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MEX-PFS

To Planetary Science Archive Interface Control Document

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Table of Contents

1 Introduction ... 1

1.1 Purpose and Scope ... 1

1.2 Archiving Authorities ... 1
1.2.1 ESA's Planetary Science Archive (PSA) ... 1

1.3 Contents ... 1

1.4 Intended Readership ... 1

1.5 Scientific Objectives ... 2

1.6 Applicable Documents ... 2

1.7 Relationships to Other Interfaces ... 3

1.8 Acronyms and Abbreviations ... 3

1.9 Contact Names and Addresses ... 4

2 Overview of Instrument Design, Data Handling Process and Product Generation ... 5

2.1 Technical description ... 6
2.1.1 Module O ... 6
2.1.2 Optical scheme of PFS-O ... 7
2.1.3 Mechanical description of PFS-O ... 8
2.1.3.1 The optical bench ... 9
2.1.3.2 The pendulum system ... 9
2.1.3.3 The gas-tight box ... 9
2.1.4 *Thermal description of PFS-O* ... 9
2.1.4.1 The thermal control ... 10
2.1.4.2 The ASTRA system ... 10

2.2 Detailed Scientific Objectives ... 10

2.3 Data Handling Process ... 11

2.4 Overview of Data Products ... 12
2.4.1 In-Flight Data Products ... 12
2.4.2 Software ... 12
2.4.3 Documentation ... 16
2.4.4 Derived and other Data Products ... 16
2.4.5 Ancillary Data Usage ... 16

3 Archive Format and Content ... 17

3.1 Format and Conventions ... 17
3.1.1 Deliveries and Archive Volume Format ... 17
3.1.2 Data Set ID Formation ... 17
3.1.3 Data Directory Naming Convention ... 18
3.1.3.1 Cruise and Near Earth Verification Phase Data Directory Structure ... 18
3.1.3.2 Nominal and Extended Mission Phase Data Directory Structure ... 18
3.1.4 File naming Convention ... 19

3.2 Standards Used in Data Product Generation ... 21
3.2.1 PDS Standards ... 21
3.2.2 Time Standards ... 21
3.2.2.1 START_TIME and STOP_TIME Formation ... 21
3.2.2.2 SC_CLOCK_START_COUNT and SC_CLOCK_STOP_COUNT ... 21
3.2.2.3 On-Board Time (OBT) to UTC time conversion ... 22
3.2.3 Cartographic Standards ... 22

3.3 Data Validation ... 22

3.3.1 Internal Data Validation 22
3.3.2 PSA and External Validations (Peer Reviews) 22

3.4 Content 23
3.4.1 Volume Set 23
3.4.2 Directories 23
3.4.2.1 ROOT Directory 24
3.4.2.2 Catalog Directory 24
3.4.2.3 Calib Directory 24
3.4.2.4 Calib_Samples Directory 25
3.4.2.5 Data Directory 25
3.4.2.6 Document Directory 26
3.4.2.7 Extras Directory 26
3.4.2.8 Index Directory 27
3.4.2.9 Geometry Directory 27
3.4.2.10 Label Directory 28
3.4.2.11 Software Directory 28

4 Detailed Interface Specifications 28

4.1 Structure and Organization Overview 28

4.2 Data Sets, Definition and Content 29

4.3 Data Product Design 30
4.3.1 Data Product Design 30
4.3.1.1 File Characteristics Data Elements 30
4.3.1.2 Data Object Pointers Identification Data Elements 30
4.3.1.3 Identification Data Elements 31
4.3.1.4 Instrument Related Parameters 31
4.3.1.5 Data Object Definition 32
4.3.2 Data Product B Design 36
4.3.2.1 Geometry Product A Design 36

5 Appendix: Example of Directory Listing of PFS Data Set 38

6 Appendix: Complete Label file Examples 43

1 Introduction

1.1 Purpose and Scope

The purpose of this EAICD (Experimenter to (Science) Archive Interface Control Document) is twofold. First, it provides users of the MEX-PFS instrument with a detailed description of the product and a description of how it was generated, including data sources and destinations. Secondly, it is the official interface between the Planetary Fourier Spectrometer (PFS) instrument and the archiving authority at the European Space Agency (ESA).

1.2 Archiving Authorities

The Planetary Data System Standard is an archiving standard used by

- NASA for U.S. planetary missions, implemented by the PDS
- ESA, for European planetary missions, implemented by the Research and Scientific Support Department (RSSD) of ESA.

1.2.1 ESA's Planetary Science Archive (PSA)

ESA implements an online science archive called the PSA:

- to support and ease data ingestion
- to offer additional services to the scientific user community and science operations teams, such as:
  - search queries that allow searches across instruments, missions and scientific disciplines
  - several data delivery options, such as:
    - direct download of data products, linked files and data sets
    - ftp download of data products, linked files and data sets

The PSA aims for online ingestion of logical archive volumes and will offer the creation of physical archive volumes on request.

1.3 Contents

This document describes the data flow of the PFS instrument on Mars Express (MEX), from the spacecraft until ingestion into the PSA for ESA. It includes information on how data were processed, formatted, labeled and uniquely identified. The document discusses general naming schemes for data volumes, data sets, data and label files. Standards used to generate the product are explained. Software that may be used to access the product is explained further on.

The design of the data set structure and the data product is provided. Examples of these are given in the appendix.

1.4 Intended Readership

This document will be of interest to any user who is interested to understand the format, design and content of the PFS data products and datasets. This will include any potential user of the MEX-PFS data sets and the staff of the archiving authority (Planetary Science Archive, ESA, RSSD, design team).

1.5 Scientific Objectives

PFS is capable of investigating both the atmospheric and surface properties of Mars, as well as the interaction between the two. The primary scientific objectives include:

- Three dimensional modelling of the current Martian climate, including physical and chemical parameters, and mapping of circulation features throughout the Mars Express mission
- Mapping seasonal variations of the atmosphere and the thermal properties of the Martian surface
- Constraining the mineralogical properties of the surface layer of Mars

Details of the individual scientific objectives and a breakdown on the measurements PFS will take to achieve these goals can be found in Section 2.2.

1.6 Applicable Documents

Rif.	Reference	Notes
[1]	Planetary Data System Standards Reference, August 1, 2003, Version 3.6, JPL, D-7669, Part 2	
[2]	Mar Express Archive Generation, Validation and Transfer Plan, May 10, 2003, Rev 1.1, ESA-MEX-TN-4009	
[3]	The Planetary Fourier Spectrometer (PFS) onboard the European Mars Express mission	see DOCUMENT/ PFS_ON_MARS_EXP RESS.PDF
[4]	Calibration of the Planetary Fourier Spectrometer Short Wavelength Channel	see DOCUMENT/ PFS_SWC_CALIB.PD F
[5]	Calibration of the Planetary Fourier Spectrometer Long Wavelength Channel	see DOCUMENT/ PFS_LWC_CALIB.PD F
[6]	PFS Flight User Manual 9, Tm_Tc interface	see DOCUMENT/ PFS_MEX_FUM9.PDF
[7]	PFS Flight User Manual 1, Instrument Description	see DOCUMENT/ PFS_MEX_FUM9.PDF
[8]	Master Science Plan Overview Documentation, Part I – Introduction MEX-EST-PL-11912	
[9]	RMCS/MMCS/VMCS Data Delivery Interface Document MEX-ESC-IF-5003	
[10]	ESA Packet Telemetry Standard ESA-PSS-04-106	
[11]	MEX-PFS-NEV-REPORT PFS Near Earth Verification Operations Report	

1.7 Relationships to Other Interfaces

- Other interfaces that have an impact upon the generation, packaging, distribution and documentation involved in the PFS dataset / volume production include:PFS raw data: these are produced from telemetry and are used to produce the PDS compliant data found in the PFS datasets. Any reprocessing of these data, for any reason, will have a direct impact upon the data provided in the datasets produced by PFS.
- SPICE data: The SPICE data used to to produce the GEOMETRY information (see Section 3.4.2.6) are retrieved from ESTEC / NAIF. Any changes made to these files will directly affect the GEOMETRY information provided in the dataset.
- Software libraries: The PSA and NAIF software libraries used for SPICE and for the generation of the geometry index file. If these libraries are update, this could lead to the generation of new geometry files for the PFS datasets.
- PFS software: software used to pipeline the PFS data to the PDS format. If this software is changed, there will be a direct impact upon the final PFS datasets.
- PFS calibration procedures: the calibration procedures affect the PFS calibrated data. Details of the calibration procedures are provided in [3] and [4].
- PSA Delivery Requirements: Any changes made to the requirements for the delivery of datasets to the PSA could change the way the PFS datasets are to be packaged and distributed.
- PVV software: The PSA Volume Verification (PVV) software is used to validate the PFS datasets before they are ingested into the Planetary Science Archive at ESA. Any updates to this software could require updates to the PFS dataset deliveries.
- Mars Express Archive Plan [2]: Any update to the Mars Express Data Archive Plan [2] can affect the design, packaging and / or deliver of the PFS data products and data sets.

1.8 Acronyms and Abbreviations

ADC	Analog Digital Converter
APID	Application Process Identifier
A/D	Analog-to-digital
CTE	Coefficient of Thermal Expansion
DDS	Data Distribution System
DOF	Degree Of Freedom
DTM	Data Transmission Mode
FFT	Fast Fourier Transformation
FOV	Field Of View
FUM	Flying User Manual
FWHM	Full width at half maximum
HK	Housekeeping
IB	Internal Blackbody
IDL	Interactive Data Language
ICD	Interface Control Document
IFSI	Istituto di Fisica dello spazio Interplanetario
INAF	Istituto Nazionale di Astrofisica
LW	Long Wavelength
MEX	Mars Express
MLI	Multi-Layer Insulation
NEB	Noise Equivalent Brightness
NER	Noise Equivalent Radiance

OB	On-Board
OBDM	Optical Bank Digital Module
OBS	On Board Software
PDF	Portable Document Format
PDS	Planetary Data System
PFS	Planetary Fourier Spectrometer
PNG	Portable Network Graphics
PSA	Planetary Science Archive
PVV	PSA Volume Verifier
SCET	Spacecraft Elapsed Time
SW	Short Wavelength
TRW	TRW Incorporeted
ZOPD	Zero Optical Path Difference

1.9 Contact Names and Addresses

The following persons are involved in the PFS instrument design and data archiving:

Institute	Name	E-Mail	Telephone	Position
INAF-IFSI	**Formisano**, Vittorio	formisano@ifsi-roma.inaf.it	+390649934362	Principal Investigator
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INAF-IFSI	**Giuranna**, Marco	giuranna@ifsi-roma.inaf.it	+390649934042	Calibrations responsible

2 Overview of Instrument Design, Data Handling Process and Product Generation

PFS is a double pendulum interferometer working in two wavelength ranges (1.2 – 5.5 and 5.5 - 45 µm). Mars radiation is split into 2 beams by a dichroic mirror and then filtered so that the two ranges also correspond to 2 planes, one on top of the other, in which the two interferometers are placed. In this way, the same motor can simultaneously move the 2 pendulums, and the two channels are sampled simultaneously and independently. The pendulum motion is accurately controlled by means of a laser diode reference channel making use of the same optics as for Martian radiation.
The same laser diode also generates the sampling signal for the A/D converter, measuring displacements of the double pendulum mirror of 600 nm (sampled 4 times per movement, back or forward).
The measurements obtained are double sided interferograms, so that on-board FFT can be computed without caring much about the zero optical path difference location.

Table 1 - *DETAILED PFS SCIENTIFICS PARAMETERS*

PARAMETERS	SW	LW	UNITS
SPECTRAL RANGE	*1.2 - 5.5*	*5.5 – 45*	*[µm]*
SPECTRAL RANGE	*1700 - 8200*	*250 - 1700*	*[cm^{-1}]*
SPECTRAL RESOLUTION (by triangular apodization)	*1.3*	*1.3*	*[cm^{-1}]*
FOV FWHM	*1.6*	*2.8*	*(deg)*
NEB	*$5\ 10^{-9}$*	*$4\ 10^{-8}$ (1)*	*[$W\ cm^{-2}\ sr^{-1}$]*
MEASUREMENT CYCLE DURATION	*8.5*	*8.5*	*[s]*
DETECTOR TYPE	*Photoconductor*	*Pyroelectric*	-
MATERIAL	*PbSe*	*$LiTaO_3$*	-
SHAPE/SIZE	*Square / 0.7x0.7*	*Round / r=1.4*	*[mm]*
NEP	*$1\ 10^{-12}$ (2)*	*$4\ 10^{-10}$ (3)*	*[W/Hz^5]*
SENSITIVITY	*90 (2)*	*30 (3)*	*[KV/W]*
TEMPERATURE	*220 (4)*	*290*	*[K]*
INTERFEROMETER TYPE	*Double Pendulum*	*Double Pendulum*	-
REFLECTING ELEMENTS	*Cubic corner reflectors*	*Cubic corner reflectors*	-
BEAMSPLITTER	*CaF_2*	*CsI*	-
REFL. ELEMENTS MOTION	*+/- 1.5*	*+/- 1.5 (5)*	*[mm]*
MAX OPTIC PATH DIFFER.	*5*	*5*	*[mm]*
TIME FOR MOTIONS	*5*	*5*	*[s]*
TIME FOR MEASUREMENTS	*4.5*	*4.5*	*[s]*
REFERENCE SOURCE	*Laser diode*	*Laser diode*	-
REF. SOURCE WAVELENGTH	*1216*	*1216*	*[nm]*
COLLECTOR OPTICS	*Parabolic mirror*	*Parabolic mirror*	-
DIAMETER	*49*	*38*	*[mm]*
FOCAL LENGTH	*20*	*20*	*[mm]*
COATING	*Gold*	*Gold*	-
SW/LW SEPARATION	*KRS-5 with a multilayer coating reflecting SW radiation*		-
OPTICS TRANSMISSION	*0.64*	*0.78 (6)*	-
MODULATION FACTOR	*0.87*	*0.98 (7)*	-
INTERFEROGRAM	*TWO-SIDED*	*TWO-SIDED*	-
SAMPLINGS NUMBER	*16384*	*4096*	-

SAMPLING STEP	*608*	*2432*	*[nm]*
DYNAMICAL RANGE	*+/- 2^{15}*	*+/- 2^{15}*	-
SPECTRA (from on-board FFT)			-
QUANTITY OF POINT	*8192*	*2048*	-
DYNAMICAL RANGE	*6000*	*6000*	-
ELECTRONICS			
MODULATION FREQUENCY RANGE	*423-1600*	*50-400*	*[Hz]*
ONB FFT COMPUTATION TIME	*3.35*	*0.83*	*[s]*
BUFFER MEMORY VOLUME	*32*		*[MBits]*

(1) Values are given for wavelengths 2.5 and 15 μm. Results of measurements for PFS FM1.
(2) In peak of the spectral responsivity curve (near 4.8 μm and for the modulation frequency 1000 Hz).
(3) By the modulation frequency 200 Hz. NEB and sensitivity are given for the output of the preamplifier.
(4) Radiative cooling.
(5) Linearized deviation from the position, corresponding to zero path difference.
(6) From measurements of reflection and transmission of optical elements. Values are given for wavelengths 2.5 and 15 μm
(7) From estimates of tolerances.Values are given for wavelengths 2.5 and 15 microns.

TABLE 2 - *DETAILED PFS TECHNICAL PARAMETERS*

PARAMETERS	VALUES	UNITS
FULL PFS MASS (all blocks)	*31.2*	*[Kg]*
MODULE O (Optics and part of electron.)	*19.9*	*[Kg]*
MODULE E (Main electronics)	*3.5*	*[Kg]*
MODULE P (DC/DC converter, Power)	*2.3*	*[Kg]*
MODULE S (Pointing/scanning system)	*4.0*	*[Kg]*
HARNESS	*1.1*	*[Kg]*
PFS POWER CONSUMPTION		
IN FLIGTH ON MARS	*5*	*[W]*
PEAK DURING OBSERVATIONS	*45*	*[W]*
ON THE ORBIT IN "SLEEPING MODE"	*10*	*[W]*

2.1 Technical description

The flight hardware of the experiment is divided into four parts called modules, plus the connecting cables. The four modules are: the Interferometer with its optics and proximity electronics, which is the core of the experiment, and is called Module O. The pointing device, which receives radiation from Mars or from the in-flight calibration sources, which is called Module S. The Digital electronics, including a 32 Mbit mass memory, and a real time FFT, called Module E. The Power Supply, Module P, with the DC/DC converter, the redundancies, and the galvanic separated power for the 16 bits A/D converters.
Below we describe Module O (the core of the experiment) in further detail. Details of other modules can be found in FUM Manual 1 [7].

2.1.1 Module O

Module O is the core of PFS. Module O (hereafter PFS-O), stands for Optical Module and contains the interferometer with its proximity electronics. PFS-O is divided into two blocks: IB (Interferometer Block) and EB (Electronics Block). The two blocks are mechanically separated but electrically connected through a six cable interface. Furthermore IB is a gas tight box filled with dry nitrogen in order to preserve the optical parts that are hygroscopic. The IB is very compact and in practice it contains two interferometers working simultaneously, covering the full range of PFS between 1.2 μm and 45 μm. The two ranges are named "SW" as Short Wavelength and "LW" as Long Wavelength. The range of the SW channel is within (1.2 - 5.5) μm while the LW is within (5.5 – 45) μm.

2.1.2 Optical scheme of PFS-O

Martian radiation

The main optical design of the PFS is shown in Figure 1. The incident IR beam falls onto the entrance filter that separates the radiation of SW channel from the LW channel and directs each into the appropriate interferometer channel.
The scanner in front of the interferometer allows the FOV to be pointed along and laterally to the projection of the flight path onto the Martian surface. It also directs the FOV at internal black body sources, diffusers and to open space for in-flight calibration.
The optical path difference is generated by the angular movement of the retroreflectors. The controller of the torque motor uses the outputs of two reference channels, which are equipped with laser diodes. This interferometer design is very robust against slight misalignment in harsh environment compared with the classical Michelson-type interferometer.

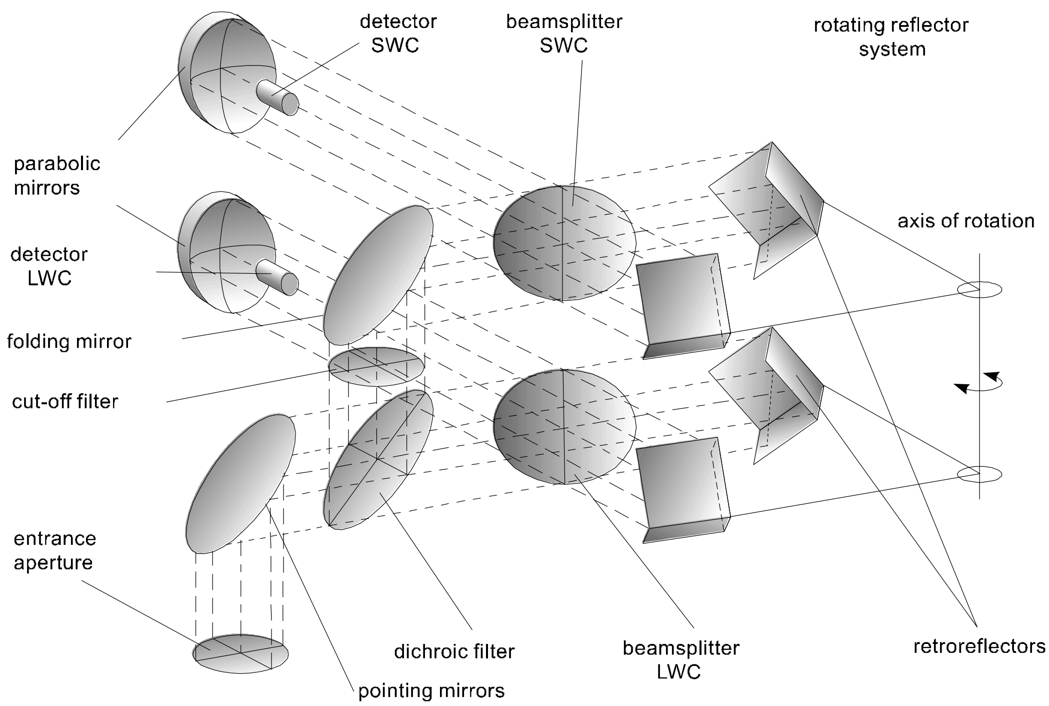


Fig.1 Optical scheme of PFS

The cube corners make it possible to use a double pendulum configuration in an easy way without complex mechanics. At the same time, they can lower the sensitivity of the interferometer in terms of mirrors tilting. Furthermore, the optical alignment of the instrument becomes easier and faster.
The double pendulum axis rotates by means of a brushless motor (two for redundancy) that does not experience any kind of mechanical friction. Thus the shaft of the double pendulum is sustained just by two preloaded ball bearings at very low friction. An additional mechanical friction instead is added for the purpose of a better stability of the pendulum speed.

The reference channel

The source of the reference beam is a laser diode (InGaAsP at 1.2 μm) and its detector is an infrared photodiode with maximum responsivity at about 1.2 μm. The beam of the reference channel is processed like the input signal so that the optical path of the reference is almost exactly coincident with the optical path of the signal to be studied. At the corner cubes the laser beam moves from one side to the other of the main beam, so that the part of the beam directed backward toward the source is displaced with respect to the inward part. This part terminates into an optical trap (one per each channel).

The zero optical path difference signal (ZOPD)

The ZOPD signal is generated using IR radiation from a TRW device, which, if a thin mirror is placed at the correct distance, will give a pulse when the mirror is in front of the device, while no signal is obtained for any other position. The linear mirror for PFS is placed on the edge of an arrow fixed to the shaft of the double pendulum. During assembly it is adjusted so that its signal is within 100 pulses from the optical zopd. During the double pendulum motion the arrow moves in front of the TRW detector so that a pulse is generated at the zopd position.

The detectors : SW

We use a photo-conductor type detector for the SW channel capable of working at temperatures down to 200K. The main characteristics of this detector are listed in Table 4.

Main characteristics of the SW detector	
Size [mm]	0.7 x 0.7 square
Spectral range [μm]	1.2 - 5.5
D*(λ max) [cm Hz1/2 /W]	0.9 1011 at 200 K, 1.2 kHz
D*(λ max) [cm Hz1/2 /W]	0.3 1011 at 250 K, 1.2 kHz

Table 4. SW detector characteristics

The SW detector is passively cooled through a radiator and its holder is partially insulated from the rest of theIB. The minimum conductance between the holder and the fixing point acts as a thermal sink to cool down the whole IB itself. The operative temperature of the SW detector is about 220K.

The detectors :LW

For the LW channel we have used a pyroelectric detector whose characteristics are listed in Table 5.

Main characteristics of the LW detector	
Size [mm]	1.4 ∅ round
Spectral cutoff [μm]	> 50
Threshold [W/ $Hz^{1/2}$]	About 5 10^{-10} at 200 Hz
Responsivity [V/W]	About 70k
Noise [V/Hz]	About 5 10^{-6}

Table 5. LW detector characteristics

The LW detector is able to work without performance degradation even at ambient temperature. In our case the ambient temperature is the temperature of the IB, which is about 13°C.

2.1.3 Mechanical description of PFS-O

Module
«O» contains the interferometer that consists of three main parts: the optical bench, the pendulum system, and the gas tight box.

2.1.3.1 The optical bench

The optical bench is a structure made in Al7075 alloy, obtained by machining and electro-erosion from a single aluminum alloy billet. All the optical elements of the interferometer are directly mounted or have a reference to the optical bench. The beam splitters are flange mounted on the reference plane of the optical bench while the supports of the axle on which the cubic corners are mounted are machined with a strict tolerance of planarity with the reference plane. The sensors are mounted on a surface of the optical bench with a 2 DOF regulation system that allows to align the detector group axes with the instrument one.

2.1.3.2 The pendulum system

The pendulum shaft is mounted on two angular contact ball bearings, axially pre-loaded with an elastic system allowing the differential thermal expansion without inducing sensible stress. The movement of the axle is a rotation of about $\pm$ 1.5° for the useful part and is up to 2.5° considering the extra-travels. The rotation is made by an electrical brushless torque motor that, for safety, is totally redundant. For the stability of the control loop a friction torque is applied to the axle. A locking device keeps the pendulum in a position outside the useful travel during the launch phase and in case of orbit correction/manoeuvring. The locking/unlocking procedures take about 10 minutes, the actuator being a paraffin one. The movement is therefore slow and no vibration or relevant electromagnetic fields are induced. The balancing mass is kinetically mounted on the pendulum axle to avoid thermal stresses induced by the different CTE of the materials. Regulation devices are mounted in place of the balancing mass during the alignment of the interferometer and afterwards removed.

2.1.3.3 The gas-tight box

The optical bench is included in a gas-tight box that during ground operation has to be filled with dry nitrogen. The gas tight box is required to avoid the degradation of the CsI beam splitter for moisture absorption. A bellow valve automatically opens and stays open when the environment pressure goes below 90 kPa allowing the inner gas to leave the instrument; when the external pressure increases above that value the valve closes again. The failure position of the valve is open in order to avoid an excessive overpressure in the instrument that would damage the entrance optics.
The gas tight box is also mechanically supporting the thermal interface to the radiator, where a thermal flexible strap is fixed.

2.1.4 *Thermal description of PFS-O*

PFS-O has four main thermal requirements: the temperature of the Short Wavelength detector, the Temperature/stability of the Long Wavelength detector, the temperature/stability of the two diode lasers and the temperature/stability of the optical bench.
The requirement for the SW detector is to have a working temperature lower than 220 K. This goal is achieved by means of a passive radiator, connected to the sensor by means of an aluminum cold finger.
The requirement for the long wavelength sensor are less stringent for the working temperature, about 25 °C, but challenging for the stability, <0.01°C/h. The sensor is mounted on an insulating stainless steel structure and the temperature is controlled by an electrical heater placed at its back, fed by an electronic circuit.
A wrong operative temperature of the diode lasers along with its fluctuations in time may cause degradation of the spectral resolution of the interferometer. For this reason the choice of the best operative temperature of the diode lasers must be planned in the calibration procedure. The temperature itself can be set in a wide range, from 2°C up to 42°C, but the maximum allowed depends on the operative temperature of the IB. In our case a gradient of 4°C between the fixing points and the laser diode case is achieved as a maximum.
In the interferometer unit there is, during operation, a dissipation of about 5 W of electrical power, mainly in the motor of the pendulum and the sensors proximity electronics. The thermal requirement is mainly in uniformity of the temperature; differences of the order of 2 °C between the average temperatures of the brackets of the pendulum leads to a reduction of the SNR of 1%. The whole

module "O" is thermally insulated from the spacecraft because of the low thermal conductance of the dampers and of the MLI covering all the external surfaces.

2.1.4.1 The thermal control

Thermal control is also very important for an infrared interferometer and for PFS this is achieved using eight points to read the temperatures across the instrument and to heat the structure. The controlling is passive so that only heating is permitted. Every point is read and set again through OBDM. Additionally, the two detectors (SW and LW) are thermally controlled. This is important to accurately maintain the radiometric calibration without greatly increasing the in-flight calibration cycles. In this way, the temperature of the IB is kept at a constant temperature of 13°C.

2.1.4.2 The ASTRA system

An additional thermal control with no electrical connections to the rest of PFS, is the block named "ASTRA". This stand-alone electronics box provides thermal control for the IB during the cruise phase, while the instrument is off. In this way, the temperature inside the IB is kept around the operative temperature and the thermal cycles are reduced ta a minimum even while PFS is in operation during the cruise phase. The total power dissipated by ASTRA is 6 W.

2.2 Detailed Scientific Objectives

The Planetary Fourier Spectrometer (PFS) is an infrared spectrometer optimised for atmospheric studies. The instrument is able to cover wavelengths from 1.2 to 45 µm, divided into two channels with a boundary at 5.5 µm.
The spectral resolution is 2 cm^{-1}. The instrument field of view (FOV) is about 1.6° for the Short Wavelength (SW) channel and 2.8 ° for the Long Wavelength (LW) channel, which corresponds to a spatial resolution of 7 and 12 km respectively, when Mars is observed from an height of 250 km (nominal height of the pericentre).
PFS can give unique data necessary to improve our knowledge not only of the atmospheric properties of Mars, but also about the mineralogical composition of the surface and the surface-atmosphere interaction.
The scientific objectives of the PFS experiment can be summarised as follows:
1) Atmospheric studies:
a) global long duration monitoring of the three-dimensional temperature field in the lower atmosphere (from the surface up to 40-60 km);
b) measurements of the minor constituents variations (water vapour and carbon monoxide);
c) search for other possible small components of the atmosphere;
d) new determination of the D/H ratio;
e) study of the optical properties of the atmospheric aerosols: dust clouds, ice clouds, hazes; determination of the size distribution and chemical composition;
f) investigation of radiance balance of the atmosphere and the influence of aerosols on energetics of the atmosphere.
g) study of global circulation, mesoscale dynamics and wave phenomena.
2) Surface studies:
a) monitoring of the surface temperature;
b) determination of the thermal inertia obtained from the daily surface temperature variations;
c) determination of constraints on the mineralogical composition of the surface layer;
d) determination of the nature of the surface condensate and seasonal variations of its composition;
e) measurements of the scattering phase function for selected regions of interest on the planet's surface;
f) local pressure and height determination (CO2 altimetry) for selected regions;
g) surface-atmosphere exchange processes.
The experiment will have real-time FFT on-board to be able to select the spectral range of interest for data transmission to ground. Measurement of the 15 micron CO_2 band is very important. Its profile gives, by means of a complex temperature profile retrieval technique, the vertical pressure temperature relation, which forms the basis of the global atmospheric study. Since the repetition time

of the measurements is 8.5 to 10 sec and the working time is ± 40 minutes around pericentre, a total of more than 564 measurements per orbit will be acquired, corresponding to 1790 measurements per day for a 7.6 hours orbit.
In the 80 minutes of data collection, the atmospheric measurements will be made at high altitude, because high space resolution is not needed, while surface oriented measurements will be taken closer to pericenter, where higher spatial resolution can be achieved. An important requirement of PFS is that we need to measure at all local times in order to have the atmospheric vertical temperature profiles also from the night side.

2.3 Data Handling Process

On the spacecraft, data from each sensor are either downloaded as raw or are downloaded after running through an onboard FFT. Both types of data are retrieved from ESA's Data Distribution System (DDS) at INAF-IFSI. These are splitted into the two sensors channel and calibrated using the procedure fully described in [4] and [5] and then distributed to Co-Is as working data for internal purposes. The calibration to this level involves Marco Giuranna. The PDS archive data are produced for each Mission Phase, i.e. Nominal Mission and Extended Mission. These data are Experimental Data Records – CODMAC level 2, and are then pipelined through to a complete PDS formatted data set via a piece of software developed at INAF-IFSI by Mario D'Amore. The rough data flow is illustrated in the figure below.

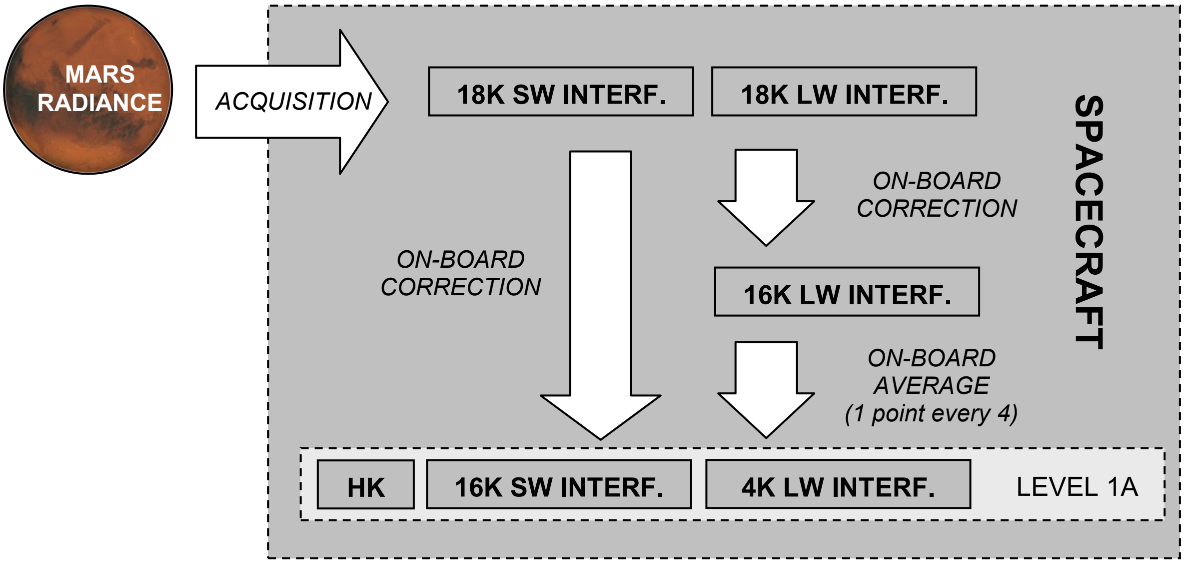


Fig.2 PFS data acquisition and processing scheme.

1. ACQUISITION

The OBS acquires 18000 points from the ADC converters of each channel in 4.5 seconds. These are sampled by a laser diode reference signal (for more information see [3])

2. ON-BOARD CORRECTION

The OBS finds the central part of the interferograms using the Hardware (HW) zero signal read from the sensor, and adds the ZOPD offset (this value is the difference between the interferogram central part and the and the position of HW zero) taking 8192 points from the left side and 8192 points from the right side. The final SW and LW size is 16384 points and both interferograms are centered to the Zero Optical.

3. ON-BOARD AVERAGE

In this stage LW interferogram is smoothed by averaging every four points, resulting in a reduction from 16384 to 4096 poins.

2.4 Overview of Data Products

2.4.1 In-Flight Data Products

Raw data (at ESOC, PSA and IFSI-INAF)

ESOC and PSA will archive all data downlinked by MEX, sorted by APID
IAS will archive the packets relevant to PFS in DDS format (definied in [9] and [10])

Experiment Data Records (at IFSI-INAF and PSA)

Level-1A Science data product filename convention :

PFS_<*orbit*>_<*inst_mode*>_<d*atatype*>_<*detector*>.DAT[1]

During cruise and Mars orbital phases, PFS produces eight files in PDS format for each orbit (or cruise sub-phase), including decompressed science data (level-1A), and all PFS acquired instrumental housekeeping information.

The product name (PRODUCT_ID) contains the following information (see Section 3.1.4 for details):

- PFS_<*orbit* or *cruise sub-phase* >_ YYYY _ ZZ _KK.DAT :
  for a fixed <*orbit*> value represent all the data from a single orbit or cruise sub-phase
- PFS_XXXX_<*inst_mode*>_ ZZ _ KK.DAT :
  for a fixed < *inst_mode*> value represent all the data from an instrument mode (i.e. calibration measurements or science data).
- PFS_ XXXX _ YYYY _<d*atatype*>_ KK.DAT :
  for a fixed < d*atatype*> value represent all the data for a single datatype *(*i.e. the housekeeping or PFS measurements)
- PFS_ XXXX _ YYYY_ ZZ _ <*detector*>.DAT :
  for a fixed <*detector*> value represent all the data from a single detector *(* i.e. SW or LW)

Letters blocks represent all the possible accepted value for each position in filename, or:

- XXXX = mission orbit
- YYYY = inst mode
- ZZ = datatype
- KK = detector

2.4.2 Software

[1] see Section 3.1.4 for details

Provided software in the SOFTWARE directory are functions in IDL language, suited to read data and labels (in FUNCTIONS subdirectory in SOFTWARE directory) both for DATA or GEOMETRY geometry products. These routines are intended as lower level interface between user program and the PFS data. Some example programs, showing how to read data products, are provided in DATA and in GEOMETRY subdirectories as IDL program files, based on routines mentioned. When downloading the SOFT.ZIP file, the user should put it in a working directory dedicated to PFS software, then unzip it. This will create two subdirectories:

/SOFTWARE/

|

|- /DATA/

|

|- /GEOMETRY/

The essential functions to open and read the data are in the **FUNCTIONS** subdirectory.

To run example code do the following steps:

1. open a .PRJ file (for DATA or for GEOMETRY)
2. change the PATH variable to your PFS Data directory
3. Menu Project > Compile > All Files
4. Menu Project > Run

Follow a list of provided functions to open and read the data and their output.

Function **read_pfs_data**(FILE,NUM,RECORDS)

return a structured variable array with the data. Array length is NUM.

Each array element is defined as :

OBT_OBSERVATION_TIME:	OUBLE PRECISION FLOAT
SCET_OBSERVATION_TIME:	UNSIGNED LONG INTEGER
INTERFEROGRAM:	INTEGER ARRAY WHITH
LENGHT = RECORDS	

INPUT:

FILE	: path of the data file to
NUM	: total number of the field (= observation) stored in the file
RECORDS	: length of a single interferogram

Function **read_pfs_hk**(FILE,NUM):

return a structured variable array with the housekeeping data. Array length is NUM.

Each array element is defined as :

OBT_OBSERVATION_TIME :	DOUBLE PRECISION FLOAT
SCET_OBSERVATION_TIME :	UNSIGNED LONG INTEGER
TypeOfMes :	UNSIGNED LONG INTEGER
SD_Version :	UNSIGNED LONG INTEGER

ZOPD_SW_FWD :	UNSIGNED LONG INTEGER
ZOPD_SW_REV :	UNSIGNED LONG INTEGER
ZOPD_LW_FWD :	UNSIGNED LONG INTEGER
ZOPD_LW_REV :	UNSIGNED LONG INTEGER
SCANPOS :	UNSIGNED LONG INTEGER
SW_ZeroX_Cutoff_Status :	DOUBLE PRECISION FLOAT
LW_ZeroX_Cutoff_Status :	DOUBLE PRECISION FLOAT
SPEEDCLOCK_Status :	DOUBLE PRECISION FLOAT
ADCCLOCK_Status :	DOUBLE PRECISION FLOAT
SW_Detector_Cutoff_Status :	DOUBLE PRECISION FLOAT
LW_Detector_Cutoff_Status :	DOUBLE PRECISION FLOAT
SWGAIN_Status :	UNSIGNED LONG INTEGER
LWGAIN_Status :	UNSIGNED LONG INTEGER
First_ADC_1_Status :	UNSIGNED LONG INTEGER
Second_ADC_1_Status :	UNSIGNED LONG INTEGER
First_ADC_2_Status :	UNSIGNED LONG INTEGER
Second_ADC_2_Status :	UNSIGNED LONG INTEGER
Select_Motor_Coil_Status :	UNSIGNED LONG INTEGER
DPDIR_Status :	UNSIGNED LONG INTEGER
SW_ZOPD_Position :	UNSIGNED LONG INTEGER
LW_ZOPD_Position :	UNSIGNED LONG INTEGER
Right_Collisions :	UNSIGNED LONG INTEGER
Left_Collisions :	UNSIGNED LONG INTEGER
SWLASERPWR_10V :	DOUBLE PRECISION FLOAT
LWLASERPWR_10V :	DOUBLE PRECISION FLOAT
SWPHOTODIODEPWR_10V :	DOUBLE PRECISION FLOAT
LWPHOTODIODEPWR_10V :	DOUBLE PRECISION FLOAT
T1_10V :	DOUBLE PRECISION FLOAT
T2_10V :	DOUBLE PRECISION FLOAT
T3_10V :	DOUBLE PRECISION FLOAT
T4_10V :	DOUBLE PRECISION FLOAT
T5_10V :	DOUBLE PRECISION FLOAT
T6_10V :	DOUBLE PRECISION FLOAT
T7_10V :	DOUBLE PRECISION FLOAT
T8_10V :	DOUBLE PRECISION FLOAT
LDTEMPSW_10V :	DOUBLE PRECISION FLOAT
LDTEMPLW_10V :	DOUBLE PRECISION FLOAT
SWTEMP_10V :	DOUBLE PRECISION FLOAT
LWTEMP_10V :	DOUBLE PRECISION FLOAT
TEMPA1_10V :	DOUBLE PRECISION FLOAT

TEMPA2_10V :	DOUBLE PRECISION FLOAT
SWTRW_10V :	DOUBLE PRECISION FLOAT
LWTRW_10V :	DOUBLE PRECISION FLOAT
CLVOLTAGE_10V :	DOUBLE PRECISION FLOAT

INPUT:

FILE :	path of the data file to open
NUM:	total number of the field (= observation) stored in the file

Function **read_pfs_label**(FILE,NAME)

return value stored in a PDS label file in the NAME field of provided LABEL file.

INPUT:

FILE :	path of the label file to open
NAME:	name if the fiel to search for (i.e. ROWS or FIELDS)

Function **reader_geometry**(FILE,NUM)

return a structured variable array with all the geometrical information. Array length is NUM.

Each array element is defined as :

SCET :	DOUBLE PRECISION FLOAT
LONGITUDE :	DOUBLE PRECISION FLOAT
LATITUDE :	DOUBLE PRECISION FLOAT
SPACECRAFT_ALTITUDE :	DOUBLE PRECISION FLOAT
Local_Time :	SINGLE PRECISION FLOAT
Solar_Longitude :	DOUBLE PRECISION FLOAT
INCIDENC_EANGLE :	SINGLE PRECISION FLOAT
EMISSION_ANGLE :	SINGLE PRECISION FLOAT
PHASE_ANGLE :	SINGLE PRECISION FLOAT
MOLA_ALTIMETRY :	SINGLE PRECISION FLOAT
LW_TANGENT_ALTITUDE :	SINGLE PRECISION FLOAT
LW_TARGET_DISTANCE :	SINGLE PRECISION FLOAT
SOLAR_DISTANCE :	SINGLE PRECISION FLOAT
SUBSOLAR_LONGITUDE :	DOUBLE PRECISION FLOAT
SUBSOLAR_LATITUDE :	DOUBLE PRECISION FLOAT
PLANETARY_PHASE_ANGLE :	SINGLE PRECISION FLOAT
SUB_SPACECRAFT_LONGITUDE :	DOUBLE PRECISION FLOAT
SUB_SPACECRAFT_LATITUDE :	DOUBLE PRECISION FLOAT
JULIAN_DATE :	DOUBLE PRECISION FLOAT

AIR_MASS :	SINGLE PRECISION FLOAT

INPUT:

FILE :	path of the geometry file to open
NUM :	total number of the field (= observation) stored in the file

The data are in standard PDS format and should be open with any standard PDS viewer also. These packages are all available for download from the PDS website (http://pds.jpl.nasa.gov).

2.4.3 Documentation

Several documents are provided in the document directory of the PFS data set. The following documents are useful to the understanding of the data set / archive, and the PFS instrument itself:

1. The PFS Experimenter to Archive Interface Control Document (this document). This document describes the details of the PFS data products and data sets and provides all of the information necessary for a user to understand how to use the data products.
2. PFS Flight User Manual, in which details of the PFS instrument are described, includes the instrument itself, the structure of the HK products, the structure of the science products, and many other aspects of the instrument operations and functionality.
3. "The Planetary Fourier Spectrometer (PFS) onboard the European Mars Express mission" document that describe the PFS instrument.
4. "Calibration of the Planetary Fourier Spectrometer Short Wavelength Channel" document that describe the procedure for the SW channel calibration.
5. "Calibration of the Planetary Fourier Spectrometer Long Wavelength Channel" document that describe the procedure for the LW channel calibration.

All documentation that is critical to the understanding and use of this data set is provided in plain ASCII format as well as other non-proprietary formats (e.g. PDF for documents and PNG for figures). Non-critical documentation is only delivered in PDF format and no ASCII version is provided.

2.4.4 Derived and other Data Products

It is intention of the PI and the team to provide in a later stage both calibrated absolute spectral radiance for both LWC and SWC plus the temperature vertical profiles retrieved from 15 μm CO_2 band in the LWC (See also documents [4] and [5]).

2.4.5 Ancillary Data Usage

Orbit, attitude and event data provided from ESOC and translated into SPK, PcK, CK, SCLK, Orbnum Spice Kernels files are used to compute the geometry files provided in the PFS data set. For each measurement, the SCET (Spacecraft Event Time) is transformed into UTC and used to compute all of the geometric and illumination parameters that describe the measurements. Information about the footprint on the planet and the relative positions of MEX, Mars, Sun and Earth are also provided. These data are distributed to the CoIs and archived in the Geometry Directory. In the Geometry file (one for each orbit), the list of the actual Spice Kernels used to compute these parameters for each measurement is provided (see par.3.4.2.9).

3 Archive Format and Content

This chapter contains general rules and constraints for the PFS data sets.The schemes or conventions used for naming the directories and files is specified below.
Specific and detailed information are provided in subchapters of chapter 4.3.

3.1 Format and Conventions

3.1.1 Deliveries and Archive Volume Format

PFS team will deliver a complete dataset for each Mission Phase (NOMINAL, EXTENDED 1 etc.),conforming to the schedule outlined in the Mars Express Archive Plan [2]. Because the PSA is an online archive, we do not deal directly with volumes in the same sense as the PDS. For the purposes of the PSA, a volume is equivalent to a dataset, so volume identifiers are typically not applicable. The VOLUME_SET_ID follows a strict formation rule defined in [1][1], section 19.5.1, with the Country (IT for Italy), Government Branch (CNR), Discipline within government branch (IFSI), mission and instrument ID (MEXPFS), and a 4-digit sequence number (1001). For the number, the first digit represents the VOLUME_SET and the last number the VOLUME within the VOLUME_SET. The keyword used thorugh the datase are then:

```
VOLUME_SERIES_NAME   =   "MISSION TO MARS"
VOLUME_SET_ID        =   IT_CNR_IFSI_MEXPFS_1000
VOLUME_SET_NAME      =   "MARS EXPRESS PFS DATA"
VOLUME_ID            =   MEXPFS_1001
VOLUME_NAME          =   "VOLUME 1: MARS EXPRESS PFS
```

3.1.2 Data Set ID Formation

The PFS data set ID is generated using the follow syntax:

<mission ID>-<target>-<instrument ID>-<processing level>-<data set type>-<description>-V*<version>*

Where:

<mission ID>:	**MEX**	this is fixed, and is the mission ID for Mars Express.
<target>:	**M**	this is fixed, and refers to the target of Mars.
<instrument ID>:	**PFS**	this is fixed and identifies the instrument as PFS (Planetary Fourier Spectrometer).
<processing level>:	**2**	this number indicates the level of processing the data has undergone on the CODMAC scale. A full description of the CODMAC levels is provided in [1].
<data set type>:	**EDR**	this represents the type of data in the data set. For the standard PFS deliveries, this will always be set to 'EDR' meaning 'Experimental Data Record'. A description of the different data set types can be found in [1].

<description>: this is a descriptive secion of the ID and will typically refer to the mission phase ID or an orbital range for the nominal mission.

	NOMINAL	nominal mission phase.
	EXT1	first extended mission phase.
	EXT2	second extended mission phase.
<version>:	**<1.0>**	this is the version of the data set, starting at 1.0 and increasing incrementally if changes are made to the products or the dataset itself.

When all of this is put together, it provides a data set ID of the form:

MEX-M-PFS-2-EDR-NOMINAL-V1.0 or **MEX-M-PFS-2-EDR- EXT1-V1.0**

3.1.3 Data Directory Naming Convention

Inside the DATA directory, the data products are organized into several subdirectories. The structure of the directories will depend upon the phase of the mission in the dataset.

3.1.3.1 Cruise and Near Earth Verification Phase Data Directory Structure

During the Near Earth Verification (NEV) and Interplanetary Cruise (IC) phases of the mission, PFS only took measurements of the internal calibration source (Internal Black Body and Lamp) and of deep space. The limited number of observations are simply divided by sensor into the following directory structure:

```
DATA
   |
   |-NEV
   |     |- LWC [Long Wave detector]
   |     |- SWC [Short Wave detector]
```

3.1.3.2 Nominal and Extended Mission Phase Data Directory Structure

For the nominal and extended mission phases at Mars, data will be split into groups of 10 orbits, whith the following syntax:

The base directory will be MARS as all products from these phases will be from the planet. Beneath this, data will be separated into observations from the long-wave (LWC) and short-wave (SWC) sensors. Finally, data will be divided into blocks of 10 orbits using the following taxonomy:

ORB<*YYY*>X

ORB	This is fixed and means ORBIT
<*YYY*>	This will be the first 3 digits of all orbits contained in this directory
X	This is fixed and means that inside this directory are data from orbits YYY0 to YYY9.

For example, the directory ORB000X will contain all products from orbits 0001 to 0009.

The DATA subdirectory structure for the nominal mission data will therefore follow the scheme:

```
DATA
 |
 |-NEV
 | |
 | |-LWC
```

```
| |-SWC
|
|- IC
| |-LWC
| |-SWC
|
|-MARS
| |
| |-LWC
| | |-ORB001X
| | |-ORB002X
| |
| |-SWC
| | |-ORB001X
| | |-ORB002X
```

3.1.4 File naming Convention

The data products are identified principally by orbit numer and detector type, following the scheme:

PFS_<*orbit*>_<*inst mode*>_<d*atatype*>_<*detector*>.<*ext*>

<orbit> Orbit number.
For the Near Earth Verification and Interplanetary Cruise Phase the Orbit field is substitute with the name of the Phase and Sub-phase (for a Phase and Sub-phase definition see [8], table.1, pag.9) <*Phase*><*Sub-phase*>.
<*Phase*>:

IC for Interplanetary Cruise Phase

NEV for Near Earth Verification Phase

<Sub-phase>:

C Check Out Sub-phase

D Dry Earth Sub-phase

E Earth Moon Sub-phase (Observation to Earth and Moon)

1 PS001 Sub-phase (First Switch ON)

2 PS002 Sub-phase (Calibration)

3 PS003 Sub-phase (DTM, Pericenter Pass Simulation, Calibration)

4 PS004 Sub-phase (FOV, Calibration)

5 PS005 Sub-phase (Calibration, heating of SW detector)

S Star Calibration Sub-phase

M Mars Crossing Sub-phase

all the sub-phases refer to specific PFS test operations performed during the NEV phase and described in [11]. Special files should have descriptive value in the <*orbit*> field different from orbit number or mission phase. These special files are the calibration tables stored in the CALIB/ directory and cointaining the average responsivity and average Deep Space observation. These special files value have an <*orbit*> field composed by:

<*orbit*> ≡<*Descpritive_Field*> = <T*ype_of_Measurement* >_<Pendulum_Direction>

<T*ype_of_Measurement* >:

DS Observation of deep space

RESP Instrumental responsivity

< Pendulum_Direction >

FWD Forward pendulum direction

REV Reverse pendulum direction

Furtehr details on the meaning of <T*ype_of_Measurement* > and <Pendulum_Direction> can be found in the CALINFO.TXT and in the [4],[5] and [6] documents.

<inst mode> Defines if the instrument is in calibration mode or in measurement mode:

CAL Calibration

MEAS Measurement

For the *HK* file <inst mode> field is referred to the corrisponding RAW file <inst mode> field.

<datatype> indicates the type of data provided: RAW – HK – RAD - GEO.

RAW contains interferogram

HK contains the HK information about PFS during the acquisition

RAD contains radiance spectra (calibrated data only).

GEO contains geometrical data and are located in the GEOMETRY directory (see Section 3.4.2.7).

<detector> defines the type of the detector used for the interferogram acquisition: Short wavelength (SW) or Long wavelength (LW).

<ext> the extension depends on the type of file (LBL for a label file, DAT for the data product associated with the label).

E.G. :

For Mars:

PFS_0010_ MEAS_HK_SW.LBL
PFS_0010_ MEAS_HK_SW.DAT

would be a PFS product from Mars orbit 0010. It would be a raw calibration data product from the short wavelength sensor with its associated label.

‘For the Near Earth Verification and Interplanetary Cruise Phase:

PFS_NEV1_MEAS_HK_SW.DAT
PFS_NEV1_MEAS_HK_SW.LBL

would be a PFS product from the PS001 Sub-phase of the Near Earth Verification phase. It would be a raw calibration product from the short wavelength sensor with its associated label.

PFS_IC_CAL_HK_SW.DAT
PFS_IC_CAL_HK_SW.LBL

would a PFS product from the Check Out sub-phase of the Interplanetary Cruise. It would be a raw calibration product from the long wavelength sensor with its associated label.

3.2 Standards Used in Data Product Generation

3.2.1 PDS Standards

The PFS archive follows the Planetary Data System (PDS) standards as detailed by the PDS Standards Reference document [1]. For this archive, we use Version 3.6 of the Standards Reference, dated August 1, 2003.

3.2.2 Time Standards

Within the data products themselves, the time standard used is SCET (Spacecraft Elapsed Time), which is an integer with seconds and fractions of seconds. This value does not have fixed calibration, and is dependent upon the spacecraft. To address this issue, the time is also provided in Julian Date, starting from 1970-01-01t12:00:00.

Outside of the products themselves, there are several instances in the PFS data sets where time flags are provided. The main time values are provided in the data product labels, which provide a start and stop time for the measurement, and a corresponding clock count from the spacecraft. Below, the standards used to define these values are described, and the method by which the on-board time is converted to universal time.

3.2.2.1 START_TIME and STOP_TIME Formation

The PDS formation rule for dates and time in UTC is:

*YYYY-MM-DD*T*hh*:*mm*:*ss.fff* or *YYYY-DDD*T*hh*:*mm*:*ss.fff*

YYYY	year (0000-9999)
MM	month (01-12)
DD	day of month (01-31)
DDD	day of year (001-366)
T	date/time separator
hh	hour (00-23)
mm	minute (00-59)
ss	second (00-59)
fff	fractions of second (000-999) (restricted to 3 digits)

This standard is followed for all START_TIME and STOP_TIME values in the products included in the PFS data sets. The first formation rule is applied for PFS (YYYY-MM-DDThh:mm:ss:fff).

3.2.2.2 SC_CLOCK_START_COUNT and SC_CLOCK_STOP_COUNT

The SC_CLOCK_START_COUNT and SC_CLOCK_STOP_COUNT values represent the on-board time counters (OBT) of the spacecraft and instrument computers. This OBT counter is given in the headers of the experiment telemetry source packets. It contains the data acquisition start time as 32-bit of unit seconds followed by 16-bit of fractional seconds. The time resolution of the fractional part is 2^-16 = 1.52×10^-5 seconds. Thus, the OBT is represented as a decimal real number in floating-point notation with 5 digits after the decimal point.
A reset of the spacecraft clock is represented by an integer number followed by a slash, e.g. “1/” or “2/”.

Example 1:
```
SPACECRAFT_CLOCK_START_COUNT = "1/21983325.39258"
```
Example 2:
```
SPACECRAFT_CLOCK_START_COUNT = "21983325.39258"
```
Example 3:
```
SPACECRAFT_CLOCK_START_COUNT = "2/0000325.39008"
```
Example 1 and Example 2 represents the same time instance.

3.2.2.3 On-Board Time (OBT) to UTC time conversion

UTC time is a function of the time correlation packages and the on-board time. The time correlation packages are archived and distributed in the SPICE auxiliary data set and contain linear segments that map the on-board time to UTC time. The linear segment is represented by a time offset and a time gradient. The conversion function is:

```
Time in utc = offset + (obt(seconds) + (obt(fractional part)*2^-16)) *gradient
```

3.2.3 Cartographic Standards

Inertial Reference frame – The Earth Mean Equator and Equinox of Julian Date 2451545.0 (referred to as the J2000 system) is standard inertial frame.

Mars Body-Fixed Frame – Body fixed frames are reference frames that do not move with respect to surface features of an object. The Mars Body-Fixed frame center is the center of mass of Mars. The spin axis of Mars defines the z-axis, whereas the prime meridian provides the direction of the x-axis that lies on the equatorial plane. The y-axis completes the right-handed frame. Values used to model the orientation of the North Pole (including precession), and the prime meridian as a function of time, are those recommended by the International Astronomical Union and adopted by the Mars Express project.

Coordinates System – We use the planetocentric coordinates system that consists of longitude measured positive eastward and planetocentric latitude, defined as the angle between the equatorial plane and a line from the center of mass of Mars to given point. This system is right-handed and identical to spherical polar coordinates as commonly defined. Longitudes range from 0 to 360 degrees, and latitudes range from –90 to 90 degrees.

Reference Surface – The standards used to model the surface of Mars is a triaxial ellipsoid centered on the planetocentric system origin, as in SPICE.

3.3 Data Validation

3.3.1 Internal Data Validation

Before delivery to the PSA for archiving, the PFS data are processed to CODMAC level 2 and are validated both in terms of PDS compliance and for quality of data. Data are checked for syntax, PDS Standards compliance and volume / data set integrity using the PVV software provided by the PSA.

3.3.2 PSA and External Validations (Peer Reviews)

Before the PFS data are archived and released to the scientific community, the data sets and documentation undergo a thorough peer review. This is completed in several stages by independent external reviewers who validate the usefulness of the archive and provide constructive input to improve the data sets in the same way as a professional paper may be reviewed.

In addition, prior to the data being ingested into the online Planetary Science Archive (http://www.rssd.esa.int/PSA), the data sets are fully tested for compliancy using the 'PVV' tool (PSA Volume Verifier Tool). This software checks the syntax of all keywords and labels within the data sets, and crosschecks values for keywords that should be identical. If the PVV tool successfully verifies a data set then the data set is PSA compliant and will be ingested into the online PSA.

3.4 Content

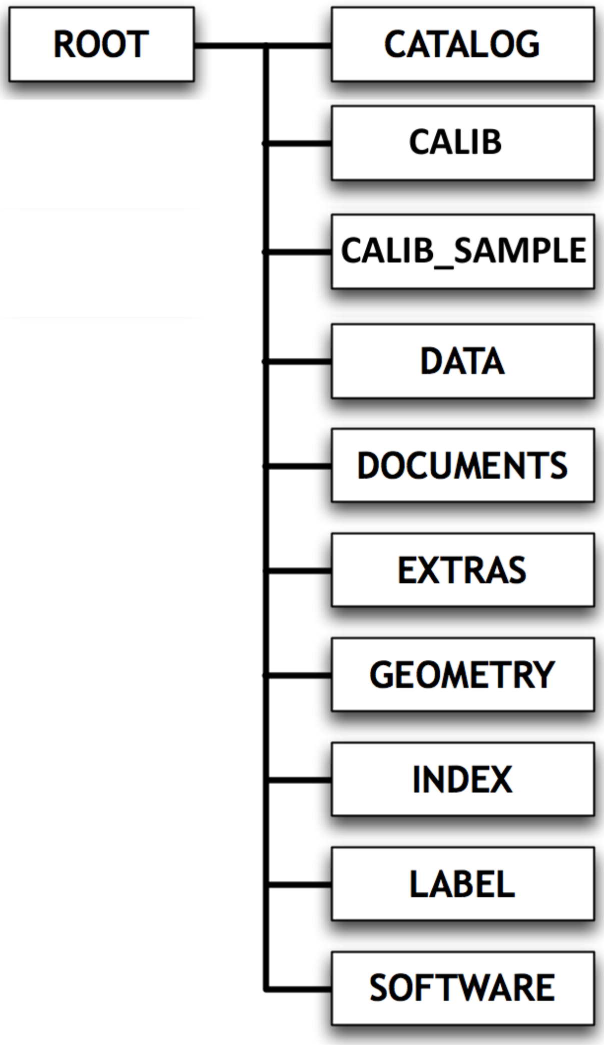
In this Section , we outline the non-data directory contents and information that will remain effectively static for all PFS data sets. This includes details of documentation, catalog information and calibration or geometry information, as well as details of the volume conventions used for PFS data sets.

3.4.1 Volume Set

For the Mars Express PFS data deliveries to the PSA, a data set is equivalent to a volume, since no physical media are to be generated. Therefore, the volume as defined by the PDS does not apply to the PFS data sets and all volume identifiers are delivered with a specific PSA defined value (see 3.1.1).

3.4.2 Directories

The structure of our volume-set/data-set is illustrated below:



3.4.2.1 ROOT Directory

The following files are contained in the data set root directory, prepared by the PFS team. These files are required by the PDS Standards [1]:

- AAREADME.TXT: This file is the entry point to the PFS data sets, and provides a complete description of the organisation and contents of the PFS data sets.
- VOLDESC.CAT: This is a description of the volume (data set) in PDS format, describing the catalog documentation provided in the archive and all volume identifiers.
- ERRATA.TXT: This file describes known errors and anomalies of PFS on this volume.

The CATALOG directory contains all standard PDS catalog files, see [1].

3.4.2.2 Catalog Directory

The CATALOG directory contains a series of plain text files describing the various elements of the PFS data set / instrument and the Mars Express spacecraft / mission. These files are a basic reference resource that should be used to provide a fundamental understanding of the PFS data, its acquisition and use, and any issues that may be present in its scientific application. The CATALOG directory contains the following files:

- **CATINFO.TXT**: This file identifies and describes the function of each file in the CATALOG subdirectory
- **DATASET.CAT**: Data set information for the PDS catalog, as know problems in the dataset at the moment of archive creation and team citation.
- **INST.CAT**: Instrument information for the PDS catalog
- **INSTHOST.CAT**: Instrument host (spacecraft) information for the PDS catalog
- **MISSION.CAT**: Mission information for the PDS catalog
- **REFERENCE.CAT**: Bibliographic reference used in the Dataset and the documentation
- **RELEASE.CAT**: For each data set, there is one release catalog file which defines, through release objects, a data products delivery to the PSA
- **SOFT.CAT**: Software information for the PDS catalog
- **TARGET.CAT**: Primary target (Mars) description

3.4.2.3 Calib Directory

The CALIB directory contains plain text calibration tables, needed to calibrate the example calibrated data stored in the CALIB_SAMPLE/ top-level directory. The files in this directory follow the special filenaming convection in 3.1.4 . The detail of the directory structure is:

- **LWC/** Directory containing the calibration tables for the long wavelenght channel
  - PFS_DS-FWD_CAL_RAW_LW.DAT > Deep Space/ Forward Pendulum Data
  - PFS_DS-FWD_CAL_RAW_LW.LBL > Deep Space/ Forward P. Label
  - PFS_DS-REV_CAL_RAW_LW.DAT > Deep Space/ Reverse P. Data
  - PFS_DS-REV_CAL_RAW_LW.LBL > Deep Space/ Reverse P. Label
  - PFS_RESP-FWD_CAL_RAW_LW.DAT > Responsivity/ Forward P. Data

- PFS_RESP-FWD_CAL_RAW_LW.LBL > Responsivity/ Forward P. Label
- PFS_RESP-REV_CAL_RAW_LW.DAT > Responsivity/ Reverse P. Label
- PFS_RESP-REV_CAL_RAW_LW.LBL > Responsivity/ Reverse P. Label

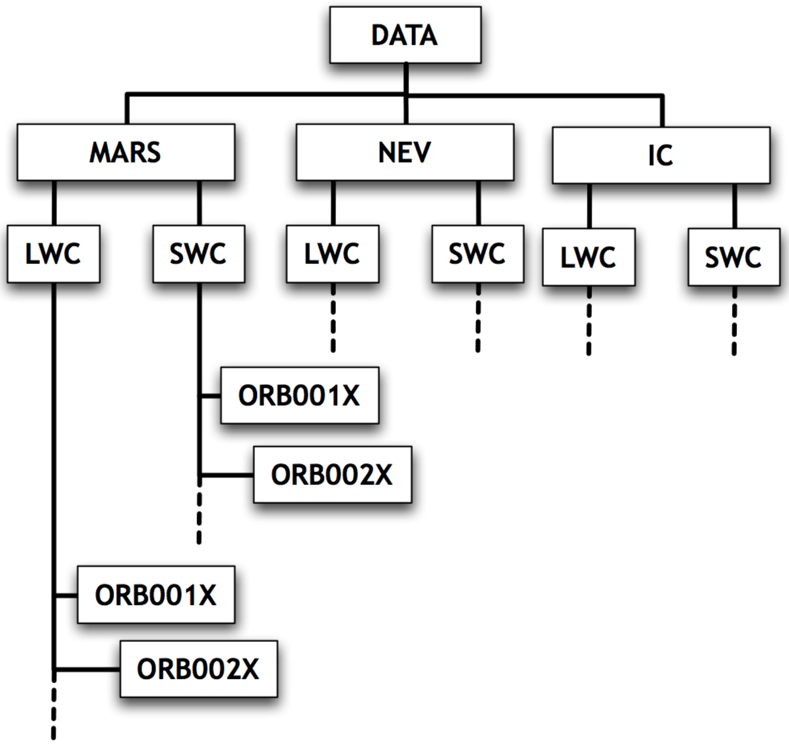
- **SWC/** Directory containing the calibration tables for the short wavelenght channel
  - **LASER_ON/** Directory for the SWC laser diode switched on
    - [Same files as in the **LWC**/ directory but for short wavelenght channel]
  - **LASER_OFF/** Directory for the SWC laser diode switched off
    - [Same files ad the LASER_ON/ directory]

3.4.2.4 Calib_Samples Directory

The CALIB_SAMPLES directory contains some examples of calibrated data products for PFS. The files in this directory follow the filenaming convection in 3.1.4, and are relative to the observation taken during the orbit 0037 and 1401 of the MEX spacecraft.

3.4.2.5 Data Directory

The DATA directory contains all data products for PFS. Each data set contains several orbits of data, organized into subdirectories containing blocks of 10 orbits. The scheme used for this is described in detail in Section 3.1.3 and is presented in the figure below.



Details of the products to be provided in the DATA directory and their structure and labelling can be found in Section 4.3 and its sub-sections.

3.4.2.6 Document Directory

This directory contains all of the Flight user manual documents, which have been divided into 9 chapters, describing in detail all of the features of the experiment. In addition, the ICD (this document) is provided also in ASCII format, and papers describing the calibration procedures for PFS are provided. A complete list and a short description:

- DOCINFO.TXT	DOCUMENTS directory content list
- CALIBR_REPORTS_LONG_TERM.TXT	Calibration Reports, warnings on Calibration and long term calibration notes.
- CALIB_SAMPLES_NOTE.TXT	Reports on how to obtain the files in CALIB_SAMPLES/ from the RAW data.
- MEX-PFS-PSA-ICD-24.ASC	Interface Control Document in ASCII Format
- MEX-PFS-PSA-ICD-24.LBL	Label file for Interface Control Document
- MEX-PFS-PSA-ICD-24.PDF	Interface Control Document in Portable Document Format
- MEX-PFS-PSA-ICD_FIG_1.PNG	ICD figure 1 – Pfs optical scheme
- MEX-PFS-PSA-ICD_FIG_2.PNG	ICD figure 2 – Data acquisition and processing scheme
- MEX-PFS-PSA-ICD_FIG_3.PNG	ICD figure 3 – High level directory structure
- MEX-PFS-PSA-ICD_FIG_4.PNG	ICD figure 4 –DATA directory structure
- MEX_ORIENTATION_DESC.LBL	Label file for Mars express spacecraft orientation
- MEX_ORIENTATION_DESC.TXT	Mars express spacecraft orientation
- PFS_CAL_LAB_1.LBL	Label file for Internal Note on Pfs Calibration – Volume I
- PFS_CAL_LAB_1.PDF	Internal Note on Pfs Calibration – Volume I
- PFS_CAL_LAB_2.LBL	Label file for Internal Note on Pfs Calibration – Volume I
- PFS_CAL_LAB_2.PDF	Internal Note on Pfs Calibration – Volume II
- PFS_CAL_NEAREARTH.LBL	Label file for Internal Note on Pfs Calibration in Space
- PFS_CAL_NEAREARTH.PDF	Internal Note on Pfs Calibration in Space
- PFS_LWC_CALIB.LBL	Label file for LWC channel Calibration article
- PFS_LWC_CALIB.PDF	LWC channel Calibration article
- PFS_MEX_FUM.LBL	Label file for FUMs Index
- PFS_MEX_FUM.PDF	FUMs Index
- PFS_MEX_FUM1.LBL	Label file for FUM 1 - Instrument description
- PFS_MEX_FUM1.PDF	FUM 1 - Instrument description
- PFS_MEX_FUM2.LBL	Label file for FUM 2 - Instrument performance budgets
- PFS_MEX_FUM2.PDF	FUM 2 - Instrument performance budgets
- PFS_MEX_FUM3.LBL	Label file for FUM 3 - Instrument software and memory map
- PFS_MEX_FUM3.PDF	FUM 3 - Instrument software and memory map
- PFS_MEX_FUM4.LBL	Label file for FUM 4 - Housekeeping information
- PFS_MEX_FUM4.PDF	FUM 4 - Housekeeping information
- PFS_MEX_FUM5.LBL	Label file for FUM 5 - Operating, non-operating conditions and interfaces
- PFS_MEX_FUM5.PDF	FUM 5 - Operating, non-operating conditions and interfaces
- PFS_MEX_FUM7.LBL	Label file for FUM 7 - Instrument operation manual
- PFS_MEX_FUM7.PDF	FUM 7 - Instrument operation manual
- PFS_MEX_FUM8.LBL	Label file for FUM 8 - Science operations
- PFS_MEX_FUM8.PDF	FUM 8 - Science operations
- PFS_MEX_FUM9.LBL	Label file for FUM 9 - Tm_tc interface data base
- PFS_MEX_FUM9.PDF	FUM 9 - Tm_tc interface data base
- PFS_ON_MARS_EXPRESS.LBL	Label file for Instruments description article
- PFS_ON_MARS_EXPRESS.PDF	Instruments description article
- PFS_SWC_CALIB.LBL	Label file for SWC channel Calibration article
- PFS_SWC_CALIB.PDF	SWC channel Calibration article

3.4.2.7 Extras Directory

The EXTRAS directory contains items that may be useful to a user, but are non-essential for the use of the data in the PFS data sets and are not essential for the PSA or compliance to the PDS Standards. The contents of the EXTRAS directory do not need to conform to PDS standards, and all files within this directory are produced and presented by the PFS team. In the PFS EXTRAS directory is a file that describes any special features of a given orbit. For example, any specific scientific objectives targeted, special events that occurred or tests that were completed for a given orbit are listed in this file. The file is presented in ASCII format.

3.4.2.8 Index Directory

In this directory, there will be the following files produced by the PFS team. The PVV tool provided by the PSA generates the standard PDS index files automatically. The geometry index files are generated using the library provided by the PSA team.

- INDXINFO.TXT: This ASCII file describes the contents of the INDEX directory
- INDEX.TAB: This table lists the PFS data products in the data set
- INDEX.LBL: This PDS detached label describes the INDEX.TAB file
- GEO_MARS.TAB: A table of geometry and position information for the data products with a target reference body of Mars.
- GEO_MARS.LBL: A PDS detached label describing the GEO_MARS.TAB file.

3.4.2.9 Geometry Directory

The GEOMETRY directory contains the geometry file for PFS observation. The sub-directory structure is the same as the DATA directory, i.e. separated for LW and SW sensor and split in groups of 10 orbits. GEOMETRY data are only provided for Mars Commissioning Phase and only during science data acquisition: for these data there is a one-to-one link between data files and geometry files. The reason is that geometry information are used to localize each single observation in the local coordinate system of Mars, thus observations not relative to Mars have not meaningful geometry data. (except for Phobos) Geometry data structure are explained in detail in Par.4.3.2.1:Geometry Product A Design . These products are essential for data calibration and data analysis.
GEOMETRY directory structure outline:

```
GEOMETRY
 |
 | -LWC
 |  |- ORB001X
 |  |- ORB002X
 |
 |- SWC
   | - ORB001X
   | - ORB002X
```

GEOMETRY files naming convection:

PFS_<orbit>_MEAS_GEO_<detector>.DAT

<orbit>	Orbit number.
<detector>	defines the type of the detector used for the interferogram acquisition: Short wavelength (SW) or Long wavelength (LW).
<ext>	extension depends on the type of file (LBL for a label file, DAT for the data product associated with the label).

E.G. :
PFS_0030_MEAS_GEO_*LW.DAT*

*PFS_0030_MEAS_GEO*_LW.*LBL*

The '.DAT' product and '.LBL' label above are product associated to data file aquired during science data acquisition in the orbit 30, namely the files

PFS_0030_MEAS_HK_LW.DAT > housekeeping information collected during science data acquisition in orbit 30
PFS_0030_MEAS_RAW_LW.DAT> RAW data collected during science data acquisition in orbit 30

3.4.2.10Label Directory

The LABEL directory includes files that describe specific aspects of the data format and organization, like the common format for housekeeping and geometric data:

- **LABINFO.TXT**: This file identifies and describes the function of each file in the LABEL subdirectory
- **PFS_HK.FMT**: PFS Housekeeping file common structure definition

3.4.2.11Software Directory

The SOFTWARE directory contains software designed to extract the data from the all the .DAT files (Raw data, housekeeping data, geometry data, calibrated data) and the calibration software used to produce the calibrated data in the CALIB_SAMPLES/ directory.
It is written in IDL language. For analyses, the PFS team use internal software specifically developed. The products are in standard PDS format, so it is possible to use PDS reader software to read all products. Subdirectory contains:

- **SOFTINFO.TXT**: This file identifies and describes the function of each file in the SOFTWARE subdirectory
- **ZIPINFO.ZIP**: This file provides an overview of the ZIP file format
- **SOFT.ZIP**: This file contains all provided software in ZIP format. For extended description see SOFT_README.TXT inside

4 Detailed Interface Specifications

This section describes in detail the contents of the PFS data sets, describing the structure of the data sets themselves and the design of the individual data products provided. The Appendices provide examples of the PDS labels and the complete directory structure of an example data set.

4.1 Structure and Organization Overview

The PFS data sets are structured as illustrated in Section 3.4.2. During the nominal mission, essentially 20 products will be provided for every observational orbit. These will be organized into DATA subdirectories as described in chapter 3.4.2.5, separating observations into groups of 10 orbits. For each orbit, 8 files will be present, 4 for each sensor. In the long-term when calibrated data are available, a further 2 products will be available, one for each sensor, as listed below:

PFS_<orbit>_CAL_RAW_SW.DAT	*PFS_<orbit>_CAL_RAW_SW.LBL*	Current Delivery
PFS_<orbit>_CAL_HK_SW.DAT	*PFS_<orbit>_CAL_HK_SW.LBL*	
PFS_<orbit>_MEAS_RAW_SW.DAT	*PFS_<orbit>_MEAS_RAW_SW.LBL*	
PFS_<orbit>_MEAS_HK_SW.DAT	*PFS_<orbit>_MEAS_HK_SW.LBL*	
PFS_<orbit>_CAL_RAW_LW.DAT	*PFS_<orbit>_CAL_RAW_LW.LBL*	
PFS_<orbit>_CAL_HK_LW.DAT	*PFS_<orbit>_CAL_HK_LW.LBL*	
PFS_<orbit>_MEAS_RAW_LW.DAT	*PFS_<orbit>_MEAS_RAW_LW.LBL*	
PFS_<orbit>_MEAS_HK_LW.DAT	*PFS_<orbit>_MEAS_HK_LW.LBL*	

PFS_<orbit>_MEAS_RAD_SW.DAT	*PFS_<orbit>_MEAS_RAD_SW.LBL*	Long term
PFS_<orbit>_MEAS_RAD_LW.DAT	*PFS_<orbit>_MEAS_RAD_LW.LBL*	

PFS_<orbit>_MEAS_GEO_SW.DAT	*PFS_<orbit>_MEAS_GEO_SW.LBL*	Current Delivery
PFS_<orbit>_MEAS_GEO_LW.DAT	*PFS_<orbit>_MEAS_GEO_LW.LBL*	

Files are named according to the scheme described in Section 3.1.4:

PFS_*<orbit>*_*<inst mode>*_<datatype>_*<detector>*.*<ext>*

As can be seen, there will be a data product, and associated geometry and housekeeping files for each orbit, along with their corresponding detached PDS label files. The data provided contain the raw data from the SW and LW sensors. These are interferograms acquired directly from PFS with no modification or validation. Currently, there are no plans to deliver higher-level products to the PSA for archiving, as the calibration is extremely unstable (see [4] and [5])

4.2 Data Sets, Definition and Content

PFS data sets will be generated and delivered to the PSA for every mission phase. The data sets will follow the identifier conventions outlined in Section 3.1.2, whereby a DATA_SET_ID will be of the form:

<mission ID>-<target>-<instrument ID>-<processing level>-<data set type>-<description>-V<version>

Where:

<mission ID>	=	**MEX**	for Mars Express

<target>	=	**M**	for Mars.
<instrument ID>	=	**PFS**	for the Planetary Fourier Spectrometer
<processing level>	**=**	**2**	the CODMAC processing level [1]
<data set type>:	**=**	**EDR**	the type of data in the data set (Experimental Data Record) [1].
<description>:	**=**	**NOMINAL**	this will refer to the mission phase.
<version>	**=**	**<1.0>**	the version of the data set

This gives a data set ID of the form:

MEX-M-PFS-2-EDR-NOMINAL-V1.0 > data set for the nominal mission phase data.
MEX-M-PFS-2-EDR-EXT1-V1.0 > data set containing data from the first extended mission phase.

During the nominal Mars phase, the Mars Express spacecraft completes approximately 100 orbits every 4 weeks, of which around 80 will be science orbits.

4.3 Data Product Design

In this section, we break down the structure of the individual product labels and describe the PDS keywords used for each data product type.

4.3.1 Data Product Design

The following is a breakdown of an example label for the data product. A complete label example is provided in Appendix 7.

4.3.1.1 File Characteristics Data Elements

These elements are present in the labels for every data product, and they describe the basic characteristics of the data product in terms of structure and naming:

RECORD_TYPE *= FIXED_LENGTH*
This describes the type of records used in the file. A 'record' is a single line in a data product, and records can therefore be fixed in length throughout the product, variable in length within a product, or can be a stream. For PFS products, every record inside the file has a fixed length.

RECORD_BYTES *= 32780*
This element defines the length for every record. The value used is different for the SW and LW channel data and depend on the transmission mode used. The example above is for data from the SW channel using DTM 17 (for details on data packet structure see [6]).

FILE_RECORDS *= 240*
This element defines the number of records inside the file. The value depends of the acquisition session duration inside the orbit.

FILE_NAME *= "PFS_0010_MEAS_RAW_SW.LBL"*
This element defines the Product File Name.

4.3.1.2 Data Object Pointers Identification Data Elements

These elements are the same for every data product, and point to the data product that corresponds to the label being read:

^TABLE *=" PFS_0010_MEAS_RAW_SW.DAT"*

For PFS, only one pointer is present, identifying the binary table within which the data are stored.

4.3.1.3 Identification Data Elements

These elements are present in every product label, and are used to describe and identify the data set, the target, and the mission.

DATA_SET_ID *= MEX-M-PFS-2-EDR-NOMINAL-V1.0*
Data set ID that uniquely identifies the PFS dataset.

DATA_SET_NAME *= "Mars Express Mars PFS EDR Nominal Mission Data V1.0"*
Dataset Name describing in long hand the identification elements of the DATA_SET_ID.

PRODUCT_ID *= PFS_0010_MEAS_RAW_SW*
This element uniquely identifies the product within the data set.

PRODUCT_CREATION_TIME *= 2007-02-01T10:08:39*
MISSION_NAME *= "MARS EXPRESS"*
INSTRUMENT_HOST_NAME *= "MARS EXPRESS"*
INSTRUMENT_HOST_ID *= MEX*
PRODUCT_TYPE *= EDR*
The product type keyword describes the type of data present. For the default PFS datasets, this will always be EDR, meaning Experiment Data Record. This corresponds to CODMAC level 2 data [1].

TARGET_NAME *= "MARS"*
Target Name for the observation: "MARS" , "PHOBOS", "INTERNAL SOURCE" or "DEEP SPACE"

TARGET_TYPE *= "CALIBRATION"*
Type of target observed: *"CALIBRATION"*, "PLANET" or "SATELLITE"

MISSION_PHASE_NAME *=" MC Phase 0"*
This identifies the phase of the mission in which the data were produced.

START_TIME *= 2004-01-10T12:55:37.796*
STOP_TIME *= 2004-01-10T12:59:37.845*
Start and stop time of the observation.

SPACECRAFT_CLOCK_START_COUNT *= 1\ 21819852.1234*
SPACECRAFT_CLOCK_STOP_COUNT *= 1\ 21819856.1234*
For details of the spacecraft, clock formation, please see Section 3.2.2 on Time Standards.

PRODUCER_ID *= "PFS_TEAM"*
PRODUCER_FULL_NAME *= "PFS SCIENCE TEAM"*
PRODUCER_INSTITUTION_NAME *= "INAF-CNR"*

4.3.1.4 Instrument Related Parameters

These elements are present in the labels of every data product

INSTRUMENT_ID *= "INFRARED INTERFEROMETER"*
INSTRUMENT_NAME *= "PLANETARY FOURIER SPECTROMETER"*
INSTRUMENT_TYPE *= "SPECTROMETER"*
INSTRUMENT_MODE_ID *= CAL_17*

Instrument mode used for this observation. For details of the various instrument modes, please see [6], chapter 4.5. Each mode contains data packets of different length and different kind: for example the most used, themode 17, contains a 256 byte header, the full interferogram from SW channel

(32768 byte) and the full interferogram from LW channel (8192 byte). On the other hand the mode 0, used to test instrument perfomances, contains a 512 byte header, a data section of 32768 bytes filled with the zero crossing of the reference channel , a 8100 byte length section containing sinewave from reference channel with different sampling and a 72 byte empty byte.

DETECTOR_ID = *"SW"*
Inside PFS, there is a Short Wavelength detector and Long Wavelength detector. This object indicates which detector is used to acquire the data: SW for Short Wavelength detector and LW for Long Wavelength detector.

DETECTOR_DESC = *"SW IS A SHORT WAVELENGTH DETECTOR; LW IS A LONG WAVELENGTH DETECTOR"*

SPACECRAFT_POINTING_MODE = *NADIR*
For Mars Express the following pointing modes are possible: NADIR, ALONGTRACK, ACROSSTRACK, TRACKING, INERT, LIMB.

SPACECRAFT_POINTING_MODE_DESC = *"NADIR - This pointing mode is used to define a pointing to center the target body"*

SPACECRAFT_ORIENTATION = (0,1,0)
^MEX_ORIENTATION_DESC = "MEX_ORIENTATION_DESC.TXT"

INSTRUMENT_CALIBRATION_DESC = *"N/A"*
The INSTRUMENT_CALIBRATION_DESC element explains the calibration method adopted and identifies reference documents, which explain in detail the calibration of the instrument. For example, this element might explain whether the calibration was time-independent (i.e. a single algorithm was used) or time-dependent, and whether the calibration was performed in-flight or in a laboratory. This keyword will only be used for the calibrated data set and will remain "N/A:" for all other data sets.

4.3.1.5 Data Object Definition

This section of the label defines the structure and content of the data product. For PFS, these are different for the LW and SW detectors. The data objects for PFS are binary tables. The columns within each table are described in the sections below.

4.3.1.5.1 SW channel RAW data file content for mesurement and calibration

C = column

TABLE **= SW_PERICENTER_UNPROCESSED_TABLE**					***SIZE*** **= 32780 byte**
C	**OBT OBSERVATION TIME**	10 byte	REAL	*enumerated*	C
	Start Time of observation given in SCET, the SCET is a time format given in sun modified Julian date starting from 1970-01-01T12:00:00 (TBC).				
C	**SCET OBSERVATION TIME**	4 byte	PC_INTEGER	*enumerated*	C
	Start Time of observation given in on-board time that is seconds and fraction of seconds since 2003-05-04 (TBC).				
C	**SW RAW POINT**	2 byte	PC_INTEGER	*enumerated*	C
	SW interferogram quantization element. This is the RAW value acquired directly from the AD converter connected to SWC detector. Every point is a 16 bit signed integer.				
TABLE **= SW_PERICENTER_UNPROCESSED_TABLE**					

RAW data file content for mesurement and calibration

C = column

***TABLE* = LW_PERICENTER_UNPROCESSED_TABLE**					***SIZE* = 8204 byte**
C	**OBT OBSERVATION TIME**	10 byte	PC_REAL	*enumerated*	**C**

Start Time of observation given in SCET, the SCET is a time format given in sun modified Julian date starting from 1970-01-01T12:00:00 (TBC).

C	**SCET OBSERVATION TIME**	4 byte	PC_INTEGER	*enumerated*	**C**

Start Time of observation given in on-board time that is seconds and fraction of seconds since 2003-05-04 (TBC).

C	**LW RAW POINT**	2 byte	PC_INTEGER	*enumerated*	**C**

SW interferogram quantization element. This is the RAW value acquire directly from the AD converter connected to LWC detector. Every point is a 16 bit signed integer.

***END TABLE* = LW_PERICENTER_UNPROCESSED_TABLE**

4.3.1.5.3 LW and SW channel HK data file content

C = column

C	**OBT OBSERVATION TIME**	10 byte	PC_INTEGER	*enumerated*	**C**

Start Time of observation given in SCET, the SCET is a time format given in sun modified Julian date starting from 1970-01-01T12:00:00 (TBC).

C	**SCET OBSERVATION TIME**	4 byte	PC_INTEGER	*enumerated*	**C**

Start Time of observation given in on-board time that is seconds and fraction of seconds since 2003-05-04 (TBC).

C	**TYPE OF MEASUREMENTS**	2 byte	PC _UNS_INT	*enumerated*	**C**

*Type of measurement: (**0**: Calibration, **1**: Real Measurement, **2**: Reference Channel).*

C	**SOFTWARE VERSION**	2 byte	PC_ UNS_INT	*enumerated*	**C**

Number of software version.

C	**ZOPD SW FW**	2 byte	PC_ UNS_INT	*enumerated*	**C**

Number of point offset for SW channel zero optical path difference in forward.

C	**ZOPD SW RV**	2 byte	PC_ UNS_INT	*enumerated*	**C**

Number of point offset for SW channels zero optical path difference in reverse.

C	**ZOPD LW FW**	2 byte	PC_ UNS_INT	*enumerated*	**C**

Number of point offset for LW channel zero optical path difference in forward.

C	**ZOPD LW RV**	2 byte	PC_ UNS_INT	*enumerated*	**C**

Number of point offset for LW channel zero optical path difference in reverse.

C	**SCANNER POSITION**	2 byte	PC_ UNS_INT	*enumerated*	**C**

*Scanner orientation: (**0** – Internal Black Body; **2** - Deep Space; **1** - Angle +25; **3** - Angle +12.5; **7** - Nadir; **6** - Angle -12.5; **4** - Angle -25; **5** – Internal Calibration lamp)*

C	**HIGHEST CUTOFF FREQ. SW ZEROX**	4 byte	PC_REAL	*Hz*	**C**

This parameter defines the period of the highest cutoff frequency for the SW Zero Crossing Preamplifier Filter (8th order). The lowest cutoff frequency is fixed (500 Hz, 2nd order) and unalterable. This value should be at least twice the reference frequency in order to maintain the speed control loop within the settling time value. This is of course true only for the reference signal used for such a purpose.

C	**HIGHEST CUTOFF FREQ. LW ZEROX**	4 byte	PC_REAL	*Hz*	C

*The same as "*HIGHEST CUTOFF FREQ. SW ZEROX*" but for the LW Zero Crossing Preamplifier Filter.*

C	**SPEED CLOCK**	4 byte	PC_REAL	*Hz*	C

This parameter sets the reference frequency for the speed control loop (normally 2000 Hz). Thus this value sets the speed of the double pendulum and consequently also the medium sampling frequency of the reference channel used for controlling the speed.

C	**ADCs SERIAL CONVERTERS CLOCK**	4 byte	PC_REAL	*Hz*	C

This parameter defines the frequency used for the serial to parallel converter for the ADCs. In normal conditions it should not be touched.

C	**HIGHEST CUTOFF FREQ. SW DET**	4 byte	PC_REAL	*Hz*	C

This parameter defines the period of the highest cutoff frequency for the SW Detector Preamplifier Filter (8th order). The lowest one is fixed (500 Hz, 2nd order). It should be set at 4 kHz but for the quantization error, it is set at 4.4 kHz. This filter is an anti-aliasing filter for the SW ADCs, so it should be changed according to the speed of the double pendulum. Along the lowest cutoff frequency, it also limits the band pass of signal and noise and consequently the spectral range, too.

C	**HIGHEST CUTOFF FREQ. LW DET**	4 byte	PC_REAL	*Hz*	C

This parameter defines the period of the highest cutoff frequency for the LW Detector Preamplifier Filter (8th order). The lowest one is fixed (50 Hz, 2nd order). It should be set at 500 Hz but for the quantization error, it is set at 513 Hz. This filter is an anti-aliasing filter for the LW ADCs, so it should be changed according to the speed of the double pendulum. Along the lowest cutoff frequency, it also limits the band pass of signal and noise and consequently the spectral range, too.

C	**SW DETECTOR GAIN**	2 byte	PC _UNS_INT	*enumerated*	C

SW detector gain (1 to 128)

C	**LW DETECTOR GAIN**	2 byte	PC _UNS_INT	*enumerated*	C

LW detector gain (1 to 8)

C	**SW ADC**	2 byte	PC _UNS_INT	*enumerated*	C

*SW channel A/D converter (**1**: Wake up ADC 1a SW signal sampled every SW zero crossing pulse (Default); **2**: Wake up ADC 2b SW signal sampled every LW zero crossing pulse (Recovery))"*

C	**SW ADC SECOND**	2 byte	PC _UNS_INT	*enumerated*	C

*Redundant SW channel A/D converter (**1**: Wake up ADC 1a SW signal sampled every SW zero crossing pulse (Default); **2**: Wake up ADC 2b SW signal sampled every LW zero crossing pulse (Recovery))"*

C	**LW ADC**	2 byte	PC _UNS_INT	*enumerated*	C

*LW channel A/D converter (**1**: Wake up ADC 2a LW signal sampled every LW zero crossing pulse (Default); **2**: Wake up ADC 1b LW signal sampled every SW zero crossing pulse (Recovery))"*

C	**LW ADC SECOND**	2 byte	PC _UNS_INT	*enumerated*	C

*Redundant LW channel A/D converter (**1**: Wake up ADC 2a LW signal sampled every LW zero crossing pulse (Default); **2**: Wake up ADC 1b LW signal sampled every SW zero crossing pulse (Recovery))"*

C	**PENDULUM MOTOR**	2 byte	PC _UNS_INT	*enumerated*	C

This value shows the double pendulum motor being used : Secondary or Primary. In case of motor or driver failure one can select the working one, if any! By default is set to the primary one (0:Secondary ;1:Primary).

C	**PENDULUM DIRECTION**	2 byte	PC _UNS_INT	*enumerated*	C

Double Pendulum direction 0:Forward; 1:Reverse).

C	**ZOPD SW**	2 byte	PC _UNS_INT	*enumerated*	C

This represents the Zero Optical Path Difference Position revealed by the TRW 1 detector (ZOPDD). This information gives to OBDM the reference in order to centre the SW interferogram. The correct value should be around 18000 (number of bytes from the beginning up to the centre of SW interferogram) but it can change a little (overall when Module-O is not horizontal) maintaining the interferogram centered.

C	**ZOPD LW**	2 byte	PC _UNS_INT	*enumerated*	C

This represents the Zero Optical Path Difference Position revealed by TRW 2 detector (ZOPDD). This information gives to OBDM the reference in order to centre the LW interferogram. The correct value should be around 4500 (number of bytes from the beginning up to the centre of LW interferogram) but it can change a little (overall when Module-O is not horizontal) maintaining the interferogram centered.

C	**PENDULUM END RIGHT**	2 byte	PC _UNS_INT	*enumerated*	C

That reveals if during the measure the double pendulum has touched the Right micro switch and, if so, how many times it did. If different from 0 this can highlight a malfunction of the motion.

C	**PENDULUM END LEFT**	2 byte	PC _UNS_INT	*enumerated*	C

That reveals if during the measure the double pendulum has touched the Left micro switch and, if so, how many times it did. If different from 0 this can highlight a malfunction of the motion.

C	**LASER 1 POWER**	8 byte	PC _REAL	*mW*	C

This parameter defines the power set point for the Short Wavelength Laser Diode. Even though the power can be changed from 0 up to 4.97 mW, normally there is an ideal value (depending on the working Temperature and on the single device), which reduces at the minimum level the low frequency modulation due to the side lobs. The narrower the emission line the better reference signal.

C	**LASER 2 POWER**	8 byte	PC _REAL	*mW*	C

The same as Laser 1 Power but for Long Wavelength.

C	**DETECTOR 1 POWER**	8 byte	PC _REAL	*mW*	C

This parameter defines the power set point for the Short Wavelength Detector.

C	**DETECTOR 2 POWER**	8 byte	PC _REAL	*mW*	C

The same as Detector 1 Power but for Long Wavelength.

C	**IB1 TEMP**	8 byte	PC _REAL	*K*	C

High thermal gradients on the mono block (the holder for the beam splitters) can be in principle not a good start point to begin a measurement, so we should reduce them. IB1, IB8 defines the set points of the 8 individual temperature controllers. Normally, in the real conditions, they should be kept at 13° C. In the FUM document you can find where the temperature readings and controlling are placed inside IB (Interferometer Block)".

C	**IB2 TEMP**	8 byte	PC _REAL	*K*	C

The same as the IB 1 temp.

C	**IB3 TEMP**	8 byte	PC _REAL	*K*	C

The same as the IB 1 temp.

C	**IB4 TEMP**	8 byte	PC _REAL	*K*	C

The same as the IB 1 temp.

C	**IB5 TEMP**	8 byte	PC _REAL	*K*	C

The same as the IB 1 temp.

C	IB6 TEMP	8 byte	PC _REAL	K	C

The same as the IB 1 temp.

C	IB7 TEMP	8 byte	PC _REAL	K	C

The same as the IB 1 temp.

C	IB8 TEMP	8 byte	PC _REAL	K	C

The same as the IB 1 temp.

C	LASER DIODE 1 TEMP	8 byte	PC _REAL	K	C

This defines the Temperature set point for the Short Wavelength Temperature controller. This should be set at least 1.5° C over the average Temperature of IB for having a good stability. In our case, it is set at 15° C. This parameter is crucial for the good working of Module-O. The Temperature of Laser, more than the power, determines the presence of the side lobs and it can make them become so strong that the speed controller could fail (in this extreme case Module-O is not capable of taking any measurements at all!). In case of this very bad condition, we can of course use the other reference channel, the one not used at the moment. The temperature of the Laser is also important for the spectral calibration, because the emission line wavelength changes versus Temperature for approximately 0.4 nm per 1K.

C	LASER DIODE 2 TEMP	8 byte	PC _REAL	K	C

The same as Laser 1 (SW) Temperature but for Long Wavelength.

C	SW DETECTOR TEMP	8 byte	PC _REAL	K	C

This parameter defines the set point temperature for the Short Wavelength detector controller and should be set between 200 K and 250 K depending on the condition. This one is important for the calibration as the detector changes its responsivity along with its temperature. Keep in mind that clearly the temperature controlling is done by set-points level.

C	LW DETECTOR TEMP	8 byte	PC _REAL	K	C

This parameter defines the set point temperature for the Long Wavelength detector controller. Also in this case the temperature controlling is done by set-points level.

C	INTERNAL BLACKBODY TEMP. 1	8 byte	PC _REAL	K	C

This parameter defines the set point Temperature for the internal Blackbody source.

C	INTERNAL BLACKBODY TEMP. 2	8 byte	PC _REAL	K	C

This parameter defines the redundant set point Temperature for the internal Blackbody source.

C	TRW 1 TEMP	8 byte	PC _REAL	K	C

Temperature of SW TRW.

C	TRW 2 TEMP	8 byte	PC _REAL	K	C

Temperature of LW TRW.

C	CALIBRATION LAMP VOLTAGE	8 byte	PC _REAL	V	C

Voltage of internal calibration lamp.

4.3.2 Data Product B Design

4.3.2.1 Geometry Product A Design

C = column

C	**SCET**	8 byte	PC_REAL	*sec*	C

Spacecraft event time

C	**LONGITUDE**	8 byte	PC_REAL	*deg*	C

FOV center Longitude

C	**LATITUDE**	8 byte	PC_REAL	*deg*	C

FOV center Latitude

C	**SPACECRAFT_ALTITUDE**	8 byte	PC_REAL	*Km*	C

Spacecraft altitude

C	**Local_Time**	4 byte	PC_REAL	*Hours*	C

FOV center local time

C	**Solar_Longitude**	8 byte	PC_REAL	*deg*	C

Solar Longitude

C	**INCIDENC_EANGLE**	4 byte	PC_REAL	*deg*	C

Incidence angle

C	**EMISSION_ANGLE**	4 byte	PC_REAL	*deg*	C

Emission angle

C	**PHASE_ANGLE**	4 byte	PC_REAL	*deg*	C

Phase angle

C	**MOLA_ALTIMETRY**	4 byte	PC_REAL	*m*	C

FOV center Mola Altimetry

C	**LW_TANGENT_ALTITUDE**	4 byte	PC_REAL	*Km*	C

Limb altitude

C	**LW_TARGET_DISTANCE**	4 byte	PC_REAL	*Km*	C

Distance from the spacecraft to the target point

C	**SOLAR_DISTANCE**	4 byte	PC_REAL	*AU*	C

Mars-Solar distance

C	**SUBSOLAR_LONGITUDE**	8 byte	PC_REAL	*deg*	C

Longitude of the sub-solar point

C	**SUBSOLAR_LATITUDE**	8 byte	PC_REAL	*deg*	C

Latitude of the sub-solar point

C	**PLANETARY_PHASE_ANGLE**	4 byte	PC_REAL	*deg*	C

Planetary phase angle

C	**SUB_SPACECRAFT_LONGITUDE**	8 byte	PC_REAL	*deg*	C

Longitude of the sub-spacecraft point

C	**SUB_SPACECRAFT_LATITUDE**	8 byte	PC_REAL	*deg*	C

Latitude of the sub-spacecraft point

C	**JULIAN_DATE**	8 byte	PC_REAL		C

Julian Date

C	**AIR_MASS**	4 byte	PC_REAL		C

Secant of the emission angle

***TABLE* = SW_PERICENTER_UNPROCESSED_TABLE**				***SIZE* = 32780 byte**	
C	**OBT OBSERVATION TIME**	10 byte	REAL	*enumerated*	**C**
Start Time of observation given in SCET, the SCET is a time format given in sun modified Julian date starting from 1970-01-01T12:00:00 (TBC).					
C	**SCET OBSERVATION TIME**	4 byte	PC_INTEGER	*enumerated*	**C**
Start Time of observation given in on-board time that is seconds and fraction of seconds since 2003-05-04 (TBC).					
C	**SW RAW POINT**	2 byte	PC_INTEGER	*enumerated*	**C**
SW interferogram quantization element. This is the RAW value acquired directly from the AD converter connected to SWC detector. Every point is a 16 bit signed integer.					
***TABLE* = SW_PERICENTER_UNPROCESSED_TABLE**					

5 Appendix: Example of Directory Listing of PFS Data Set

A full example of PFS Dataset structure is listed here. Some obvious repetition are not shown here, but replaced with […] : e.g., for DATA subdirectory, from LW/ to SW/ subdirectories the only changes is “LW” to “SW” in filename.

```
ROOT/
   |-AAREADME.TXT
   |
   |-CATALOG/
   |     |-CATINFO.TXT
   |     |-DATASET.CAT
   |     |-INST.CAT
   |     |-INSTHOST.CAT
   |     |-MISSION.CAT
   |     |-REFERENCE.CAT
   |     |-RELEASE.CAT
   |     |-SOFT.CAT
   |     |-TARGET.CAT
   |
   |-CALIB/
   |     |-CALINFO.TXT
   |     |-LWC/
   |     |       |-PFS_DS-FWD_CAL_RAW_LW.DAT
   |     |       |-PFS_DS-FWD_CAL_RAW_LW.LBL
   |     |       |-PFS_DS-REV_CAL_RAW_LW.DAT
   |     |       |-PFS_DS-REV_CAL_RAW_LW.LBL
```

```
|   |     |-PFS_RESP-FWD_CAL_RAW_LW.DAT
|   |     |-PFS_RESP-FWD_CAL_RAW_LW.LBL
|   |     |-PFS_RESP-REV_CAL_RAW_LW.DAT
|   |     |-PFS_RESP-REV_CAL_RAW_LW.LBL
|   |
|   |-SWC/
|   |     |-LASER_OFF/
|   |     |    |-PFS_DS-FWD_CAL_RAW_SW.DAT
|   |     |    |-PFS_DS-FWD_CAL_RAW_SW.LBL
|   |     |    |-PFS_DS-REV_CAL_RAW_SW.DAT
|   |     |    |-PFS_DS-REV_CAL_RAW_SW.LBL
|   |     |    |-PFS_RESP-FWD_CAL_RAW_SW.DAT
|   |     |    |-PFS_RESP-FWD_CAL_RAW_SW.LBL
|   |     |    |-PFS_RESP-REV_CAL_RAW_SW.DAT
|   |     |    |-PFS_RESP-REV_CAL_RAW_SW.LBL
|   |     |
|   |     |-LASER_ON/
|                    |-PFS_DS-FWD_CAL_RAW_SW.DAT
|                    |-PFS_DS-FWD_CAL_RAW_SW.LBL
|                    |-PFS_DS-REV_CAL_RAW_SW.DAT
|                    |-PFS_DS-REV_CAL_RAW_SW.LBL
|                    |-PFS_RESP-FWD_CAL_RAW_SW.DAT
|                    |-PFS_RESP-FWD_CAL_RAW_SW.LBL
|                    |-PFS_RESP-REV_CAL_RAW_SW.DAT
|                    |-PFS_RESP-REV_CAL_RAW_SW.LBL
|
|-CALIB_SAMPLES/
|      |-CALSAMPLESINFO.TXT
|      |-LWC/
|      |  |-PFS_0037_MEAS_RAD_LW.DAT
|      |  |-PFS_0037_MEAS_RAD_LW.LBL
|      |-SWC  /
|      |     |-LASER_OFF/
|      |     | |-PFS_1401_MEAS_RAD_SW.DAT
|      |     | |-PFS_1401_MEAS_RAD_SW.LBL
|      |  |
|      |     |-LASER_ON/
|      |       |-PFS_0037_MEAS_RAD_SW.DAT
|      |       |-PFS_0037_MEAS_RAD_SW.LBL
```

```
|
|-DATA/
|     |-IC/
|     |   |-LWC/
|     |   |   |-PFS_ICM_CAL_HK_LW.DAT
|     |   |   |-PFS_ICM_CAL_HK_LW.LBL
|     |   |   |-PFS_ICM_CAL_RAW_LW.DAT
|     |   |   |-PFS_ICM_CAL_RAW_LW.LBL
|     |   |   |-PFS_ICM_MEAS_HK_LW.DAT
|     |   |   |-PFS_ICM_MEAS_HK_LW.LBL
|     |   |   |-PFS_ICM_MEAS_RAW_LW.DAT
|     |   |   |-PFS_ICM_MEAS_RAW_LW.LBL
|     |   |-SWC/
|     |       |-[...]
||
|     |-MARS/
|     |   |LWC/
|     |   |   |-ORB001X/
|     |   |   |   |-PFS_0010_CAL_HK_LW.DAT
|     |   |   |   |-PFS_0010_CAL_HK_LW.LBL
|     |   |   |   |-PFS_0010_CAL_RAW_LW.DAT
|     |   |   |   |-PFS_0010_CAL_RAW_LW.LBL
|     |   |   |   |-PFS_0010_MEAS_HK_LW.DAT
|     |   |   |   |-PFS_0010_MEAS_HK_LW.LBL
|     |   |   |   |-PFS_0010_MEAS_RAW_LW.DAT
|     |   |   |   |-PFS_0010_MEAS_RAW_LW.LBL
|     |   |   |-ORB002X/
|     |   |       [...]
|     |   |-SWC/
|     |       |-[...]
|     |-NEV/
|         |-LWC/
|         |   |-PFS_NEV2_CAL_HK_LW.DAT
|         |   |-PFS_NEV2_CAL_HK_LW.LBL
|         |   |-PFS_NEV2_CAL_RAW_LW.DAT
|         |   |-PFS_NEV2_CAL_RAW_LW.LBL
|         |   |-PFS_NEV2_MEAS_HK_LW.DAT
|         |   |-PFS_NEV2_MEAS_HK_LW.LBL
|         |   |-PFS_NEV2_MEAS_RAW_LW.DAT
```

```
|         |  |-PFS_NEV2_MEAS_RAW_LW.LBL
|         |-SWC/
|            |-[...]
|
|-DOCUMENT/
|    |-DOCINFO.TXT
|    |-CALIBR_REPORTS_LONG_TERM.TXT
|    |-CALIBR_REPORTS_LONG_TERM.LBL
|    |-CALIB_SAMPLES_NOTE.TXT
|    |-CALIB_SAMPLES_NOTE.LBL
|    |-MEX-PFS-PSA-ICD-24.ASC
|    |-MEX-PFS-PSA-ICD-24.LBL
|    |-MEX-PFS-PSA-ICD-24.PDF
|    |-MEX-PFS-PSA-ICD_FIG_1.PNG
|    |-MEX-PFS-PSA-ICD_FIG_2.PNG
|    |-MEX-PFS-PSA-ICD_FIG_3.PNG
|    |-MEX-PFS-PSA-ICD_FIG_4.PNG
|    |-MEX_ORIENTATION_DESC.LBL
|    |-MEX_ORIENTATION_DESC.TXT
|    |-PFS_CAL_LAB_1.LBL
|    |-PFS_CAL_LAB_1.PDF
|    |-PFS_CAL_LAB_2.LBL
|    |-PFS_CAL_LAB_2.PDF
|    |-PFS_CAL_NEAREARTH.LBL
|    |-PFS_CAL_NEAREARTH.PDF
|    |-PFS_LWC_CALIB.LBL
|    |-PFS_LWC_CALIB.PDF
|    |-PFS_MEX_FUM.LBL
|    |-PFS_MEX_FUM.PDF
|    |-PFS_MEX_FUM1.LBL
|    |-PFS_MEX_FUM1.PDF
|    |-PFS_MEX_FUM2.LBL
|    |-PFS_MEX_FUM2.PDF
|    |-PFS_MEX_FUM3.LBL
|    |-PFS_MEX_FUM3.PDF
|    |-PFS_MEX_FUM4.LBL
|    |-PFS_MEX_FUM4.PDF
|    |-PFS_MEX_FUM5.LBL
|    |-PFS_MEX_FUM5.PDF
```

```
|    |-PFS_MEX_FUM7.LBL
|    |-PFS_MEX_FUM7.PDF
|    |-PFS_MEX_FUM8.LBL
|    |-PFS_MEX_FUM8.PDF
|    |-PFS_MEX_FUM9.LBL
|    |-PFS_MEX_FUM9.PDF
|    |-PFS_ON_MARS_EXPRESS.LBL
|    |-PFS_ON_MARS_EXPRESS.PDF
|    |-PFS_SWC_CALIB.LBL
|    |-PFS_SWC_CALIB.PDF
|
|-ERRATA.TXT
|
|-EXTRAS/
|    |-EXTRINFO.TXT
|    |-PFS_REPORT.LBL
|    |-PFS_REPORT.TXT
|
|-GEOMETRY/
|    |-GEOMINFO.TXT
|    |-LWC/
|    |   |-ORB001X/
|    |   |   |-PFS_0010_MEAS_GEO_LW.DAT
|    |   |   |-PFS_0010_MEAS_GEO_LW.LBL
|    |   |-ORB002X/
|    |       |-[...]
|    |-SWC/
|        |-[...]
|
|-INDEX/
|
|-LABEL/
|    |-LABINFO.TXT
|    |-PFS_HK.FMT
|
|-SOFTWARE/
|    |-SOFT.LBL
|    |-SOFT.zip
|    |-SOFTINFO.TXT
```

```
|    |-ZIPINFO.TXT
|
|-VOLDESC.CAT
```

6 Appendix: Complete Label file Examples

PDS_VERSION_ID	**=**	PDS3
LABEL_REVISION_NOTE	**=**	"PFS PRODCUTION SOFTWARE 2.10"
/* File Characteristics */		
RECORD_TYPE	**=**	FIXED_LENGTH
RECORD_BYTES	**=**	8204
FILE_RECORDS	**=**	240
FILE_NAME	**=**	"PFS_0010_MEAS_RAW_LW.LBL"
RELEASE_ID	**=**	1
REVISION_ID	**=**	0
/* Data Pointers */		
^TABLE	**=**	"PFS_0010_MEAS_RAW_LW.DAT"
/* Identification Elements */		
DATA_SET_ID	**=**	"MEX-M-PFS-2-EDR-NOMINAL-V1.0"
DATA_SET_NAME	**=**	"Mars Express Mars PFS EDR Nominal Mission Data V1.0"
PRODUCT_ID	**=**	PFS_0010_MEAS_RAW_LW
PRODUCT_CREATION_TIME	**=**	2007-02-06T15:10:25.980
MISSION_NAME	**=**	"MARS EXPRESS"
INSTRUMENT_HOST_NAME	**=**	"MARS EXPRESS"
INSTRUMENT_HOST_ID	**=**	MEX
PRODUCT_TYPE	**=**	EDR
TARGET_TYPE	**=**	"PLANET"
TARGET_NAME	**=**	"MARS"
MISSION_PHASE_NAME	**=**	"MC Phase 0"
ORBIT_NUMBER	**=**	10
START_TIME	**=**	2004-01-10T11:04:12.189
STOP_TIME	**=**	2004-01-10T12:55:38.719
SPACECRAFT_CLOCK_START_COUNT	**=**	21819852.18989
SPACECRAFT_CLOCK_STOP_COUNT	**=**	21826538.71960
PRODUCER_ID	**=**	PFS_TEAM
PRODUCER_FULL_NAME	**=**	"PFS SCIENCE TEAM"
PRODUCER_INSTITUTION_NAME	**=**	"INAF-CNR"
INSTRUMENT_ID	**=**	PFS
INSTRUMENT_NAME	**=**	"PLANETARY FOURIER SPECTROMETER"

INSTRUMENT_TYPE	=	"INFRARED INTERFEROMETER"
INSTRUMENT_MODE_ID	=	MEAS_17
DETECTOR_ID	=	LW
DETECTOR_DESC	=	"SW IS A SHORT WAVELENGTH DETECTOR; LW IS A LONG WAVELENGTH DETECTOR"
SPACECRAFT_POINTING_MODE	=	NADIR
SPACECRAFT_POINTING_MODE_DESC	=	"NADIR - This pointing mode is used to define a pointing to centre the target body"
SPACECRAFT_ORIENTATION	=	(0,1,0)
^MEX_ORIENTATION_DESC	=	"MEX_ORIENTATION_DESC.TXT"
INSTRUMENT_CALIBRATION_DESC	=	"N/A"
/* Object Definitions */		
OBJECT	=	TABLE
NAME	=	PFS_LW_RAW_DATA
INTERCHANGE_FORMAT	=	BINARY
ROWS	=	240
ROW_BYTES	=	8204
COLUMNS	=	3
DESCRIPTION	=	RAW DATA
OBJECT	=	COLUMN
BYTES	=	8
DATA_TYPE	=	REAL
NAME	=	"OBT OBSERVATION TIME"
START_BYTE	=	1
UNIT	=	"second"
DESCRIPTION	=	"START TIME OF OBSERVATION GIVEN IN SCET, THE SCET IS A TIME FORMAT GIVEN IN SUN MODIFIED JULIAN DATE "
END_OBJECT	=	COLUMN
OBJECT	=	COLUMN
BYTES	=	4
DATA_TYPE	=	LSB_FLOAT
NAME	=	"SCET OBSERVATION TIME"
START_BYTE	=	9
UNIT	=	"UT"
DESCRIPTION	=	"START TIME OF OBSERVATION GIVEN IN ON-BOARD TIME THAT IS SECONDS SINCE 2003-05-03 "
END_OBJECT	=	COLUMN
OBJECT	=	COLUMN
BYTES	=	8192
DATA_TYPE	=	LSB_INTEGER
NAME	=	"INTERFEROGRAM RAW DATA"
ITEMS	=	4096

ITEM_BYTES	**=**	2
DESCRIPTION	**=**	"RAW INTERFEROGRAM ACQUIRED DIRECTLY FROM LW CHANNEL"
START_BYTE	**=**	13
UNIT	**=**	"N/A"
END_OBJECT	**=**	COLUMN
END_OBJECT	**=**	TABLE
END		