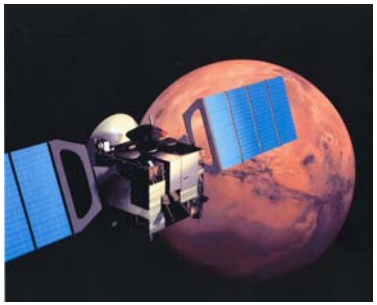
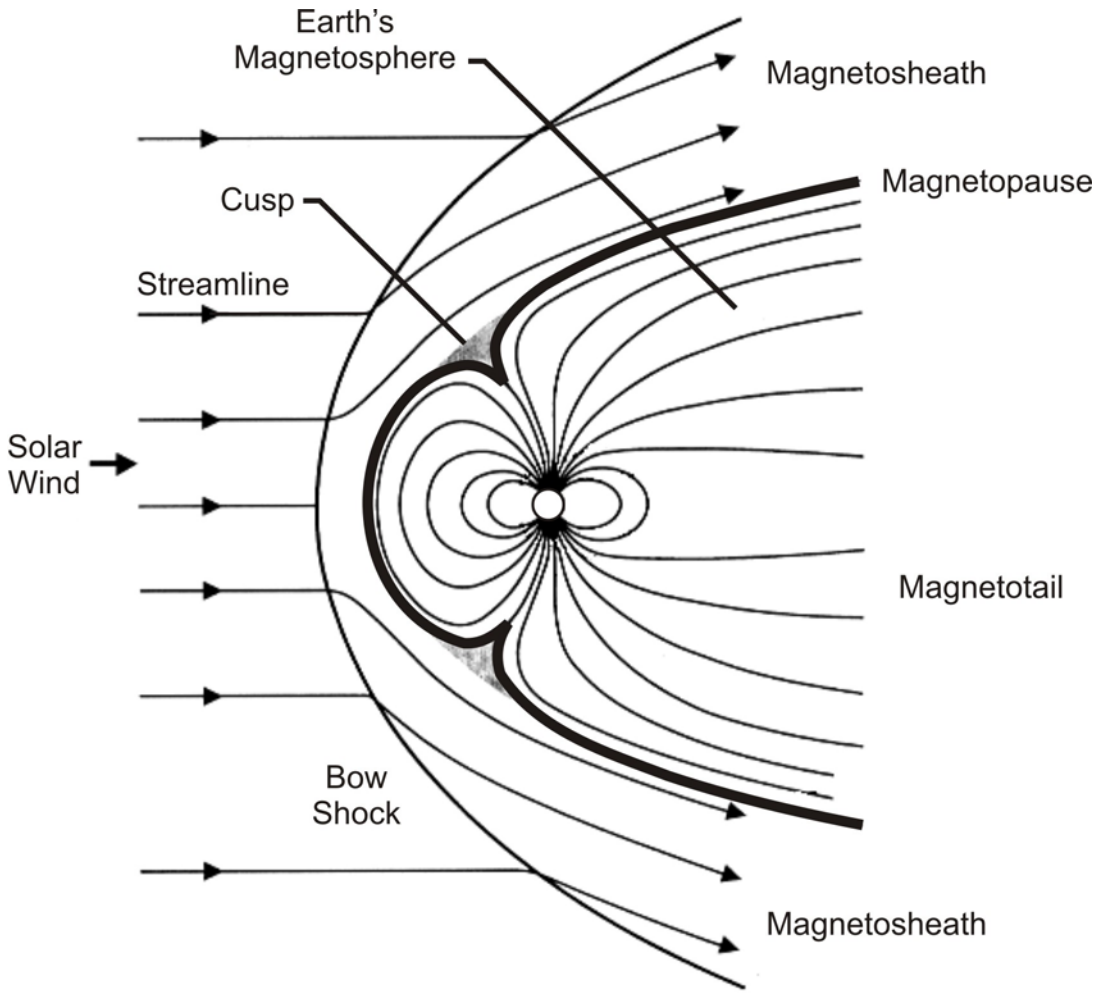


QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

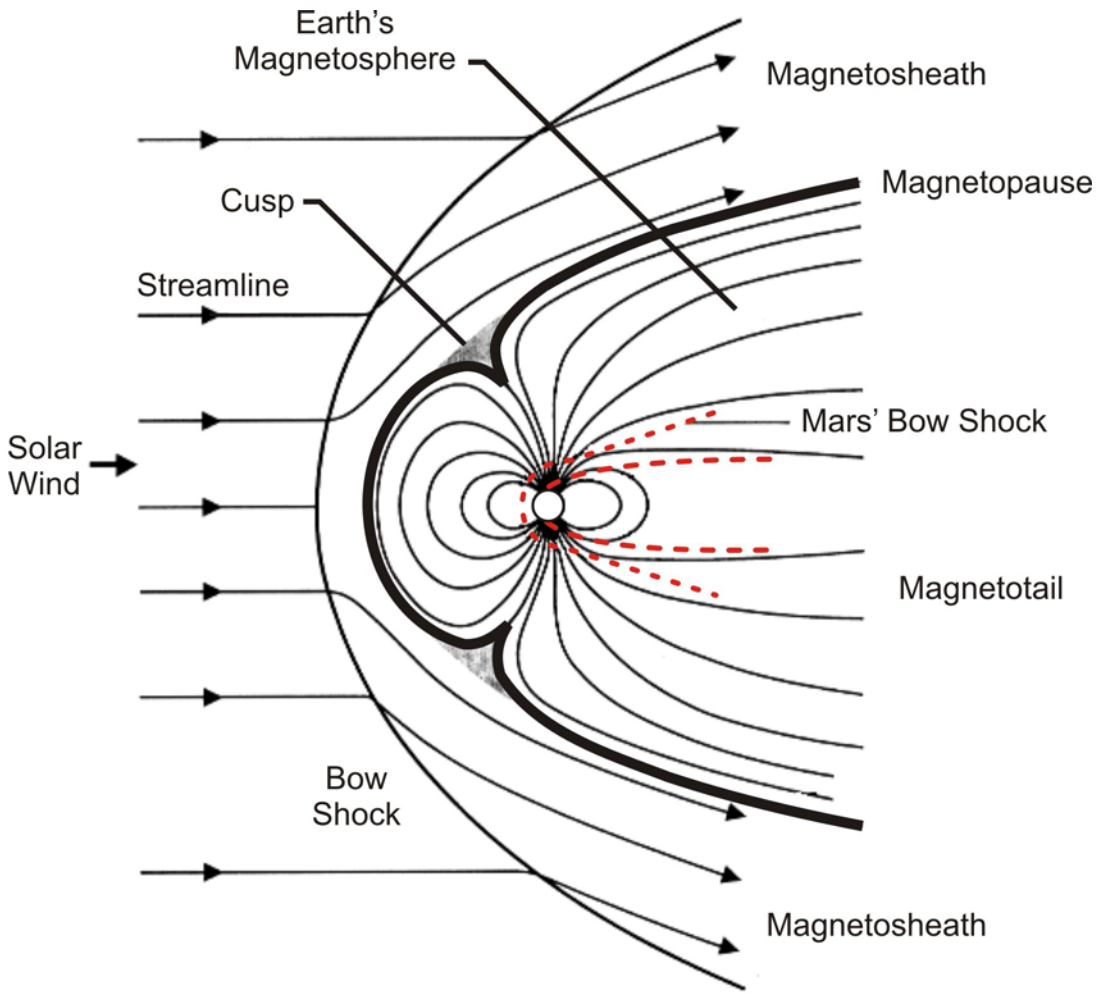
Initial Results of Particle Measurements on Mars Express

Dr. James R. Sharber
Department of Space Science
Southwest Research Institute
San Antonio, Texas



Comparison of the spatial extent of the Martian solar wind interaction to that of the Earth [adapted *Luhmann and Brace* 1991].

TA004550B



Comparison of the spatial extent of the Martian solar wind interaction to that of the Earth [adapted *Luhmann and Brace* 1991].

TA004550

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

MARS EXPRESS

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

Trinity Univ. Oct 12 2004 J Sharber

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

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THE MISSION

Mars Express is a mission of comparative planetology. It will make observations of the surface, atmosphere, surface - atmosphere, and atmosphere - interplanetary medium interactions.

SCIENCE OBJECTIVES

- *Global high-resolution photogeology (including topography, morphology, paleoclimatology) at 10 m resolution*
- *Global spatial high-resolution mineralogical mapping of the Martian surface at 100 m resolution*
- *Global atmospheric circulation and high-resolution mapping of atmospheric composition*
- *Subsurface structures at km-scale down to permafrost*
- *Surface-atmosphere interaction*
- ***Interaction of the atmosphere with the interplanetary medium***

ASPERA-3
Analyzer of Space Plasmas and Energetic Atoms

Rickard Lundin, P. I.
Stanislav Barabash, Co-P.I.

Swedish Institute of Space Physics + 14 teams from Finland, France, Japan, Germany, Ireland, Italy, Russia, Switzerland, UK, and USA

***Question*:** **Is the solar wind erosion the prime reason for the present lack of water on Mars?**

***Objective*:** **To measure solar wind scavenging: The slow escape of volatiles (atmosphere, hydrosphere) from Mars.**

Solar wind erosion at Mars

Planetary wind = Outflow of atmosphere and ionosphere (cometary interaction)

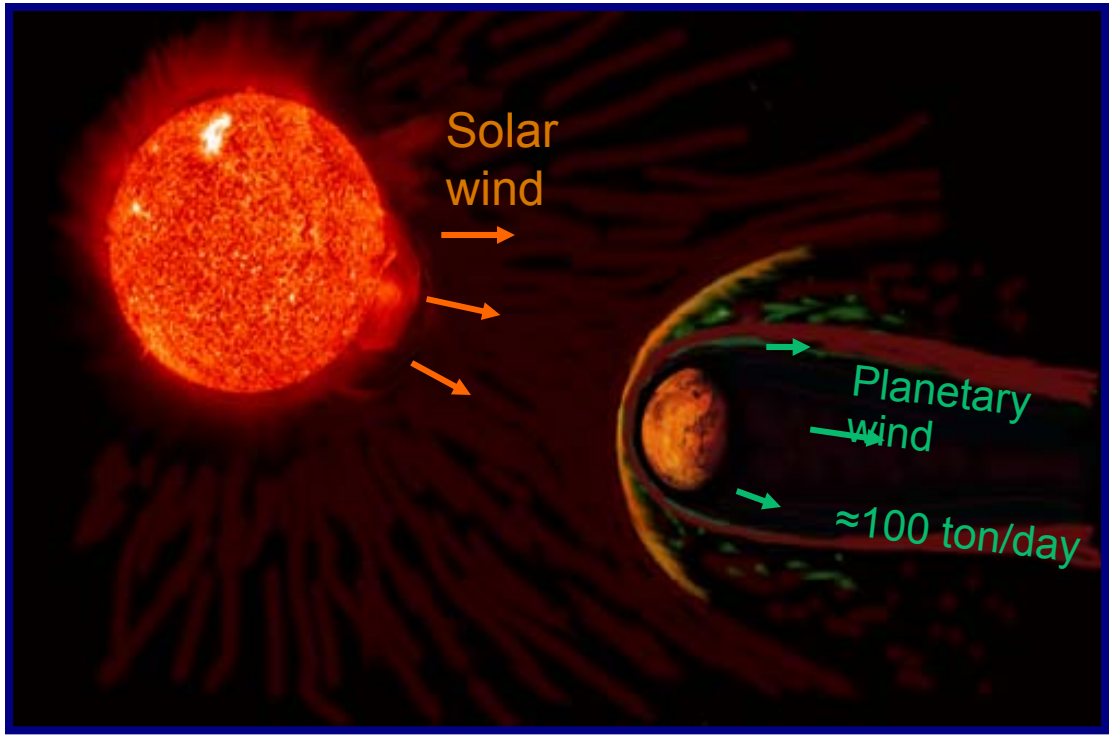
ASPERA will do global imaging and *in-situ* measurements of:

Inflow — solar wind

Outflow — planetary wind

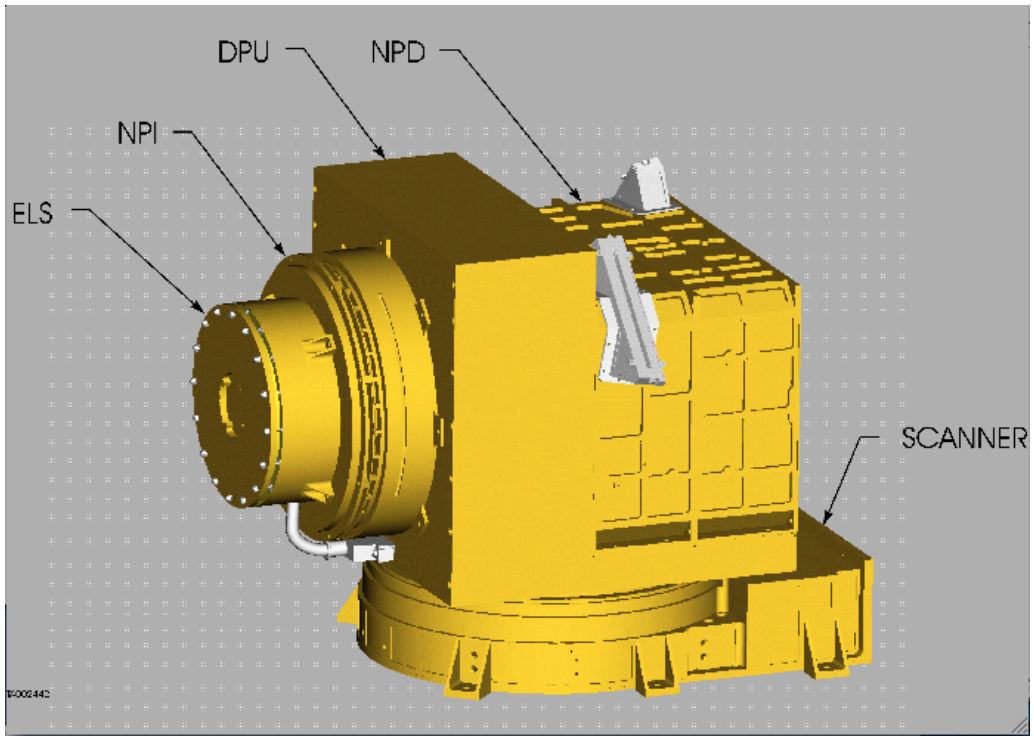
using:

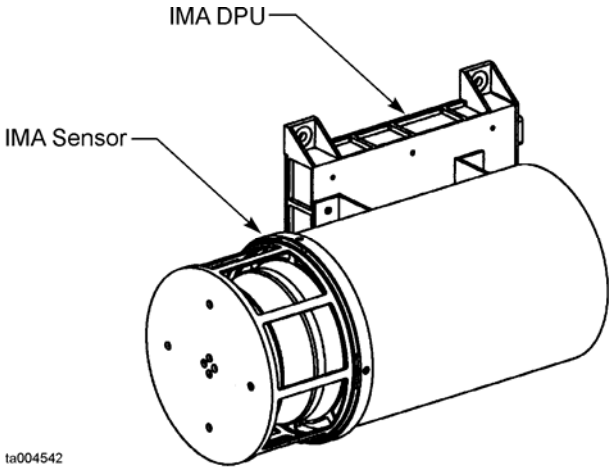
Energetic neutral atom cameras and plasma spectrometers (ion+electron)



Note: Mars (and Venus) are planets lacking a strong intrinsic magnetic field (umbrella) => dehydration.

ASPERA Instrumentation



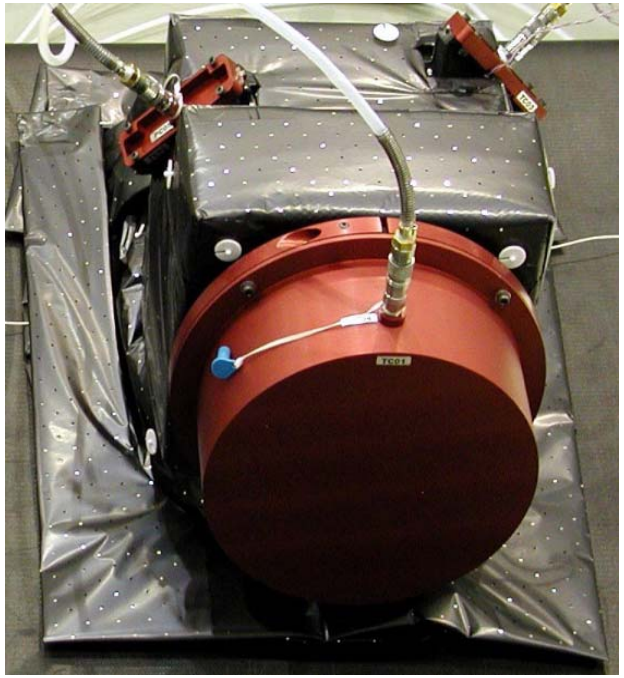


Ion Mass Analyzer (IMA)

Main Unit:

- Neutral particle imagers (NPI, NPD)
- Electron spectrometer (ELS)
- Data processing unit (DPU)
- Mechanical scanner

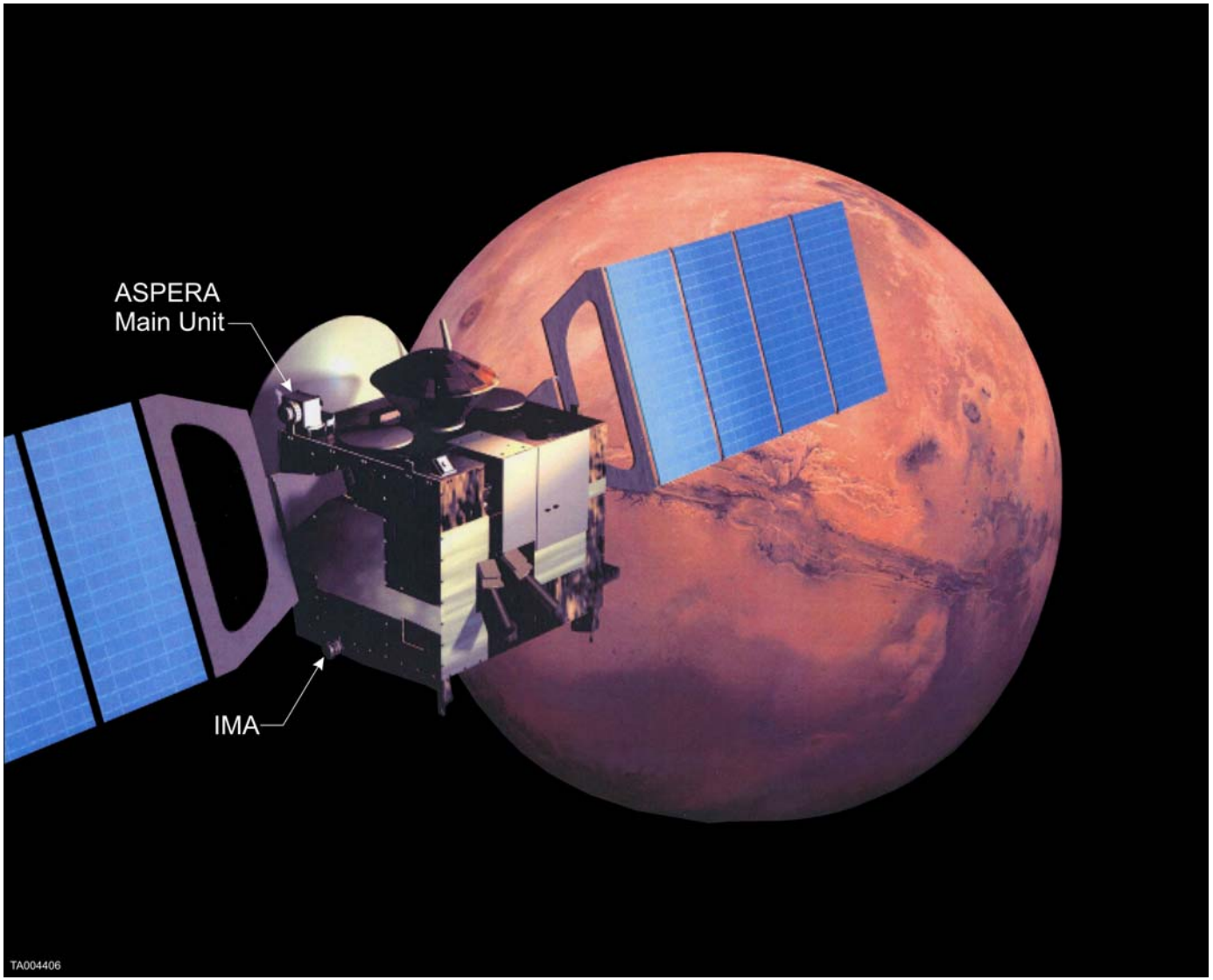
Packaged for Pre-launch Testing



Main Unit:

- **Neutral particle imagers (NPI, NPD)**
- **Electron spectrometer (ELS)**
- **Data processing unit**
- **Mechanical scanner**

- **Ion Mass Analyzer**



Mars Express was launched on June 2, 2003 and executed its orbital insertion burn on December 25, 2003.

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

Electron Spectrometer (ELS)

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

The Electron Spectrometer (ELS) sensor is a light-weight, low-power, spherical top-hat electrostatic analyzer with collimation, detection, and readout system.

It measures the electron spectrum:
electrons/cm^2 s sr eV vs. energy

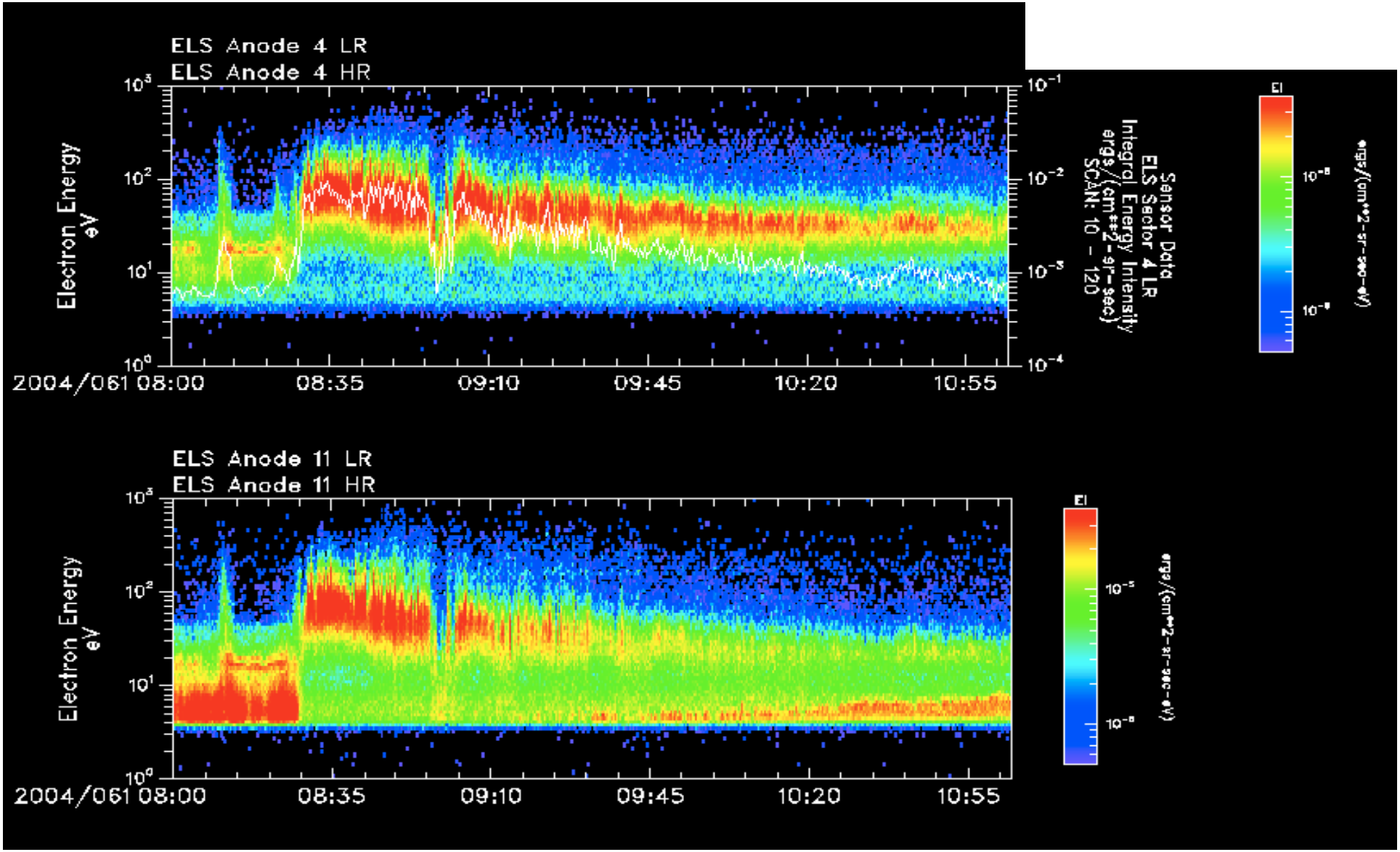
Energy range: 1 eV/q to 20 keV/q, one energy sweep (128 energy levels) per four seconds.

Energy resolution is 7%.

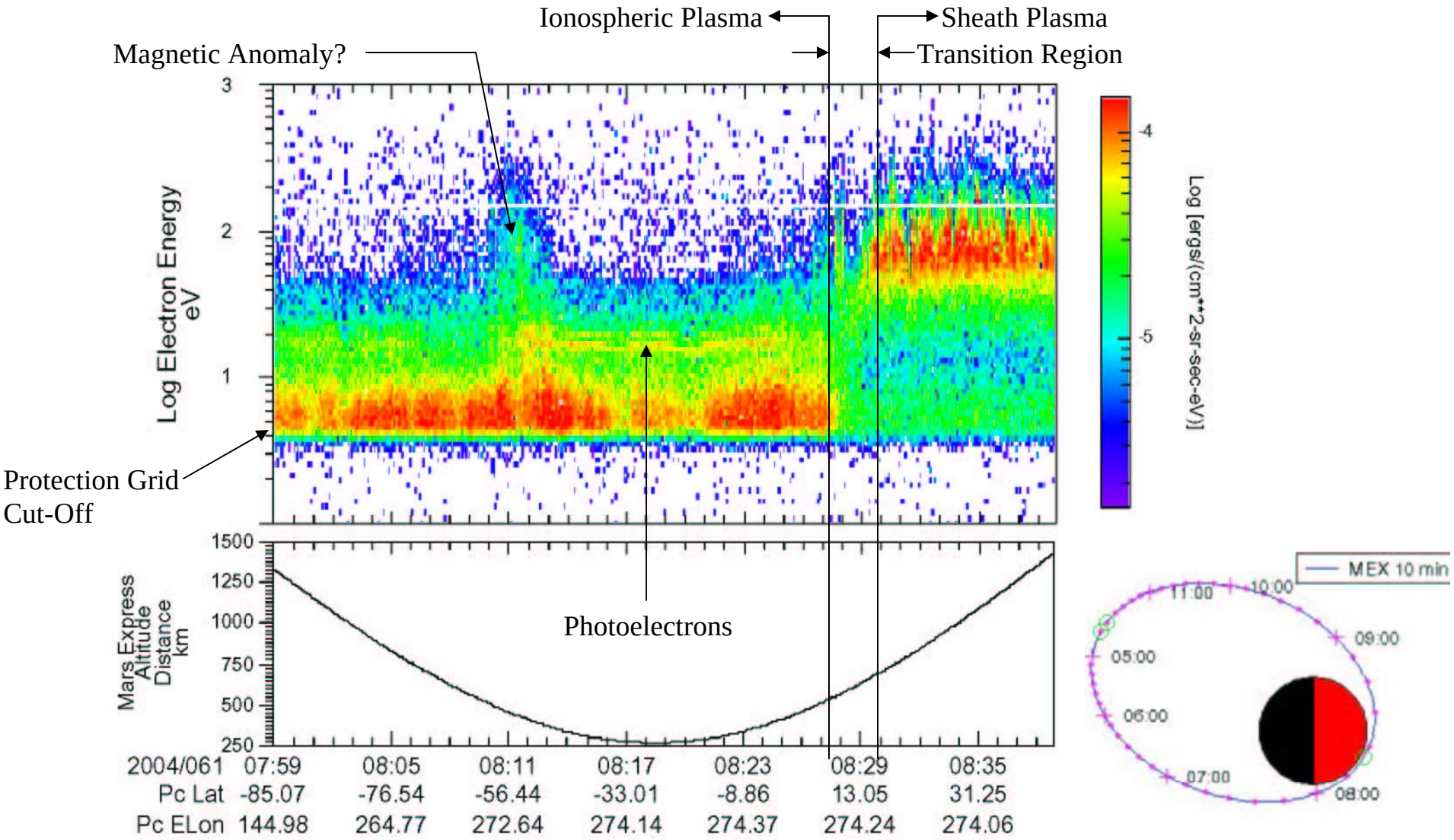
There are 16 anodes around a 360° fov, each defining a 22.5 ° sector.

Geometric factor (per sector) is 7.5 x 10 -5 cm^2 sr.

Electron Spectrometer (ELS)
Mar 1, 2004



Electrons in the Mars Ionosphere



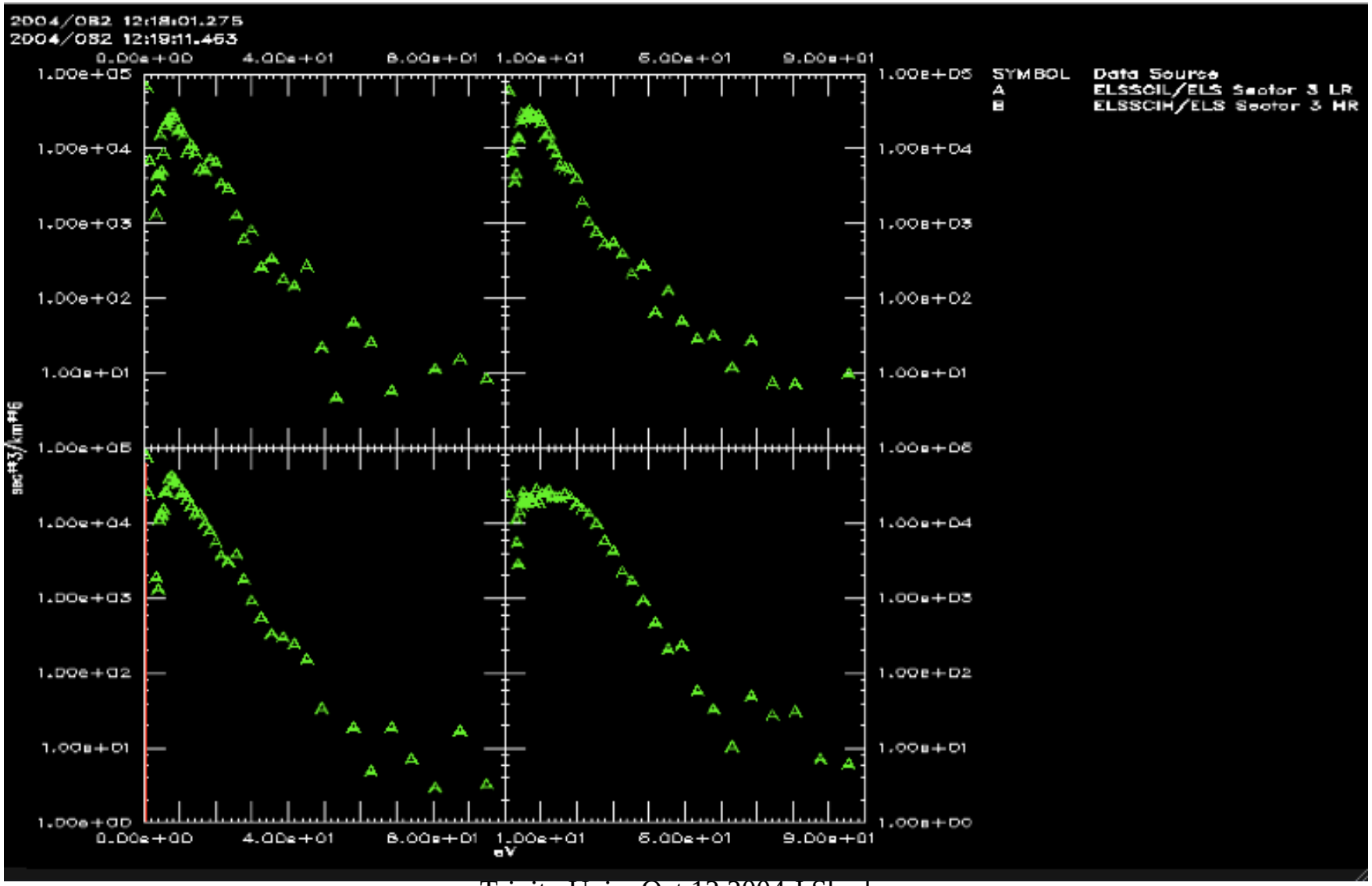
The Transition Region

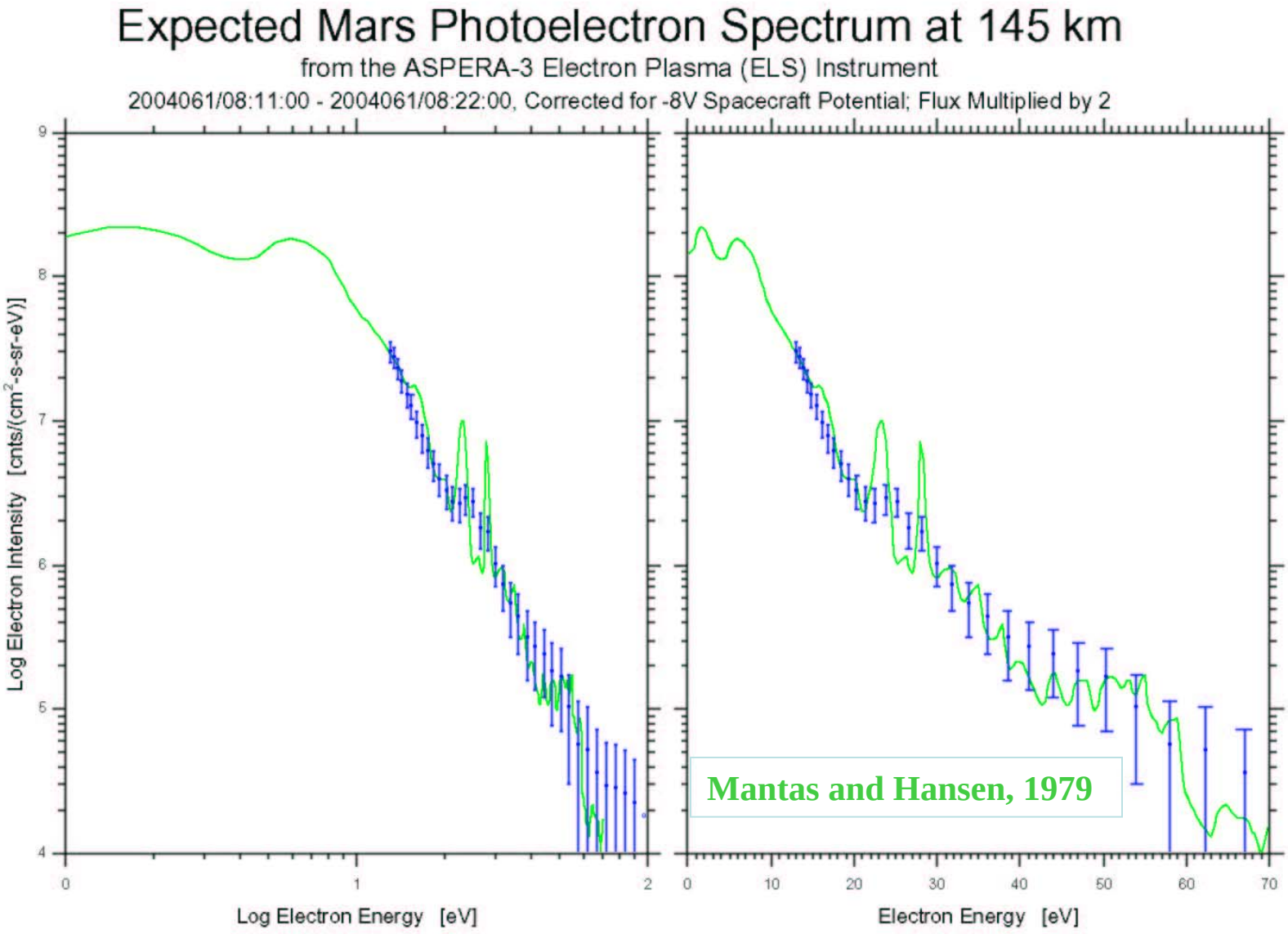
The magnetosheath has an inner boundary consistent with loss due to impact ionization of sheath electrons on atmospheric neutrals.

In the transition region magnetic field lines must be long enough that the photoelectrons suffer significant atmospheric degradation, which would not occur in a vertically stratified non-magnetized model.

As MEX moves further down in altitude, we are reach a region where the mass density along the path becomes significantly less, enabling a measurement of the photoelectron peaks near their production altitude.

ELS Spectra - Mar 22, 2004

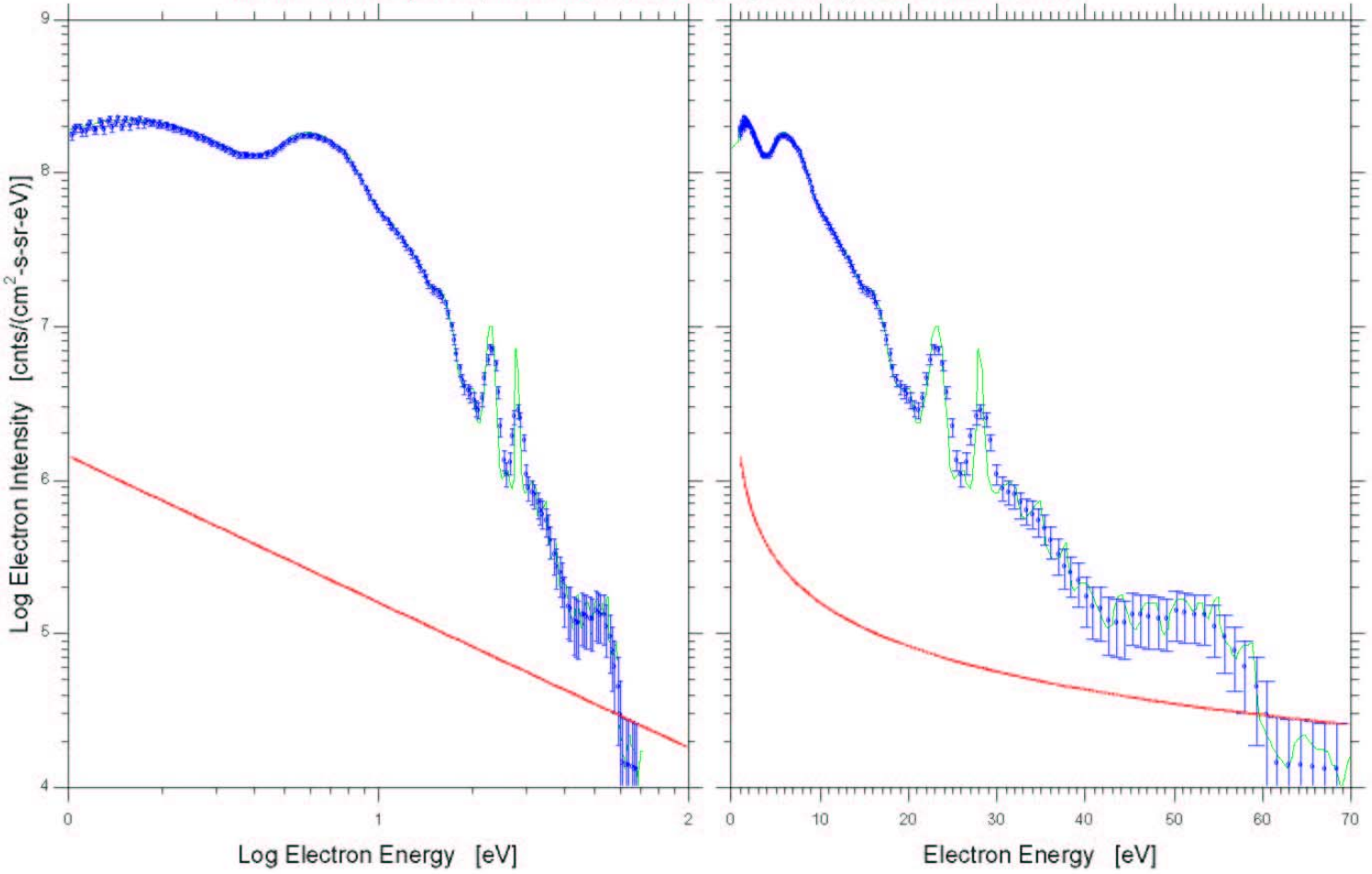



Expected Mars Photoelectron Spectrum at 145 km
from the ASPERA-3 Electron Plasma (ELS) Instrument
2004061/08:11:00 - 2004061/08:22:00, Corrected for -8V Spacecraft Potential; Flux Multiplied by 2
Log Electron Intensity [cnts/(cm2-s-sr-eV)]
Log Electron Energy [eV]
Electron Energy [eV]
Mantas and Hansen, 1979

Expected Mars Photoelectron Spectrum at 145 km

from the ASPERA-3 Electron Plasma (ELS) Instrument

Instrument Response, Instrument Threshold (2 count), and Poisson Errors



Ion Mass Analyzer (IMA)

This instrument consists of an electrostatic analyzer followed by a mass analysis section employing a cylindrical magnetic field.

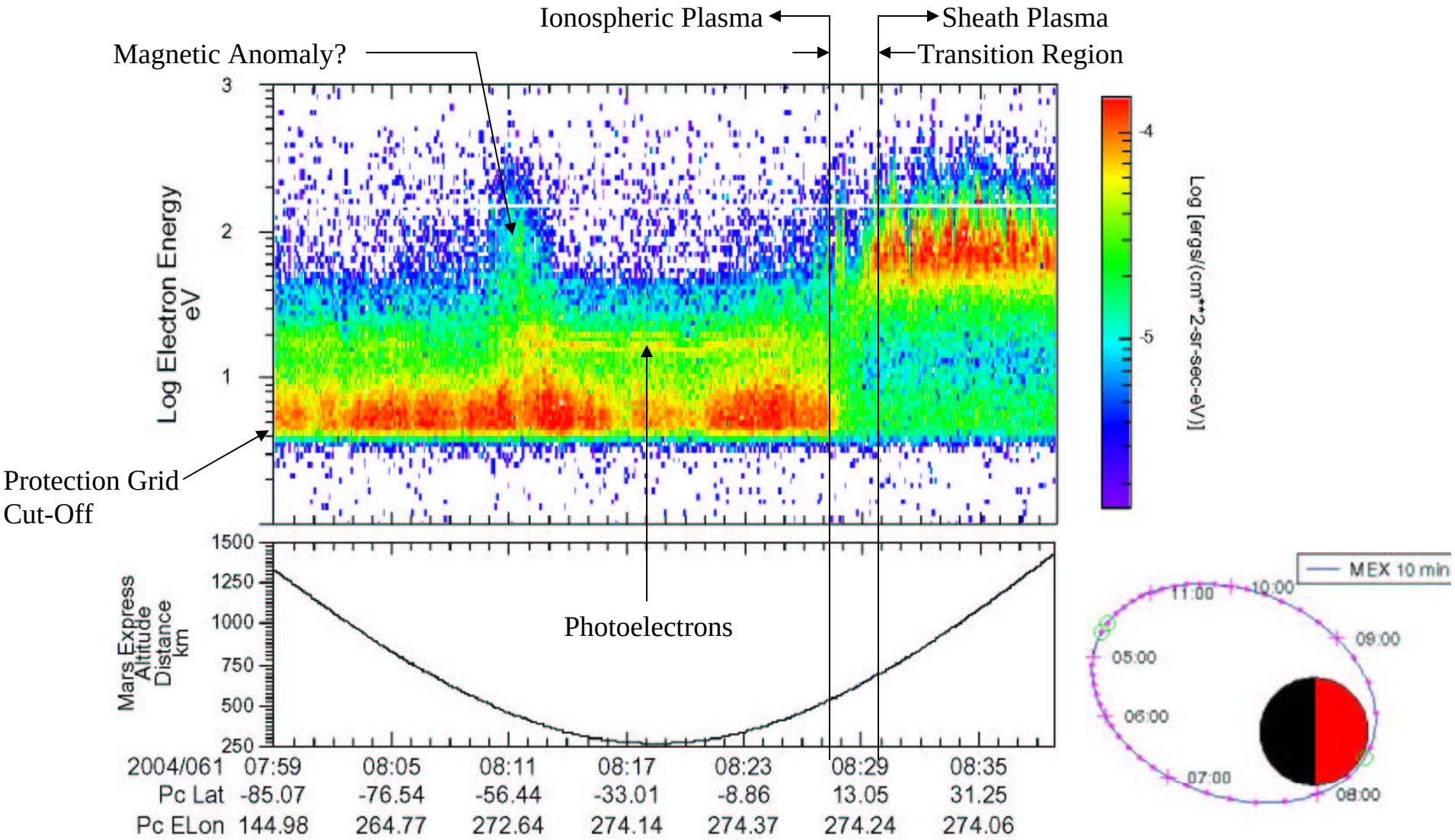
The acceptance geometry is 16 sectors of 22.5° each around 360°

Energy resolution is 7%.

Mass resolution: $M/\Delta M$ ~6. (m/q = 1,2,4,8,16, molecular ion group (m/q>20))

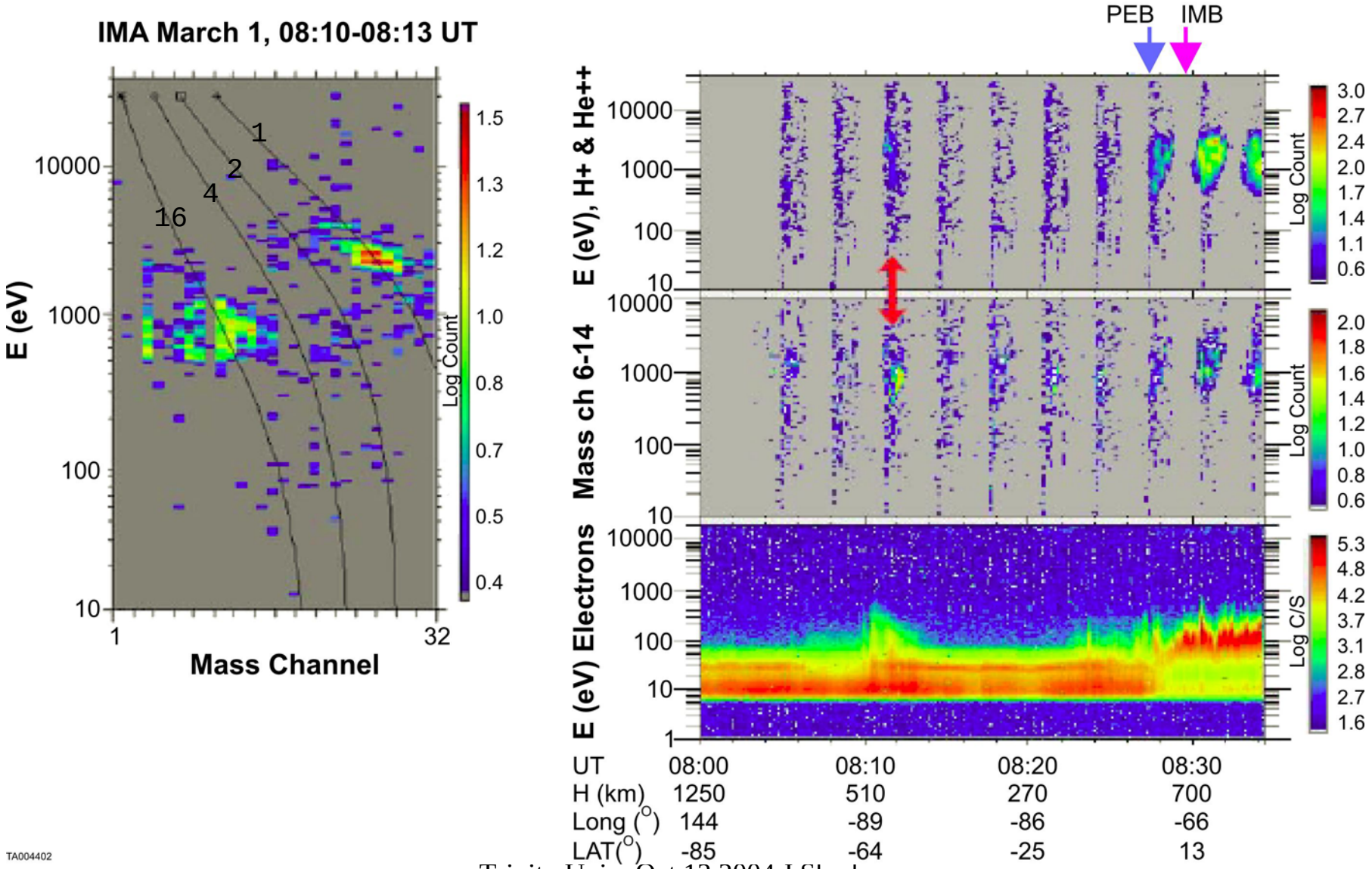
Geometric factor (per sector): 3.5×10^{-4} cm^2 sr.

Electrons in the Mars Ionosphere



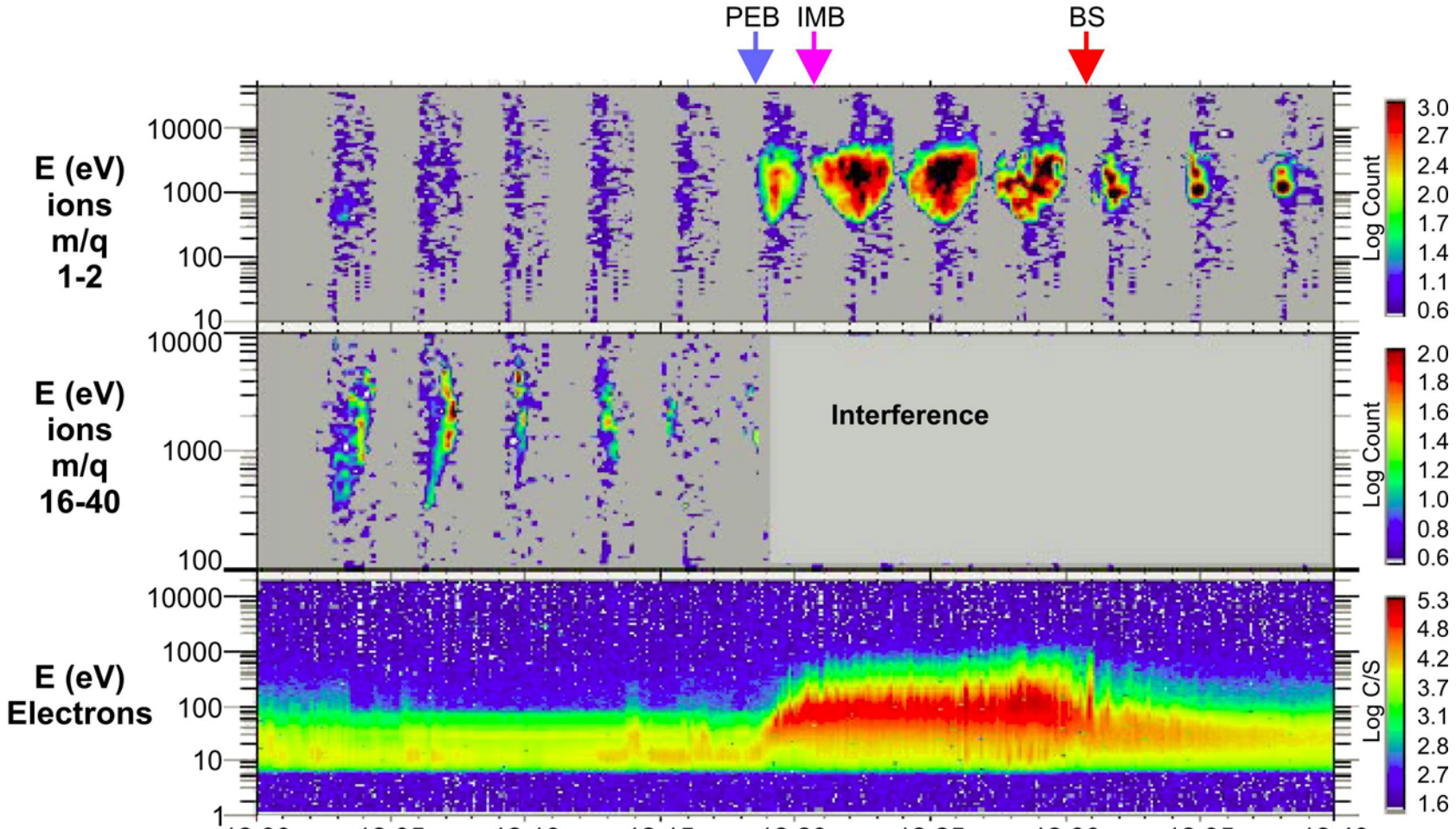
Frahm et al., Fall AGU, Dec. 2003

ASPERA-IMA, ELS 1 March 2004



TA004402

ASPERA-IMA, ELS 22 March 2004



X_RM_MSD	0.21	0.53	0.81	1.03	1.17	1.25	1.27	1.24	1.19
Y_RM_MSD	-0.57	-0.51	-0.42	-0.29	-0.14	0.02	0.17	0.33	0.42
Z_RM_MSD	-0.99	-0.81	-0.57	-0.29	0.01	0.32	0.61	0.88	1.12
ALTITUDE_KM	544	340	272	374	611	985	1427	1902	2378
LONG_DEG	38.92	45.66	47.16	47.47	47.37	47.31	46.81	46.55	46.40
LAT_DEG	-75.38	-56.98	-38.87	-16.92	1.21	16.74	29.85	40.33	49.21

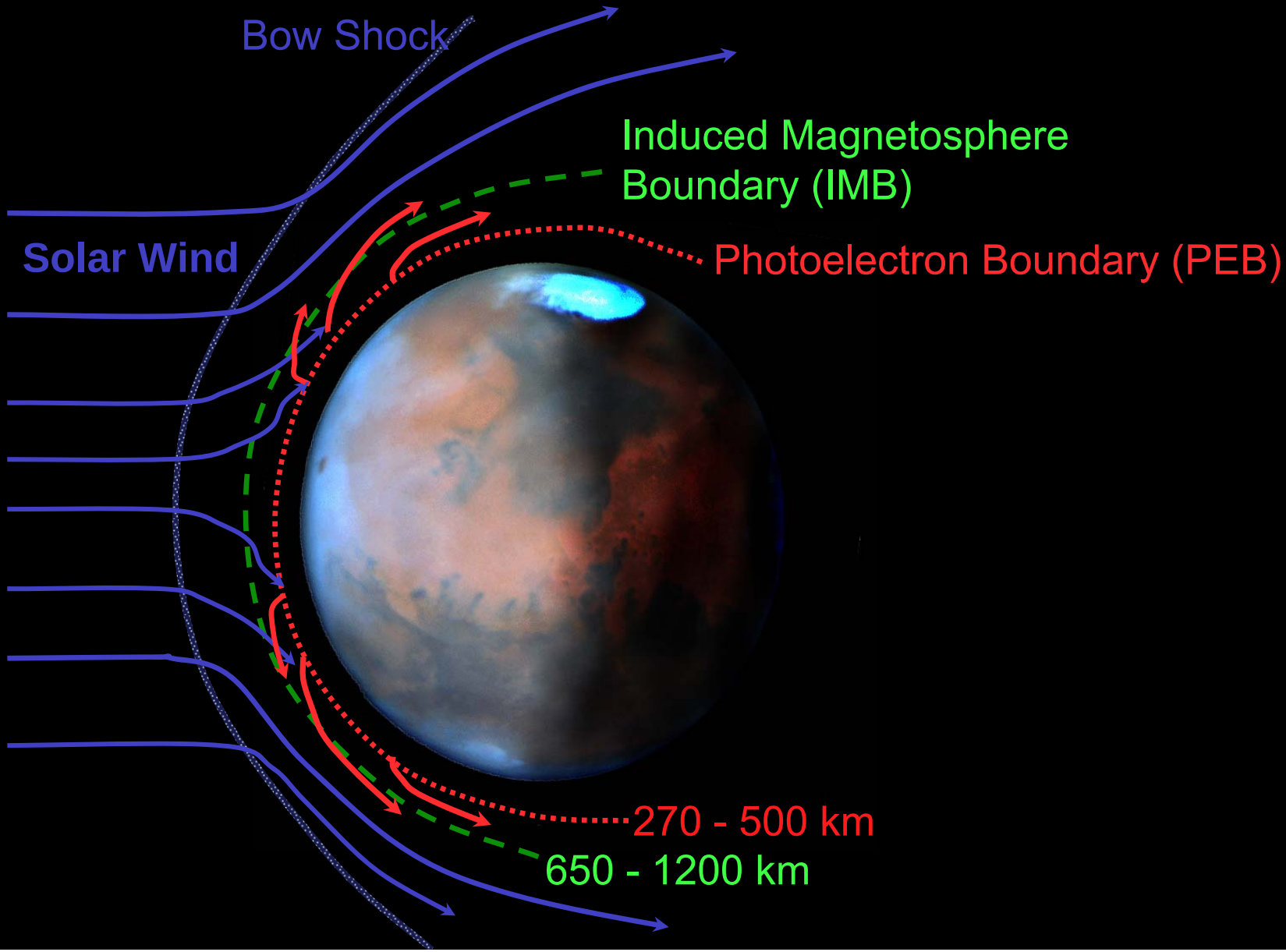
TA004401

ASPERA-3 New Findings - Escape

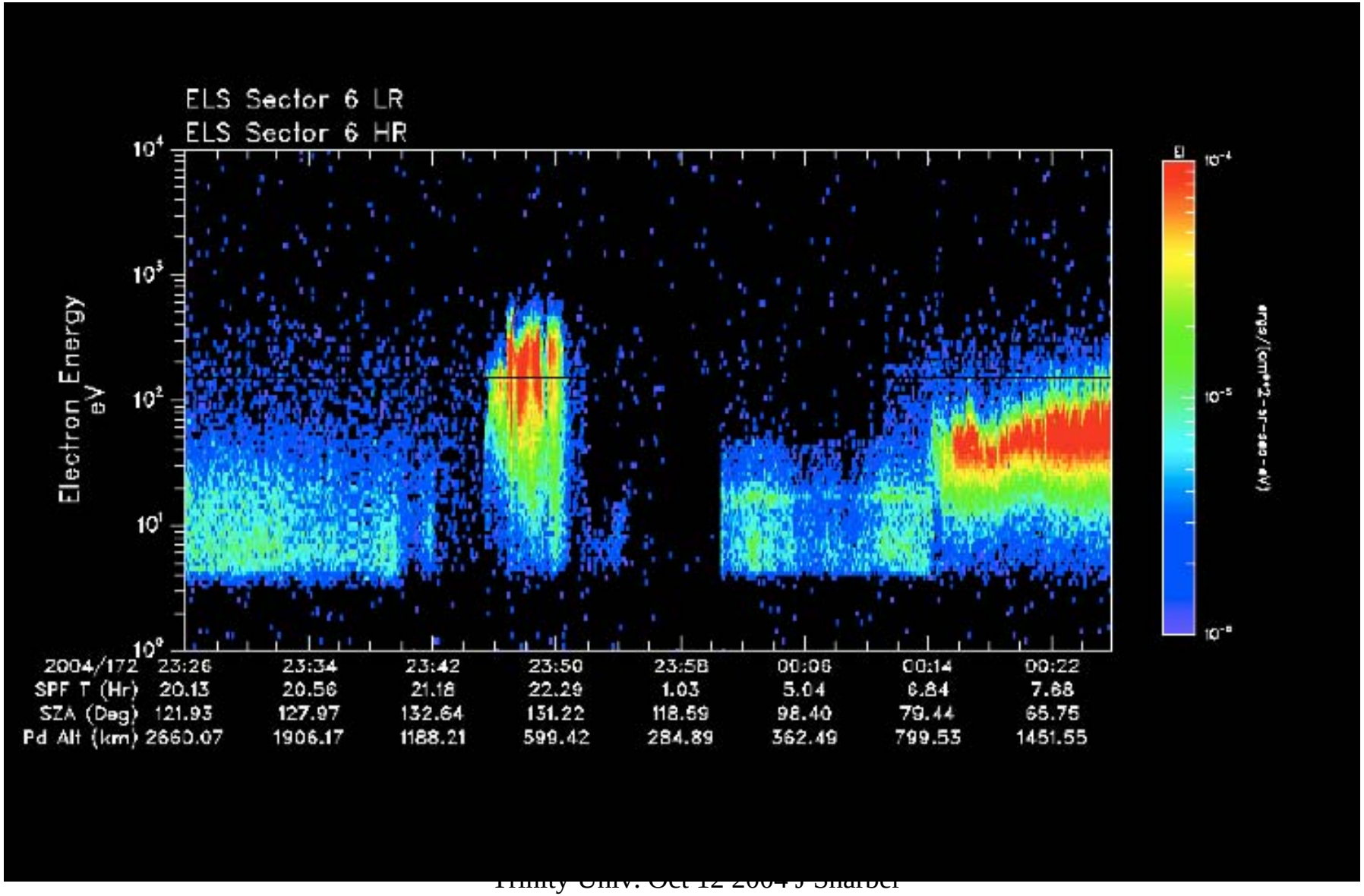
Presented by R. Lundin at EGS, Spring 2004

1. **The Solar wind** may protrude very deep into the atmosphere - down to pericenter altitudes ≈270 km.
2. Acceleration processes responsible for the erosion of atmosphere - **the planetary wind** - start as low as ≈270 km above the surface of Mars.
3. Accelerated/outflowing O^+ may reach **several keV at 300 km** altitude.
4. The planetary wind also contains **molecular species** (e.g. CO_2^+ and O_2^+), consistent with acceleration processes reaching low altitudes.
5. Statistical results on dayside magnetosphere boundaries (Photoelectron Boundary and Induced Magnetosphere Boundary)

Atmospheric Outflow from Mars



Electron Acceleration - Nightside



Summary

Several study areas are continuing with the in-situ instrumentation:

Photoelectron spectrum: work in progress to determine our ability to measure the identifying peaks in order to use ELS as a remote sensor of atmospheric properties at distant locations along the magnetic field line.

Characteristics and dynamics of the various plasma regions and the locations of their boundaries will continue with the objective of further specifying the nature and causes of the escape of ions from the atmosphere.

Comparison of particle observations with magnetic anomaly locations will continue in an effort to determine the effect of the anomalies on entry of particle populations into the Mars atmosphere and outflow of planetary atmospheric constituents.