



ORANGE TEAM 2019

*Critical Design Review (CDR)
20 February 2019*



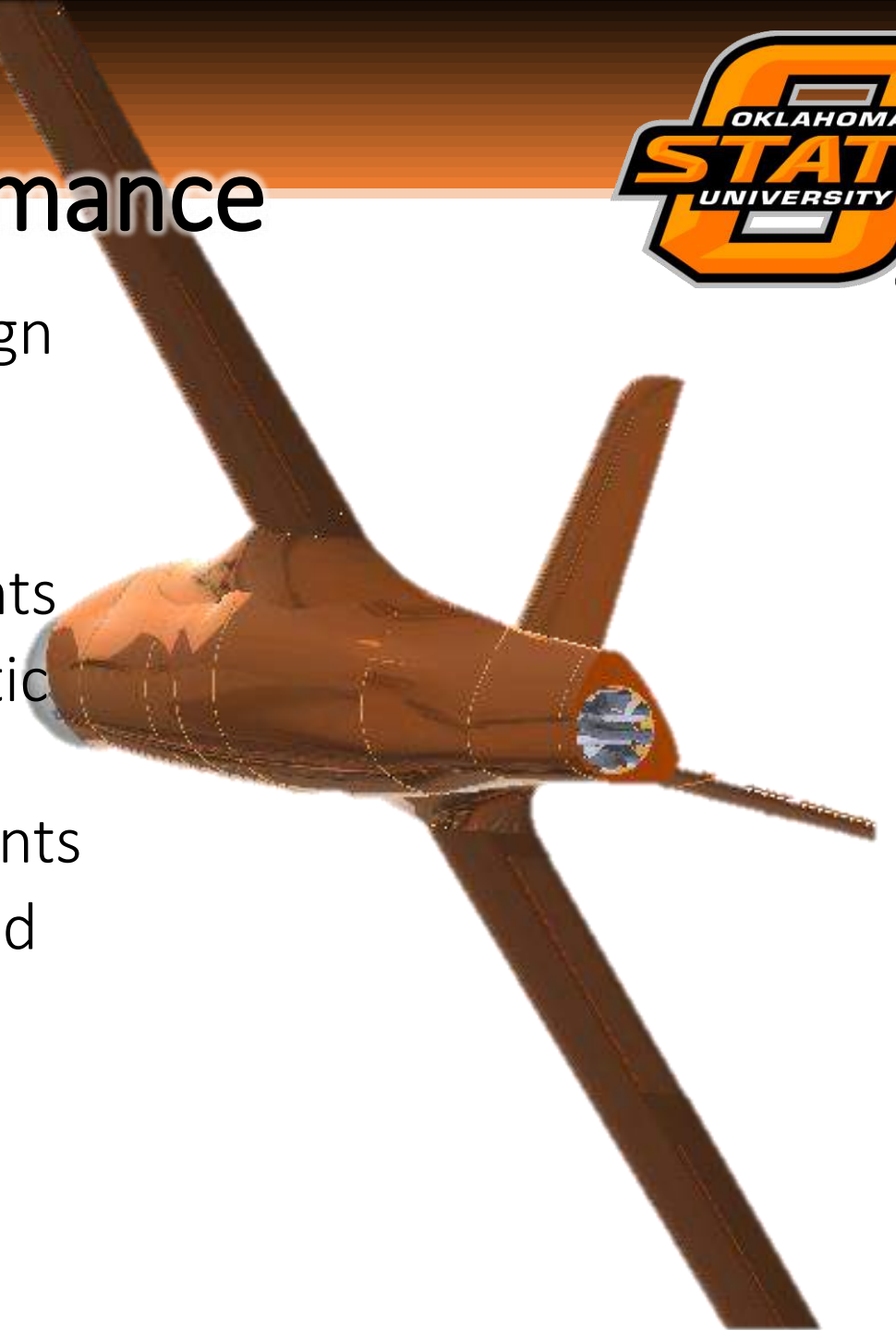
Overview

1. Overall Timeline and Goals for Phase 3
2. Overview of Concept
3. Manufacturing Timeline
4. Structures: Manufacturing and Materials
5. Structures: Aircraft Configurations
6. Ground Equipment
7. Launch and Recovery
8. Aerodynamics
9. Propulsion
10. Review
11. Backup Slides



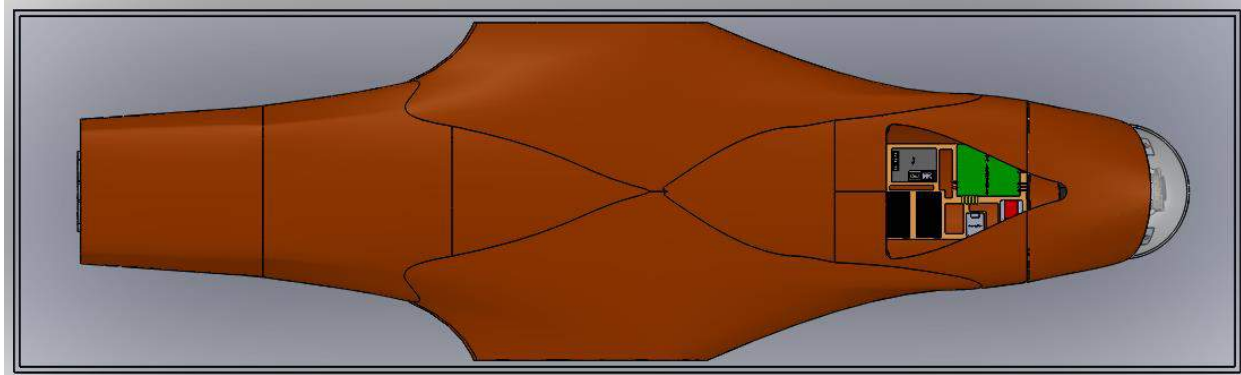
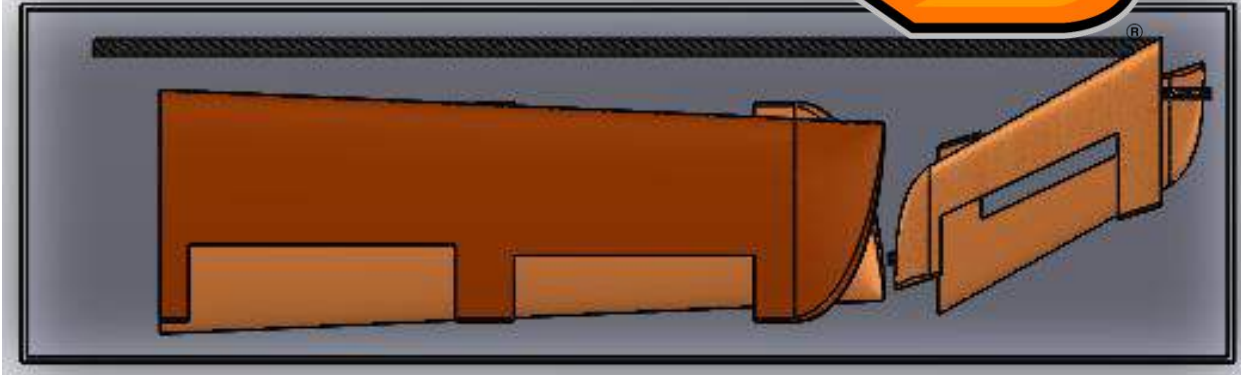
Overview: HawkEye Performance

- Small, compact, and high speed design
- 25% static margin
- Max GTOW = 17.9lb
- Ground launched, meets requirements
- Lobed exhaust and K-wool for acoustic cancellation
- Meets all range and loiter requirements
- 30x optical zoom with 3-axis stabilized gimbal
 - Long range targeting
 - Low acoustic signature at distance



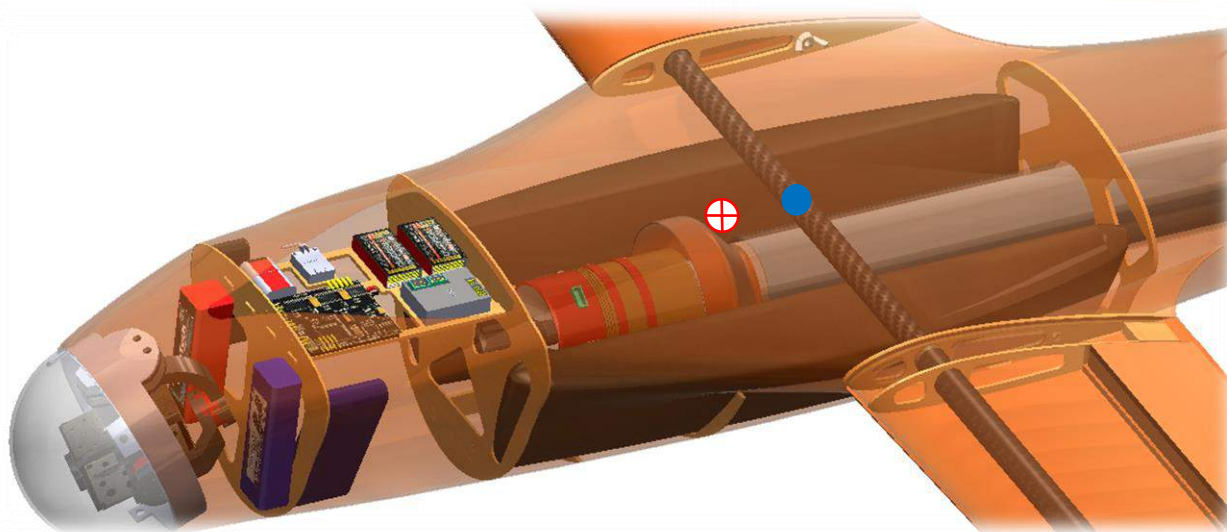
HawkEye: Inside the Box

- Small, compact, and high speed design
- Aircraft fits in 2 designated Pelican Cases
- Third case used for ground equipment



HawkEye: Basic Figures

- Max Thrust: 15.5lb
- Max Speed: 132 ~ 151 kts
- Max GTOW: 17.9lb
 - Empty Weight: 10.96lb
- SM: 18.6%
 - CG @ 22.1 in from nose
 - Quarter Cord @ 24 in





STRUCTURAL DESIGN AND MANUFACTURING

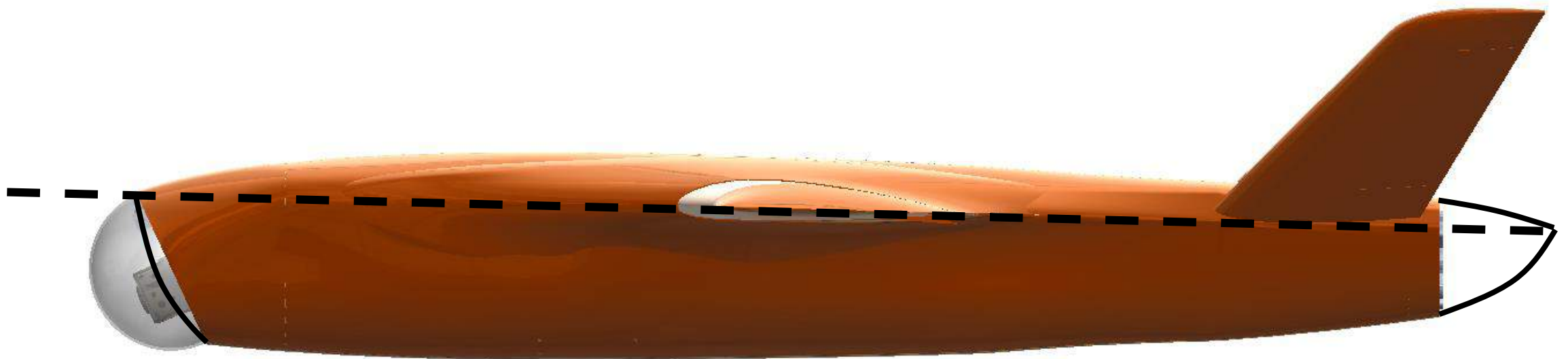


Tasks Accomplished Since PMR

- Finalized wing and tail attachment structure
- CDR Specific Tasks
 - Takeoff/landing strategies
 - Molding strategy
 - Fuselage skin layup and weight estimations
 - Internal components, electronics, camera and bulkhead configuration
 - Inlet and hatch integration
 - Camera and acrylic dome integration
 - Specified skin weights and C.G. calculations

Aircraft Molding Strategy

- Top-bottom molds for both fuselage body and wings
- Left-right mold for V-tail



Core Option 1: Balsa Wood

- Thickness: 1/16"
 - Density: 6~10 lb/ft³
- Has traditionally been used in past Speedfest aircraft
- Easy to mold to shape of aircraft



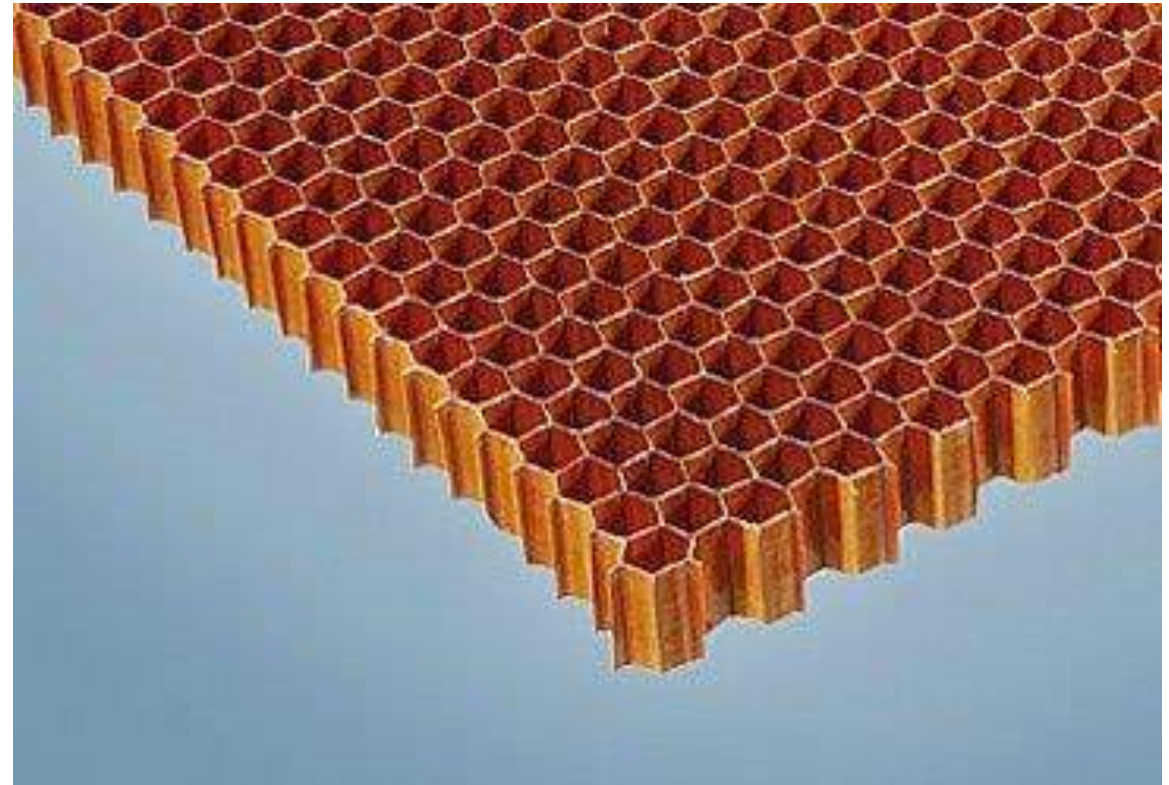
Core Option 2: Divinycell Foam

- Thickness: 1/8"
 - Thicker foam available
 - Density: 3lb/ft³
 - Also is available in 5 lb/ft³
- Easy to mold to shape of mold
- More simple to repair than balsa



Core Option 3: Honeycomb

- ~~Thickness: 0.20-0.25 inches~~
 - Density: 3 lb/ft³
 - Available in 1.8 lb/ft³; considered too weak
- Different strength properties based on direction of loading
- Best strength-weight ratio





Skin Selection

- Core selection:
 - Divinycell 1/8" foam core chosen
- 2 oz., 1610 fiberglass:
 - Allows for extremely lightweight structure
 - Does not carry flight loads sufficiently unless multiple layer layup
- **3 oz., 120 fiberglass:**
 - 4 harness weave allows for easier contoured layups than plain weave
- 4 oz., 1522 fiberglass:
 - Structurally sufficient; could use fewer layers of fabric



Skin Layup

- Semi-monocoque structure
- Skin carrying torsional loads during flight
- Carbon tow implemented along high stress areas



45° bias, 3 oz. fiberglass



1/8" Divinycell Foam Core



90° bias, 3 oz. fiberglass



45° bias, 3 oz. fiberglass



Customized Composite Fuel Tank

- Top-bottom mold for customized fuel tanks
- Tooling glass will be used
- 400/215 epoxy mixture



45° bias, 9.6 oz. fiberglass



90° bias, 9.6 oz. fiberglass



45° bias, 9.6 oz. fiberglass



Skin Weight (Best Case)

1:1 Fiberglass to epoxy ratio

3 lb/ft³ Divinycell foam

- 2 layers fiberglass - foam - 1 layer fiberglass
- Total Skin Weight: 2.441 lb.

5 lb/ft³ Divinycell foam

- 2 layers fiberglass - foam - 1 layer fiberglass
- Total Skin Weight: 2.742 lb.



Skin Weight (Worst Case)

1:1.5 Fiberglass to epoxy ratio

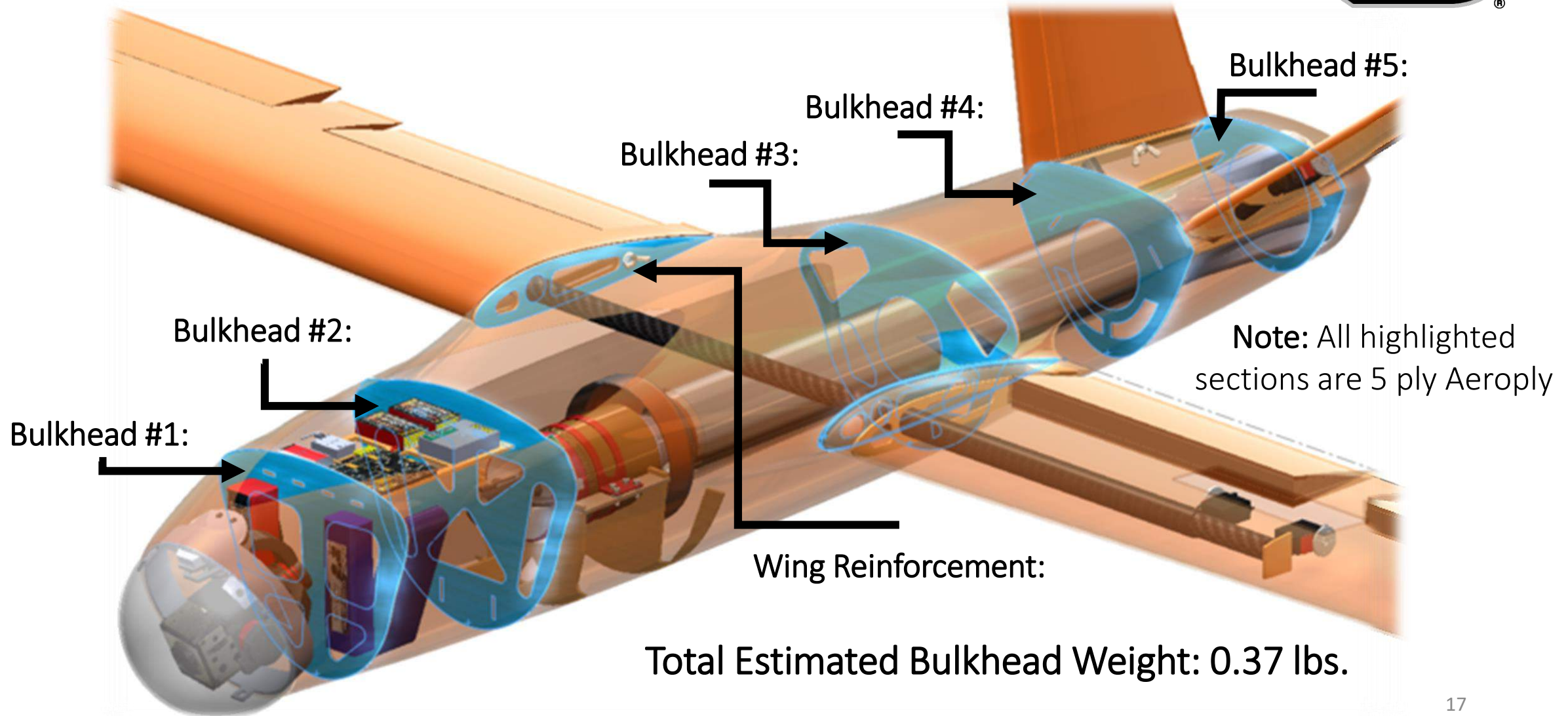
3 lb/ft³ Divinycell foam

- 2 layers fiberglass - foam - 1 layer fiberglass
- Total Skin Weight: 2.938 lb.

5 lb/ft³ Divinycell foam

- 2 layers fiberglass - foam - 1 layer fiberglass
- Total Skin Weight: 3.239 lb.

Bulkhead Configuration

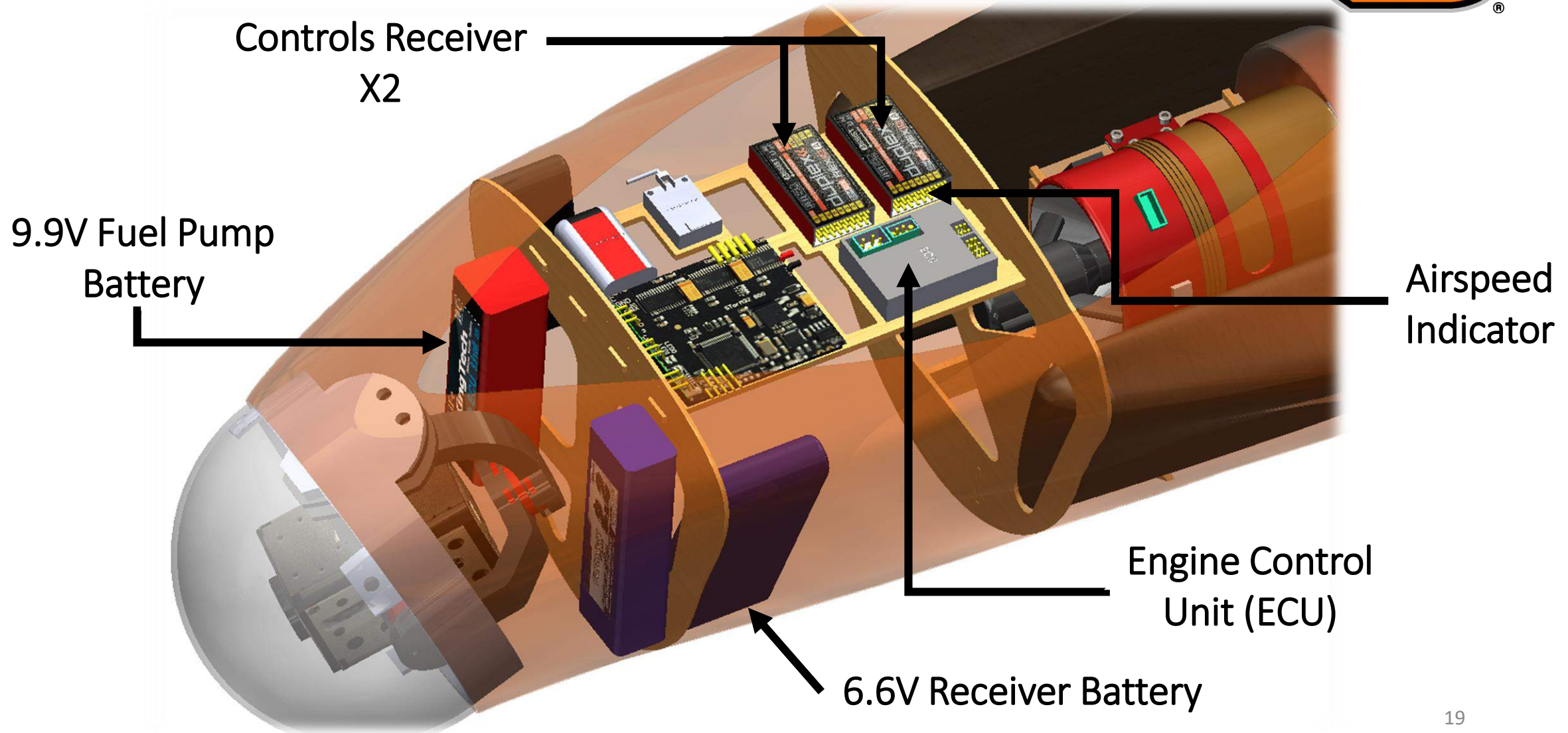




Bulk Heads Materials

- Material: Birch Aircraft Plywood (aero-ply)
- Sizes: 5-ply (0.028lb/in^3) and 3-ply (0.023lb/in^3)
- Light weight and strong for application
- Has been successfully used on previous OSU Speedfest aircraft
- 5 ply used for bulk head/wing attachments and engine mount structure
- 3 ply used for remaining ribs and internal wing structure

Avionics Bay Configuration



Electronics Bay Component Costs

Video Transmitter – Wolfwhoop T86P 5.8GHz \$13.00

Brushless Gimbal Controller - Storm 32 BGC \$35

Aircraft Controls Receiver – 2 Jeti Duplex \$175 *2

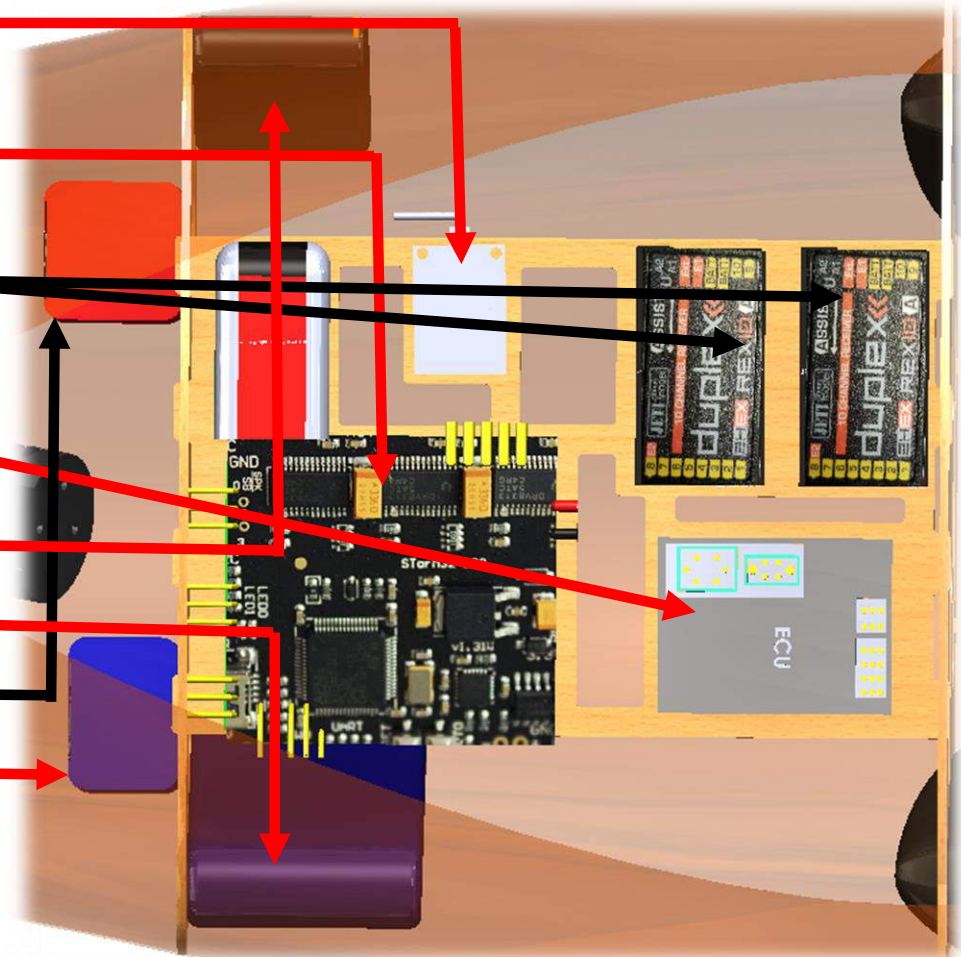
Engine Control Unit – Included in the K70

Batteries – Venom 850mAh 6.6v \$24.44

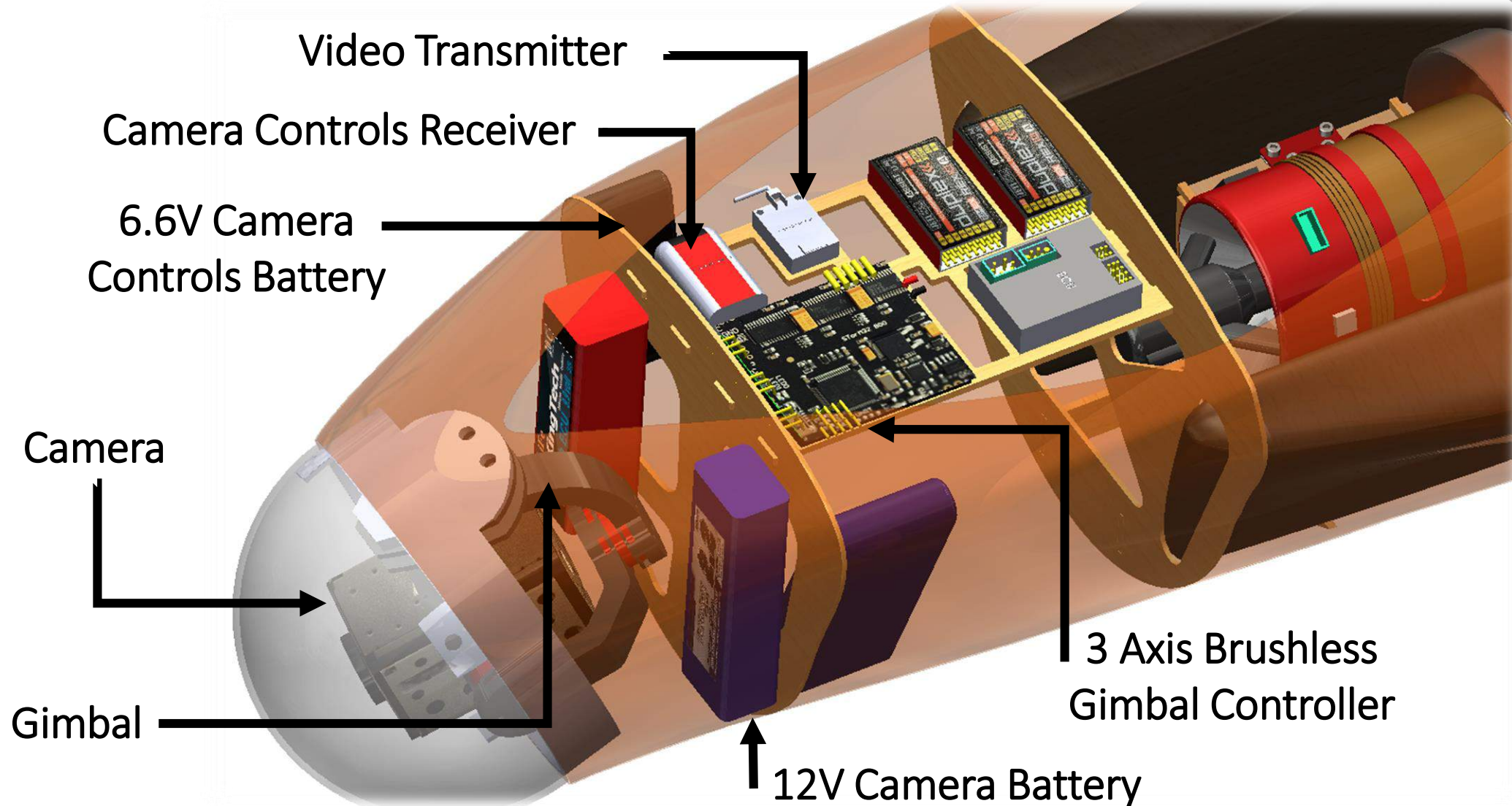
Nano-tech 2000mAh 2S \$13.78

Kingtech 2100mAh 9.9v \$48

Turnigy 2200mAh 3S Lipo Pack \$11

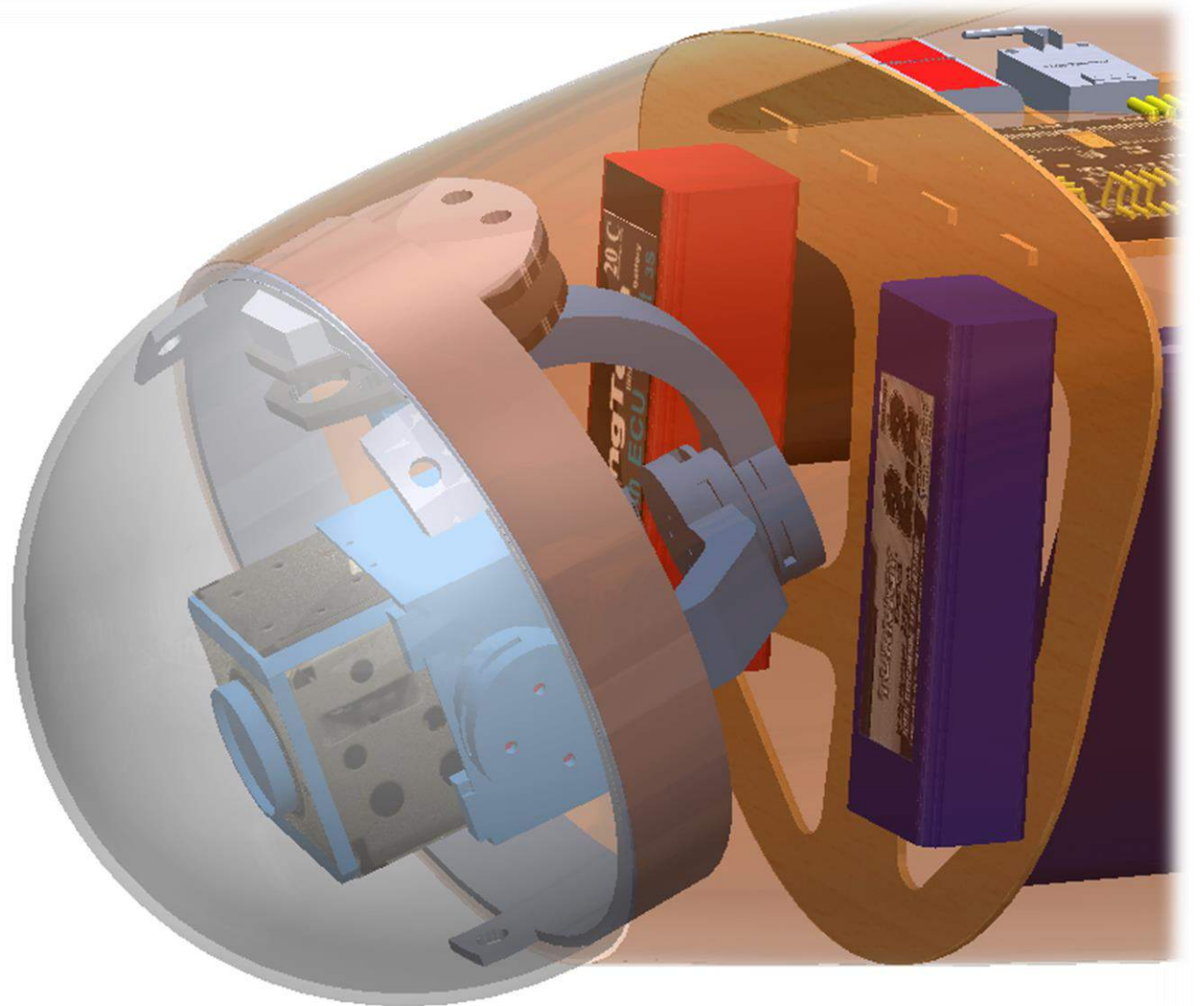


Optics Configuration

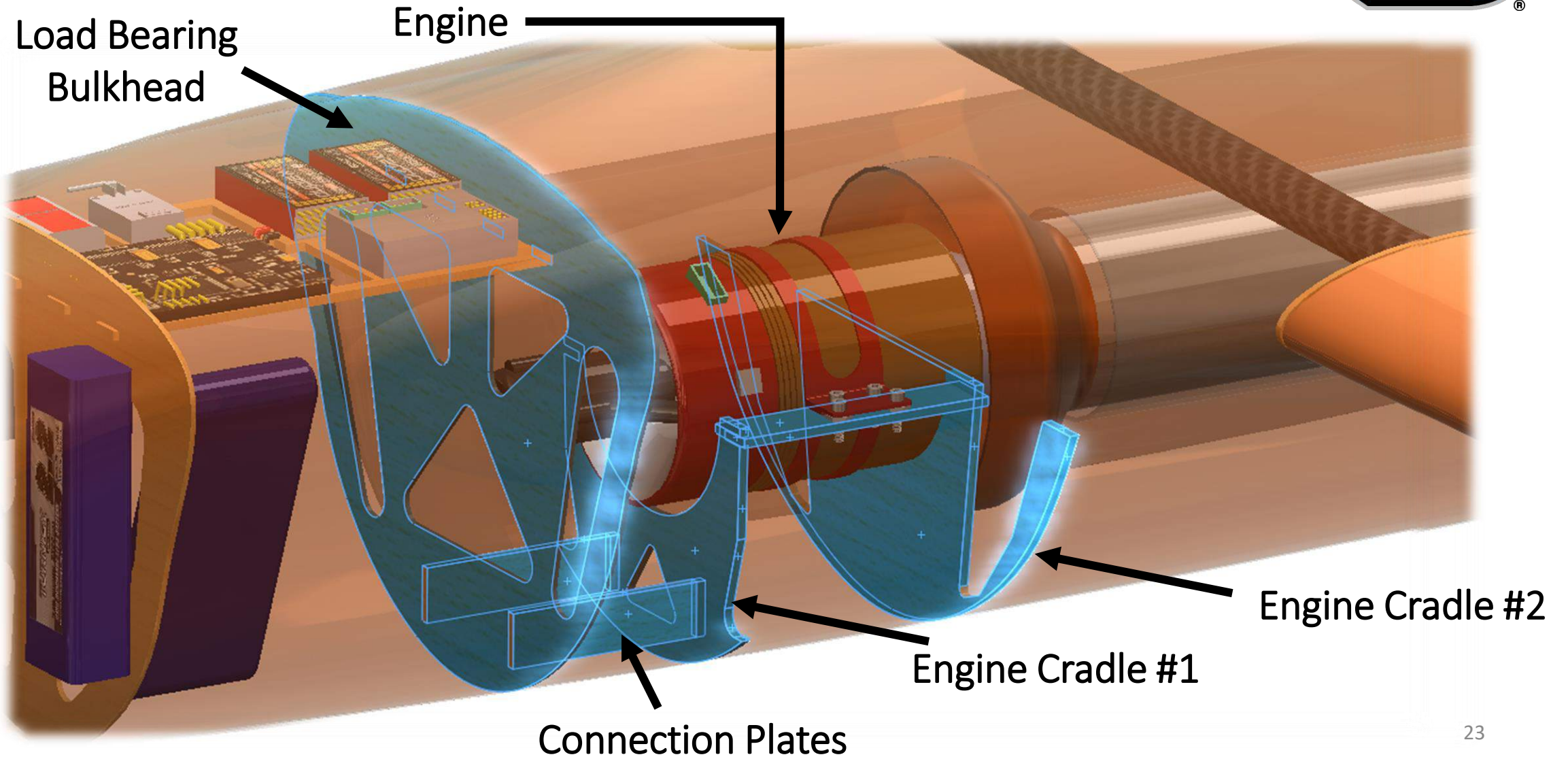


Optics Component Costs

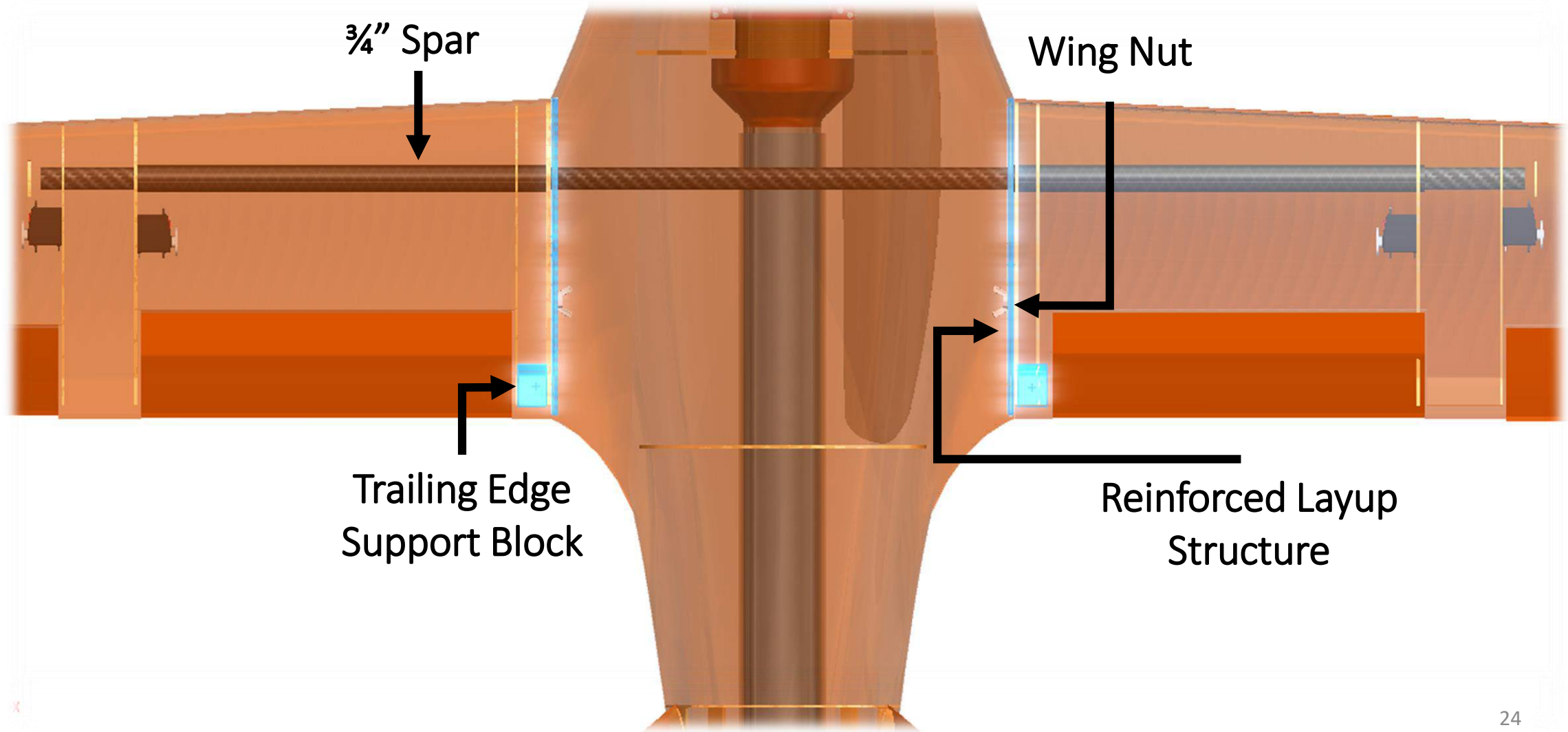
- Camera
 - 17.5° view horizontal
 - 13° view vertical
- Brushless Custom Gimbal
- Two Flight Operators
 - ECO-ABS
- Total Cost: \$206



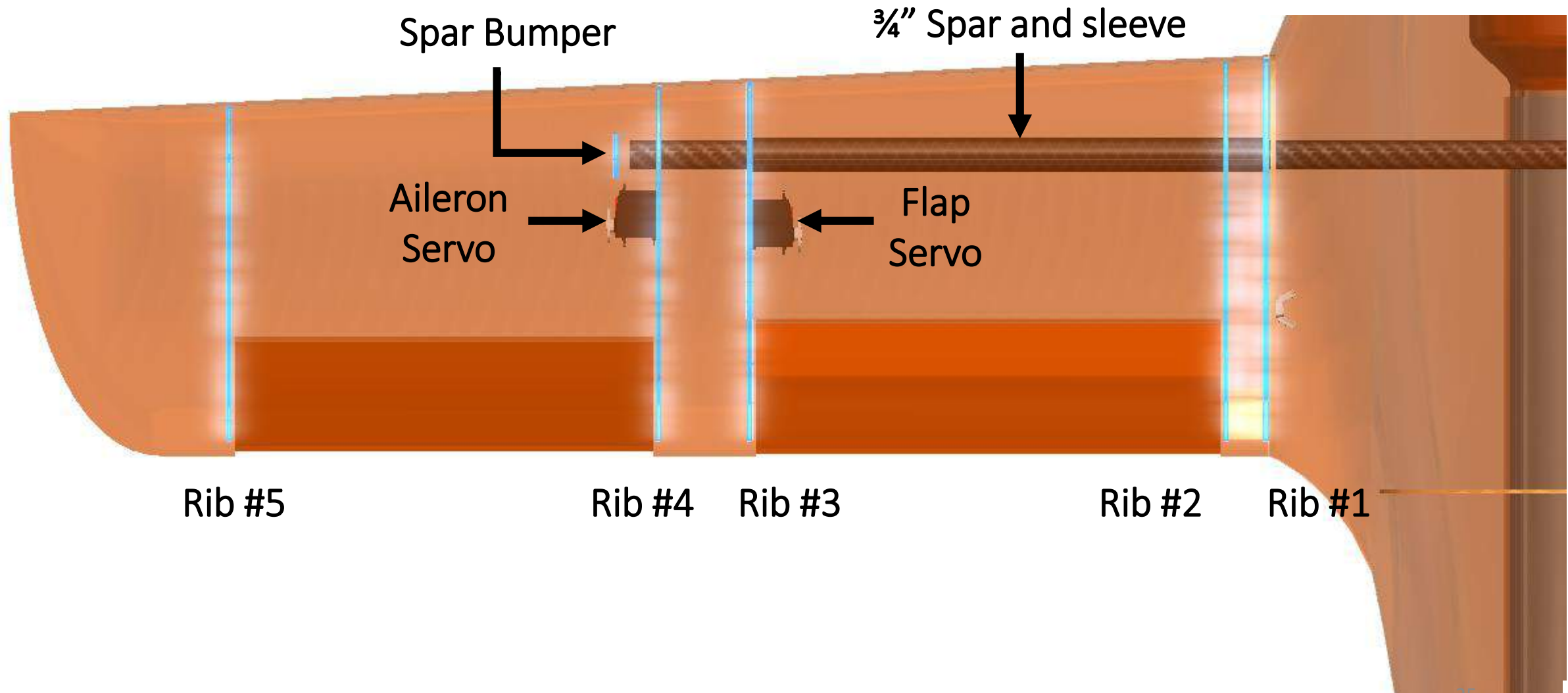
Engine Attachment Configuration



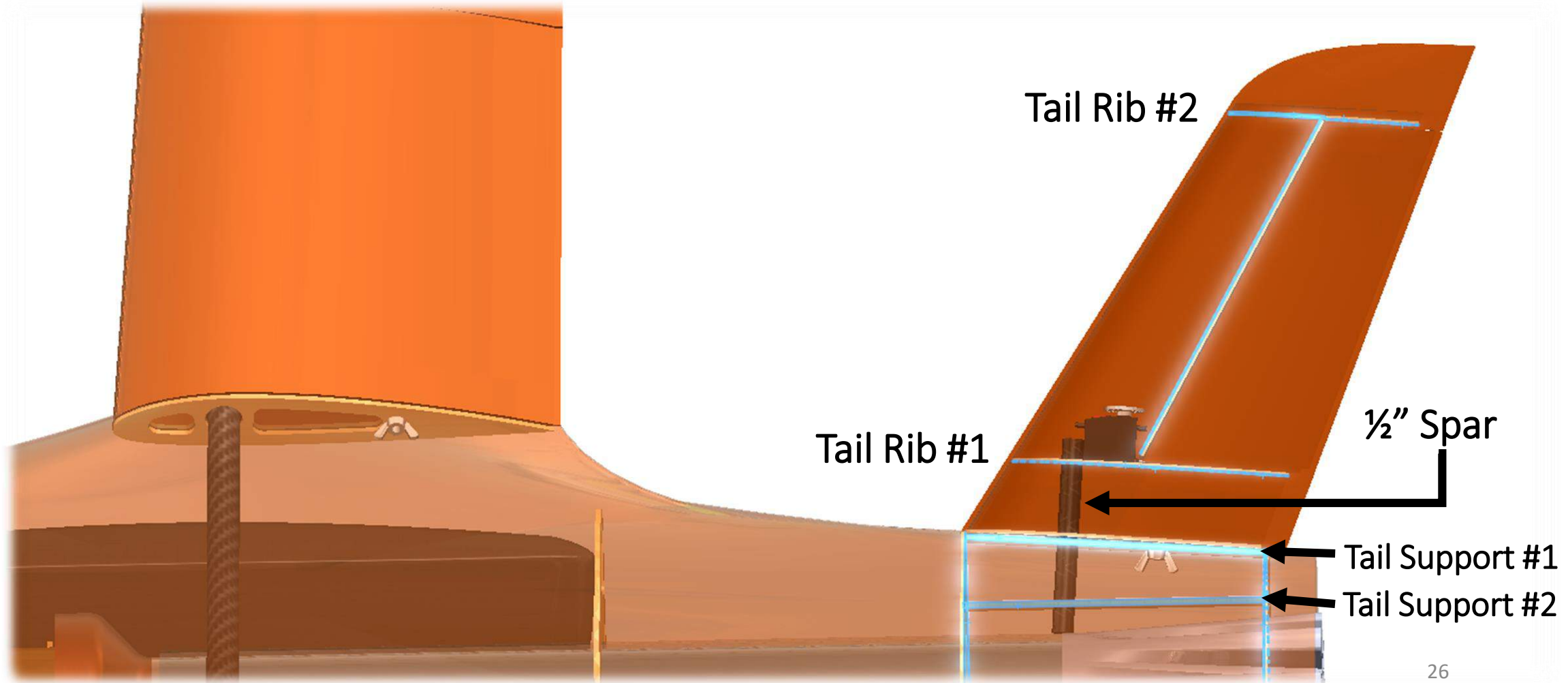
Wing Attachment Configuration



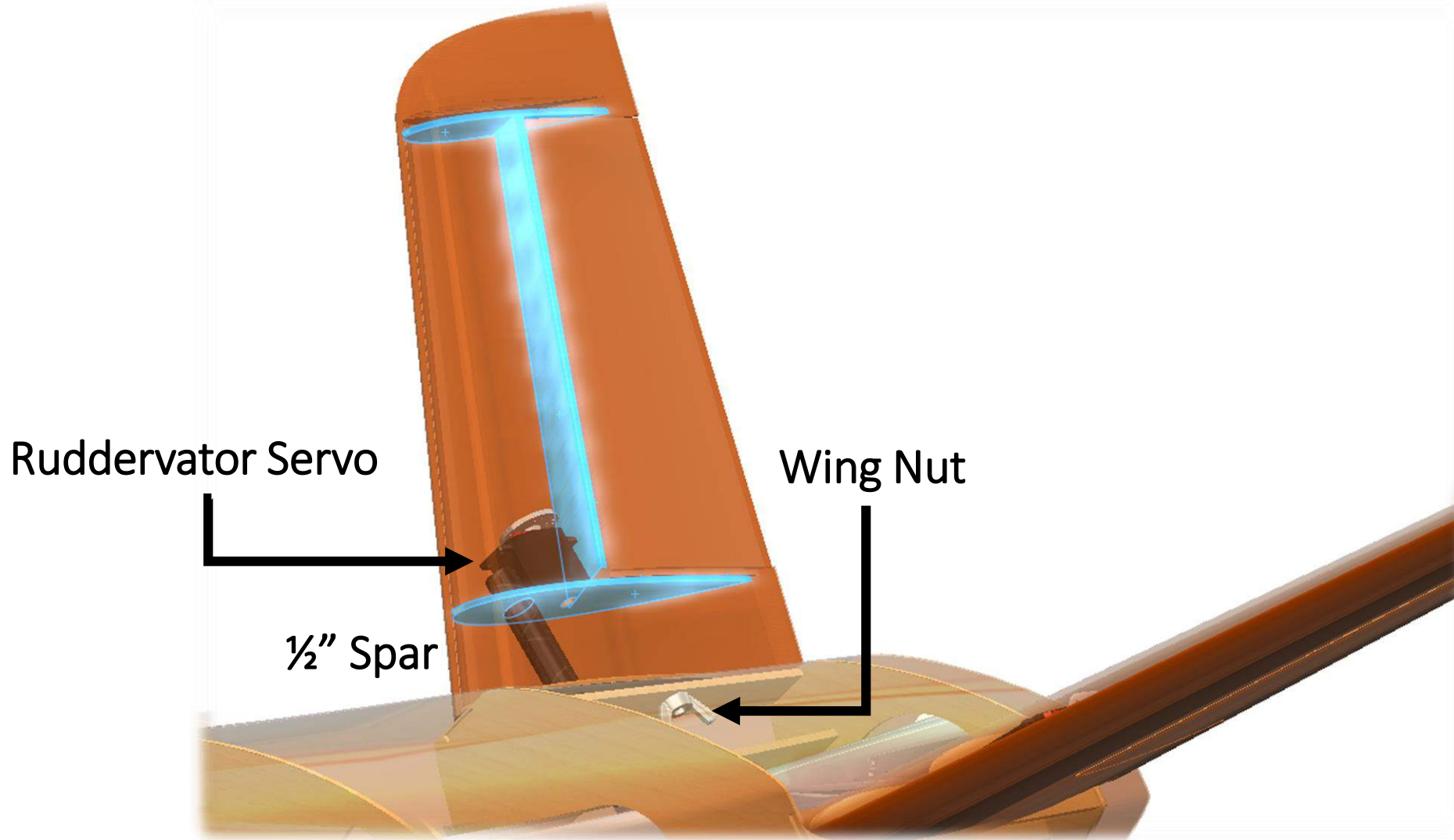
Internal Wing Configuration



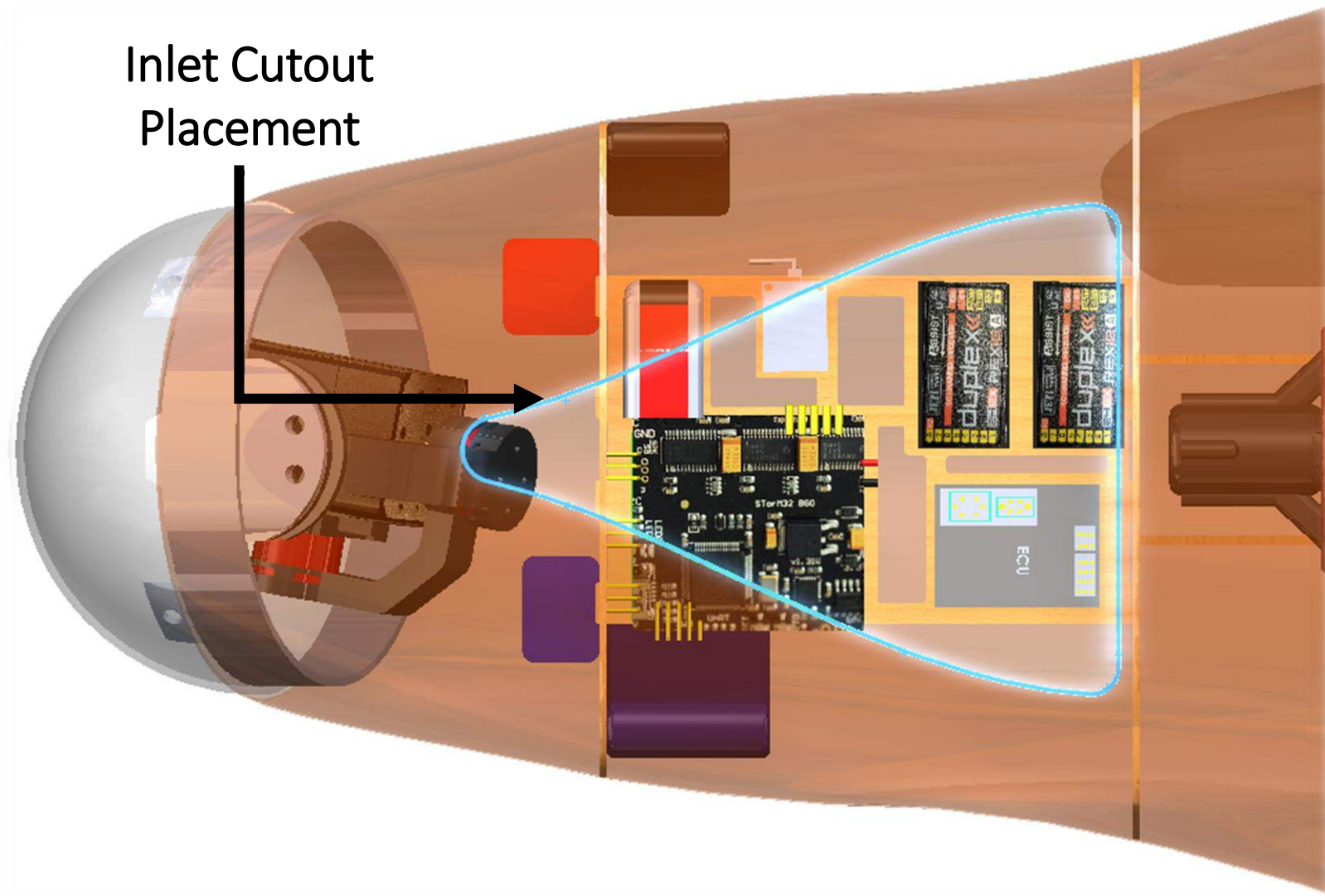
Tail Attachment Configuration



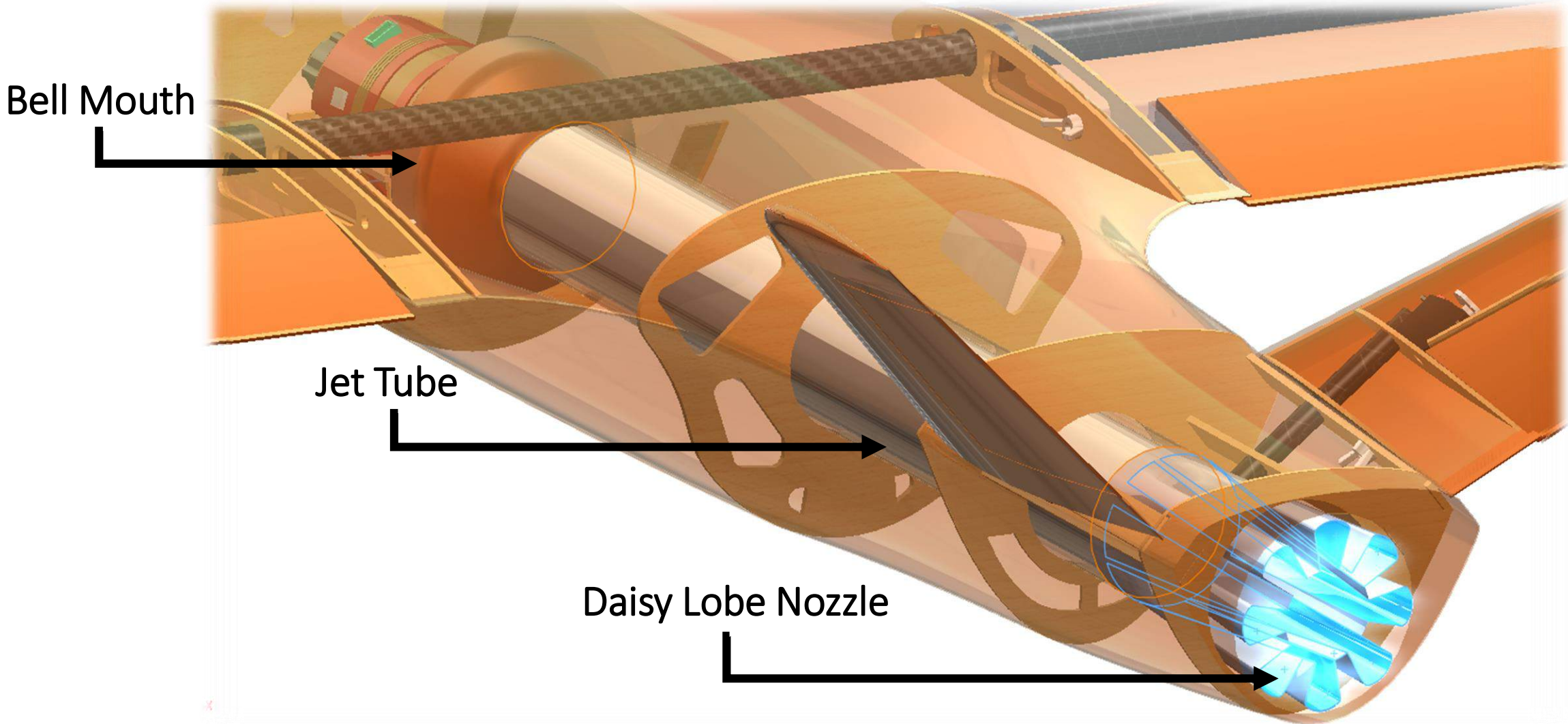
Internal Tail Configuration



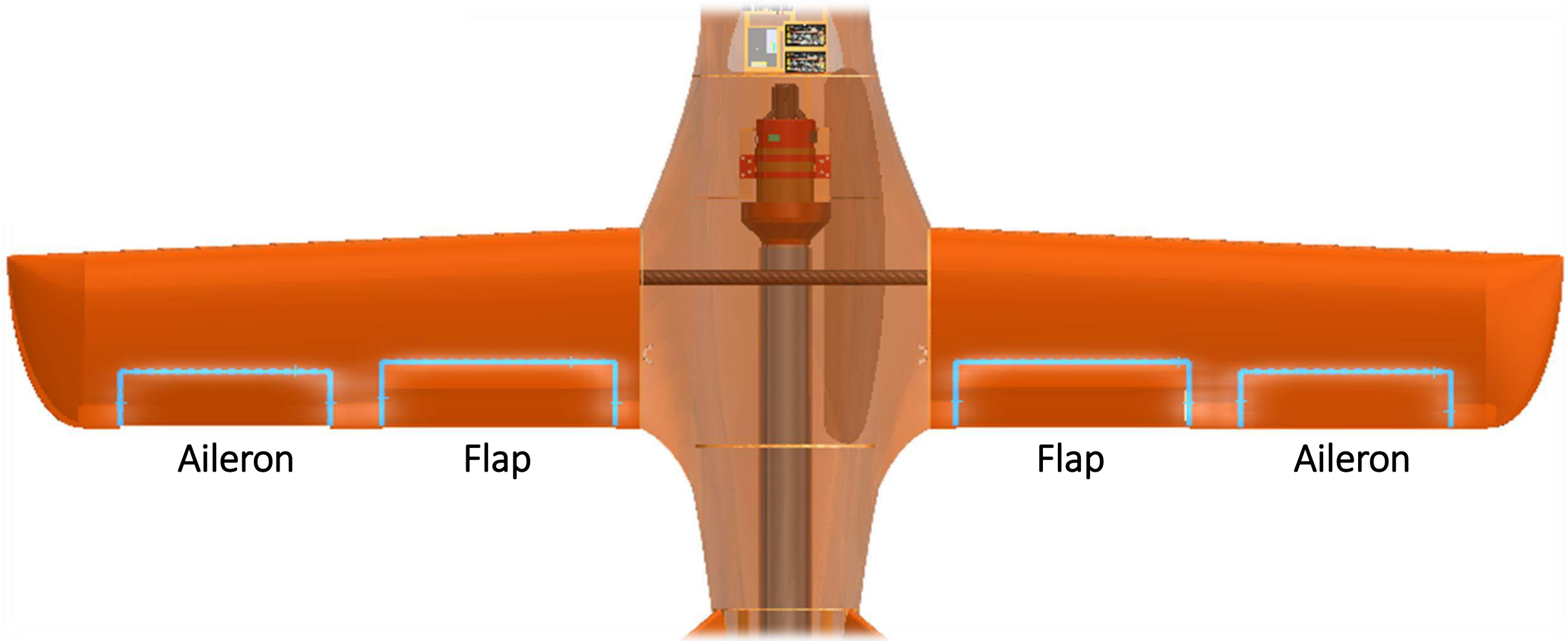
Inlet Integration



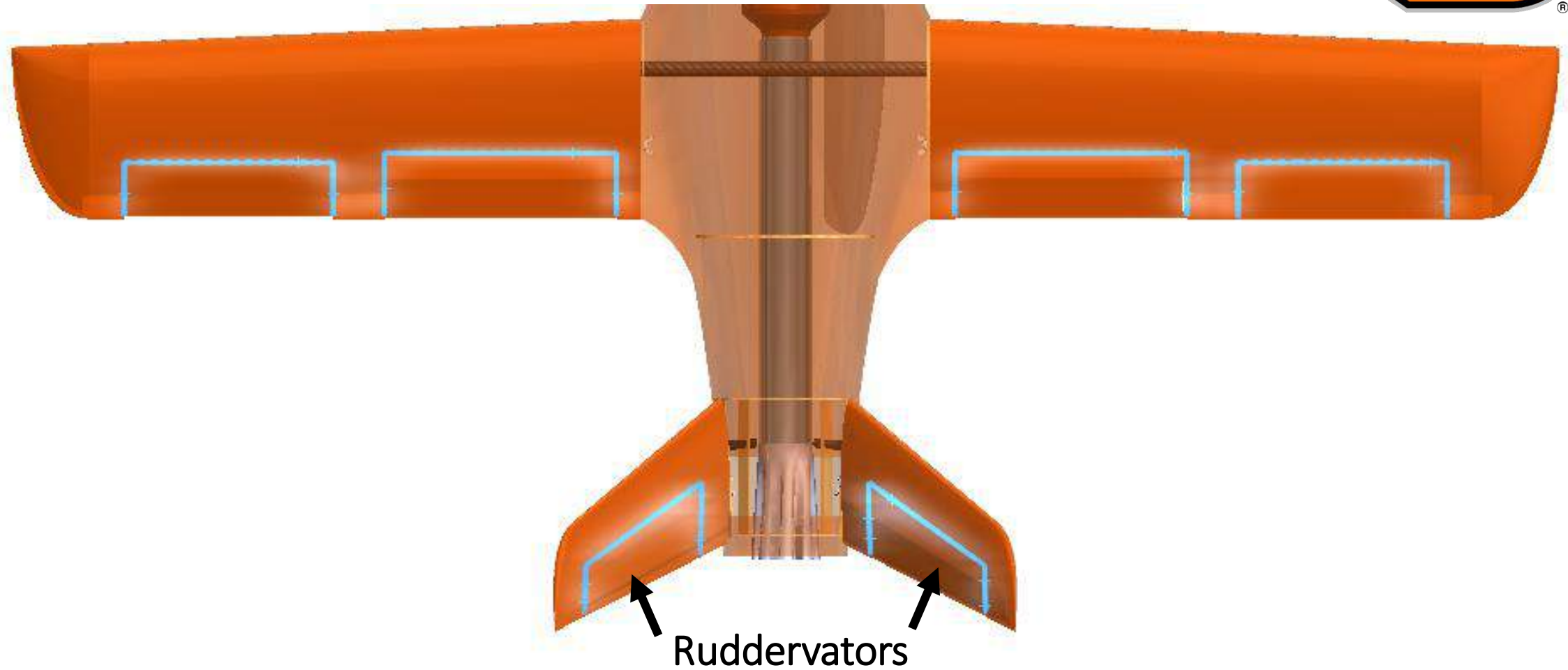
Propulsion Configuration



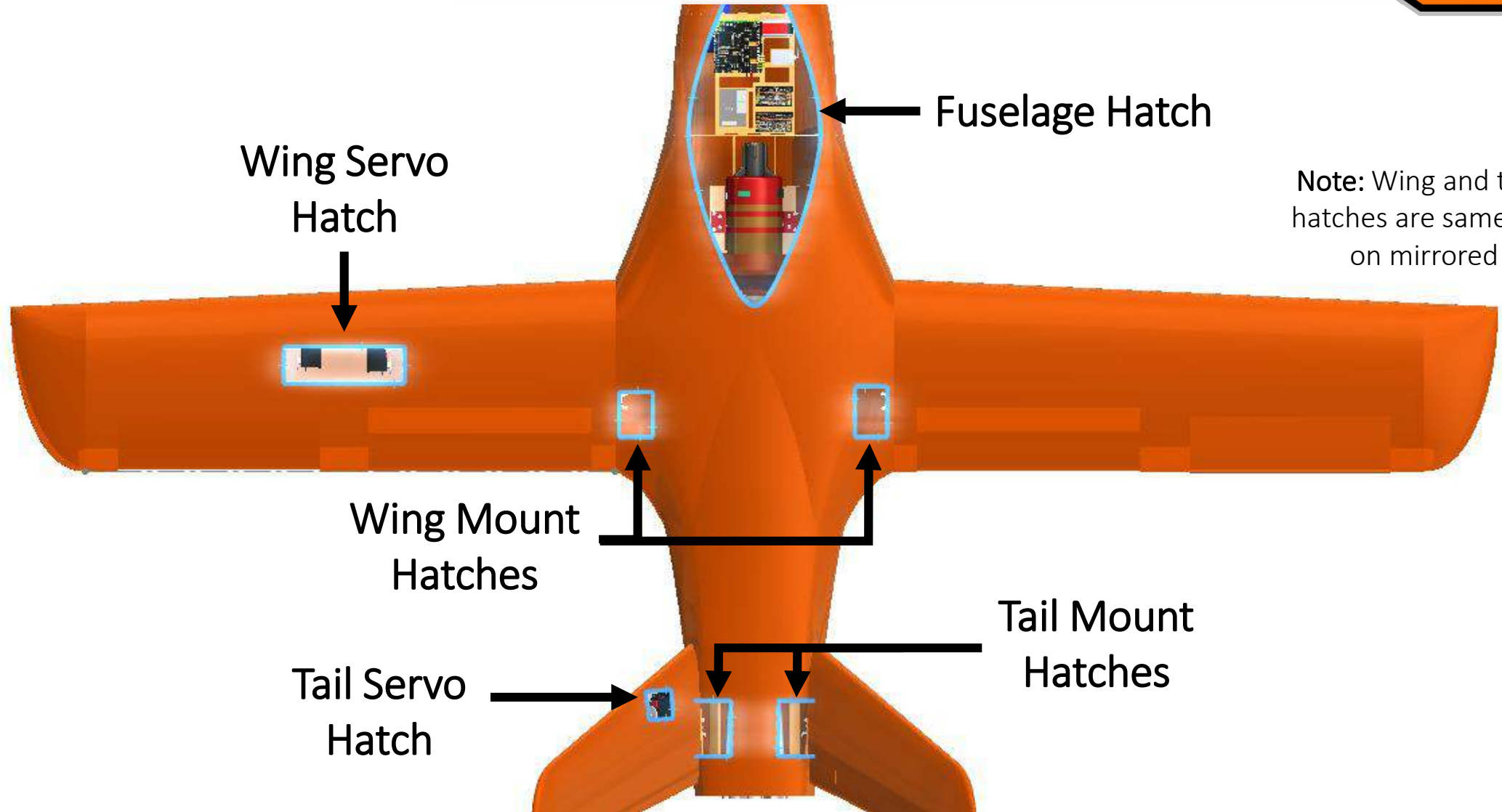
Wing Control Surfaces



Tail Control Surfaces

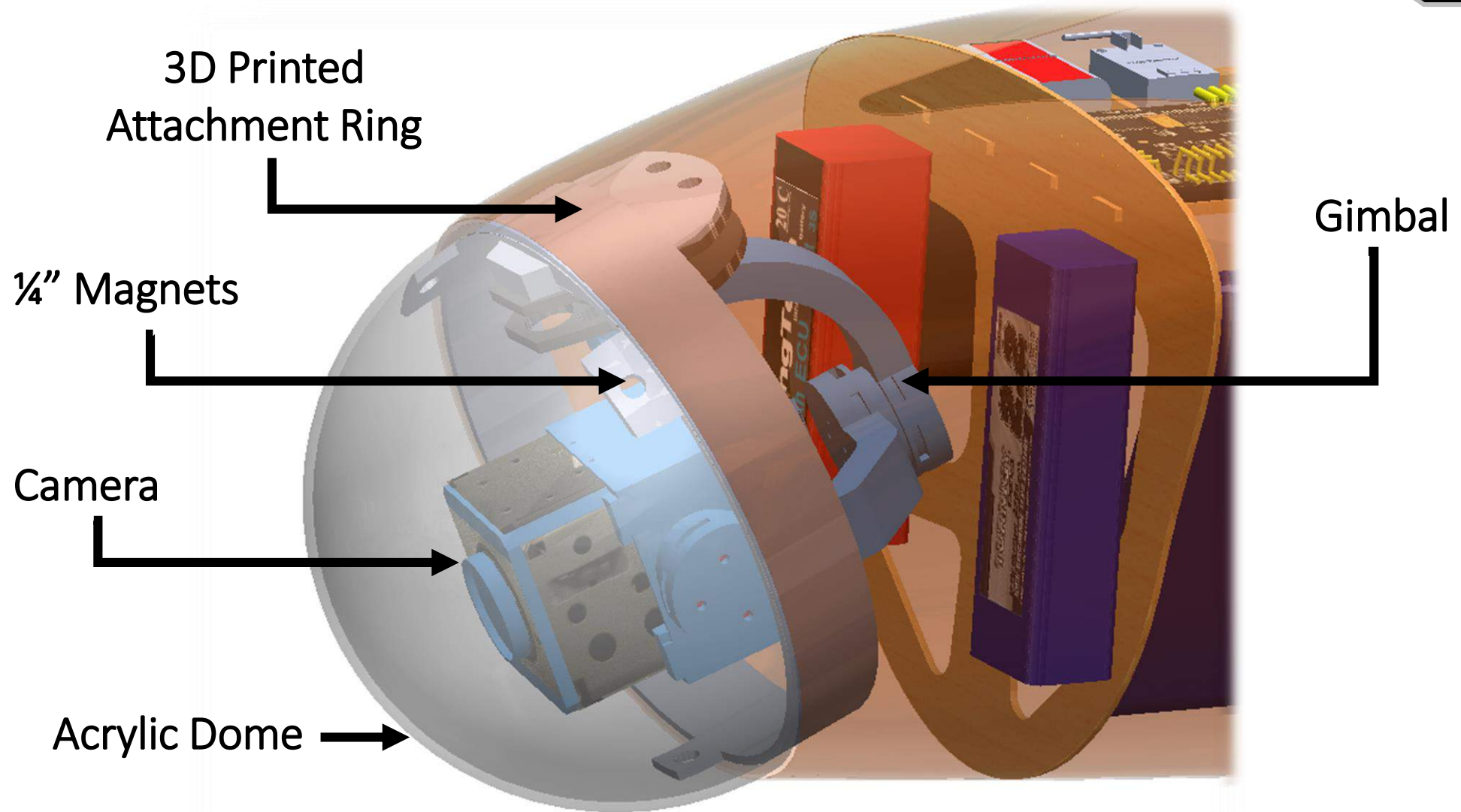


Hatch Integration & Placement



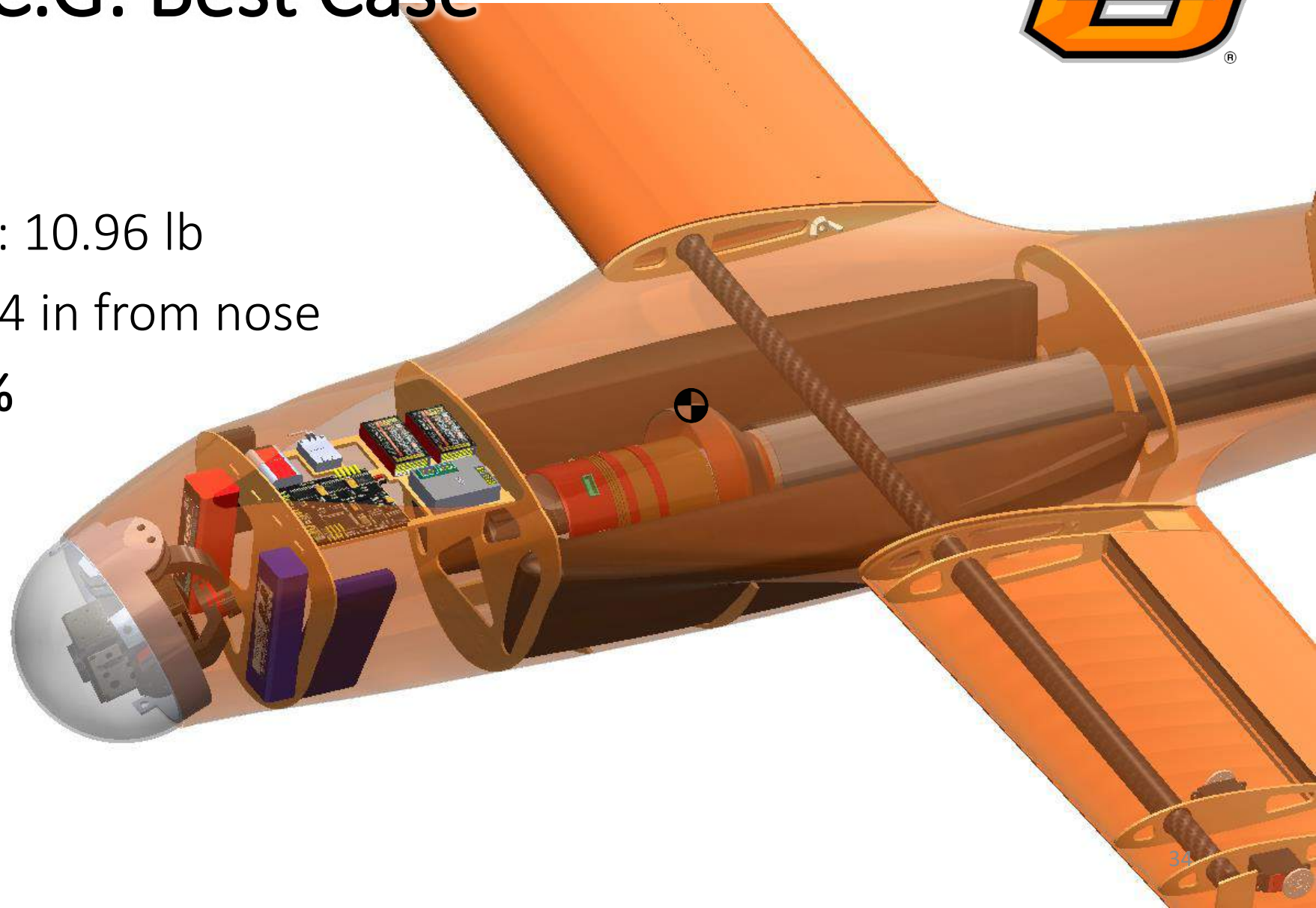
Note: Wing and tail servo hatches are same location on mirrored side

Acrylic Dome Integration



Weight and C.G: Best Case

- No fuel weight
- Weight of aircraft: 10.96 lb
- CG Location: 21.54 in from nose
- Static margin: 25%



Weight and C.G: Worst Case

- Full fuel tanks: 6.94 lb of fuel
- Weight of aircraft: 17.9 lb
- CG Location: 22.10 in from nose
- Static margin: 18.6%



- *Won't need full fuel tanks to complete Speedfest Mission***

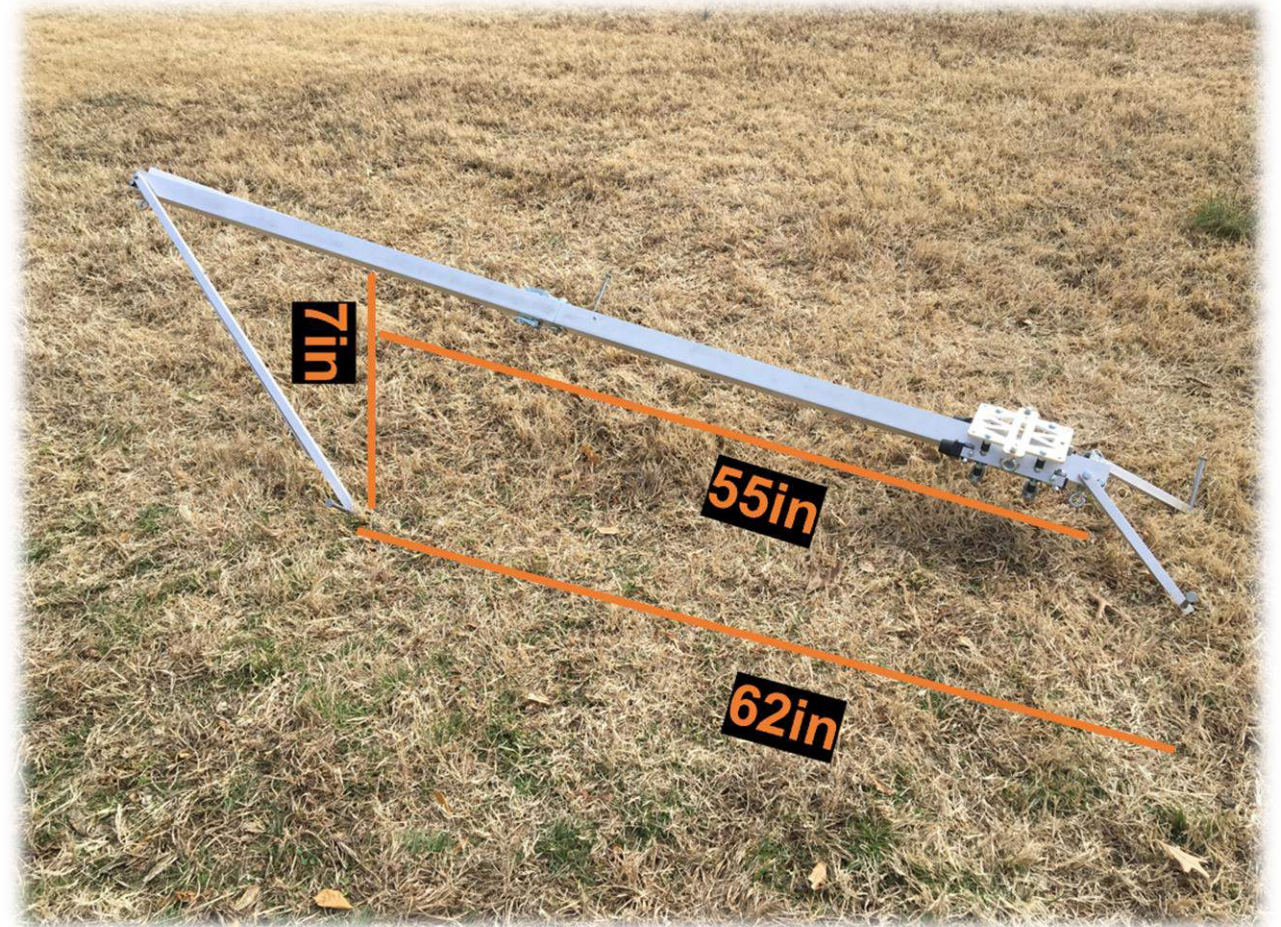
Ground Control System

- Skylark Outdoor Highlight FPV Ground Station
- 1000cd/m² 10.4 inch Monitor
- Live video feed
- Mini Joystick will be added to control Gimbal System
- Potentiometer will be added to control camera zoom



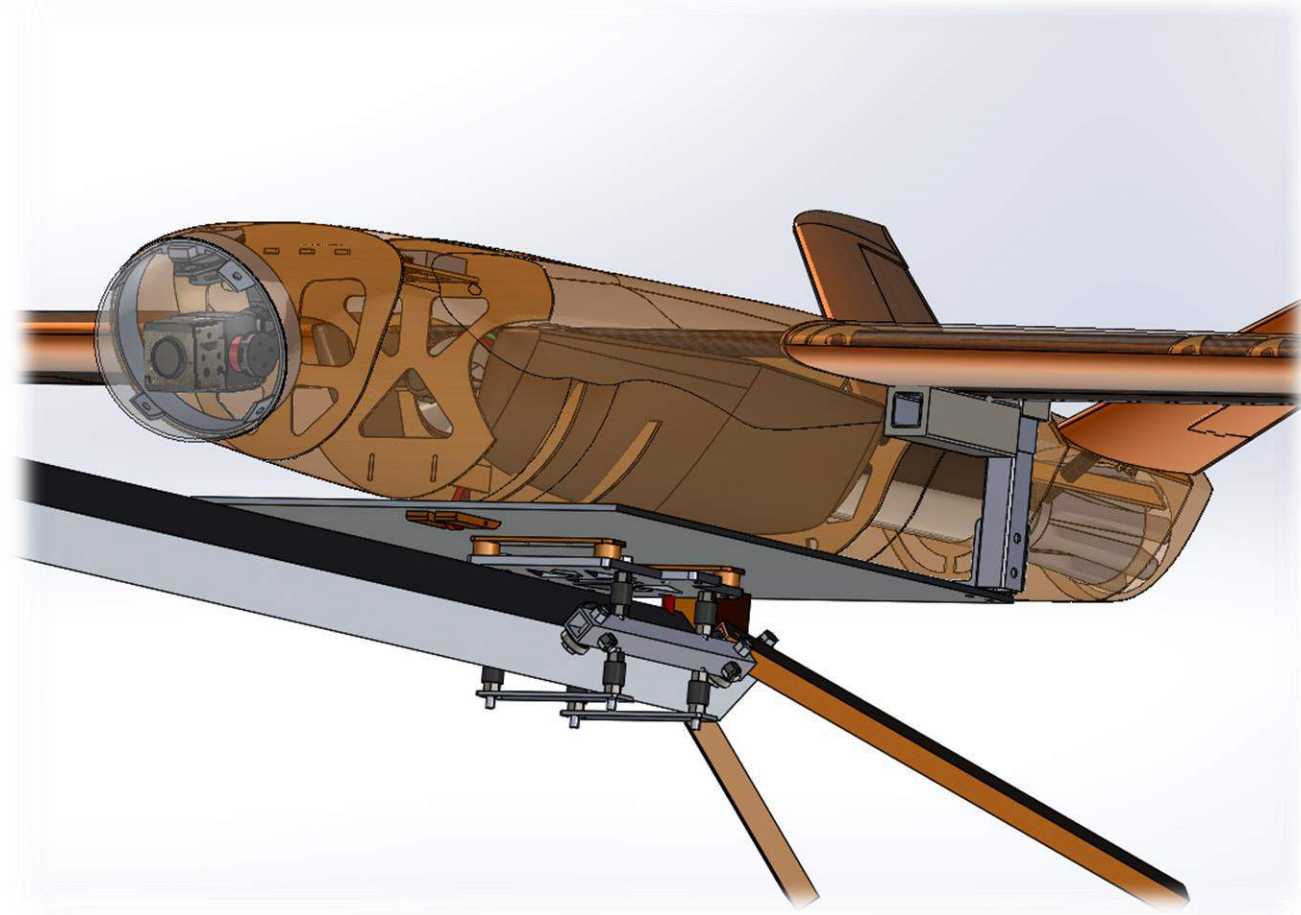
Launching Strategy

- Configured Launch Mechanism
 - 8 foot launcher
 - Legs staked inside required launching area, 6ftx6ft (@ 62 in)
 - 12° launch angle
 - \$898.00 Total
 - \$225.00 per aircraft



Launching Mechanism Design

- Launch force applied along wing root
- Holding pin implemented in front of C.G. on engine bulkhead
- Foam-filled cutout to store holding pin
 - Reshapes to prevent whistling after pin is released
- Further testing to ensure safety of tail
- Rotating pushers possible



Launching Mechanism Design

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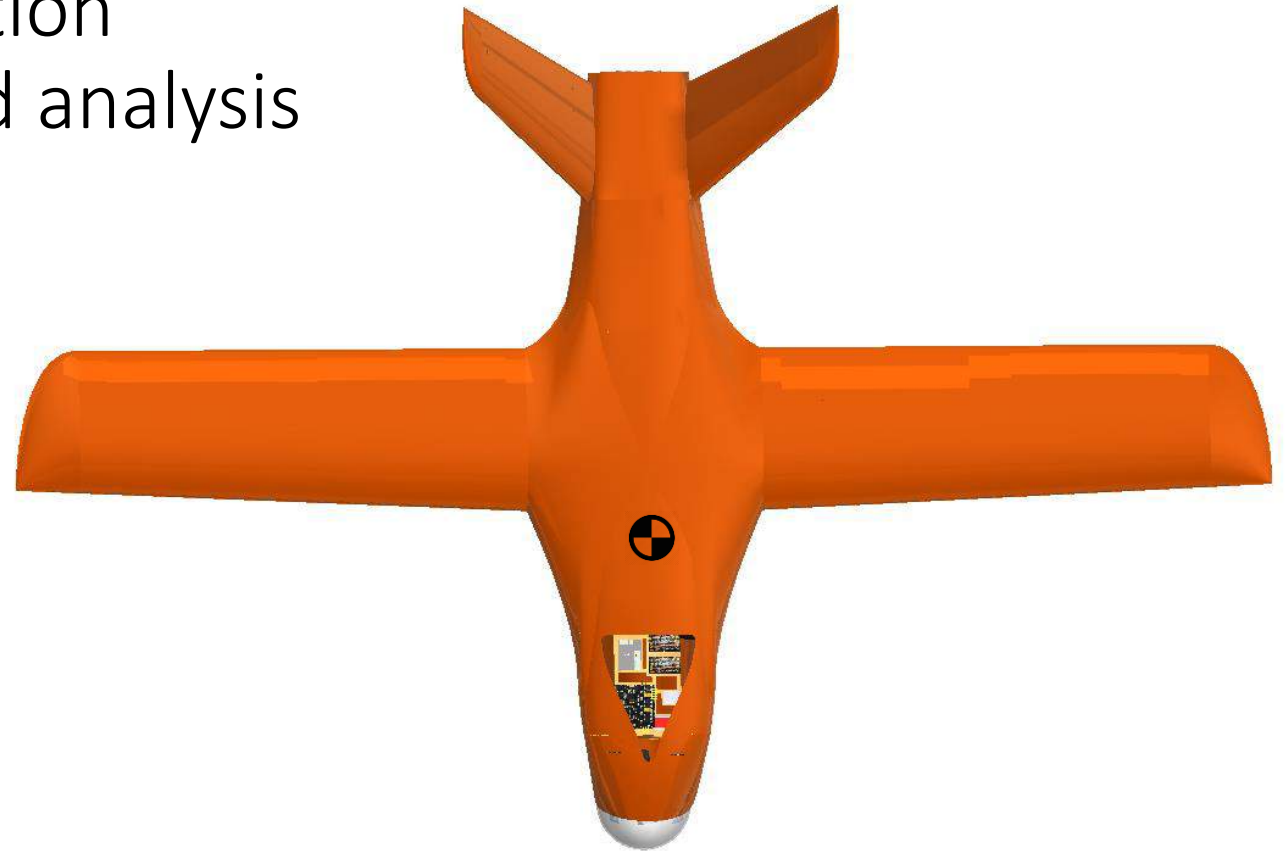




AERODYNAMICS

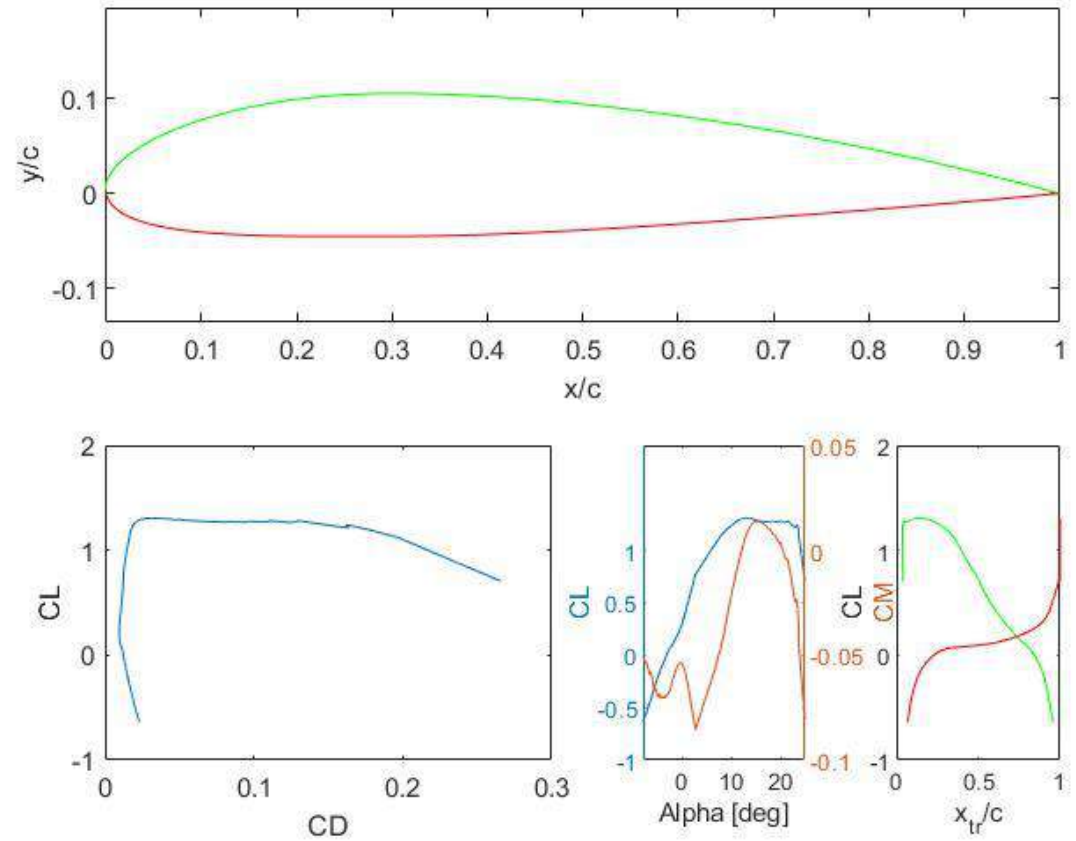
Tasks Accomplished Since PMR

- Airfoil analysis and selection
- Wing Planform sizing and analysis
- Static Stability Analysis
- Tail Sizing
 - V-tail tail volume
 - Control surfaces
- Fuselage analysis



Airfoil Analysis

- Analysis tool: MatLab & XFLR5
- Potential airfoil pool:
 - CLARK Y
 - SD 7032
 - NACA 3315
 - SD 7062
 - NACA 4415

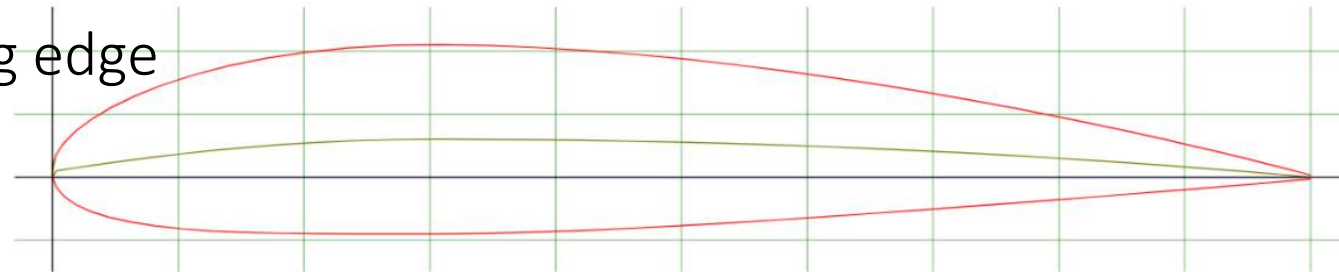


NACA 3315 Plots from Matlab-Xfoil Interface

Airfoil Selection

➤ Wing Selection: NACA 3315

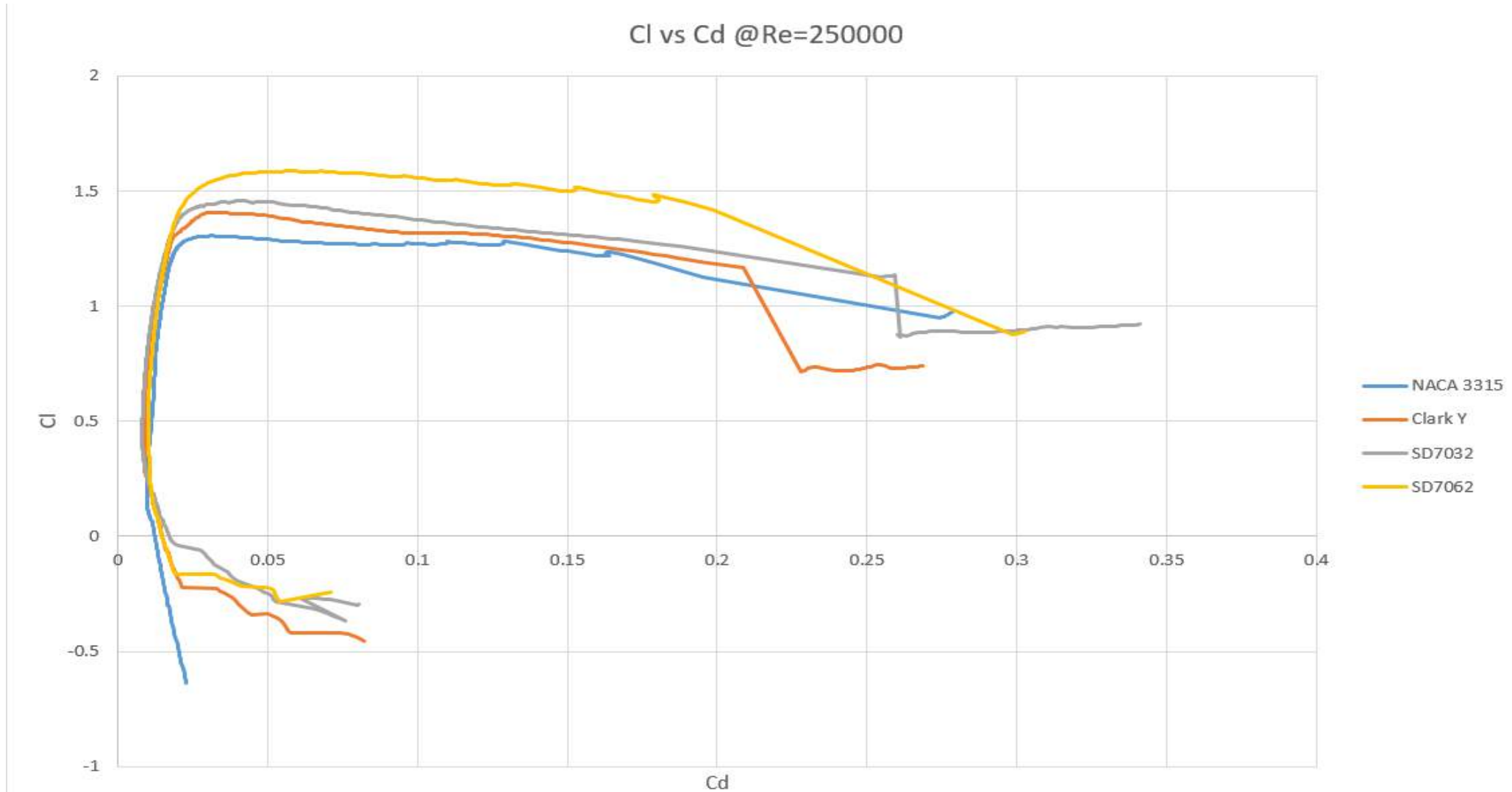
- SD 7032 & SD 7062: sharp trailing edge
- CLARK Y: lower C_l at 0 AOA
- NACA 4415 has higher drag



➤ Tail Selection: NACA 0015

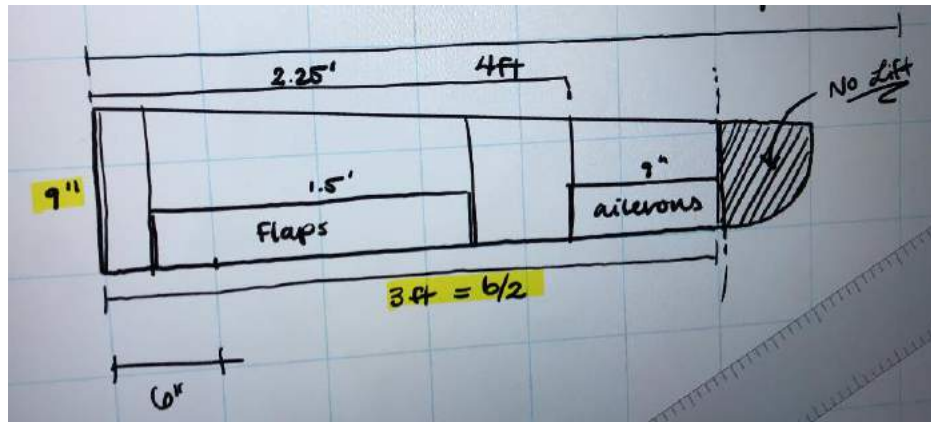
- Needed symmetric airfoil w/ servo room

C_l v C_d Comparison



Wing Planform Design

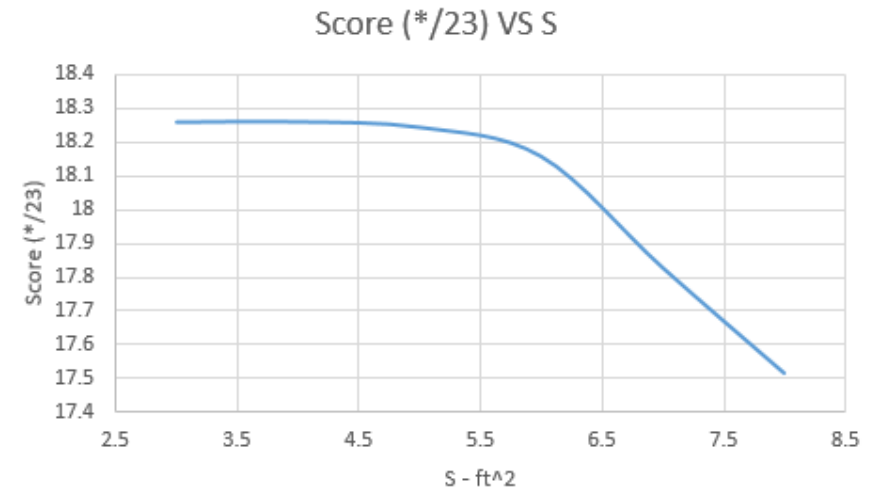
Planform Iteration Start



➤ Goals:

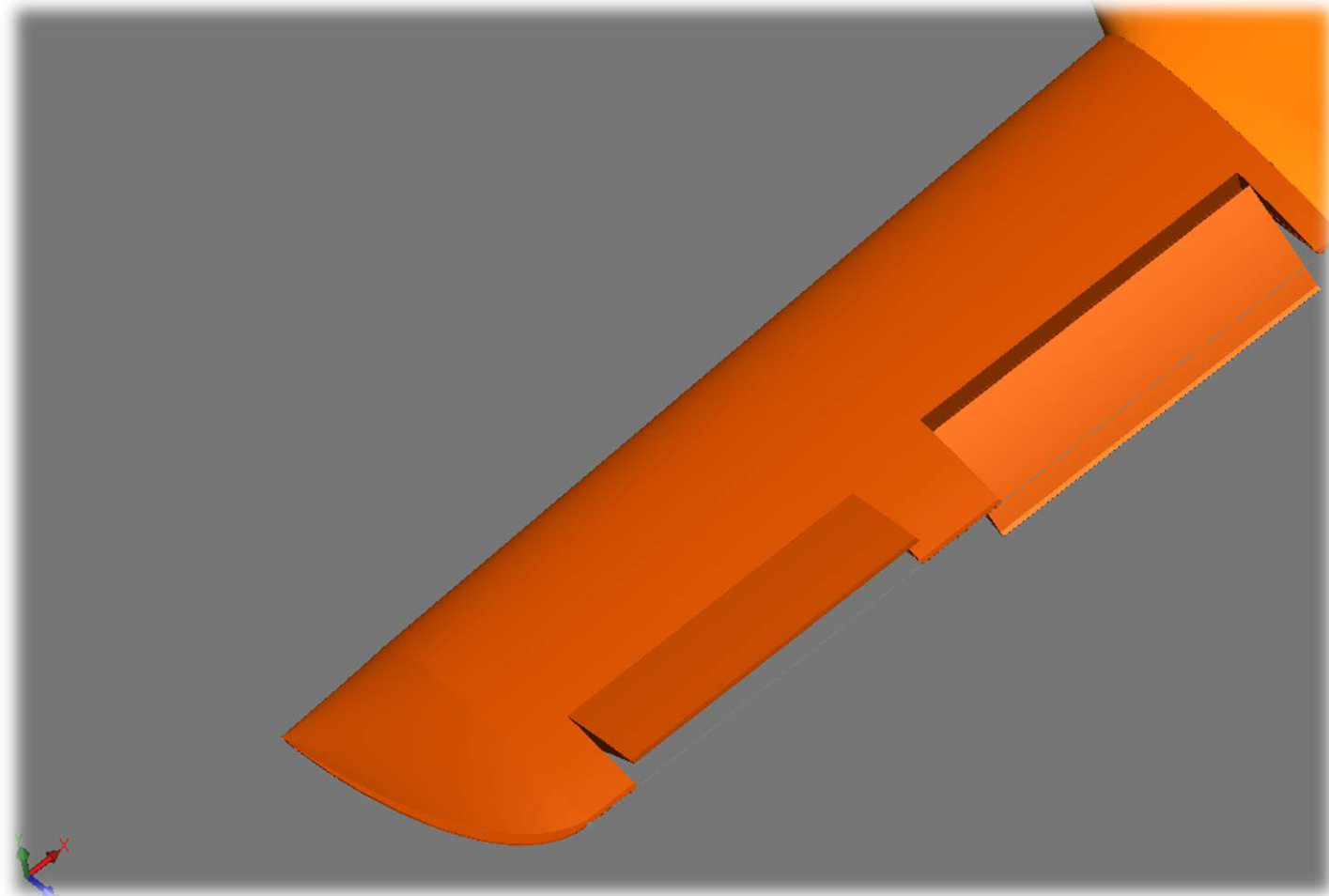
- Keep $AR \leq 8$
- Estimate score with different wing area
- Result: $S = 5 \text{ ft}^2$, $b = 6 \text{ ft}$, $MAC = 10 \text{ in}$, $\lambda = 9/11$

Score Trade-off



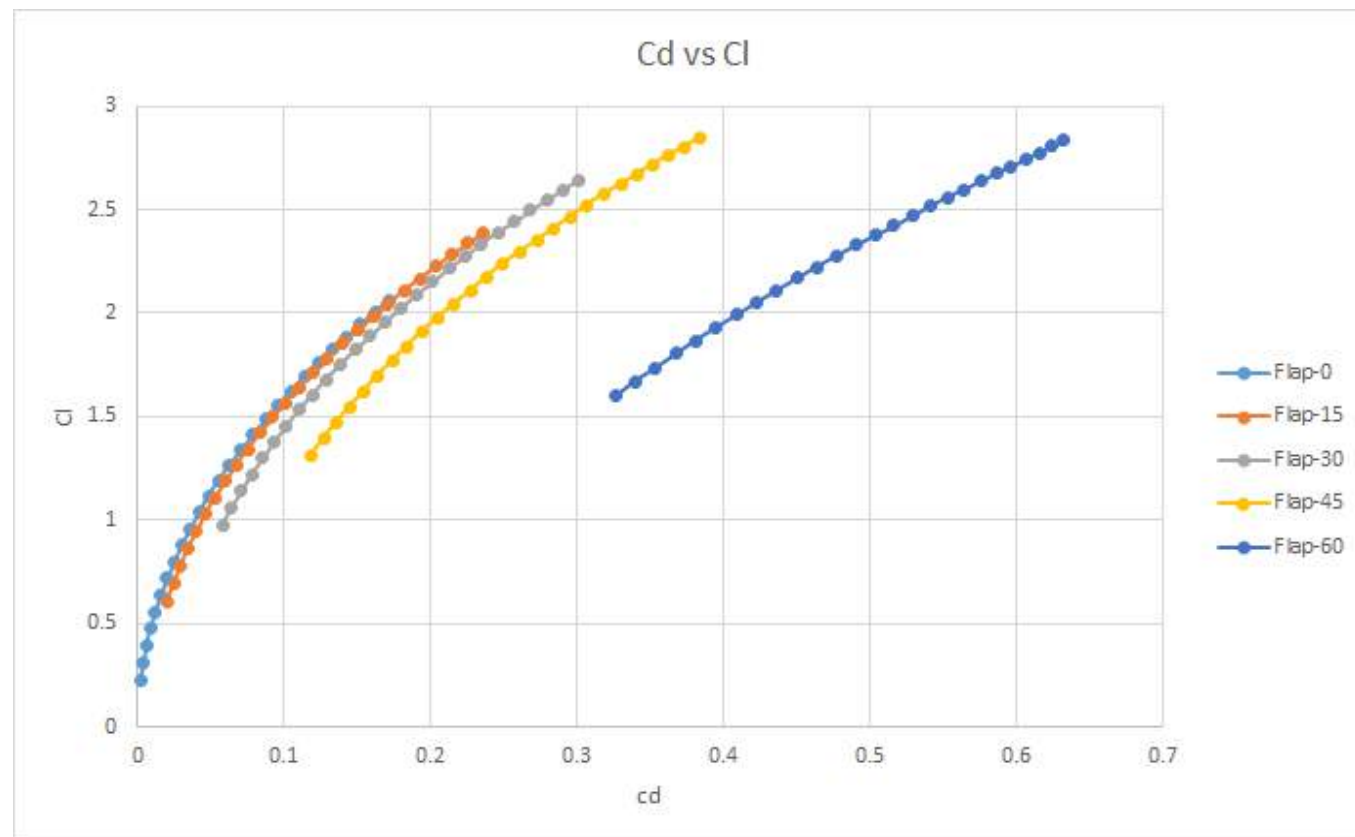
Wing Planform Design

- Results:
 - $S = 5 \text{ ft}^2$
 - $b = 6 \text{ ft}$
 - $MAC = 10 \text{ in}$
 - $\lambda = 9/11$

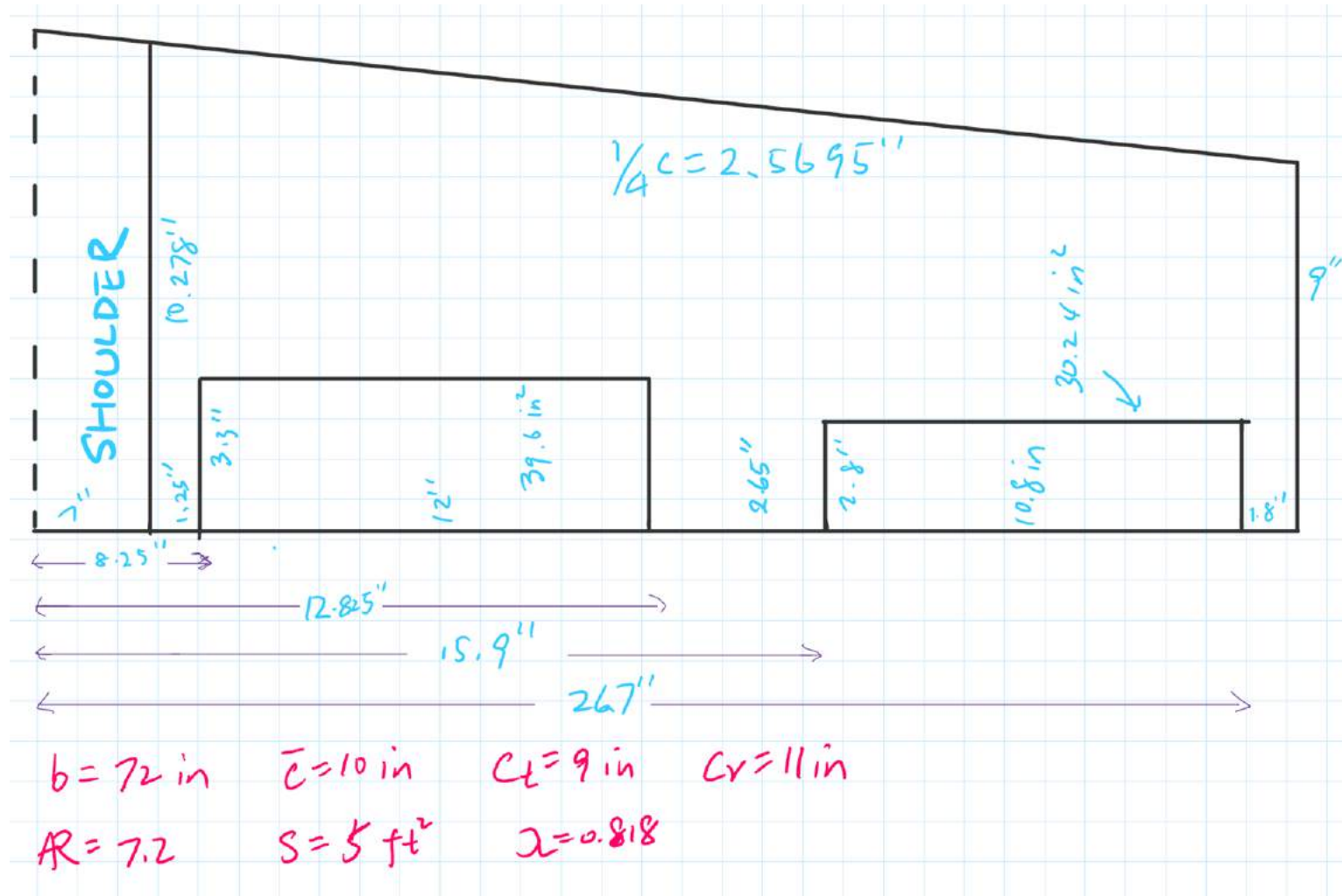


Aileron and Flap Sizing

- Conventional benchmark aileron location, 65%-95% span location
- Adequate roll control @ stall velocity (47 ft/s)
 - Flaps based on benchmarking, verified by XFLR5



Final Wing Planform





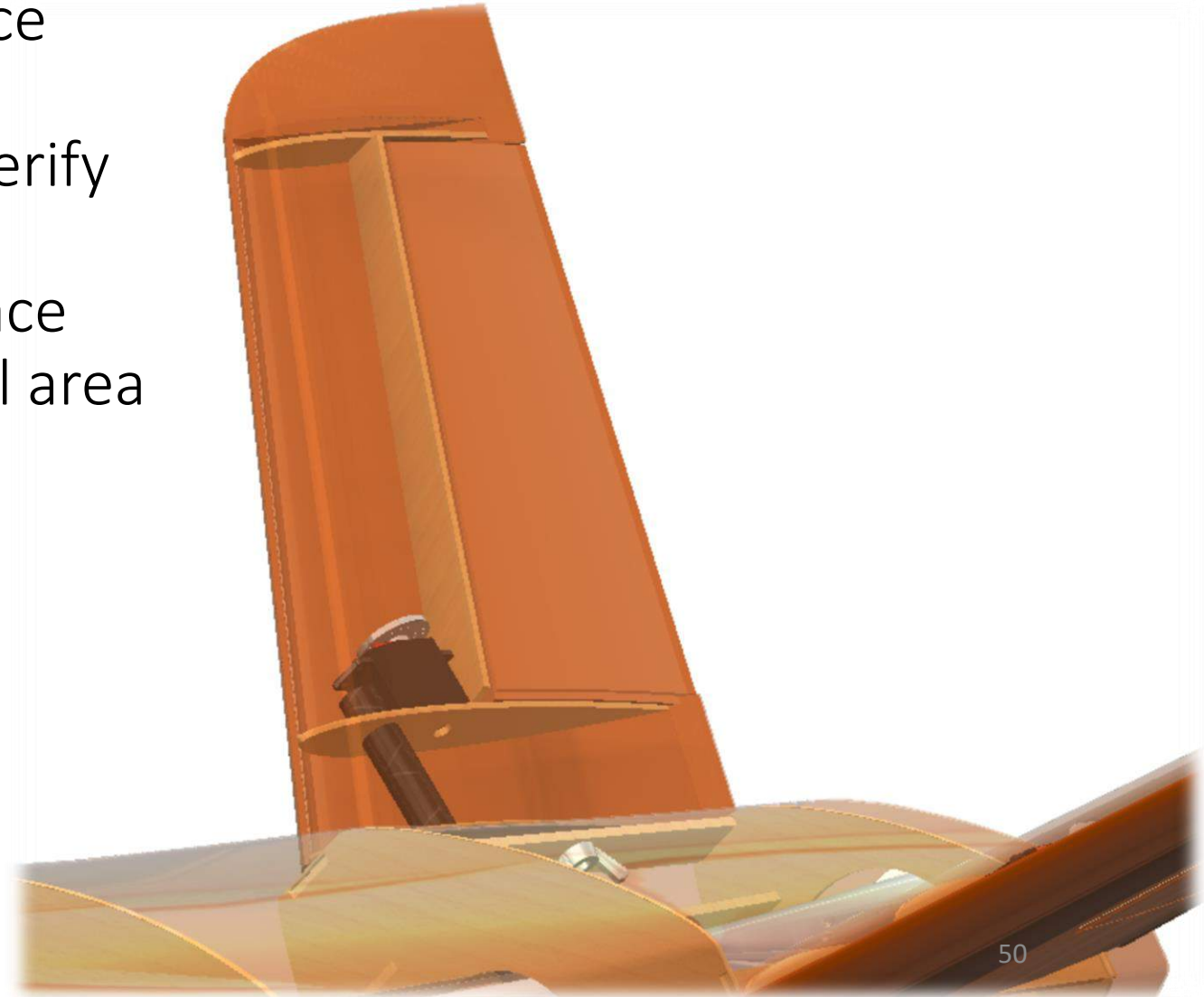
Tail Volume

- Range of acceptable V-Tail angles found with heat map
- Tail Volume code gives optimal V-Tail mount angle

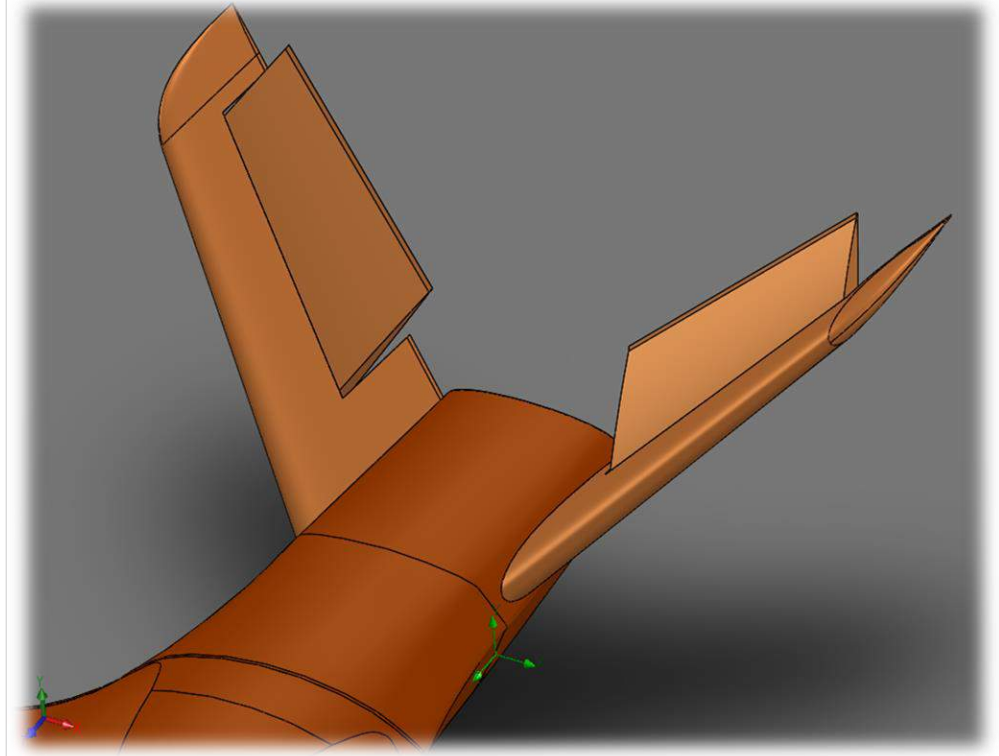
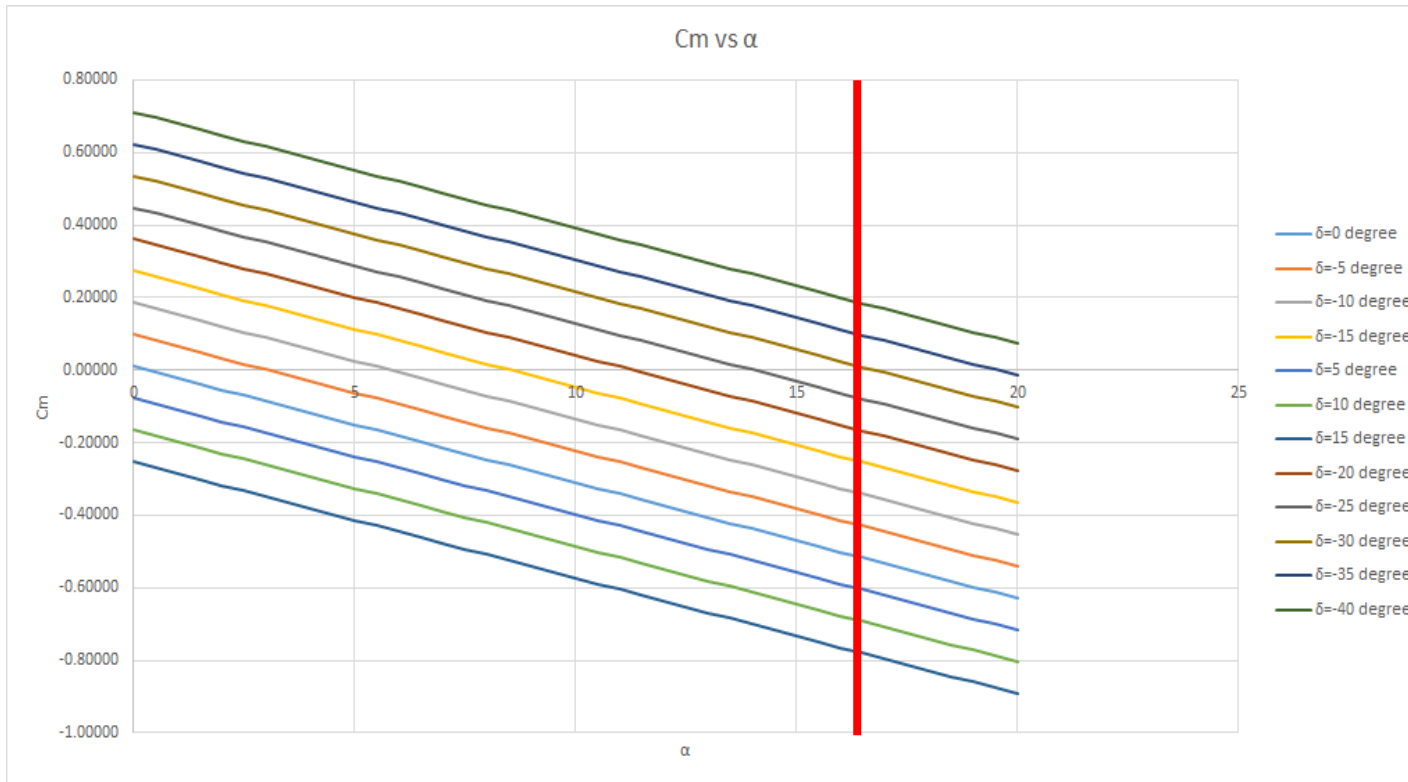
0.0388	0.0389	0.0392	0.0395	0.0398	0.0401	0.0404	0.0407	0.041	0.0413	0.0416	0.0419	0.0422	0.0425	0.0428	0.0431	0.0434	0.0437	0.044	0.0443	0.0446	0.0449
42.81223	43.03351	43.25215	43.47080	43.68737	43.90235	44.11572	44.32750	44.53764	44.74610	44.95284	45.15784	45.36108	45.56256	45.76228	45.96024	46.15644	46.35090	46.54362	46.73460	46.92384	47.11134
42.82791	42.74894	42.86142	43.11633	43.42271	43.78051	44.19074	44.65341	45.16996	45.74150	46.36904	47.05358	47.79512	48.59366	49.44920	50.36174	51.33128	52.35782	53.44136	54.58190	55.77944	57.03498
42.54037	42.40761	42.28286	42.16741	42.06242	41.96803	41.88449	41.81197	41.75064	41.70060	41.66194	41.63464	41.61870	41.61422	41.62030	41.63694	41.66414	41.70180	41.75000	41.80774	41.87502	41.95184
41.98677	42.18268	42.40815	42.65315	42.91761	43.19149	43.47484	43.76772	44.07010	44.38196	44.70338	45.03534	45.37782	45.73082	46.09536	46.47144	46.85906	47.25822	47.66902	48.09146	48.52554	48.97126
41.69267	41.81491	42.12978	42.50037	42.92778	43.41209	43.95340	44.55171	45.20802	45.92333	46.69864	47.53495	48.43226	49.39157	50.41288	51.49619	52.64250	53.85181	55.12412	56.45943	57.85774	59.31905
41.4315	41.84180	41.89134	42.07152	42.29238	42.55483	42.85807	43.20210	43.58691	44.01346	44.48173	44.98282	45.51673	46.08344	46.68275	47.31506	47.98037	48.67868	49.41099	50.17730	50.97861	51.81492
41.18233	41.37231	41.43027	41.58126	41.73501	41.89150	42.05073	42.21280	42.37771	42.54546	42.71597	42.88924	43.06537	43.24436	43.42621	43.61090	43.79843	43.98880	44.18193	44.37782	44.57645	44.77772
40.93853	41.15445	41.37029	41.58614	41.79201	41.98790	42.17481	42.35274	42.52170	42.68171	42.83276	42.97494	43.10825	43.23269	43.34826	43.45497	43.55282	43.64181	43.72204	43.79351	43.85632	43.91049
40.69228	40.94193	41.18844	41.43293	41.67542	41.91591	42.15440	42.39089	42.62438	42.85487	43.08236	43.30685	43.52734	43.74383	43.95632	44.16481	44.36930	44.56979	44.76628	44.95877	45.14726	45.33175
40.45185	40.69810	40.93819	41.17212	41.40089	41.62450	41.84305	42.05654	42.26503	42.46846	42.66683	42.86014	43.04843	43.23172	43.41001	43.58330	43.75159	43.91488	44.07317	44.22646	44.37475	44.51804
40.20414	40.32217	40.43948	40.55601	40.67176	40.78673	40.90092	41.01435	41.12702	41.23895	41.35014	41.46059	41.57030	41.67927	41.78750	41.89499	42.00174	42.10775	42.21302	42.31755	42.42134	42.52439
39.94819	40.05505	40.23178	40.48911	40.81839	41.22072	41.69805	42.25138	42.88071	43.58704	44.37037	45.23070	46.16803	47.18236	48.27369	49.44202	50.68835	52.01268	53.41501	54.89534	56.45367	58.09000
39.68529	39.71251	39.83889	39.96514	40.09135	40.21652	40.34165	40.46672	40.59179	40.71680	40.84177	40.96669	41.09156	41.21639	41.34117	41.46590	41.59058	41.71521	41.83979	41.96432	42.08881	42.21325
39.42044	39.51671	39.59182	39.74619	39.97049	40.26479	40.62909	41.06339	41.56769	42.14199	42.78629	43.50059	44.28489	45.13919	46.06349	47.05779	48.12209	49.25639	50.46069	51.73499	53.07929	54.49359
39.15559	39.28151	39.40829	39.53581	39.66409	39.79213	39.92093	40.05049	40.18081	40.31285	40.44561	40.57909	40.71329	40.84821	40.98385	41.12021	41.25729	41.39501	41.53337	41.67237	41.81191	41.95199
38.89111	38.91287	38.94244	38.97081	39.00798	39.05395	39.10872	39.17229	39.24456	39.32563	39.41550	39.51417	39.62154	39.73761	39.86238	39.99585	40.13802	40.28889	40.44746	40.61373	40.78690	40.96707
38.62733	38.61287	38.60244	38.59601	38.59268	38.59245	38.59532	38.60039	38.60766	38.61713	38.62880	38.64277	38.65904	38.67761	38.69868	38.72205	38.74772	38.77559	38.80566	38.83793	38.87240	38.90907
38.36411	38.31287	38.26244	38.21281	38.16498	38.11895	38.07472	38.03229	37.99166	37.95283	37.91580	37.88057	37.84694	37.81491	37.78448	37.75565	37.72842	37.70279	37.67876	37.65633	37.63550	37.61627
38.10189	38.01287	37.92244	37.83281	37.74398	37.65595	37.56872	37.48229	37.39666	37.31183	37.22780	37.14457	37.06204	36.98021	36.89908	36.81865	36.73892	36.66000	36.58188	36.50455	36.42792	36.35199
37.84011	37.71287	37.58244	37.44881	37.31198	37.17195	37.02872	36.88229	36.73266	36.58083	36.42690	36.27097	36.11304	35.95311	35.79118	35.62725	35.46132	35.29339	35.12446	34.95353	34.78060	34.60567
37.57833	37.41287	37.24244	37.06881	36.89198	36.71195	36.52872	36.34229	36.15266	35.96083	35.76790	35.57397	35.37804	35.18011	34.98018	34.77825	34.57432	34.36839	34.16046	33.95053	33.73860	33.52467
37.31655	37.11287	36.90244	36.68481	36.45898	36.22495	35.98272	35.73229	35.47366	35.20683	34.93290	34.65197	34.36404	34.06911	33.76618	33.45525	33.13632	32.80939	32.47546	32.13453	31.78660	31.43267
37.05477	36.81287	36.56244	36.30481	36.03998	35.76795	35.48872	35.20229	34.90846	34.60723	34.30060	33.98867	33.67144	33.34991	33.02408	32.69395	32.35042	31.99349	31.62306	31.23913	30.84170	30.43077
36.79299	36.51287	36.22244	35.92481	35.61898	35.30495	34.98272	34.65229	34.31366	33.96683	33.61290	33.25197	32.88404	32.51011	32.12918	31.74125	31.33732	30.91739	30.48146	30.02953	29.56260	29.07567
36.53121	36.21287	35.88244	35.54481	35.19898	34.84495	34.48272	34.11229	33.73446	33.34923	32.95760	32.55967	32.15534	31.74461	31.32748	30.90395	30.47302	30.02469	29.56876	29.09583	28.60590	28.09897
36.26943	35.91287	35.54244	35.15981	34.76498	34.35795	33.93872	33.50729	33.06346	32.60723	32.13730	31.65367	31.15634	30.64541	30.12108	29.58335	29.03242	28.46829	27.89076	27.29983	26.69540	26.07747
36.00765	35.61287	35.19244	34.75981	34.31498	33.85795	33.38772	32.90429	32.40746	31.89723	31.37360	30.83697	30.28734	29.72481	29.14838	28.55805	27.95392	27.33609	26.70456	26.05923	25.40010	24.72717
35.74587	35.31287	34.86244	34.39981	33.92498	33.43795	32.93872	32.42729	31.90246	31.36423	30.81360	30.25067	29.67534	29.08761	28.48768	27.87555	27.25122	26.61469	25.96596	25.30403	24.62870	23.94077
35.48409	35.01287	34.52244	34.02481	33.51898	32.99495	32.45272	31.89429	31.31946	30.72723	30.11760	29.49067	28.84634	28.18461	27.50558	26.80925	26.09552	25.36439	24.61576	23.85963	23.09600	22.32487
35.22231	34.71287	34.19244	33.66481	33.12898	32.58495	32.02272	31.44329	30.84646	30.23223	29.60060	28.95167	28.28534	27.60431	26.90858	26.19895	25.47542	24.73809	23.98696	23.22103	22.44140	21.64827
34.96053	34.41287	33.86244	33.30981	32.75398	32.19495	31.62272	31.03729	30.43846	29.82623	29.19960	28.55917	27.90484	27.23681	26.55518	25.85985	25.15072	24.42779	23.69106	22.94053	22.17620	21.39927
34.69875	34.11287	33.54244	32.97481	32.40898	31.83495	31.25272	30.65329	30.03646	29.40123	28.74760	28.07567	27.39534	26.70661	26.00958	25.30425	24.59052	23.86839	23.13786	22.39913	21.65220	20.89787
34.43697	33.81287	33.22244	32.63481	32.04898	31.45495	30.85272	30.24229	29.61346	28.96623	28.30060	27.61667	26.91434	26.20361	25.48458	24.75775	24.02302	23.28029	22.52956	21.77083	21.00410	20.23027
34.17519	33.51287	32.90244	32.30981	31.71498	31.11695	30.51472	29.90829	29.28746	28.65323	28.00560	27.34467	26.67034	25.98261	25.28158	24.56725	23.84452	23.11339	22.37386	21.62613	20.87020	20.10607
33.91341	33.21287	32.59244	31.97481	31.35898	30.74495	30.12272	29.49229	28.84346	28.17623	27.49060	26.79667	26.09434	25.38361	24.66458	23.93725	23.20152	22.45739	21.70486	20.94393	20.17460	19.39767
33.65163	32.91287	32.28244	31.65481	31.02898	30.40495	29.77272	29.13229	28.47346	27.79623	27.10160	26.39867	25.68734	24.96761	24.23958	23.50325	22.75852	22.00539	21.24486	20.47693	19.70160	18.91867
33.38985	32.61287	31.97244	31.33481	30.69898	30.06495	29.42272	28.77329	28.10646	27.42123	26.71760	26.00567	25.28534	24.55761	23.82258	23.08025	22.33052	21.57339	20.80886	20.03693	19.25760	18.47067
33.12807	32.31287	31.66244	31.01481	30.36898	29.72495	29.07272	28.41329	27.73646	27.04223	26.33060	25.61067	24.88234	24.14661	23.40358	22.65325	21.89552	21.13039	20.35786	19.57793	18.79060	18.00567
32.86629	32.01287	31.34244	30.68481	30.02898	29.37495	28.71272	28.04329	27.35646	26.65223	25.93960	25.21867	24.48934	23.75261	23.00858	22.25725	21.50852	20.75239	19.98886	19.21793	18.43920	17.65267
32.60451	31.71287	31.03244	30.37481	29.71898	29.06495	28.40272	27.73229	27.04346	26.33723	25.62260	24.89967	24.16834	23.42961	22.68358	21.93025	21.16952	20.40139	19.62586	18.84293	18.05260	17.25487
32.34273	31.41287	30.73244	30.07481	29.41898	28.76495	28.10272	27.43229	26.74346	26.03723	25.32260	24.59967	23.86834	23.1								

Ruddervator Sizing

- First iteration using 30% surface area benchmark
- Excel and CFD to iterate and verify effectiveness
- Final iteration at 38% tail surface area and oversized for 50% tail area



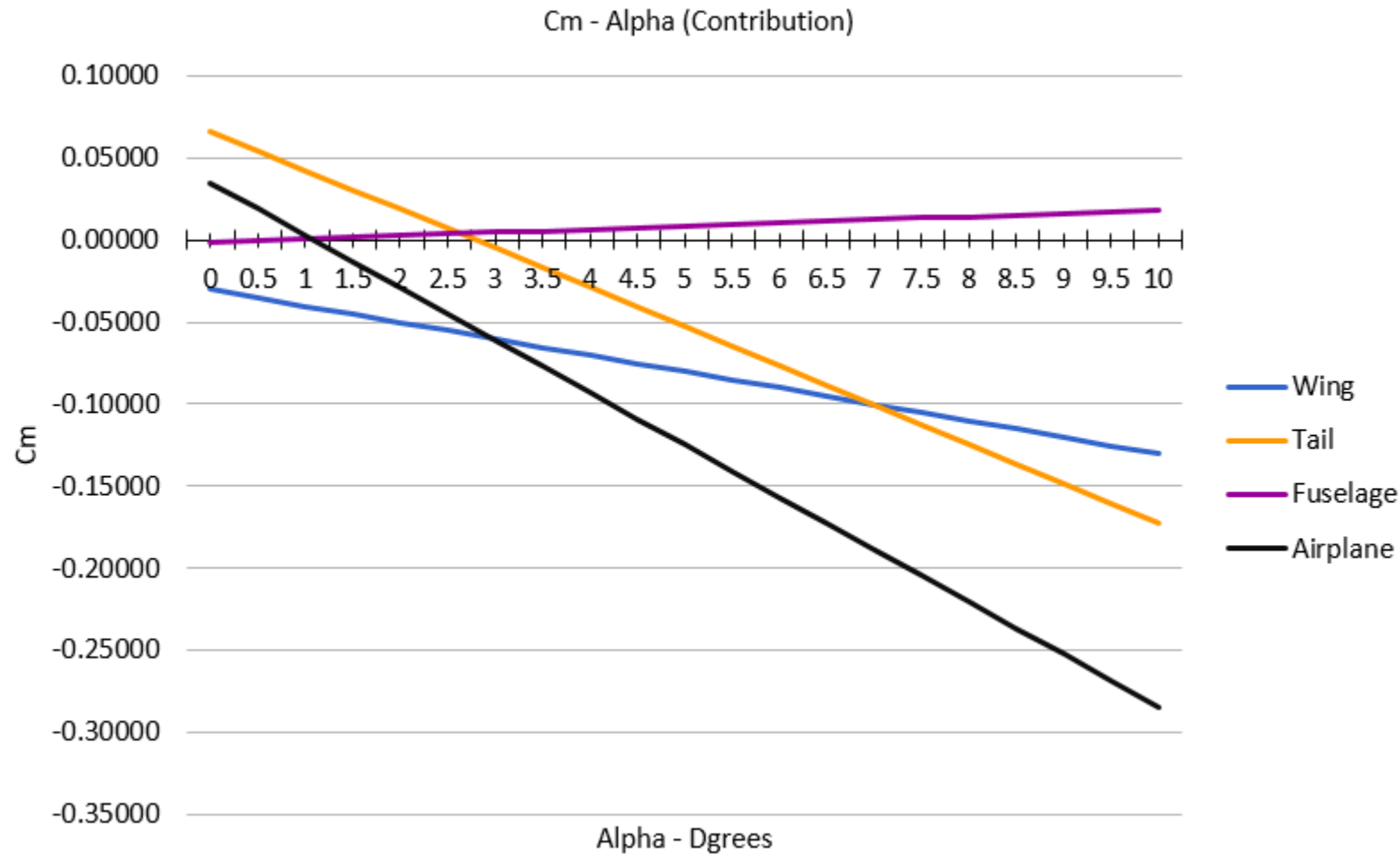
Ruddervator Effectiveness



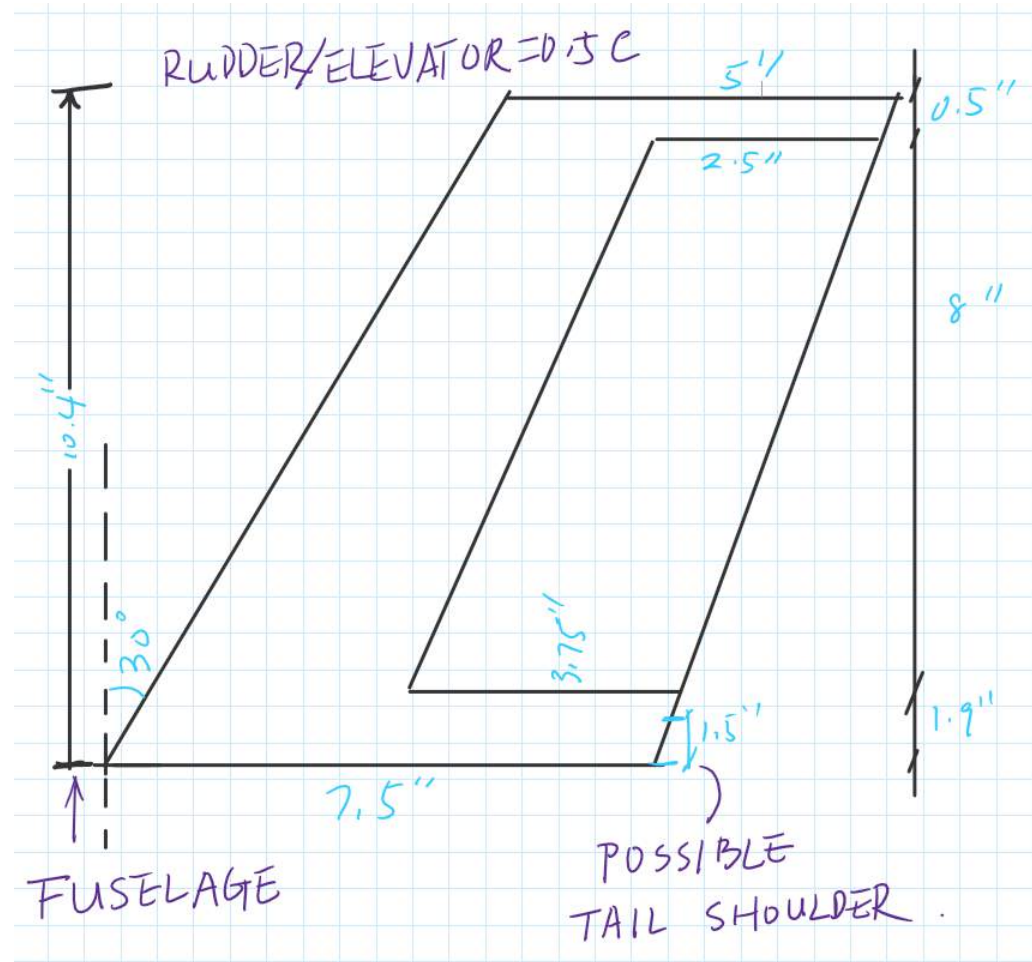
Ruddervator Effectiveness from -40 degree to 15 degree deflection



Fuselage Analysis: Pitching Moment

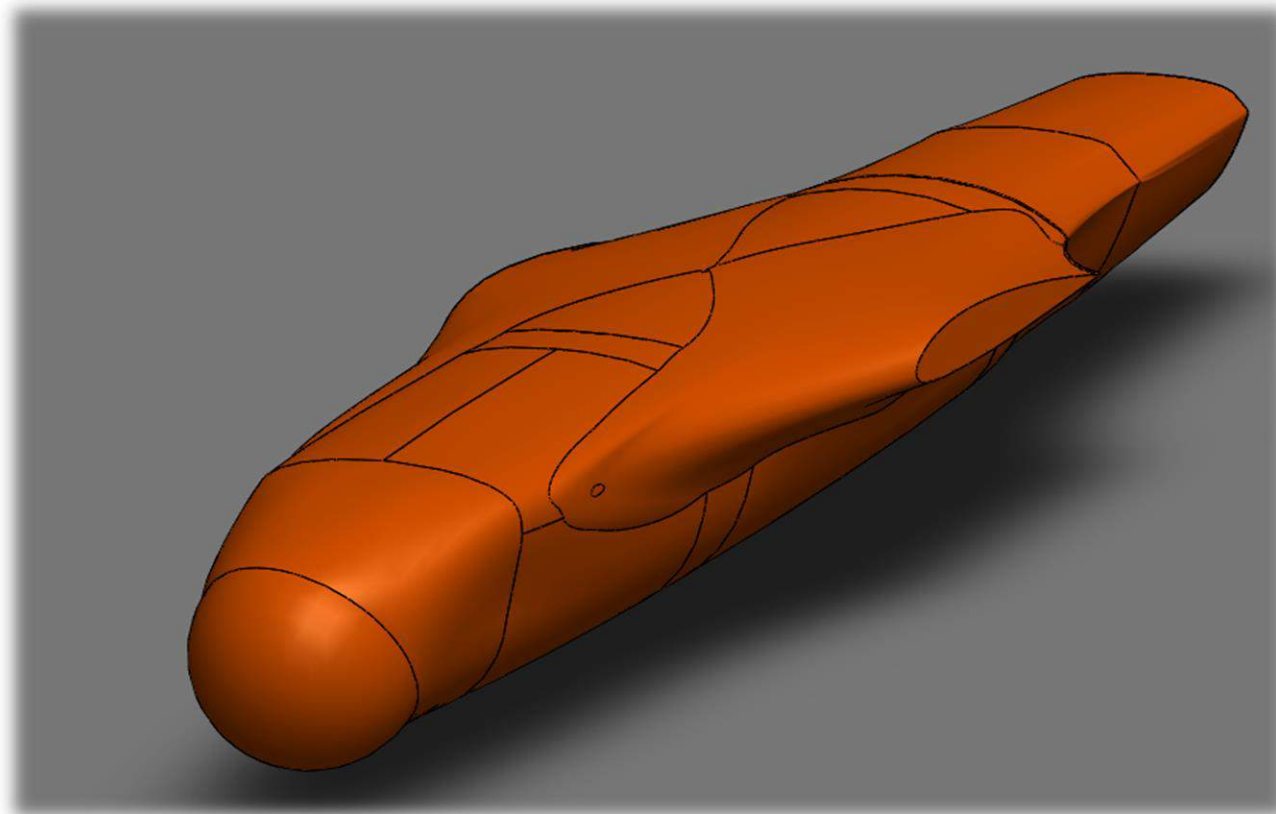


Final Tail Planform



Fuselage Design

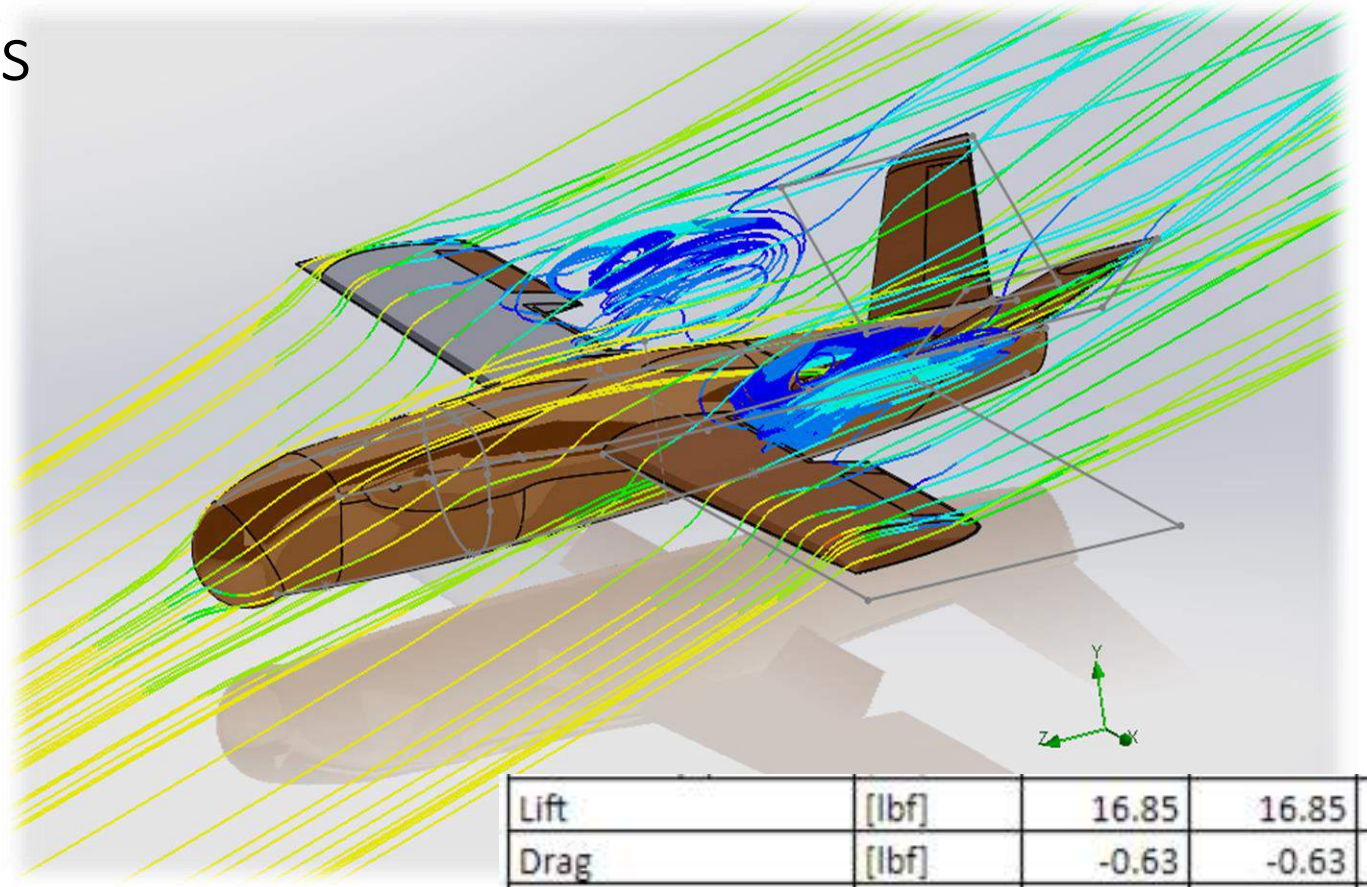
- Designed for high speed and low drag
- Fuselage drag estimated with CFD in combination with all other components



CFD Results

Landing Configuration:

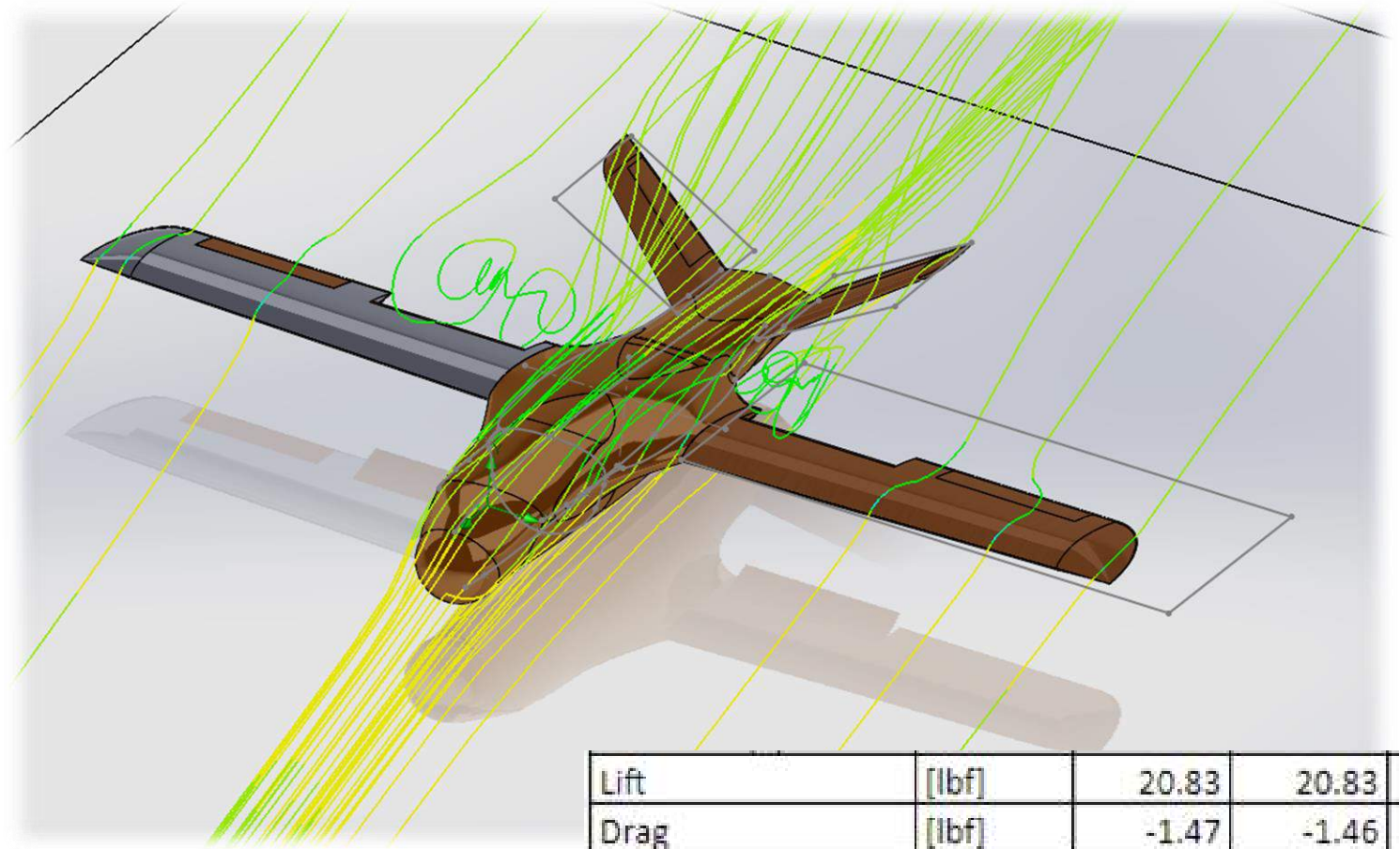
- Landing velocity: 55 ft/s
- Flaps deflection: 40°
- AoA: 15°



CFD Results

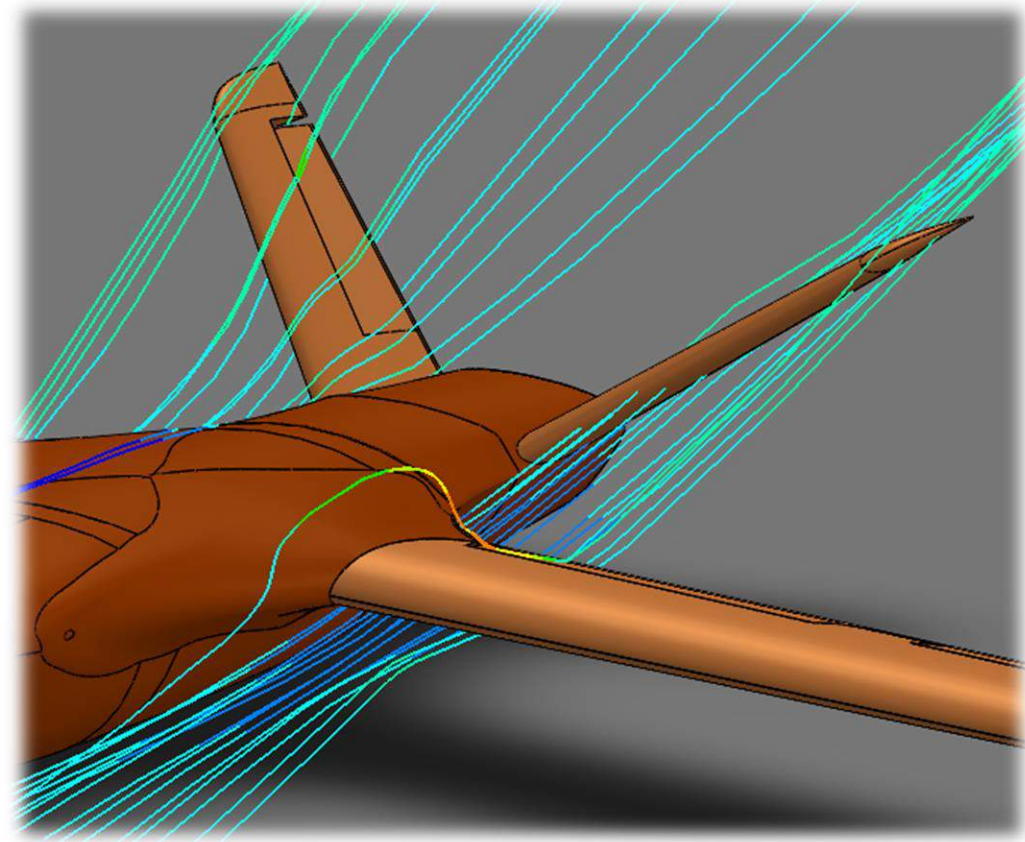
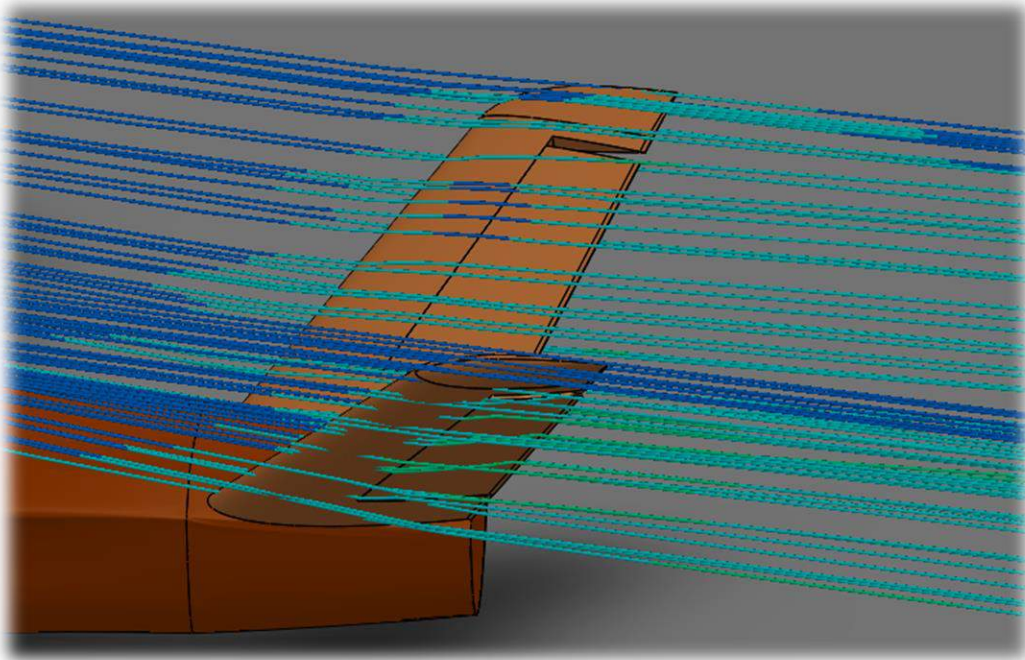
Takeoff Configuration

- 50 ft/s
- Flaps 20°
- AoA 17°



CFD Results

- Tail Flow Characteristics
 - CFD @ 17° AOA



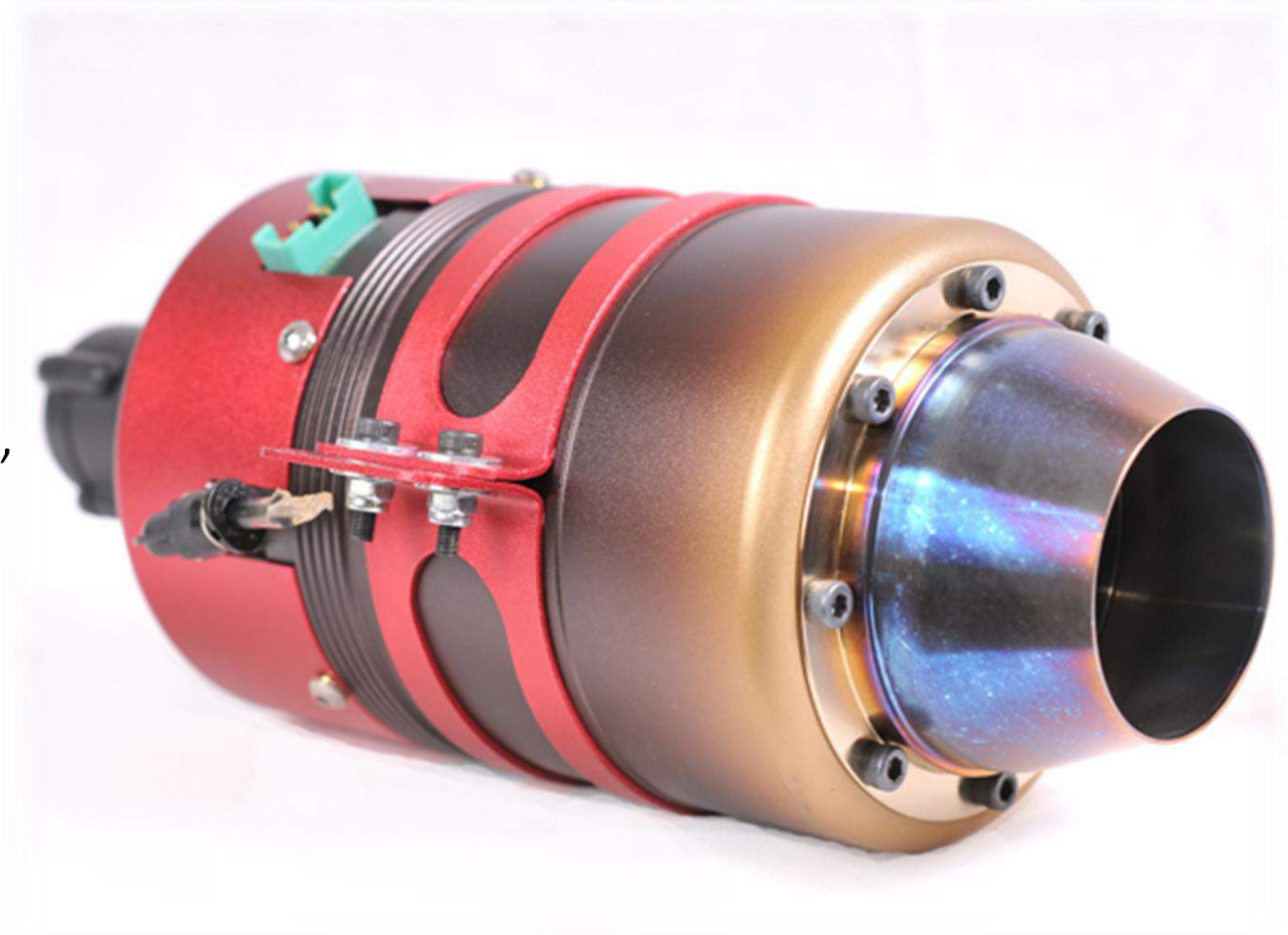


PROPULSION

Engine Selection

KingTech K-70G2

- Thrust: 15.5 lb @ 15°C
- Cost: \$1,650.00
- Weight: 1 lb 9.3 oz
- Fuel Consumption: 8.11 oz/min
- Dimensions (D x L): 2.99" x 7.68"



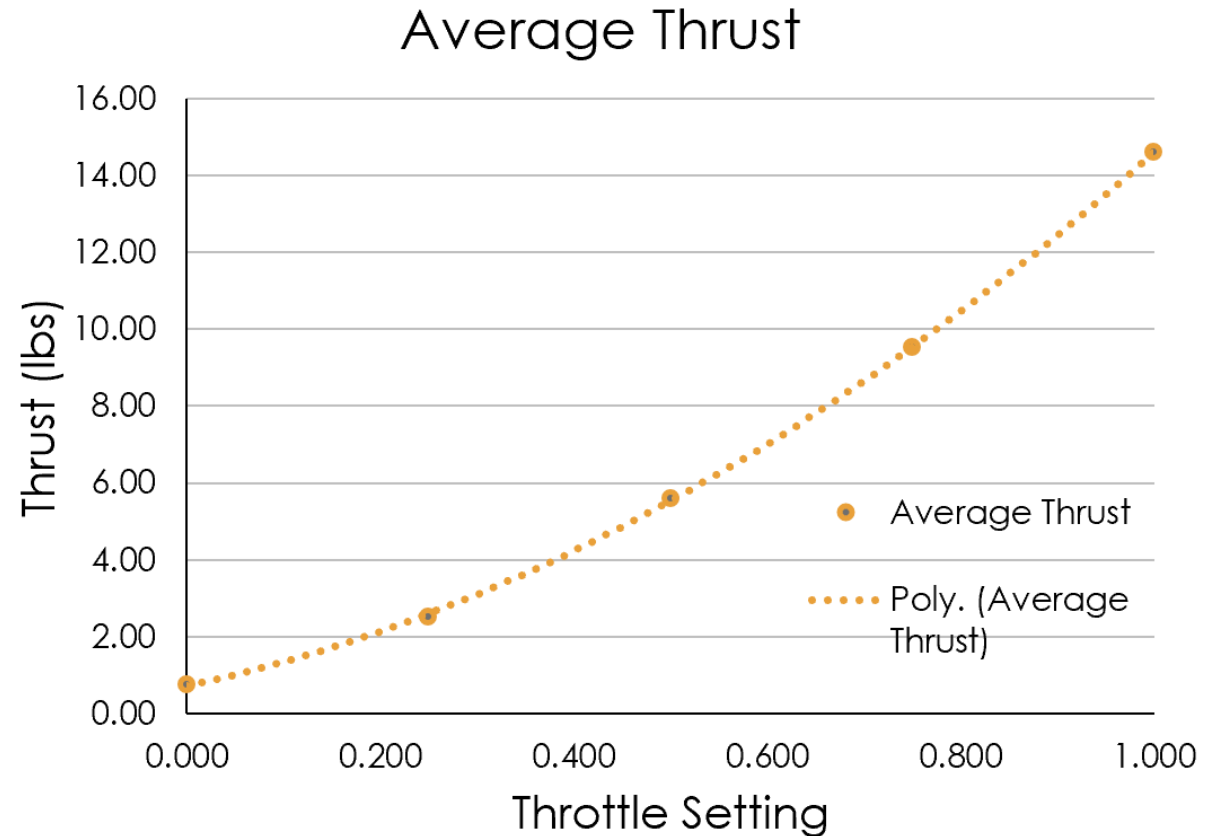


Previous Engine Testing

Thrust vs. Throttle Setting

- Average thrust at idle: 0.75 lbf @ 60,000 RPM
- Average thrust at full throttle: 14.6 lbf @ 180,000 RPM

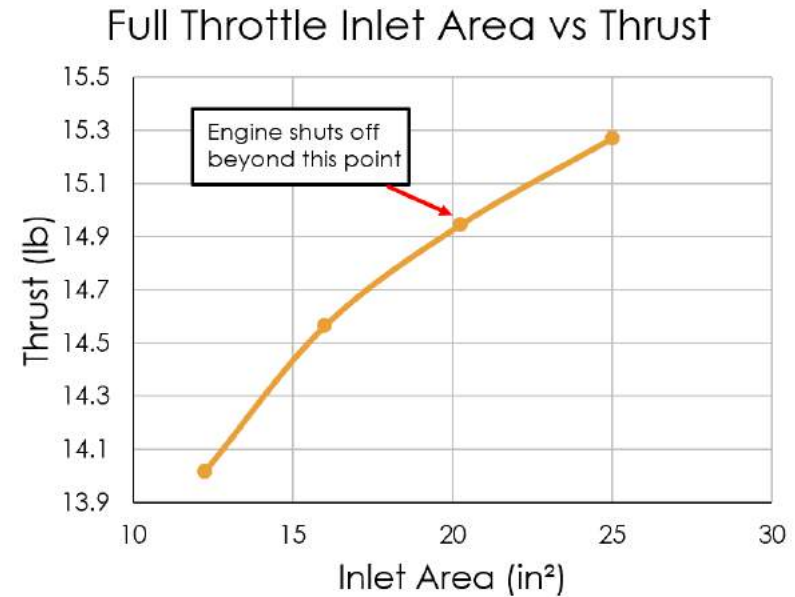
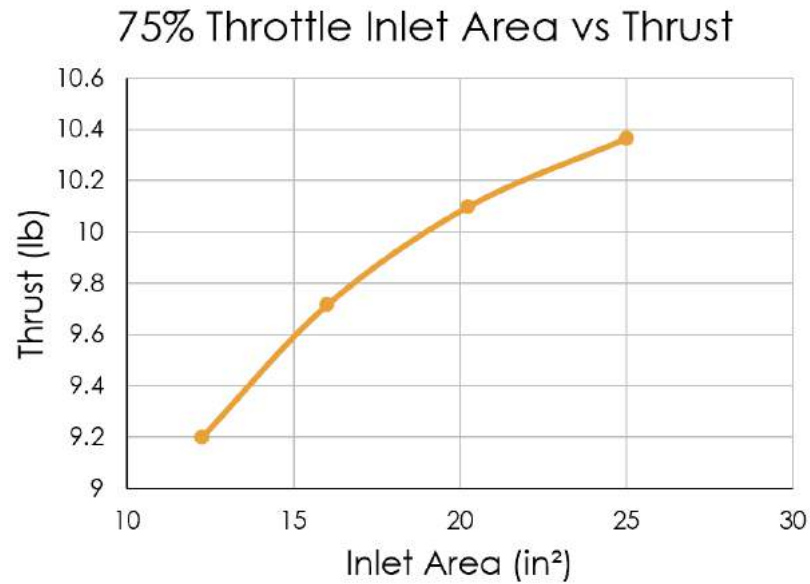
*Engine testing and analysis done by Orange Team 2018



Inlet Sizing

Baseline of at least 25 in² inlet area

- Determined based on Orange Team 2018 inlet tests
- Similar K-70G2 engine with thrust tube set-up



Inlet Design

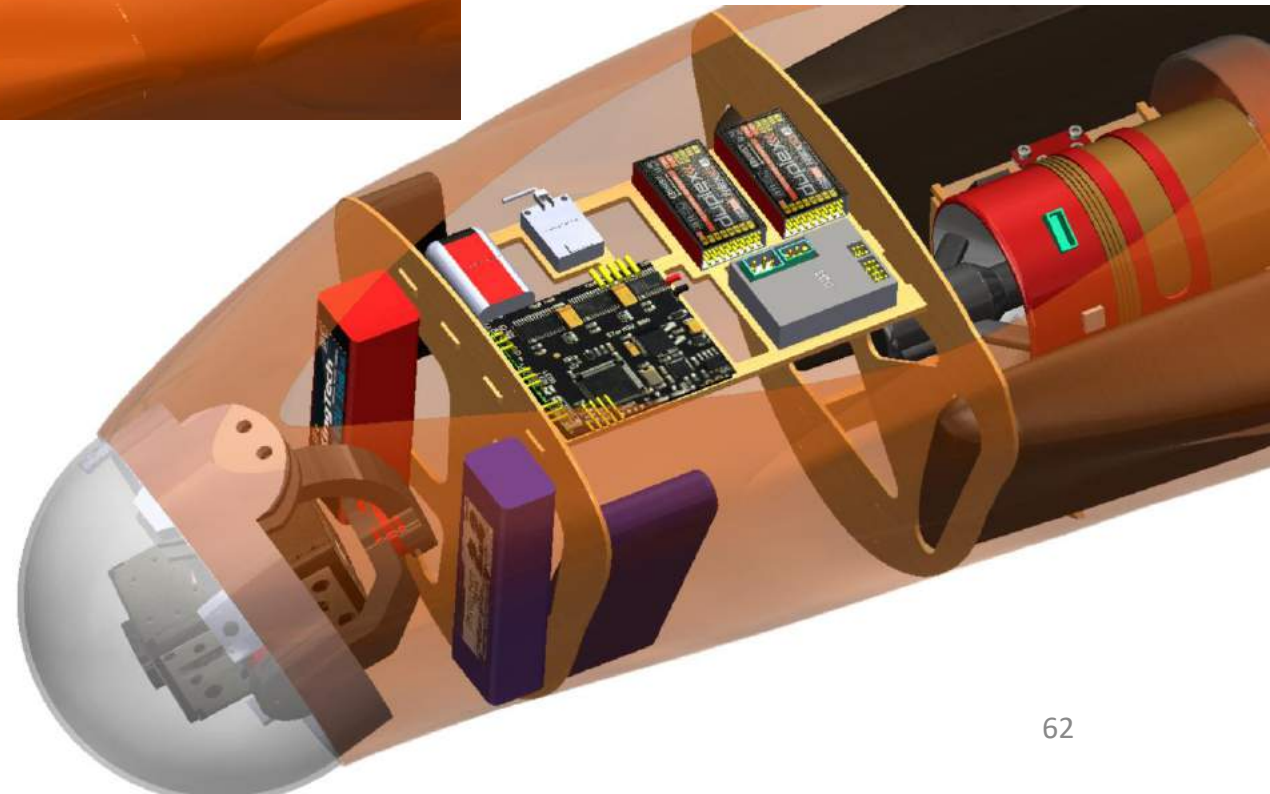
Size

- NACA Inlet shaped
- Minimum of 25 in²
- Modeled as approximately 26 in²



Airflow

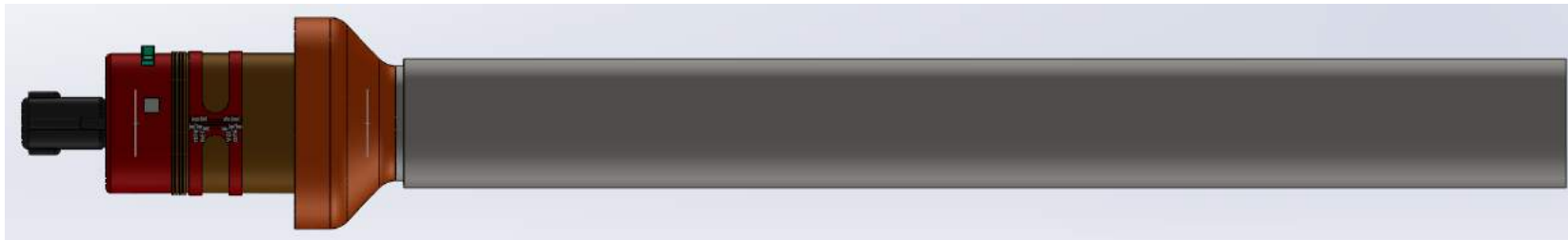
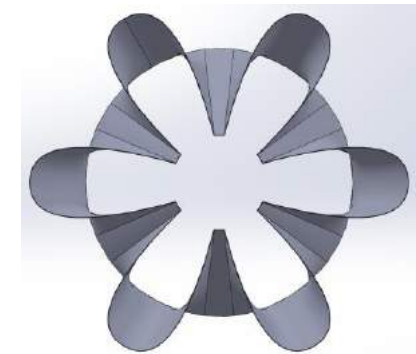
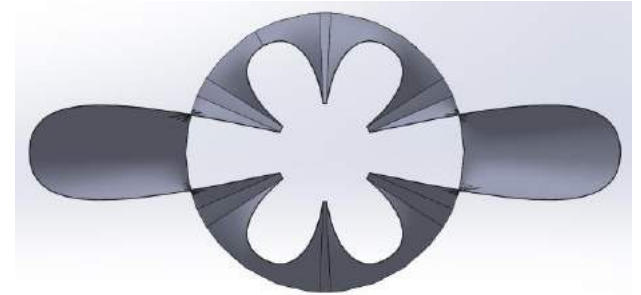
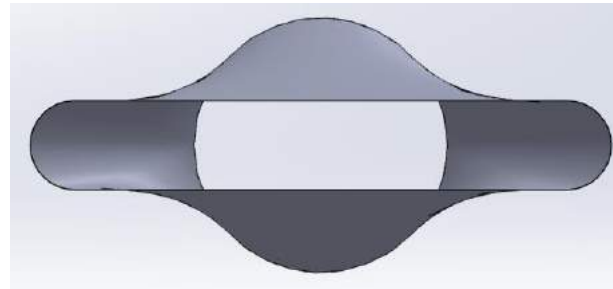
- Cutouts in the bulkheads are at least the same area as inlet
- Flow goes around avionics for cooling



CFD Estimations On Different Nozzles

Main Focus of CFD

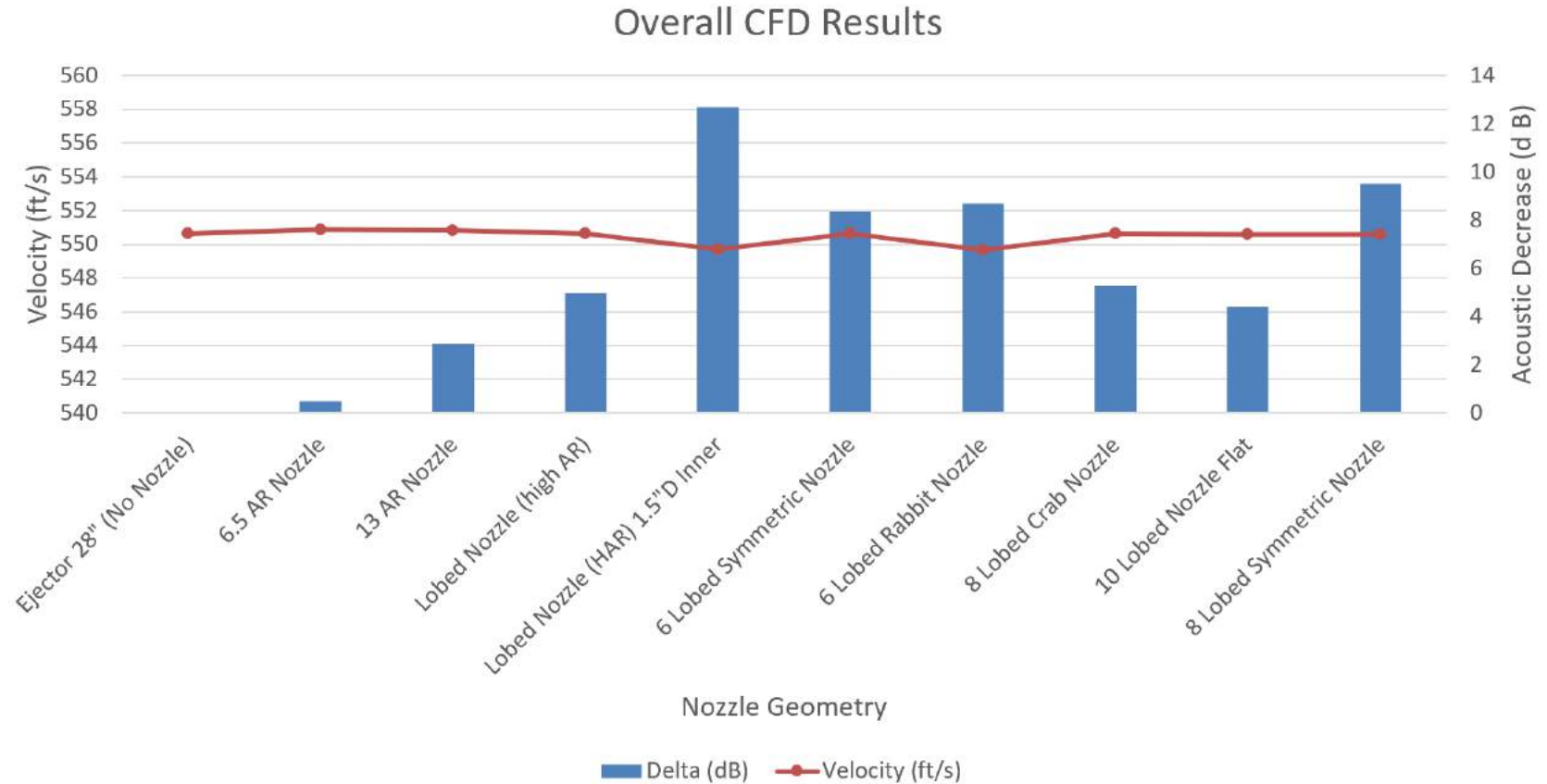
- Find optimum geometry for decrease in dB while keeping:
 - Constant area at nozzle exit
 - Constant total length from bell mouth to nozzle exit
 - Maximum 7° taper of nozzle
- Geometries being tested:
 - High aspect ratio nozzles
 - Lobed nozzles
 - Combination of the two



CFD Results

Conclusions

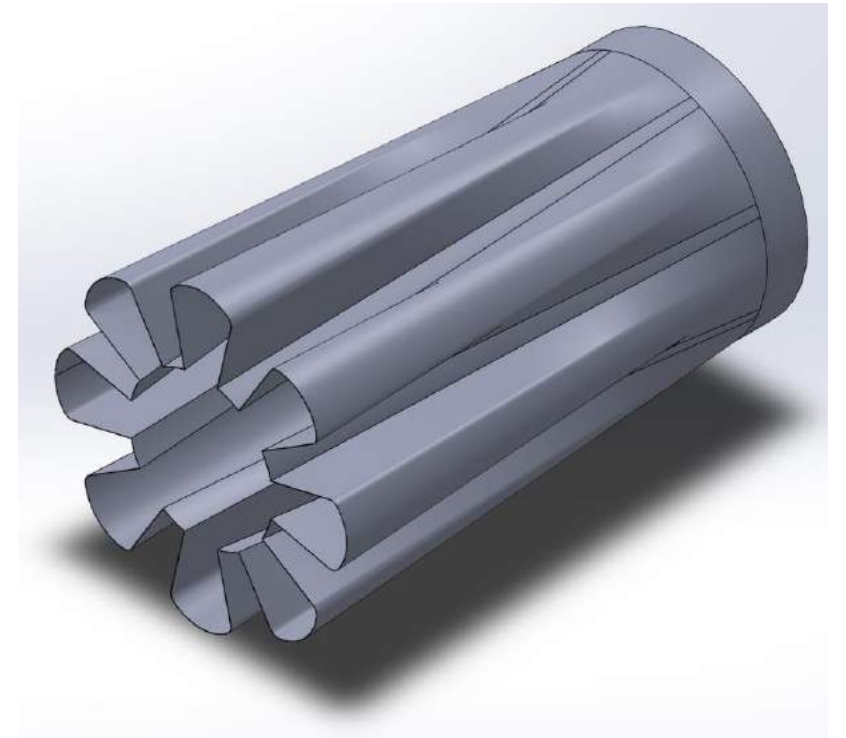
- Average velocity at nozzle exit stays constant with input velocity
- Lobes > High AR
 - Much more surface area



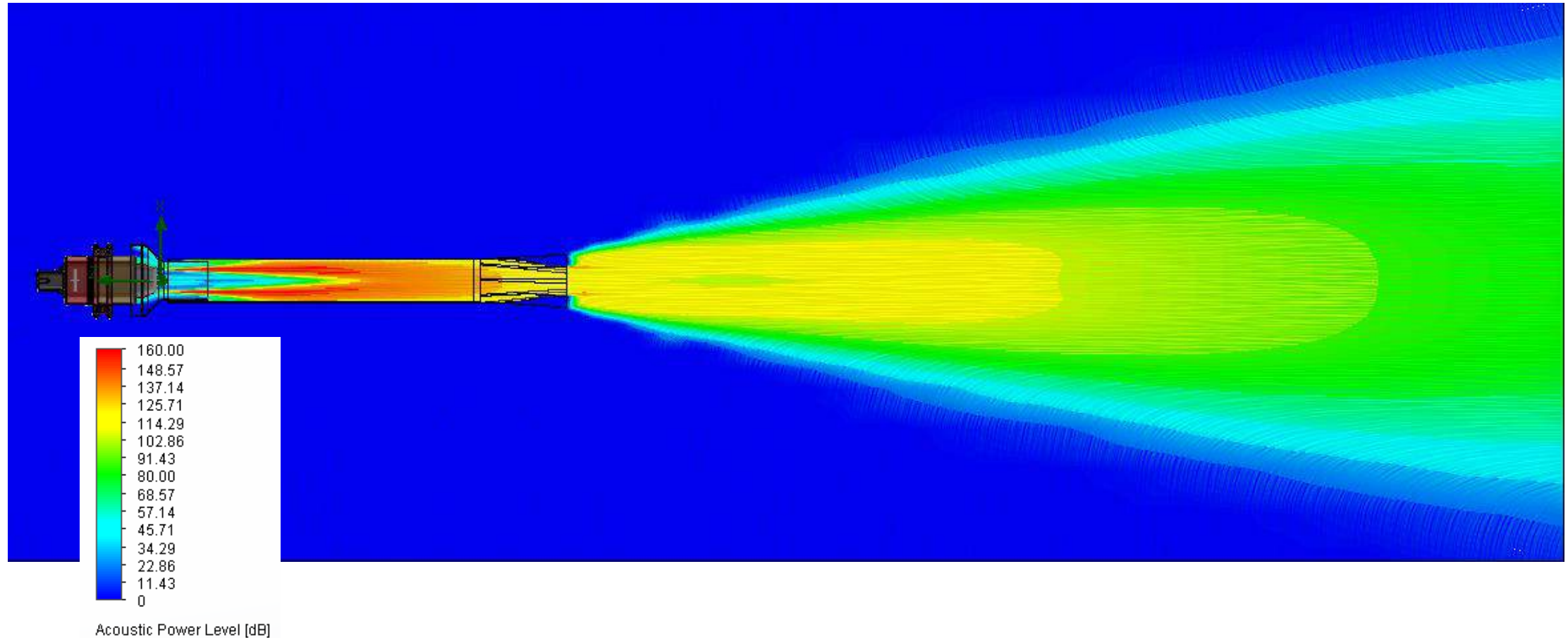
Chosen Nozzle Geometry

8 Lobed Symmetric Nozzle

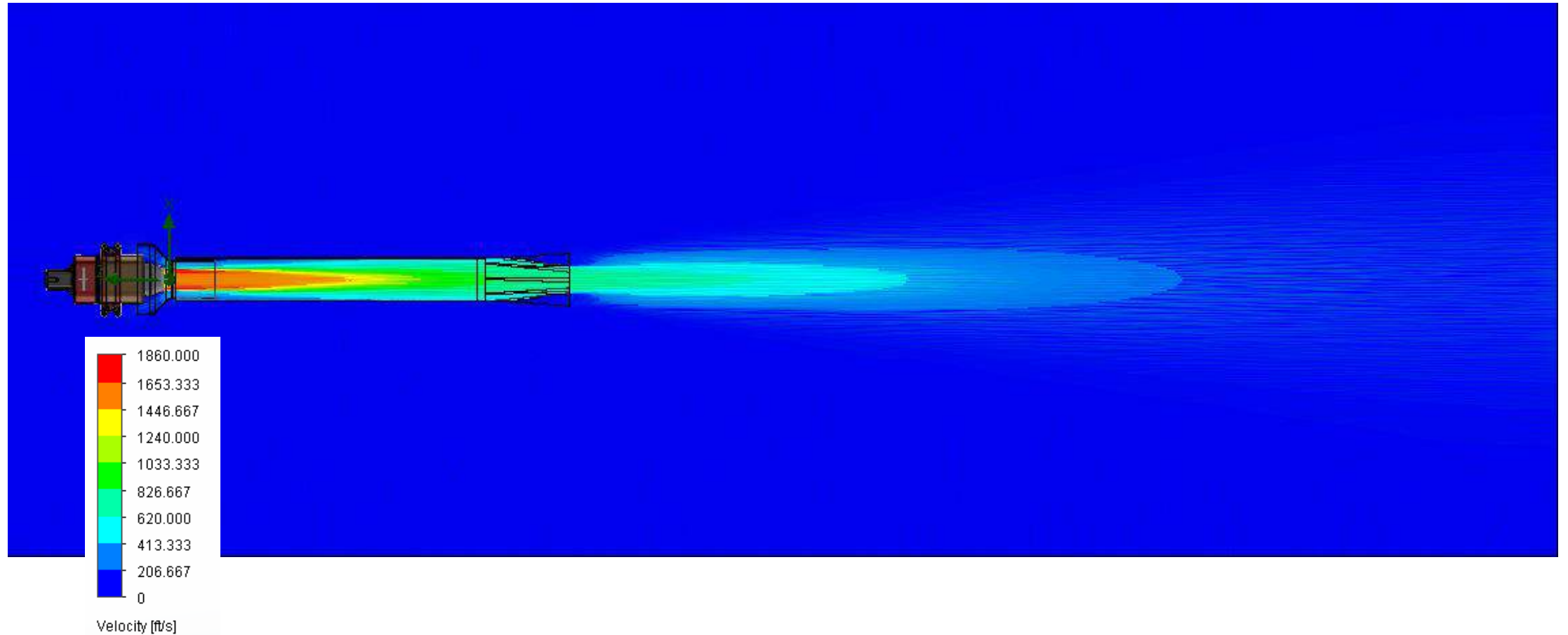
- Length of 5.5"
- Large amount of surface area for more mixing
- 2nd lowest dB delta of tested geometries
- Accommodates structure of V-tail spars



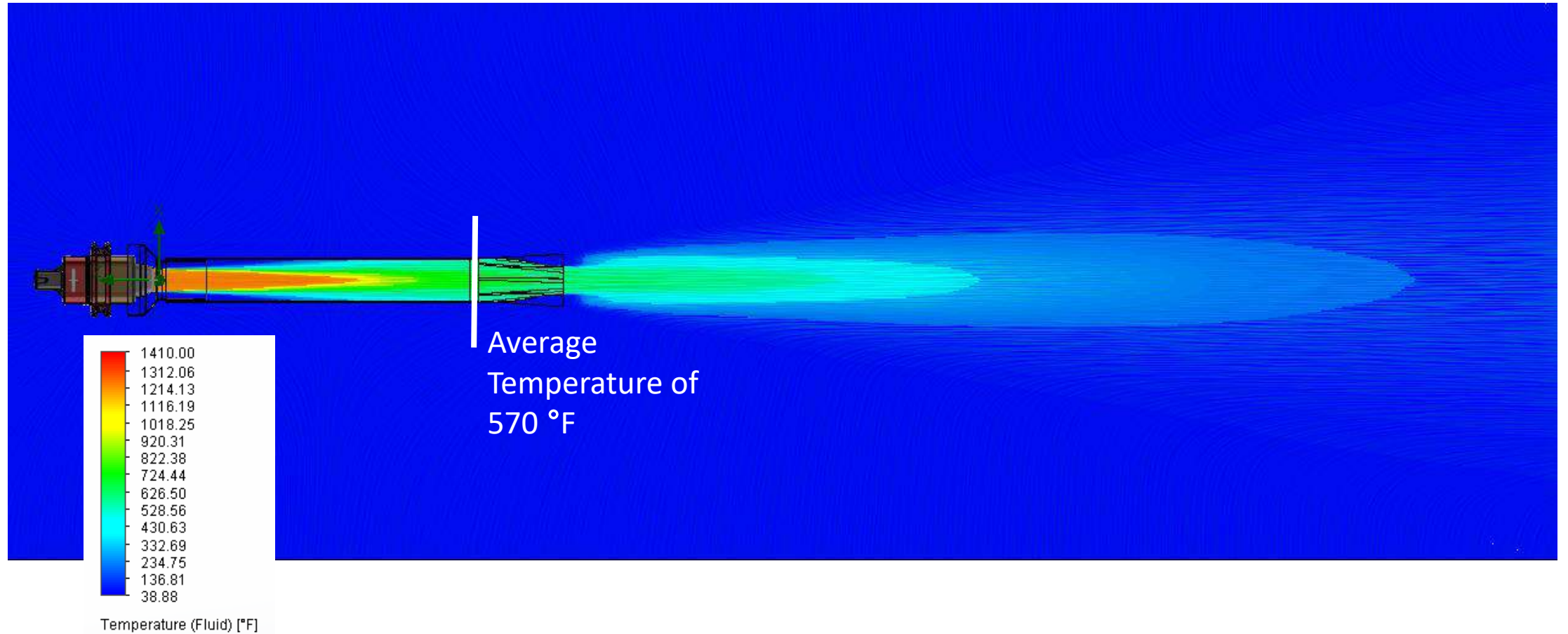
Nozzle Acoustic Power Level



Nozzle Velocity



Nozzle Temperature



Nozzle Manufacturing

Methods

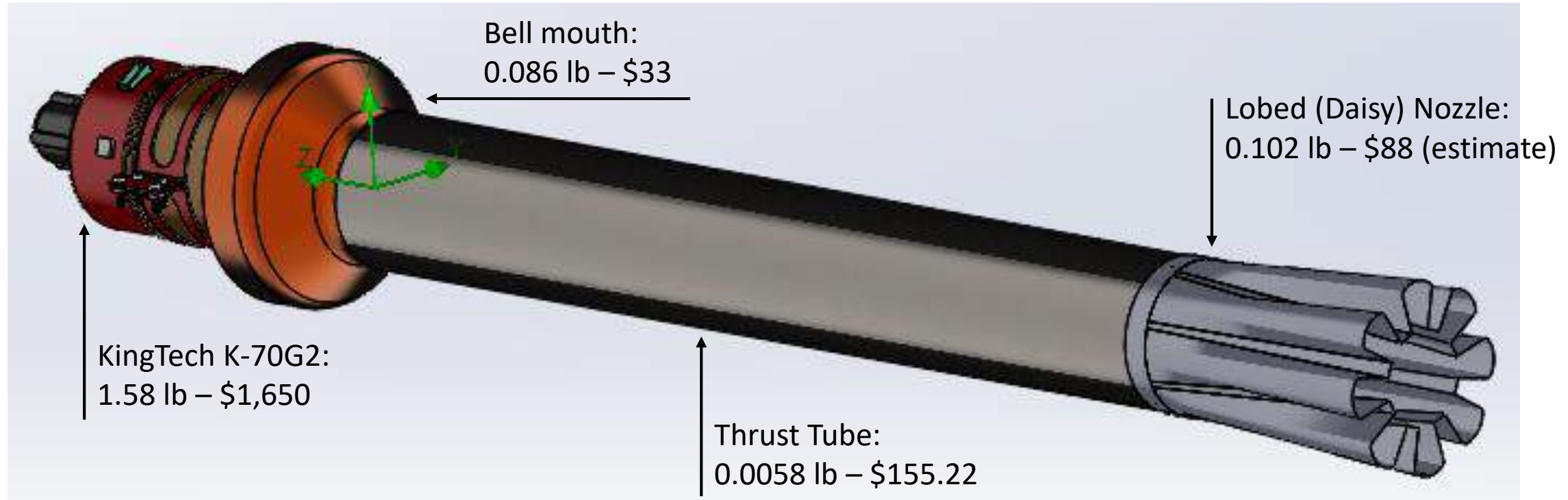
- 3D printed molds
- Press brake

Material

- Sheet Metal
 - Aluminum
 - Stainless Steel



Component Breakdown



- Possible use of mesh surrounded by K-Wool near bell mouth.
 - Dependent on test results of nozzle (use only if nozzle is insufficient, testing will need to be conducted)



Fuel Required for Cruise and Loiter

Aircraft Estimates

- Empty Weight: 13 lb
- Fuel Weight: ~7 lb
- Wing Area: 5 ft²
- Wing Span: 6 ft
- Parasite Drag: 0.15

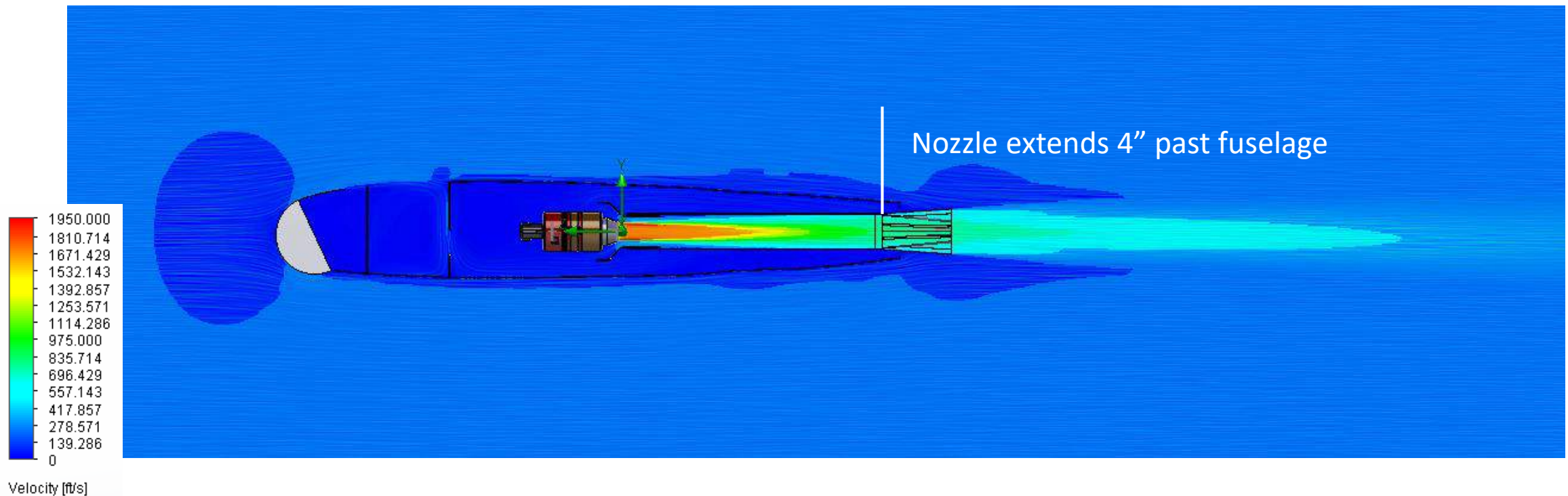
K-70	Cruise Conditions	Loiter Conditions
Throttle Setting (%)	65	20
Average Velocity (kts)	113	63
Time Required (min)	11.2	10
Weight of Required Fuel (lbf)	4.20	2.38
Weight of Required Fuel for Total Mission (lbf)	6.58	

Current Fuel Capacity

- Diesel (6.94 lb/gal)
- 1 gal fuel capacity

Possible Placement Within Aircraft

- Aircraft Velocity and Streamlines
- *Lowers acoustic signature by 7.85 dB (CFD)*
 - *Will be tested in prototype flight tests***





After CDR: Aerodynamics

- Working close with structures and optics with next steps in manufacturing
- Compare results from prototype flight to CFD analysis
- Check aircraft



After CDR: Propulsion

- Work with optics on flight path, find best flying altitude and distance from judges stand
- Layout of fuel lines, fuel pump, and tank attachments
- Optimization of nozzle manufacturing
- Engine testing for nozzle
 - If nozzle isn't sufficient, do testing with mesh and K-wool additions to fuselage



After CDR: Optics and Avionics

- Iterative 3D printing gimbal to make sure it fits
- Camera range
- Fine tune gains on motor controller

- Wiring schematics
- Hooking up and testing complete avionics package
- Tuning stability for Jeti
- Ordering all components



Review

1. Overall Timeline and Goals for Phase 3
2. Overview of Concept
3. Manufacturing Timeline
4. Structures: Manufacturing and Materials
5. Structures: Aircraft Configurations
6. Ground Equipment
7. Launch and Recovery
8. Aerodynamics
9. Propulsion
10. After CDR
11. BFD_cW



BACKUP



Sound dampening back up slides

➤ Kaowool specs

Acoustical performance per ASTM C-423 A and E-795, Sound Absorption Coefficient

Kaowool Blanket	250Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC
1"- 4 pcf	0.29	1.00	1.04	0.99	0.98	0.85
1"- 8 pcf	0.50	0.92	0.91	0.91	0.94	0.80
2"- 4 pcf	0.92	1.01	1.01	1.03	1.10	1.00
2"- 8 pcf	0.80	0.72	0.86	0.92	1.02	0.85

➤ Quiet Batt soundproofing insulation

Acoustic Data:

frequency	125	250	500	1K	2K	4K	NRC*	SAA*
3 inch	.39	.86	.99	.92	.96	1.01	0.95	0.94

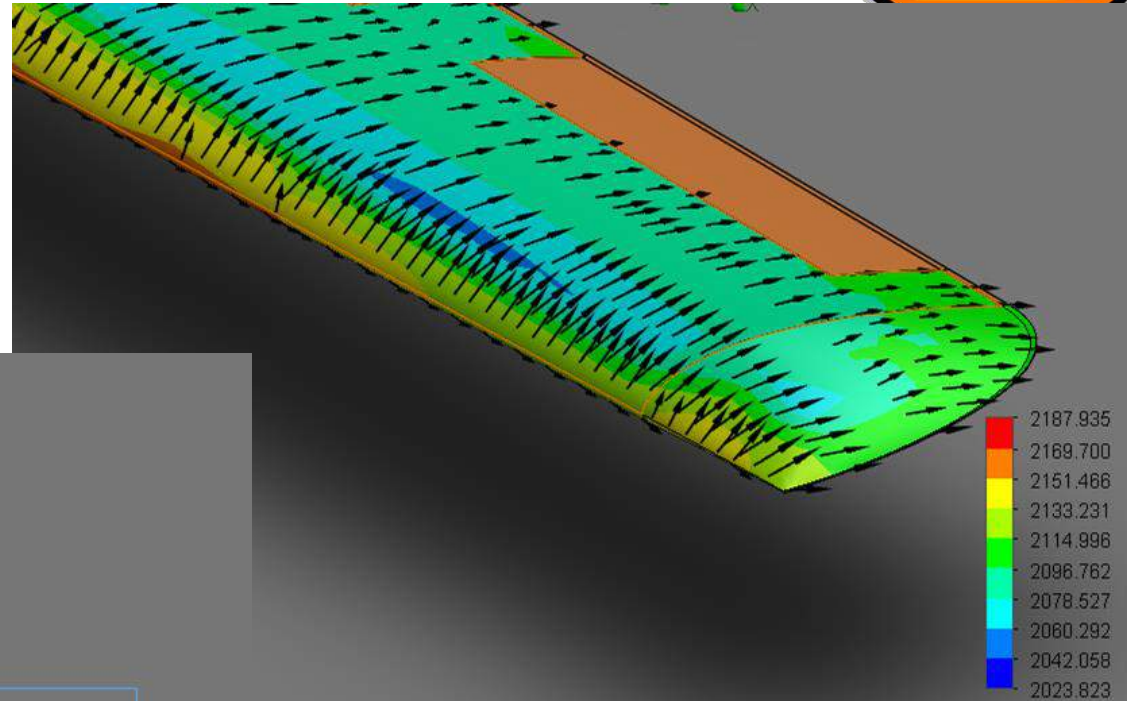
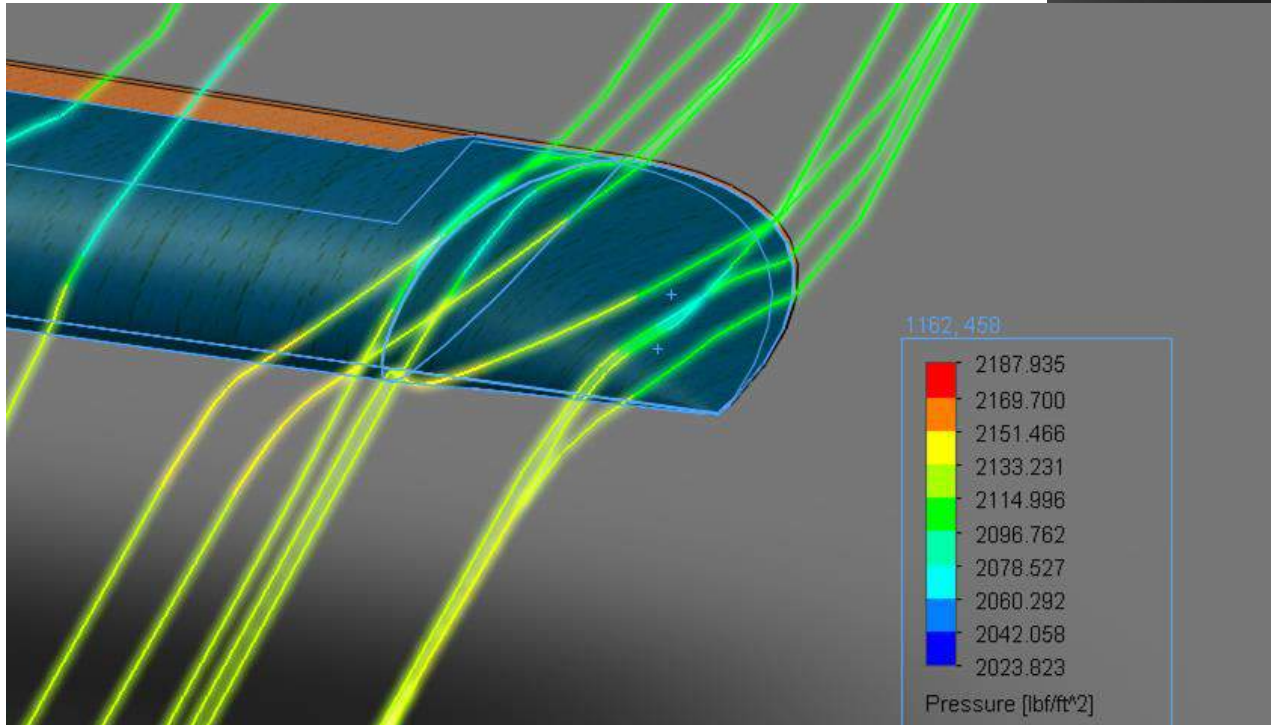
* NRC = noise reduction coefficient

➤ Auralex StudioFoam Pyramids

	2" Studiofoam Pyramid	4" Studiofoam Pyramid
Overall NRC:	0.70	0.95

CFD Results: Tip Stall

- Tip Stall @ 20° and 200 ft/s, but will effect launch angle considerations





Skin Weight (Foam Core; 1:1; 3oz)

Skin Layup (2 oz, PW) - Assuming 1:1 Ratio of Fabric/Epoxy					
#	Material	Bias	Material Density (lb/ft ²)	Thickness (in)	Weight (lb)
1	Fiberglass	45	0.017	0.004	0.246
2	Epoxy	-	0.017	0.002	0.246
3	Fiberglass	90	0.017	0.004	0.246
4	Epoxy	-	0.017	0.002	0.246
5	Divinycell Foam Core (1/8")	-	0.031	0.125	0.452
6	Fiberglass	45	0.017	0.004	0.246
7	Epoxy	-	0.017	0.002	0.246
Total Skin Weight Estimation (lb)					1.927
Total Skin Thickness Estimation (in)					0.141

Skin Layup (3 oz, 4H) - Assuming 1:1 Ratio of Fabric/Epoxy					
#	Material	Bias	Material Density (lb/ft ²)	Thickness (in)	Weight (lb)
1	Fiberglass	45	0.023	0.006	0.331
2	Epoxy	-	0.023	0.003	0.331
3	Fiberglass	90	0.023	0.006	0.331
4	Epoxy	-	0.023	0.003	0.331
5	Divinycell Foam Core (1/8")	-	0.031	0.125	0.452
6	Fiberglass	45	0.023	0.006	0.331
7	Epoxy	-	0.023	0.003	0.331
Total Skin Weight Estimation (lb)					2.441
Total Skin Thickness Estimation (in)					0.152

Skin Layup (4 oz, PW) - Assuming 1:1 Ratio of Fabric/Epoxy					
#	Material	Bias	Material Density (lb/ft ²)	Thickness (in)	Weight (lb)
1	Fiberglass	45	0.028	0.008	0.405
2	Epoxy	-	0.028	0.004	0.405
3	Fiberglass	90	0.028	0.008	0.405
4	Epoxy	-	0.028	0.004	0.405
5	Divinycell Foam Core (1/8")	-	0.031	0.125	0.452
6	Fiberglass	45	0.028	0.008	0.405
7	Epoxy	-	0.028	0.004	0.405
Total Skin Weight Estimation (lb)					2.882
Total Skin Thickness Estimation (in)					0.161

Skin Layup (9 oz, 8H) - Assuming 1:1 Ratio of Fabric/Epoxy					
#	Material	Bias	Material Density (lb/ft ²)	Thickness (in)	Weight (lb)
1	Fiberglass	45	0.063	0.012	0.911
2	Epoxy	-	0.063	0.006	0.911
3	Fiberglass	90	0.063	0.012	0.911
4	Epoxy	-	0.063	0.006	0.911
5	Divinycell Foam Core (1/8")	-	0.031	0.125	0.452
6	Fiberglass	45	0.063	0.012	0.911
7	Epoxy	-	0.063	0.006	0.911
Total Skin Weight Estimation (lb)					5.919
Total Skin Thickness Estimation (in)					0.179



Skin Weight (Foam Core; 1:1.5; 3oz)

Skin Layup (2 oz, PW) - Assuming 1:1.5 Ratio of Fabric/Epoxy					
#	Material	Bias	Material Density (lb/ft ²)	Thickness (in)	Weight (lb)
1	Fiberglass	45	0.017	0.004	0.246
2	Epoxy	-	0.026	0.002	0.369
3	Fiberglass	90	0.017	0.004	0.246
4	Epoxy	-	0.026	0.002	0.369
5	Divinycell Foam Core (1/8")	-	0.031	0.125	0.452
6	Fiberglass	45	0.017	0.004	0.246
7	Epoxy	-	0.026	0.002	0.369
Total Skin Weight Estimation (lb)					2.296
Total Skin Thickness Estimation (in)					0.141

Skin Layup (3 oz, 4H) - Assuming 1:1.5 Ratio of Fabric/Epoxy					
#	Material	Bias	Material Density (lb/ft ²)	Thickness (in)	Weight (lb)
1	Fiberglass	45	0.023	0.006	0.331
2	Epoxy	-	0.034	0.003	0.497
3	Fiberglass	90	0.023	0.006	0.331
4	Epoxy	-	0.034	0.003	0.497
5	Divinycell Foam Core (1/8")	-	0.031	0.125	0.452
6	Fiberglass	45	0.023	0.006	0.331
7	Epoxy	-	0.034	0.003	0.497
Total Skin Weight Estimation (lb)					2.938
Total Skin Thickness Estimation (in)					0.152

Skin Layup (4 oz, PW) - Assuming 1:1.5 Ratio of Fabric/Epoxy					
#	Material	Bias	Material Density (lb/ft ²)	Thickness (in)	Weight (lb)
1	Fiberglass	45	0.028	0.008	0.405
2	Epoxy	-	0.042	0.004	0.607
3	Fiberglass	90	0.028	0.008	0.405
4	Epoxy	-	0.042	0.004	0.607
5	Divinycell Foam Core (1/8")	-	0.031	0.125	0.452
6	Fiberglass	45	0.028	0.008	0.405
7	Epoxy	-	0.042	0.004	0.607
Total Skin Weight Estimation (lb)					3.489
Total Skin Thickness Estimation (in)					0.161

Skin Layup (9 oz, 8H) - Assuming 1:1.5 Ratio of Fabric/Epoxy					
#	Material	Bias	Material Density (lb/ft ²)	Thickness (in)	Weight (lb)
1	Fiberglass	45	0.063	0.012	0.911
2	Epoxy	-	0.095	0.006	1.367
3	Fiberglass	90	0.063	0.012	0.911
4	Epoxy	-	0.095	0.006	1.367
5	Divinycell Foam Core (1/8")	-	0.031	0.125	0.452
6	Fiberglass	45	0.063	0.012	0.911
7	Epoxy	-	0.095	0.006	1.367
Total Skin Weight Estimation (lb)					7.286
Total Skin Thickness Estimation (in)					0.179



Skin Weight (Foam Core; 1:1; 5oz)

Skin Layup (2 oz, PW) - Assuming 1:1 Ratio of Fabric/Epoxy					
#	Material	Bias	Material Density (lb/ft ²)	Thickness (in)	Weight (lb)
1	Fiberglass	45	0.017	0.004	0.246
2	Epoxy	-	0.017	0.002	0.246
3	Fiberglass	90	0.017	0.004	0.246
4	Epoxy	-	0.017	0.002	0.246
5	Divinycell Foam Core (1/8")	-	0.052	0.125	0.753
6	Fiberglass	45	0.017	0.004	0.246
7	Epoxy	-	0.017	0.002	0.246
Total Skin Weight Estimation (lb)					2.229
Total Skin Thickness Estimation (in)					0.141

Skin Layup (4 oz, PW) - Assuming 1:1 Ratio of Fabric/Epoxy					
#	Material	Bias	Material Density (lb/ft ²)	Thickness (in)	Weight (lb)
1	Fiberglass	45	0.028	0.008	0.405
2	Epoxy	-	0.028	0.004	0.405
3	Fiberglass	90	0.028	0.008	0.405
4	Epoxy	-	0.028	0.004	0.405
5	Divinycell Foam Core (1/8")	-	0.052	0.125	0.753
6	Fiberglass	45	0.028	0.008	0.405
7	Epoxy	-	0.028	0.004	0.405
Total Skin Weight Estimation (lb)					3.183
Total Skin Thickness Estimation (in)					0.161

Skin Layup (3 oz, 4H) - Assuming 1:1 Ratio of Fabric/Epoxy					
#	Material	Bias	Material Density (lb/ft ²)	Thickness (in)	Weight (lb)
1	Fiberglass	45	0.023	0.006	0.331
2	Epoxy	-	0.023	0.003	0.331
3	Fiberglass	90	0.023	0.006	0.331
4	Epoxy	-	0.023	0.003	0.331
5	Divinycell Foam Core (1/8")	-	0.052	0.125	0.753
6	Fiberglass	45	0.023	0.006	0.331
7	Epoxy	-	0.023	0.003	0.331
Total Skin Weight Estimation (lb)					2.742
Total Skin Thickness Estimation (in)					0.152

Skin Layup (9 oz, 8H) - Assuming 1:1 Ratio of Fabric/Epoxy					
#	Material	Bias	Material Density (lb/ft ²)	Thickness (in)	Weight (lb)
1	Fiberglass	45	0.063	0.012	0.911
2	Epoxy	-	0.063	0.006	0.911
3	Fiberglass	90	0.063	0.012	0.911
4	Epoxy	-	0.063	0.006	0.911
5	Divinycell Foam Core (1/8")	-	0.052	0.125	0.753
6	Fiberglass	45	0.063	0.012	0.911
7	Epoxy	-	0.063	0.006	0.911
Total Skin Weight Estimation (lb)					6.220
Total Skin Thickness Estimation (in)					0.179



Wing Servo Option #1



HS-5245MG Servo Specifications

Performance Specifications	
Operating Voltage Range (Volts DC)	4.8V ~ 6.0V
Speed (Second @ 60°)	0.15 ~ 0.12
Maximum Torque Range oz. / in.	61 ~ 76
Maximum Torque Range kg. / cm.	4.4 ~ 5.5
Current Draw at Idle	3 mA
No Load Operating Current Draw	300 mA
Stall Current Draw	1,200 mA
Dead Band Width	4 μ s
Physical Specifications	
Dimensions (Inches)	1.27 x 0.66 x 1.21
Dimensions (Metric)	32.4 x 16.8 x 30.8
Weight (Ounces)	1.12
Weight (Gram)	32.0
Circuit Type	G1 Programmable Digital
Motor Type	3 Pole Metal Brush Ferrite
Gear Material	Metal
Bearing Type	Dual Ball Bearing
Output Shaft (type / \varnothing mm)	Standard 24
Case Material	Plastic
Dust / Water Resistance	N / A
Connector Gauge (AWG) / Strand Count	25 / 40

Tail Servo



HS-5070MH Servo Specifications

Performance Specifications	
Operating Voltage Range (Volts DC)	6.0V ~ 7.4V
Speed (Second @ 60°)	0.14 ~ 0.12
Maximum Torque Range oz. / in.	42 ~ 52
Maximum Torque Range kg. / cm.	3.0 ~ 3.7
Current Draw at Idle	3 mA
No Load Operating Current Draw	240 mA
Stall Current Draw	1,300 mA
Dead Band Width	2 μ s
Physical Specifications	
Dimensions (Inches)	0.92 x 0.45 x 1.14
Dimensions (Metric)	23.6 x 11.6 x 28.1
Weight (Ounces)	0.50
Weight (Gram)	14.2
Circuit Type	G1 Programmable Digital
Motor Type	3 Pole Metal Brush Neodymium
Gear Material	Metal
Bearing Type	Top Ball Bearing
Output Shaft (type / \varnothing mm)	Micro 23
Case Material	Plastic
Dust / Water Resistance	N / A
Connector Gauge (AWG) / Strand Count	28 / 20