



## GALILEO 2 EXTRUDER

Planetary power for your gardening-tool-built space shuttle.

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VERSION 14MAY2024

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**PART PRINTING GUIDELINES**

Galileo 2 follows the Voron Team standards. The Voron Team has provided the following print guidelines for you to follow in order to have the best chance at success with your parts. There are often questions about substituting materials or changing printing standards, but we recommend you follow these.

**3D PRINTING PROCESS**

Fused Deposition Modeling (FDM)

**INFILL TYPE**

Grid, Gyroid, Honeycomb, Triangle or Cubic

**MATERIAL**

ABS/ASA

**INFILL PERCENTAGE**

Recommended: 40%

**LAYER HEIGHT**

Recommended: 0.2mm

**WALL COUNT**

Recommended: 4

**EXTRUSION WIDTH**

Recommended: Forced 0.4mm

**SOLID TOP/BOTTOM LAYERS**

Recommended: 5

**FILE NAMING**

By this time you should have already downloaded the STL files from the Galileo 2 GitHub repository. You might have noticed that we have used the Voron standard naming convention for the files. This is how to use them.

**PRIMARY COLOR**

`front_body_ECAS_coupler.stl`

These files will have nothing at the start of the filename.

**ACCENT COLOR**

`[a]_front_bearing_holder.stl`

We have added “[a]” to the front of any STL file that is intended to be printed with accent color.

### HOW TO GET HELP

If you need assembly assistance, we're here to help. Head on over to the Voron Discord group and post your questions. This is our primary medium to help Voron Users and we have a great community that can help you out if you get stuck.



**Discord**

<https://discord.gg/voron>



**VORON  
FORUM**

<https://forum.vorondesign.com>

#### REPORTING AN ISSUE

Should you find an issue in the documentation or have a suggestion for an improvement, please consider opening an issue on GitHub (<https://github.com/JaredC01/Galileo2/issues>). When raising an issue, please include the relevant page numbers and a short description; annotated screenshots are also very welcome. We periodically update the manual based on the feedback we get.



<https://github.com/JaredC01/Galileo2>

### WHAT IS GALILEO?

Galileo is a series of planetary-gearred projects designed for use in Voron printers designed by JaredC01. This document covers Galileo 2, or G2, which has an incredible 9:1 gear ratio in a custom-designed planetary gearbox. This manual covers the Galileo 2 Extruder, or G2E, specifically. There are also other G2-based projects, such a G2Z drives and a standalone extruder design, which will be covered in separate manuals.

### WHAT BIG GEARS YOU HAVE!

In addition to the planetary gear reduction, G2E also features a custom 16mm RNC-coated filament drive gear. This means more grip on the filament, helping to minimize filament slip and maximize extruder output.

### DROP IN REPLACEMENT FOR CW2

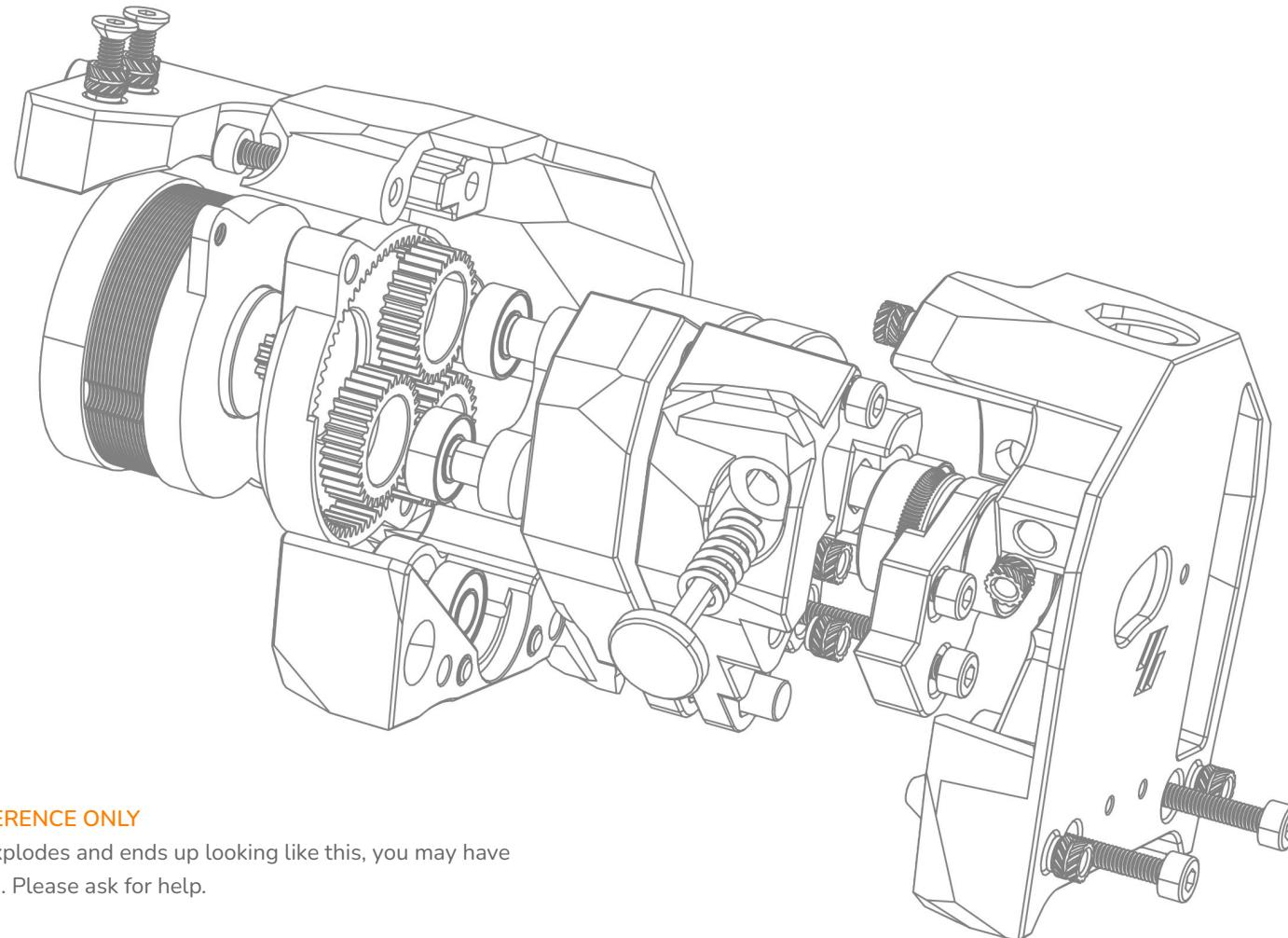
The G2E assembly is already “stealthed” so it aesthetically matches Clockwork 2, and with a few configuration tweaks, drops right in on a Stealthburner MGN12 toolhead. This makes it compatible with Voron Tap as well as the standard inductive probe carriages.

### G2E CONFIGURATION

You must update both the gear\_ratio and rotation\_distance in your Klipper configuration and do a standard [extruder calibration](#) after installing the Galileo 2 Extruder. Additionally, your run\_current will need to be updated.

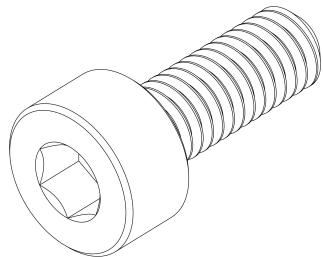
```
[extruder]
rotation_distance: 47.088
gear_ratio: 9:1
microsteps: 16

[tmc2209 extruder]
run_current: 0.6
```



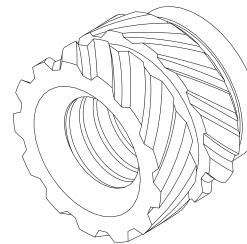
**FOR REFERENCE ONLY**

If yours explodes and ends up looking like this, you may have a problem. Please ask for help.

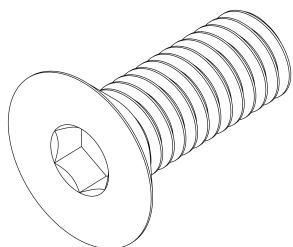
**SOCKET HEAD CAP SCREW (SHCS)**

Metric fastener with a cylindrical head and hex drive. The most common fastener used on the Voron.

ISO 4762

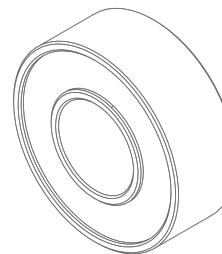
**HEAT SET INSERT**

Heat inserts with a soldering tip so that they melt the plastic when installed. As the plastic cools, it solidifies around the knurls and ridges on the insert for excellent resistance to both torque and pull-out.

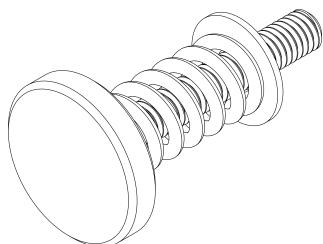
**FLAT HEAD COUNTERSUNK SCREW (FHCS)**

Metric fastener with a cone shaped head and a flat top.

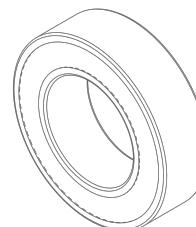
ISO 10642

**MR148 BEARING**

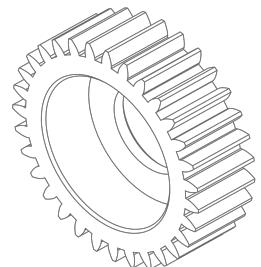
Main shaft support

**EXTRUDER THUMSCREW**

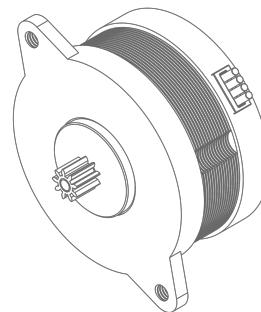
Spring will be stiff

**MR115 BEARING**

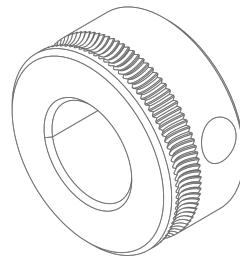
Planetary and idlers



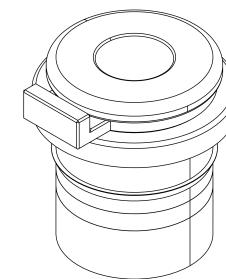
**PLANETARY GEAR**  
31-Tooth MJF Gear



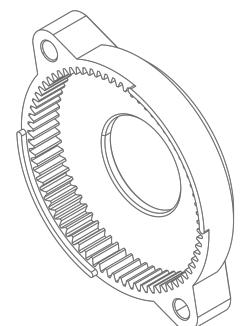
**NEMA 14 PANCAKE STEPPER**  
9T, 20mm



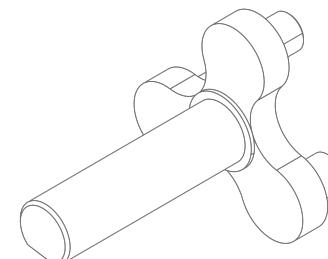
**GALILEO 2 EXTRUDER GEAR**  
RNC-Coated 16mm Drive Gear



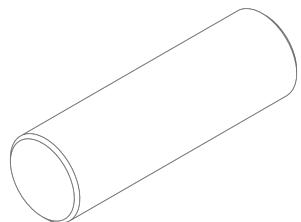
**ECAS fitting**  
You won't need the black rubber part on the bottom



**RING GEAR HOUSING**  
72-Tooth MJF Housing

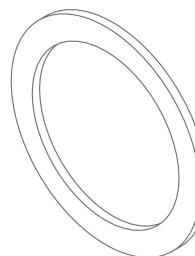


**PLANETARY CARRIER SHAFT**  
Aluminum Carrier



PIN

16mm x 5mm OD

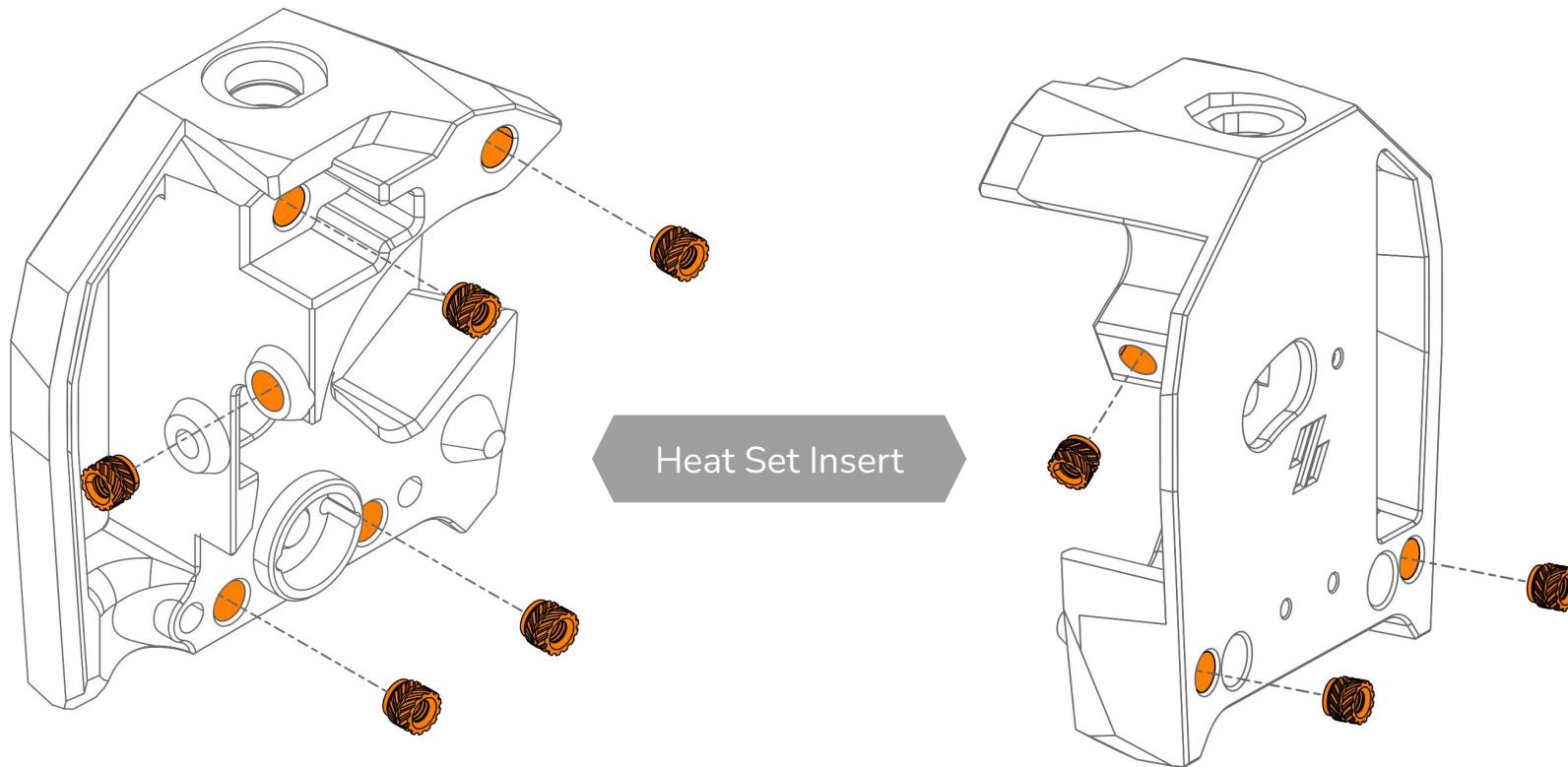


SHIM

8MM ID, 0.5MM THICK



 GALILEO 2



<https://voron.link/m5ybt4d>

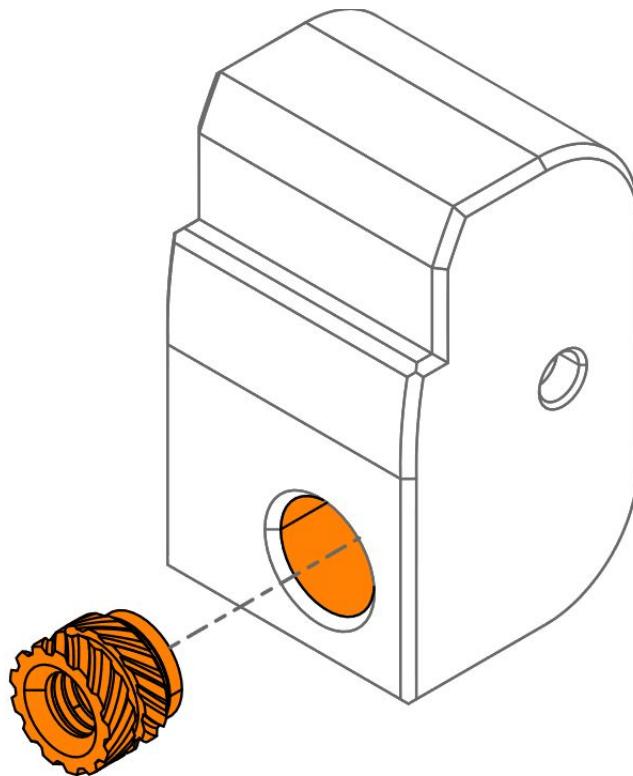
#### HEAT SET INSERTS

This design relies on heat set inserts. Make sure you have the proper inserts (check the hardware reference for a close-up picture, and the BOM for dimensions).

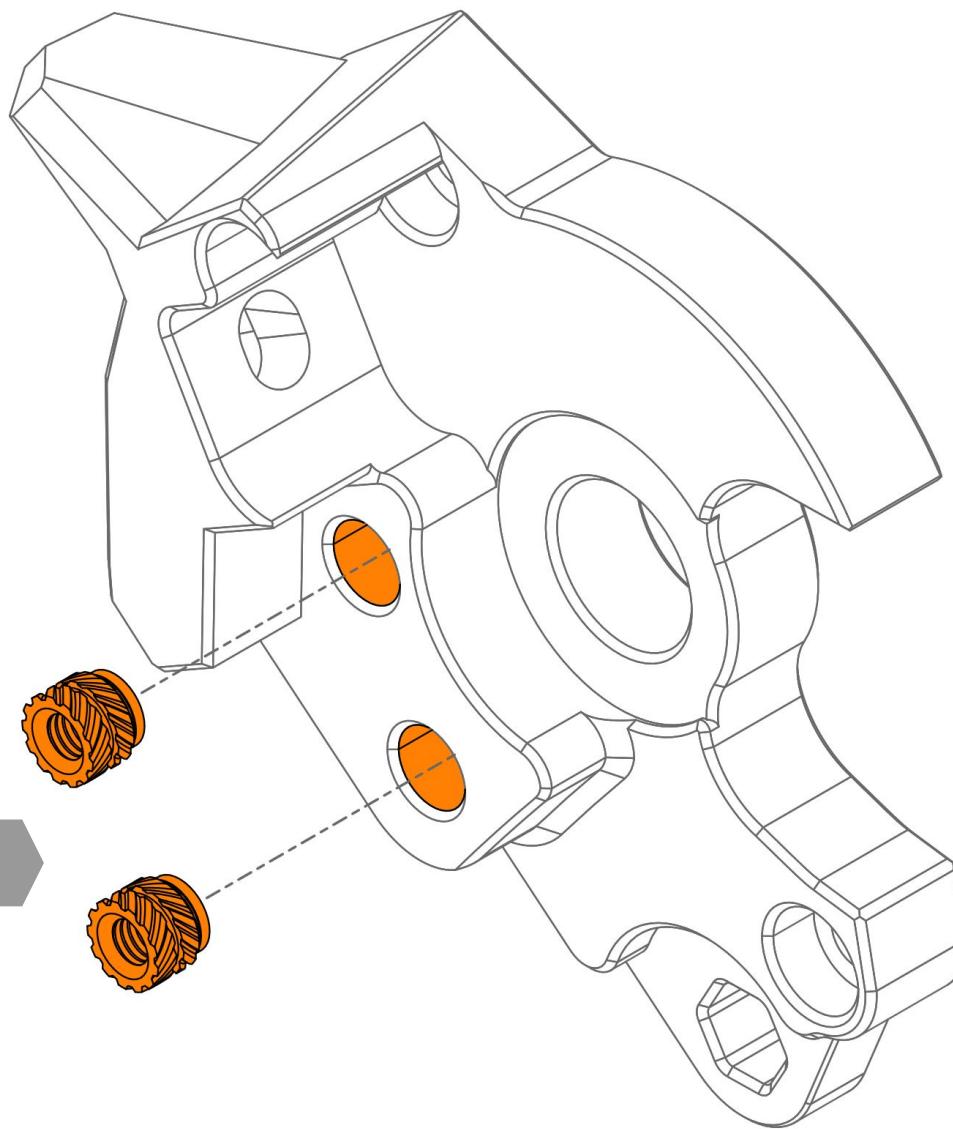
If you've never worked with heat set inserts before, we recommend you watch the linked guide.

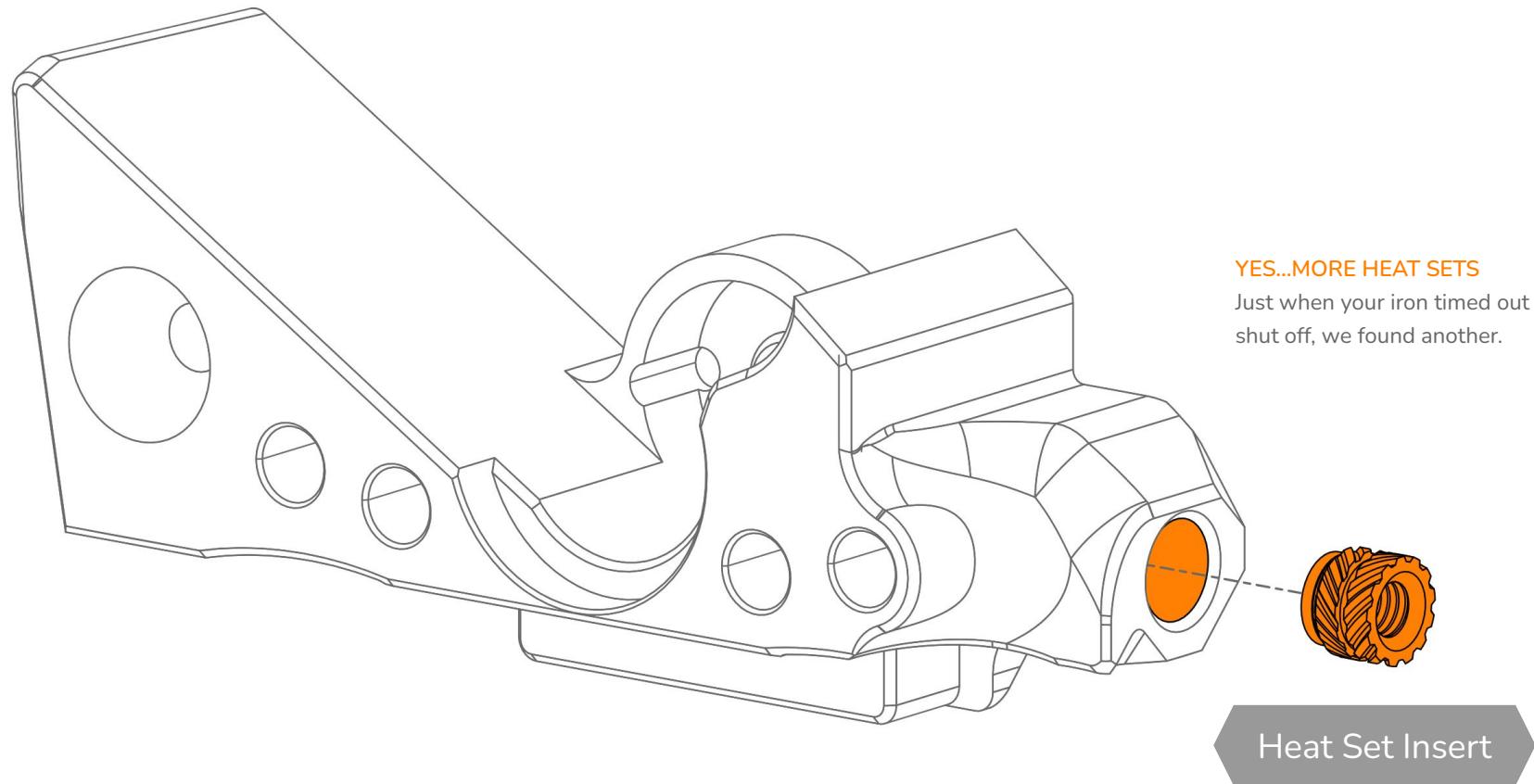
**THAT LITTLE GUY?**

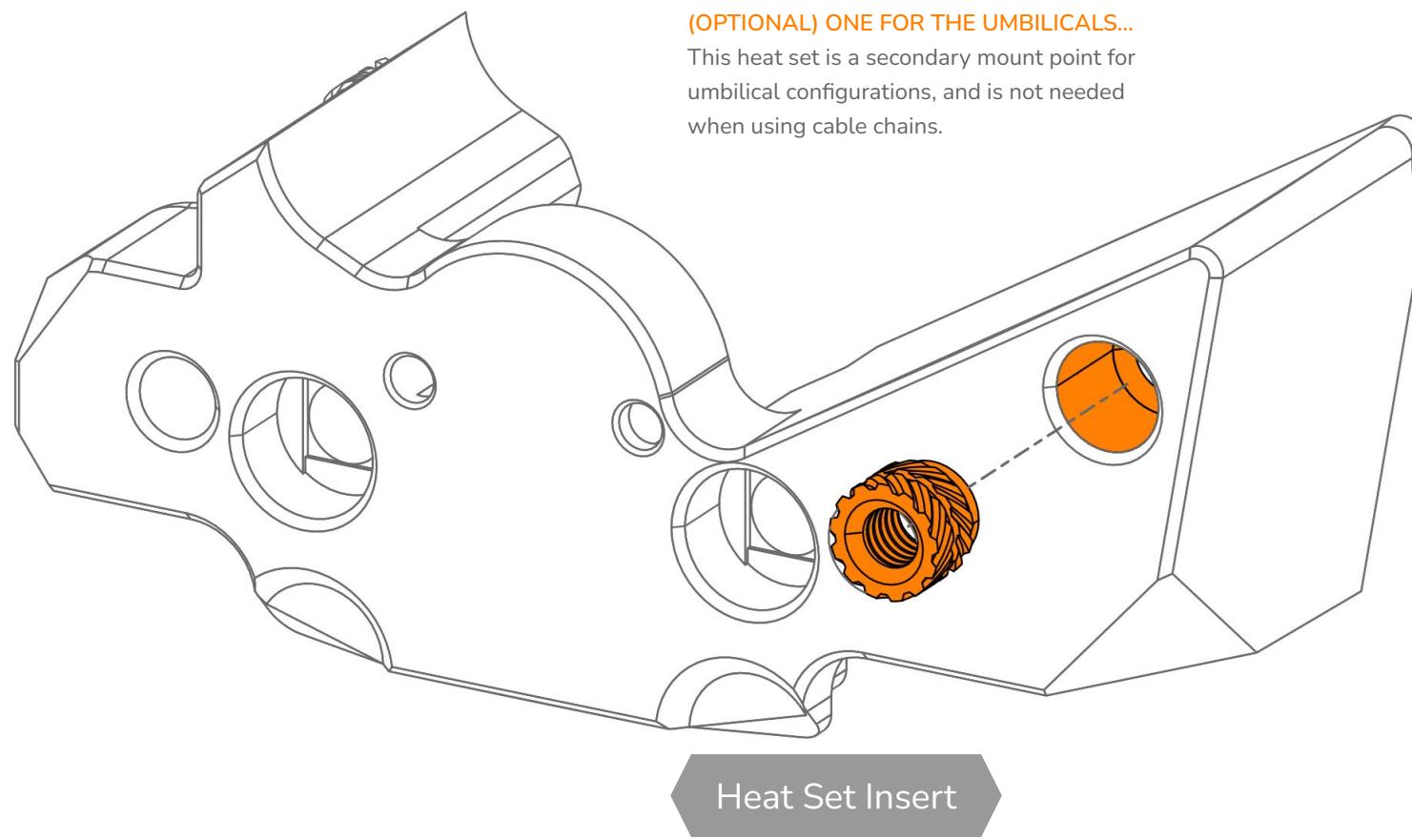
Don't forget the heatset in the idler bearing cover, which is also part of the front body assembly.



Heat Set Insert

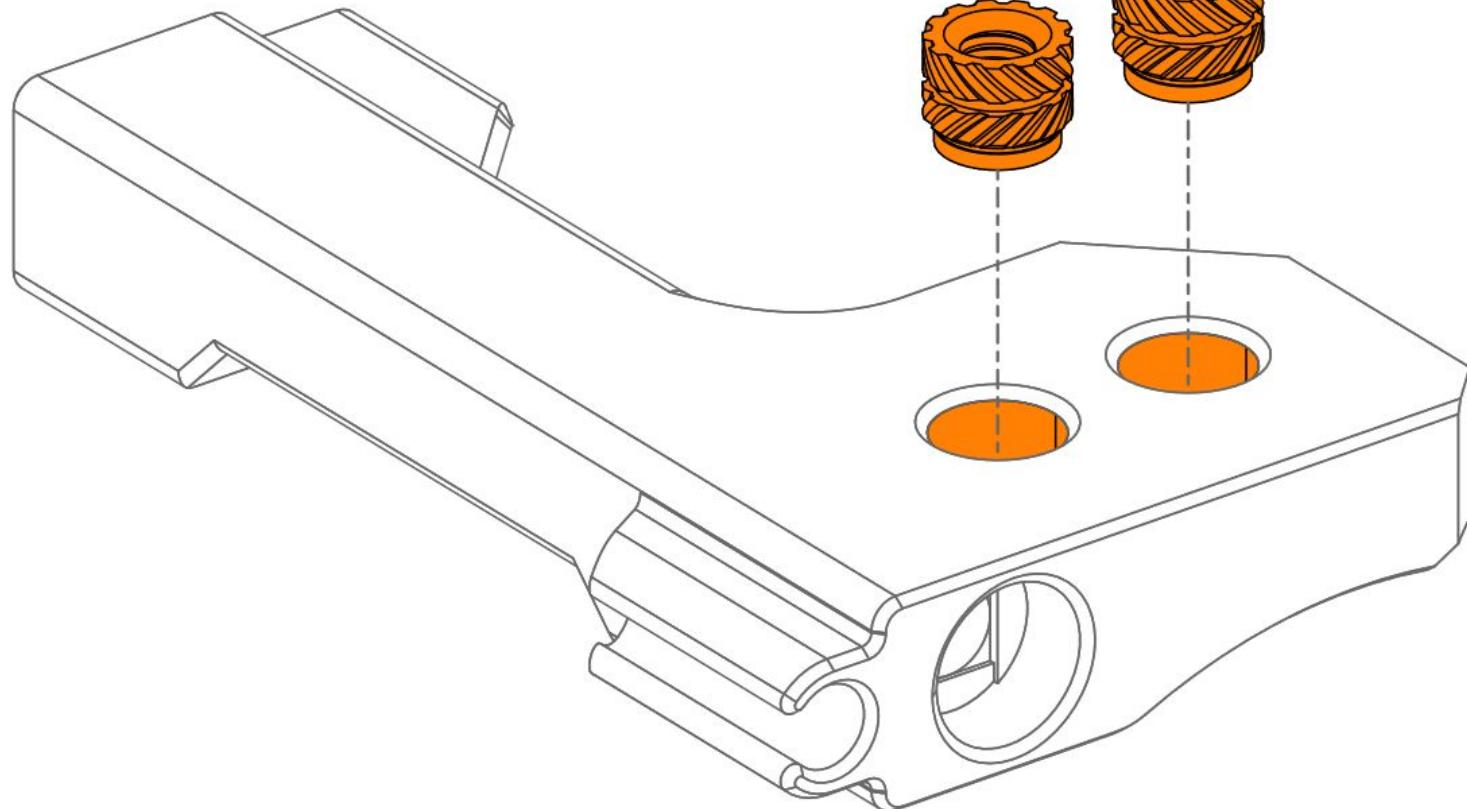


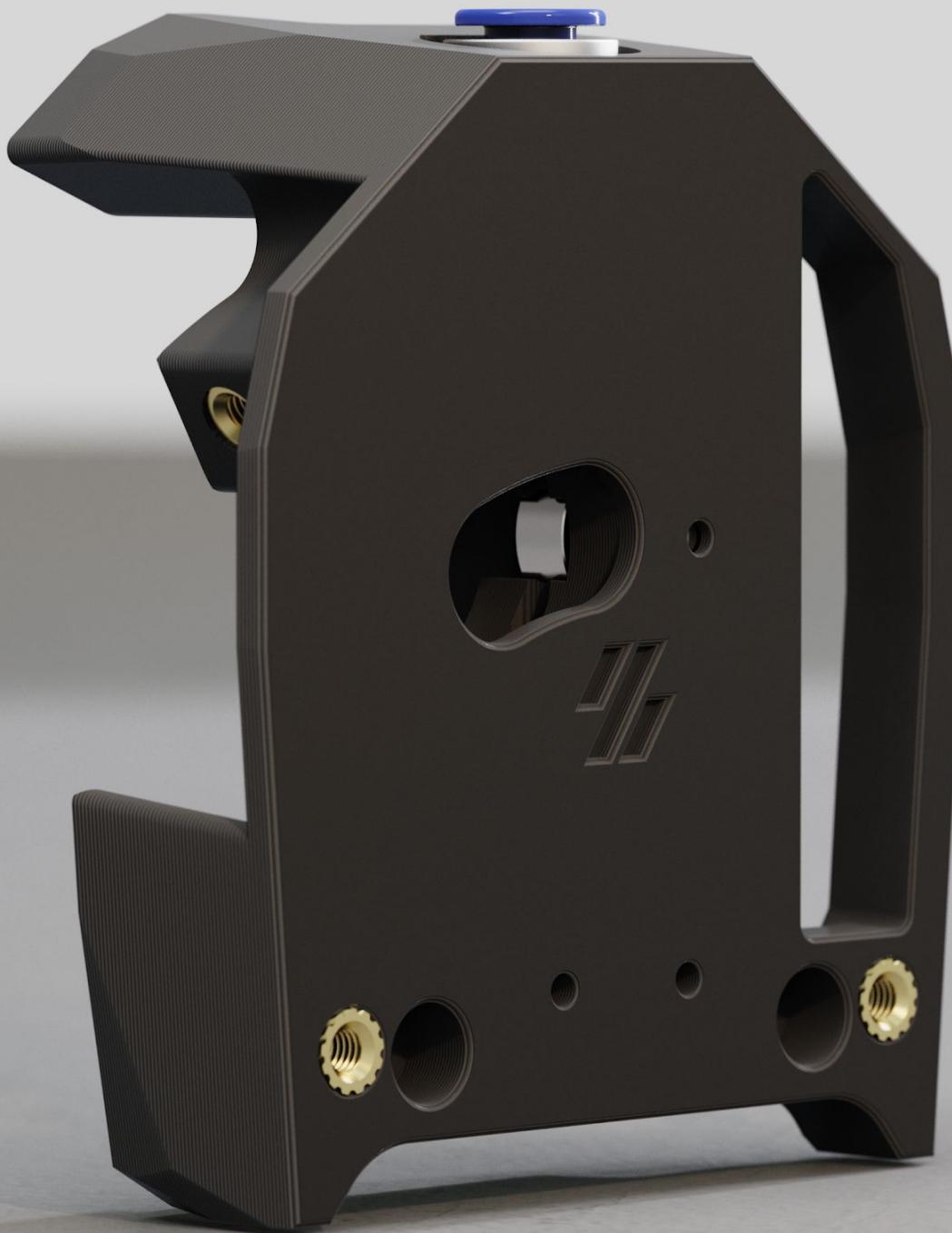




**GOT CHAINS?**

Make sure to print the version that matches your chains—  
some take two screws (shown), some take three.

**Heat Set Insert**



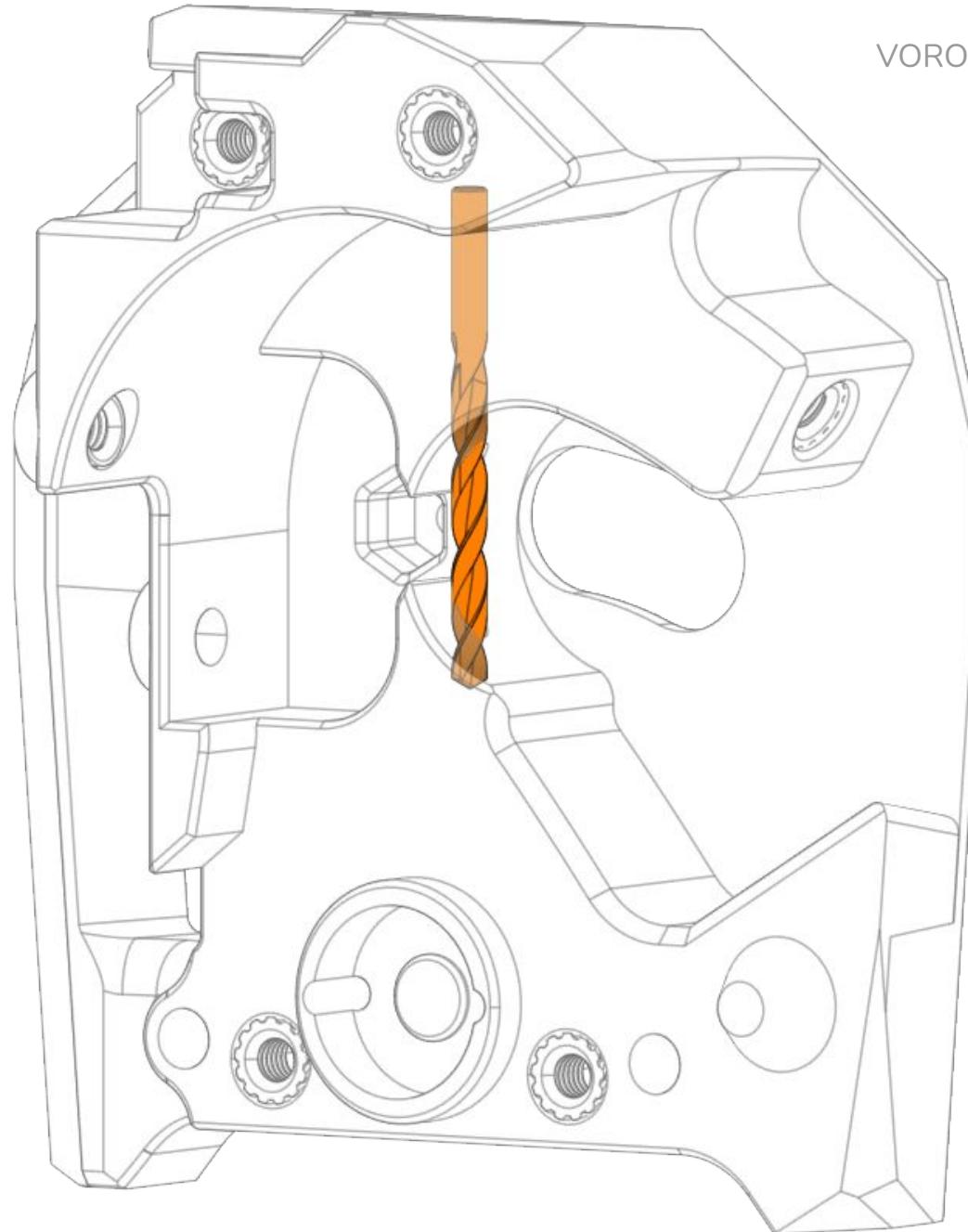
 GALILEO 2

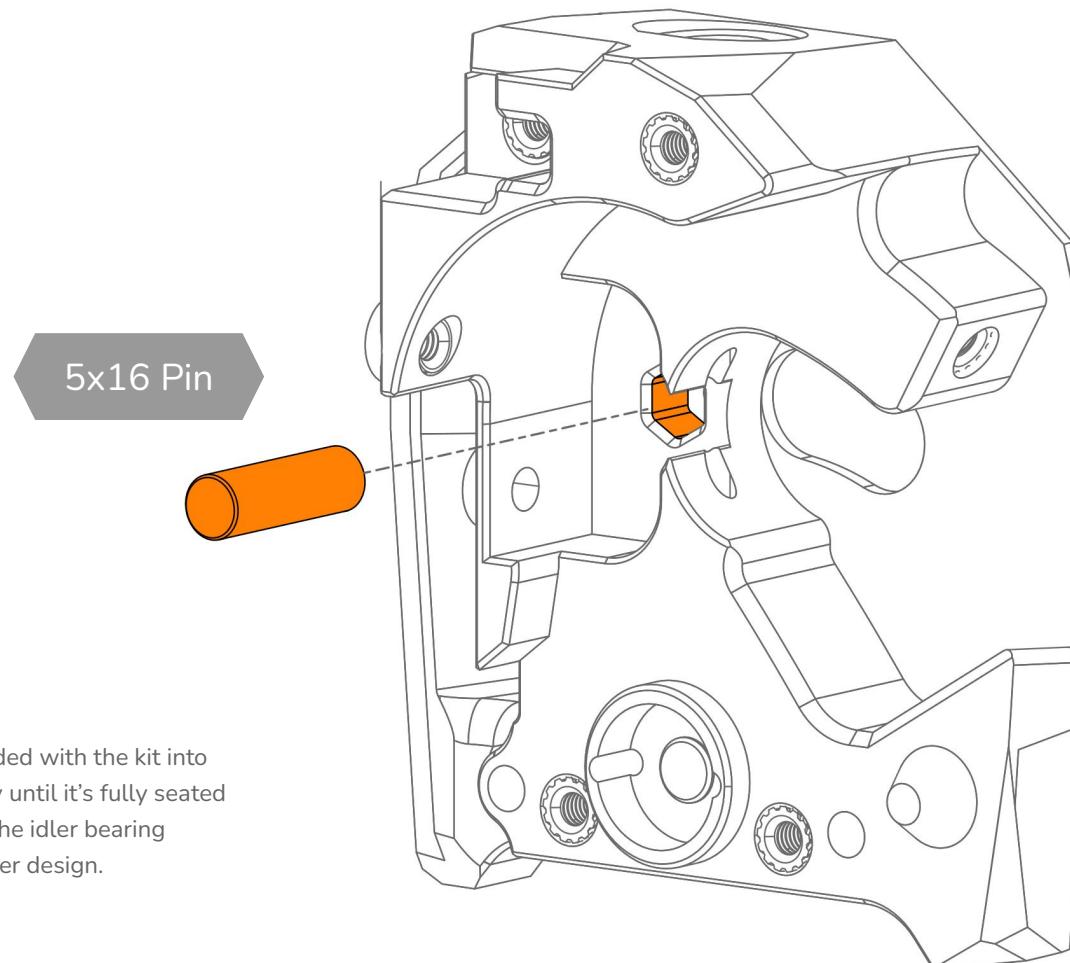
2mm Drill Bit

**THIS IS NOT A... WAIT**

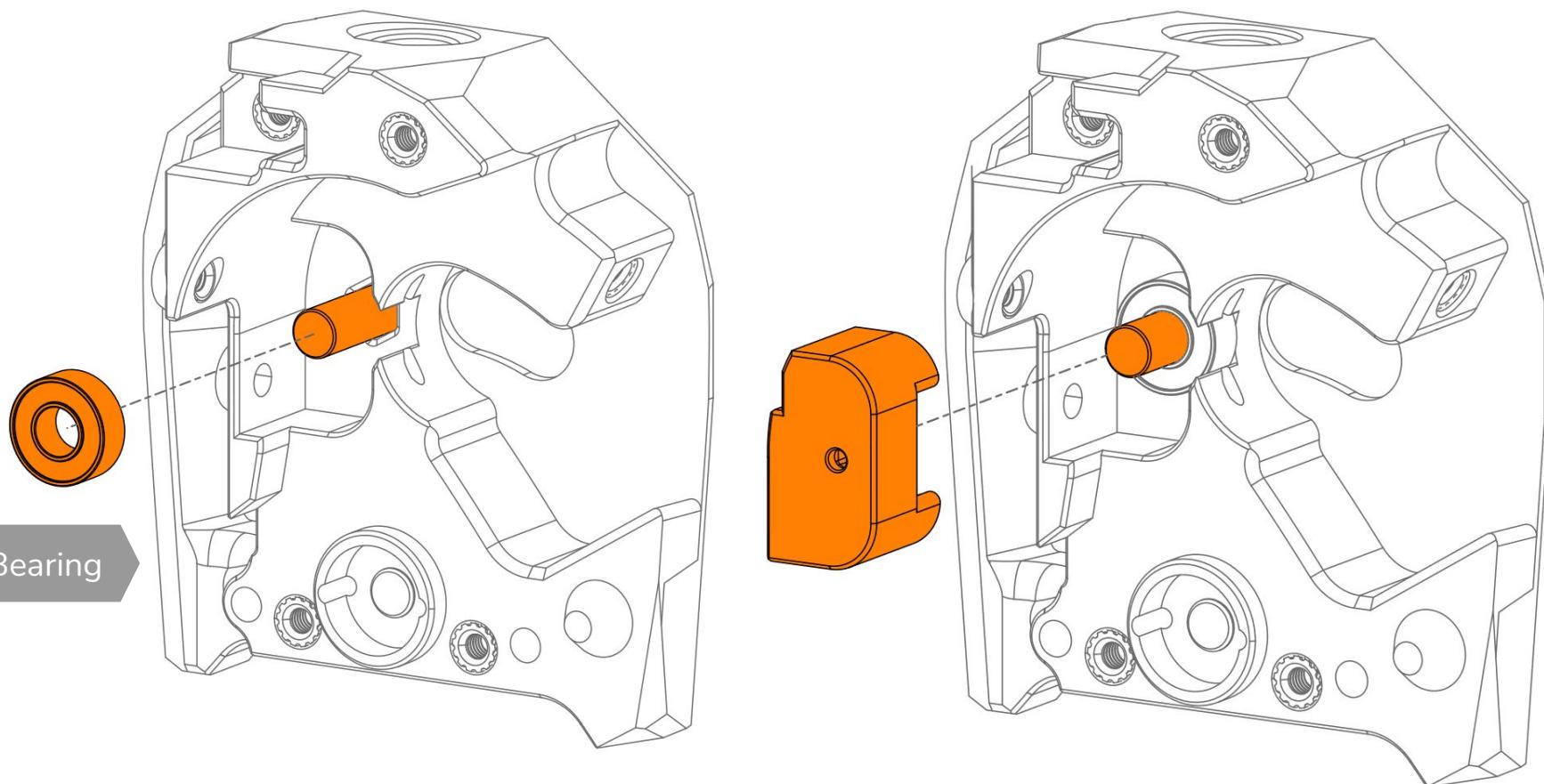
Use a 2mm or 5/64" drill bit to run down the filament path. This should be done by hand unless you are comfortable using power tools with soft plastic.

**NOTE:** Revision C kits from LDO should have a 2mm drill bit included.



**PUT A PIN IN IT**

Install the first of the two pins included with the kit into the hexagonal hole in the front body until it's fully seated into the housing. This pin will hold the idler bearing opposite the drive gear in G2 extruder design.

**IDLING ON BY**

Seat the idler bearing onto the pin, taking care to fully seat the bearing until it is flat against the printed part.

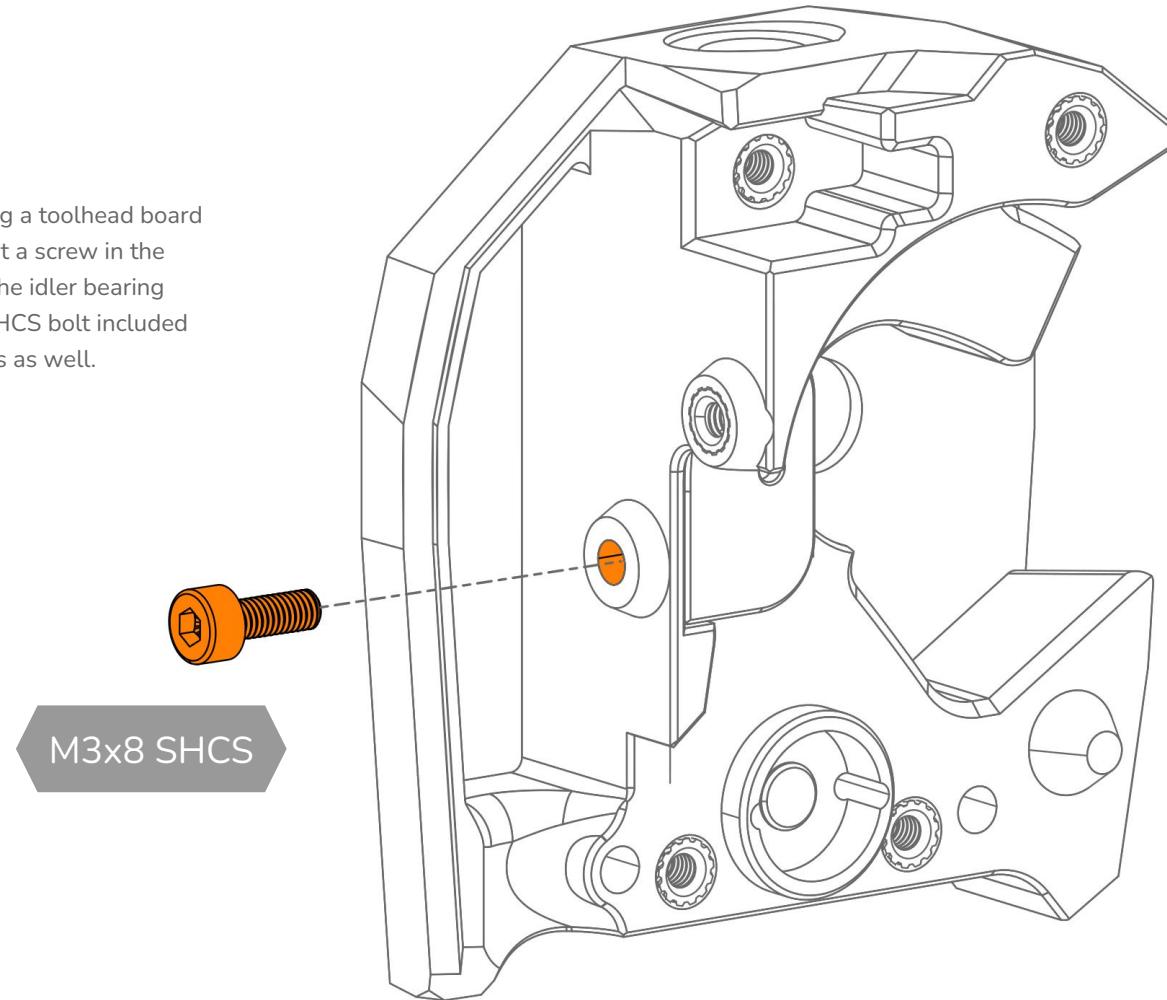
**NOTE:** The pin and bearing have very tight tolerances; if you notice the bearing is hard to install, remove the bearing, clean the pin and bearing, then assemble again.

**TAKE COVER!**

Install the idler bearing cover onto the back of the 5mm pin, seating it fully into place. When fully inserted, the heatset insert on the idler bearing cover should align with the screw hole on the front body.

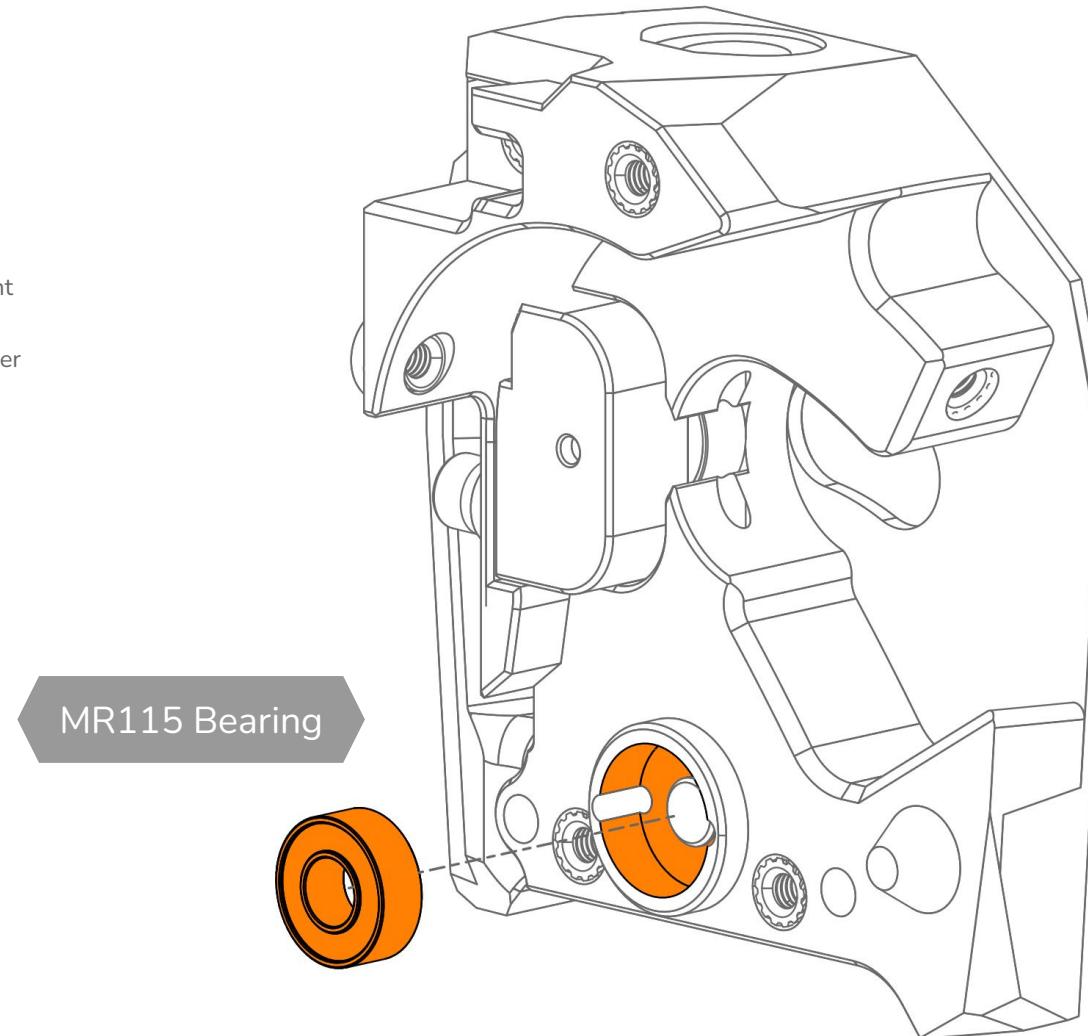
**BEARING SECURITY**

Whether or not you are using a toolhead board with G2, you will need to put a screw in the front mount hole to secure the idler bearing cover properly. The M3x8 SHCS bolt included will fit most toolhead boards as well.



**PIVOT BEARING**

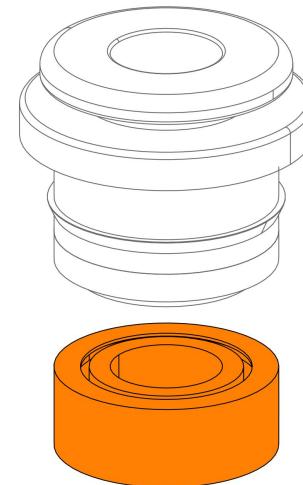
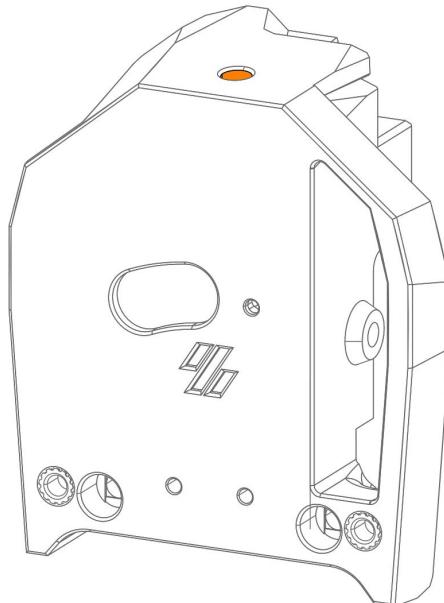
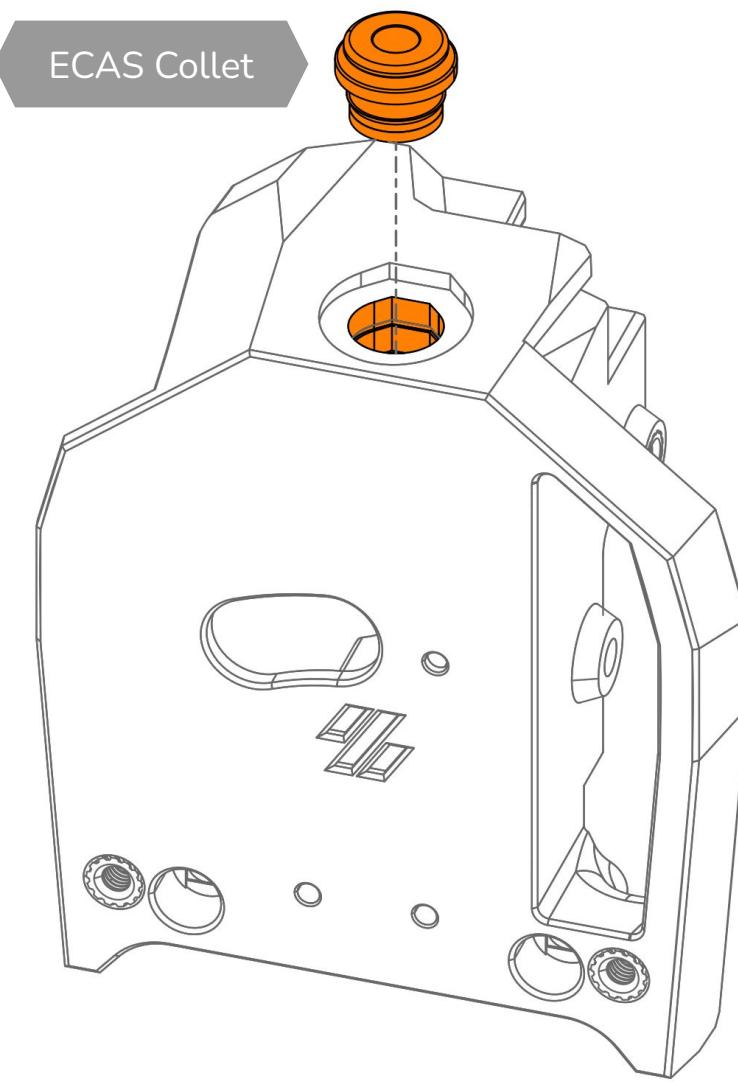
Insert the bearing into the front body. This should install with a small amount of force and should sit flush with the raised lip around the bearing. If you ever need to remove this bearing, use the ejecto-seato holes in the front!



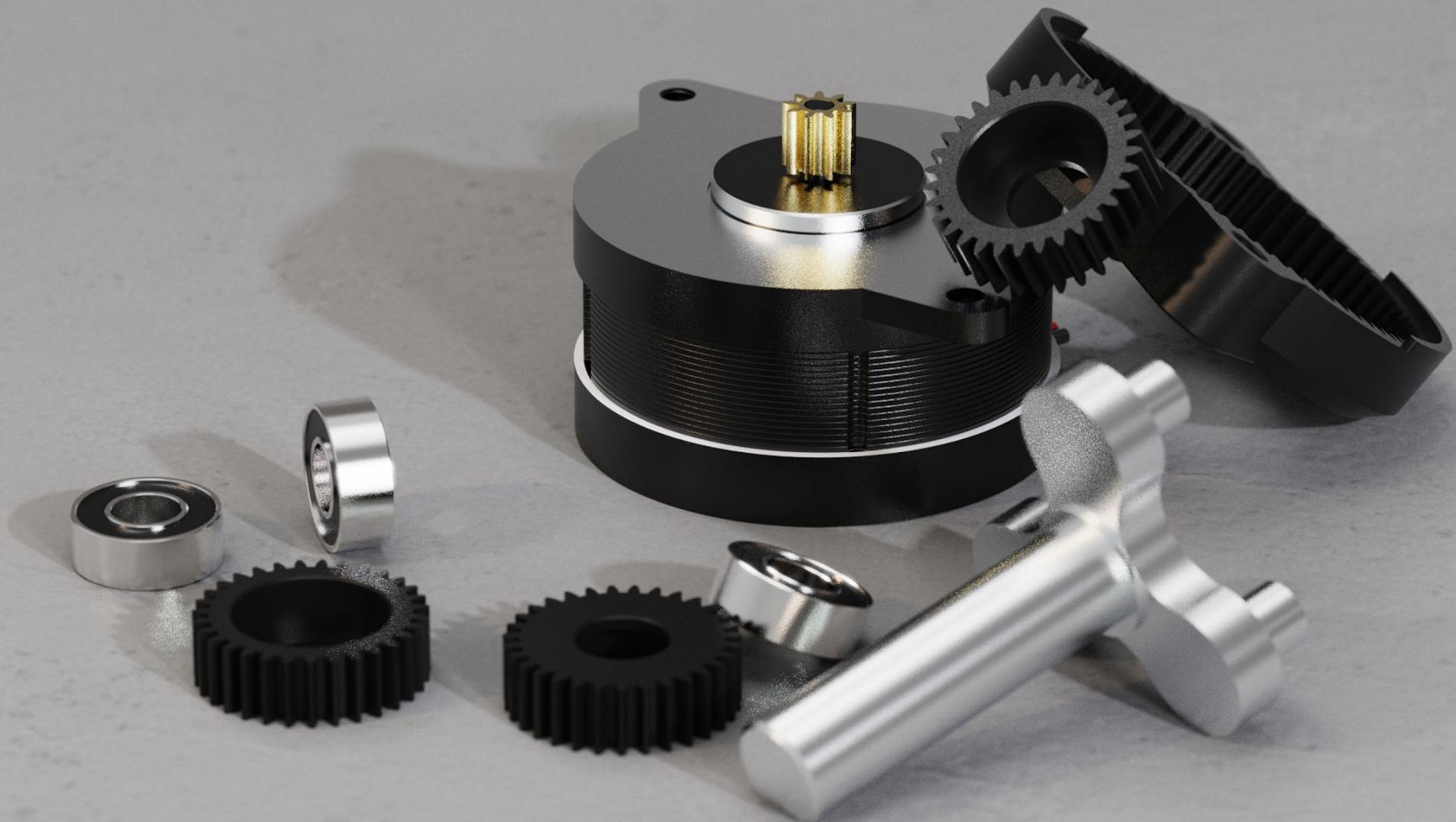
**ECAS PREP**

The rubber donut on the bottom highlighted here is not used in this build. Pry the rubber donut off and set it aside where pets won't find a way to use it to increase your vet bill.

Press the collet straight down into the extruder body. This may be a tight fit—you can start it by hand, then push against it using a doorway, the floor, etc. Just try not to ding the pointy top of the printed part.

**ECAS Collet**

**NOTE:** If you're using the press-fit front body, you can skip this step!



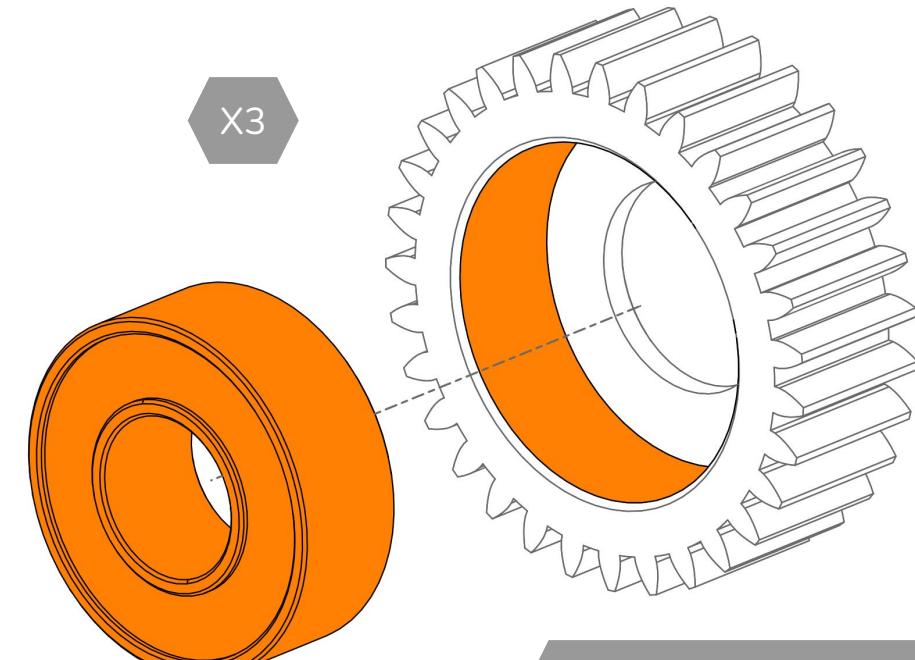
**HOW DO YOU THROW A PARTY  
ABOUT SPACE?....YOU PLANET!**

Planetary gearbox assembly can be a tedious process, but following these steps closely will ensure a smoothly running gearbox!

**INTERGALACTIC, PLANETARY!**

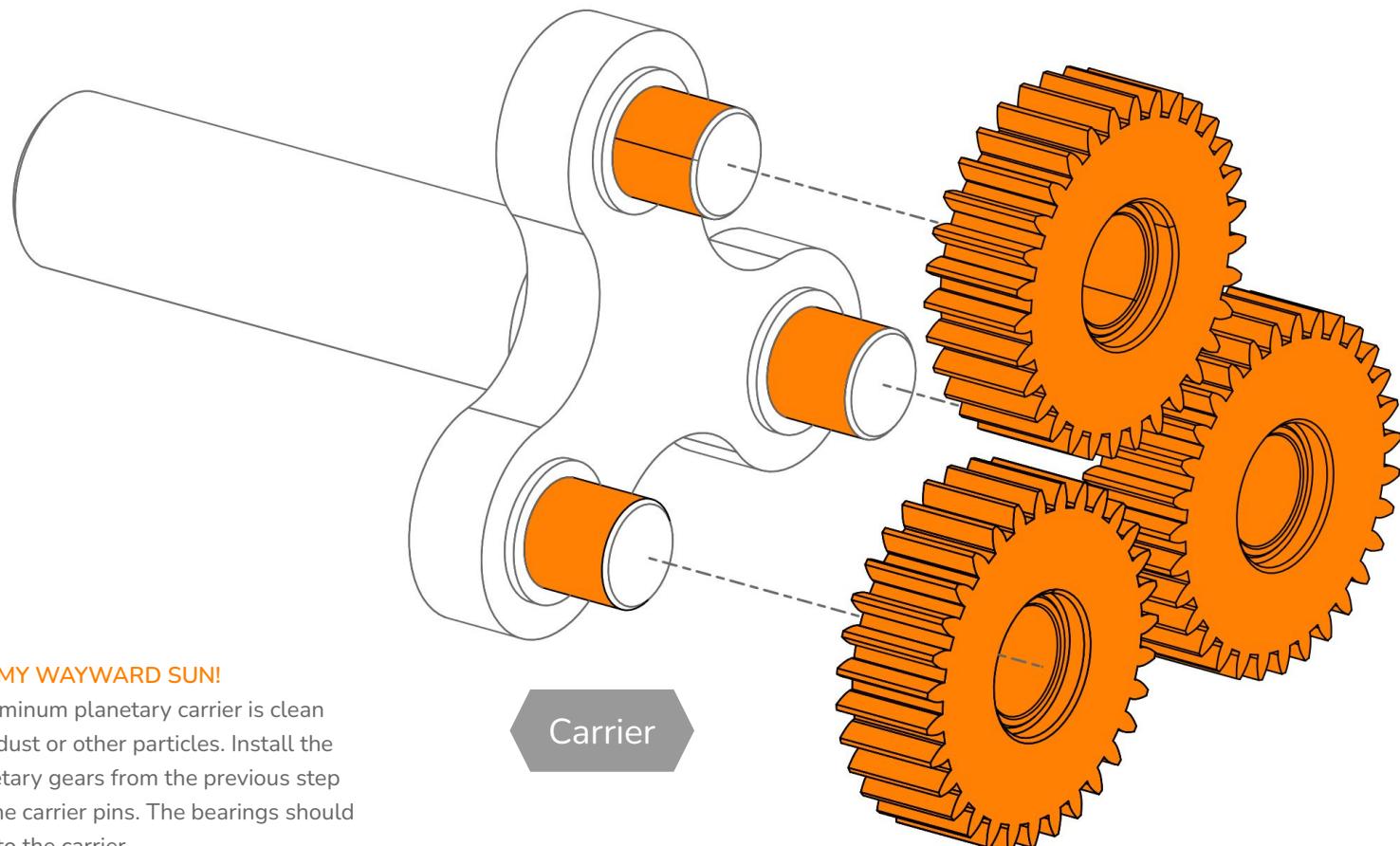
Start by inserting the bearings for each of the three (3) planetary gears. The bearings should press fit into place with little effort. It's okay if the bearings are loose enough to fall out on their own; they will be held captive when the gearbox is assembled.

X3



Planetary Gear

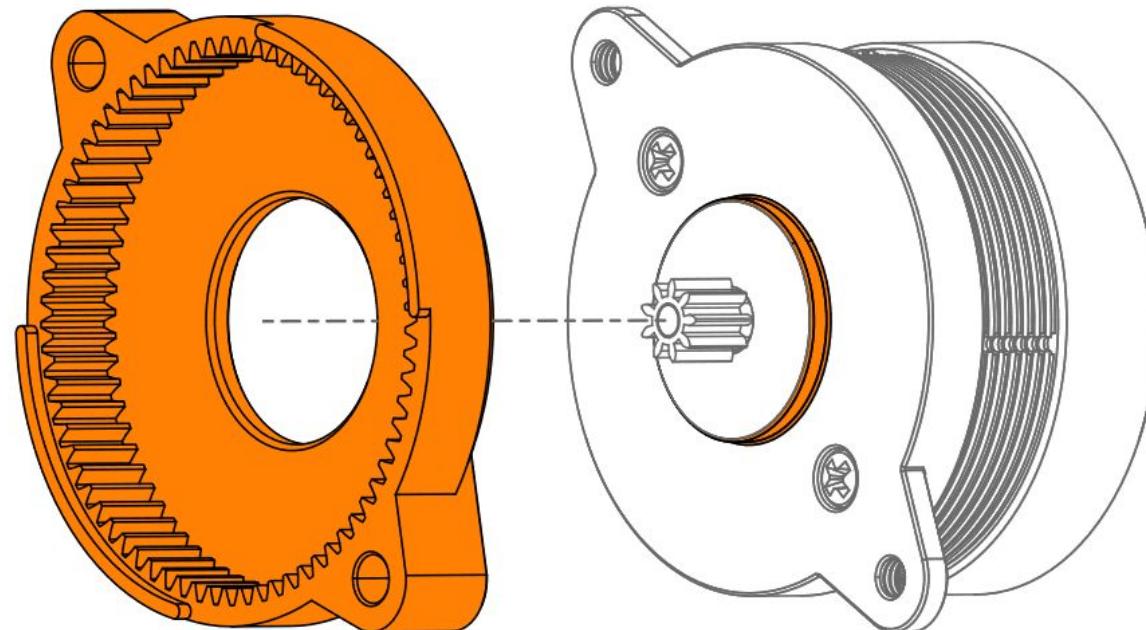
MR115 Bearing

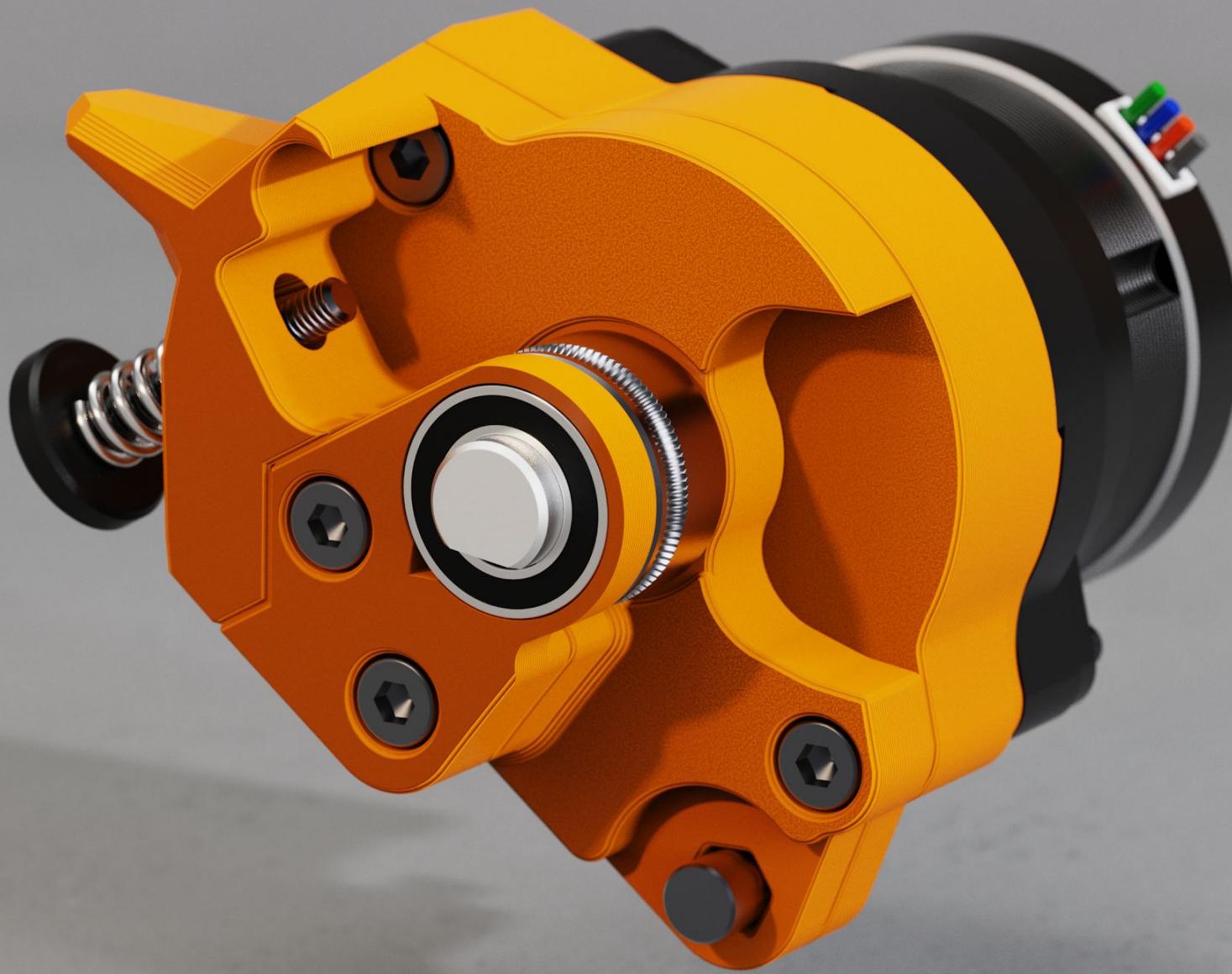
**CARRIER ON MY WAYWARD SUN!**

Ensure the aluminum planetary carrier is clean and free from dust or other particles. Install the three (3) planetary gears from the previous step onto each of the carrier pins. The bearings should slide easily onto the carrier.

**Ring Gear****THE SNAP**

The ring gear housing should have a sharp snap onto the stepper when installed properly. Set the ring gear housing onto the stepper, then use both thumbs to press on the inner edge of the ring gear housing until it snaps into place. Once the ring gear is seated on the stepper, rotate the ring gear until the holes line up properly with the stepper.



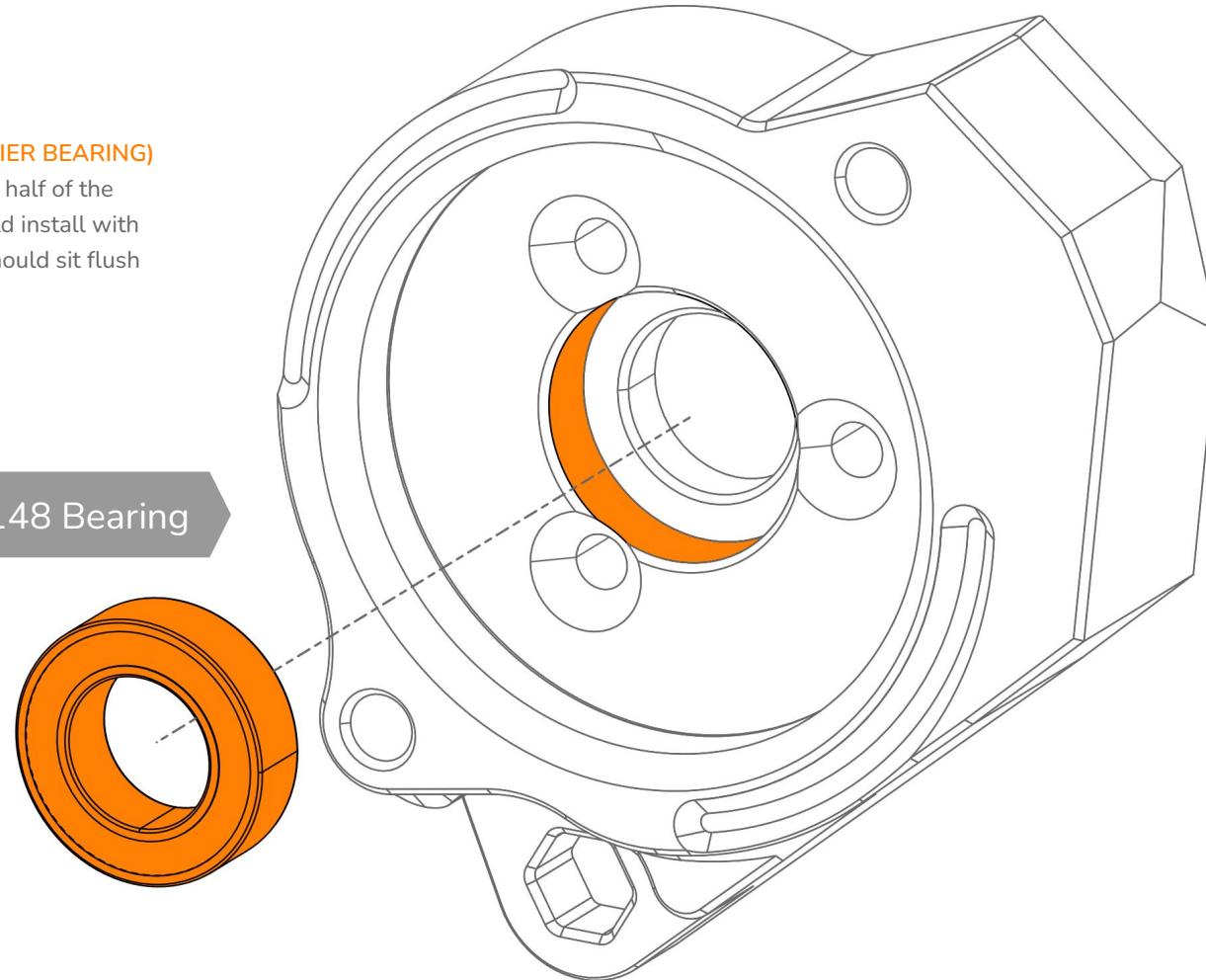


 GALILEO 2

**CARRY HER BEARING (CARRIER BEARING)**

Insert the bearing into the rear half of the G2 Module. This bearing should install with a small amount of force and should sit flush with the lip of the printed part.

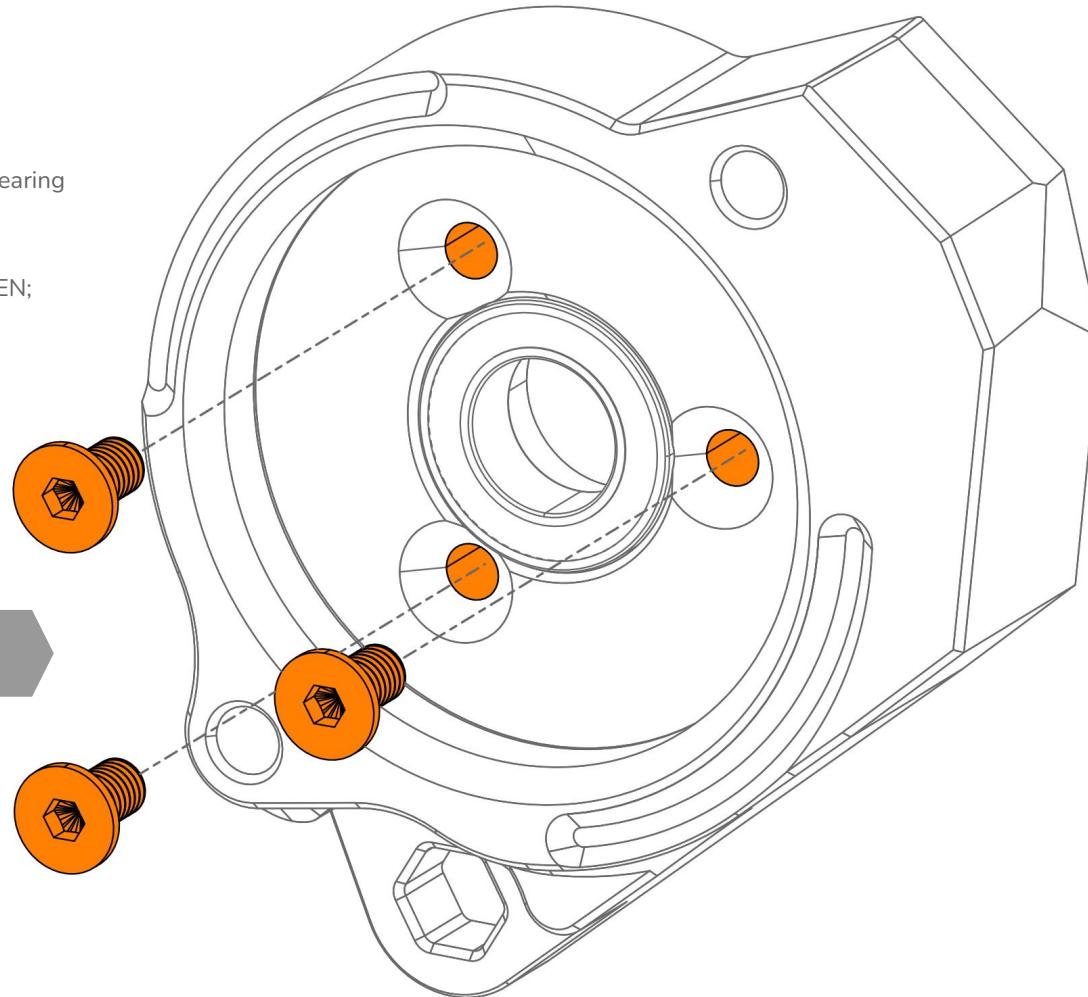
MR148 Bearing

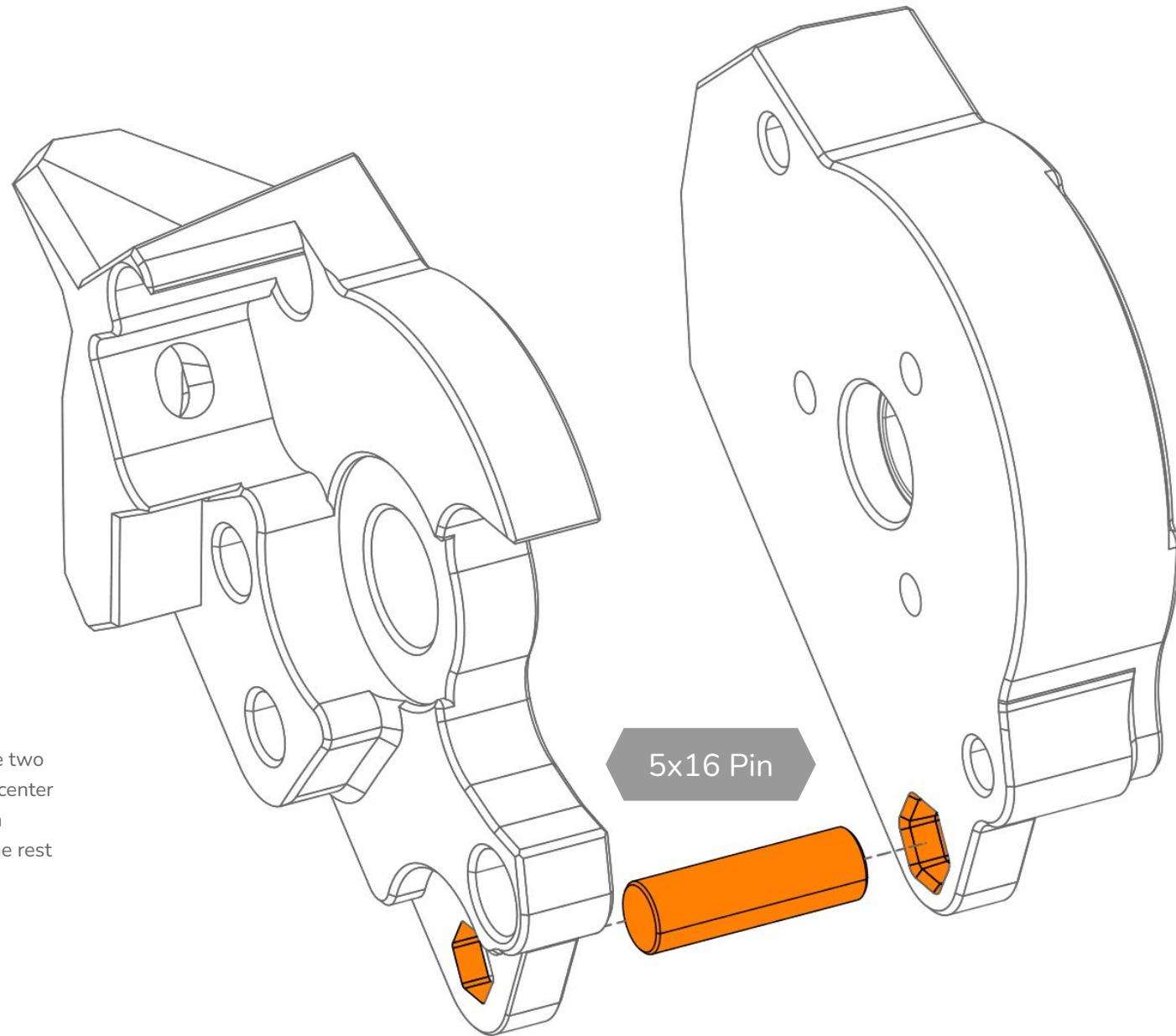


**BEARING RETAINER SCREWS**

These capture the outer edge of the bearing and will retain it in the printed part.

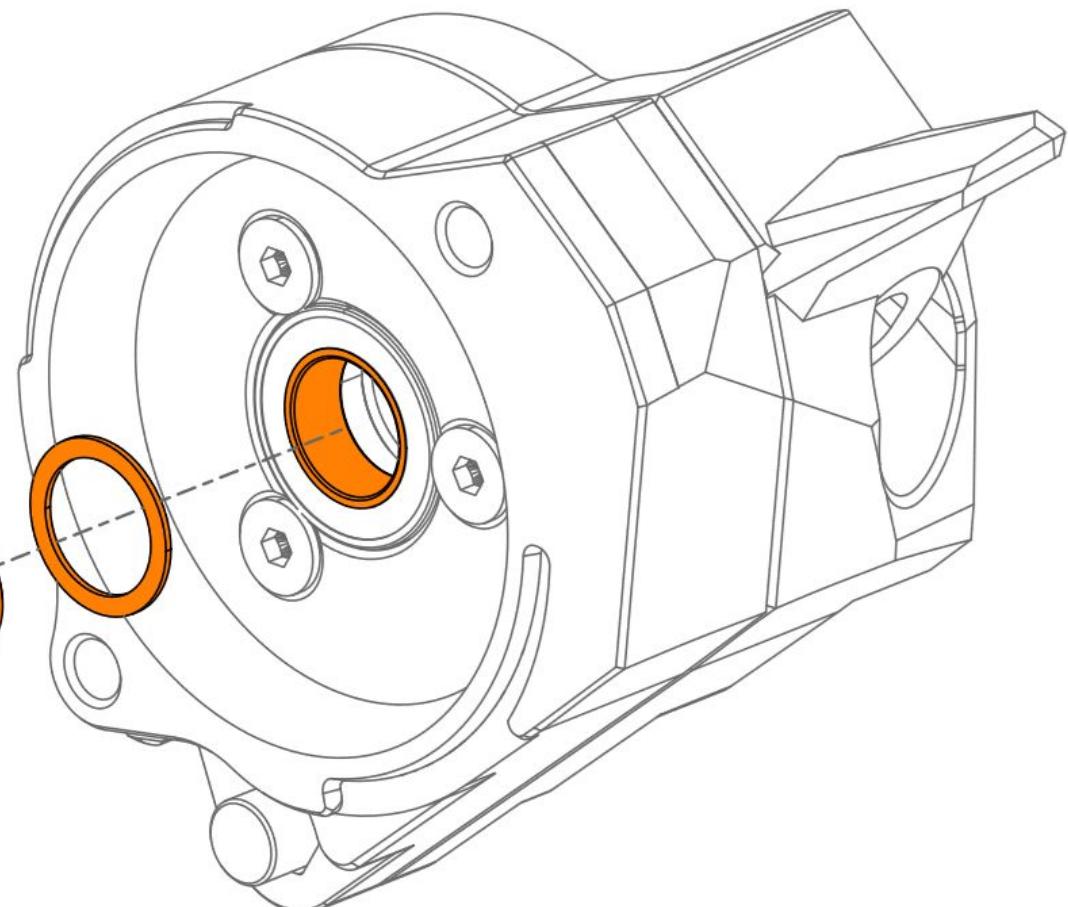
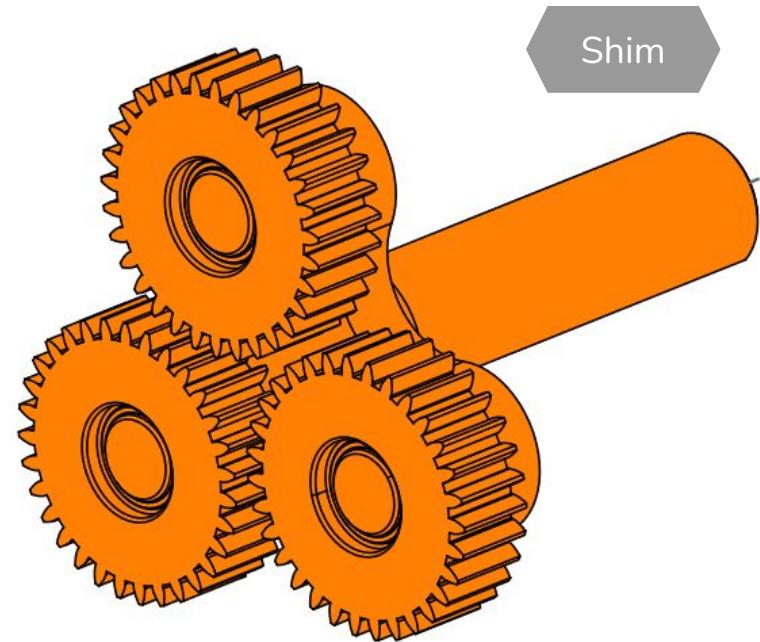
They should be just above flush when fully tightened. DO NOT OVERTIGHTEN; they are threaded into plastic!

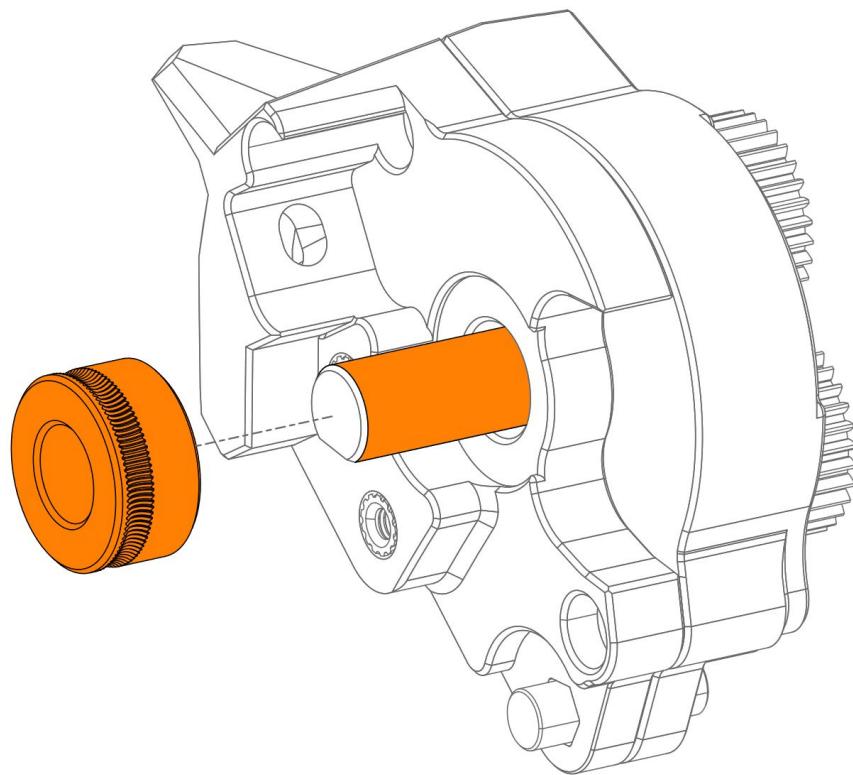




**THE PLANETS ARE ALIGNING (AND SHIM-ING ALONG)**

Install the completed carrier assembly into the rear bearing assembly of the G2 Module. Make sure you install the 8x11x0.5mm shim onto the carrier shaft before installing into the G2 Module.





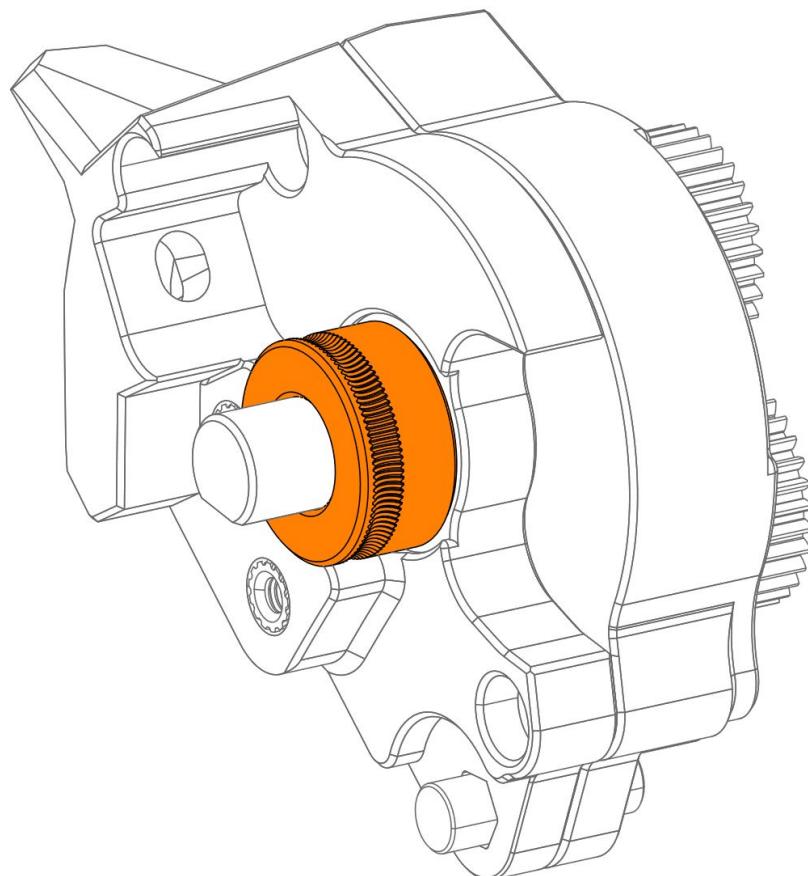
**GEARS SPIN, GRUB SCREWS PIN!**  
**VERY IMPORTANT STEP!**

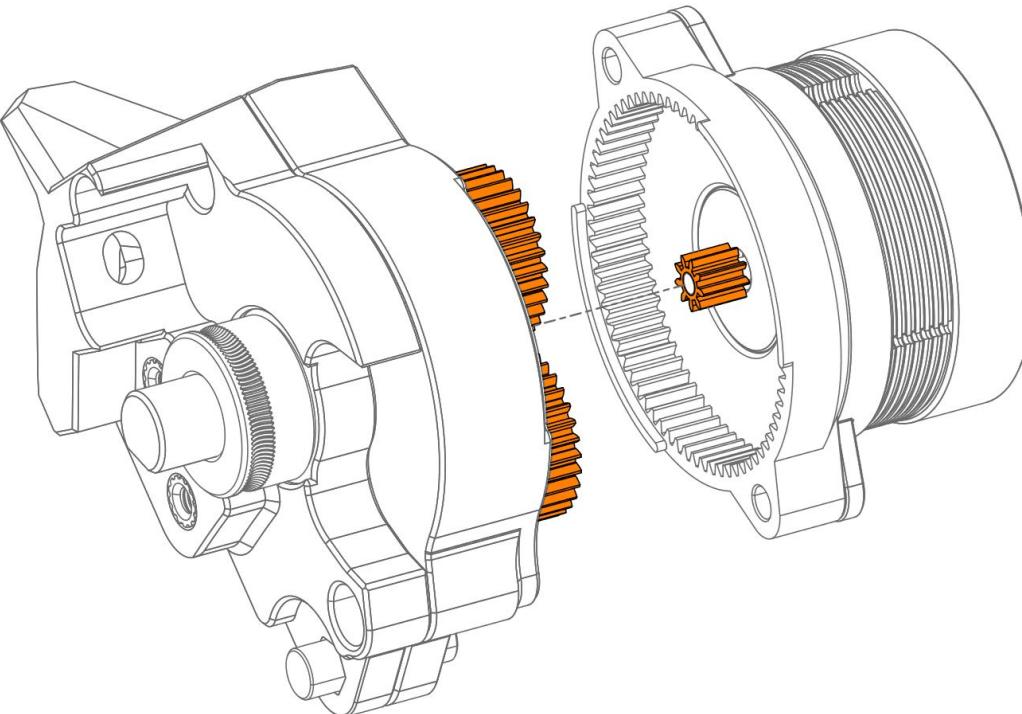
To properly align the drive gear and the carrier shaft, press the carrier shaft IN from behind (pressing on the planetary gears) until the carrier and shim stack is firmly against the bearing.

With the carrier shaft fully seated, slide the drive gear flat against the printed surface, then tighten the grub screw. If your grub screw didn't come with threadlocker pre-applied, use a small drop of threadlocker to ensure the grub screw doesn't come loose over time.

#### PLANETARY EXTRUSION? IT'S OUT OF THIS WORLD!

Ensure the flat face of the carrier shaft is facing out towards the opening in the G2 Module so that the drive gear grub screw is accessible (not shown in the image). Install the custom 16mm drive gear onto the carrier shaft, ensuring the filament path is facing AWAY from the G2 Module. Leave the grub screw loose for the next step.



**EVERY STEP COUNTS**

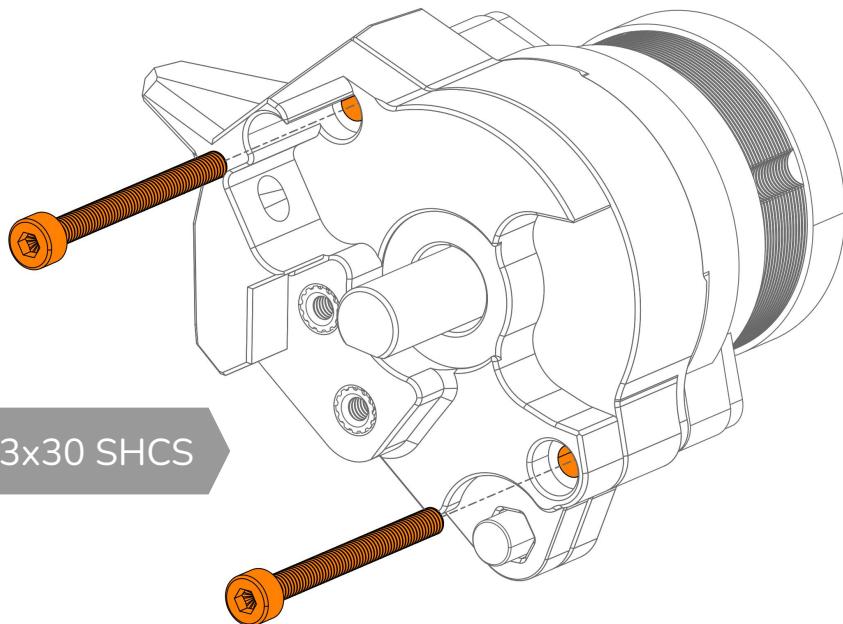
With the rear-half of the G2 Module assembled, it's time to put on the front! Slide the front half of the G2 Module onto the carrier shaft and fasten everything together with 2x M3x30 SHCS.

**ONE SMALL STEP FOR THE MOTOR...ONE GIANT REVOLUTION FOR THE GEARBOX (AND LET'S GET GREASY)**

Aligning the stepper is one of the more challenging parts of G2, as it can be installed a tooth off, which will cause binding during operation. When installed properly, the ring gear housing should "fall" or "drop" into place with ZERO force required.

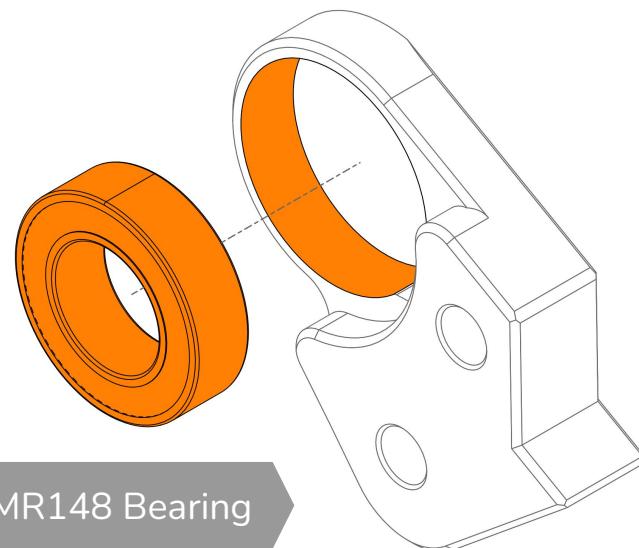
Before final assembly of the two halves, put a pea-sized blob of grease on the bottom flat surface of the ring gear housing.

To properly align the stepper, align the stepper and ring gear over the carrier and slide the two halves together. If there's any resistance, pull the halves apart, rotate the stepper sun gear one step, and try again until the two halves go together easily. Once together, rotate the extruder gear / carrier shaft one full rotation to check for binding. If binding occurs before a full rotation, repeat the above until aligned properly.

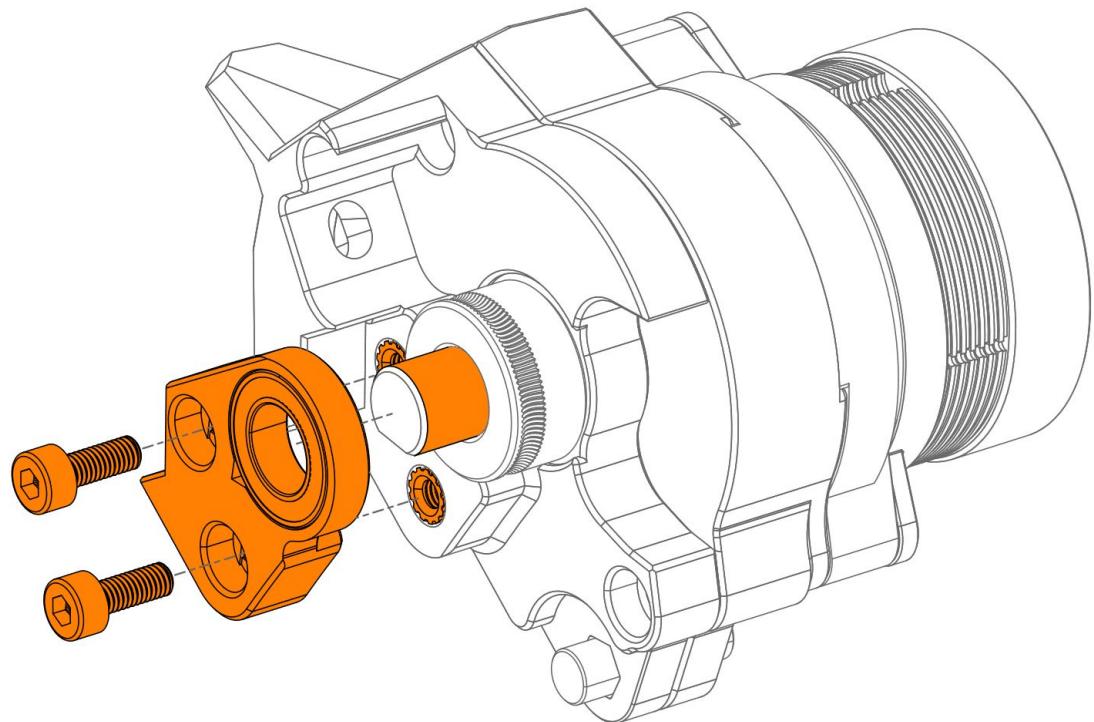


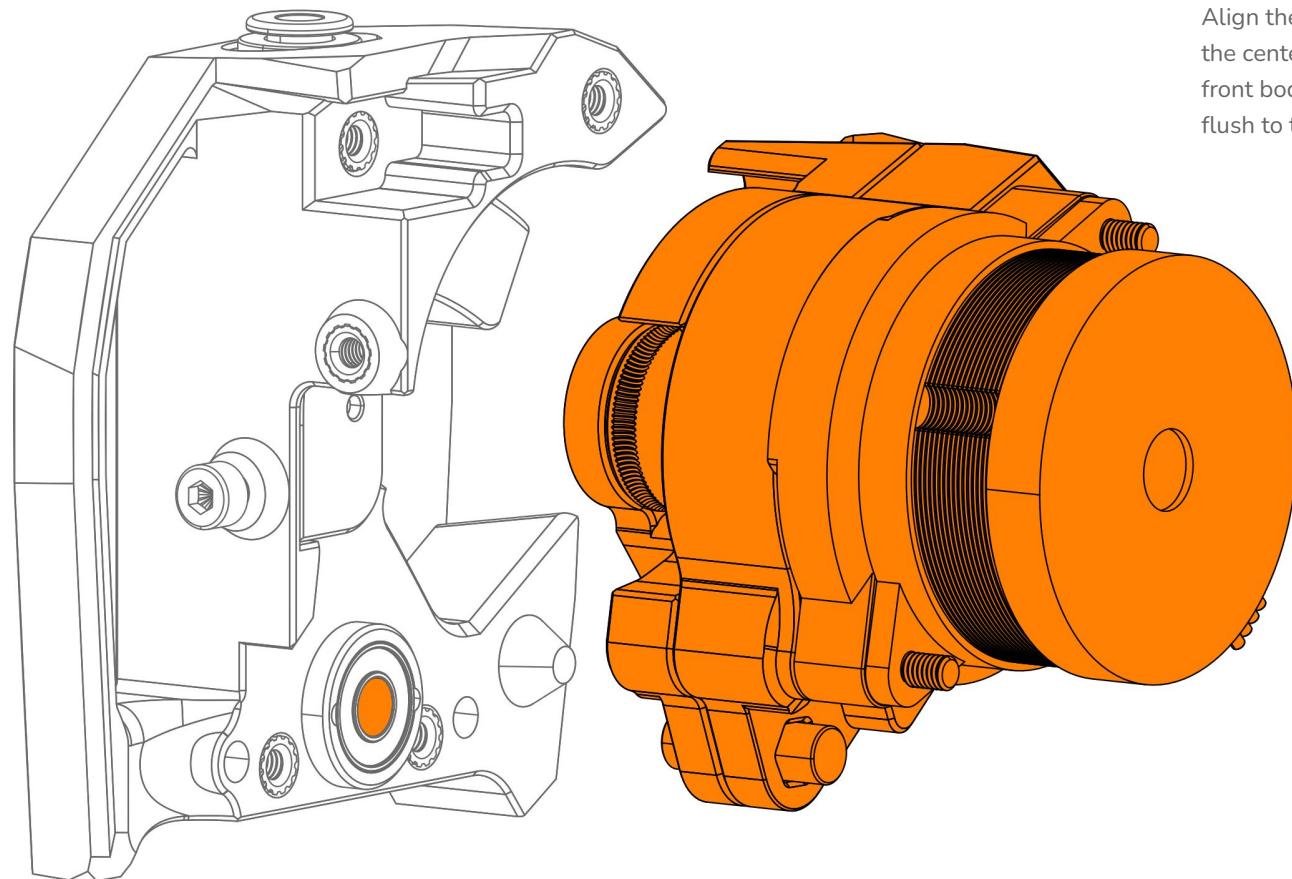
**SHAFT SUPPORT**

The shaft support bearing needs to be pressed into the front bearing holder until it is flush with the outside face of the printed part. Slide the completed front bearing holder over the carrier shaft, align the screw holes, then attach to the rest of the G2 Module assembly using 2x M3x8 SHCS.



MR148 Bearing



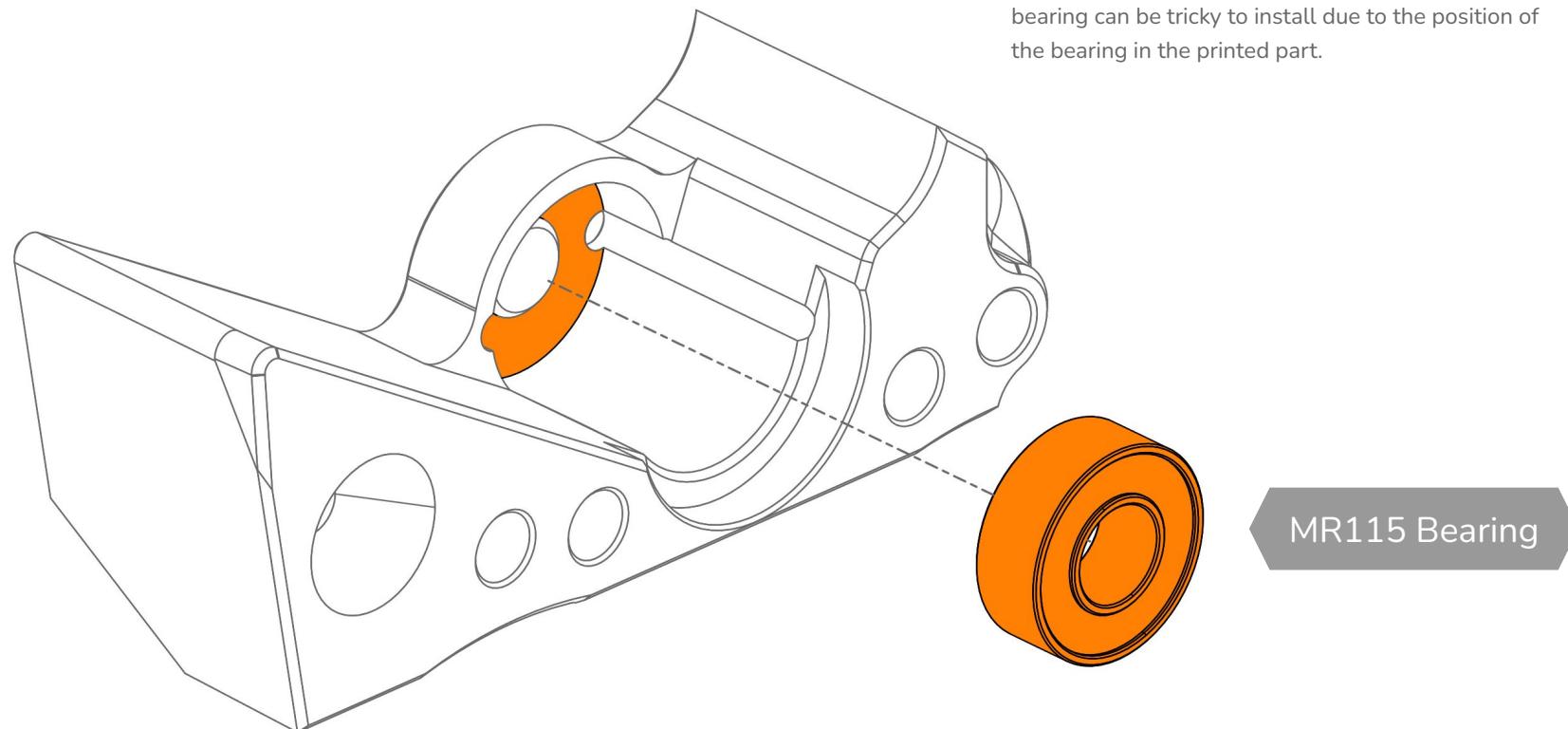


**PREPARE FOR DOCKING!**

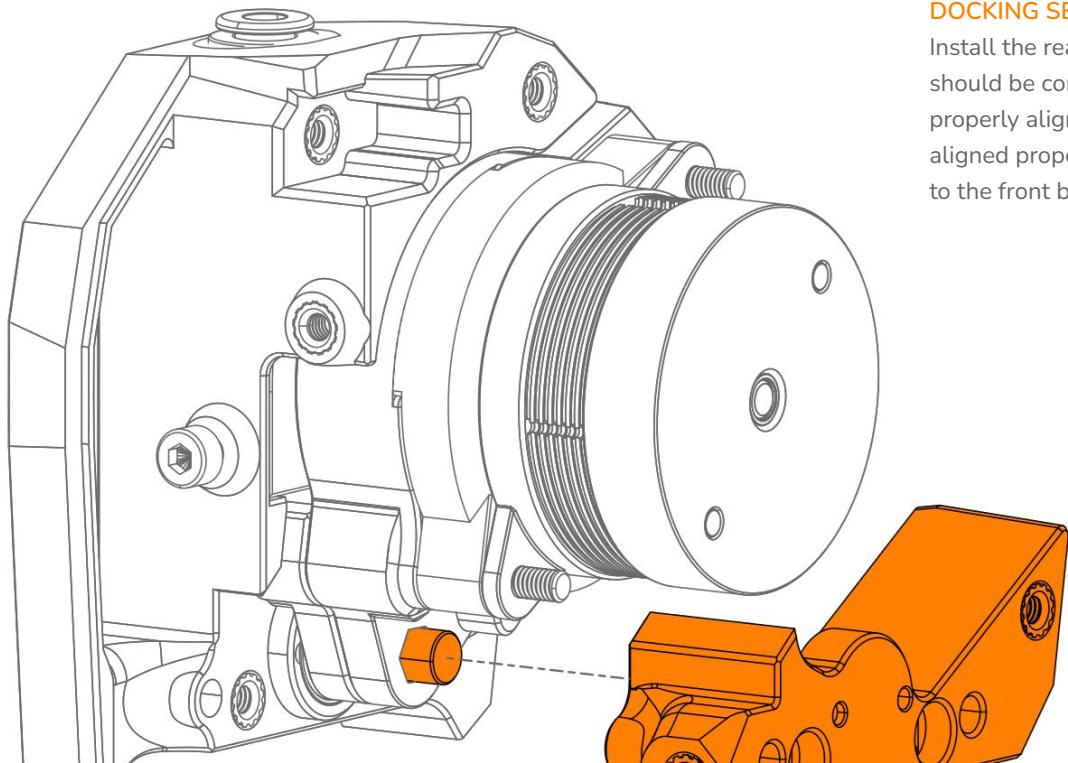
Align the G2 Module's pivot pin with the center of the pivot bearing in the front body and install the G2 Module flush to the bearing.



 GALILEO 2

**LOST IN SPACE? BETTER FIND YOUR BEARINGS!**

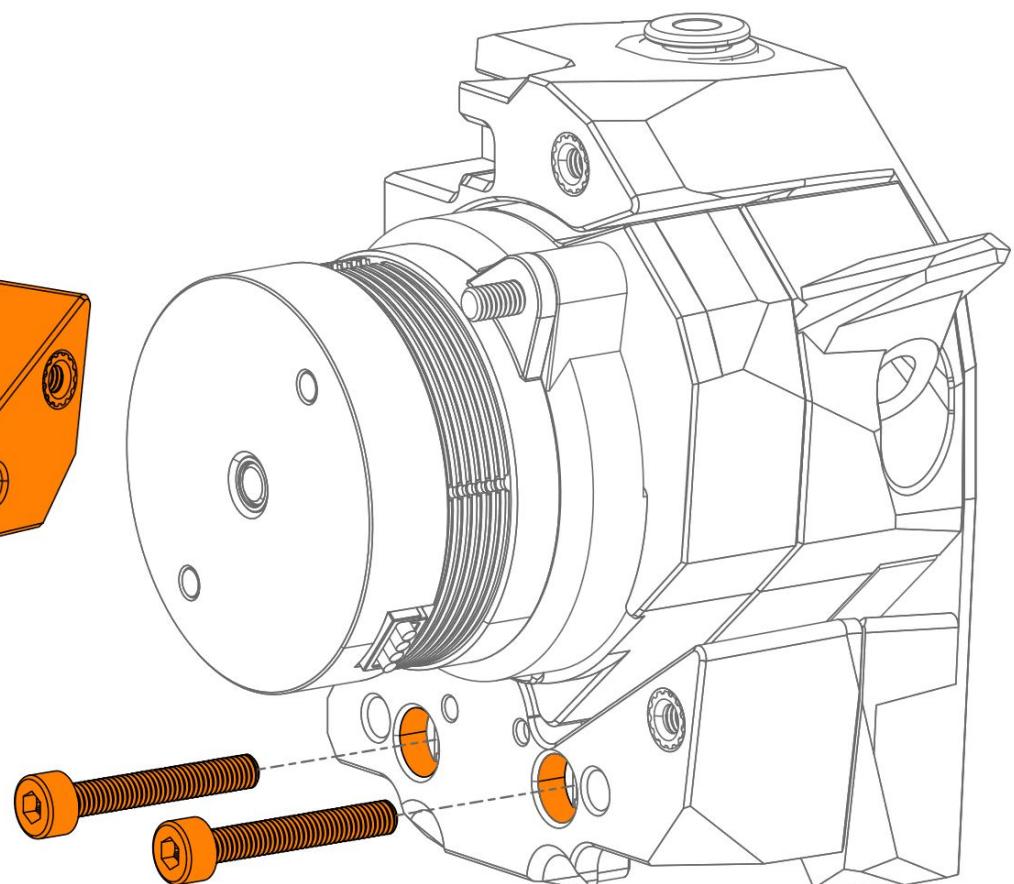
Install the FINAL bearing, making sure to prevent the bearing from tilting sideways while inserting. This bearing can be tricky to install due to the position of the bearing in the printed part.

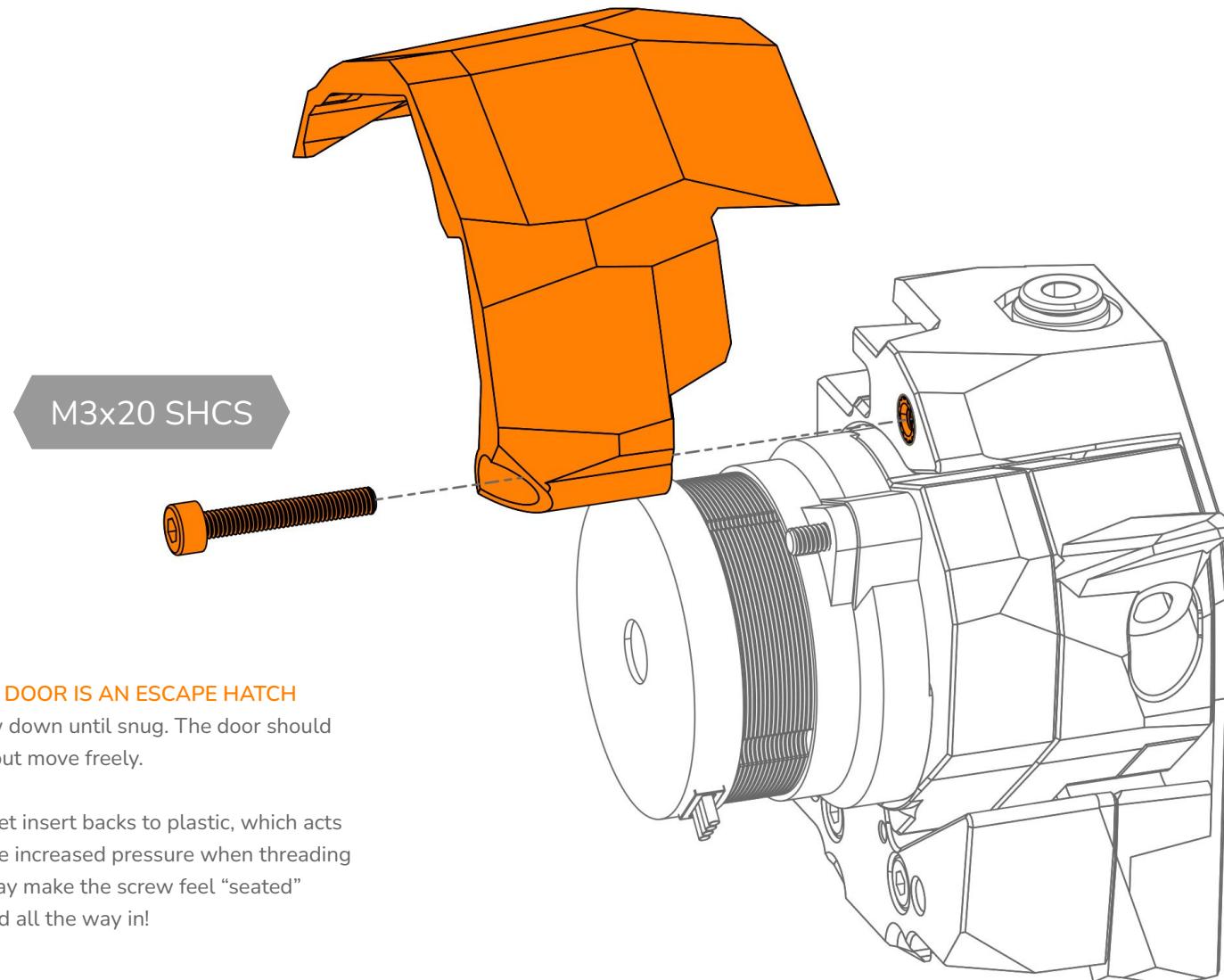


M3x20 SHCS

#### DOCKING SEQUENCE INITIATED

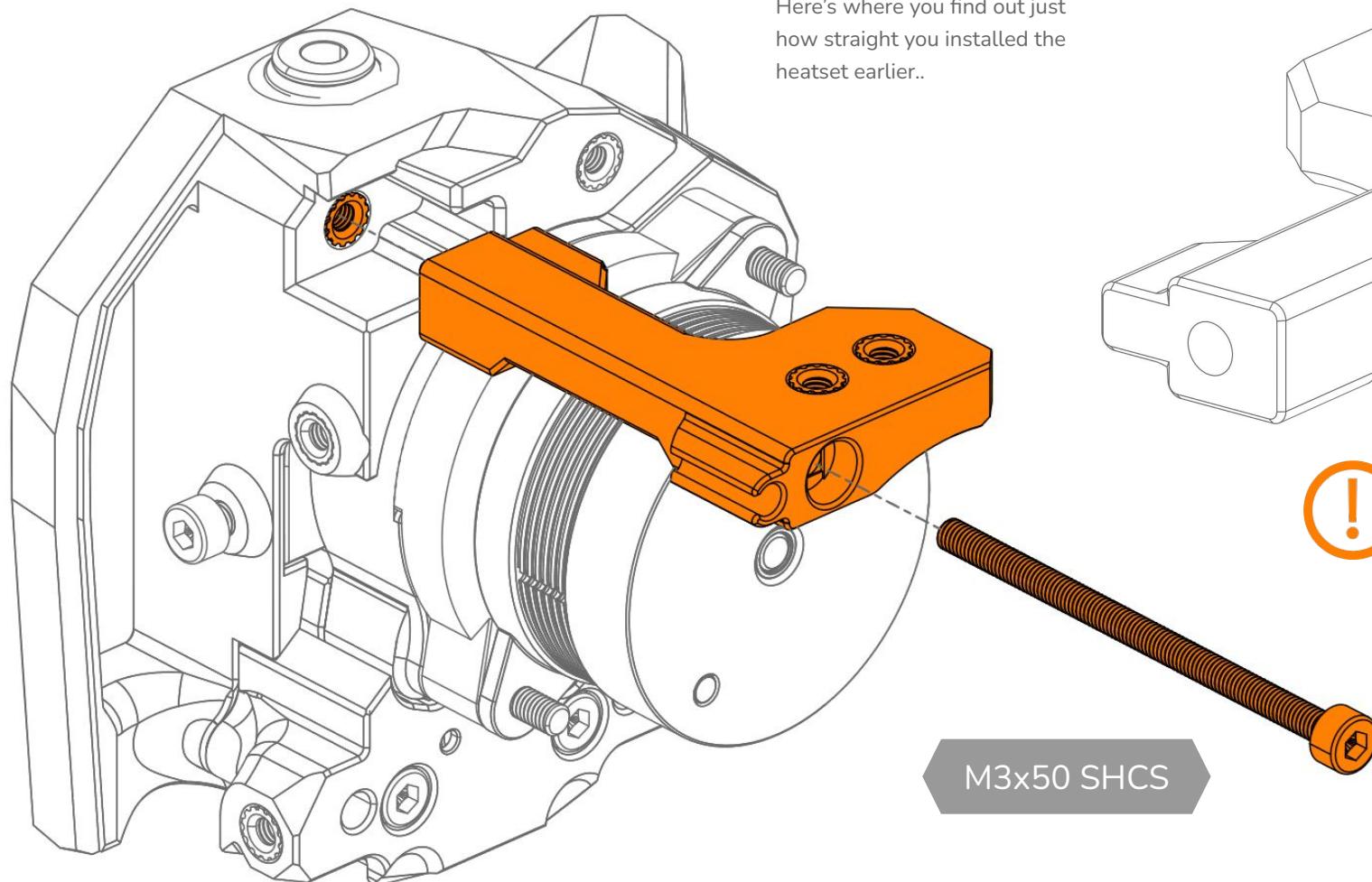
Install the rear body over the pin in the G2 Module, pressing firmly. The rear body should be completely flush with the front body when the pin in the G2 Module is properly aligned/centered. It may take a bit of force to get the G2 Module pin aligned properly and the rear body seated fully. Once seated, attach the rear body to the front body with 2x M3x20 SHCS.



**IN SPACE EVERY DOOR IS AN ESCAPE HATCH**

Tighten the screw down until snug. The door should hold itself open, but move freely.

**NOTE:** The heat set insert backs to plastic, which acts like a lock nut. The increased pressure when threading into the plastic may make the screw feel “seated” before it's screwed all the way in!

**CHAINED UP!**

Here's where you find out just how straight you installed the heatset earlier..

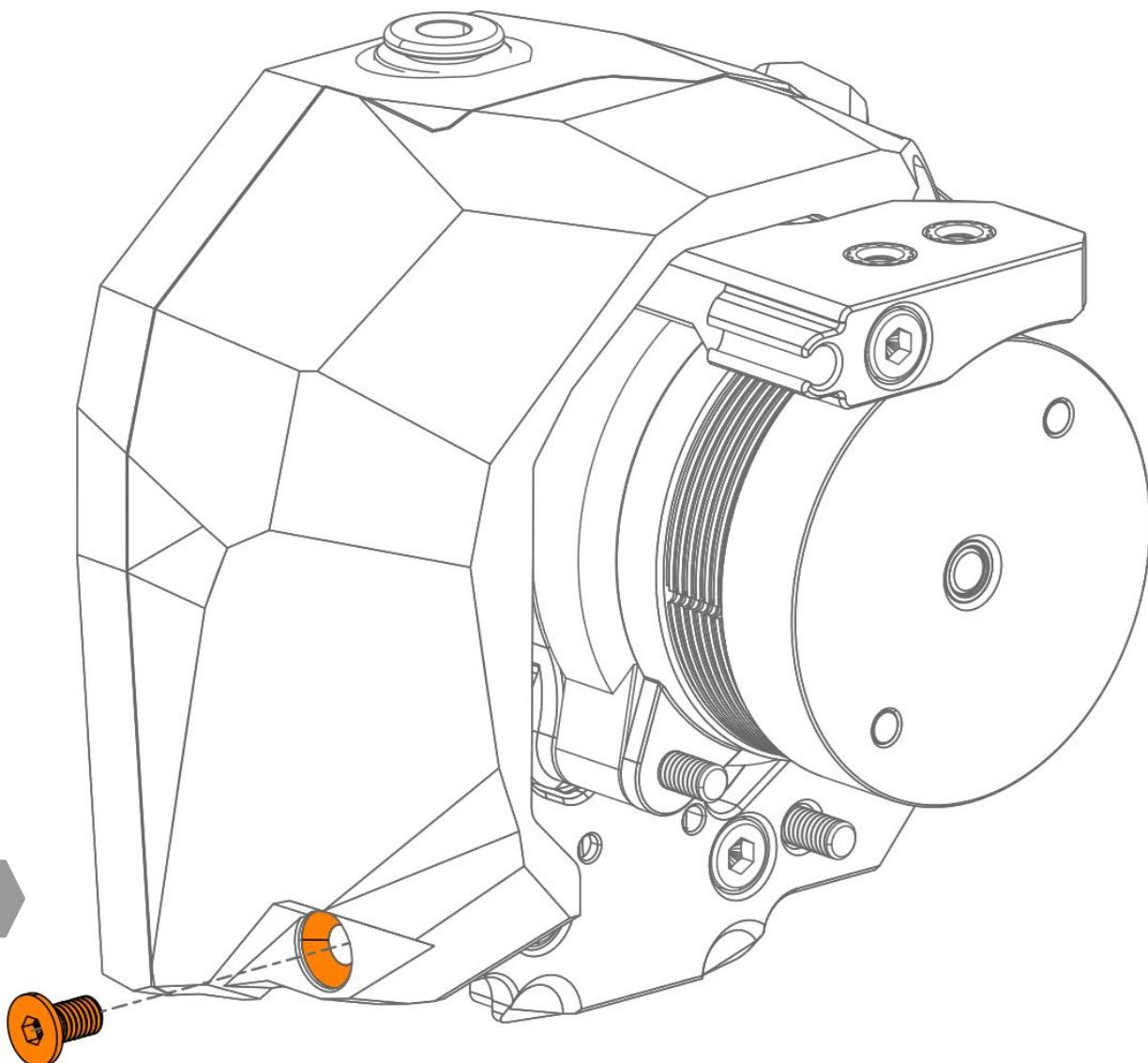


**NOTE:** Optional chamber thermistor mount is included on the chain mounts

SHUT THAT DOOR...  
YOU'LL LET THE VACUUM IN!

The wire cover gets fastened with a single M3x6 FHCS. Install it for now, but know it will need to be removed for wiring when installing the extruder to the toolhead.

M3x6 FHCS



LATCHES? WHERE WE'RE GOING,  
WE DON'T NEED LATCHES

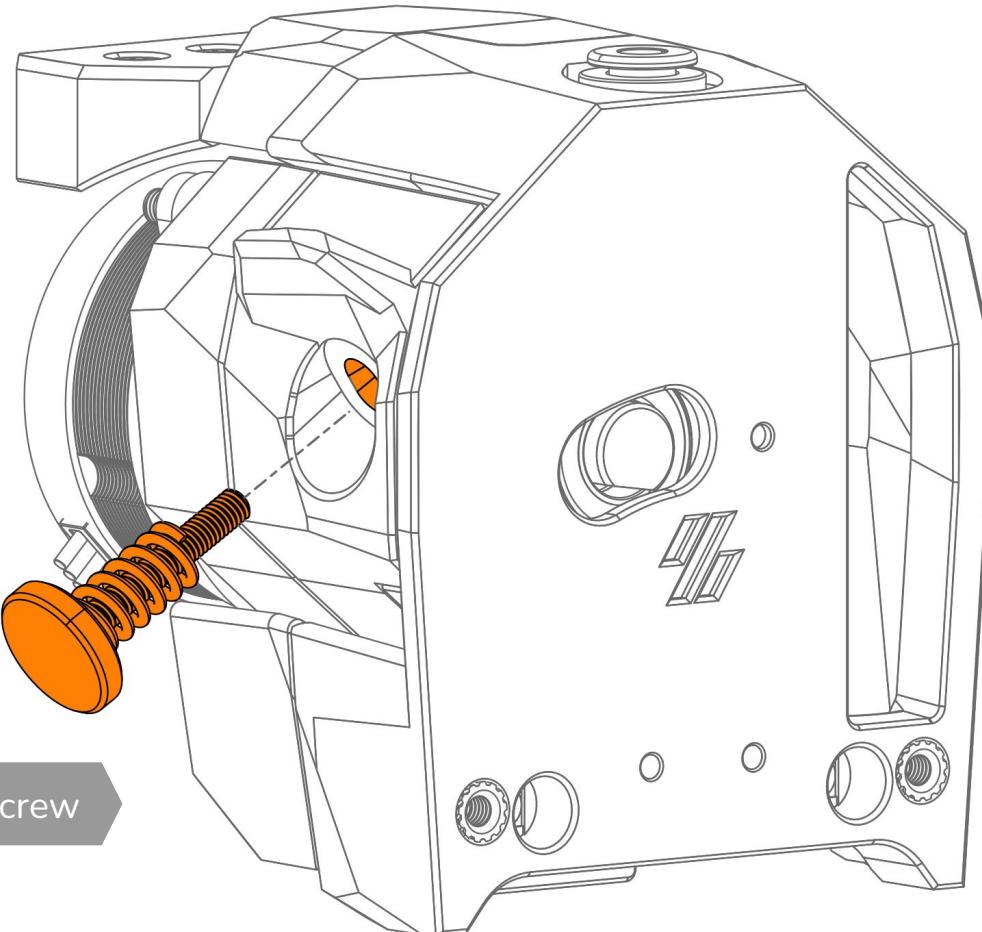
G2E does away with the latch and instead uses the M3 Thumbscrew and a finger hold to load/unload filament.

With the G2 Module fully installed, and G2E nearly complete, install the tension thumbscrew through the G2 Module and into the heatset in the Front Body.

**NOTE:** Due to the design nature of G2E, you will NOT need a lot of tension on this screw. Start with two (2) full turns IN from fully loose, then adjust while extruding as needed.

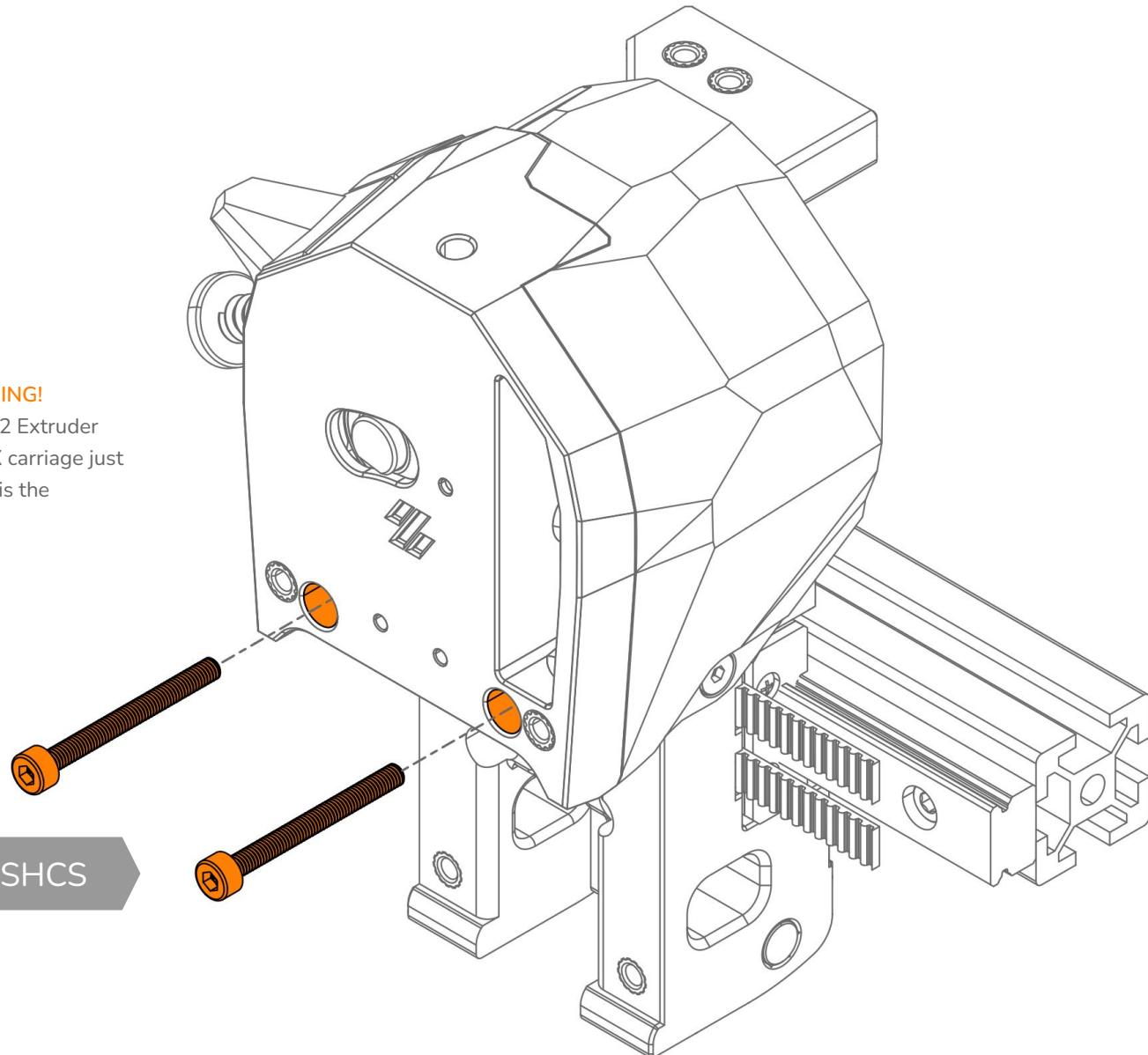
Ideally you want just enough tension to cause the extruder to skip rather than to grind filament in the event of a hotend clog.

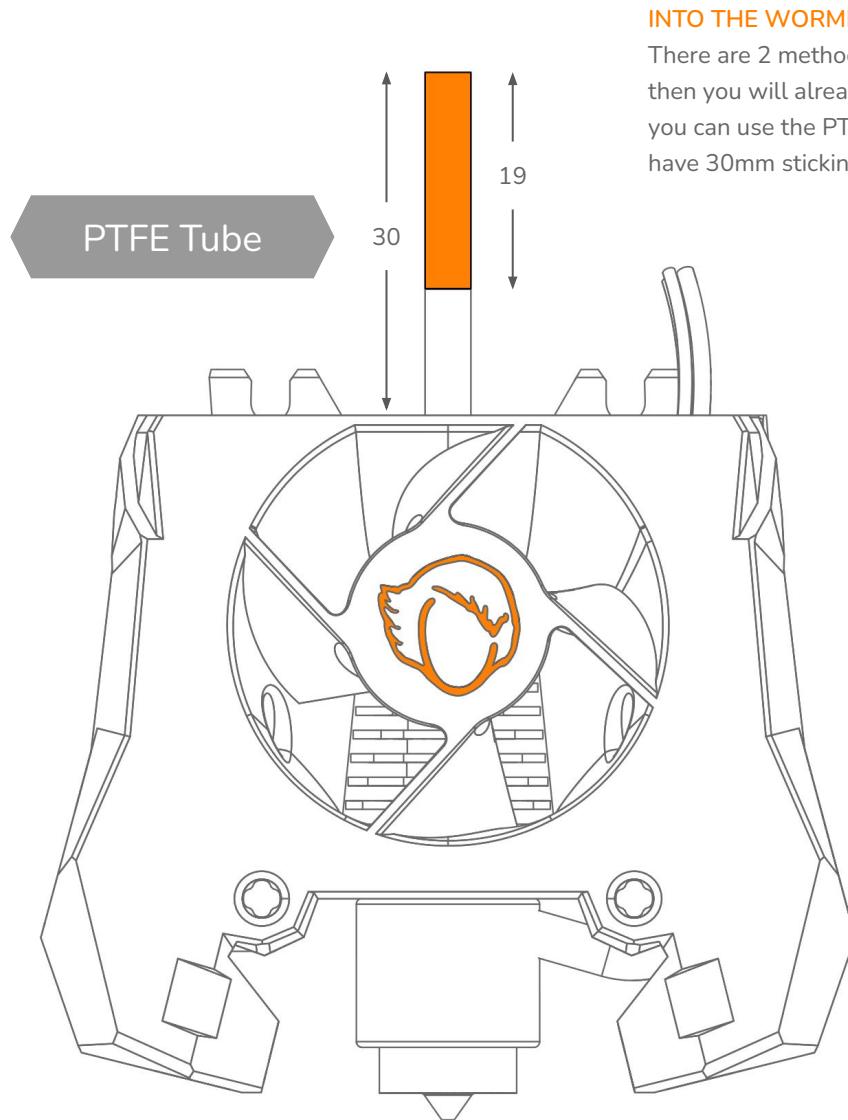
M3 Thumbscrew



**COOPER WHAT ARE YOU DOING? DOCKING!**

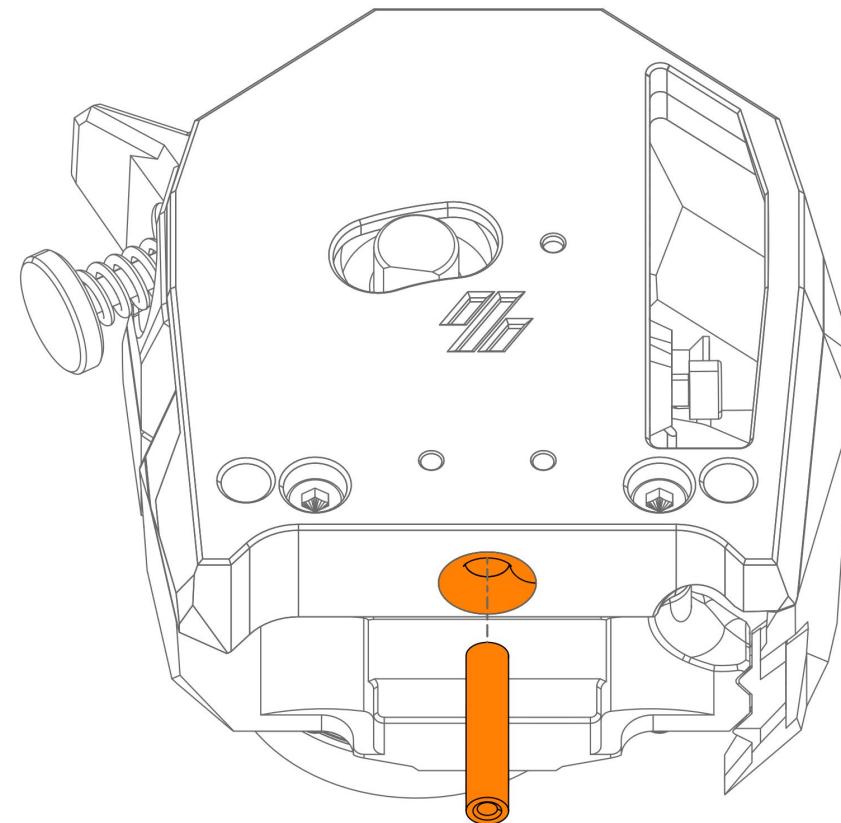
At this point it is time to install the Galileo 2 Extruder onto the X carriage. The G2 slots into the X carriage just like CW2. The only difference in mounting is the hardware used.

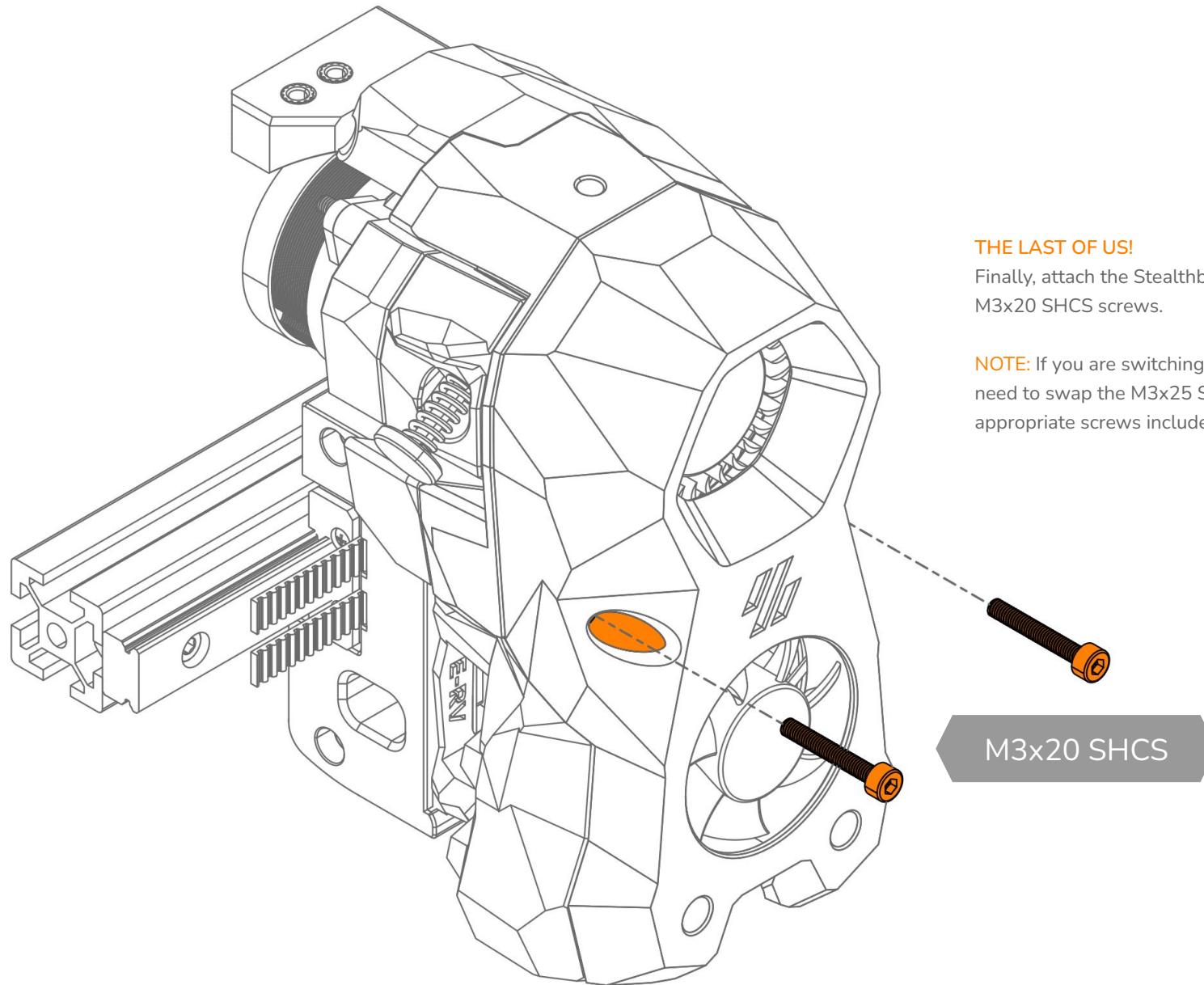




#### INTO THE WORMHOLE

There are 2 methods you can use to setup the PTFE tube. If you are swapping from CW2 then you will already have a PTFE tube you can just add to that with a new 19mm piece or you can use the PTFE cutting jig in the G2 repo and cut a new piece. The new piece should have 30mm sticking out the top of the hotend mount.



**THE LAST OF US!**

Finally, attach the Stealthburner faceplate using M3x20 SHCS screws.

**NOTE:** If you are switching from CW2, you will need to swap the M3x25 SHCS screws for the appropriate screws included with the kit.



 GALILEO 2

