



Titan Dynamics

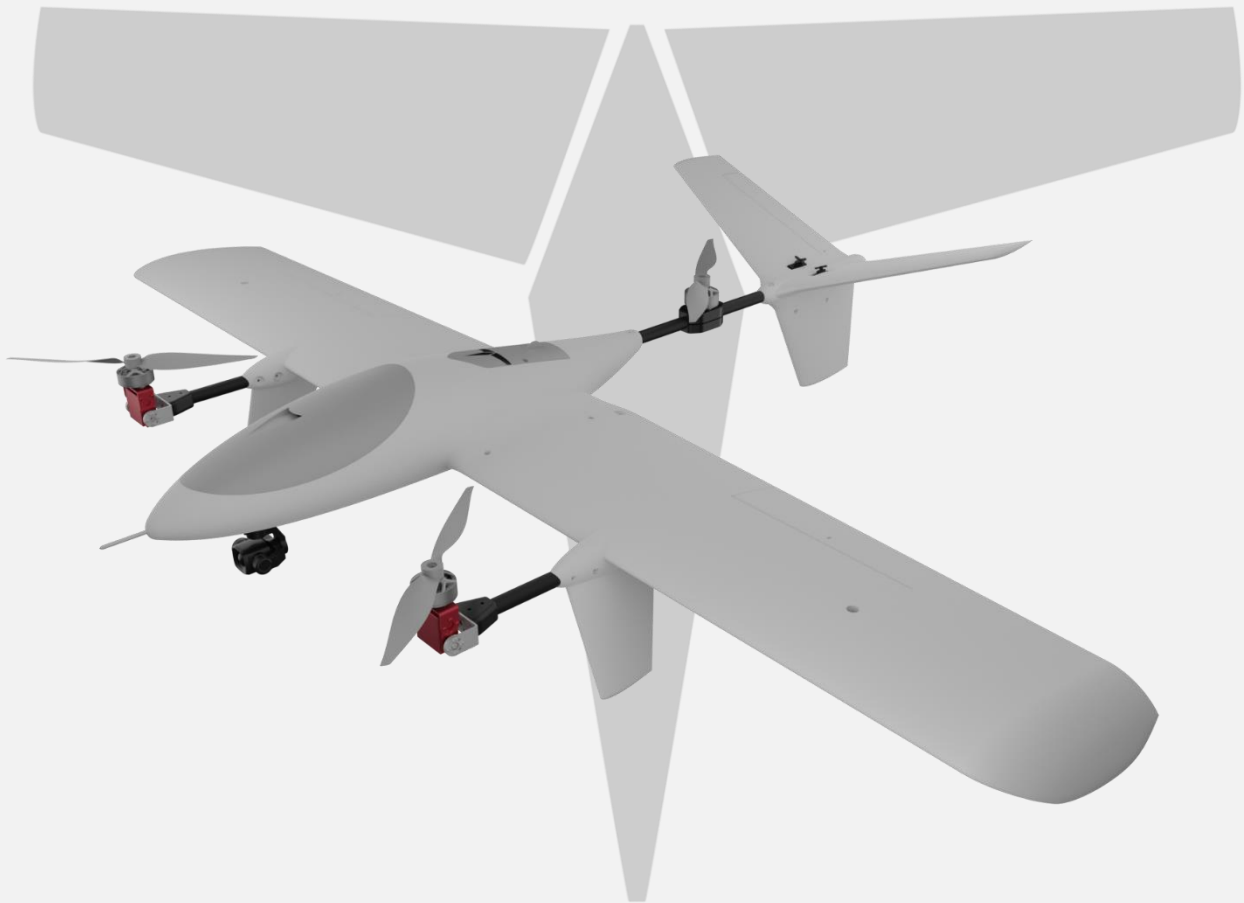
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Titan Dynamics – Viper

<https://www.titandynamics.org/3dhangar/p/titan-viper>



Build & User Manual
Revision 2.1



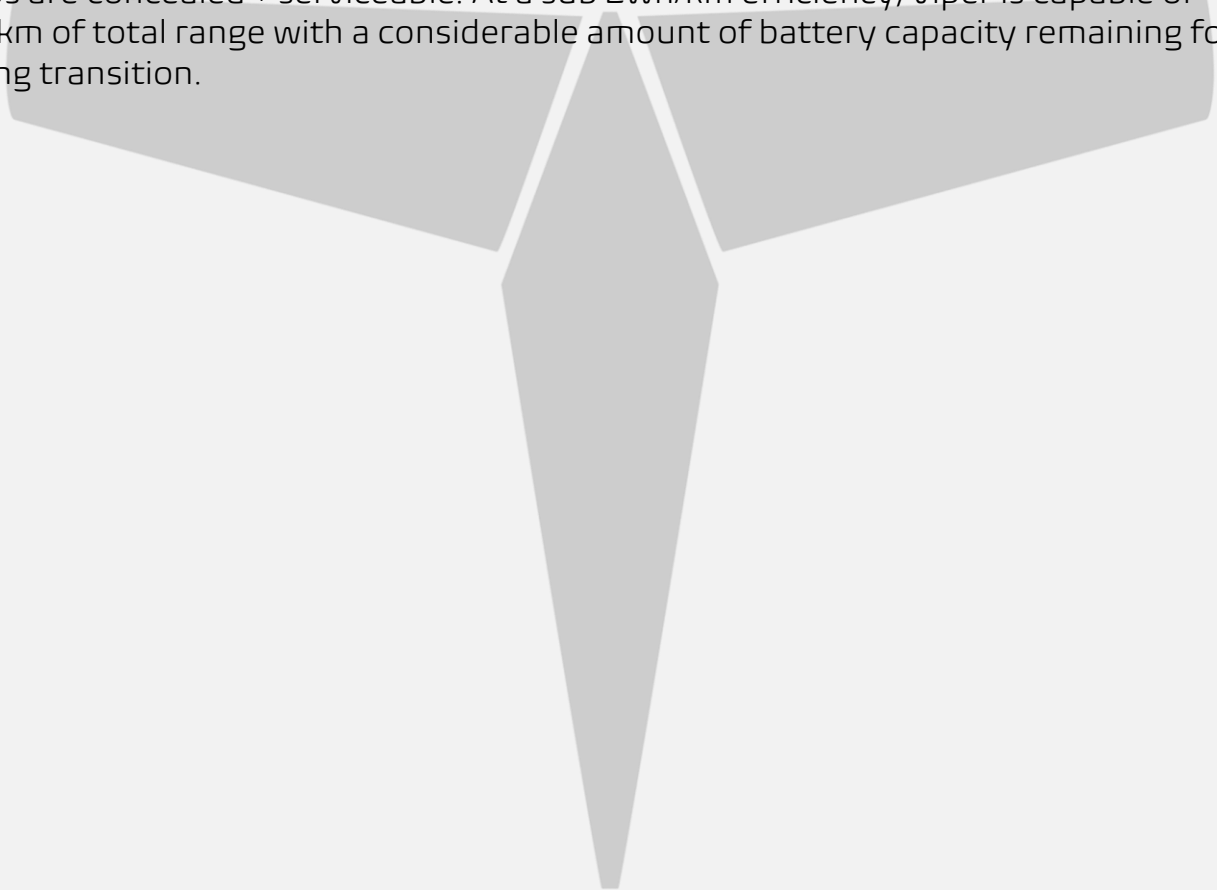
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Section 1: Model Information

Introducing the Titan Viper, a 1.6m wingspan Tri-Tiltrotor VTOL designed to carry an underslung camera system. Multiple camera mounts are included for SIYI A8, analog, analog pan, analog pan/tilt, and DJI as well as a blank for the community to mod. Incredible attention to detail has gone into making Viper lightweight yet structurally rigid, especially around the landing legs. The wings and tail are fully removable for ease of transport. It features large wing bays for mounting the VTX/RX with maximum antenna separation as well as SIYI antenna mounting points. All control surfaces feature nearly 0 gap with rounded leading edges that are sunk into the wings/stabs, and all servos are concealed + serviceable. At a sub 2wh/km efficiency, Viper is capable of 100+km of total range with a considerable amount of battery capacity remaining for landing transition.





Section 2: Model Specifications & Performance

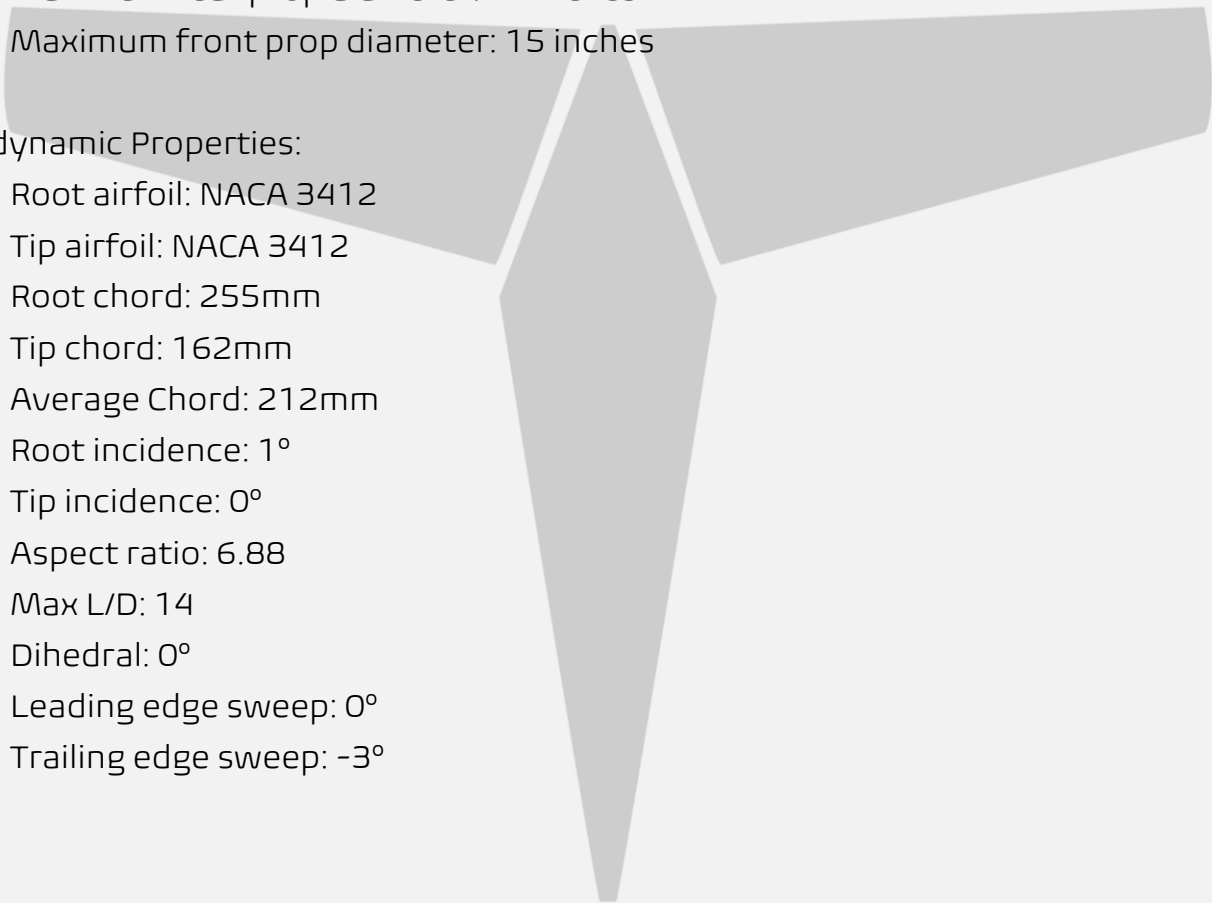
2.1: Physical Characteristics

General Stats:

- Wingspan: 1608mm
- Wing area: 3757cm²
- Maximum take-off Weight: 5.5kg
- Efficiency: 1.95 Wh/km @ 4.0kg
- Cruise speed: 45-60kph
- Maximum rear prop diameter: 15 inches
- Maximum front prop diameter: 15 inches

Aerodynamic Properties:

- Root airfoil: NACA 3412
- Tip airfoil: NACA 3412
- Root chord: 255mm
- Tip chord: 162mm
- Average Chord: 212mm
- Root incidence: 1°
- Tip incidence: 0°
- Aspect ratio: 6.88
- Max L/D: 14
- Dihedral: 0°
- Leading edge sweep: 0°
- Trailing edge sweep: -3°





2.2: Aircraft Performance:

Below are some plots showing aircraft performance at different all-up weights. **The values predicted are not perfect, and values like efficiency can vary greatly based on the choice of motor and propeller, among many other factors.** These just serve to give a rough idea of the sort of performance you can expect and give you an idea of the flight envelope of your aircraft before you fly it and help narrow in on the most efficient cruise speed. The stall speed assumes a C_{Lmax} of 1.3, and the minimum speed line is just 20% above stall speed. Below the minimum speed, a tailwind gust can cause the aircraft to stall unexpectedly, so be careful.

Using the drag plot can help figure out how much thrust you'll need in level flight at a given speed. This allows for the use of propeller data from companies like APC to choose the best propeller for the type of flying you want to do.

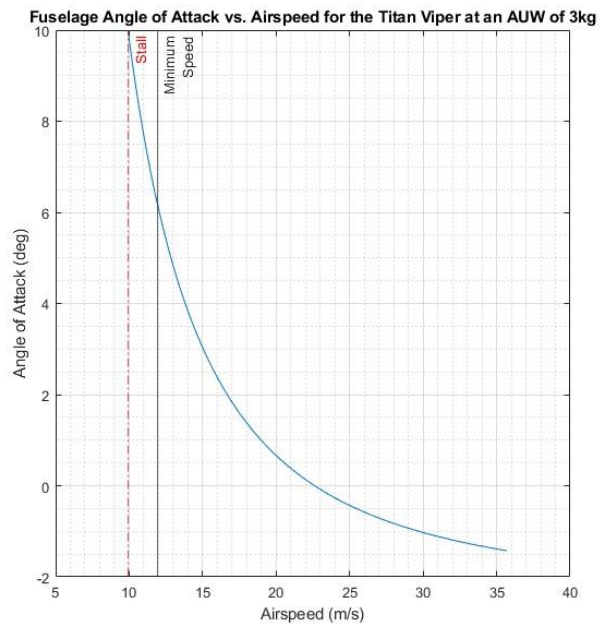
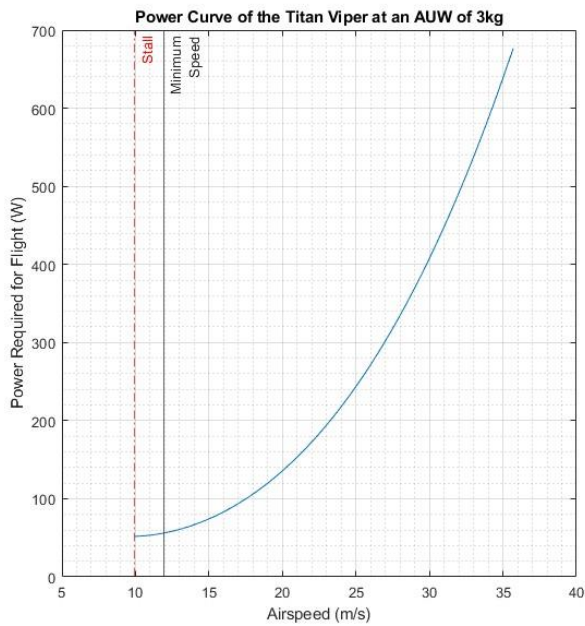
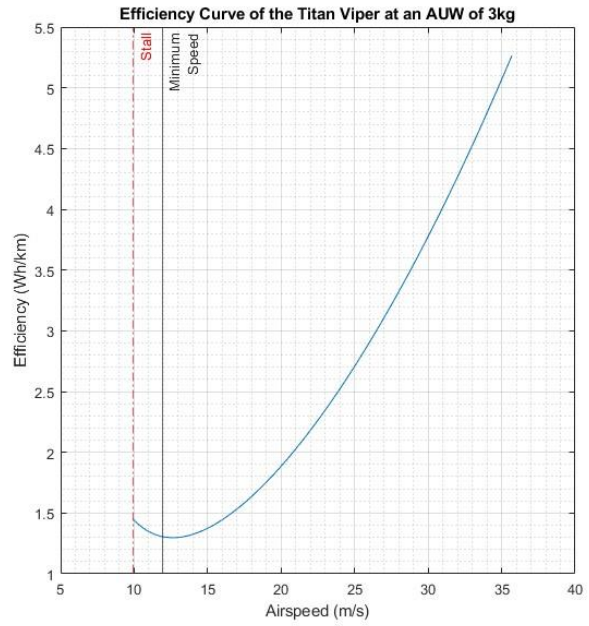
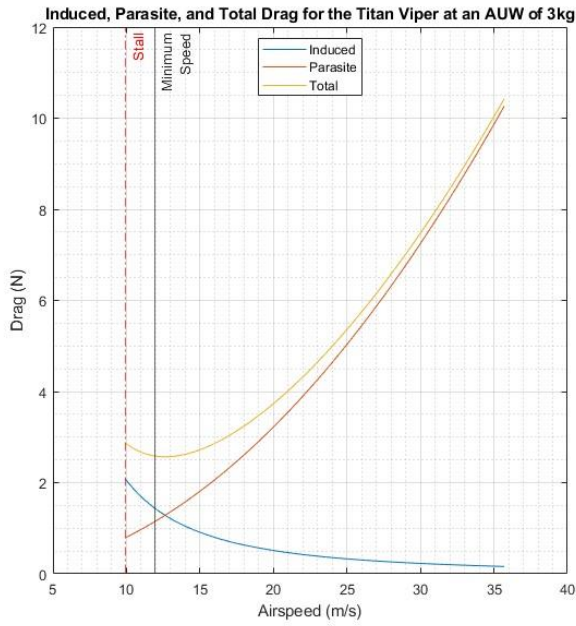
The plot depicting power required for flight can help you estimate your loiter endurance at a given speed. If you want the maximum time in the air, fly at the speed which uses the least power to stay in the air.

The efficiency plot shows you what sort of efficiency to expect at each speed. With it, it's possible to choose the best cruise speed for your setup and see how changes in that speed may affect your efficiency.

The fuselage angle of attack plot shows you what angle of attack the fuselage will be at a given speed. This can be useful when setting the TRIM_PITCH_CD parameter in Arduplane to the angle of attack value that corresponds with your cruise speed.

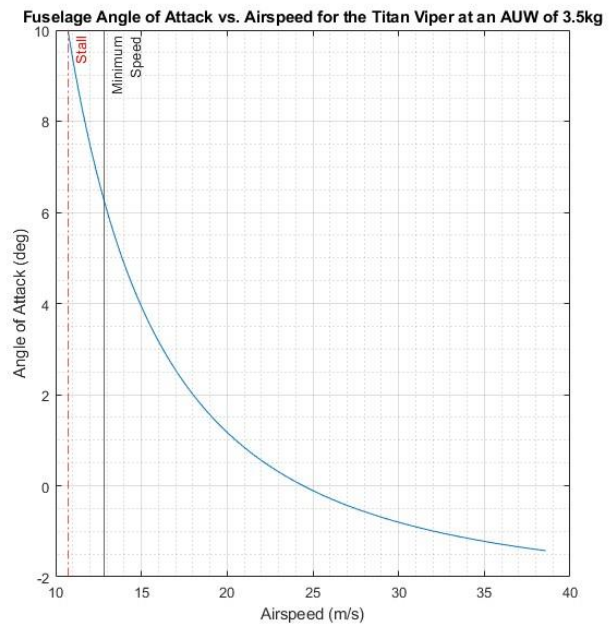
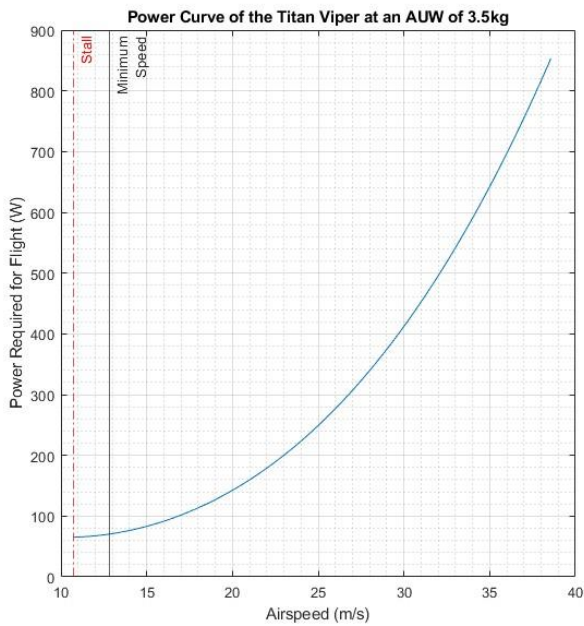
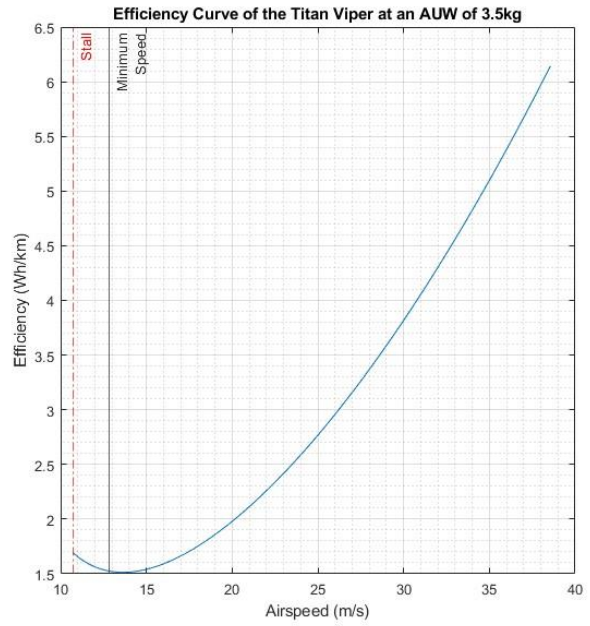
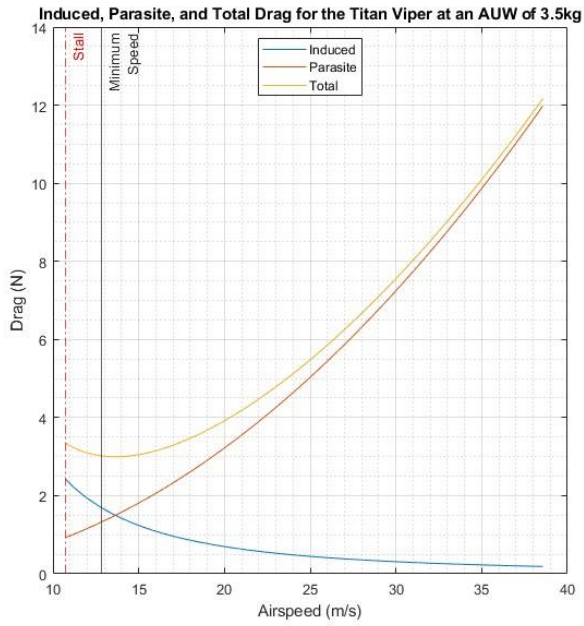


2.2.1: 3.0kg AUW



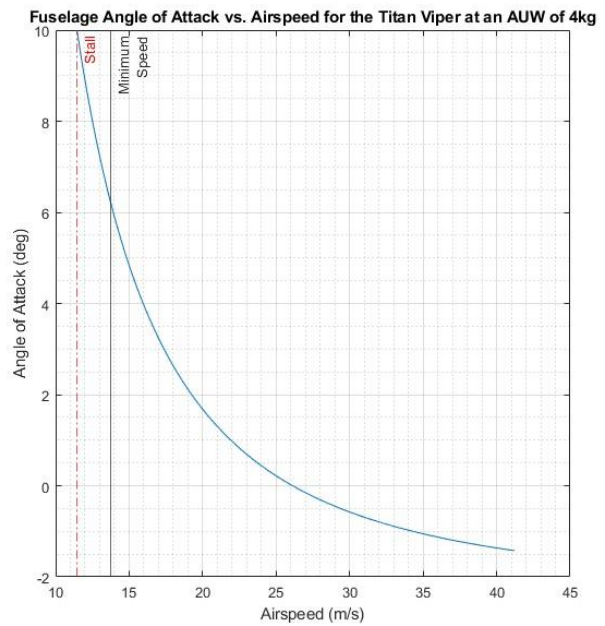
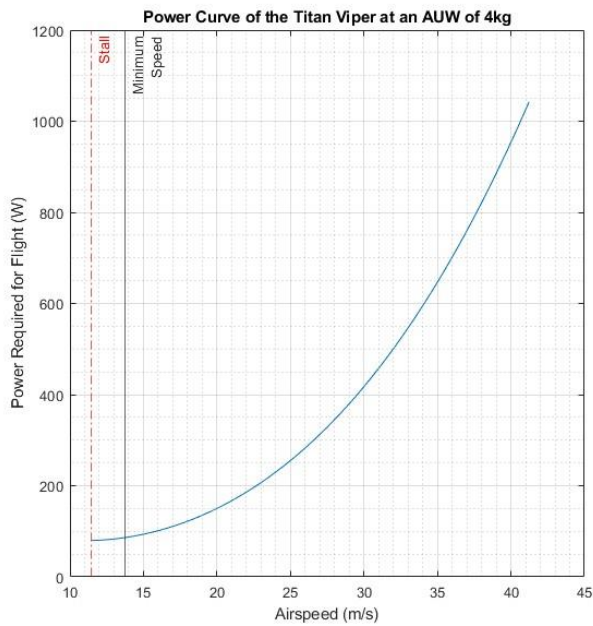
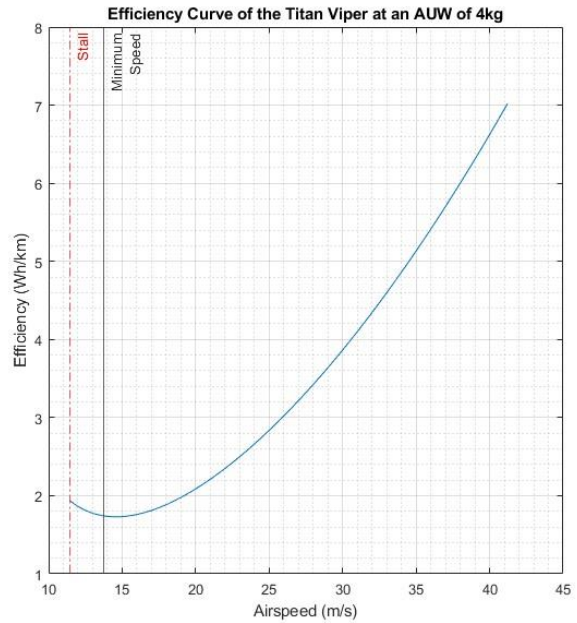
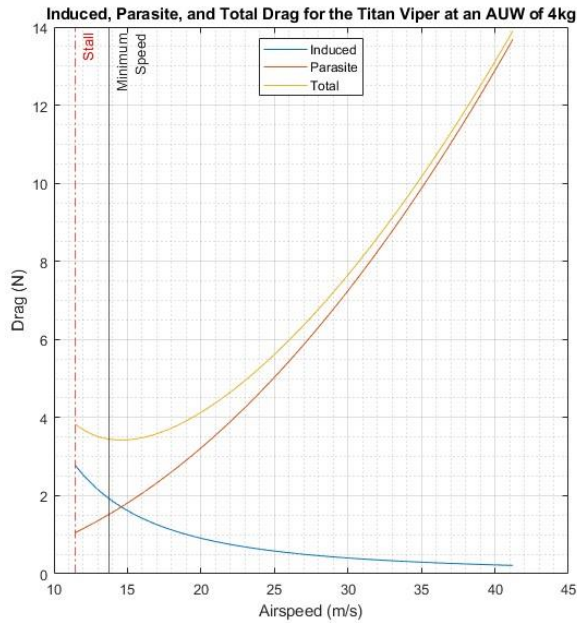


2.2.2: 3.5kg AUW



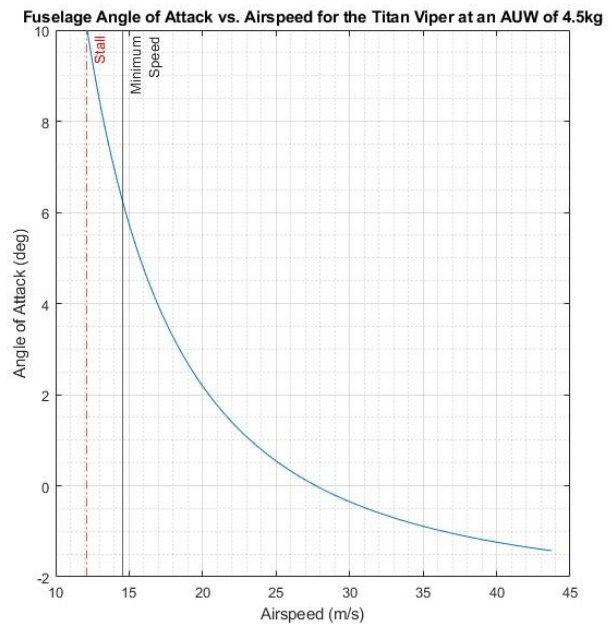
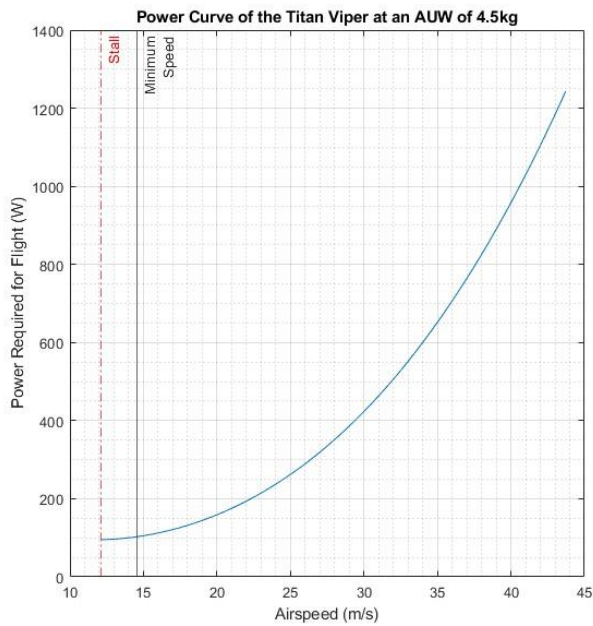
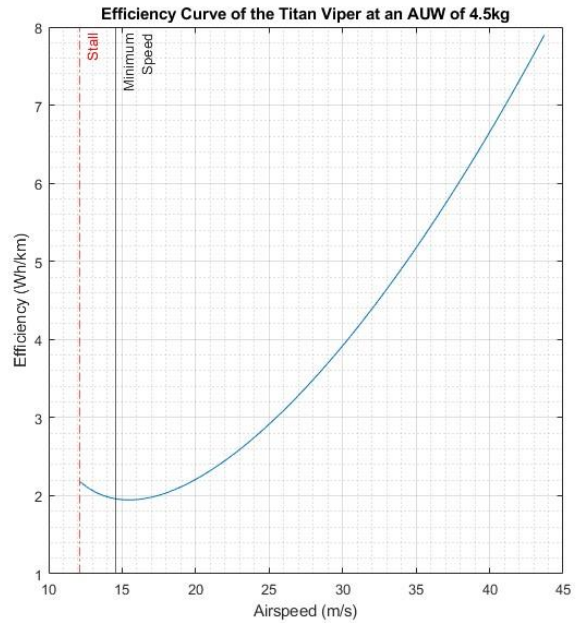
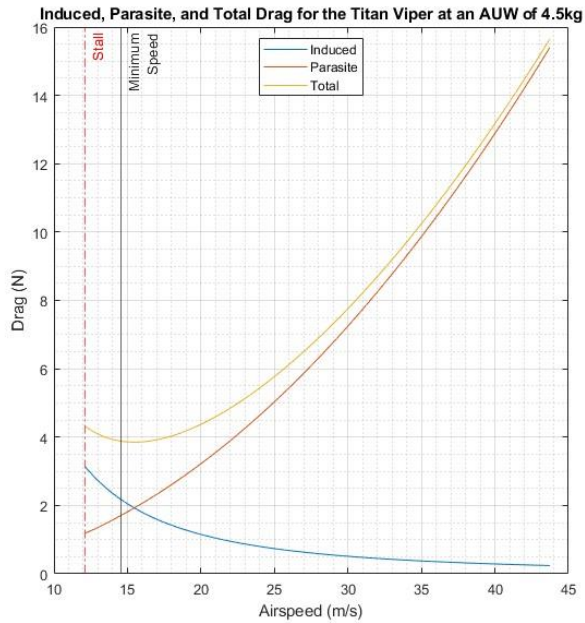


2.2.3: 4.0kg AUW



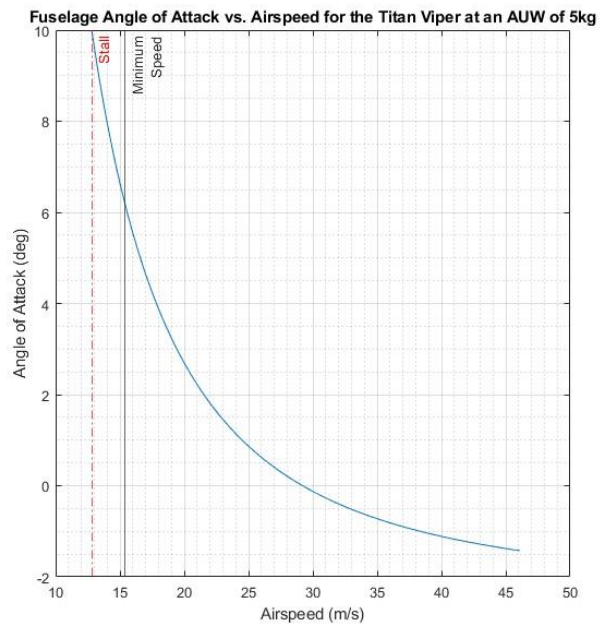
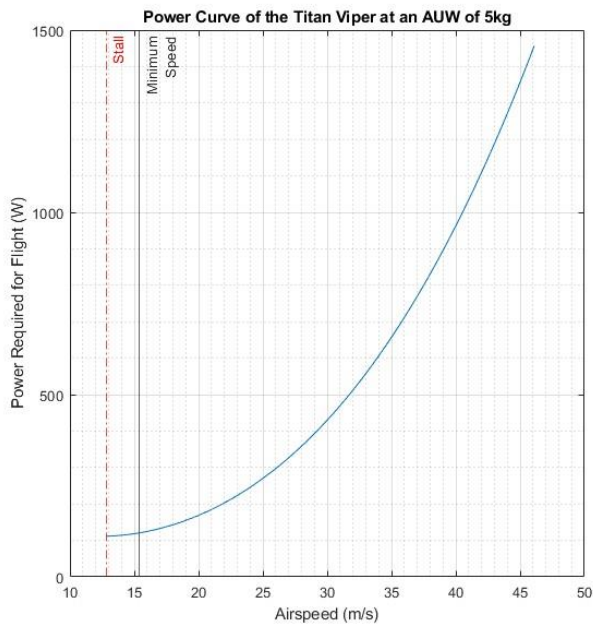
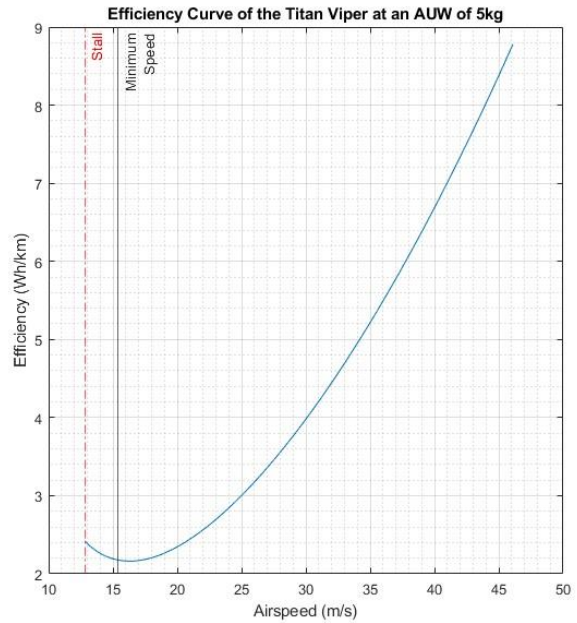
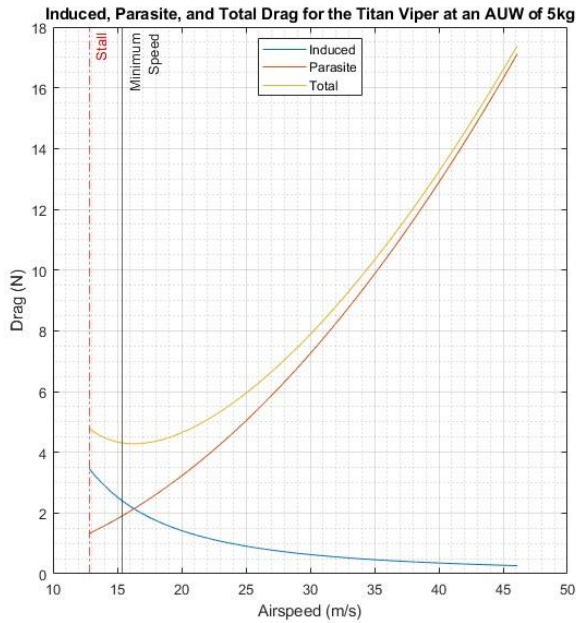


2.2.4: 4.5kg AUW



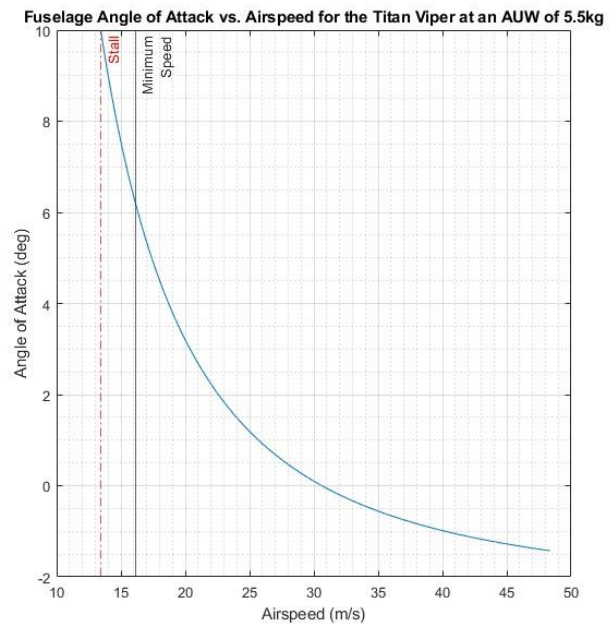
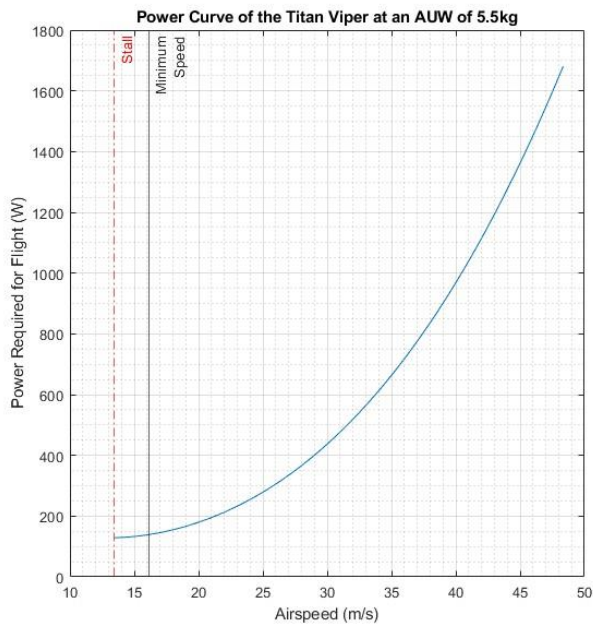
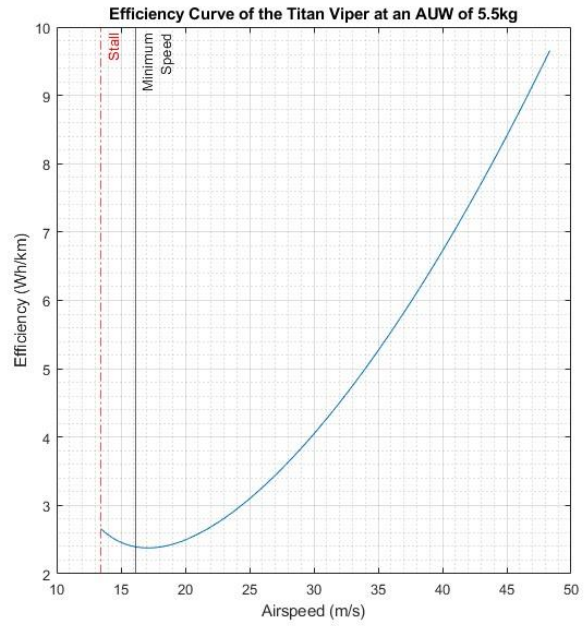
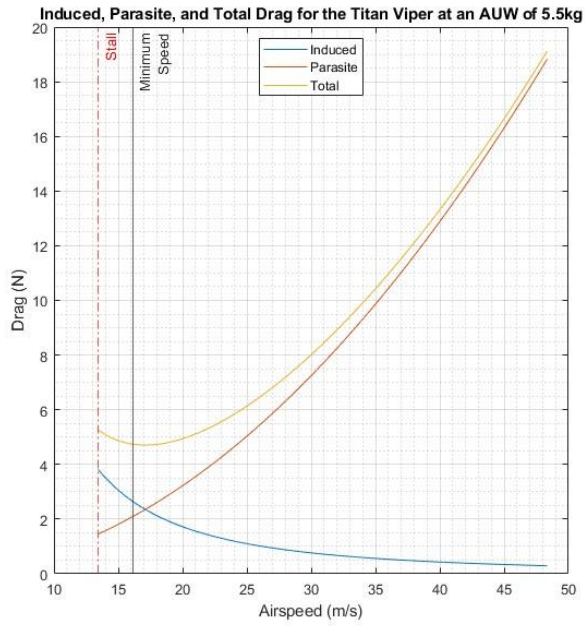


2.2.5: 5.0kg AUW





2.2.6: 5.5kg AUW





Section 3: Required Build Materials

Spars needed:

- (2) 16 OD 14 ID x 230mm - Front motor arms
- (1) 16 OD 14 ID x 600mm - Tail boom
- (2) 10 OD 8 ID x 1000mm - Main wing spars
- (2) 8 OD 6 ID x 500mm - Wing support
- (2) 4x400mm solid - Aileron hinge
- (2) 4x100mm solid - Front landing leg spar
- (4) 3x280mm solid - Tail support + ruddervator hinge
- (1) 4x140mm solid - Rear landing leg spar

Recommended motor and prop: Brotherhobby Tornado T5 3115 640kv | APC 13x8E/ APC 13x8EP - this prop is not meant to hover for long and is optimized for forward flight. If you want to hover longer use a 12x6.

Tilt Servo:

20kg Dual output servo with metal brackets. There are many variants of this, use best judgement if the exact one linked below is not available in your area.

<https://amzn.to/3UFCKbv>

<https://www.aliexpress.us/item/3256804872953262.html>





Recommended electronics:

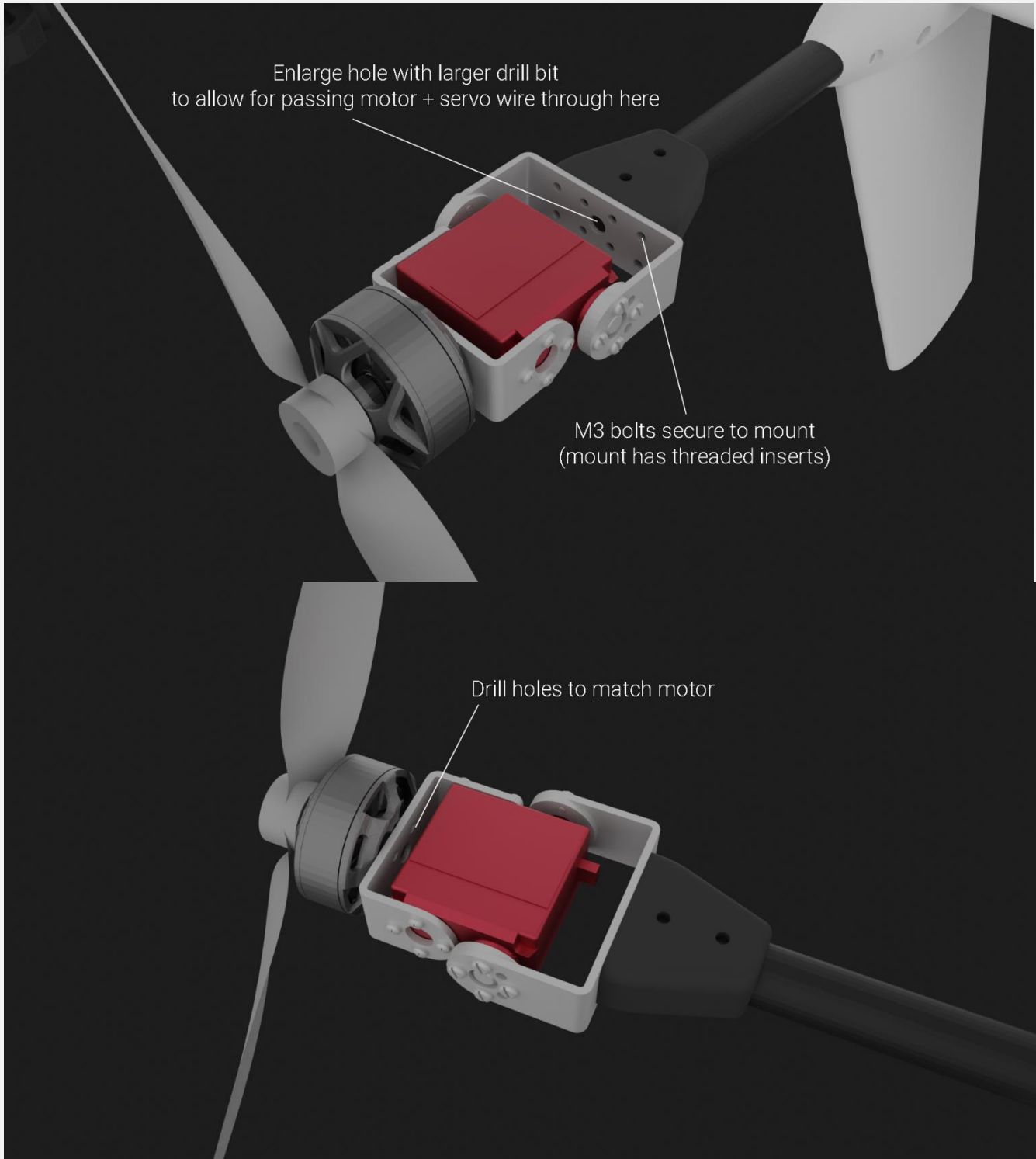
- TBS crossfire / ELRS / Dragonlink / SIYI HM30 or MK15
- 5.8ghz / 1.2ghz video / DJI / Walksnail / HDZero or an underslung gimbal such as the SIYI A8
- Matek F405-VTOL flight controller (mounts directly)
- Matek M10-5883 GPS/Compass or similar
- Tmotor 55A 4in1 ESC or 3 Lumenier 51A BLHeli_32 ESCs
- (4) Emax ES08MAII servos. 2 for ailerons, 2 for ruddervators
- Example battery for beginners: 5000mah 6S LiPo
- Example battery for max endurance: 13500mah Molicel P45B 6S3P

Misc:

- 1+ 750g rolls of Polymaker Polylite prefoamed LWPLA – It can be printed in one, but have some extra in case of reprints
- Polycarbonate, PETG or other high-temp filament for the motor mounts
- Medium CA glue for gluing printed parts together
- 220x220x250 minimum size print bed (Ender 3)
- Control horns ([this one](#))
- M3 threaded inserts (max 6mm height)
- M3 bolts of various sizes and locknuts
- (4) 6x3mm magnets



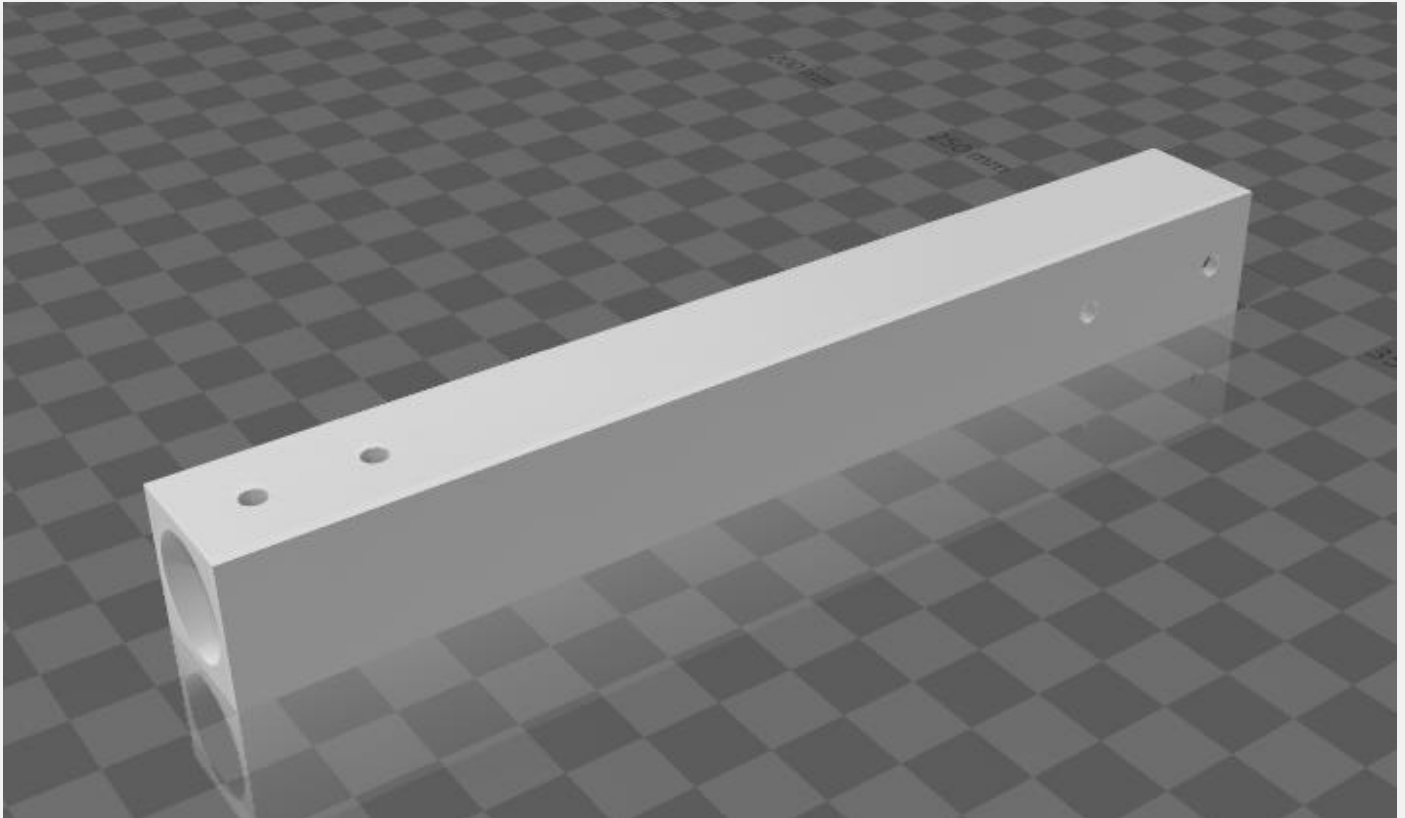
Tilt Servo Mounting:





Drilling the 16mm spar for the arms:

Print the `nacelle_drilling_jig.stl` out of any material, and use it as a guide to drill the spars for the arms in this orientation where the top/bottom holes face forward. This is where the tilt servo mount will be bolted to. Print this part upright (tall) to ensure good fitment of the spar. Push the spar into this part and drill the holes through it. An M3 bolt goes through each hole, and a locknut goes on the other end to retain it.

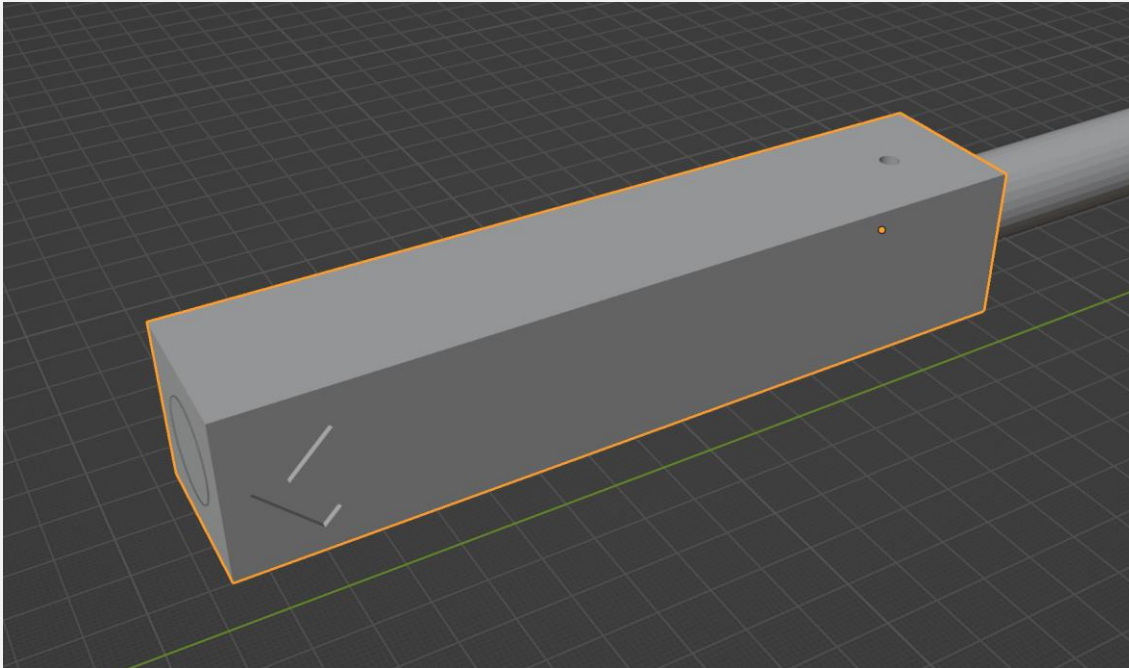




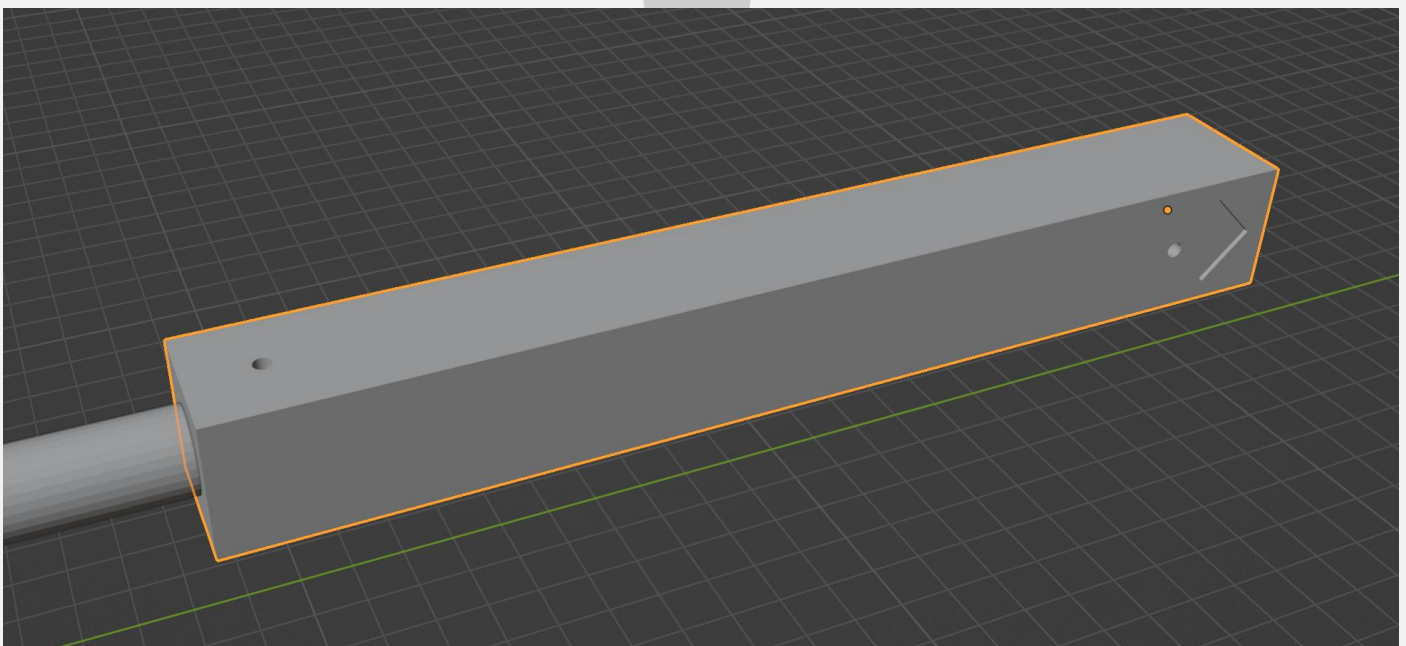
Drilling the tail boom:

Use both jigs below in unison to lay the tail boom (spar) on a flat table and drill holes into it. Be sure that either jig does not move as you're drilling. Use tape or glue to secure them to the boom temporarily.

Use tail_drilling_jig_a.stl as a guide to drill the front of the tail boom. The arrow on the jig should point towards the nose of the aircraft. This will align the hole towards the rear of the jig with exactly where it needs to be drilled out.



Use tail_drilling_jig_b.stl as a guide to drill the rear of the tail boom where the actual tail with the stabilizers and leg mounts. The arrow on this jig should point to the very rear of the of the aircraft. Use the holes in this jig to drill the necessary holes to mount the tail.





Section 4: 3D printing

4.1: Things to know before you start printing.

1. Titan Dynamics strongly recommends using Polymaker PolyLite prefoamed LWPLA for the best results. This filament is much easier to tune your printer for and has less stringing than active foaming filaments.
2. You likely will not get good results unless your printer is well maintained and calibrated, we would suggest learning how to check and adjust your printer to perform at its absolute best before starting. This website has useful guides: <https://teachingtecht.github.io/calibration.html#intro>.
3. All the below guidance should be taken as a starting point only. Print a test piece and check things like retraction settings and fitment of the carbon rods in the wings for yourself as every printer is different. If the carbon rods are too tight, increase the "Hole Horizontal Expansion" setting in Cura (or the equivalent setting in other slicers).
4. All our models are designed to be printed predominantly in LW-PLA filament. All fuselage, tail, and wing parts should be printed in LW-PLA.

There are 3 levels of infill / wall settings that we recommend for the LWPLA parts:

1. Maximum efficiency: 3% cubic subdivision, single wall
2. Balanced efficiency and strength: 5% cubic subdivision, single wall
3. Maximum strength: 8% cubic subdivision, single wall

Notes:

- For the best flight characteristics and maximum range, LWPLA parts should be printed with single wall and 3% cubic subdivision infill.
- Cubic subdivision infill can be increased to 5 or 8% to increase durability, but this will have an impact on maximum payload capacity (battery), and range by extension. We recommend and use 3% cubic subdivision infill as it has been tested to survive 6.4G in flight, but some may desire greater general durability when handling/carrying the model around etc. It will still break if you crash it!
- Because the fuselage takes the most abuse during landings, some may choose to just print the fuselage sections in higher infill. Using a higher infill just for the fuselage (4%-8%) can greatly increase the longevity of the plane without as much of a weight penalty as printing the entire plane in high infill.

Polycarbonate, PETG or other high-temp filament should be used for the motor nacelle caps and wing bay covers.

- High temp Polycarbonate or PETG parts should be double wall and high infill (25%).

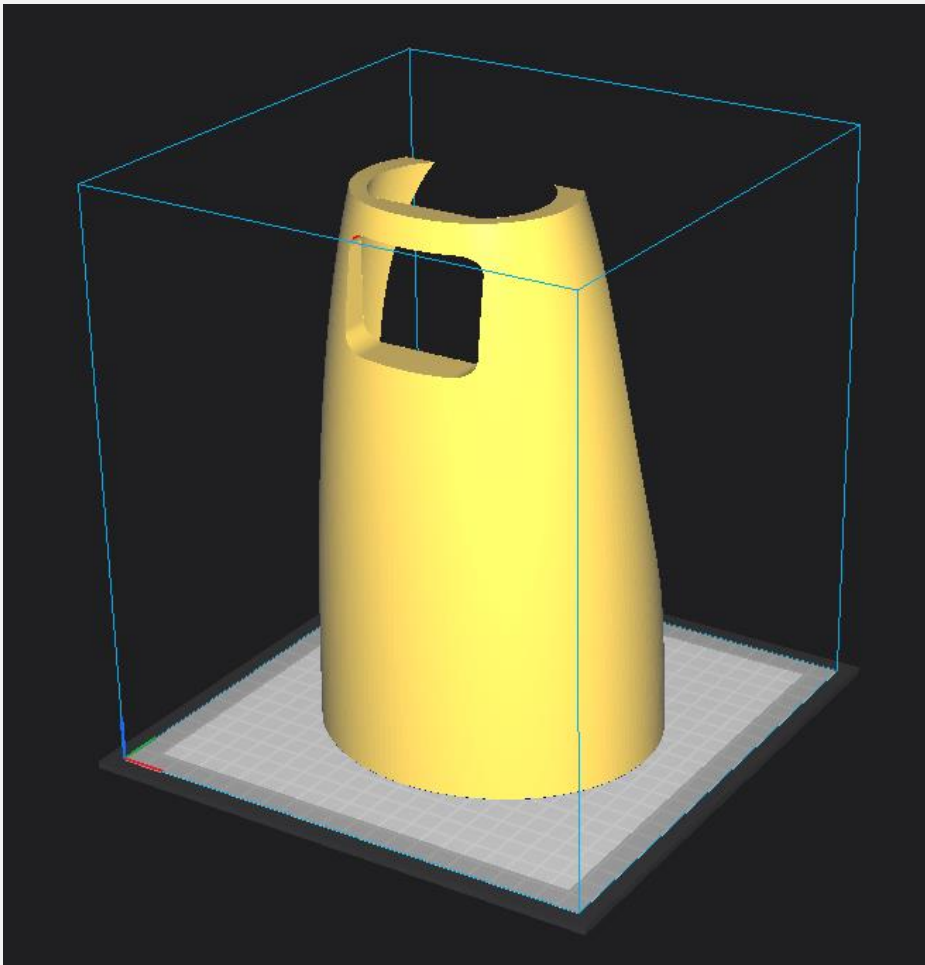
We recommend using the newest version of Ultimaker Cura. [This link](#) can be used to download our own slicer profile.

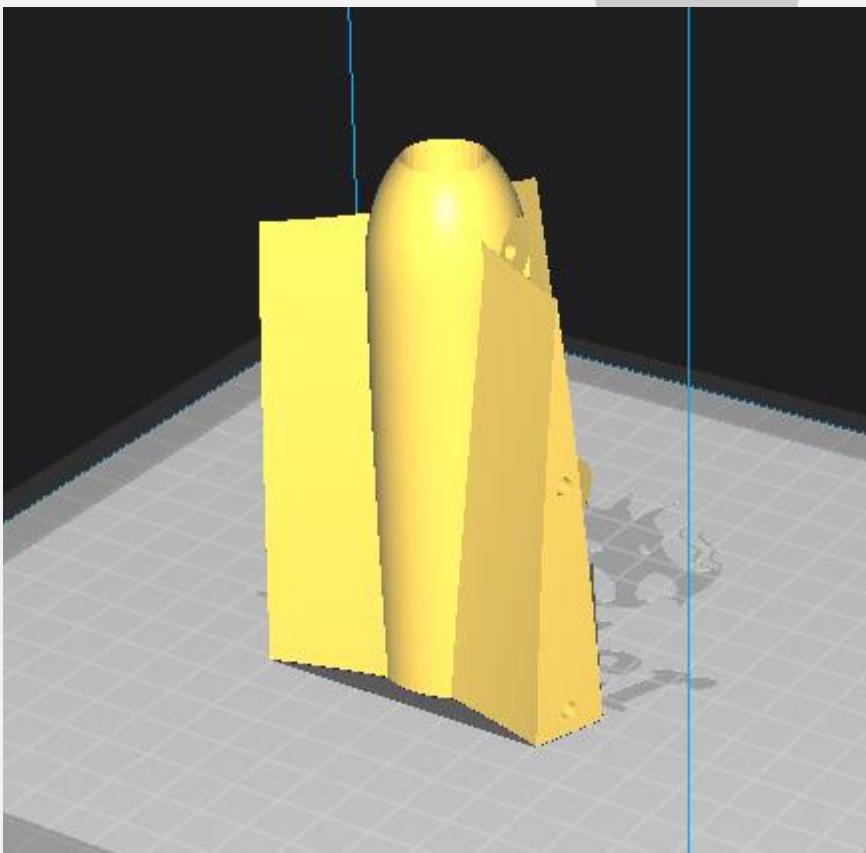
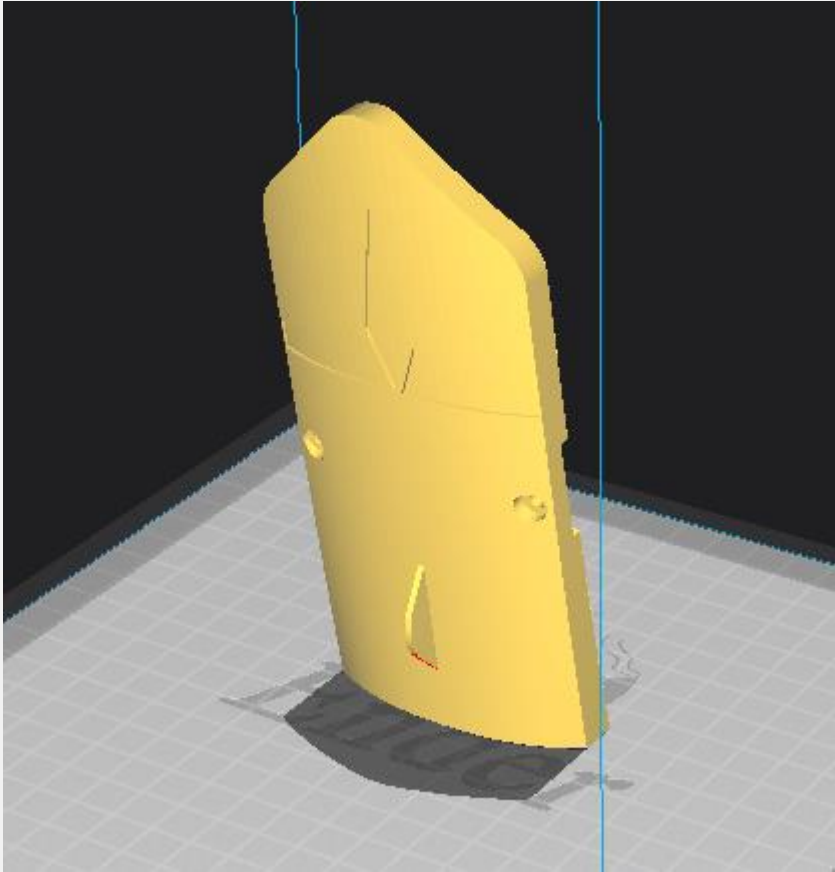


4.2: Part Orientation

It is necessary to orient each part correctly on the build plate to avoid disconnected overhangs. Take care when doing this as the entire model is designed to be printed with no supports. If you orient some parts wrong, the print will fail. It may also be necessary to rotate and carefully position some parts to fit within the build area on smaller printers.

Examples for part orientation:





4.3: Tuning “hole horizontal expansion”

It is very important to check the fitment of the carbon rods in their holes on the first parts you print. Because everyone may be using different printers, materials and slicer



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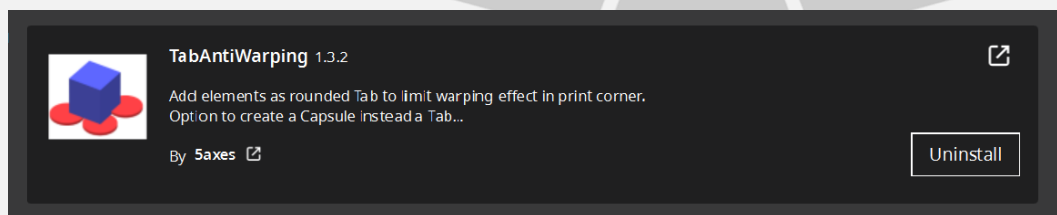
settings, it is not possible to provide the models with a slicing profile and hole size that will work for everyone.

Print your first part with carbon spar hole and check fitment, if it is too tight increase the hole horizontal expansion setting in the "walls" section in Cura (or your slicer's similar setting). A good starting point is 0.25mm. If it is too loose, just decrease the setting until you can reliably push the rods in and still get a snug fit.

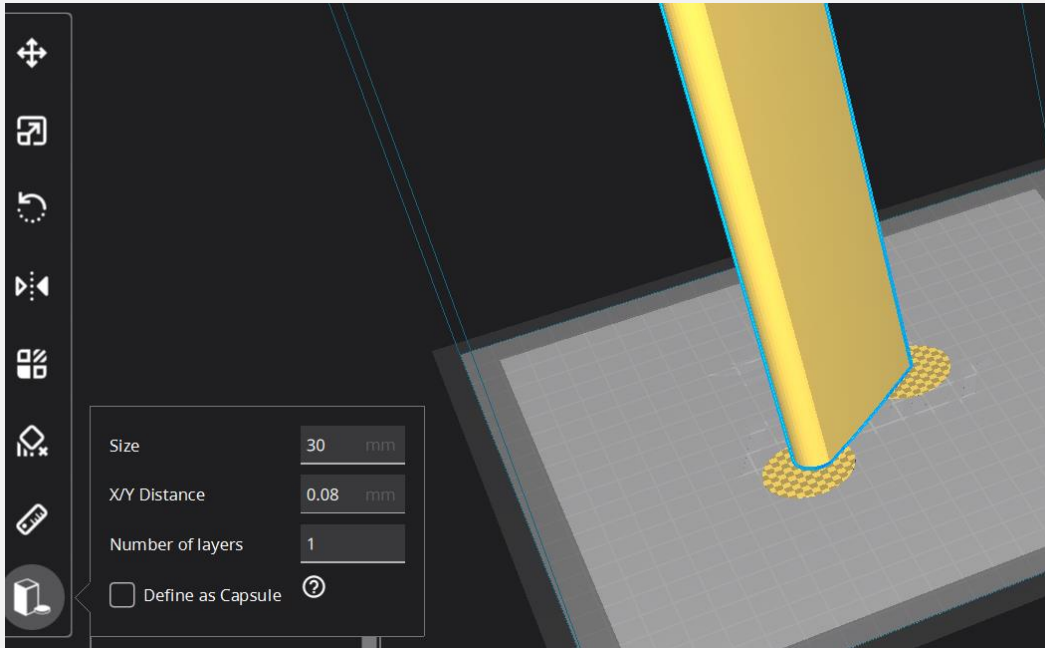
4.4: Bed Adhesion and warping

When printing tall parts like this model requires, having good print adhesion to the bed is a necessity. Ideally you will print each part without any extra aids, however this may not be possible for many, especially those printing without an enclosure for their printer. A full brim can be used but this will typically have mixed results. If it works for you, use a glue stick on the print surface to improve adhesion. Cura also has a plugin that can be used to help with bed adhesion and to avoid warping.

Cura Marketplace: TabAntiWarping Plugin.



When installed, use the new icon at the bottom of the left menu to choose tab diameter and thickness, then click on the model to add a tab at each point you think is at risk of warping or poor adhesion (typically parts with low surface area in contact with the print surface in relation to their height). These new tabs can now be moved around to fine tune their position using the normal move controls on Cura.



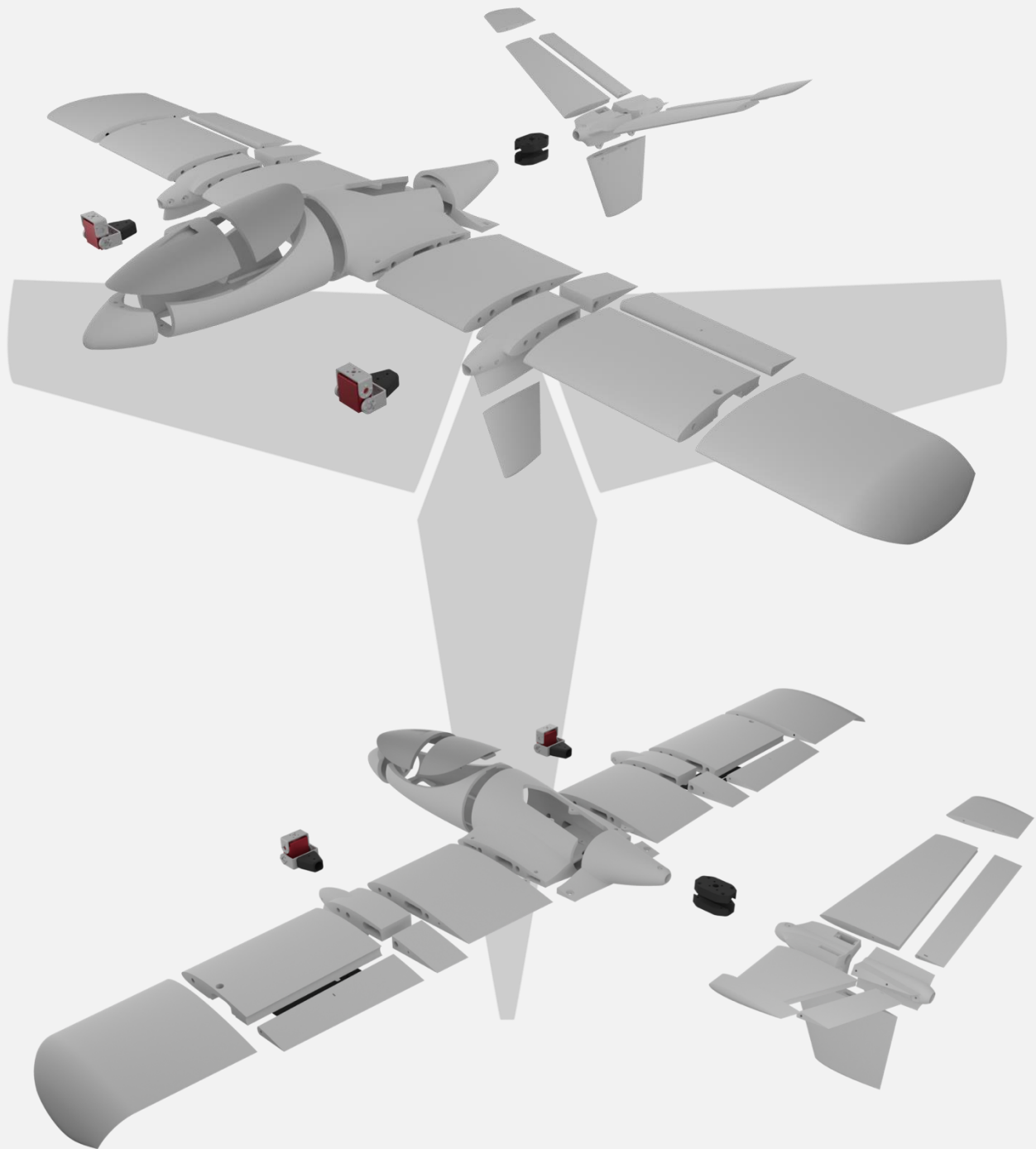
Once completed, be careful when removing these tabs from the print as they are quite strong and can damage the bottom of your part if not removed carefully. Re-open any holes the tab may have filled on the bottom of the print.

If you find these hard to remove from the print bed, select the “Define as Capsule” option. This makes the edge of the tabs raised, so you can get a scraper underneath them.



Section 5: Assembly of 3D Printed Parts

Below are a few exploded views of the Viper to help with assembly.



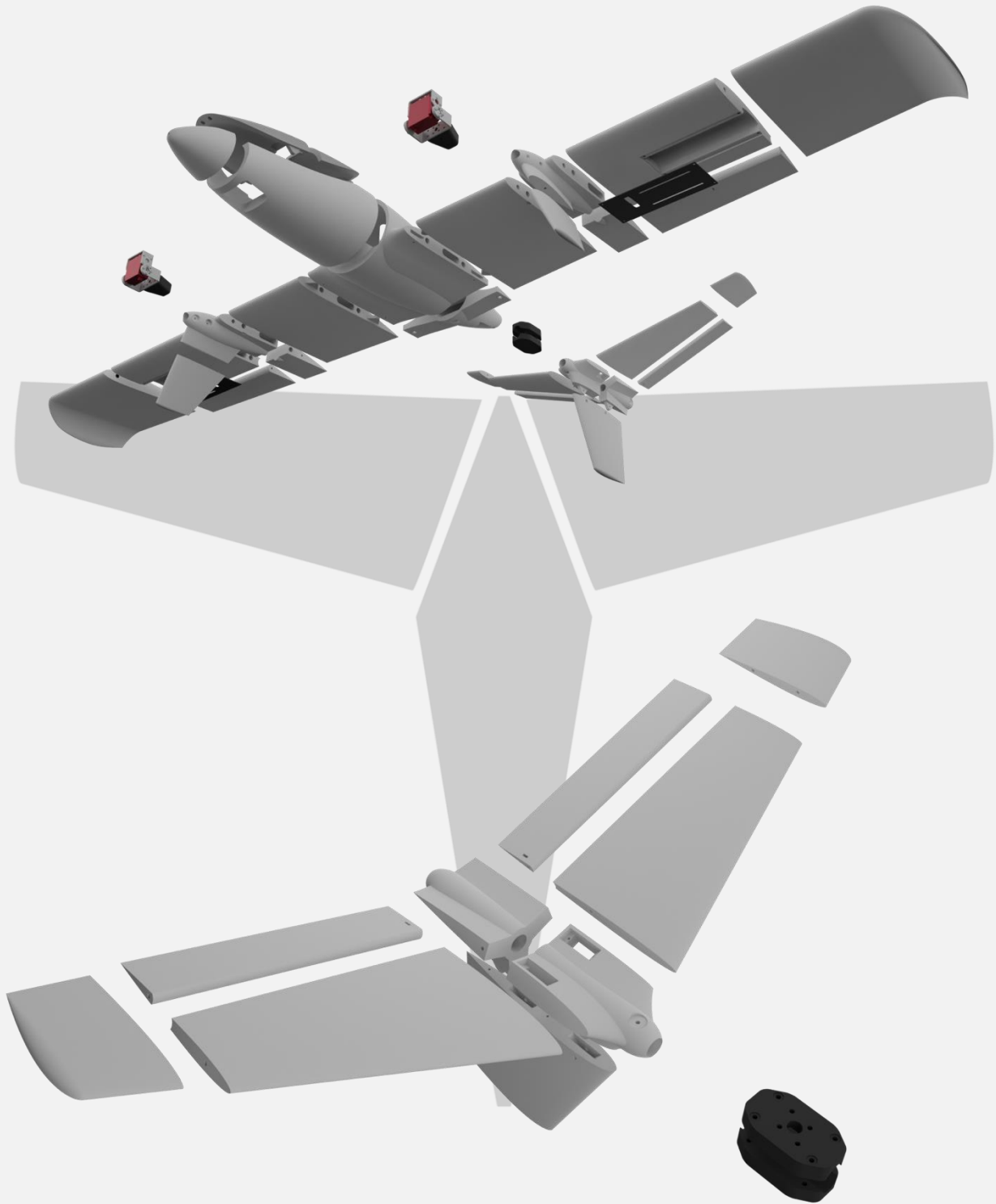


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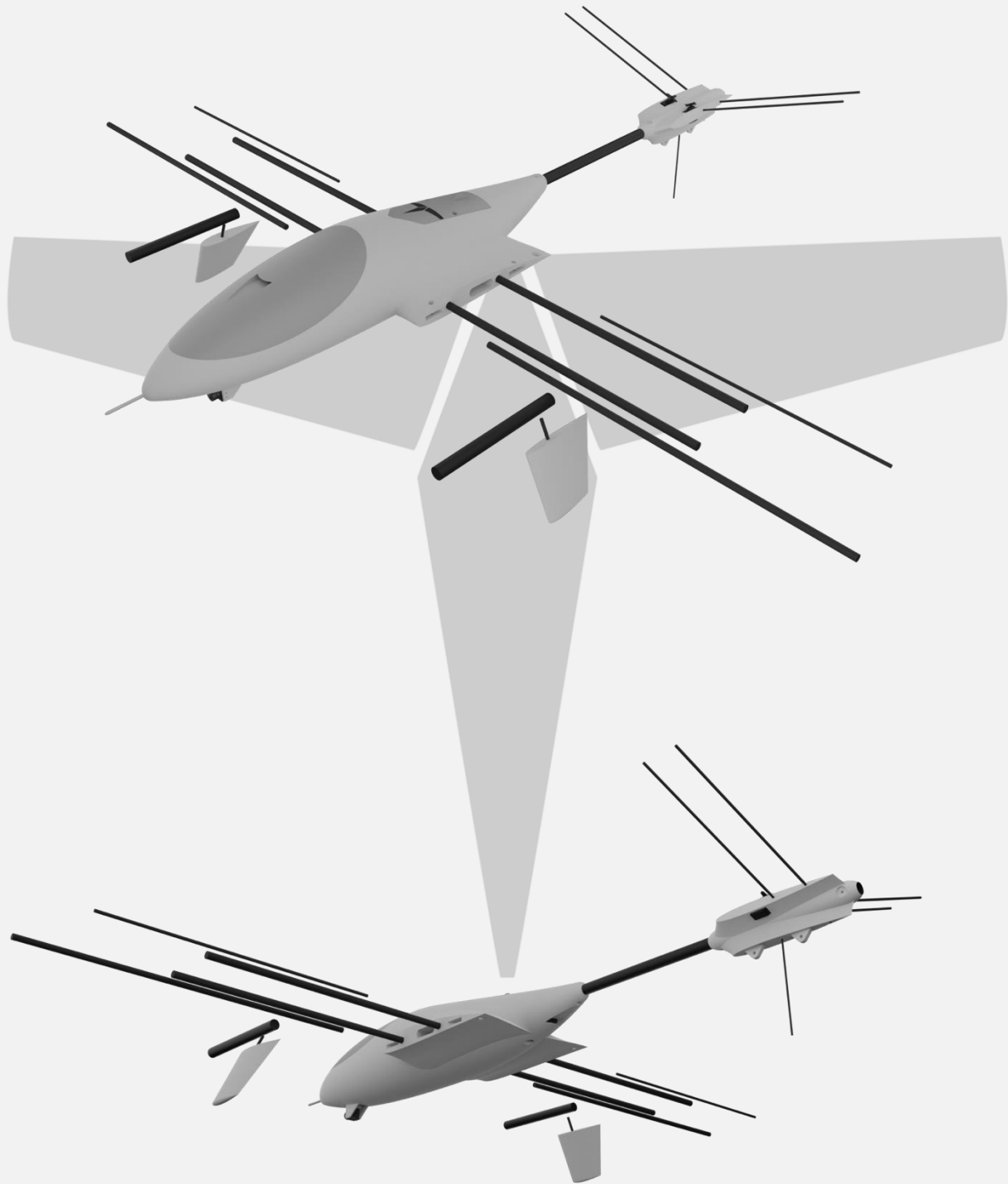
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The spar layout for Viper is as depicted below. None of the spars need to be glued in, they will all be retained by the printed parts. The two wing spars that intersect the fuselage are the joiners for the wings and the fuselage and can be removed completely from the fuselage and wing during transport. The tail can also be removed.





Assembly tips:

- Medium CA glue should be used to assemble all fuselage parts
- When first putting the glued parts together be sure to wipe any excess glue off before it sets. A kicker may then be used to speed up the setting time; technically this results in a weaker joint, however it will still be stronger than the base material LW-PLA.
- Use care when aligning parts for gluing. With medium CA, you should have a few seconds to get alignment right. Small mistakes in alignment can stack up and eventually lead to a part not fitting perfectly. We have taken care when designing the aircraft to make sure there is tolerance for some minor mistakes, but try to be as perfect as possible when gluing.
- When gluing the wings together, use the carbon rods to ensure alignment however be careful not to glue them in, they should not be glued in on the final product.
- **IMPORTANT!** - Do not glue the wing tips on until you have the carbon rod and aileron/flap installed as it's the wing tip that secures these in place. If you glue the wing tip on before inserting the control surfaces + carbon rod you will not be able to insert them afterwards.
- Threaded inserts can be properly installed by using a soldering iron at low heat setting, a good guide for doing this can be found at [this link](#).



Section 6: Final Setup & Tuning Tips

- Titan Dynamics strongly recommends the use of Arduplane for all our models.
- Give all control surfaces +- 35 degrees or more throw.
- CG is marked under the wing

Ardupilot setup:

Please read in detail the documentation for setting up quadplanes on Ardupilot:

<https://ardupilot.org/plane/docs/quadplane-building.html>

Viper is a tri-tiltrotor. The front two motors tilt while the rear is stationary.

`Q_FRAME_CLASS = 7`

`Q_TILT_MASK = 3`

`Q_TILT_TYPE = 0`

Please read in detail the setup instructions for tilt rotor VTOLs here:

<https://ardupilot.org/plane/docs/guide-tilt-rotor.html>

Use of the airspeed sensor is highly recommended. Hover PIDs will vary with motor and prop setup, but it's highly recommended to greatly bump the yaw PIDs to get a less wiggly yaw in hover.



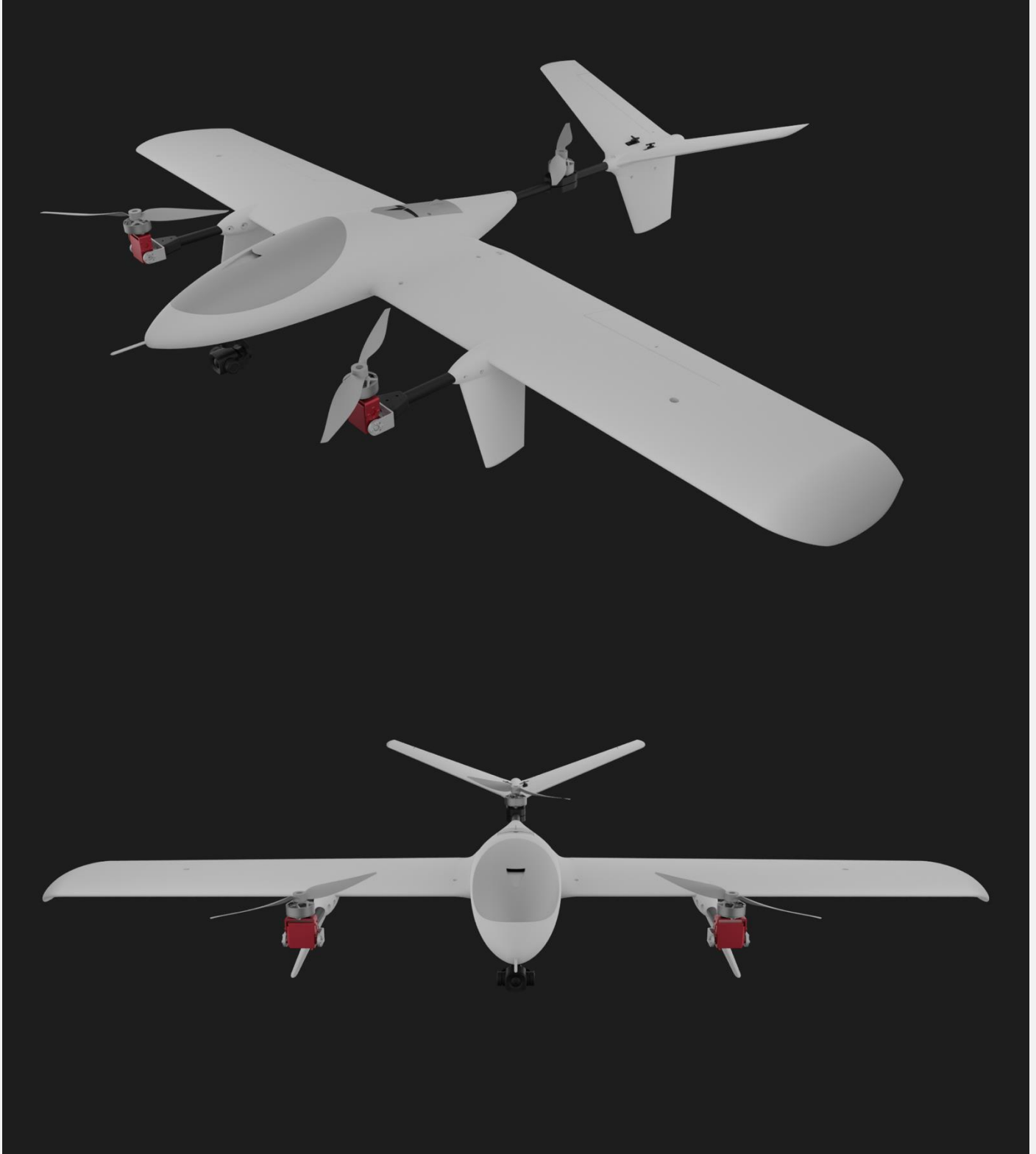
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Section 7: Additional Images



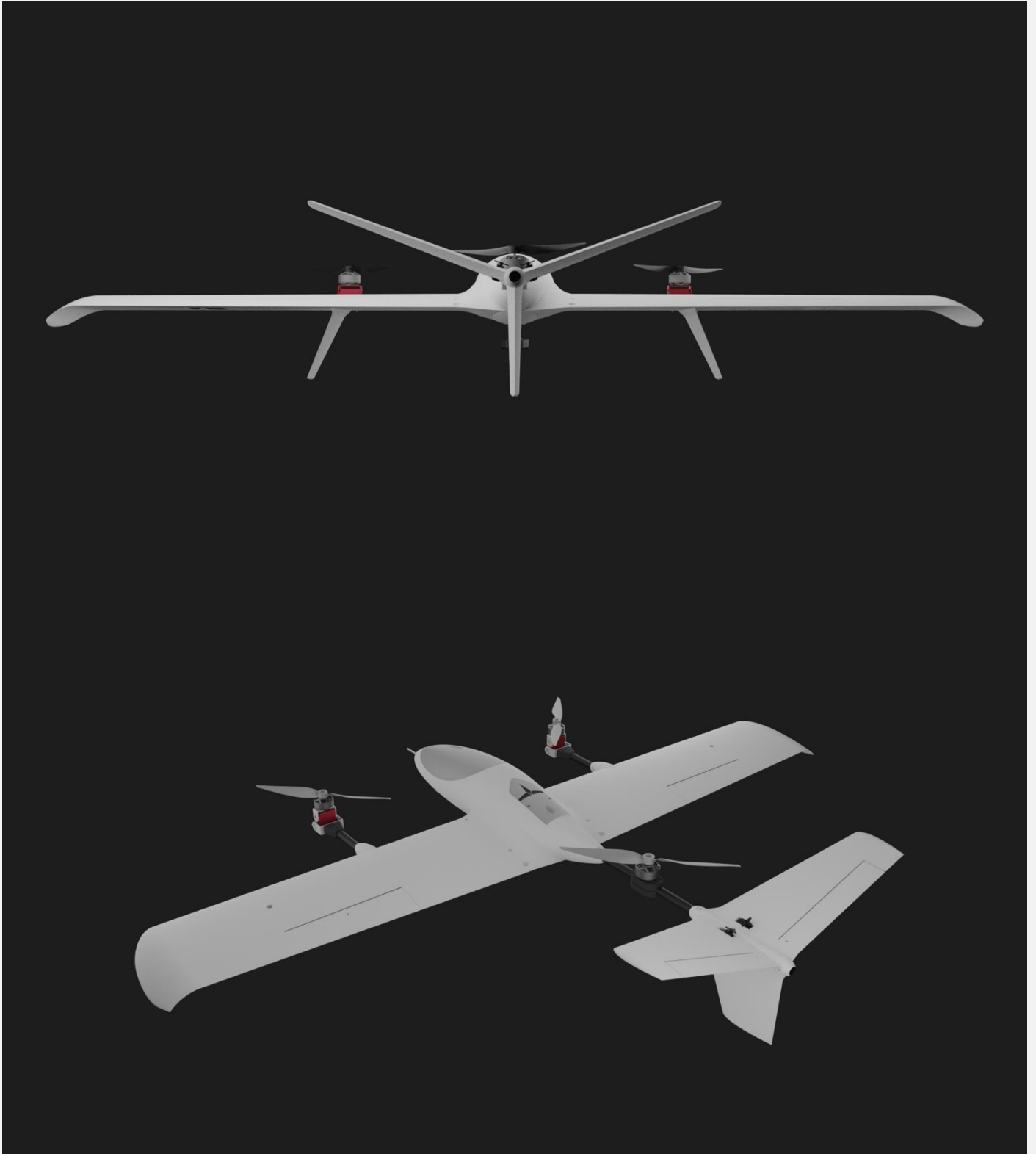


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