# SCIENTIFIC PAYLOAD OF THE EMIRATES MARS MISSION:
# EMIRATES EXPLORATION IMAGER (EXI)

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## Emirates Mars Mission [EMM]

- EMM is the first outer-planetary Arab mission to be launched by 2020.
- The mission focuses on developing national capabilities in both science and engineering within the UAE, and on contributing with novel science to the human knowledge and civilizations.

*Table 1: EMM Science Questions And Objectives*

| Motivating Questions | EMM Science Objectives | EMM Science Investigations |
|---|---|---|
| How does the Martian lower atmosphere respond globally, diurnally and seasonally to solar forcing? | A. Characterize the state of the Martian lower atmosphere on global scales and its geographic, diurnal and seasonal variability | 1. Determine the three-dimensional thermal state of the lower atmosphere and its diurnal variability on sub-seasonal timescales. |
| | | 2. Determine the geographic and diurnal distribution of key constituents in the lower atmosphere on sub-seasonal timescales. |
| How do conditions throughout the Martian atmosphere affect rates of atmospheric escape? | B. Correlate rates of thermal and photochemical atmospheric escape with conditions in the collisional Martian atmosphere. | 3. Determine the abundance and spatial variability of key neutral species in the thermosphere on sub-seasonal timescales. |
| How do key constituents in the Martian exosphere behave temporally and spatially? | C. Characterize the spatial structure and variability of key constituents in the Martian exosphere. | 4. Determine the three-dimensional structure and variability of key species in the exosphere and their variability on sub-seasonal timescales. |

## EXI Science Operations

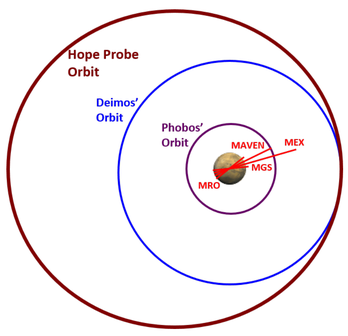



*Figure 1: EMM Target Science Orbit*

- EMM science orbit enables comprehensive observations of the exosphere, and full sampling of latitude, longitude, and local time.
  - 20,000km x 43,000
  - 25° inclination
  - 55 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 4 EXI Observational Strategy*

| Observation Strategy | Observation Strategy Set |
|---|---|
| EXI OS 1 (science) | 4 Contemporaneous images<br>• 220 nm, 260 nm, 320 nm, 635 nm<br>• Incident <80°; emergence < 70°<br>• 2 x 2 pixel binning<br>(≤ 0.19 mrad spatial resolution)<br>2 dark images (for each detector) |
| EXI OS 2 (science) | 4 Contemporaneous images<br>• 220 nm, 260 nm, 320 nm, 635 nm<br>• Incident <80°; emergence < 70°<br>• 16 x 16 pixel binning<br>(≤ 0.49 mrad spatial resolution)<br>2 dark images (for each detector) |
| EXI OS 3 (PR) | 3 Contemporaneous visible images<br>• 437 nm, 546 nm, 635 nm<br>• Full resolution (≤ 0.11 mrad spatial resolution) |

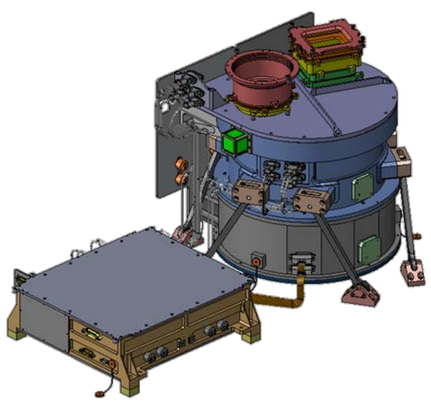
## EXI Science Targets

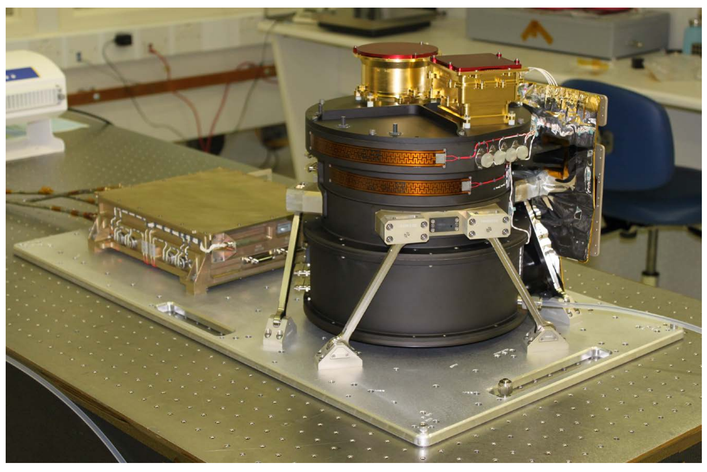
**Determine the geographic and diurnal distribution of key constituents in the lower atmosphere on sub-seasonal timescales.**

This investigation will help in better understanding the processes that are driving the global circulation in the current Martian climate by sampling key constituents (**dust**, **water ice clouds** and **ozone**) in the lower atmosphere on sufficient spatial and temporal scales. EXI will be able to capture the ice optical depth, dust optical depth as well as the column abundance of ozone.

*Table 1 EXI physical parameters and their observable requirements*

| Physical parameter | Observable Quantity | Observable Quantity Requirement |
|---|---|---|
| Ice column-integrated optical depth | radiance at 305-335nm | Radiometric accuracy ≤ 10% (± 0.03 optical depth) |
| Dust column-integrated optical depth | radiance at 205-235nm | Radiometric accuracy ≤ 10% (± 0.1 optical depth) |
| Ozone column-integrated abundance | radiance at 245-275nm | Radiometric accuracy ≤ 10% (± 0.5µm-atm) |





## Implementation Overview

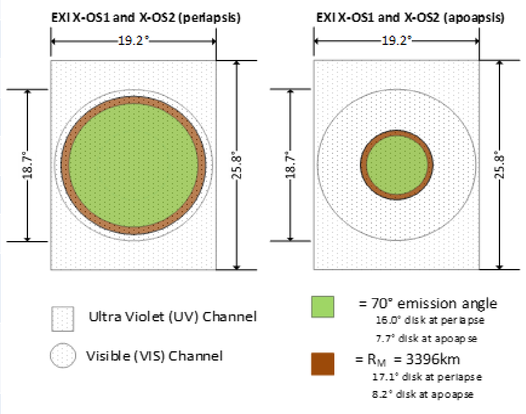
EXI is a multi-band, radiation tolerant camera capable of taking 12 megapixel images while maintaining the radiometric calibration needed for detailed scientific analysis.

- Dual lens assembly separating the UV and VIS optical paths.
- Selector wheel mechanism consisting of 6 discrete bandpass filters.

*Table 2 EXI Instrument Specifications*

| Specification | UV | VIS |
|---|---|---|
| Focal Plane Format | 12.6MP 4:3 format 4096x3072 @ 5.5um | |
| Technology | CMOS | |
| Dynamic Range | 12-bit 13,500 e full well | |
| Lens System | 48 mm, f/3.6 | 51 mm, f/4.25 |
| Field of View | 19.0° | 25.8° by 19.2° |
| Pixel Angular View | 23 arcsec per pixel | 22 arcsec per pixel |
| Plate Scale | 0.85 mm/° | 0.90 mm/° |
| Distortion @ 9.35° | +6% | -2% |
| Ground coverage at Apoapsis | Full disk | |
| Ground resolution at Apoapsis | 4.9 km per pixel | 4.6 km per pixel |
| Ground coverage at Periapsis | Full disk | |
| Ground resolution at Periapsis | 2.3 km per pixel | 2.2 km per pixel |
| Filter Spectral Bands | UV1: 205 – 235 nm<br>UV2: 245 – 275 nm<br>UV3: 305 – 335 nm | Blue: 405 – 469 nm<br>Green: 506 – 586 nm<br>Red: 625 – 645 nm |

*Figure 2 EXI Coverage at Periapsis and Apoapsis*




## Data Completeness

*Table 5 EXI Coverage Requirement*

| EXI Coverage Requirement | |
|---|---|
| Diurnal requirement | In any given span of 10 days, the 4 three-hour intervals spanning 6am-6pm local time are sampled with at least 80% coverage of longitude in:<br>≥ 3 local time intervals for all latitude equatorward of ±30°<br>≥ 2 local time intervals for all latitude equatorward of ±50°<br>In any given span of 10 days, at least one in the 4 three-hour intervals spanning 6am-6pm local time is sample with at least 50% coverage of the longitudes for all latitude equatorward of ±80° |
| Geographic requirement | ≥ 80% of the geographic area of Mars sampled more frequently than every 72 hours.<br>Latitude ≤80°sampled more frequently than every 72 hours. |
| Seasonal requirement | Observations over 1 full Martian year (Goal: 20 of the 24 15° intervals of $L_s$ sampled) |