Ionospheric photoelectrons from Mars Express ASPERA-ELS

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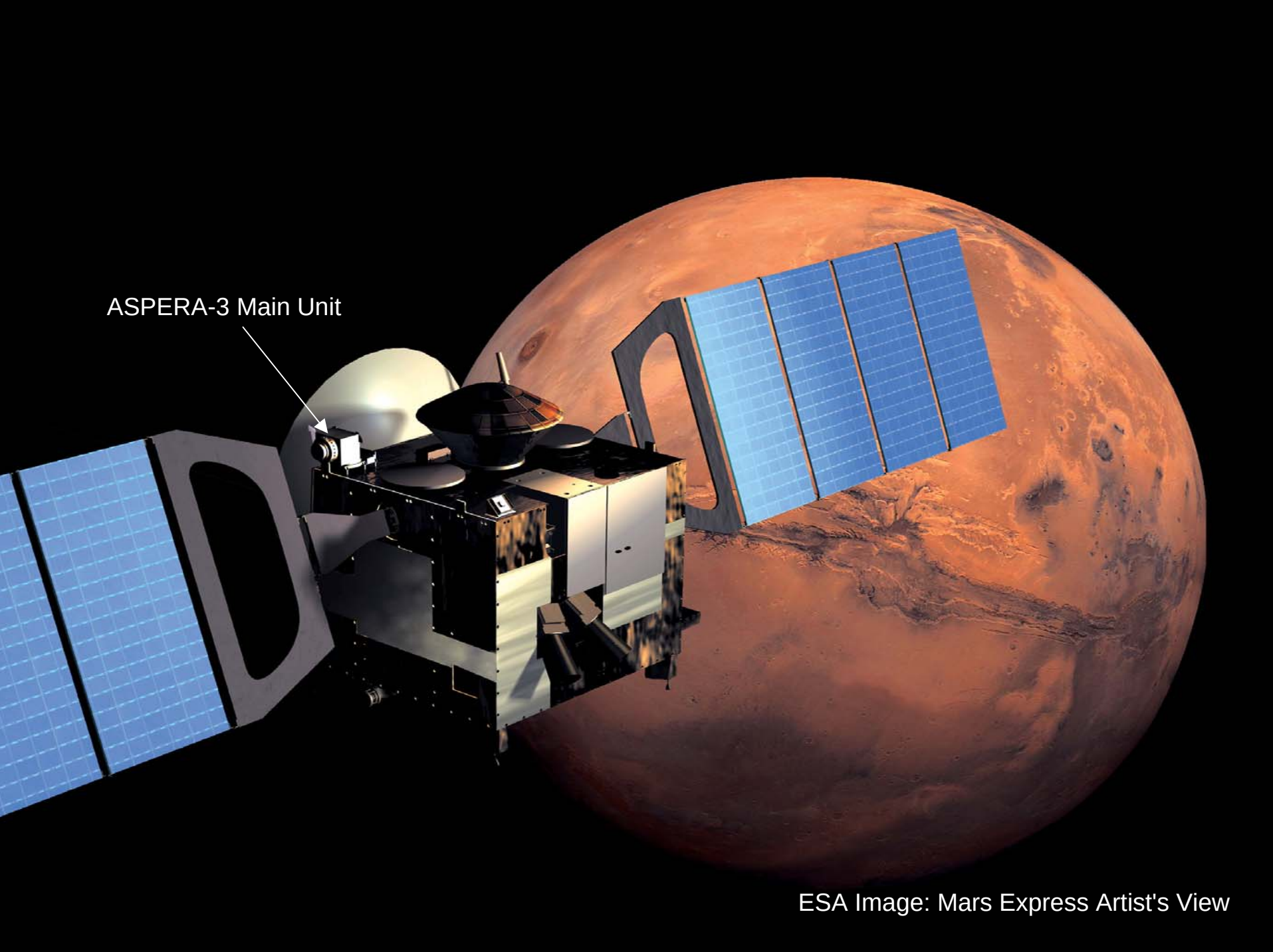


ESA Image: Mars Express Artist's View

Instrument performance

Table 2. Baseline performances of the NPI, NPD, ELS and IMA sensors.

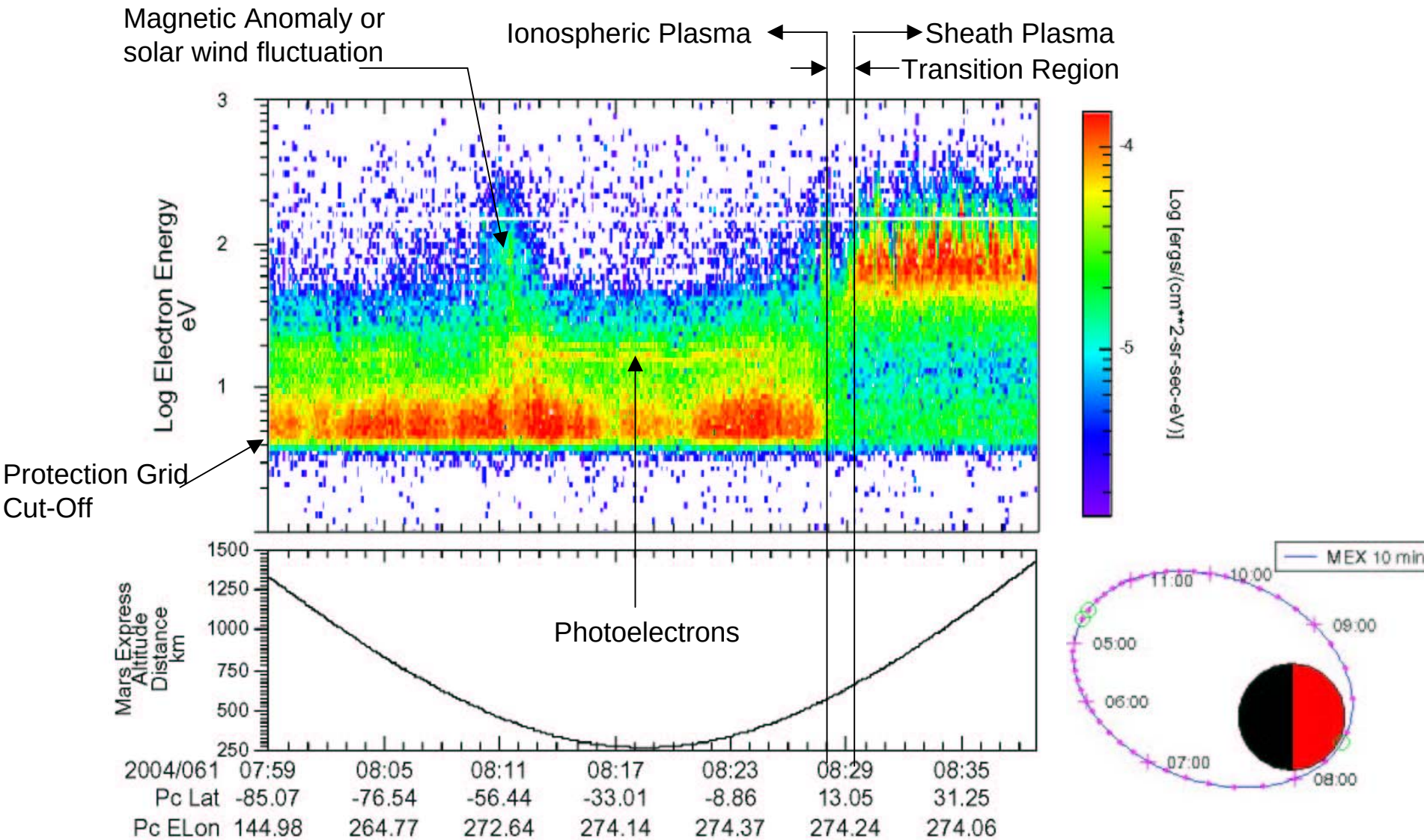
Parameter	*NPI*	*NPD*	*ELS*	*IMA*
Particles to be measured	ENA	ENA	electrons	ions
Energy range, keV per charge	= 0.1 - 60	0.1 - 10	0.01 - 20	0.01 - 30
Energy resolution, $\Delta E/E$	No	0.8	0.08	0.07
Mass resolution	No	H, O	–	m/q = 1, 2, 4, 8, 16, >20
Intrinsic field of view	9 x 344°	9 x 180°	10 x 360°	90 x 360°
Angular resolution (FWHM)	4.6 x 11.5°	5 x 30°	10 x 22.5°	4.5 x 22.5°
G-factor*/ pixel, cm^2 sr	2.5×10^{-3} (ε not incl.)	6.2×10^{-3} (ε not incl.)	5×10^{-4}	3.5×10^{-4}
Efficiency, ε, %	~ 1	0.1-20	inc. in G	inc. in G
Time resolution (full 3D), s	32	32	32	32
Mass, kg	0.7	1.3	0.3	2.2
Power, W	0.8	1.5	0.6	3.5

*G-factor is the instrument geometrical factor

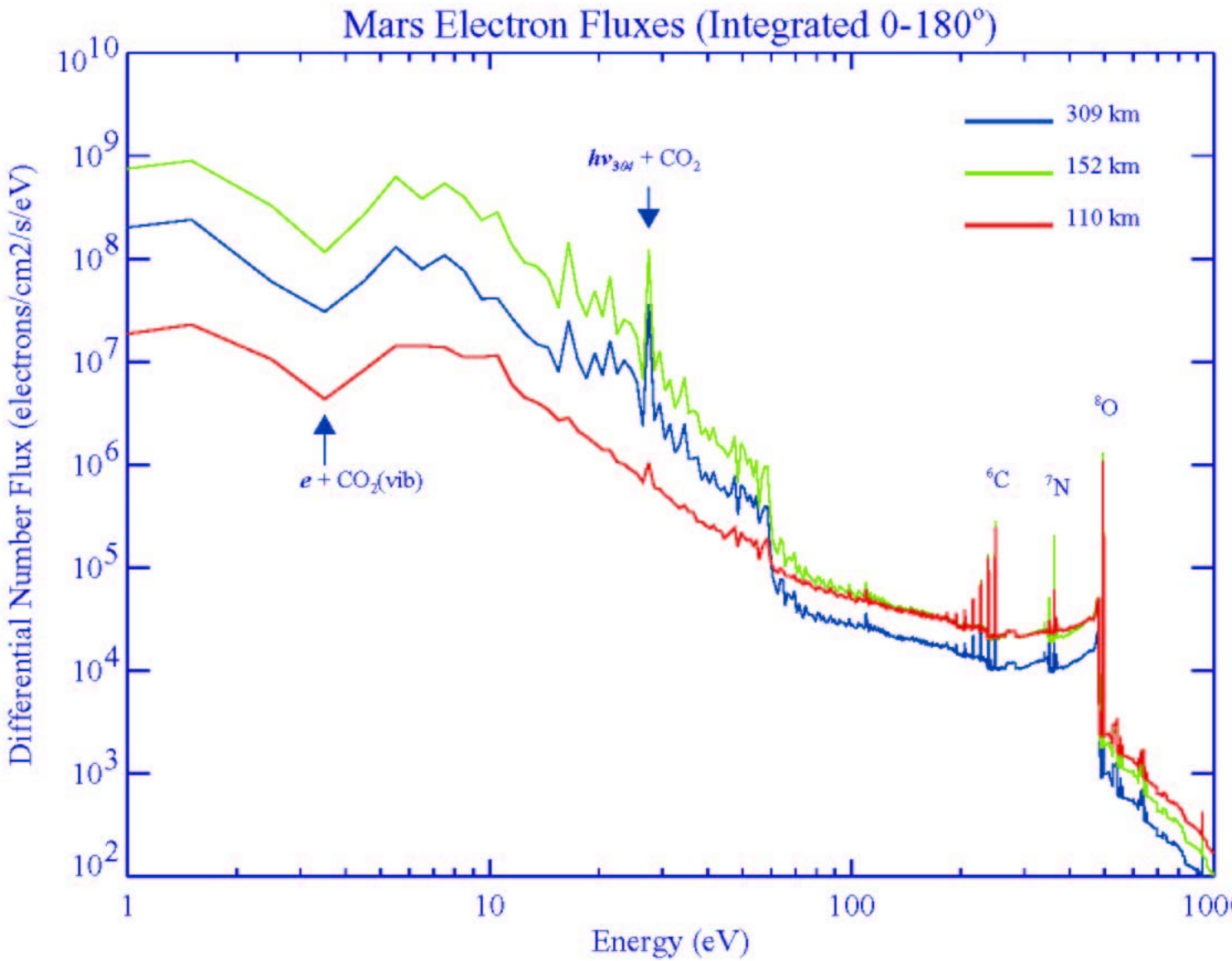
Value in high resolution mode.
Normal mode 0.24

Also an ‘oversampling’ mode

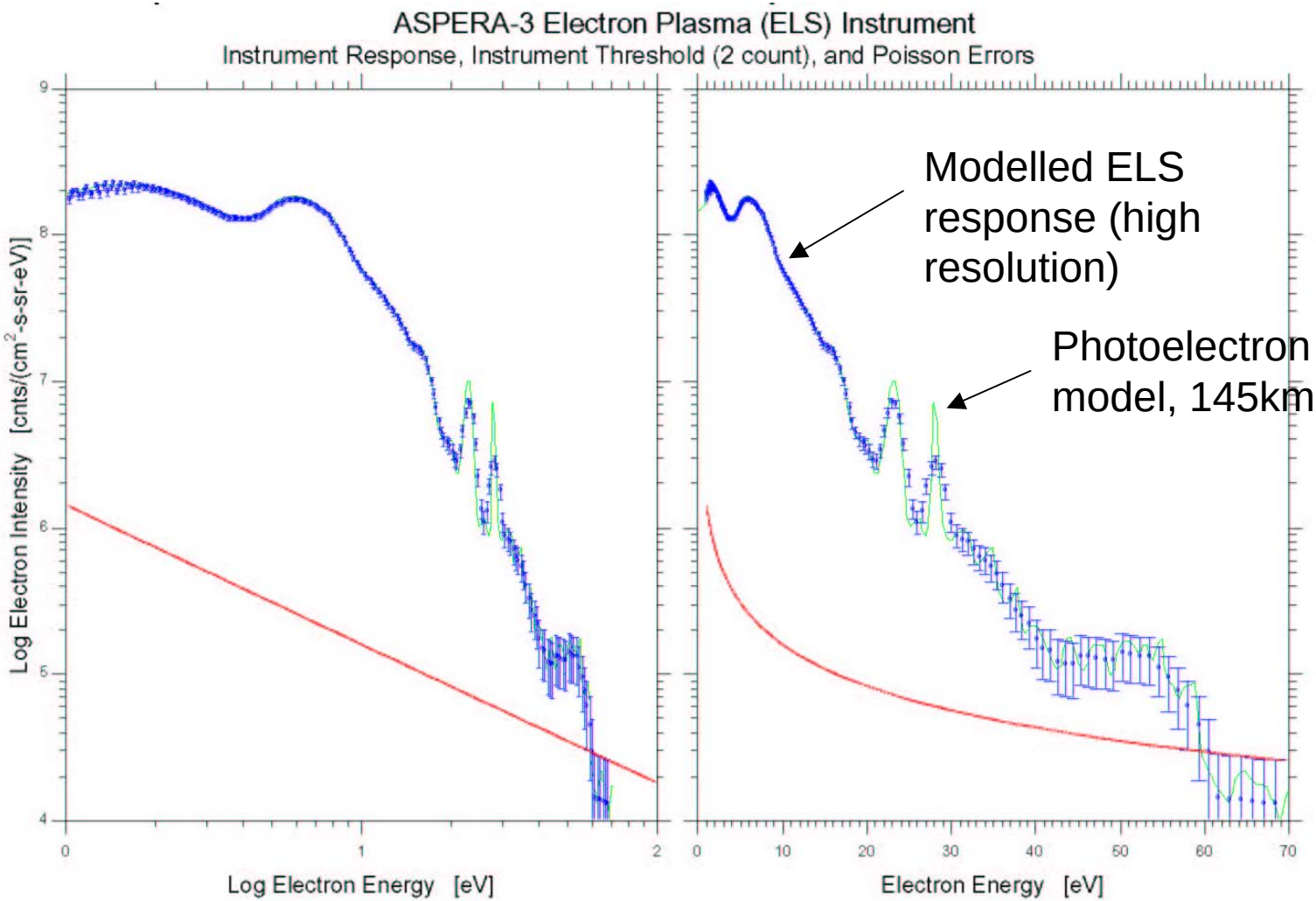
Electrons in the Mars Ionosphere

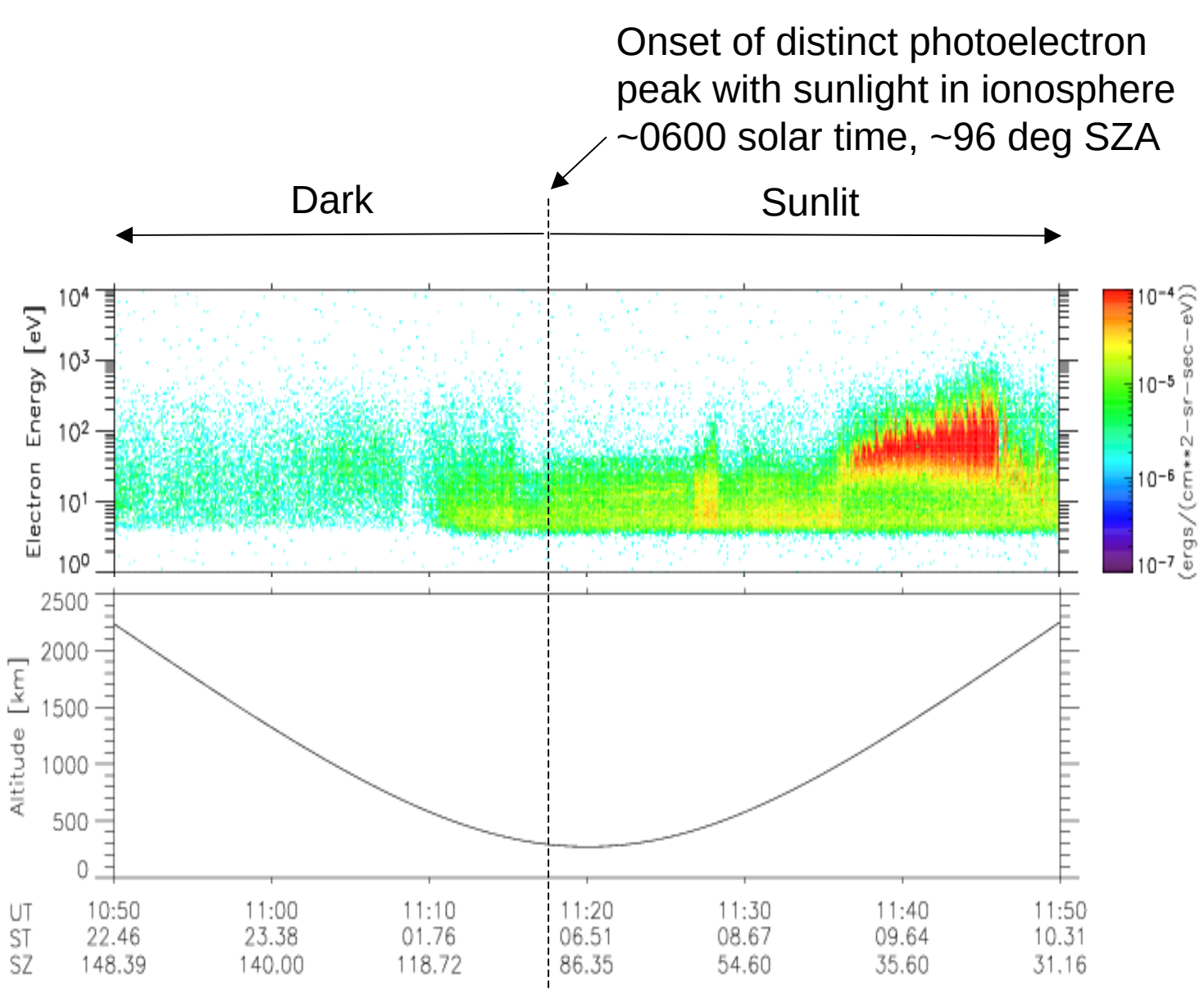


Mars Photoelectron Spectrum

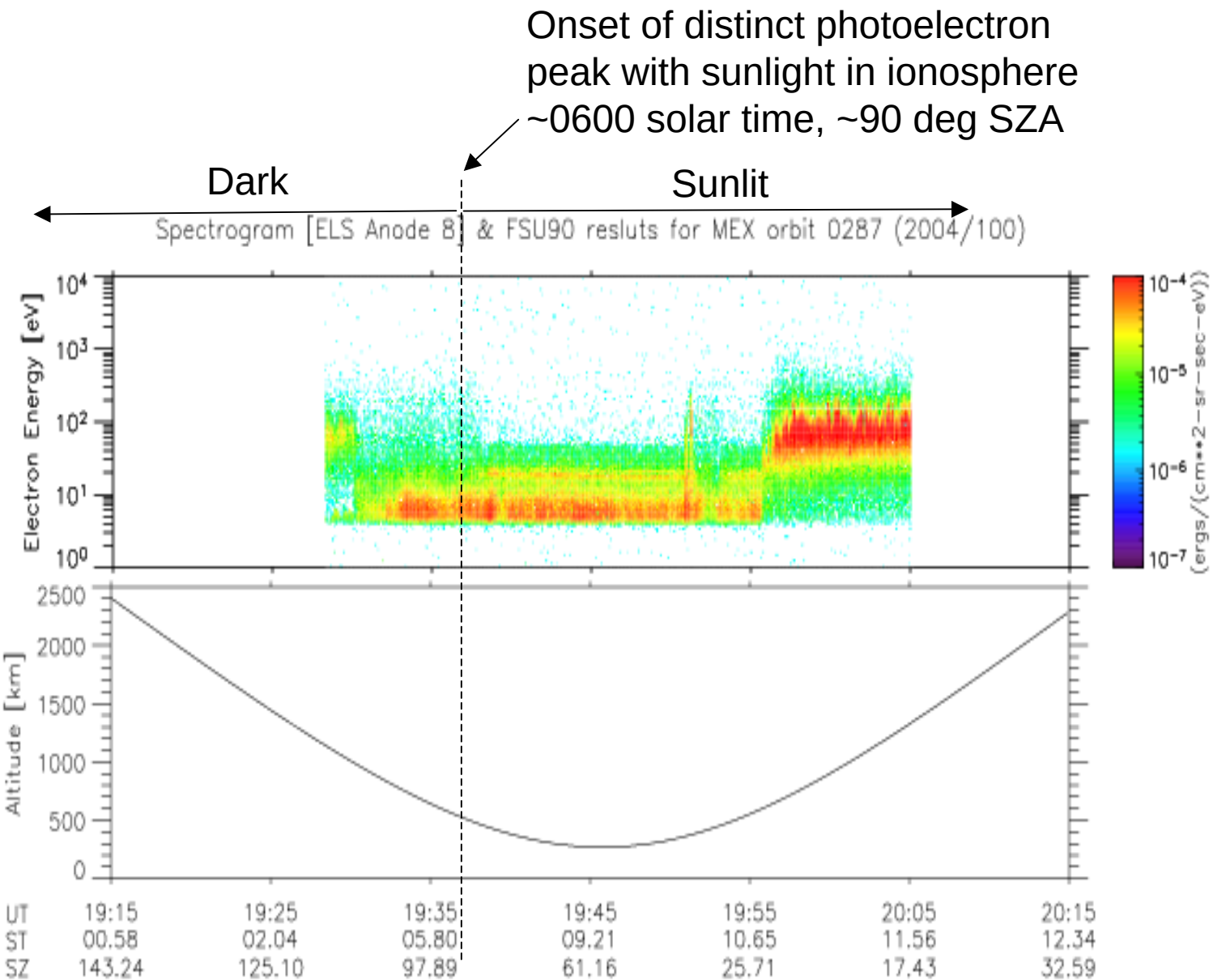


R. Link


ASPERA-3 Electron Plasma (ELS) Instrument
Instrument Response, Instrument Threshold (2 count), and Poisson Errors
Log Electron Intensity [cnts/(cm^2-s-sr-eV)]
Log Electron Energy [eV]
Electron Energy [eV]
Modelled ELS response (high resolution)
Photoelectron model, 145km

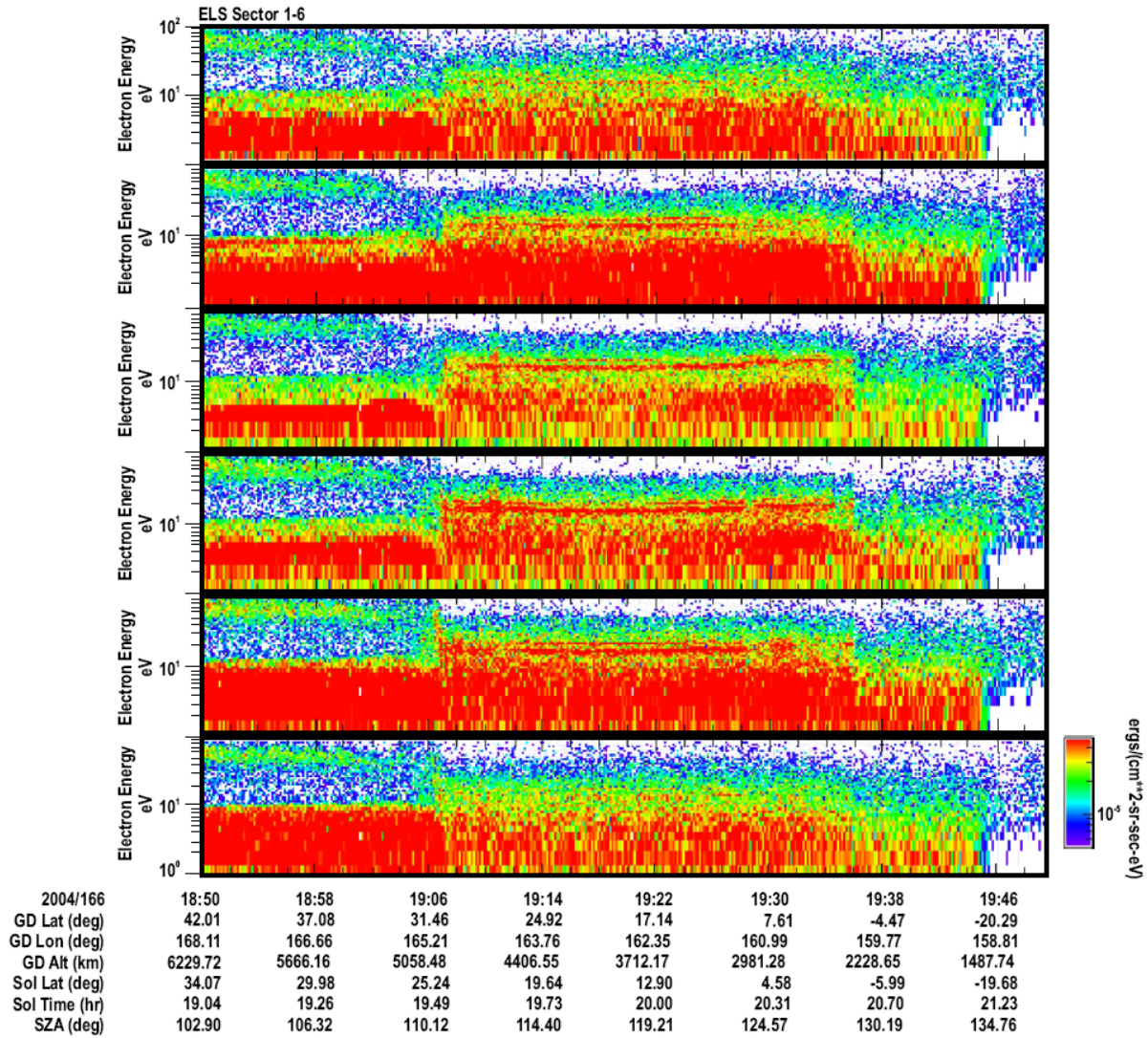


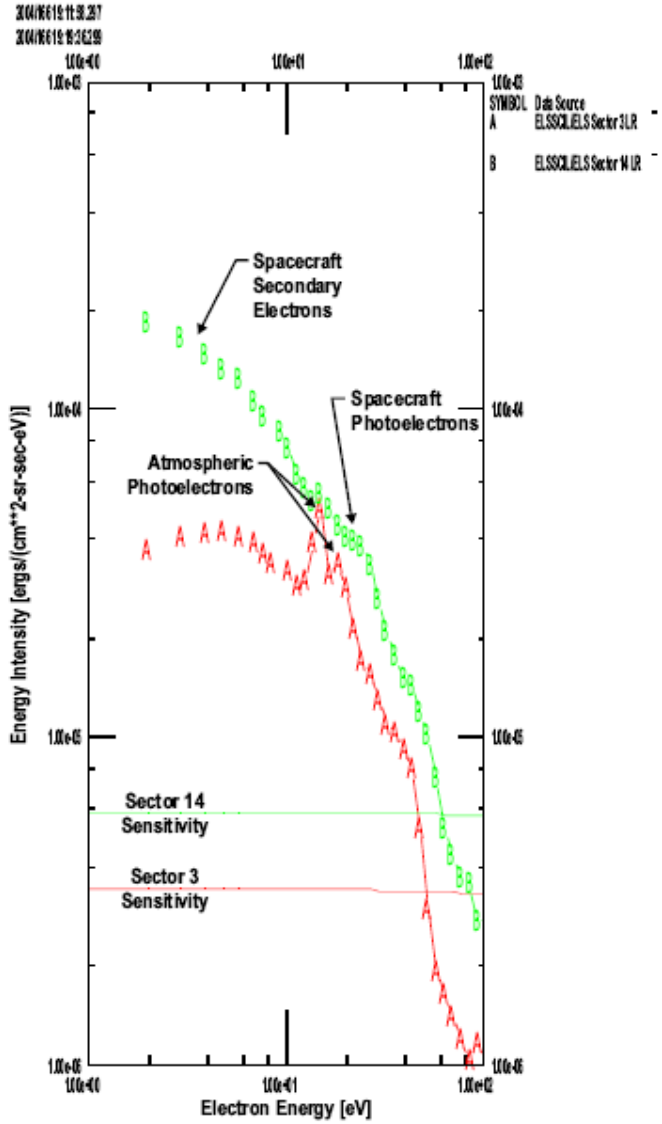
Orbit 399 (2004/135), anode 8



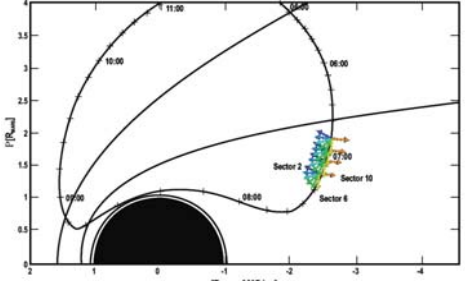
Orbit 287 (2004/100), anode 8

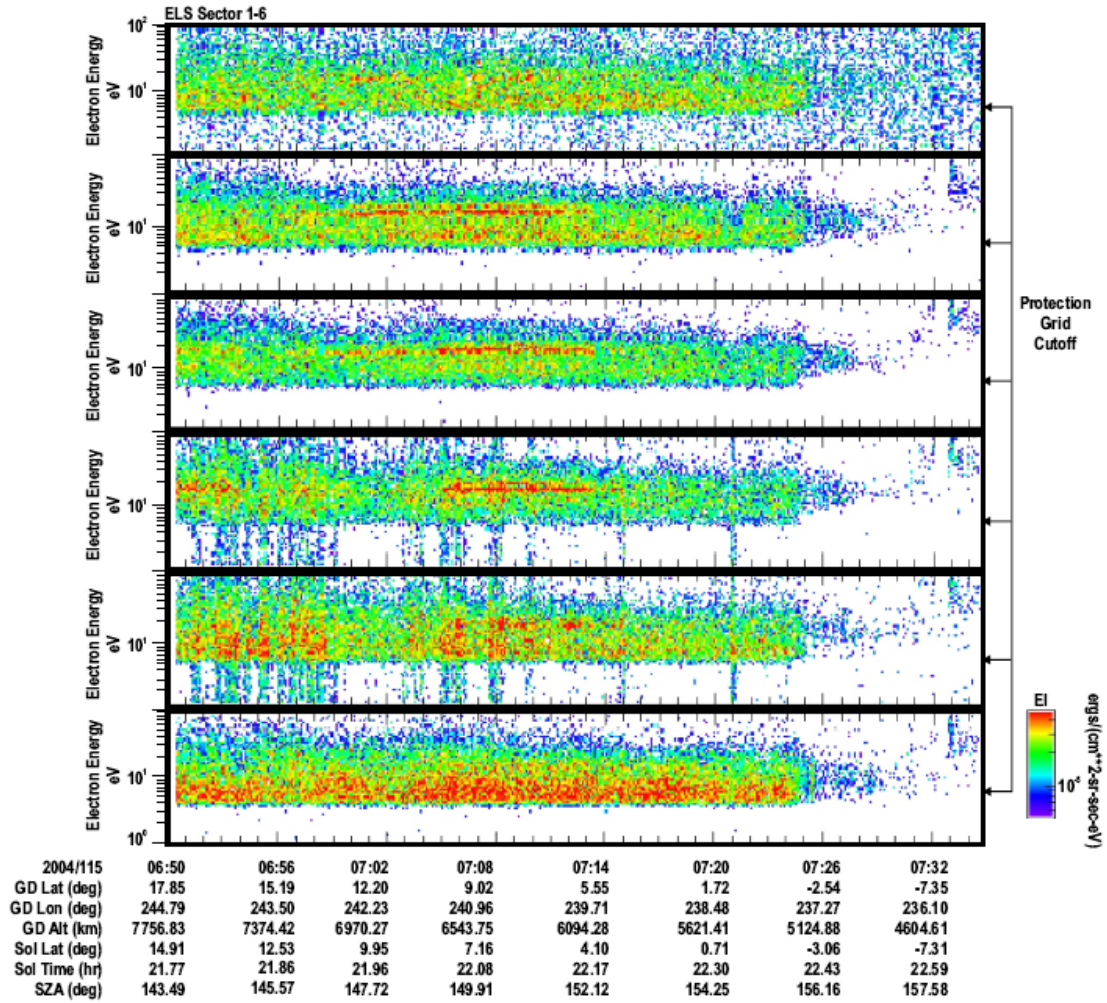
Tail, ~4000 km (2004/166)

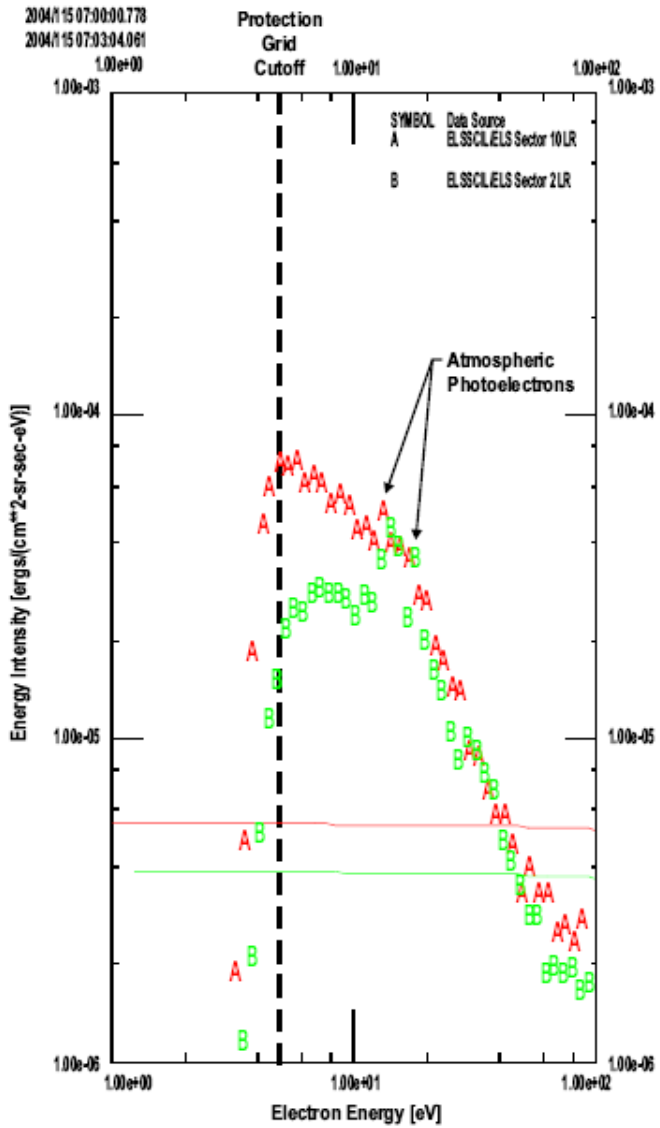




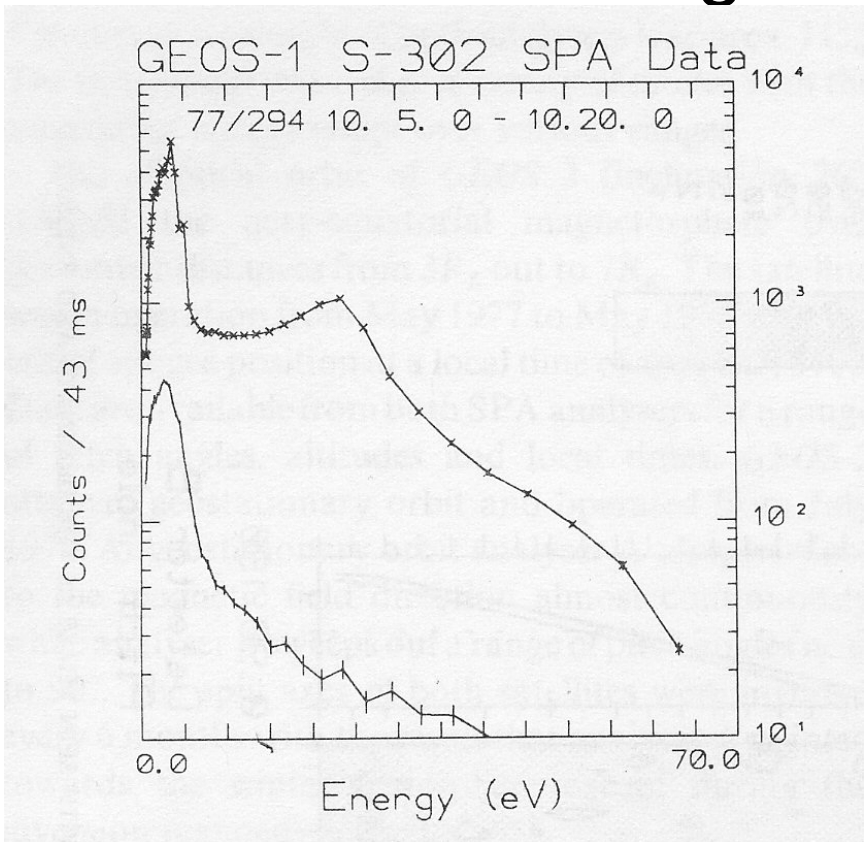
Tail, ~7000 km (2004/115)

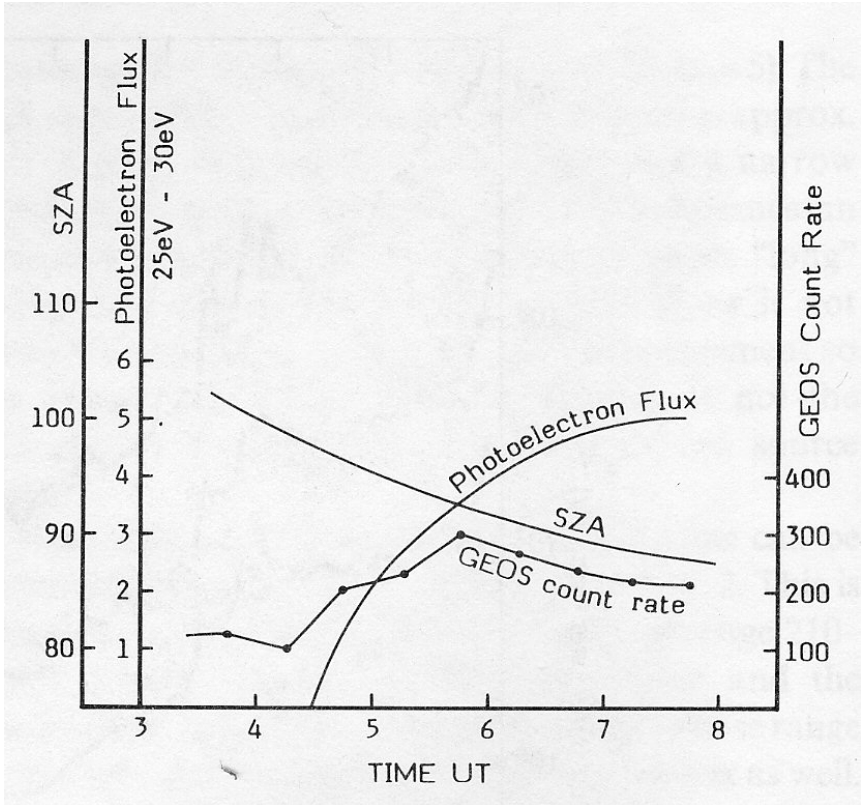






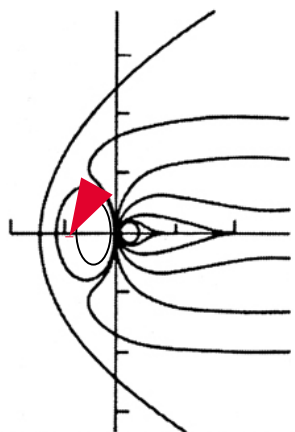
Photoelectrons high in Earth's magnetosphere



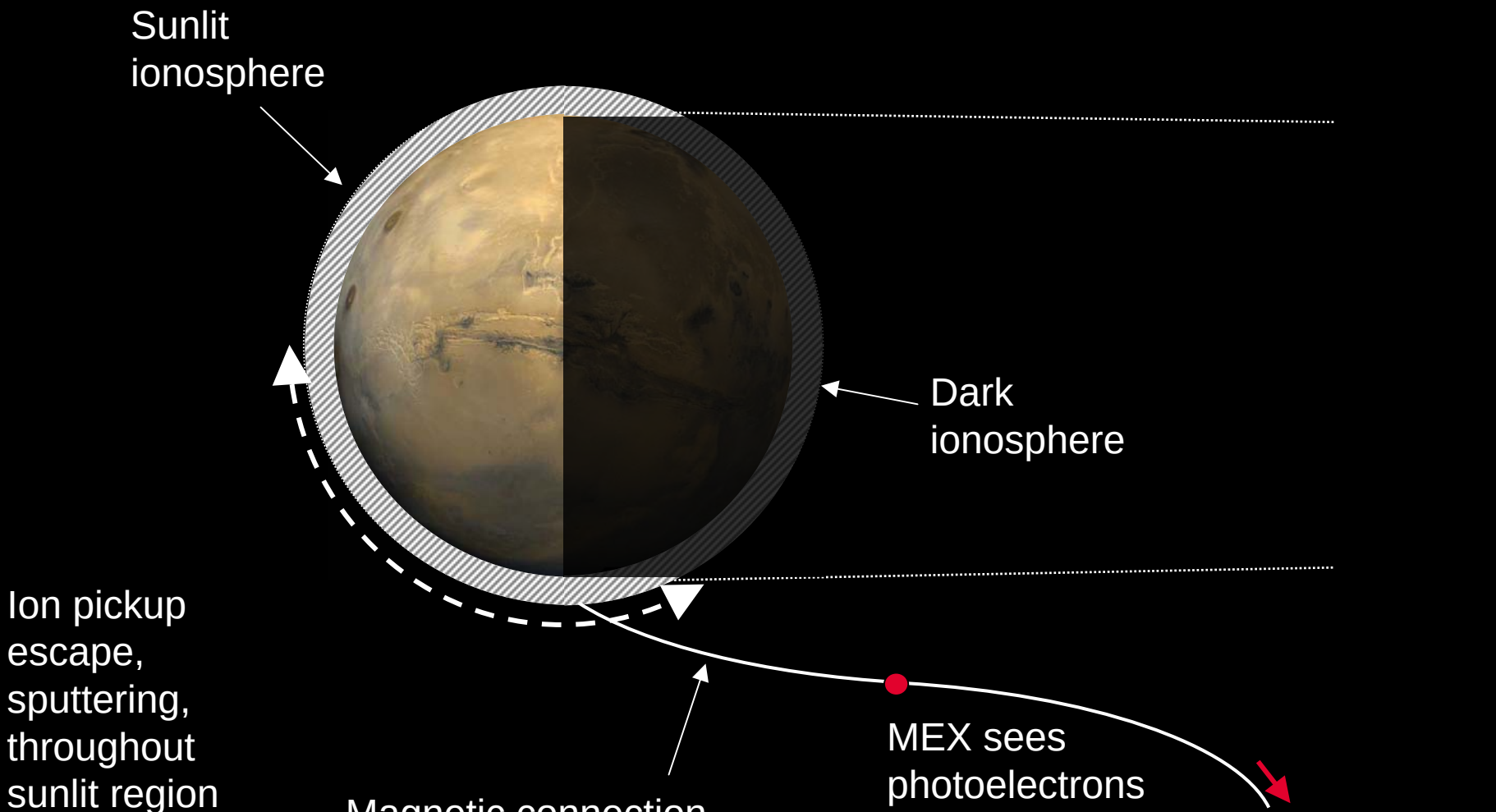


Ionospheric photoelectrons in Earth's magnetosphere up to 6.6 R_e (Coates et al, 1985)

Fluxes seen for SZA < 97° in the ionosphere at foot of modelled Earth magnetic field



- Magnetic connection from sunlit ionosphere to spacecraft
- Provides non-thermal escape mechanism – electric field set up


Sunlit ionosphere
Dark ionosphere
Ion pickup escape, sputtering, throughout sunlit region
Magnetic connection anywhere in sunlit ionosphere, via draped solar wind field or flux ropes (may not need this)
MEX sees photoelectrons
Photoelectron-drawn escape throughout dayside region – particularly along connected field?

Conclusions

- ELS spectra at Mars show ionospheric photoelectron peak(s)
- Ionosphere – peaks due to CO_2^+ (e.g., Mantas & Hanson, Link)
- Onset of sunlight in ionosphere starts photoelectrons
- Photoelectrons seen on night side and at high altitudes at times
- Magnetic connection to sunlit ionosphere, similar to Earth?
- May extract ions via electric field: photoelectrons pull ions
- Process seen at Mars, Earth, Titan – Venus?