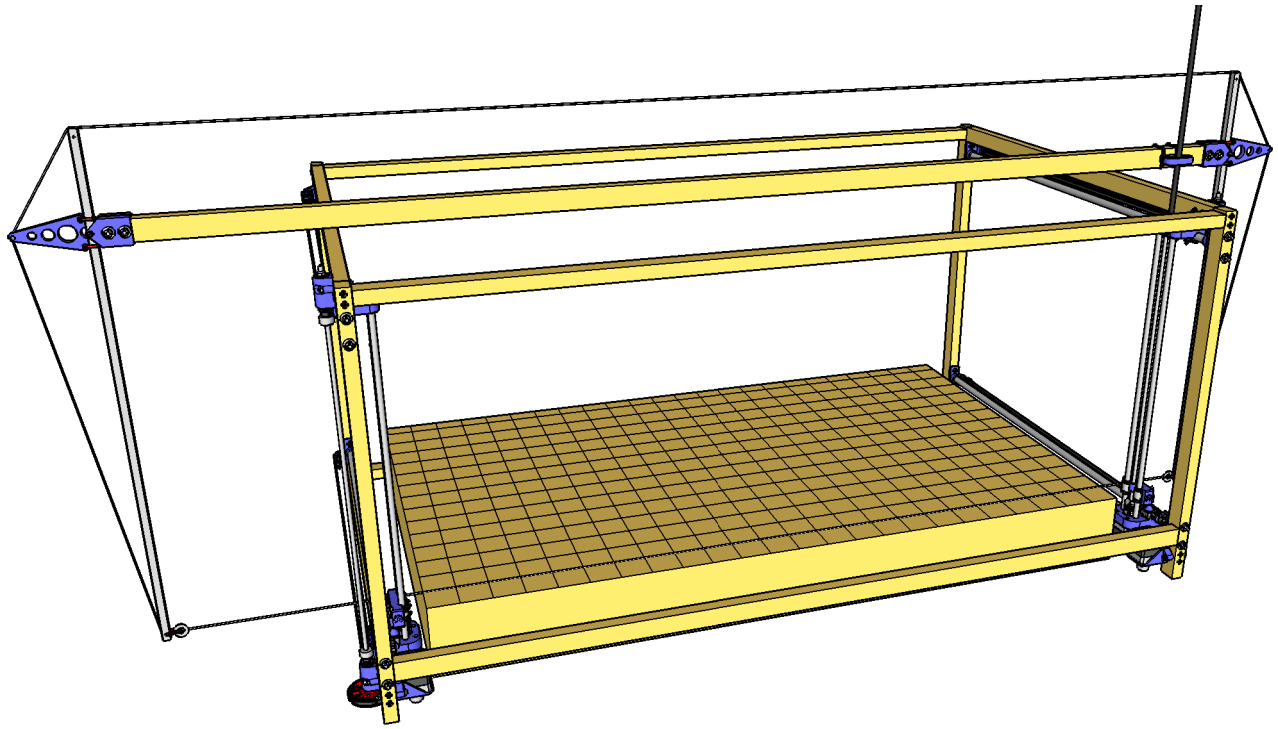
Open Source Foam Cutter

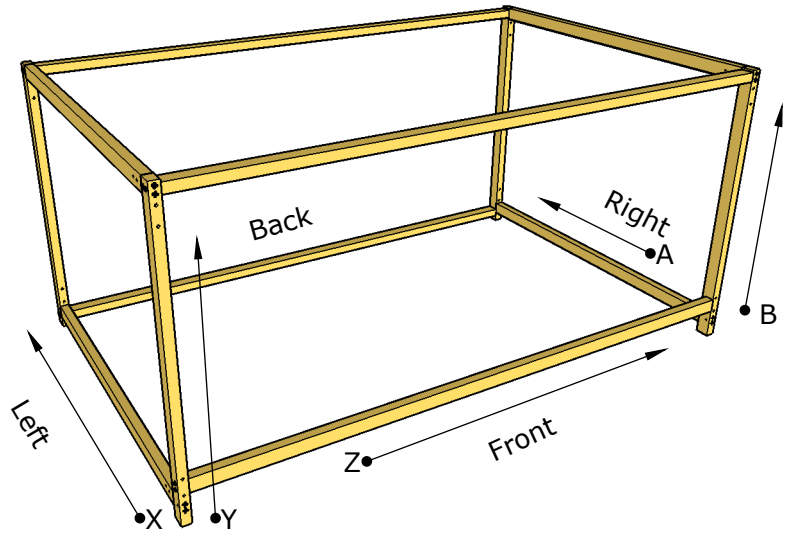


4 axis, cheap, modular CNC hot wire foam cutter

Ver.	Desc.	By	Date
0.2	OpenSCAD version	R. Lodde	22-10-15

Specifications

This machine cuts foam (EPS, EPP, etc.) by moving a hot wire. The wire is suspended between two frames, each with two independent axes. The picture below shows the axes arrangement and the directions used in this document.



Having four independent axes allows to cut also non square objects like tapered model airplane wings.

The work area is 650x440x1200mm. However, it's very easy to change the Z lenght by assembling the machine using shorter (or longer) spars. Lesser Z means better accuracy when cutting small parts and also greater taper angle possibilities. The tempered steel shaft are also oversized, it's possible to build bigger machine just using longer rods and frame elements.

It is also possible to implement a 5th axis, a rotating plate on the XZ plane. The option is absolutely feasible from a mechanical point of view but it's not implemented yet.

Key features

The main goal was to achieve the highest possible precision while keeping the overall complexity and price low; this drove the design in the following direction:

- The wire is supported by an arc which is not part of the main frame: the wire tension doesn't pull on the guides but is completely on the arc itself.

- After some iterations, we opted for an arc built in a way that all the forces are converted into tension on a surrounding wire. This allowed to reduce the structure size and weight, further reducing the load on the frame.

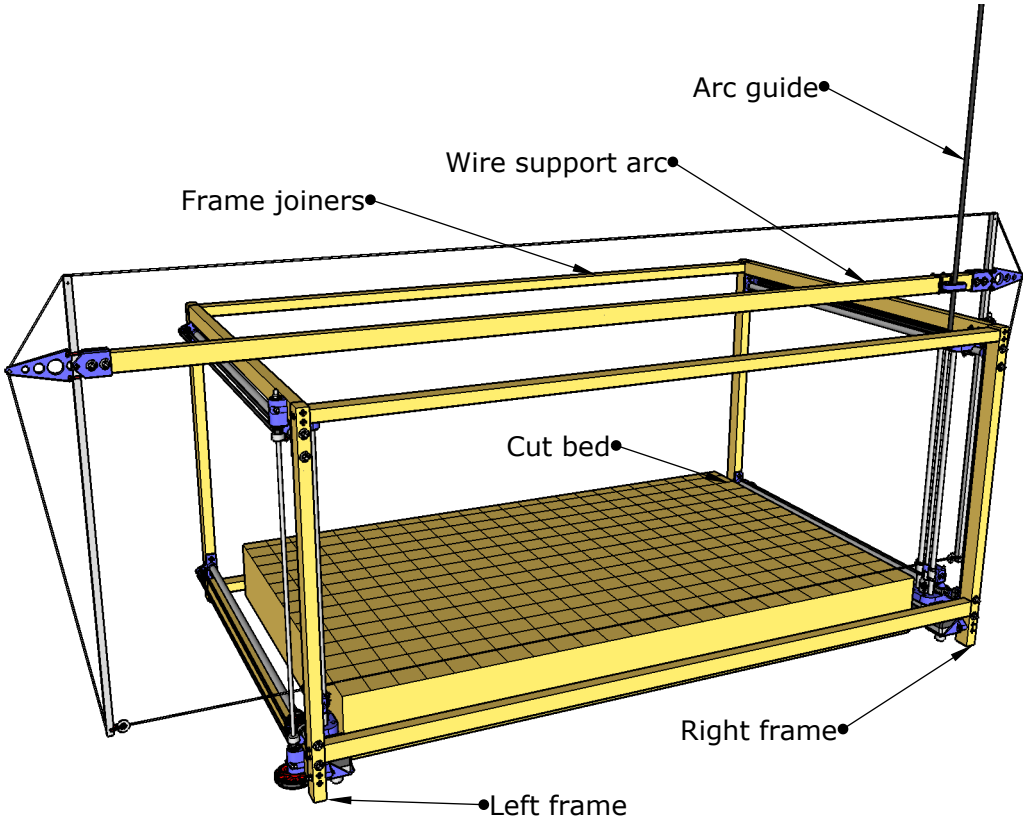
- Once off loaded of almost all the forces, the frame can be built with light, cheap and easy to work 20*30mm wood profiles.

- To reduce assembly time and skills required, we made extensive use of multi functional 3D printed parts. The only specialized tool we advice to use is a drill press for making the holes in the wood parts.

- The control system is based on components such as pulleys, belts and linear bearings that are widely used in the DIY 3D printers; there is a huge market for those parts and they are relatively cheap and easy to source.

The design is released under the GNU GPL v2 license.

Anatomy



All the actuator and electronic systems are mounted on the side frames.

The wire support arc holds the cutting wire resting on the two vertical carriages. The extra lenght is necesary to compensate the distance increase when doing tapered cuts.

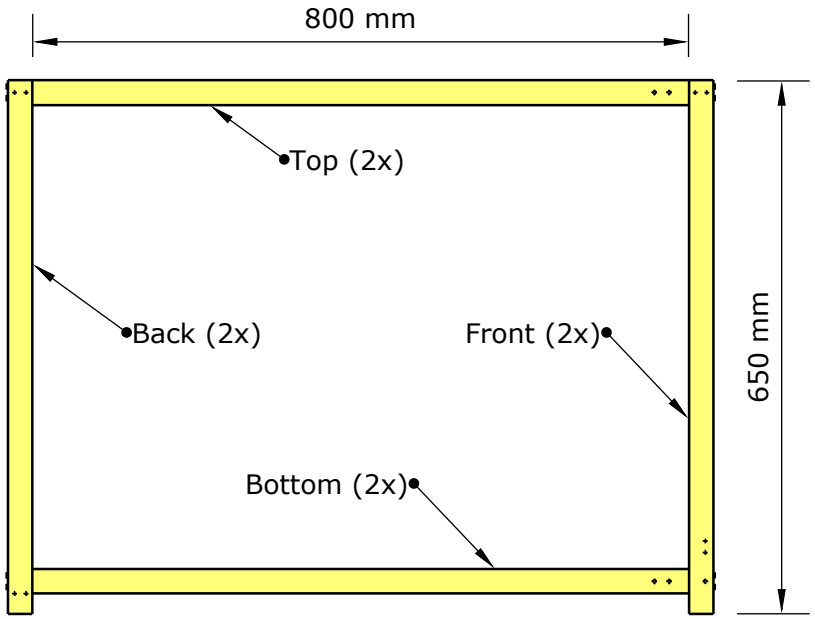
The arc guide is necessary to avoid the arc falling when the Y and / or B axes rise.

The cut bed has the only purpose to hold the material at working height. It's nice to have reference lines on it every 5 cm because some cuts require to place the material at a given distance from the towers. Size is 1200x730x120 mm. The reference guides distance is 50mm.

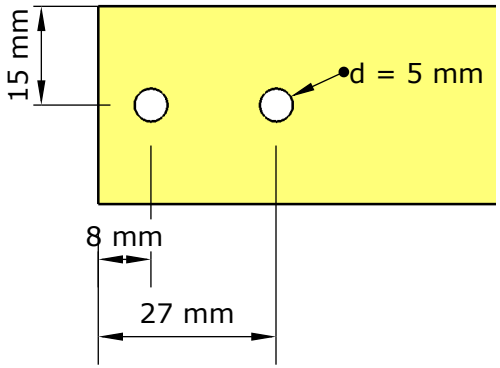
The wire current is controlled using a RC battery charger (iCharger 106 B+) that has a dedicated function. The best way to control the wire temperature is to work in constant current mode, it will give more or less the same temperature even if the wire length changes.

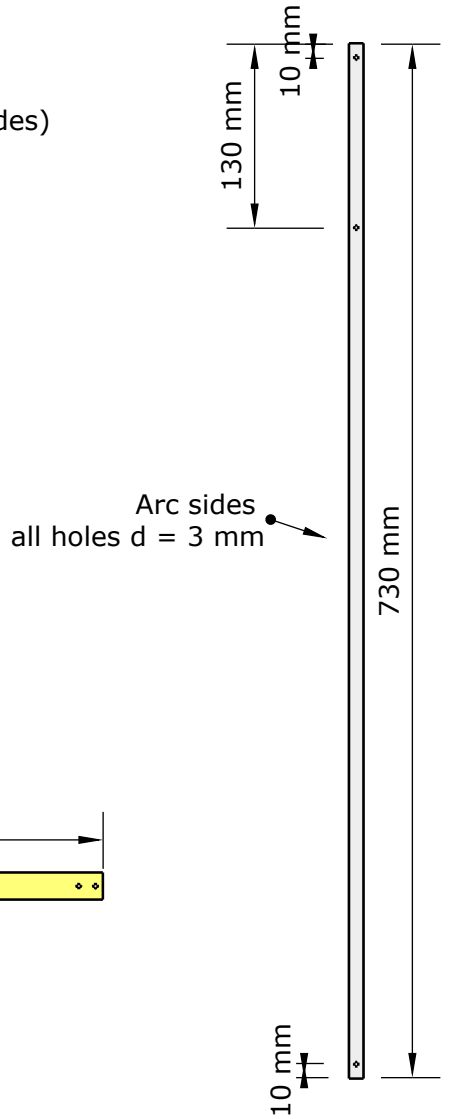
The motion control runs on a PC and a DB25 interface port from ebay.

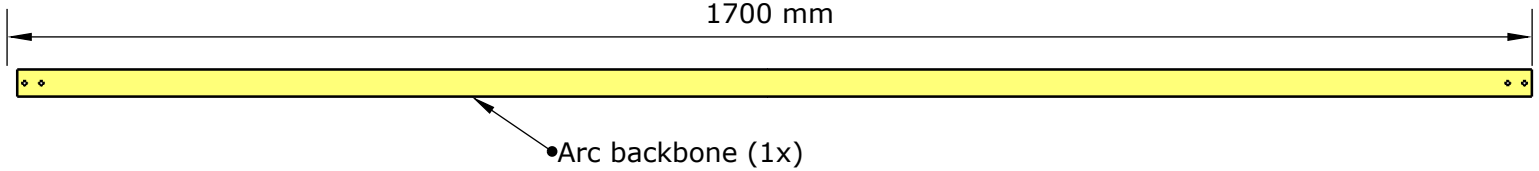
Cut the raw materials

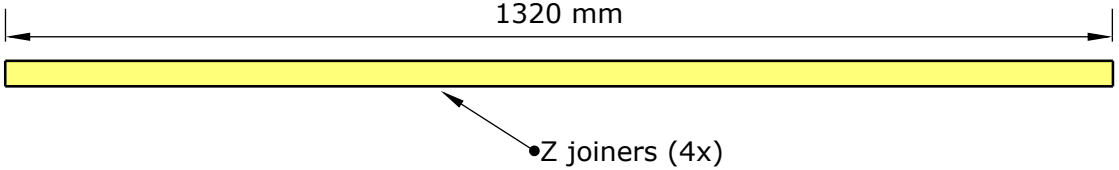


Arc backbone holes template(both sides)









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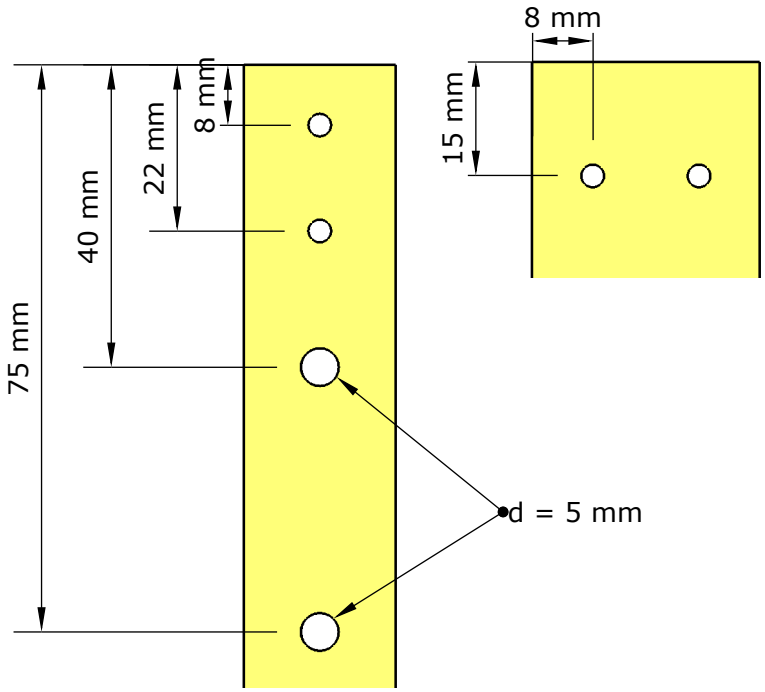
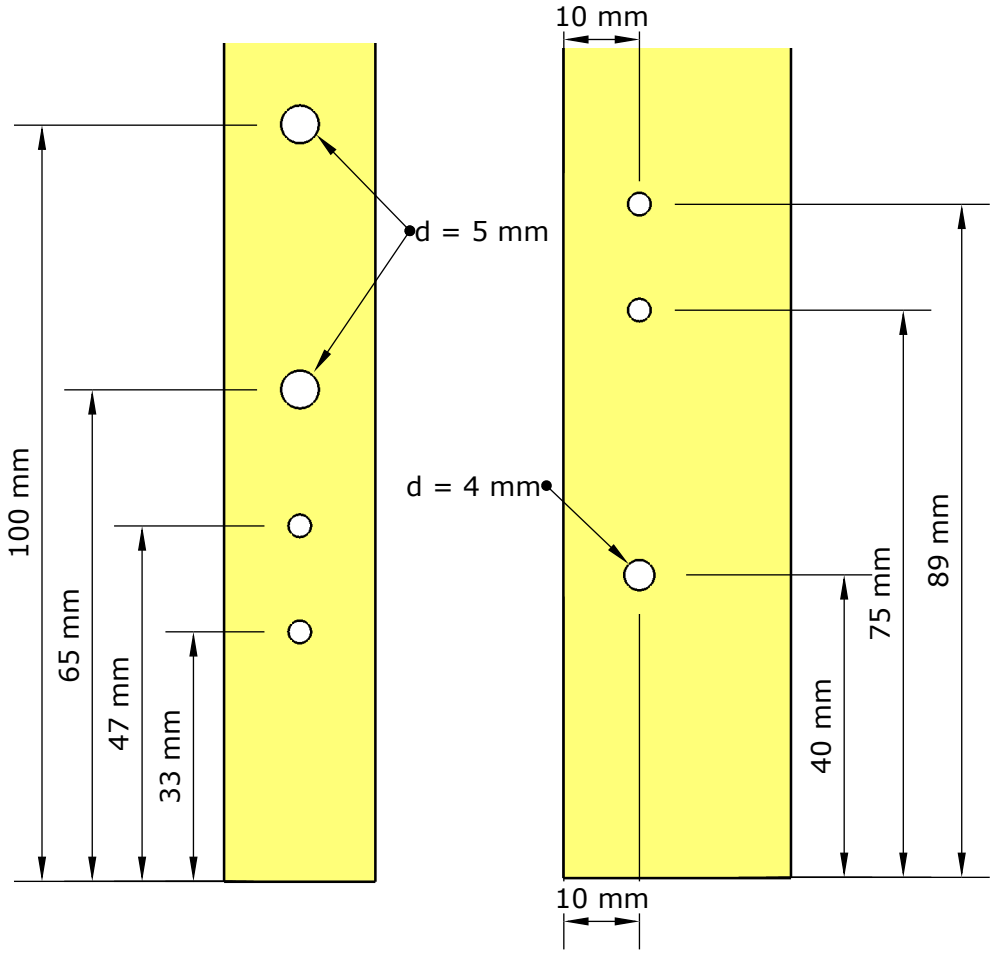
Front frame element drill template

top



bottom



All holes d = 3 mm unless otherwise specified
All holes on center line if no horizontal quote is present

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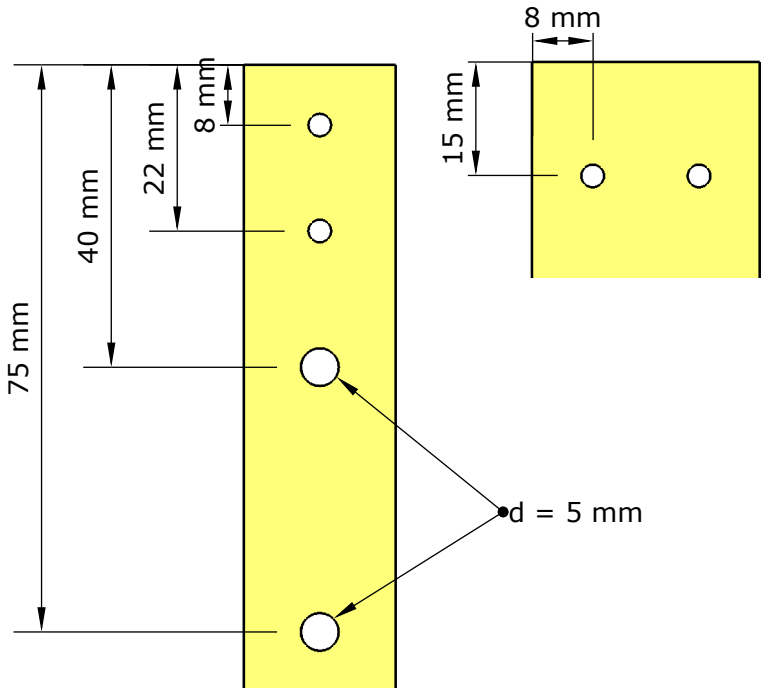
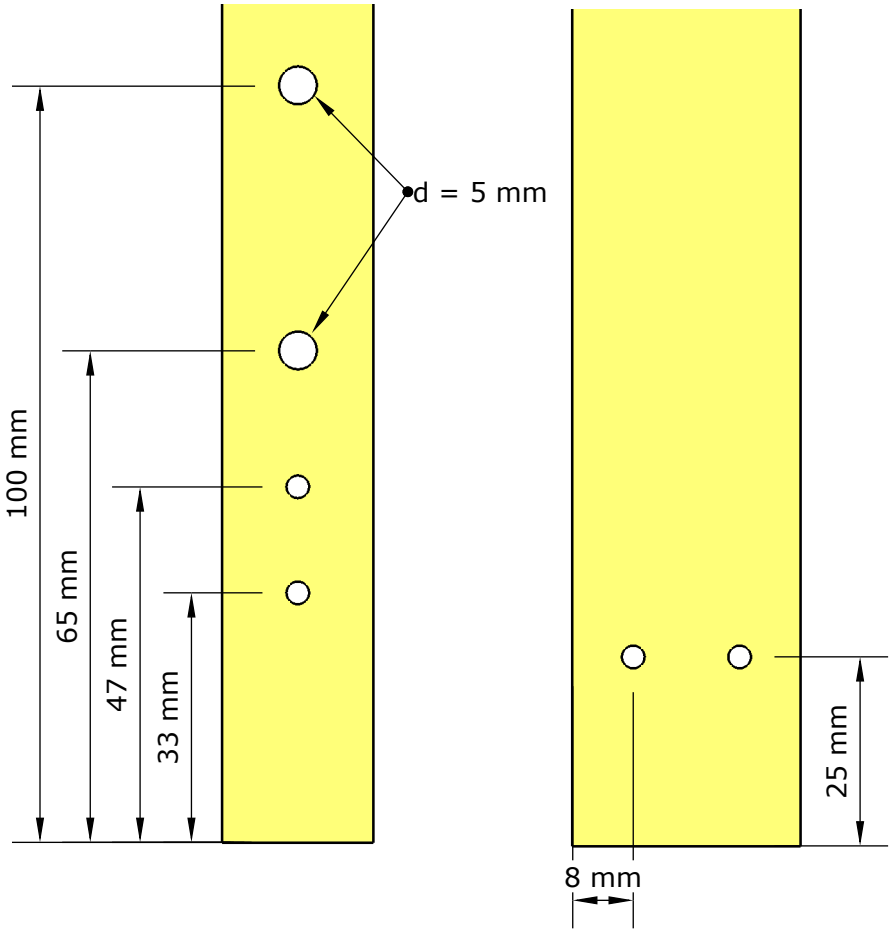
Back frame element drill template

top



bottom



All holes d = 3 mm unless otherwise specified
All holes on center line if no horizontal quote is present

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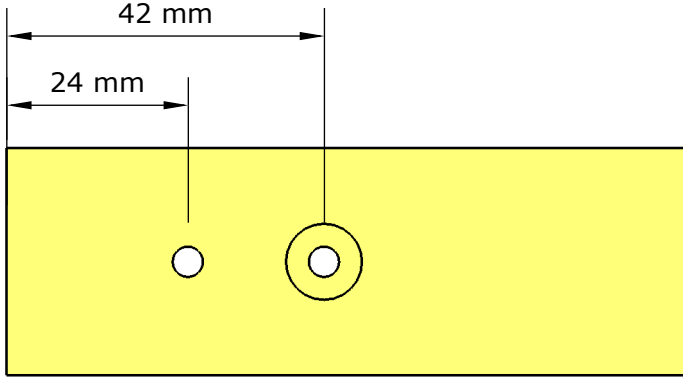
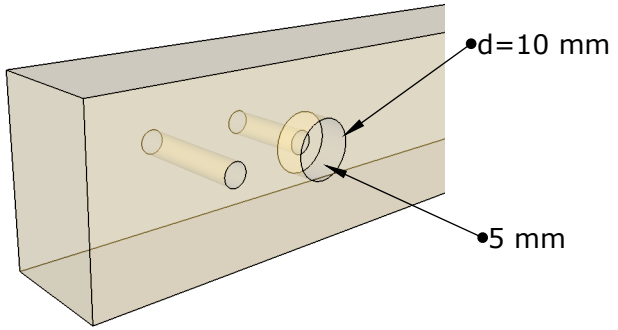
Top and bottom frame elements drill template





Note: countersink hole in the bottom element only.

All holes d = 3 mm unless otherwise specified
All holes on center line if no verticall quote is present

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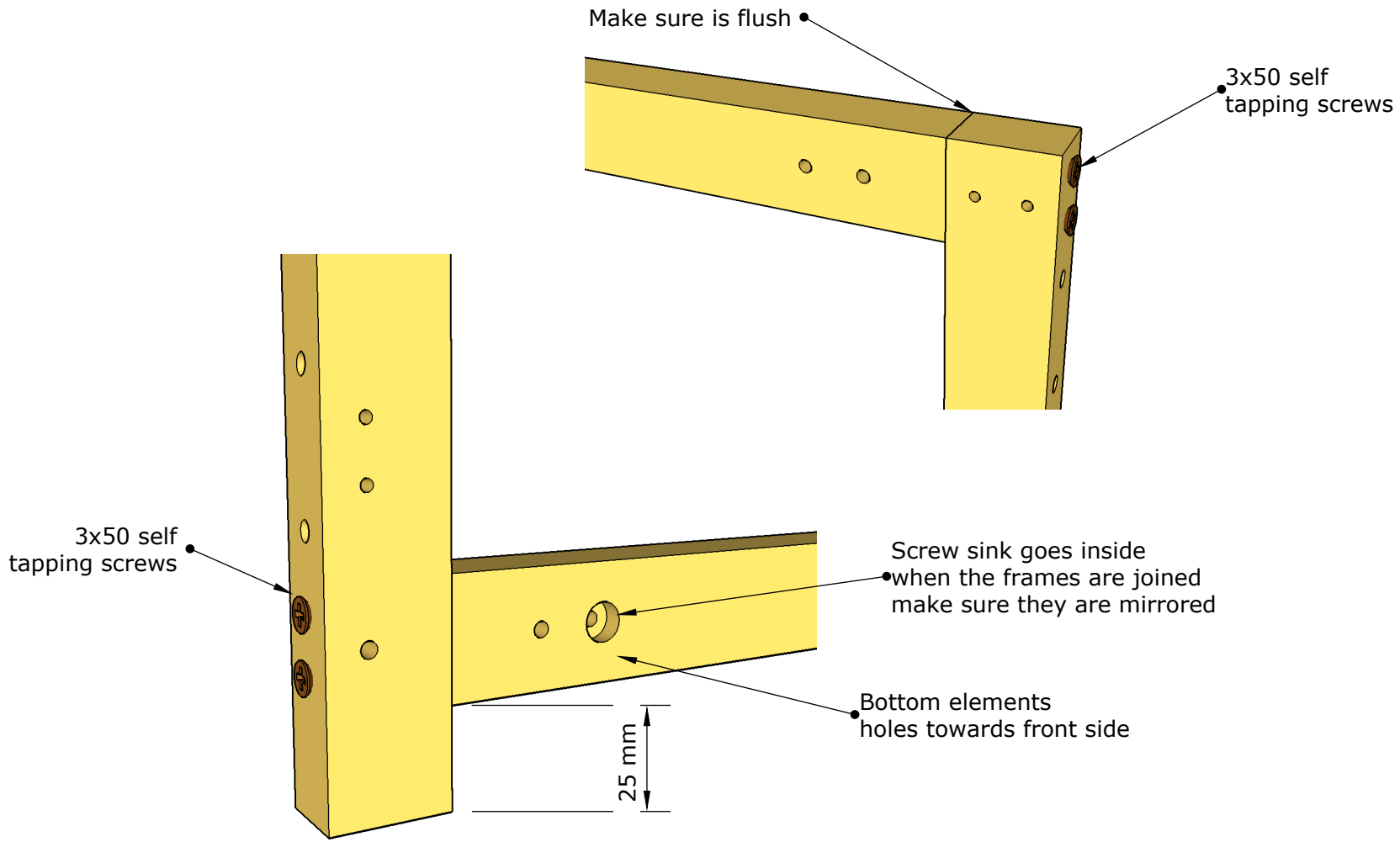
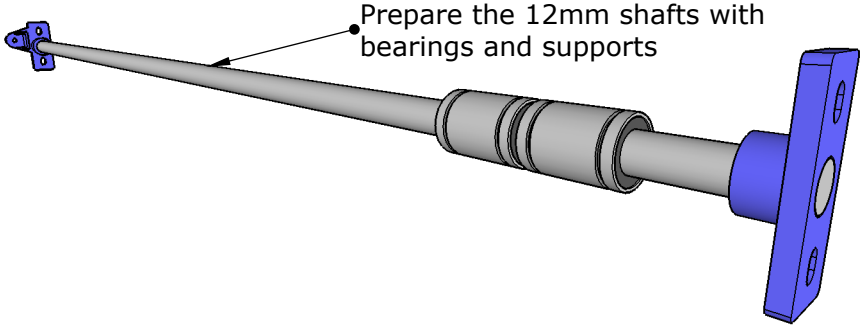
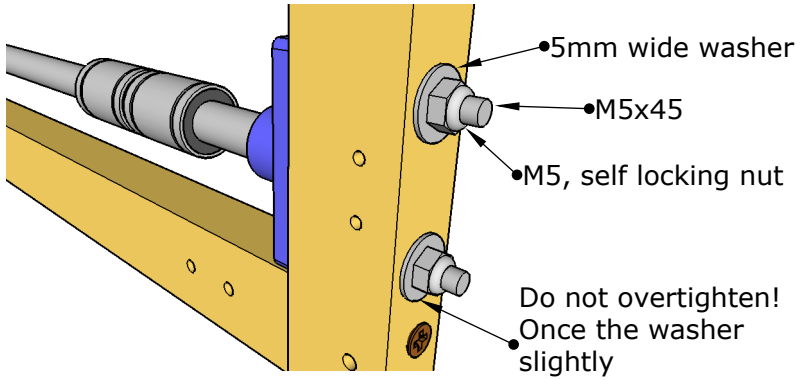
Side frames assembly

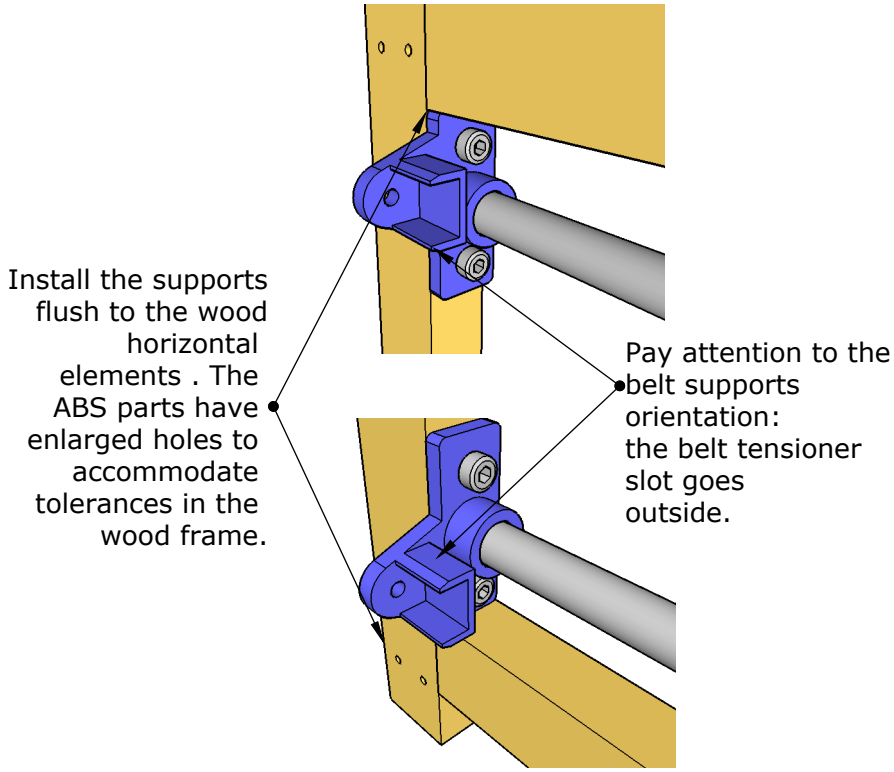


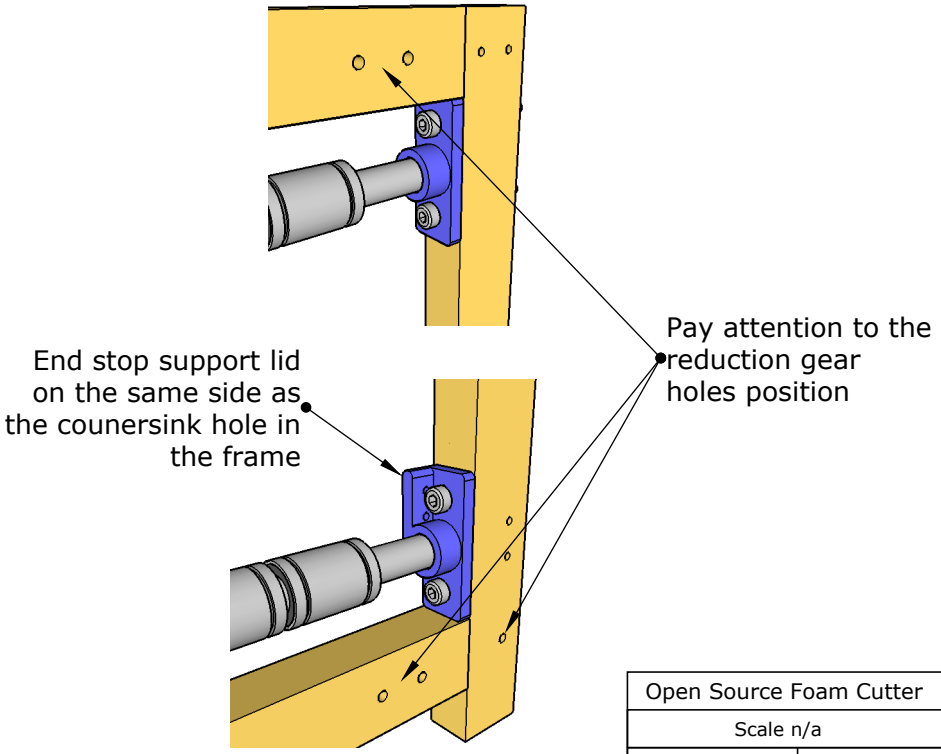
Note: all the images in this document refer to the left panel.

Horizontal guides installation









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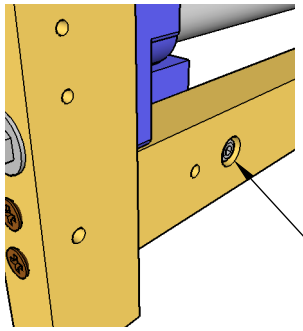
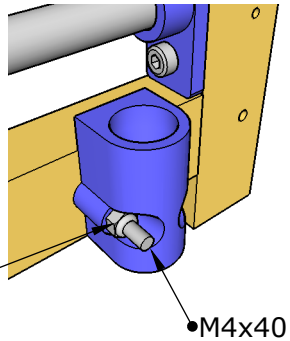
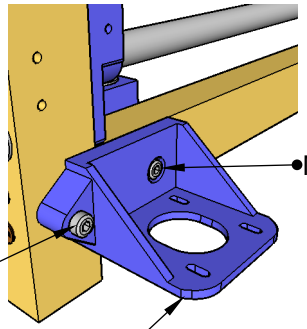
Horizontal drive installation - part 1



Mount the screw
in the countersink
hole first



M4x40



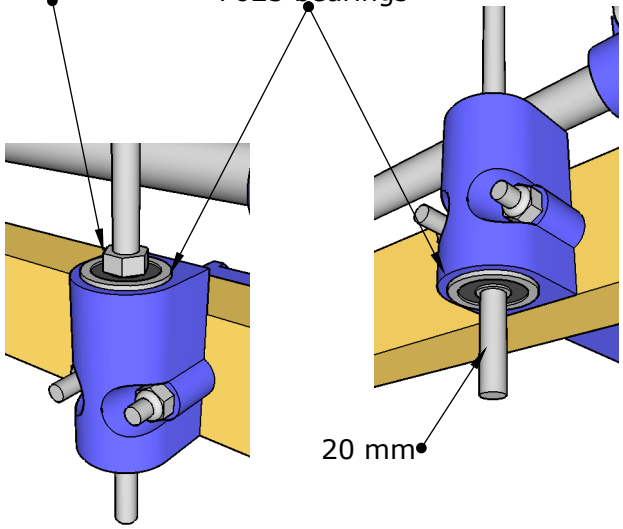
M4x45

M4x40

Install the motor support

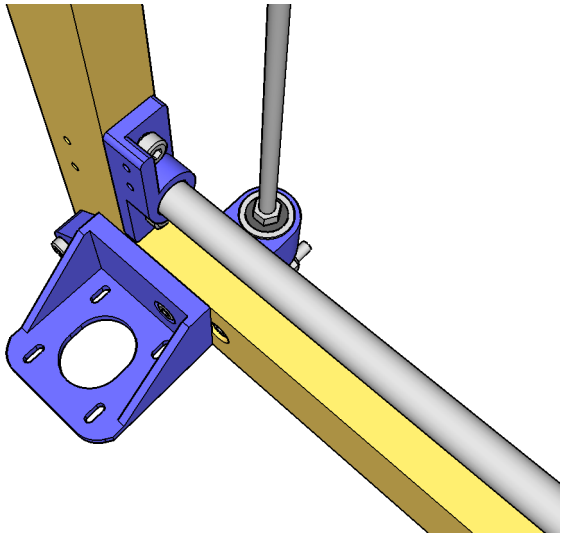
M5 nut

F625 bearings

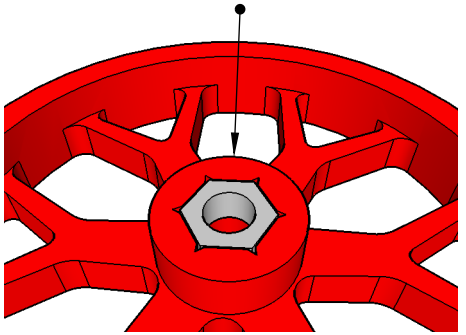


20 mm

Overall view



M5 nut - use heat
and / or glue to fix it



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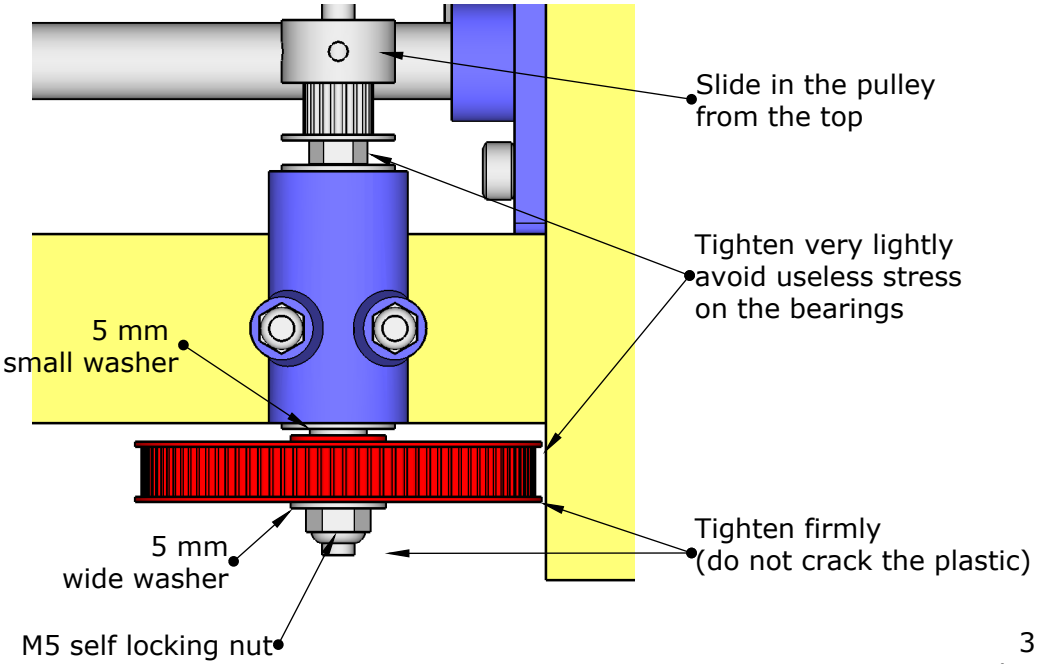
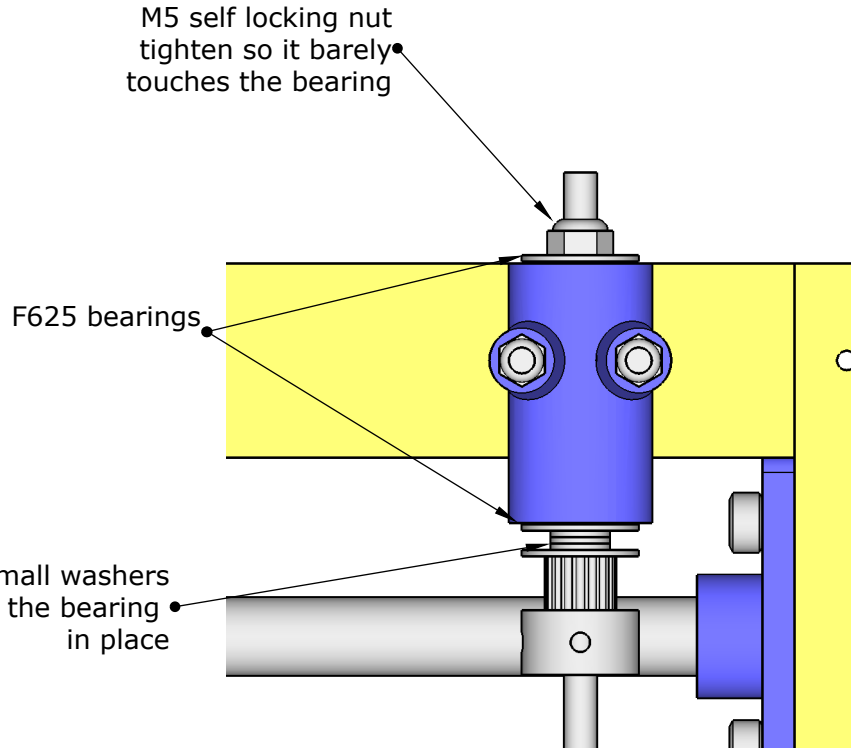
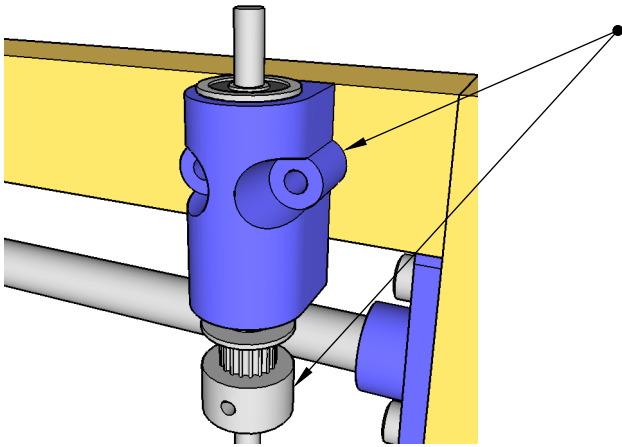
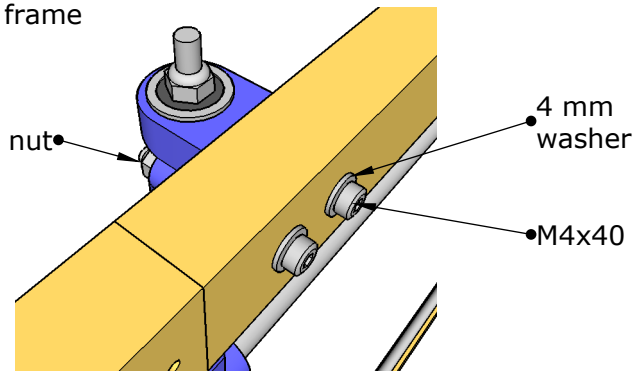
Horizontal drive installation - part 2









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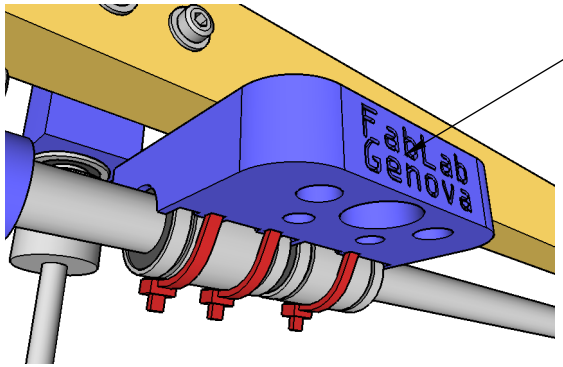
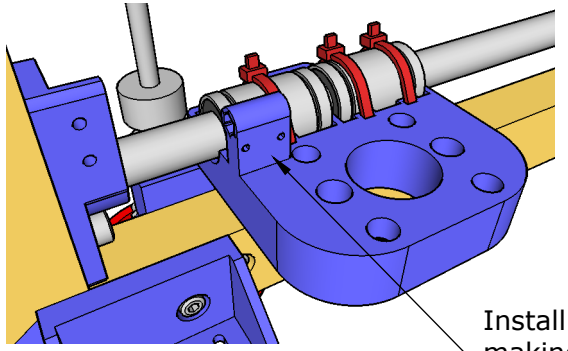
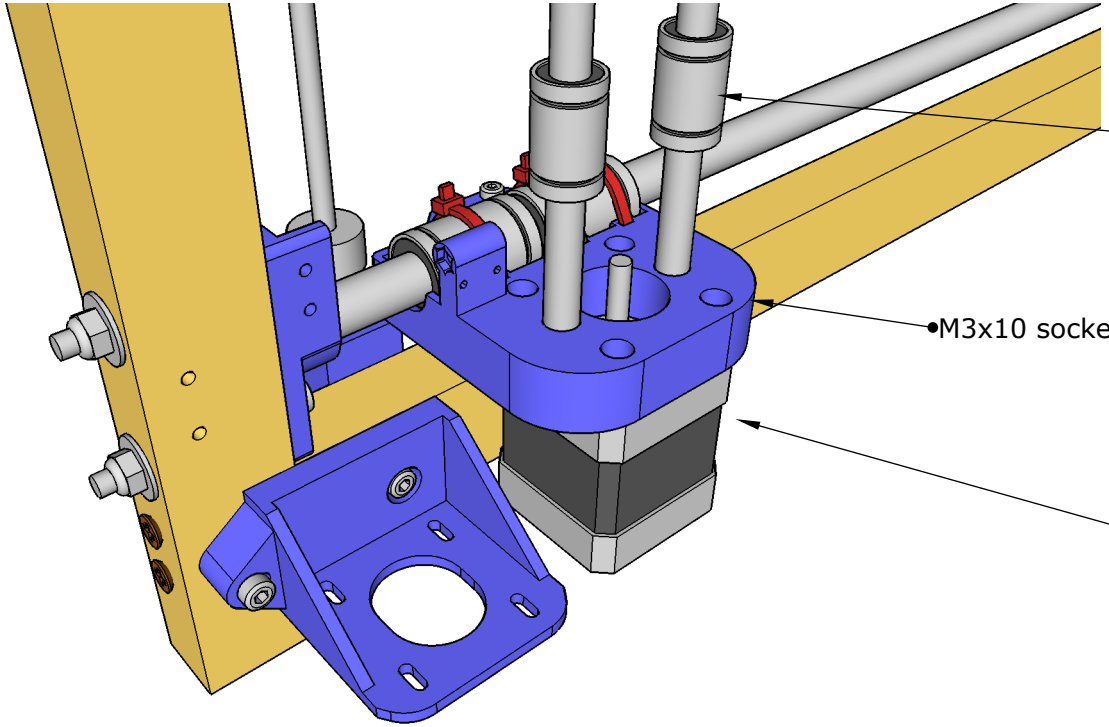
Vertical guides installation



Install the upper carriage.



Install the lower carriage making sure that the end stop support is towards the AX end stop.



Slide the shaft through the upper carriage, insert the bearings, slide through the lower carriage until they rest on the stepper motor face

M3x10 socket head screws

Install the motor before sliding in the 8mm shafts

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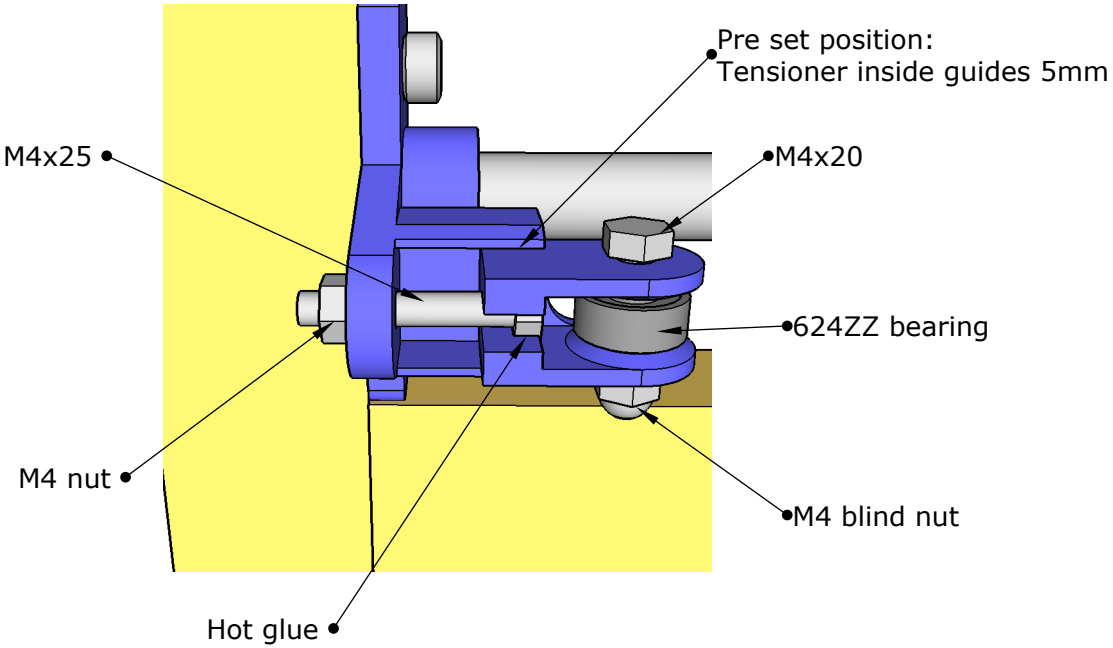
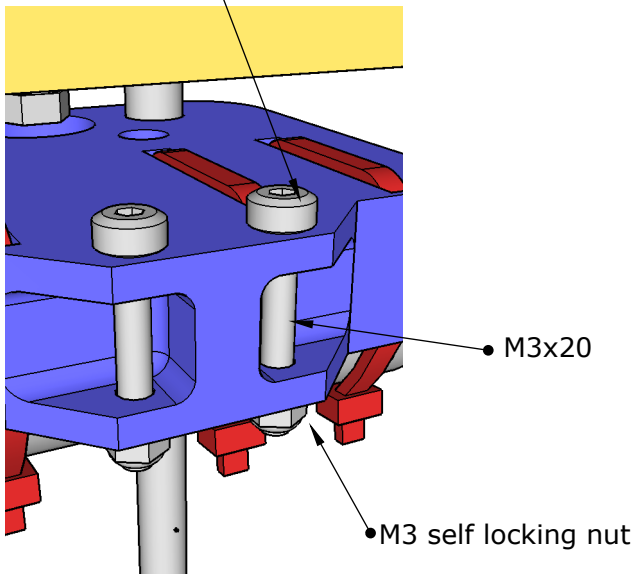
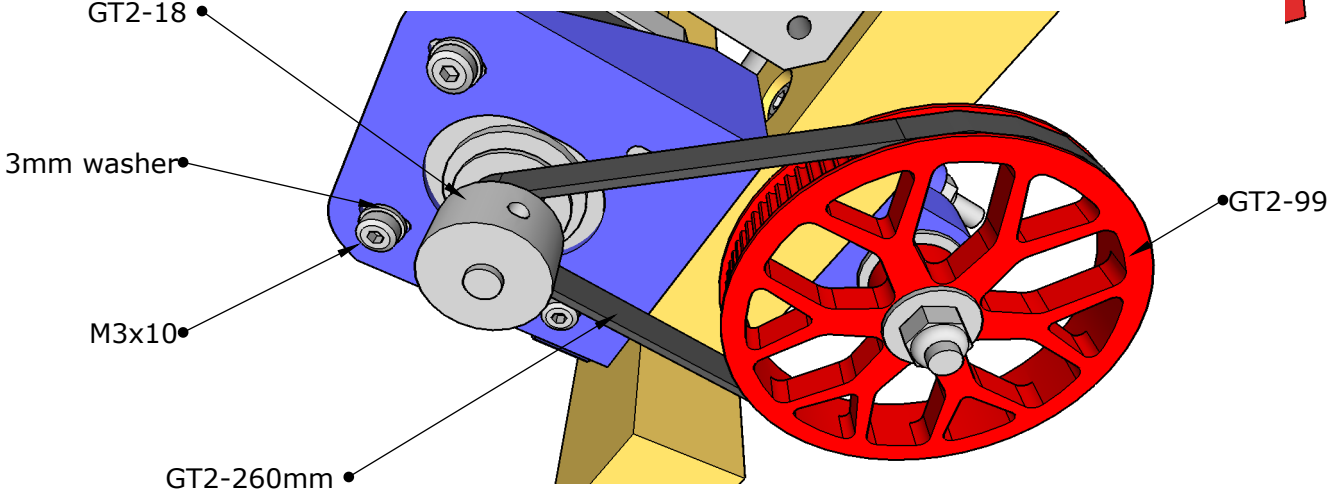
Horizontal drive installation - part 3



Install the screw pins in the upper and lower carriages where the belt will lock to. Do not over tighten or the plastic might crack





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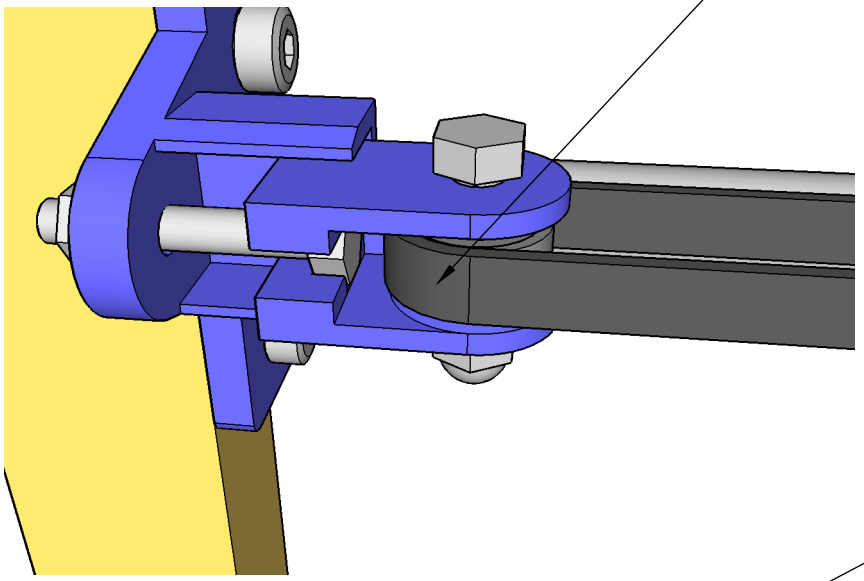
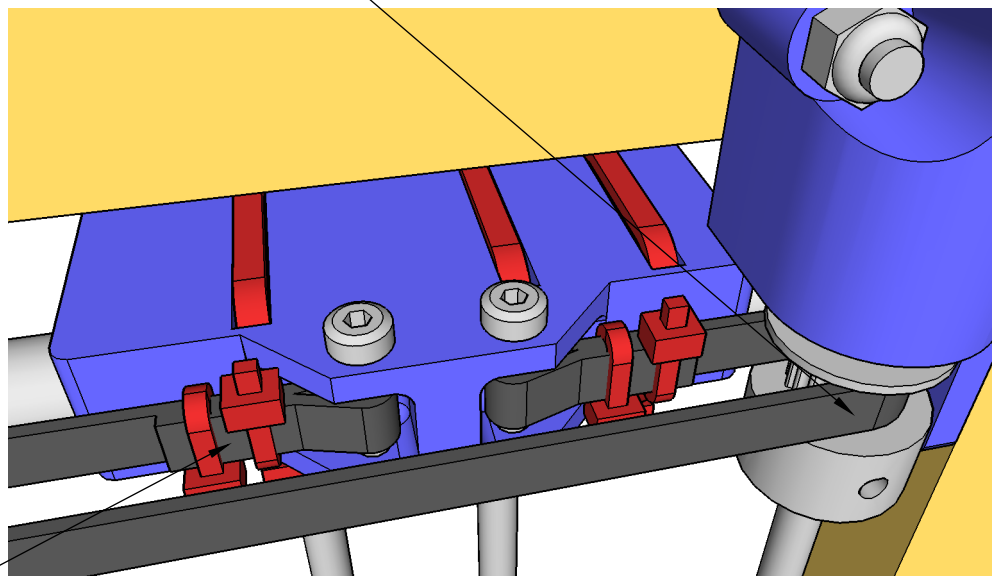
Horizontal drive installation - part 4



Insert the belt from the outside, teeths inside



Lock the belt on the screws using two zip ties on each side

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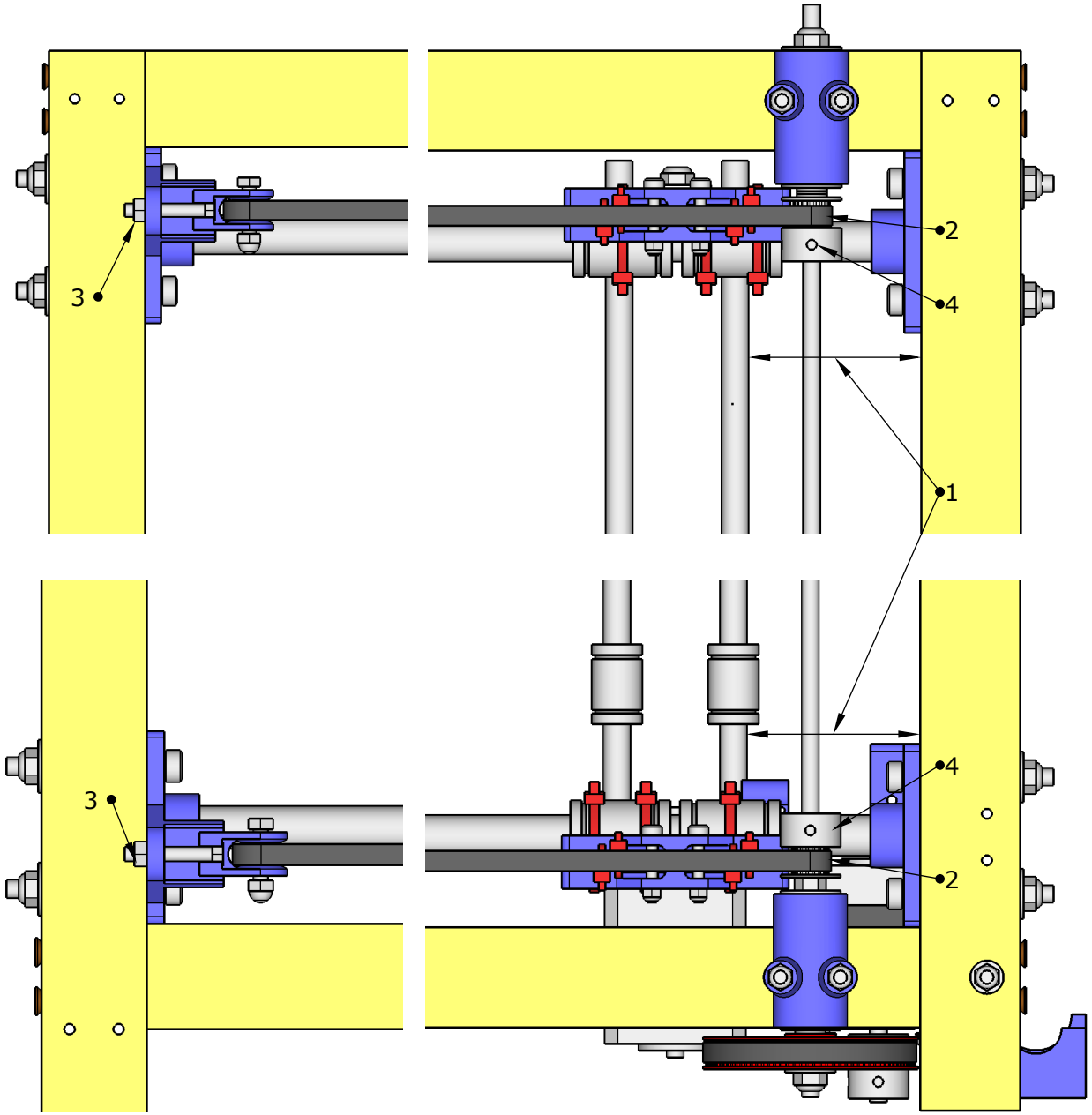
Horizontal drive main belts setup



Make sure the 18 teeth pulleys are free to move before starting.

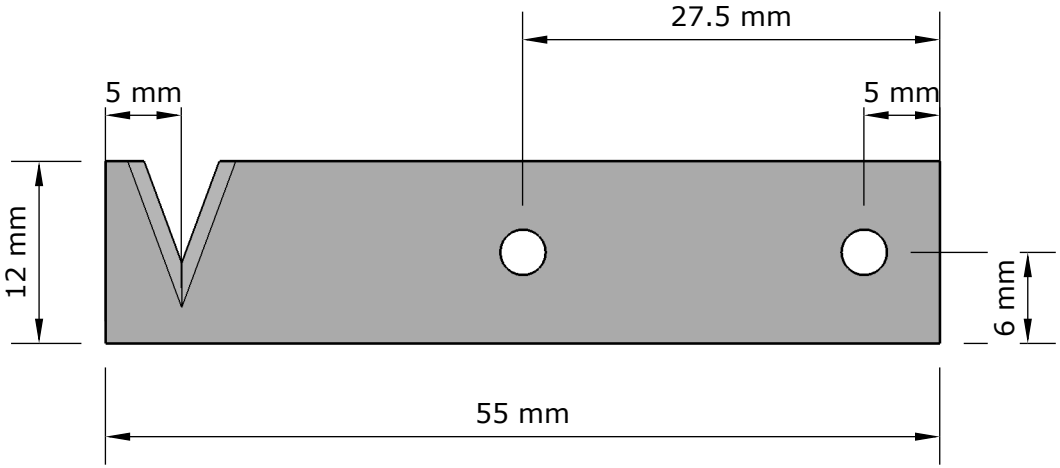
1) check that the 8mm guides are vertical and parallel to the frame. The parts are not on the same plane, using a wood block as reference helps.

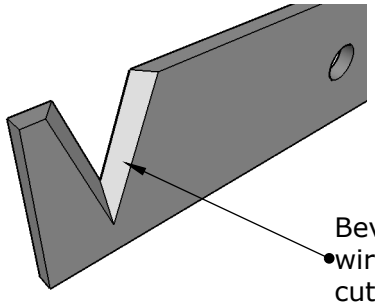
2) ensure that the pulleys are at the right height and the belt is straight

3) adjust the belt tension: since the machine moves very slow, it doesn't need to be super tight. Be careful to not bend the 5mm shaft.

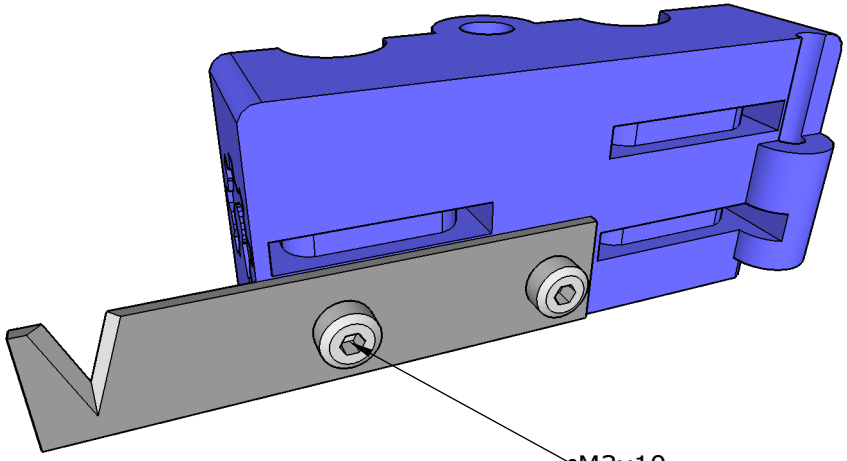
4) double check the measurements and tighten the pulleys set screws.

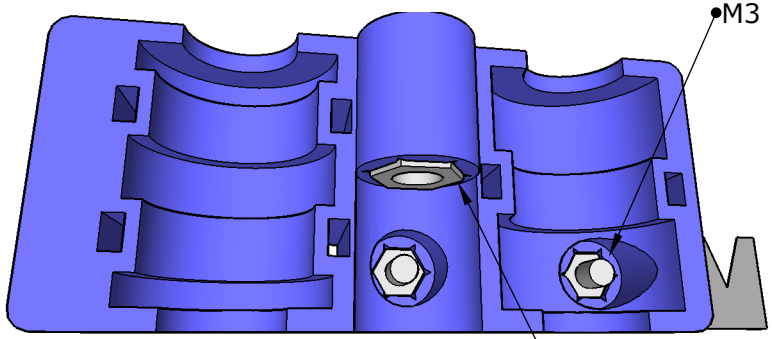
Vertical carriage preparation





Bevel the edges so the wire will not jam when cutting at high angles





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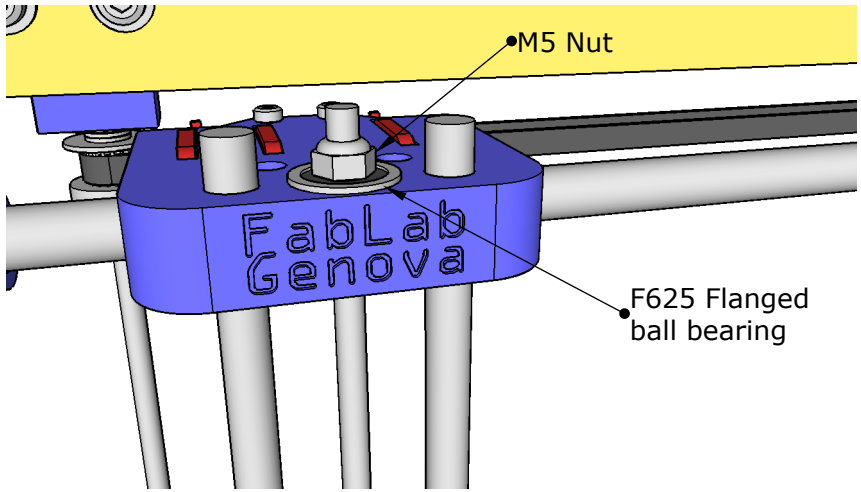
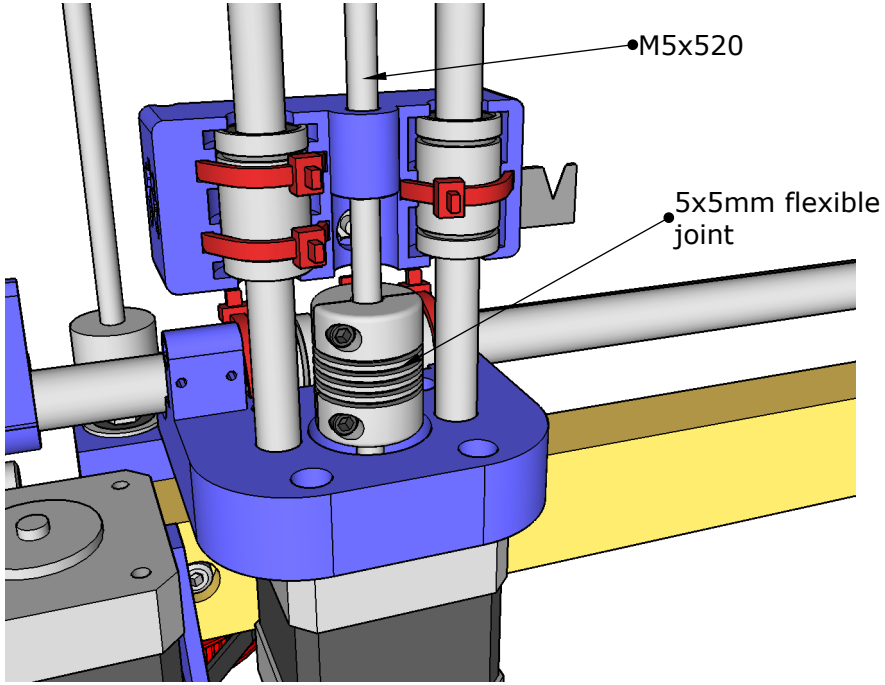
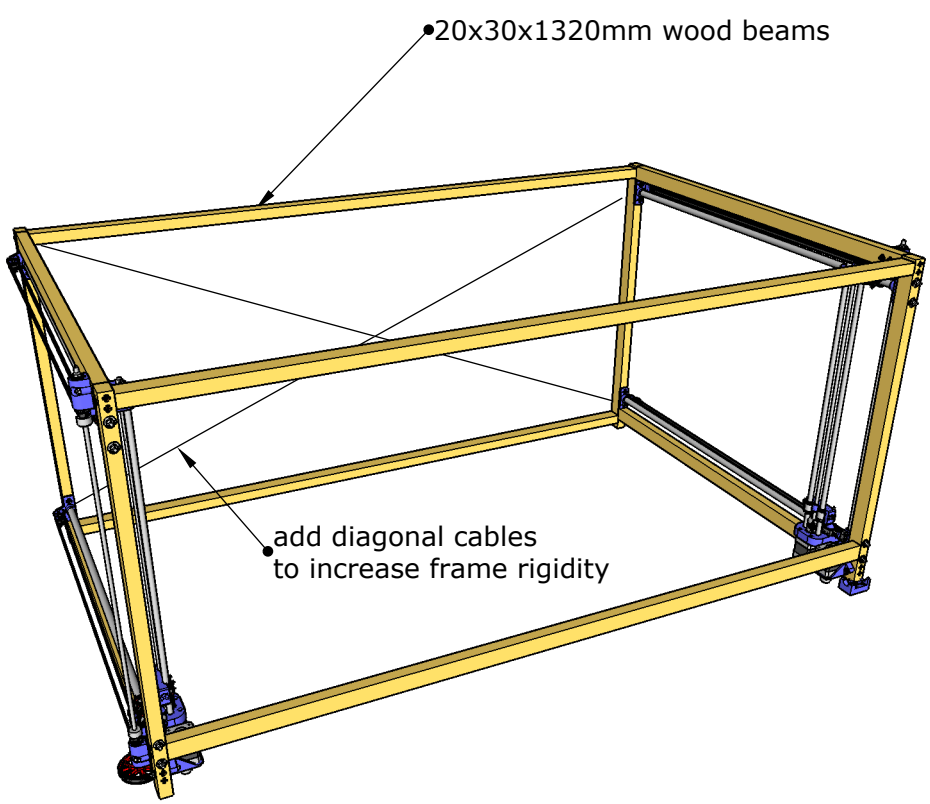
Vertical carriage installation

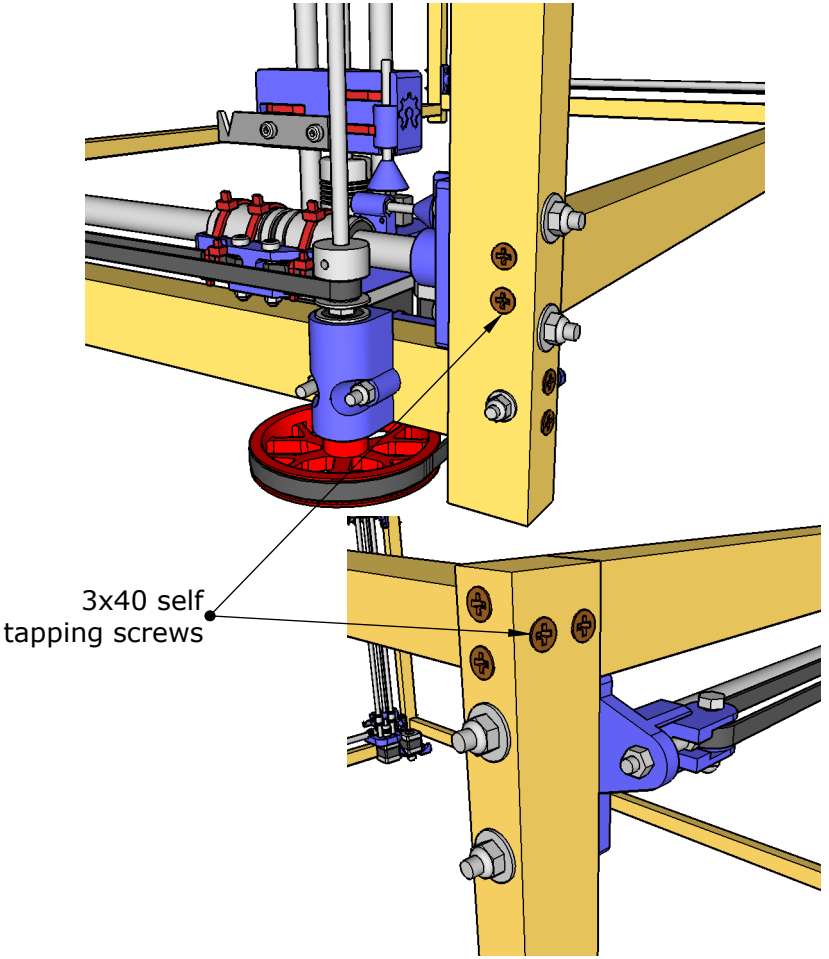




Slide the 5*520 threaded rod through the upper carriage, screw through the cursor and fix it to the flexible joint. Insert the flanged bearing on the upper carriage and screw in the retaining nut - it has to be tighten so it just touches the bearing.

Main assembly





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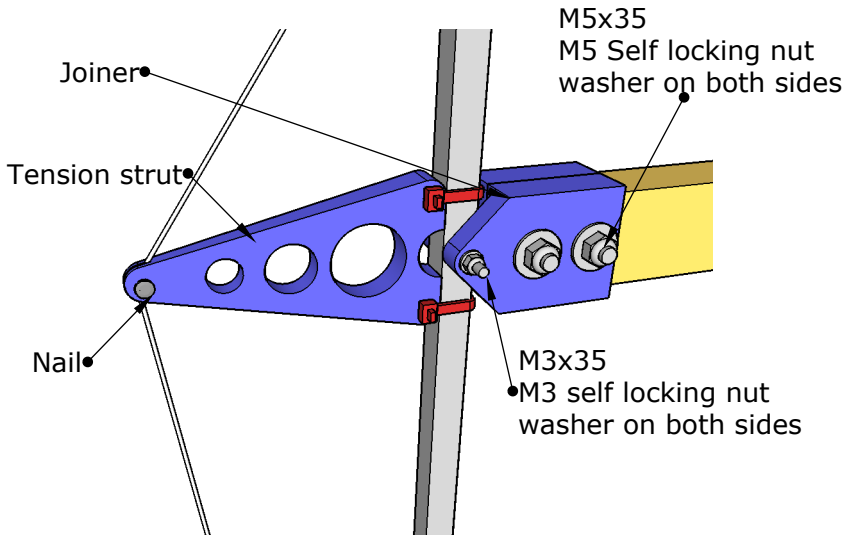
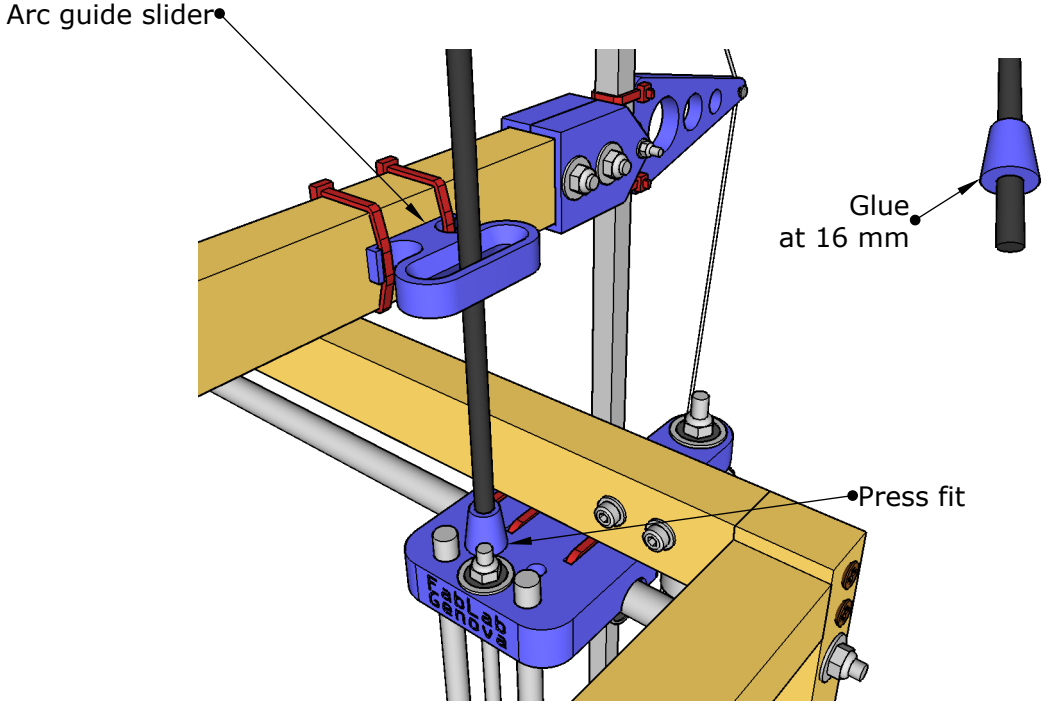
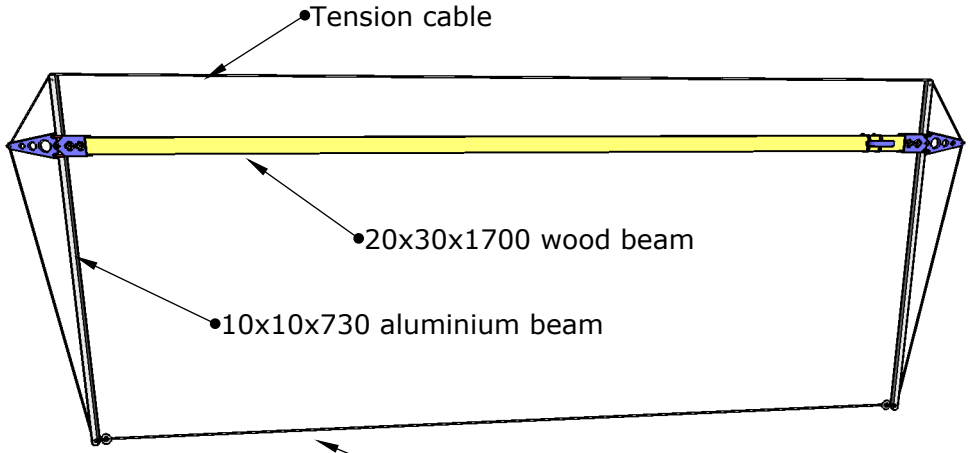
Wire support arc assembly

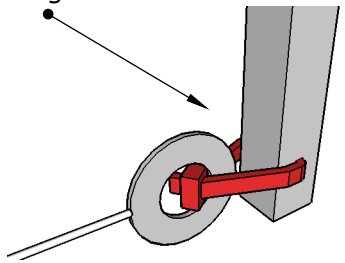






Note: the wire must be installed when the arc is already on the main machine frame

The cutting wire must be electrically isolated from the supporting arc



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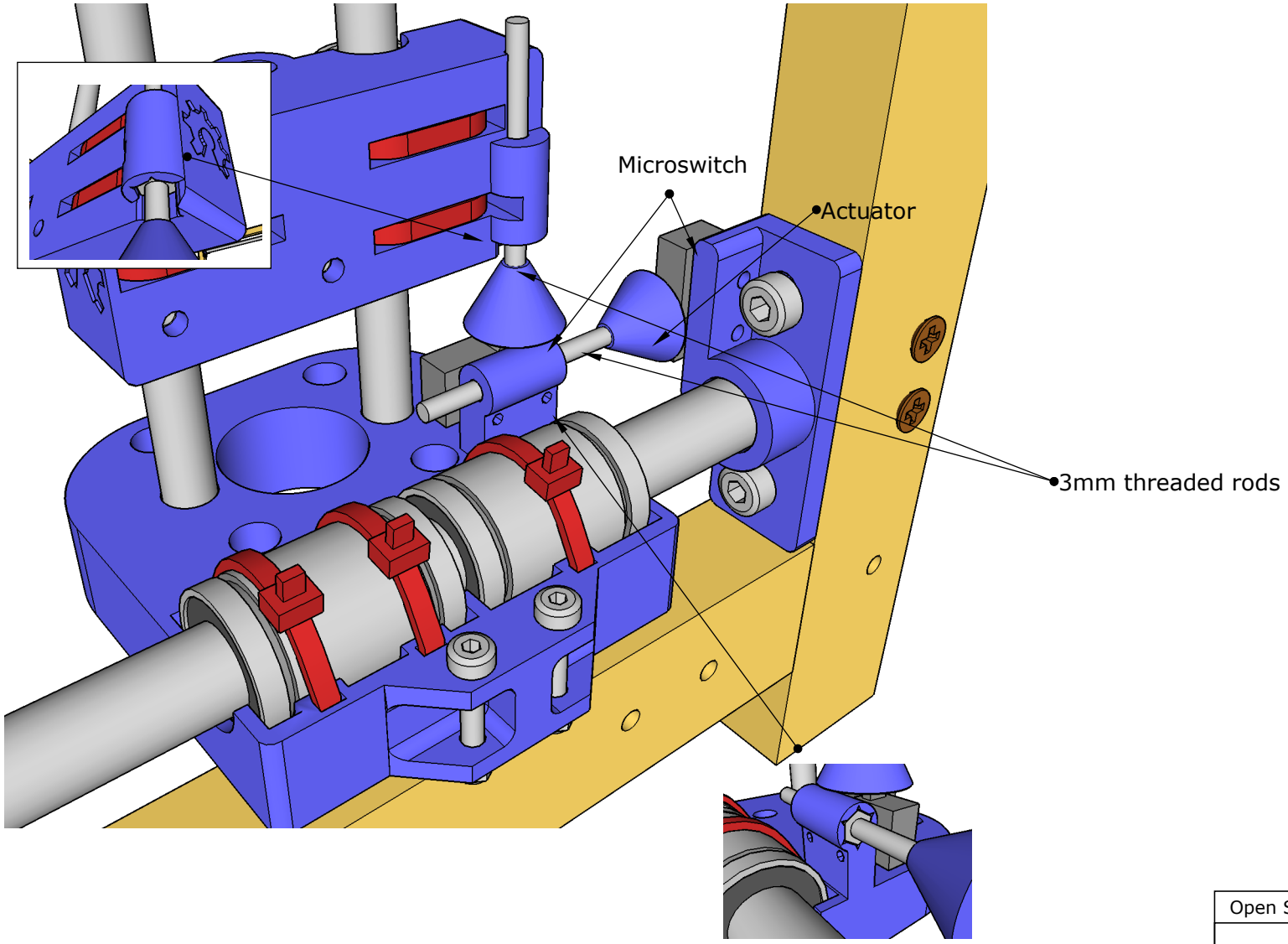
End stop installation

xx



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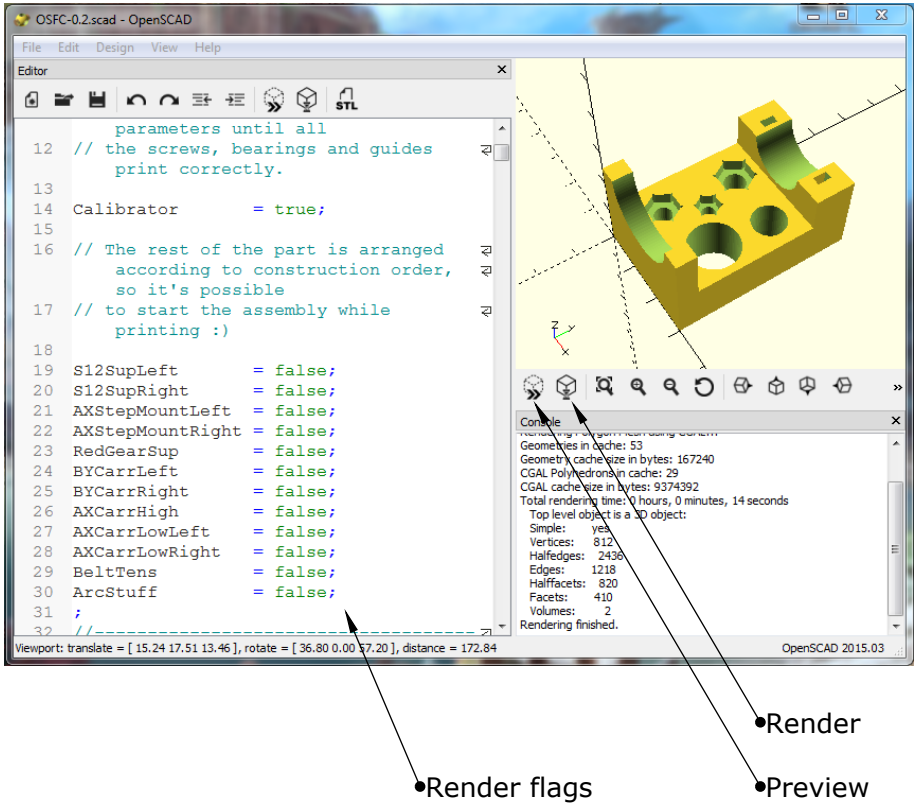
Generate the STL files

The STL files are not distributed directly, it's necessary to generate them using OpenSCAD: an open source, multi platform, solid 3D CAD modeller. Download it from:

www.openscad.org

Download the file OSFC-Oscad-0.2 and uncompress to a convenient location. Install the OCR-A fonts since they are used to generate the logos on the parts.

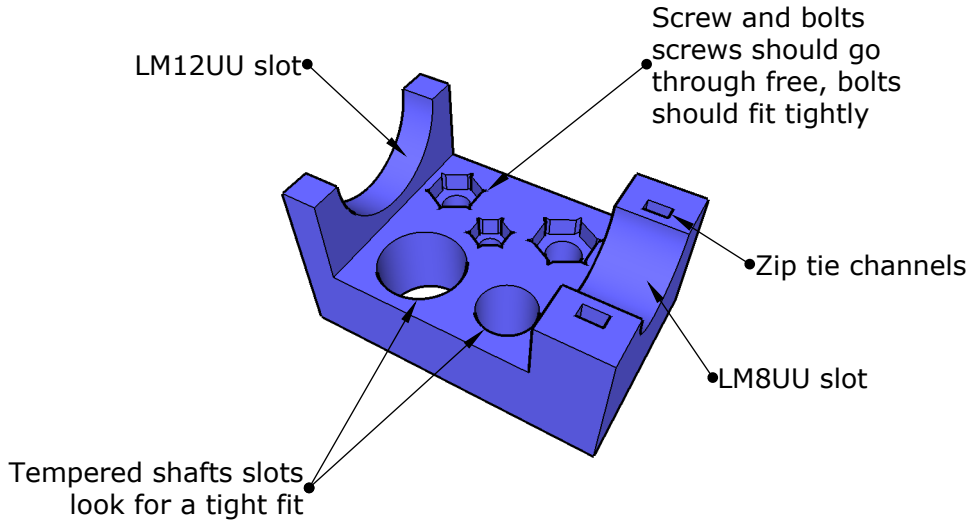
Open the file OSFC-0.2.scad



STL creation workflow:

- Select the parts setting the render flags
- Preview the result
- Render the result
- Export the STL file using the ***file - export - export as STL*** command.

We recommend printing the calibrator part first, check that the tolerances are OK and then go ahead with the other parts. The OpenSCAD file has comments that explain how to tweak the parameters.



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Hardware Store		
Item	Description	Qty
1	3x50 self tapping screw	16
2	3x40 self tapping screw	16
3	M5x45 socket head screw	16
4	M5 x 15mm washer	26
21	M5 x 10 mm washer	8
5	M5 self locking nut	26
6	M5 nut	6
7	M4x40 socket head screw	8
27	M4x45 socket head screw	2
8	M4x25 hexagonal head screw	4
9	M4x20 hexagonal head screw	4
10	M4 nut	4
11	M4 blind nut	4
12	M4 self locking nut	10
13	M4 washer	6
14	M3x10 socket head screw	18
15	M3x20 socket head screw	8
16	M3 washer	10
17	M3 nut	8
18	M3 self locking nut	10
19	M5x660 Threaded rod	2
20	M5x520 Threaded rod	2
23	M3x35 Socket head screw	2
24	M5x35 Socket head screw	4
25	Soft steel nails	2
26	M3x45 Threaded rod	4

CNC Hardware Store		
Item	Description	Qty
31	12x800mm tempered steel shaft	4
32	8x550mm tempered steel shaft	4
33	LM12UU linear motion bearing	8
34	LM8UU linear motion bearing	4
35	F625ZZ flanged ball bearing	10
36	6254ZZ ball bearing	4
37	5x5mm flexible joint	2
38	GT2-2mm 18 teeth aluminium pulley	6
39	0.8A Nema 17 stepper motor	4
40	Micro size switch	4
41	6x260mm closed loop GT2 belt	2
42	GT2 belt, 1600mm	4

Miscellaneous		
Item	Description	Qty
91	20x30x800 wood side frame top	2
92	20x30x800 wood side frame bottom	2
93	20x30x650 wood side frame front	2
94	20x30x650 wood side frame front	2
95	20x30x1320 wood frame connectors	4
96	Cutting Bed	1
97	Wire support blade	2
98	20x30x1700 wood arc main beam	1
99	10x10x730 aluminum arc sides	2
100	6x650mm carbon fiber arc guide	1

3D printed parts		
Item	Description	Qty
61	Tempered shaft support - LF	2*
62	Tempered shaft support - LR	2
63	Tempered shaft support - HF	2
64	Tempered shaft support - HR	2
65	Reduction gear support	4
66	GT2-2mm 99 teeth ABS pulley	2
67	Belt Tensioner	4
68	Stepper motor support	2
69	AX Carriage - low	2*
70	AX Carriage - high	2
71	BY Carriage	2*
72	End stop actuator	4
74	Arc Joiner - 20x30	4
75	Arc tension strut	2
76	Arc reference plug 90°	1
77	Arc guide slider	1
78	Arc guide foot	1

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