EPSC Abstracts
Vol. 10, EPSC2015-609, 2015
European Planetary Science Congress 2015

Rosetta mission status: challenges of flying near a comet

P. Martin (1), M. Taylor (2), M. Kueppers (1), L. O'Rourke (1), S. Lodiot (3) and the Rosetta RSGS and RMOC teams
(1) European Space Astronomy Centre, Madrid, Spain, (2) European Space Technology Centre, The Netherlands, European Space Operations Centre, Germany (patrick.martin@sciops.esa.int)

Abstract

Recent operational events, most likely due to the increased presence of dust near the spacecraft during close flybys of C67P/Churyumov-Gerasimenko in the comet escort phase, have led to a redefinition of the Rosetta mission through the design of new trajectories allowing the spacecraft and its payload to continue flying safely around the comet while augmenting the wealth of scientific data and results that has characterized the beginning of the mission so far. A decision process is being put in place in view of finding the best ways forward operationally so as to recover some capabilities that will allow Rosetta to continue optimising its scientific mission, in both the nominal and expected extended mission intervals.

1. Introduction

The Rosetta nominal mission is in full swing, following successful exit from hibernation in January 2014, the subsequent approach to C67P/Churyumov-Gerasimenko in the Summer of that year, and the astonishing touchdown of its Philae lander on the surface of the comet on 12 November 2014. With gained experience flying near the comet, down to a 10-km bound orbit, the ESA operations teams were confident of remaining very close to the comet through the perihelion passage due to occur this August. However, two very close flybys in early 2015 have demonstrated the difficulties of remaining close to a comet whose activity is on the increase. The following sections describe the events and ongoing activities of the process developed to adapt to the new, evolving situation.

2. The C67P/C-G Escort Phase

Having dropped the Philae lander module in its final resting place of Abydos on the comet's surface, the Rosetta spacecraft has continued to orbit C67P/Churyumov-Gerasimenko through bound orbits until early February 2015, in view of further characterizing the small body. The post-landing operations initiated the so-called Comet Escort Phase, designed for the orbiter spacecraft to follow the comet on its path toward the Sun and back in the course of 2015.

Since 4 February the mission no longer could fly bound orbits around the comet but was designed to fly, until the end of the nominal mission, dedicated trajectory patterns which included a number of flybys at varying distances adapted to the scientific needs of the mission (Figure 1). The first one was the closest flyby to be flown, on 14 February, with the spacecraft passing at 6 km from the comet's surface. The second very close flyby occurred on 28 March.

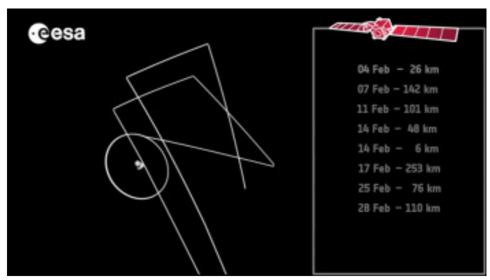

Figure 1. Example of Rosetta's planned flyby trajectories at Comet 67P/C-G. Credit: ESA.

3. Close Flybys Operational Events

However, during the 14 February flyby, with the spacecraft so close to the comet environment, severe star tracker issues were experienced and the spacecraft was very close to ending up in safe mode.

During the second close flyby performed on 28 March other, worse star tracker (STR) issues were experienced, despite measures taken to address those that had occurred during the first close flyby. Tracking issues started at 50 km from the comet, with tracking fully lost at 23 km. Tracking was recovered on the outbound leg of the flyby on 29 March, at a distance of 75 km from the comet, after around 24 hours with no STRs. But at that time there was a clear indication of High Gain Antenna off-pointing, with the imminent risk of losing contact from the ground. During recovery actions, on-board surveillances checking consistency between STR and gyro measurements triggered twice (due to STR locking on dust particles seen as false stars), the second one of which leading to safe mode.

With no indication of degraded STR optics, and tracked stars being measured with expected magnitude, both STRs behave in the same way and the above issues only seem to appear close to the comet where the number of particles is expected to be much larger. As a result of these operational events, the spacecraft performance in a more active environment is being characterised and mitigation measures explored so as to minimise both likeliness and impact of reoccurrence.

4. Adapting Rosetta's Trajectories

As a result of the safe mode, Rosetta moved onto an 'escape trajectory' taking it approximately 400 km from Comet 67P/C-G. An orbital correction manoeuvre was executed on 1 April to start to bring the spacecraft back again toward the comet, and with a second manoeuvre executed on 4 April, the target distance of 140 km was reached on 8 April.

But as a consequence of the star tracker issues, confidence in flying the spacecraft in the close vicinity of the comet has been damaged, therefore close flybys are not possible for the time being. A path to rebuild confidence and re-establish science operations in the coming weeks, while ensuring the safety of the spacecraft, had to be chosen.

A revised science operations plan was agreed for the months ahead leading to perihelion, using a trajectory scheme of pyramid and terminator arcs starting at around 100 km but with the aim of optimising the distance to the comet over time. The Rosetta Science Ground Segment (RSGS) and Rosetta Mission Operations Centre (RMOC) teams are assessing the optimal trajectories and the pointing capabilities of such trajectories. At the same time, lander communication opportunities have to be reassessed.
Three of these pyramid trajectories (Figure 2) are currently planned up until the end of April. The RMOC operations team will assess the situation each week before deciding to move closer or, if necessary, to move further away again.

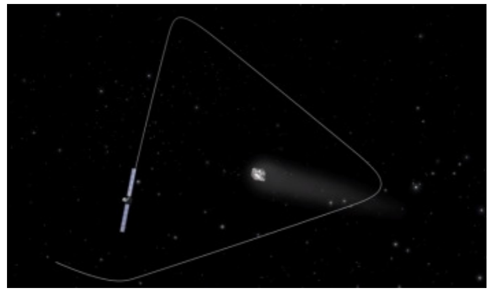

Figure 2: An example of 'pyramid' trajectories close to the comet. Credit: ESA.

Adapting the Rosetta mission to such trajectory schemes may allow flying closer to the comet again in the near future, albeit with significant constraints and limitations required for spacecraft safety in an increasingly active comet environment.

In addition to the above issues, the Rosetta teams have to monitor the state of the spacecraft reaction wheels. One of the reaction wheels actually started displaying increasingly high friction levels early in 2015, which led the RMOC operations team to recommend bringing maximum wheel speeds to lower values. This has been applied and will result in slightly longer spacecraft slew durations, while wheel speeds will be monitored, and will have a small impact on science.

5. Summary and Conclusions

At time of writing, Rosetta continues to recover well from the significant operational problems experienced during the close flybys of 14 February, and over the weekend of the 28th of March that resulted in the spacecraft entering safe mode. The scientific payload is now switched back on again, acquiring invaluable data from the nearby C67P/C-G.

Scientific and operations teams are now dedicating most of their activities toward optimising the already replanned and future science observations and associated spacecraft pointings in connection with newly adapted flight trajectory schemes. As we move forward and closer to perihelion, with a foreseen increase in comet activity, we will analyse what can be further modified and improved in order to maximise science return within the capabilities of the Rosetta spacecraft. Those are the challenges of flying really close to a comet approaching the Sun.