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.
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.	2. Determine the geographic and diurnal distribution of key constituents in the lower atmosphere on sub-seasonal timescales. 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 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 300-340nm	Radiometric accuracy ≤ 5% (± 0.03 optical depth)
Dust column-integrated optical depth	radiance at 205-235nm	Radiometric accuracy ≤ 5% (± 0.1 optical depth)
Ozone column-integrated abundance	radiance at 245-275nm	Radiometric accuracy ≤ 5% (± 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 UV2: 245 – 275 nm UV3: 305 – 335 nm	Blue: 427 – 447 nm Green: 536 – 556 nm Red: 625 – 645 nm

EXI Science Operations

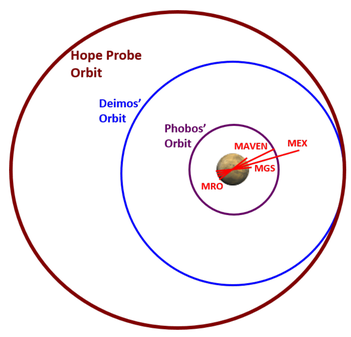
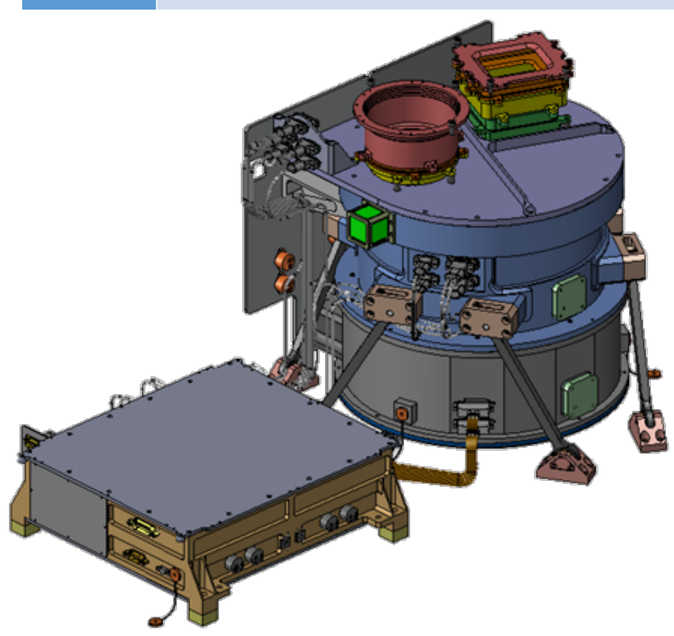


Figure 1: EMM Target Science Orbit

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



Data Completeness

Figure 2 EXI Coverage at Periapsis and Apoapsis

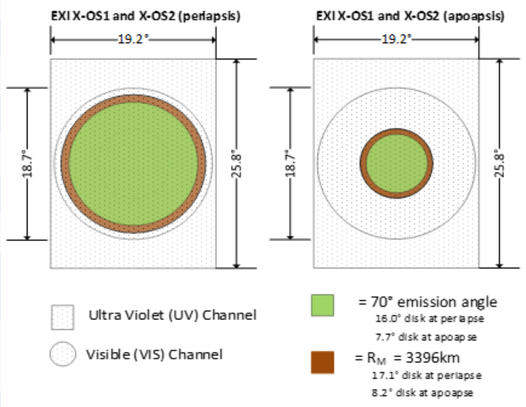


Table 5 EXI Coverage Requirement

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: ≥ 3 local time intervals for all latitude equatorward of ±30° ≥ 2 local time intervals for all latitude equatorward of ±50° 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. 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)