Supplementary notes.

In considering the instrument background it must be noted that a unique feature of the Ptolemy instrument was the nano-tip ionisation source. The choice of this type of electron ionisation source was driven by mass and power constraints on the spacecraft. The Ptolemy electron source consists of an array of 1600 nano-tips which generate an electron beam by field effect emission when a voltage of ~80 V is applied between the tips and gate electrodes. As a consequence the ion source is only switched on during the ionisation phase (~10% duty cycle) of the mass spectrometer operation (Morse et al. 2016) and is off at all other times. Whereas with electron sources created by hot filaments considerable time (~hours) is required from switch on before measurement to allow the source to reach a stable temperature and to outgas.

Measurements of the background levels are confounded by spacecraft operations during the Cruise and Pre-landing phases of the mission with the Lander normally shielded from the sun and maintained at a temperature of around -30⁰C. Table 1 is a list of results from the pre-delivery operations where Ptolemy was operated in the same way for each of the Abydos and Agilkia measurements. The closest scenario to the Abydos measurements were those made during the Lutetia asteroid flyby (12:10 on 10-July). Here Ptolemy made measurements at approximately hourly intervals whilst the orientation spacecraft tracked the asteroid. In pre-asteroid rehearsals, ROSINA detected an increase in spacecraft outgassing when instruments were switched on, lasting several hours. To avoid interfering with the ROSINA measurements the Lander and Ptolemy were switched on 4 hours before close approach and remained on until the end of the forth measurement to allow the outgassing pulse to subside. The increase in water at close approach is attributed to outgassing as the spacecraft rotated so that instruments could track the asteroid. For the fifth measurement Ptolemy was switched on and operated as at Abydos.

Table 1. Background measurements made at the comet prior to Lander delivery and during the asteroid flyby. Ptolemy temperature is the temperature measured by Ptolemy housekeeping data with a resolution of 1.8⁰C. Ptolemy is located within the Philae thermal compartment.

|  |  |  |  |
| --- | --- | --- | --- |
| Date | Time (UTC) | Ptolemy Temperature (⁰C) | Ion intensity (ion counts) |
| ‘Water’(m/z 16 to 19) | ‘Carbon monoxide’(m/z 28 and 29) | ‘Carbon dioxide’(m/z 44 and 45) |
| Pre-Delivery Science and Calibration  |
| 13-07-2014 | 22:39 | -28.9 | 149 | 3 | 16 |
| 14-07-2014 | 13:09 | -23.0 | 81 | 5 | 7 |
| 15-09-2014 | 09:04 | -32.8 | 68 | 3 | 14 |
| 06-10-2014 | 15:39 | -32.8 | 65 | 4 | 1 |
| 07-10-2014 | 20:04 | -23.0 | 96 | 1 | 6 |
| 16-10-2014 | 15:04 | -30.8 | 112 | 5 | 10 |
| 17-10-2014 | 18:34 | -21.0 | 117 | 5 | 5 |
| Average ± 1 stdev | 98 ± 30 | 3.7 ± 1.5 | 8.4 ± 5.3 |
| Lutetia flyby |
| 10-07-2010 | 13:20 | -32.8 | 43 | 4 | 7 |
| 10-07-2010 | 15:10 | -28.8 | 85 | 1 | 21 |
| 10-07-2010 | 15:53 | -25.0 | 158 | 6 | 15 |
| 10-07-2010 | 17:10 | -21.0 | 129 | 3 | 6 |
| 10-07-2010 | 16:10 | -21.0 | 118 | 1 | 3 |
| Average ± 1 stdev | 107 ± 44 | 3.0 ± 2.1 | 10.4 ± 7.4 |

The results from table 1 indicate that the instrument background was for H20, CO and CO2 was 100, 4 and 10 ion counts respectively, whilst Philae was attached to the space craft and at temperatures ranging from -30⁰C to -20⁰C. ⁰C

Philae was at a relatively high temperature during the landing, however it had been at this higher temperature in the days before lander release and also had a seven hour decent. It is notable that the by the forth Abydos measurement the measured ion intensities are at or below background measurements made on the spacecraft even though the Lander was still at a temperature of -3.5⁰C. Philae outgassing as a source of the background during the first 4 Abydos measurements is considered unlikely as the temperature only dropped from 0.4⁰C to -3.5⁰C during these 8 hours.