Need to get Planck version of this - important input to proposal. Draft SIP required as part of proposal

FIRST

SCIENCE OPERATIONS

IMPLEMENTATION REQUIREMENTS

DOCUMENT

(SIRD)

PT-03646 (DRAFT #3)
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1st Draft	30 November 1996
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DOCUMENT CHANGE RECORD

Revision Status			Pages affected
Rev	Date	Approval	
Draft 1	30.11.96		All (First Working Draft) for discussion within ESA and the FIRST Science Operations Definition Group (FSODG)
Draft 2	31.07.97		All changes to Draft 1 are indicated by a vertical bar in the margin. Affected pages: all
Draft 3	30.09.97		Updated after SSD's "Rolling Review Board" meeting of 16.09.97. Major changes: Document has been restructured. Chapter 1-3 and 7 now for background only. Responsibilities of PST and FOT clarified. FSCOM role redefined. Requirements have been renumbered. Several minor clarifications added to the text. Figures 7.1 and 7.5 updated. Affected pages: all

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ACRONYM LIST

*It is assumed that an overall **FIRST** acronym list will be available at a later time. The present list therefore only contains the acronyms which are used in the context of the FIRST operations and Ground Segment definition.*

ADC	Analog to Digital Converter
AIV	Assembly Integration Verification
AMS	Archive Management System
AND	Alphanumeric Display
APID	Application Packet Identifier
AO	Announcement of Opportunity
AOCS	Attitude & Orbit Control System
AOS	Acquisition of Signal
AOT	Astronomical Observation Template
APH	Attitude Pointing History
AWG	(ESA) Astronomy Working Group
BOL	Bolometer Instrument (In FIRST Model Payload)
CC	Configuration Control
CCS	Central Command Schedule
C/O	Check-Out
Co-I	Co-Investigator
Co-PI	Co-Principal Investigator
CRP	Contingency Recovery Procedure
CS4	Cornerstone 4 (in Horizon 2000, i.e. FIRST)
CUS	Calibration Uplink System
DBI	Digital Bus Interface
DBU	Data Bus Unit
Dec	Declination
DPU	Data Processing Unit
D/Sci	(ESA) Director of Scientific Programmes
EGSE	Electrical Ground Support Equipment
EID	Experiment Interface Document
EMC	Electro-magnetic Compatibility
EMI	Electro-magnetic Interference
ESD	Electro-static Discharge
ESA	European Space Agency
ESOC	(ESA) Space Operations Centre

FCP	Flight Control Procedure
FD	Flight Dynamics
FFT	Fast Fourier Transform
FINDAS	FIRST Integrated Network & Data Archive System
FIRST	Far Infrared & Submillimetre Telescope
FITS	Flexible Image Transport System
FM	Flight Model
FOIRD	FIRST Operations Interface Requirements Document
FOP	Flight Operations Plan
FSCOM	FSC Operations Manager
FSCOT	FSC Operations Team
FOTAC	FIRST Observing Time Allocation Committee
FOV	Field Of View
FSC	FIRST Science Centre
FST	FIRST Science Team
FTP	File Transfer Protocol
FWHM	Full Width Half Maximum
GO	Guest Observer
GRD	Graphic Display
GSAG	Ground Segment Advisory Group
GSID	Ground Segment Interface Document
GTO	Guaranteed Time Observer
GUI	Graphical User Interface
Gb	GigaBit
HET	Heterodyne Instrument (in FIRST model payload)
HK	Housekeeping
H/W	Hardware
IA	Interactive Analysis
ICC	Instrument Control Centre
ICD	Interface Control Document
ICS	Instrument Command Sequence
IFOP	Instrument Flight Operations Plan
IFCP	Instrument Flight Control Procedure
ICRP	Instrument Contingency Recovery Procedure
IID	Instrument Interface Document
ISO	(ESA) Infrared Space Observatory
ITT	Invitation to Tender
JD	Julian Day
KAL	Keep Alive Line
kb	kilobit

LAN	Local Area Network
LEOP	Launch & Early Orbit Phase
LOS	Loss Of Signal
L2	L2 Lagrangian point of the Earth-Sun System
Mb	MegaBit
MCR	Main Control Room
MDB	Mission Data Base
MIRD	Mission Implementation Requirements Document
MIP	Mission Imlementation Plan
MMI	Man Machine Interface
MMU	Mass Memory Unit
MOC	Mission Operations Centre
MS	Mission Scientist
OBDH	On Board Data Handling
OBSW	On Board SoftWare
OHF	Observation History File
PC	Personal Computer
PES	Proposal Entry System
PH	Proposal Handling
PHOC	Photoconductor instrument (in FIRST model payload)
PI	Principal Investigator
PID	Packet Identifier
PLM	Payload Module
PM	Project Manager
POF	Planned Observation File
PR	Public Relations
PRP	Public Relations Plan
PROM	Programmable Read Only Memory
PS	Project Scientist
PST	Project Scientist Team
PV	Performance Verification
PWG	Payload Working Group
QLA	Quick Look Assessment
QM	Qualification Model
Ra	Right Ascension
RAM	Random Access Memory
RMS	Root Mean Sqared
ROM	Read Only Memory
RTA	Real Time Assessment

SAG	(FIRST) Science Advisory Group
SCOS	SpaceCraft Operations Control System
SCP	Satellite Commissionning Phase
SEU	Single Event Upset
SIRD	Science Implementation Requirements Document
SIP	Science Implementation Plan
SOC	Science Operations Centre
SOL	Sequenced Observations List
SPACON	Spacecraft Controller
SMP	Science Management Plan
SPR	Software Problem Report
SPC	(ESA) Science Programme Committee
SRD	Software Requirements Document
SSAC	(ESA) Space Science Advisory Committee
SSD	(ESA) Space Science Department
SVM	Service Module
S/C	Spacecraft
S/N	Signal to Noise
S/W	Software
TBC	To Be Confirmed
TBD	To Be Defined
TC	Telecommand
TM	Telemetry
TOO	Target Of Opportunity
TTC	Telemetry, Tracking & Commanding
URD	User Requirements Document
UT	Universal Time
UTC	Universal Time Cordinated
WIMP	Windows, Icons, Mouse and Pull-down menus
WWW	World Wide Web

1. INTRODUCTION

1.1 SCOPE OF DOCUMENT

The Science Operations Implementation Requirements Document (SIRD) is the highest level document defining the requirements for the scientific operations of the FIRST Observatory.
It also defines the related responsibilities and tasks of the various participants in the FIRST Project of ESA's Scientific Programmes.

These requirements are compatible with the overall FIRST mission concept and with the requirements levied on D/OPS in the Mission Implementation Requirements Document (MIRD) for the implementation of the overall Mission.

Implementation of the SIRD requirements shall be compatible with the programmatic, schedule and budgetary constraints applicable to the FIRST Programme.

During the design and development phases (phase B and phase C/D) the scope of the SIRD encompasses all tasks required for the provision of the necessary FIRST Science Operations facilities.

During the in-orbit operations phase (phase E), the scope of the SIRD encompasses all tasks required to carry out FIRST scientific operations in the optimal way compatible with the available resources. For this phase, the detailed activities required to support the scientific operations will be covered in the relevant operations-related documents which will be subordinate to the SIRD.

For the Post-Operations phase (see paragraph 2.4) the scope of the SIRD encompasses all tasks required to establish the FIRST "Archive" which is the ultimate legacy of the FIRST mission. As for the previous phase the corresponding detailed activities and supporting documents must be compatible with the SIRD.

The "Historical" Archive phase (see paragraph 2.4) is *not* covered in the SIRD.

The SIRD, therefore, has validity throughout all phases of the FIRST Programme, with the exception of the "Historical" Archive phase.

The SIRD will be placed under formal Configuration Control starting with Issue 1 (draft versions are not subjected to this mechanism). Changes in the contents of this document will normally result in changes in cost, schedule and/or performance. Any modification to the SIRD requires formal approval of the FIRST Project Manager and agreement of the Project Scientist, Instrument Control Centres (ICCs) Managers, FIRST Science Centre Operations Manager (FSCOM) and the ESOC Ground Segment Manager.

Chapters 1to 3, and chapter 7 provide background information.
The response to the SIRD will be contained in the Sci ence Operations Implementation Plans (SIPs) generated by the entities responsible for implementation, n amely the ICCs (one SIP per ICC) and the FSC. In case differences arise between the SIR D requirements and the SIPs, the SIRD will have precedence .**The SIPs shall be limited to responding to the requirements set in chapters 4, 5, 6, 8 and 9 of the SIRD**. They shall clearly identify the tasks and resources required to fulfil the SIRD's requirements.

1.2 APPLICABLE / REFERENCE DOCUMENTS

Applicable documents

AD1: FIRST Satellite System Spec. (PT-SP-00211)
AD2: FIRST Mission Requirements Document (TBW)
AD3: FIRST Science Management Plan
AD4: FIRST Instrument Interface Document, part A
AD5: FIRST Instrument Interface Document, part B
- Heterodyne Instrument (HET)
- Photoconductor Instrument (PHOC)
- Bolometer Instrument (BOL)

AD6: FIRST Operations Interface Requirements Document (FOIRD)
AD7: Guide to applying the ESA Software Engineering Standards (PSS-05-0) t o small Software Projects, BSSC(96)2
AD8: ESA Packet Telemetry Standard (PSS-04-106)
AD9: ESA Packet Telecommand Standard (PSS-04-107)
AD10: FIRST Packet Structure Definition (TBW)
AD11: FIRST Mission Implementation Requirements Document (TBW)
AD12: FIRST Ground Segment Interface Document (GSID)

Reference documents

RD1: FIRST Science Operations Concept and Ground Segment Document (PT - 03056)
RD2: FIRST Instruments Performance Specifications (TBW)
RD3: The FIRST AO
RD4: FIRST Spacecraft User Manual (TBW)
RD5: Mission Implementation Plan (MIP) -TBW-
RD6: Instrument Proposal HET
RD7: Instrument Proposal PHOC
RD8: Instrument Proposal BOL
RD9: FIRST Science Operations Implementation Plans (SIPs) for:
- The HET Instrument Control Centre (HET-ICC)
- The PHOC Instrument Control Centre (PHOC-ICC)

- The BOL Instrument Control Centre (BOL-ICC)
- The FIRST Science Centre (FSC)

RD10: Configuration Management and Control for ESA Space Systems (PSS-01-11)

1.3 FIRST MISSION OVERVIEW

1.3.1 Spacecraft

The spacecraft, of a modular design, (cf. figure 1.1) consists of three parts: the Telescope Assembly (TA) comprising the 3.5 m telescope inside its sunshade, the Payload Module (PLM), with the cryogenically cooled focal plane science instruments, and the Service Module (SVM) which also accommodates the 'ambient' temperature payload electronics.
The cryostat (which contains 2560 l of superfluid helium at 1.7 K) is directly derived from the ISO cryostat. The SVM is adapted from the XMM/INTEGRAL SVM.

1.3.2 Orbit

The nominal operational orbit for FIRST is a Lissajous orbit around the 2nd Lagrangian Libration Point (L_2) in the Earth/Moon-Sun system. Figure 1.2 shows the location of the L_2, the location of the other four Libration Points as well as the rotating orbit reference system $X_0Y_0Z_0$. The origin of this frame is at the Earth-Moon barycentre with the $+Z_0$-axis pointing towards the North ecliptic pole and the $+X_0$-axis pointing towards L_2.

The in-ecliptic and out-of-ecliptic motions are periodic with a period of about 6 months. The orbit amplitudes are approximately within the following ranges:

X	200,000 - 360,000 kms
Y	600,000 - 1,000,000 kms
Z	150,000 - 650,000 kms

The distance between the Earth and the spacecraft varies between 1.2×10^6 and 1.8×10^6 and the Sun-S/C-Earth angle varies between about 8 and 40 °.

In the Lissajous orbit the spacecraft will be well outside the Earth's shadow and *no* eclipses will occur. The transfer trajectory can be designed such that it is also free of eclipses.

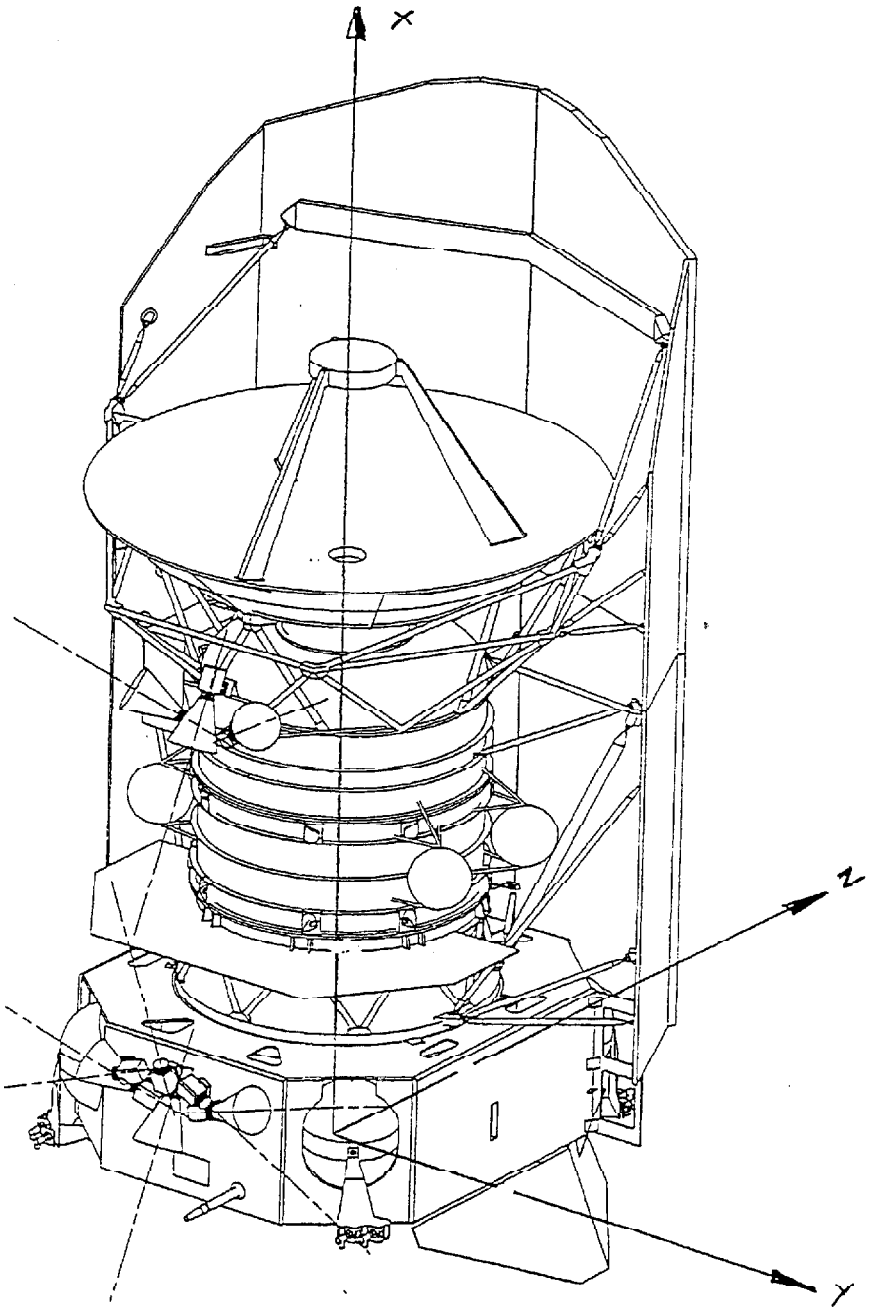

Fig. 1.1 The FIRST spacecraft based on the ISO cryostat

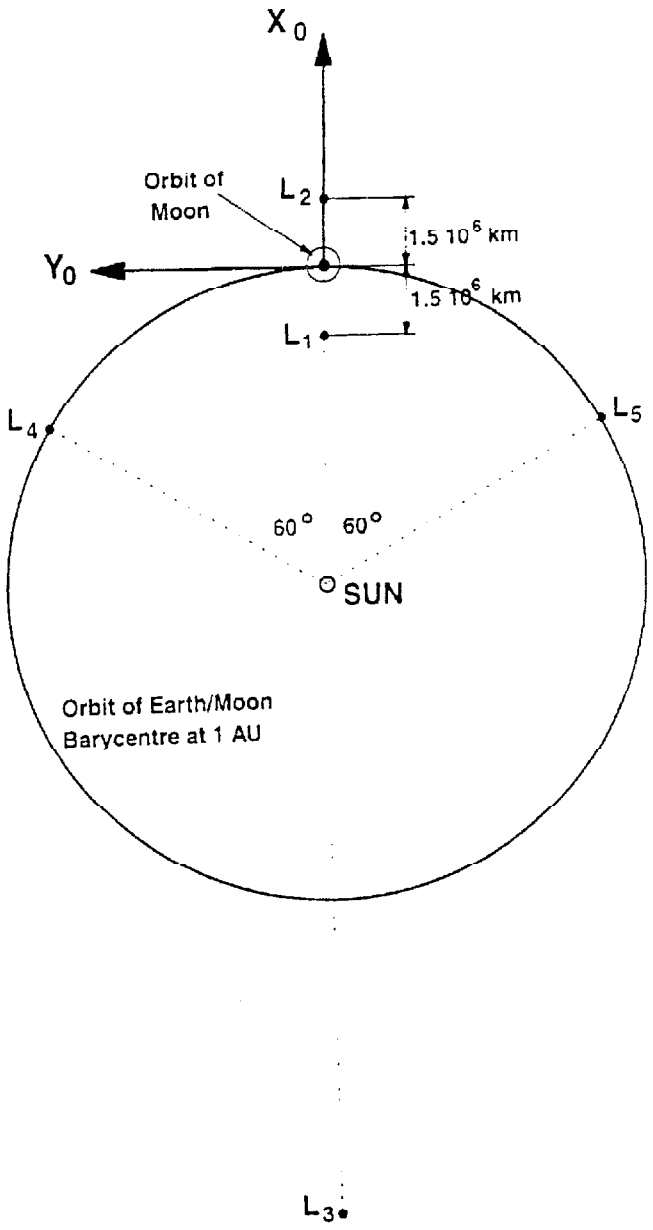

Fig. 1.2 The five Libration points and the rotating orbit reference system

1.3.3 Instruments

The scientific instruments are designed and built by single science institutes o r consortia of institutes under the responsibility of a Principal Investigator (PI). The PI has the overall respons ibility vis-a-vis ESA for the delivery of the instrument, and, in addition, for its corresponding Instrument Control Centre (ICC).

The Scientific Instruments are:

- The Heterodyne Instrument (HET) -TBC-
  Principal Investigator: TBD
- The Photoconductor Instrument (PHOC) -TBC-
  Principal Investigator: TBD
- The Bolometer (BOL) -TBC-
  Principal Investigator: TBD

Details of the Scientific Instruments can be found in the Instrument Interfac e Documents (IIDs) - AD4 and AD5-

1.3.4 Ground Segment

The Ground Segment for FIRST in the operational configuration consists of th e elements shown in Fig. 1.3.

The overall ground segment is implemented as a distributed architecture, where the required facilities are located in five distinct Centres:

- The Mission Operations Centre (MOC) located in ESOC
- Three Instrument Control Centres (ICCs), one per Scientific Instrument, located at the PI Institutes.
- The FIRST Science Centre (FSC) located at TBD

The doted lines in Fig. 1.3 delimit the elements contributed by the various centres. Mission scheduling is seen as a shared respo nsibility between the FSC and the MOC. Interface with the Observers is an FSC responsibility. The Observers interact with the Ground Segment via FINDAS.

Data Communication lines link the ICCs to the FSC, and the FSC to the MOC. Non-operational communications between the centres are carried out via Internet (o r equivalent), phone and mail.

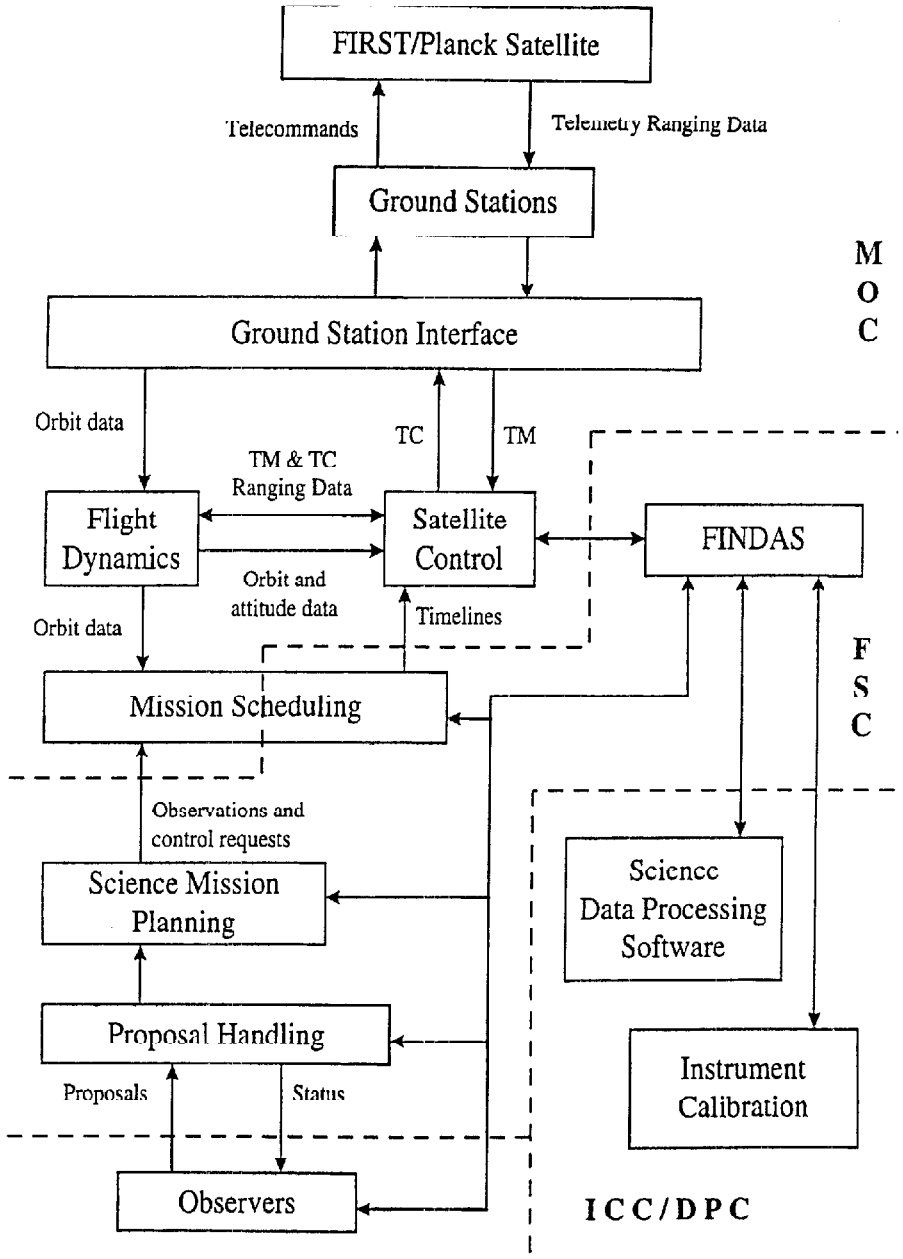

Fig. 1.3 Ground Segment Overview

1.3.5 Operations

FIRST is an Observatory-class mission including key programs and surveys.

From an L_2 orbit there are no constraints set by the Earth on the fraction of time which can be usefully employed as observing time. It is presently planned to conduct science operations 22 (TBC) hours per day, the remaining 2 hours per day being used for data downlink by repointing the spacecraft toward the Earth. By analogy with ISO it is expected that dedicated instrument engineering/calibration tasks will require about one day out of seven, or approximately 14% of the observing time. The remaining time will be divided into 'guaranteed' and 'open' time. The guaranteed time will be shared between the instrument/ICC PIs, the FSC, and the Mission Scientists. The open time will be allocated to the general astronomical community, including the guaranteed time holders, on the basis of submission of observing proposals and competitive selection. A small fraction of the open time will be allocated to discretionary time and Targets of Opportunity (ToOs). Given the science objectives of the FIRST mission it is anticipated that key projects in the form of large spatial and spectral surveys, as well as specific 'self-contained' key programs, will consume a significant amount of the available time of the overall mission. It is foreseen that there will be a separate initial call for observing proposals for key programs and surveys only at an early stage. Only when these programs have been established will the first call for 'normal' observing proposals be issued. At least one additional call for observing proposals will be issued after the initial survey data have become public.

Allocation of the available observing time, as well as selection mechanism and data access rights are described in AD3.

During the Satellite Commissioning and Performance Verification phases two Ground Stations Perth and Kourou- (TBC) will provide nearly full coverage.

In routine phase all operations will be conducted through a single ground station (Perth).

The observation schedule will normally be executed autonomously from telecommands stored on board. The command schedule will be up linked daily from the ground station(s).

Telemetry gathered during periods of non-visibility (routine phase) will be stored on board and transmitted in parallel with real time data when the satellite is in view of the ground station.

Spacecraft and instrument control will be performed by a single Mission Operations Centre (MOC) according to procedures. Specialists from the instrument developers will not be required during routine operations but will be accommodated at the MOC with their equipment during the Satellite Commissioning and Performance Verification

phases and in case of contingencies.

All TM, TC and other operational data will be stored by the MOC in a data repository (Archive). This MOC archive is a short term store -a couple of weeks maximum - which could be used for MOC operations activities and as a buffer store for replay to the permanent mission Archive (FIN DAS) in case of real time data transfer problems. Access to the Archive will be controlled by the means of specific access rights.
The observation pattern will be single instrument observations lasting from minutes to hours. The other two instruments may be on, gathering data in a unique mode. They will not point at the prime target but will be pointing within the 30' diameter FOV.

The scheduling of observations will maximise scientific return. It will be stochastic but will permit some fixed-time observations. A mechanism will be provided to handle Targets of Opportunity (ToOs).

1.4 GLOBAL RESPONSIBILITIES

D/Sci has overall responsibility for all phases of the FIRST Project.

D/Ops has overall responsibility for execution of all FIRST in-orbit operations.

D/Ops has responsibility for the design, implementation and operation of the FIRST Mission Operations Centre (MOC), ground stations and related elements.

Responsibility for the design, implementation and operation of the ICCs rests with the PIs (each PI for the corresponding ICC)

Responsibility for the design, implementation and operation of the FSC rests with ESA.

During Phase B and Phase C/D overall project management is ensured by the FIRST Project Manager located in ESTEC. The FIRST Project Scientist represents the interests of the scientific community.

During Phase E, following successful completion of the Commissioning Phase, H/SSD/SA will take over the tasks and responsibilities of the Project Manager.

For all phases of FIRST development and operations a " Ground Segment Advisory Group" (GSAG) comprising representatives of the ICCs, FSC, MOC and ESA monitors the activities of the main Ground Segment elements. It advises the FIRST Project Manager during the development phase and the FIRST Project Scientist during the operational phase.

1.5 MAJOR PROJECT MILESTONES

The following information is provided for the purpose of cost assessment only. The Project will review and update the project plan and milestones as necessary, but milestones changes will not lead to a separate update of this section.

1.5.1 Satellite Milestones

(1)	System Review	Jul. 1997
(2)	Issue AO	Sep. 1997
(3)	Mission Approval & Payload selection	May. 1998
(4)	Issue ITT (Phase B & CD)	Mar. 1999
(5)	Start Phase B	Apr. 2000
(6)	Start Phase C/D	Jul. 2001
(7)	Instrument QM deliveries	May. 2002
(8)	QM System Test (start)	Aug. 2003
(9)	Instrument FM deliveries	Jan. 2004
(10)	FM System Test (start)	Sep. 2004
(11)	Launch Campaign/Contingency (start)	Jun. 2005
(12)	Launch	Dec. 2005

1.5.2 Ground Segment Milestones

Due to the very long duration of the FIRST Pre-Phase B the major FIRST Ground Segment milestones do not fit into a typical scientific Project framework. In a "typical" project the Ground Segment Requirements Review and the Ground Segment Design review take place around L - 5 years and L - 3 years respectively. The milestones below have been adjusted to take the FIRST situation into account. They need to be carefully reviewed.

(1)	Ground Segment Requirements Review	L - 6 years (TBC)
(2)	Ground Segment Definition Review	L - 5 years (TBC)
(3)	Ground Segment Design Review	L - 4 years (TBC)
(4)	Ground Segment Implementation Review	L - 2 years (TBC)
(5)	Ground Segment Validation Review	L - 1 year (TBC)
(6)	End-to-End Test # 1 (EE-1)	L - 9 months (TBC)
(7)	End-to-End Test # 2 (EE-2)	L - 6 months (TBC)
(8)	Ground Segment Readiness Review	L - 3 months (TBC)
(9)	Start of Scientific Mission Phase	L + 2 months (TBC)
(11)	End of Nominal Mission	L + 4.5 years (TBC)

1.6 TOP LEVEL DOCUMENTATION

Fig. 1.4 shows the top level documentation relevant to the Ground Segmen t activities.

- The Mission Requirements Document (MRD) is prepared by the Project Scientis t (PS) and approved by the Project Manager (PM).

- The Science Management Plan (SMP) is prepare d by the PS and, upon approval by H/SA and D/Sci, forwarded to the SPC for endorsement.

- The Ground Segment and Operations Concept Document is prepared jointly by the Project, Instrument representatives, the PS and D/TOS. It is approved by the PM.

- The Satellite System Specification (SSS) is issued by the Project, as well as al l other related lower level documents such as the Space-to-Ground Interfac e Document and Spacecraft User Manual (UM).

- The Instruments Interface Documents -IIDs- (one per selected instrument) ar e issued by the Project. They include the instrument performance requirement s which must be met by the instruments in order to fu lfill FIRST scientific objectives. These requirements serve as a yardstick for evaluation of the instruments in-orbit performances.

- The Mission Implementation Requirements Document (MIRD) is generated jointl y by the Project and D/Ops. It is for mally issued by the PM. D/TOS formal answer is contained in the Mission Implementation Plan (MIP). The MIP must be approved by the PM.

- The Science Operations Implementation Requirements Document (SIRD) thi s document- is prepared by the Project. It must be agreed by the PS, the IC C Manager, the FSCOM and the ESOC Ground Segment Manager. The SIRD i s formally issued and approved by the PM.

- The Operations Interface Requirements Document (OIRD) is issued by D/TOS. I t specifies the requirements which must be fulfilled by the spacecraft and the instruments in order to allow D/TOS to operate them safely and efficiently (mainly requirements on TM, TC, autonomy, internal r edundancy, etc.). The OIRD must be approved by the PM.

Note: Many of the interfaces between the various elements of the FIRST Ground Segment will be defined via FINDAS. It is therefore foreseen to generate at an early stage (early 1999 -TBC-) the corresponding FINDAS Interface Document. The first DRAFT will be issued shortly after the completion of the FINDAS prototype implementation.

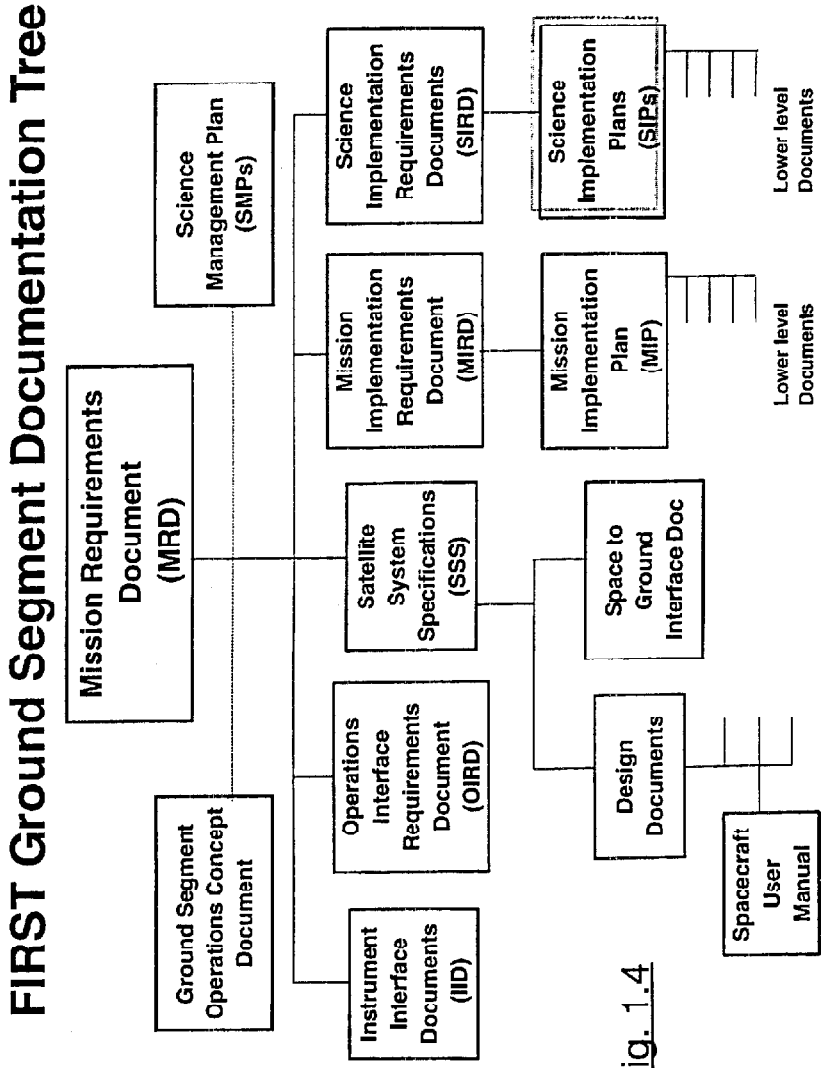
FIRST Ground Segment Documentation Tree
Mission Requirements Document (MRD)
Science Management Plan (SMPs)
Ground Segment Operations Concept Document
Instrument Interface Documents (IID)
Operations Interface Requirements Document (OIRD)
Satellite System Specifications (SSS)
Mission Implementation Requirements Document (MIRD)
Science Implementation Requirements Documents (SIRD)
Space to Ground Interface Doc
Design Documents
Spacecraft User Manual
Mission Implementation Plan (MIP)
Science Implementation Plans (SIPs)
Lower level Documents
Lower level Documents

Fig. 1.4

2. ASSUMPTIONS

The following assumptions are used as a basis for the planning of the scientific operations related tasks. It is understood that changes to these assumptions may change the scope and resources required.

2.1 LAUNCH

FIRST will be launched from the Centre Spatial Guyanais (CSG) in Kourou, French Guiana by a dedicated Ariane 5 intoa direct transfer trajectory to the L_2 Point.

2.2 ORBIT

Baseline is as described in section 1.3.2.
Launch window to be compatible with maximum visibility of the Galactic Centre during the first year of operations

2.3 OPERATIONAL PERIOD

Assumed launch date: December 2005
Duration of orbital operations: 4.5 years (4.25 years routine phase, 3 months for cool-down, commissioning, performance verification)

2.4 MISSION PHASES AND FACILITY UTILISATION

The following mission phases are identified (in agreement with AD1):

2.4.1 Development Phase

For the activities covered by the SIRD this phase formally starts at instrument/ICC selection and ends at the start of the LEOP phase. MOC, FSC and ICCs are involved.

2.4.2 Pre-launch Phase

From six to eight weeks prior to launch till launch minus 8 hours. This phase encompasses the final simulations and data flow tests, including Dress Rehearsal and the final Mission Readiness Tests (MRTs) between the ground satations, the MOC, the ICCs and the FSC.

2.4.3 Launch and Early Orbit phase (LEOP)

This phase comprises 3 sub-phases as described in AD1. They are briefly summarised here. During LEOP the instruments are switched off.

2.4.3.1 Launch Countdown Phase

Connection of the launch vehicle to the launch table, start of the final countdow n sequence (at H_0 - 6h00). RF flight configuration set up, switch over to interna l spacecraft power.

2.4.3.2 Launch Phase

Starts with the removal of the ombilical and ends at separation of the spacecraft in a 3-axis attitude. Phase duration approximatively 110 minutes (TBC).

Note: Spacecraft separation (i.e. end of the Launch phase) marks the beginning of the Transfer phase to L_2. The Transfer phase lasts several months, up to 8 months (TBC) depending on initial conditions and final orbit characteristics. Commissionning, PV phase and part of the routine phase are thus carried out during the transfer phase.

2.4.3.3 Initial Orbit Phase (IOP)

After separation from the launch vehicule the ESA Network (Kourou, Perth , Villafranca) establishes contact with the spacecraft for T C, TM and Ranging. The first orbit correction takes place approximatively 6 hours after injection. If necessary a second orbit correction is carried out about one day after the 1st correction . Subsequently, additional fin e orbit trimm manoeuvres will be executed, if necessary, to reach the correct conditions for entering the operational Lissajous orbit.

2.4.4 Commissioning Phase

Complete check-out of spacecraft functions and verification of all subsyste m performances. About 3 weeks (TBC) after launch, after proper outgassing, opening of the cryocover, switch-off of the telescope decontamination heaters and payloa d functional checkout (by the ICCs).
Expected duration of the commissionning phase is 1 month (TBC).
Ground stations: Perth and Kourou (VILSPA as back up if required).

2.4.5 Performance Verification Phase

Starts after successful completion of the commissionning activities. In addition to the normal, routine satellite control, includes determination of the satellite pointing capabilities, calibration of the spacecraft sensors, determination of instrument performance in all modes, and initial instrument calibrations. MOC, ICCs and FSC are involved. Expected duration about two months. The objective of this phase is to demonstrate the observatory (satellite + Ground Segment) scientific capability.

Note: Additional PV-like activities may be required outside the PV phase proper. In this case they would be scheduled as 'normal' engineering/calibrations/observation activities.

Note: ISO scientific operations have demonstrated that there is no sharp cut-off between PV activities and 'nominal' routine phase activities. It is conceivable (likely) that for a given instrument some mode(s) will have been released for 'nominal', routine operations, while other modes will still be under verification. The Ground Segment facilities (in particular mission planning and scheduling) shall ensure that this is possible without having to use specific, non standard, processes.

2.4.6 Routine Operations Phase

Nominal duration 4.25 years
Serendipity mode: baseline is to operate one or more instruments during slews (TBC)
Parallel mode: baseline is to operate non prime instruments in parallel with the prime instrument. (TBC)

2.4.7 Post-Operational Phase

The Post Operational Phase starts at the end of the orbital operations. It has a total duration of 3.25 years (TBC). It comprises the following sub-phases:

2.4.7.1 Run-down phase

Nominal duration: 3 months (TBC).
During this phase the final spacecraft calibrations accuracy data are derived (e.g. pointing), final spacecraft-related processing is carried out and the corresponding data are stored into FINDAS. The necessary transfer of knowledge between MOC and FSC-ICCs takes place, the MOC dedicated facilities are dismantled.
The MOC is no longer involved in the subsequent activities.

2.4.7.2 Mission Consolidation phase

Nominal duration: 6 months (TBC).
Includes consolidation of the archive contents, including processing tools and documentation, as well as the tools necessary to allow the various users (e.g. 'browsers', surveyers', 'expert', etc.) to access the archive.

2.4.7.3 'Active' Archive phase

Nominal duration: 2 years (TBC)
During this phase the FSC staff, the ICCs'staff and the scientific community access the Archive established at the end of the previous phase.
The experience gained and feed-back from the community are used to improve the instrument calibrations, cros-calibrations, processing tools as well as community support and acess to the Archive (e.g. speed, flexibility and frienliness).
Complete reprocessing (TBC) of all observations is carried out, and the 'products' which will constitute the final archive are generated.

2.4.7.4 Archive Consolidation phase

Nominal duration: 6 months (TBC). The goal of this phase is, building up upon the previous phase, to provide a 'final', complete, stand-alone FIRST Archive of data, products, documentation and software that will - with zero further development and minimal maintenance and operational costs- permit continued exploitation of the FIRST legacy by the astronomical community for at least the following 10 years (TBC).

2.4.7.5 ' Historical' Archive phase

Duration: at least 10 years (TBC). During this phase no further 'products' are generated and stored into the FIRST Archive and no further developments are undertaken. ESA's involvement is reduced to the absolute minimum. It is up to the astronomical community to make the best use of the FIRST archive
The 'Historical' Archive phase is *outside* the scope of the SIRD.

2.5 SATELLITE

Details on the Satellite, its performance and characteristics are contained in the applicable documents. Of particular note are the following:

- FIRST is a 3 axis stabilized satellite with 3 instruments

- Satellite telemetry (TM) and telecommand (TC) will be in accordance with ESA packet standards. The raw TM data acquisition rate on board, for thre e instruments, will be 68 Kbs (TBC). This is the data generation rate, not th e transmission rate.

- The satellite will be provided with a mass data store which will contain:
  - all commands for the observation schedule during one day.
  - telemetry data gathered during the Daily Science Operations Phase (DSOP) The transmission data rate will be 600 Kbs (TBC)

- The satellite provides for safe autonomous operation for a period of 72 hours.

- Satellite pointing will be constrained by p ermissible earth and sun angles and be restricted by other bright celestial bodies.

2.6 ON-BOARD SOFTWARE

All instrument on board S/W will be maintained by the PIs pre- and post-launch. On board S/W management i.e. loading, dump ing and comparing memory images will be carried out by the MOC.

3. RESPONSIBILITIES

Responsibility for the implementation of the FIRST ground segment and scientifi c operations is shared between:

- The FIRST Project Team (D/SCI (PT))
- The Directorate for Technical and Operational Support (D/TOS)
- The Project Scientist Team (D/SCI (SSD))
- The Principal Investigators Teams (PI) through the Instrument Control Centres (ICCs)
- The FIRST Science Centre Operations Team (FSCOT)
- The Observers

D/TOS responsibilities are covered in the FIRST MIRD (AD11). The responsibilities of the other parties are defined in the following sections.

3.1 FIRST PROJECT TEAM RESPONSIBILITIES

Th FIRST Project Team's responsibilities are defined below.

Note: Most of the corresponding tasks are carried out in close collaboration with the other parties which have ground segment and operations responsibilities.

- assume overall coordination and management responsibility for the d efinition and implementation of the elements of the FIRST Ground Segment and missio n operations.
- establish the overall mission requirements.
- define the standards which ensure compatibility, commonalit y, and maximum re-use of hardware and software between all phases of the project.
- define the interface requirements for the scientific instruments on-boar d software design.
- establish and maintain interface control between the elements of the groun d segment in collaboration with the ICCs, FSC and MOC.
- set up and coordinate all FINDAS prototyping activities until the FSC i s established.
- review and agree the requirements on the various elements of the groun d segment i.e. ICCs, FSC and MOC. Ensure timely implementation.

- review and agree the instrument flight operations procedures (nominal an d contingency). Ensure timely delivery.
- review and agree the ground segment operations procedures. Ensure timel y delivery.
- set up the Ground Segment Advisory Group (GSAG).
- set up and ensure smooth operations of the ground segment Integration an d Test Team (ITT). The ITT must be established prior to the first SVT.
- establish and maintain the overall Ground Segment schedule.
- monitor design and implementation of the scientific instruments on-boar d software.
- provide to the ICCs the required inputs for the definition of the instrumen t simulators.
- organise (jointly with D/TOS) all major ground segment and mission operations reviews.
- assume overall responsibility for the definition and execution of the Satellit e Commissioning phase.
- provide ad-hoc specialist support during flight operations.

3.2 PROJECT SCIENTIST RESPONSIBILITIES

The FIRST Project Scientist (PS) is responsible for the management of the FIRS T scientific programme, the safeguard of the scientific interests of the scienc e community, and the maximisation of the s cientific return of the FIRST mission during all its phases.

The PS leads a team (the PST) which, advised by the F IRST Science Team (FST) and the FIRST Observing Time Allocation Committee (FOTAC) is responsible fo r formulating and implementing the overall science strategy.

The PS is ESA's interface to the scientific community, including instrument/ICC P I consortia, the Mission Scientists (MSs) and the FOTAC, for all FIRST scientifi c matters. He organises and chairs the FST meetings.

The PS liaises with the FIRST Project Manager (PM) and the Project Team in th e development phase and coordinates all scientific issues with them. In particular the

PS advises the FIRST project Payload Manager on te chnical matters when they affect scientific performance.

After completion of the in-orbit operations the PS monitors the transition into th e post-operational phase.

Within the framework of his overall responsibil ities the PS, supported by his team, is, within the context of FIRST science ope rations and ground segment, responsible for:

- issuing the FIRST Science Management Plan (SMP) and get it approved by the SPC.
- issuing the "Scientific Capabilities of the FIRST Payload" document.
  Note: This document summarises the characteristics and expected performances of the three Instruments that form the scientific payload of FIRST.
- supporting all ground segment reviews.
- attending (as permanent member) all meetings of the GSAG.

3.3 PI RESPONSIBILITIES

Each FIRST Principal Investigator (PI) shall set up a dedicated Instrument Contro l Centre (ICC) through which all PI ground segment-related contributions will b e provided. He/she shall nominate an ICC manager, r eporting to him/her, and who shall have full authority for the day-to-day management of the ICC.

3.4 FIRST SCIENCE CENTRE (FSC) RESPONSIBILITIES

The FIRST Science Centre (FSC) is the single-point interface to the 'outside' world - including not only the general scientific community but also the press and genera l public. It will be located at a suitable location in an ESA member state. Provision of the FSC is an ESA responsibility.

The FSC has two fundamental functions:

- It shall insure that the sci entific productivity and impact of the FIRST mission is maximised within the given constraints. This is the responsibility of the Project Scientist Team (PST) led by the Project Scientist.
- It is responsible for a number of functional tasks, including the development and maintenance of FINDAS. These tasks are the responsibility of the FS C Operations Team (FSCOT) which is led by the FSC Operations Manage r

(FSCOM). The FSCOM is an ESA staff member. During the development phase the FSCOM reports (functionally) to the FIRST Pr oject Manager (PM). During the in-orbit and post operational phases he reports to the PS.

3.5 OBSERVERS RESPONSIBILITIES

Observers and potential observers have no responsibility as such in the scienc e operations. They, however, play an active role in the overall activity of the FIRS T Observatory. They communicate with the FSC, at their own cost, through norma l means such as the World Wide Web (WWW), electronic mail (E-mail), and othe r Internet-like services, fax and phone. In some cases visits to the FSC may b e required. Their "responsibilities" are listed below:

- send a letter of intent to the FSC (TBC) prior to formally submitting observin g proposals.

  Note: this allows formal user registration at the FSC.

- access the "Call for Proposal" documentation and associated supportin g software (through WWW or equivalent). Generate, check and submit observing proposals to the FSC.

- communicate, as required, with the FSC central help-desk facility.

- update their observing proposals post-la unch, as required, according to the FSC instructions, in order to take into account the in-orbit performance of th e satellite.

- access (through WWW or equivalent) the facilities (log of observing proposals, status of executed observations, etc.) required to assess the status of thei r proposal/observations.

- access their observation data as well as the auxiliary data, calibration data and scientific processing software required to process their observations. Generate the corresponding output products.

- access (through the WWW or equivalent) as required, every data of interes t which is publicly available on FINDAS (e.g. newsletter, publications, "official " FIRST documentation, etc.)

- (for specific users) draft/supply, upon FSC request, material for press releases, PR activities, etc.

- provide feedback to the FSC on FIRST scientific operations.

4. INSTRUMENT CONTROL CENTRE: DELEGATED TASKS

4.1 FUNCTIONAL REQUIREMENTS

Under the PI authority, the ICC manager and his team are responsible for th e following tasks:

ICCF-005 establishment, jointly with ESA, of the detailed list of ICC tasks and deliveries.

ICCF-010 generation of the ICC Implementation Plan.

ICCF-015 overall ICC organisation. ICC Team set up and management

ICCF-020 establishment and maintenance of the ICC schedule.

ICCF-025 management of the ICC interfaces with the ESA Project Team, th e other ICCs, the FSC and the MOC.

ICCF-030 support to the ground segment reviews.

ICCF-035 ICC Manager attendance (as a permanent membe r) to the meetings of the GSAG.

ICCF-040 establishment, jointly with ESA, of the set of documents (includin g software documentation) to be produced by the ICC.

ICCF-045 Provide the infrastructure (building, hardware, office space , communication equipment. etc.) as well as the support facilitie s (secretariat, clerical support, etc.) required, pre- and post-launch, to support the development, and later, mission operations work allocated to the ICC .

Note: ICCF-050 to ICCF-110 are carried out in close collaboration with the instrument designers.

ICCF-050 definition of the various TM and TC packets required to operate th e instrument.

ICCF-055 definition of the various instrument modes.

ICCF-060 definition of the set of Instrument Command Sequences (ICSs) necessary to operate the instrument.
Note: This set will be available to the Mission Planning and Scheduling systems.

ICCF-065 definition and delivery to the MOC of the set o f Permanent Instrument Command Sequences (PCSs).
Note: This set will be available to the SPACONs. It contains the fixed instrument command sequences, normally not used for observations, e.g. activation/de-activation, serendipity or parallel operations, contingency switch-off, etc. The structure of ICSs and PCSs is identical.

ICCF-070 definition of the initial set of Astronomical Observation Template s (AOTs) required to carry out the instrument scientific observations.
Note: The AOTs implement, at user level, the instrument modes defined in ICCF-055

ICCF-075 definition of the set of Science-HK parameters to be mo nitored by the MOC in order to ensure instrument health and safety.
For each of the parameter to be monitored:
- define the parameter limits (hard and soft -TBC-)
- define the validity conditions
- specify monitoring frequency

ICCF-080 definition of the instrument "dummy" commands (*directives)* and associated parameters necess ary to allow processing, on the ground, of the instrument observations (i.e. TDATA functionality in ISO)

ICCF-085 provision of the instrument TM/TC data base.

ICCF-090 provision of the Instrument User's Manual including "nominal" an d "contingency" Instrument Operations Procedures.

ICCF-095 generation and validation of the "nominal" Instrument Operation s Procedures. This would typically include:
- start up procedure
- instrument commissioning procedures
- "first light" procedure
- "engineering" and "diagnostic" procedures
- shut-down procedure
- calibration procedures
- observation procedures
- instrument on-board S/W update procedure

ICCF-100 generation and validation of the "contingency" Inst rument Operations Procedures. This would typically include:
- reset procedures (i.e. procedures to set the instrument into an y predefined standard "default" mode)

- "safing" procedures (i.e. procedures to cater for unforeseen events such as "bright" star encountered while slewing)
- back-up procedures (e.g. activation of a redundant sub-system in case of failure of the prime system)
- procedures for safety parameters out of limits
- procedures for recovery from instrument command verificatio n failure.
- procedures for other instrument anomaly recovery.
- procedure for instrument emergency switch-off .

Note: The procedures listed in ICCF-095 and ICCF-100 must take into account the requirements for ***instrument autonomy****, i.e. the instruments shall be able to operate for extended periods without ground control.*

Note: The instrument operations procedures will be incorporated into the Flight Operations Plan by the MOC together with any related spacecraft procedure.

ICCF-105 provision of a "time estimator" for the instrument.

ICCF-110 provision of an Instrument Command Translator (ICT) according t o MOC requirements.

Note: The ICT translates the "symbolic" instrument command language (mnemonics + parameters) into the binary command patterns to be uplinked by the MOC.

ICCF-115 generation and validation of the ground segment-related IC C Operations Procedures (nominal and contingency).

ICCF-120 definition (jointly with ESA, the FSC and the MOC) of the instrument data to be stored in the Archive.

ICCF-125 definition (jointly with ESA, the FSC and the MOC) of the relationships between these data items, and between instr ument data and FSC and MOC-provided data items.

ICCF-130 design, implementation, test and validation of the S/W requ ired for the Scientific Processing of the instrument data. This includes;

- Real Time Assessment/Quick-look Analysis (RTA/QLA) S/W
- Trend Analysis for long term behaviour of instrument and detectors
- Calibration Analysis
- Interactive Science Analysis
- Scientific Processing S/W.
- Any ad-hoc tool (e.g. uplink-downlink "correlators", telemetr y "viewers", *non*-standard data processing packages, etc.)

Note: The RTA/QLA software will be used during Instrument Level Tests (ILTs), IMTs, ISTs, Simulations and during all phases of the mission. It shall be designed and implemented in such a way that it can be used on-line for real-time monitoring and control of the instrument and off-line for instrument troubleshooting.
The Project will guarantee that the hardware and software interfaces will be identical in checkout and during operations.

ICCF-135 definition (jointly with the Project Scientist Team) of the Instrumen t Calibration Plan.

Note: This Plan should cover pre- and post-launch instrument calibration activities.

ICCF-140 set-up and management of the instrument ground calibration dat a base.

Note: This data base will be set up using the basic FINDAS capabilities. If required, "local" copies will be installed at the ICC. (TBC)

ICCF-145 provide input, as required, to the FSC, for the implementation of the ground based calibration programme which might be necessary t o support instrument calibration pre- and post-launch.

ICCF-150 design, Implementation, test and validation of the S/W Instrumen t Simulator. The following requirements must be fulfilled (TBC):
- "integration" with the MOC-provided simulator shall be possible.
- the simulator shall be adequate for validation of instrument fligh t operations procedures and scientific processing S/W.
- the simulator shall be adequate for the functional v alidation of post-launch instrument on-board S/W updates.

Note: The level of "fidelity" required from the Simulator must be agreed between the ICC and the Project Scientist.

ICCF-155 set up and maintain at the ICC an instrument on-board S/ W maintenance and validation facility. (pre- and post-launch)

ICCF-160 deliver (to the MOC) the instrument on-board software uplink images according to an agreed format.
- format to be defined in an ICD produced by the MOC.
- format will be the same for all instruments.

ICCF-165 define jointly with the FSC the data and operati onal interface between the ICC and the FSC.
- The interface will be defined in an ICD produced by the FSC.
- The interface will be identical for all ICCs.

ICCF-170 define jointly with the MOC the data and operational interfac e between the ICC and the MOC.
- The interface will be defined in an ICD produced by the MOC.
- The interface will be identical for all ICCs.

Note: There are no formal data or operational interfaces between the ICCs. It is expected, however, that communications between the ICCs will be frequent and extensive in order to achieve the commonality objectives of the FIRST programme.

ICCF-175 provide support for the definition of FINDAS.

ICCF-180 ensure that the commonality standards defined jointly with ESA, the FSC and the other ICCs are adhered to in the S/W design an d implementation.

ICCF-185 set up and operation (pre- and post-launch) of the ICC hardware and software Configuration Control System.

ICCF-190 provision, to the agreed standards, of all ICC-related documentation. This includes:
- on-board S/W documentation
- instrument simulator documentation
- S/W users manuals
- ICC H/W and S/W Integration and Test Plans
- S/W test procedures and test results.
- ICC Operations Plan

ICCF-195 provide the necessary input, as required, to the Integration and Test Team (ITT) for the generation of ground segment Integration an d Validation Plans, as well as Simulation Plans.

ICCF-200 participation, as required, in pre-launch ground segment integratio n tests, validation tests (e.g. listen-in, S VTs, end-to-end tests, etc.) and simulations.

ICCF-205 deliver to the MOC the necessary hardware (Instrument Station) and software (RTA/QLA, etc.) requi red to support the Commissioning and Performance Verification phases. Support installation as required.

4.2 OPERATIONAL REQUIREMENTS

ICCO-005 set up and train the ICC operations team required to support the instrument operations during all phases of the mission.

Note: The operations staff will be located at the ICC during the routine phase. The necessary accommodations and logistical support shall be provided by the ICC

ICCO-010 provide instrument training, as required, to selected FSC and MOC (SPACONs) staff.

Note: Training shall take place in accordance with a training plan approved by ESA. The plan shall identify duration of each training activity and number of staff involved -trainers and trainees-.

ICCO-015 provide to the MOC the operations staff (instrument specialists) required to support the Commissioning and Performance Verification phases.

Note: These specialists will be located at the MOC for the duration of these two phases. The necessary accommodations and logistical support will be provided by the MOC
At any time in the course of the mission ICC staff may have to be recalled at the MOC to provide payload contingency support in case of serious malfunction of the instrument.

The scope and/or frequency of some of the operational tasks listed below might change between the various mission phases. The details shall be elaborated in the relevant operations plans. In broad term the ICC operations will entail the following tasks:

ICCO-020 maintenance of the instrument on-board S/W until the end of orbital operations.

Note: This includes diagnostic of the malfunction or improvement required, implementation of the required S/W changes, validation on the ICC-provided on -board S/W validation facility and submission of the changes to the MOC.
Note: A new on-board S/W version can only be uplinked upon Project Scientist's approval. Uplink is carried out by the MOC according to agreed operational procedures.

ICCO-025 support the FSC helpdesk on specific instrument-related queries

Note: This is for queries from the community that the FSC cannot answer directly. This includes queries on instrument-related software. It is anticipated that this is only a punctual, low-level activity. Interaction is with the FSC not directly with the originator of the query.

ICCO-030 provision of instrument "calibration" requests, instrument "engineering" requests, instrument "diagnostic" requests, instrument "on-board memory dump" requests, etc. to the FSC for the upcoming mission planning period.

Note: requests to be provided nominally 2 to 3 weeks in advance (TBD), for a period of 2 to 3 weeks (TBD). If "re-planning" is required the turn-around time will be faster.
The format will be defined in an ICD produced by the FSC.
The format will be the same for all instruments.

ICCO-035 perform (near real-time) instrument health and status monitoring (RTA). This includes;
- get (near real-time) TM data from the MOC (via FINDAS)
- display and monitor instrument status.
- derive and display additional parameters. perform limit checking.
- perform instrument command verification (TBD)
- identify possible instrument reconfiguration and/or changes in parameter settings for current or future observations (TBD)
- provide instrument mode/parameter change requests to the MOC (TBD)

Note: This function is carried out on the Instrument Station (IS) running RTA. During Commissioning and PV phase the IS is located at the MOC. Instrument "safety" is ensured by the MOC.

ICCO-040 perform (near real-time) instrument performance monitoring. This includes;
- select and display science data.
- derive and display additional parameters.
- perform preliminary assessment of detector behaviour (sensitivity, saturation, spiking, dark current, etc.)
- perform pointing verification (TBD)
- establish if spacecraft attitude trim is required (TBD)
- identify possible instrument reconfiguration and/or changes in parameter settings (e.g. gain settings, bias voltages, change of filters, etc.) for current or future observations (TBD)

- produce IS report and file on FINDAS. -preliminary assessment of success/failure of the observation-.
- provide instrument mode/parameter change requests or spacecraft attitude trim requests to the MOC (TBD)

Note: This function is carried out on the Instrument Station (IS) running QLA. During Commissioning and PV phase the IS is located at the MOC. Change requests (as well as the requests resulting from RTA) are checked by the MOC and, if granted, carried out by the SPACONs

ICCO-045 perform RTA/QLA functions in off-line mode.

Note: This function is carried out on the Instrument Station (IS) running RTA/QLA using data retrieved from FINDAS to perform instrument troubleshooting and diagnostic. During Commissioning and PV phase the IS is located at the MOC, during routine phase it is located at the ICC. No change requests to the MOC can be derived from this activity.

Note: In the routine phase, the data gathered on-board during the Daily Science Operations Phase (DSOP) is already "old" data by the time it is transmitted to the ground during the DTCP (Daily TeleCommunication Period) and made available at the MOC. Near real-time data during the routine phase is thus only the data gathered during the DTCP and transmitted in parrallel to the stored data. (TBC)

ICCO-050 perform instrument calibration. This includes;

- schedule "calibration" observations on external standard calibration sources.
- schedule "calibration" observations with instrument internal calibration sources.
- process calibration observations with RTA/QLA
- process calibration observations with Interactive Analysis (IA) and/or Calibration Analysis (CA) S/W.
- compare calibration derived parameters with pre-launch values
- update calibration files/tables (e.g. Cal_G and Cal_Q files for ISO) and archive into FINDAS.
- update calibration history
- carry out Trend Analysis (using QLA, or CA, or IA, or specific Trend Analysis S/W).
  - Derive long-term trend data for instrument performance evolution.
  - Derive instrument calibration tables (e.g. CAL_U files in ISO) and archive into FINDAS.

ICCO-055 propose changes to instrument operations scenario. Coordinate with MOC and FSC.

Note: It may be that, based on the results of any of the activities ICCO-035 to ICCO-050, the instrument operations scenario for the instrument has to be changed. Instrument operations may have to be suspended until further notice in case of serious instrument malfunction and/or it may be that a specific instrument mode (or AOT) does not work. It is the responsibility of the ICC operations staff to propose changes to the operations scenario in order to overcome the problem(s).

Note: changes must be coordinated with the MOC and FSC and can only be implemented after Project Scientist's authorisation. Implementation is carried out by the FSC Operations Manager.

ICCO-060 support "specific" instrument modes (TBD). This could include;
- instrument "parallel" mode.
- instrument "serendipity" mode.
- instrument operations during "slews".

Note: Specific instrument modes, if defined, shall be supported (planning, health and performance monitoring, calibration, data analysis, etc.) by the ICC operations team in agreement with the overall science objectives established by the Project Scientist.

ICCO-065 validate scientific processing S/W. Release for use by t he community.

Note: the scientific data processing software ("pipeline", and Interactive Analysis) will evolve considerably during the mission from the basic, imperfect set available at launch. The ICC team shall process "selected" observations in order to validate the various processing algorithms. Upon validation the S/W is released for use by the community through FINDAS. Observations shall be selected in such a way that all instrument modes (AOTs) are covered as well as possible.

ICCO-070 perform quality checks of the mission products

Note: "standard" products (TBD/TBC) are derived by the users applying the "pipeline" S/W to their observation data. The ICC team shall process "selected" observations at regular intervals in order to verify that the products derived from this processing satisfy the required quality standards. This activity is closely related with ICCO-013.

ICCO-075 maintain optimal scientific instrument performance. This includes;
- regular generation of instrument calibration parameters.
- maintenance of AOTs and ICSs
- maintenance/update of the on-board S/W.
- issue, as required, Instrument Anomaly Reports. follow up.
- adaptation to radiation environment.

ICCO-080 maintain the ICC. This includes the following tasks:
- maintain and update as required the general ICC infrastructure.
- maintain and update as required the ICC software.
- maintain and update as required the ICC hardware. Carry ou t regular preventive H/W maintenance (including installation, i f necessary, of new versions of operating systems)
- perform routine S/W and data backups.
- maintain the ICC documentation.
- train (re-train) ICC staff as required.
- operate the ICC hardware and software Configuration Contro l system. (maintain a central list of all ICC Software Problem s Reports)

ICCO-085 produce monthly (TBC) ICC operations reports.

4.3 POST-OPERATIONS REQUIREMENTS

These activities concern essentially the tasks required to produce an archive of FIRST data and data products, proc essed with the best calibration possible and make them available to the community. The tasks are shared by the FSC and the ICCs. The FSC contribution is described in chapter 5.3.

The ICCs shall, as a minim um, carry out the tasks listed below. The list is limited to the tasks *required* in support of the FIRST mission. The ICCs may want to perfor m additional ICC-specif ic tasks. In this case the ICC manpower allocated must be such that these additional tasks do not compromise the tasks listed below.

ICCA-005 Monitor (jointly with the FSC) the run-down activities in order t o ensure that all required spacecraft data are secured.

ICCA-010 Define (jointly with the FSC) the type of data and data 'products' to store into the archive for the various types of users (e.g. 'browsers', 'survey' users, 'experts', etc.)

ICCA-015 Define (jointly with the FSC) the processing tools and archive access tools to be provided, as well as data quality goals.

ICCA-020 support (jointly with the FSC) the archive users in the reduction o f their data.

ICCA-025 Improve calibration files/data. Deliver updates to the FSC (via FINDAS)

ICCA-030 Improve processing algorithms. Deliver updates to the FSC (vi a FINDAS)

ICCA-035 Support 'validation' of the data products generated with improve d algorithms/calibration data.

ICCA-040 Process (as applicable) 'parallel' and/or 'serendipity' data generated by their instrument. Deliver to the FSC (via FINDAS)

ICCA-045 Cross-calibrate their results with other instruments (TBC)

ICCA-050 Maintain the necessary facilities and staff throughout the post - operations phase.

5. FIRST SCIENCE CENTRE (FSC): RESPONSIBILITIES AND DELEGATED TASKS

The tasks described here are carried out either by the Project Scientist Team (PST), led by the Project Scientist (PS): or by the FSC Operations Team (FSCOT), led by the FSC Operations Manager (FSCOM). The PST will pro vide definitions of functional and operational tasks to be performed, the FSCOT will be responsible for th c implementation. The FSCOT will provide the infrastructure and tools n ecessary for the PST and FSCOT to carry out their respective tasks.

In the development phase the FSCOM reports to thc Project Manager (PM) who has the ultimate responsibility for a succesful and timely implementation of the entir e ground segment. In thc routinc operations phase the infrastructure and tools will be used by the PST and FSCOT according to their respective responsibilities. In thi s phase the FSCOM reports to the PS. In the post-operational phase the FSCOT wil l cease to exist as an entity, partly being absorbed by a reorganised PST.

5.1 FUNCTIONAL REQUIREMENTS

5.1.1 Project Scientist Team (PST)

The PS/PST is responsible for the execution of the tasks listed below:

FSCF-005 act as the point-of-contact between the FIRST observatory and th e outside world.

FSCF-010 provide overall science coordination.

FSCF-015 set up the FOTAC on behalf of D/Sci, and provide the terms o f reference for the FOTAC.

FSCF-020 provide support to the FOTAC and the science community. Thi s includes tasks such as:

issue Call(s) for Proposals.

provide support to proposers re the tools and documentatio n (available through FINDAS) required to complete and submi t proposals; e.g. PGA or equivalent, proposal entry forms, instrument "time estimators", observer guide, instrument users manual, etc.

provide support to FOTAC re the tools required (available throug h FINDAS) to assess and grade the observing proposals.

ensure availability of specialised instrument and data processin g knowledge (e.g. by training, colocation, exchange of staff , participation in specific instrument activities, guaranteed tim e observations, etc.)

set up a central help-desk service to handle all requests from th e community.

Note: Requests which call upon specialised instrument knowledge not available at the FSC will be relayed by the FSC to the relevant ICC. The ICC answers will be addressed to the FSC who will forward them to the initial requesters. This mechanism off-loads the ICCs from the burden of communicating with the external community. It is expected that such specialised requests will represent a small percentage of all queries addressed to the FSC.

publish news-letters.

provide statistics to FOTAC and ESA as required.

provide support to authorised users in accessing their data an d science processing software required to process their observations.

provide support to the community re performing data processing.

FSCF-025 provide support to key programme (e.g. sur vey) activities as required, including:

support in the definition

overall coordination

processing of programme inputs

processing of data and making results available (via FINDAS) to th e general community

Note: It is assumed that "standard" FSC and ICC facilities and tools would not be sufficient for certain programmes. If "tailored" tools are needed, their provision would be the responsibility of the the FSCOT and/or ICCs, as required.

FSCF-030 provide support to the ESA Public Relations (PR) effort.

FSCF-035 specify (in collaboration with the ICCs and the FSC) the Use r Requirements for all operational "scientific" software to be used in the

ground segment.

FSCF-040 monitor proper implementation of the requirements defined above by means of regular progress meetings, reviews, participati on in software tests and user "trials".

Note: it is assumed that the PST will review and approve the ICCs' and FSC software test plans and procedures, witness selected tests (TBC) and, after formal software validation, perform scientific user trials.

FSCF-045 definition (jointly with the ICCs and the MOC) of the data an d operational interfaces between the FSC and the science communit y and the FOTAC.

FSCF-050 review and approve the ground segment science operation s procedures.

Note: this task is shared with the FIRST Project team. The Project team ensures that the ground segment science operations procedures are safe. The PS team ensures that, as defined, the procedures will maximise the science return.

FSCF-055 monitor instrument design and characterisation activities. Chec k against instrument performance requirements.

FSCF-060 define (jointly with the ICCs) the Instruments c alibration requirements. Set up and run the FIRST Calibration Working Group.

FSCF-065 coordination (with the ICCs) of the ground-based calibratio n programme which might be necessary (TBC) to support instrumen t calibrations pre- and post-launch.

FSCF-070 monitor the instrument calibration activities (on ground).

FSCF-075 preparation (with the ICCs) of the in-orbit instrument calibratio n programme. This requires:

definition (with the ICCs) and maintenance of a consolidate d Calibration Target List.

procurement and set up of various astronomical stars catalogues (e.g. IRAS catalogue, ISO catalogue, Hipparcos catalogue, Bright Star s catalogue, etc.)

FSCF-080 define (jointly with the ICCs) the instruments in-o rbit cross- calibration Plan.

FSCF-085 define (jointly with the ICCs and the FSC) the Instrument in-orbi t Performance Verification Plan.

FSCF-090 review and approve the instrument flight operations procedure s (nominal and contingency).

Note: this task is shared with the FIRST Project team. The Project team ensures that the instrument flight procedures are safe and compatible with the spacecraft procedures. The PST ensures that, as defined, the instrument flight procedures will maximise the science return.

FSCF-095 participation, as required, in pre-launch ground segment integration, validation tests and simulations. Support, as required, to groun d segment reviews and project meetings.

FSCF-100 define, in collaboration with the FSC and the ICCs, the data an d facilities required at the FSC to support the post-operational phas e including:

archive contents (science data, calibration data, auxilliary an d ancilliary data, documentation, etc.).

processing tools.

archive access facilities.

Note: It is assumed that the GSAG (without MOC and Project representatives) will ensure monitoring of the post- operational phase activities.

FSCF-105 monitor the run-down activities to ensure that all spacecraft dat a required for the post-operational phase are collected and secured . Ensure necessary transfer of knowledge between the MOC, FSC and ICC teams.

5.1.2 FSC Operations Team (FSCOT)

The FSCOM/FSCOT is responsible for the execution of the tasks listed below:

FSCF-120 establishment, jointly with the PST, of the detailed list of FSC task s and deliveries.

FSCF-125 generation of the FSC Implementation Plan.

FSCF-130 overall FSC functional organisation. FSC Operations Team (FSCOT) set up and management.

FSCF-135 establishment and maintenance of the overall FSC schedule.

FSCF-140 provide and manage the infrastructure (building, hardware, offic e space, communication equipment, etc.) as well as the suppor t facilities (secretariat, clerical support, etc.) required, pre- and post - launch, to support the development, and later, mission operation s work allocated to the FSC.

Note: This include accomodation and provision of the required logistical support to the Project Scientist and his team when they are located at the FSC.

FSCF-145 management of the FSC functional interfaces with the Project Team, PST, ICCs, and MOC.

FSCF-150 provide and manage the FIRST Integrated Network and Data Archiving System (FINDAS). This includes tasks such as:

definition (jointly with PST, ICCs and MOC) of all the data items to be stored in FINDAS.

definition (jointly with PST, ICCs and MOC) of the relationship s between these data items.

implementation of the FIRST data model.

definition, procurement and set up of the required hardware facilities.

procurement (and if required tailoring to FIRST's needs) of th e (underlying) Archive Management System.

management of FINDAS (pre- and post-launch). This includes all the necessary steps requi red to solve the issues of configuration control, data access rights, data security, archive integrity, etc.

set up of the required FINDAS Server(s) and communication pr otocols.

Note: The communications links between FSC, ICCs and MOC are procured and set up by the MOC.

FSCF-155 provide and manage a Proposal Handling System. This system shall include the facilities required for:

reception, filing, sorting (if necessary) and checking of the observing proposals ("open time" proposals, "guaranteed time" proposals and key programmes.

generation and maintenance of the Proposal Data Base.

preliminary screening of proposals (technical feasibility, etc.) detection and flagging of duplicate proposals.

Note: "checking" implies verifying completeness and syntax of proposals and verifying that the submitter is properly registered. "screening" implies a scientific/technical evaluation of the adequacy of selected sensitivity, requested observing time, target, observing mode, etc. "checking" is an FSCOT task, "screening" is a PST task.

generation of a proposal evaluation report for FOTAC.

submission of the proposals to FOTAC.

acceptance of the graded proposals from FOTAC.

provision of feedback to the proposers.

generation of proposals statistics.

FSCF-160 provide and manage a Scientific Mission Planning System. This system shall include the facilities required for:

selection from the Mission Data Base of a set of observations (may contain "guaranteed time" observations, "open time" observations, "key programme type" observations, "filler" observations, "fixed-time" observations, and ToOs).

selection of "calibration" (origin ICCs) and/or "cross-calibration" observations as required.

selection of instrument "engineering" observations requests as required (origin ICCs).

selection of on-board memory load requests as required (origin ICCs.)

handling of re-planning requests from the observers (faile d observations) and/or the ICCs (failed calibrations, follow- up instrument diagnostic activities, etc.)

scheduling, based on priority or any other scientific or technica l considerations.

making available of a selected set of observat ions (or schedule) to the MOC.

Note 1: the selection involves a coordination process between all instruments in such a way that science output is maximised in accordance with a strategy formulated by the PST.

Note 2: "linked" observations are allowed, "concatenated" observations are not.

Note 3: current baseline (for costing purpose) is that the FSC will carry out scheduling of the science activities. An alternative could be for the FSC to pass to the MOC a list of "observations" in no particular order and let the MOC carry out the scheduling in an automated way. Such a list would have to include more observations than could be fitted into a given time slot. This would allow an optimisation (in terms of efficiency in the use of the spacecraft time) by the scheduling program.

FSCF-165 provide and manage the Mission Data Base (MDB). This includes:

define (jointly with ICCs and MOC) the structure and contents of the MDB according to PST requirements.

populate the MDB with "observations" using the PDB following th e proposal selection process(es).

set up and maintain the MDB throughout the mission, ensuring it s integrity at all times.

update the MDB, as required, to take into account changes in mission parameters (e.g. instrument sensitivities, observing times, priorities , etc.) and/or spacecraft and/or instrument anomalies.

update the MDB, as required, in order to flag executed observations, block/unblock observations, re-s chedule (failed) observations (on PST request), etc.

Note: observations with one instrument mode might be "blocked" in the MDB, i.e. set to "do_not_schedule" in case of an anomaly with the instrument. Once the anomaly is corrected, the corresponding observation can be "unblocked" i.e. released for scheduling.

provision of a "safe" editor, including audit trail (TBC) for updatin g selected entries into the MDB; the editor should support "global " editing and "undo" facilities.

Note: It is anticipated (TBC) that most of the required MDB set up and management facilities will be provided by FINDAS.

FSCF-170 design, implementation, testing, validation and maintena nce of all S/W packages and tools required to carry out the tasks listed abov e including implementation of the AOT-logic.

FSCF-175 definition (jointly with the ICCs and the MOC) of the data an d operational interfaces between the FSC and the MOC and the ICCs.

FSCF-180 ensure that the commonality standards defined jointly with ESA and the ICCs are adhered to in the S/W design and implementation.

FSCF-185 provision, to the agre ed standards, of all FSC-related documentation, including:

operators and software users manuals (e.g. Proposal Handling , Mission Planning, FINDAS management, etc.).

FSC H/W and S/W Integration and Test PLans.

S/W test procedures and test results.

FSC-related ground segment operations procedures.

FSCF-190 provide the necessary inputs , as required, to the Integration and Test Team (ITT) for the generation of the ground segment Integration and Validation Plans as well as Simulation Plans.

FSCF-195 participation, as required, in pre-launch ground segment integration, validation tests and simulations. Support, as required, to groun d segment reviews and project meetings.

FSCF-200 FSCOM attendance (as a permanent member) to the meetings of the GSAG.

FSCF-205 provide trained FSCOT man power, as required, to support pre-launch ground segment integration, validation tests and simulations.

FSCF-210 provide the trained FSCOT manpower required to support operations of the FSC.

5.2 OPERATIONAL REQUIREMENTS

The scope and/or frequency of some of the operational tasks listed below migh t change between the vario us phases of the Project. The details shall be elaborated in the relevant operations plans. In broad terms, th e FSC operations will entail the tasks listed below.

5.2.1 Project Scientist Team (PST)

The PS/PST is responsible for the execution of the tasks listed below:

FSCO-005 set up and train the team required to support the FSC activities pre- and post-launch.

Note: Training shall take place in accordance with an approved training plan. The Plan shall identify duration of each training activity and number of staff involved (trainers and trainees). Training external to the FSC, e.g. training involving MOC and/or ICCs shall be identified in the Plan.

FSCO-010 operate the Proposal Handling system:

accept proposals from any "registered" location.

provide support to the proposers.

process proposals.

manage the Proposal Data Base.

provide feed-back to the proposers.

provide statistics to the FOTAC and ESA as required.

provide FOTAC support.

FSCO-015 provide science community support:

operate the Central Help-desk.

post information of general interest on the WWW or equivalent.

FSCO-020 provide support to the ESA Public Relations (PR) effort.

FSCO-025 release for access by the community the observations for which the "proprietary" period has expired.

5.2.2 FSC Operations Team FSCOT)

The FSCOM/FSCOT is responsible for the execution of the tasks listed below:

FSCO-040 set up and train the operations team required to support the FS C activities pre- and post-launch.

Note: Training shall take place in accordance with an approved training plan. The Plan shall identify duration of each training activity and number of staff involved (trainers and trainees). Training external to the FSC, e.g. training involving MOC and/or ICCs shall be identified in the Plan.

FSCO-045 provide to the MOC, if required, the FSC operations staff necessary to support the Commissionning and Perfor mance Verification phases.

Note: These specialists would be located at the MOC for the duration of these two phases. The necessary accomodations and logistical support would be provided by the MOC

FSCO-050 maintain the Proposal Handling System

FSCO-055 maintain and operate FINDAS:

ensure that performance and availability requirements are met.

ensure that all mission data ar e safely archived and made available to the authorised users.

ensure that communications within the FIRST ground segment an d between FSC and outside world are satisfactory. If necessary improve procedures and/or software.

FSCO-060 maintain and operate the Science Mission Planning System:

generation and maintenance of long term observing strategie s according to PST strategy.

generation and maintenance of up-to-date complete observin g schedules through the end of the mission.

generation of related statistical information as required.

liaison with the ICCs for planning of calibration and cross- calibration activities.

liaison with the ICCs for planning of specific instr ument activities, e.g. "engineering" or "diagnostic" observations, instrument on-boar d software maintenance, etc.

generation for each daily operations period of the observation an d instrument command fi les required by the MOC's scheduling system.

checking of the summary timeline generated by the MOC upon MOC scheduling.

liaison with the MOC for re-iteration of the planning cycle (whe n required) e.g. problems with the summary timeline, handling o f contingencies and ToOs.

re-submission of an updated observation set (or sche dule) to the MOC after re-iteration of the planning cycle.

FSCO-065 maintain and operate the Mission Data Base (MDB) i.e. update th e MDB:

to reflect the history of the previous observations.

after reception of the proposals from a new "call".

after PV (required "tuning" following assessment of in-fligh t performances).

to accomodate linked observations.

to accomodate requ est for corrections/changes from the community.

FSCO-070 set up and manage the Observation History Log.

Note: This log allows quick and easy access to the status of all observations (sheduled, not_scheduled, blocked, executed-when-successful, failed, released, not_released, etc.).

FSCO-075 maintain the FSC. This includes the following tasks:

maintain and upgrade as required the general FSC infrastructure.

maintain and upgrade as required the FSC software.

maintain and upgrade as required the FSC hardware. C arry out regular preventive H/W maintenance (this includes installation, if necessary, of new versions of operating systems).

perform routine S/W and data backups.

maintain the FSC operational documentation.

train (re-train) FSC staff as required.

operate the FSC hardware and software Configuration Control system. (maintain a central list of all FSC Software Problem Reports).

FSCO-080 produce monthly FSC operations reports.

5.3 POST-OPERATIONS REQUIREMENTS

These activities concern essentially the tasks required to produce an archive of FIRST data and data products, proc essed with the best calibration possible and make them available to the community. The tasks are shared by the (reorganised) PST and the ICCs. The ICC contributions are described in the corresponding chapter.

It must be noted that several of the task s described here must be initiated before the end of the in-orbit operations.

The PS/(reorganised)PST is responsible for the execution of the tasks listed below:

FSCA-001 ensure overall management of the post-operations phase including:

overall coordination and liaison.

technical interfaces and schedule.

overall configuration and quality control.

protection of Archive against catastrophic loss.

FSCA-002 monitor run-down activities in order to ensure that:

all required spacecraft data are secured.

necessary MOC knowledge is transferred to the FSC.

FSCA-003 overall consolidation of the Archive including:

consolidate Archive hardware (e.g. hardware upgrades, storag e facilities, communication lines, etc.).

consolidate Archive software (including FINDAS).

consolidate Archive contents.

consolidate data processing tools.

consolidate Archive access tools (emphasis on community access).

consolidate documentation.

FSCA-004 support the "active" Archive phase, including:

support to the community (helpdesk maintenance and upgrade).

support visitors to the FSC (TBC).

support for software and analysis methods.

reprocessing of all observations.

overall re-calibration and cross-calibration.

definition and production of catalogues and atlasses (TBC).

handling of specific requests (re-processing, re-calibration) (TBC)

monitoring of data quality.

making available data, software, and (final) data products to th e community through FINDAS.

FSCA-005 transfer into the "Historical Archive" phase including:

carry out overall Archive improvement programme (e.g. improv e user's interface. calibration and cross-calibration data, fina l "products", access speed, help facilities, etc.).

publish "final" accuracy figures (e.g. relative/absolute flu x calibrations, relative/absolute wavelength calibrations, instrumenta l calibrations, effects of pointing errors, etc.).

perform "final" update of the documentation.

transfer overall Archive system to ESTEC (TBC).

6. PERFORMANCE AND AVAILABILITY REQUIREMENTS

6.1 GENERAL

PERF-001 The FIRST Science Centre (FSC) shall be staffed on the basis of 8 hours/day, 5 days/week as a minimum.

Note: Extended hours (TBC) may be required during specific mission phases e.g. commissioning and PV.

PERF-002 The Instrument Control Centres (ICCs) shall be staffed on the basis of 8 hours/day, 5 days/week as a minimum.

Note: Extended hours (TBC) may be required during specific mission phases e.g. commissioning and PV.

PERF-003 The FSC and the ICCs shall be organised and staffed in such a way that the activities of "mission preparation" (e.g. for subsequent Calls for Proposals) and "mission operations" can proceed in parallel.

PERF-004 The overall availability figure for the ICC and FSC operational systems shall be 95 % minimum (TBC)

6.2 OBSERVATION PROPOSAL HANDLING

PERF-010 The Proposal Handling system shall be able to accept observation proposals 24 hours per day.

PERF-011 Maximum downtime of this function: 48 hours (TBC)

PERF-012 Proposal submitters shall be informed within 2 weeks (TBC) as to the validity (technical feasibility) of the proposal. For survey-type proposals this delay is extended to 4 weeks (TBC). If proposal submission is interactive feed-back on syntax errors shall be immediate.

PERF-013 Proposal submitters shall be informed within 1 month (TBC) after proposal submission deadline of the FOTAC evaluation as to the status of their proposal. This requirement is not applicable to survey-type proposals.

PERF-014 The Proposal Handling system shall be available at least 3 months (TBC) prior to the issue of the first Call for Proposals.

6.3 SCIENTIFIC MISSION PLANNING AND SCHEDULING

PERF-020 The Mission Planning and Scheduling facilities shall be able to generate individual daily schedules up to 3 weeks in advance (TBC)

PERF-021 The Mission Planning and Scheduling facilities shall be able to generate up to 8 individual daily schedules within 8 hours (TBC)

Note: This requirement applies to the H/W and S/W facilities needed, it is not a requirement on the Mission Planners.

PERF-022 -deleted-

PERF-023 Maximum down time for the Mission Planning and Scheduling functions: 24 hours (TBC)

PERF-024 The Mission Planning and Scheduling systems shall be available at least 3 months (TBC) prior to the issue of the first Call for Proposals.

6.4 MISSION DATA BASE (MDB)

PERF-030 The Mission Data Base (MDB) shall not be unavailable (for whatever reason) for more than 24 hours (TBC)

PERF-031 The MDB update facilities shall allow modification of up to 2000 (TBC) observations per week.

Note: It is likely that the characteristics of many FIRST observations will need to be updated post-launch once spacecraft and instrument performances are measured in orbit.

6.5 CENTRAL HELP DESK

PERF-040 The Central Help Desk facility set up by the FSC shall be able to answer queries from the scientific community within 1 week on average (TBC). Maximum allowable answer time shall not exceed 3 weeks (TBC)

PERF-041 FIRST news of interest to the scientific community or the press shall be available on the World-Wide-Web (WWW) -or equivalent- with a maximum delay of 1 week (TBC)

PERF-042 The Central Help Desk facility shall be in place at least 3 month s (TBC) prior to the issue of the first Call for Proposals.

6.6 FIRST INTEGRATED NETWORK AND DATA ARCHIVE SYSTEM (FINDAS)

PERF-050 FINDAS shall be available 24 hours a day.

PERF-051 FINDAS maximum downtime: TBD

PERF-052 FINDAS Archive Server shall guarantee near real-time access (dela y of not more than 60 secs. -TBC-) t o the down-linked telemetry during all mission phases.

PERF-053 FINDAS shall be able to support up to 30 (TBC) interactive user s logged on simultaneously.

PERF-054 FINDAS shall allow several (authorised) users to read a data item i n parallel.

WRITE and UPDATE rights to a particular item shall only be granted to one user at a time.

PERF-055 FINDAS shall allow data deleted accidentally to be recovered up to 5 days (TBC) after the deletion.

PERF-056 All the data archived in the last 30 days (TBC), as well as the latest versions of the S/W and calibration files s hall be ready to be delivered to authorised users within 5 minutes (TBC) of a request. Othe r archived data shall be ready to be delivered within 30 minutes (TBC)

Note: actual delivery time will depend on the size of the files to be downloaded, and on network performance and load. They are outside FINDAS control.

PERF-057 Maximum allowable response time per user category and per data - item: TBD

PERF-058 FINDAS basic functionality (TBD) shall be in place at least 6 months (TBC) prior to the start of the first Instrument Level Test (ILT).
The facilities required to handle documentation shal l be in place earlier (goal: early-1999 TBC)

6.7 SCIENTIFIC DATA PROCESSING

PERF-060 All data required to fully process a given observation shall be available to the corresponding proposer on FINDA S within 1 week (TBC) of the execution of his/her observation.

PERF-060a MOC-provided data (command history, attitud e- and orbit-related data , etc.) shall be available on FINDAS within 48 hours (TBC) of th e execution of the corresponding observation.

PERF-060b At any time in the mission (including prior to launch) the latest , "approved" versions of the required instrument "calibration" files and scientific data processing software shall be available on FINDAS.

PERF-061 All observations belonging to a survey-type observing programm e shall have been processed (processing level TBD) at the latest 3 months (TBC) after execution of the last observation in th e programme.

Note: It is expected that processing results will be released as they become available.

PERF-062 The Real-Time-Assessment/Quick-Look Analysis (RTA/QLA) systems -generally used off-line in the ICCs- shall be capable of processin g telemetry at least at the real time speed. G oal is several times the real time speed (e.g. 4 to 10 times).

Note: This requirement covers Satellite Commissioning Phase and PV phase when RTA/QLA runs in "near real-time" in the MOC.

7. PHASING AND ORGANISATION

The organisation of the project changes according to the various phases of implementation and operations. The various mission phases and responsibilities for the main sectors of the project are given as an overview in the table below:

Mission Phase	Highest authority/responsibility for Project Sector			
	Project/ Mission	Spacecraft Operations	Instrument Operations	Science
Development	PM	GSM	PM	PS
Launch and Early Orbit Phase (LEOP)	MD (=PM)	FOD	N/A	PS
Commissioning	PM	MOM	MOM	PS
Performance Verification	H/SSD/SA	MOM	MOM	PS
Routine Operations	H/SSD/SA	SOM	SOM	PS
Post-operations	H/SSD/SA	N/A	N/A	PS

PM = FIRST Project Manager (D/SCI)
MD = Mission Director (= PM in LEOP phase)
FOD = Flight Operations Director (D/TOS))
GSM = Ground Segment Manager (D/TOS)
SOM = Spacecraft Operations Manager (D/TOS)
H/SSD/SA= Head of Astrophysics Div., Space Science Dept. (D/SCI)
PS = Project Scientist (reports to H/SSD/SA)
MOM = Mission Operations Manager (D/TOS)
normally the GSM (TBC)

Overall responsibility for the FIRST Project is transferred from the FIRST PM to H/SSD/SA at the end of the Commissioning Phase.

The responsibility and authority of all participants to the FIRST mission operations is defined in the Mission Operations Management Plan issued by D/OPS.

In the routine phase the SOM has full authority for the safety and integrity of the mission and will be responsible for maximising the time during which scientific observations are made.

The PS reports to H/SSD/SA. He is responsible for the long term scientific objectives of the mission.

The main activities and organisation for each phase are further described below.

7.1 DEVELOPMENT PHASE

7.1.1 Activities

This phase covers all activities up to the launch of the satellite (= spacecraft + scientific instruments). For the ICCs and the FSC, this includes design, implementation, integration and validation of their respective systems as well as verification of all interfaces, in particular interfaces with the MOC, and training of operations personnel. This phase culminates at the Flight Readiness Review which establishes Launch readiness. It formally ends at L - 8 hours (beginning of the LEOP phase).

7.1.2 Organisation

Fig 7.1 shows the top level organisation during the Development phase.
Before the end of the Development phase (around L - 6 months -TBC-) the build up of the FIRST Operations Team at the MOC will start.

This team will perform all spacecraft and instrument operations until the end of the orbital operations

7.2. LAUNCH AND EARLY ORBIT (LEOP) PHASE

7.2.1 Activities

The LEOP is the first operational phase in the FIRST mission.

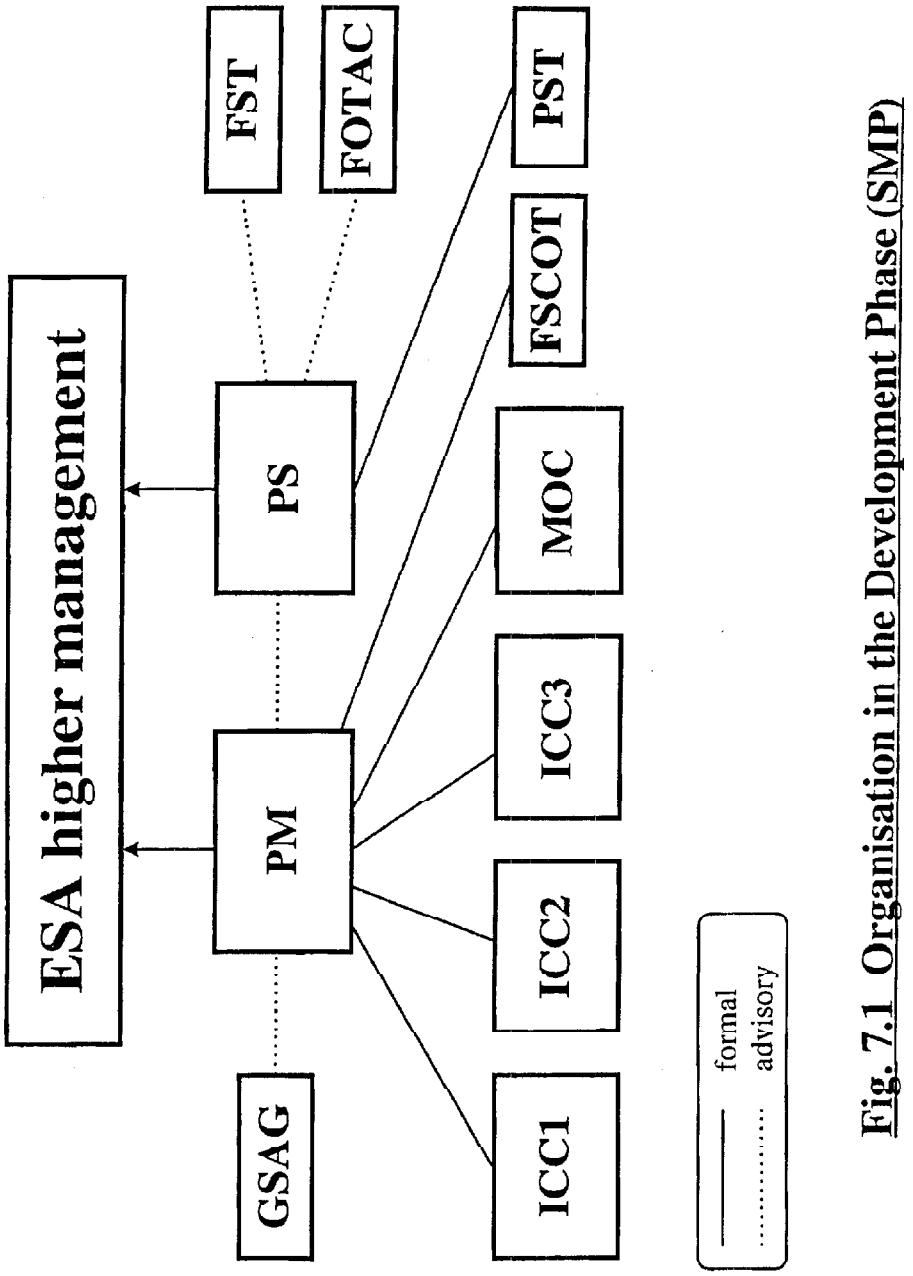

Fig. 7.1 Organisation in the Development Phase (SMP)

The LEOP phase is conducted from the Main Control Room in ESOC according to th e practices laid down in the ESTRACK Operations Manual (EOM). Mission rules an d detailed LEOP activities are defined in the FIRST Flight Operations Plan (FOP).

During LEOP, checkout of essential spacecraft function s will be carried out. The scientific instruments are switched off.
Nominally, LEOP dura tion will be less than 10 days. At the end of the LEOP, the satellite shall be in a condition where payload and instrument-related operations can begin.

During LEOP telemetry will be acquired and archived on FINDAS. If required the IC C Instrument Stations running RTA/QLA will be on-line in "listen-in" mode in the MOC' s Instrument Support Area although no scientific data will be available.

7.2.2 Organisation

Fig 7.2 shows the overall top level organisation during the LEOP phase.

LEOP is a D/TOS responsibility. It is conducted by the FIRST Flight Control Team (FCT) under the authority of the Flight Operations Director, appointed by D/TOS. Overal l supervision is ensured by the FIRST Project Manager acting as Mission Director.

The FCT is made up of several different groups, FIRST dedicated groups, and non-FIRST dedicated support groups mannin g the various Operations Control Centre (OCC) support area(s)/rooms.

The FCT will be run on a twenty four hour shift basis for at least the first 10 days of LEOP.

7.3. COMMISSIONING PHASE

7.3.1 Activities

At the end of the LEOP phase, spacecraft an d instrument control will be transferred to the FIRST Dedicated Control Room (DCR).

In addition, ICC operations staff, located in the Instrument Support Area in the MOC, will monitor execution of their instrument activities using the hardware and softwar e (Instrument Stations and RTA/QLA software) which they have used d uring instrument level tests and AIV operations.

During this phase the checkout of the spacecraft subsystems will be completed (a s necessary) if completion was not achieved at the end of the LEOP phase. The scientific instruments will then be turned on and checked out. Check out will be carried out b y repeating a subset of the Integrated System Test (IST). No astronomical data will be taken during this period.

The next activities will be dedicated to satellite commissioning.

The purpose is to assess in-orbit performance of the satellite since this will determine to a large extent how the routine operations will be carried out.

The following major activities are foreseen:

- assessment of FIRST pointing pe rformances: This implies determination of Attitude Pointing Error (APE), Attitude Pointing Drift (APD), Relativ e Pointing Error (RPE) and Absolute Measurement Accuracy (AMA);

- assessment of straylight and telescope performances: This includes measurement of Self Emission, Off-Axis Rejection, Straylight induced by a bright source in the field of view, as well as determination of the Point Spread Function and Focal Plan e Geometry Calibration. [1]

The sequence of operations, their durations and the corresponding detailed activities will be defined in the FIR ST Flight Operations Plan (FOP) issued by D/TOS and the Satellite Commissioning Plan (SCP) issued by the FIRST Project.

Telemetry will be acquired and archived on FINDAS.

7.3.2 Organisation

Overall responsibility for this phase lies with the Project sup ported as required by Industry, ESOC and the ICC operations staff. Fig. 7.3 shows the overall organisation.

Operations will be under the responsibility of the MOM.

The FCT will have the responsibility to carry out the satellite commissioning activities as described in the FOP and SCP. Processing of the relevant data will provide the necessary performance information. Project, Industry, ESOC and ICC staff will assess thi s information and determine pointing and telescope performances as well as initia l instrument operability.
It is anticipated that the "P roject Scientist" Team will be involved in the activities covering straylight measurement and telescope performance evaluation. In this case the relevant PST members will be located at the MOC.

The ICC staff at the MOC will report to the MOM. As required, the ICC staff will liaise with and obtain support from the ICC personnel which has remained at the ICC. Participation of the FSC in this phase is TBD.

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1 Some of these activities might have to be delayed to later phases.

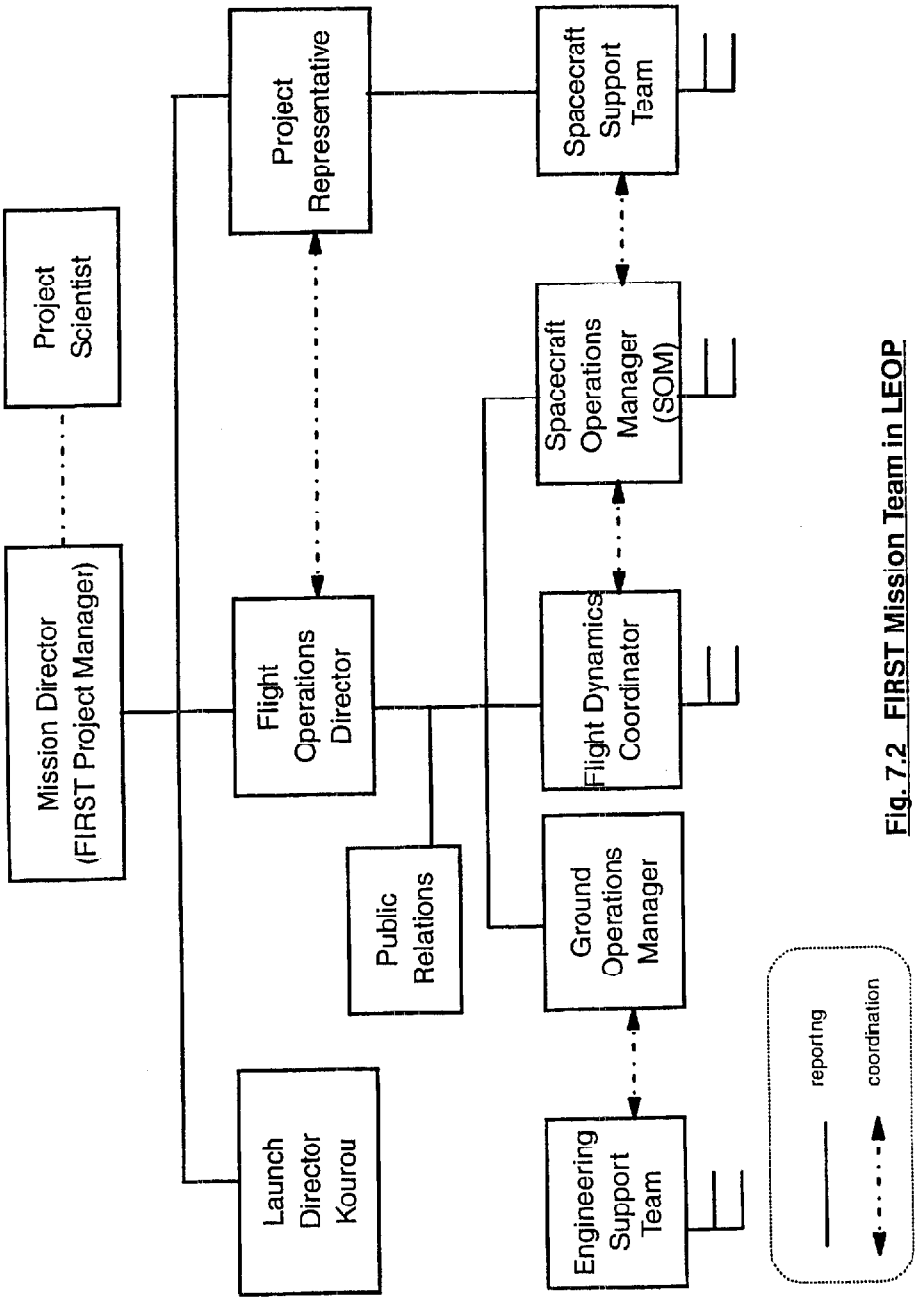

Fig. 7.2 FIRST Mission Team in LEOP

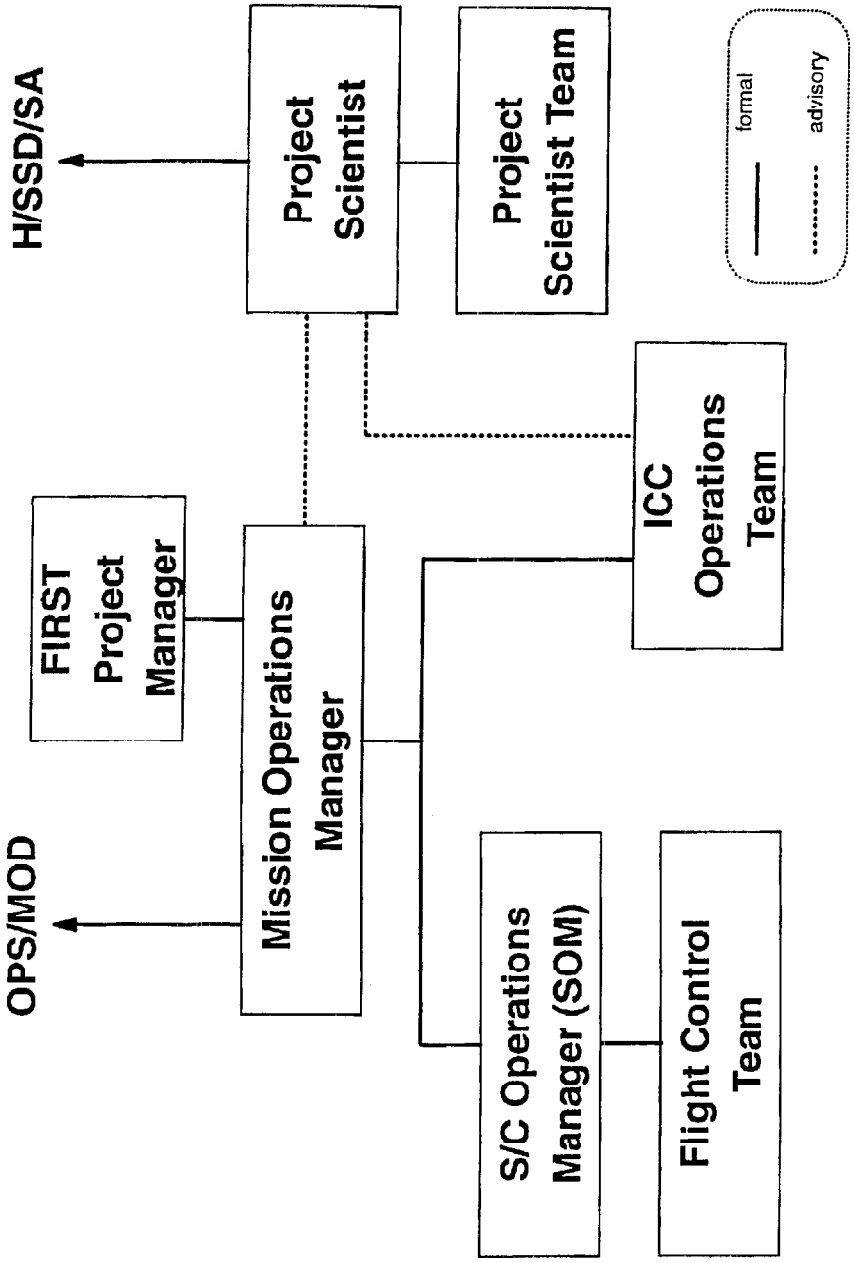

Fig. 7.3 Organisation in the Satellite Commissioning Phase

At the end of the commissioning phase the FIRST Project Manager responsibilities are formally transferred to H/SSD/SA.

7.4. PERFORMANCE VERIFICATION PHASE (PV PHASE)

7.4.1 Activities

During this phase, calibrations of the scientific instruments will be made and scientific measurements on celestial sources will be started. The "Commissioning" of the overal l ground segment that started in the previous phases will be completed.

The following major activities are planned:

- instrument "core" calibration;
- AOT's verification: functional and scientific aspects;
- Full observatory verification i.e. verifying that facilities and teams are ready t o support the routine scientific observations.

The sequence of operations, their durations and the corresponding detailed activities will be defined in the FIRST Flight Operations Plan (FOP) and in the Performance Verification Plan.

As in the previous phase the ICC operations staff , located in the Instrument Support Area, will monitor the activities of their instrument. The FSC will be fully involved in this phase. Co-location of FSC personnel at the MOC is however not foreseen

Starting with this phase, all operations should be pre-planned

At the end of the Performance Verification phase the S/C, payload and Ground Segment will be considered operational.

7.4.2 Organisation

The organisation during the PV phase will be similar to the organisation during th e commissioning phase. The FIRST Project is no longer involved. The PM's responsibility is taken over by H/SSD/SA.
Fig. 7.4 shows the overall organisation in this phase.

Operations are under the responsibility of the MOM.
The FSC functional tasks (essentially management of FINDAS and science missio n planning) are carried out by the FOT. Both PST and FOT are located at the FSC. Th e external science community is not involved.

7.5. ROUTINE OPERATIONS PHASE

7.5.1 Activities

This phase is the main data gathering phase in FIRST's lifetime and, during this period, surveys, "guaranteed" observations and "open-time" observations will be made.

During the Routine Operations phase all activities are pre-planned. The observatio n schedule will normally be executed autonomously from telecommands stored on-board . The command schedule will be up-linked daily from the ground station.

7.5.2 Organisation

Fig. 7.5 shows the overall organisation in this phase.

All spacecraft and instrument operations are carried out by the SOM and his/her team . ICC manpower is no longer required at the MOC.

Thc Instrument Support Area in the MOC is no longer in daily use but is not de - commissioned. In case of unforeseen problems or contingencies ICC staff may be re - called at the MOC on short notice.

The MOM function is terminated and day-to-day operational responsibility is transferred to the SOM.

The ICCs and the FSC enter their steady mode of operations. The external scientifi c community is involved.

7.6. POST- OPERATIONAL PHASE

7.6.1 Activities

The activities carried out in this phase are as described in chapter 2.4.7.
The FOT's activities are limited to the management of FINDAS. MOC-related activities are terminated at the end of the run-down phase. The bulk of the work is carried out by th e PST and the ICCs.

7.6.2 Organisation

Until the end of the run-down phase the organisation is as shown in Fig. 7.5. The SOM's team is a reduced team (mainly FD specialists and maintenance staff). The FOT is also reduced since Proposal Handling and Mission Planning are no longer re quired. At the end

of this phase the SOM and his team are no longer involved. Involvement of the FSCOM in the post-operational phase is TBD.

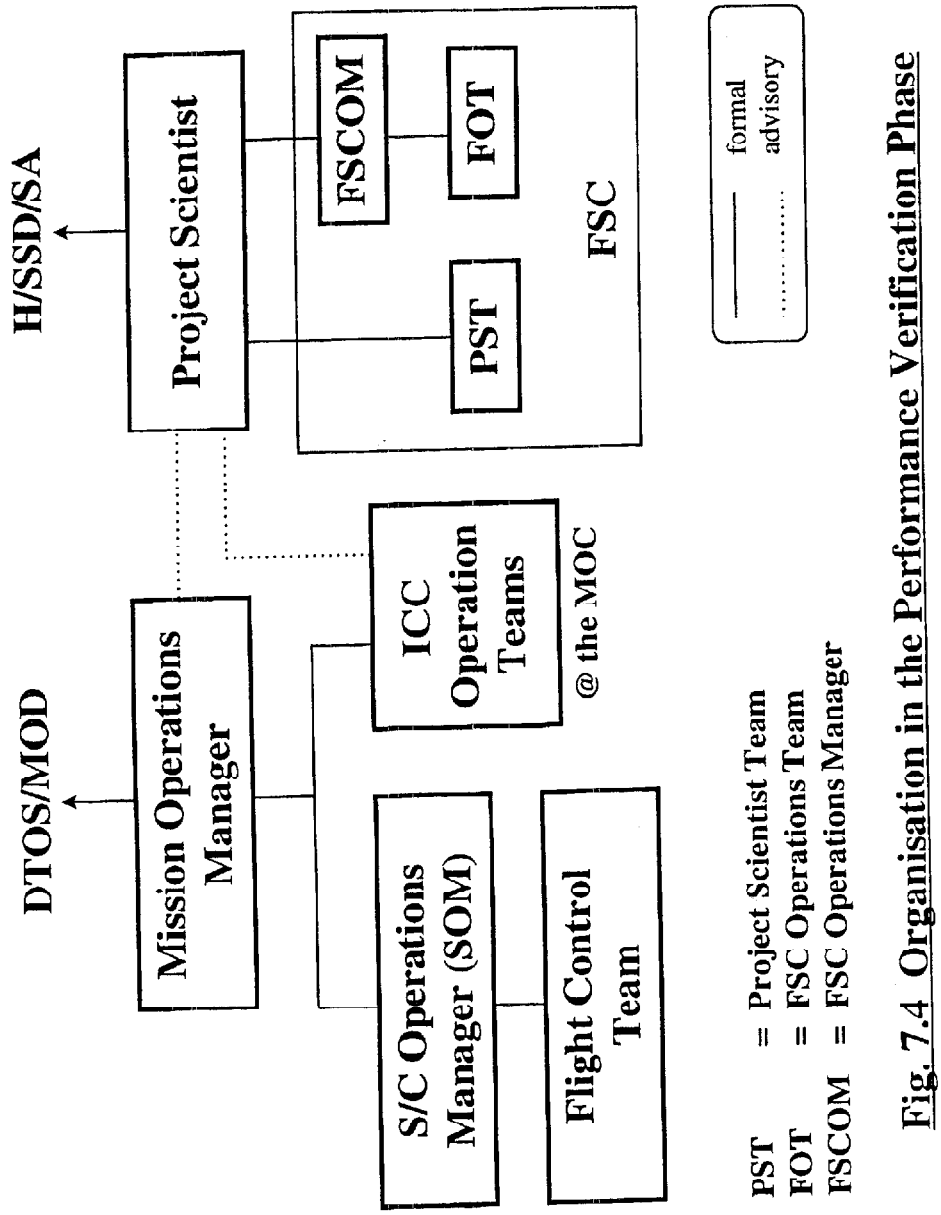

Fig. 7.4 Organisation in the Performance Verification Phase

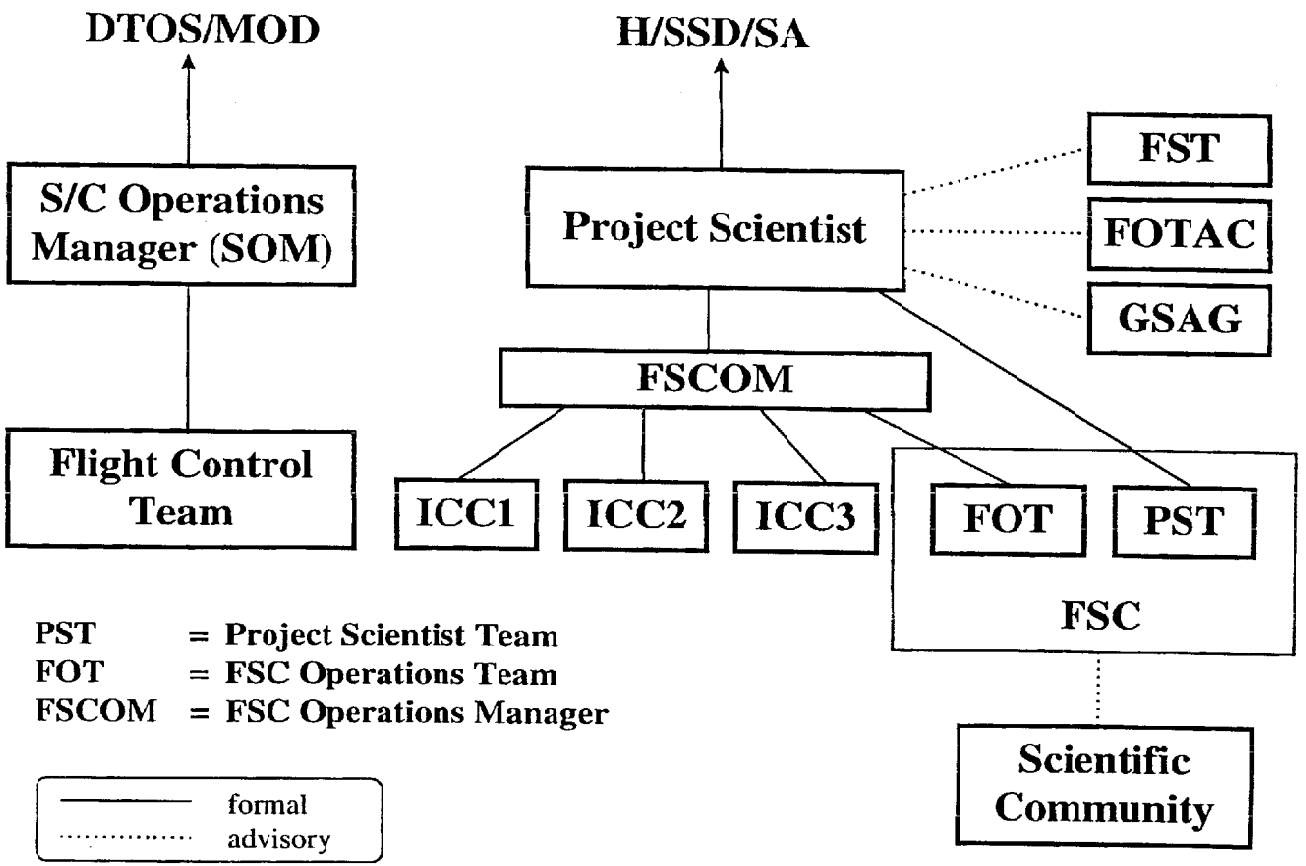

Fig. 7.5 Organisation in the Routine Operations Phase

8. PRODUCT ASSURANCE and QUALITY ASSURANCE REQUIREMENTS

8.1 GENERAL

These general requirements are applicable to all the entities which contribute to the preparation and execution of the FIRST operations.

PAQA-001 During all phases of the FIRST mission implementation (i.e. design , development, integration and test of the total ground segment both hardware and software) each contributor shall carry out a Produc t Assurance/Quality Assurance (PA/QA) activity.

The purpose of the PA/QA activity is two-fold:

- It ensures during each phase conformity of the outputs with the inputs from a previous phase. It ensures traceability from requirements to design for both hardware and software elements.

- it ensures adherence to the standards established for the FIRST mission. It ensures that all hardware and software elements of the ground segment implementation will comply with all mission requirements.

PAQA-002 The PA/QA activity sha ll also be exercised throughout the operations phase of the mission to ensure that all satellite operations are carried out in accordance with agreed flight procedures, and that al l modifications requested by any authorised party will be controlled by a formal Change Control (CC) procedure.

PAQA-003 The ground segment shall provide for appropriate redundancy in it s elements commensurate with the availability objectives defined i n chapter 6.

PAQA-004 It is the responsibility of the FIRST PA Manager (TBC) to ensure that the overall PA/QA requirements established for the FIRST groun d segment are met by the various contributors.

8.2 DOCUMENTATION

PAQA-010 Documentation shall be structured in a specification tree and a corresponding plan tree. The documents shall be referenced i n accordance with an identification procedure c onsistent with the trees.

PAQA-010a The trees shall be structured in such a way that the scope and applicability of each document as well as the documents' inter-relationships are easily seen. Each top level tree shall hold on a single A4 page.

PAQA-010b Requirement specifications, design specifications, test specifications, interface control documents and user manuals shall belong to the specification tree.

PAQA-010c Implementation plans and procedures, test plans and procedures, and operations plans and procedures shall belong to the plan tree with the corresponding execution reports.

PAQA-011 Software documentation shall conform to the ESA Software Engineering Standards (AD7)
Note: The ESA Software Standards adopted here are the standards applicable to small projects. They offer the same rigorous approach to the software development process as the full standards but significantly reduce the documentation overhead.

PAQA-012 The FIRST documentation which will be accessible through FINDAS shall conform to the 'electronic' standards (e.g. Word/WordPerfect, TEX, etc.) defined for the FIRST Programme.

Note: These standards must be defined and agreed jointly by the FSC, ICCs, MOC and FIRST Project.

8.3 TEST REQUIREMENTS

These test requirements are applicable to the entities (in particular ICCs and FSC) which contribute to the FIRST Science Operations. Test requirements specific to the MOC are addressed in the MIRD (AD11)

PAQA-020 All operational science functions of the Ground Segment shall be tested and validated before launch.

PAQA-021 All functions of the FIRST Integrated Network and Data Archive System (FINDAS) shall be tested and validated before launch.

Note: The basic FINDAS functions will be tested prior to the Instrument Level Tests (ILTs). Early FINDAS prototyping is planned.

PAQA-022 Subsystem and system tests shall be conducted according to approved test plans and test reports shall be issued.

PAQA-023 The adequacy of the science operations procedures shall be determined by means of realistic simulators covering at least:

- execution of all nominal procedures;

- execution of all foreseen contingency procedures.

PAQA-024 The ICCs and the FSC shall be included, as required, in the Satellite Verification Tests (SVTs) in order to verify their interfaces with the satellite and the other elements of the ground segment.

PAQA-025 The ICCs and the FSC shall be included in the End-to-End Tests (EEs) which validate proper operations of the entire space- ground segment system.

PAQA-026 The ICCs and the FSC shall be included in the overall simulation programme which determines the adequacy of operations procedures and training of mission controllers, computer operators and all other operations staff

8.4 CONFIGURATION CONTROL

8.4.1 Hardware Configuration Control

PAQA-030 The ICC and FSC H/W configurations (Computers, Work-Stations, Peripherals, LANs, communication equipment, etc.) shall be maintained under Configuration Control according to the general guidelines in RD9.

8.4.2 Software Configuration Control

PAQA-031 All ICC and FSC S/W elements, documentation and data items shall be delivered for integration and archiving in accordance to FINDAS Configuration Control mechanisms.

PAQA-032 The CC function shall be carried out in accordance to a (common) Software Configuration Management Plan (SCMP) to be produced jointly by the ICCs and the FSC. The SCMP shall be concurred with by the FIRST PA manager (TBC).

8.5 SOFTWARE QUALITY ASSURANCE

PAQA-033 All ICC and FSC S/W elements shall be produced in accordance to a (common) Software Quality Assurance Plan (SQAP) to be produce d jointly by the ICCs and the FSC. The SQAP shall be concurred with by the FIRST PA manager (TBC).

9. MANAGEMENT REQUIREMENTS

9.1 TOP LEVEL RESPONSIBILITIES

The FIRST Ground Segment architecture is a decentralised architecture. The allocation of responsibilities for the monitoring, management, coordination and implementation of the tasks specified in this document reflects this decentralised structure.

MNGT-001 For each of the Instrument Control Centres (ICCs) -one per Instrument- there shall be an ICC Manager with overall responsibility for the timely execution of all ICC-related tasks specified in this document.

MNGT-002 Timely delivery of all the FSC-related tasks specified in this document shall be ensured jointly by the FIRST Project Scientist (PS) and the FSC Operations Manager (FSCOM)

MNGT-003 The "Ground Segment Advisory Group" (GSAG) shall be responsible for the monitoring of the ICCs, FSC and MOC activities in order to verify that the tasks specified in this document are carried out according to specification and in agreement with the overall Ground Segment development schedule.

MNGT-004 The Integration and Test Team (ITT), under the authority of an IT T Manager, shall be responsible for the overall ground segment Integration and the definition and execution of the system-level tests defined in chapter 8.

9.2 PLANNING REQUIREMENTS

MNGT-010 In response to the requirements specified in this document each ICC manager and the FSC Operations Manager shall issue a Science Implementation Plan (SIP) covering the tasks under his/her responsibility. After approval by the FIRST Project Manager and FIRST Project Scientist, and agreement by D/TOS and D/SCI the SIPs shall serve for monitoring progress of the tasks identified therein.

MNGT-011 The SIPs shall respond to the requirements specified in this document. in particular each SIP:

MNGT 011a shall contain a Project Management Plan;

MNGT-011b shall contain a description of the related science operations concept and baseline design. It shall be as detailed as needed to allow a committing schedule, and a well-established work package breakdown structure;

MNGT-011c shall contain the definition of the work packages with the corresponding inputs, deliverable items, tasks specifically excluded, progress measurement points and start and completion criteria;

MNGT-011d shall cover for each work package, the identification of the cost driving parameters and the corresponding estimates of resources spread over time (manpower, computers and other investment and running expenditure);

MNGT-011e shall define the schedule for the complete set of work packages supported by the corresponding schedule planning;

MNGT-011f shall contain the documentation trees and the corresponding identification.

MNGT-012 Any change in the contents of a SIP might imply changes in cost, schedule and/or performance of the corresponding science function; therefore any modification to the SIP, or tasks, or baseline identified therein shall be formally approved by the FIRST Project Manager and FIRST Project Scientist.

9.3 REPORTING REQUIREMENTS

MNGT-020 The ICCs managers will hierarchically belong to the corresponding PI-Institutes. On FIRST Project matters and "day-to-day" progress, the ICC managers report to the FIRST Project Manager or to his delegate.

MNGT-021 The FSC Operations Manager (FSCOM) will hierarchically belong to SSD. On FIRST Project matters and "day-to-day" progress, he reports to the FIRST Project Manager or to his delegate.

MNGT-022 The ICC managers and the FSCOM will, as required, attend the meetings of the GSAG (of which they are permanent members) in order to provide progress reporting.

MNGT-023 The ICC managers and the FSCOM will, as needed, attend the FIRST meetings and reviews, management meetings and delegate body meetings.

MNGT-024 The SIPs shall define in detail the reporting mechanisms which shall include, as a minimum, quarterly (TBC) management informatio n reports. These reports should be brief and include the followin g information:

MNGT-024a brief summary of the progress achieved since the previous reporting period.

MNGT-024b concise description of the main problem areas, their criticality an d anticipated impacts (e.g. delays in the schedule or non conformance with the requirements)

MNGT-024c status of the technical design, of proposed solutions to the problem areas and of engineering, product assurance and testing activities.

MNGT-024d per Work Package the manpower usage showing actual versu s planned and estimation at completion

MNGT-024e overall manpower usage chart

MNGT-024f update of the overall schedule with latest predi ction of the completion dates of the identified milestones.

MNGT-024g a list of relevant action items and their status.

Note: It is expected that ICC and FSC managers will produce financial information reports containing actual expenditure related to work packages for manpower usage, infrastructure, investment, etc. These reports may be attached to the management information reports if deemed useful but this is ***not*** *a SIRD requirement.*

MNGT-025 The SIPs shall identify the technical documents to be produced for the implementation of the tasks specified in the SIRD; it shall also define the review procedure and the approval authority for the variou s documents.