ONE MARTIAN YEAR OF MARS EXPRESS SCIENCE OPERATIONS PLANNING. R. Pischel[1,6], T. Zegers[1], F. Jansen[1], A. Chicarro[1], P. Martin[1], H. Walker[2], M. Denis[3], A. Moorhouse[3], E. Rabenau[4], S. Peschke[3], J. Schulster[5], C. McCarthy[1];
[1]ESA-ESTEC, Keplerlaan 1, 2201 AZ Noordwijk ZH, The Netherlands; (rene.pischel@rssd.esa.int), [2]Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire OX11 OQX, UK, [3]ESA-ESOC, Robert Bosch Strasse 5, 64293 Darmstadt, Germany, [4]NOVA Space Associates Ltd, 11 Kingsmead Square, Bath, BA1 2AB, UK, [5]Scisys Space GmbH Robert Bosch Strasse 7, 64289, Darmstadt, Germany, [6]Deutsches Zentrum für Luft- und Raumfahrt (DLR), German Aerospace Center, Institute for Planetary Research; Rutherfordstr. 2, 12489 Berlin, Germany

Introduction: Europe's Mars Express mission has achieved the milestone of 1 Martian year in orbit, after its arrival at Mars in December 2003. During the 23 months of the nominal mission the spacecraft has orbited Mars 2400 times and the 7 payload experiments have acquired outstanding scientific data. This paper describes the science operations for Mars Express throughout the nominal mission, emphasising on how the original science mission goals have been achieved, on the impact on the science return of the varying constraints during different mission phases and on special operations such as the link demo tests between the Mars Express lander communications package and the MER rovers.

Optimum Science Return: Mars Express' elliptical orbit provides ideal science opportunities for the suite of orbiter instruments, varying from monitoring the plasma environment (ASPERA) and the atmosphere (PFS, SPICAM, MaRS) to high-resolution surface imaging (HRSC, OMEGA) and sub-surface sounding (MARSIS). The diversity of the ambitiously set science goals for various instruments, plus the continuous variability in the combination of the main mission parameters (pericentre latitude and illumination, occultations, eclipses, data rate, solar distance; see Fig. 1) lead to a high complexity of the Mars Express science operations. This is further constrained by the spacecrafts fixed high gain antenna which prevents data transmission to Earth during science pointings, and aggravated by the reduced spacecraft power limiting the science operations capabilities during low- power periods (long eclipses, very far Mars- Sun distances).

Throughout the nominal mission the pericenter latitude moved from the South pole to the North pole and back: during the 3 phases of favourable illumination conditions HRSC has covered 24% of the Martian surface in stereo and color at high resolution better than 20 m/pixel and OMEGA has covered the entire surface with its global resolution mode of a few km resolution. After its deployment in June 2005 MARSIS has started to provide startlingly detailed insight into the Martian sub- surface. During the different seasons SPICAM and PFS have made global measurements of the density and pressure of the atmosphere between 10 and 100 kilometers altitude, and ASPERA studied atmospheric escape processes in the upper layers of the atmosphere. Three occultation periods were used for MaRS radio science measurements.

By building up a global data set for composition and characteristics of the surface, subsurface and atmosphere, Mars Express has revealed new aspects of Mars and its history.

A valuable part of the planning flexibility and of the amount of downloaded data was gained by the availability of the NASA DSN stations which are routinely used by Mars Express.

The MEX-MER link: In addition to the nominal science operations, special observations have been conducted which were not part of the original Science Plan. For example, the Mars Express orbiter-lander communication package Melacom (initially installed for the link with the Beagle 2 lander) was used for link tests with the MER rovers. These tests included tracking the MER carrier signal and measurement of it's Doppler shift during overflights. MEX also commanded the U.S. rover and acquired images taken by the MER cameras which were subsequently downlinked to the ESA control centre. These tests demonstrate MEX' capability to support the tracking of and the communication with future NASA Mars lander missions as the MEX mission could potentially last for a number of years even after the extended mission.

Conclusion: During its nominal mission of one Martian year the European Mars Express mission has been contributing in building a new legacy of Mars imagery, subsurface and atmospheric data and in updating our view of Mars, its history and evolution. This has been done with optimum use of spacecraft and ground segment resources.

The mission extension for another Martian year gives Mars Express ample opportunities to continue fulfilling and exceeding its scientific mission goals.

References: [1] R. Pischel et al, (2005), *36. LPSC*, Abstract #1017; [2] Martin P. et al (2001) *32. LPSC* Abstract #1575

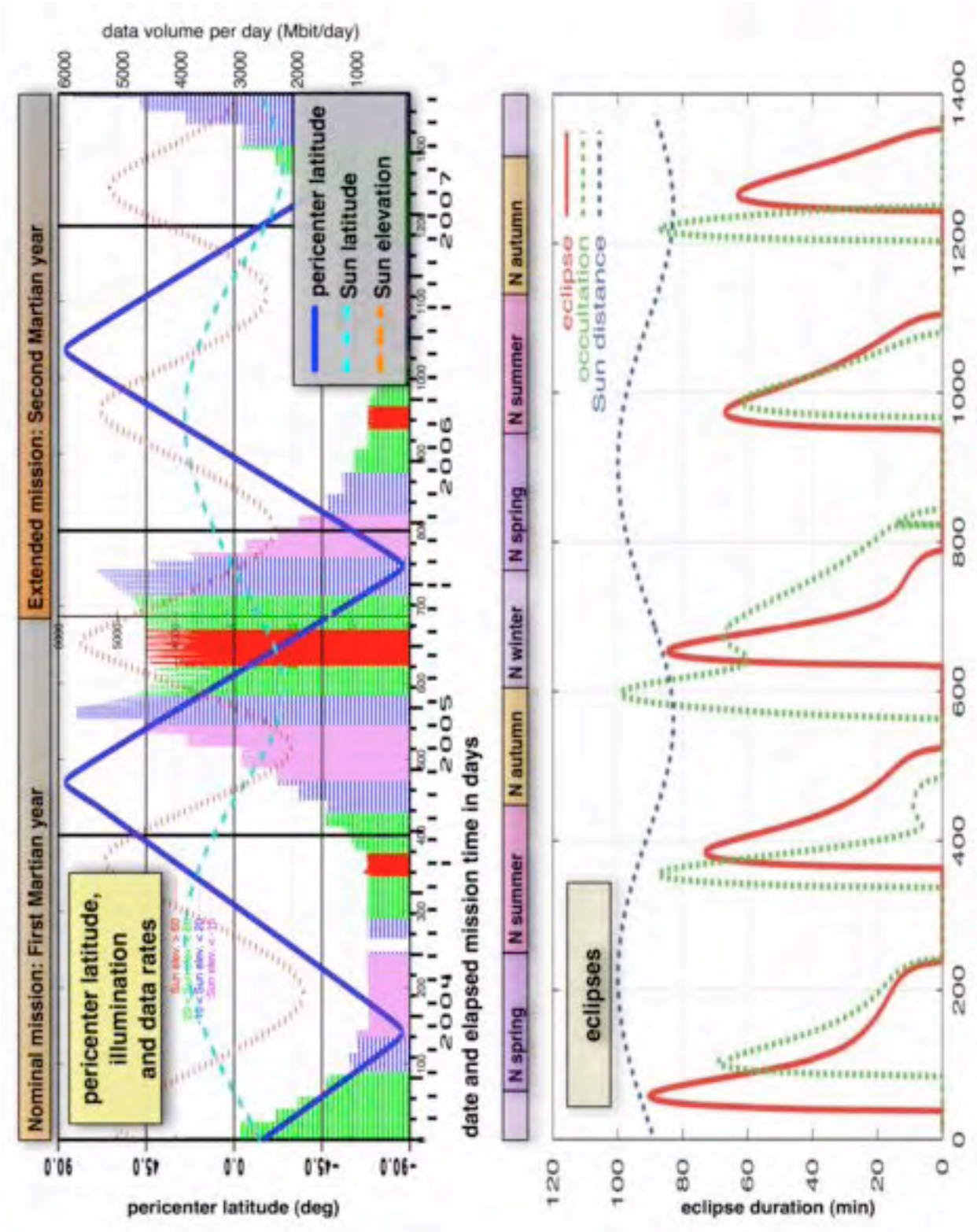

Fig. 1: MEX mission characteristics over 2 Martian years (Nominal and Extended Mission: left- pericenter latitude coverage (blue line), Sun elevation at pericenter (dashed dark orange line) both in deg and referring to the left axis; data volume assuming an average of 8 hours downlink per day in Mbit (bars, different colors reflect different solar elevation at pericenter) referring to the right axis; right- eclipse duration (red line) and occultation duration (dashed green line) in minutes referring to the left axis; all parameters are related to elapsed mission days starting 1. January 2004