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Destiny+ Dust Analyzer – Campaign & timeline preparation for interplanetary & interstellar dust observation during the 4-year transfer phase from Earth to Phaethon

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The Destiny+ mission (Demonstration and Experiment of Space Technology for Interplanetary voyage Phaethon fLyby and dUst Science) has been selected as part of its M-class Space Science Program by the Japanese space agency JAXA/ISAS and is set to launch in 2023/2024. The mission target is the active asteroid (3200) Phaethon with a projected flyby in early 2028. The scientific payload consists of two cameras (the Telescopic Camera for Phaethon, TCAP, and the Multi-band Camera for Phaethon, MCAP), and the Destiny+ Dust Analyzer (DDA). DDA is the technological successor to the Cosmic Dust Analyzer (CDA) aboard Cassini-Huygens, which prominently investigated the dust environment of the Saturnian system. The DDA sensor is designed as a combination of impact ionization time-of-flight mass spectrometer and trajectory sensor, which will allow for the analysis of sub-micron and micron sized dust particles with respect to their composition (mass resolution $m/\Delta m \approx 100$-150), mass, electrical charge, velocity (about 10% accuracy), and impact direction (about 10° accuracy).

Besides attempting to sample the impact-generated dust cloud around Phaethon during the flyby, DDA will be actively observing the interplanetary & interstellar dust environment over the roughly four years spanning cruise phase from the Earth-Moon system through interplanetary space. After launch into a GTO-like orbit, Destiny+ will first employ its solar-electric propulsion system to spiral up to the lunar orbit within about 18 months, followed by a series of lunar swingbys and interim coasting phases in distant cislunar space, accumulating momentum to leave the Earth-Moon system at high excess velocity. The subsequent roughly 2-year interplanetary transfer to intercept Phaethon will be characterized by moderate orbital eccentricity of up to 0.1 and largely unpowered coasting phases.

During these four years, the DDA sensor will benefit from a maximum pointing coverage range enabled by its dual-axis pointing mechanism and spacecraft attitude flexibility (during times of unpowered flight). This will allow for exhaustive mapping and analysis of the different interplanetary dust populations, as well as interstellar dust encountered in the region between 0.9-1.1 AU.

Here, we give a progress report on the science planning efforts for the 4-year transfer phase. We present a tentative observation timeline that assigns scientific campaigns to different phases of the mission, taking into account results of various dust models, as well as operational and technical constraints.