OVERVIEW OF THE DRAGONFLY ENTRY AEROSCIENCES MEASUREMENTS (DrEAM) SUITE
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Brief Presenter Biography: Dr Brandis is a senior research scientist employed by AMA Inc in the Aerothermodynamics branch at NASA Ames. He is the DrEAM PI, Dragonfly aerothermal lead and PI for NASA’s Entry Systems Modeling project. His research focuses on shock layer radiation with the NEQAIR code and EAST shock tube.

Abstract: NASA Ames and Langley are partnering with DLR to propose a comprehensive instrumentation suite known as the Dragonfly Entry Aerosciences Measurements (DrEAM). DrEAM being the first competed mission to fly EDL instrumentation as part of NASA’s Engineering Science Investigation (ESI). DrEAM will provide key aerothermodynamic data and performance analysis for Dragonfly’s forebody and backshell thermal protection system (TPS), and also includes a DLR-provided Data Acquisition System (DAS).

Titan’s atmosphere predominantly consists of nitrogen (~98% by mole) with small amounts of methane (~2% by mole) and other trace gases. CN is a strong radiator and is found in nonequilibrium concentrations for Titan entry. The accurate modeling of nonequilibrium CN radiation has proven to be a difficult task. Prompted by the Huygens mission, many experimental campaigns and analyses were performed to better understand the aerothermal environments experience by the probe during Titan entry [1]. However, the Huygens probe carried no heatshield instrumentation. Therefore, the DrEAM instrumentation suite will significantly advance the state-of-the-art not only by documenting the environment and performance of Dragonfly’s entry system but also by making key measurements in Titan’s atmosphere for the first time, thus providing new benchmark data applicable to entry science more generally.

Current Measurement Goals: Aerothermal environments and TPS response will be measured using sensors similar to the Mars Entry, Descent, and Landing Instrumentation 2 (MEDLI2) Integrated Sensor Plug (MISP) and the COMbined Aerothermal and Radiometer Sensor (COMARS) suite [2], with the latter supplied by DLR. For MEDLI2, MISP used embedded thermocouples (TCs) to directly measure in-depth temperature of the TPS at several locations, which can also be used to infer surface environments via inverse analysis. For DrEAM, the MISP style plugs will be known as Dragonfly Sensors for Aero-Thermal Reconstruction (DragSTR) plugs. On Schiaparelli, the COMARS suite included three total surface-mounted heat flux sensors, three pressure sensors, and one radiometer. For DrEAM, the COMARS package will be known as COMbined Sensor System for Titan Atmosphere (COSSTA). Atmospheric density measurements and capsule aerodynamic data will be obtained through the onboard Inertial Measurement Unit (IMU), supplemented by pressure transducers similar to those used by the MEDLI Mars Entry Atmospheric Data System (MEADS). The DrEAM pressure sensors will be known as Dragonfly Atmospheric Flight Transducers (DrAFT).

Both DragSTR and DrAFT have flight heritage from MISP and MEADS on the MSL and Mars 2020 missions, and the COMARS suite successfully flew on the ESA Schiaparelli EDM lander. A preliminary layout of the sensors is shown in Fig. 1. Because Dragonfly uses the same aeroshell provider (i.e., Lockheed Martin) and materials for the TPS, with what are expected to be similar thicknesses as MSL and Mars 2020 on both the heat shield and backshell, the DrEAM instrumentation will look to utilize the same techniques and processes as developed by MEDLI and MEDLI2 for vehicle integration. This commonality also enables DrEAM to leverage the extensive ground test qualifications performed for MEDLI and MEDLI2 and claim substantial heritage for this system.

References: