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Long-Term Planning Framework and Key Scientific Inputs for the M-MATISSE mission

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The Mars Magnetosphere ATmosphere Ionosphere and Space-weather SciencE (M-MATISSE) mission is an ESA Medium-class (M7) Phase A candidate. Its twin orbiters—Henri and Marguerite—operate in complementary eccentric trajectories to sample Mars's magnetosphere–ionosphere–thermosphere (MIT) system under varying solar-wind conditions. Science objectives include (1) mapping MIT coupling, (2) characterizing the radiation environment, and (3) probing ionosphere–surface interactions.

The Science Ground Segment (SGS) at ESAC brings over two decades of mission-operations heritage—supporting Mars Express, ExoMars, BepiColombo, and JUICE, between others—providing end-to-end planning, health monitoring, and quick-look analysis using tools such as MAPPS/EPS-AGM and SPICE. The Mars Science Centre (MSC) adds specialist scientific oversight: defining observation strategies, refining event triggers, and ensuring agile responses to space-weather alerts and transient phenomena.

Long-Term Planning (LTP), conducted at least six months before science operations, converts high-level objectives into:

- **Observation Definitions (ObsDefs):** generic templates for instrument modes (continuous, burst, event-driven), pointing and calibration requirements, and inter-instrument coordination.

- **Resource Envelopes:** power, data-rate, and thermal budgets for each ObsDef, generated via MAPPS/EPS-AGM to guarantee feasibility under worst-case margins.
- **Preliminary Event Files:** time-tagged orbital and geometric triggers—e.g., altitude crossings, solar-longitude markers, alignment windows—that drive ObsDef activation and feed into Medium-Term (MTP) and Short-Term Planning (STP).

By front-loading these products, SGS and MSC ensure that all six instruments (COMPASS, M-EPI, M-MSA, M-SoSpIM, MaCro, M-AC) can seamlessly transition between routine monitoring and rapid-response campaigns, maximizing scientific return within spacecraft constraints.

The LTP poster translates these products into a clear visual planning aid, highlighting representative mission-critical windows and sample plots rather than an exhaustive list. Key elements include:

- **Annotated Eclipse & Occultation Intervals:** shadow passages and Earth–line-of-sight losses, showing when instruments switch to safe or calibration modes.
- **Flyby & Alignment Opportunities:** selected Phobos/Deimos close approaches and inter-spacecraft proximity events, illustrating windows for radio-science occultations and coordinated measurements.
- **Orbit-Regime Passages:** representative sheath, magnetotail, and induced-magnetosphere boundary intervals, derived from SPICE-based analyses, indicating when to switch ObsDefs.
- **Data-Rate Forecasts:** sample bitrate-vs.-time curves annotated with solar-longitude markers, guiding allocation of high-data-volume burst modes.
- **Trigger-Timeline Charts:** simplified periapsis altitude and geometry plots labeled with example windows (e.g., terminator-ionosphere, dayside vs. nightside passes).

Each figure is annotated with relevant parameters—solar longitude (Ls), solar-zenith-angle ranges, and spacecraft altitudes—to guide science and operations teams in correlating orbital geometry with ObsDef activation. By presenting a curated set of examples, the poster serves as an actionable blueprint, ensuring transparent communication of planning constraints and opportunities, and preparing M-MATISSE to capture both steady-state and transient Martian space-weather phenomena.

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