PFS MEASUREMENTS AND STATISTICS BETWEEN ORBIT 17 AND 116 OF MARS EXPRESS MISSION.

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Introduction:

The initial orbits of the future Mars Express Mission have already been planned. Orbits between 1 and 16 are in the phase after the Mars Orbit Insertion used to stabilize and commissioning the spacecraft prior to reach the so called "superfrozen groundtrack". Routine science operations will begin starting from orbit 17. Some of these orbits are not Nadir pointing but 3 axis stabilized with the High Gain Antenna for telecommunications in "Earth Pointing Phase" in the period around the pericentre, as requested by MaRS, the Radio Science experiment. During this period, the pointing direction of PFS is continuously changing respect to nadir and our procedures calculate when the track is on the planet's surface and when we are looking at the limb. In this paper we show the results of some simulations we made to know what kind of measurements we will have for PFS after the first month (one month is about 100 orbits) of the Mars Express mission.

*** THE REST OF THIS ABSTRACT HAS BEEN WROTE USING AN OLD VERSION OF THE ORBIT PARAMETERS AND IS USED ONLY TO SHOW THE POTENTIALITY OF SUCH A STUDY ***

Spatial Coverage:

After first month, 27 orbits will be with PFS operating in Mode 1, that is PFS measuring full interferograms in the Short and Long Wavelength Channel (respectively SWC and LWC).

Among these, 17 orbits will be 3 axis stabilized with the High Gain Antenna for telecommunications in "Earth Pointing Phase". This kind of measurements is of primary importance for PFS because it's the only way for us to take measurements at limb. These measurements will be used to study the temporal and spatial behaviour of aerosols suspended in the Martian atmosphere, and in the search for minor constituent of the atmosphere.

In Figure 1 are shown all the orbits for operation Mode 1 of PFS, drawn following the time operation and attitude limitations for each orbit as in the Master Science Plan.

The spots are representative of the real footprint size on the planet; yellow spots are daily measurements, red ones are nightly.

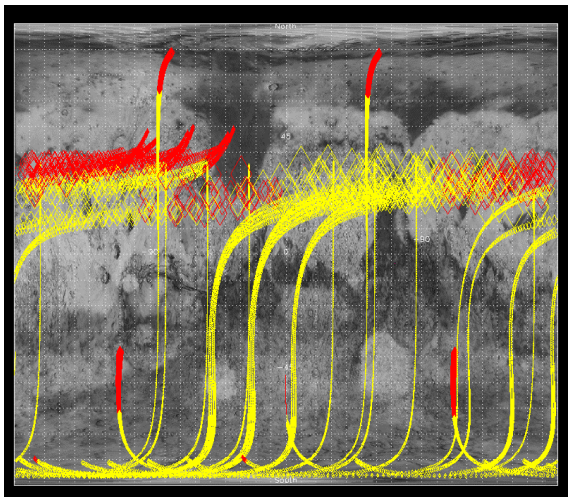

Figure 1, Spots on the planet when PFS is operating in Mode 1. Red spots are nightly observations, yellow ones are daily.

During the 17 orbits in the 3 axis stabilized phase, we have 680 minutes of operations. Among these measurements, 2457 are at limb condition, that is the field of view don't cross the surface of Mars. In this range there are 30 measurements with the air mass along the path of radiation received by our instrument greater than one. In Figure 2 are shown the histograms for the air masses calculated for limb observations. For a better visualization of data, the air masses between 0 and 1 are plotted in base 10 logarithmic scale.

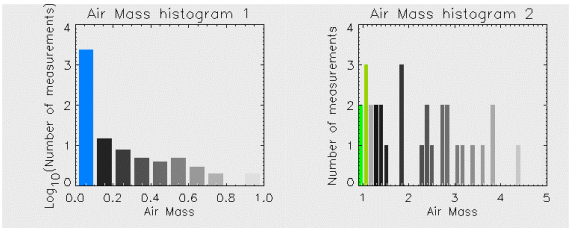

Figure 2, Histograms for air masses between 0 and 1 (left one, in logarithmic scale) and air masses greater then 1 (right

one) for the spots that do not cross the planet surface.

The remaining 4343 measurements in the 3 axis stabilized phase, have the planet surface inside the field of view. The air masses histogram for these measurements is shown in Figure 3.

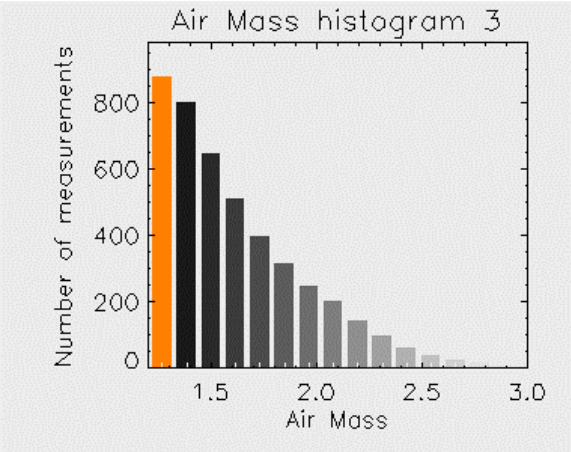

Figure 3, Histogram for air masses of planet crossing spots.

Note that for the first month of observations we decided to operate in Mode 1 all the times the spacecraft is in the 3 axis stabilized phase.
Globally there are 27 orbits in operating Mode 1, 1222 minutes of activity, 12220 interferograms and 1620 calibrations.
In the remaining 74 orbits PFS is "Nadir viewing" and will take measurements in the operating Mode 9, that is modules of Spectra in the SW and LW Channel. In Figure 4 are shown all the orbits for operation Mode 9 of PFS, drawn following the time limitations for each orbit as in the Master Science Plan (MSP). The spots are representative of the real footprint size on the planet; yellow spots are daily measurements, red ones are nightly.

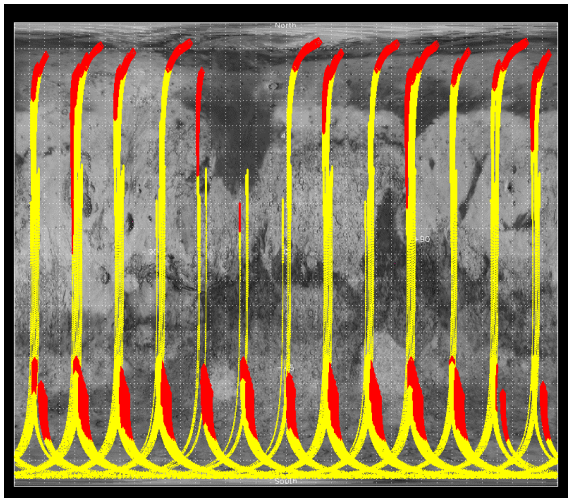

Figure 4, Spots on the planet when PFS is operating in Mode 9.

For the 74 orbits in operation Mode 9, we have a total of 5200 minutes of activity, with 52000 spectra and 4440 calibrations.
Globally, in this first period of PFS operations we have 101 orbits, 6422 minutes of activity, 64220 measurements and 6060 calibrations.
The Mars Express spacecraft runs on a polar orbit, so during the first month of activity, many measurements will be taken over the two polar caps. We estimated that during this period of observations (Ls between 330 and 347) the North Polar Cap will extend to 70°N of latitude while the South Polar Cap is centred around –86.5°S, 30°E. Globally we have 1959 measurements of North Polar Cap, 1064 in the day side and 895 in the night. For the South Polar Cap we have 1364 measurements: all in the day side. In Figure 5 are shown the results for the two polar caps. The spots are representative of the real footprint size on the planet; yellow spots are daily measurements, red ones are nightly.

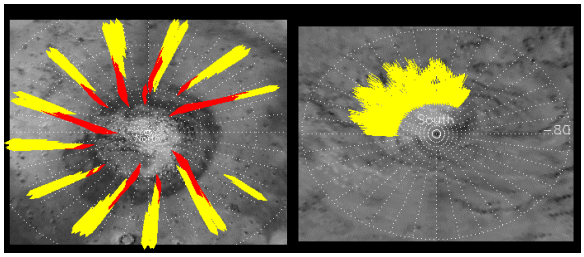

Figure 5, Spots on the North Polar Cap (left one) and South Polar Cap (right one). Yellow spots are the day side, red ones are night.

In Figure 6.1, 6.2 are shown respectively the footprint sizes histograms for the spots on the North Polar Cap and on the South Polar Cap.

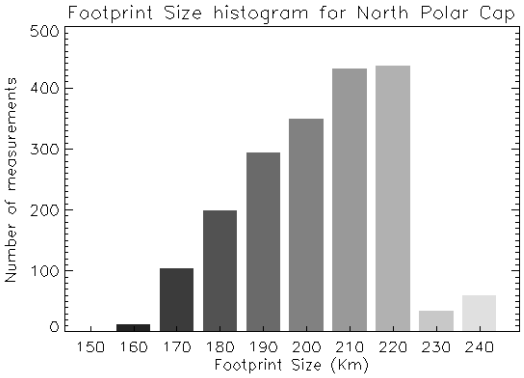

Figure 6.1, Footprint sizes for the spots on the North Polar Cap.

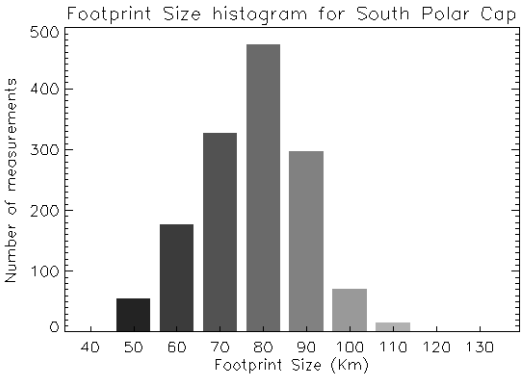

Figure 6.2, Footprint sizes for the spots on the South Polar Cap.

Temporal coverage:

During the first month of mission, observations will span all the local times but will be located principally around morning and night hours.

The afternoon measurements are due to the case with 3 axis stabilized, when the increasing angle respect to the nadir cause the spots for a single orbit to be spread along almost all the longitudes.

In Figure 7 are shown the local times for the 101 orbits following the time of operations and attitude limitations as described by the MSP.

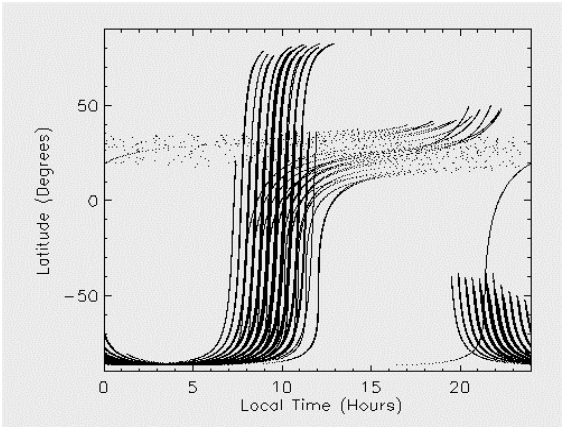

Figure 7, Local Times versus Latitudes following the MSP for the first month of observations.

Note that only the centre of the spot is plotted, without regarding for the real footprint size.

In Figure 8 we show the Local Times data on histogram with the number of measurements for each time interval. The local time bins are defined as one hour.

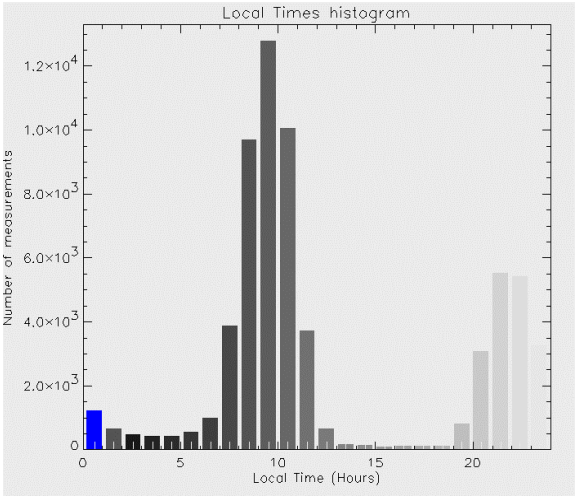

Figure 8, Local Times versus Number of Measurements histogram for the first month of observations.

Altitude and Altimetry coverage:

It's interesting to know the target distance for all the observations, so to know the footprint size. For observations at pericenter (250 Km above the surface) the footprint diameter is about 9 Km; it becomes 100 Km around 3000 Km of altitude from the planet surface. In Figure 9 we show a histogram of Altitudes versus Number of Measurements for the whole first month of operations. The Altitude range is divided in 100 Km wide intervals. From this picture we can see that most of our measurements will be taken between 250

and 1500 Km of altitude respect to the planet surface, so that the footprint diameter will be between 9 and 50 Km.

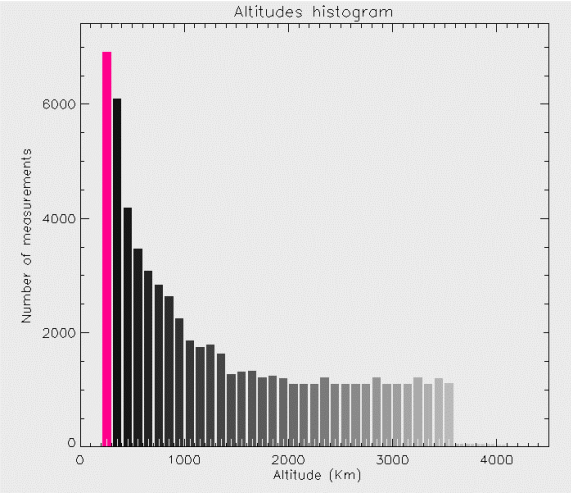

Figure 9, Altitudes versus Number of Measurements histogram for the first month of observations.

Using the Mars Observer Laser Altimeter (MOLA) data we can determine the altimetry of the locations in the center of the spot for each PFS measurement. During the first month we will take many measurements in the Tharsis region and Hellas basin; altimetry data will be very useful for our studies on vertical distribution of water vapour, structure of the atmosphere on the flanks of great volcanoes, surface properties related to volcanic domes and basins.

In Figure 10 is shown the histogram of Altimetry versus Number of Measurements (plotted in base 10 logarithmic scale for a better visualization of data) for the first month of operations. The Altimetry range is divided in 1000 Km wide intervals. Minima values are for measurements inside the Hellas Basin, maximal are for the Tharsis region.

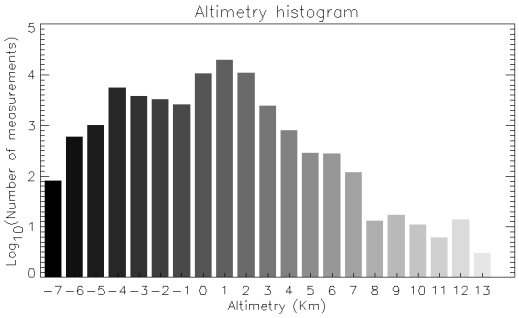

Figure 10, Altimetry versus Log10(Number of Measurements) histogram for the first month of observations.

The Beagle-2 Encounter:

The Beagle 2 project is the British led effort to land on Mars as part of the European Space Agency's Mars Express Mission.

Five days before the Mars Express reaches the planet, Beagle-2 will be separated from the spacecraft and will reach the Martian surface following parachute braking and inflation of gas-filled landing bags.

The landing is currently scheduled for 26 December 2003. The landing site is centred near 11°N, 270°W, in eastern Isidis Planitia.

The floor of this basin exhibits chains of pitted ridges, numerous smaller meteor impact craters, and a variety of light-toned ripples and small dunes.

The scientific payload of Beagle-2 is composed by the Mass Spectrometer, three cameras, sample collector, Mossbauer spectrometer, the X-ray detector and seven environmental sensors.

The science targets for Beagle-2 are the search for criteria relating to past life on Mars on the surface, seek trace atmospheric species indicative of extant life, appraise the environmental conditions including temperature, pressure, wind speed, UV flux, oxidation potential, dust environment etc.

It's important for PFS to know which orbit crosses the Beagle2 landing site, so to compare our retrieved surface pressure, temperature, water vapor and atmospheric dust content with the ones measured by Beagle-2.

Conclusions:

In the first month of observations PFS will take a lot of measurements for different locations, Local Times and attitude of satellite. Note that in only one month we will take three times the number of spectra measured from IRIS spectrometer on Mariner 9 for the whole mission.

The spatial coverage of the entire planet will be achieved after about 9 months, but in this first month several interesting targets, like the Tharsis region and Hellas basin, will be well covered.

Limb observations will be possible when the spacecraft is 3 axis stabilized with the High Gain Antenna for telecommunications in "Earth Pointing Phase".

Local Times will be concentrated around the morning and night hours.

Distances from the target will span from 250 Km at pericentre (with the footprint

diameter size of 9 Km) to about 4200 Km (footprint diameter around 140 Km). Most of the measurements will be taken with target distances between 250 and 1500 Km of altitude respect to the planet surface, so that the footprint diameter will be between 9 and 50 Km.

We will compare our retrieved values of pressure, temperature, water vapor and atmospheric dust content with the ones measured by Beagle2.

All these results, achieved just in the first month of operations, are a good start for a mission with a nominal duration of 2 years and a possible extended duration of 2 years too.