Dust Detection Reimagined:
New Insights from the DESTINY+ DDA

The 15th Meeting on Cosmic Dust at Osaka Sangyo University, Osaka, Japan on Tuesday, September 16, 2025 - Saturday, August 20, 2025

Denis Acker[1], Jonas Simolka[1], Heiko Strack[1], Janwei Li[1], Florian Rieth[1], Ralf Srama[1]

[1] *Institute of Space Systems (IRS), University of Stuttgart, Germany*

The DESTINY+ Dust Analyzer (DDA) serves as the primary scientific instrument on the DESTINY+ mission, focusing on in situ analysis of cosmic dust. It examines interplanetary and interstellar dust within 1 AU of the Sun and explores the dust environment surrounding asteroid (3200) Phaethon. By integrating a trajectory sensor with a time-of-flight mass spectrometer, the DDA captures data on the size, velocity, charge, and composition of individual dust grains. Its two-axis pointing system enhances sky coverage, establishing the DDA as a crucial tool for advancing our understanding of cosmic dust streams and composition throughout the DESTINY+ trajectory.

The recent completion of the DDA flight hardware, combined with its extensive dust accelerator test campaign, has significantly enhanced our understanding of DDA's detection and diagnostic capabilities. These initiatives validated the instrument's performance across various particle sizes and speeds, confirming its ability to detect and analyse individual particles down to submicron dimensions. The test campaign demonstrated precise trajectory reconstruction and reliable mass spectral identification, even for complex and diverse dust samples. Additionally, impact simulations performed at realistic interplanetary and near-Phaethon velocities confirmed that DDA's high resolution enables it to identify spectral signatures of elements, including sodium. These signatures are crucial for comprehending the contentious activity mechanisms of Phaethon, which may include thermal fracturing, surface dehydration, or thermal breakdown of rock-forming minerals- processes recognised to emit volatiles such as sodium on other inner solar system bodies.

This talk summarises the recent test results, highlights performance improvements achieved through the calibration of PFM software and provides a scientific perspective on how these advancements enhance DDA's capability to detect dust during the Phaethon flyby (approximately 500 km altitude) and throughout the cruise phase compared to previous instruments.

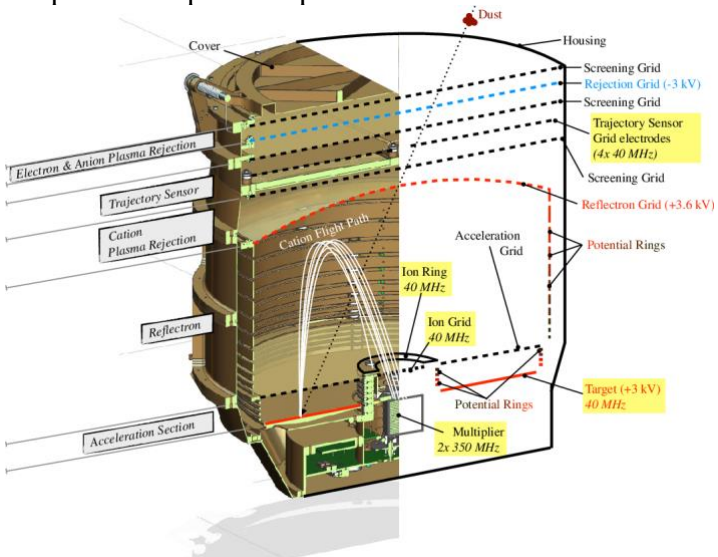

Figure 1: Schematics of the DDA sensor head. Dust enters from the top. Structures drawn in black are electrically grounded. Blue represents negative bias voltages, whereas red represents positive bias voltages. The labels with a green background indicate the locations of measurements. The number of measurement channels and digitisation frequency are given. On the left side of the figure, the flight path of the cations is illustrated.