DUST CHARGE MEASUREMENTS BY LDEX

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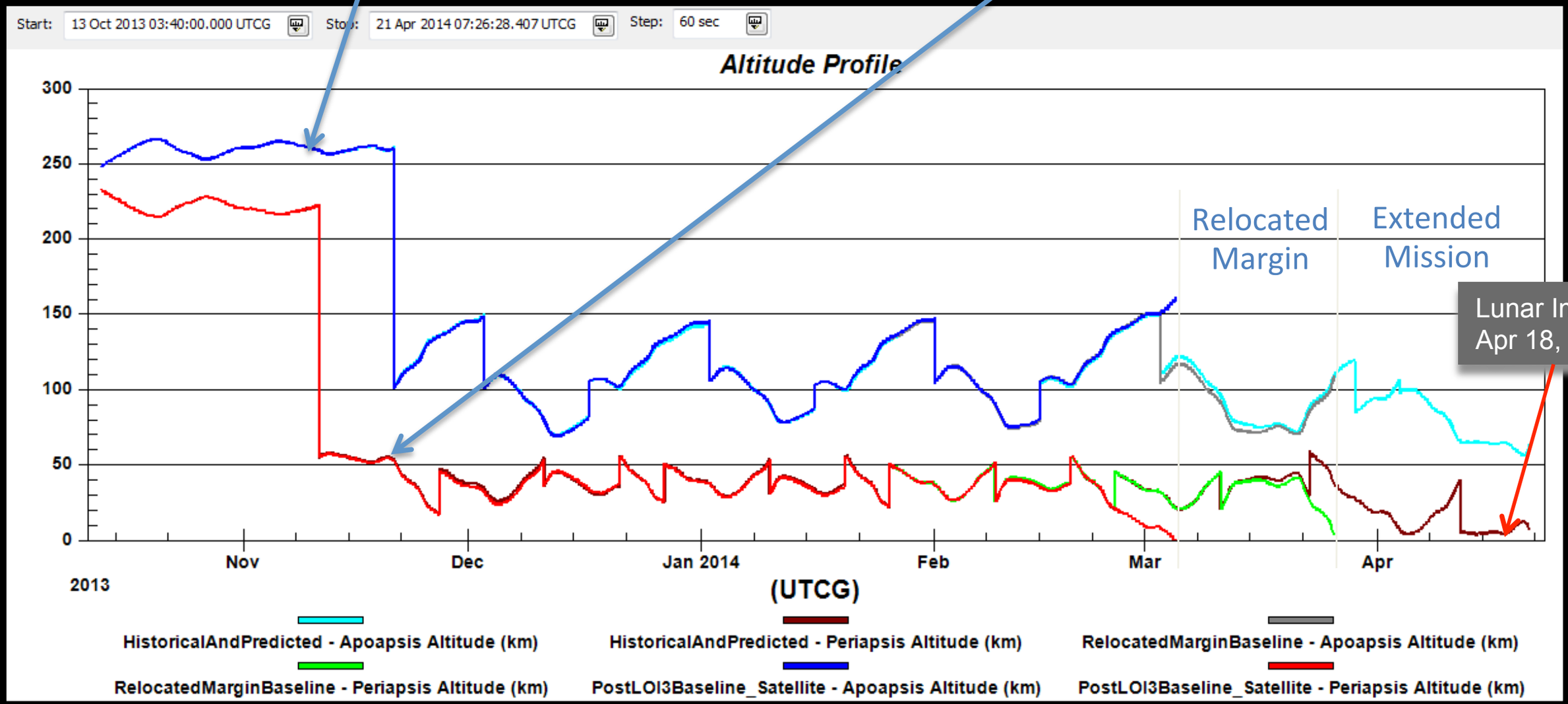
1) Mission
2) LDEX instrument
3) Science results
   a) permanently present dust exosphere
   b) no evidence for lofted dust over the terminators
   c) large electrostatic dust charges

LADEE's Science Orbit

LADEE's apoapsis

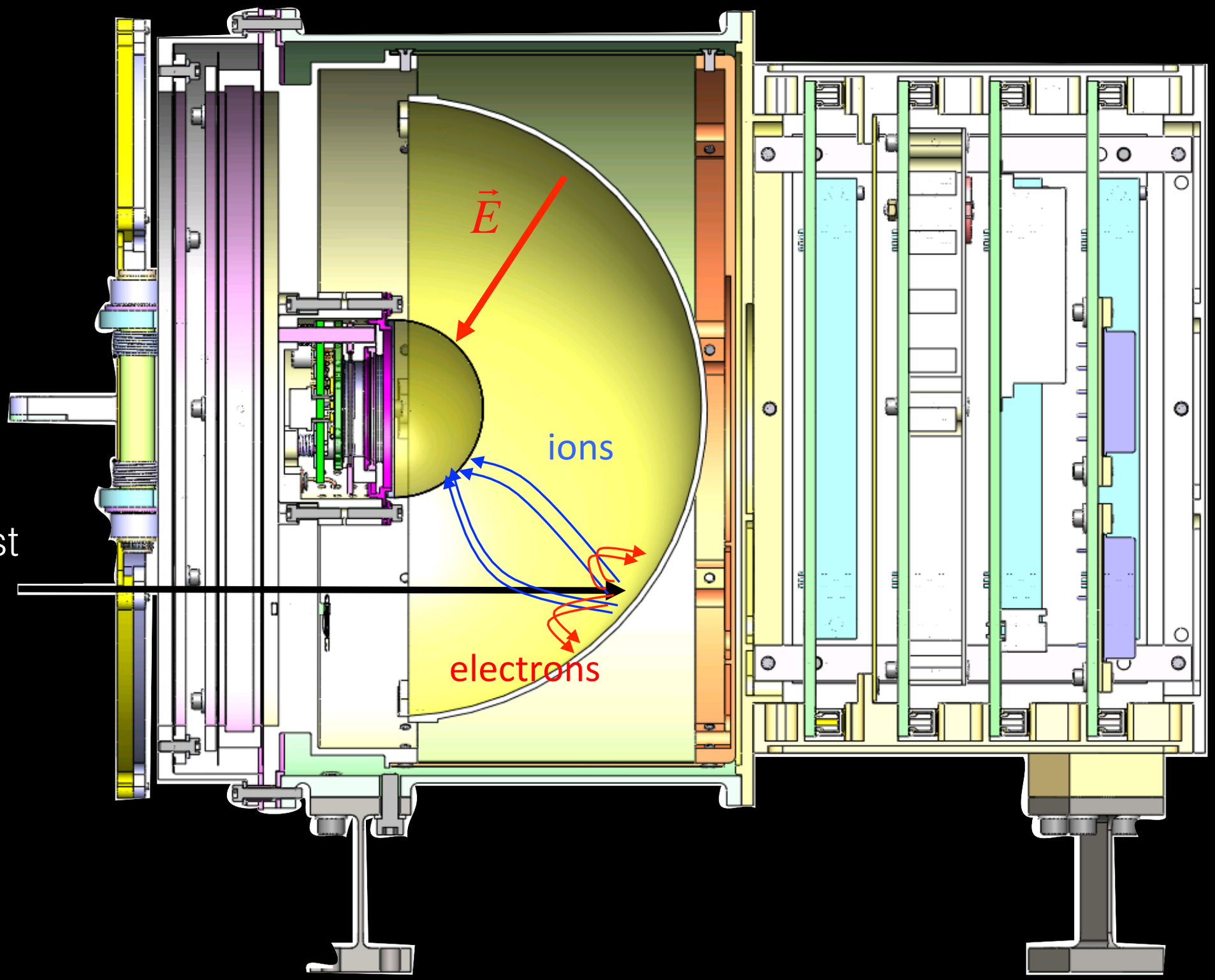
LADEE's periapsis

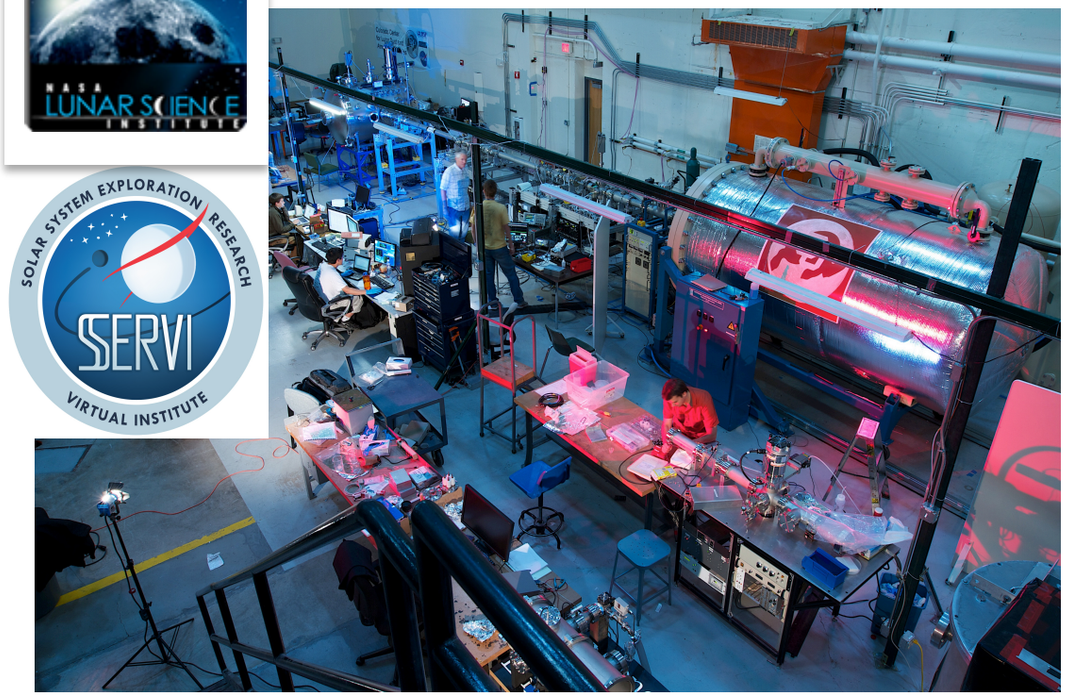


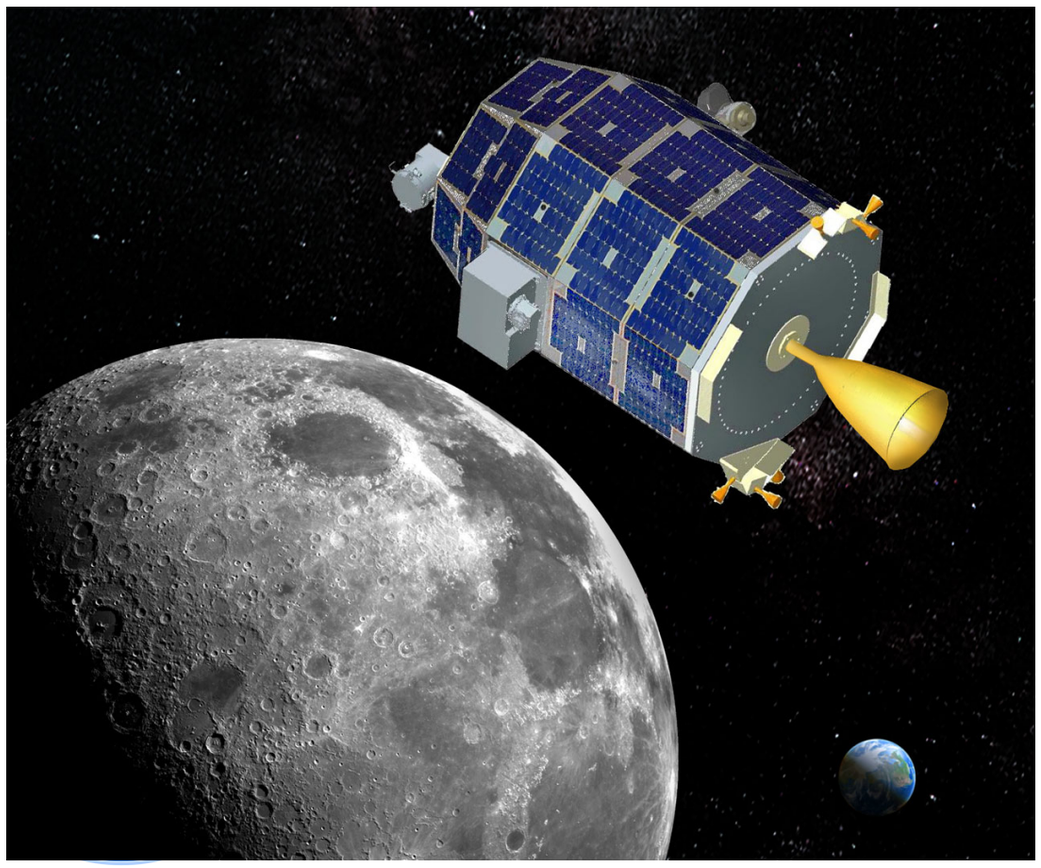
62 more days

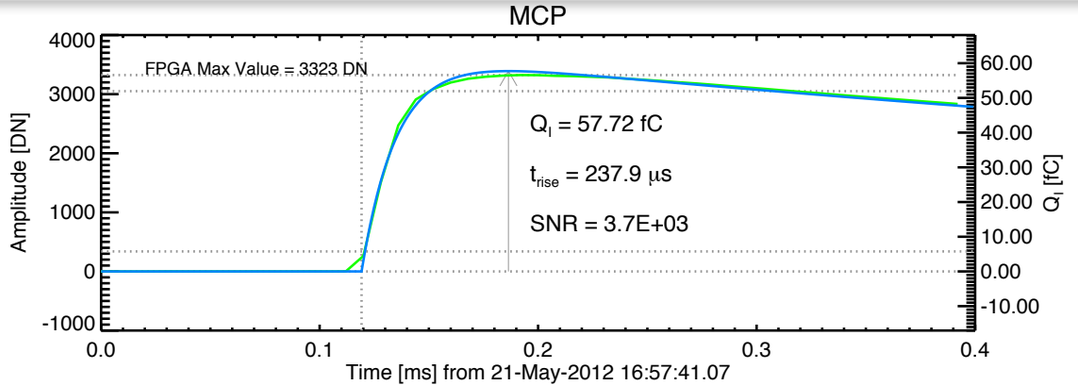
NASA Ames Research Center
NASA Goddard Space Flight Center

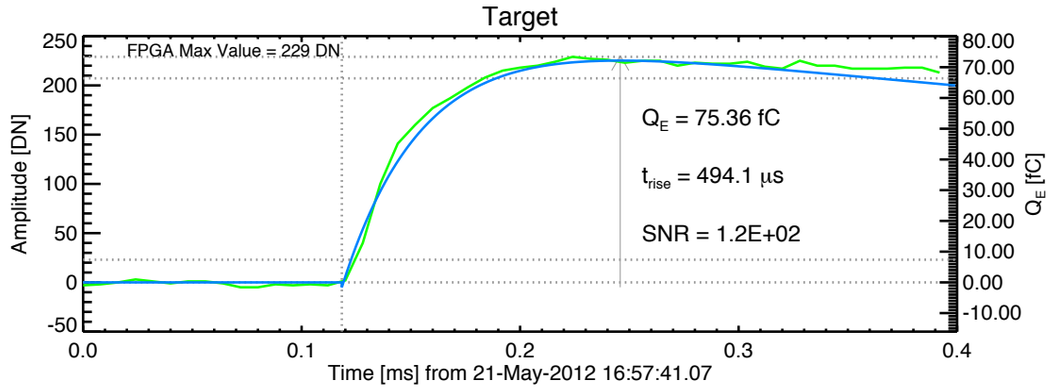
LDEX

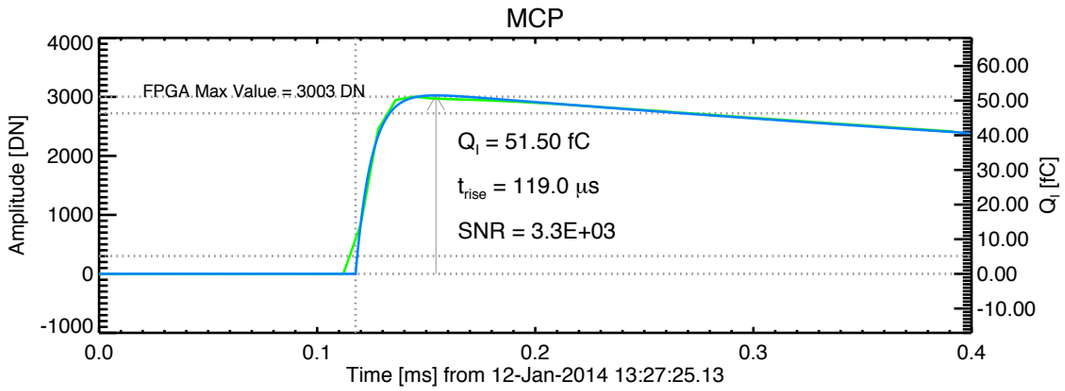


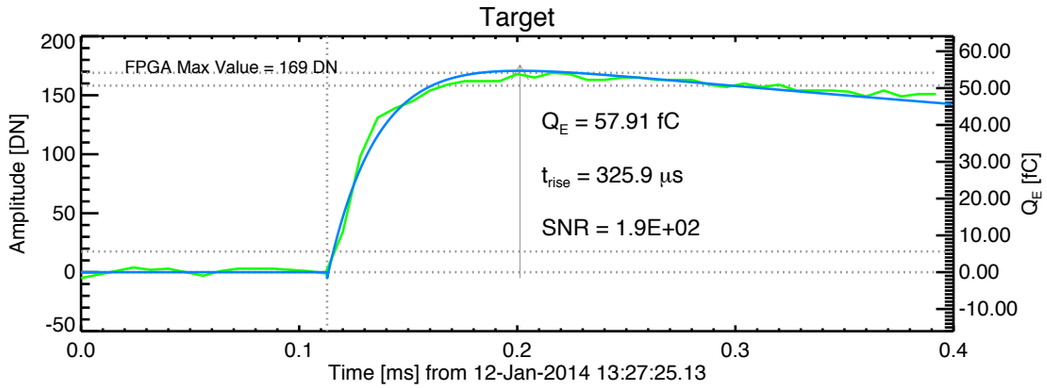




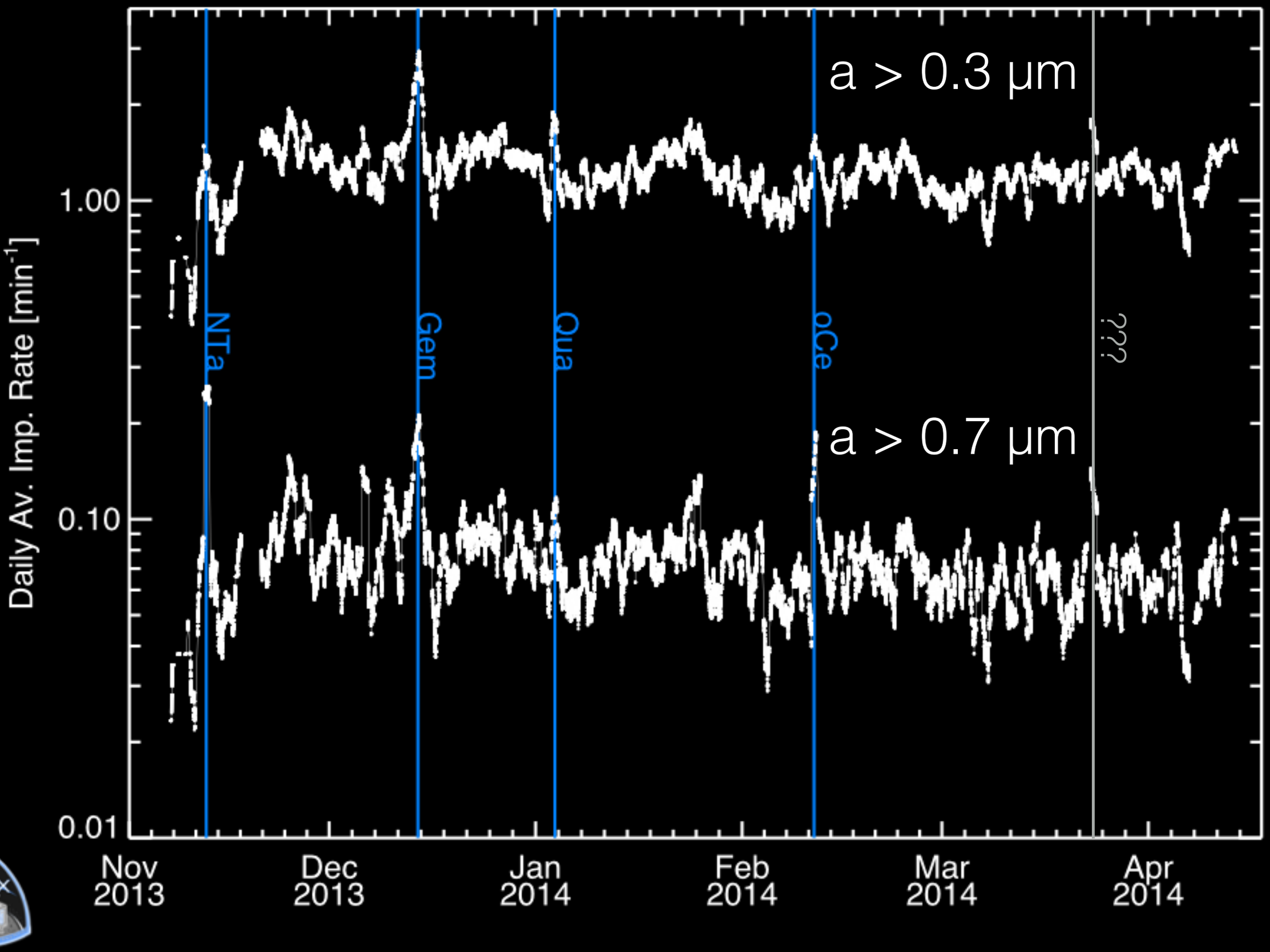

MCP
FPGA Max Value = 3323 DN
Q_I = 57.72 fC
t_{rise} = 237.9 μs
SNR = 3.7E+03
Amplitude [DN]
Q_I [fC]
Time [ms] from 21-May-2012 16:57:41.07


Target
FPGA Max Value = 229 DN
Q_E = 75.36 fC
t_{rise} = 494.1 μs
SNR = 1.2E+02
Amplitude [DN]
Q_E [fC]
Time [ms] from 21-May-2012 16:57:41.07

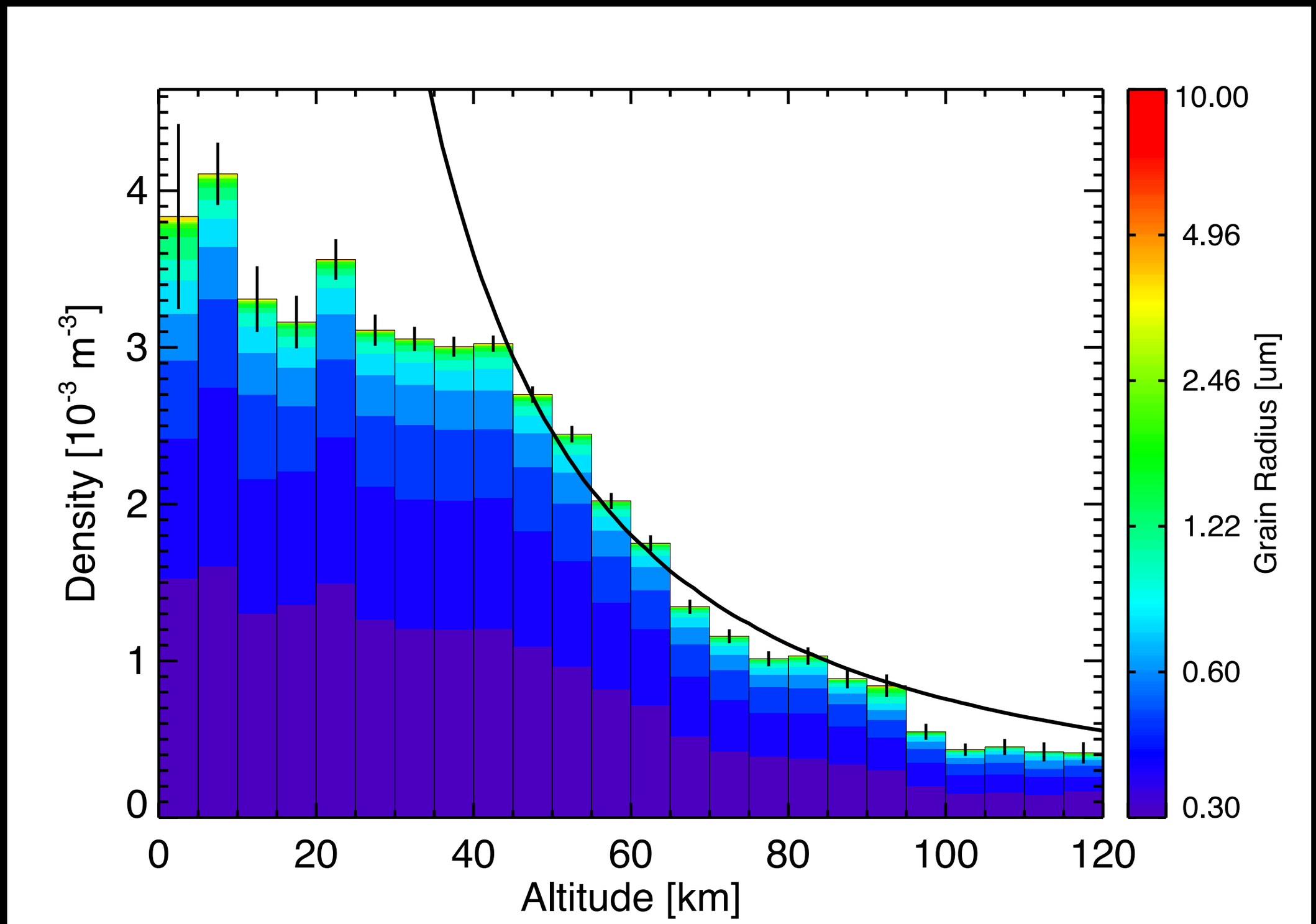

MCP
FPGA Max Value = 3003 DN
Q_I = 51.50 fC
t_{rise} = 119.0 μs
SNR = 3.3E+03
Amplitude [DN]
Q_I [fC]
Time [ms] from 12-Jan-2014 13:27:25.13


Target
FPGA Max Value = 169 DN
Q_E = 57.91 fC
t_{rise} = 325.9 μs
SNR = 1.9E+02
Amplitude [DN]
Q_E [fC]
Time [ms] from 12-Jan-2014 13:27:25.13

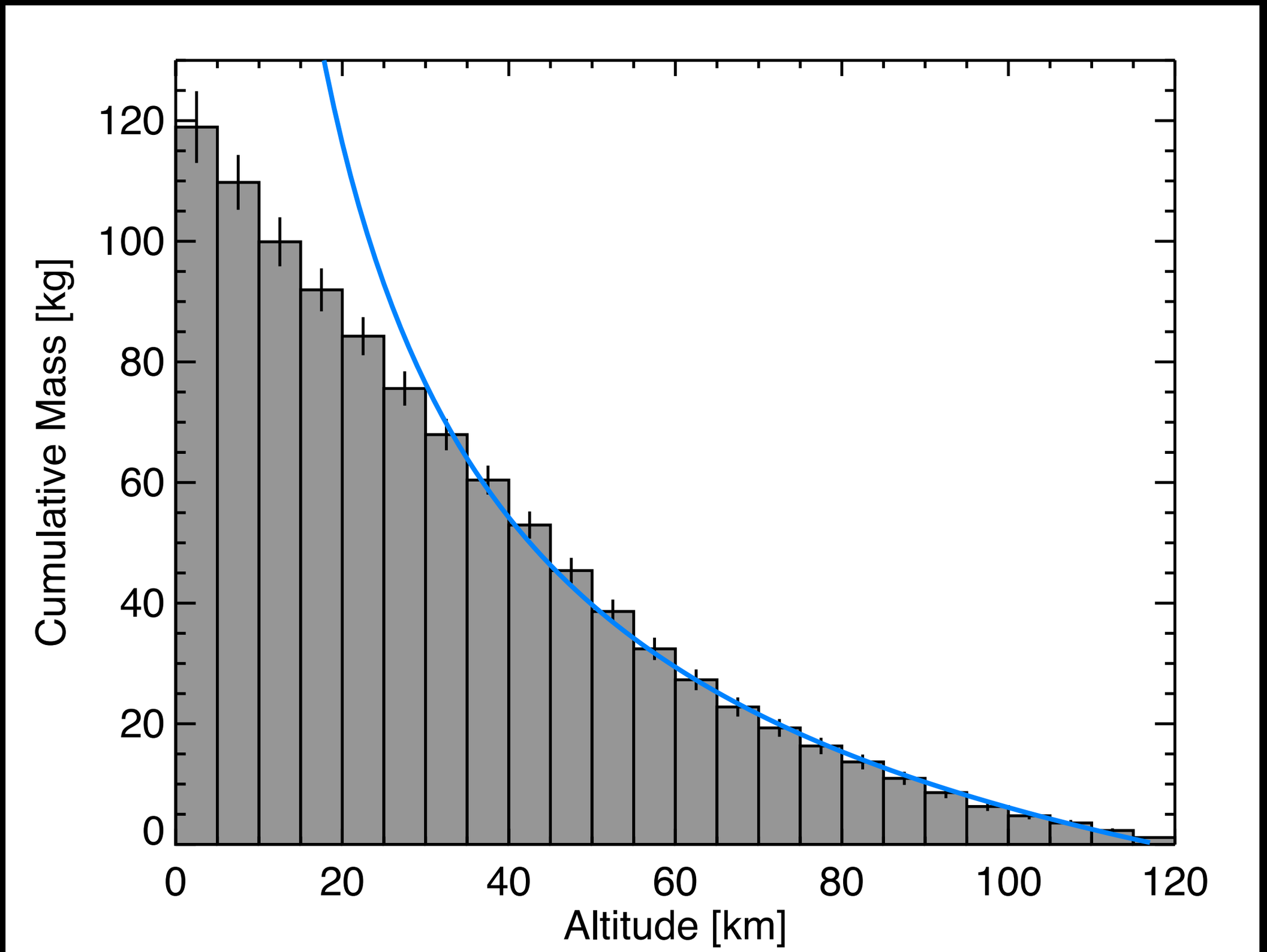
Impact Rate


a > 0.3 µm
a > 0.7 µm
Daily Av. Imp. Rate [min^{-1}]
1.00
0.10
0.01
NTa
Gem
Qua
oCe
¿¿¿
Nov 2013
Dec 2013
Jan 2014
Feb 2014
Mar 2014
Apr 2014

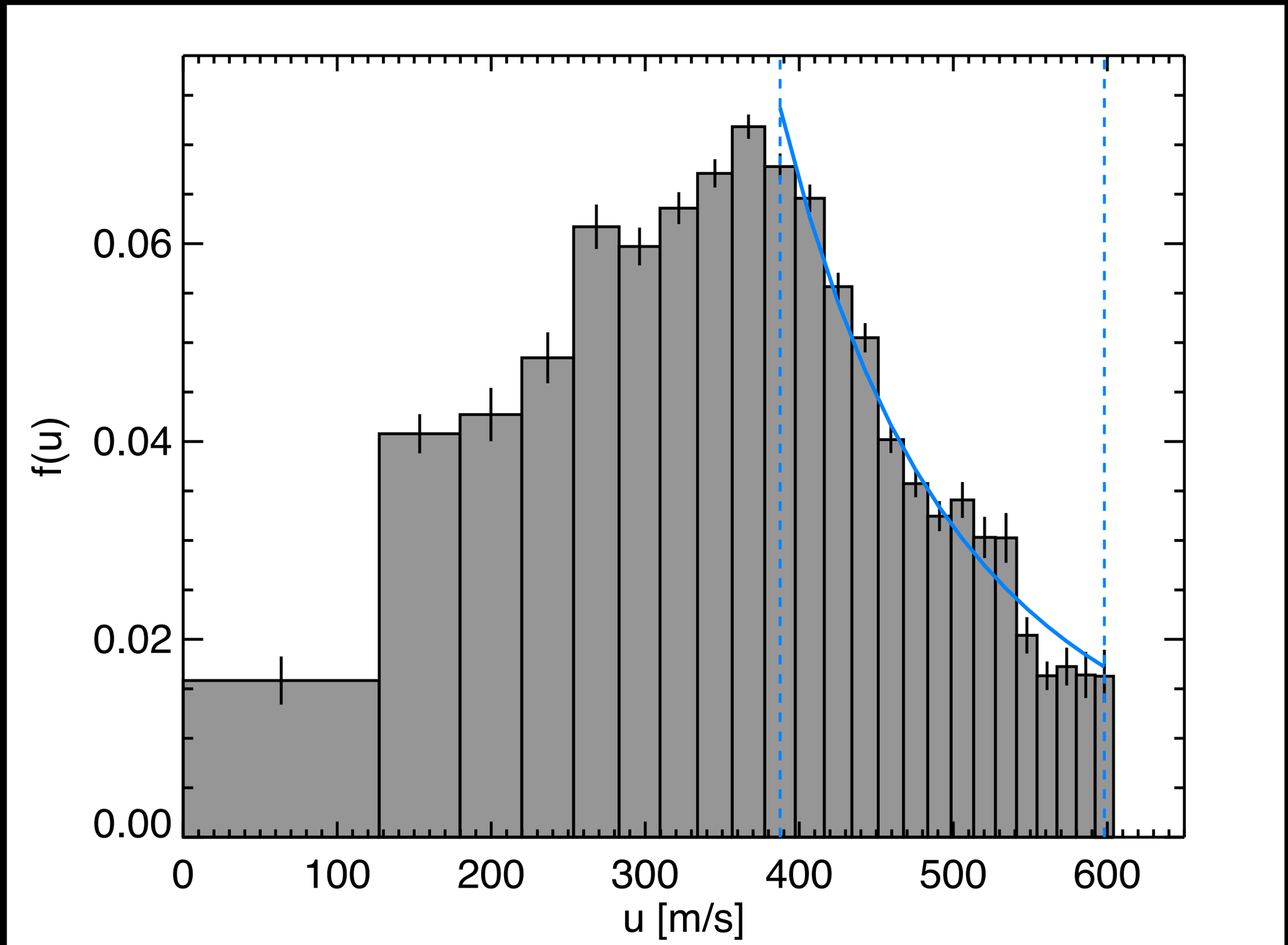
DENSITY


Density [10^-3 m^-3]
0
1
2
3
4
0
20
40
60
80
100
120
Altitude [km]
10.00
4.96
2.46
1.22
0.60
0.30
Grain Radius [um]

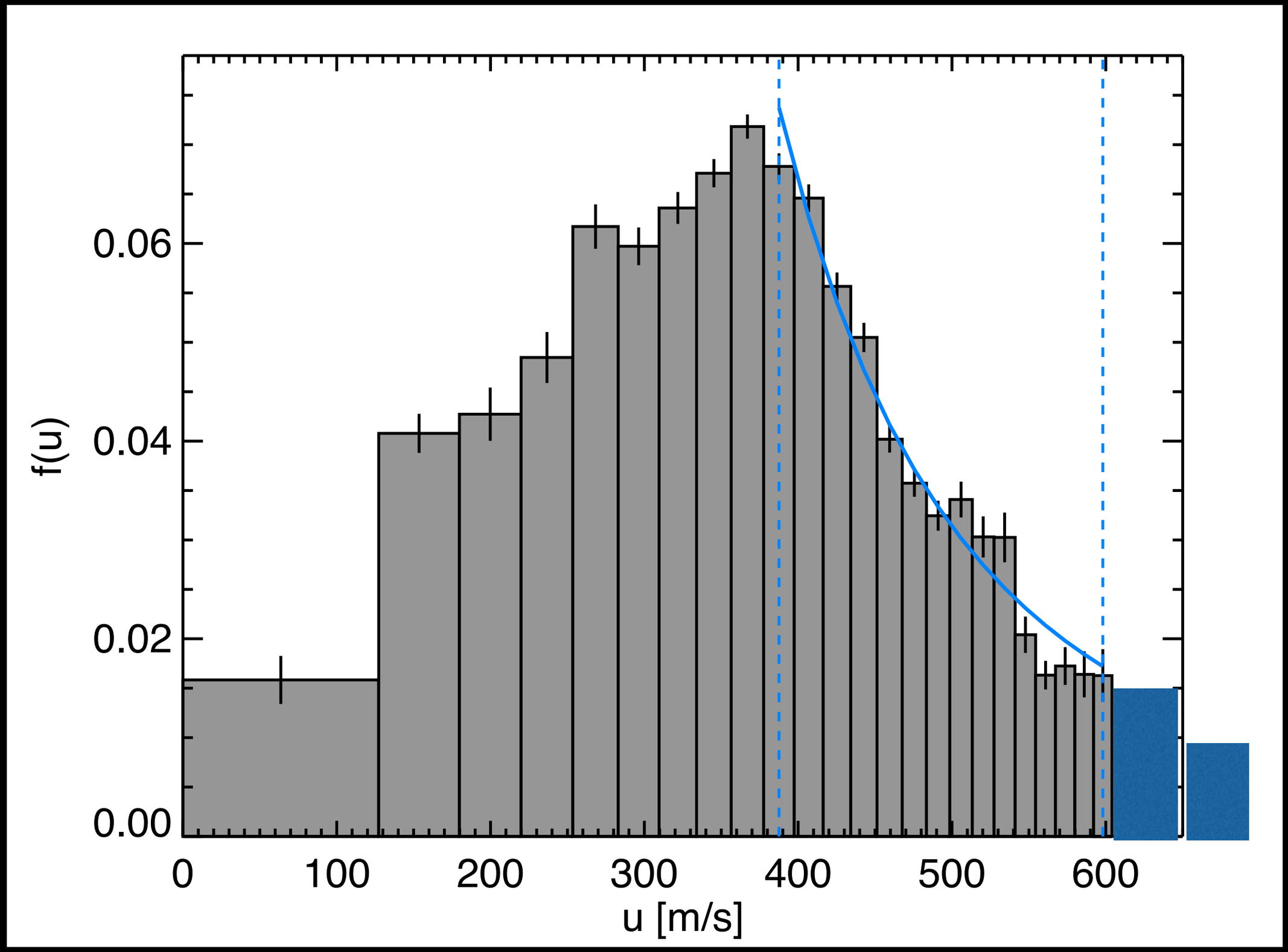
MASS


Cumulative Mass [kg]
0
20
40
60
80
100
120
Altitude [km]
0
20
40
60
80
100
120

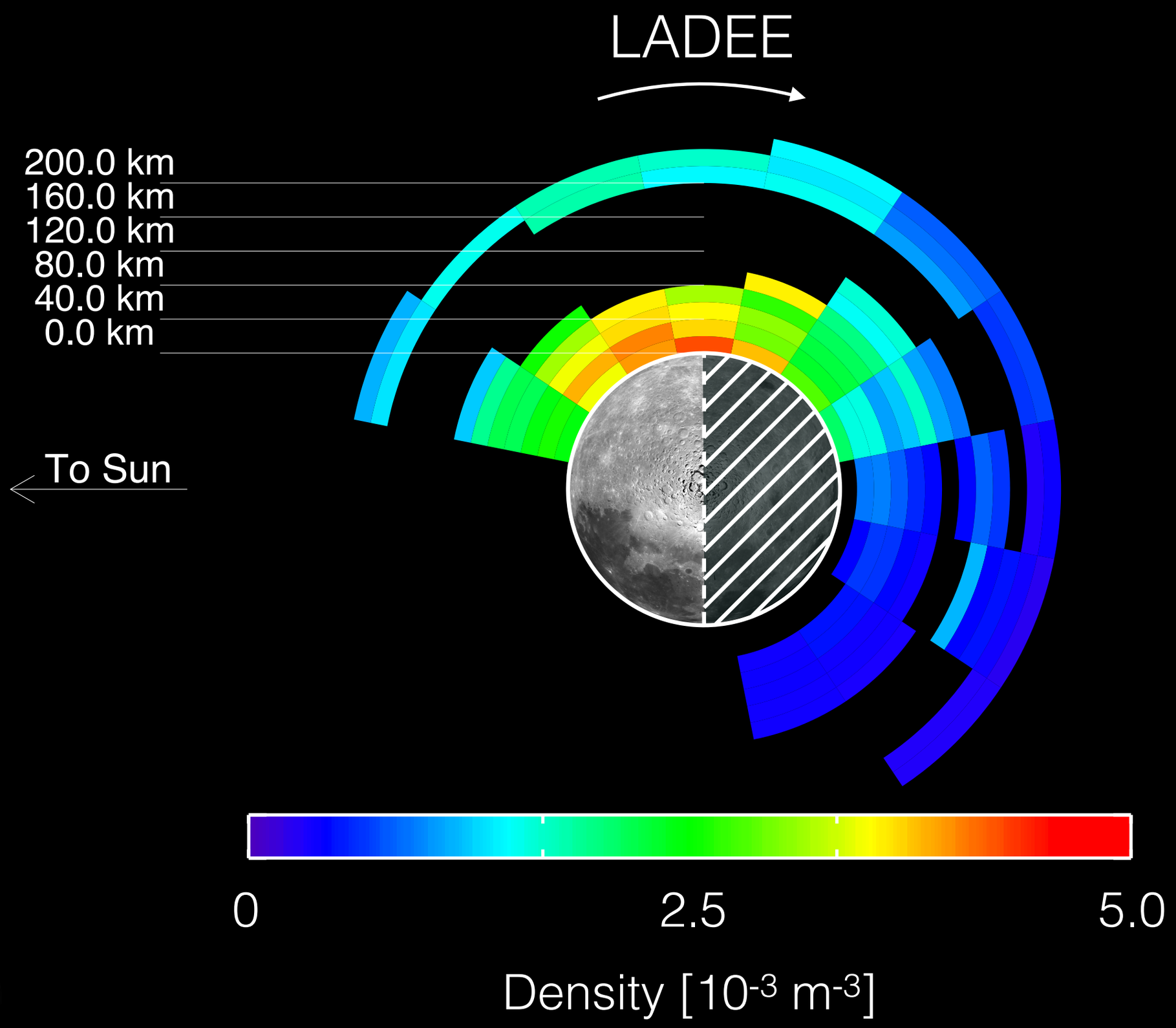
INITIAL SPEED



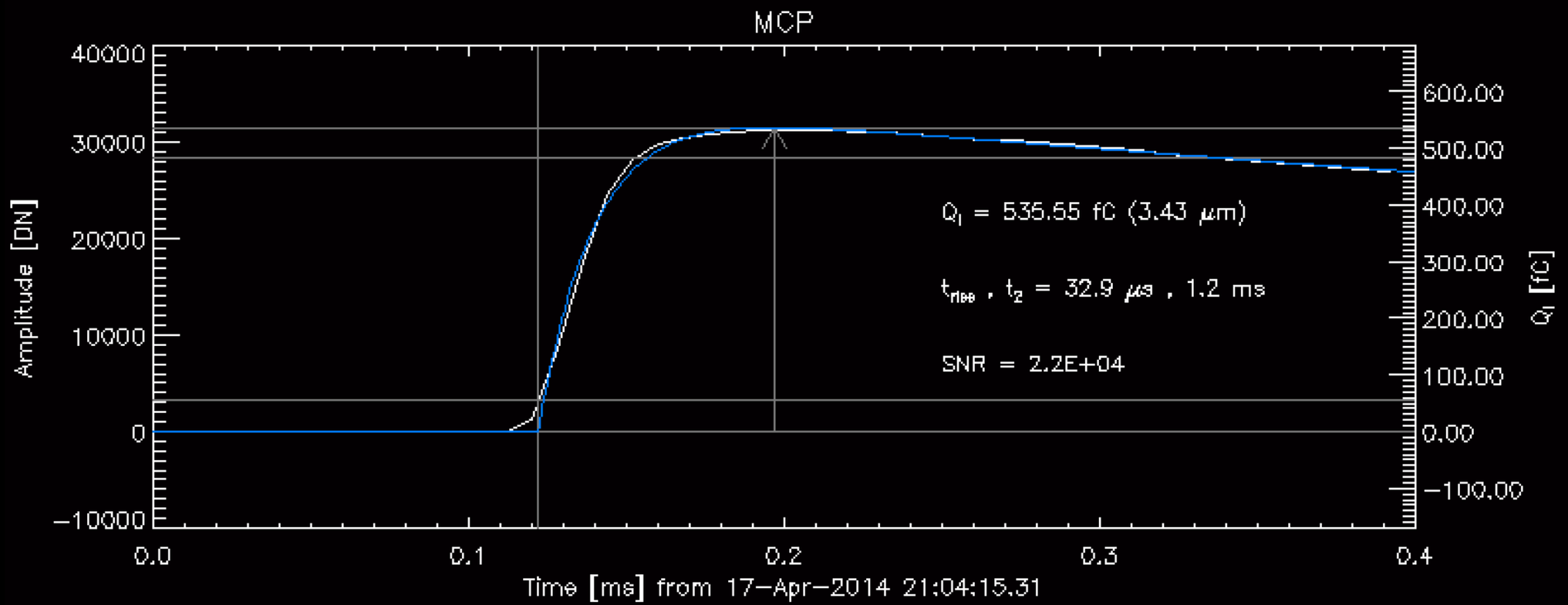
INITIAL SPEED



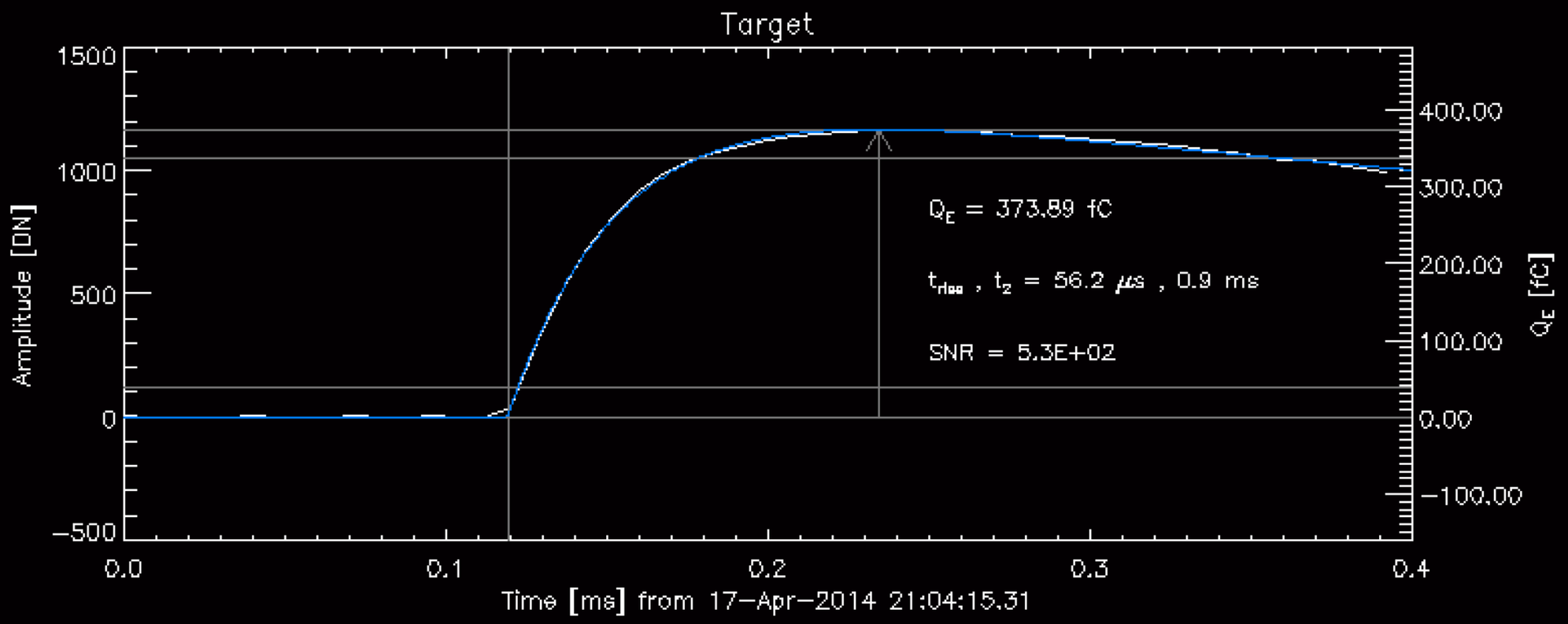
Density (a > 0.3 μm)



Charge Detection

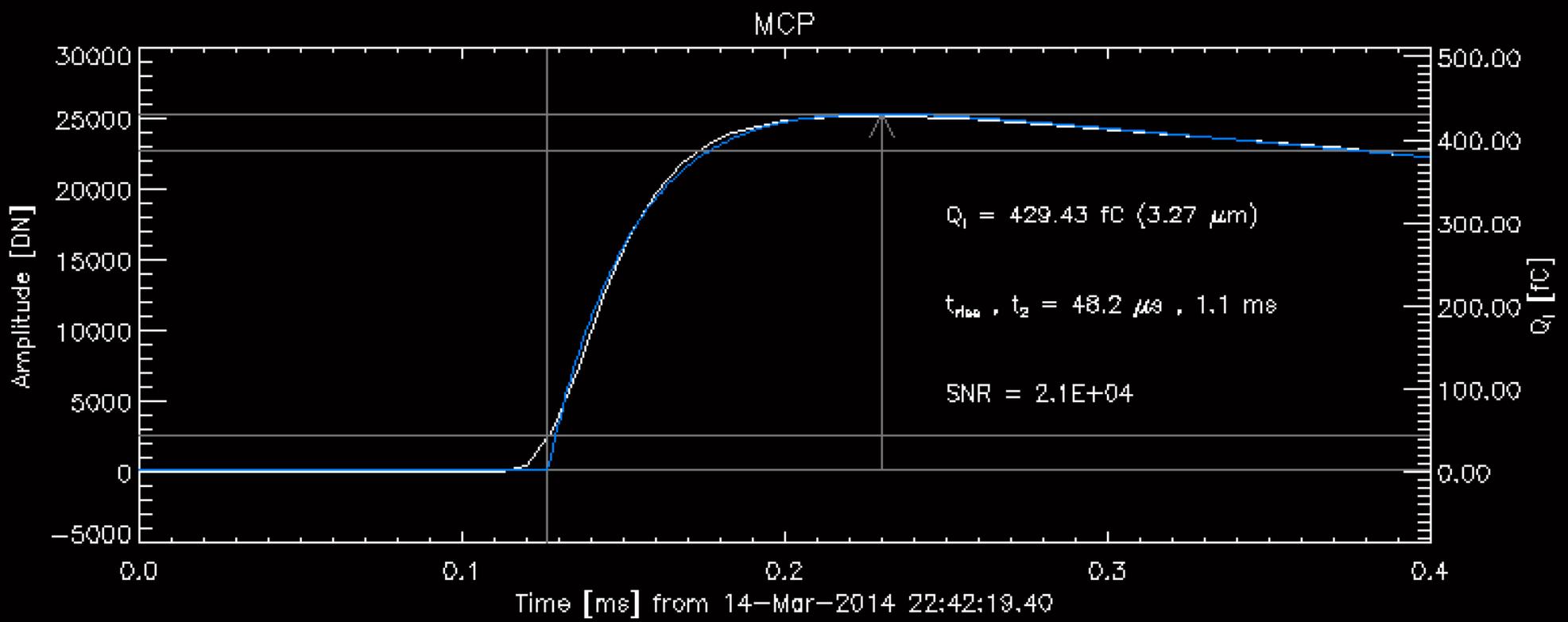


Quality: 1 2 3 4 5

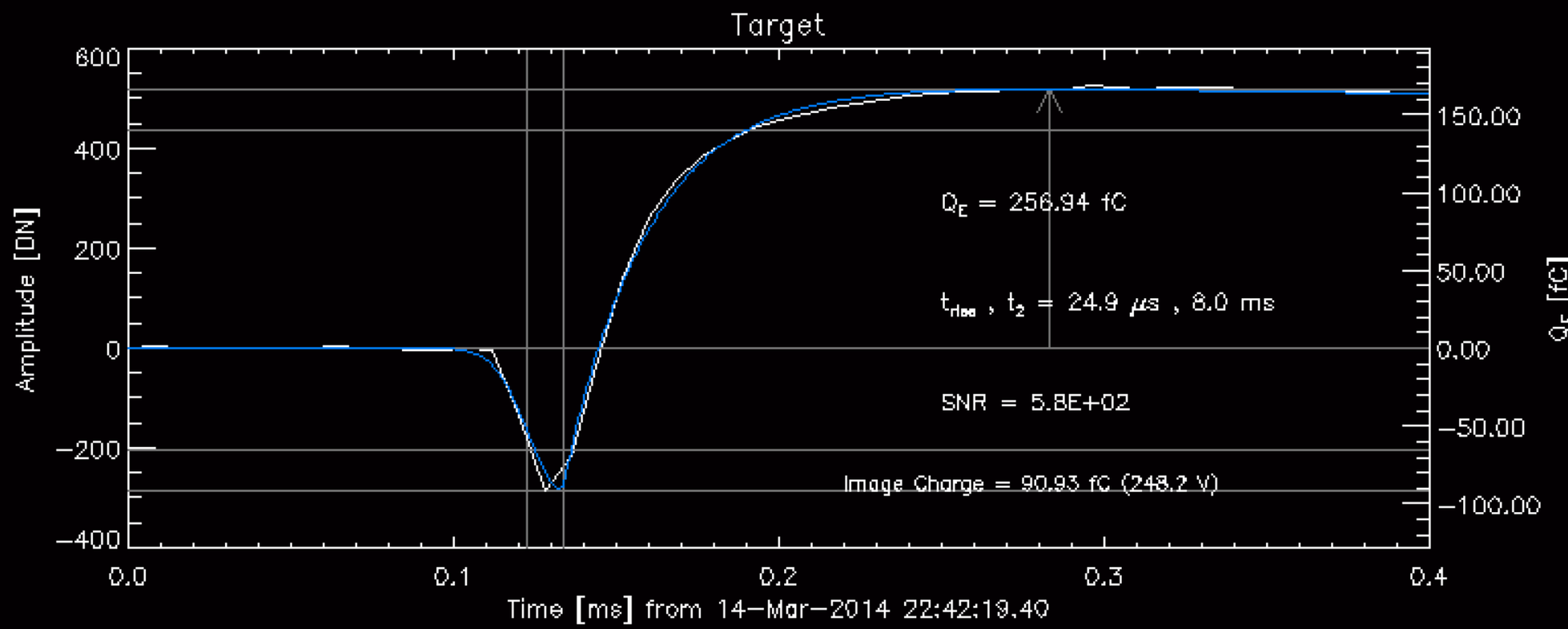


1 fC ~ 6000 e

Charge Detection



Quality: 1 2 3 4 5



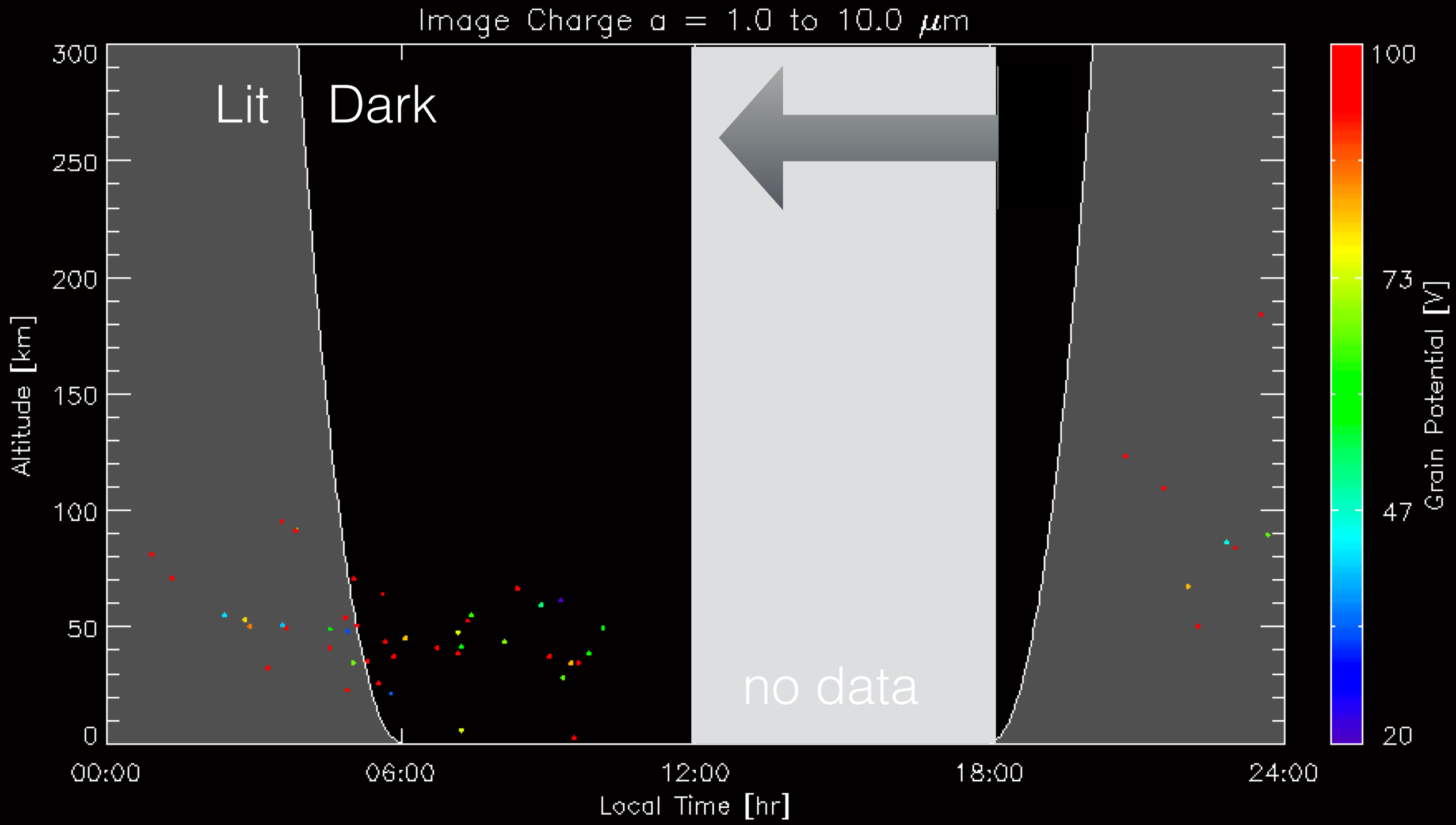
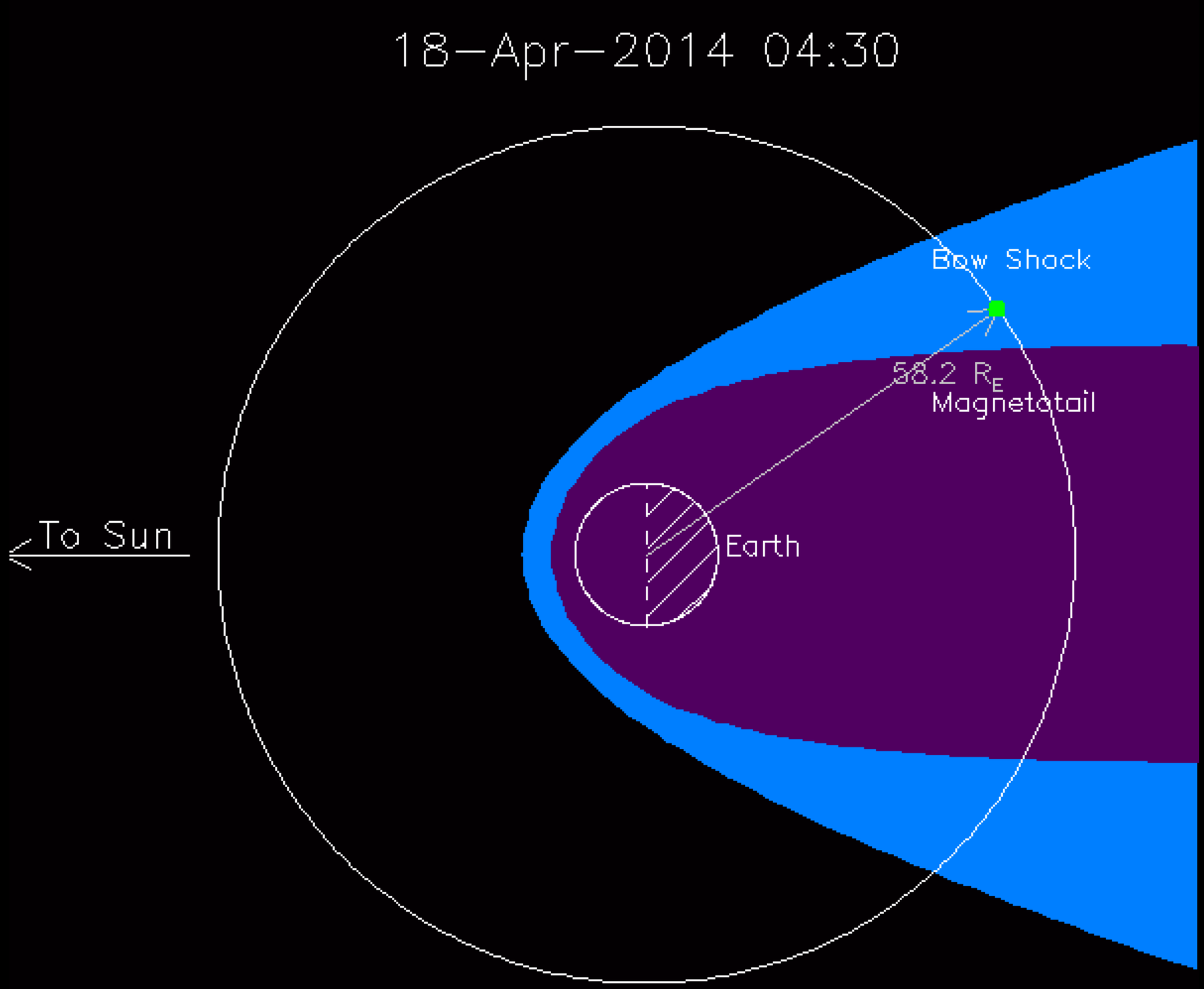
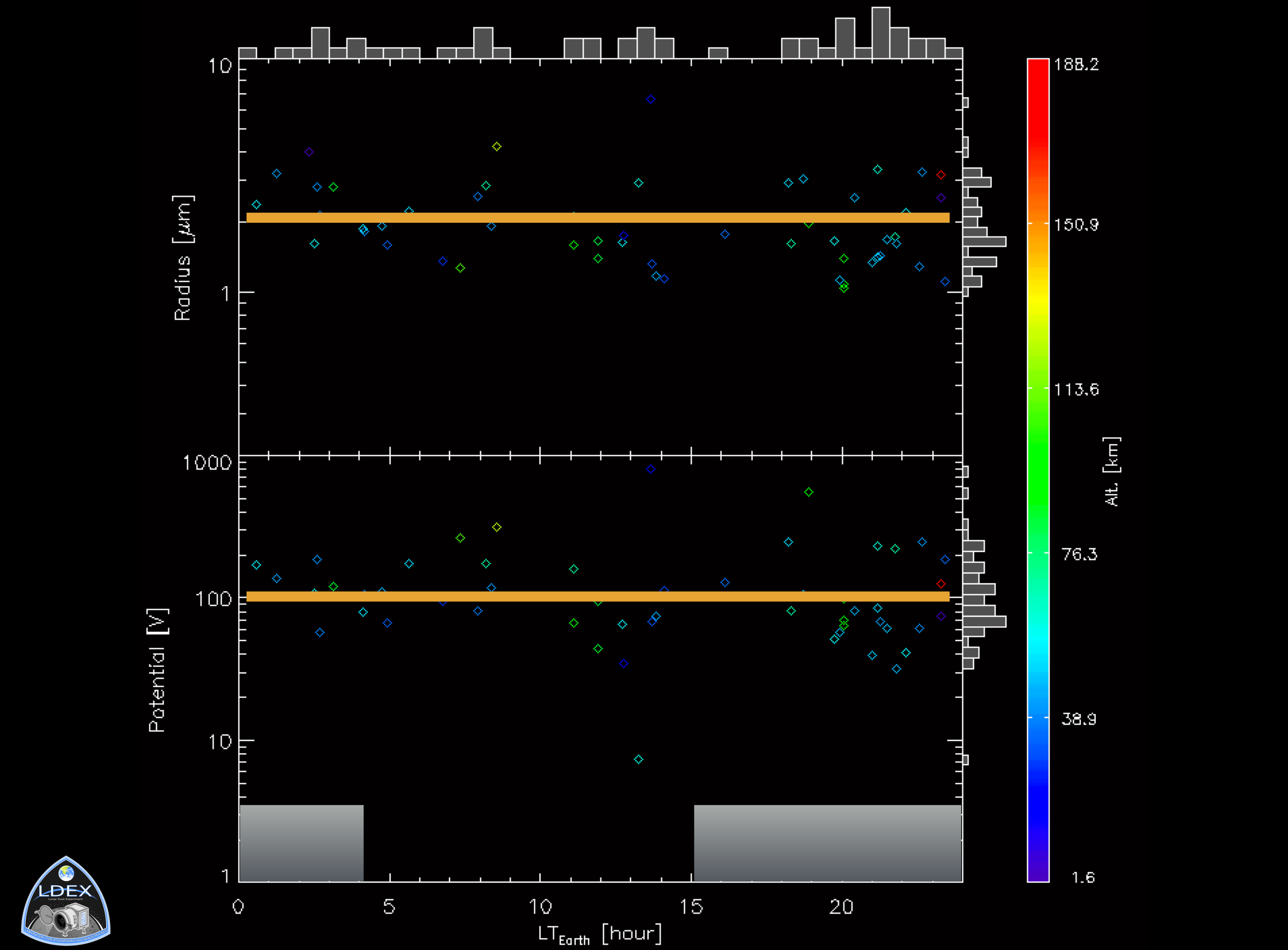


Image Charge a = 1.0 to 10.0 μm
Lit
Dark
no data
Altitude [km]
300
250
200
150
100
50
0
00:00
06:00
12:00
18:00
24:00
Local Time [hr]
100
73
47
20
Grain Potential [V]

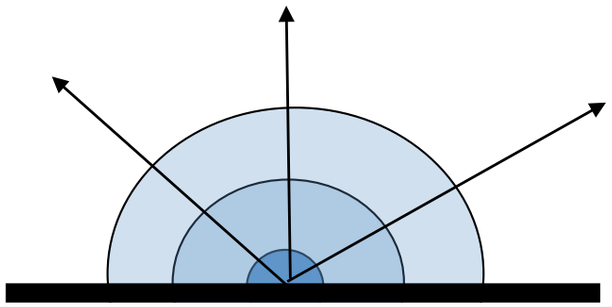
UV exposure



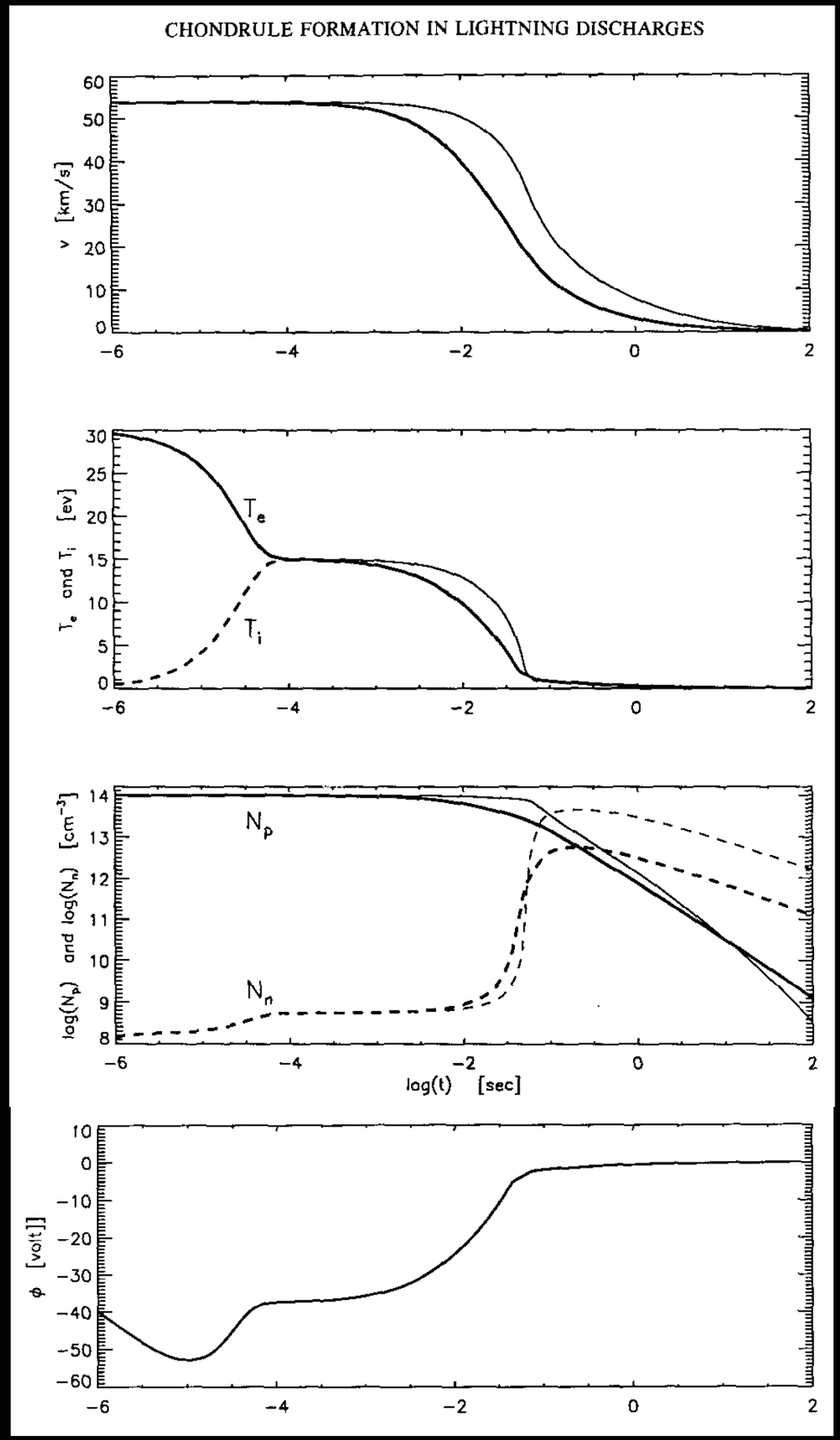
Plasma environment


Radius [μm]
10
1
1000
Potential [V]
100
10
1
0
5
10
15
20
LT Earth [hour]
188.2
150.9
113.6
76.3
38.9
1.6
Alt. [km]
LDEX
Lunar Dust Experiment

Initial plasma density ~ $\frac{Q}{m} \sim 10^{16}$



Charging

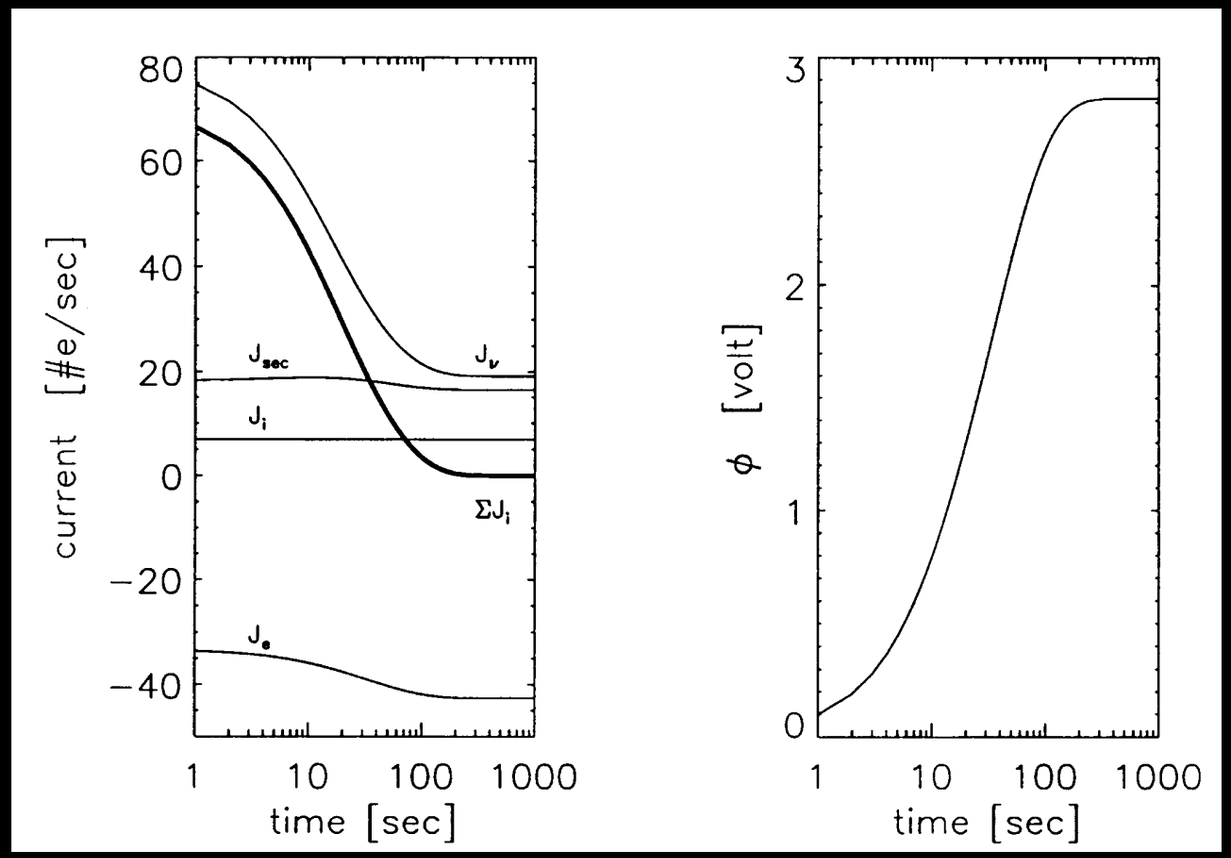


V

T

N

ϕ_{Dust}



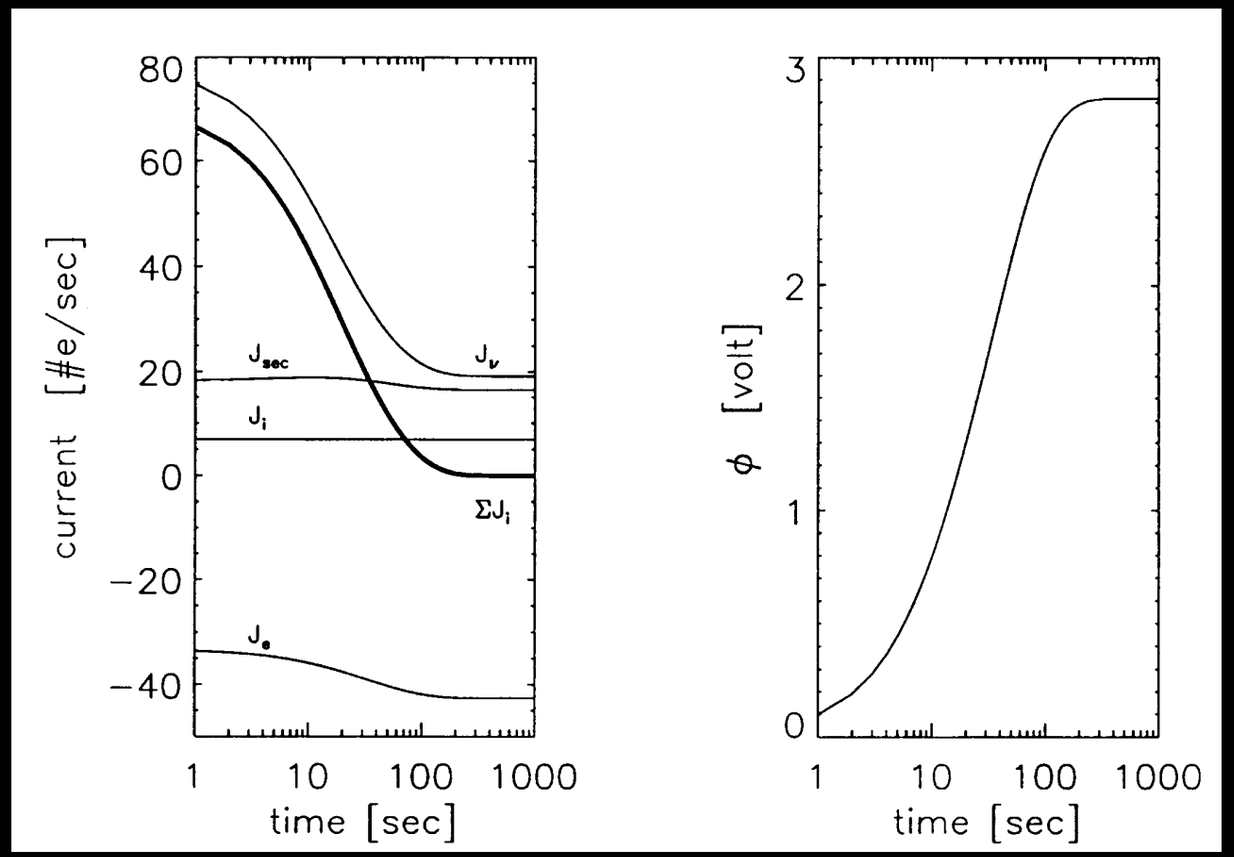
Discharging

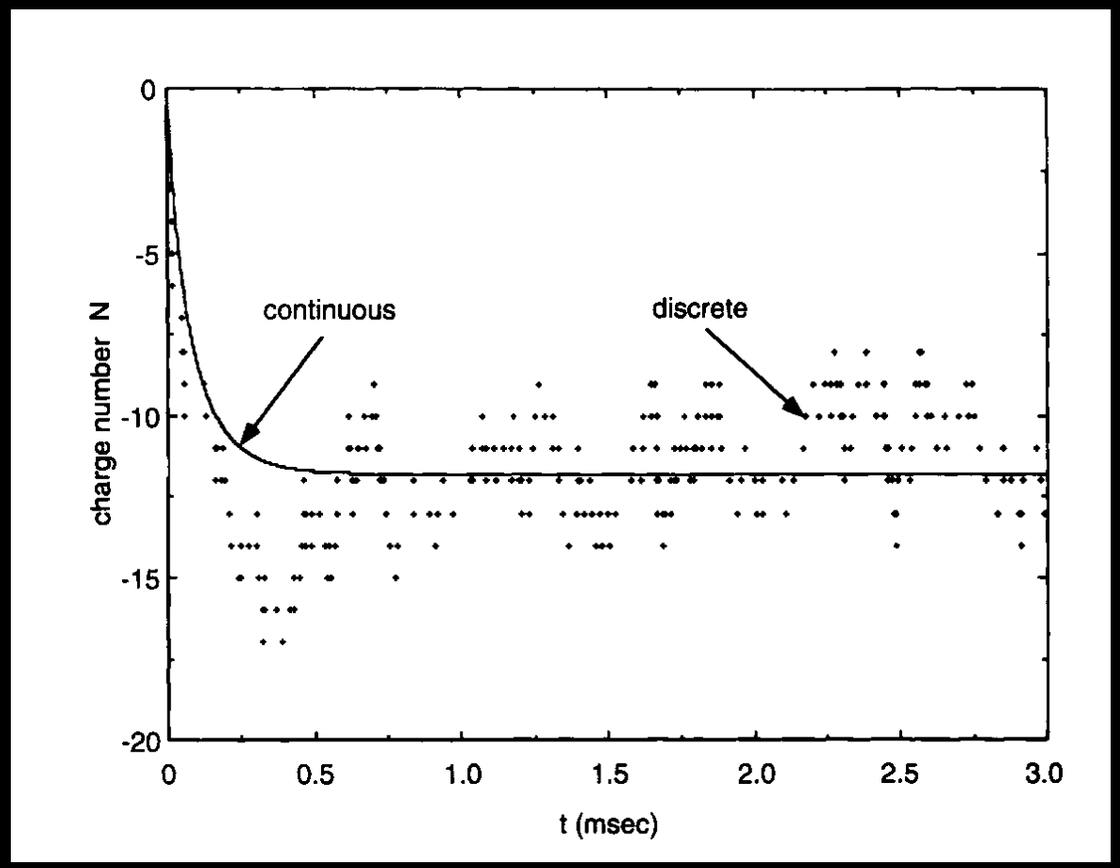
1 micron @ 1 AU

Discharge time: Q/J_e ~ 200 s vs Rise time = $(2 h/g)^{1/2}$ ~200 s

$J_e = J_{e0} (1 + eV/kT)$ ~300 e/s

Q = 100 x 700 e





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$J_e = J_{e0} (1 + eV/kT)$ ~300 e/s

Q = 100 x 700 e

SUMMARY

1) LDEX observed a permanently present asymmetric dust ejecta cloud engulfing the Moon

2) A small fraction (<0.1 %) of particles carried unusually large positive charges

3) Both the generation and the retention of large charges remain challenging, and perhaps due to a combination of conspiring stochastic events

4) Breakup and/or charging are good candidates