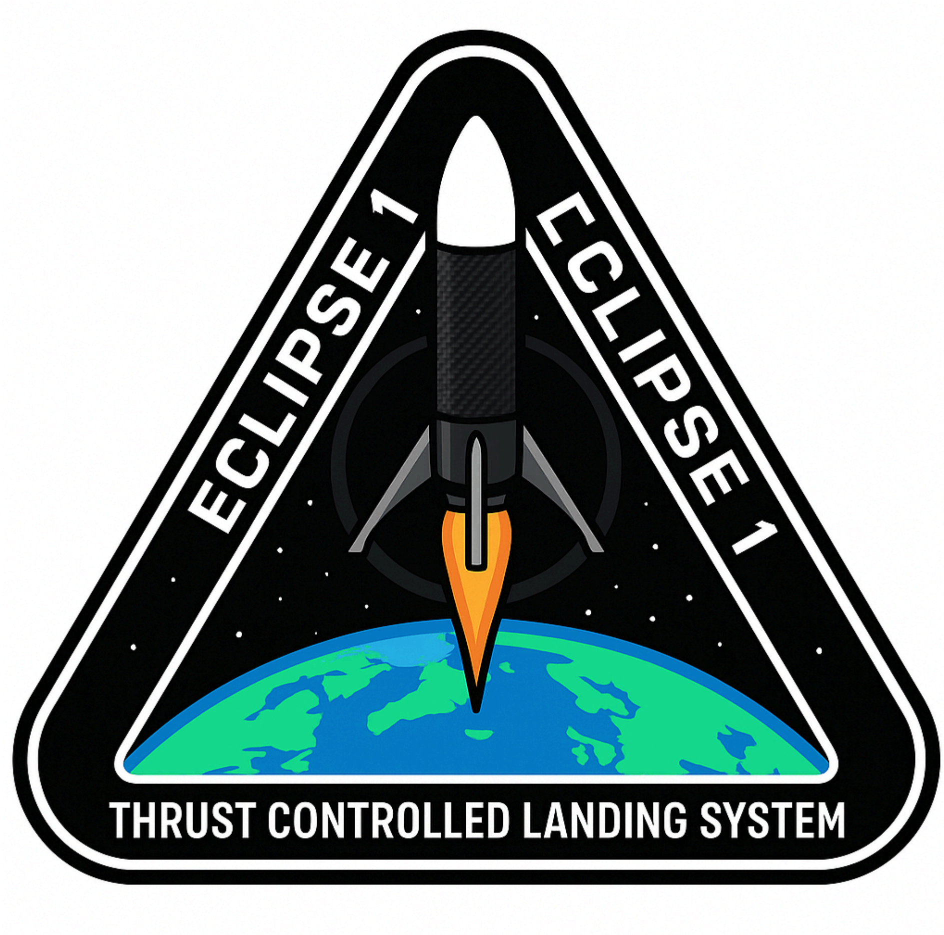
Eclipse 1

TCLS Rocket



Lead Engineer: Xavier Vimard Started : 29/10/25 Finished :

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1.Proof of concept and expectation

<u>Proof of concept:</u>

This project aims to develop a fully functional landing system using many different techniques such as thrust vectoring, aerodynamic control and landing legs. This project is planned to last at least a year, focusing mainly on the TCLS and less on the rocket itself. The development will start with the thrust controlled landing system followed by static fire tests and data collection. This will be followed by the creation of a stability assistance system as well as the development of a reaction wheel and landing legs. The use of all of these functions I listed will be covered down below in the design section.

<u>Expectations (This list will be updated as I carry on the project):</u>

- This project will mark its debut on 27/09/2025 and is expected to be finished by 20/05/2026 as the launch is to take place after that date.
- For this project, I must create a reliable thrust controlled landing system using a variety of skills I have learnt over the entirety of MYP and meet the required deadlines.
- I must ensure that all tests are recorded and that data is collected as well as analyzed and inserted in this document)

<u>Time table:</u>

My project follows a structured month-by-month roadmap:

- Nov 2025: Design, print and stress test the TVC mount, the reaction wheel and the payload bay.

- Dec 2025: Design and simulate and prepare the code for the PCB and hand in the repo for evaluation on Blueprint.

- Jan 2026: Test the TVC with real motors, sssemble prototype rocket (without parachute), refine TVC mount, begin full system dry runs.

- Feb 2026: First flight test of the prototype, collect IMU/GPS data, evaluate control authority.

- Mar 2026: Analyze flight performance, improve PID tuning, begin landing system integration.

- Apr 2026: Integrate final landing mechanism, conduct ground validations.
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- May 2026: Perform full integration test and finalize launch preparation for main flight.

- Jun 2026: Full-system launch and documentation of results.

2. Design

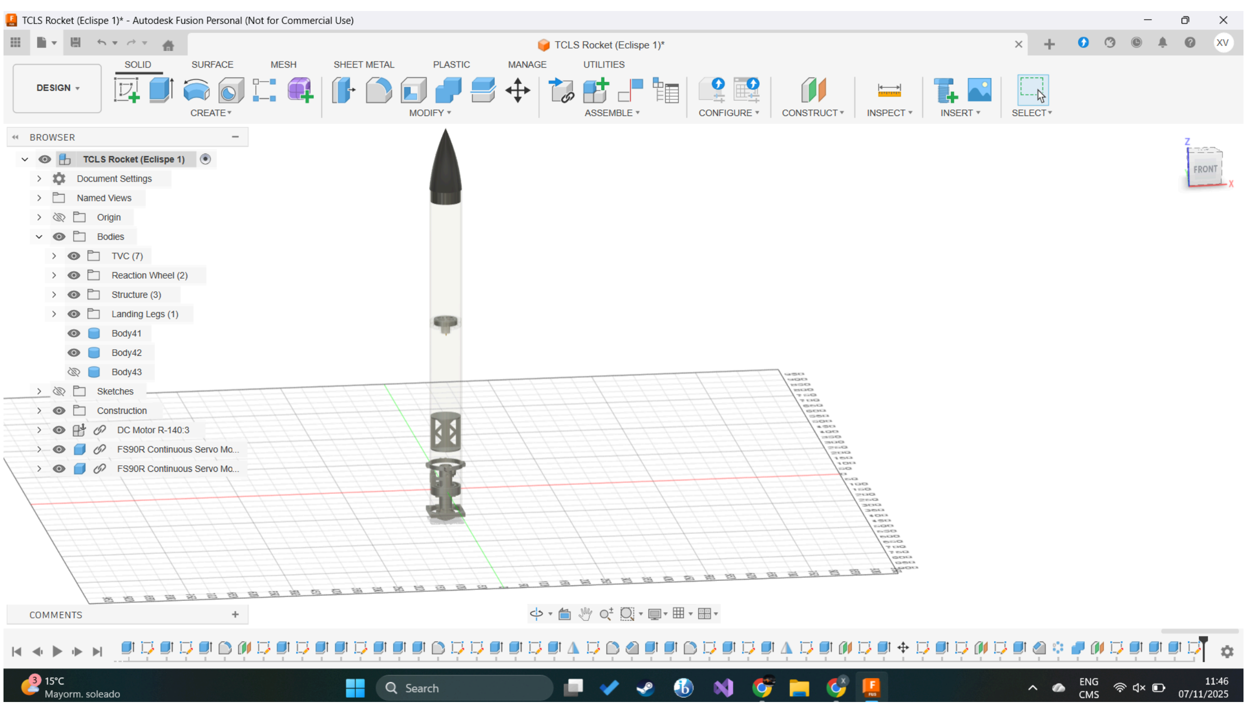
<u>Requirements:</u>

This is a list of all components that should be designed and included in the document.

For this project I will need to develop 5 main components for the mission to succeed. Firstly, the thrust vectoring system should be able to point in the 4 cardinal directions helping the rocket to stay straight while going up and landing. Secondly, the stability assist that will help the thrust vectoring system do the minor stability arrangements in the form of grid fins like the ones used on Spacex's rocket. Thirdly, the reaction wheel system, a component that should prevent the rocket from rolling which would make the thrust vectoring system inoperable. Fourthly, the landing leg system which will deploy at landign time so the rocket stays firmly on the ground once it has landed. All of these components will each have a section of their own for the design concepts and development comments. Lastly, the rocket which will be the vehicle where the TCLS will be mounted onto.

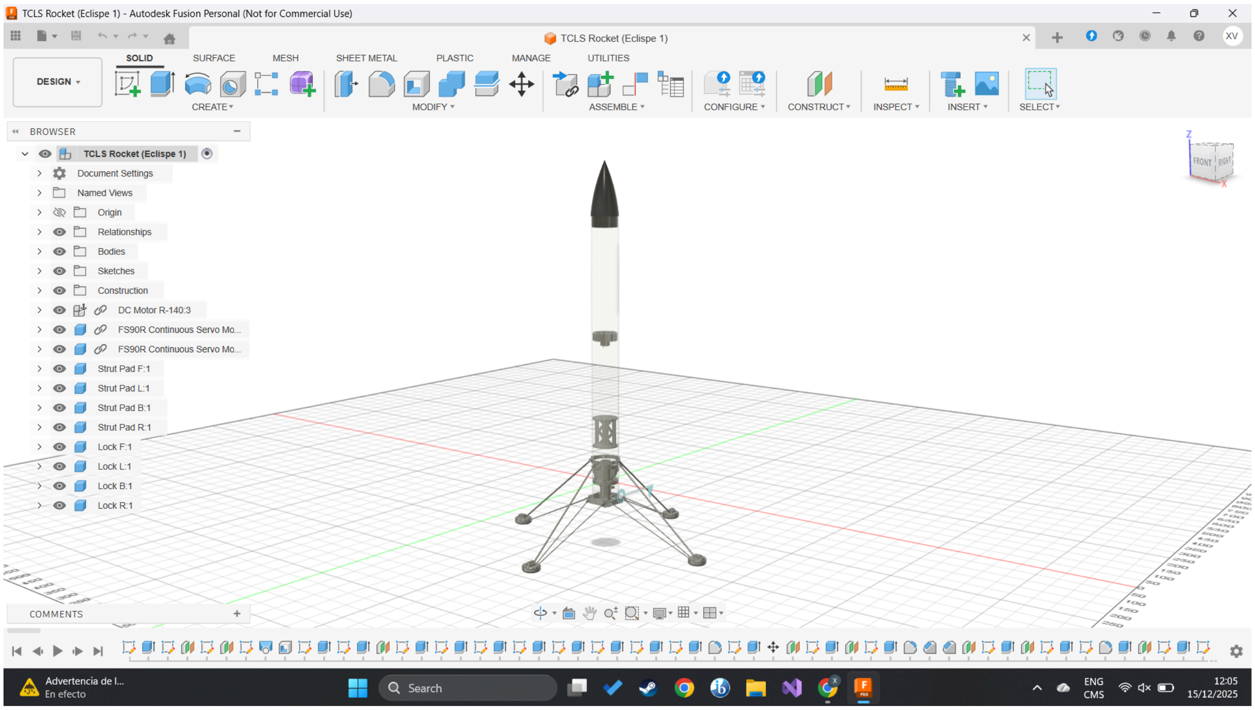
<u>CAD Models:</u>

November 7th:



This is a more finalized version of the TVC and reaction wheel. In the model we can see the reaction wheel which is the grey component under the nose cone. It will be equipped with a 5v dc motor to counteract the roll axis, helping the TVC to function better. We can also see the thrust vectoring system with the onion gimbal and the payload bay placed right above it. This design choice is because servo cables are very small and adding extensions would lower their reaction time.

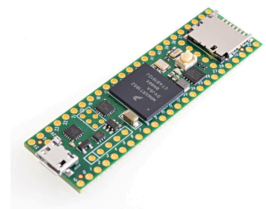
December 7th:

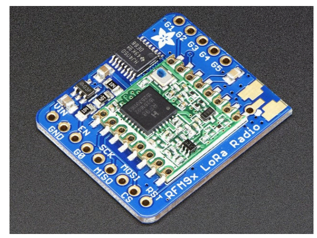


The main updates since last month were the landing legs and a wahole redesign of the TVC. For the landing legs struts, I will use carbon fiber tubes as well as TPU printed pads for shock absorption, furthermore, they will be released using a heated nichrome wire which will cut an elastic band and it will let gravity deploy the legs. For the TVC upgrades, I made the whole onion layers smaller as the rings were too wide, furthermore, I added structural support as fillets and chambers between perpendicular surfaces. Additionally, At the bottom of the motor tube, there is a latch for the thrust arms which will cut the plume in order to reduce and control the thrust.

Components:

Rocket:

Teensy 4.1	
74mm θ carbon fiber tubes	
TSP F-35 P Motor	
BMI 088	

MS5611	
Lora Module	
5v DC motor	
9g and 5g servos	

<u>PCB Design and chips:</u>

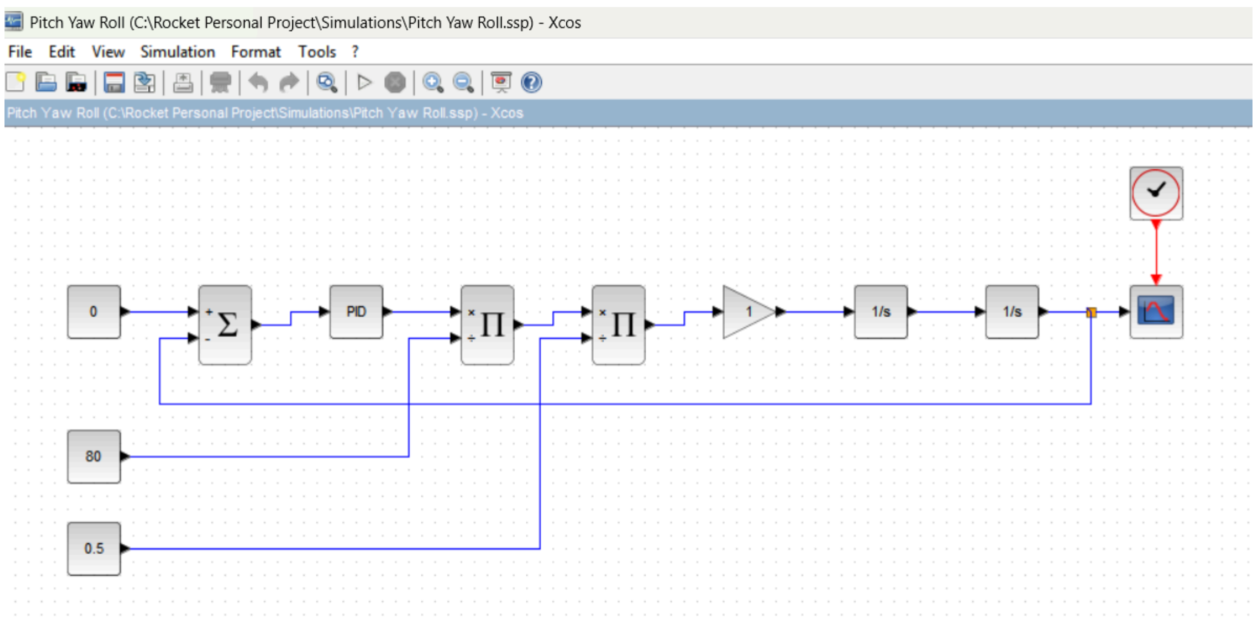
IMU: Bosch BMI088, Explicitly designed for high vibration robustness and thermal stability.

MCU: Teensy 4.1, Eliminates cache-miss latency for true hard real-time, deterministic performance.

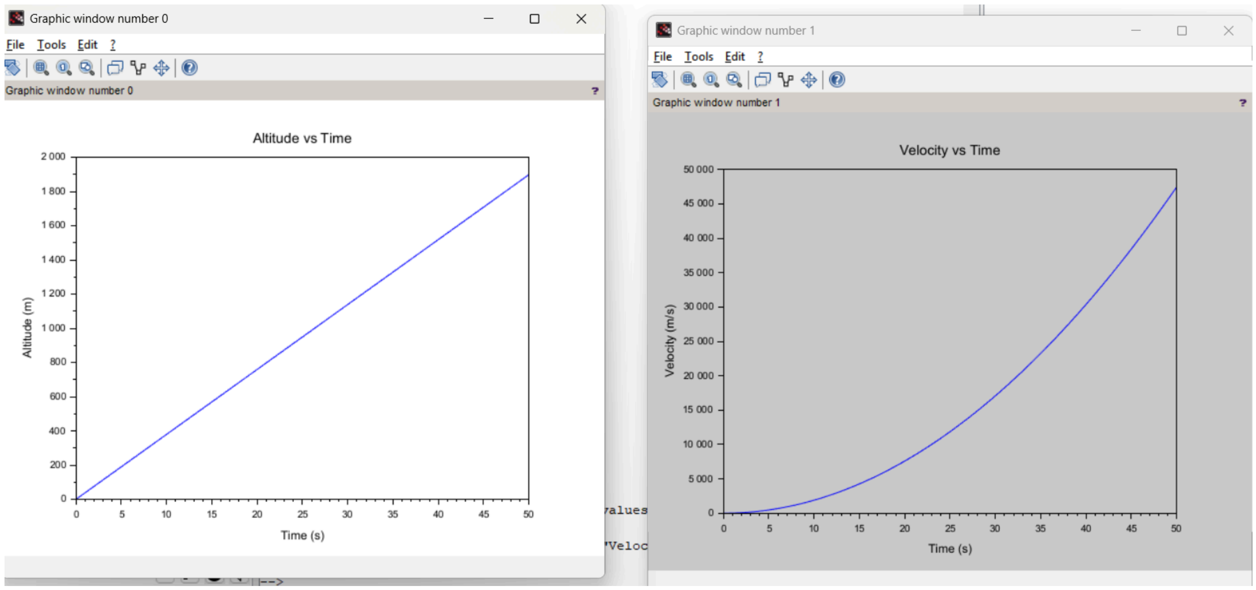
Baro: TE MS5611, Exceptional 10cm resolution for precise apogee detection; requires OSR configuration.

Simulations:

In order to check and to prove that what I want to do is possible, I have to simulate the launch and landing of the rocket. This is crucial as it will help me visualise what I will have to improve in order to make the rocket land successfully. For this, I will be using Xcos from SciLab as it is a free version of Simulink.



That was my attempt at creating the gyro function to prove it could really work. I had to do a few calculations involving velocity and make the simulation fix any change that derives from being perfectly vertical and then it would all show the ascent data in a graph.



Here we can see the graph on whichthe altitude vs time and velocity evolve over time. From this we can understand that the altitude will constantly move linearly without any drops meaning that we do not have to focus on controlling thrust during the ascent which would have added a big layer of complexity. As for the velocity over time graph, we can see that the vehicle picks up speed meaning that our motor is powerful enough to overcome the weight of the rocket.

3. Assembly

Price:

Taking a look at all the components we have, this project will be expensive and for that the cost has to be logged. Additionally, we have a certain budget we do not want to go over which in this case is 400 euros. Knowing that I already have access to a 3D printer and filament, that can be taken off the expensive materials list. Using the ist of components before, I was able to find all of the components I needed on different websites. This helped me establish the following cost list.

Teensy 4.1: https://www.amazon.es/dp/B08CTM3279 57,25 euros

TSP F35-p x2:
https://www.sierrafoxhobbies.com/en/2439-f35-p-single-use-tsp-29-mm-model-rocket-engine-2-pcs.html 64 euros

BMI088:
https://www.mouser.es/ProductDetail/Bosch-Sensortec/BMI088-Shuttle-Board-30
16.54 euros

MS5611: https://www.manomano.es/componentes-electronicos-4189 7.87 euros

Lora: https://www.amazon.es/dp/B07J66GFS5 9.99 euros

5v DC motor: https://www.amazon.es/dp/B07HBMQ4GF 7.99 euros

9g servos: https://www.amazon.es/dp/B0DP3VG59G 11.99 euros

5g servos: https://www.amazon.es/dp/B0CQWPPTFV 11.13 euros

Esp 32 + Wroom module: https://www.amazon.es/dp/B0F48GSWKP 14.99 euros

SX1276 Lora receiver: https://www.amazon.es/dp/B0B1LYDMTN 7.06 euros

Antenna: https://www.amazon.es/dp/B0F9F38JWH 18.57 euros

For the carbon fiber tubes, as there is no european seller that sells exactly what I need, I will have to make it manufactured as a custom part, I expect the price to be around 50-70 euros. Adding all of the prices, it will give us a rough grand total of **298** euros.

Materials

Since I have acces to 3D printers, I have decided to print what would have taken a long time to manufacture with a CNC machine or an online manufacturing store. For these prints I will list the material I will use and the infill as well as the infill pattern. Keep in mind that I am using a Bambulab A1 mini and that all the infill settings are in Bambu Studio.
For the TVC, I will use PETG for its strength and resistance to sudden changes in forces applied on it. To further solidify the print and remove stress from connection points between perpendicular surfaces, I will use the gyroid infill and set it to 20%. I could have used PLA Carbon for all of these criterias but the main advantage of PETG is its resistance to heat as the motor tube will be in close range to the rocket motor’s plume.
For the landing leg pads, I will use TPU at 40% infill as I want to maximise shock absorption and printing it with a higher infill would have made it too rough.
I also decided to print the reaction wheel, the nose cone, the landing leg attachements and the payload bay. For them, I will use regular PLA as they will not experience tremendous forces and PLA saves money in comparison to more specialised filaments. I will use 30% infill as the payload bay wall are very thin and use a rectilinear pattern.

As for my body tube, I will use a polished 6 layers carbon fiber tube of 80cm in length and 74mm of inner diameter as well as all the tubes for my landing legs that I will order on a custom carbon fiber part seller in Germany.