RPW Operations

X.Bonnin and the ROC Team

Outline

- Operation preparation planning

- SOLO operations planning concept

- RPW operations preparation

Outline

- Operation preparation planning at ESA level

- SOLO operations planning concept

- RPW operations preparation

System Validation Tests (SVT)

- **SVT-0** — From a first set of instrument FOP procedures — planned on [*2017-08-22/24*]

- **SVT-1** — Systematic test of instrument FOP procedures — planned on [*2018-05-09/18*]

- **SVT-2** — Re-test of any anomalies found during the SVT-1a — planned on [*2018-07-06/13*]

Ref: https://confluence-lesia.obspm.fr/display/ROC/Instrument+Commanding+Workshop

Instrument User Manual Complete [L – 1 year]: All the inputs required for Near Earth Commissioning Phase and Cruise Phase (timeline and procedures). Instrument Teams to provide inputs and support iterations as necessary.

Inputs for System Validation Test [L – 1 year]: All inputs required to test on the PFM to validate as far as possible instrument database and procedures. Instrument Teams to provide all test inputs.

SVT-1 [L – 9 months]: Instrument Team with decision authority to support test at test site. Up to two instruments tested in parallel.

Ref: https://confluence-lesia.obspm.fr/display/ROC/Instrument+Commanding+Workshop

Instrument Commanding IF Test [around L-9 months]: Instrument teams to test all commanding interfaces to MOC: PORs, MDORs, PDORs. To be coordinated with MOC&SOC.

Cruise Operations end-to-end test [around L-6 months]: IS Instrument teams to validate end-to-end routine operations planning process, including both TM and TC chains. To be coordinated with SOC.

SVT-2 [L-4 months]: Retest of any problems found with Instruments during SVT-1.

FOP approval [L-3 m]: Instrument teams for review and formally approve all procedures as defined in the Flight Operations Plan (FOP).

NECP [L to L+3 months]: Instrument teams to support commissioning operations. Co-location at ESOC expected, including delivery of any support equipment.

Ref: https://confluence-lesia.obspm.fr/display/ROC/Instrument+Commanding+Workshop

System Operation Validation (SOV)

- **SOV-0** — MOC DDS tests (Test Instrument TM & Command Request transfer capability — [L - 10 months]

- **SOV-1** — MOC Interface Test (Systematic verification of all file change (PDOR, MDOR) — [L - 9 months]

- **SOV-2** — In-Situ Operations E2E (Processing of a realistic CP STP data request. IT submit to SOC, and SOC to MOC) — [L - 6 months]

- **SOV-3** — Checkout window E2E (Same as above, but including RS operations   for a checkout window) — [L - 6 months]

Ref: https://confluence-lesia.obspm.fr/display/ROC/Instrument+Commanding+Workshop
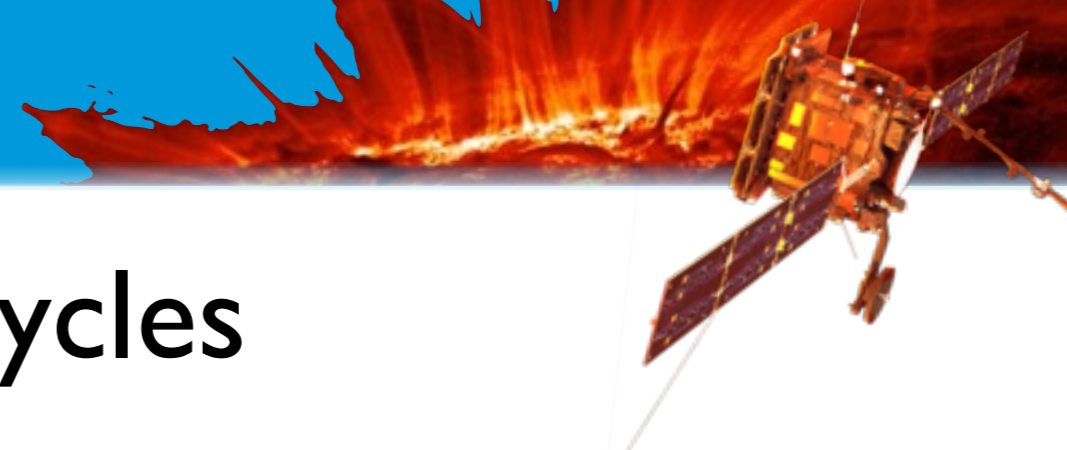
In situ operations E2E (SOV-2, August 2018 TBC)
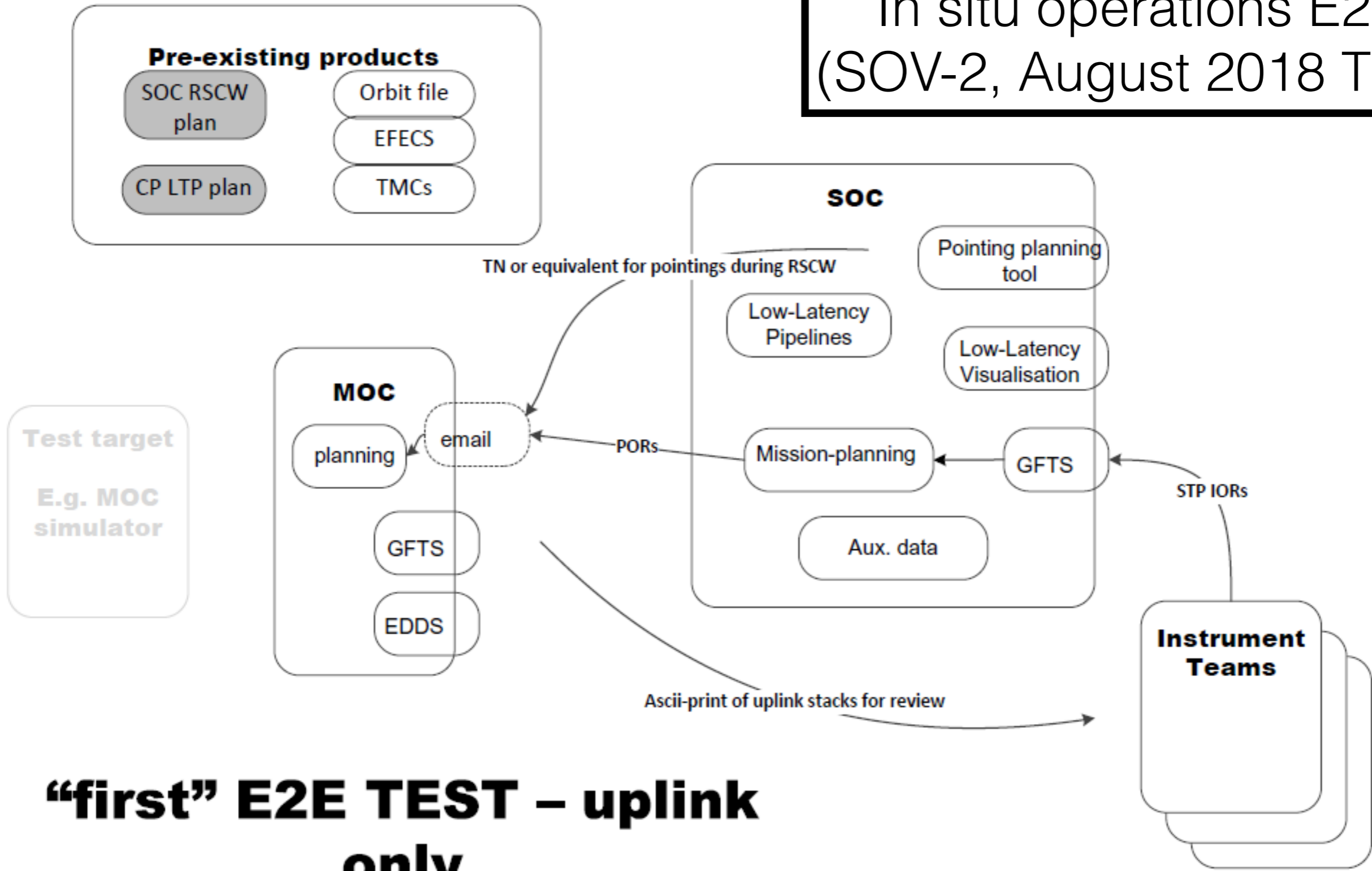


"first" E2E TEST – uplink only

As executed at STP

Outline

- Operation preparation planning

- **SOLO operations planning concept**

- RPW operations preparation

Science Operations Planning Cycles

- *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, planned ≥ 6 months before execution (~ 1 orbit; fixes ground stations allocation)*
  - *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.*

- *Medium-Term Planning (MTP)*
  - *Covers 6 months, fixed 4 weeks before execution (defines top-level science operations per orbit: fixes S/C resources, instrument modes, default pointing)*

- *Short-Term Planning (STP)*
  - *Covers 1 week, planned ~1 week before execution (generates detailed schedules of commands for S/C and payload; last opportunity to modify instrument ops. modes)*

- *Very-Short-Term Planning (VSTP)*
  - *For subset of remote-sensing windows only: update S/C fine pointing to track features on solar disk*
  - *Opportunity for fine-pointing updates: once per 24h, time between pointing definition and execution ≤ 3 days*

From Y. Zouganelis, SOWG8
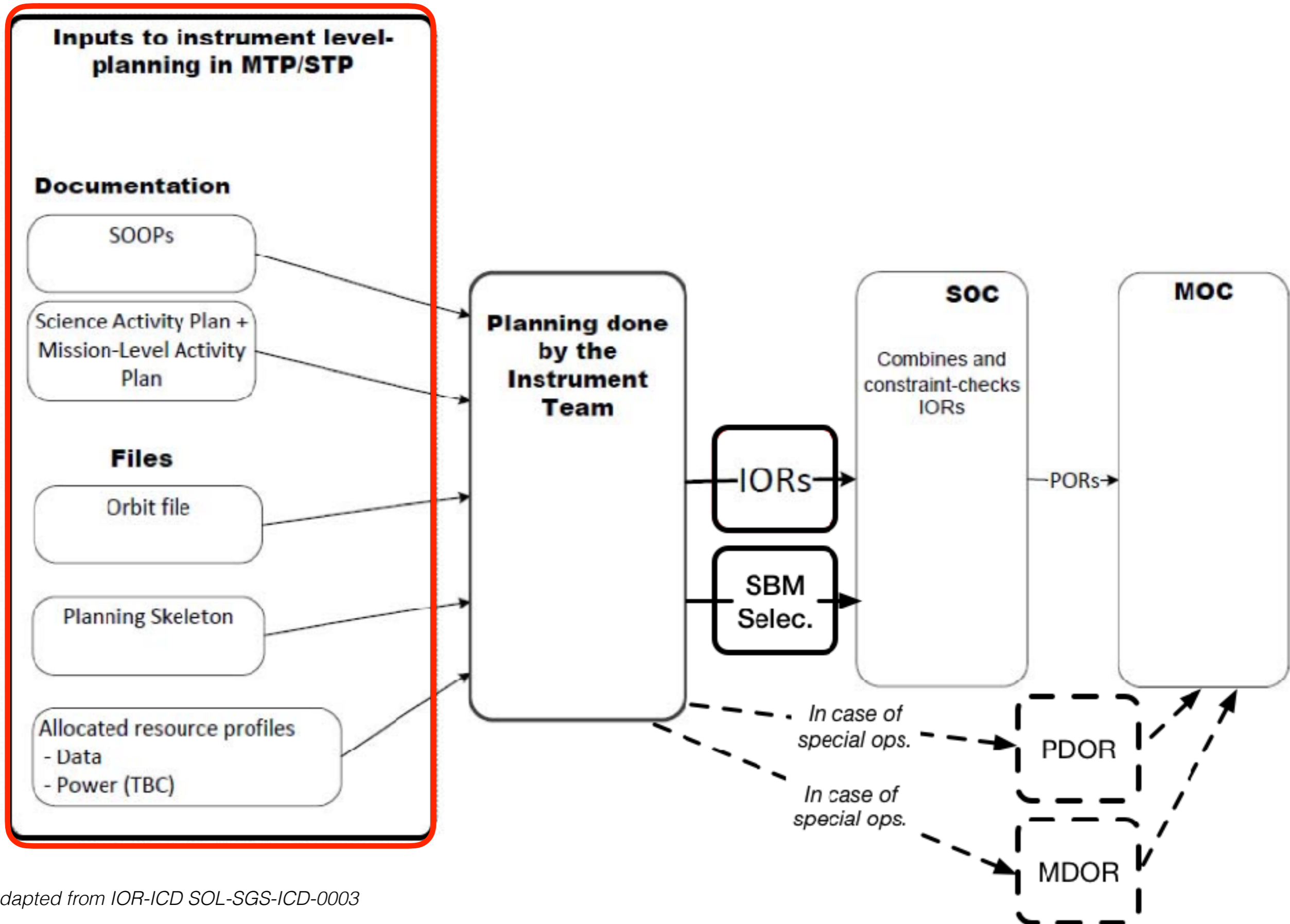
Adapted from IOR-ICD SOL-SGS-ICD-0003

Science Activity Plan

The Science Activity Plan (SAP) describes in a structured way all scientific activities to be carried out by the instruments throughout the cruise and nominal phases in order to fulfill the Science Requirements of the mission.

Top-level science objectives

↓

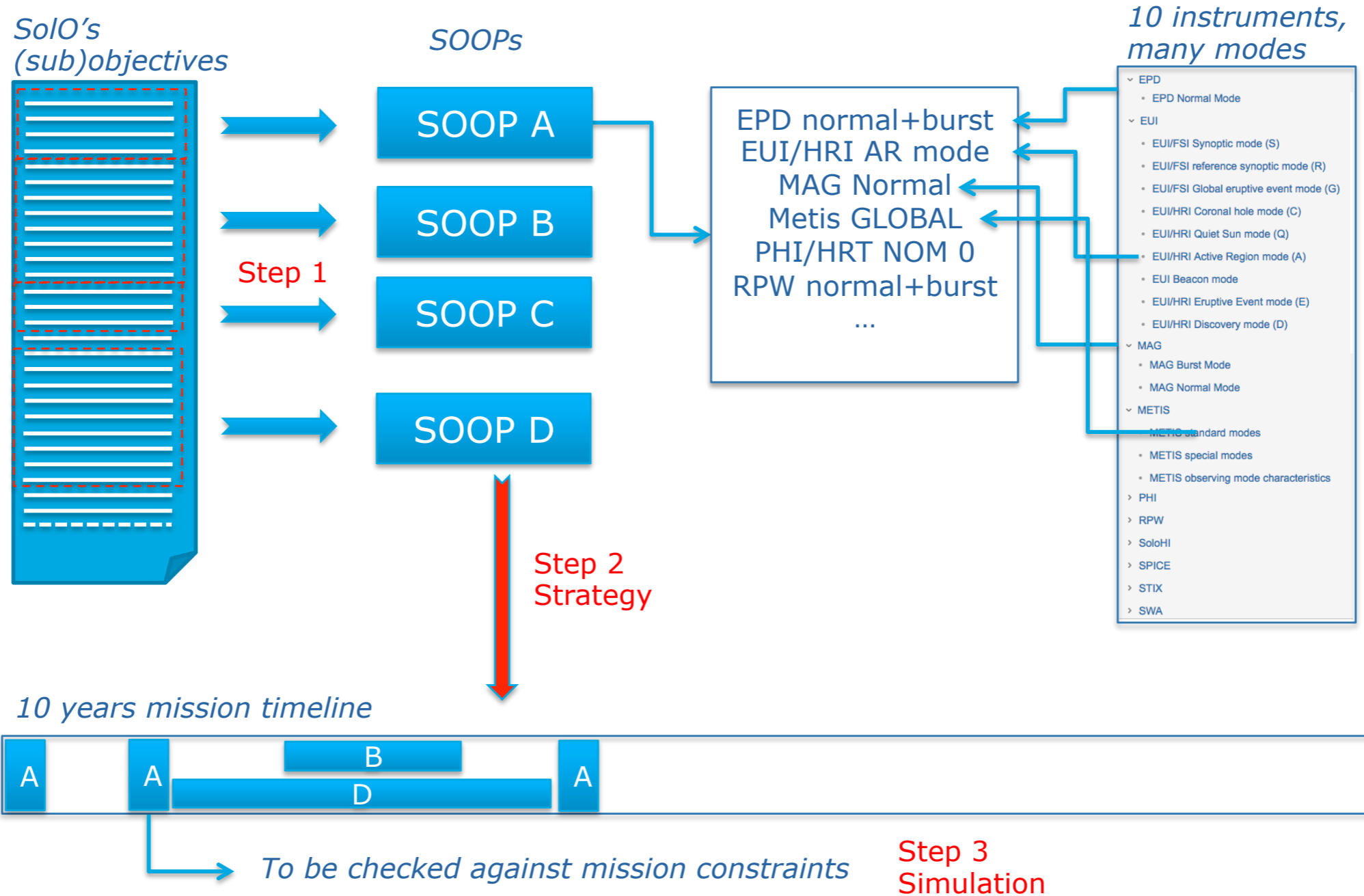Detailed science objectives

↓

Specific Science Activities

↓

Science Orbits

How to build a SAP

How to build a mission-long SAP?

SolO's (sub)objectives

SOOPs

10 instruments, many modes

SOOP A

SOOP B

SOOP C

SOOP D

Step 1

EPD normal+burst
EUI/HRI AR mode
MAG Normal
Metis GLOBAL
PHI/HRT NOM 0
RPW normal+burst
...

- EPD
  - EPD Normal Mode
- EUI
  - EUI/FSI Synoptic mode (S)
  - EUI/FSI reference synoptic mode (R)
  - EUI/FSI Global eruptive event mode (G)
  - EUI/HRI Coronal hole mode (C)
  - EUI/HRI Quiet Sun mode (Q)
  - EUI/HRI Active Region mode (A)
  - EUI Beacon mode
  - EUI/HRI Eruptive Event mode (E)
  - EUI/HRI Discovery mode (D)
- MAG
  - MAG Burst Mode
  - MAG Normal Mode
- METIS
  - METIS standard modes
  - METIS special modes
  - METIS observing mode characteristics
- PHI
- RPW
- SoloHI
- SPICE
- STIX
- SWA

Step 2 Strategy

10 years mission timeline

A A B D A

To be checked against mission constraints

Step 3 Simulation

From Y.Zouganelis, SOWG8
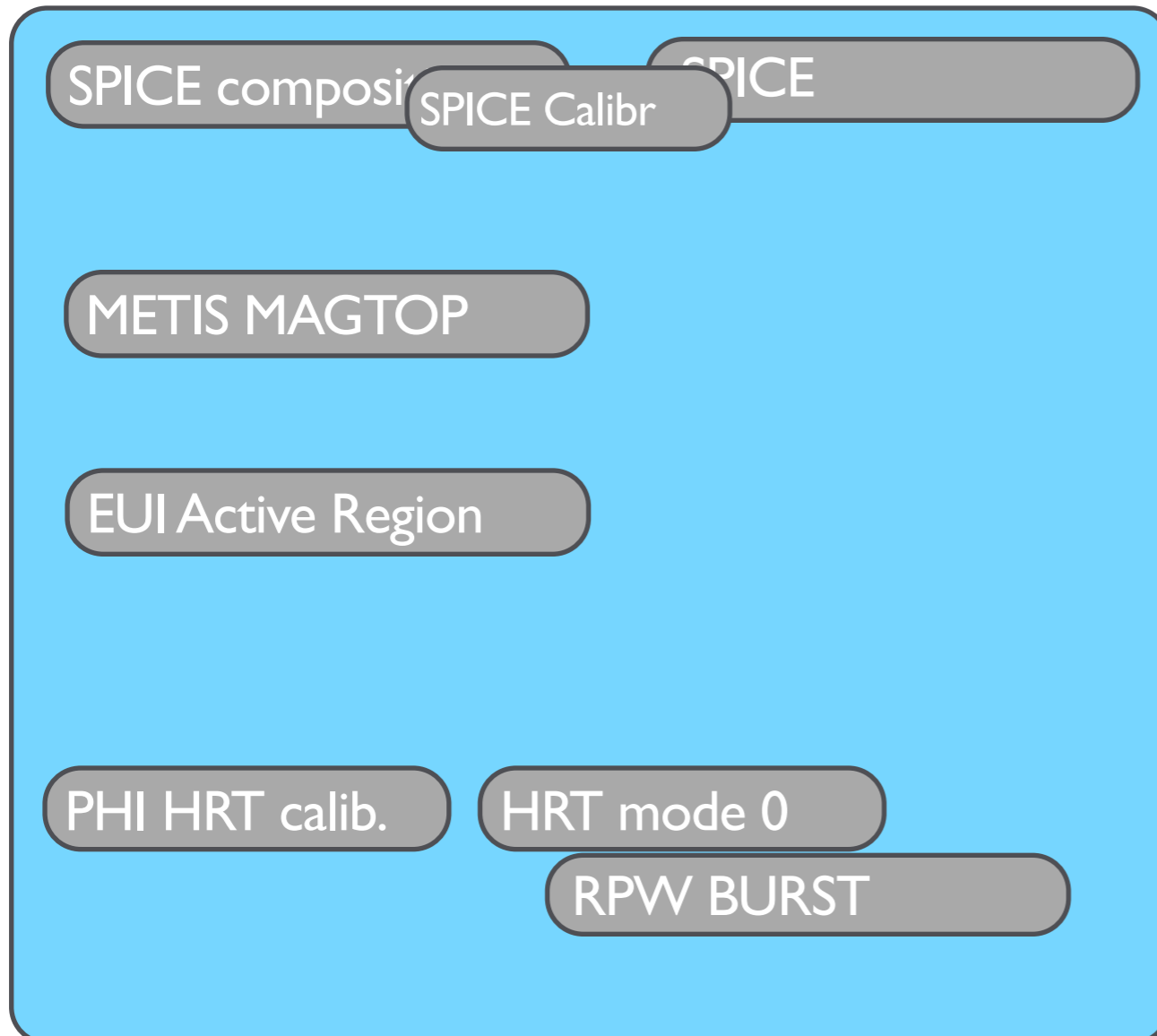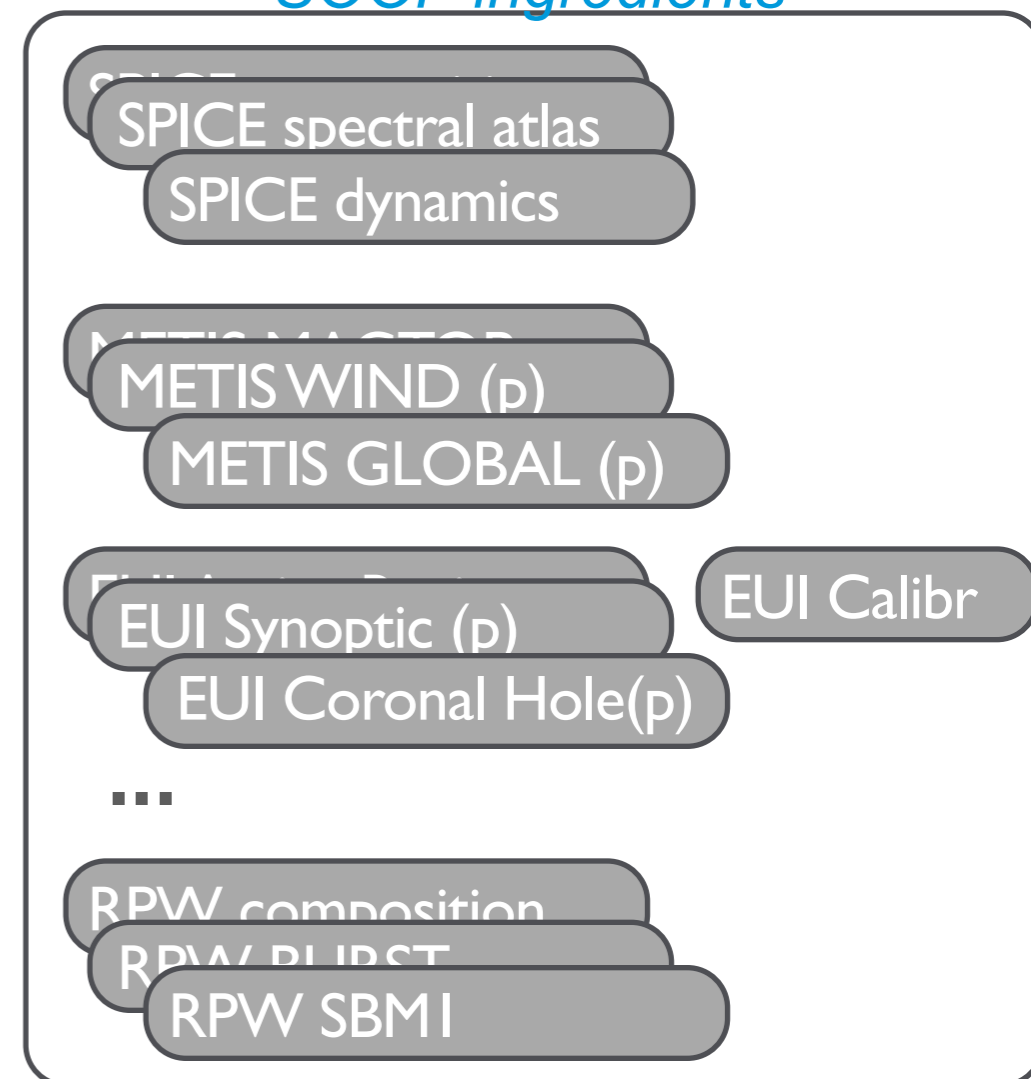
LTP & SOOP concept

□ SOOP = collection of instrument operations that belong together, i.e serve a common science goal *(or calibration goal during manoeuvre)*

Header: goal, instruments, ops reqs, duration, ...

SPICE compositi... SPICE
SPICE Calibr

METIS MAGTOP

EUI Active Region

PHI HRT calib.   HRT mode 0
RPW BURST

Library of science & aux. modes
'SOOP ingredients'

SPICE spectral atlas
SPICE dynamics

METIS WIND (p)
METIS GLOBAL (p)

EUI Synoptic (p)   EUI Calibr
EUI Coronal Hole(p)

...

RPW composition
RPW BURST
RPW SBM1

+ Metadata: **average** power, TM **rate**, conflicts & dependencies

□ High-level ops, no time-stamping, durations (~resources) can be tweaked □ 4

IT operations inputs

In preparation to each MTP (6-months planning-cycle), SOC will deliver to IT:

- Resource allocation profiles by instrument:

    - Telemetry Corridor (TMC)

    - Power consumption constraint (TBD)

- Planning skeleton (E-FECS)

- Predictive Orbit/attitude/time data (SPICE kernels)

Inputs will be refreshed by SOC during the MTP as soon as real data are available (including actual SSMM data volume)

Downlink & Storage limitations

Theoretical Downlink Allocation to RPW and Average TM generation

Above TM corridor = overrun data will be overwritten in SSMM

Below TM corridor = Underrun Downlink opportunity lost

Theoretical Corridor
Lost Data: old data overwritten
Unused downlink: not guaranteed to get back
Corridors only work if independent
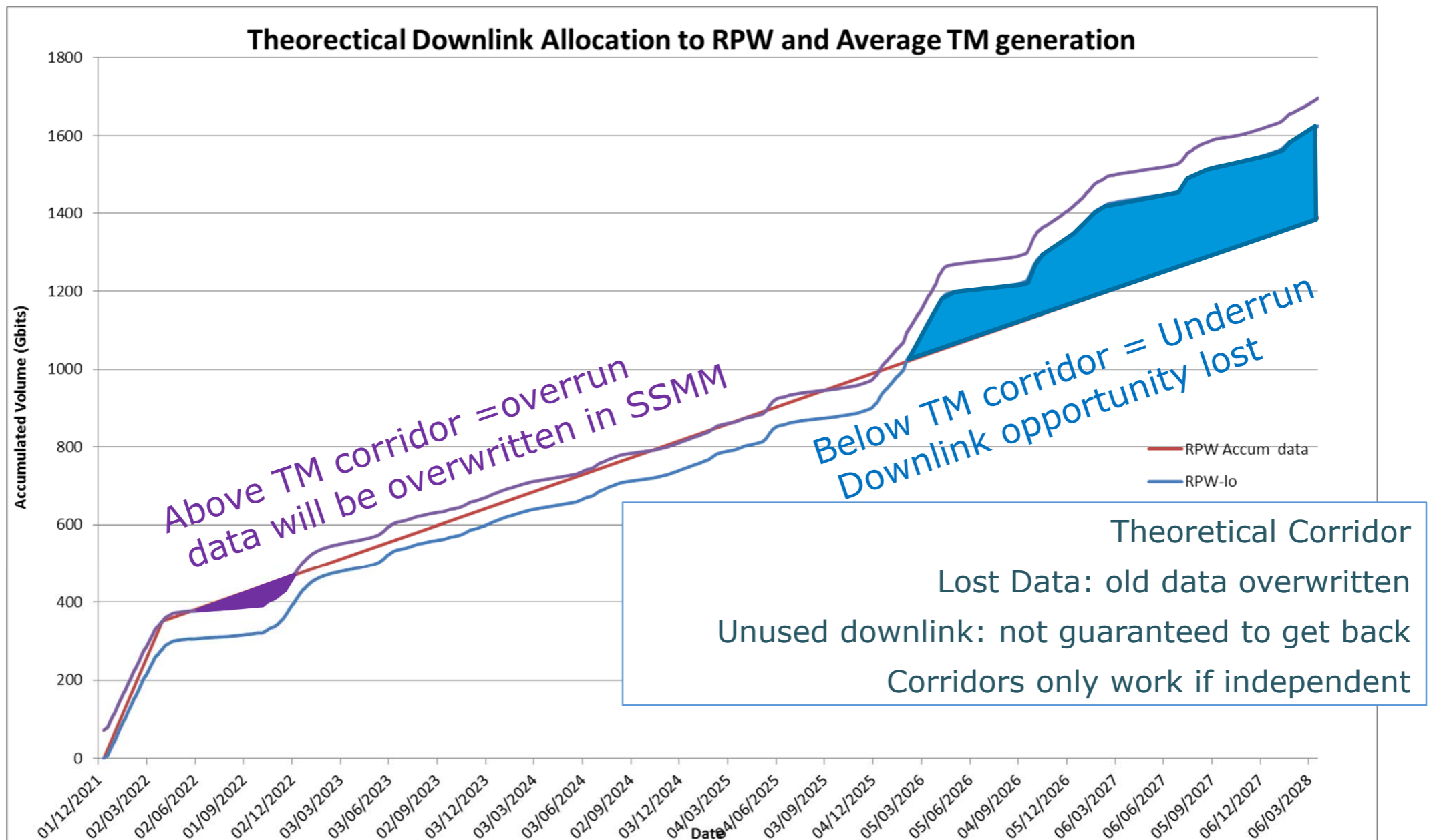
RPW Operations Workshop, 05 May 2015 | Andrew Walsh/Jayne Lefort| Data Downlink | Slide 14

European Space Agency
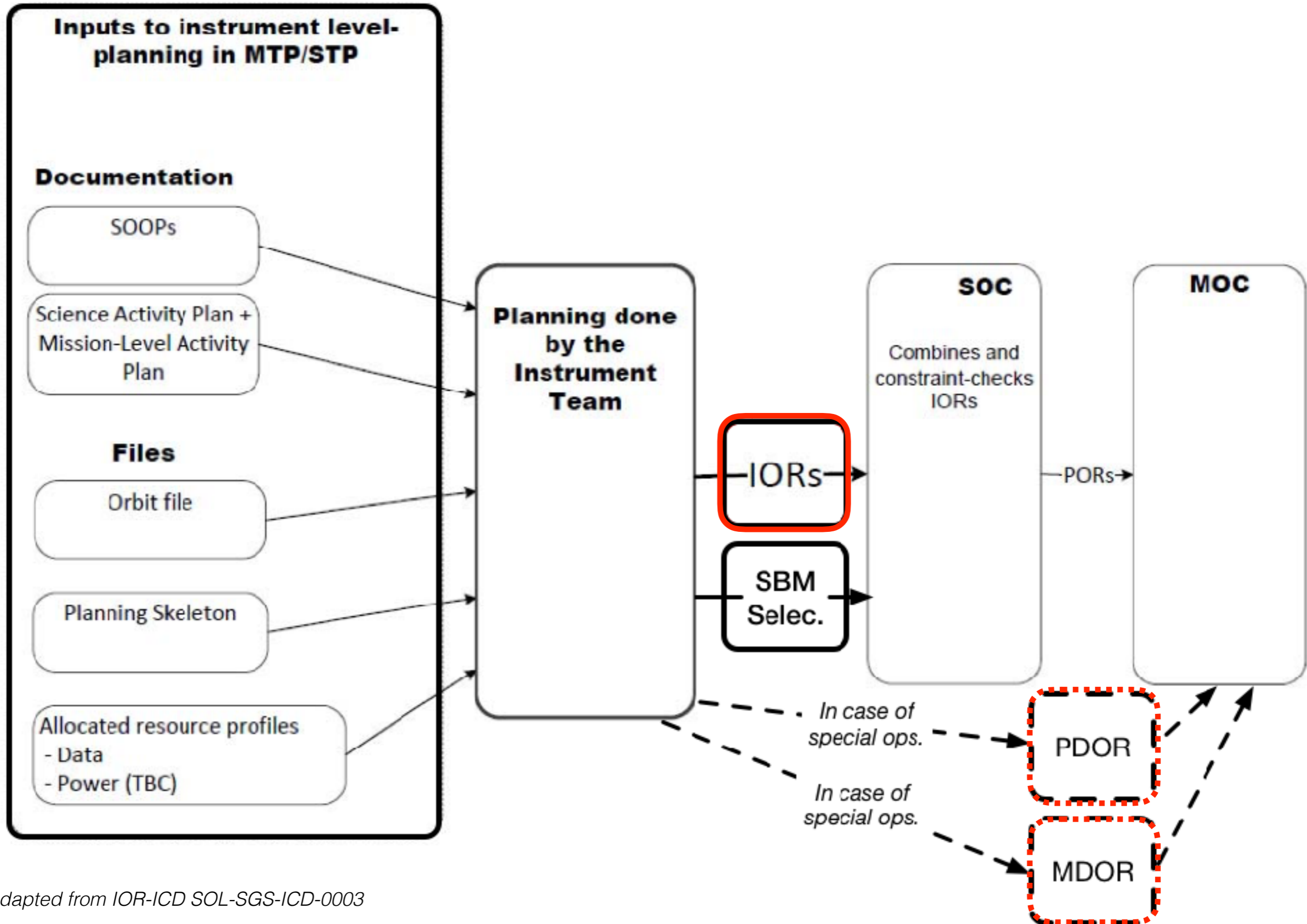
Adapted from IOR-ICD SOL-SGS-ICD-0003

Flight Procedures

- Contains generic sequences of TCs to be used during the whole missing

- 3 categories : Flight Control Procedure (FCP), Contingency Recovery Procedure (CRP), Commissioning procedure (COM)

- Must be delivered by the IT to the MOC in the MOIS import format (Excel 97-2003 format) [SOL-ESC-IF-10002_FOP-ICD]

- Must be validated by the MOC to be integrated into the Flight Operation Plan (FOP) [SOL-ESC-PL-10001_FOPPP]

- Except for identified TC parameters (i.e., « formal » parameters), the values of TC parameters must be fixed in the procedures!
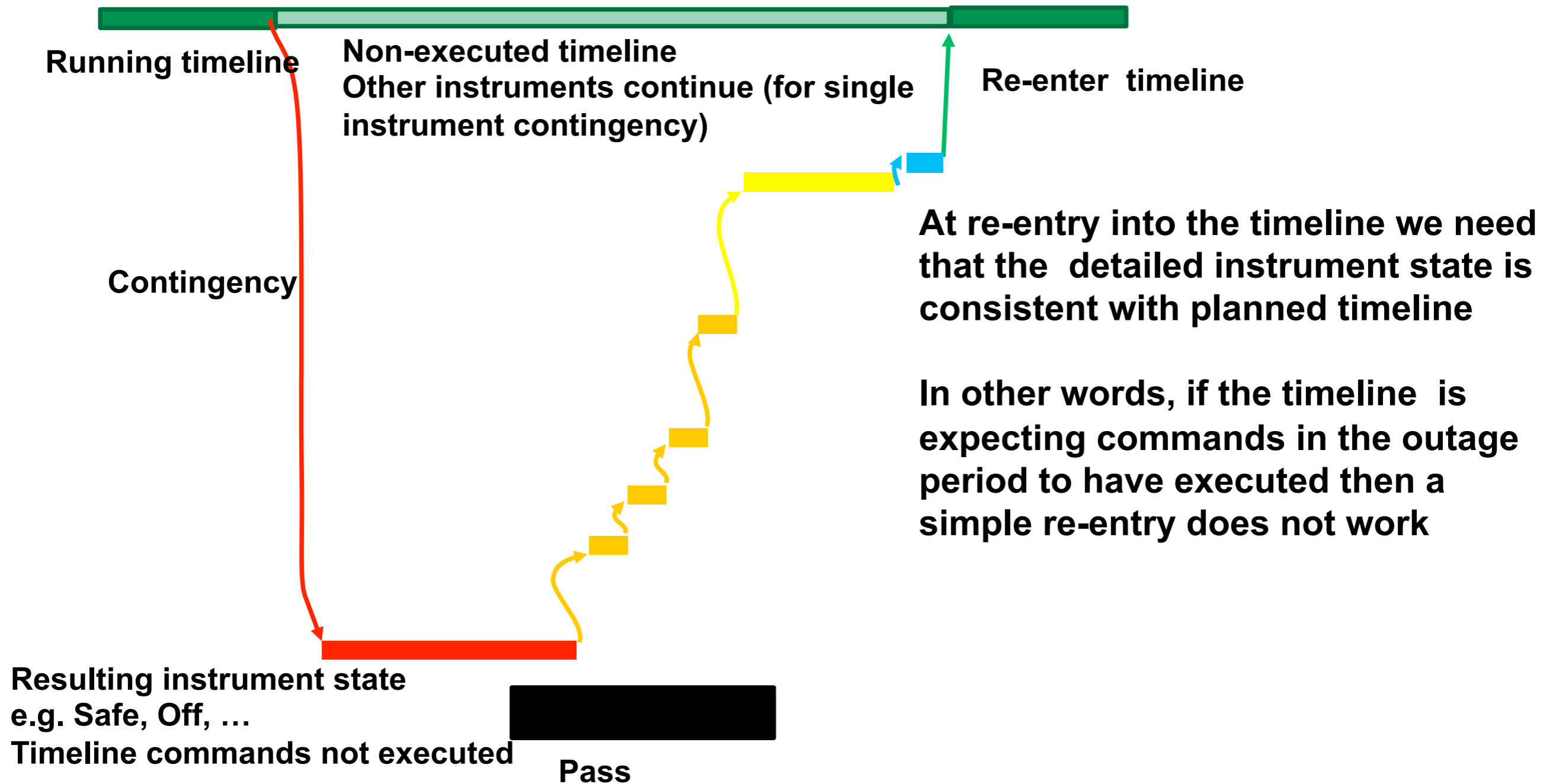
Operation Requests (IOR/PDOR/MDOR)

- In practice, IT will do not submit procedures directly, but the list of procedures to be uplinked

- For routine operations, the IT will be submitted the so-called « instrument operation requests » XML files (IOR) to the SOC (at MTP and STP levels) [IOR-ICD SOL-SGS-ICD-0003]

- For non-routines operations, the IT will interact directly with the MOC using specific XML format files: Memory Direct Operation Request (MDOR) for operations linked to memory, i.e., on-board software patches, and Payload Direct Operation Request (PDOR) for other special operations (NECP, contingency,...) [SOL-ESC-IF-05010_PLID]

Flight Operations Concept: Commanding

❑ Routine Instrument operations will be <u>off-line</u>. No real-time commanding.

- o Instrument commanding prepared in advance.
- o Operations built in atomic sequences, <u>uplinked as safe end-to-end activities</u>. These activity cycles will speed up return to science.
- o At the boundaries of the activity cycles are the so-called re-entry points.
- o Instrument User Manuals must define operations in terms of sequences:
- o In-situ example:
  - ▪ Default Mode -> Adjust operational parameters -> Command Mode X -> Return to Default
- o Remote Sensing example:
  - ▪ Switch ON -> Warm up detector -> Adjust operational parameters -> Command Mode X -> Go back to Stand-by

European Space Agency

OPS-OP - Solar and Planetary Missions Division

Timeline re-entry Graphically…

Running timeline

Non-executed timeline
Other instruments continue (for single instrument contingency)

Re-enter timeline

Contingency

At re-entry into the timeline we need that the detailed instrument state is consistent with planned timeline

In other words, if the timeline is expecting commands in the outage period to have executed then a simple re-entry does not work

Resulting instrument state
e.g. Safe, Off, …
Timeline commands not executed

Pass

Science default state

Instrument Teams must define a so-called « science default » state (cf. « Instrument Commanding Workshop » at MOC on Sept. 2016)

This state must be the baseline for operation cycle (i.e., first science config. when re-entrying the timeline, cycle operations shall return to this state.)

Most cover the main RPW science objectives

Must be initially based on the data rate defined in the EID-A (5.5 kbps for RPW) — But it will be actually constrained by the real allocated data rate (cf. TMC)

Outline

- Operation preparation planning

- SOLO operations planning concept

- RPW operations preparation

RPW Operations

LEOP

- ANT & Boom deployments

NECP

- Instrument auto-compatibility interference campaign

- RPW-PAS filtering tune campaign
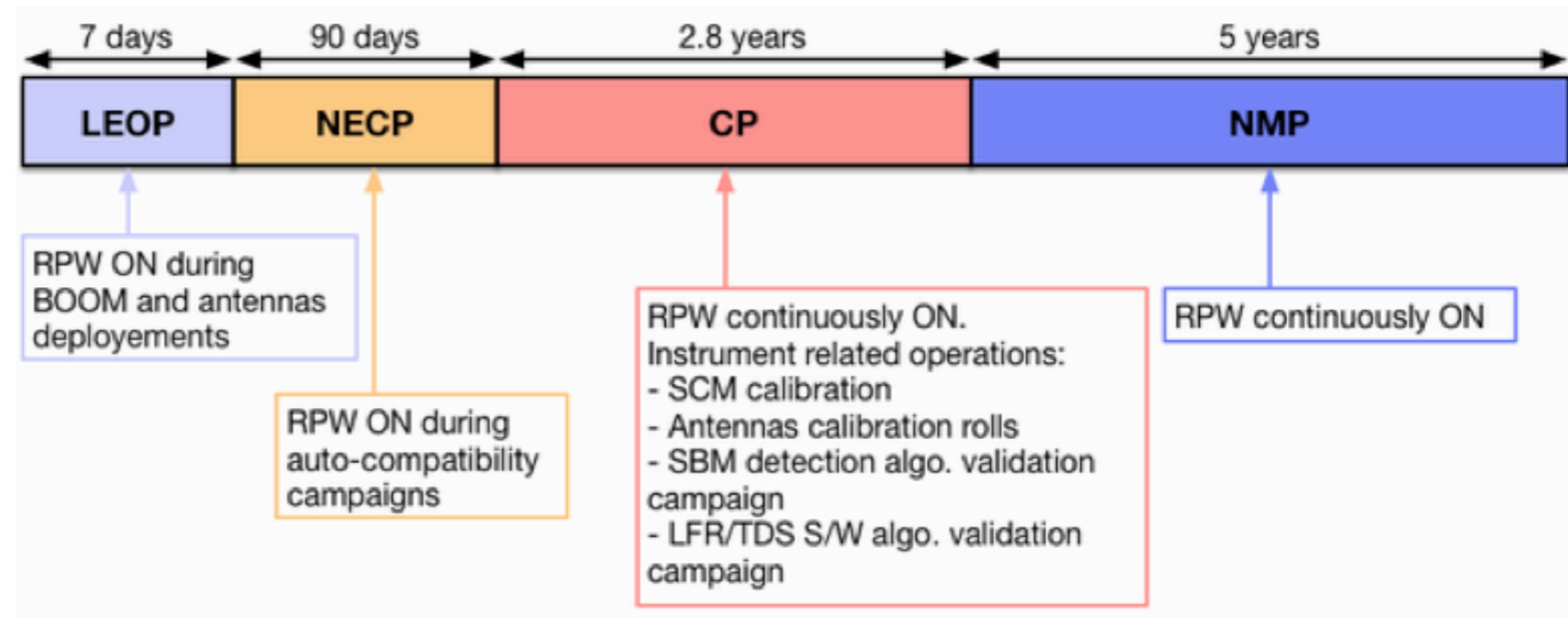
- TDS/LFR internal algo. validation campaign

CP

- Calibration rolls campaign

- SCM noise measurement campaign

- SBM algo. validation campaign (TBC)

NMP

- Routine operations (including regular Bias current setting and SBM selective downlink)

Instrument Operations Timeline

7 days	90 days	2.8 years	5 years
LEOP	**NECP**	**CP**	**NMP**

RPW ON during BOOM and antennas deployements

RPW ON during auto-compatibility campaigns

RPW continuously ON.
Instrument related operations:
- SCM calibration
- Antennas calibration rolls
- SBM detection algo. validation campaign
- LFR/TDS S/W algo. validation campaign

RPW continuously ON

From current RPW User Manual

Preliminary weekly on-board operations

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
02:00 - BIAS cal. (10 min.) 06:00 - BIAS sweeping (10 min.) 18:00 - Starting burst mode (10 min.)	02:00 - THR internal cal. (10 min.) 18:00 - Starting burst mode (10 min.)	02:00 - SCM TDS - LFR internal cal. (10 min.) 18:00 - Starting burst mode (10 min.)	18:00 - Starting burst mode (10 min.)	18:00 - Starting burst mode (10 min.)	18:00 - Starting burst mode (10 min.)	18:00 - Starting burst mode (10 min.)

STP IORs are delivered in a batch to cover a time-range of 1 week. Limited to 150 TCs/day, but SOC asks to have as much as possible 150 TCs per STP IOR

This time-range of execution begins on a Saturday

The STP IOR files must be delivered to SOC on the Tuesday 10 days prior to this Saturday

The BIAS current setting request submission might be not done every week

Case of SCM heaters to be discussed

Case of « Galaxy » state to be discussed

ROC activity planning on-ground is in progress (first draft available in the RPW User Manual)

Flight Control Procedures (FCP) shall cover 90% of the needs during the mission

They can be as much as possible re-used for commissioning and recovery operations

ROC has started to prepare FCP with the support of the CNES and RPW sub-system teams for:

- Timeline re-entry (including « science ready » state)

- « Science default » state

For engineering operations preparation (LEOP, NECP)

- Specific working groups coordinated by the ROC and CNES

For science routine operations preparation

- Timeline re-entry and science default procedures in progress (first set was tested during deltacal. Cf. Antonio/Yvonne' slides)

- Bias routine operations working group (cf. splinter session)

- Which strategy for defining instrument configurations for science?

    - Same strategy than SOOP, but at RPW level (based on SAP)?

    - SAP and science default state could be good starters

Anomalies

- Organization and procedures at RPW level needs to be clarified

- Role of CNES during mission in case of anomalies?

GSE capability/availability during the mission

- ROC needs to test its procedures and operation requests (IOR/MDOR/PDOR) before submission at MOC/SOC

- GSE capability in case of anomaly investigation