Research and Development of Autonomously Controlled Wings for Reusable Solid-Fuel Model Rocket

Netitorn Kawmali, Chaiyutpong Piboon

Have you seen them before?

Space Technology and knowlegde is a valuable resorce though, It’s still very underdeveloped in Thailand

I.C.

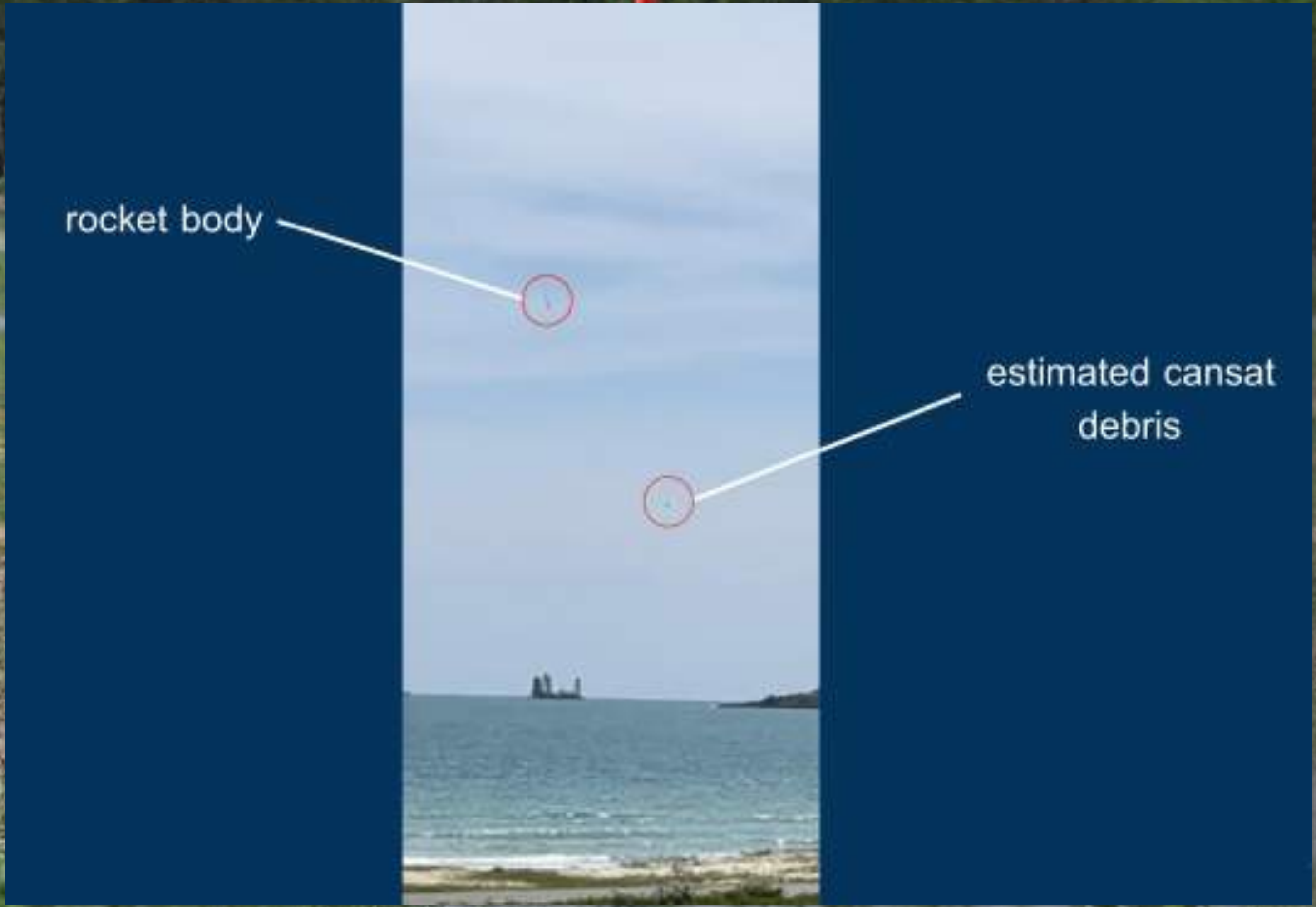
Freeze dried food

Firefighter mask

These examples are all product of space development

We want to learn it and develop something so we joined “cansat 2022 competition”

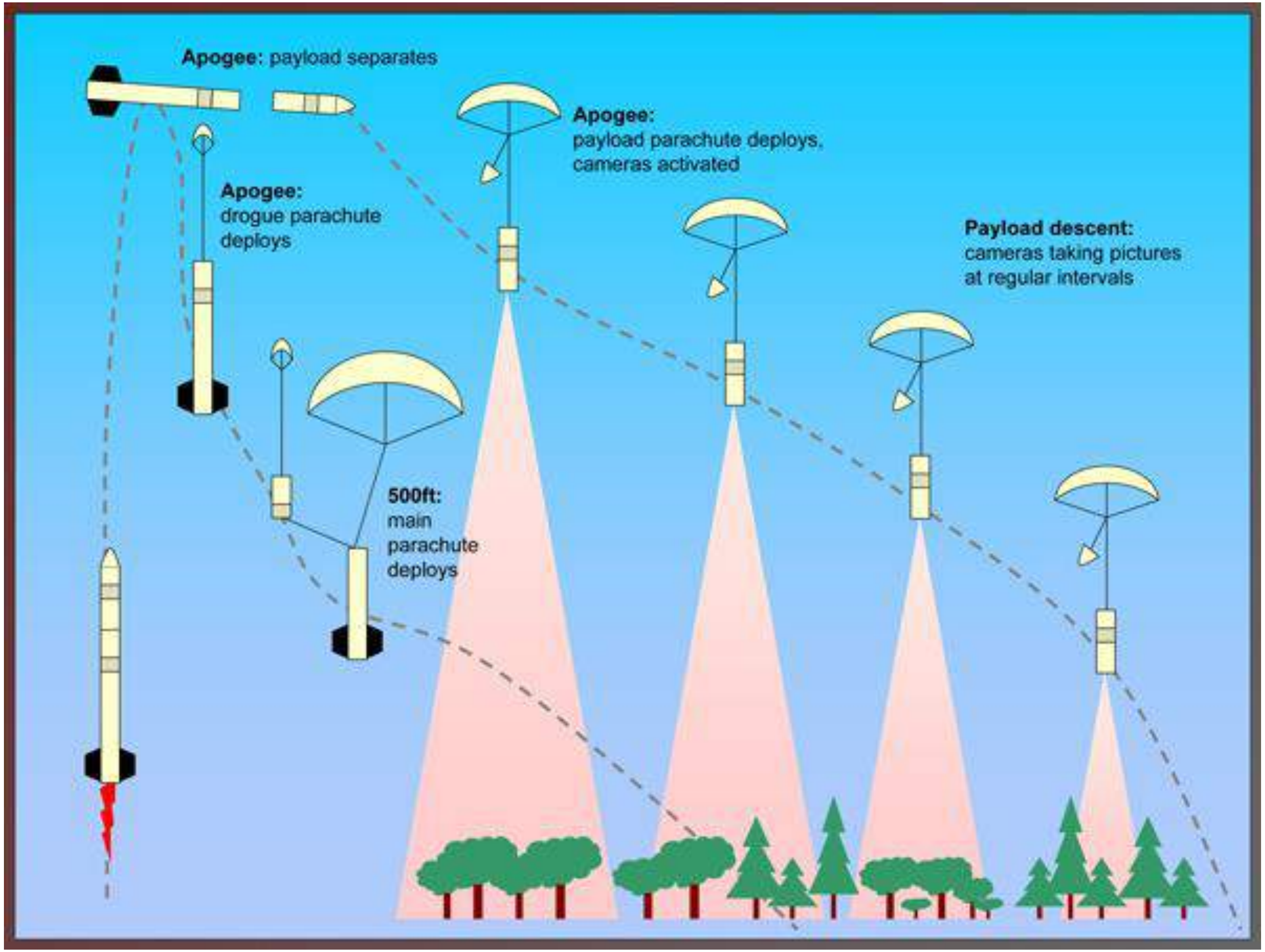
Unexpected failure from cansat



Our rocket flew into the sea making it unrecoverable

So we try to find new solution

Dual deployment?



This doesn’t really work because we cant control it

So we ought to find a new solution

And we’ve found this

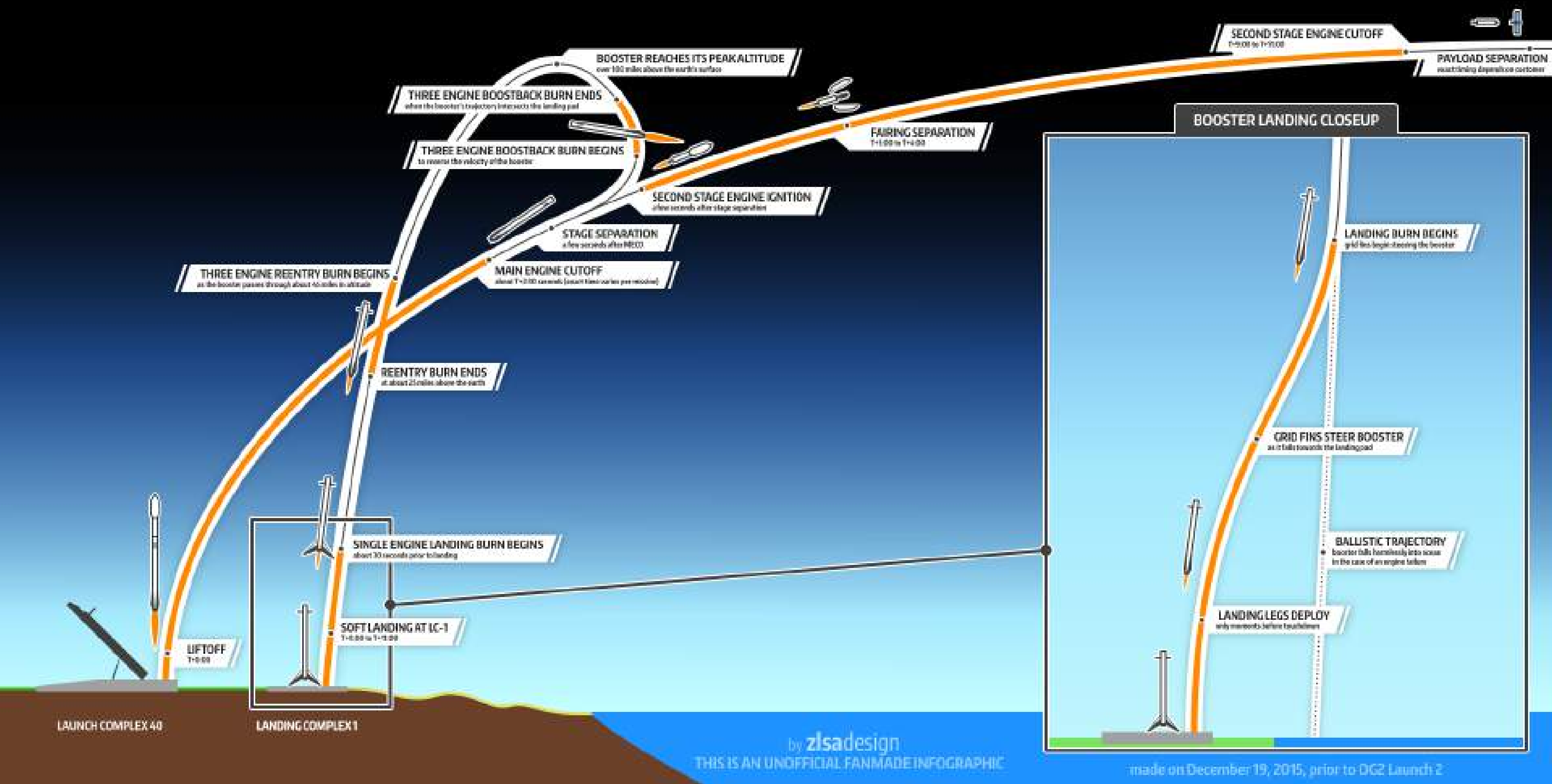
SpaceX NROL-87 mission

Falcon 9 launches the NROL-87 spacecraft and Falcon 9 first stage landing

2 February 2022

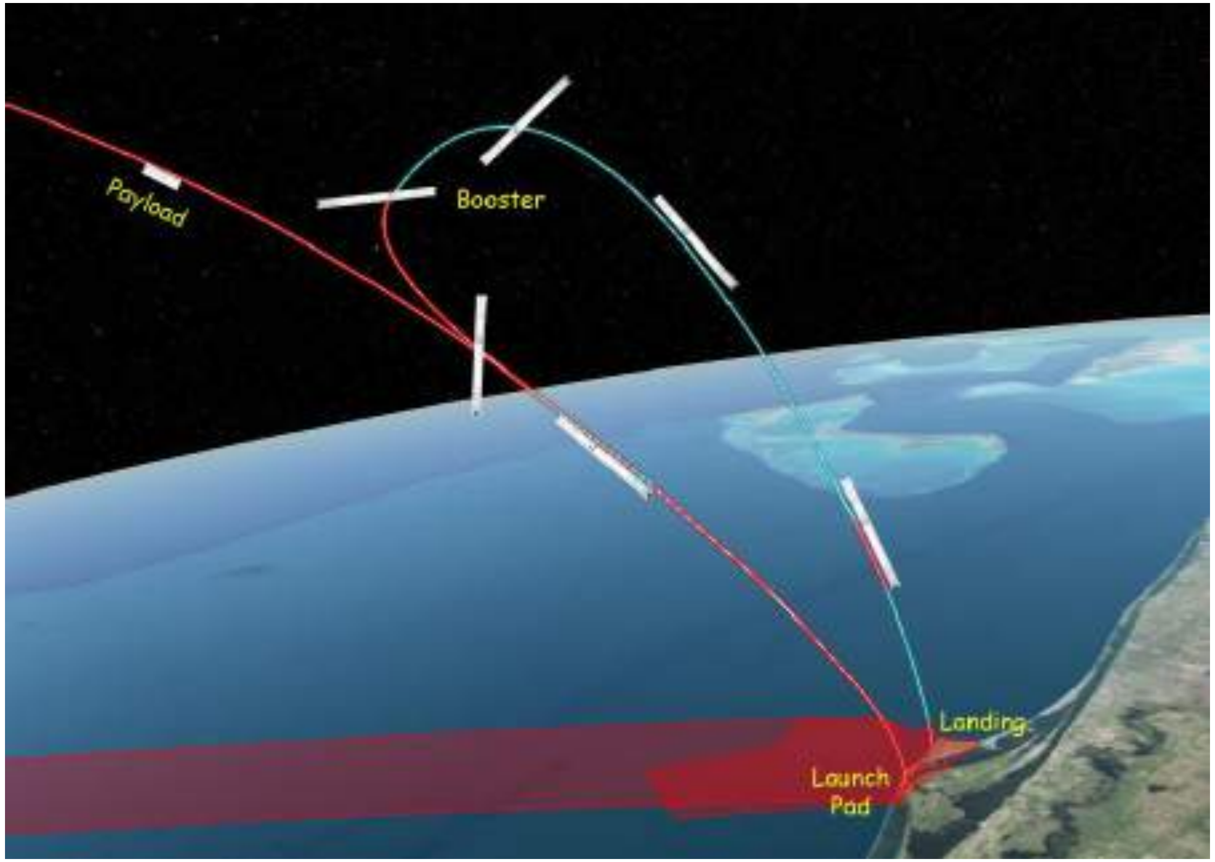
SPACEX FALCON 9 LAUNCH AND LANDING PROFILE

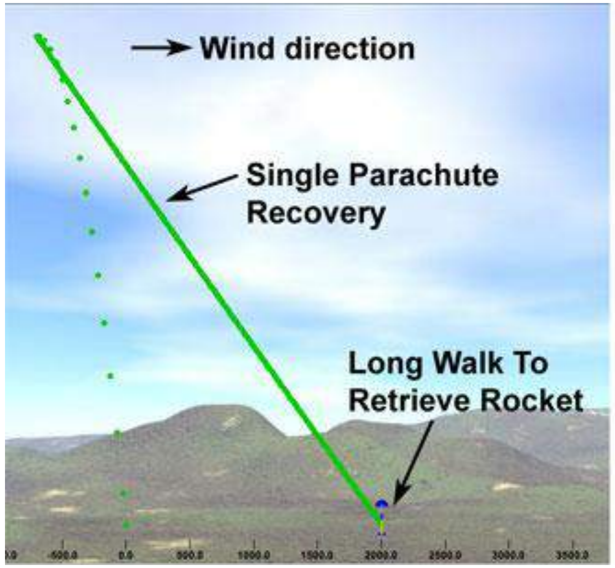
NOTE: NOT TO SCALE/TRAJECTORY IS NOT EXACT

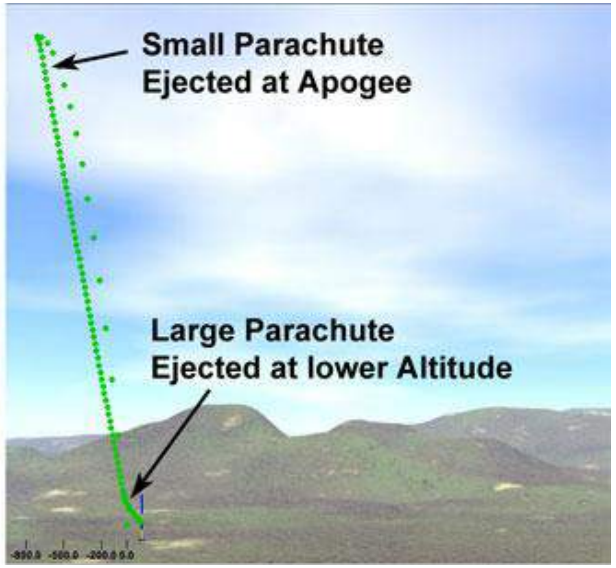


So we try to replicate their method using our new invention

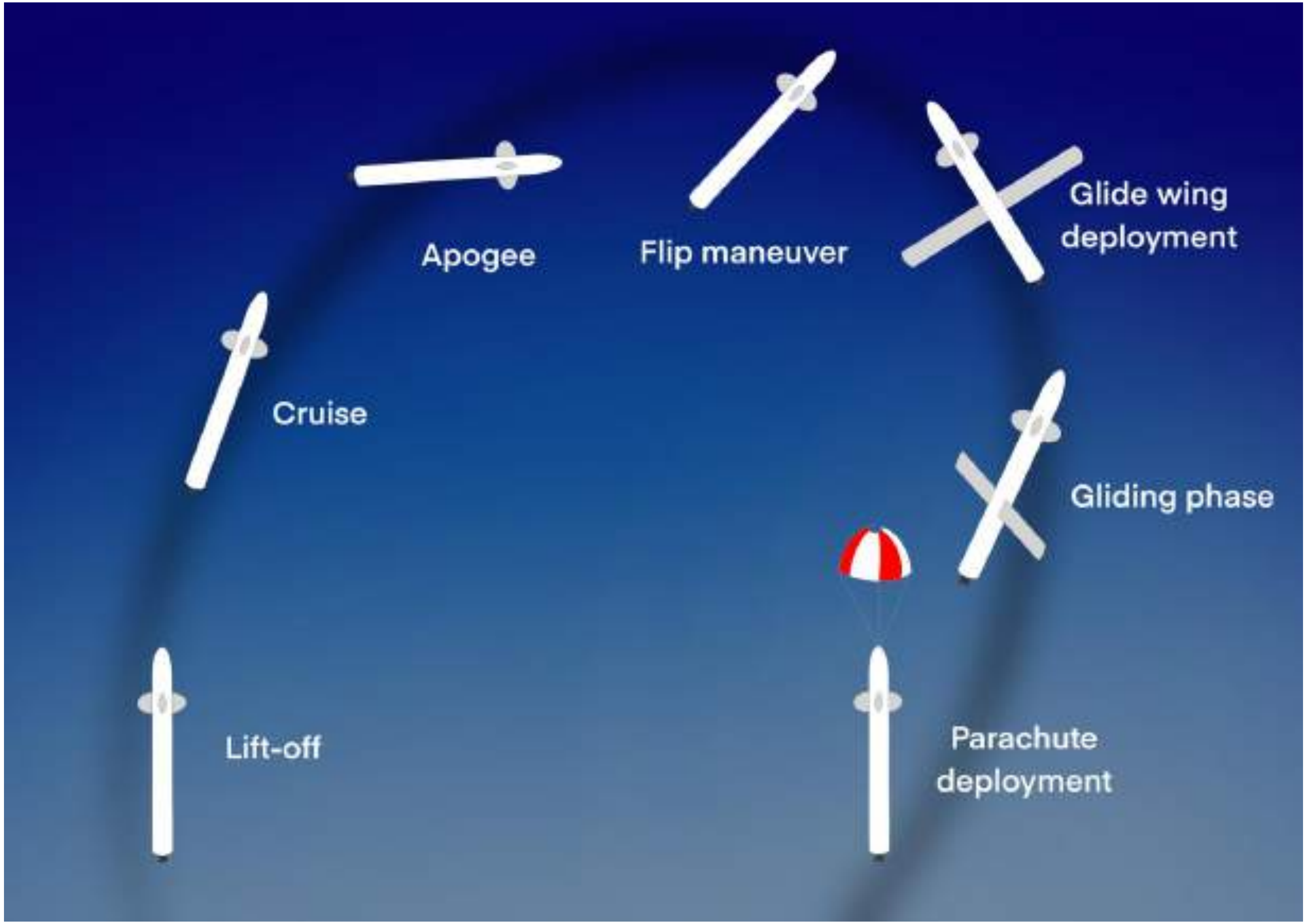
combine two method





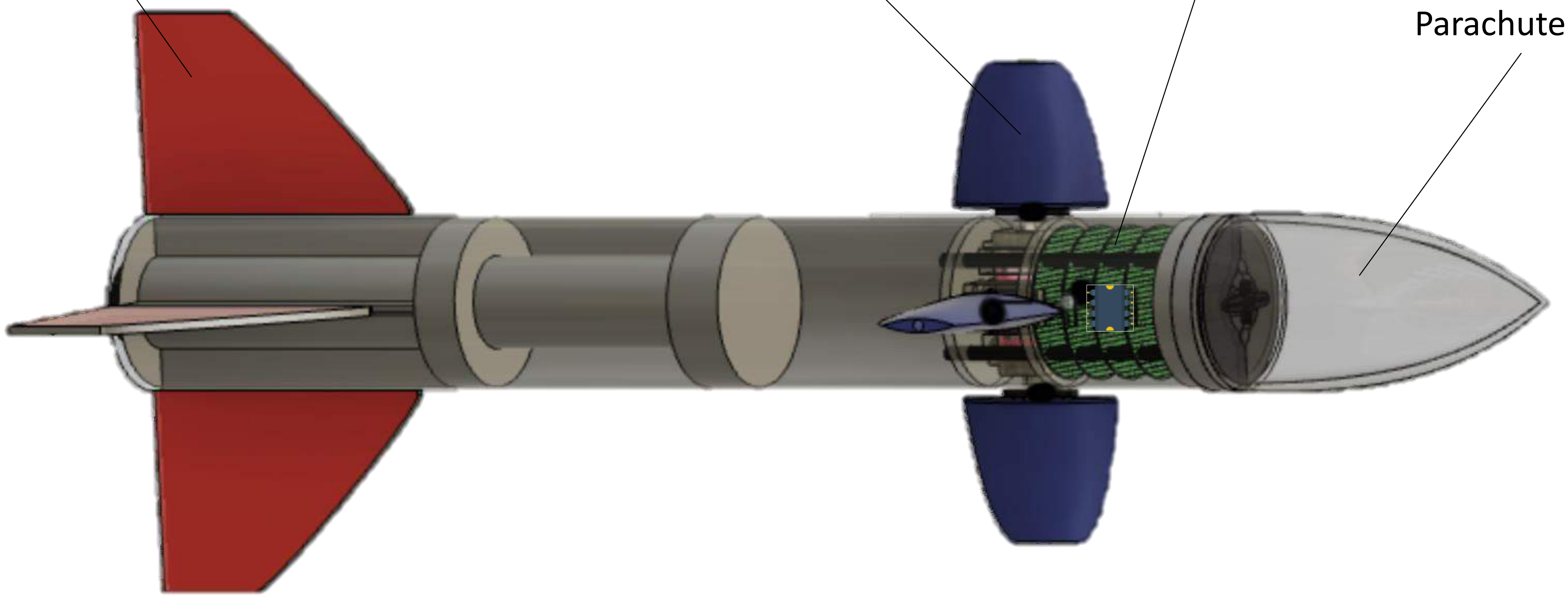


Our Flight path



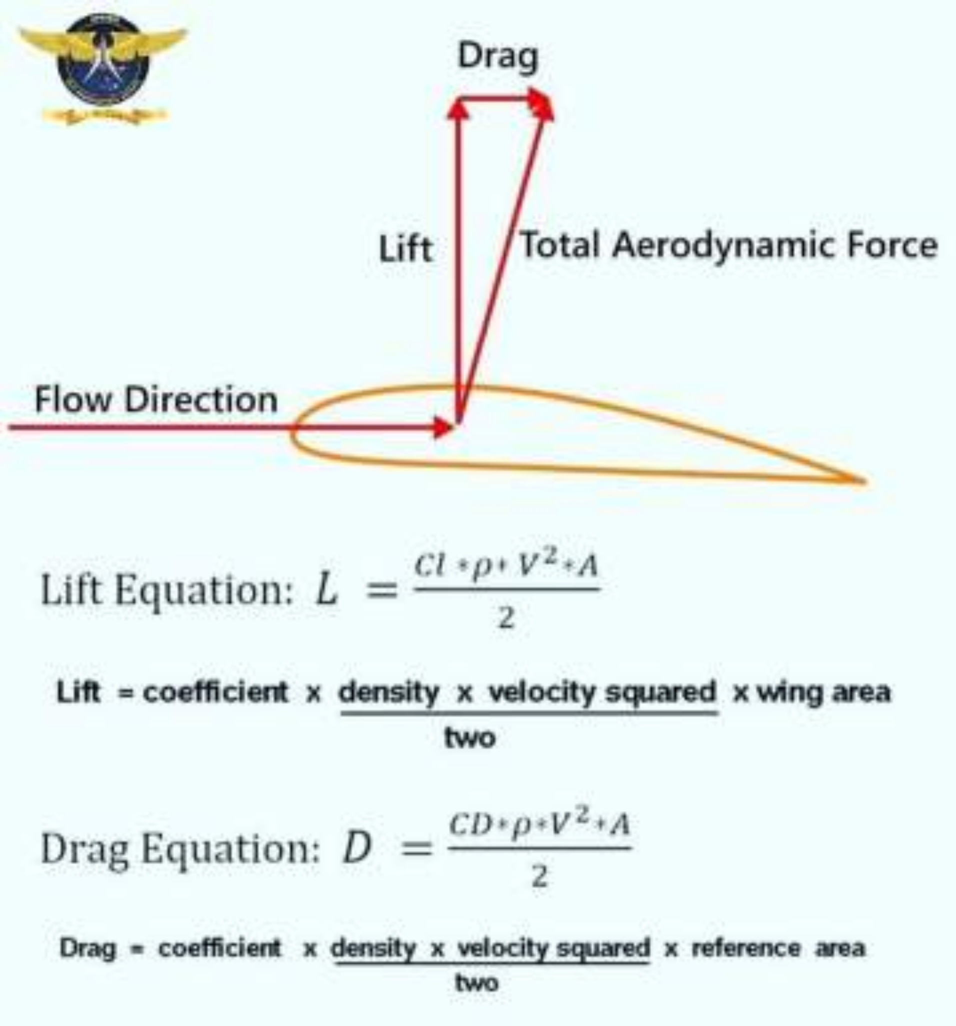
Building process :

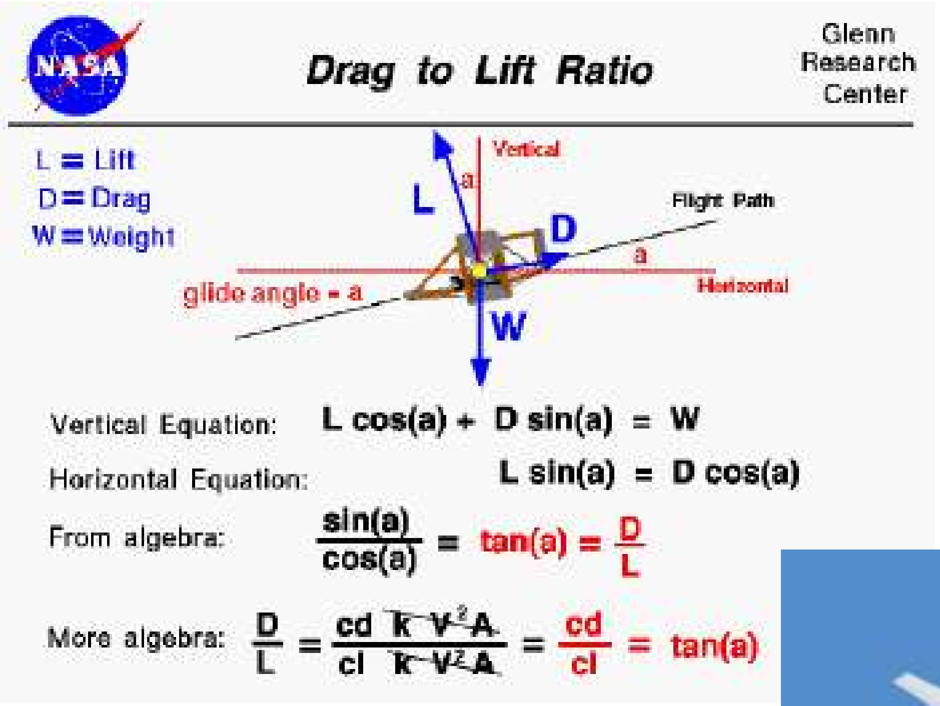
Autonomously ControllEd Wings for Reusable Solid-Fuel Model Rocket



Side view of Nominal 1

FINS and WINGS

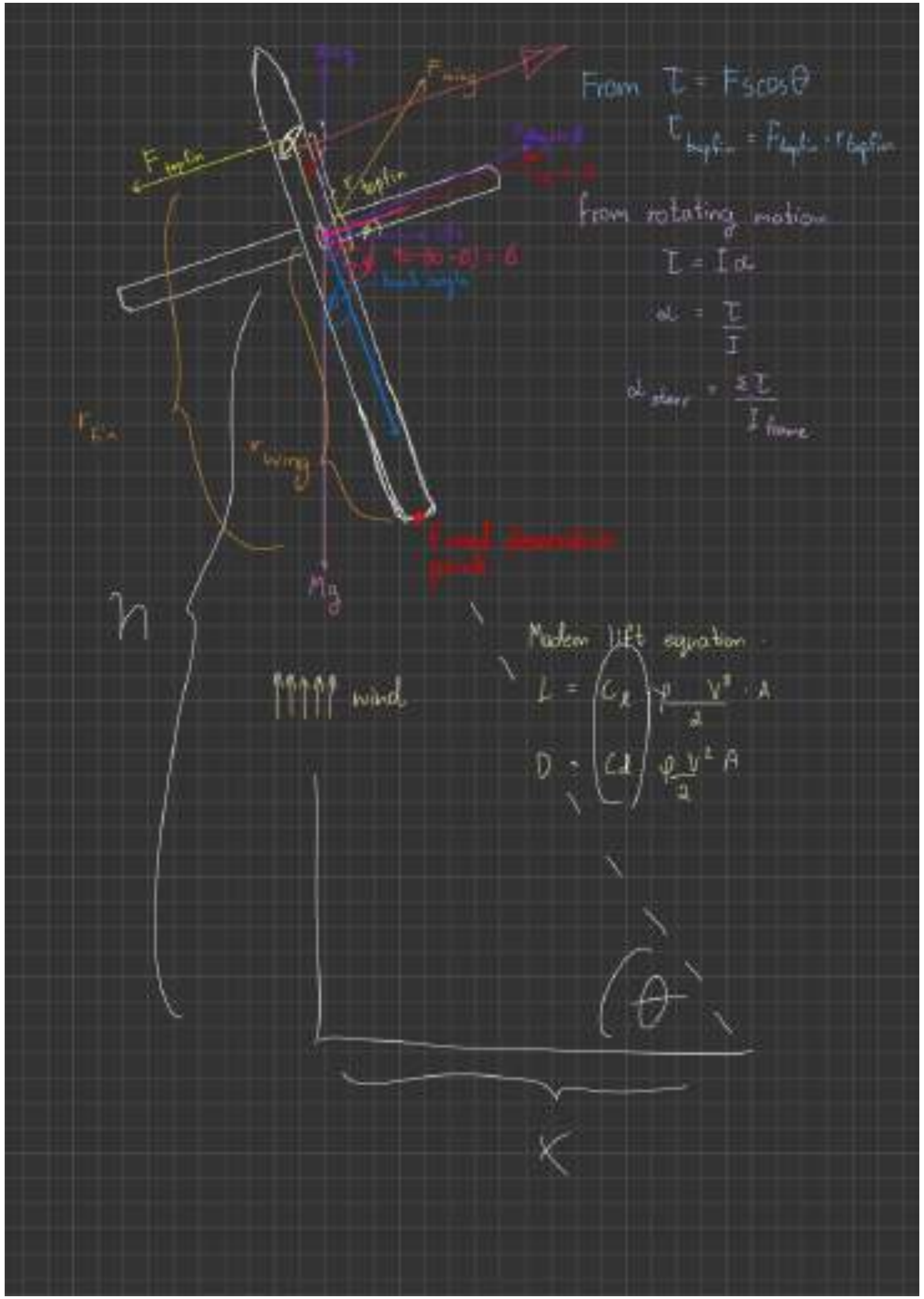




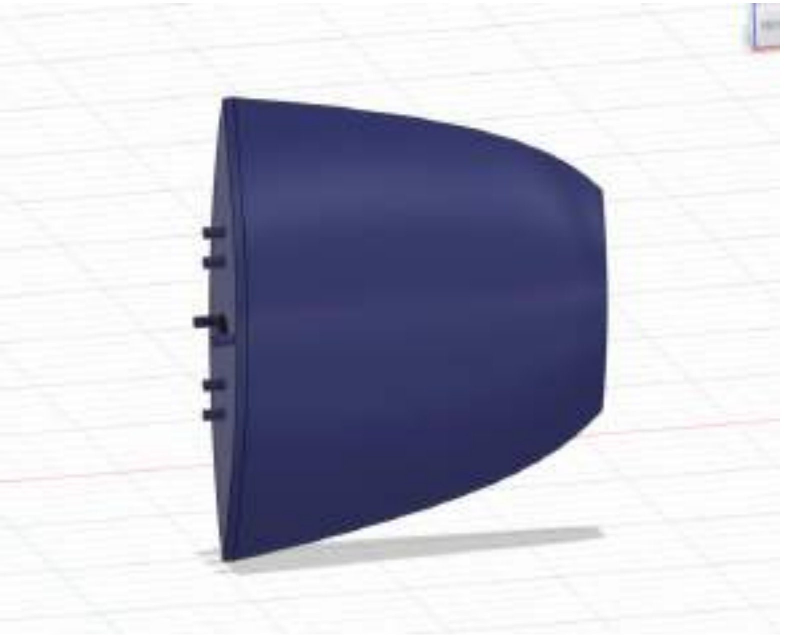
Then,

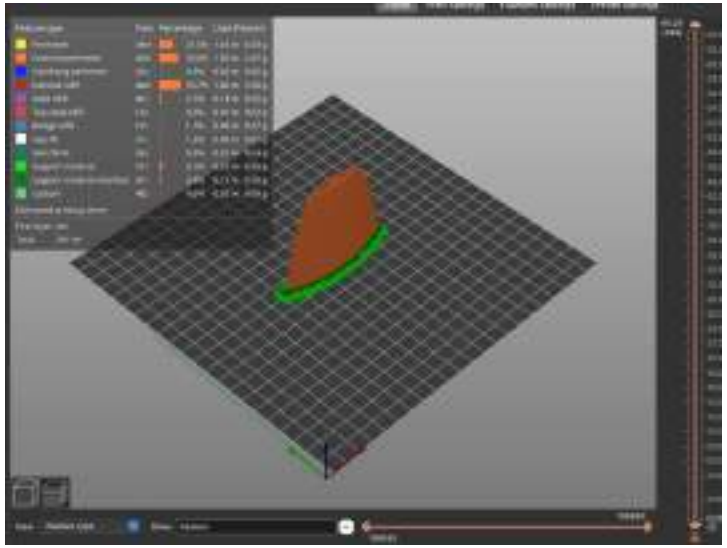
Utilize it for

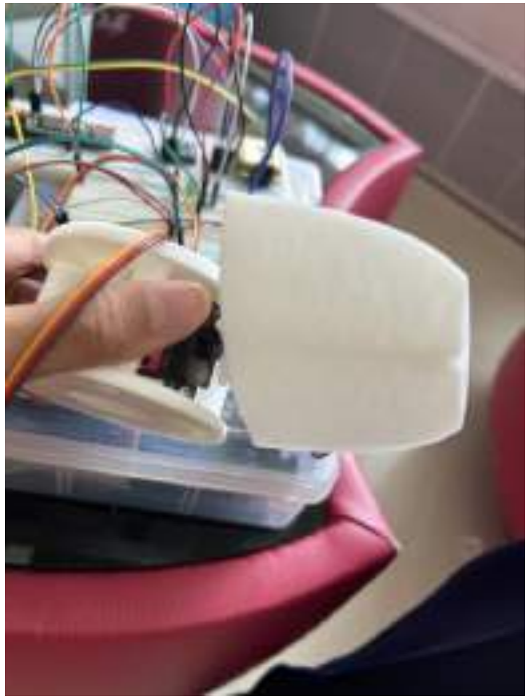
steering



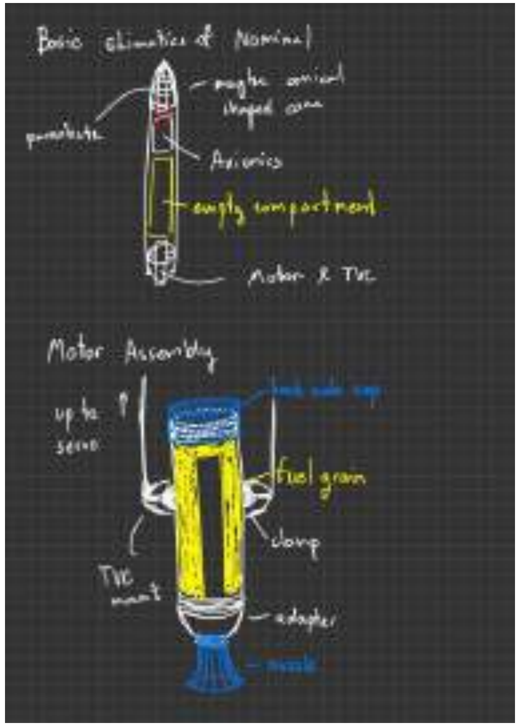
Steps of creating a fin

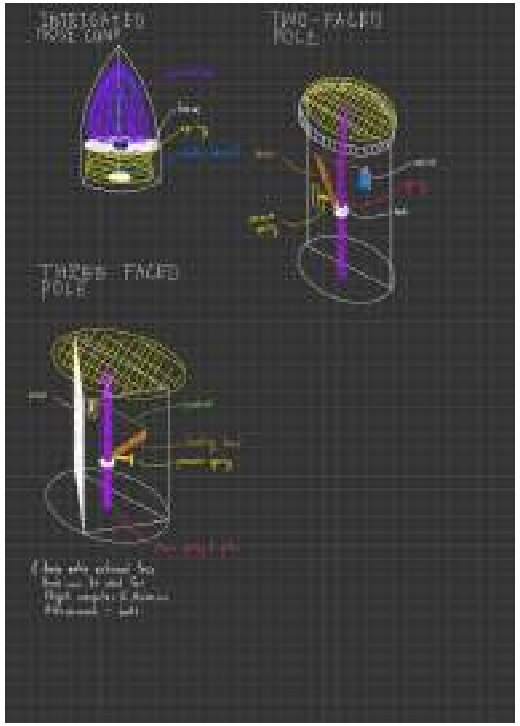


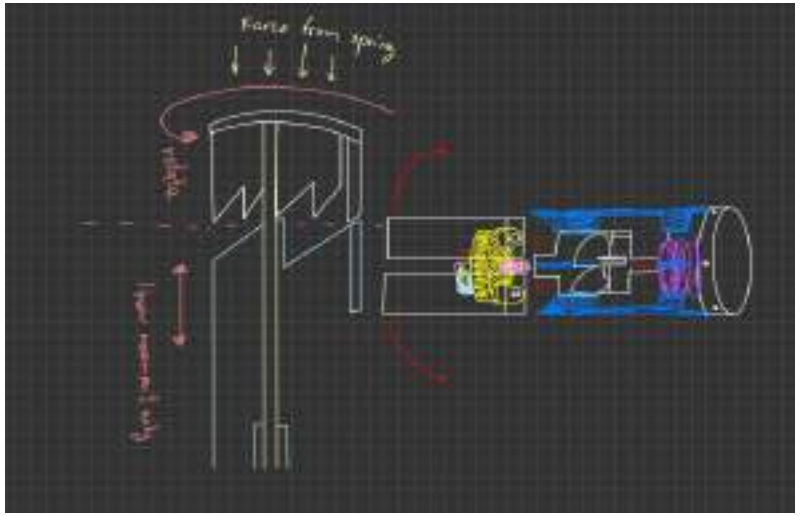




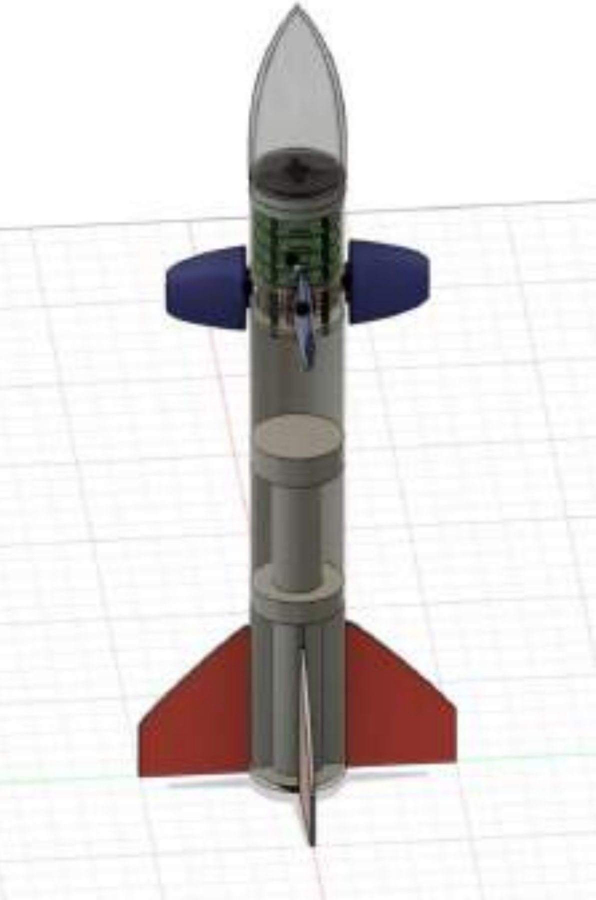
Design drawing

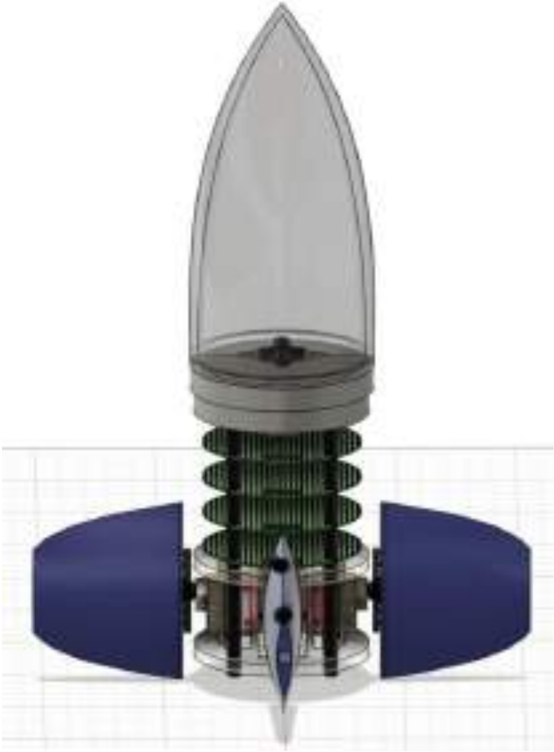




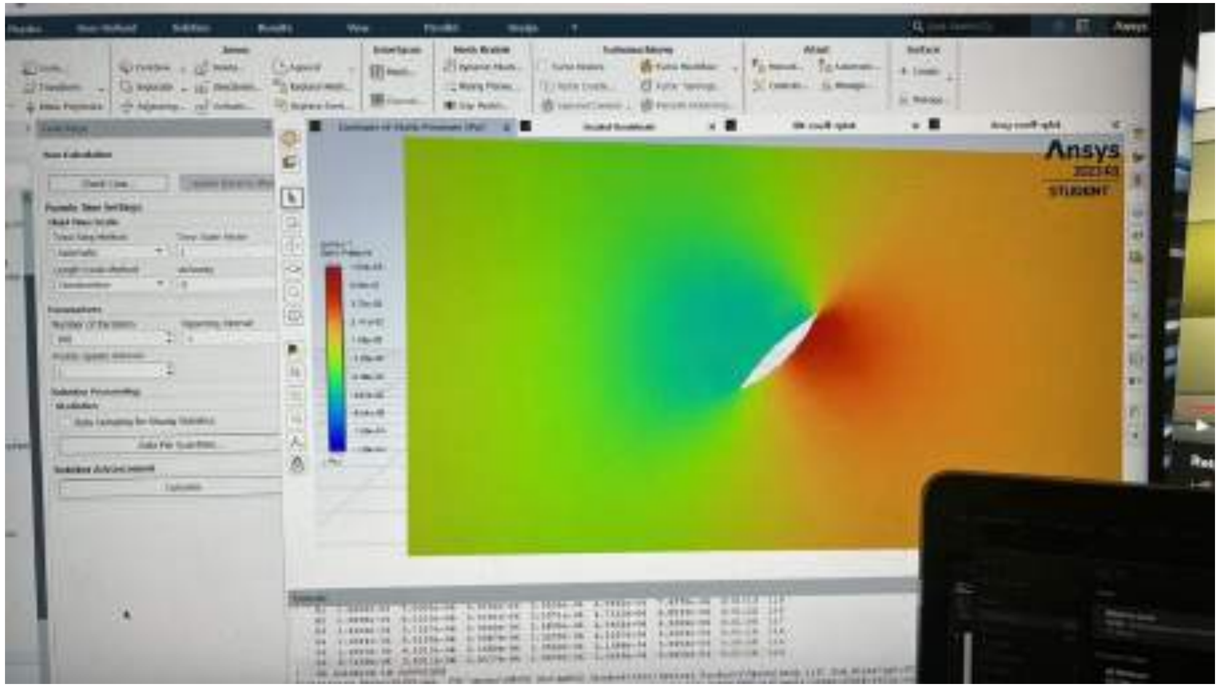


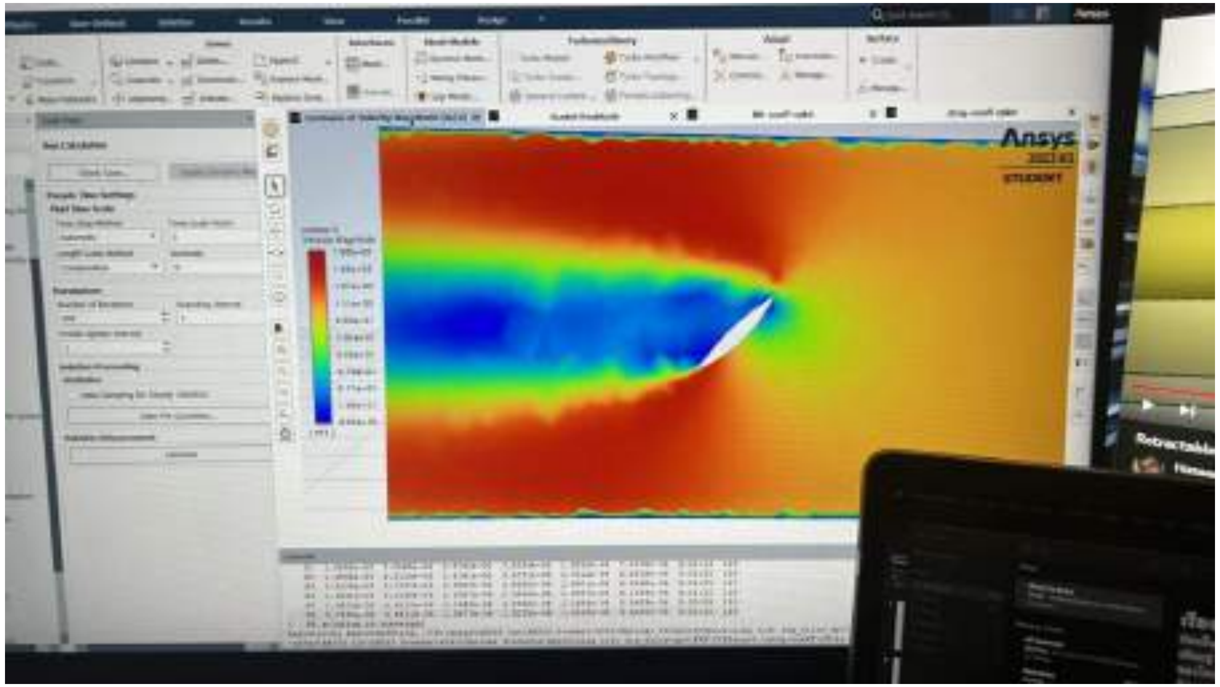
3d model prototype



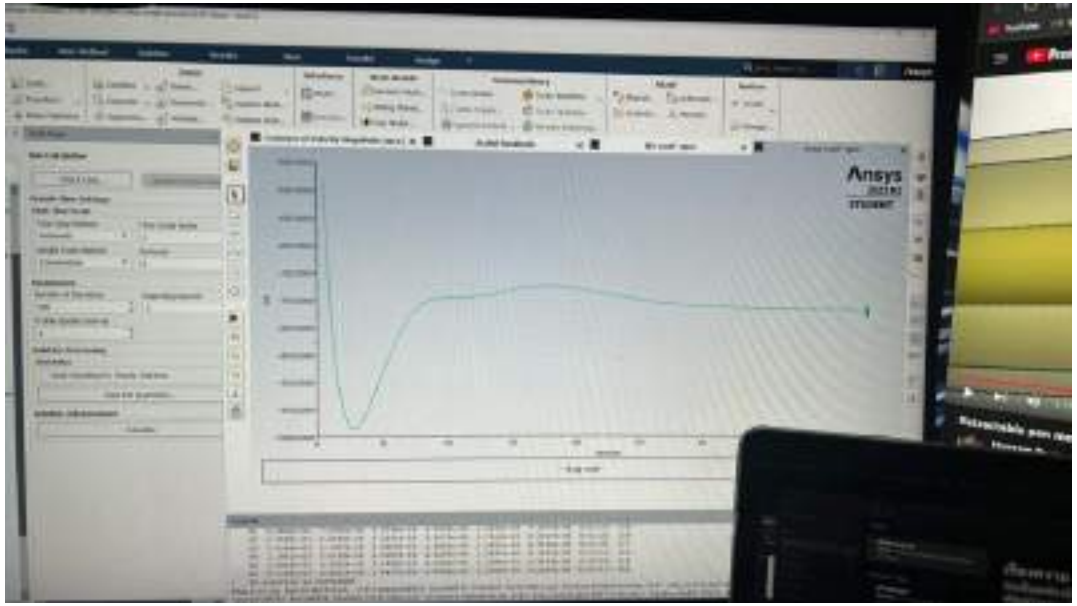


Then test the wings in Ansys Fluent

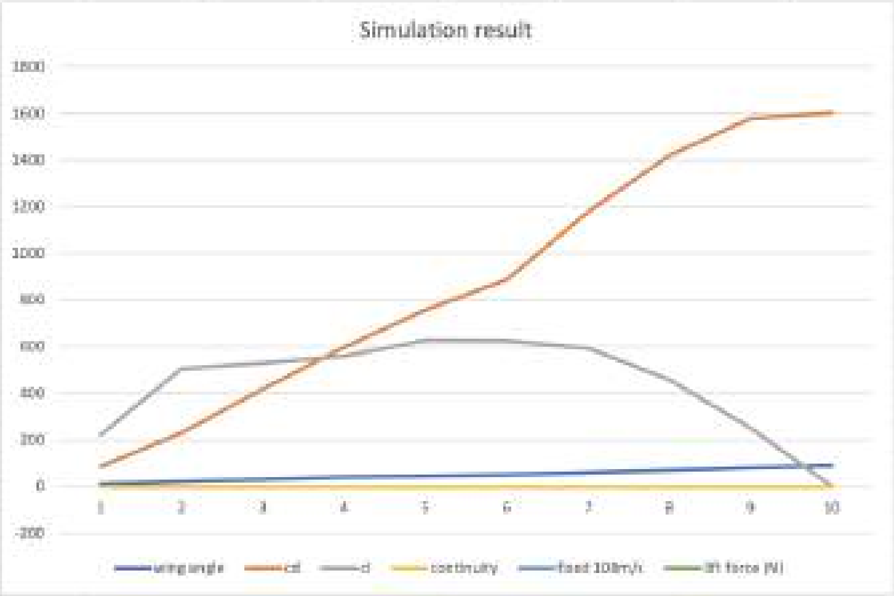




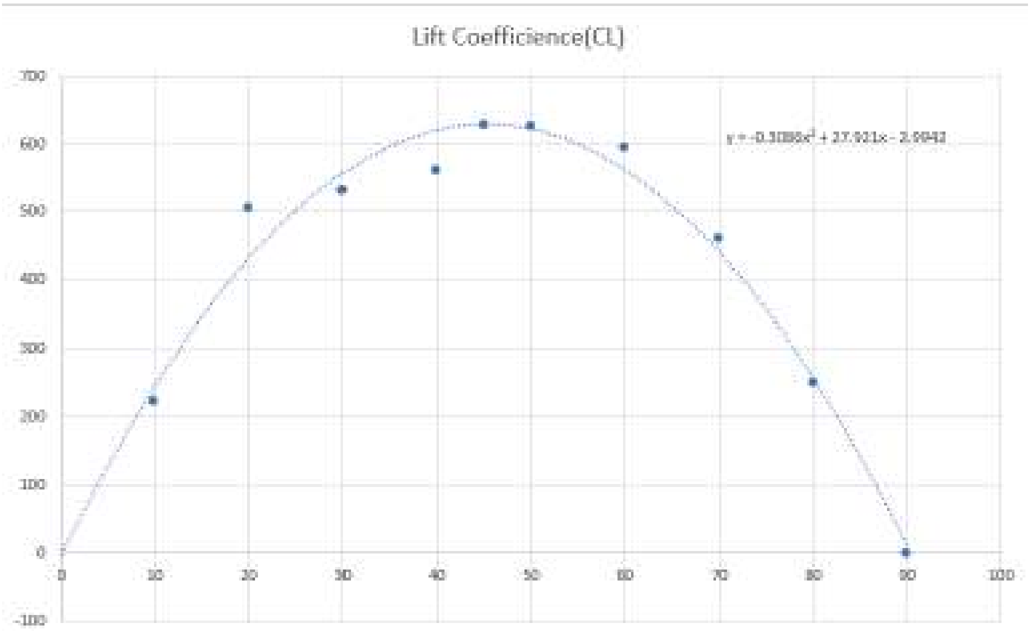
Simulation data :



wing angle	cd	cl	continuity	fixed 108m/:	lift force (N)
10	84.893	222.2159	4.00E-02		
20	230.3596	504.7655	1.00E-03		
30	417.7364	530.1816	9.00E-04		
40	596.9681	559.9018	1.00E-03		342.9112
45	758.7496	626.9592	1.00E-03		
50	888.5911	624.9909	1.00E-03		
60	1177.7903	593.8303	1.00E-03		
70	1419.0558	459.7123	9.00E-04		
80	1579.4091	250.4597	9.00E-04		
90	1603.571	-0.6697	1.00E-03		



And use the data for full simulation in flight computer

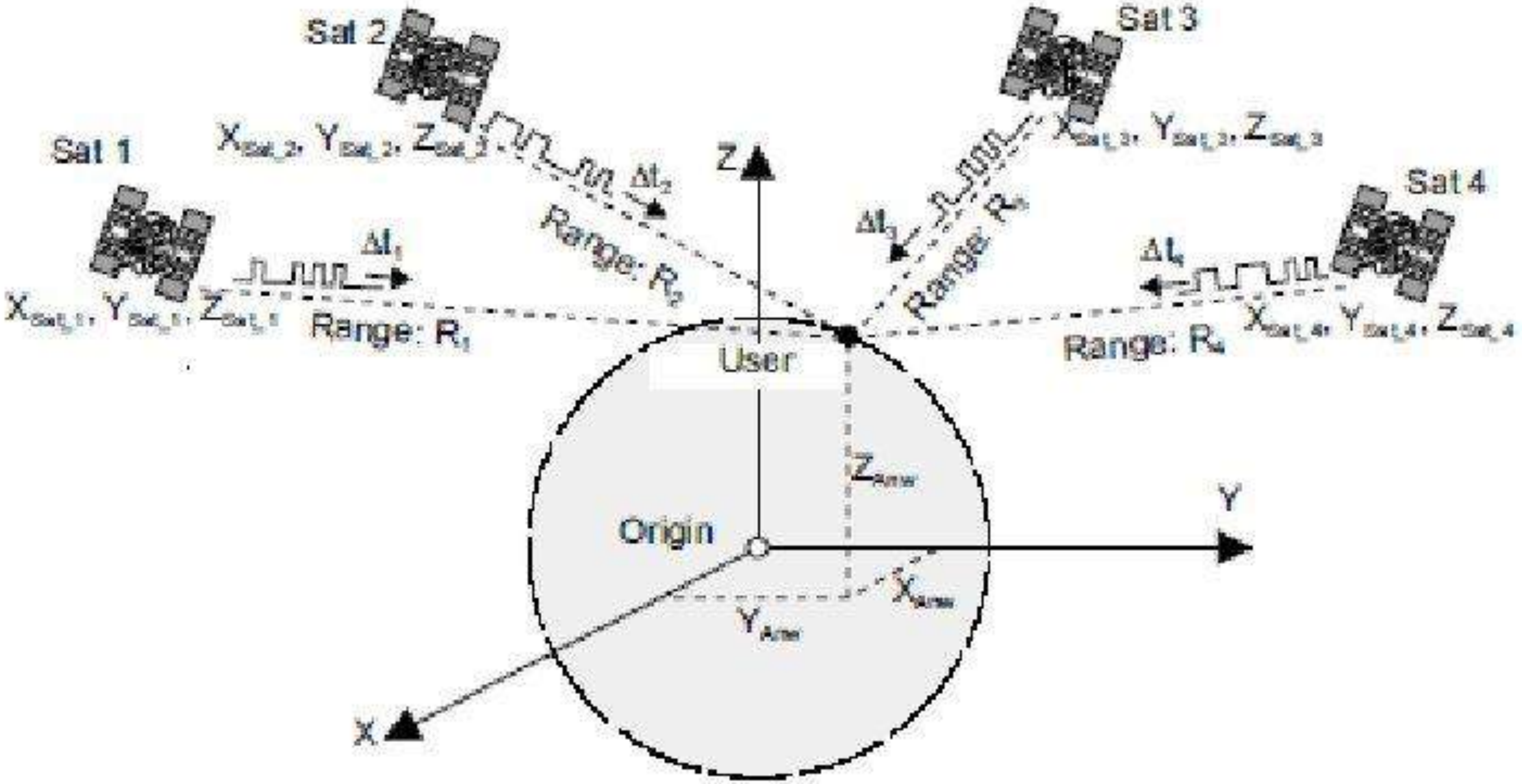


Before we can control the rocket

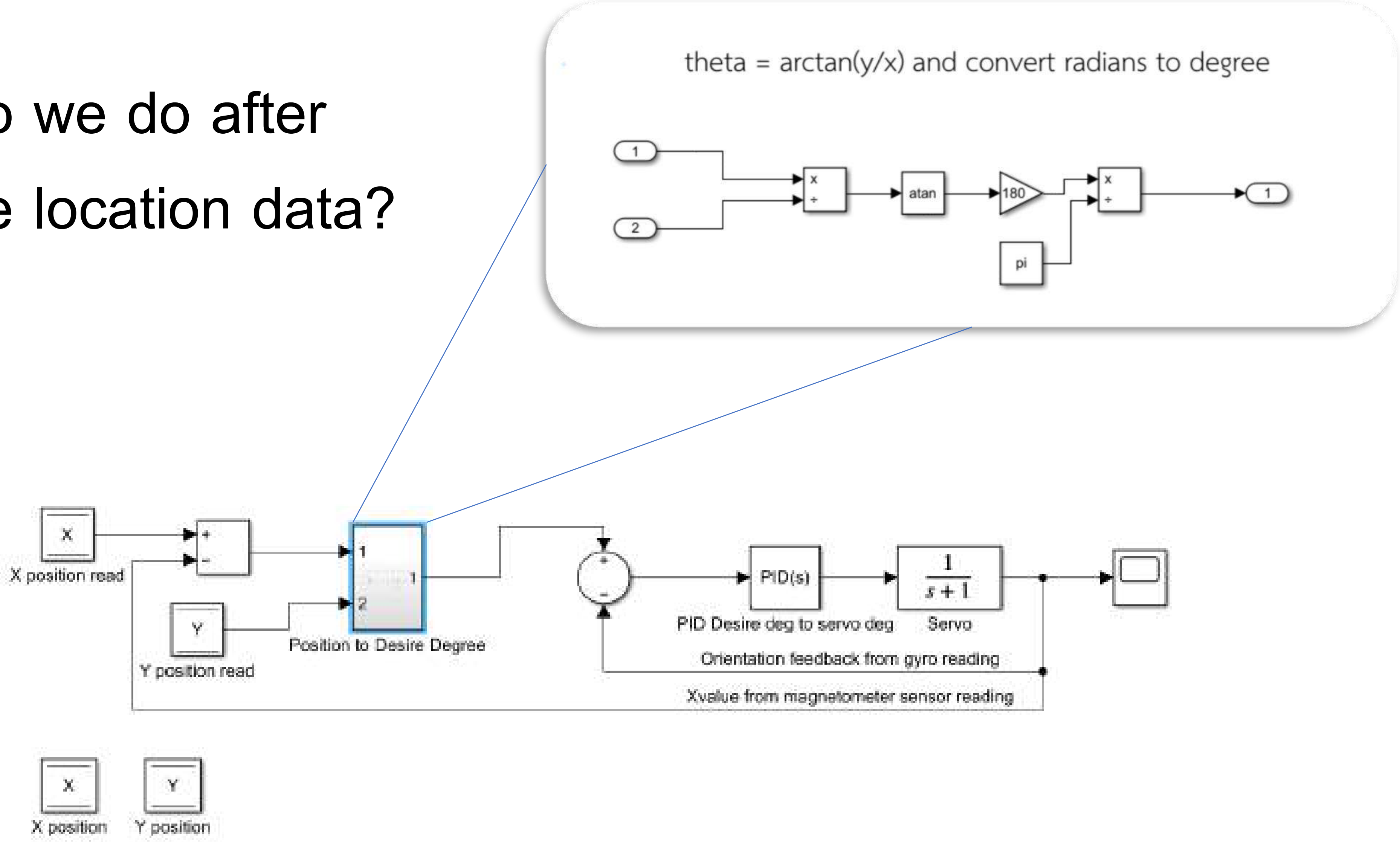
How do we know where we are?

Calculating Position

GPS module



What do we do after we have location data?

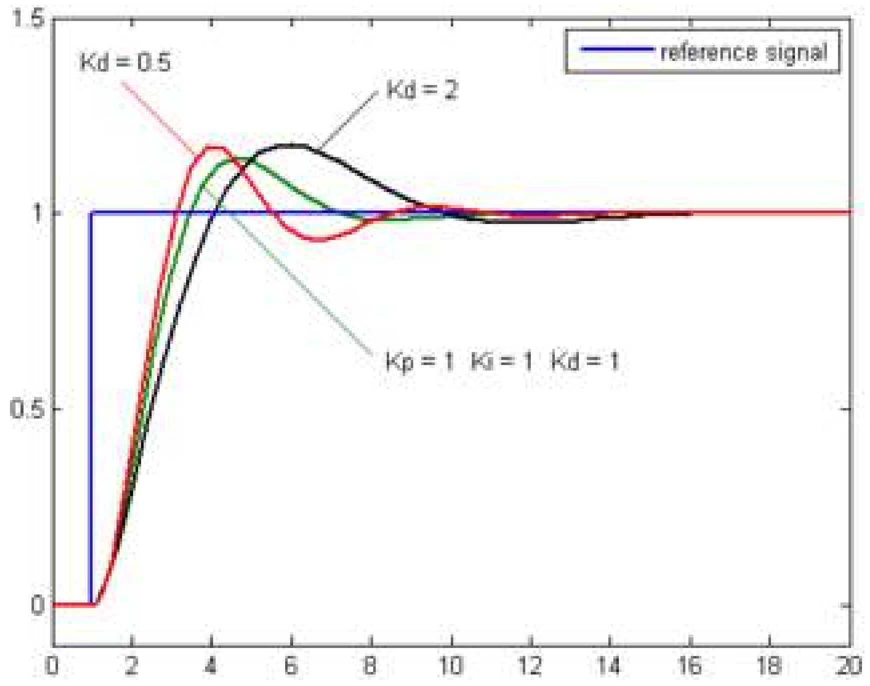


But why using PID control ?

$$u(t) = K_p\left(e(t) + \frac{1}{T_i}\int_0^t e(\tau)d\tau + T_d\frac{d}{dt}e(t)\right)$$

Pid is one of feedback control loop

Result of PID control (simulation)



Pid control graph

Result of Roll simulation

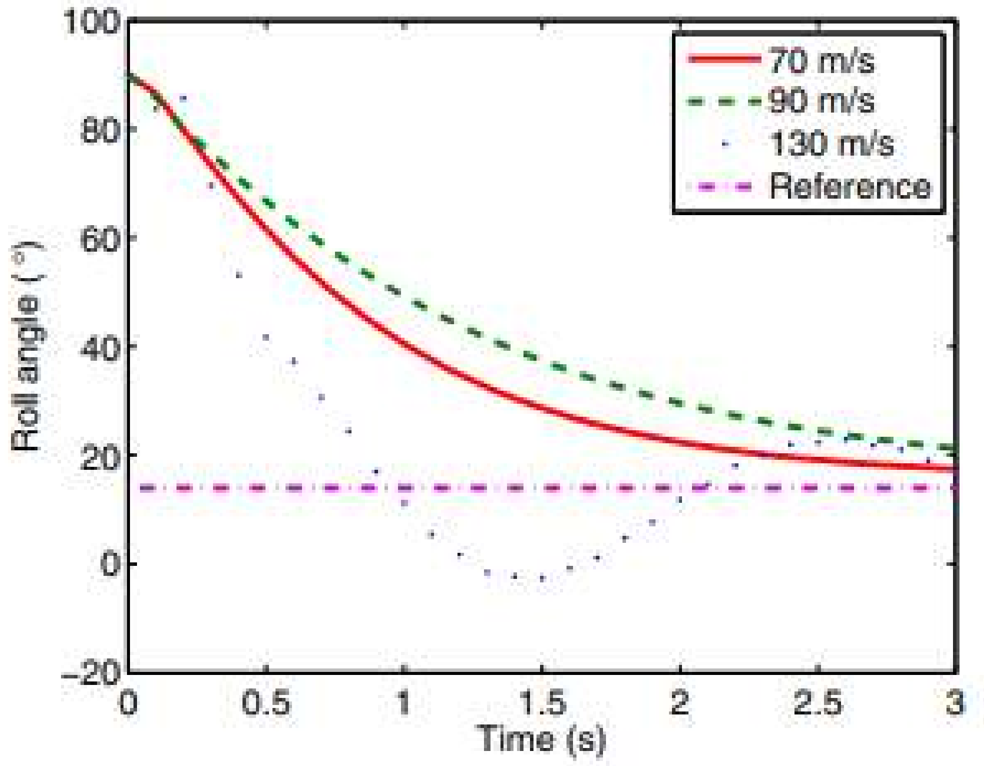
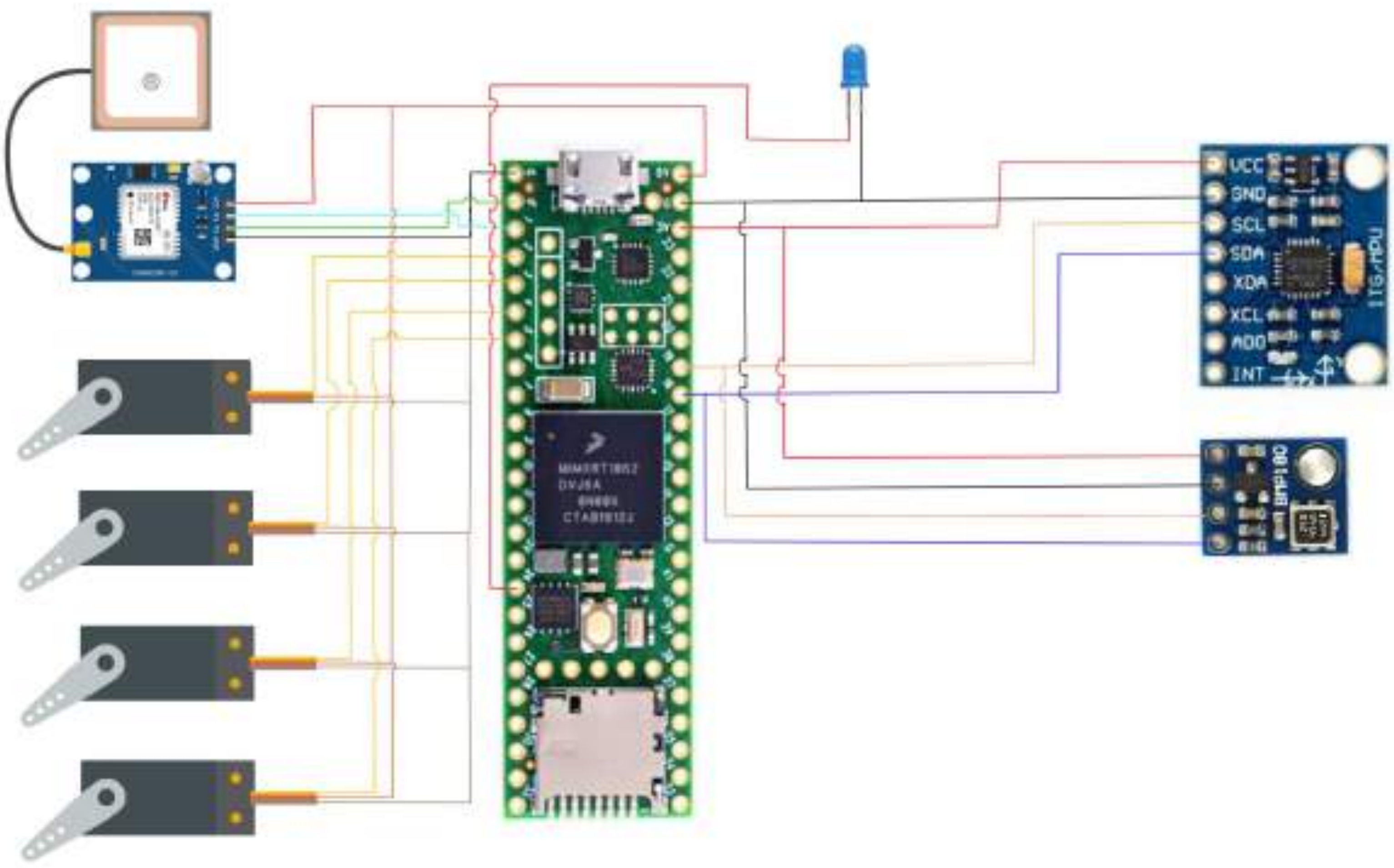


Fig. 12 Roll simulation at 70 m/s, 90 m/s and 130 m/s

Data from Design, Development and Flight Experiment of a Small Reusable Rocket that Glides Using Two-stage Parachute, Kyoshiro ITAKURA and co., 2011

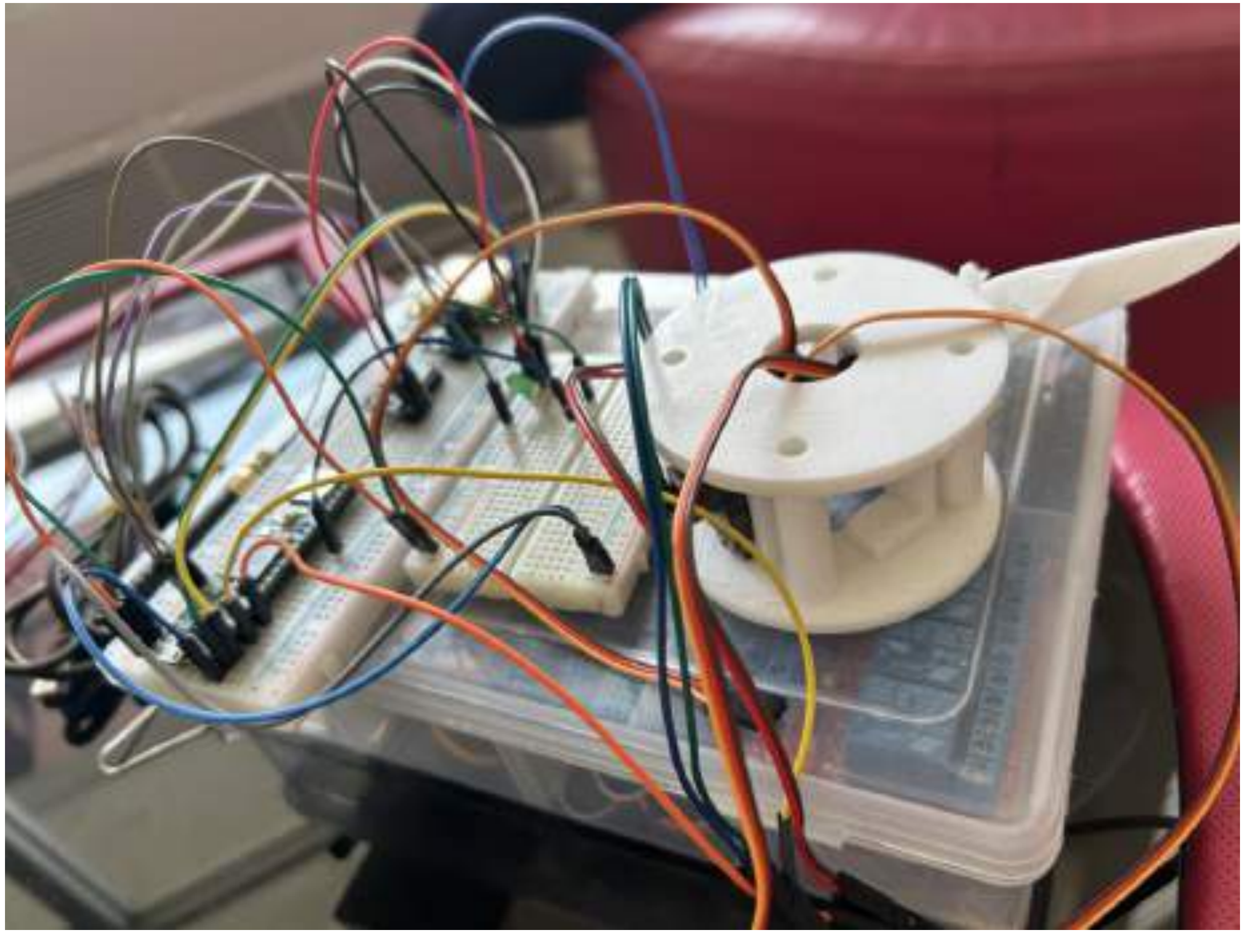
It worked!!!

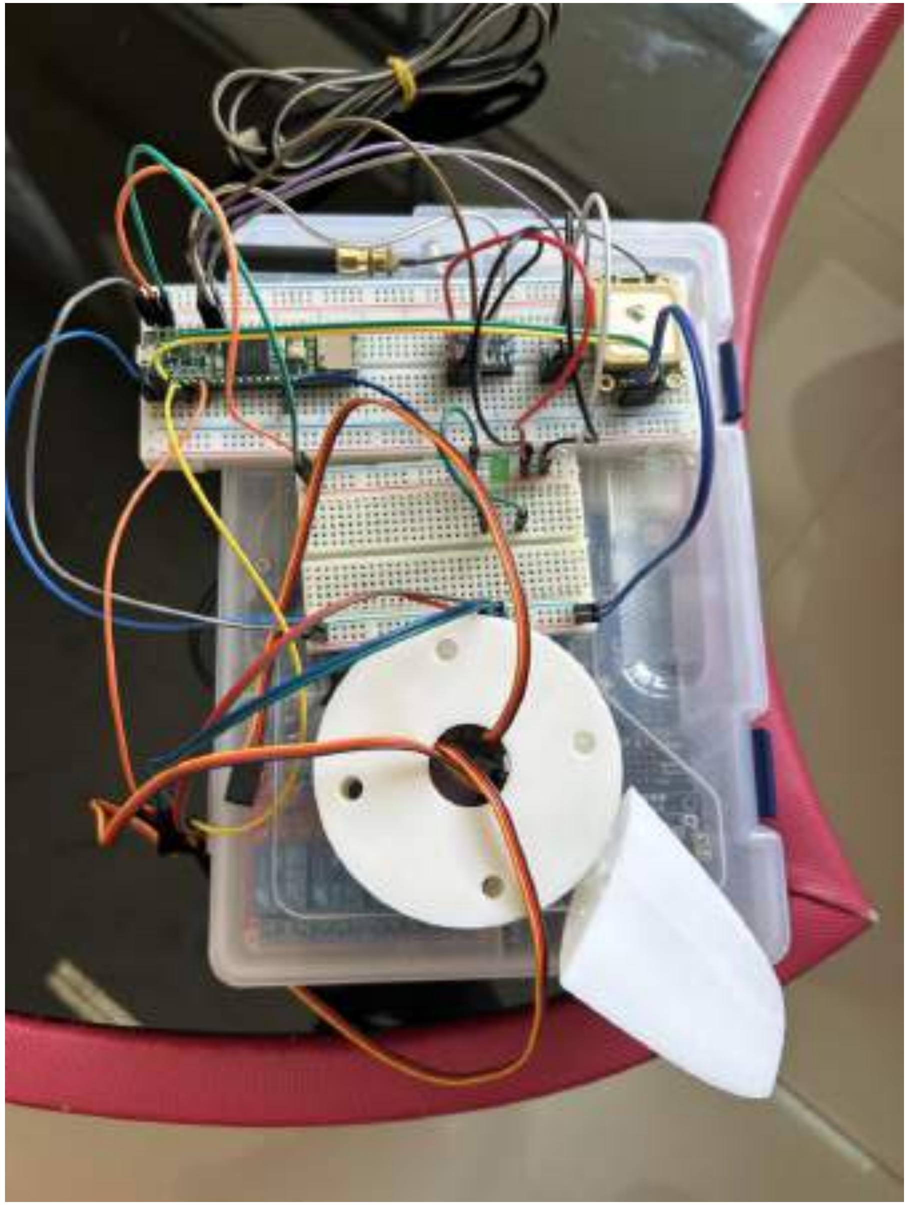
Wiring diagram



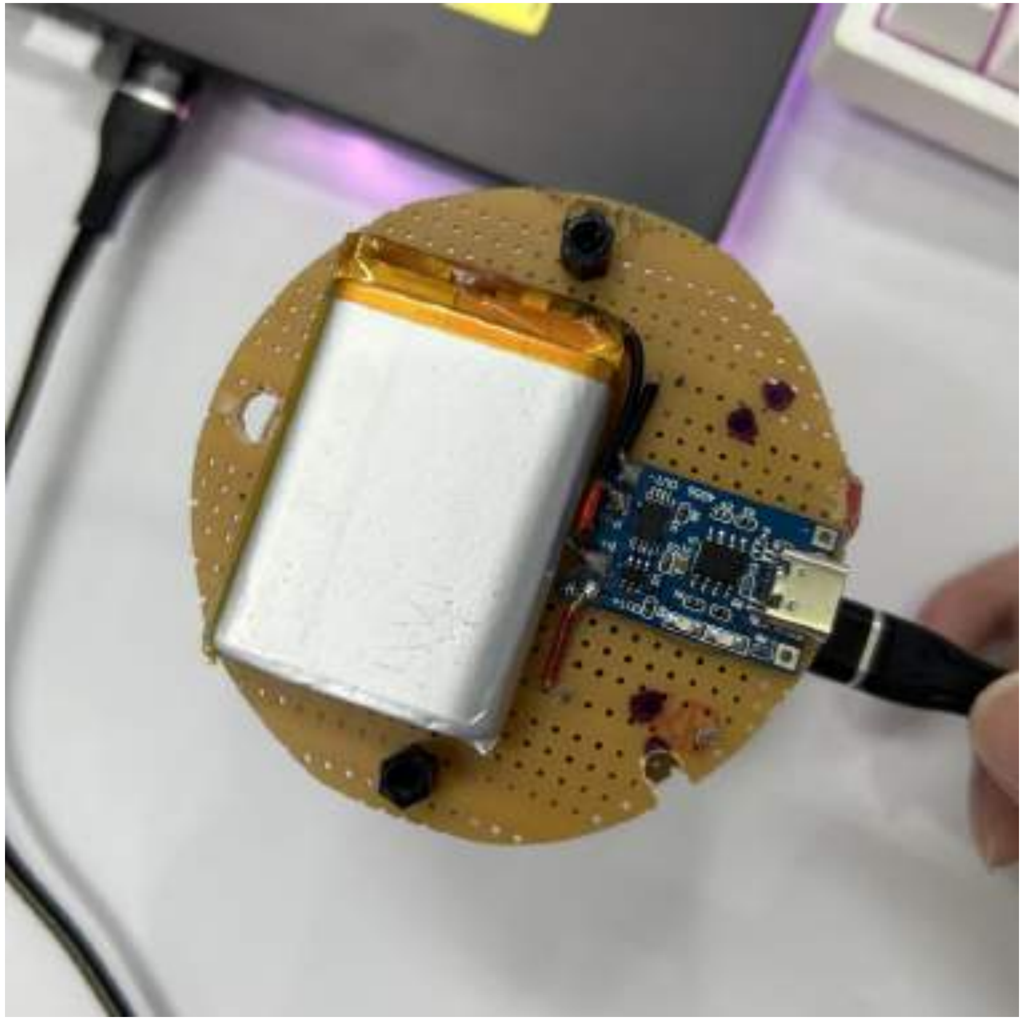
Result

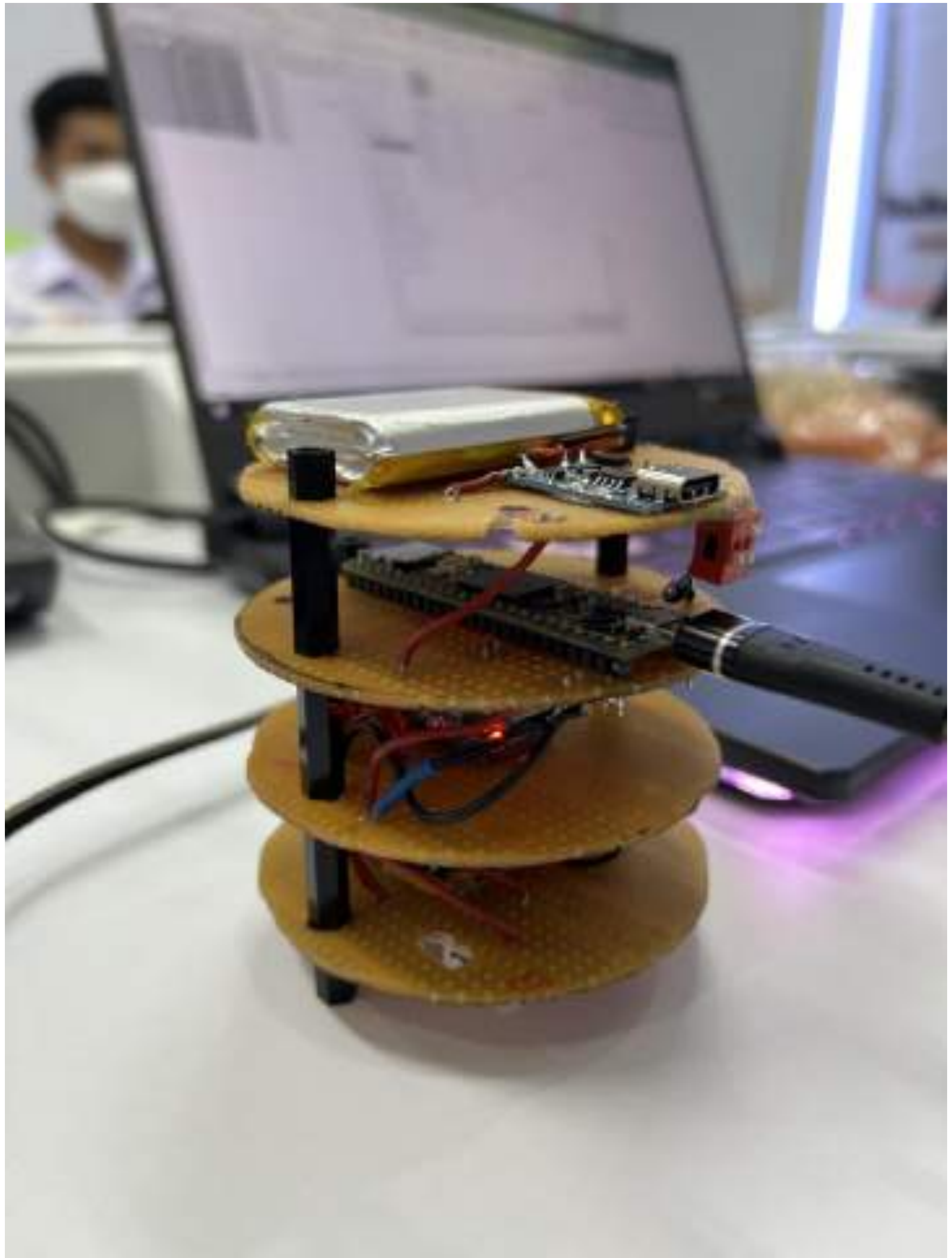
pre alpha model





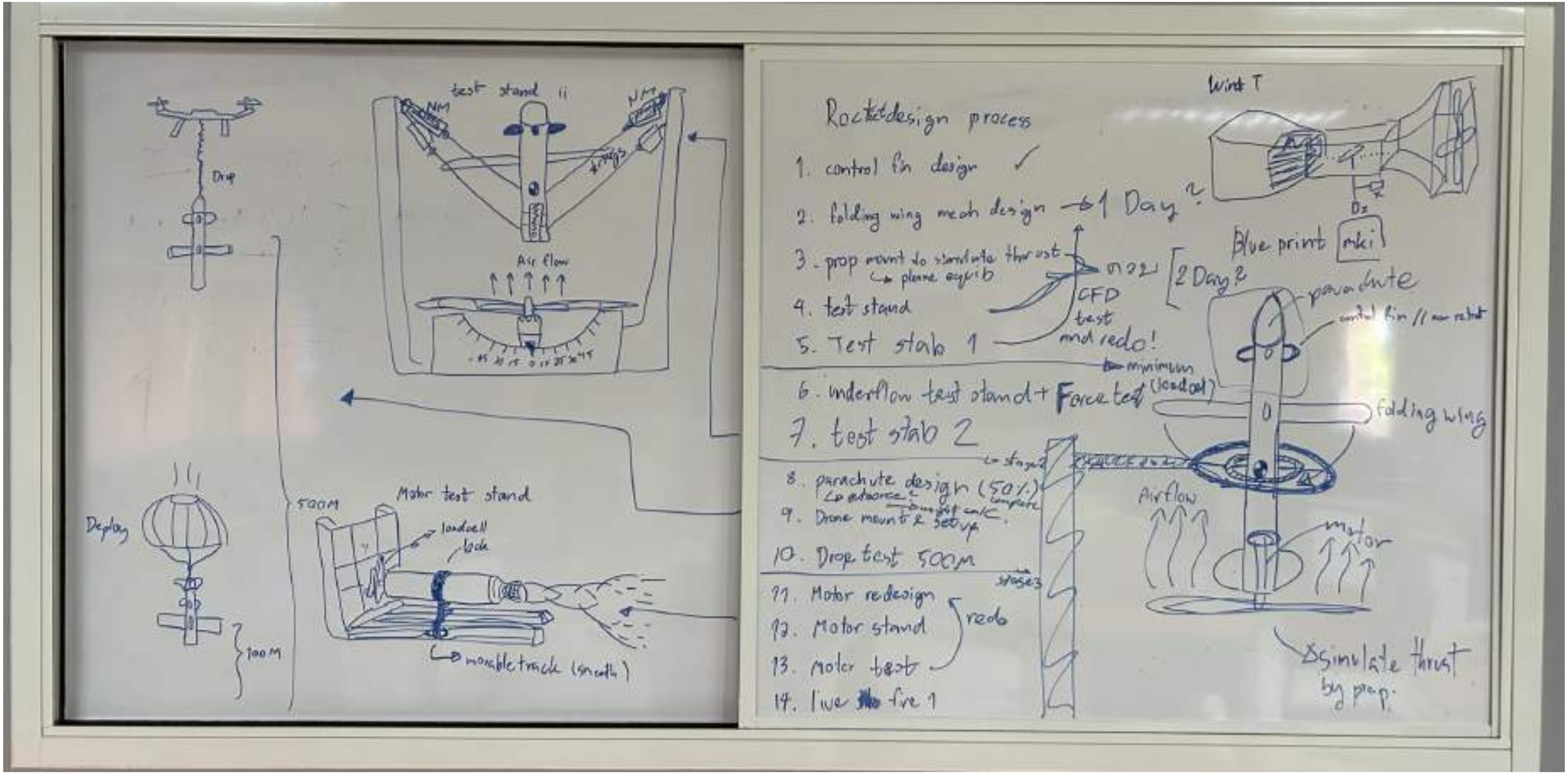
Alpha flight computer :





Future Plans

Real world testing method design



Build test stand structure from aluminium profiles