LUNAR IMPACT EJECTA CLOUDS OBSERVED BY LADEE/LDEX

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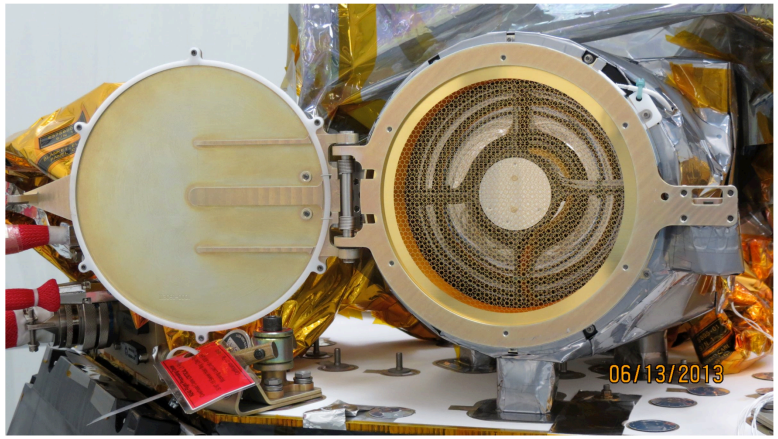
1) Expectations
2) LDEX
    a) principle of operation
    b) test & calibration
3) Results:
    a) dust ejecta clouds
    b) horizon glow
4) Outlook

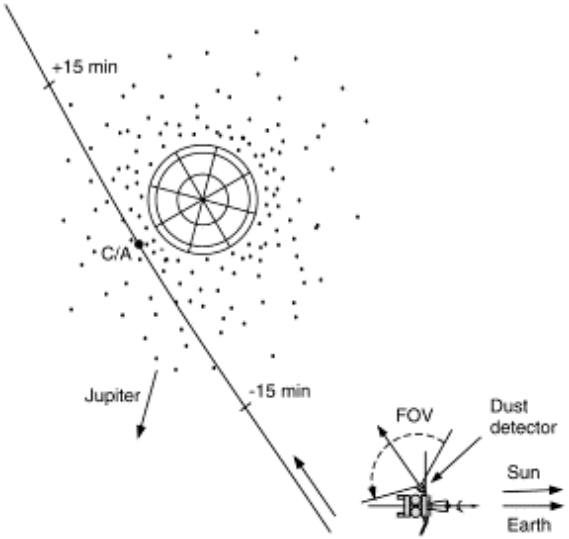


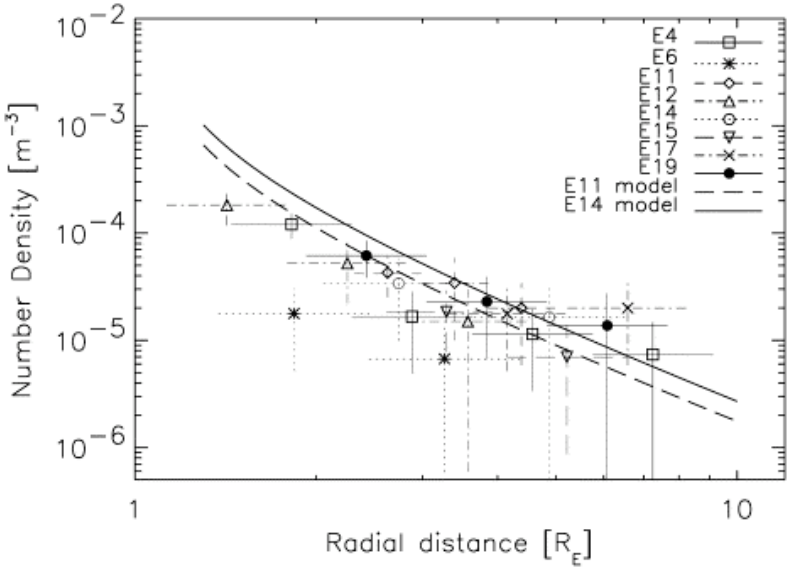
Lunar Dust Cloud

1) Spherically symmetric continually present ejecta cloud generated by interplanetary dust impacts

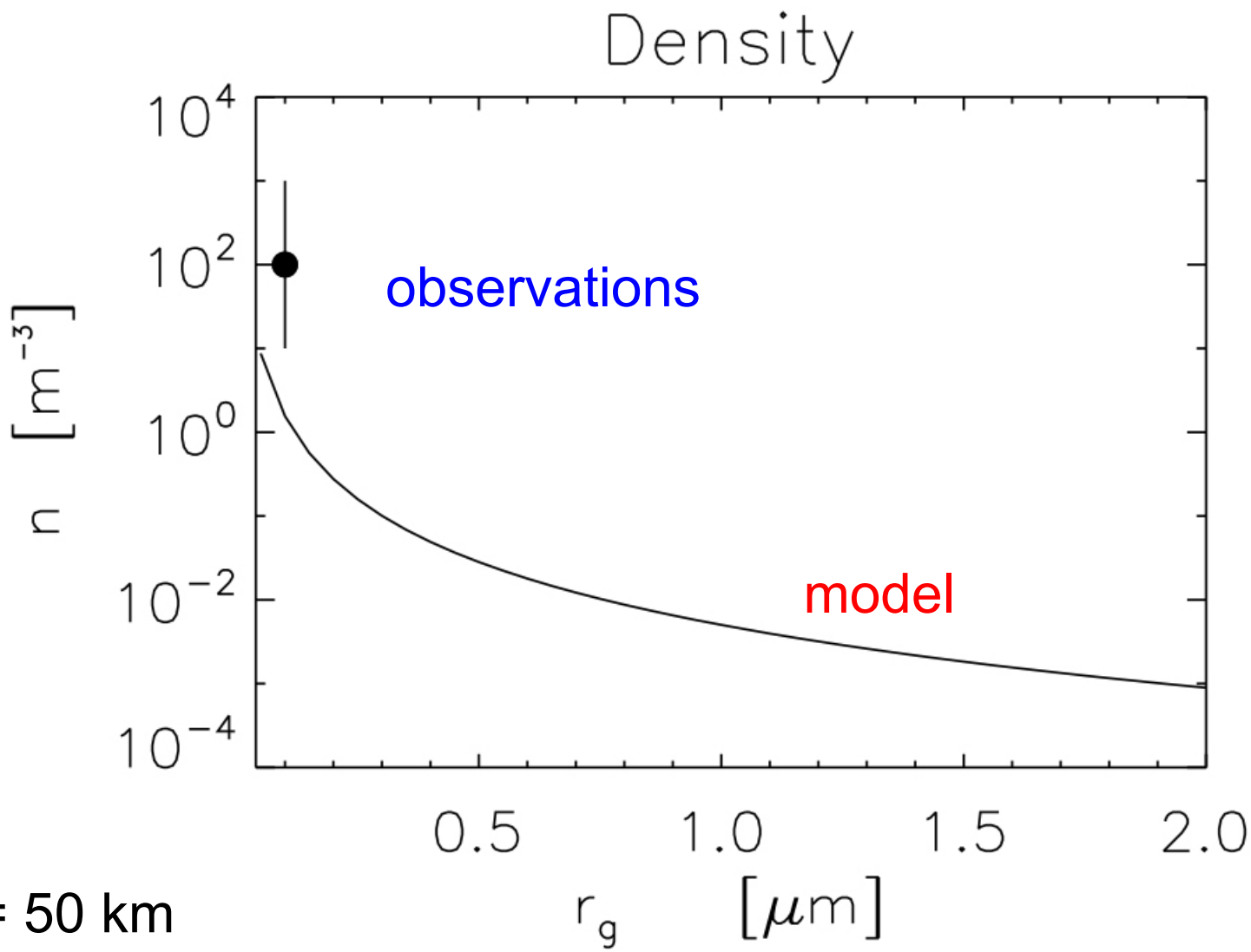
2) Temporal & spatial variability due to meteor showers on time scales of days

3) Density enhancements of small grains over the terminators due to plasma effects, expected to be correlated with solar wind conditions and UV variability on time scales of hours



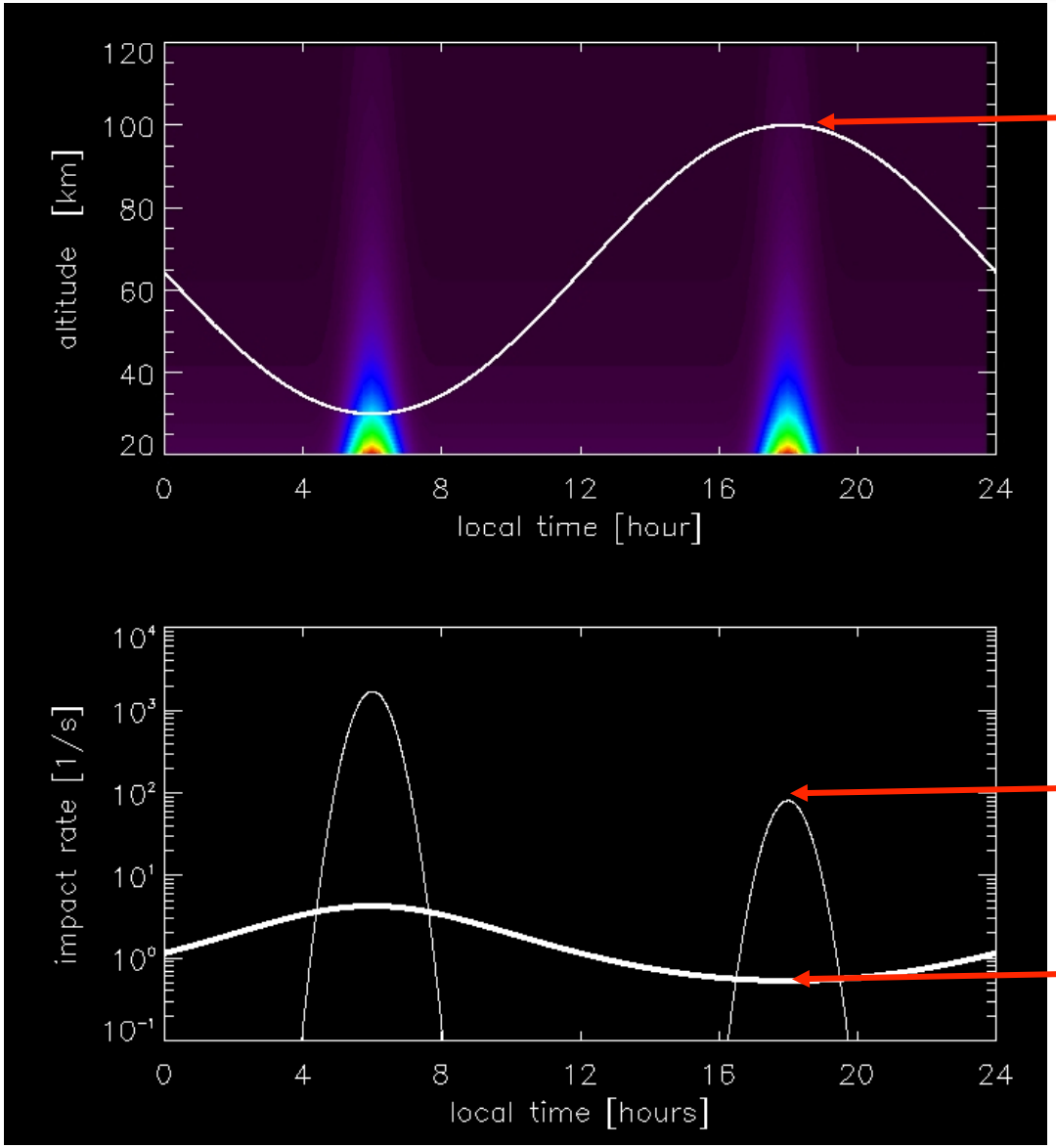


Lunar Dust Environment



h = 50 km

Expected Dust Impact Rates



30 x 100 km orbit

Periselene over the morning terminator

A = 100 cm^2

≤ 0.3 μm

> 0.3 μm

LDEX Measurement Requirements

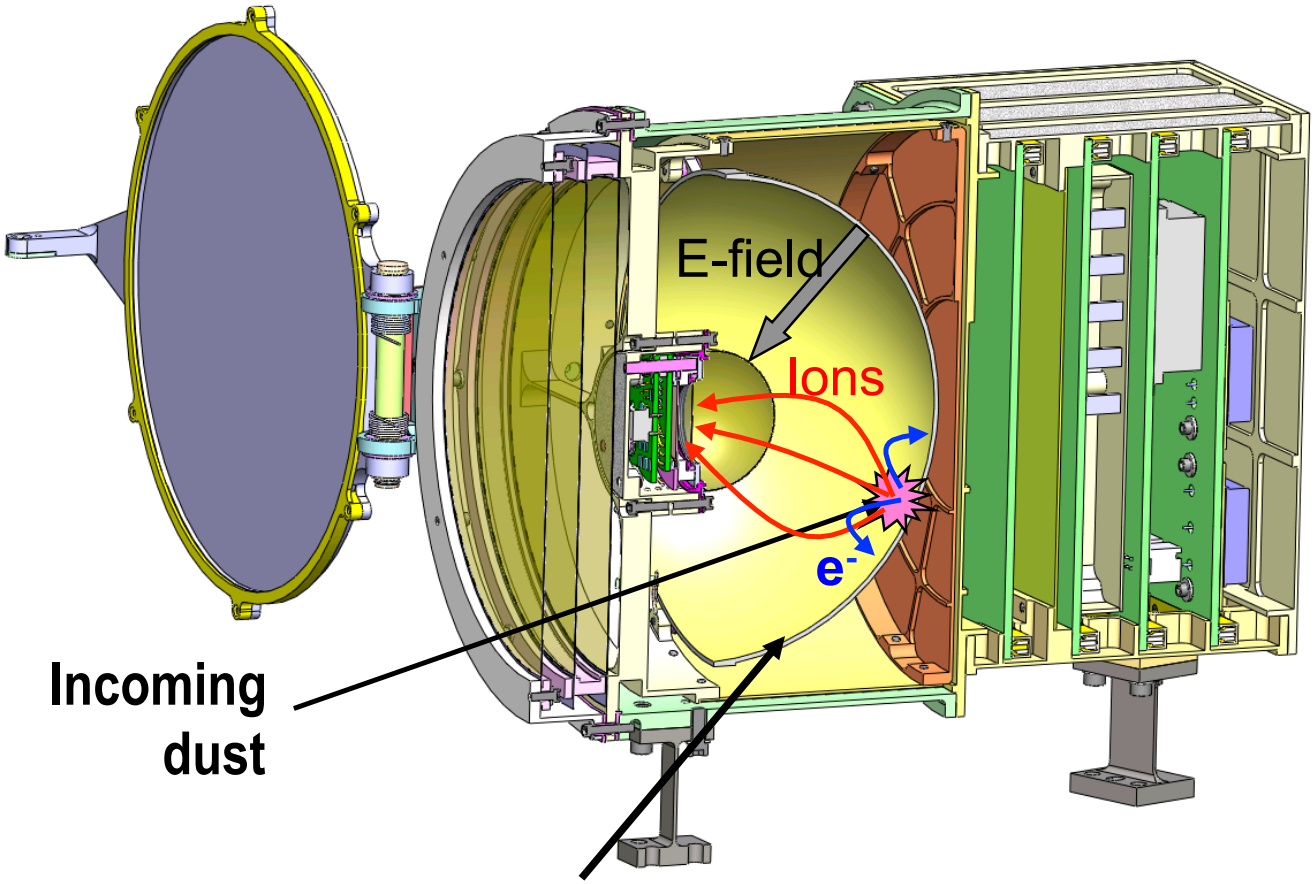
Single grain detection:

1. LDEX shall be capable of detecting individual dust particles that have a radius of less than 1 micron or greater.
2. LDEX shall be capable of measuring the size distribution in at least 5 bins covering the dust particle radius range of 1 to 5 micron.
3. LDEX shall be capable of detecting all particles with radii > 5 micron.
4. LDEX shall be capable of detecting more than 1 dust particle impact per second.

Collective signal detection:

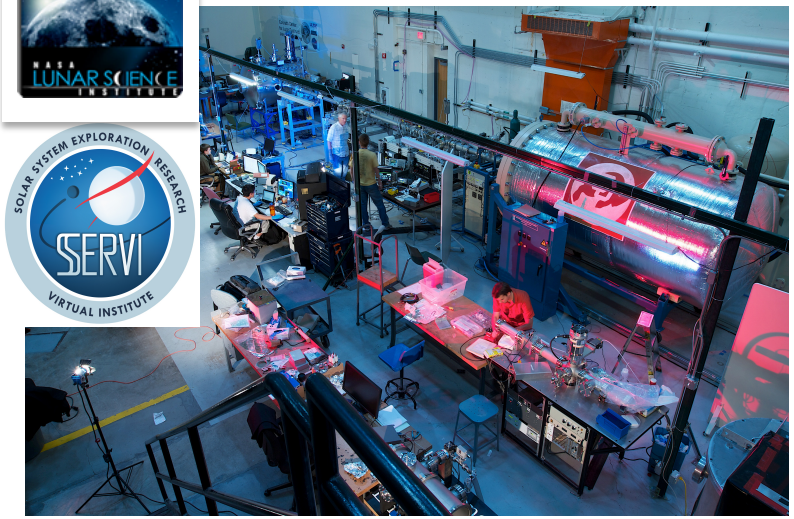
5. LDEX shall be capable of detecting the collective signal of particles with the radius range of 0.1 micron to 1 micron.
6. LDEX shall be capable of making more than 100 measurements of the collective signal within the six minutes immediately prior to sunrise terminator crossing in the lunar orbit (assuming a 50 km circular orbit).

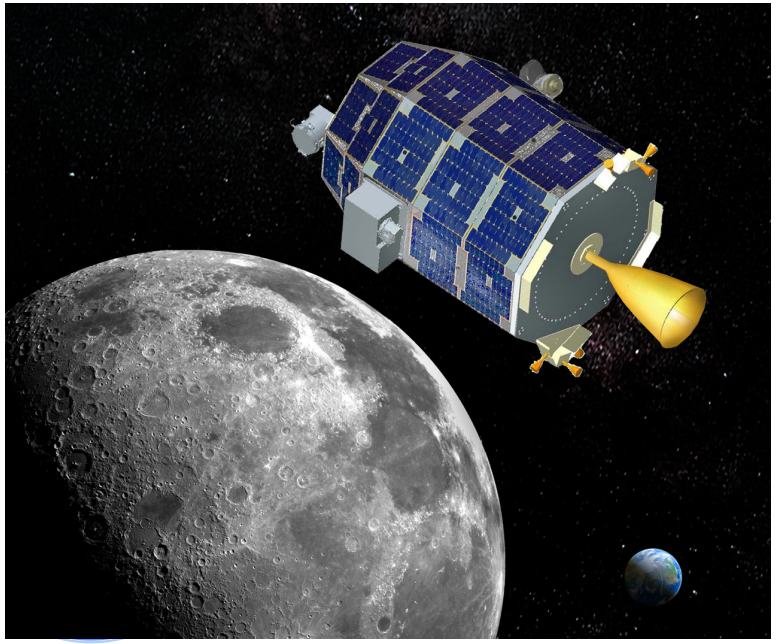
LDEX

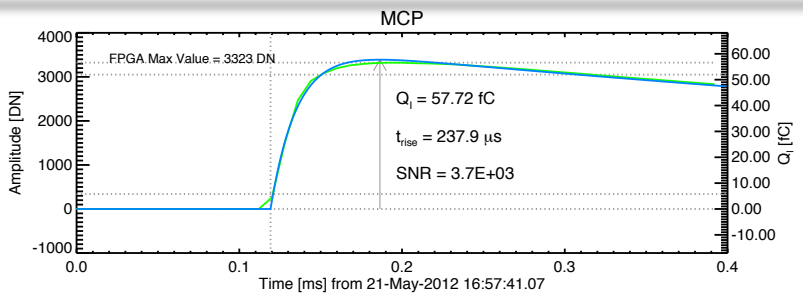


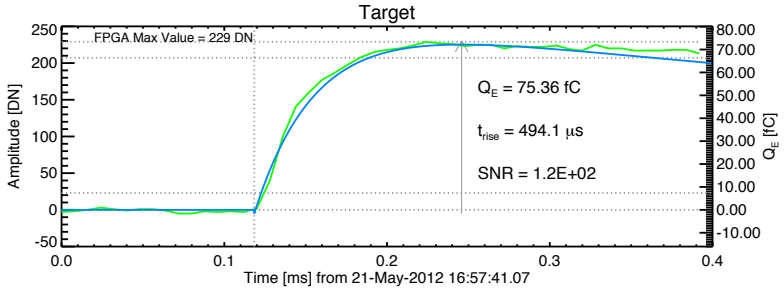
1) Single impacts
2) Collective dust signal

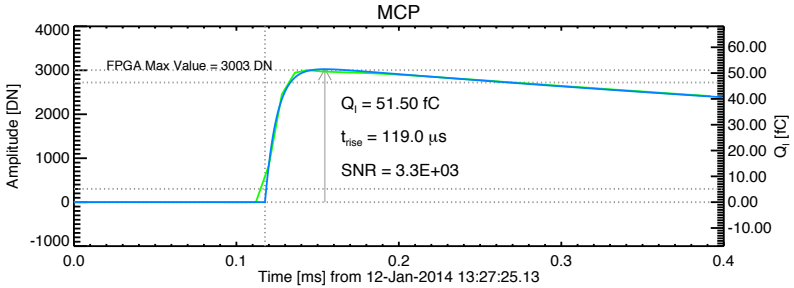
LDEX Calibration/Test

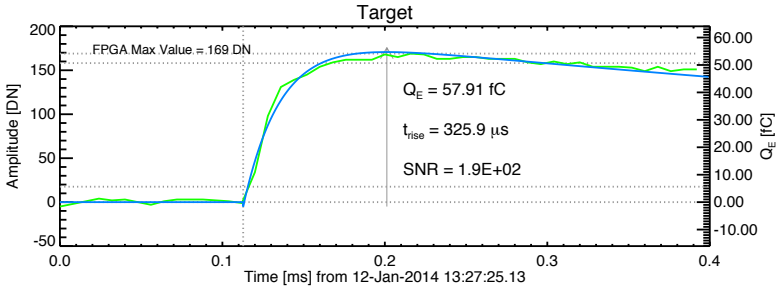




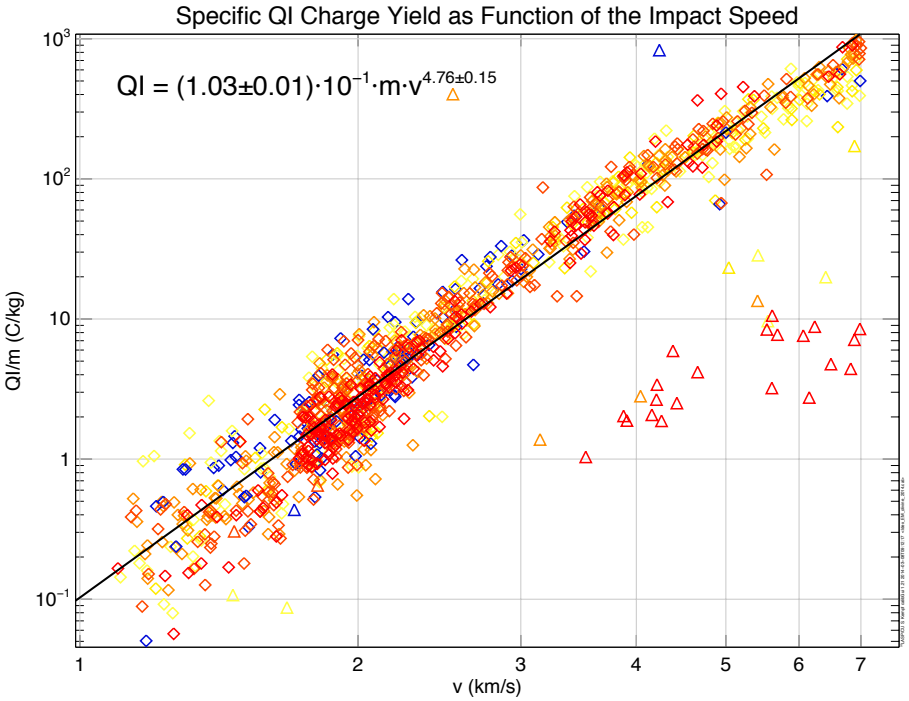


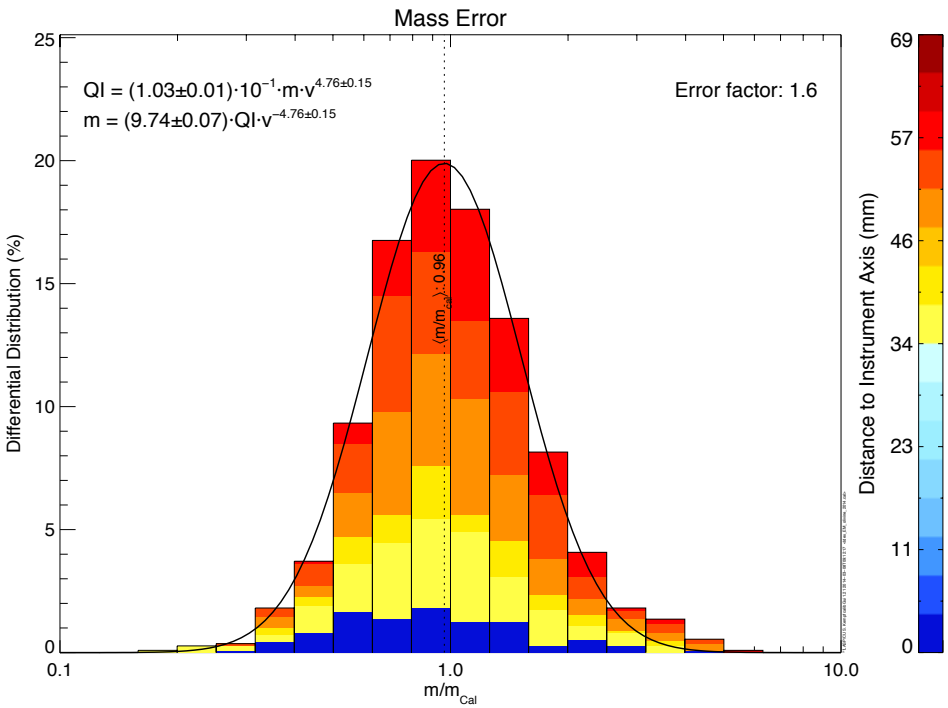




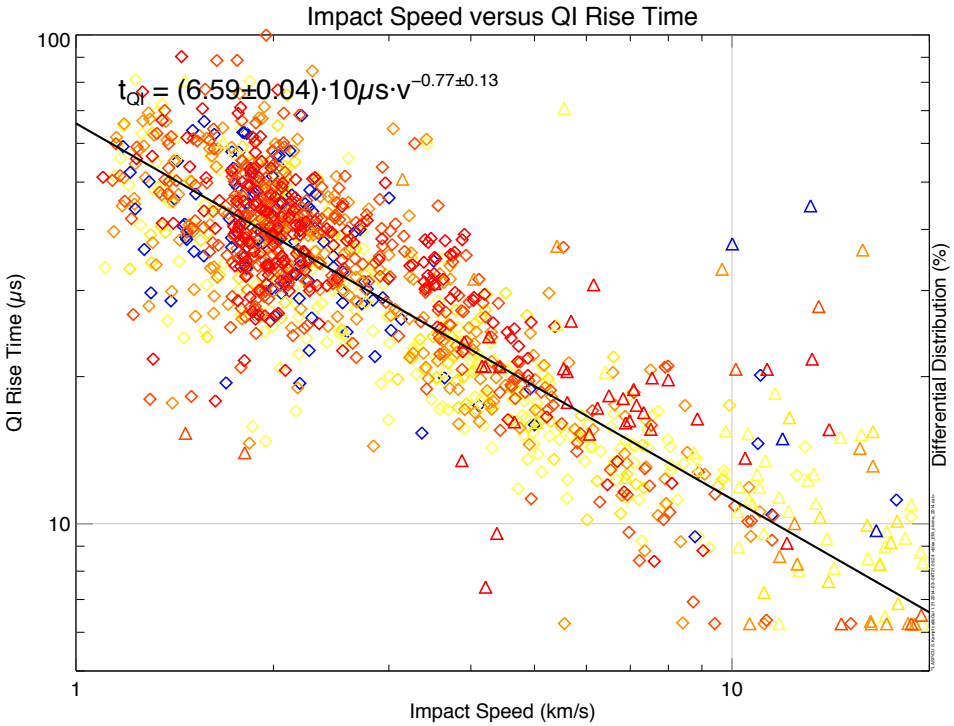


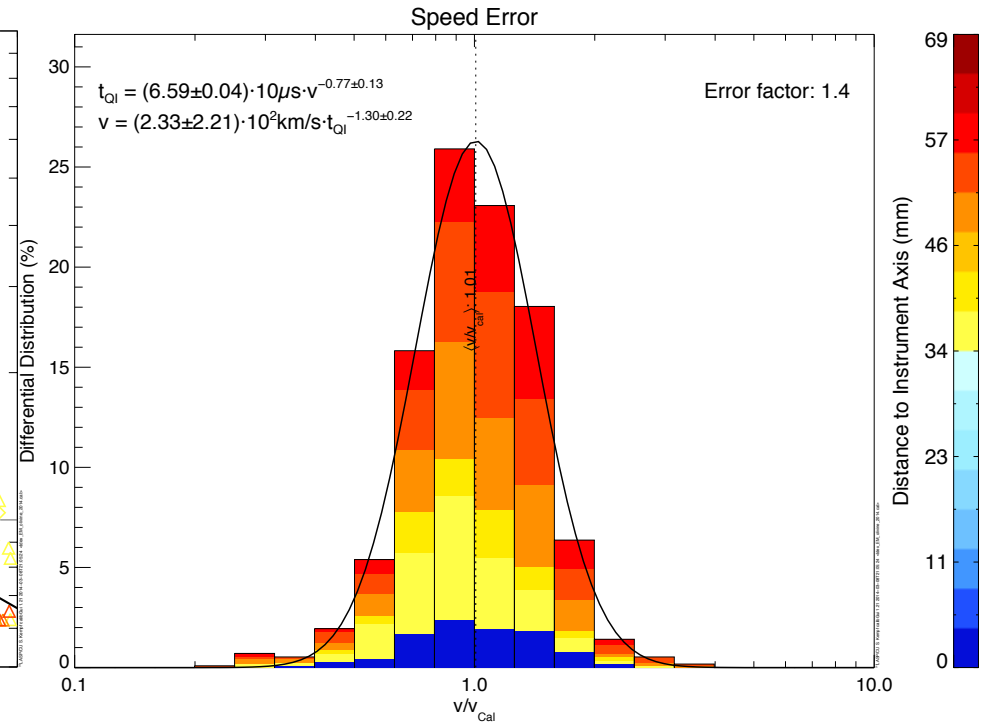
Calibration



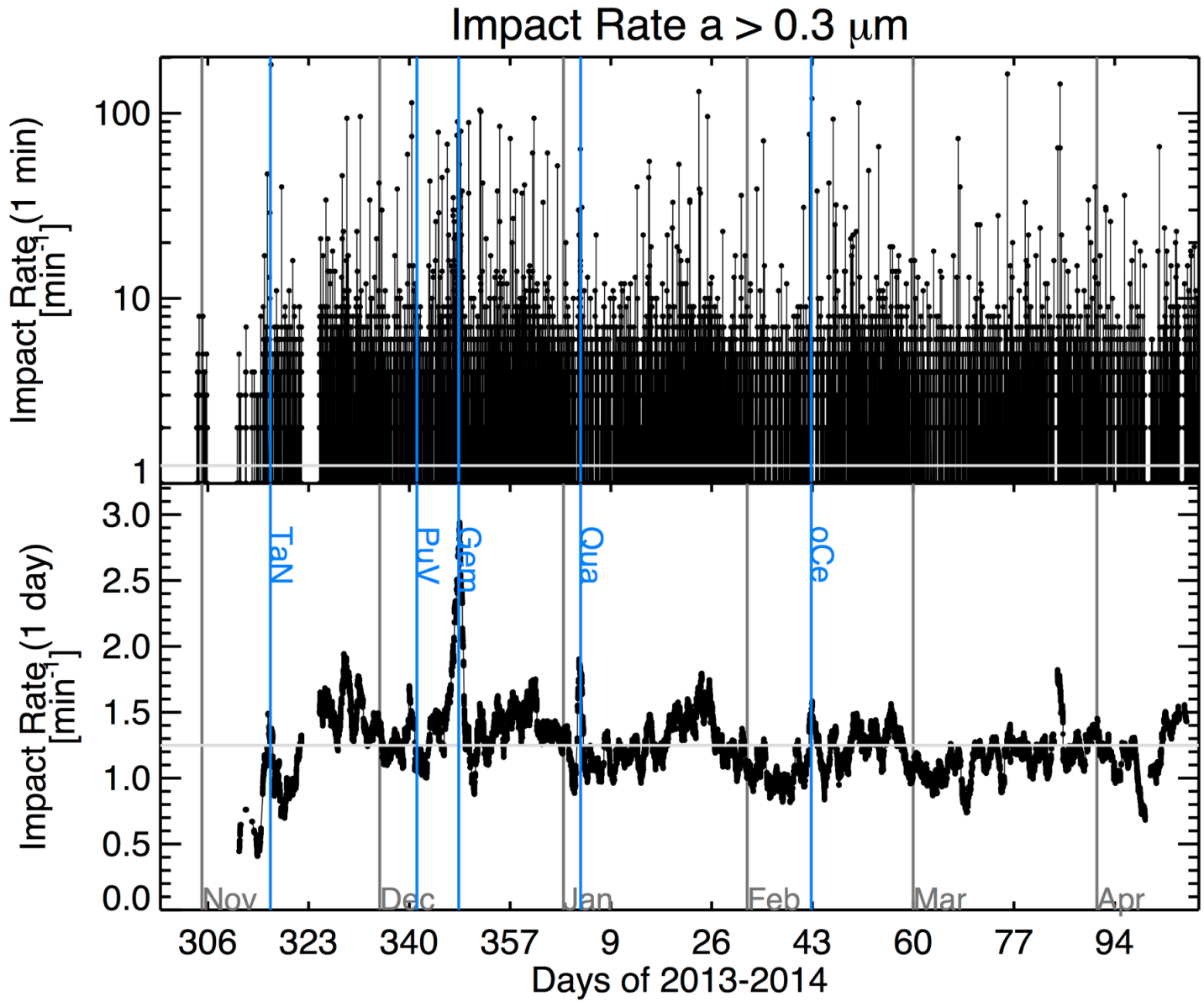


Calibration

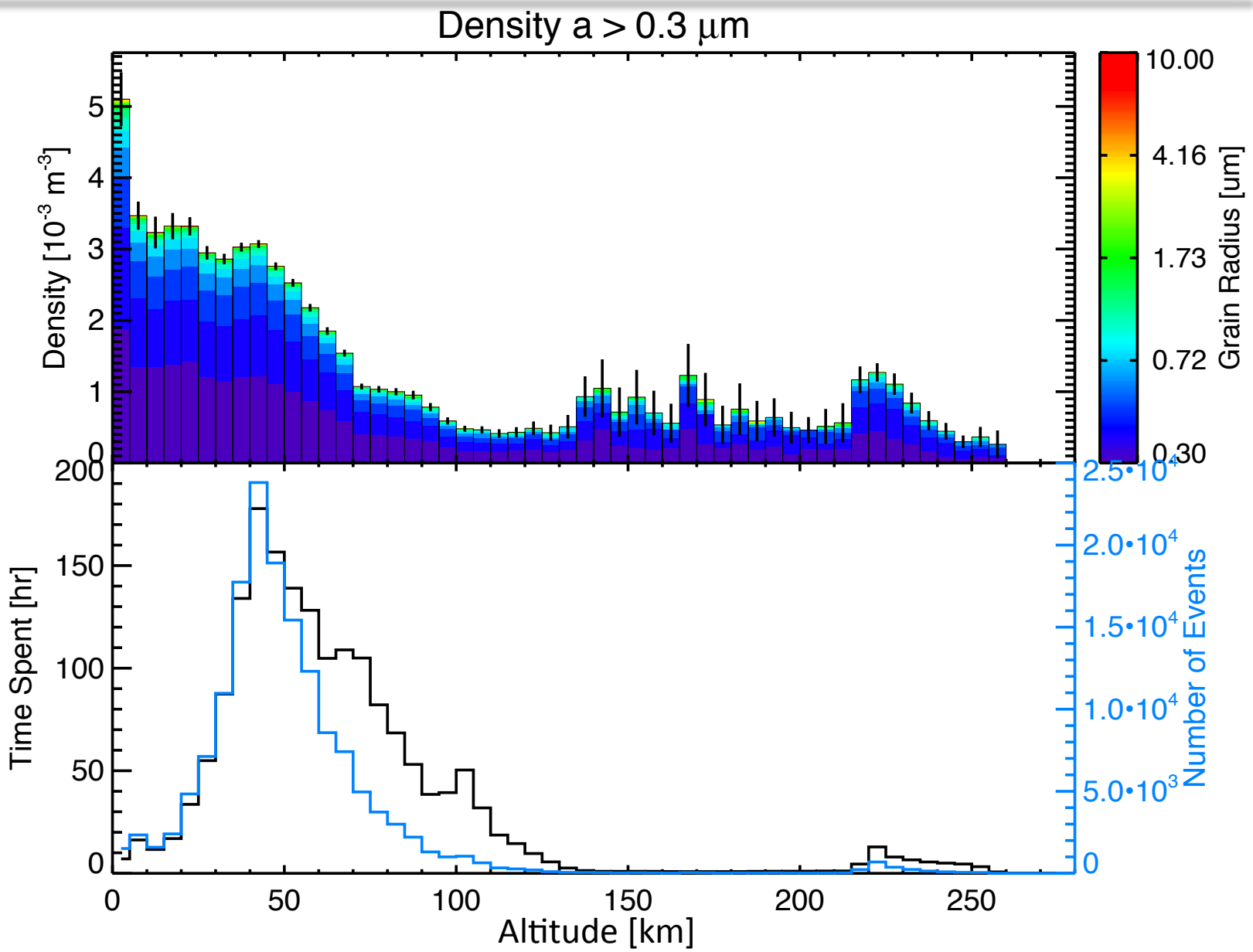




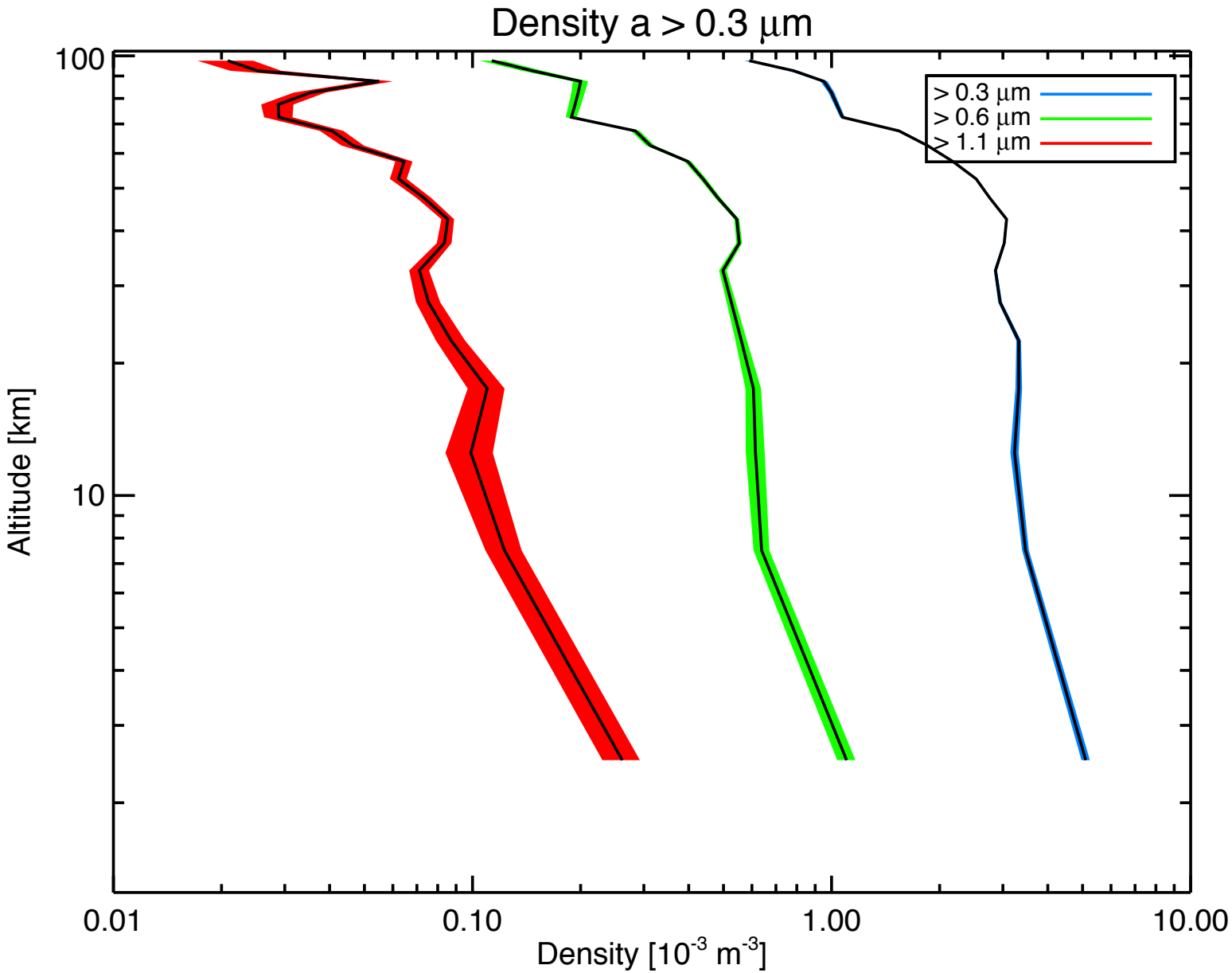
Results


Impact Rate a > 0.3 μm
Impact Rate (1 min) [min^{-1}]
100
10
1
Impact Rate (1 day) [min^{-1}]
3.0
2.5
2.0
1.5
1.0
0.5
0.0
TaN
PuV
Gem
Qua
oCe
Nov
Dec
Jan
Feb
Mar
Apr
306
323
340
357
9
26
43
60
77
94
Days of 2013-2014

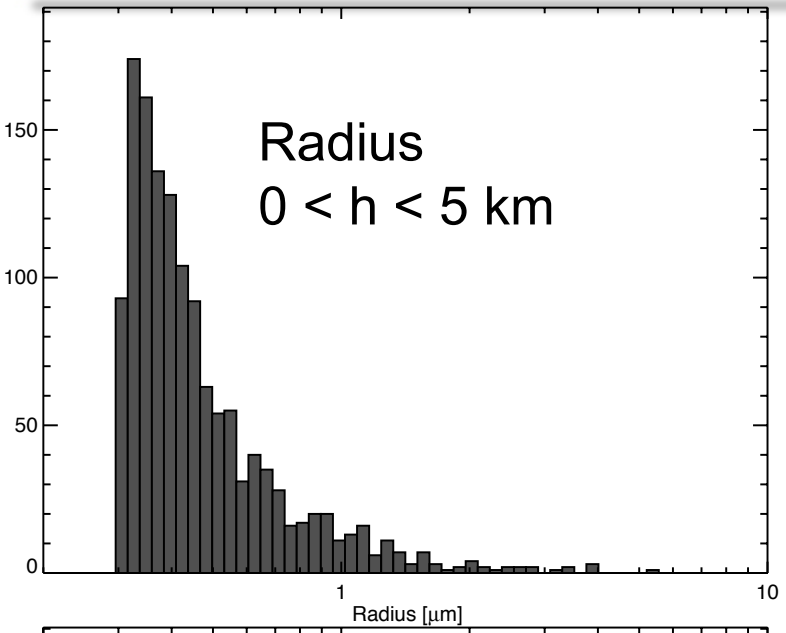
Average Dust Cloud

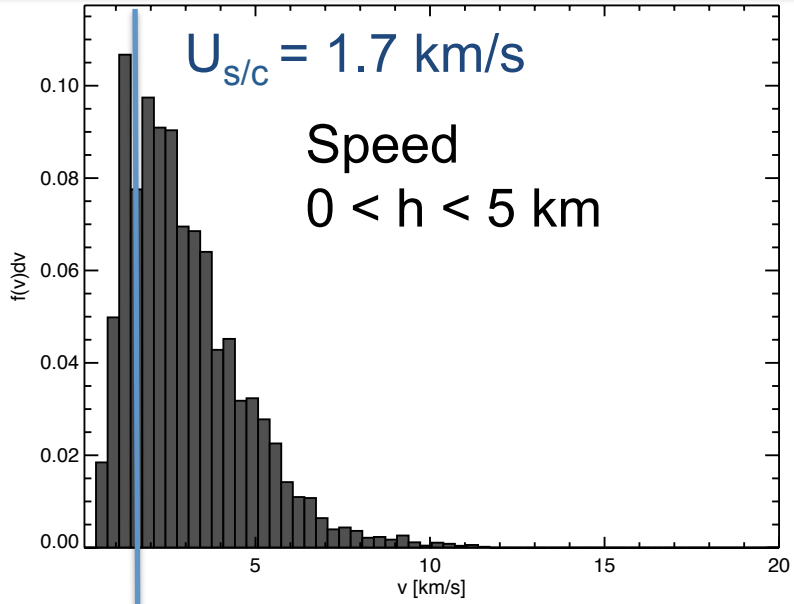


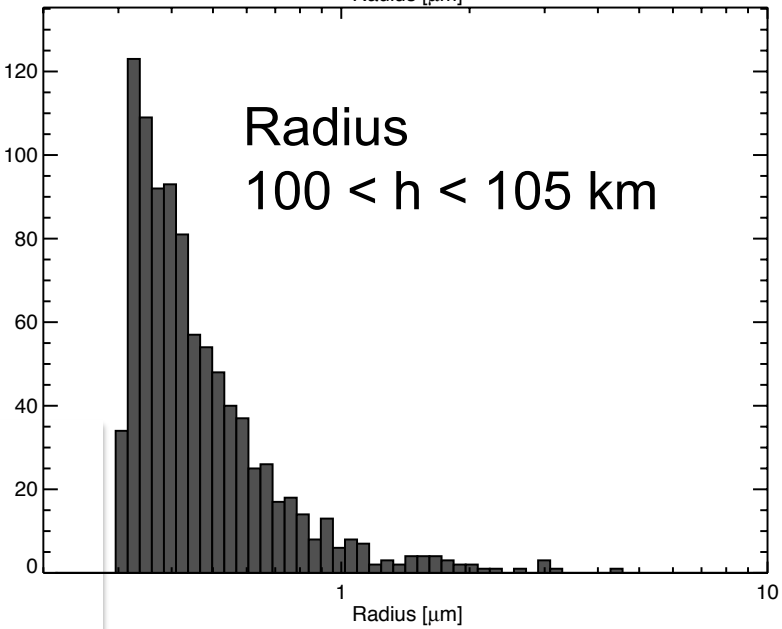
Dust Exosphere

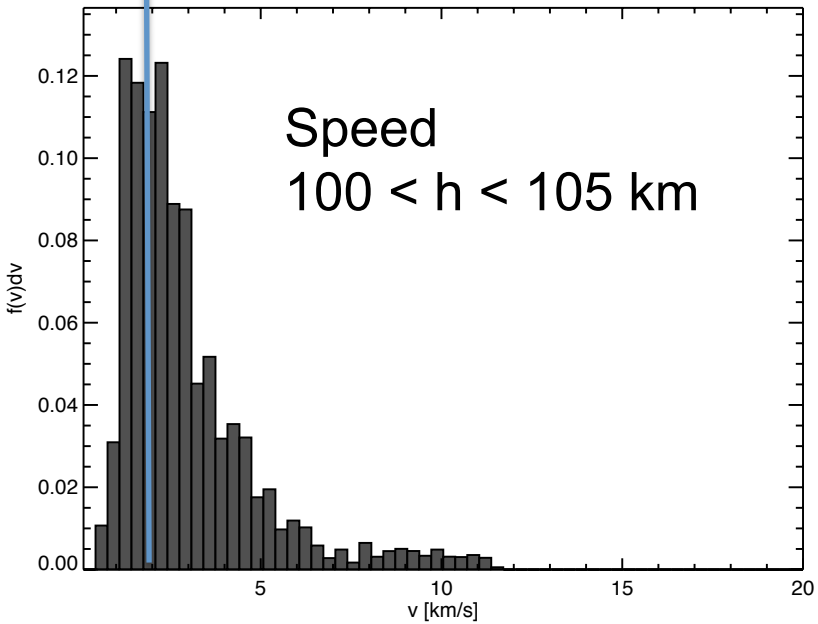


Ejecta Cloud Properties

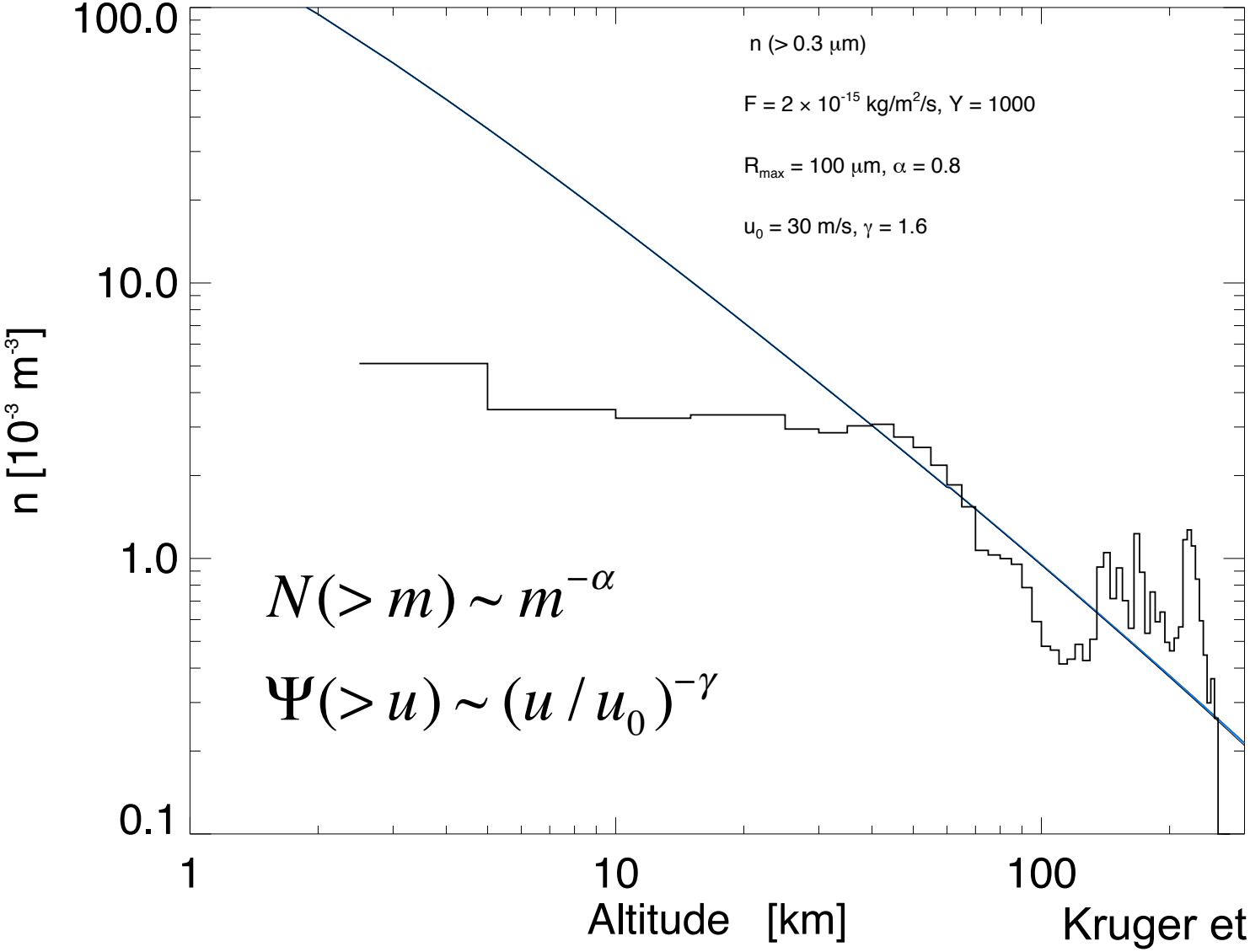








Ejecta Cloud Models

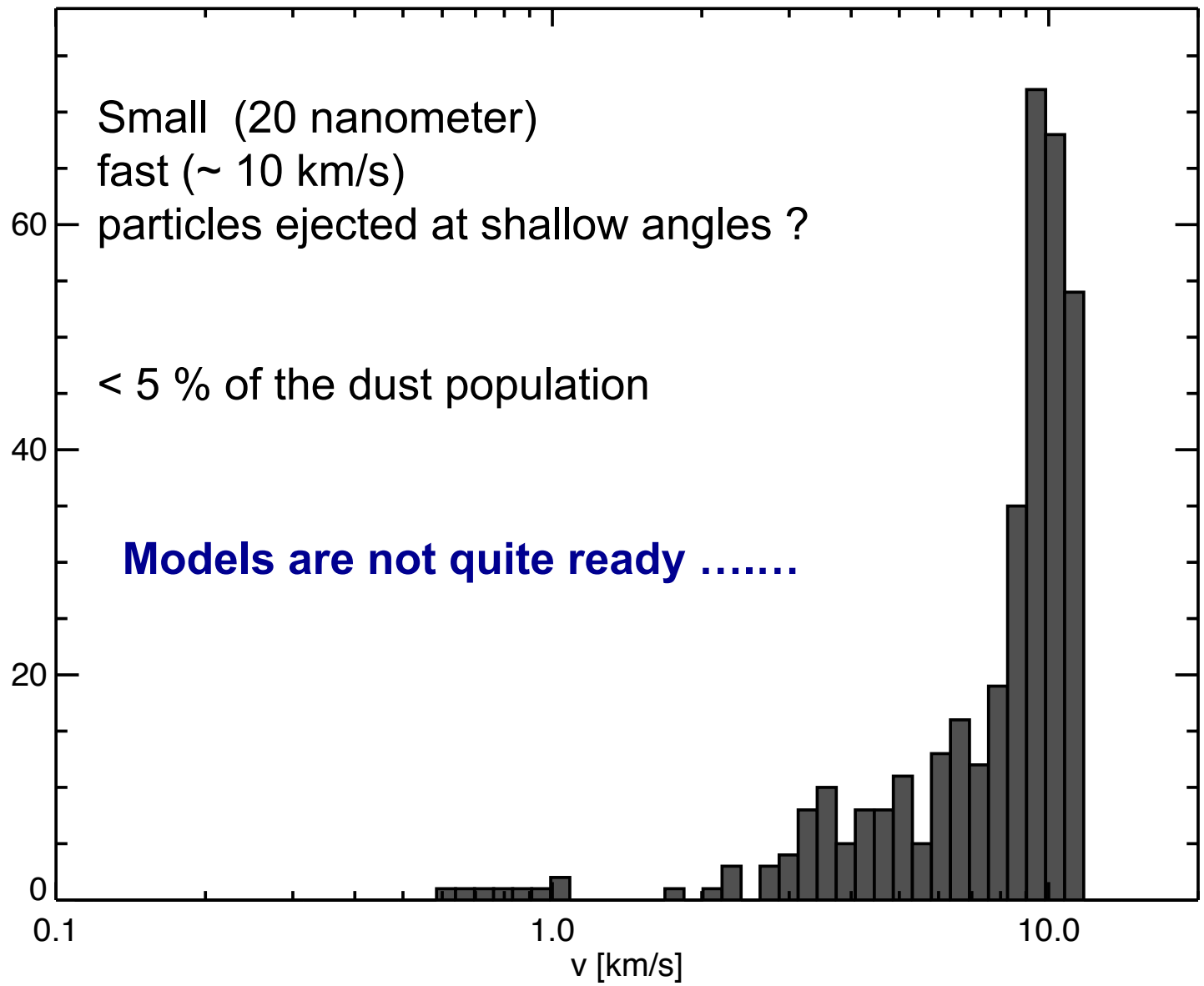


$$N(>m) \sim m^{-\alpha}$$

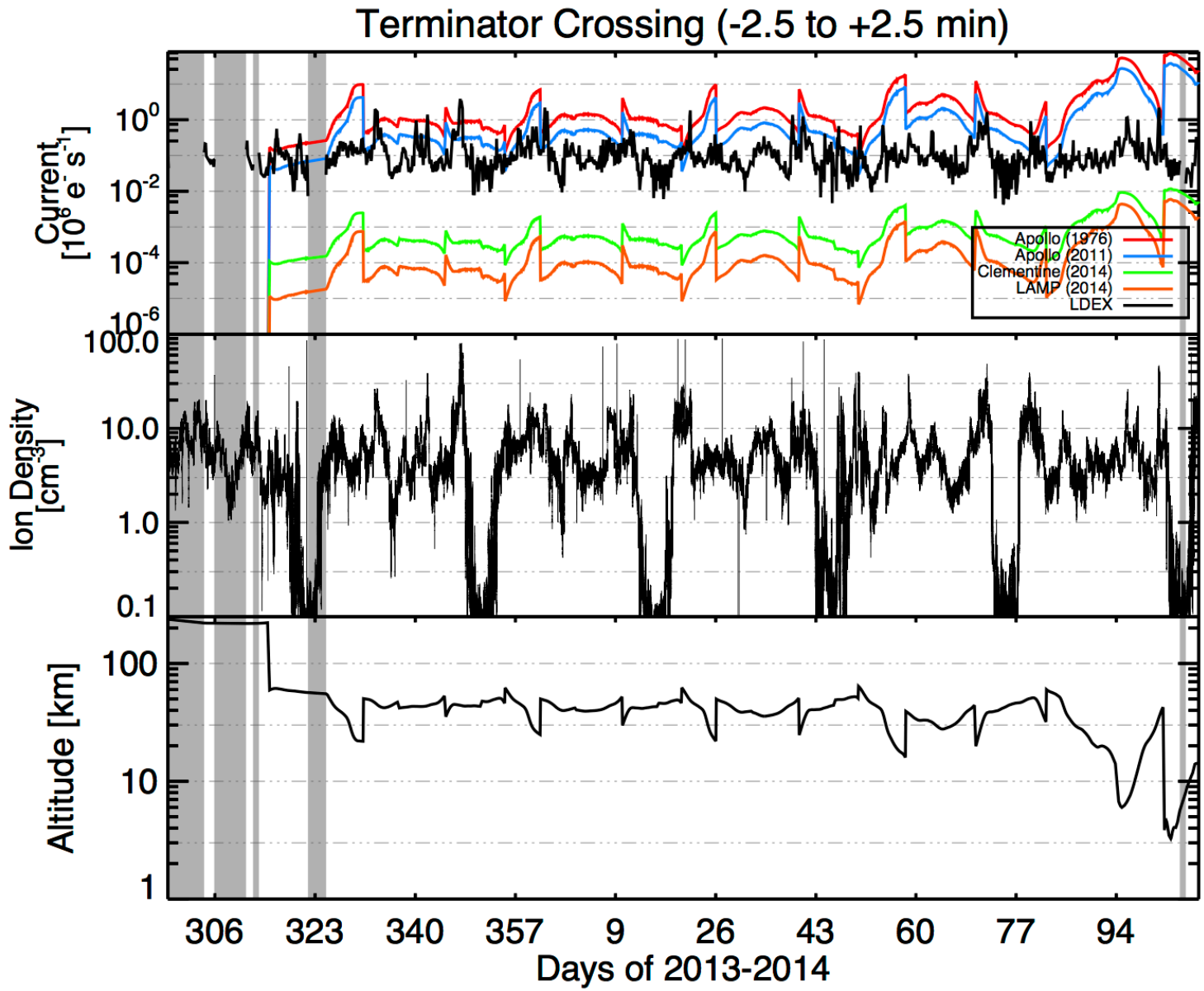
$$\Psi(>u) \sim (u/u_0)^{-\gamma}$$

Kruger et al., 2000

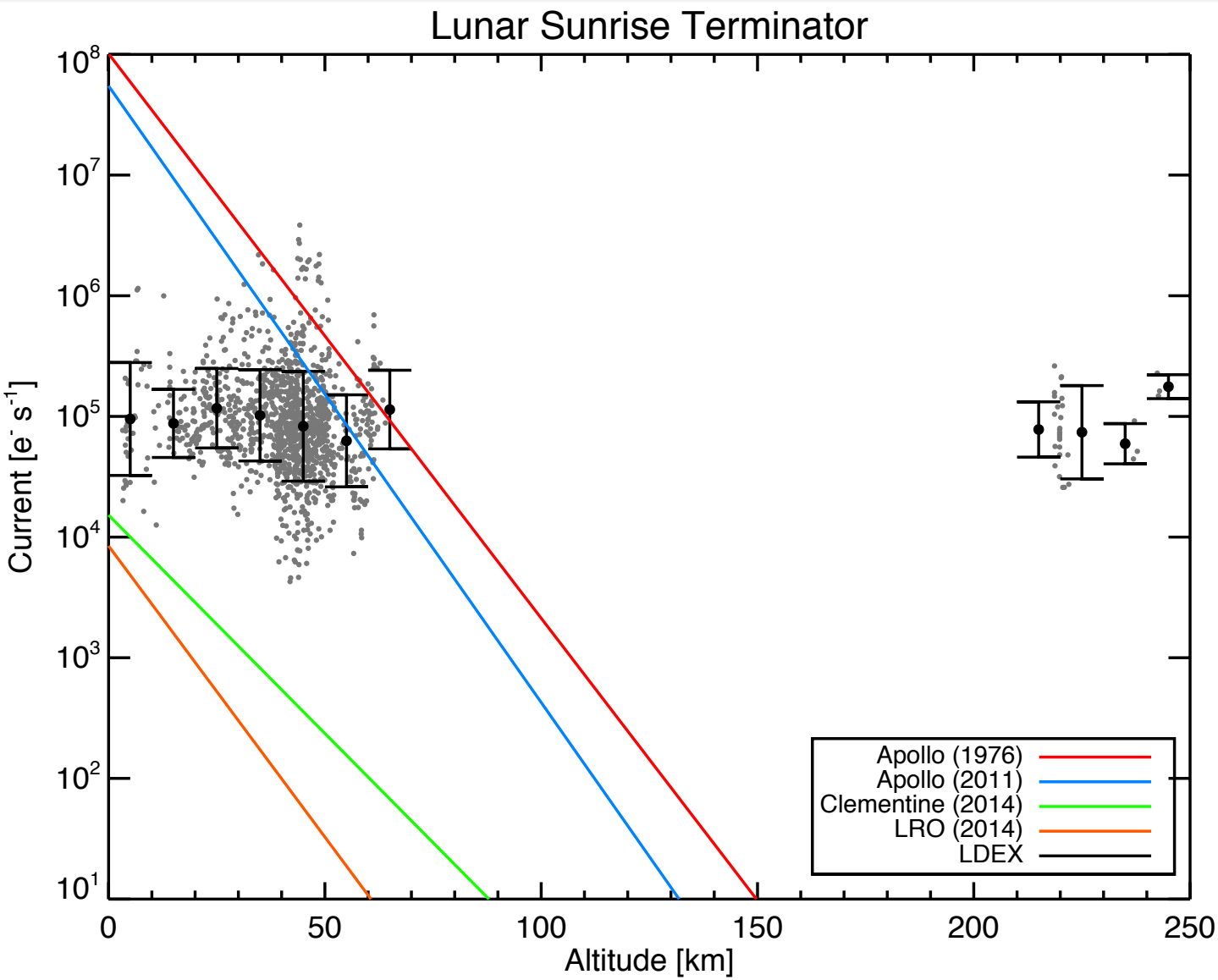
Anti-ram data (< 4.5 days)



Plasma lofted dust?



No Electrostatic Effects ?



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LADEE did well !

LDEX discovered the lunar dust exosphere, and it provides new insight into the physics of ejecta production from the Moon.

LDEX found no evidence for plasma lofted, small dust particles over the terminators.

The ejecta clouds provide a unique opportunity to learn about the **composition** and the **geotechnical properties** of the surfaces of airless planetary bodies. A combination of nadir pointing remote sensing and ram pointing dust instruments collect information from the same real estate.

The Moon, asteroids, Phobos, Deimos provide a large ‘amplification’ of the impactor flux, and could be used to improve our models for estimating dust hazard.