RPW Operation Centre

ROC Software System Specification

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Change Record

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1	0	09/01/2017	X.Bonnin	First issue (incomplete: only first list of interface and capability requirements).
1	1		X.Bonnin	Add reference to the PLID Update

Acronym List

Acronym	Definition
ANC	Ancillary (data)
CCSDS	Consultative Committee for Space Data Systems
CDF	Common Data Format
CP	Cruise Phase
CUC	CCSDS Unsegmented time Code
DDS	Data Dissemination System
DPS	Data Processing System
EDDS	EGOS Data Dissemination System
EGOS	ESA Ground Operation System
Faust	Flight operAting Request Editor
Figaro	Flight Operation Procedure Editor
GSE	Ground Support Equipment
GUI	Graphical User Interface
HF	High Frequency
HK	HouseKeeping

ICD	Interface Control Document
ID	Identifier
IOR	Instrument Operation Request
IT	Instrument Team
I/O	Input / Output
LESIA	Laboratoire d'Etudes Spatiales et d'Instrumentation en Astrophysique
LF	Low Frequency
LLD	Low Latency Data
MCS	Monitoring and Control System
MDOR	Memory Direct Operation Request
MEB	Main Electronic Box
MOC	Mission Operation Centre
NECP	Near Earth Commissioning Phase
NMP	Nominal Mission Phase
OPera	Operation Planning IntERfAce
PDOR	Payload Direct Operation Request
RCS	RPW Calibration Software
RLLP	RPW Low Latency Pipeline
ROC	RPW Operation Centre
ROADS	ROC Operations And Data System
RODP	RPW Operations and Data Pipeline
RPW	Radio and Plasma Waves instrument
RSS	ROC Software System
SCM	Search Coil Magnetometer
SGS	Science Ground Segment
SGSE	Software Ground Support Equipment
SHA	Secure Hash Algorithm
SISSI	SBM Interactive Selection System Interface
SOC	Science Operation Centre
SolO	Solar Orbiter
TBC	To Be Confirmed
TBD	To Be Defined
TBW	To Be Written
TC	Tele-command

TDS	Time Domain Sampler
THR	Thermal Noise and High Frequency Receivers
TM	Telemetry
SCET	Spacecraft Elapsed Time
SWF	Snapshot Waveform
UTC	Coordinated Universal Time
XML	eXtended Markup Language

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1 GENERAL

1.1 Scope of the Document

This document is the Software System Specification (SSS) of the RPW Operation Centre (ROC), in charge of the RPW ground segment activities.

According to [RD17], the Software System Specification (SSS) contains the customer's requirements (capabilities requirements, interface requirements, performances requirements, design requirements, etc.) generated by the system engineering process related to software. It is the highest-level description of the software products and of the software interfaces. It is part of the requirement baseline. It provides the criteria that are used to validate and accept the software. Especially, the specification defined in the present document must comply with the implementation requirements defined in [AD1].

This SSS is applicable to the software equipment of the ROC Operations And Data System (ROADS) only. Especially, the software specification related to the ROC Ground Support Equipment (ROC GSE) system is not covered by the present document.

1.2 Applicable Documents

This document responds to the requirements of the documents listed in the following table:

Mark	Reference/Iss/Rev	Title of the document	Authors	Date
AD1	ROC-GEN-SYS-PLN-00002-LES/1/1	ROC Concept and Implementation Requirements Document (CIRD)	Y. de Conchy X. Bonnin	26/10/2015
AD2	SOL-SGS-ICD-0003/0/6	Solar Orbiter Instrument Operation Request Interface Control Document (IOR ICD)	C. Watson	25/01/2016
AD3	SOL-SGS-TN-0006/1/1	Solar Orbiter SOC Engineering Guidelines for External Users (SEGU)	R. Carr	06/07/2015
AD4	SOL-SGS-0004/0/3	Solar Orbiter Interface Control Document for Low Latency Data CDF files	A. Walsh	Feb., 2015
AD5	SOL-ESC-IF-05011/1/0	Solar Orbiter Data Delivery Interface Control Document	L. Michienzi	10/09/2013
AD6	SOL-ESC-IF-10002/2/0	Solar Orbiter Instrument FOP Procedure Input Interface Control Document	D. Lakey	12/06/2014
AD7	SOL-ESC-IF-05010/1/2	Planning Interface Control Document	L. Michienzi	07/2015
AD8	SOL-SGS-ICD-0009/1/0	Solar Orbiter File-Transfer SOC<-> Instrument Teams ICD	E Salazar, C.Watson	24/03/2017
AD9	SOL-SGS-PL-	Solar Orbiter Archive Plan	Pedro Osuna	01/07/2015

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1.3 Reference Documents

This document is based on the documents listed in the following table:

Mark	Reference/Iss/Rev	Title of the document	Authors	Date
RD1	SOLO-RPWSY-IF-55-CNES/5/3	Experiment Interface Document Part B for RPW (EID-B)	RPW team	07/10/2015
RD2	SOL-SGS-TN-0003/1/1	Solar Orbiter Low Latency Data: Concept and Implementation	A. DeGroof	Sept. 2014
RD3	ROC-TST-GSE-SPC-00004-LES/1/0	ROC-SGSE software design document	X.Bonnin	14/02/2016
RD4	ROC-GEN-SYS-NTT-00038-LES/1/1	ROC Mission Database Description	X.Bonnin	09/01/2017
RD5	ROC-GEN-SYS-NTT-00008-LES/1/3	ROC Engineering Guidelines	X.Bonnin	16/11/2016
RD6	ROC-PRO-PIP-ICD-00037-LES/1/0	RPW Calibration Software Interface Control Document	Manuel Duarte, Xavier Bonnin	16/11/2016
RD7	SOL-SGS-TN-0009/1/0	Metadata Definition for Solar Orbiter Science Data	Anik De Groof	15/01/2015
RD8	ROC-GEN-SYS-PLN-00015-LES/2/2	ROC Software Development Plan	X.Bonnin	27/09/2016
RD9	ROC-GEN-SYS-SSD-00036-LES/0/1	ROC Software System Design Document	X.Bonnin	09/01/2017
RD10	ROC-OPS-SFT-SWU-00039-LES/1/0	ROC Human Machine Interface User Requirements	ROC Team	20/12/2016
RD11	ROC-OPS-LLD-SPC-00018-LES/0/1	RPW Low Latency Virtual Machine Design Document	S.Lion	
RD12	EGOS-GEN-EDDS-ICD-1001/6/0	External User ICD : EGOS Data Dissemination System (EDDS)	EDDS team	28/05/2014
RD13	ROC-TST-GSE-SUM-00035-LES/1/0	POPPy framework user manual	M.Duarte	24/06/2016
RD14	ROC-GEN-MGT-PLN-00013-LES/1/0	ROC Project Management Plan (PMP)	Y. de Conchy X. Bonnin	13/04/2016
RD15	ROC-GEN-OTH-NTT-XXXX-LES/1/0	ROC Glossary of terms	X.Bonnin	24/01/2017
RD16	ROC-PRO-DAT-NTT-00006-LES/1/0	RPW Data Products	X.Bonnin	16/11/2016
RD17	RPW-SYS-MEB-GSE-SPC-00125-LES/1/1	MEB GSE Description	L.Gueguen	26/11/2012
RD18	RPW-SYS-MEB-GSE-NTT-000792-	C-SGSE User Manual	A.Gaget	22/05/2014

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1.4 About this document

1.4.1 Access policy

The present document is accessible without any restriction.

Any modification of this document must be approved by the RPW Ground Segment Project Manager before publication.

1.4.2 Terminology

Definitions of terms used in the present document can be found in [RD15].

1.4.3 Requirement identification

According to [RD14], every requirement defined in this document shall be assigned a requirement identifier (ID) of the form "**REQ-ROC-SSS-XXXX"**, where "REQ=Requirement", "SSS"=Software System Specification" and "XXXX" is a 4-digits number starting at 0001, and that must be incremented by 1 each time a new requirement is provided (e.g., the first requirement identifier found in the document will be "REQ-ROC-SSS-0001", the second one "REQ-ROC-SSS-0002", etc.). The structure of the requirements shall comply the definition given in [AD2].

A summary list of all of the requirement IDs for this document is available in the appendix 12.1.

1.4.4 Naming convention in the document

The *generic variables* are used in the document to define parameters that have no specific value, or that need to be identified easily from a requirement to another. They can be typically: file/directory names or paths, software configuration values, interfaces, sets of data, etc.

The generic variables are represented in the document using capital letters in italic. They must contain alphanumerical and underscore "_" characters only (e.g., "*DDS_TR_HIGH_START*").

2 INTRODUCTION

2.1 Context & Philosophy

The ROC is in charge of the ground segment activities of the RPW experiment on-board the Solar Orbiter spacecraft.

As listed in the ROC Concept and Implementation Requirements Document (CIRD) [AD1], it consists mainly of:

- Preparing and submitting the instrument operations, in agreement with the planning and constraints at the spacecraft level
- Analysing the instrument behaviour from incoming data, and optimizing the science return
- Ensuring the instrument maintenance and on-board software patching
- Retrieving, processing (e.g., calibrating) and delivering to the ESA data archive centre, the RPW science data.

The centre has thus to foreseen dedicated software tools, forming the ROADS, to support these tasks during the mission.

2.2 Concepts and definitions

2.2.1 ROADS instance definition

As explained in the ROC Software Development Plan" (SDP) [RD8], several instances of the ROADS are planned to be deployed and run on different sites during the mission. However, there will be only one main instance, hereafter identified as "primary instance", which will be hosted at the ROC site, located in the Laboratoire d'Etudes Spatiales et d'Instrumentation en Astrophysique (LESIA) in Meudon (France). Especially, this instance will be in charge to produce RPW data to be publicly distributed and it shall be the only one used to planify and submit instrument operations.

All other ROADS instances, dedicated to specific tasks, are hereafter identified as "secondary instances".

2.2.2 ROADS user definition

There are three types of users, which differ by their access permissions to functionalities of the ROADS: ***observer***, ***operator*** and ***administrator***.

- An ***observer*** is someone, potentially out the ROC team, who wants to access a part or all of the ROADS tools, but in a passive way (i.e., read-only access). It might concern more specifically people who want to see incoming data and operation planning from the graphical user interfaces (GUI) of the ROADS.
- An ***operator*** is a member of the ROC operations team. Her/his responsibility includes planning the observations, taking into account the scientific objectives and the operational constraints. He/she also in charge of monitoring the instrument incoming data, and notify the right people in case of problems.
- The ***administrator***, in charge of administrating and maintaining the ROADS software and databases. An administrator might have all the right permissions on the whole

system. Especially, she/he is expected to support any issue that an ***observer/operator*** can encounter when using the ROADS GUI.

The way the three types of users can use the ROADS tools can differ from a tool to another.

2.2.3 Human-machine interface (HMI) definition

The human-machine interface (HMI) of the ROADS gathers two categories of user interfaces:

- The Graphical User Interfaces (GUI), which should be developed and used in priority to support the ROC team in the instrument monitoring and operations activities.
- The Command Line Interfaces (CLI), only available from a terminal. This type of interface shall be reserved to the ROC team to administrate the ROADS software and databases.

3 GENERAL DESCRIPTION

3.1 ROC Operations And Data System (ROADS) product perspective

3.1.1 ROADS overview

The ROADS gathers the following software units, in support the ROC activities during the Solar Orbiter mission:

- The ROC Operations and Data Pipeline (RODP), in charge of retrieving and processing the incoming RPW-related data (science, HK, ancillary, etc.)
- The RPW Calibration Software (RCS), which produce RPW science calibrated data files. In practice, the RCS are planned to be run by the RODP
- The Monitoring and control subsystem User Interface (MUSIC), a Web interface, which contain tools for the instrument commanding, operations planning as well as the data monitoring and analysis
- The RPW Low Latency Virtual Machine (LLVM), a virtual machine dedicated to the RPW Low Latency data (LLD) processing. The primary instance of the RPW LLVM is planned to be run at the Solar Orbiter Science Operations Centre (SOC), located at the European Space Astronomy Centre (ESAC) in Madrid (Spain).
- The ROC Mission Database (MDB), the main database used by the ROADS software.

An overview of the ROADS software design can be found in the SDP.

3.1.2 ROADS external interfaces overview

3.1.2.1 Interfaces with the Solar Orbiter ground segment centres

The Data Dissemination System (DDS) for Solar Orbiter [AD5] will be the main interface, used by the ROADS, to retrieve TM binary packets during the mission. Additional data, such as the catalogue of executed TCs, will be also available through the DDS.

The DDS will be hosted and maintained by the Solar Orbiter Mission Operation Centre (MOC), located at the European Space Operations Centre (ESOC) in Darmstadt (Germany).

The Generic File Transfer System (GFTS) for Solar Orbiter [AD8] will be the main interface, for the ROADS, to exchange data files with the SOC and the MOC. The following data is planned to be transferred using the GFTS:

- Inputs, provided by the SOC, to prepare the instrument operations requests (E-FECS, TMC, orbit/attitude/time/frames SPICE kernels)
- Science operation requests, submitted by the instrument teams (IT) to the SOC, using the dedicated instrument operation request (IOR) format [AD2].
- Non-routine operation requests, submitted by the instrument teams (IT) to the MOC, using the dedicated Payload Direct Operation Request (PDOR) or Memory Direct Operation Request (MDOR) formats [AD7].
- Instrument science data to be archived at ESAC [AD9].

3.1.2.2 Interfaces with the MEB GSE

Direct interface between the ROADS and the MEB GSE [RD17] is not currently planned. Nevertheless, the ROADS tools shall have the capability to generate files to be imported into the MEB C-SGSE tool [RD18].

3.1.3 ROADS software covered by the ROC Software System Specification (SSS)

The diagram below presents the ROADS software covered by this SSS. The specification of the RCS only concerns the calling interface with the RODP.

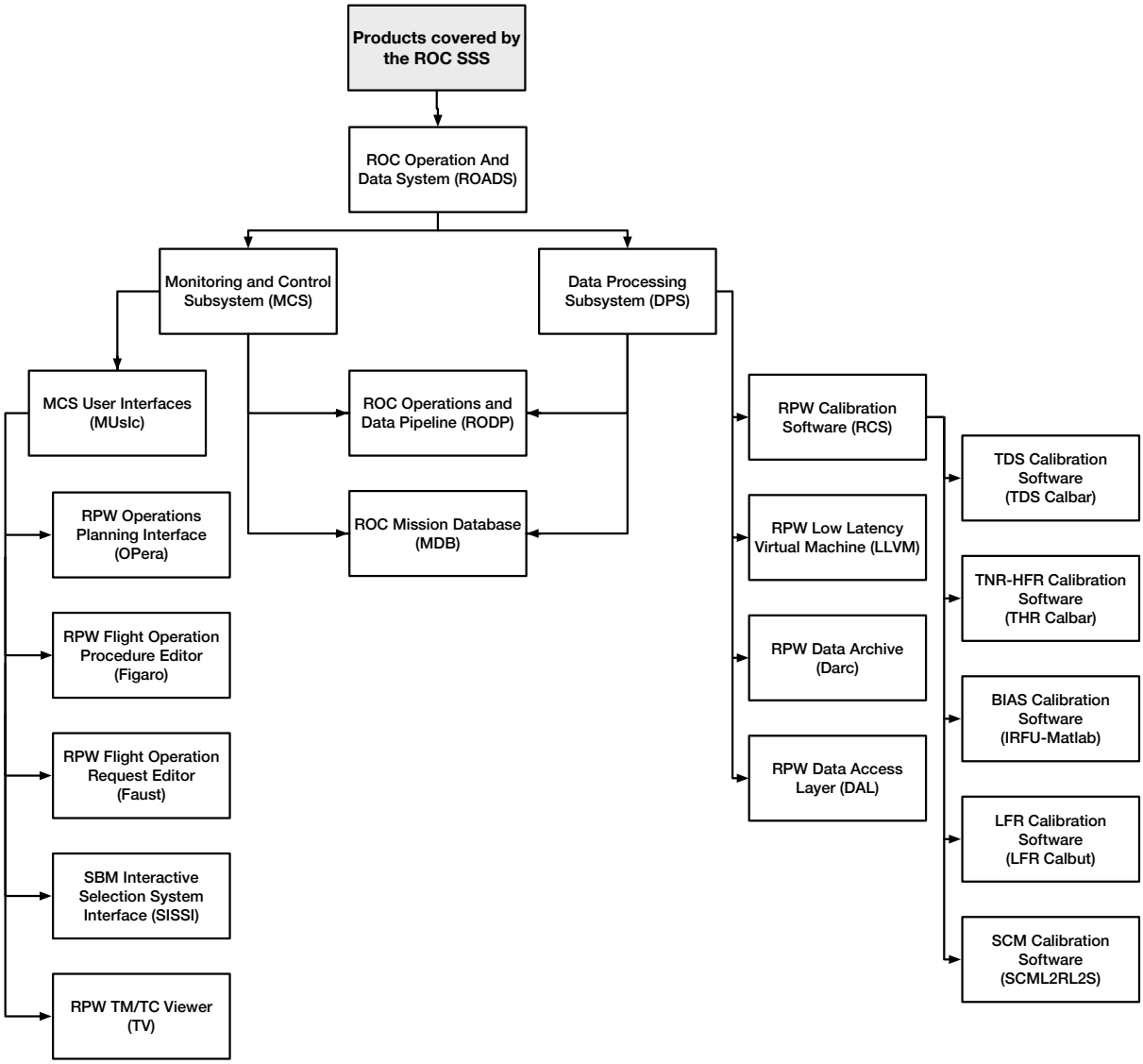

Figure 1. Products covered by the ROC SSS.

3.2 General constraints

3.2.1 Constraints relative to the ROADS software development and execution environment at the LESIA

The development and execution of the primary instance of the ROADS will be realized on VMs hosted by the LESIA computing service (see the SDP for more details). Expected operational environment relative to the primary instance is described in the section 3.3.1.

3.2.2 Constraints relative to the Near Earth Commissioning Phase (NECP) operations

During the Near Earth Commissioning Phase (NECP), a part of the ROC team will have to be present at the MOC site, in order to support critical operations concerning the RPW instrument (i.e., switching-on, antennas and boom deployments, interference campaigns). Instances of the ROADS will have thus to be deployed locally in order to receive, process and analyse the RPW data generated on-board during these operations.

It will require having an operational environment suitable enough to install and run these instances, but in agreements with the constraints imposed by the MOC. The expected operational environment is described in the section 3.3.2.

3.2.3 Constraints relative to the Low Latency Virtual Machine (LLVM) development, delivery and execution

The RPW LLVM is the only software equipment that must be delivered and run at the SOC site. In consequence, the ROC team shall ensure that the LLVM has been fully tested and validated in the same environment than at the SOC site.

In the same time, the ROC team shall ensure that the primary instance of the ROADS is also able to process the RPW LLD at the LESIA site. The way the LLD processing approach shall be realized shall be as much as possible similar to the LLVM instance at SOC.

The technical specification relative to the LLVM and the operational environment at SOC are given in [AD3]. The specification requirements, relative to the RPW LLD processing by the ROADS primary instance at LESIA, are listed in the section **Erreur ! Source du renvoi introuvable.**.

3.2.1 Constraints relative to the MEB GSE usage

During the mission the MEB GSE facilities will be regularly used to investigate the instrument behaviour on-board, especially in case of anomalies. The ROADS will not have direct interface with the MEB GSE, the ROC-SGSE will be used instead to process and analyse data produced on-ground by the RPW spare model and stored into the MEB GSE mission database.

Nevertheless the ROC team plans to use also the MEB GSE facilities to simulate and validate their operation requests on-ground. It means that the ROADS software shall permit to export RPW operation request files (ROR), namely: Instrument Operation Request (IOR), Memory Direct Operation Request (MDOR) and Payload Direct Operation Request (PDOR) into the file format compliant with the MEB GSE commanding tools.

3.3 Operational environment

3.3.1 At the ROC site

The primary instance of the ROADS will be deployed and run on several Linux servers hosted by the LESIA.

ROADS will use the intranet network to exchange data between its software units (RODP, MUSIC, MDB) installed on different servers. Interfaces with external systems (DDS, GFTS) will be performed through dedicated proxy servers.

Furthermore, the DDS and GFTS data exchange mechanism will require deploying a dedicated ROC SFTP server at the LESIA site.

3.3.2 At the MOC site

The operational environment that will be available at the MOC site during the NECP-related RPW operations, is not know in details at this stage of the project.

Nevertheless, the members of the RPW team, which will be present at the MOC site during this period, will need to promptly process and analyse data generated by RPW on-board Solar Orbiter.

These will require to locally install dedicated ROADS instances on computer equipment brought by the ROC team. This equipment might have to be easily deployable and have to work as stand-alone systems, being able to retrieve in quasi-real time RPW data through the MOC DDS. Use of laptops - with network access - should be hence privileged.

3.3.3 At the SOC site

Only the RPW LLVM is planned to run at the SOC site to produce RPW LLD.

The RPW LLVM operational environment shall comply the specification described in [AD3]. In the same way, the RPW LLVM shall be delivered to the SOC following the mechanism defined in [AD3] too.

3.4 General capabilities

3.4.1 Use case overview

Table below gives the ROADS general use cases to apply during the mission. The column on the right indicates the corresponding software unit(s) in charge. Main use cases can be associated with dedicated RODP workflows as presented in the next sections.

Use case	Software in charge
Retrieve the RPW TM/TC and ancillary data from the dedicated Solar Orbiter SOC/MOC interface (DDS, GFTS)	RODP
Process the RPW TM raw packet data in order to produce higher-level science data products (e.g., LZ, L0, L1, L1R, L2, HK, summary plots, ancillary data, LL01 at LESIA)	RODP (for LZ, L0, L1, HK, plots, ancillary data production) RCS (for L1R, L2 data production) LLVM (for LL01 data production at LESIA)
Make available as soon as possible the L0, L1, L2 and HK data products to the RPW consortium and ESA	RODP
Support the archiving of the RPW data products at the ESA archive data centre and the “Centre de Données de Physique des Plasma” (CDPP)	RODP
Giving regular reports of the DPS software activity and data status	RODP
Ensuring the self deployment, self-test validation and the processsing of the RPW Low Latency data (LLD) as expected by the SOC [AD3]	LLVM

Promptly visualize the instrument event, HK and science data	RODP for the data retrieval and processing MUSIC-TV for the data visualization
Control the on-board data storage and power consumption, according to the TM corridor (TMC) and the power consumption corridor (TBC) constraints.	The TM Rate Calculator (TRaC) software unit The Power Consumption Analyser (PoCA) software unit The MonA software unit (for the monitoring)
Prepare and submit to ESA the flight procedures for RPW	MUSIC-FIGARO
Prepare, validate and submit to ESA the RPW operation requests (IOR, MDOR or PDOR), in agreement with the mission planning and constraints	MUSIC - FAUST for the operation request edition and submission MUSIC-OPERA for the operation scenario edition and mission planning visualization
View the list of SBM1/SBM2 events detected on-board and select the events for which data must be downlinked	MUSIC-SISSI

Table 1. ROADS general use cases.

3.4.2 RODP specific use cases

3.4.2.1 Retrieving RPW-related data with the MOC/SOC interfaces

Figure 2 shows the nominal use case to retrieve RPW-related data, instrument TM/TC raw/report data and mission ancillary data, through the MOC DDS and the SOC GFTS Web interfaces respectively.

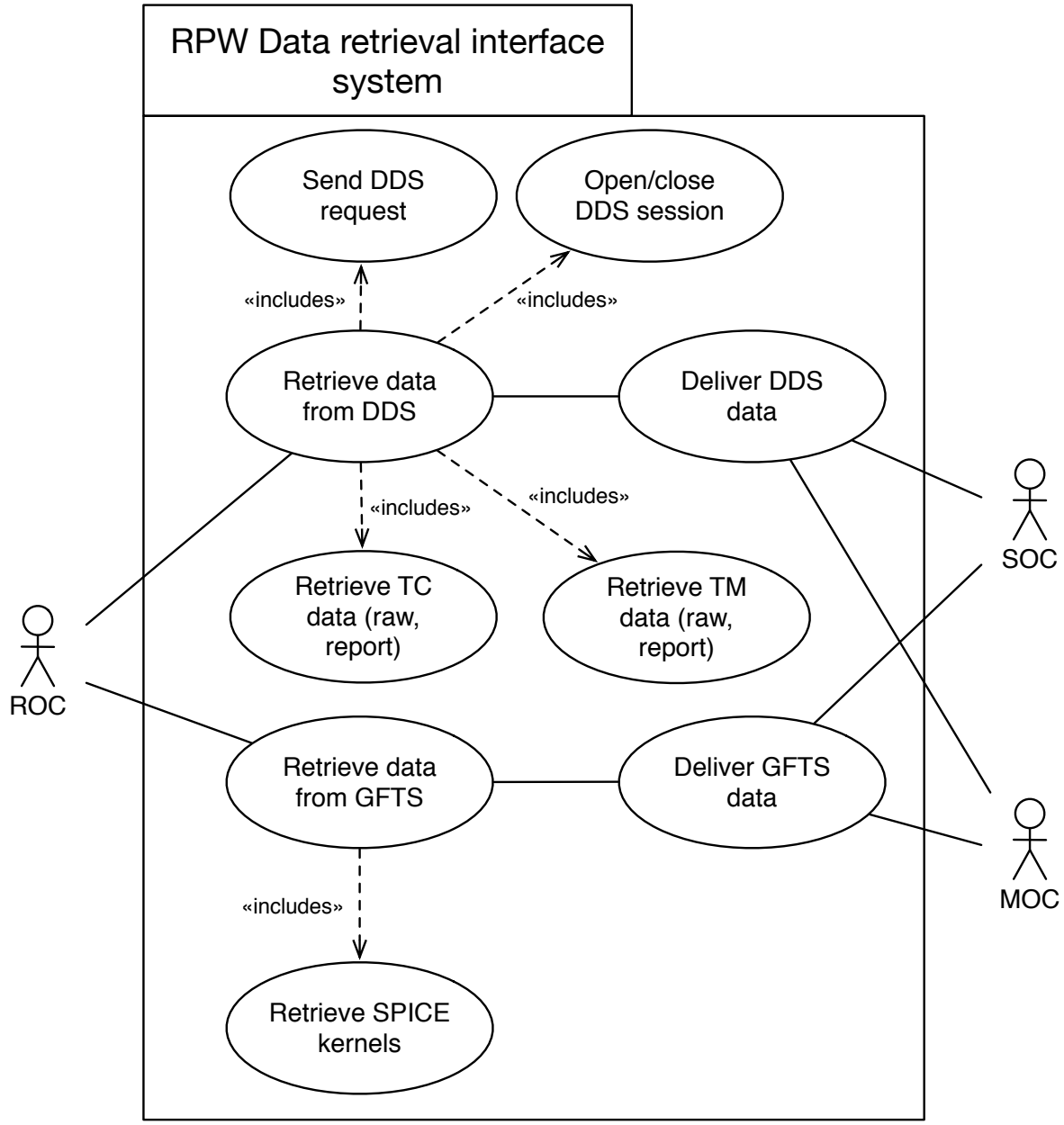

Figure 2. RPW data retrieval interface nominal use case.

Figure 3 displays the nominal use case to process RPW science data, including the production of full-calibrated data by the RPW sub-system teams, and the delivery to the ESAC and CDPP (CNES) data archive centres.

3.4.2.2 Processing RPW science data

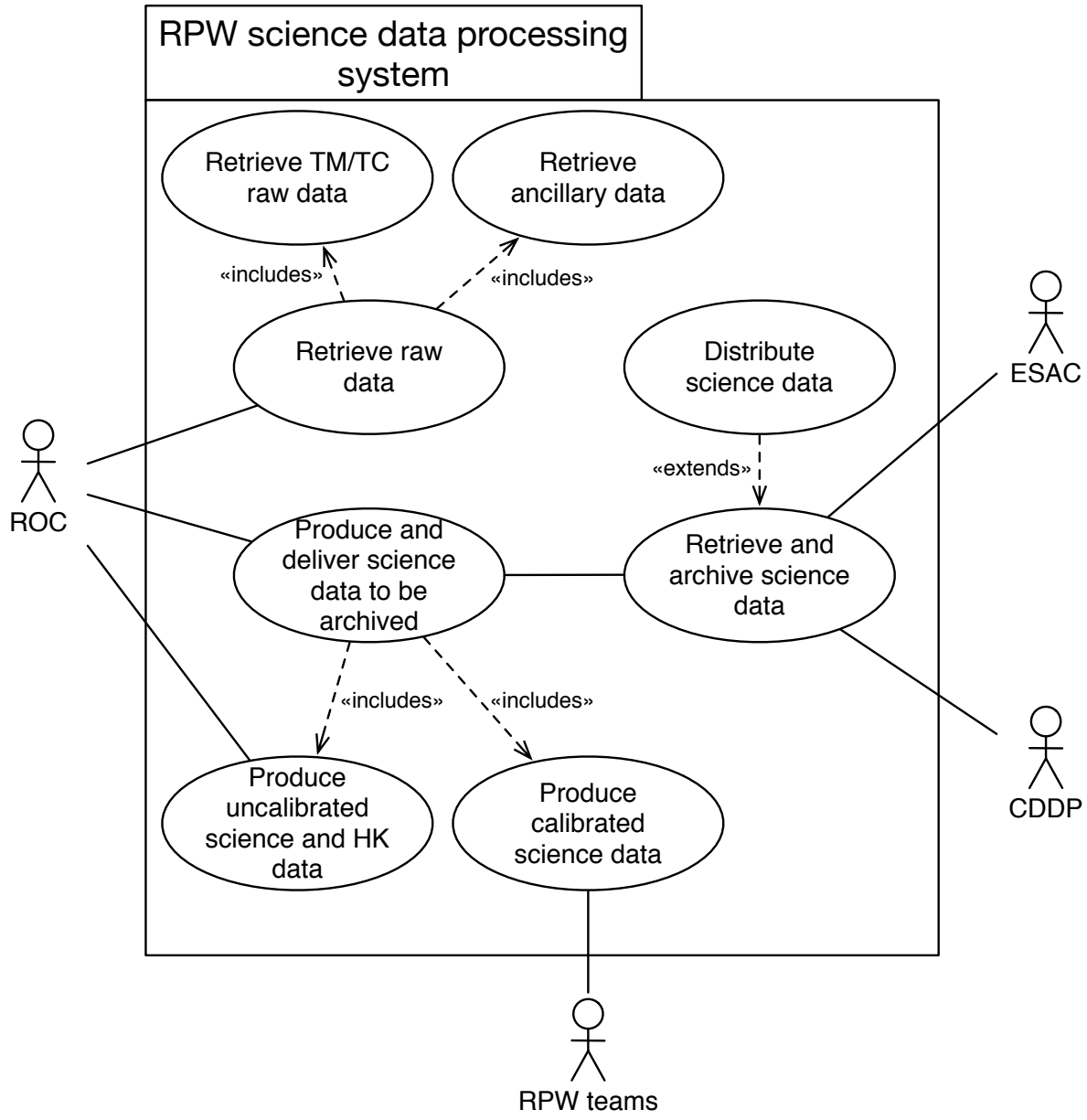

Figure 3. RPW science data processing nominal use case.

Figure 4 displays the nominal workflow to retrieve and process RPW TM raw packet data, in order to produce RPW LZ, L0, L1, HK and L2 data files.

This retrieving and processing workflow, hereafter called “processing workflow”, involves the Dare plugin for requesting data and saving LZ file (steps 1 to 4), the Film plugin for producing the LZ, L0, L1 and HK files (steps 5 to 7), the CaWa plugin that run the RCS for producing L2 data files (step 9 to 13). The RPL plugin as well as the MDB database are also used to analyse the incoming TM raw packets and store process information respectively.

The SOC/MOC DDS interface is the primary source of data to run this workflow. However processing some data shall require additional data (TBD) that can be retrieved from the other SOC/MOC interfaces.

In practice, the processing workflow is run three times at three different rate:

- A first *high* rate processing workflow in order to promptly retrieve and analyse the latest RPW packet data delivered by the MOC/SOC. This cadence is typically required for monitoring data during the mission. During the NECP, this cadence shall be maximized to be able to follow the RPW related operations in quasi-real time.
- A second *daily* rate processing workflow in order to retrieve possible missing packets and produce RPW daily data files to be distributed. During this phase, the L1 HK and L2 daily files are tagged as preliminary (PRE)
- A third *monthly* (TBC) rate processing workflow in order to produce definitive (DEF) L1, HK and L2 daily files to be distributed and archived.

The main steps of the workflow are:

1. Requesting RPW TM raw packets from the MOC DDS server.
2. Downloading DDS response file(s) into the dedicated directory on the ROC file system. This step might require to have a SFTP server to be used separately at LESIA (TBC).
3. Checking and moving the valid DDS response file(s)
4. Retrieving and identifying the list of TM raw packets
5. Storing the TM packet information and binary data into the MDB
6. Ending the Dare plugin related tasks and starting the FilM plugin related tasks
7. Retrieving the list of TM packets from the MDB and the corresponding binary data.
8. Producing the RPW LZ, L0, L1, HK data files
9. Storing relative information into the MDB
10. Ending the FilM plugin related tasks and starting the CaWa plugin related tasks
11. Retrieving information about the RPW LZ, L0, L1, HK data files from the ROC file system
12. Executing the RCS to produce the L2 data files
13. Reading L1/HK data files required to produce L2 data files. (This step is performed by the RCS)
14. Producing the L2 data files. (This step is performed by the RCS)
15. a) Verifying the production of L2 data files, b) storing related information into the MDB, and ending the CaWa plugin related tasks.

It must be noticed that some steps above are not performed by all of the *high, daily* or *monthly* rate workflows. The section **Erreur ! Source du renvoi introuvable.** gives the details about the capability requirements for each of the steps of each of the workflows.

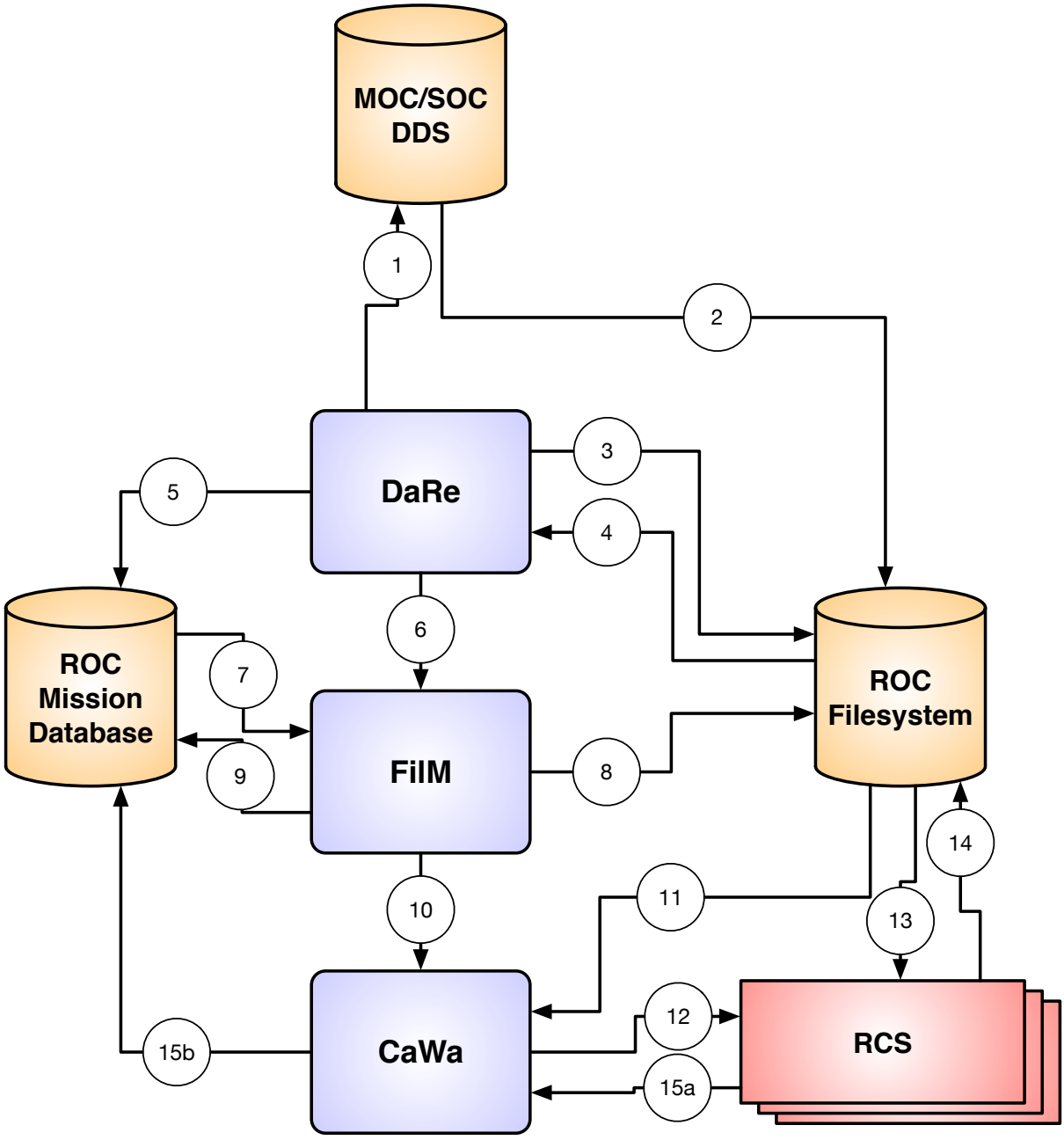

Figure 4. RPW TM raw packet data retrieving and processing workflow.

3.4.2.3 RPW Low Latency data retrieving and processing

Figure 5 gives the nominal use case concerning the LLD processing for RPW. The main instance of the RPW LLVM will have to be deployed and run at the SOC site. The ROC shall thus ensure that LLVM is ready to be delivered (i.e., LLD processing and LLVM automated self-deployment and test processes are validated). In parallel the ROC shall produce its own LLD data using an execution environment as much as similar to the SOC.

From the LL01 data produced by the dedicated RLLP installed in the LLVM, the SOC will produce post-processed data at LL02 level. These LL02, which will serve as a basis for IT and SOC to prepare the instrument operations and monitor on-board payload activities (e.g. SBM), will be visible from the dedicated SOC LL Web page. The IT will also be able to retrieve LL01 and LL02 data files generated by the SOC (TBC).

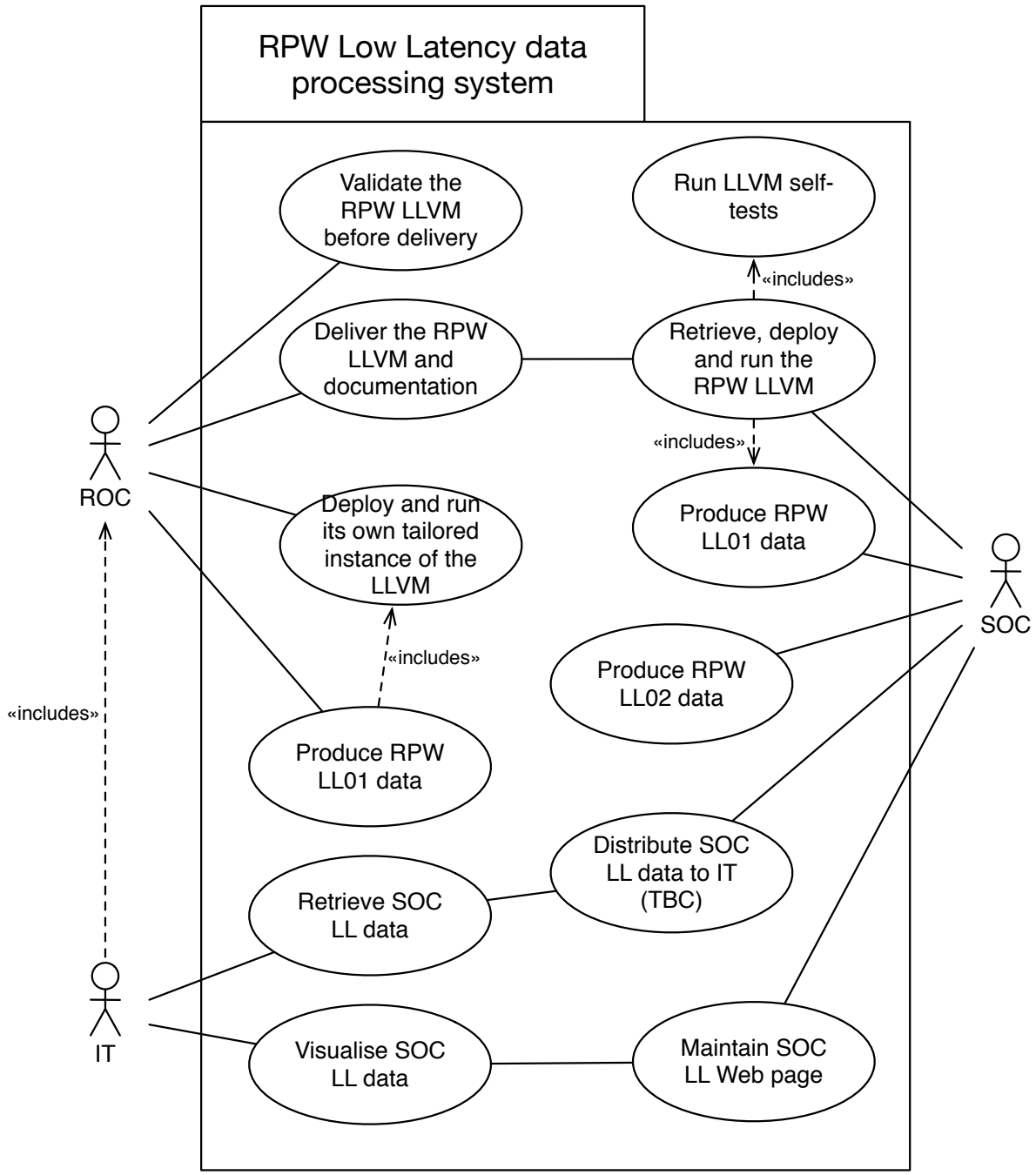

Figure 5. RPW Low Latency data processing nominal use case.

The RPW LLD are expected to be processed in priority at the SOC site, using the RPW LLVM delivered by the ROC. However the ROC shall also plan to process the LLD using the primary instance of the ROADS at the LESIA site. The LLD retrieving and processing workflow shall respect the following main steps:

1. From the list of RPW LLD TM packets stored in the MDB, the FilM plugin shall regularly generate a specific LLD LZ file in the dedicated directory.
2. The RLLP plugin shall be then run to process this LLD LZ file.
3. Processed LLD TM packets shall be then saved into a specific LL01 data file in a dedicated directory.

Details of the requirements for the LLD processing by the prime ROADS is listed in the section **Erreur ! Source du renvoi introuvable.**.

3.4.3 MUSIC specific use cases

3.4.3.1 Instrument event, HK and science data monitoring

Figure 6 shows the nominal use case concerning the monitoring of RPW data. Especially the ROC shall be able to promptly process and visualize data for a first primary investigation. The ROADS shall also include automated processes to check the data integrity and validity, as well as to control the data executed and returned by the on-board instrument (including the TC acknowledge, TM production rate, instrument HK and event reports, etc.). The ROADS shall support the automated publication of reports with at frequencies, depending of the severity of data analyse results.

Some of these reports will have to be distributed to the RPW teams involved in the ground segment activities. The RPW teams can use them in complement to the processed RPW data, to analyse their sub-system state and to supply expertise in case of anomalies.

In some specific cases (e.g., instrument failures, special operations), the ROC might also ask for support from the SOC/MOC.

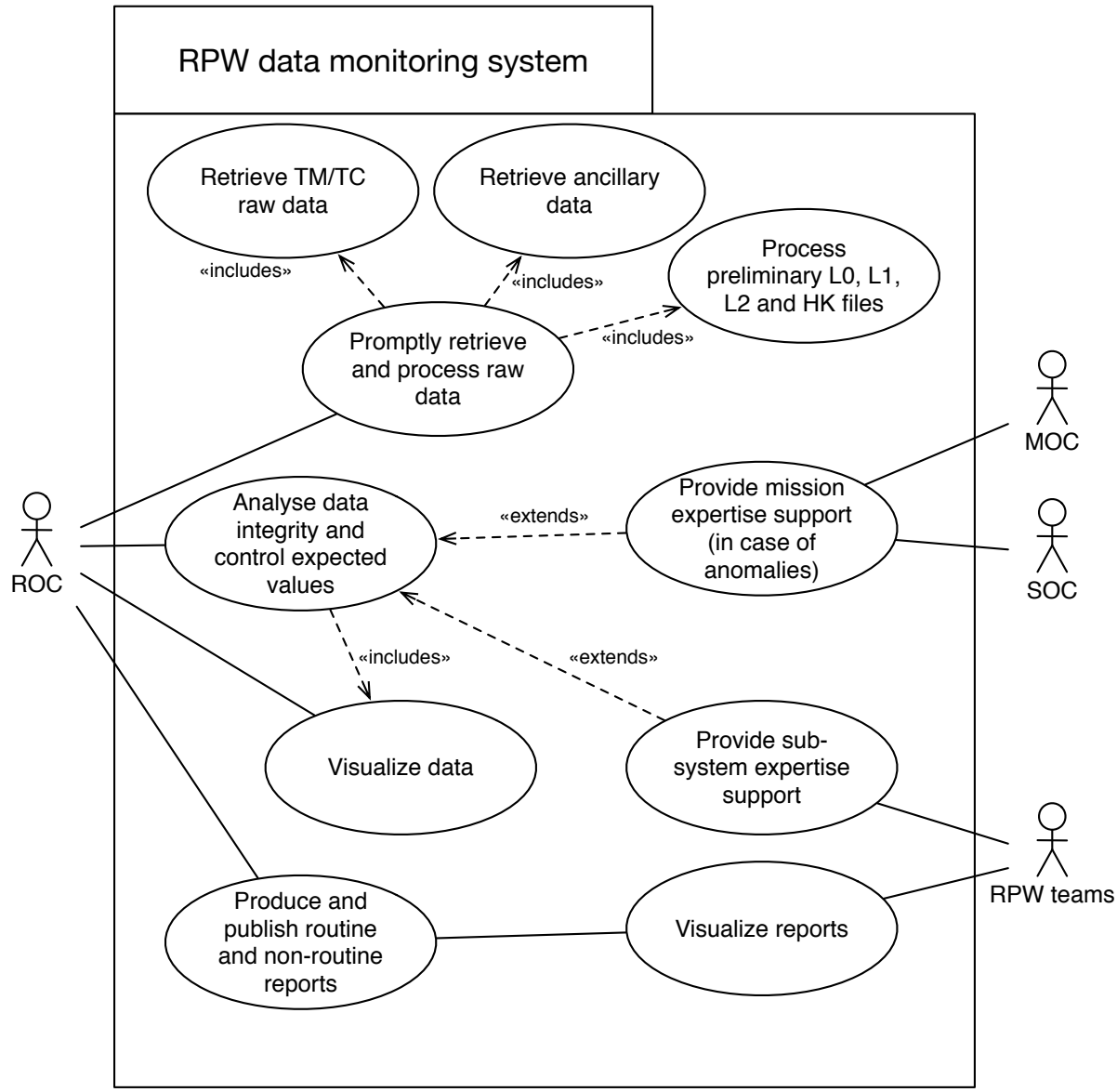

Figure 6. RPW data monitoring nominal use case.

In order to support the ROC team in the analysis of instrument data, the RODP shall implement the following workflows to perform primary automated survey of the incoming data flow:

- An event monitoring workflow to filter and report information in the "event reporting" TM packets.
- An HK/science data basic monitoring based on notifications, which can be triggered if the value of the packet parameters exceeds threshold values.

The way these workflows shall be triggered and run by the RODP is covered in the section **Erreur ! Source du renvoi introuvable.**. The triggering methods will have to rely on dedicated input files containing the threshold value and the action to be performed.

This task will be performed by the MonA plugin. Some results will be visible from the TV and summarized reports will be regularly published by the Pipeline Unit Keeper (PUNK) plugin (see the next section).

Especially the PUNK plugin of the RODP shall regularly generate reports. These reports will provide information about the instrument data activity. The content, the number, the production rate, the format and the targeted people of these reports are detailed in the ROC Operation Management Plan (OMP) [RD??]. The relative capacity requirements are in listed in the section **Erreur ! Source du renvoi introuvable.**.

3.4.3.2 RPW Instrument Operation Request (IOR) creation, validation and submission

Figure 7 presents the nominal use case to prepare and submit RPW operation requests to the SOC/MOC. Main inputs required to prepare the operations shall be provided by the SOC via its GFTS interface. It concerns namely: Orbit files, Enhanced-Flight Events and Communication Skeleton (E-FECS), Telemetry Corridor (TMC), and power allocation (TBC) files. Additionally the Solar Orbiter Observing Plans (SOOPs), the Science Activity Plan (SAP) and the Mission-Level Activity Plan (MLAP) (not in the figure) will be also distributed to the ITs to prepare their Medium Term, Short Term and Very Short Term Planning (MTP, STP, VSTP) requests.

The IT IORs shall be delivered to the SOC via the GFTS mechanism. The SOC will then perform a first “rough” validation of the IORs and check that they are consistent with the mission operations timeline constraints and science objectives. Then IORs will be converted by the SOC into Payload Operation Requests (POR) and send with the expected additional inputs (e.g., orbit/attitude data request) to the MOC.

The IT MDOR/PDOR shall be directly delivered to the MOC via its GFTS interface. This interface will be only used for special operation requests (e.g., LEOP, NECP, on-board software patches, etc.).

Both IOR and MDOR/PDOR shall be generated from flight procedures, which will have to be validated by the MOC before use.

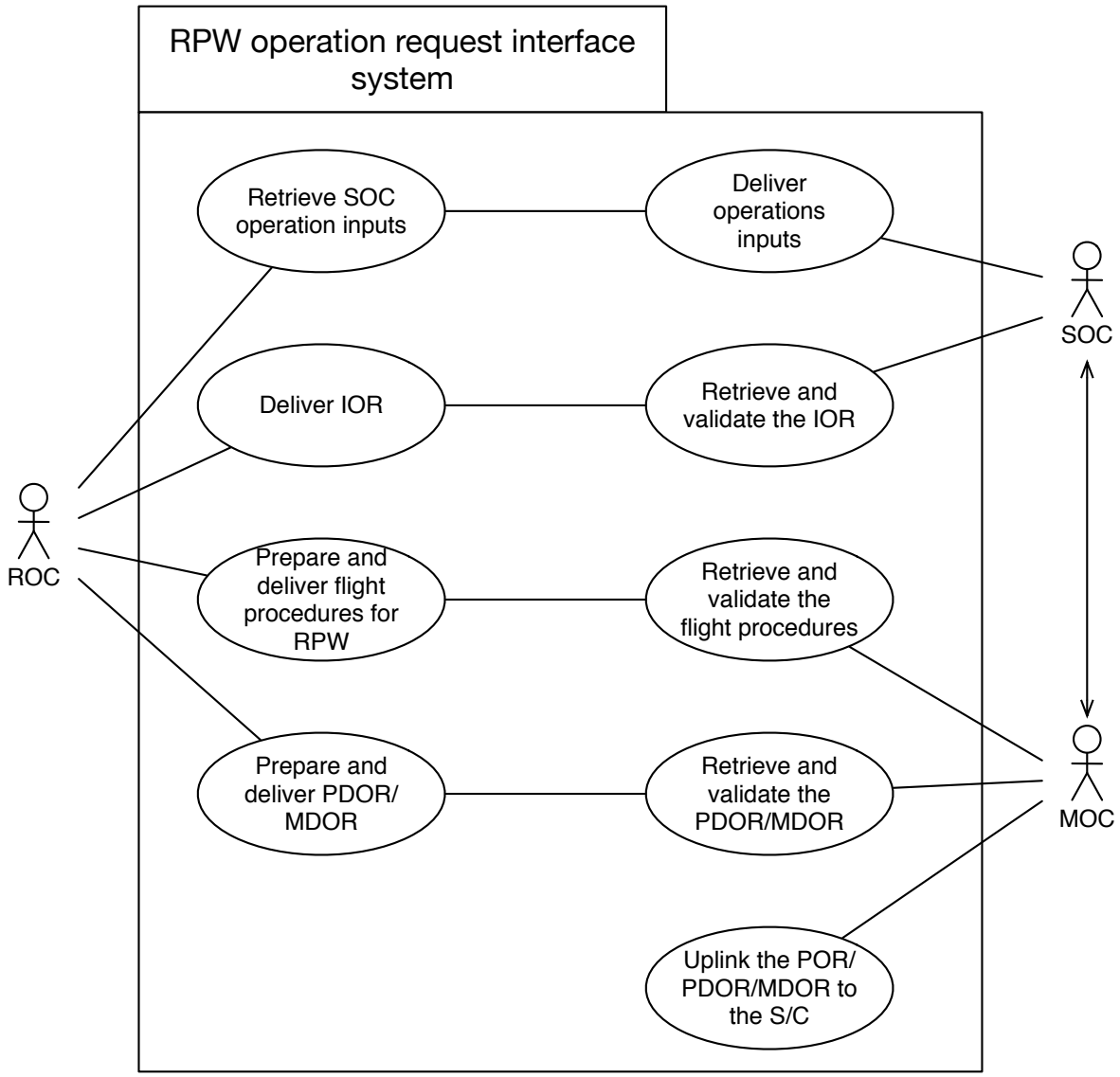

Figure 7. RPW operation requests interface nominal use case.

Figure 8 presents the nominal workflow related to the preparation, the validation and the submission of a ROR. ROR is the generic term to denote the IOR, PDOR and MDOR format. The same workflow but from the user point of view can be found in [AD3]. The capability requirements relative to this workflow is detailed in the section **Erreur ! Source du renvoi introuvable.**.

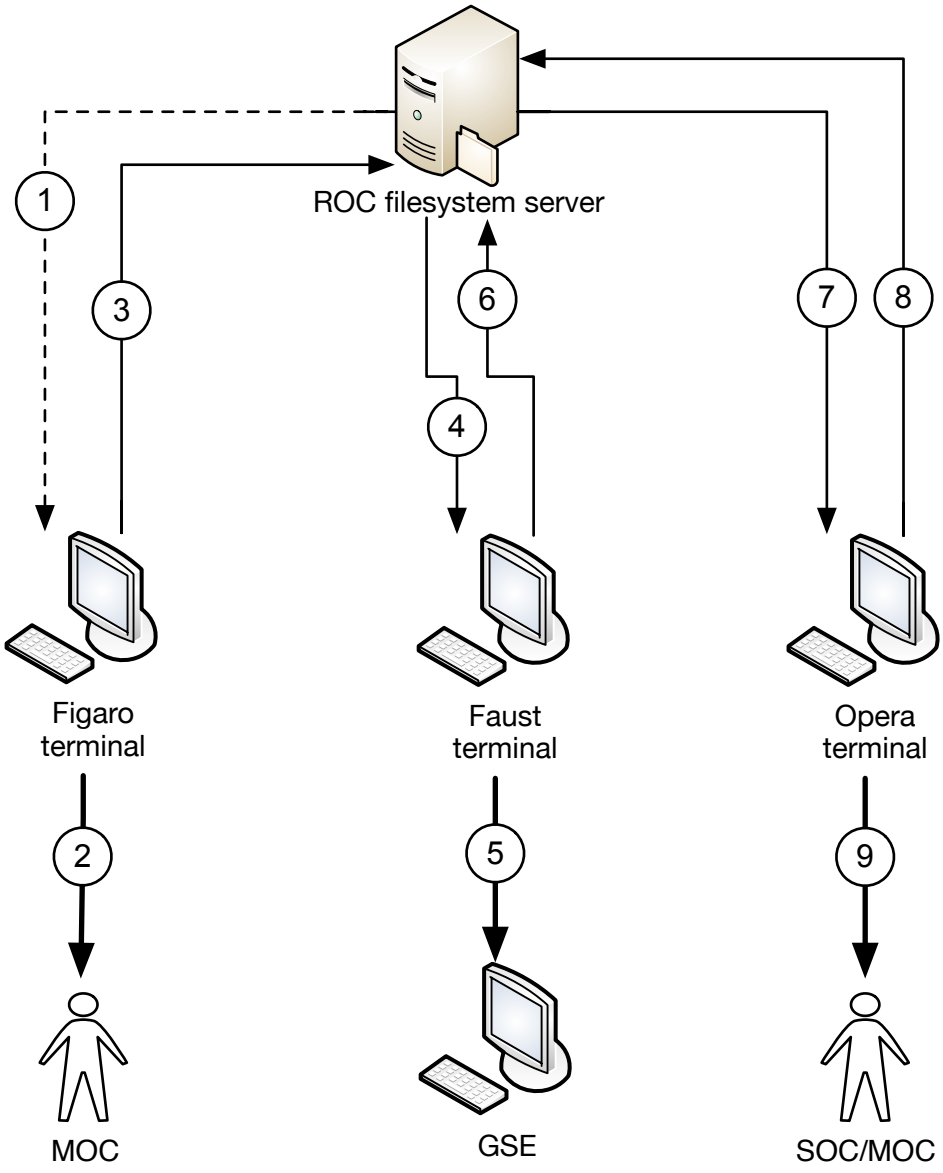

Figure 8. RPW Operation Request (ROR) preparation, validation and submission workflow.

3.4.3.3 Selected Burst Modes (SBM) event data selection

Figure 9 shows the nominal use case about the SBM event data selection for RPW. The selection process involves the SOC for data delivering (also possible using the MOC) and LLD summary plots prompt publication on the dedicated SOC LL Web page, and the IT (mainly in-situ teams) for the selection of SBM1/SBM2 event data to be downlinked. To assist the ROC team in the selection, a dedicated SISSI Web page will be used to publish the list of SBM events detected on-board. This interface shall allow very few authorized people to perform a first selection of the events (final selection will have to be validated by the RPW ground segment project manager before requesting). The SISSI page shall be also accessible in "read-only" mode to the appropriate people in the other IT concerned. (*Do the other IT will provide additional tool and/or data support for the selection?*). After validation, the system shall permit to accelerate the selection-to-request process, by automatically generating a preliminary version of IOR to submit from the selected SBM event list.

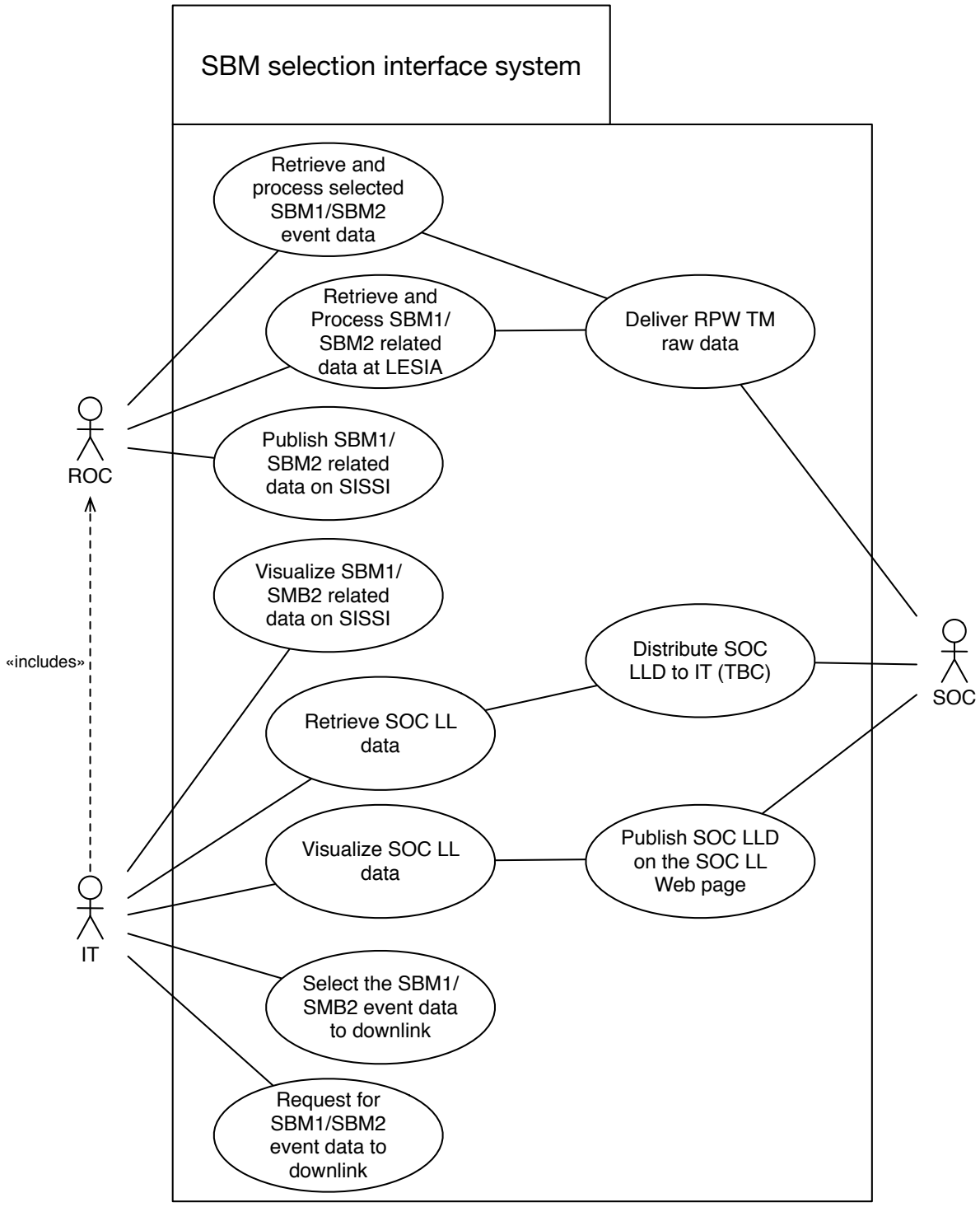

Figure 9. SBM event data selection nominal use case.

Figure below gives the steps to be performed to select the SBM event data and submit the selection request for downlink. The same workflow presented from the user point of view can be found in [AD3]. Technical specification required to perform each of these steps is detailed in the section **Erreur ! Source du renvoi introuvable.**.

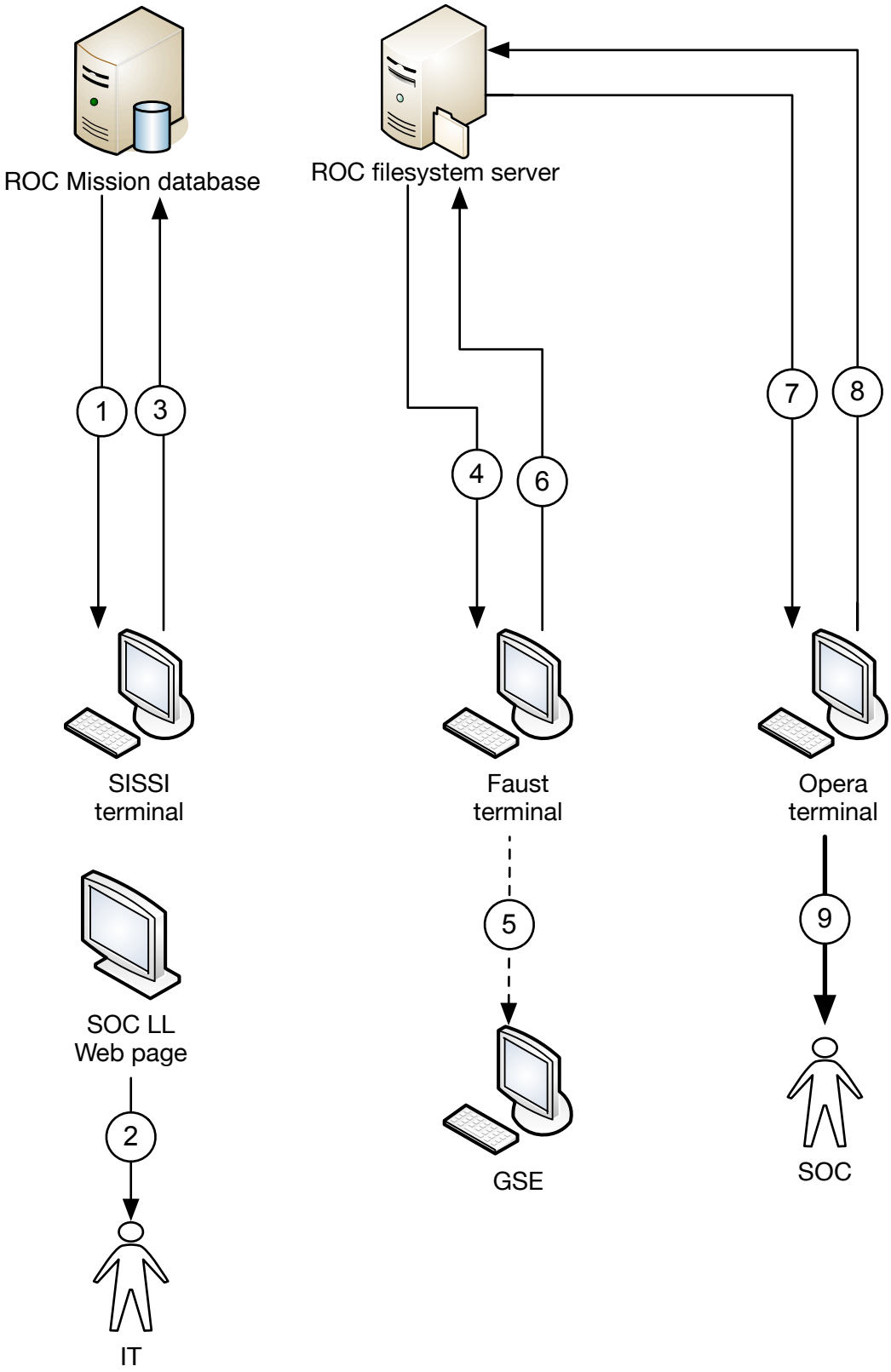

Figure 10. SBM event data selection main steps.

4 ROADS GENERAL REQUIREMENTS

5 MUSIC SPECIFIC REQUIREMENTS

5.1 MUSIC capabilities requirements

5.1.1 MUSIC general capabilities requirements

5.1.1.1 User access and authentication

The MUSIC primary instance, deployed on the ROC site, shall only be accessible from the LESIA intranet. It implies that the MUSIC tools at ROC are only visible from people who have a valid LDAP user account at the LESIA.

REQ-ROC-SSS-0001	**MUSIC: user authentication**
Access to the MUSIC tools shall require an authentication.	

In the case of the primary instance at the ROC site, the MUSIC users might sign in with their LESIA LDAP accounts too. However, since the LESIA LDAP account verification could be not available from the MOC site during the NECP, another backup mechanism might be implemented for logging to the MUSIC MOC instances.

REQ-ROC-SSS-0002	**MUSIC: user account registration**
MUSIC users shall be able to register (i.e., create an account) them-selves. However, before completion, the registration shall be validated/rejected by an administrator, which also shall give the user permissions (“observer” or “operator”).	

The users should be notified by email, when the registration is accepted/rejected.

REQ-ROC-SSS-0003	**MUSIC: user account registration parameters**
When registering, a new user shall provide the following information: • First name • Last name • Email • Organization (optional) • Login (must be unique) • Password (must be unique)	

5.1.1.2 Main page

REQ-ROC-SSS-0004	**MUSIC: main page content:**
MUSIC shall have a main page, from which the users can: • Sign up (i.e., register) • Sign in • Access to the tools • Contact the ROC support (i.e., webmaster)	

- View the MUSIC user manual
- Check the version of MUSIC and its components
- Go to relevant external links (e.g., RPW Web page, etc.)

The MUSIC main page is the only page of the interface visible by people who are not registered. In addition, it should give a short description of the content, acknowledgements and current status of the interface (i.e., “up-and-running”, “maintenance”, etc.)

5.1.1.3 User preference settings

REQ-ROC-SSS-0005	MUSIC: saving users preference settings
MUSIC shall allow a user to save its preference settings.	

It might help users to retrieved customized settings, or store specific settings (e.g., for NECP RPW-related operations).

MUSIC might let the user chooses if he/she wants to open a frame in a new window or in a new tab.

5.1.2 MUSIC-TV specific capabilities requirements

The MUSIC-TV tool provides panels dedicated to the RPW-related data visualization. It helps ROC operators to promptly check the instrument status and the downlinked/uplinked RPW data flows: TM, TC ack., event reports... It also offers basic plotting tool to observers to analyse RPW HK and science data as well as statistics related to the instrument.

REQ-ROC-SSS-0006	MUSIC-TV expected data
The RPW TV main window shall allows users to view the following data: • Instrument TM history log • Instrument TC history log • RPW and RODP events history log • Instrument general and sub-system status • Packet statistics • RPW TM data (e.g., packet, science, HK, etc.)	

Each of these data should be accessible from different panels.

5.1.2.1 MUSIC TV general functionalities

REQ-ROC-SSS-0007	MUSIC-TV: Displaying continuously new data option
TV shall allow users to easily see the newest data received at the ROC site. Especially it shall be possible to continuously refresh the plots with new data, without any human intervention.	

This option should be activated/deactivated by users.

REQ-ROC-SSS-0008	MUSIC-TV: data plotting general options
When the option of displaying continuously new data is deactivated, TV shall allow users to:	

- Select a given time range of data to plot
- Change the duration of the time window

REQ-ROC-SSS-0009 MUSIC-TV: time series plots units

TV shall allow users to plot time series with the following units:

- Count (i.e., sequence number of the data sample)
- RPW on-board time
- UTC time

REQ-ROC-SSS-0010 MUSIC-TV: Ordering rows in a table

TV shall allow users to sort the rows in a table by decreasing/increasing values of a given column.

5.1.2.2 Displaying RPW TM history log

The TV shall have a panel to display the RPW TM history log. It shall help the ROC users to promptly and easily visualize the list of RPW TM packets downlinked by the MOC from the on-board instrument. It is the primary tool used by the ROC team, in order to perform a first analysis of the TM flows, and promptly detect anomalies.

REQ-ROC-SSS-0011 MUSIC-TV: TM packet list

The TM log panel shall display the list of received RPW TM packets, as a table with the following columns:

- Packet count, sequence number of the packet, related to the DAS packet counter.
- Packet index. First 7 characters of the packet ROC ID in the MDB.
- Packet reception time – It must be the reception local time of the TM. (The format is "YYYY-MM-DD HH:MM:SS.FFF".)
- Packet creation time – It must be the on-board TM packet creation time (The format is "YYYY-MM-DD HH:MM:SS.FFF".)
- Packet time synchronization flag
- Packet APID – Apid of the packet
- Packet name – human-readable name of the packet
- Packet status – One of the following TM statuses: "Received" (received by the ROC), "Validated" (packet integrity and identification validated), "Corrupted" (packet content is partially or fully corrupted), "Processed" (packet data has been processed correctly)

By default, the TMs might be sorted by decreasing packet creation time (i.e., most recent TM at the top of the list).

In the case where a packet has been identified, but the content is corrupted (i.e., partially corrupted), all columns shall be provided, but the status shall be set to "Corrupted".

In the case where a packet cannot be identified (i.e., fully corrupted), only the packet count, index, reception time and status - with "Corrupted" value - columns shall be provided.

REQ-ROC-SSS-0012	MUSIC-TV: TM packet list colour configuration
MUSIC shall offer the possibility to display or not TM using colour configurations. The configuration shall depend of the type or category of TM (e.g., low/medium/high event reporting, HK, science, etc.).	

The user might be able to change the default colour configuration.

REQ-ROC-SSS-0013	MUSIC-TV: TM packet description
When clicking on a given TM packet, MUSIC shall open a new window providing the description of the packet, including the binary and human-readable parameter values.	

5.1.2.3 Displaying RPW TC history log

The panel for the RPW TC history log shall have the same function than the TM log, but for the list RPW TCs submitted to the SOC/MOC.

REQ-ROC-SSS-0014	MUSIC-TV: TC packet list
The TC log panel shall display the list of submitted RPW TC packets, as a table with the following columns: • Packet count, sequence number of the packet. • Packet index. First 7 characters of the packet ROC ID in the MDB. • Packet submission time – It must be the submission local time of the TC. (The format is "YYYY-MM-DD HH:MM:SS.FFF".) The submission local time corresponds to the time when the corresponding operation request file has been sent to the SOC/MOC. • Packet execution time – It must be the on-board TC packet execution time in UTC. (The format is "YYYY-MM-DD HH:MM:SS.FFF".) • Packet APID – Apid of the packet • Packet name – human-readable name of the packet • Packet status – One of the following TC statuses: "Submitted" (submitted to the SOC/MOC), "Rejected" (rejected by the SOC/MOC), "Accepted" (accepted by the RPW DPU on-board), "Executed" (executed by the RPW DPU on-board), "Acceptance failed" (Acceptance by the RPW DPU on-board has failed), "Execution failed" (Execution by the RPW DPU on-board has failed).	

By default, the TCs might be sorted by decreasing packet execution time (i.e., last executed packets at the top of the list).

In the case where a submitted TC has not been executed yet or not correctly, the expected packet execution time shall be used instead.

REQ-ROC-SSS-0015	MUSIC-TV: TC packet list colour configuration
MUSIC shall offer the possibility to display or not TC using colour configurations. The configuration shall depend of the type or category of TC (e.g., enter modes, SBM selection, etc.).	

The user should be able to change the default colour configuration.

REQ-ROC-SSS-0016	MUSIC-TV: TC packet description
When clicking on a given TC packet, MUSIC shall open a new window providing the description of the packet, including the human-readable parameter values and the associated operation request file information (e.g., IOR, STP/MTP)	

5.1.2.4 Displaying RPW/RODP events log

The event log panel permits to view the events activity reported by the RPW DPU on-board (e.g., event reporting TM), but also by the RODP on-ground (e.g., automated data monitoring events). It shall help the ROC operators to have an overview of both the DPU and RODP monitoring activity.

REQ-ROC-SSS-0017	MUSIC-TV: Event log table content

The event log panel shall display the list of events, as a table with the following columns:

- Event count, sequence number of the event.
- Event occurrence local date/time (can be also given in UTC)
- Event type: “RPW event reporting”, “RODP event reporting”
- Event severity: “Low”, “Medium”, “High”, “Critical”
- Event status: “Fixed”, “Isolated”, “In progress”, “Ended” (TBC)
- Comment

By default, the list of event shall be sorted by decreasing date/time (i.e., last event at the top of the list).

5.1.2.5 Displaying instrument general and sub-systems status

This panel shall give an overview of the instrument general and sub-systems status.

REQ-ROC-HMI-0018	MUSIC-TV: status parameters
The MUSIC TV shall offer a dedicated panel to display the instrument general and sub-system status. It concerns the parameters listed in the Table 2.	

Parameter name	Description	Source	Possible values
DPU Status			
Active DPU			Nominal, Redundant
Active SW			DBS, DAS
DBS SW Version			
DAS SW Version			
FPGA Version			
Current Mode			
Compr.			ON, OFF
Reset cause			
DAS Sw Addr			Unknown, RAM, EEPROM1, EEPROM2

Boot Addr. LFR			Not booted, RAM, EEPROM1, EEPROM2
Boot Addr TDS			Not booted, RAM, EEPROM1, EEPROM2
Boot Addr THR			Not booted, RAM, EEPROM1, EEPROM2
DAS Config in EEPROM			Missing, OK, Corrupted
BIAS Calib			
DPU Recovery			ON, OFF
DPU Status - Anomalies stat.			
Anomalies count - Low			
Anomalies count - Medium			
Anomalies count - High			
Last error - Code			
Last error - RID			
Last error - Time			
DPU Status - Sub-Systems State			
THR – Hear beat			ON, OFF
THR – Link Err.			ON, OFF
THR – Transp. Mode			ON, OFF
LFR – Hear beat			ON, OFF
LFR – Link Err.			ON, OFF
LFR – Transp. Mode			ON, OFF
TDS – Hear beat			ON, OFF
TDS – Link Err.			ON, OFF
TDS – Transp. Mode			ON, OFF
BIAS – Hear beat			ON, OFF
BIAS – Link Err.			ON, OFF
PDU – Hear beat			ON, OFF
PDU – Link Err.			ON, OFF
DPU Status - TM Statistics			
DPU - SSMM			
DPU - OBC			
LFR – w/o SBM			
LFR - SBM			

TDS – w/o SBM			
TDS - SBM			
THR – w/o SBM			
DPU Status – Link Status			
LVDS Status – THR/LFR			
LVDS Status – TDS/BIAS			
SiS Status - PDU			
SiS Status - BIAS			
SpW Links – Link S/C - Enable			
SpW Links – Link S/C - State			
SpW Links – Link S/C – Rx Max			
SpW Links – Link S/C – Tx Max			
SpW Links – Link THR - Enable			
SpW Links – Link THR - State			
SpW Links – Link THR – Rx Max			
SpW Links – Link THR – Tx Max			
SpW Links – Link TDS - Enable			
SpW Links – Link TDS - State			
SpW Links – Link TDS – Rx Max			
SpW Links – Link TDS – Tx Max			
SpW Links – Link LFR - Enable			
SpW Links – Link LFR - State			
SpW Links – Link LFR – Rx Max			
SpW Links – Link LFR – Tx Max			
DPU Status – DPU Statistics			
CPU load – Max.			
CPU Load Ave.			
S/C TX FIFO Rate			

Ave			
DPU Elapsed Time			
Maximal FIFO Size - TC			
Maximal FIFO Size - COMP			
Maximal FIFO Size – HK TM			
Maximal FIFO Size – SVY TM			
Maximal FIFO Size – OBC TM			
Maximal FIFO Size – SBM TM			
PDU Status – Cmd/TM Counters			
Cmd (Write)			
Cmd (Failed)			
Telem. (Read)			
PDU Status – Cmd/TM Counters			
Voltage - Primary			
Voltage - Heater			
Current - Primary			
Current - Heater			
PDU Status – Temperature			
Temp1			
Temp2			
PDU Status – Power / Overcurrent			
CONV – Power On/Off			ON, OFF
SCM – Power On/Off			ON, OFF
ANT1 – Power On/Off			ON, OFF
ANT2 – Power On/Off			ON, OFF
ANT3 – Power On/Off			ON, OFF
BIAS – Power On/Off			ON, OFF
TNR/HFR – Power On/Off			ON, OFF
LFR – Power On/Off			ON, OFF
TDS – Power			ON, OFF

On/Off			
SCM – Over Current	3 sub-parameters: Global, -5V, +12V		ON, OFF
ANT1 – Over Current	3 sub-parameters: Global, +5V, -5V		ON, OFF
ANT2 – Over Current	3 sub-parameters: Global, +5V, -5V		ON, OFF
ANT3 – Over Current	3 sub-parameters: Global, +5V, -5V		ON, OFF
BIAS – Over Current	5 sub-parameters: Global, +5V, -5V, +3.3V, +1.5V		ON, OFF
TNR/HFR – Over Current	6 sub-parameters: Global, +5V, -5V, +12V, +3.3V, +1.5V		ON, OFF
LFR – Over Current	5 sub-parameters: Global, +5V, -5V, +3.3V, +1.5V		ON, OFF
TDS – Over Current	5 sub-parameters: Global, +5V, -5V, +3.3V, +1.5V		ON, OFF
BIAS Status - Mode			
Version			
ActiveLink			
HV			
BIAS 1			
BIAS 2			
BIAS 3			
Diff. Probe 1			
Diff. Probe 2			
Diff. Probe 3			
Byp. Probe 1			
Byp. Probe 2			
Byp. Probe 3			
Multiplexer Set - Mode			
Multiplexer Set – BIAS_1			
Multiplexer Set – BIAS_2			
Multiplexer Set – BIAS_3			
Multiplexer Set – BIAS_4			
Multiplexer Set – BIAS_5			

Multiplexer Set – Operation			
BIAS Status - Status			
Cmd Count			
Cur. Select. PAge			
Dummy			
AC Diff. gain			

BIAS Status - Temperature			
ANT1			
ANT2			
ANT3			
PCB			
BIAS Status - Saturation			
Probe 1			
Probe 2			
Probe 3			
BIAS Status - Setting			
Probe 1			
Probe 2			
Probe 3			
BIAS Status - Voltage			
Reference - Ground			
Reference - +1.5V			
Reference - +2.5V			
High Voltage - -100V			
High Voltage - +100V			
LFR Status – LFR Status			
Current Mode			
Reset Cause			
Watchdog			ON, OFF
Calibration			ON, OFF
Sw Version			
FPGA Version			
LFR Status – LFR Configuration			
Gain			
V			
E1_F0			
E1_F1			
E1_F2			
E1_F3			
E2_F0			
E2_F1			
E2_F2			
E2_F3			
LFR Status – LFR Temperature			
PCB			
SCM			
FPGA			

LFR Status – LFR SpW Links			
Enable			ON, OFF
State			ON, OFF
LFR Status – LFR TC Statistics			
TC Count – Update Info			
TC Count – Update Time			
TC Count – Exe Tc			
TC Count – Rejected TC			
Last Executed TC - ID			
Last Executed TC - Type			
Last Executed TC - SubType			
Last Executed TC - Time			
Last Rejected TC - ID			
Last Rejected TC - Type			
Last Rejected TC - SubType			
Last Rejected TC - Time			
LFR Status - LFR Anomalies stat.			
Anomalies Count - Low			
Anomalies Count - Medium			
Anomalies Count - High			
Last Error - Code			
Last Error -RID			
Last Error - Time			
TDS Status – TDS Status			
Current Mode			
Reset Cause			
Watchdog			ON, OFF
Calibration			ON, OFF
Sw Version			
FPGA Version			

SpW Links - Enable			ON, OFF
SpW Links - State			ON, OFF
Configuration Status	Common, Normal, Burst, SBM1, SBM2, LFM		ON, OFF
TDS Status – TDS Snapshot Statistics			
Processed since last dump			
Q Factor	Min, Max		
Valid snapshot in queue	Norm, SBM2		
TDS Status – TDS Temperature			
PCB			
FPGA			
SRAM			
TDS Status – TDS TC Statistics			
TC Count – Update Info			
TC Count – Update Time			
TC Count – Exe Tc			
TC Count – Rejected TC			
Last Executed TC - ID			
Last Executed TC - Type			
Last Executed TC - SubType			
Last Executed TC - Time			
Last Rejected TC - ID			
Last Rejected TC - Type			
Last Rejected TC - SubType			
Last Rejected TC - Time			
TDS Status - TDS Anomalies stat.			
Anomalies Count - Low			
Anomalies Count - Medium			

Anomalies Count - High			
Last Error - Code			
Last Error -RID			
Last Error - Time			
THR Status – THR Status			
Current Mode			
Reset Cause			
Watchdog			ON, OFF
Calibration			ON, OFF
Sw Version			
FPGA Version			
THR Status – THR Anomalies stat.			
Anomalies Count – Low			
Anomalies Count – Medium			
Anomalies Count – High			
Last Error - Code			
Last Error - RID			
Last Error - Time			
THR Status – THR Temperature			
PCB			
FPGA			
ANT1			
ANT2			
ANT3			
THR Status – THR TC Statistics			
TC Count – Update Info			
TC Count – Update Time			
TC Count – Exe Tc			
TC Count – Rejected TC			
Last Executed TC - ID			
Last Executed TC - Type			
Last Executed TC - SubType			
Last Executed TC - Time			

Last Rejected TC - ID			
Last Rejected TC - Type			
Last Rejected TC - SubType			
Last Rejected TC - Time			
THR Status – THR SpW Links			
Enable			ON, OFF
State			ON, OFF

Table 2. Instrument general and sub-system status parameters.

REQ-ROC-SSS-0019	**MUSIC-TV: system status plotting**
The Instrument general and sub-system status panel shall be able to plot one or more status parameters as a function of time.	

5.1.3 Packet statistics

The statistics panel provides general statistical information about the RPW packet data.

REQ-ROC-SSS-0020	**MUSIC-TV: Statistics data**
The statistics panel shall be able to display the following parameters: • TM total count number • TM count number since last counter reset on-board • Received/validated/corrupted/processed TM total count number • Received/validated/corrupted/processed TM count number since last counter reset on-board • TC total count number • TC failed (acceptance)/failed (execution) total count number These parameters can be viewed over all the TM/TC, but it shall also be possible to see statistics for a given TM/TC or by category (e.g., Low/medium/high event reporting TM).	

REQ-ROC-SSS-0021	**MUSIC-TV: Statistics plotting**
The statistics panel shall allow users to view data using tables and/or histograms.	

REQ-ROC-SSS-0022	**MUSIC-TV: Statistics exporting format**
The statistics panel shall allow users to export data in one of the following file formats: • CSV • JSON	

5.1.4 RPW TM data plotting

The purpose of the RPW TM packet data panel is to provide a first primary plotting tool for the analysis of the incoming RPW TM data flow.

- The panel shall be able to display RPW TM packet data, and more specifically

the following data:

- RPW TM packet data
- RPW science data
- RPW HK data
- Ancillary data (TBC)

5.1.4.1 General functionalities

REQ-ROC-SSS-0023	MUSIC-TV: displaying missing data
TV shall allow users to display or not missing data (i.e., fillval values).	

REQ-ROC-SSS-0024	MUSIC-TV: sub-system calibration notification
TV shall allow users to know when calibrations occurred on-board (i.e., THR internal calibrations, LFR-SCM calibrations, BIAS calibrations).	

REQ-ROC-SSS-0025	MUSIC-TV: Bias sweeping notification
TV shall allow users to know when Bias sweeping occurred on-board.	

REQ-ROC-SSS-0026	MUSIC-TV: data plots export formats
TV shall allow users to export science data plots in the following formats: • PDF • JPG	

REQ-ROC-SSS-0027	MUSIC-TV: data export formats
TV shall allow users to export plotted data in the following formats: • CDF • JSON	

In the case of the CDF format, the tool might return the original file used to plot the data (e.g., L1, HK, etc.).

5.1.4.2 TM Packet data plotting

REQ-ROC-SSS-0028	MUSIC-TV: TM packet data plotting
TV shall permit to browse and select RPW TM packet data to plot. Especially, it shall be possible to display one or more TM parameters values.	

REQ-ROC-SSS-0029	MUSIC-TV: TM packet data plotting filters
When selecting RPW TM packet data to plot, it shall be possible to filter by:	

- Time range (start and/or stop date/time)
- Category of TM (e.g., science, HK, event, etc.)

REQ-ROC-SSS-0030 **MUSIC-TV: TM packet data plotting options**

When plotting RPW TM packet data to plot, it shall be to display graphs (default) or table.

5.1.4.3 TDS science data plotting

REQ-ROC-SSS-0031 **MUSIC-TV: TDS Science data selection**

It shall be able to select and plot science data over the selected time range for the following modes, data processing levels and product types:

- (NORMAL_SURVEY, BURST_SURVEY, SBM1, SBM2), (L1, L2), (Waveforms, histo1d, histo2d, stats, mamp and LFM data)

REQ-ROC-SSS-0032 **MUSIC-TV: TDS science data visualization**

The TV shall be able to display the following specific data for the TDS receiver:

- Regular Waveform Snapshots (E+B)
- Triggered Waveform Snapshots (E+B)
- 1D histogram
- 2D histogram
- Low rate information
- LFR redundancy mode parameters

REQ-ROC-SSS-0033 **MUSIC-TV: TDS calibrated science data**

TV shall possible to plot TDS science data in both TM units (L1; uncalibrated) or physical units (L2; calibrated).

REQ-ROC-SSS-0034 **MUSIC-TV: TDS snapshot waveforms displaying**

TV shall allow users to plot a given TDS snapshot waveform as a function of time. Time shall be given in count (i.e., TM units) or microseconds since the beginning of the snapshot.

5.1.4.4 LFR science data plotting

REQ-ROC-SSS-0035 **MUSIC-TV: LFR science data selection**

It shall be able to select and plot science data over the selected time range for the following modes, data processing levels and product types:

- (NORMAL_SURVEY, BURST_SURVEY, SBM1, SBM2), (L1, L2), (Spectral and waveform data, BP1, BP2)

REQ-ROC-SSS-0036 **MUSIC-TV: LFR science data visualization**

The TV shall be able to display the following data for the LFR sub-system:

- Snapshots waveforms:

- V, E1, E2, B1, B2, B3 of a given frequency f0, f1 or f2 at the same time or separately.
- Snapshots waveforms should be displayed for a given time range and in TM units
- Continuous waveforms:
- V, E1, E2, B1, B2, B3 of a given frequency f1, f2 or f3 at the same time or separately.
- Continuous waveforms should be displayed for a given time range and in TM units.
- Average spectral matrices (ASM):
- Values in TM and physical units
- Possibility to plot frequency spectra (up to 9 elements of the matrix amongst 25 on the same window to be chosen by user).
- Possibility to plot color dynamical spectra: all frequencies (from f0, f1 and f2) for a given time range and for up to 9 elements of the matrices.
- Basic parameters (BP):
- For BP2, same as ASM
- For BP1, same as ASM applied to the de-commuted BP1 parameters (11 max.): PE, PB, NVEC_V0/V1/V2, ELLIP, DOP, SX, SX_Arg, VPHI, VPHI_Arg.
- LFR waveforms versus TDS waveforms:
- TDS “Low frequency mode” parameters (TC_TDS_LOAD_LFM_PAR)
- It shall be able to combine LFR and TDS “low frequency mode” waveforms, cross and power spectrum plots (TM_TDS_SCIENCE_LFM_*) for a given time range overlayed on same graph/window.

It could be useful to be able to overlay snapshots and continuous waveforms of the different frequencies (f0, f1, f2 and f3).

5.1.4.5 TNR science data plotting

REQ-ROC-SSS-0037 **MUSIC-TV: TNR science data selection**

It shall be able to select and plot science data over the selected time range for the following modes, data processing levels and product types:

- (NORMAL_SURVEY, BURST_SURVEY), (L1, L2), Spectral products

REQ-ROC-SSS-0038 **MUSIC-TV: TNR science data visualization**

The TV shall be able to display the following TNR data for a given time range:

- AGC values as a function of time.
- Auto-correlation and cross-correlation values as a function of time for a given frequency range. If more than one time series are found in the frequency range, it shall be able to plot the individual data curves, an integrated curve or the maximal values.

- Auto-correlation and cross-correlation values as a function of frequency for a given time range. If more than one spectrum are in the time range, it shall be able to plot individual data curves, an integrated curve, or max.
- Auto-correlation and cross-correlation values as functions of time and frequency (i.e., dynamical spectrum).
- Phase in degrees as a function of frequency.

Moreover, it shall be able to display AGC, auto and cross–correlation values in TM units (i.e., L1) or calibrated values (i.e., L2) if possible. Time shall be given in count since the beginning of the test or in seconds and frequency in kHz.

It shall be possible to plot TNR data for one or both channels (1 and 2) on the same plot and for each receiver band (A, B, C and D).

5.1.4.6 HFR science data plotting

REQ-ROC-SSS-0039 MUSIC-TV: HFR science data selection

It shall be able to select and plot science data over the selected time range for the following modes, data processing levels and product types:

- (NORMAL_SURVEY, BURST_SURVEY), (L1, L2), Spectral products

REQ-ROC-HMI-0040 MUSIC-TV: HFR science data visualization

The TV shall be able to display the following HFR data for a given time range:

- AGC values as a function of time for a given frequency range. If more than one time series are found in the frequency range, it shall be able to plot individual data curves or an integrated curve.
- AGC values as a function of frequency for a given time range. If more than one spectrum are found in the time range, it shall be able to plot individual data curves or an integrated curve.
- AGC values as functions of time and frequency (i.e., dynamical spectrum).

It shall be able to display AGC values in TM units or calibrated values (i.e., dB(V^2/Hz)) if possible. Time shall be given in count since the beginning of the test or in seconds and frequency in kHz.

It shall be possible to plot HFR data for one or both channels (1 and 2) on the same plot and for each receiver band (HF1 and HF2). Figure 2 gives an idea of what a time series plot should look like in the HFR panel view.

5.1.4.7 BIAS data plotting

The Bias unit does not produce science data strictly speaking, however operators should be able to display related data.

REQ-ROC-SSS-0041 MUSIC-TV: Bias sweeping data plotting

TV shall allow users to visualize the Bias sweeping data occurred on-board.

REQ-ROC-SSS-0042 MUSIC-TV: Bias sweeping data plots filtering

It shall be possible to filter data for:

- A given time range (start and/or stop time)
- A given Bias sweeping

5.1.5 HK parameters plotting

TBW

5.1.6 Ancillary data

TBW

5.1.7 FIGARO specific capabilities requirements

FIGARO is the MUSIC tool that allows operators to create or edit flight procedures for RPW.

5.1.7.1 General

REQ-ROC-SSS-0043 **FIGARO: flight procedures status values**

RPW flight procedure created with FIGARO shall have one the following status:

- "**created**" - This is the default status
- "**tested**" - The procedure has been successfully tested using the instrument simulator
- "**submitted**" - The procedure has been sent to MOC
- "**validated**" - The procedure has been validated by MOC
- "**rejected**" - The procedure has been refused by MOC

5.1.7.2 Flight procedure edition

REQ-ROC-SSS-0044 **FIGARO: flight procedure edition user permissions**

Users logged as "observers" shall have a read only access to the FIGARO tool. It means that they can only load and view a given procedure.

Users logged as "operators" shall be authorized to create/edit/delete a procedure.

REQ-ROC-SSS-0045 **FIGARO: flight procedure creation**

FIGARO shall allow an operator to create a new procedure.

REQ-ROC-SSS-0046 **FIGARO: flight procedure loading**

FIGARO shall allow a user to load an existing procedure from the MDB.

REQ-ROC-SSS-0047 **FIGARO: flight procedure import formats**

FIGARO shall allow a user to import a procedure in one of the following formats:

- MOIS importer Excel file format [AD6]
- MEB C-SGSE file format [RD?]

REQ-ROC-SSS-0048 **FIGARO: flight procedure saving**

FIGARO shall allow an operator to save a procedure into the MDB.

REQ-ROC-SSS-0049 FIGARO: flight procedure export formats

FIGARO shall allow a user to export a procedure in one of the following formats:

- MOIS importer Excel file format [AD6]
- MEB C-SGSE file format [RD?]

REQ-ROC-SSS-0050 FIGARO: flight procedure locking

FIGARO shall allow an operator to lock/unlock the procedures she/he has created.

When a procedure is locked, other operators shall not be able to modify and save it. (Nevertheless it shall be still possible to load it and duplicate it, in order to create a new procedure).

REQ-ROC-SSS-0051 FIGARO: flight procedure status setting

FIGARO shall allow an operator to set a procedure status to “tested”, “submitted”, “rejected” or “validated”.

REQ-ROC-SSS-0052 FIGARO: validated flight procedure constraints

FIGARO shall not allow an operator to edit and save a procedure with the “validated” status.

This constraint only applies for a given version of the procedure.

Since the number of procedures is limited, it may require in some specific cases to update a “validated” procedure. It should be thus relevant to

REQ-ROC-SSS-0053 FIGARO: flight procedure versioning mechanism

FIGARO shall include a versioning mechanism to keep a track of the procedure modification history.

Especially each procedure shall have a version number, which is an integer starting at 1.

This version number shall be stored into the MDB.

REQ-ROC-SSS-0054 FIGARO: flight procedure new version creation

FIGARO shall allow an operator to create a new version of a “validated” procedure.

The version of the new procedure shall be the incremented version of the previous one (Vprev_pro + 1) and the creation status of the new procedure shall be “created”.

REQ-ROC-SSS-0055 FIGARO: flight procedure initial IDB version

FIGARO shall allow an operator to select the IDB version used for the procedure creation.

REQ-ROC-SSS-0056 FIGARO: changing flight procedure IDB version

FIGARO shall allow an operator to change the IDB version of a “unlocked” procedure. However the tool shall alert the operator about possible consequences.

The IDB version of procedures of a given version and with “Submitted” or “Validated” status, cannot be changed.

REQ-ROC-SSS-0057	FIGARO: flight procedure IDB version checking
FIGARO shall notify an operator when the IDB version of the current procedure is different that the "operational" version used by the MOC. This only concerns procedures generated with the MIB.	

REQ-ROC-SSS-0058	FIGARO: flight procedure status notification
FIGARO shall allow user to easily check the current procedure status.	

5.1.8 FAUST specific capabilities requirements

FAUST is the MUSIC tool that offers the possibility to create, edit and submit to ESA an RPW operation request (ROR) directly. A ROR can be imported/exported from/to an IOR, but also a MDOR, PDOR or C-SGSE script.

Note that the proper way of creating an ROR is to use the scenario editor of OPERA. Nevertheless, it is possible to create or update an ROR with FAUST when finer control is needed.

5.1.8.1 RPW operation request edition

REQ-ROC-SSS-0059	FAUST: User permissions
Users logged as "observers" shall have a read only access to the FAUST tool. It means that they can only load and view a given ROR. Users logged as "operators" shall be authorized to create/edit/delete a ROR.	

REQ-ROC-SSS-0060	FAUST: ROR status values
ROR created with FAUST shall have one the following request status: • "**created**" This is the default status • "**submitted**" The ROR has been sent to ESA • "**received**" The ROR has been received by ESA • "**rejected**" The ROR has been refused by ESA	

The ROR can be marked as "**rejected**" in two ways, by ESA when it receives the ROR, or by the operator himself, if ESA tells her/him that the ROR is not acceptable.

There is no "**accepted**" status; it is assumed that if the ROR has been received and not rejected, it is accepted.

REQ-ROC-SSS-0061	FAUST: ROR creation
FAUST shall allow an operator to create a new ROR.	

REQ-ROC-SSS-0062	FAUST: operation request type
When creating a new ROR, FAUST shall allow an operator to select the request type: • "IOR" (default) • "PDOR" • "MDOR"	

The request type determines the submission process: IOR are delivered to the SOC, MDOR/PDOR to the MOC.

REQ-ROC-SSS-0063 **FAUST: ROR loading/importing**

FAUST shall allow a user to load an ROR from the MDB or import it from one of the expected file formats.

REQ-ROC-SSS-0064 **FAUST: ROR visualization**

FAUST shall allow a user to visualize an existing ROR and it's status.

REQ-ROC-SSS-0065 **FAUST: ROR updating/deleting**

FAUST shall allow an operator to update or delete an existing ROR, only if it has not yet been submitted or locked by another operator.

REQ-ROC-SSS-0066 **FAUST: saving ROR**

FAUST shall allow an operator to save an ROR into the MDB.

REQ-ROC-SSS-0067 **FAUST: ROR data to save**

When saving an ROR in the MDB, FAUST shall write the following data into the MDB:

- ROR name – The name of the ROR
- ROR description – short description of the ROR (512 characters max.)
- Author(s)
- Generation local date/time
- Request type: “IOR” (default), “MDOR”, “PDOR” or “GSEscript”
- ICD Version
- Validity start Time
- Validity stop Time
- Request status
- List of sequences with the expected execution times

If the author(s) field is empty, then FAUST might save the login username.

REQ-ROC-SSS-0068 **FAUST: ROR export/import file formats**

FAUST shall permit to export/import the ROR in the following file formats:

- SOC IOR file format [AD2]
- MOC MDOR file format [AD7]
- MOC PDOR file format [AD7]
- MEB C-SGSE script file format [RD?]

REQ-ROC-SSS-0069 **FAUST: ROR submission user permissions**

FAUST shall allow an operator to submit an existing ROR file to the ESA in one of the expected format: IOR for SOC and PDOR/MDOR for MOC.

REQ-ROC-SSS-0070 FAUST: ROR submission criteria verification

When submitting, FAUST shall ensure that the ROR file is consistent relative to the following criteria:

- The validity time range is consistent with the operation planning (i.e., STP/MTP)
- All of the expected parameters are provided (e.g., formal parameters)
- The file structure and format is compliant with the expected destination: IOR for SOC and MDOR/PDOR for MOC
- The IDB used to generate the sequences called inside the request file, is compatible with the operational IDB (i.e., currently used by the MOC in operations).

If at least one of the criteria above is not fulfilled, then FAUST shall stop the submission process and notify the operator.

REQ-ROC-SSS-0071 FAUST: ROR submission process

When submitting a ROR file, FAUST shall perform the following tasks:

- Verify the request submission criteria
- Deliver a copy of the ROR file via the dedicated GFTS interface (i.e., SOC GFTS for IOR and MOC GFTS for MDOR/PDOR)
- Write in the MDB: the name of the operator who has submitted the ROR file, the submission local date/time and the status of the ROR (i.e., “submitted”).
- Set the request status to “submitted” in the MDB

5.1.9 OPERA specific capabilities requirements

OPERA is the MUSIC tool in charge of displaying the mission planning. It also offers the possibility to build instrument operation timeline scenarios for one or more planning cycle. The scenarios can be used to generate automatically RORs, which can be seen and submitted with FAUST.

5.1.9.1 ROR scenario edition

The purpose of the scenario edition is to do the planning of the commanding of the instrument for an entire MTP or even more. It also permits to test alternate version of the planning.

REQ-ROC-SSS-0072 OPERA: ROR scenario edition user permissions

Only a user logged as an operator is authorized to create, edit or delete scenarios.

Users logged as “observer” can visualize the scenarios only.

REQ-ROC-SSS-0073 OPERA: ROR scenario generation

OPERA shall allow an operator to create a new scenario with sequence calls and re-entry points.

REQ-ROC-SSS-0074 OPERA: loading ROR scenario

OPERA shall allow an operator to load an existing scenario from the MDB.

REQ-ROC-SSS-0075	OPERA: saving ROR scenario
OPERA shall allow an operator to save a scenario into the MDB.	

REQ-ROC-SSS-0076	OPERA: ROR scenario deleting/updating
OPERA shall allow an operator to update or delete a scenario if it has no associated ROR.	

REQ-ROC-SSS-0077	OPERA: ROR scenarios comparison
OPERA shall allow an operator to compare 2 or more scenarios.	

REQ-ROC-SSS-0078	OPERA: ROR scenario duplication
OPERA shall allow an operator to duplicate a scenario.	

5.1.9.2 Mission planning

In the mission planning, the user can find all the necessary mission information to establish the instrument commanding planning while respecting the IOR constraints.

The information is split in the following categories:

- Enhanced Flight Event Communication Skeleton (E-FECS) -- the E-FECS files contain all the events that impact the instrument operations.
- Telemetry corridor (TMC) -- The telemetry corridor is a maximum and minimum curve of allocated cumulative telemetry downlink through the ~six month planning period. Providing an instrument team maintains their data-production between the maximum and the minimum curves then their data-return can be considered guaranteed.

REQ-ROC-SSS-0079	OPERA: mission planning user permissions
Users logged as both “observer” and “operator” shall both be able to visualize the mission planning with OPERA.	

REQ-ROC-SSS-0080	OPERA: mission planning display
OPERA shall display the mission planning as a timeline chart.	

It might be helpful to also allow users to optionally display the planning as a calendar.

REQ-ROC-SSS-0081	OPERA: mission planning E-FECS data
OPERA shall allow users to display the E-FECS events on the mission planning.	

Especially, OPERA might display by default the following E-FECS parameters, which are more relevant to RPW:

- Medium Term Planning Boundary (MTP_BOUND) The beginning of a MTP planning cycle
- Short Term Planning Boundary (STP_BOUND) The beginning of a STP planning cycle
- Remote Sensing Window (RSW) and EUI Extended Remote Sensing Window (RSW_EXT_EUI) Period when observations can take place

- EMC Mandatory Quiet Window (EMC_MAND_QUIET) Period when executing any EMC noisy activity is forbidden
- EMC Preferred Noisy Windows (EMC_PREF_NOISY) Period when executing EMC noisy activity is desirable; some sequences flagged as EMC_noisy_required must be scheduled during these windows
- X-Band ON (TX_ON) Also called pass, period when VSTP IOR can be sent to the space craft (to be confirmed)
- Burst mode time (TBD), centred time of the burst mode windows, used for in situ instrument burst mode synchronization.
- Solar Probe Conjonction (SOLAR_PROB_CONJ), Period when Solar Orbiter and Parker Solar Probe spacecraft are in conjonction (TBC)

REQ-ROC-SSS-0082	**OPERA mission planning TMC data**
OPERA shall allow users to display a chart for the RPW TMC on the mission planning. The chart shall plot 3 curves: “allowed minimum”, “allowed maximum” and “RPW data production” cumulative TM rates, when the “RPW data production” rate can be the expected or the real values.	

5.1.10 SISSI specific capabilities requirements

TBW

5.2 MUSIC interface requirements

5.2.1 MUSIC external interface requirements

5.2.1.1 Interface between MUSIC and ROC MDB

REQ-ROC-SSS-0083	**MUSIC-MDB interface**
MUSIC shall have read-write access only to one dedicated schema of the MDB. In another word, MUSIC shall have a read-only permission concerning all other schemas used by the RODP, including the IDB.	

5.2.1.2 Interface between MUSIC and RODP

No direct interface is planned between MUSIC and the RODP at this stage of the project. All of the interactions shall be done via the information stored into the ROC MDB.

5.2.1.3 Interface between MUSIC and ROC GSE

No direct interface is planned between MUSIC and the ROC GSE.

5.2.1 MUSIC internal interface requirements

6 RODP SPECIFIC REQUIREMENTS

6.1 RODP capabilities requirements

6.1.1 RODP general capabilities

6.1.2 RODP data retrieval capabilities

REQ-ROC-SSS-0084	RODP: MOC DDS TM raw data request
The RODP shall be able to request RPW TM raw data for a given time range using the MOC DDS interface.	

REQ-ROC-SSS-0085	RODP: MOC DDS TC report data request
The RODP shall be able to request RPW TC report data for a given time range using the MOC DDS interface.	

REQ-ROC-SSS-0086	RODP: SOC GFTS data request
The RODP shall be able to request RPW TC report data for a given time range using the MOC DDS interface.	

6.1.3 RODP data processing capabilities

6.1.4 RODP data dissemination capabilities

6.2 RODP interface requirements

TBW

7 ROADS SOFTWARE RESOURCE ALLOCATION REQUIREMENTS

7.1 ROADS hardware resource

7.1.1 Software and data storage resource

REQ-ROC-SSS-0087	ROADS software volume capacity
The ROADS software shall require not more than 20 Gigabytes of free space to be stored.	

The ROADS incoming and produced data volume, without the MDB, might not exceed TBD Terabytes per

The MDB data volume might Terabytes of free space to store.

7.1.2 Memory and CPU hardware resource

REQ-ROC-SSS-0088	Hardware: minimum system configuration
The ROADS shall be able to run on a laptop with a typical hardware configuration (2.3 GHz CPU frequency and 16 Gigabytes of RAM).	

7.2 RCS specific hardware resource

TBW

8 SOFTWARE DESIGN REQUIREMENTS AND CONSTRAINTS

8.1 RODP design requirements and constraints

REQ-ROC-SSS-0089 **design requirements and constraints**

In order to maximise the re-use of the ROC-SGSE design, the RODP shall be built using the POPPy framework.

REQ-ROC-SSS-0090 **design requirements and constraints**

The following MCS and DPS software units shall be implemented as plugins into the RODP:

- Dare
- Film
- CaWa
- RLLP
- RPL
- Fire
- PoCA
- MonA
- TraC
- PUNK

9 ROADS SOFTWARE IMPLEMENTATION REQUIREMENTS AND CONSTRAINTS

REQ-ROC-SSS-0091 **Software environment**

The ROADS software shall run on the Debian Jessie Operating System.

REQ-ROC-SSS-0092 **Software database requirements**

It shall be able to run several instances of the RODP with different software environments in the same server at the LESIA.

REQ-ROC-SSS-0093 **Capability requirements**

The rate value of the *high*, *daily* and *monthly* workflows shall be configurable parameters.

10 SOFTWARE MAINTENANCE REQUIREMENTS

TBW

11 SOFTWARE DATABASE REQUIREMENTS

11.1 ROC Mission Database (MDB)

11.1.1 General design requirements

REQ-ROC-SSS-0094	Software database requirements
The ROC MDB shall be designed to work with the RODP and MUSIC.	

11.1.2 Data retrieving and processing related requirements

REQ-ROC-SSS-0095	Software database requirements
Every file shall have a unique entry in the *FILE_COLLECTION* table of the MDB.	

REQ-ROC-SSS-0096	Software database requirements
Every TM packet shall have a unique entry in the *TM_HISTORY* table of the MDB.	

REQ-ROC-SSS-0097	Software database requirements
Every TC packet shall have a unique entry in the *TC_HISTORY* table of the MDB.	

REQ-ROC-SSS-0098	Software database requirements
TM packet binary data shall be stored in hexadecimal format in the *TM_QUEUE* table of the MDB.	

REQ-ROC-SSS-0099	Software database requirements
The number of entries in the *TM_QUEUE* table of the MDB shall not exceed TBD. This number shall be computed in such a way that the data of the TM_QUEUE table does exceed the *ROC_MDB_FREE_STORAGE* data storage capacity value.	

11.1.3 Monitoring and control related requirements

REQ-ROC-SSS-0100	Software database requirements
The *RFP_NAME* field shall be unique in the *table RPL_COLLECTION* table.	

11.2 RPW Instrument Database (IDB)

REQ-ROC-SSS-0101	Software database requirements
The ROC instance of the IDB shall be designed to be stored in a specific schema of the MDB.	

11.3 Mission information base (MiB)

TBW

11.4 ROC MEB GSE Database (MGD)

TBW

12 APPENDICES

12.1 Summary list of ROC SSS requirements

TBW

13 LIST OF TBC/TBD/TBWS

TBC/TBD/TBW			
Reference/Page/Location	Description	Type	Status

14 DISTRIBUTION LIST

LISTS See Contents lists in "Baghera Web": Project's informations / Project's actors / RPW_actors.xls and tab with the name of the list or NAMES below		
		Tech_LESIA
		Tech_MEB
		Tech_RPW
		[Lead-]CoIs
		Science-CoIs

INTERNAL

LESIA CNRS		

LESIA CNRS		

EXTERNAL (To modify if necessary)

CNES		C. FIACHETTI
		C. LAFFAYE
		R.LLORCA-CEJUDO
		E.LOURME
		M-O. MARCHE
		E.GUILHEM
		J.PANH
		B.PONTET
IRFU		L. BYLANDER
		C.CULLY
		A.ERIKSSON
		SE.JANSSON
		A.VAIVADS
LPC2E		P. FERGEAU
		G. JANNET
		T.DUDOK de WIT
		M. KRETZSCHMAR
		V. KRASNOSSELSKIKH
SSL		S.BALE

AsI/CSRC		J.BRINEK
		P.HELLINGER
		D.HERCIK
		P.TRAVNICEK
IAP		J.BASE
		J. CHUM
		I. KOLMASOVA
		O.SANTOLIK
		J. SOUCEK
		L.UHLIR
IWF		G.LAKY
		T.OSWALD
		H. OTTACHER
		H. RUCKER
		M.SAMPL
		M. STELLER
LPP		T.CHUST
		A. JEANDET
		P.LEROY
		M.MORLOT