



FALCON 9 ROCKET SIMULATOR

Real time first stage simulator with all telemetry data live on-screen. 3D OpenGL model and real video playing at same time to compare the accuracy. Fully parameterizable. Throttle and altitude controlled by user drawn curves.

Simulation Developed By: Rajan Singh

TECHNICAL OVERVIEW

HEIGHT	MASS	PAYLOAD TO <u>LEO</u>	PAYLOAD TO <u>MARS</u>
70 m 229.6 ft	549,054 kg 1,207,920 lb	22,800 kg 50,265 lb	4,020 kg 8,860 lb
DIAMETER	STAGES	PAYLOAD TO <u>GTO</u>	
3.7 m 12 ft	2	8,300 kg 18,300 lb	

About Project:

This application uses engineering equations to simulate the first stage of a Falcon 9 rocket in real-time. You can simulate efforts, performance, control throttle and vehicle attitude through user drawn curves.

The application is still being developed, therefore, the experience includes the launching stage and it goes on up to the separation of the second stage.

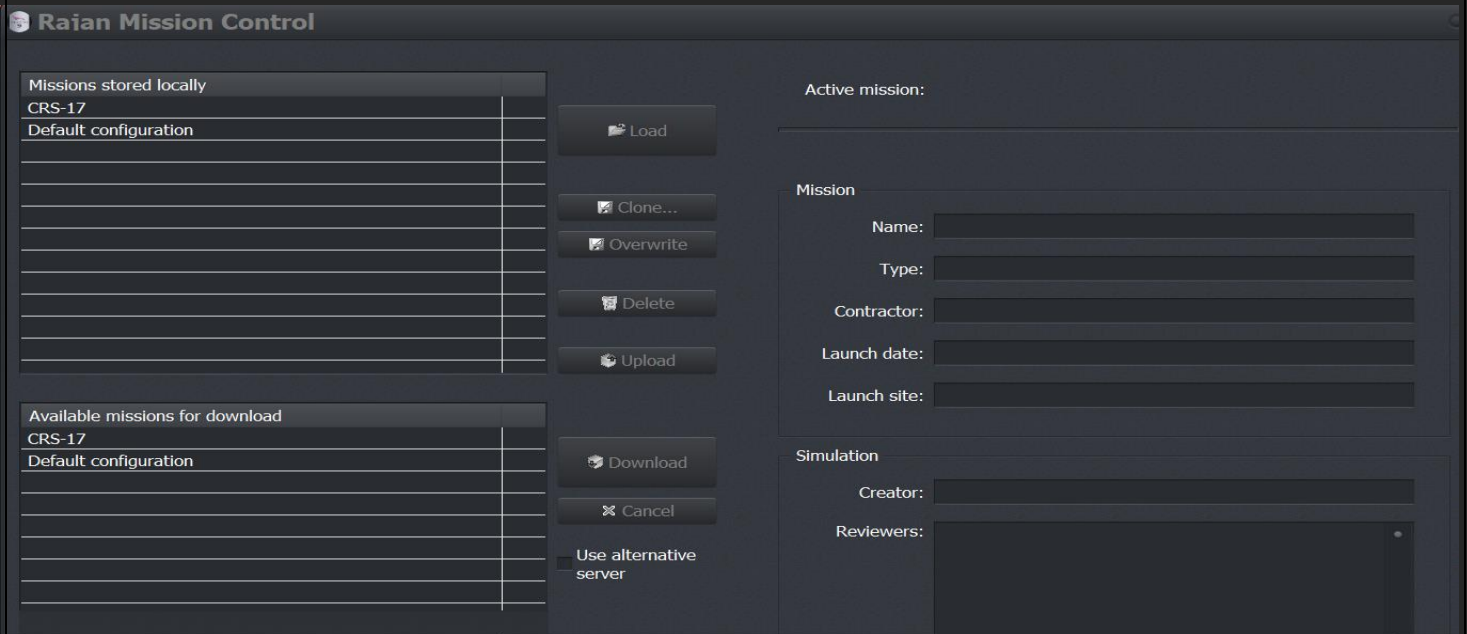
Main Screen:

You can see the progress of the simulation in real-time, including speed, altitude, linear and angular accelerations, monitor engine performance, throttle and thrust, fuel flow and consumption, aerodynamic and structural loads, spatial positioning, etc on live on-screen.



Mission Selector:

Mission Selector provide an open choice to upload the selected mission into the simulator module. It's a pre-recorded real time data of the past missions which can apparently visualized after launch of the selected mission.



Engine Configuration:


Configuration of Merlin 1 D engine used in Falcon 9 First stage rocket. Can be customized to derive test simulations regarding the engine performance and subject to necessary adjustments in terms of various payloads.



Structural Configuration:

With the structural configuration panel you can configure masses and center of gravity (and some aerodynamic parameters) of any part of the rocket like octaweb, legs, fuel tanks, grid fins, second stage, payload, etc. With the engine configuration panel you can configure parameters like thrust and specific impulse for sea level and vacuum condition.

Rocket Structural Configuration by Raian Singh - Falcon 9 Rocket Launch Data by NASA

Masses		Distances (C.G.)	
Payload fairing <input type="text" value="1700"/> [kg]		Payload fairing <input type="text" value="60"/> [m]	Full rocket height: 70.0 m First Stage height: 47.9 m Second Stage height: 22.1 m
Payload <input type="text" value="2500"/> [kg]		Fairing height: 11.8 m	
Geostationary orbit: 5500 kg Low Earth orbit: 10886 kg		Payload <input type="text" value="62"/> [m]	
Second stage (including propellant) <input type="text" value="111500"/> [kg]		Coupling section height: 1.4 m	
Inter stage <input type="text" value="500"/> [kg]		Second stage <input type="text" value="52"/> [m]	Fairing
Grid fins <input type="text" value="1000"/> [kg]		Second Stage height: 8.9 m	Maximum diameter <input type="text" value="5.18"/> [m]
		Inter stage <input type="text" value="44.5"/> [m]	Subsonic drag coefficient <input type="text" value="0.3"/> [m]
		Inter Stage height: 6.9 m	(used for drag calculation during ascent)
Fuel tanks <input type="text" value="11000"/> [kg]		Grid fins <input type="text" value="40.6"/> [m]	First Stage
Liquid Oxygen (LOX) <input type="text" value="287400"/> [kg]		Fuel tanks <input type="text" value="29"/> [m]	Maximum structure diameter <input type="text" value="4.6"/> [m]
Kerosene (RP-1) <input type="text" value="123500"/> [kg]	First Stage height: 39.9 m	(used for drag calculation during reentry)	
Legs <input type="text" value="2000"/> [kg]	Legs (folded) <input type="text" value="7.1"/> [m]	Subsonic drag coefficient <input type="text" value="0.3"/> [m]	
	Legs (extended) <input type="text" value="0.4"/> [m]	(used for drag calculation during reentry)	
		Subsonic lift coefficient <input type="text" value="0.3"/> [m]	
		(used for lift calculation during reentry)	

Developed by Rajan Singh-Lockdown 2020

Flight Plan:

Flight Plan can be customized by users in terms of MECO (Main Engine Cutoff Altitude) & SECO (Second stage Engine Cutoff Altitude).

Raian Flightplan

Mission

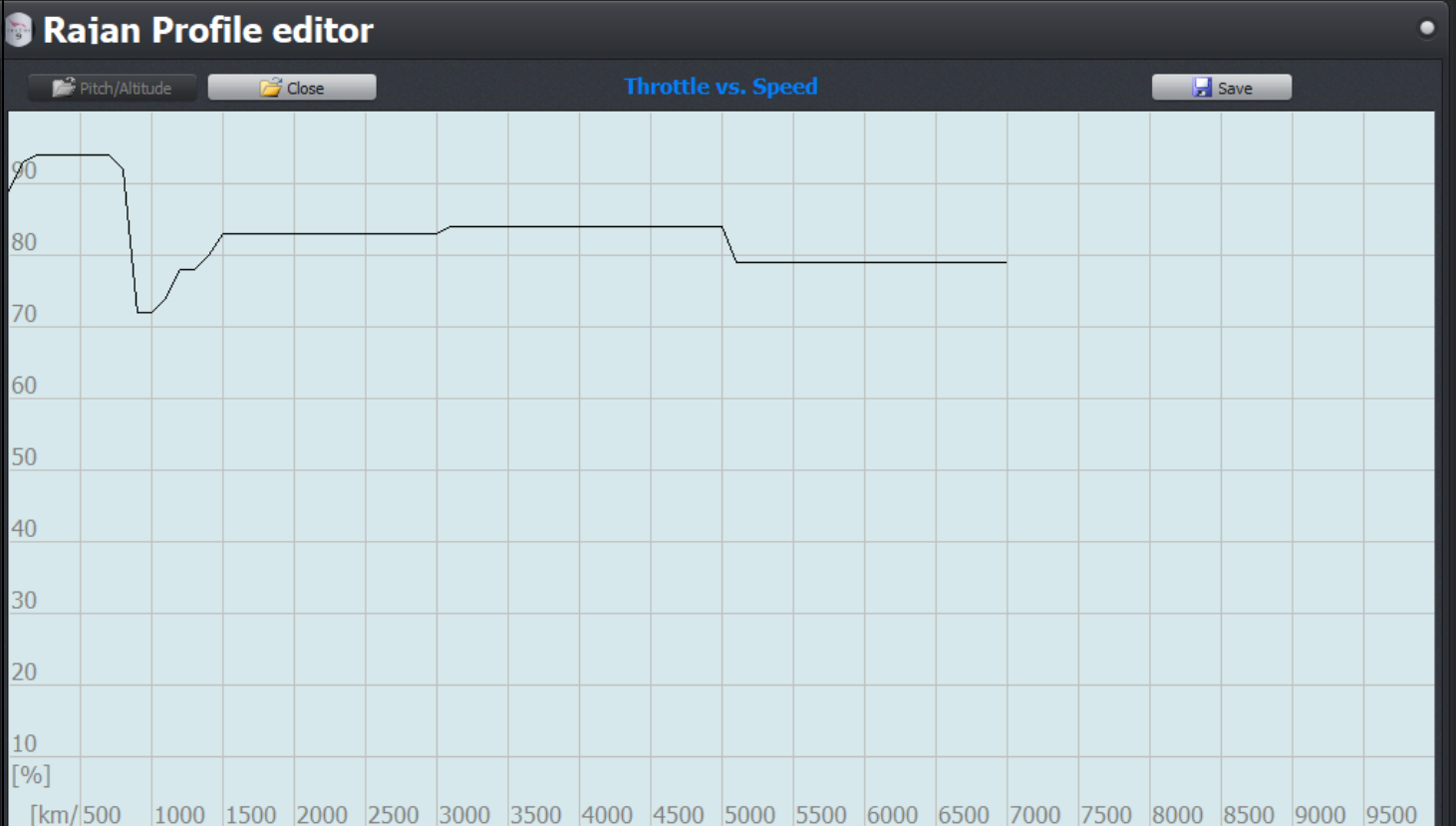
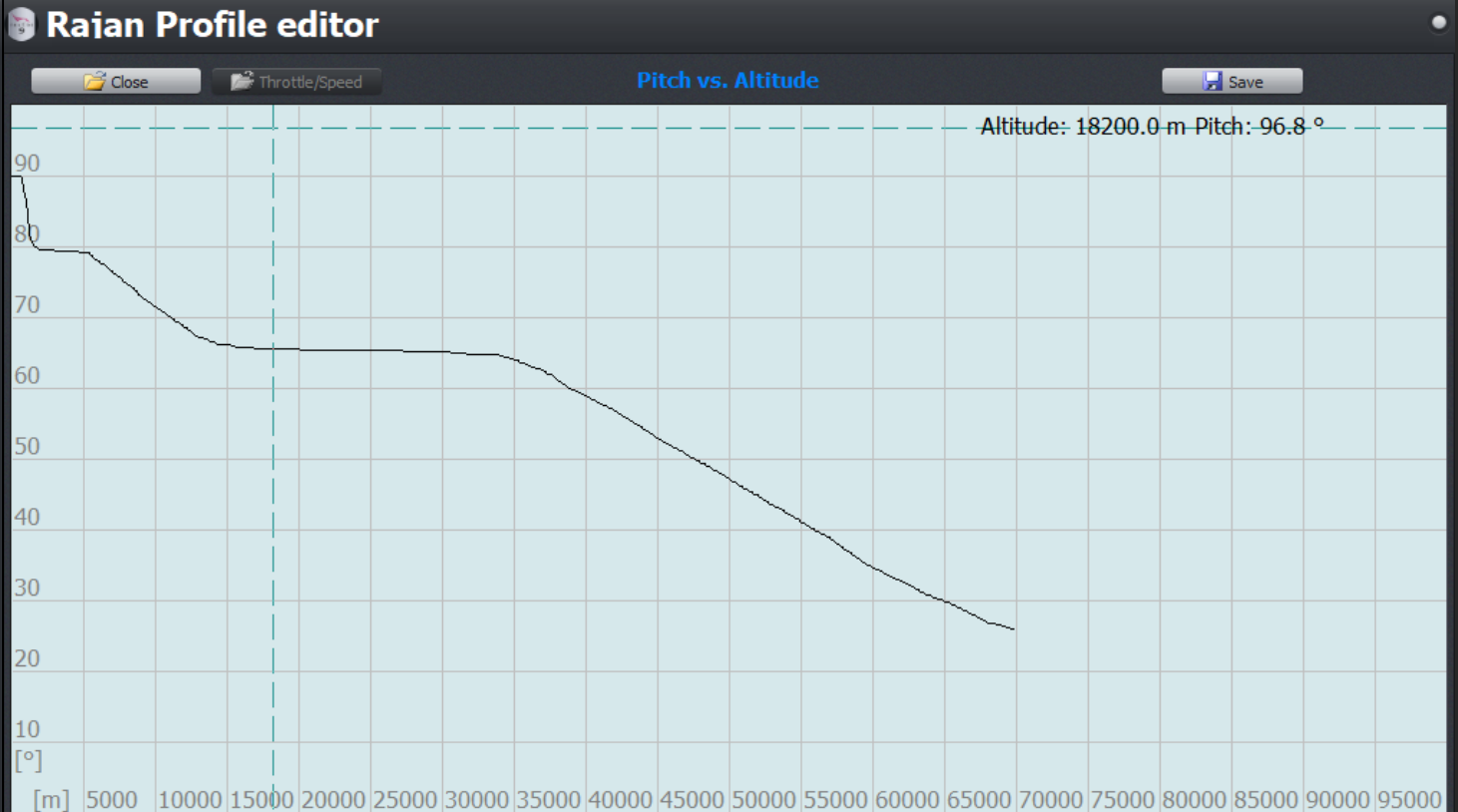
Ground altitude [m]
Main Engine Cutoff altitude [m]
Stage Separation altitude [m]

Video



Flight Profiles:

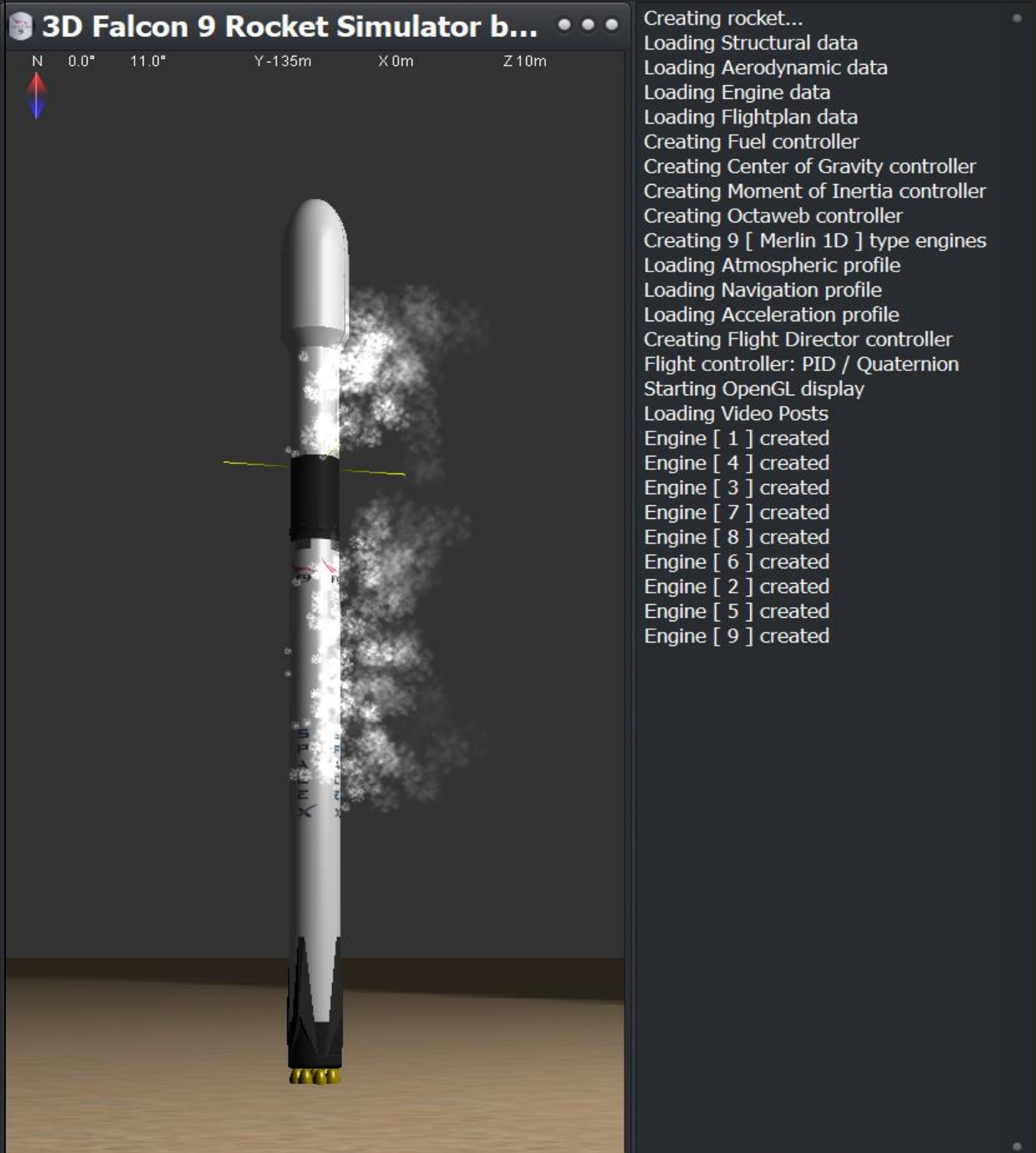
With flight profile configuration panel you can draw curves to control throttle modulation and vehicle attitude during flight. With the flight plan configuration panel you can setup Main Engine Cut off (MECO) and Stage Separation triggers and configure the real video, which is useful to compare the accuracy of the simulation & to configure the Pitch, Altitude, Speed and Throttle.



3D Virtual Simulator & Live Mission Status Analyzer :

3D Virtual Rocket Simulator simulates the entire flight plan as per user's configuration and Mission status reader displays the ongoing process on Live screen. The entire process is also recorded at back end which can be downloaded in CSV file by Black box tab.

3D Sim window appears just after the Launch followed by countdown.

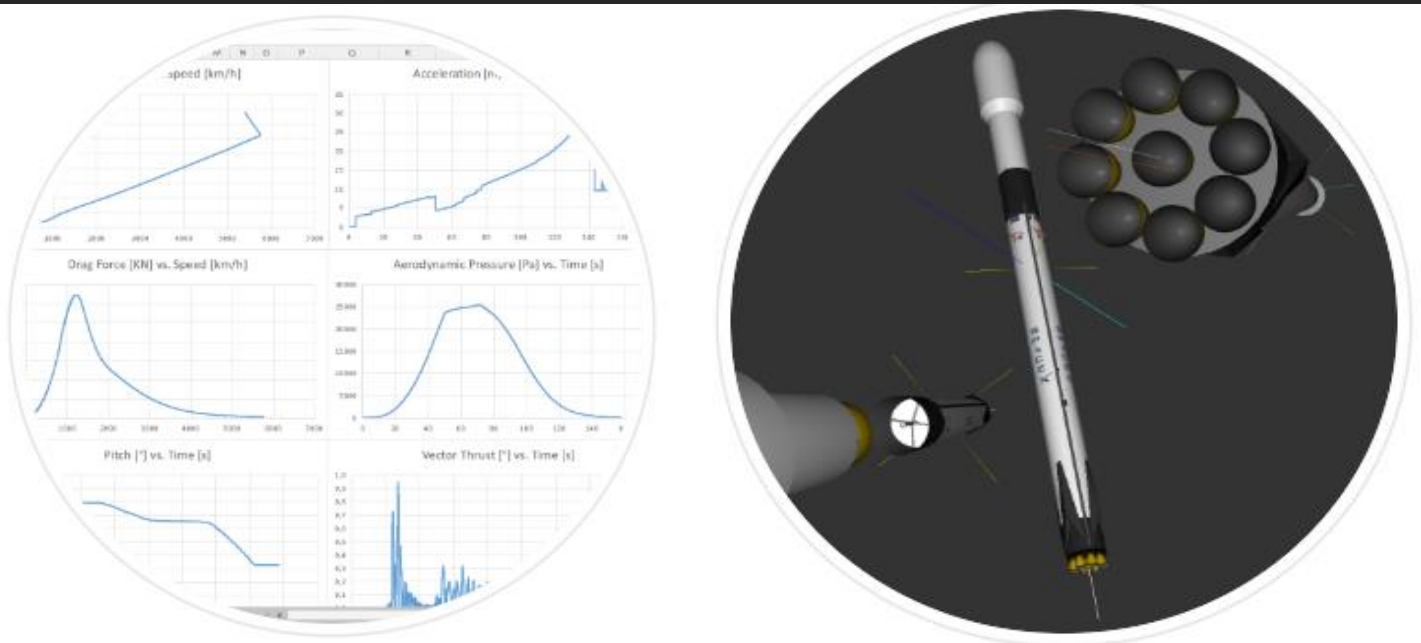


3D OpenGL Display:

The simulator provides a 3D display where you can see the flight attitude and different behaviors from the point of view you choose. You can configure different camera posts, relative to ground or inflight, as well as its exact point of entry into the scene using an altitude trigger.

Flight Log Export:

Once completed the simulation you can download an Excel (CSV) file with 18 parameters measured every 25ms (40 times per sec.). This information is useful to plot charts and compare with real flight telemetry information.



Disclaimer:

All structural, performance and telemetry data used to produce this application are publicly available in SpaceX website, forums and video channels. This application is intended only for educational purposes and can be freely distributed. This application is not affiliated with, maintained, authorized, endorsed, or sponsored by SpaceX or any of its affiliates. SpaceX and Falcon 9 are registered trademarks of Space Exploration Technologies Corporation.

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F9sim32.exe