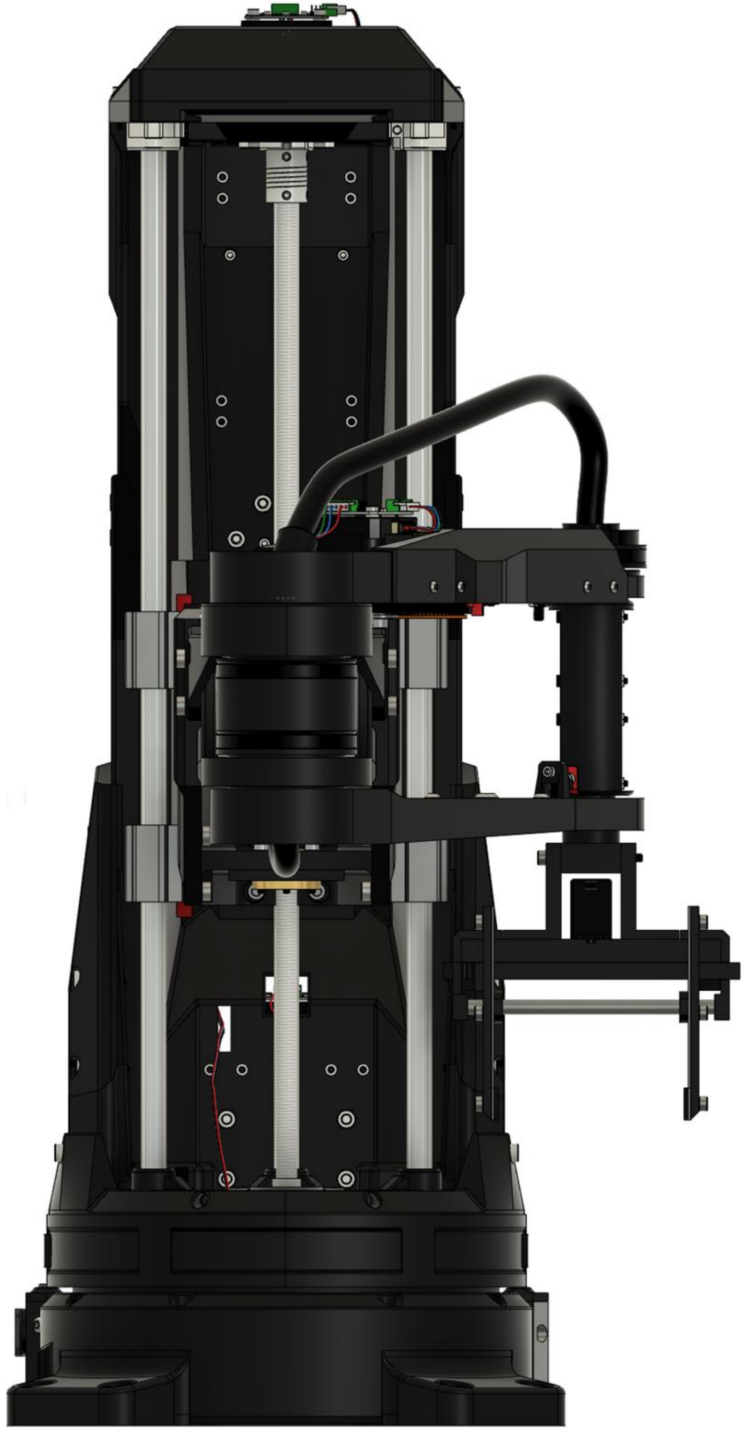


BIO SCARA MANUAL v2

May 2025

NOTE:

This User Guide is largly based on Bioscara v1 and hence not most 3D graphics, assembly instructions and print guides are not yet updated

PROPOSAL

CONTROL BOARDS

The robots consists of two boards:

- MKS GEN L2.1 handling low-level control of actuators and sensors
- Raspberry Pi 4

The reason for dividing the control system into two parts was to have a dedicated motherboard facilitating all the necessary I/O pins for all the peripherals. This board would serve as a slave and complete all received commands while the Raspberry would serve as the master where the scripts can be easily adapted without interfering with the low-level control scripts. This was an attempt to make the robot more user friendly since the programming on the robot revolves around some basic python scripts.

The MKS Gen L2.1 is a 3d printer motherboard and is a combination of Ramps 1.4 with ATMEGA2560. One advantage of using this board was the available open-source software Marlin. With some changes, it can be used to control a robot rather than a 3d printer.

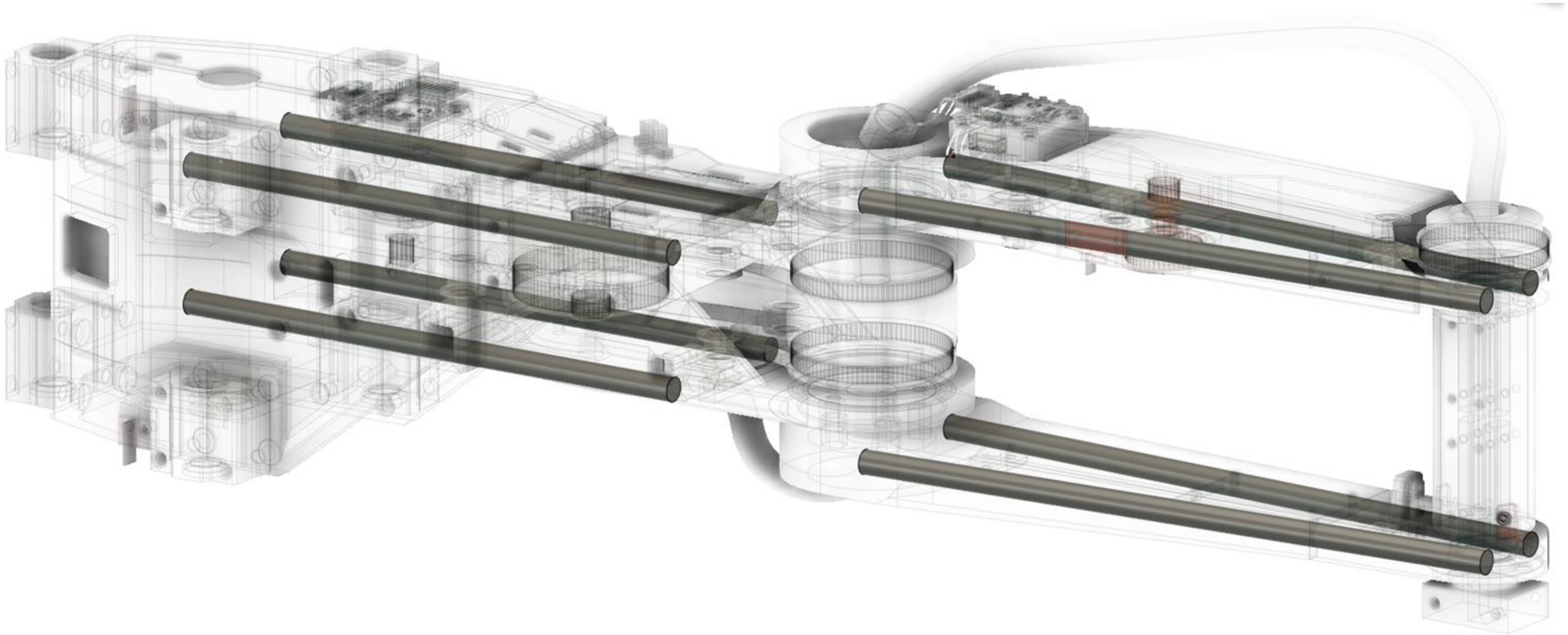
Even though Marlin comes with some built in features, a single-board system should be considered. This custom board would have to facilitate the connection of stepper drivers (in this case MKS Servo42C and other peripherals such as the endstop sensors.

STRUCTURE REINFORCEMENT

The overall mechanical structure should be reinforced with light-weight rigid parts (such as metal or carbon-fiber tubes). This should reduce the arm's flexibility which should also reduce the end-effector's vibrations. As an example, consider the same arm structure but with holes parallel to the arm. These would be designed for the insertion of rods of tubes.

These would improve the mechanical properties of the arm in the weakest point.

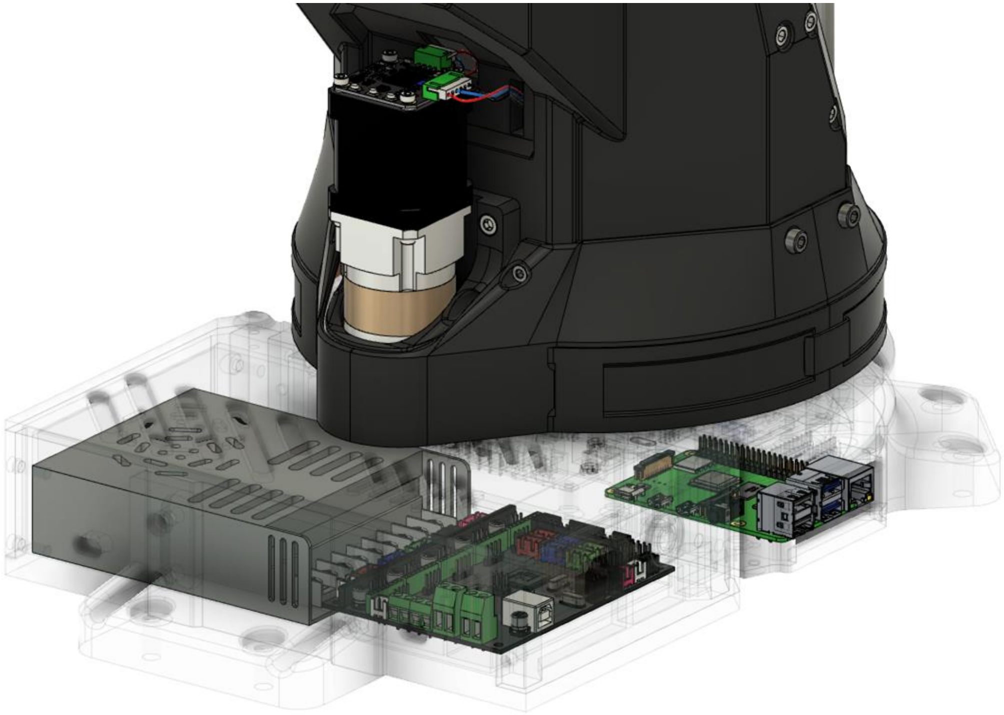
Of course, the flexibility will always remain in the parts where the arm links are connected through joints (for example due to the reliance on timing belts) but it should be to a smaller extent.



POWER SUPPLY

The robot uses no more than 30% of the maximum possible output power (400W), therefore it is possible to use a smaller and cheaper power supply which also results in a more compact design. A 100W power supply is enough to power all actuators and electronics however one should consider the specific application in which the robot will be used. This includes considerations on what end-effector will be used and if other peripherals will be powered from the robot's power supply.

Using a more compact power supply would result in more available space left for the electronics where for example, a control board could be placed to improve the cable management of joint 1.



GRIPPER

The robot can be equipped with various gripper types or devices. In the initial application, the gripper is responsible for pick and place tasks of well plates and that is why the gripper tries to mimic the standard grippers used in the bio industry however while utilizing only off the shelf components.

Standardization of well plates follows the ANSI/SLAS Microplate Standards. For this project, the main aspects of these standards included the ANSI/SLAS 12004 for footprint dimensions, ANSI/SLAS 22004 for height dimensions, and ANSI/SLAS 42004 for well positions. Such standardization ensures compatibility with a range of automated laboratory equipment. The standardized footprint for microplates is 127.76 mm by 85.48 mm, with a tolerance of ± 0.5 mm. It is important to note that while the footprint and well positions of these plates are standardized, the height dimension and number of wells can vary. This variation comes from different volumes the plates are designed to hold and the specific designs of the wells

By building a prototype, It was determined that having a strictly 3D printed gripper is not feasible. Various materials have been used, ranging from a typical PLA to much stronger materials like PA CF. By doing several iterations and building multiple prototypes, it has been concluded that building a gripper made out of both plastic and metal is the suitable solution.

Note:

The gripper design still has a lot of room for improvements, with the main focus on making the gripper more compact, rigid as well as to increase its strength.

PARTS
LIST

SCREWS, NUTS, WASHERS

M5

NUTS
87x M5 NUT

WASHERS
13x M5 WASHER

SCREWS
5x M5X100
1x M5X75
4x M5X50
2x M5X45
2x M5X40 FLAT HEAD
4x M5X40
3x M5X35 FLAT HEAD
3x M5X30 FLAT HEAD
6x M5X30
32x M5X20
44x M5X15
10x M5X10

M4

NUTS
44x M4 NUT

WASHERS
2x M4 WASHER

SCREWS
3x M4X70
4x M4X40
1x M4X30
4x M4X20
18x M4X15
38x M4X10
4x M4X8 FLAT HEAD
5x M4X8

M3

NUTS
33 M3 NUT

WASHERS
4 M3 WASHER

SCREWS
8x M3X30
4x M3X20
4x M3X10 FLAT HEAD
52x M3X10
29x M3X8
9x M3X6

M2

NUTS
33 M3 NUT

WASHERS
4 M3 WASHER

SCREWS
4x M2x6

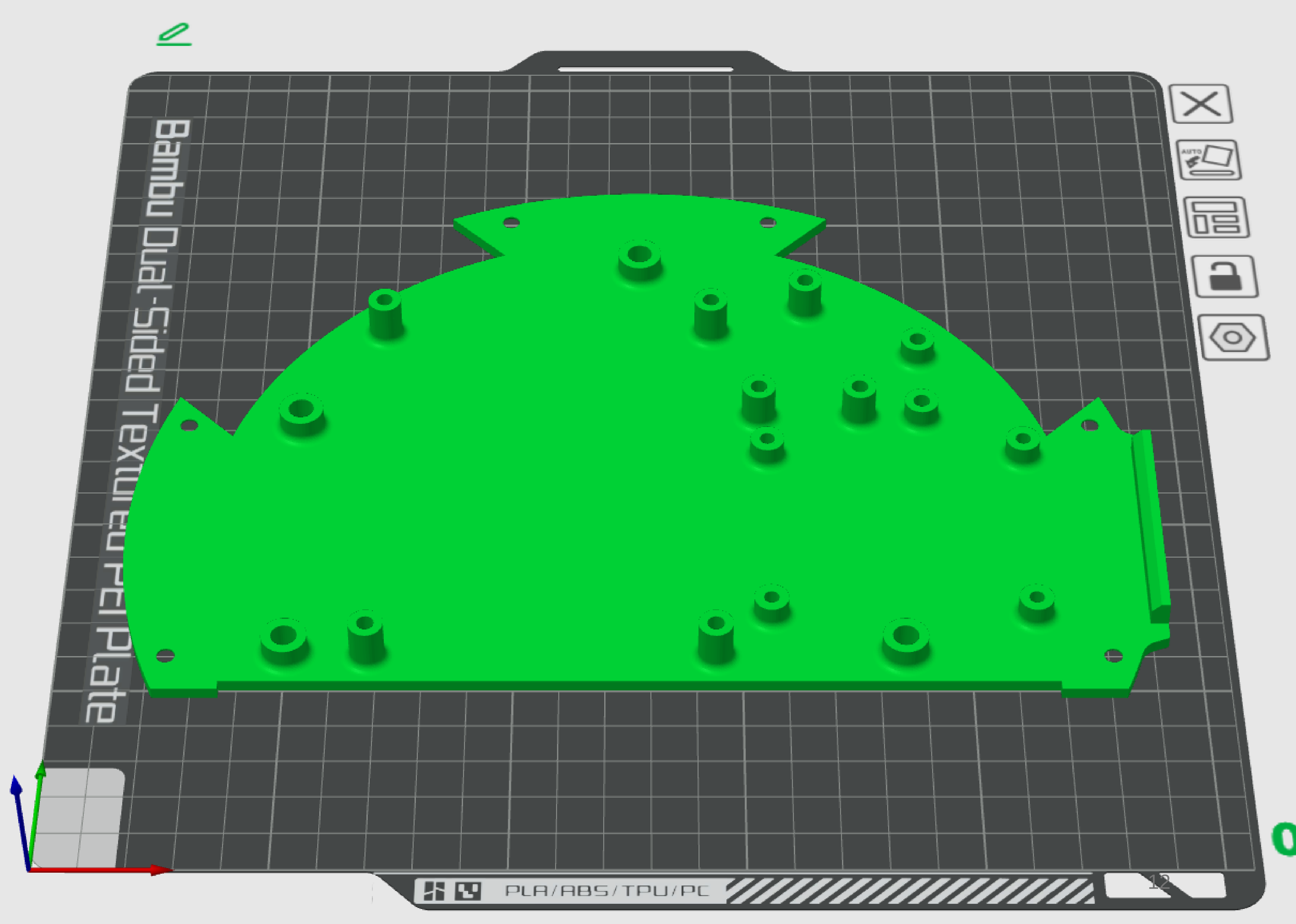
3D PRINTING

3D PRINTER
Parts have been printed on a Bambulab P1S printer. This printer has a print volume of 25dm^3. This volume is required for some bigger parts of the robot base and joint 1.
FILAMENT
The parts have been manufactured from PLA and PETG. It has been estimated that around 4kg of filament is required (1kg of PLA and 3kg of PETG but this ratio depends on the user’s choice of filament where the filament type could be either of those.
MODELS
STL files have been added A complete Fusion360 model can also be found on github
MANUFACTURING
The following slides illustrate the suggested print parameters for each model as well as the correct print orientation. Of course, multiple parts can be printed at once to reduce overall print time .

Bottom cover

Print parameters:

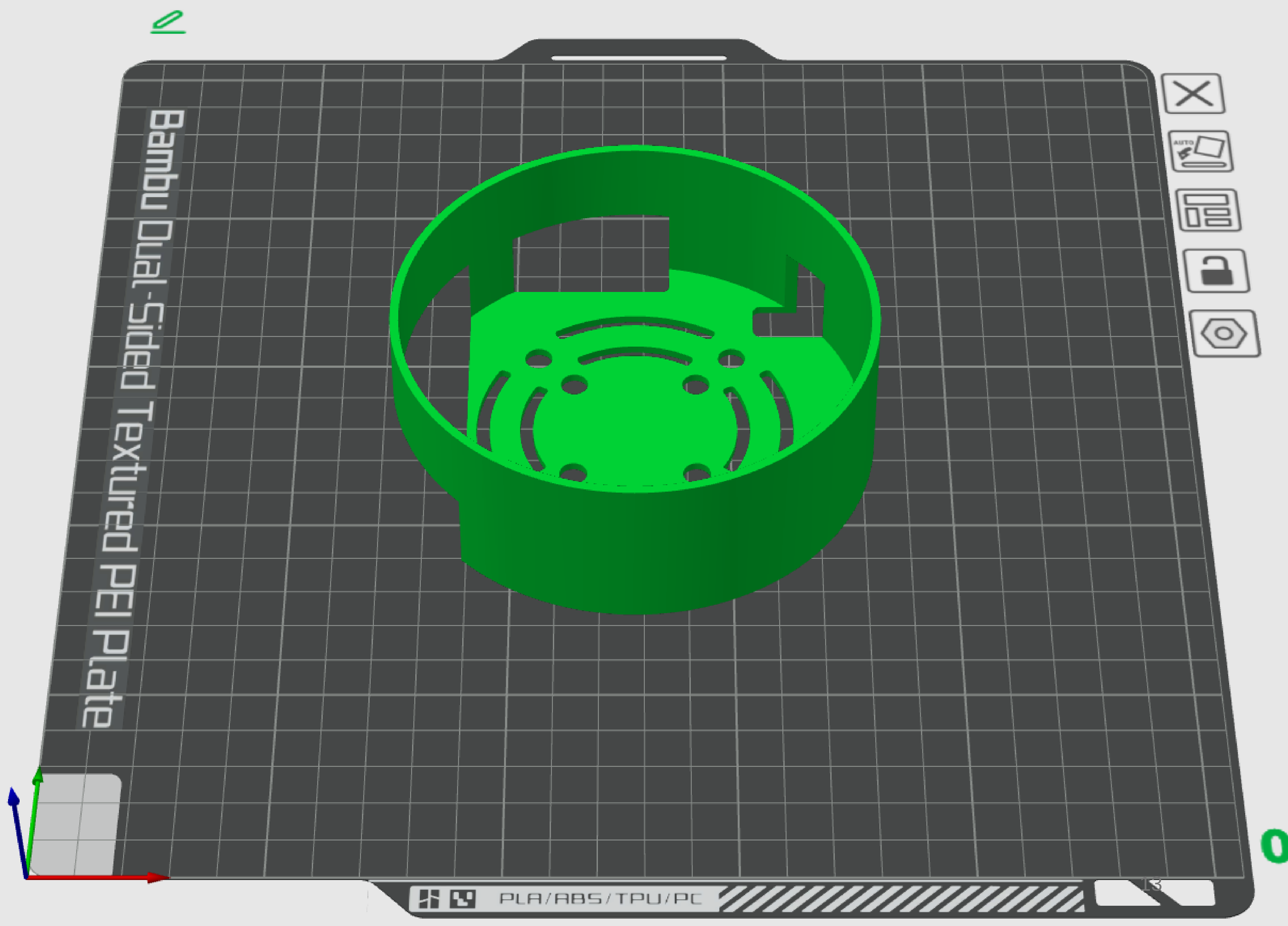
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 2**



Cable box

Print parameters:

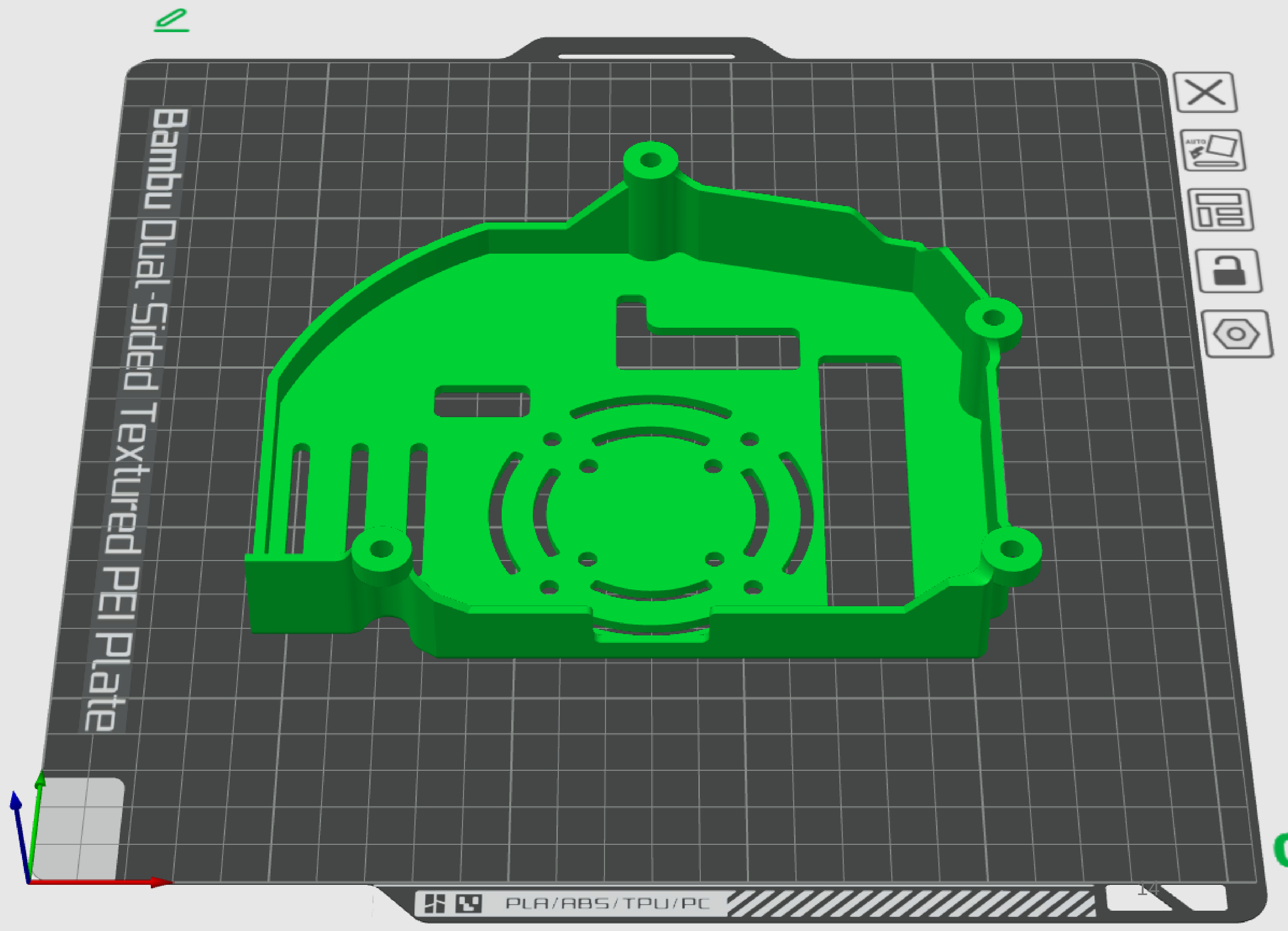
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 2**



Note:
Support is required

Electronics cover

Print parameters:
- Material: PETG
- Layer height: 0.2mm
- Infill: 15%
- Wall loops: 2

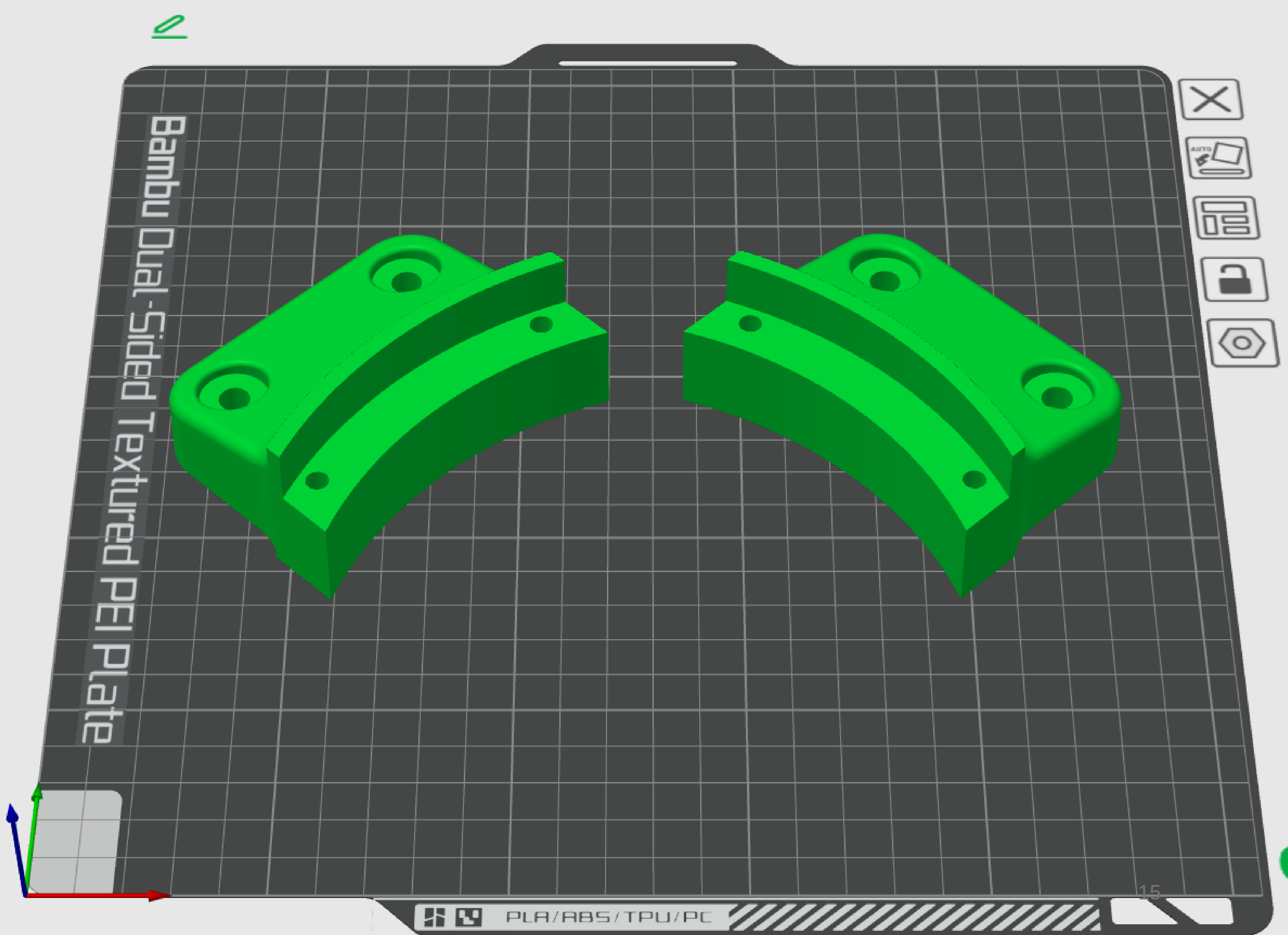


Note:
Support is required

Leg 1&2

Print parameters:

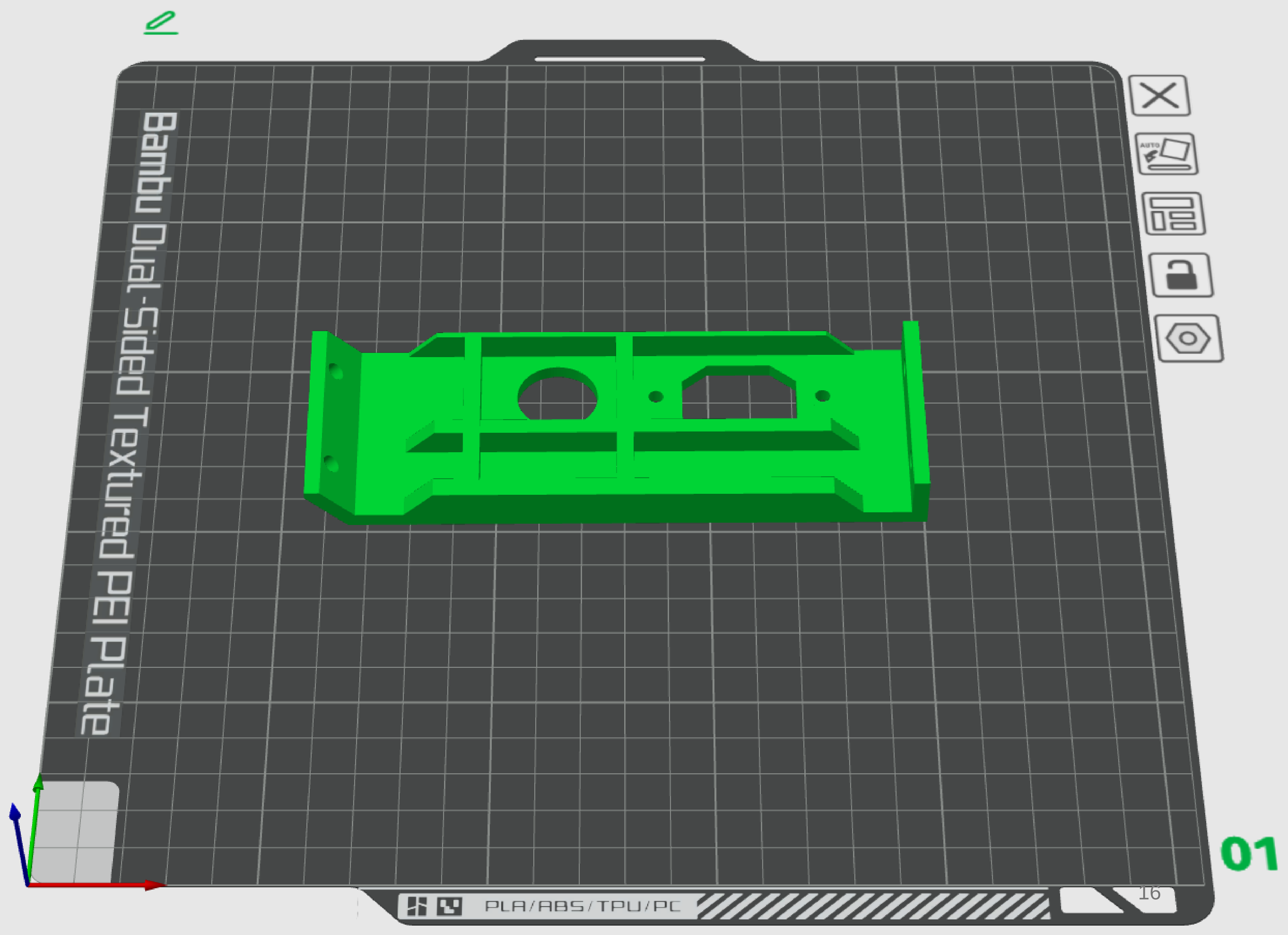
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**



PSU front panel

Print parameters:

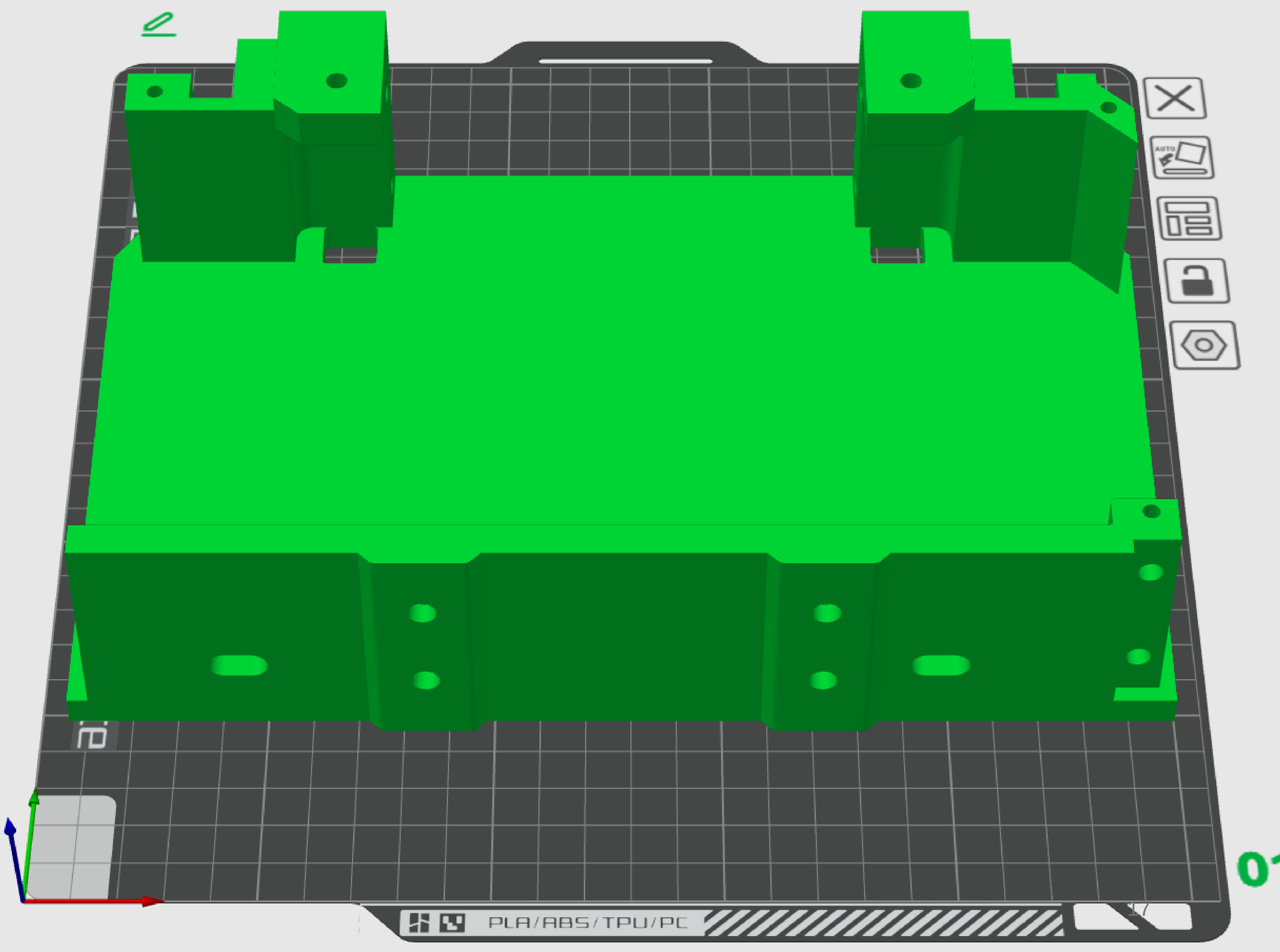
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**



PSU box

Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**

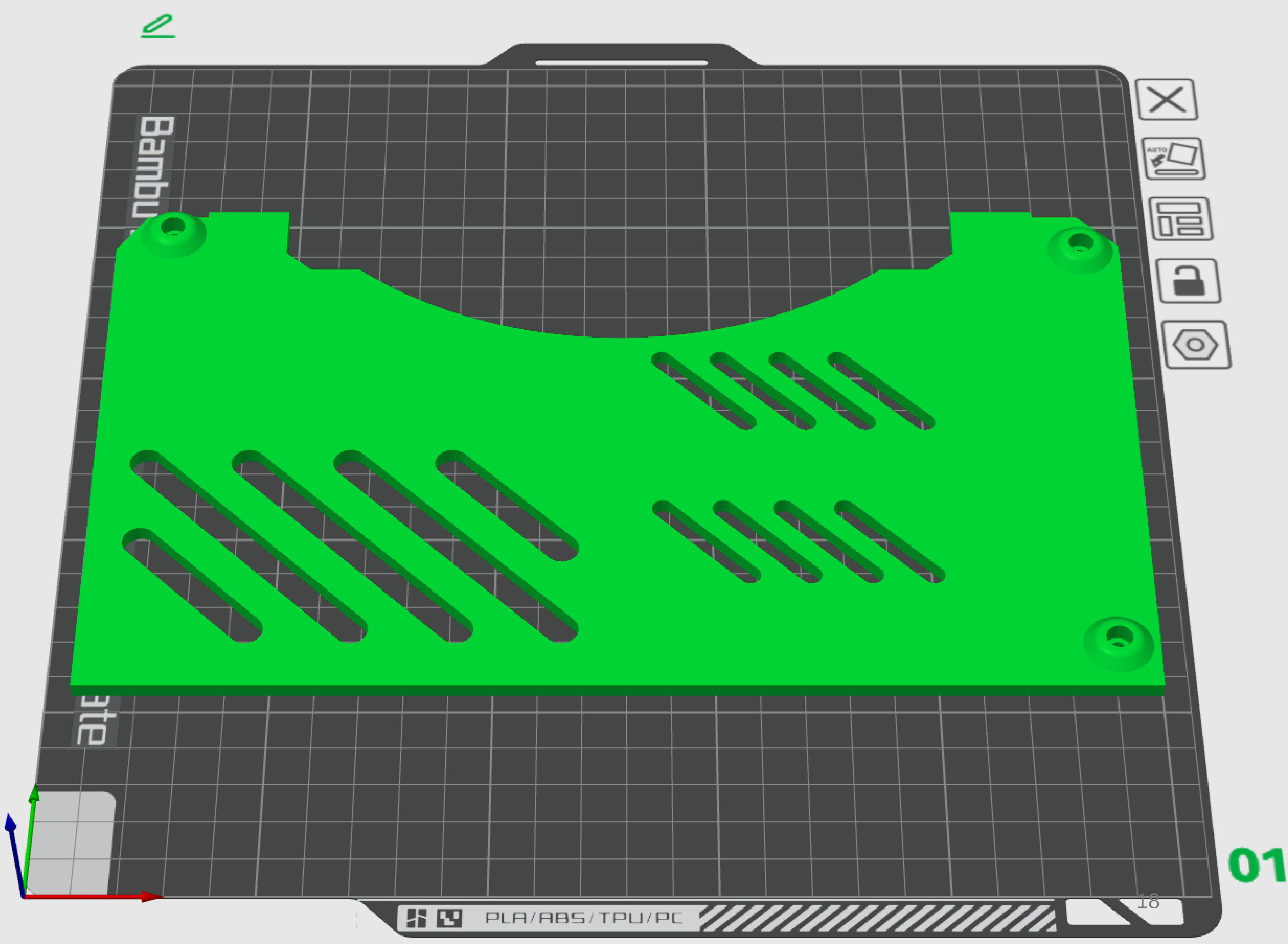


Note:
Support is required

PSU cover

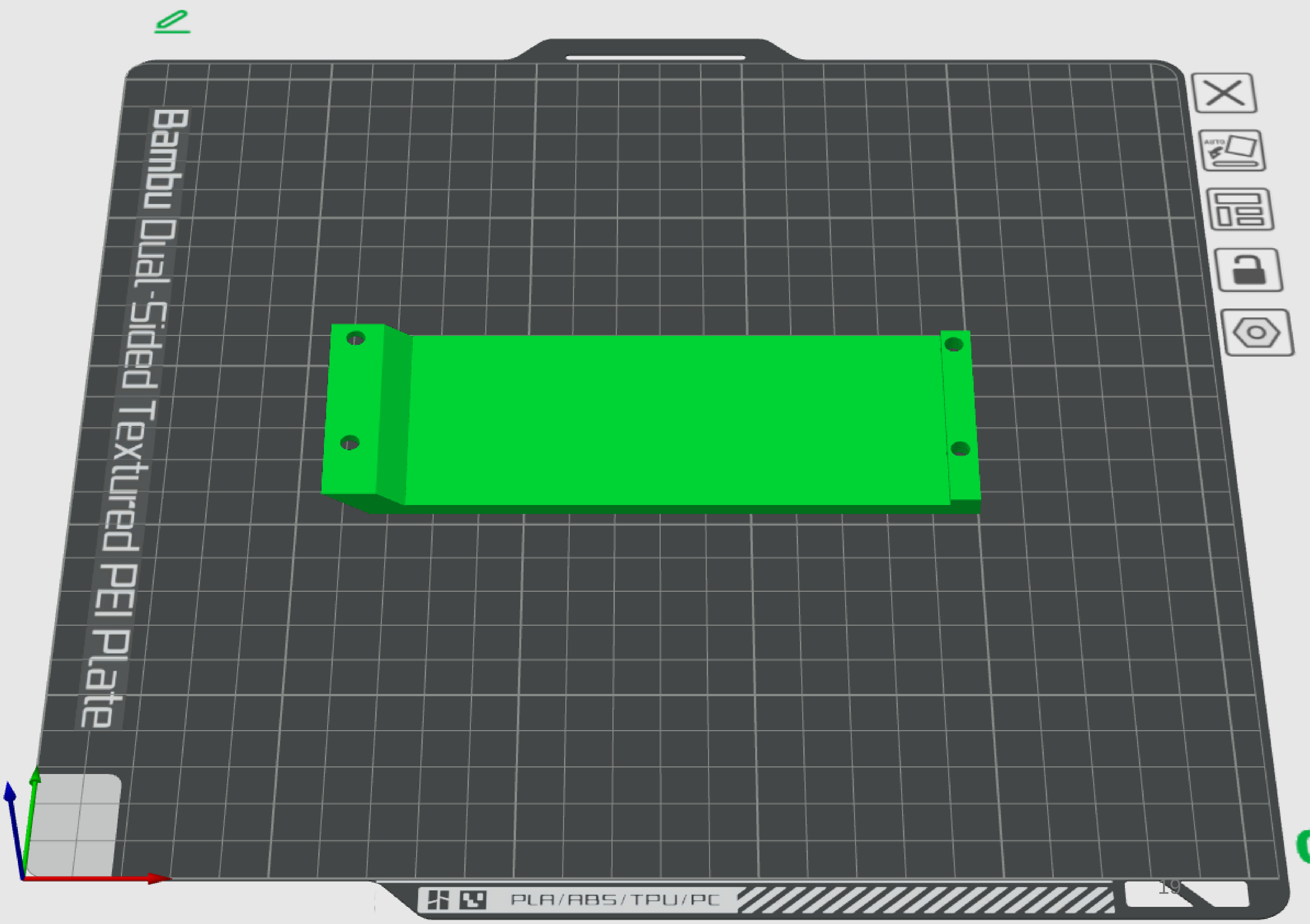
Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 2**



PSU rear wall

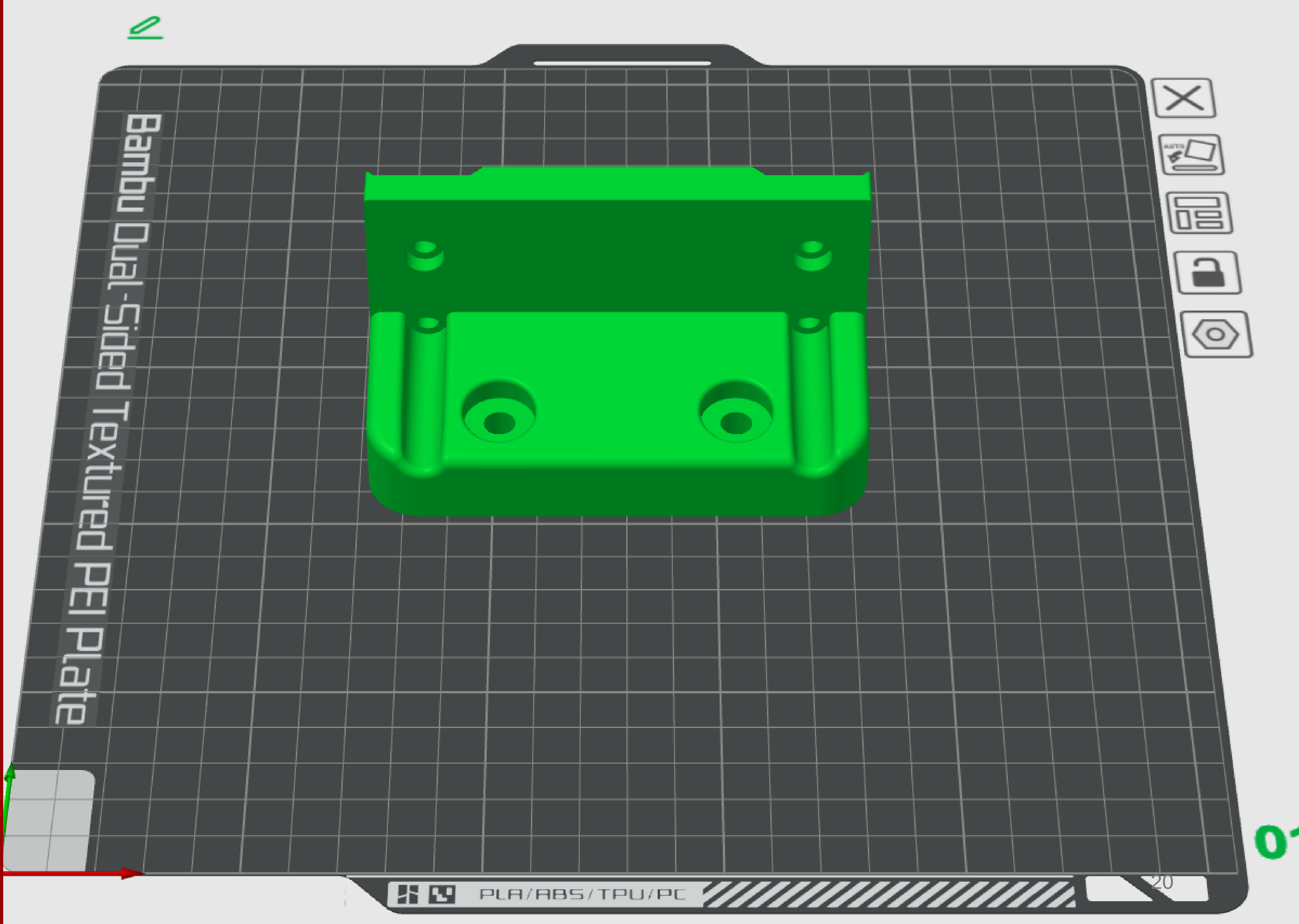
Print parameters:
- Material: PETG
- Layer height: 0.2mm
- Infill: 15%
- Wall loops: 2



Rear leg

Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**

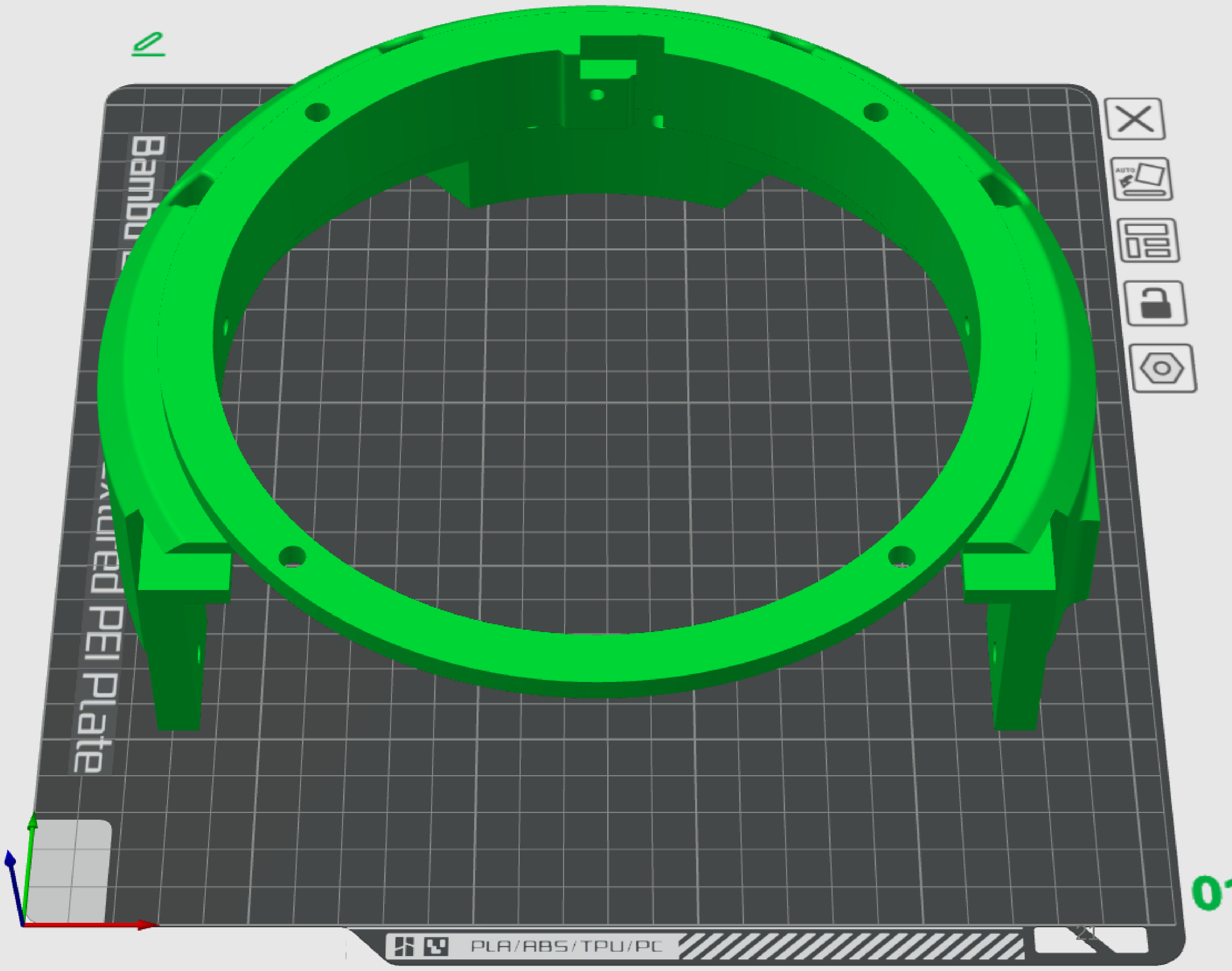


Robot base body

Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**

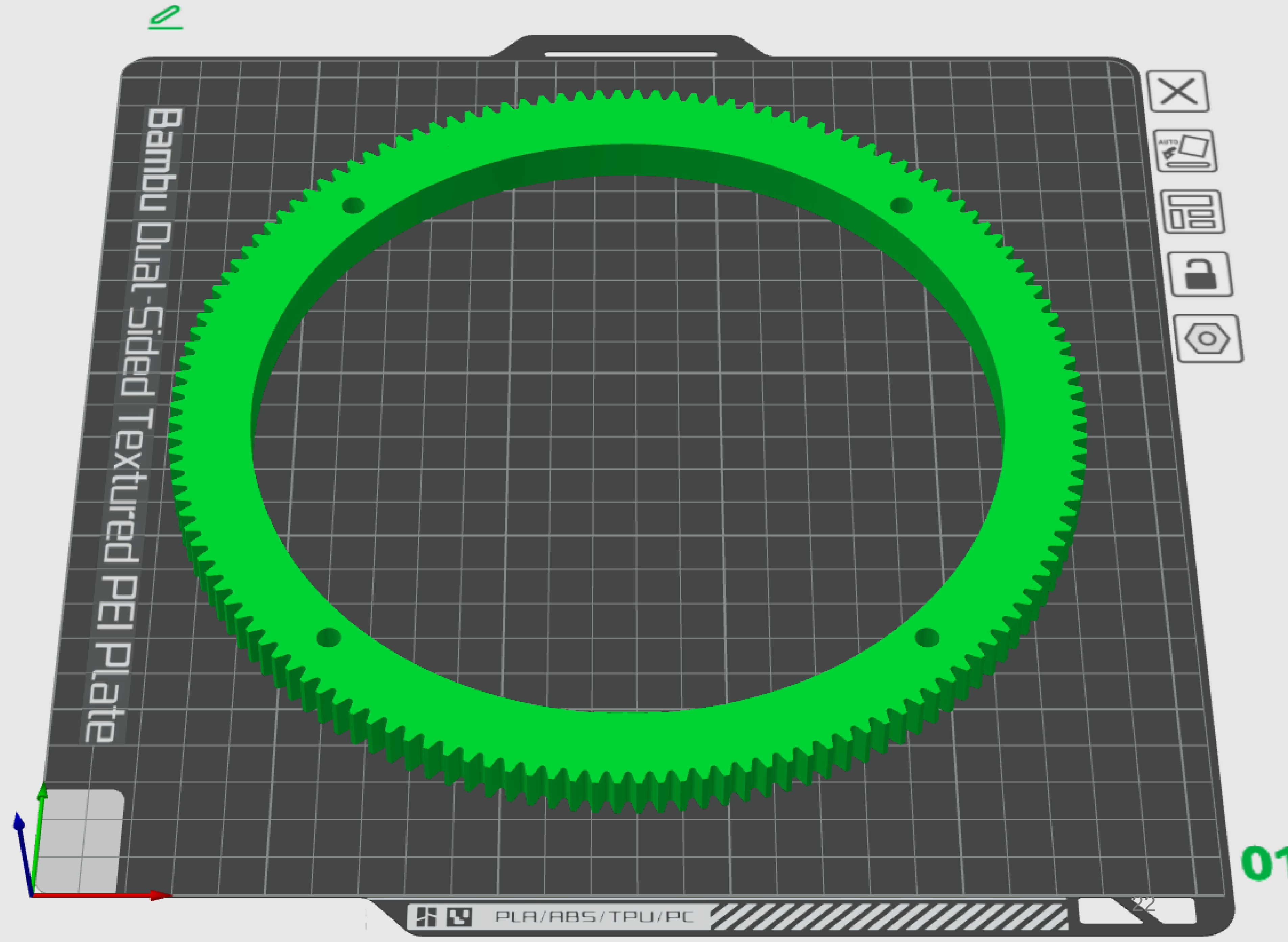
Note:
Support is required



Spur gear 140T

Print parameters:

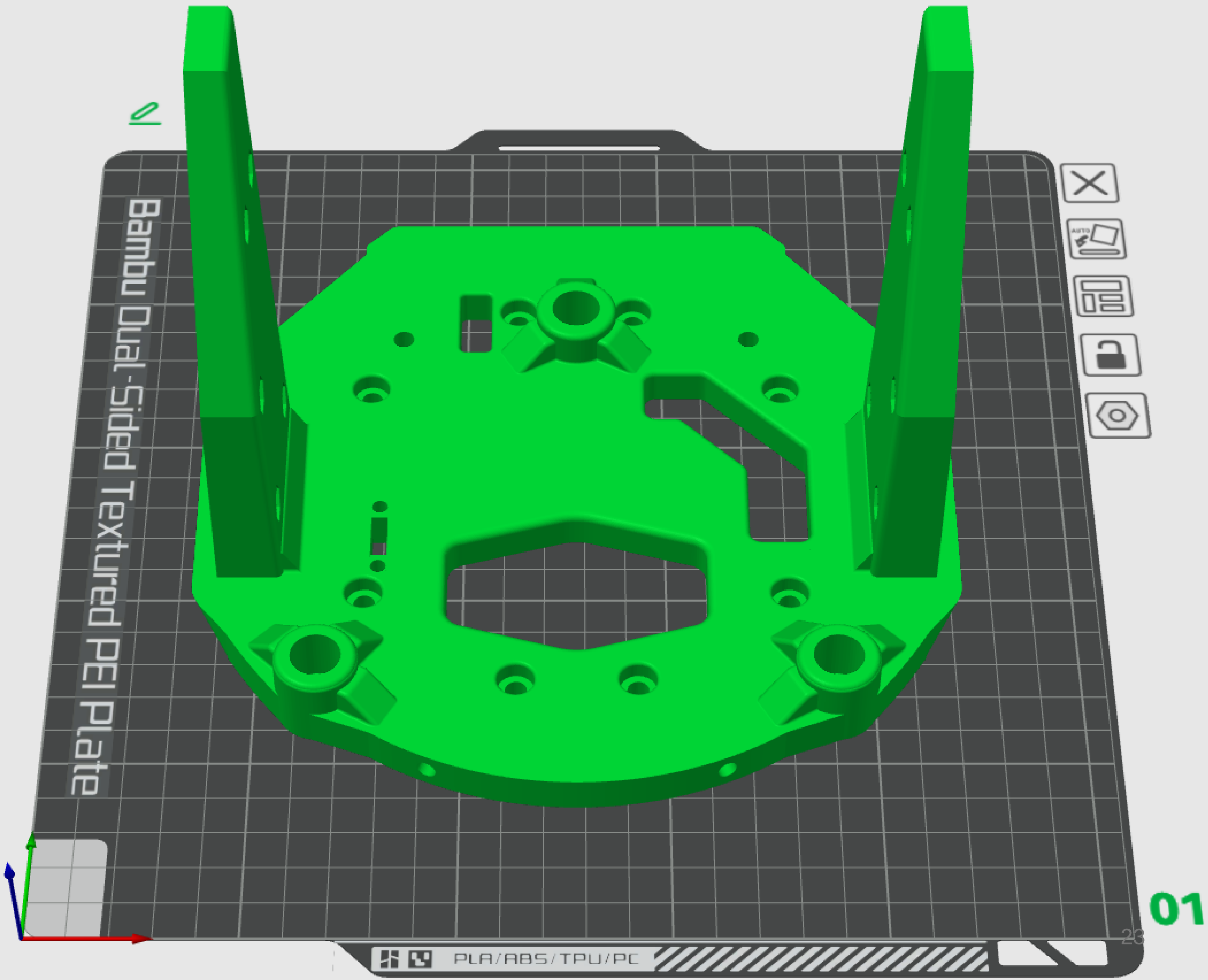
- **Material: PETG**
- **Layer height: 0.1mm**
- **Infill: 100%**
- **Wall loops: 4**



Shell mount

Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**

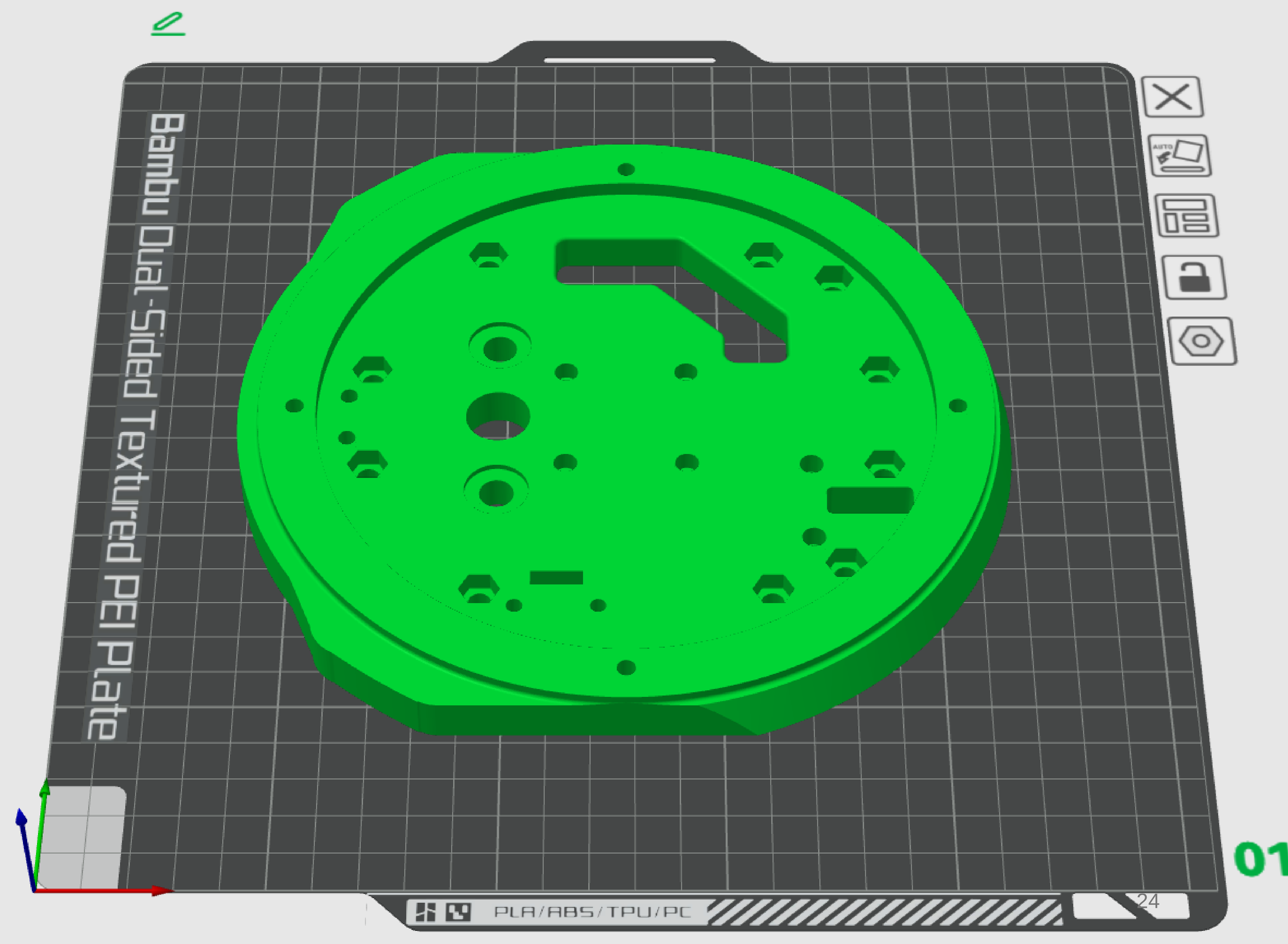


J1 base

Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**

Note:
Support is required

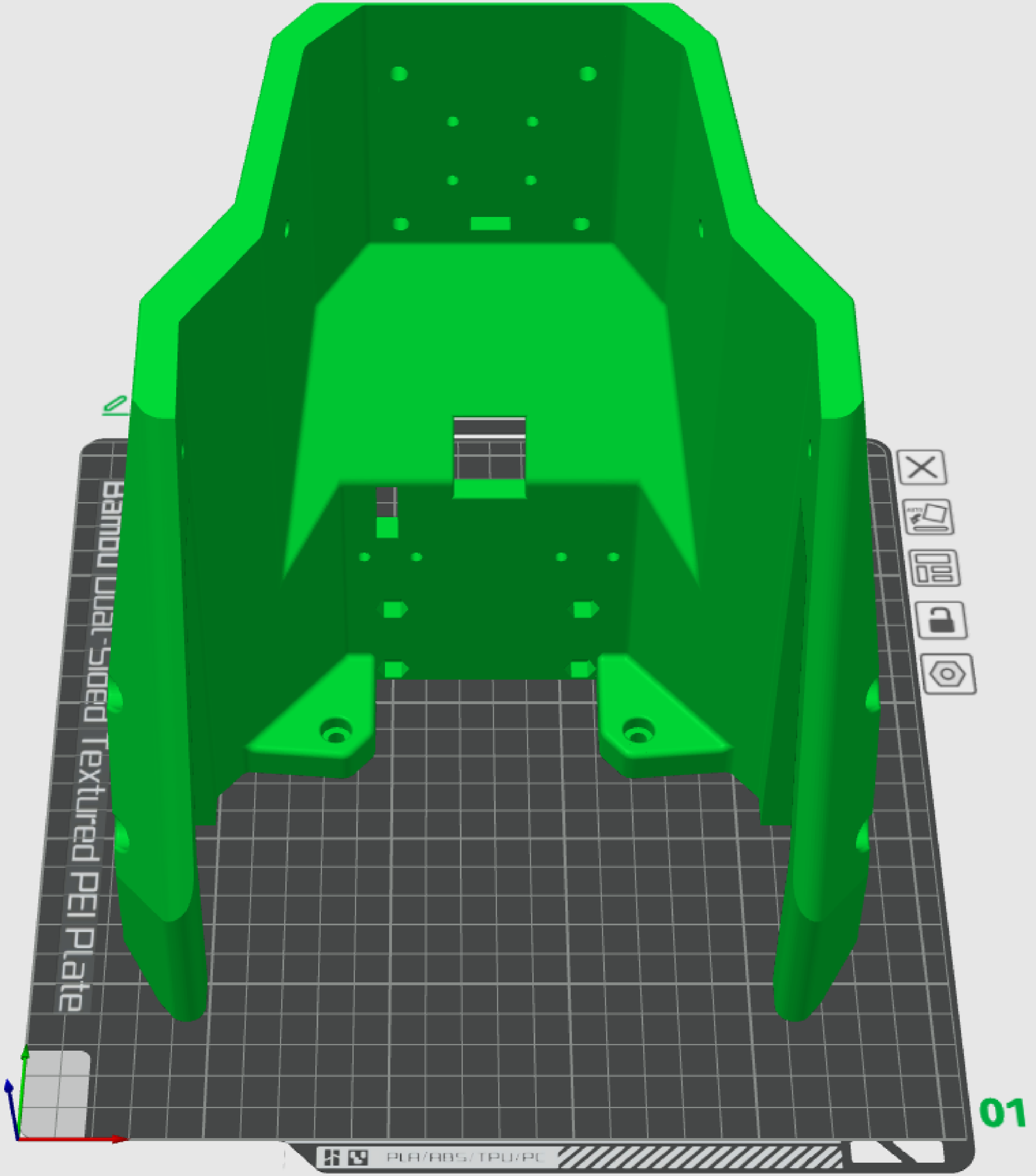


Bottom shell

Print parameters:

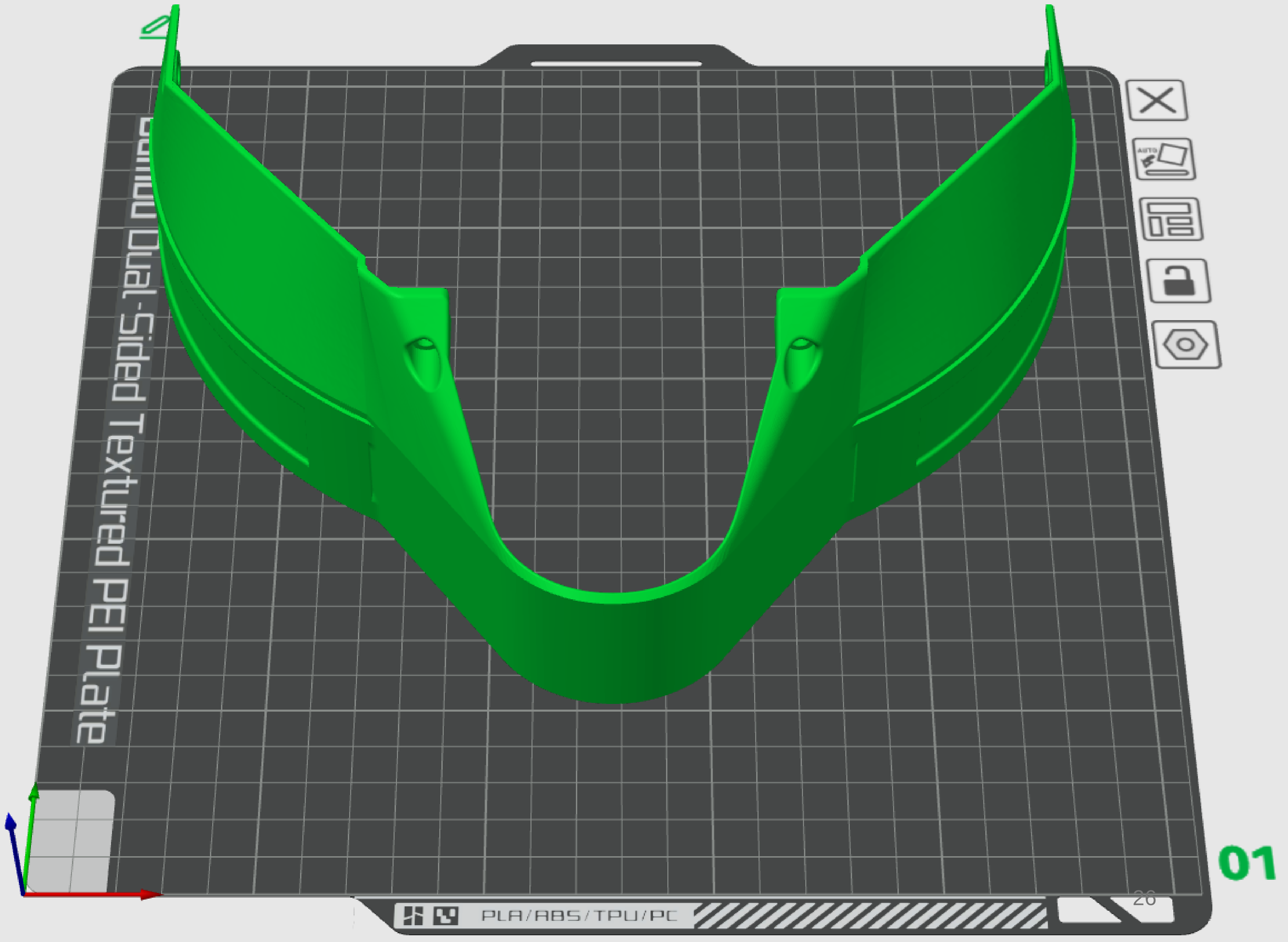
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 3**

Note:
Support is required



Rear cover

Print parameters:
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 2**



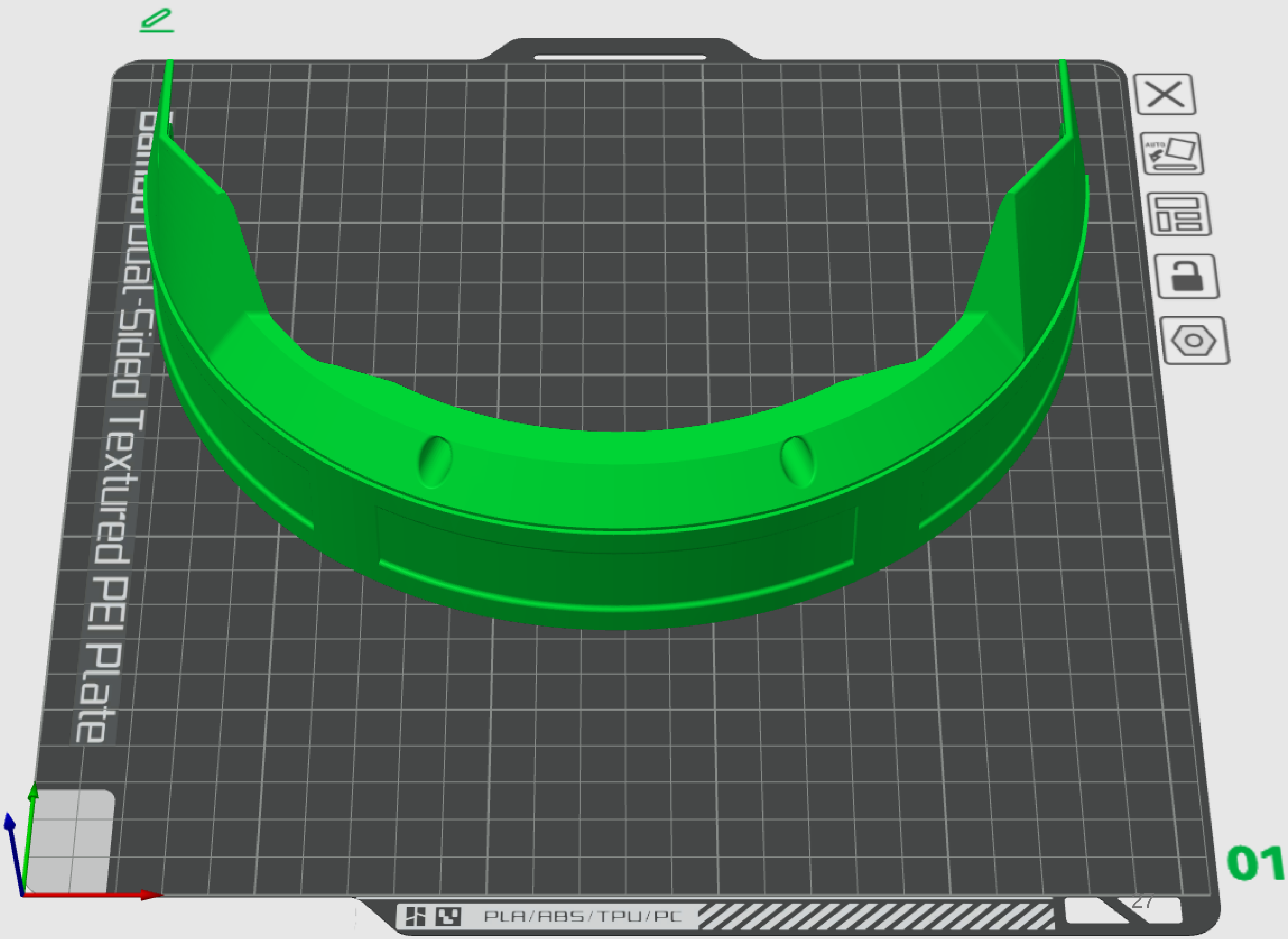
Note:
Support is required

Front cover

Print parameters:

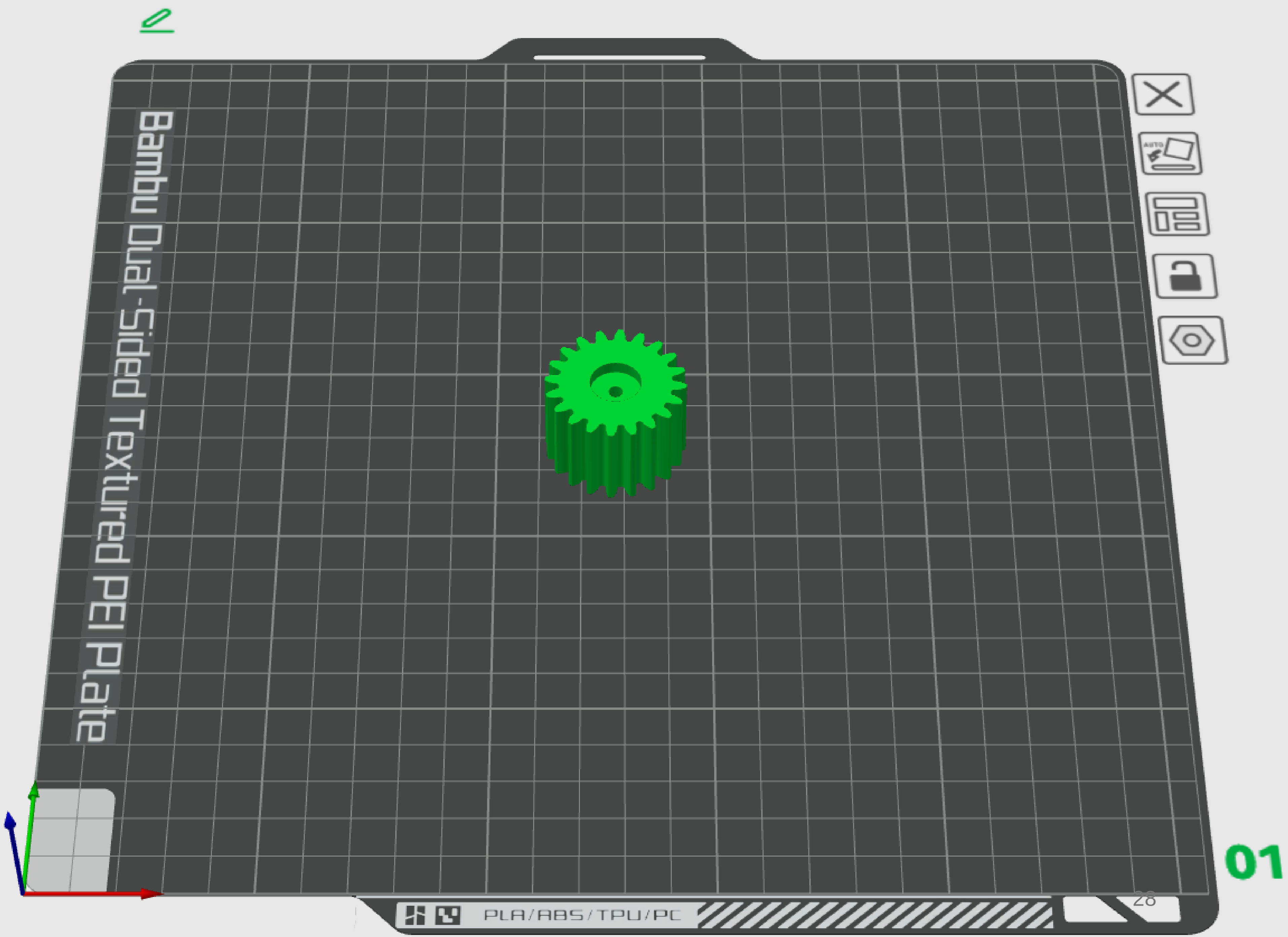
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 2**

Note:
Support is required



Spur gear 20T

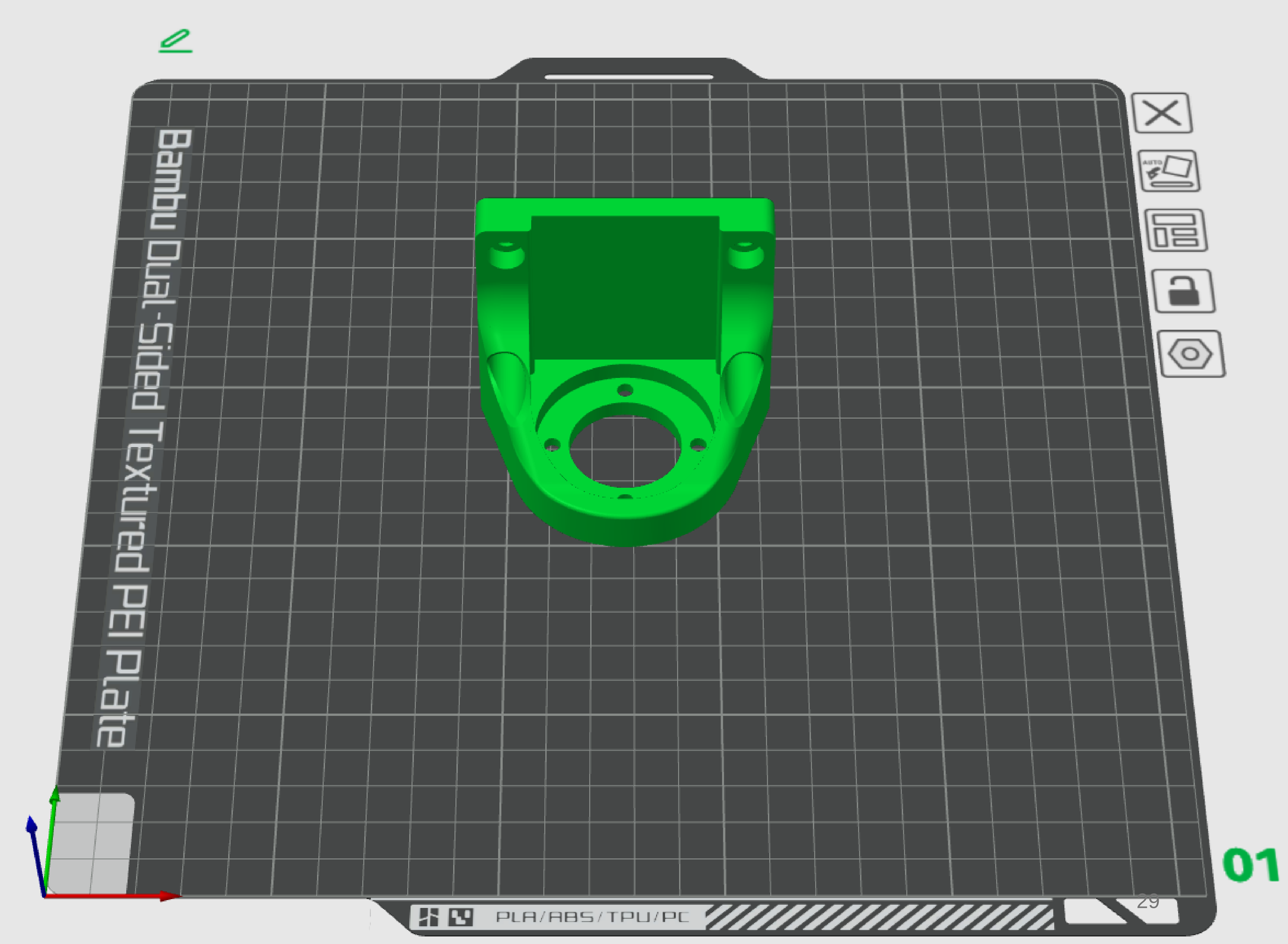
Print parameters:
- Material: PETG
- Layer height: 0.1mm
- Infill: 100%
- Wall loops: 4



M1 mount

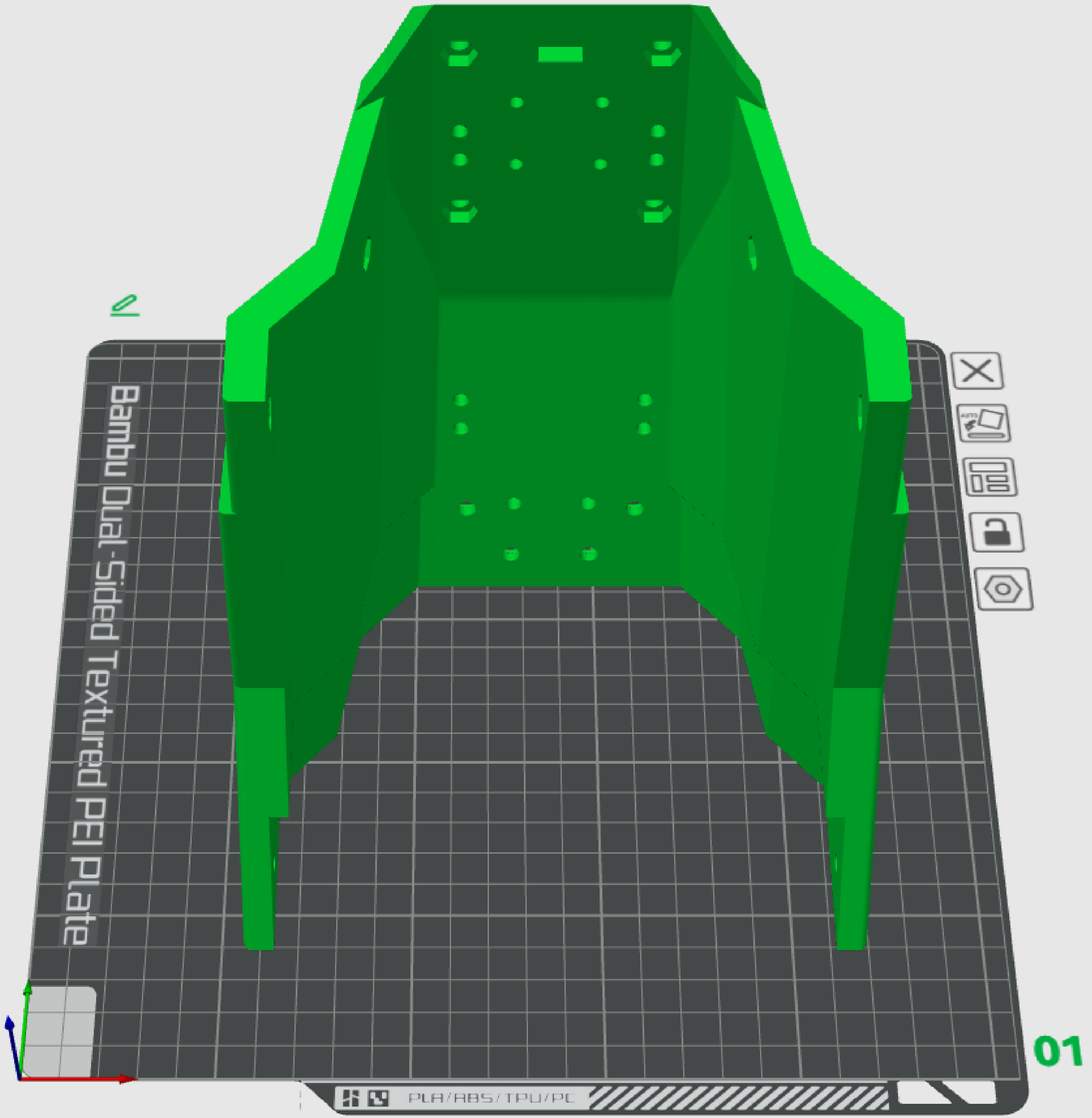
Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**



Middle shell

Print parameters:
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 3**

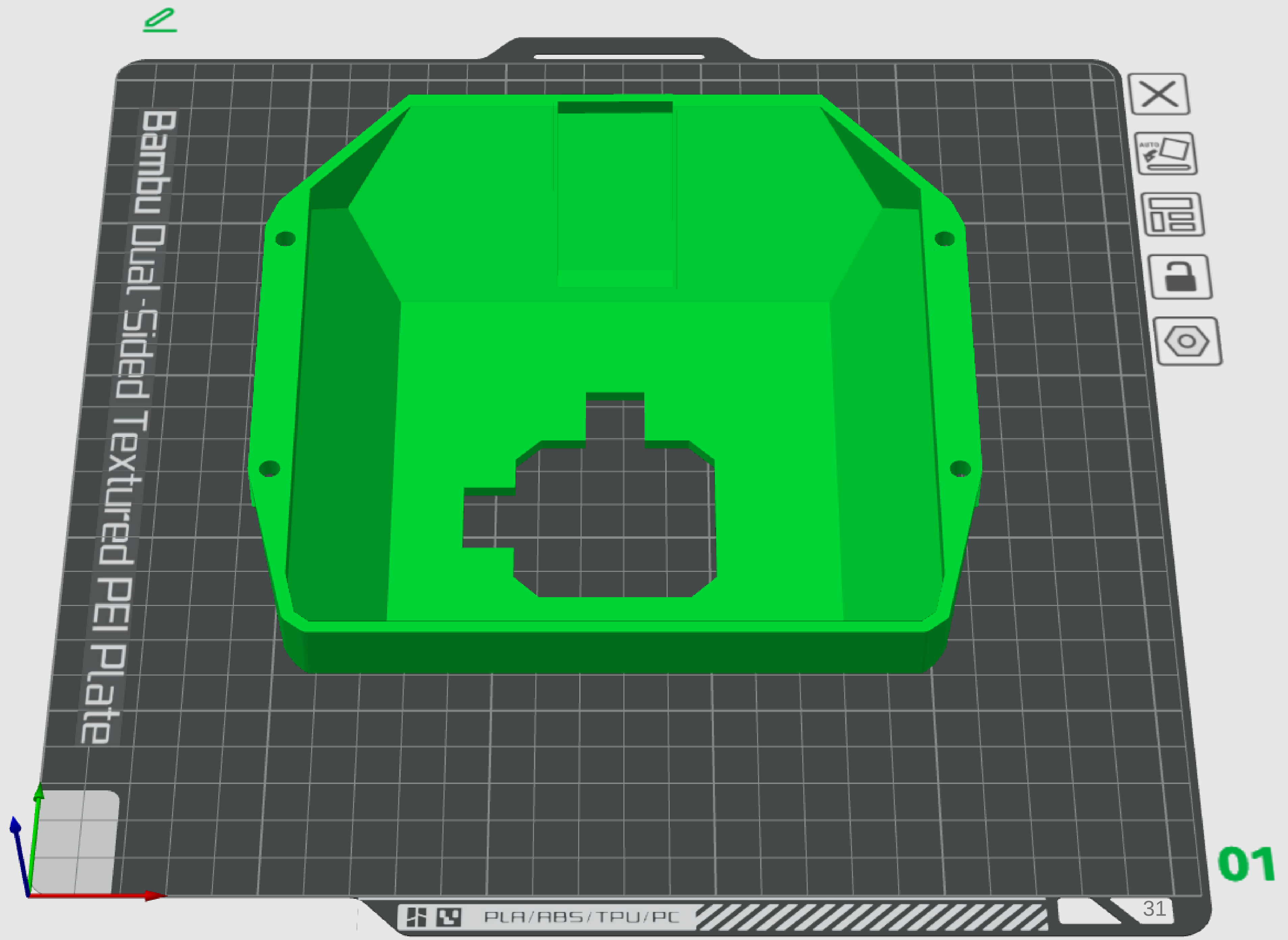


Note:
Support is required

Top cover

Print parameters:

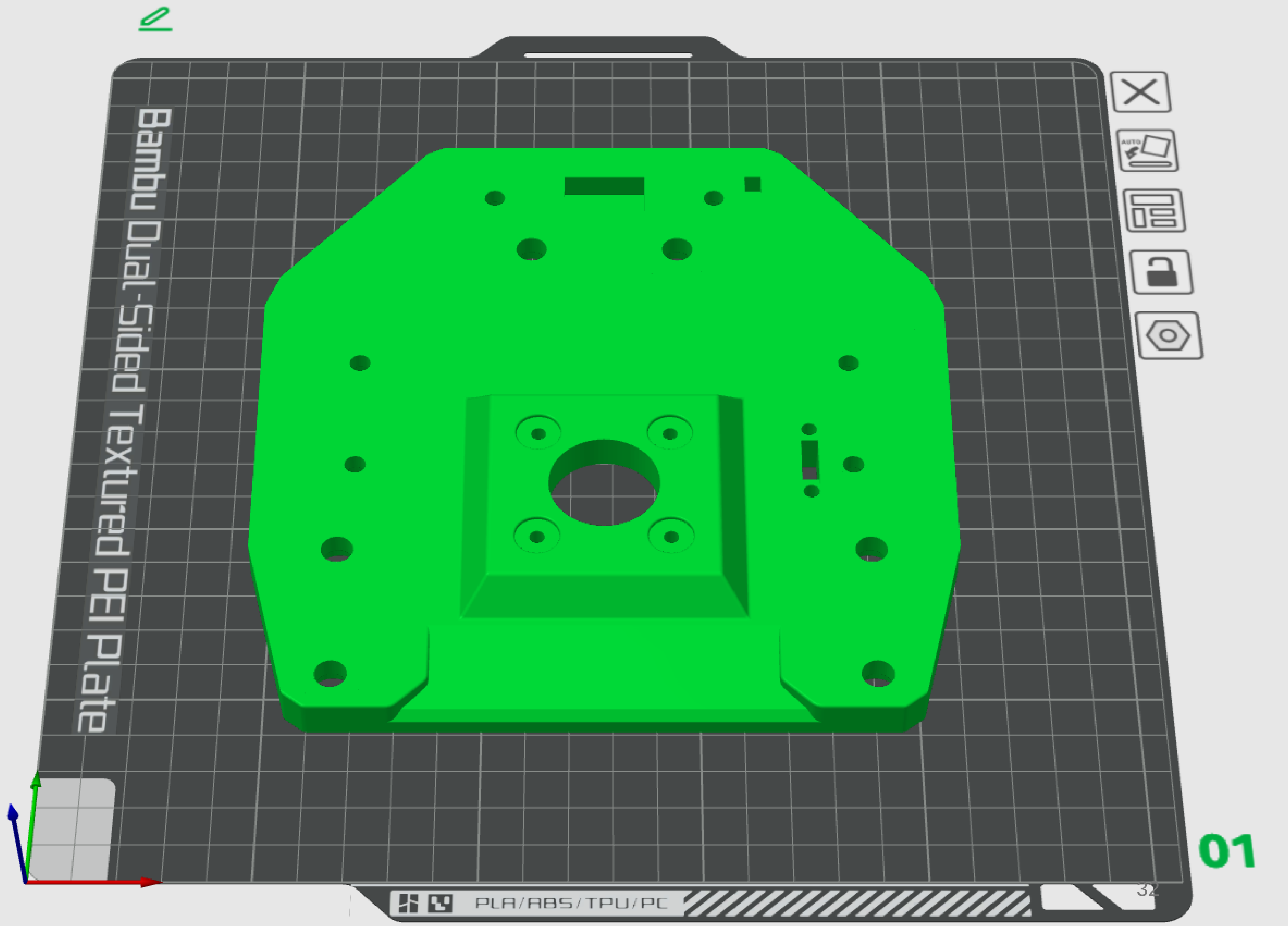
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 3**



Note:
Support is required

Top mount

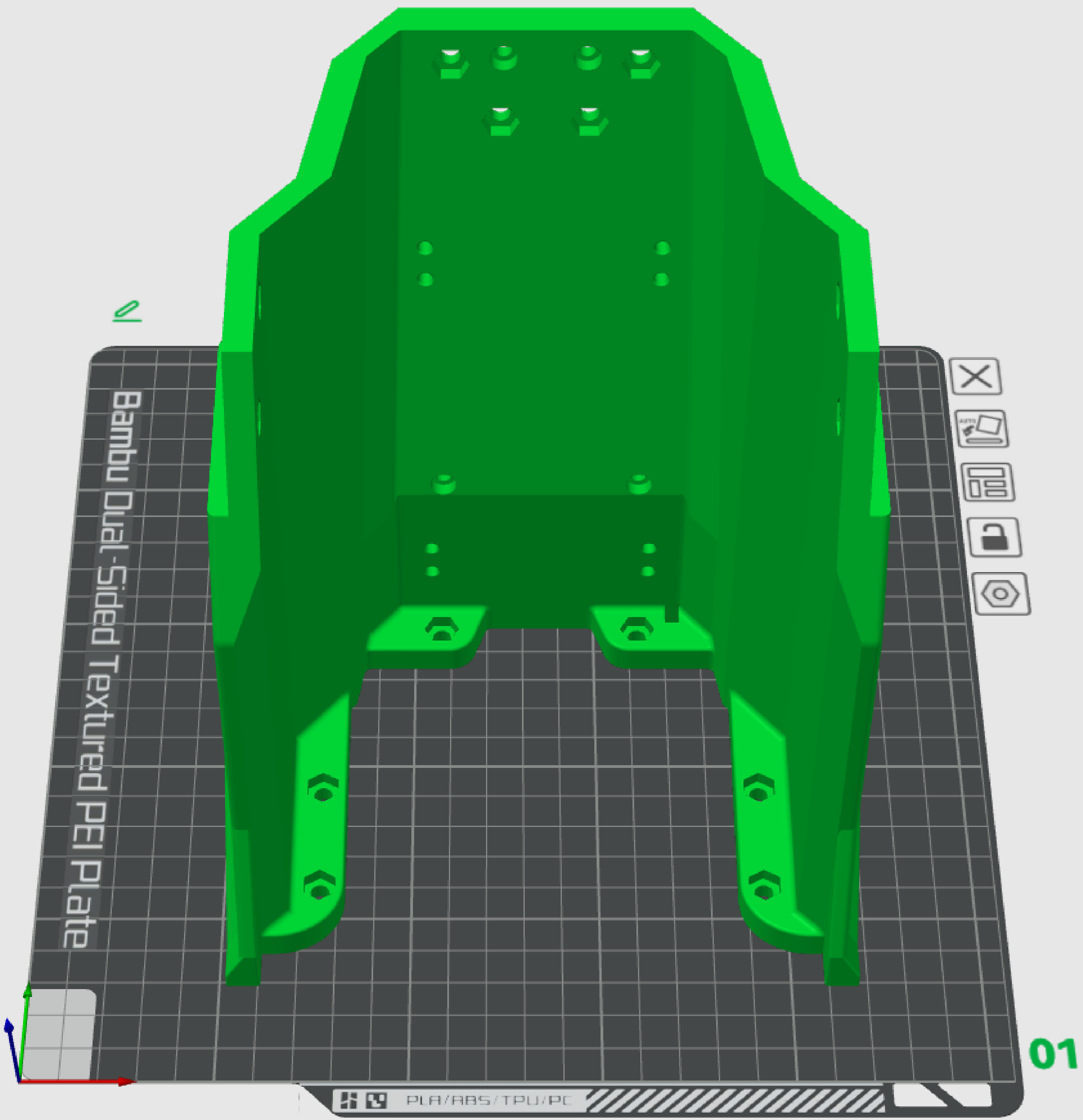
Print parameters:
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**



Note:
Support is required

Bottom shell

Print parameters:
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 3**

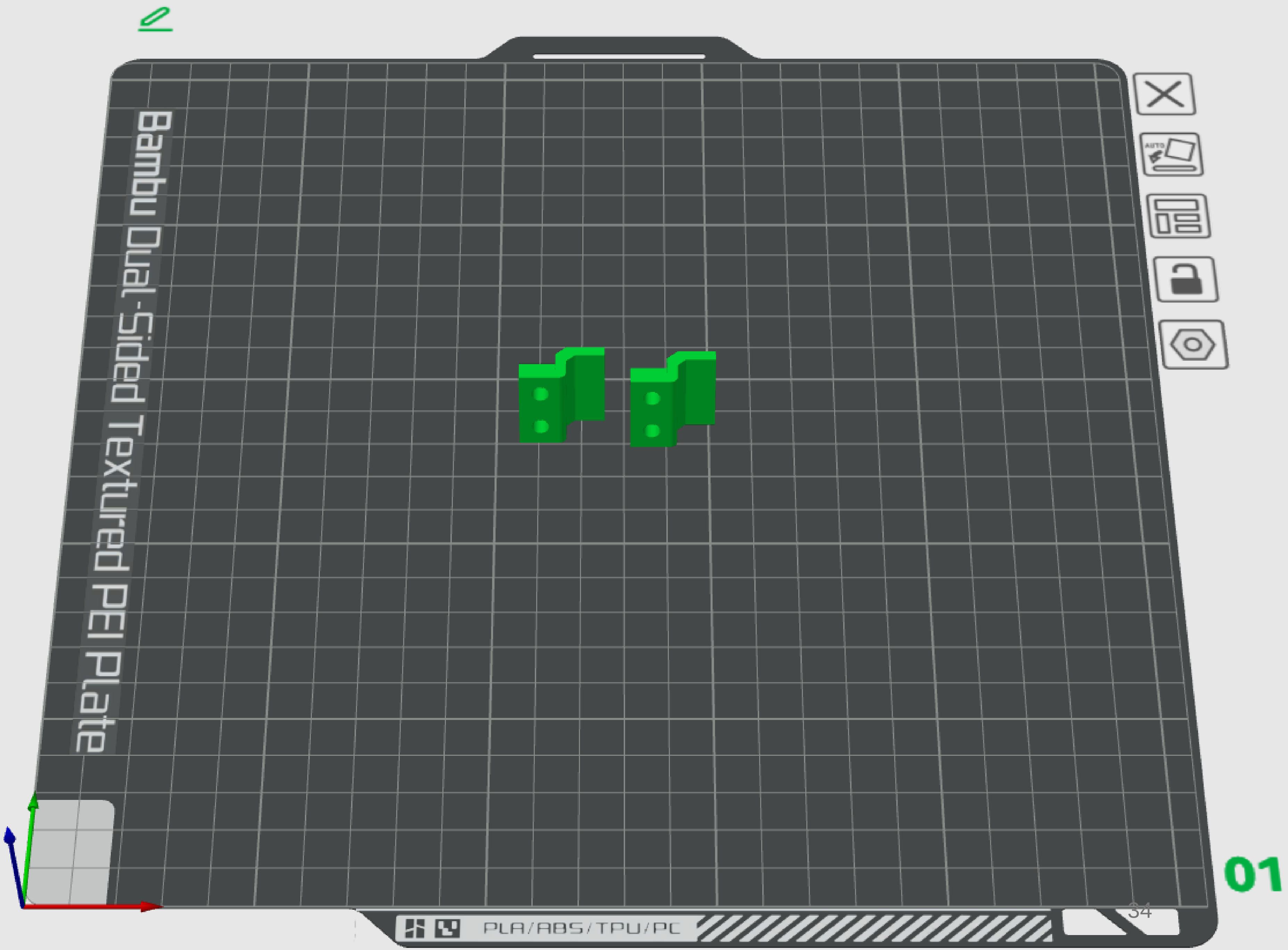


Note:
Support is required

J1 cable holder

Print parameters:

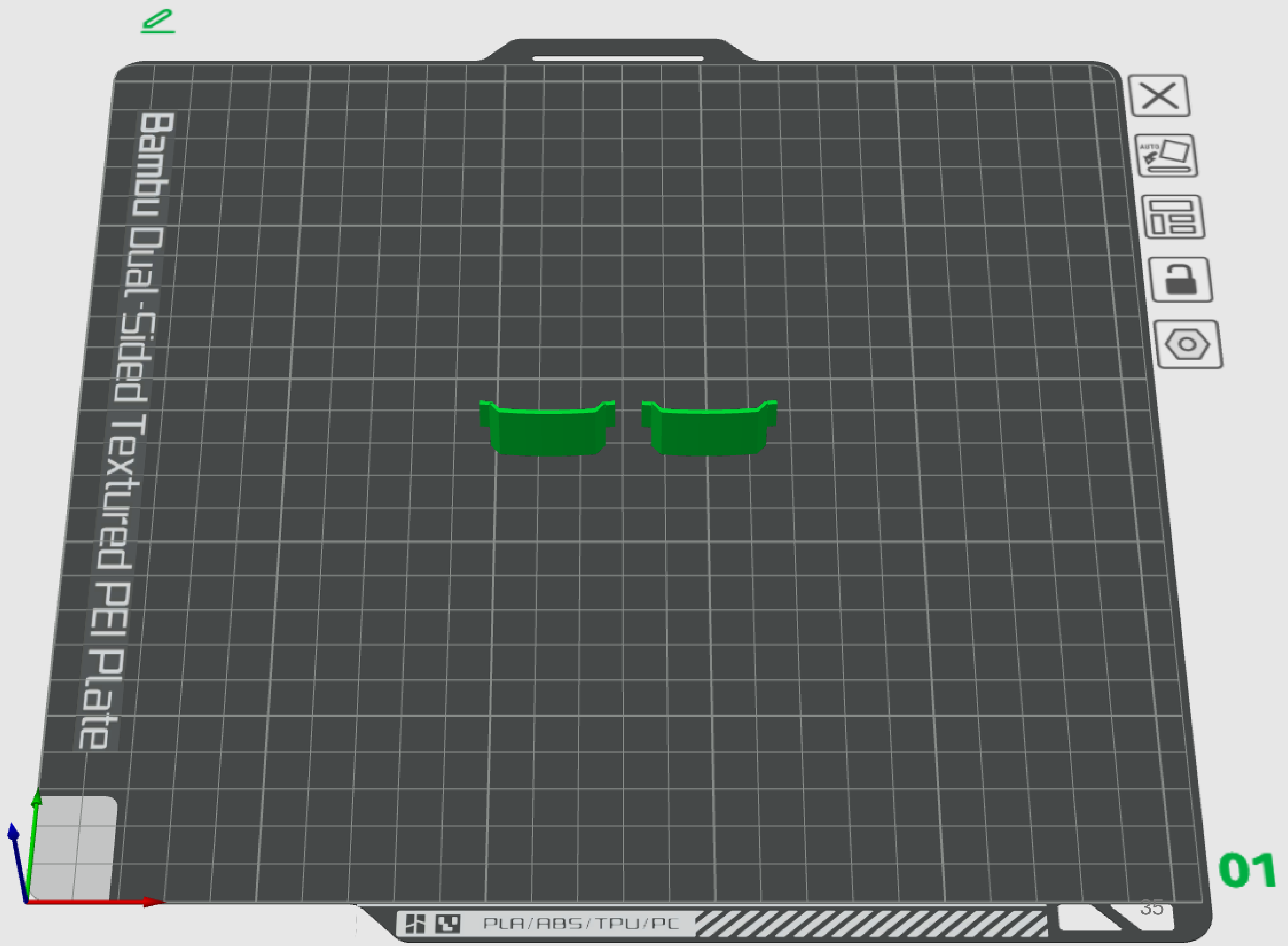
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 2**



Cover clip 1&2

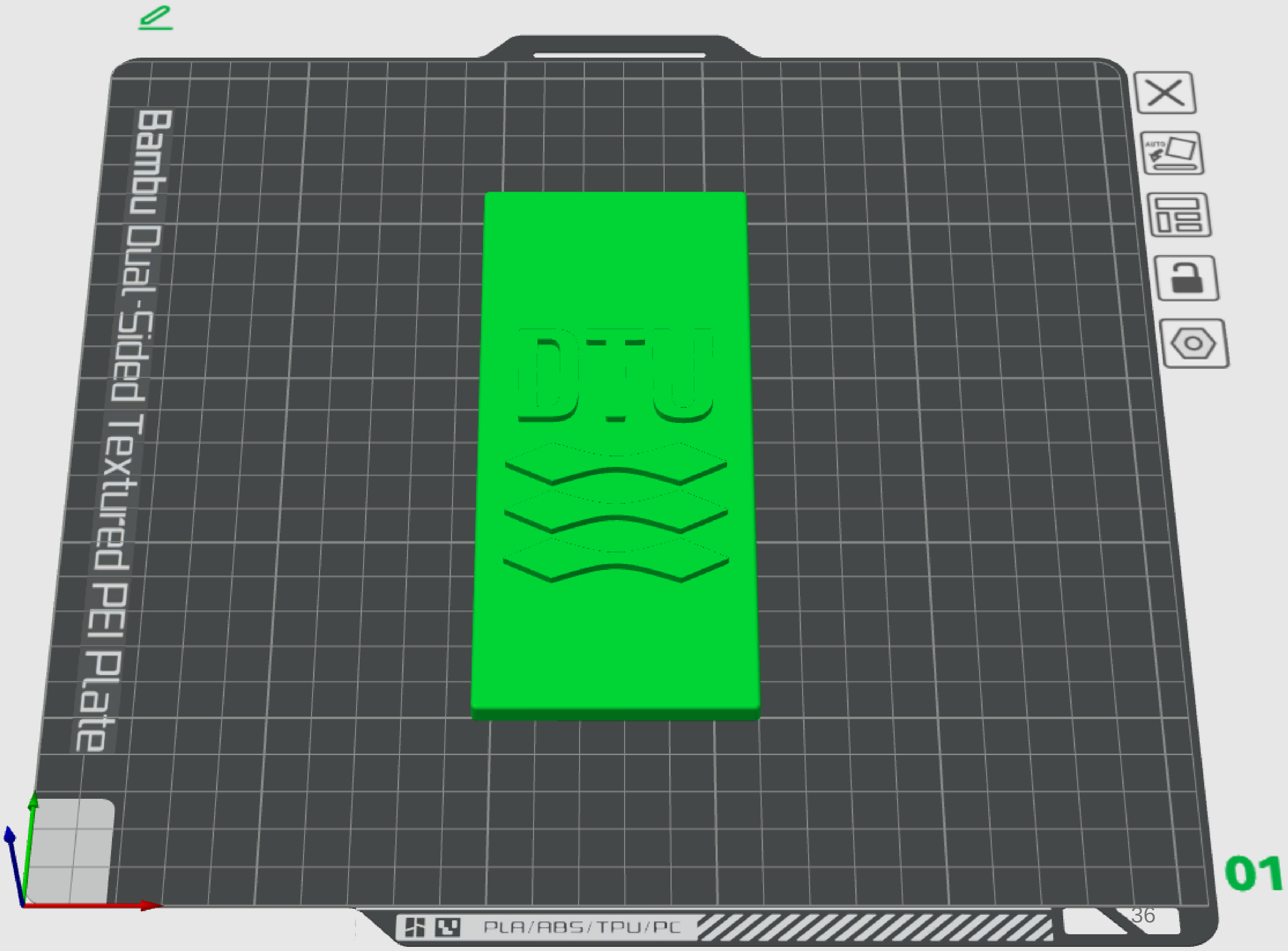
Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 2**



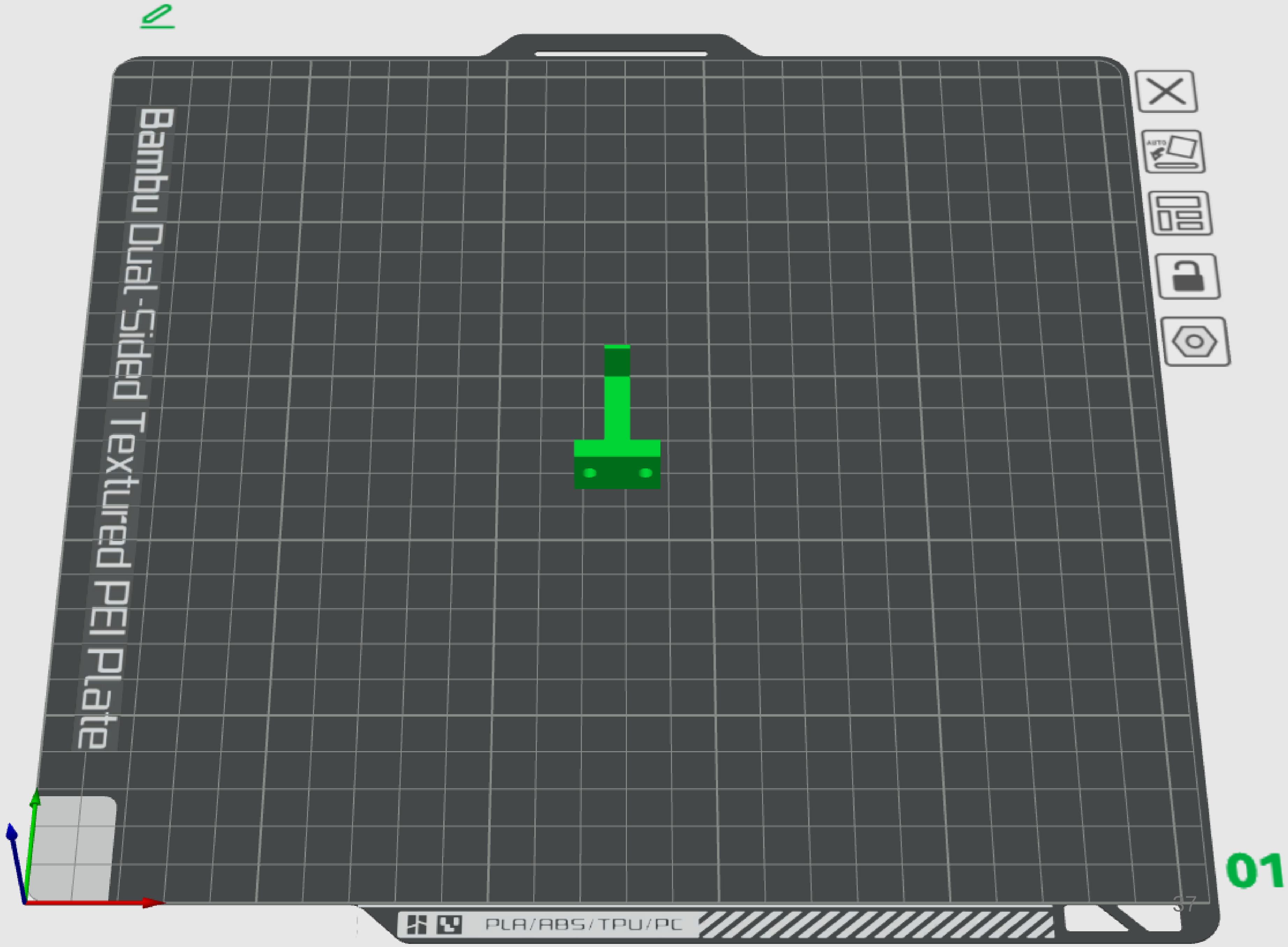
Logo

Print parameters:
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 2**



J1 sensor trigger

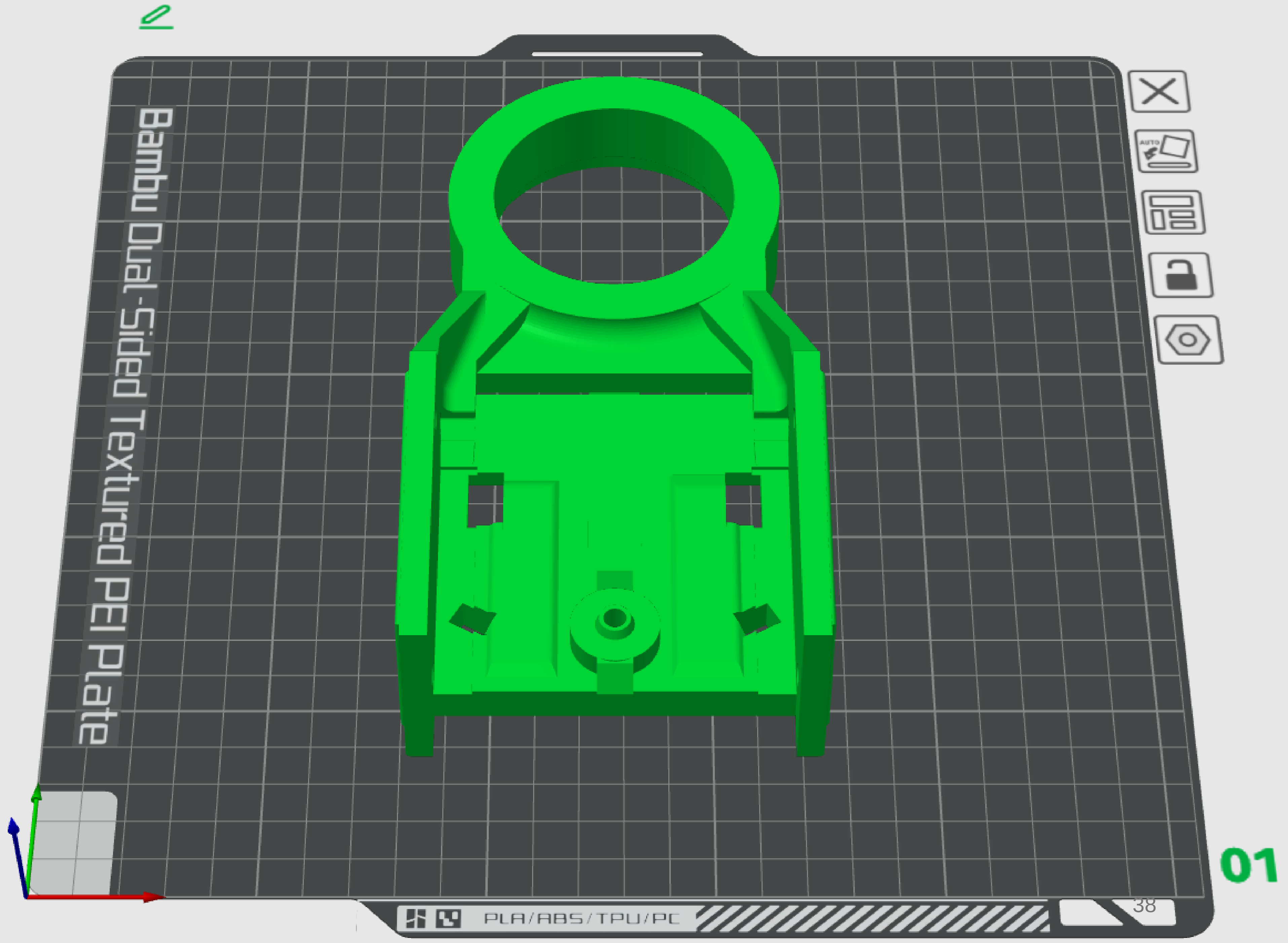
Print parameters:
- Material: PETG
- Layer height: 0.2mm
- Infill: 20%
- Wall loops: 4



Arm link top

Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**

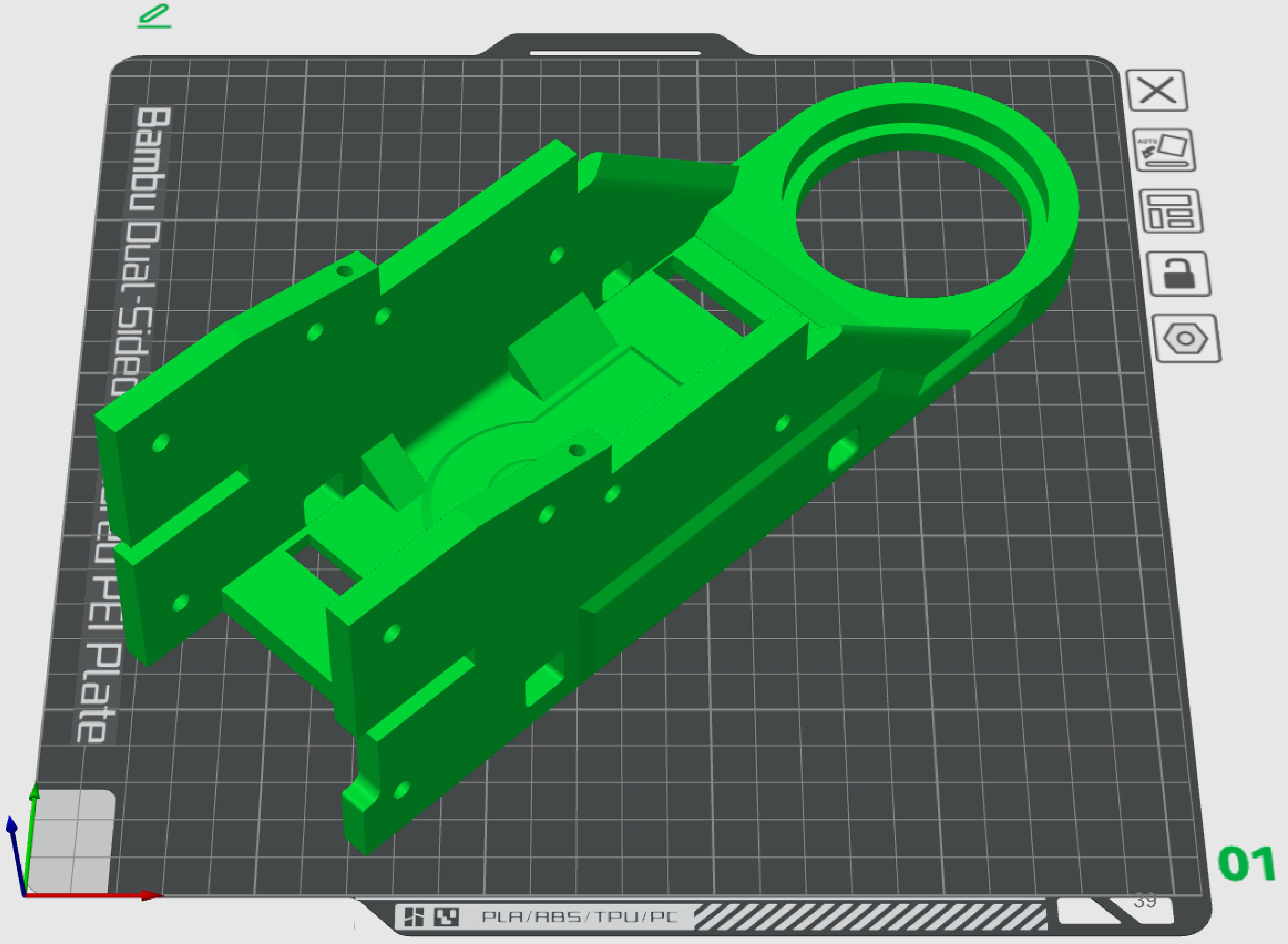


Note:
Support is required

Arm link bottom

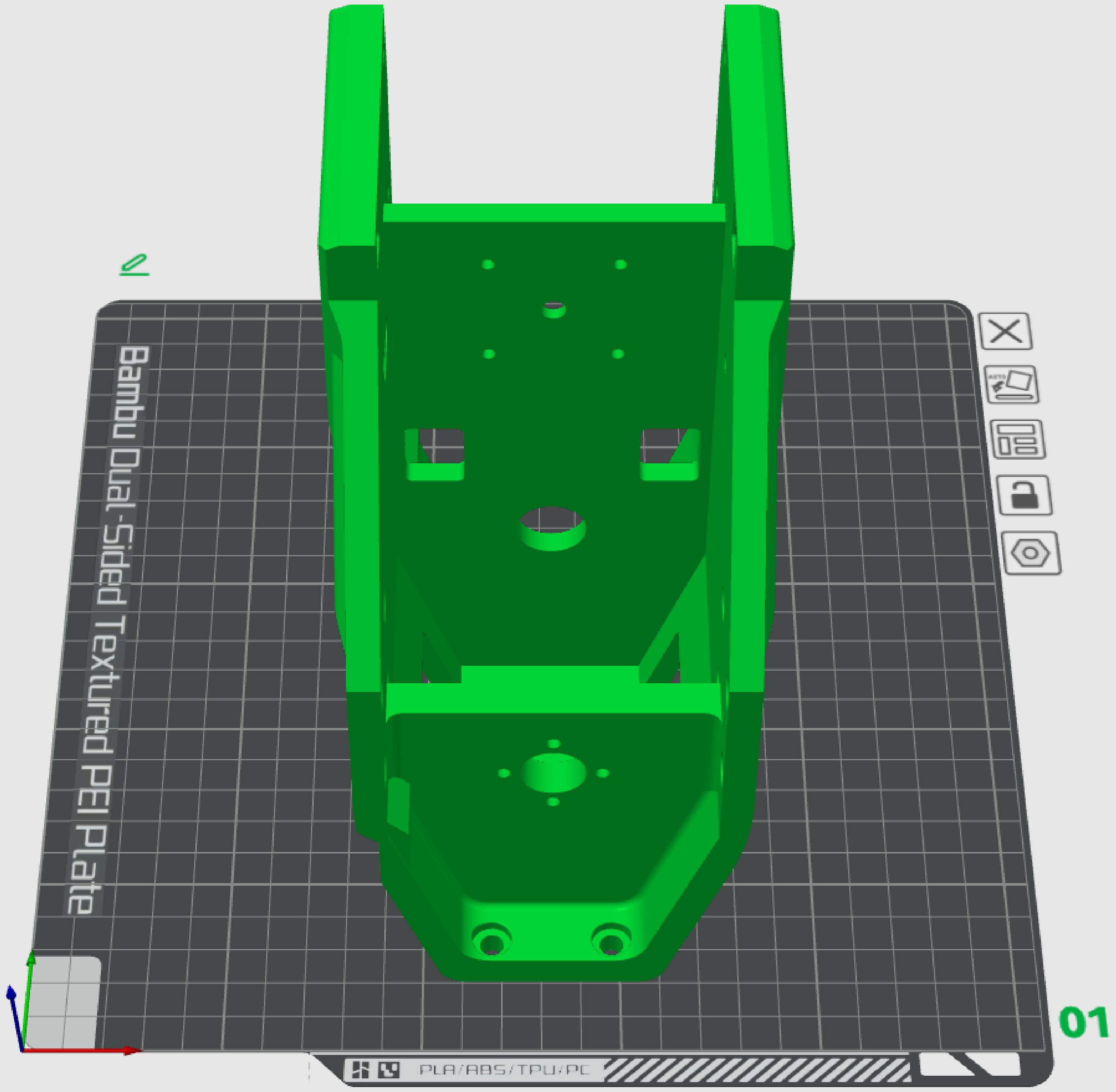
Print parameters:
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**

Note:
Support is required



Arm mount

Print parameters:
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**

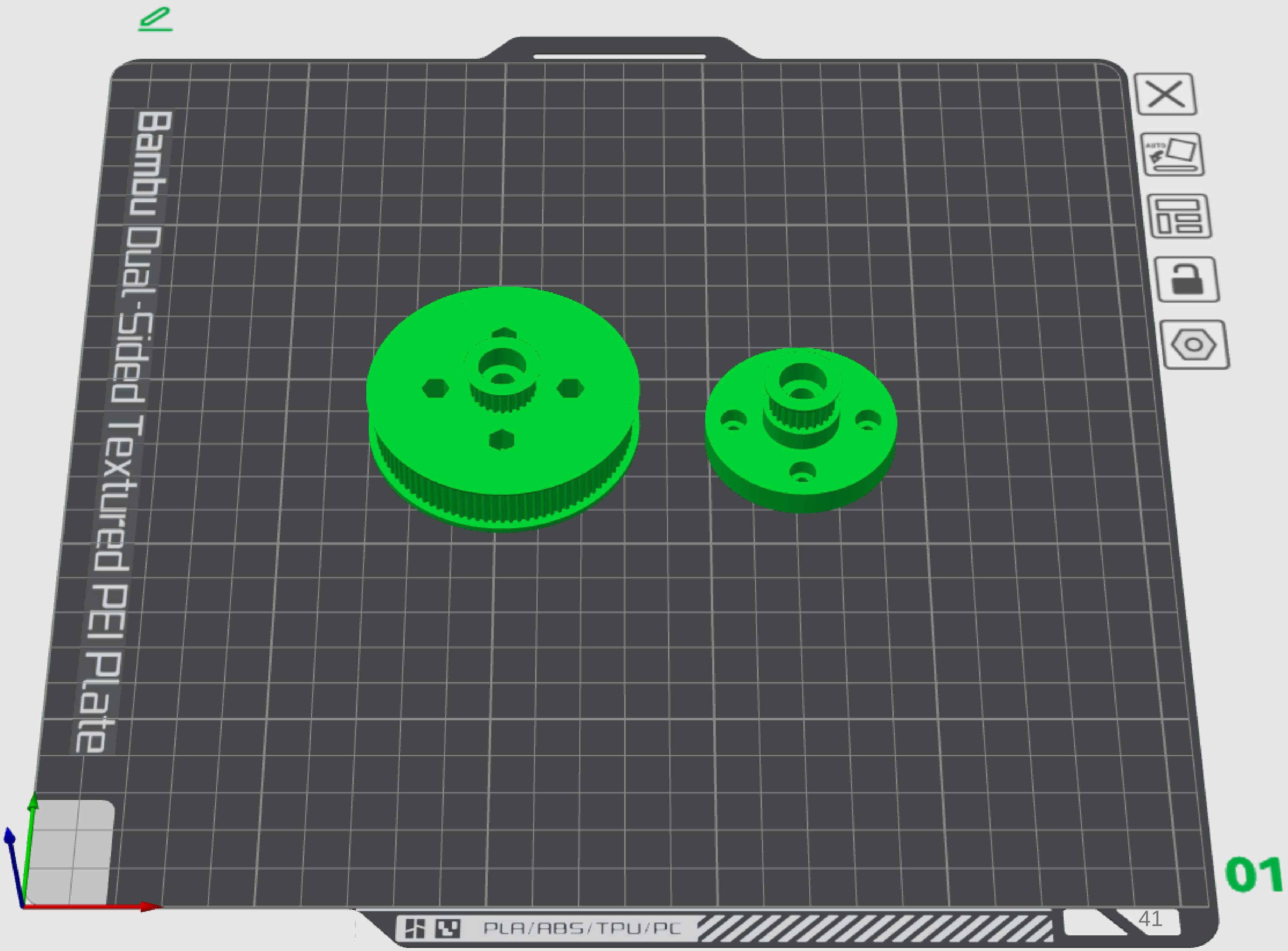


Note:
Support is required

Gear 25T & 96T

Print parameters:

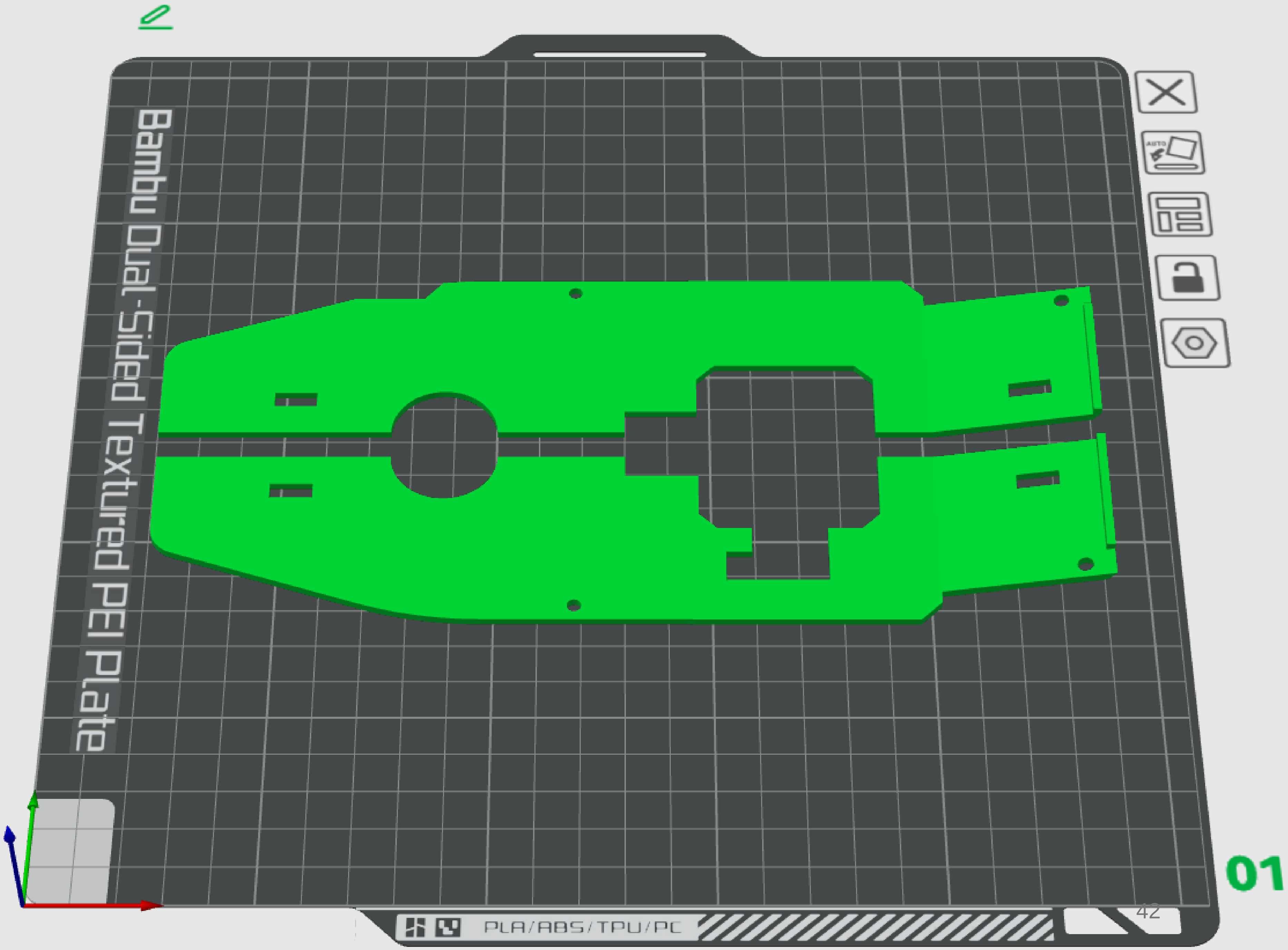
- **Material: PETG**
- **Layer height: 0.1mm**
- **Infill: 100%**
- **Wall loops: 4**



Arm cover 1&2

Print parameters:

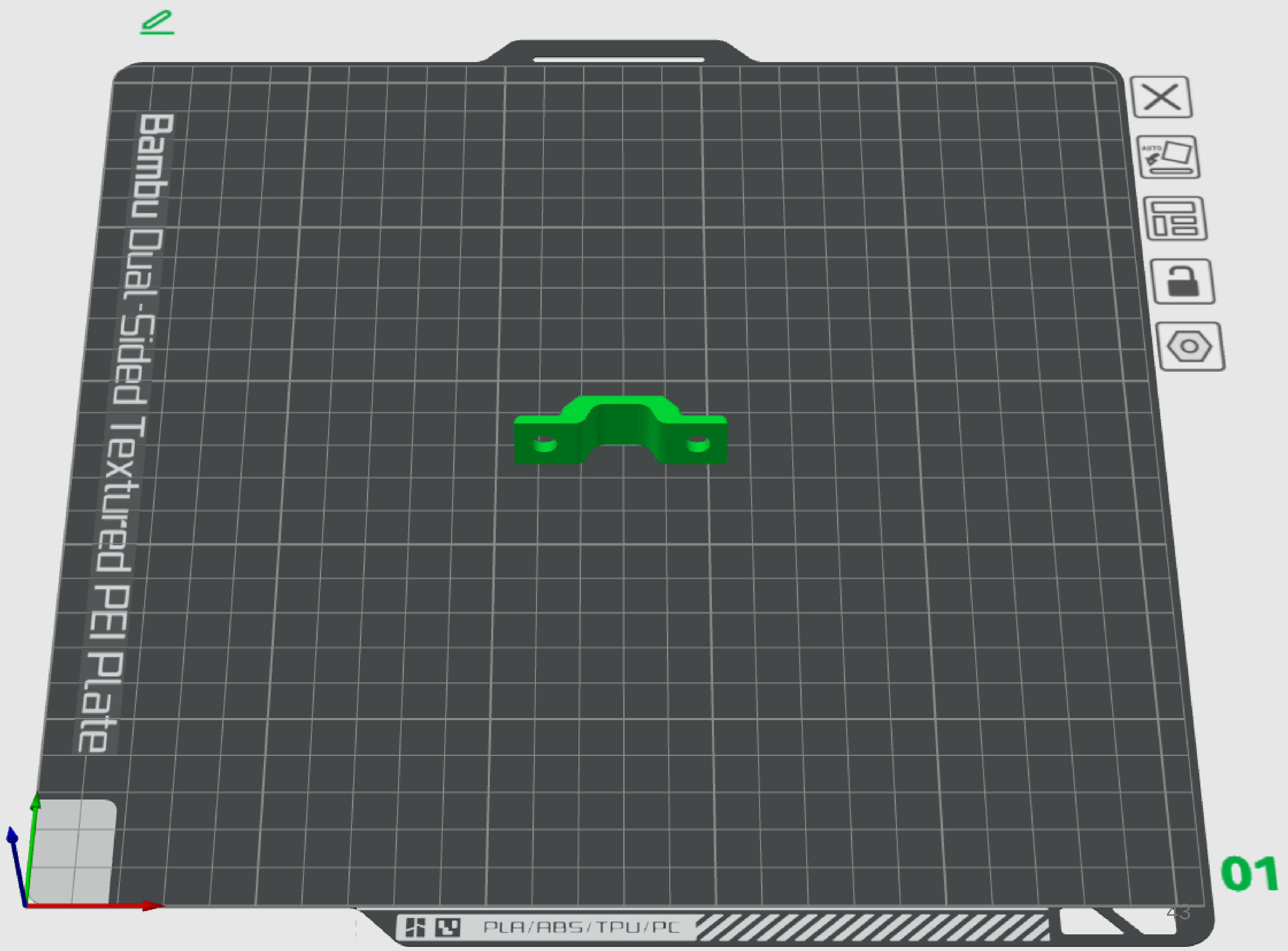
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 2**



Note:
Support is required

J2 Cable holder

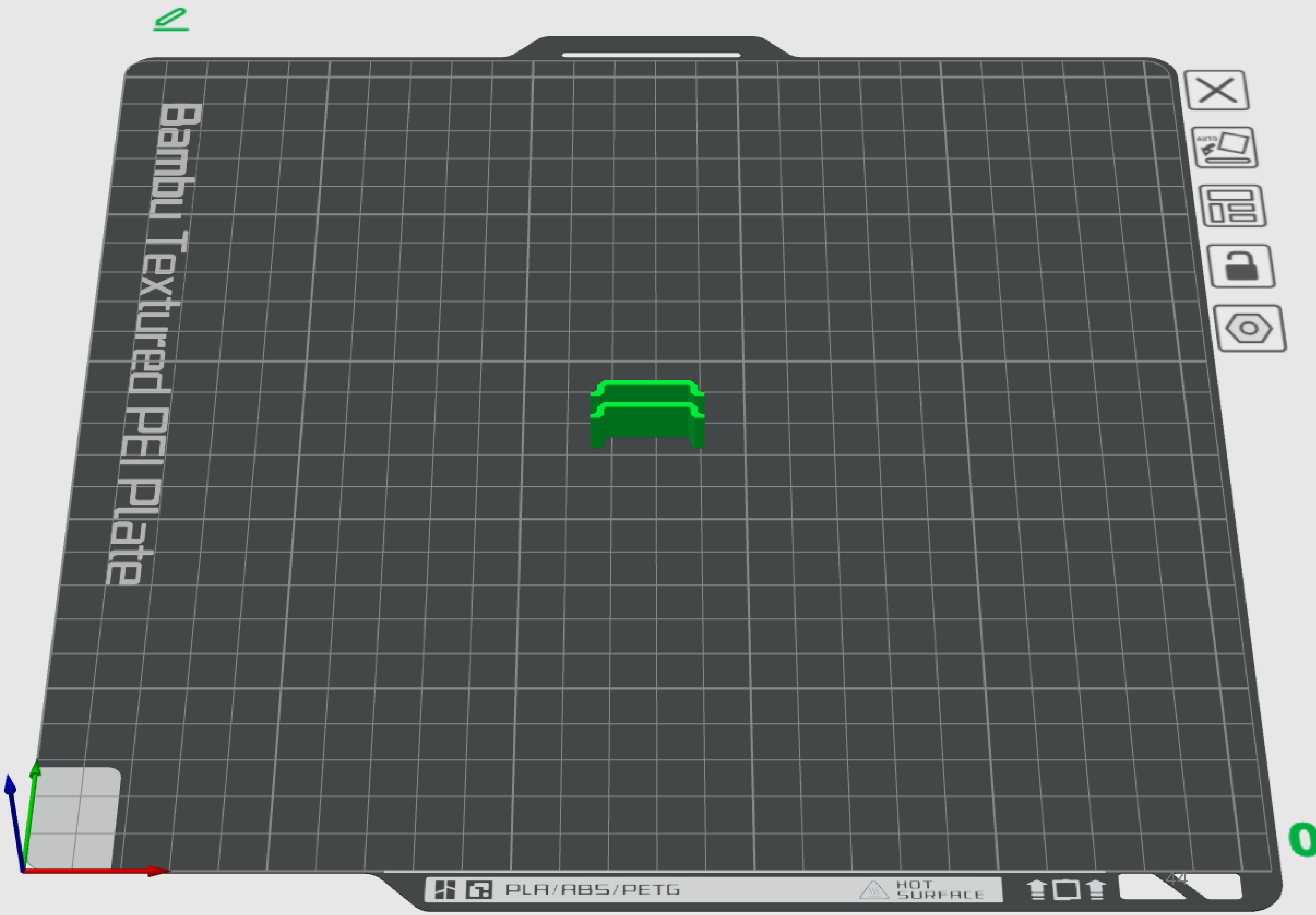
Print parameters:
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 3**



J2 Cover clip 1&2

Print parameters:

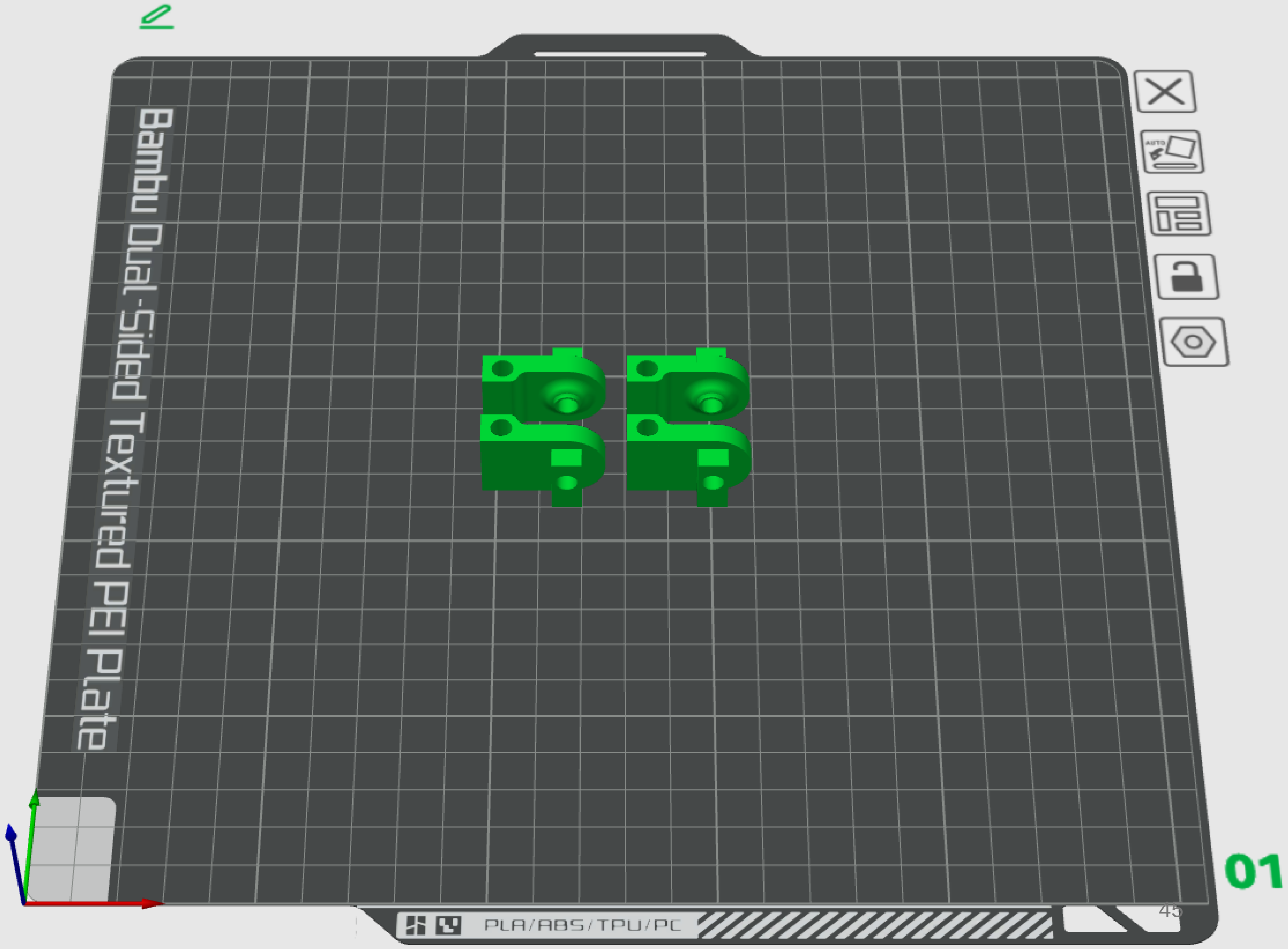
- Material: PETG
- Layer height: 0.2mm
- Infill: 15%
- Wall loops: 2



J2 Belt tensioner 2
1&2&3&4

Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 3**



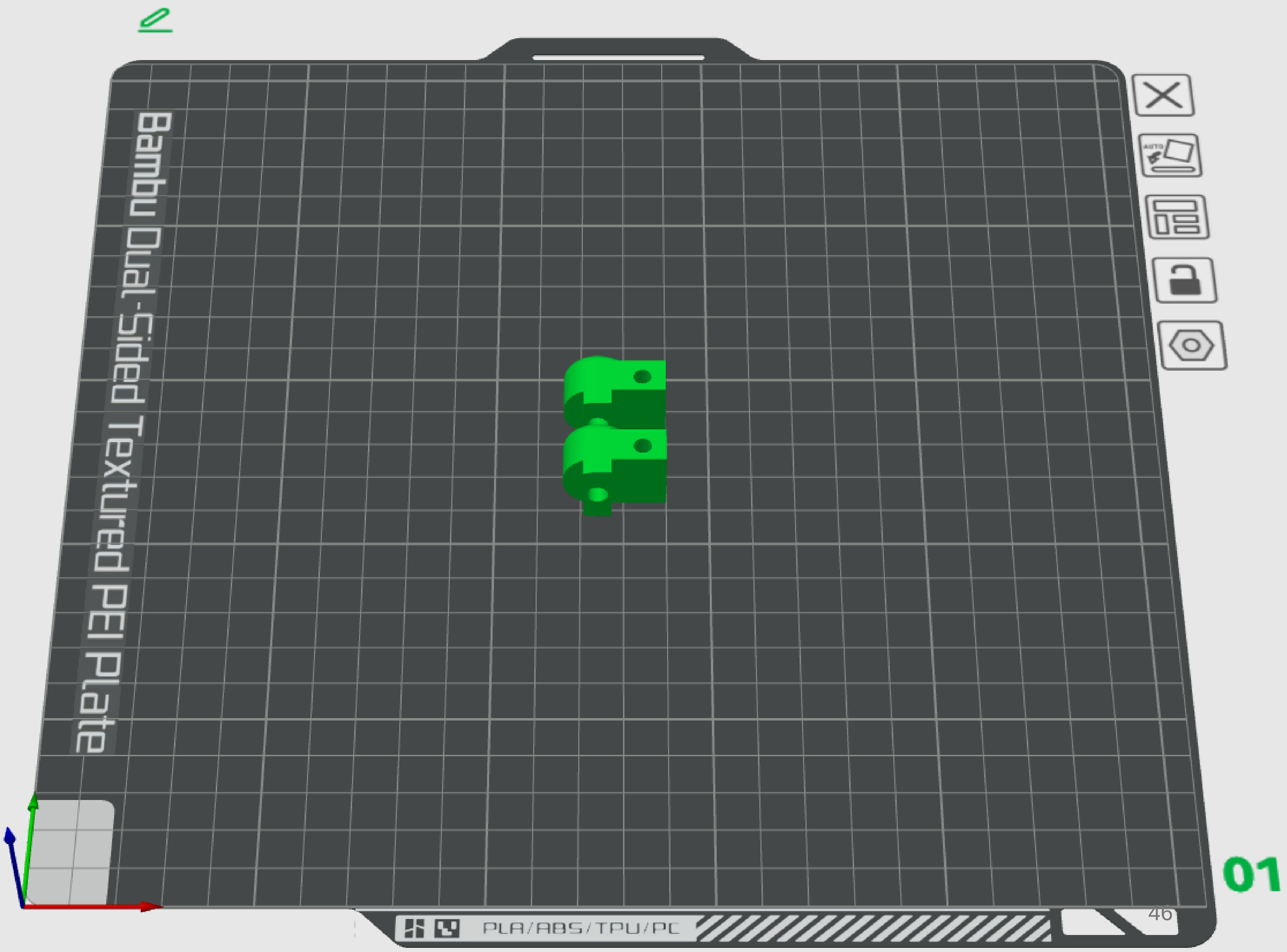
Note:
Support is required

J2 Belt tensioner
1
1&2

Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 3**

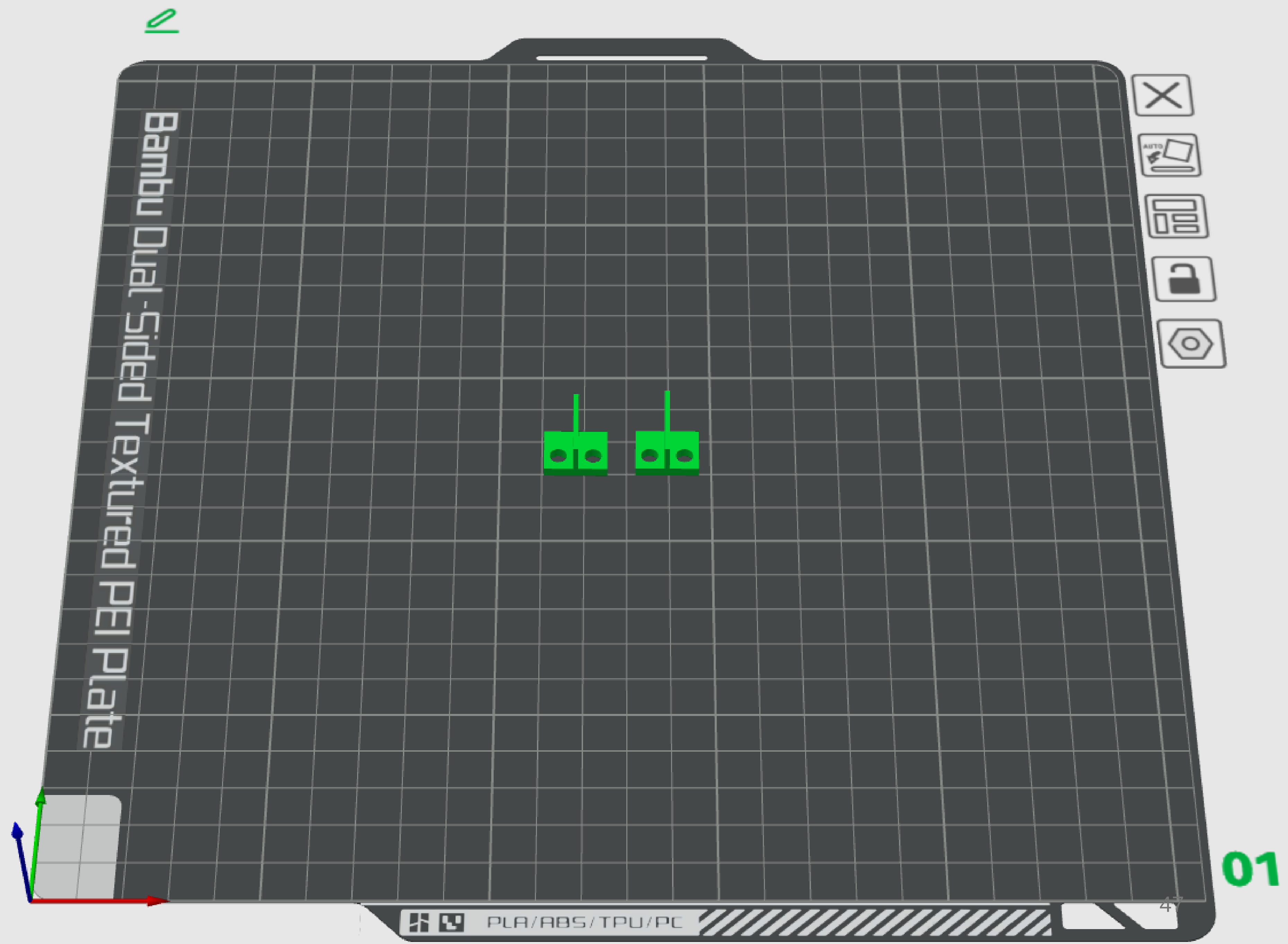
Note:
Support is required



J2 Sensor trigger 1&2

Print parameters:

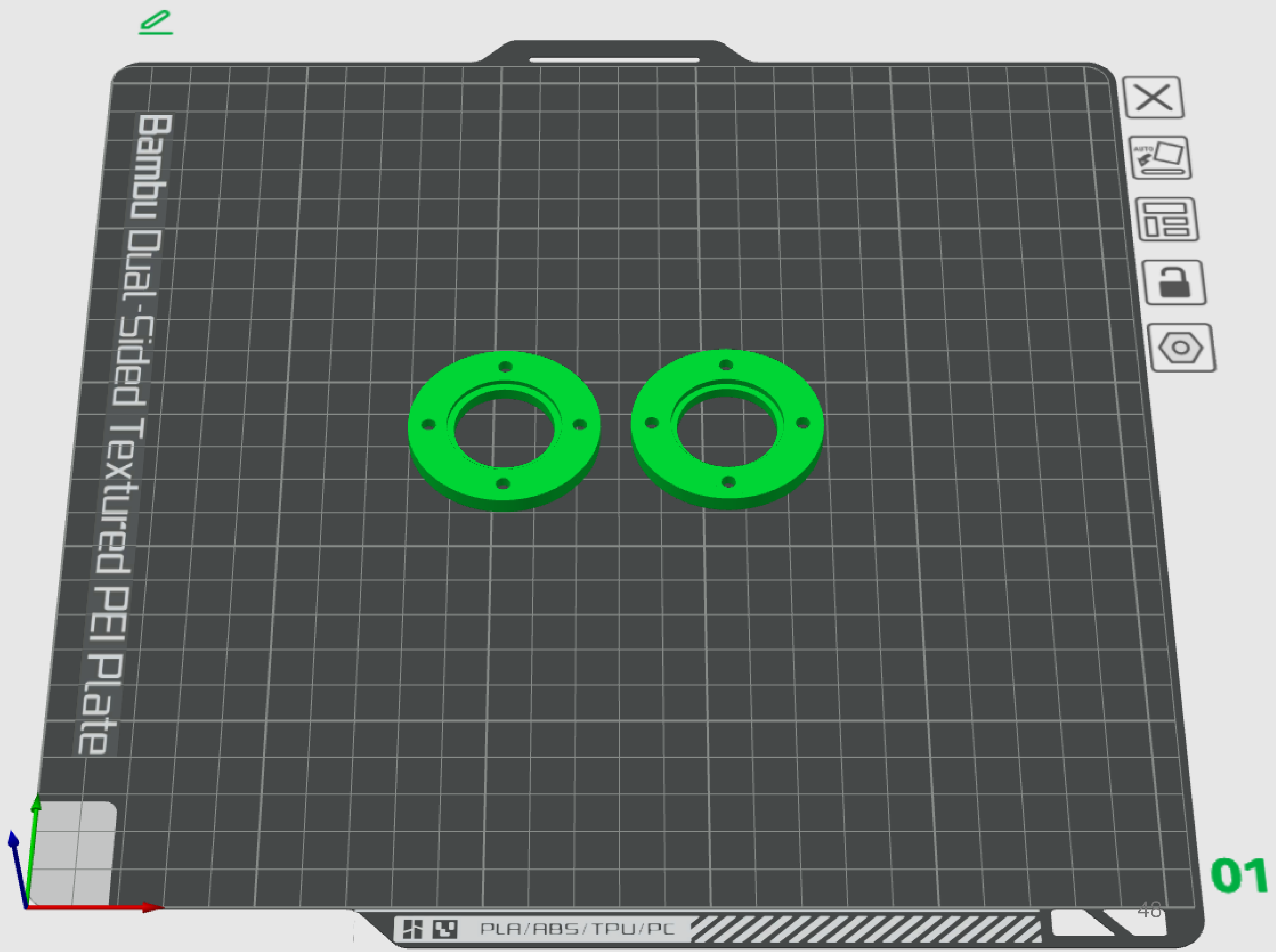
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**



BB mount bottom&top

Print parameters:

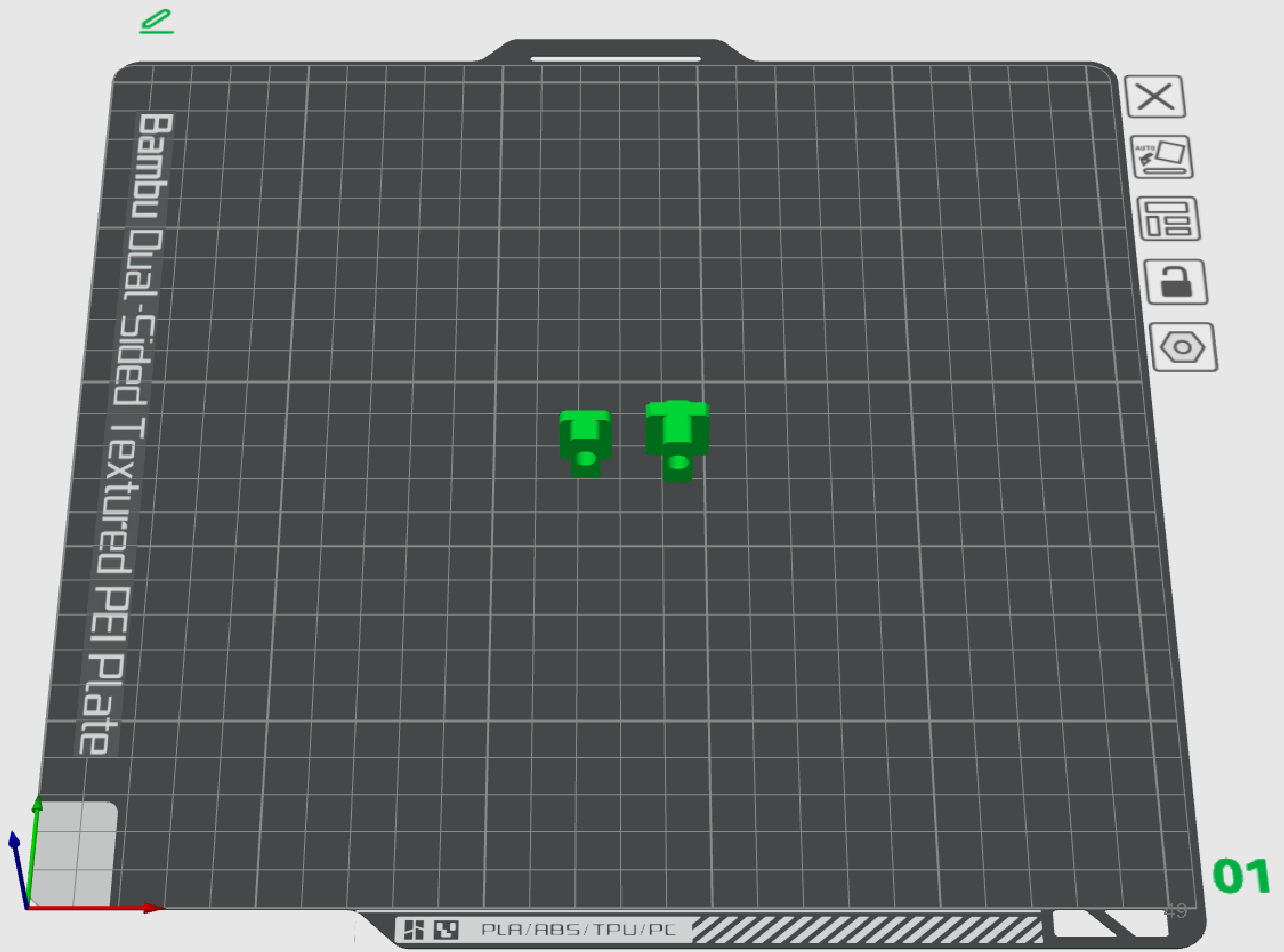
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 3**



J3 Belt tensioner 1&2

Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 3**

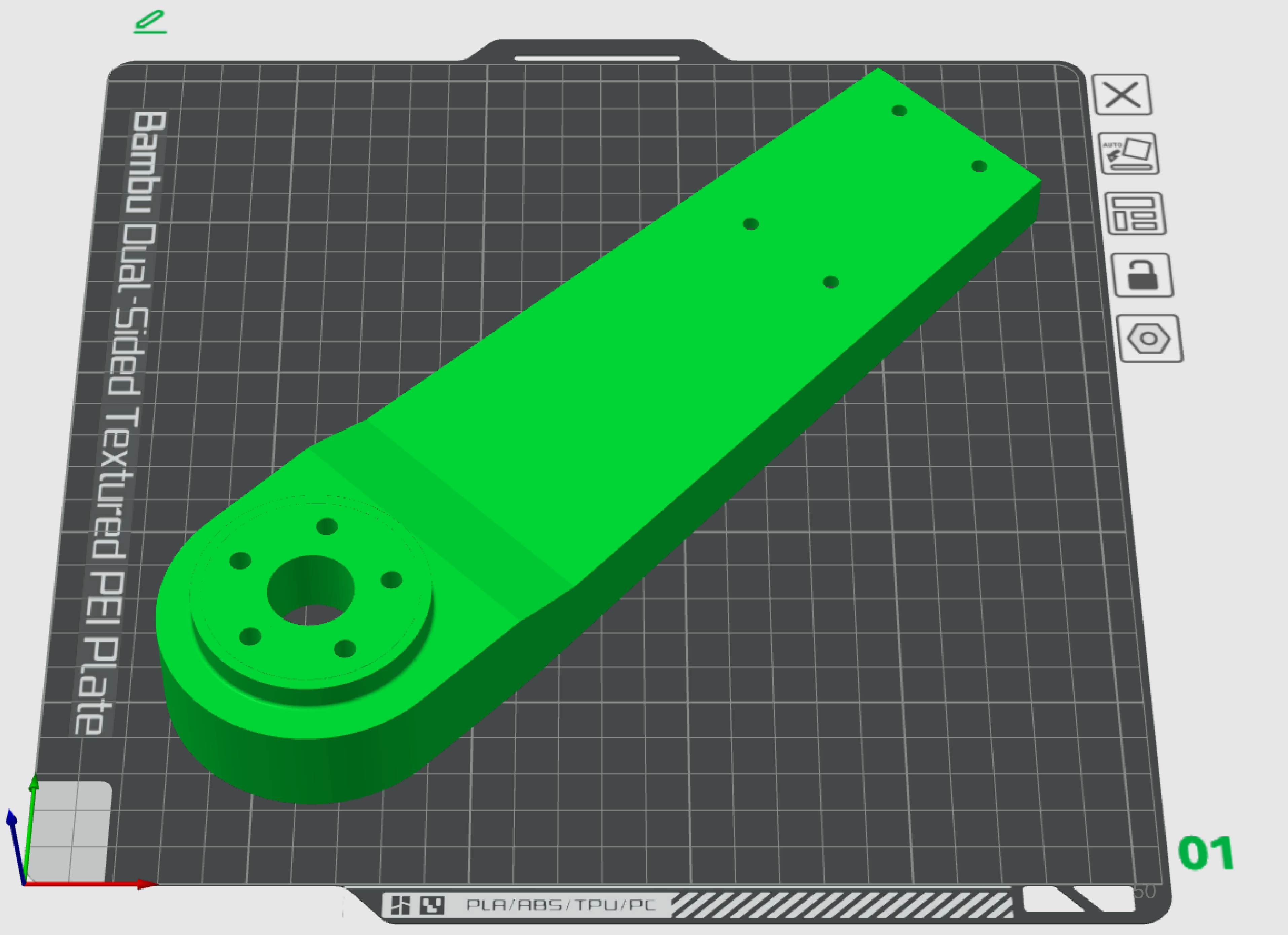


Note:
Support is required

Bottom link long

Print parameters:

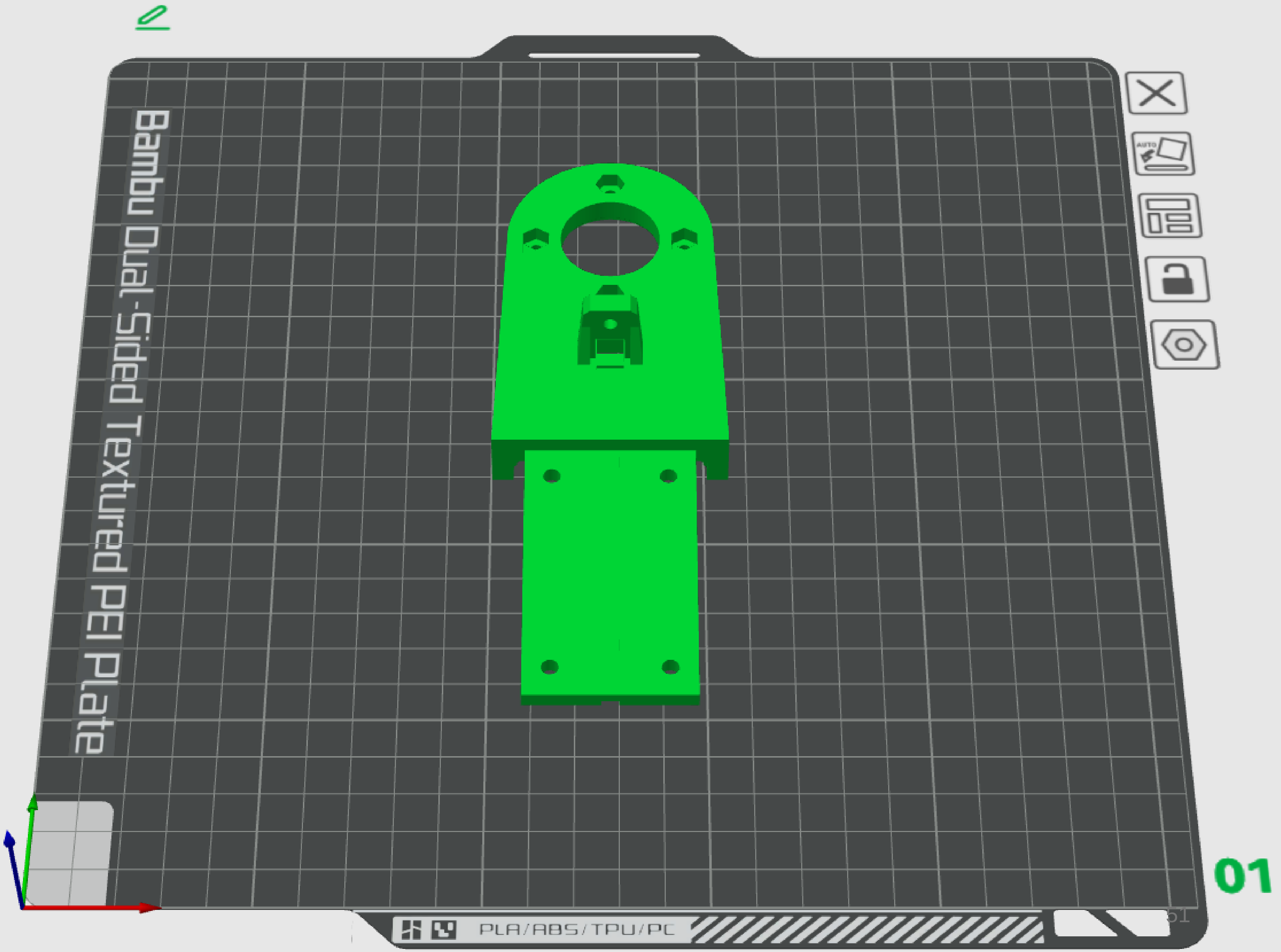
- **Material: PLA**
- **Layer height: 0.2mm**
- **Infill: 35%**
- **Wall loops: 5**



Note:
Support is required

Bottom link short

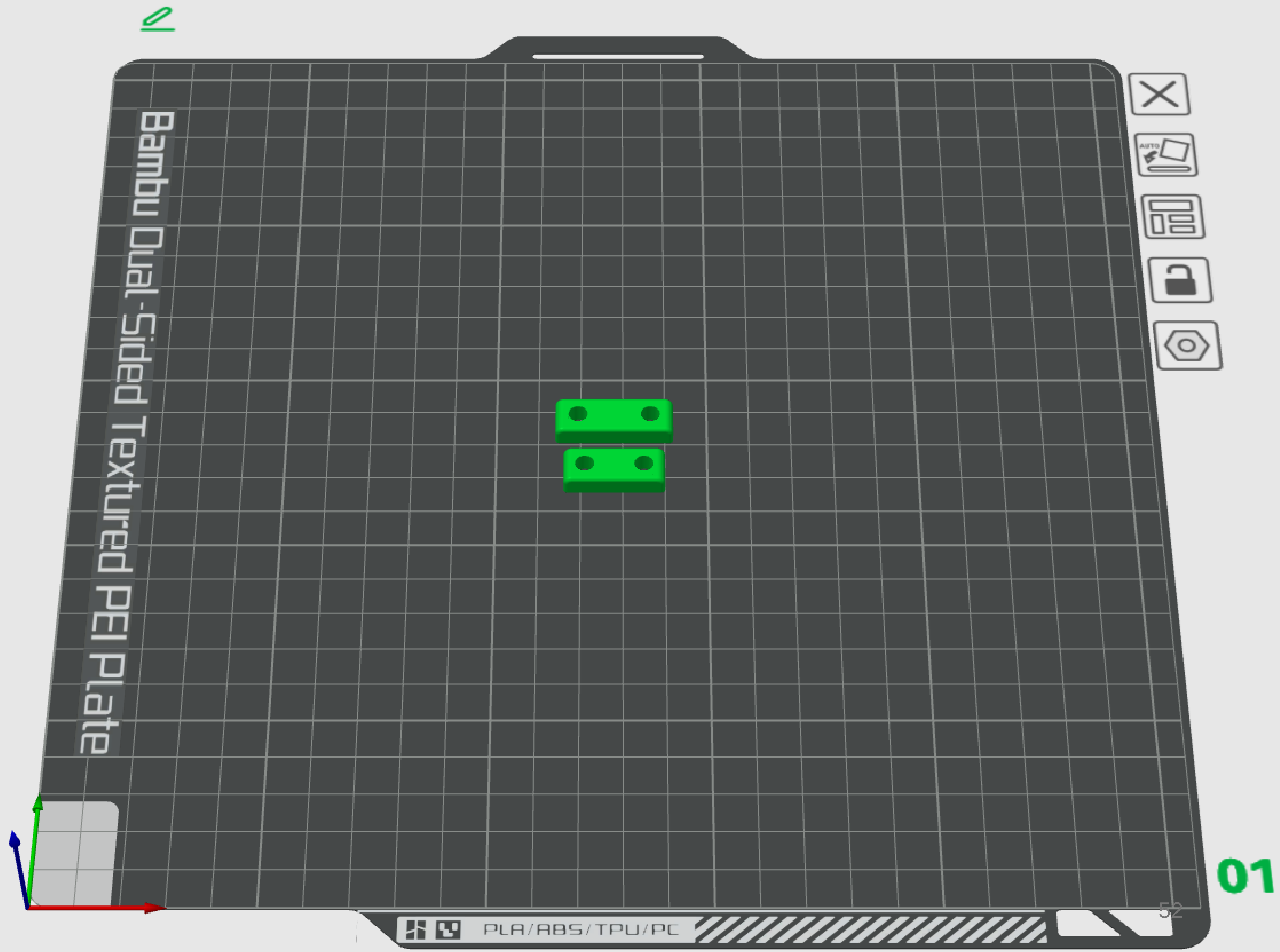
Print parameters:
- **Material: PLA**
- **Layer height: 0.2mm**
- **Infill: 35%**
- **Wall loops: 5**



Note:
Support is required

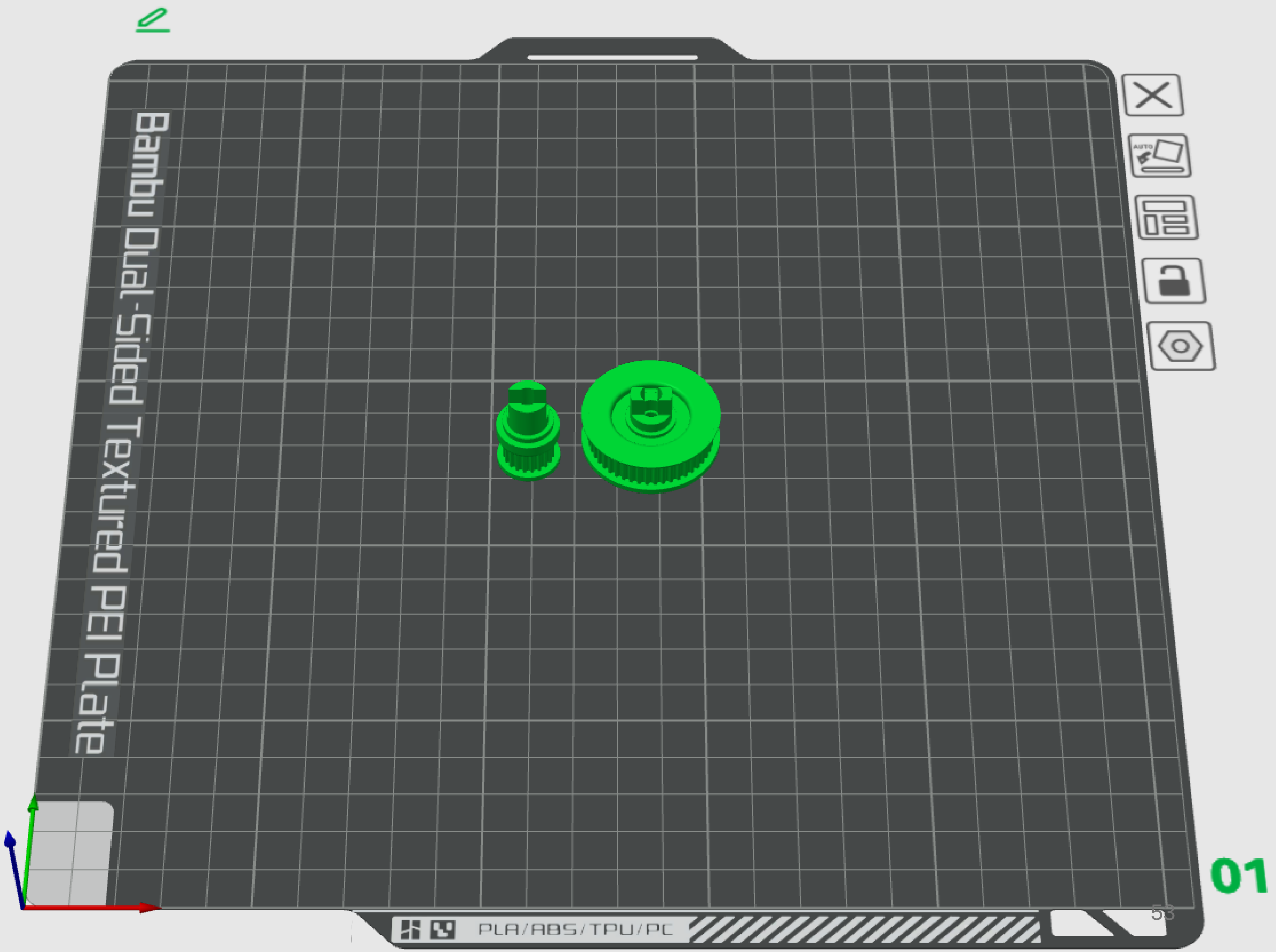
J3 Cable holder 1&2

Print parameters:
- Material: PETG
- Layer height: 0.2mm
- Infill: 15%
- Wall loops: 2



Gear 20T & 48T

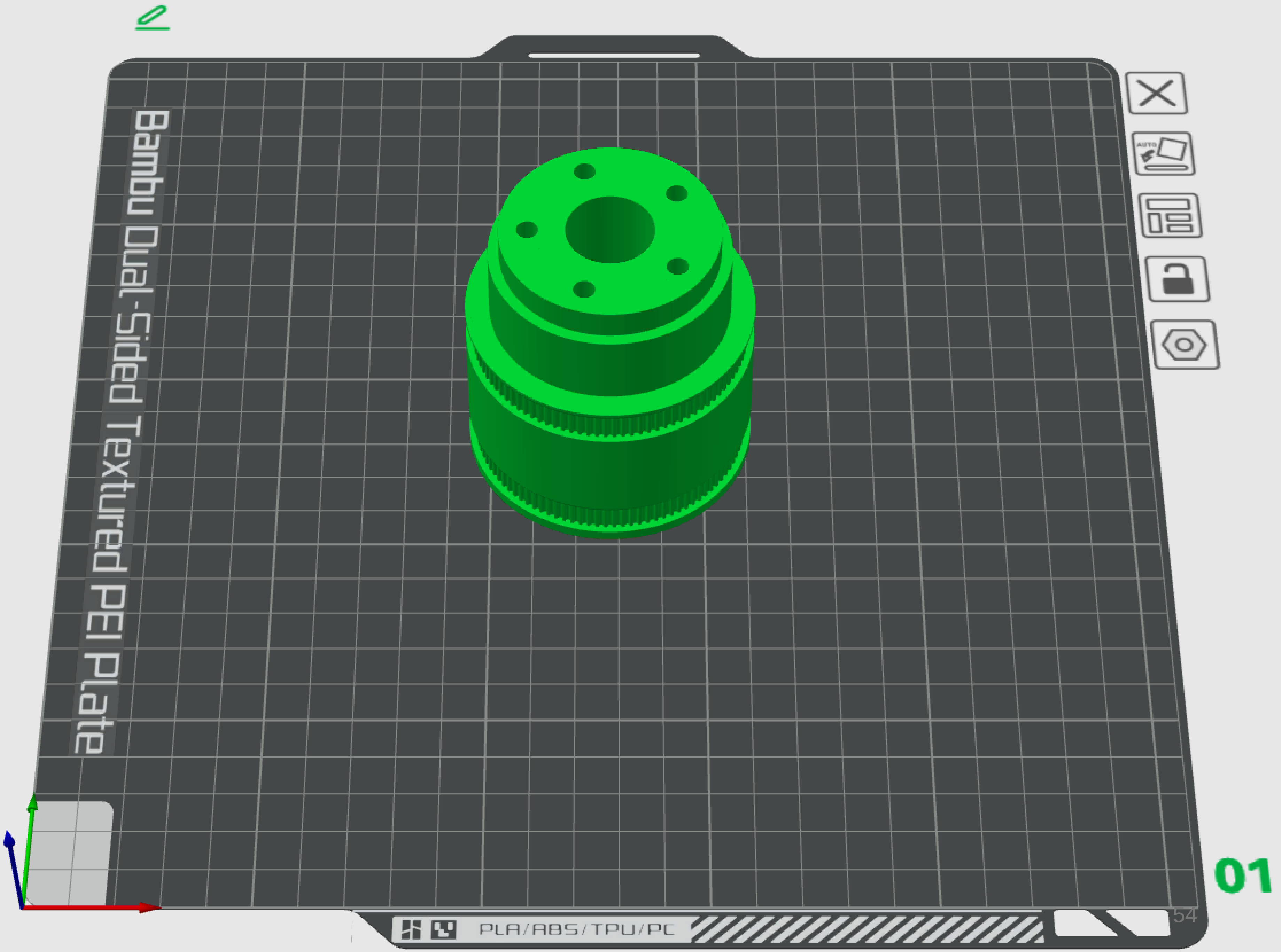
Print parameters:
- Material: PETG
- Layer height: 0.2mm
- Infill: 100%
- Wall loops: 4



Double gear 100T

Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 30%**
- **Wall loops: 5**

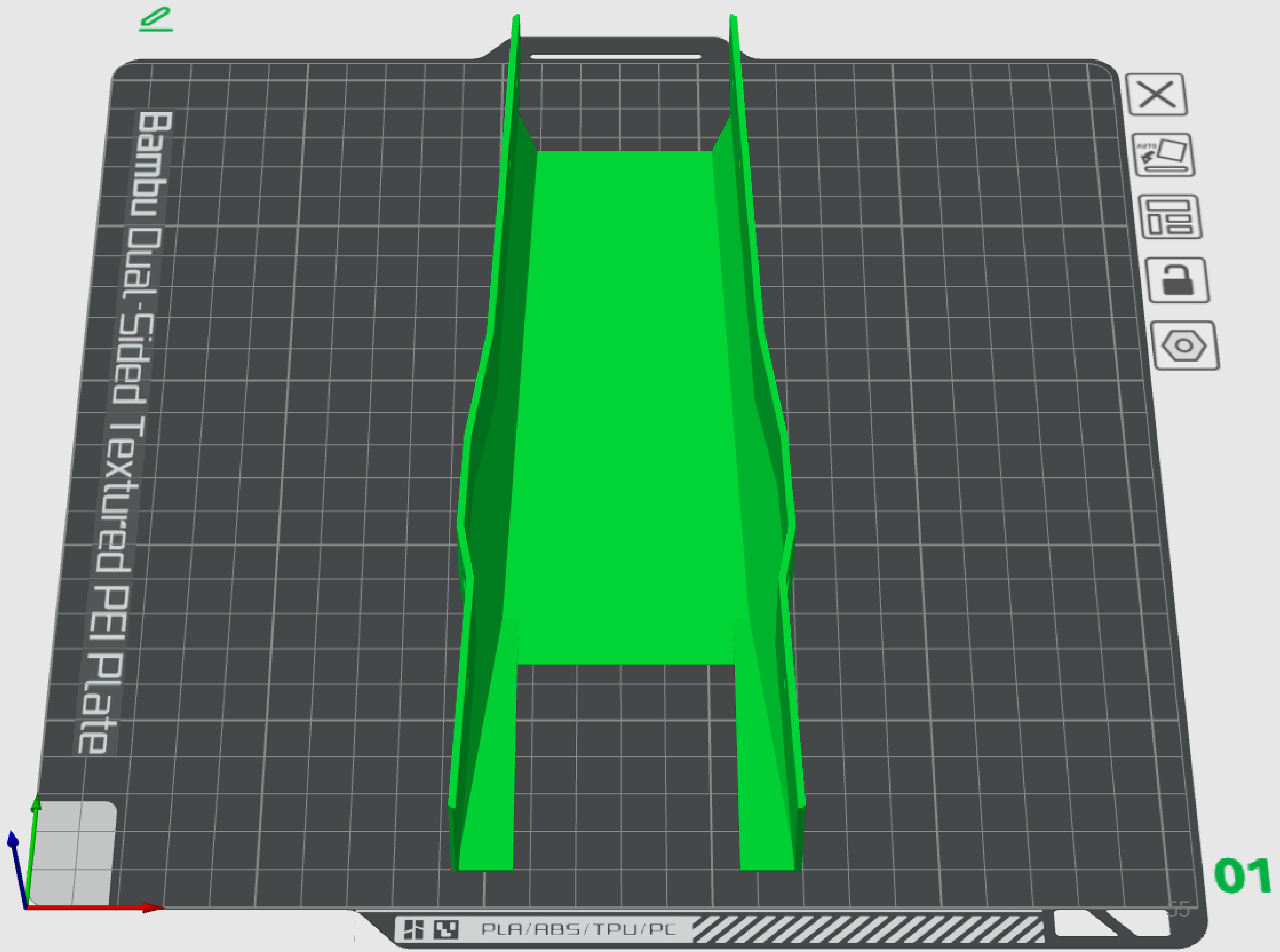


Note:
Support is required

J3 Cover

Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 2**

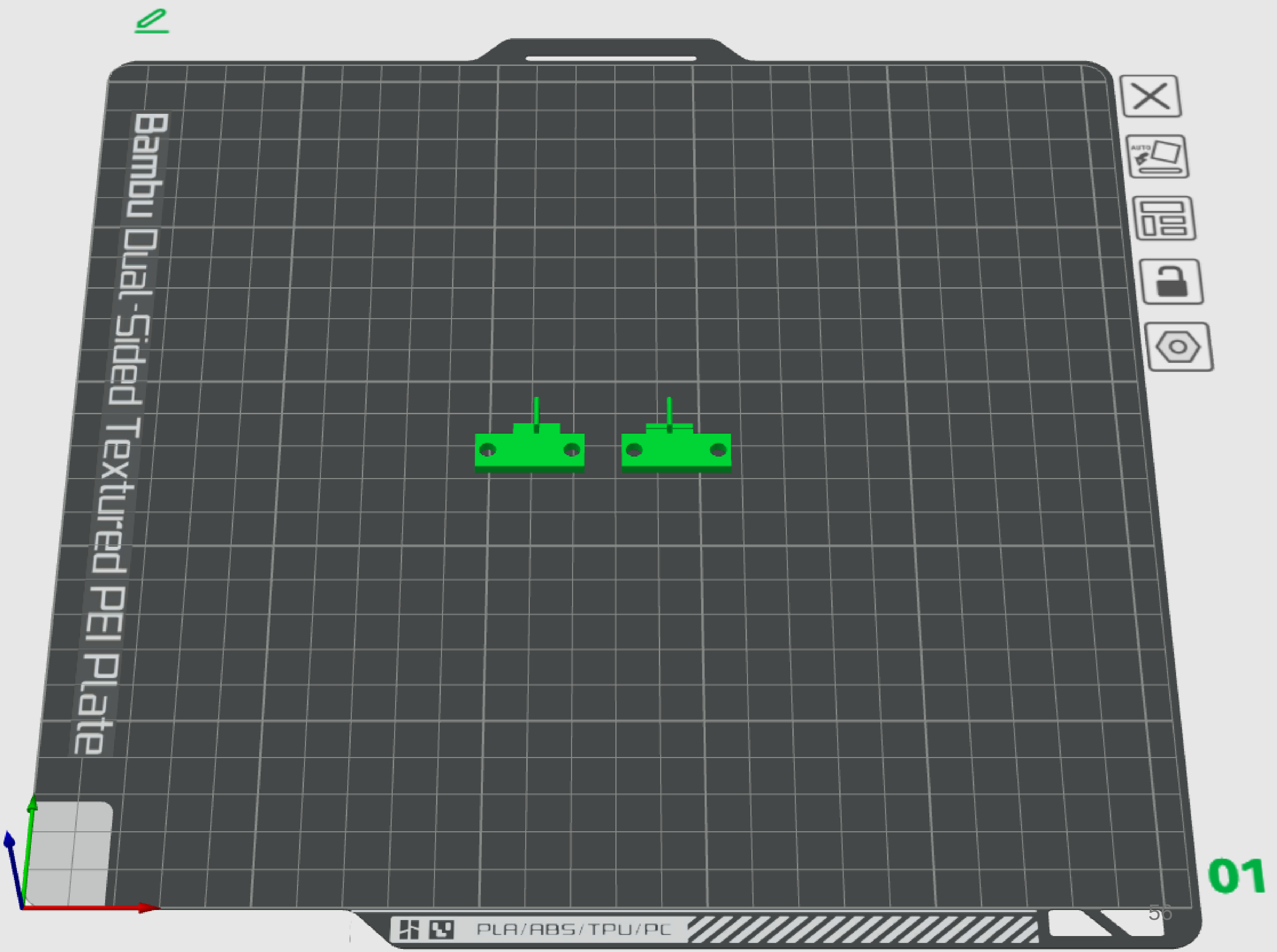


Note:
Support is required

J3 Sensor trigger 1&2

Print parameters:

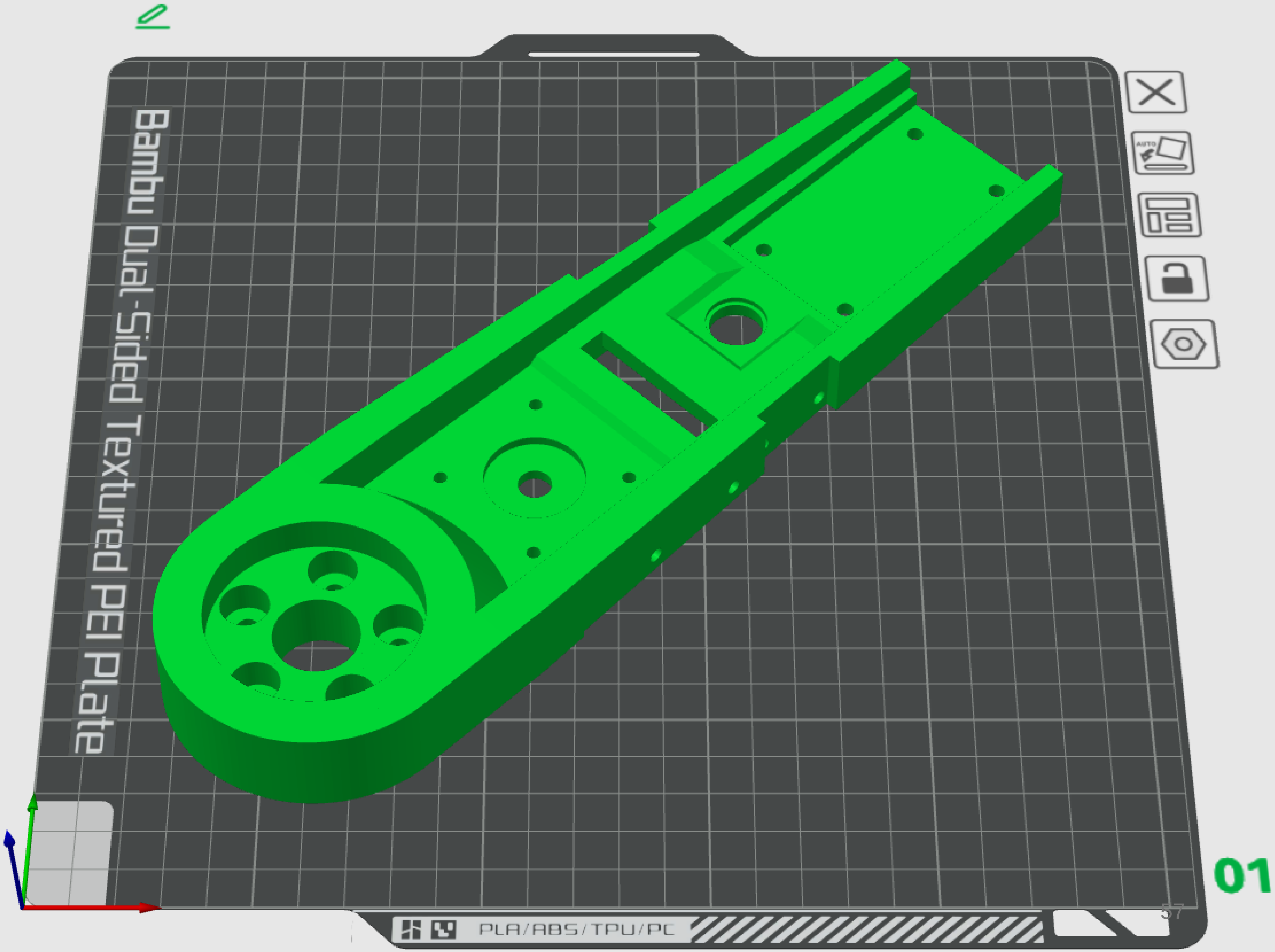
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**



Top link long

Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 35%**
- **Wall loops: 5**



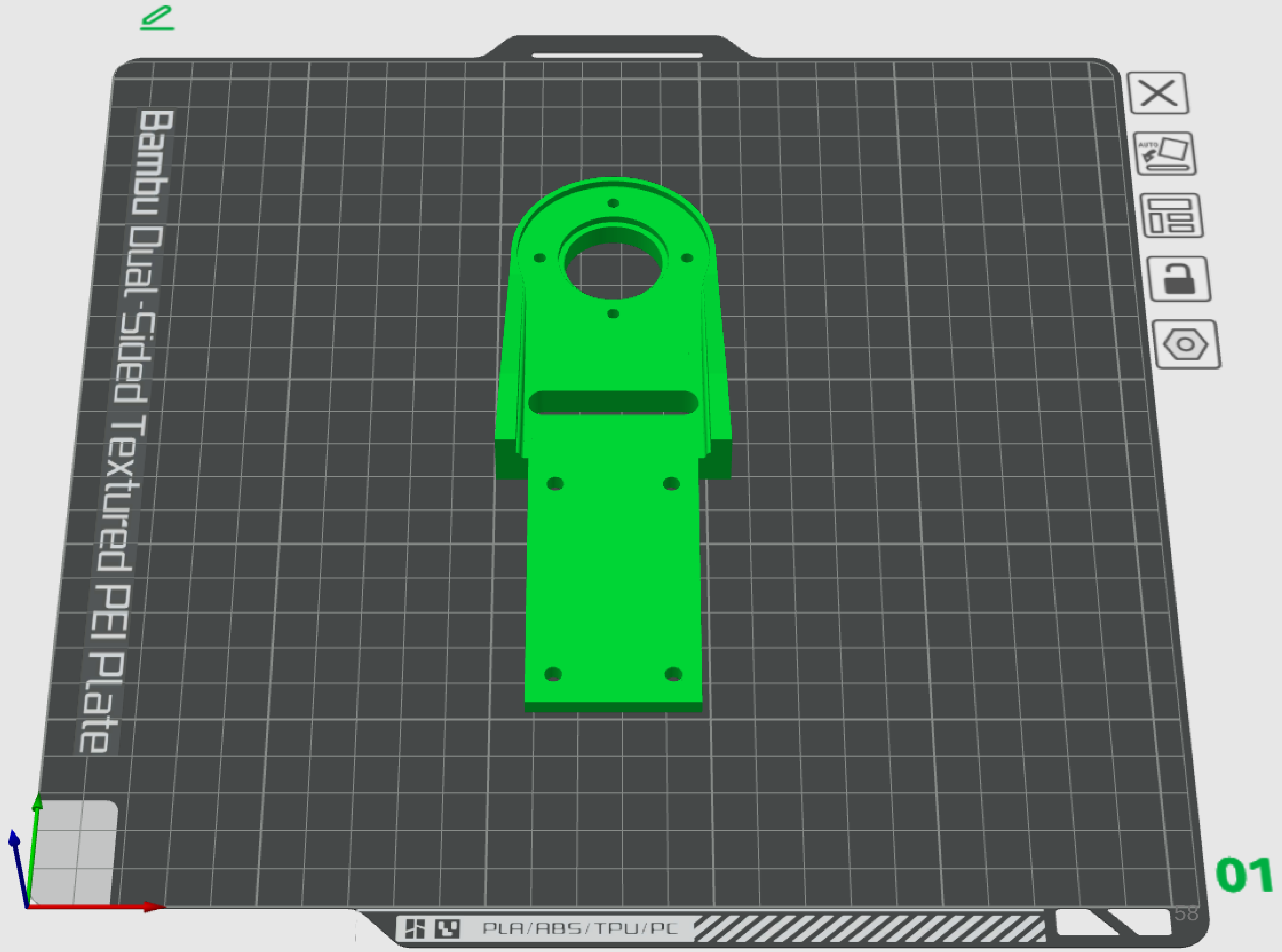
Note:
Support is required

Top link short

Print parameters:

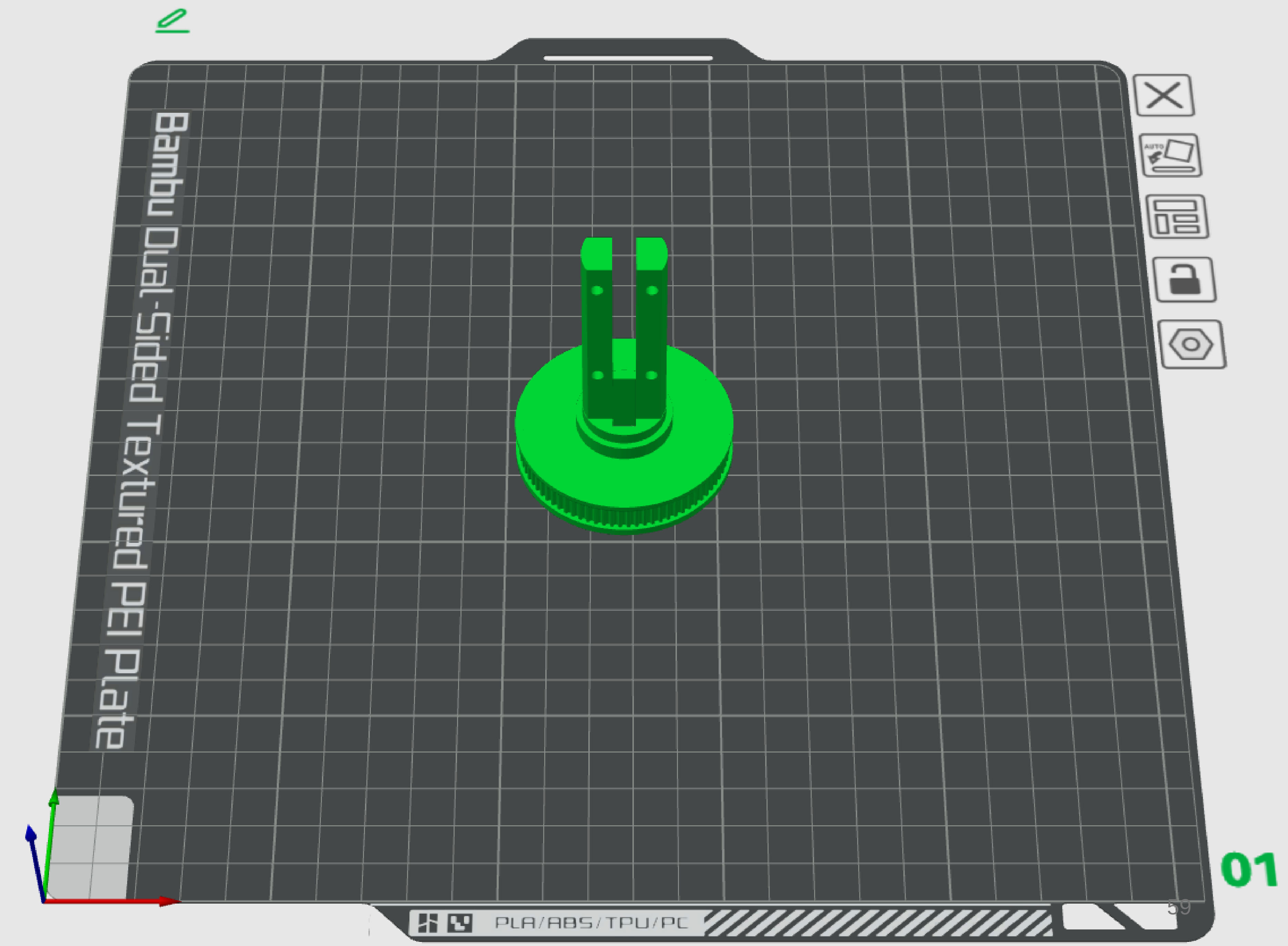
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 35%**
- **Wall loops: 5**

Note:
Support is required



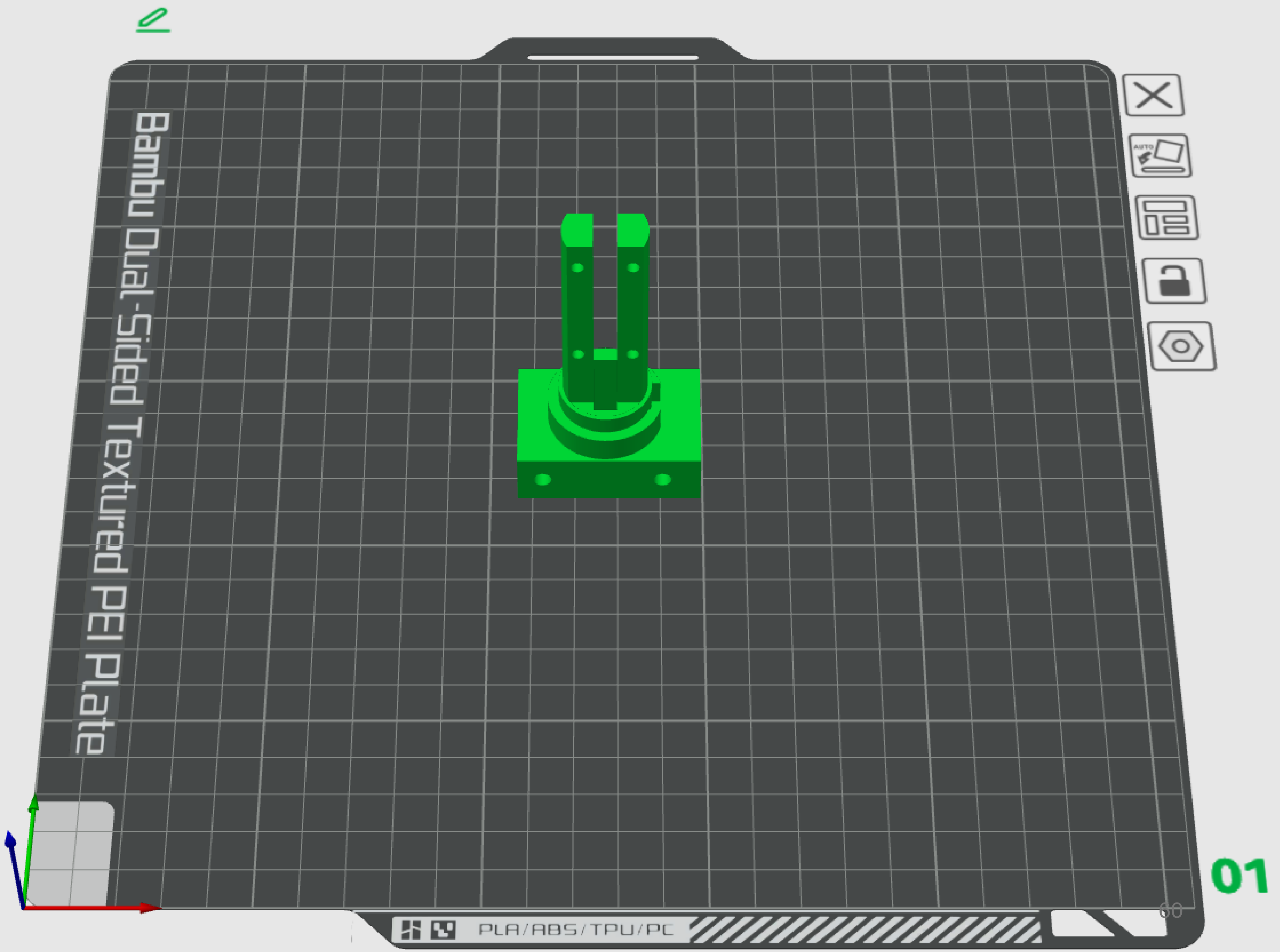
Gear 80T

Print parameters:
- Material: PETG
- Layer height: 0.1mm
- Infill: 100%
- Wall loops: 4



Gripper mount

Print parameters:
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 35%**
- **Wall loops: 5**

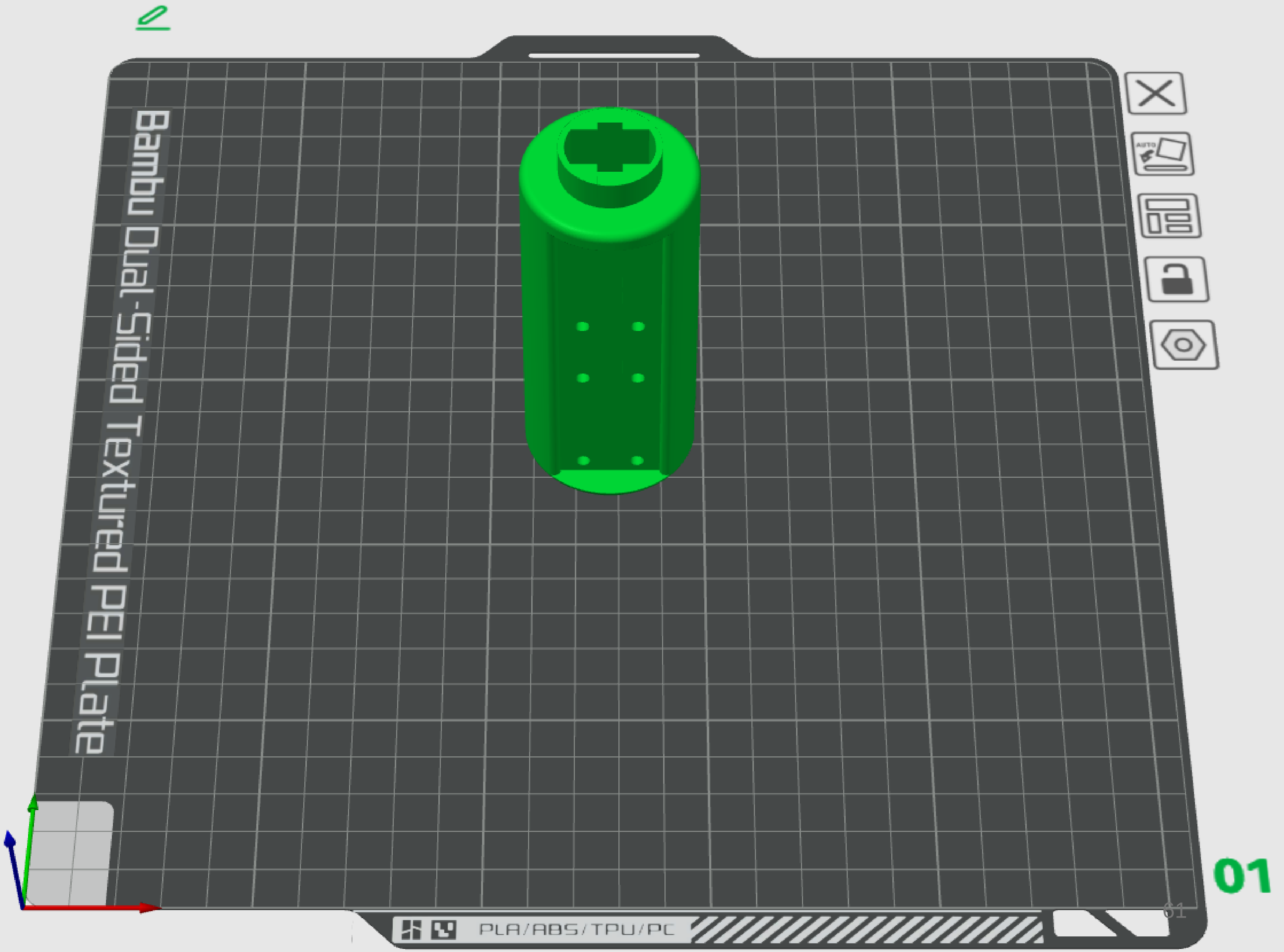


Note:
Support is required

J4 Roller

Print parameters:

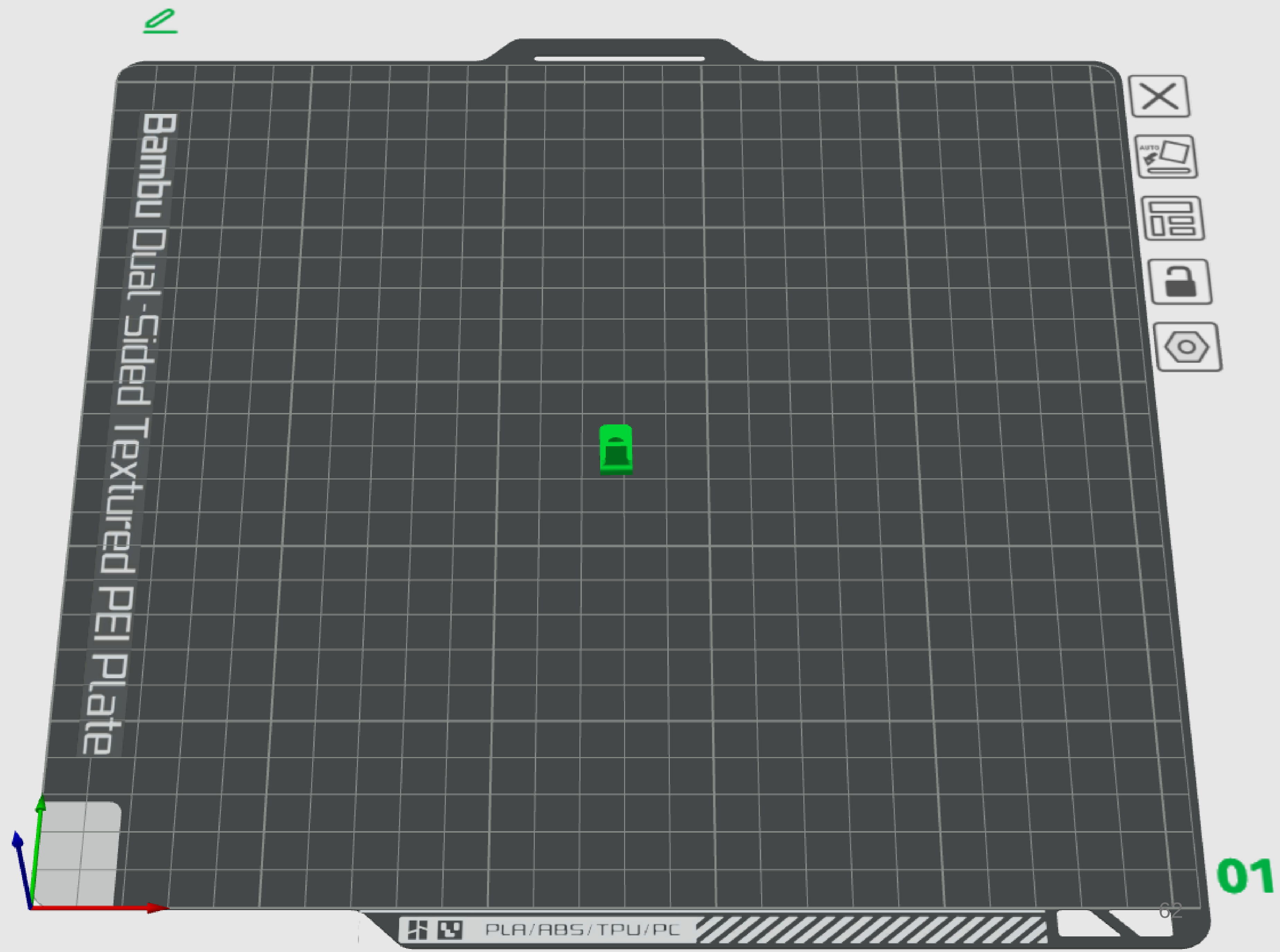
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 3**



Note:
Support is required

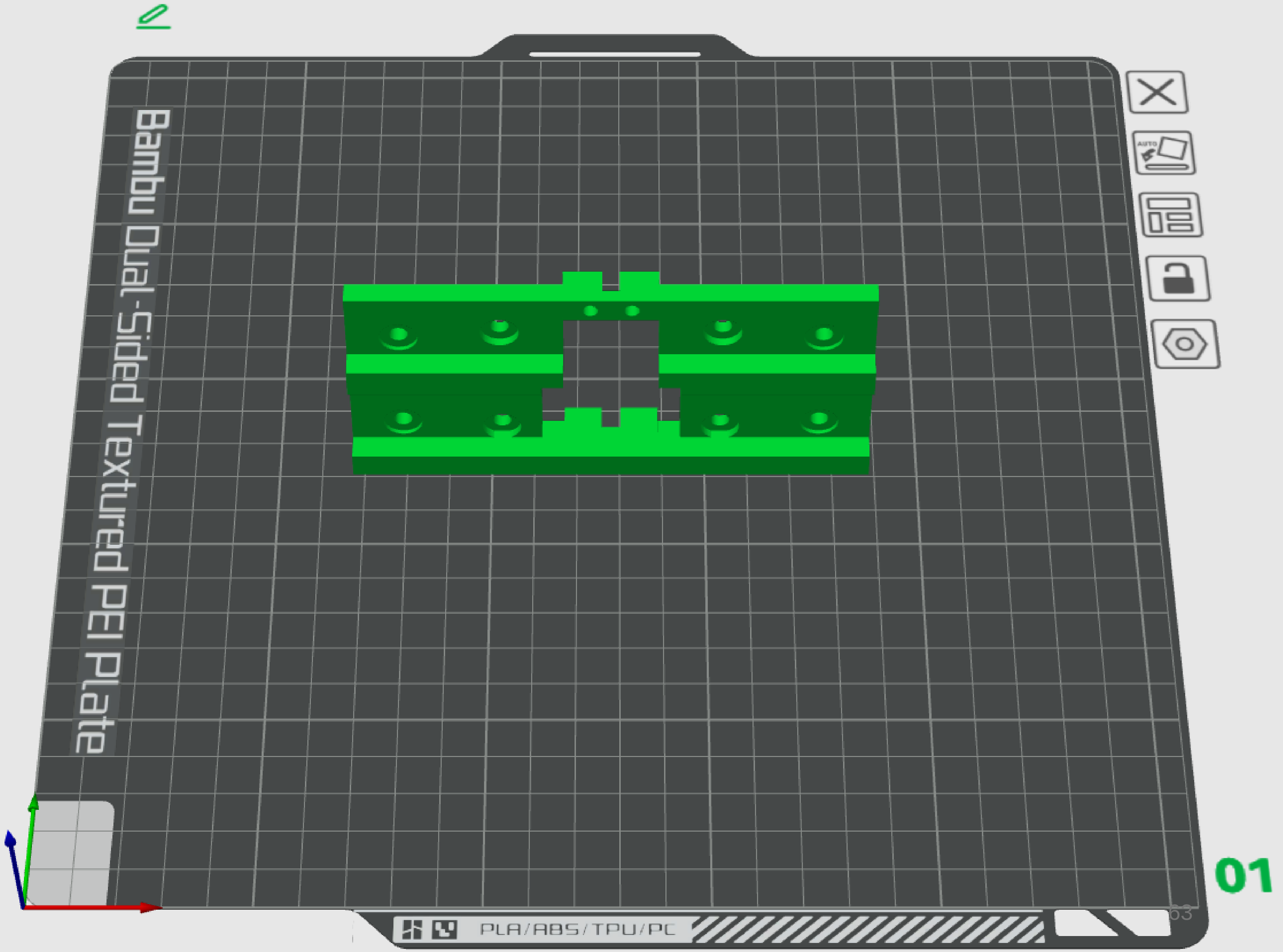
J4 Sensor trigger

Print parameters:
- Material: PETG
- Layer height: 0.2mm
- Infill: 20%
- Wall loops: 4



Gripper base

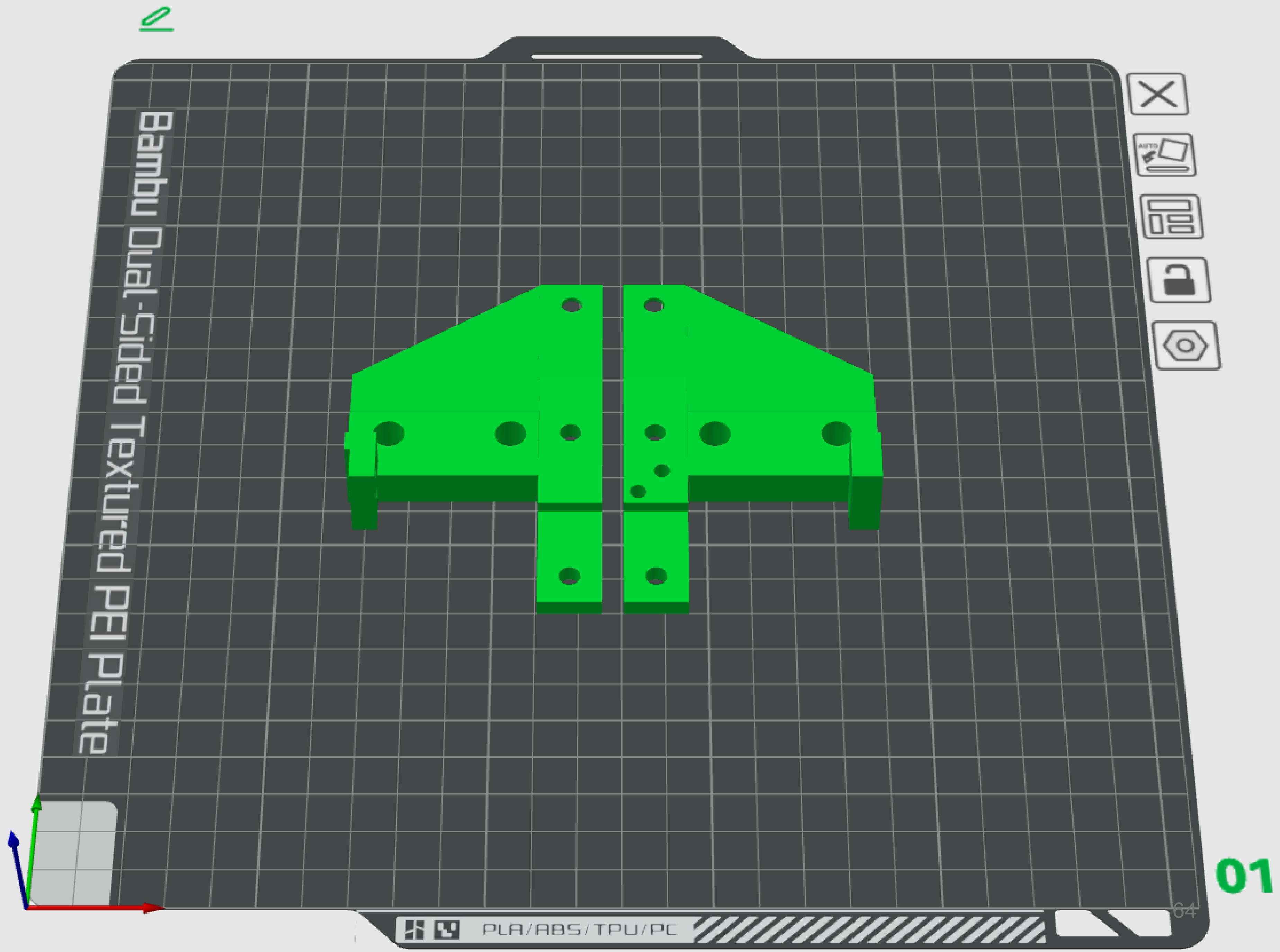
Print parameters:
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 2**



Note:
Support is required

Claw mount right & left

Print parameters:
- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 20%**
- **Wall loops: 4**

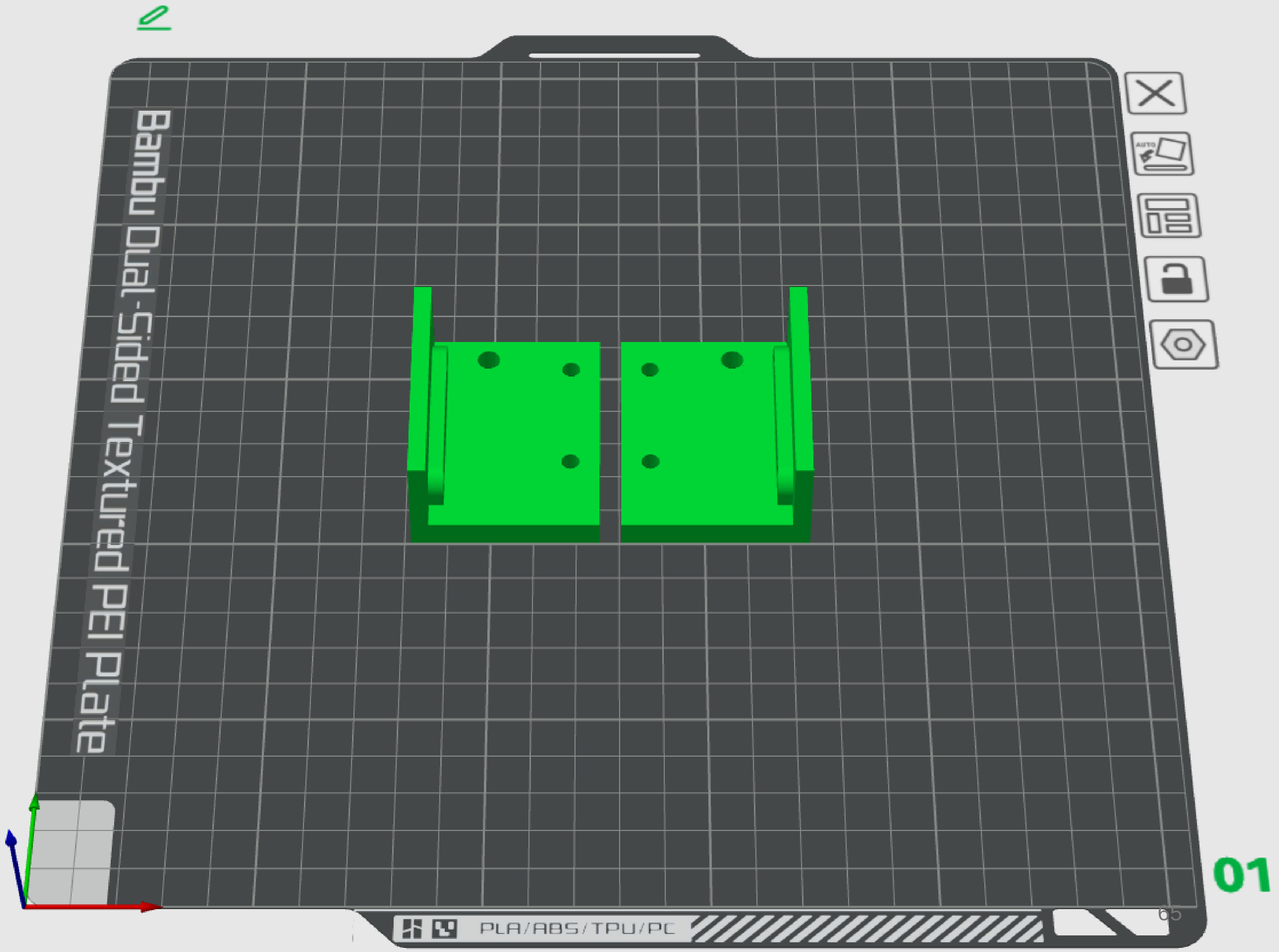


Note:
Support is required

Gripper mount left & right

Print parameters:

- **Material: PETG**
- **Layer height: 0.2mm**
- **Infill: 15%**
- **Wall loops: 2**



Note:
Support is required

Tube mount left & right

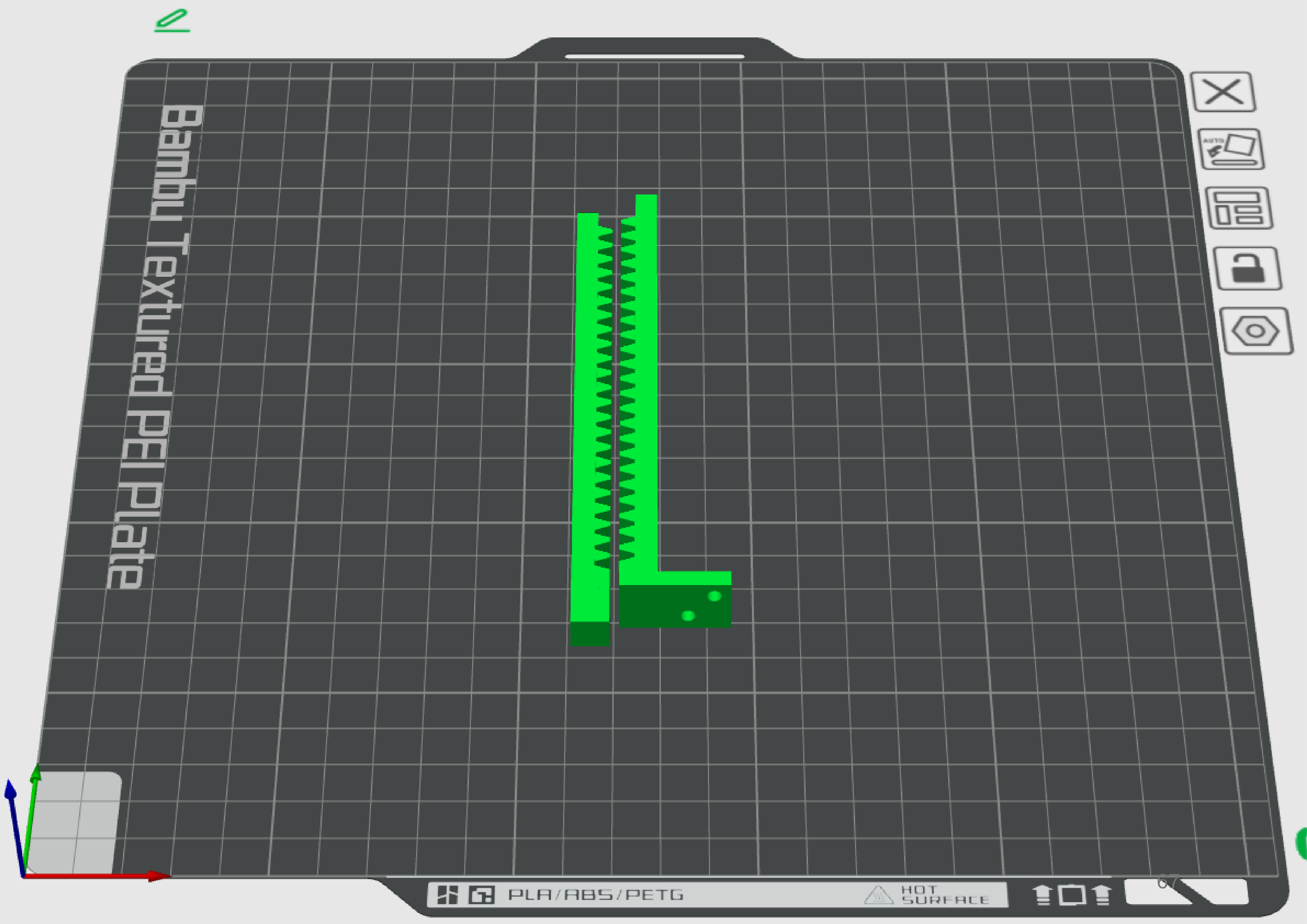
Print parameters:
- Material: PETG
- Layer height: 0.2mm
- Infill: 15%
- Wall loops: 3

Note:
Support is required

Rack gear left & right

Print parameters:

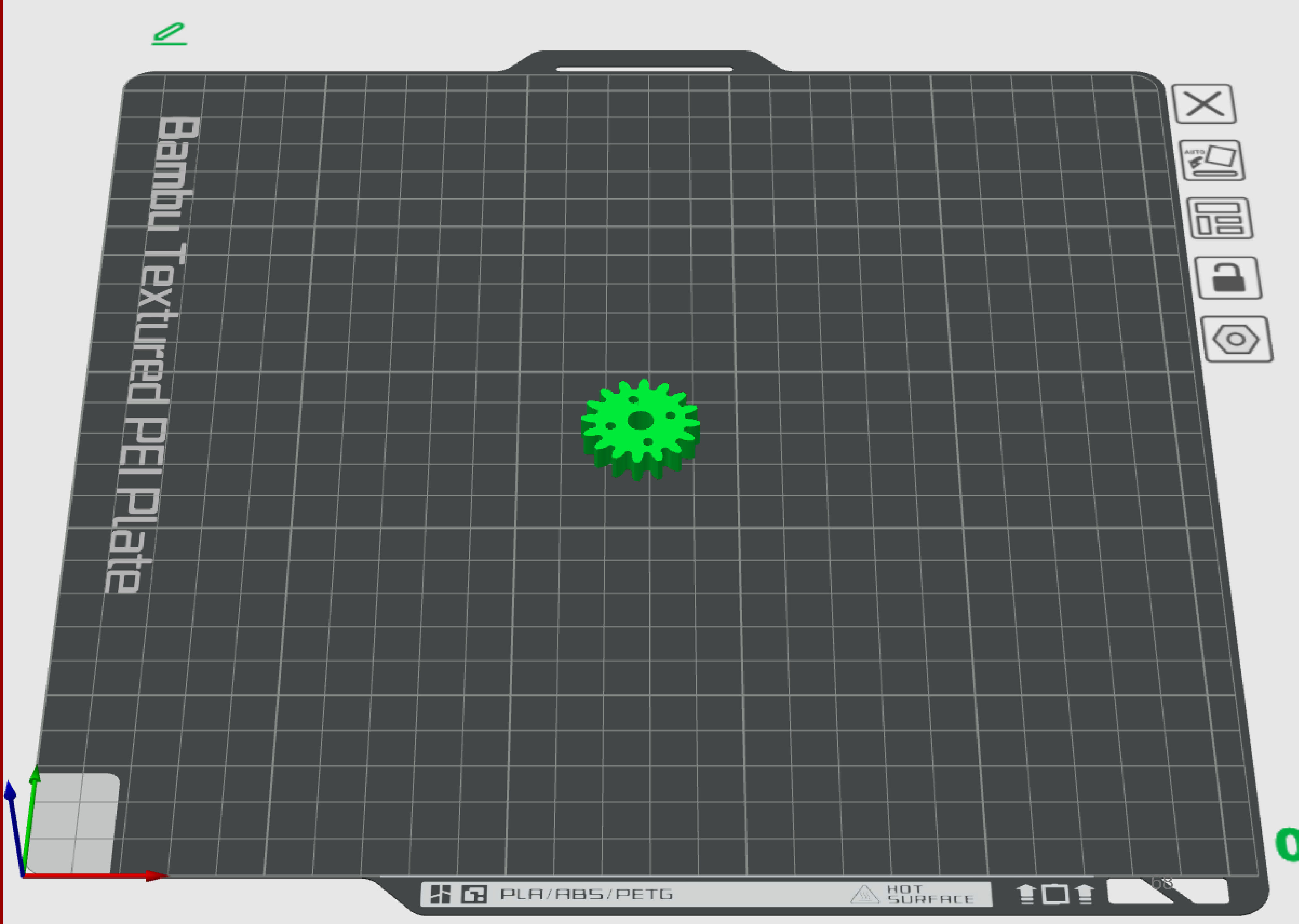
- **Material: PETG**
- **Layer height: 0.1mm**
- **Infill: 100%**
- **Wall loops: 4**



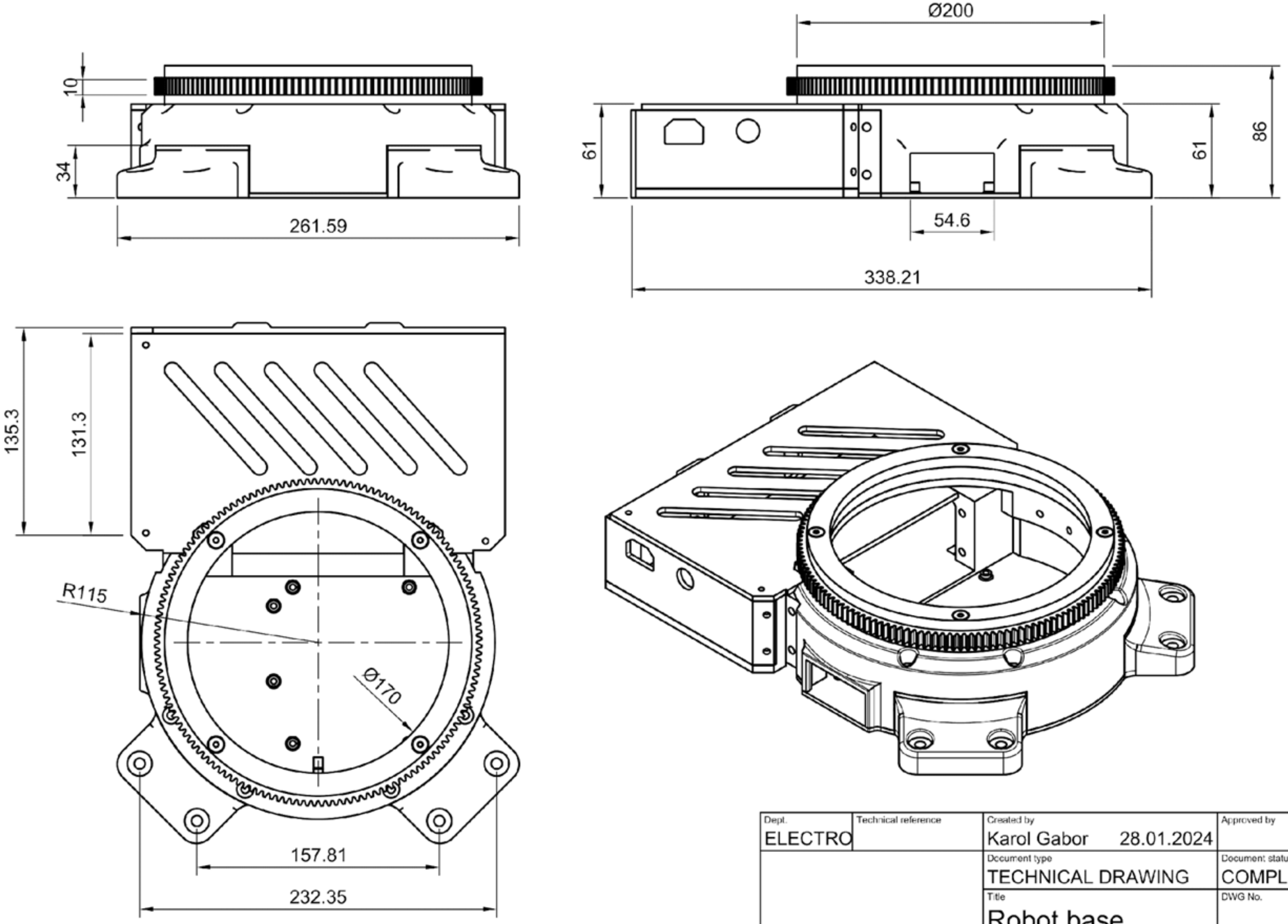
Spur gear 16T

Print parameters:

- Material: PETG
- Layer height: 0.1mm
- Infill: 100%
- Wall loops: 4



JOINTS



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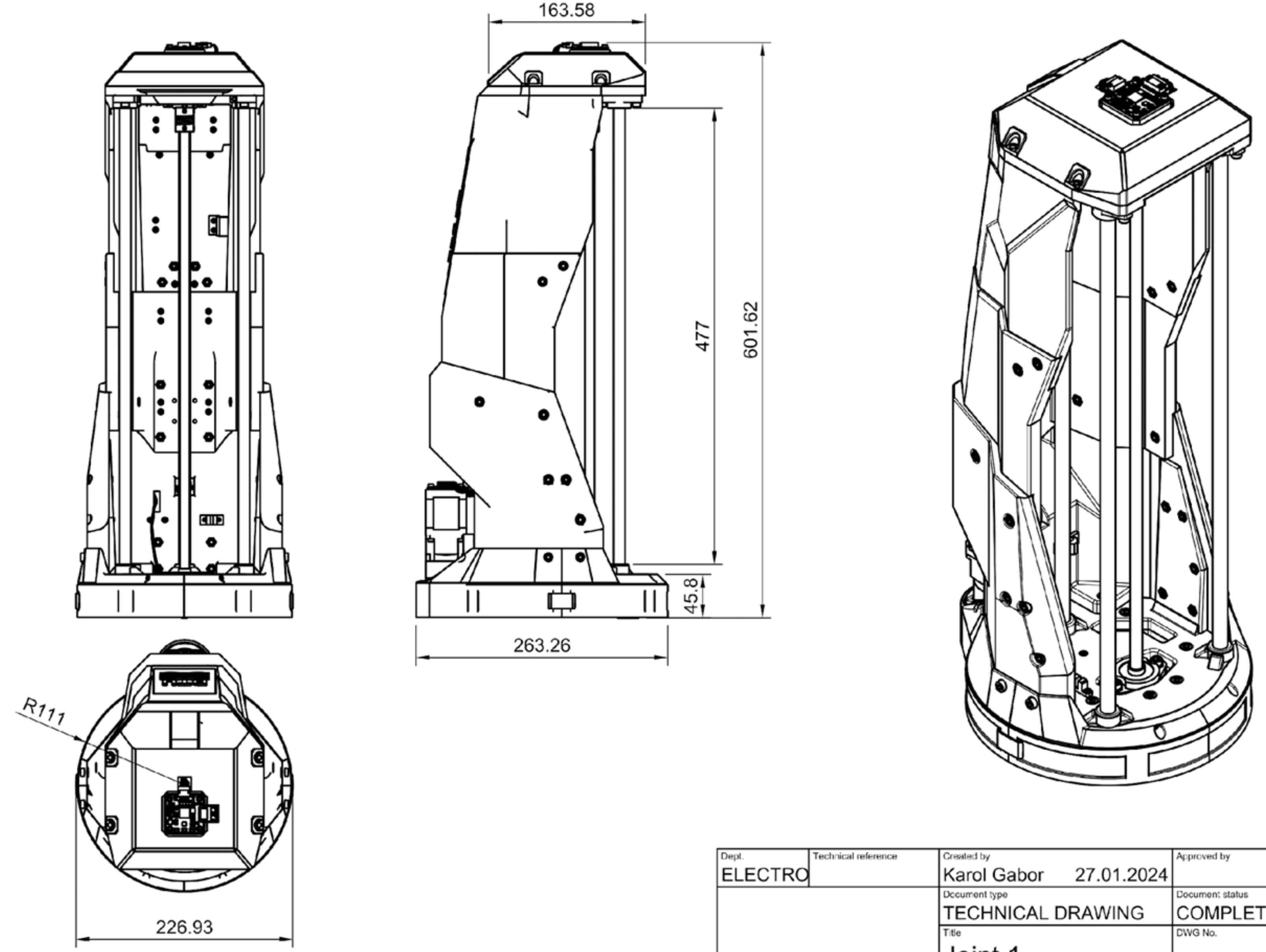
ELECTRO		Karol Gabor 28.01.2024	
		Document type: TECHNICAL DRAWING	Document status: COMPLETED
		Title: Robot base DTU SCARA v1	DWG No.: 1
			Rev.: 1 · Date of issue: 28.01.2024 · Sheet: 1/1



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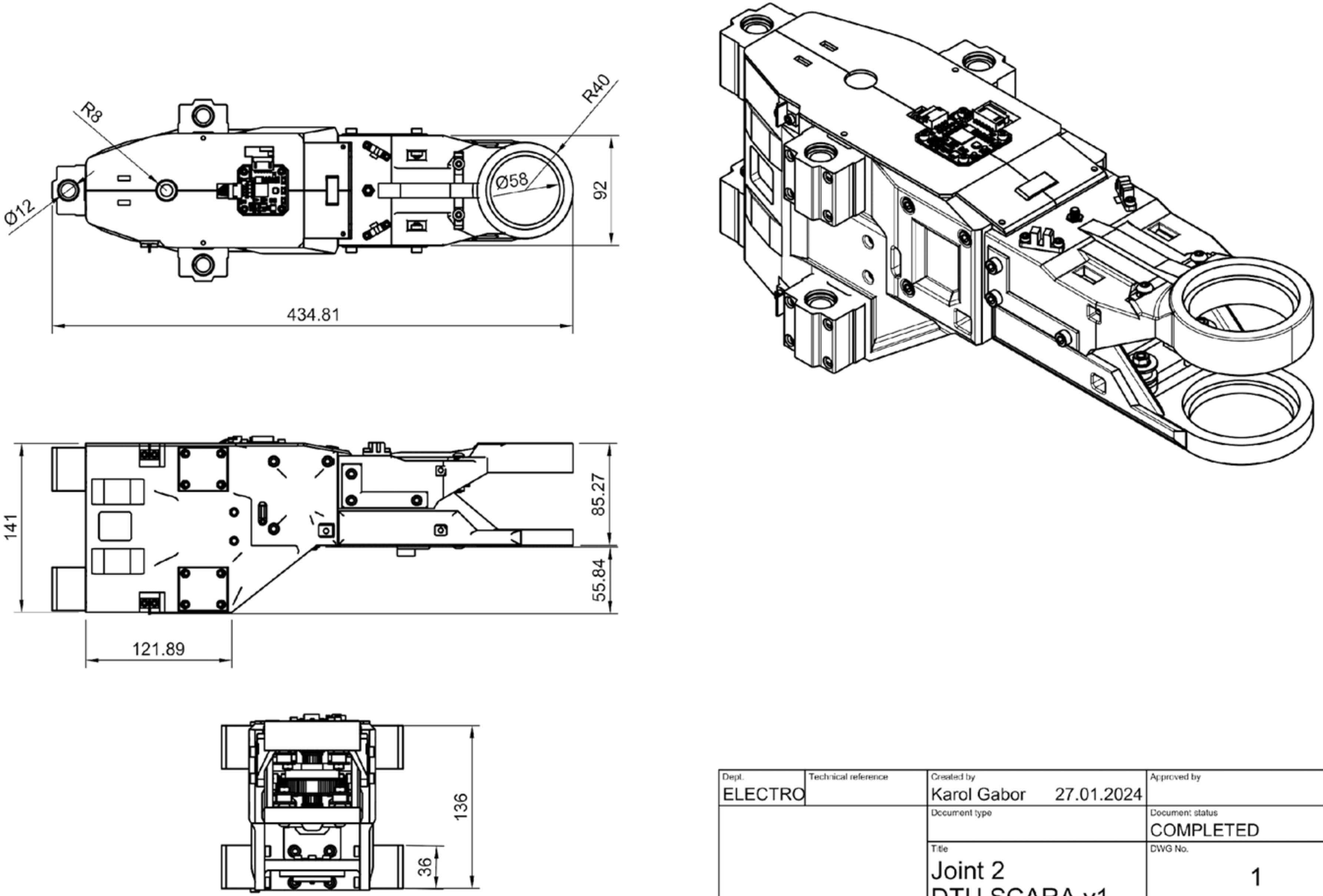
ELECTRO		Karol Gabor 27.01.2024	
		Document type: TECHNICAL DRAWING	Document status: COMPLETED
		Title: Joint 1 DTU SCARA v1	DWG No.: 1
			Rev.: 1 / Date of issue: / Sheet: 1/1



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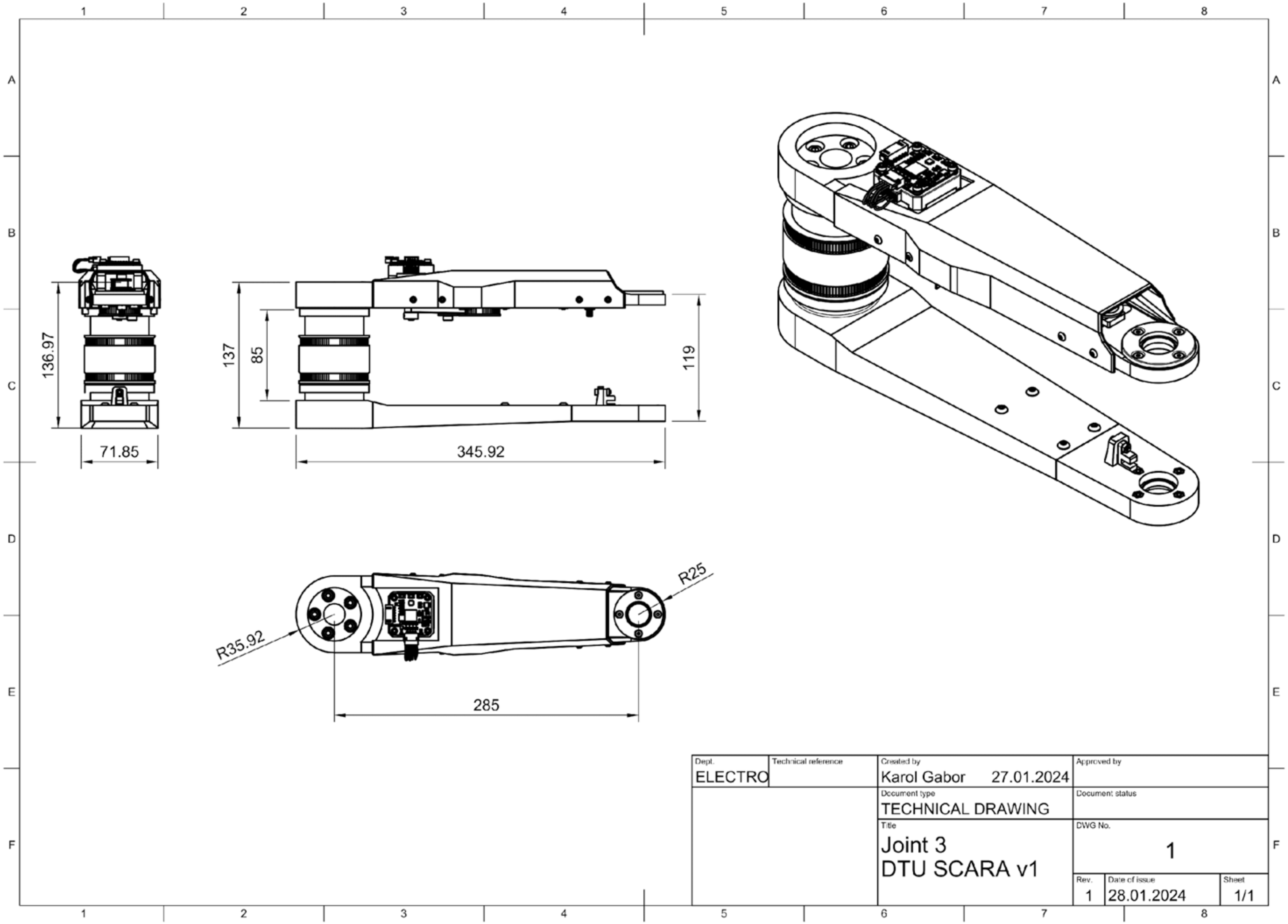
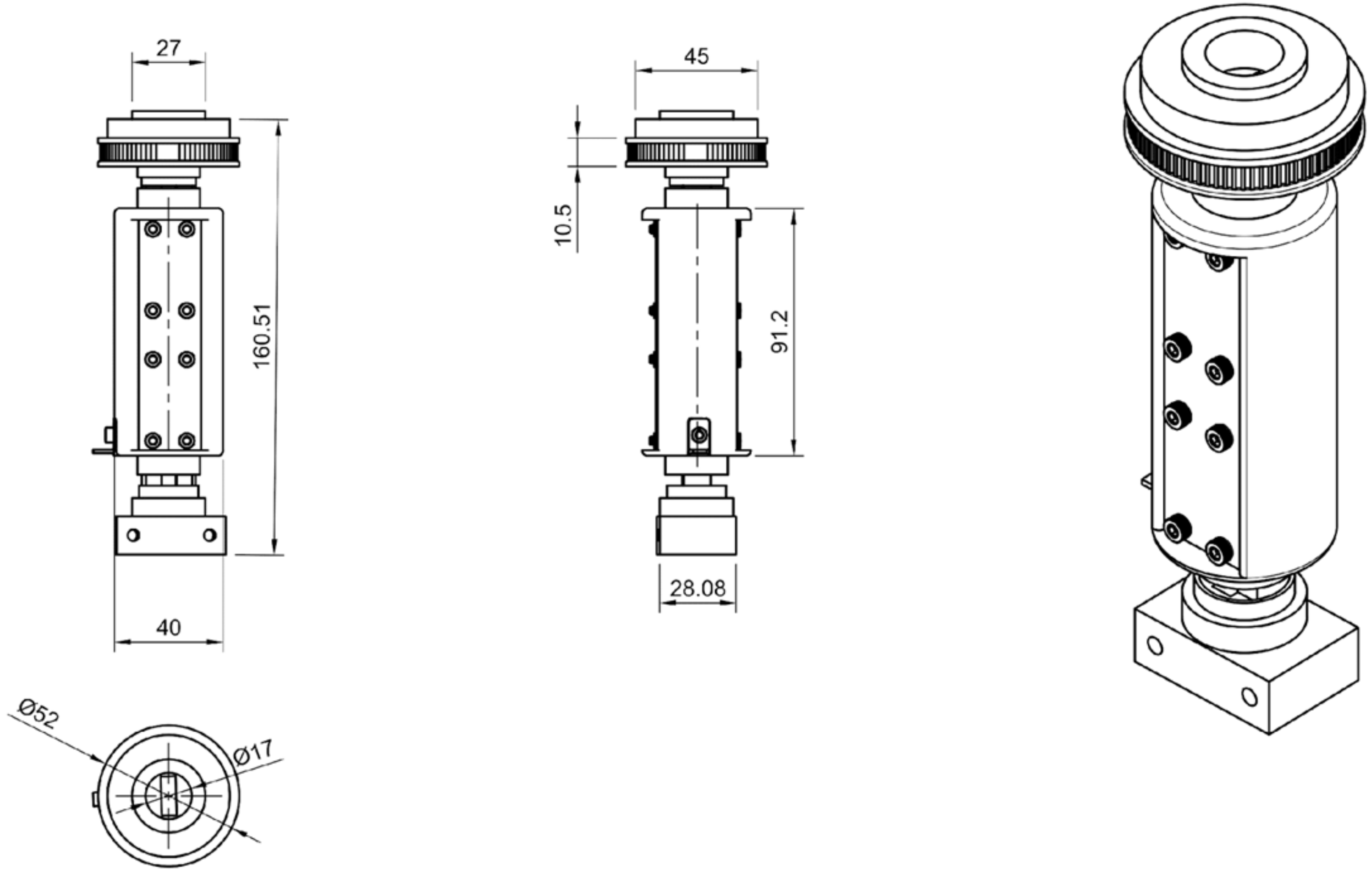
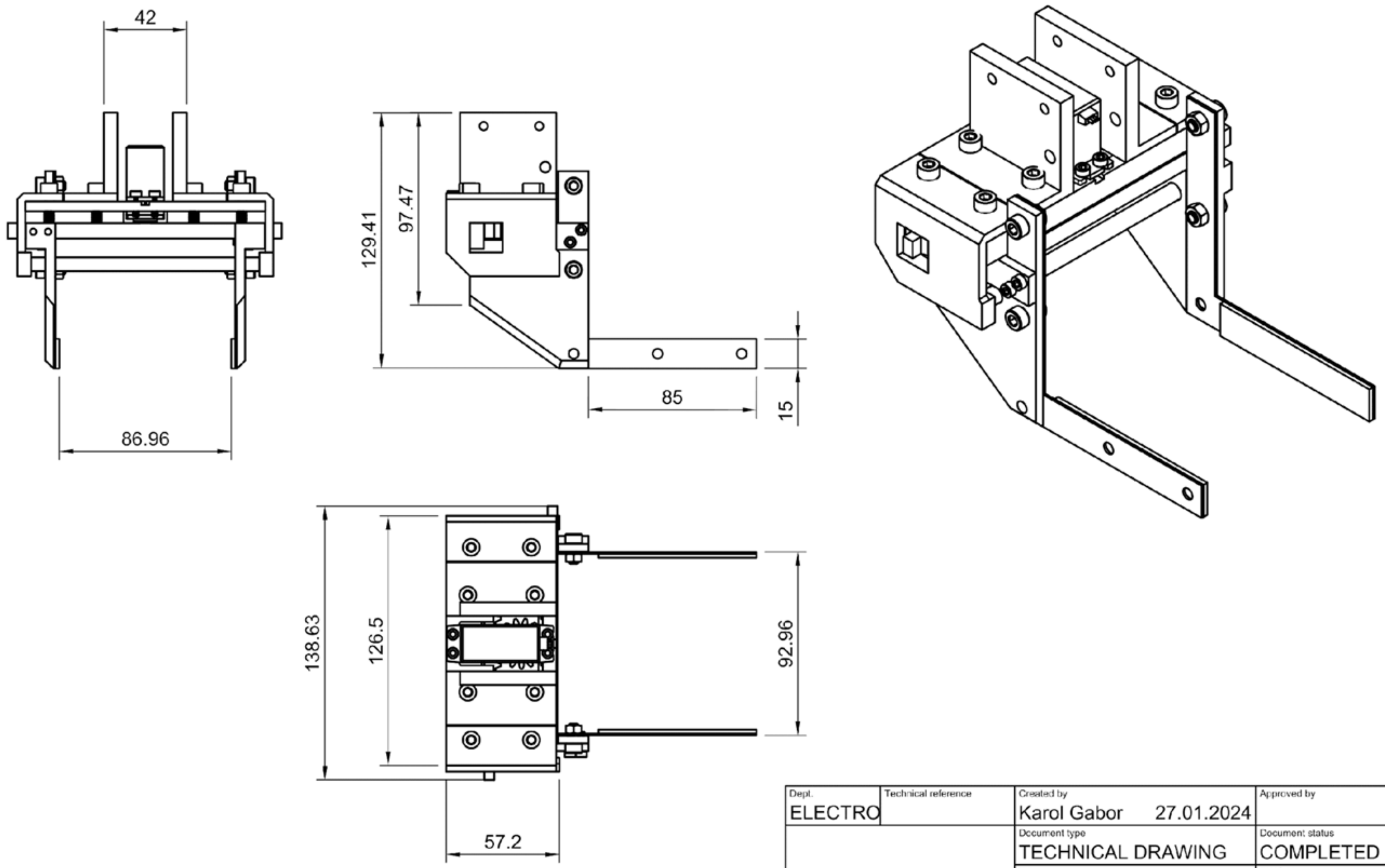
		Title: Joint 2 DTU SCARA v1	DWG No.: 1
			Rev.: 1 / Date of issue: 28.01.2024 / Sheet: 1/1



136.97
71.85
137
85
345.92
119
R35.92
R25
285
Dept.
ELECTRO
Technical reference
Created by
Karol Gabor 27.01.2024
Approved by
Document type
TECHNICAL DRAWING
Document status
Title
Joint 3
DTU SCARA v1
DWG No.
1
Rev.
1
Date of issue
28.01.2024
Sheet
1/1



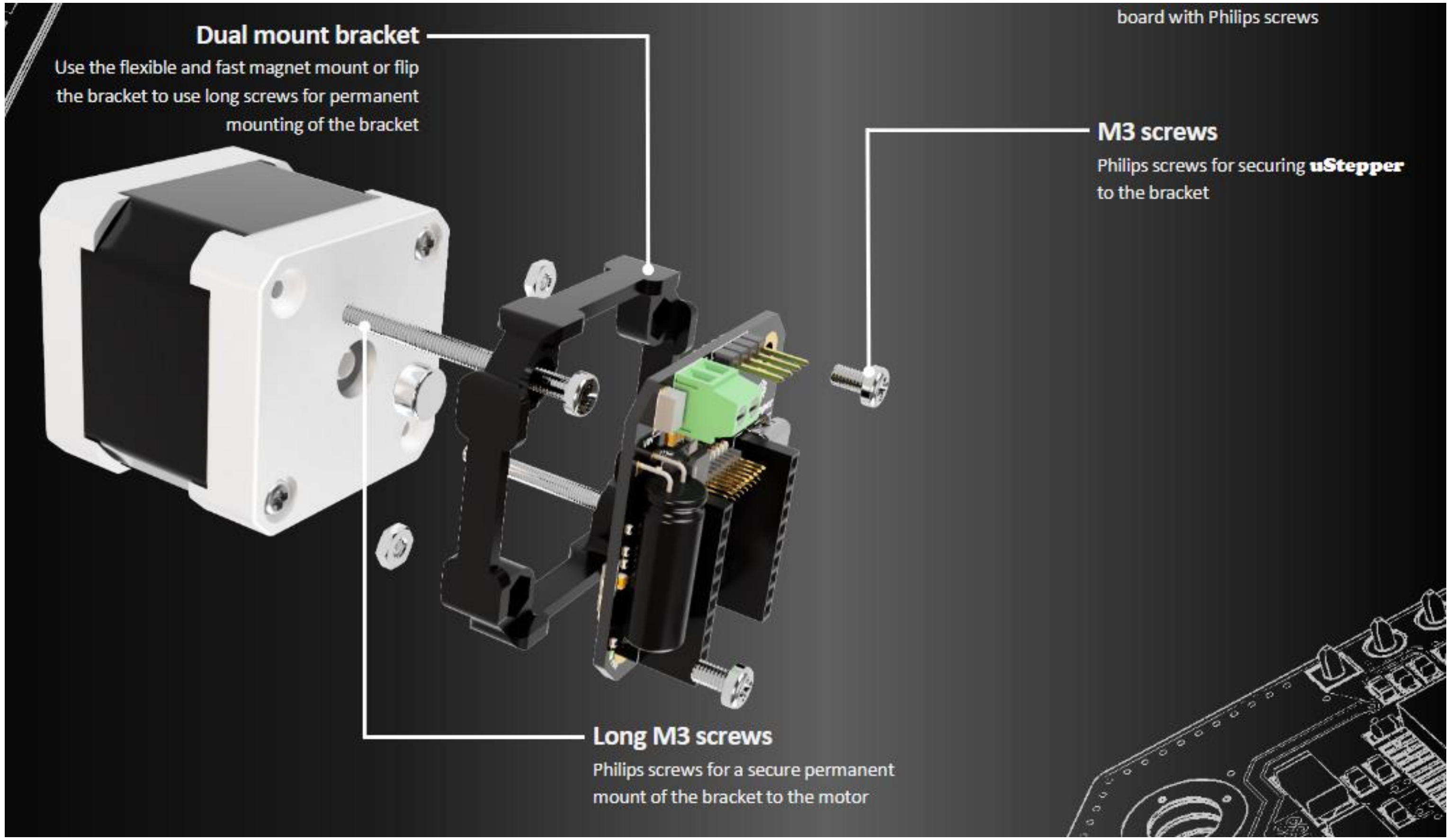
Dept. ELECTRO	Technical reference	Created by Karol Gabor 27.01.2024	Approved by
		Document type TECHNICAL DRAWING	Document status COMPLETED
		Title Joint 4 NEW DTU SCARA v1	DWG No. 1
			Rev. 1 · Date of issue 28.01.2024 · Sheet 1/1



Dept.	Technical reference	Created by	Approved by
ELECTRO		Karol Gabor 27.01.2024	
		Document type: TECHNICAL DRAWING	Document status: COMPLETED
		Title: Gripper DTU SCARA v1	DWG No.: 1
			Rev.: 1 · Date of issue: 28.01.2024 · Sheet: 1/1

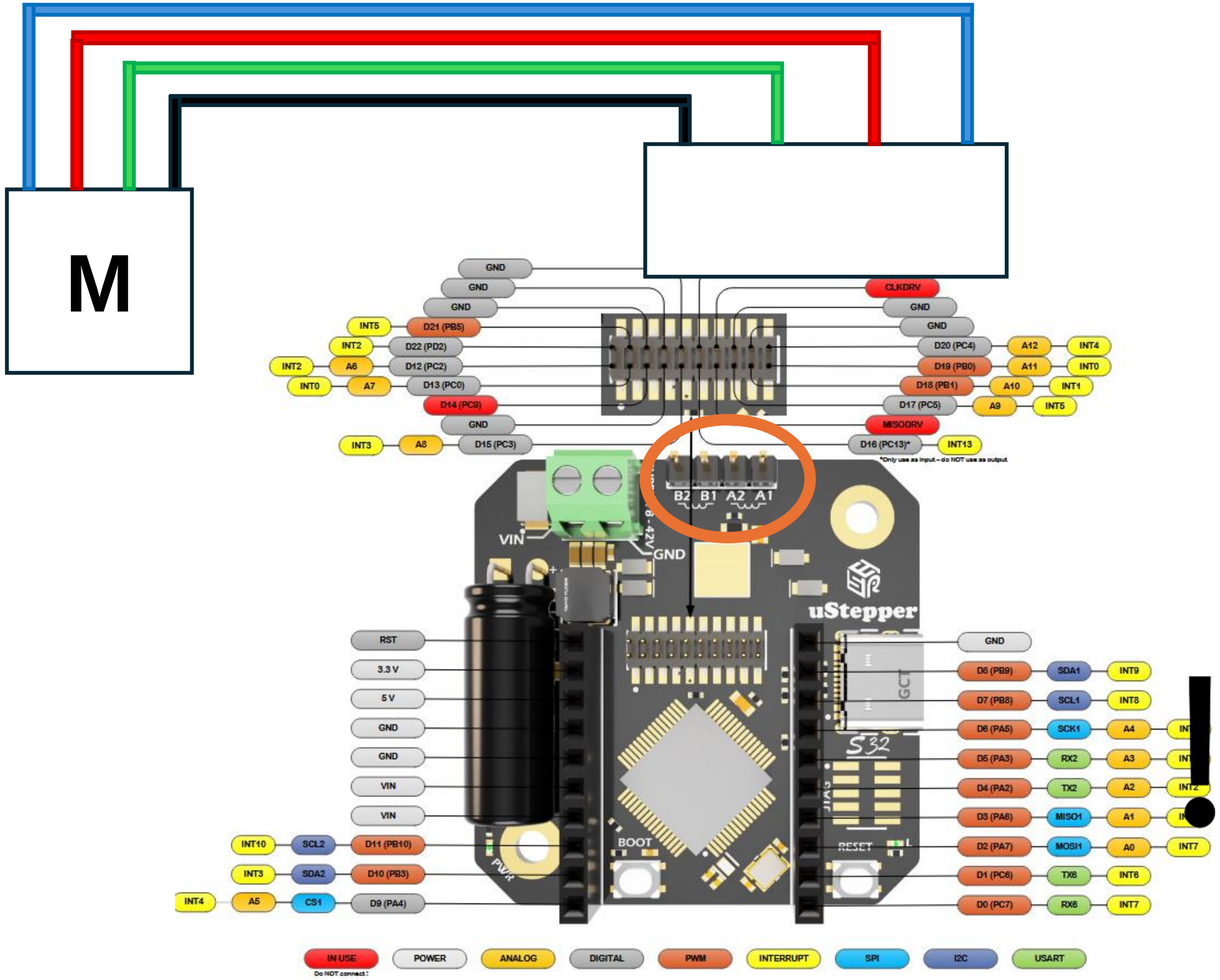
ACTUATORS

MOTORS
Place the magnet on the motor’s shaft rear end (gluing it is good practice to ensure it will stay put). Try to align the magnet on the shaft as precise as possible. Mount the as described by the manufacturer: https://ustepper.com/productsheets/Product_sheet_S32.pdf



WIRING SEQUENCE

Connect the motor to the MKS Servo 42C using the JST XH2.54-4Y connector. Refer to the previous page regarding the phase wiring sequence. The motor wiring is an important step that has to be checked before assembling the whole robot.



The default wiring sequence for the motor used in joint 4 is different than in the other motors. Use the cable provided for this motor. (assuming the components are identically sourced)

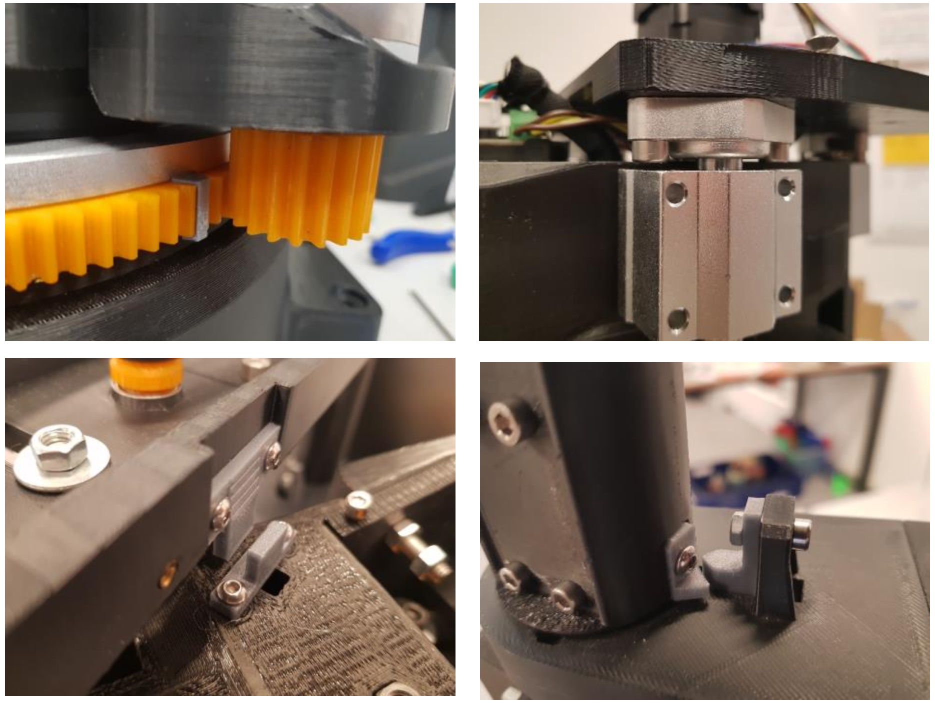
To make sure the wiring is correct, you can measure the resistance between the wires after it has been connected to the motor. In a bipolar stepper motor, the ends of the coil are represented as two pairs – A+ and A- as well as B+ and B-. The measured resistance between the two ends of each pair should be 0 Ω.

An incorrectly wired motor will result in a short when powered. This might indicate by the motor not being able to move, very high current draw and a buzzing sound.

ENDSTOPS

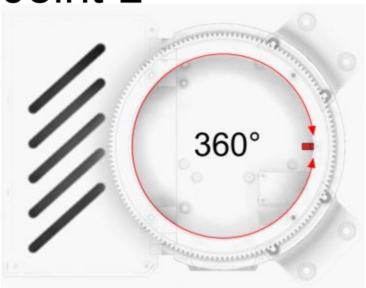
ENDSTOPS

Physical Endstops need to be placed to limit the motion and provide a back stop for the sensorless homing.



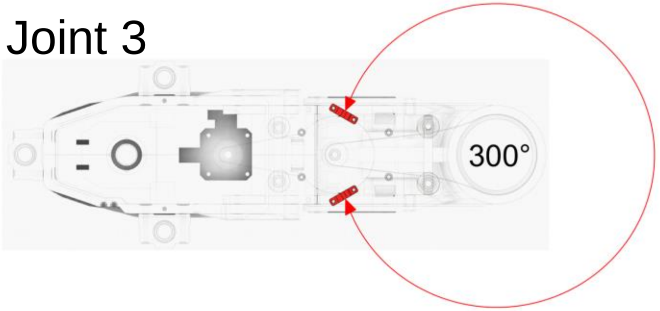
For Joint 1: place the endstop exactly in the front. Symmetrically counting teeth helps finding the middle.

Joint 1

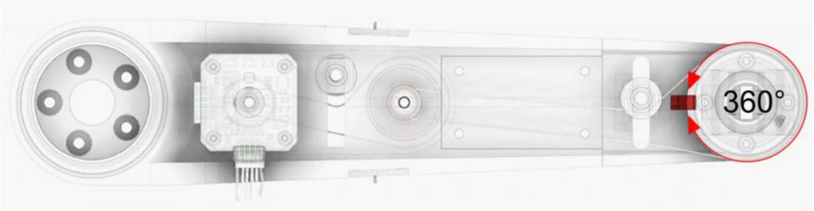


Joint 2

Joint 3



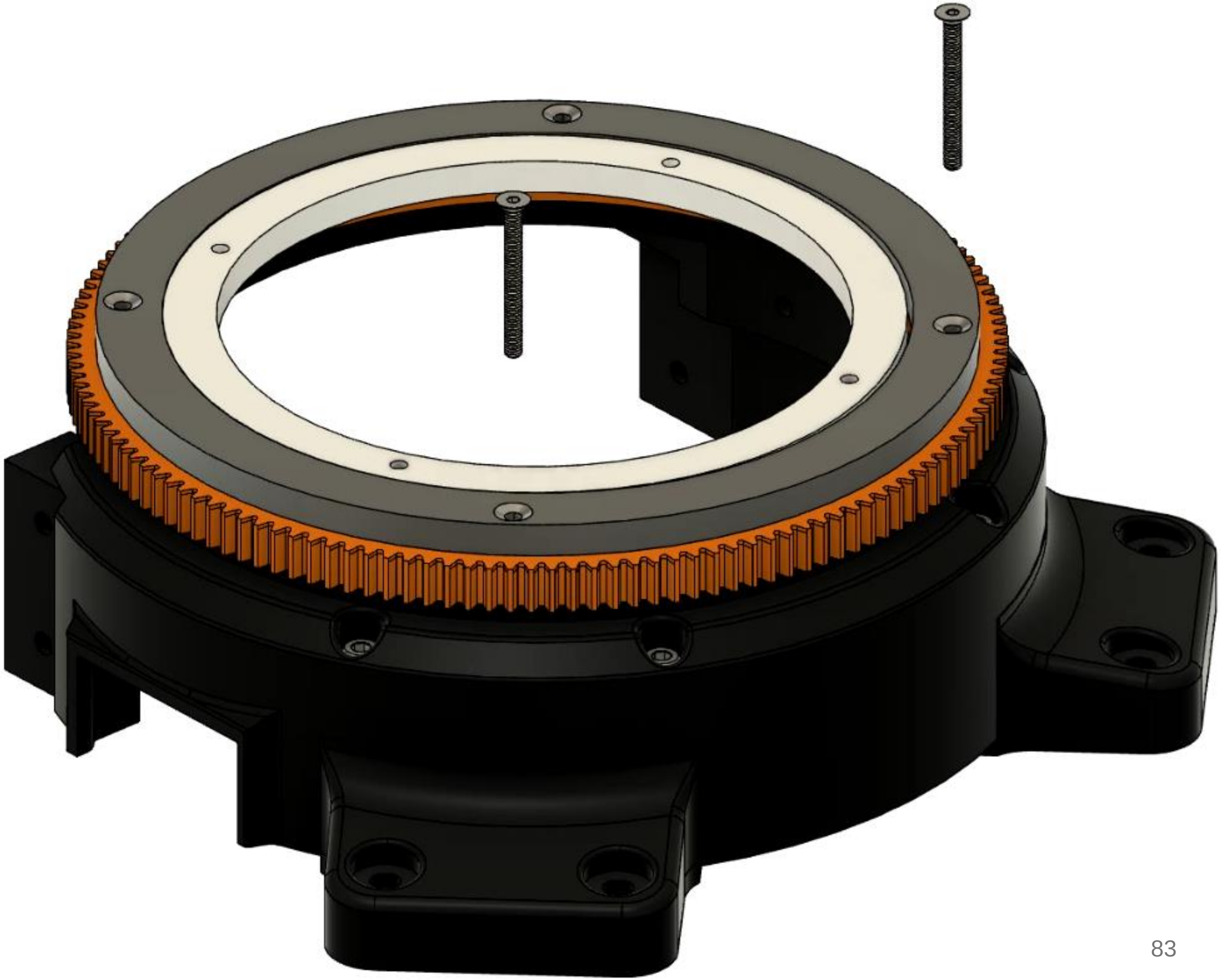
Joint 4



ASSEMBLY

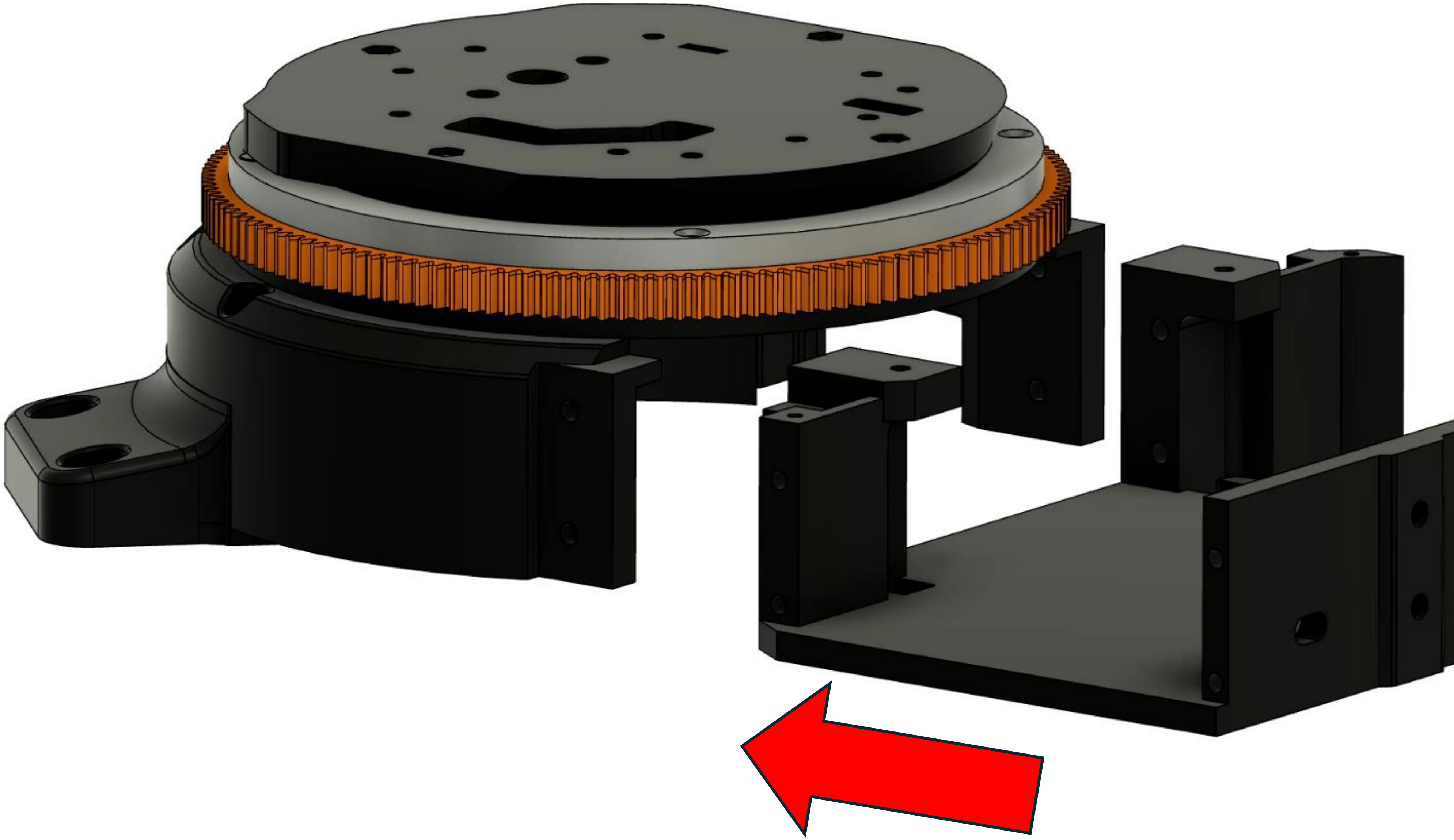
4x M5x40
4x M5 nut

2x M4x40
2x M4 nut



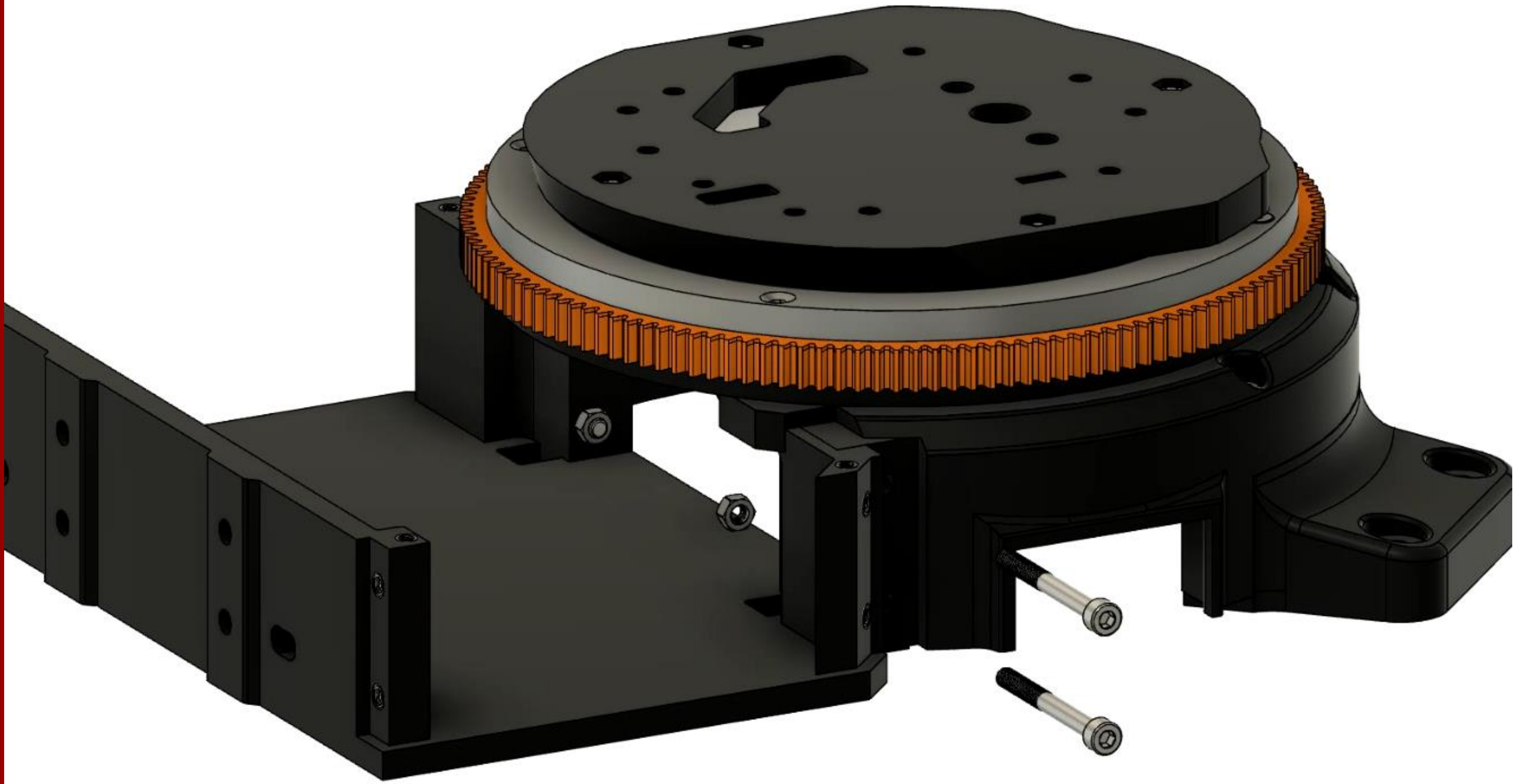
Note:
Don't insert all 4 screws!

4x
M4x20
4x M4
nut



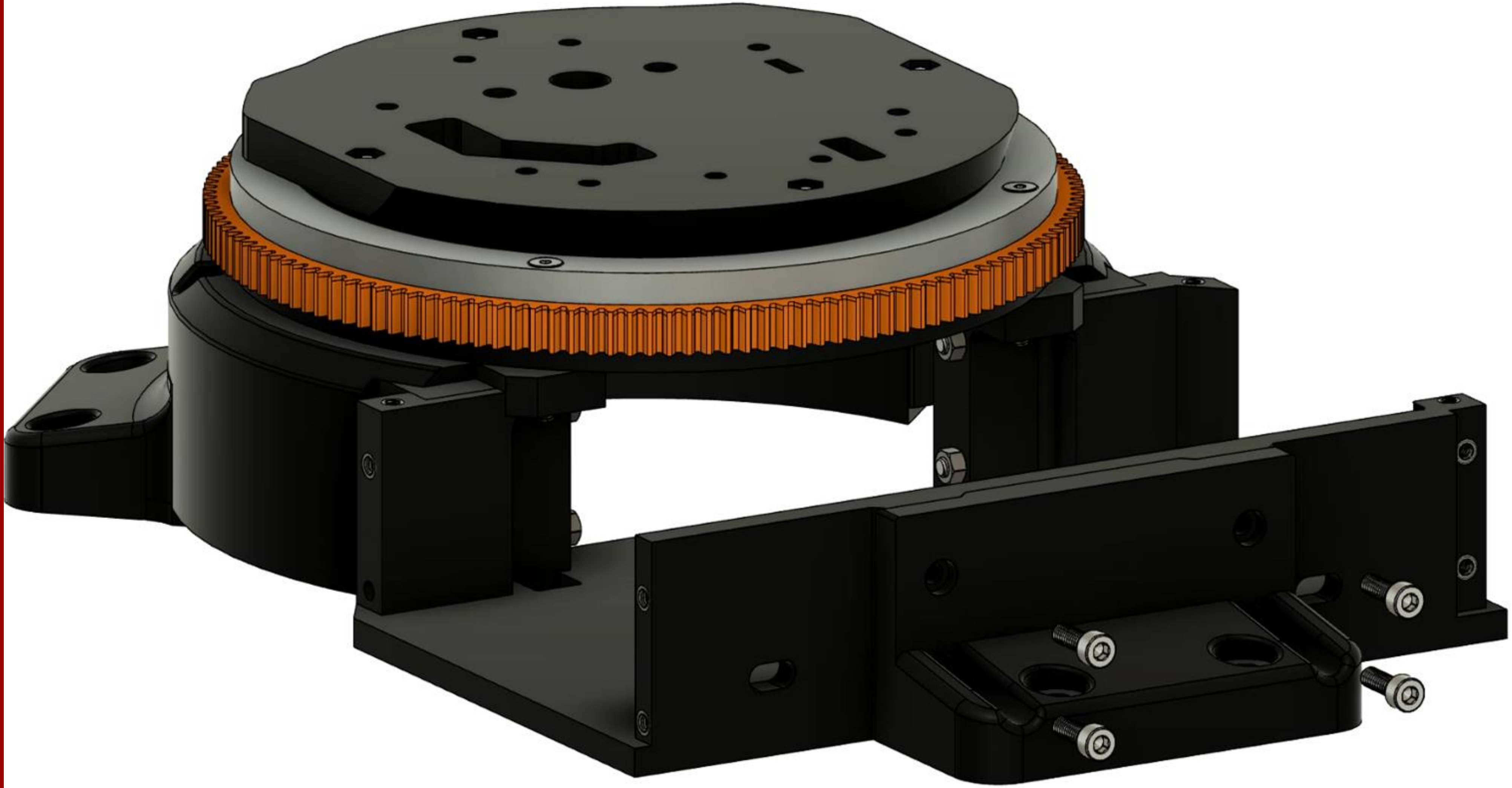
2x M5x50
2x M5 nut

2x M5x50
2x M5 nut

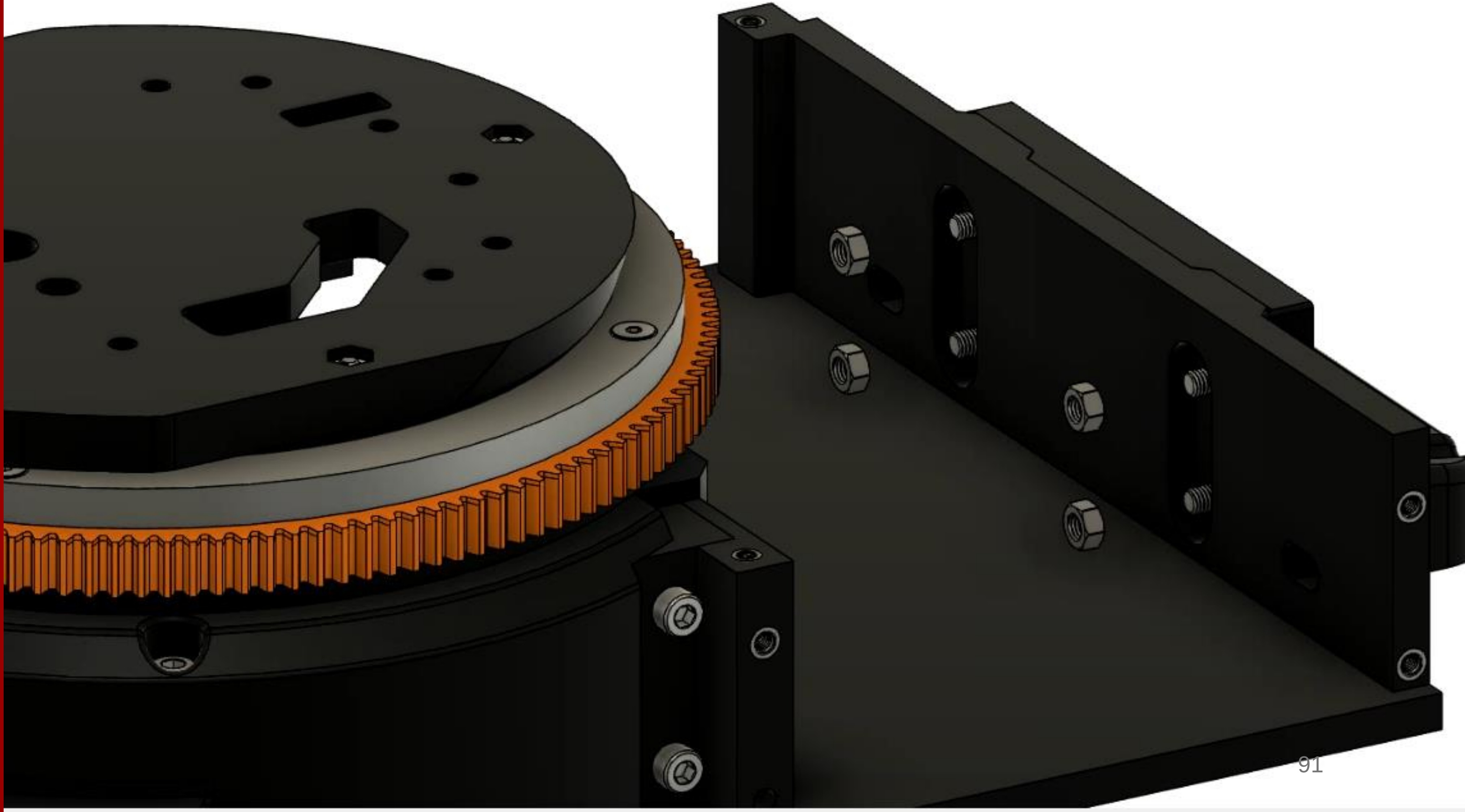


2x
M4x40
2x M4
nut

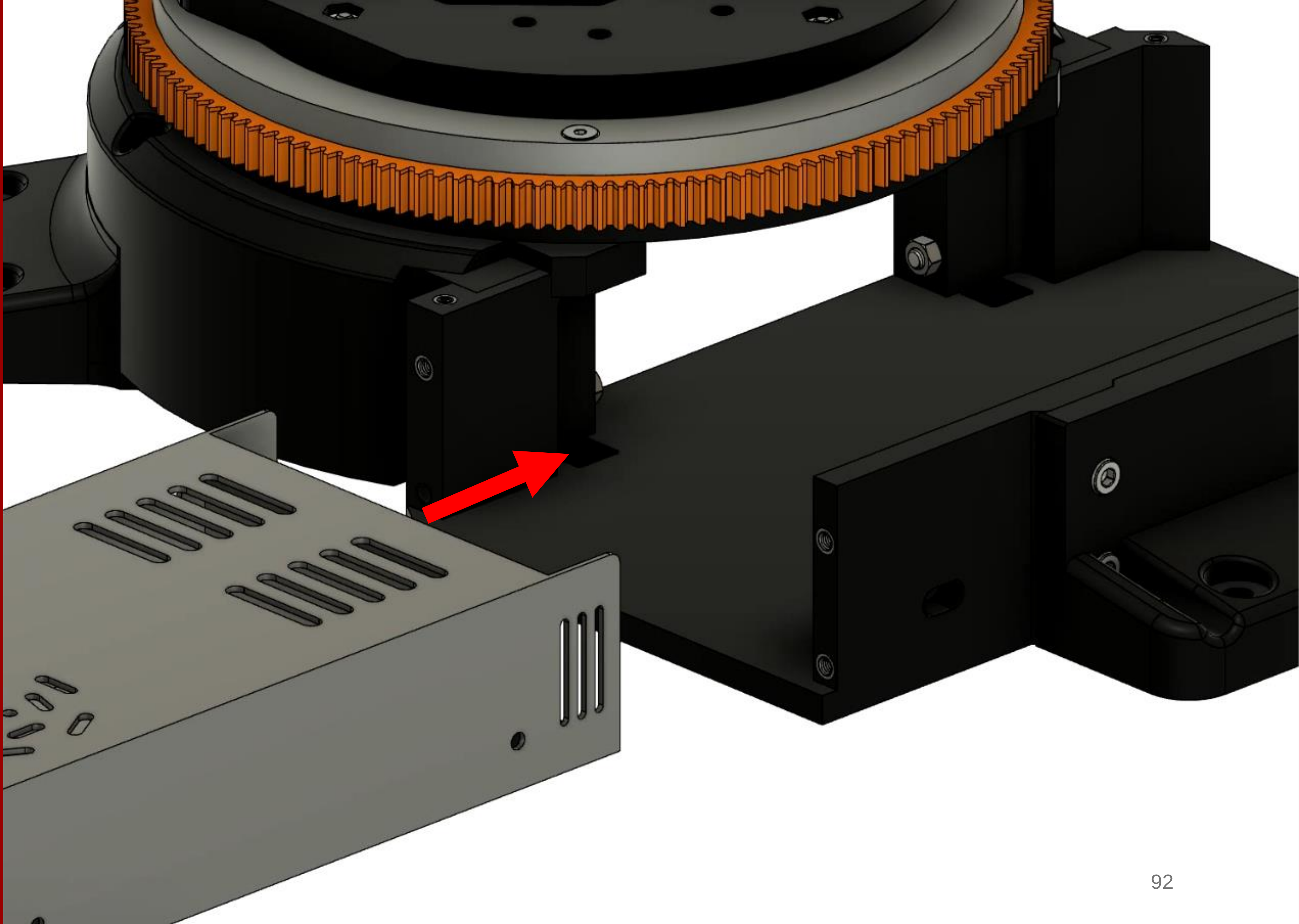
4x
M5x15



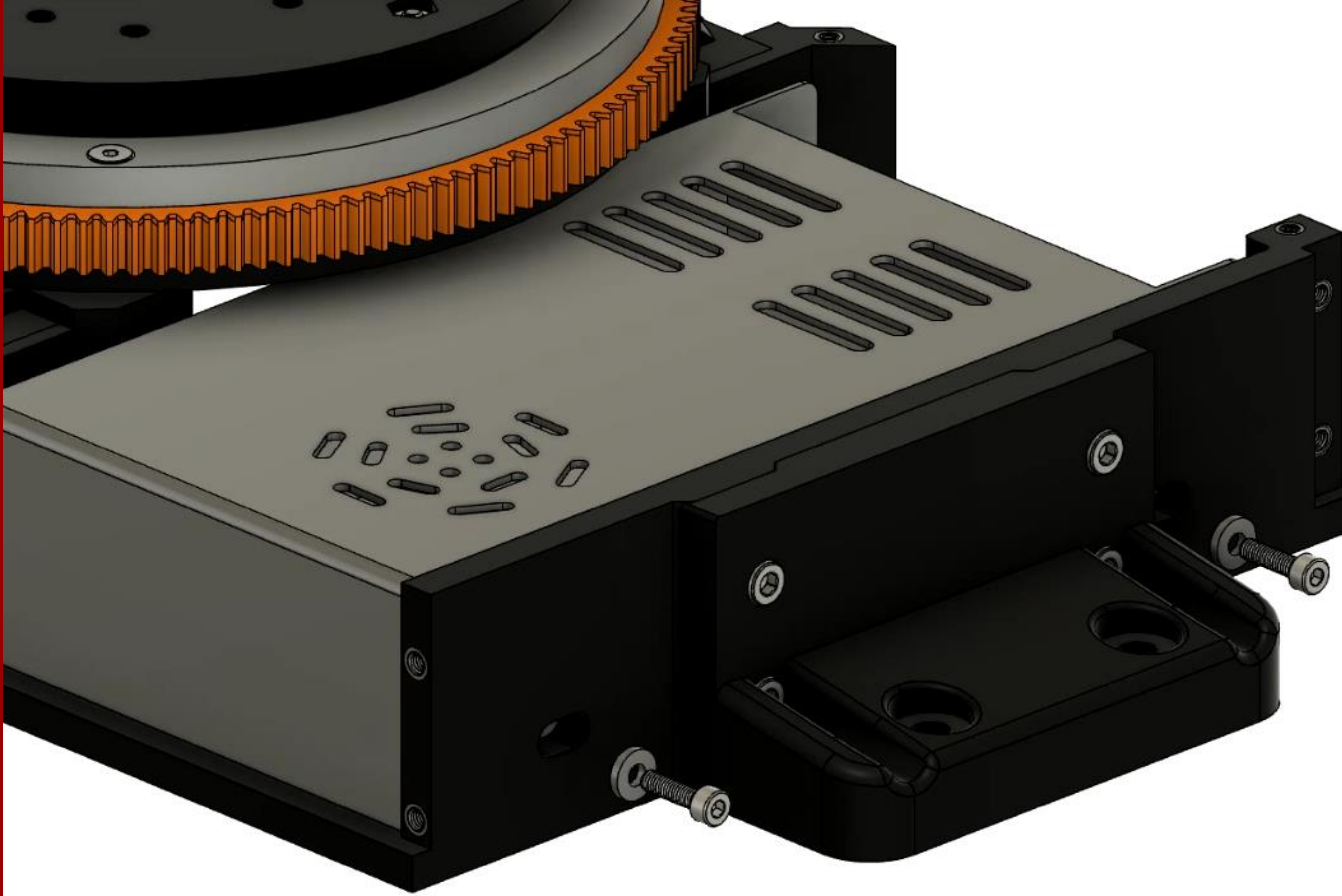
4x M5 nut



Insert power supply into the PSU box

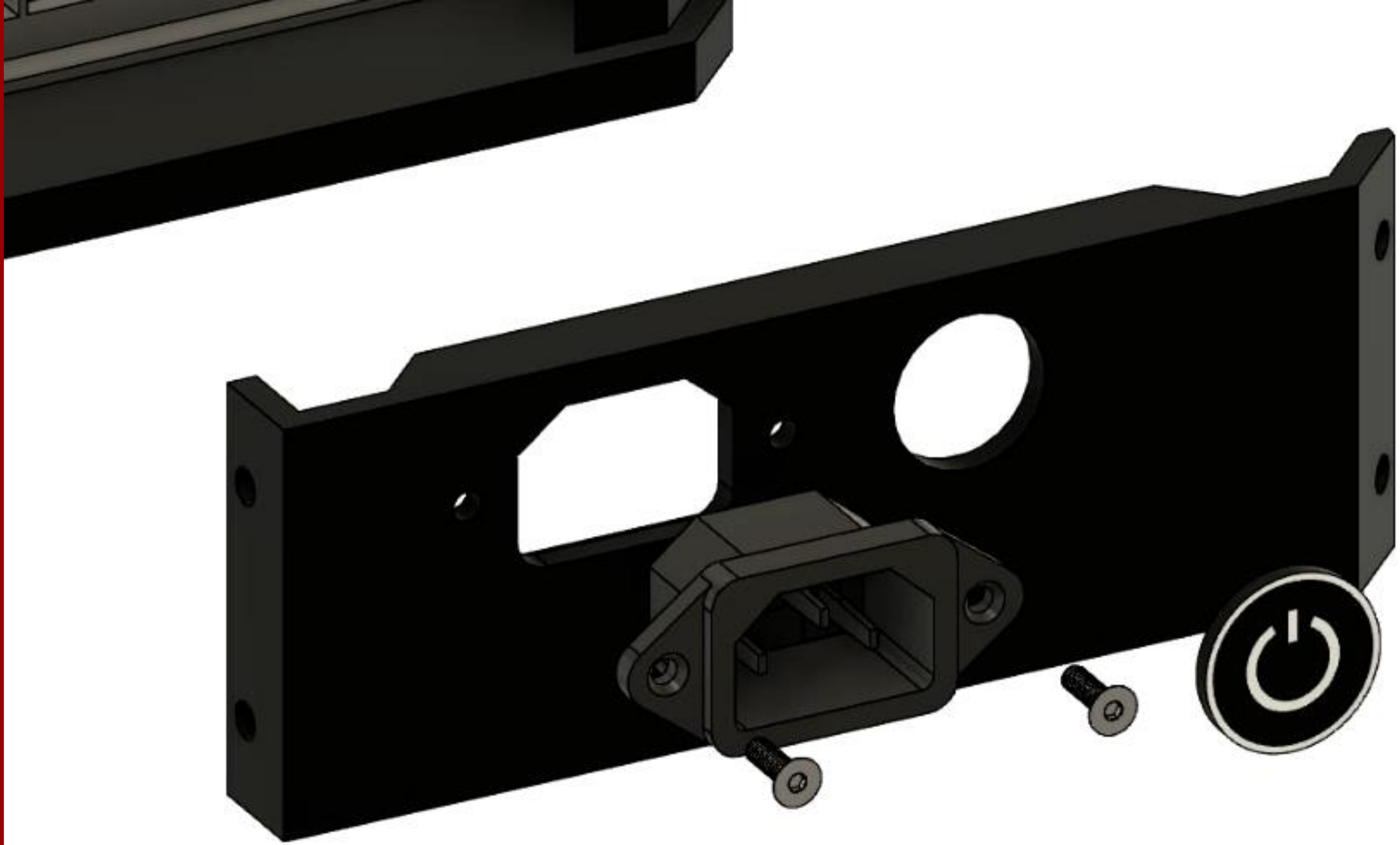


2x M4x15
2x M4
washer



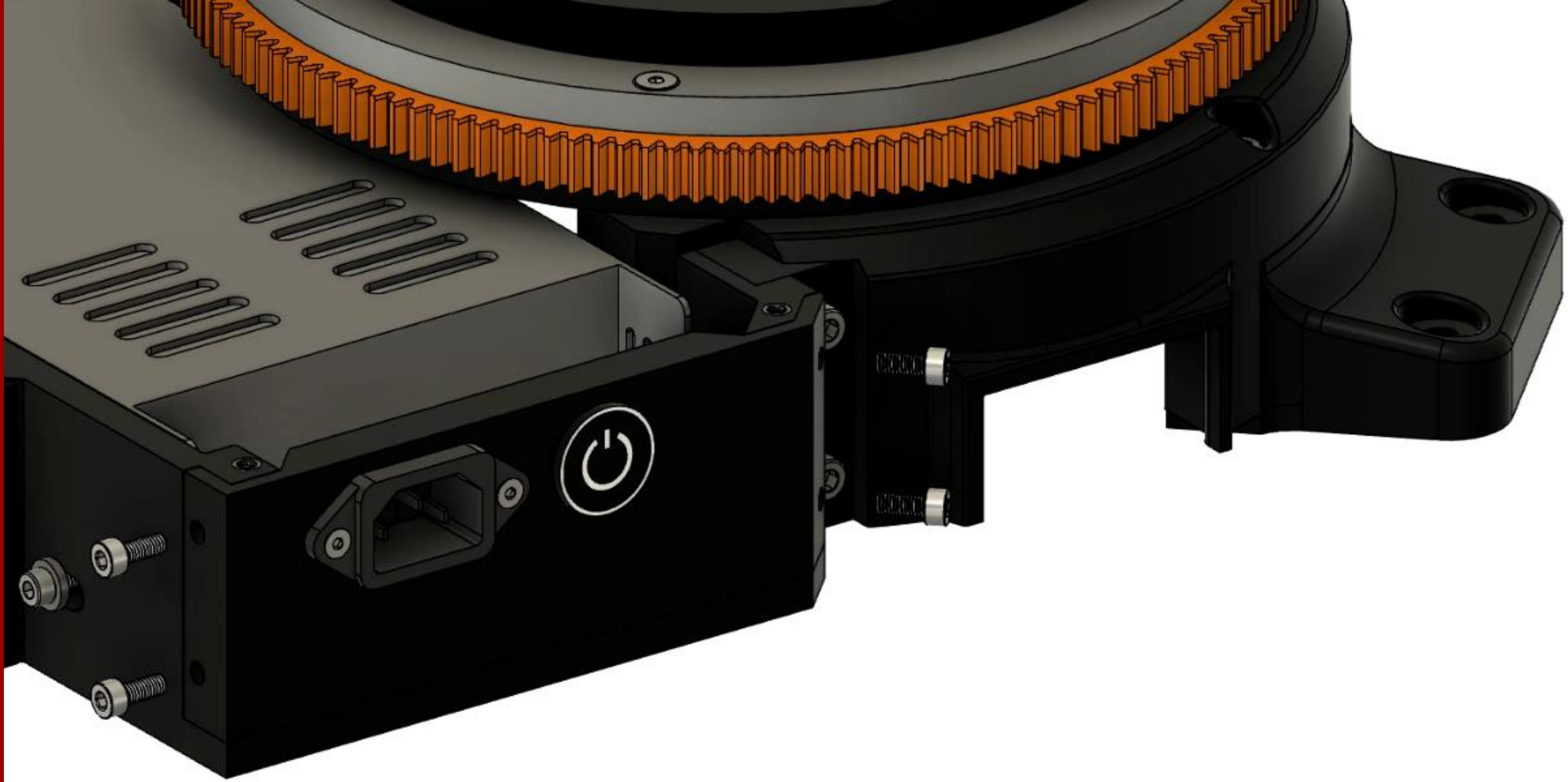
4x
M4x10

2x M3x10 flat head screw
1x Power button
1x C14 socket

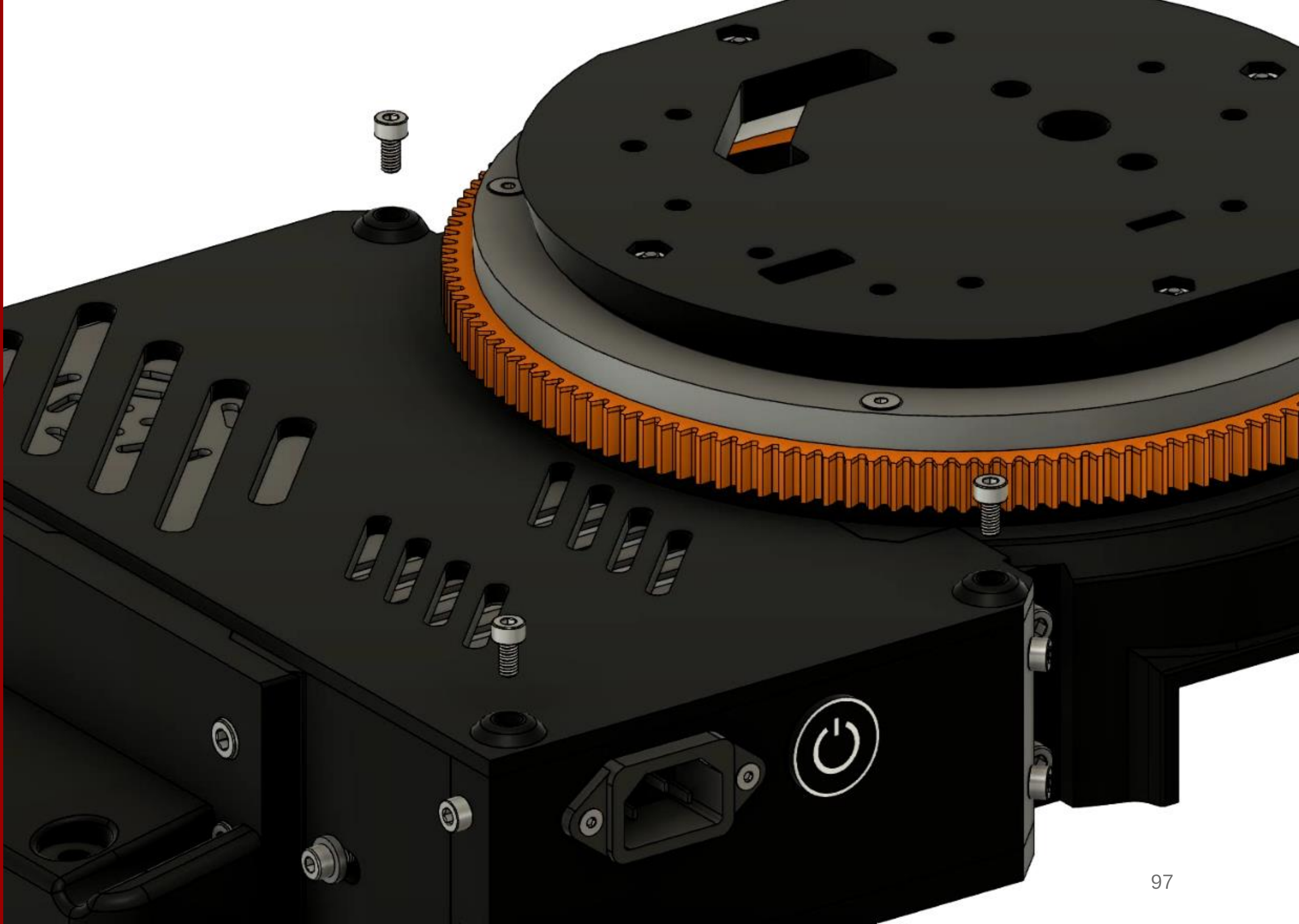


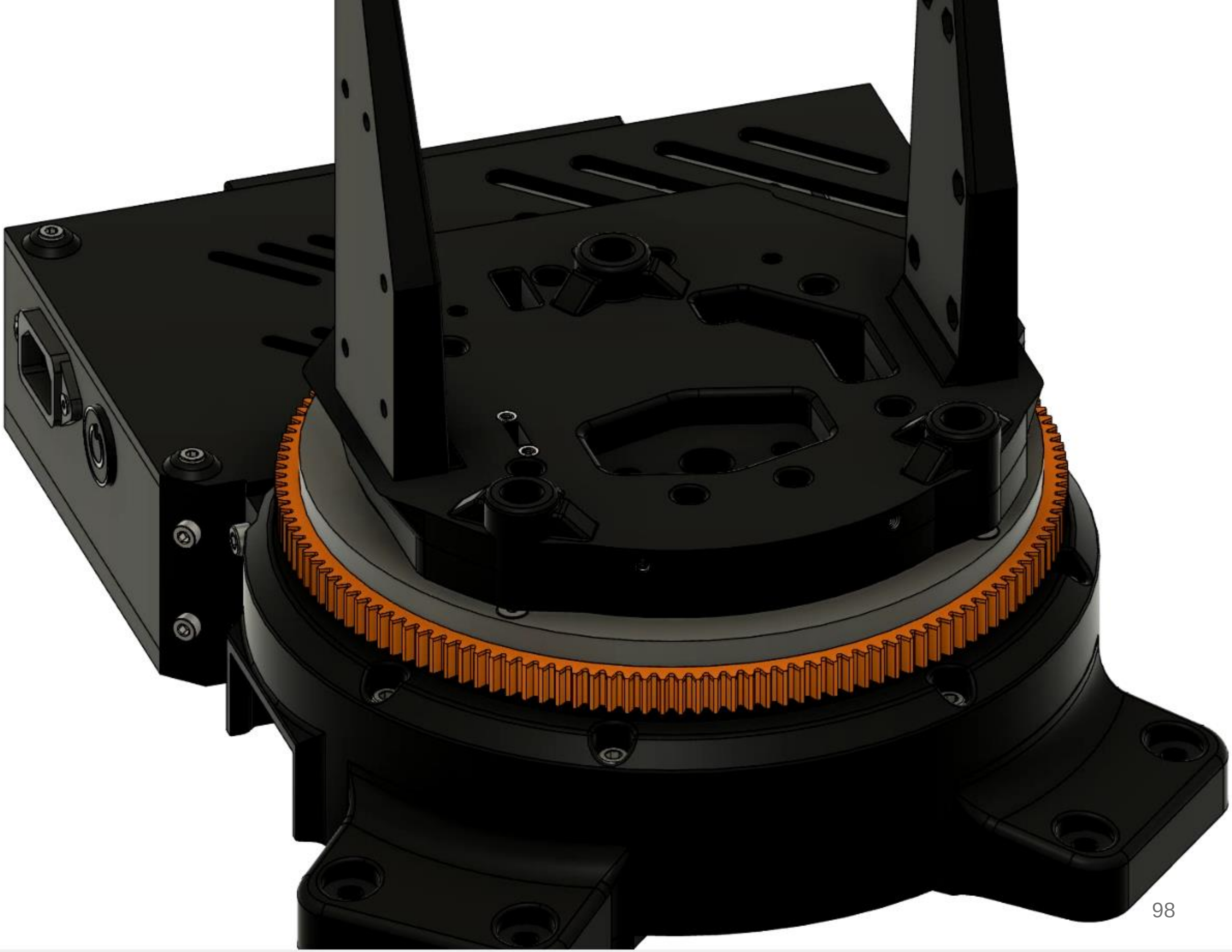
The front panel button and socket wiring have been described later in the manual

4x
M4x10



3x
M4x8

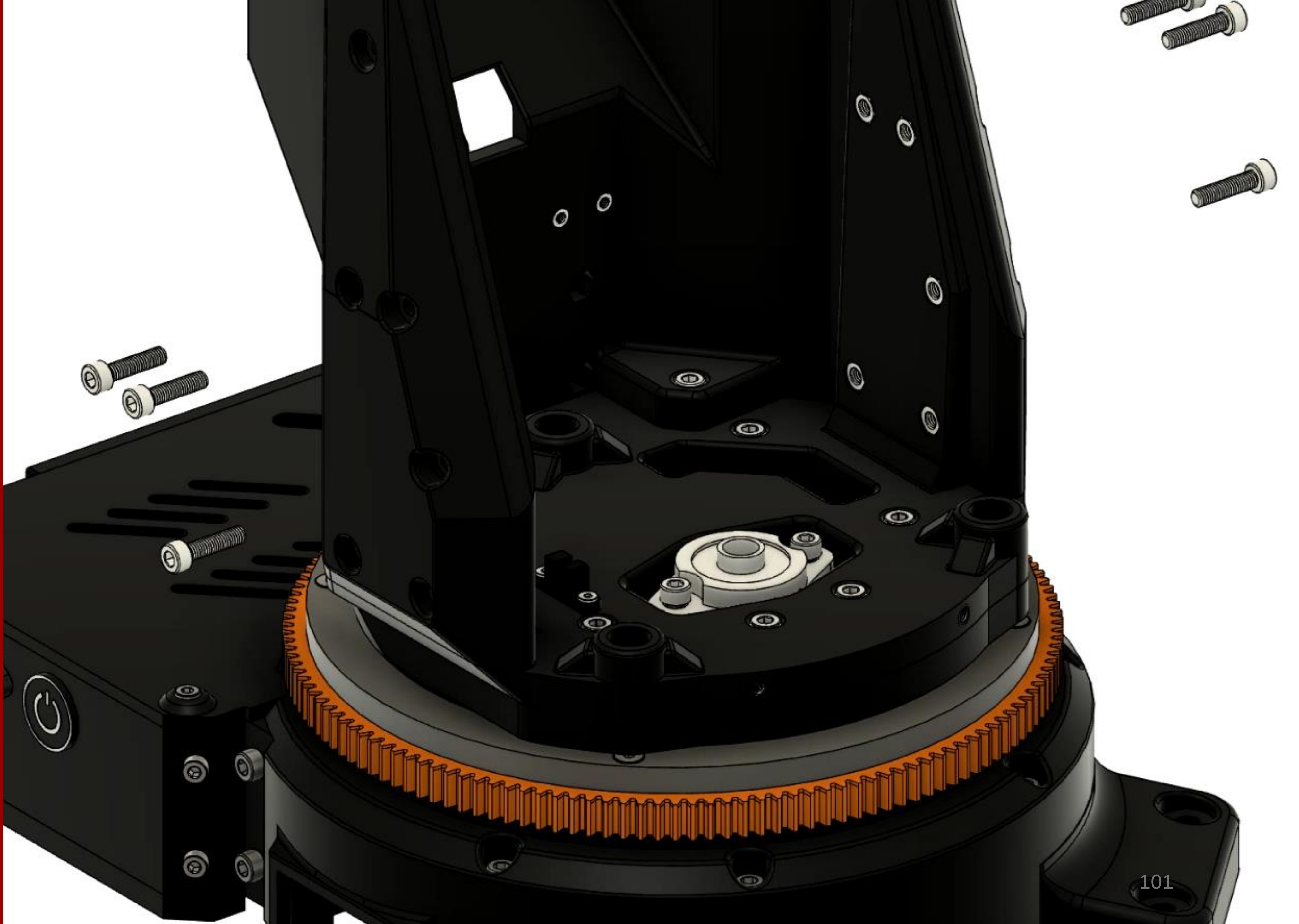




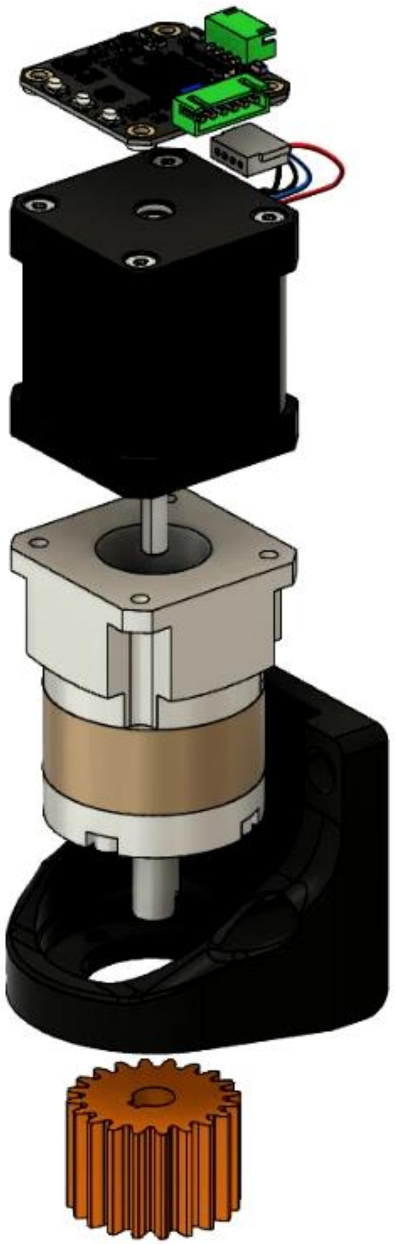
1x 10mm Pillow ball bearing
10x M5x20
10x M5 nut

2x M5x30
2x M5 nut

6x
M5x20
6x M5
nut

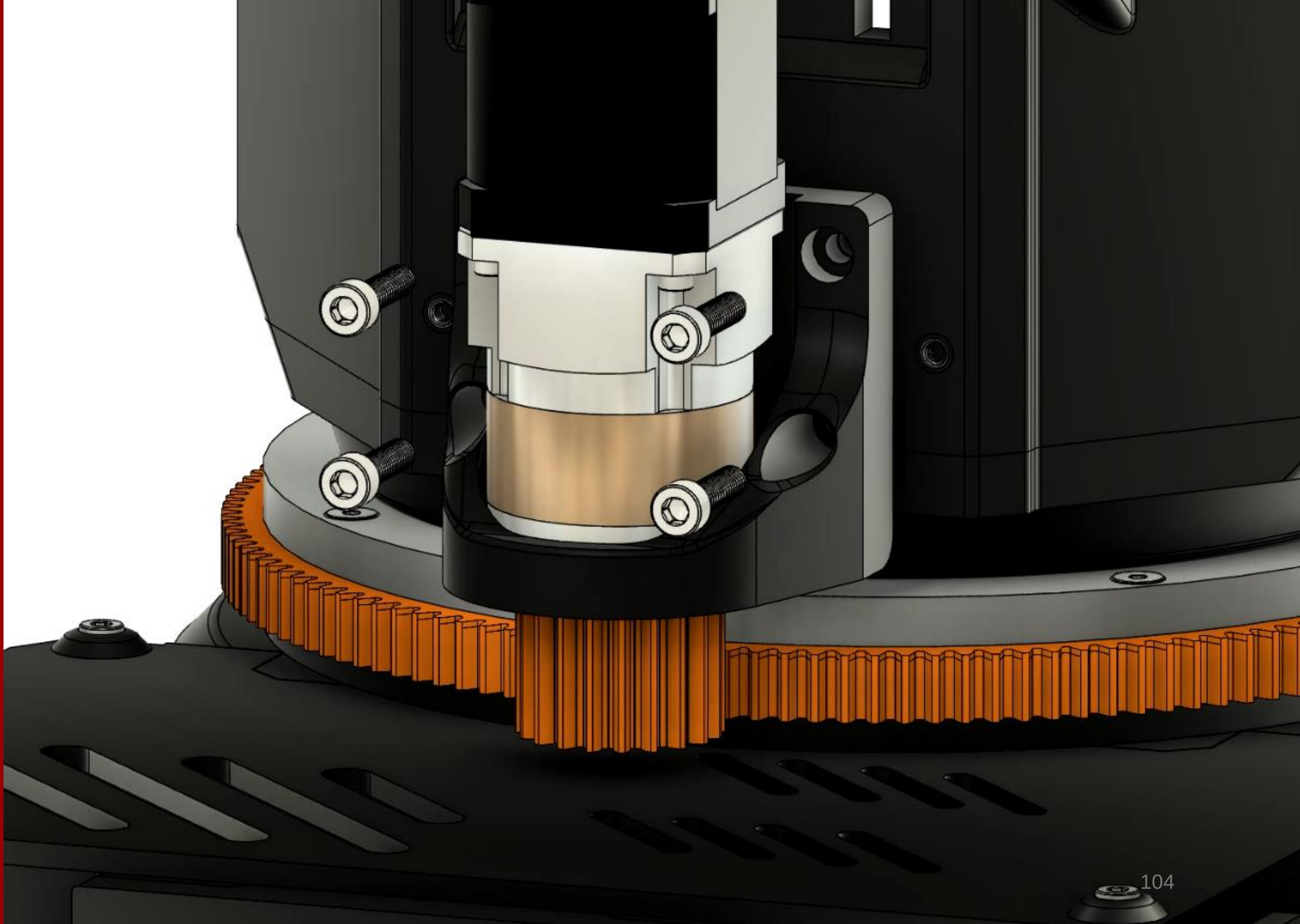


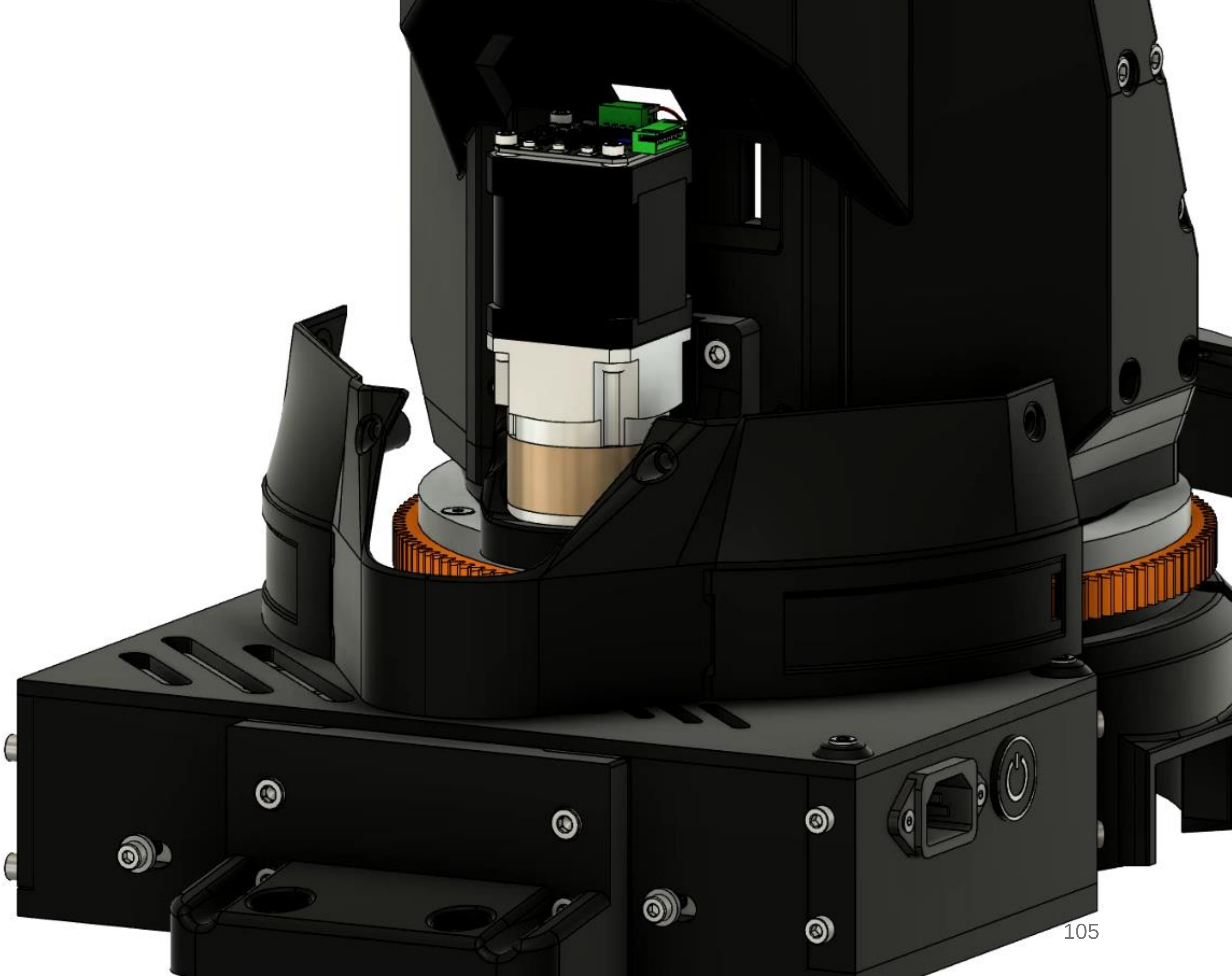
1x MKS Servo42C
1x Nema 17 (17HS19-2004S1)
1x Planetary Gearbox 5:1
4x Distance washer



4x M3x8
4x M3x10
4x M4x8 flat head screw
1x M3x10

4x M5x20
4x M5 nut



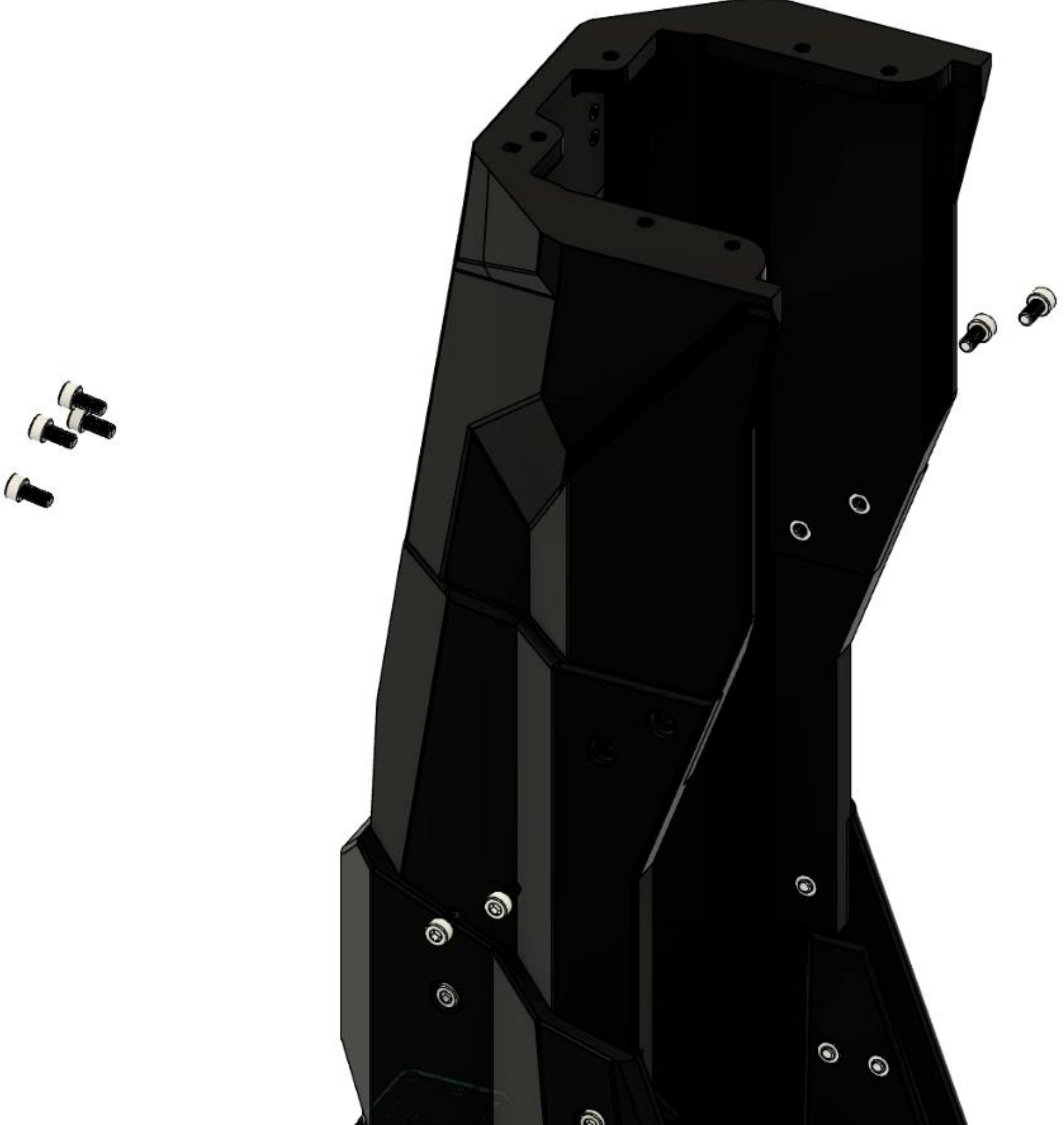


2x
M4x10

4x
M5x30
2x
M4x10
4x M5
nut

2x
M5x20
2x
M5x10
4x
M5x15
8x M5
nut

8x
M5x10
8x M5
nut

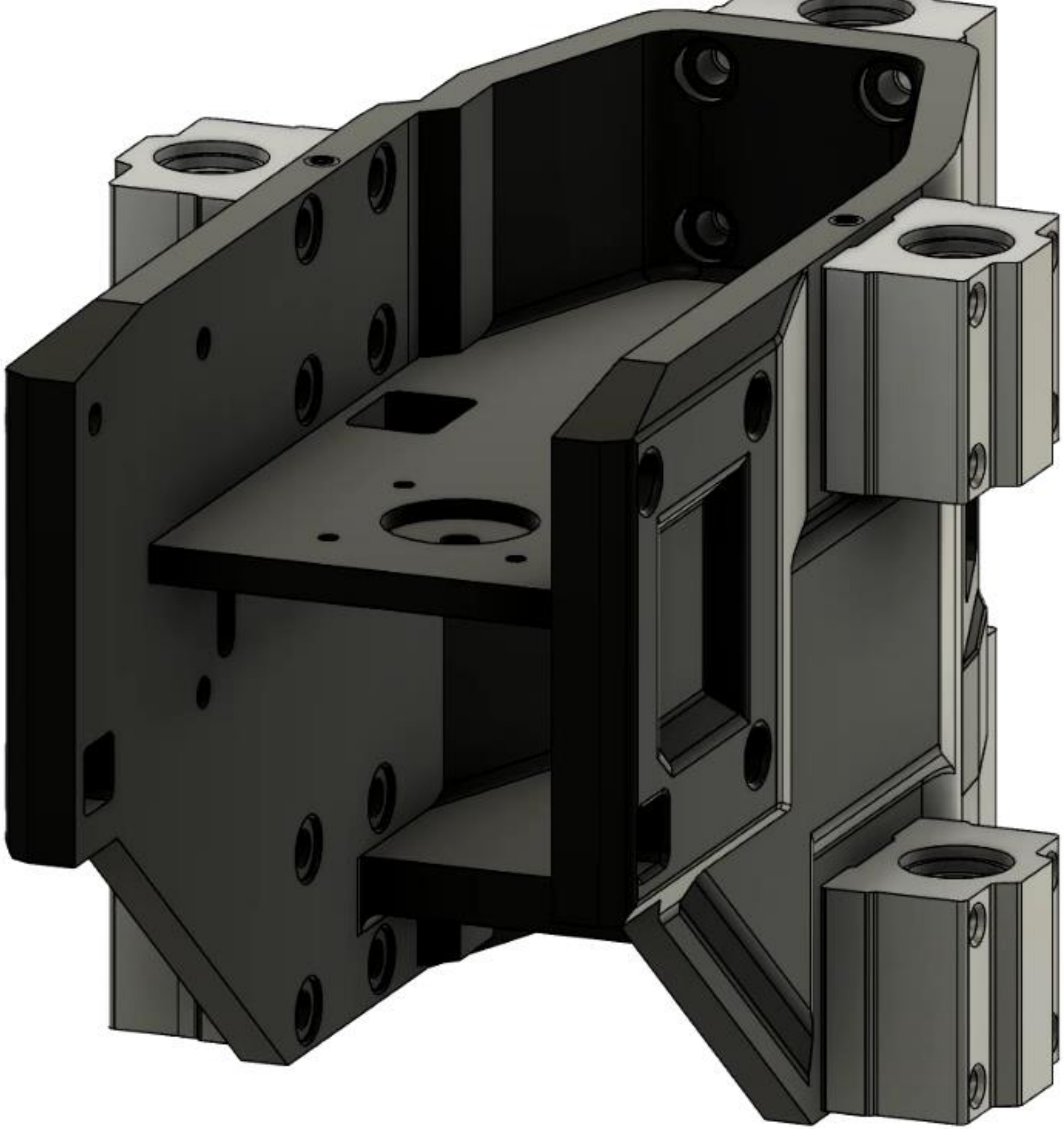



DTU

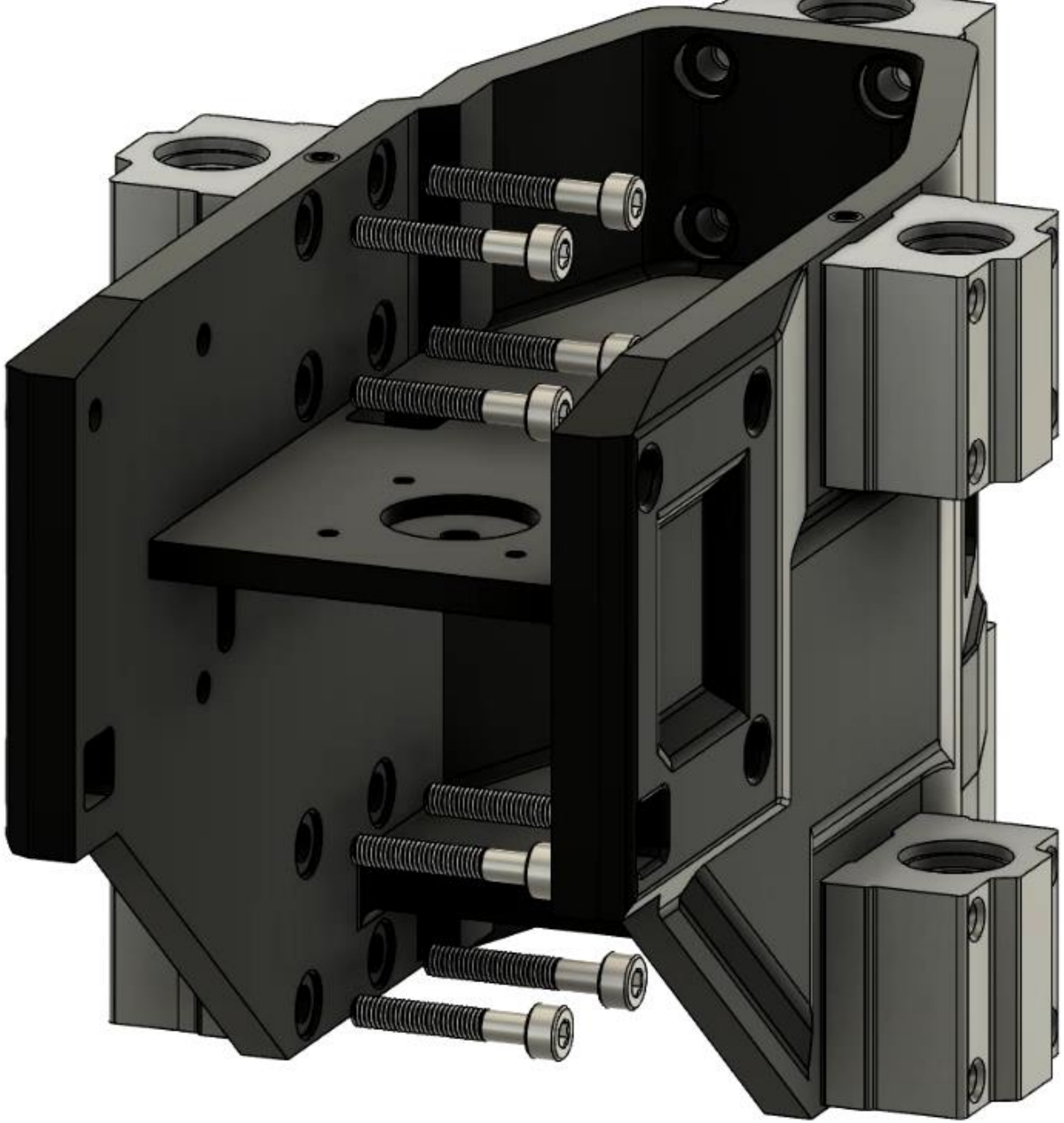
4x
M3x15

3x Steel rod 500x12
1x 4mm Lead screw 500x10

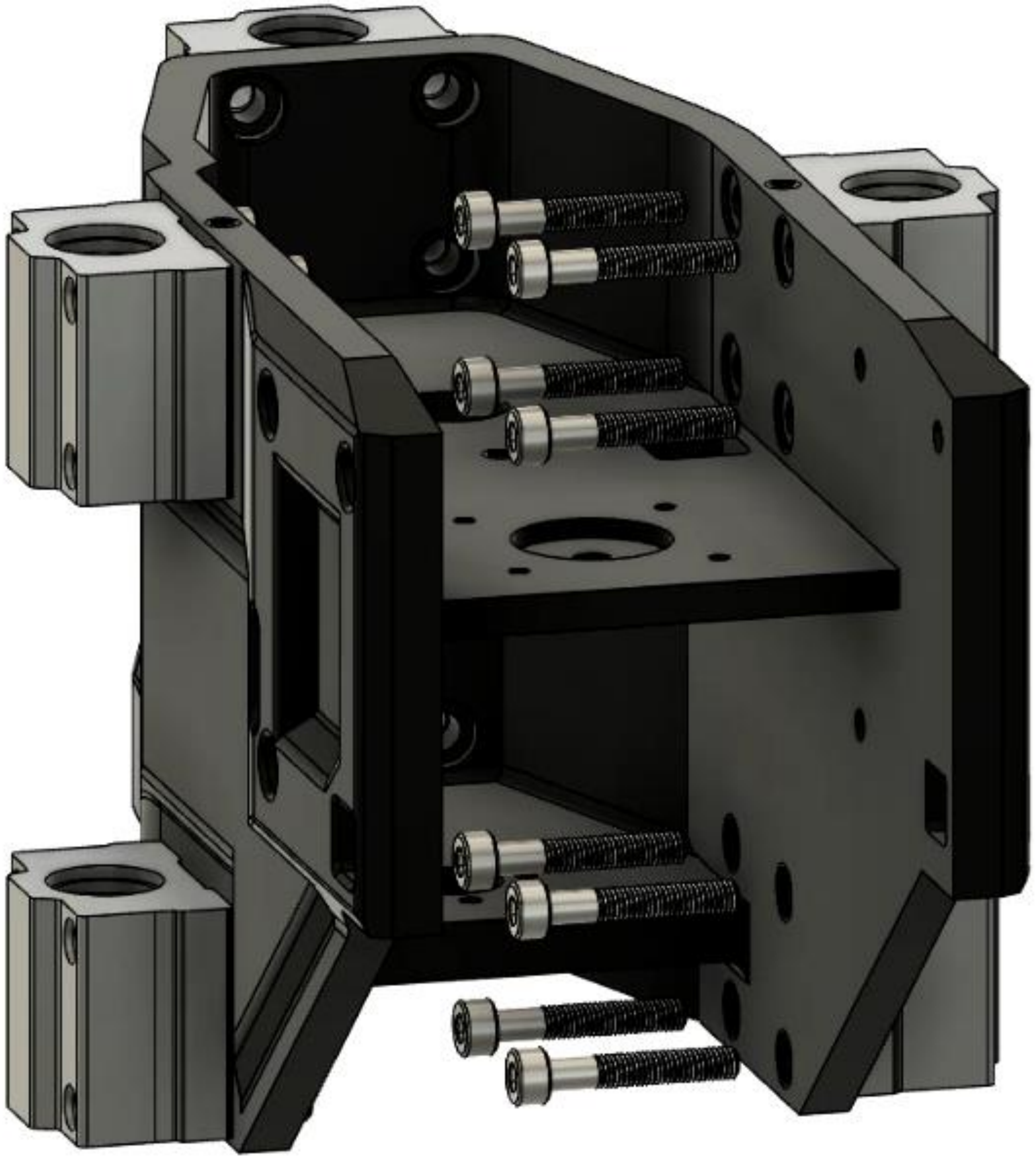
6x Linear ball bearing block



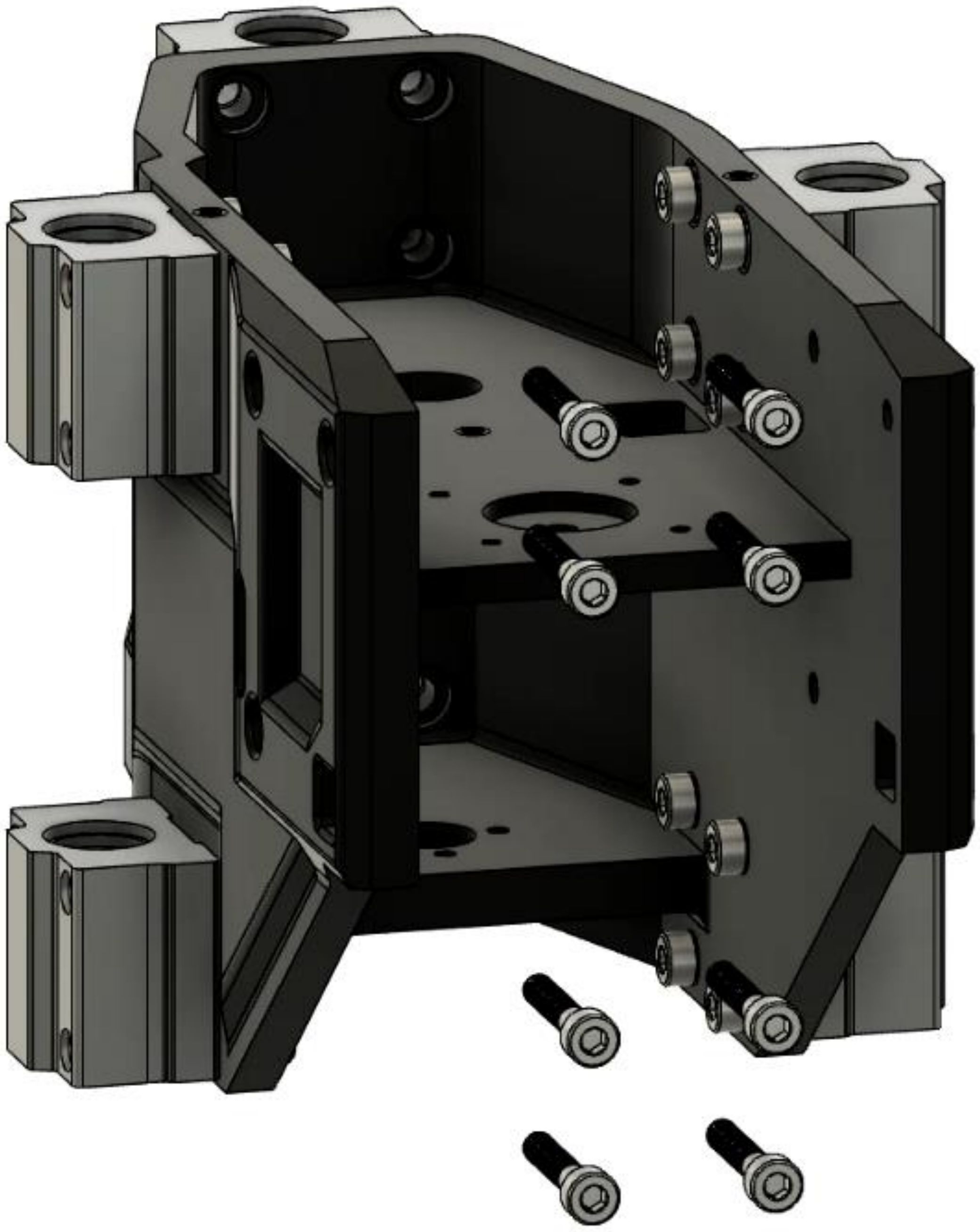
8x
M5x15



8x
M5x15

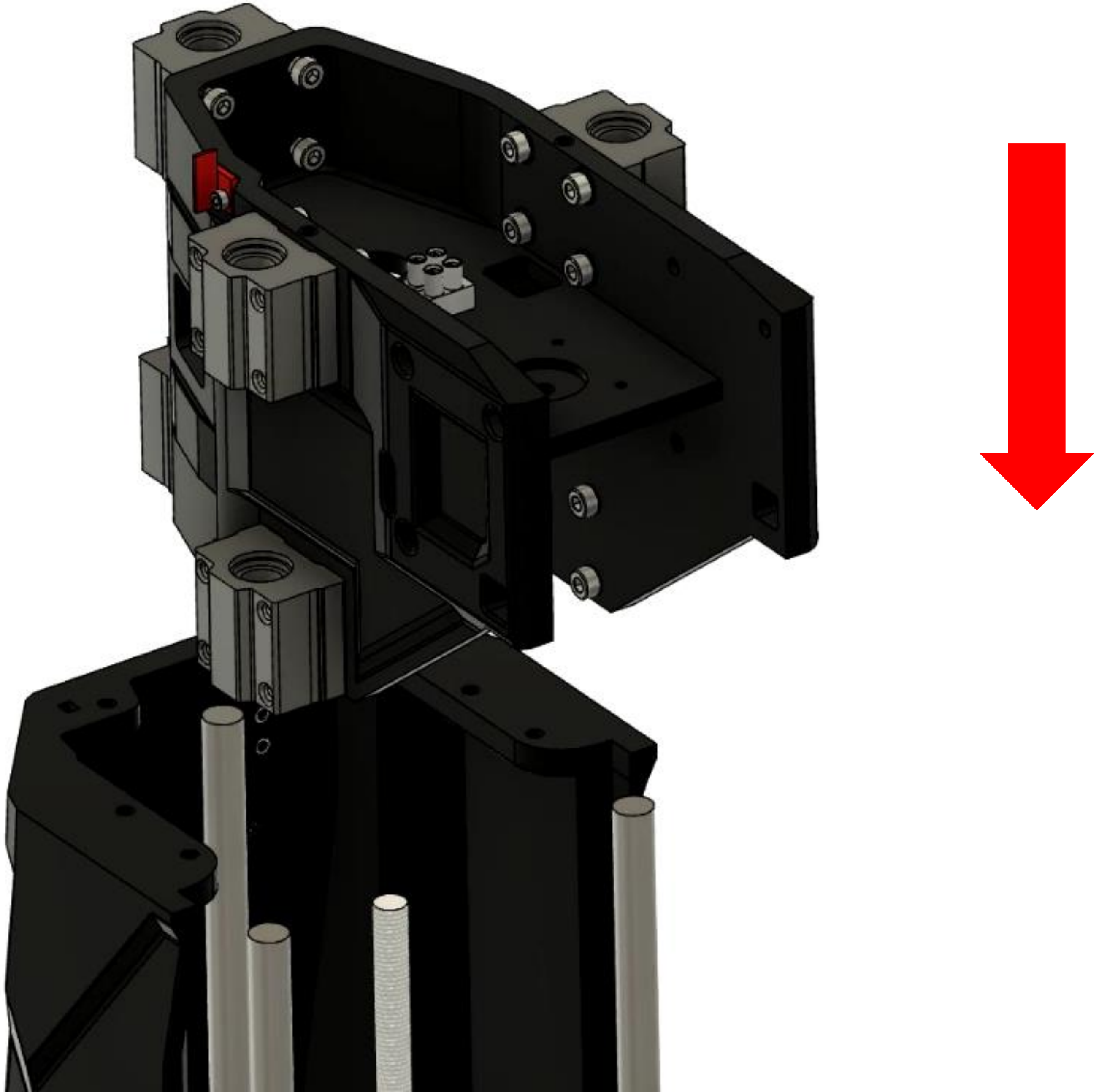


8x
M5x15



1x Lead screw
nut
4x M3x20
4x M3 nut

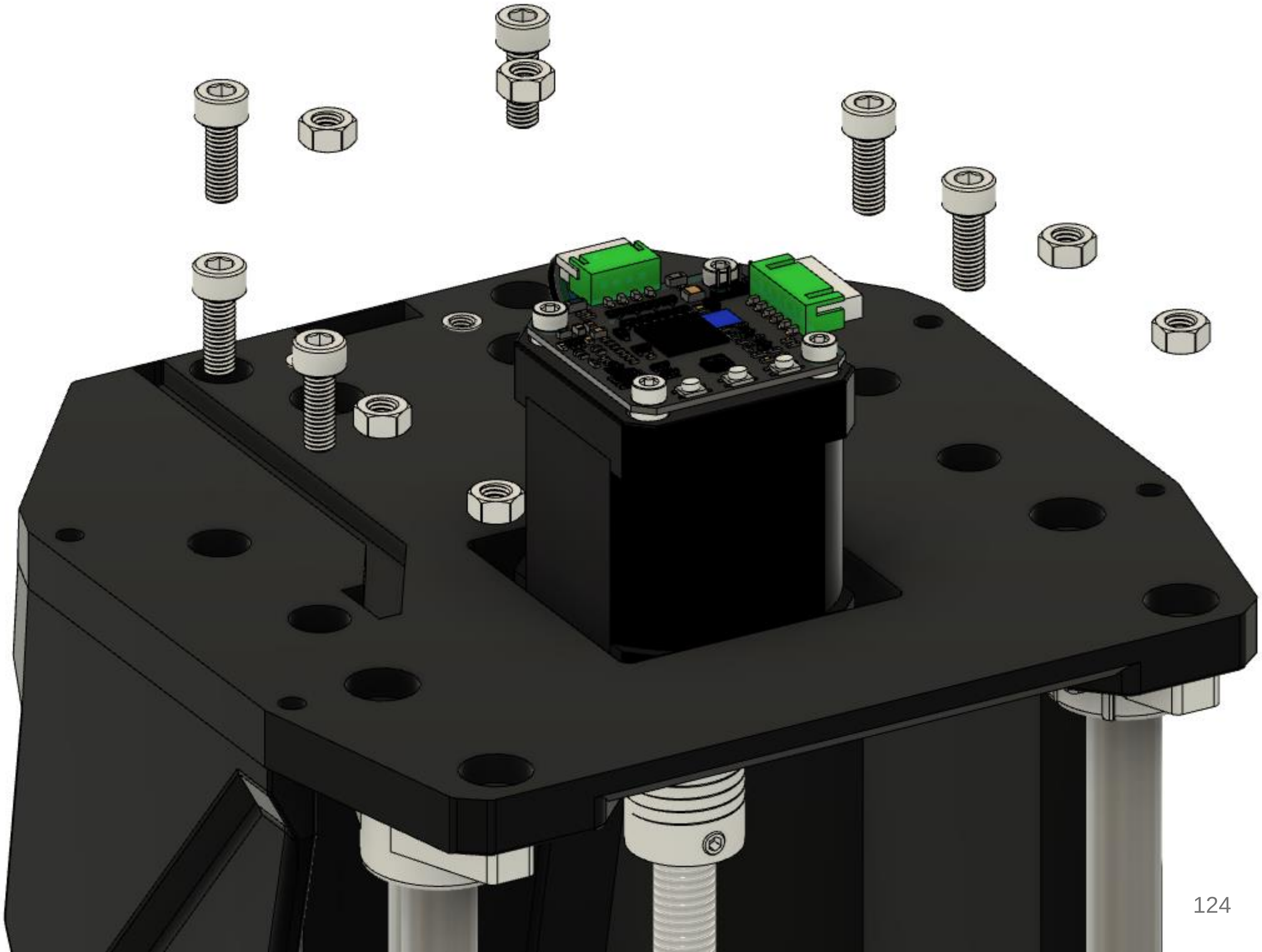
Slide arm onto rods and check if lead screw rotates freely.



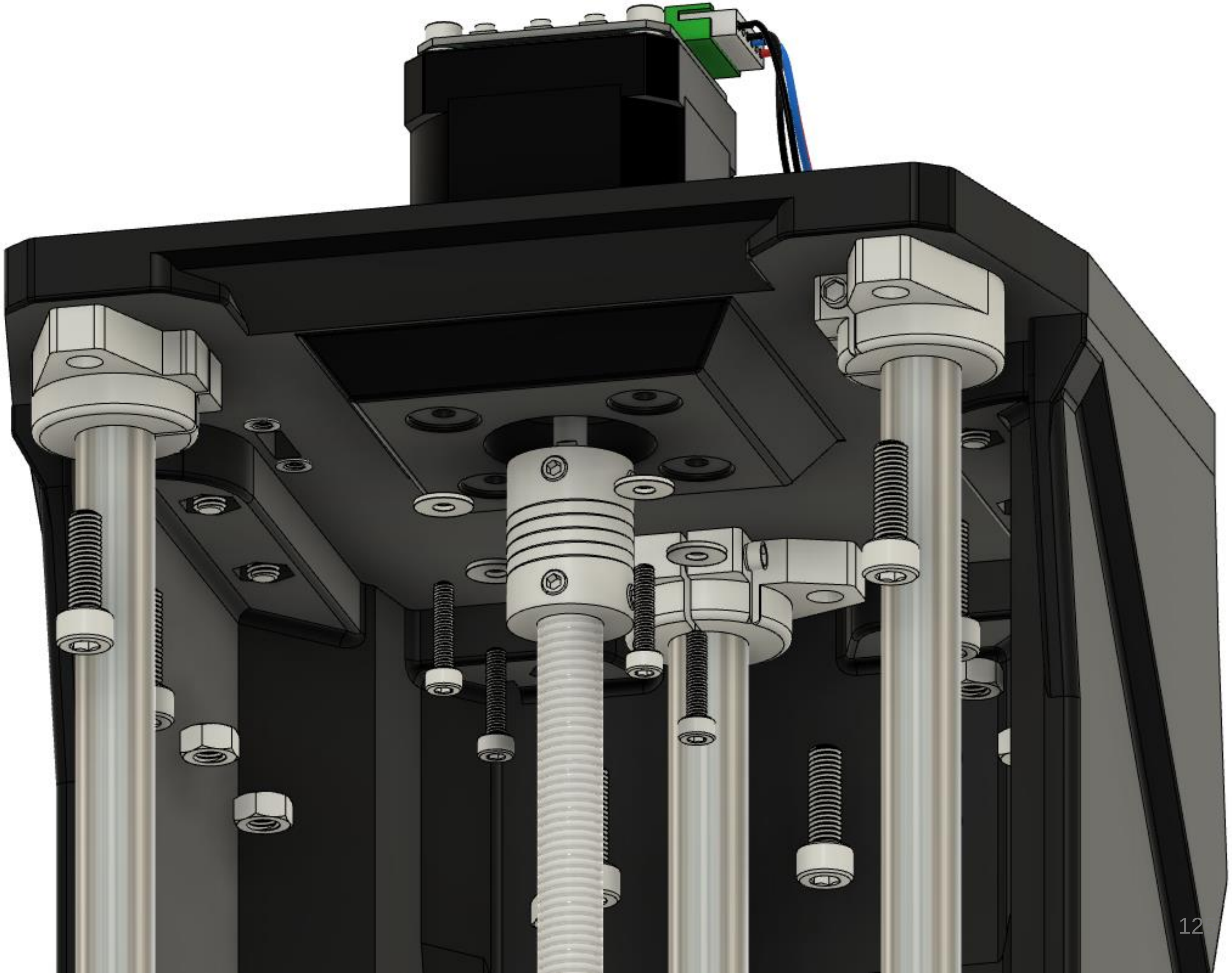
1x Shaft coupling 5x10
3x Rod support SHF12

1x Nema 17 (17HS19-2004S1)
1x MKS Servo42C

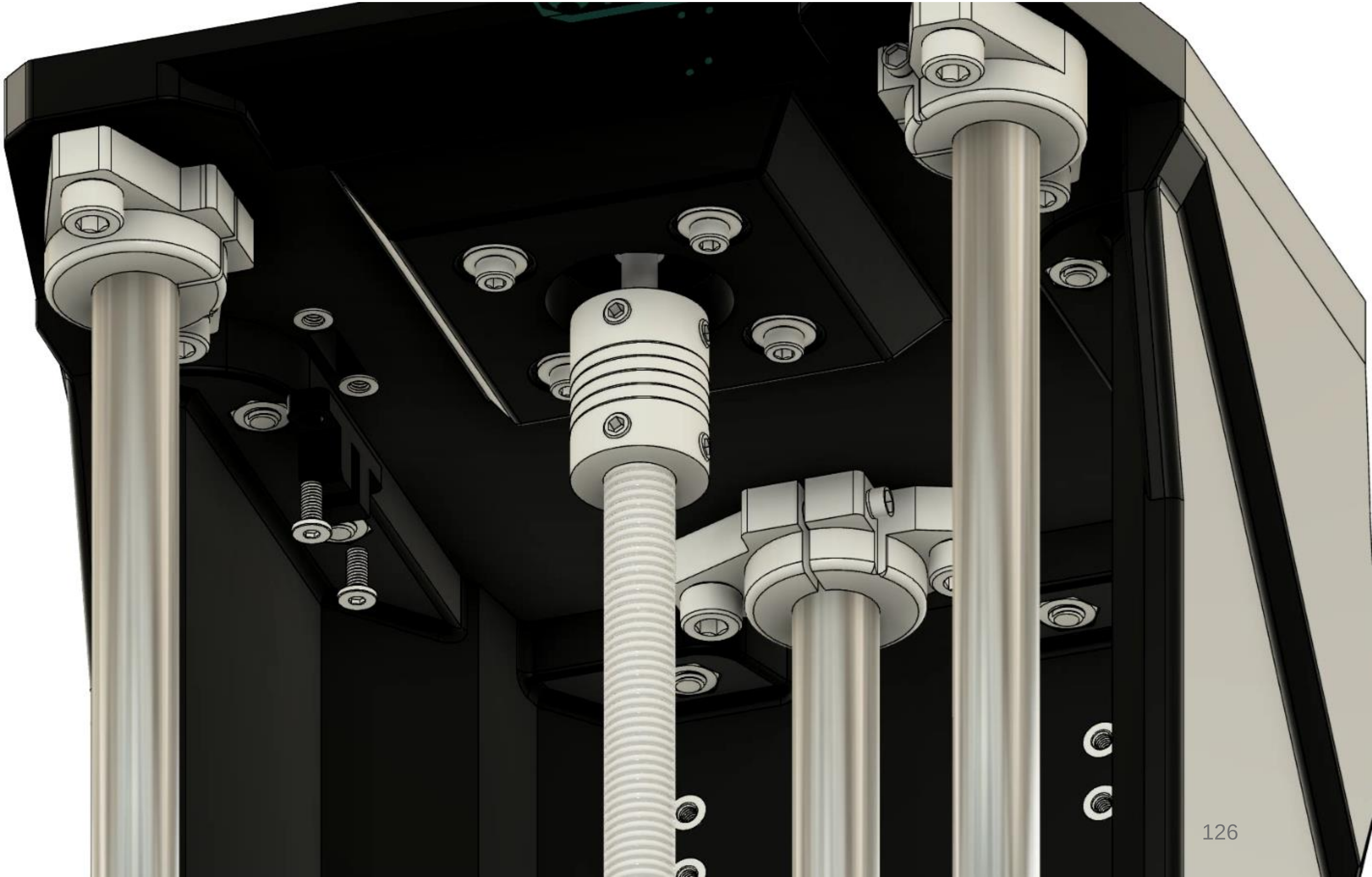
6x M5x15
6x M5 nut
4x M3x10

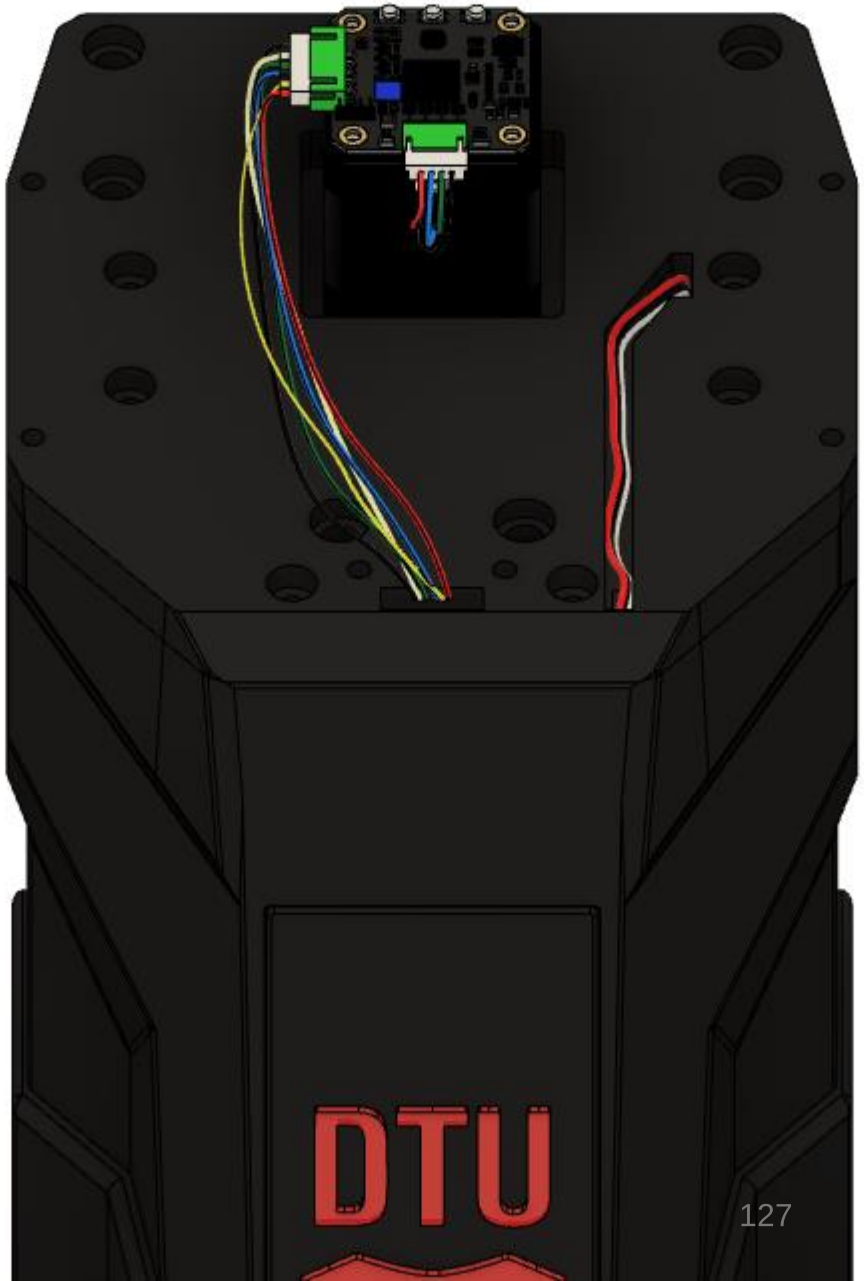


4x M3x15
4x M3
washer
6x M5x15
6x M5 nut



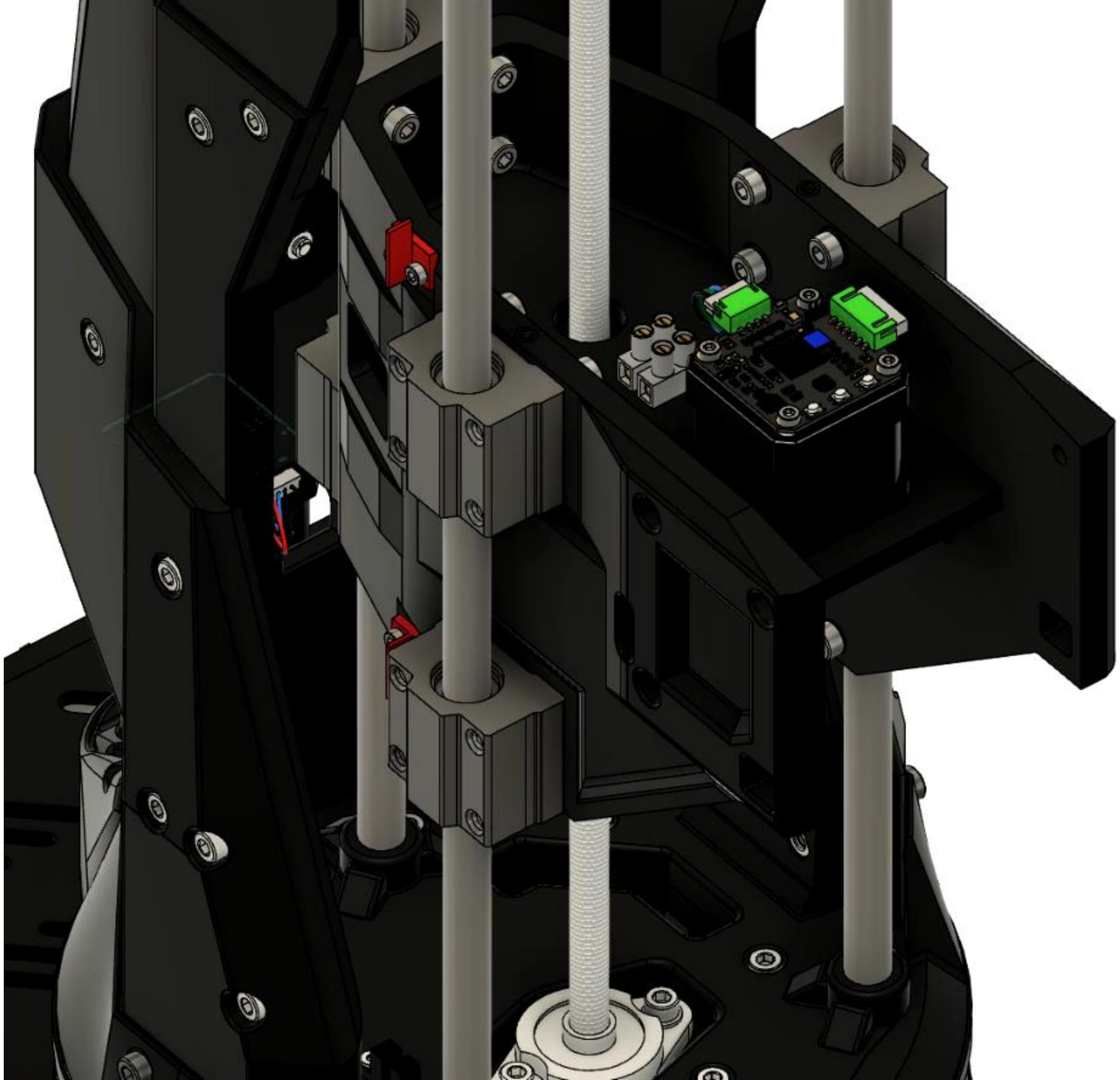
1x
TCST2103
2x M3x8



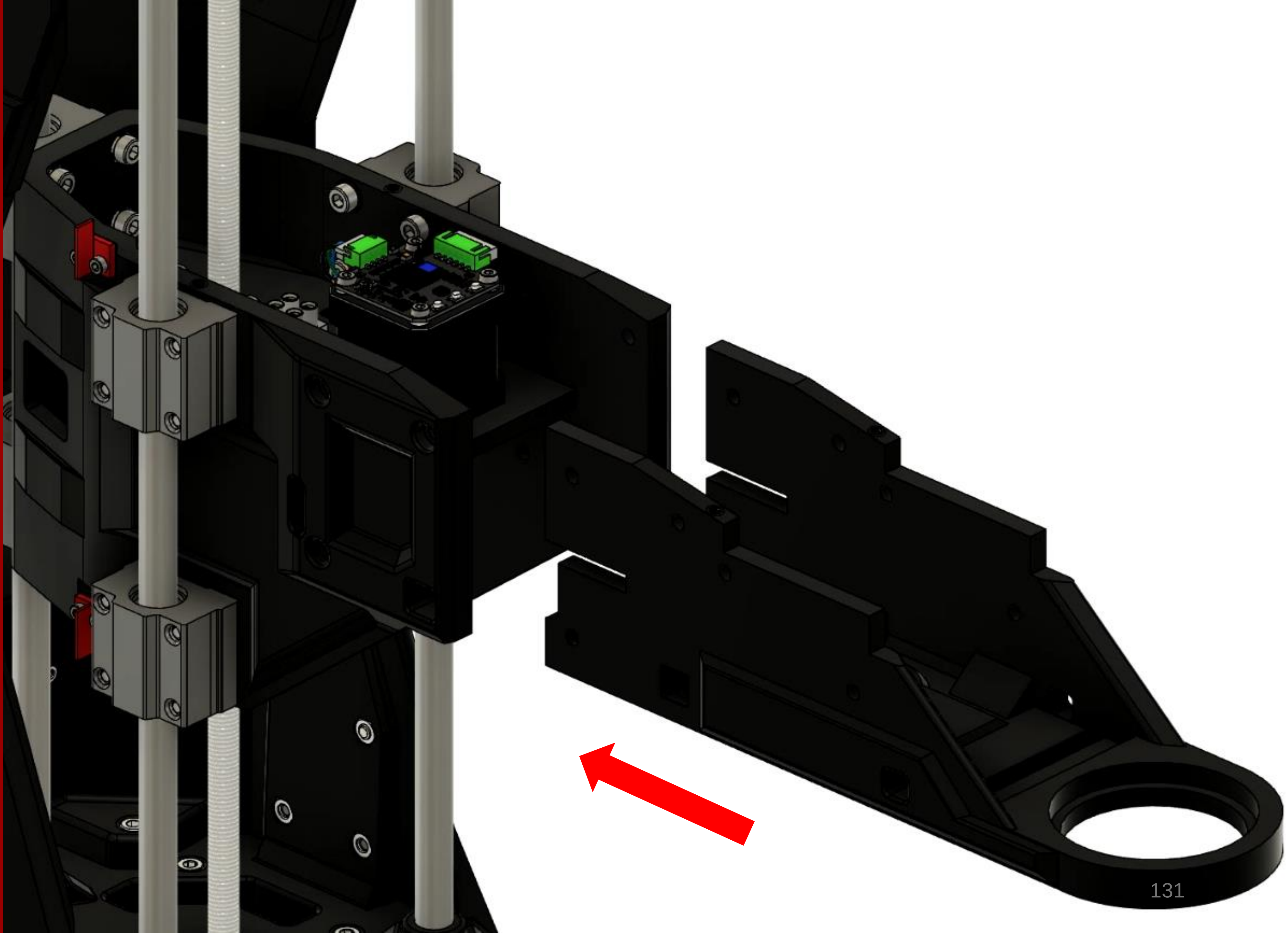

DTU

4x
M4x10

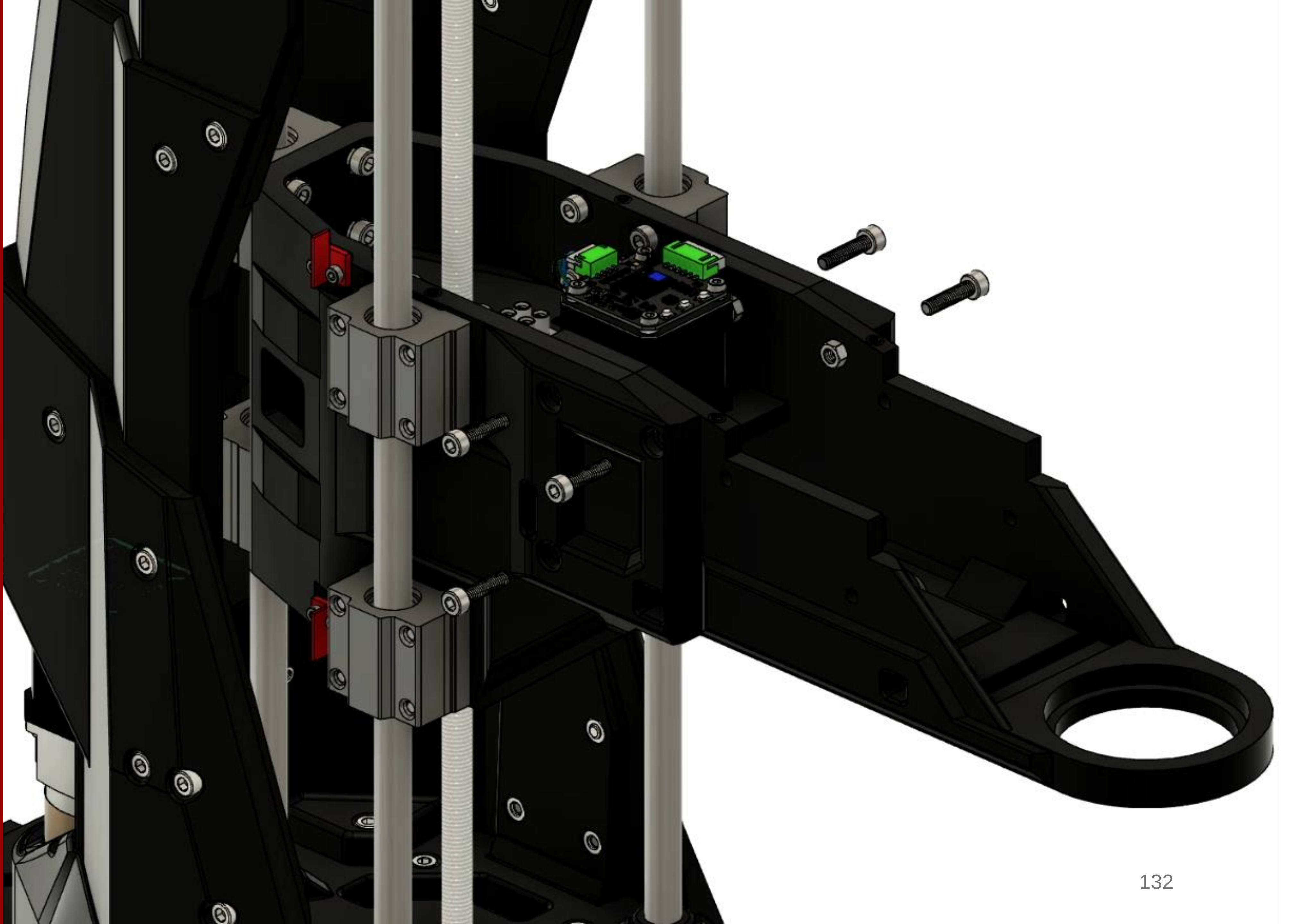
1x Nema 17 (17HS15-1504S1)
1x MKS Servo42C
4x M3x10
4x Distance washer



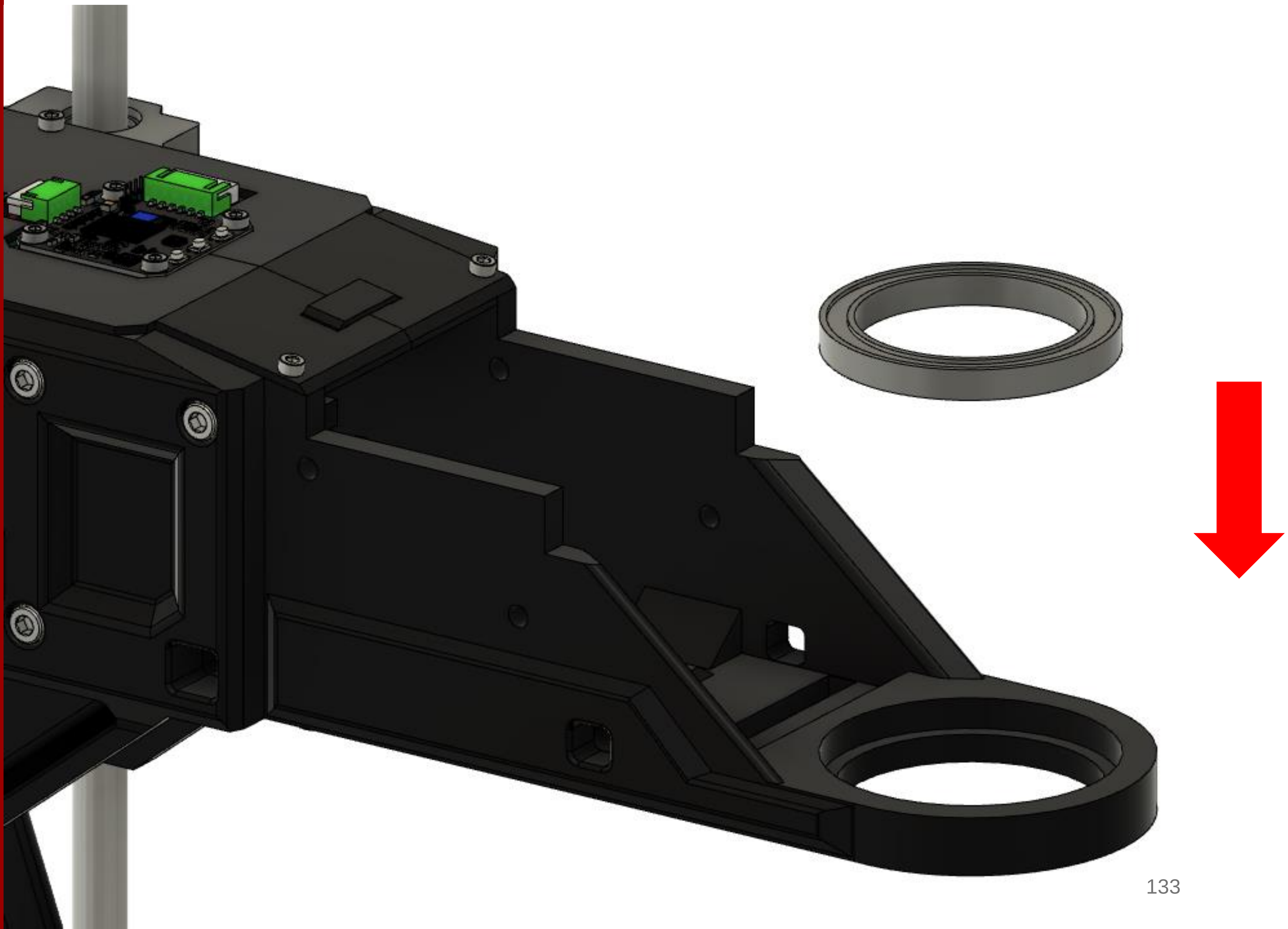
1x GT2 16T Pulley
4x M3x10



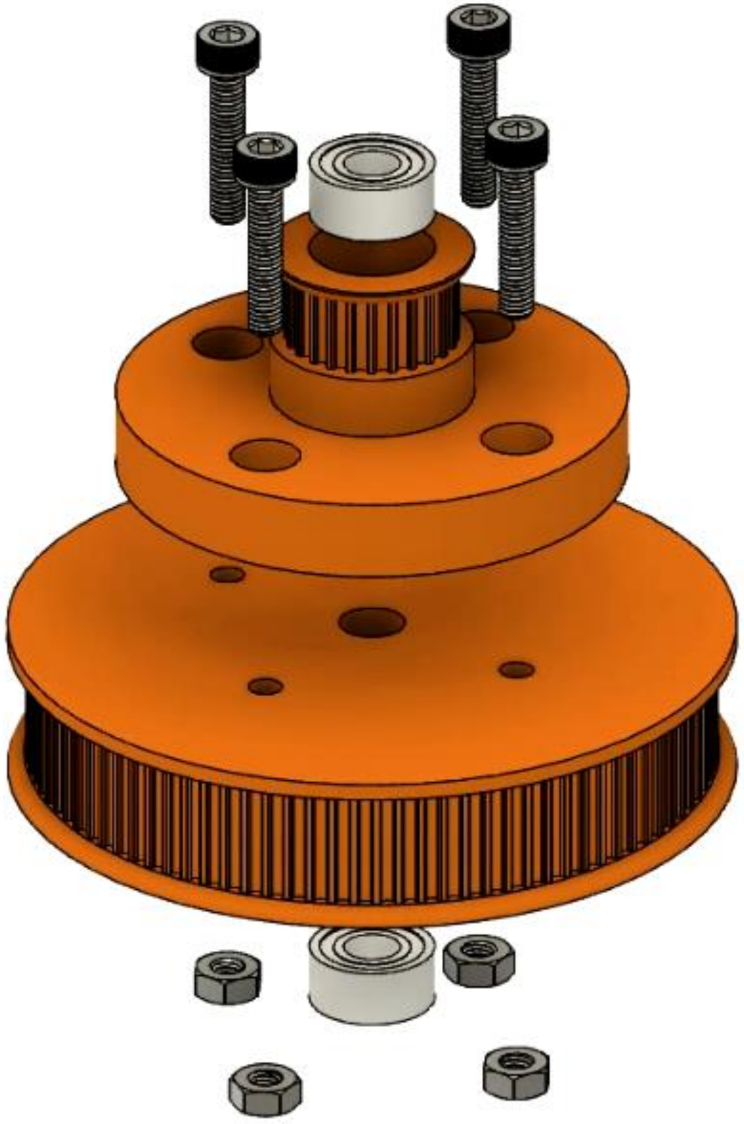
6x
M5x20
6x M5
nut



1x Ball bearing 50x65x7

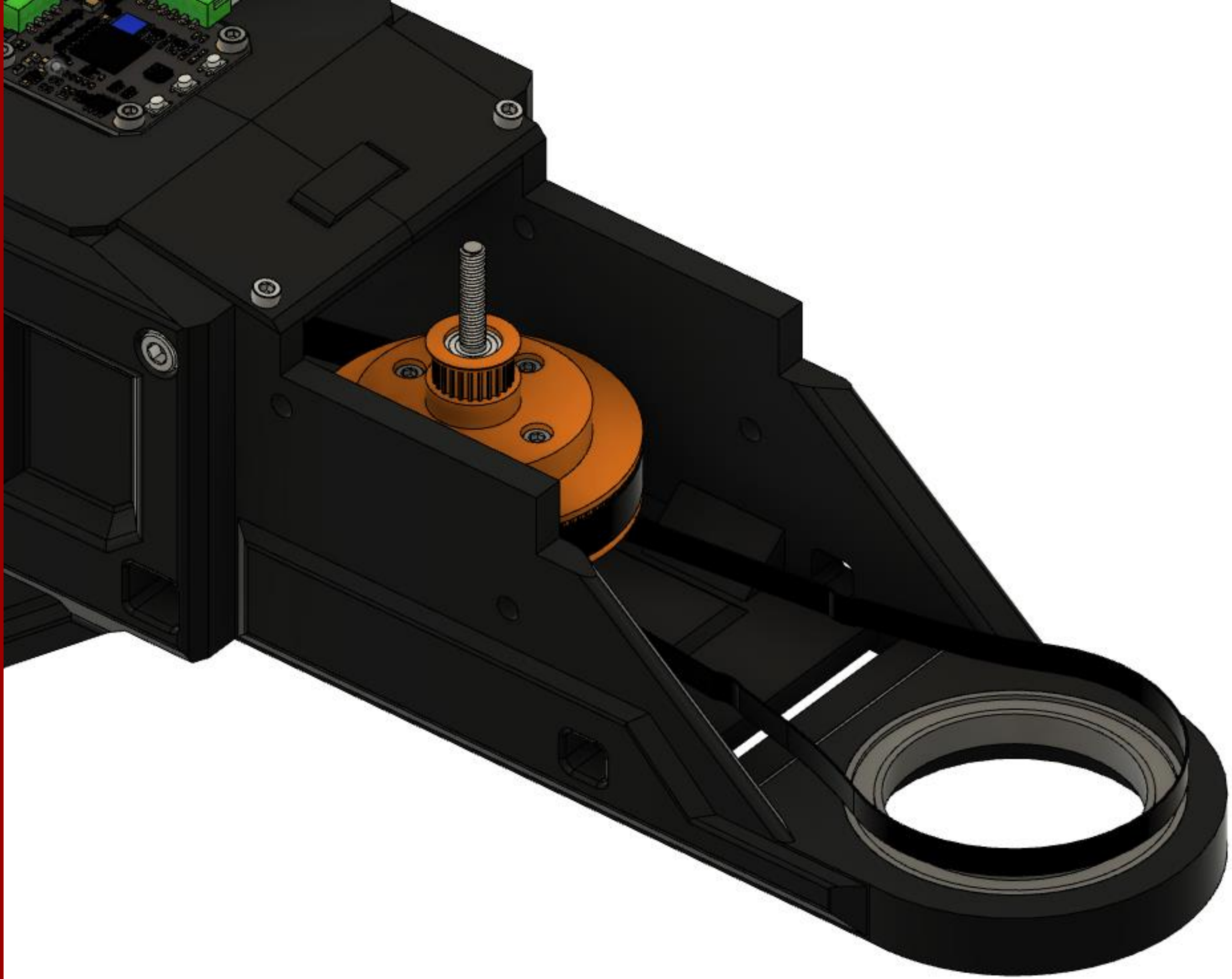


2x Ball bearing
5x11x5
4x M3x15
4x M3 nut

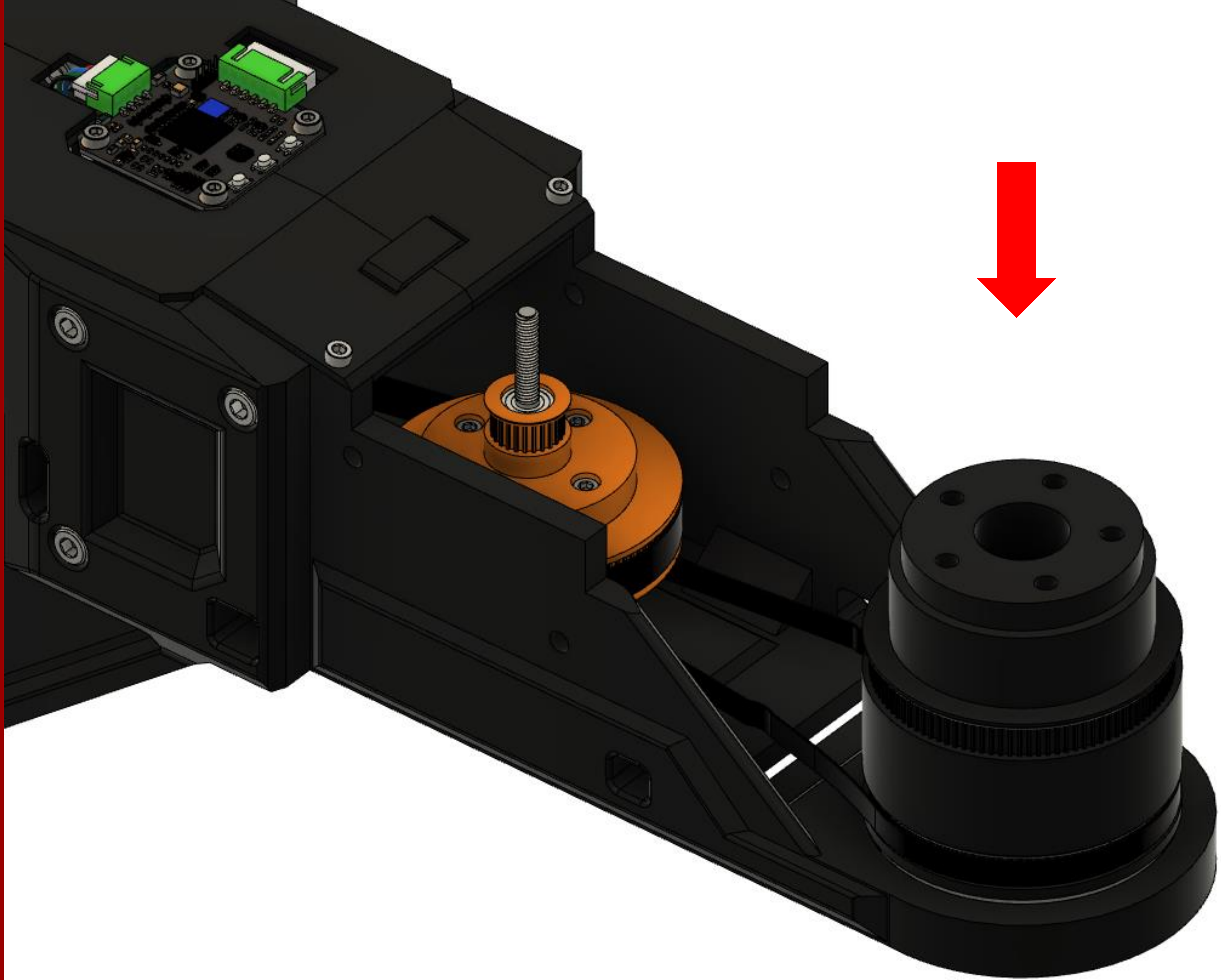


1x M5x75
1x GT2 belt 10x294
1x GT2 belt 6x400

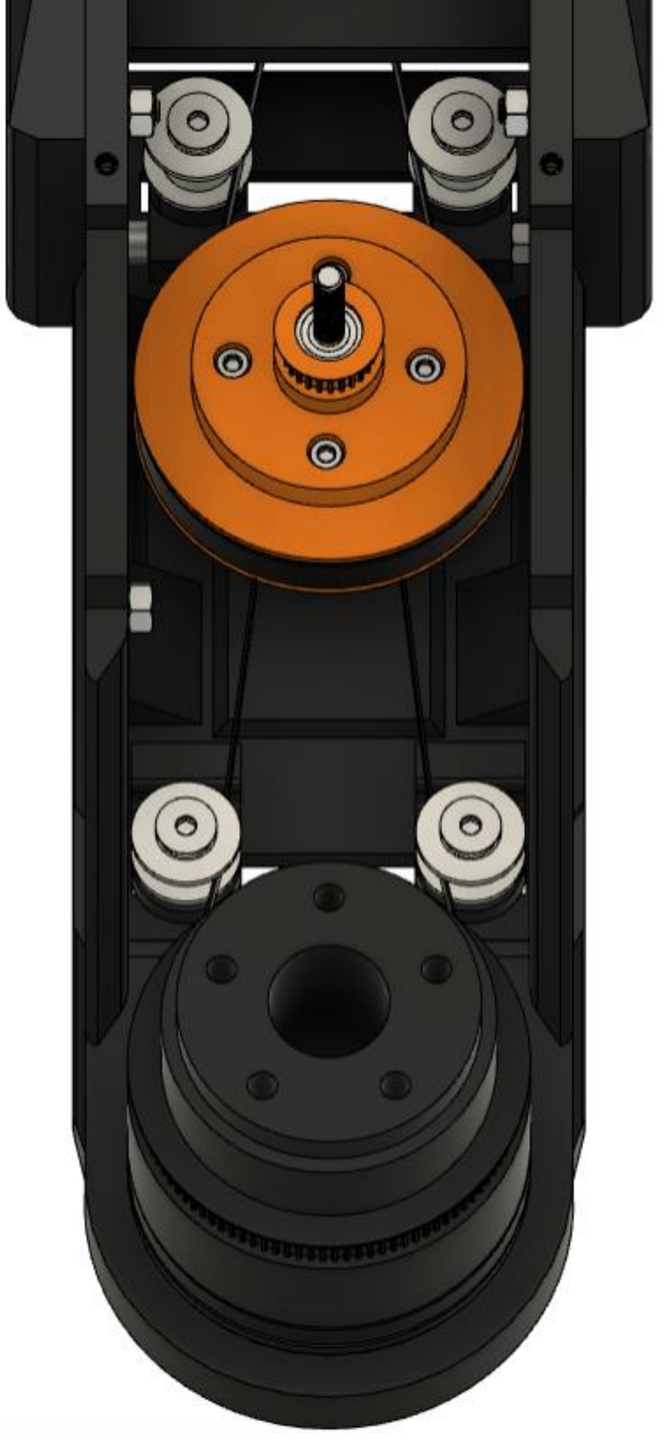
Add the belts onto the 3d printed pulley
Position the pulley inside the arm and insert the screw



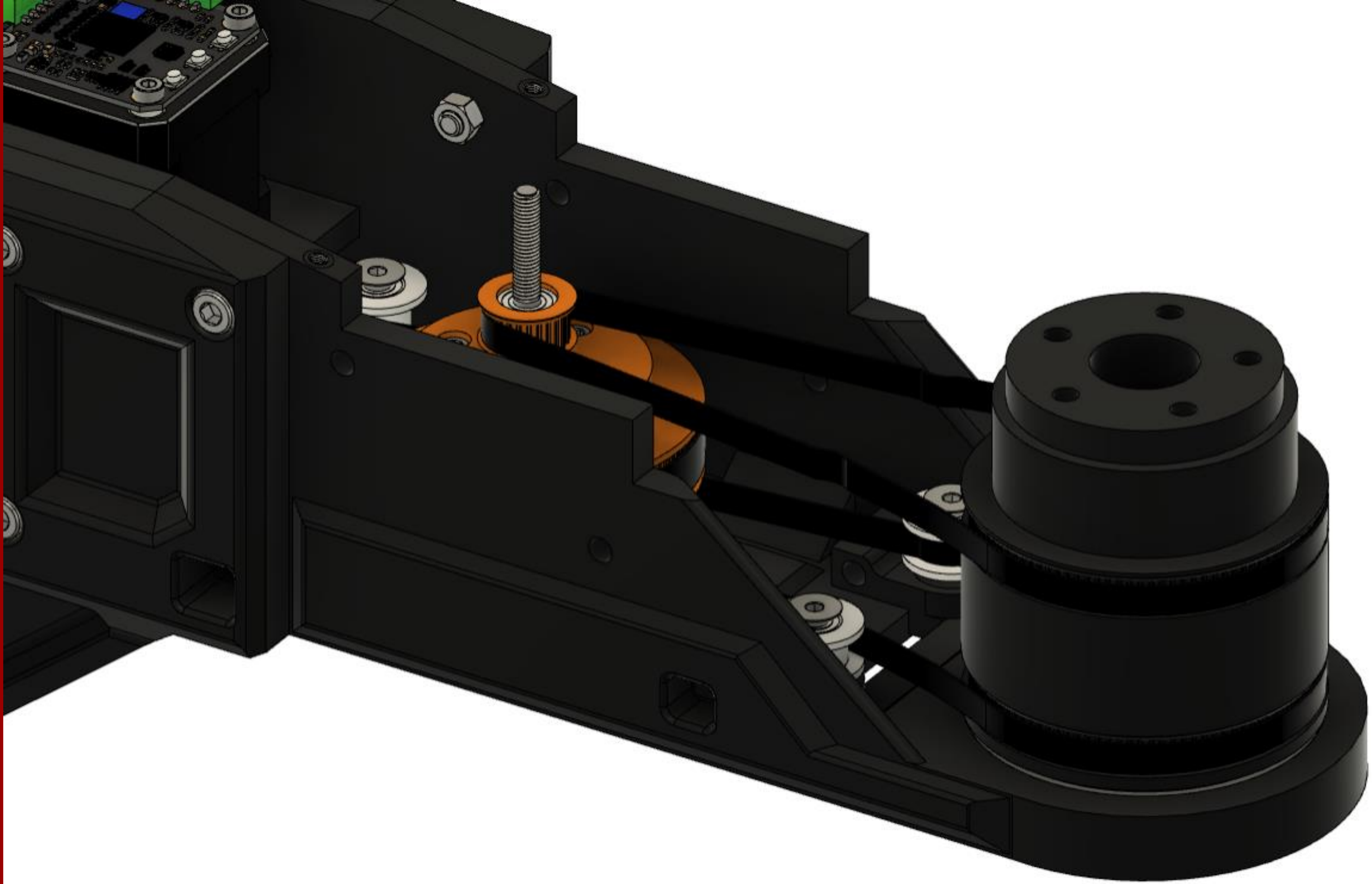
2x Ball bearing
5x11x5
4x M3x15
4x M3 nut



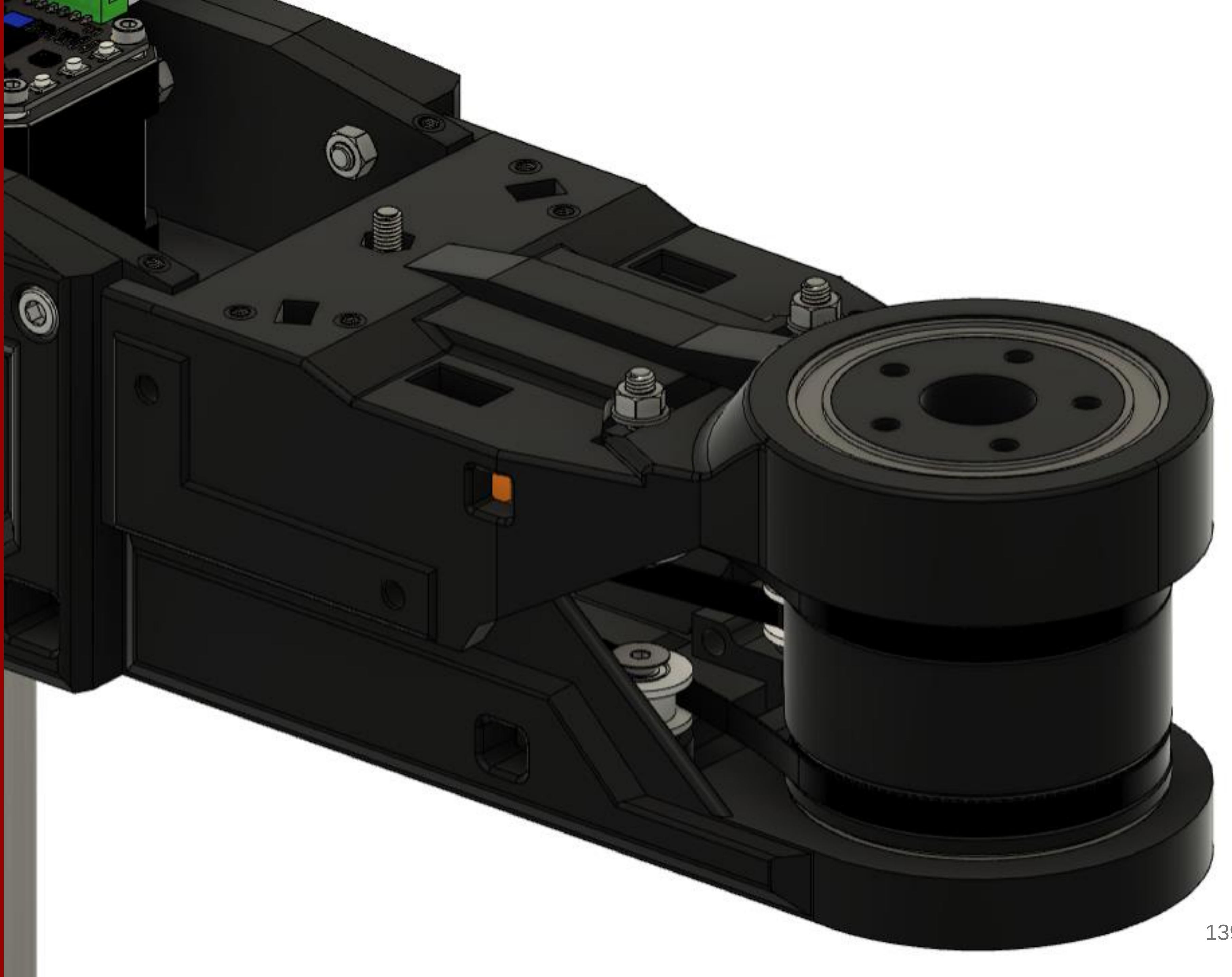
Belt tensioning system:
4x Pulley
2x M5x30 flat head screw
2x M5x40 flat head screw
4x M5 washer
4x M5 nut



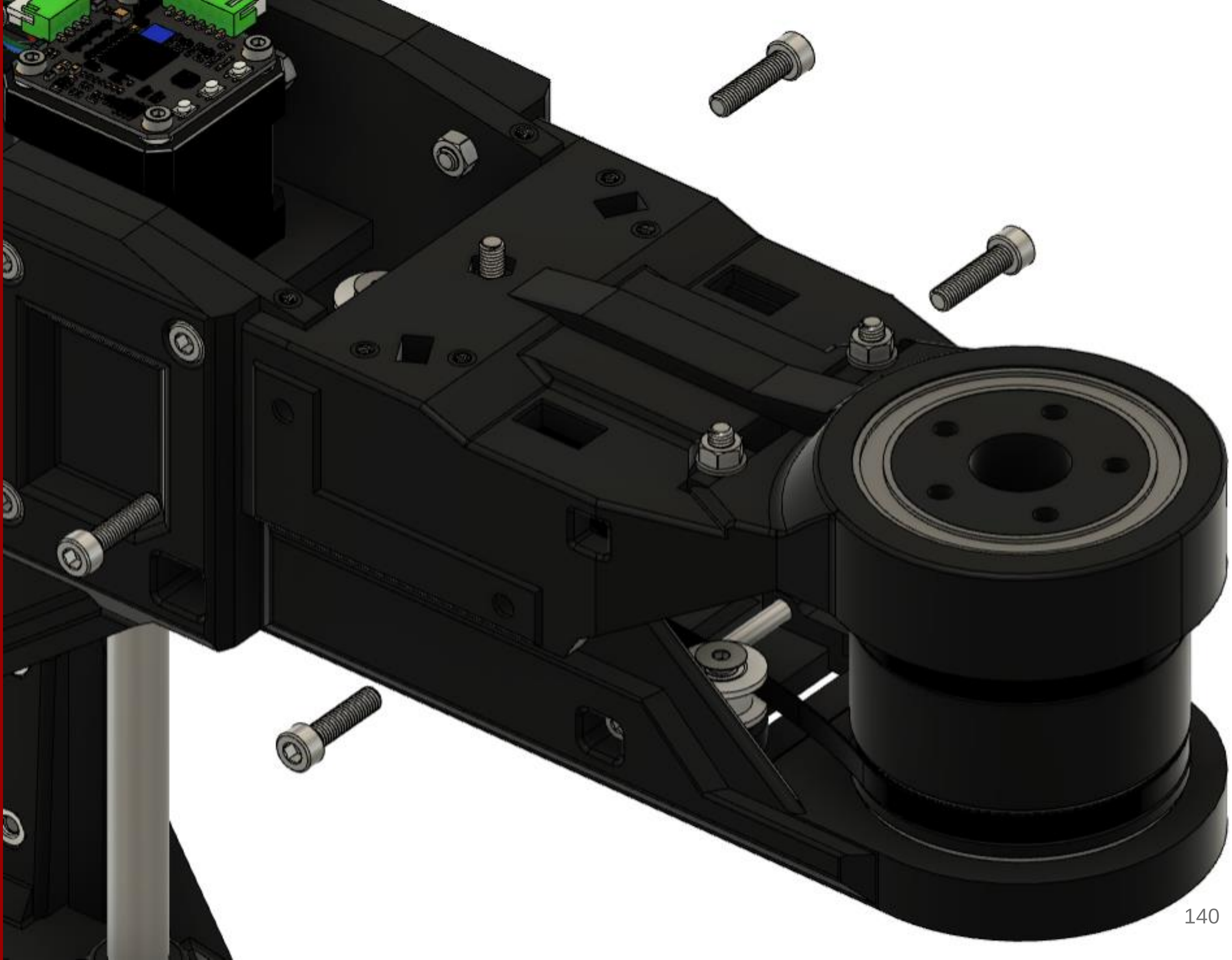
1x GT2 belt
6x400



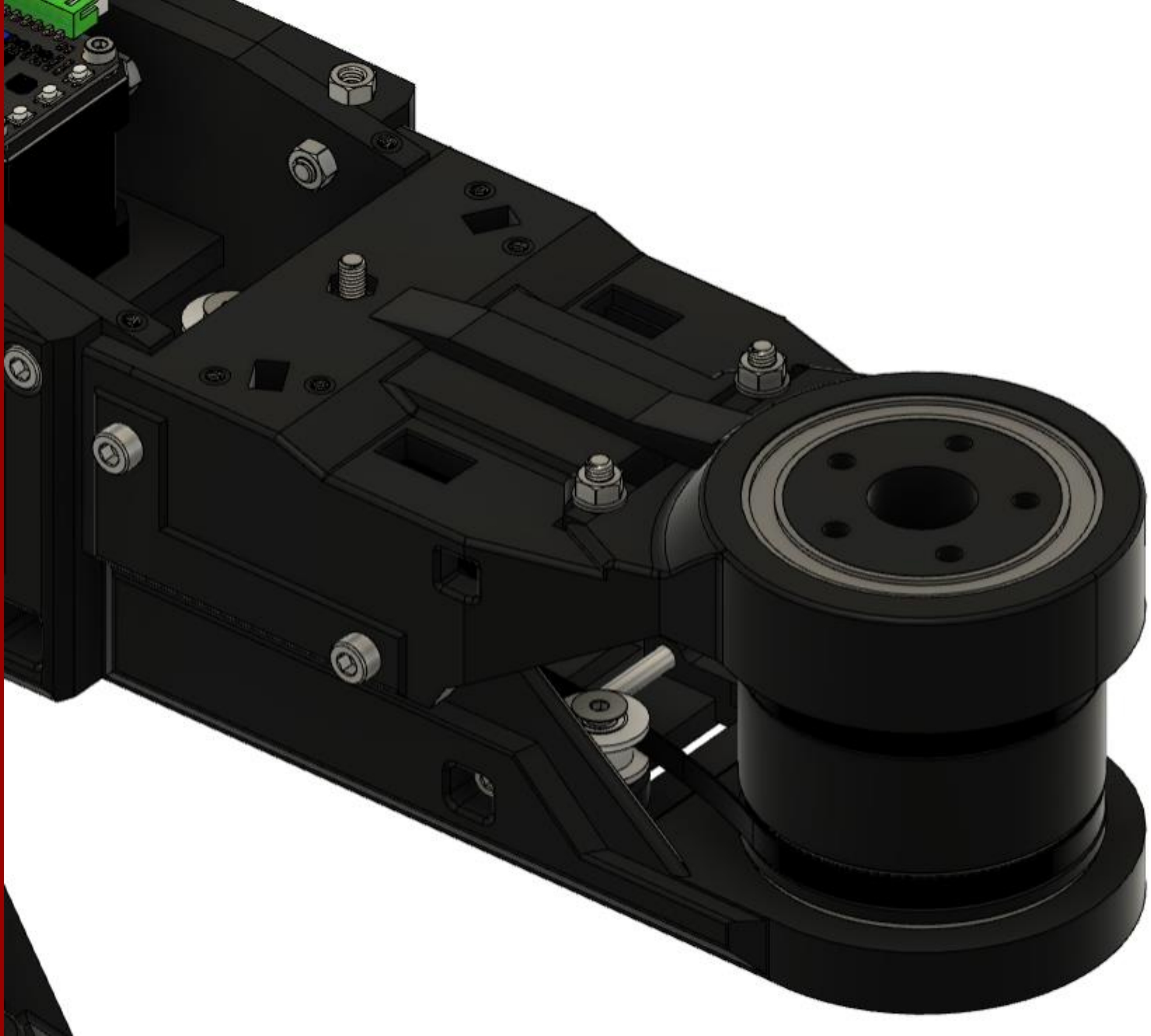
1x Ball bearing 50x65x7
2x Pulley
2x M5x35 flat head screw
2x M5 washer
2x M5 nut



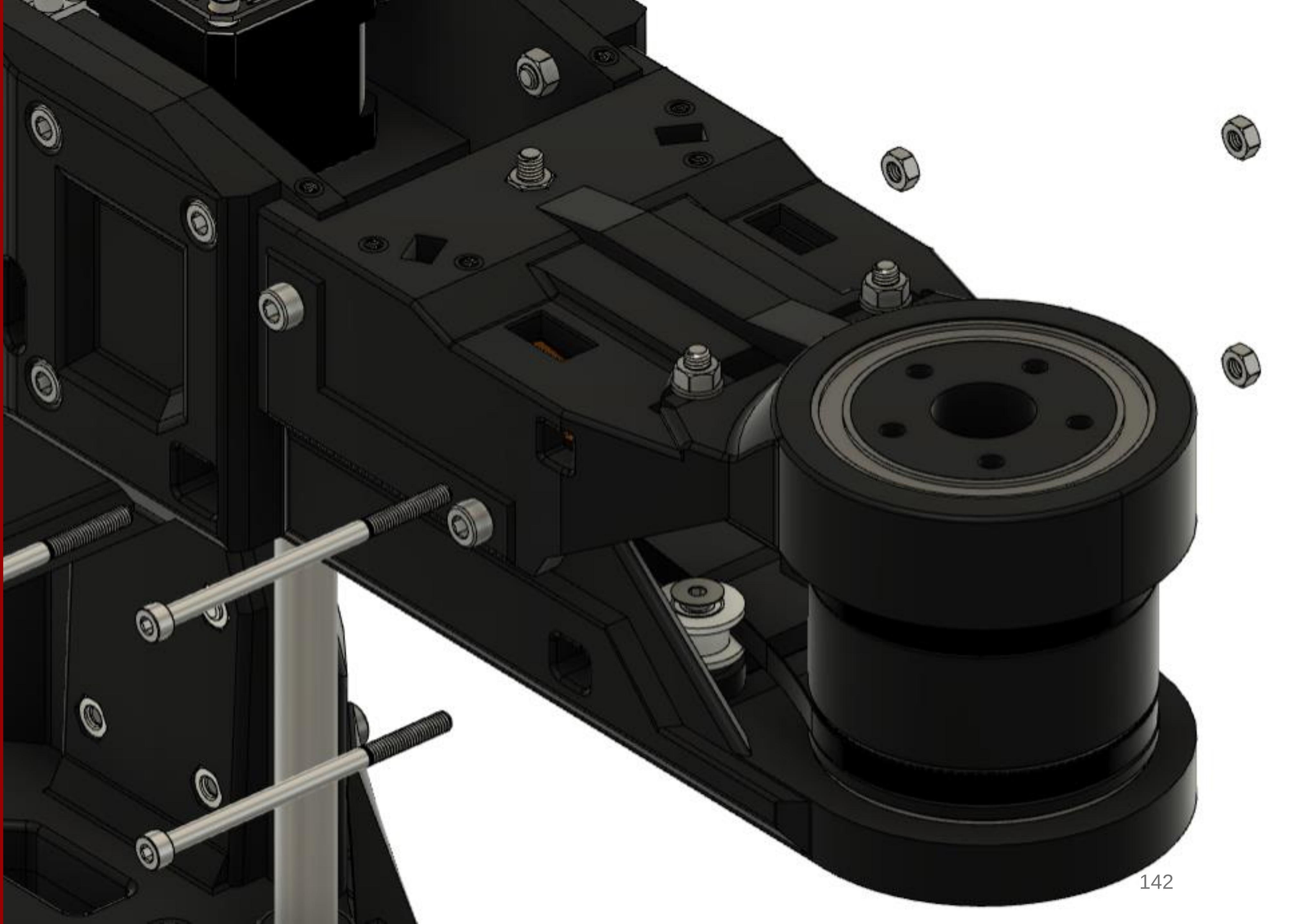
4x
M5x20
4x M5
nut



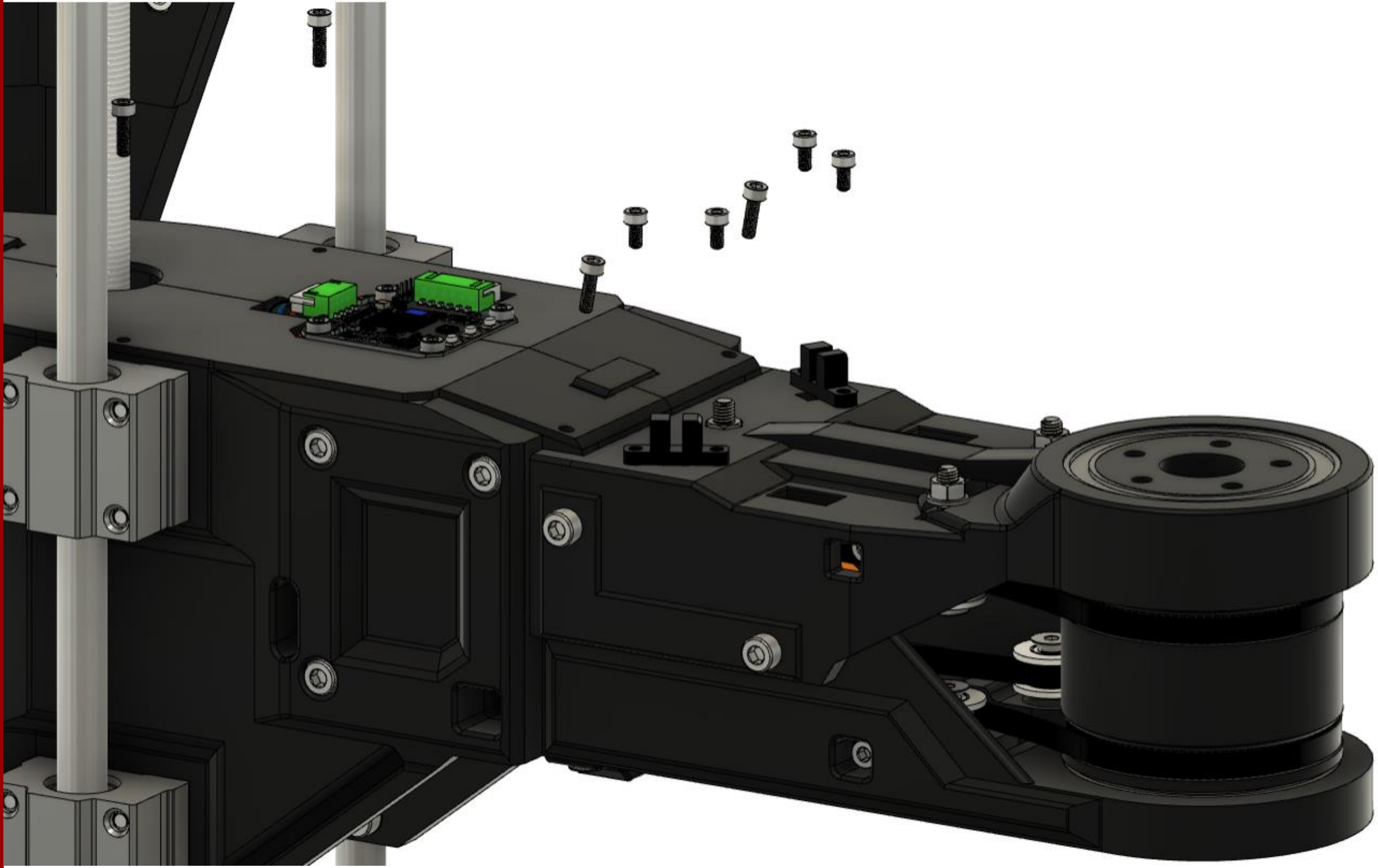
1x M5
nut



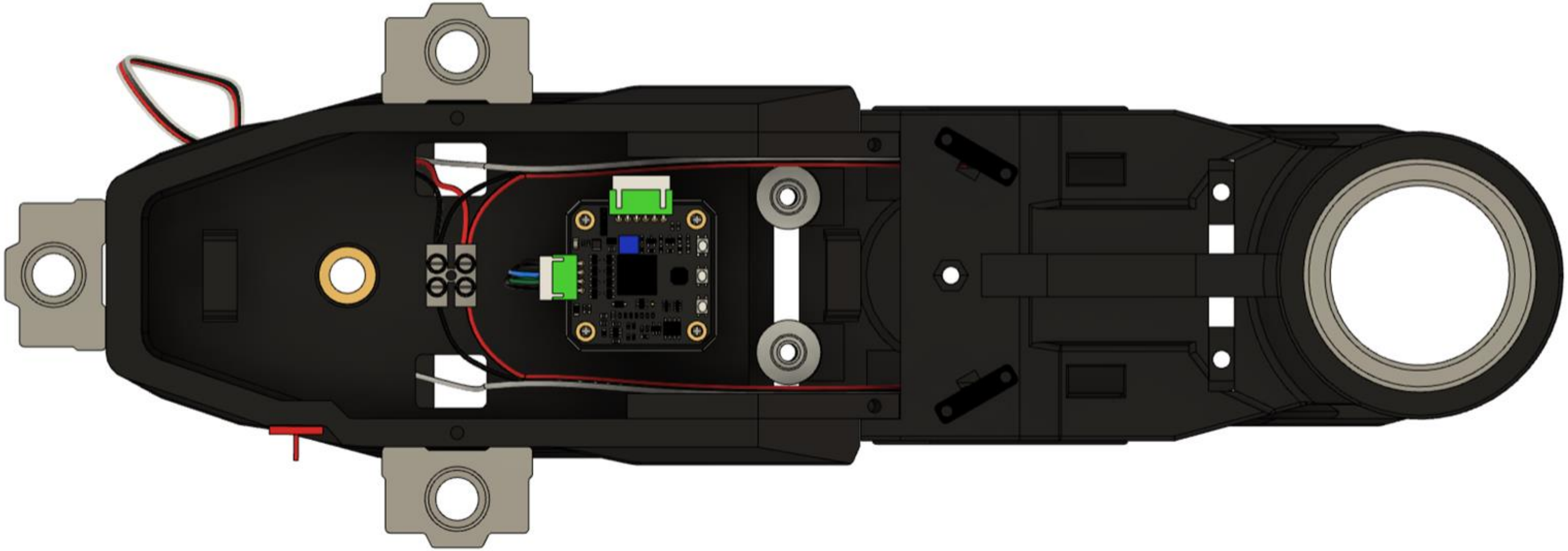
3x
M4x70
3x M4
nut



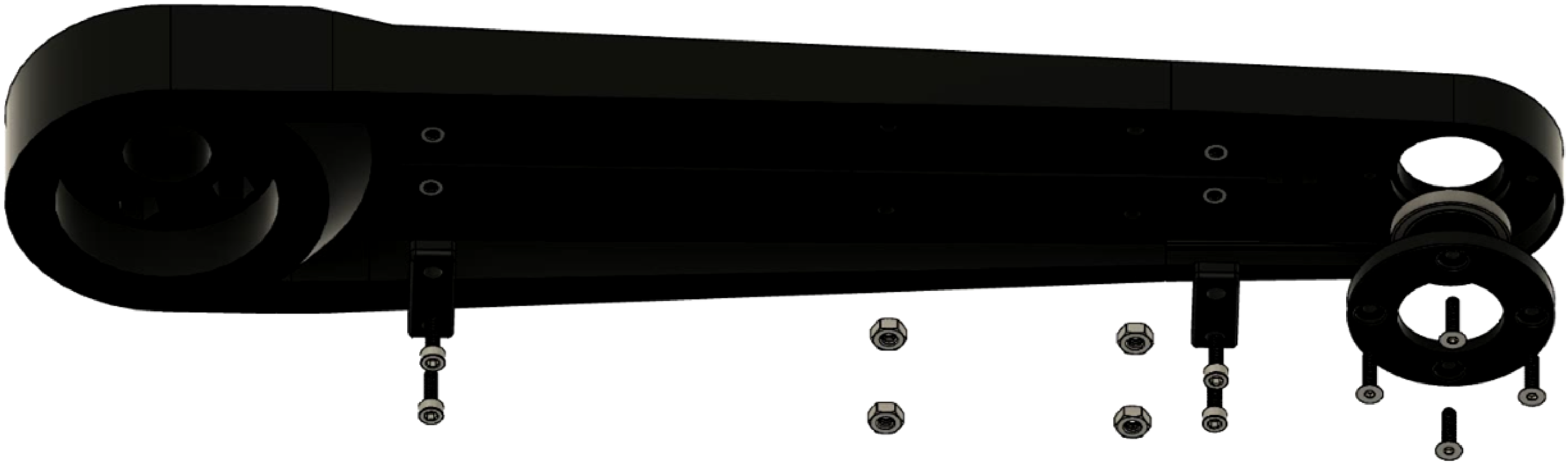
2x TCST2103
4x M3x10
4x M3x8



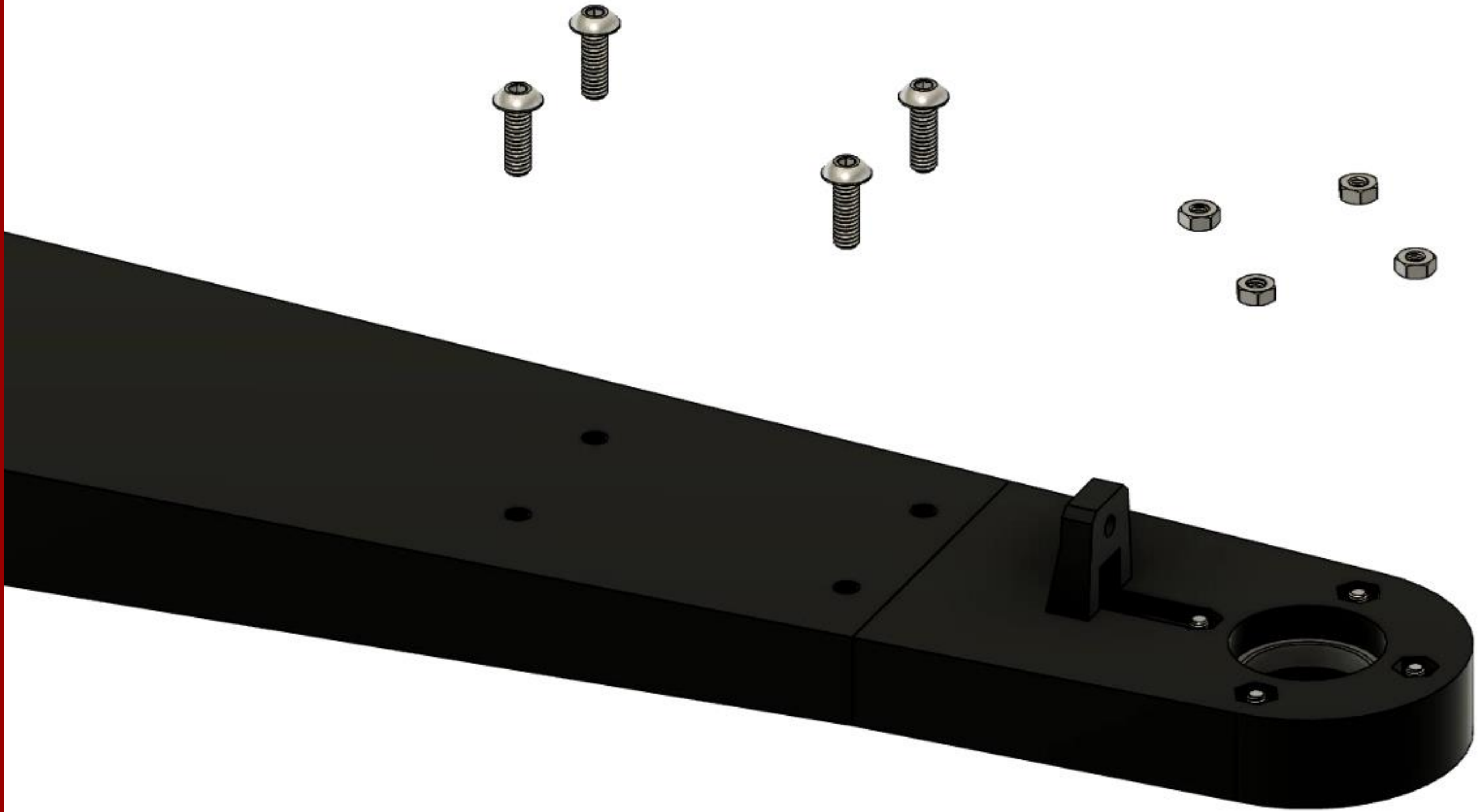
Note:
Do not mount the cover, this
should be done later, after the wiring is completed



1x Ball bearing 20x27x4
4x M3x10
4x M3x10 flat head
screw
4x M4 nut

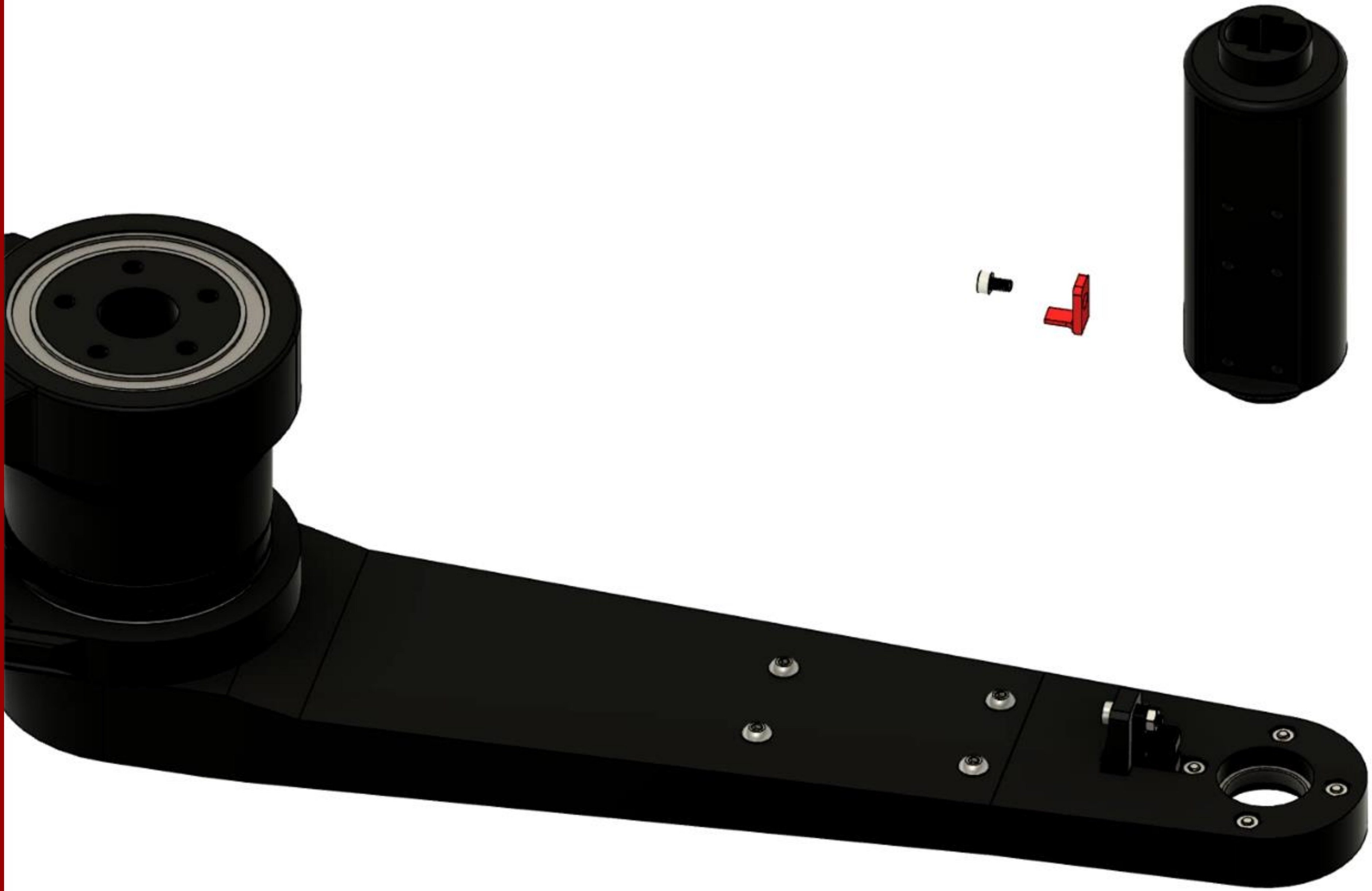


4x
M4x15
4x M3
nut

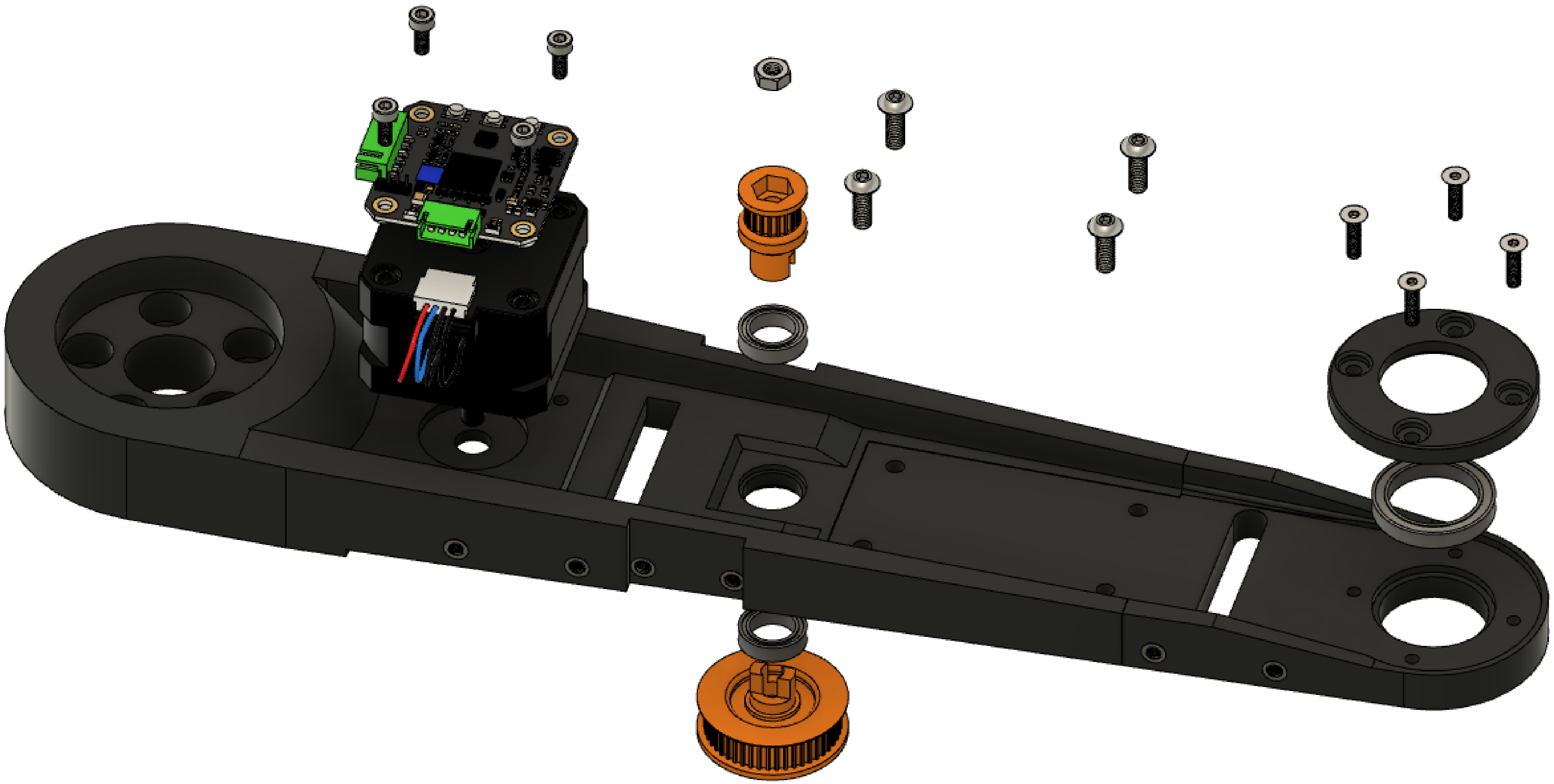


1x TCST2103
1x M3x10
1x M3 nut

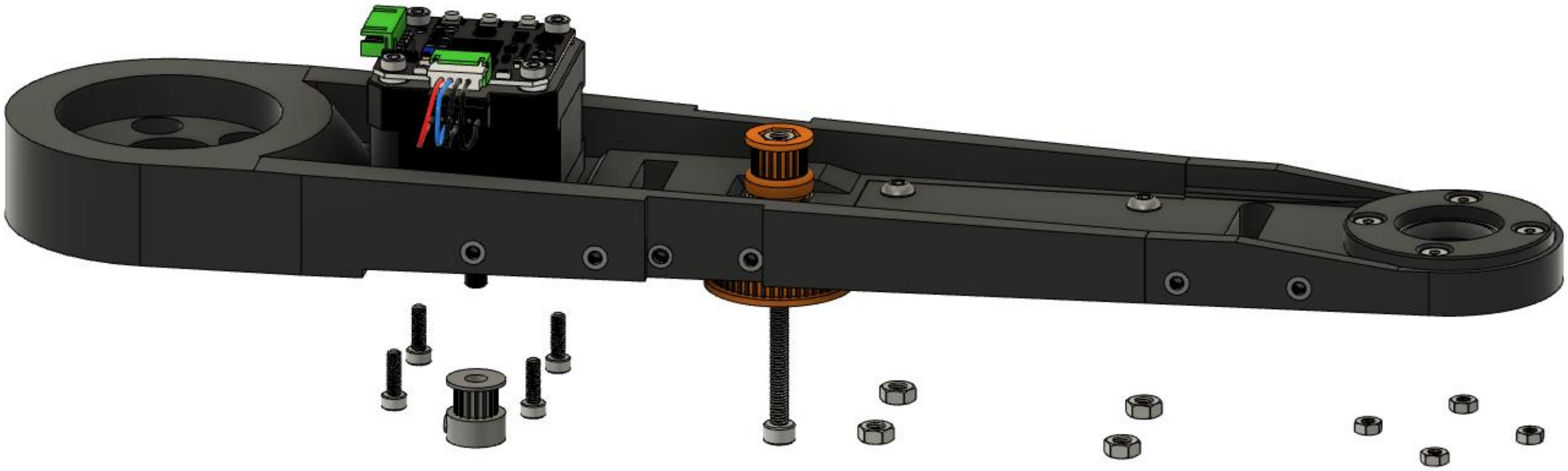
1x
M3x8



1x Nema 17 (17HE12-1204S)
1x MKS Servo42C
4x Distance washer
1x Ball bearing 20x27x4
2x Ball bearing 10x15x4
4x M3x10 flat head screw
4x M4x15
4x M3x10
1x M4 nut

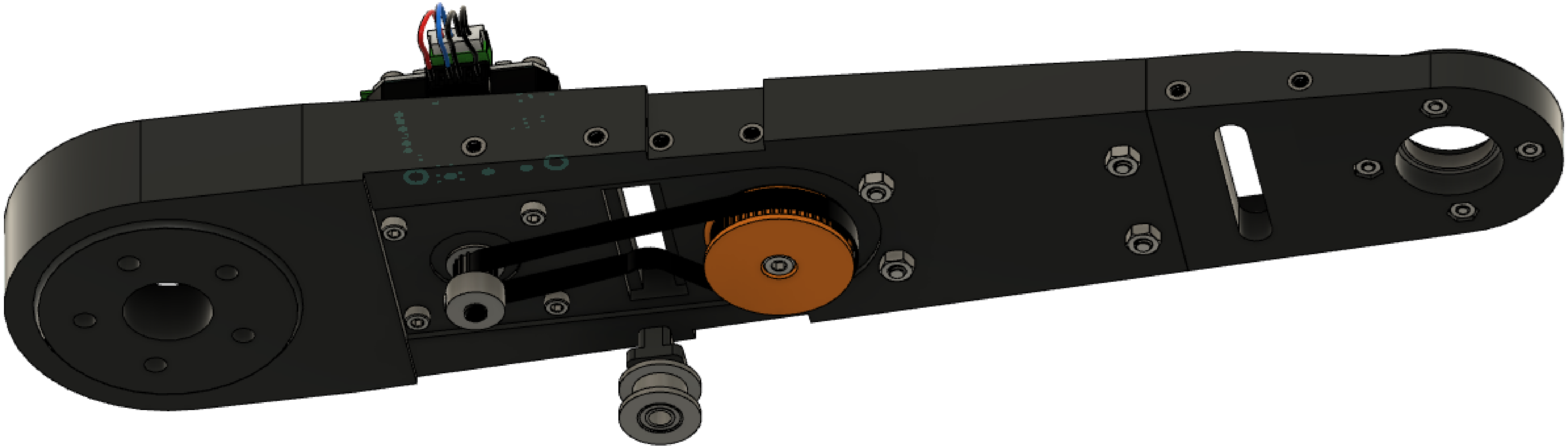


1x GT2 16T
Pulley
4x M3 nut
4x M4 nut
1x M4x30
4x M3x10

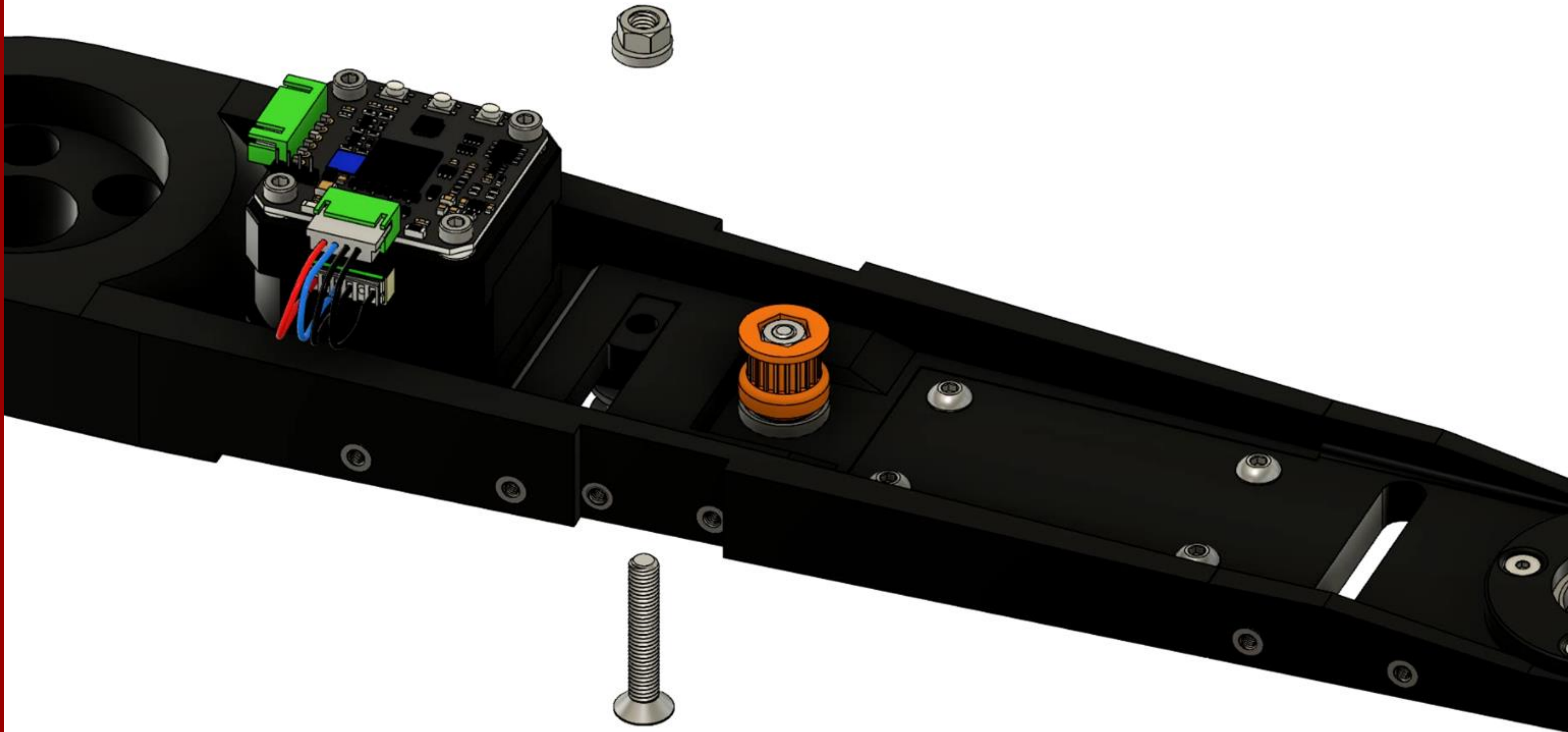


1x GT2 Belt
6x202

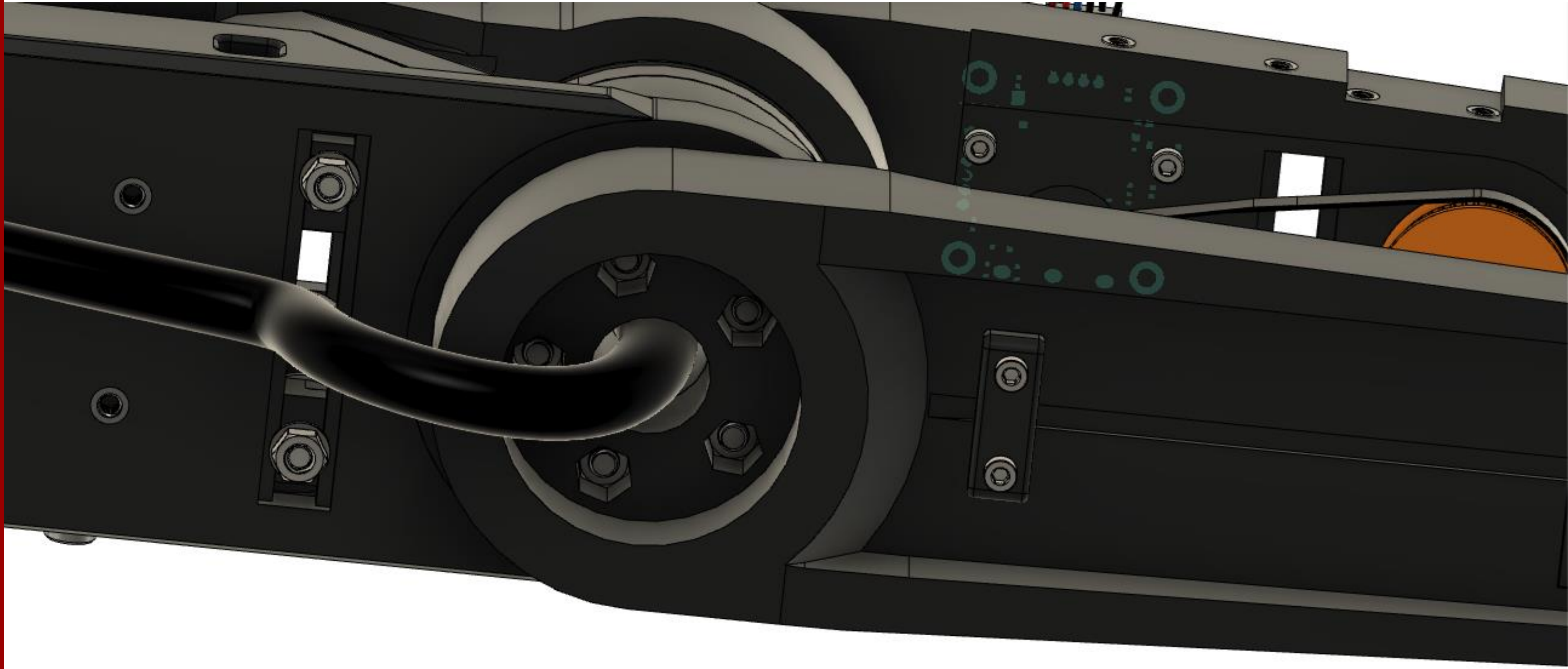
1x
Pulley



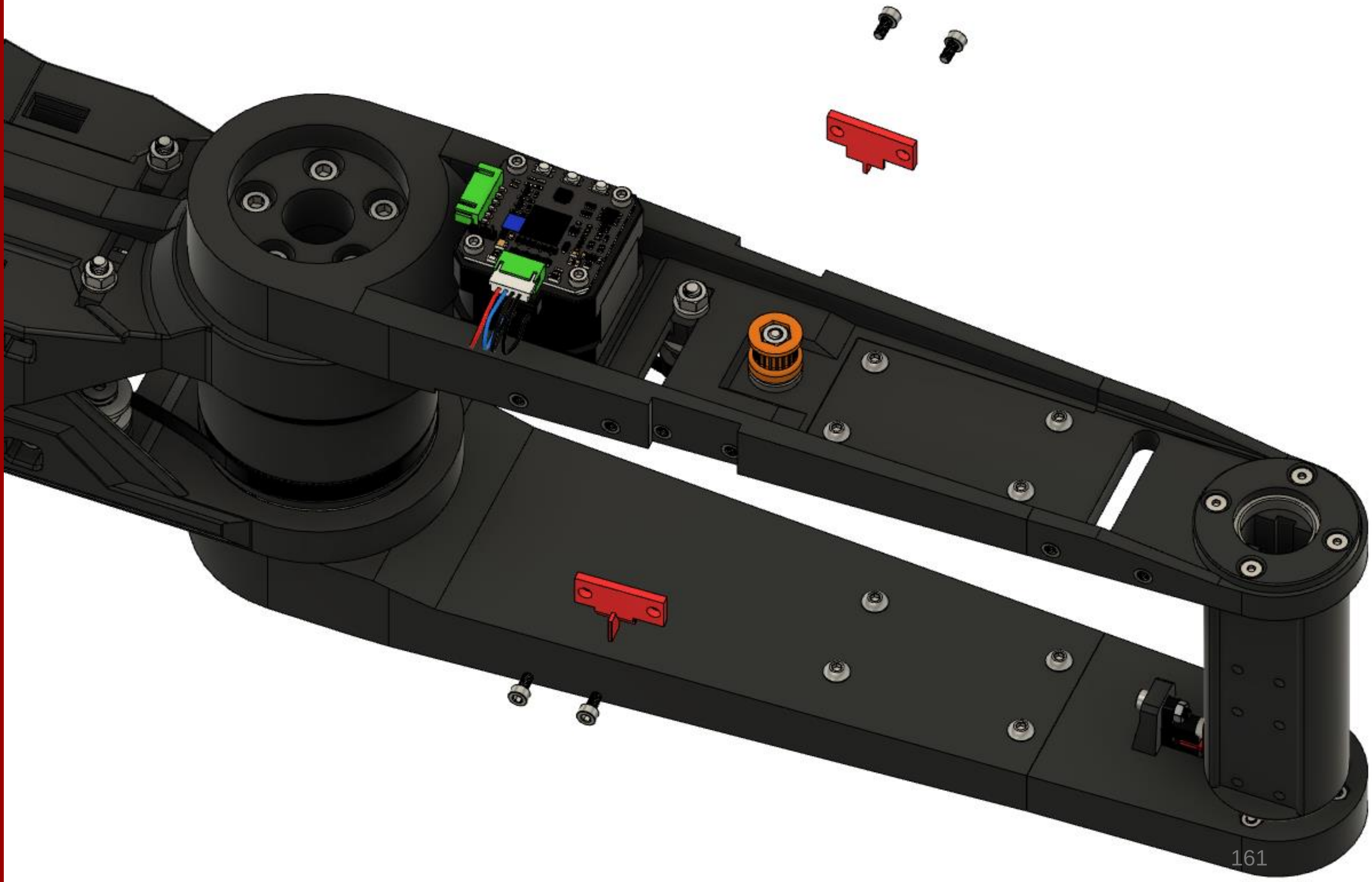
1x M5x30 flat head screw
1x M5 nut
1x M5 washer

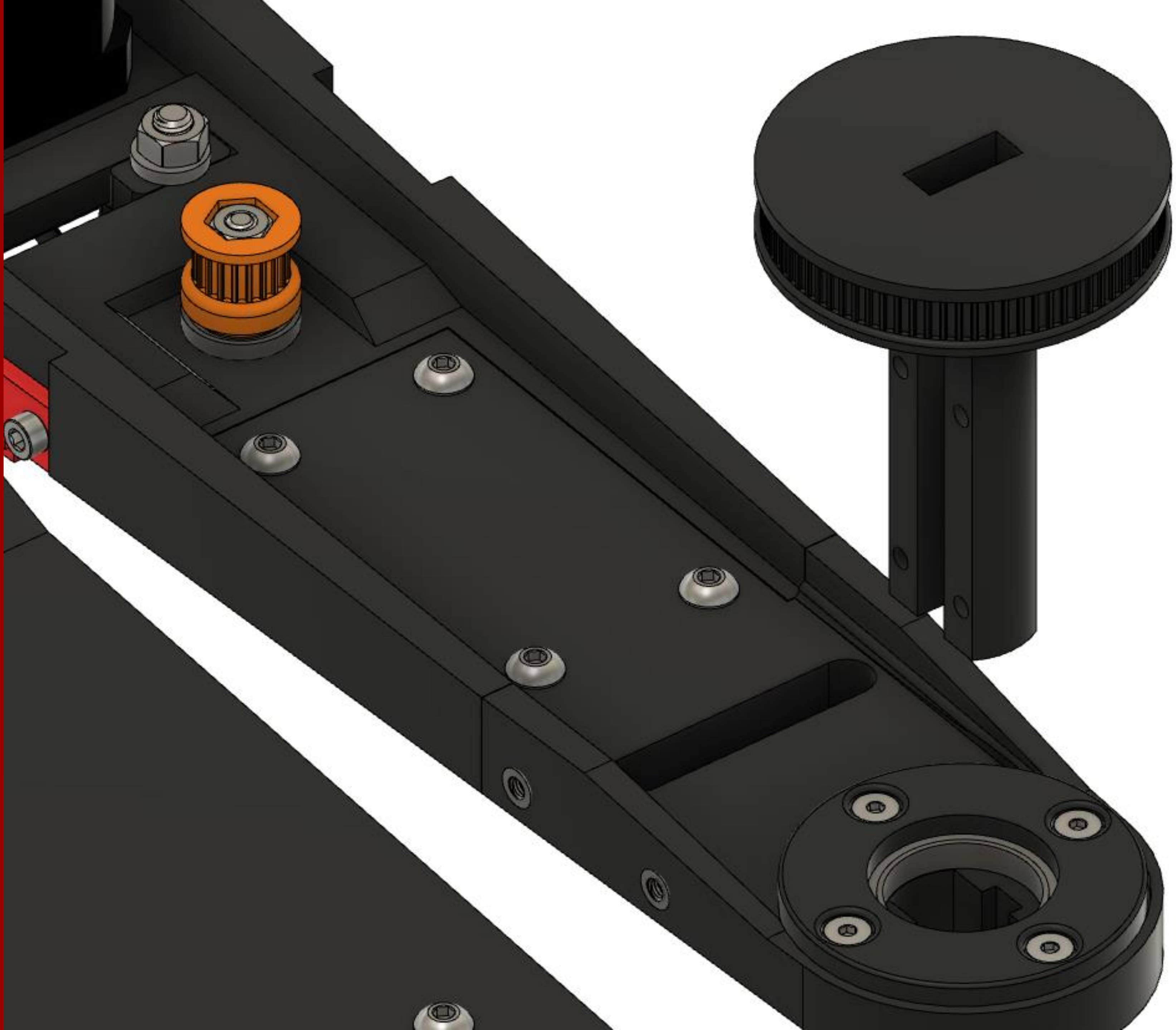


5x M5x100
5x M5
washer

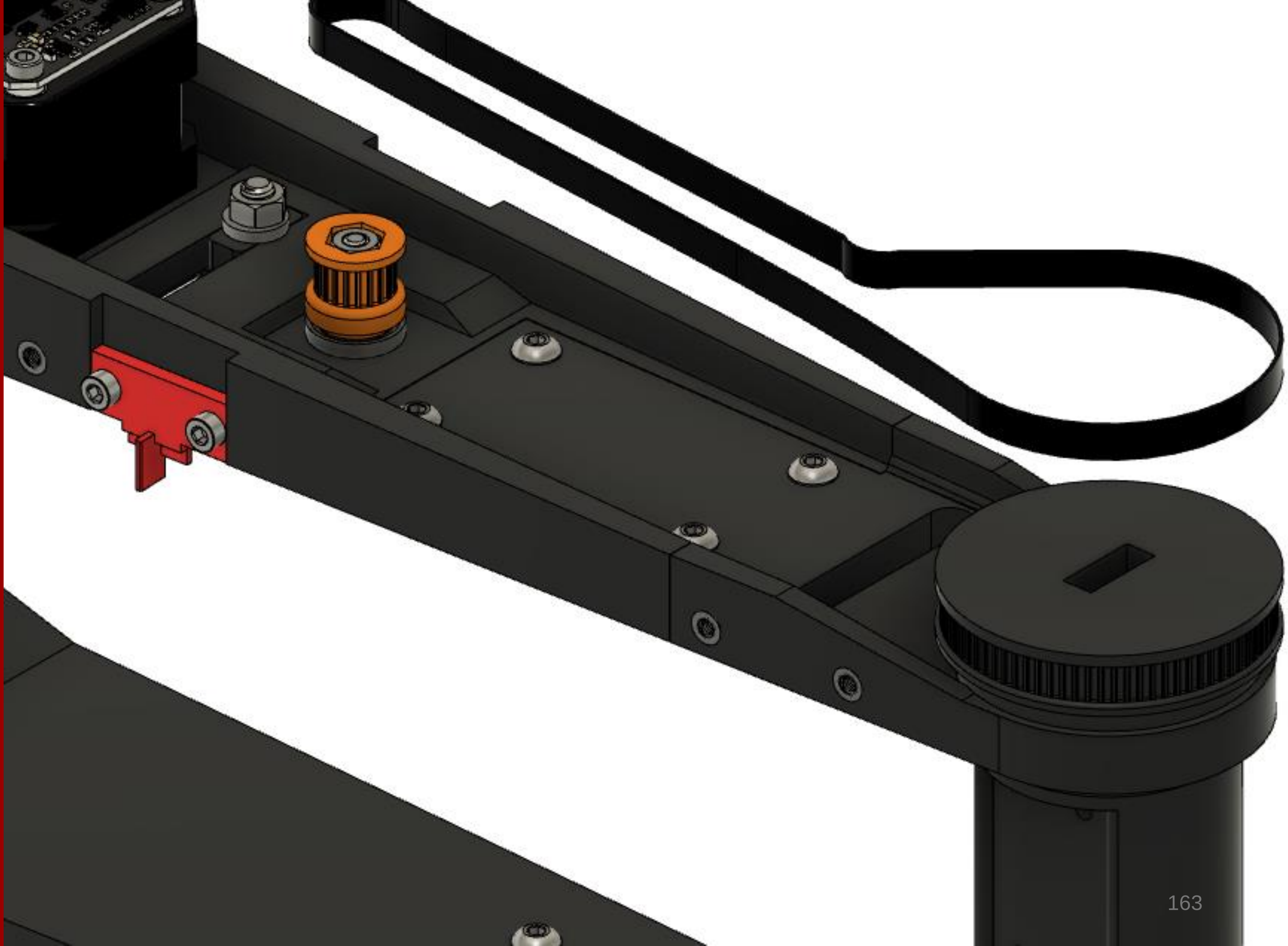


4x
M3x8

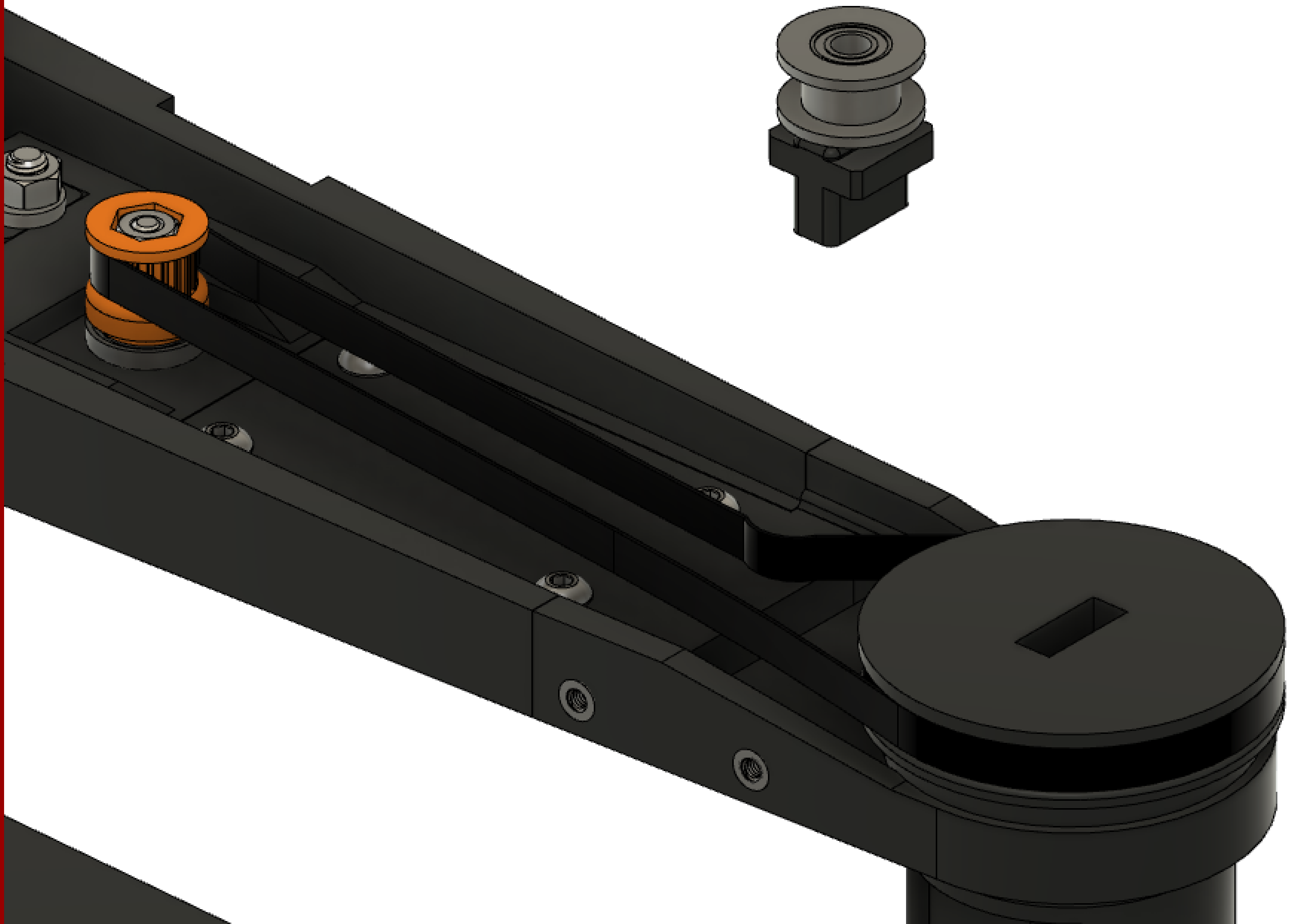




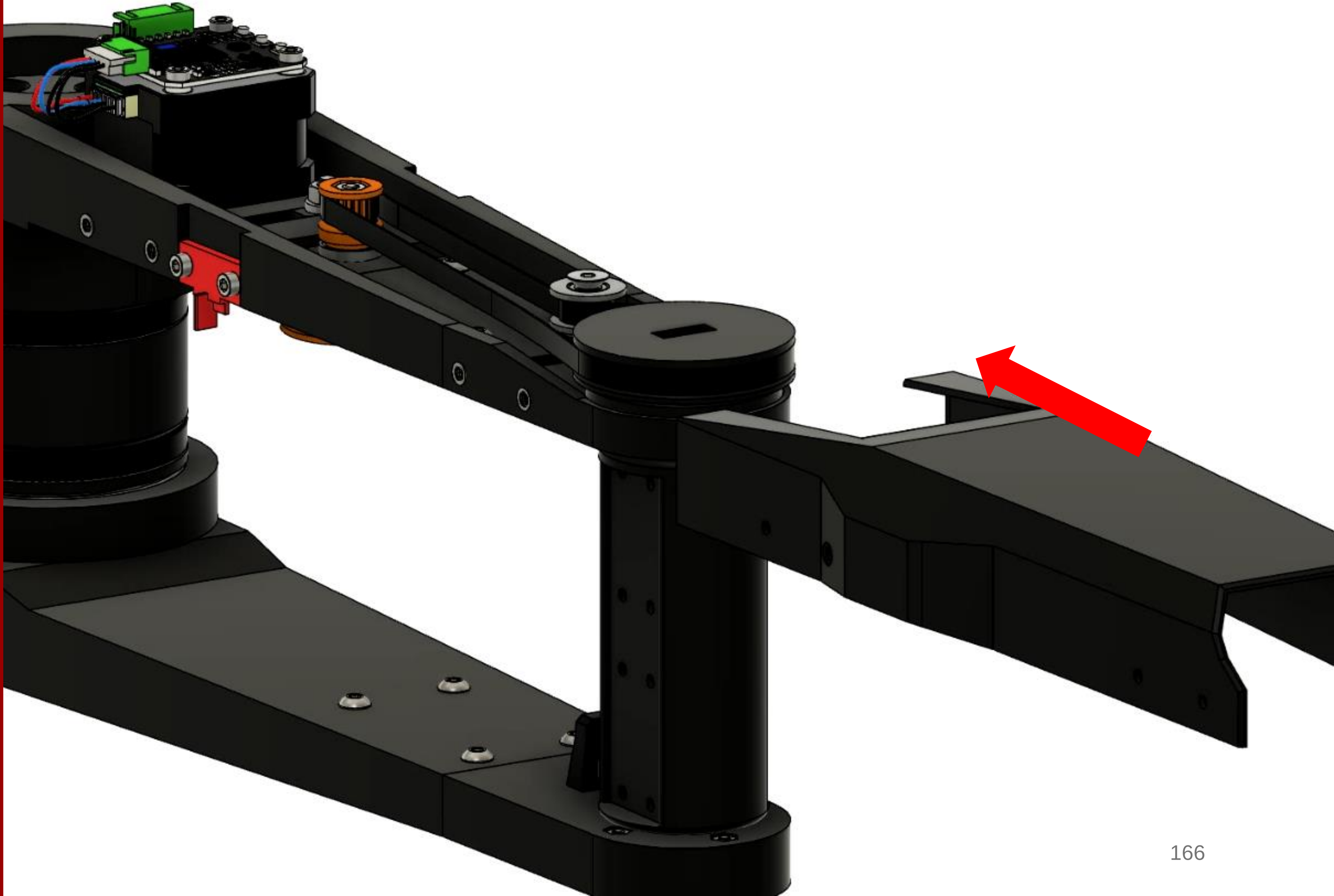
1x GT2 Belt
6x406



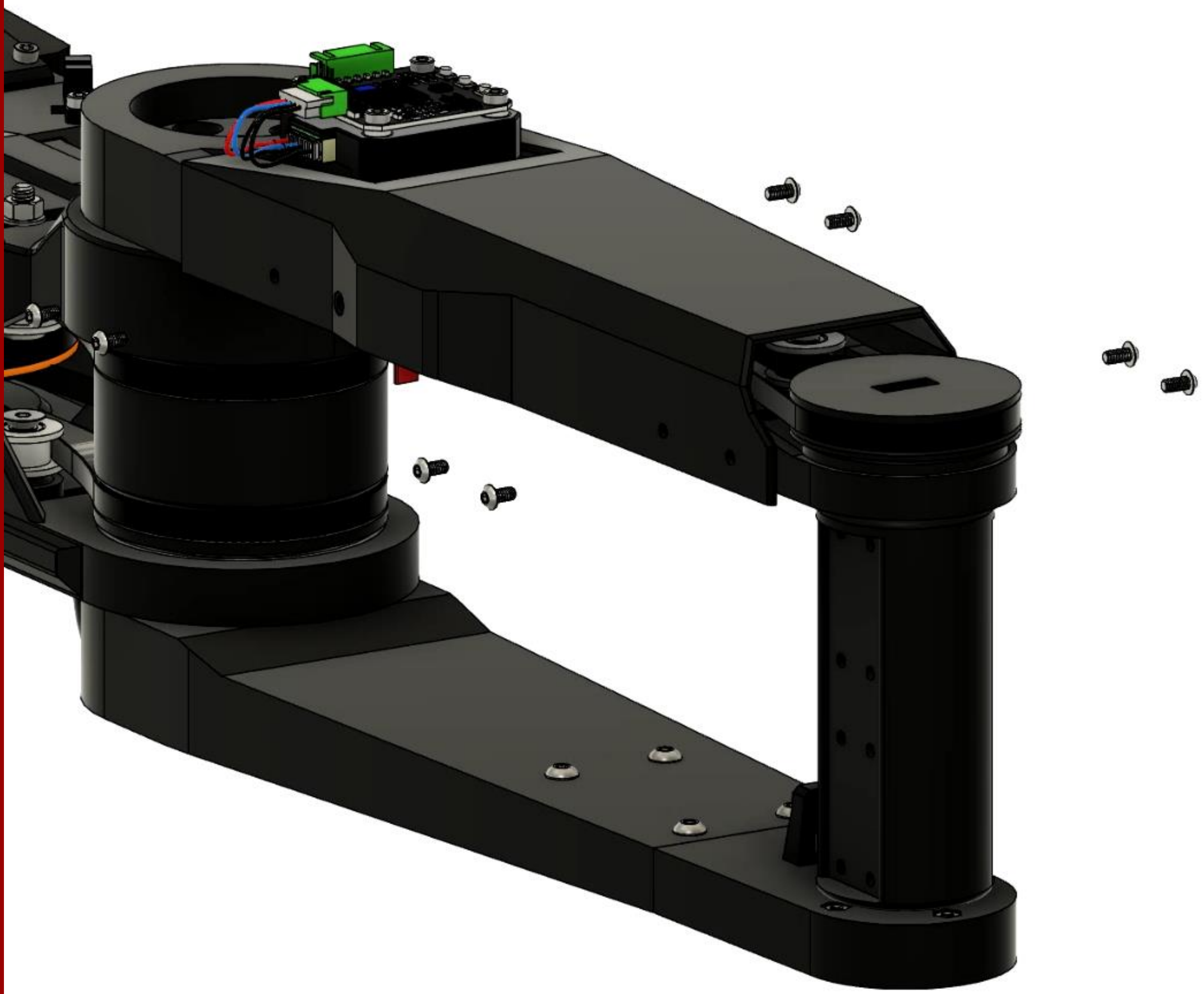
1x
Pulley



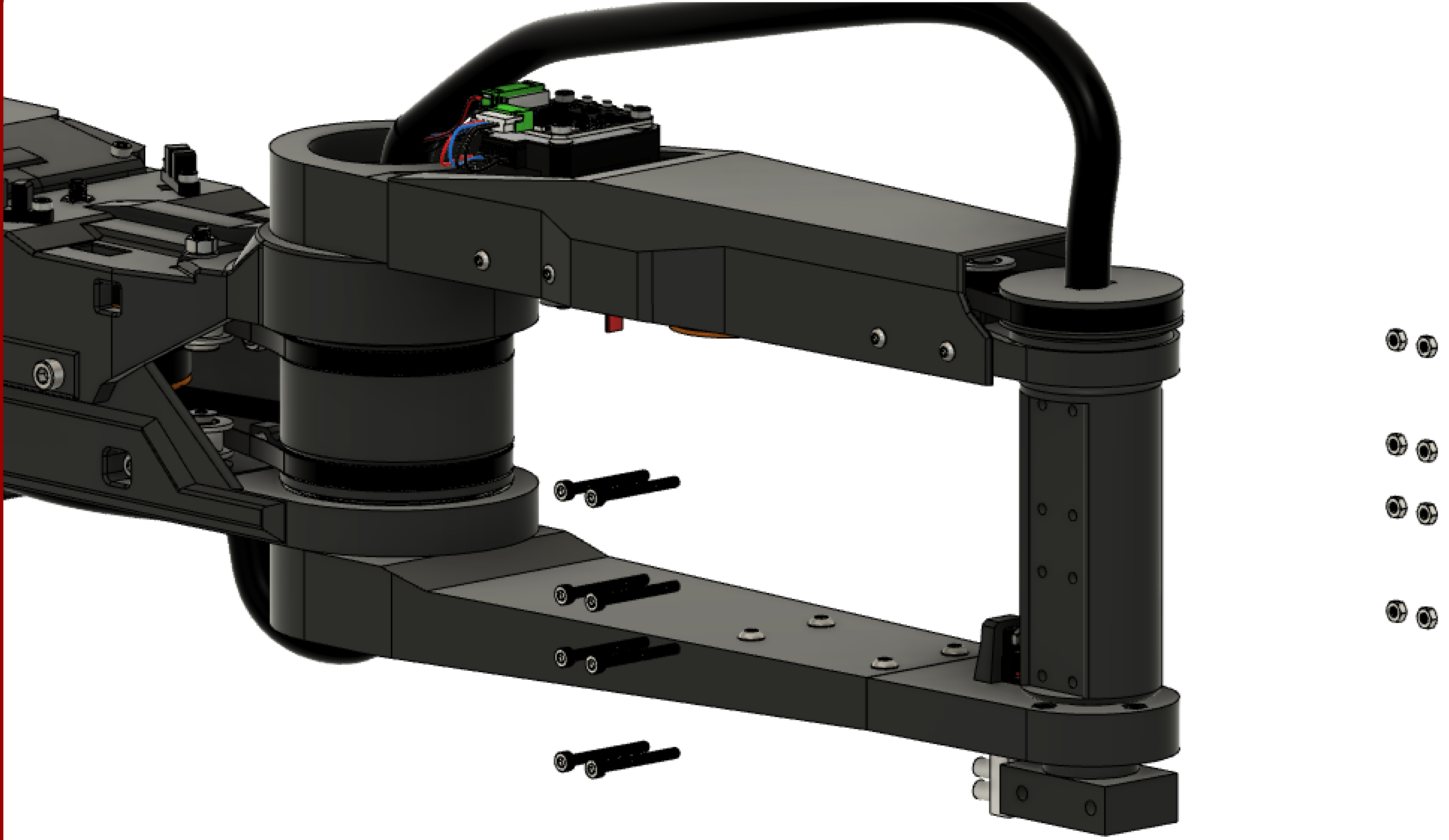
1x M5x35 flat head screw
1x M5 washer
1x M5 nut

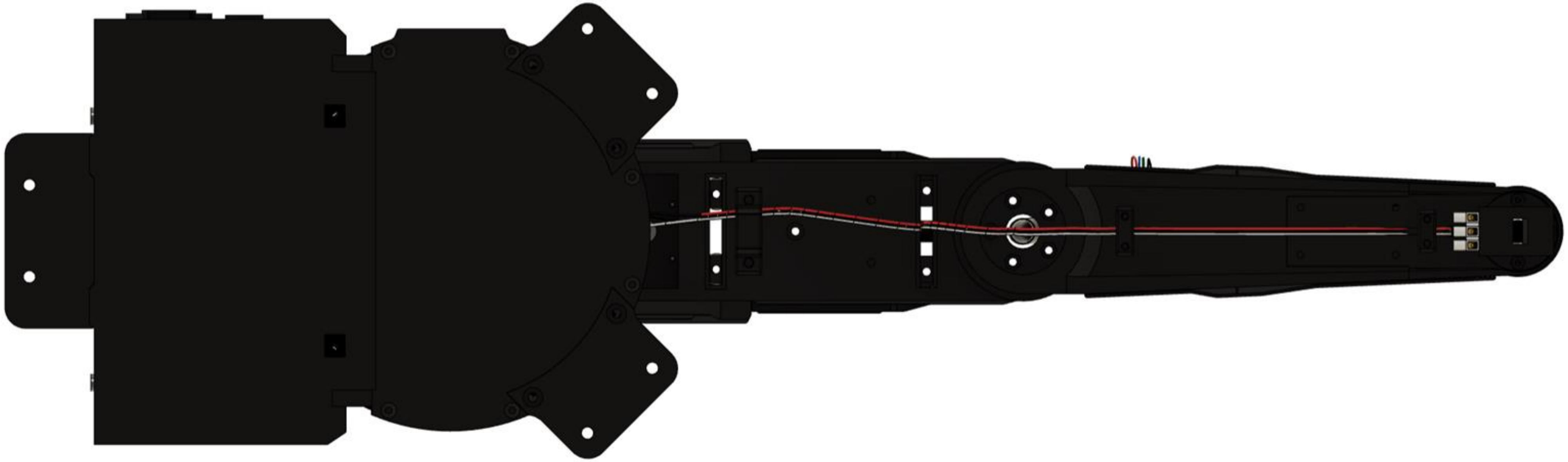


4x
M3x8



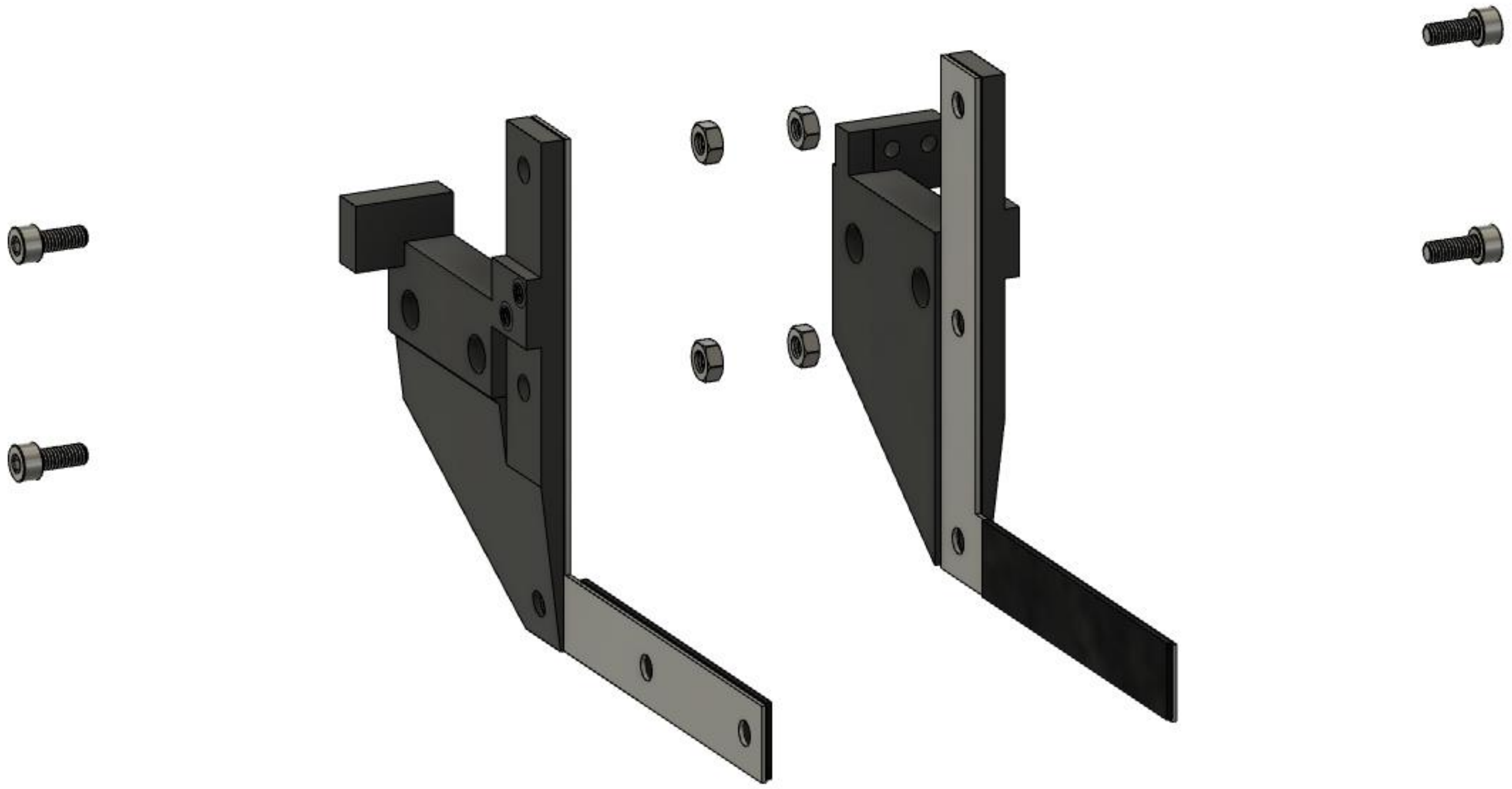
8x
M3x30
8x M3
nut





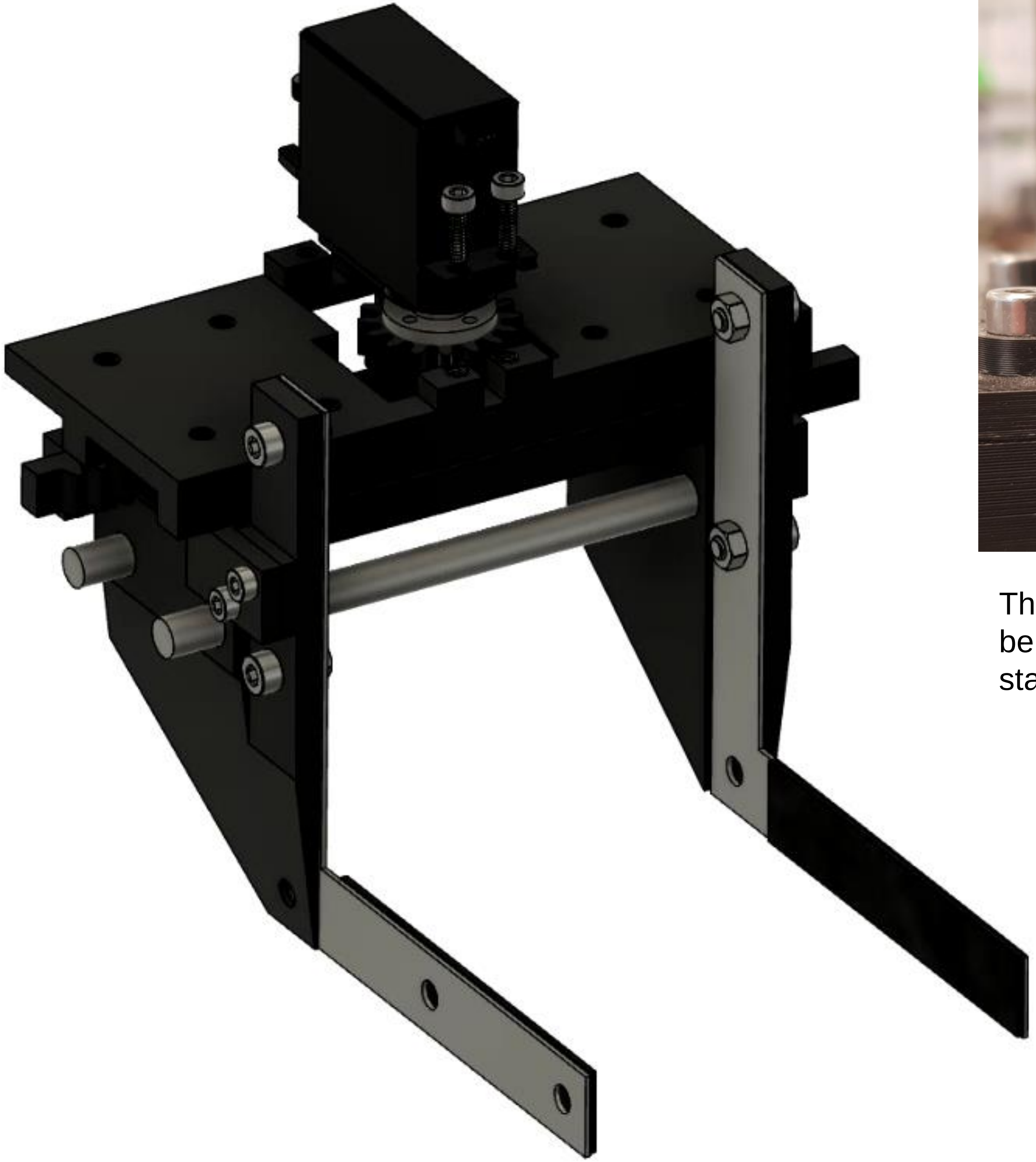
View from underneath

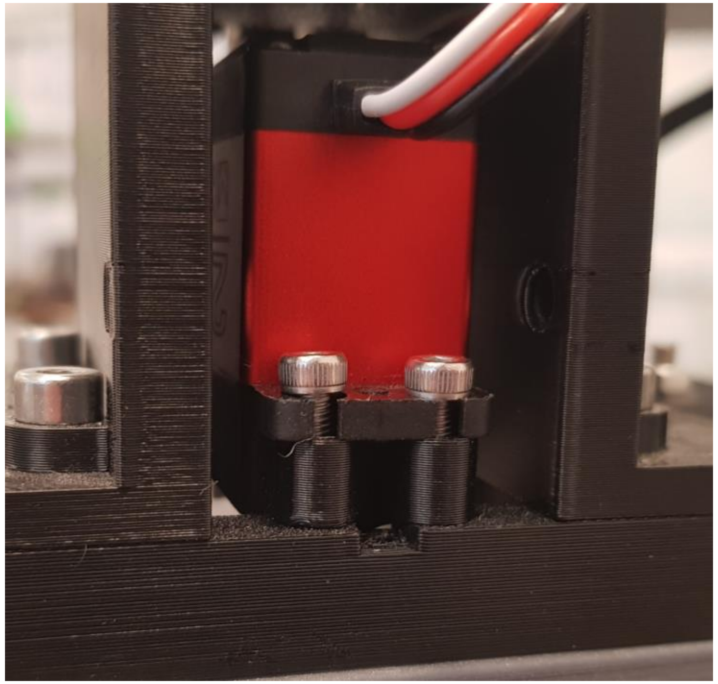
4x M4x10
4x M4 nut



4x
M3x10

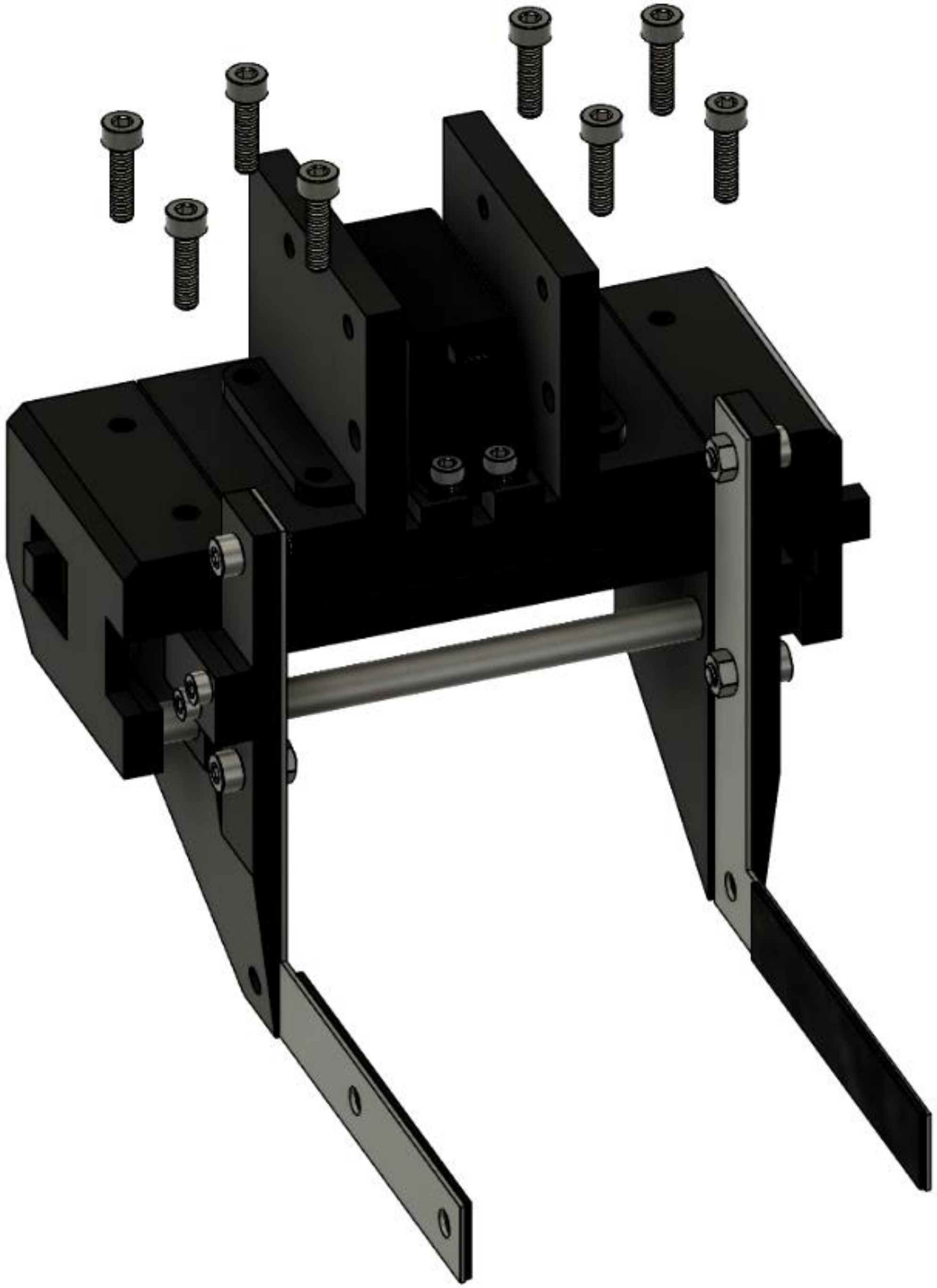
1x DS3218 Servo
2x M3x10
2x M3x15
2x M3 nut



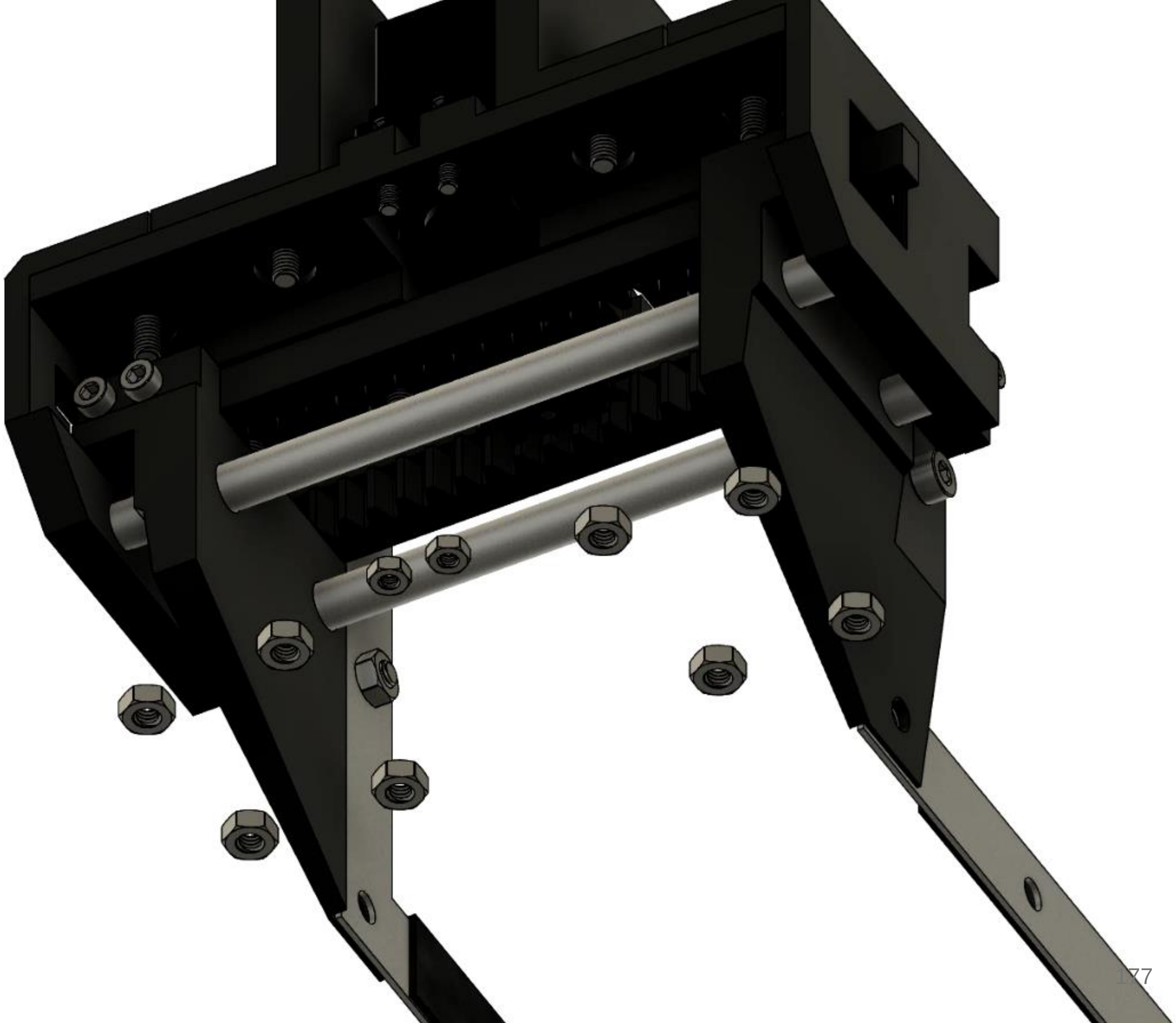


The gripper servo shall be mounted with 10mm stand-offs

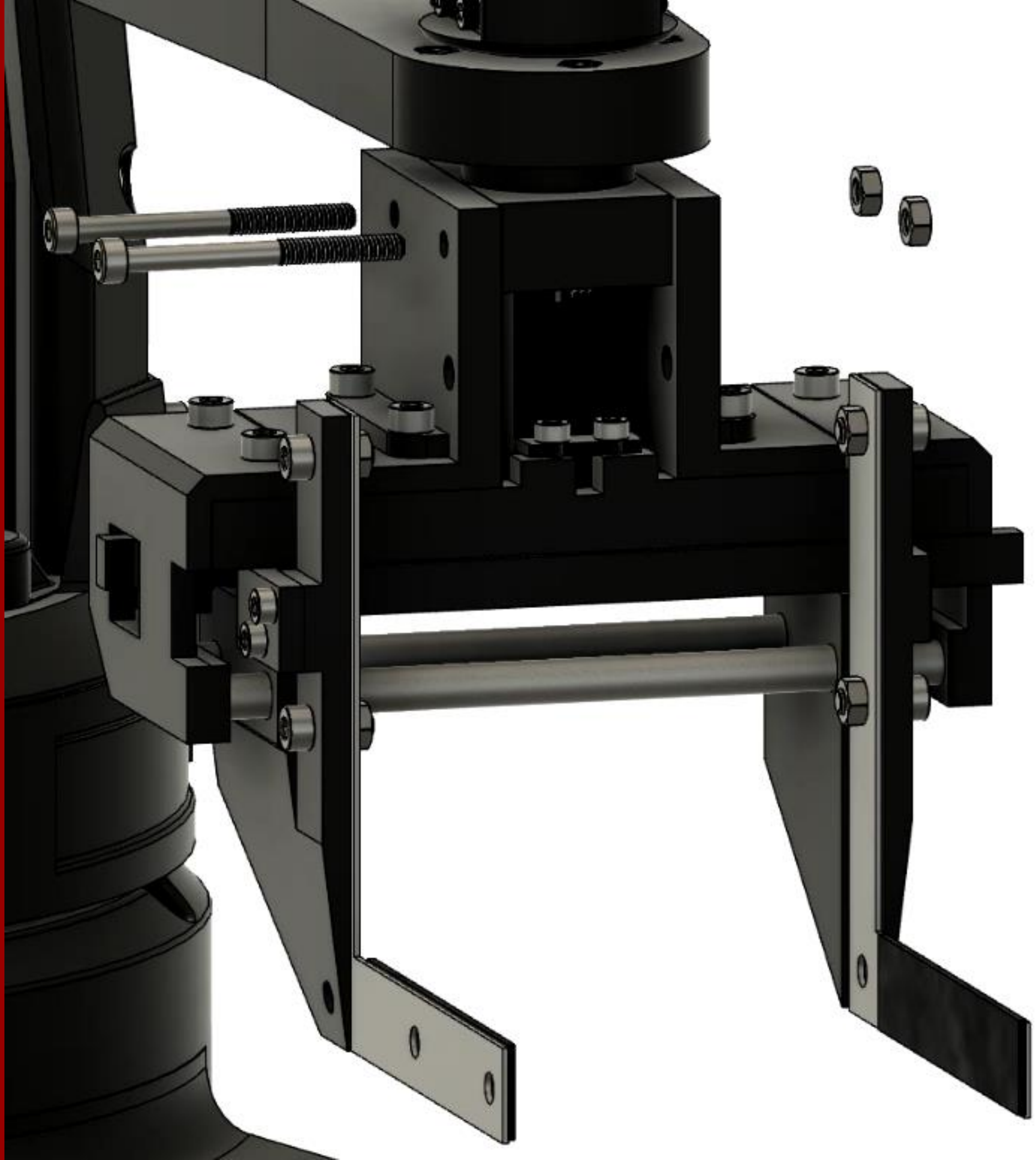
8x
M4x15

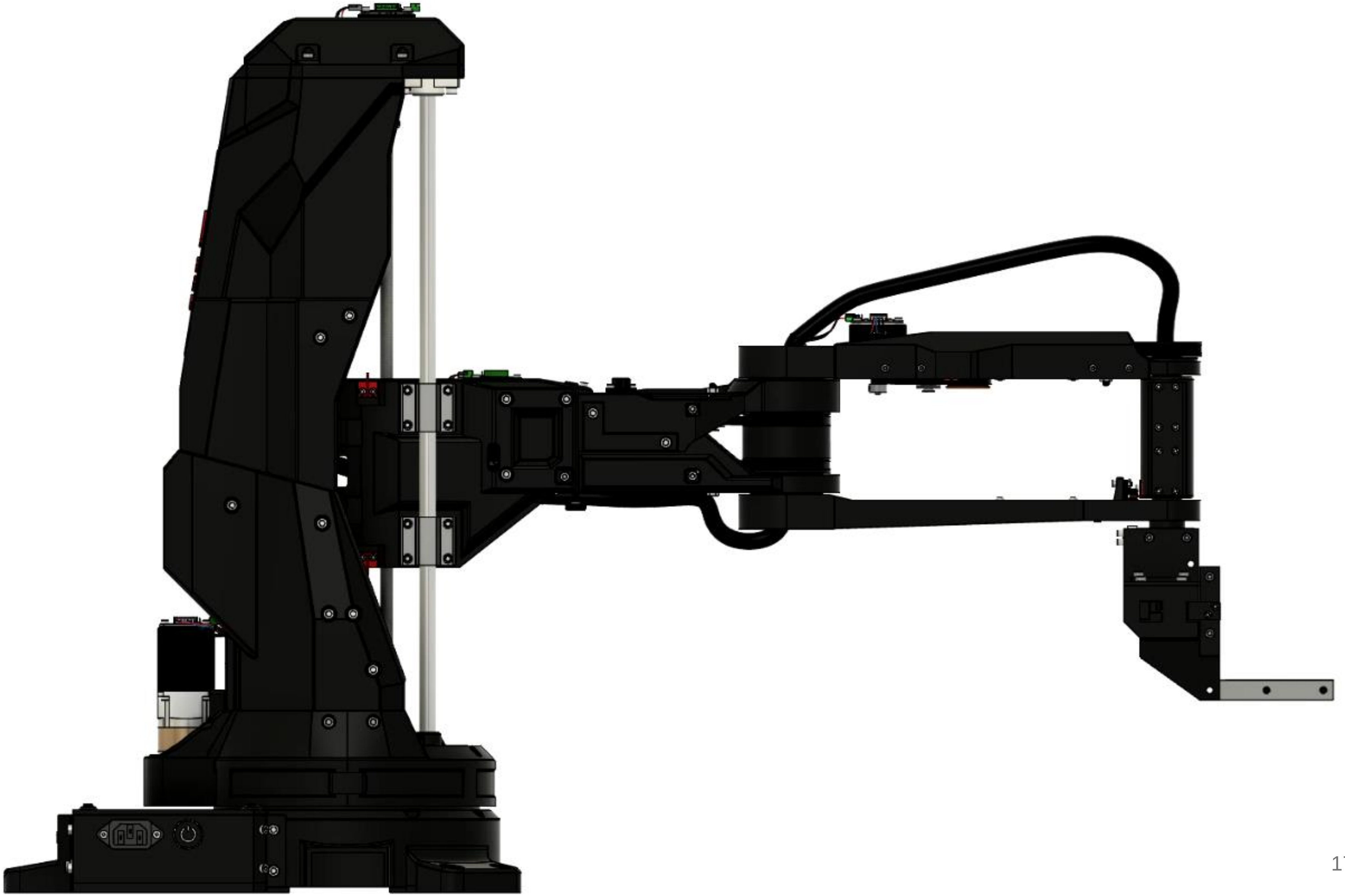


8x M4
nut
2x M3
nut



2x M5x45
2x M5 nut





ELECTRONICS

Actuators:

1x Nema 17 17HE12-1204S 

2x Nema 17 17HS19-2004S1 

1x Nema 17 17HS15-1504S1 

1x DS3218 Servo 

Control boards:

4x Ustepper S32 

1x Raspberry Pi 4 

Power:

1x 400W Power Supply 

1x 24V/5V Step Down 

1x Power Button 

1x C14 PLUG 

1x USB C Wire 

Miscellaneous:

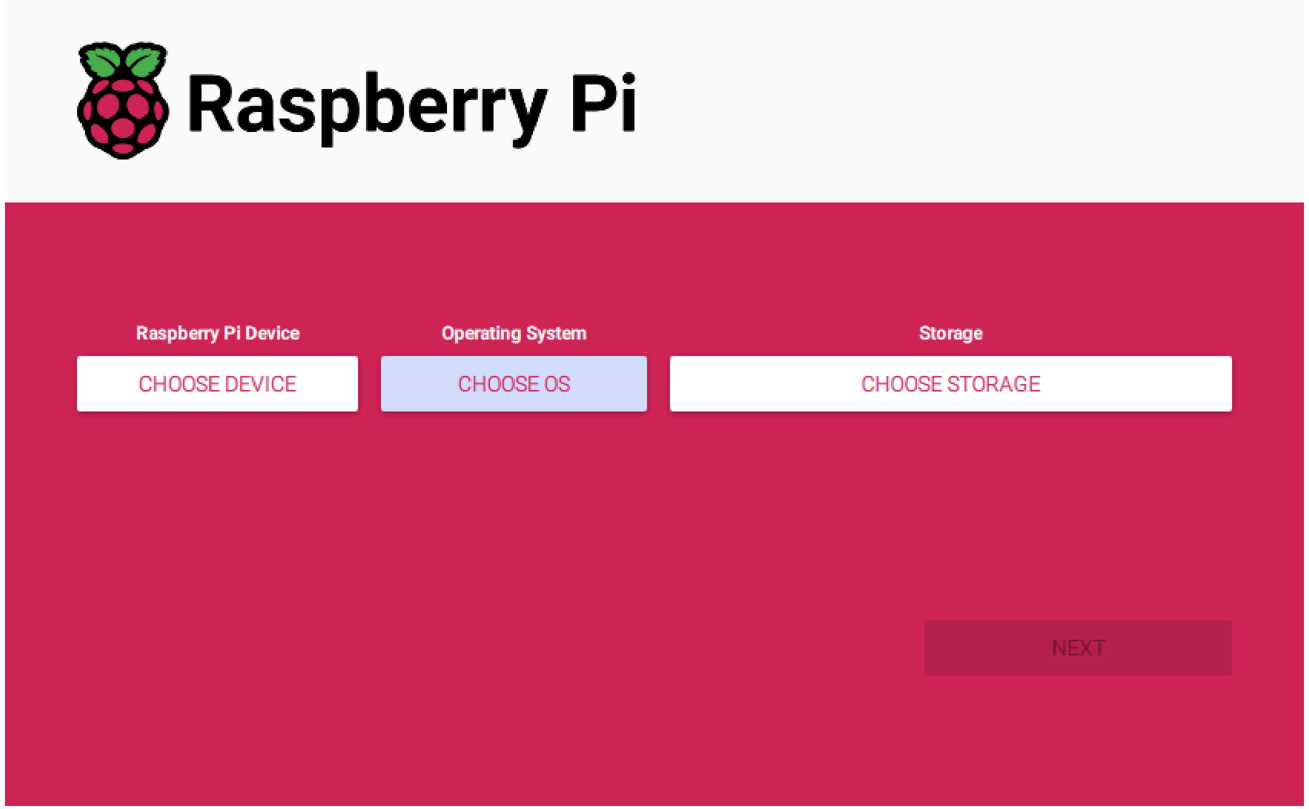
DIN Rail (~10 cm)

10x Terminal Blocks

RASPBERRY SETUP

SETUP

1. Follow the Documentation on Github to install Ubuntu on the Raspberry Pi



Ustepper S32

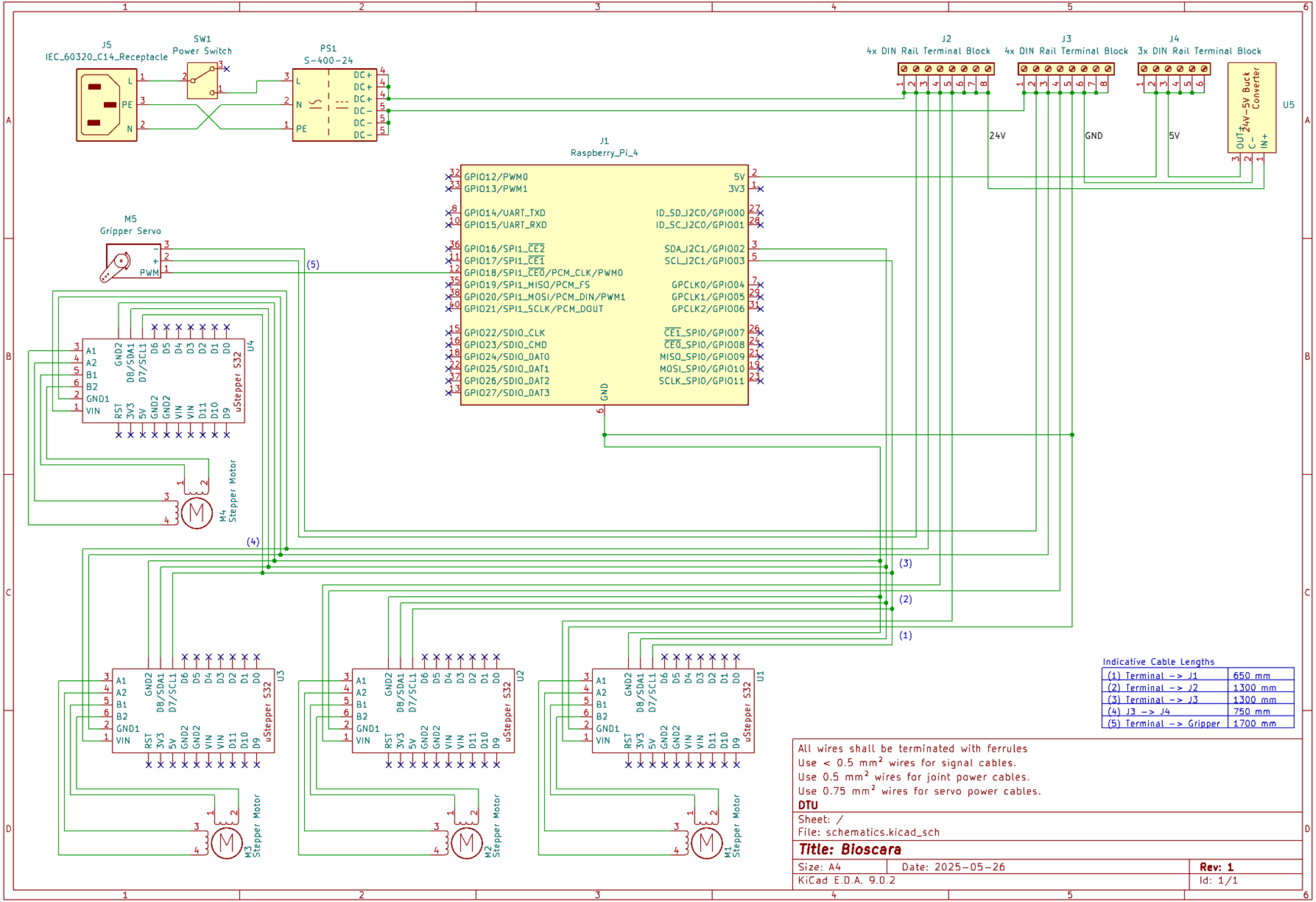
Flashing Firmware: https://www.ustepper.com/getting-started-with-ustepper/

To add hardware support for uStepper S32 in the Arduino IDE do the following:
First of you need to install the STM32 CUBE Programmer from here: https://www.st.com/en/development-tools/stm32cubeprog.html
Next up is to set it up in the Arduino IDE:
– Open Arduino
– Go to "File->preferences"
    – Almost at the bottom there is a field stating: "Additional Boards Manager URLs" insert this url:
    https://raw.githubusercontent.com/uStepper/uStepperSTM32Hardware/master/package.json
– Press OK
– Go to "Tools->Board->Boards Manager…"
– Go to the bottom (after it has loaded new files) select "uStepper STM32 boards" and press install
– You have now added uStepper STM32 hardware support and should be able to select uStepper STM32 boards under tools -> boards.

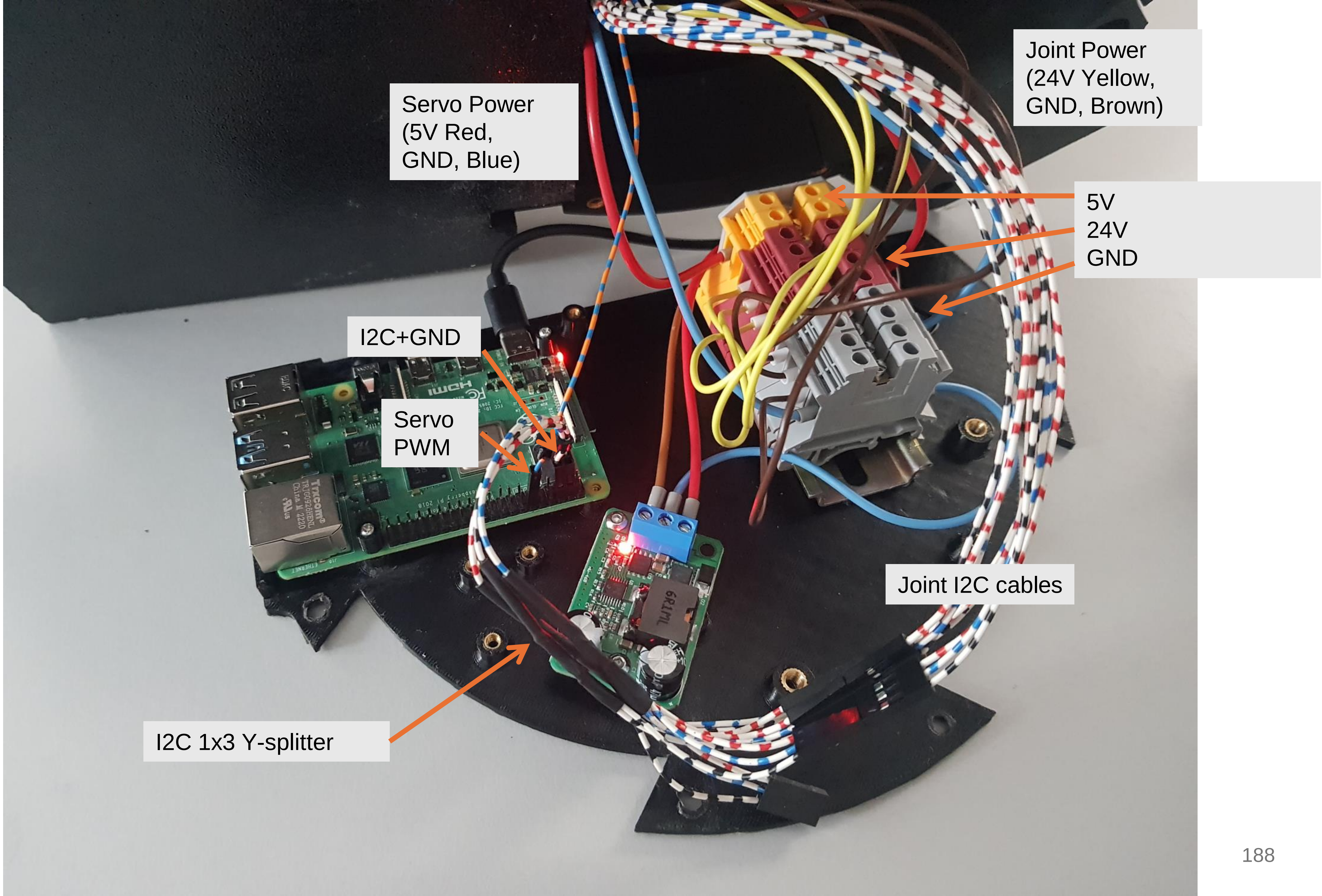
To add the uStepper S32 library do the following:
– Open Arduino IDE (Version 1.8.8 or above)
– Go to "Sketch->Include Library->Manage Libraries…"
– Search for "uStepper S32"
– Select "uStepper S32" and press install
– Close Library Manager

To test the uStepper You can set up one of our pre-written examples
Go to Files -> Examples -> uStepper S32 -> click on your chosen example -> follow the following steps to upload, and voila!
Since uStepper S32 uses an STM32 MCU the procedure for programming involves some specific steps.
When programming attach your uStepper S32 board to your PC and verify it shows up under "port" in the tools menu. Load your program and compile it.
Once error free do as follows:
– Press and hold down the "boot" switch.
– Press the "reset" switch and release it again and then.
– Release the "boot" switch.
– Now press upload in the Arduino IDE and the program will upload.

SCHEMATIC

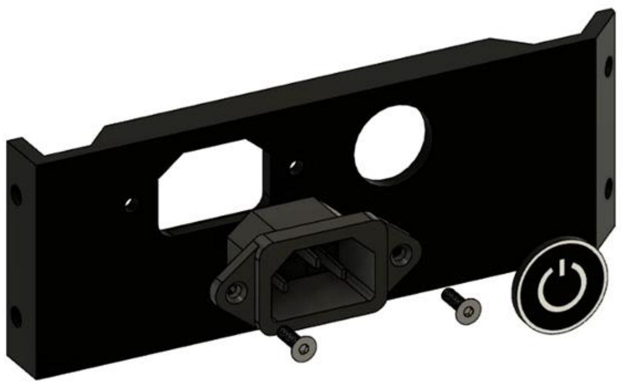


J5
IEC_60320_C14_Receptacle
SW1
Power Switch
PS1
S-400-24
J2
4x DIN Rail Terminal Block
J3
4x DIN Rail Terminal Block
J4
3x DIN Rail Terminal Block
U5
24V-5V Buck Converter
24V
GND
5V
J1
Raspberry_Pi_4
M5
Gripper Servo
U4
U3
U2
U1
uStepper S32
M4 Stepper Motor
M3 Stepper Motor
M2 Stepper Motor
M1 Stepper Motor
Indicative Cable Lengths
(1) Terminal -> J1 650 mm
(2) Terminal -> J2 1300 mm
(3) Terminal -> J3 1300 mm
(4) J3 -> J4 750 mm
(5) Terminal -> Gripper 1700 mm
All wires shall be terminated with ferrules
Use < 0.5 mm² wires for signal cables.
Use 0.5 mm² wires for joint power cables.
Use 0.75 mm² wires for servo power cables.
DTU
Sheet: /
File: schematics.kicad_sch
Title: Bioscara
Size: A4
Date: 2025-05-26
Rev: 1
KiCad E.D.A. 9.0.2
Id: 1/1

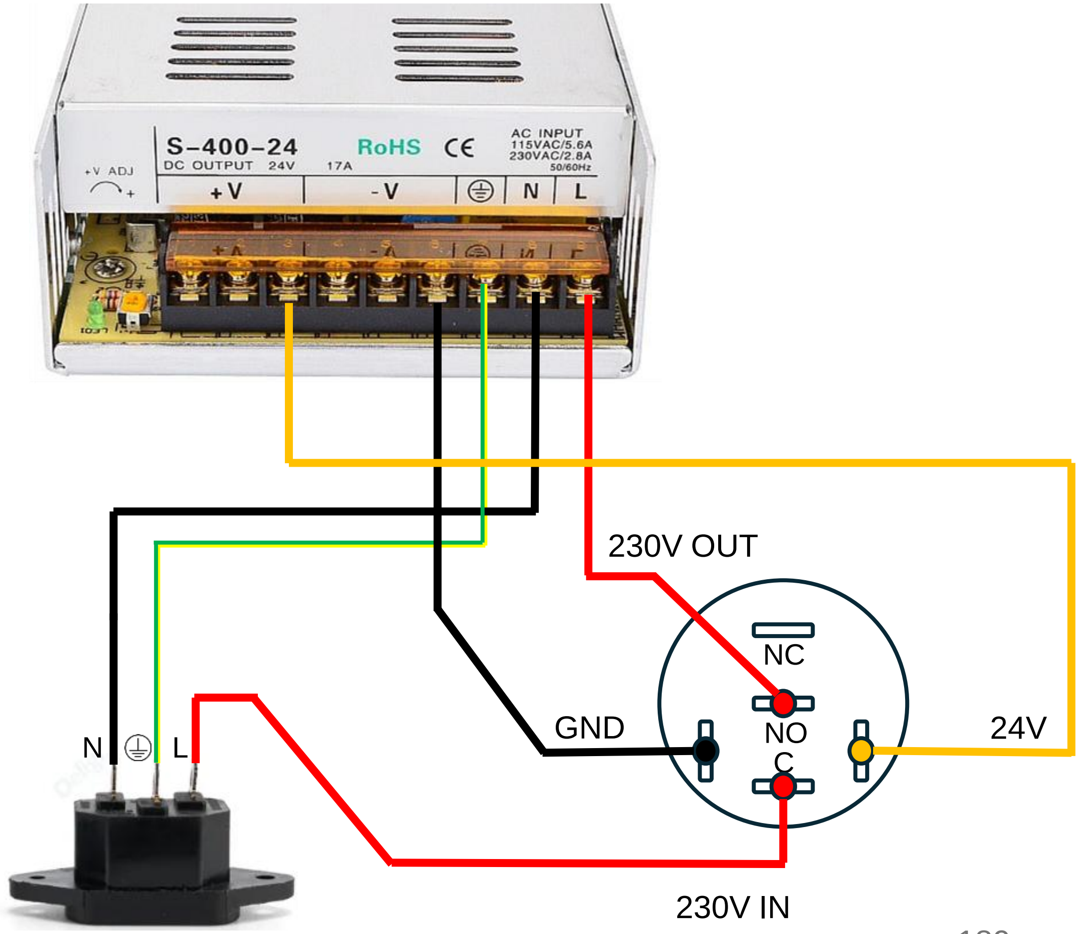

Servo Power
(5V Red,
GND, Blue)
Joint Power
(24V Yellow,
GND, Brown)
5V
24V
GND
I2C+GND
Servo
PWM
Joint I2C cables
I2C 1x3 Y-splitter

FRONT PANEL WIRING

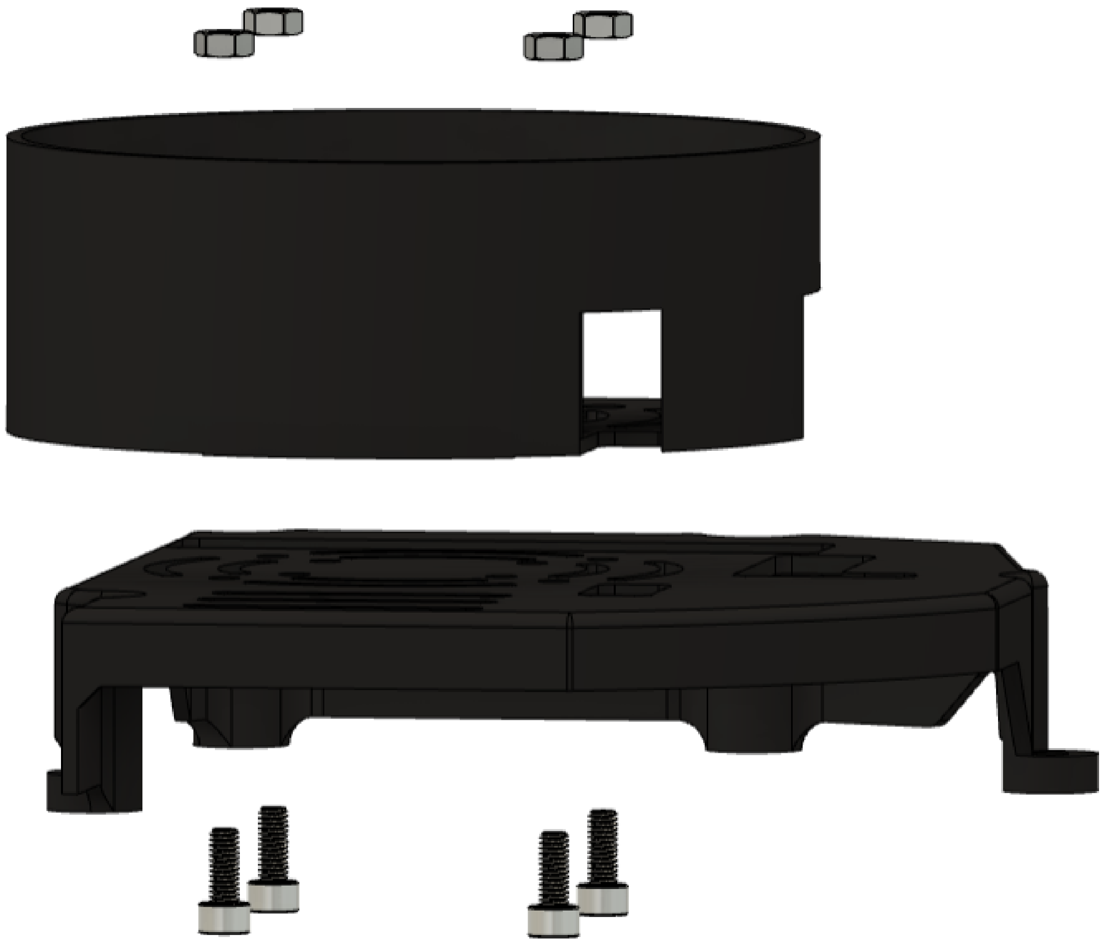
1. Mount the socket and button onto the front panel



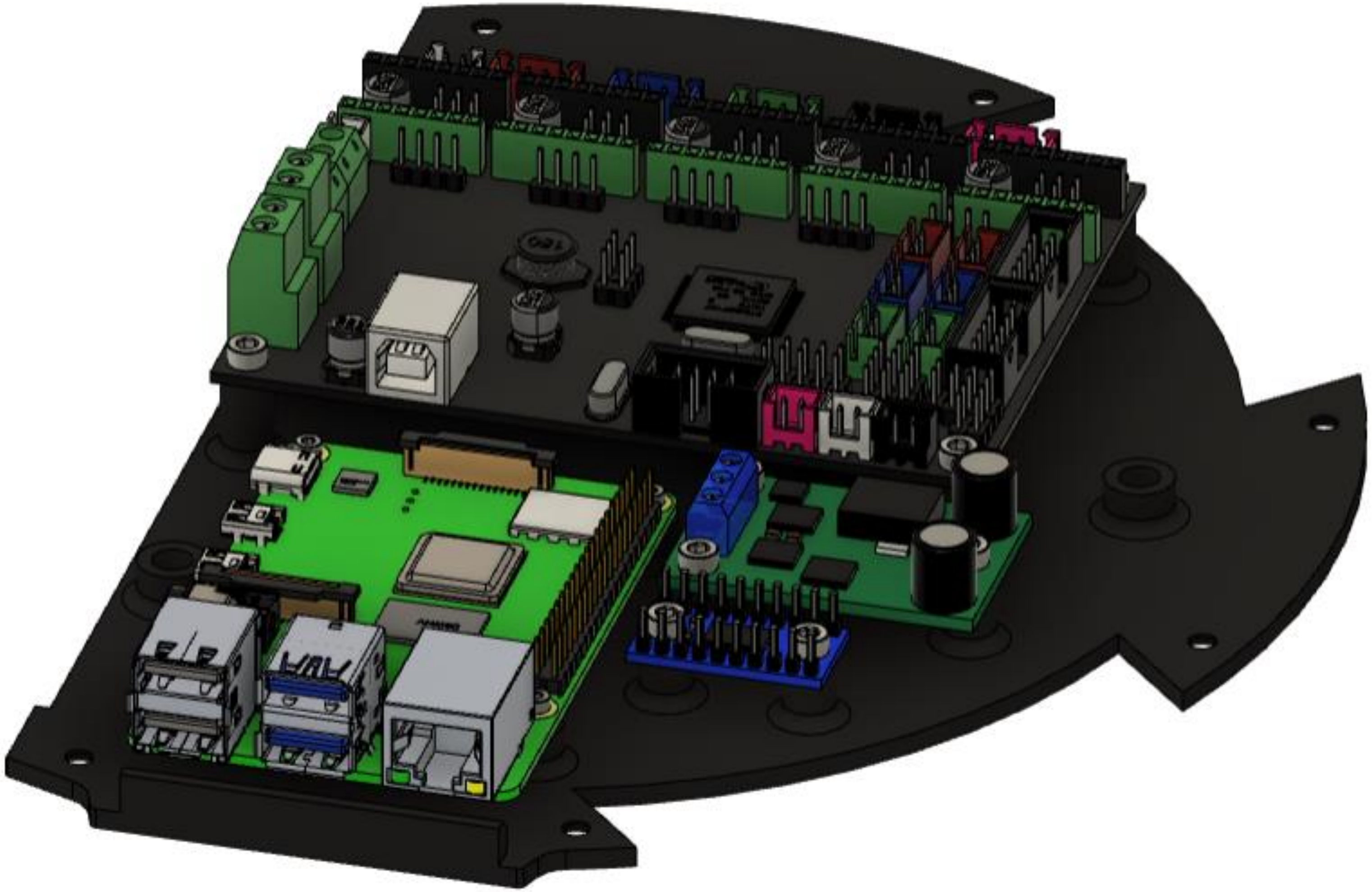
2. Connect the button and power socket to the power supply



4x M4x10
4x M4 nut

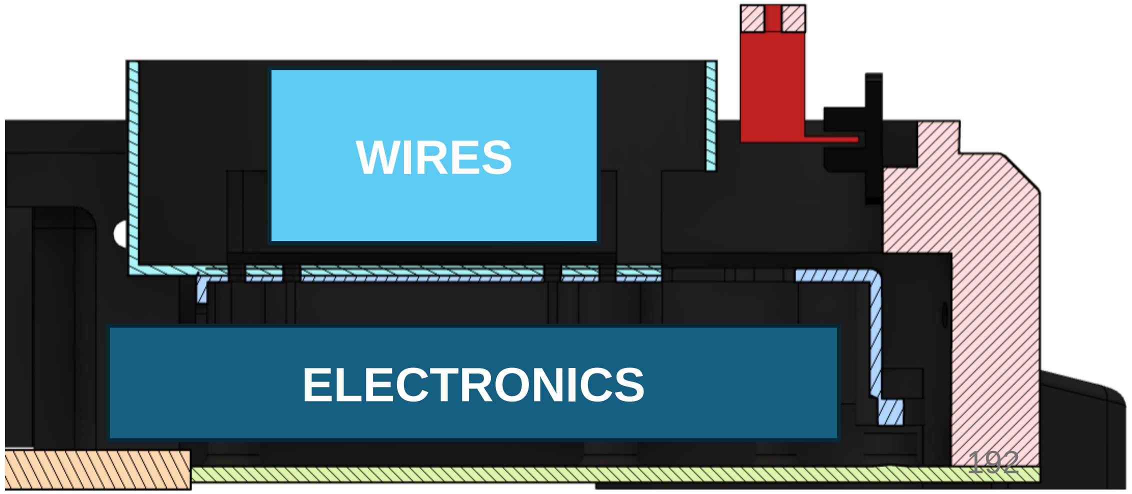


4x
M2x6
9x
M3x6



4x
M4x10

These parts serve as a cover for the electronics and wires. It is important to ensure that the wires are being kept away from the endstop of joint 1 and its trigger to prevent possible entanglement.



SOFTWARE

Homing