Exploring Low-Cost DIY Rockets with Flight Recording using 3D Printing and Low-Cost Sensors

Design, Launch, Data Analysis, and Lessons Learned

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1 Goals

1. The rocket should be easy and cheap to build. It should be possible to build multiple rockets of the same type and losing some of them should not hurt financially.
2. The rocket should be able to handle a variety of different motor sizes. Ideally a launch campaign would start at small altitudes and work its way up.
3. During the flight the rocket should be capable of recording as much flight data as possible and store it to be analyzed later.

2 Design

The design section is divided into three parts. The first covers the rocket's overall design, detailing its structure and components. The second explains the simulations conducted to evaluate the rocket's expected performance and stability. The final part outlines the features of the flight recorder and the key decisions made during its development.

2.1 Rocket Structure

The rocket follows a traditional hobbyist design, featuring a single motor located at the base with no active guidance system (Center, 2024). To ensure stability during flight, fins are positioned at the bottom. Additionally, since the rocket is intended for recovery, the nosecone must be detachable, triggered by the ejection charge from the motor. This requires the ejection blast to travel the full length of the rocket to the nosecone without damaging the on-board electronics responsible for recording flight data. Based on these goals, the following decisions were made regarding the design and manufacturing of the rocket:

2.1.1 The Case for 3D Printing

Due to the goals of affordability and easy of manufacturing the decision to use 3D printing to manufacture as many pieces of the rockets as possible was made. 3D printing allows anybody with access to the 3D model of the rocket to produce it nearly identical. The widespread adoption of 3D printing for hobby projects made printers as well as filament widely available, cheap to obtain and easy use. Therefore the rocket can not only be replicated with low complexity for the builder but also at a minimal cost or effort involved (Pearce & Qian, 2022). Additionally the process of 3D printing allows to easily build geometries that would usually be hard or expensive to machine or produce at small production volumes and scales (Berman, 2012, 2020). Specifically FDM 3D printing was used to build the complete Rocket structure.

Different 3D printing filaments offer different strength or density properties that might be more beneficial to use on different parts of the rocket (Bambu Lab, 2024). The most used hobbyist Filament, PLA, is an all rounder, offering good toughness, strength, stiffness, layer adhesion and ease of printing for a low price per kilogram. For this reason, PLA was chosen as the default material for most parts of the rocket that aren't subjected to high forces or extreme temperatures.

The option of printing certain components in more expensive, ultra-lightweight filaments like ASA Aero (ASA infused with a temperature-activated foaming agent) was considered. However, this approach was ultimately set aside due to the reduced strength and increased printing complexity, which limits the ability to create intricate designs to some extent.

2.1.2 Selected Materials

There are 2 parts on the rocket that required further consideration before selecting the filament:

1. The fins of a rocket are often quite thin and stick out of the rocket body often making contact first when impacting during soft landings or transportation. Therefore requiring a higher impact resistance.
2. The parts coming into contact with the rocket motor will heat up more and should be made out of a material capable of handling higher temperatures than PLA.

Therefore these 2 parts were printed together in PA6-CF which features both a high impact and temperature resistance. The other parts of the rocket were all printed in cheap, easy to use PLA.

Figure 1: Rocket components and assembly

2.1.3 Parts

The rocket consists of 6 components.

The fins and motor assembly is split in two halves and screws into the white flight computer assembly. This allows mounting motors of different sizes by using various sized adapter before closing the motor assembly and screwing it in.

The red tube is just a cover with holders for the launch rods as well as openings for LEDs and sensors. The detachable nosecone is placed on top of the tube. A small thin disk is placed on top of the flight recorder to create a small parachute compartment. On top of the parachute compartment a nose cone is placed loosely.

The flight computer assembly is built around a hollow tube that starts at the motor assembly. This directs the blast upwards to the parachute compartment. The blast will push the parachute against the nose cone, separating it from the rocket and opening up the parachute.

2.2 Performance & Stability Simulations

The whole rocket with all parts and weights was replicated in OpenRocket to predict the stability and flight characteristics. Later on the actual data will be compared with the simulated data.

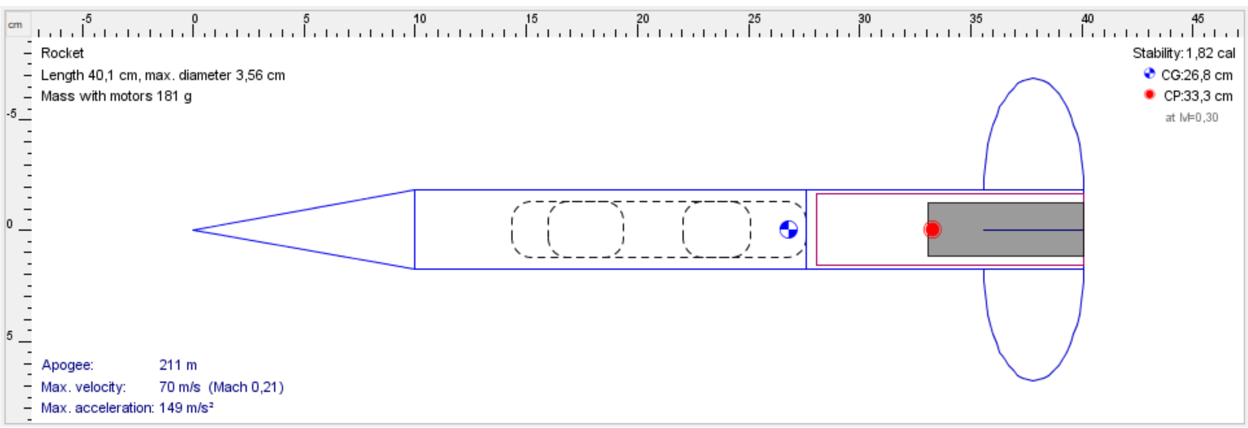

Figure 2: Simulated rocket

2.3 Flight Recording System

The goal of the flight recording system was to cheaply record as much data as possible. The heart of the system was a Lolin32. The WiFi capability allowed connecting to the flight recording system on the launch pad to ensure that all sensors were working. Additionally it supports charging and using a small 3.7v LiPo battery which was used to power the rocket during flight.

To store the recorded data a cheap SPI micro SD module was used.

3 types of sensors were added to the flight recording system. All of them are widely available and cheap making them ideal to build multiple flight recorders in the future without being afraid of losing some.

1. For measuring barometric pressure the BMP388 was chosen. This sensor should be able to provide the most accurate altitude data.
2. To measure the rockets acceleration and orientation the MPU6050 was chosen as an IMU.
3. In order to get the precise location of the rocket above the ground the BE-220 was used as a GPS. The GPS was also re-programmed to allow for a higher data rate.

3 Launch

In this chapter I will first analyse the launch based on the data the various sensors recorded. Following that I will compare the actual measurements with the result of the simulation. This chapter concludes with a failure analysis that summarizes all encountered issues and investigates their root causes, aiming to prevent similar and related failures in the future.

The launch was conducted with a D12-5 motor.

3.1 Data Analysis

The data analysis will first take a look at each sensors individual measurement. At the end the data of multiple sensors will be combined to get a more comprehensive understanding of the flight and to compare performance as well as accuracy of sensors.

3.1.1 Pressure Sensor

The primary function of the barometric pressure sensor is to measure the rocket's altitude throughout its flight. With an accuracy of approximately ±8 Pa, it can determine altitude to within ±0.5 m (Gravity, 2020). Since each point in the following figure represents the difference between the initial ground measurement and the reading at that specific moment, the cumulative accuracy adjusts to about ±1m — still providing a very reliable measurement. Additionally locally weighted scatterplot smoothing (LOWESS) has been used to plot an additional curve that is less susceptible to the minor variations in the sensors measurements.

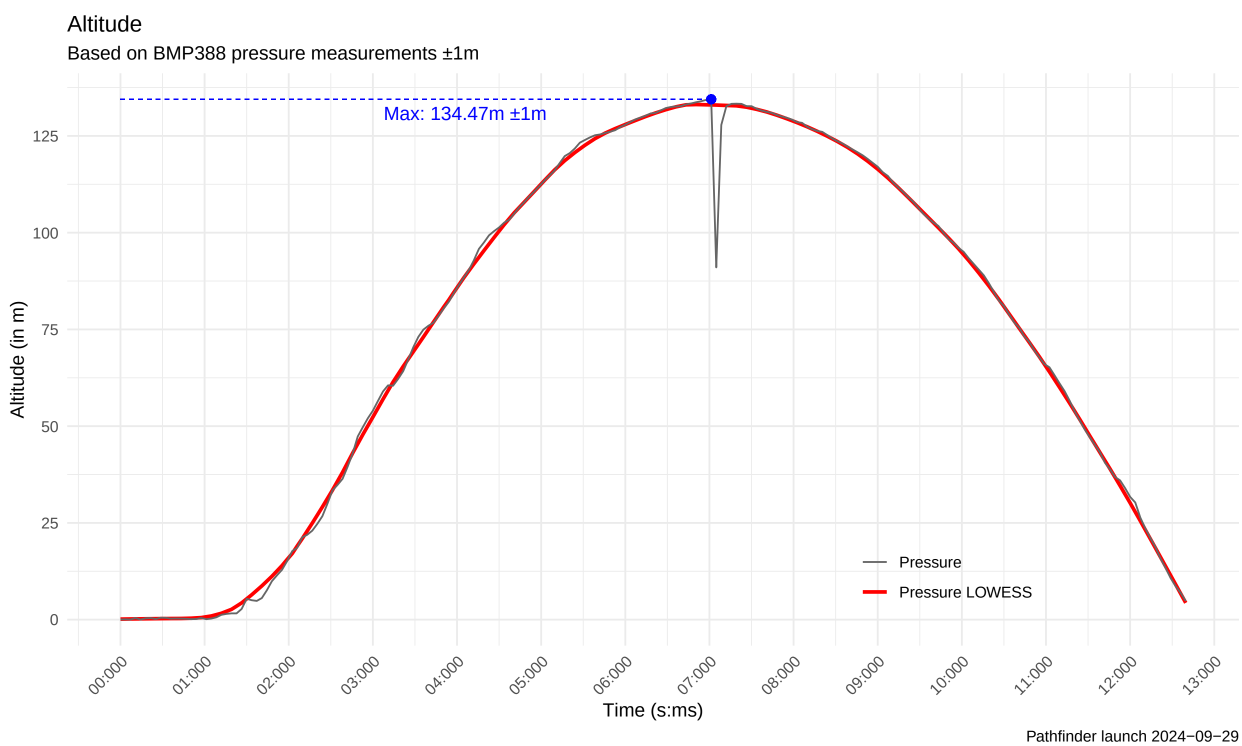

Figure 3: Altitude as measured by the barometric pressure sensor

The data shows a steep ascent between 1:00 and 2:00 followed by a slow increase until the peak of 134.47m is reached at 7:00. At this point all upwards velocity is lost due to gravity and friction. Gravity now continues to accelerate the rocket towards the ground again. Since the rocket moves faster and faster towards the ground it becomes apparent that the parachute system failed. The ejection charge was supposed to release the parachute at roughly 8:00 but the nose did not manage to seperate causing the rocket to impact the ground without slowing down.

The sudden drop shortly after the peak is reached (or perhaps covering the timeframe where the peak was really reached) is quite interesting to see. It's difficult to determine whether this dip is due to measurement error occurring coincidentally at this time, or if the rocket encountered a unique pressure phenomenon at its peak Additional flights might bring more insight if this is merely a correlation or if this is actually caused be the rocket reaching its peak. Perhaps future flights might also profit from redundant sensors.

Using the altitude data, the gradient of altitude can be calculated to determine the rocket's vertical speed. While the barometric pressure recorded by the sensor might look smooth at a first glance it becomes apparent that the minimal variations in the sensors measurements result in huge spikes when calculating the gradient. Calculating the gradient of the altitiude LOWESS yields a lot better and cleaner results that should still be very accurate since it only reduces the variation and doesnt alter the curves trajectory. This graph shows that the maximum vertical speed was around 40 m/s.

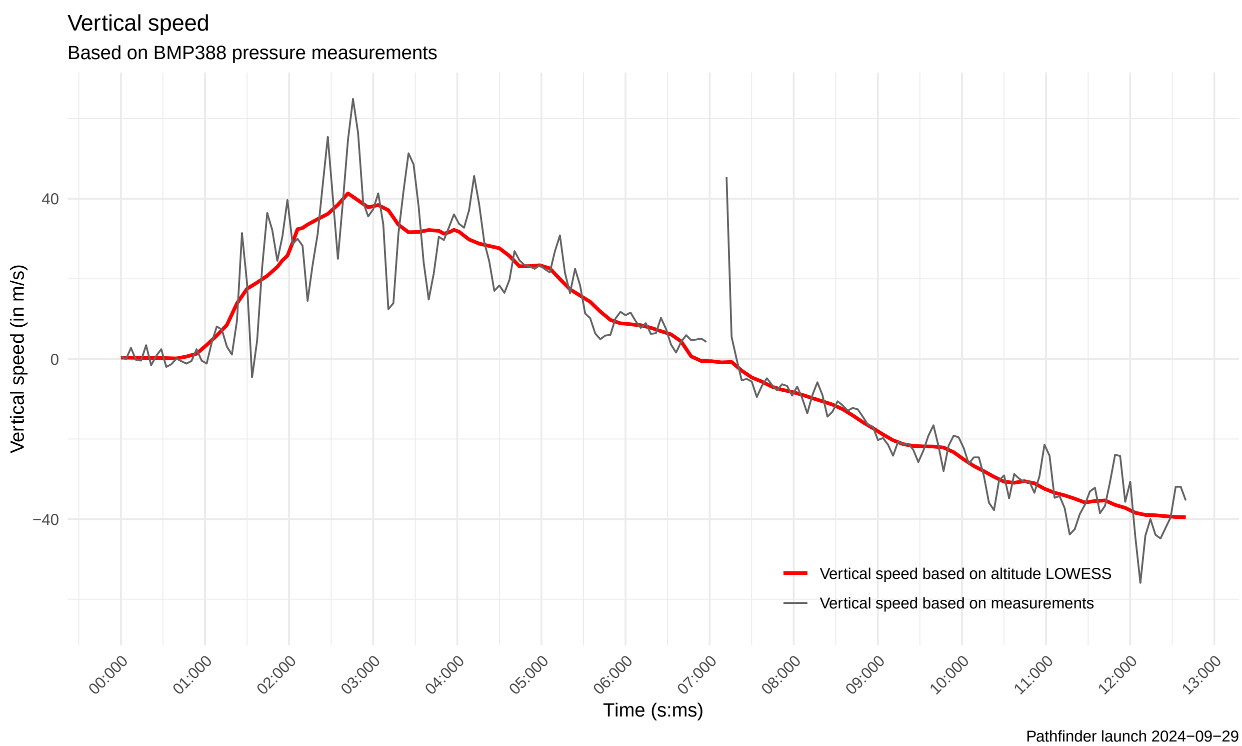

Figure 4: Vertical Speed as measured by the barometric pressure sensor

Trying to calculate a gradient from either of the calculated vertical speeds yielded no usable results. In this case even the variations of the LOWESS are to significant to produce usable data. Perhaps calculating another LOWESS based on the Vertical speed LOWESS might produce nicer looking results but it is questionable how accurate those would still be.

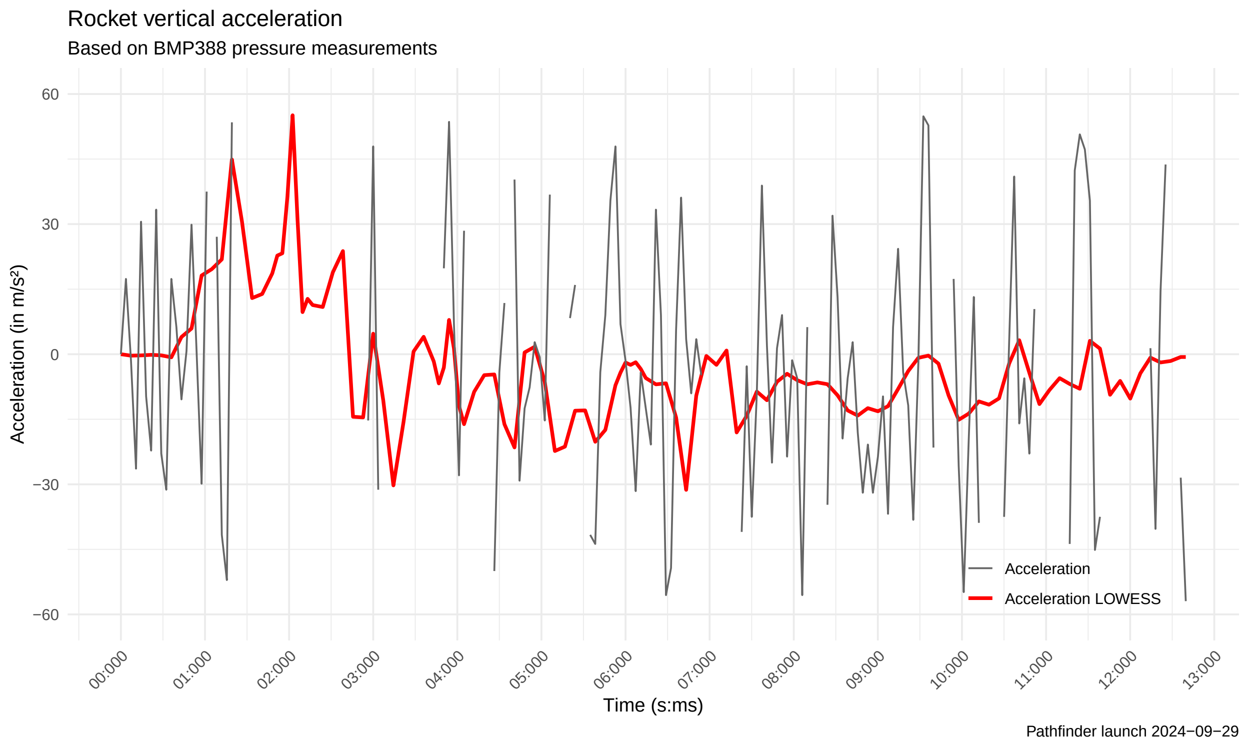

Figure 5: Vertical Acceleration as measured by the barometric pressure sensor

The barometric pressure sensor is the perfect sensor for determining the altitude during the flight accurately. The high velocity of the rocket does not seem to have decreased the quality of measurements except perhaps the sudden decrease and increase shortly after or during the peak of the rocket. Variations in the individual measurements make it hard to calculate a gradient but using local regression it is possible to still determine the speed of the rocket during the launch. The variations seem to be to high to calculate the acceleration of the rocket though which is a bummer since it would have been interesting to compare the vertical acceleration measured by the pressure sensor and the accelerometer.

3.1.2 Accelerometer

The accelerometer recorded the acceleration of the rocket in 3 axis during the launch. The most interesting axis is the vertical axis labeled with Y in the graphic below. As expected the vertical acceleration matches the thrust curve of a D12-5 engine in shape and duration (Estes, 2023) confirming the validity of measurements to some degree.

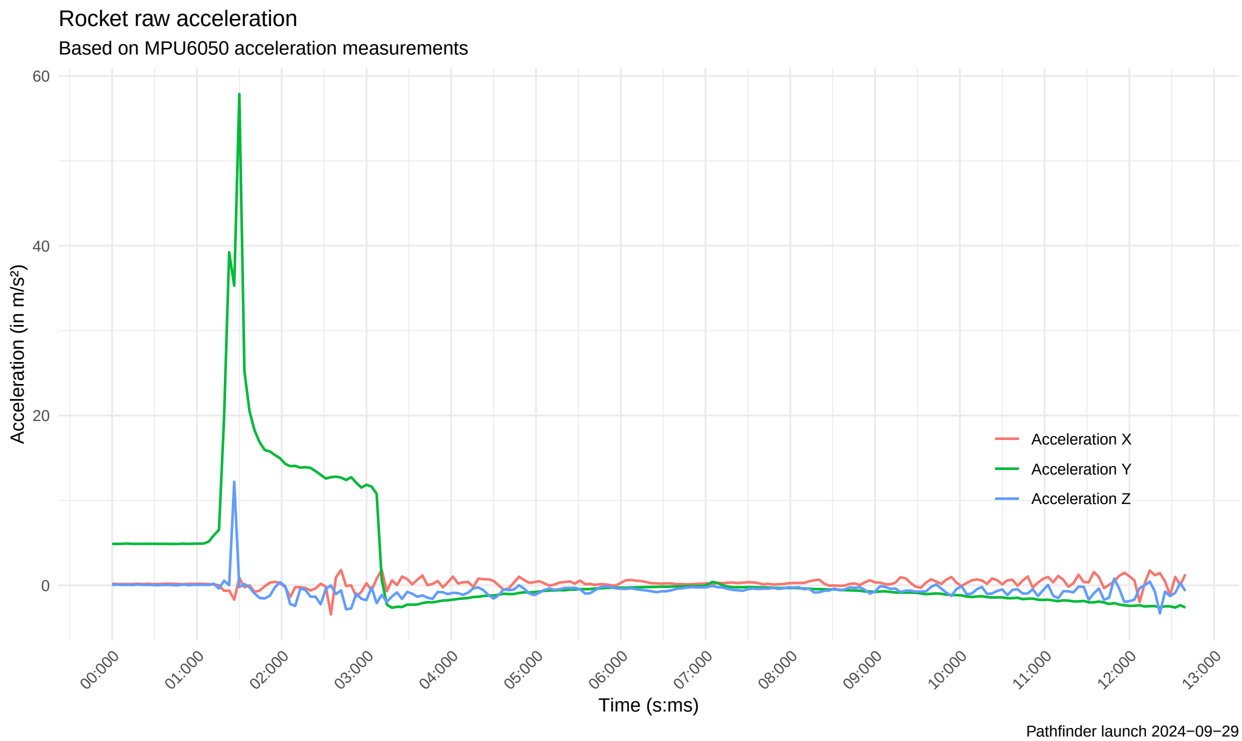

Figure 6: Raw Acceleration as measured by the Accelerometer

While the general shape of the thrust might look okay and follow expectations a closer inspection shows that the accelerometer data is actually flawed. During the period on the ground before lift-off there should have been a force of roughly 9.81 m/s^2 representing gravity. Instead the total acceleration on all axis before liftoff was only 4.87-4.91m/s^2. This seems to be pretty exactly half of the expected acceleration hinting at a scaling issue in either the library or the accelerometers scale factor that is calibrated at the factory. Simply multiplying measured values by two yielded unsatisfactory results and it is very likely that poor understanding and integration of this sensor ahead of flight made the data unusable.

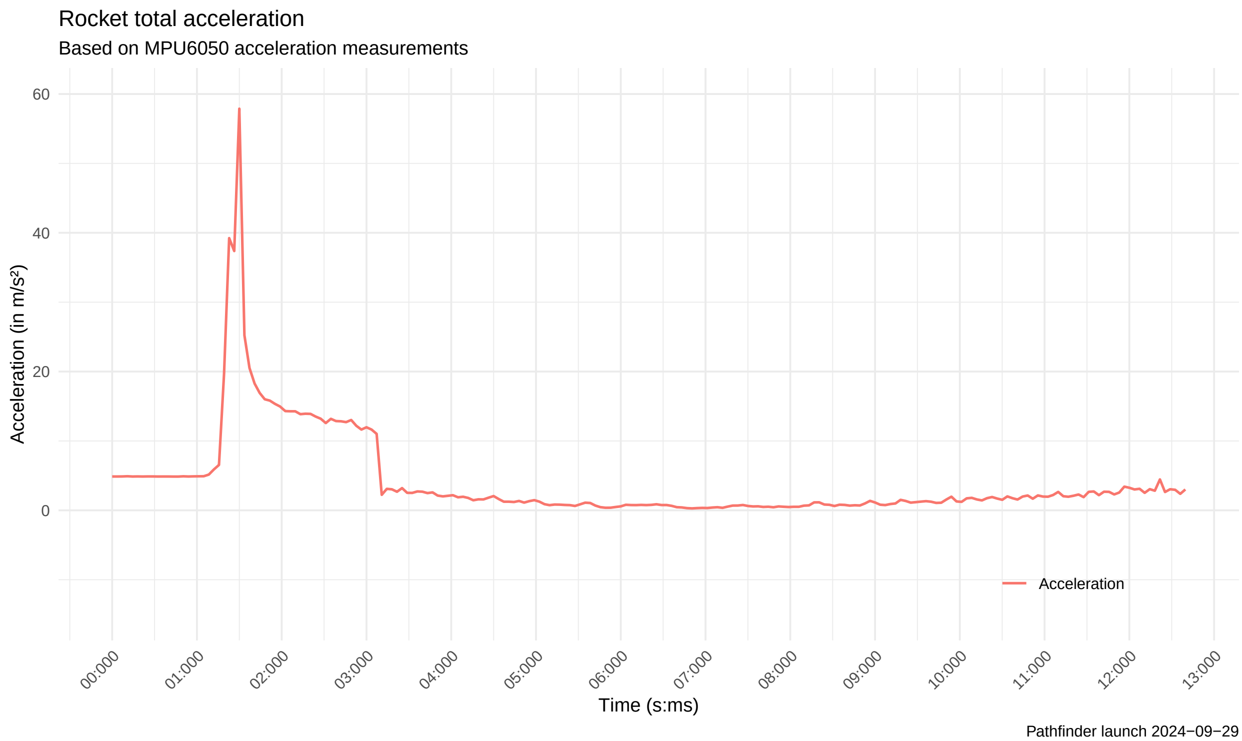

Figure 7: Total Acceleration as measured by the Accelerometer

Further flights must take a closer look at the accelerometer before launching, particularly ensuring that the expected acceleration of gravity is present before launch for the collected data to be trustworthy. Also settings like the accelerometer range and filter bandwidth as well as other settings must be better understood before taking flight. It might also make sense to compare multiple different libraries or reading the sensor directly to get all the raw data that can be processed after and not during the flight.

3.1.3 Gyroscope

The angular speed measured by the gyroscope during the flight can be seen below. It is immediatelly obvious that the rocket experienced the highest angular speed around its roll axis during the flight.

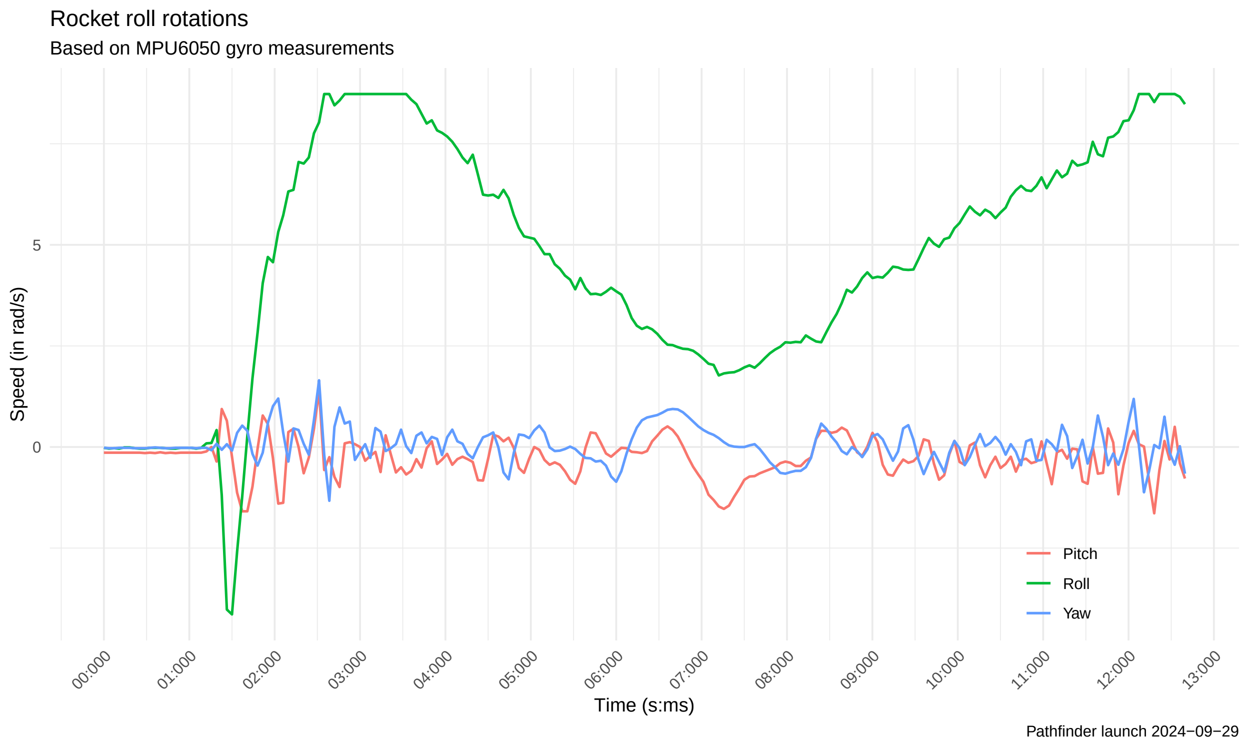

Figure 8: Rocket roll rotations during flight

As seen here the roll speed of the rocket was even greater than the limit of 500 deg/s. This limit was arbitrarily chosen before the flight and options for 1000 deg/s as well as 2000 deg/s were also available. The chart highlights that this limit was crossed in two intervals during the flight leading to the loss of data that could have been prevented with a better understanding of data ranges before the flight. It also is visible, that the highest roll speed was achieved during ascent an descent of the rocket.

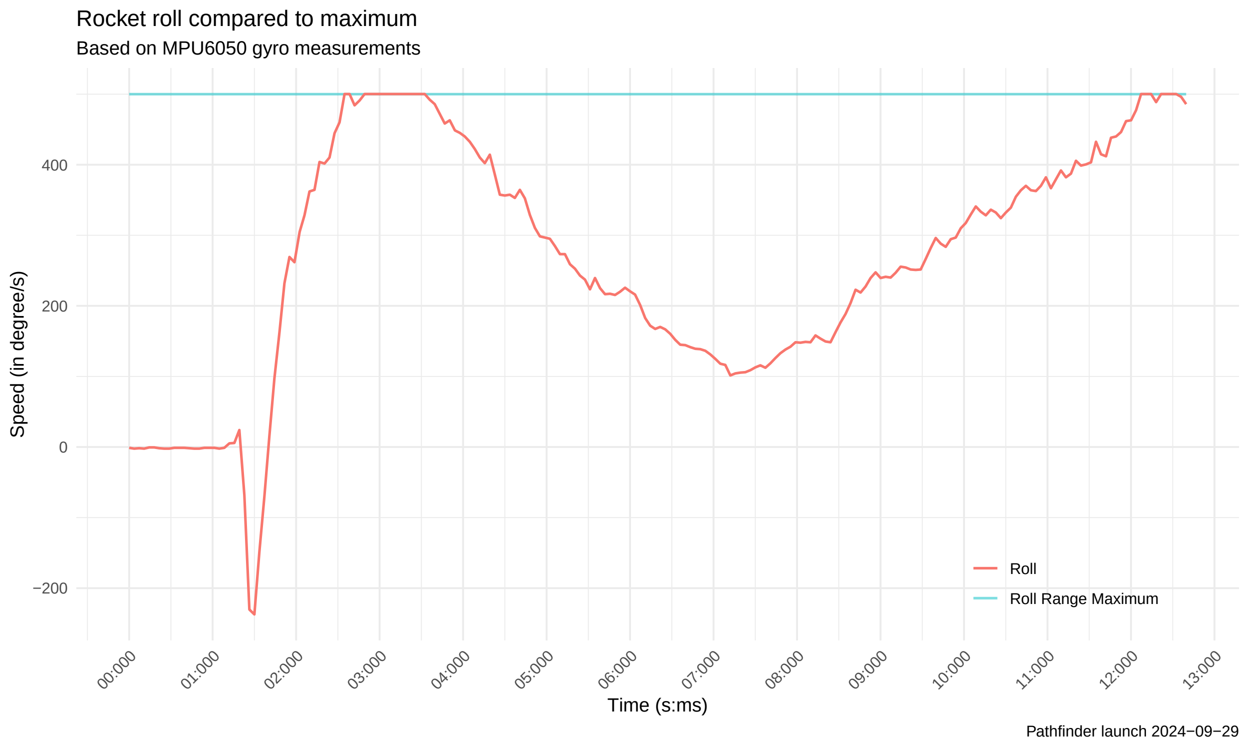

Figure 9: Measured roll compared to maximum range

Overall the roll axis speed was quite high. Calculating the total amount of rotations by integrating the speed shows that the rocket did at least 9.39 rotations in a timeframe of 11.1 seconds averaging 0.85 rotations per second. Since roll data was lost the actual amount of rotations is assumed to be even higher. This is significant because future rockets might have a camera attached to them. A high roll rate will make the recorded footage during ascent and decent unusable.

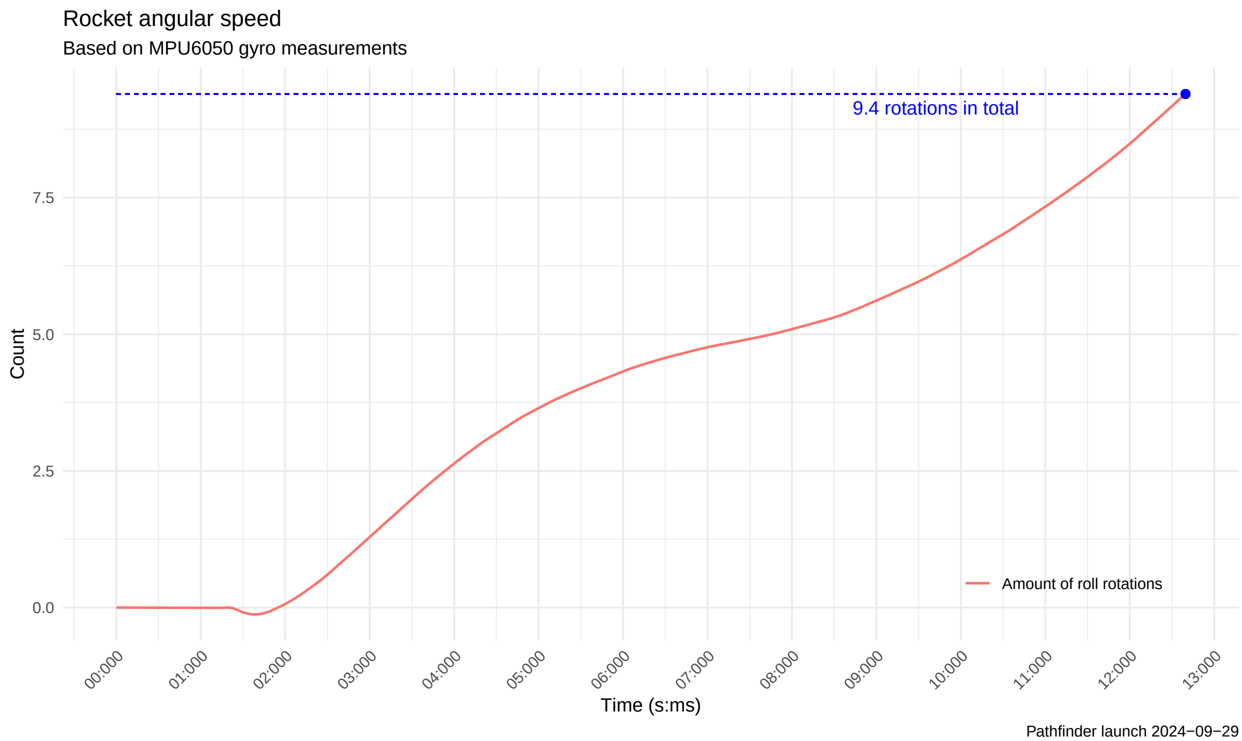

Figure 10: Amount of rotations around roll axis

Even though this rocket did not use any active steering method the gyro measurements still provided valuable data. Understanding the stability of the rocket during the flight is crucial for further rocket builds. A later graphic will also show the rocket orientation during the flight. Once again the sensor and the expected values were poorly understood before the launch. This resulted in the choice for an insufficient measurement range leading to the loss of some roll data.

3.1.4 GPS

An error in the flight recorder software caused it not to record the amount of visible satellites during the launch. This would have been interesting data to have to compare signal accuracy with different numbers of satellites. Additionally only the horizontal dilution of precision (HDOP) was tracked since the used library did not include the vertical dilution of precision (VDOP) by default. In hindsight this data would still have been relevant and should be recorded for future launches.

The chart below shows the HDOP during the flight on a logarithmic scale. The 0.54s period with a very high HDOP is noticeable and will also be highlighted in following graphics that might require horizontal precision.

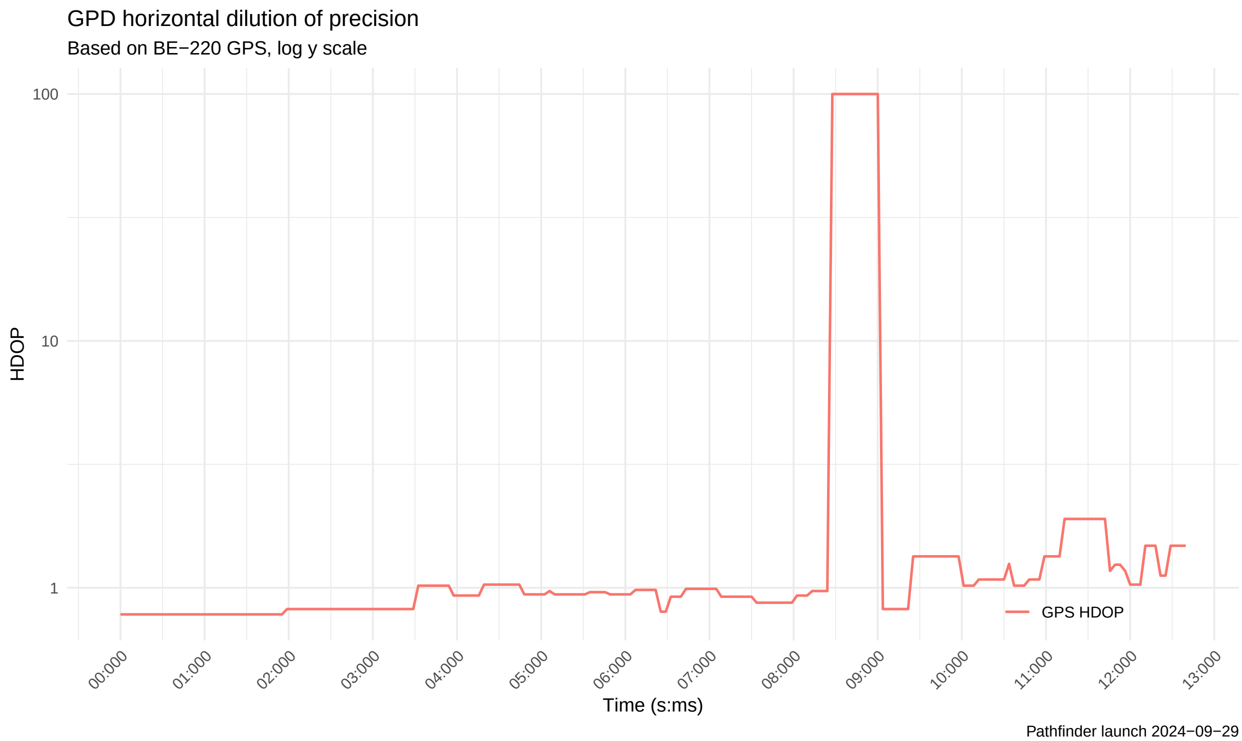

Figure 11: GPS horizontal dilution of precision

The total speed of the rocket as tracked by the gps is very inaccurate with big jumps and does not match the actual flight path or the data obtained by the barometric pressure sensor a lot. The brief period with high HDOP seems to have no influence on the tracked speed.

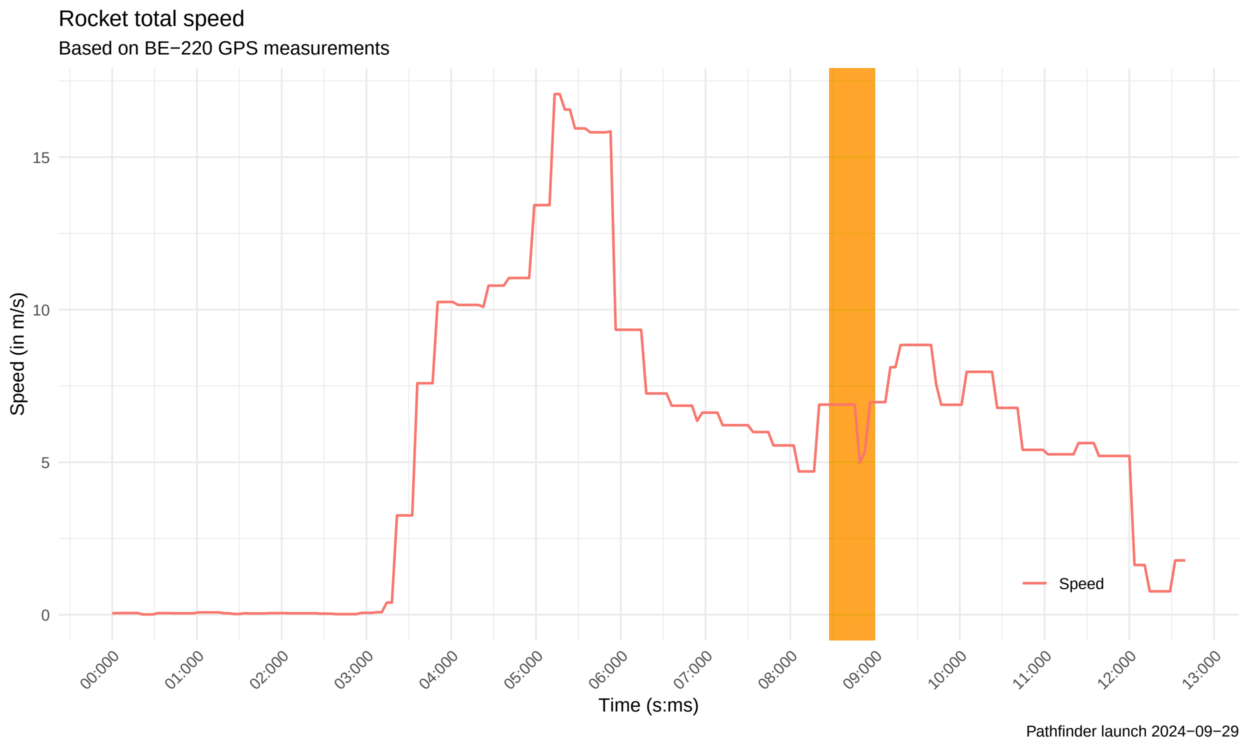

Figure 12: Total speed measured by GPS

The altitude data recorded by the gps seems to have a very strong delay. It first measured a noticeable ascent of the rocket 5 seconds after the actual launch.

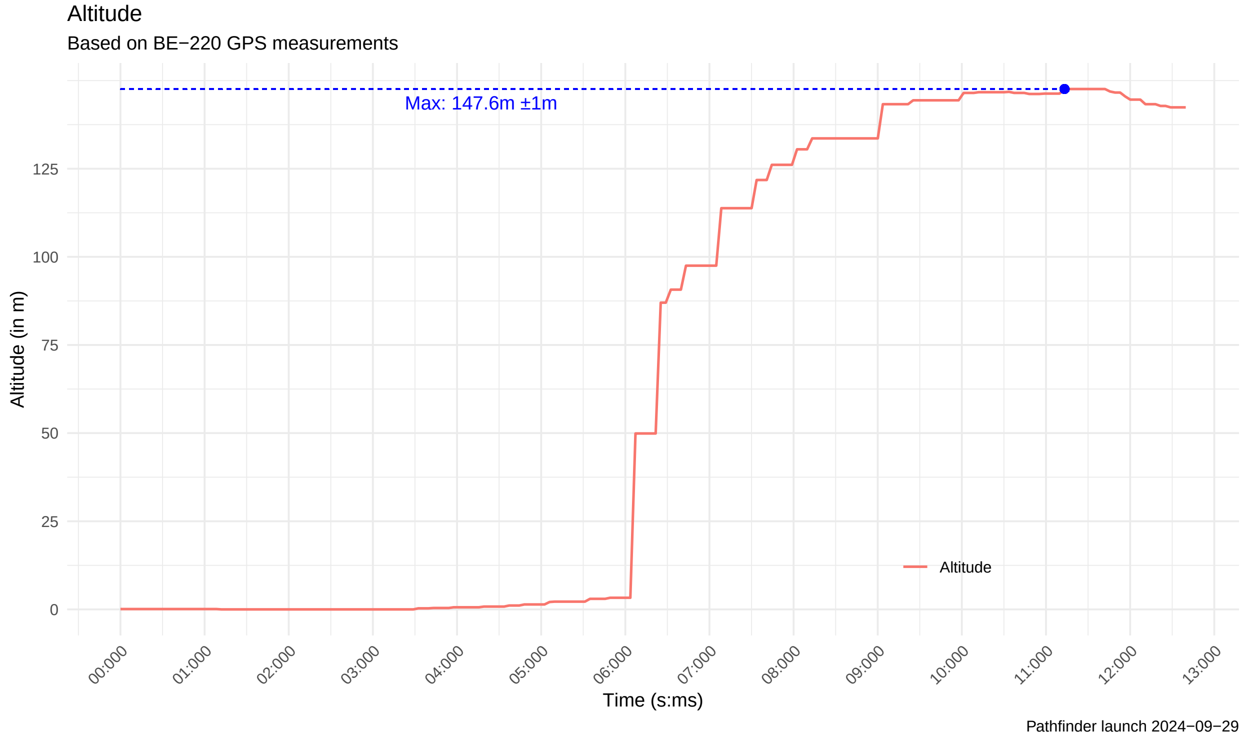

Figure 13: Altitude measured by GPS

The most interesting data recorded by the GPS is most likely the 2D position of the rocket. No other sensor on the rocket was capable of measuring the data. The following chart shows the path of the rocket as seen from above. This also shows that there was quite a big jump in the recorded gps data. It is unlikely that the rocket actually flew exactly this path.

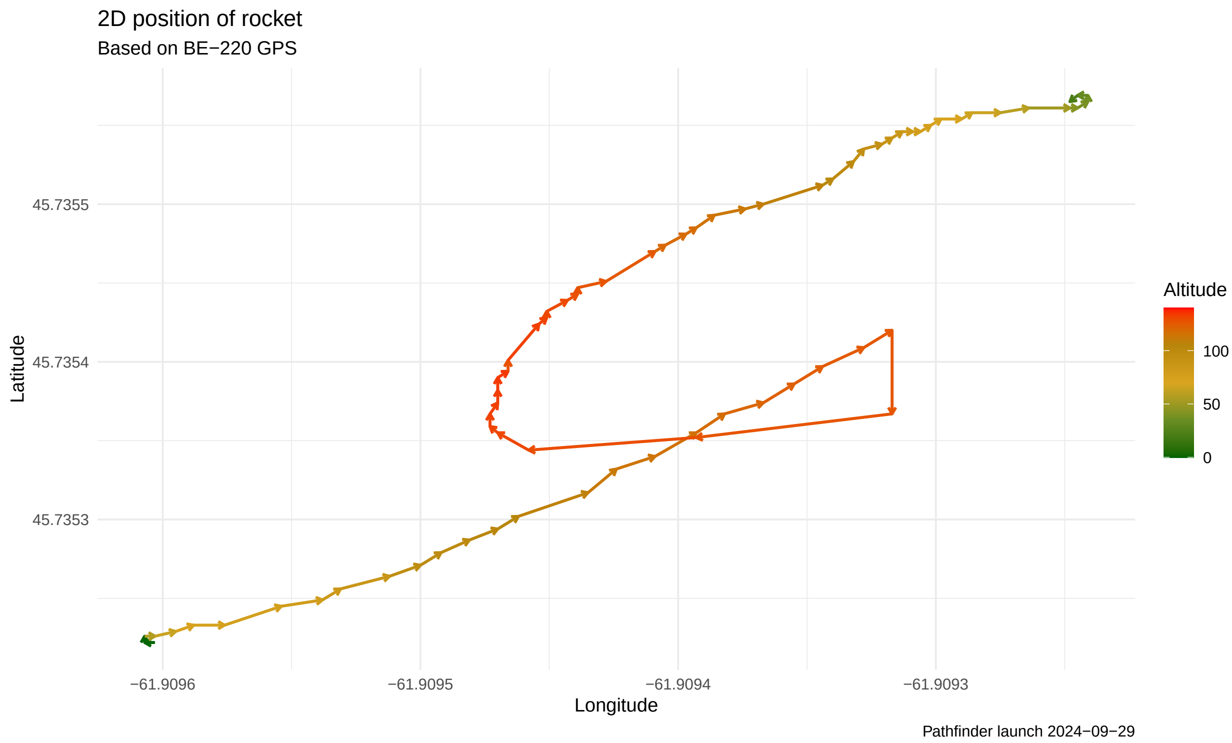

Figure 14: 2D position of rocket based on GPS

Calculating the horizontal distance covered by the rocket based on the individual gps 2D positions yields the grey curve. Using the lowess it is possible to exclude the sudden jump caused by the gps mid-flight. Using the previous chart and this one it becomes apparent that the rocket covered a lot more horizontal ground during ascent than descent.

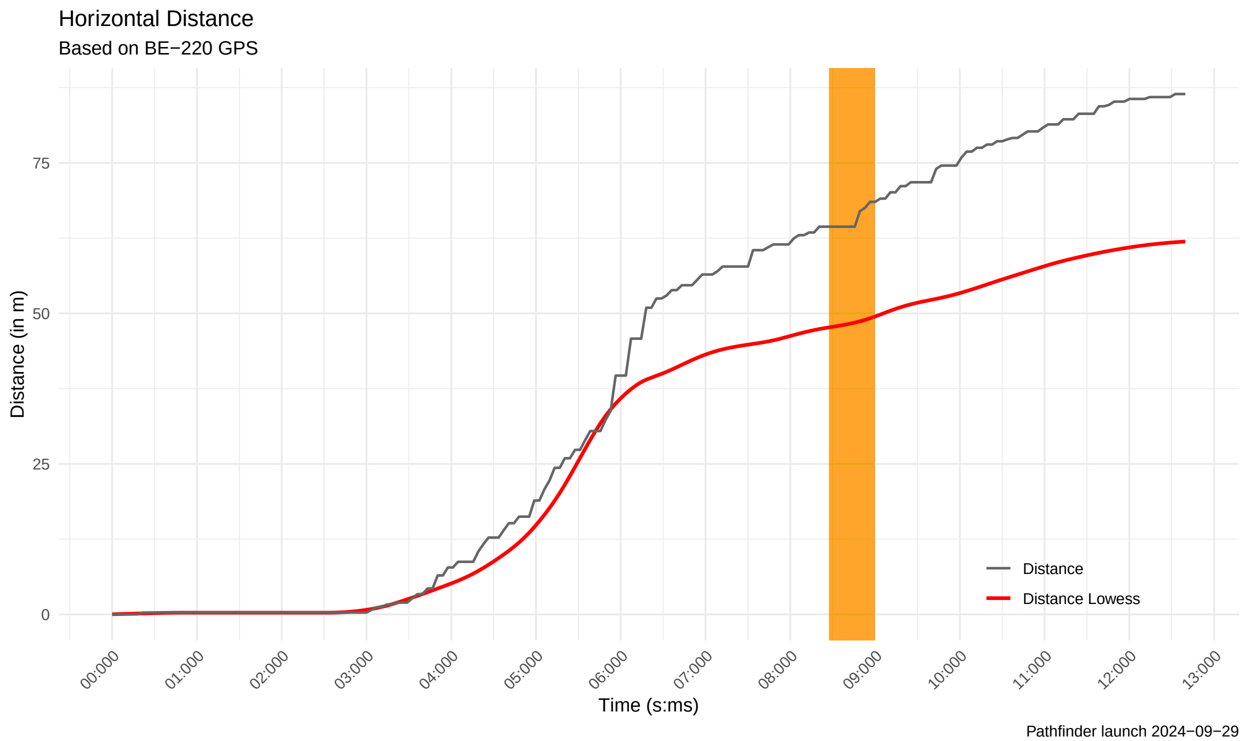

Figure 15: Horizontal distance of rocket based on GPS

Using the gradient to calculate the horizontal speed also highlights the previous conclusion. Although this once again highlights that calculating the gradient of even LOWESS smoothened only approximates the real speed with a high variance.

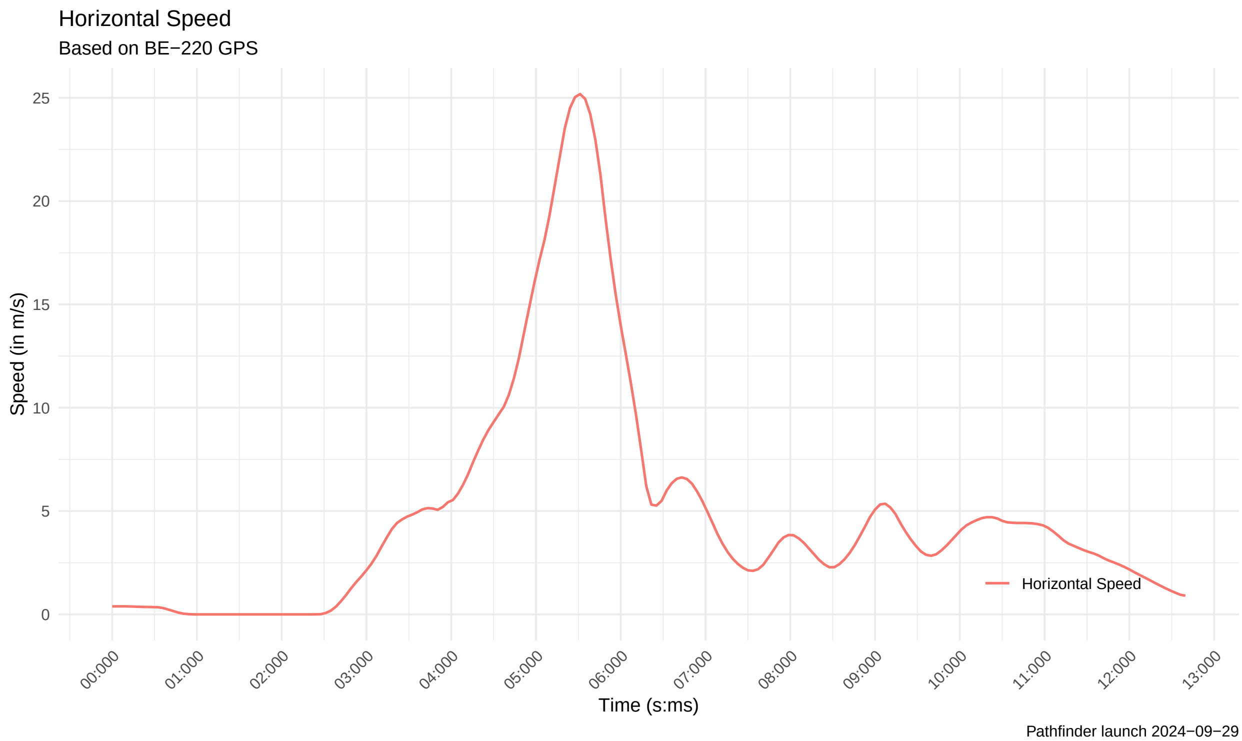

Figure 16: Horizontal speed of rocket based on GPS

Overall the gps measured some unique data like the absolute position of the rocket and the 2D track of the rocket. Altitude and speed measurements seem to be inaccurate though and the gps seems to have quite a high delay at times. The 2D position of the rocket often was redundant with multiple measurements having the same coordinates. Additionally there was a sudden jump in gps positions decreasing the quality of the data a lot. For future launches it should be checked if there are setting to decrease jumps or the delay.

3.1.5 Combining measurements

The previous chapters only looked at the data measured by individual sensors. The goal of this chapter is to explore if combining and enhancing data collected by different sensors will result in new insights. This also makes it possible to compare the quality of data recorded by different sensors.

Gps and barometric pressure sensor are both capable of measuring the rockets altitude during the flight. The following graphic shows the altitude measured by the GPS in green and the barometric altitude in blue. It is obvious that the gps data contains a lot more jumps and it seems to be delayed by quite a bit. The red line syncs barometric pressure and gps at their respective peaks. While peak measured by the gps is only off by 13.13 $\pm$1m the data overall doesnt describe the ascent of the rocket very well. Moving forward the altitude measured by the barometric pressure sensor will be used when determining the altitude of the rocket.

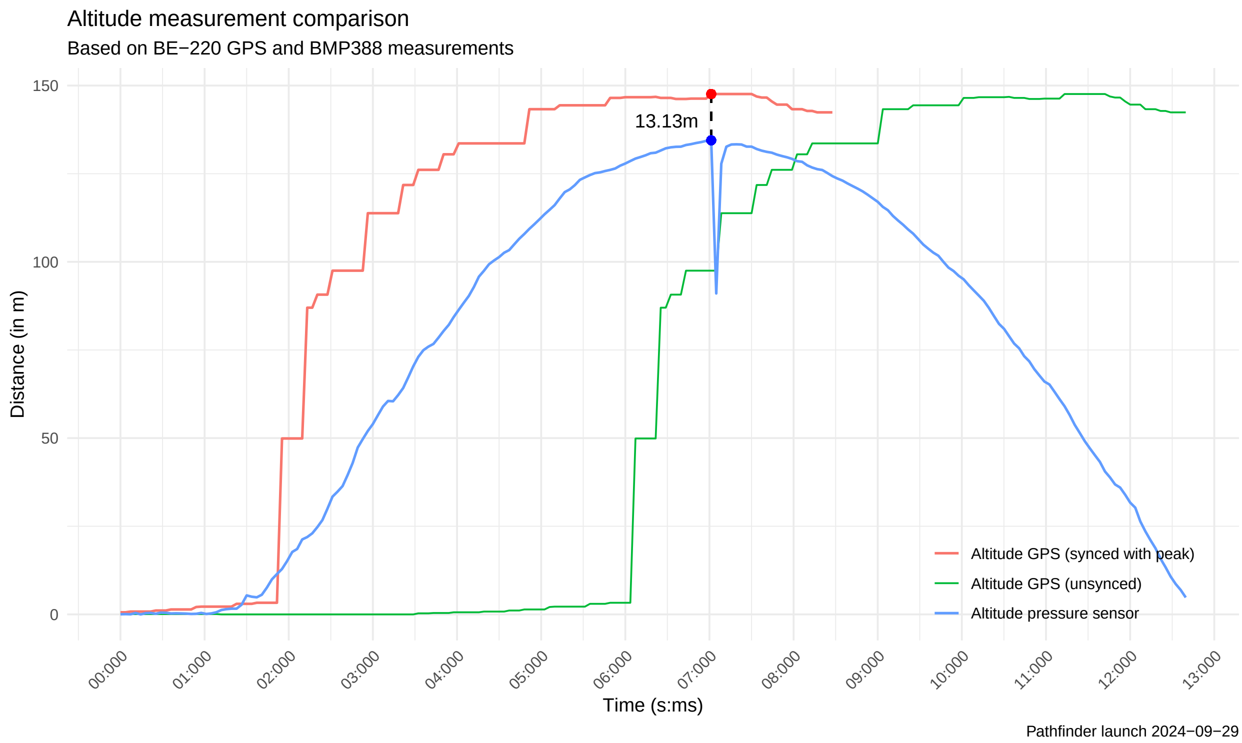

Figure 17: Comparison of GPS and barometer altitude measurements

Using the altitude measured by the pressure sensor and the 2D position measured by the gps makes it possible to approximate the flight path of the rocket in 3D.

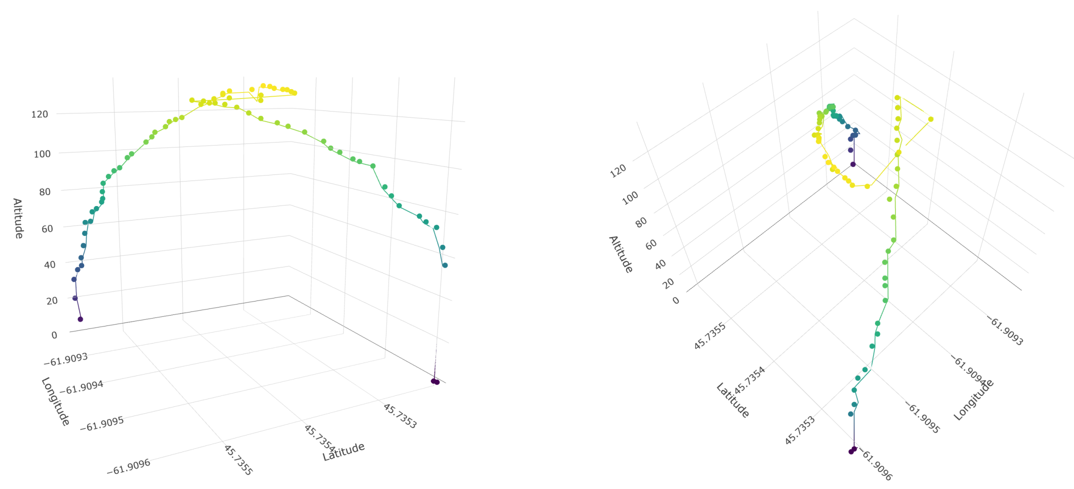

Figure 18: 3D position of rocket based on GPS and Barometer data

Based on this 3D flight path it is possible to calculate the total distance covered by the rocket.

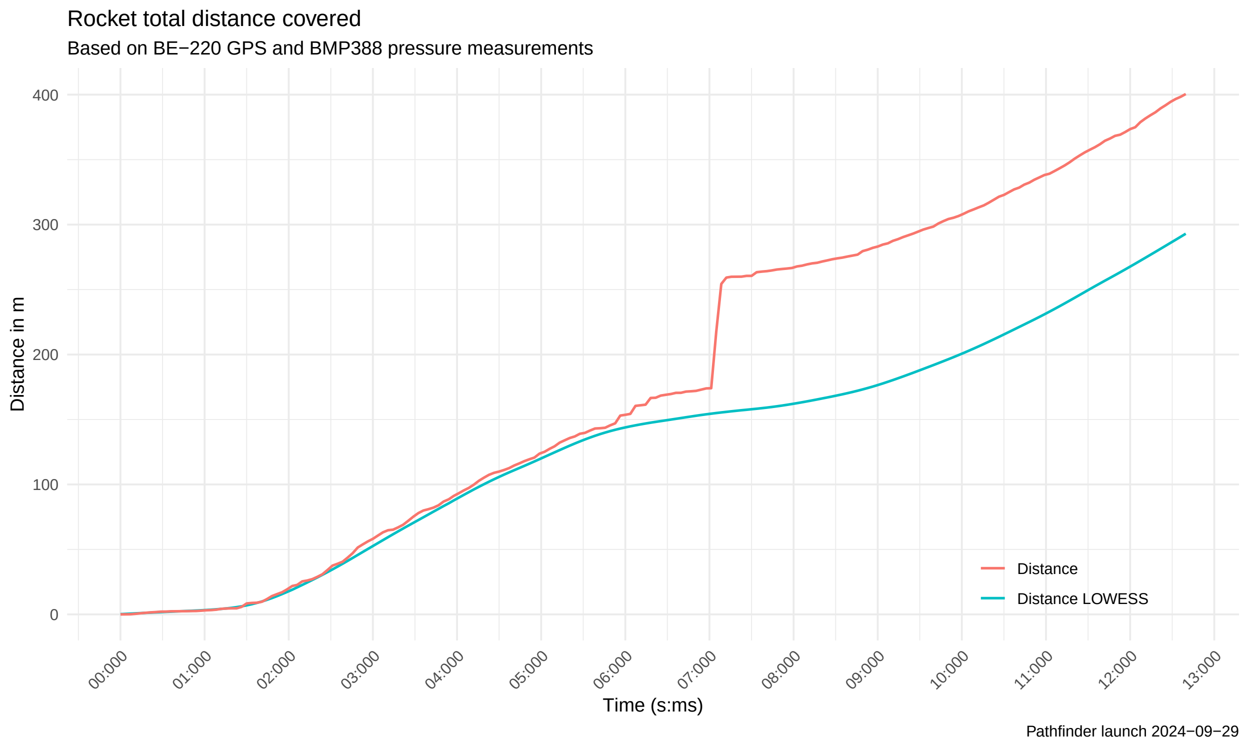

Figure 19: Total distance covered by rocket based on GPS and Barometer

And by calculating the gradient of that the total speed of the rocket can be calculated. Previous speed measurements were mostly horizontal or vertical speed, making this chart as the rockets true speed quite interesting. This shows how combining gps and barometric data can result in a new understanding of the rocket during flight.

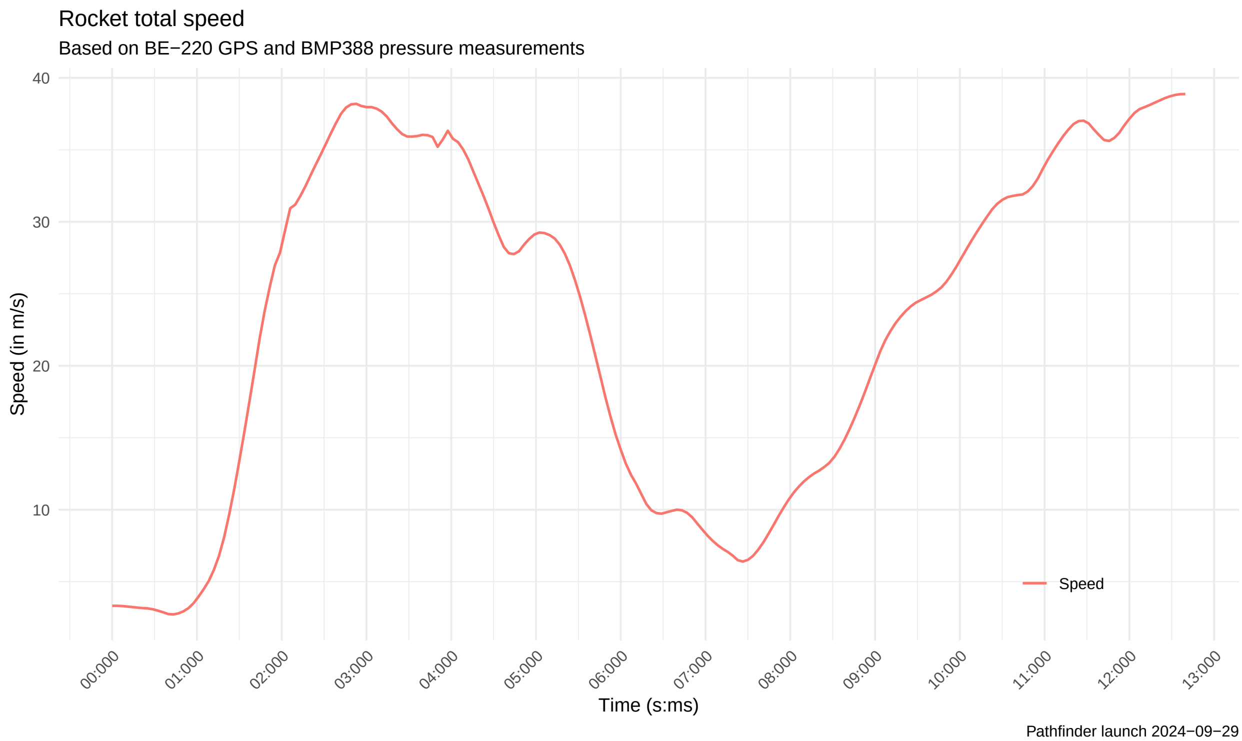

Figure 20: Total speed of rocket based on GPS and Barometer

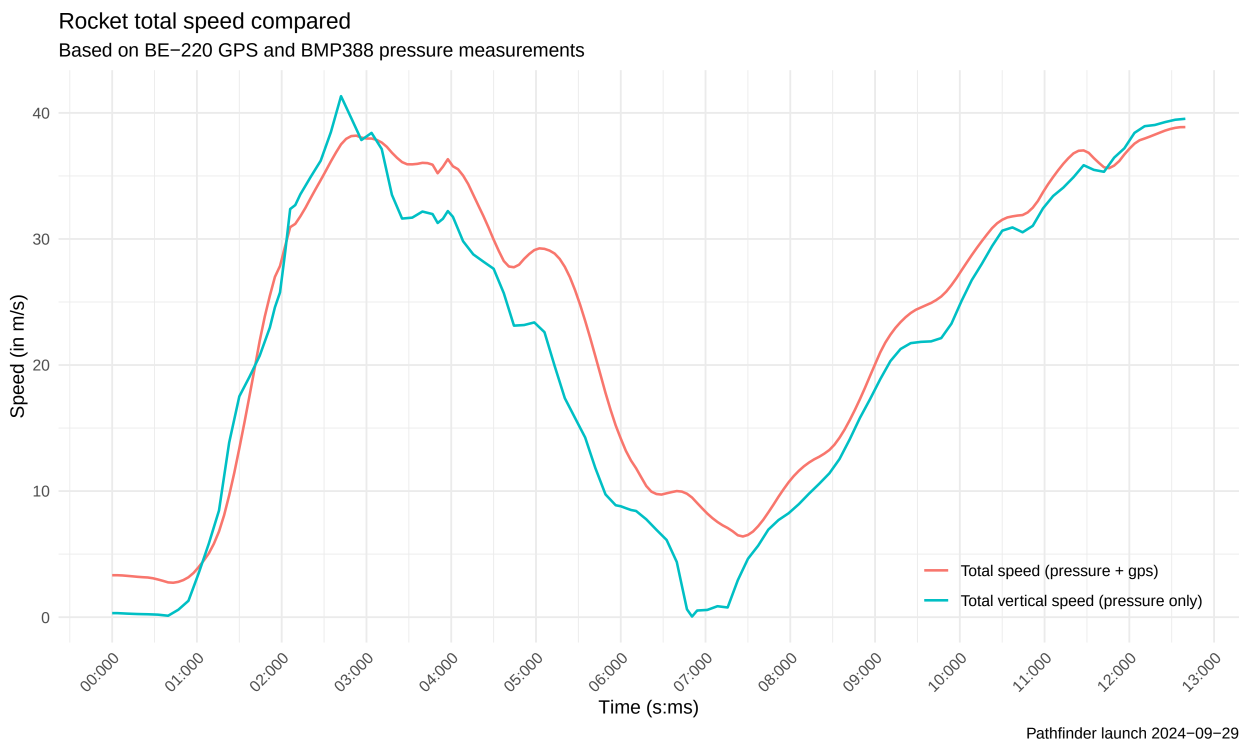

Figure 21: Total speed of rocket compared to vertical speed

Using the data of multiple sensors can also explain the nature of the high roll rate mentioned earlier. The total speed calculated above and the roll rate have a correlation of 0.927. Therefore they are strongly correlated. The chart below uses two different scales with a scale factor to highlight this relationship. This data points to an asymmetric geometry of the rocket causing uneven drag at high speeds. Most likely this is due to the fins not aligning perfectly and being at a slight angle.

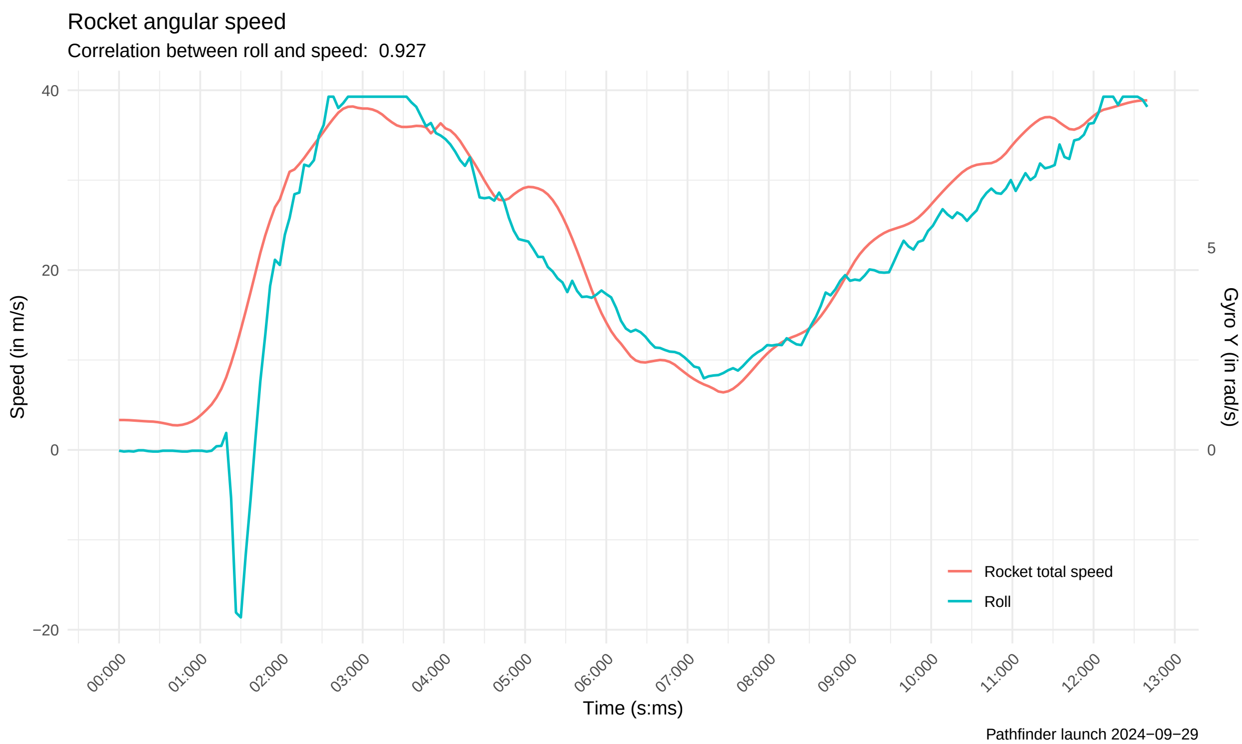

Figure 22: Correlation between speed and roll

The rockets orientation during the flight can also be displayed by using the barometric pressure sensors altitude and the rockets orientation measured by the gyro sensor. It is important to note that the x-axis here does not track distance but time.

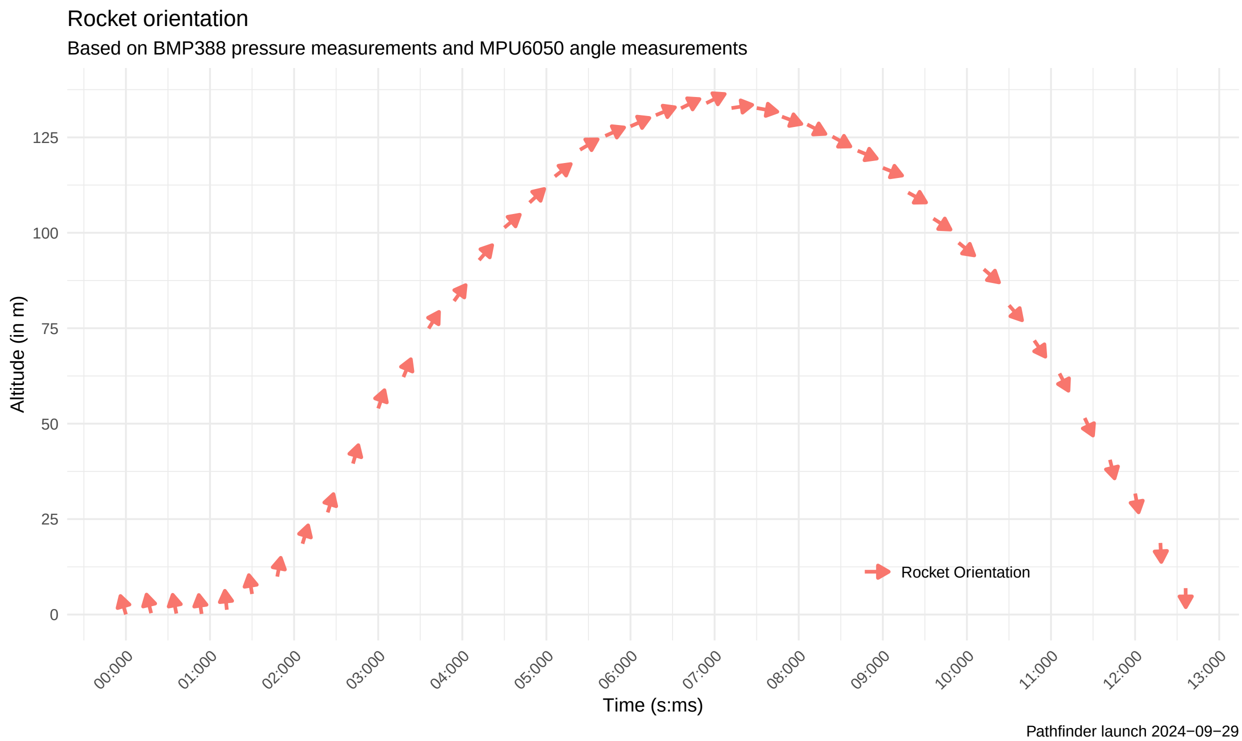

Figure 23: Rocket rotation during flight

3.2 Comparison with simulation

Weirdly enough the data recorded does not match the simulations at all. The achieved altitude was a lot lower than the simulated altitude.

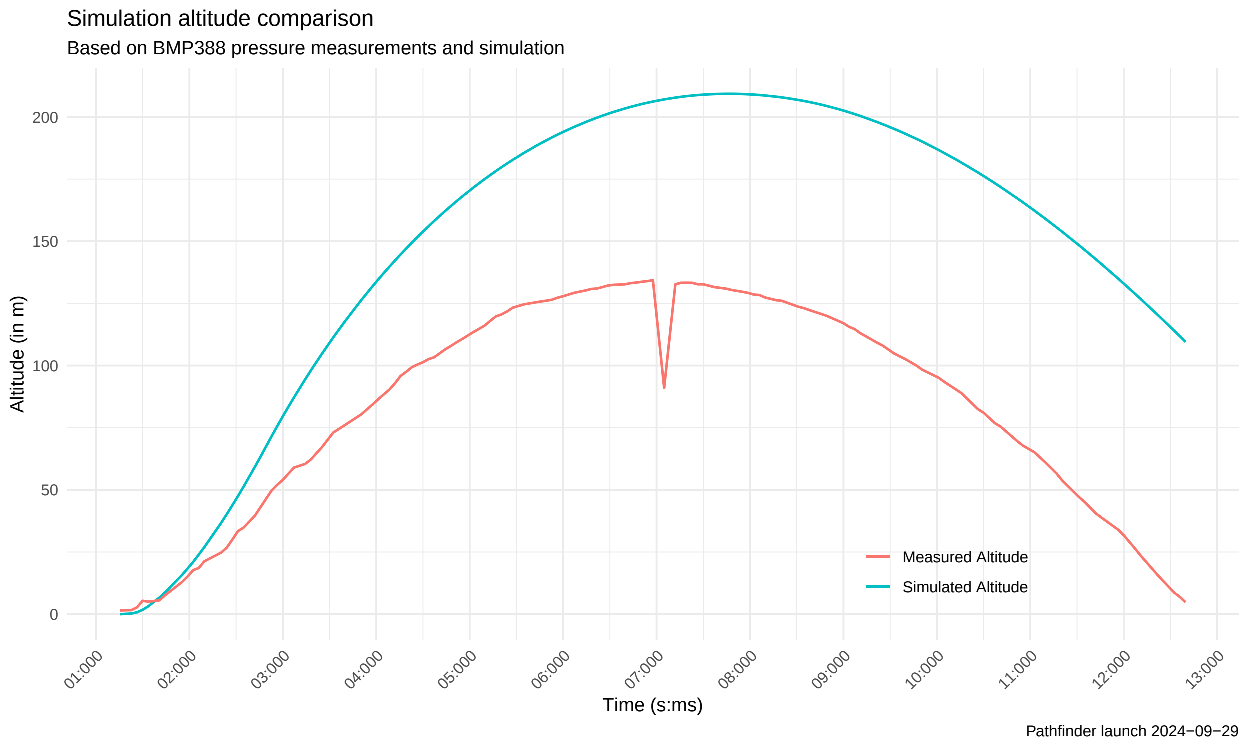

Figure 24: Simulated altitude compared with measured altitude

Comparing the thrust of the simulation with the actual thrust shows that the simulated D12 engine behaved a lot differently than the real one. It burned longer and most likely with a lot less thrust resulting in the reduced altitude. Even increasing the weight or friction of the rocket will not result in such big differences in acceleration and the burn time should have been the same either way.

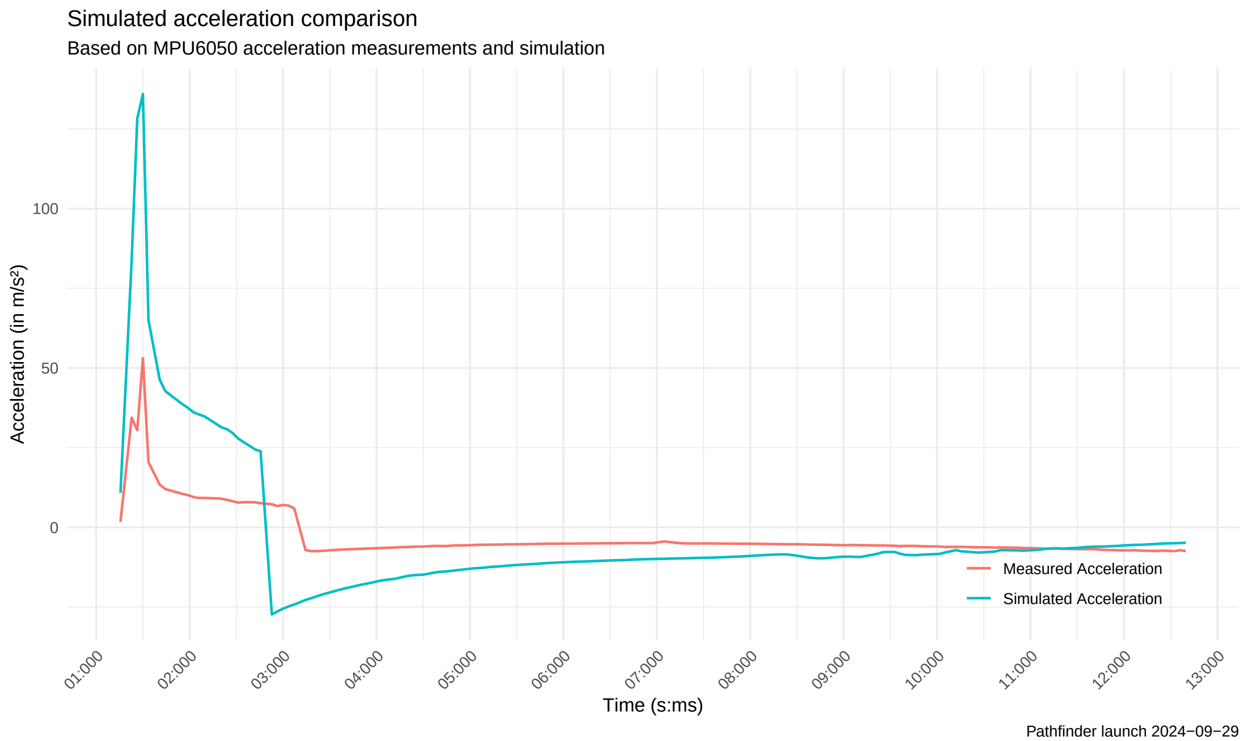

Figure 25: Simulated vertical acceleration compared with measured acceleration

For future launches the simulation software has to be better understood and the root cause of this large difference has to be identified. Otherwise judging the altitude and trajectory of the rocket prior to launch will not be possible.

3.3 Failure Analysis

The parachute compartment of the rocket was way to small to fit a properly sized parachute. During the design phase there was no parachute on hand resulting in very rough and very wrong estimations. This is why integrating a properly sized parachute was impossible. Even a smaller parachute barely fit, had to be folded incorrectly and was cramped into the available space. Ultimately cramping the parachute in was the reason it jammed and failed to deploy.

The parachute was once tested successfully on the ground using an A motor. In theory the system with a hollow inner tube directing the ejection charge to the nozzle works. Most likely the only thing needed to fix the parachute system is a longer rocket.

4 Conclusion

4.1 Critical Reflection

4.1.1 Mistakes

In hindsight multiple mistakes in the rockets design and launch are obvious.

4.1.1.1 Insufficient understanding of sensors In multiple occasions and for multiple different sensors there was not enough planning concerning the calibration and settings used.

This was especially noticeable with the IMU. The accelerometer was not studied in detail before the launch resulting in unusable data. For the gyroscope the expected data range was not correctly set resulting in some data loss concerning the rockets roll.

The gps had an error where it only wrote 0 for the amount of available satellites onto the SD card. Additionally the data included large jumps during the launch that may have been prevented with proper settings. Due to bad research valuable data like VDOP was not known before the launch and not recorded during the flight.

4.1.1.2 Bad planning The parachute compartment was way to small. The design and manufacturing techniques used would have easily allowed for a larger parachute area. But during the design the parachute was the only part that was not on hand and not measured out to test with the overall build. This eventually lead to the rocket crashing.

Additionally the simulation did not match the actual flight characteristics but this has to be looked into further.

4.1.2 Successes

Even though the rocket crashed recovering it was never a main goal. Recovering the data itself can already be considered a success and provided valuable insight into the flight. It was possible to prove that 3D printed rockets are not only cheap to produce but also make creating complex geometries easy. Additionally the viability of different sensors could be proven and the lessons learned from bad sensor readings will be applied on future flights.

Overall I do not deem this launch a failure since all the initial goals were achieved. Recovering the rocket intact would have been nice though.

4.2 Next steps

I would like to have these features on future rockets (ordered by decreasing importance):

1. Fixing all outlined sensor issues
2. A working parachute system
3. A built in camera filming the rockets POV during the flight
4. The ability for the rocket to launch itself allowing the flight recorder to know the precise time the engine was lit
5. Custom made PCBs instead of soldered together sensor modules
6. A recovery system where the rocket can transmit its location after landing

5 Appendix

5.1 Raw barometric pressure sensor data

Milliseconds	Temperature	Pressure	Altitude
1393931	36.77	101069.30	21.30
1393991	36.77	101068.85	21.34
1394051	36.77	101069.40	21.29
1394111	36.77	101064.82	21.67
1394171	36.77	101069.70	21.26
1394231	36.77	101066.84	21.62
1394291	36.77	101067.32	21.67
1394351	36.76	101067.70	21.43
1394411	36.76	101063.82	21.76
1394471	36.76	101064.24	21.72
1394531	36.76	101066.60	21.52
1394591	36.77	101066.20	21.56
1394651	36.77	101066.48	21.53
1394711	36.77	101066.97	21.49
1394771	36.77	101068.24	21.39
1394831	36.77	101067.70	21.43
1394891	36.76	101064.78	21.68
1394951	36.77	101068.30	21.38
1395011	36.77	101066.37	21.54
1395071	36.77	101062.43	21.87
1395131	36.77	101054.76	22.51
1395191	36.77	101051.88	22.75
1395251	36.77	101050.35	22.88
1395311	36.77	101050.33	22.88
1395371	36.77	101036.69	24.02
1395431	36.76	101005.15	26.65
1395491	36.76	101009.55	26.28
1395551	36.75	101011.70	26.10
1395611	36.75	101002.97	26.83
1395671	36.75	100978.70	28.85
1395731	36.74	100950.57	31.20
1395791	36.75	100932.49	32.71
1395851	36.74	100915.34	34.14
1395911	36.75	100901.79	36.37
1395973	36.74	100857.39	38.98
1396031	36.74	100847.52	39.81
1396091	36.73	100815.06	42.52
1396151	36.72	100806.92	43.20
1396211	36.72	100794.25	44.26
1396271	36.71	100773.10	46.02
1396331	36.70	100749.32	48.01
1396391	36.69	100710.65	51.24
1396451	36.68	100669.80	54.66
1396511	36.66	100652.80	56.08
1396571	36.66	100633.98	57.66
1396631	36.66	100596.38	60.80
1396691	36.65	100555.52	64.22

Milliseconds	Temperature	Pressure	Altitude
1396751	36.65	100503.38	68.59
1396811	36.65	100474.72	70.99
1396871	36.65	100447.34	73.29
1396931	36.64	100423.73	75.26
1396991	36.63	100393.82	77.77
1397051	36.62	100364.67	80.22
1397111	36.62	100345.79	81.80
1397171	36.61	100346.81	81.71
1397231	36.61	100325.91	83.47
1397291	36.60	100302.03	85.47
1397351	36.60	100265.99	88.49
1397411	36.61	100228.59	91.63
1397471	36.61	100196.53	94.32
1397531	36.62	100183.41	96.20
1397591	36.62	100168.20	97.21
1397651	36.61	100152.98	97.98
1397711	36.61	100131.73	99.77
1397771	36.61	100109.41	101.64
1397833	36.61	100088.65	103.39
1397891	36.61	100062.48	105.59
1397951	36.61	100037.88	107.65
1398011	36.61	100014.29	109.64
1398071	36.62	99991.23	111.58
1398131	36.62	99961.22	114.10
1398191	36.62	99926.09	117.06
1398251	36.63	99906.27	118.73
1398311	36.63	99884.31	120.57
1398371	36.63	99871.48	121.65
1398431	36.63	99860.05	122.61
1398491	36.62	99845.37	123.85
1398551	36.61	99836.65	124.59
1398611	36.61	99817.23	126.22
1398671	36.61	99798.21	127.82
1398731	36.61	99782.21	129.17
1398791	36.60	99764.93	130.63
1398851	36.60	99749.39	131.94
1398911	36.59	99732.85	133.33
1398971	36.59	99716.05	134.75
1399031	36.59	99700.91	136.02
1399091	36.58	99685.34	137.34
1399151	36.58	99669.27	139.24
1399211	36.59	99652.70	141.04
1399271	36.58	99632.18	141.82
1399331	36.59	99618.05	143.01
1399391	36.60	99600.16	144.52
1399451	36.60	99591.92	145.21
1399511	36.60	99584.09	145.88
1399571	36.61	99577.46	146.43
1399631	36.60	99575.04	146.64
1399691	36.60	99570.56	147.02
1399751	36.59	99566.78	147.34
1399811	36.59	99561.99	147.74

Milliseconds	Temperature	Pressure	Altitude
1399871	36.59	99552.41	148.55
1399931	36.58	99545.23	149.15
1399991	36.58	99536.88	149.86
1400052	36.58	99528.70	150.55
1400112	36.58	99523.38	151.00
1400172	36.58	99517.68	151.48
1400232	36.58	99510.73	152.07
1400292	36.58	99508.77	152.23
1400352	36.57	99501.54	152.84
1400412	36.57	99494.26	153.46
1400472	36.57	99490.96	153.74
1400532	36.57	99489.16	153.89
1400592	36.57	99488.72	153.93
1400652	36.56	99483.07	154.40
1400712	36.56	99480.31	154.64
1400772	36.57	99476.48	154.96
1400832	36.57	99475.64	155.22
1400892	36.56	99472.44	155.57
1400952	36.56	99467.41	155.73
1401012	36.56	99982.77	112.29
1401072	36.57	99545.91	149.10
1401132	36.57	99488.67	153.93
1401192	36.57	99481.34	154.55
1401252	36.58	99480.88	154.59
1401312	36.58	99481.43	154.54
1401372	36.59	99488.47	153.95
1401432	36.59	99488.51	153.94
1401492	36.60	99496.55	153.27
1401552	36.61	99502.05	152.80
1401612	36.61	99506.08	152.46
1401672	36.60	99508.98	152.22
1401732	36.60	99515.37	151.68
1401792	36.60	99520.01	151.28
1401852	36.60	99524.35	150.92
1401912	36.60	99529.70	150.47
1401972	36.60	99537.36	149.82
1402032	36.59	99539.48	149.64
1402092	36.59	99551.31	148.64
1402152	36.58	99558.82	148.01
1402212	36.57	99564.29	147.55
1402272	36.58	99567.07	147.31
1402332	36.57	99577.00	146.47
1402392	36.56	99587.62	145.58
1402452	36.57	99594.33	144.89
1402512	36.56	99601.88	144.31
1402572	36.56	99612.20	143.50
1402632	36.55	99621.00	142.76
1402692	36.56	99629.69	142.03
1402752	36.56	99638.88	141.25
1402812	36.55	99650.14	140.30
1402872	36.55	99662.25	139.28
1402932	36.55	99674.25	138.27

Milliseconds	Temperature	Pressure	Altitude
1402992	36.55	99691.10	136.85
1403052	36.54	99702.34	135.90
1403112	36.54	99721.55	134.28
1403172	36.54	99736.80	133.00
1403232	36.53	99751.05	131.80
1403292	36.53	99767.08	130.45
1403352	36.53	99781.18	129.26
1403412	36.53	99799.34	127.73
1403472	36.53	99817.84	126.17
1403532	36.53	99831.95	124.98
1403592	36.52	99845.13	123.87
1403652	36.52	99855.65	122.99
1403712	36.52	99876.20	121.26
1403772	36.52	99895.54	119.63
1403832	36.52	99907.00	118.66
1403892	36.52	99922.85	117.33
1403952	36.52	99934.97	116.31
1404012	36.52	99954.55	114.66
1404072	36.53	99968.96	113.17
1404132	36.52	99985.20	111.71
1404192	36.53	100007.32	110.22
1404252	36.53	100031.40	108.20
1404312	36.53	100058.64	105.91
1404372	36.53	100085.25	103.67
1404432	36.52	100101.88	102.27
1404492	36.53	100126.86	100.18
1404552	36.53	100151.62	98.09
1404612	36.52	100167.84	96.73
1404672	36.53	100194.48	94.50
1404732	36.52	100211.71	93.05
1404792	36.52	100238.09	90.83
1404852	36.52	100259.48	89.04
1404912	36.52	100280.07	87.31
1404972	36.53	100290.15	86.47
1405032	36.54	100314.62	84.41
1405092	36.54	100339.73	82.31
1405152	36.54	100363.70	80.30
1405212	36.54	100393.05	77.84
1405272	36.54	100426.41	75.04
1405332	36.54	100453.86	72.74
1405392	36.54	100481.86	70.39
1405452	36.54	100506.08	68.37
1405512	36.54	100529.32	66.42
1405572	36.54	100552.08	64.51
1405632	36.54	100584.48	61.80
1405692	36.54	100600.19	60.11
1405752	36.54	100624.52	58.12
1405812	36.55	100638.94	57.24
1405872	36.55	100663.24	55.21
1405932	36.56	100690.18	52.96
1405992	36.56	100707.24	51.53
1406052	36.57	100753.87	47.63

Milliseconds	Temperature	Pressure	Altitude
1406112	36.56	100787.52	44.82
1406172	36.56	100817.17	42.34
1406232	36.56	100844.95	40.02
1406292	36.56	100880.34	37.07
1406352	36.56	100909.39	34.64
1406412	36.56	100940.87	32.01
1406472	36.55	100966.33	29.89
1406532	36.57	100986.84	28.18
1406592	36.57	101012.25	26.06

5.2 Raw gyro data

Milliseconds	Acceleration_X	Acceleration_Y	Acceleration_Z	Gyro_X	Gyro_Y	Gyro_Z
1393931	0.18	4.87	0.03	-0.14	-0.02	-0.02
1393991	0.14	4.87	0.07	-0.14	-0.04	-0.03
1394051	0.14	4.88	0.03	-0.14	-0.03	-0.03
1394111	0.13	4.91	0.04	-0.14	-0.04	-0.02
1394171	0.13	4.87	0.02	-0.14	-0.01	-0.02
1394231	0.18	4.88	0.07	-0.14	-0.01	-0.02
1394291	0.14	4.87	0.04	-0.14	-0.03	-0.03
1394351	0.16	4.88	0.04	-0.14	-0.04	-0.03
1394411	0.13	4.88	0.02	-0.15	-0.04	-0.03
1394471	0.14	4.87	0.00	-0.14	-0.02	-0.02
1394531	0.16	4.87	0.03	-0.15	-0.02	-0.01
1394591	0.18	4.87	0.04	-0.13	-0.02	-0.02
1394651	0.16	4.86	0.00	-0.15	-0.03	-0.03
1394711	0.15	4.86	0.00	-0.14	-0.04	-0.03
1394771	0.12	4.90	0.08	-0.15	-0.04	-0.02
1394831	0.16	4.87	0.00	-0.14	-0.02	-0.02
1394891	0.15	4.89	0.04	-0.14	-0.02	-0.02
1394951	0.18	4.90	0.04	-0.14	-0.02	-0.02
1395011	0.16	4.91	0.05	-0.14	-0.04	-0.03
1395071	0.13	5.15	0.02	-0.14	-0.02	-0.02
1395131	0.08	5.89	0.18	-0.11	0.09	-0.02
1395191	0.00	6.53	-0.40	0.00	0.10	-0.08
1395251	-0.66	19.69	0.53	-0.36	0.42	0.08
1395311	-0.64	39.23	0.00	0.94	-1.19	-0.07
1395371	-1.70	35.29	12.18	0.65	-4.02	0.07
1395431	0.86	57.88	-0.23	-0.24	-4.14	-0.09
1395491	-0.24	25.23	0.14	-1.13	-2.59	0.35
1395551	-0.02	20.51	-0.26	-1.59	-1.22	0.53
1395611	-0.78	18.23	-0.98	-1.59	0.28	0.40
1395671	-0.64	16.84	-1.51	-0.98	1.70	-0.17
1395731	-0.12	15.93	-1.56	-0.04	2.83	-0.46
1395791	0.30	15.76	-1.23	0.78	4.05	-0.14
1395851	0.40	15.34	-0.25	0.57	4.70	0.59
1395911	0.23	14.96	0.35	-0.28	4.57	1.01
1395973	-0.23	14.30	-0.11	-1.40	5.32	1.20
1396031	-1.39	14.03	-2.23	-1.38	5.73	0.35
1396091	-0.24	14.06	-2.44	0.37	6.32	-0.36
1396151	-0.24	13.85	-0.38	0.45	6.36	0.46
1396211	-0.34	13.91	-0.57	0.00	7.05	0.42
1396271	-0.63	13.82	-1.35	-0.65	7.01	0.08
1396331	-0.38	13.44	-1.36	-0.26	7.16	-0.19
1396391	0.17	13.01	-2.25	0.45	7.76	0.67
1396451	-0.16	12.57	-0.45	1.40	8.03	1.65
1396511	-3.44	12.73	-0.02	-0.57	8.73	-0.19
1396571	0.92	12.79	-1.05	-0.25	8.73	-1.33
1396631	1.79	12.69	-0.60	-0.74	8.45	0.50
1396691	-0.09	12.39	-2.84	-0.99	8.57	0.98
1396751	-0.02	12.73	-2.74	0.09	8.73	0.58
1396811	-1.35	12.07	-0.99	0.12	8.73	0.63
1396871	-0.77	11.50	-1.61	0.07	8.73	-0.32

Milliseconds	Acceleration_X	Acceleration_Y	Acceleration_Z	Gyro_X	Gyro_Y	Gyro_Z
1396931	0.23	11.84	-1.75	0.00	8.73	-0.12
1396991	-0.61	11.62	-0.25	-0.34	8.73	0.07
1397051	0.76	10.79	-2.11	-0.22	8.73	-0.27
1397111	1.81	0.66	-1.13	-0.12	8.73	0.47
1397171	-0.71	-2.28	-1.97	-0.62	8.73	0.38
1397231	0.57	-2.66	-1.33	0.29	8.73	-0.10
1397291	0.01	-2.54	-0.85	-0.18	8.73	-0.03
1397351	1.02	-2.57	-1.62	-0.63	8.73	0.07
1397411	0.73	-2.28	-0.79	-0.50	8.73	0.43
1397471	0.10	-2.30	-1.00	-0.68	8.73	0.02
1397531	0.64	-2.27	-1.36	-0.59	8.59	-0.15
1397591	1.15	-2.11	-1.20	-0.30	8.48	0.28
1397651	0.00	-2.00	-1.47	-0.51	8.24	0.36
1397711	0.15	-2.02	-1.61	-0.03	8.00	0.09
1397771	0.50	-1.91	-0.79	0.14	8.08	0.25
1397833	-0.25	-1.81	-0.84	-0.42	7.83	0.20
1397891	0.33	-1.78	-1.05	-0.31	7.77	-0.20
1397951	1.02	-1.70	-0.90	-0.17	7.68	0.24
1398011	0.20	-1.62	-0.93	-0.44	7.55	0.43
1398071	0.34	-1.56	-1.13	-0.30	7.37	0.14
1398131	0.39	-1.51	-0.87	-0.24	7.16	0.08
1398191	-0.21	-1.39	-0.36	-0.30	7.02	-0.17
1398251	0.77	-1.36	-0.26	-0.37	7.23	-0.28
1398311	0.71	-1.27	-0.59	-0.82	6.74	0.00
1398371	0.69	-1.22	-1.16	-0.83	6.24	0.24
1398431	0.51	-1.21	-1.58	-0.29	6.22	0.29
1398491	-0.02	-1.12	-1.18	0.30	6.24	0.36
1398551	-0.56	-1.01	-0.46	0.26	6.16	-0.01
1398611	-0.35	-1.04	-0.59	0.14	6.36	-0.63
1398671	0.32	-1.04	-0.50	0.23	6.15	-0.80
1398731	1.00	-0.91	0.00	-0.02	5.74	-0.15
1398791	0.61	-0.84	-0.40	-0.52	5.42	0.31
1398851	0.29	-0.85	-0.97	-0.64	5.21	0.29
1398911	0.35	-0.81	-1.17	-0.29	5.18	0.22
1398971	0.48	-0.75	-0.88	0.00	5.15	0.41
1399031	0.21	-0.67	-0.54	-0.07	4.97	0.53
1399091	-0.06	-0.63	-0.39	-0.32	4.77	0.36
1399151	0.09	-0.62	-0.55	-0.44	4.77	-0.01
1399211	0.32	-0.58	-0.48	-0.38	4.52	-0.10
1399271	0.37	-0.60	-0.32	-0.44	4.41	-0.09
1399331	0.44	-0.51	-0.33	-0.60	4.24	-0.05
1399391	0.19	-0.52	-0.30	-0.81	4.14	0.01
1399451	0.54	-0.46	-0.49	-0.91	3.90	-0.05
1399511	0.12	-0.47	-0.99	-0.60	4.18	-0.17
1399571	0.15	-0.46	-0.94	-0.02	3.93	-0.27
1399631	0.03	-0.38	-0.57	0.36	3.78	-0.28
1399691	0.13	-0.37	-0.23	0.34	3.79	-0.36
1399751	0.10	-0.33	-0.14	0.10	3.76	-0.34
1399811	0.00	-0.30	-0.23	-0.16	3.84	-0.46
1399871	-0.06	-0.30	-0.37	-0.24	3.94	-0.73
1399931	0.27	-0.28	-0.42	-0.13	3.85	-0.86
1399991	0.59	-0.31	-0.44	-0.02	3.77	-0.60

Milliseconds	Acceleration_X	Acceleration_Y	Acceleration_Z	Gyro_X	Gyro_Y	Gyro_Z
1400052	0.61	-0.27	-0.36	-0.03	3.51	-0.16
1400112	0.53	-0.25	-0.47	-0.12	3.19	0.19
1400172	0.49	-0.24	-0.56	-0.13	3.00	0.48
1400232	0.37	-0.22	-0.62	-0.15	2.92	0.66
1400292	0.24	-0.21	-0.72	-0.10	2.97	0.73
1400352	0.22	-0.20	-0.82	0.14	2.91	0.76
1400412	0.18	-0.17	-0.72	0.28	2.80	0.79
1400472	0.22	-0.18	-0.71	0.43	2.65	0.85
1400532	0.20	-0.16	-0.59	0.51	2.53	0.92
1400592	0.13	-0.14	-0.41	0.42	2.52	0.94
1400652	0.13	-0.13	-0.37	0.26	2.47	0.93
1400712	0.10	-0.11	-0.28	0.02	2.43	0.86
1400772	0.12	-0.10	-0.23	-0.25	2.42	0.75
1400832	0.16	-0.10	-0.26	-0.49	2.38	0.63
1400892	0.19	-0.11	-0.27	-0.68	2.29	0.51
1400952	0.23	0.06	-0.23	-0.86	2.18	0.42
1401012	0.05	0.39	-0.08	-1.18	2.06	0.35
1401072	0.28	0.26	-0.23	-1.31	2.03	0.30
1401132	0.24	-0.01	-0.27	-1.47	1.77	0.22
1401192	0.29	-0.16	-0.42	-1.53	1.82	0.12
1401252	0.31	-0.24	-0.56	-1.45	1.84	0.04
1401312	0.26	-0.24	-0.59	-1.23	1.85	0.01
1401372	0.30	-0.25	-0.66	-1.03	1.90	0.00
1401432	0.35	-0.22	-0.47	-0.81	1.97	0.00
1401492	0.32	-0.24	-0.39	-0.73	2.02	0.04
1401552	0.26	-0.25	-0.45	-0.72	1.96	0.07
1401612	0.09	-0.26	-0.40	-0.65	2.07	-0.05
1401672	0.17	-0.27	-0.41	-0.60	2.20	-0.21
1401732	0.08	-0.29	-0.32	-0.55	2.32	-0.38
1401792	0.11	-0.33	-0.44	-0.50	2.41	-0.50
1401852	0.14	-0.33	-0.37	-0.40	2.48	-0.64
1401912	0.23	-0.33	-0.25	-0.36	2.59	-0.66
1401972	0.27	-0.33	-0.28	-0.39	2.58	-0.62
1402032	0.27	-0.35	-0.25	-0.47	2.60	-0.59
1402092	0.27	-0.39	-0.48	-0.47	2.59	-0.59
1402152	0.45	-0.39	-0.39	-0.34	2.76	-0.50
1402212	0.58	-0.46	-0.87	-0.26	2.68	-0.27
1402272	0.65	-0.46	-0.83	0.20	2.61	0.21
1402332	0.18	-0.48	-0.66	0.40	2.59	0.58
1402392	-0.06	-0.50	-0.62	0.40	2.84	0.45
1402452	-0.03	-0.49	-0.38	0.35	3.08	0.26
1402512	-0.07	-0.54	-0.60	0.38	3.29	0.11
1402572	-0.05	-0.59	-0.51	0.48	3.56	-0.10
1402632	0.15	-0.61	-0.26	0.41	3.89	-0.18
1402692	0.20	-0.63	-0.31	0.15	3.82	0.00
1402752	0.02	-0.65	-0.25	-0.13	3.97	-0.10
1402812	0.35	-0.74	-0.56	-0.22	4.18	-0.25
1402872	0.58	-0.74	-0.99	0.01	4.32	-0.06
1402932	0.33	-0.79	-0.73	0.35	4.18	0.27
1402992	0.31	-0.74	-0.11	0.12	4.21	0.32
1403052	0.11	-0.72	-0.20	-0.44	4.19	0.19
1403112	0.11	-0.79	-0.43	-0.68	4.31	-0.08

Milliseconds	Acceleration_X	Acceleration_Y	Acceleration_Z	Gyro_X	Gyro_Y	Gyro_Z
1403172	0.31	-0.85	-0.40	-0.71	4.46	-0.34
1403232	0.94	-0.87	-0.80	-0.49	4.44	-0.11
1403292	0.81	-0.87	-0.64	-0.31	4.39	0.46
1403352	0.25	-0.87	-0.64	-0.39	4.38	0.54
1403412	-0.18	-0.89	-0.75	-0.35	4.39	0.18
1403472	-0.29	-0.97	-0.74	-0.22	4.65	-0.32
1403532	0.30	-1.06	-0.73	0.19	4.92	-0.67
1403592	0.69	-1.01	-0.21	0.15	5.17	-0.37
1403652	0.44	-0.97	0.10	-0.41	5.03	-0.12
1403712	0.15	-1.01	-0.40	-0.81	4.95	-0.37
1403772	0.65	-1.11	-0.87	-0.70	5.14	-0.62
1403832	0.97	-1.16	-1.26	-0.18	5.18	-0.14
1403892	0.30	-1.16	-0.45	0.15	5.41	0.15
1403952	-0.10	-1.21	-0.12	-0.37	5.54	-0.03
1404012	0.25	-1.33	-1.07	-0.44	5.75	-0.45
1404072	0.57	-1.39	-0.99	0.04	5.95	-0.25
1404132	0.68	-1.33	-0.48	0.11	5.82	0.05
1404192	0.56	-1.30	-0.20	-0.45	5.73	0.32
1404252	0.16	-1.40	-1.04	-0.75	5.87	0.02
1404312	0.80	-1.45	-0.97	-0.45	5.80	0.10
1404372	0.58	-1.44	-0.68	-0.24	5.66	0.25
1404432	0.10	-1.43	-0.49	-0.52	5.80	0.10
1404492	0.57	-1.53	-1.17	-0.42	5.92	-0.19
1404552	0.64	-1.53	-0.55	-0.24	6.19	0.07
1404612	-0.07	-1.48	-0.47	-0.61	6.35	-0.12
1404672	0.53	-1.64	-0.98	-0.32	6.46	-0.45
1404732	1.04	-1.59	-0.98	-0.29	6.35	0.14
1404792	-0.28	-1.58	-0.47	-0.40	6.33	0.19
1404852	0.30	-1.70	-1.28	-0.36	6.46	-0.34
1404912	0.73	-1.74	-0.61	0.14	6.67	-0.32
1404972	0.98	-1.70	0.04	-0.40	6.40	0.18
1405032	0.33	-1.80	-1.24	-0.92	6.62	0.07
1405092	1.10	-1.88	-1.52	-0.13	6.84	-0.10
1405152	0.64	-1.79	-0.71	-0.07	6.67	0.55
1405212	-0.19	-1.81	-0.72	-0.29	6.76	0.27
1405272	0.24	-1.91	-0.84	-0.04	7.08	-0.52
1405332	1.24	-1.91	-0.16	-0.06	6.96	-0.22
1405392	0.38	-1.85	-0.19	-0.85	6.99	0.18
1405452	0.34	-2.02	-1.71	-0.91	7.04	-0.41
1405512	1.55	-2.02	-0.96	0.00	7.55	0.00
1405572	0.97	-1.92	-0.38	-0.66	7.24	0.78
1405632	-0.35	-2.03	-1.72	-0.64	7.19	0.25
1405692	0.03	-2.22	-1.47	0.46	7.65	-0.45
1405752	0.45	-2.11	0.77	0.11	7.68	-0.16
1405812	1.10	-2.28	-0.40	-1.17	7.79	-0.44
1405872	1.47	-2.37	-1.97	-0.45	8.06	-0.05
1405932	1.06	-2.43	-1.88	0.10	8.08	0.62
1405992	0.55	-2.42	-1.70	0.40	8.33	1.19
1406052	-1.99	-2.36	-0.34	0.07	8.73	0.04
1406112	0.21	-2.51	-0.02	0.01	8.73	-1.12
1406172	1.74	-2.47	0.43	-0.83	8.73	-0.59
1406232	1.18	-2.46	-0.73	-1.64	8.53	0.05

Milliseconds	Acceleration_X	Acceleration_Y	Acceleration_Z	Gyro_X	Gyro_Y	Gyro_Z
1406292	1.43	-2.60	-3.32	-0.58	8.73	-0.03
1406352	0.45	-2.49	-0.75	0.15	8.73	0.75
1406412	-1.18	-2.49	-1.28	-0.31	8.73	-0.14
1406472	0.98	-2.64	-0.90	0.50	8.73	-0.44
1406532	0.01	-2.36	0.26	-0.40	8.66	0.02
1406592	1.29	-2.63	-0.68	-0.78	8.48	-0.66

5.3 Raw gps data

Milliseconds	Count	HDOP	Latitude	Longitude	Altitude	Course	Speed	Time
1393931	0	0.78	45.73522	-61.90960	40.6	6154.57	0.17	17:39:22.60
1393991	0	0.78	45.73522	-61.90960	40.6	6154.57	0.19	17:39:22.70
1394051	0	0.78	45.73522	-61.90960	40.6	6154.57	0.20	17:39:22.80
1394111	0	0.78	45.73522	-61.90960	40.6	6154.57	0.20	17:39:22.80
1394171	0	0.78	45.73522	-61.90960	40.6	6154.57	0.20	17:39:22.80
1394231	0	0.78	45.73522	-61.90960	40.6	6154.57	0.20	17:39:22.90
1394291	0	0.78	45.73522	-61.90961	40.6	6154.57	0.04	17:39:23.00
1394351	0	0.78	45.73522	-61.90961	40.6	6154.57	0.04	17:39:23.00
1394411	0	0.78	45.73522	-61.90961	40.6	6154.57	0.04	17:39:23.00
1394471	0	0.78	45.73522	-61.90961	40.6	4544.11	0.19	17:39:23.20
1394531	0	0.78	45.73522	-61.90961	40.6	4544.11	0.19	17:39:23.20
1394591	0	0.78	45.73522	-61.90961	40.6	4544.11	0.19	17:39:23.20
1394651	0	0.78	45.73522	-61.90961	40.6	4544.11	0.17	17:39:23.40
1394711	0	0.78	45.73522	-61.90961	40.6	4544.11	0.17	17:39:23.40
1394771	0	0.78	45.73522	-61.90961	40.6	4544.11	0.17	17:39:23.40
1394831	0	0.78	45.73522	-61.90961	40.6	4544.11	0.17	17:39:23.50
1394891	0	0.78	45.73522	-61.90961	40.6	4544.11	0.17	17:39:23.50
1394951	0	0.78	45.73522	-61.90961	40.6	4544.11	0.28	17:39:23.70
1395011	0	0.78	45.73522	-61.90961	40.6	4544.11	0.28	17:39:23.70
1395071	0	0.78	45.73522	-61.90961	40.6	4544.11	0.28	17:39:23.70
1395131	0	0.78	45.73522	-61.90961	40.5	4544.11	0.28	17:39:23.80
1395191	0	0.78	45.73522	-61.90961	40.5	4544.11	0.28	17:39:23.80
1395251	0	0.78	45.73522	-61.90961	40.5	4544.11	0.17	17:39:24.00
1395311	0	0.78	45.73522	-61.90961	40.5	4544.11	0.17	17:39:24.00
1395371	0	0.78	45.73522	-61.90961	40.5	4544.11	0.09	17:39:24.10
1395431	0	0.78	45.73522	-61.90961	40.5	4544.11	0.09	17:39:24.10
1395491	0	0.78	45.73522	-61.90961	40.5	4544.11	0.17	17:39:24.20
1395551	0	0.78	45.73522	-61.90961	40.5	4544.11	0.15	17:39:24.30
1395611	0	0.78	45.73522	-61.90961	40.5	4544.11	0.15	17:39:24.30
1395671	0	0.78	45.73522	-61.90961	40.5	4544.11	0.15	17:39:24.30
1395731	0	0.78	45.73522	-61.90961	40.5	4544.11	0.15	17:39:24.30
1395791	0	0.78	45.73522	-61.90961	40.5	4544.11	0.19	17:39:24.50
1395851	0	0.78	45.73522	-61.90961	40.5	4544.11	0.19	17:39:24.50
1395911	0	0.82	45.73522	-61.90961	40.5	4544.11	0.19	17:39:24.60
1395973	0	0.82	45.73522	-61.90961	40.5	4544.11	0.19	17:39:24.60
1396031	0	0.82	45.73522	-61.90961	40.5	4544.11	0.17	17:39:24.80
1396091	0	0.82	45.73522	-61.90961	40.5	4544.11	0.17	17:39:24.80
1396151	0	0.82	45.73522	-61.90961	40.5	4544.11	0.17	17:39:24.80
1396211	0	0.82	45.73522	-61.90961	40.5	4544.11	0.17	17:39:24.90
1396271	0	0.82	45.73522	-61.90961	40.5	4544.11	0.17	17:39:24.90
1396331	0	0.82	45.73522	-61.90961	40.5	4544.11	0.17	17:39:24.90
1396391	0	0.82	45.73522	-61.90961	40.5	4544.11	0.13	17:39:25.10
1396451	0	0.82	45.73522	-61.90961	40.5	4544.11	0.13	17:39:25.20
1396511	0	0.82	45.73522	-61.90961	40.5	4544.11	0.13	17:39:25.20
1396571	0	0.82	45.73522	-61.90961	40.5	4544.11	0.07	17:39:25.30
1396631	0	0.82	45.73522	-61.90961	40.5	4544.11	0.07	17:39:25.30
1396691	0	0.82	45.73522	-61.90961	40.5	4544.11	0.07	17:39:25.40
1396751	0	0.82	45.73522	-61.90961	40.5	4544.11	0.07	17:39:25.50
1396811	0	0.82	45.73522	-61.90961	40.5	4544.11	0.07	17:39:25.50
1396871	0	0.82	45.73522	-61.90961	40.5	4544.11	0.22	17:39:25.60

Milliseconds	Count	HDOP	Latitude	Longitude	Altitude	Course	Speed	Time
1396931	0	0.82	45.73522	-61.90961	40.5	4544.11	0.22	17:39:25.60
1396991	0	0.82	45.73523	-61.90961	40.5	4544.11	0.22	17:39:25.70
1397051	0	0.82	45.73522	-61.90961	40.5	4544.11	0.30	17:39:25.80
1397111	0	0.82	45.73522	-61.90961	40.5	4544.11	0.30	17:39:25.80
1397171	0	0.82	45.73523	-61.90961	40.5	322.91	1.43	17:39:25.90
1397231	0	0.82	45.73523	-61.90961	40.5	322.91	1.43	17:39:25.90
1397291	0	0.82	45.73523	-61.90960	40.5	39.05	11.72	17:39:26.00
1397351	0	0.82	45.73523	-61.90960	40.5	39.05	11.72	17:39:26.00
1397411	0	0.82	45.73523	-61.90960	40.5	39.05	11.72	17:39:26.00
1397471	0	1.02	45.73523	-61.90960	40.8	39.05	11.72	17:39:26.10
1397531	0	1.02	45.73523	-61.90959	40.8	56.58	27.32	17:39:26.20
1397591	0	1.02	45.73523	-61.90959	40.8	56.58	27.32	17:39:26.20
1397651	0	1.02	45.73523	-61.90958	40.9	56.58	27.32	17:39:26.30
1397711	0	1.02	45.73523	-61.90958	40.9	56.58	27.32	17:39:26.30
1397771	0	1.02	45.73524	-61.90955	40.9	61.17	36.91	17:39:26.50
1397833	0	1.02	45.73524	-61.90955	40.9	61.17	36.91	17:39:26.50
1397891	0	0.93	45.73525	-61.90954	41.1	61.17	36.91	17:39:26.60
1397951	0	0.93	45.73525	-61.90954	41.1	61.17	36.91	17:39:26.60
1398011	0	0.93	45.73526	-61.90953	41.1	55.44	36.56	17:39:26.70
1398071	0	0.93	45.73526	-61.90953	41.1	55.44	36.56	17:39:26.70
1398131	0	0.93	45.73526	-61.90953	41.1	55.44	36.56	17:39:26.70
1398191	0	0.93	45.73526	-61.90953	41.1	55.44	36.56	17:39:26.70
1398251	0	1.03	45.73526	-61.90951	41.3	55.44	36.56	17:39:26.90
1398311	0	1.03	45.73527	-61.90950	41.3	51.51	36.34	17:39:27.00
1398371	0	1.03	45.73528	-61.90949	41.3	48.59	38.84	17:39:27.10
1398431	0	1.03	45.73528	-61.90949	41.3	48.59	38.84	17:39:27.10
1398491	0	1.03	45.73528	-61.90949	41.3	48.59	38.84	17:39:27.10
1398551	0	1.03	45.73529	-61.90948	41.6	48.59	38.84	17:39:27.20
1398611	0	1.03	45.73529	-61.90947	41.6	45.46	39.74	17:39:27.30
1398671	0	1.03	45.73529	-61.90947	41.6	45.46	39.74	17:39:27.30
1398731	0	0.94	45.73530	-61.90946	41.9	45.46	39.74	17:39:27.40
1398791	0	0.94	45.73530	-61.90946	41.9	45.46	39.74	17:39:27.40
1398851	0	0.94	45.73530	-61.90946	41.9	45.46	39.74	17:39:27.40
1398911	0	0.94	45.73532	-61.90944	41.9	42.11	48.34	17:39:27.60
1398971	0	0.94	45.73532	-61.90944	41.9	42.11	48.34	17:39:27.60
1399031	0	0.97	45.73533	-61.90942	42.6	42.11	48.34	17:39:27.70
1399091	0	0.94	45.73534	-61.90941	42.7	42.11	48.34	17:39:27.80
1399151	0	0.94	45.73535	-61.90939	42.7	39.68	61.45	17:39:27.90
1399211	0	0.94	45.73535	-61.90939	42.7	39.68	61.45	17:39:27.90
1399271	0	0.94	45.73537	-61.90938	42.7	39.57	59.62	17:39:28.00
1399331	0	0.94	45.73537	-61.90938	42.7	39.57	59.62	17:39:28.00
1399391	0	0.94	45.73537	-61.90937	42.7	41.84	57.39	17:39:28.10
1399451	0	0.94	45.73537	-61.90937	42.7	41.84	57.39	17:39:28.10
1399511	0	0.96	45.73539	-61.90935	43.5	41.84	57.39	17:39:28.20
1399571	0	0.96	45.73540	-61.90934	43.5	39.96	56.93	17:39:28.30
1399631	0	0.96	45.73540	-61.90934	43.5	39.96	56.93	17:39:28.30
1399691	0	0.96	45.73540	-61.90934	43.5	39.96	56.93	17:39:28.30
1399751	0	0.94	45.73541	-61.90933	43.8	39.96	56.93	17:39:28.40
1399811	0	0.94	45.73542	-61.90932	43.8	40.60	57.04	17:39:28.50
1399871	0	0.94	45.73537	-61.90932	43.8	30.25	33.63	17:39:28.60
1399931	0	0.94	45.73537	-61.90932	43.8	30.25	33.63	17:39:28.60
1399991	0	0.94	45.73537	-61.90932	43.8	30.25	33.63	17:39:28.60

Milliseconds	Count	HDOP	Latitude	Longitude	Altitude	Course	Speed	Time
1400052	0	0.98	45.73535	-61.90939	90.4	30.25	33.63	17:39:28.70
1400112	0	0.98	45.73535	-61.90939	90.4	30.25	33.63	17:39:28.70
1400172	0	0.98	45.73535	-61.90939	90.4	30.25	33.63	17:39:28.70
1400232	0	0.98	45.73534	-61.90946	90.4	27.08	26.11	17:39:28.90
1400292	0	0.98	45.73534	-61.90946	90.4	27.08	26.11	17:39:28.90
1400352	0	0.80	45.73535	-61.90947	127.5	27.08	26.11	17:39:29.00
1400412	0	0.80	45.73535	-61.90947	127.5	27.08	26.11	17:39:29.00
1400472	0	0.92	45.73536	-61.90947	131.2	27.08	26.11	17:39:29.10
1400532	0	0.92	45.73537	-61.90947	131.2	27.49	24.67	17:39:29.20
1400592	0	0.92	45.73537	-61.90947	131.2	27.49	24.67	17:39:29.20
1400652	0	0.99	45.73537	-61.90947	138.0	27.49	24.67	17:39:29.30
1400712	0	0.99	45.73537	-61.90947	138.0	27.49	24.67	17:39:29.30
1400772	0	0.99	45.73537	-61.90947	138.0	27.49	24.67	17:39:29.30
1400832	0	0.99	45.73538	-61.90947	138.0	23.71	22.87	17:39:29.50
1400892	0	0.99	45.73539	-61.90947	138.0	23.39	23.85	17:39:29.60
1400952	0	0.99	45.73539	-61.90947	138.0	23.39	23.85	17:39:29.60
1401012	0	0.99	45.73539	-61.90947	138.0	23.39	23.85	17:39:29.60
1401072	0	0.92	45.73539	-61.90947	154.3	23.39	23.85	17:39:29.70
1401132	0	0.92	45.73540	-61.90947	154.3	23.04	22.37	17:39:29.80
1401192	0	0.92	45.73540	-61.90947	154.3	23.04	22.37	17:39:29.80
1401252	0	0.92	45.73540	-61.90947	154.3	23.04	22.37	17:39:29.80
1401312	0	0.92	45.73540	-61.90947	154.3	23.04	22.37	17:39:29.80
1401372	0	0.92	45.73540	-61.90947	154.3	23.04	22.37	17:39:29.80
1401432	0	0.92	45.73540	-61.90947	154.3	23.04	22.37	17:39:29.80
1401492	0	0.87	45.73542	-61.90945	162.3	24.93	21.56	17:39:30.20
1401552	0	0.87	45.73542	-61.90945	162.3	24.93	21.56	17:39:30.20
1401612	0	0.87	45.73542	-61.90945	162.3	24.93	21.56	17:39:30.20
1401672	0	0.87	45.73543	-61.90945	166.6	24.93	21.56	17:39:30.30
1401732	0	0.87	45.73543	-61.90945	166.6	28.75	19.98	17:39:30.40
1401792	0	0.87	45.73543	-61.90945	166.6	28.75	19.98	17:39:30.40
1401852	0	0.87	45.73543	-61.90945	166.6	28.75	19.98	17:39:30.40
1401912	0	0.87	45.73543	-61.90945	166.6	28.75	19.98	17:39:30.40
1401972	0	0.93	45.73544	-61.90944	171.0	28.75	19.98	17:39:30.60
1402032	0	0.93	45.73544	-61.90944	171.0	27.39	16.91	17:39:30.70
1402092	0	0.93	45.73544	-61.90944	171.0	27.39	16.91	17:39:30.70
1402152	0	0.97	45.73545	-61.90944	174.1	27.39	16.91	17:39:30.80
1402212	0	0.97	45.73545	-61.90944	174.1	27.39	16.91	17:39:30.80
1402272	0	0.97	45.73545	-61.90943	174.1	45.19	24.80	17:39:30.90
1402332	0	0.97	45.73545	-61.90943	174.1	45.19	24.80	17:39:31.00
1402392	0	99.99	45.73545	-61.90943	174.1	45.19	24.80	17:39:31.00
1402452	0	99.99	45.73545	-61.90943	174.1	45.19	24.80	17:39:31.00
1402512	0	99.99	45.73545	-61.90943	174.1	45.19	24.80	17:39:31.00
1402572	0	99.99	45.73545	-61.90943	174.1	45.19	24.80	17:39:31.00
1402632	0	99.99	45.73545	-61.90943	174.1	45.19	24.80	17:39:31.30
1402692	0	99.99	45.73545	-61.90943	174.1	45.19	24.80	17:39:31.30
1402752	0	99.99	45.73547	-61.90941	174.1	29.26	17.91	17:39:31.40
1402812	0	99.99	45.73547	-61.90940	174.1	32.04	19.28	17:39:31.50
1402872	0	99.99	45.73548	-61.90940	174.1	50.74	25.09	17:39:31.60
1402932	0	99.99	45.73548	-61.90940	174.1	50.74	25.09	17:39:31.60
1402992	0	0.82	45.73548	-61.90939	183.8	50.74	25.09	17:39:31.70
1403052	0	0.82	45.73548	-61.90939	183.8	50.74	25.09	17:39:31.70
1403112	0	0.82	45.73549	-61.90939	183.8	52.18	29.21	17:39:31.80

Milliseconds	Count	HDOP	Latitude	Longitude	Altitude	Course	Speed	Time
1403172	0	0.82	45.73549	-61.90939	183.8	52.18	29.21	17:39:31.80
1403232	0	0.82	45.73550	-61.90937	183.8	55.79	31.84	17:39:31.90
1403292	0	0.82	45.73550	-61.90937	183.8	55.79	31.84	17:39:31.90
1403352	0	1.34	45.73550	-61.90937	184.9	55.79	31.84	17:39:32.00
1403412	0	1.34	45.73550	-61.90937	184.9	55.79	31.84	17:39:32.00
1403472	0	1.34	45.73550	-61.90937	184.9	55.79	31.84	17:39:32.20
1403532	0	1.34	45.73550	-61.90937	184.9	55.79	31.84	17:39:32.20
1403592	0	1.34	45.73550	-61.90937	184.9	55.79	31.84	17:39:32.20
1403652	0	1.34	45.73551	-61.90934	184.9	46.59	27.19	17:39:32.30
1403712	0	1.34	45.73552	-61.90934	184.9	51.37	24.78	17:39:32.40
1403772	0	1.34	45.73552	-61.90934	184.9	51.37	24.78	17:39:32.40
1403832	0	1.34	45.73552	-61.90934	184.9	51.37	24.78	17:39:32.40
1403892	0	1.34	45.73552	-61.90934	184.9	51.37	24.78	17:39:32.40
1403952	0	1.02	45.73553	-61.90933	187.0	51.37	24.78	17:39:32.60
1404012	0	1.02	45.73553	-61.90933	187.0	32.53	28.67	17:39:32.70
1404072	0	1.02	45.73553	-61.90933	187.0	32.53	28.67	17:39:32.70
1404132	0	1.08	45.73554	-61.90932	187.2	32.53	28.67	17:39:32.80
1404192	0	1.08	45.73554	-61.90932	187.2	32.53	28.67	17:39:32.80
1404252	0	1.08	45.73554	-61.90932	187.2	32.53	28.67	17:39:32.90
1404312	0	1.08	45.73554	-61.90932	187.2	32.53	28.67	17:39:32.90
1404372	0	1.08	45.73555	-61.90931	187.2	44.46	24.41	17:39:33.00
1404432	0	1.08	45.73555	-61.90931	187.2	44.46	24.41	17:39:33.00
1404492	0	1.25	45.73555	-61.90931	187.3	44.46	24.41	17:39:33.10
1404552	0	1.02	45.73555	-61.90931	187.0	44.46	24.41	17:39:33.20
1404612	0	1.02	45.73555	-61.90931	187.0	44.46	24.41	17:39:33.20
1404672	0	1.02	45.73555	-61.90930	187.0	50.88	19.46	17:39:33.30
1404732	0	1.08	45.73555	-61.90930	186.7	50.88	19.46	17:39:33.40
1404792	0	1.08	45.73555	-61.90930	186.7	50.88	19.46	17:39:33.40
1404852	0	1.08	45.73555	-61.90930	186.7	50.88	19.46	17:39:33.40
1404912	0	1.34	45.73555	-61.90929	186.8	50.88	19.46	17:39:33.50
1404972	0	1.34	45.73556	-61.90929	186.8	62.32	18.93	17:39:33.60
1405032	0	1.34	45.73556	-61.90929	186.8	62.32	18.93	17:39:33.60
1405092	0	1.34	45.73556	-61.90929	186.8	62.32	18.93	17:39:33.70
1405152	0	1.90	45.73556	-61.90928	188.1	62.32	18.93	17:39:33.80
1405212	0	1.90	45.73556	-61.90928	188.1	62.32	18.93	17:39:33.80
1405272	0	1.90	45.73556	-61.90928	188.1	62.32	18.93	17:39:33.80
1405332	0	1.90	45.73556	-61.90926	188.1	72.30	20.26	17:39:34.00
1405392	0	1.90	45.73556	-61.90926	188.1	72.30	20.26	17:39:34.00
1405452	0	1.90	45.73556	-61.90926	188.1	72.30	20.26	17:39:34.00
1405512	0	1.90	45.73556	-61.90926	188.1	72.30	20.26	17:39:34.00
1405572	0	1.90	45.73556	-61.90925	188.1	81.35	18.74	17:39:34.20
1405632	0	1.90	45.73556	-61.90925	188.1	81.35	18.74	17:39:34.20
1405692	0	1.17	45.73556	-61.90924	187.4	81.35	18.74	17:39:34.30
1405752	0	1.24	45.73557	-61.90924	187.1	81.35	18.74	17:39:34.40
1405812	0	1.24	45.73557	-61.90924	187.1	81.35	18.74	17:39:34.40
1405872	0	1.17	45.73557	-61.90924	186.0	81.35	18.74	17:39:34.50
1405932	0	1.03	45.73557	-61.90924	185.1	81.35	18.74	17:39:34.60
1405992	0	1.03	45.73557	-61.90924	185.1	55.58	5.87	17:39:34.70
1406052	0	1.03	45.73557	-61.90924	185.1	55.58	5.87	17:39:34.70
1406112	0	1.48	45.73557	-61.90924	183.8	55.58	5.87	17:39:34.80
1406172	0	1.48	45.73557	-61.90924	183.8	41.41	2.76	17:39:34.90
1406232	0	1.48	45.73557	-61.90924	183.8	41.41	2.76	17:39:34.90

Milliseconds	Count	HDOP	Latitude	Longitude	Altitude	Course	Speed	Time
1406292	0	1.12	45.73557	-61.90924	183.3	41.41	2.76	17:39:35.00
1406352	0	1.12	45.73557	-61.90924	183.3	41.41	2.76	17:39:35.00
1406412	0	1.48	45.73557	-61.90924	182.9	41.41	2.76	17:39:35.10
1406472	0	1.48	45.73557	-61.90925	182.9	151.18	6.41	17:39:35.20
1406532	0	1.48	45.73557	-61.90925	182.9	151.18	6.41	17:39:35.20
1406592	0	1.48	45.73557	-61.90925	182.9	151.18	6.41	17:39:35.20

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