Delta IV launch fuel dump observed out to nearly 20 000 km

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As with many launches from the United States, South Africa was downrange along the ground track (see Fig. 2) of the launch of the military WGS 4 mission on a Delta IV rocket from Cape Canaveral, Florida, planned for 20 January 2012 at 00:38 UTC. At 01:09:36 UTC, the second stage burn was scheduled to insert itself and its payload into a highly elliptical orbit of approximately 440 X 67 000 km with the payload separating about 10 minutes later into a supersynchronous transfer orbit. The Boeing-built satellite would then use its onboard propulsion to reach geostationary orbit, matching the Earth's rotation and appear fixed above the equator to cover the Middle East and Southeast Asia. The payload was part of a network of the U.S. Air Force's Wideband Global SATCOM 4 communications spacecraft to route essential communications to U.S. military forces and improve data links to unmanned aerial drones.

I was alerted to this viewing opportunity by Greg Roberts' group of enthusiasts who specialise in tracking classified launches and payloads. With their vast knowledge and experience of previous launches and with the limited information published on this mission, orbital analysts Ted Molczan and Mike McCants calculated a probable orbit. Using this element set, Greg did a detailed prediction for Sutherland where I happened to be at the time and this showed that the rocket would come out of the Earth's shadow at about 03:12 SAST, 18 degrees above my northern horizon, at a range of about 2 600 km. It would still climb a few degrees as it moved NE, before starting to dip towards the eastern horizon.

A very exciting prospect that presented an interesting viewing possibility, was a series of scheduled propellant dumps. After payload separation the 2nd stage rocket would first perform a short burn to separate itself from WGS 4. This manoeuvre, called the Collision and Contamination

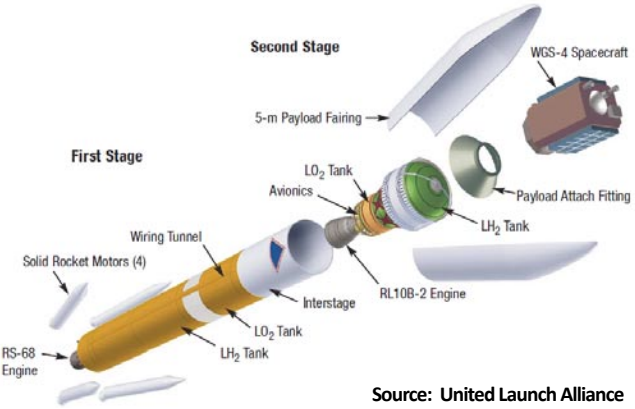

Fig. 1: Details of the rocket stages and payload are shown here. The fuel dump originated from the 2nd stage after payload separation.

Source: United Launch Alliance

Avoidance Manoeuvre (CCAM – see Fig. 2) is intended to put a bit of distance between the two and enable the 2nd stage to dump any remaining propellant without risk of colliding with its payload or spraying it with fuel. Such dumps of excess hydrogen, oxygen and hydrazine have become standard these days to completely depressurise spent rocket bodies, minimising any possibility of an explosion or involuntary orbital changes. Visibility for me was however far from ideal, due to the predicted ultra-low elevation of the 2nd stage above my horizon at the time of the fuel dump. At this point the rocket would be almost halfway to Australia so observing it from the Sutherland SAAO observing plateau with its unobstructed horizons and dark conditions was thus very fortunate.

I set my alarm for 02:15 and upon getting up, I immediately checked the weather which looked fair, as seen from the hostel. Since the predictions were only valid if the launch occurred on time it was very useful (and exciting) to watch it live on the Internet. A textbook launch set the scene for some great viewing. As I headed up the plateau at 03:00, two possible obstacles became apparent; some scattered cloud along the flight path and a crescent Moon rising in the east, just about where the fuel dump should happen.

Since I was not aware of the launch when I packed for my Sutherland trip, I was ill prepared and only "armed" with my camera and a small tripod that lives in my locker. After an unsuccessful search to borrow a pair of binoculars from one of the domes,

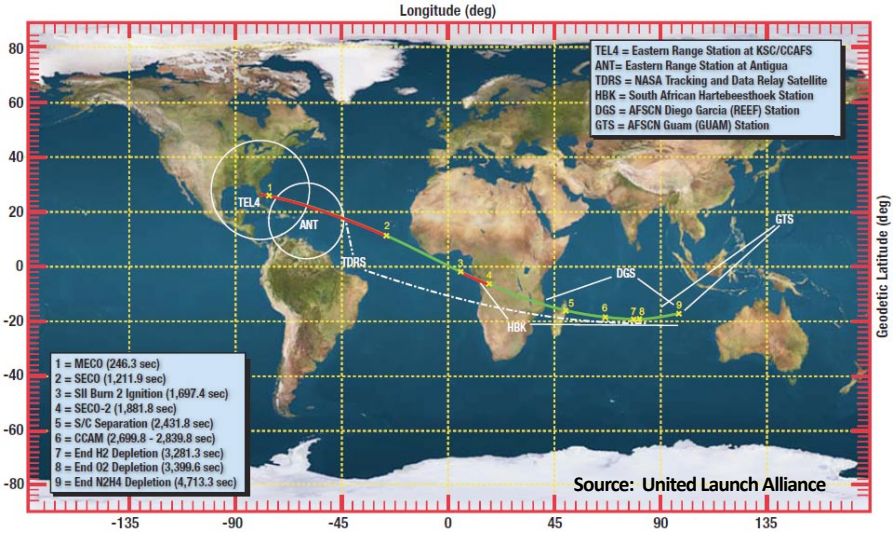

Fig. 2: Ground track of the launch with all the trajectory burns as well as the telemetry downlinks indicated. The observed fuel dump happened between points 8 & 9.

I set up the camera in a clear spot amongst the domes. It has a function to shoot a sequence up to 10 consecutive pictures which I set up to do 15 second exposures at full aperture. Since no satellite could be seen, I just aimed the camera blindly along the predicted path, shooting through scattered cloud all the time. It was rather disappointing when I reached the end of the predictions and still saw nothing. At about the time when the hydrogen and oxygen dumps were scheduled to be finished, I reached the end of an of exposure sequence. I was ready to give up and head back to bed. Conditions due to cloud and the Moon in the target area were not ideal. However, for good measure, I decided to shoot one last series of exposures for incase the orbital elements or predictions were off.

Then, suddenly I noticed it! A bright blob appeared to the left and below the Moon, in between the cloud layers! Checking the camera's display as every new picture appeared, it was seen to be slowly moving! The rapidly expanding gas plume, back-illuminated by the sun, created a brilliant cloud. It was still getting brighter. An easy naked eye object, even though right next to the Moon, behind thin cloud and very low on the horizon. In order to reduce the glare of the Moon, I placed the camera such that a dome was obscuring it. I continued shooting until nearly 04h00 by which time it was starting to disappear into the cloud and had dimmed substantially.

I was now wide awake and before sharing the excitement with the others, back at the hostel, I first downloaded the pictures from my camera to scrutinise them thoroughly. No trace of the satellite during the early part of the orbit was recorded. The first appearance of the fuel dump on my pictures was at 03:35. Comparing this to the launch schedule, both the hydrogen and oxygen dumps had just finished by then. Hydrazine depletion was scheduled to finish at 03:56 SAST which was obviously what

Fig. 3: A single 15 second exposure shows the fuel dump as a bright 1 degree blob (arrowed), easily visible, even with the crescent Moon close by and through thin cloud. This picture was taken at about 03:50 SAST when the 2nd stage was only at elevation 3.7 degrees and 16 700 km range. At 16 700 km radius, one degree is about 290 km, giving an idea of the actual size of the fuel cloud.

Fig. 4: Five 15-second exposures were stacked to produce this image, showing the satellite leaving a streak as it moved. The Moon was deliberately obscured by the building to try and reduce its glare.

I saw. At that time the comet-like cloud was 8.1 degrees above the horizon and at a range of about 11 500 km. I eventually managed to follow it to just 2.6 degrees elevation and 18 800 km distant, then at an altitude of 13 700 km above the Earth. The fact that it was still visible to the naked eye at this enormous distance, gives an idea of how bright it was. It is actually surprising that no sightings from further east were reported.

Before getting a little more sleep, I sent off a quick report and pictures to Ted, Mike and Greg who were all very thrilled. Ted's final report, posted to the SeeSat mailing list (http://satobs.org/seesat/Jan-2012/0270.html), sums up this remarkable "collaboration" nicely: "Thank you, Willie for getting up in the middle of the night to make these observations and for sharing them with us. Thank you also to Mike McCants who noticed the opportunity and alerted Greg Roberts, who alerted Willie about it. Greg also stayed up for the event in the faint hope that his overcast sky would clear; alas it did not." But to give credit where it's due, Ted's element set was virtually spot on which was the key to making this observation possible. ☆