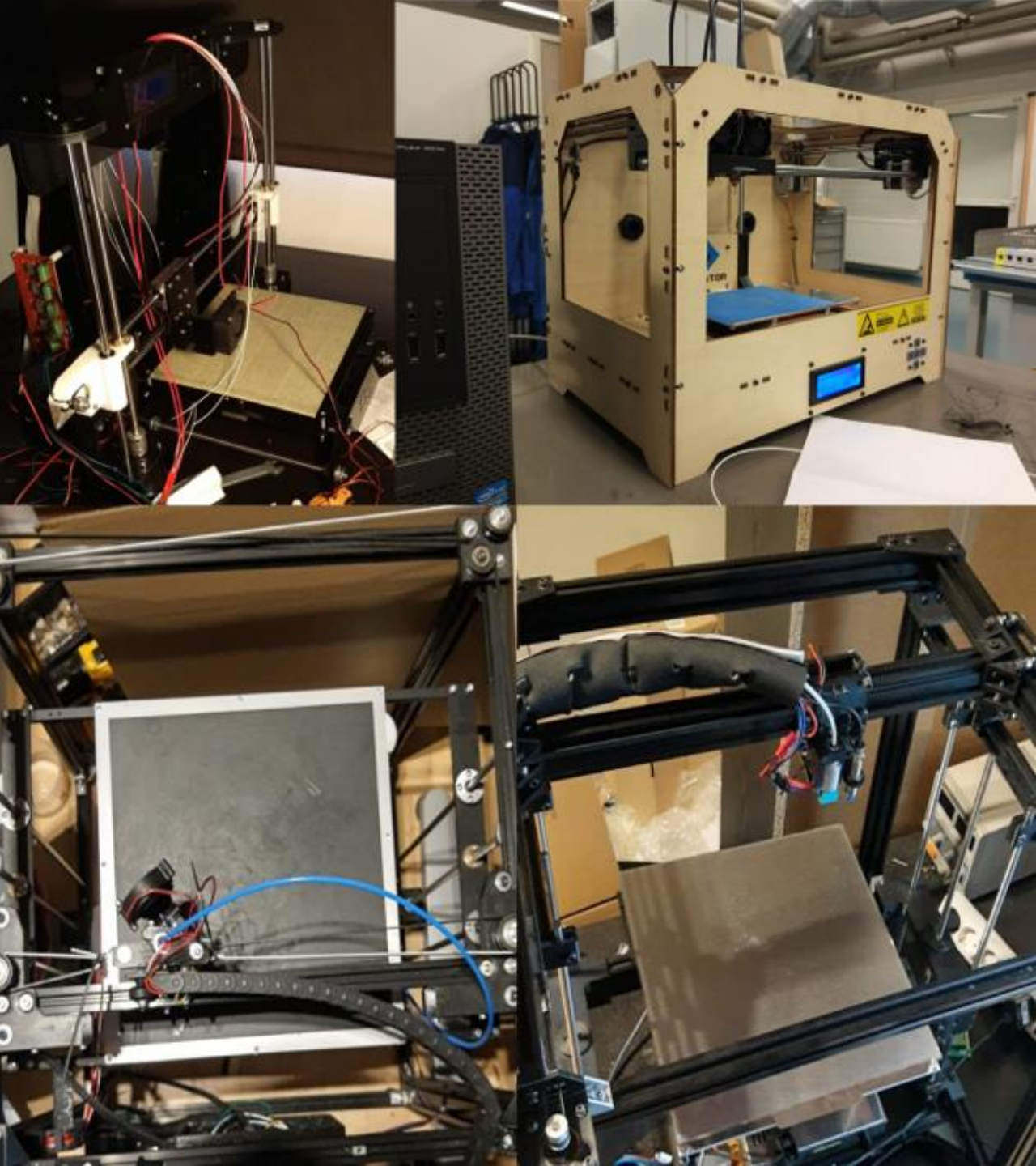# Building a FDM 3D-printer

MECHANICS / FRAME
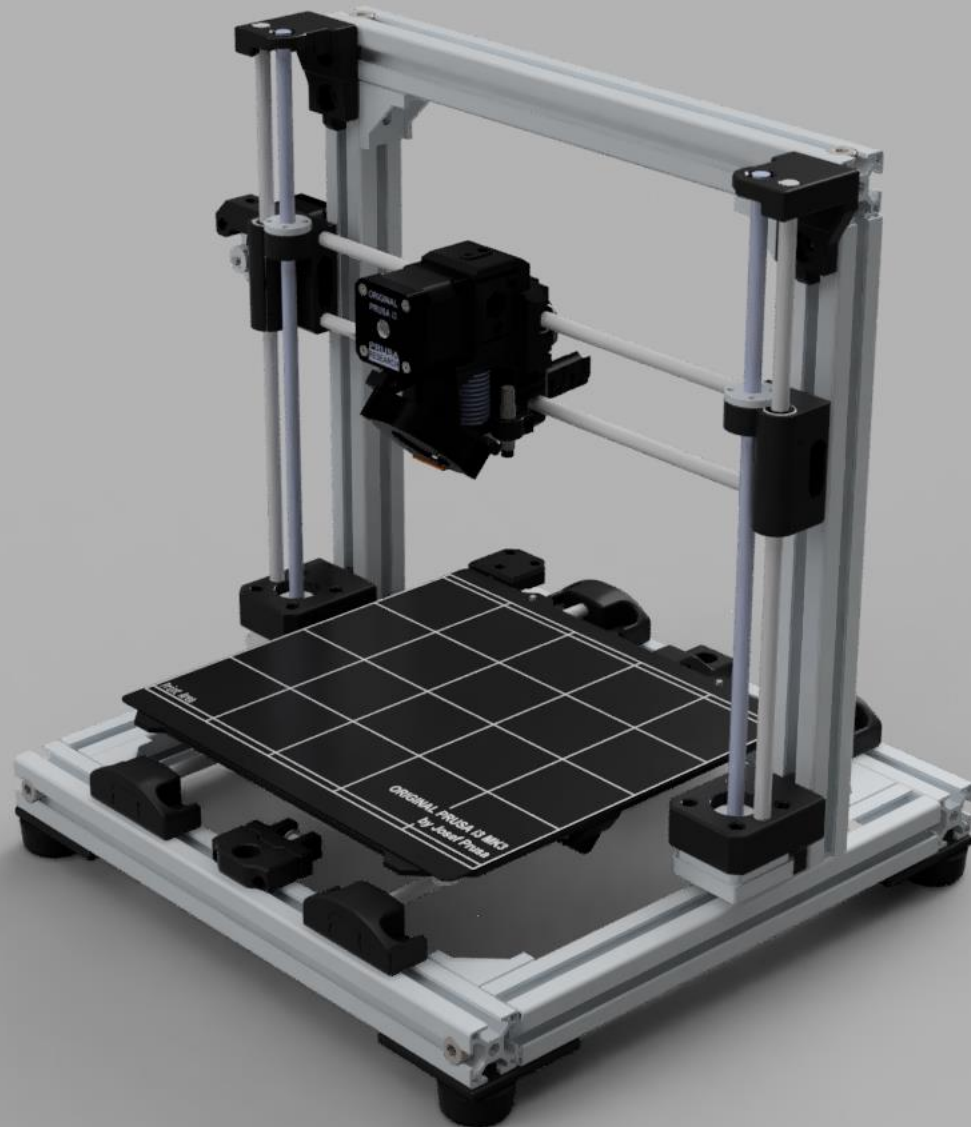
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Need for a 3D printer?

- Big prints?

- Does printing time matter?

- Multimaterial?

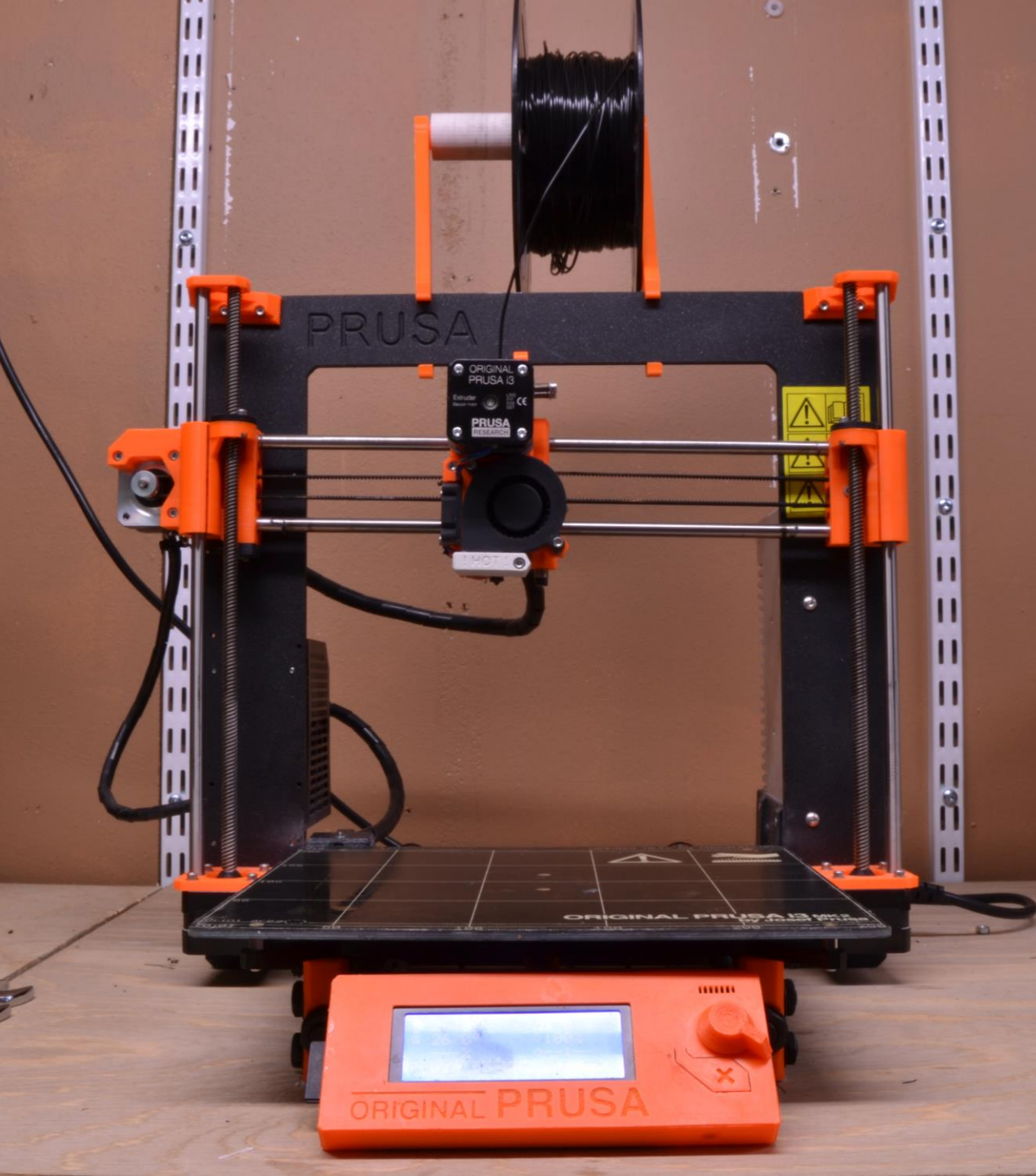- Printable materials?

- Kit, project or a ready to print?

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Kinematics + Frame material

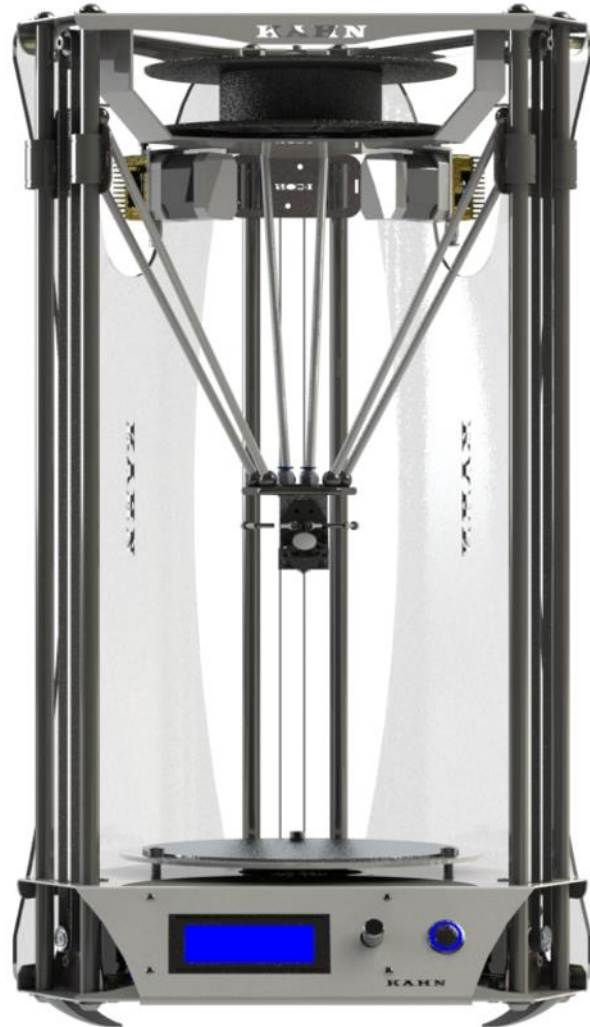- Cartesian
- CoreXY / H-Bot / D-Bot
- Delta

Cartesian

- -

- Reasonable build area

- Speed isn't everything

- Frame material is important

- Reasonable priced
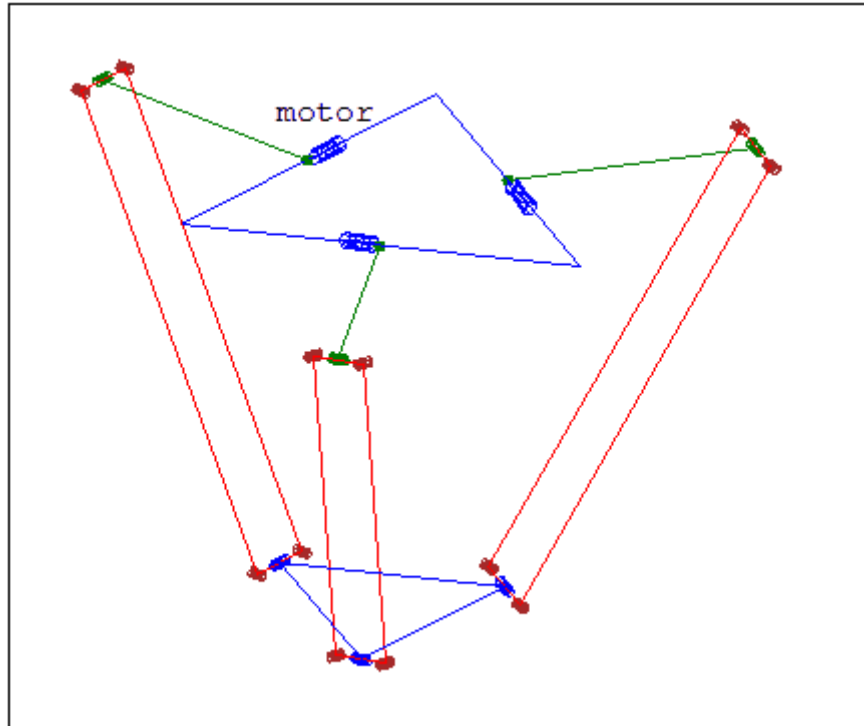
- Very wide community

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Cartesian

- Heated bed moves in Y-direction, printing head moves in X- and Z-directions

- Simple kinematics

- Bowden and direct-drive

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Delta

- Speed

- Limited build area (Circular)

- Bowden

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Delta

Picture ZD.net

- Kinematics based on co-operation of 3 motors

- Motors move carriages which hold rods which then are attached to the printing head

- Requires calculation for motions, which means it's recommended to use a better controller

- https://www.geogebra.org/m/Br52nAjP
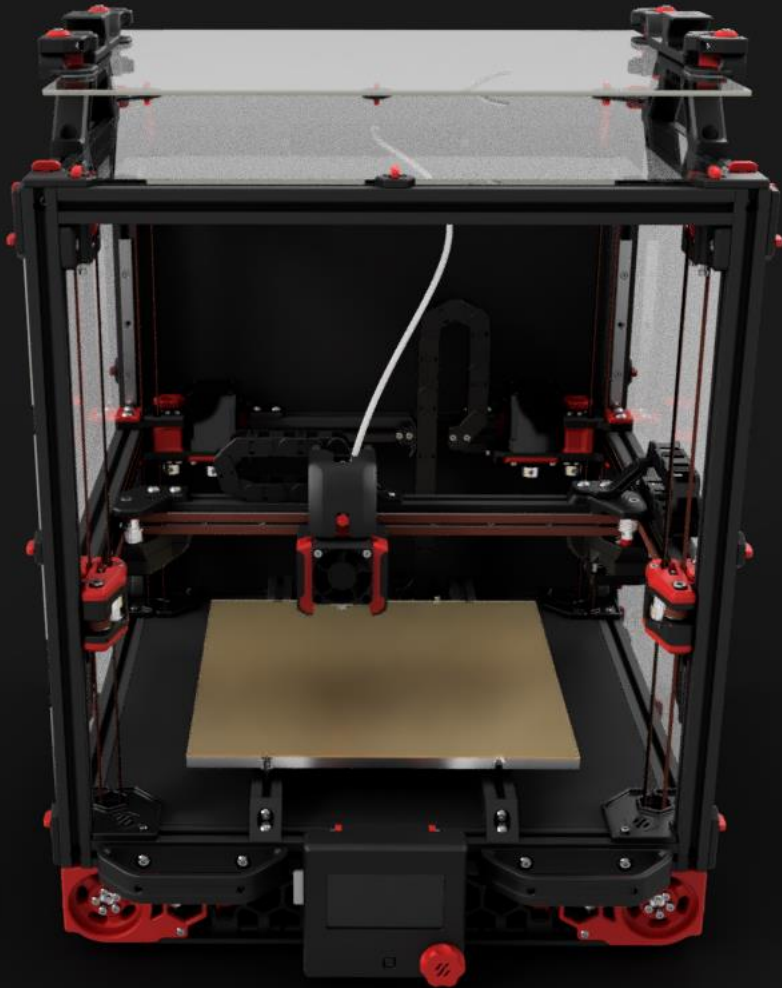
CoreXY / H-Bot / D-Bot

- Rigidness and speed
- Heated bed moves in Z-direction, printing head moves in X- and Y-direction with the help of belts.
- Easily added "printing chassis"
- Mostly are bowden, but can be modified into a direct-drive
- Printer footsize is very optimized to build area
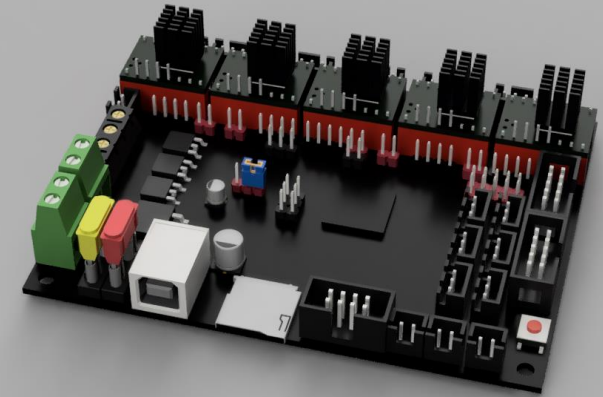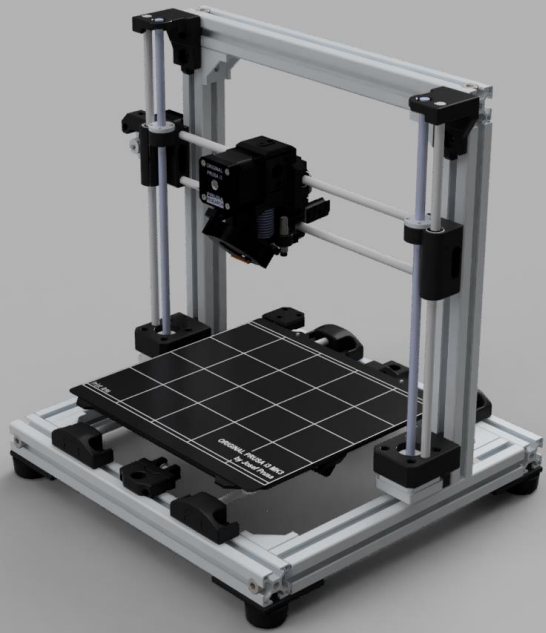
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Kuva: laserbeavers.com

CoreXY / H-Bot / D-Bot

- Kinematics based on co-operation of A and B motors

- Motor movement in opposite directions causes straight line movements

Pictures: https://www.jjrobots.com/
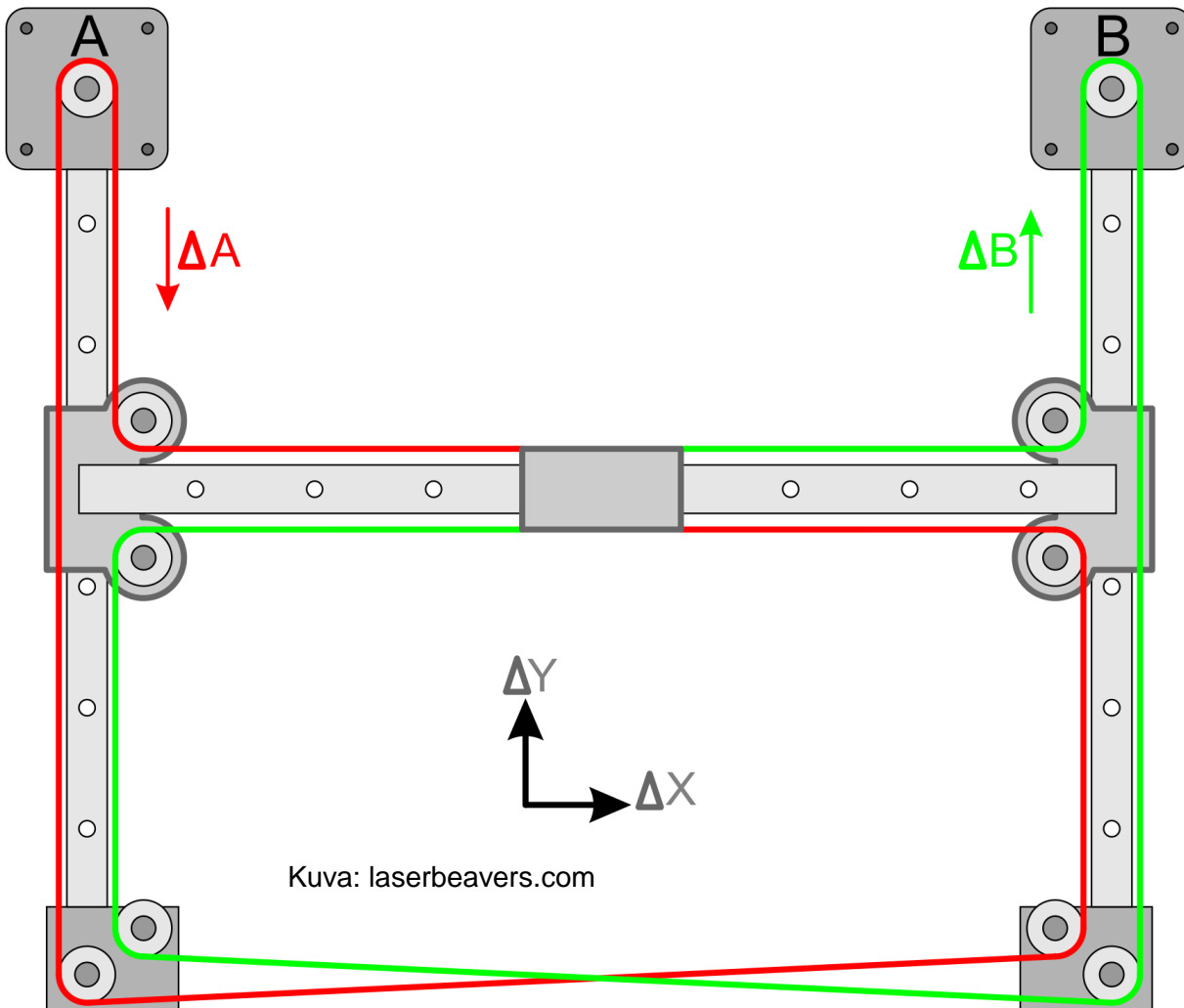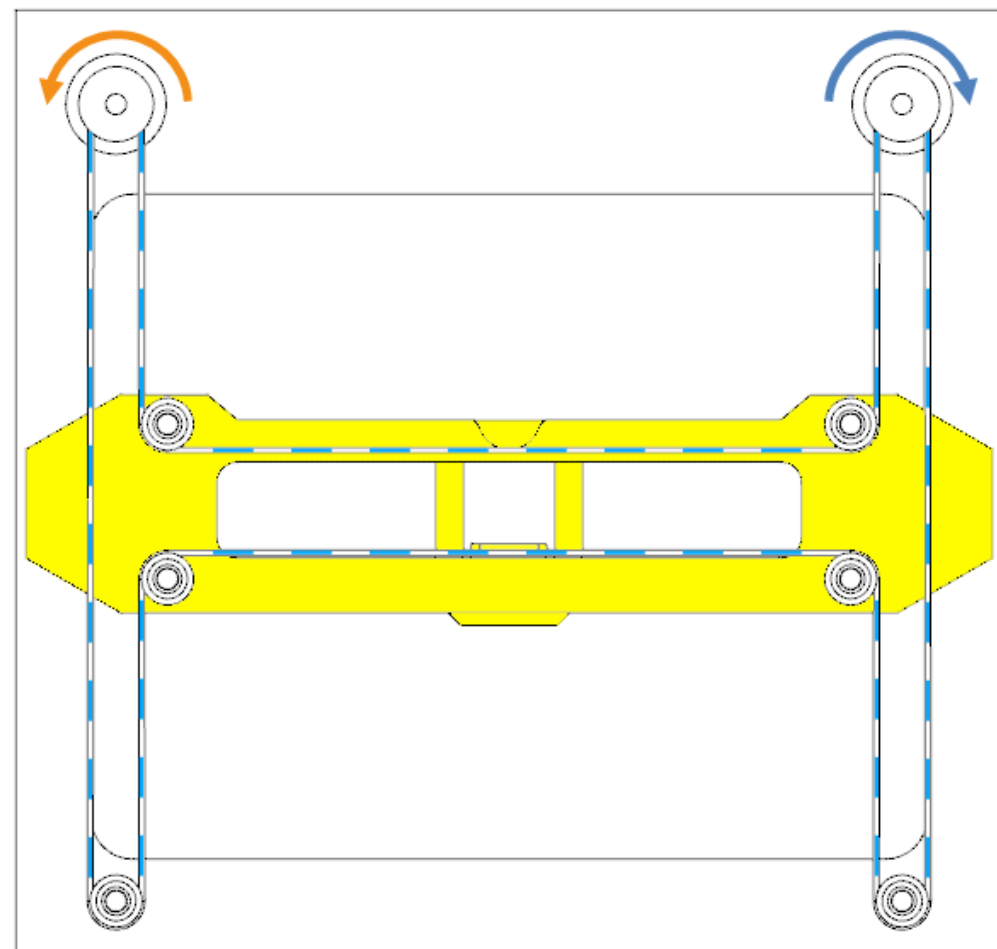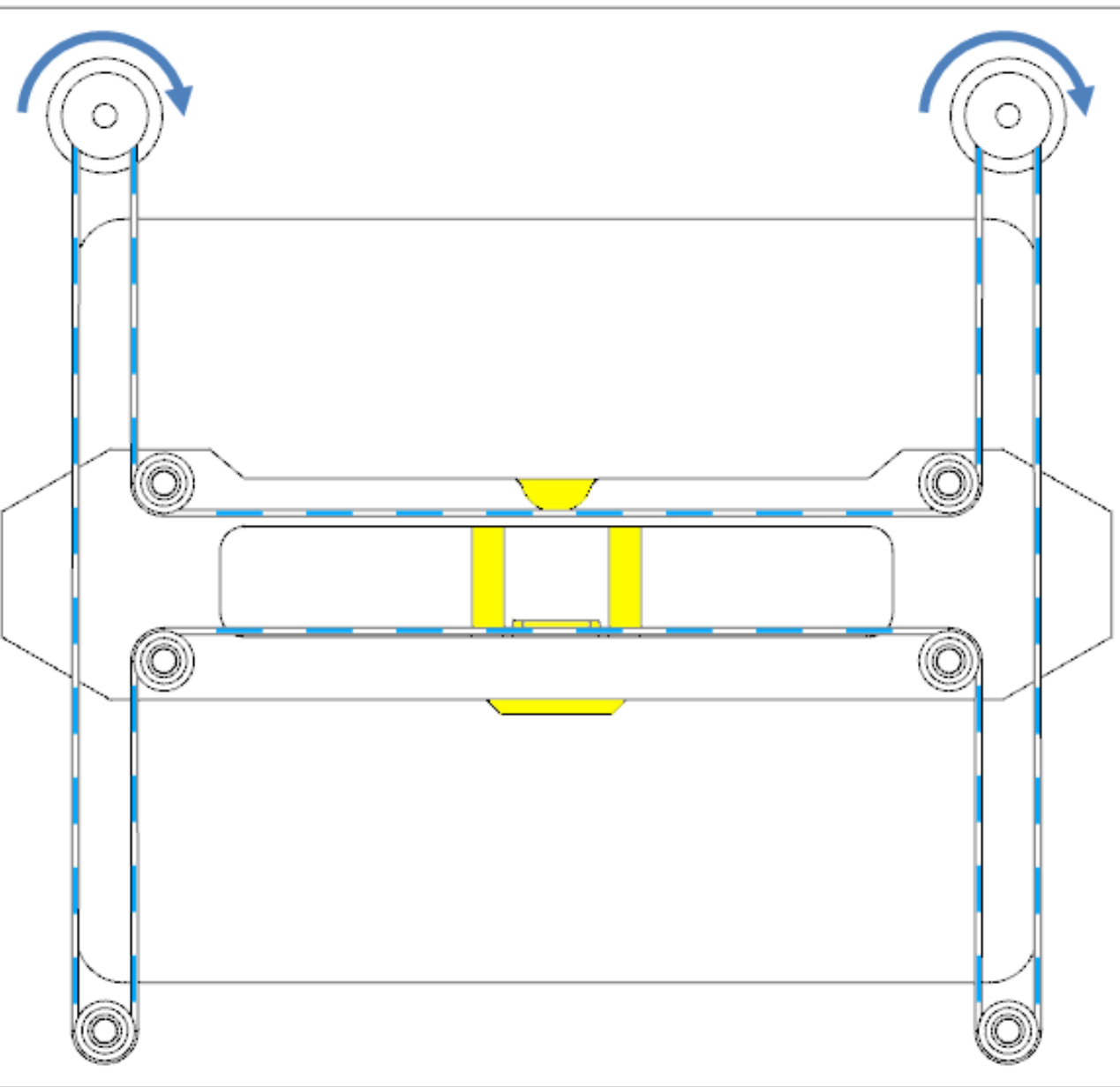
What does an FDM 3D-printer consist of?

Building a FDM 3D-printer

MECHANICS / MOVEMENT

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Kuva: aus3d.com/au

Power transfer

- Movement is formed from stepper motors, but it has to be transmitted somehow

- Usually with belt or trapezoid screws

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Belt

- Most common width 6 mm
- Teethprofile GT2
- Basic rubber belt
- Metal reinforced nylon belt
- Gates-belt

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Different movement options

- Linear bearing and metal rod

- V-wheel and aluminium profile

- Linear rail and aluminium profile

- Trapezoid rod and metal rod

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Linear bearings

Kuva: thingiverse

Kuva: amazon.com

- Chinasium, IKO, SKO, Igus, self-printed
- Price can vary from 0.5 – 20 € per bearing

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V-wheel

Kuva: openbuilds.com
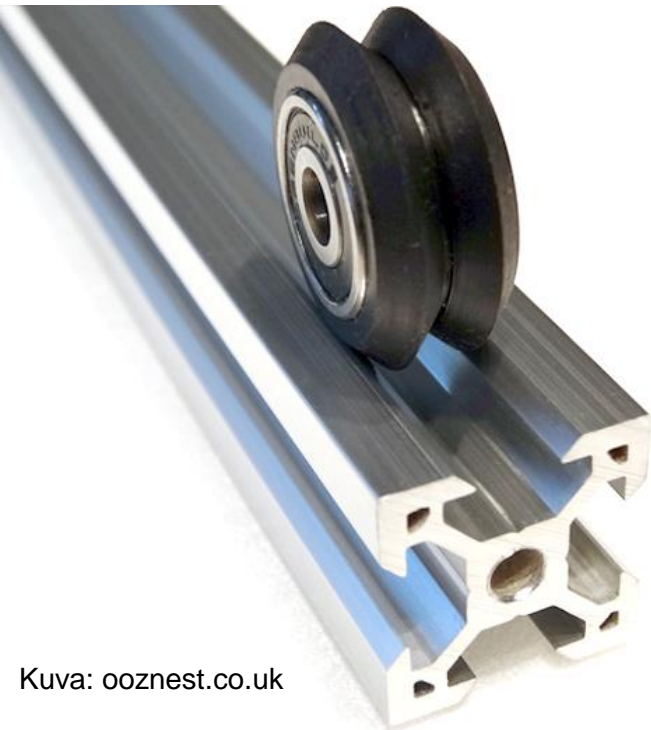

Kuva: ooznest.co.uk

- POM or Delrin

- Works best with certain aluminium profiles

- Different aluminium profiles for different wheels
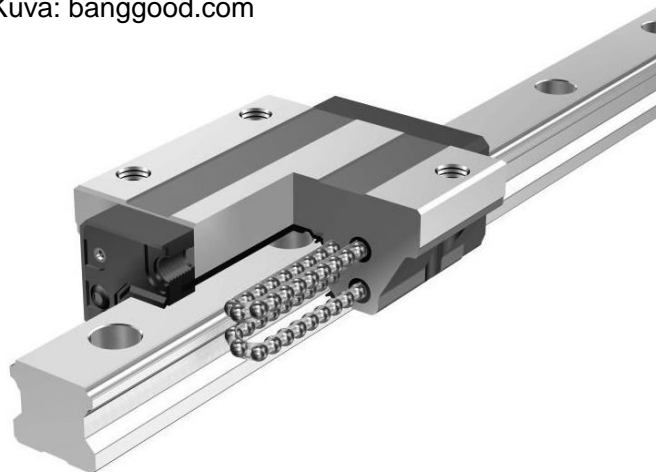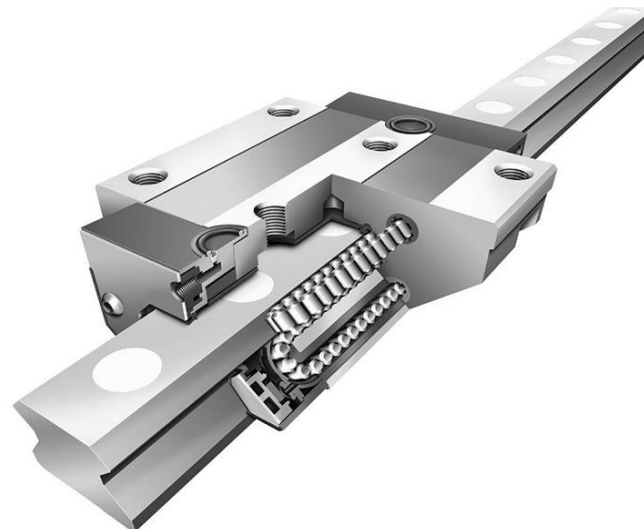
- Price : 0.35 € - 5 € per wheel

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Linear rail

Kuva: banggood.com

Kuva:linearmotiontips.com

- "Doesn't" wiggle

- Installed usually on aluminiu profile

- Chinasium, HIWIN, SKO

- Different sizes, MGN7, MGN9, MGN12, MGN15 – Choose according to profile

3D-Printing - FDM – Mechanics, movement

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Building a FDM 3D-printer

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Kuva: WEHO
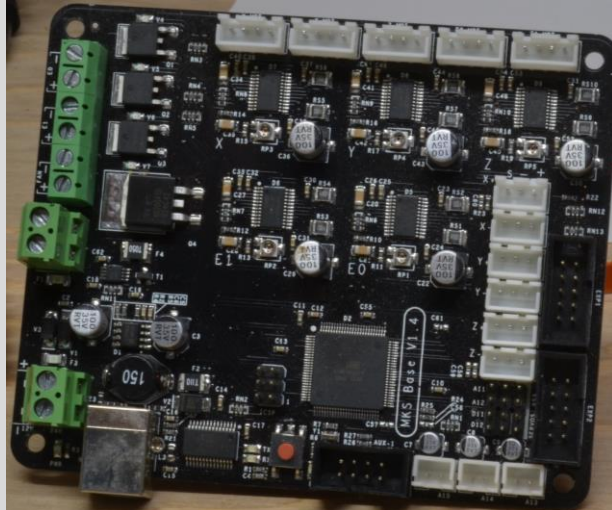
Powersupply

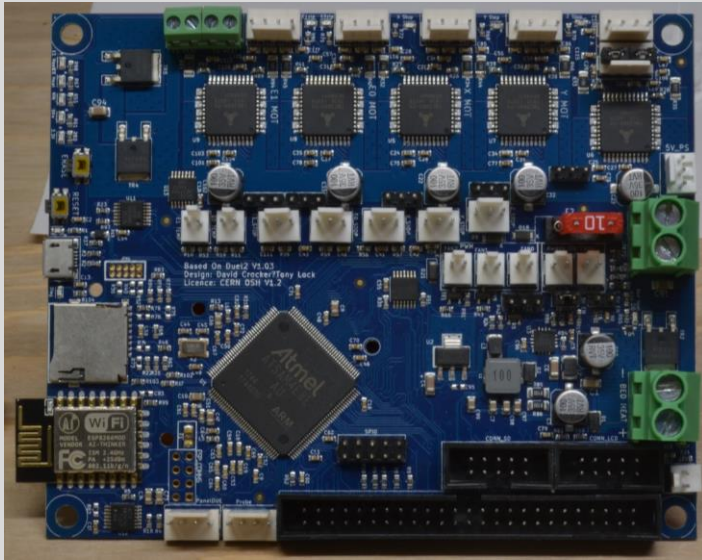
- 12V or 24V

- Avoid chinese

- ATX, "LED"-powersupply or a server powersupply

- MeanWell / WEHO / Delta Electronics

- Extra care, because 240V

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Powersupply

- Should always be covered
- Printable chassis or a integrated solution
- C13 Socket for ease of use
- Overscale your PSU for safety

Picture :thingiverse.com
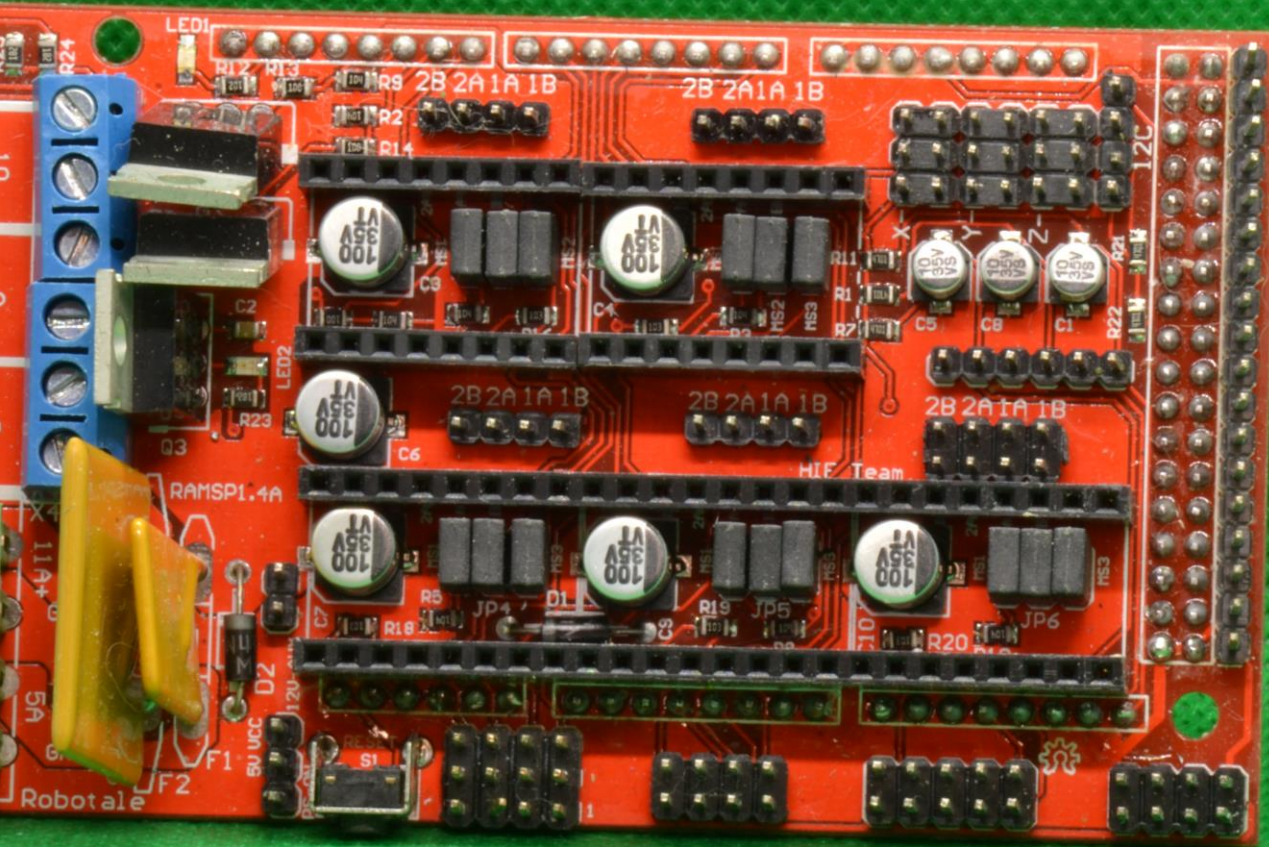
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Controller board

- 12V or 24V (Depends on PSU)

- 8-bit or 32-bit

- Stepper drivers

- SSR or controller controls heated bed

- Possibility for a display
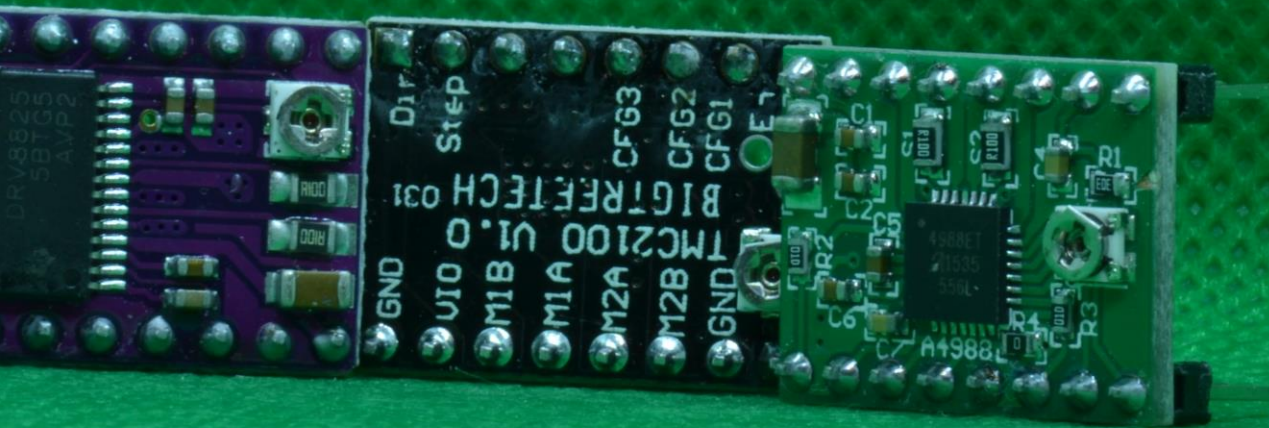
- Connections

- Firmware

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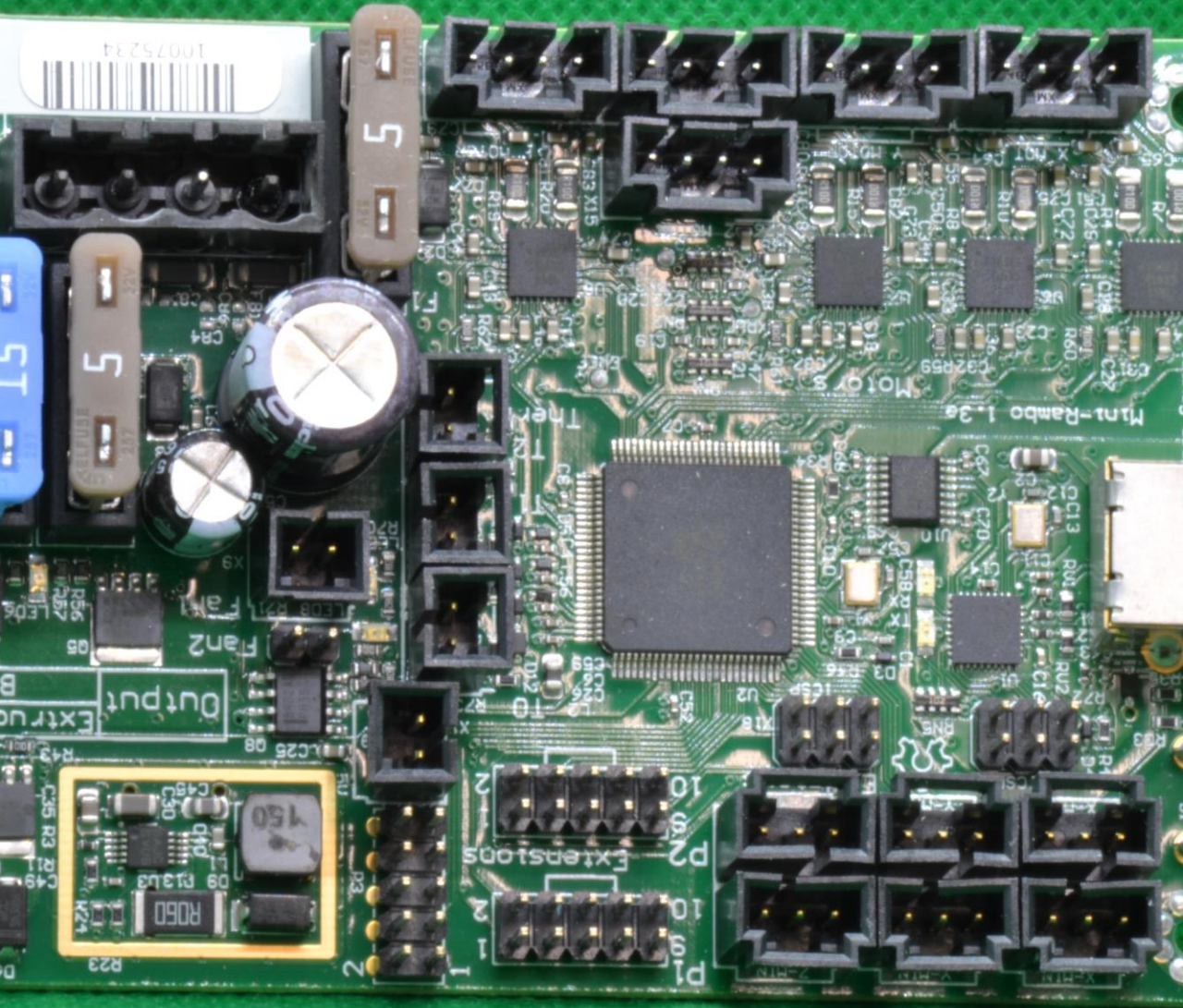
Controller board

- Due+RAMPS (10 – 60 €)
- Duet3D (70 - 150 €)
- MKS Gen/Base 1.4 (25 €)
- SKR 1.3/1.4 (14-40 €)
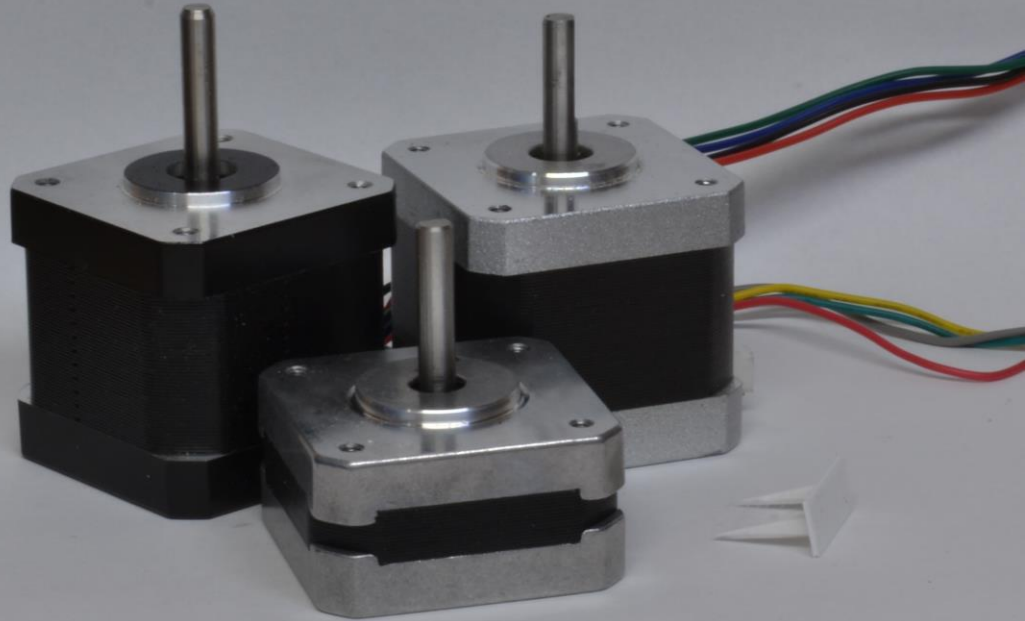- SKR Mini (25-30 €)
- Einsy Rambo / Retro (~50-100 €)

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Stepper driver

- Their use is to control stepper motors for movement

- Integrated and seperate

- Cooling is good (fan or heatsink)

- Microsteps
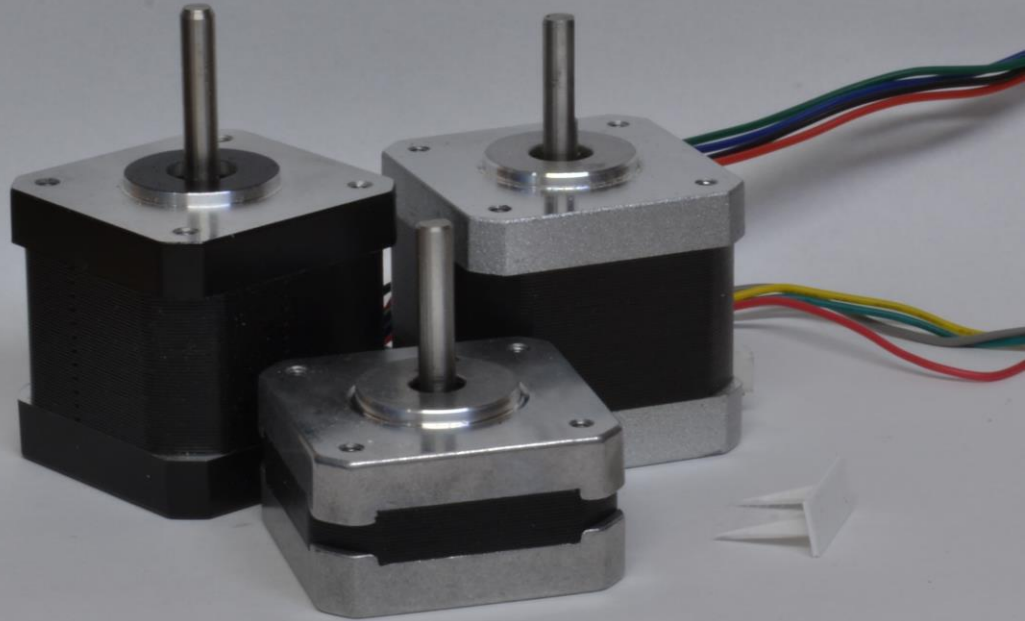
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Stepper driver

- A4998 – most common (halpis) 0.5 €

- DRV8825 0.9 €
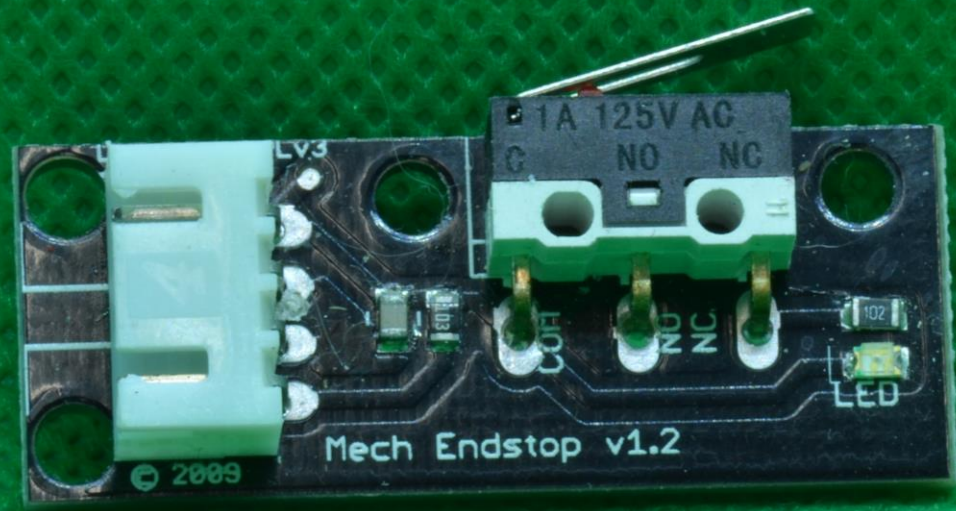
- TMC2XXX 5-10 €

- TMC5XXX 13-15 €

Stepper motors

- Most common motor size factory is Nema 17, there's several different sizes in that category.

- "Pancake"

- Standard

- "Beefed"

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Stepper motors

- Some have flat sides some not

- Available with 0.9 degree or 1.8 degree per step.

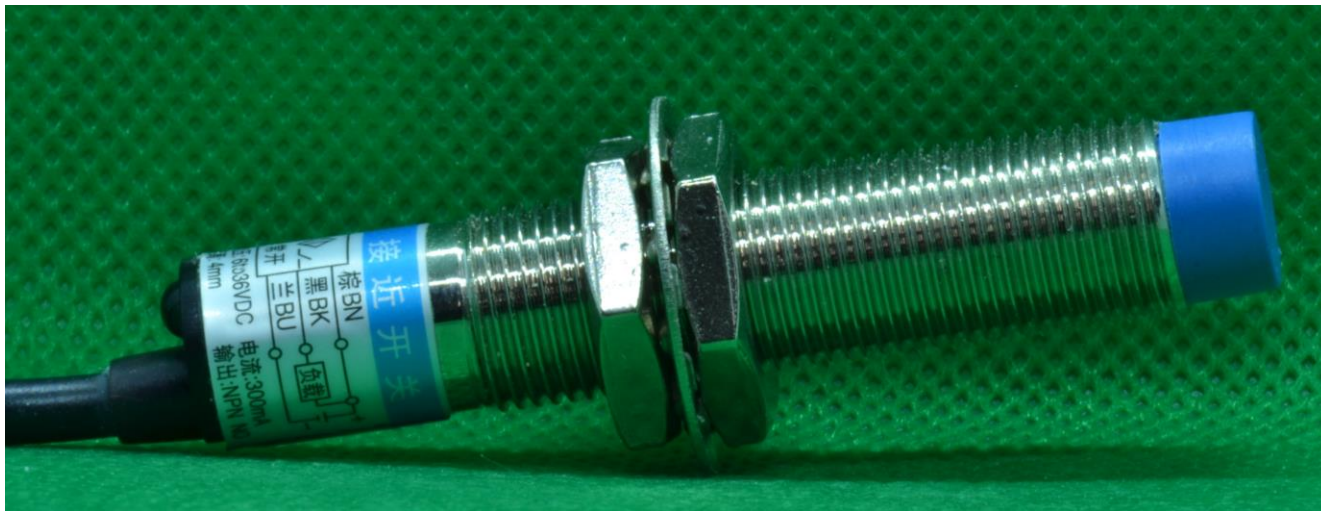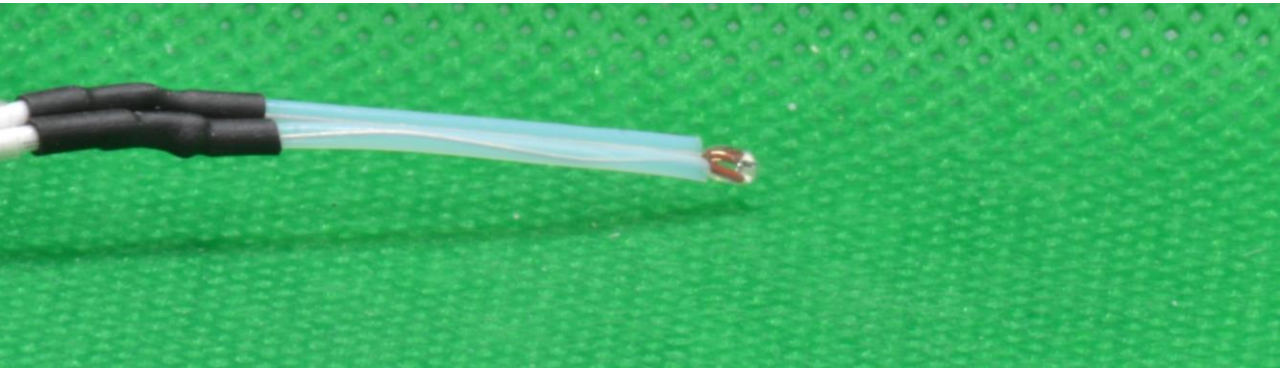- Current consumption should be taken into consideration

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Endstops

- Endstops work as homing switches
- Mechanical
- Optical
- Integrated in stepper driver

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Endstops (Z)

- Microswitch

- BLTouch
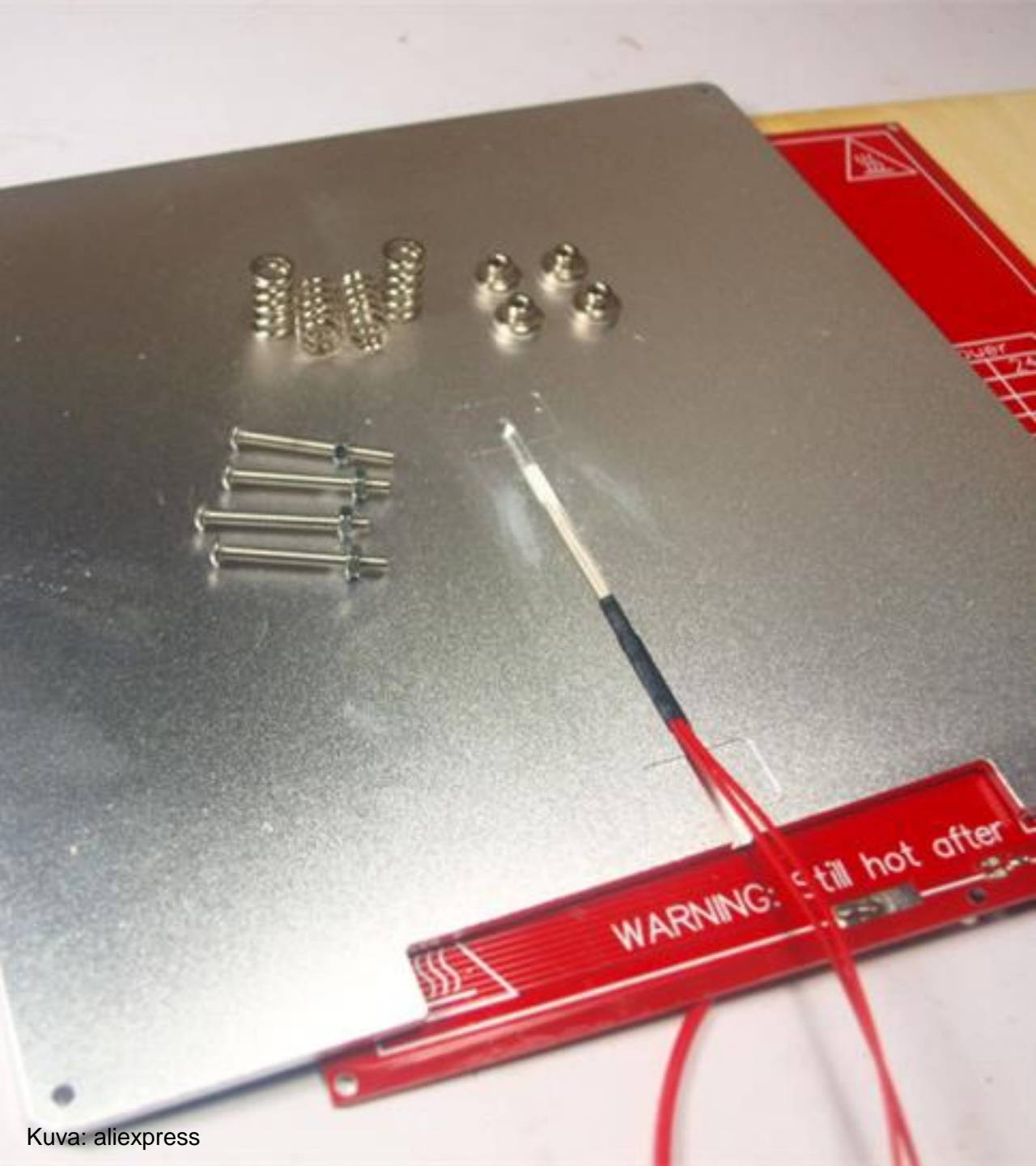
- Inductive

- Capasitive

- Piezo

Thermal sensors

- Thermistor
- RTD
- Thermocouple
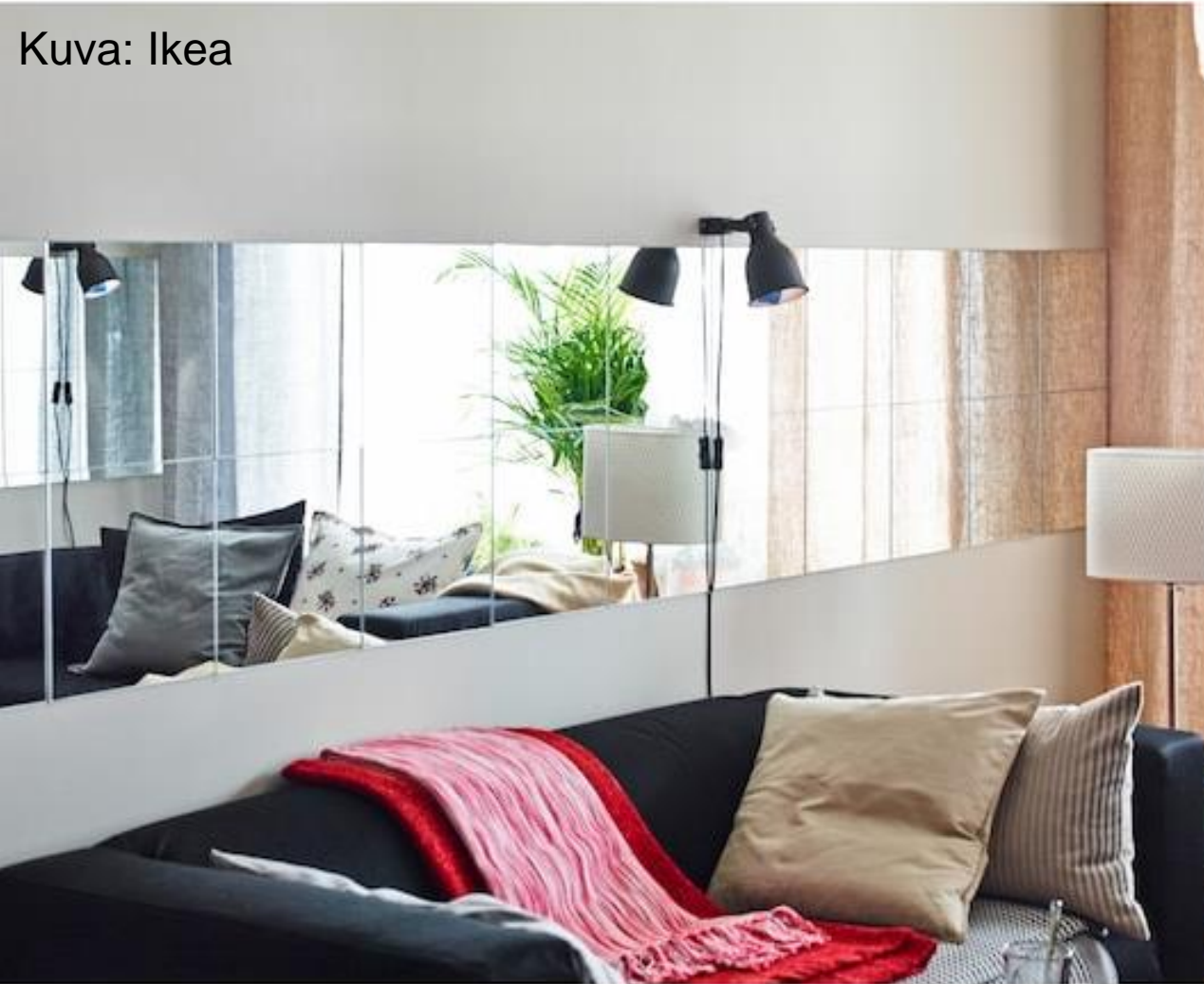
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Heated bed

- PCB, Silicone heater or polymide film?

- A metal plate or a glass should be put on top of heater, never print directly on heater

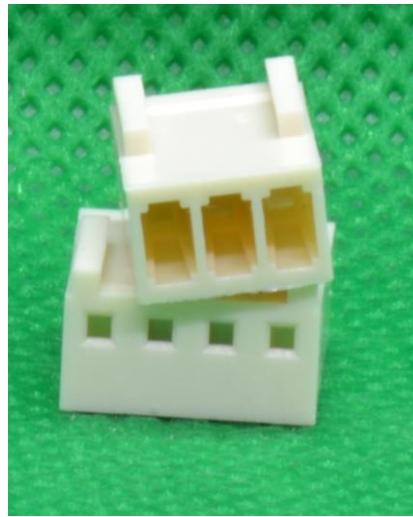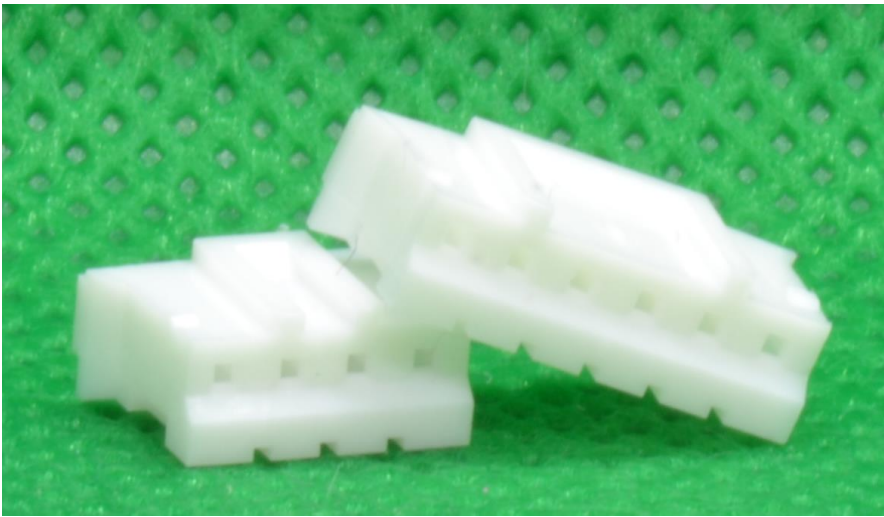- Heaters with integrated mangets

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Kuva: Ikea

Printbed

- Straight onto metal? No way Jóse.
- Glass
- PEI-sheet
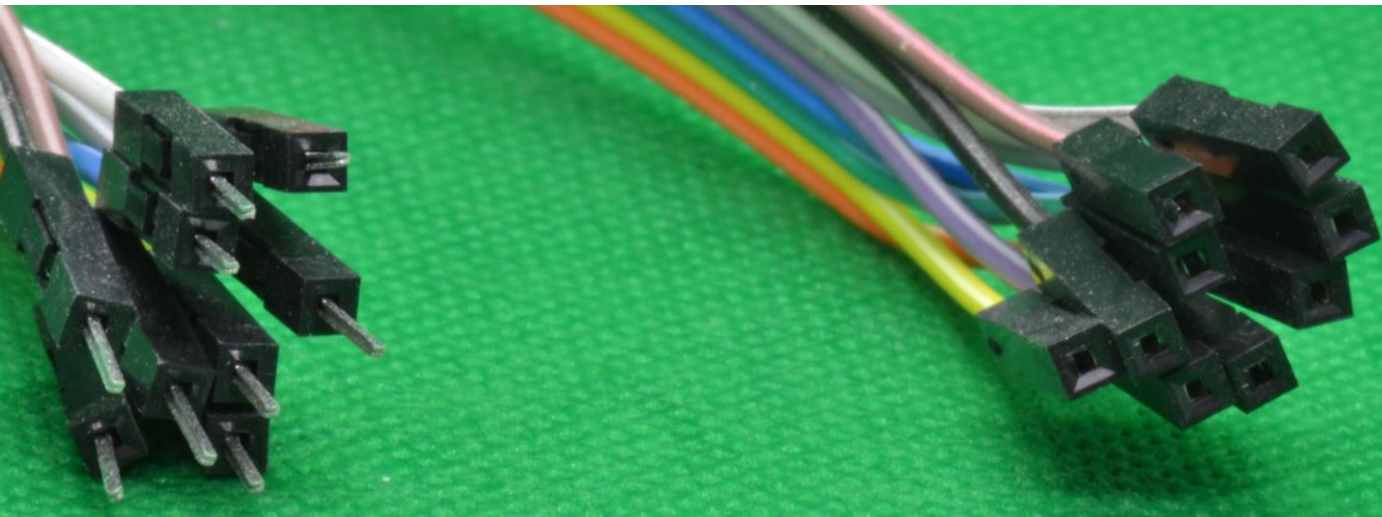- Mirror
- Buildtak
- Magnetic metal sheet with PEI

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Wiring

- Thick cables (Overscaled)
- Silicone cable if possible for flexibility
- Up to 20A of current
- Energy chain
- Cable ties and printed holders
- Cable extensions
- Strain relief

Kuva: Aliexpress

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Connectors

- JST-XH
- Dupont
- JST-PH
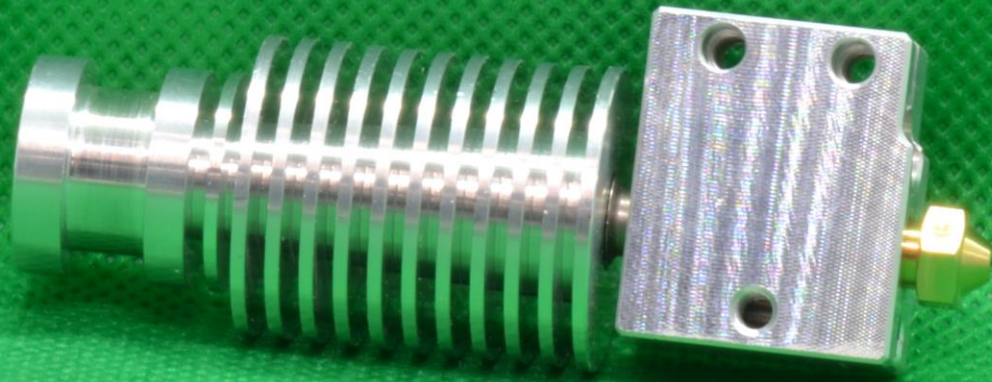- JST-VH
- Molex
- JST-SYP
- JST-ZH

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Tools

- Dupont crimping tool
- JST crimping tool
- Wire cutter
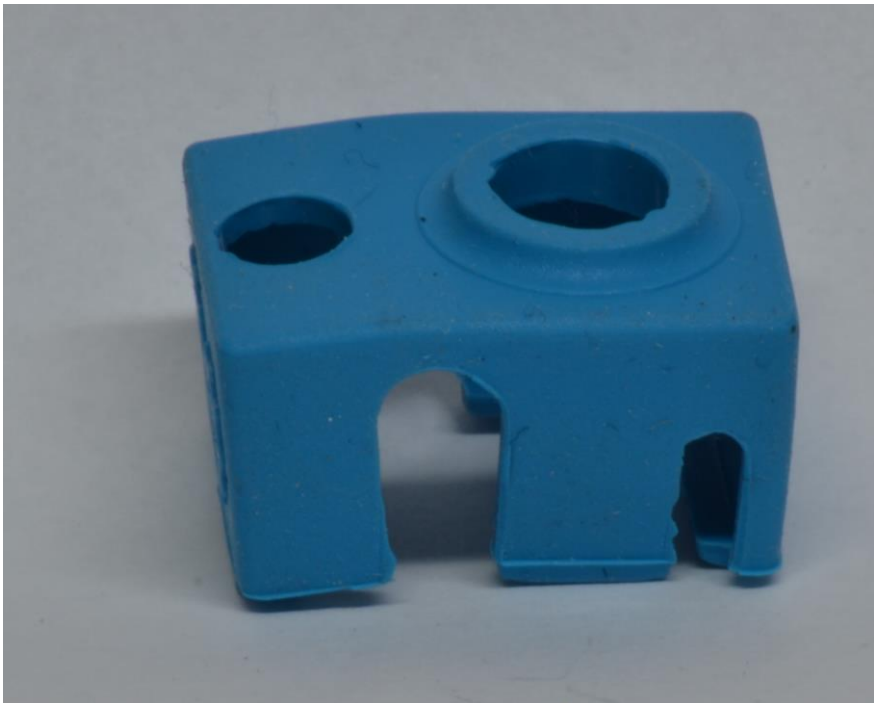- Scalpel
- Tweezers
- 7 mm wrench / socket

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Building a FDM 3D-printer

EXTRUDER AND HOTEND

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Hotend

- 4 parts
- Nozzle
- Aluminium block
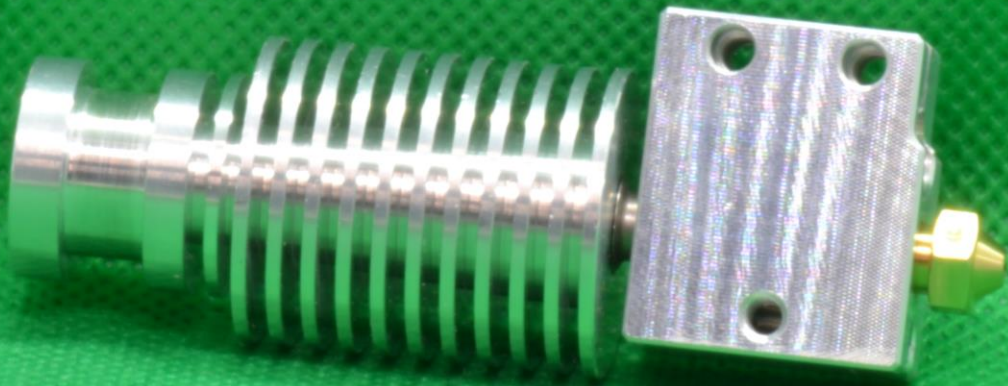- "Heat break"
- "Heatsink"

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Block

- All hotend parts are connected to this
- Slots for heater and thermistor
- Silicone sock
- Different types for different hotends

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"Throat" / Heat break

- Transfer material from Heatsink to heatblock

- To work also as a seperator between block and heatsink

- Dissipates heat to heatsink

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"Heat sink"

- Keep heat off from heatbreak so that filament doesn't melt inside
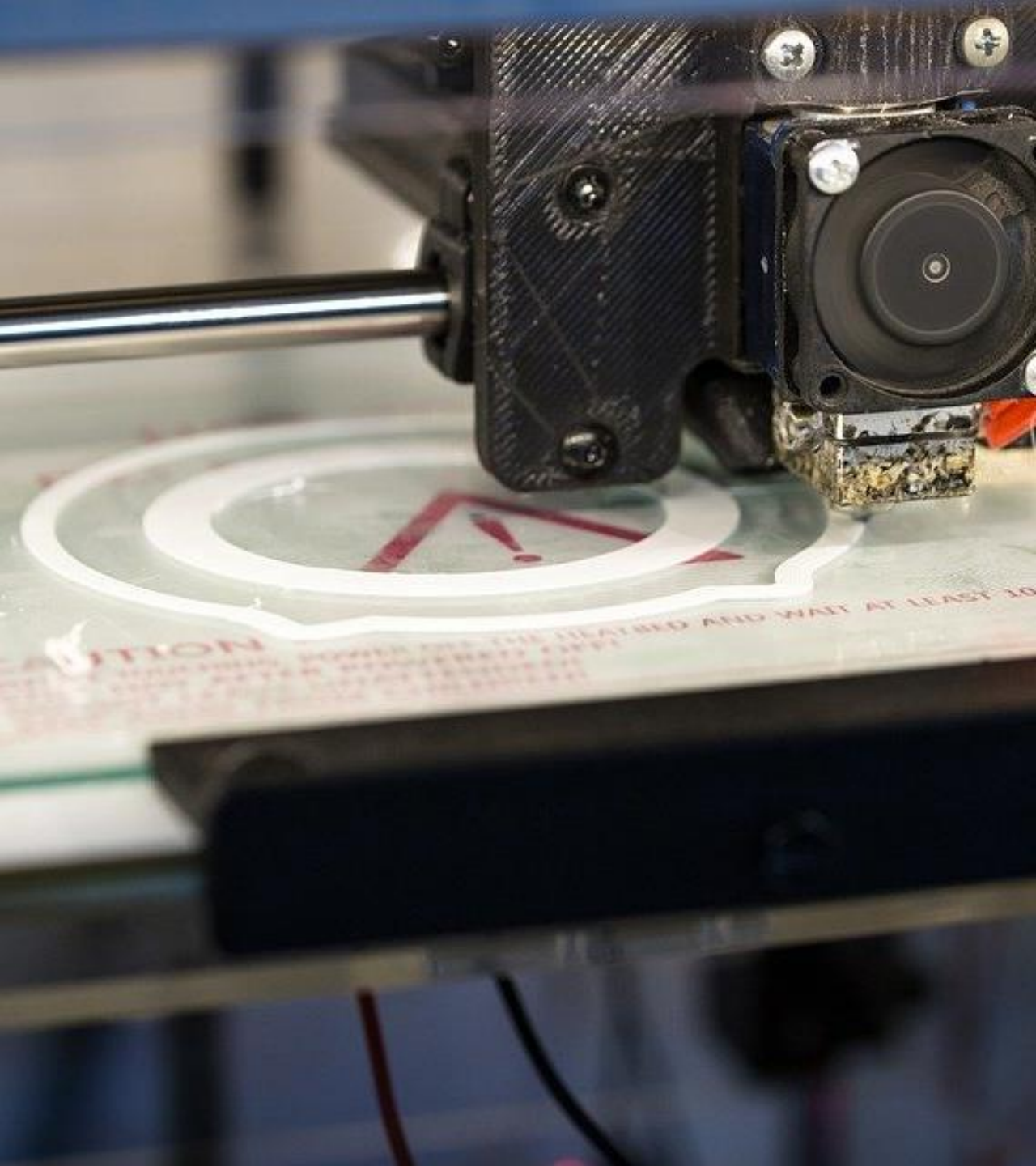- Always with a fan

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Nozzle

- Many type of nozzles

- From left E3D V6, MK10 ja MK8

- Nozzle size can vary from 0.25 mm to 1.2 mm and even more.

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E3D V6

- Most common nozzle type
- Many different versions available, and nozzle sizes
- Brass, steel, stainless steel, nozzle x, ruby nozzle

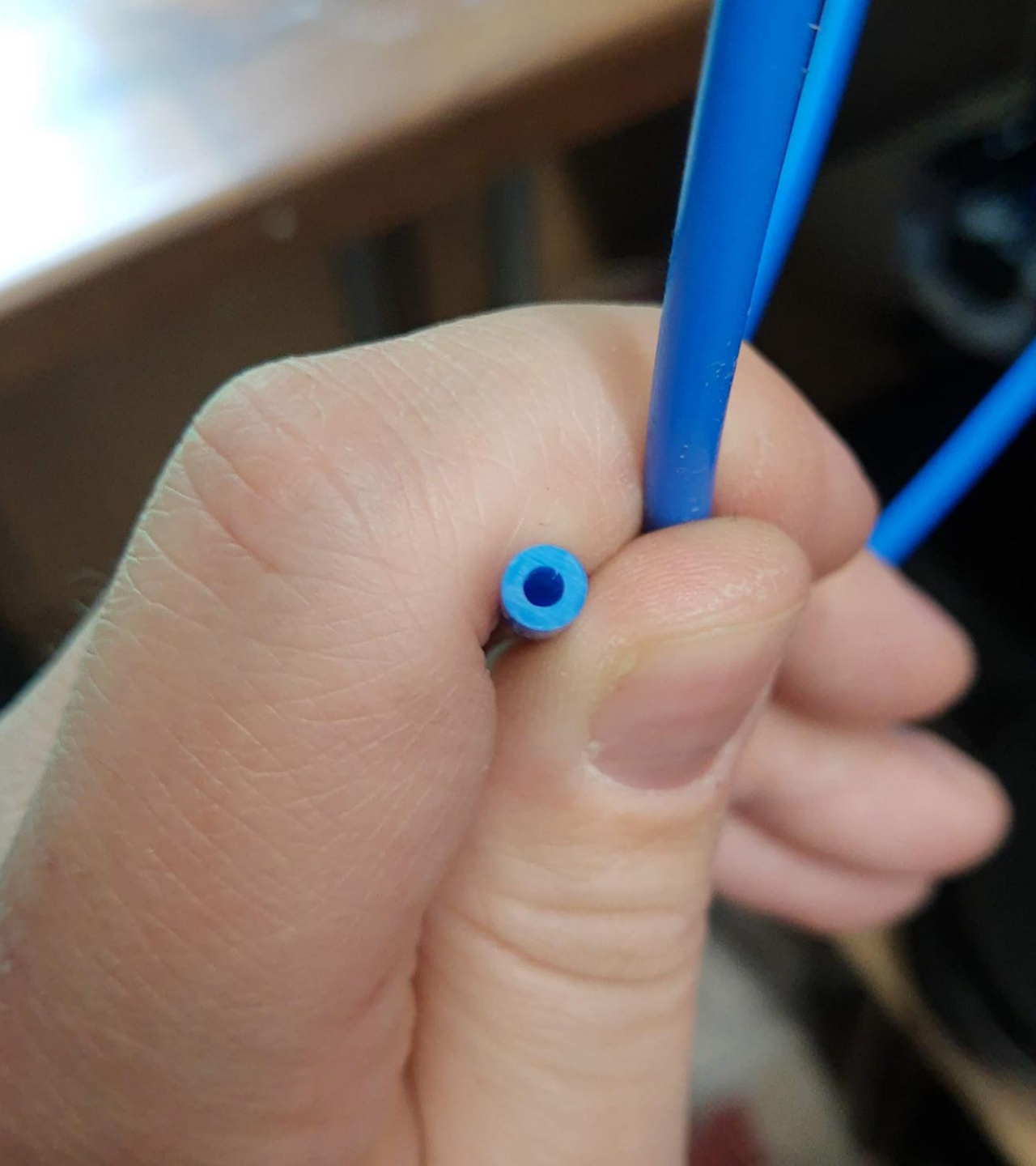samk

Feeder

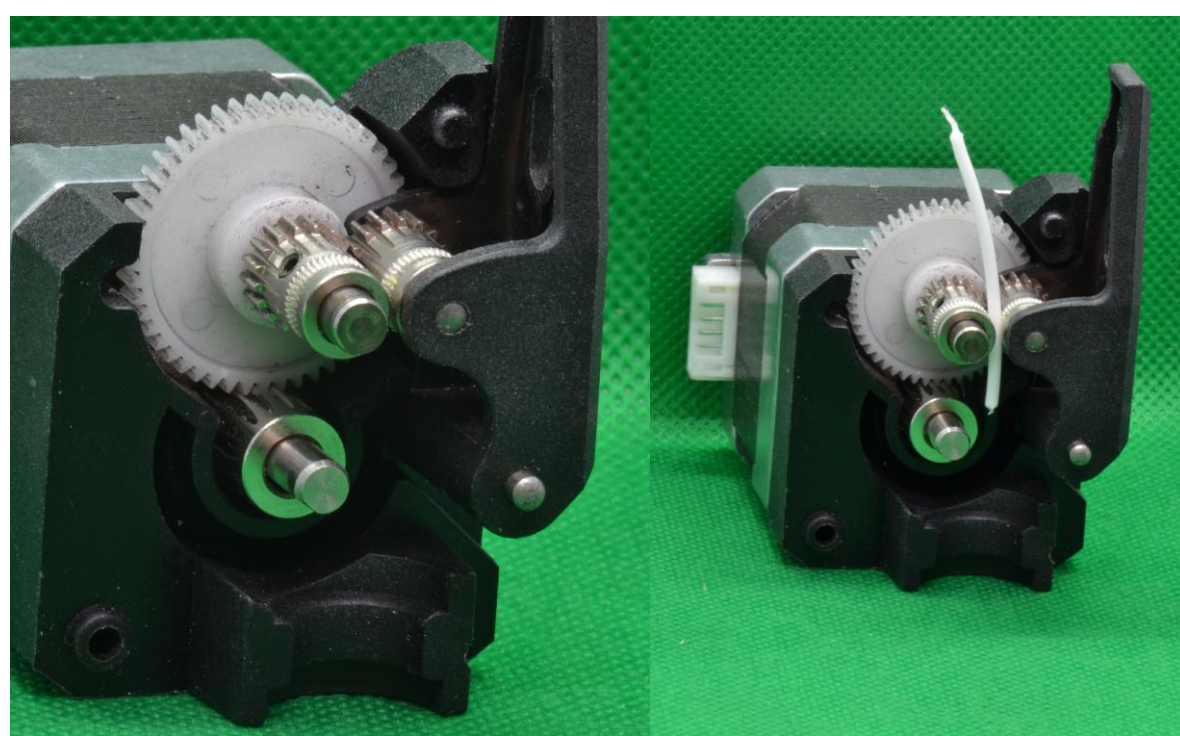- Direct or Bowden?
- "Fast" printing?
- Flexibles?

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Direct-drive

- "Workhorse"
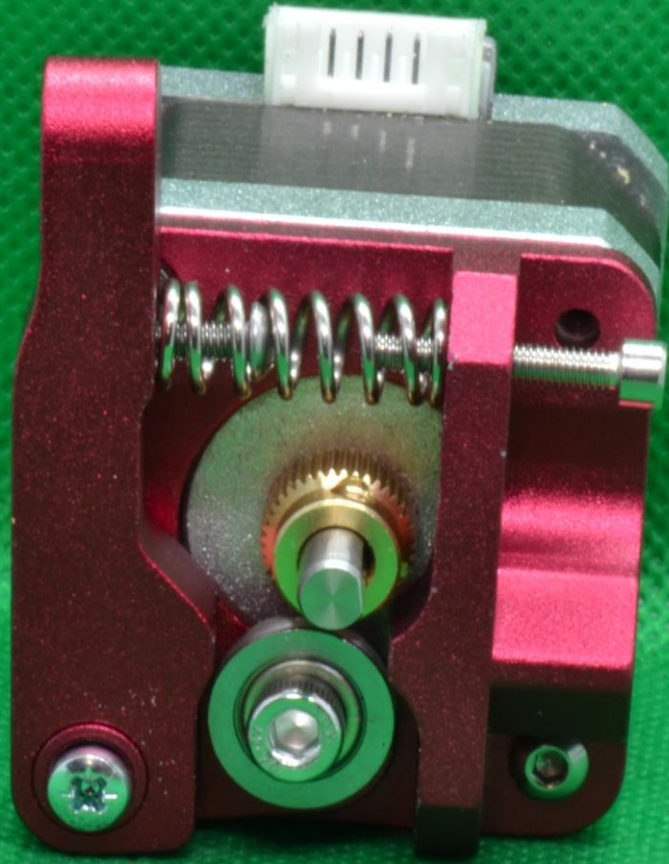- More mass (because of motor)
- Flexibles, A+

Bowden

- Requires PTFE-tube

- Quality tube is important

- Makes fast movements possible (less mass)

- Flexible materials trickier

- Should clean tube from time to time

- Own challenges with retract

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BMG

- Gears which grip filament from both sides.

- Bowden and direct-drive

- Very good grip

- Pancake motor possible

- Price 25 - 90 €
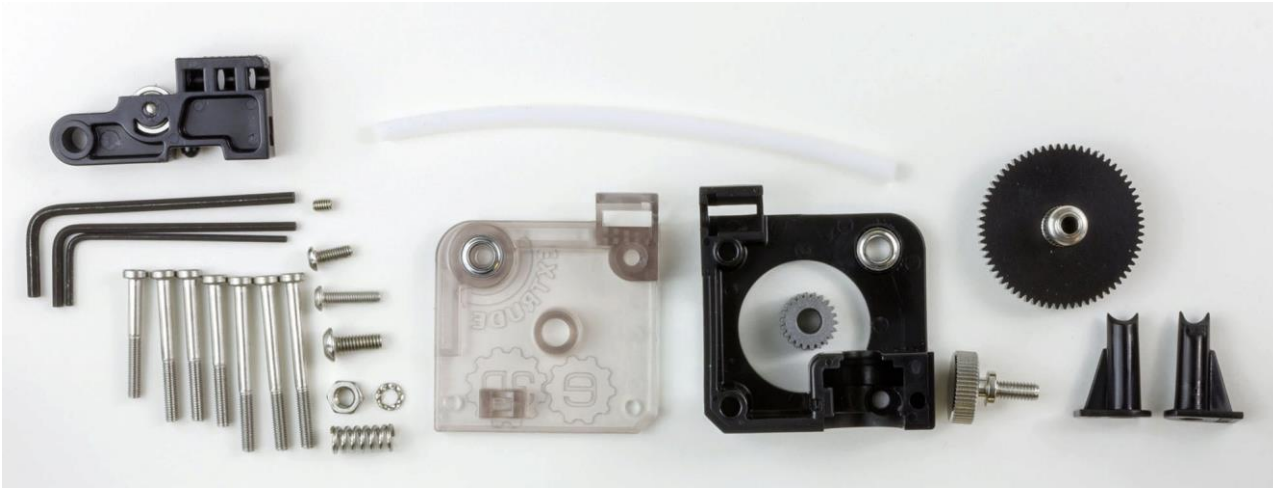
Basic metal feeder

- Spring which pushes a lever which pushes a bearing against a gear.

- Bowden and direct-drive

- Semi-good grip (Not really)

- Requires a normal size motor

- Not for flexibles without addons

- Price 3 - 8 €

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Hemera

- Works with bowden and direct
- Excellent grip
- Requires certain type of a motor
- Flexibles, A++
- Price 90 - 130 €

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Kuva: e3d

e3d Titan

- Works for direct and bowden
- Ok grip on filament
- Not that suitable for flexibles
- Price 20 - 120 €

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Firmwares

Marlin

- Most common firmware

- Very versatile

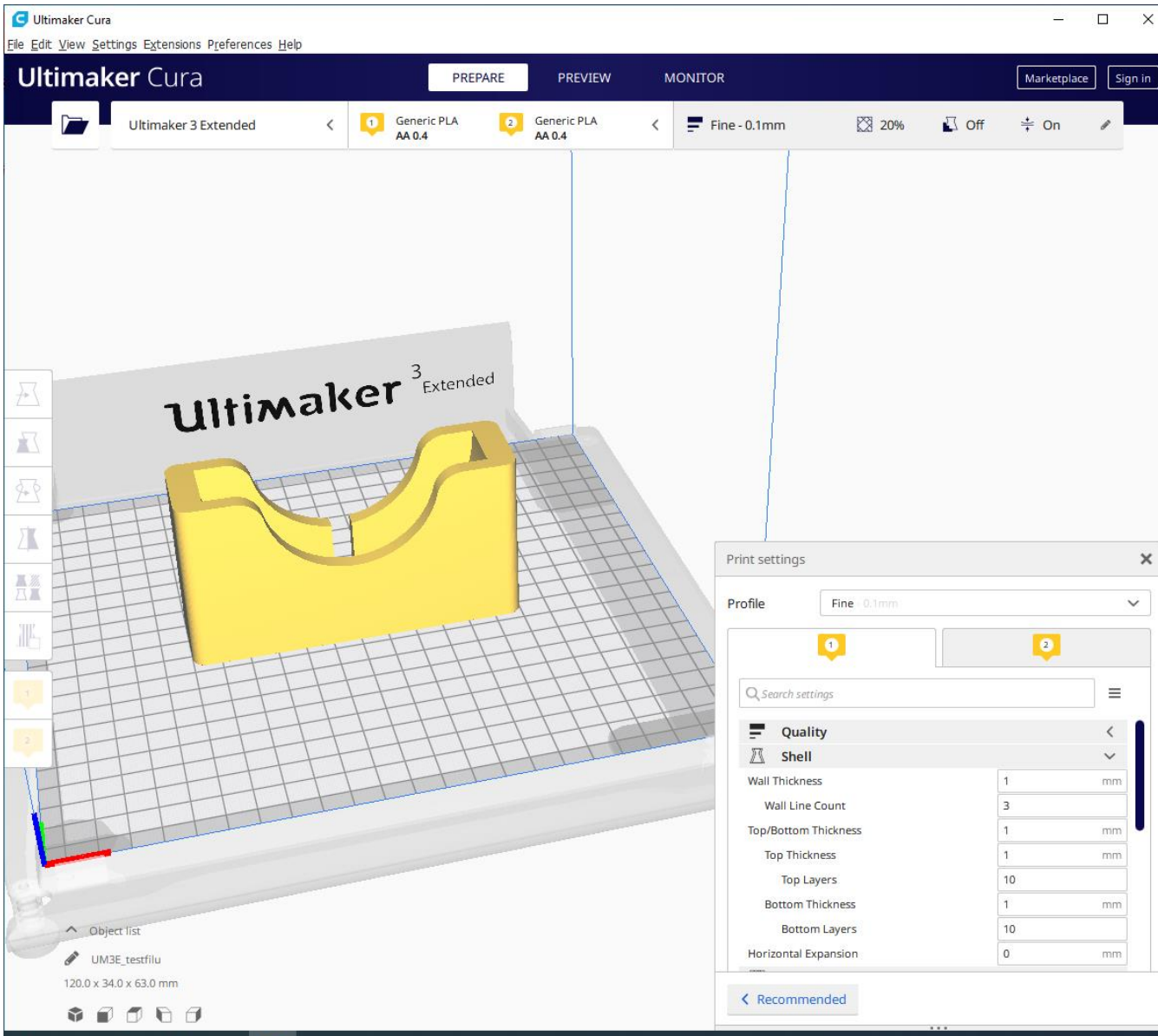- Supports 8-bit and 32-bit boards

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Klipper

- Firmware runs on Rpi, controller board takes commands from Rpi.

- All calculations are on Rpi

- Fast. Octoprint included

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RepRap Firmware

- Works with Duet-boards
- Comes with a web-based GUI, also possible to add a display (with Duet)
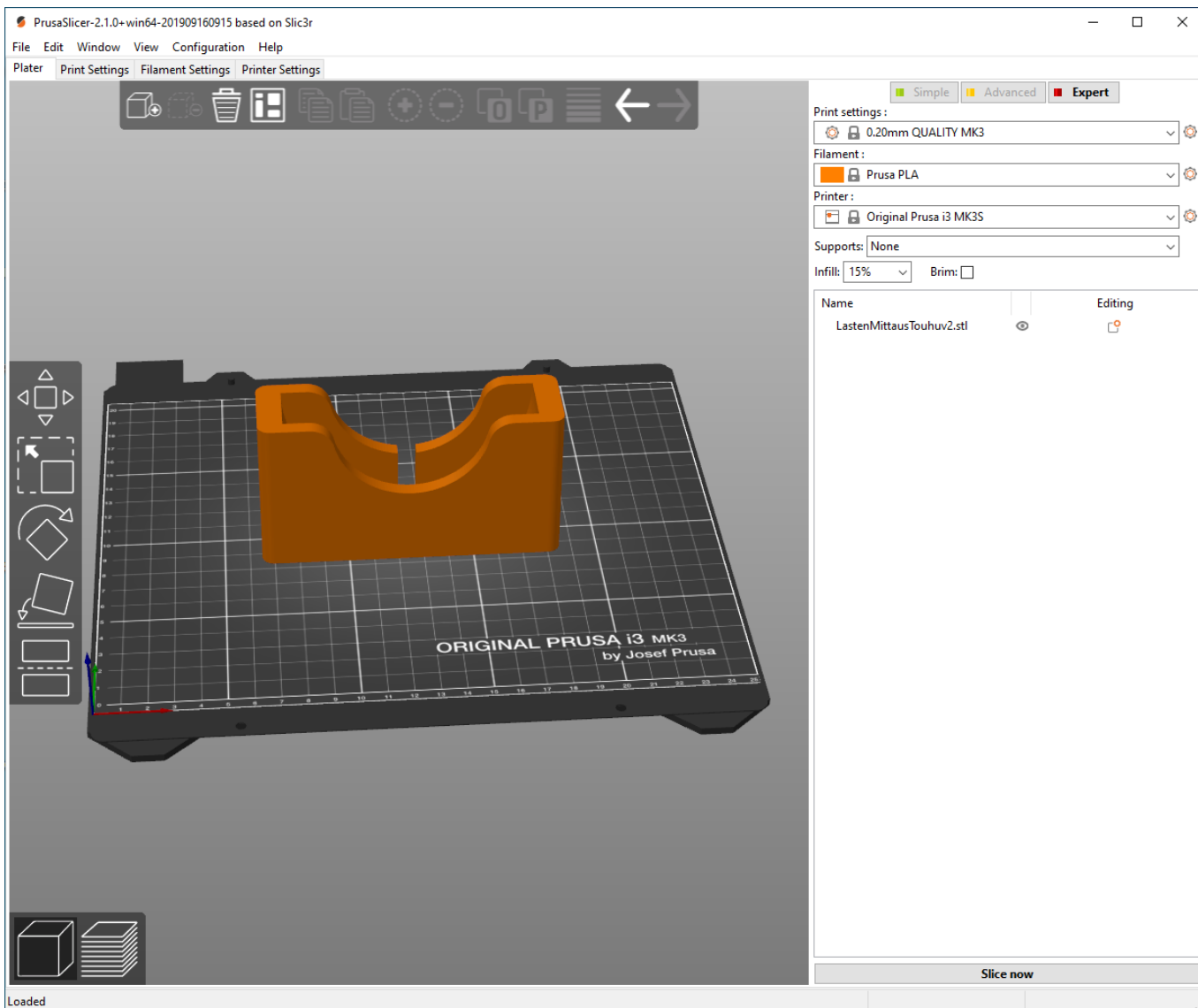- Supports every printer type
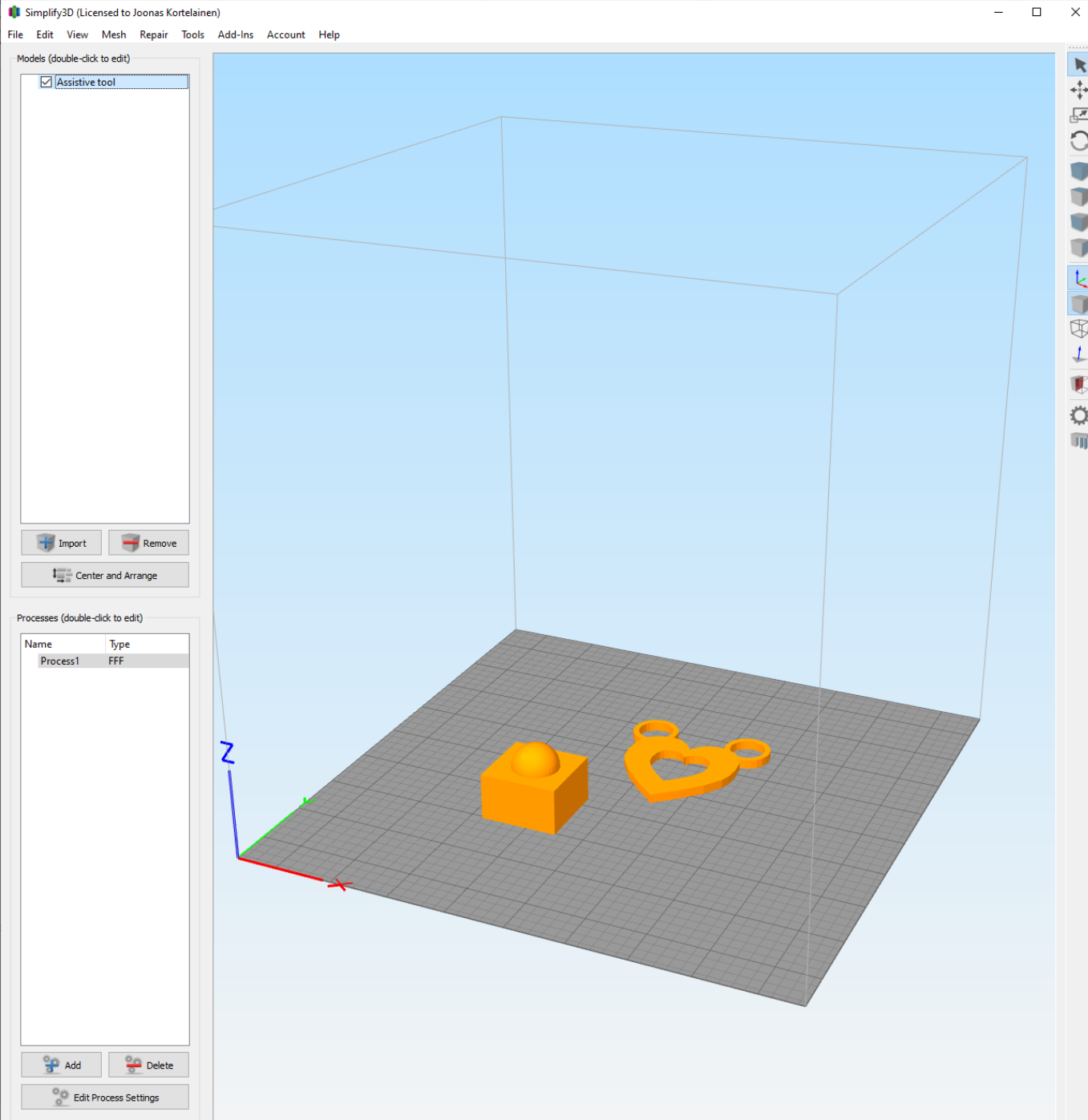
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Slicers

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Cura

- Free
- Works with every printer type
- A lot of ready to print profiles
- Can tune each setting

PrusaSlicer

- Free
- Works with every printer type
- A lot of ready to print profiles
- Can tune each setting

Simplify3D

- Pricey (~150 €)
- Works with every printer type
- A lot of ready to print profiles
- Can tune each setting