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# Preliminary analysis of PFS/MEx observations of Comet Siding Spring

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## Abstract

On October 19th 2014, Mars experienced a close encounter with Comet C/2013 A1 (Siding Spring), at a distance of 138,000 km. We analyze observations by the Planetary Fourier Spectrometer (PFS) [1] onboard Mars Express performed between October 13th and October 21st 2014 to search for spectral signatures of the comet and to investigate possible effects of its passage on the suspended dust and ice content in the Martian atmosphere.

## 1. Measurements and datasets

*PFS Observations*

PFS observations dedicated to the Siding Spring comet flyby were performed between October 13th and October 21st 2014, and in particular around the closest approach (19 October 2014 at 18:28 UT, Ls 217). Given the large FoV of PFS (1.52° FWHM for the Short-wavelength channel, SWC, and 2.69° FWHM for the Long-wavelength channel, LWC; [2,3]), and the large distance of the target, the spectral signatures of the comet, if any, are expected to be very weak in the PFS spectra, and most likely to be observed only around the closest approach. We used the SPICE-enhanced Cosmographia Mission Visualization Tool v3.0 [4,9] for a 3D visualization of Mars Express, Mars and the comet at closest approach (Figure 1). As the two PFS channels have slightly different boresight directions, we used the WebGeocalc online tool [5] with the latest kernel of the comet to investigate when the comet is expected to be within the PFS SWC and LWC FoV. As a result, for the day of the closest approach, we found four time windows (Table 1).

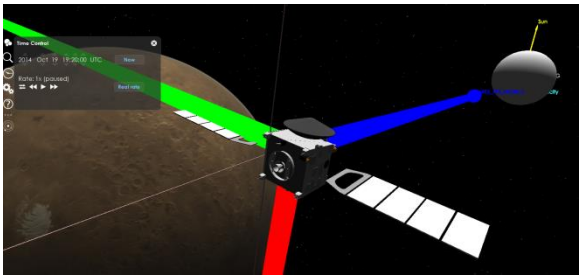


***Figure 1:*** 3D visualization of Mars Express, Mars and the comet at closest approach with the SPICE enhanced Cosmographia Mission Visualization Tool v3.0. The comet is defined with a sphere of 15,000 km (inner coma). The blue vector represents the PFS SWC nadir boresight.

| | Start Time | Stop Time | Duration (secs) |
|---|---|---|---|
| 1 | 2014-10-19 15:31:29.430102 UTC | 2014-10-19 15:51:53.160819 UTC | 1223.73071754 |
| 2 | 2014-10-19 19:20:26.581536 UTC | 2014-10-19 19:21:02.702504 UTC | 36.12096786 |
| 3 | 2014-10-20 03:26:38.262334 UTC | 2014-10-20 03:57:42.493487 UTC | 1864.23115331 |
| 4 | 2014-10-20 20:26:33.985109 UTC | 2014-10-20 21:01:19.595671 UTC | 2085.61056215 |

| | Start Time | Stop Time | Duration (secs) |
|---|---|---|---|
| 1 | 2014-10-19 15:30:05.761012 UTC | 2014-10-19 15:56:53.407226 UTC | 1607.64621437 |
| 2 | 2014-10-19 19:20:20.371114 UTC | 2014-10-19 19:21:09.958563 UTC | 49.58744907 |
| 3 | 2014-10-20 03:26:24.454111 UTC | 2014-10-20 03:57:59.363859 UTC | 1894.90974790 |
| 4 | 2014-10-20 20:26:24.136971 UTC | 2014-10-20 21:02:19.138034 UTC | 2155.00106317 |

***Table 1***: Time windows, for the day of the closest approach, when the Siding Spring comet is expected to be within the PFS SWC (top panel) and LWC (bottom panel) FoVs.

*PFS Retrievals*

We use PFS retrievals of suspended dust and water ice opacity [6,7,8] to investigate possible effects of

Comet Siding Spring's passage on the suspended dust and ice content in the Martian atmosphere.

## 2. Preliminary analysis

Clear spectral signals in the PFS data could only be detected for the MEX orbit 13709, which is exactly when PFS observed Siding Spring around its closest approach. Three spectra can be easily distinguished from the others in both the SWC and the LWC, being well above the instrumental noise level. We can also exclude a random/unusual fluctuation of the PFS spectra, because the three spectra correspond in the two channels (same spectrum number in both channels). We confirm that these spectra were acquired within the time window when the Siding Spring comet was inside the PFS SWC and LWC FoV (Table 1). Given the large distance, the comet is only a small percentage of the PFS FoV, but this seems to be enough to measure some signal in the thermal range. Proper calibration and interpretation of these PFS spectra will be challenging. We performed PFS retrievals for the observations recorded during 126 MEX orbits. We separated all observations performed before 19 October 2014 from those performed after this date. We binned data in 1° of latitude. The results are shown in Figure 2.

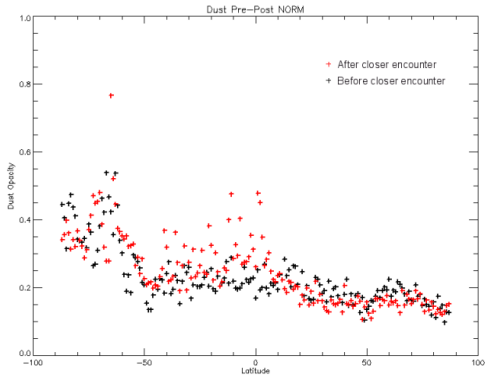



***Figure 2:*** PFS dust opacities retrieved in October 2014 before (black crosses) and after (red crosses) the closest approach

Dust Opacities are normalized to the mean Martian surface pressure (6.1 mbar). Black crosses in Figure 2 are for observations performed before the closest approach, while Red crosses are for subsequent observations. These preliminary results indicate an increase of dust in the Martian atmosphere after the comet's closest approach, especially in the latitude range 40°S-10°N.

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## References

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