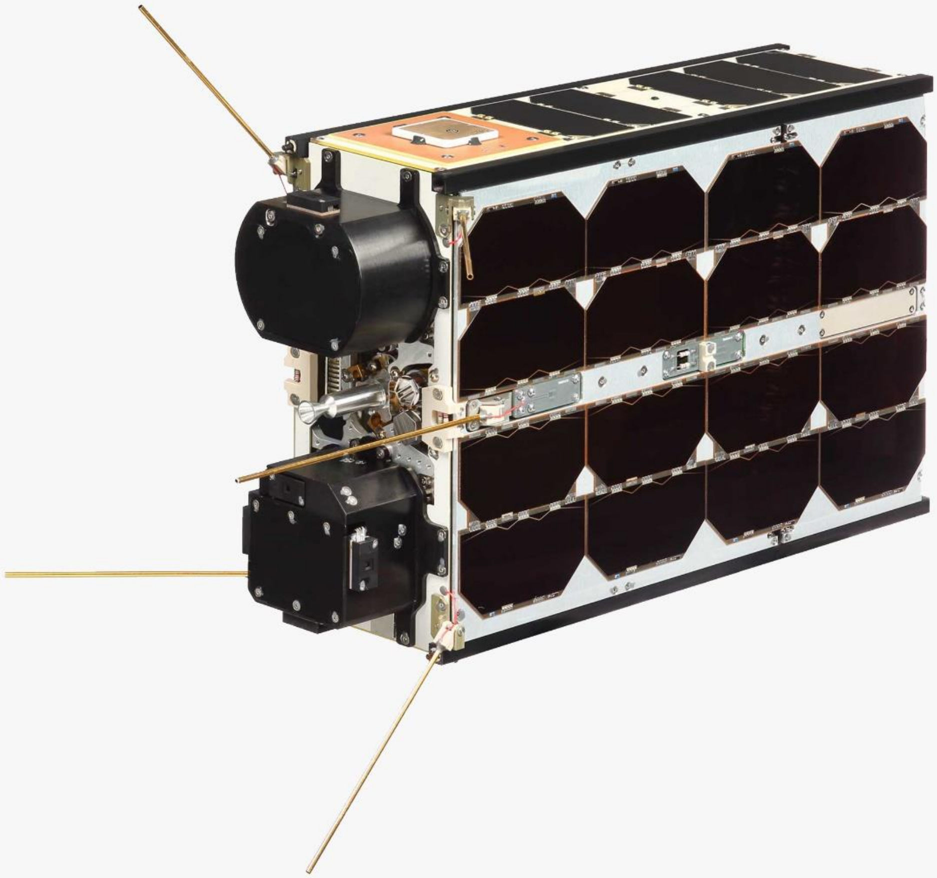

M6P Nano-Satellite In-Orbit Performance Data

Overview

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In this document NanoAvionics provides data from the satellites that are currently operating in orbit. As a realistic example the data is taken from the M6P mission that was launched on April 1st, 2019. The data is given for different subsystems. Please note that the data for different subsystems is not necessarily given for the same timestamp.

EPS

The data from the Electrical Power System (EPS) is given below in the Figure 1. The data is given for a continuous 8-hour period.

The top plot shows the solar power generation. As it can be seen, as soon as the satellite exits the eclipse, the power generation rockets. The satellite is in the Nadir pointing mode, with occasional ground station tracking periods, which explains for some of the fluctuations. The other fluctuations are due to various factors contributing to the noise, such as MPPT.

The middle plot indicates how EPS autonomously switches to battery pack supply as soon as the satellite enters the eclipse. It can be seen that the battery voltage is decreasing when the solar power generation is zero.

The bottom plot is there to illustrate the power supply to the customer's payload. This particular mission had payloads from 2 clients, in the so called rideshare configuration. Both payloads had strict working schedules, essentially rendering a requirement to turn one payload off while the other is working. The step function like behavior is observed, illustrating the on-off behavior of each payloads. Please note that these actions are carried out autonomously, based on the predefined rules. In this particular case, the predefined rules are such that Payload 2 operates only when the satellite is within the predefined coordinate bounds.

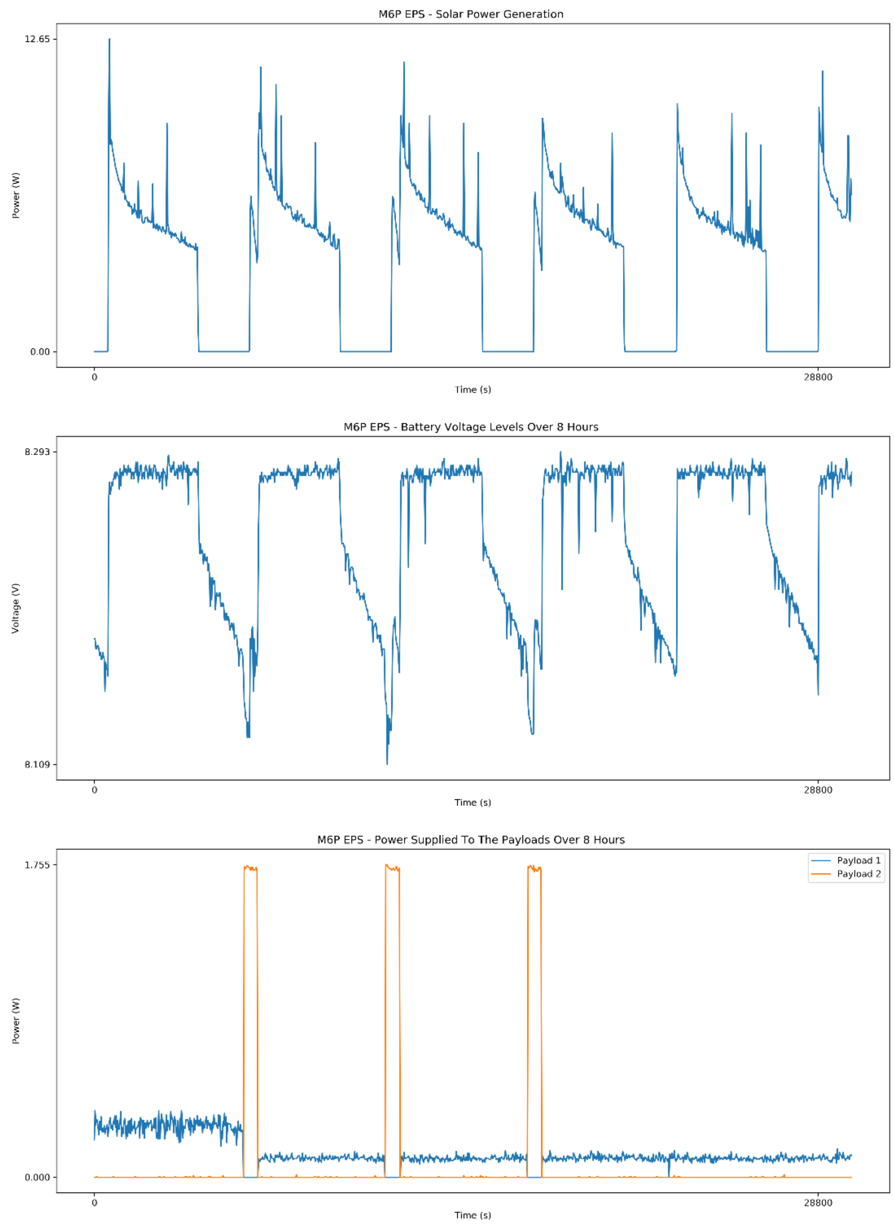

Figure 1: Plotted EPS performance from the M6P mission.

ADCS

The data from M6P Attitude Determination and Control System (ADCS) is shown in Figure 2. The top graph shows the sun-sensor readings, the middle 2 plots depicts magnetorquers and reactions wheels actions while the last plot illustrates resulting satellite rotation as derived from the gyroscope readings. In other words, the plots show what happens with the satellite going from sensing to actuation.

As it can be seen on the top plot, sun sensors behave periodically – as expected given the orbiting nature of the satellite.

The middle plots react predictably to the input from the sun sensors – reaction wheels exert "bumps" in rotation speed when re-entering sun. Also, when readings of the sun sensor are obstructed, the reaction wheels and magnetorquers react instantly.

The same can be said about gyroscope readings as well: when the satellite exists the eclipse, the reaction wheels accelerate the spacecraft to correct its attitude.

Reaction wheels are critical to the performance of the ADCS and it is worthwhile to explore them in more detail. Below, in Figure 3, the reaction wheel performance is plotted. Each plot represents one of the 4 reaction wheels present on the satellite. Each plot has two lines: the set speed of the reaction wheel and the actual speed of the reaction wheel.

As it can be seen the reaction wheels follow the set speed almost perfectly, with occasional visible discrepancies only at the sharp changed in the set speed.

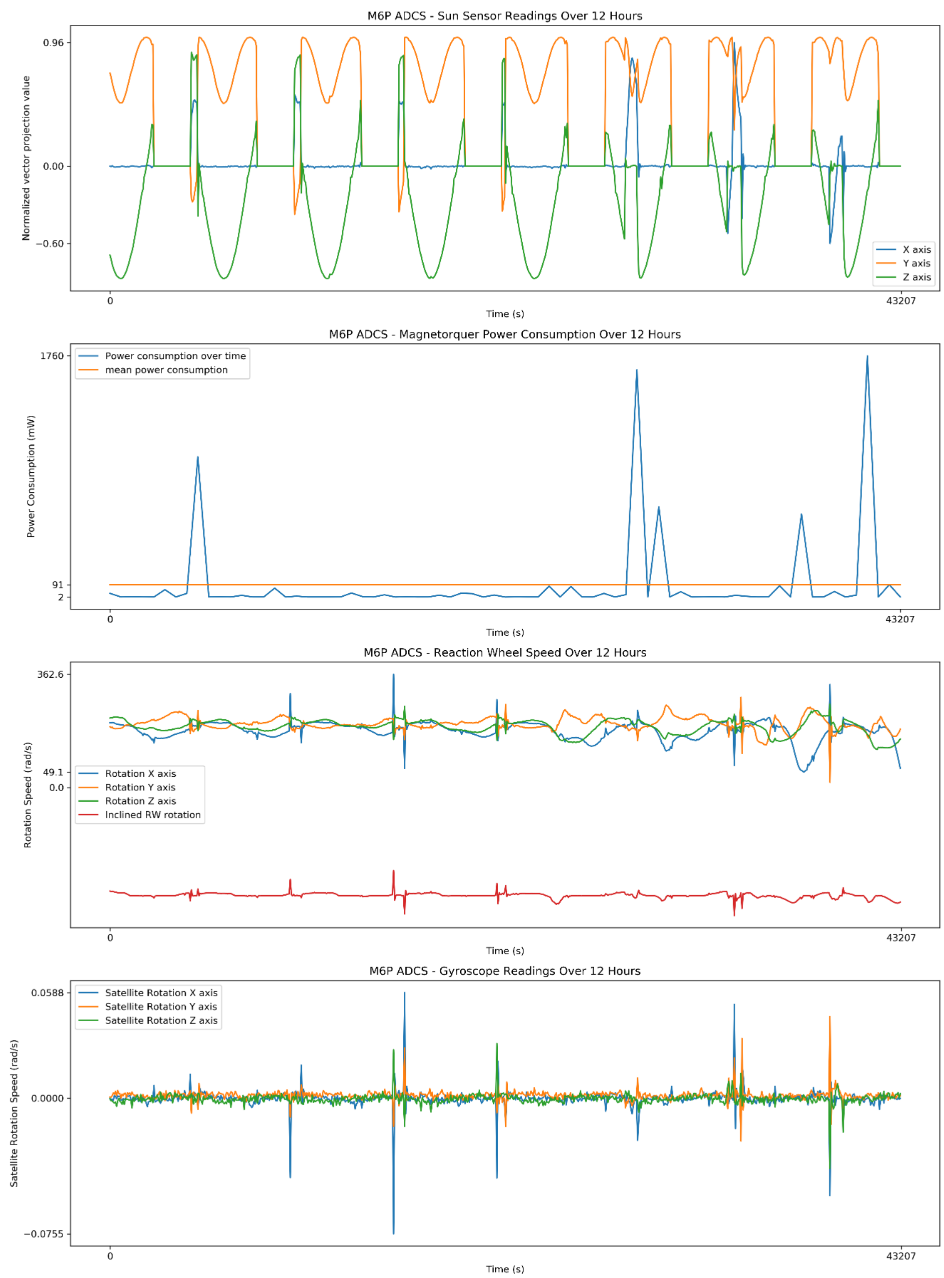

Figure 2: Plotted ADCS performance from the M6P mission.

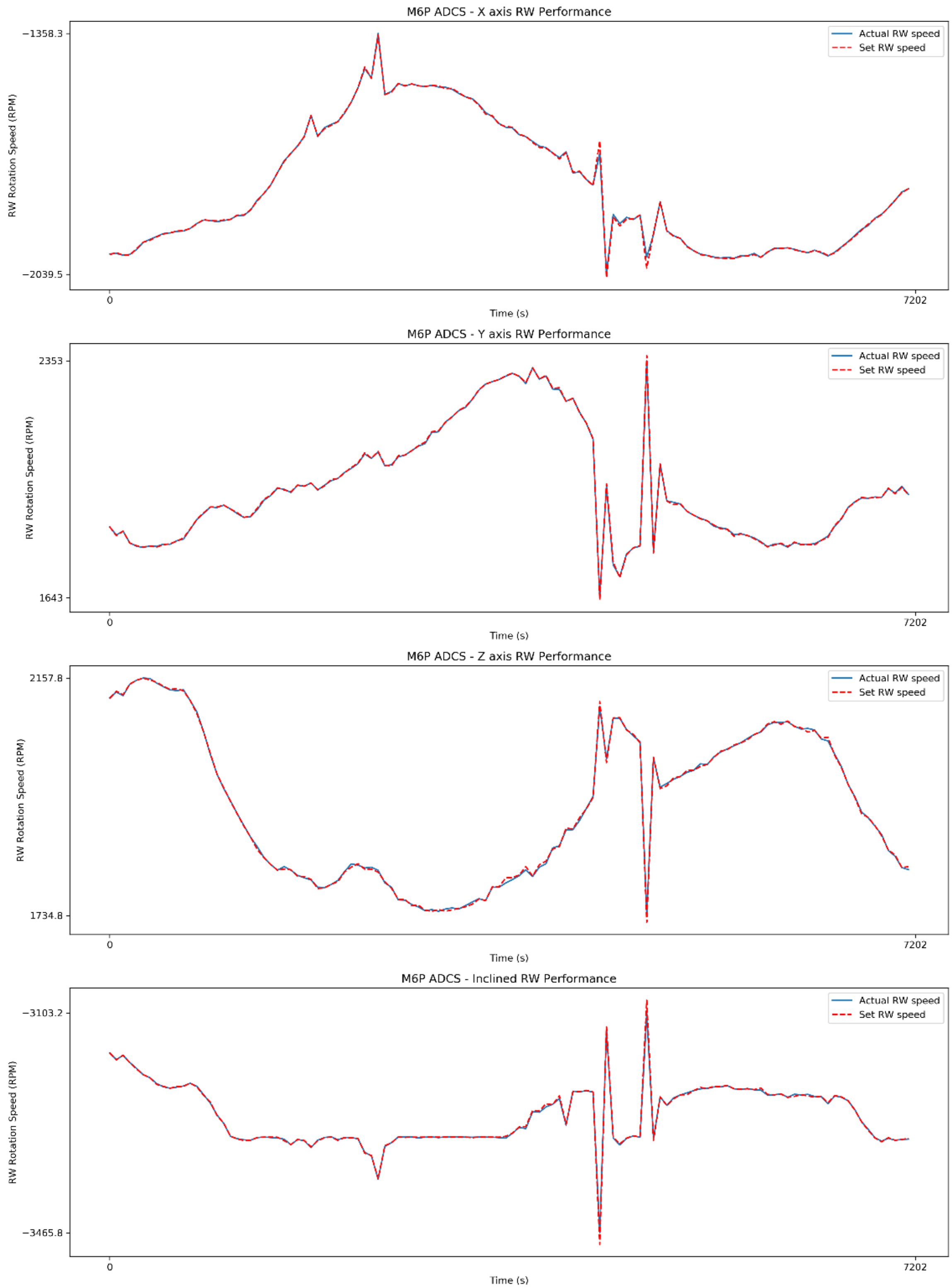

Figure 3. Plotted reaction wheels performance from the M6P mission.

PC

The data from M6P Payload Controller (PC) is shown in Figure 4. As it can be seen, the payload controller behaves nominally, executing submitted requests and storing the payload data in a synchronous manner.

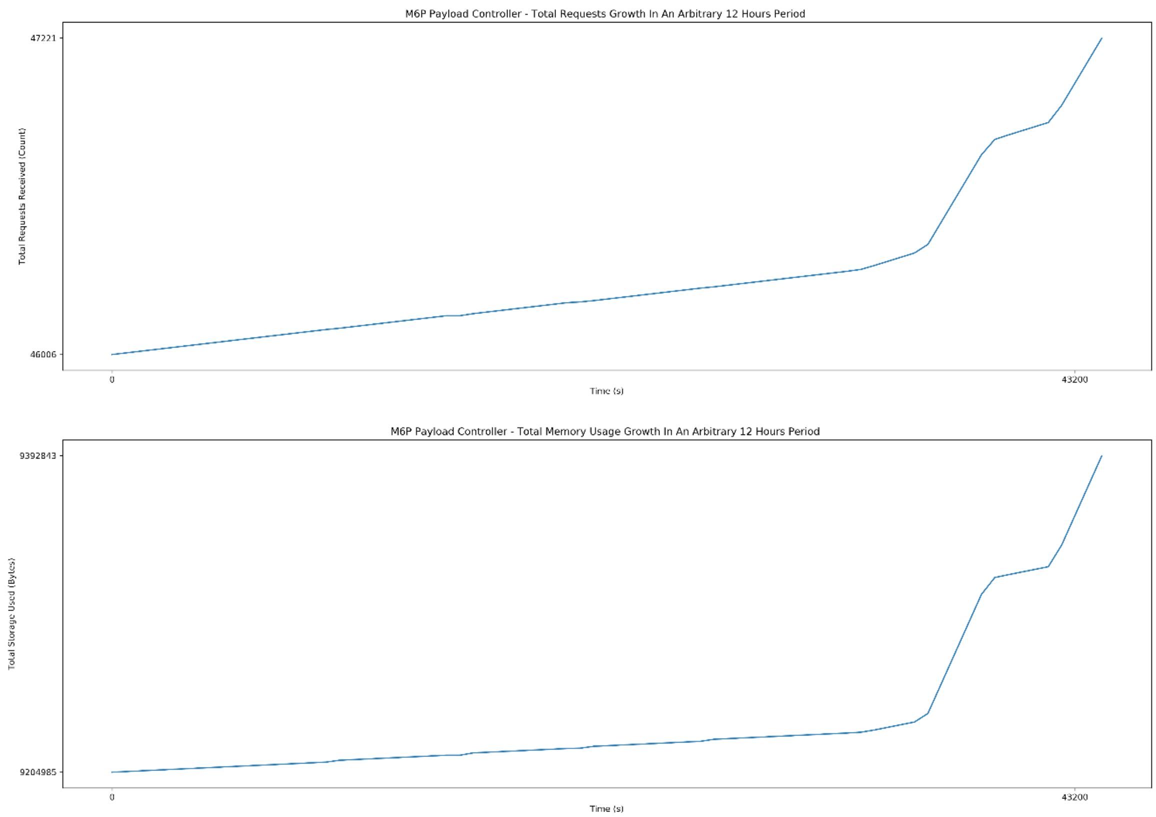

Figure 4. Plotted payload controller performance from the M6P mission.

S-Band

The data from the M6P S-band is shown in Figure 5. There are two plots visualizing the same kind of data for two scenarios. The top plot shows the number of bit & byte error corrections made by the Forward Error Correction (FEC) for low elevations of the satellite, while the bottom plot shows the same for the higher elevations.

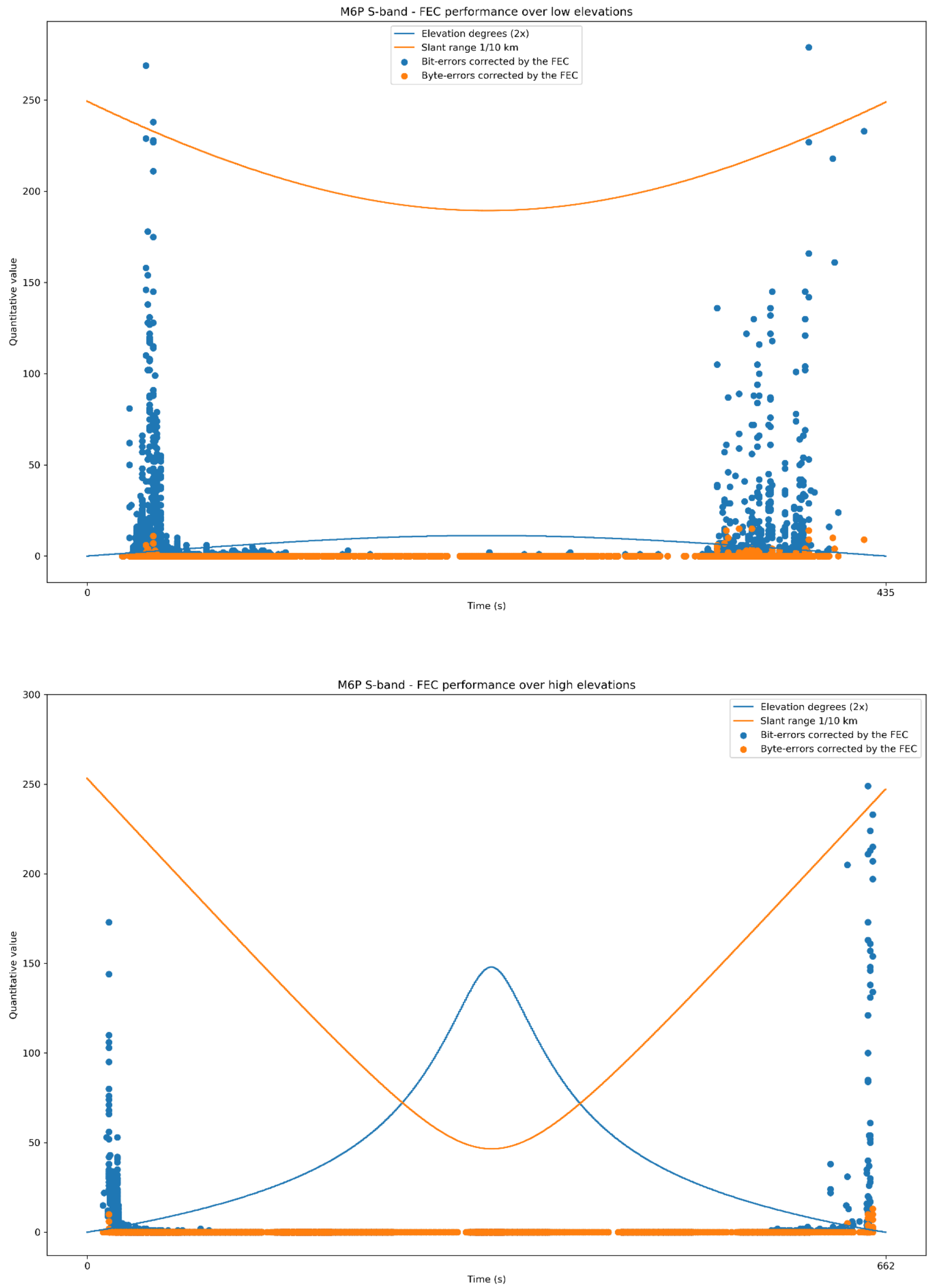

Figure 5: Plotted S-band performance from the M6P mission.

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