

BIO SCARA MANUAL v2

NOTE:

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

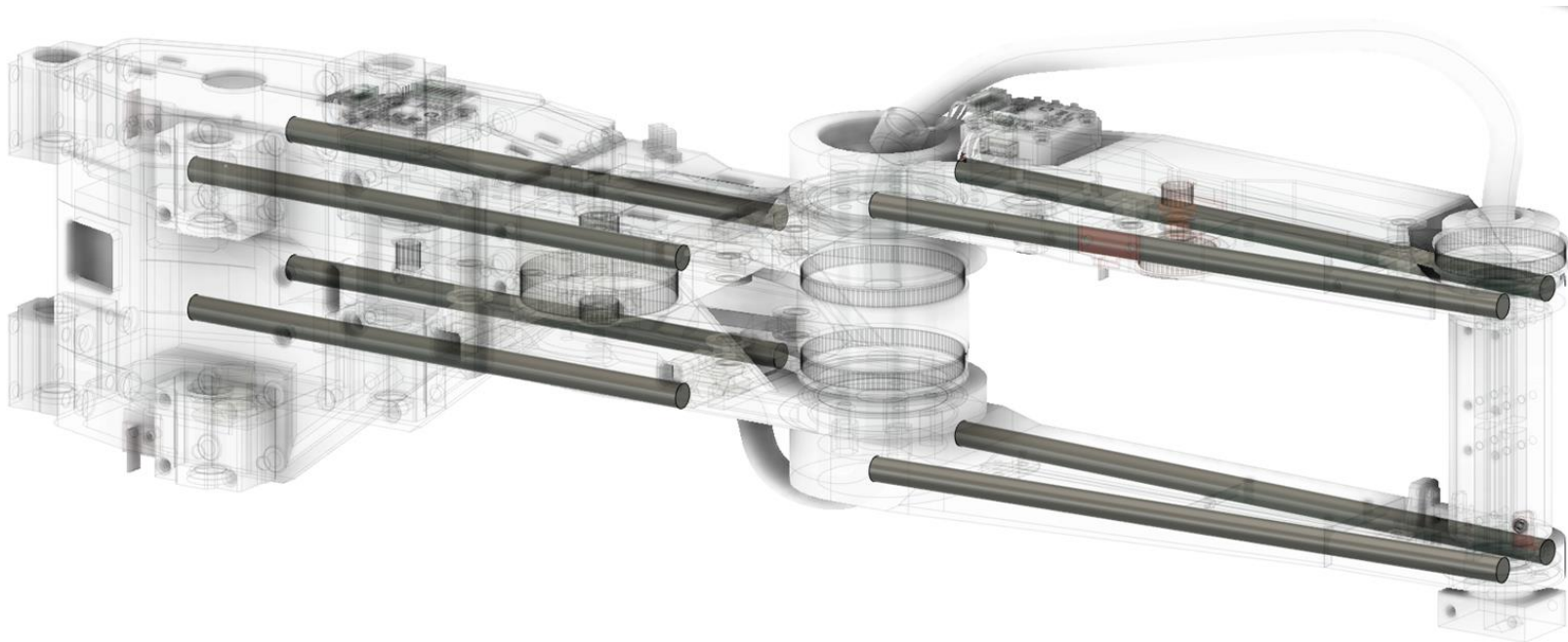
PROPOSAL

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 or tubes.

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

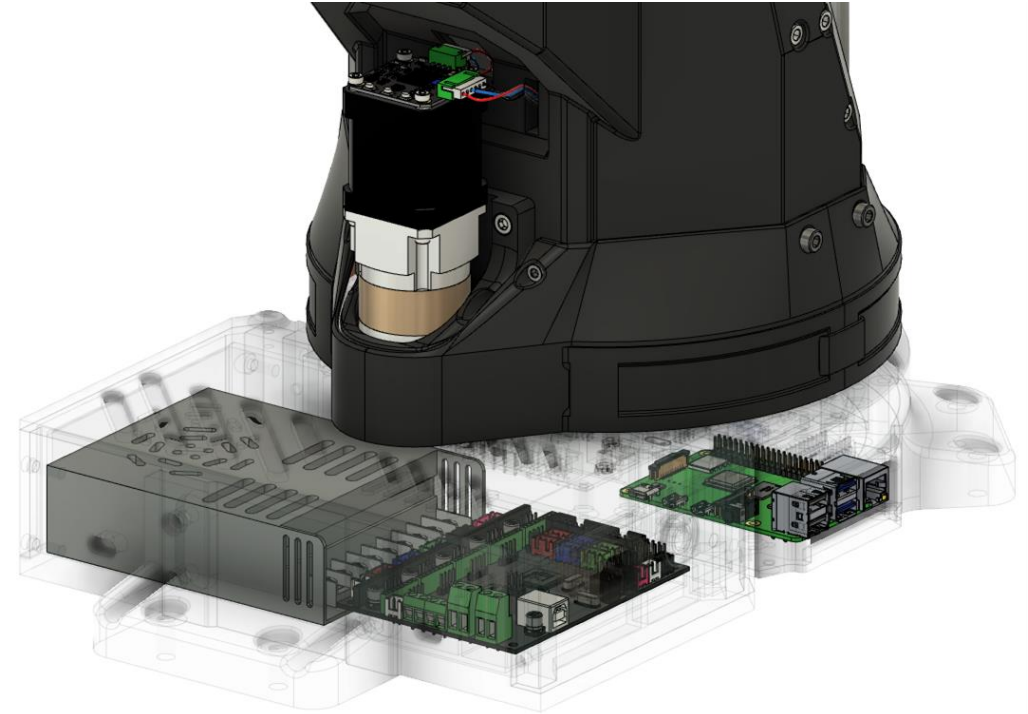
Of course, the flexibility will always remain in the parts where the arm links are connected through joints (for example due to the reliance on timing belts) but it should be to a smaller extent.



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

Outdated, use only as
indication

3D PRINTING

3D PRINTER

Parts have been printed on a Bambulab P1S printer. This printer has a print volume of 25dm³. 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

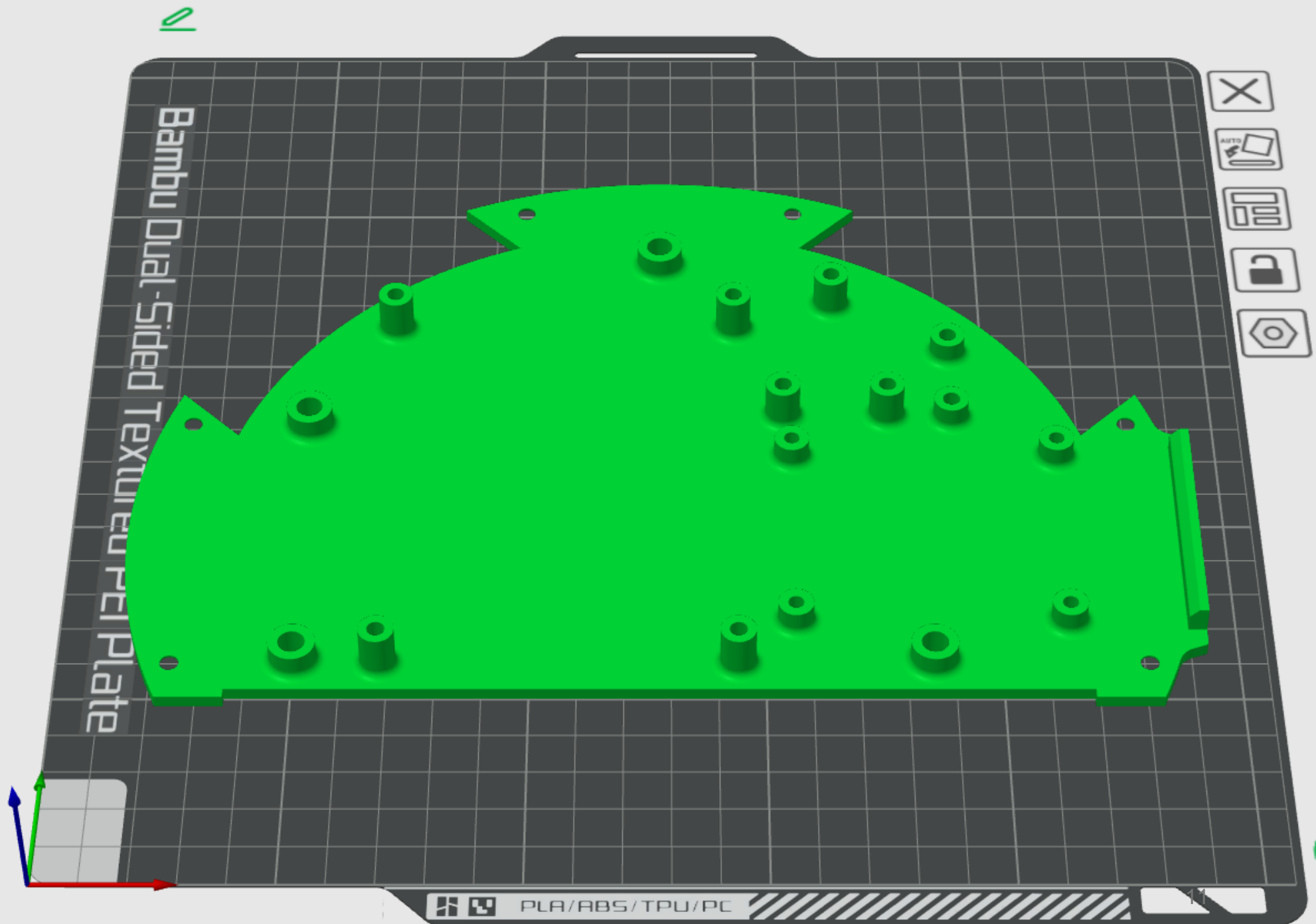
MANUFACTURING

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

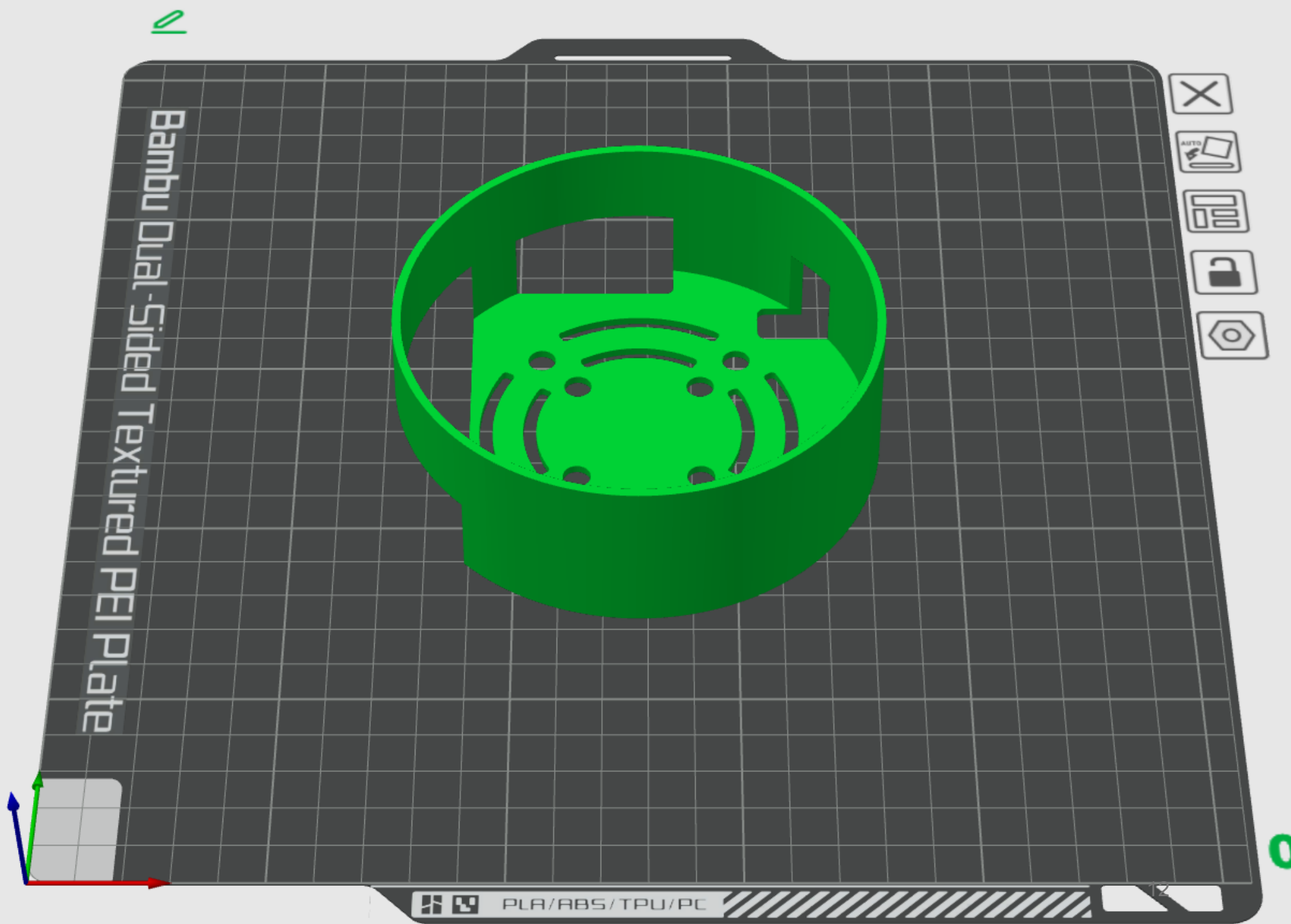


Cable box

Print parameters:

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

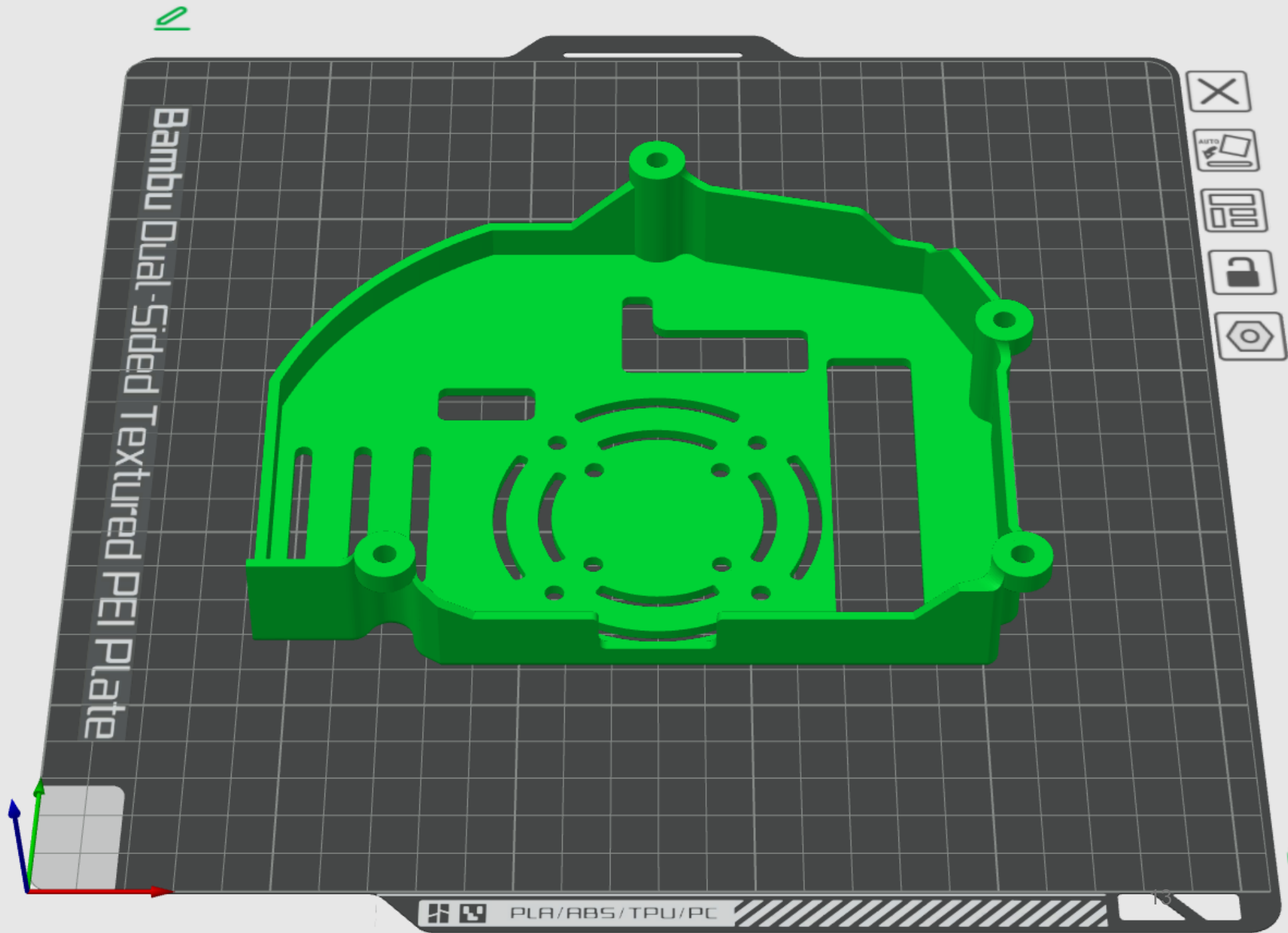
Note:
Support is required



Electronics cover

Print parameters:

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

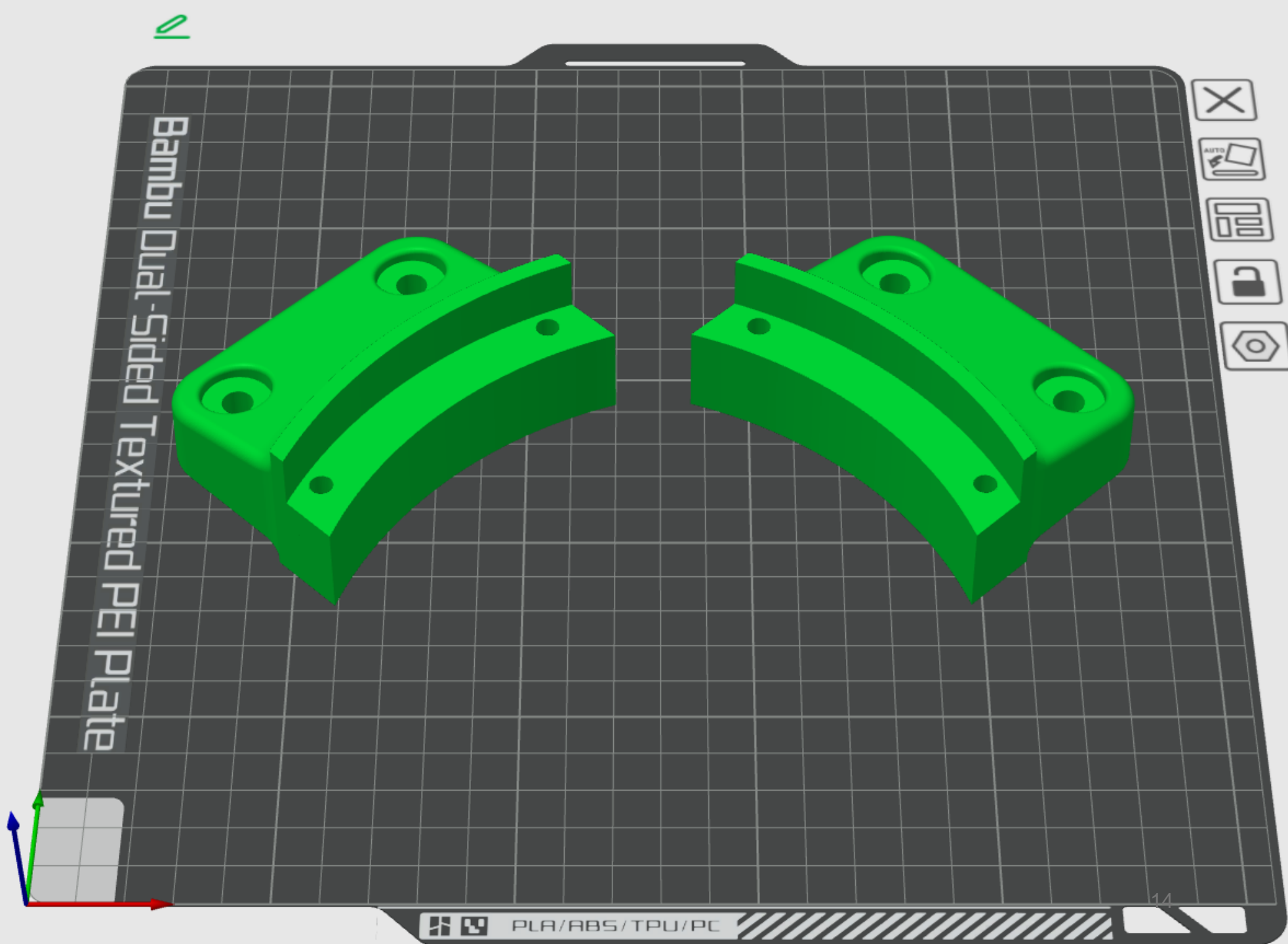


Note:
Support is required

Leg 1&2

Print parameters:

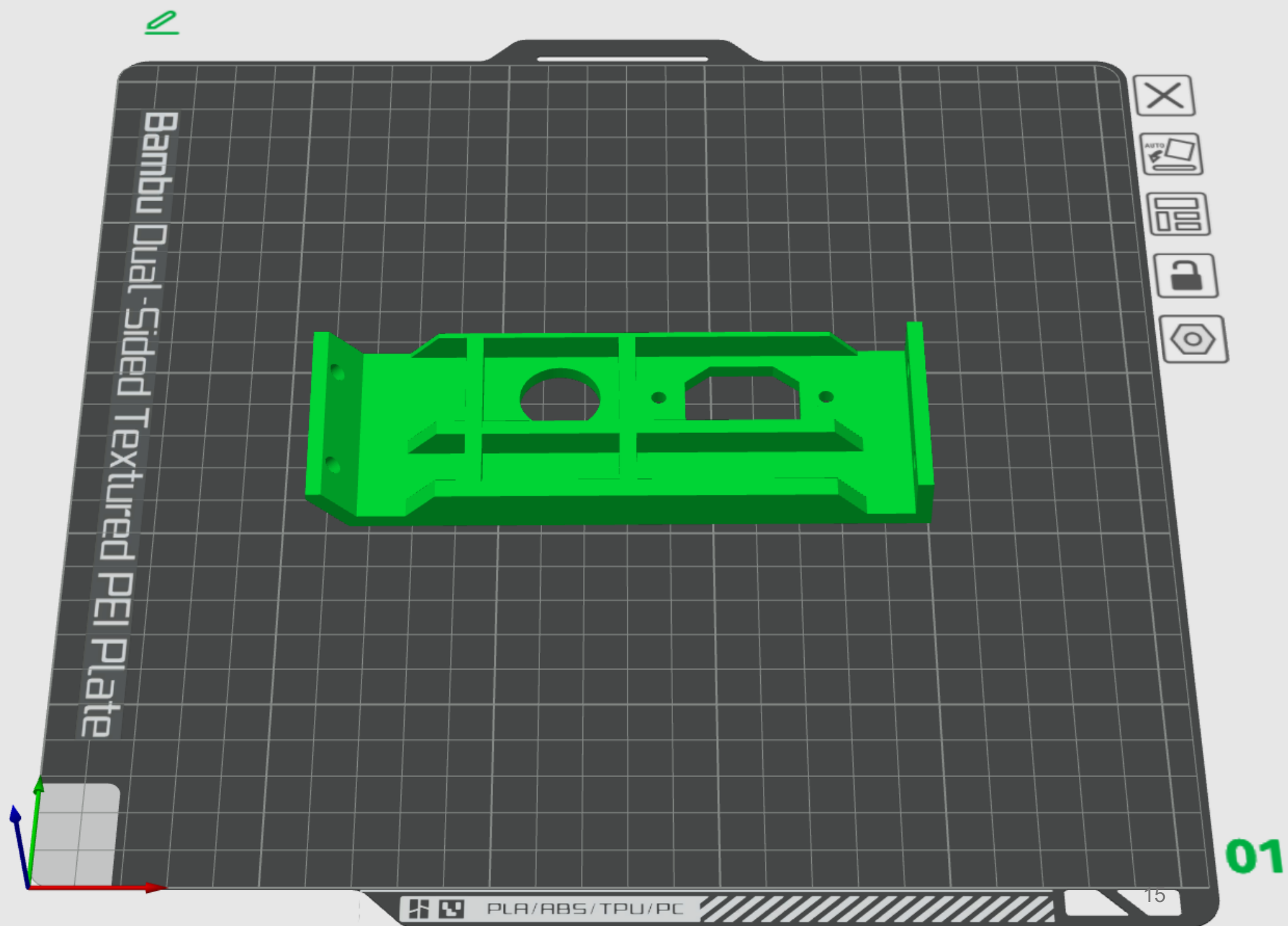
- Material: PETG
- Layer height: 0.2mm
- Infill: 20%
- Wall loops: 4



PSU front panel

Print parameters:

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

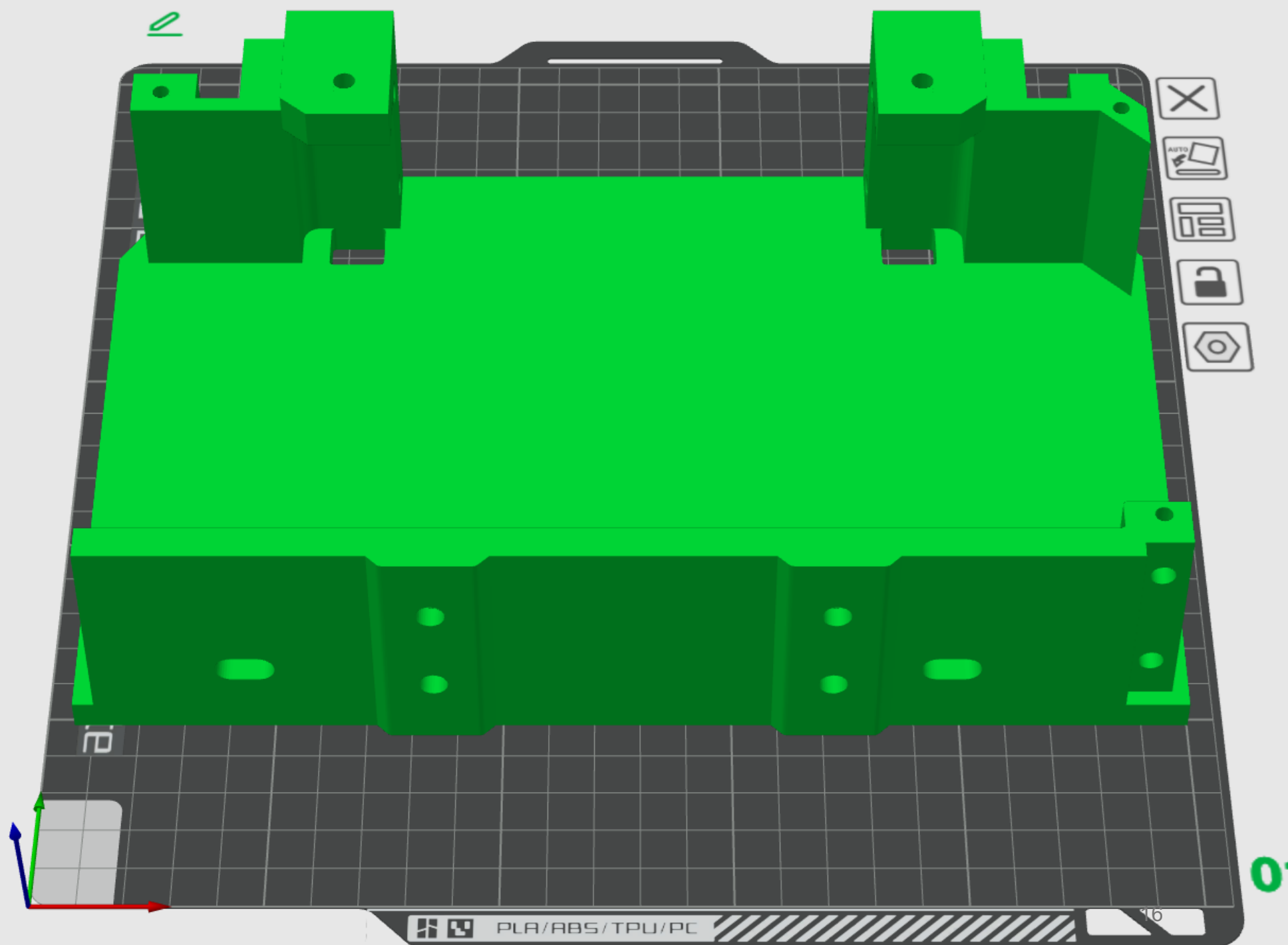


PSU box

Print parameters:

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

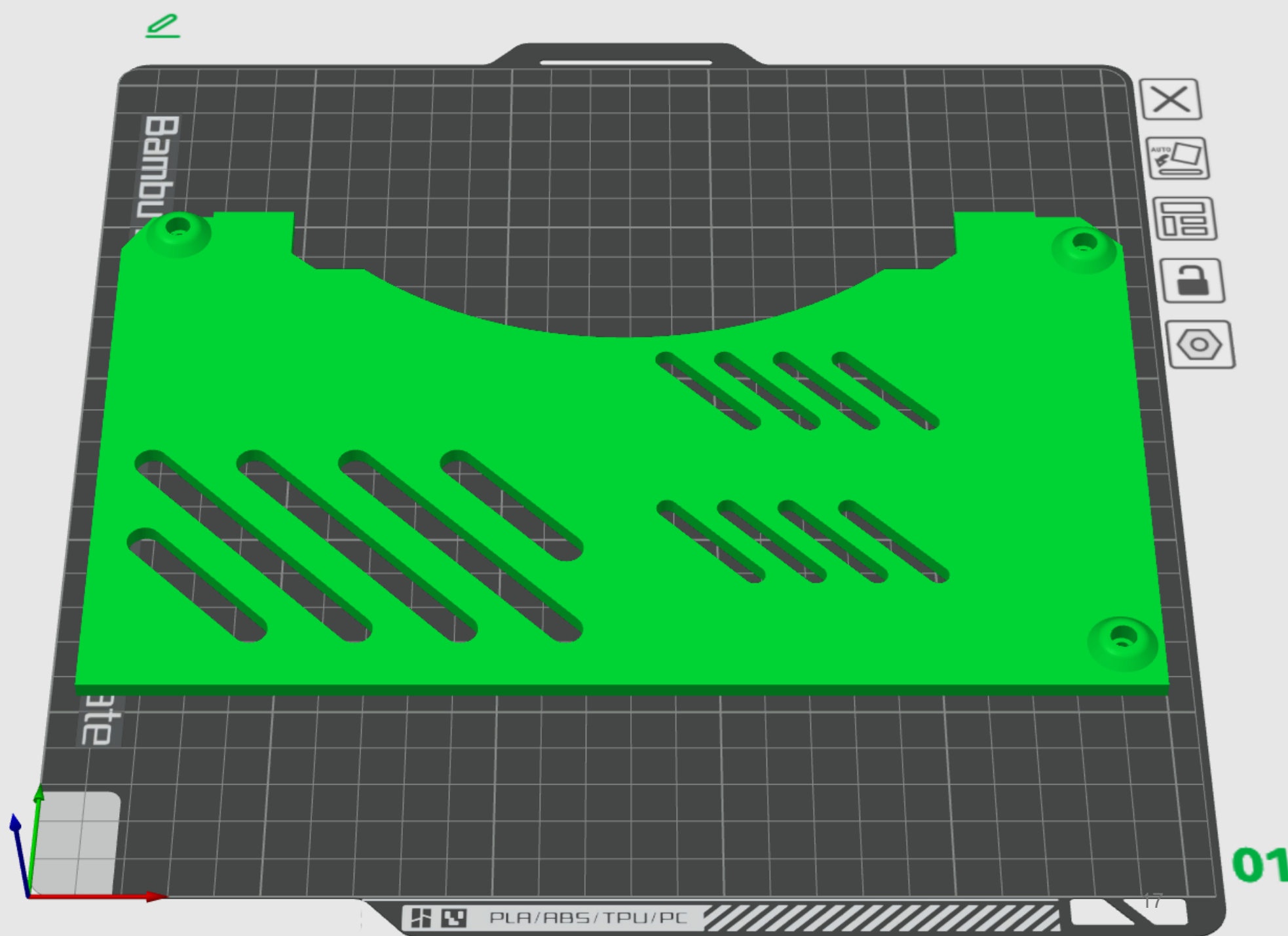
Note:
Support is required



PSU cover

Print parameters:

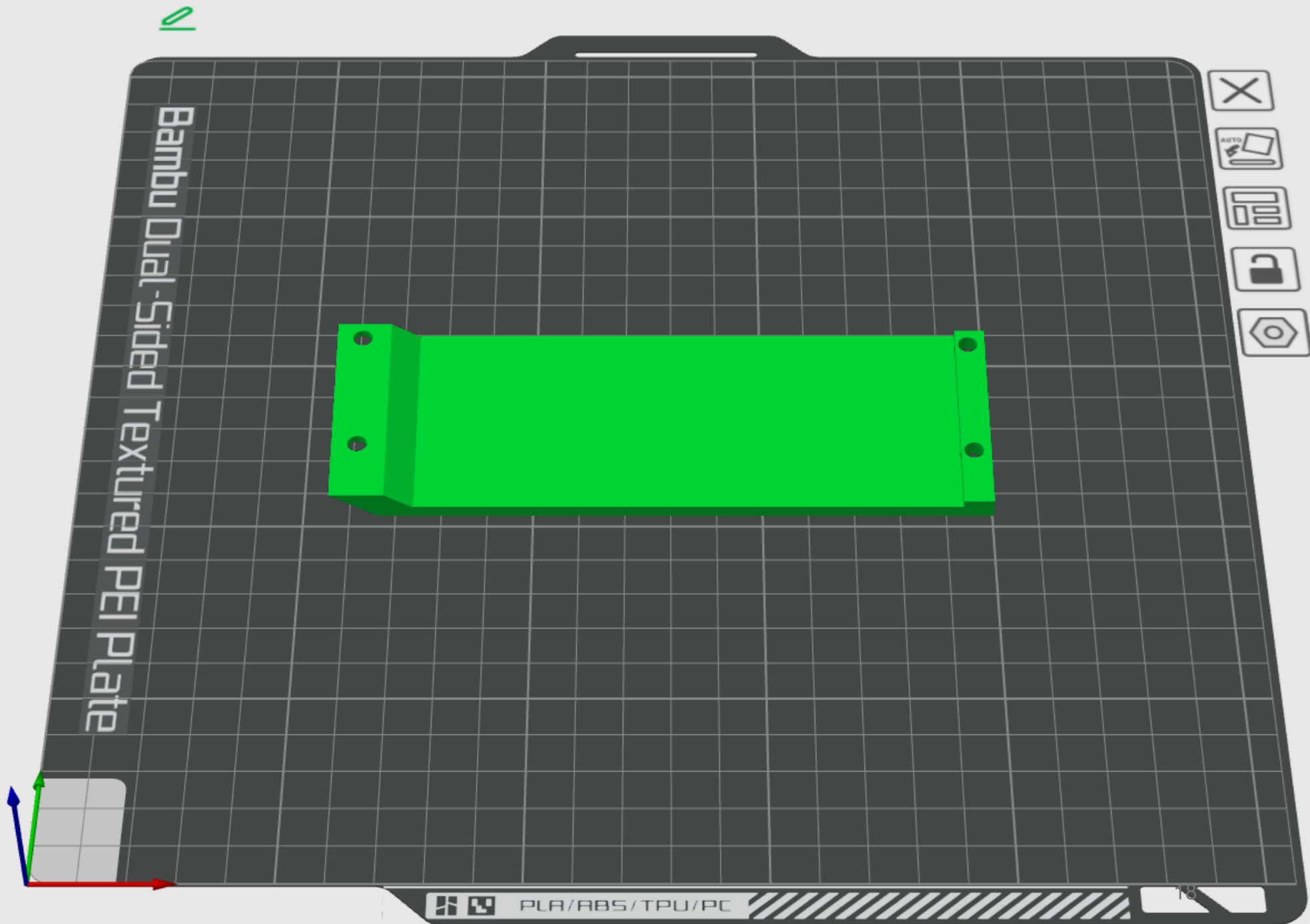
- Material: PETG
- Layer height: 0.2mm
- Infill: 15%
- Wall loops: 2



PSU rear wall

Print parameters:

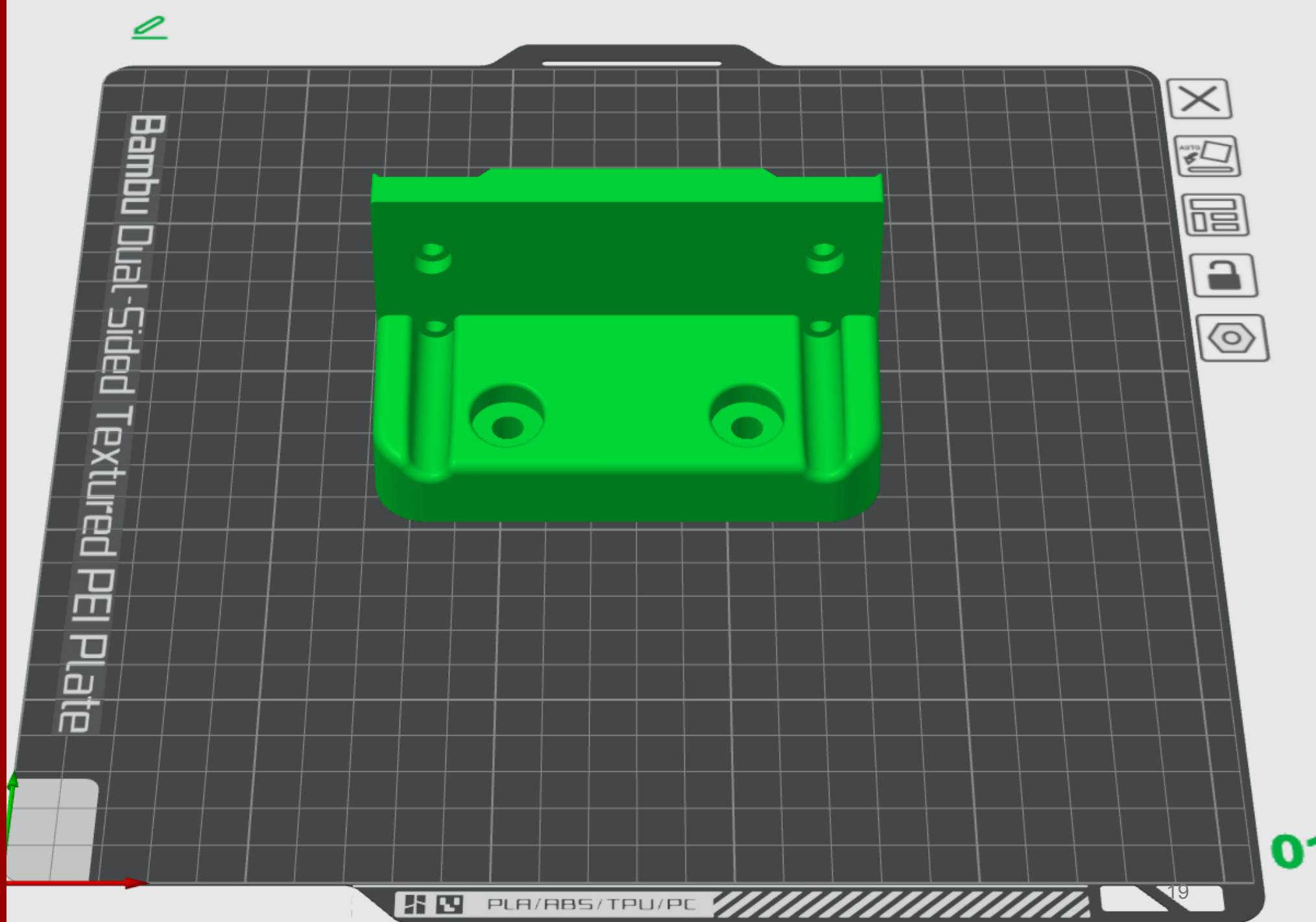
- Material: PETG
- Layer height: 0.2mm
- Infill: 15%
- Wall loops: 2



Rear leg

Print parameters:

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

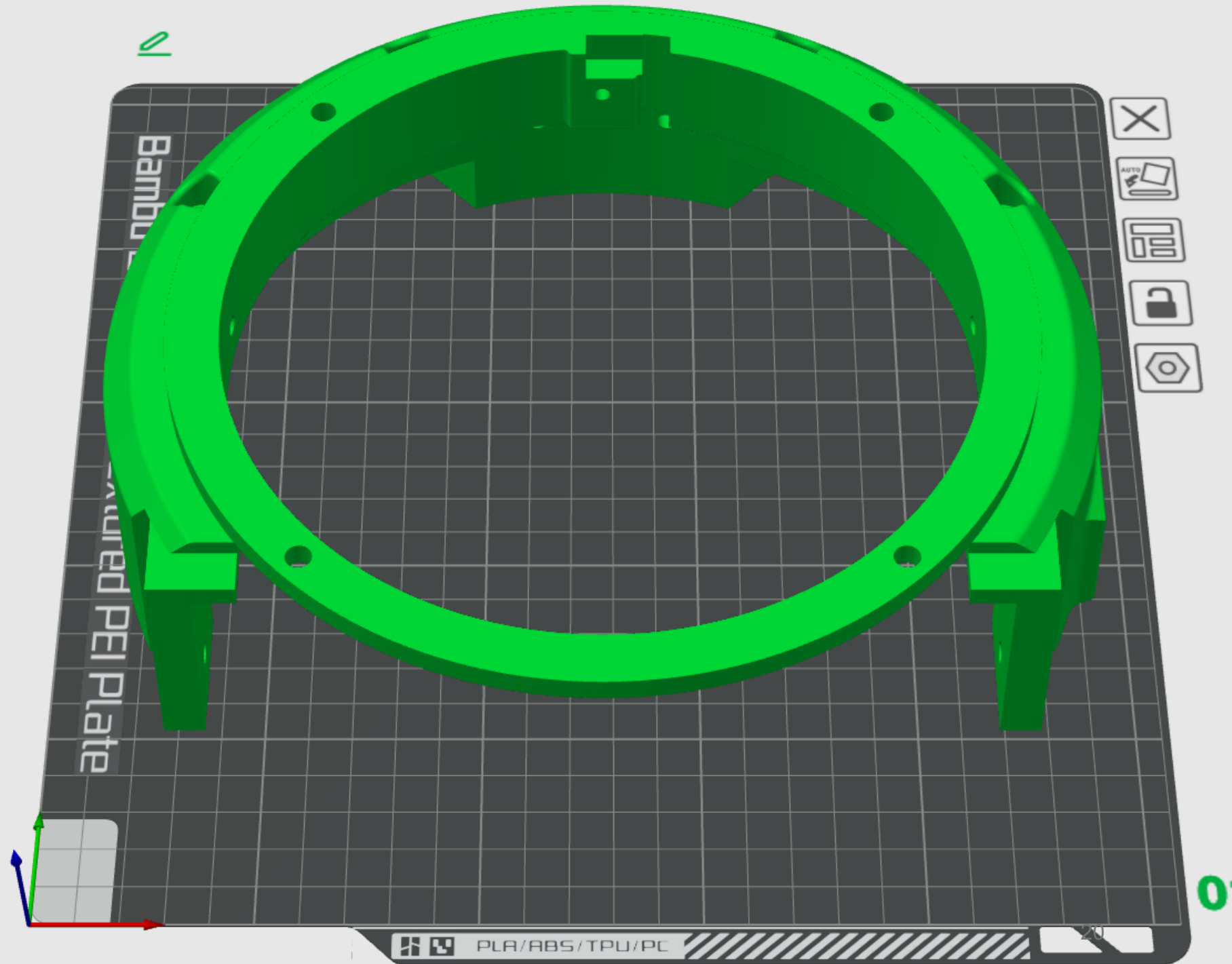


Robot base body

Print parameters:

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

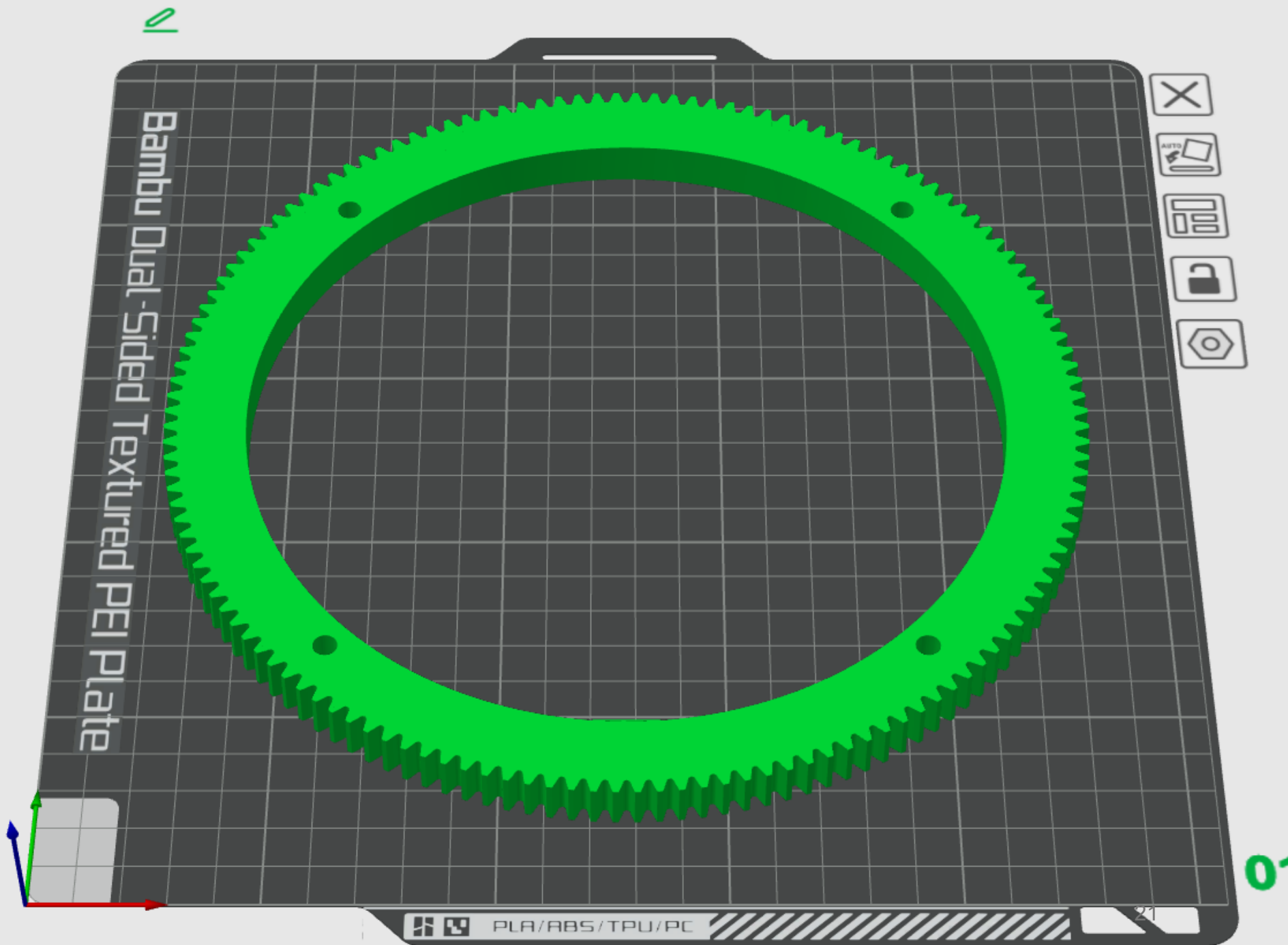
Note:
Support is required



Spur gear 140T

Print parameters:

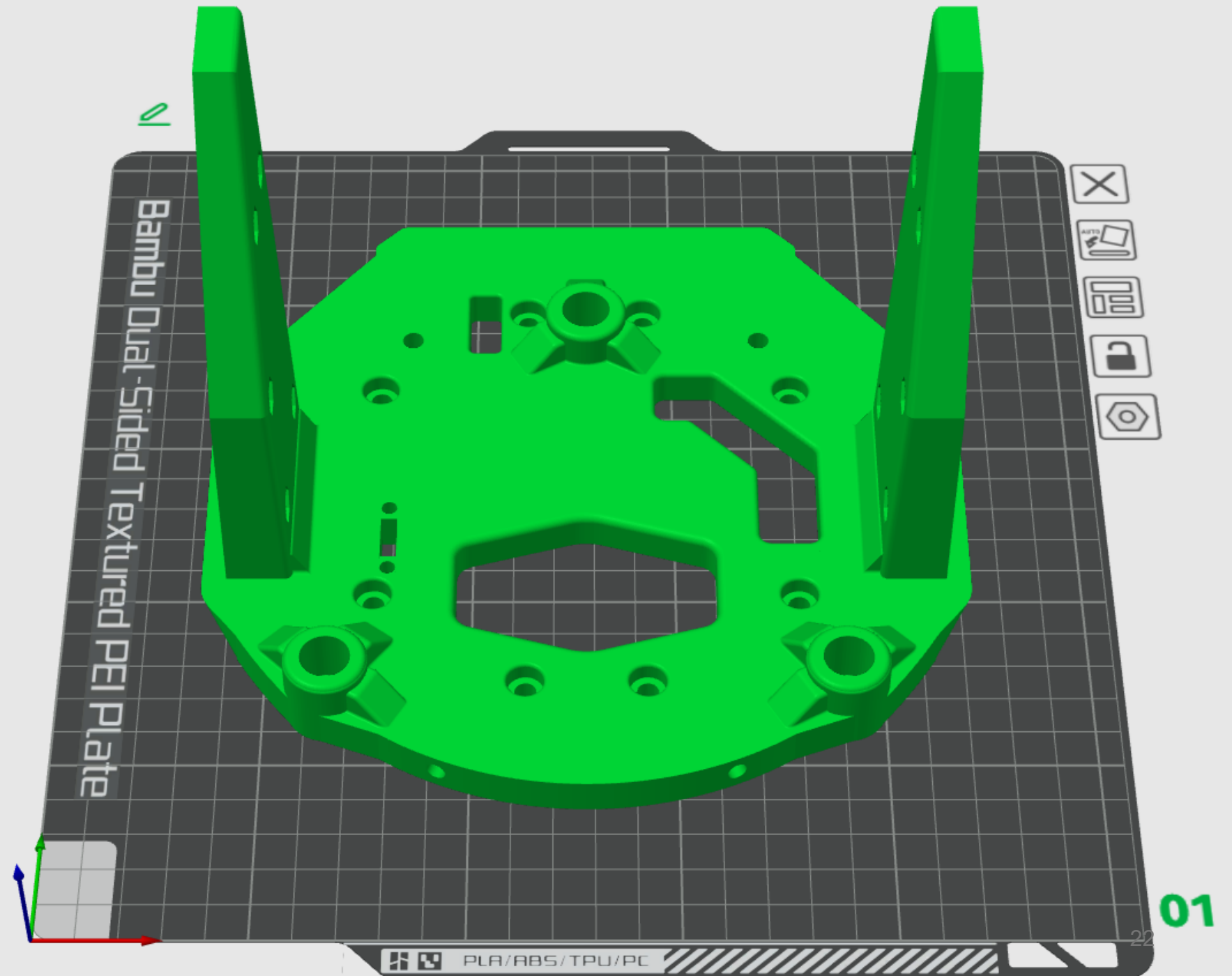
- Material: PETG
- Layer height: 0.1mm
- Infill: 100%
- Wall loops: 4



Shell mount

Print parameters:

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

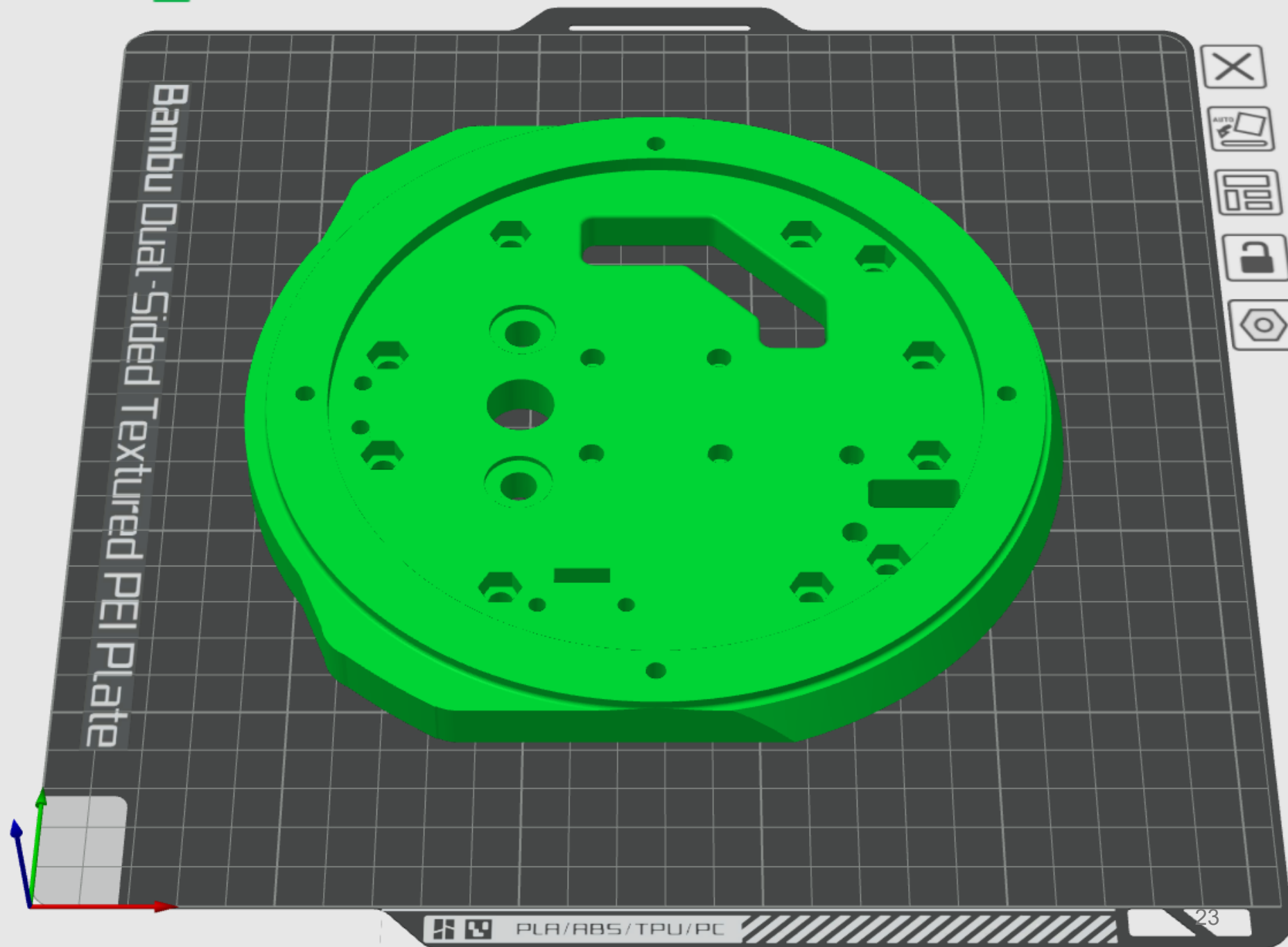


J1 base

Print parameters:

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

Note:
Support is required



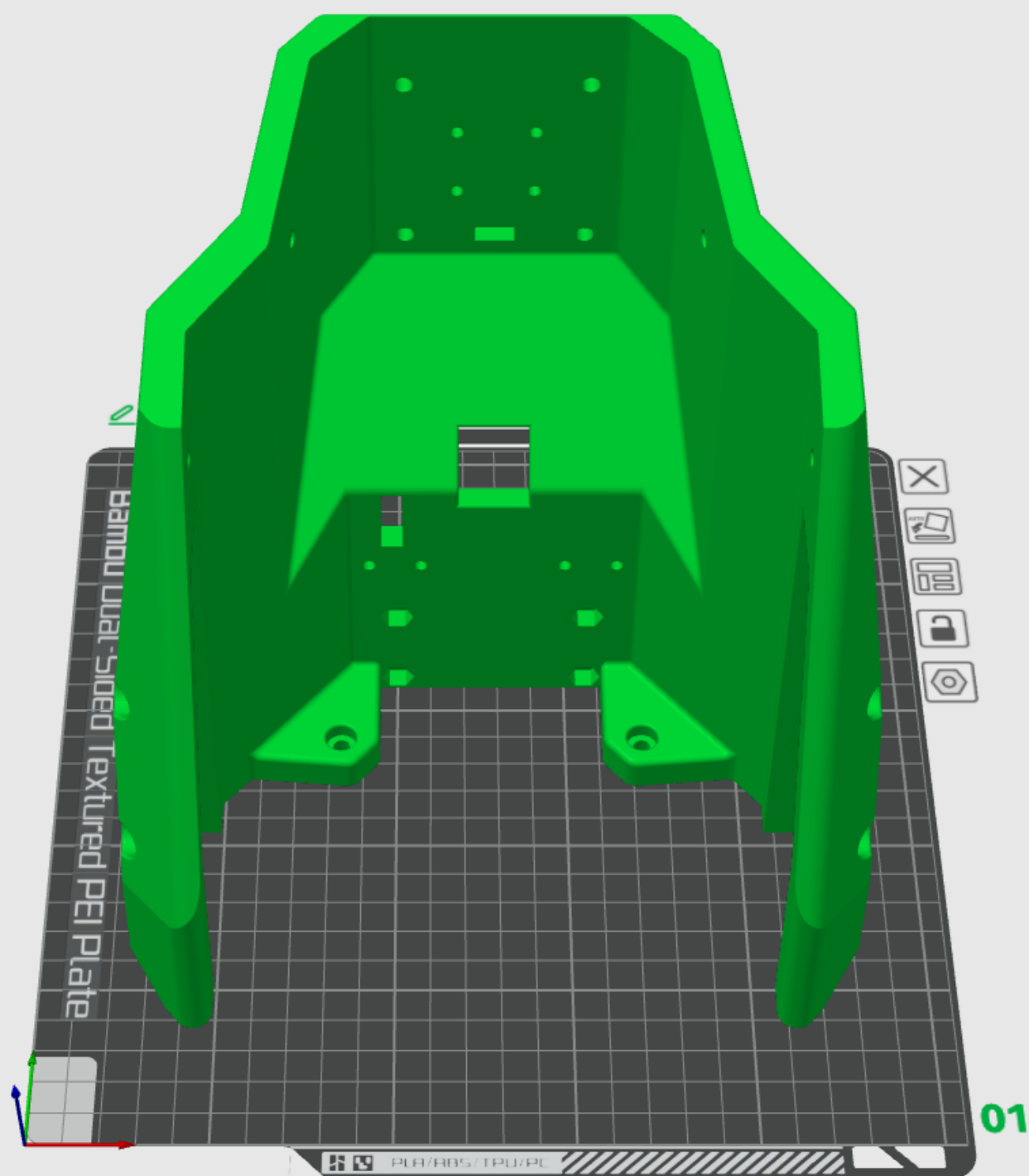
01

Bottom shell

Print parameters:

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

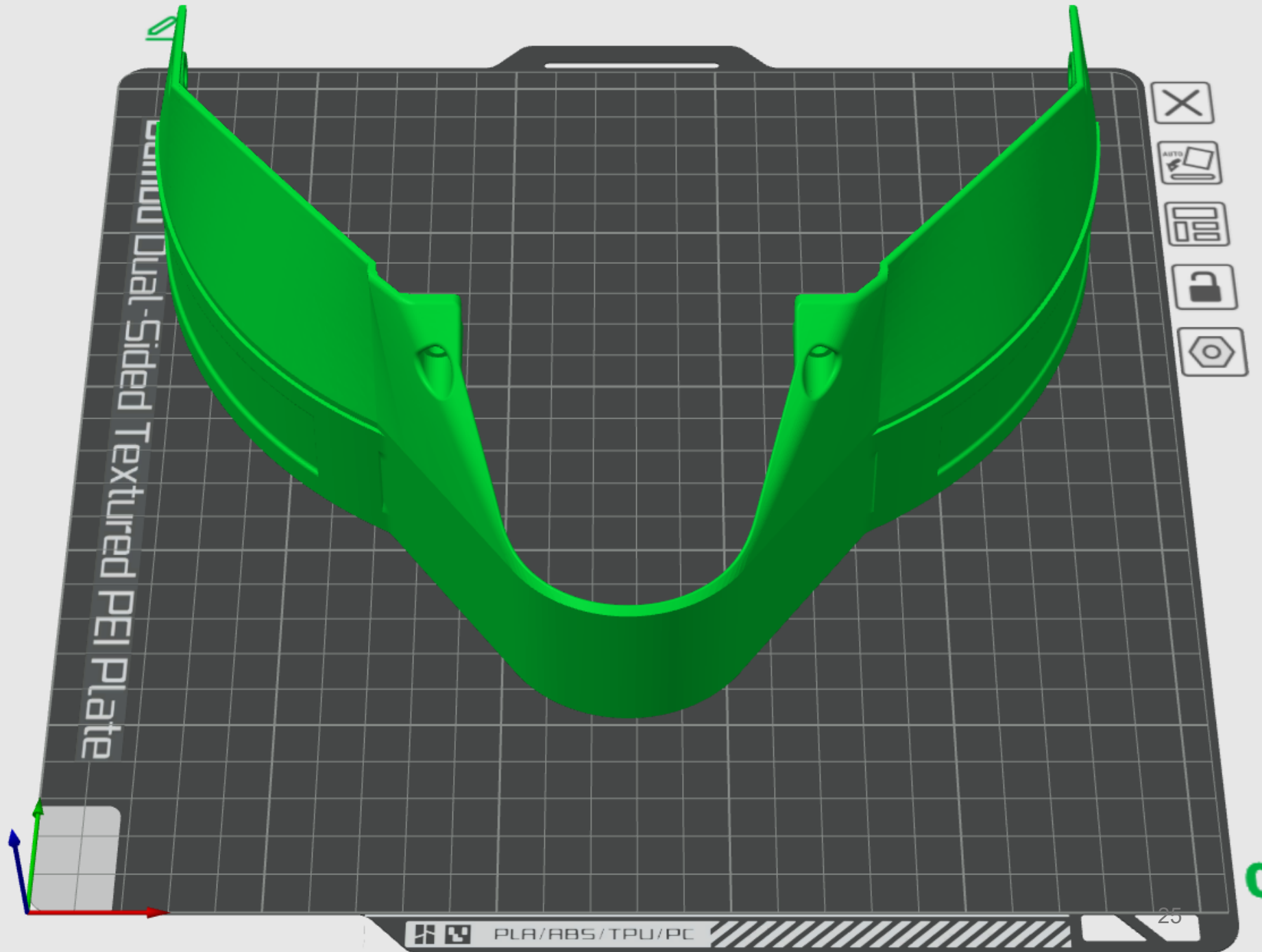
Note:
Support is required



Rear cover

Print parameters:

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



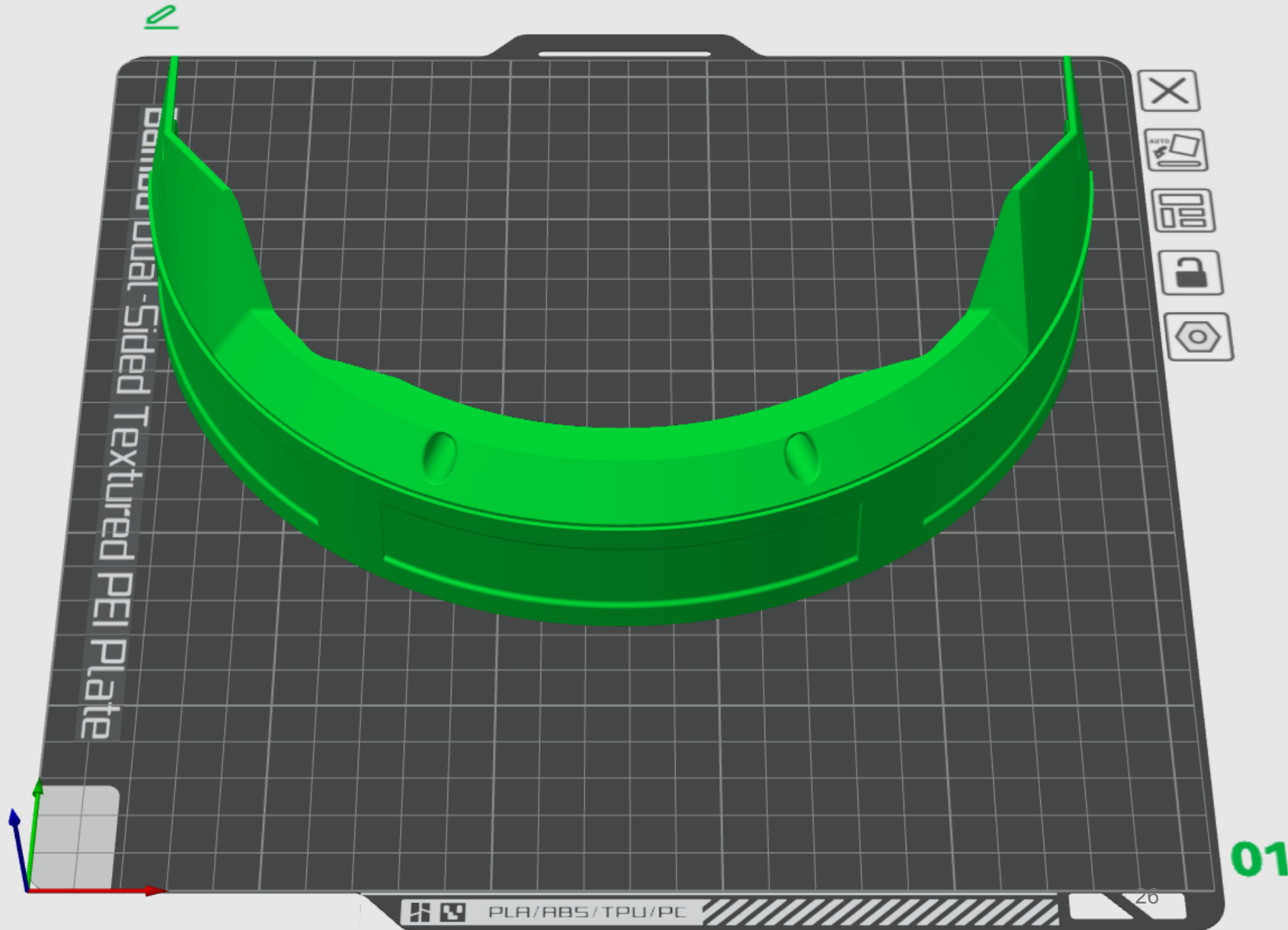
Note:
Support is required

Front cover

Print parameters:

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

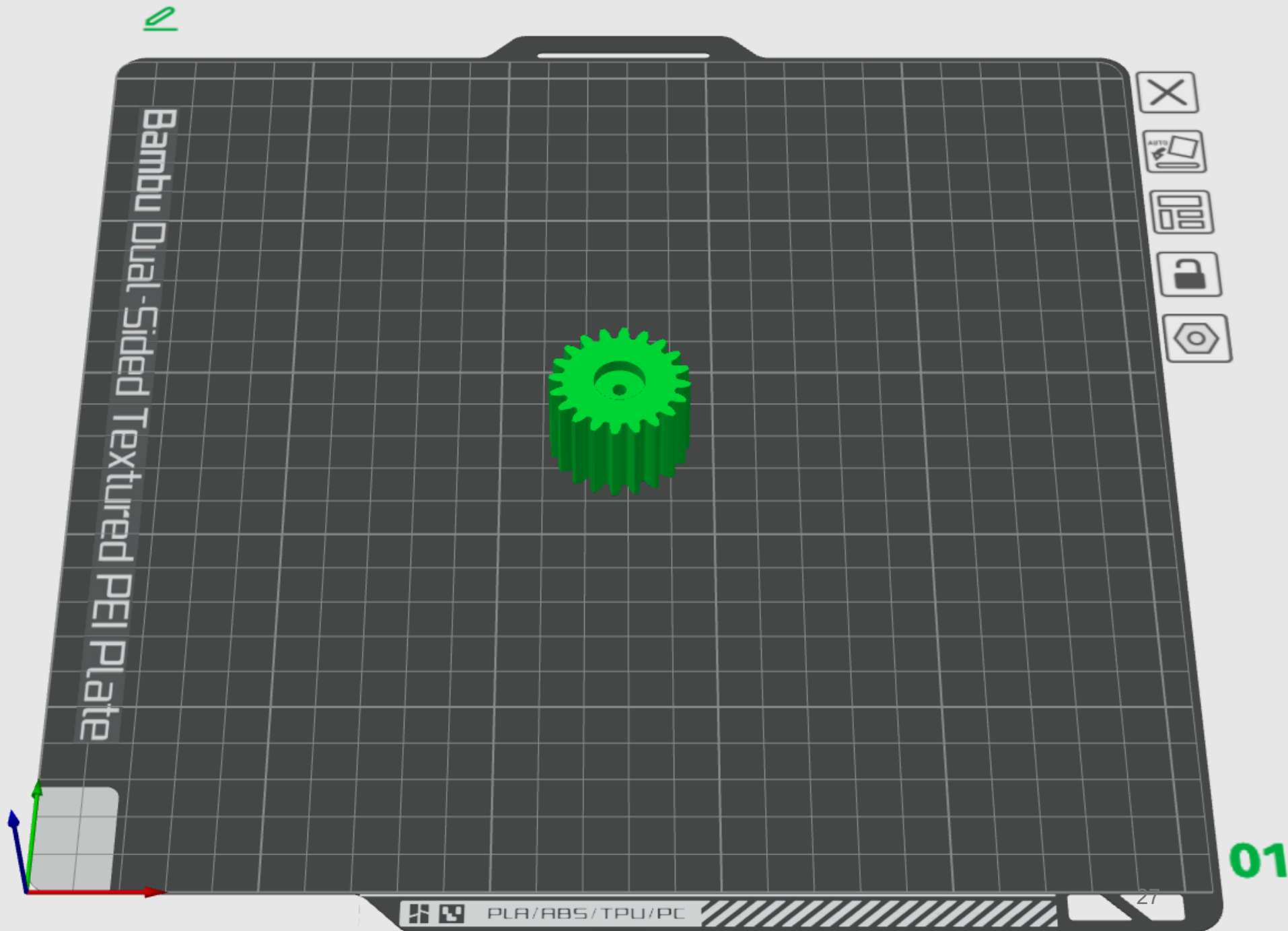
Note:
Support is required



Spur gear 20T

Print parameters:

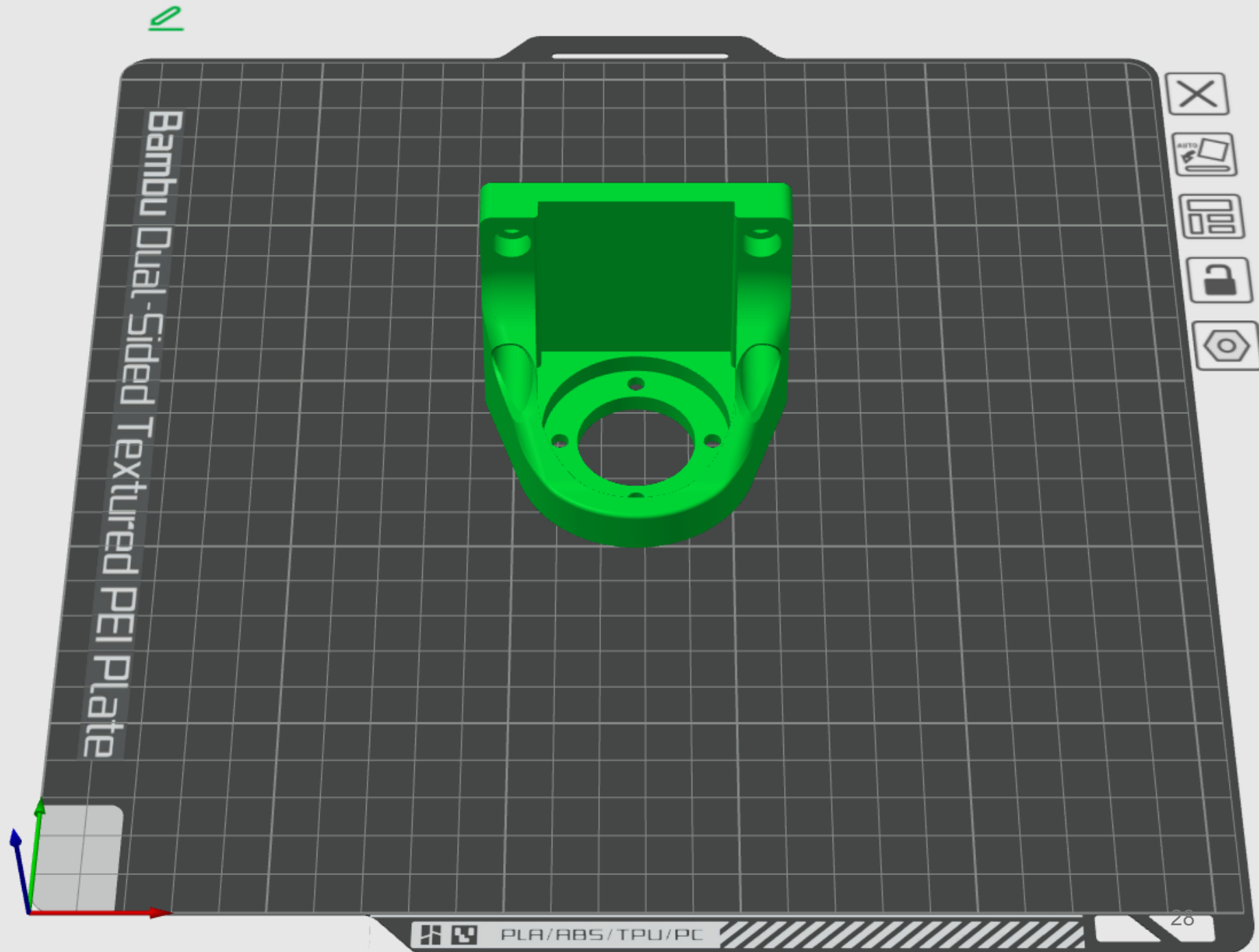
- Material: PETG
- Layer height: 0.1mm
- Infill: 100%
- Wall loops: 4



M1 mount

Print parameters:

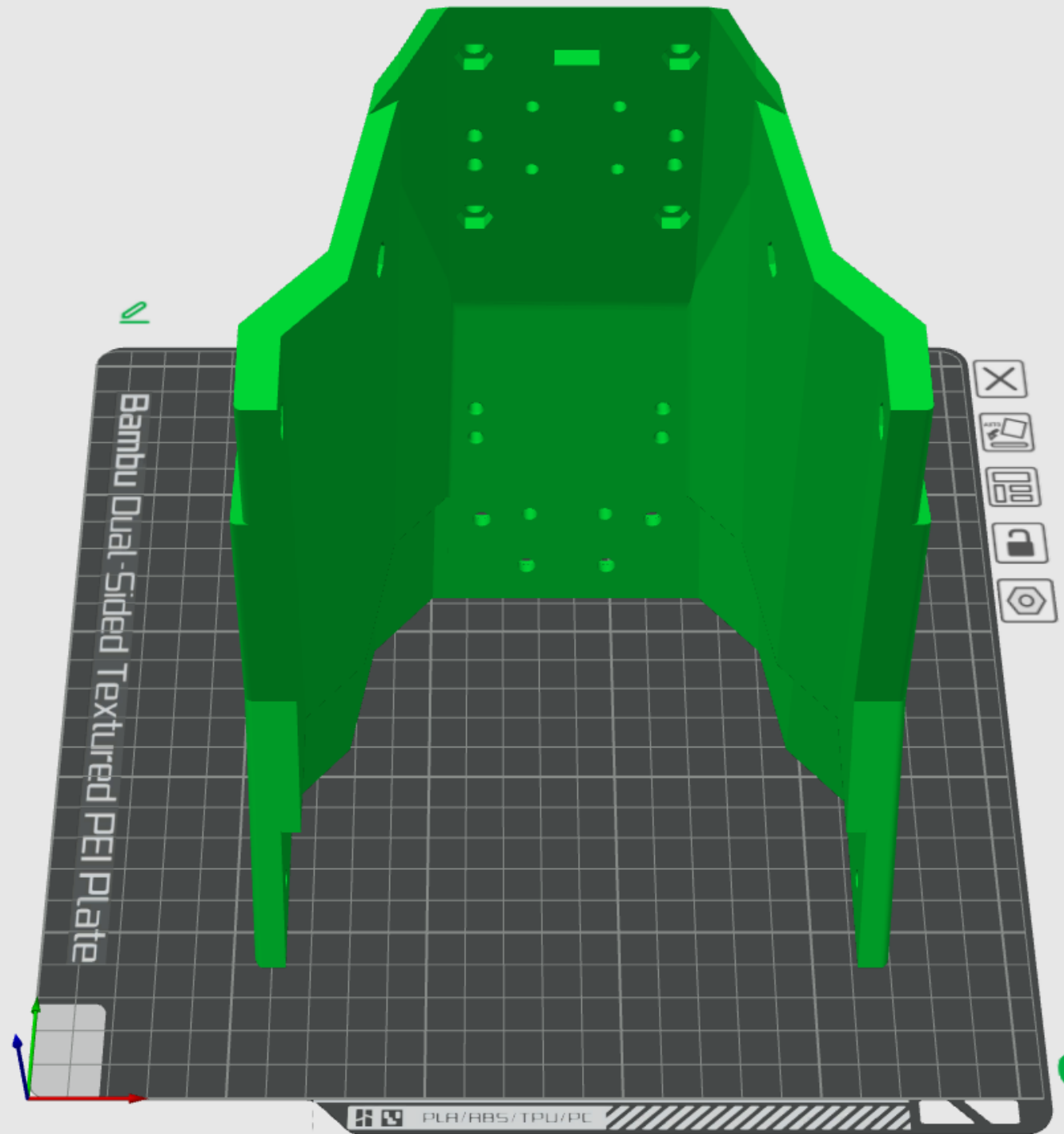
- Material: PETG
- Layer height: 0.2mm
- Infill: 20%
- Wall loops: 4



Middle shell

Print parameters:

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

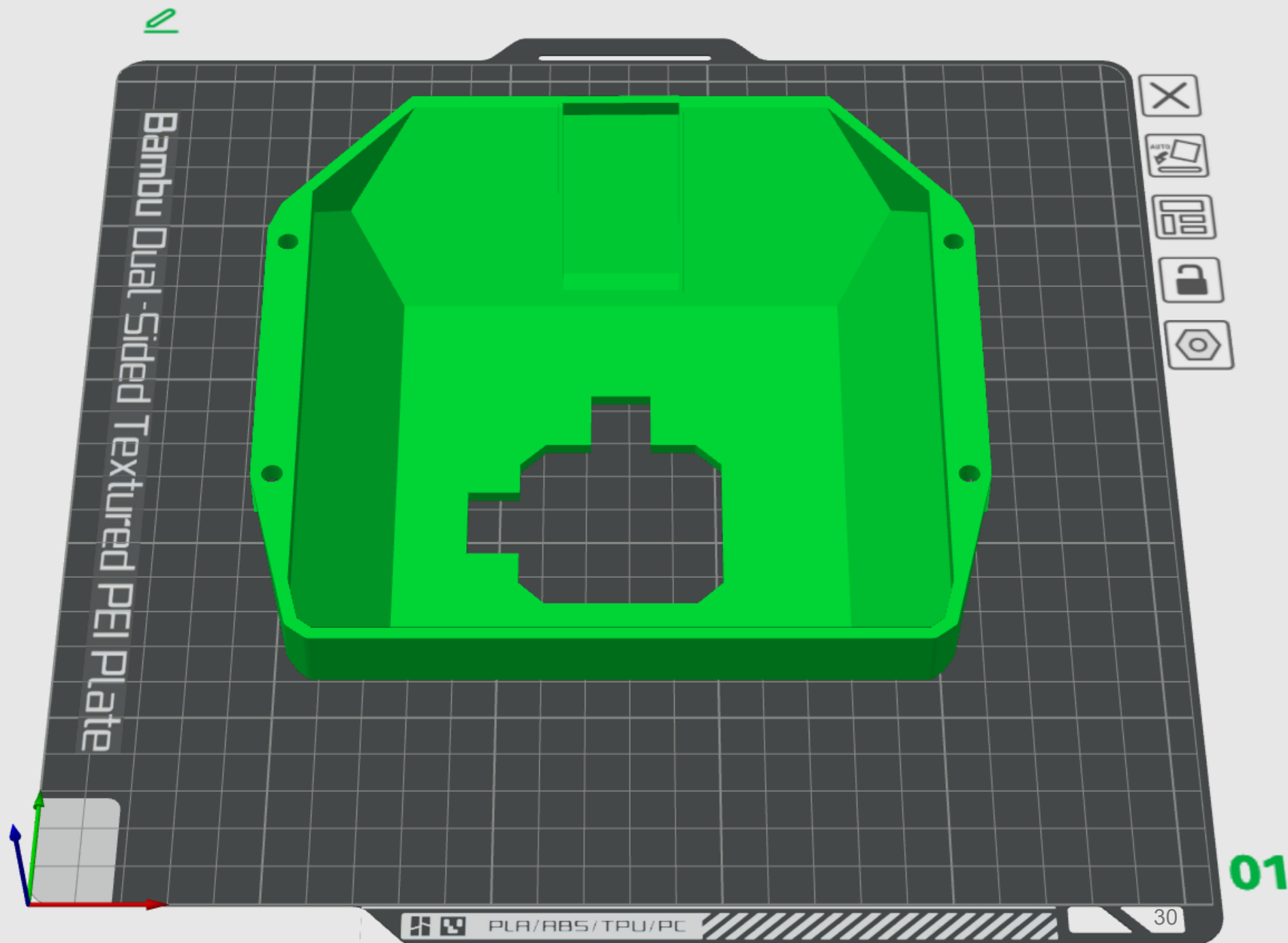


Note:
Support is required

Top cover

Print parameters:

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



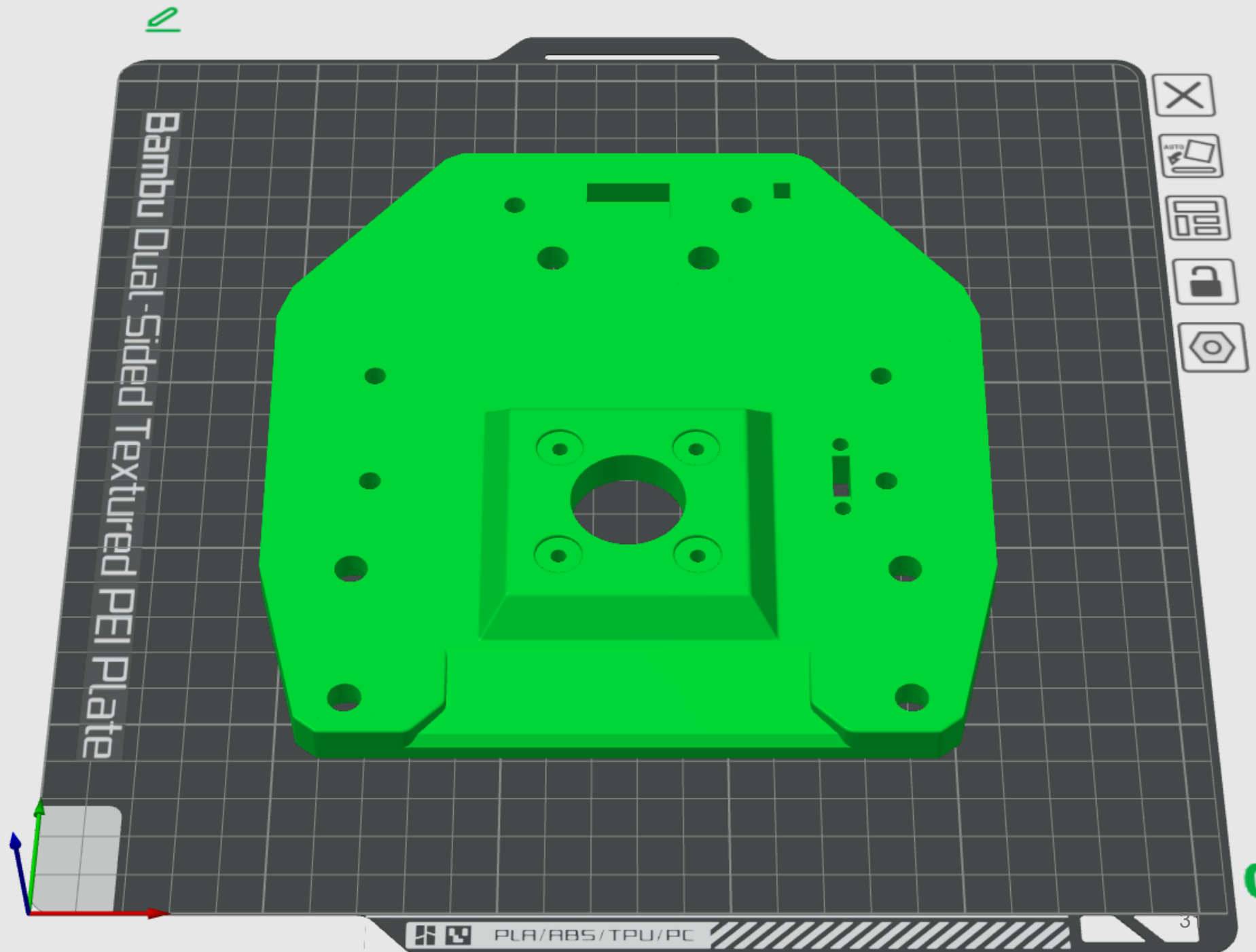
Note:
Support is required

Top mount

Print parameters:

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

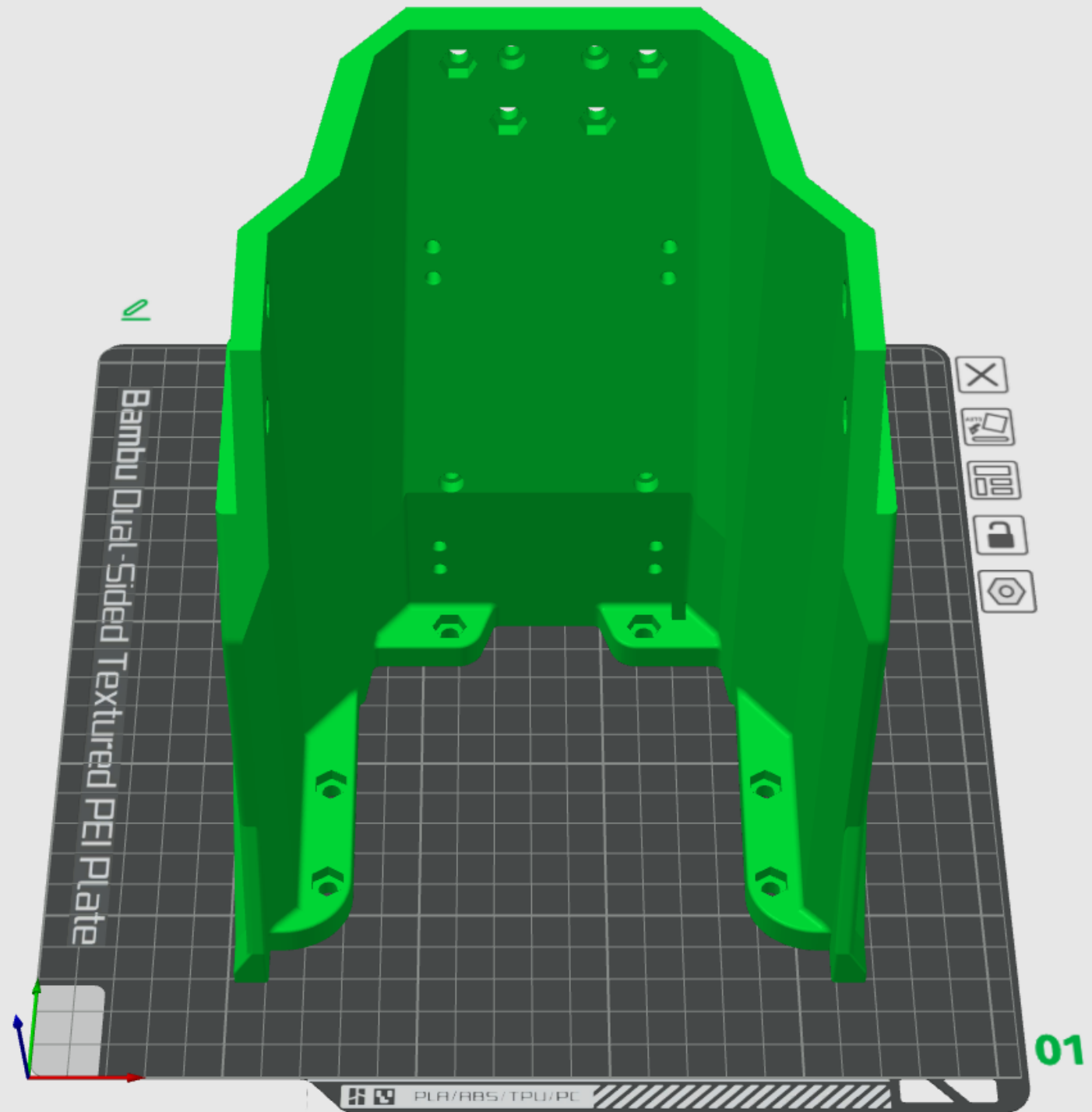
Note:
Support is required



Bottom shell

Print parameters:

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

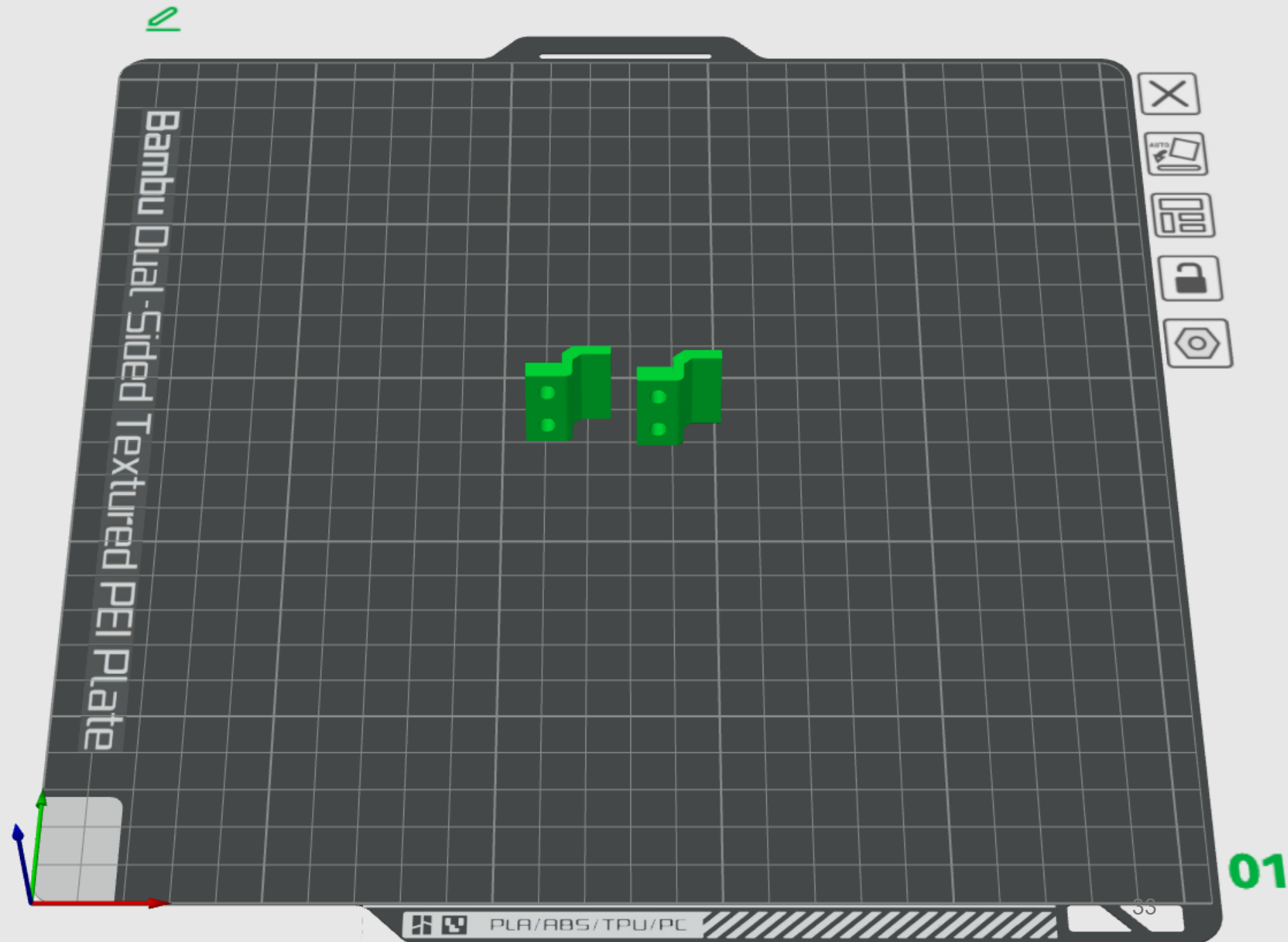


Note:
Support is required

J1 cable holder

Print parameters:

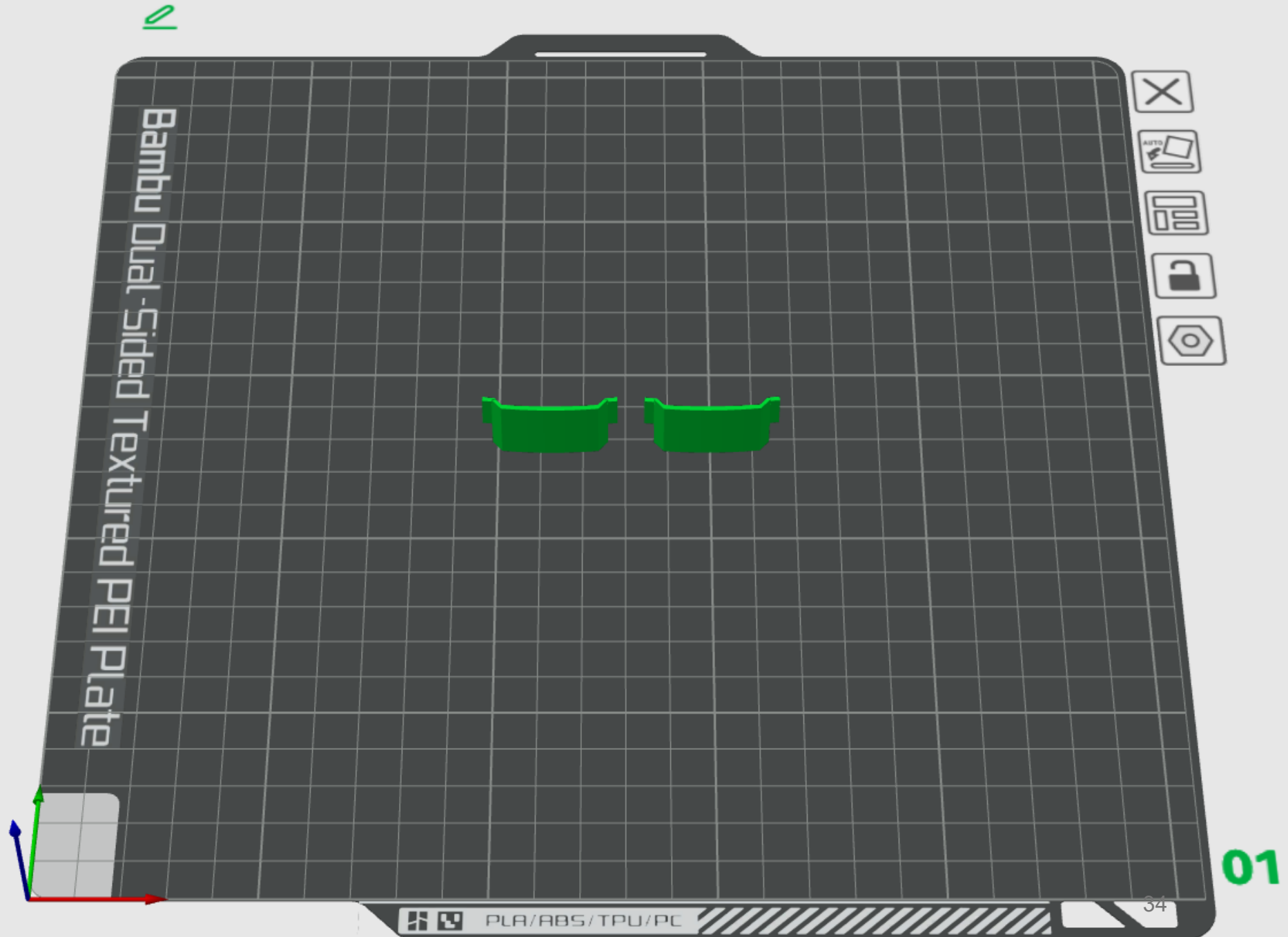
- Material: PETG
- Layer height: 0.2mm
- Infill: 15%
- Wall loops: 2



Cover clip 1&2

Print parameters:

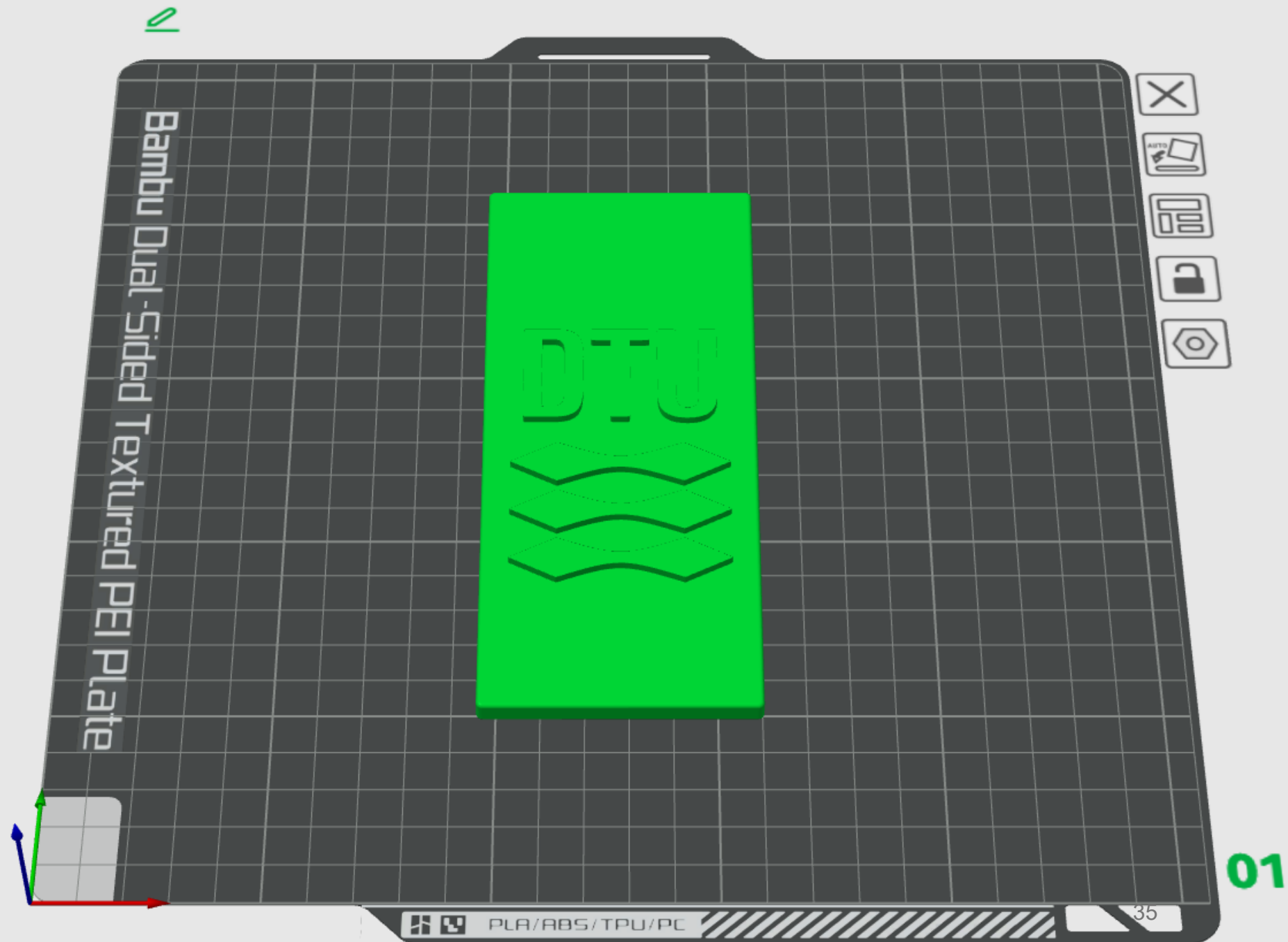
- Material: PETG
- Layer height: 0.2mm
- Infill: 15%
- Wall loops: 2



Logo

Print parameters:

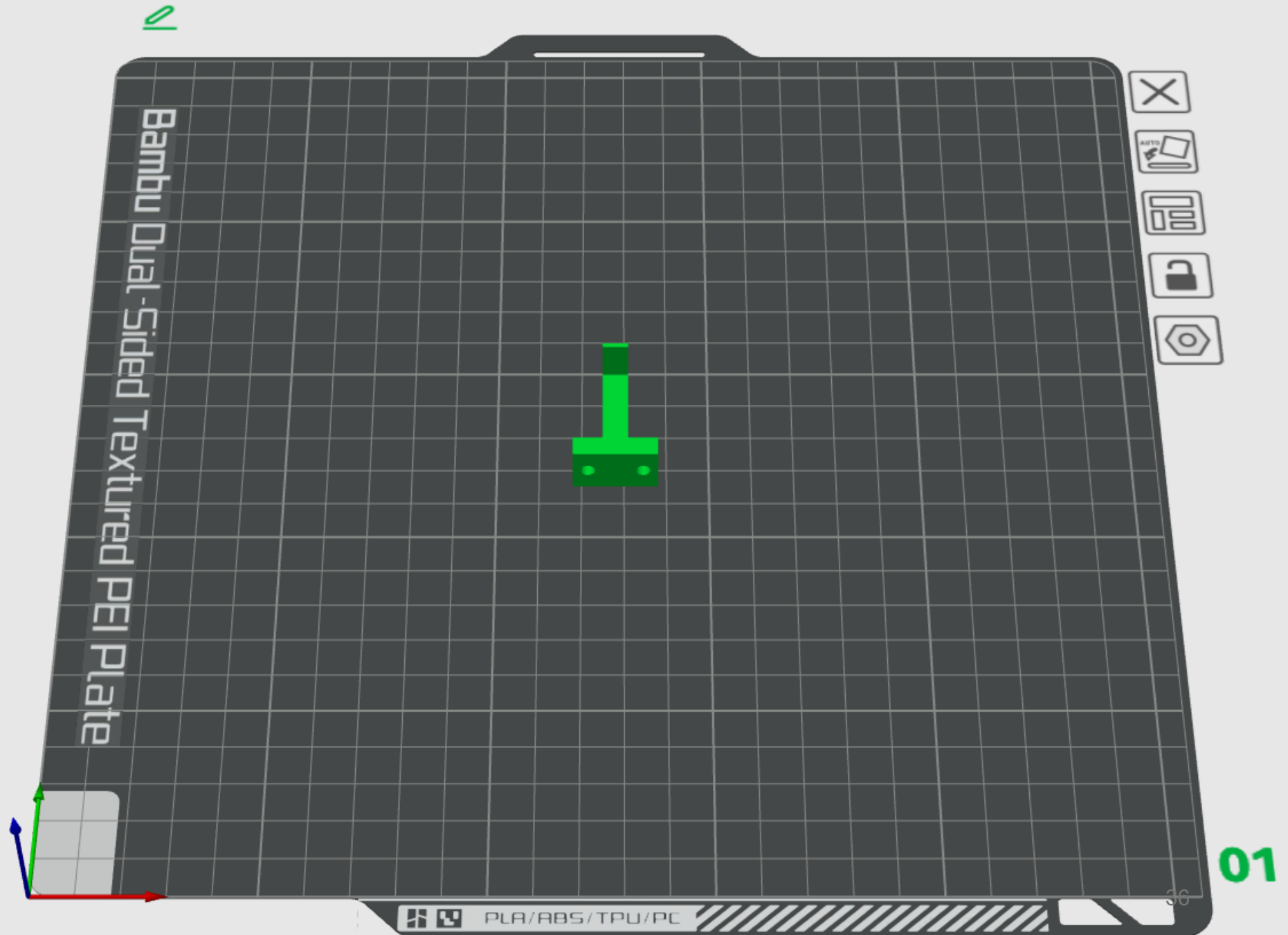
- Material: PETG
- Layer height: 0.2mm
- Infill: 15%
- Wall loops: 2



J1 sensor trigger

Print parameters:

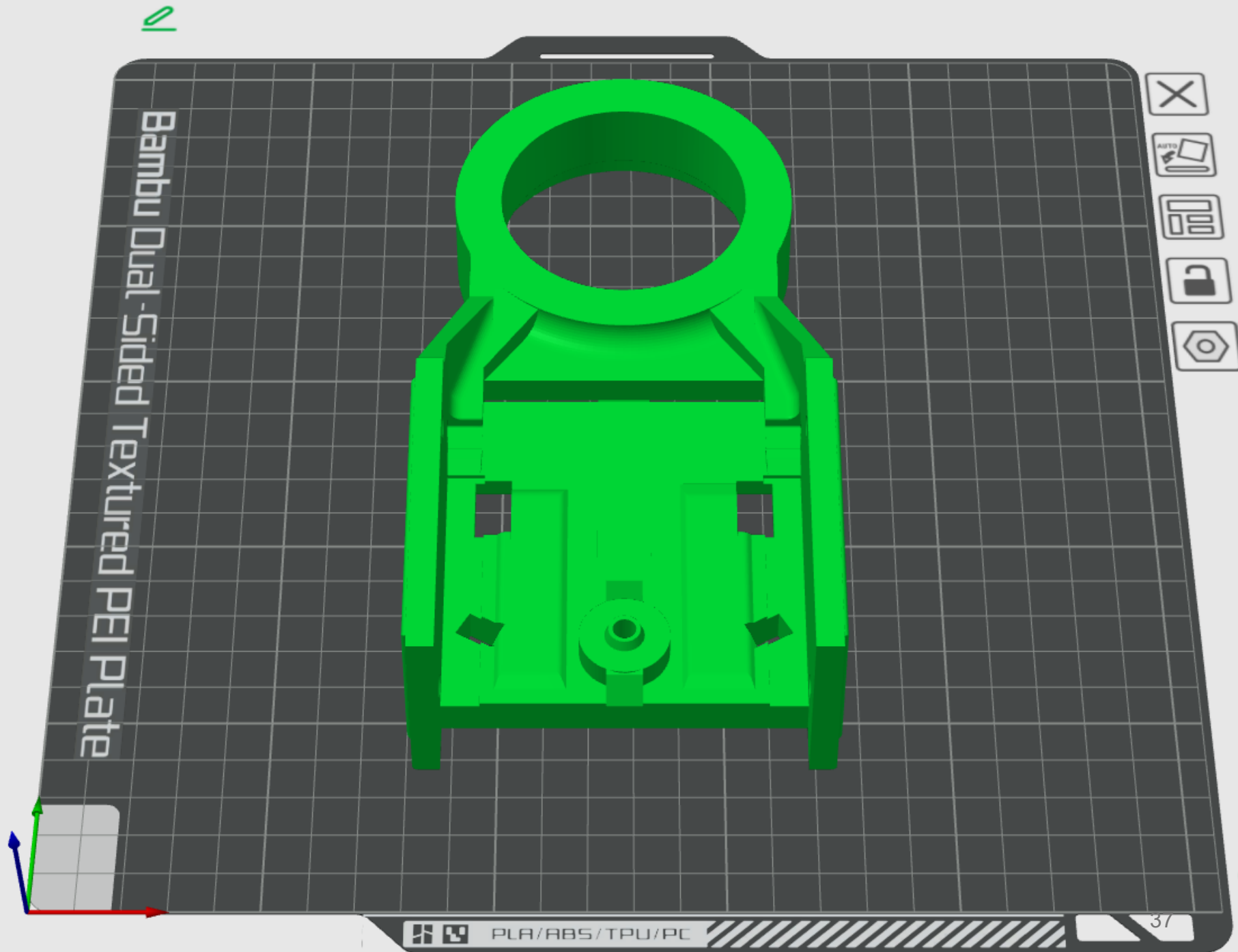
- Material: PETG
- Layer height: 0.2mm
- Infill: 20%
- Wall loops: 4



Arm link top

Print parameters:

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



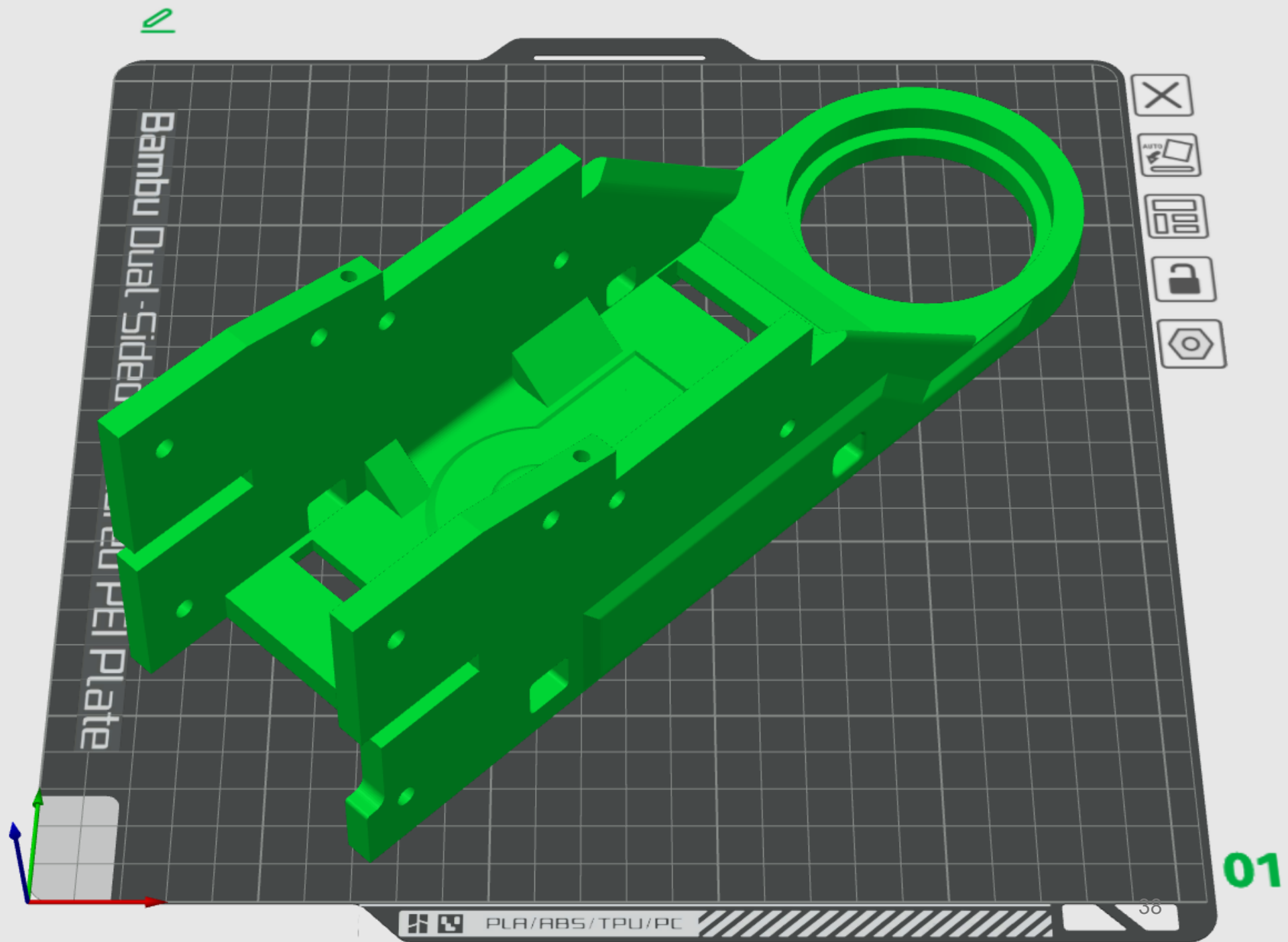
Note:
Support is required

Arm link bottom

Print parameters:

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

Note:
Support is required

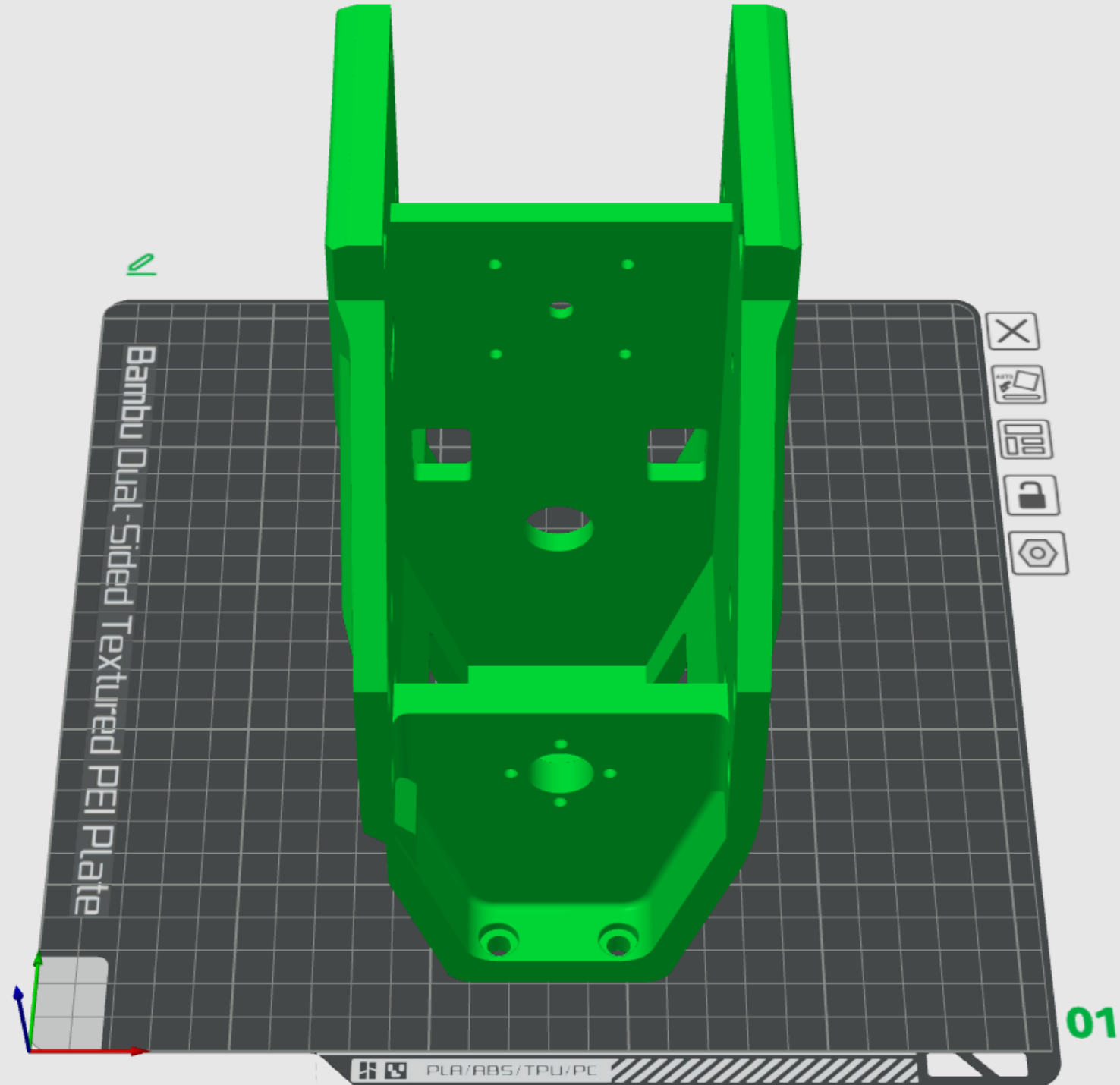


Arm mount

Print parameters:

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

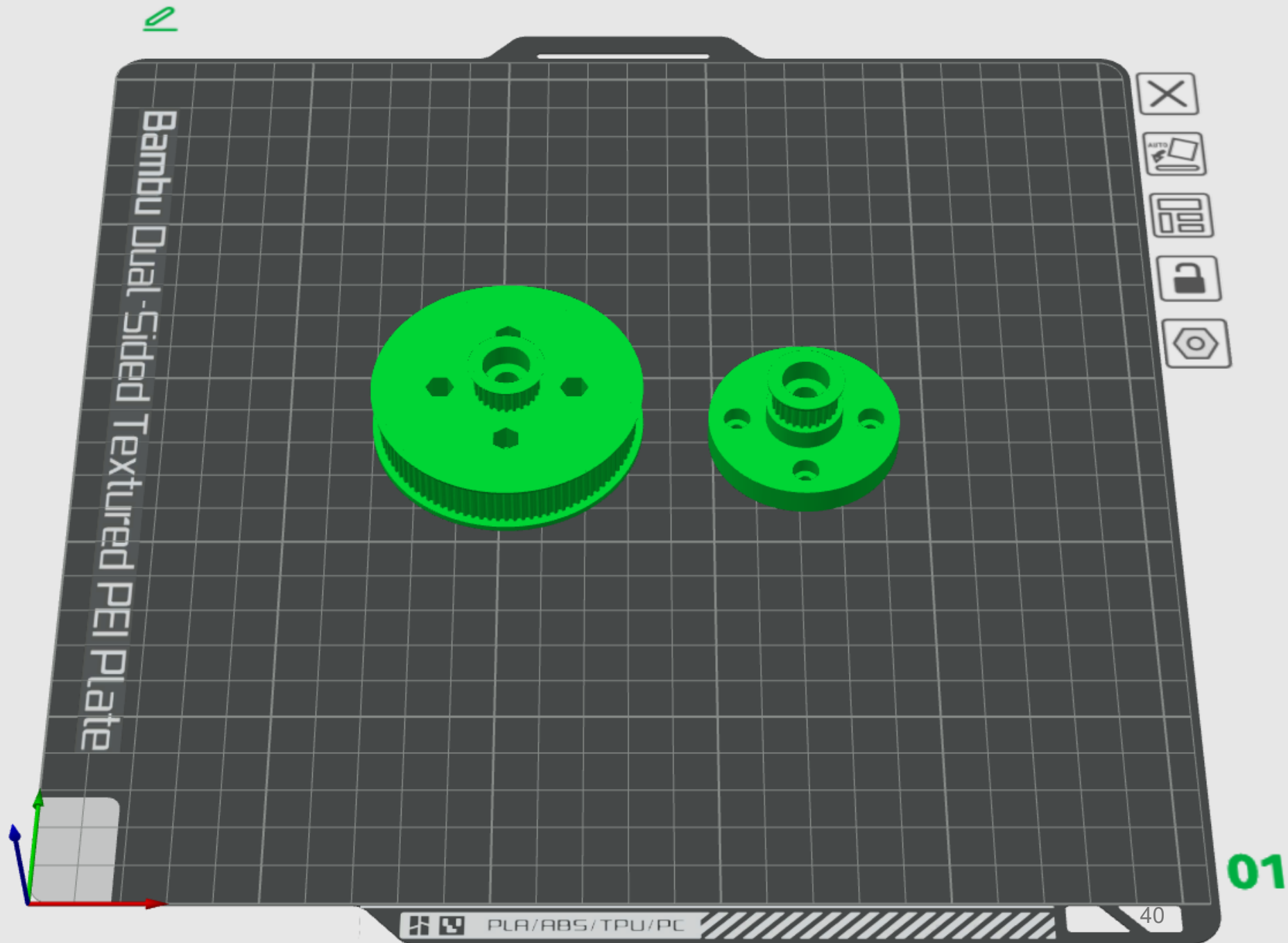
Note:
Support is required



Gear 25T & 96T

Print parameters:

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

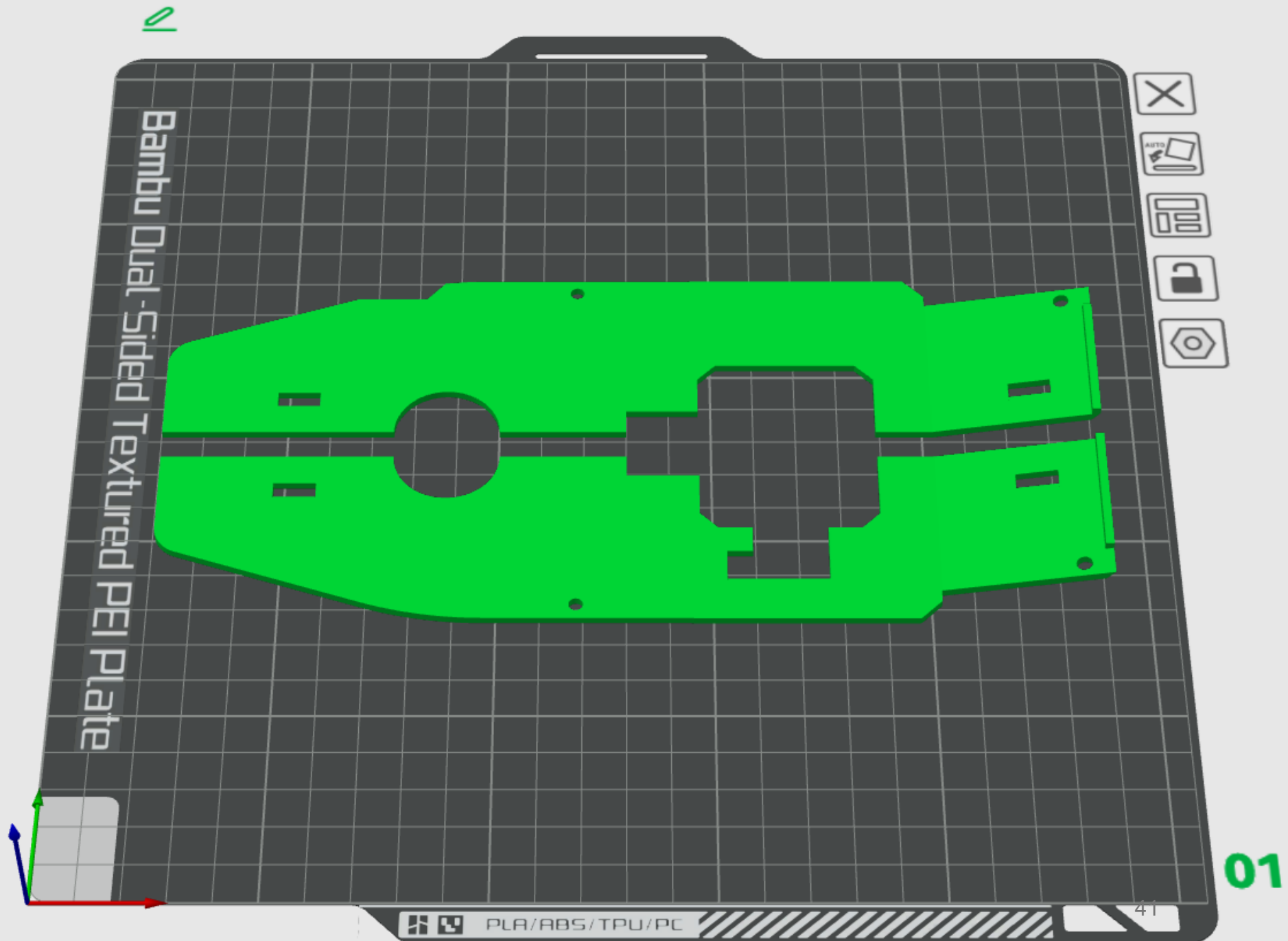


Arm cover 1&2

Print parameters:

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

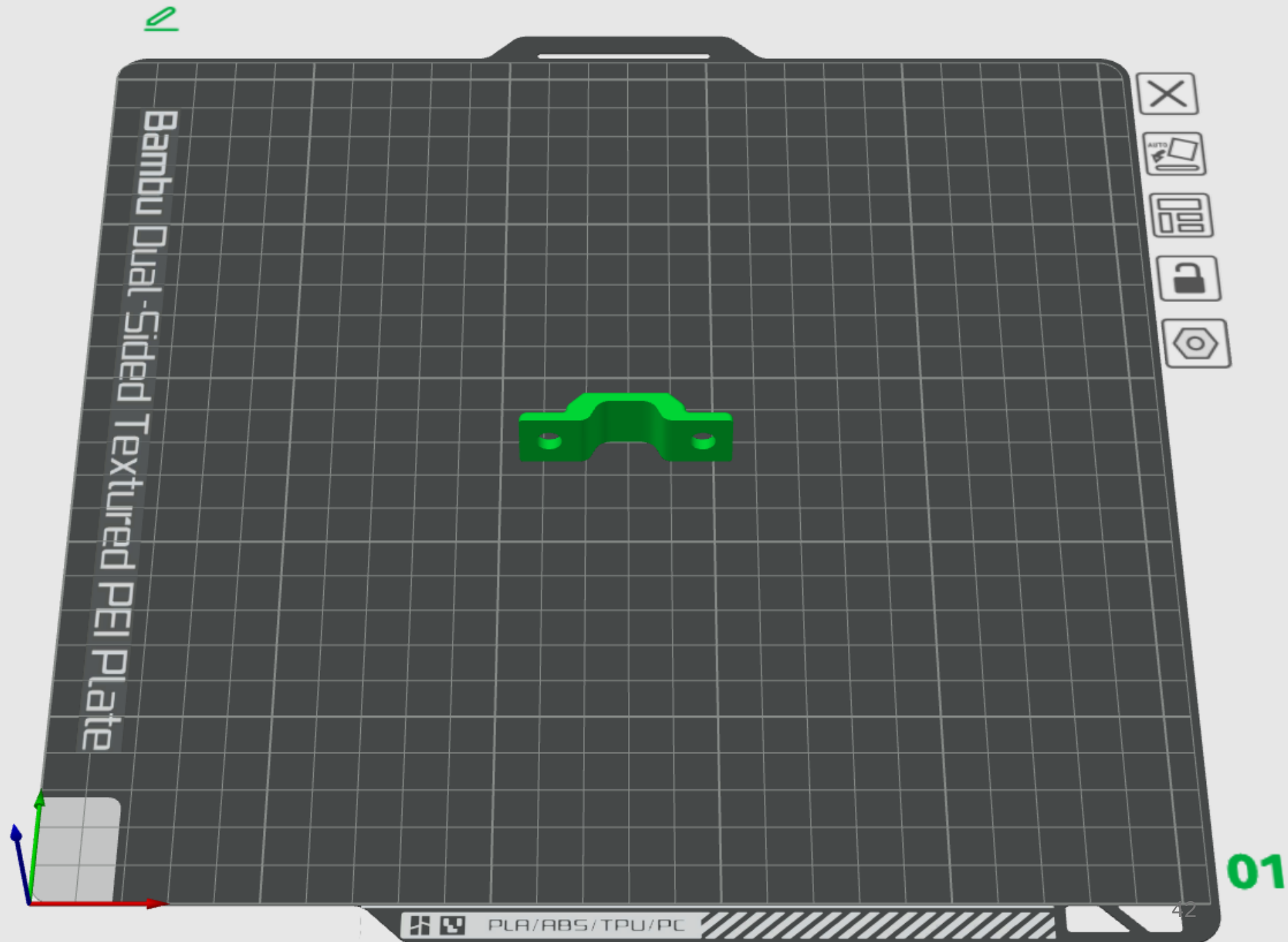
Note:
Support is required



J2 Cable holder

Print parameters:

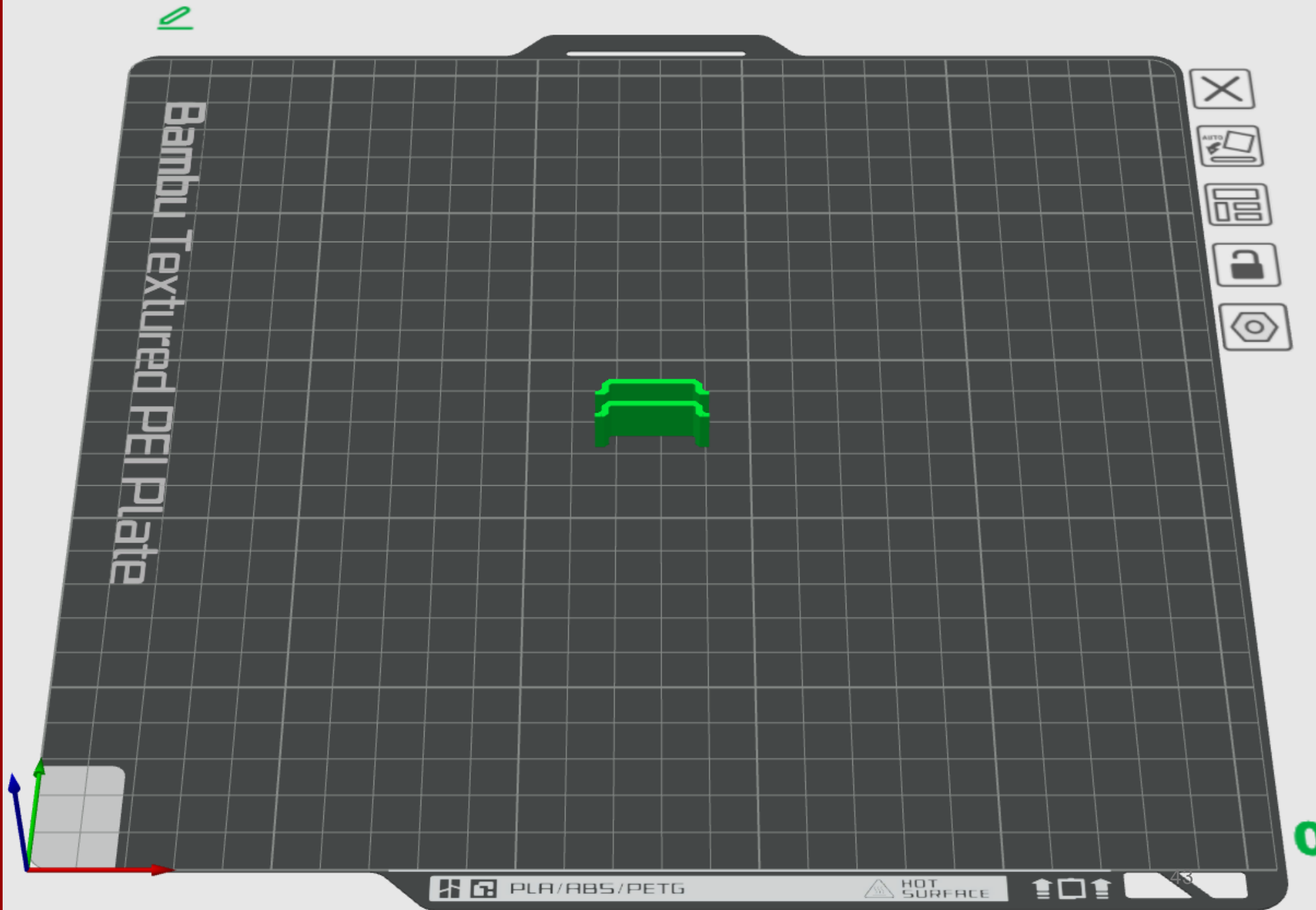
- Material: PETG
- Layer height: 0.2mm
- Infill: 15%
- Wall loops: 3



J2 Cover clip 1&2

Print parameters:

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

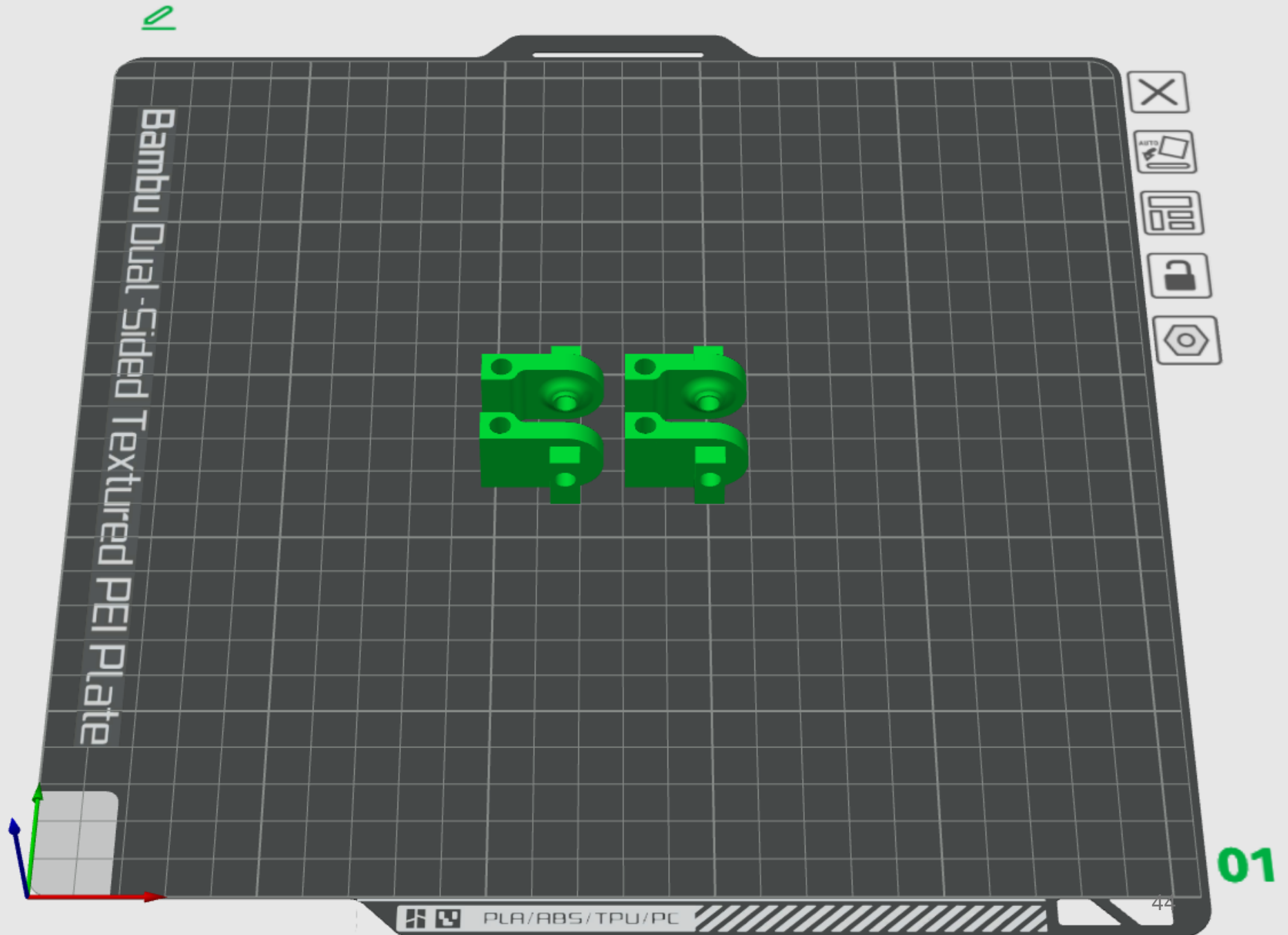


J2 Belt tensioner 2 1&2&3&4

Print parameters:

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

Note:
Support is required



J2 Belt tensioner

1

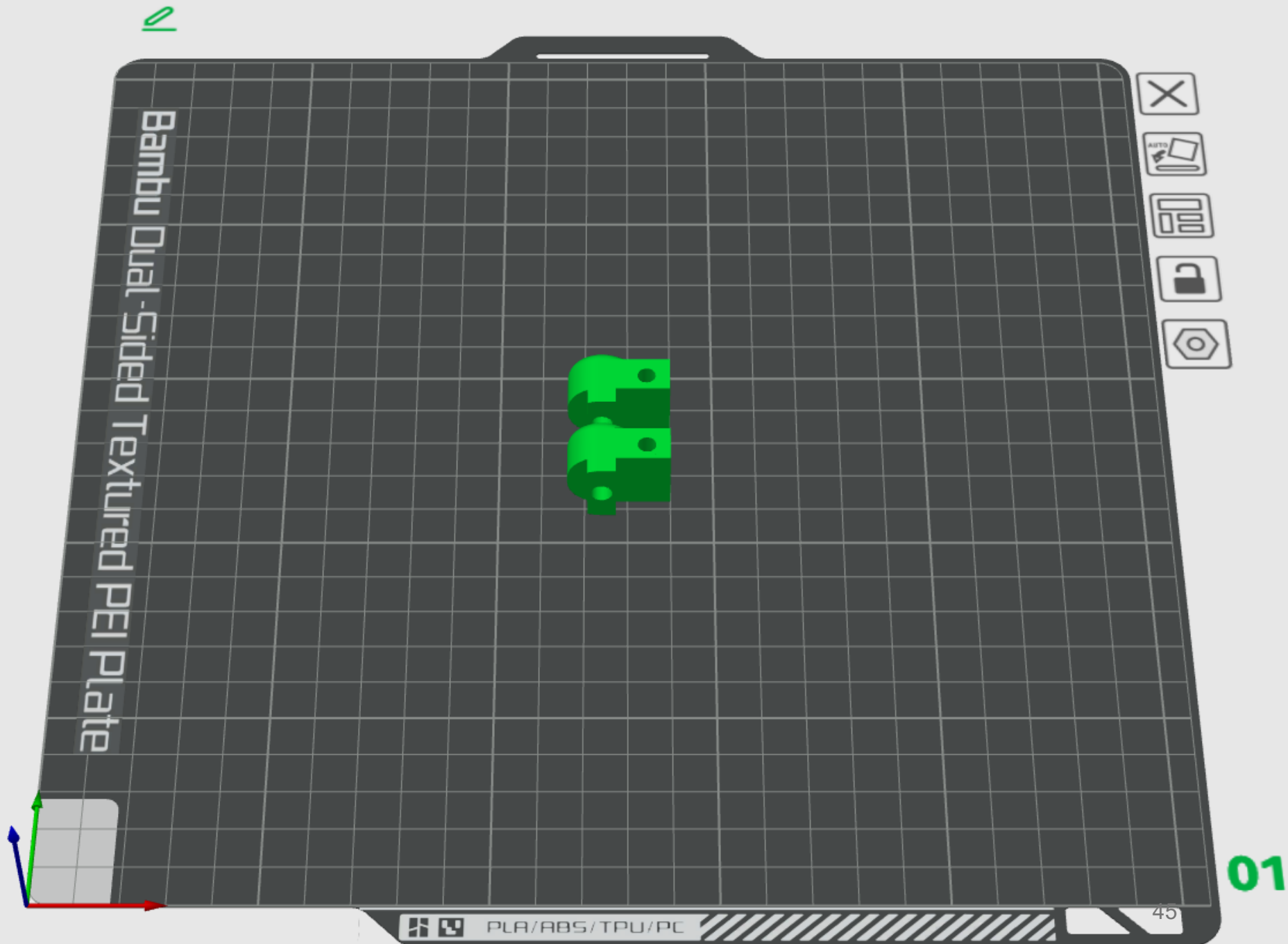
1&2

Print parameters:

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

Note:

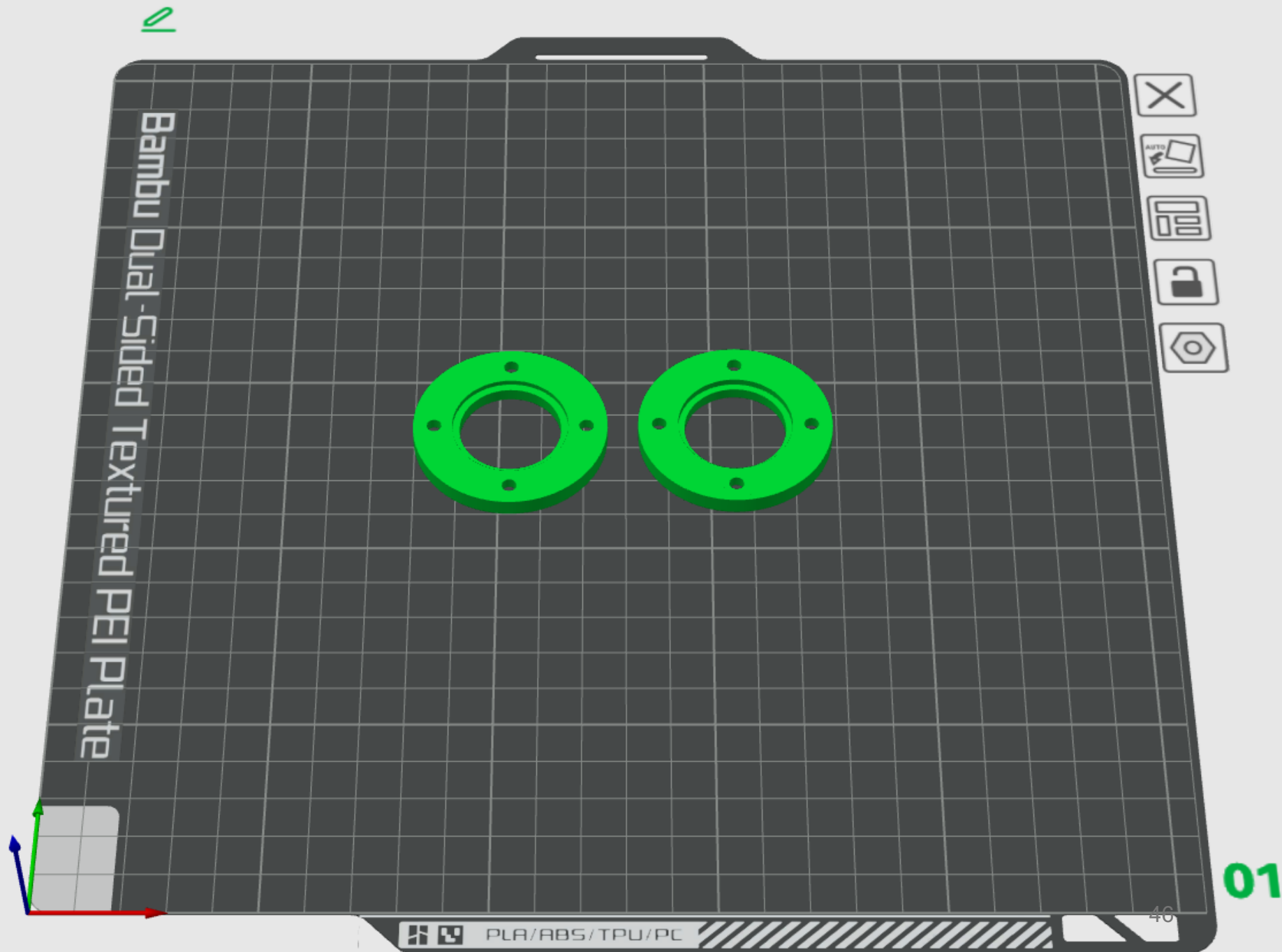
Support is required



BB mount bottom&top

Print parameters:

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

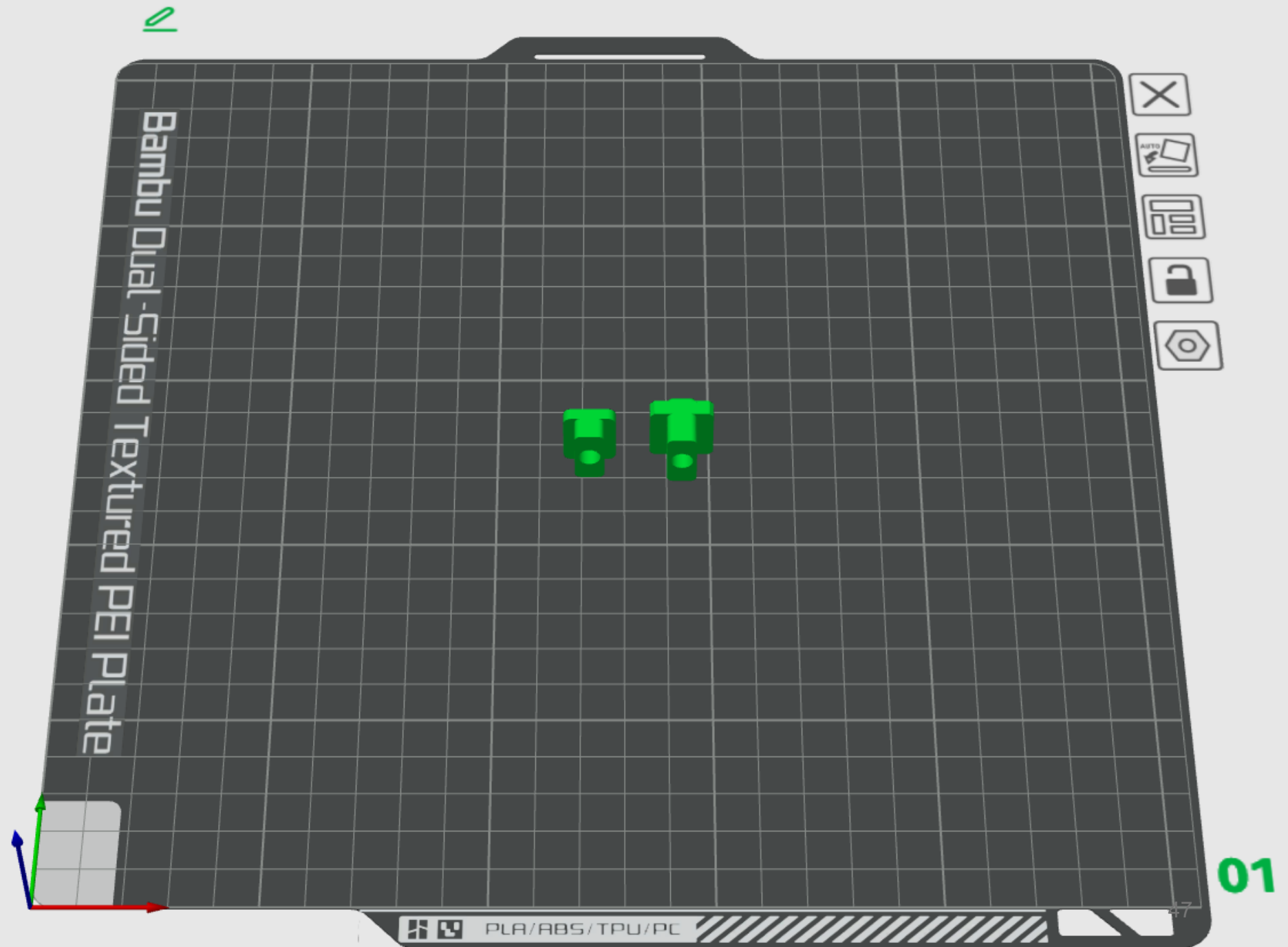


J3 Belt tensioner 1&2

Print parameters:

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

Note:
Support is required

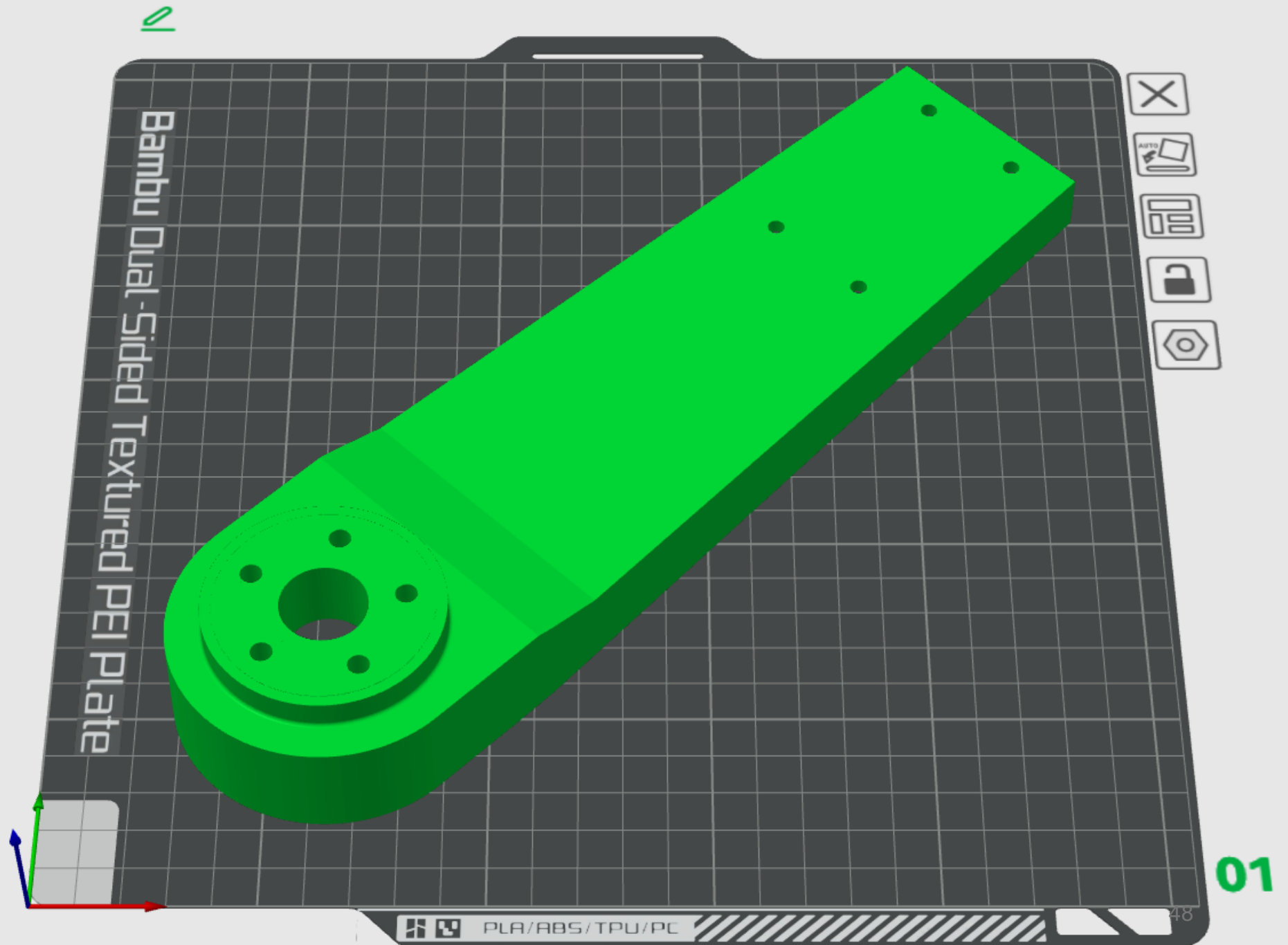


Bottom link long

Print parameters:

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

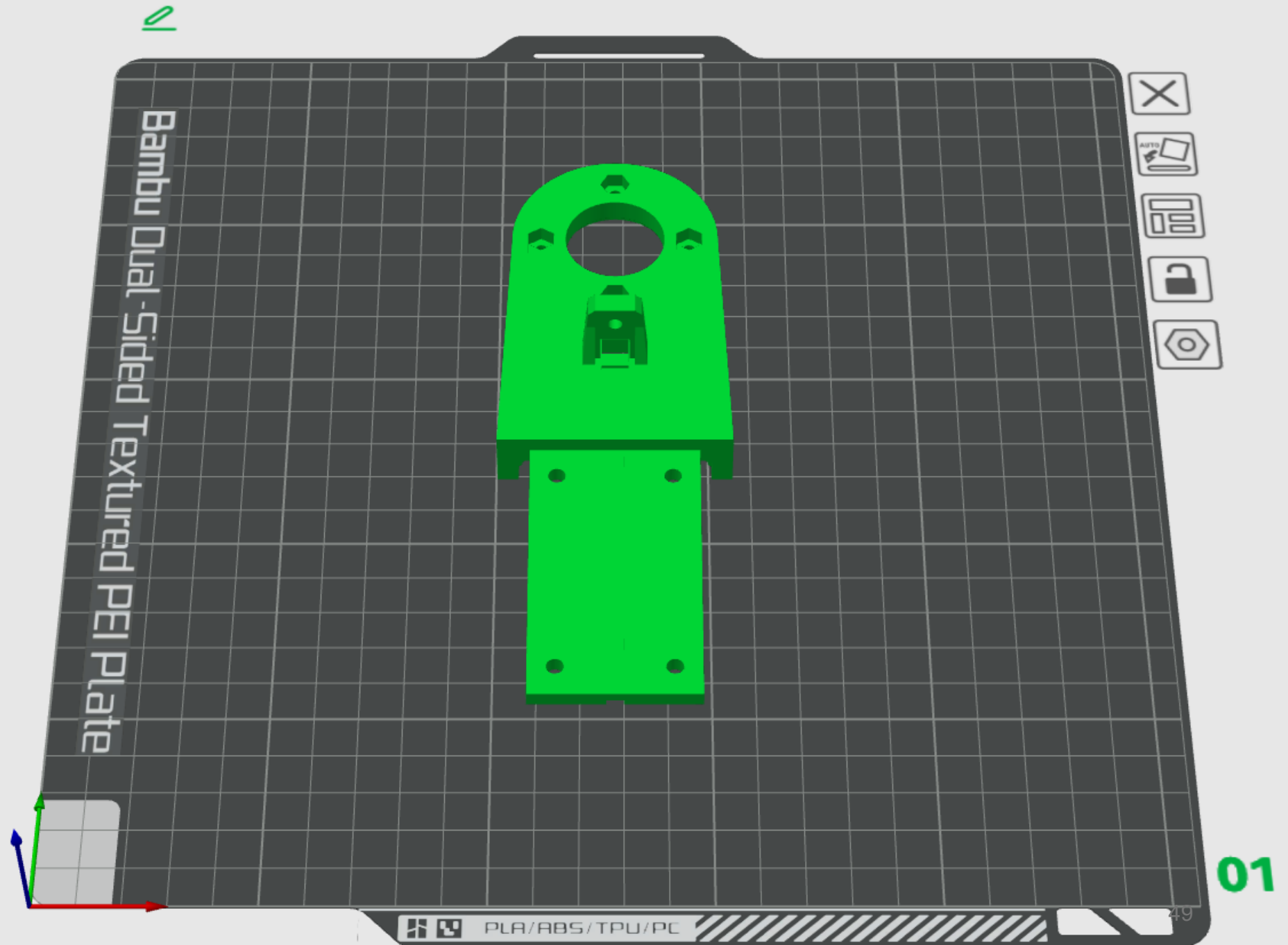
Note:
Support is required



Bottom link short

Print parameters:

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

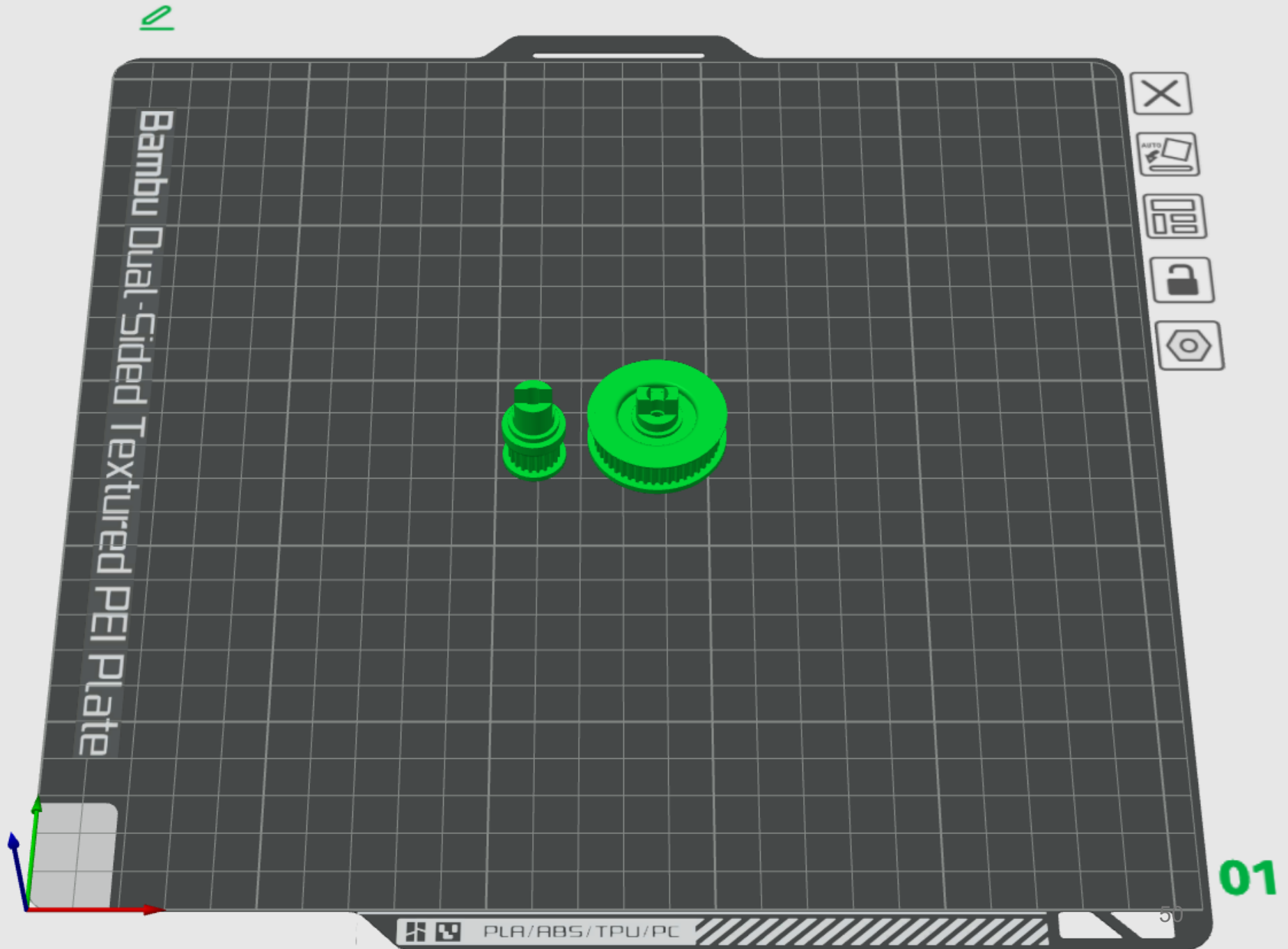


Note:
Support is required

Gear 20T & 48T

Print parameters:

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

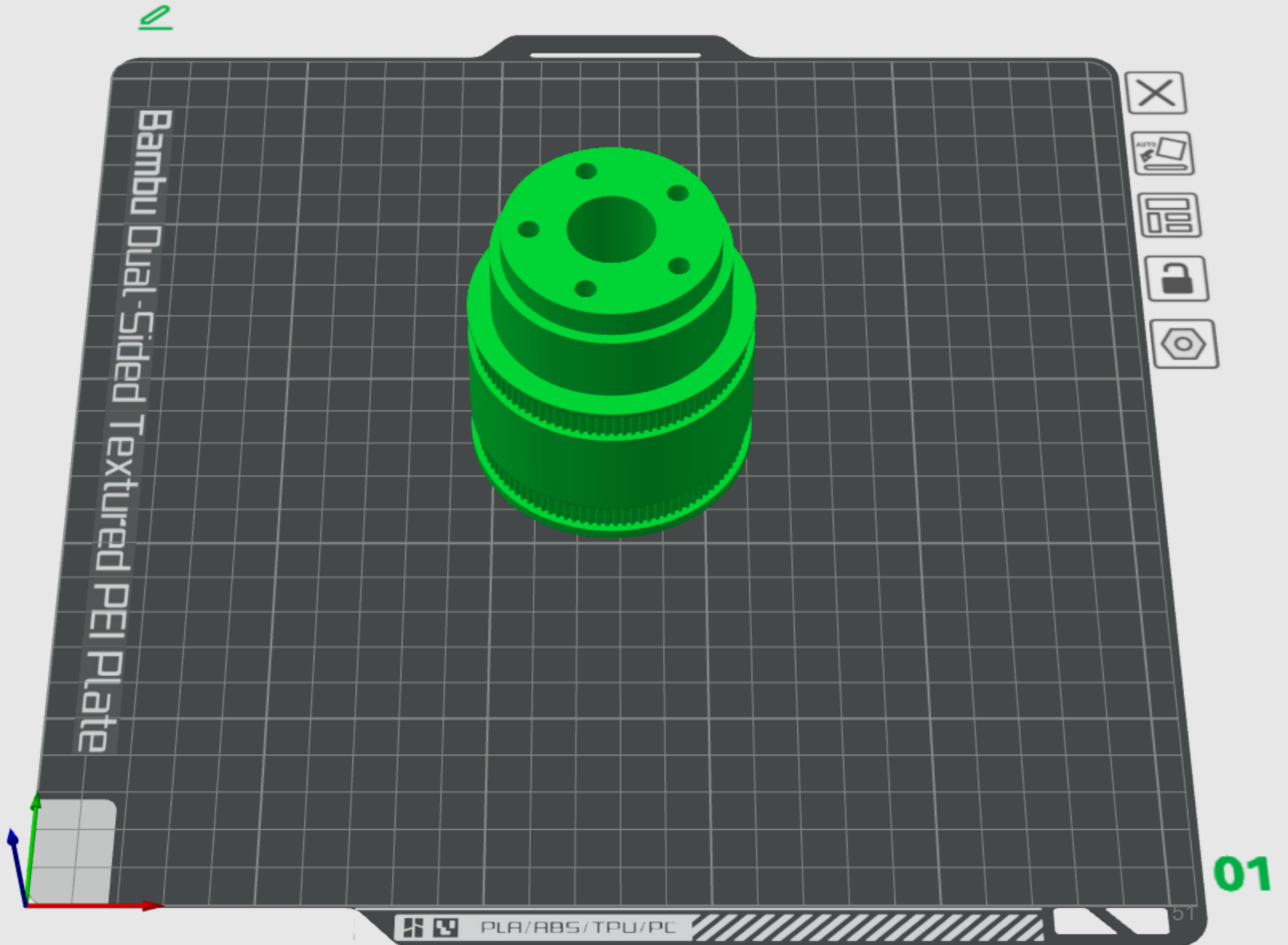


Double gear 100T

Print parameters:

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

Note:
Support is required

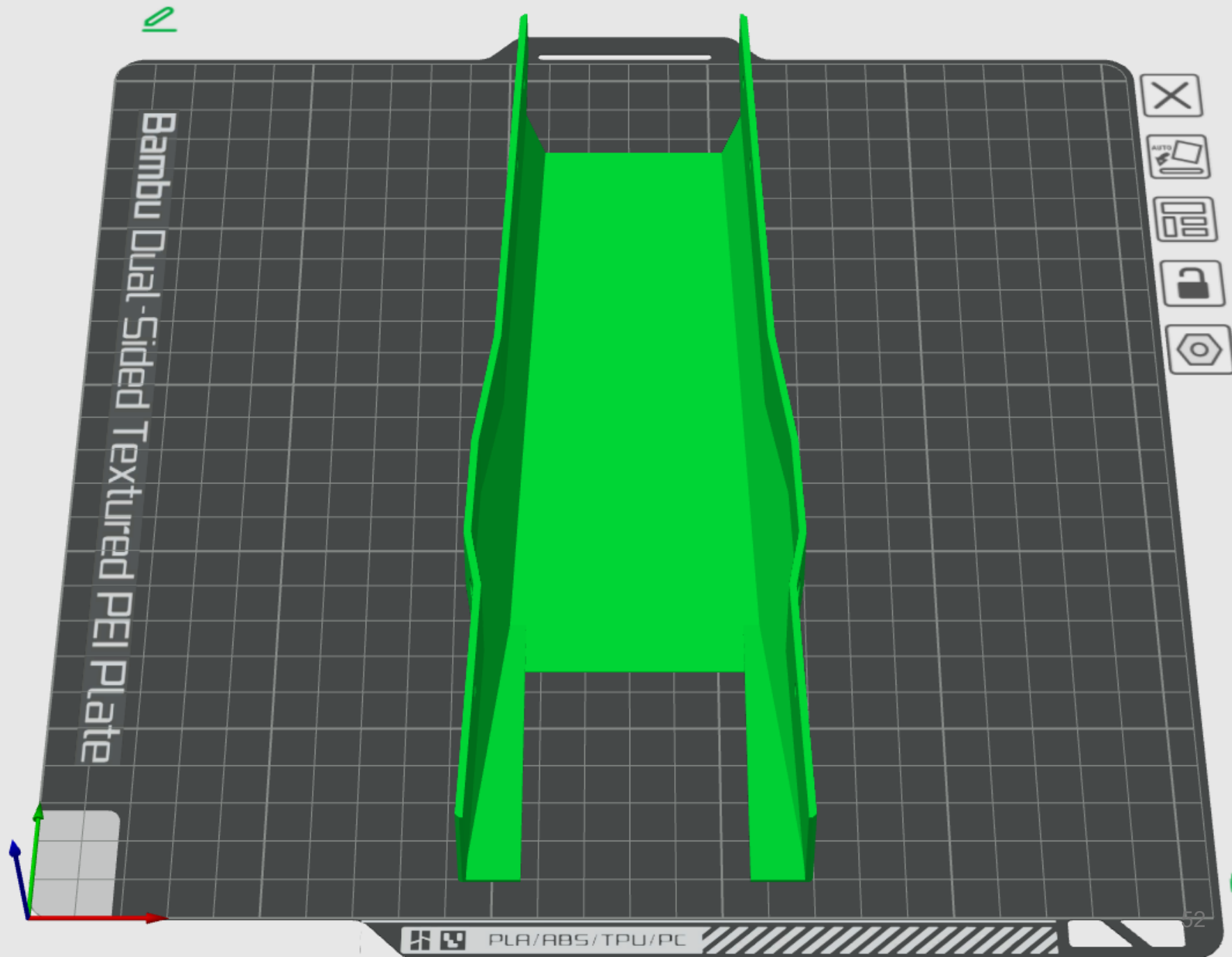


J3 Cover

Print parameters:

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

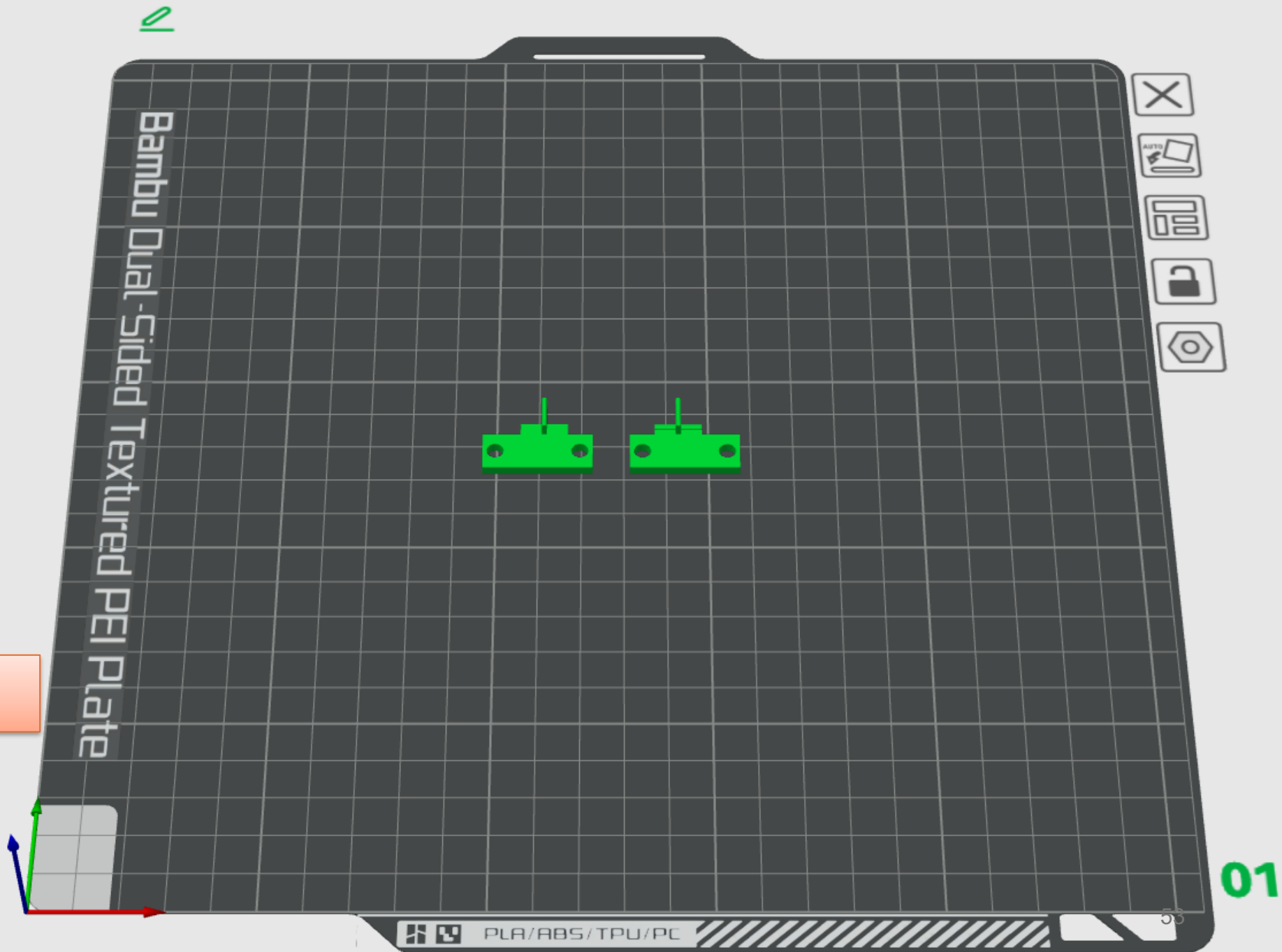
Note:
Support is required



J3 Sensor trigger 1&2

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

Print the latest verison instead

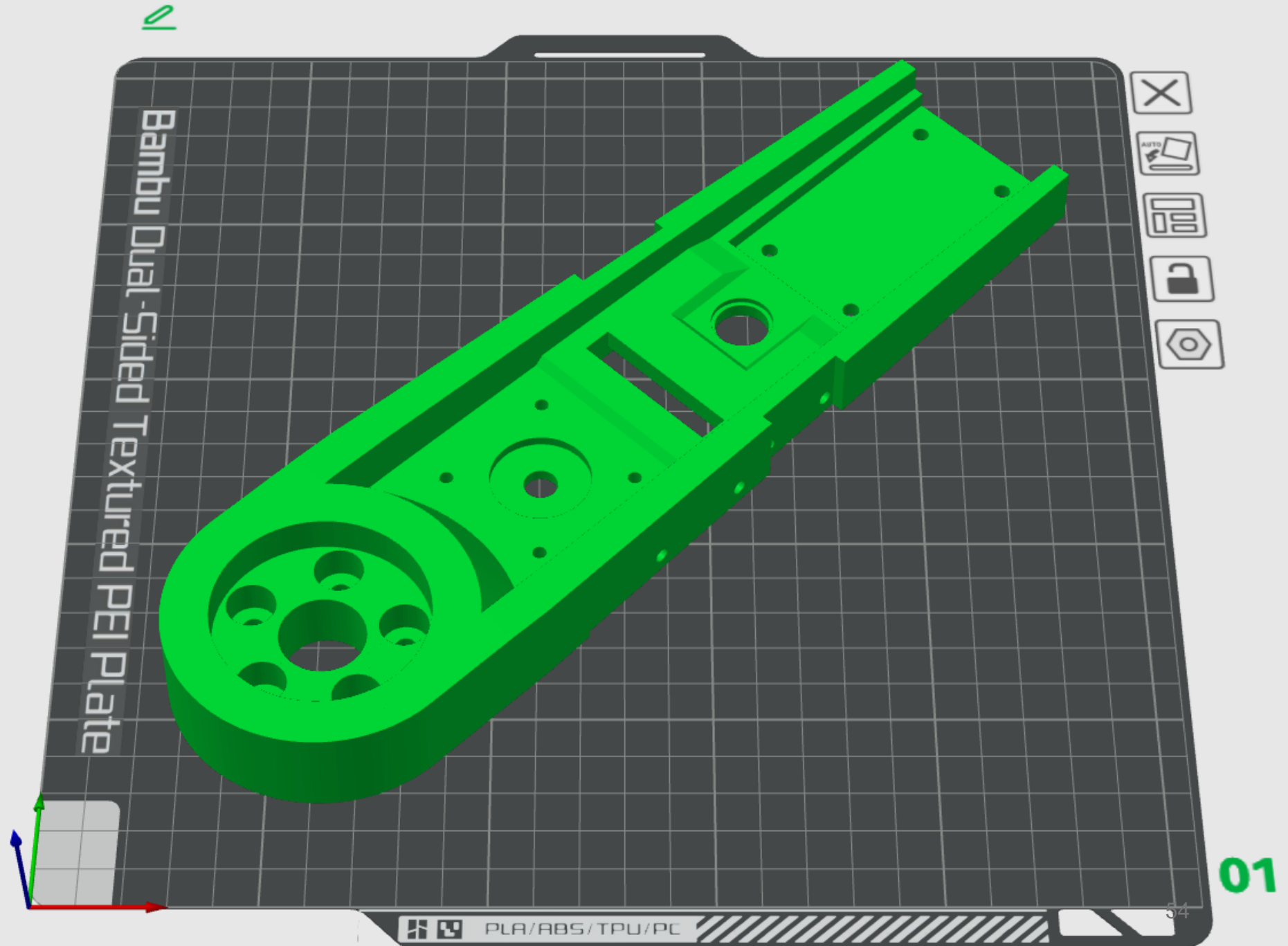


Top link long

Print parameters:

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

Note:
Support is required

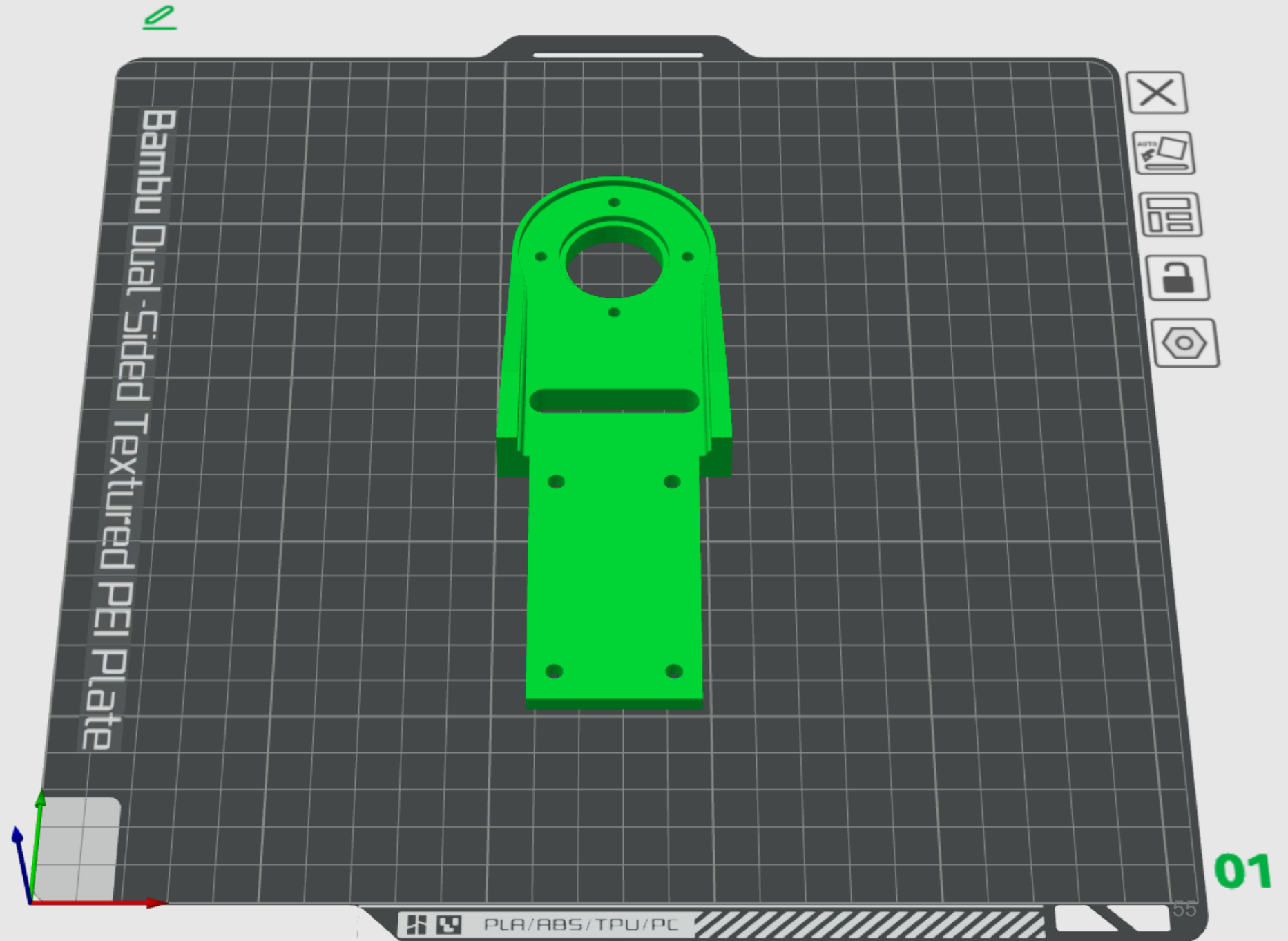


Top link short

Print parameters:

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

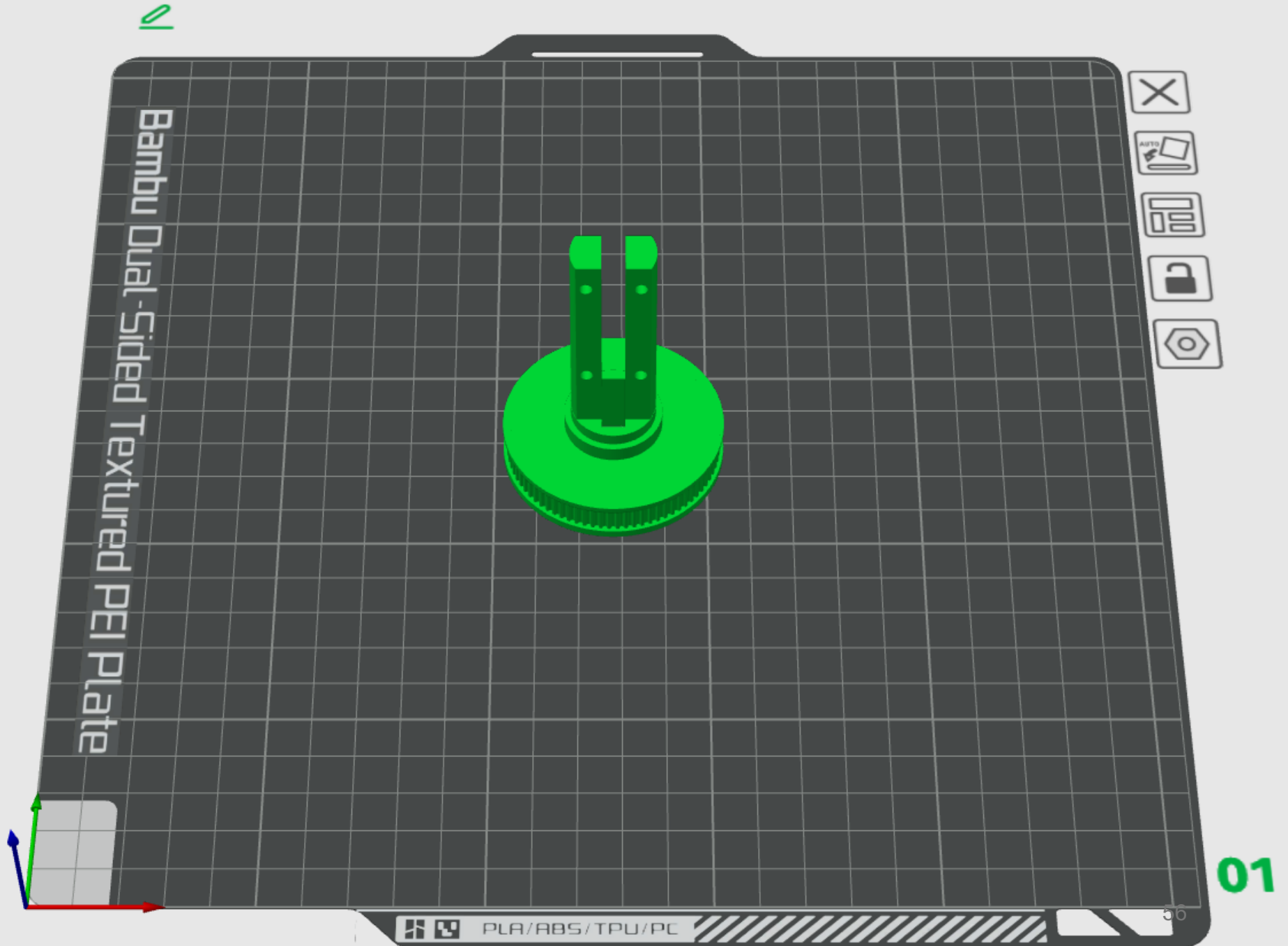
Note:
Support is required



Gear 80T

Print parameters:

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

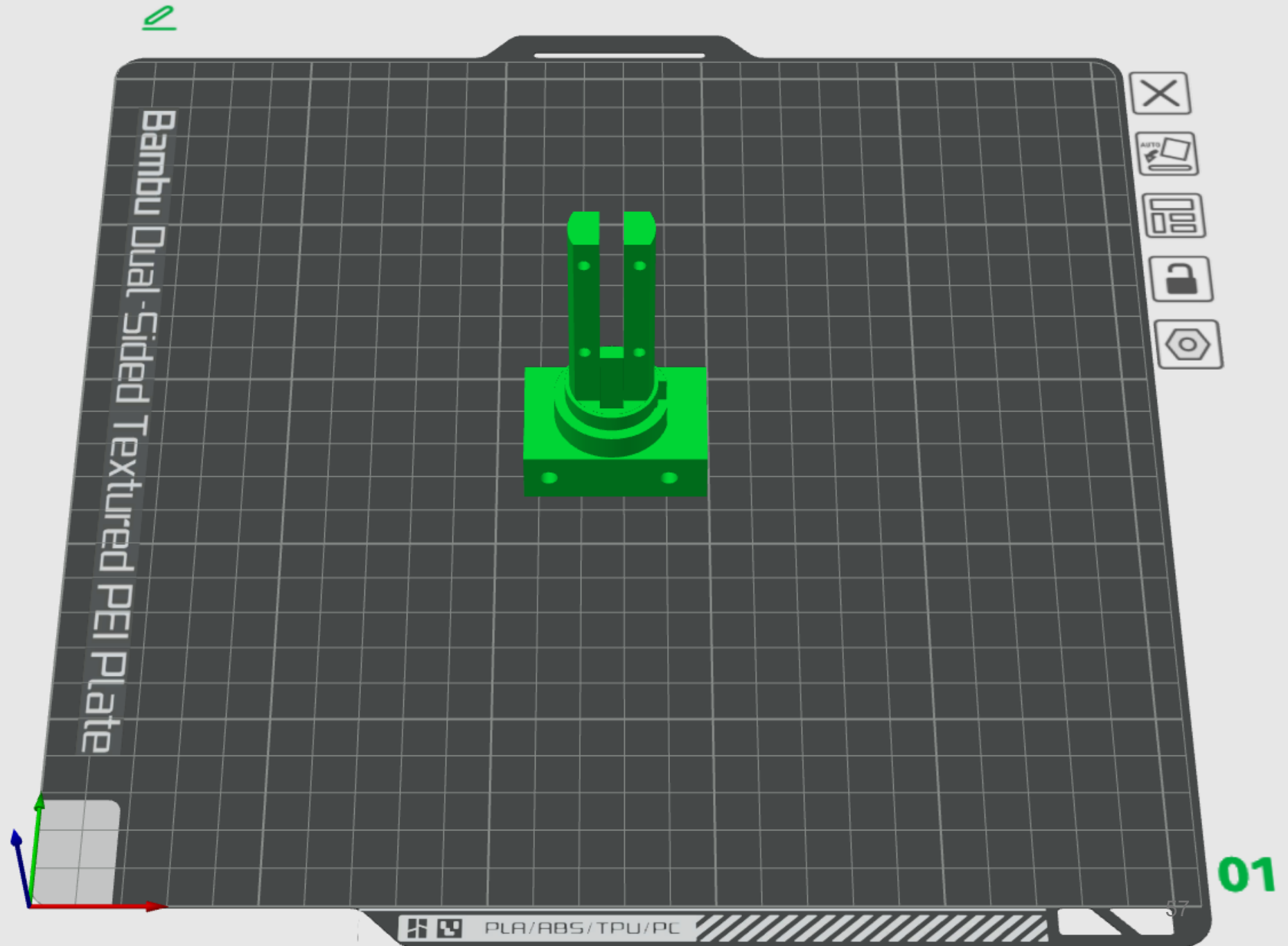


Gripper mount

Print parameters:

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

Note:
Support is required

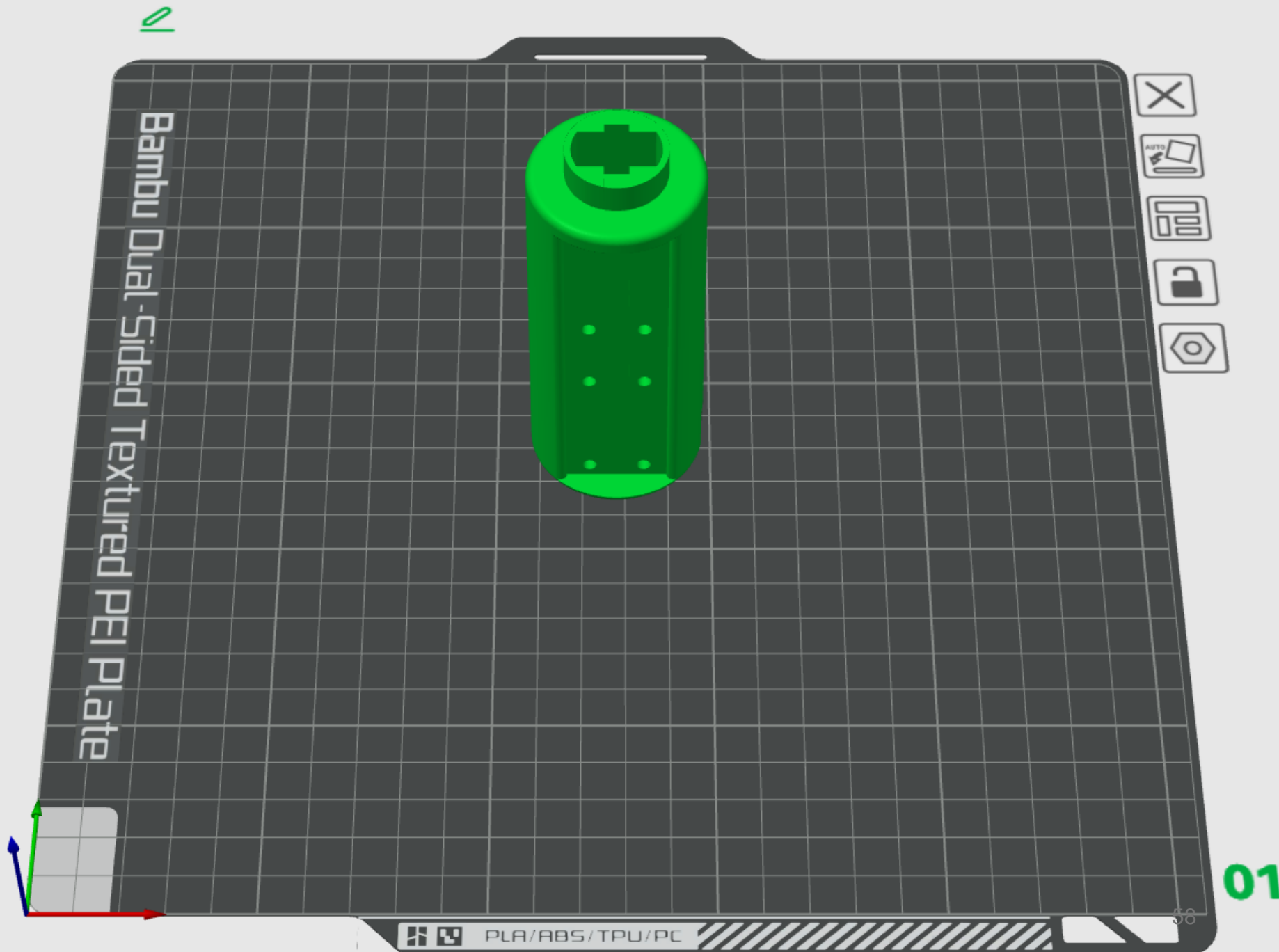


J4 Roller

Print parameters:

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

Note:
Support is required

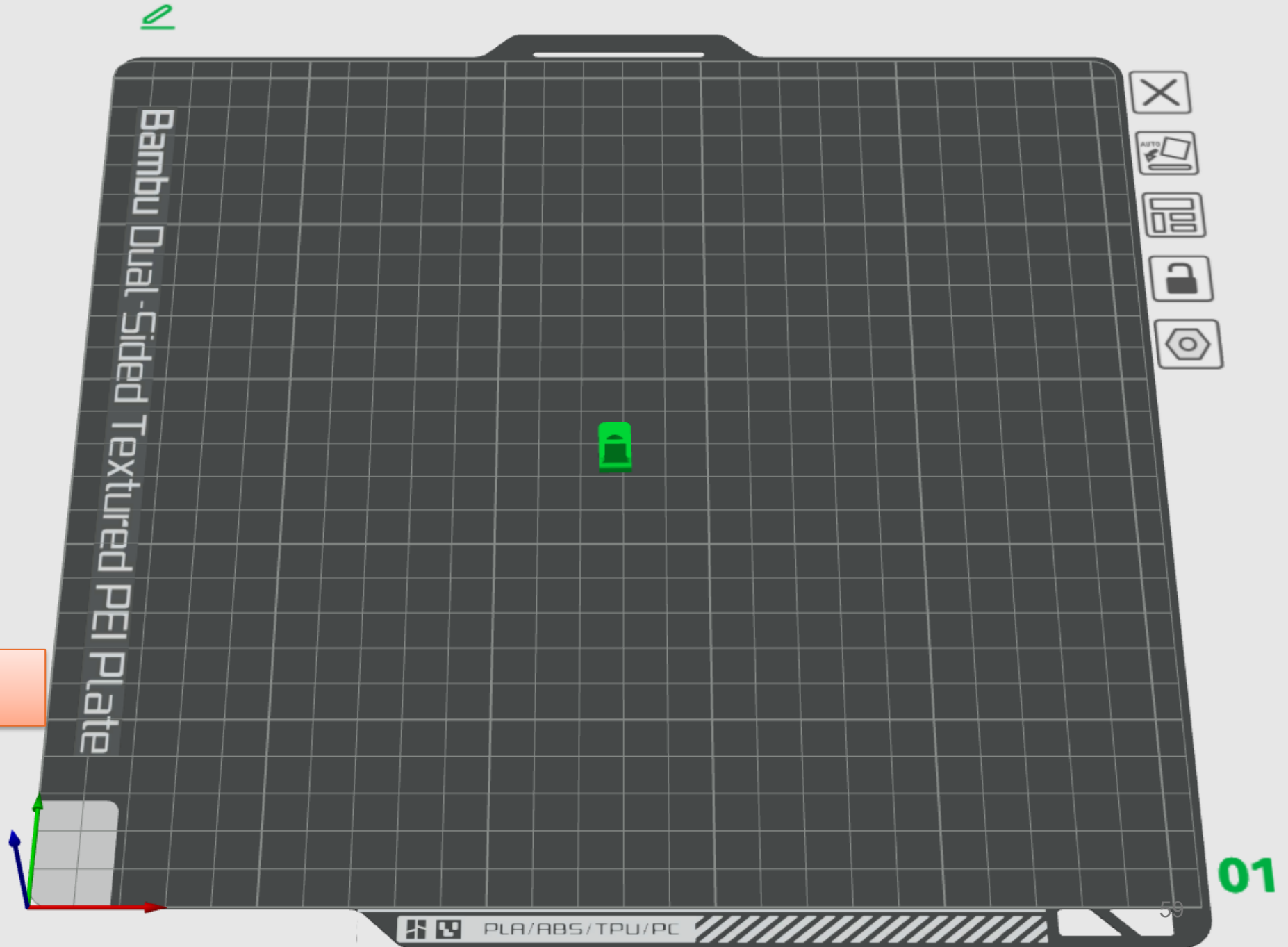


J4 Sensor trigger

Print parameters:

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

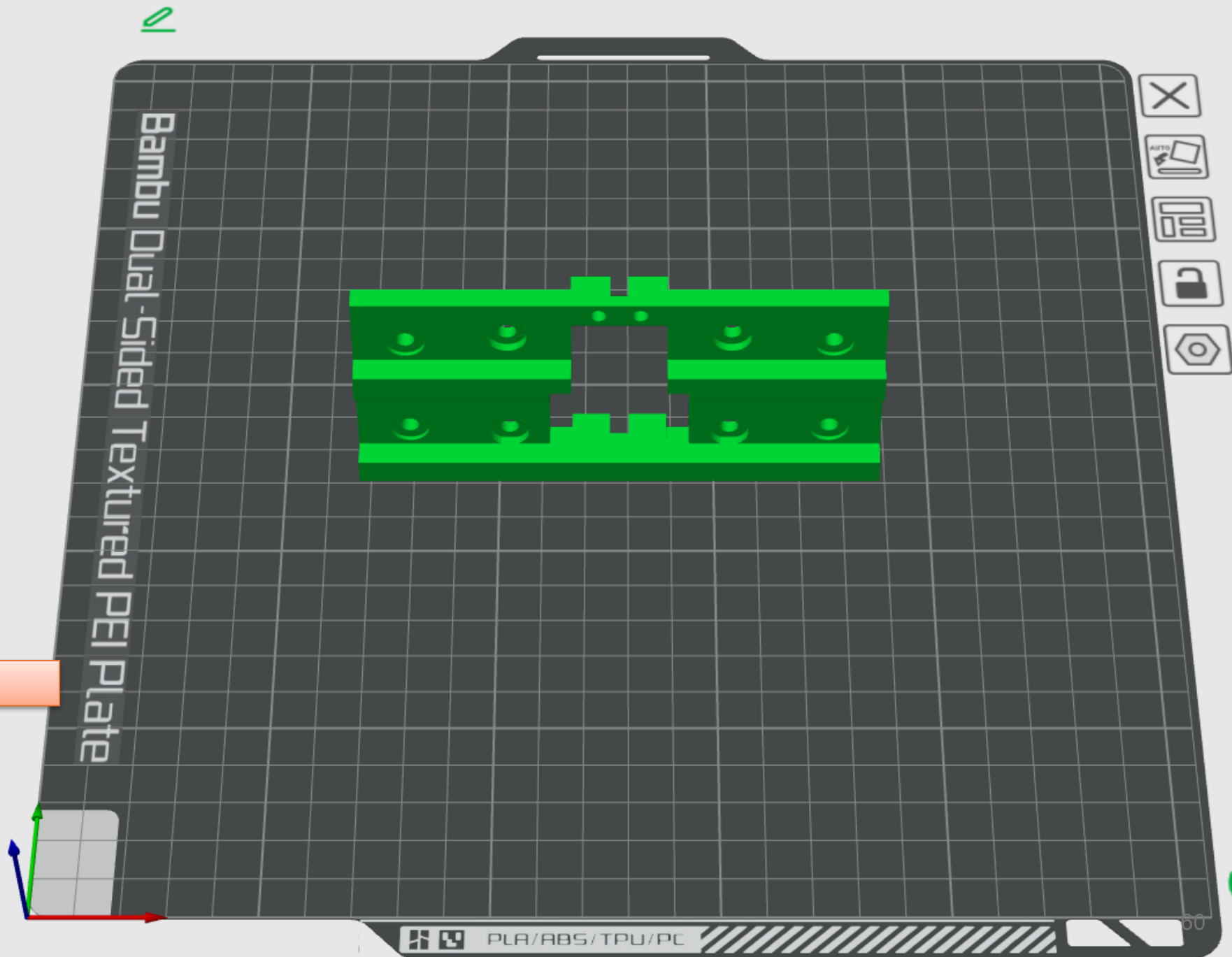
Print the latest version instead



Gripper base

Print parameters:

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



Old gripper

Note:
Support is required

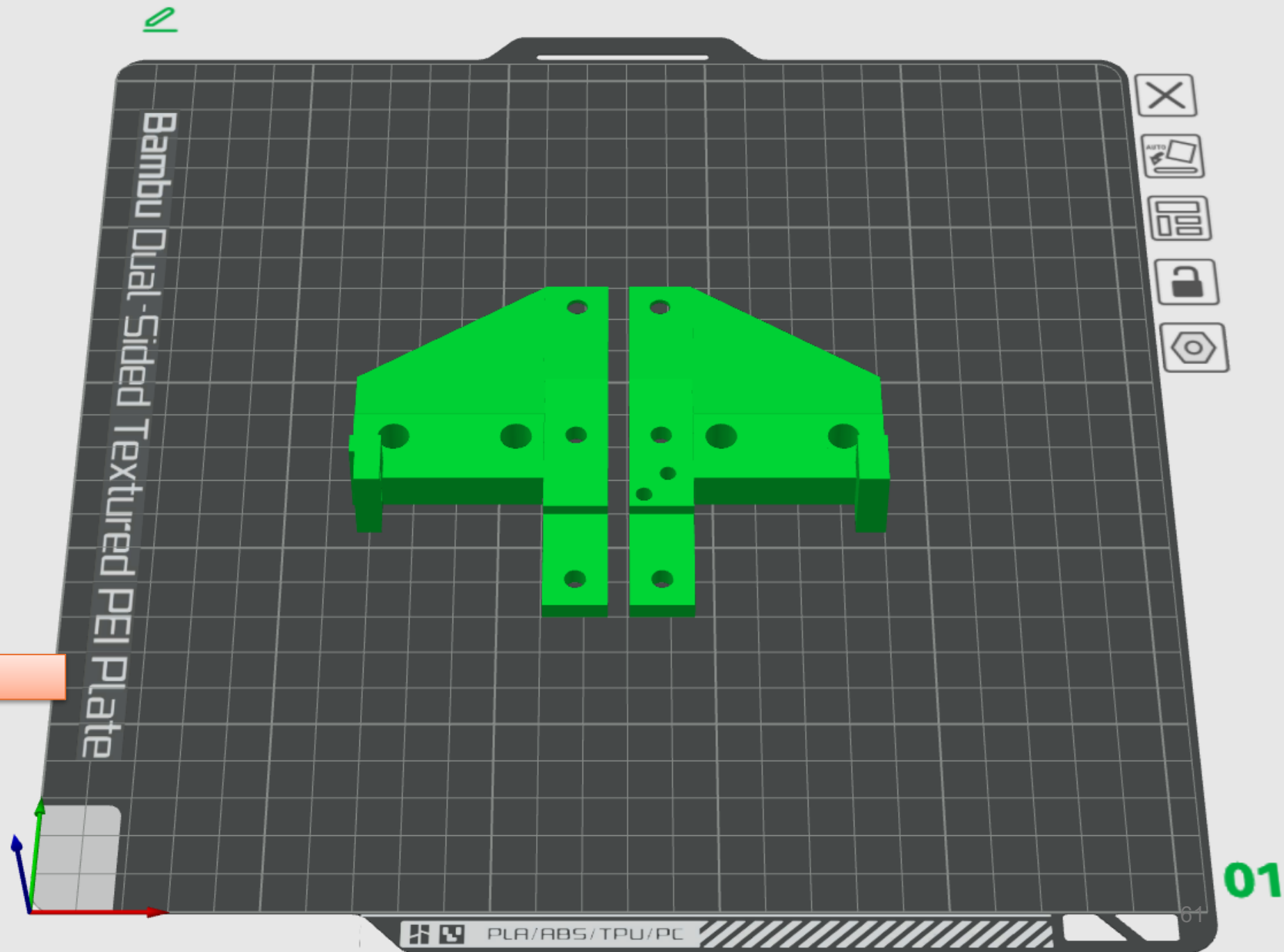
Claw mount right & left

Print parameters:

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

Old gripper

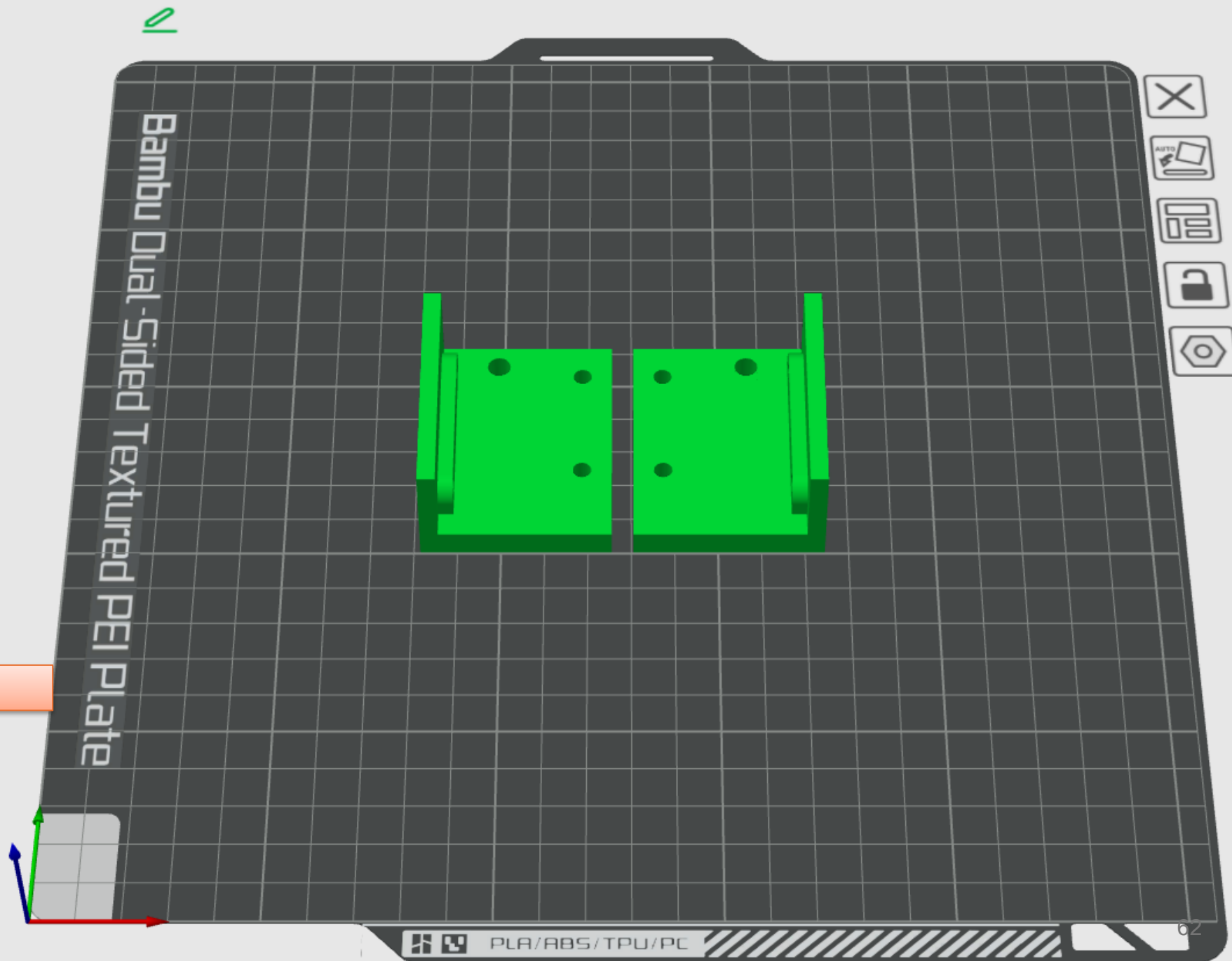
Note:
Support is required



Gripper mount left & right

Print parameters:

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



Old gripper

Note:
Support is required

Tube mount left & right

Print parameters:

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



Old gripper

Note:
Support is required

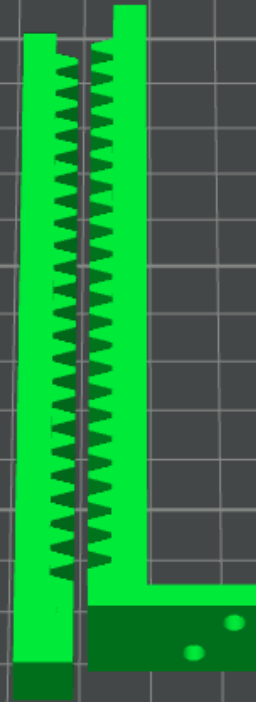


Rack gear left & right

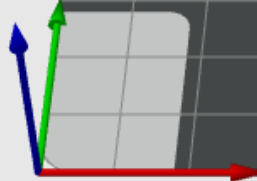
Print parameters:

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

Bambu Textured PEI Plate



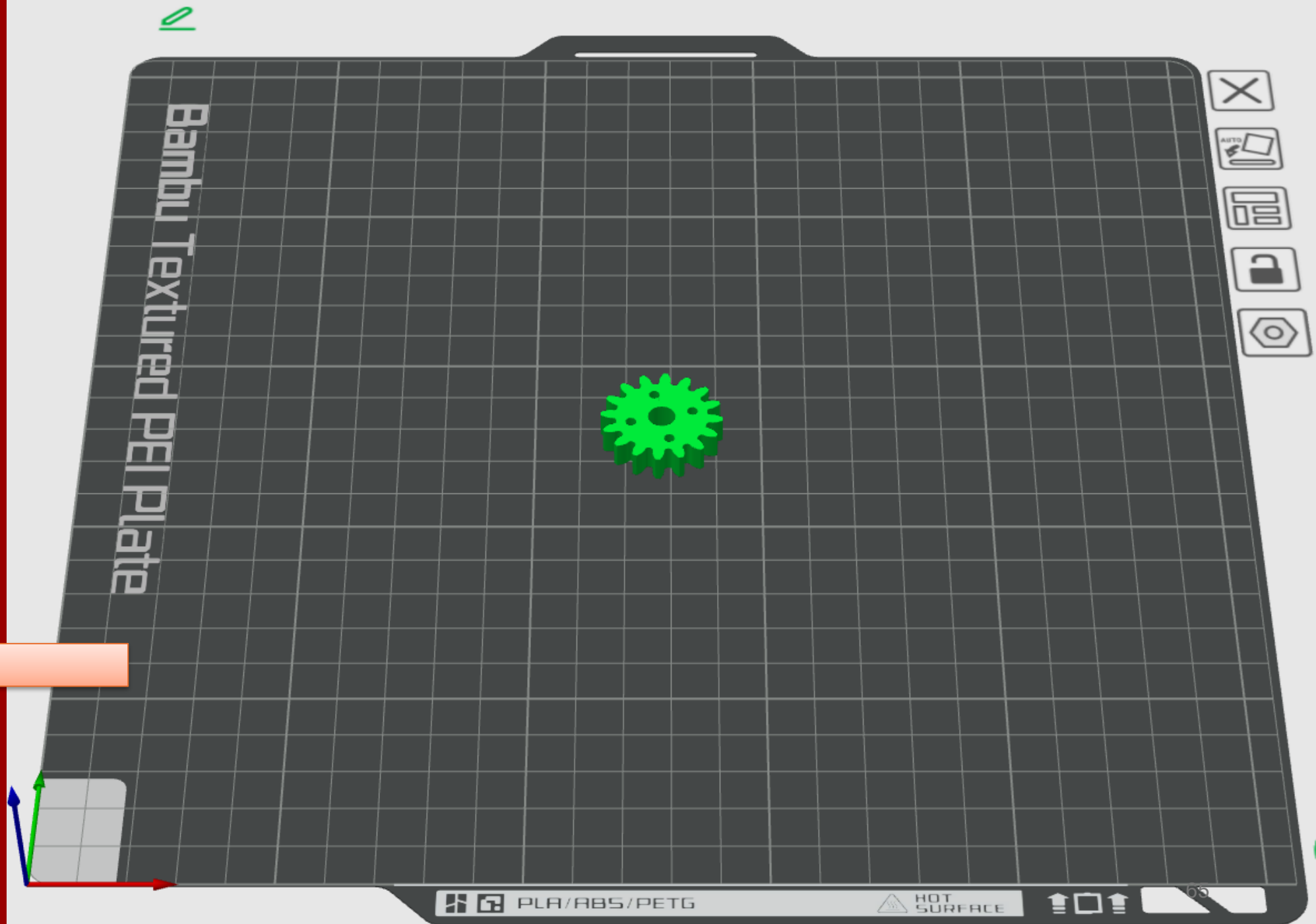
Old gripper



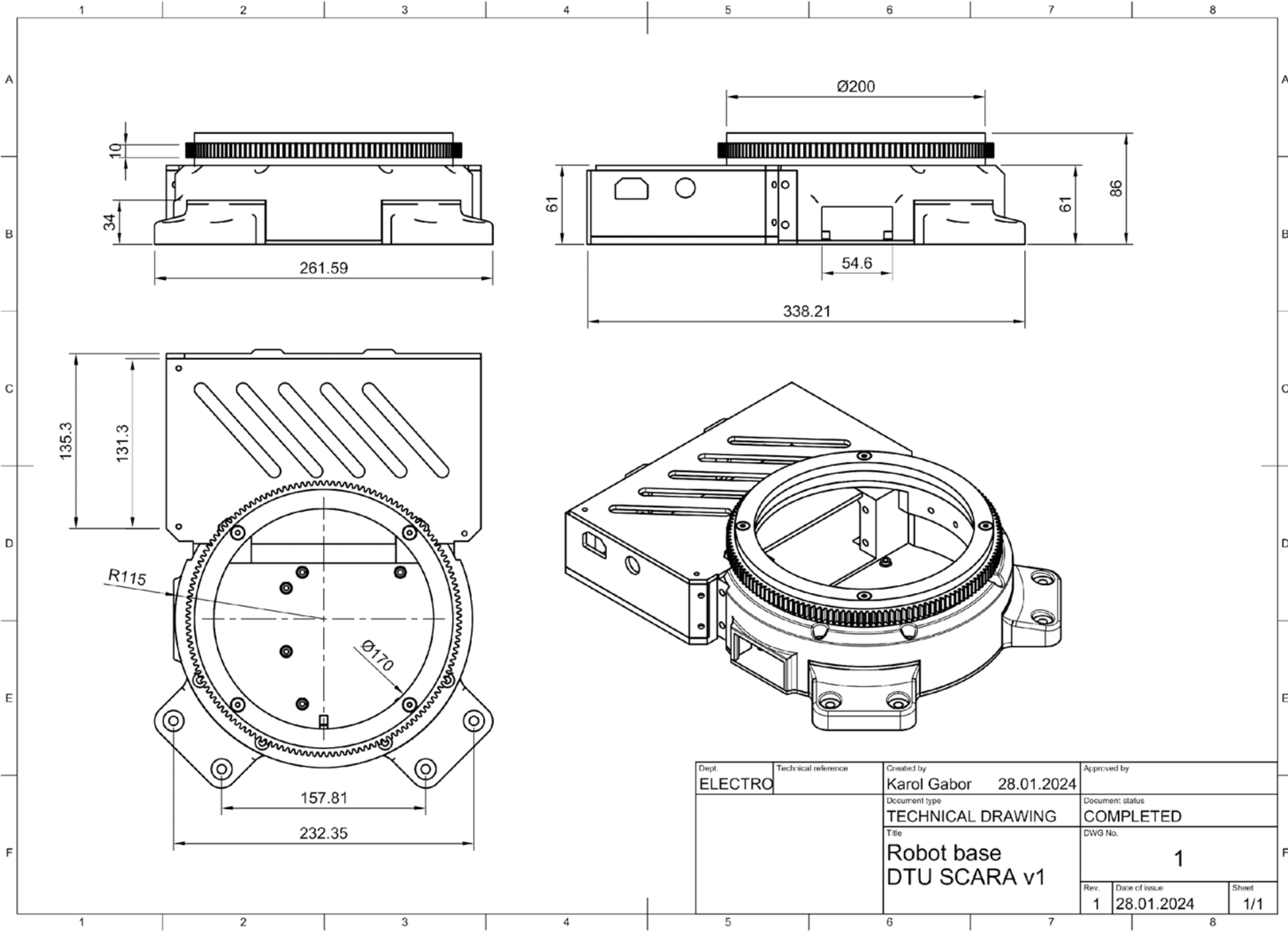
Spur gear 16T

Print parameters:

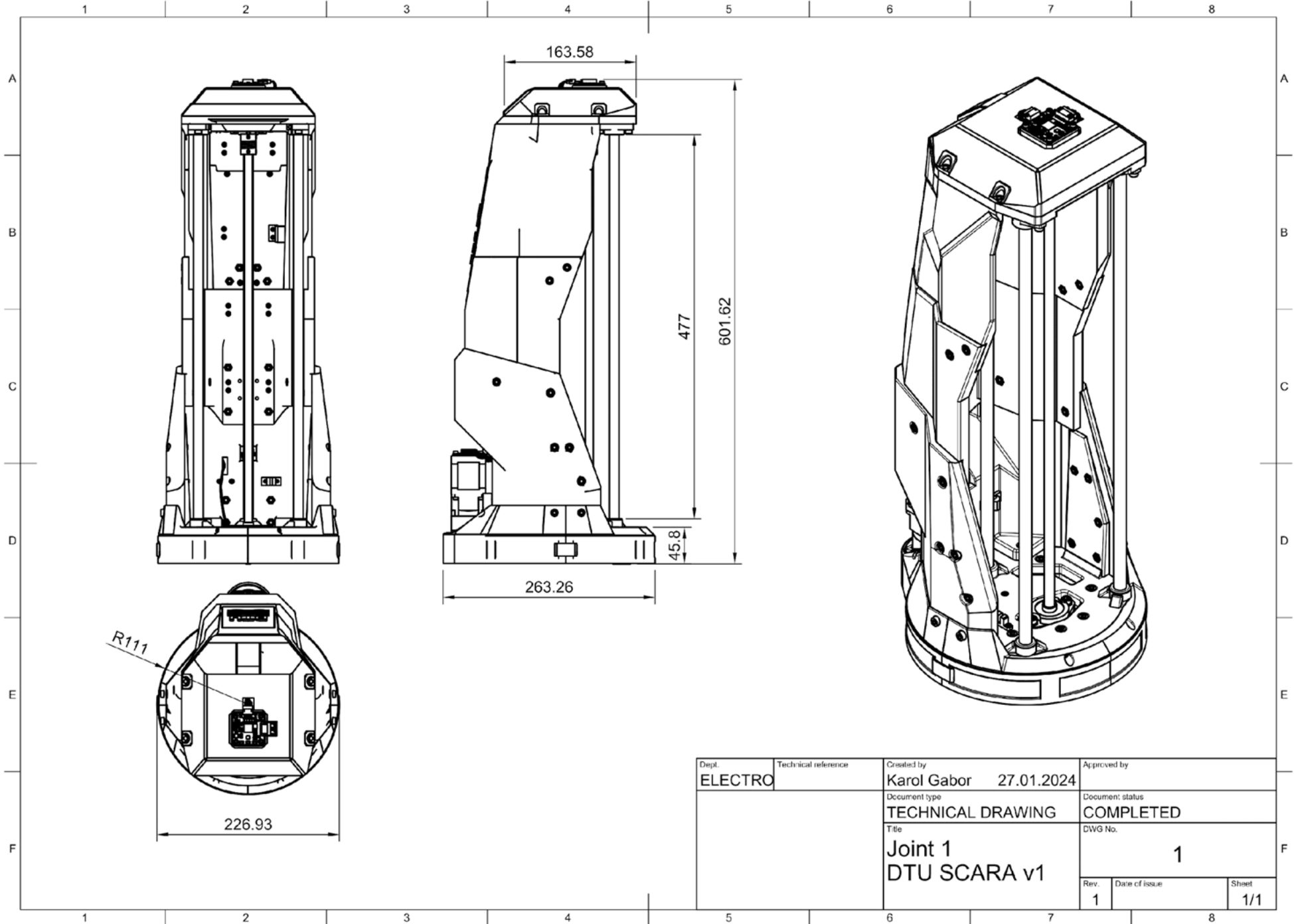
- Material: PETG
- Layer height: 0.1mm
- Infill: 100%
- Wall loops: 4

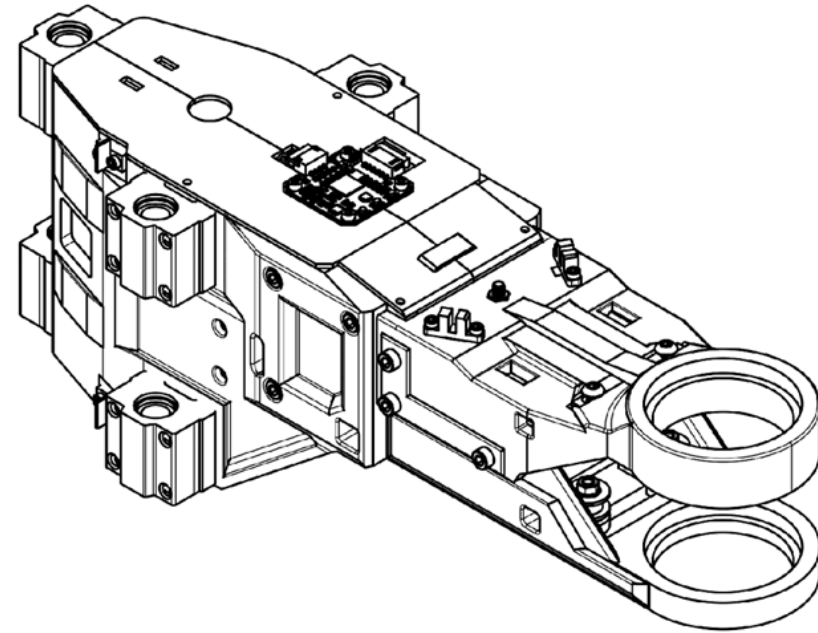
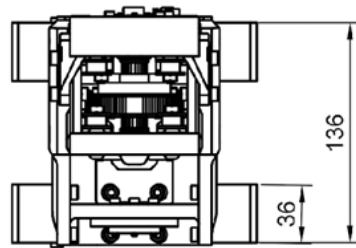
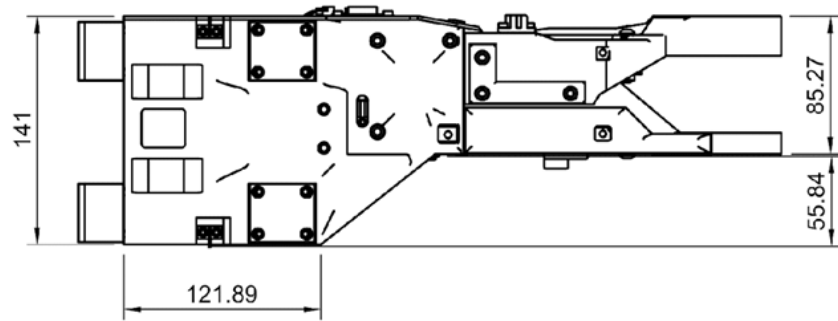
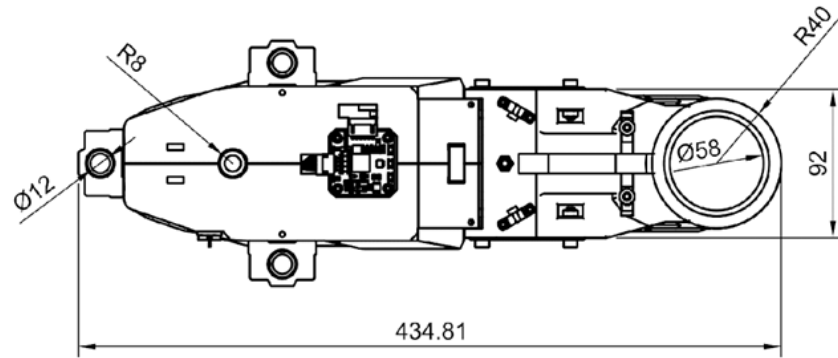


JOINTS

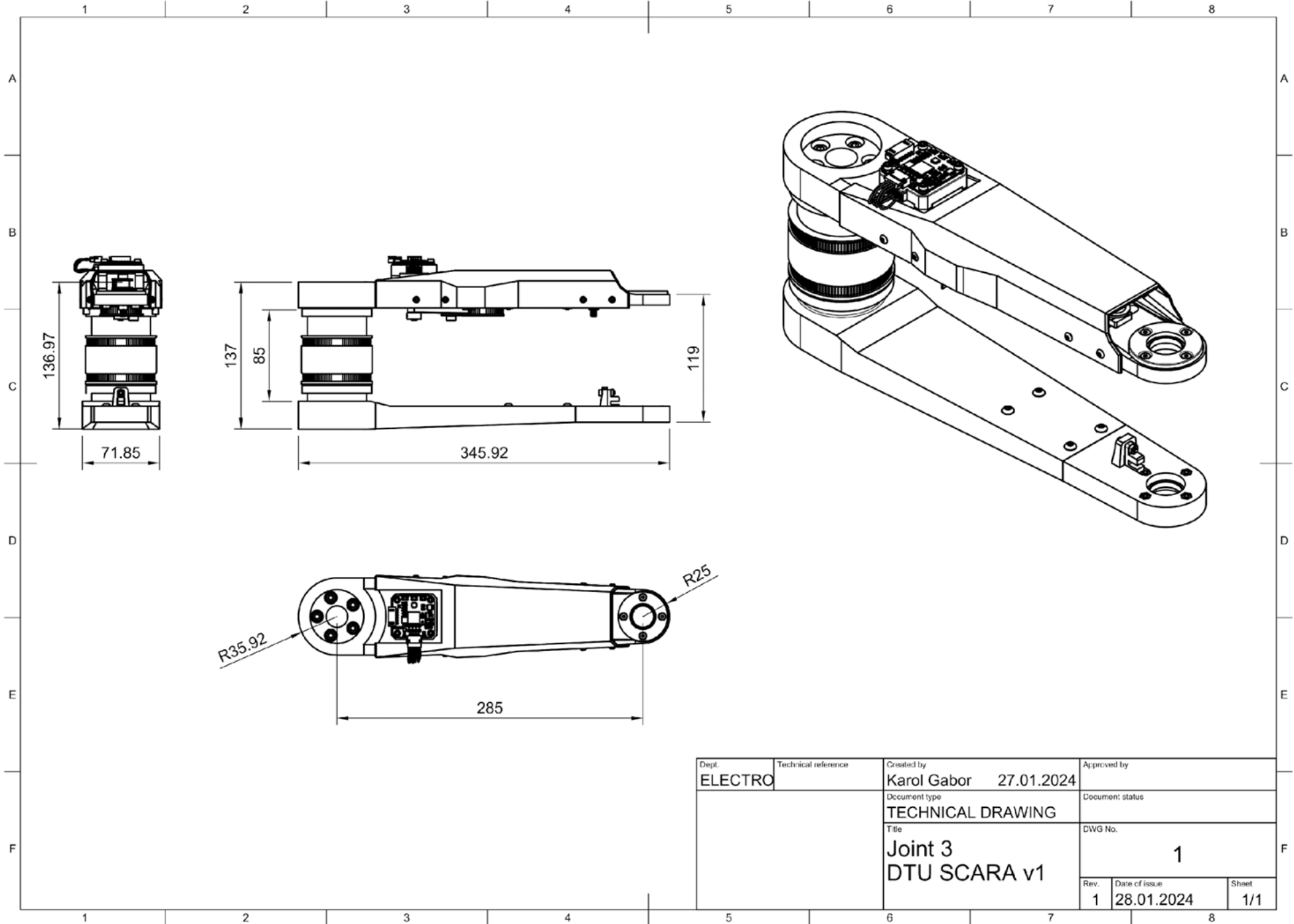


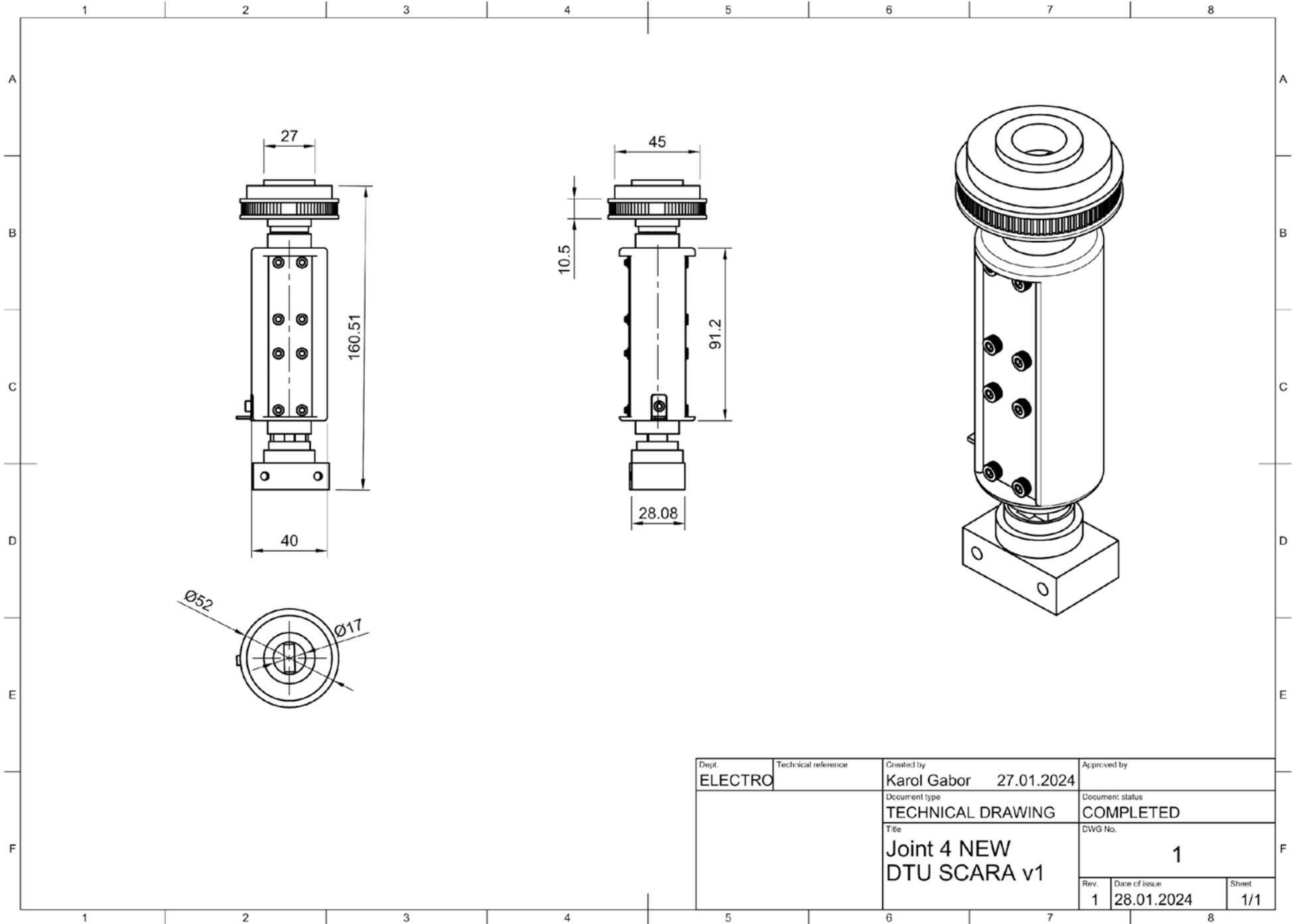
Dept. ELECTRO	Technical reference	Created by Karol Gabor 28.01.2024	Approved by
		Document type TECHNICAL DRAWING	Document status COMPLETED
		Title Robot base DTU SCARA v1	DWG No. 1
		Rev. 1	Date of issue 28.01.2024
			Sheet 1/1

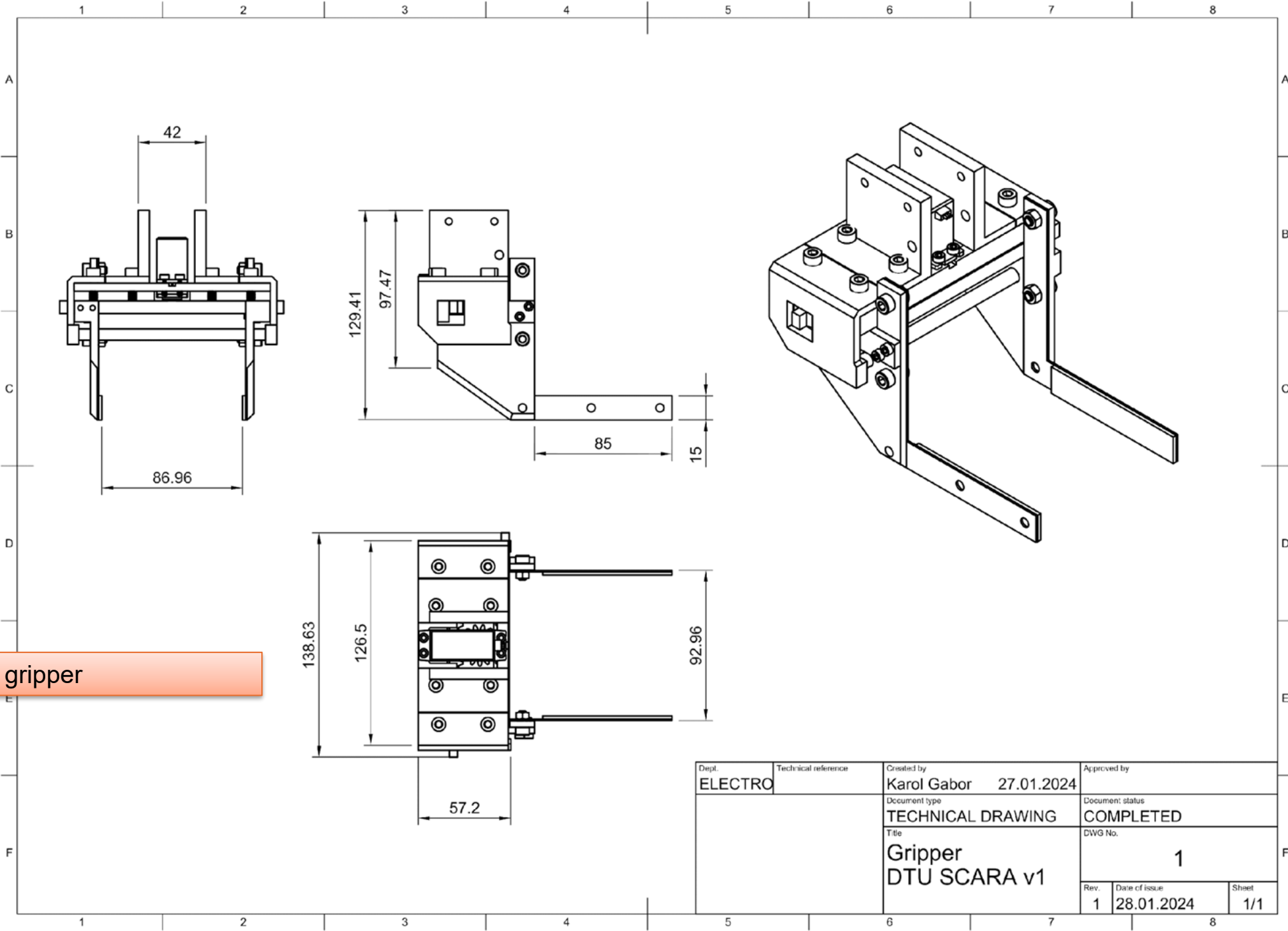




Dept. ELECTRO	Technical reference	Created by Karol Gabor 27.01.2024	Approved by	
		Document type	Document status COMPLETED	
		Title Joint 2 DTU SCARA v1	DWG No. 1	
		Rev. 1	Date of issue 28.01.2024	Sheet 1/1







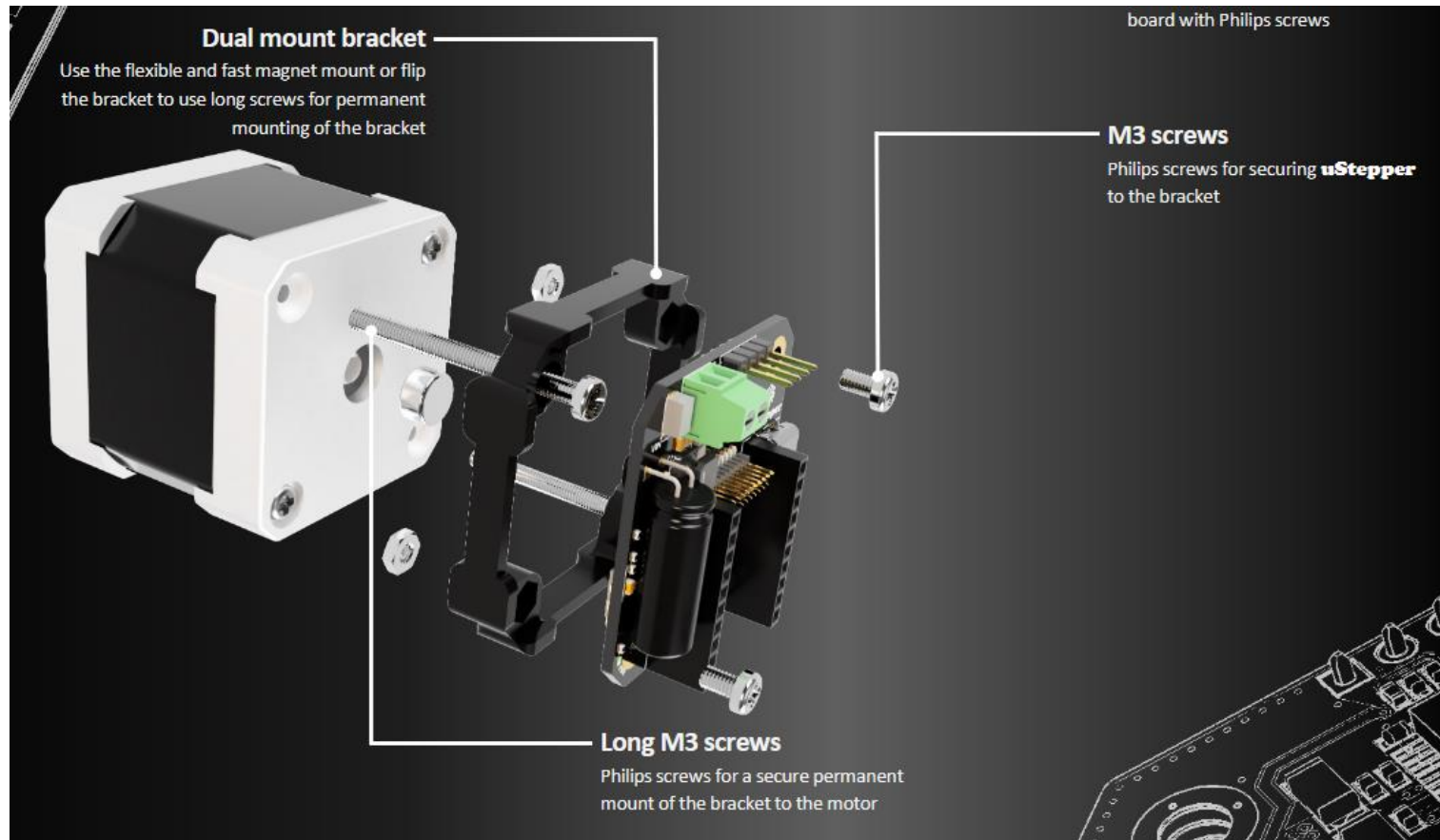
Old gripper

Dept. ELECTRO	Technical reference	Created by Karol Gabor 27.01.2024	Approved by	
		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

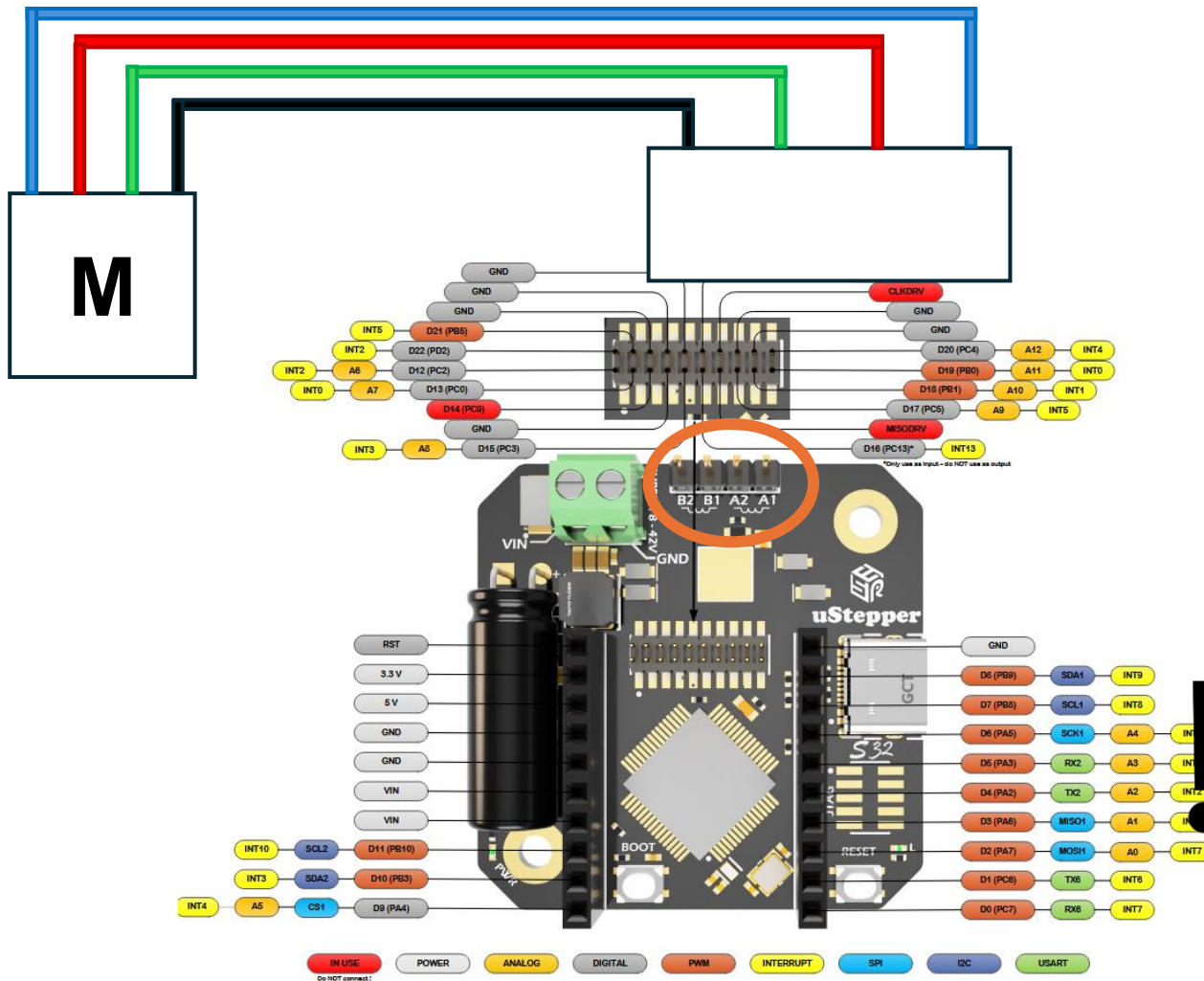
MOTORS

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)

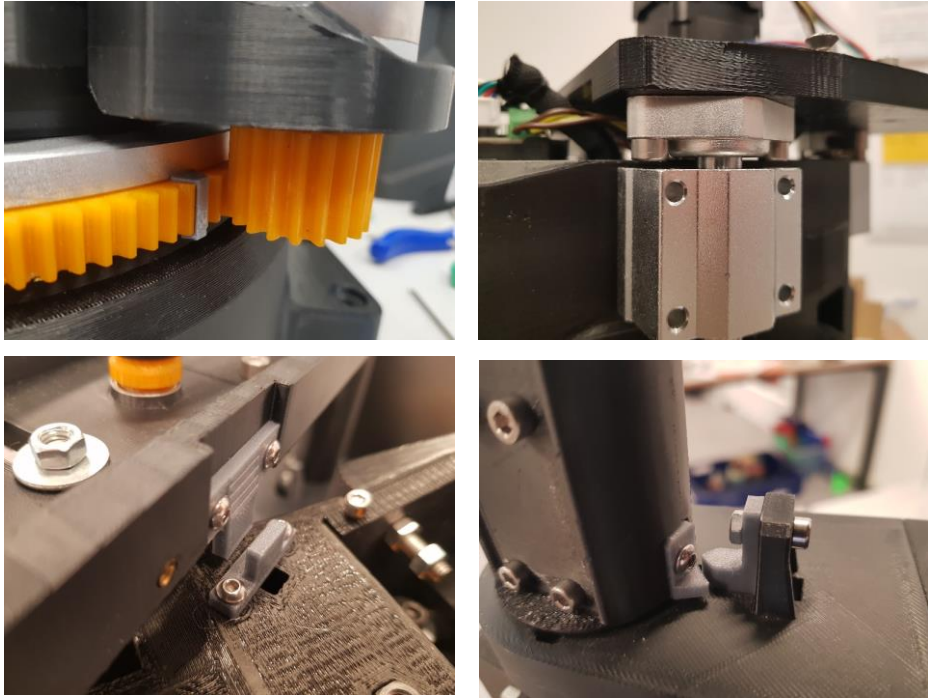
To make sure the wiring is correct, you can measure the resistance between the wires after it has been connected to the motor. In a bipolar stepper motor, the ends of the coil are represented as two pairs – A+ and A- as well as B+ and B-. The measured resistance between the two ends of each pair should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

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

ENDSTOPS

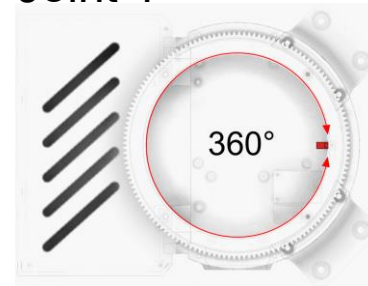
ENDSTOPS

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.

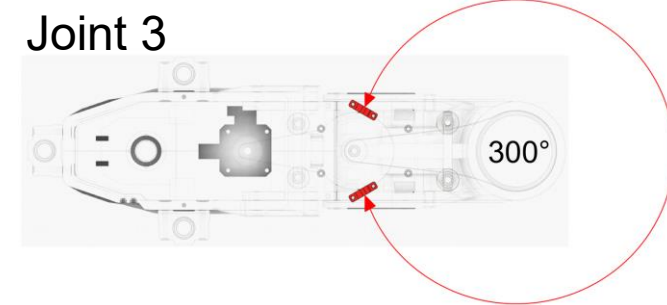
Joint 1



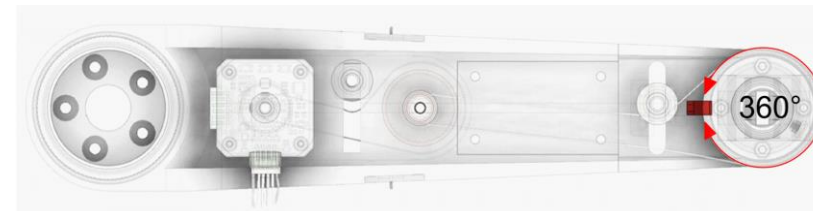
Joint 2



Joint 3



Joint 4



ASSEMBLY

4x M5x40
4x M5 nut



2x M4x40
2x M4 nut

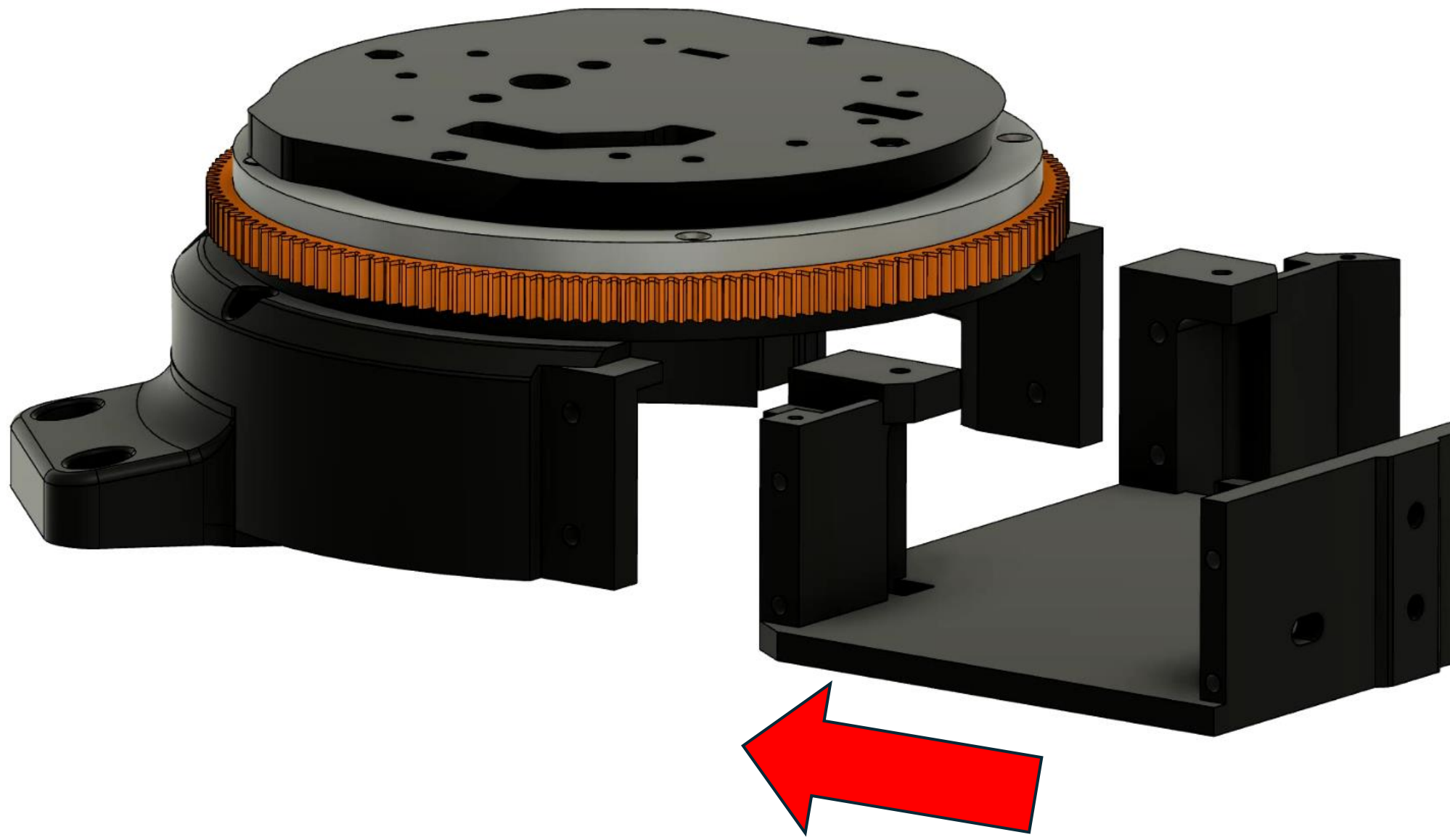


Note:
Don't insert all 4
screws!



4x M4x20
4x M4 nut

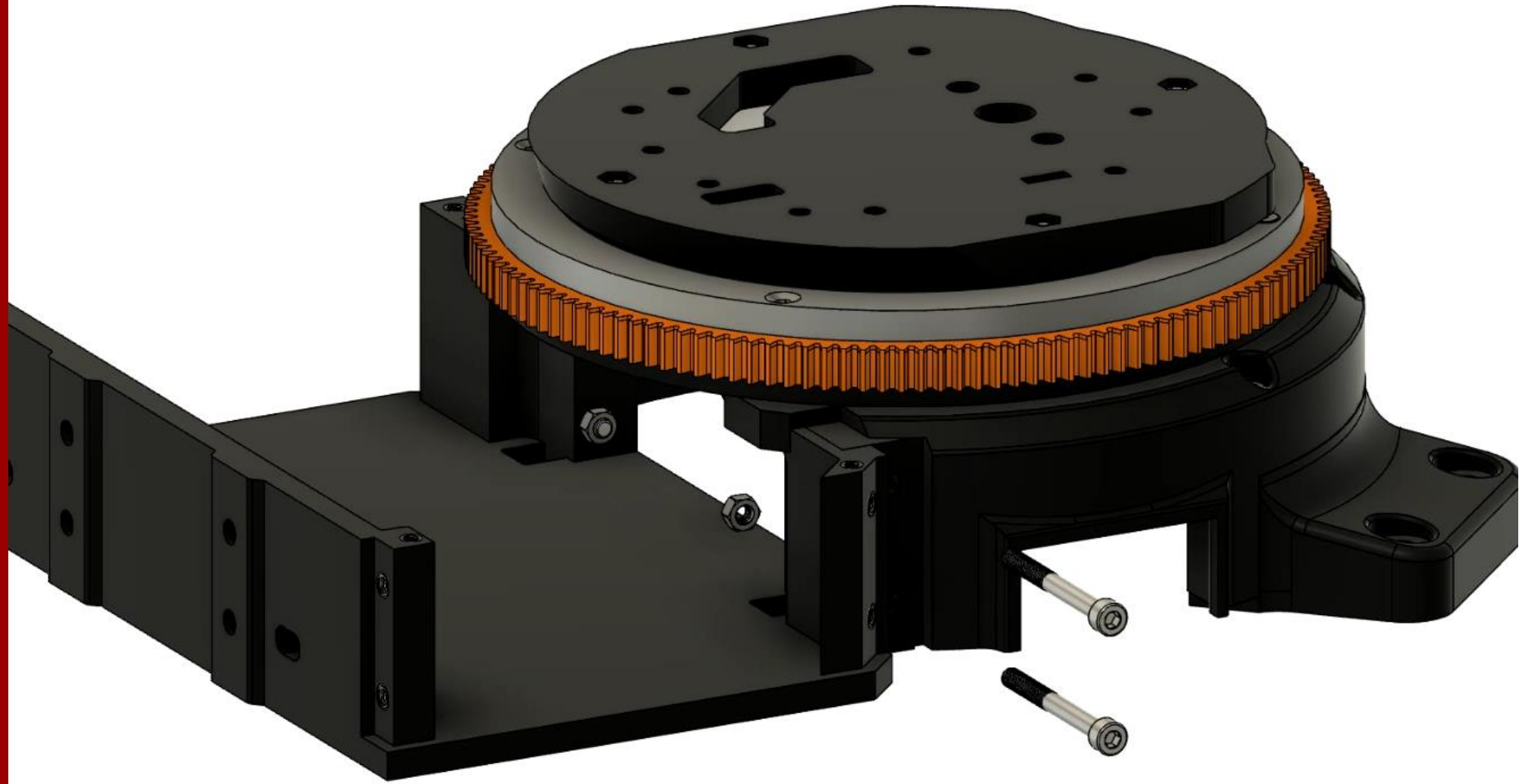




2x M5x50
2x M5 nut



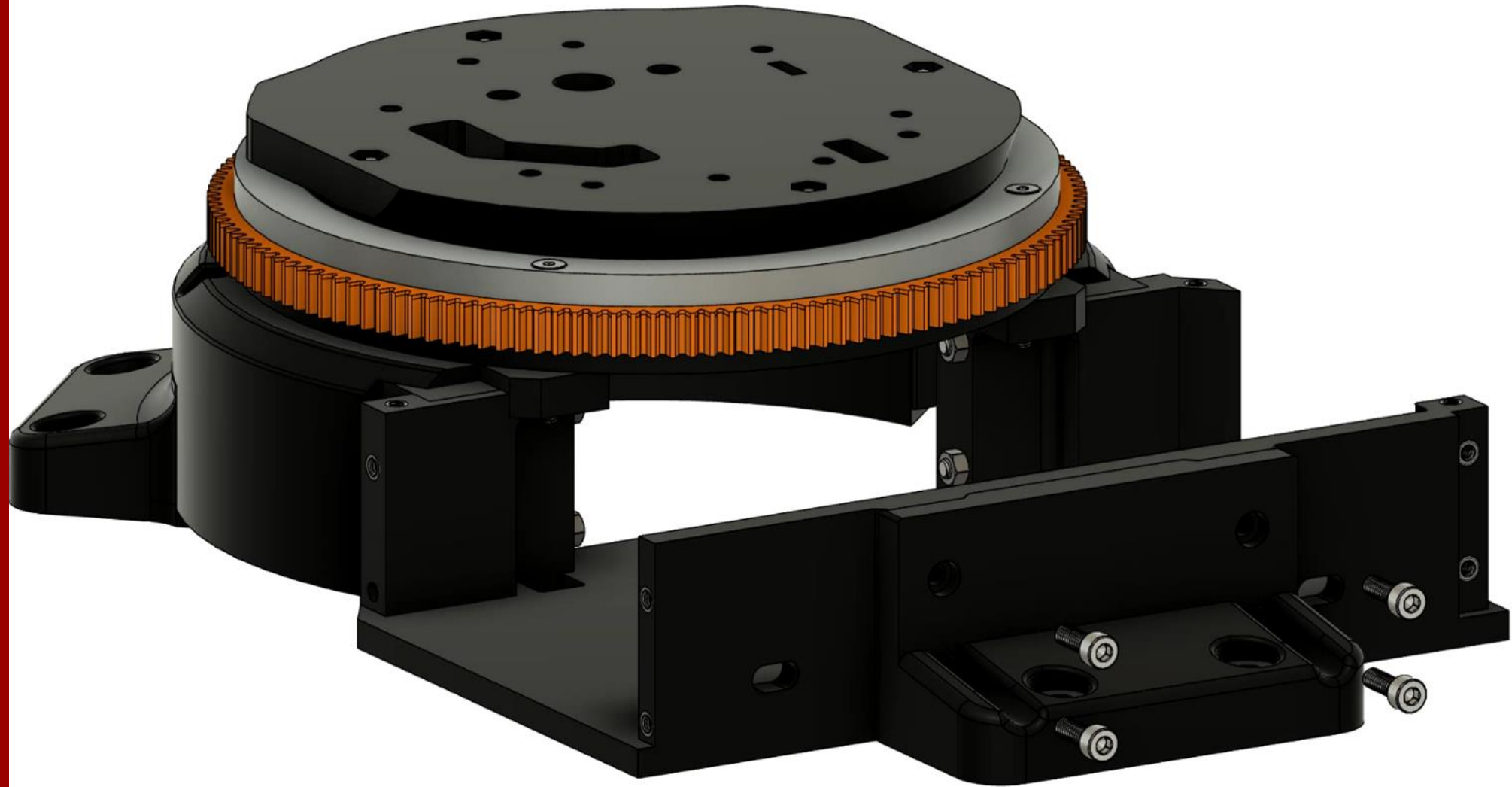
2x M5x50
2x M5 nut



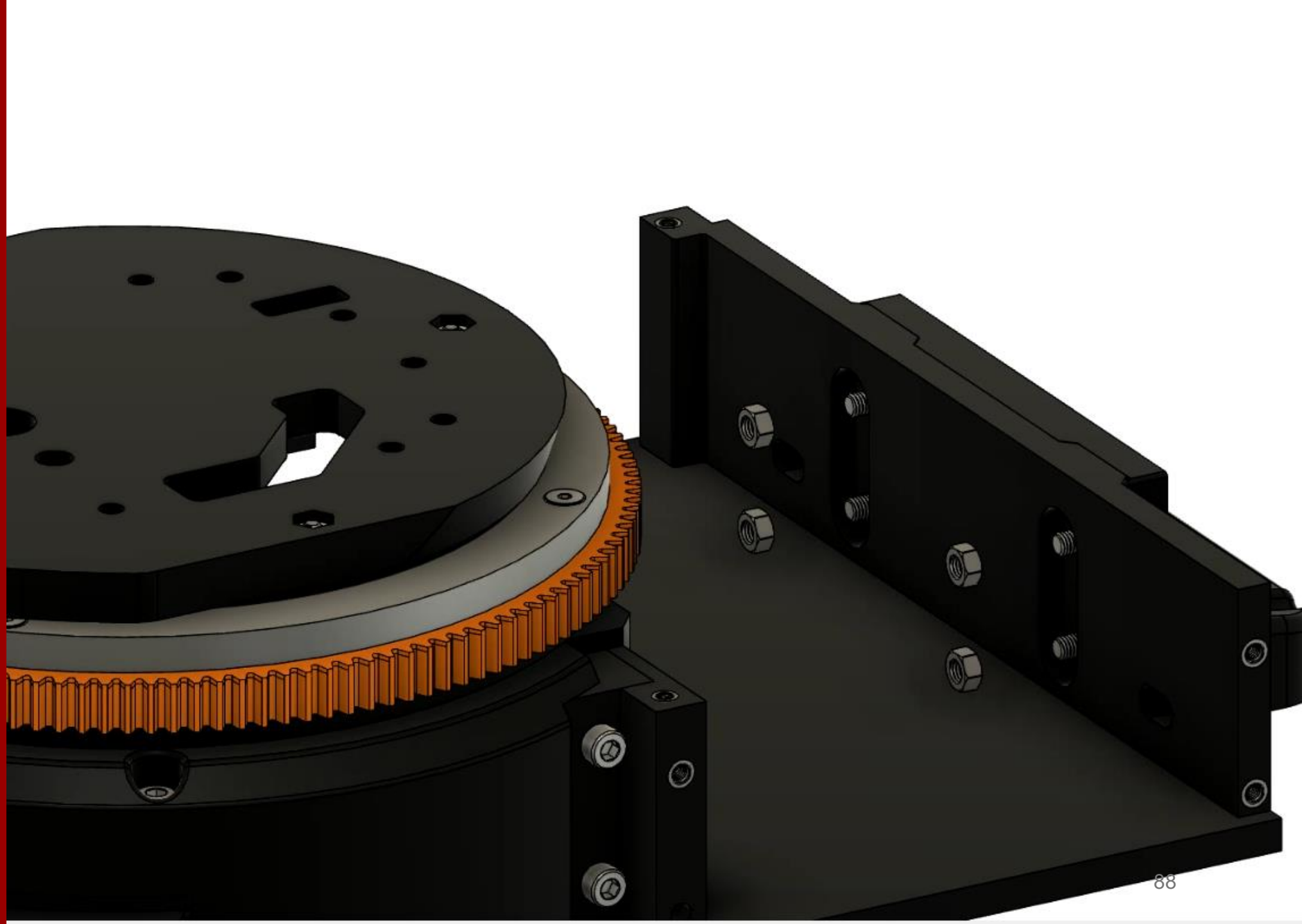
2x M4x40
2x M4 nut



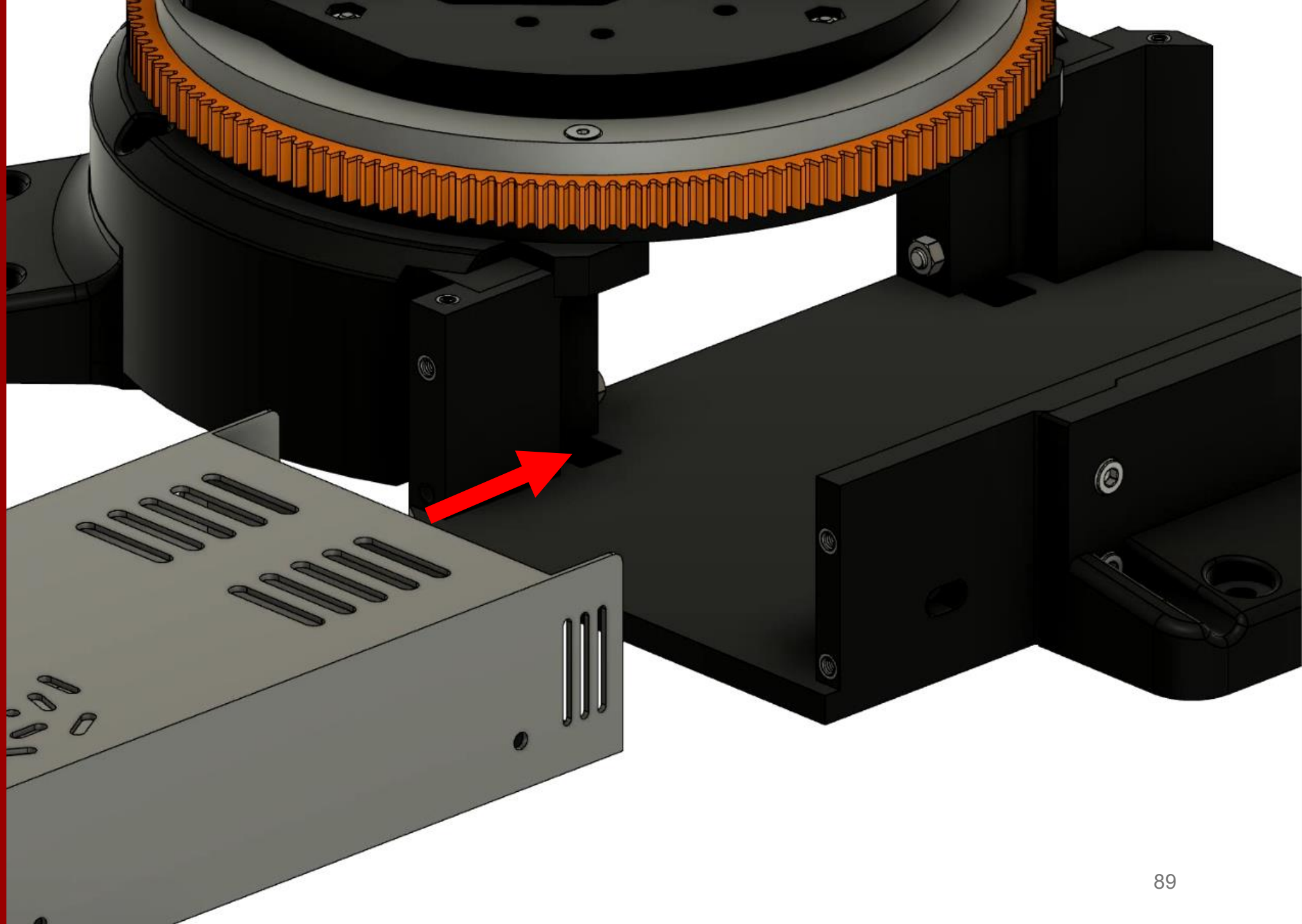
4x M5x15



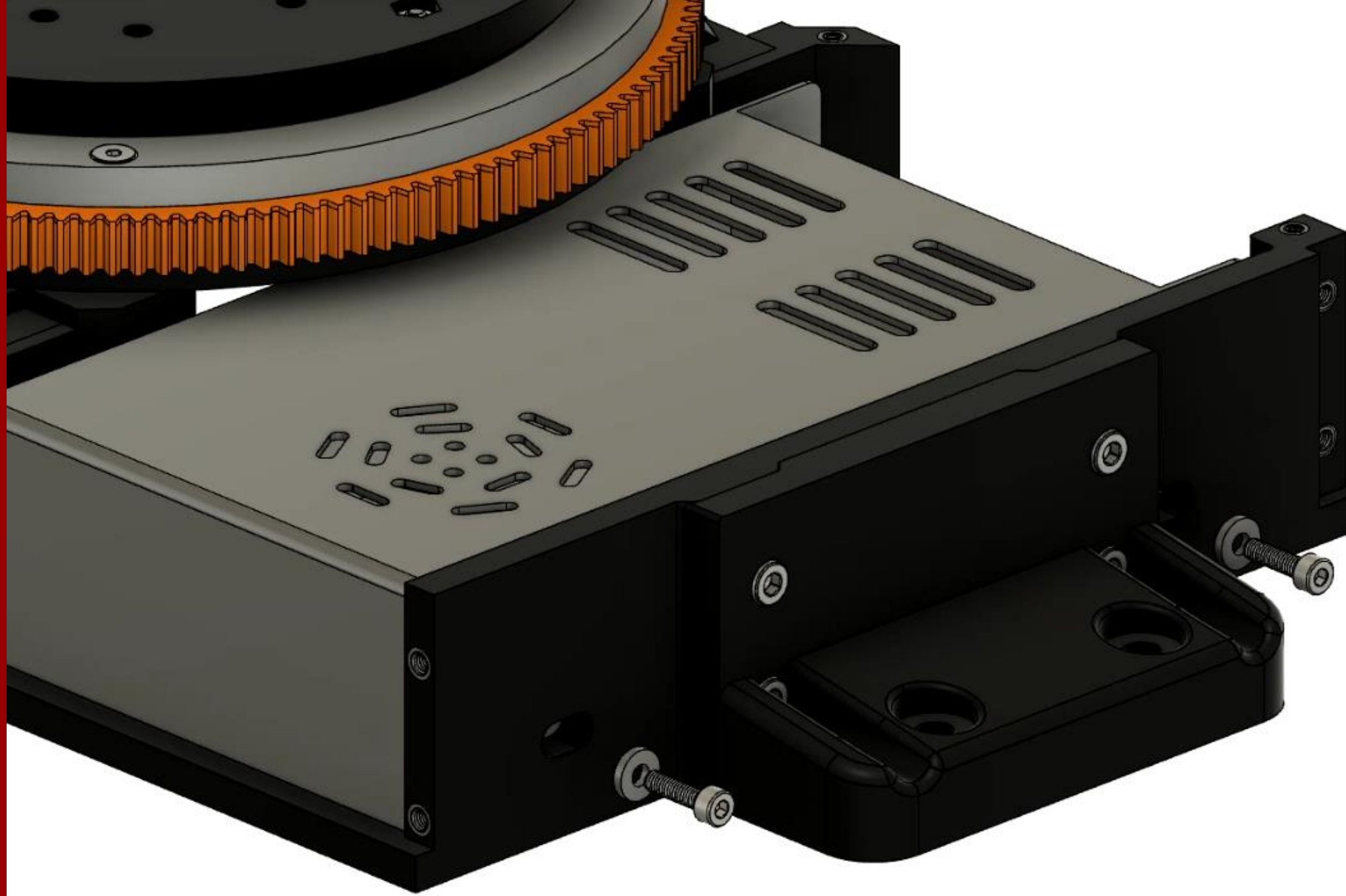
4x M5 nut



Insert power supply into the PSU box



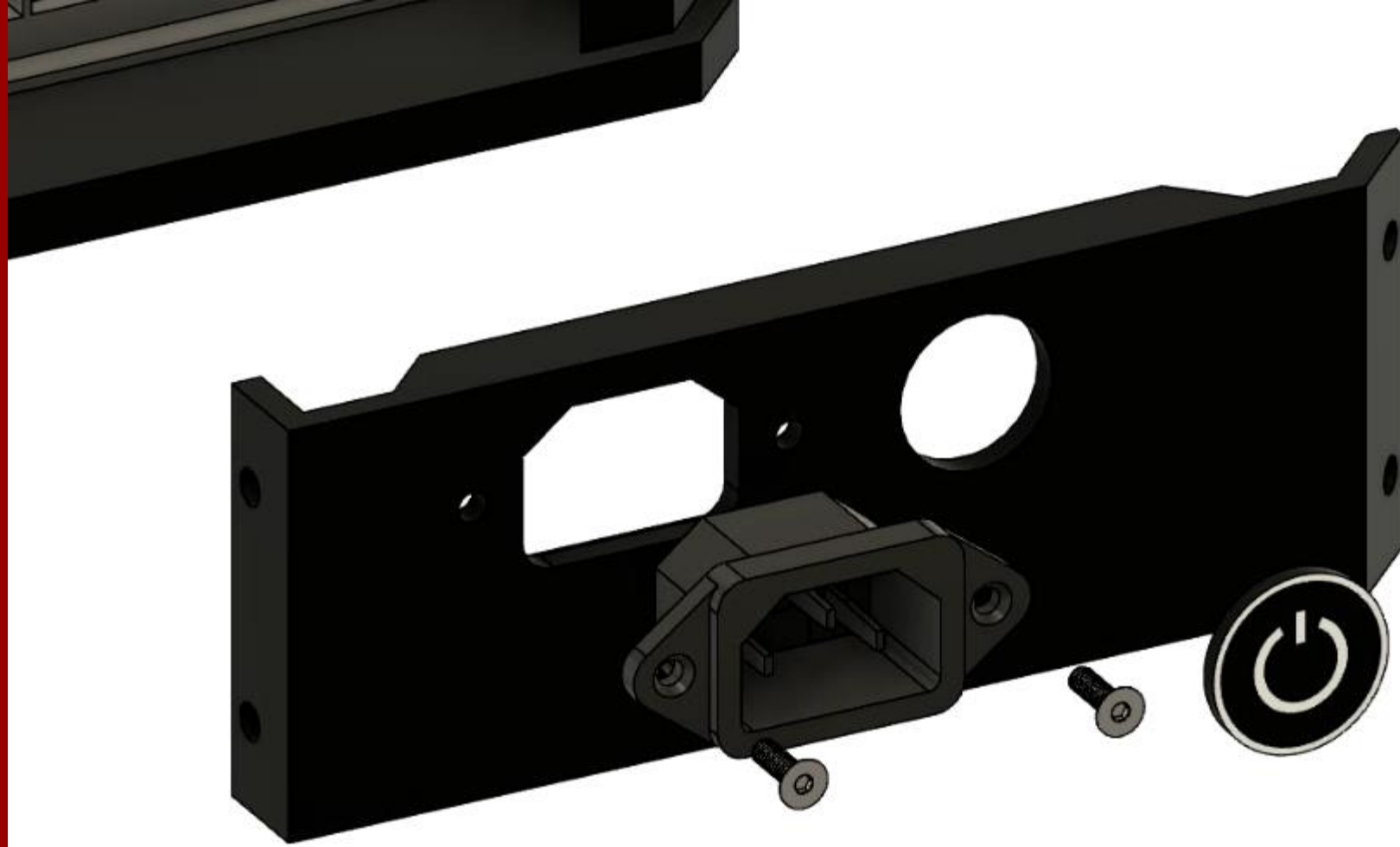
2x M4x15
2x M4 washer



4x M4x10

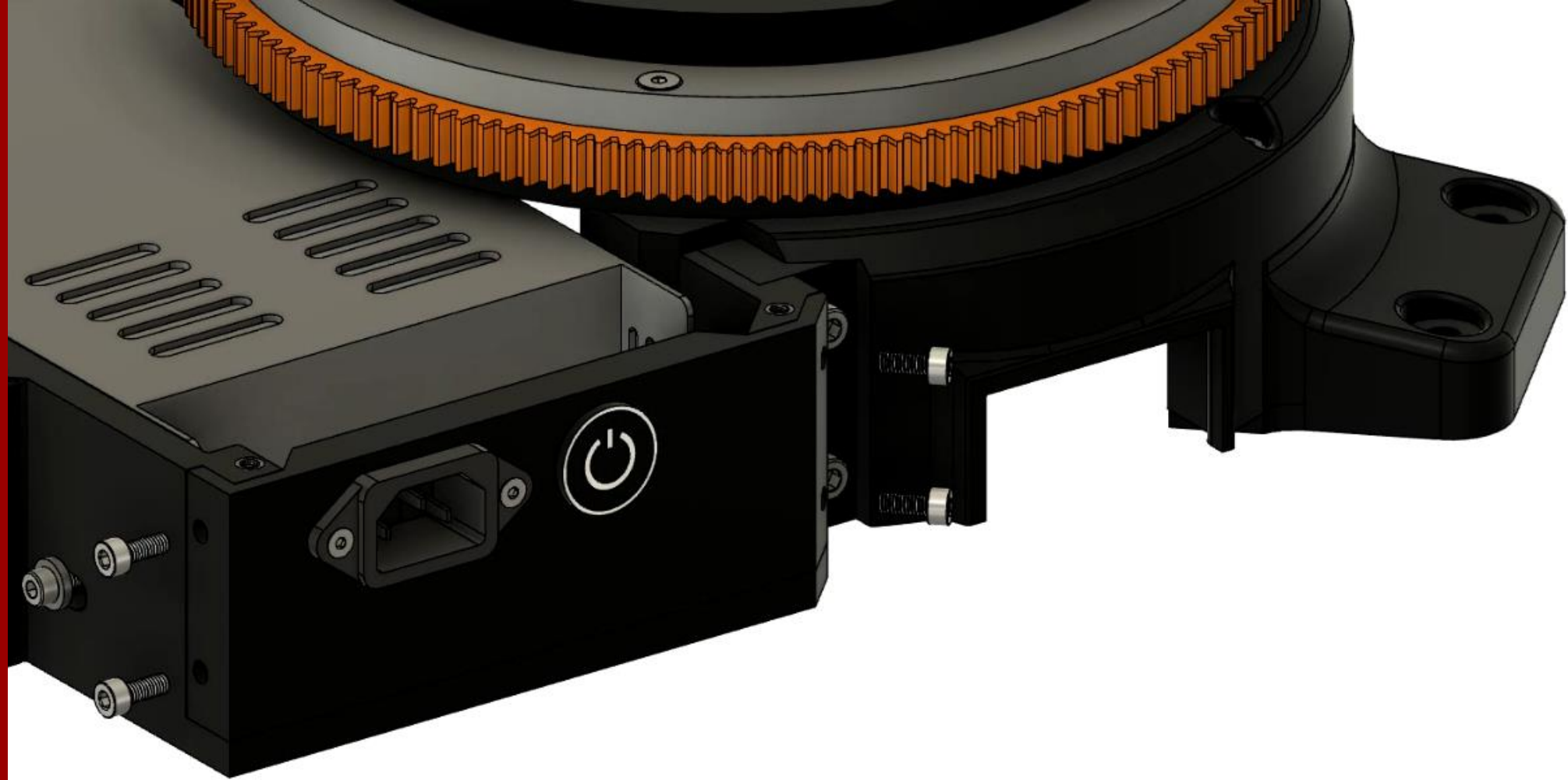


2x M3x10 flat head screw
1x Power button
1x C14 socket

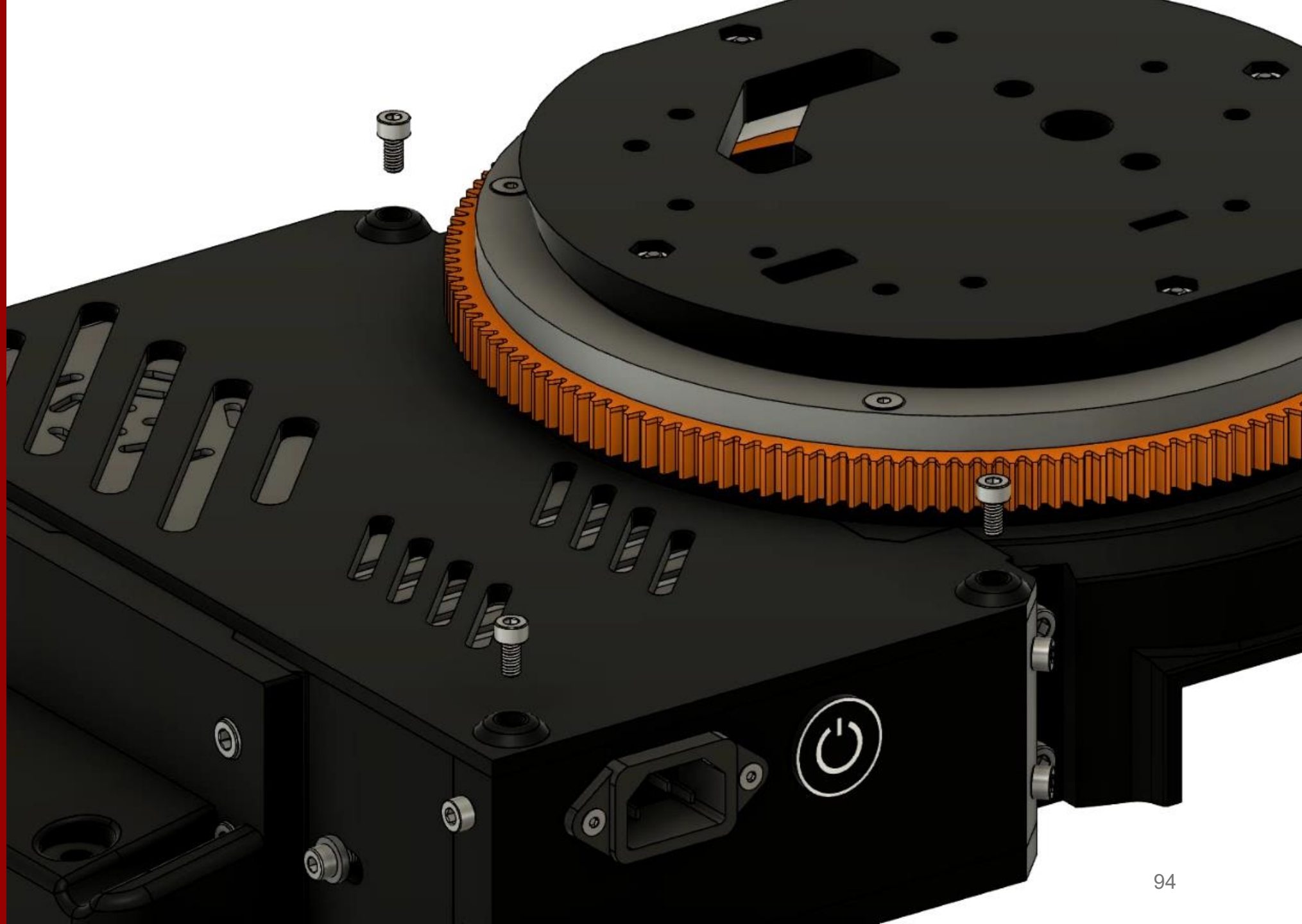


The front panel button and socket wiring have been described later in the manual

4x M4x10



3x M4x8





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



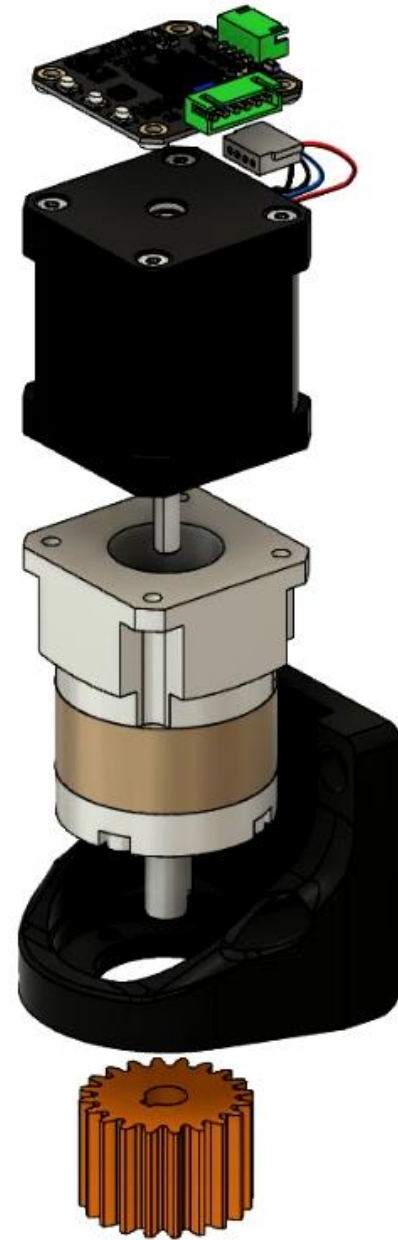
2x M5x30
2x M5 nut



6x M5x20
6x M5 nut



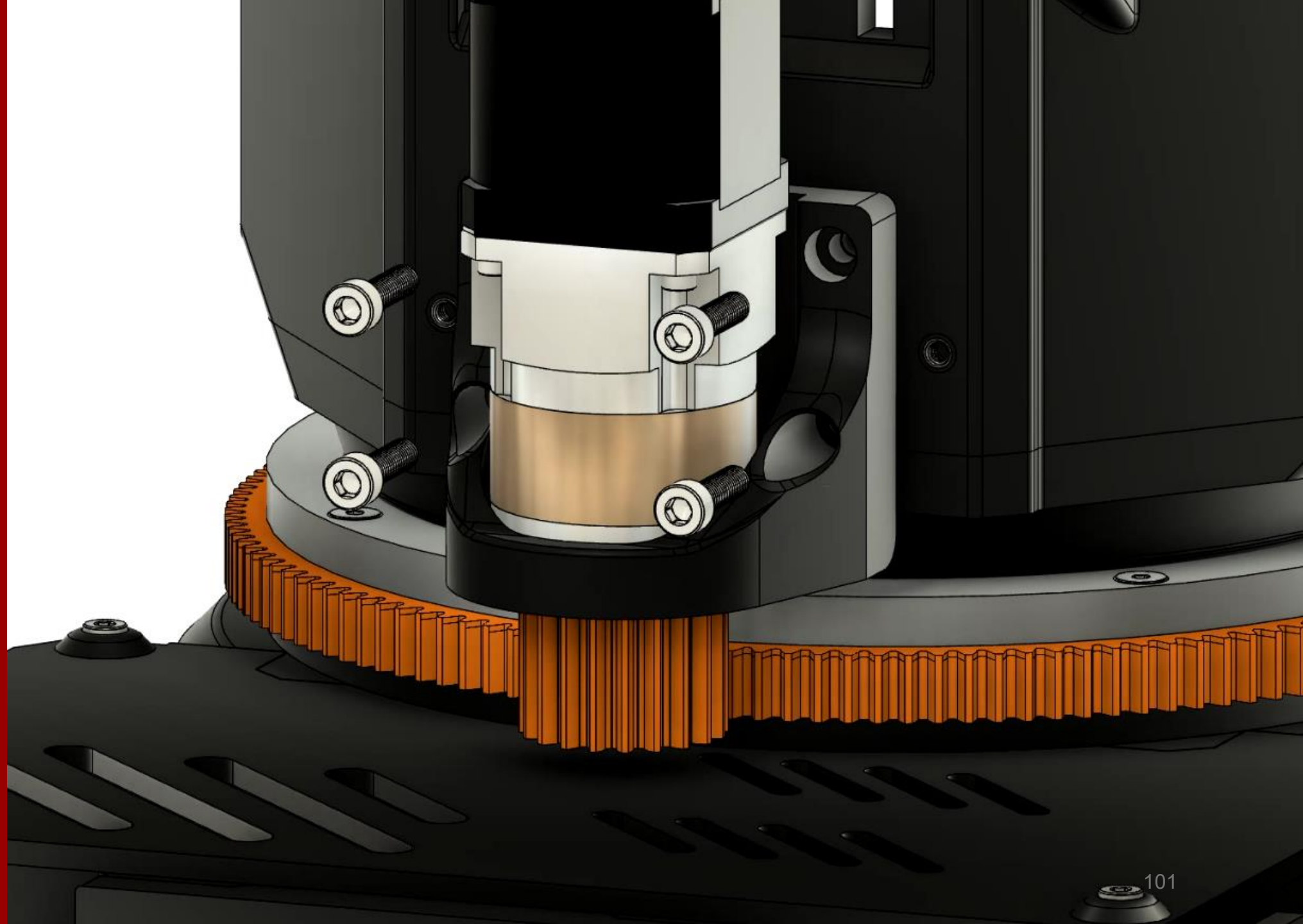
1x Ustepper S32
1x Nema 17 (17HS19-2004S1)
1x Planetary Gearbox 5:1
4x Distance washer

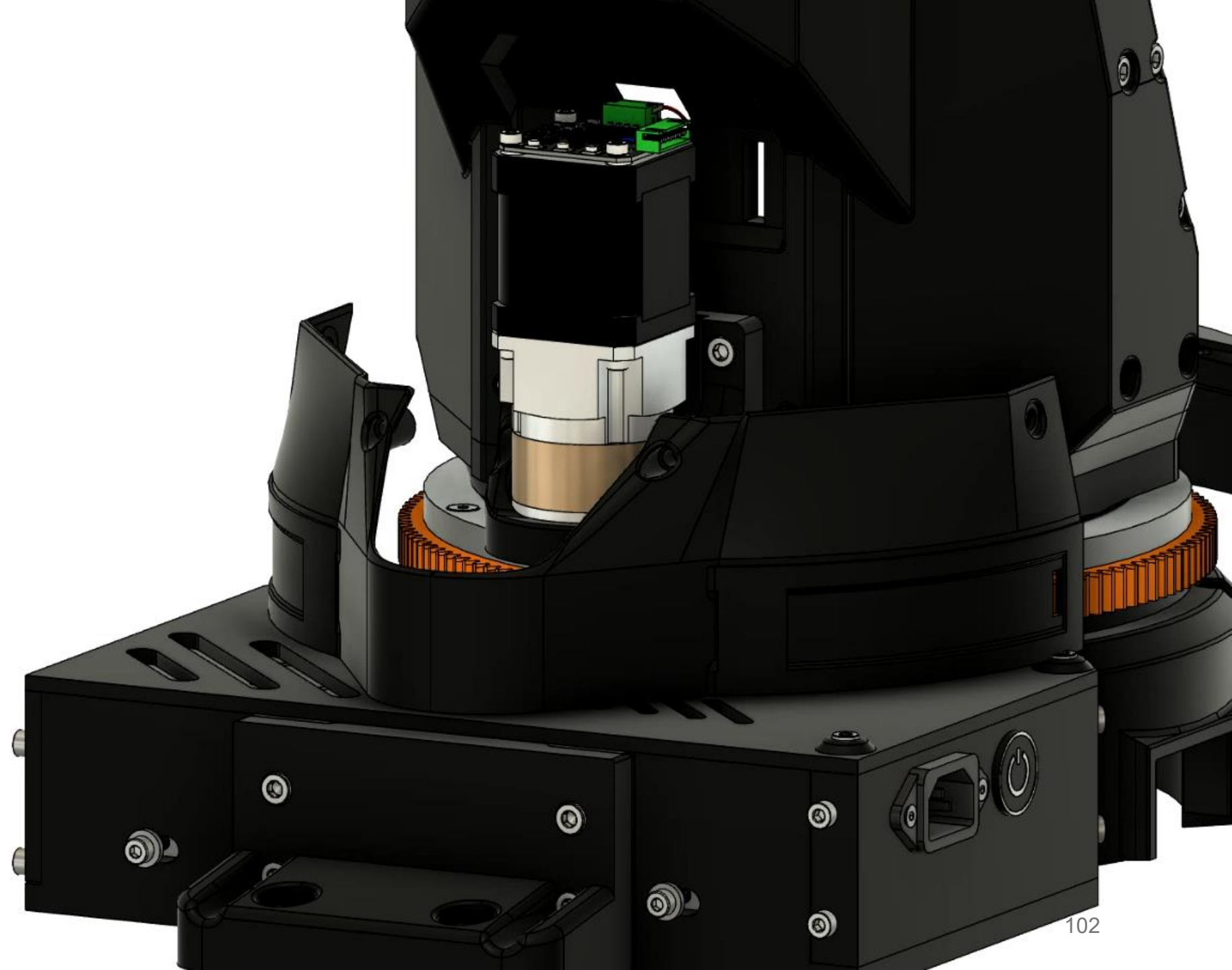


4x M3x8
4x M3x10
4x M4x8 flat head screw
1x M3x10



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





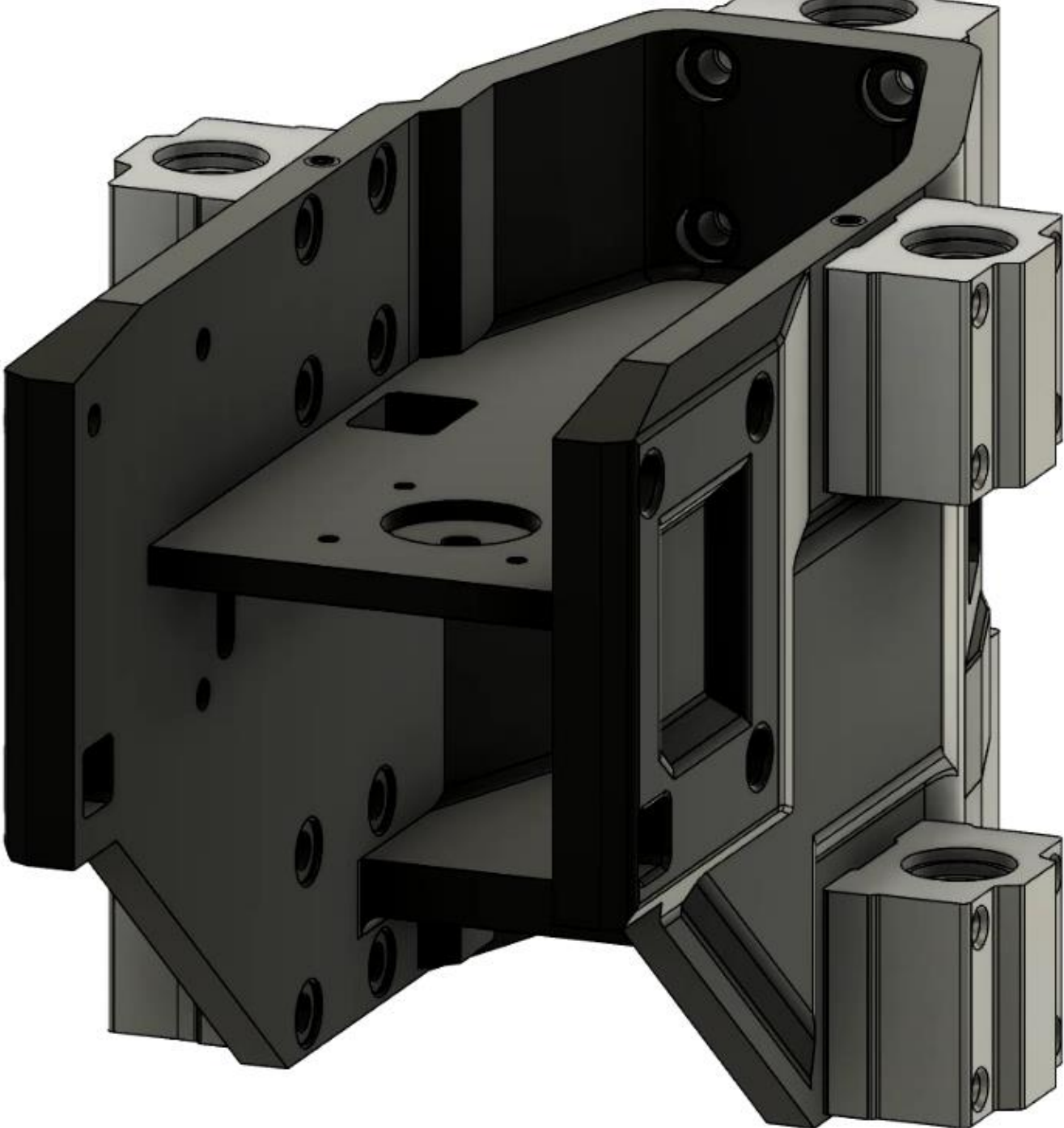
4x M3x15



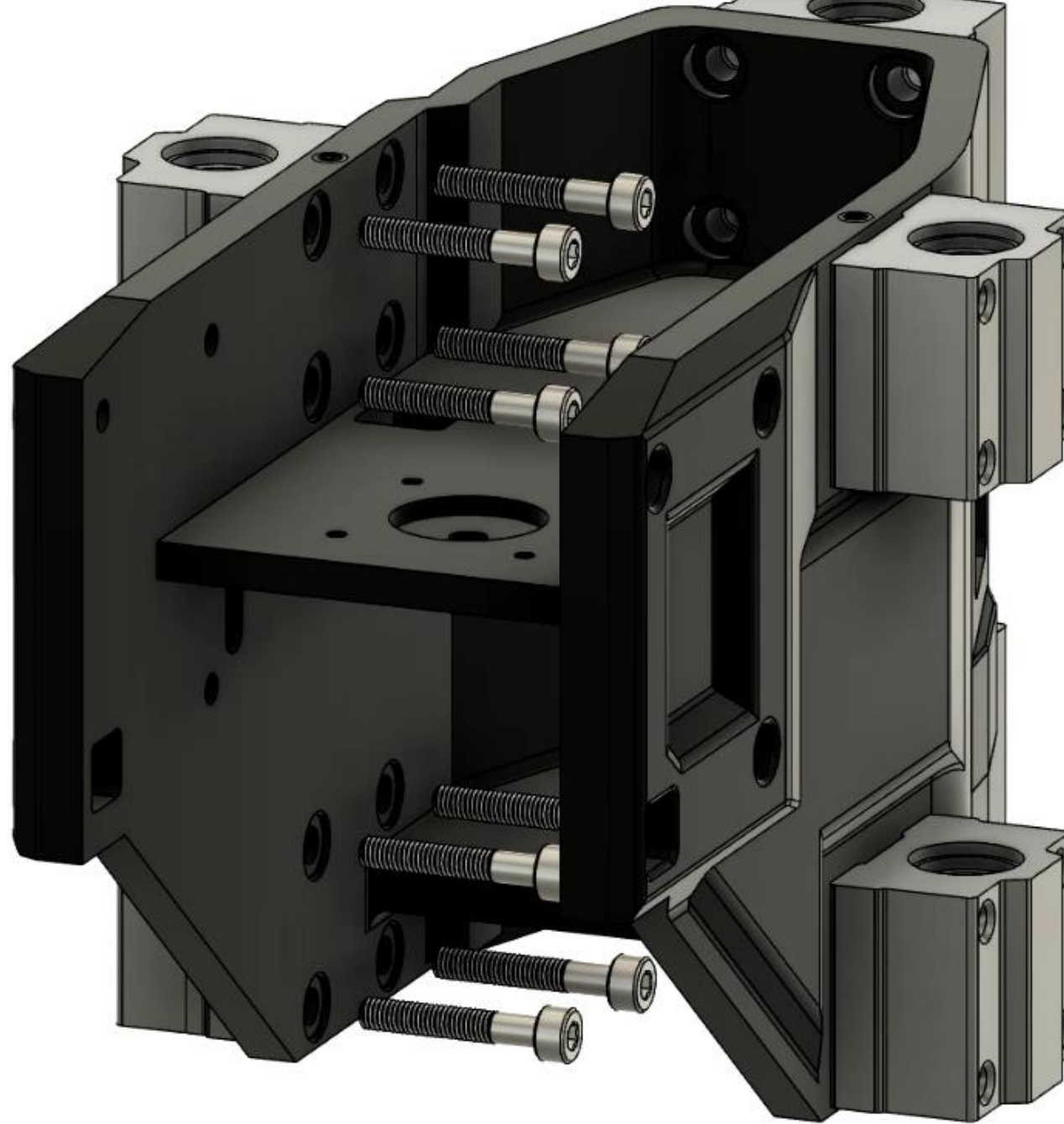
3x Steel rod 500x12
1x 4mm Lead screw 500x10



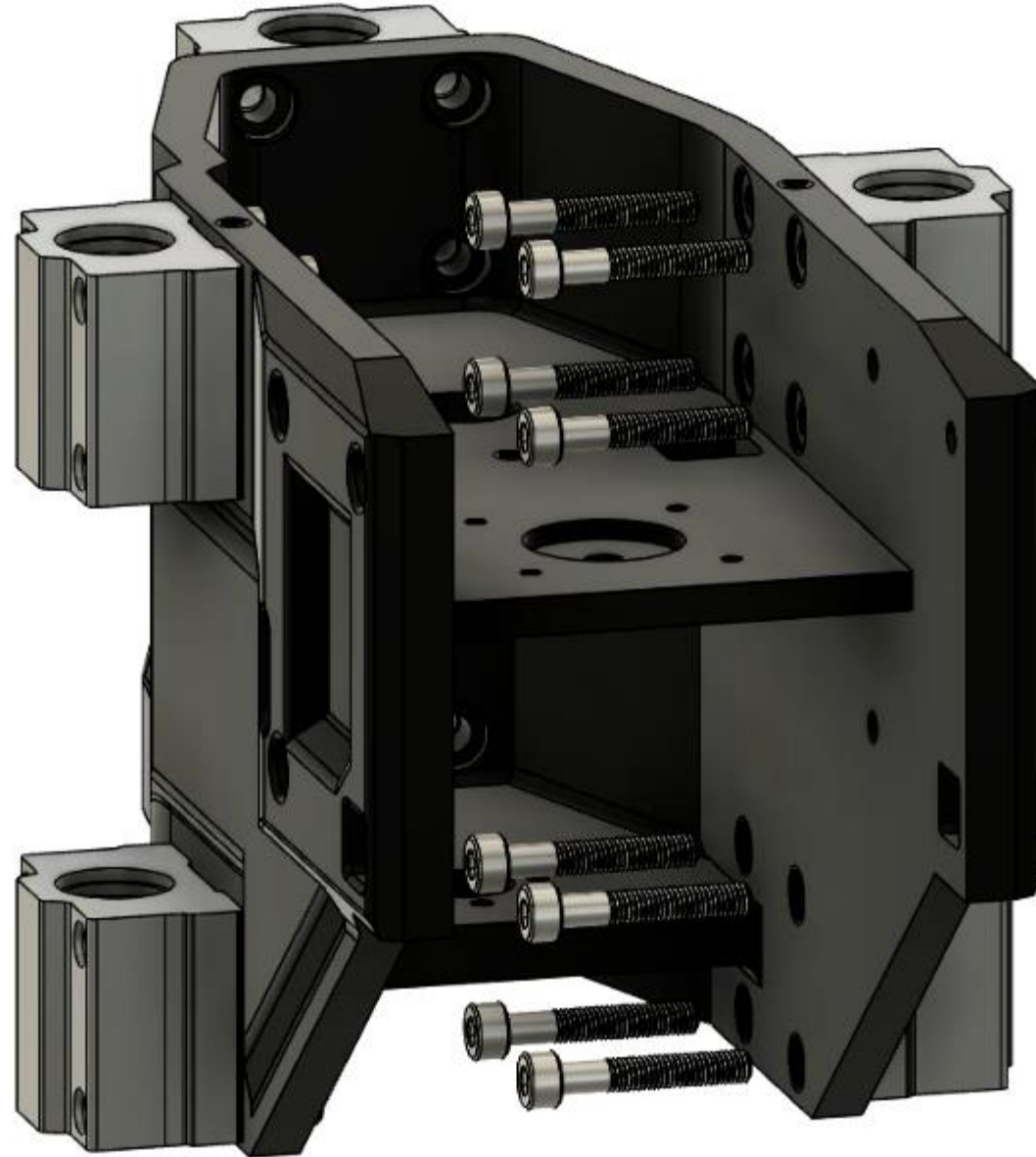
6x Linear ball bearing block



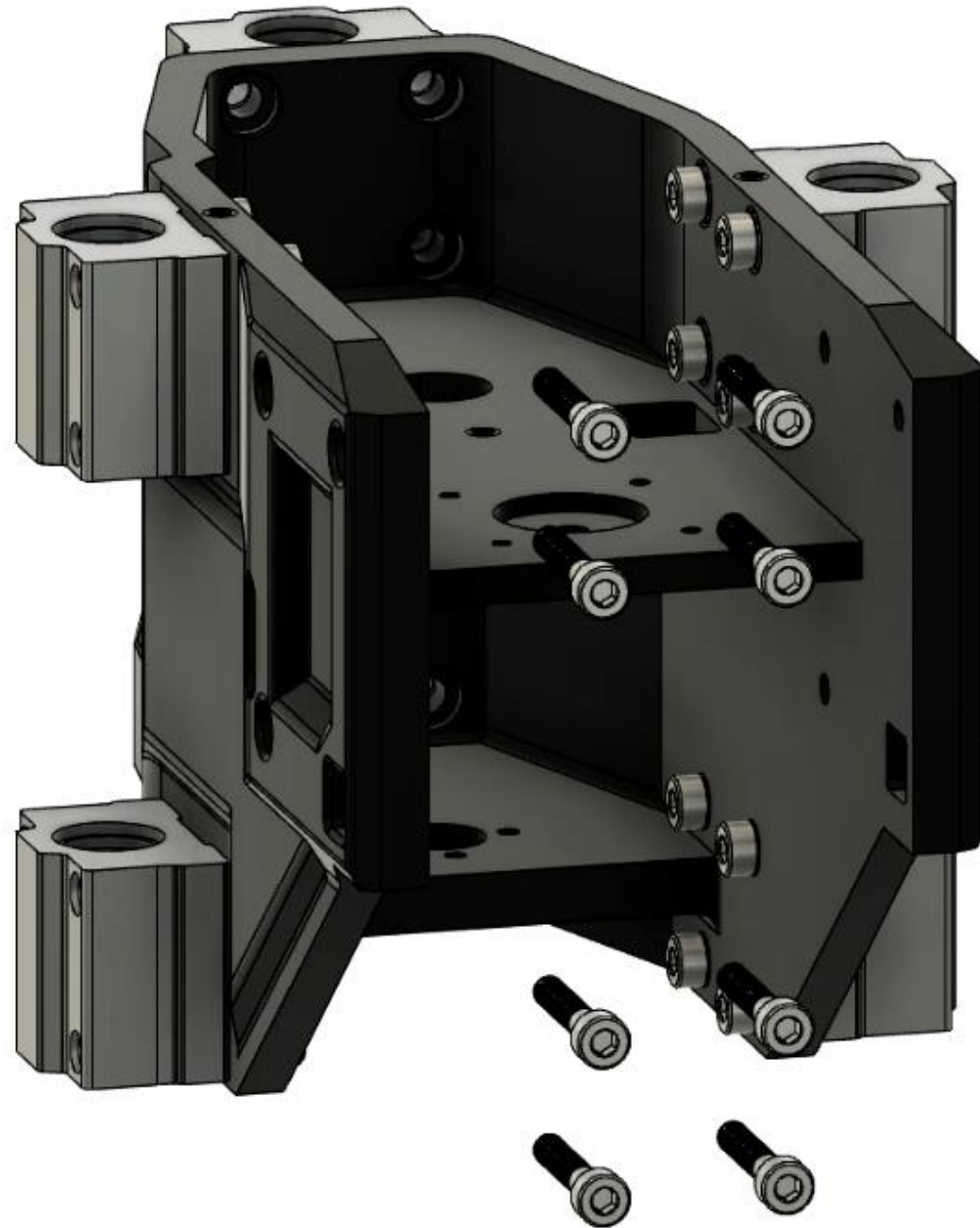
8x M5x15



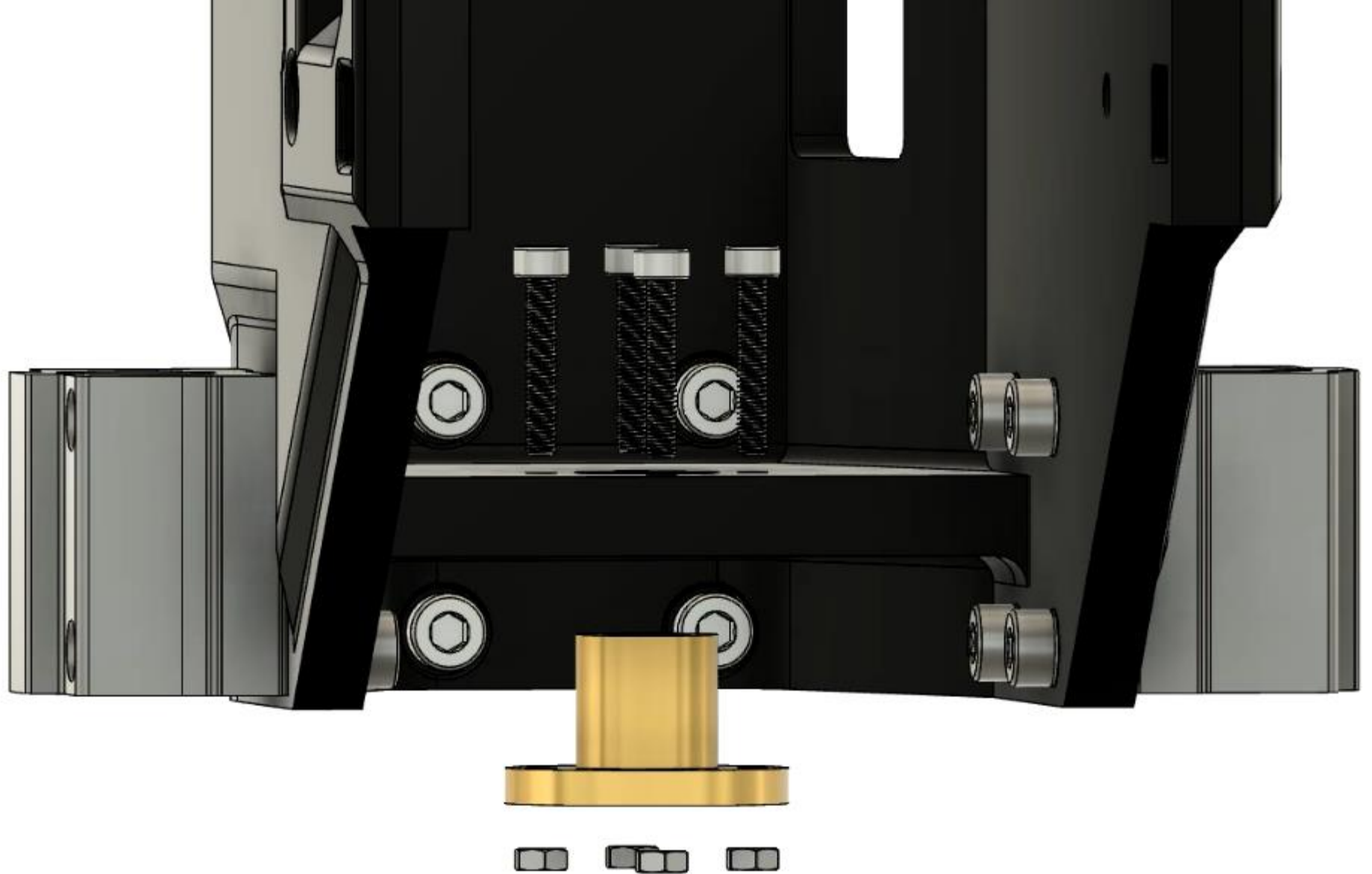
8x M5x15



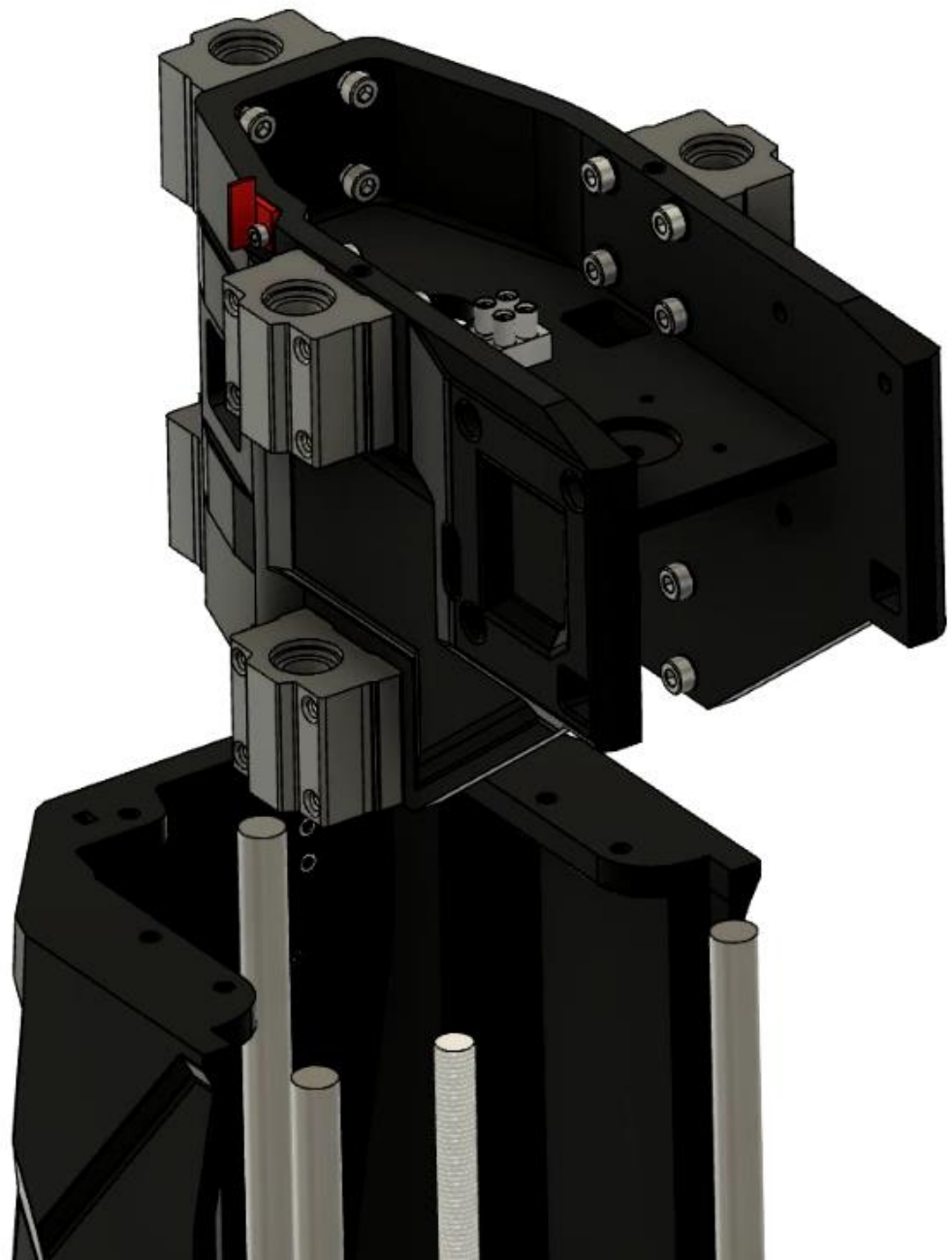
8x
M5x15



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

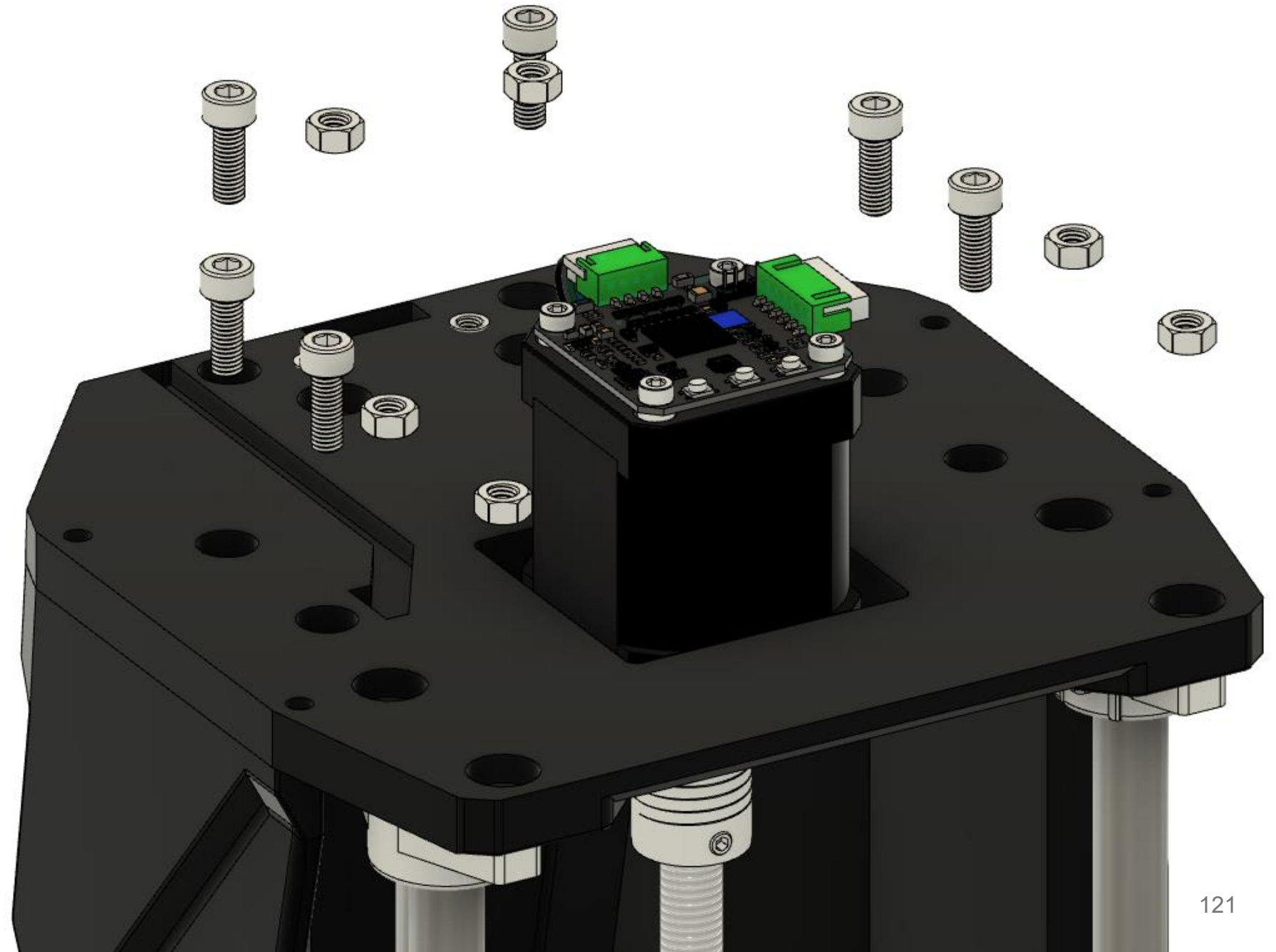




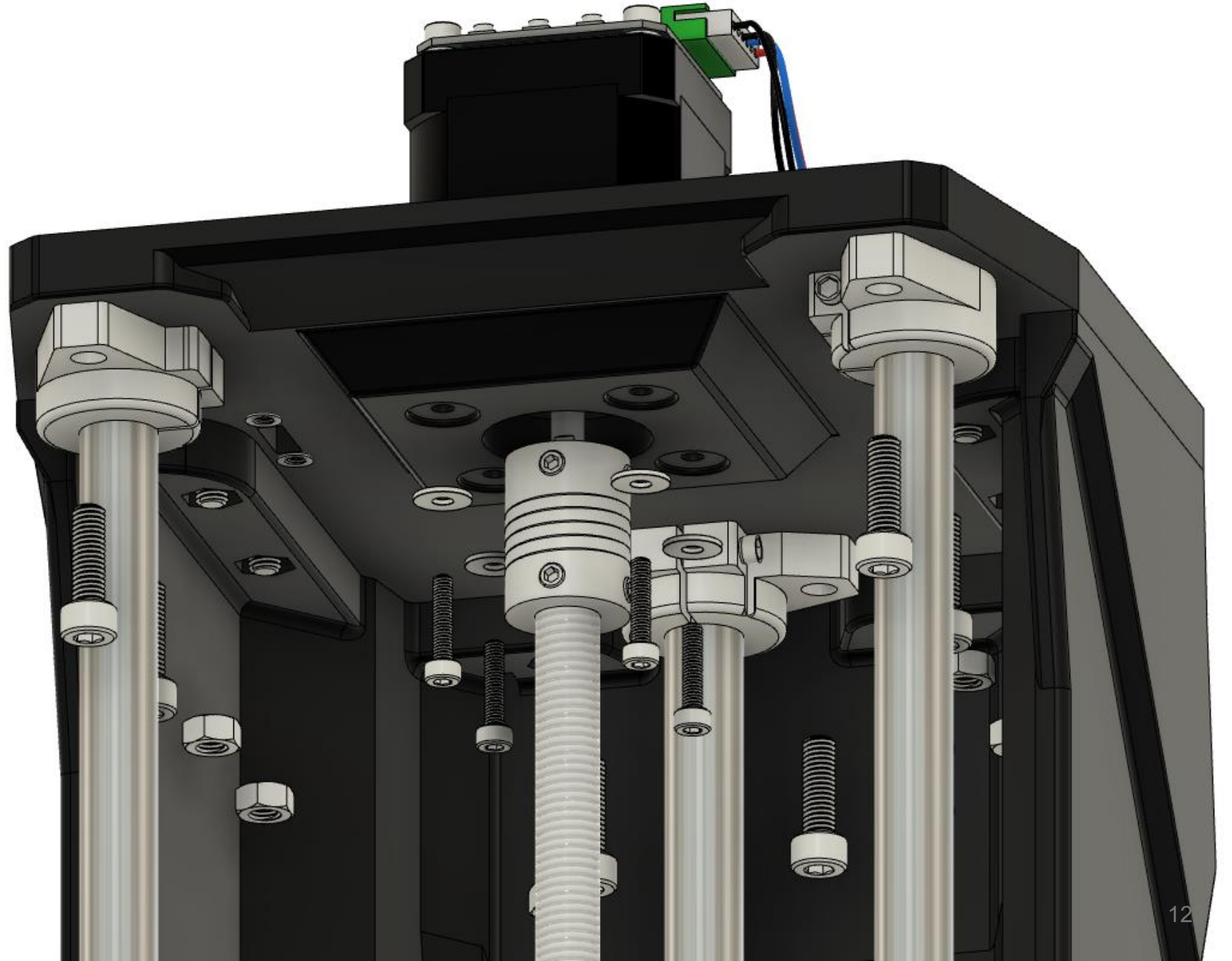
1x Nema 17 (17HS19-2004S1)
1x Ustepper S32



6x M5x15
6x M5 nut
4x M3x10



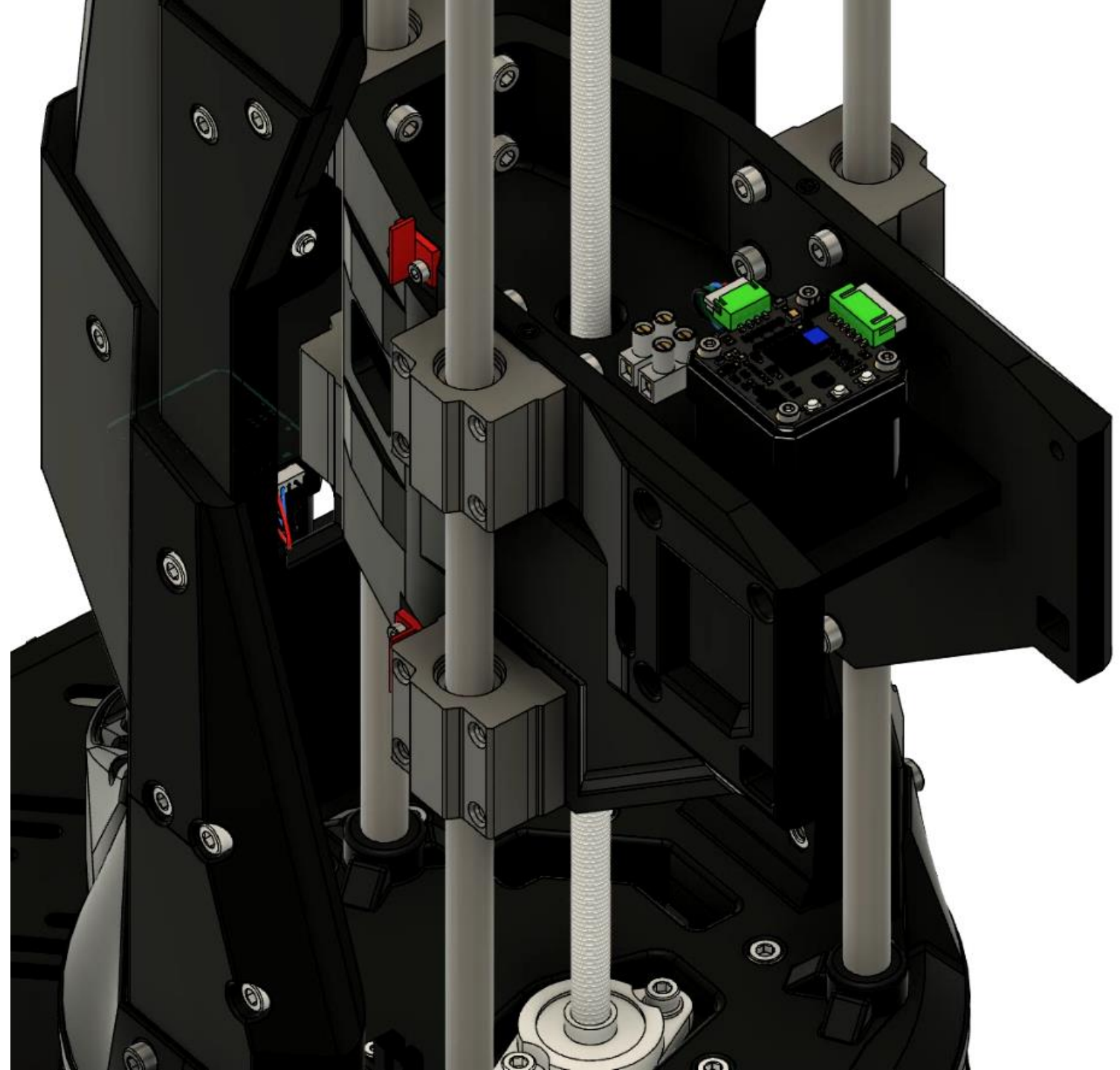
4x M3x15
4x M3 washer
6x M5x15
6x M5 nut



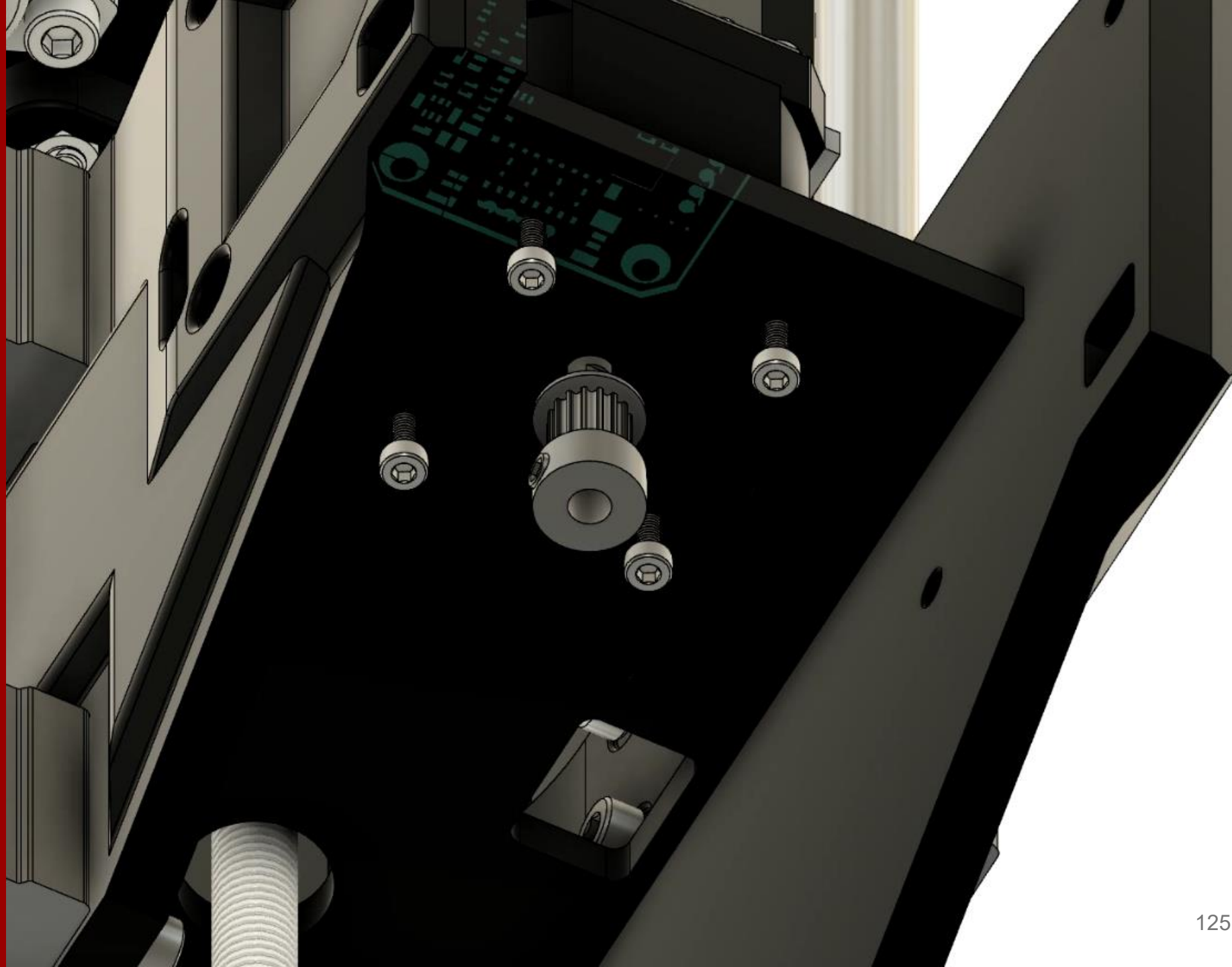
4x M4x10

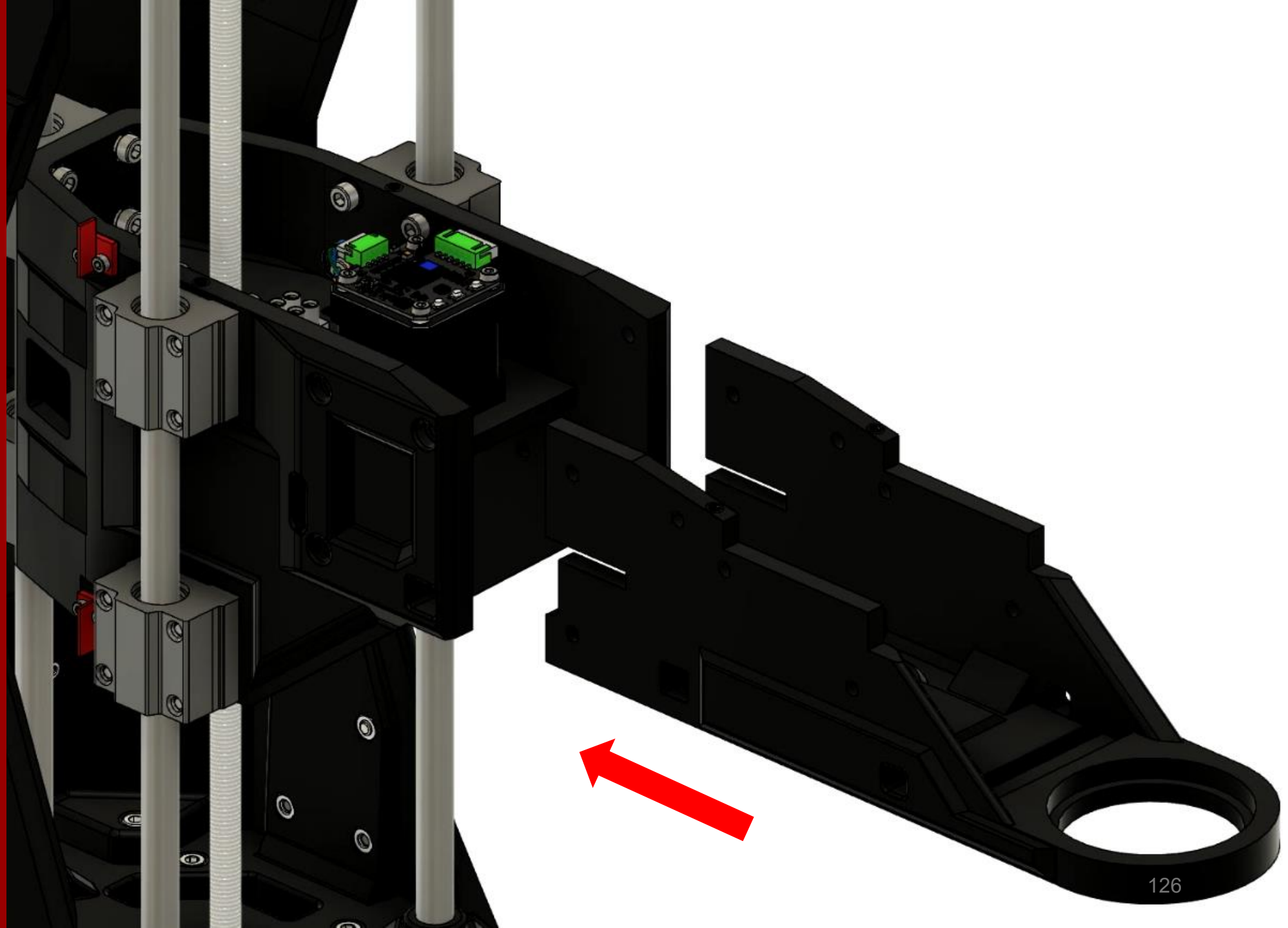


1x Nema 17 (17HS15-1504S1)
1x MKS Servo42C
4x M3x10
4x Distance washer



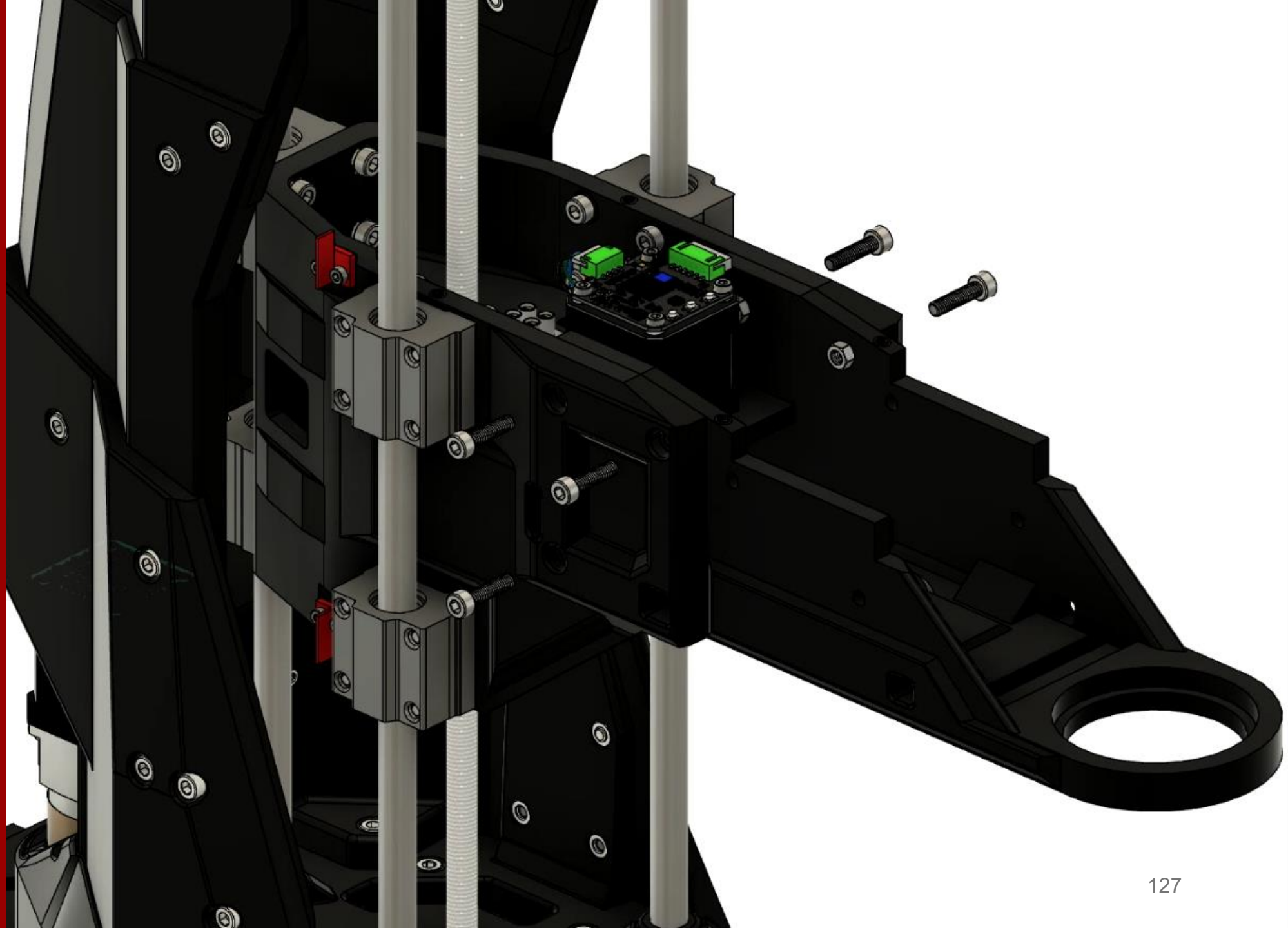
1x GT2 16T Pulley
4x M3x10



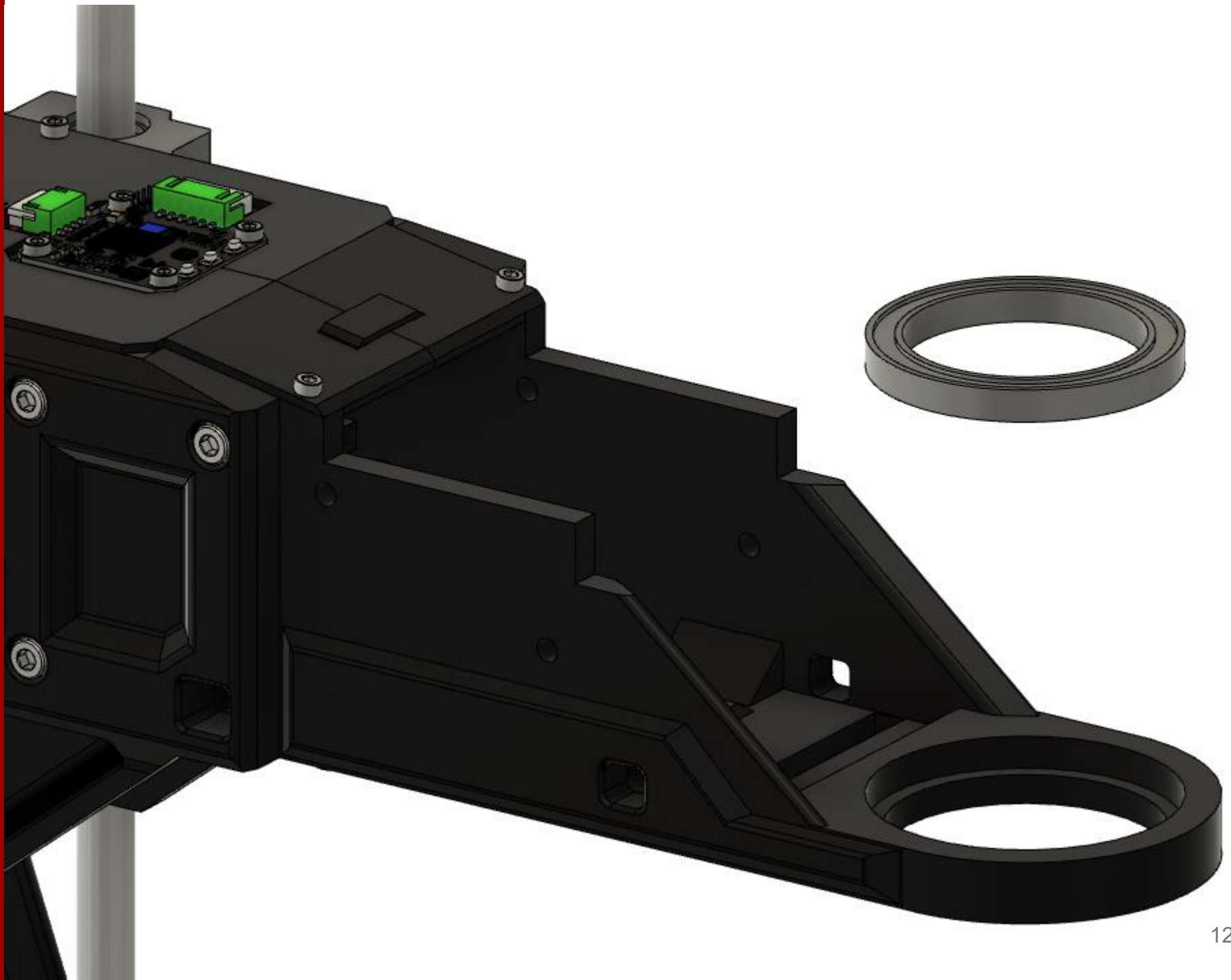


126

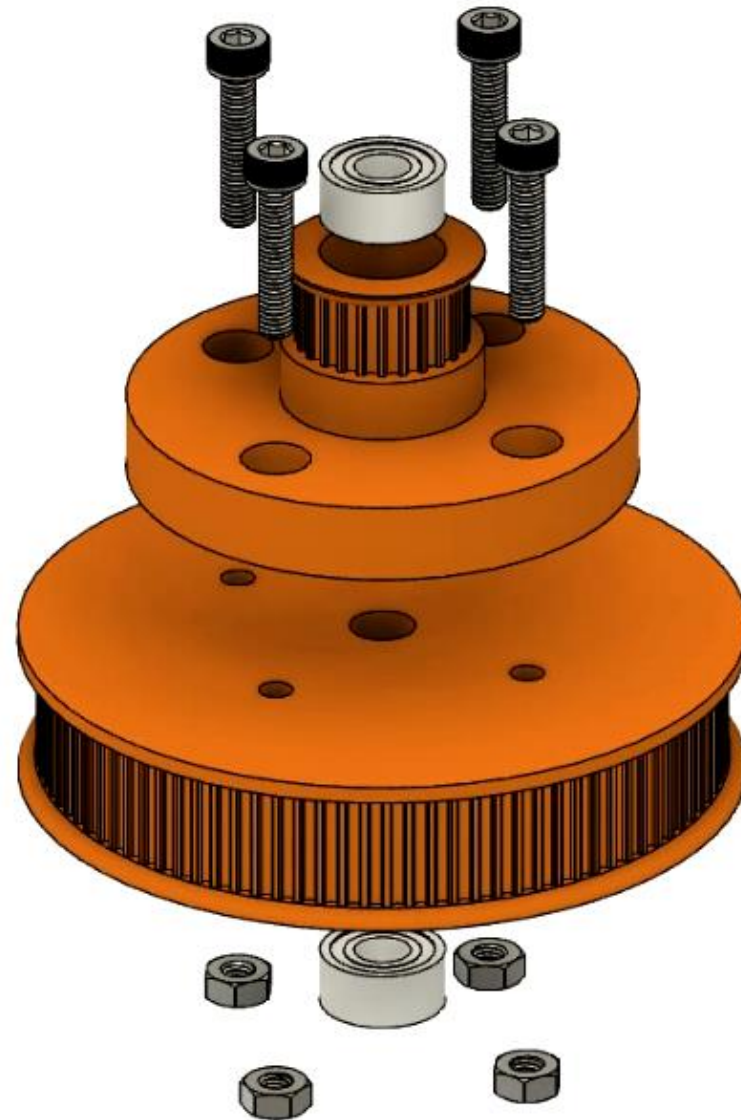
6x M5x20
6x M5 nut



1x Ball bearing 50x65x7

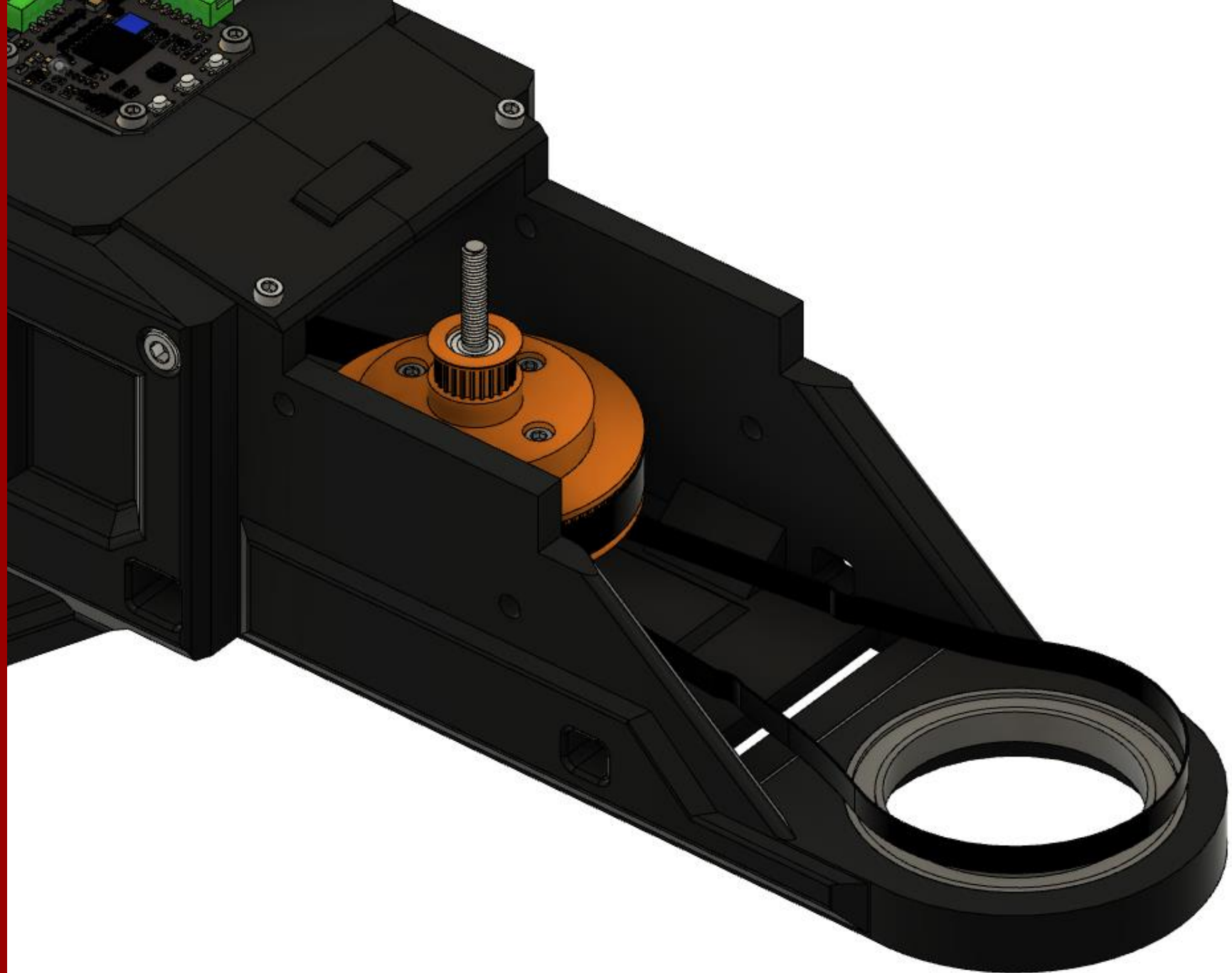


2x Ball bearing 5x11x5
4x M3x15
4x M3 nut

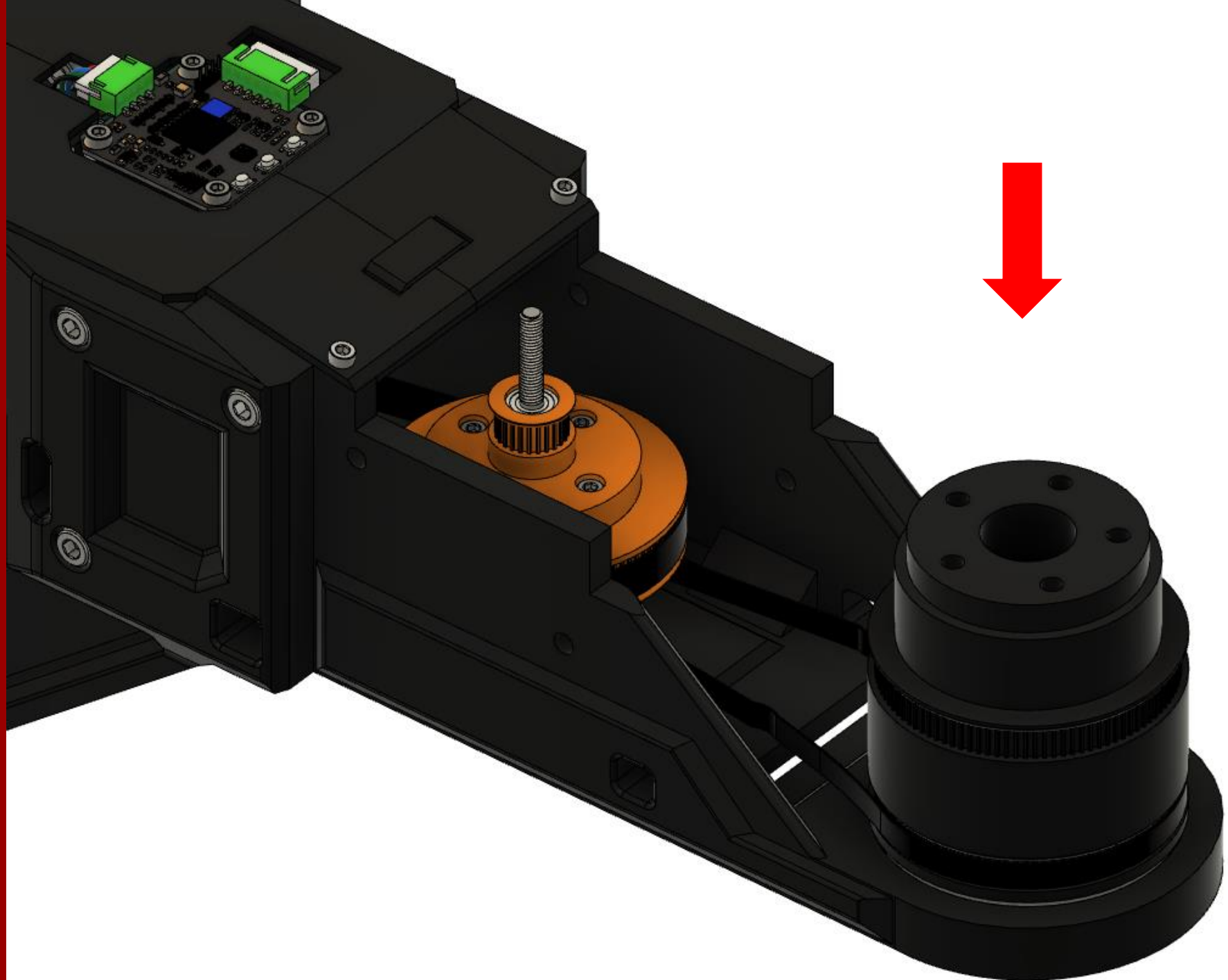


1x M5x75
1x GT2 belt 10x294
1x GT2 belt 6x400

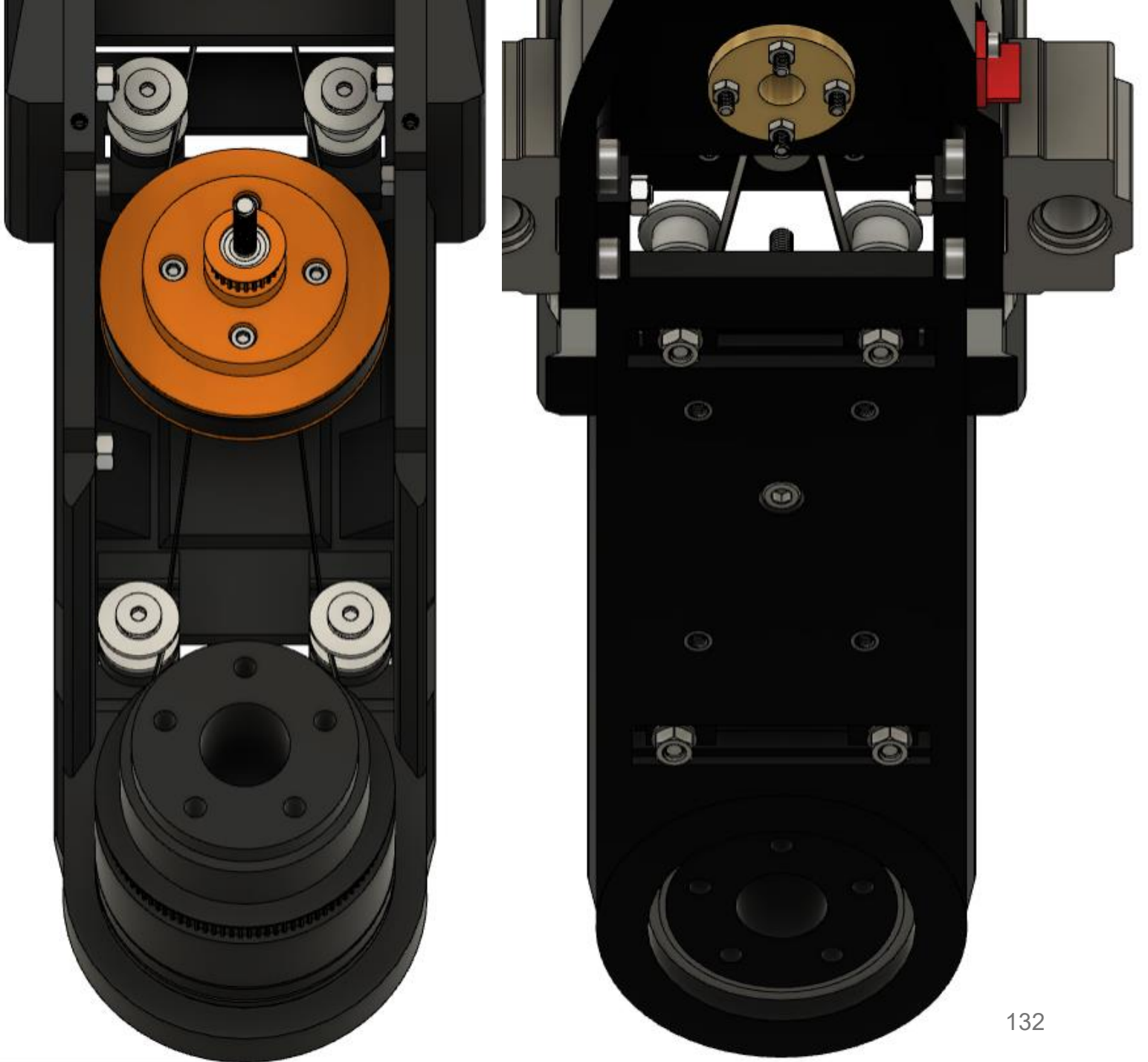
**Add the belts onto the
3D printed pulley
Position the pulley
inside the arm and insert
the screw**



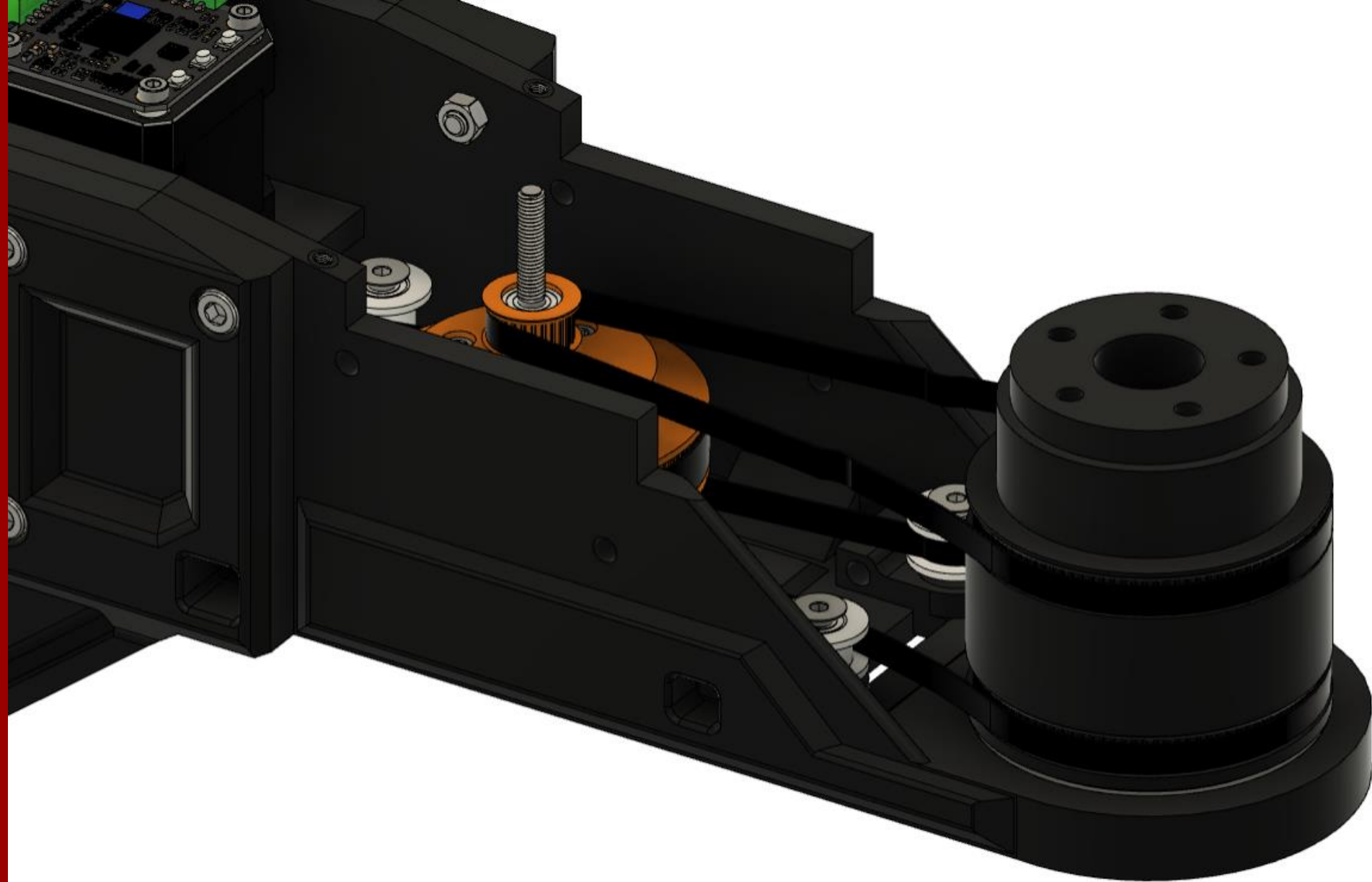
2x Ball bearing 5x11x5
4x M3x15
4x M3 nut



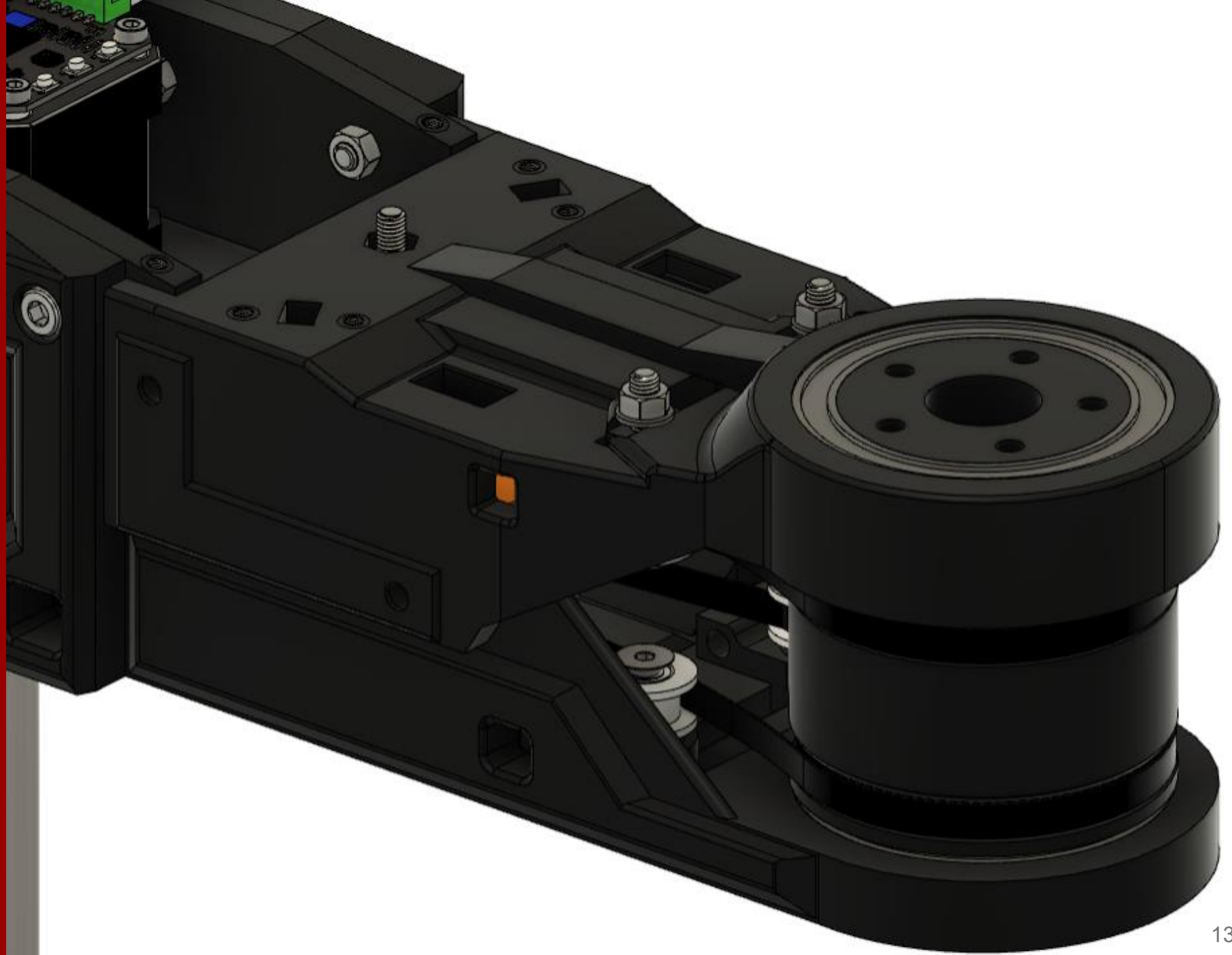
Belt tensioning system:
4x Pulley
2x M5x30 flat head screw
2x M5x40 flat head screw
4x M5 washer
4x M5 nut



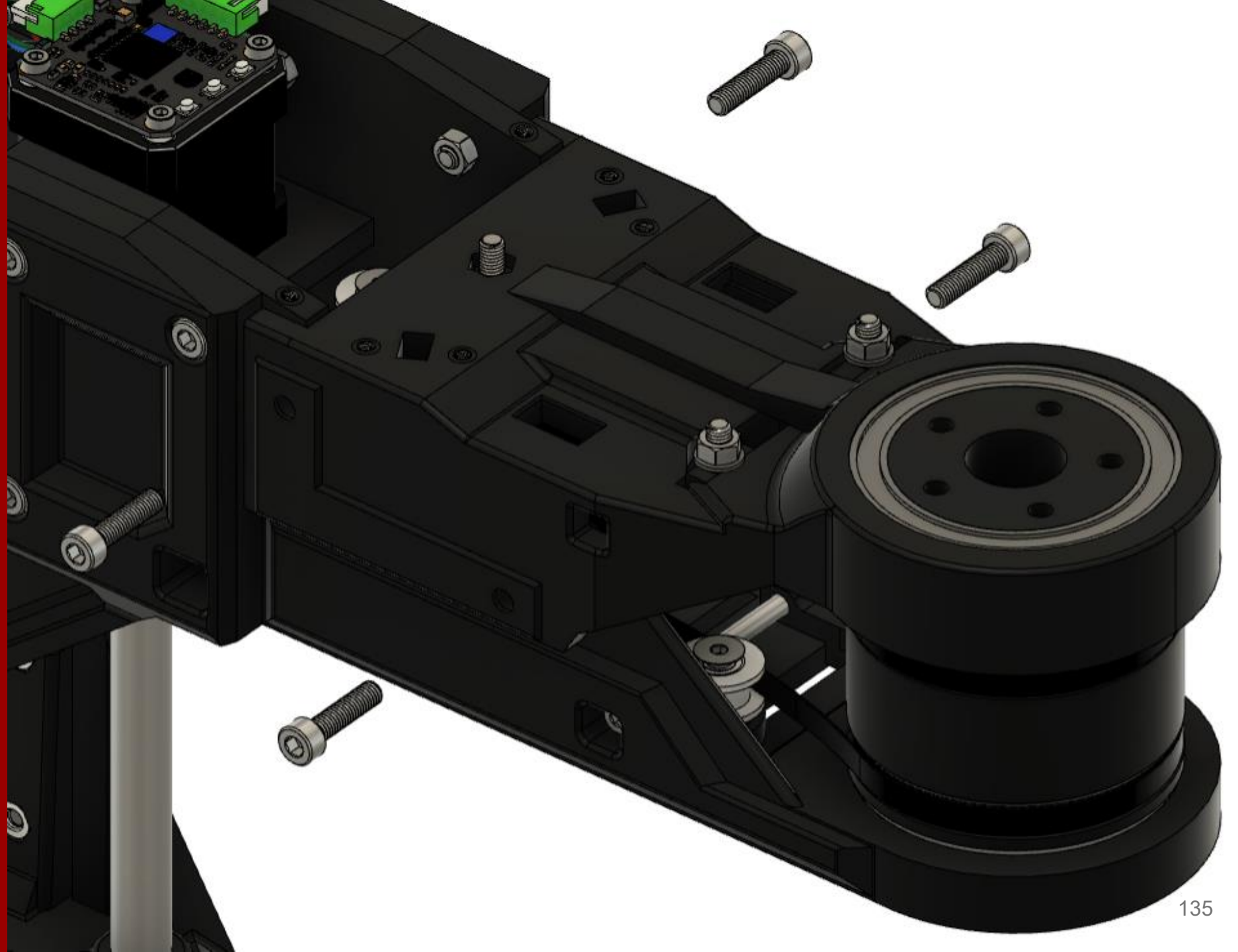
1x GT2 belt 6x400



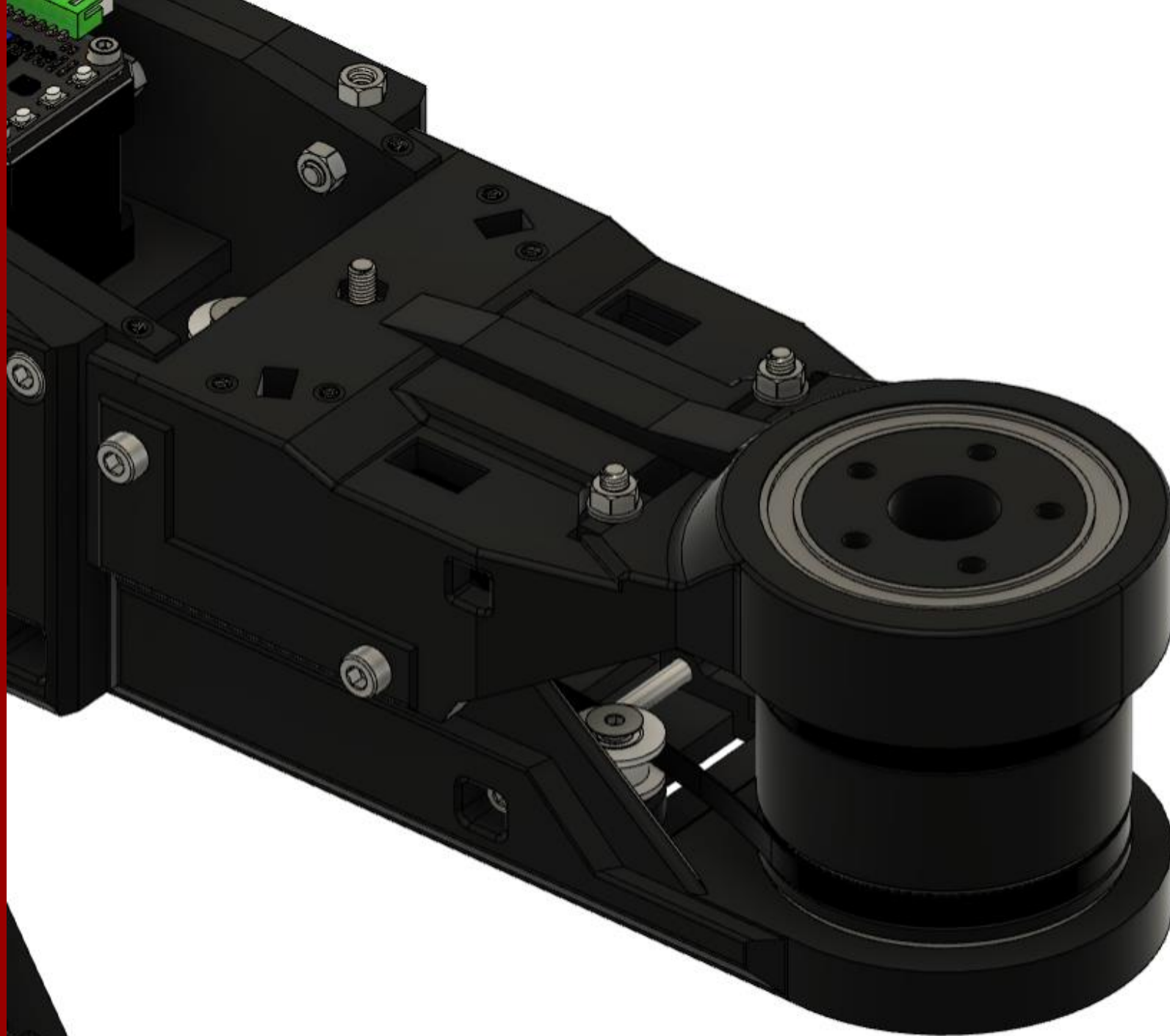
- 1x Ball bearing 50x65x7
- 2x Pulley
- 2x M5x35 flat head screw
- 2x M5 washer
- 2x M5 nut



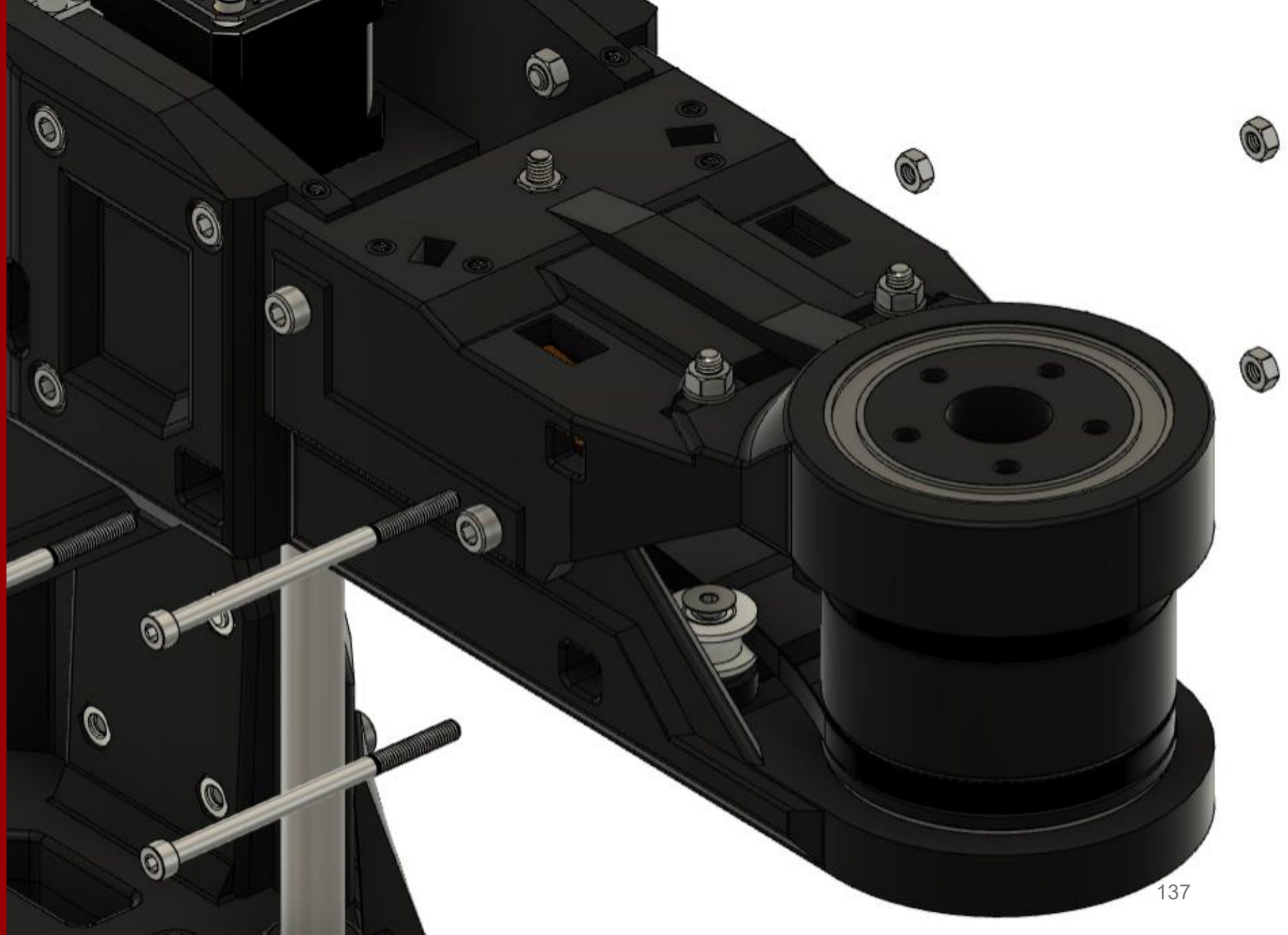
4x M5x20
4x M5 nut



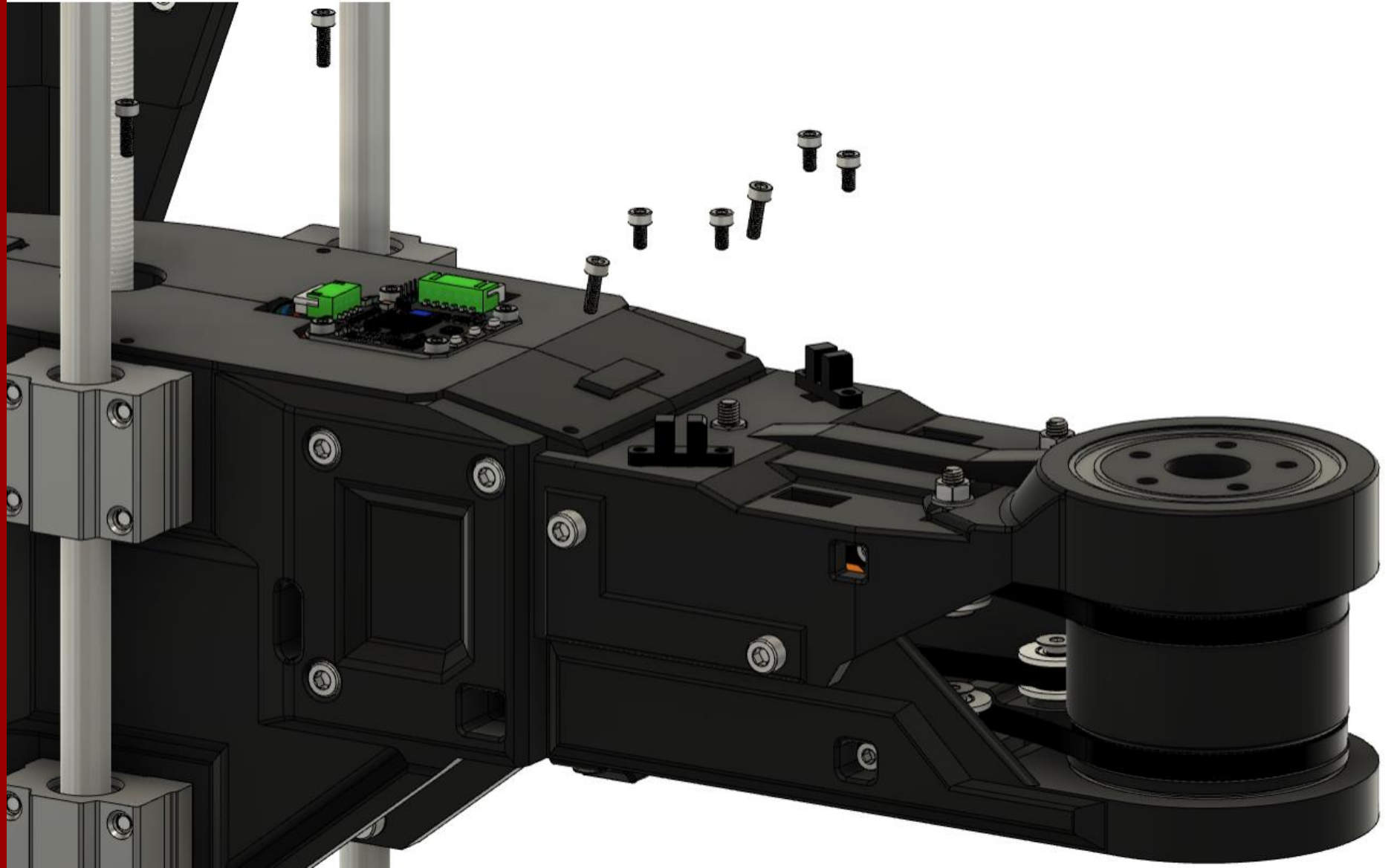
1x M5 nut



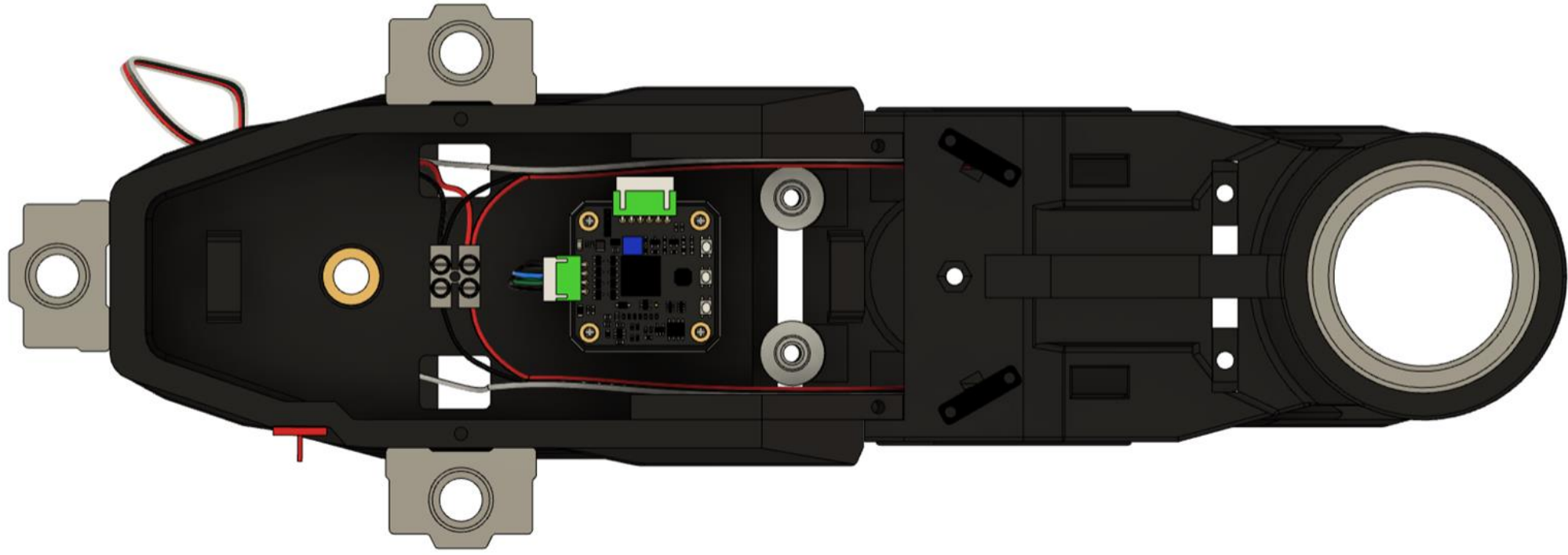
3x M4x70
3x M4 nut



2x TCST2103
4x M3x10
4x M3x8

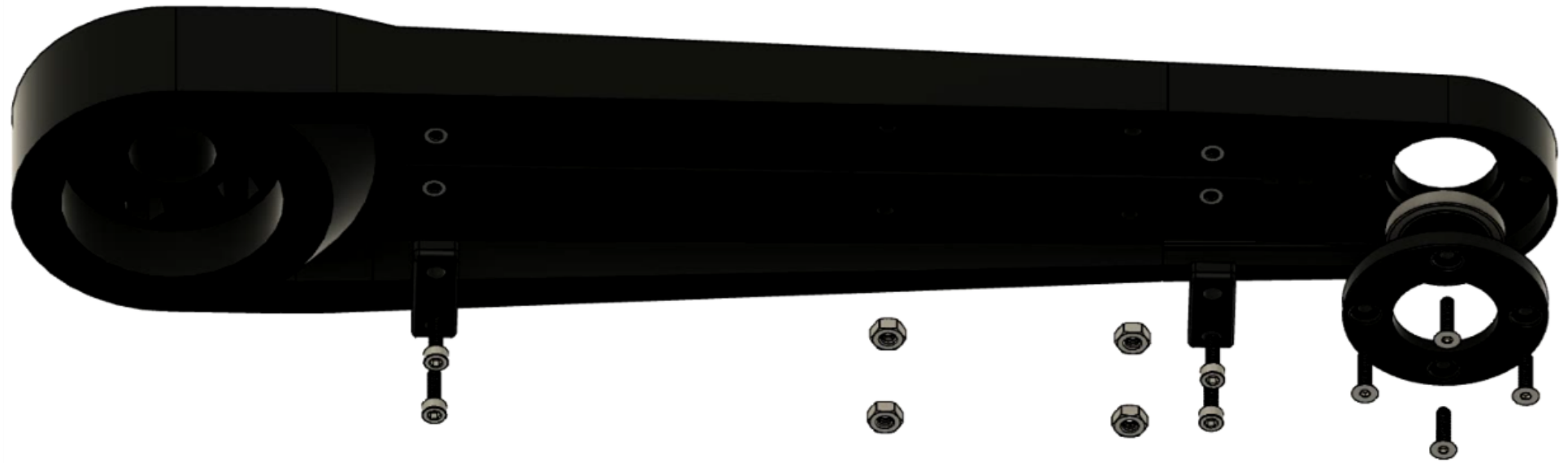


Note:
*Do not mount the cover,
this
should be done later, after
the wiring is completed*

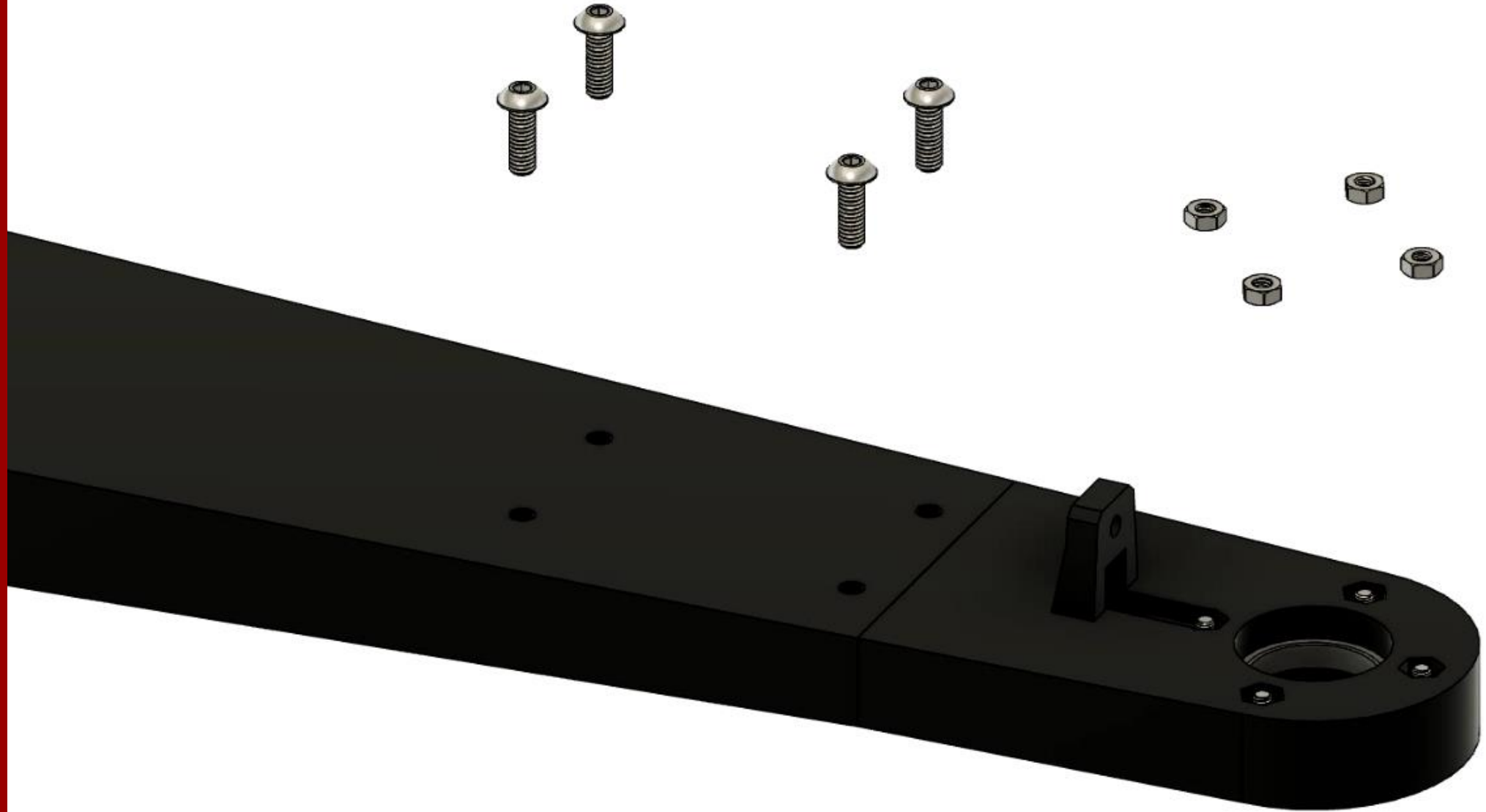




1x Ball bearing 20x27x4
4x M3x10
4x M3x10 flat head
screw
4x M4 nut



4x
M4x15
4x M3
nut



1x
TCST2103
1x M3x10
1x M3 nut

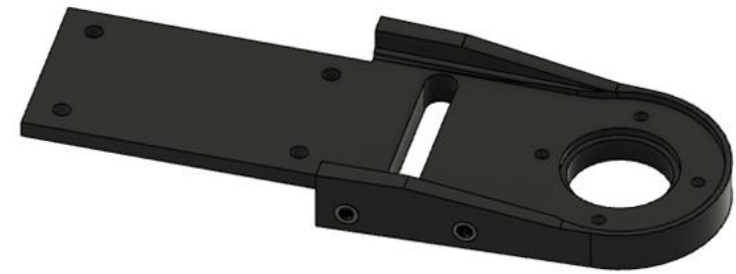
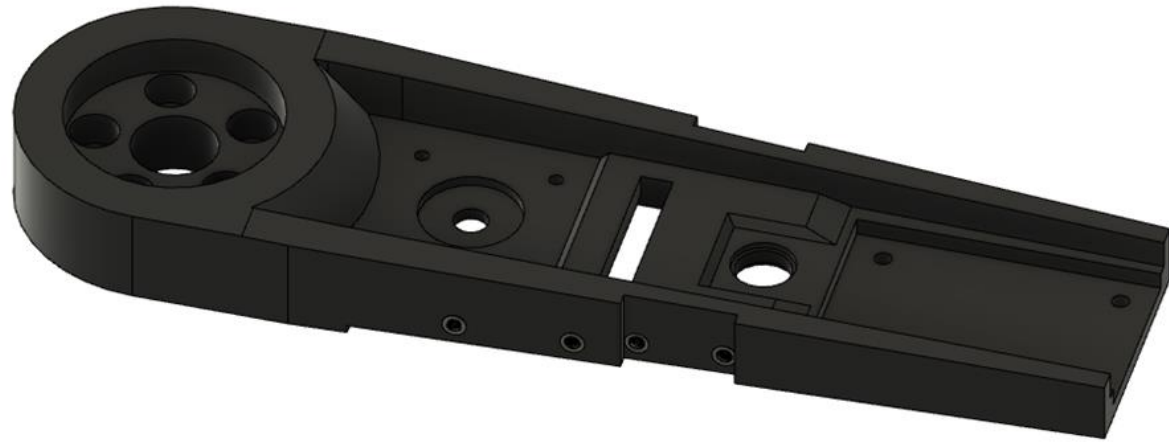




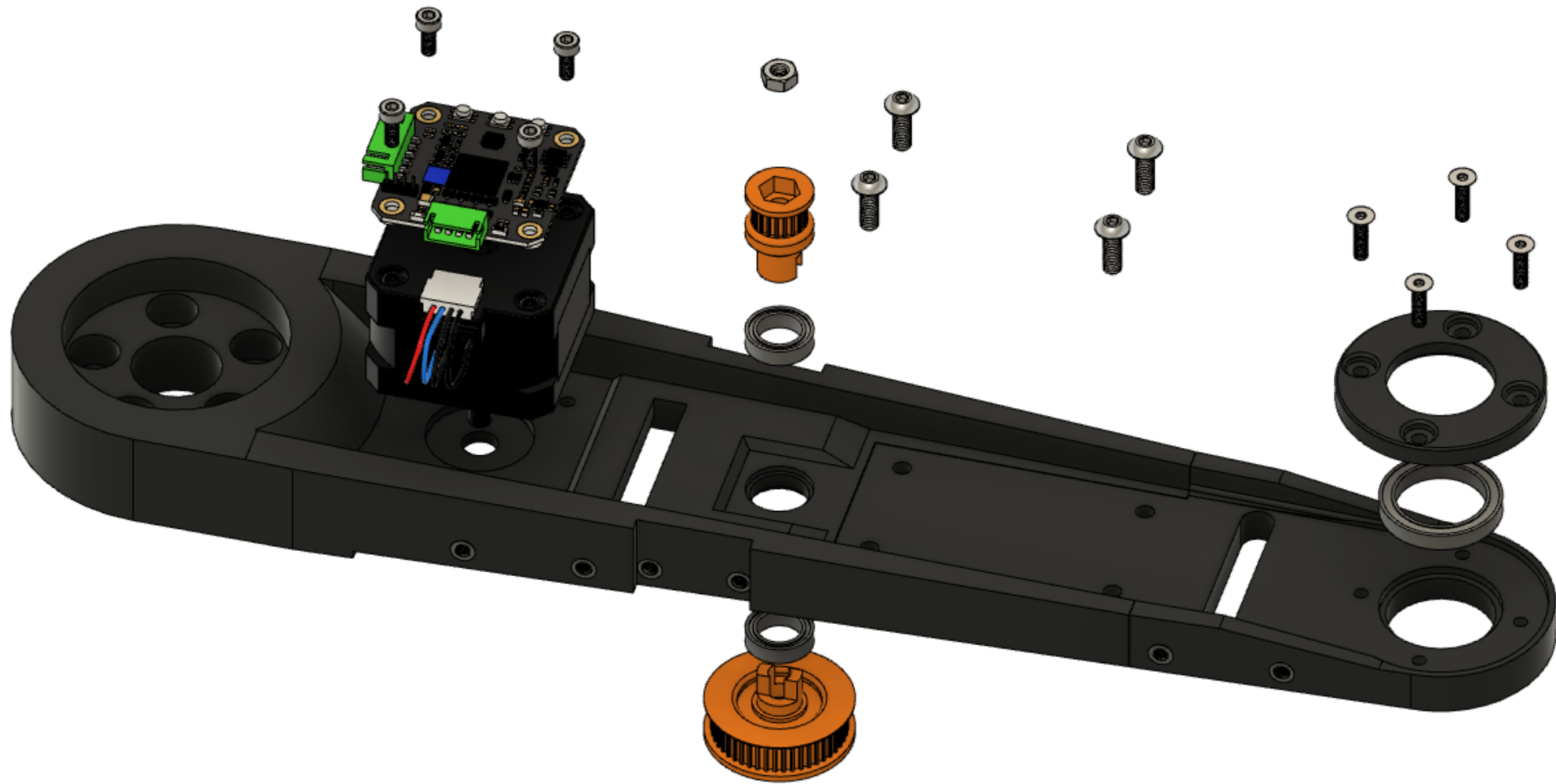
1x
M3x8



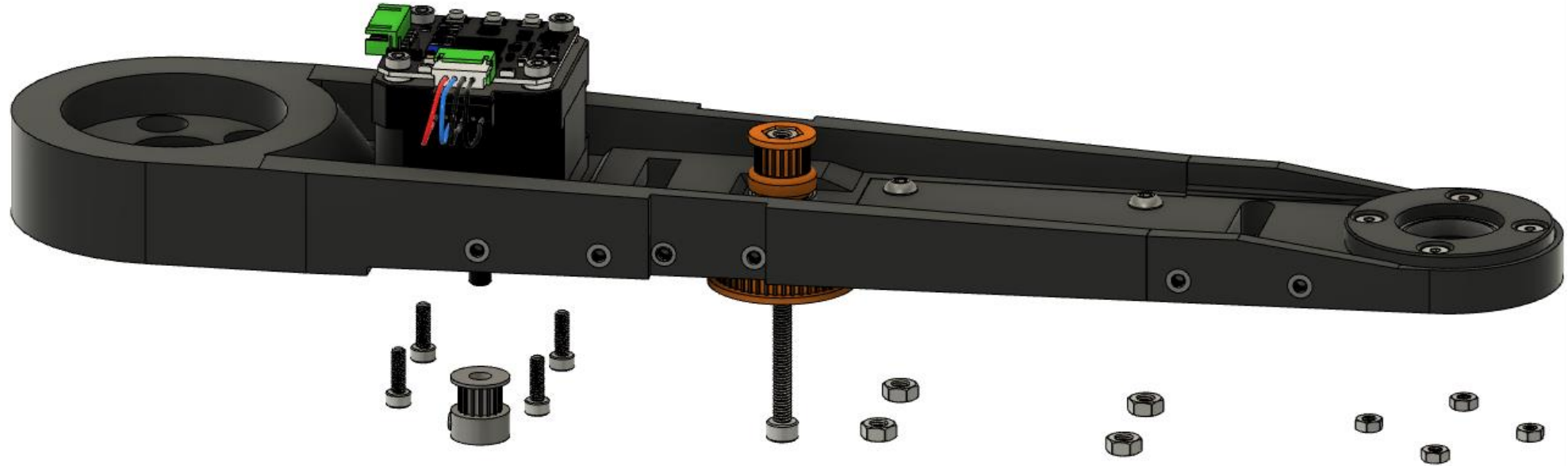




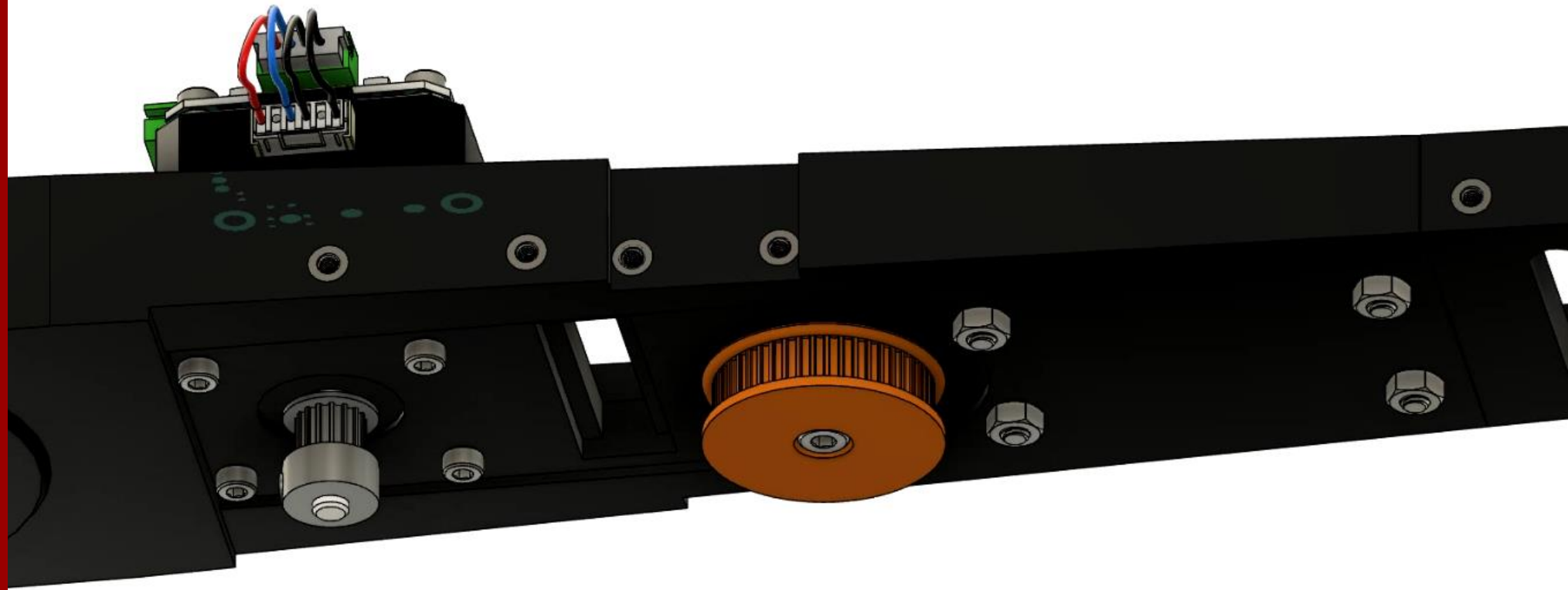
1x Nema 17 (17HE12-1204S)
1x MKS Servo42C
4x Distance washer
1x Ball bearing 20x27x4
2x Ball bearing 10x15x4
4x M3x10 flat head screw
4x M4x15
4x M3x10
1x M4 nut



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

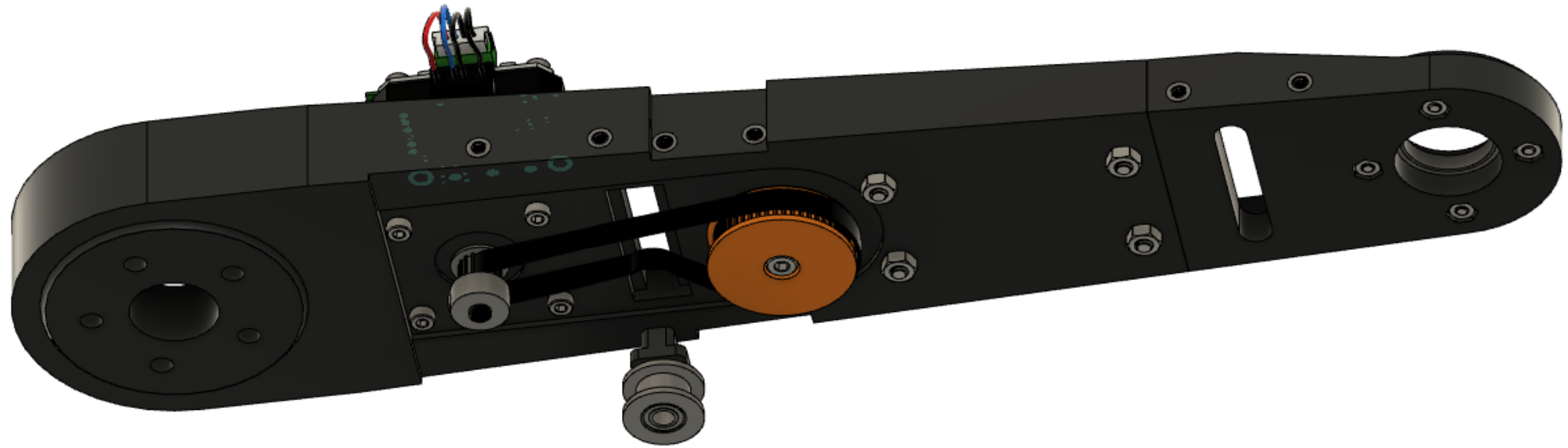


1x GT2 Belt
6x202

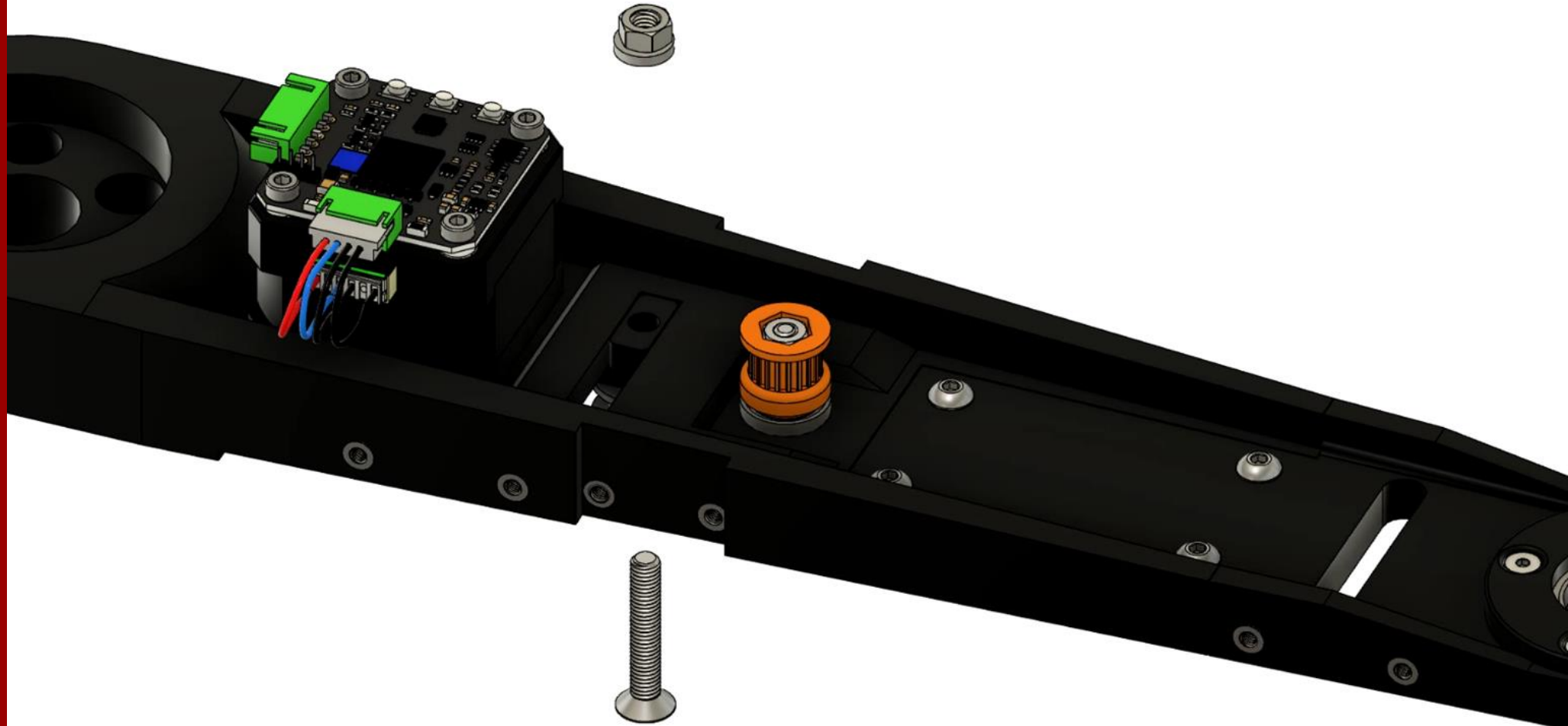




1x Pulley

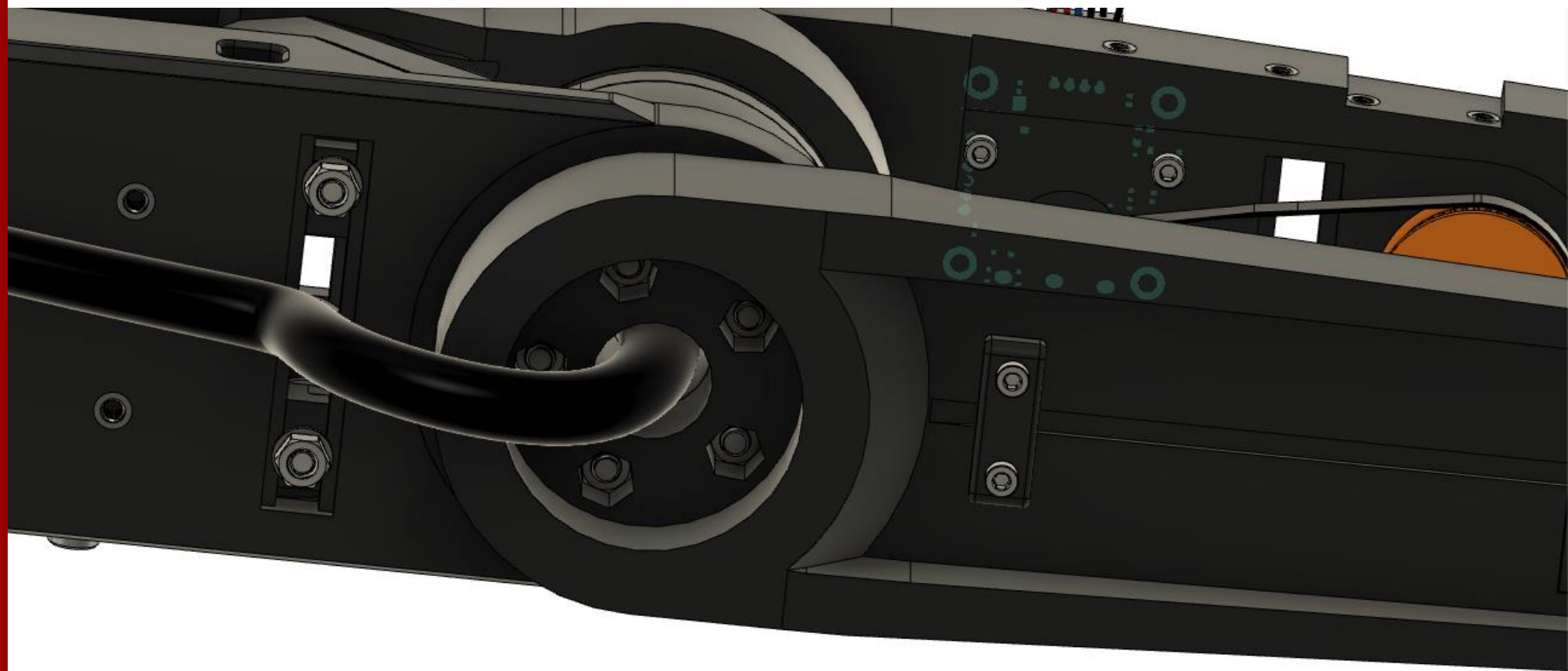


1x M5x30 flat head
screw
1x M5 nut
1x M5 washer

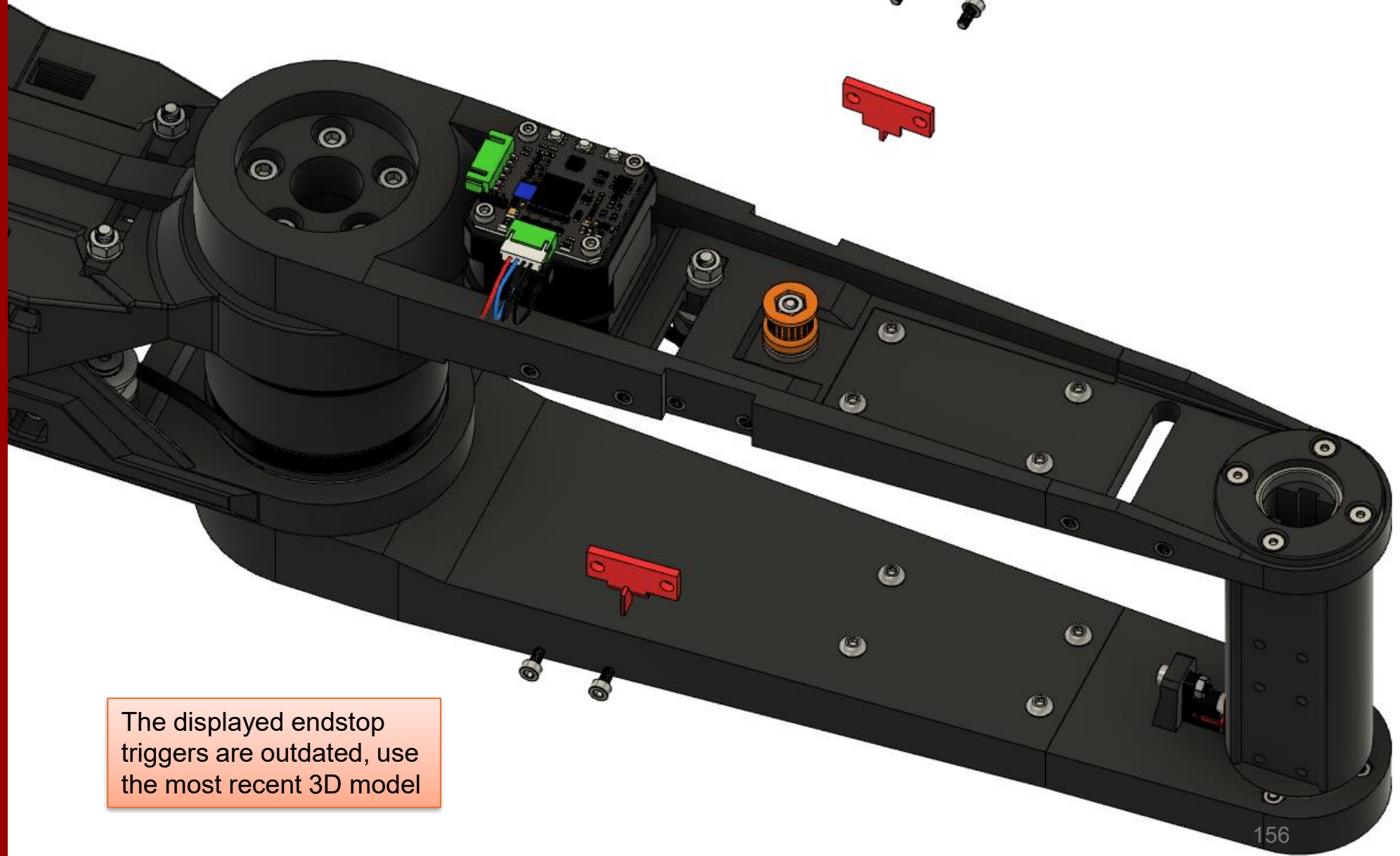


5x M5x100
5x M5 washer





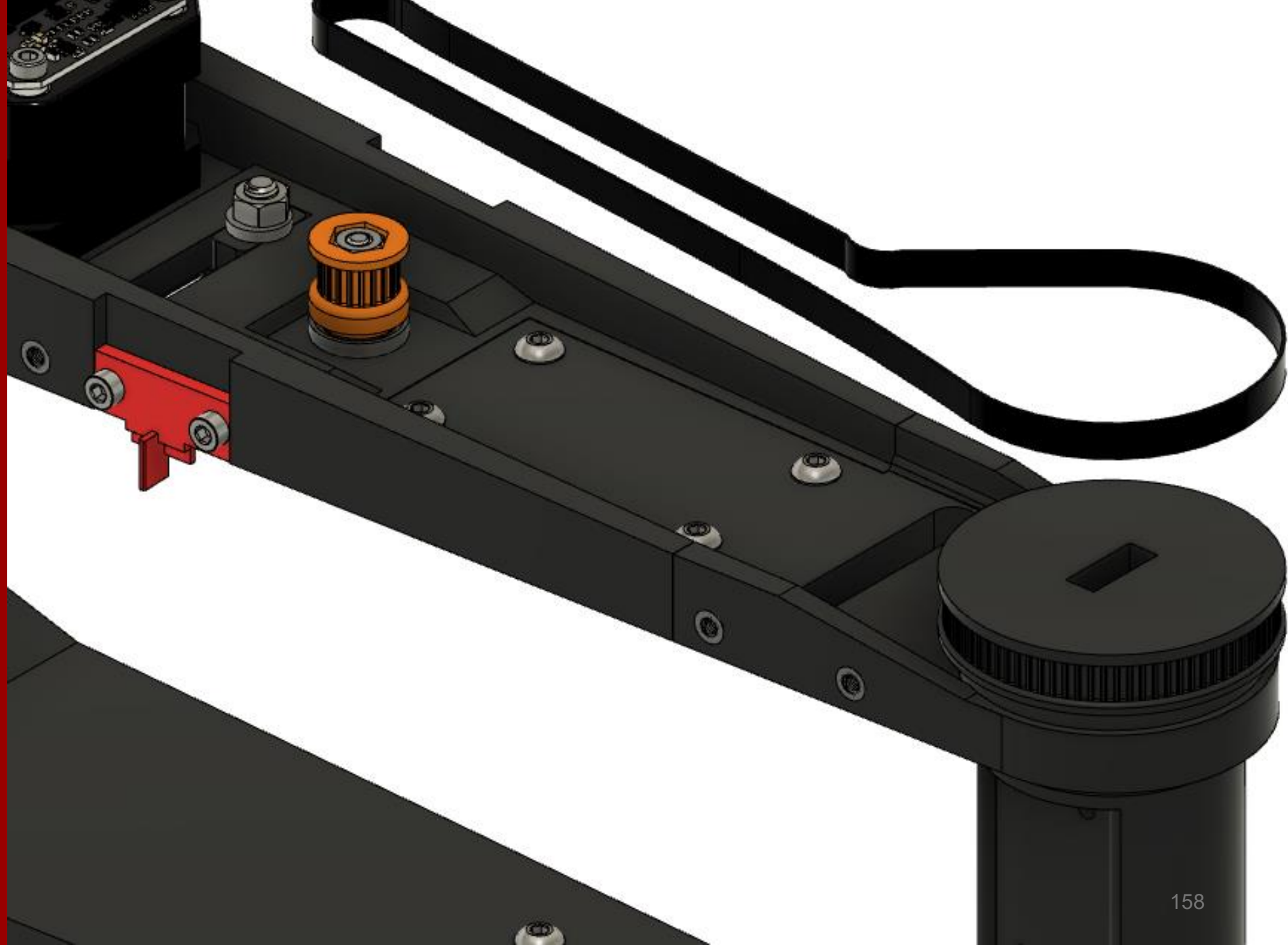
4x M3x8



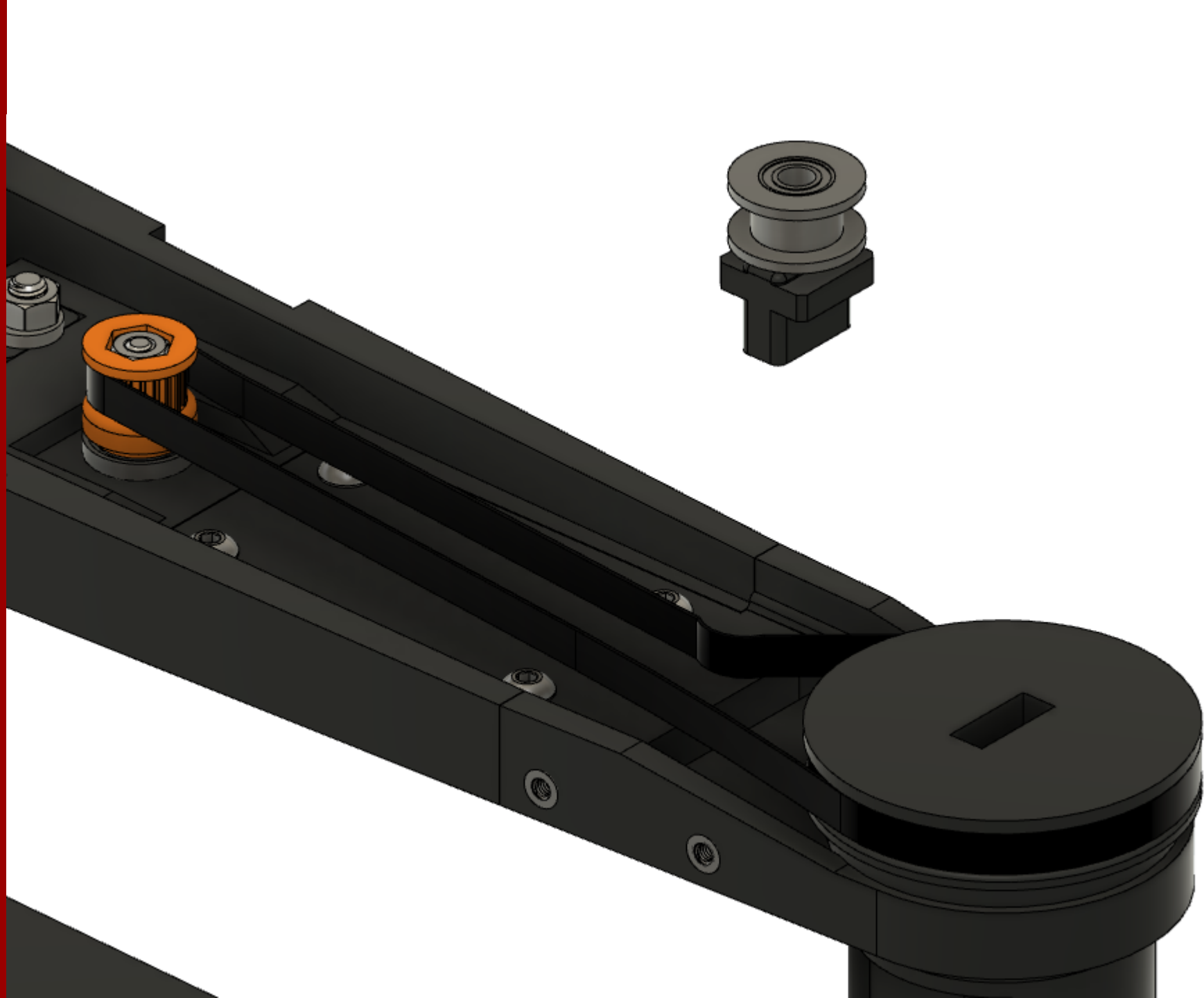
The displayed endstop triggers are outdated, use the most recent 3D model



1x GT2 Belt 6x406

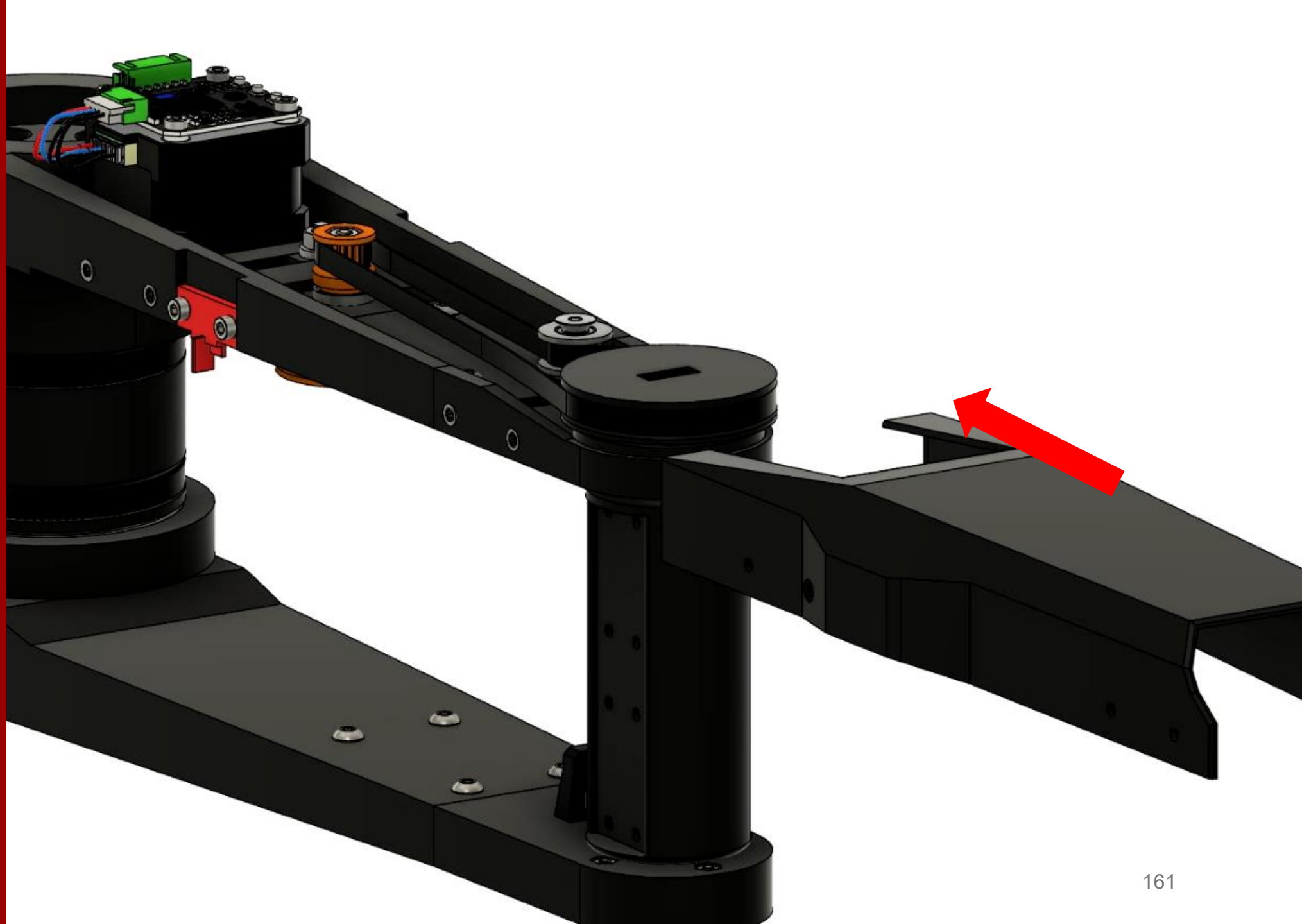


1x Pulley

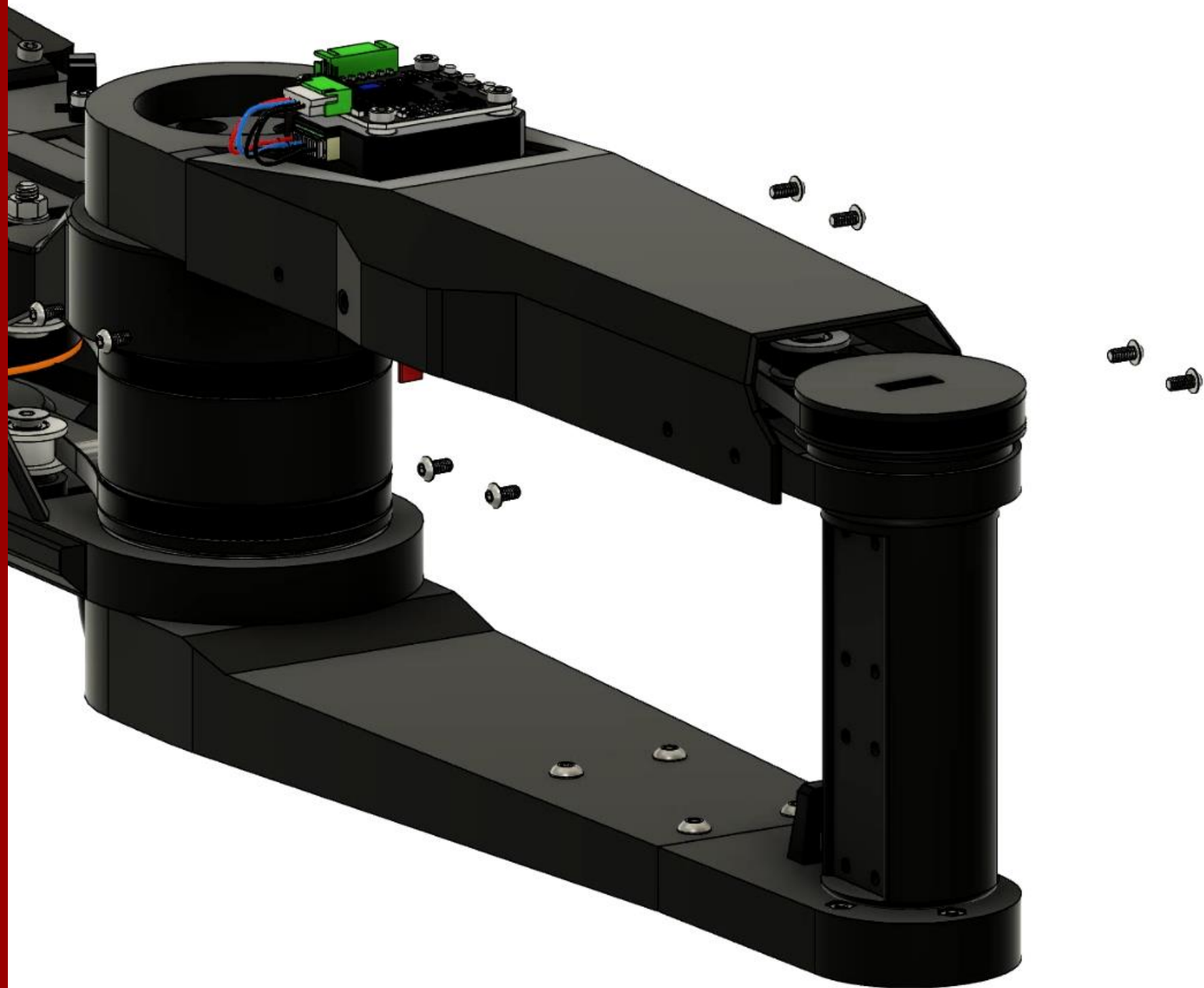


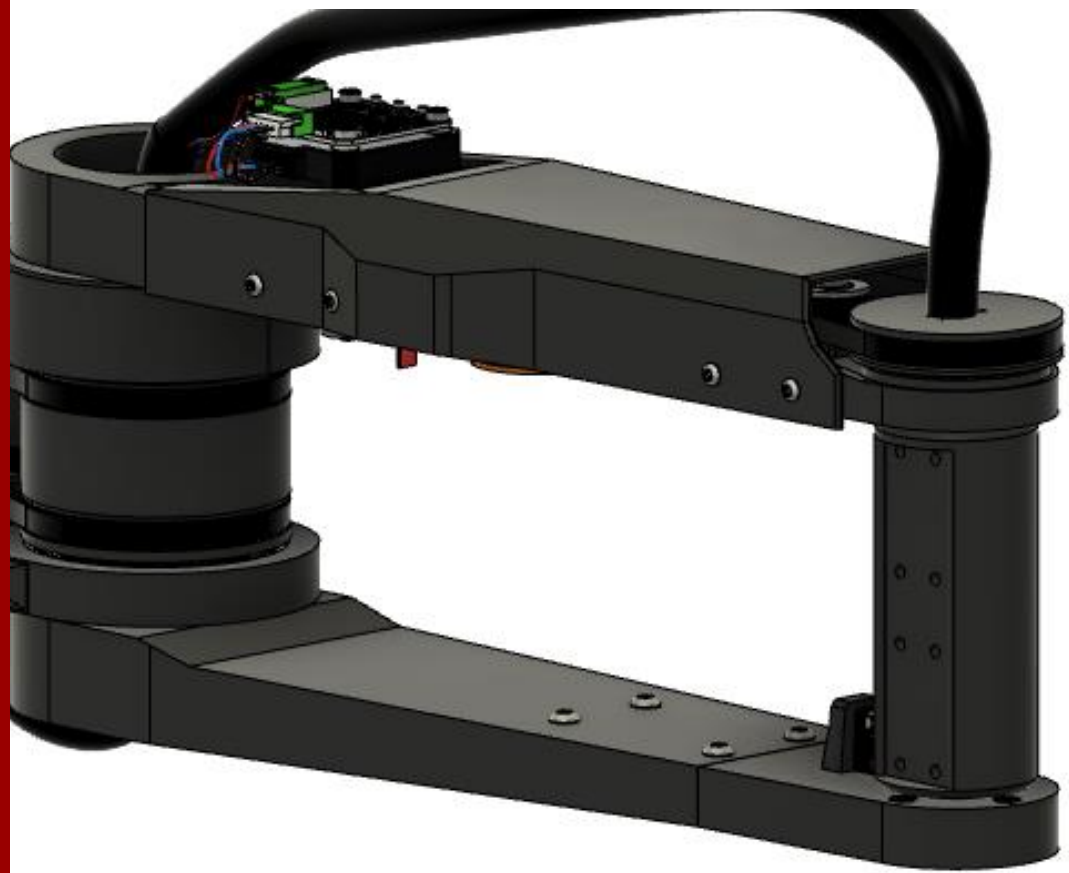
1x M5x35 flat head
screw
1x M5 washer
1x M5 nut



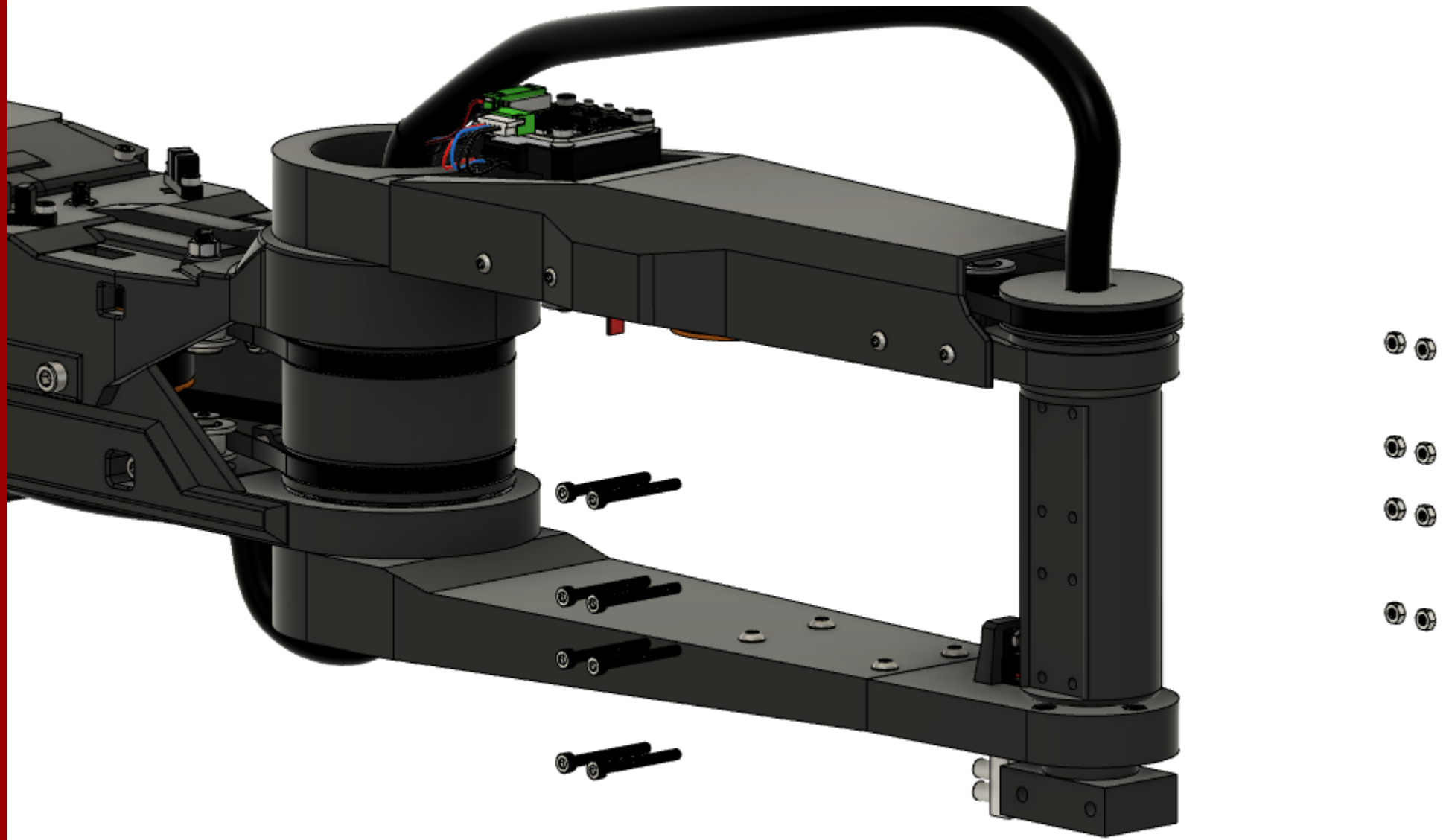


4x
M3x8





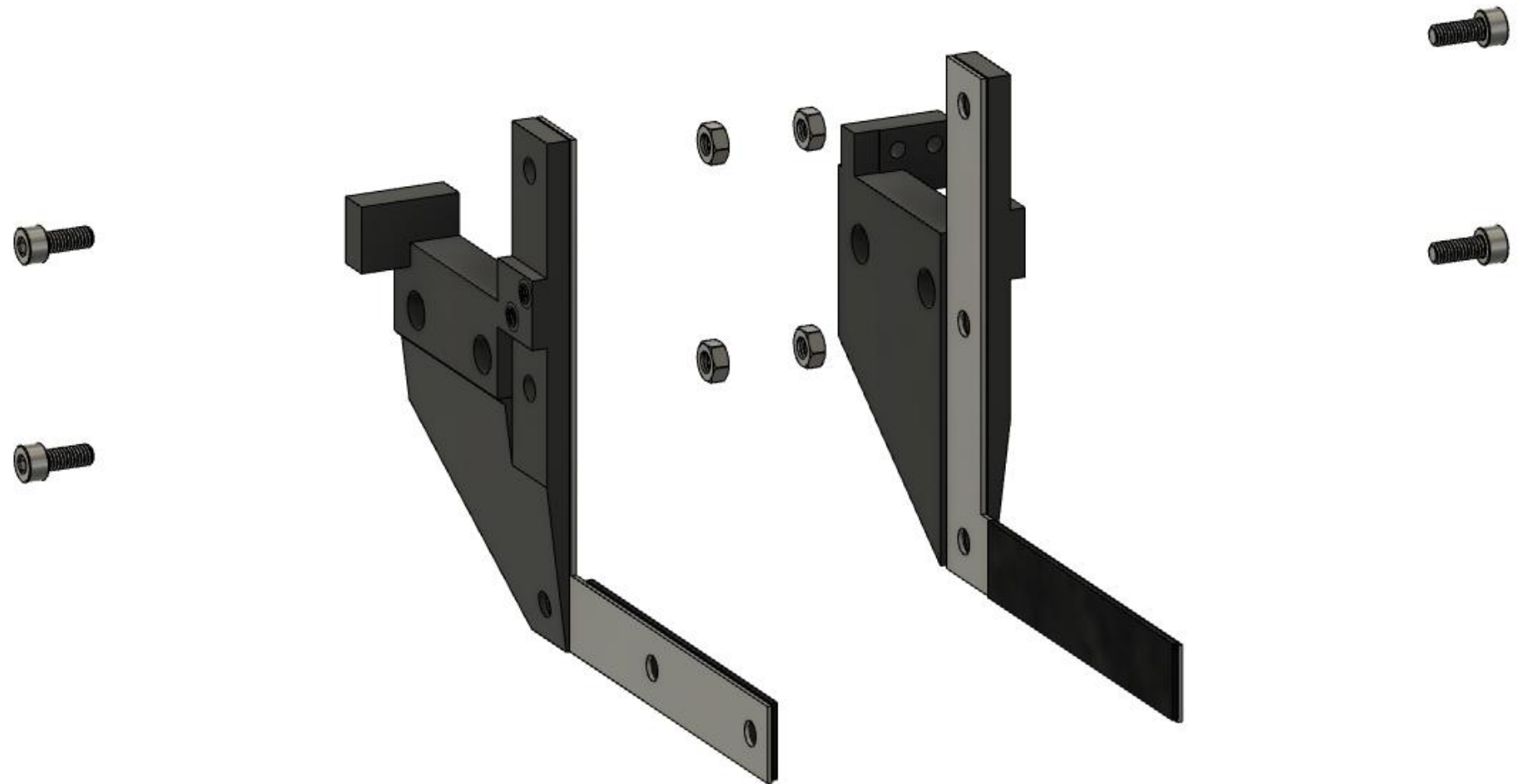
8x
M3x30
8x M3
nut



Original Gripper

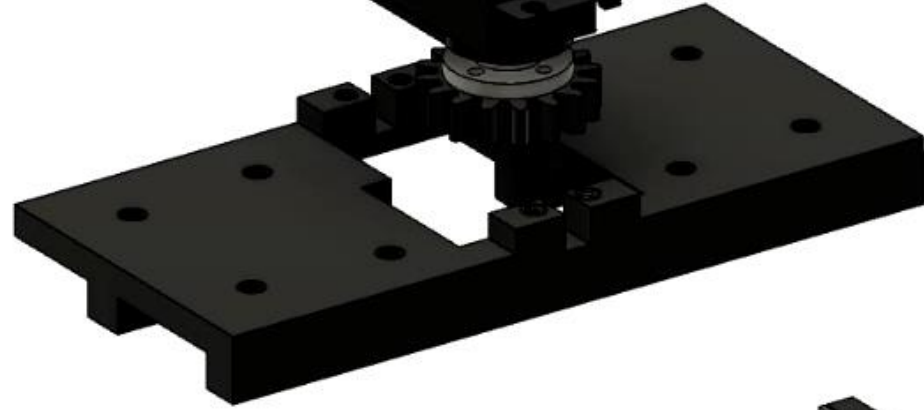
The following instructions describe the assembly of the original gripper hardware.

4x M4x10
4x M4 nut

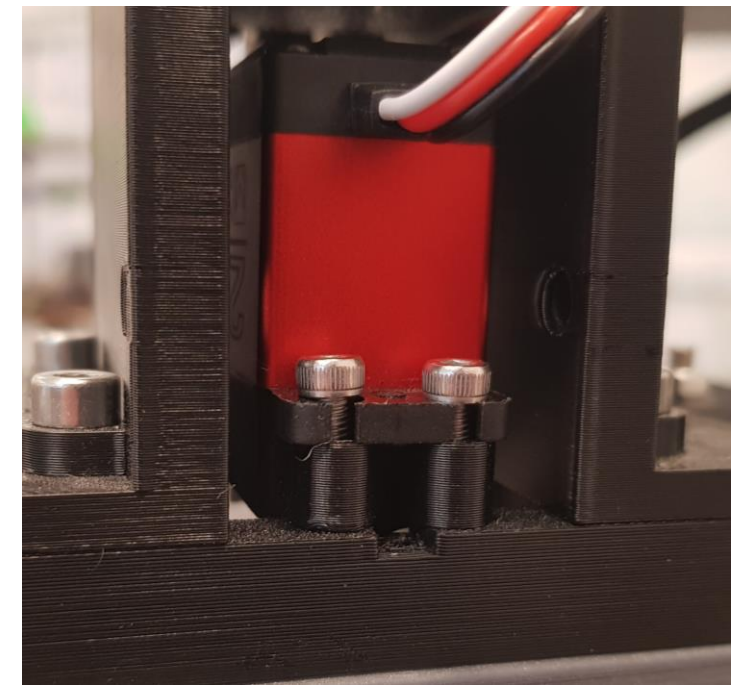


4x M3x10





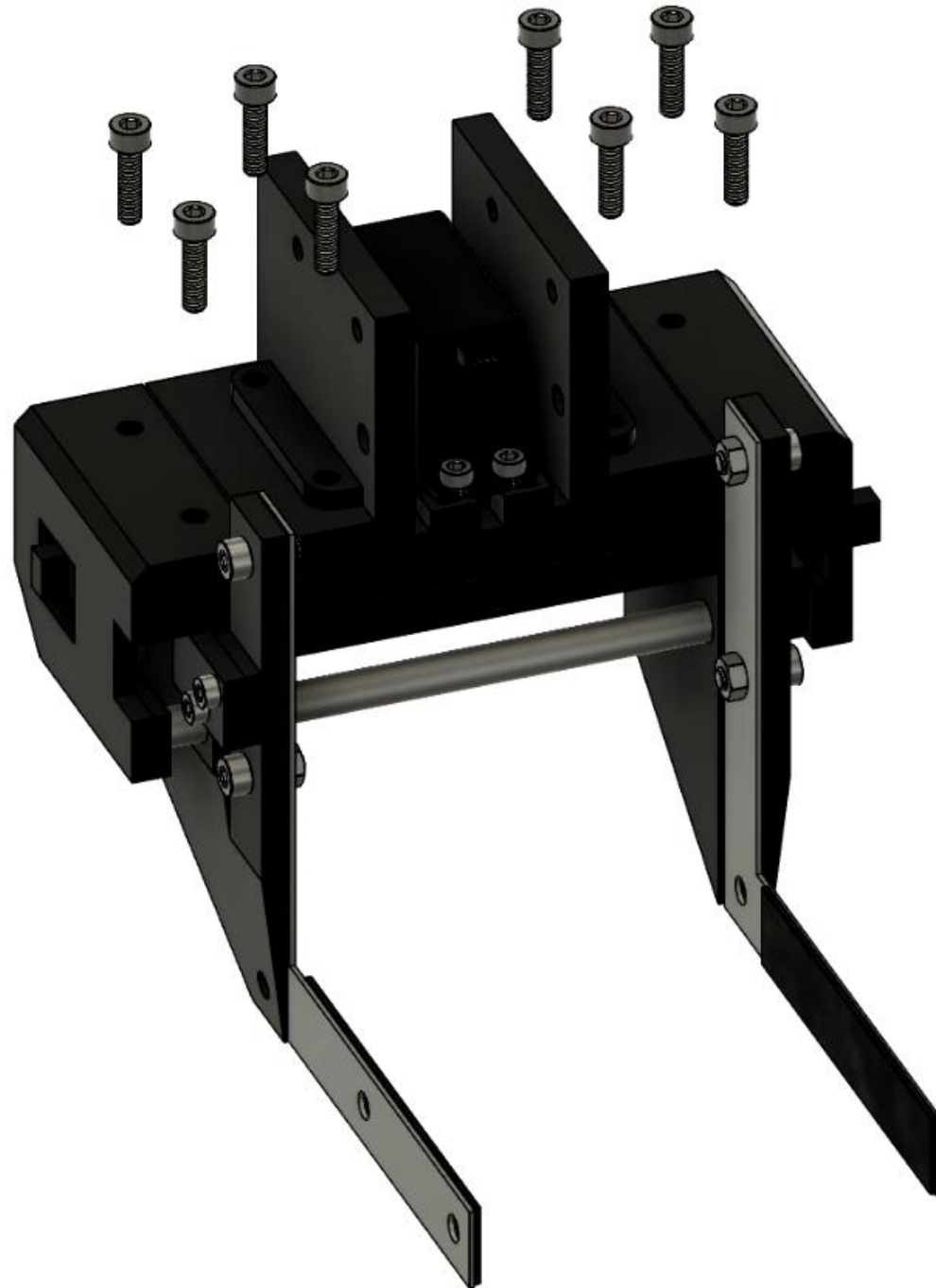
1x DS3218 Servo
2x M3x10
2x M3x15
2x M3 nut



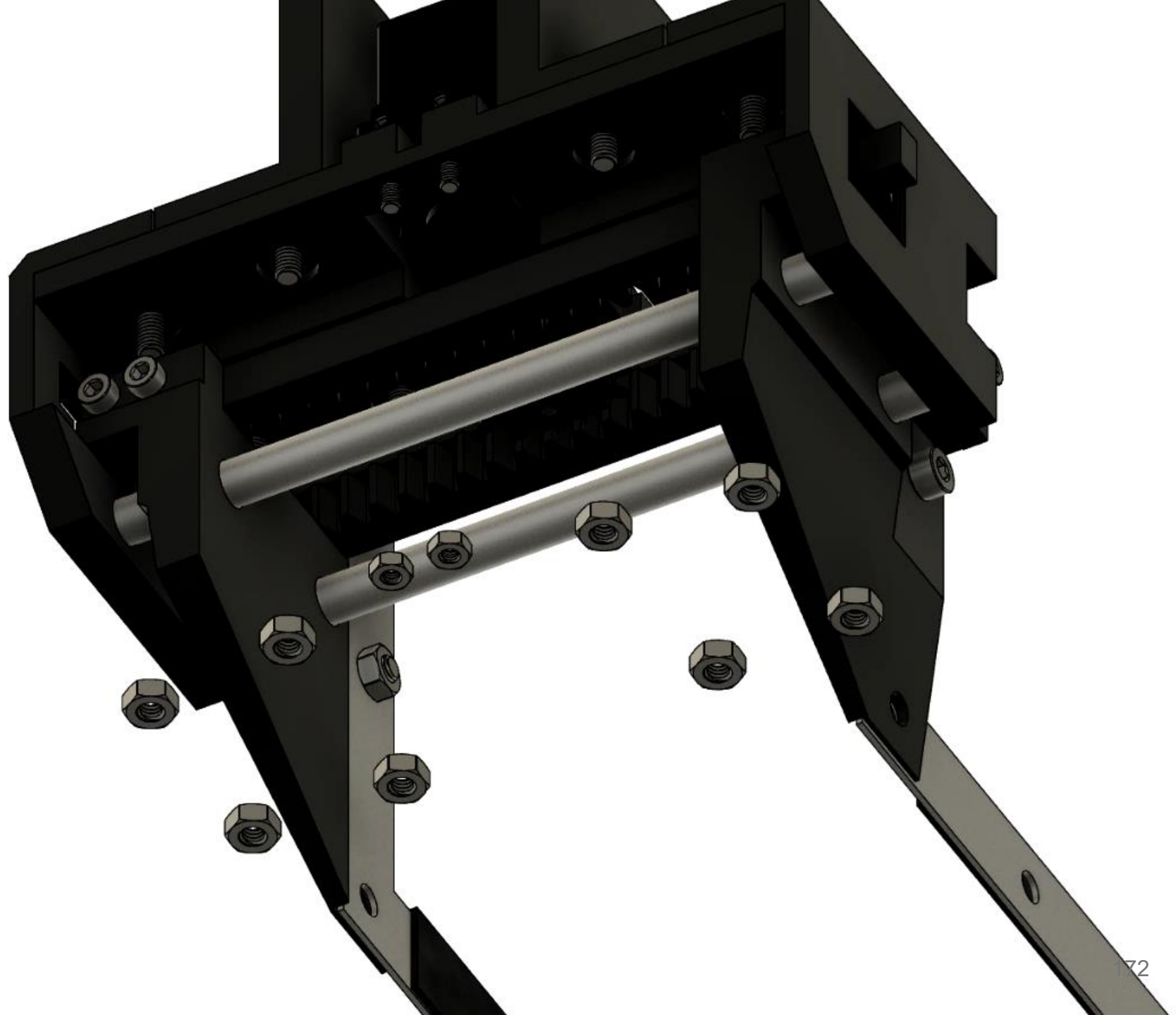
The gripper servo shall be mounted with 10mm stand-offs



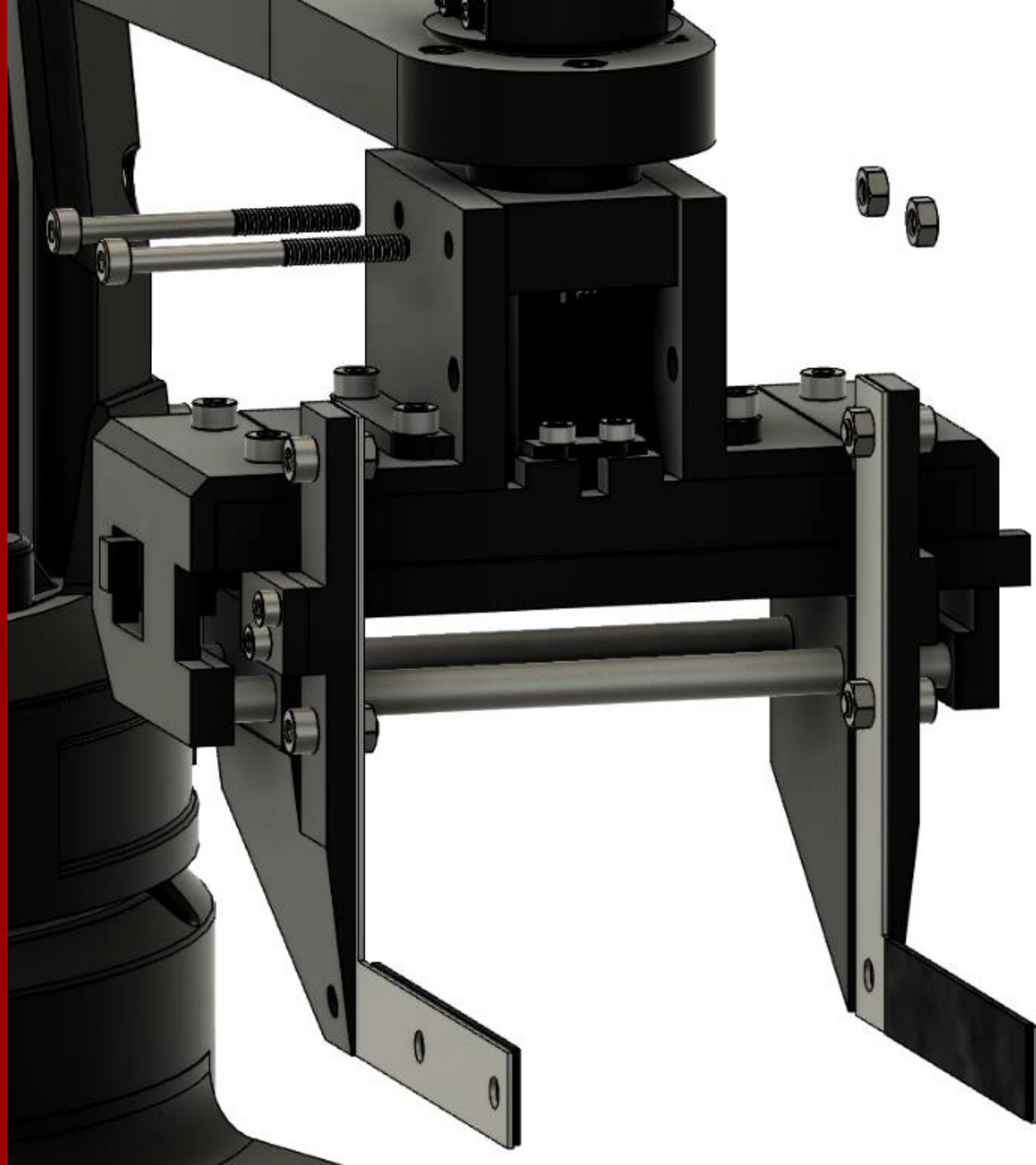
8x M4x15

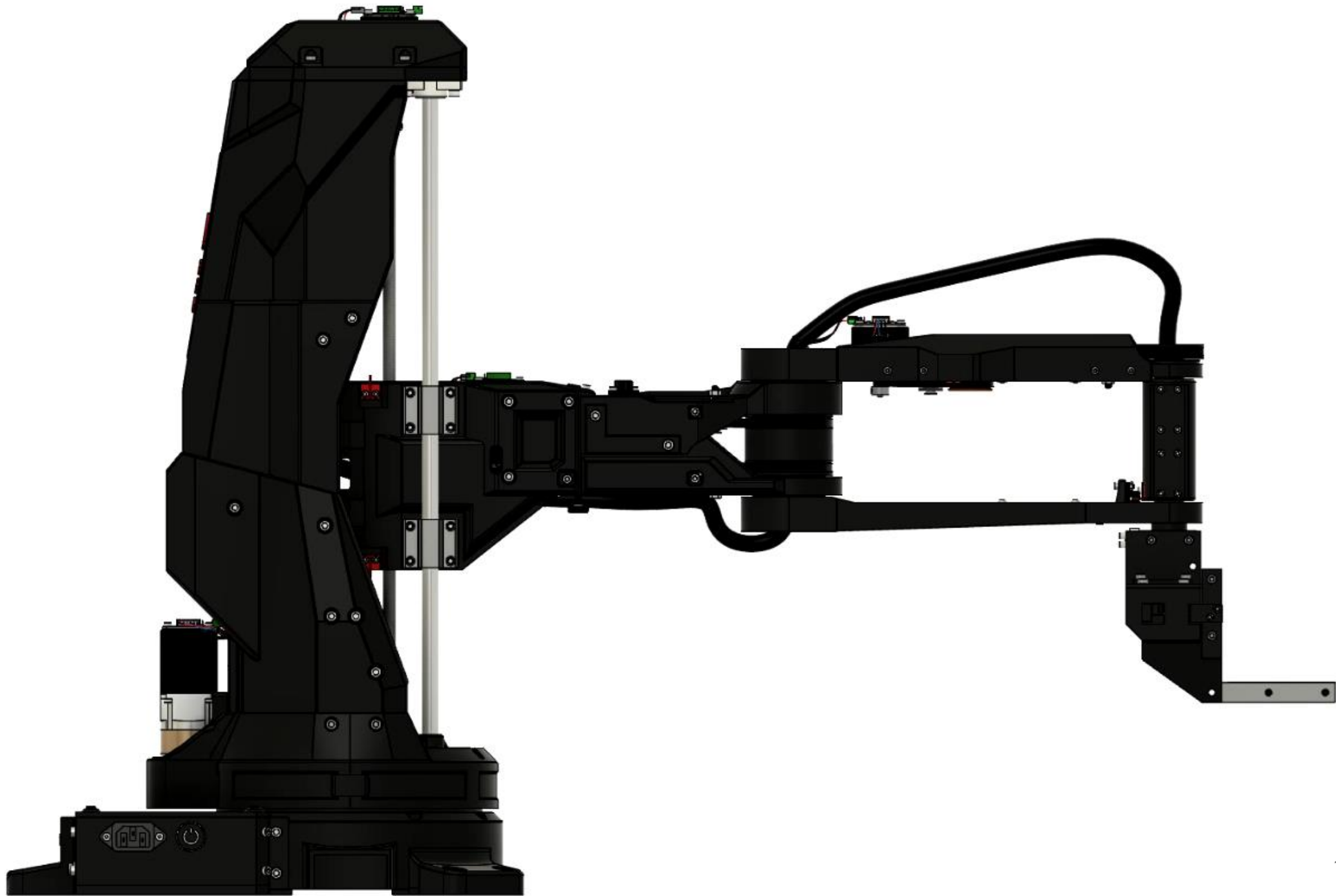


8x M4 nut
2x M3 nut



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



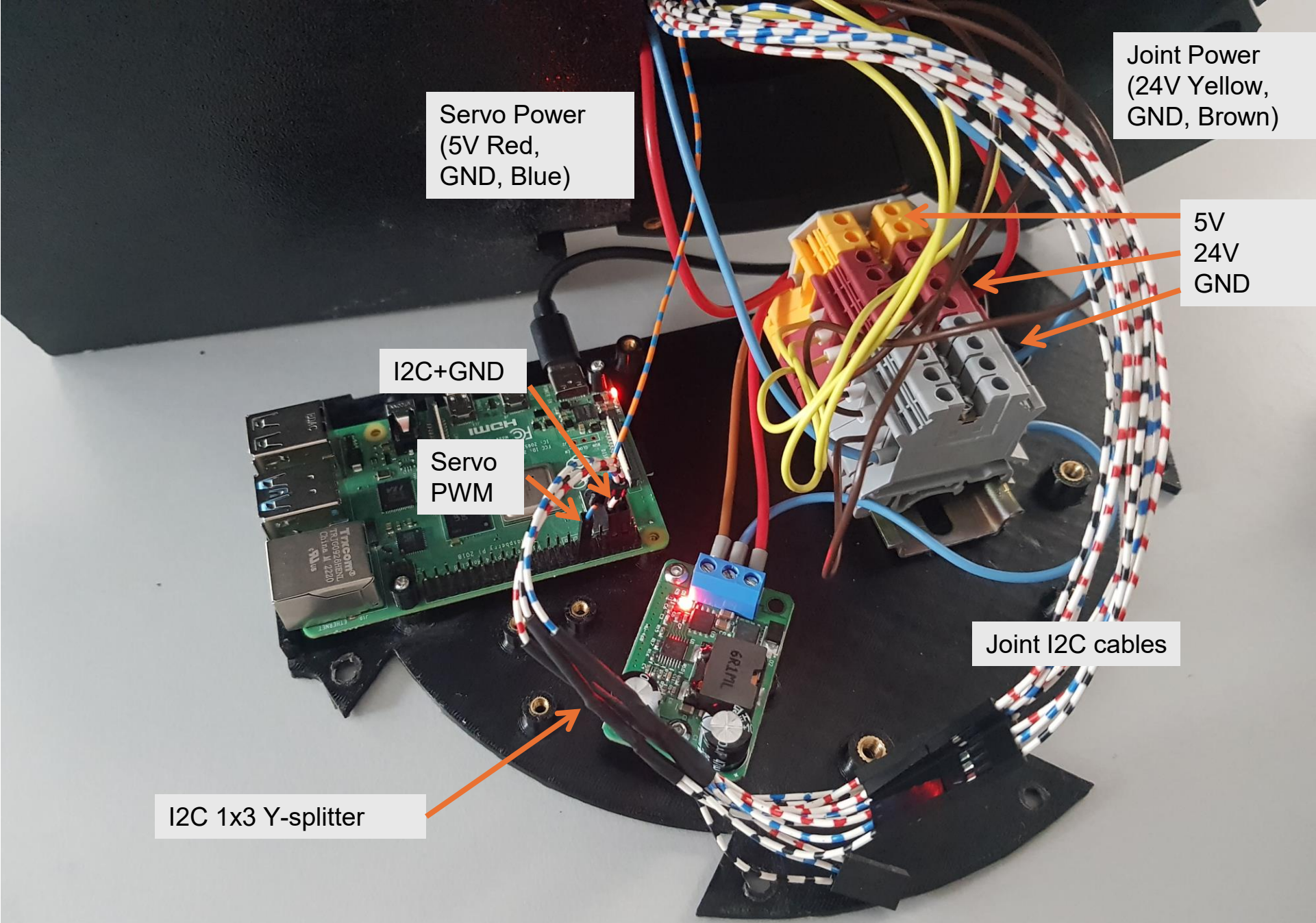
1x USB C Wire



Miscellaneous:

DIN Rail (~10 cm)

10x Terminal Blocks



Servo Power
(5V Red,
GND, Blue)

Joint Power
(24V Yellow,
GND, Brown)

5V
24V
GND

I2C+GND

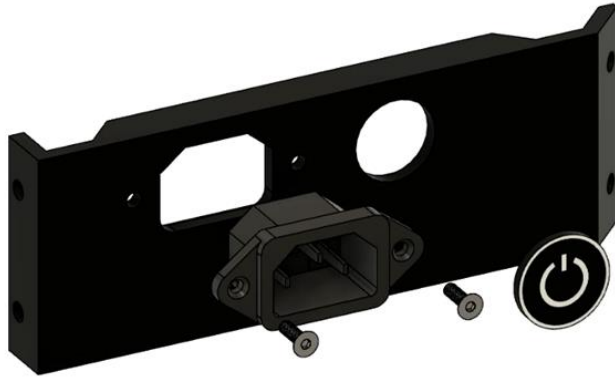
Servo
PWM

Joint I2C cables

I2C 1x3 Y-splitter

FRONT PANEL WIRING

1. Mount the socket and button onto the front panel



The current version uses a rocker switch to switch the power. The original button has failed.

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

