The Demonstration and Science Experiments (DSX) Mission

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Abstract: In 2016, the Air Force Research Laboratory will launch its Demonstration and Science Experiments mission to investigate wave-particle interactions and the particle and space environment in medium Earth orbit (MEO). The DSX spacecraft includes three experiment packages: The Wave Particle Interaction Experiment (WPIx) will perform active and passive investigations involving VLF waves and their interaction with plasma and energetic electrons in MEO. The Space Weather Experiment (SWx) includes five particle instruments to survey the MEO electron and proton environment. The Space Environmental Effects Experiment (SFx) will investigate effects of the MEO environment on electronics and materials. We will describe the capabilities of the DSX science payloads, science plans, and opportunities for collaborative studies such as conjunction observations and far-field measurements.

WPIx: Wave Particle Interaction Experiment
- Transmitter (TNT): UMass Lowell, SWRI, Lockheed-Martin
  - 3 – 50 kHz at up to 5 kV (9 kV at end of life)
  - 50 – 750 kHz at 1W (local electron density)
  - 3 B components (TASC), 2 E components (dipole antennas)
- Frequency range: 100 Hz – 50 kHz
- DC Magnetometer

Payload Module (PM):
- VLF Broad Band Receiver
- VLF Narrow Band Receiver
- VLF Transmitter/Amplifier Tuners
- Loss Cone Imager (LCI)
- Space Weather Instruments:
  - LEESA, CEASE, LIPS, HIPs
  - Radiometers
  - Photometers

SWx: Space Weather Experiment
- Low Energy ElectroStatic Analyzer (LEESA): AFRL/RVB
  - 5 angular zones, total FOV 120° x 12°, 30 eV – 50 keV e- ions
- Compact Environmental Anomaly Sensor (CEASE): AFRL/RVB
  - telescope: FOV 60°; dosimeters: FOV 90°; 100 keV – 6.5 MeV e-; 20 – 100 MeV p+
- Low-energy Imaging Particle Spectrometer (LIPS): PSI, AFRL
  - 8 angular zones, FOV 78° x 8°; 30 keV – 2 MeV e-; p+
- High-energy Imaging Particle Spectrometer (HIPs): PSI, AFRL
  - 8 angular zones, FOV 90° x 12.5°; 1 – 10 MeV e-; 30 – 300 MeV p+
- High Energy Proton Spectrometer (HEPS): ATC, Amptek, AFRL
  - 1 look direction, FOV 24° (±p); 40° (±e); 20 – 440 MeV p+

DSX secondary mission: map electron and proton particle populations in MEO
- SWx will also study dynamics of the particle population in the slot region (see figure at right)
- LEESA will support WPIx by diagnosing the plasma environment during experiments

SFx: Space Environmental Effects Experiment
- Space Environment Testbed (SET): NASA/JPL
  - Quantity effects of the MEO environment on new technologies
  - CREDANCE (Cosmic Ray Environment Dosimetry And Charging Experiment), ESA particle sensor and dosimeter
  - DIME-1 and -2 dosimeters (Clemson Univ.)
  - ELDRS (AZ State) proton effects on bipolar junction transistors
  - COTS-2 (CNES/NASA)
  - COTS (Commercial-off-the-shelf) Radiometers and Photometers: AFRL/RQ

ACE: Adaptive Control Experiment
- Validation of attitude control technologies targeting flexible structural modes: AFRL

Summary
- DSX will be a unique mission, studying active VLF transmission interactions with the MEO plasma and particle environments.
  - It will also study the ambient particle and wave environments, including opportunistic conjunction experiments with ground transmitters and with other satellites.
  - DSX supports diverse opportunities for collaborative studies.
- DSX mission particle data is already cleared for release to collaborators; similar approval for wave data is expected.