MAPPS: Science Planning and Simulation Tool for ESA Planetary Missions

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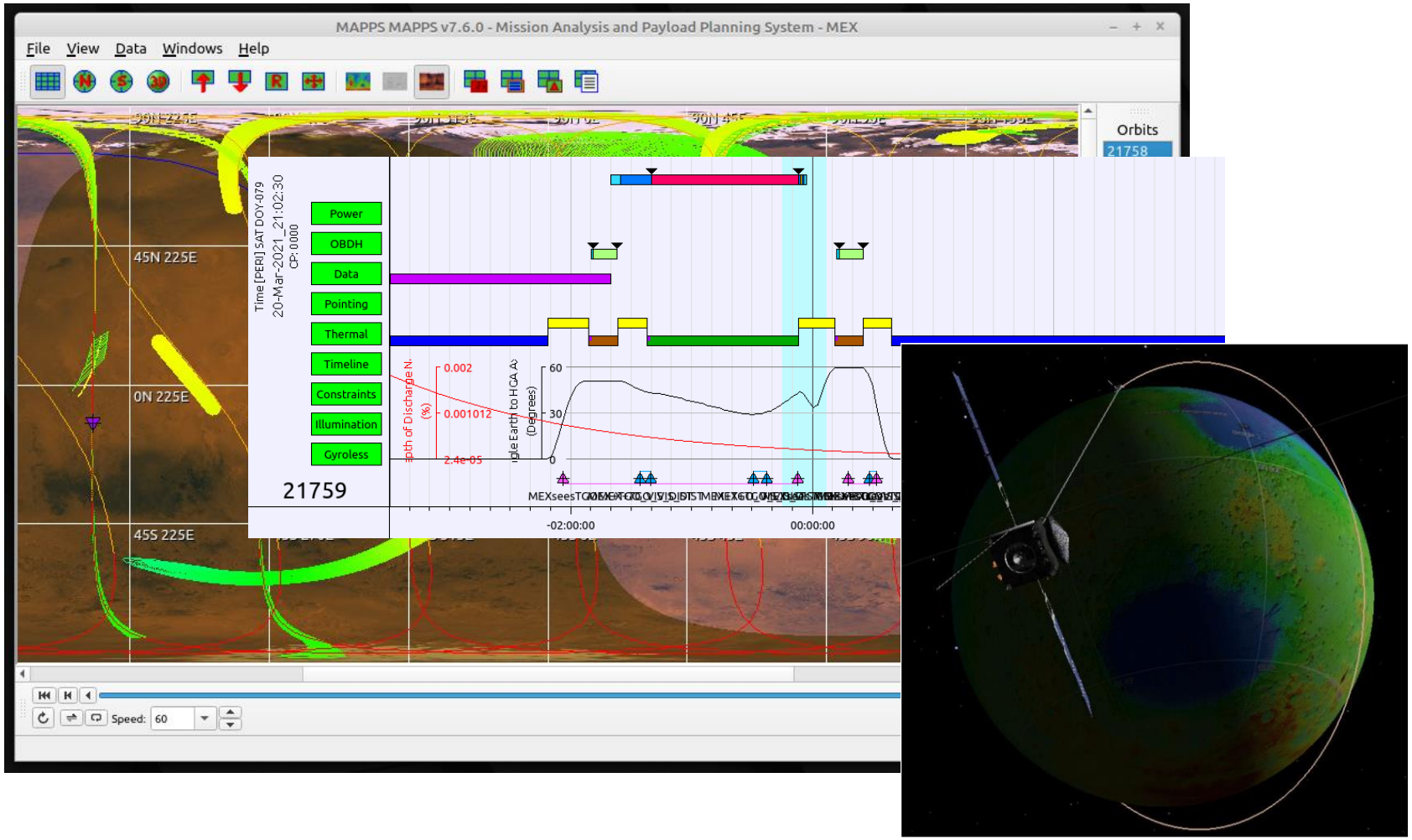
MAPPS is the software tool that support the science operations planning of the planetary missions at ESAC.

It consists of four parts:

- A **scientific payload simulator**
- A **graphical timeline**
- **2D surface maps**
- A **3D tool**



MAPPS MISSIONS

Past

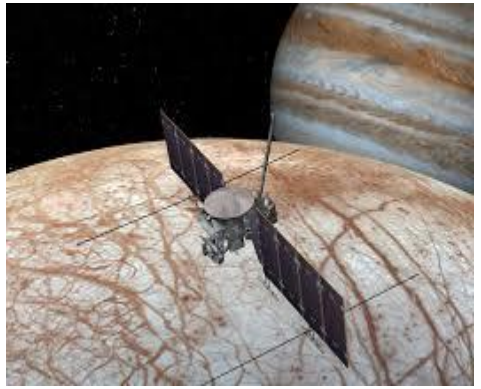
- Smart-1
- Venus Express (VEX)
- Rosetta

Present

- Mars Express (MEX)
- Exomars 2016 (TGO)
- Bepi Colombo
- Solar Orbiter

Future

- Juice
- Envision



PAYLOAD TIMELINE

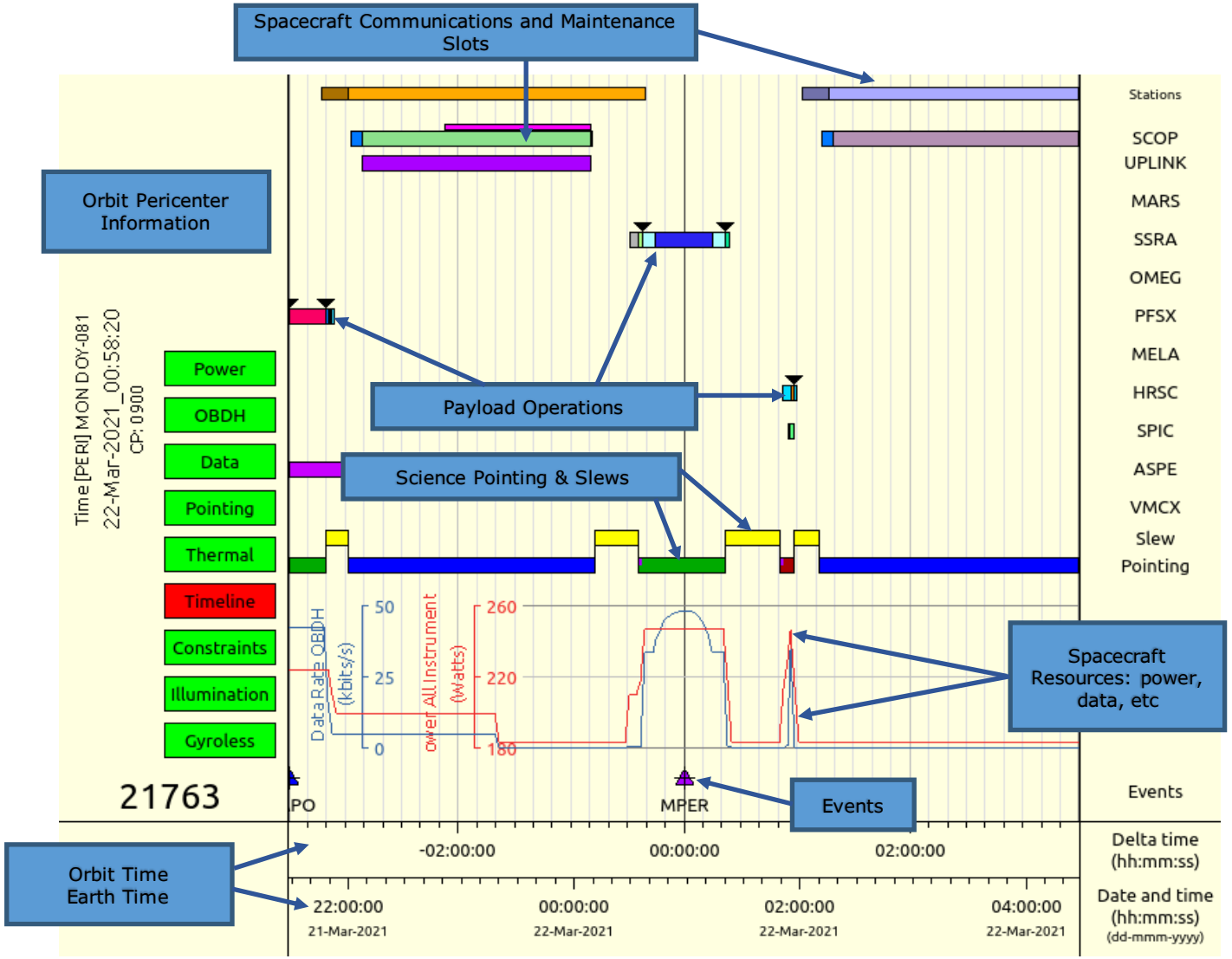
- **EPS** (Experiment Planning System) is MAPPS **scientific payload simulator**

- It simulates:
  - Instruments sequences and telecommands
  - Simulate the instruments:
    - Modes and states
    - Data rates
    - Data volumes
    - Power

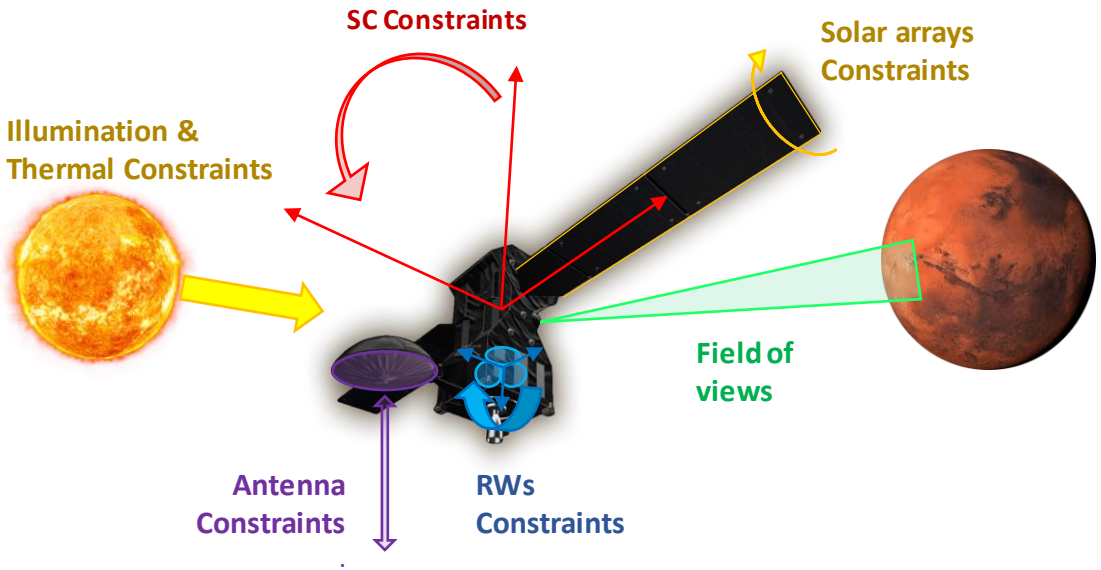
- Check for **constraints** violations

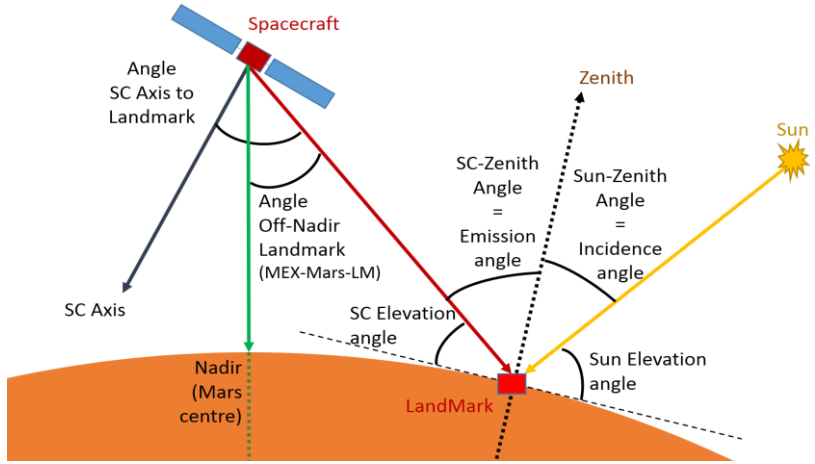
- Creates the operational files that are being sent to the **MOC** (Mission Operations Centre) to upload in the SC

- The result of the simulation is displayed in a rich **graphical timeline** that provides a visual overview of:
    - Instrument operations
    - Data downlink
    - Power consumption
    - Spacecraft attitude and other relevant parameters



ATTITUDE & GEOMETRY





- **AGM** is MAPPS Attitude and Geometry module
- AGM computes the spacecraft attitude from the **Pointing Request Files (PTR),** which are based on the observations requested by the instrument teams
- Once the attitude is computed, it is possible to check the **spacecraft and geometry constraints**
  - Max/min duration of pointings and slews
  - SC angular rates/torques/accelerations
  - Reaction wheels rates/accelerations
  - Solar Arrays angles/rates
  - Antennas' angles/rates
  - Illumination/Albedo constraints
- Once the attitude is computed, it is possible to compute and display any of the **geometry angles** between the SC and the targets in the body (for i.e, sun elevation, incidence, off-nadir angles)
- The output of the AGM module is a **validated pointing timeline**, free of geometry or SC attitude dependent constraint violations

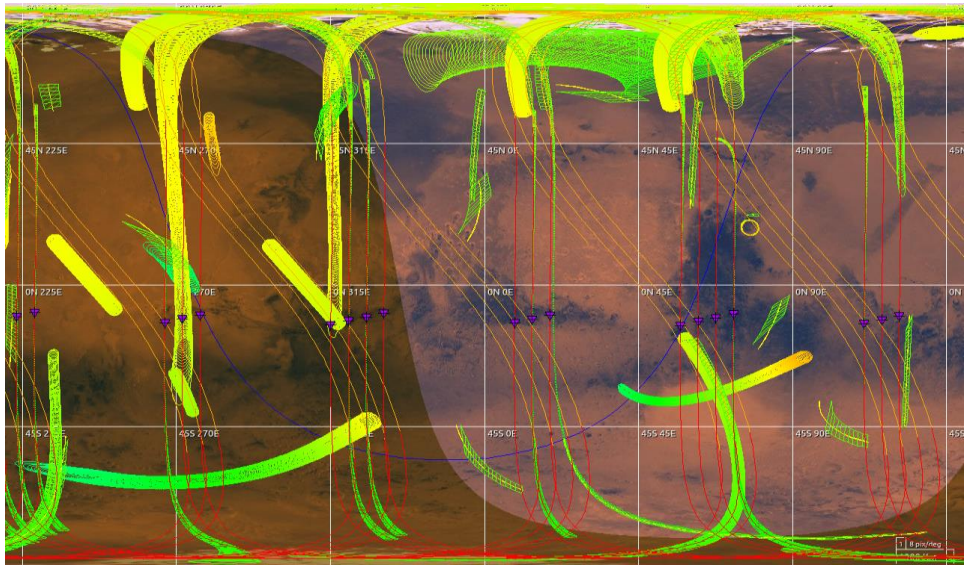
2D/3D VISUALIZATION

Data visualization tools are necessary to support the science planning process

The **2D surface maps** and the **3D tool** are used to:

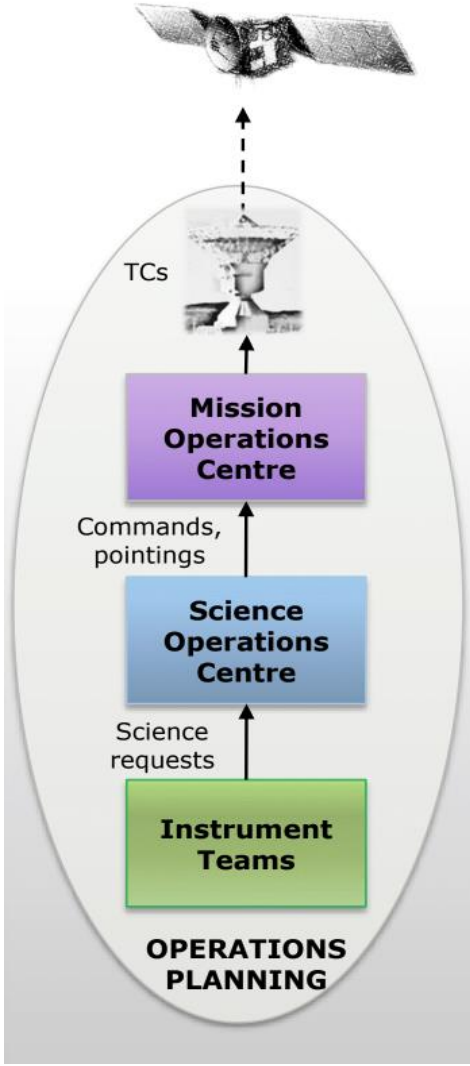
- Verify the SC trajectory and orbit
- Verify **instruments field of views** and **swaths**
- Understand the attitude during **spacecraft pointings**
- Check the **High Gain Antenna (HGA) blockages** and other moving parts
- Understand complex **geometry**. For example, illumination conditions or spacecrafts combined operations
- Validate actual images with planned images
- Illustrate and understand science operations

The 2D maps and 3D tool are connected to the timeline, combining both the **spatial** and **time** domains



MAPPS INPUTS AND OUTPUTS

- MAPPS is a centralized planning tool for **simulation** and **command generation**
- It sits in the middle between the **Instrument Teams** and the **Mission Operations Centre**
- It assists the science operators during all the stages of the science operations workflow
- Its main role is to aid in the validation and consolidation of the instruments timelines so that they can be sent to the MOC to upload safely in the SC, free of any constraint violations
- The **inputs** are:
  - **Science requests** from the instrument teams via well-defined interface systems
  - **Operational inputs** provided by the MOC in ESOC. For example, SC constraints or ground stations availability
- The **outputs** that are sent to the MOC are:
  - **Payload Operations Request (POR)** files containing the sequences and telecommands to operate the instruments on-board
  - **Payload Pointing Requests (PTR)** files containing the requests on how to point the SC during the scientific observations



References and scientific use cases

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