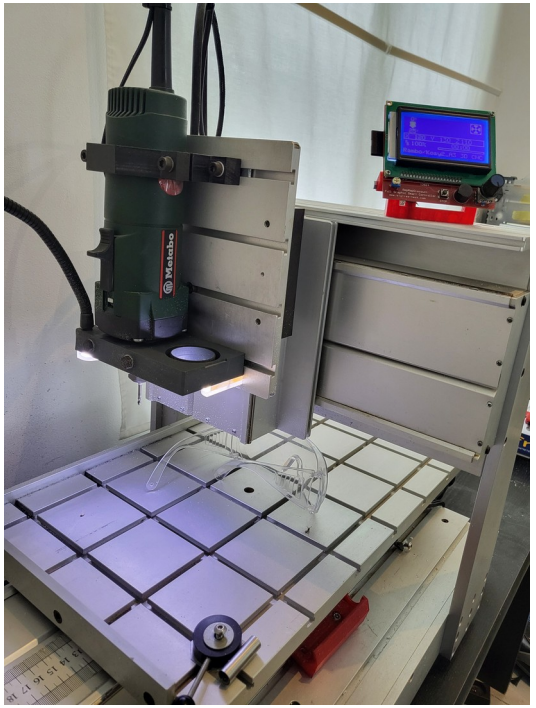
- One-stop shop
- CAM module
  - Profile / Contour
  - Drilling
  - Engraving
- Highly configurable
- Python scripting
- Mature

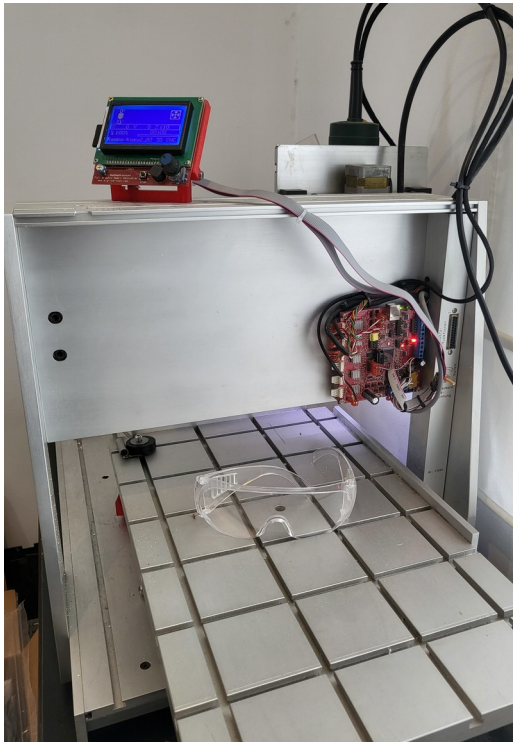


CNC – Machine

Kosy A3

- ~1992
- Robust HW & Electronics
  - Stepper motors, end stops
  - Power supply 24V
- Outdated mainboard, firmware
  - Non standard protocol
- Limited host tools
  - not open-source / free
  - OS





CNC – Machine

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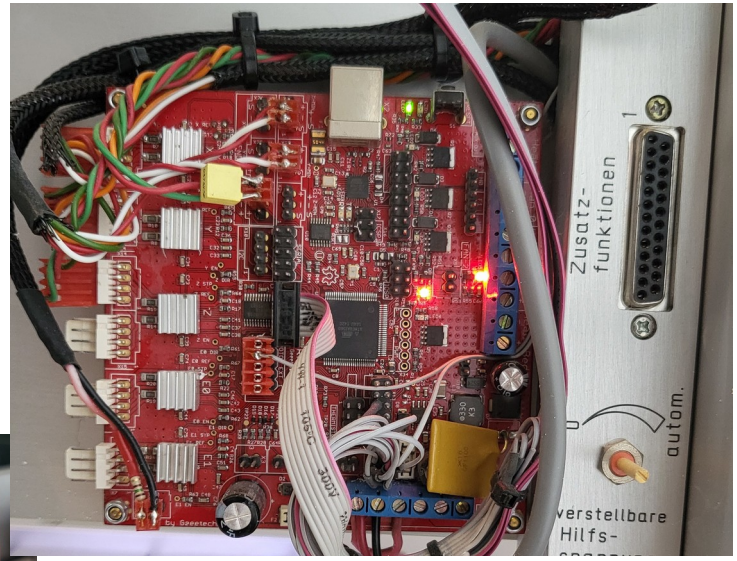
Solution

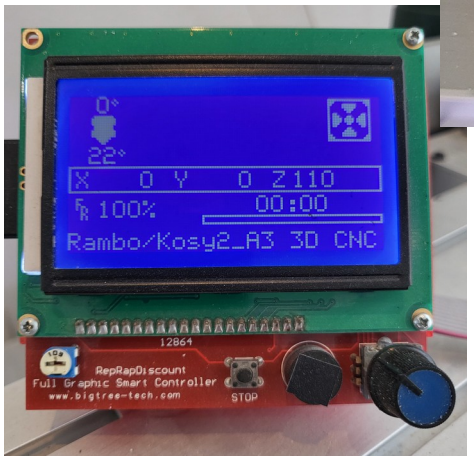
- Leverage HW & Electronics
- Leverage 3D Printing HW & firmware



Rambo board

- 24V
- Reprap / Arduino / Marlin
- USB

Reprap LCD / SD Card / Buttons



CNC – Firmware

Marlin - patch

- Main board
- Stepper motors: max current, resolution
- End stops / Bed size
- Spindle control
- LCD / SD / Buttons

- ~40 LOC ;-)
- Cf. github repo for scripts and doc

CNC – FreeCAD

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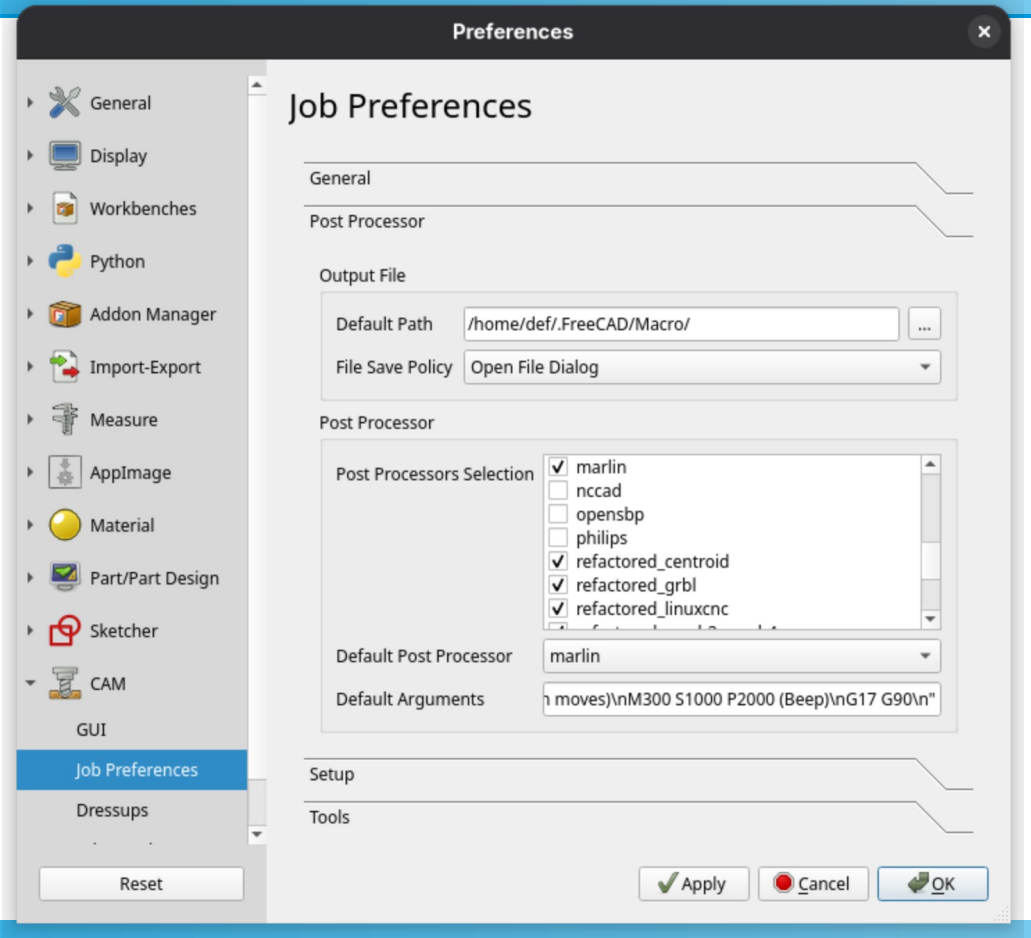
FreeCAD – Parameters & Scripts

- Pre and post-amble G-code
  - Start reference point G92
  - Spindle control M3 / M5
- Marlin G-code post-processor
  - ~/.FreeCAD/Macro/ marlin_post.py
  - Fixes for syntax, fast moves G0, units
  - Progress display



CNC – PCB with FreeCAD

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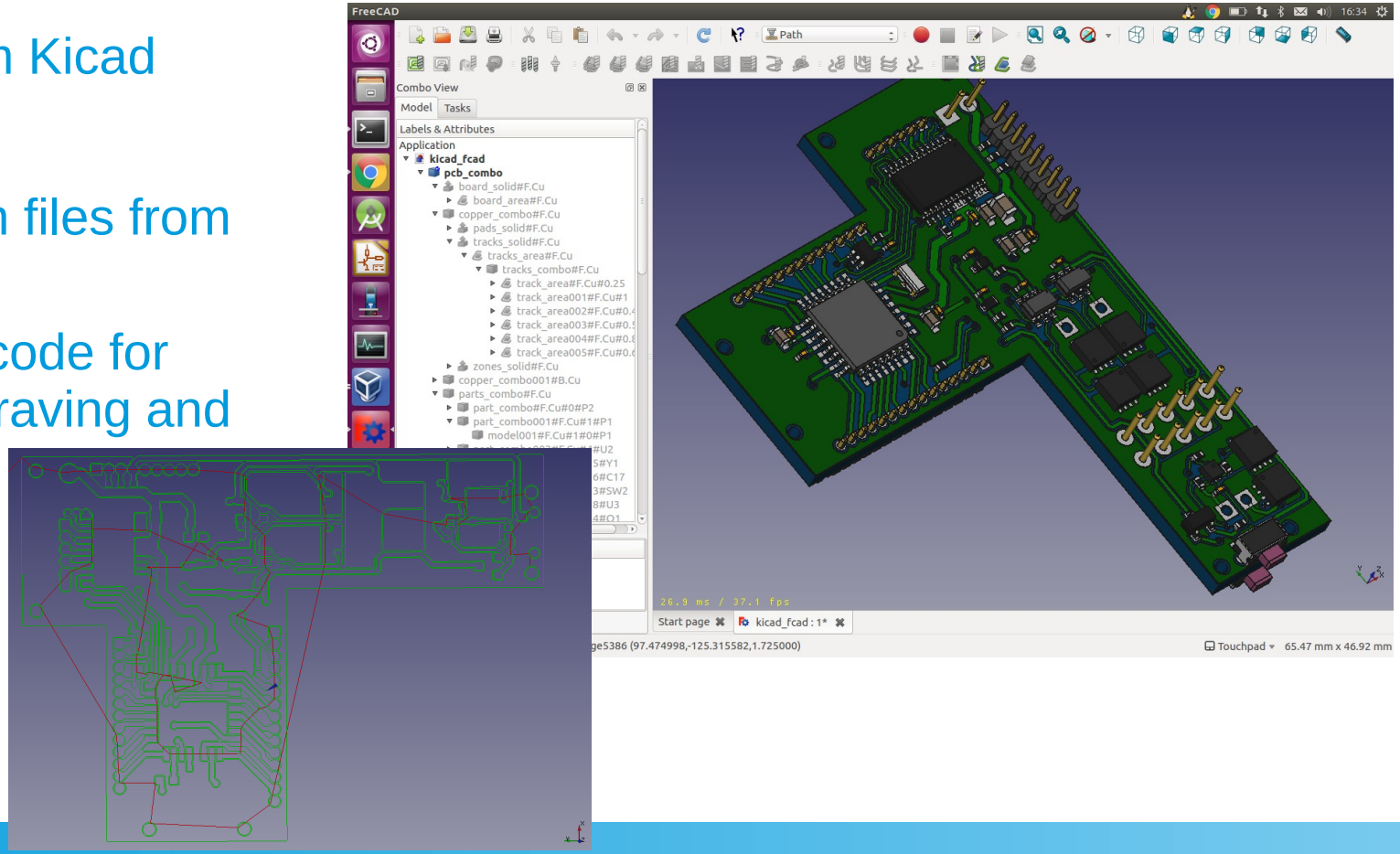
FreeCAD - PCB from Kicad

fcad_pcb plugin:

- Import design files from Kicad
- Generate G-code for profiling, engraving and drilling



Conclusion

Open source for 3D Printing

- Mature
- Robust - 24/7
- Fully featured
- Choice is key: printers, firmware, slicers, host tools

Open source for CNC

- Less common but still suppported
- Maturity > OK
- Solution for small companies: freedom, $

Demo – FreeCAD CNC

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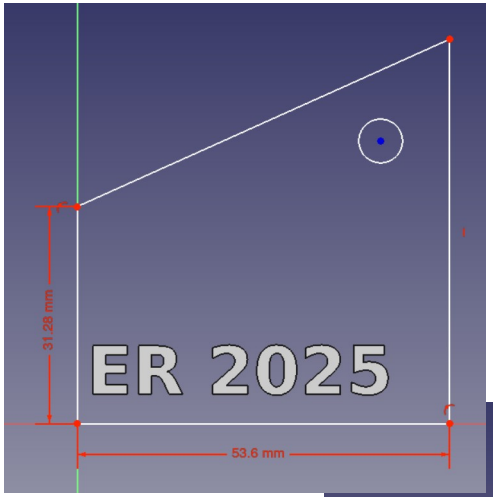
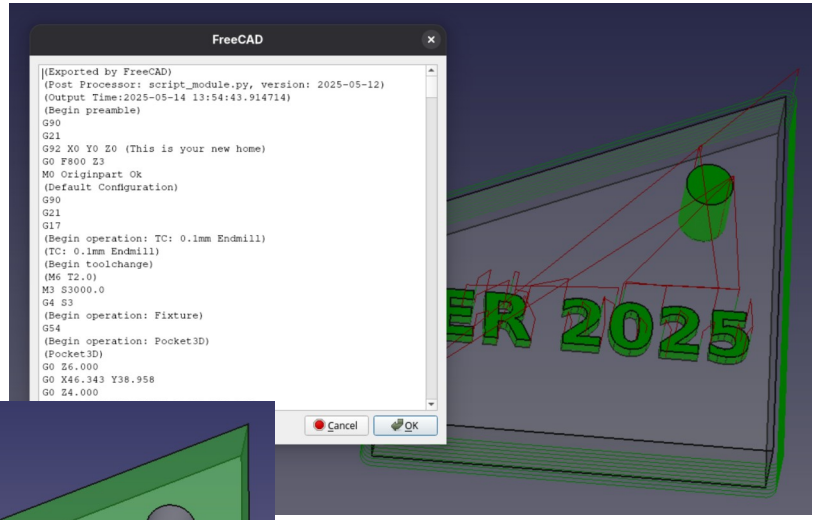
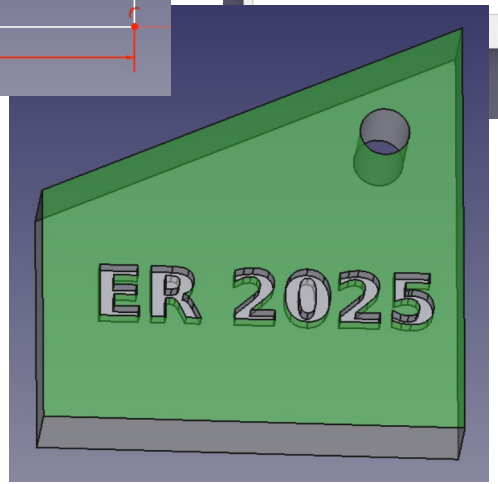
- Setup / parameters
- Sketch / Part
- CAM
  - Job
  - Tools
  - Operations: profile, engrave
  - Export G-code

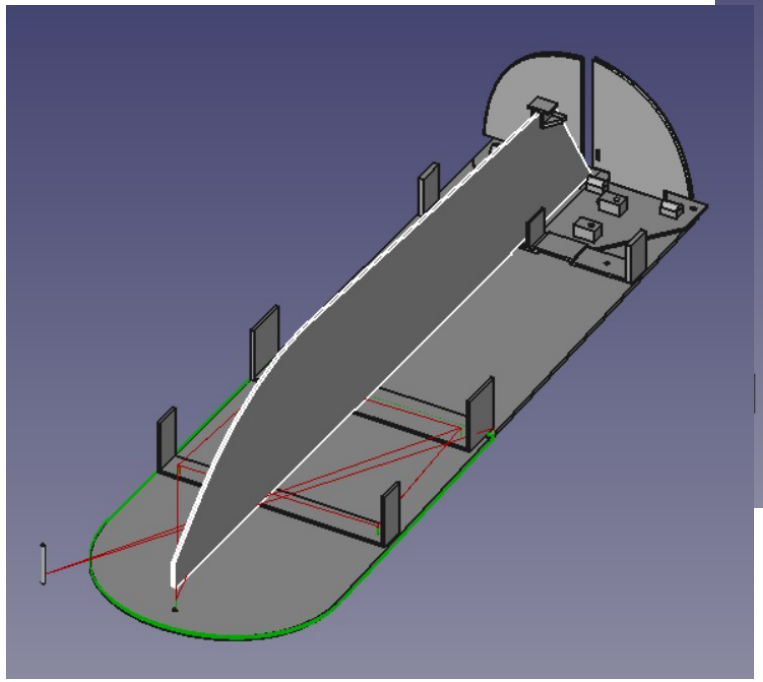


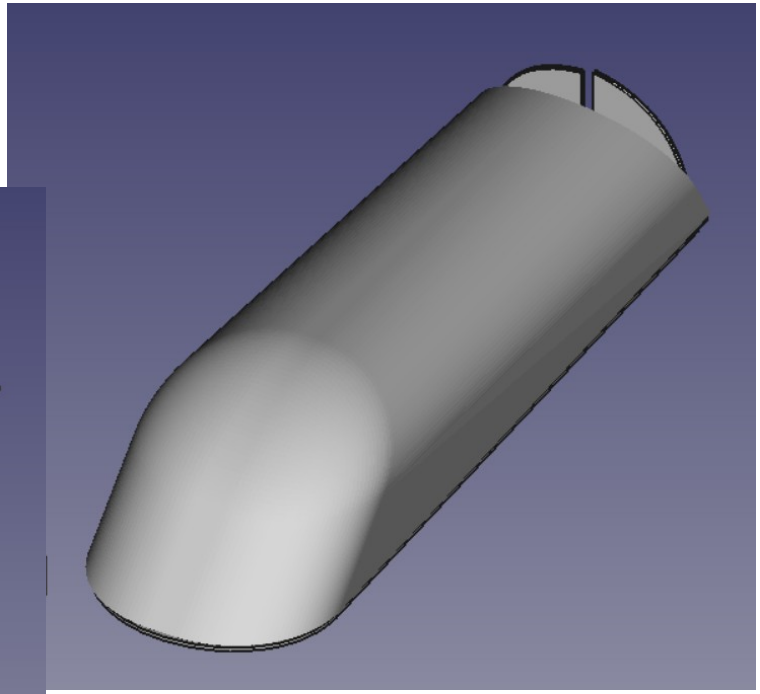




Demo – FreeCAD CNC

- Combination of 3D Printing & CNC





Questions

- Questions or remarks ?
- Other open-source CAD / CAM packages ?

References

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