

# Open-source 3-in-1 CNC Machine MK1

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This machine was developed as part of my dissertation for Mechanical Engineering Degree. The aim is to develop a design which incorporates the key features necessary for the three manufacturing processes: 3D printing, laser cutting, and milling, into a single machine with a modular approach to the toolhead for minimal reconfiguration time. The machine is designed to be built using 3D printed components and standard engineering hardware.

## Specification

Build Volume: 200x200x200mm

PSU: 12V, 350W

Control Board: Arduino Mega

XY Drive Type: Belts

Z Drive Type: Leadscrew

Maximum Speed: 200mm/s

### 3D Printing

Hotend: E3D V6

Nozzles: 1

Feed Type: Bowden

Filament Type: 1.75mm

Heated Bed: Up to 80°C

### Laser Engraving

Laser Head: 20W NEJE Focusable

Optical Power: 5.5W

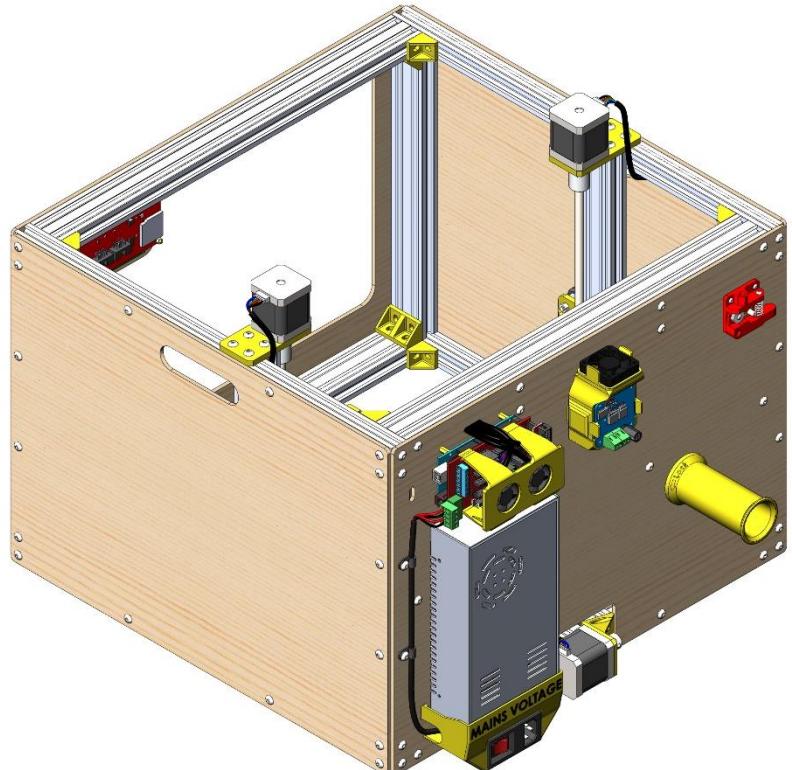
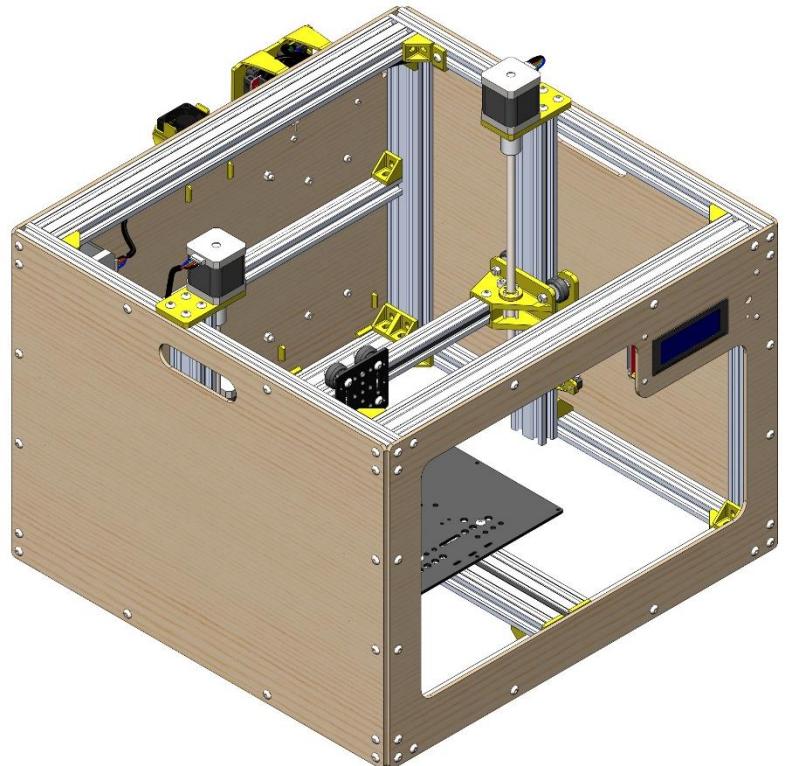
Laser Wavelength: 450nm

### CNC Milling

Milling Head: RS775 DC Motor

Max Spindle Speed: 7,000RPM

Attachment: ER11 Collet



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## 1. Parts List

### 1.1. Purchase BOM (Common Assembly)

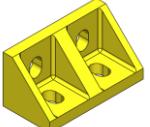
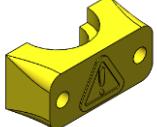
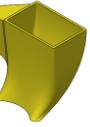
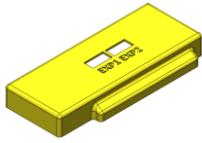
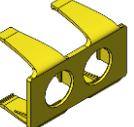
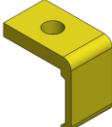
Part	QTY
V-Slot 20X20 (L=460 , No Tapping) (Rear Brace)	1
V-Slot 20X20 (L=480 , Both Ends Tapped) (H Frame)	4
V-Slot 20X40 (L=460 , No Tapping) (H Frame)	4
V-Slot 20X40 (L=320 , No Tapping) (V Frame)	4
V-Slot 20X40 (L=360 , One End Tapped) (Z Rail)	2
V-Slot 20X60 (L=460 , Both Ends Tapped) (Y Rail)	1
V-Slot 20X20 (L=370, No Tapping) (X Rail)	1
NEMA17 Stepper Motor (1.8 - 1704HS168A77oz - 1.68A)	4
Build Plate	1
Delrin Dual V Wheel Kit (Spacer: 6mm Alu)	6
Delrin Dual V Wheel Kit (Spacer: 6mm Eccentric)	6
Eccentric Spacer (6mm)	4
Aluminium Spacer (6mm)	4
Precision Shim	8
V-Slot Gantry Plate Kit – Small (Wheel Type: Delrin)	1
Drop in Tee Nuts (M5)	150
Axial Fan (30x30, 12v)	1
PSU (250W, 12v)	1
Ramps 1.4 Control board kit (inc LCD and stepper drivers)	1
2GT Belt (5mm) (Per Meter)	3
2GT Pulley (20 Tooth)	2
2GT Tooothed Idler (20 Tooth, 6mm Belt)	3
2GT Smooth Idler (6mm Belt, 5mm Bore)	2
ACME 8mm Lead Screw (Length: 290mm)	2
ACME Brass Nut	2
Flexible Motor Shaft Coupler (5x8mm)	2
Micro Limit Switch	3
14AWG Silicone Black (per meter)	2
14AWG Silicone Red (per meter)	2
PVC Sheath I.D.10mm (per meter)	2
PVC Sheath I.D.6mm (per meter)	4

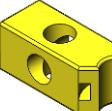
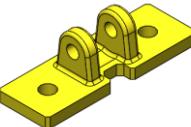
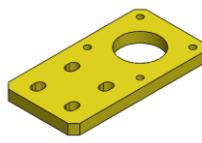
Part	QTY
Nylon P-Clip I.D. 8mm	12
M2x12 Pan Head Screw	6
M2 Plain Nut	6
M3X10 Standoff (M/F)	4
M3X10 Standoff (F/F)	4
M3 Nyloc Nut	4
M3x8 Hex Socket	26
M3x25 Hex Socket	2
M3x35 Hex Socket	6
M4x12 Hex Socket Screw	4
M5x10 Hex Socket Button	160
M5x16 Hex Socket Button	6
M5x25 Hex Socket Button	7
M5x40 Hex Socket Button	10
M5 Nyloc Nut	23
4mm Birch Laser Plywood (600mm x 400mm)	4

## 1.2. Purchase BOM (Configuration Specific)

Configuration	Part	QTY
3D Printing	E3D V6 Lite extruder (12v, Bowden)	1
	Pre-Soldered Aluminium PCB Heated Bed MK2B	1
	CR10 Extruder	1
	NEMA17 Stepper Motor (1.8 - 1704HS168A77oz - 1.68A)	1
	Blower Fan, 40x20mm, 12v)	1
	Compression Springs	4
	M3x35 Hex Socket Screw	4
	M3x30 Pan Head Screw	2
	M3x16 Pan Head Screw	2
	M3x12 Pan Head Screw	2
	M3 Plain Hex Nut	2
	M3 Wingnut	4
Laser	NEJE 20W Laser Module	1
	M3x10 Hex Standoff (M/F)	4
	M3x12 Pan Head Screw	4
CNC Mill	RS775 DC Motor (Spindle)	1
	ER 11 Chuck	1
	BTS7960 H-Bridge	1
	40mm Cooling Fan (12V)	1
	M5x25 Hex Socket Screw	2
	M5 Plain Hex Nut	2

### 1.3. 3D Printable BOM

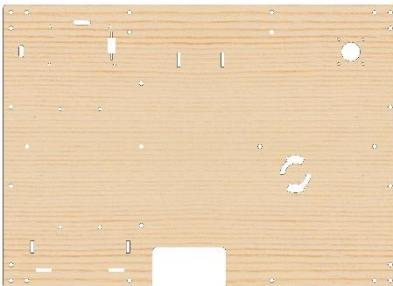
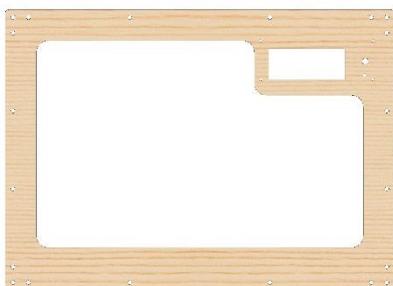
Part	File Name	Qty	Part	File Name	Qty
	BTS7960_COOLING_DUCT_V3	1		INTERFACE_PLATE_775_DC_MOTOR	1
	CORNER_BRACKET_DOUBLE	9		HOTEND_CLAMP	1
	CORNER_BRACKET_SINGLE	10		HOTEND_COOLING_DUCT	1
	CORNER_BRACKET_TRIPLE	1		LCD_ENCLOSURE	1
	CONTROL_BOARD_COVER	1		MAINS_VOLTAGE	1
	END_STOP_SWITCH_MOUNT	3		PSU_SHROUD	1
				PSU_SPCR_5MM	4
	INTERFACE_PLATE_E3D_HOTEND	1		RIBBON_CABLE_CLIP	6
	INTERFACE_PLATE_20W_LASER_MODULE	1		SPOOL HOLDER V2	1

Part	File Name	Qty	Part	File Name	Qty
	TIE_BASE_BLOCK	2		Z_GANTRY_PLATE_INNER_V2	2
	X_STEPPER_MOUNT_V2	1		Z_GANTRY_PLATE_OUTER	2
	Y_AXIS_IDLER_BRACKET	1		Z_MOTOR_MOUNT_PLATE	2
	Y_STEPPER_MOUNT	1			

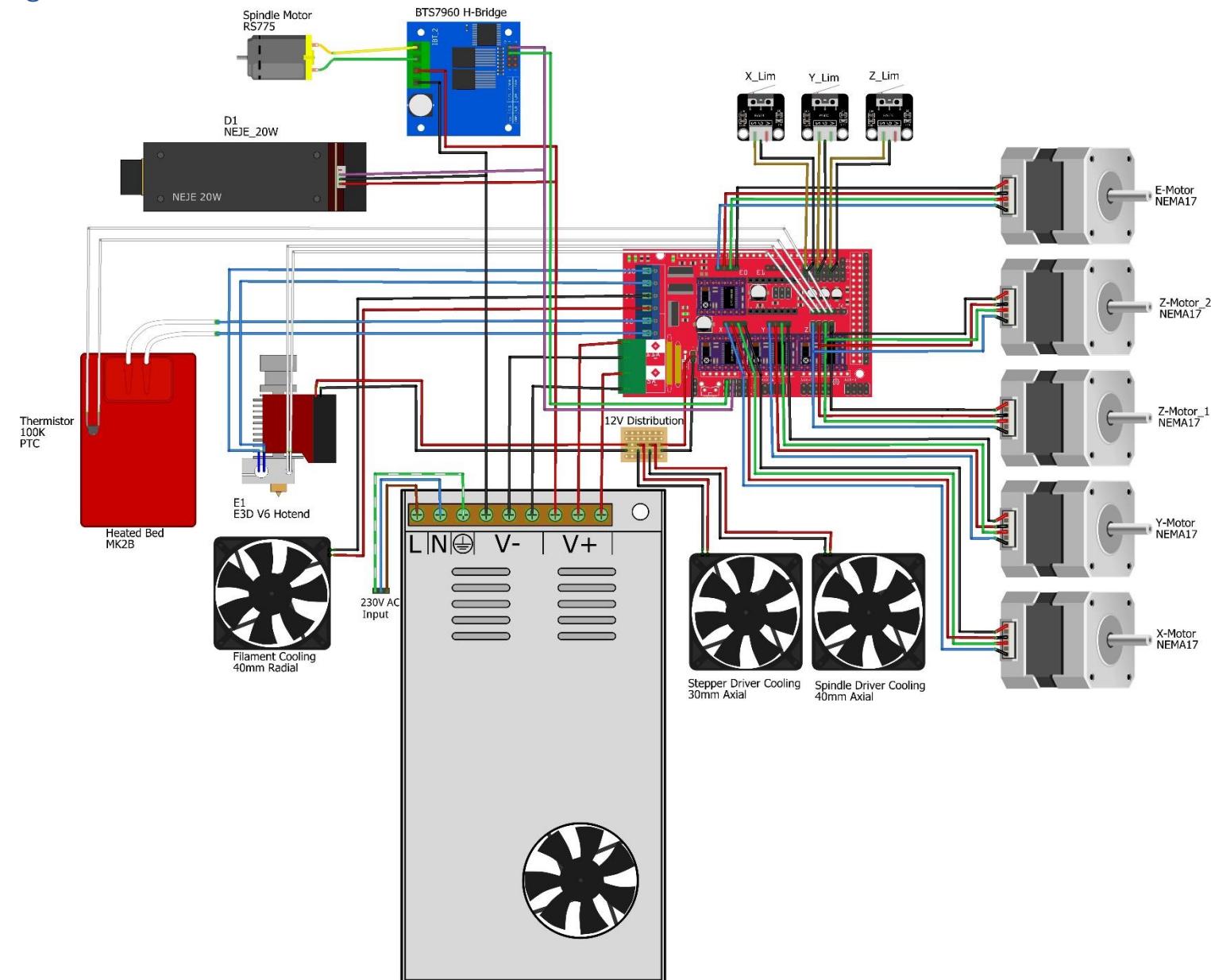
\*All parts can be printed in PLA using 0.4mm nozzle, 0.25mm layer thickness, and 20% infill.

\*\*Italics indicate configuration specific components.

#### 1.4. Lasercut BOM

Part	File Name	QTY	Sheet Thickness (mm)	Min Stock Size (mm)
	BACK_PANEL_4MM_QTY1.DXF	1	4	500x360
	FRONT_PANEL_4MM_QTY1.DXF	1	4	500x360
	SIDE_PANEL_4MM_QTY2.DXF	2	4	480x360
	SACRIFICIAL_PLATE.DXF	1	10-16	206x206

## 2. Electrical Diagram

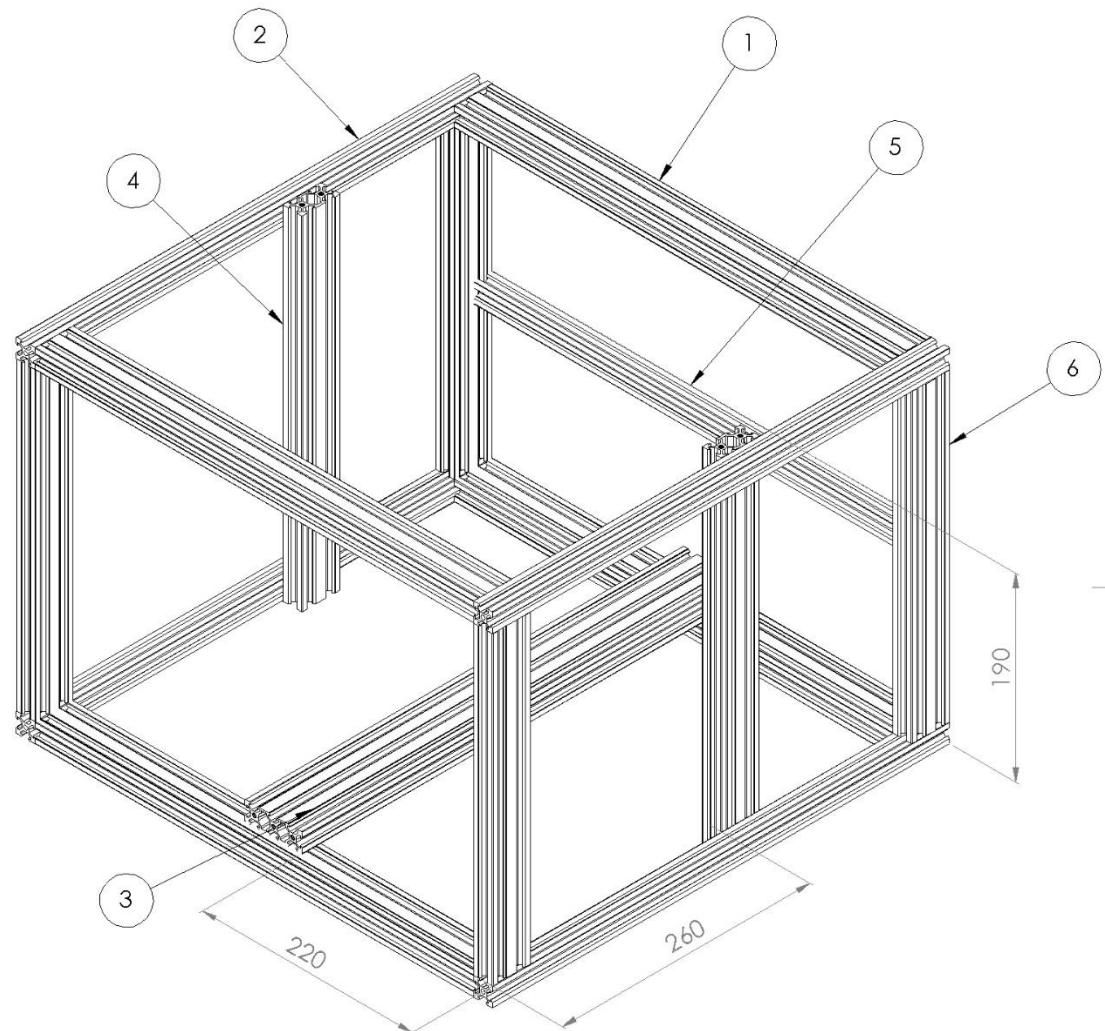


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### 3. Assembly Steps

#### 3.1. Frame assembly

QTY.	ITEM NO.	SECTION	LENGTH	THREADED M5X0.5
4	1	20X40	460	NO
4	2	20X20	480	BOTH ENDS
1	3	20X60	460	BOTH ENDS
2	4	20X40	360	ONE END
1	5	20X20	460	NO
4	6	20X40	320	NO





X11



X9



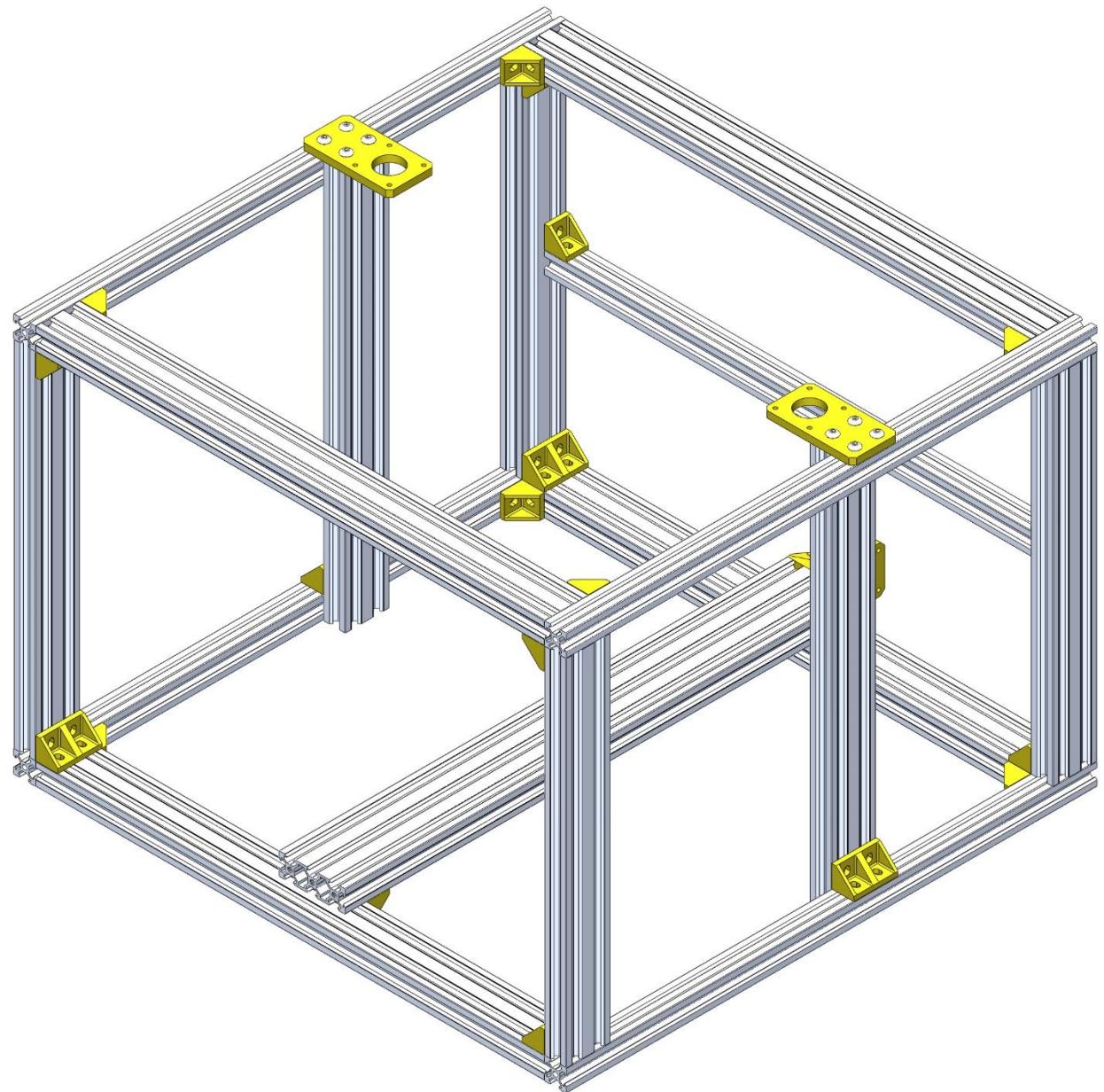
X1



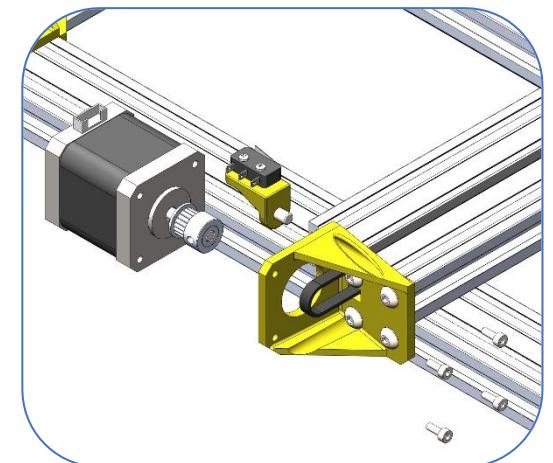
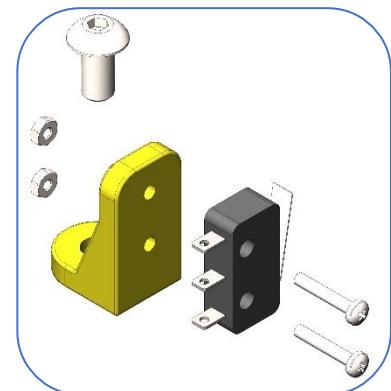
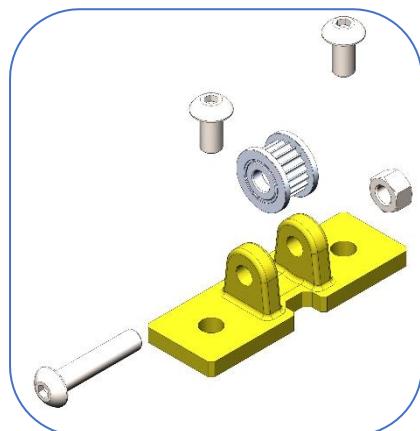
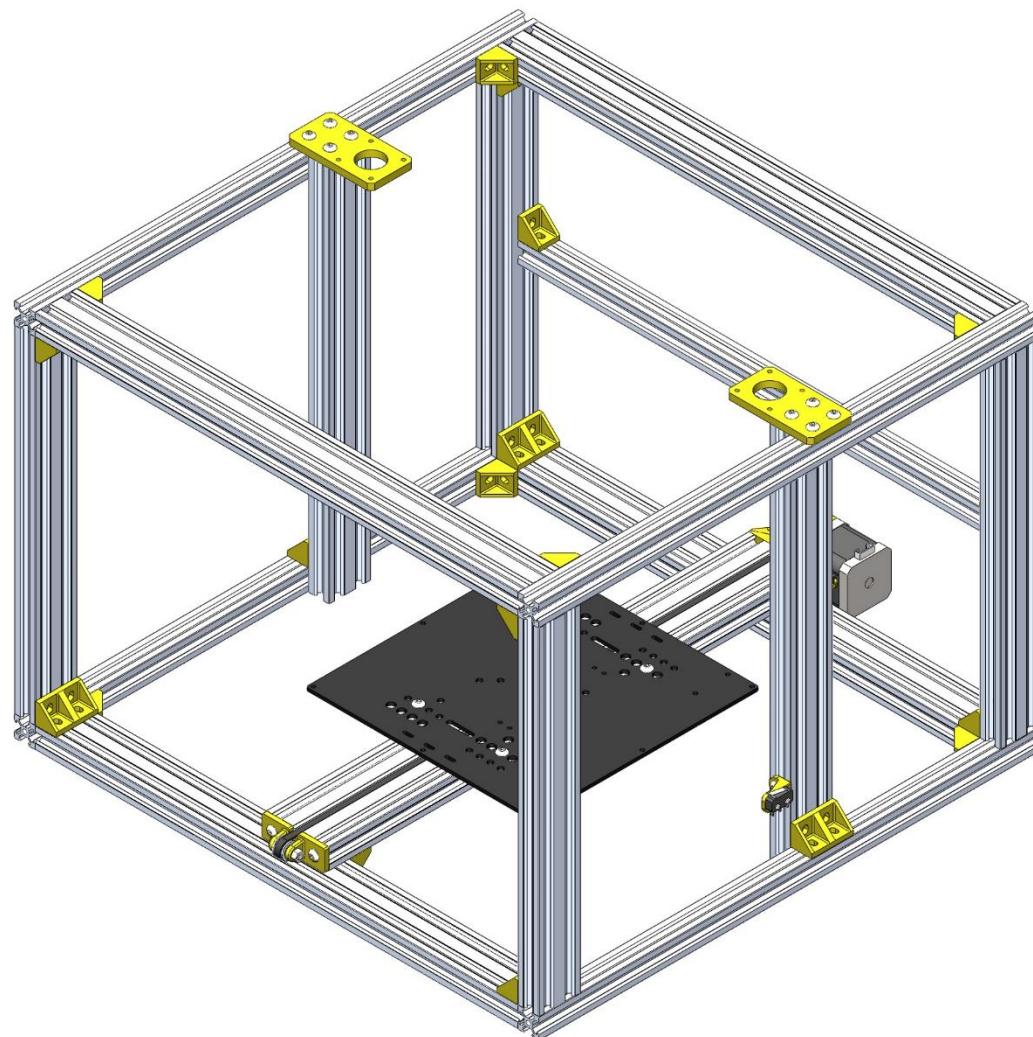
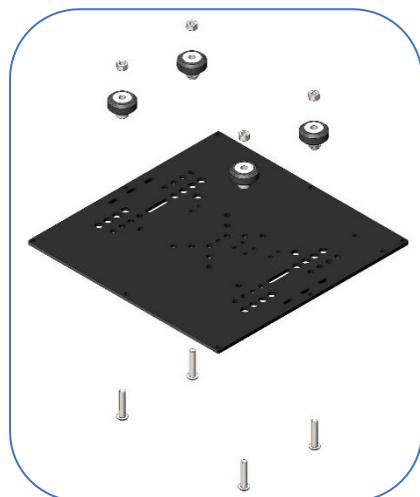
X2



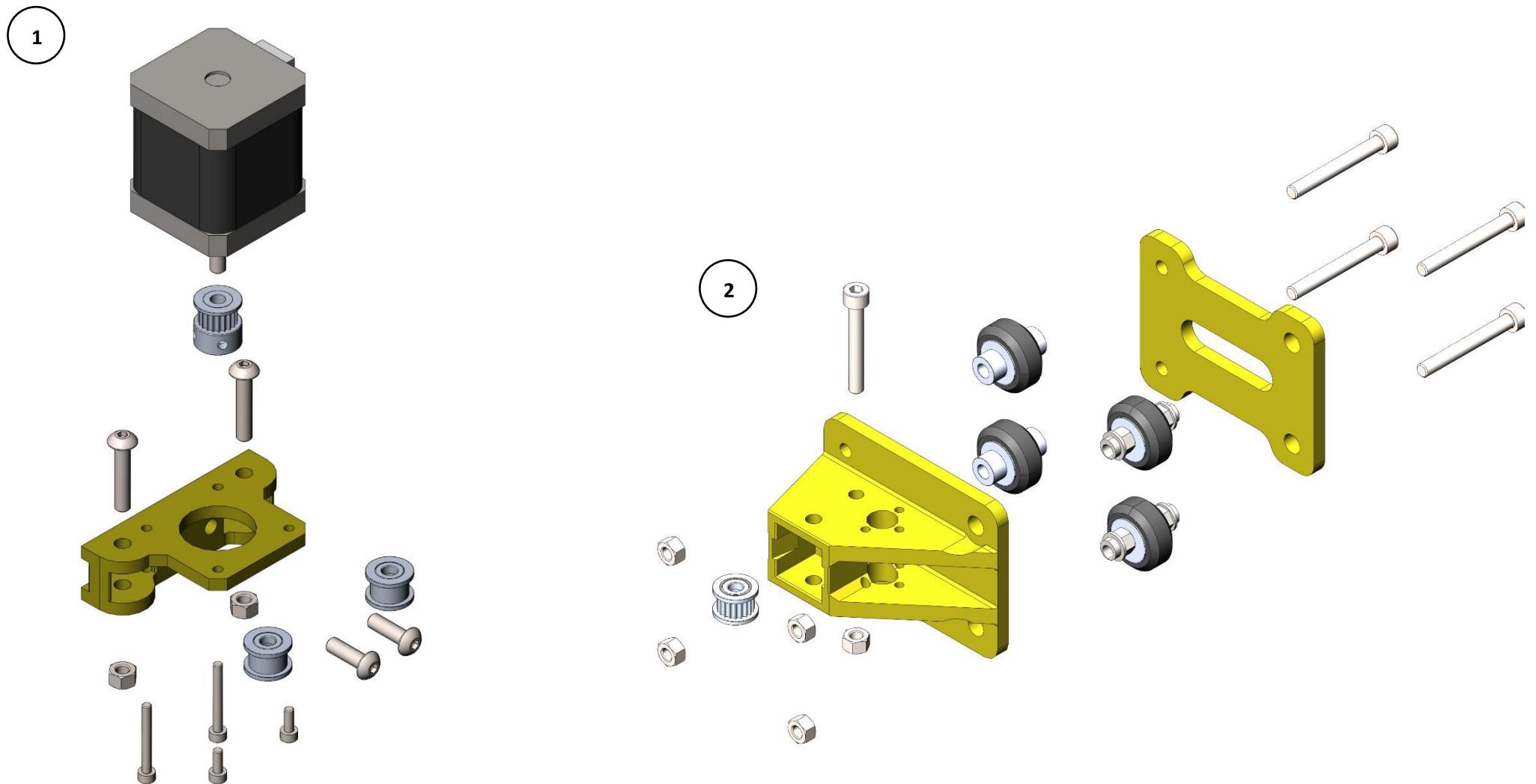
X1

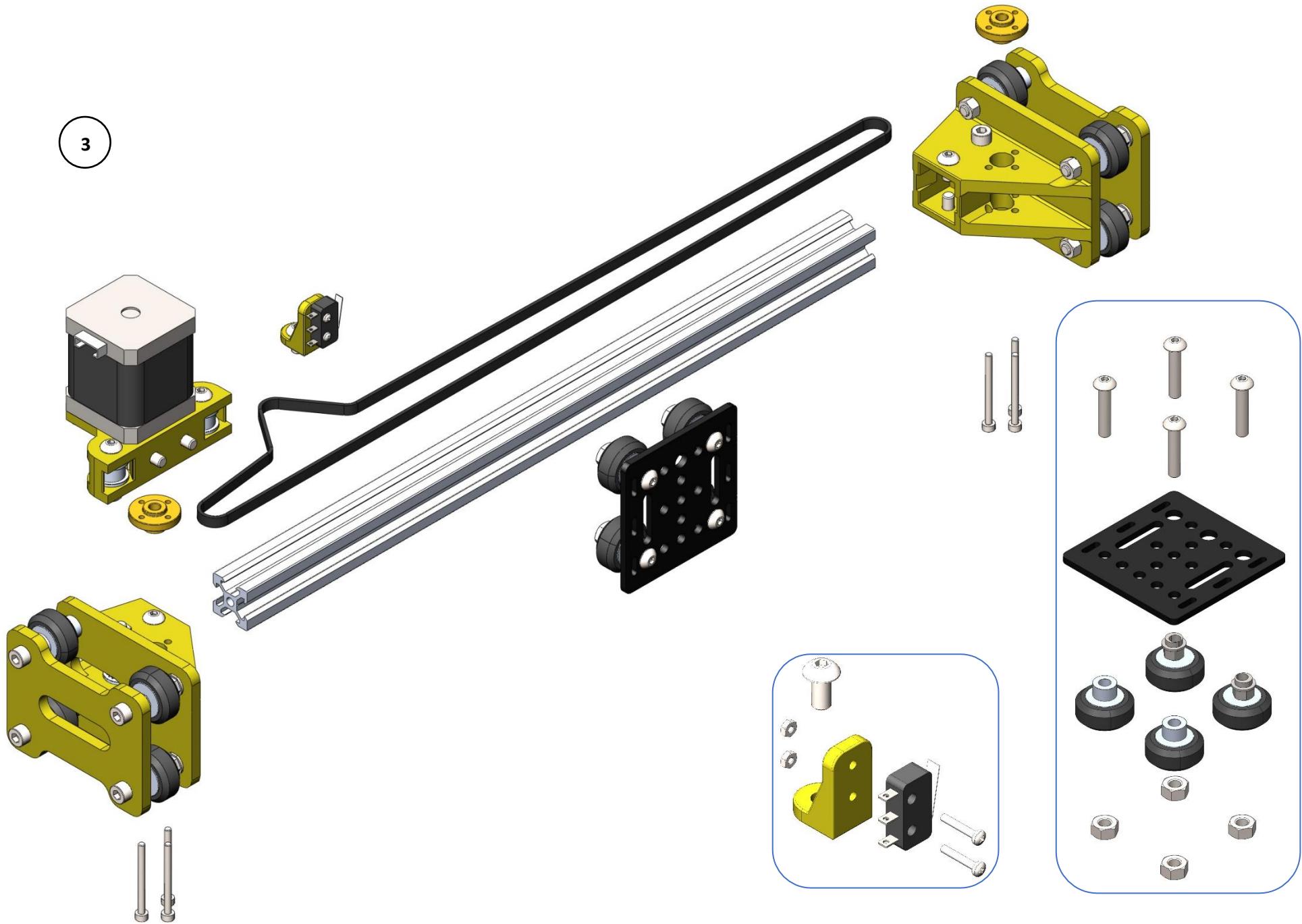


### 3.2. Y Carriage & Actuator Installation

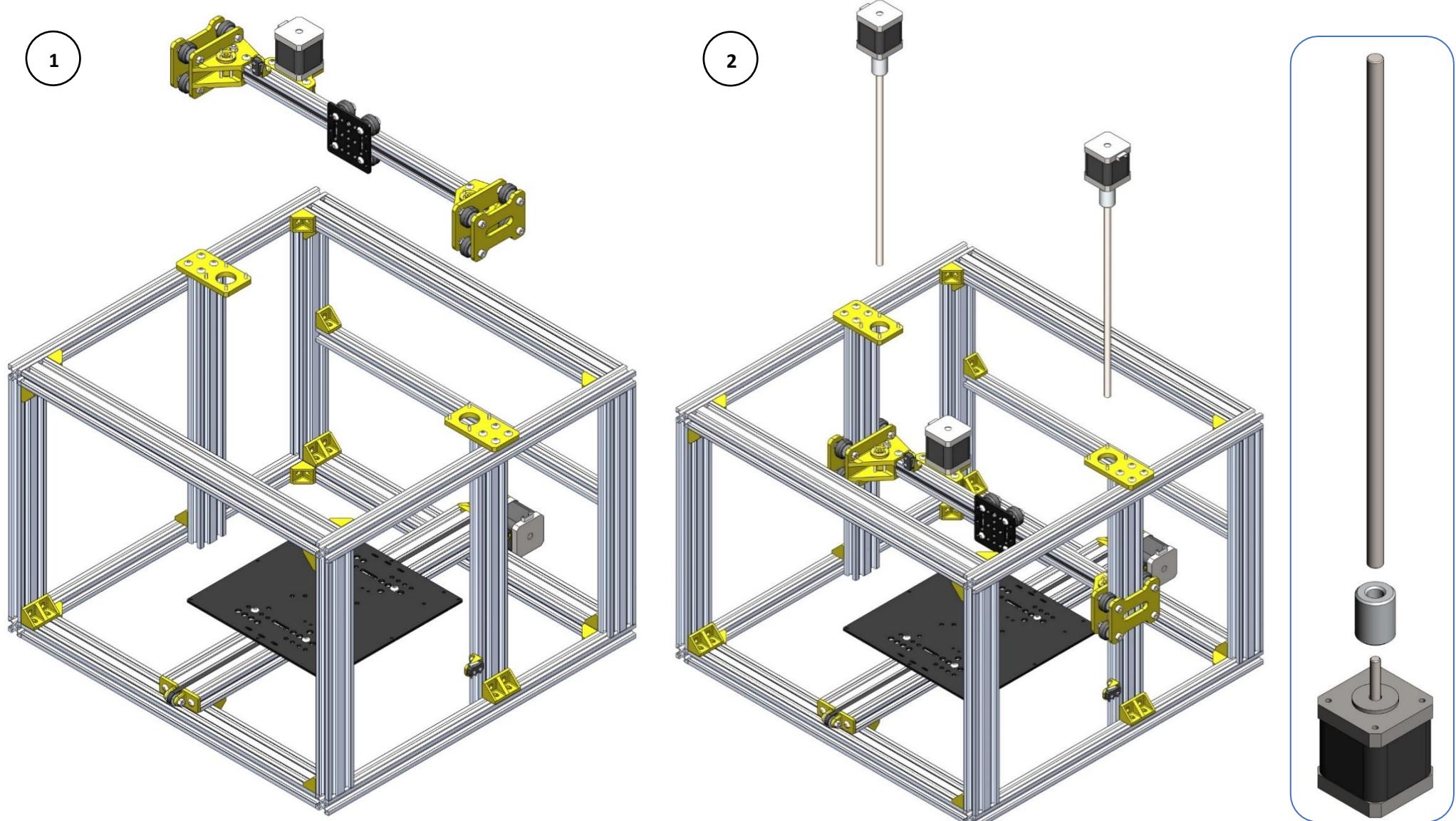


### 3.3. Gantry Assembly



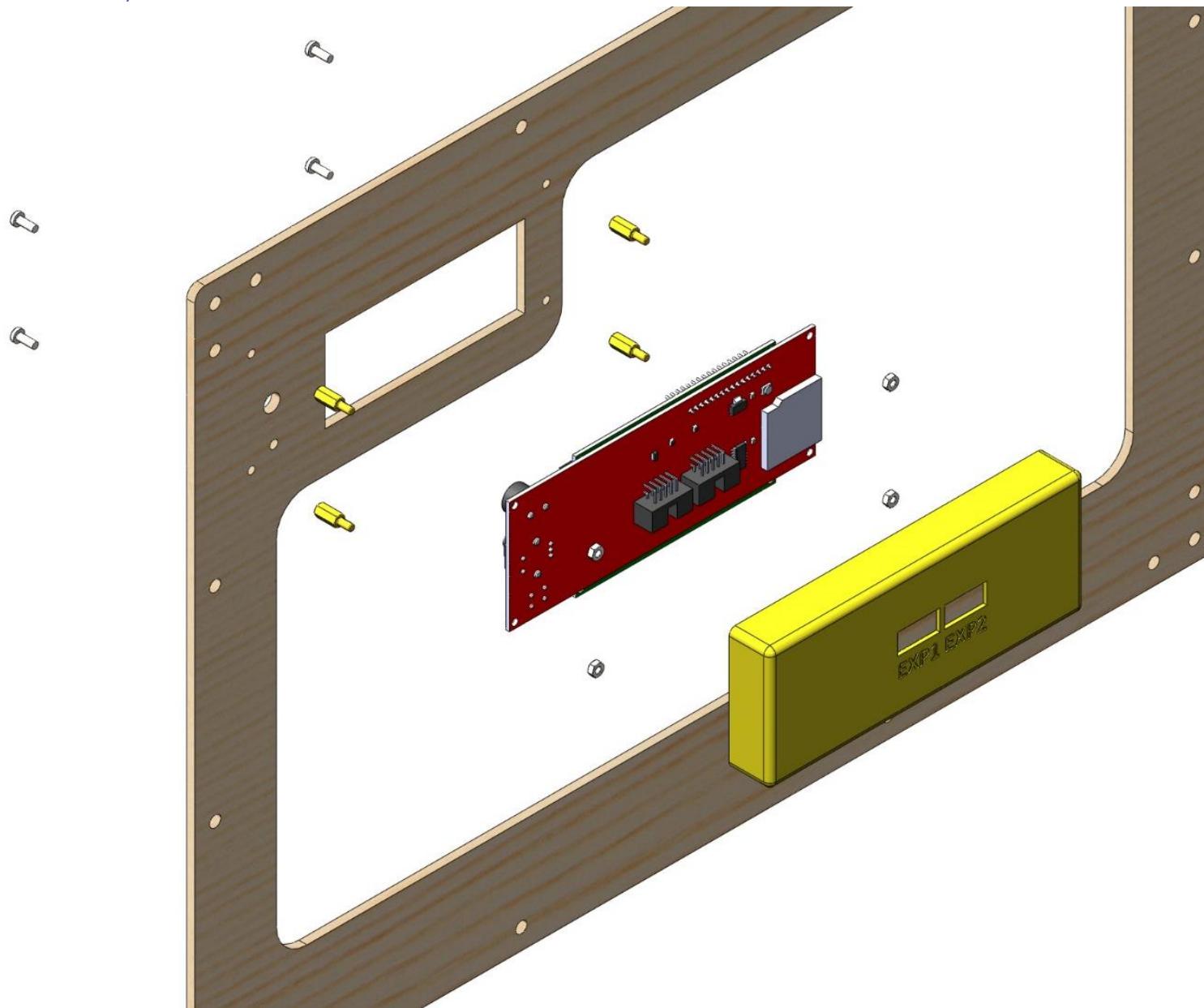


### 3.4. Z-axis Screw & Gantry Installation

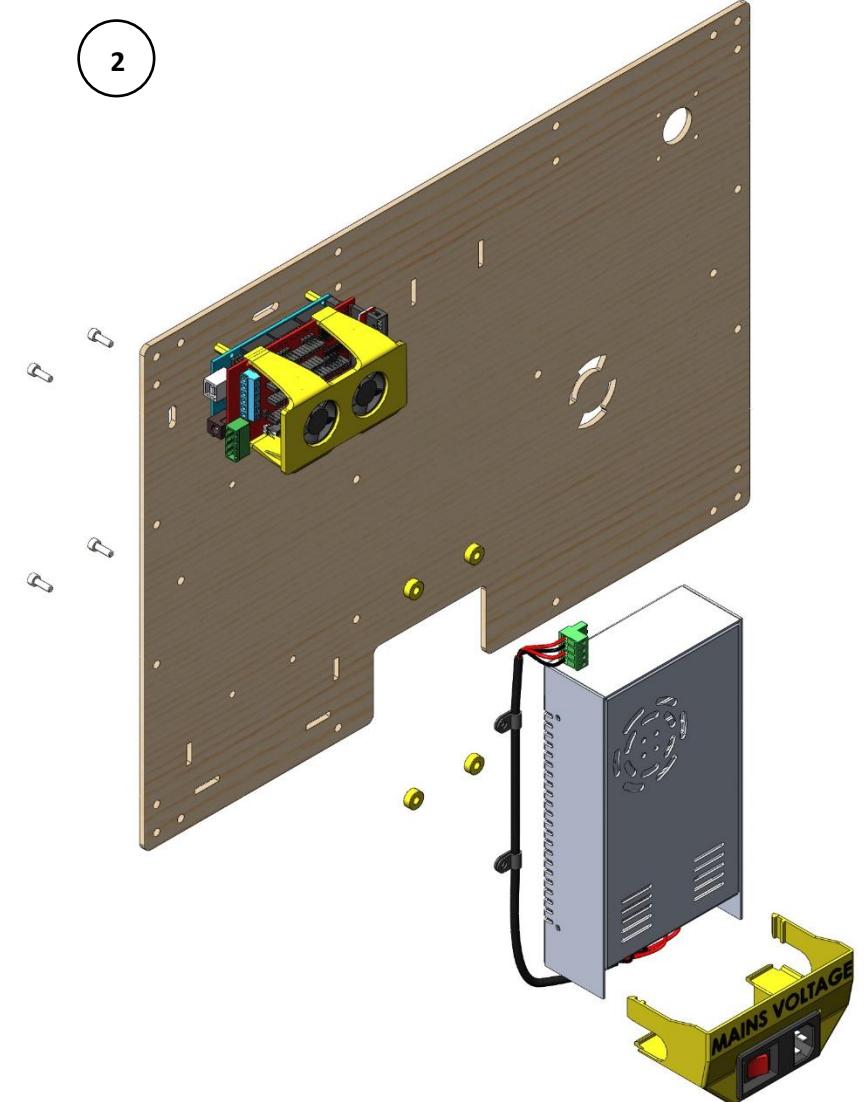
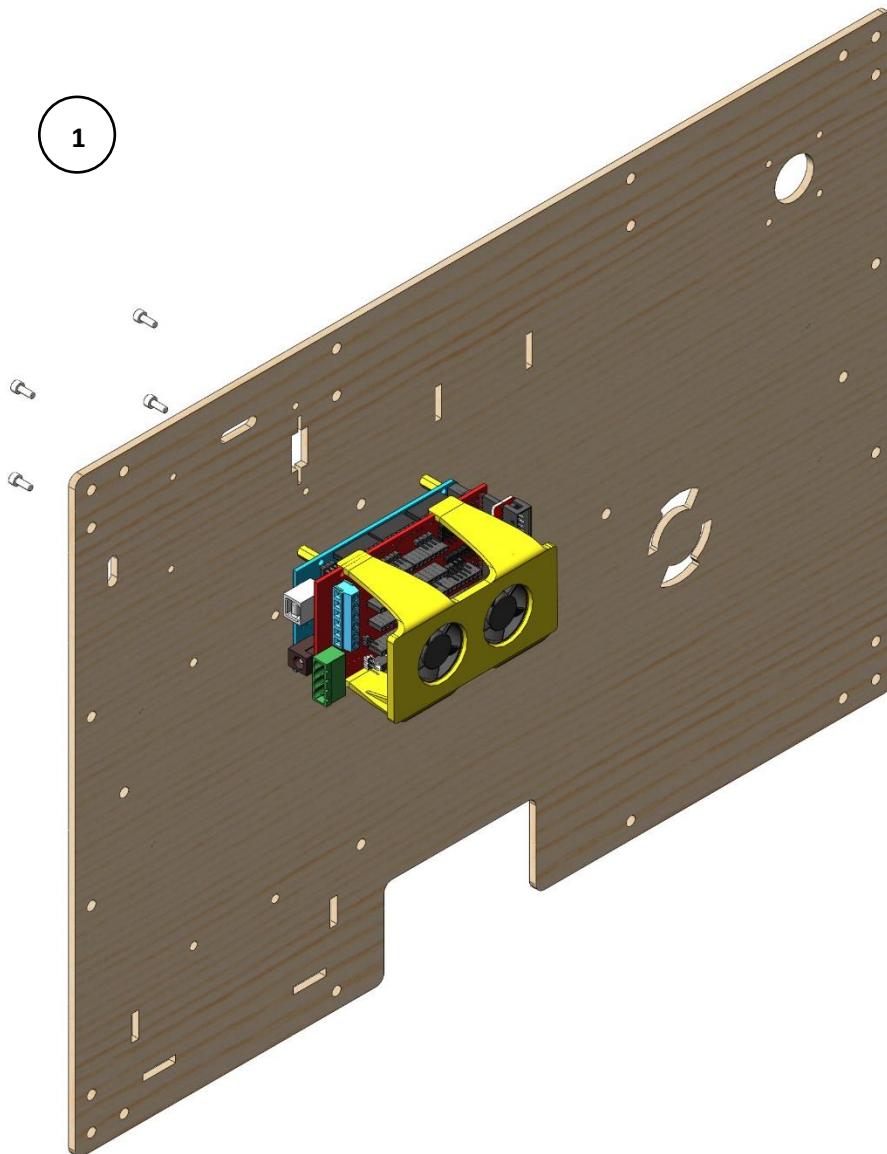


\*Z-Beams must be removed and slid through gantry end plates first.

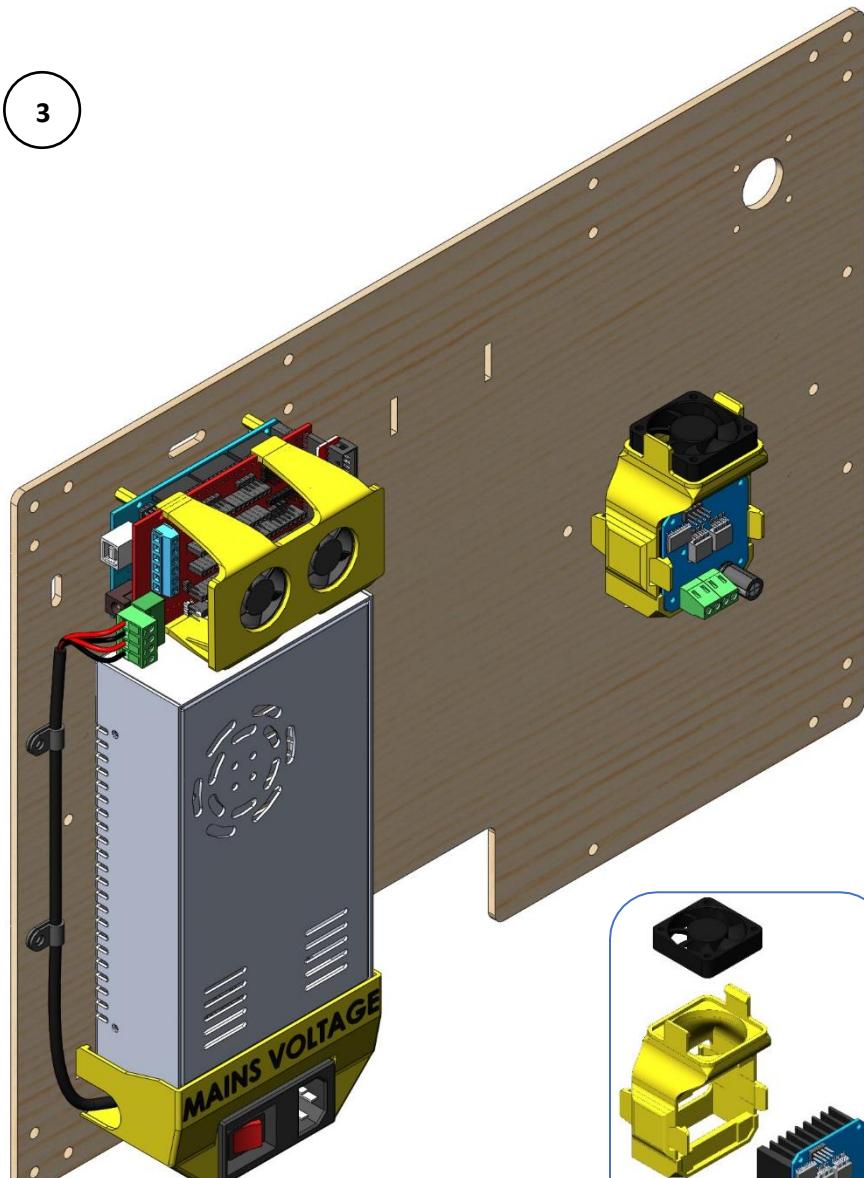
### 3.5. Front Panel Assembly



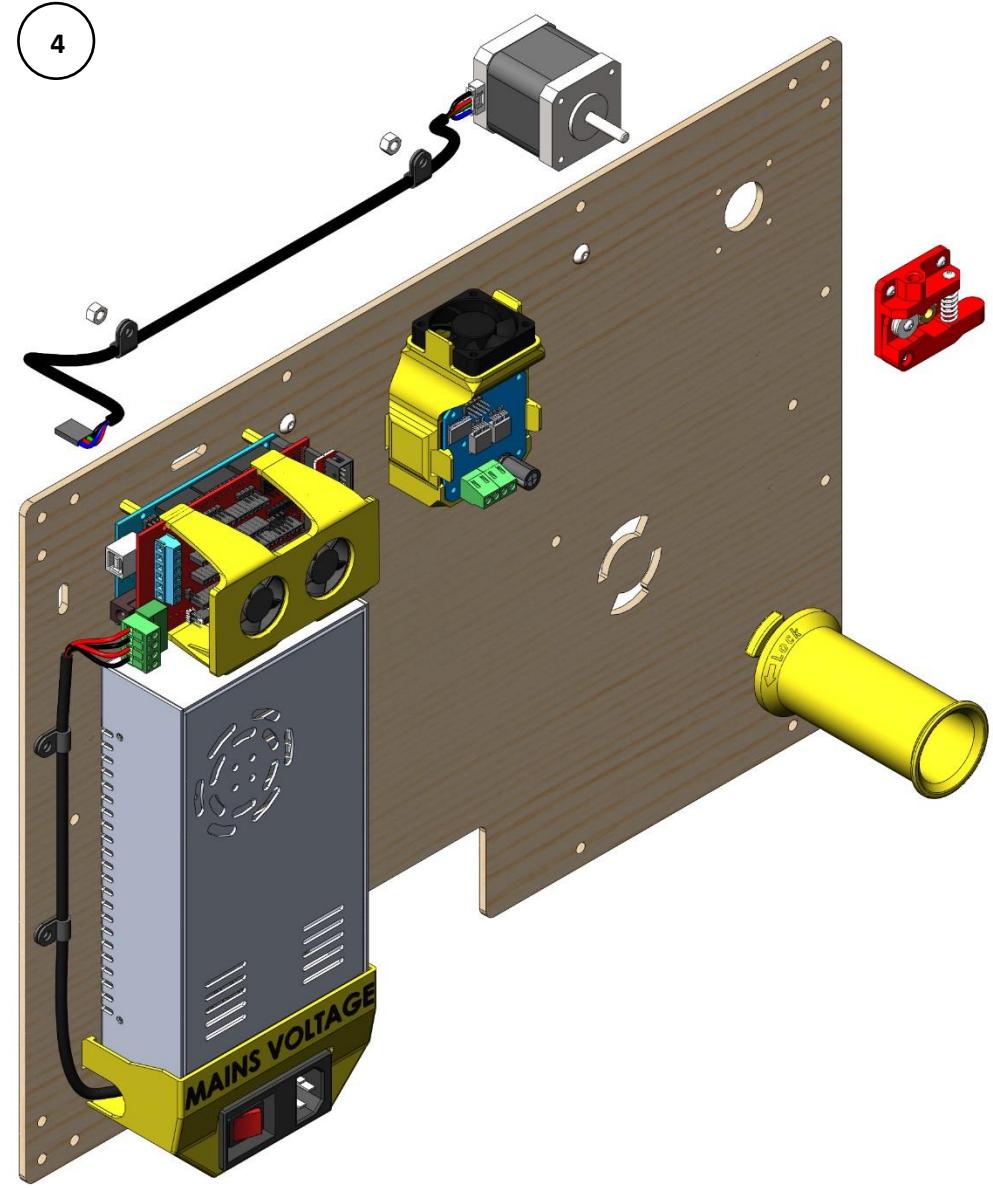
### 3.6. Rear Panel Assembly

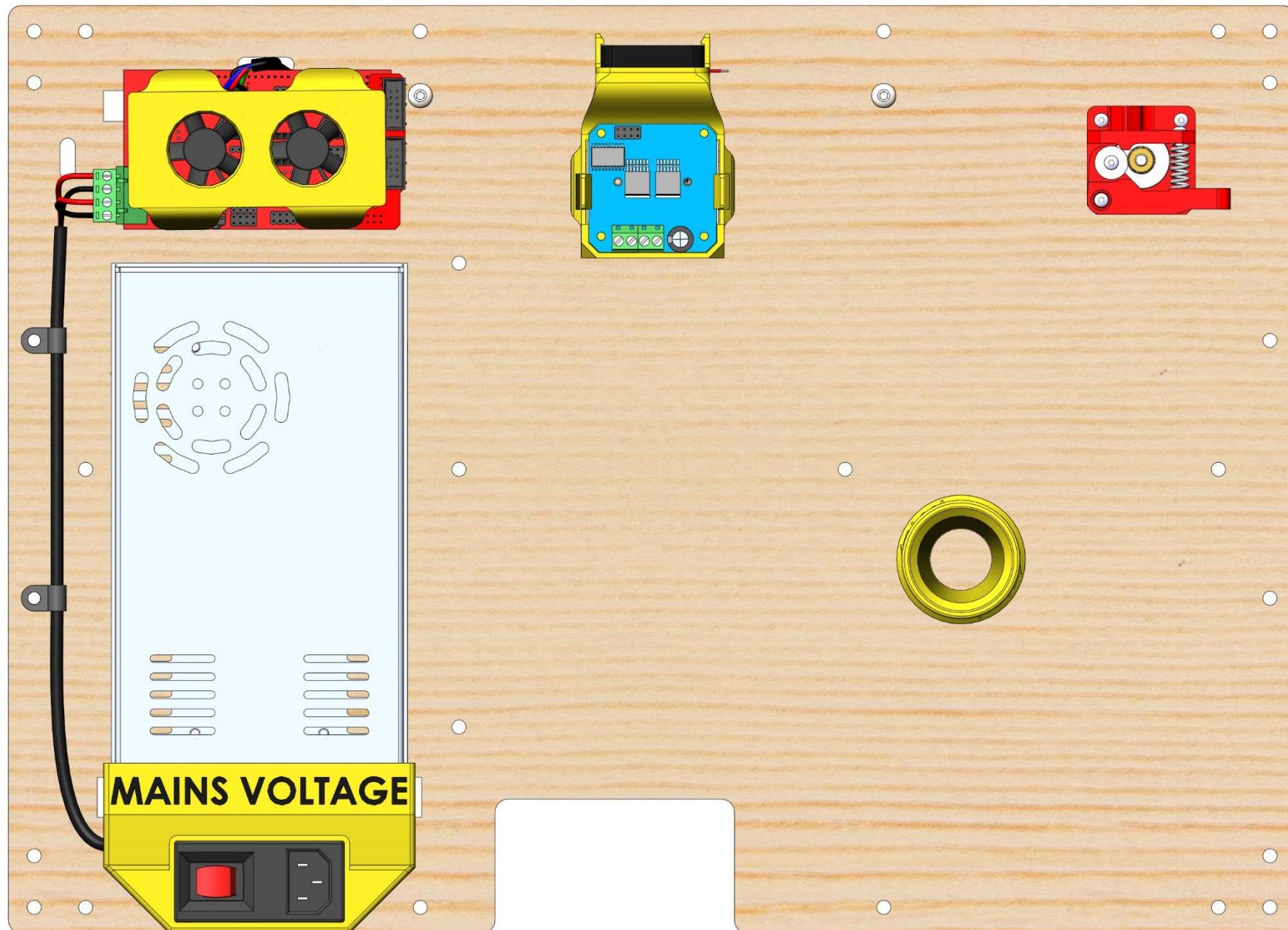


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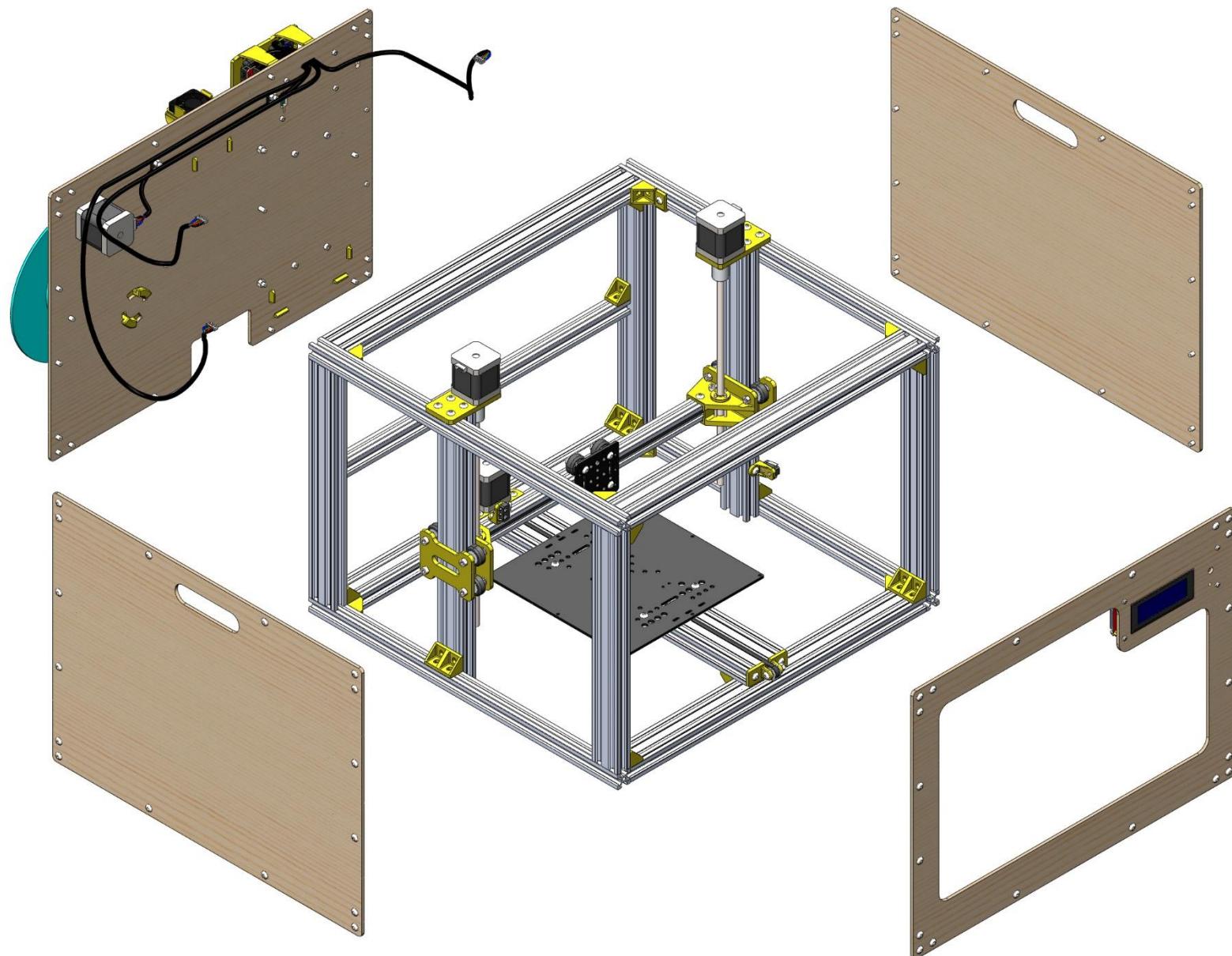


4



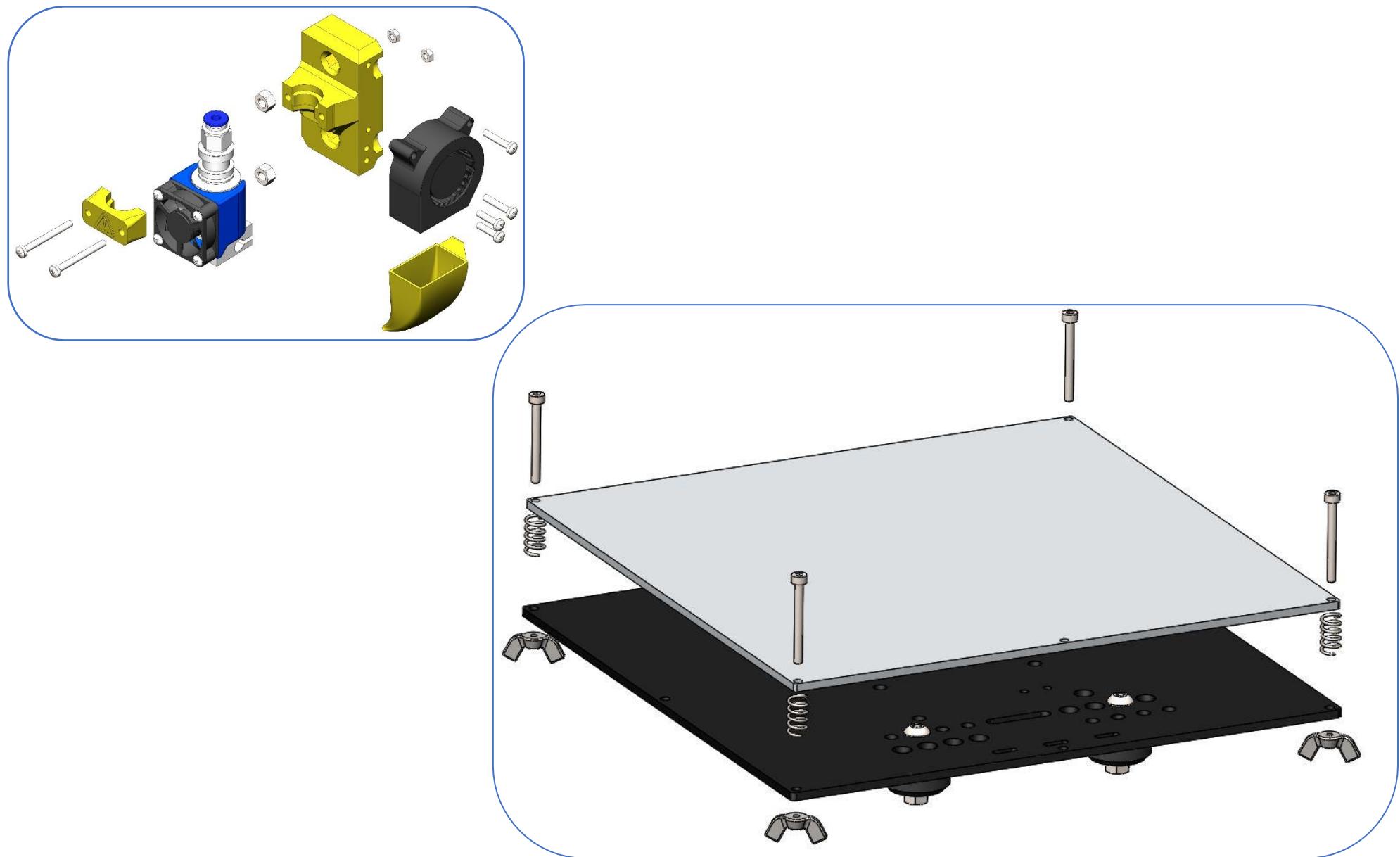


### 3.7. Panel to Frame Installation

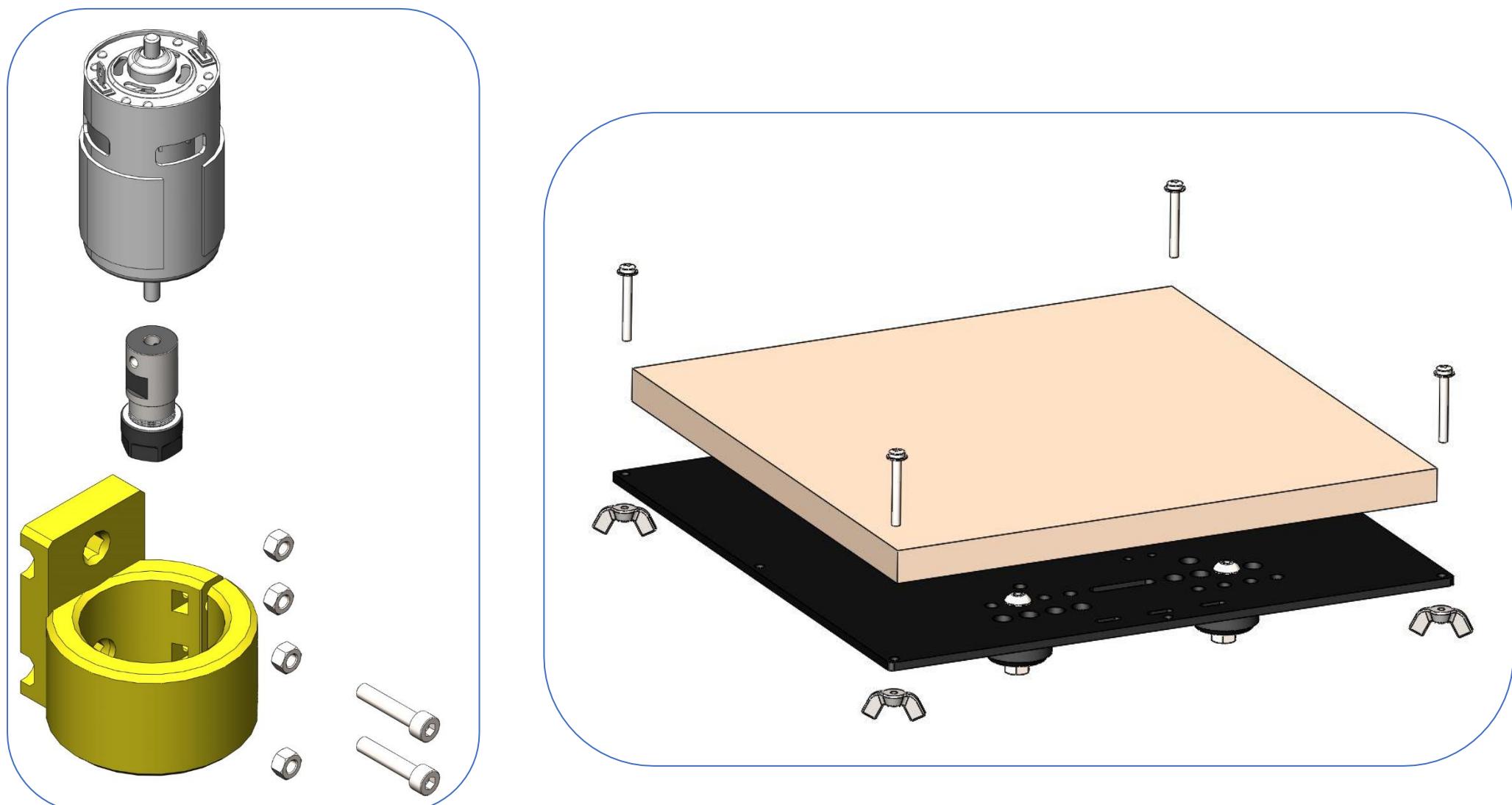


### 3.8. Configurations

#### 3.8.1. 3D Printer



### 3.8.2. CNC Mill



### 3.8.3. Laser Engraver

