EMUS Overview

- The EMUS instrument is a far ultraviolet imaging spectograph that will characterize the escape of hydrogen and oxygen from Mars and the state of the Mars Thermosphere.
- It consists of a single telescope mirror feeding a Rowland circle imaging spectograph with a photon-counting and locating detector.
- The EMUS spatial resolution of less than 300km on the disk is sufficient to characterize spatial variability in the Martian atmosphere (100-200 km altitude) and exosphere (>200 km altitude).

- The instrument and the mission is managed by MBRSC.
- The instrument development is led by LASP with a detector from SSL.
- The EMUS science team comprises of people from MBRSC, LASP, and SSL.

EMUS Data Sets

- Standard Cadence will sample sub-seasonal variation; High Cadence will sample shorter timescale variation (e.g., solar rotation).

<table>
<thead>
<tr>
<th>Data Sets</th>
<th>Standard Cadence</th>
<th>High Cadence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermospheric Measurements:</td>
<td>At least 6 images (OS1) taken on the dayside within 1 orbit (55 hours)</td>
<td>At least 12 images (OS1 or OS2) taken on the dayside within 1 orbit (55 hours)</td>
</tr>
<tr>
<td>Coronal Measurements:</td>
<td>At least 5 images (OS2) taken within 1 orbit</td>
<td>At least 4 images (2 coronal, 2 background) (OS3) taken within 1 orbit</td>
</tr>
<tr>
<td>Cadence:</td>
<td>At least 1 image set taken per week (3 orbits) for OS3, at least 1 image set taken every other week</td>
<td>At least 3 image sets taken within 1 week (3 consecutive orbits)</td>
</tr>
<tr>
<td>Seasonal Coverage:</td>
<td>At least 20 times per Martian year</td>
<td>At least 7 times per Martian year</td>
</tr>
<tr>
<td>Coronal Strafe:</td>
<td>Two profiles (1 coronal, 1 background) (OS4) from 1.06 to ≥ 6 Mars radii taken at least once per month</td>
<td></td>
</tr>
</tbody>
</table>

EMUS Data Targets

- EMUS comprises 10 R$_1$, SSL team, the Emirates Imaging Imager (EXI) and Emirates Mars Infrared Spectrometer (EMIRS) which will focus on the lower atmosphere observing dust, ice clouds, water vapor and ozone.
- EMUS Mars Ultraviolet Spectrometer (EMUS) will focus on both the thermosphere of the planet and its exosphere.

<table>
<thead>
<tr>
<th>Table 1: EMUS Science Targets and Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>How does the Martian exosphere respond globally, initially and seasonally to solar forcing?</td>
</tr>
<tr>
<td>How do conditions throughout the Martian atmosphere affect rates of atmospheric escape?</td>
</tr>
<tr>
<td>How do key constituents in the Martian exosphere behave temporally and spatially?</td>
</tr>
<tr>
<td>How does the Martian upper atmosphere affect the conditions in the collisional atmosphere?</td>
</tr>
</tbody>
</table>

Table 2: EMUS Science Targets

- Hydrogen: 102.6, 121.6 nm
- Oxygen: 130.4, 135.6 nm
- Carbon Monoxide: 496-140.70 nm

EMUS Science Operations

- EMUS science orbit enables comprehensive observations of the exosphere, and full sampling of latitude, longitude, and local time.
- 20,000km x 43,000km
- 25° inclination
- 15 hour orbital period
- The Science Phase is planned for 2 Earth years (just over 1 Mars year long) to cover all the seasonal variations in the atmosphere.

Table 3: EMUS Instrument Parameters

<table>
<thead>
<tr>
<th>Detector / View</th>
<th>Wavelength range</th>
<th>Spatial resolution with narrow slit</th>
</tr>
</thead>
<tbody>
<tr>
<td>CsI Rowland</td>
<td>100 – 170 nm</td>
<td>0.14° x 0.20°</td>
</tr>
</tbody>
</table>

EMUS Science Investigations

- Determine the three-dimensional structure and variability of key constituents in the thermosphere on sub-seasonal timescales.
- Characterize the spatial structure and variability of key constituents in the Martian exosphere.
- Determine the three-dimensional thermal state of the lower atmosphere and its thermal variability on sub-seasonal timescales.
- Dertermine the geographic and thermal distribution of key constituents in the lower atmosphere on sub-seasonal timescales.
- Characterize the spatial structure and variability of key constituents in the lower atmosphere.

Image: Figure 2: EMUS Optical Layout

Table 4: EMUS Science Investigations

- Hydrogen Thermosphere
- Oxygen Thermosphere
- Carbon Monoxide Thermosphere
- Hydrogen Corona
- Oxygen Corona
- Hydrogen Stratosphere
- Oxygen Stratosphere

Image: Figure 4: EMUS Target Science Orbit

Figure 3: EMM Target Science Orbit

Figure 6: Atomic oxygen image from MAVEN IUVS

Figure 7: Atomic hydrogen image from MAVEN IUVS

Figure 8: Oxygen Altitude Profile from MAVEN IUVS

Figure 1: EUV spectrum of Mars

Figure 5: Atomic carbon image from MAVEN IUVS

Figure 9: Solar corona when instrument is on dayside with solar local time.