



ROC Concept and Implementation Requirements Document

Ref: ROC-GEN-SYS-PLN-00002-LES
Issue: 02
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Date: 07/05/2019

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SOLAR ORBITER



RPW Operations Centre

ROC Concept and Implementation Requirements Document

ROC-GEN-SYS-PLN-00002-LES
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CLASSIFICATION

PUBLIC



RESTRICTED



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Change Record

Issue	Rev.	Date	Authors	Modifications
0	0	17/09/2014	Yvonne de Conchy	First draft
0	1	06/01/2015	Xavier Bonnin	Second draft
0	2	24/06/2015	Xavier Bonnin	Third draft, document merged with the "ROC concept" document
1	0	24/06/2015	Xavier Bonnin	First release
1	1	29/10/2015	Yvonne de Conchy	Second release
1	2	20/04/2016	Xavier Bonnin	Add section about the RPW science objectives Add the compliance matrices related to EID-A and Solar Orbiter Science Requirements Document (SIRD) Update the applicable/reference documents list
1	3	20/12/2016	Yvonne de Conchy	Third release
1	4	17/11/2017	Xavier Bonnin	Major modifications: <ul style="list-style-type: none"> • Adding section about the Solar Orbiter Ground Segment design • Remove sections about ROC activities and add sections about ROC responsibilities • Upgrades the implementation requirements
2	0	07/05/2019	Xavier Bonnin	Major modifications: <ul style="list-style-type: none"> • Add "ROC environment" section • Update the content, structure and styles of the requirements



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Acronym List

Acronym	Definition
AIT	Assembly Integration Test
AIV	Assembly Integration Validation
ANT	(Electrical) antennas
APID	Application Process ID
CDPP	Centre de Données de Physique des Plasmas
CIRD	Concept and Implementation Requirements Document
CNES	Centre National d'Etudes Spatiales
CNRS	Centre National de Recherche Scientifique
CoI	Co Investigator
CP	Cruise Phase
DDS	Data Dissemination System
DPU	Digital Processing Unit
EDDS	EGOS Data Dissemination System
EID-A	Experiment Interface Document - Part A
EMP	Extended Mission Phase
EPD	Energetic Particles Detector
ESA	European Space Agency
ESAC	European Space Astronomy Centre
ESOC	European Space Operation Centre
FDIR	Failure Detection Isolation and Recovery
FOP	Flight Operation Plan
GIGL	Groupe d'Informatique Générale du LESIA
HFR	High Frequency Receiver
HK	Housekeeping parameters
IAP	Institute of Atmospheric Physics
ID	Identifier
IOR	Instrument Operation Request
IT	Instrument Team
ISM	Instrument State Model
IOP	Instrument Operation Planner
IOR	Instrument Operation Request
LEOP	Launch & Early Operations Phase
LESIA	Laboratoire d'Etudes Spatiales et d'Instrumentations en Astrophysiques
LFR	Low Frequency Receiver
LLVM	Low Latency Virtual Machine
LPC2E	Laboratoire de Physique et Chimie de l'Environnement et de l'Espace
LPP	Laboratoire de Physique des Plasma
LVPS-PDU	Low Voltage Power Supply - Power Distribution Unit



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MDOR	Memory Direct Operation Request
MOC	Solar Orbiter Mission Operation Centre
NECP	Near Earth Commissioning Phase
NMP	Nominal Mission Phase
OGS	Operations Ground Segment
OS	Operating System
PDOR	Payload Direct Operation Request
PI	Principal Investigator
PM	Ground Segment Project Manager
PMP	Project Management Plan
POR	Payload Operations Request
RFP	RPW Flight Procedure
RGS	RPW Ground Segment
ROC	RPW Operation Centre
RPW	Radio and Plasma Waves
RSR	RPW Science Requirements document
RSS	ROC Software System
RSW	Remote-sensing Window
SDP	Software Development Plan
S/C	Spacecraft
S/W	Software
SBM	Selective Burst Mode
SCM	Search Coil Magnetometer
SGS	Science Ground Segment
SGSE	Software Ground Support Equipment
SIRD	Solar Orbiter Science Implementation Requirements Document
SOC	Solar Orbiter Science Operation Centre
SOOP	Solar Orbiter Observing Plan
SOV	System Operation Validation
SOWG	Science Operations Working Group
SSL	Space Science Laboratory
SSMM	Solid State Mass Memory
SVT	System Validation Tests
SWT	Science Working Team
TC	Telecommand
TDS	Time Domain Sampler
TM	Telemetry
TNR	Thermal Noise Receiver
VM	Virtual Machine



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1 GENERAL

1.1 Scope of the Document

The ROC Concept and Implementation Requirements Document (CIRD) presents the RPW Operations Centre (ROC) objectives, overall organization, responsibilities and design.

It also addresses the technical specification requirements about the ROC implementation.

Especially, the CIRD must comply the requirements defined in the Experiment Interface Document Part A (EID-A) [AD1] and the ROC Requirements [AD2]. It is also expected to be consistent with the Solar Orbiter Science Management Plan (SMP) [RD8], the Solar Orbiter Science Implementation Requirements Document (SIRD) [RD9] and the RPW Science Requirements document (RSR) [RD12].

The ROC is in charge of the ground segment activities for the Radio and Plasma Waves (RPW) instrument [RD1] on-board Solar Orbiter spacecraft (S/C).

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	SOL. EST.RCD.0050/05/00	Experiment Interface Document Part A (EID-A)	Solar Orbiter Team	16/03/2015
AD2	ROC-GEN-OTH-REQ-00081-LES/01/00	ROC Requirements	Milan Maksimovic	
AD3				
AD4				
AD5				
AD6				
AD7				

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_0401.pdf/05/04 (=EID-B)	Experiment Interface Document Part B (EID-B) for RPW	RPW Team	28/11/2016
RD2	RPW-SYS-SSS-00013-LES/04/04	RPW Software System Specification (RSSS)	Philippe Plasson	05/05/2017
RD3	SOL-ESC-PL-00001/1/1	Solar Orbiter Mission Implementation Plan (MIP)	Ignacio Tanco	31/01/2013
RD4	SOL-ESC-IF-05011/1/0	Solar Orbiter Data Delivery Interface Control Document	Luca Michienzi	10/09/2013
RD5	SOL-SGS-ICD-0003/0/2	Solar Orbiter Instrument Operation Request Interface Control Document (IORICD)	Christopher Watson	19/08/2014
RD6	SOL-SGS-TN-0009/2/2	Metadata Definition for Solar Orbiter Science Data	A. de Groof	23/07/2015



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RD7	SOL-SGS-ICD-0009/0/3	Solar Orbiter File-Transfer SOC<->Instrument Teams ICD	Emilio Salazar, Christopher Watson	20/01/2017
RD8	SOL-EST-PL-00880/02/02	Solar Orbiter Science Management Plan (SMP)	Richard Marsden	16/02/2012
RD9	Solar_Orbiter_SIRD_v1.2_DM_2013-03-18	Solar Orbiter Science Implementation Requirements Documents (SIRD)	Daniel Müller	18/03/2013
RD10	SOLO-RPWSY-PT-1235-CNES/1/0	RPW Instrument Calibration Plan	Milan Maksimovic RPW teams	11/12/2015
RD11	RPW-GEN-PLN-00130-LES/01/00	RPW Operations Concept	Milan Maksimovic	08/03/2012
RD12	RPW-SYS-SRD-00040-LES/02/01	RPW Science Requirements (RSR)	Milan Maksimovic	16/06/2015
RD13	RPW-SYS-SOW-001518-LES/02/00	RPW Science Performance	Milan Maksimovic	15/05/2018
RD14	SOL-SGS-PL-0009/0/2	Solar Orbiter Archive Plan	Pedro Osuna	01/07/2015
RD15	SOL-ESC-PL-10001/1/2	Solar Orbiter FOP Preparation Plan	Ignacio Tanco	18/01/2017
RD16	ROC-GEN-SYS-CVM-00049-LES/01/00	ROC top-level traceability matrix	Xavier Bonnin	17/11/2017
RD17	SOL-ESC-RP-05500/04/00	Solar Orbiter : Consolidated Report on Mission Analysis (CReMA)	J.M. Sanchez Perez G.I. Varga	28/10/2016
RD18	ROC-PRO-DAT-NTT-00006-LES/1/1	RPW Data Products	Xavier Bonnin	17/11/2017
RD19	SOL-ESC-TN-12000/1/2	Solar Orbiter – Mission Planning Concept (MPC)	SOL FCT	27/06/2014
RD20	SOL-ESC-TN-10034/1/0	Instrument Operations Definition Guidelines	Solar Orbiter Flight Control Team	24/05/2016
RD21	SOL-ESC-IF-05010/1/0	Solar Orbiter Planning ICD (PLID)	Luca Michienzi	21/05/2013
RD22	SOL-ESC-IF-10002/2/0	Solar Orbiter Instrument FOP Procedure Input ICD	Daniel Lackey	12/06/2014
RD23	SOL-SGS-TN-0006/1/2	SOC Engineering Guidelines for External Users (SEGU)	Richard Carr	03/08/2017
RD24	SOL-SGS-ICD-0003/1/3	Solar Orbiter Interface Control Document for Low Latency Data CDF Files	Andrew Walsh	09/02/2017
RD25	SOL-SGS-TS-0006/0/0	Solar Orbiter Instrument Teams – SOC Test Specification	Nana Bach	25/05/2016
RD26	SOL-SGS-ICD-0007/1/0	Solar Orbiter Telemetry Corridor Interface Control Document	Christopher J. Watson	14/03/2017
RD27	SOL-SGS-ICD-0006/1/2	Solar Orbiter Enhanced-Flight Events Communications Skeletons Interface Control Document	Christopher Watson	31/10/2017
RD28	SOL-SGS-ICD-0007/1/0	Solar Orbiter Telemetry Corridor Interface Control Document	Christopher J. Watson	14/03/2017
RD29	SOL-SGS-TN-0003/1/2	Solar Orbiter Low-Latency Data: Concept and Implementation	Anik De Groof	19/09/2017



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RD30	ROC-GEN-OTH-SPC-00064-LES/1/0	ROC User Requirements Document (URD)	ROC Teams	
RD31	TBD	RPW Commissioning requirements	Eric Lorfevre	
RD32	ROC-GEN-SCI-PLN-00077-LES/01/00	RPW science Data Validation and Verification Plan (DVVP)	X.Bonnin, S.Lion	
RD33	DNO-DA-AQ-2017-0016646/1/0	Quality Assurance Specification for Software Development with laboratories	Antony Ricard, Sandra Steere	10/11/2017

1.4 About this document

1.4.1 Access policy

This document is accessible without any restriction.

Any modification of the CIRP requires formal approval of the RPW Ground Segment Project Manager (PM) before publication.

1.4.2 Requirement identification

The structure of requirement is a following:

Req. reference	Req. title	Req. verif.
Req. description		
Req. target	Implements:	
Req. comment		

Where:

- “Req. reference” is the reference identifier of the requirement. It must “REQ-ROC-CIRD-XXXX”, where “XXXX” is a unique 4-digits integer over the document. This field must be defined.
- “Req. title” is the title of the requirement. This field must be defined.
- “Req. description” gives the description of the requirement. This field must be defined.
- The way the requirement is verified must be reported into the “Req. verif.” cell. The possible values are: “Test”, “Demo”, “Code inspection”, “Review”. This field must be defined.
- “Req. target” indicates for which system or entity the requirement must be applied. This field is optional.
- The reference of the parent requirement(s) (i.e., the higher-level requirements covered by the requirement) must be listed in the “Implements:” cell. This field is mandatory if any parent requirement is identified.
- “Req. comment” cell can be used to add any comment or justification relative to the requirement. This field is optional.



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2 RADIO AND PLASMA WAVES EXPERIMENT (RPW)

2.1 RPW Science objectives

RPW will make key measurements in support of the first three, out of four top-level scientific questions, which drive Solar Orbiter overall science objectives:

- How and where do the solar wind plasma and magnetic field originate in the corona?
- How do solar transients drive heliospheric variability?
- How do solar eruptions produce energetic particle radiation that fills the heliosphere?
- How does the solar dynamo work and drive connections between the Sun and the heliosphere?

Here is the summary of the specific RPW Science Objectives.

Solar & Interplanetary Radio Burst

- What is the role of shocks and flares in accelerating particles near the Sun?
- How is the Sun connected magnetically to the interplanetary medium?
- What are the sources and the global dynamics of eruptive events?
- What is the role of ambient medium conditions on particle acceleration and propagation?
- How do variations and structure in the solar wind affect low frequency radio wave propagation?

Electron density & temperature measurements with the Quasi-Thermal Noise spectroscopy

- Precise measurement of both the electron density and temperature, with accuracies respectively of a few % and around 10 %, at perihelion.
- Study the non-thermal character of the electron distributions at perihelion.

Radio emission processes from electron beams: Langmuir waves and electromagnetic mode conversion

- Measurements for the first time in the Solar Wind of both the electric and magnetic field waveforms at high time resolution (up to 500 kSs).
- Study of the mode conversion from Langmuir to electromagnetic waves.
- Study of the energy balance between electron beams, Langmuir waves and e.m. radio waves at several radial distances

Solar wind microphysics and turbulence

- Measure of the waves associated with the plasma instabilities that are generated by temperature anisotropies in the solar wind.
- First DC/LF electric field measurements in the inner heliosphere and over a large radial distance in the solar.

Shocks, Reconnection, Current Sheets, and Magnetic Holes



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- Identification & study of the reconnection process in current sheets with thickness down to the ion scales and smaller.
- Determination of the interplanetary shock structure down to the spatial and temporal scales comparable and smaller than the typical ion scales.
- Determination of different particle energisation mechanisms within shocks and reconnection regions.
- Distinguish different radio burst generation mechanisms.

Interplanetary Dust

- Determination, in combination with the EPD instrument, the spatial distribution, mass and dynamics of dust particles in the near-Sun heliosphere, in and out of the ecliptic.

To cover its specific Science Objectives, RPW will measure magnetic and electric fields at high time resolution using a number of sensors, to determine the characteristics of electromagnetic and electrostatic waves in the solar wind. More precisely, RPW will:

- Make the first-ever high accuracy, high-sensitivity and low noise measurements of electric fields at low frequencies (below ~1 kHz) in the inner Heliosphere.
- Measure the magnetic and electric fields of the solar wind turbulence with high sensitivity and dynamic range along the spacecraft trajectory.
- Store high-resolution data from scientifically interesting regions such as in-situ shock crossings, in-situ Type III events and others.
- Measure the satellite potential with high temporal resolution permitting to estimate the density fluctuations in the solar wind and allowing higher accuracy particle instrument measurements.
- Measure the quasi thermal noise and Langmuir waves around the local plasma frequency
- Measure for the first time the high frequency magnetic counterpart of Langmuir waves associated with in-situ Type III bursts
- Observe the solar and interplanetary radio burst
- Observe the radio counterpart of dust particle impacts
- Detect on-board in-situ shock crossings and store the corresponding data
- Detect on-board in-situ Type III events and store the corresponding data

2.2 RPW instrument

RPW will provide *in situ* and remote sensing measurements of both electrostatic and electromagnetic fields and waves in a broad frequency range, typically from a fraction of Hertz to a few tens of MHz.

RPW is developed by a consortium composed of the following institutes/agencies:

- LESIA, Observatoire de Paris, CNRS, UPMC, Université Paris Diderot, Meudon, France
- CNES, Centre Spatial de Toulouse, France
- LPP, CNRS, Ecole Polytechnique, UPMC, Université Paris Sud, Palaiseau, France



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- LPC2E, CNRS, Université d'Orléans, Orléans, France
- IAP (Institute of Atmospheric Physics), Academy of Sciences, Prague, Czech Republic
- Astronomical Institute (AsI) of the CSRC, Prague, Czech Republic
- IRF-U (Swedish Institute of Space Physics, Uppsala) and KTH (Royal Institute of Technology, Stockholm) Sweden
- Space Research Institute (IWF), Grätz, Austria
- Space Sciences Laboratory (SSL) of the University of California Berkeley

In addition, the SSL is strongly contributing to the RPW science through the science synergy with the FIELDS instrument on the NASA Solar Probe Plus mission.

Table 1 presents the instrument sub-systems.

Name	Short name	Description	Responsible
Time Domain Sampler	TDS	TDS captures waveform up to 500 kSPS. LFR redundancy module	IAP
Thermal Noise and High Frequency Receivers	TNR-HFR	Electron measurements at the local plasma frequency and remote detection of radio emissions. TNR-HFR will provide electric power spectral densities from 4 kHz up to 16 MHz and magnetic power spectral densities from 10 kHz up to 500 kHz.	LESIA
Low Frequency Receiver	LFR	LFR covering both in-situ electric and magnetic measurements from DC to about 10 kHz. LFR will provide both waveform and power spectral densities in this frequency range.	LPP
Biasing unit	BIAS	BIAS will allow DC electric measurements. The BIAS drive a constant current to the electric antennas allowing reliable DC/LF electric field and satellite potential measurements.	IRF/KTH
Digital Process Unit	DPU	DPU will handle commands, data and communication with S/C.	LESIA, IWF
Low Voltage Power Supply - Power Distribution Unit	LVPS-PDU	Since the LVPS unit produces the secondary voltages, the PDU distributes the output voltages	AsI



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		toward the various RPW subunits.	
Search Coil Magnetometer	SCM	The SCM is an inductive magnetic sensor. It is made of a core in a high permeability material (ferrite or perm-alloy) on which are wound a main coil with several thousand turns and a secondary coil with a few turns.	LPC2E
Electrical antennas, Pre-Amplifiers	ANT, PA	<p>Each ANT monopole serves as a simple voltage sensor. At low frequencies, an antenna is coupled to the local plasma potential through a photoelectron sheath. Successful measurement of DC/low frequency plasma electric fields requires that the antenna be biased (as described below). At sufficiently high (radio) frequencies, an antenna behaves as if in a vacuum.</p> <p>Each monopole is connected to the inputs of both: A low frequency and high frequency preamplifiers.</p>	CNES, SLL, Stellar

Table 1. RPW sub-systems.



3 SOLAR ORBITER MISSION OVERVIEW

3.1 Solar Orbiter mission phases

Figure 1 presents an overview of the Solar Orbiter mission timeline.

The mission has five phases for an expected total duration of 10.35 years:

- The Launch and Early Operations Phase (LEOP), starting at launch and during 7 days. It is reserved for critical platform operations. Especially the I-Boom and RPW electrical antennas (ANT) will be deployed during this phase.
- The Near-Earth Commissioning Phase (NECP), following the LEOP and lasting 90 days. The payload is switched on and characterized. Besides, the instrument auto-compatibility interference campaign will be performed towards the end of the NECP during this phase.
- The Cruise Phase (CP), which lasts ~2.8 years. Only the in-situ payload will be continuously operational during this phase. The remote-sensing payload will be on during specific check-out windows. No selective downlink will be operated nominally during this phase.
- The Nominal Mission Phase (NMP) will last around 5 years, when the in-situ payload will be continuously on and the remote-sensing payload will be on during specific windows, named “Remote-sensing Windows” (RSW). 3 RSW per orbit is planned.
- The Extended Mission Phase (EMP) is planned to last 2.5 years.

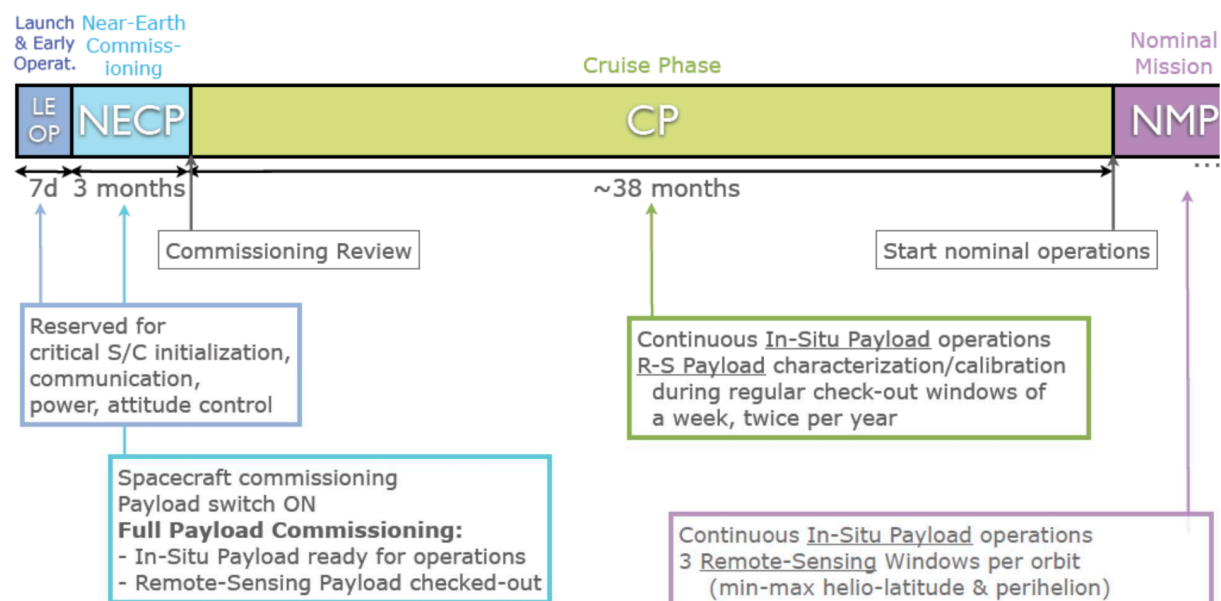


Figure 1. Solar Orbiter mission phases and main operations timeline.

N.B. The RPW commissioning will start during the LEOP, since the instrument needs to be up-and-running to perform measurements for the I-Boom and RPW ANT deployments.



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3.2 Solar Orbiter orbital parameters

The orbital parameters of the Solar Orbiter spacecraft are reported in [RD17].

3.3 Solar Orbiter mission implementation plan

The way the Solar Orbiter mission will be implemented is described in the Solar Orbiter mission implementation plan (MIP) [RD3].

3.4 Solar Orbiter science operations and planning concept

The science operations and planning concept for Solar Orbiter is presented in the Solar Orbiter science implementation requirements (SIRD) [RD9] and mission planning concept (MPC) [RD19]. These two documents should be read first.

For convenience, the table below summarizes the overall concept of the science operations planning cycles.

Planning cycle	Objective	Planning constraints	Operations constraints
Mission-level planning	Science Working Team (SWT) defines top-level science activities for the entire mission (Science Activity Plan, SAP), as well as detailed science goals for each orbit.		
Long-Term Planning (LTP)	Covers 6 months. Given input from SWT, the Science Operations Working Group (SOWG) defines a coherent mission-level observing plan for a given orbit. They will be assisted by the SOC, which will provide detailed information on the resources available.	Planned > 6 months before execution (~1 orbit; fixes ground stations allocation)	
Medium-Term planning (MTP)	Covers 6 months. Defines top-level science operations per orbit:	Fixed 4 weeks before execution	Fixes spacecraft (S/C) resources, instrument modes, default pointing
Short-Term Planning (STP)	Covers 1 week. Generates details schedules of commands for spacecraft and	Planned 1 week before execution	Instrument ops. modes must stay within



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	payload. Last opportunity to modify instrument ops. modes.		resources allocations limits defined at MTP level.
Very-Short-Term Planning (VSTP)	For subset of remote-sensing windows only: update spacecraft fine pointing to track features on the solar disk. Opportunity for fine-pointing updates	Once per 24h, time between pointing definition and execution	Same than for STP.

Table 2. Science operations planning cycles.

3.5 Solar Orbiter ground segment design overview

3.5.1 Ground segment overview

The Ground Segment for Solar Orbiter in the operational configuration consists of the following elements:

- The Operational Ground Segment (OGS) that includes the Mission Operations Centre (MOC) located at ESOC and the Ground Stations and Communication Network (ESTRACK).
- The Science Ground Segment (SGS) that includes the Science Operations Centre (SOC) located at ESAC and the PI facilities used to manage their respective instruments and perform data processing.

Figure below shows the main components of the SGS and the OGS, and the interactions between them.

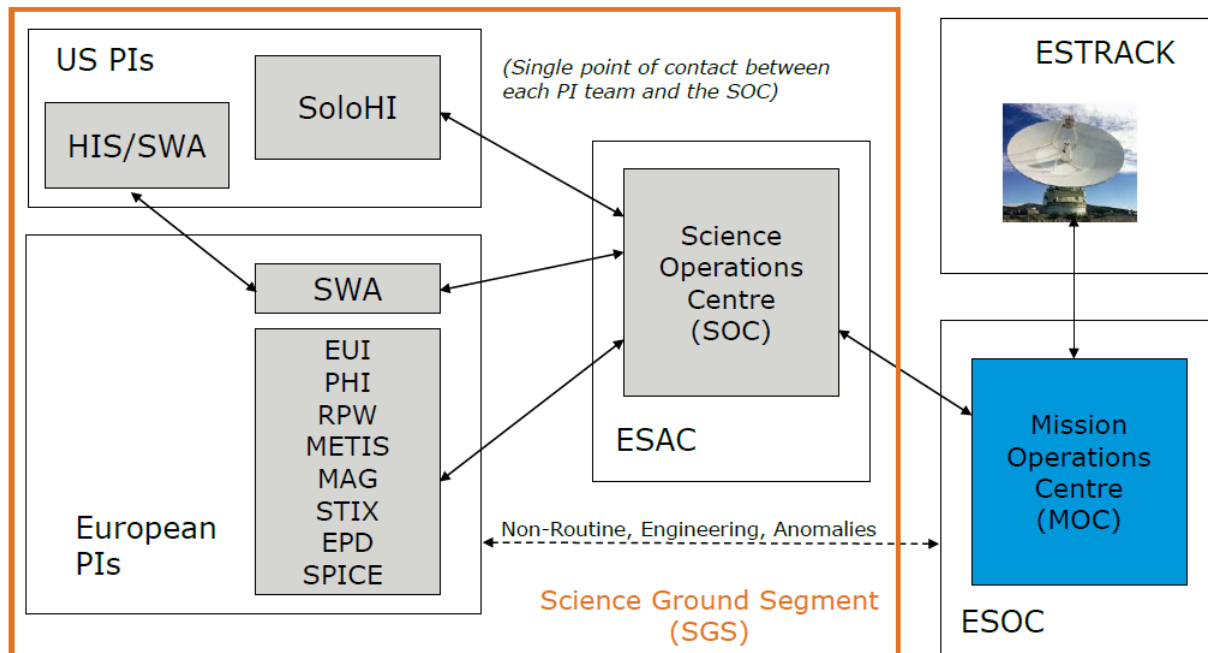


Figure 2. The Solar Orbiter ground segment main components.

3.5.2 Mission Operation Centre (MOC)

The MOC is a part of the OGS, responsible for all mission operations planning, execution, monitoring and control activities [RD3].

The MOC will, in particular, be responsible for the following tasks, relevant to science operations:

- Overall mission planning
- Provision of instrument raw data, spacecraft housekeeping and auxiliary data to the SOC and Instrument Teams (IT), via the Solar Orbiter Data Dissemination System (DDS) [RD4] in a timely manner and in an agreed format
- Performing anomaly (out of limit) checks on a set of payload parameters
- Notifying payload anomalies to the SOC/Pis.

Non-routine, engineering and anomalies payload operations are directly managed between the MOC and IT.. The operation requests to MOC will be performed by IT through the Payload Direct Operation Request (PDOR) and Memory Direct Operation Request (MDOR) mechanisms [RD21]. Especially, the latter is dedicated to on-board memory-related operations.

During the commissioning phase, the MOC will supply a dedicated PI Support Area (PISA). As indicated in the MIP, the PI Support Area will host the IT and their dedicated equipment for monitoring of the performance of their instruments during NECP activities requiring their presence at ESOC. These teams will have access to their data streams and will be able to submit command requests via electronic links for processing and uplink. It should be noted that this support area, differently from all other control rooms, will only be equipped with one standard spacecraft control work position, to allow the expert PI teams to monitor the operations performed by the Flight Control Team (FCT). This area will be used dedicated to Solar Orbiter during the NECP.



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3.5.3 Science Operation Centre (SOC)

The SOC is responsible for supporting the planning of science operations and the coordination of the science operations plans of the IT to generate a conflict-free science operational timeline [RD9]. This timeline will be prepared from inputs provided by the IT and by the MOC, with feedback to the Science Operations Working Group (SOWG), which is responsible for top-level science operations planning.

In order to prepare the science operations, the SOC will deliver to IT:

- Mission planning and related events via the Enhanced-Flight Events Communications Skeletons (E-FECS) mechanism [RD27].
- The telemetry corridors (TMC) constraints [RD28]

All nominal instrument planning and commanding activities after commissioning will take place through the SOC.

The instrument operations requests (IOR) [RD5] generated by the individual IT will be collected at the SOC, and merged in a single payload operations request (POR) to be submitted to the MOC on a periodic basis, as part of the mission planning process. The MOC will be in charge of including the requests in the overall mission operations timeline to be uplinked periodically to the spacecraft.

The SOC will also process the ancillary data (ANC) received from the MOC and produce ancillary data products that will be provided to the IT in support of the science operations planning process as well as interpretation of instrument data. These ancillary data products include orbit and attitude profiles (both as NAIF SPICE kernels, daily files), event predictions, time correlation details and other mission specific information.

The SOC will also construct a mission data archive [RD14], which includes all data received from the MOC (e.g. spacecraft raw data and auxiliary data) as well as all data received from the IT. NASA will mirror the Solar Orbiter archive.

The SOC will pre-process a reduced set of science telemetry (TM) - “prompt science” data, i.e. TM downlinked with low latency – [RD29] with the use of PI-provided software to convert specific telemetry Application Process IDs (APIDs) into usable data for SOC planning purposes. RPW Operations Centre (ROC)

3.6 ROC objectives

The ROC is the main component of the RPW Ground Segment (RGS). It gathers the functions supported by both the operations and data processing centres for the RPW instrument.

According to [AD1, RD8, RD9, RD10, RD11, RD12, RD13, RD14, RD15], the ROC is expected to:

- Agree on a long-term science activity plan and define the scientific priorities of scientific goals.
- Support the definition of the science operations.
- Provide inputs for the definition and implementation of the science operation planning, data handling and archiving concepts
- Support the definition and implementation of the Solar Orbiter scientific data archive, as part of the pre-launch tasks.



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- Supervise the preparation of the instrument operation timelines, in agreement with the planning at the mission level
- Prepare and submit to the MOC the sequences of telecommands (TC) – inside flight procedures - to be used during the mission.
- Prepare and submit the science instrument operation requests to the SOC during the mission
- In case of non-routine/special operations, prepare and submit directly to the MOC the instrument operation requests
- Control and monitor the instrument state during the different phases of the mission
- Monitor and optimize the instrument performances and the science data return
- Maintain the instrument flight software
- Retrieve and process the TM packets for RPW
- Deliver calibrated and high level processing data, including relevant calibration products, to the Solar Orbiter scientific archive within 3-months.
- Provide to ESA unlimited access to all processed and analysed data for public relation purposes during the 3-months proprietary period.
- Provide summaries of the main scientific results at regular intervals
- Be present at MOC site during the commissioning phase, in order to support MOC in the RPW-related operations.
- Develop, deliver to the CNES AIT/AIV team and maintain a Software Ground Support Equipment (SGSE), in support to the RPW ground calibration campaigns data post-mortem analysis.

Most of the ROC tasks are carried out in close collaboration with the other parties, who have delegated responsibilities for the ground segment and operations.

The ROC is located at the “Laboratoire d’Etudes Spatiales et d’Instrumentation en Astrophysique” (LESIA) at Meudon (France), which is also the RPW PI-ship laboratory.

3.7 ROC environment

3.7.1 Institutes involved in the RPW ground segment activities

The ROC is the main coordinator of the RGS activities and the single point of contact with the Solar Orbiter MOC and SOC during the mission.

To ensure its tasks, the ROC will rely on several institutes, which are presented in the figure 3. Except the ESOC and ESAC, all the institutes can be considered as a component of the RGS.

N.B. The RPW CNES teams will be not involved anymore in the RGS engineering activities (i.e., AIT-AIV, system, command/control) after the NECP.

Institutes	Main responsibilities
CNES (Toulouse, France)	Until the end of commissioning phase: <ul style="list-style-type: none"> - RPW project manager - RPW AIT/AIV manager - RPW system manager - RPW command/control support In charge of:



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	<ul style="list-style-type: none"> - Supervise the writing of and the deliver of the RPW user manual - Be responsible of the RPW commissioning in-flight and related activities - Provide support (system and control/command) in the preparation of the CP and NMP operations - Supervise the RPW AIV/AIT activities, including performance, calibration and S/C-level tests - Providing to the ROC the data and related documentation produced by the CNES during the ground test campaigns performed on RPW. Especially, the CNES MEB GSE and ROC-SGSE data, GSE setup metadata, calibration plan and report)
ESAC (Madrid, Spain)	<p>Solar Orbiter Science Operations Centres (SOC), in charge of:</p> <ul style="list-style-type: none"> - Develop, test, validate, run and maintain software and interfaces allowing ROC to: <ul style="list-style-type: none"> * Submit IORs [RD8] to the SOC via the SOC GFTS interface * Retrieve auxiliary data (e.g., SPICE kernels) via the SOC GFTS, as well as the inputs for the science operations preparation (TM corridor, Power consumption range, etc.) * Archive Solar Orbiter final data sets * Provide a dedicated interface for data archiving process * Deliver and run the RPW low latency data pipelines - Write, deliver and keep up-to-date associated documentation - Coordinate Solar Orbiter science observation campaigns (i.e., SAP, SOOP)
ESOC (Darmstadt, Germany)	<p>Solar Orbiter Mission Operations Centre (MOC), in charge of:</p> <ul style="list-style-type: none"> - Develop, test, validate, run and maintain software and interfaces allowing ROC to: <ul style="list-style-type: none"> * Submit RPW flight procedures to the MOC * Submit Memory Direct Operation Request (MDOR) and Payload Direct Operation Request (PDOR) to the MOC [RD14] via the MOC GFTS interface. * Retrieve RPW TM packet raw data through the MOC EDDS interface * Ensure the analysis of instrument data in quasi-real time during the LEOP/NECP RPW-related operations at ESOC. * Retrieve the Mission information Base (MiB) - Write, deliver and keep up-to-date associated documentation - Monitoring the instrument - Alert ROC in case of instrument failures/anomalies
IAP (Pragues, Czech Republic)	<p>TDS Lead CoI-ship laboratory, in charge of:</p> <ul style="list-style-type: none"> - Calibrating TDS sub-system - Assist the ROC in the definition of L1 and HK data sets for TDS - Deliver to the ROC the CDF skeletons for TDS L2 data sets - Deliver to the ROC the calibration tables for TDS - Develop, test, validate, deliver and maintain TDS software allowing ROC to produce <ul style="list-style-type: none"> * TDS science data files at L1R level (only for waveform data) * TDS science data files at L2 level (only for non-waveform data) - Contribute to the validation of the science data produced by the TDS S/W - Write, deliver and keep up-to-date associated documentation
IRF-U (Uppsala, Sweeden)	<p>Bias Lead CoI-ship laboratory, in charge of:</p> <ul style="list-style-type: none"> - Calibrating Bias unit - Assist the ROC in the definition of L1 and HK data sets for Bias - Deliver to the ROC the CDF skeletons for TDS/LFR electrical waveform L2 data sets - Deliver to the ROC the calibration tables for Bias unit



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	<ul style="list-style-type: none"> - Develop, test, validate, deliver and maintain Bias software allowing ROC to produce <ul style="list-style-type: none"> * TDS/LFR electrical waveform science data files at L2 level - Contribute to the validation of the science data produced by the Bias S/W - Write, deliver and keep up-to-date associated documentation
LESIA	<p>RPW PI-ship laboratory RPW system manager RPW MEB manager DPU Flight S/W architect & control/command manager TNR-HFR Lead CoI-ship laboratory RPW MEB GSE manager RPW AIT/AIV support at LESIA. ROC manager</p> <p>The LESIA will take the overall responsibility of the instrument and related engineering activities after the end of the commissioning and the dissolution of the RPW instrument team at CNES.</p>
LESIA (AIT/AIV team)	<ul style="list-style-type: none"> - Support CNES during RPW AIT/AIV activities at LESIA on-ground - Ensure the availability of the facilities required to run the RPW MEB ground model at LESIA during the mission
LESIA (GIGL)	<p>The Groupe Informatique Générale du LESIA (GIGL) is in charge of:</p> <ul style="list-style-type: none"> - Making available the ROC servers and services (Wiki, issue tracker tool, Web page) - Creating the LDAP user accounts, which allow ROC users to access to the ROC servers and services on the Paris Observatory intranet. - Ensure that the ROC team can use the LESIA visiocon facilities and providing helpdesk
LESIA (MEB team)	<ul style="list-style-type: none"> - Provide MEB expertise support
LESIA (MEB GSE team)	<ul style="list-style-type: none"> - Ensure the availability of the MEB GSE during all the phases of the project. - Provide MEB GSE expertise support - Write and deliver the up-to-date MEB GSE documentation
LESIA (ROC team)	<ul style="list-style-type: none"> - Supervize the RPW ground segment activities during the different phases of the Solar Orbiter project - Develop, test, validate, run and maintain software and/or interfaces in order to: <ul style="list-style-type: none"> * Monitor the instrument data in support to MOC during the mission * Plan the science observation campaigns * Prepare, submit to the SOC and control the operation requests for RPW * Support CNES during RPW commissioning * Produce and distribute RPW science and HK data to the instrument consortium * Produce and deliver RPW science data to ESAC (Madrid) and CDPP (Toulouse) for archiving - Maintain up-to-date the infrastructure during the mission - Support CNES during the ground calibration campaigns at the system level - Deliver a low latency data processing pipeline for RPW to the SOC. - Write, deliver and keep up-to-date associated documentation
LESIA (RPW DPU flight software team)	<ul style="list-style-type: none"> - Deliver the RPW Instrument Database (IDB) to ESA - Provide expertise support to the ROC for the RPW command/control and monitoring operations involving the flight software (e.g., FDIR, flight software patching, etc.) - Write and deliver the corresponding up-to-date documentation
LESIA (THR team)	<ul style="list-style-type: none"> - Calibrating THR receiver - Calibrating electrical antennas and PA-HF in-flight - Assist the ROC in the definition of L1 and HK data sets for THR - Deliver to the ROC the CDF skeletons for THR L2 data sets - Deliver to the ROC the calibration tables for THR, antennas and PA-HF - Develop, test, validate, deliver and maintain THR software allowing ROC to



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	<p><i>produce</i></p> <ul style="list-style-type: none"> * THR science data files at L2 level - Contribute to the validation of the science data produced by the THR S/W - Write, deliver and keep up-to-date associated documentation
LPC2E (SCM)	<p>SCM Lead CoI-ship laboratory, in charge of:</p> <ul style="list-style-type: none"> - Calibrating SCM sensor - Assist the ROC in the definition of L1 and HK data sets for SCM - Deliver to the ROC the CDF skeletons for TDS/LFR magnetic waveform L2 data sets - Deliver to the ROC the calibration tables for SCM - Develop, test, validate, deliver and maintain SCM software allowing ROC to produce * TDS/LFR magnetic waveform science data files at L2 level - Contribute to the validation of the science data produced by the SCM S/W - Write, deliver and keep up-to-date associated documentation
LPP (LFR)	<p>LFR Lead CoI-ship laboratory, in charge of:</p> <ul style="list-style-type: none"> - Calibrating LFR sub-system - Assist the ROC in the definition of L1 and HK data sets for TDS - Deliver to the ROC the CDF skeletons for LFR L2 data sets - Deliver to the ROC the calibration tables for LFR - Develop, test, validate, deliver and maintain LFR software allowing ROC to produce * LFR science data files at L1R level (only for waveform data) * LFR science data files at L2 level (only for non-waveform data) - Contribute to the validation of the science data produced by the LFR S/W - Write, deliver and keep up-to-date associated documentation

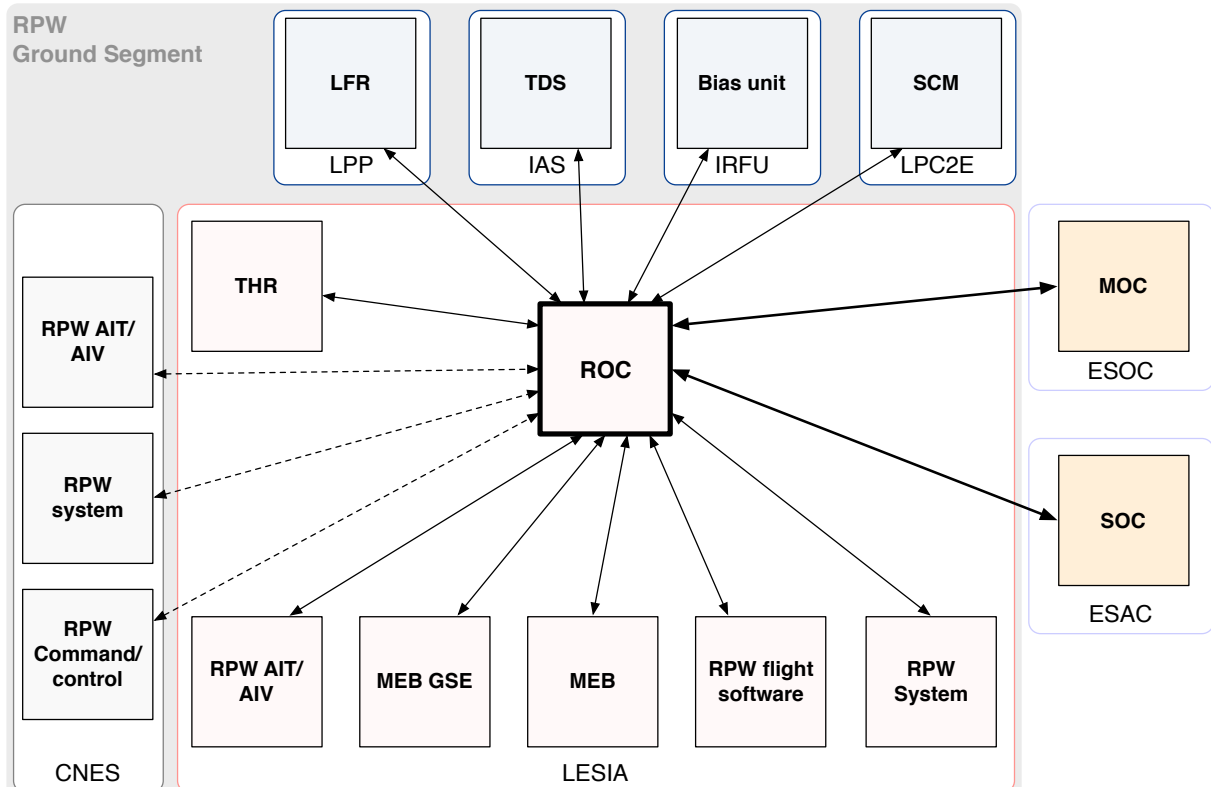


Figure 3. RPW ground segment involved institutes.

The institutes and the main functions are summarized in the table below.



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Table 3. Entities involved in the RPW ground segment activities.

3.7.2 RPW Teams at CNES

The ROC will rely on the RPW AIT/AIV, command/control and system teams at CNES to prepare the instrument operations and monitoring activities. Besides, the CNES will be in charge of coordinating and performing the in-flight validation of RPW during the instrument commissioning.

Additionally, the ROC is expected to supply SGSE facilities the CNES RPW AIT/AIV team, in support to the ground calibration campaigns at system level.

It must be noticed that the participation of the CNES to the RPW engineering activities will terminate with the end of the NECP.

3.7.3 RPW Teams at LESIA

The RPW team at LESIA gathers the instrument AIT/AIV, MEB GSE (SGSE and E-GSE parts), system, MEB and DPU flight software teams.

During instrument validation campaigns on-ground, the ROC will have to interact with these teams in order to:

- Supporting the RPW flight software in the validation of the SBM1/SBM2 detection algorithms
- Supplying SGSE facilities in support to the ground calibrations at system level, realized at both LESIA (Meudon) and CNES (Toulouse) sites.

After the instrument delivery at ESA, the activities of the RPW teams at LESIA will start to decrease significantly. During the mission, their task will mainly consist of ensuring expertise and supporting the ROC in case of flight software upgrading or anomaly investigation.

3.7.4 RPW analyser and sensor Teams

The analyser/sensor Lead CoI teams - TDS, LFR, THR, Bias and SCM – are expected to provide to the ROC expertise support concerning their sub-system, but also to deliver to the ROC and to ensure the maintenance of the software that calibrates their sub-system science data. Besides, they will have an active participation in the definition and the validation of the RPW science data.

3.7.5 RPW Operations Board (ROB)

The RPW Operations Board (ROB) is in charge of defining the operations planning for RPW, in agreements with the RPW Consortium as well as the SOWG and SWT. Moreover, it shall select the SBM event data to downlink.

See more details about the ROB in [AD2].

3.7.6 ROC staff at LESIA

Figure below presents the organization of the key personnel and teams belonging to or directly involved in the ROC.



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The centre is under the science and technical responsibility of the RPW Principal Investigator (PI) and the RPW Ground Segment Project Manager (GSPM) respectively.

The ROC quality assurance is controlled by the RPW ground segment software product assurance manager (GSSPAM).

The ROC is divided in four main teams:

- The *management team*, which is the board in charge of driving the project, namely : the RPW PI who be responsible of the science activities, ROC GSPM who ensures the management of the ROC, the GSSPAM who follows the quality product assurance activities.
- The *Data processing team*, in charge of developing, testing, validating, executing and maintaining the RPW data processing activities at ROC.
- The *Operations team*, in charge of the RPW operations activities. It consists of preparing the instrument planning, commanding and executing the operations (i.e., submitting sequences of TCs and verifying the instrument state and allocated resources).
- The *Ground support team*, which implements and maintains the ROC GSE facilities.
- The *RPW ground segment science support team*, which gathers scientists directly involved in the ROC activities.

The responsibilities of the ROC key personnel are detailed in the section 3.8.

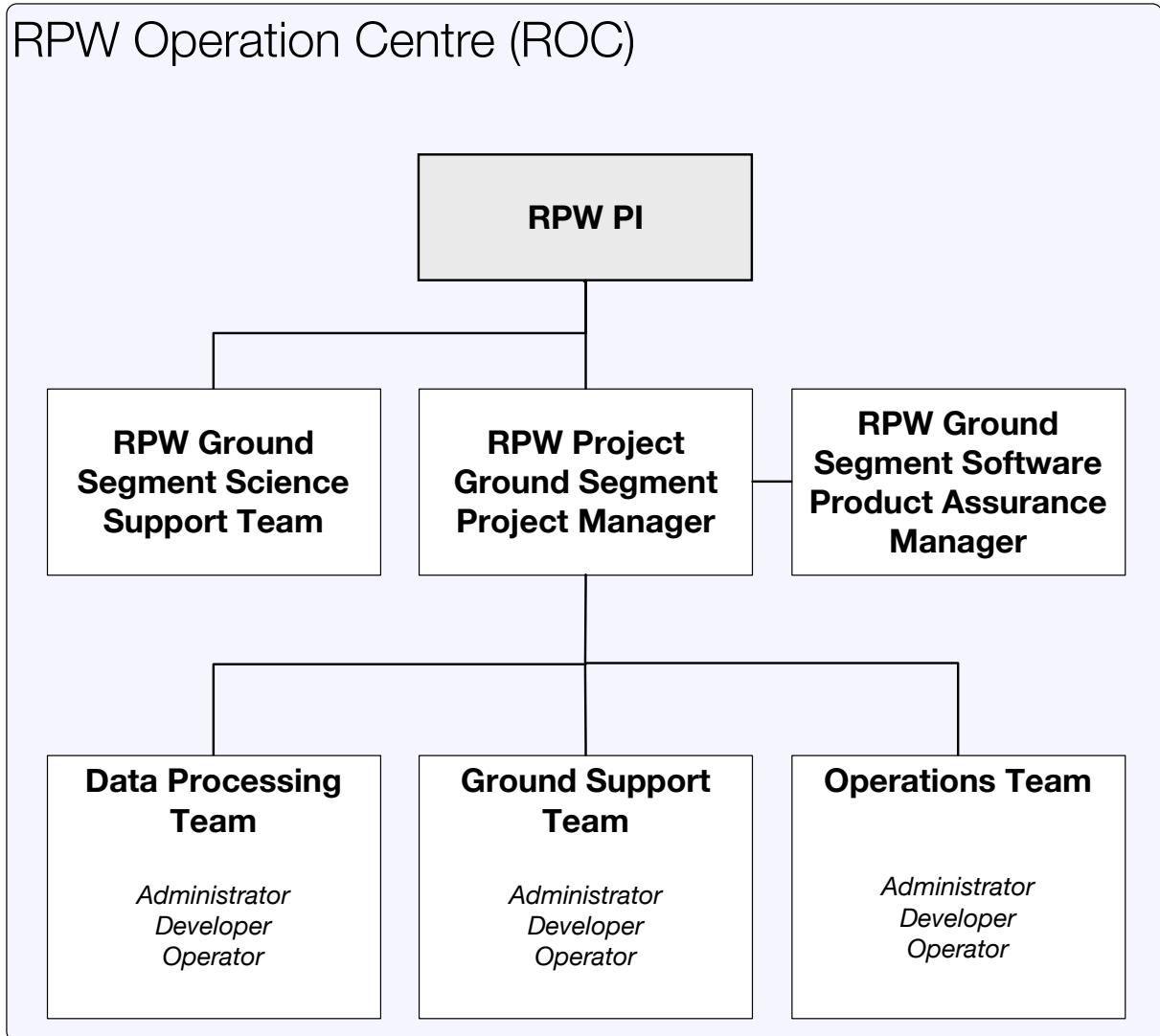


Figure 4. ROC overall organization.

3.8 ROC environment

Figure 5 shows the ROC environment and the main exchanges between involved entities.



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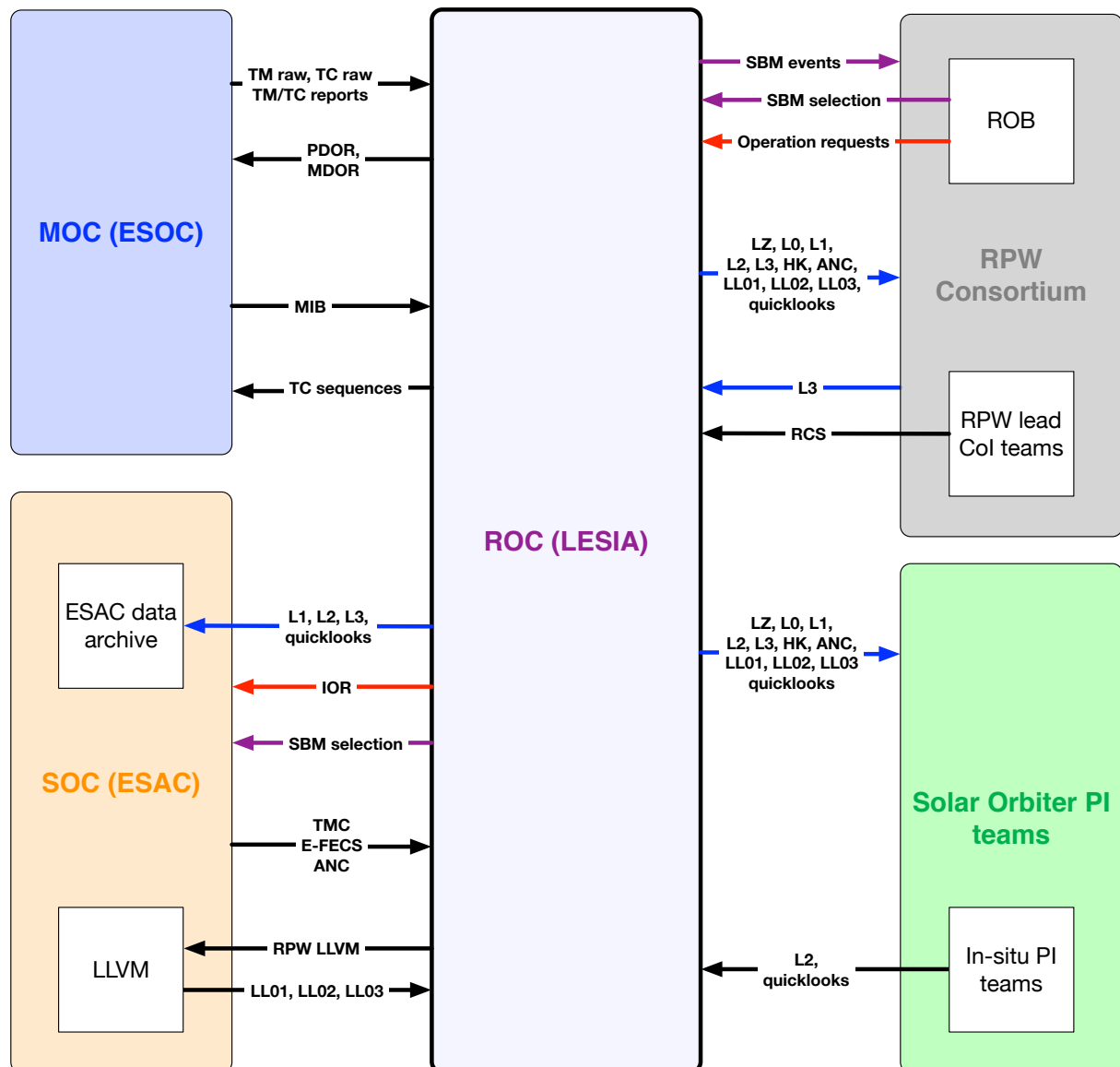


Figure 5. ROC environment.

The main exchanges are:

- TC sequences delivered to the MOC to populate the MIB used in operation
- Special operations requests (PDOR, MDOR) submitted to the MOC
- Mission operations inputs (TMC, E-FECS, ANC) provided by the SOC to the IT
- Instrument operation requests (IOR) submitted to the SOC from the ROB requests
- List of SBM data event to downlink, which is submitted to the SOC from the ROB selection
- RPW Low Latency Virtual Machine (LLVM), delivered to SOC to be run at ESAC site. SOC will then provide resulting LL01, LL02 and LL03 data products [RD24] through the dedicated LL Web page.



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- RPW TM raw data and related products (TM/TC report, TC raw), which are made available at MOC.
- RPW L1, L2 science data and quicklooks, which are produced at ROC, distributed to the RPW consortium and Solar Orbiter PI teams and archived at ESAC. (Archiving at CDPP is also planned.)
- L2, quicklooks data from other in-situ instrument teams to perform cross-calibrations and support the selection of the SBM data events.

3.9 The ROC infrastructure

The ROC shall implement at LESIA (Meudon, France) and maintain up-and-running over the entire Solar Orbiter mission, a software system infrastructure.

Especially, this ROC Software System (RSS) shall include tools to:

- Generate, test and deliver to MOC flight procedures for RPW
- View the mission and instrument-levels operations planning
- Prepare, test and submit to SOC the science instrument operation requests (IOR)
- Prepare, test and submit to SOC engineering operation requests (MDOR/PDOR)
- Select and request to SOC the SBM1/SBM2 events data to downlink
- Check the instrument commanding and control the expected state
- Monitor the instrument health and view the RPW HK/science data
- Support instrument calibration activity
- Support the data analysis of the anomaly investigation
- Retrieve, produce and distribute the RPW science data and quicklooks, as defined in [AD2]

The system infrastructure shall also include all the interfaces to exchange files and data with the external sites (MOC, SOC, CDPP, RPW Consortium, Solar Orbiter instrument teams, public, etc.)

3.10 ROC activities

This section presents the activities to be supported by the ROC during each phase of project.

3.10.1 ROC science activities

The ROC shall support the following science activities:

- Preparing and updating the RPW science activity plan and the resulting operations planning in accordance with the Solar Orbiter mission science and operations plans.
- Producing RPW science data compliant with the data formats defined in [RD6].
- Ensuring the validation and the quality assessment of the RPW science data products.
- Providing full access to the RPW science data products to the RPW Consortium and the SOC.



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- Delivering the required RPW science data products at the SOC mission data archive at ESAC and the Centre de Données de Physique des Plasmas (CDPP)¹ at Toulouse (France).
- Ensuring the long-term storage of the RPW science data products archived at the LESIA.
- Ensuring that the documentation related to the science activities at the ROC is up-to-date and available.

3.10.2 ROC operations activities

As soon as the on-board RPW instrument is switched-on, the ROC shall ensure the sustainability of the following routine operations activities at the LESIA:

- Monitoring the instrument health and performance.
- Optimizing the instrument performances and science data returns.
- In agreement with the mission operation planning and constraints at the Solar Orbiter level:
 - Preparing and commanding the RPW flight operating modes
 - Controlling the RPW on-board data storage and power consumption
 - Controlling the RPW TM/TC data rate.
- Maintaining and upgrading the on-board DPU software
- Setting the on-board BIAS current
- Optimizing the SBM1/SBM2 algorithms detection rates on-board.
- Managing the SBM1/SBM2 event data selection and downlink
- Monitoring the instrument science and engineering data validity and consistency
- Providing full access to its instrument science and engineering data archive to the RPW Consortium and the SOC/MOC.
- Being the main interlocutor with the SOC/MOC in case of non-routine procedures (e.g., anomalies, flight software updates).
- Supervizing the instrument anomaly verification and resolution.
- Ensuring that the documentation related to the RPW instrument operations activities at the ROC is up-to-date and available.

3.10.3 ROC activities prior to the launch

3.10.3.1 RPW operations preparation activities

- Define, prepare and validate the RPW operation planning concept for the different phases of the mission. This task shall be done in agreement with the Solar Orbiter mission planning.
- Prepare the RPW commissioning and cruise phase activities and dedicated support software, data and documentation, including dedicated RPW flight procedures (RFP).
- Define, prepare and validate the RPW operations data products.
- Specify, design, develop, test, validate, deliver and run facilities related to the RPW operation planning, the instrument monitoring and commanding, and the data processing. These tools shall be fully operational at the launch. The maintenance and the possible upgrades are under the responsibility of the ROC.
- Participate to the writing of the RPW user manual to be delivered by the CNES to the MOC before the launch.

¹ Delivering data to the CDPP is not a high level requirement.



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- Prepare expected inputs and participate to the System Validation Tests (SVT) and System Operation Validation (SOV) campaigns at the MOC/SOC levels.
- Prepare and submit to the MOC, the instrument state model (ISM) for RPW

3.10.3.2 RPW data processing activities

- Define, prepare and validate the RPW science data products.
- Support the definition of data formats for the science products (contributor in the Modeling and Data Analysis Working Group for Solar Orbiter, MADAWG)
- Design, develop, test, validate and deliver to the SOC, a Low Latency Virtual Machine (LLVM) for RPW, according to the SOC technical specification and delivery planning.

3.10.3.3 RPW ground support activities

Before the launch, the ROC shall participate the ground calibration campaigns at system level:

- Develop, test, validate and deliver to the CNES and LESIA AIT/AIV teams a SGSE in support to the RPW ground calibration validations. The ROC shall also ensure the maintenance and the possible upgrades of this SGSE.
- Develop, test, validate, deliver and run software tools to support the RPW flight software team in the validation of the SBM1/SBM2 detection algorithms. The ROC shall also ensure the maintenance and possible upgrades of these tools after the launch.
- Participate to the SOC<->IT interface tests
- Participate to the MOC<->IT interface tests
- Participate to the Low latency test schedule of the SOC.
- Retrieve and implement the RPW subsystems calibration software that will be developed in the Lead CoI institutes. It concerns more specifically the following sub-systems:
 - ANT Estimation of L_{eff} in BF (SPIS simulation, $E=-VXB$), estimation of L_{eff} in HF (CNES& Austrian simulations, use of Rolls)
 - SCM Transfer functions & calibrations, merging with MAG data
 - LFR Transfer functions & calibrations
 - BIAS Determination of BIAS current depending on R
 - TDS Transfer functions & calibrations
 - TNR-HFR Transfer functions & calibrations

3.10.4 ROC activities related to the RPW commissioning

3.10.4.1 ROC activities during the Launch and Early Operation Phase (LEOP)

The following operations related to RPW will be realized during the LEOP:

- RPW first switching-on and preliminary verification tests
- I-Boom deployment
- ANT deployments

The RPW first switching-on and verification tests shall allow the RPW team to check the good health of the instrument after the launch and its readiness to perform the next operations.



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The i-Boom and ANT deployments will be triggered and controlled by the MOC team, with the support of the RPW team.

The presence at ESOC of people from the RPW team will hence be required during these operations.

The preparation and participation to the RPW LEOP-related operations are under the responsibility of the CNES. Especially, the CNES will be in charge of performing the in-flight instrument verification and validation during the commissioning.

The ROC will support to the RPW CNES team by providing the equipment required to retrieve and analyze RPW TM data at ESOC and maintaining, in case of problem, the interface that permits to submit TC sequences to MOC.

3.10.4.2 ROC activities during the Near Earth Commissioning Phase (NECP)

The RPW instrument will be switched-on during the NECP in order to perform:

- The inter-instruments interference campaign
- RPW instrument characterization and performance validation (including TDS/LFR flight software algorithm validation and RPW-PAS filtering tune)
- The ANT calibration rolls and to the analysis of the resulting data. The roll campaigns shall lead to the delivery of direction and length parameters of the flight effective ANT vectors.
- The SCM noise measurement in the Earth magnetic lobes and coordinating resulting data analysis

As for LEOP, people from the RPW team may need to be at ESOC during these operations.

3.10.5 ROC activities related to the RPW exploitation in-flight

3.10.5.1 ROC activities during the Cruise Phase (CP)

During the Cruise Phase (CP), the ROC shall perform the following specific tasks:

- Evaluating, validating and optimizing the RPW on-board data storage, power consumption and TM/TC data rate. This task will be done in collaboration with the SOC team, which in charge of providing to IT periodic information about available data rates (e.g, "corridor" data).
- Evaluating, validating and optimizing the instrument scientific return
- Evaluating, validating and optimizing the on-board SBM1/SBM2 detection algorithms and the SBM1/SBM2 events data downlink management
- Evaluating, validating and optimizing the BIAS current setting life-cycle Ensuring the standard operations as defined in the sections 3.10.1 and 3.10.2.

3.10.5.2 ROC activities during the Nominal Mission Phase (NMP) and Extended Mission Phase (EMP)

During the Nominal Mission Phase (NMP) and the Extended Mission Phase (EMP), the ROC team shall ensure the routine operations, as defined in the sections 3.10.1 and 3.10.2.

In addition, scientific cooperation with other mission teams (e.g. FIELDS/Solar Probe Plus) needs to be reinforced.



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3.10.6 ROC specific post-operation phase-related activities

At the end of the mission, the ROC shall:

- Finalize the science data processing and archiving for all of the mission phases.
- Maintain the data access interface for ESAC, CDPP and RPW Consortium users and provide a helpdesk to support solving problems related to (a) the usage of the data retrieval system and (b) retrieving actual data.

4 DATA DESCRIPTION

The description of the RPW data is given in [RD18].

5 ROC FUNCTIONAL REQUIREMENTS

5.1 Data retrieval

The RPW TM data and additional information (e.g., TM/TC report, TC binary, etc.) shall be requested by the ROC, via the dedicated Solar Orbiter EGOS Data Dissemination System (EDDS). The EDDS is a Web service hosted by MOC.

REQ-ROC-CIRD-0010	Retrieving RPW data	Test
<p>The ROC shall be able of requesting and retrieving the following data from MOC:</p> <ul style="list-style-type: none"> - The RPW TM raw data - The RPW TC raw data - The RPW TM report - The RPW TC report <p>For a given APID and time ranges.</p> <p>The request shall be done using the mechanism defined in [RD4].</p>		
ROC	Implements:	

REQ-ROC-CIRD-0020	Retrieving Mission operation input data	Test
<p>The ROC shall be able of retrieving the operation input data files (i.e., E-FECS , TMC), as soon as their are made available by SOC.</p> <p>The data shall be retrieved via the mechanism defined in [RD7].</p>		
ROC	Implements:	

REQ-ROC-CIRD-0030	Retrieving Mission ancillary data	Test
<p>The ROC shall be able of retrieving the Solar Orbiter mission ancillary data (e.g., SPICE kernels,</p>		



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CDF-digest files), as soon as their are made available by SOC.

The data shall be retrieved via the mechanism defined in [RD7].

ROC	Implements:

5.2 Data production

5.2.1 Producing RPW data files

The ROC will produce RPW science data files daily.

The convention concerning the Solar Orbiter payload science data is described in [RD6]. The list of RPW science data to be produced by the ROC is available in [AD2]. Other data products are described in [RD18].

REQ-ROC-CIRD-0040	Producing RPW LZ data	Test
The ROC shall produce the RPW LZ data defined in [RD18]. The LZ data files shall store the RPW TM packet data as delivered by the MOC.		
ROC	Implements:	

REQ-ROC-CIRD-0050	Producing RPW L0 data	Test
The ROC shall produce the RPW L0 science data defined in [RD18].		
ROC	Implements:	

REQ-ROC-CIRD-0060	Producing RPW L1 data	Test
The ROC shall produce the RPW L1 science data defined in [AD2].		
ROC	Implements:	
EIDA R-359 EIDA R-697 REQ-ROC-016		

REQ-ROC-CIRD-0070	Producing RPW L2 data	Test
The ROC shall produce the RPW L2 science data defined in [AD2]. The L2 data will be generated using the software and calibration tables provided by the sub-system teams (BIAS, LFR, TDS, THR, SCM)		



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ROC	Implements: EIDA R-359 EIDA R-697 REQ-ROC-016 REQ-ROC-017 REQ-ROC-020 REQ-ROC-021 REQ-ROC-022
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REQ-ROC-CIRD-0080	Producing RPW L3 data	Test
The ROC shall support the production of the RPW L3 science data defined in [AD2].		
ROC	Implements: EIDA R-697 REQ-ROC-016 REQ-ROC-023	
<i>The production of the L3 science data files will have to be realized by the teams which have the expertise. However, the ROC shall ensure that:</i> <ul style="list-style-type: none"> - The teams have the expected RPW L2 data inputs - The resulting L3 data files are regularly sent to the ROC, in order to be archived at ESAC - The ROC maintains the interfaces to retrieve L3 data files. 		

REQ-ROC-CIRD-0090	Producing RPW HK “digest” data	Test
The ROC shall produce RPW HK parameter “digest” files, as defined in [RD18].		
ROC	Implements:	
<i>These files are not archived at ESAC, but will be used by the ROC and RPW sub-systems teams to analyze the instrument behaviour and to calibrate the science data.</i>		

REQ-ROC-CIRD-0100	Producing RPW data summary plots	Test
The ROC shall produce the RPW data summary plots defined in [AD2].		
ROC	Implements: REQ-ROC-019	

5.2.2 Processing mission ancillary data files

The ROC does not plan to produce any ancillary data files. Especially, the SOC will deliver orbitography parameters - orbit, attitude, reference frame, OBT-UTC time conversion coefficients - as SPICE kernels, but also as digested CDF files.



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The SPICE kernels will be used by the ROC to process RPW science data files, which required specific orbitography parameters.

Additionally, the ROC will made available the SPICE kernels and CDF files on its data server.

5.2.3 Producing RPW Low Latency data

The payload Low Latency (LL) data will be produced by the SOC from data processing pipelines delivered by each IT.

REQ-ROC-CIRD-0110	Delivering Low Latency data processing pipeline	Review
<p>The ROC shall deliver to the SOC a data processing pipeline to produce the LL01 for RPW. The delivery mechanism and expected pipeline specification are defined in [RD23]. The LL01 expected format and content is given in [RD24]. The ROC shall support the maintenance and possible upgrades of the pipeline during the mission.</p>		
ROC	Implements:	EIDA R-360

In addition to the prime instance of the RPW LL data pipeline used by SOC, the ROC will maintain at LESIA a backup instance for testing and data verification purposes.

5.2.4 Validating RPW data

REQ-ROC-CIRD-0120	Validating RPW data	Test
<p>The ROC shall support the RPW data validation process defined in the RPW Data Verification and Validation Plan (DVVP) [RD32].</p>		
ROC	Implements:	REQ-ROC-024

5.2.5 Re-processing RPW data

REQ-ROC-CIRD-0130	Re-processing RPW data	Test
<p>The ROC shall support the capability of fully/partially re-processing the RPW data stored at LESIA. Data that are already publicly available at ESAC Solar Orbiter archive shall be re-processed and re-delivered following the strategy defined in [AD2].</p>		
ROC	Implements:	REQ-ROC-018

5.2.1 Converting on-board time

REQ-ROC-CIRD-0140	Converting on-board time	Test
<p>The ROC shall be able of converting the On-board Time (OBT) to Univeral Time Coordinated</p>		



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reference time.	
ROC	Implements:

5.3 Data distribution

5.3.1 Distributing preliminary RPW data

As soon as new RPW data have been received at LESIA and processed by the ROC, they will be stored in a dedicated data server. These data are labelled as “preliminary” as long as they are not publicly archived at ESAC.

REQ-ROC-CIRD-0150	Distributing preliminary RPW data	Test
The ROC shall make available its preliminary RPW data to the Solar Orbiter and RPW consortium teams. It includes: <ul style="list-style-type: none"> - L1, L2, L3 data files - Quick-looks - HK “digest” files - RPW Low Latency prime and backup data produced at SOC and LESIA respectively Data is labelled as “preliminary” as long as their are not publicly archived at ESAC.		
ROC	Implements:	REQ-ROC-025 REQ-ROC-026 REQ-ROC-028 REQ-ROC-030

5.3.2 Distributing definitive data

The ROC is not expected to be a public data provider for RPW. Access to the RPW public data will under the responsibility of the ESAC data archive. Nevertheless, RPW data sent by the ROC to the ESAC data archive should be also made available on a public HTTPS server at LESIA.

The RPW data archived at ESAC are labelled as “definitive” (which does not mean that re-processing is not possible.)

5.3.3 Distributing ancillary data

REQ-ROC-CIRD-0160	Distributing mission ancillary data	Test
The ROC shall make available to the RPW consortium teams the mission ancillary data provided by the SOC (SPICE kernels and CDF digest files containing the orbit, attitude, OBT-UTC time conversion, reference frame).		
ROC	Implements:	REQ-ROC-027



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5.4 Data storage and archiving

5.4.1 Storing data at LESIA

REQ-ROC-CIRD-0170	Storing data at LESIA	Test
<p>The ROC shall host at the LESIA site, a RPW data file server storing all the RPW-related data produced before, during the mission and post-operations phases.</p> <p>It shall include at least:</p> <ul style="list-style-type: none"> - RPW TM, LZ, L0, L1, L2, L3 and HK-digest data - RPW data summary plots - RPW LL01, LL02 and LL03 data, produced at SOC - Mission ancillary data (SPICE kernels and CDF-digest) - Submitted RPW operation files (IOR, MDOR/PDOR, procedures) - SOC operation inputs (E-FECS, TMC, MTL Soopkitchen export) - RPW TC-report 		
ROC	Implements:	

5.4.2 Archiving RPW data

The RPW science data products will be sent to the ESAC data archive through the SOC GFTS interface.

REQ-ROC-CIRD-0180	Archiving RPW data at ESAC	Test
<p>The ROC shall be able to deliver to ESAC data archive the RPW data within 3 months.</p> <p>The delivery mechanism shall comply the specification defined in [RD14].</p> <p>It concerns the following data:</p> <ul style="list-style-type: none"> - L1 data - L2 data - L3 and summary plots data - Calibration tables <p>This function will have to be operational at the beginning of the cruise phase.</p>		
ROC	Implements: EIDA R-355	

In addition to the ESAC, the ROC will plan to deliver RPW data to the Centre de Données de Physiques des Plasmas (CDPP) at Toulouse (France).

REQ-ROC-CIRD-0190	Archiving RPW data at CDPP	Test



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The ROC shall be able to deliver to the CDDP data archive its RPW data as defined in [AD2].
The delivery mechanism shall comply the specification defined in [RD?].

ROC

Implements: REQ-ROC-029

5.5 Data visualization

REQ-ROC-CIRD-0200	Visualizing data	Demo
The ROC shall support the capability of viewing the RPW data. The user requirements related to this functionality shall be listed in [RD30].		
ROC	Implements:	

REQ-ROC-CIRD-0210	Visualizing RPW data availability	Demo
The ROC shall maintain a up-and-running Web page to view the availability status of the RPW science data products. The interface will have to be public and accessible from the RPW Web portal at LESIA.		
ROC	Implements:	

5.6 Instrument commanding

5.6.1 Requesting Medium-Term Planning (MTP) instrument operations

The RPW configurations planned over a given orbit (~6 months) are first defined at the mission planning level (MLP). The resulting LTP will then lead to produce a first ~6 months timeline of operations at MTP level, as explained in the section 3.4.

At this stage, the ROC will have to deliver to the SOC, a first set of IOR files for the incoming MTP cycle. It has to be done between 6 and 4 months prior to the beginning of the MTP. This set will be used by SOC to prepare the operations, but will be not contain the TC sequences to be effectively. Besides, the SOC will also check that the MTP IOR set submitted by ROC is consistent with the SOOPs, TM corridors (TMC) and power consumption constraints.

REQ-ROC-CIRD-0220	Producing RPW MTP IOR	Test
The ROC shall support the generation of RPW IOR files for MTP planning cycles. The IOR files shall be saved in the format defined in [RD5].		
ROC	Implements: EIDA R-382	



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REQ-ROC-CIRD-0230	Submitting RPW MTP IOR	Test
<p>The ROC shall support the submission to the SOC of RPW IOR files for MTP planning cycles. The IOR files shall be submitted using the mechanism defined in [RD7].</p>		
ROC	Implements: EIDA R-382	
<p><i>It shall be possible to activate/deactivate this functionality on demand if necessary.</i></p>		

REQ-ROC-CIRD-0240	RPW MTP IOR constraints	Test
<p>The ROC shall ensure that the operations timeline within the RPW MTP IOR files delivered to SOC, are consistent with the instrument resource allocations (TM corridors and power consumption).</p>		
ROC	Implements: REQ-ROC-002 REQ-ROC-010	

REQ-ROC-CIRD-0250	Computing RPW resources	Test
<p>The ROC shall support the capability of compute the RPW resources, instantaneous and daily average TM bit rate as well as power consumption, over a given MTP cycle.</p> <p>Especially, both predictive and real TM bit rates calculation shall be supported, in order to:</p> <ul style="list-style-type: none"> - Ensure a priori that the expected bit rate is inside the MTP Telemetry corridors (TMC) [RD26], delivered by SOC for planning the operations. - Verify a posteriori the real bit rate using the downlinked data and refine, if required, the expected bit rate for the next incoming STP cycles. <p>The TM bit rate computation tools will have to be accessible to the RPW consortium and ROB</p>		
ROC	Implements: REQ-ROC-006	
<p><i>This functionality shall support the RPW team when planning the operations with the TM bit rate constraint (i.e., TMC).</i></p>		

5.6.1 Requesting Short-Term Planning (STP) instrument operations

In the nominal case, the instrument is commanded by submitting to the SOC the time of execution of the TC sequences for each STP cycle (i.e., approx. 1 week during the NMP). The process is done through the IOR mechanism. Implementing the operation requests at VSTP cycle (i.e., within few days) is **TBC**.

Additionally, the SBM1/SBM2 event data to downlink will be requested every week (**TBC**) to SOC via a dedicated interface **TBD**.



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As for the MTP cycle, the operations performed through the STP IOR mechanism will have to be consistent with the constraints, defined by both the ROB and SOC, at RPW and Solar Orbiter levels respectively.

REQ-ROC-CIRD-0260	Producing RPW STP IOR	Test
The ROC shall support the generation of RPW IOR files for STP planning cycles. The IOR files shall be saved in the format defined in [RD5].		
ROC	Implements: EIDA R-373 REQ-ROC-007	
<i>The STP IOR timeline for a given STP cycle should be initially generated from the associated MTP IOR timeline submitted to SOC.</i>		

REQ-ROC-CIRD-0270	Submitting RPW STP IOR	Test
The ROC shall support the submission to the SOC of RPW IOR files for STP planning cycles. The IOR files shall be submitted using the mechanism defined [RD7].		
ROC	Implements:	

The ROC shall ensure that the RPW IOR files delivered to SOC for STP planning are consistent with the ROB and SOC inputs (SOOP, TMC).

REQ-ROC-CIRD-0280	Requesting SBM1/SBM2 events data	Test
The ROC shall support the capability of requesting to SOC, the SBM1/SMB2 events data to be downlinked from the on-board SSMM. The request shall be performed using the mechanism defined [RD?] and in the format defined in [RD?].		
ROC	Implements: EIDA R-354 REQ-ROC-009	

5.6.2 Requesting non-routine instrument operations

In case of non-routine, engineering and anomalies payload operations, the requests will have to be directly sent to the MOC, using the PDOR/MDOR format and via the dedicated delivery mechanism [RD?].

These operations will be planned and operated outside of the scope of the science operations timeline driven by SOC.



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REQ-ROC-CIRD-0290	Producing RPW PDOR	Test
<p>The ROC shall support the generation of RPW PDOR files. The PDOR files shall be saved in the format defined in [RD21].</p>		
ROC	Implements:	

REQ-ROC-CIRD-0291	Submitting RPW PDOR	Test
<p>The ROC shall support the submission to the MOC of RPW PDOR files. The PDOR files shall be submitted using the mechanism defined [RD?].</p>		
ROC	Implements:	

REQ-ROC-CIRD-0300	Producing RPW MDOR	Test
<p>For direct operations related to the on-board memory (patching), the ROC shall support the generation of MDOR. The MDOR files shall be saved in the format defined in [RD21].</p>		
ROC	Implements: EIDA R-379	

REQ-ROC-CIRD-0301	Submitting RPW MDOR	Test
<p>For direct operations related to the on-board memory (patching), the ROC shall support the submission to the MOC of MDOR. The MDOR files shall be submitted using the mechanism defined [RD?].</p>		
ROC	Implements: EIDA R-379	

5.6.3 Producing, delivering and using instrument command sequences

The TC sequence is the baseline granularity to command the instrument during the mission (see [RD20] for more details). The ROC will have to deliver to the MOC the command sequences for RPW.



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All of the sequences required to perform the RPW commissioning and CP operations will have to be supplied prior to the launch. Especially, specific tests (i.e., SVT) will be performed on-ground with the MOC, in order to ensure the validity of these sequences. At the end, only sequences, validated by MOC and stored in the Flight Operation Plan (FOP), will be integrated into the MOC Mission Information Base (MIB) and, thus, available for performing in-flight operations.

REQ-ROC-CIRD-0310	Producing RPW TC sequences	Test
<p>The ROC shall support the generation of TC sequences for RPW. The sequences shall be saved in the format defined in [RD22].</p>		
ROC	Implements:	
<i>There is no formal mechanism to deliver the sequences.</i>		

REQ-ROC-CIRD-0311	Submitting RPW TC sequences	Test
<p>The ROC shall support the submission to the MOC of TC sequences for RPW. The sequences shall be delivered using convention defined in [RD15].</p>		
ROC	Implements:	
<i>There is no formal mechanism to deliver the sequences.</i>		

REQ-ROC-CIRD-0320	Testing TC sequences execution	Test
<p>The ROC shall be capable of testing the execution of RPW TC sequences on GSE at LESIA. This functionality will have to be kept up-and-running during the mission.</p>		
ROC	Implements:	
<i>This functionality will allow to pre-validate the RPW command sequences before being delivered to MOC.</i>		

REQ-ROC-CIRD-0330	RPW TC sequences source and version	Test
<p>The ROC shall only use the operational version of the MIB to submit its operation requests (IOR, MDOR, PDOR) during the Solar Orbiter mission.</p>		
ROC	Implements:	
<i>This functionality ensures that the ROC uses the same version of the sequences and IDB than MOC to perform in-flight operations.</i>		



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5.7 Instrument monitoring

The monitoring of the Solar Orbiter payload will be first performed by MOC operators from the instructions given in the RPW user manual.

Nevertheless, the ROC shall also implement its own system to monitor the instrument good health and notify identified people in case of anomalies.

5.7.1 Monitoring instrument data

REQ-ROC-CIRD-0340	Monitoring RPW instrument data	Test
The ROC shall be able of: <ul style="list-style-type: none"> - Monitoring the status of the instrument - Monitoring some HK parameters at spacecraft level (solar array and HGA position, temperature probes, etc.) (TBC) - Reporting anomaly events triggered on-board - Automatically publish summary reports about the instrument status every 24 hours - Generate tendency report on demand, in order to follow the instrument behaviour over the mission (i.e., internal calibration, hardware aging, time synchronization, ...) 		
ROC	Implements: EIDA R-367 EIDA R-371	

5.7.2 Checking instrument command execution

This functionality will be at a first step ensured by the MOC from the Service 1 TM and information given in the TC sequences . The results of the MOC TC verifications will be available in the TC-report files, downloadable via its EDDS interface.

Nevertheless, the ROC needs also to keep a trace of the TM/TC data flow and verified that the instrument is the expected state.

REQ-ROC-CIRD-0350	Monitoring TM Service 1	Test
The ROC shall be capable of verifying the acceptance and execution completion of a RPW TC uplinked on-board. The verification shall be realized using the Service 1 telemetry.		
ROC	Implements:	

REQ-ROC-CIRD-0360	Checking expected instrument state	Test
The ROC shall be capable of verifying that the instrument is in the expected configuration after TC		



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executions on-board.	
ROC	Implements:

REQ-ROC-CIRD-0370	Checking flight software update	Test
The ROC shall be capable of verifying that a flight software update has been correctly applied.		
ROC	Implements:	EIDA R-380

5.8 Ground support

The ROC will participate to the RPW calibration campaigns on-ground, supervised by CNES AIT/AIV team.

REQ-ROC-CIRD-0380	Supporting RPW calibration campaigns on-ground: data visualization	Test
The ROC shall support the capability of visualizing the RPW and E-GSE stimuli data generated during the ground calibration campaigns at system level.		
ROC	Implements:	
<i>This facilities will be mainly used by the CNES AIT/AIT team to check and process test data.</i>		

REQ-ROC-CIRD-0390	Supporting RPW calibration campaigns on-ground: data distribution	Test
The ROC shall support the capability of retrieving, producing and distributing to the RPW consortium, the RPW data and E-GSE stimuli generated during the ground calibration campaigns at system level.		
ROC	Implements:	

The ROC shall be of maintaining up-and-running GSE during the mission to support the RPW teams in case of anomaly investigation or testing activities on-ground.

REQ-ROC-CIRD-0400	Supporting RPW anomaly investigation	Test
The ROC shall support the capability of retrieving, producing and distributing to the RPW consortium, the RPW data and E-GSE stimuli generated on-ground during the mission (mainly for anomaly investigations and testing purposes.)		
ROC	Implements:	EIDA R-369



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Besides, the ROC is involved in the validation of the RPW DPU SBM1/SBM2 detection algorithms by the flight software team. Software simulators are hence required to reproduce the detection algorithms behaviour and to analyze detection rates from synthesized input data.

These simulators will be also used during the mission to parametrize the algorithms and optimize the detection rates, from real data analysis.

REQ-ROC-CIRD-0410	Supporting RPW DPU SBM1/SMB2 detection algorithms simulation	Test
The ROC shall support the capability of simulating the RPW DPU SBM1/SBM2 detection algorithms behaviour.		
ROC	Implements:	
<i>This function shall support the ROC in the parametrization of the DPU SBM detection algorithms on-board.</i>		

5.9 ROC infrastructure monitoring

REQ-ROC-CIRD-0420	ROC infrastructure monitoring	Test
The ROC shall be capable of monitoring the good health of its software infrastructure and related processes, more particularly:		
<ul style="list-style-type: none"> - The processing, data and user interface servers works - The data processing pipelines are up-and-running - The operation tools is available - The external interfaces are reachable (DDS and GFTS) 		
Results of the monitoring shall be at least reported into log files, readable by the ROC administrator and operator.		
ROC	Implements:	
<i>Access to the software log information through specific GUI should be envisaged.</i>		

5.1 Communication and science support

REQ-ROC-CIRD-0430	ROC support to the RPW Web page	Demo
The ROC shall be support the RPW PI to maintain the RPW Website at LESIA by:		
<ul style="list-style-type: none"> - Providing information about RPW data generated at LESIA - Providing information about software to read and view the RPW data - Providing information related to the ROC and its activity 		
ROC	Implements:	REQ-ROC-029



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6 ROC OPERATIONAL REQUIREMENTS

6.1 Organization

The science mission is under the responsibility of the Solar Orbiter ESA board and payload PIs. The SOC coordinates the science operation planning and performs the archiving of the science data. The MOC ensures the execution of the operations, the platform and primary payload monitoring and the anomaly procedures.

The RPW PI shall guarantee the science objectives of the instrument. The ROC shall ensure the RPW ground segment activities.

The CNES and LESIA are in charge of the activities related to the instrument until the end of the NECP. Especially, the CNES shall coordinate and ensure the commissioning of RPW.

After the end of the NECP, the exploitation of RPW is under the responsibilities of the ROC, with the science coordination of the ROB and RPW consortium.

6.2 ROC key personnel responsibilities

6.2.1 RPW Principal Investigator (PI)

In the framework of the RPW ground segment, the RPW PI shall be in charge of:

- Supporting the Solar Orbiter science operation definition.
- Defining the RPW science operation planning for all phases of the mission in accordance with the Solar Orbiter mission planning.
- Approving the ROC CIRD and Project Management Plan (PMP).
- Approving the financial and technical proposal document
- Validating RPW science data calibrations.
- Ensuring the RPW performance fulfilled the science requirements [AD6].
- Assuming overall responsibility about the RPW science data in terms of quality, dissemination and archiving.
- Share overall responsibility with the RPW Project Manager at the CNES for the definition and execution of the RPW operations during the NECP.
- Assume overall responsibility for the definition and execution of the RPW operations during the CP, the NMP and the EMP.
- Supervising the selection of SBM event data to be downlinked from the SSMM. This activity shall be performed in collaboration with other instrument PIs involved.
- Being the main interlocutor between the RPW ground segment and the Solar Orbiter consortium concerning RPW science operation planning at S/C level.
- Approving the instrument operations reports released after each in-flight phase
- Co-approving the FOP for the RPW relevant sections
- Liaising with the science community concerning the RPW science data exploitation.
- Liaising with the NASA Solar Probe Plus FIELDS PI team in common development and data processing.
- Participating to the ROB



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6.2.2 RPW Ground Segment Project Manager (GSPM)

The RPW Ground Segment Project Manager is responsible of supervising the RPW ground segment activities. After the launch, she/he also ensures the tasks of the RPW exploitation manager.

Especially she/he shall:

- Establish the overall RPW ground segment activities and RSS capabilities implementation requirements.
- Establish the concepts to ensure compatibility, commonality, and maximum re-use of hardware and software between all phases of the project.
- Assume overall coordination for the definition and implementation of the elements of the ROC.
- Establish the ROC PMP.
- Establish the technical and financial proposal document (PTF).
- Assume overall responsibility for the ROC infrastructure availability during all phases of the mission
- Assume overall responsibility for the RPW ground segment configuration and documentation management, in terms of consistency and accessibility policy.
- Write the CIRP, update as required.
- Approve all changes of the RPW Software Development Plan (SDP).
- Ensure the instrument operations comply the science and operation planning at both payload and S/C levels.
- Supervise the TC sequences preparation, validation and delivery.
- Assume overall responsibility for the remote control of the RPW operational modes. It includes the SOOP to IOR/PDOR/MDOR translation as well as the IOR/PDOR/MDOR preparation, validation and transmission to the SOC/MOC.
- Coordinate the RPW routine and non-routine (e.g., flight software patching, contingency recovery) operations.
- Assume overall responsibility for the RPW performances during all in-flight phases of the mission.
- Ensure the monitoring of the RPW performance as well as on-board data storage and power management.
- Coordinate the instrument failure and anomaly operation management.
- Establish and maintain the overall RPW ground segment development and sustainability.
- Act as the main interface with the RPW Lead CoI ground segment teams.
- Act as the main interface with the MOC and SOC about RPW operations, data processing and archiving technical issues. Especially, the RPW Ground Segment Project Manager should participate to the Science Operations Working Group (SOWG).
- Supervize and participate to the RSS development and validation, more particularly the ROC SGSE, RPW science operation planning tools, data processing pipelines, instrument monitoring tools as well as the software interfaces with the MOC/SOC.
- Ensure the sustainability, the availability and the maintenance of the RSS during all phases of the mission.
- Issue instrument operations reports after each in-flight phase.



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- Co-approving the FOP for the RPW relevant sections
- Ensure the availability of the software equipment in support to the validation activities. Especially, the Ground Segment Project Manager shall ensure that the monitoring of the RPW-related operations execution during the LEOP/NECP at MOC can be fully performed.
- Assume the responsibility of the RPW science performance validation in-flight.
- Establish the ROC SDP, the ROC Software System Specification (SSS), the Software Design Documents (SDD) and Interface Control Documents (ICD) concerning the RSS.
- Coordinate the writing and delivery of the ROC User Manual (RUM).
- Establish guidelines about RPW ground segment engineering development, including procedures for testing, validating, delivering, executing and maintaining applications to be run by the ROC.
- Be the main interlocutor between the ROC and the LESIA in terms of hardware/software logistic support.
- Ensure the archiving and accessibility of the RPW ground segment documentation
- Liaise with the RPW Lead CoI ground segment teams about RPW sub-system science data processing software and data to be implemented in the RSS.
- Participating to the ROB

Depending of the context, a part of these tasks may be supported by a deputy project manager if required.

REQ-ROC-CIRD-0440	RPW User manual updating	Review
The RPW ground segment project manager shall be responsible of the RPW user manual updates during the exploitation phase of the mission (CP, NMP, EMP).		
ROC	Implements:	EIDA R-392
<i>The writting, delivery and maintenance of the RPW User manual will under the CNES responsibility until of the NECP.</i>		

REQ-ROC-CIRD-0450	Single point of contact	Review
The RPW ground segment project manager shall be the single point of contact for instrument planning activities and for data deliveries to the Solar Orbiter Archive		
ROC	Implements:	EIDA R-698

REQ-ROC-CIRD-0460	Change requests	Review
The RPW ground segment project manager, or her/his representative, shall submit change requests to the MOC for approval, in case of deviations from foreseen procedures and activities		
ROC	Implements:	EIDA R-727



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6.2.3 RPW Instrument Scientist

The RPW Instrument scientists are in charge of supporting the RPW science activities in the ROC, and maximizing the scientific return of the instrument. Her/his main tasks shall consist of:

- Verifying the RPW performance fulfilled the science requirements [AD6].
- Participating of the RPW science data format definition.
- Supervising the validation of the RPW science data calibrations
- Optimizing and validating the SBM detection algorithms.
- Ensuring the quality of RPW science data produced during the mission.
- Participating to the preparation of the science operations for RPW.
- Participating to the discussions concerning the RPW science in the dedicated working groups.
- Supervising the ROB

She/he will be supported in her/his tasks by the RPW PI, Lead CoI, CoI and the ground segment science support team.

6.2.4 RPW Lead Co-Investigators (Lead CoIs)

In the framework of the RGS, the Lead Co-Is shall:

- Ensure the calibration of its RPW sub-system.
- Support the RPW sub-system data product definition
- Support the validation of its RPW sub-system science data.
- Ensure the quality of its RPW sub-system calibrated science data.
- Provide expertise support in case of failure or anomalies involving its RPW sub-system.
- Assume the development, test, validation, delivery and maintenance of the software that produce science data for their RPW sub-system. These software shall be designed to be runnable in the RSS.
- Participate to the preparation of the RPW operations.
- Participate to the ROB

6.3 ROC operational staff responsibilities

6.3.1 ROC exploitation manager

She/he is in charge of the exploitation of the ROC. She/he ensures the human and financial resources of the ROC during the mission and drives the daily activities of the centre.

6.3.2 ROC administrator

The ROC administrator is in charge of maintaining the ROC infrastructure up-and-running.

She/he has hence all the rights on the ROC servers and can start/stop processes, configure system and software execution, add/delete data if required.

Since the ROC infrastructure is hosted at LESIA, the ROC administrator works in close collaboration with the administrators of the laboratory.



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6.3.3 ROC operator

The ROC operator ensures the daily tasks of the ROC:

- She/he monitors the activities from report logs and dedicated dashboards
- She/he checks the operation planning, instrument control/command and ensures the RPW data monitoring
- She/he performs the routine manual procedures (processing, reprocessing, etc.)
- She/he notifies the identified people in case of problems.

6.3.4 LESIA computer administrator

The LESIA computer administrator is in charge of the hardware maintenance of the ROC servers. She/he is also responsible of the Internet/Intranet network access and computer security.

6.3.5 ROC users

The ROC user definition covers the following people:

- RPW PI and Lead CoI
- RPW science CoI
- RPW instrument teams
- RPW consortium
- RPW Operations Board (ROB)
- Solar orbiter MOC and SOC
- Solar Orbiter PIs and ITs
- External guests (e.g., science collaborators)
- Public

REQ-ROC-CIRD-0470	ROC software tools user access	Test
<p>The ROB and RPW consortium shall have an access to the following ROC tools:</p> <ul style="list-style-type: none"> - RPW operation planning user interface - RPW SBM1/SBM2 data selection user interface - RPW data visualization and monitoring user interface <p>The read/write user permission shall be approved individually by the ROC ground segment project manager. Especially, the selection of the SBM1/SBM2 data to downlink shall be validated by the ROB chair (instrument scientist) from the votes of the ROB members. (TBC)</p>		
ROC	<p>Implements:</p> <p style="margin-left: 20px;">REQ-ROC-005</p> <p style="margin-left: 20px;">REQ-ROC-019</p>	



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Access to the some Solar Orbiter PIs can be envisaged to perform the selection of SBM1/SBM2 event data to downlink.

REQ-ROC-CIRD-0480	ROC data user access	Test
<p>The RPW consortium (i.e, PI, Lead Cols, Cols and instrument teams) and Solar Orbiter MOC, SOC and PIs shall have a full access to retrieve RPW data files stored by the ROC at LESIA.</p> <p>External guests can also ask for an access, but it shall be formally accepted by the RPW PI.</p>		
ROC	Implements:	
<p><i>The read/write permissions on the RPW file servers will be attributed individually by the ROC GSPM depending on the needs.</i></p>		

6.4 ROC operational working requirements

REQ-ROC-CIRD-0490	ROC routine operational procedure	Review
<p>The manual procedures related to the routine operations shall be performed by ROC operators during working days and hours only. Outside of these periods, procedures taht can be automated shall be launched autonomously.</p>		
ROC	Implements:	

REQ-ROC-CIRD-0500	ROC anomaly operational procedure	Test
<p>Outside of the working days and hours, any identified anomaly shall be saved automatically and notified to the ROC operator when she/he is present at ROC.</p>		
ROC	Implements:	

6.5 RPW routine operations activity requirements

6.5.1 Planning instrument science operations

The instrument science planning process will be driven by the RPW Operation Board (ROB) [AD2] with the support of the RPW consortium. Especially, the ROB has to ensure that operation requests are consistent with the science objectives at both Solar Orbiter and RPW levels.

REQ-ROC-CIRD-0510	ROC science operations support	Review
<p>The ROC shall participate to the preparation of the science operations at mission level.</p>		



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Especially, the RPW ground segment project manager, or her/his representative, shall be a member of the Solar Orbiter Science Operations Working Group (SOWG).

ROC	Implements: EIDA R-354
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REQ-ROC-CIRD-0520	ROB ROC support	Review
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The ROC shall provide all the inputs required by the ROB and RPW consortium, in order to prepare and follow the status of the instrument observing plan at each cycle levels (i.e., MLP, LTP, MTP and STP).

The inputs are defined in [AD2].

ROC	Implements: REQ-ROC-005
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REQ-ROC-CIRD-0530	RPW science operations planning	Review
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The ROC shall prepare the RPW operations planning, following the ROB instructions. Especially, the RPW ground segment project manager shall be a member of the ROB.

The ROC shall ensure that the RPW operations planning is consistent with the mission timeline defined by the Solar Orbiter Science Working Team (SWT), SOWG and In-Situ Working Group (ISWG), including:

- Science objectives defined in the Science Activity Plan (SAP)
- Solar Orbiter Observing Plans (SOOP) allocation
- Resources allocation (TMC, power)
- Coordinated operations (e.g., in situ burst survey mode synchronisation)

ROC	Implements: REQ-ROC-003 REQ-ROC-008
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6.5.2 In-flight RPW calibrations

On-board internal calibrations will have to be planned as routine operations by the ROC. It concerns the LFR/SCM, TNR-HFR and Bias unit sub-systems.

REQ-ROC-CIRD-0540	Performing TNR-HFR in-flight calibration	Review
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The ROC shall perform at least once a week a TNR-HFR calibration on-board.

ROC	Implements: REQ-ROC-014
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REQ-ROC-CIRD-0550	Performing LFR/SCM in-flight calibration	Review
The ROC shall perform at least once a week a LFR/SCM calibration on-board.		
ROC	Implements:	REQ-ROC-015

REQ-ROC-CIRD-0560	Performing Bias unit in-flight calibration	Review
The ROC shall perform at least once a week a BIAS calibration, in the science operations timeline.		
ROC	Implements:	REQ-ROC-013

6.5.3 In-flight RPW Bias current setting

Maintaining the RPW electrical antennae potential close to the local plasma potential, will require to regularly adjust the current values injected by the Bias unit in each of the three antennae.

Additionally, Bias current sweepings will have to be run on-board as often as possible, in order to refine with the best accuracy the Bias currents predictive model along the spacecraft orbit.

REQ-ROC-CIRD-0570	Performing in-flight Bias current setting	Review
The ROC shall perform at least every week the update of the BIAS currents applied on-board, from the inputs provided by the Bias Lead Col team and in accordance with the operation plans defined by the RPW consortium and ROB.		
ROC	Implements:	REQ-ROC-004 REQ-ROC-013

REQ-ROC-CIRD-0580	Performing in-flight Bias sweeping	Review
The ROC shall perform at least once a week a BIAS sweeping, in the science operations timeline.		
ROC	Implements:	REQ-ROC-013

REQ-ROC-CIRD-0590	Making available Bias operation data	Test
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The ROC shall made available to the BIAS team all downlinked telemetry data required to control and refine the BIAS current values applied on-board.

ROC

Implements:

REQ-ROC-CIRD-0600

Retrieving Bias operation inputs

Test

The ROC shall provide a dedicated interface that allows the Bias team to request the Bias current values to be applied on the threere antennas on-board.

As soon as the Bias team has submitted new current values, it shall take not longer than a week to be added in the RPW science operations timeline.

ROC

Implements:

6.5.4 TDS triggering snapshot dumping

REQ-ROC-CIRD-0610

Dumping TDS triggered snapshots

Test

The ROC shall be able of dumping at least 4 times a day the TDS triggered snapshots stored on-board.

ROC

Implements:

6.5.5 RPW selective downlinking

REQ-ROC-CIRD-0620

Supervizing SBM1/SBM2 event data selection

Test

The ROC shall supervise the process of the SBM1/SBM2 event data selection at RPW level.

The supervision shall consist of:

- Providing the data and facilities to support the selection process
- Ensuring the SBM selection operation requests to SOC
- Producing history log of SBM selected and retrieved

ROC

Implements:

REQ-ROC-CIRD-0630

RPW SBM selection responsibilities

Review

The ROC shall be the main interface between SOC, payload PIs, ROB and RPW consortium in case of discussions concerning the RPW selective downlink.

ROC

Implements:



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6.6 RPW non-routine operations activity requirements

6.6.1 RPW flight software operations

REQ-ROC-CIRD-0640	RPW flight software patching	Test
The ROC shall ensure flight software patching (service 6) operations.		
ROC	Implements:	
<i>Especially, it shall be capable of verifying that software patch has been correctly applied on-board by performing software dumping.</i>		

6.6.2 RPW contingency recovery operations

REQ-ROC-CIRD-0650	RPW contingency recovery supervision	Review
The ROC shall supervise the contingency recovery operations at the RPW Consortium level. (The contingency recovery operations are led by the MOC at mission level.)		
ROC	Implements:	

6.6.3 RPW anomaly investigation support

REQ-ROC-CIRD-0660	RPW instrument anomaly investigation support	Review
The ROC shall coordinate the anomaly investigation and resolution related to RPW. Especially, it shall be the main point of contact between Solar Orbiter teams (MOC, SOC, PIs) and the RPW consortium.		
ROC	Implements: EIDA R-369 REQ-ROC-012	

6.7 RPW commissioning activity requirements

The RPW commissioning is under the responsibility of the CNES. However, the ROC will have an active participation to support the preparation, the execution and the validation of this critical phase.

REQ-ROC-CIRD-0670	ROC support during RPW commissioning	Review
During RPW commissioning, the ROC shall support the CNES for the in-flight validation of the instrument. Especially it shall:		



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- Support the CNES in the preparation of the commissioning operations.
- Ensure the availability of the facilities required to perform the instrument commissioning and its validation
- Be the main interface with the MOC to retrieve RPW TM data and submit TC.
- Participate to the writing of the RPW commissioning-related report and review

ROC	Implements: EIDA R-372 REQ-ROC-001
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6.8 ROC ground support activity requirements

REQ-ROC-CIRD-0680	ROC GSE support	Test
<p>The ROC shall maintain up-and-running its GSE during the RPW AIT-AIV campaigns and in-flight instrument commissioning.</p> <p>Moreover, the ROC GSE will have to be available during the exploitation of RPW (mainly for anomaly investigation and TC execution testing).</p>		
ROC	Implements:	

6.9 ROC lifetime

REQ-ROC-CIRD-0690	ROC lifetime	Review
<p>After launch the ROC lifetime shall be at least 12 years.</p> <p>Approx. 10 years of operations plus 2 years of post-operations.</p>		
ROC	Implements:	

7 VERIFICATION TEST AND VALIDATION REQUIREMENTS

7.1 ROC infrastructure verification test and validation

REQ-ROC-CIRD-0700	ROC verification test system	Test
<p>The ROC shall implement verification test system in order to ensure that its infrastructure is operational and performs as expected the functionalities described in the CIRD.</p> <p>In operation, this system will have to be run at least every 24 hours (TBC) at LESIA and generate report log files.</p>		
ROC	Implements:	
<p><i>The testing system shall include unit, integration and interface tests at both software and system levels (e.g., functional test, input/output test, end-to-end test, ping, etc.)</i></p>		



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REQ-ROC-CIRD-0710	ROC infrastructure validation	Review
<p>The ROC shall support the validation of its infrastructure during the dedicated campaigns at LESIA or ESOC (for commissioning). It includes:</p> <ul style="list-style-type: none"> - The tools required to perform the validation - The writing of the validation plan and the report documentation at RPW level - The organization of the validation campaign at LESIA (including TRR/TRB meetings) - The participation to the validation campaigns. 		
ROC	Implements :	

7.1 ROC interfaces verification test and validation

REQ-ROC-CIRD-0720	SOC – ROC interfaces validation	Review
<p>The ROC shall support the test campaigns planned by SOC to validate its interface with the IT. It concerns more specifically:</p> <ul style="list-style-type: none"> - Interface compatibility tests - Interface integration tests - Interface validation tests <p>As described in [RD25]</p>		
ROC	Implements:	

REQ-ROC-CIRD-0730	MOC – ROC interfaces validation	Review
<p>The ROC shall support the test campaigns planned by MOC to validate its interfaces with the IT (i.e. DDS and GFTS). It concerns more specifically:</p> <ul style="list-style-type: none"> - Interface compatibility tests - Interface integration tests - Interface validation tests <p>As described in [RD?]</p>		
ROC	Implements: EIDA R-389	

7.2 Operations verification test and validation

The ROC will be involved in the IGST and SVT campaigns by delivering the instrument procedures to be tested as well as the input documentation (RPW user manual and instrument



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state model). It will also participate to the tests at MOC and to the analysis of the results, including anomaly investigations.

REQ-ROC-CIRD-0740	System Validation Test support	Review
The ROC shall support the preparation, execution and results analyzing of the IGST and SVT campaigns performed by MOC.		
ROC	Implements: EIDA R-383 EIDA R-384 EIDA R-385 EIDA R-386 EIDA R-387 EIDA R-388	

In the same way, the ROC will provide inputs for the SOV campaigns and more specifically, the end-to-end tests involving the MOC, SOC and IT. It will participate to the analysis of the results and potential anomaly investigations.

REQ-ROC-CIRD-0750	System Operation Validation support	Review
The ROC shall support the preparation, execution and results analyzing of the SOV campaigns performed by MOC.		
The SOV includes more particularly the end-to-end tests to validate the whole loop operational process between IT, SOC and MOC.		
ROC	Implements: EIDA R-390	

REQ-ROC-CIRD-0760	Mission operations rehearsals	Review
The ROC shall support the preparation, execution and results analyzing of operation rehearsals including RPW. It include at least:		
<ul style="list-style-type: none"> - Commissioning phase rehearsal coordinated by MOC before the launch (TBC) - Remote-sensing checkout window rehearsal coordinated by SOC prior to the NMP (TBC) 		
ROC	Implements:	

REQ-ROC-CIRD-0770	RPW instrument state model	Review
The ROC shall deliver to MOC and SOC, RPW an instrument state model (i.e., state transitions versus command sequences).		



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The ROC will be in charge of keeping up-to-date the instrument state model during all the phases of the project.

ROC	Implements: EIDA R-361
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8 ROC PERFORMANCE AND DESIGN REQUIREMENTS

8.1 Data retrieving, processing and distributing performance requirements

During cruise and nominal phases, the ROC will run the production of science data files every 24h. This process will be performed in an autonomous way and the distribution of data will be available within few hours after the end of the day.

REQ-ROC-CIRD-0780	RPW data processing performance	Test
The ROC shall be capable of producing RPW L0, L1 and HK data files in less than 60 seconds (TBC), assuming an input telemetry data volume of ~60 Megabytes (i.e., approx.. a day at 5.5 kbps). This duration does not include the time required to query and retrieve the data from the MOC.		
ROC	Implements:	
<i>This performance is constrained by the expected RPW team reactivity latency, needed during the near real-time commissioning operations at MOC.</i>		

REQ-ROC-CIRD-0790	RPW data dissemination nominal performance	Test
During the cruise and nominal phases, the ROC shall support the capability of distributing RPW L0, L1 and HK data files within 48h after the reception at LESIA.		
ROC	Implements:	
<i>The first distributed data files may be incomplete since some TM packets can be available with some delay (due to late packet downlinking or MOC DDS server processing). If missing TM packets are lately retrieved, new versions of the related files shall be generated and distributed within 24h.</i>		

8.2 Data visualization performance requirements

REQ-ROC-CIRD-0800	RPW data visualization nominal performance	Test
During the cruise and nominal phases, the ROC shall be capable of visualizing the RPW data retrieved by MOC since the last spacecraft pass in less than 24 hours. This duration does not include the possible latency due to the MOC DDS server response.		
ROC	Implements:	



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REQ-ROC-CIRD-0810	RPW data visualization performance during commissioning	Test
<p>During the RPW commissioning, the ROC shall be capable of visualizing the RPW data retrieved by MOC since the last spacecraft pass in less than TBD hour.</p> <p>This duration does not include the possible latency due to the MOC DDS server response.</p>		
ROC	Implements:	
<p><i>This requirements should be more particularity needed for RPW operations, which could require near real-time reactivity.</i></p>		

8.3 ROC operations-related activity performance requirements

REQ-ROC-CIRD-0820	Instrument status nominal reporting	Test
<p>During the cruise and nominal phases, the ROC shall support the capability of reporting every 24 hours about the in-flight instrument operations status and health, to the RPW Consortium.</p>		
ROC	Implements:	
<p><i>The daily reporting should be done in autonomuous way. The information shall be clearly sorted by level of severity.</i></p>		

REQ-ROC-CIRD-0830	Instrument status reporting during commissioning	Test
<p>During the commissioning, the ROC shall support the capability of reporting every TBD hours about the in-flight instrument operations status and health, to the RPW Consortium.</p>		
ROC	Implements:	

REQ-ROC-CIRD-0840	Anomaly notification latency performance	Review
<p>As soon as the ROC has identified an anomaly, it shall be capable of informing the MOC, SOC and RPW Consortium within 24 hours.</p>		
ROC	Implements: REQ-ROC-011	

8.4 ROC availability and security requirements

8.4.1 ROC availability requirements

REQ-ROC-CIRD-0850	ROC operational availability	Review
<p>The ROC shall be fully operational at launch.</p> <p>Especially, the ROC system will have to be up-and-running and perform automated tasks 24 hours a day and 7 days a week.</p>		



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At least one ROC operator and one administrator will have to be present at the LESIA site during the working days and hours, in order to monitor activity and perform manual tasks.

ROC	Implements:

REQ-ROC-CIRD-0860	ROC unavailability	Demo
In the nominal case, the ROC shall not be unavailable for more than 3 consecutive days (TBC).		
ROC	Implements:	
<i>This requirement does not concern the near real-time operations during RPW commissioning activity at MOC, where the ROC system and staff will have to be available.</i>		

8.4.2 ROC security requirements

The security of the ROC prime instance at LESIA is ensured by the GIGL, which hosts and maintains the ROC servers and network interfaces. Nevertheless, the ROC shall check that no contaminated file is introduced into its system. Moreover, it shall control the access to its tools by using an authentication mechanism.

REQ-ROC-CIRD-0870	ROC servers and interfaces accessibility	Test
Except the RPW public Web page and ROC public Web server, the ROC system and interfaces shall behind the LESIA firewall and thus only accessible from the LESIA Intranet only. Moreover: - ROC users shall be registered in the ROC database before using ROC operation tools. - ROC production servers shall only be accessible to the ROC administrators.		
ROC	Implements:	

8.5 ROC data storage capacity requirements

The nominal RPW TM raw data rate on-board is 5.5 kbps [AD1], which corresponds to a volume of 59.4 MB per day. Nevertheless, the actual rate might be increased up to three times this value during best data downlink windows.

According to this, an estimation of the full RPW data volume after processing (i.e., HK, L1 and L2 data files production) for a day can be ~2 GB. Additionally, the ROC will have to store L3 and ancillary data (i.e., SPICE kernels), summary plots and operations-related files (i.e., E-FECS, TMC, IOR, procedures etc.), which should occupy around 1 GB per day.

REQ-ROC-CIRD-0880	ROC data total volume	Review
The ROC shall be capable of storing at least 32 Terabytes of data over the 10 years of mission. This volume does not include the ROC databases.		



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ROC	Implements:

The ROC databases will be hosted on the LESIA database server. The ROC databases total size is ~3 TB over 10 years.

REQ-ROC-CIRD-0890	ROC database total volume	Review
The ROC shall allocate 3 Terabytes to save its databases content.		
ROC	Implements:	

9 HIGH LEVEL REQUIREMENTS APPLICABLE TO THE ROC IMPLEMENTATION

For convenience the high level requirements from the “Experiment Interface Document Part A” (EID-A) document [AD1] are reported in the table below. Other requirements can be found in the [AD2] document.

Requirement reference ID	Description	Origin
EIDA R-354	The PI shall make available the necessary resources to support the science operations conducted from the SSOC	[AD1]
EIDA R-355	The PI shall deliver the Level 1b, Level 2, and Level 3 data to the Solar Orbiter Archive.	[AD1]
EIDA R-356	The PI shall ensure that the Level 1b and the level 2 processing SW comply with the requirements specified in [NR-15], “Software”	[AD1] ([NR-15] not defined)
EIDA R-359	The PI shall deliver to the SSOC and maintain the software implementing the data processing pipelines to Level 1b and Level 2.	[AD1]
EIDA R-360	The PI shall make available	[AD1]



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	the necessary resources to support the installation and the maintenance of any relevant software at the SSOC.	
EIDA R-361	The PI shall provide inputs, for the instrument modelling at the SSOC.	[AD1]
EIDA R-367	The PI shall identify unambiguously in the non-science TM packets the type of potential instrument failures / anomalies.	[AD1]
EIDA R-369	The PI shall support the investigation and resolution of Instrument-related anomalies in-flight.	[AD1]
9.1.1.1.1.1.1.1 EIDA R-370	The PI shall comply with the in-flight thermal control requirements, specified in the Solar Orbiter Operation Requirements Document [NR-27] section 2.3.7.	9.1.1.1.1.1.1.2 [AD1]
EIDA R-371	The PI shall issue instrument operations reports after each in-flight phase.	[AD1]
EIDA R-372	The PI shall make available the necessary resources during NECP for the installation of instrument EGSE equipment at the SMOC to monitor the operations execution in near-real time and to support GO/NOGO decisions at predefined steps in the procedures.	[AD1]
EIDA R-373	The PI shall submit operations requests to the SSOC.	[AD1]
EIDA R-376	The PI shall maintain the instrument on-board software	[AD1]



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	throughout the mission.	
EIDA R-379	The PI shall submit SW modifications including memory maintenance requests in form of text files.	[AD1]
EIDA R-380	The PI shall be responsible for the verification of correct loading of the instrument software updates, since science telemetry processing will not be performed at the SMOC.	[AD1]
EIDA R-381	The PI shall support the preparation of the Solar Orbiter Mission Planning, including exchange of files between the SSOC and SMOC in line with the requirements set out in the SGS-OGS ICD [NR-TBD].”	[AD1] (NR not defined)
EIDA R-382	The PI shall provide inputs to the SSOC for the requested science operations for integration in the mission planning products.	[AD1]
EIDA R-383	The PI shall make available the necessary resources to support the satellite interface tests outlined below through preparation of related inputs, review of test plans and procedures, and if required, through actual participation in the tests themselves.	[AD1]
EIDA R-384	The PI shall provide instrument test procedure inputs for the relevant part of the SVTs.	[AD1]
EIDA R-385	The PI shall review and approve instrument procedures defined by the	[AD1]



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	SMOC for the relevant part of the SVTs.	
EIDA R-386	The PI shall make available the necessary resources for real-time support at test site and/or at the SMOC during SVT execution.	[AD1]
EIDA R-387	The PI shall support the evaluation of the relevant part of the SVT results.	[AD1]
EIDA R-388	The PI shall support instrument anomaly investigation and resolution for the relevant part of the SVTs.	[AD1]
EIDA R-389	The PI shall make available the necessary resources to support the procedure definition, the procedure approval, the text execution, the results analysis and the anomaly investigation/resolution for the Data Disposition System Interface Test (DDSIT).	[AD1]
EIDA R-390	The PI shall make available the necessary resources to support the procedure definition, the procedure approval, the results analysis and the anomaly investigation/resolution for the SMOC-SSGS End-to-End Test.	[AD1]
EIDA R-391	The PI shall make available the necessary resources to support the procedure definition, the procedure approval, the test executions, the results analysis and the anomaly investigation/resolution for the first instrument switch-on Simulation campaign.	[AD1]



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EIDA R-392	The PI shall ensure that the list of contents for the instrument user manual complies with the Solar Orbiter Instrument User Manual DRD [NR-39].	[AD1]
EIDA R-393	The PI shall review and approve the FOP for the aspects/sections relevant to instrument operations.	[AD1]
EIDA R-697	The PI shall be responsible for Level 1b, Level 2 and Level 3 processing.	[AD1]
EIDA R-698	The PI shall identify a single point of contact for instrument planning activities and for data deliveries to the Solar Orbiter Archive.	[AD1]
EIDA R-727	The PI shall submit change requests to the SMOC for approval, in case of deviations from foreseen procedures and activities.	[AD1]

Table 4. High level requirements.

10 TRACEABILITY MATRIX

The traceability matrix concerning the ROC implementation requirements is given in [RD16].

11 LIST OF TBC/TBD/TBWs

TBC/TBD/TBW



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12 DISTRIBUTION LIST

<p style="text-align: center;">LISTS</p> <p>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</p>	Tech_LESIA
	Tech_MEB
	Tech_RPW
	[Lead-]Cols
	Science-Cols

INTERNAL

LESIA CNRS		

LESIA CNRS		

EXTERNAL (To modify if necessary)

CNES	C. FIACHETTI
	C. LAFFAYE
	R.LLORCA-CEJUDO
	E.LOURME
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IRFU	L. BYLANDER
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