CanSat 2019
Post Flight Review (PFR)
Version 1.0

#6203

APIS ARGE TEAM

Presentation Outline

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Introduction	İsmail ÖZCAN	2-3
Systems Overview	İsmail ÖZCAN	4-13
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Failure Analysis	İsmail ÖZCAN	37-38
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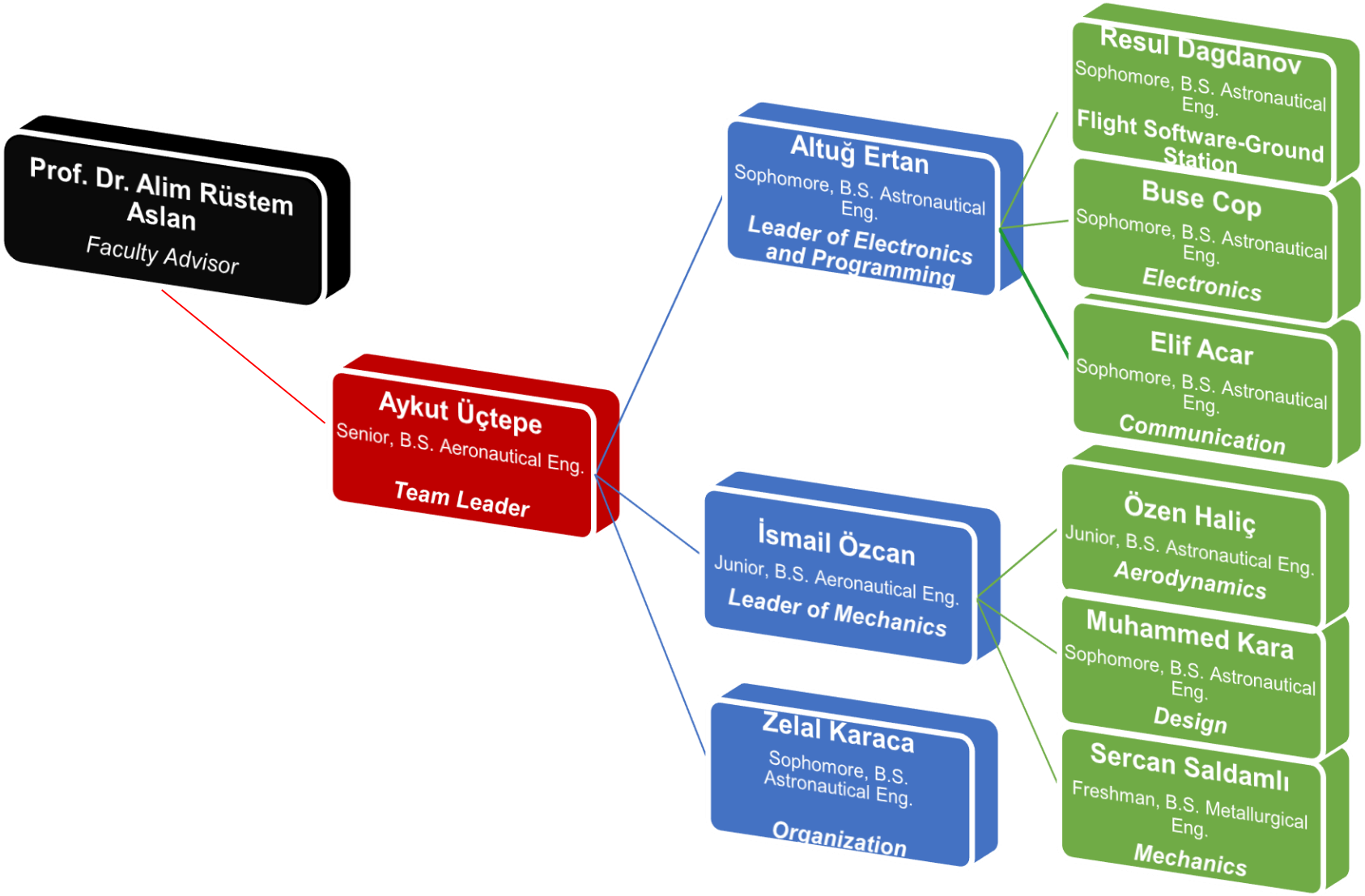
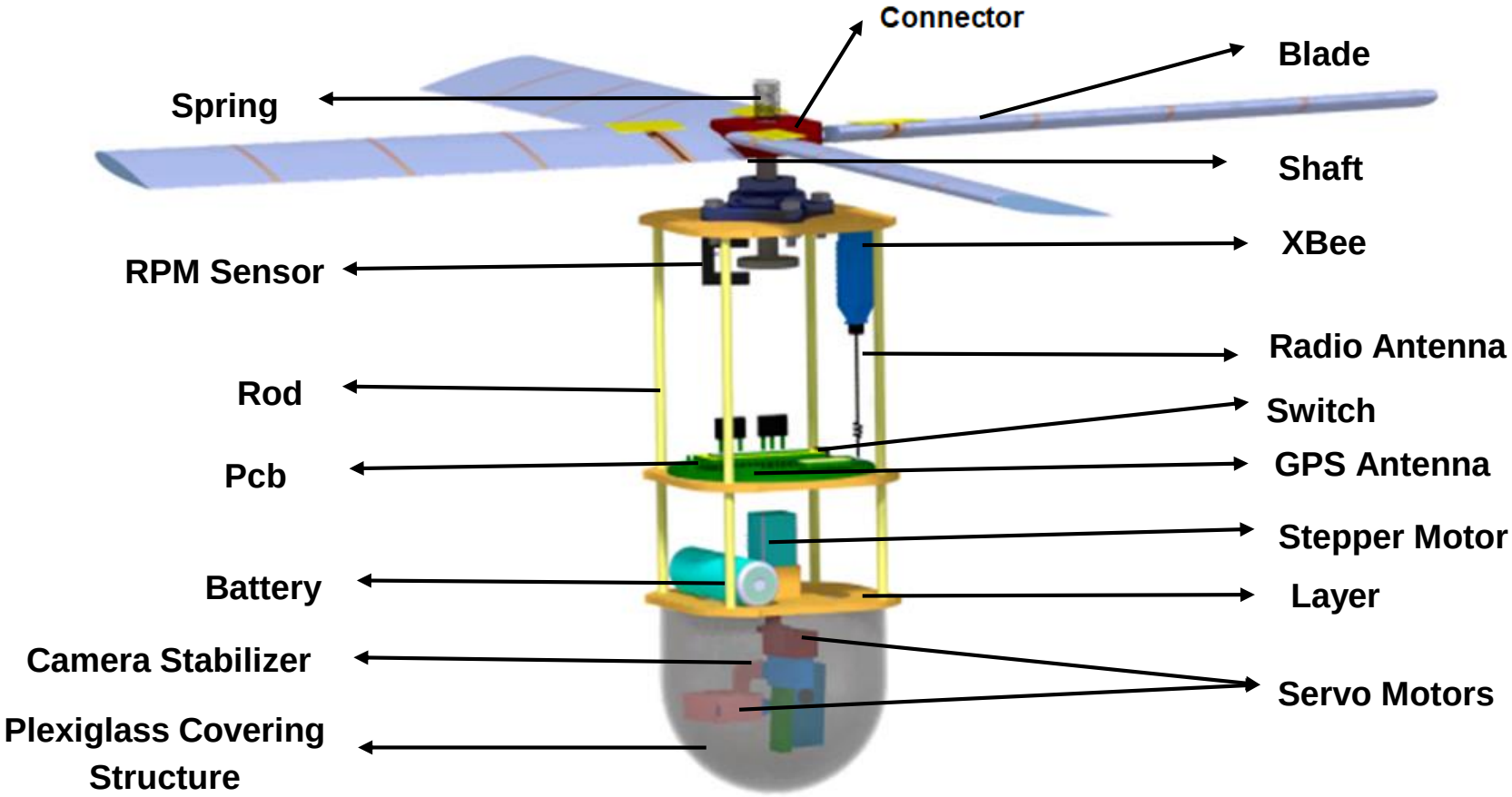
Team Organization



System Overview

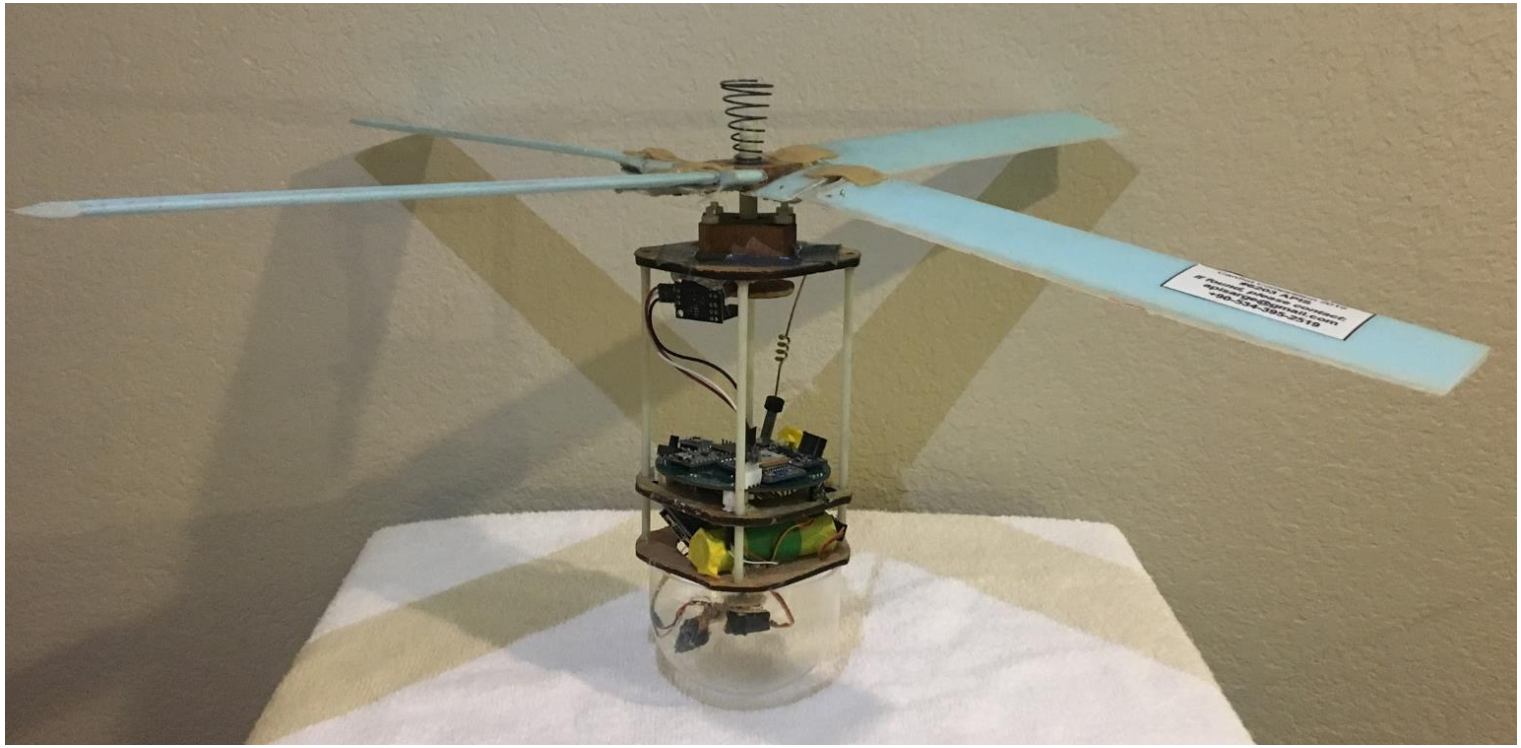
Payload Design Overview (1/6)

PAYLOAD



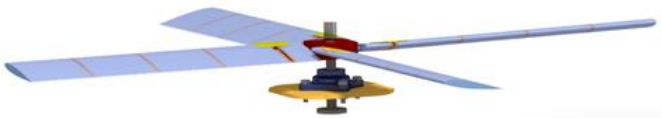
Payload Design Overview (2/6)

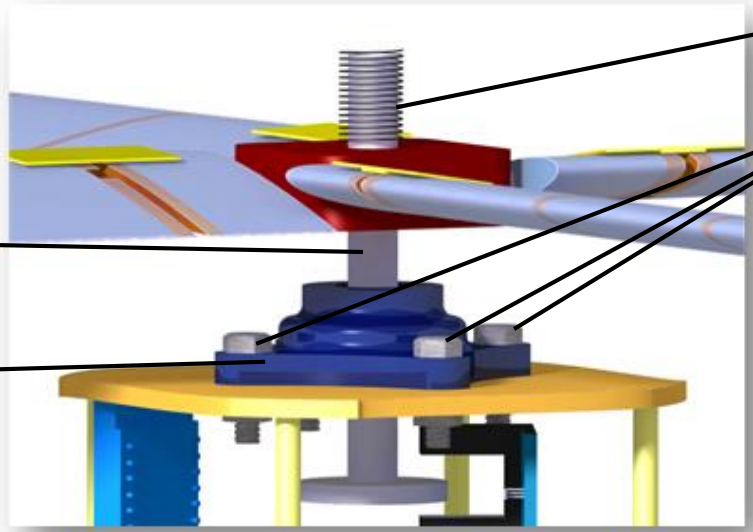
Real Prototype

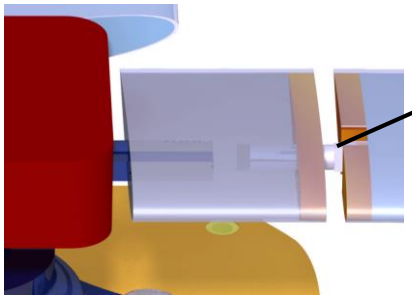


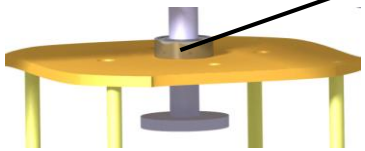
Payload Design Overview (3/6)

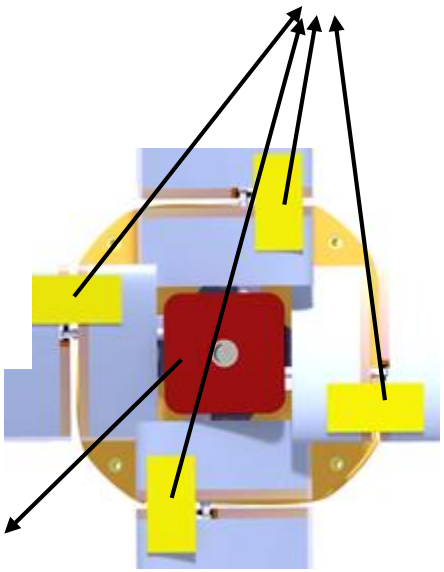
Auto-gyro Mechanism





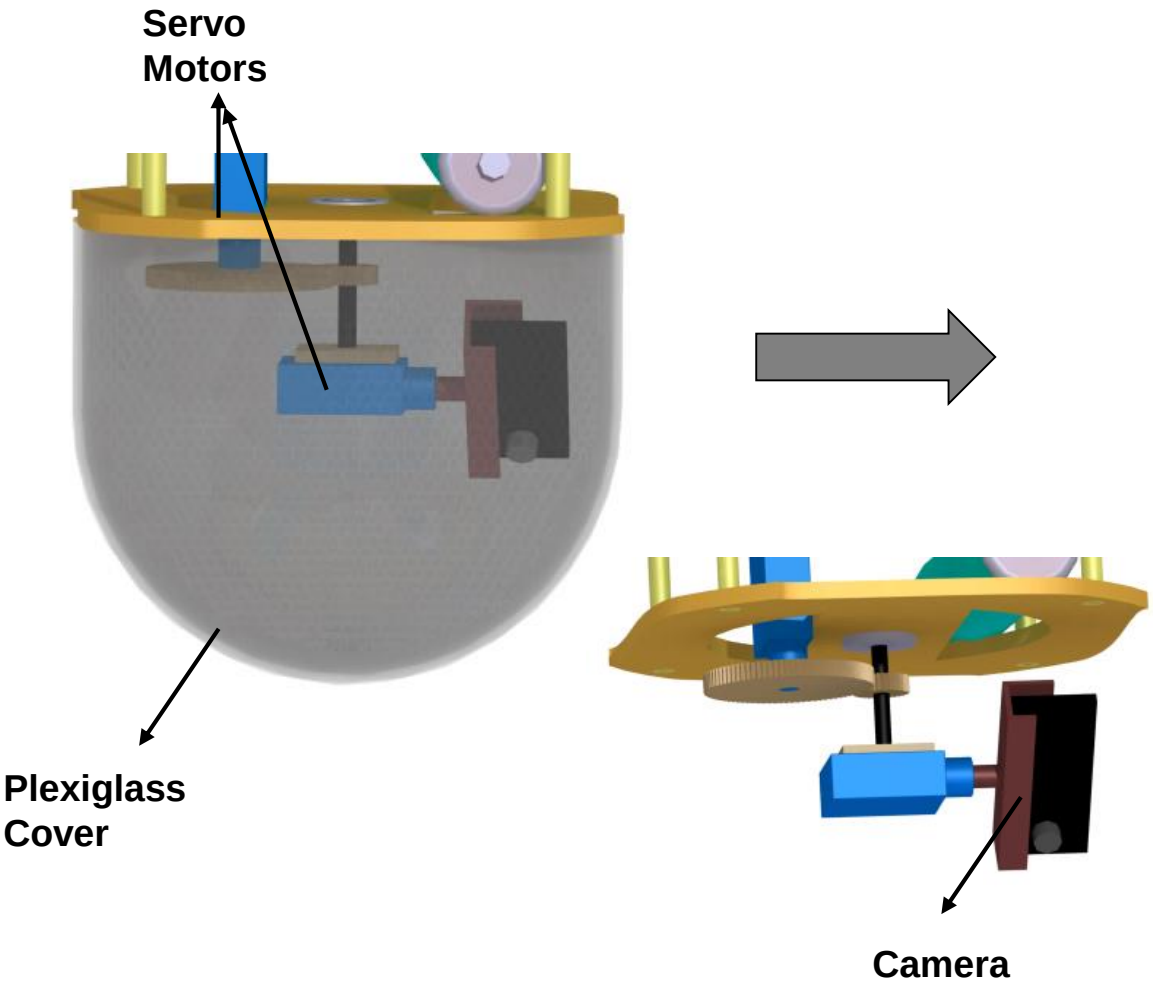


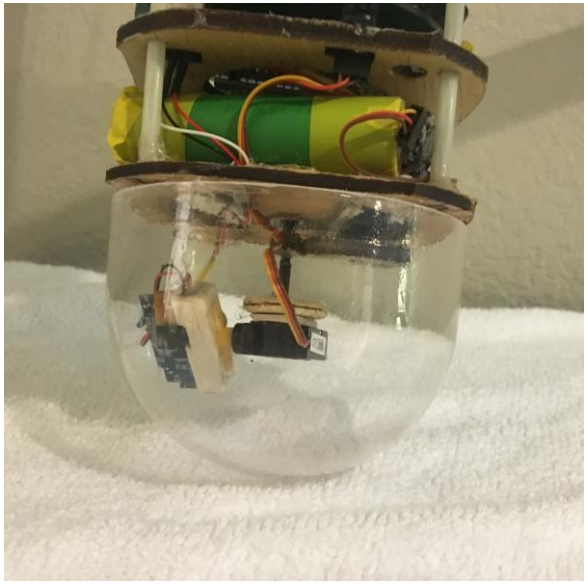




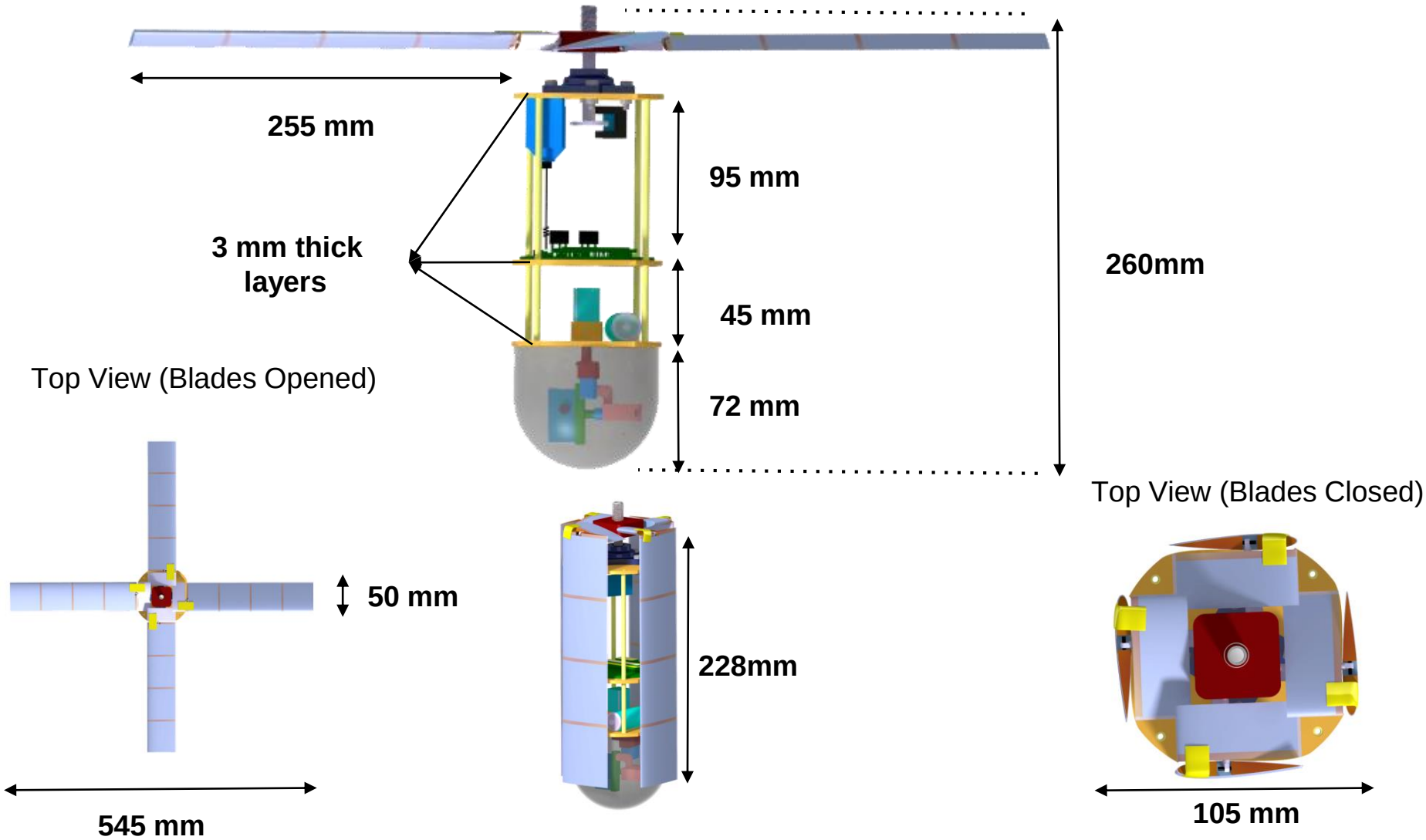
Payload Design Overview (4/6)

Camera Stabilizer Mechanism





Payload Design Overview (5/6)

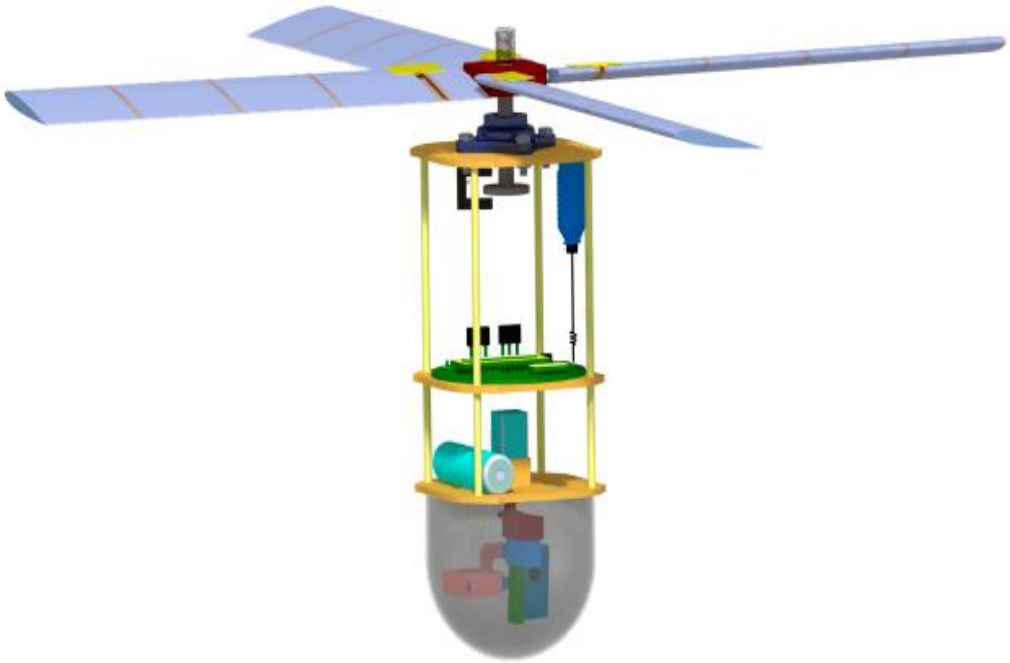


Payload Design Overview (6/6)

CANSAT

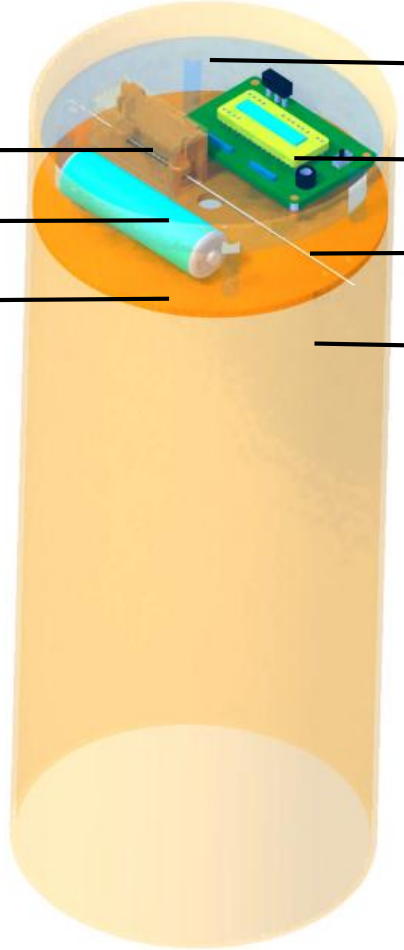
Launch Configuration

Deployed Configuration

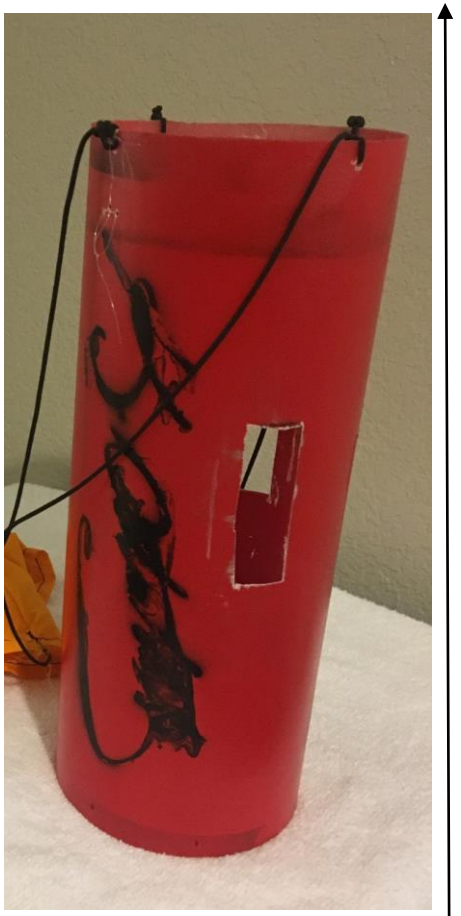


Container Design Overview (1/2)

CONTAINER



Container Design Overview (2/2)

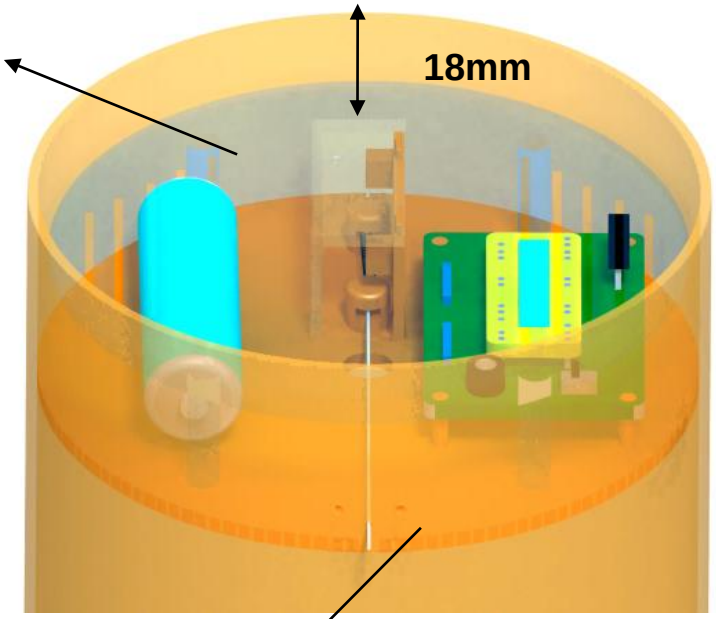


310mm

120 mm

2 mm thick
top layer

18mm

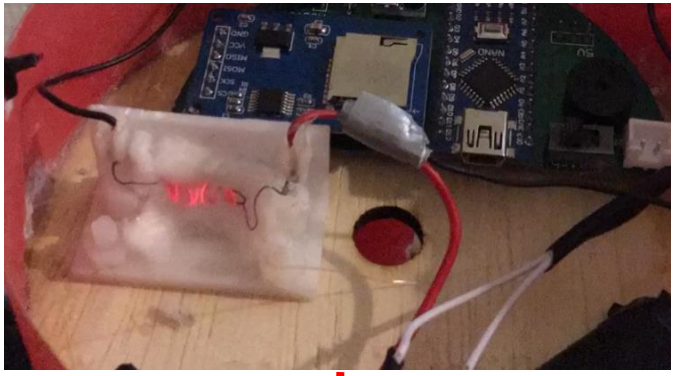


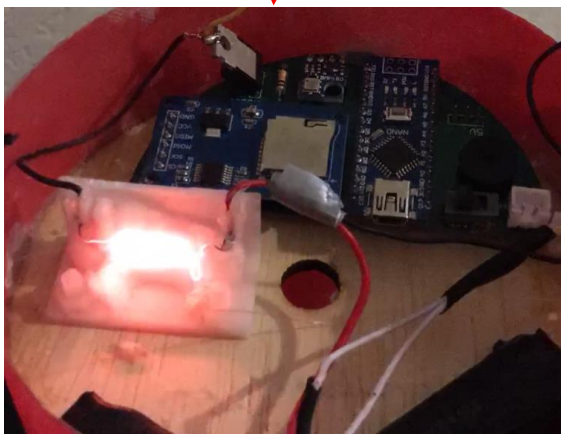
40 mm

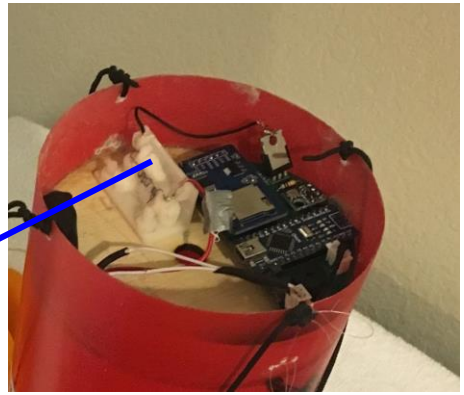
3 mm thick
intermediate layer

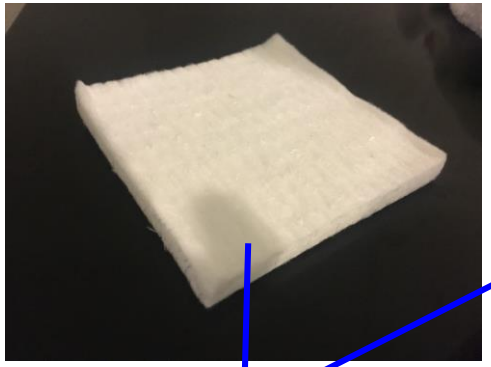
Safety Precautions of Release Mechanism

- It is shown that the effect of heat, produced by nichrome wire, to environment.
- Aluminium silicate cover the nichrome wire to minimize the heat transfer between container and release mechanism.









Aluminium silicate

CONOPS (Concept of Operations)
&
SOE (Sequence of Events)

Comparison of planned and actual CONOPS

Planned CONOPS

Pre-Launch

- Competition area arrival.
- Team briefing.
- Electronic and mechanic integrity checks.
- GCS and antenna set up.
- Damage control before the flight by CanSat Crew.
- Double check for final CanSat integrity configuration and release mechanism by Inspection Crew.
- Making sure mass is between 490 g and 510 g

Launch

- Placement of Cansat into rocket payload section by Cansat Crew.
- Launch, and events of CONOPS (given in previous slide).
- Telemetry data obtaining and .csv file creation via GCS software.

Post-Launch

- Recovery of payload with indicators fluorescent color, GPS telemetry and audio beacon.
- Recovery of container with indicators fluorescent color.
- Recovered CanSat is brought to GCS.
- Analysis of sampled data.
- Preparation of PFR.
- PFR presentation to jury.

Inspection Crew

Mechanics: İsmail - Özen

Electronics: Altuğ - Resul

Cansat Crew

İsmail - Sercan

Comparison of planned and actual CONOPS

1	Placement	• Power on the Cansat. • Check the communication between payload and GCS. • Placement to rocket payload section.	**Mission Control Officer:** Aykut
2	Launch	• Rocket takes off. • Parachute opens at apogee. Cansat starts to descent with parachute until 450m.	**GCS Officer:** Resul
3	Seperation	• At 450m, the separation mechanism is activated and payload is released. • At same altitude, camera starts to capturing the descent. • During descend, CanSat continues to collect: air pressure,temperature,voltage,GPS data,tilting,software state, RPM until the landing..	Recovery Crew
4	Recovery	• The Payload lands with auto-gyro mechanism. • The payload finishes descent, stops telemetry and initiates audio beacon. • The Container lands with parachute.	**Payload:** Özen - Altuğ **Container:** İsmail - Buse
5	Data Analysis	• Analyzing the data retrieved from descent control devices. • Delivering requested data to jury. • Getting ready for PFR.	**PFR:** İsmail - Altuğ - Resul - Aykut

Comparison of planned and actual CONOPS

Planned CONOPS are same with the real CONOPS.

Pre-Launch	Launch	Post-Launch
• Competition area arrival. • Team briefing. • Electronic and mechanic integrity checks. • GCS and antenna set up. • Damage control before the flight by CanSat Crew. • Double check for final CanSat integrity configuration and release mechanism by Inspection Crew. • Making sure mass is between 490 g and 510 g	• Placement of Cansat into rocket payload section by Cansat Crew. • Launch, and events of CONOPS (given in previous slide). • Telemetry data obtaining and .csv file creation via GCS software.	• Recovery of payload with indicators fluorescent color, GPS telemetry and audio beacon. • Recovery of container with indicators fluorescent color. • Recovered CanSat is brought to GCS. • Analysis of sampled data. • Preparation of PFR. • PFR presentation to jury.

Inspection Crew

Mechanics: İsmail - Özen

Electronics: Altuğ - Resul

Cansat Crew

İsmail - Sercan

Comparison of planned and actual CONOPS

1	Placement	• Power on the Cansat. • Check the communication between payload and GCS. • Placement to rocket payload section.	**Mission Control Officer:** Aykut
2	Launch	• Rocket takes off. • Parachute opens at apogee. Cansat starts to descent with parachute until 450m.	**GCS Officer:** Resul
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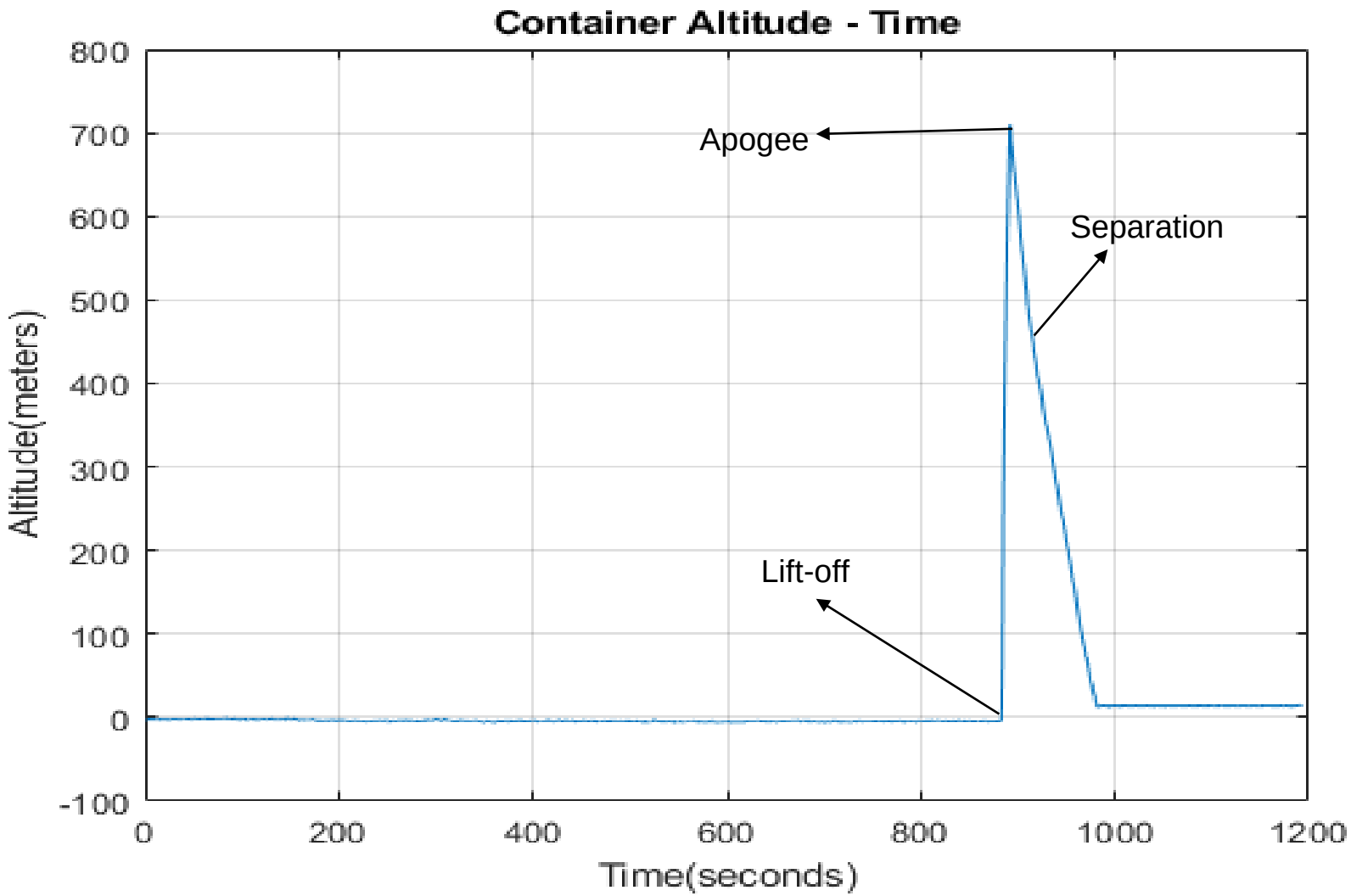
5	Data Analysis	• Analyzing the data retrieved from descent control devices. • Delivering requested data to jury. • Getting ready for PFR.	**PFR:** İsmail - Altuğ - Resul - Aykut

Comparison of planned and actual SOE

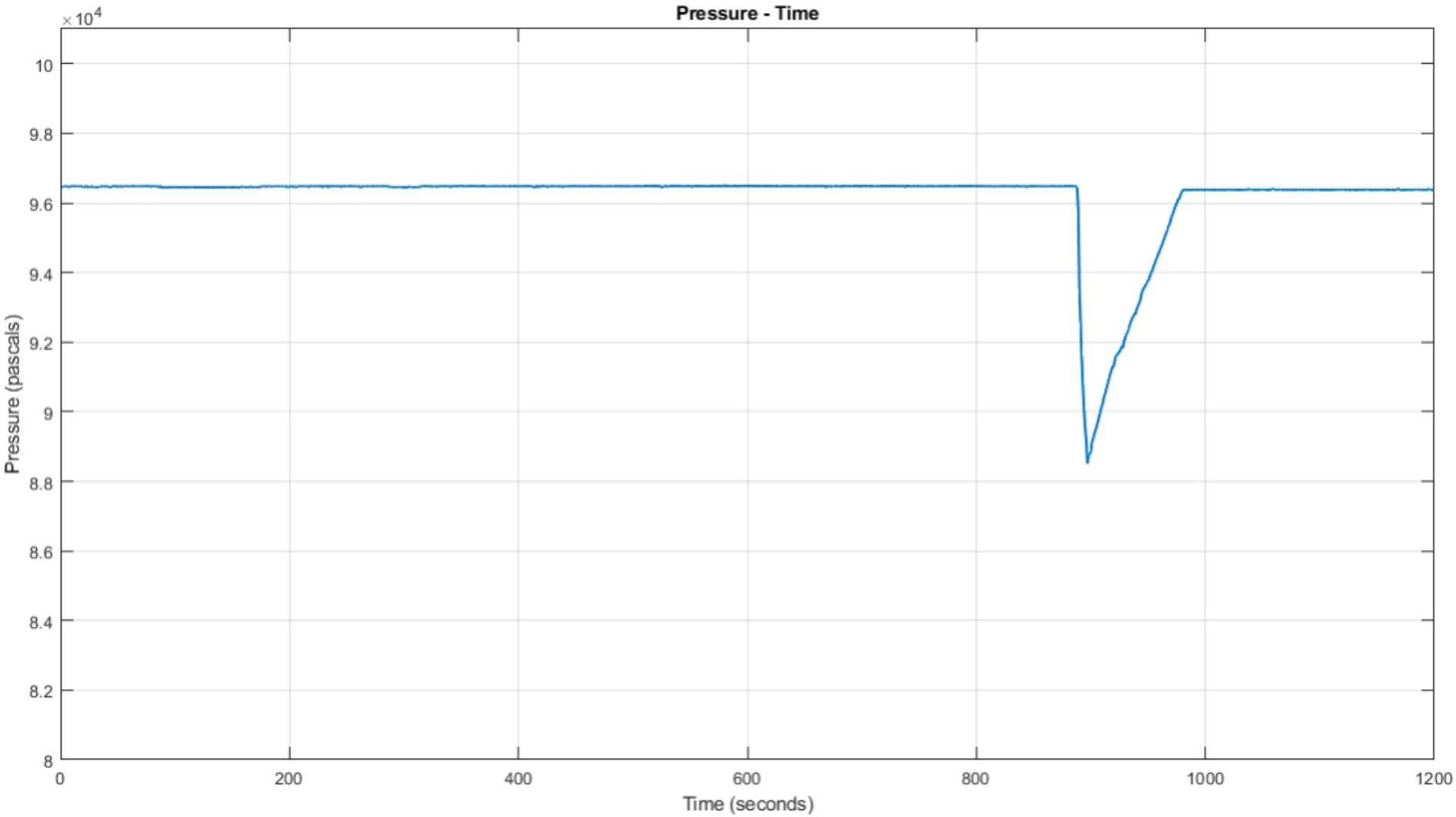
PLANNED	ACTUAL	
	Succesful	Unsuccesful
Put the CanSat inside the rocket properly.	Accomplished	
Starting telemetry before launch.	Accomplished	
Send calibration command from ground station to Payload.	Accomplished	
Deployment from rocket.	Accomplished	
Parachute open after deployment from the rocket.	Accomplished	
Payload separation and blades deployment at 450 meters.	Accomplished	
Continuous telemetry transfer during flight.	Accomplished	
Capturing the descent after Payload Separation.	Accomplished	
Buzzers worked when payload and container landed in order to ensure easier recovery.	Accomplished	
Recovery.	Accomplished	
Protecting the integrity of payload and container after landing.	Accomplished	
Descent rates of container and payload meet mission req.	Partial	

Flight Data Analysis

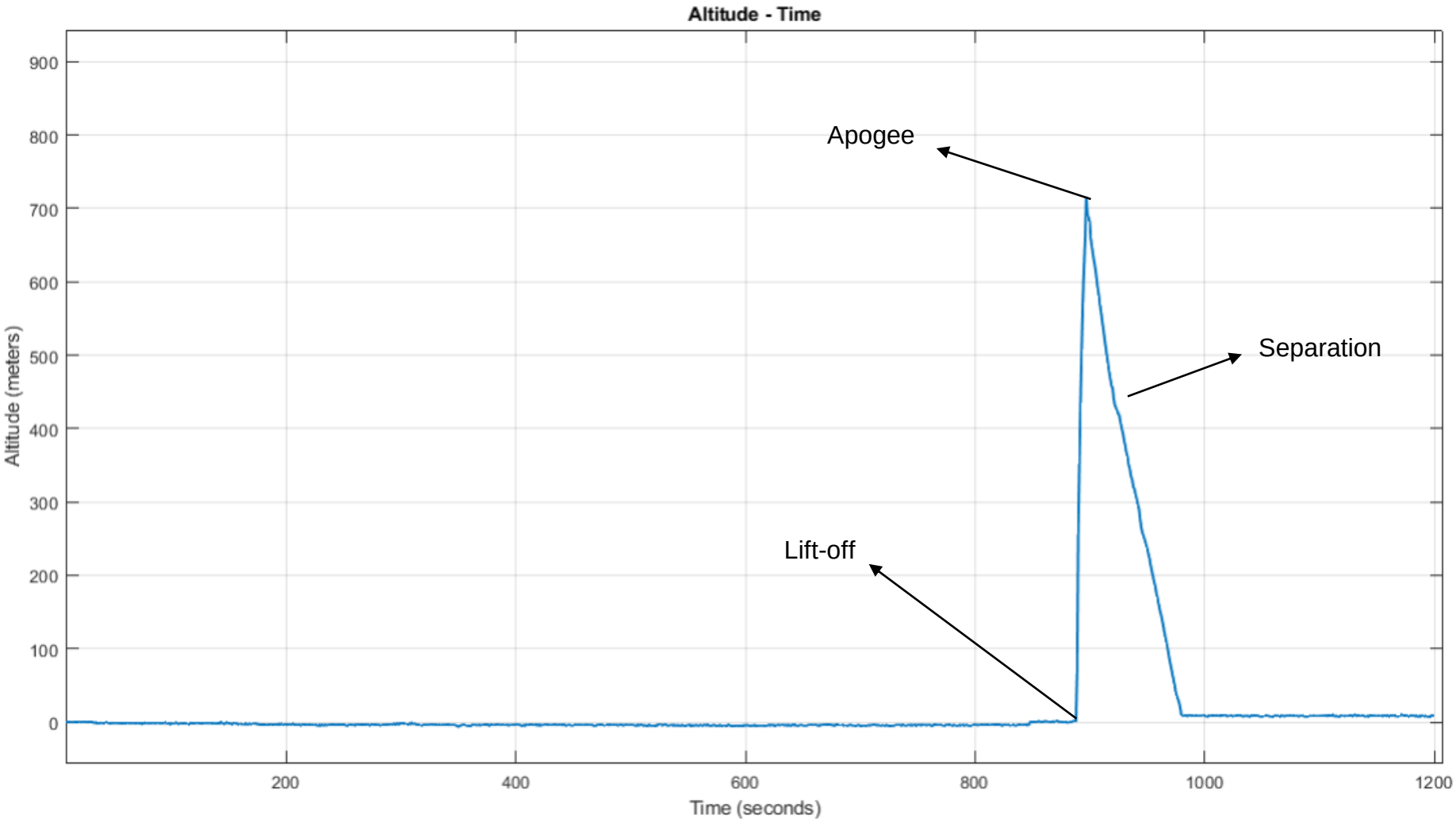
Container Separation Altitude Plot



Payload Pressure Sensor Data Plot



Payload Altitude Plot



Payload Separation Altitude

Flight_6203 - Excel

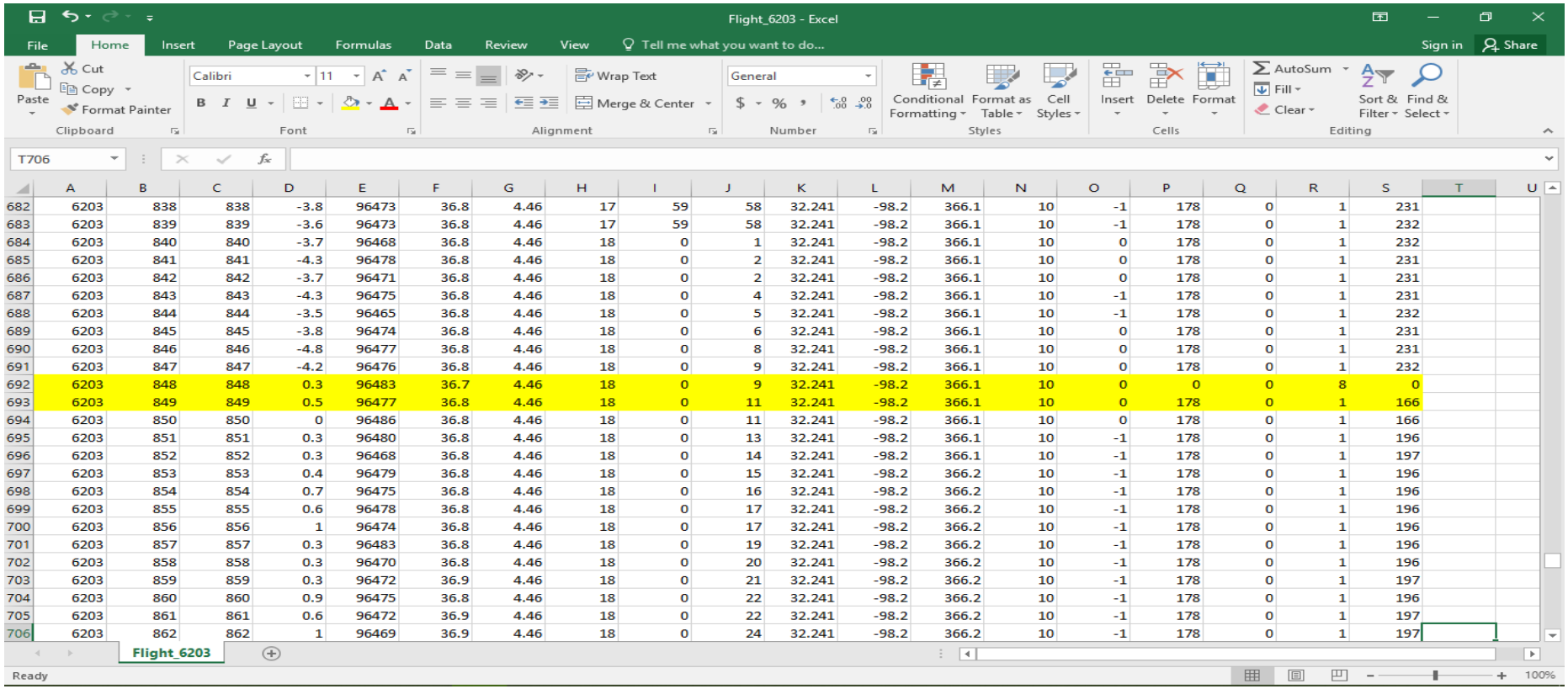
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
752	6203	909	909	567.8	90093	35.3	4.45	18	1	14	32.243	-98.202	473.8	9	27	13	0	4	171
753	6203	910	910	557.9	90199	35.2	4.45	18	1	15	32.241	-98.2	414.1	10	-35	-34	0	4	131
754	6203	911	911	545.1	90342	35.1	4.46	18	1	16	32.241	-98.2	416.1	10	59	36	0	4	181
755	6203	912	912	533.9	90471	35	4.46	18	1	16	32.241	-98.2	416.1	10	-23	-20	0	4	356
756	6203	913	913	521.3	90591	34.8	4.46	18	1	18	32.242	-98.2	418.1	11	29	-62	0	4	181
757	6203	914	914	510.2	90727	34.7	4.46	18	1	18	32.242	-98.2	418.1	11	53	23	0	4	200
758	6203	915	915	498.3	90841	34.6	4.43	18	1	20	32.242	-98.2	420.9	11	47	-52	0	4	299
759	6203	916	916	487.3	90986	34.5	4.46	18	1	21	32.242	-98.2	421.3	11	14	8	0	4	73
760	6203	917	917	477.4	91093	34.4	4.46	18	1	21	32.242	-98.2	421.3	11	13	17	0	4	137
761	6203	918	918	467.4	91196	34.4	4.45	18	1	23	32.242	-98.2	422.5	11	13	-40	0	5	10
762	6203	919	919	458.3	91287	34.3	4.42	18	1	23	32.242	-98.2	422.5	11	49	-65	0	5	10
763	6203	920	920	455.3	91327	34.1	4.44	18	1	25	32.242	-98.199	424.5	11	-66	-155	180	8	13
764	6203	921	921	439.4	91500	33.5	4.45	18	1	26	32.242	-98.199	424.9	10	-35	36	120	5	7
765	6203	922	922	431.3	91597	33.1	4.33	18	1	28	32.243	-98.199	423.5	11	16	-1	480	5	19
766	6203	923	923	427.4	91643	33.2	4.44	18	1	28	32.243	-98.199	423.5	11	6	0	780	5	3
767	6203	924	924	423.5	91685	33.1	4.44	18	1	30	32.243	-98.199	424.6	10	14	10	720	5	11
768	6203	925	925	419.6	91729	33.1	4.44	18	1	31	32.243	-98.199	425	11	-38	-22	720	5	9
769	6203	926	926	416.5	91789	32.8	4.35	18	1	31	32.243	-98.199	425	11	-34	-15	600	5	9
770	6203	927	927	406.9	91885	32.5	4.44	18	1	33	32.243	-98.199	423	11	-40	3	480	5	0
771	6203	928	928	399.8	91833	31.5	4.44	18	1	33	32.243	-98.199	423	11	41	-35	540	5	15
772	6203	929	929	393.2	92029	31.9	4.4	18	1	35	32.244	-98.199	418.7	11	35	-25	420	5	9
773	6203	930	930	383.3	92110	31.7	4.44	18	1	36	32.244	-98.199	415.4	11	44	7	480	5	16
774	6203	931	931	375.4	92222	31.5	4.44	18	1	36	32.244	-98.199	415.4	11	-29	-42	480	5	6
775	6203	932	932	367	92294	31.3	4.44	18	1	38	32.244	-98.199	412.8	11	34	-6	420	6	3
776	6203	933	933	361.1	92378	31.1	4.41	18	1	39	32.244	-98.199	410.1	11	6	76	480	6	0

- Column D shown the *"Altitude".*
- Column R shown the *"Software State".*

At software state 5 - Separation - the release mechanism is activated.

At the altitude **455.3** meters, the separation occurs and the auto-gyro mechanism starts to operate.

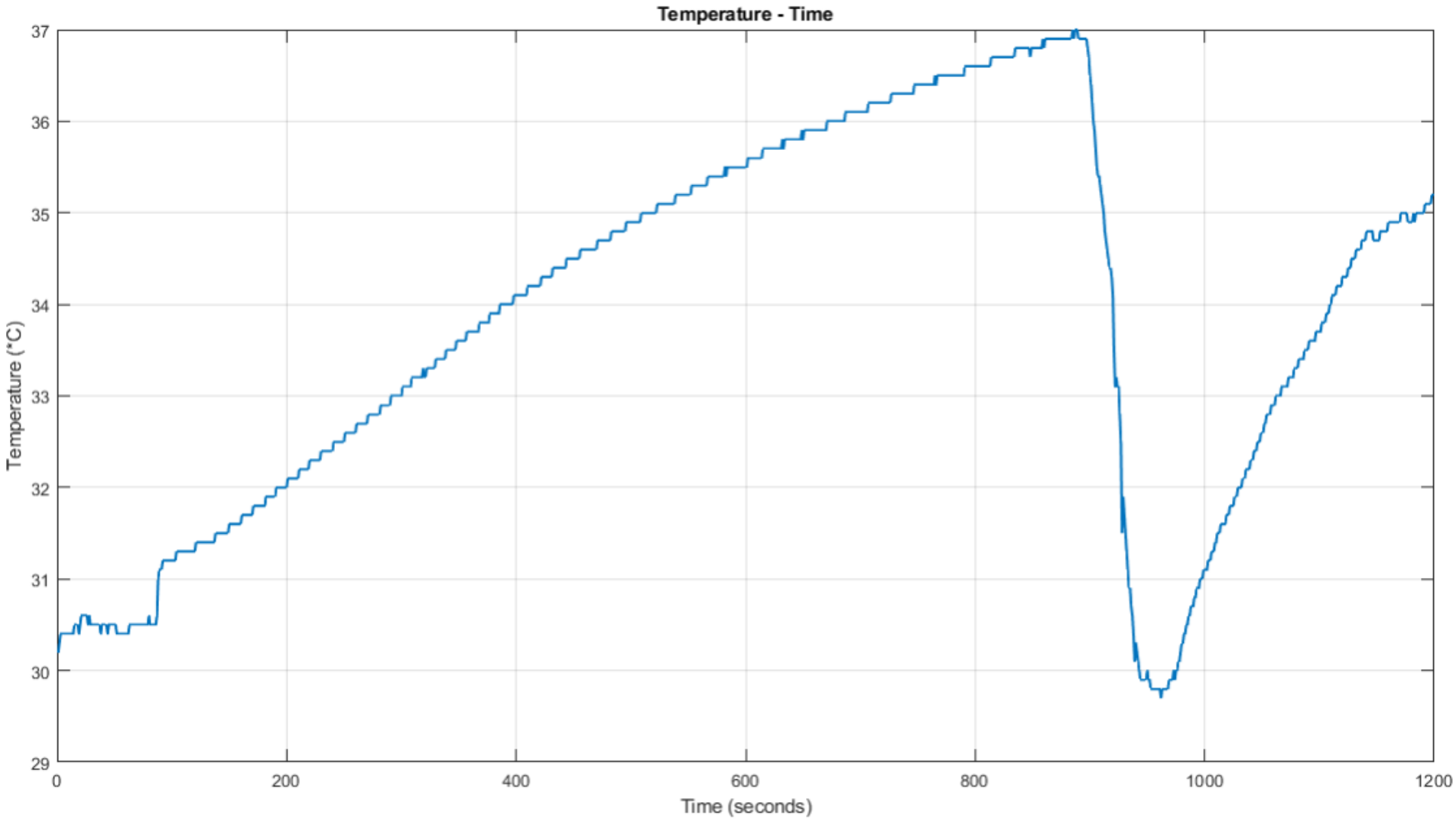
Payload Calibration Command



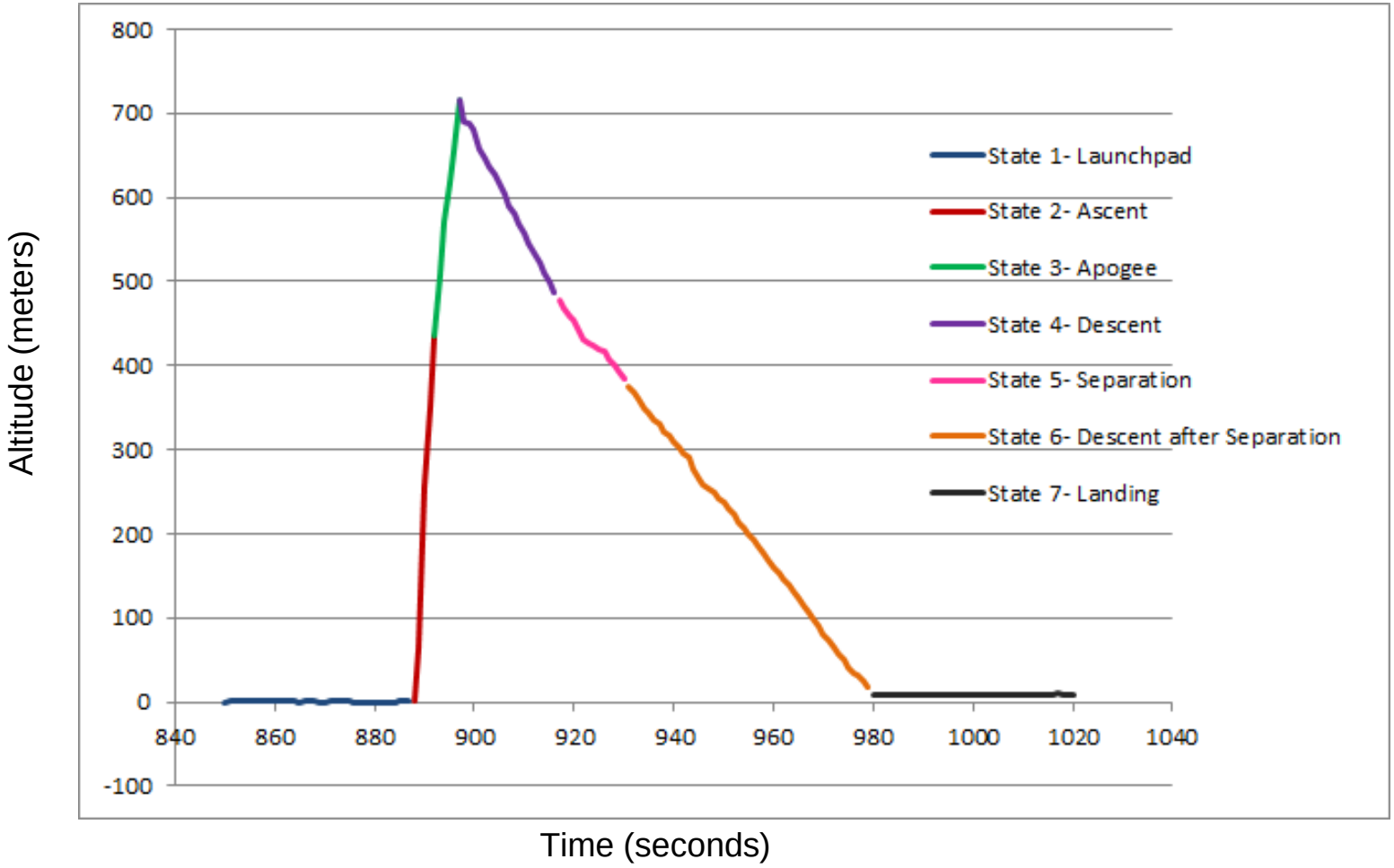
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
682	6203	838	838	-3.8	96473	36.8	4.46	17	59	58	32.241	-98.2	366.1	10	-1	178	0	1	231		
683	6203	839	839	-3.6	96473	36.8	4.46	17	59	58	32.241	-98.2	366.1	10	-1	178	0	1	232		
684	6203	840	840	-3.7	96468	36.8	4.46	18	0	1	32.241	-98.2	366.1	10	0	178	0	1	232		
685	6203	841	841	-4.3	96478	36.8	4.46	18	0	2	32.241	-98.2	366.1	10	0	178	0	1	231		
686	6203	842	842	-3.7	96471	36.8	4.46	18	0	2	32.241	-98.2	366.1	10	0	178	0	1	231		
687	6203	843	843	-4.3	96475	36.8	4.46	18	0	4	32.241	-98.2	366.1	10	-1	178	0	1	231		
688	6203	844	844	-3.5	96465	36.8	4.46	18	0	5	32.241	-98.2	366.1	10	-1	178	0	1	232		
689	6203	845	845	-3.8	96474	36.8	4.46	18	0	6	32.241	-98.2	366.1	10	0	178	0	1	231		
690	6203	846	846	-4.8	96477	36.8	4.46	18	0	8	32.241	-98.2	366.1	10	0	178	0	1	231		
691	6203	847	847	-4.2	96476	36.8	4.46	18	0	9	32.241	-98.2	366.1	10	0	178	0	1	232		
692	6203	848	848	0.3	96483	36.7	4.46	18	0	9	32.241	-98.2	366.1	10	0	0	0	8	0		
693	6203	849	849	0.5	96477	36.8	4.46	18	0	11	32.241	-98.2	366.1	10	0	178	0	1	166		
694	6203	850	850	0	96486	36.8	4.46	18	0	11	32.241	-98.2	366.1	10	0	178	0	1	166		
695	6203	851	851	0.3	96480	36.8	4.46	18	0	13	32.241	-98.2	366.1	10	-1	178	0	1	196		
696	6203	852	852	0.3	96468	36.8	4.46	18	0	14	32.241	-98.2	366.1	10	-1	178	0	1	197		
697	6203	853	853	0.4	96479	36.8	4.46	18	0	15	32.241	-98.2	366.2	10	-1	178	0	1	196		
698	6203	854	854	0.7	96475	36.8	4.46	18	0	16	32.241	-98.2	366.2	10	-1	178	0	1	196		
699	6203	855	855	0.6	96478	36.8	4.46	18	0	17	32.241	-98.2	366.2	10	-1	178	0	1	196		
700	6203	856	856	1	96474	36.8	4.46	18	0	17	32.241	-98.2	366.2	10	-1	178	0	1	196		
701	6203	857	857	0.3	96483	36.8	4.46	18	0	19	32.241	-98.2	366.2	10	-1	178	0	1	196		
702	6203	858	858	0.3	96470	36.8	4.46	18	0	20	32.241	-98.2	366.2	10	-1	178	0	1	196		
703	6203	859	859	0.3	96472	36.9	4.46	18	0	21	32.241	-98.2	366.2	10	-1	178	0	1	197		
704	6203	860	860	0.9	96475	36.8	4.46	18	0	22	32.241	-98.2	366.2	10	-1	178	0	1	196		
705	6203	861	861	0.6	96472	36.9	4.46	18	0	22	32.241	-98.2	366.2	10	-1	178	0	1	197		
706	6203	862	862	1	96469	36.9	4.46	18	0	24	32.241	-98.2	366.2	10	-1	178	0	1	197		

- Before the flight the calibration command from the ground control station is send to the payload.
- Calibration command calibrated payload to the true the magnetic north direction. *(Column “S”)*
- Altitude data of the payload is calibrated to 0 meters. *(Column “D”)*
- Roll and Pitch data are calibrated with respect to the payload. *(Roll: Column “O”; Pitch: Column “P”)*

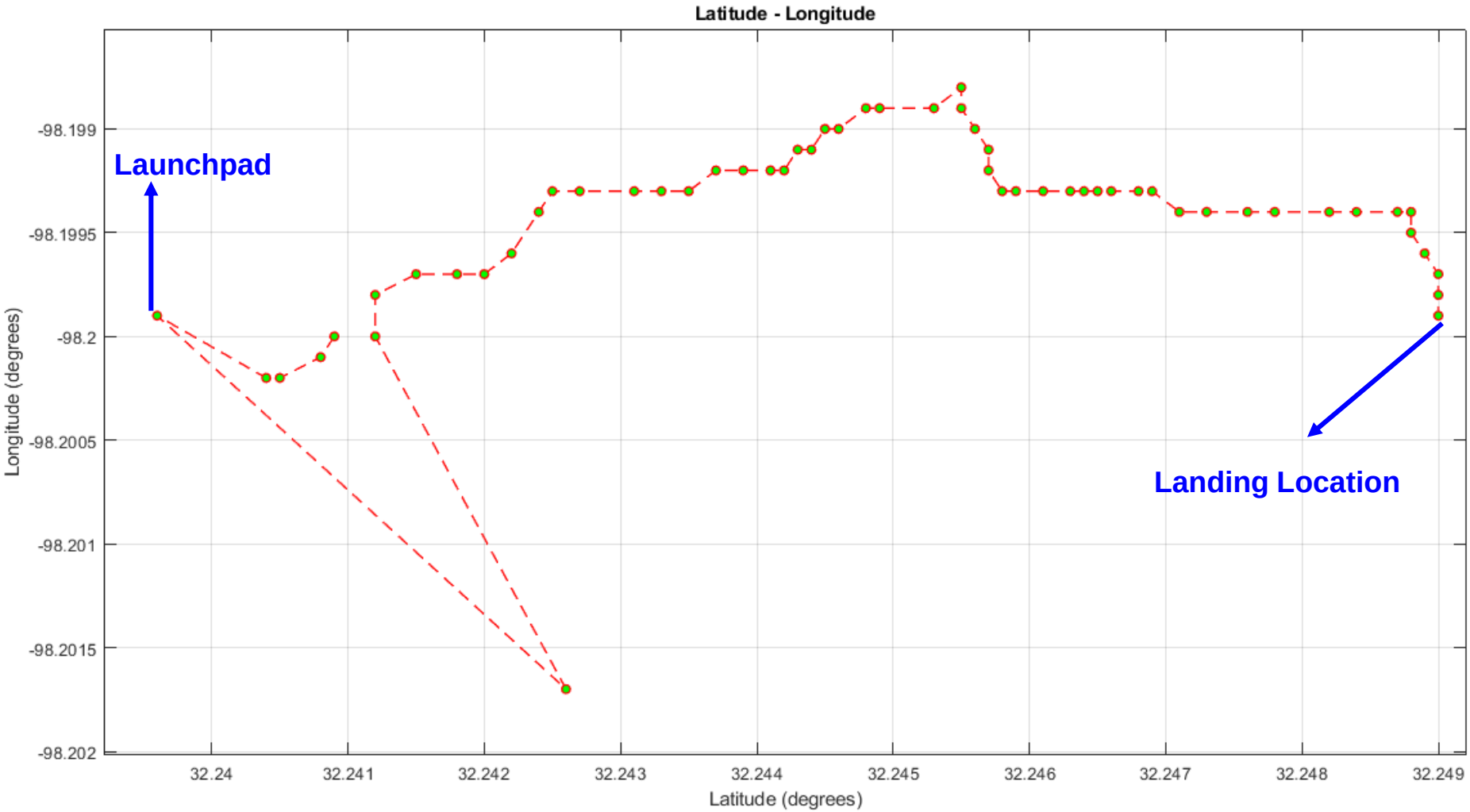
Payload Temperature Sensor Plot



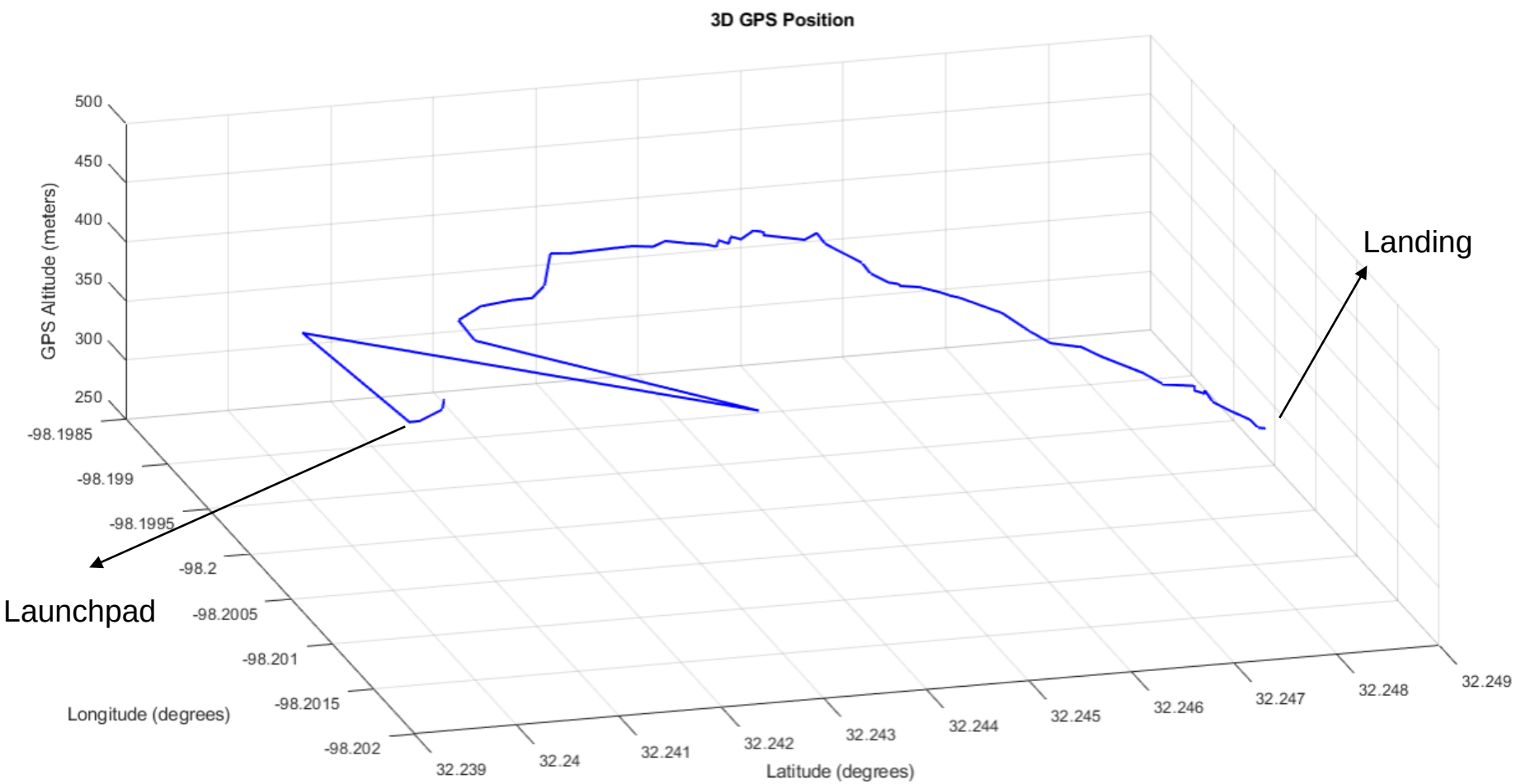
Change of Software States



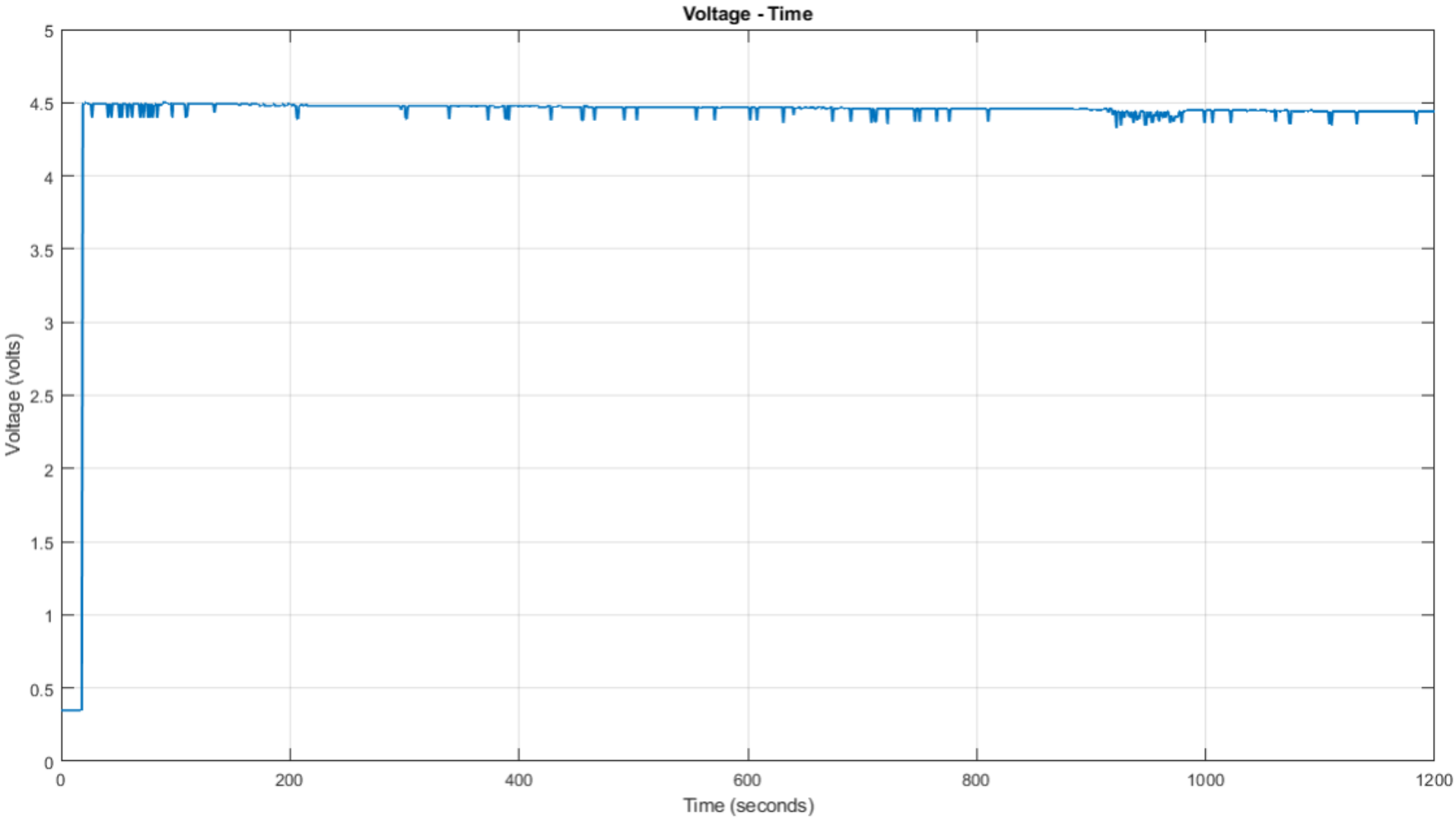
Payload 2D GPS Plot



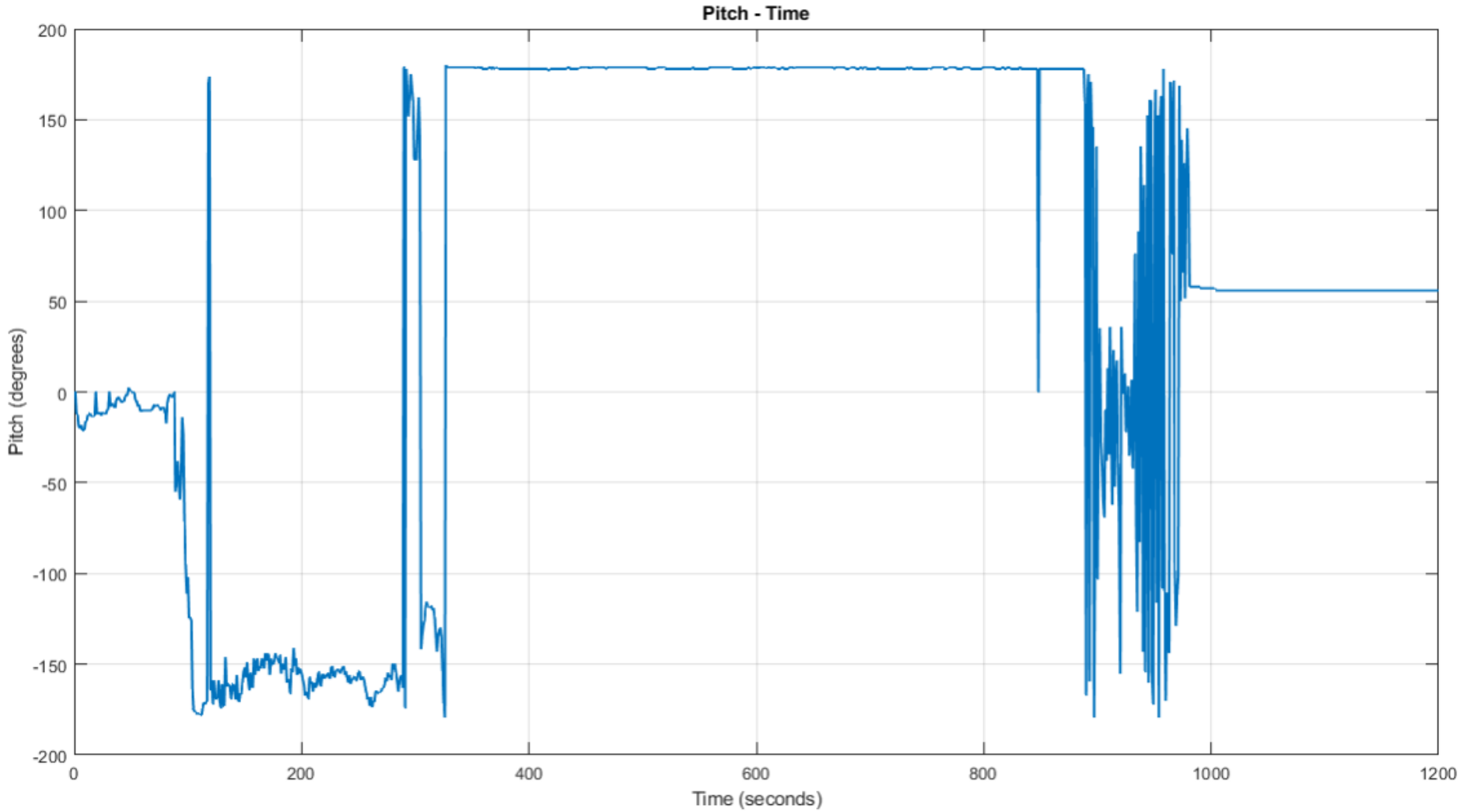
Payload 3D GPS Plot



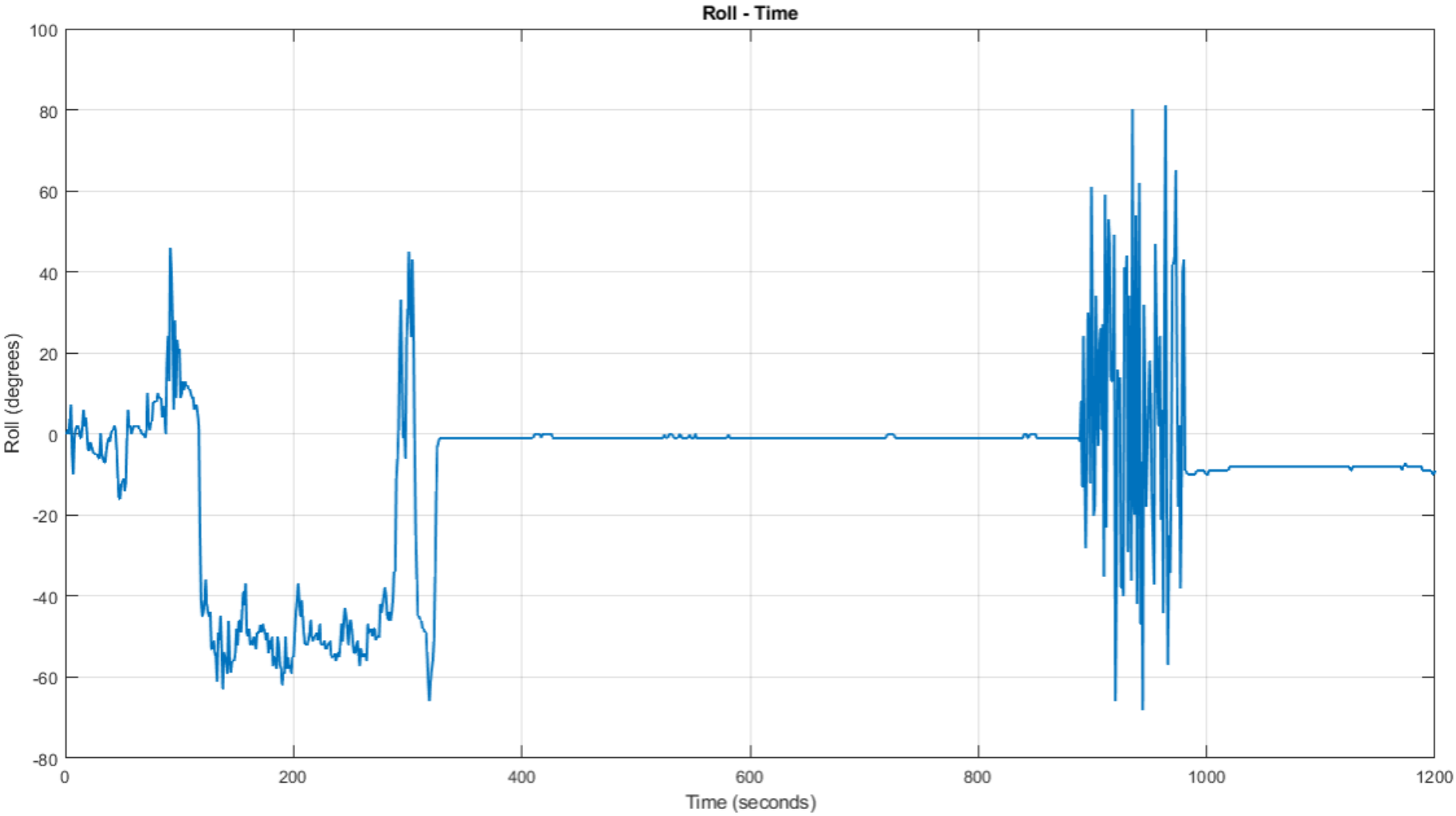
Payload Battery Power Plot



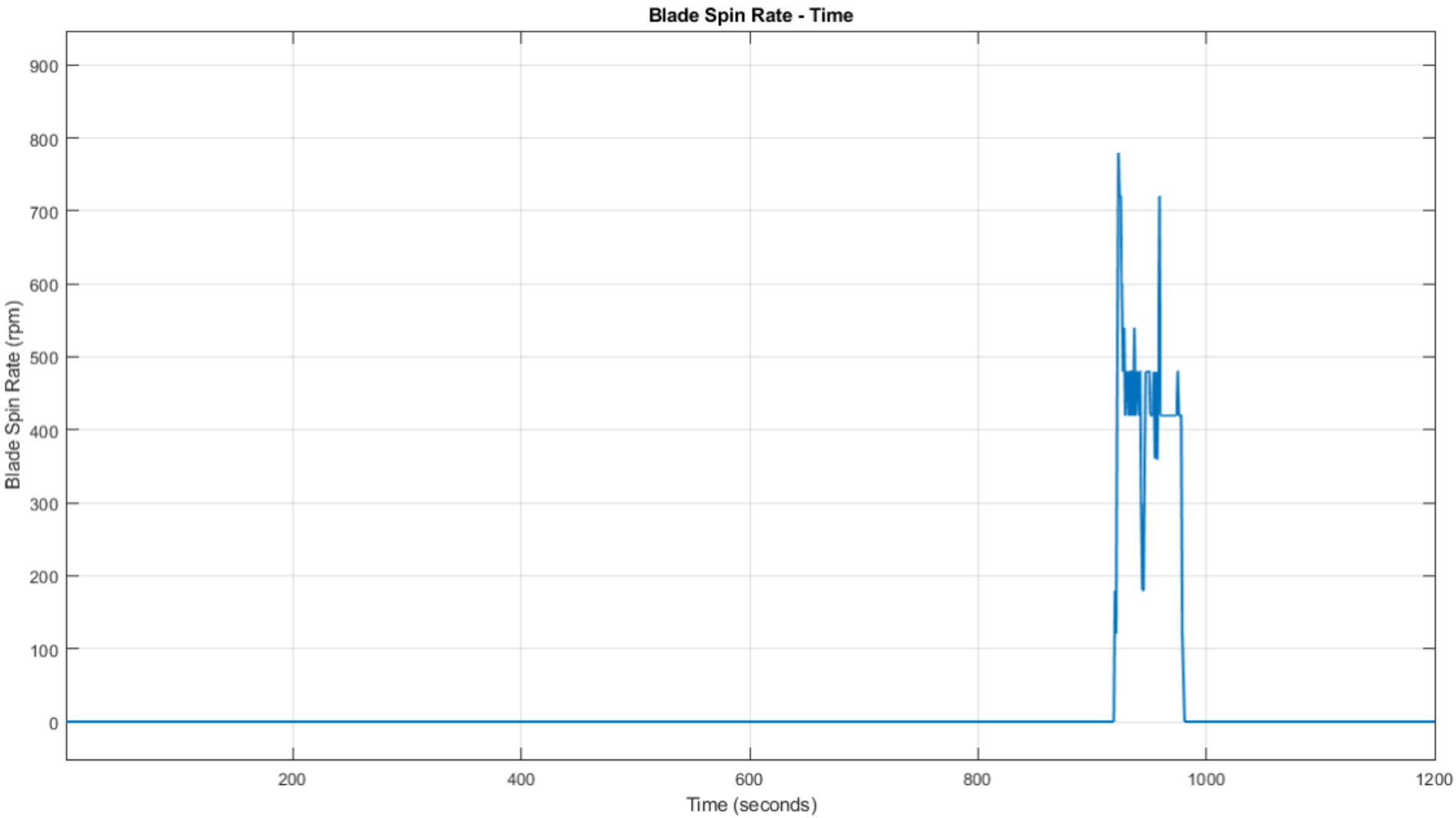
Tilt Sensor Plot (1/2)



Tilt Sensor Plot (2/2)



Auto-gyro Blade Spin Rate Plot

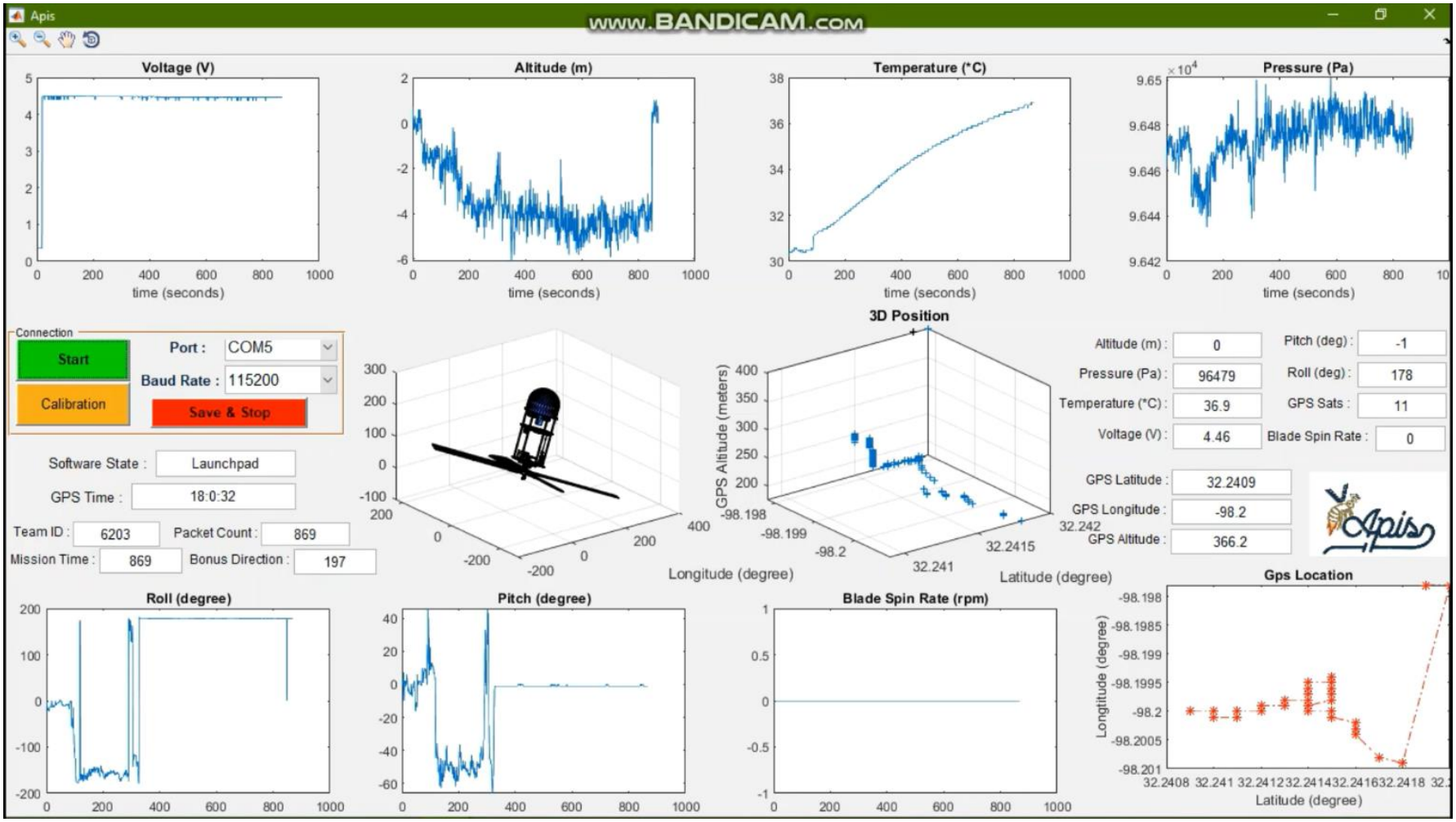


Camera Video

Video Link:

https://youtu.be/dA2NRpcGzOY

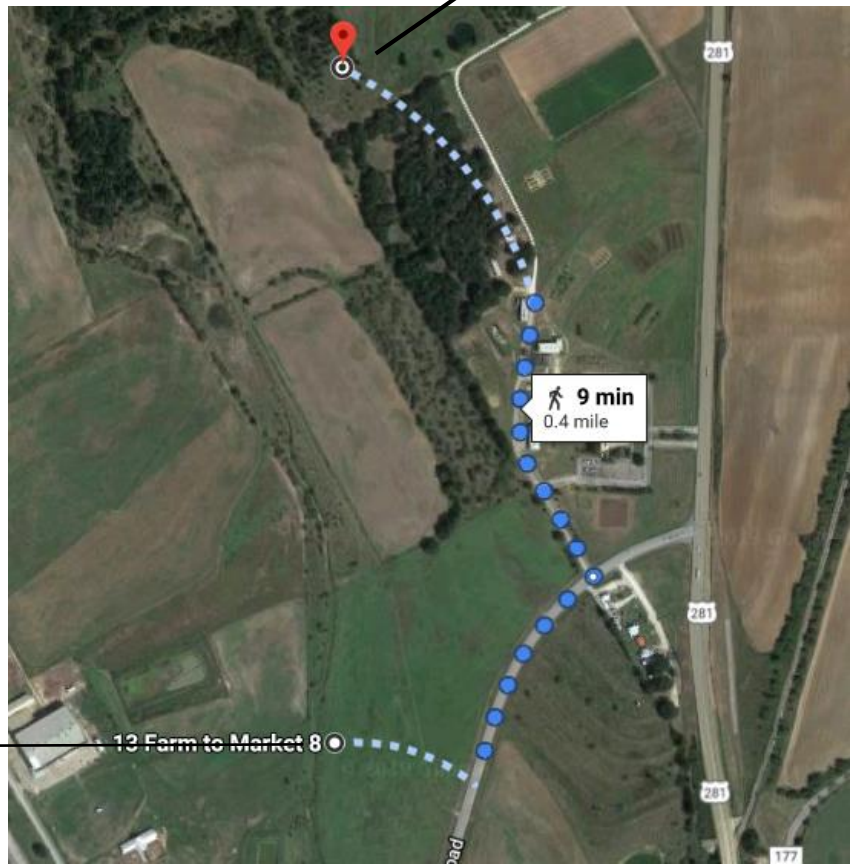
Ground Station Real Time Plots



Video Link: **https://youtu.be/sswmaIKrpN0**

Recovery

Latitude: 32.2486
Longitude: -98.1999



Latitude: 32.2409
Longitude: -98.2000

Failure Analysis

Minor Failures

Minor Failures:

➔ Descent rate of the container and payload is slightly different than the mission requirements.

Descent rate of the payload is 7.44 m/s. (Mission Req. is 10-20 m/s)

Descent rate of the container+payload is 11.48 m/s.

(Mission Req. is 15-25 m/s)

Correction Methods:

➔ Weather conditions should be considered more.

➔ Certain mass measurement should be done earlier to produce more convenient descent systems.

Lessons Learned

Discussions of what worked and what didn't

WORKED	DIDN'T WORK
No Data Lost	
Separation Mechanism	
Auto-gyro Mechanism	
Camera	
Buzzer	
Parachute	
Deployment of Rotor Blades	
Calibration Command	

Conclusions

•Considering the previous table, the mission was a major success.

•Most of the components are specifically designed according to competition purposes and withstand extreme forces of lift-off. Therefore, components worked very well.

•Electronic and mechanical requirements analyzed carefully, and the space is used efficiently with reliable and sturdy mechanism while providing flight, we managed to design and manufacture a CanSat matching all 50 requirements.