

# The Geospace Dynamics Observatory; A Mission of Discovery for Geospace

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# summary

## Transformative Science

- Opens a window to discovery that will revolutionize our view of near-Earth space
- Provides a key link to understand the coupled Sun-Earth system
- Fills gaps for space weather
- Is consistent with the 2012 Heliophysics Decadal Survey to investigate the coupled magnetosphere/ionosphere/mesosphere system

## Observatory Class Facility

- New for Heliophysics

# three examples of transformative scientific advances enabled by GDO

- Unparalleled advances in the connection of the upper atmosphere to the Sun.
  - In the aurora and lower latitudes, extending the duration of uninterrupted images provides advances in understanding of the transfer energy from the Sun to the upper atmosphere and its response to the interplanetary space environment.
- Advances in the influence of waves and tides and winds on the upper atmosphere.
  - Increasing both the signal to noise and the duration of the observations reveals contributions that are not identifiable using other approaches.
- The ability to probe the mechanisms that control the evolution of planetary atmospheres.
  - The vantage point provided by GDO allows the outflow of hydrogen and oxygen (which is tied to the escape of water from a planet) to be mapped globally. It provides new observations of changes in the atmospheric structure and their causes.

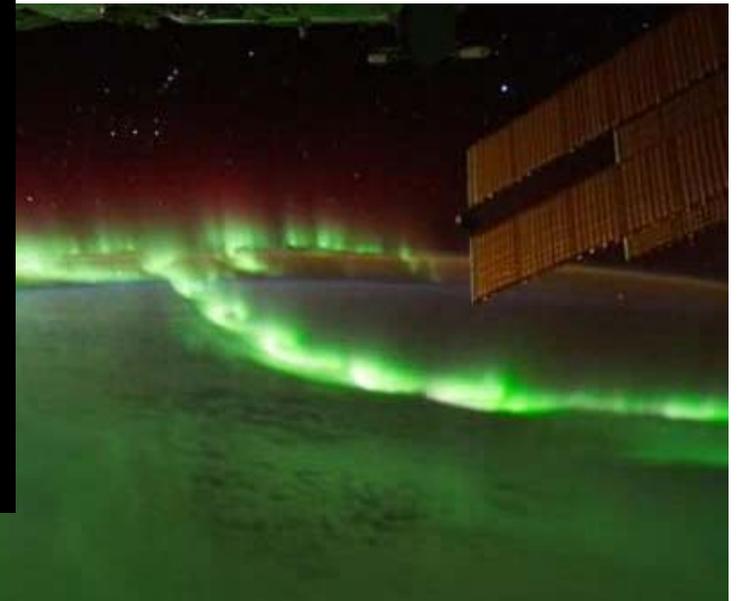
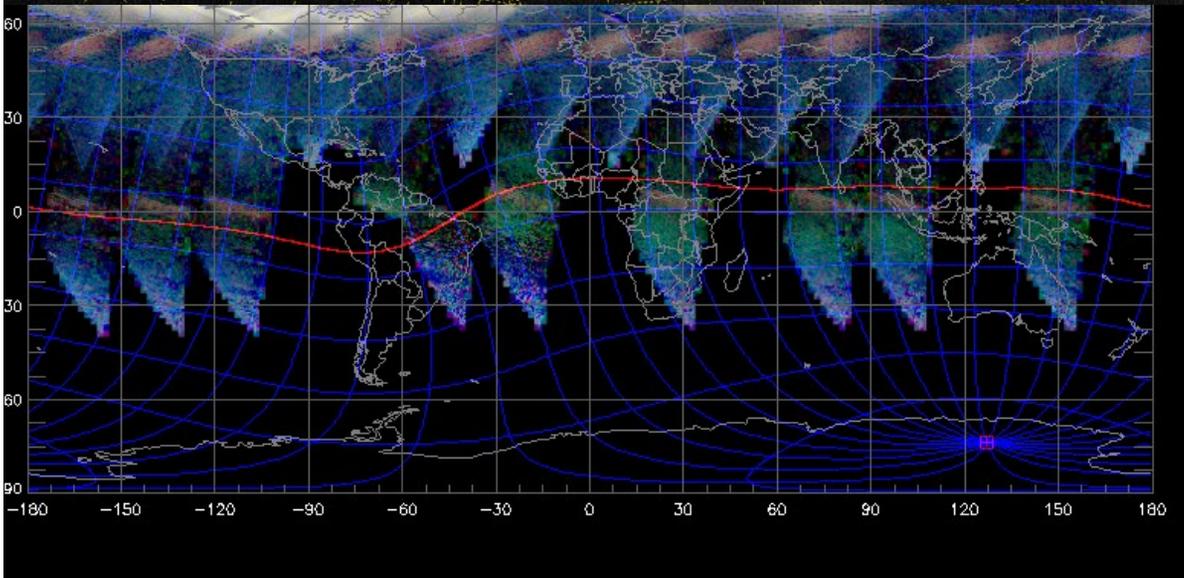
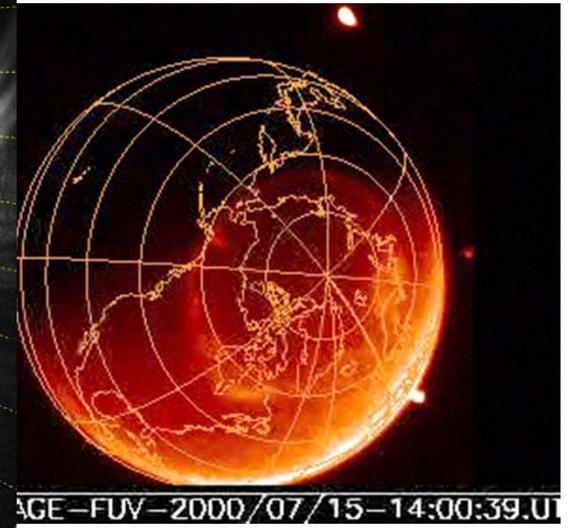
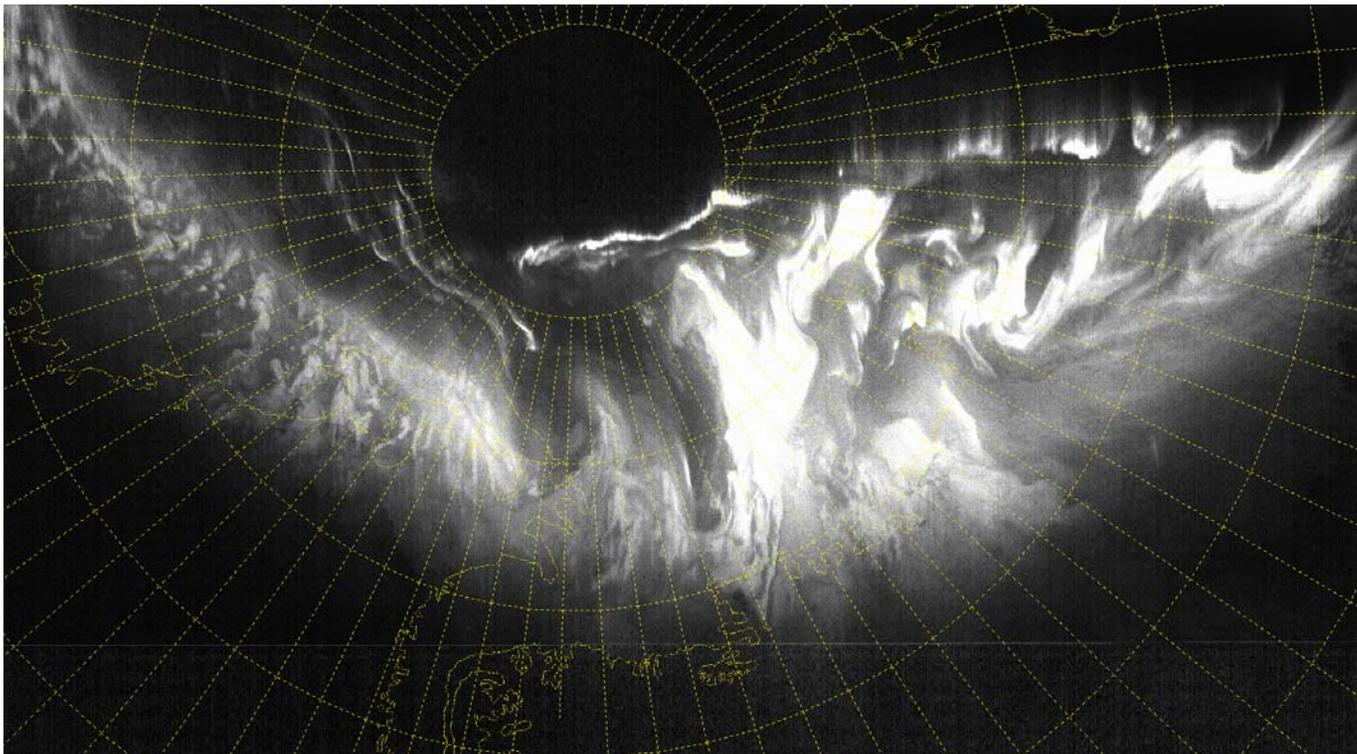
# GDO mission concept

- The Geospace Dynamics Observatory (GDO) mission observes Geospace with unprecedented resolution, scale and sensitivity.
- At a distance of  $60 R_e$  in a near-polar circular orbit (27-day period), GDO images the near-earth region and ionosphere with
  - far ultraviolet, co-aligned simultaneous imagers
  - a spectrometer in the near to far ultraviolet range that can probe any portion of the disk and simultaneously observe the limb.
  - Other auxiliary observations TBD

# previous mission and GDO design performance

	Viking (UofC)	Freja (UofC)	IMAGE WIC	POLAR UVI	SPANN (SPIE)	UVAMC (2X2)	UVAMC (3X3)	GDO
	Previous Missions				Proposed Designs			
	Spinning Platform			Spin Stabilized				
FOV (°) degree	20 x 25	22.4 x 30	17.2	8	20	20	20	<b>3x3</b>
Image Shape	Rectangle	Rectangle	Circle	Circle	Circle	Circle	Circle	<b>Circle</b>
No of Pixels	288 x 385	228 x 385	256	228 x 200	512	512	341	<b>4Kx4K</b>
Number of Mirrors	2	2	2	3	4	4	4	<b>7</b>
Integration Period (s)	1.0	0.37	6.0	37	20	20	20	<b>1</b>
Image Cadence (s)	20	6.0	120	300	20	20	20	<b>1</b>
Apogee Height (km)	13,500	1,700	44,000	57,400	38,000	38,000	38,000	<b>380,000</b>
Global View	No	No	Yes	No	Yes	Yes	Yes	<b>Yes</b>
Nadir Resolution (km x km)	20.7 x 15.3	5.8 x 4.5	52	35 x 40	26	26	40	<b>&lt;2</b>
Input Aperture Area (cm <sup>2</sup> )	0.72*	1.6*	1.6	11.75	3.14	7.1	7.1	<b>36,615.5</b>
Photons/R at Image	0.059	0.082	0.79	0.79	0.98	2.22	4.99	<b>5.34</b>
Mass (kg)	2.0*	1.9	4.1	15	6	10	10	<b>2,000</b>
Visible Rejection	1.0	0.0009	0.0021	0.00042	0.0000044	0.0000044	0.0000044	<b>0.000004</b>
Sensitivity (Photons/sec/R at Image)	0.000004	0.000004	0.000004	0.000004	0.000004	0.000004	0.000004	<b>0.000004</b>
	0.25	0.25	0.25	0.25	0.25	0.25	0.25	<b>5.34</b>

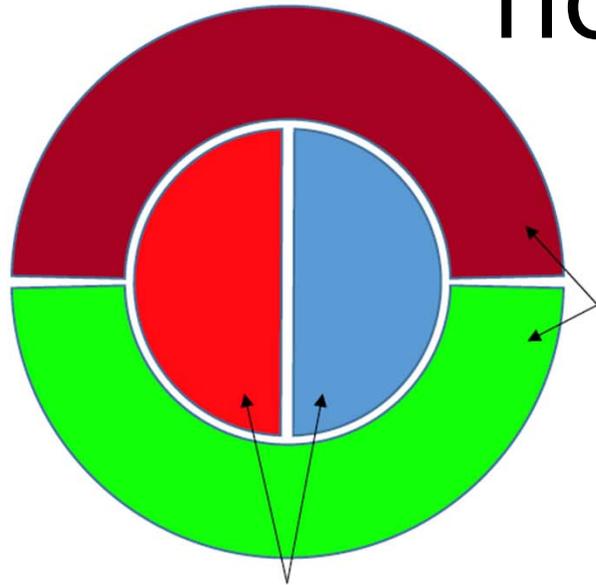
\* Best estimates based on information in published journal articles  
 Most of content courtesy of Donovan, Spanswick and Cunick



# telescope measurement characteristics

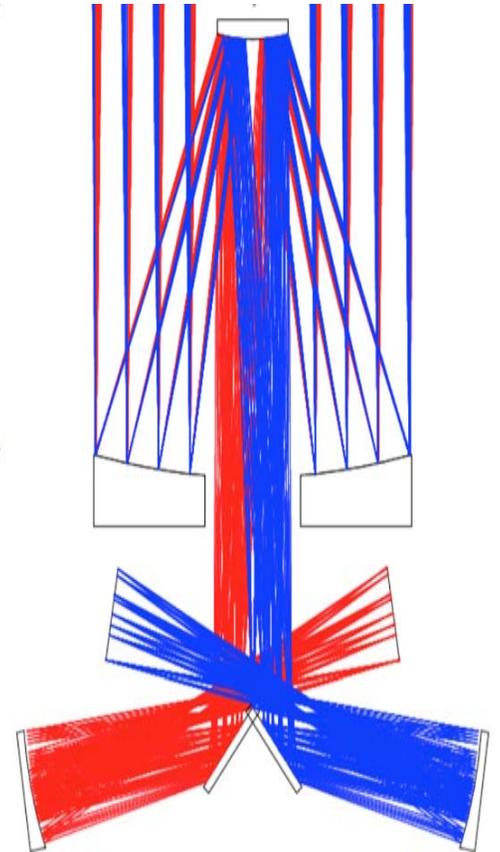
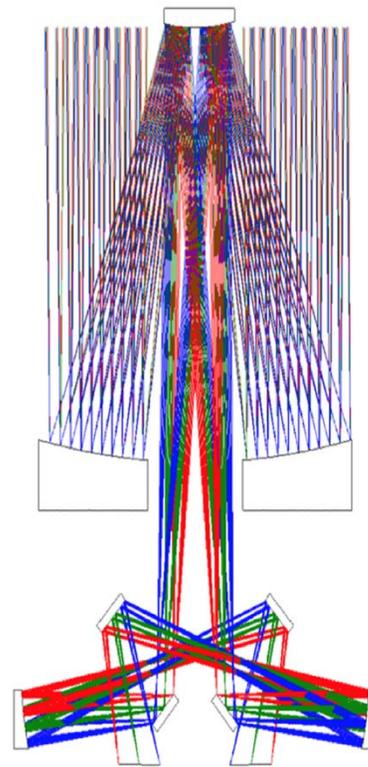
- 2.4 m primary mirror
- 1.5 degree full field of view - full Earth disk image
- Spatial resolution of  $< 2$  km at nadir
- Integration time of 1 sec
- Sensitivity of 100 R with SNR=5 per pixel per 1 second image

# nominal optics



0.25 degree radial,  
~180 degree extent annulus

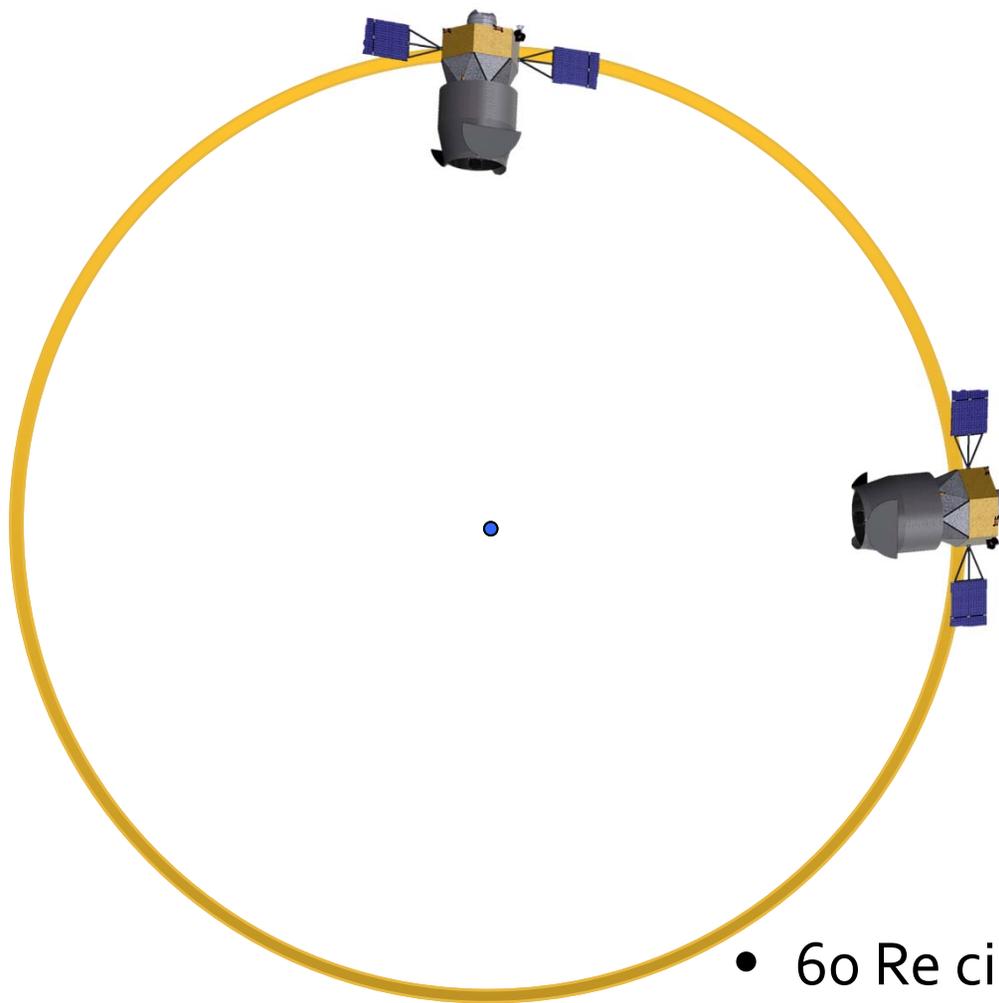
Half of 1 degree diameter disk



# mission characteristics

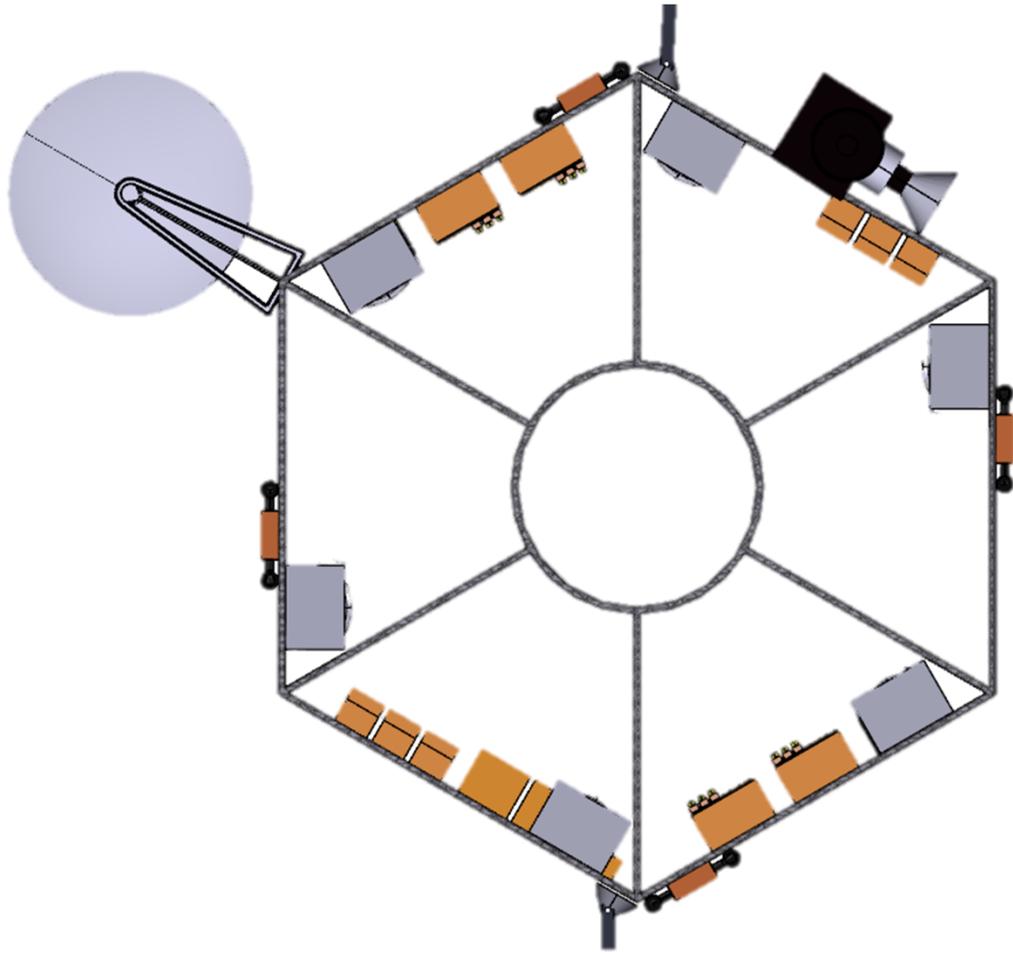
- Nadir pointing with commanded pointing
  - Pointing resolution 0.5 km, knowledge 0.2 km
  - Pointing accuracy 0.1 arc sec
- Far UV < 200 nm
- Multiple sensors at focal plane (FUV, spectrograph)
- Large bandwidth (3.2 mbps, 11 terabits/day)
- Circular polar orbit of > 60 Re – maximize time over earth high and mid latitudes

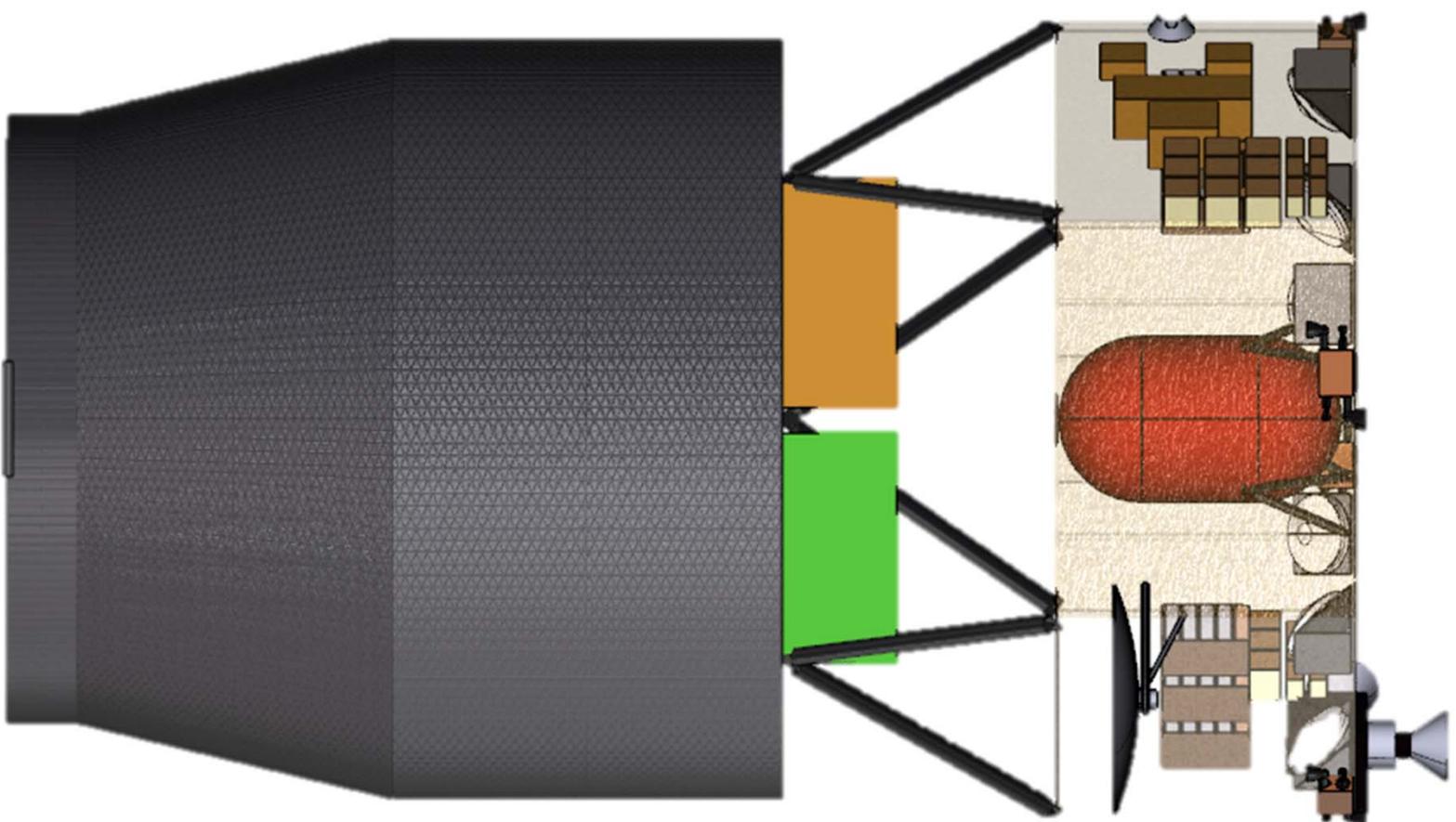
# mission concept



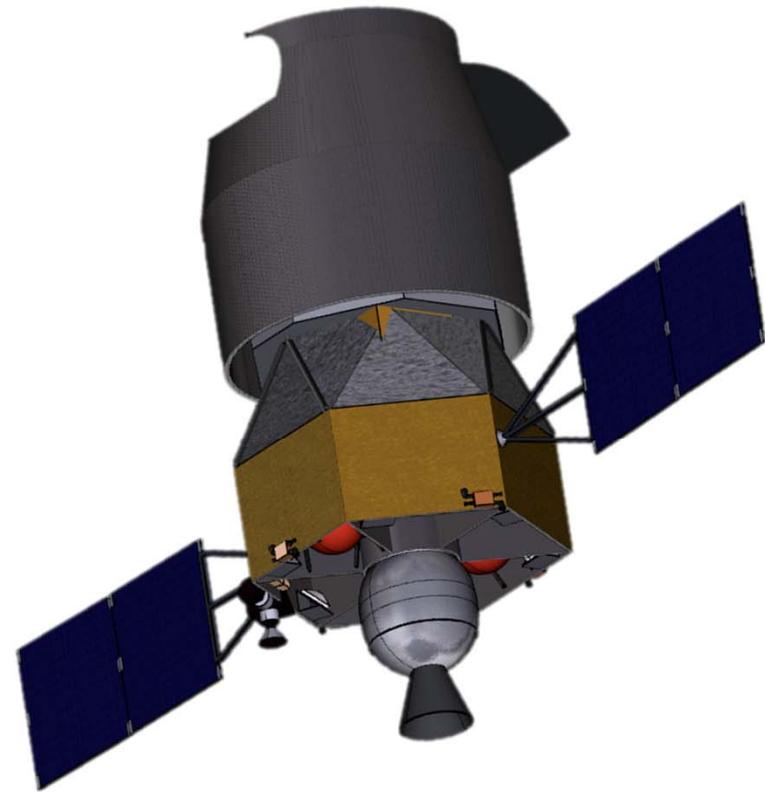
- 60 Re circular polar orbit
- 27 day period

# spacecraft





# Atlas V 541 Star Motor



# technical challenges

- Solar blind sensors
  - Sensor – 45 cm focal plane
  - Large arrays, four 4K sensor arrays
- Optics
  - FUV dichroic optics
- Telemetry
  - Real time vs. full science data
  - Gbps

# unprecedented capabilities

- GDO provides unprecedented improvement in signal to noise for global-scale imaging of the near-Earth space environment.
  - enables changes in the Earth's space environment to be resolved with orders of magnitude higher temporal and spatial resolution compared to existing data and other approaches.
- GDO provides a new view of the Earth.
  - continuously views the global-scale evolution while simultaneously capturing the changes at scales smaller than are possible with other methods. It has an unrivaled capability for resolving the temporal evolution, over many days, in local time or latitude.
  - provides the capability to observe with interferometers and image emissions too faint to observe otherwise.

# GDO provides the first . . .

- full near-Earth imagery of the storm and circulation systems of the upper atmosphere
- observations of the ionosphere on a global and long-time scale basis with unprecedented resolution
- probe of the mechanisms that control the evolution of planetary atmospheres
- test of our understanding of how the Earth is connected to the Sun on a global scale

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