

*JETWORKS*



*Panavia*  
**TORNADO**

Photograph of actual aircraft.



4th Generation Fighter Jet

**Construction Guide**  
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# Tornado History

The Panavia Tornado is a family of twin-engine, variable-sweep wing multirole combat aircraft, jointly developed and manufactured by Italy, the United Kingdom and West Germany. There are three primary Tornado variants: the Tornado IDS (interdictor/strike) fighter-bomber, the suppression of enemy air defences Tornado ECR (electronic combat/reconnaissance) and the Tornado ADV (air defence variant) interceptor aircraft.

The Tornado was developed and built by Panavia Aircraft GmbH, a tri-national consortium consisting of British Aerospace (previously British Aircraft Corporation), MBB of West Germany, and Aeritalia of Italy. It first flew on 14 August 1974 and was introduced into service in 1979–1980. Due to its multirole design, it was able to replace several different fleets of aircraft in the adopting air forces.

The Tornado was operated by the Royal Air Force (RAF), Italian Air Force, and RSAF during the Gulf War of 1991, in which the Tornado conducted many low-altitude penetrating strike missions. The Tornados of various services were also used in The Bosnian War, Kosovo War, Iraq War, in Libya during the Libyan civil war, as well as smaller roles in Afghanistan, Yemen, and Syria. Including all variants, 990 aircraft were built.

The Panavia Tornado is a multirole, twin-engined aircraft designed to excel at low-level penetration of enemy defences. The mission envisaged during the Cold War was the delivery of conventional and nuclear ordnance on the invading forces of the Warsaw Pact countries of Eastern Europe; this dictated several significant features of the design. Variable wing geometry allowed for minimal drag during the low-level dash towards a well-prepared enemy. Advanced navigation and flight computers, including the then-innovative fly-by-wire system, greatly reduced the workload of the pilot during low-level flight and eased control of the aircraft.

As a multirole aircraft, the Tornado is capable of undertaking more mission profiles than the anticipated strike mission; various operators replaced multiple aircraft types with the Tornado – the use of dedicated single role aircraft for specialist purposes such as battlefield reconnaissance, maritime patrol duties, or dedicated electronic countermeasures (ECM) were phased out – either by standard Tornados or modified variants, such as the Tornado ECR. The most extensive modification from the base Tornado design was the Tornado ADV, which was stretched and armed with long range anti-aircraft missiles to serve in the interceptor role.

In order for the Tornado to perform well as a low-level supersonic strike aircraft, it was considered necessary for it to possess good high-speed and low-speed flight characteristics. To achieve high-speed performance, a swept or delta wing is typically adopted, but these wing designs are inefficient at low speeds. To operate at both high and low speeds with great effectiveness, the Tornado uses a variable-sweep wing. The variable wing can adopt any sweep angle between 25 degrees and 67 degrees, The weapons pylons pivot with the angle of the variable-sweep wings so that the stores point in the direction of flight and do not hinder any wing positions.

In development, significant attention was given to the Tornado's short-field take-off and landing (STOL) performance. Germany, in particular, encouraged this design aspect. For shorter take-off and landing distances, the Tornado can sweep its wings forwards to the 25-degree position, and deploy its full-span flaps and leading edge slats to allow the aircraft to fly at slower speeds. These features, in combination with the thrust reverser-equipped engines, give the Tornado excellent low-speed handling and landing characteristics.

Source : Wikipedia

# TORNADO

# Designers Notes

As a child of the 80's The Tornado was Britains primary fighter and it inspired me to become a fast jet pilot. I sadly I grew too tall and needed spectacles, so I knew I would never get there, so I gave up my dream of being a Tornado pilot.

Having built and sadly lost my scratchbuilt Steve Shumate F-14 Tomcat. I wanted to build another swing wing plane. I then realised I could take the concept of Steve's excellent swing wing mechanism and make a Tornado. 30 years later and I can finally say I finally made it as a Tornado Pilot!!

The model flies really gently with the wings outspread, when tucked in it gives an insane roll rate, so choose your elevon expo and throws carefully. Also, ensure that your pushrods don't flex as sadly mine did and caused a minor crash! (repaired)

Although not quite as agile as my Typhoon design, The variable wing's aerodynamic effects offer much to enjoy. It's a nice plane to fly, and really gives that familiar shape in the air.

This RC model has variable geometry sweep wings, along with variable geometry drop tanks.

It can be built as a pusher prop version, a single 64 or 70mm EDF.

PLEASE NOTE : This design can become quite heavy as 3d printed parts along with EDF Units can add a surprising amount of weight. It will fly with the weight, but you may need to bungee launch it depending on what components you choose.



# Before you start.



## Adhesives

- > For the majority of construction :
  - UHU Creativ for Styrofoam (also called UHU POR)
  - 3M 77 Spray adhesive.
- > For wing spars and motor mounts :
  - Epoxy. (5 and 15mins cure times are the most convenient)  
micro-balloons can be added to reduce weight.
- > For servo's / and quick grab :
  - Hot melt glue gun - Caution if the glue gets too hot it will melt foam - test first!

## Tapes

- > For holding parts tightly together whilst glue sets
  - Low tack masking tapes
- > For leading edges, hinges, general strengthening
  - 3M Gift tape (Purple - not green one!) - I prefer lightweight plastic hinges.

## Cutting parts

1. Print the plans,
  2. Cut around each part using scissors - allow a border of approx (1/4") 6mm
  3. Use either 3M spray mount or a very light coat of 3M 77 to the back of the parts and stick in an economical layout on the Depron foam.
  4. Using a safety rule and craft knife over a cutting mat - important! use a fresh blade otherwise it will drag and spoil the foam. (I find the stanley knife perfect) make the straight edge cuts, then the curved parts freehand.
  5. Once the parts are cut-out, keep the template stuck to the part until just before needed to help identify the parts.
  6. After use, I find it helpful to keep all the used tempates in case replacement parts need making. (the glue eventually dries and they don't stick together!)
- IMPORTANT** Wherever the plans call for marking guidelines onto the depron, please ensure that you do otherwise it can cause problems later on. I suggest you use a Sharpie Fineliner to transfer the lines.

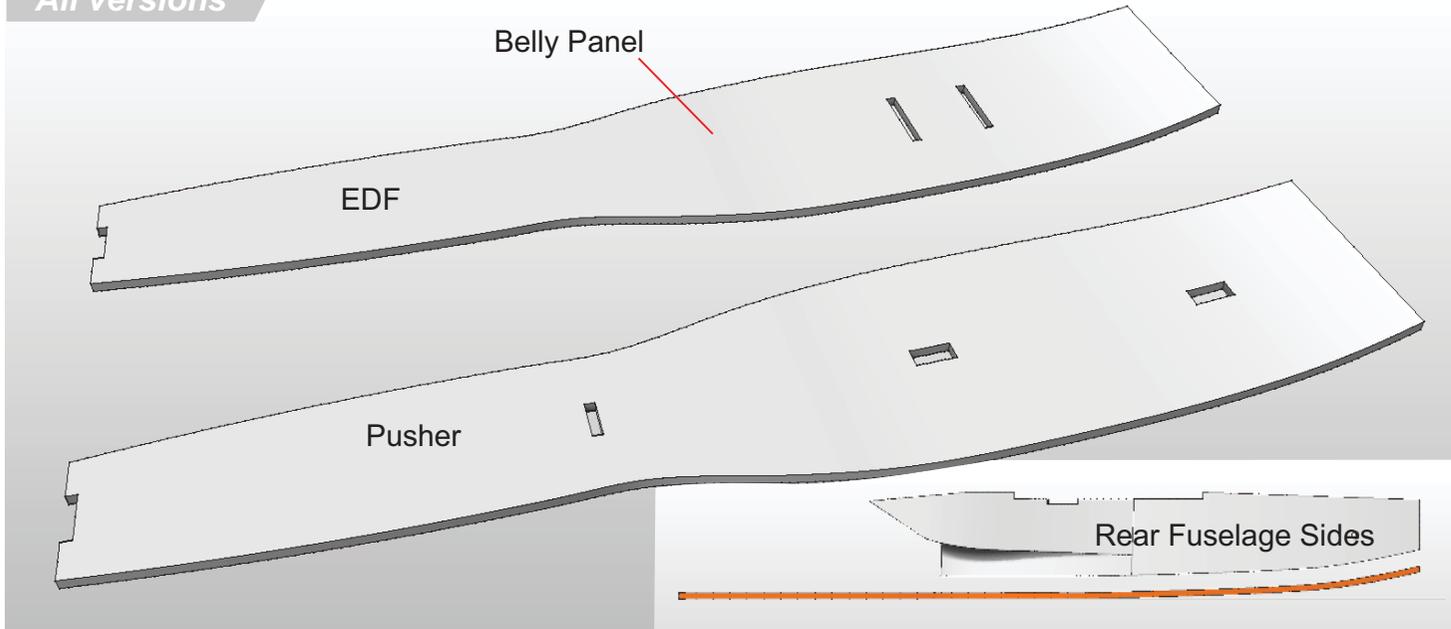


## Glueing parts together.

1. Ensure a really good fit - this will reduce the amount of adhesive used. The Bar Sander is a great tool for this.
2. Follow the adhesive instructions closely.
3. Use ordinary steel head pins to help keep the parts located whilst epoxy sets.
4. Use objects as weights such as paperweights to apply pressure whilst adhesive sets.
5. Use masking tape to apply pressure whilst adhesive sets. Also use masking tape to along the slots for the wing spars whilst gluing the carbon rod spars into the wings.



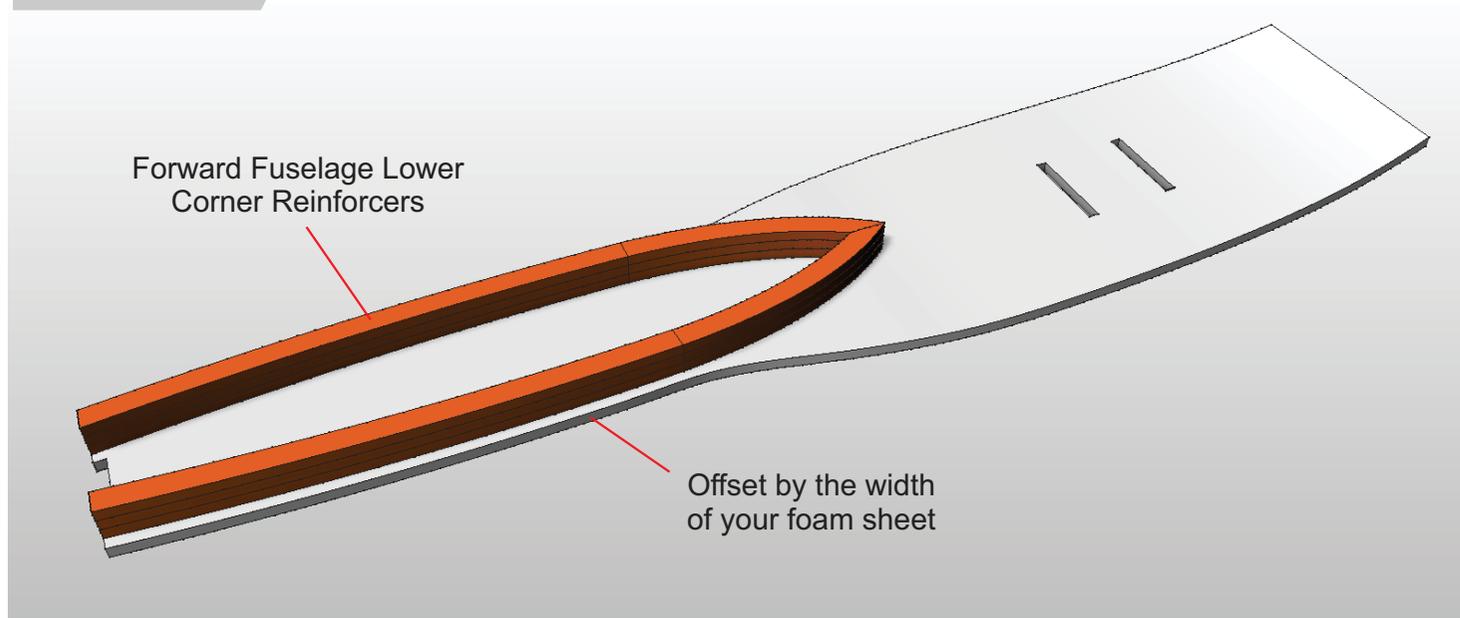
All versions



Choose either the EDF or Pusher **Belly Panel** to suit your power choice.

Using the table edge bending technique, shape the rear of the **Belly Panel** to match the shape of the **Rear Fuselage Sides**.

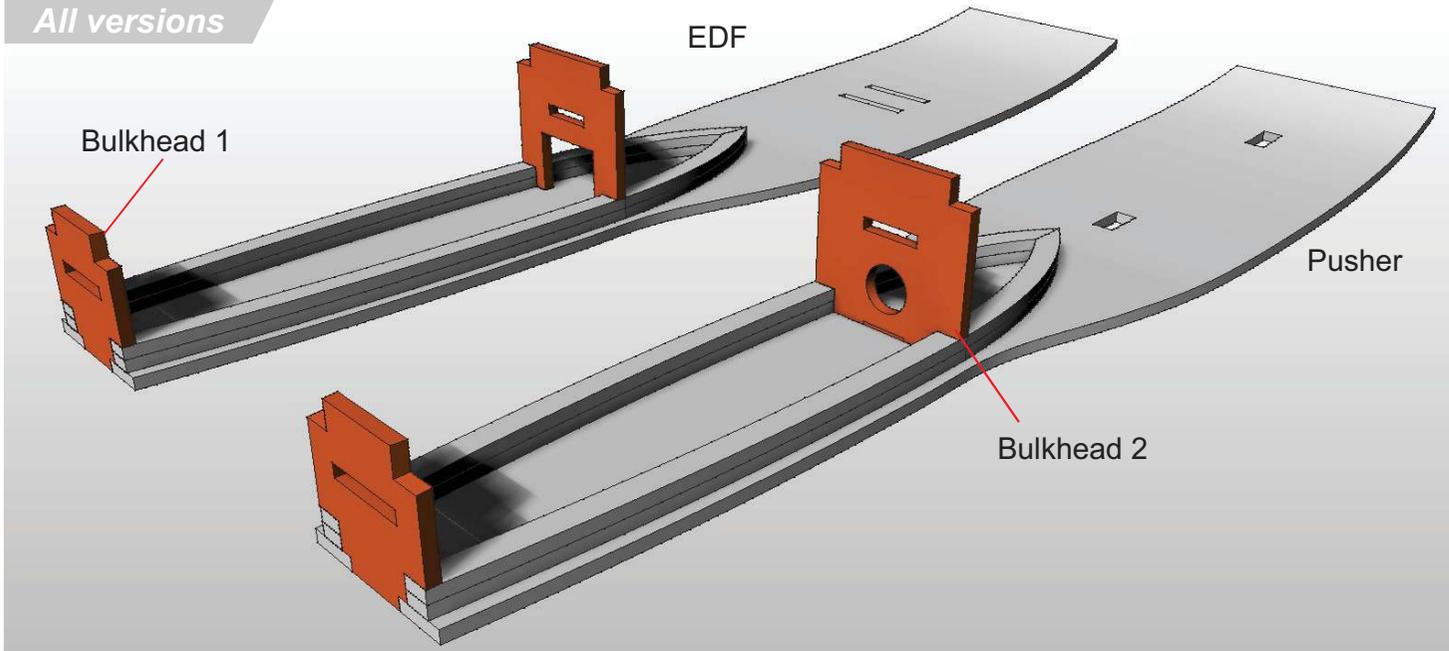
All versions



Glue the two pairs of the **Forward Fuselage Lower Corner Reinforcement** pieces together and glue to the belly panel - offset 6mm from the edge (or the width of your foam sheet).



All versions

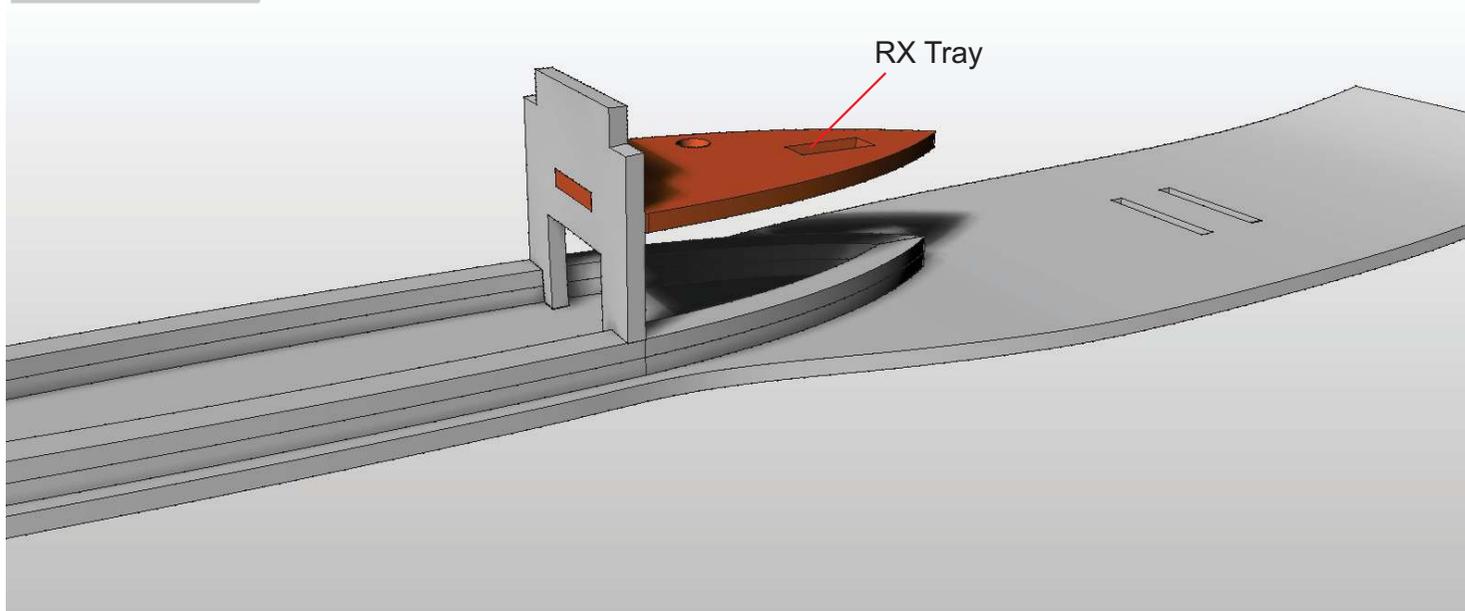


Glue **Bulkhead 1** and **Bulkhead 2** in place.

The pusher version slots into the locating slot. The EDF version needs to be manually positioned according to the plans.



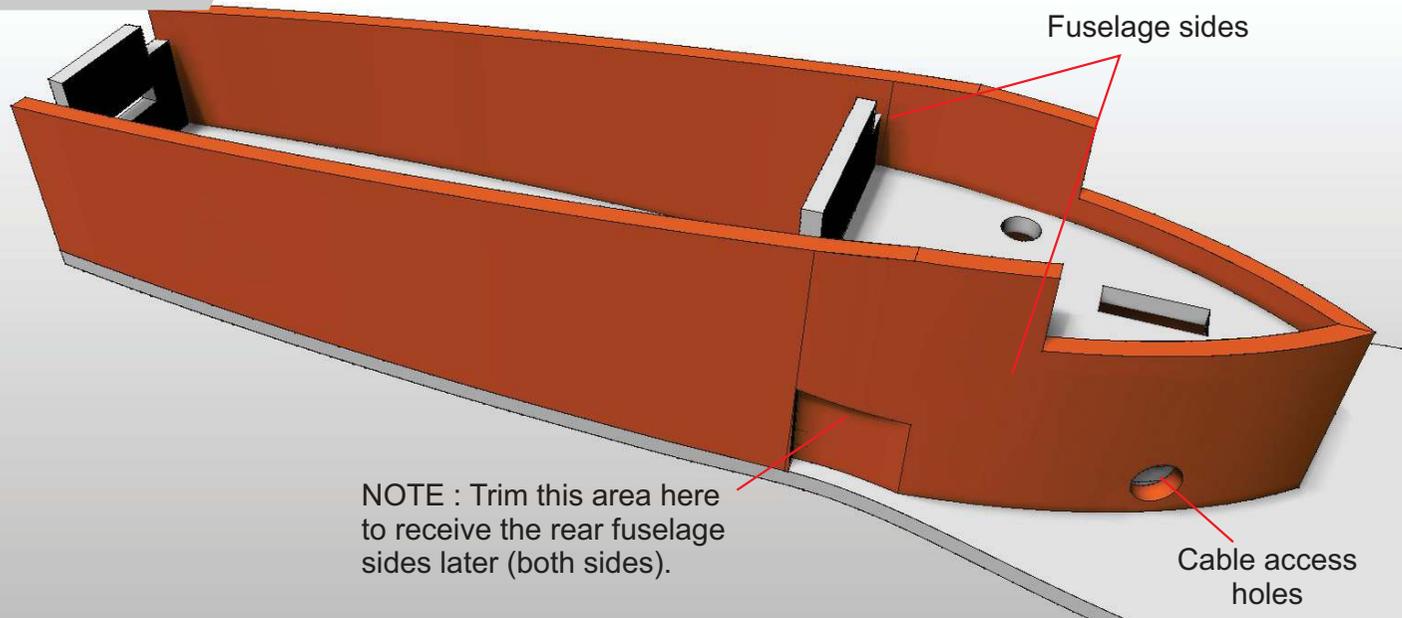
All versions



Glue the **RX tray** in place.



All versions

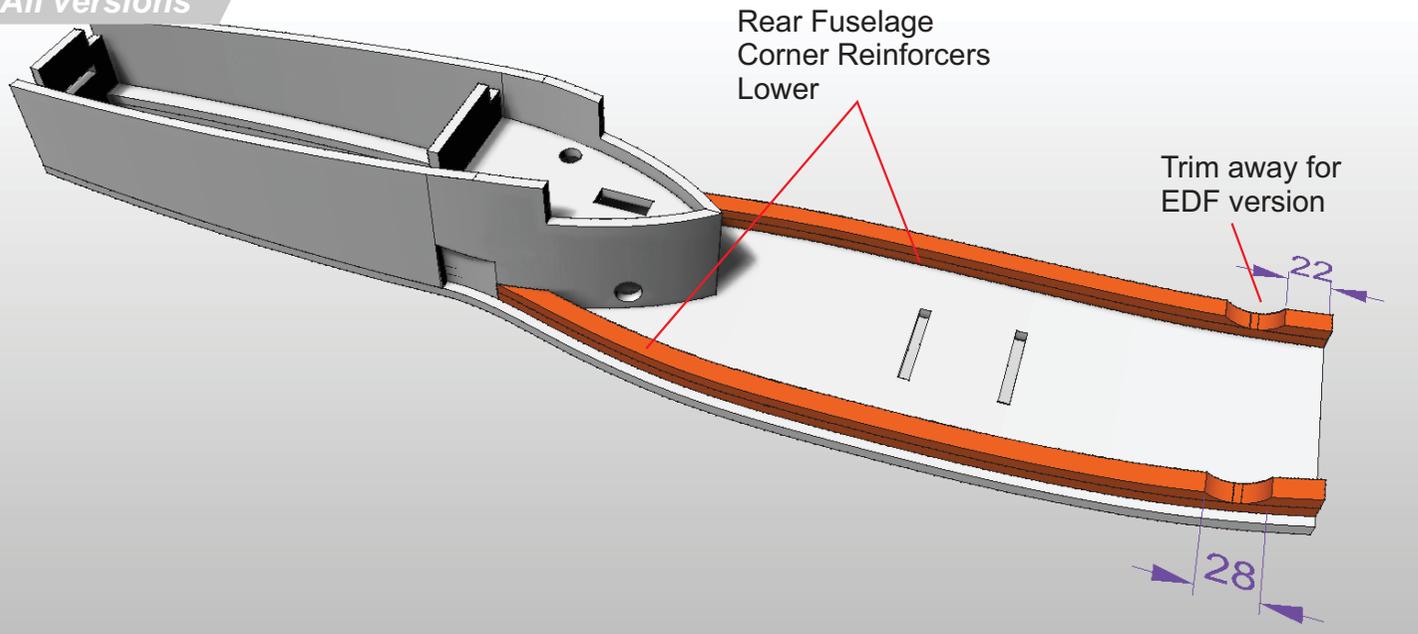


Shape the **Fuselage sides** to match the assembly and glue in place.

Using a needle file, file away the corner reinforcers behind the cable access holes



All versions

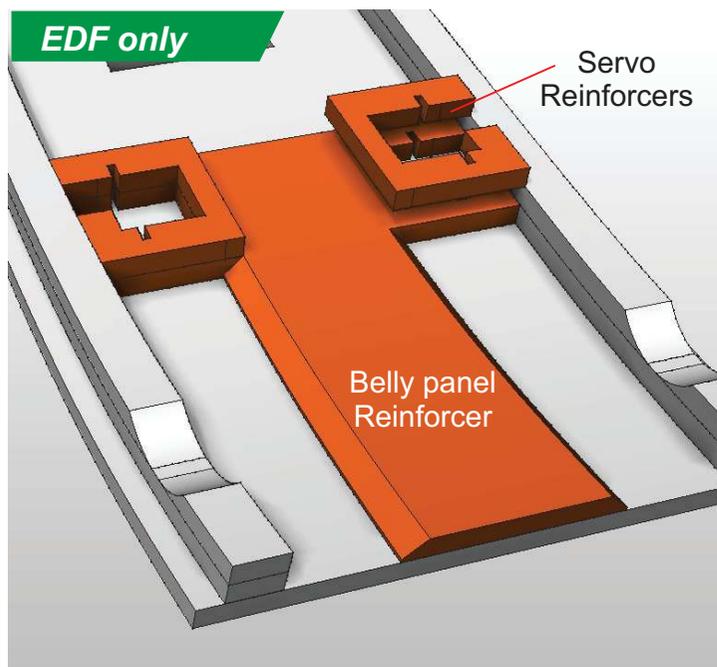
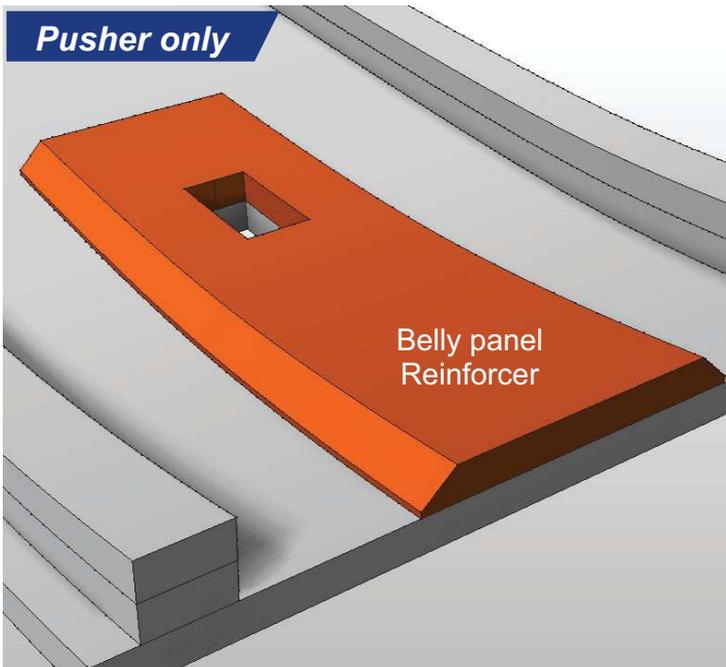


Glue the two **Rear Fuselage Corner Reinforcers Lower** together and glue in place 6mm from the outer edge of the belly panel.

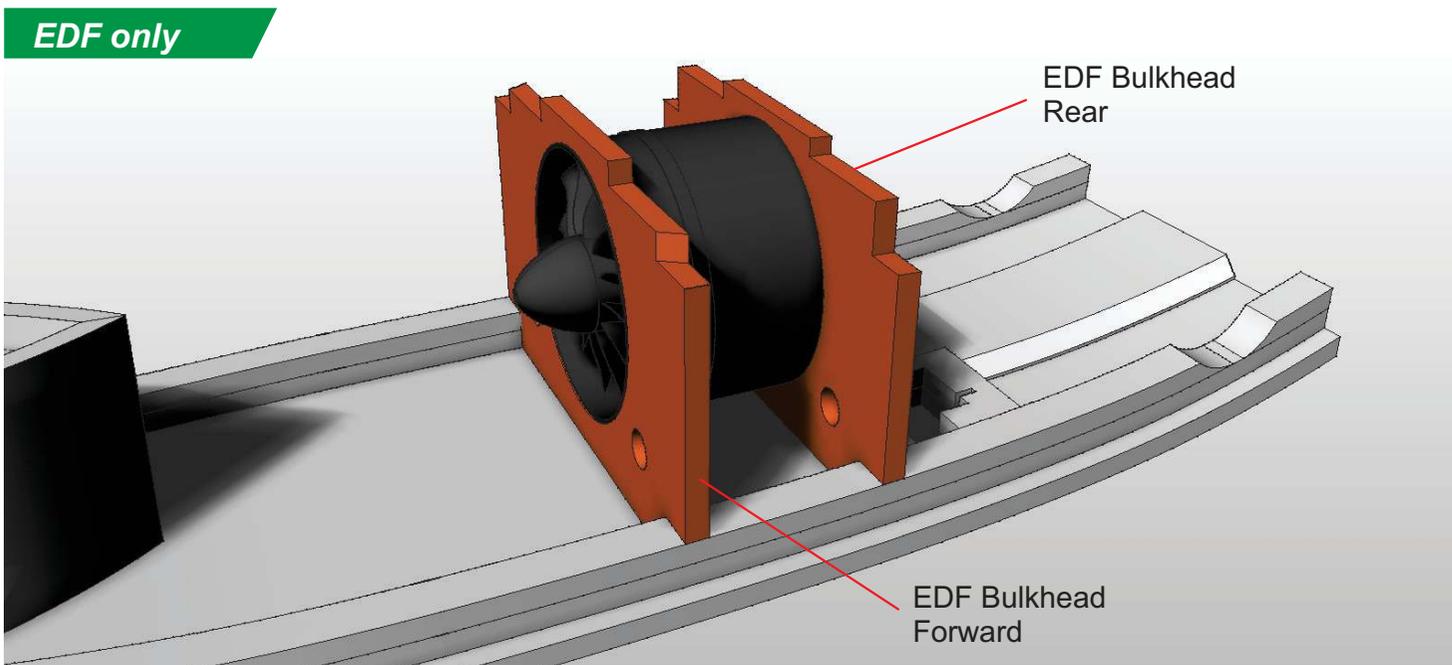


**TORNADO**



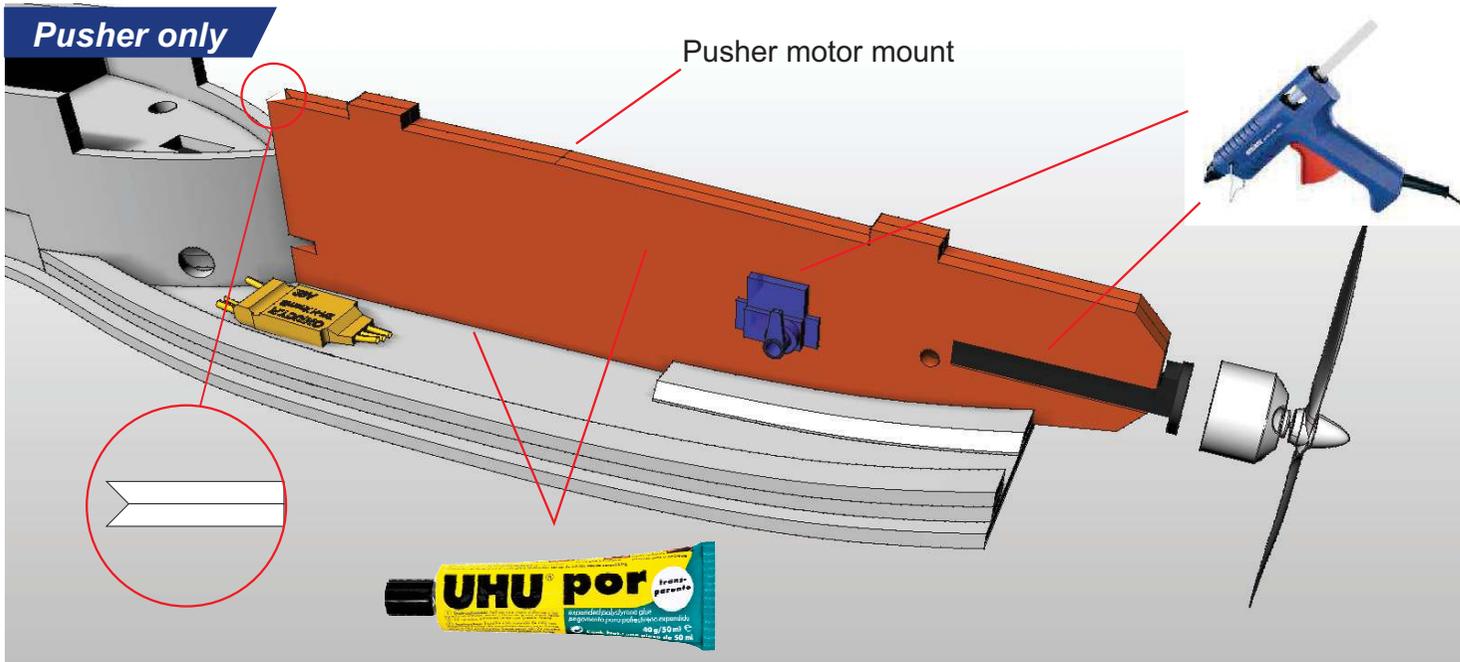


Chamfer the edges and glue the **Belly Panel Reinforcer** in place.



Dry fit the EDF unit into the two **EDF Bulkheads** and then Glue both bulkheads into the assembly.



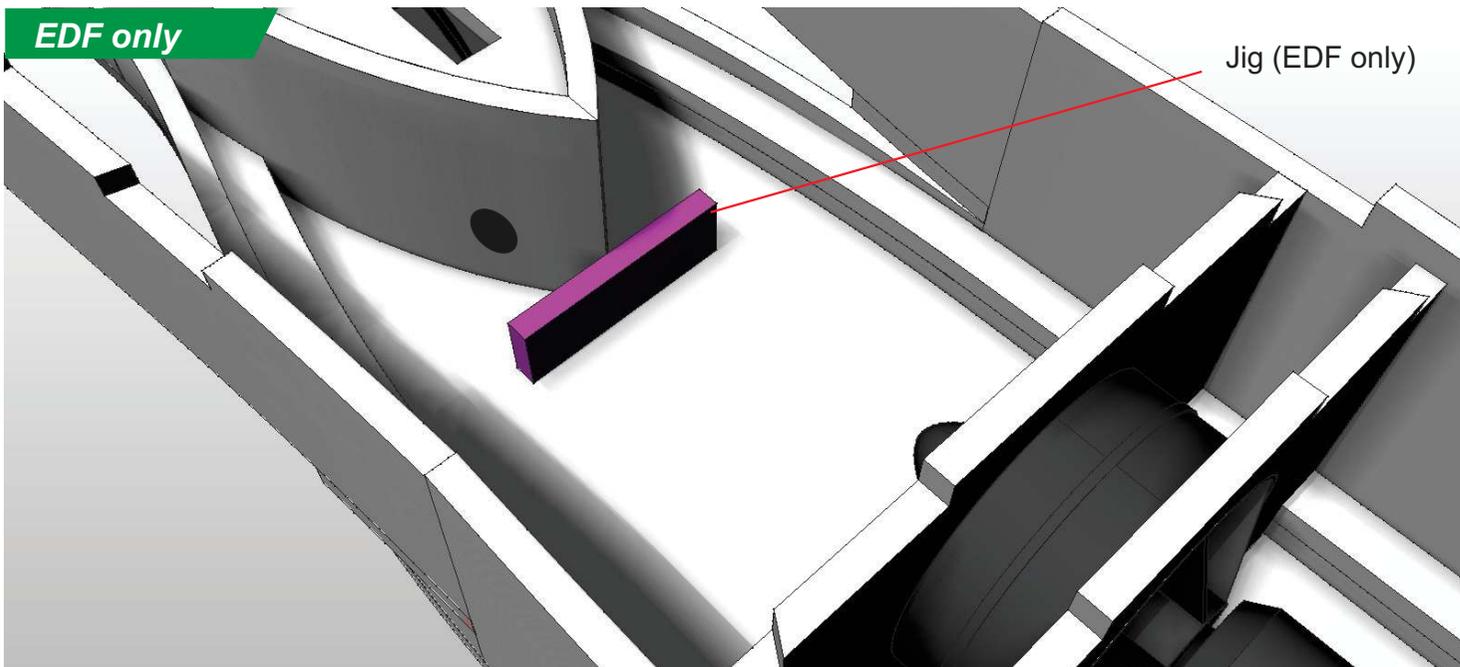


Shape the forward edges of the **Pusher motor mount** to fit to the end of the forward fuselage sides, then Glue together.

Using Hot melt glue, attach the motor mount stick mount

Using UHU Por, glue the motor mount to the assembly.

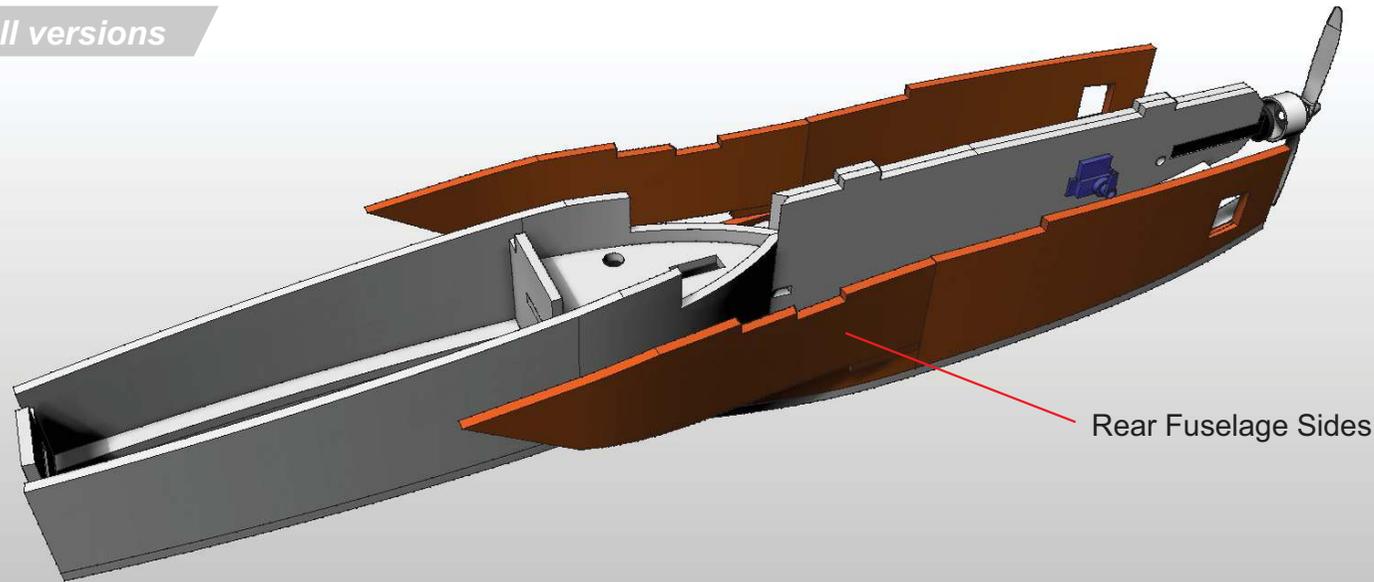
Glue the Elevon Servos in place with the servo horns on opposite sides.



For the EDF version, use the positioning jig to help align the lower intake pieces (next step) - **DO NOT GLUE!**



All versions



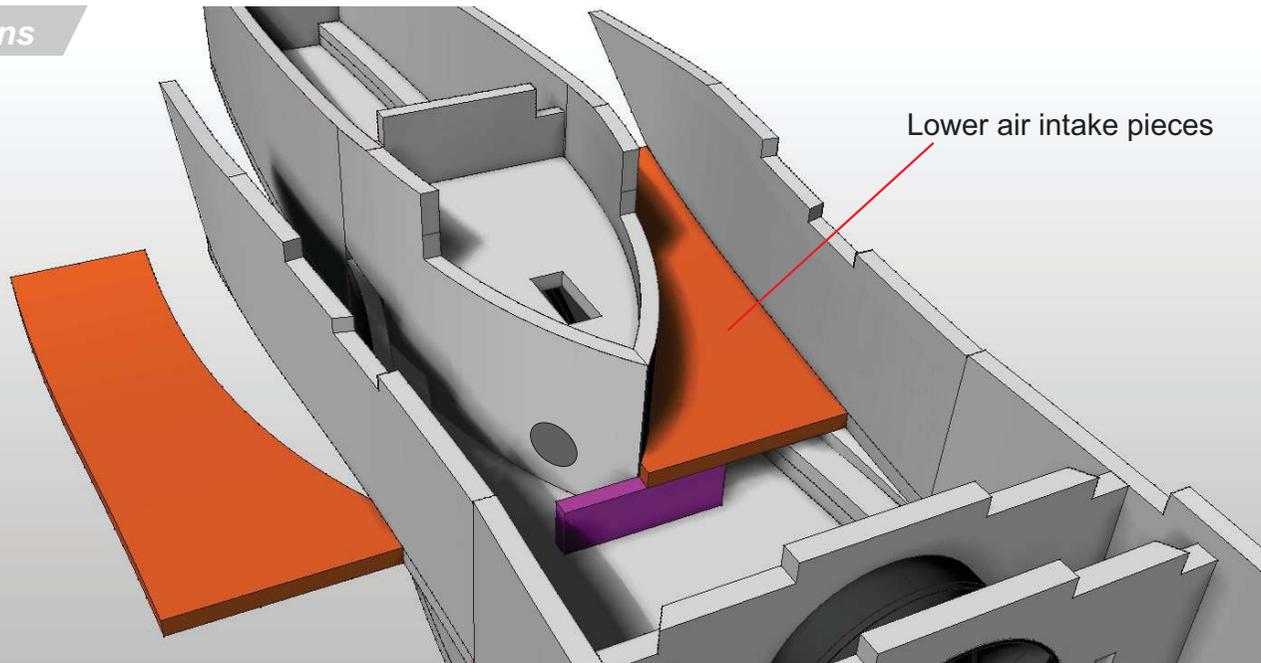
Rear Fuselage Sides

Pre-shape the **Rear Fuselage Sides** and glue in place.

Please note the differences between the Pusher and EDF versions.



All versions



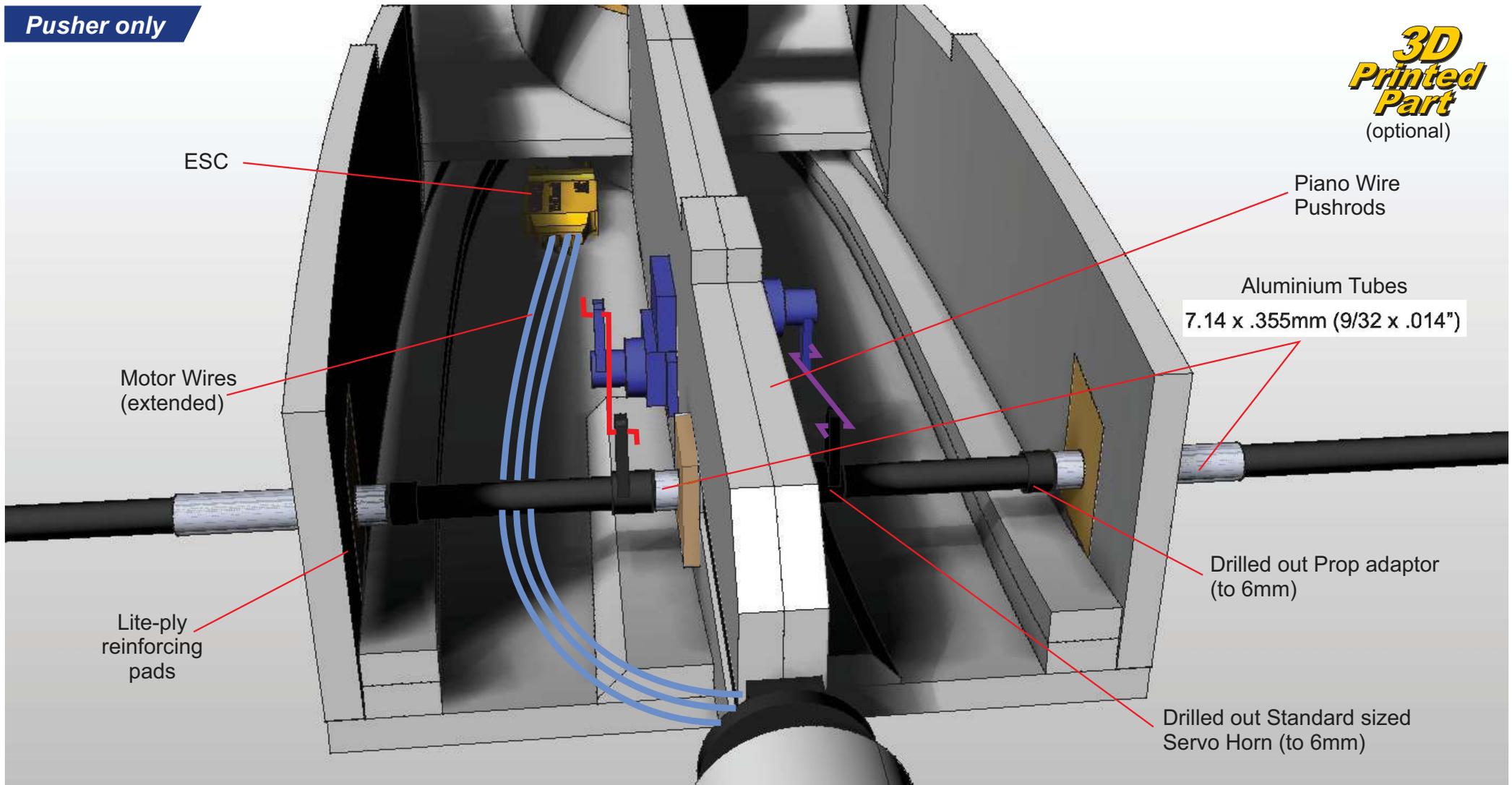
Lower air intake pieces

Glue the **Lower Air Intake Pieces** in place. (Both sides)

remove the alignment jig after the intake pieces are in place.

The Pusher version has a slot in the motor mount to fit these pieces into.





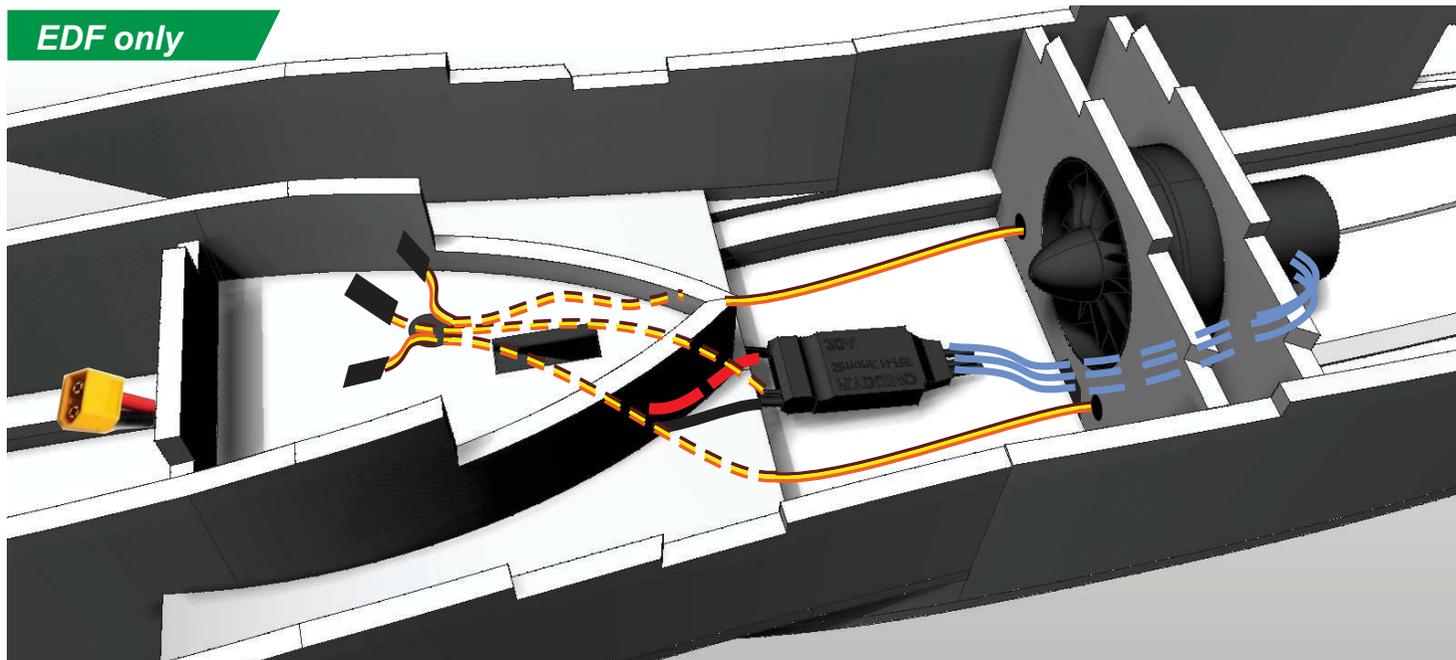
Construct the two rotating Elevon spar assemblies as shown. Connect all the electronics and mechanisms. Ensure the pushrods do not flex as their will be a lot of load on them.

Glue the two drilled-out servo horns to the 2 carbon spars using CA (Superglue)

Glue the Lite ply reinforcing pads to the foam and aluminium using epoxy. There are 3d printable equivalent parts available.



EDF only

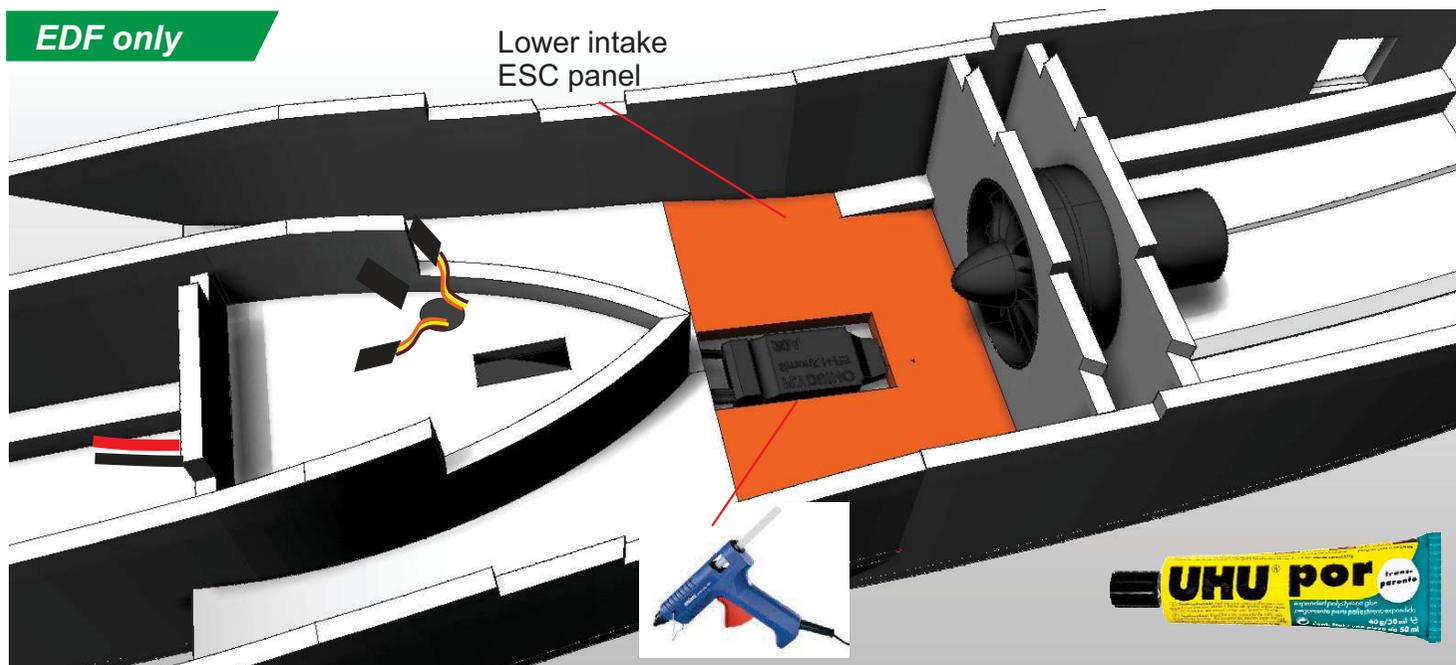


## ALL EDF VERSIONS

Run the EDF motor cables forward. Run the ESC servo wire into the RX tray, and the Power cable into the battery compartment.

Using Metal Gear type, plug the Elevon servos into their positions, Run the servo cables through the EDF bulkheads and into the

EDF only



Lower intake  
ESC panel

## NON 3D PRINTED VERSION

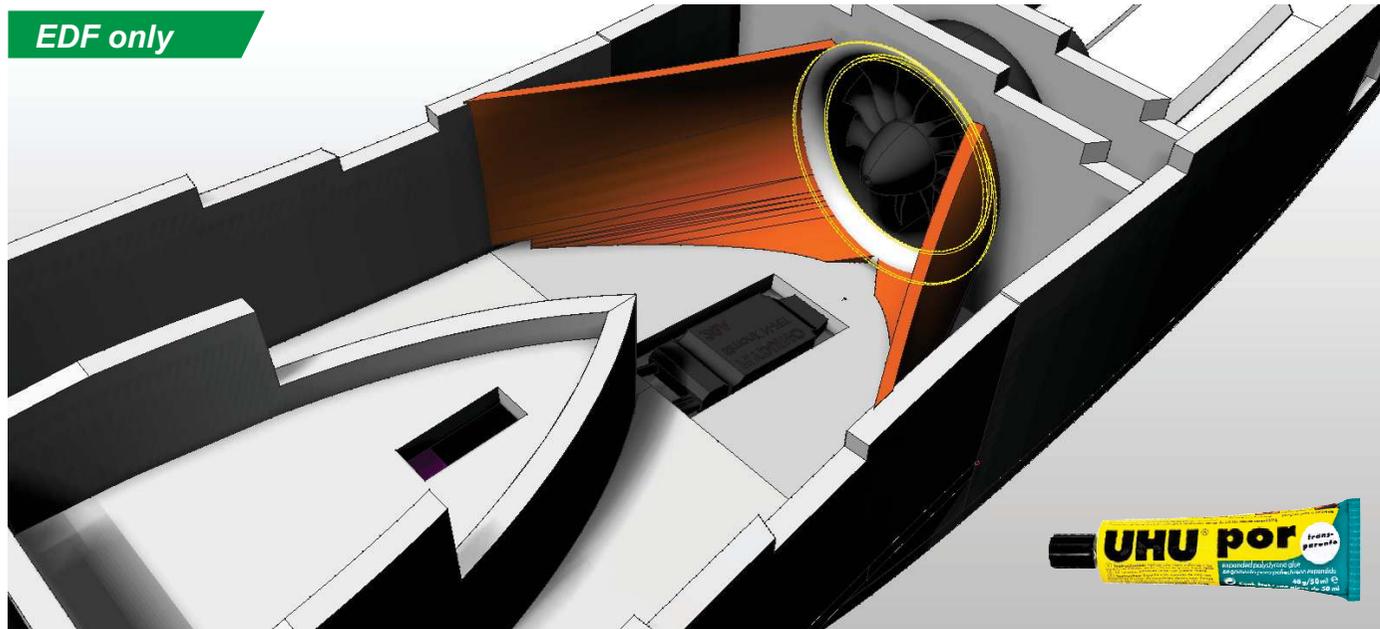
Trim where necessary for a good fit and glue the **Lower Intake ESC Panel** to the assembly as shown using UHU por.

Fix the ESC in place using Hot-melt glue - ensure a smooth airflow.

# TORNADO

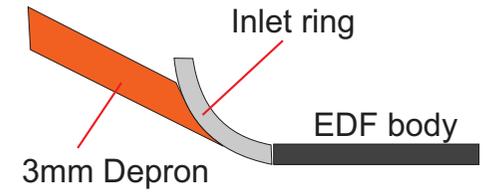


EDF only



### NON 3D PRINTED VERSION

Pre-shape 3mm depron, and create an inlet ducting as shown. Carefully align tangentially onto the EDF inlet ring.

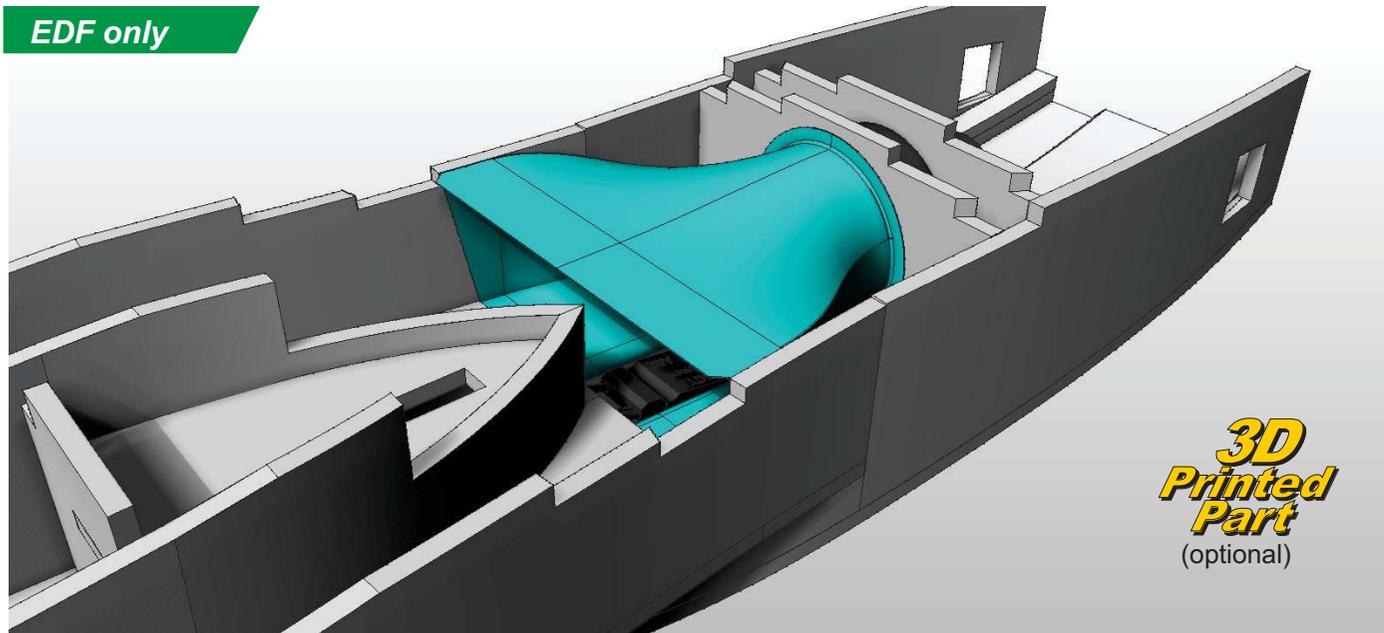


### 3D PRINTED VERSION

Glue the inlet duct in place using all mating faces.

The lip on the top hooks over the wing box lip to prevent deformation with the EDF suction.

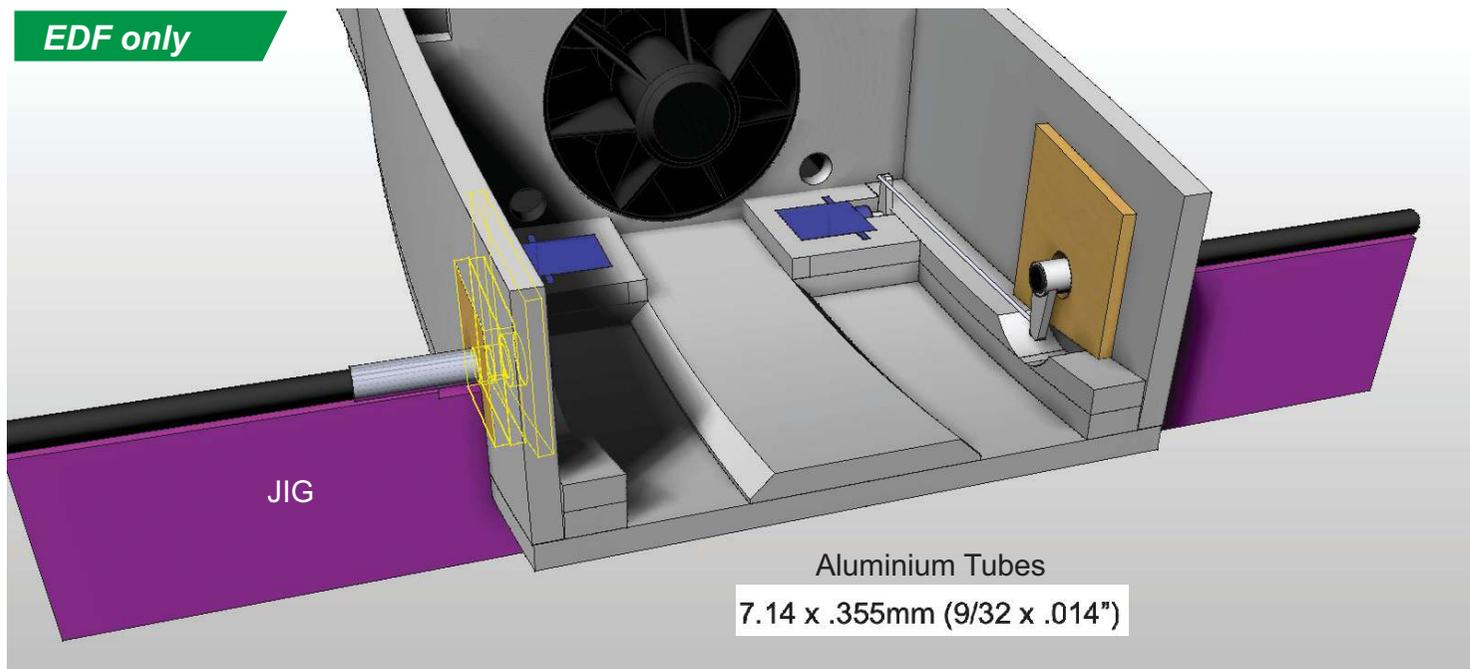
EDF only



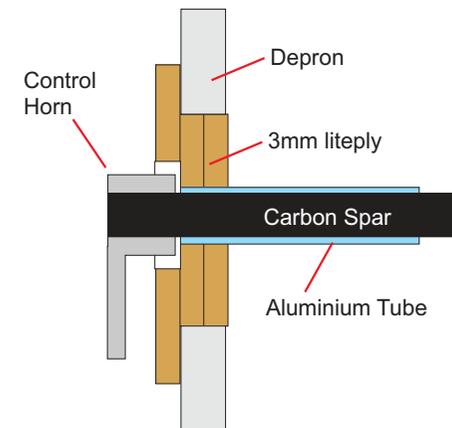
# TORNADO



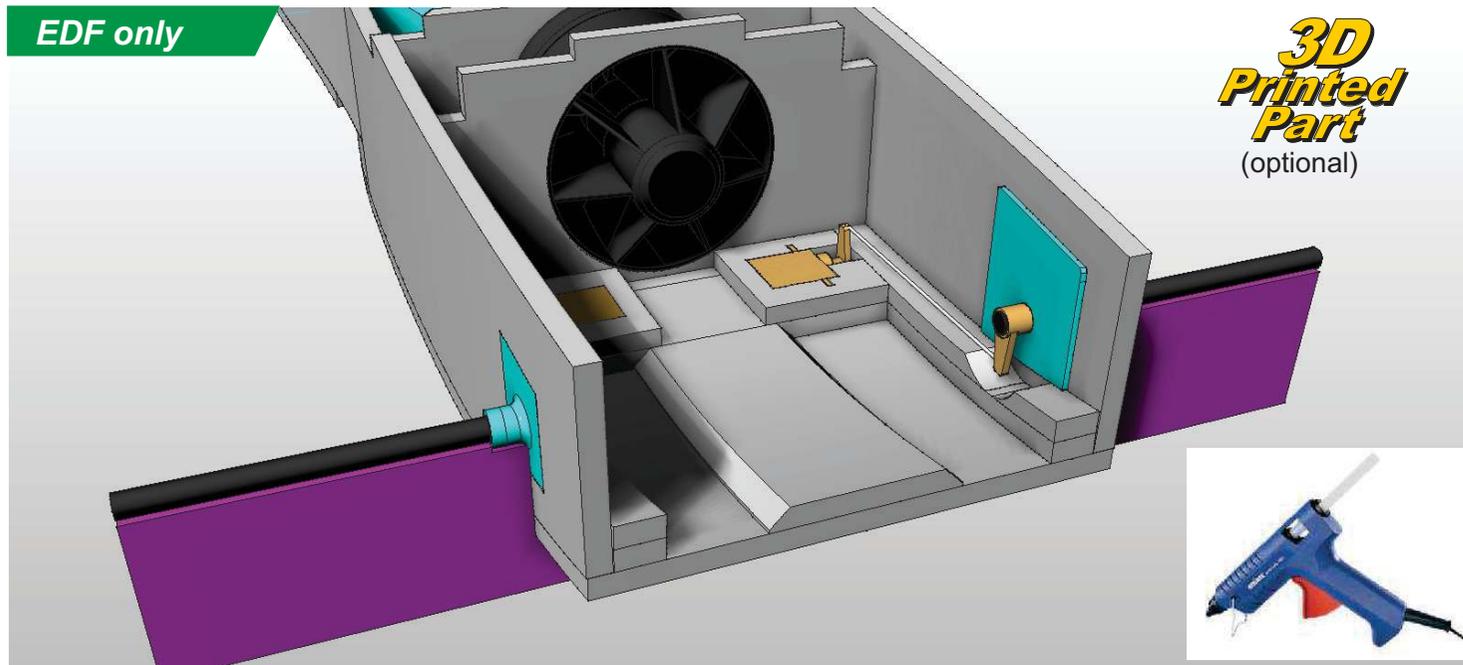
EDF only



NON 3D PRINTED.  
Laminate the 3mm lite-ply and ally tube assembly as shown below. The control horn is recessed due to lack of space.



EDF only



Glue the Servos in place using hot melt glue.

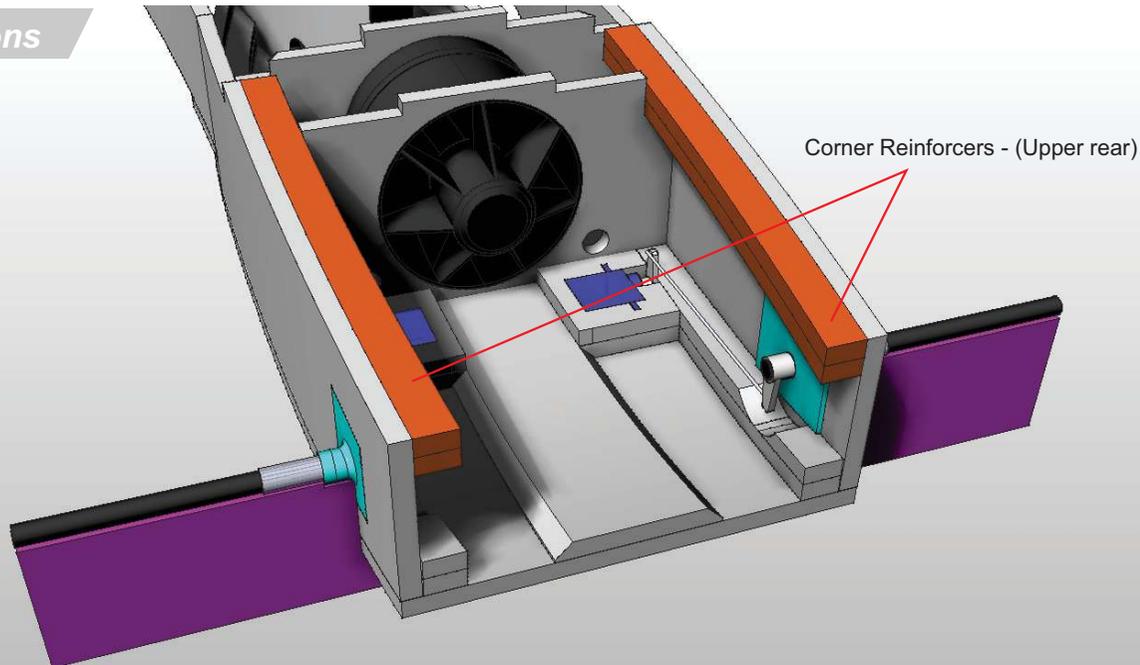
Cut away the corner reinforcer to allow clearance for the ELevon servo horn to move.

Glue the drilled out servo horns to the carbon spars using CA glue and slide in place.

Connect using a stiff piano wire (no flex!). Ensure no slop in the movement.



All versions

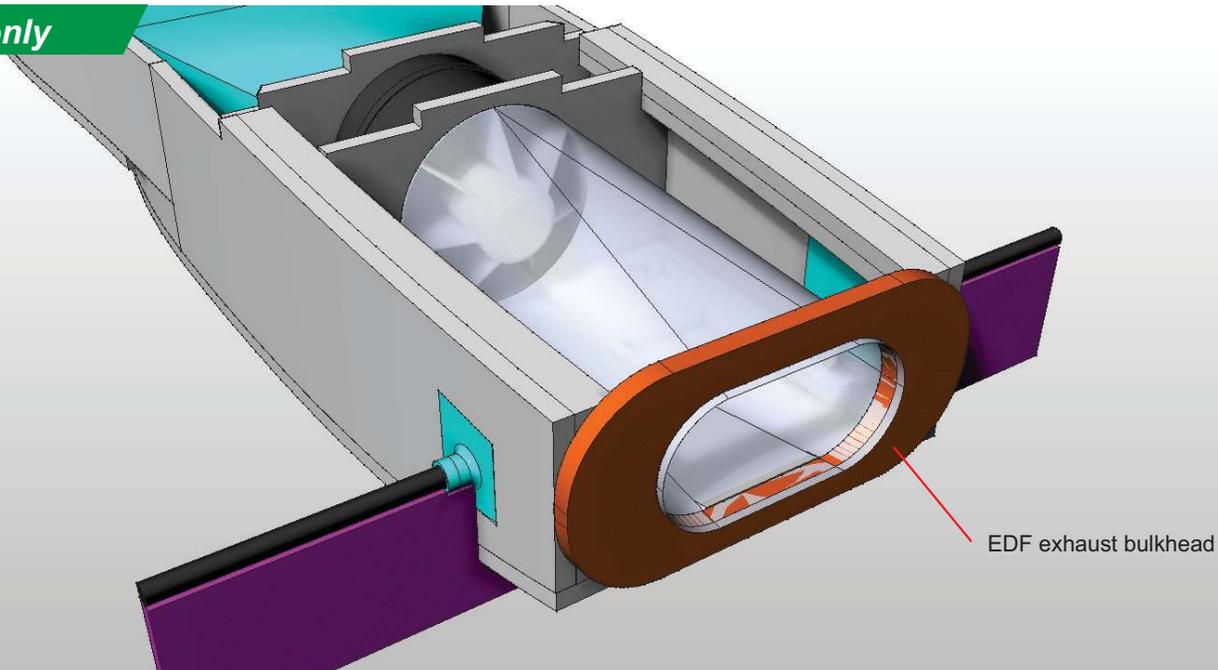


Leave the jig in place to cradle the assembly until the fuselage top is fitted.

Glue the **Corner Reinforcers - (Upper rear)** in place.



EDF only



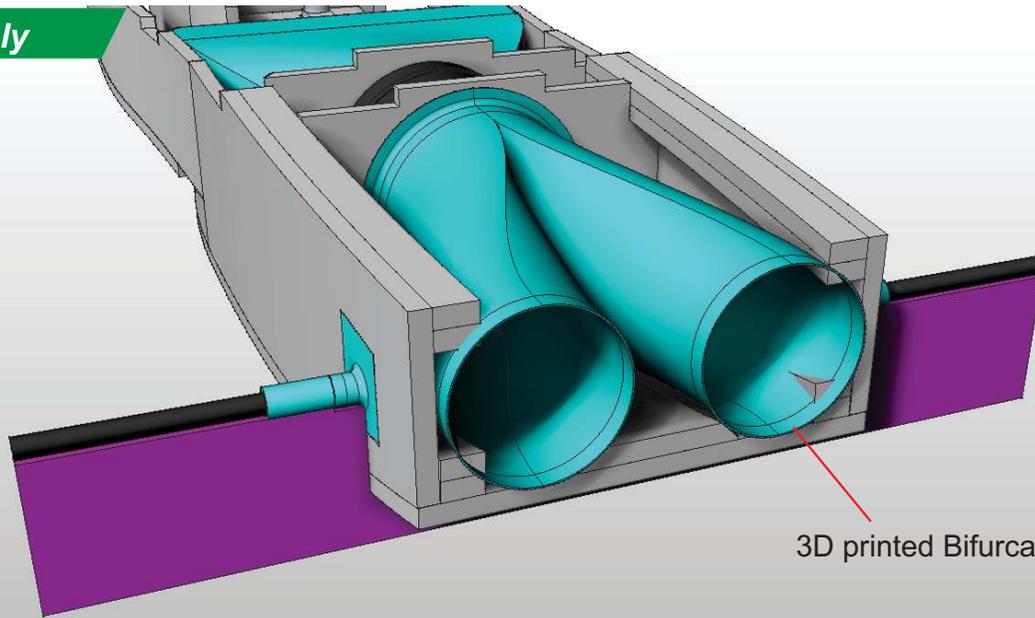
### NON-3D PRINTED VERSION

Glue the EDF exhaust bulkhead to the assembly - leaving the top edge 6mm higher. Construct the thrust tube from 0.3-0.5mm plastic sheet, taped together using nylon reinforced tape.

Use Hot melt glue to secure in place - be careful not to melt the plastic tube. Use scrap depron blocks to help support the gluing.



EDF only



3D printed Bifurcated thrust tube

**3D  
Printed  
Part**  
(optional)

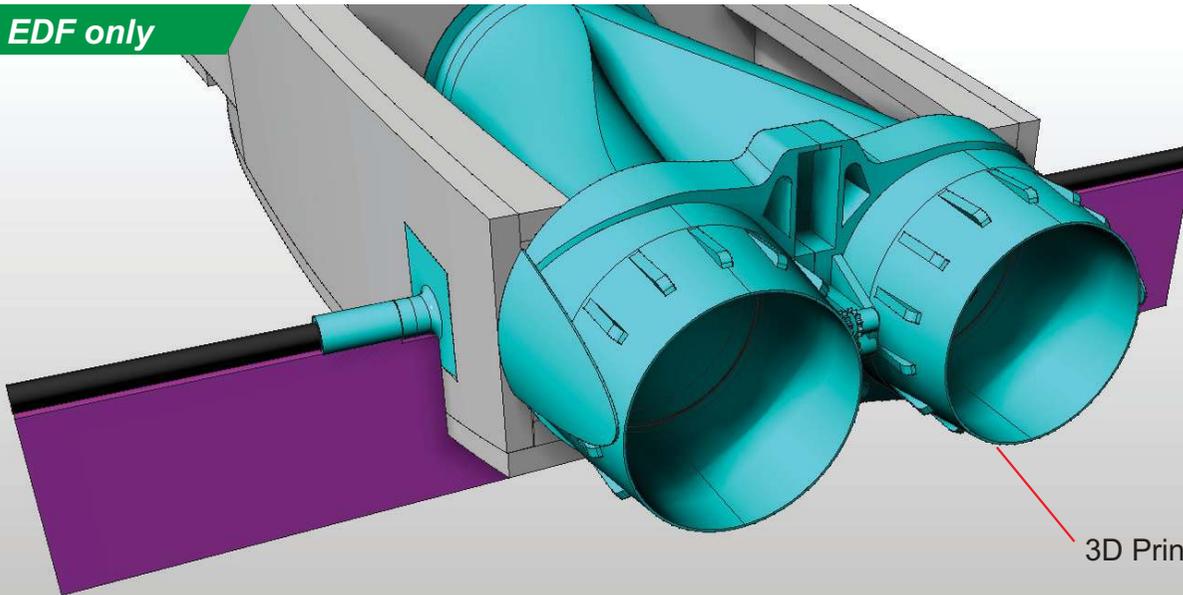
Trim the corner reinforcers to make space for the **3D Printed Bifurcated Thrust tube**.

Test fit the 3d printed exhaust (image below) - use to align the thrust tube correctly.

Glue the front face of the tube to the rear face of the rear EDF bulkhead.



EDF only



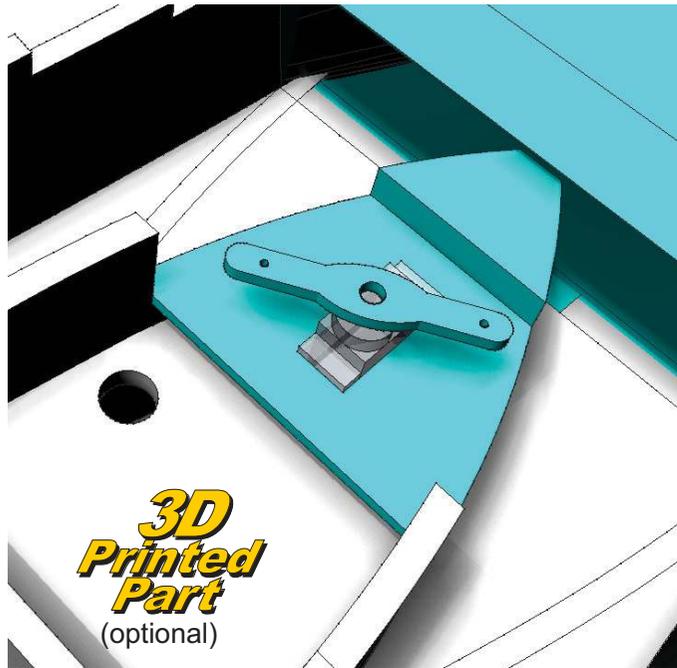
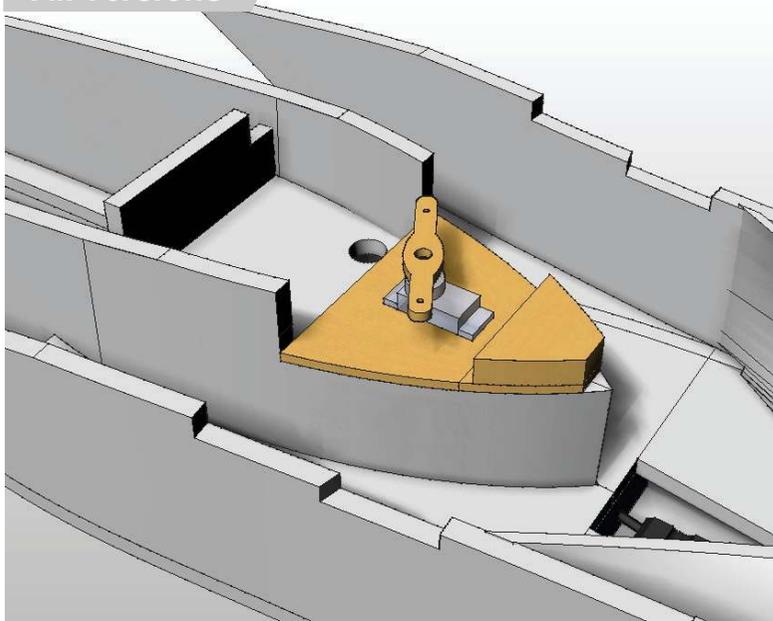
3D Printed exhaust.

**3D  
Printed  
Part**  
(optional)

Glue the **3D printed Exhaust** to the fuselage - carefully aligning to the bottom and sides of the fuselage - the top should sit higher (ultimately to the top panel - not fitted yet)



All versions



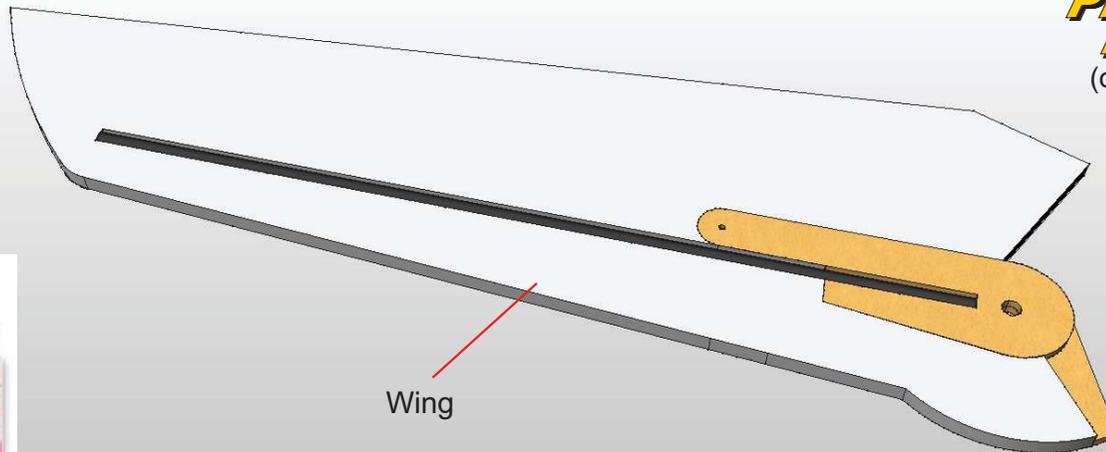
**3D Printed Part**  
(optional)

Either fabricate the Swing Wing Servo Tray from 3mm Lite-ply & Balsa or 3D print the parts.

Glue into the fuselage using UHU por.



All versions



**3D Printed Part**  
(optional)

Either print a pair of 3d printed wing hinges or fabricate a pair using a two pieces of 3mm Lite-ply.

Glue the Carbon spar along with the wing hinge to the wing as shown.

Make a mirrored pair.



Wing

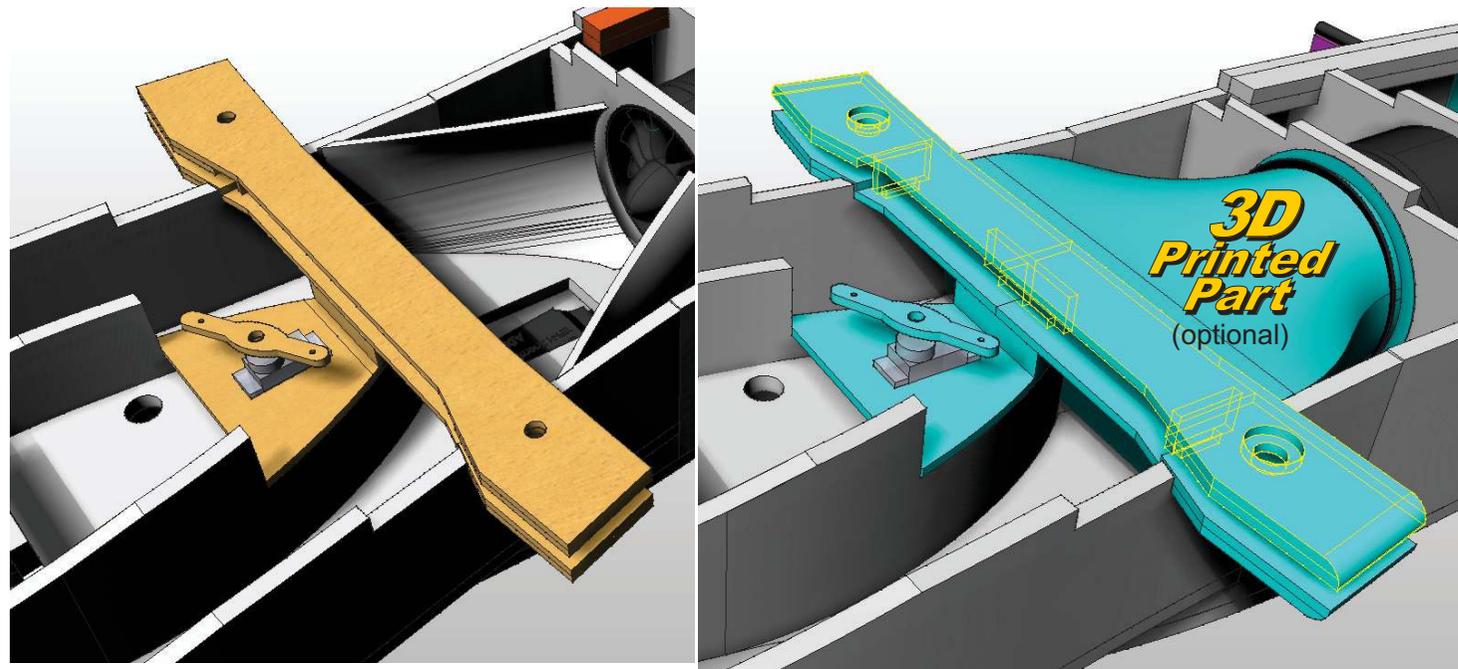




Either 3d print or construct the lower wing box using 3mm lite ply as shown.

Glue in place to the fuselage using epoxy.

Reinforce the inside corners between the box and the depron nacelle inners using 0.6oz fiberglass and epoxy (both Liteply and 3d printed variants)



Glue the upper wing box to the lower wing box.

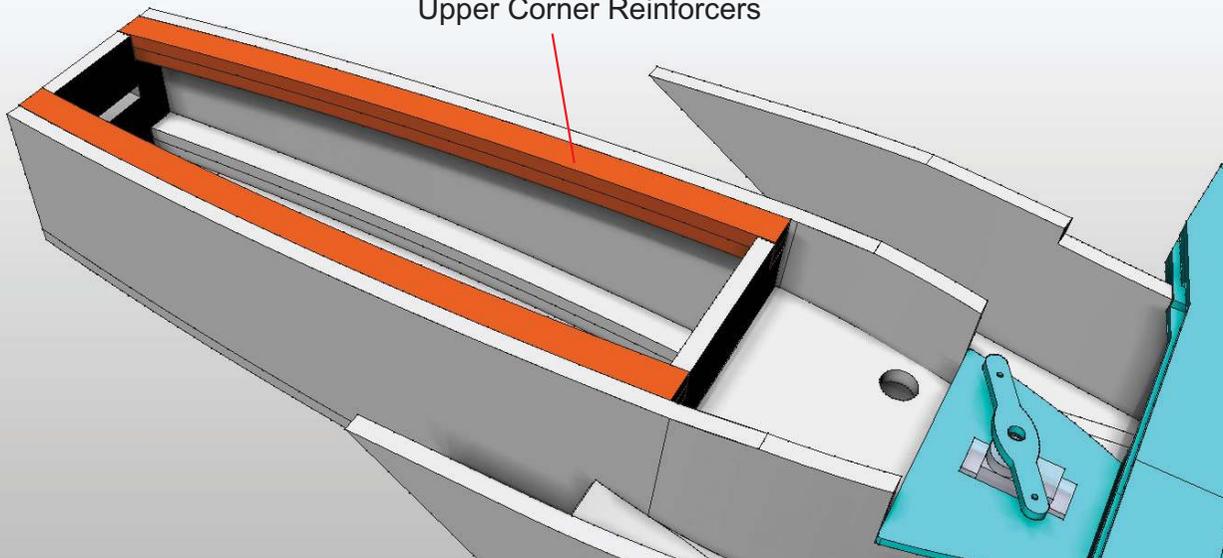
use CA (Superglue) Gel for the 3d printed parts.

Use Epoxy for the Lite-ply parts.



All versions

Forward Fuselage  
Upper Corner Reinforcers

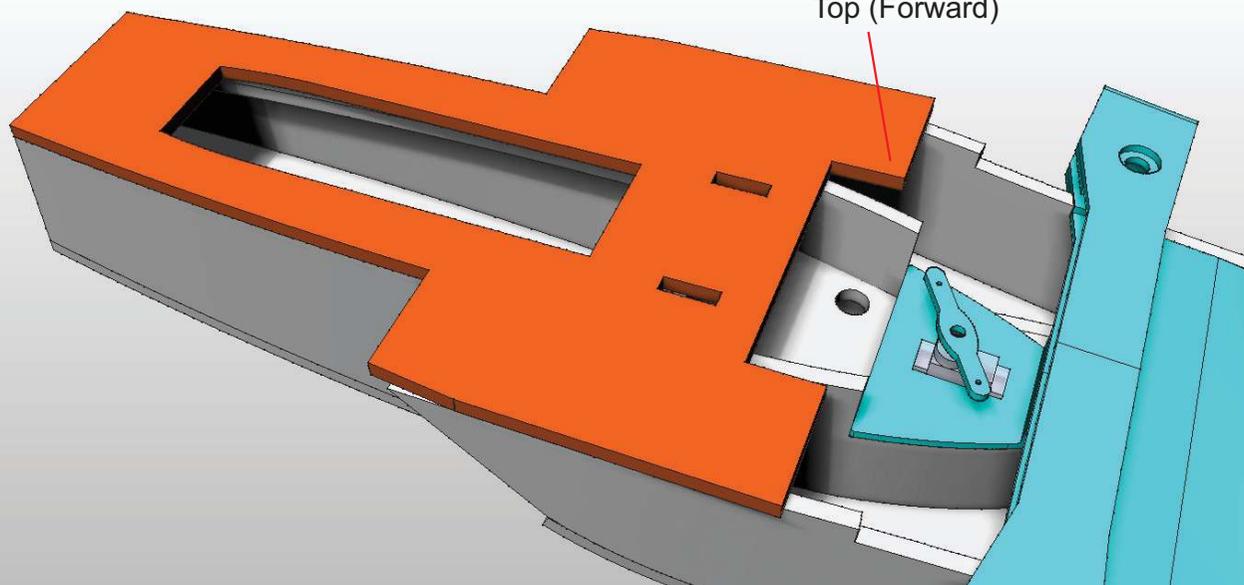


Glue the Forward Fuselage  
Upper Corner Reinforcers in  
place.



All versions

Fuselage  
Top (Forward)



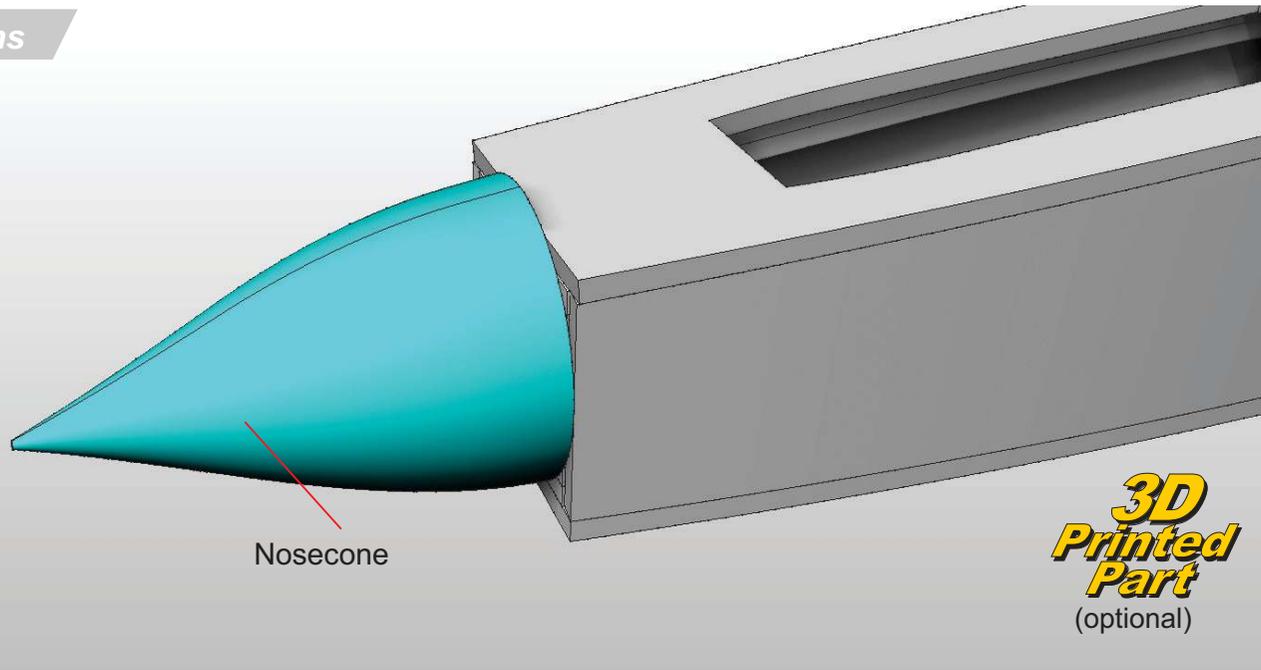
Glue the Fuselage Top  
(Forward) in place.



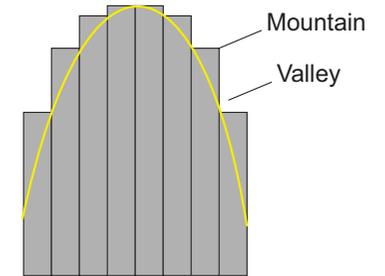
**TORNADO**



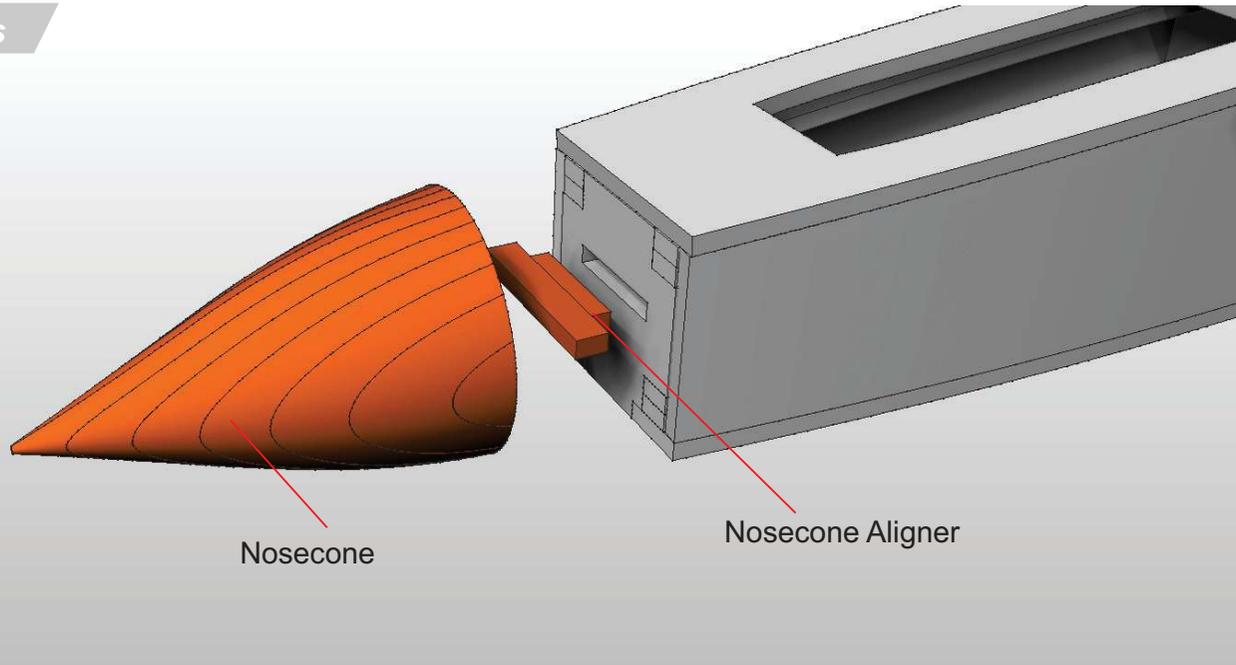
All versions



Create either a 3d printed Nosecone or a nosecone consisting of layers of foam sanded to get the right shape, by removing the 'mountains' until the 'valleys' are no more.



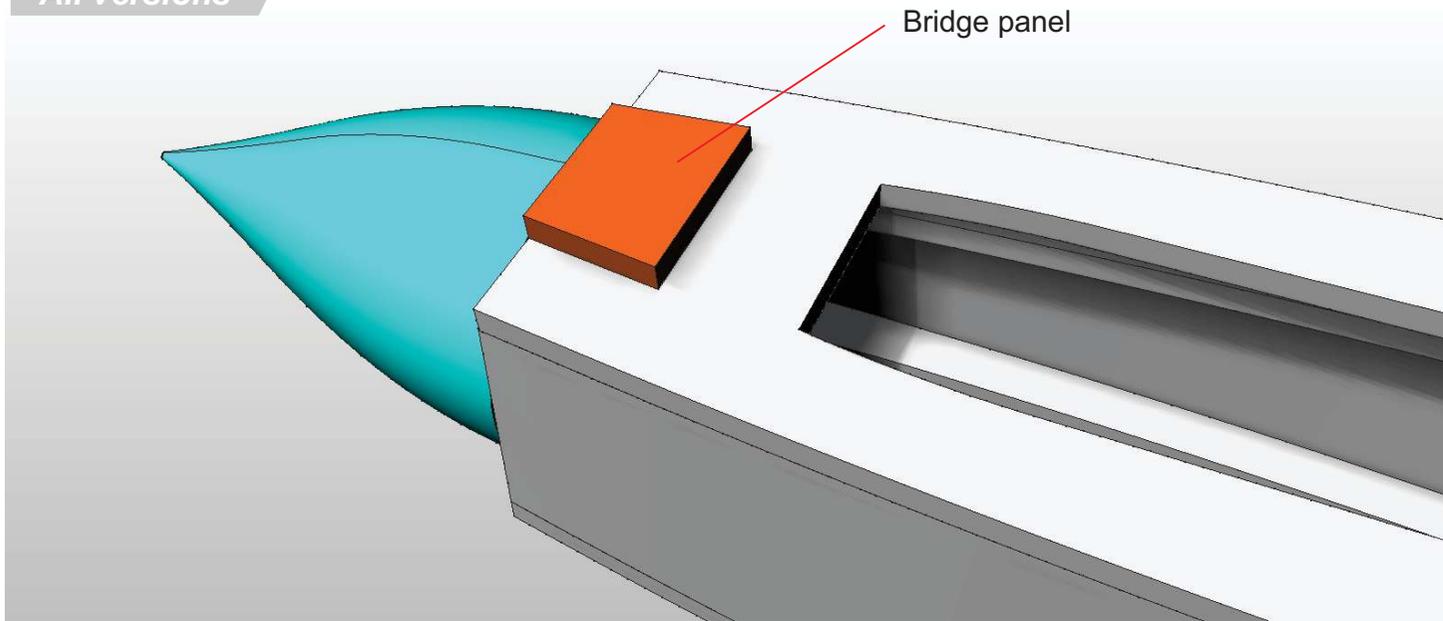
All versions



Glue the **Nosecone** to the assembly using the **Nosecone aligner** to ensure accurate positioning



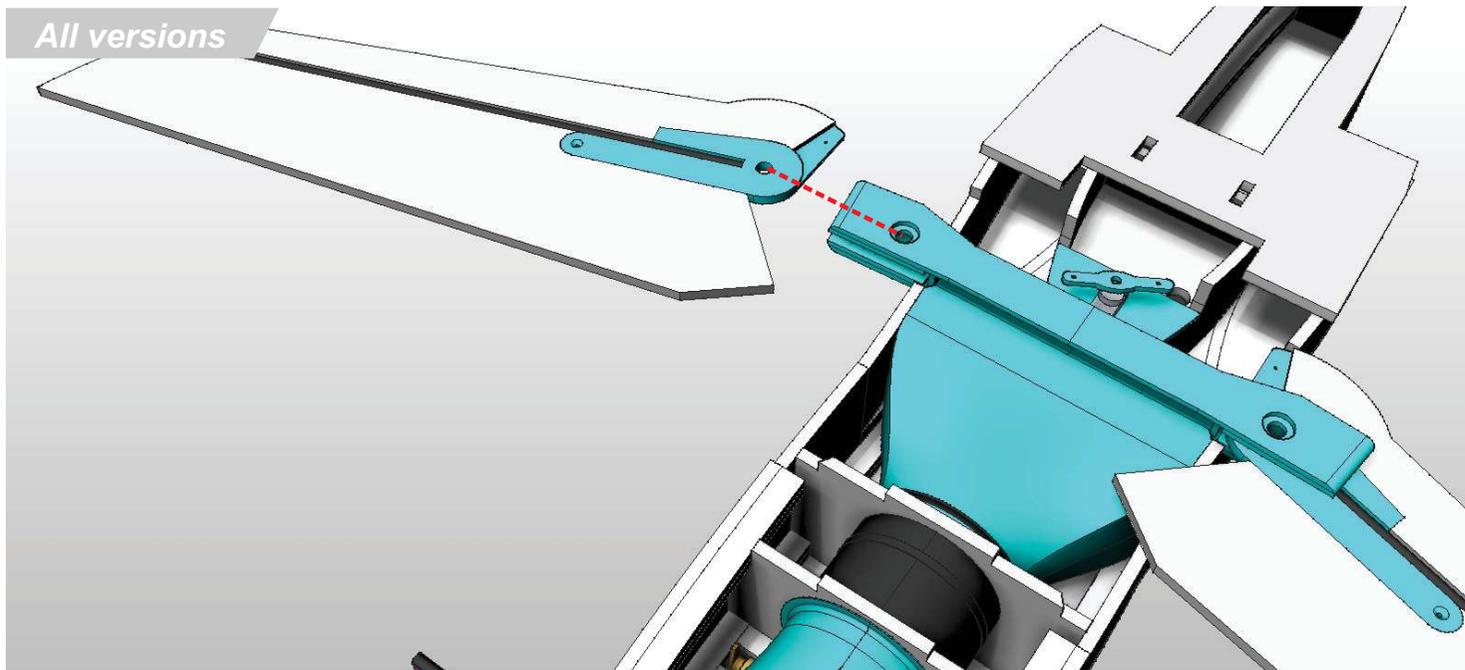
All versions



Glue the Bridge panel in place.



All versions

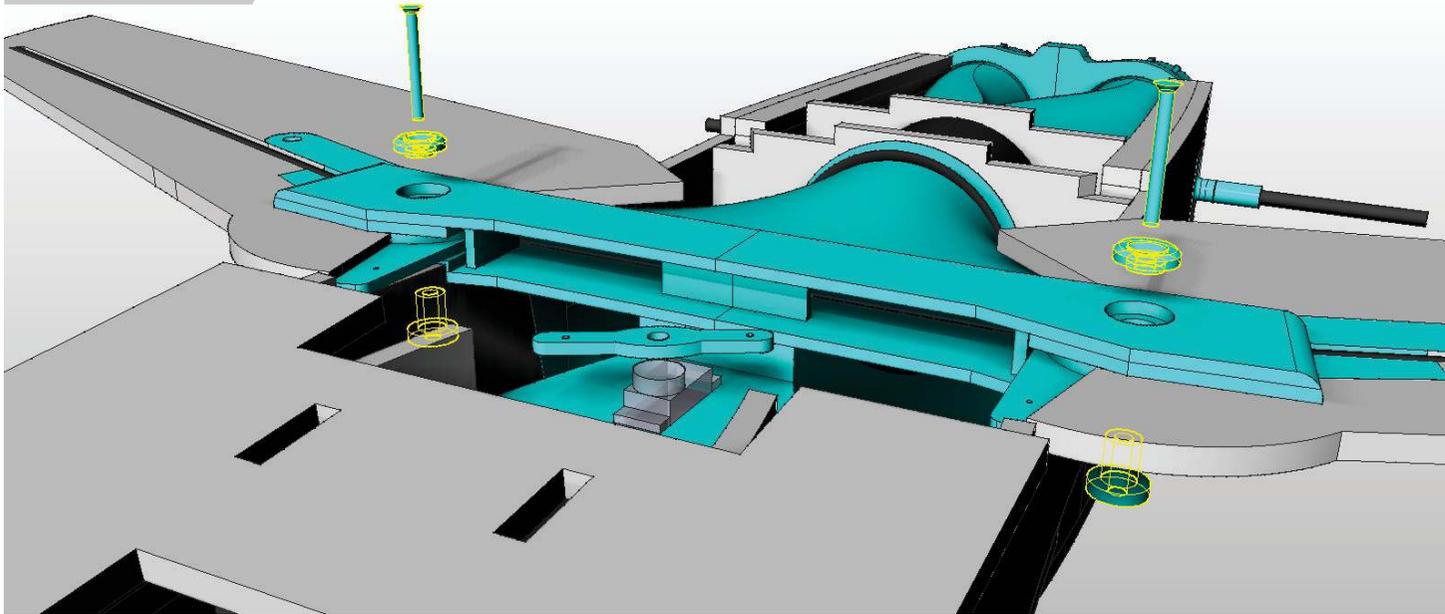


Slot the wings into the wing boxes

**TORNADO**



All versions



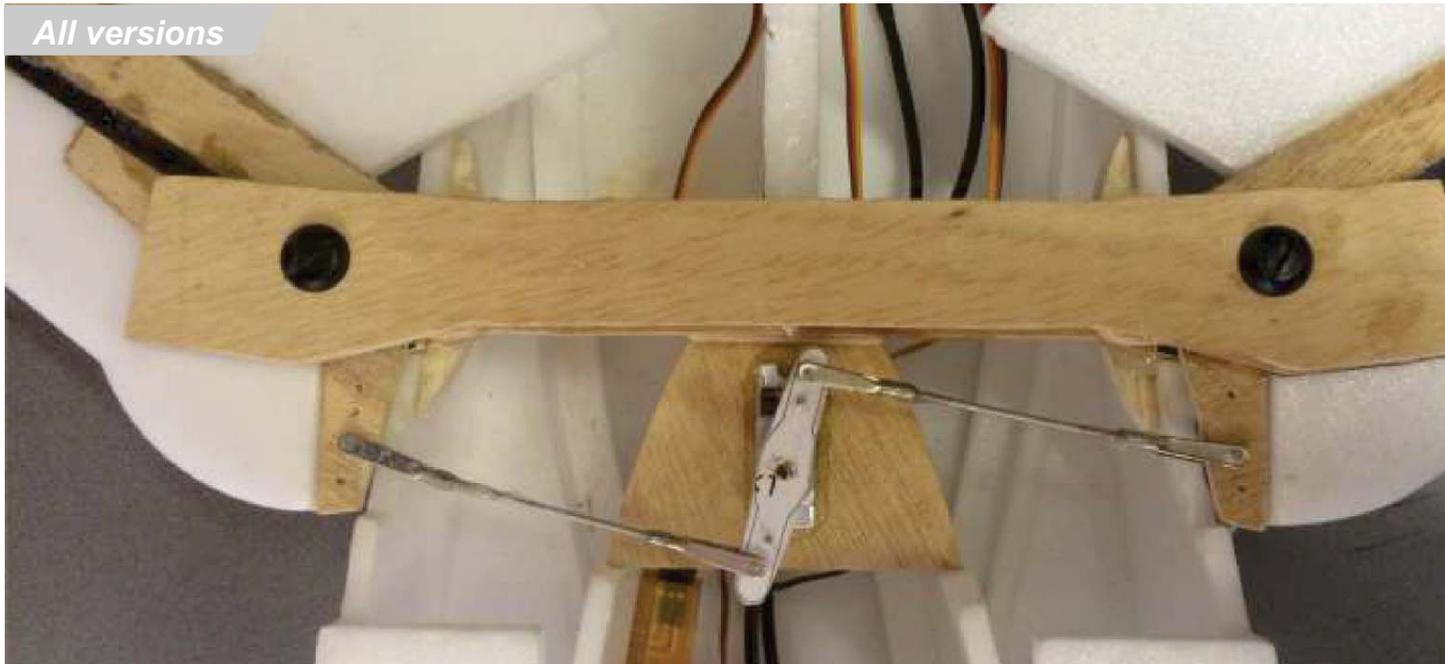
PLY VERSION :

Use 6mm Plastic bolts and nuts to secure the wings to the assembly

3D PRINTED VERSION :

Use 3mm countersunk bolts and nuts along with the 3D printable wing bush.

All versions



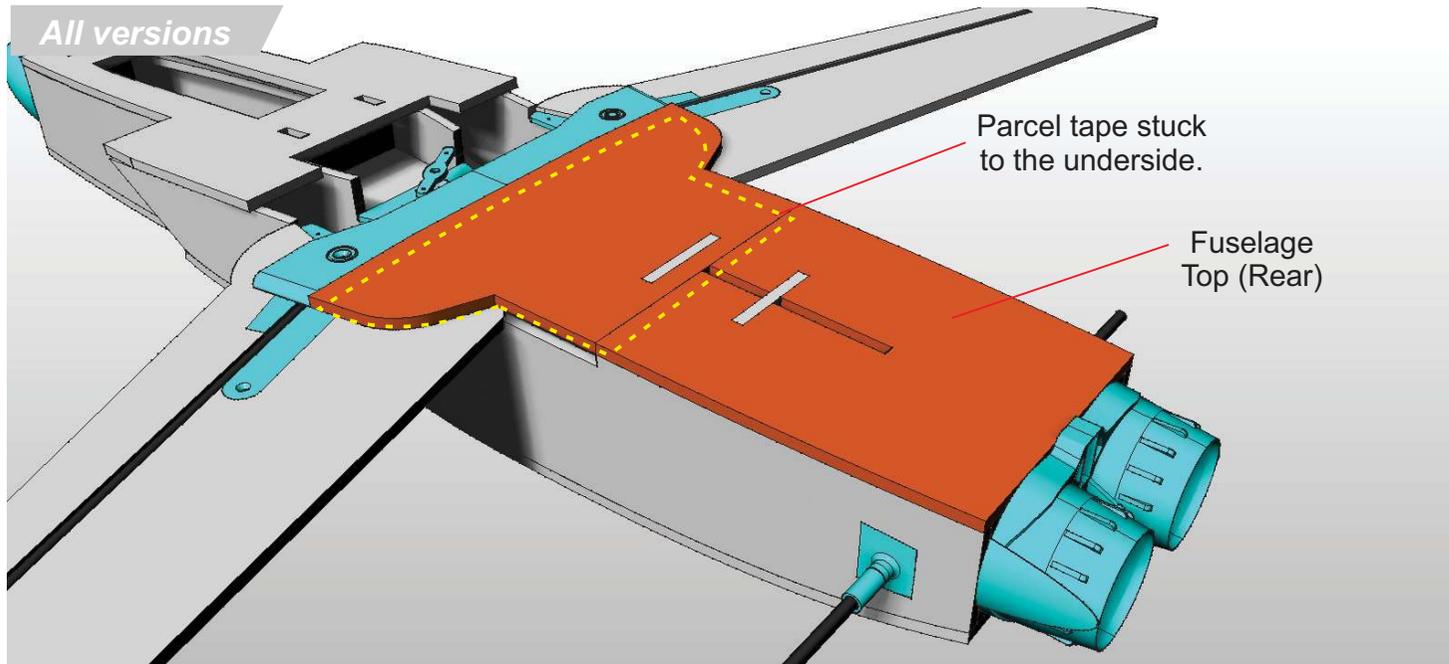
Screw a 17g metal gear servo into the servo slot.

Attach the servo extension arm onto the servo horn using small self tapping screws.

Using 2mm threaded bar and clevis connect the servo arm to the wings.

Create the Geometry as shown.

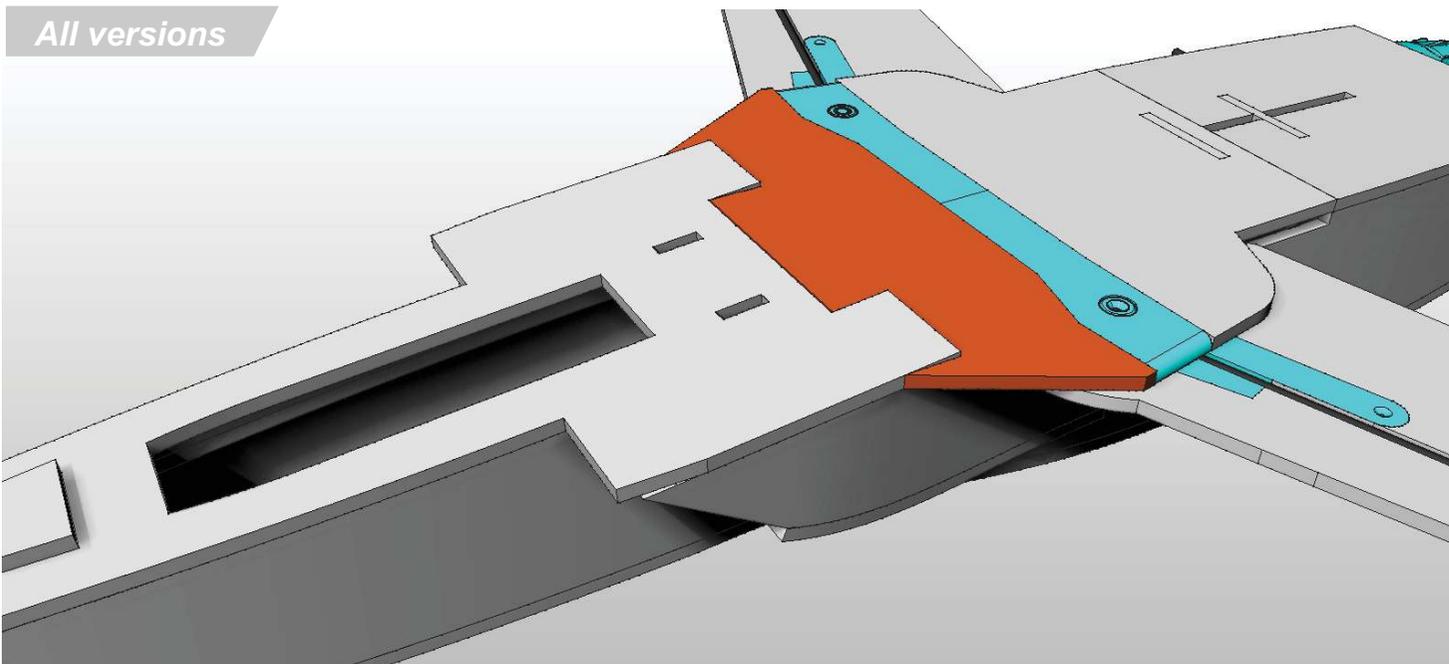




Stick parcel tape on the **Fuselage Top (Rear)** underside in the areas that may come into contact with the sweeping wing.

Glue the to the assembly. Sticking the front edge to the upper wing box.

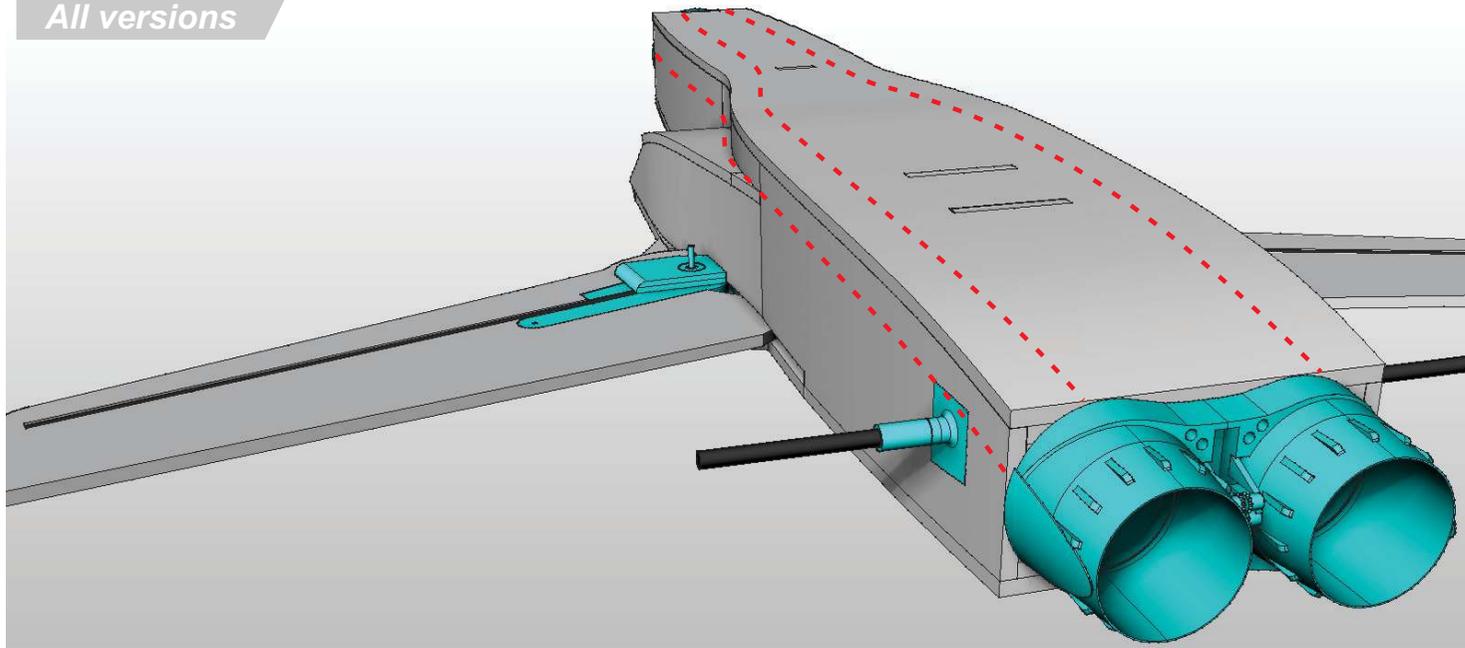
Check for a smooth motion



Once it has been fully checked and adjusted. Glue the **Fuselage Top (Middle)** in place.



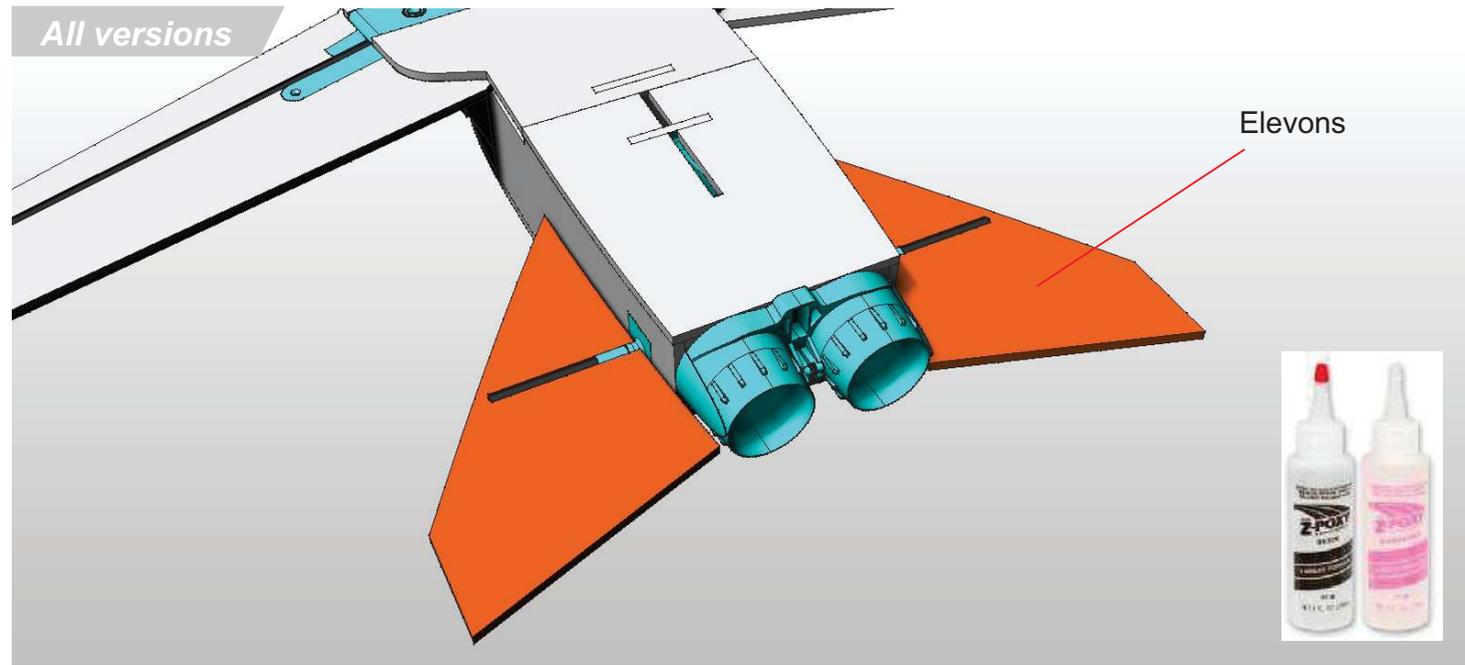
All versions



Study the images of the underside of the real tornado and shape the belly corners to match.

The front and rear should match the exhaust and nosecone shapes.

All versions



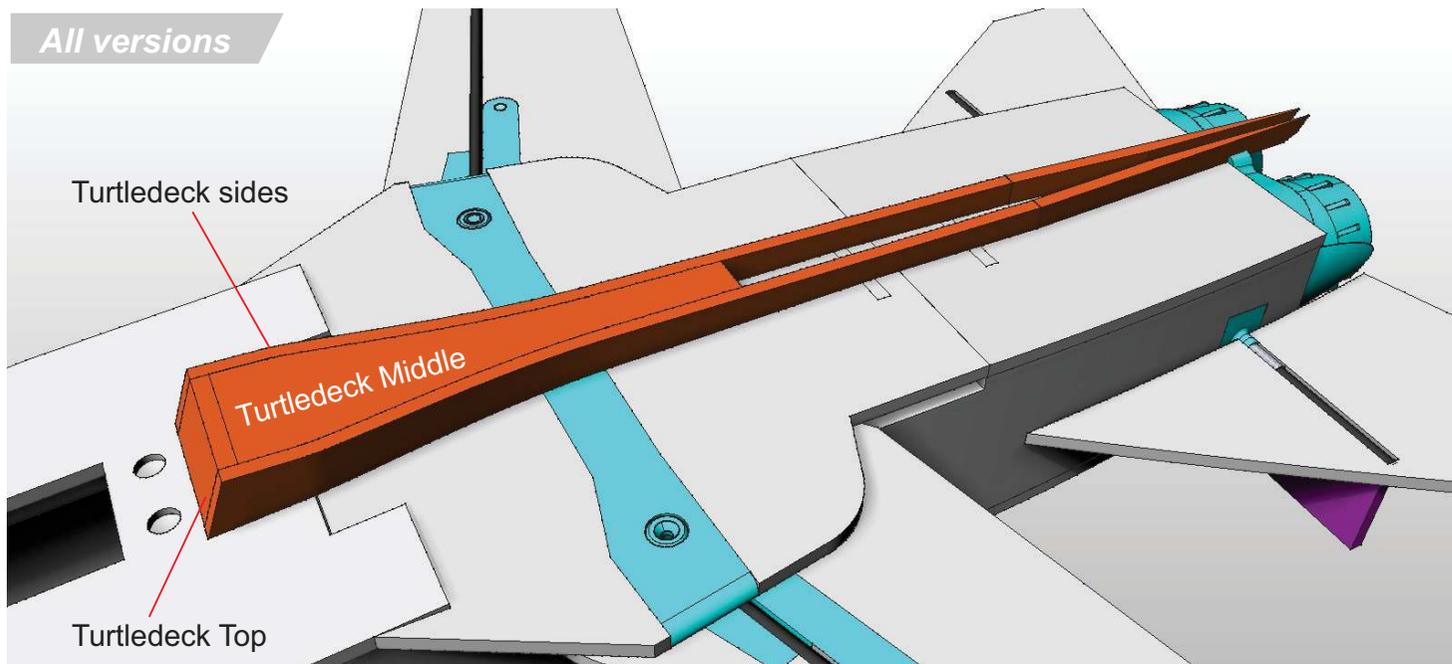
Using Masking tape to prevent drips and epoxy - Glue the Elevons to the Elevon spars, keeping epoxy away from the edge of the tube.

Support them on two piles of books while the glue sets to hold them horizontally.

**TORNADO**



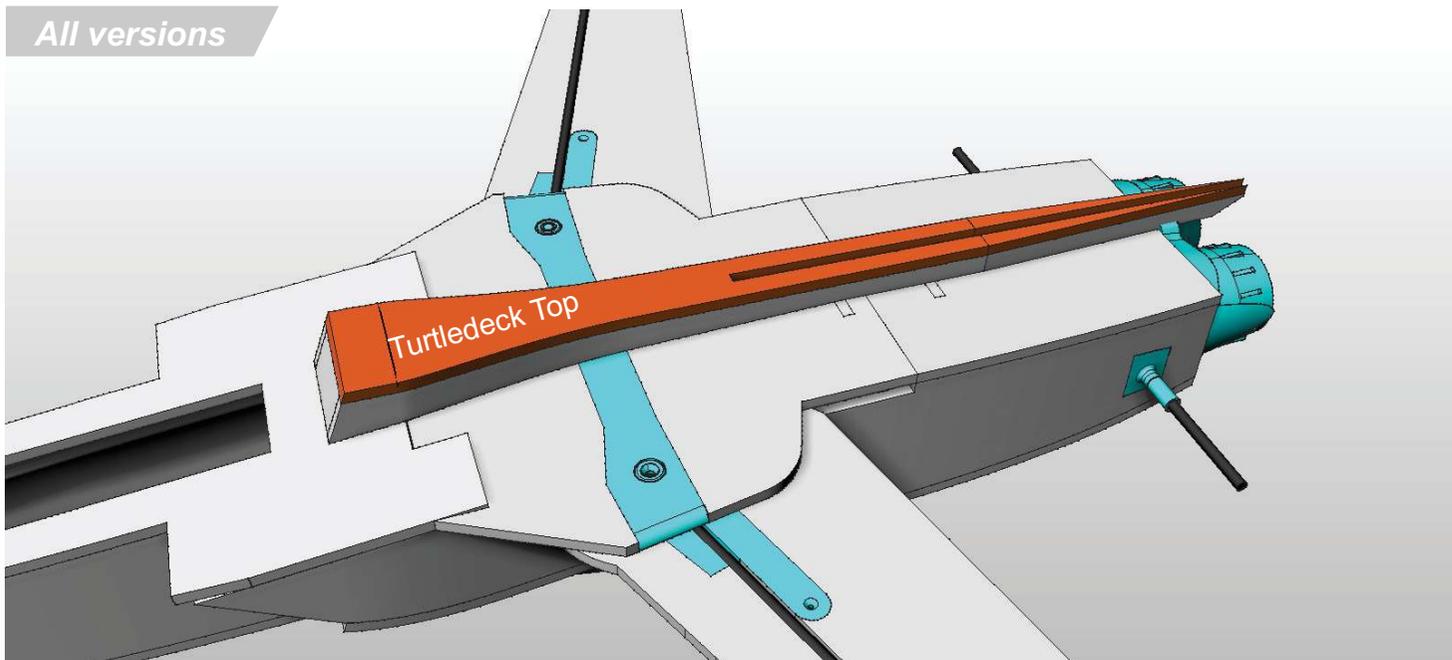
All versions



Glue the Turtledeck parts together and then glue to the Fuselage on centreline



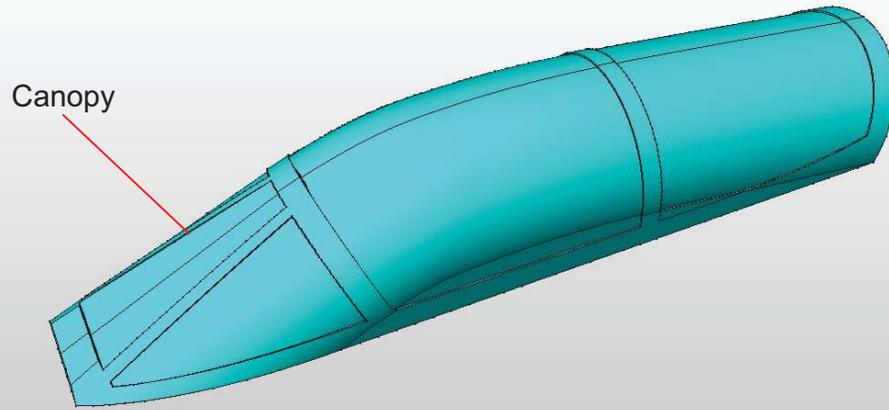
All versions



Glue the Turtledeck top to the assembly



All versions



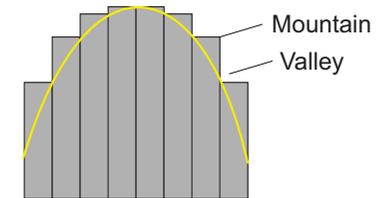
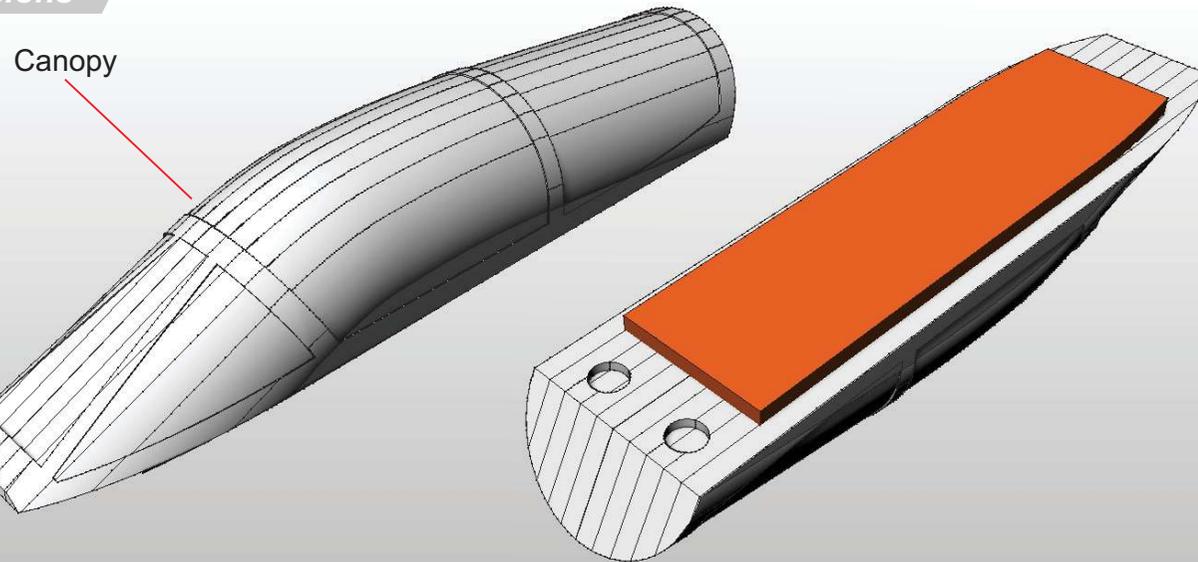
**3D  
Printed  
Part**  
(optional)

Create either a :-

- 3d printed Canopy
- Vac formed canopy
- Laminated Canopy

a laminated canopy consists of layers of foam sanded to get the right shape, by removing the 'mountains' until the 'valleys' are no more.

All versions



Fuselage upper corner reinforcers

Fuselage side (Inner)

Pusher only

All versions

EDF only

PARTS 'CUT AWAY' FOR ILLUSTRATION PURPOSES

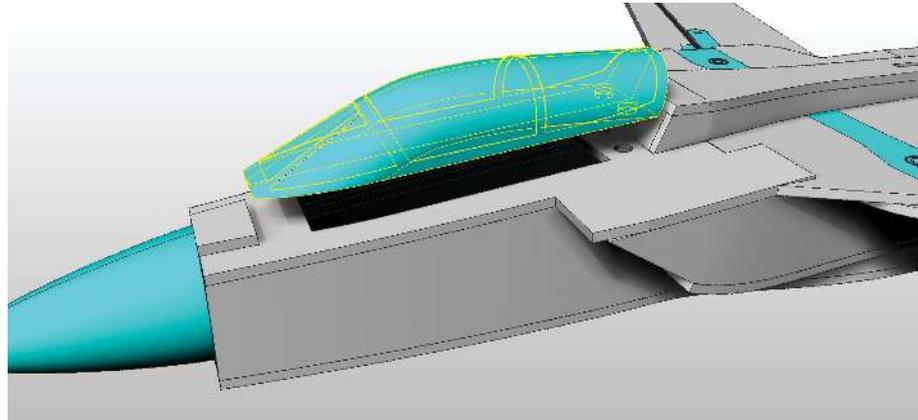
Pusher Bulkhead 4

6mm

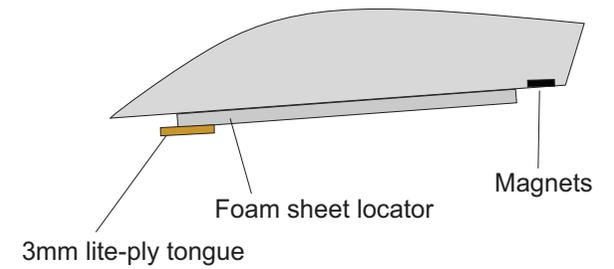
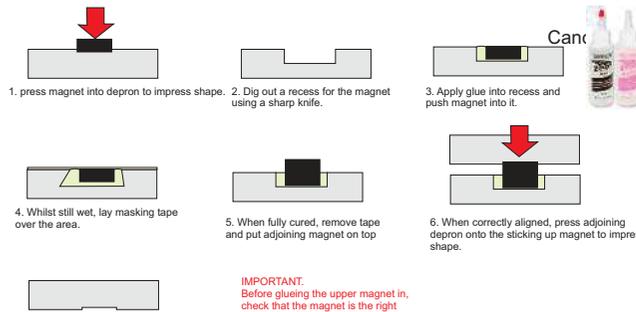


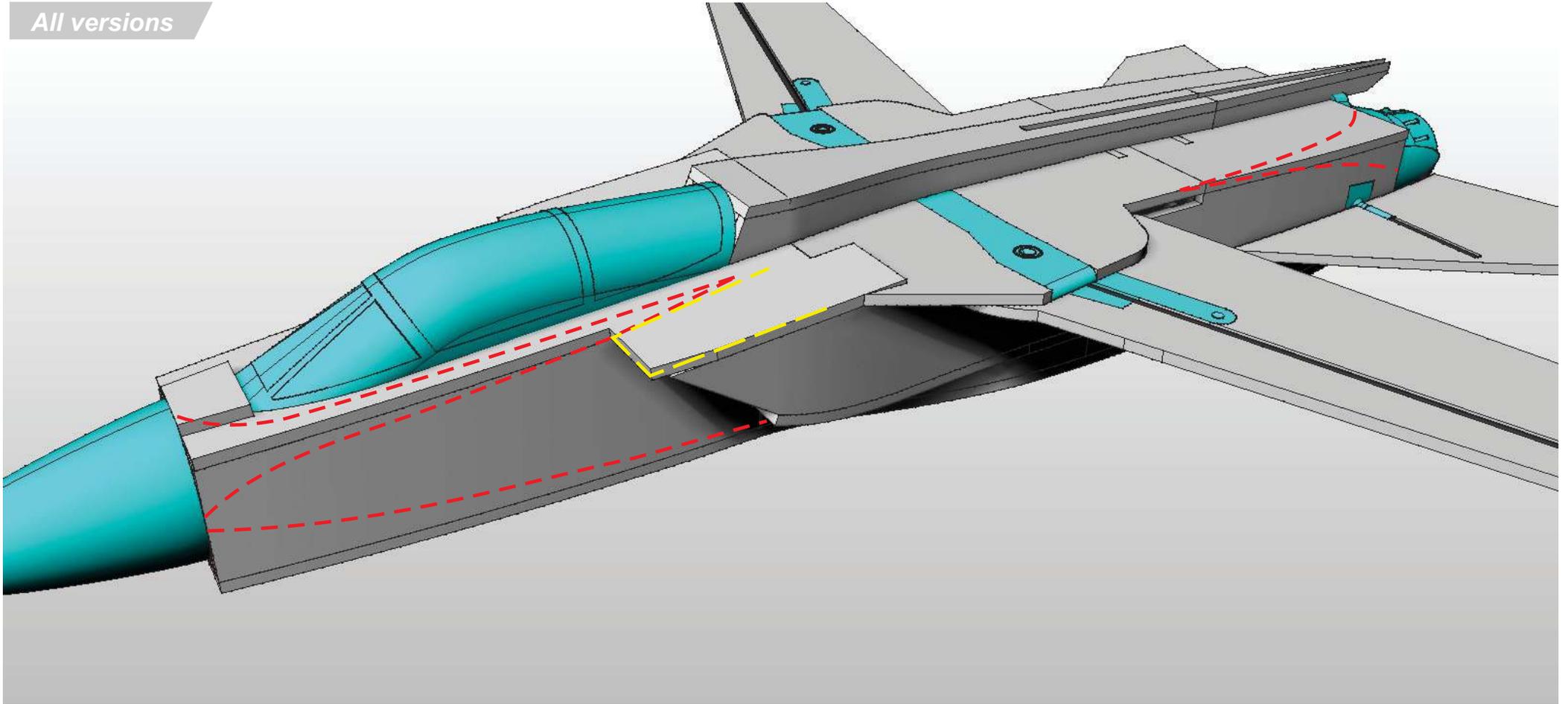
All versions

EDF only



Add magnets and tongue as shown. .

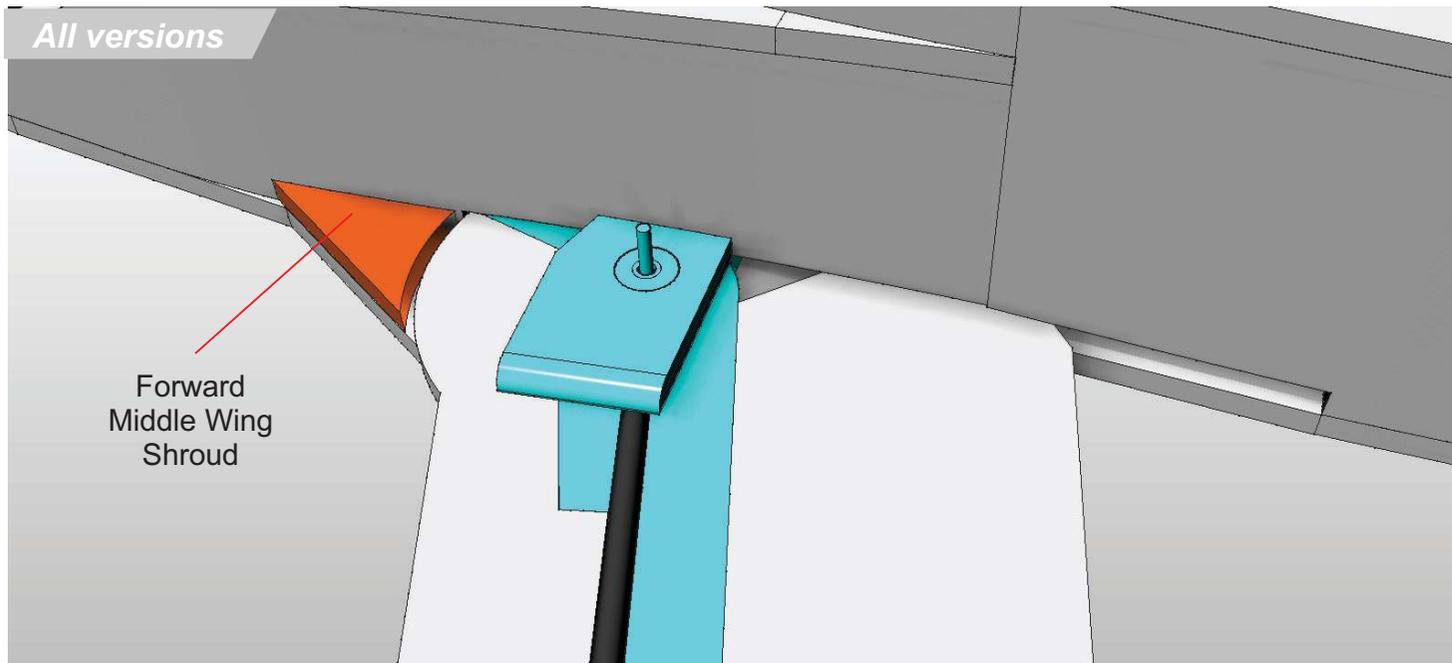




Use images of the real aircraft to guide you and sand the edges of the fuselage to create the form as shown.



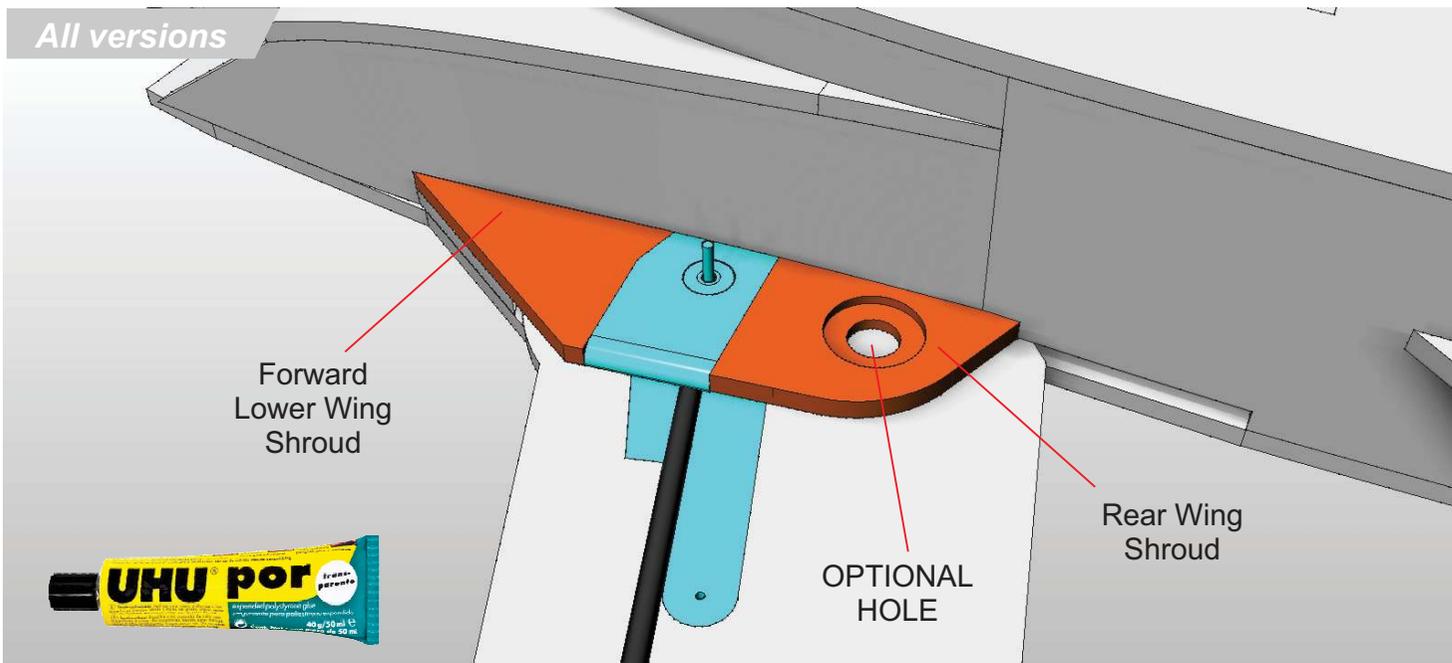
All versions



Glue the **Forward Middle Wing Shroud** to the underside of the Fuselage top (Middle) as shown



All versions



Sand away a wing clearance gap then glue the **Forward Lower Wing Shroud** to the assembly.

On the upper face of the **Rear Wing Shroud** apply parcel tape to reduce friction.

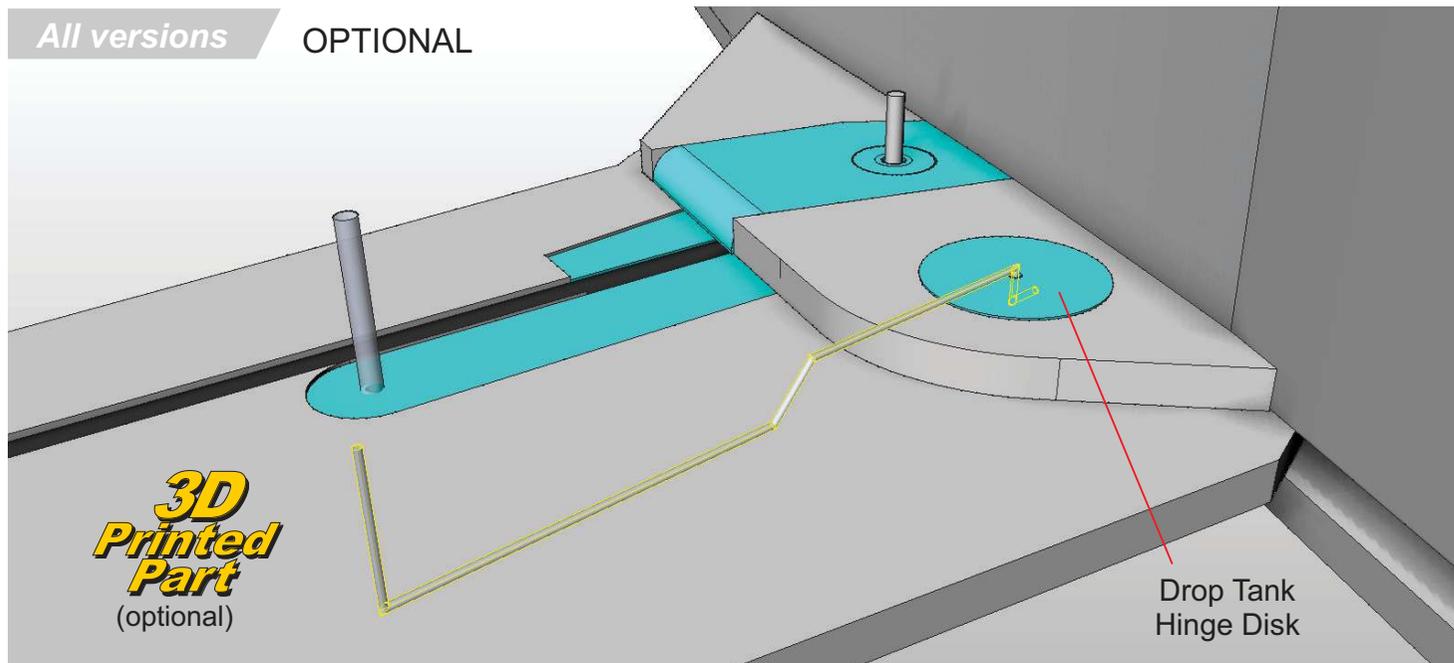
OPTIONAL

If you are fitting the swinging drop tanks then you will need to carefully make a hole and flange to receive the disk as shown.



All versions

OPTIONAL

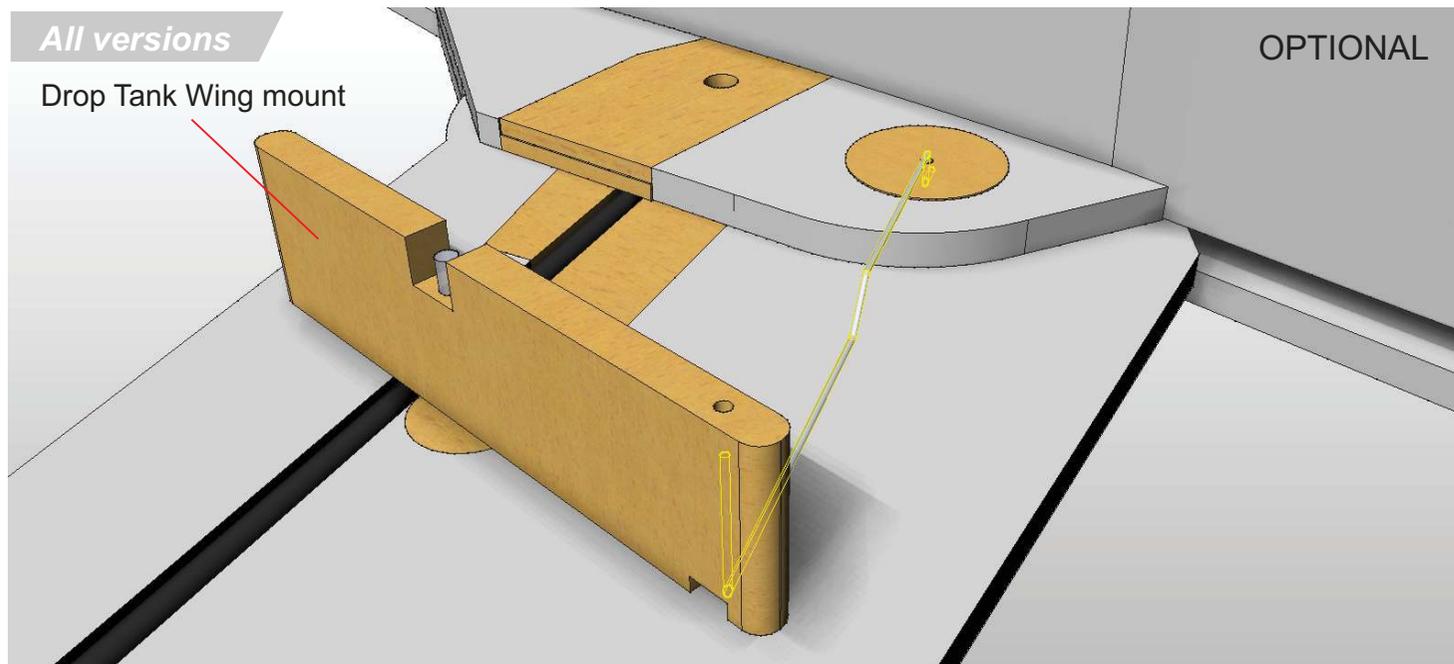


Glue the **Drop Tank Hinge Disk** into place on the rear wing shroud.

Bend the piano wire to the correct shape and locate into the disk as shown.

All versions

OPTIONAL



PLY VERSION ONLY

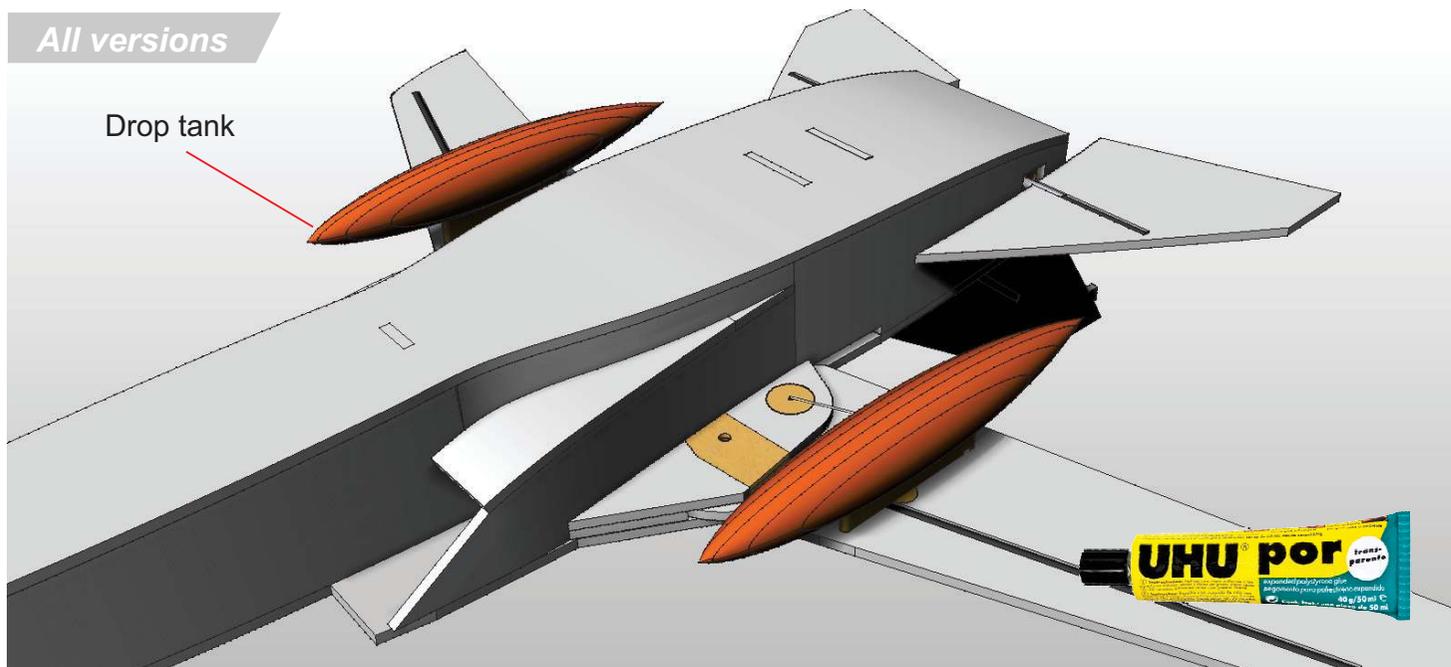
Assemble the two halves of the **Drop Tank Wing Mount**. Drill through in two places - one for the 3mm countersunk and one for the piano wire.

Using an M3 Nylock nut screw onto the bolt, don't overtighten.

Check the mechanism for smooth operation.



All versions



Fabricate the drop tanks either from Depron or 3d Print them.

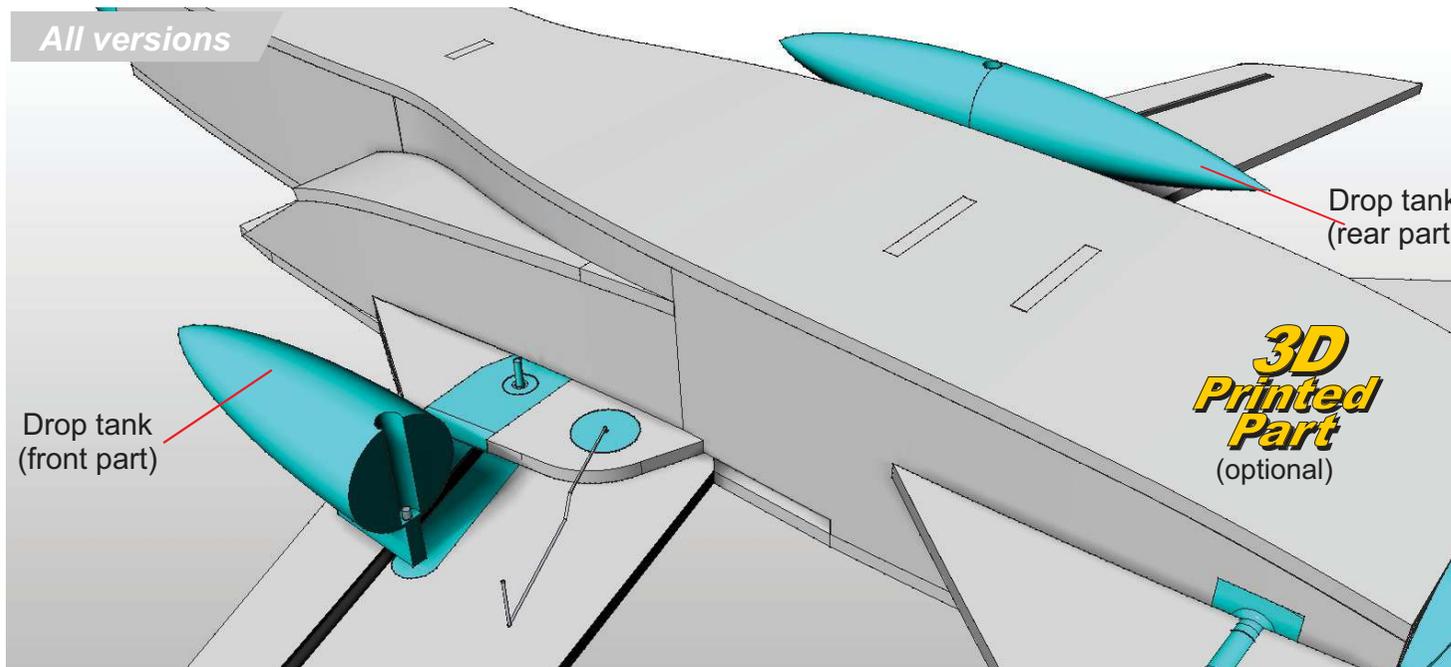
NON 3D PRINTED :

Glue the Drop tanks onto the liteply wing mounts.

3D PRINTED :

The drop tanks are made in two parts. Attach the forward drop tank part to the wing bolt by sliding over the wing bolt and fitting an m3 nut.

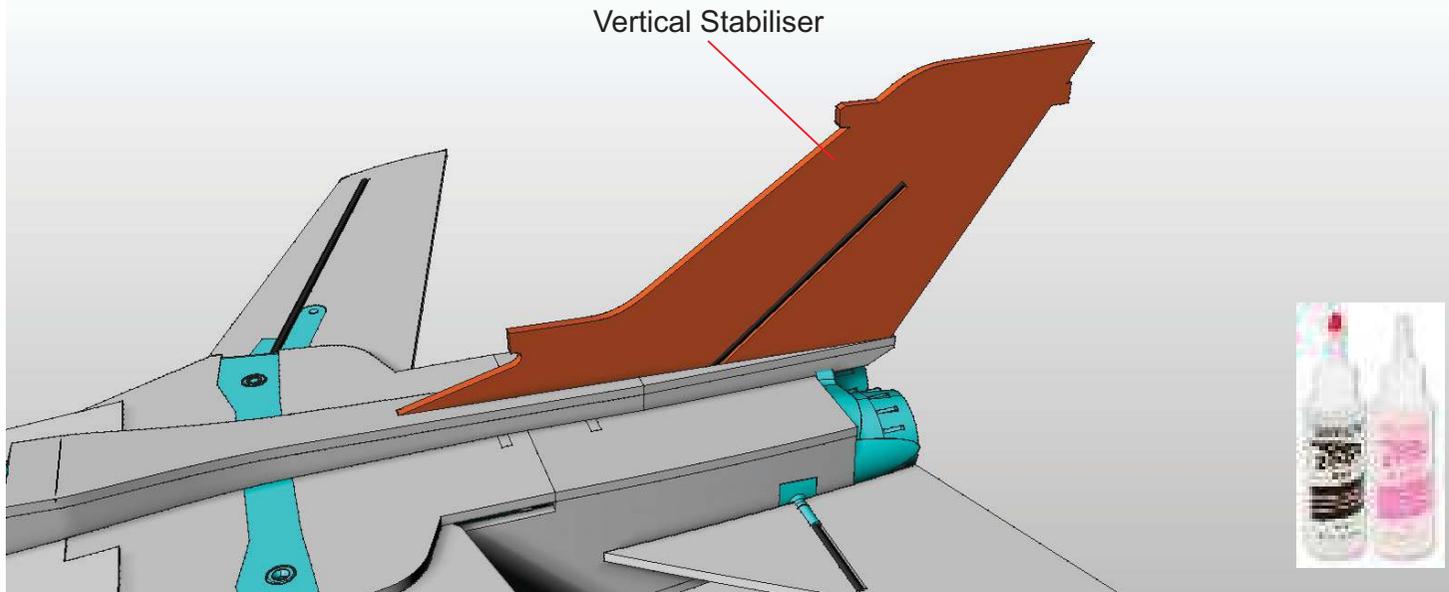
All versions



After this, Glue the rear part to the front part using CA Glue - whilst slotting the piano wire into place on in the hole in the rear part.



All versions

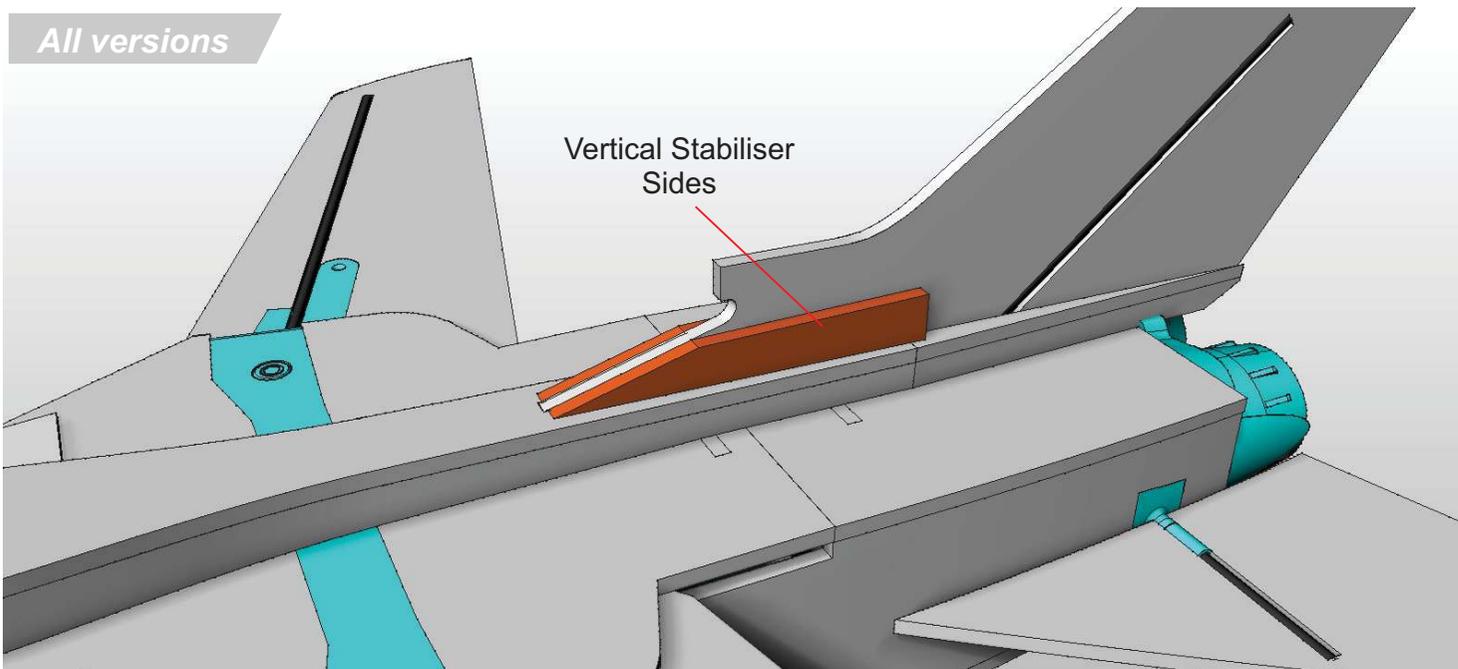


Using Epoxy and Masking tape, Glue the Spar into the **Vertical Stabiliser**.

When set, Glue into the slot in the fuselage using epoxy.

Support the Vertical Stabiliser to remain vertical while the glue sets.

All versions



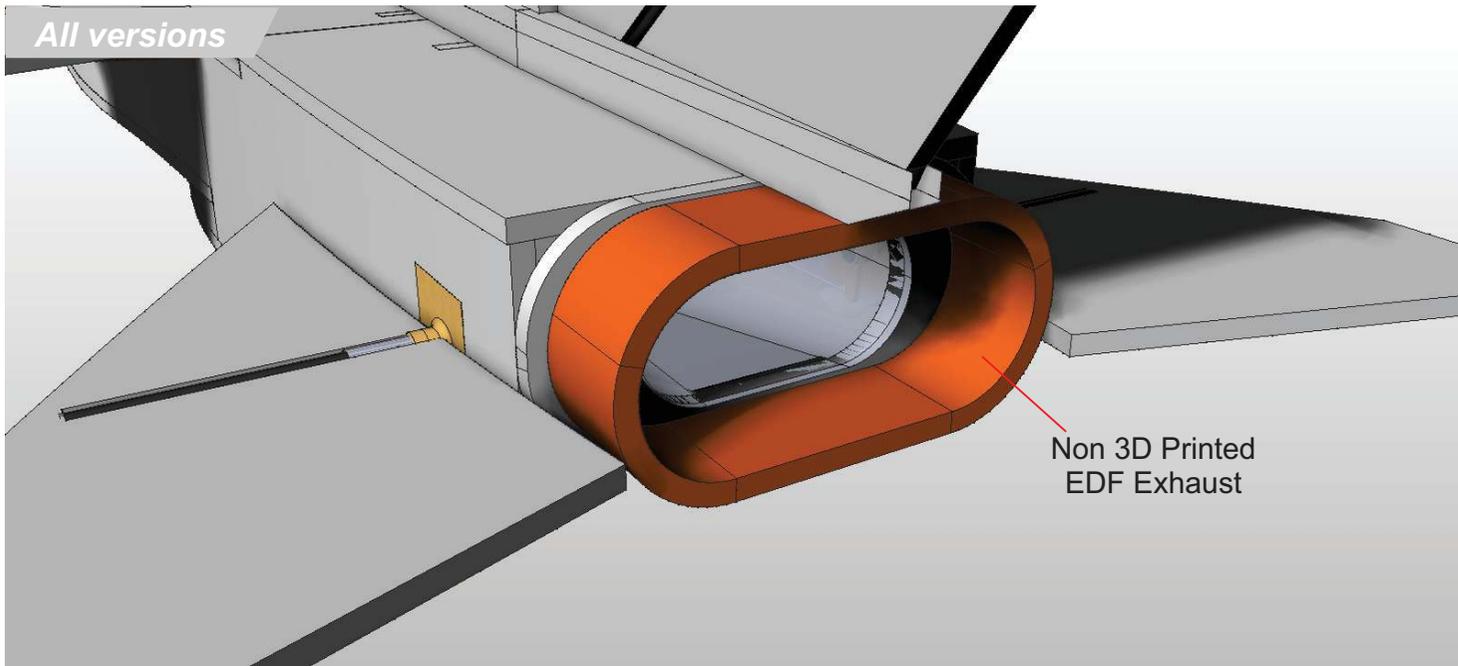
Glue the **Vertical Stabiliser Sides** in place.



**TORNADO**



All versions



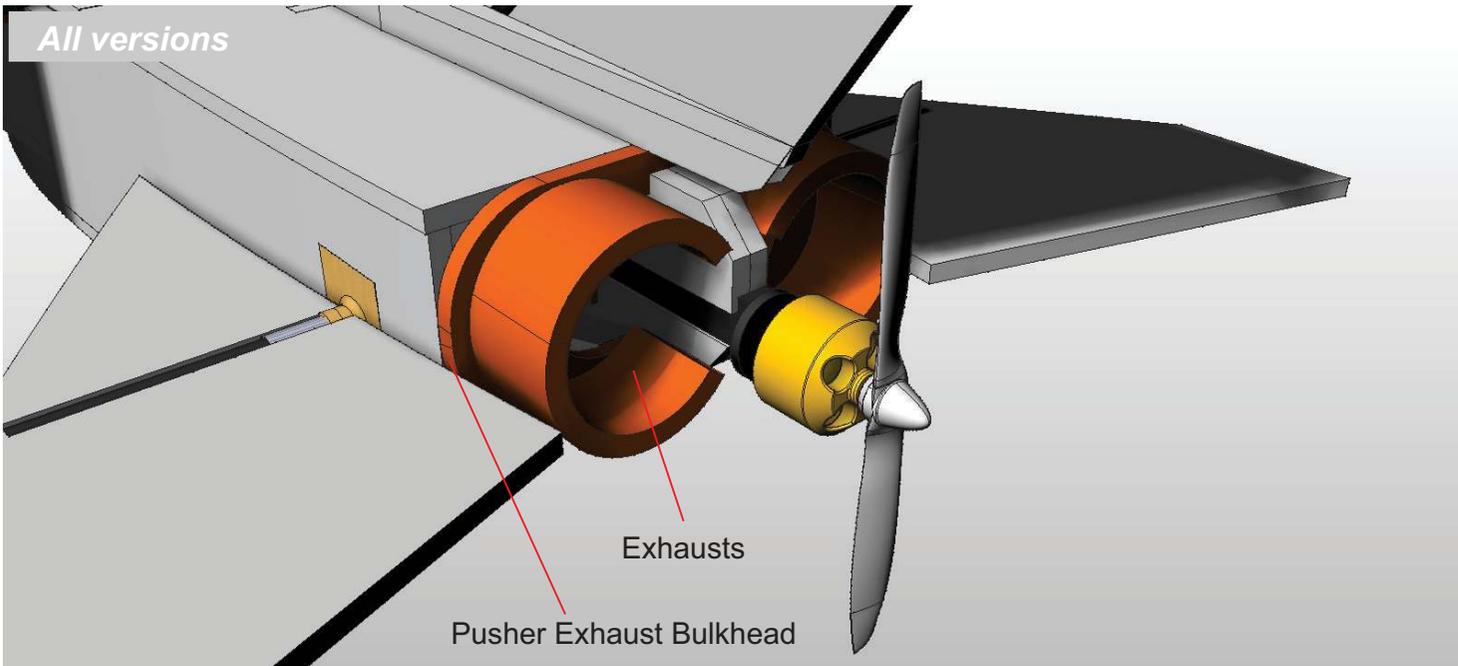
NON-3D PRINTED

Create the **EDF exhaust** using the JIGS and two layers of 3mm Depron.

Glue in place.



All versions



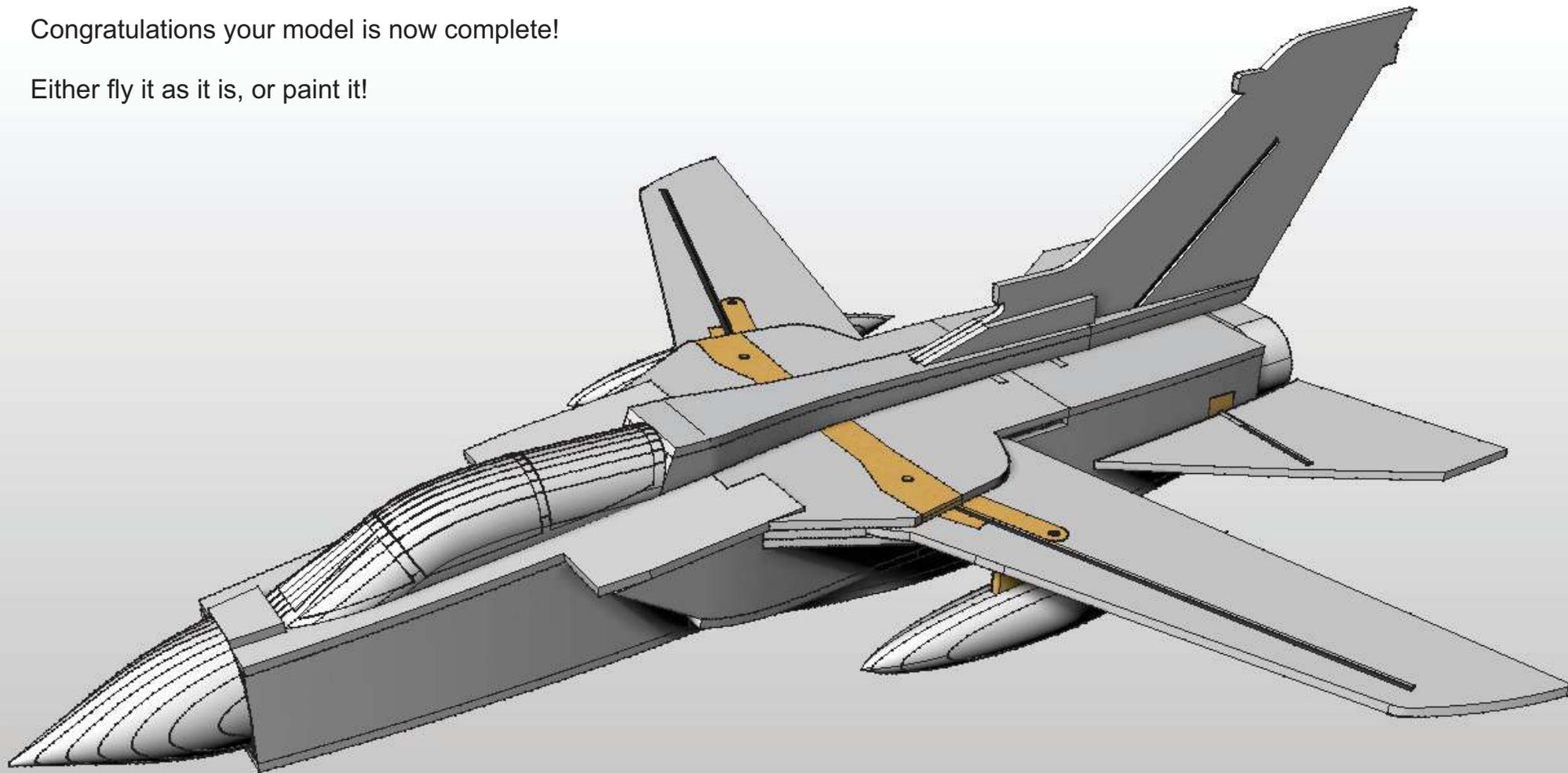
Glue the **Pusher Exhaust bulkhead** in place, then the two **Exhausts** using two layers of 3mm depron wrapped around the JIGS.

Glue in place.



Congratulations your model is now complete!

Either fly it as it is, or paint it!



There are various photos of the Fullback available on Google images to help you with the shaping and details.



**TORNADO**

