

Physics of the Lunar Surface

Outline:

- 1) Apollo: Visiting the lunar surface
- 2) Hovering dust clouds ?
- 3) Solar plasma & radiation
- 4) Laboratory studies
- 5) Recent and future spacecraft observations

Graduate Planetary Seminar

[ASTR/GEOL 5835](#)

March 3, 2010

The 6 manned moon landings:

Apollo 11 - landed 20 July, 1969

Apollo 12 - landed 19 November, 1969

Apollo 14 - landed 5 February, 1971

Apollo 15 - landed 30 July, 1971

Apollo 16 - landed 20 April, 1972

Apollo 17 - landed 11 December, 1972

The men who walked on the Moon :

Apollo 11 - Neil Armstrong (of "One small step for a man, one giant leap for mankind" fame); Buzz Aldrin

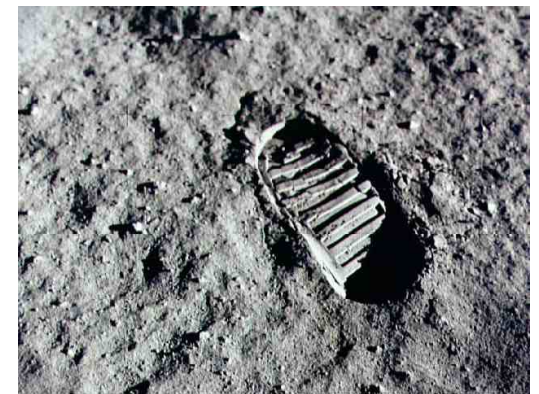
Apollo 12 - Pete Conrad; Alan Bean

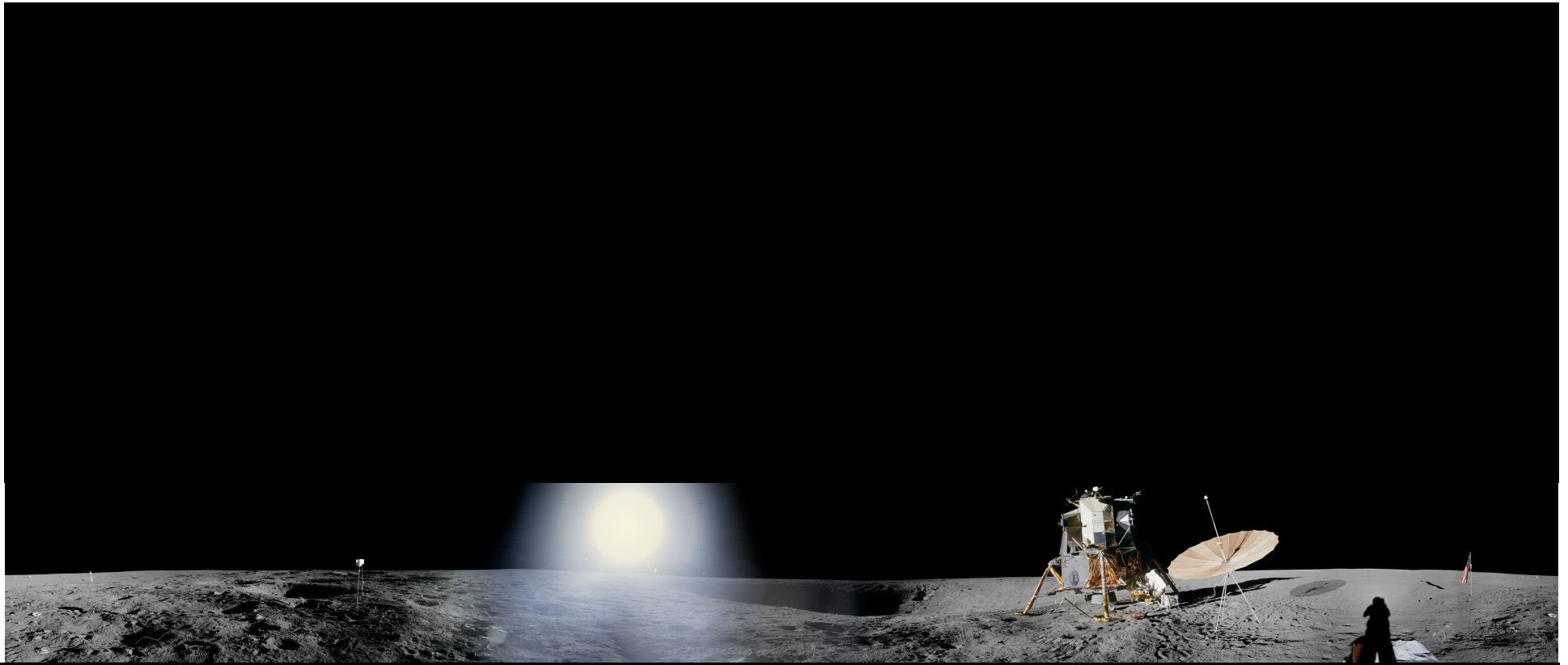
Apollo 14 - Alan Shepard; Edgar Mitchell

Apollo 15 - David Scott; James Irwin

Apollo 16 - John W. Young; Charles Duke

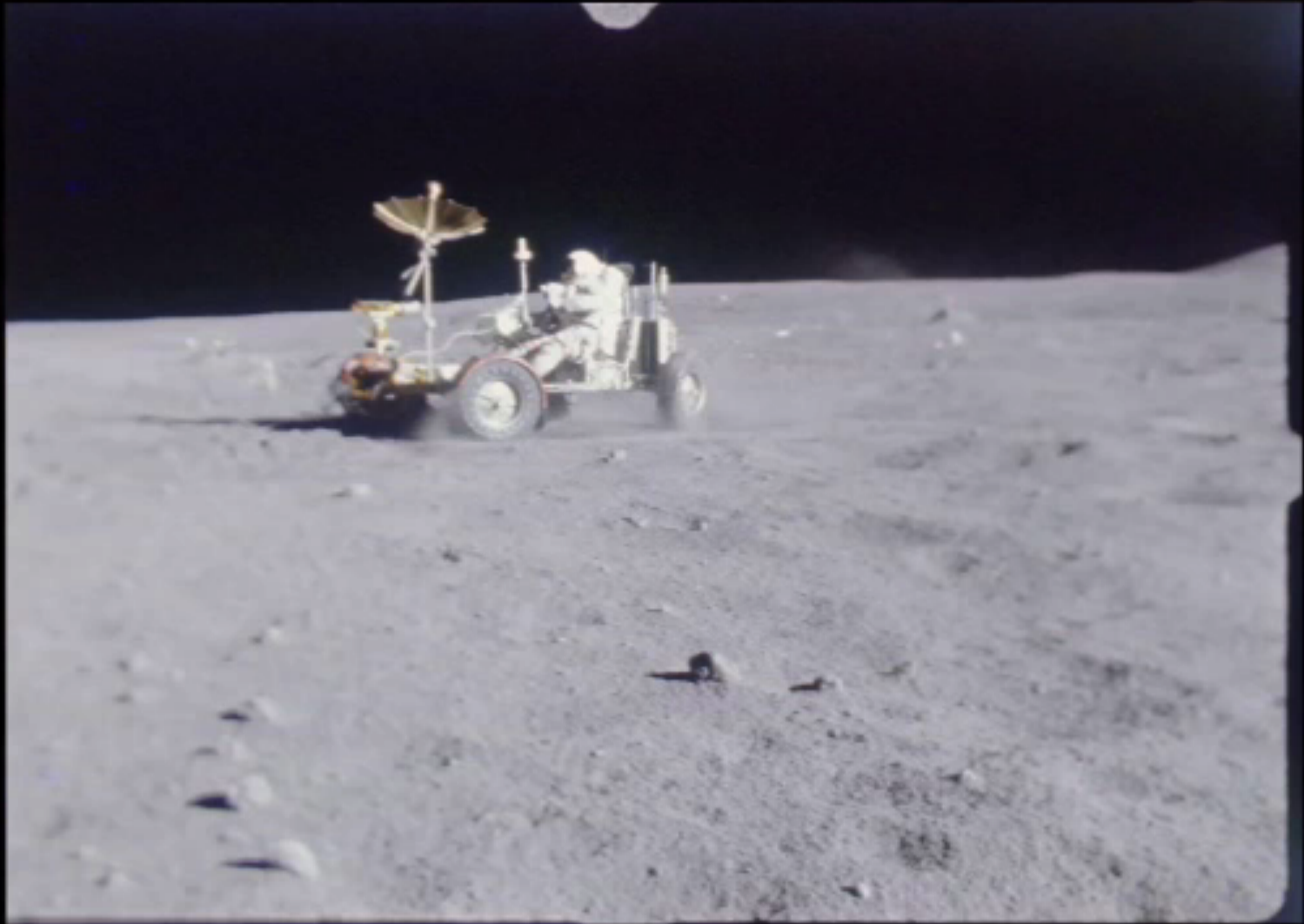
Apollo 17 - Eugene Cernan; Harrison Schmitt





Apollo 12

<http://www.lpi.usra.edu/resources/apollopanoramas/>

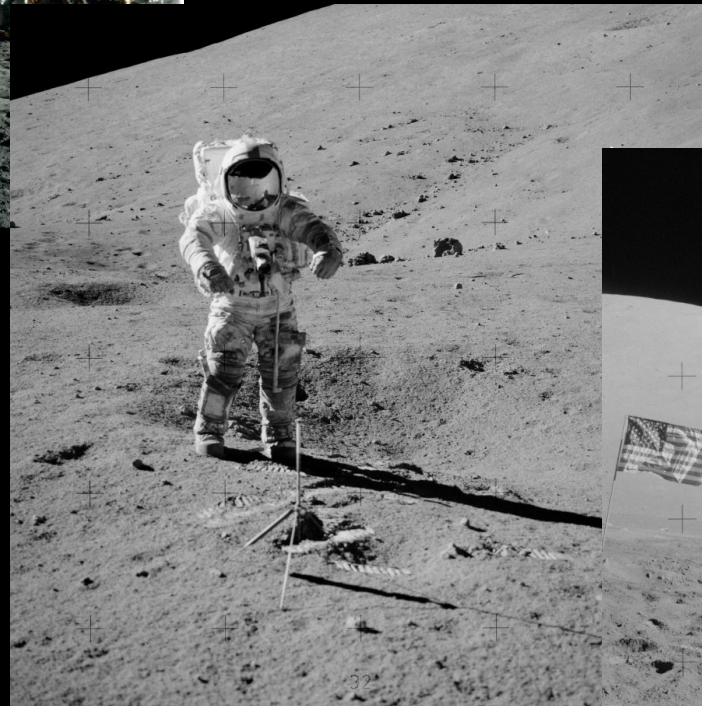
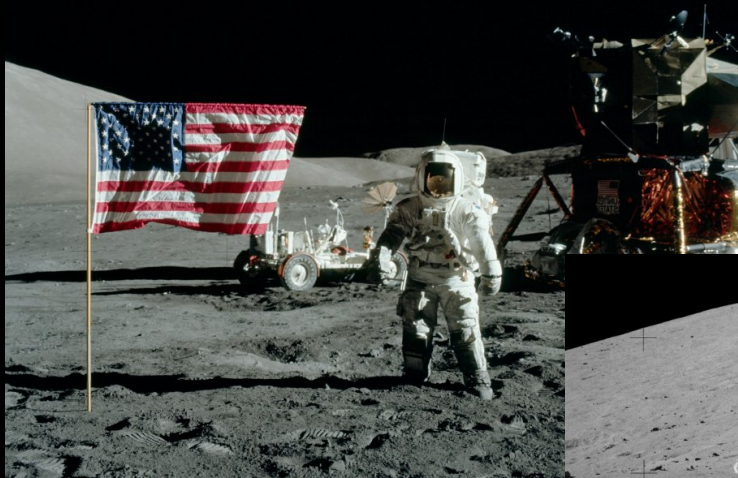


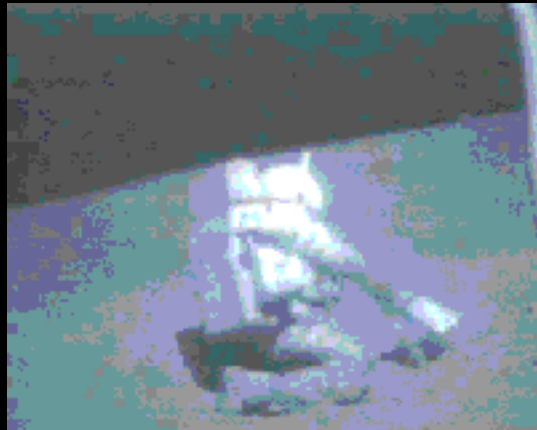
Apollo 15

D.R. Scott, Comander

J.B. Irwin, Lunar Module Pilot

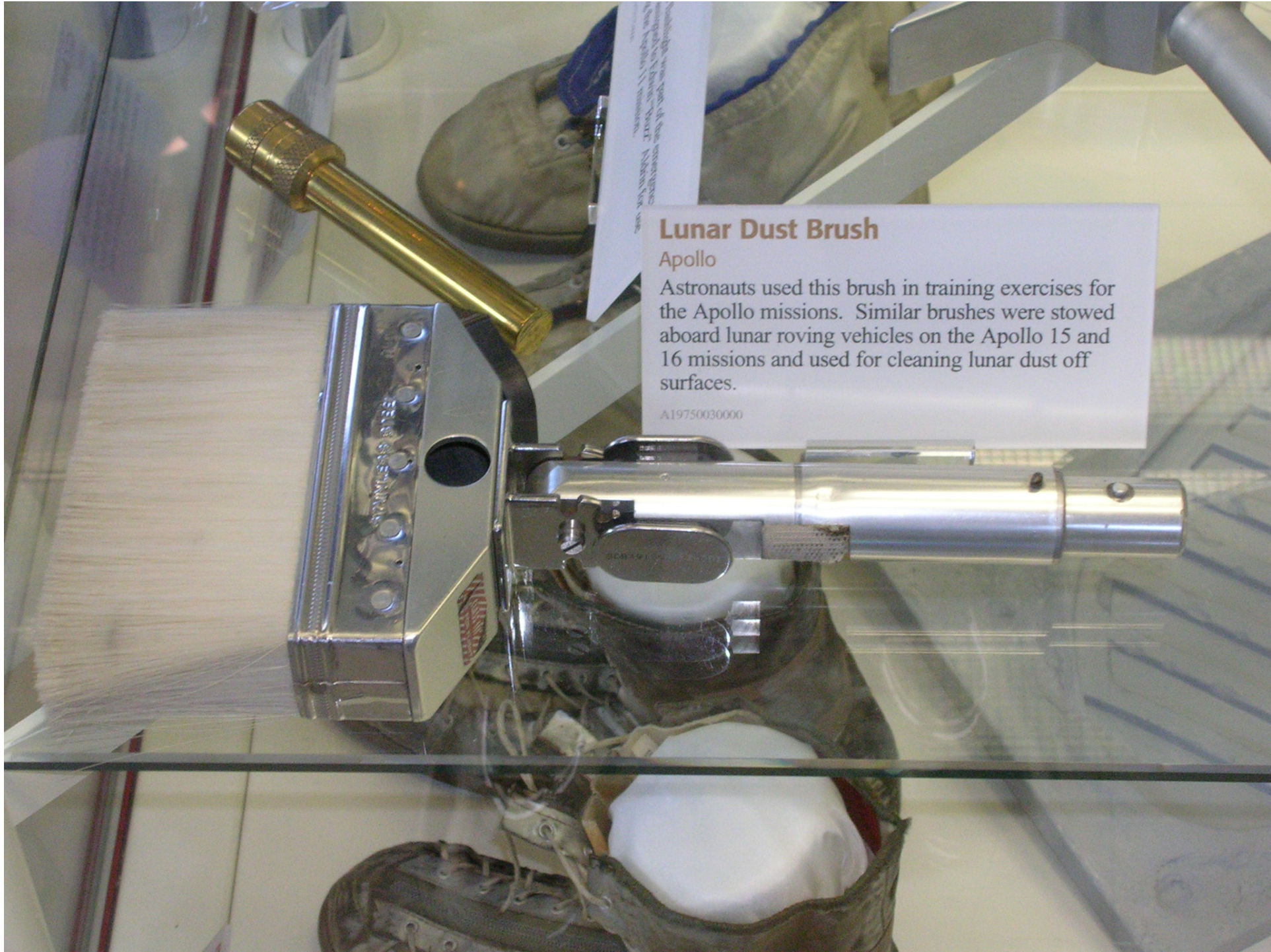
A.M. Worden, Command Module Pilot







E. Cernan

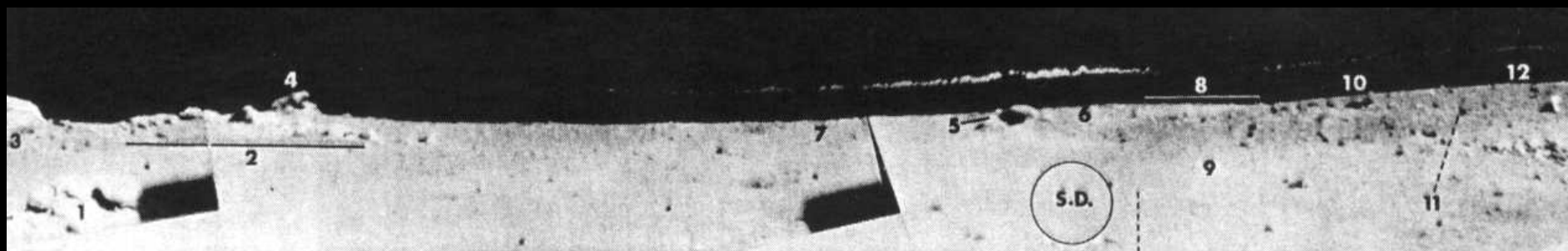


Lunar Dust Brush

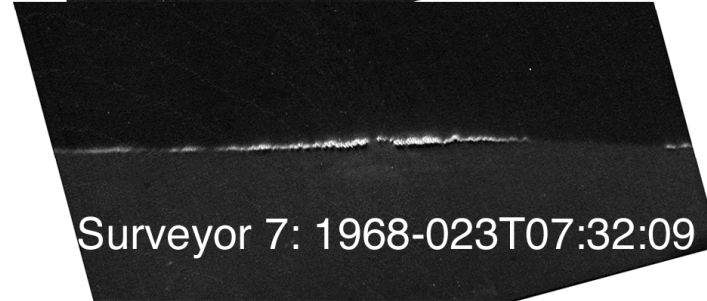
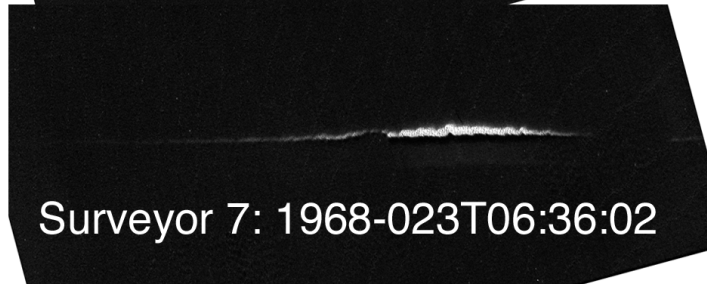
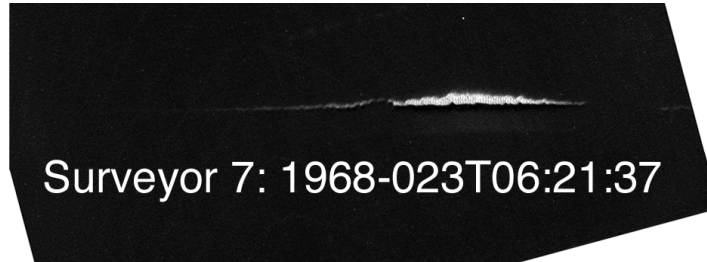
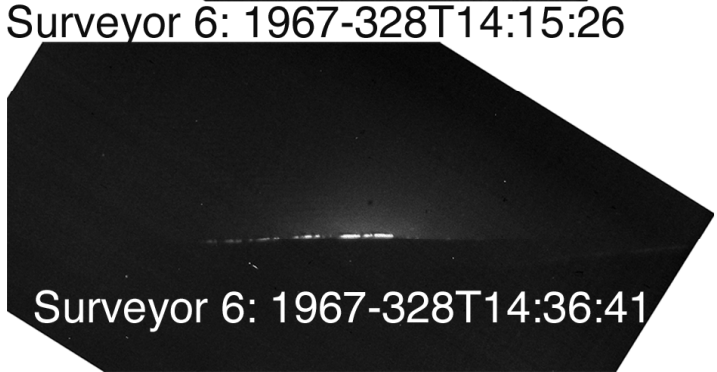
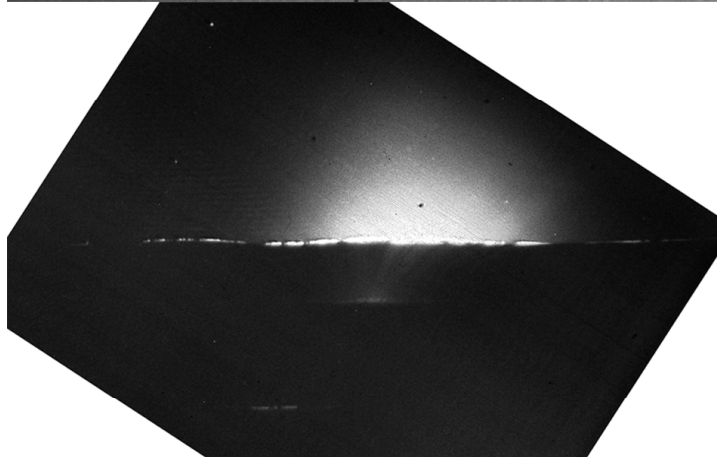
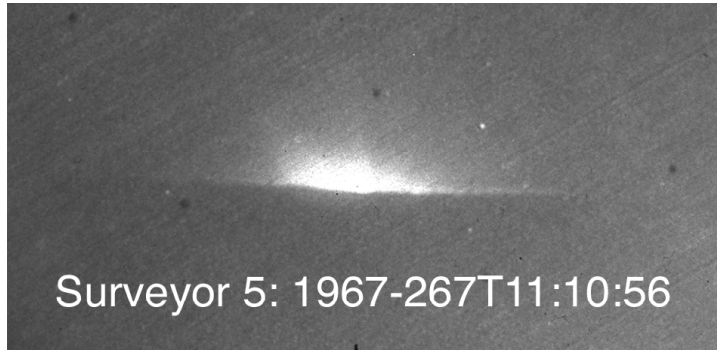
Apollo

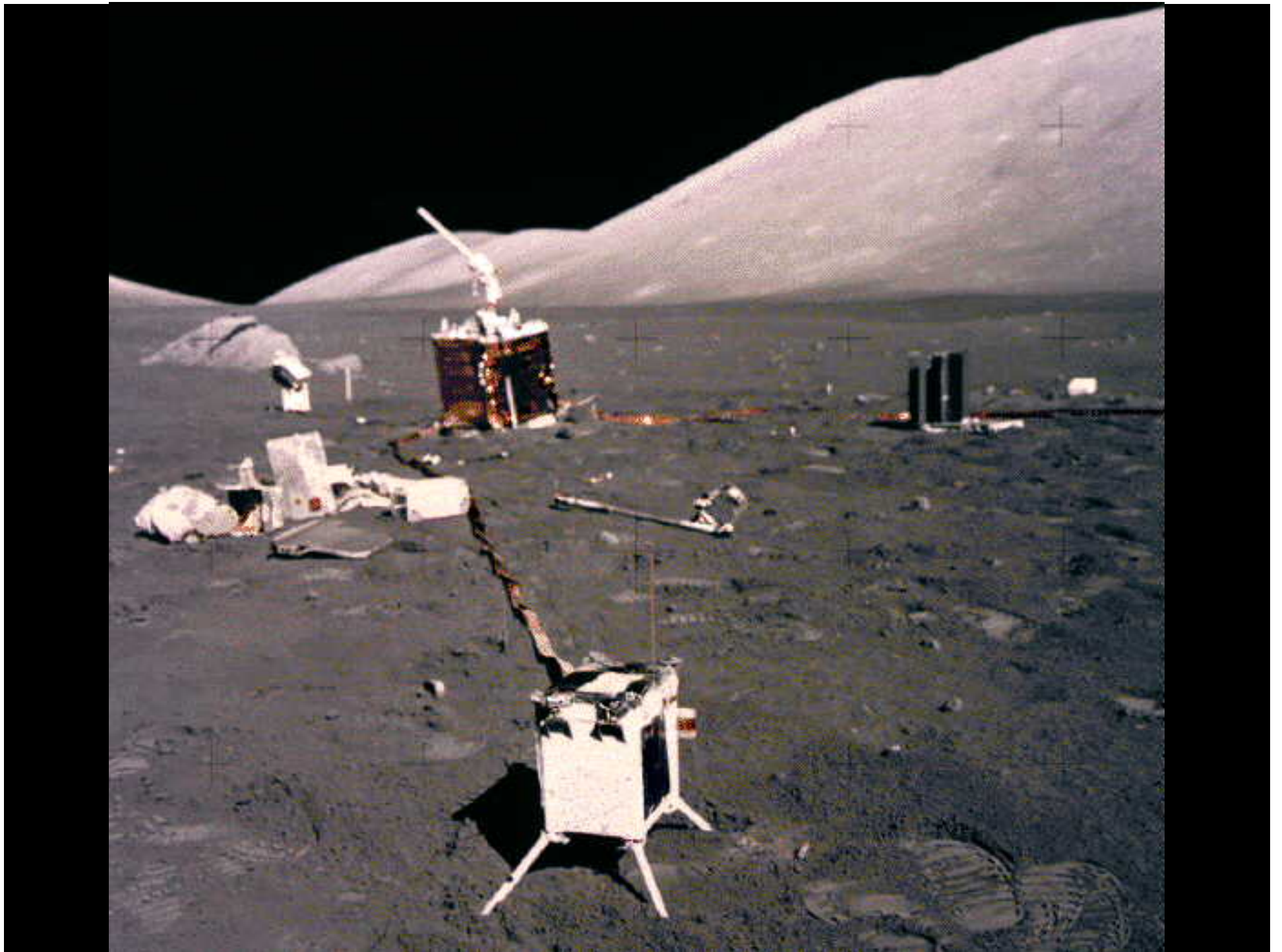
Astronauts used this brush in training exercises for the Apollo missions. Similar brushes were stowed aboard lunar roving vehicles on the Apollo 15 and 16 missions and used for cleaning lunar dust off surfaces.

A19750030000

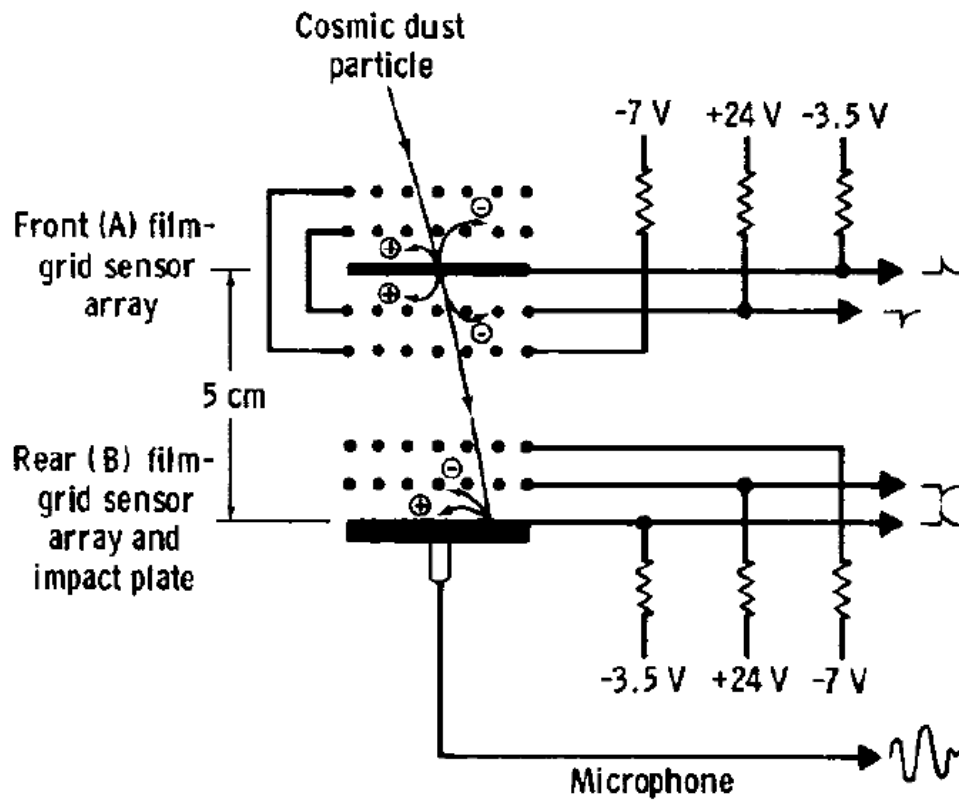


Lunar Horizon Glow - 2



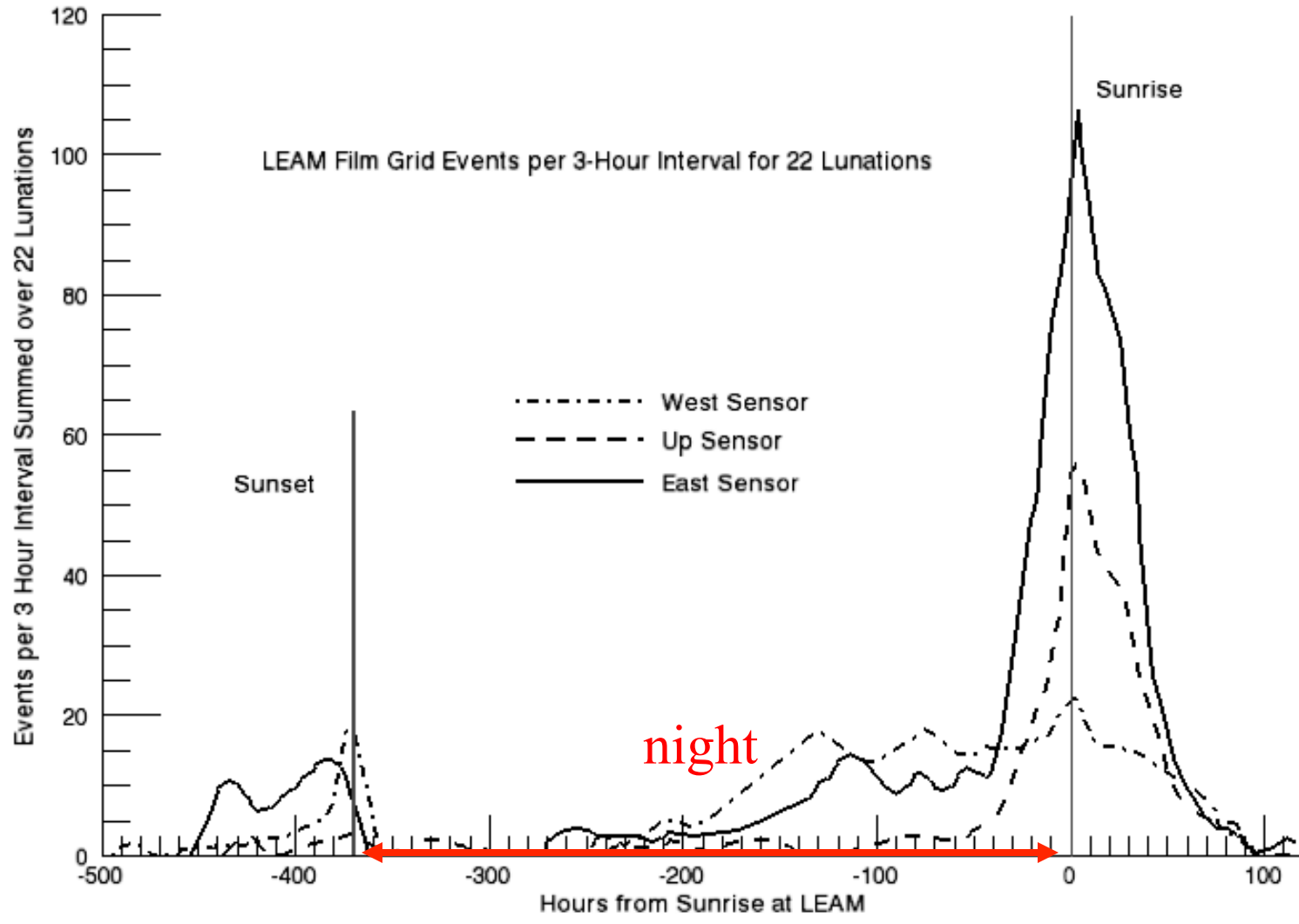


LEAM electronics

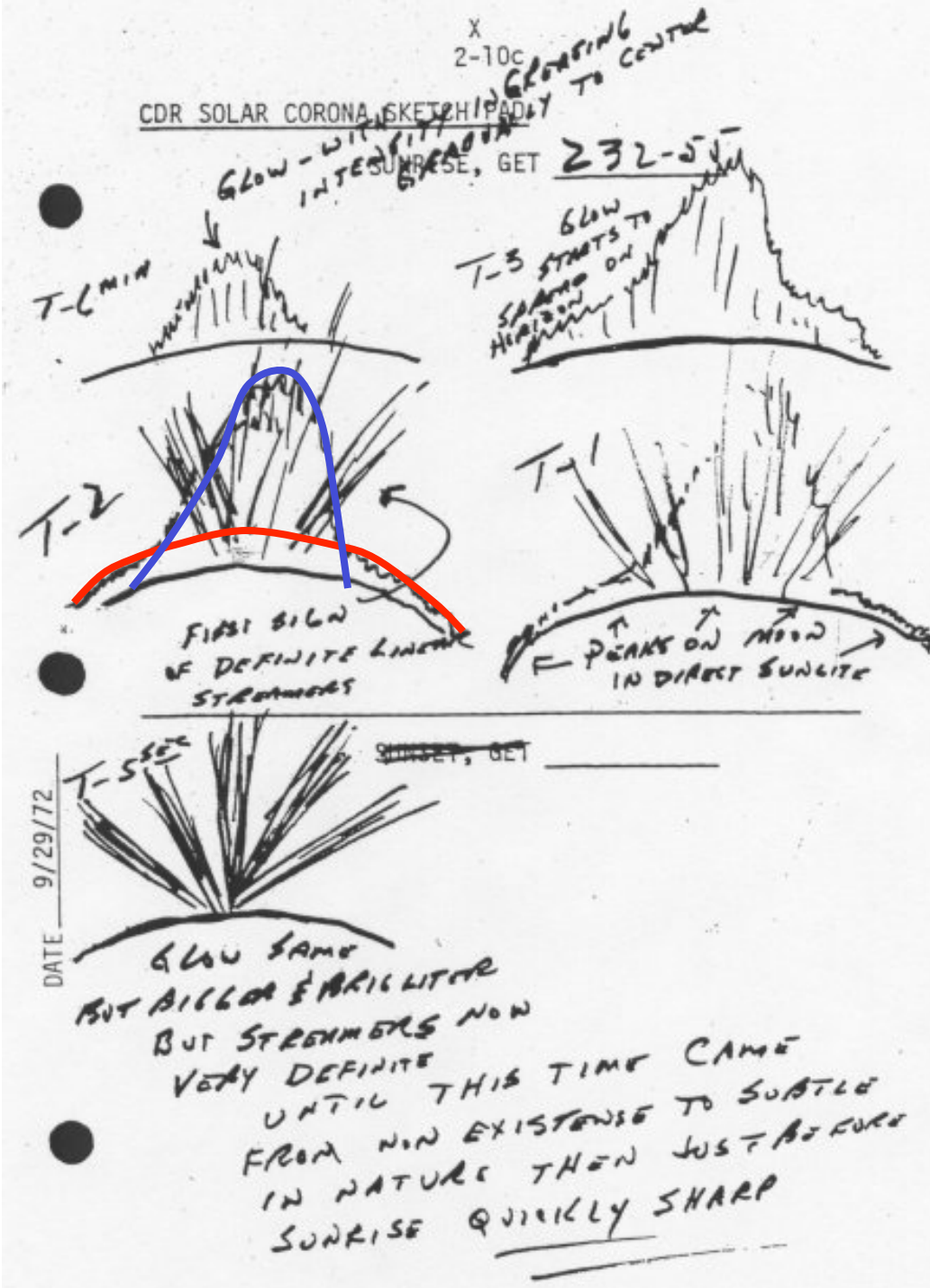


Pulse height recorded in 3 digits:

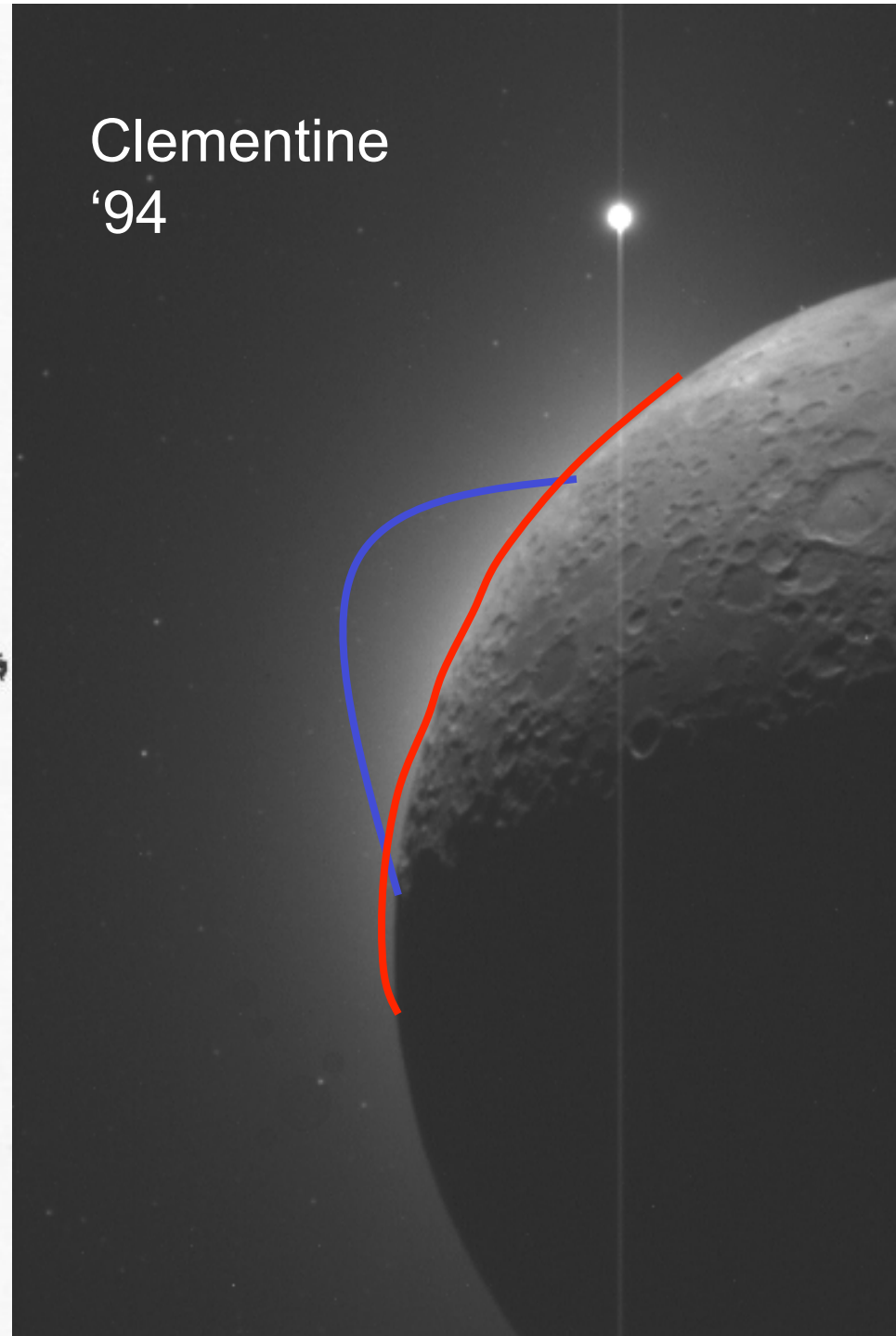
001 to 111

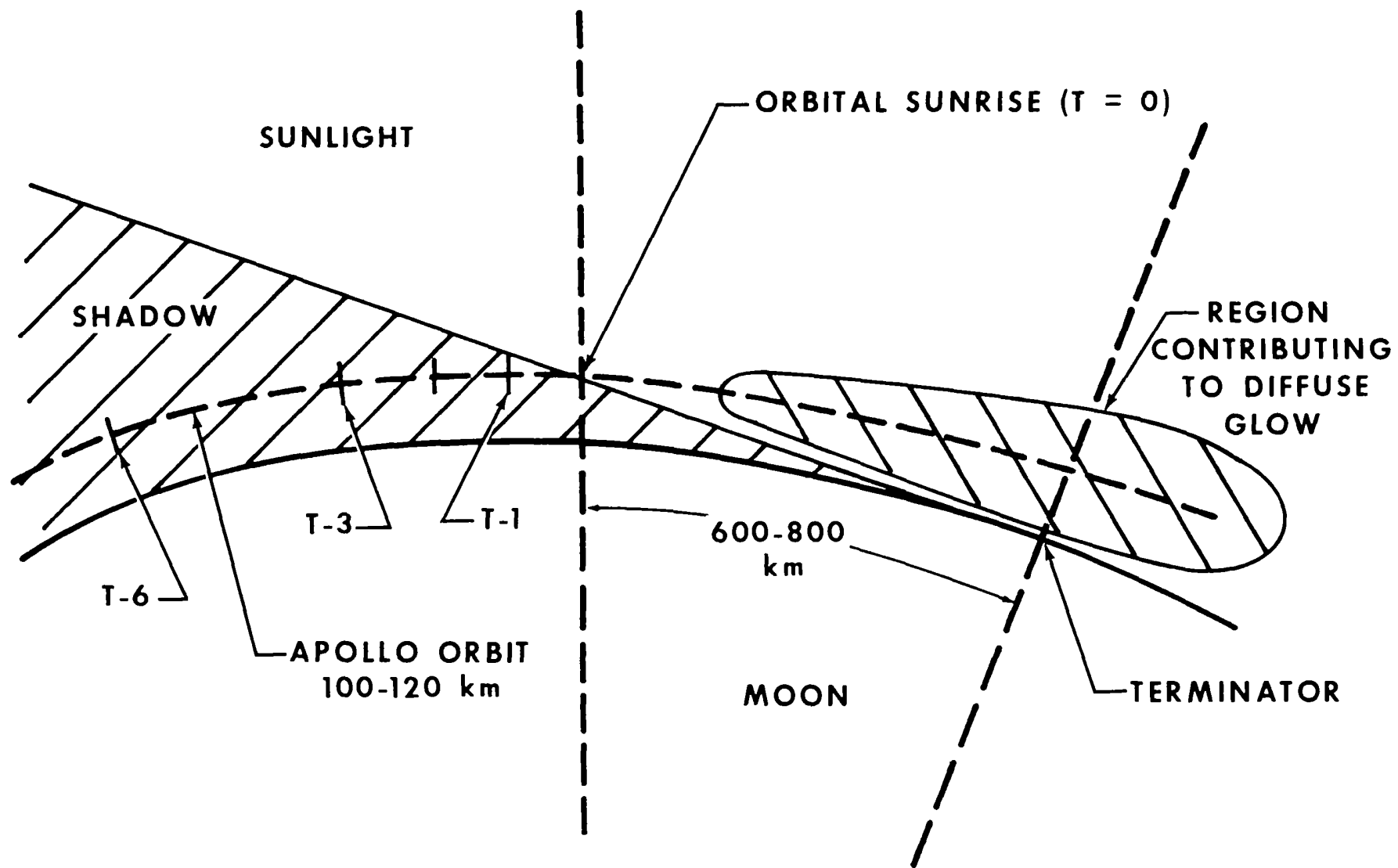


Large signals (PH 7) but only on the front film!

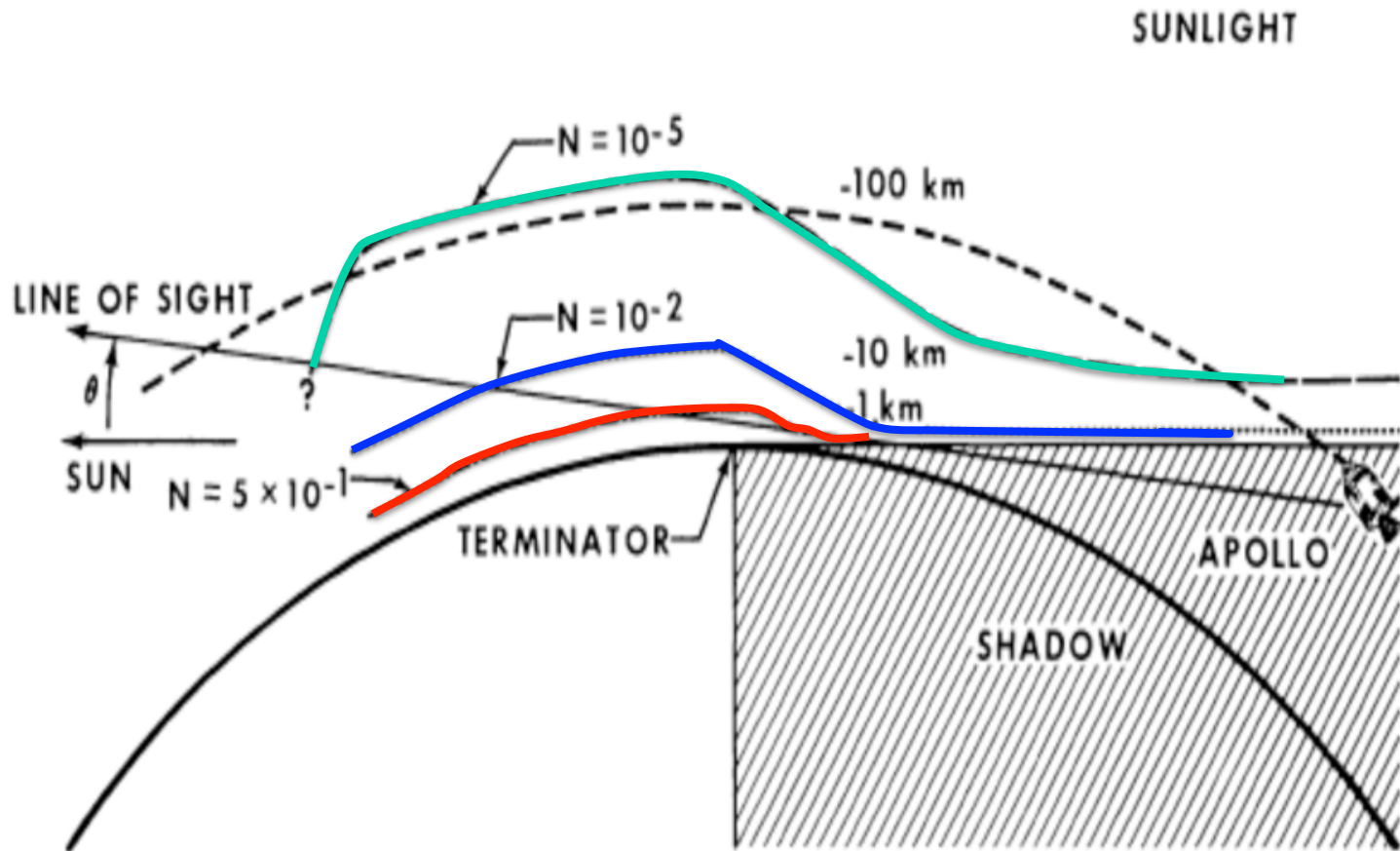


Clementine
'94

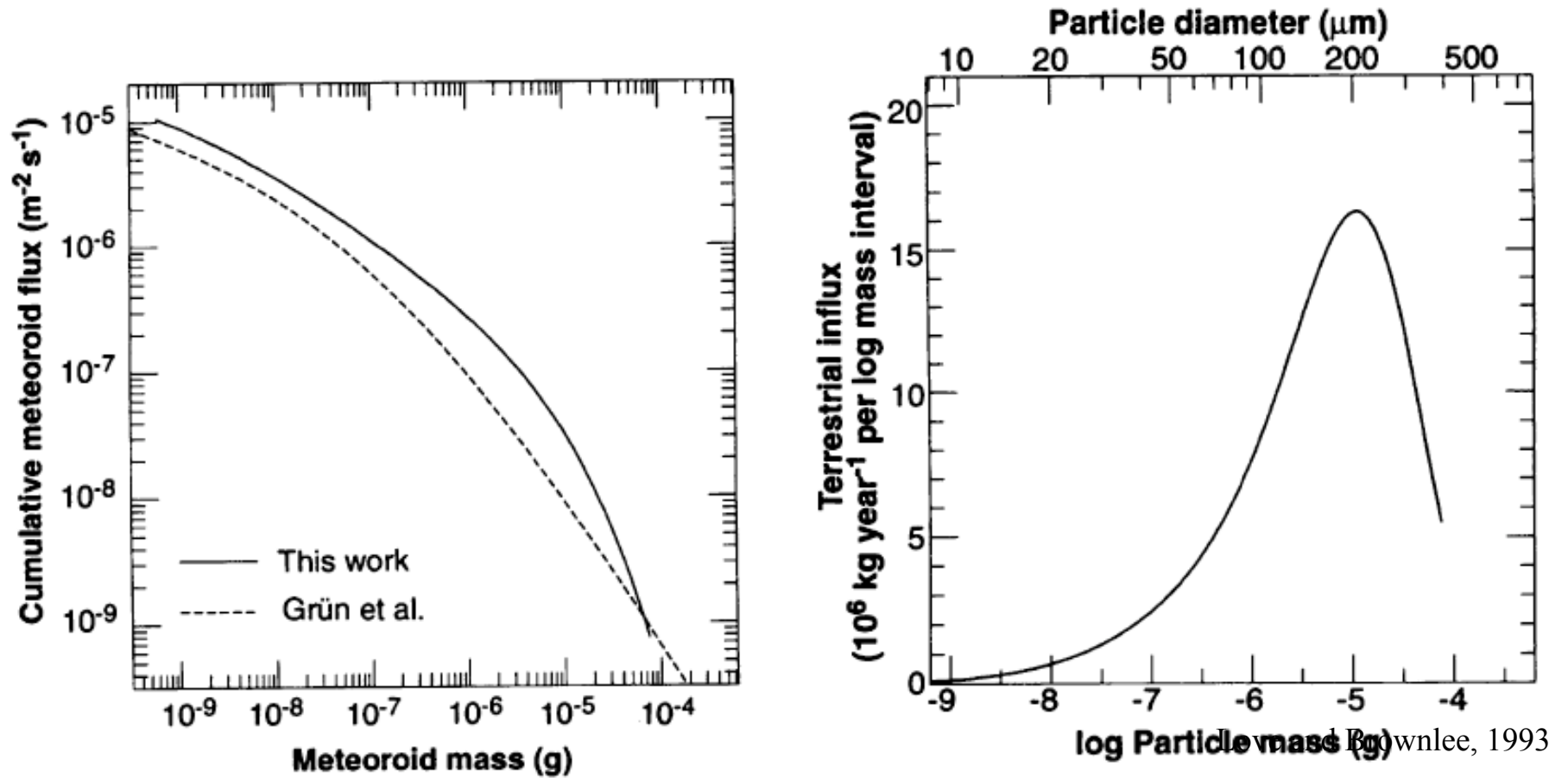




Observations



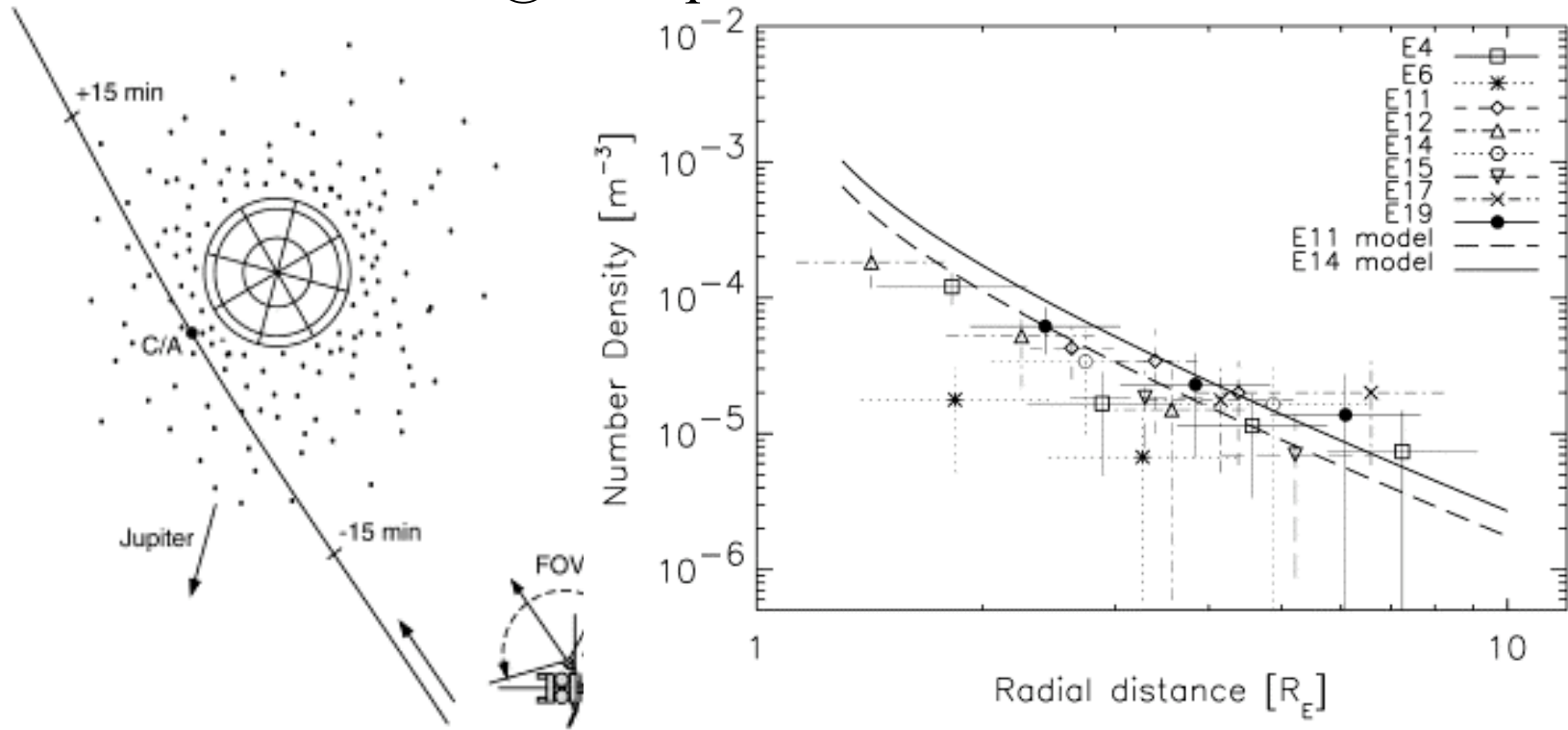
Interplanetary Dust Bombardment



100 ton/day @ Earth → 5 ton/day @ Moon

Secondary Ejecta

Galileo @ Europa

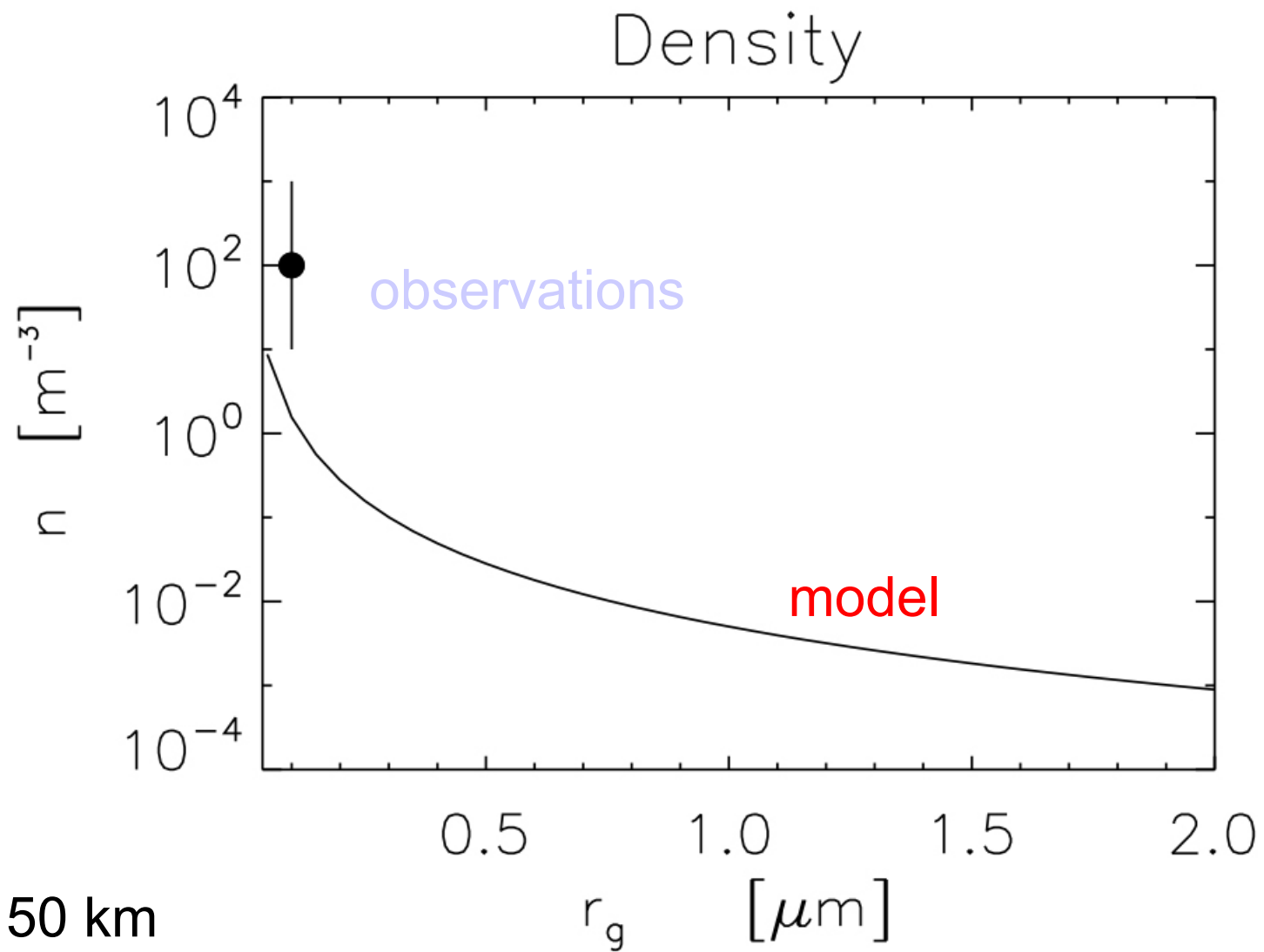


Kruger et al,

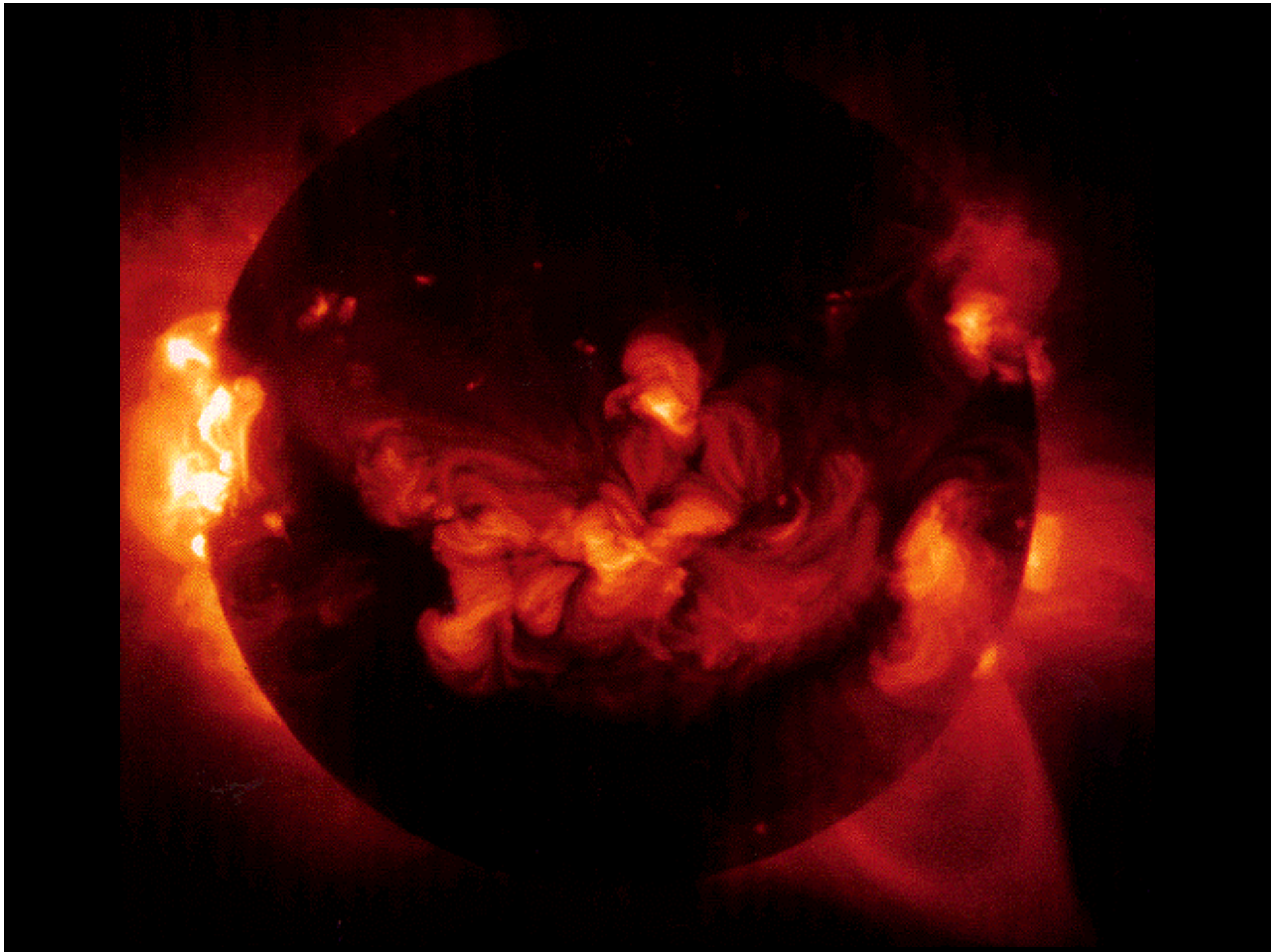
2003

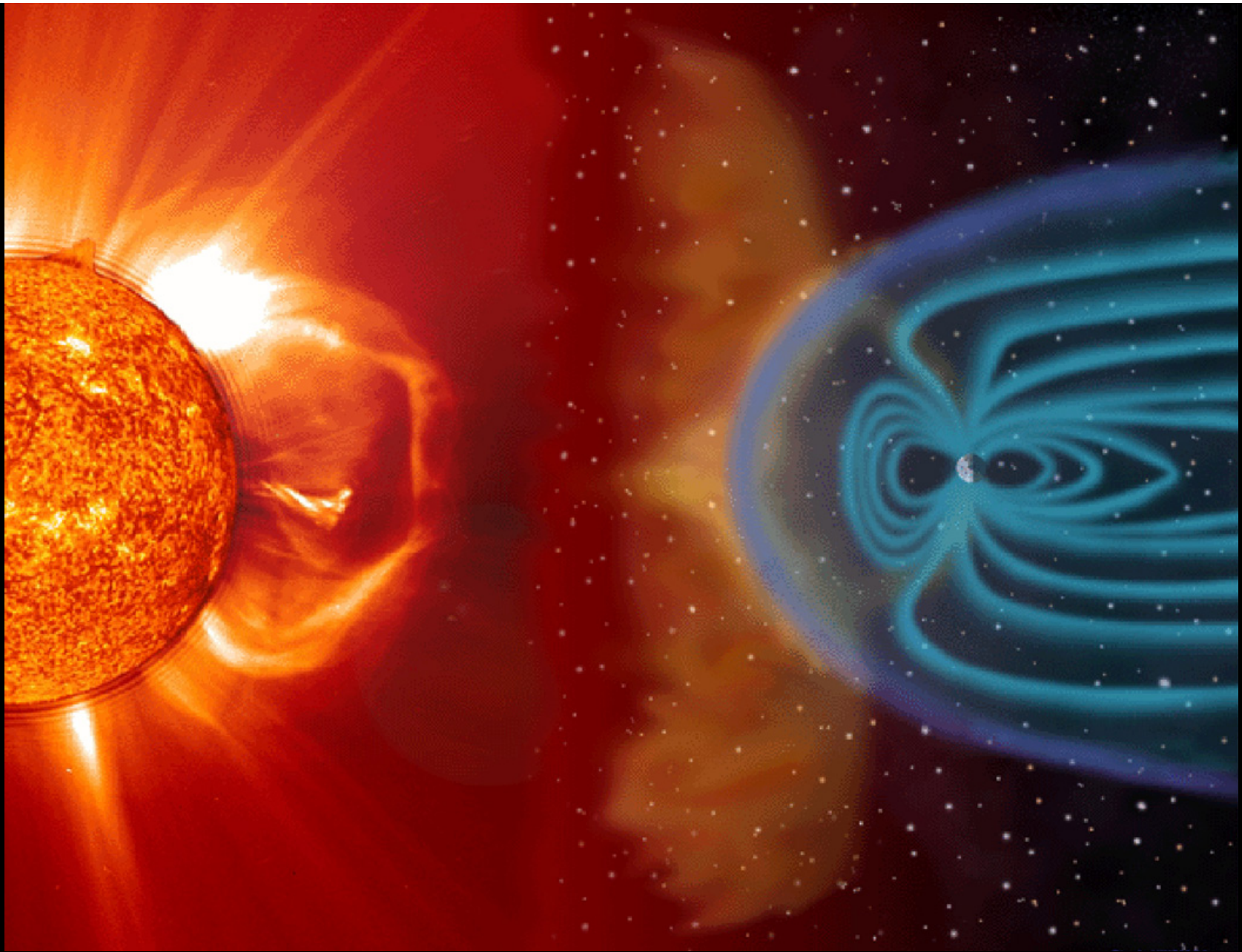
Parameters: yield, ejecta mass and velocity distributions

Lunar Ejecta



$h = 50 \text{ km}$

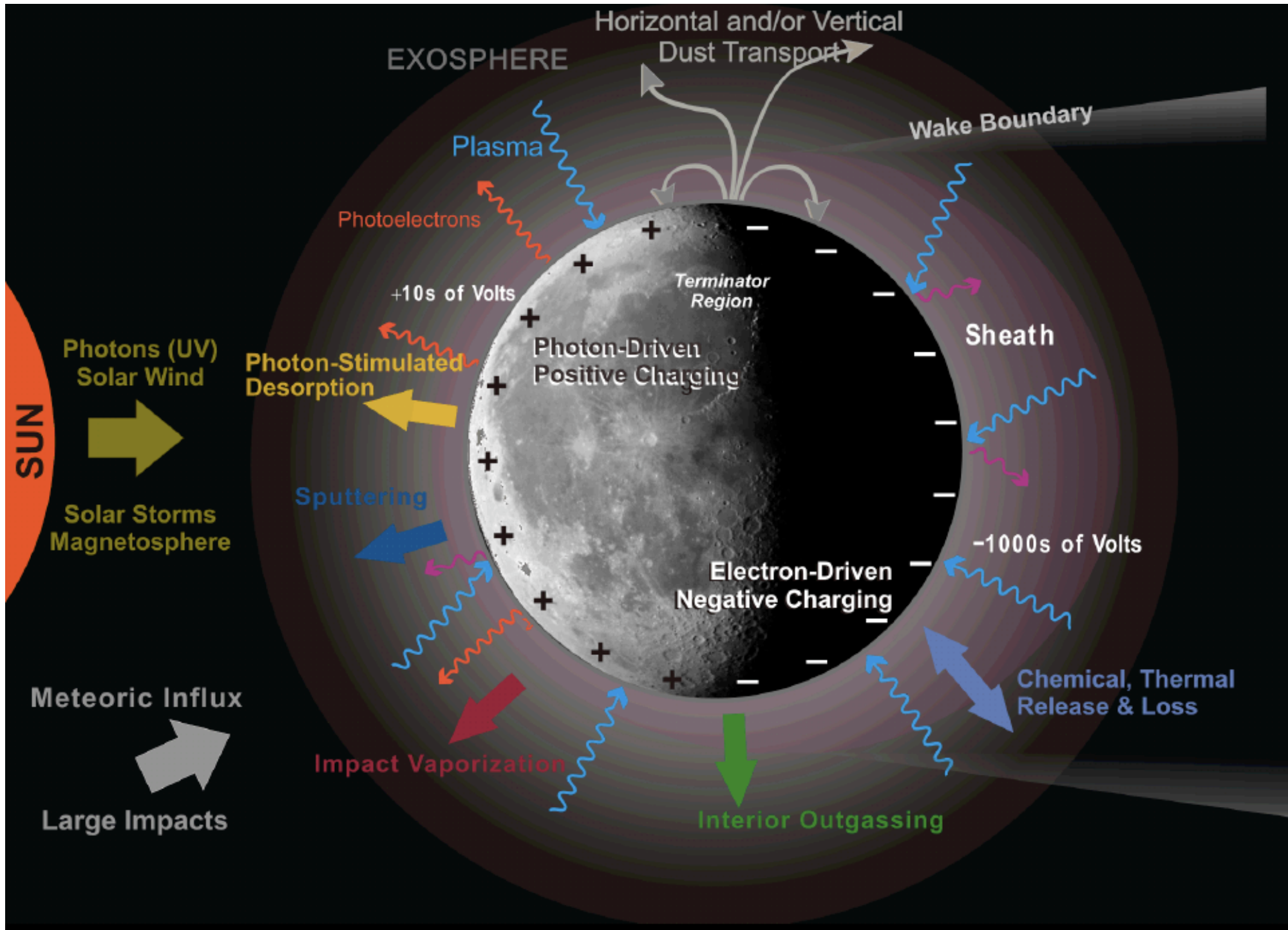




and the solar wind



Fall 2003



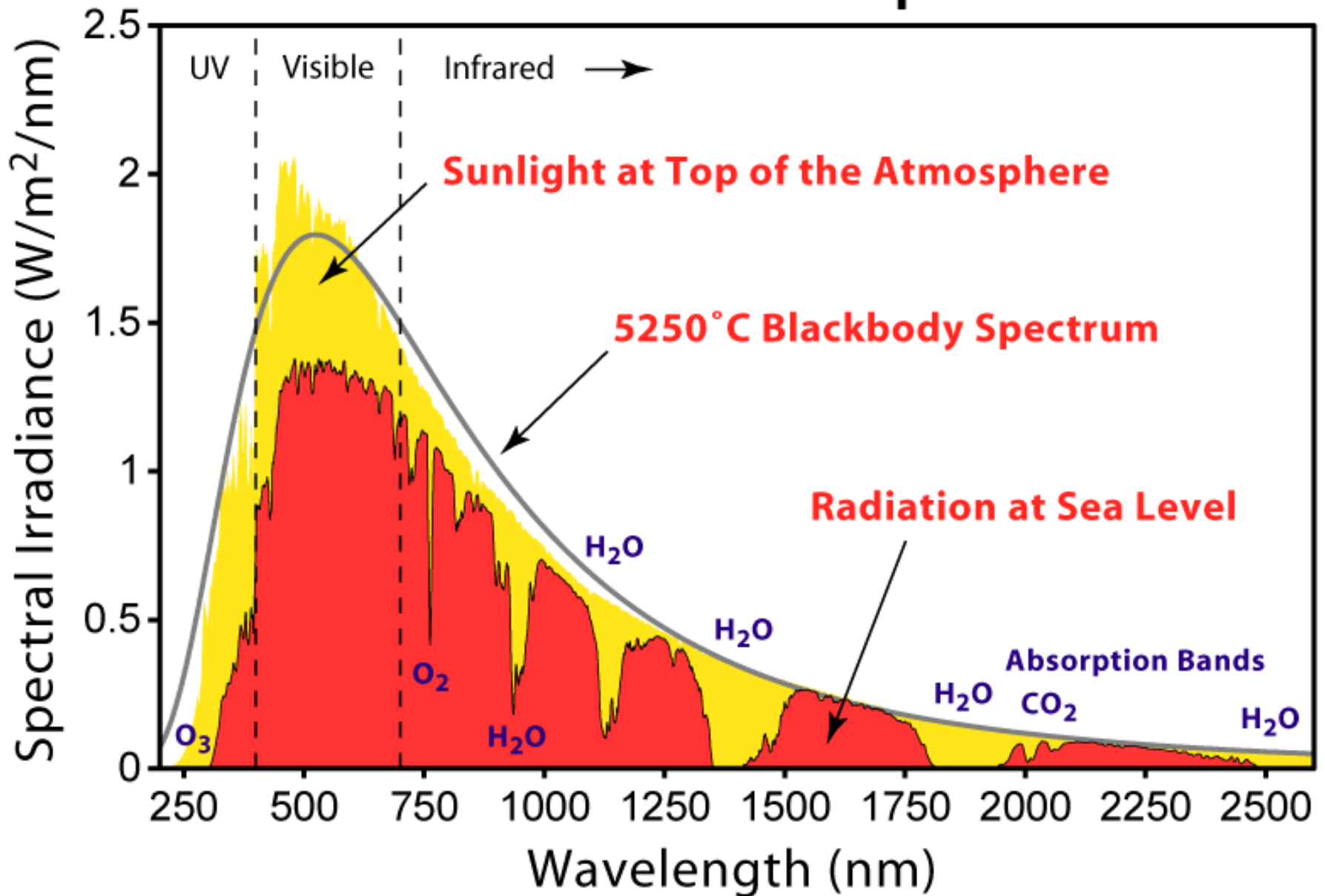
Plasma Parameters

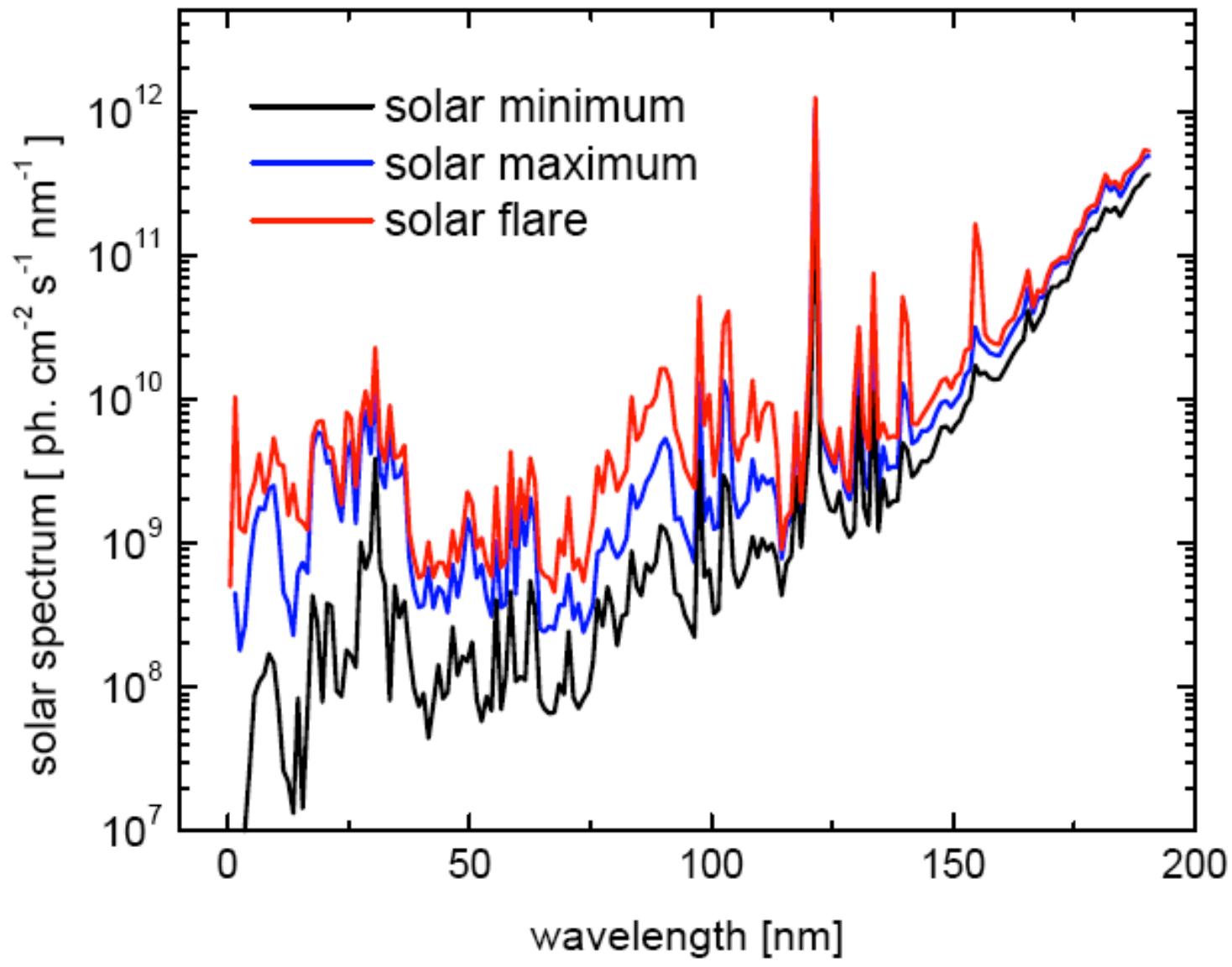
SOLAR WIND CONDITIONS

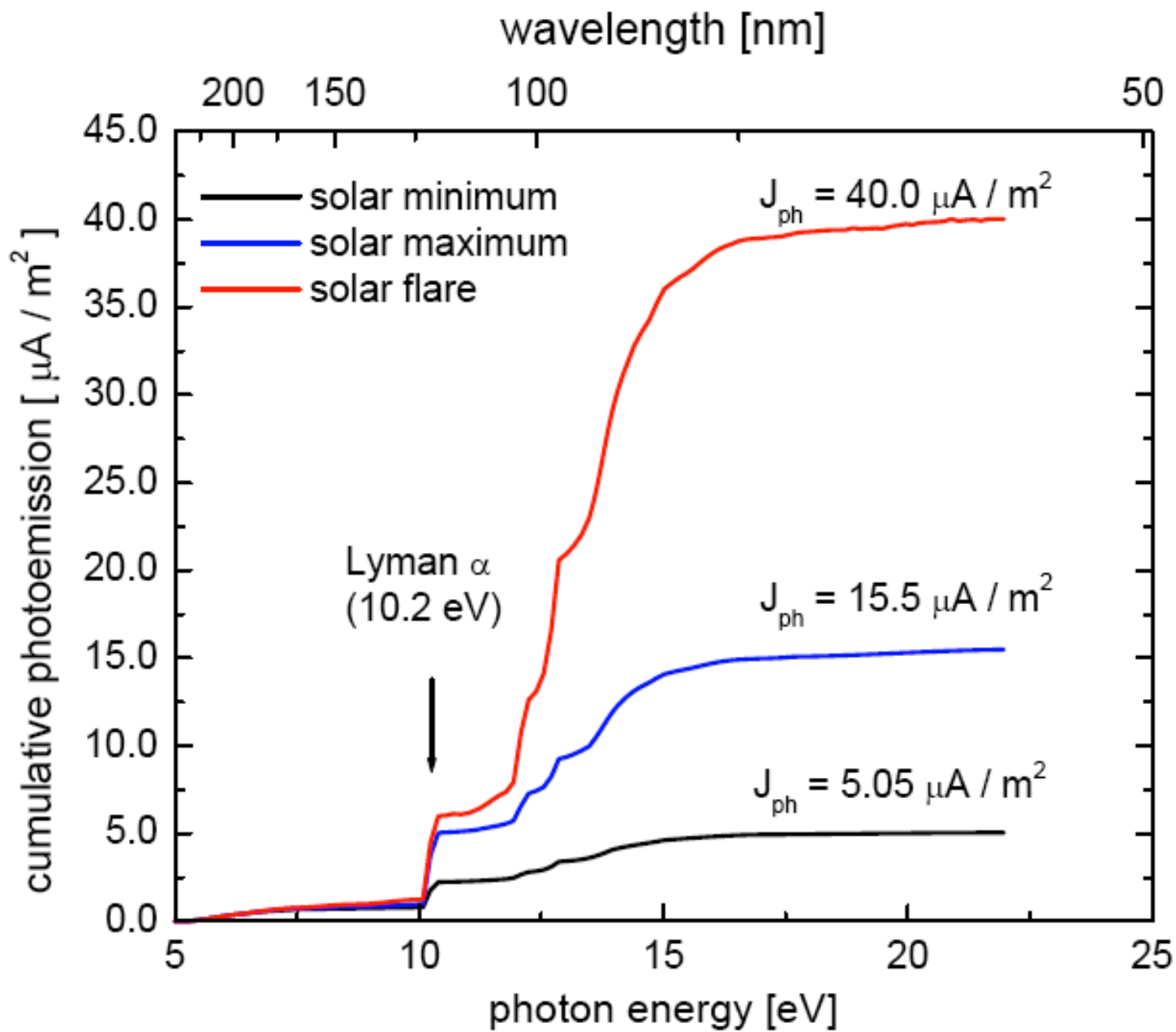
		DAYSIDE	NIGHTSIDE
Photoelectron flux	Γ_0 cm ⁻² s ⁻¹	3×10^9	0
Plasma density	n_p cm ⁻³	100	0.01
Plasma temperature	T_p eV	2	10
Debye length	λ_D m	1	$> 10^3$
Surface potential	Φ_S V	+5	-1000
Surface charge density	σ_e cm ⁻²	3×10^4	2×10^3
Surface electric field	E_s V/m	5	< 1
Probability of 1 <i>e</i> charge	P_e	$10^{-3} a_\mu^2$	$5 \times 10^{-4} a_\mu^2$

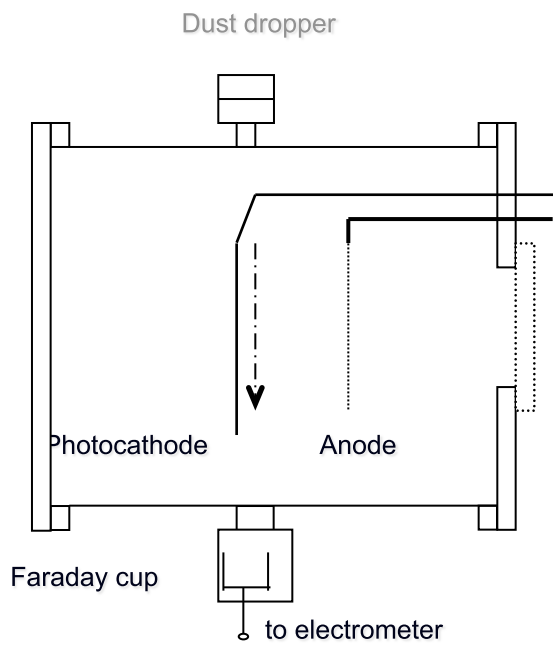
Most grains remain uncharged on the surface !

Solar Radiation Spectrum

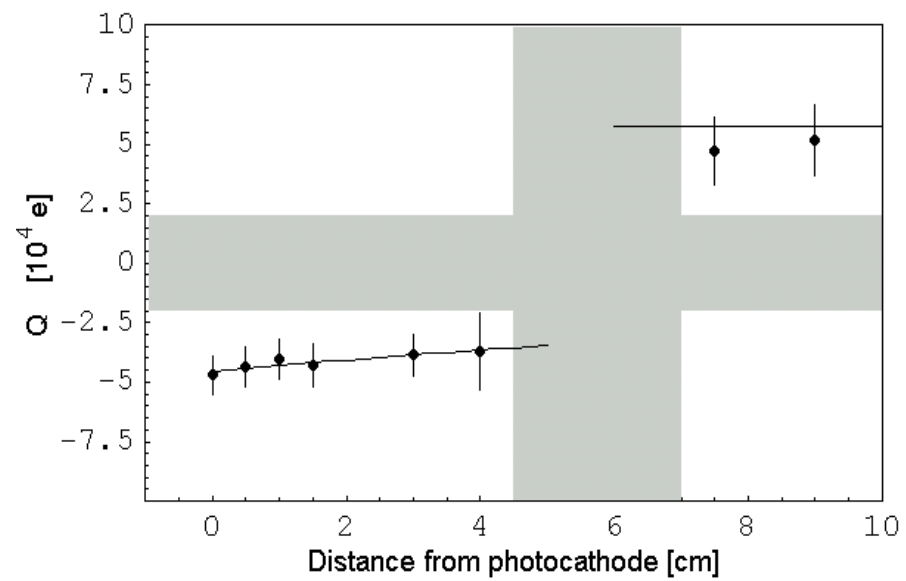
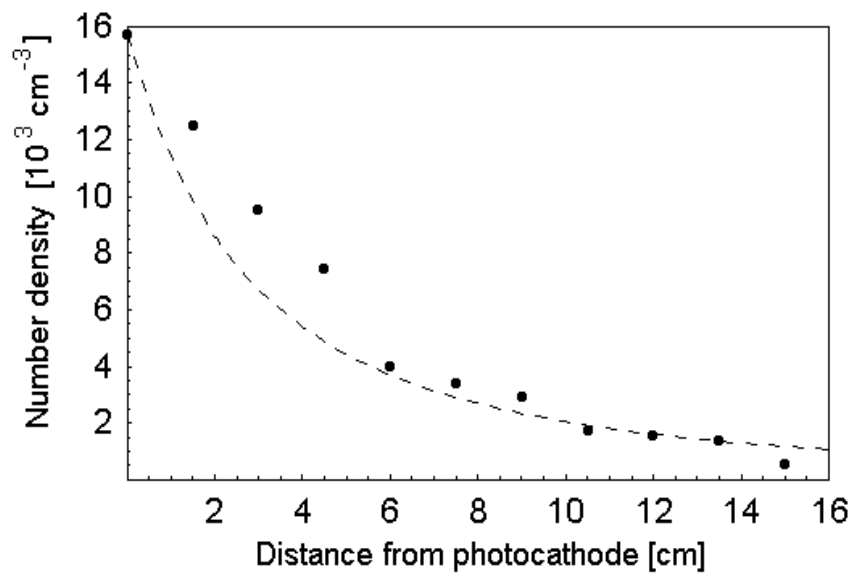
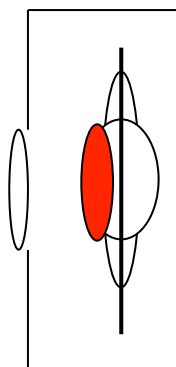


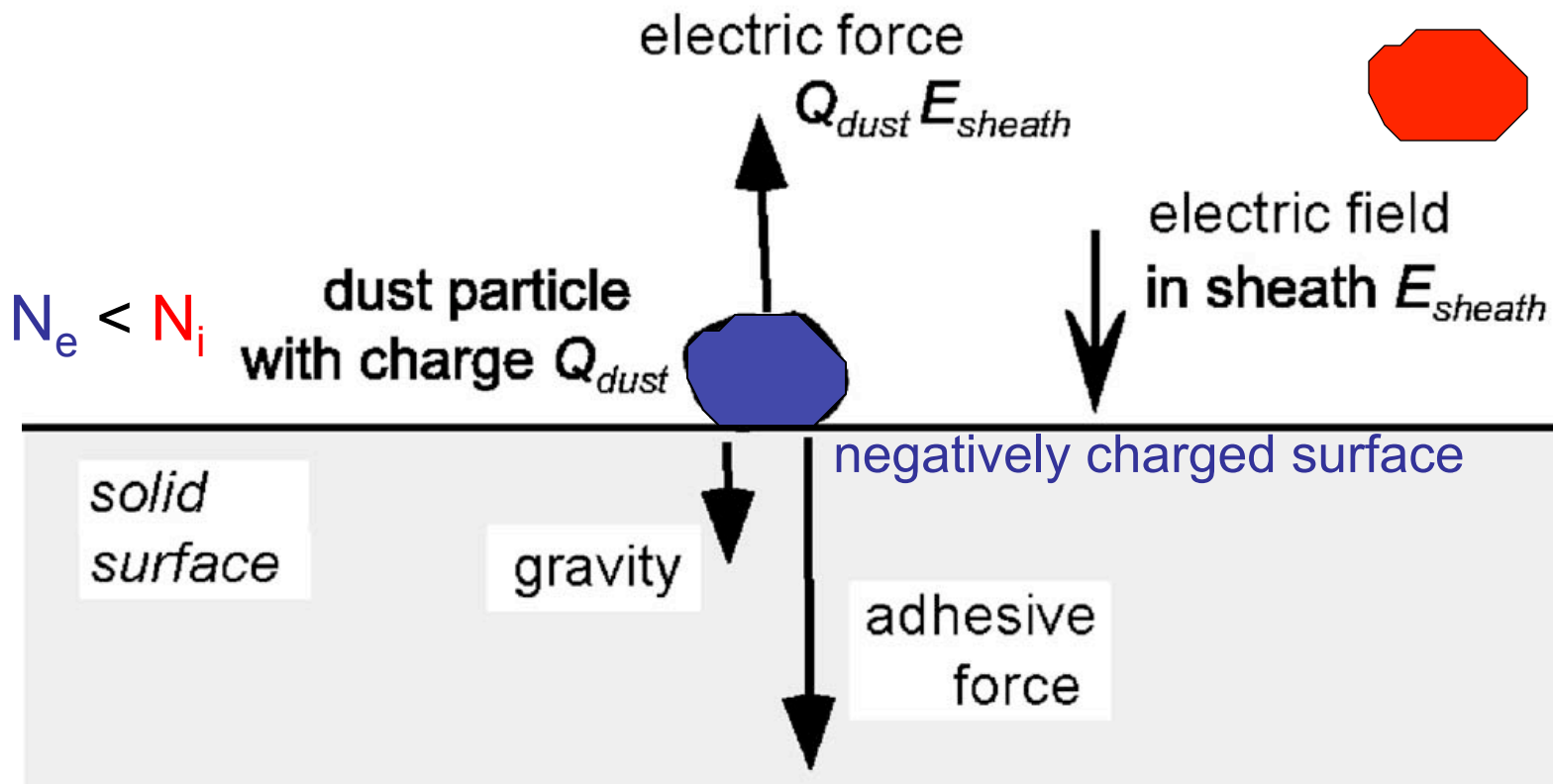
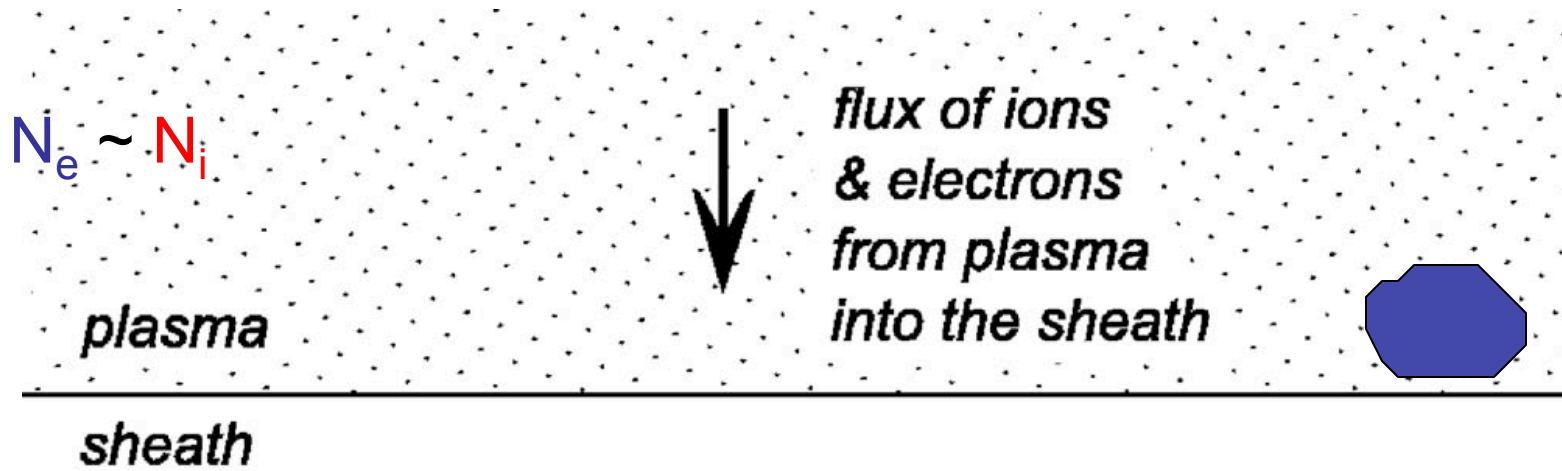


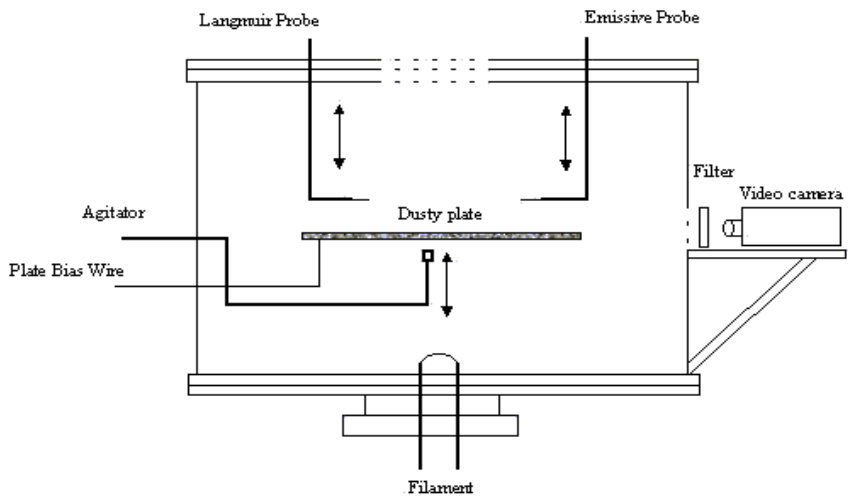
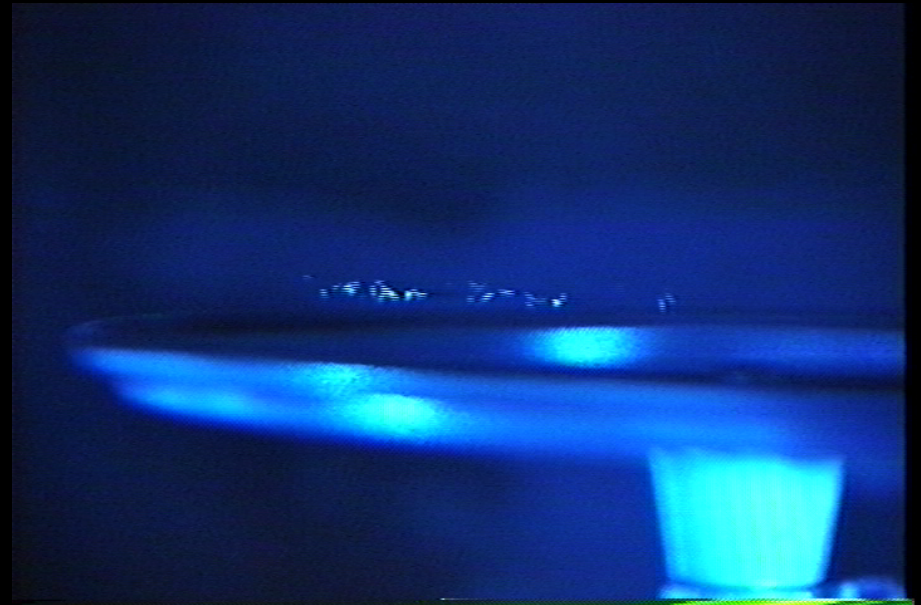
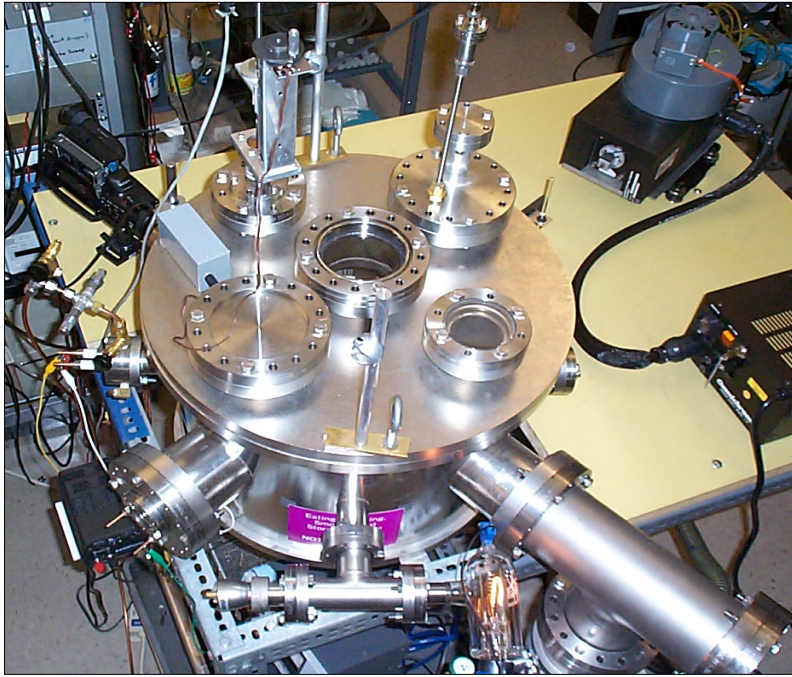


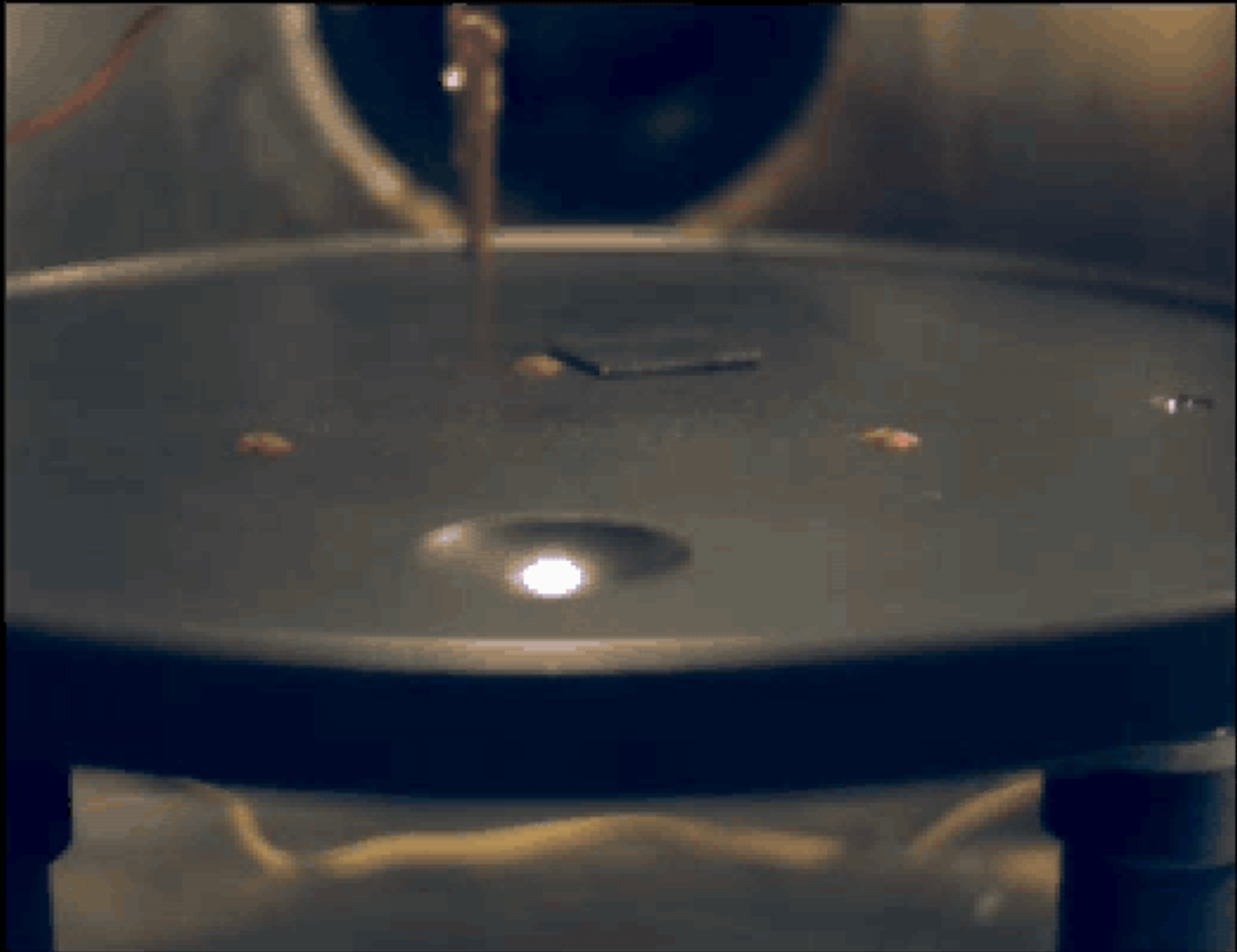


UV source

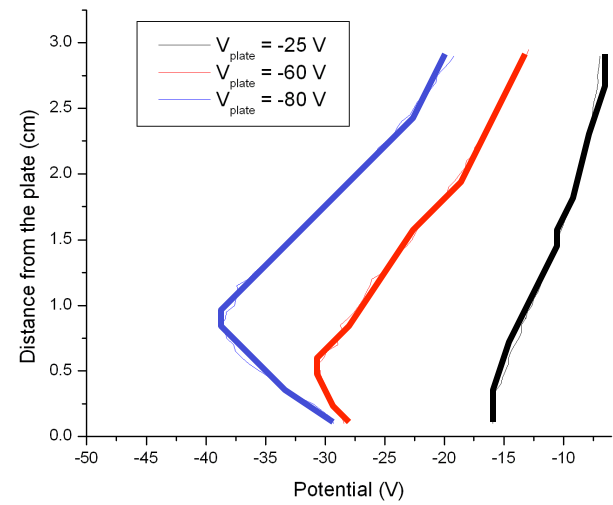
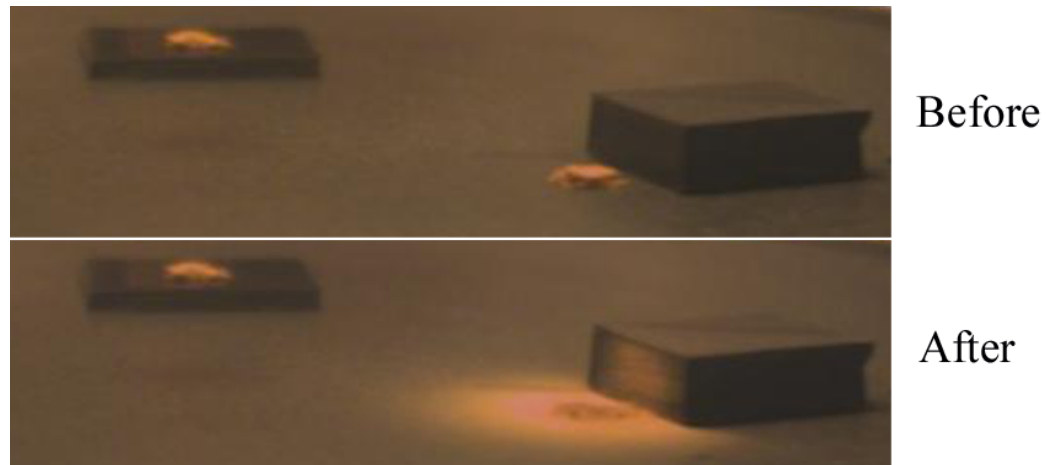
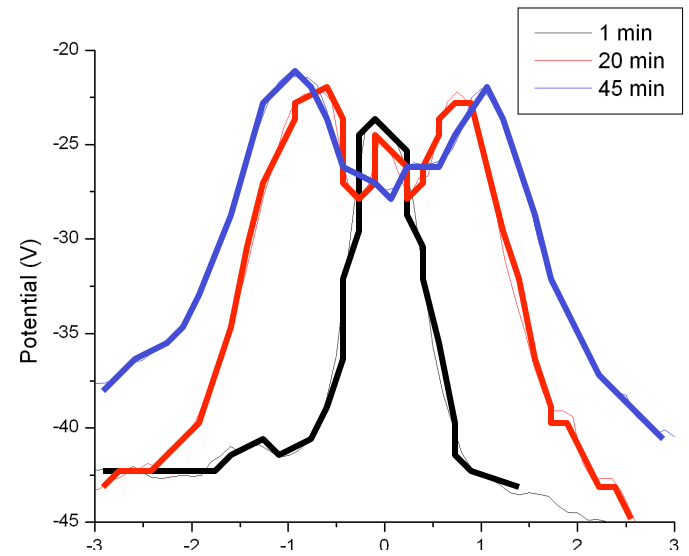
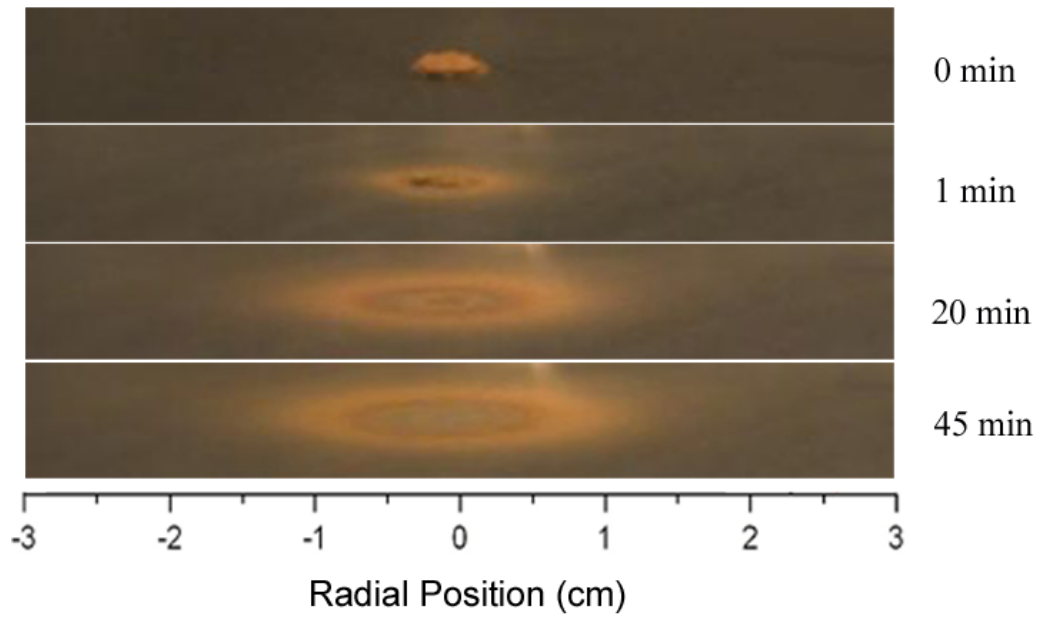




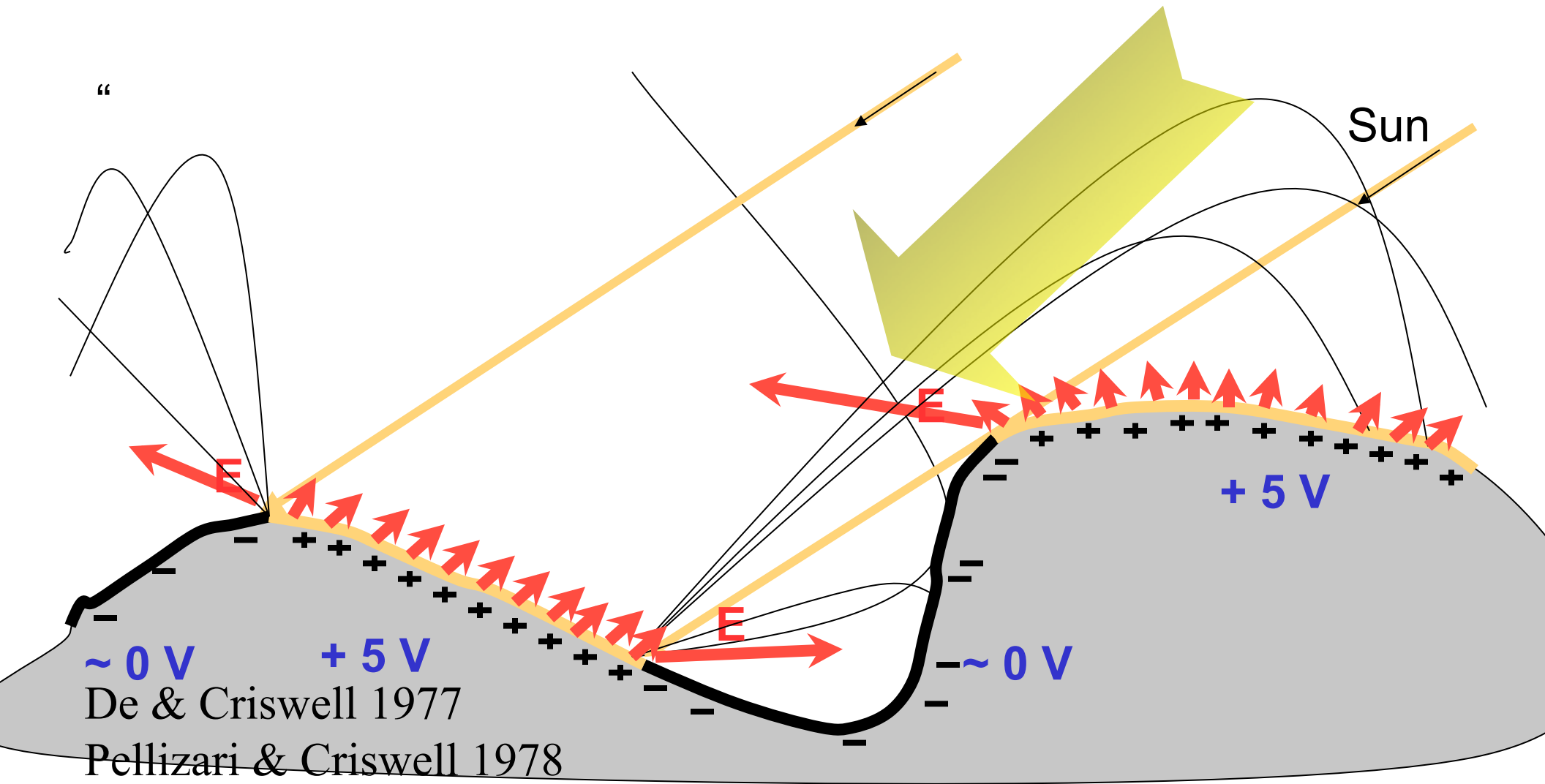


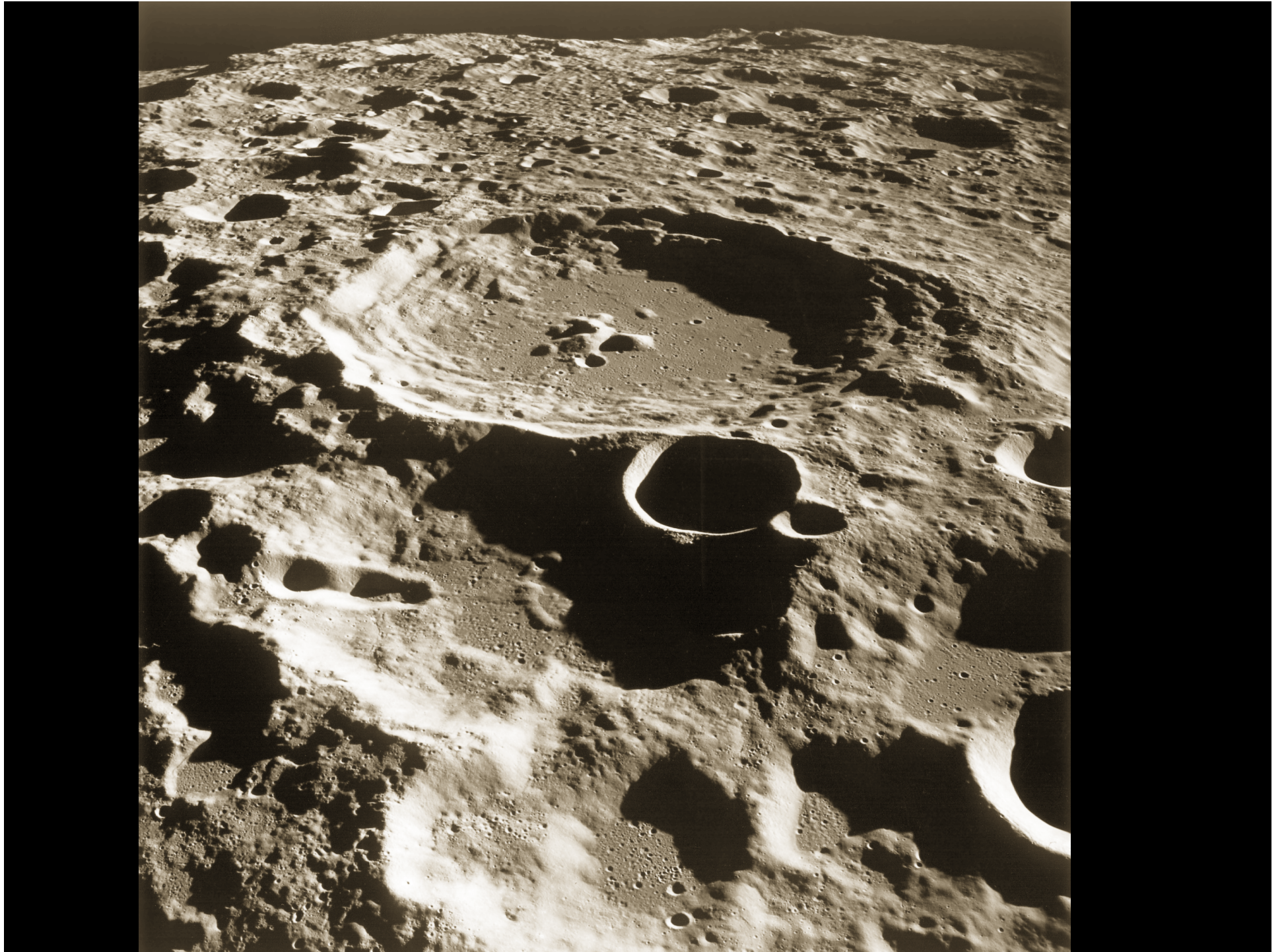


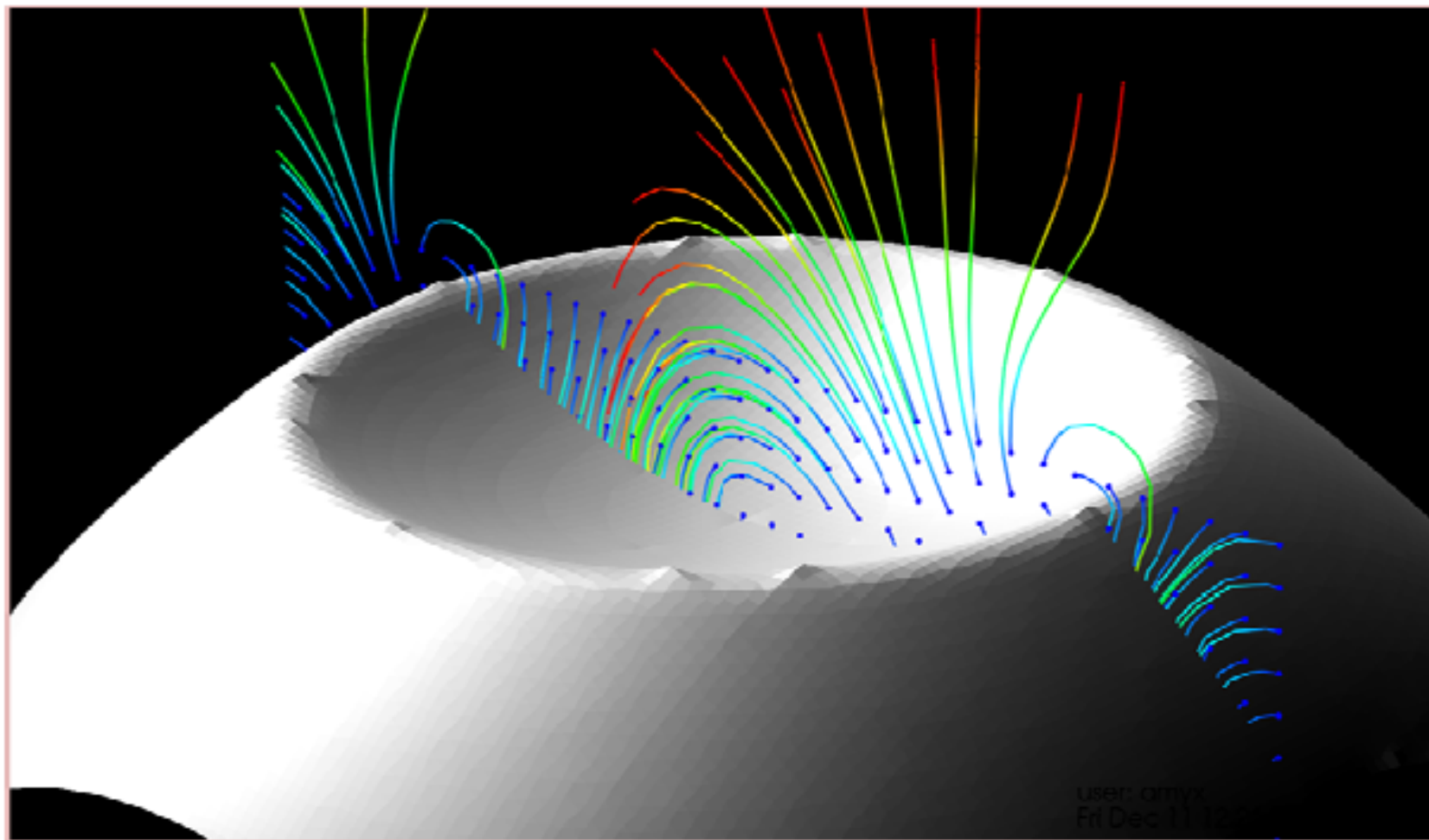
Dust transport

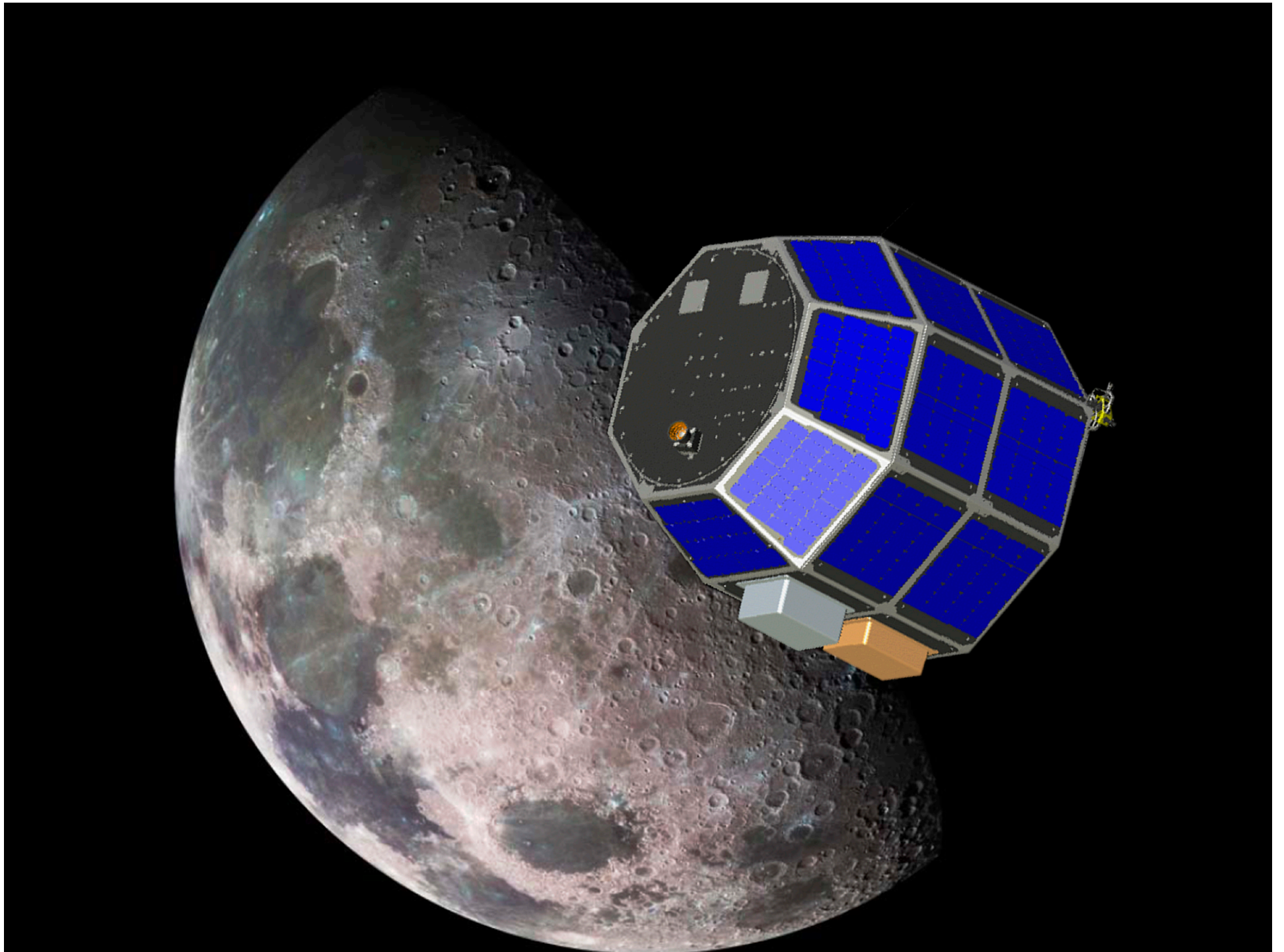


Differential & Supercharging

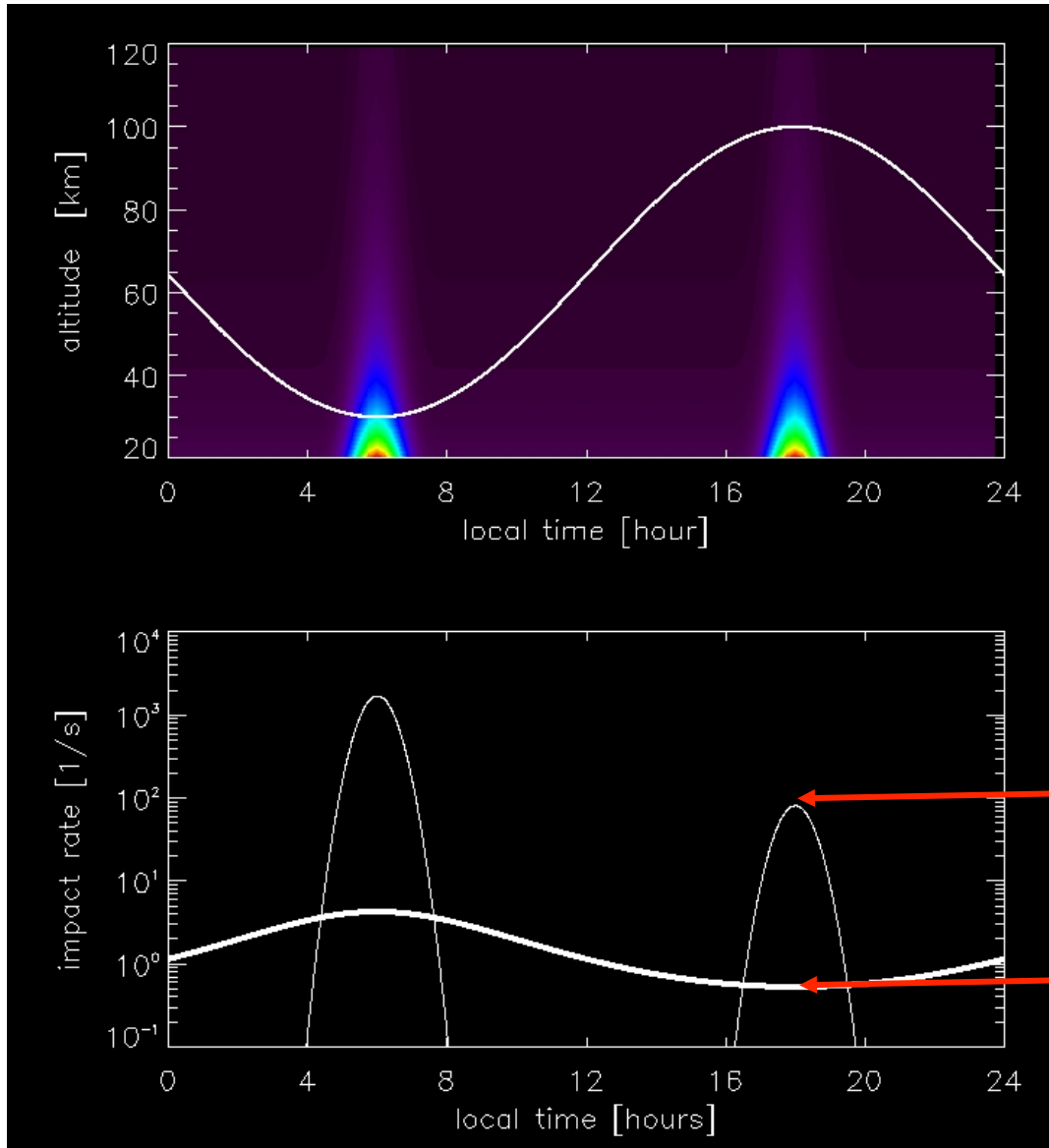








Expected Impact Rates



30 x 50 km orbit

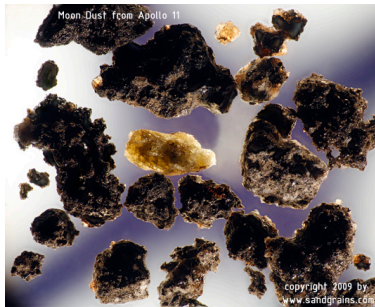
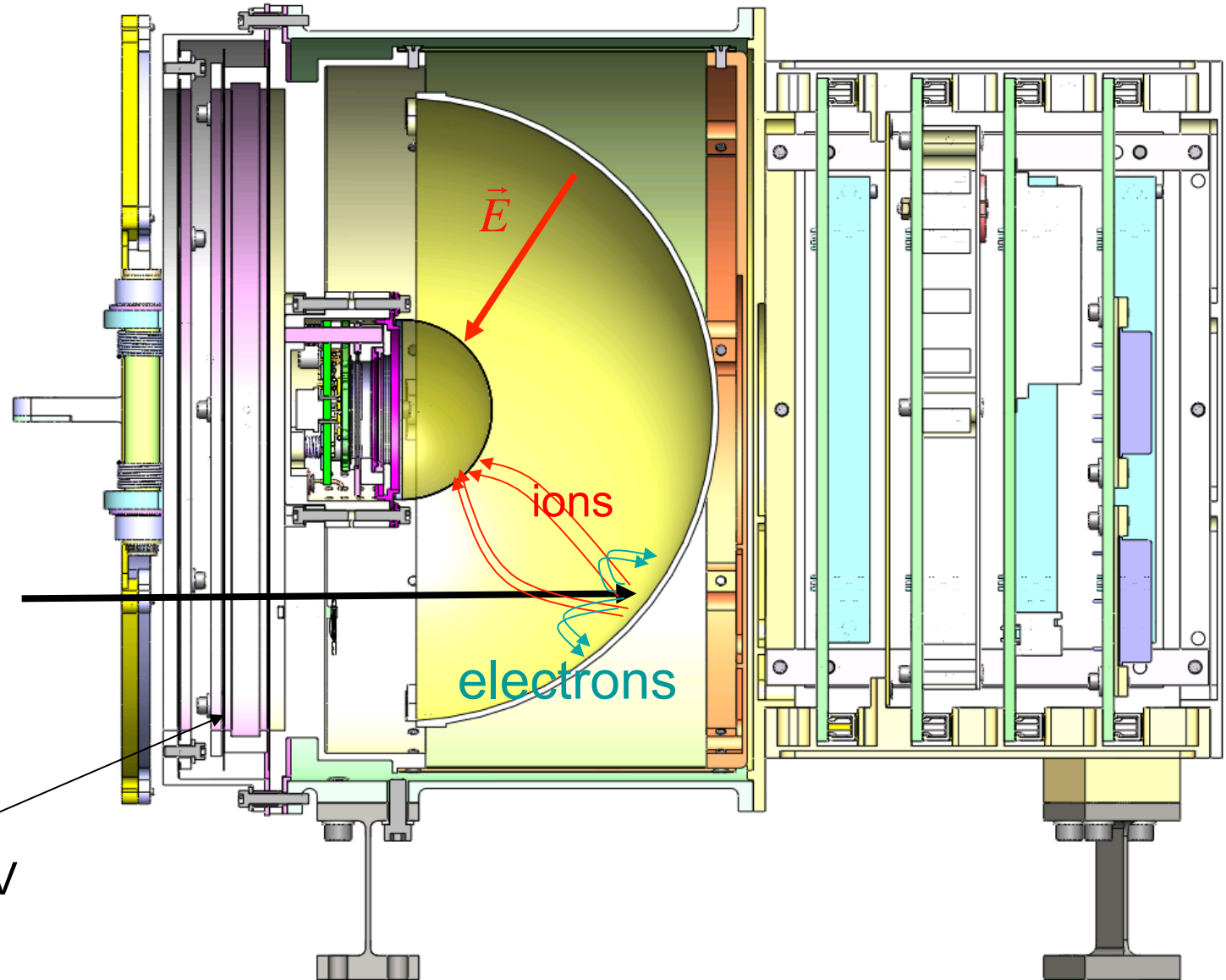
Pericenter over the
morning terminator

$A = 100 \text{ cm}^2$

$\leq 0.3 \mu\text{m}$

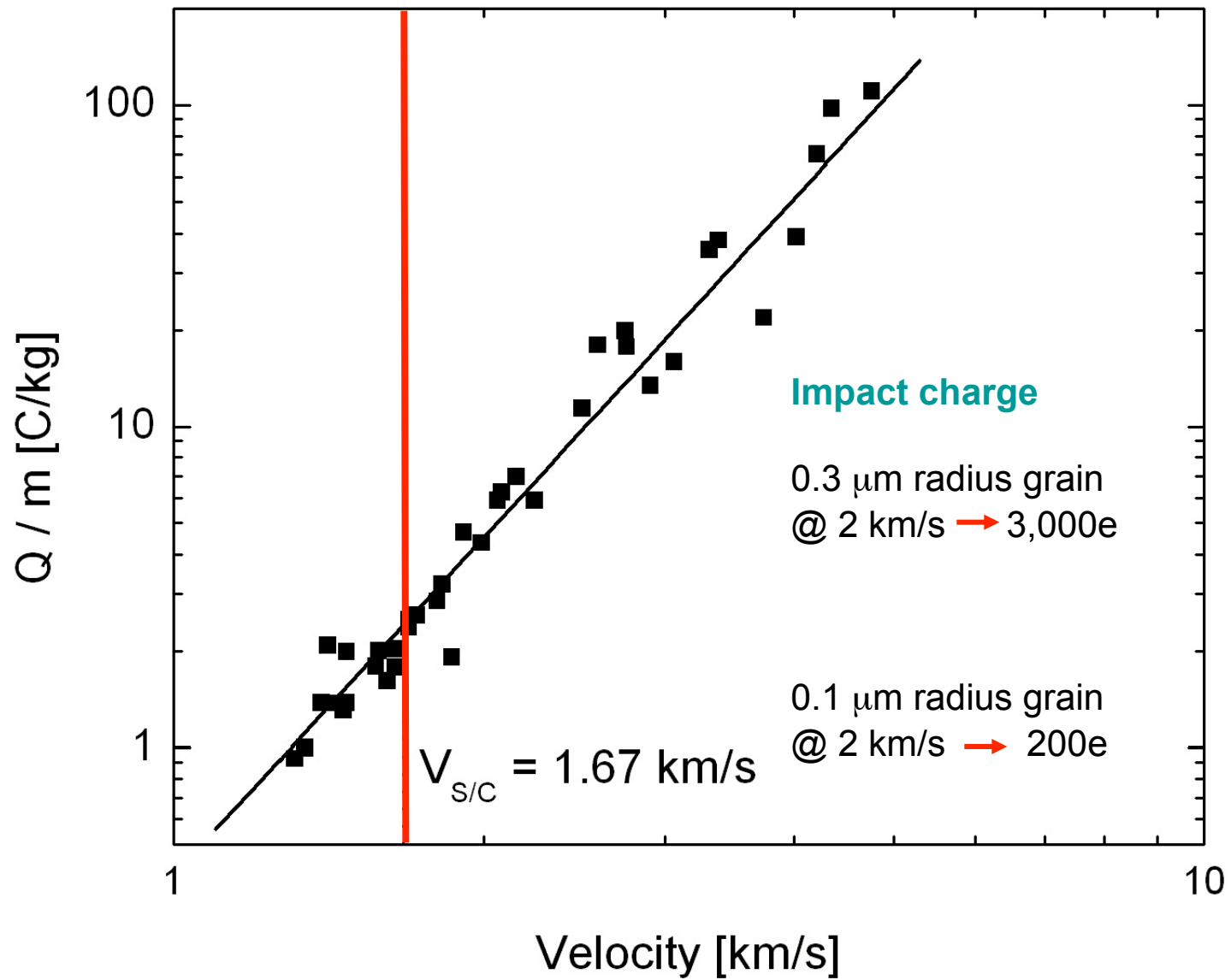
$> 0.3 \mu\text{m}$

LDEX Instrument

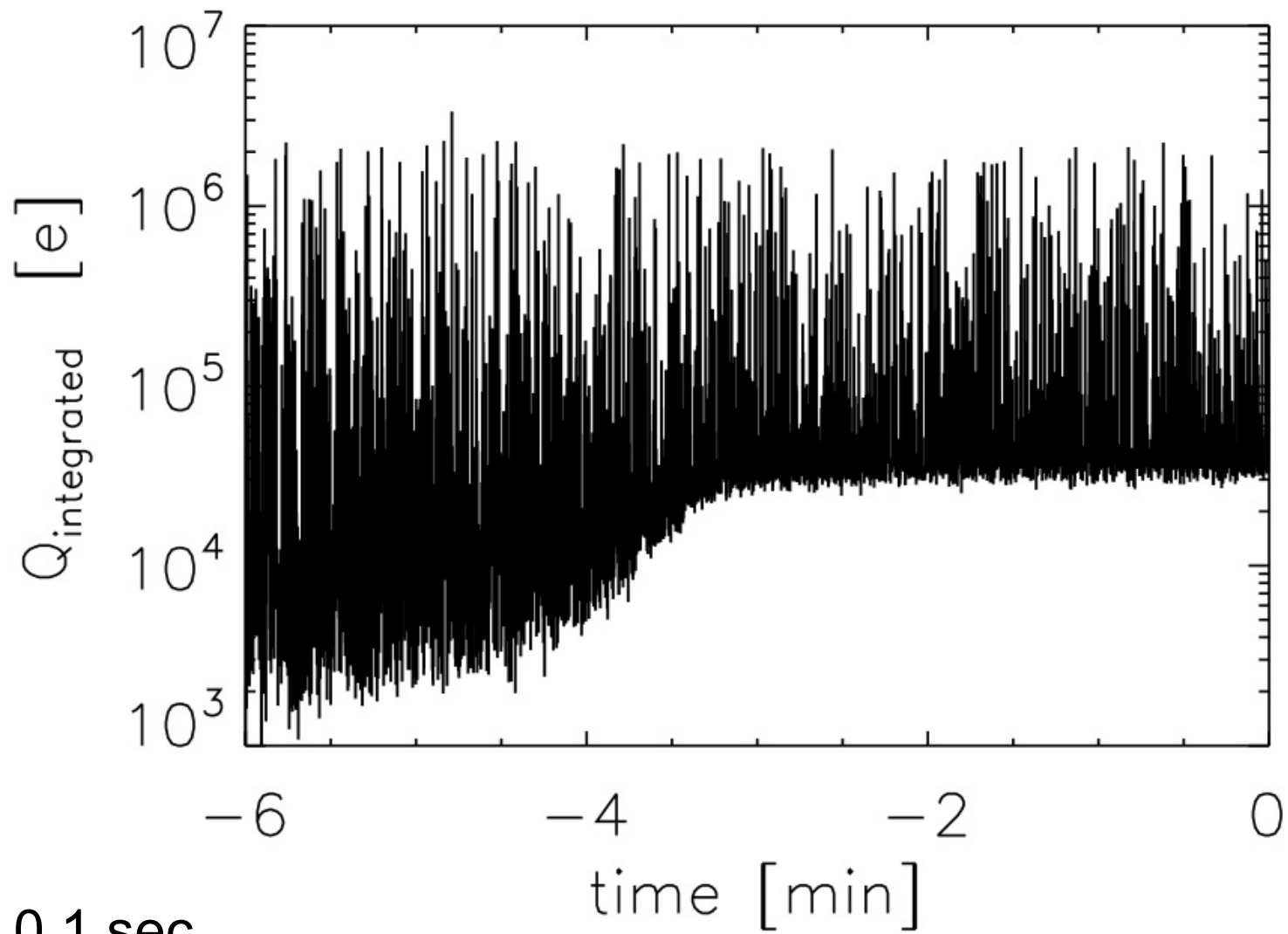


-100 V

Impact Charge

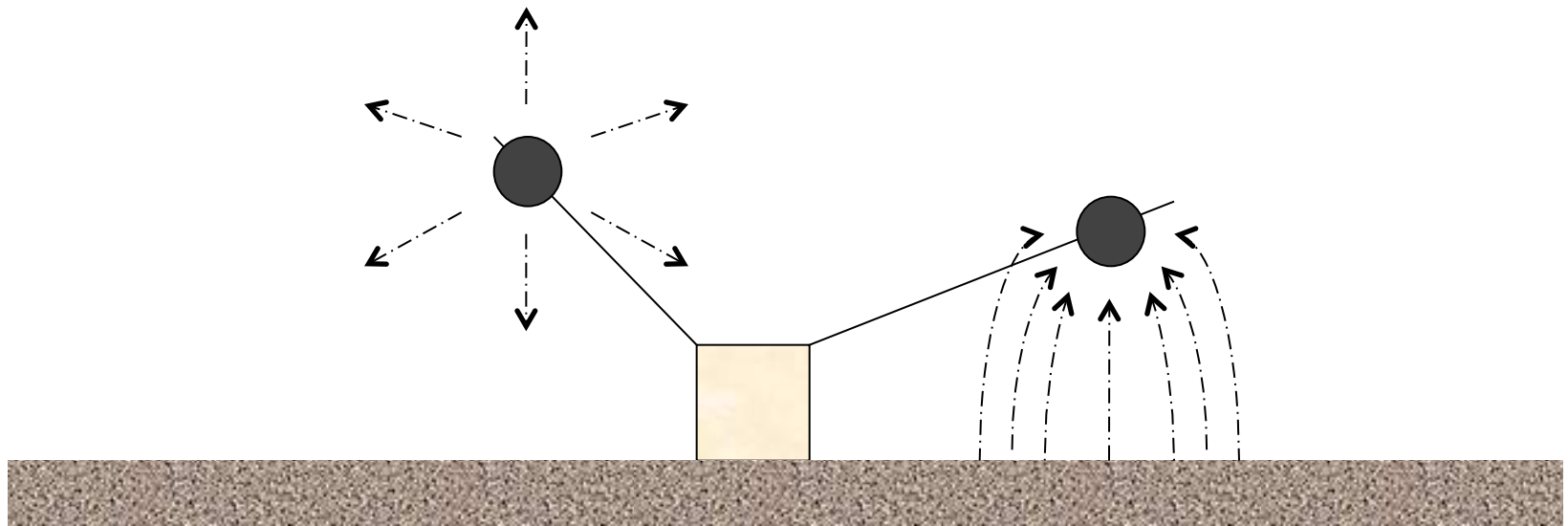


Expected Signal

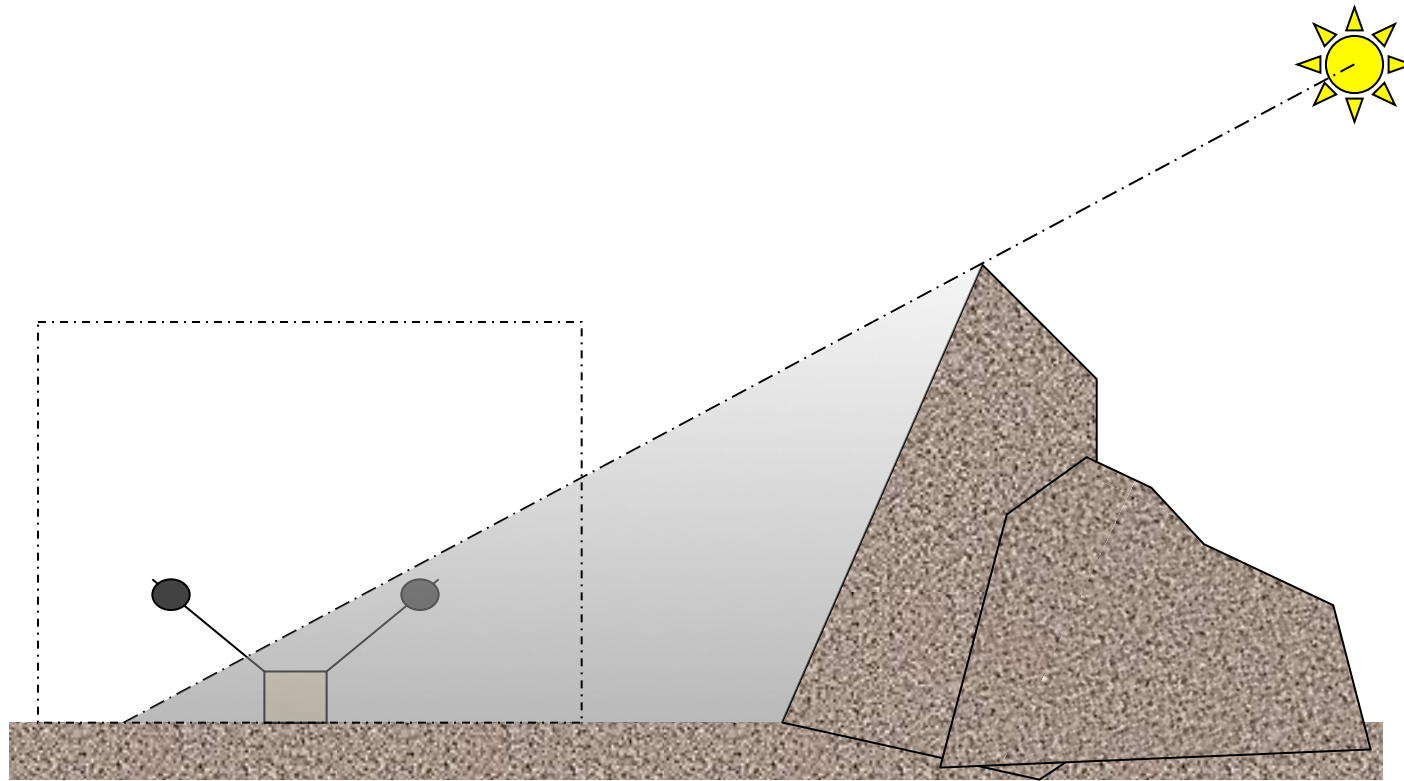


$dt = 0.1 \text{ sec}$

Probes on the lunar surface



Probes at the terminator

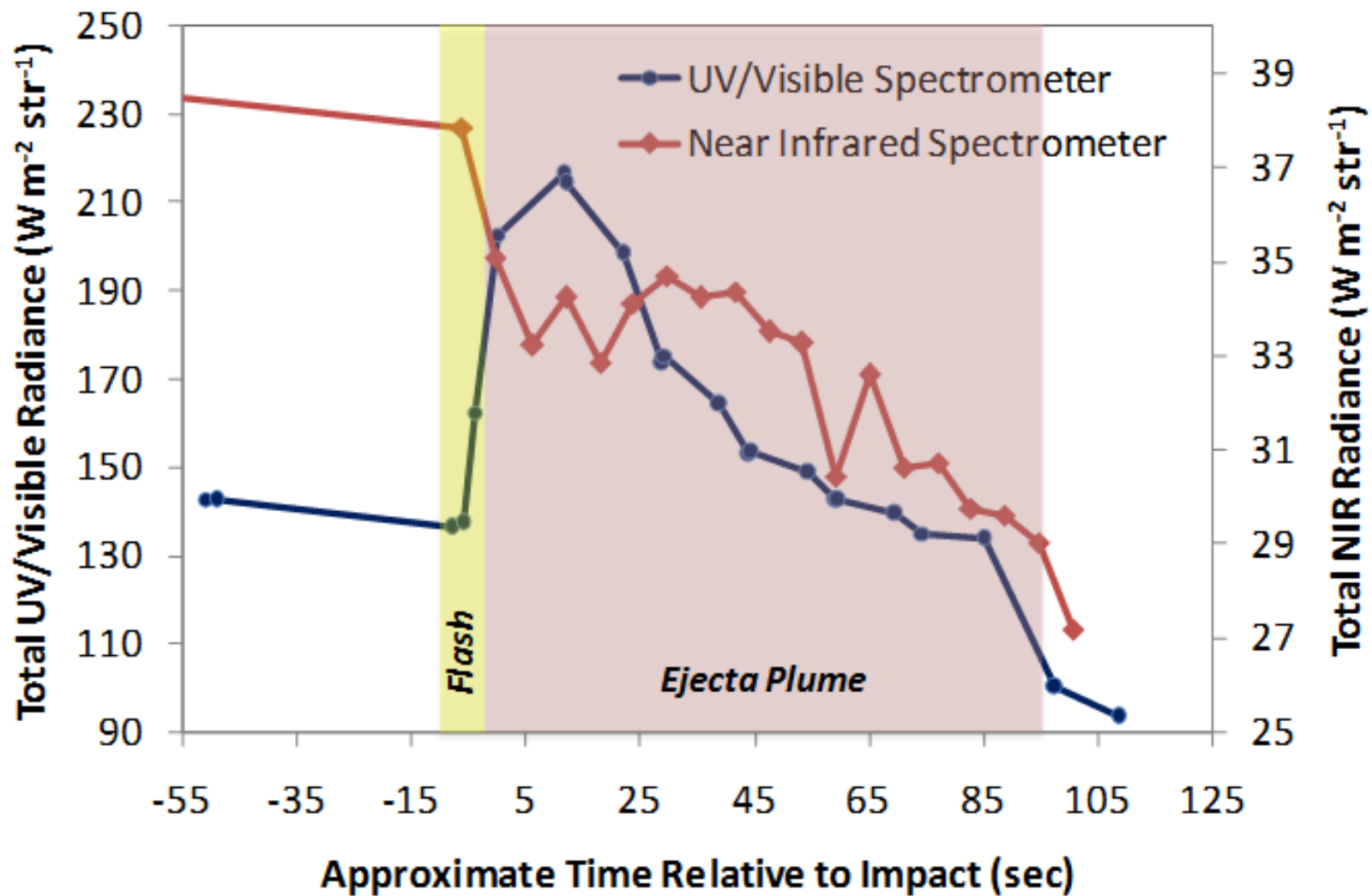


Time dependent environment

VisibleCamera Images from LCROSS Shepherding Spacecraft

**POST-IMPACT IMAGE CO-ADD –
ZOOMED IMAGE**







433 Eros



NEAR - 433 Eros

April 26 2000 06:24:59

-58° 49°

