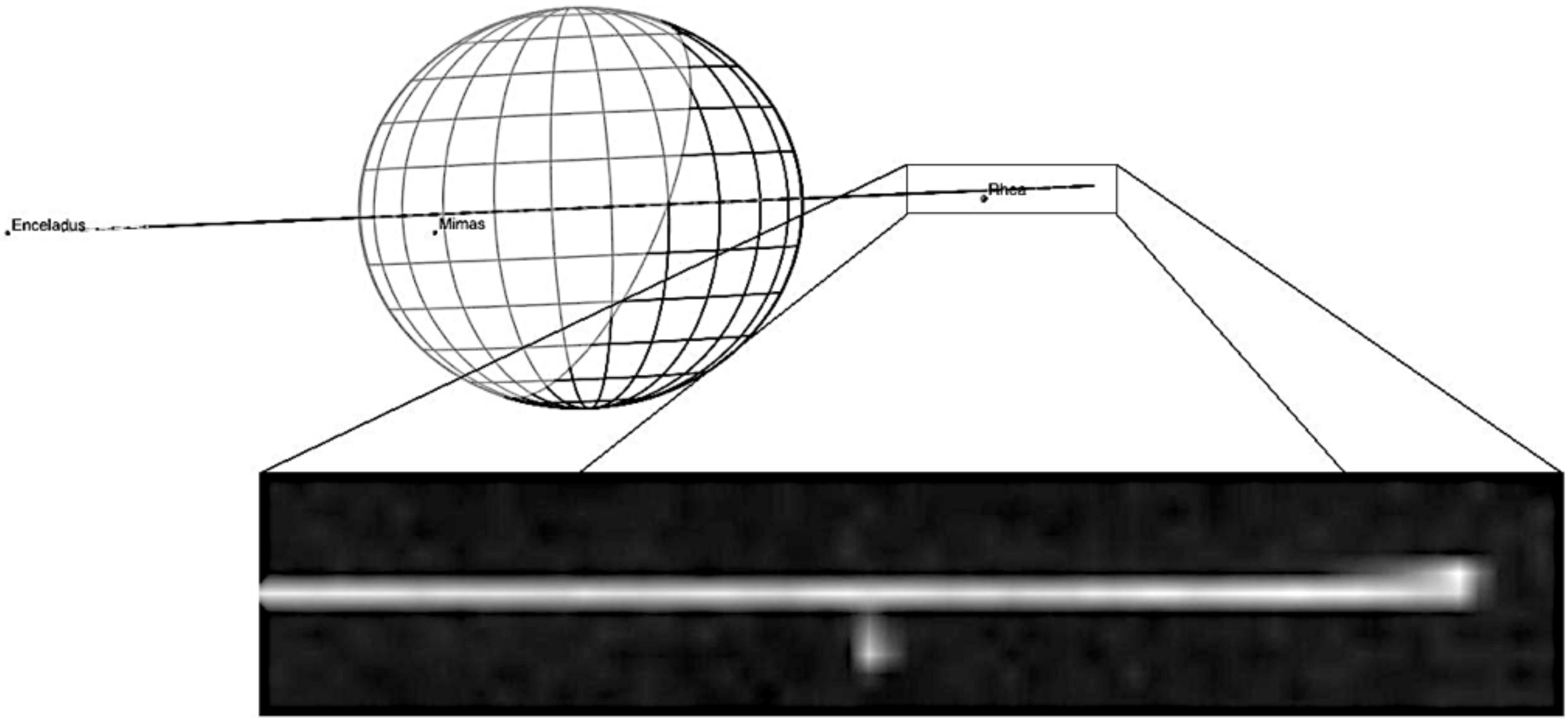
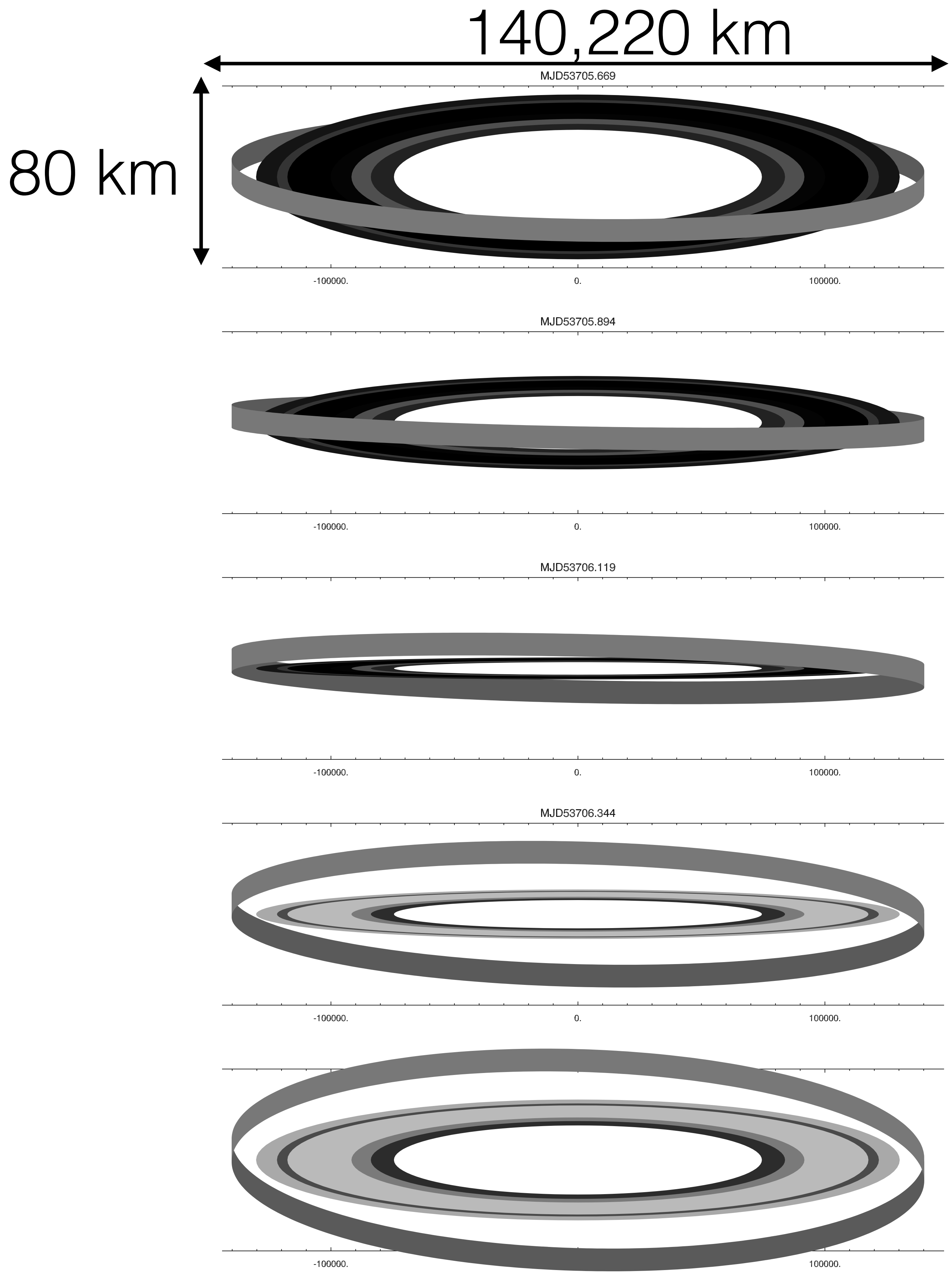
For there is nothing covered, that shall not be revealed;
neither hid, that shall not be known.
Therefore whatsoever ye have spoken in darkness
shall be heard in the light.
—Luke 2:12-13

Unveiling Saturn's F ring at ring-plane crossing

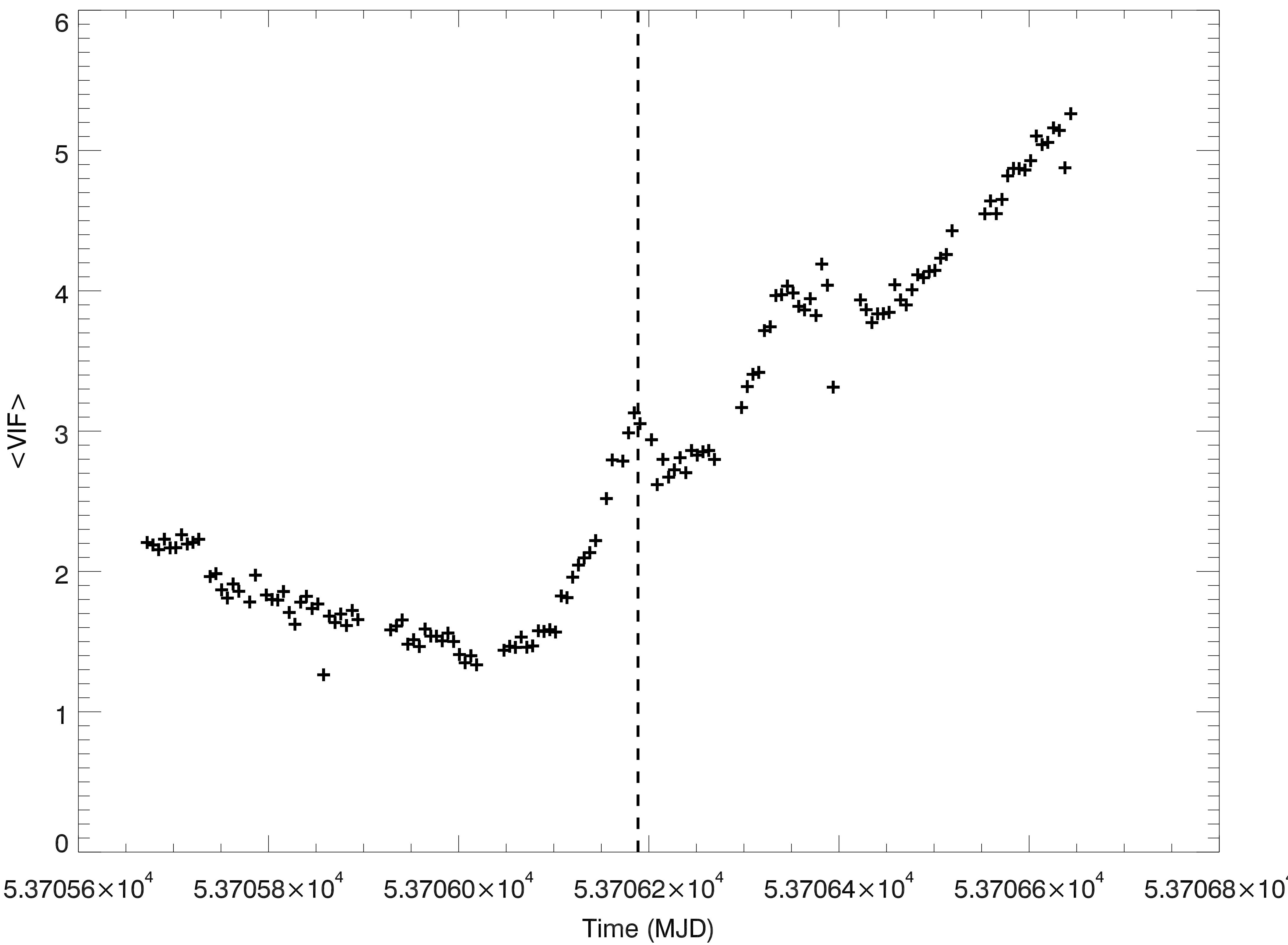
Britt Scharringhausen
Beloit Astronomy Research Group
Planetary Rings Workshop
August 15, 2014, Boulder, CO

VIMS Observation, Dec 1-2, 2005

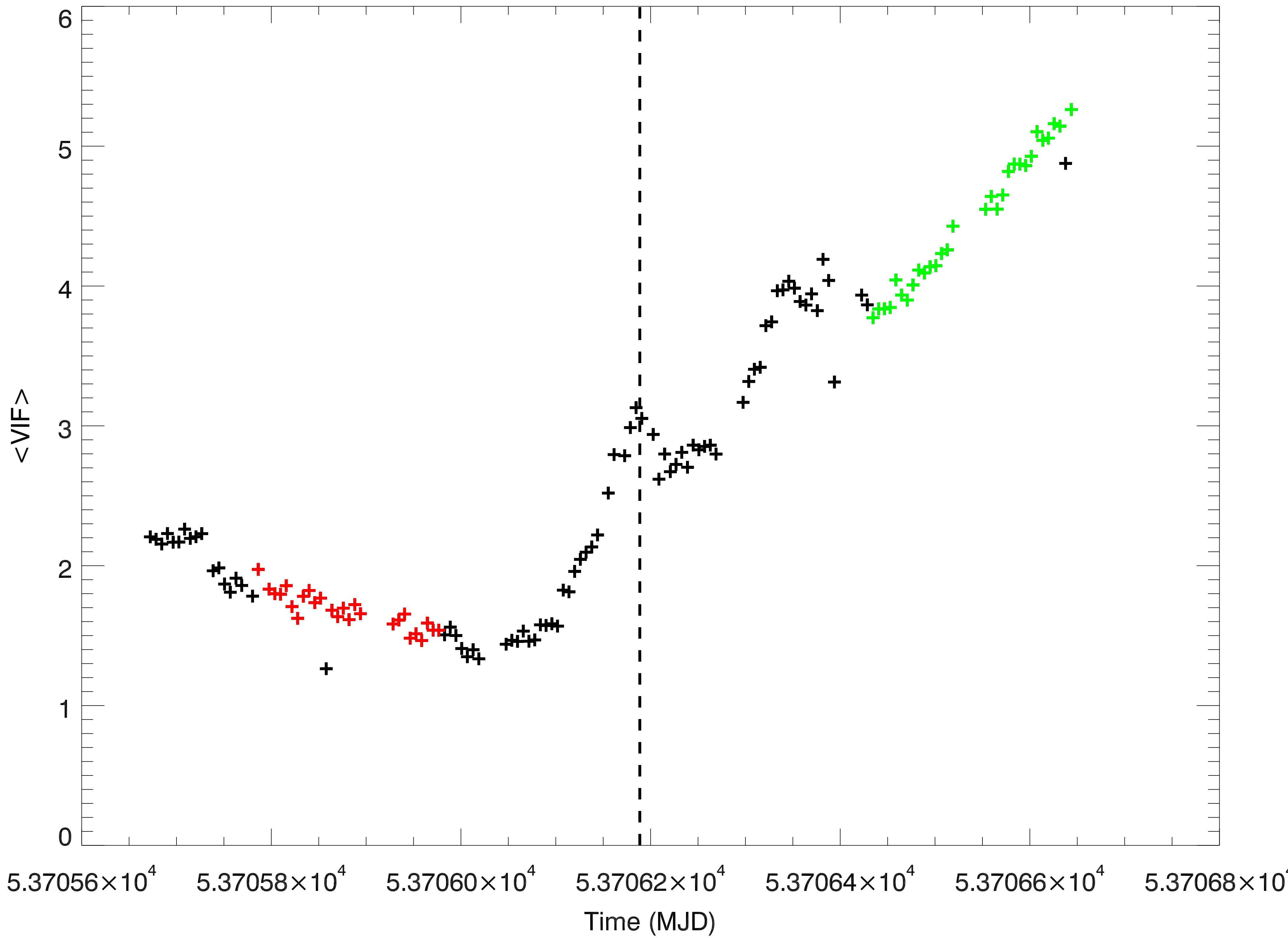



140,220 km
80 km
MJD53705.669
-100000.
0.
100000.
MJD53705.894
-100000.
0.
100000.
MJD53706.119
-100000.
0.
100000.
MJD53706.344
-100000.
0.
100000.
-100000.
100000.

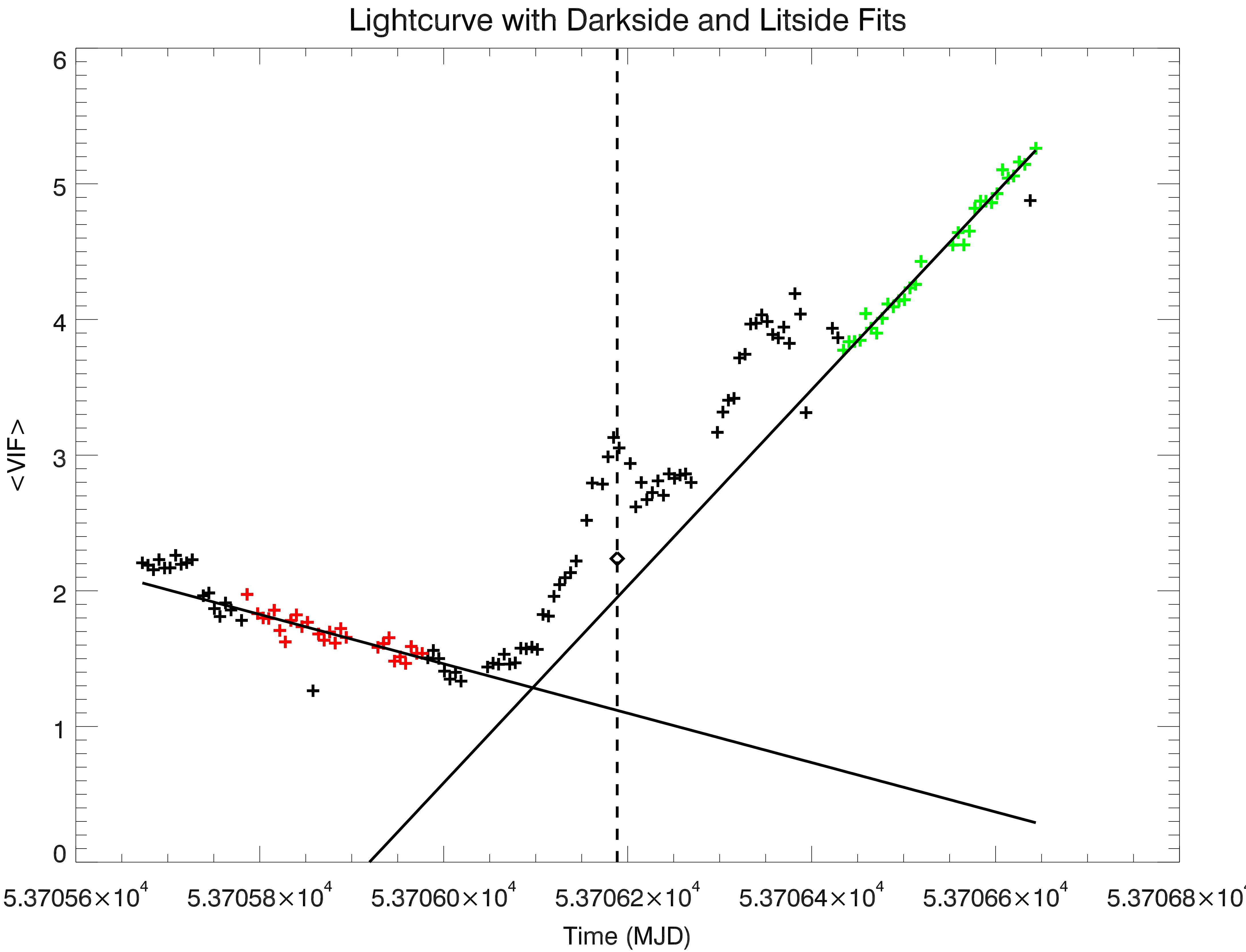
RPX Lightcurve, Dec 1-2, 2011

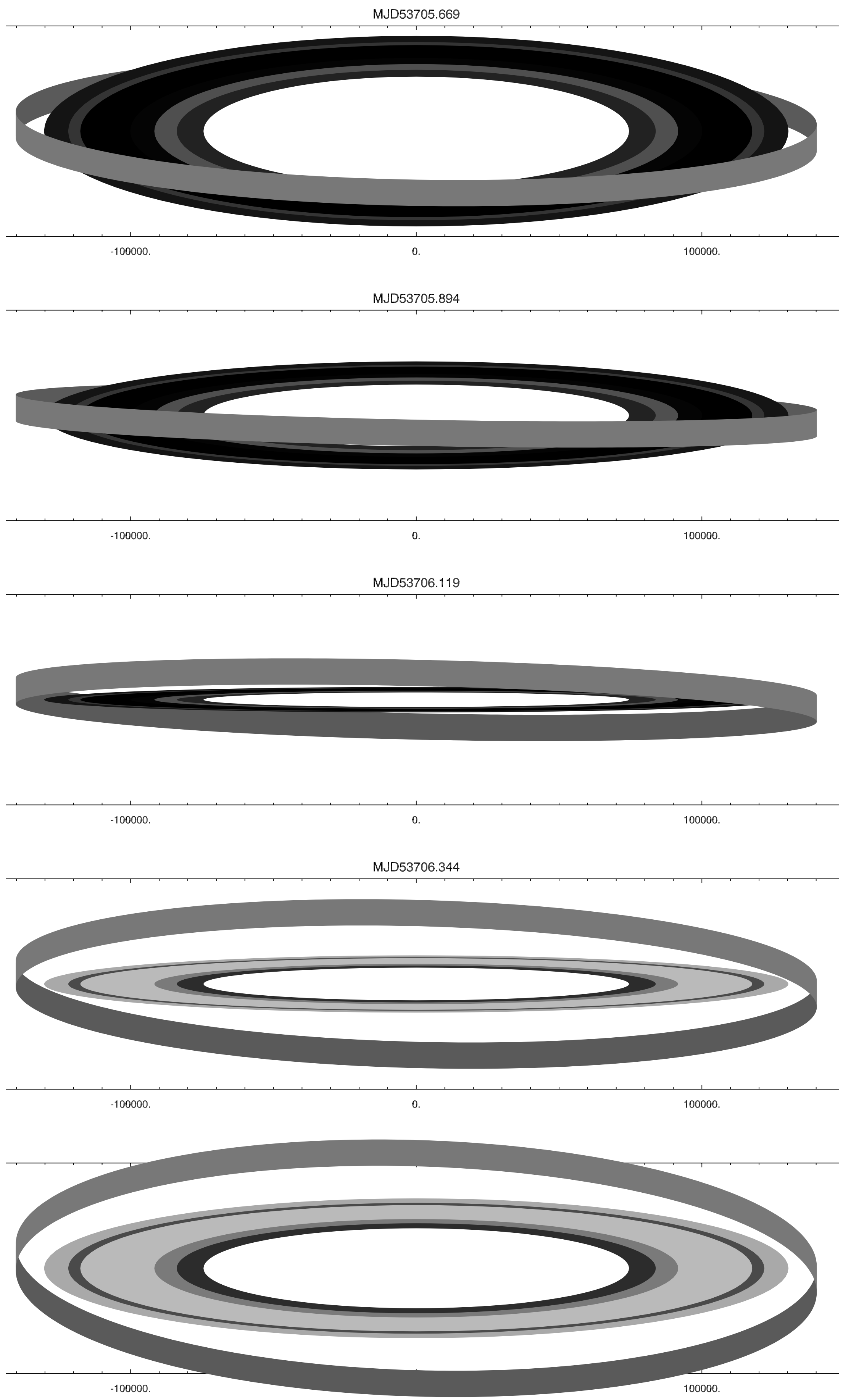


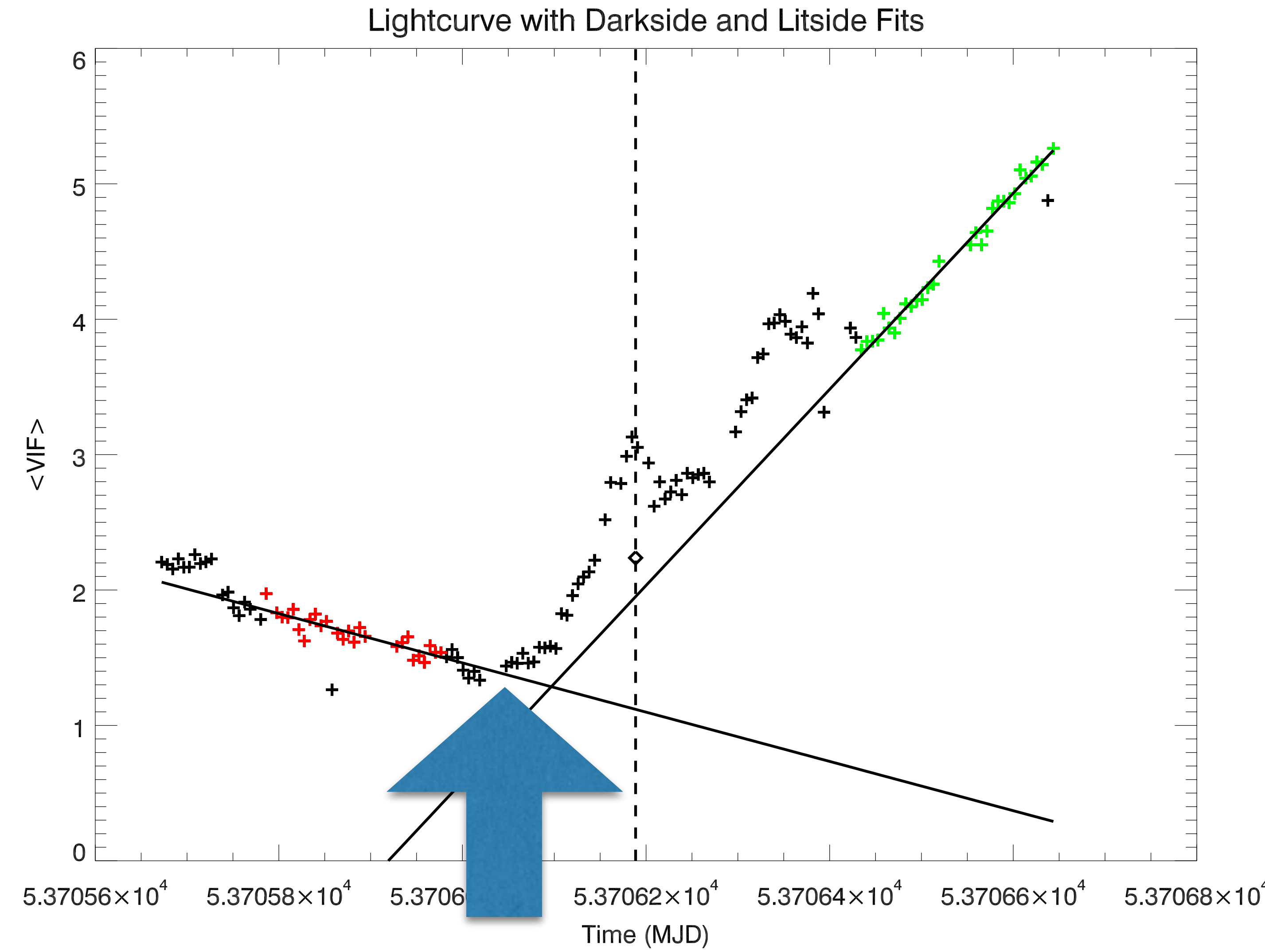
RPX Lightcurve, Dec 1-2, 2011



RPX Lightcurve, Dec 1-2, 2011



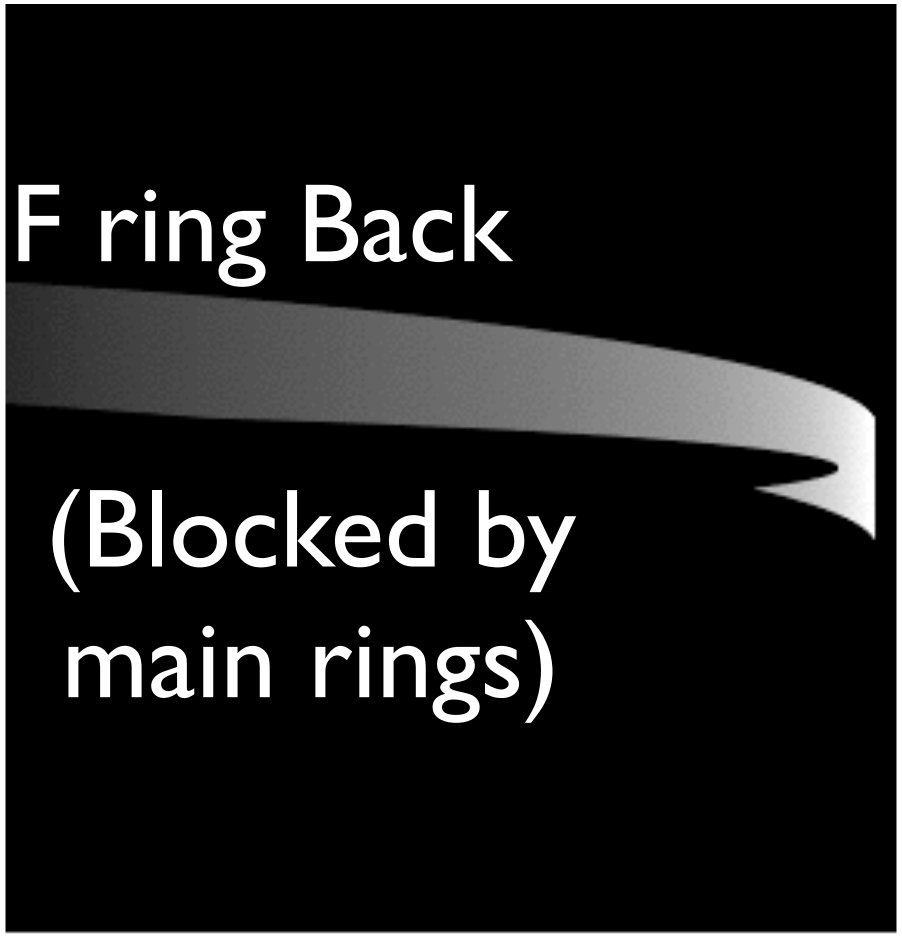




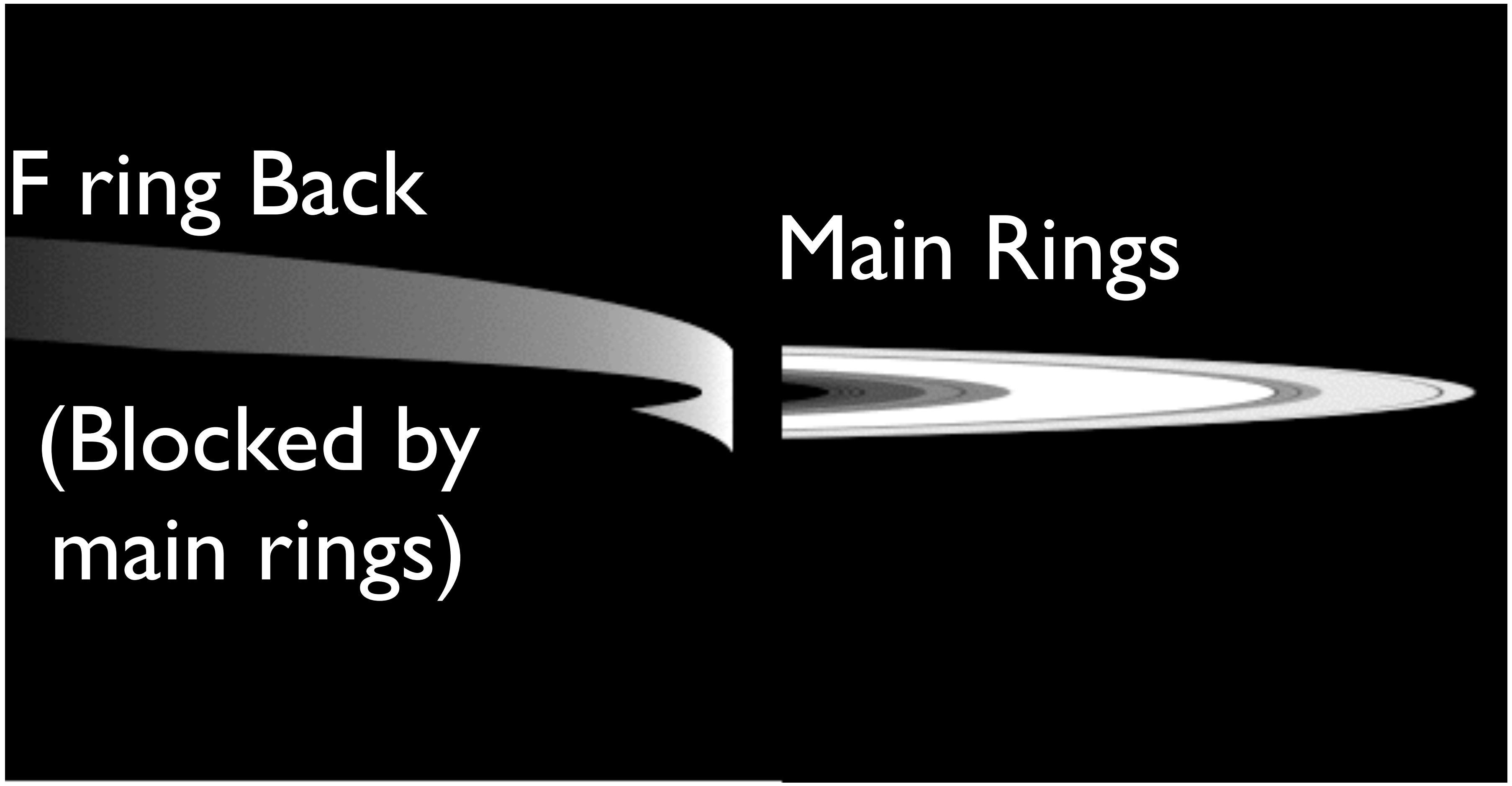
- Start of ramp-up is a strong constraint on the location of the lower edge of the brightest part of the F ring.

- Unfortunately, the RPX and clumps make it harder to constrain the upper edge.

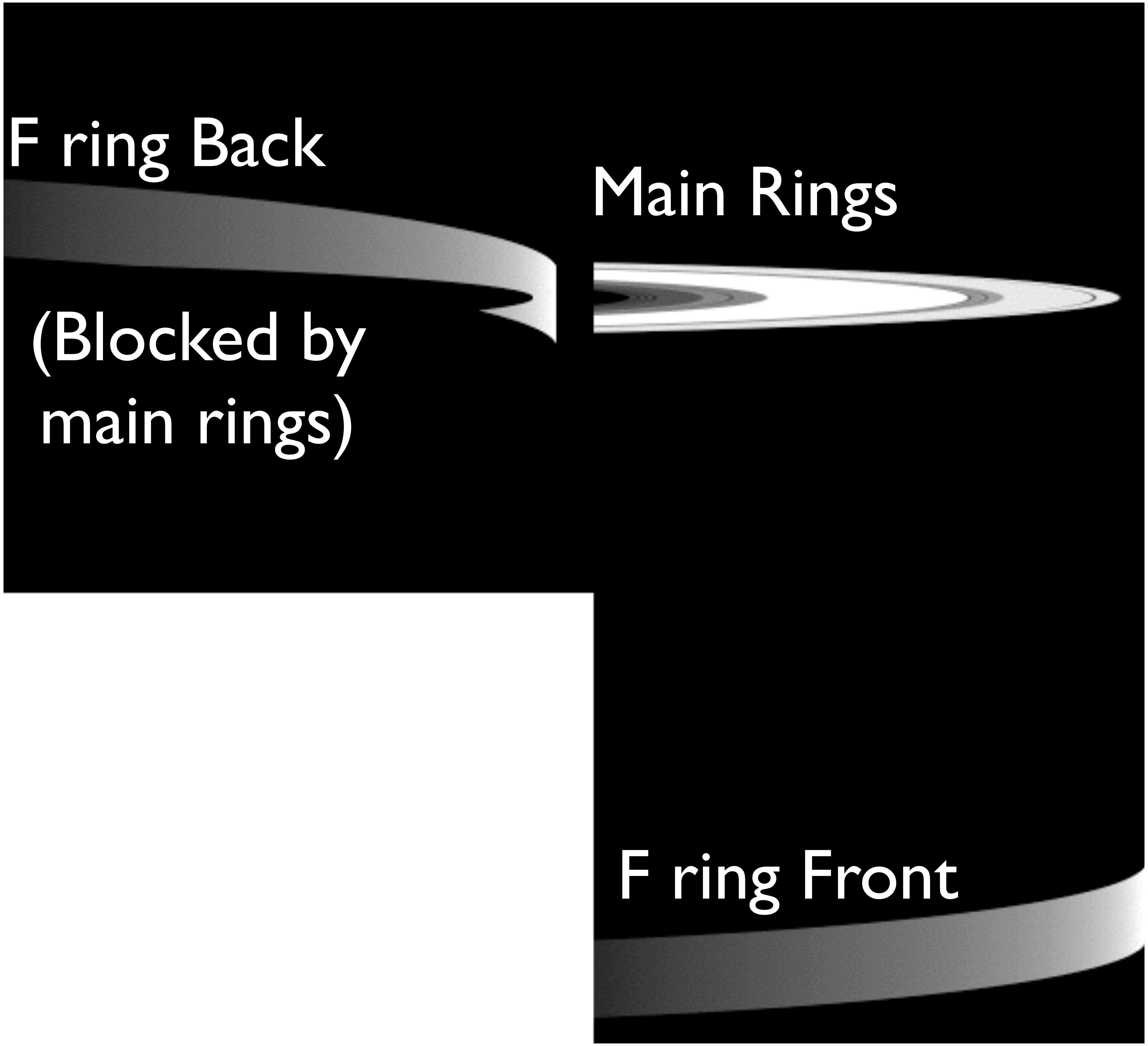
Ring Model Layers



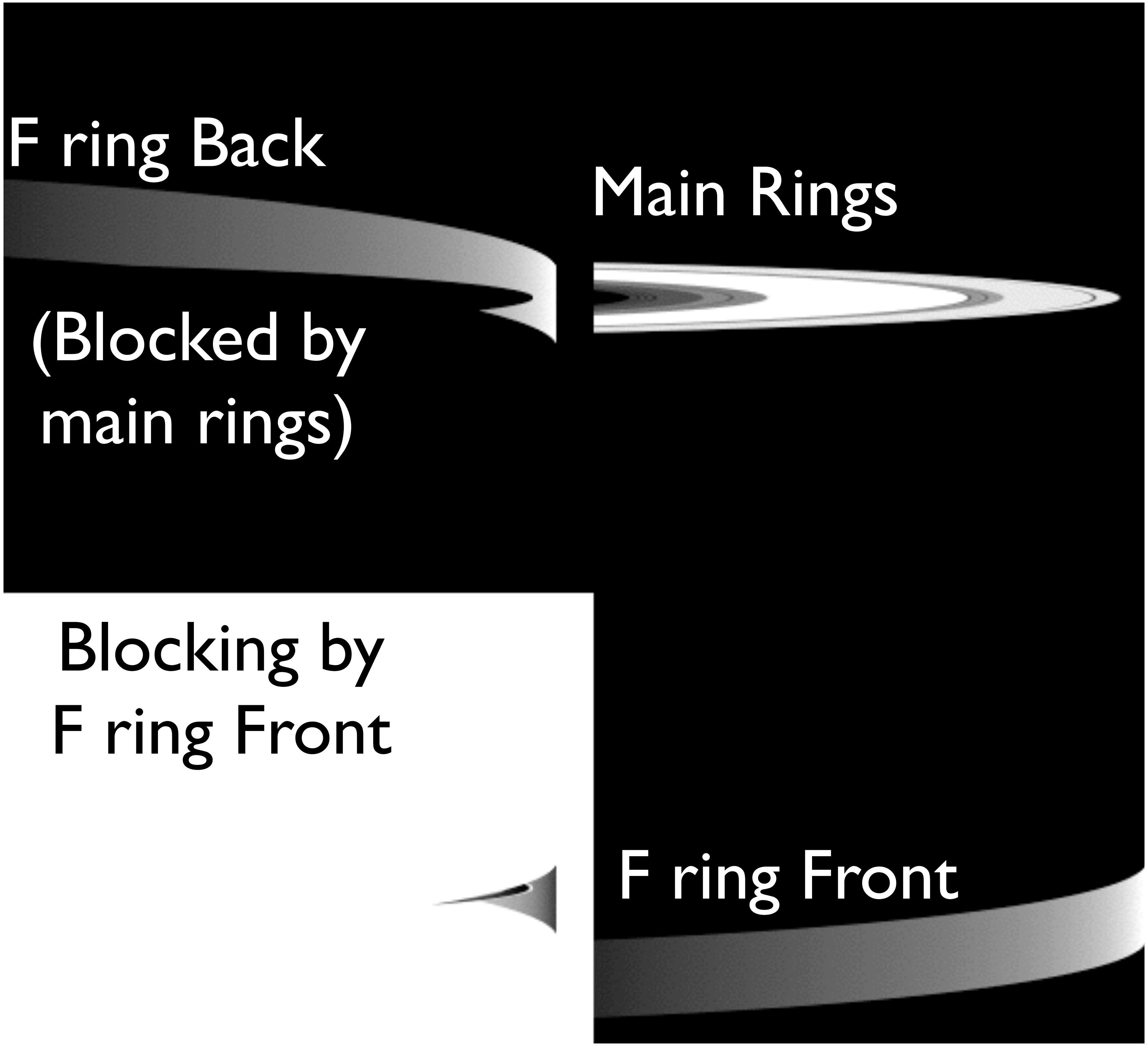
Ring Model Layers

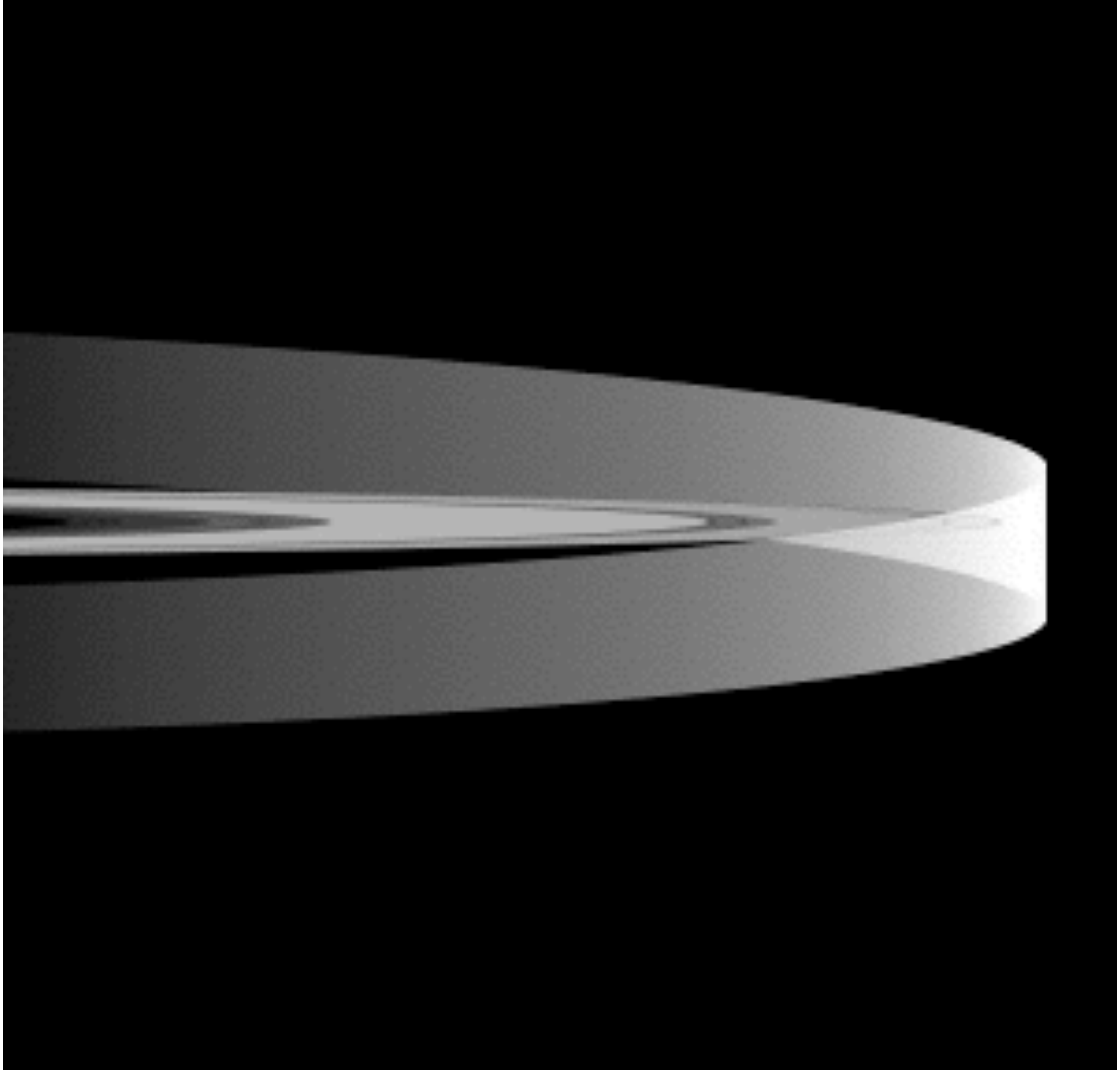


Ring Model Layers

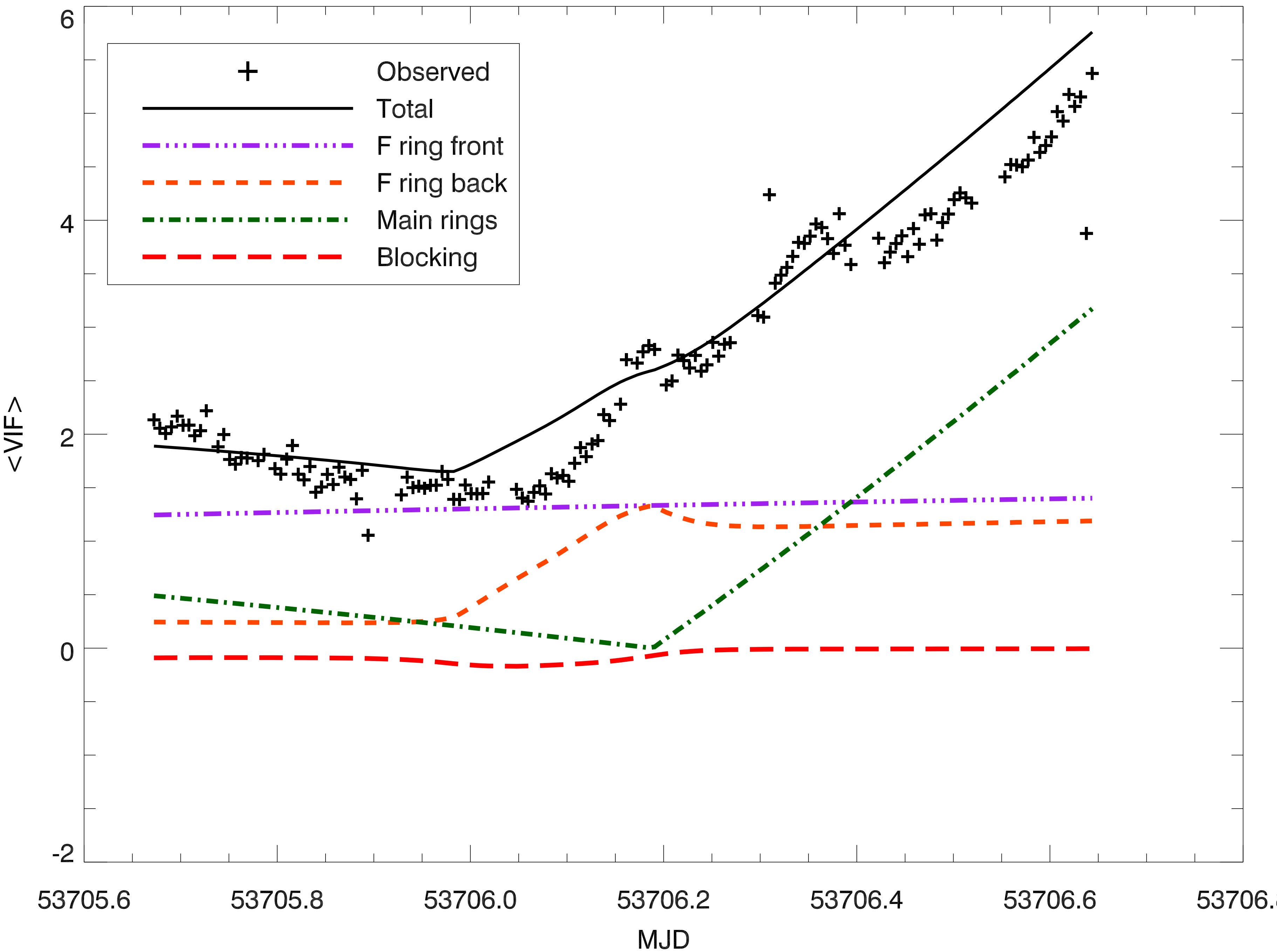


Ring Model Layers

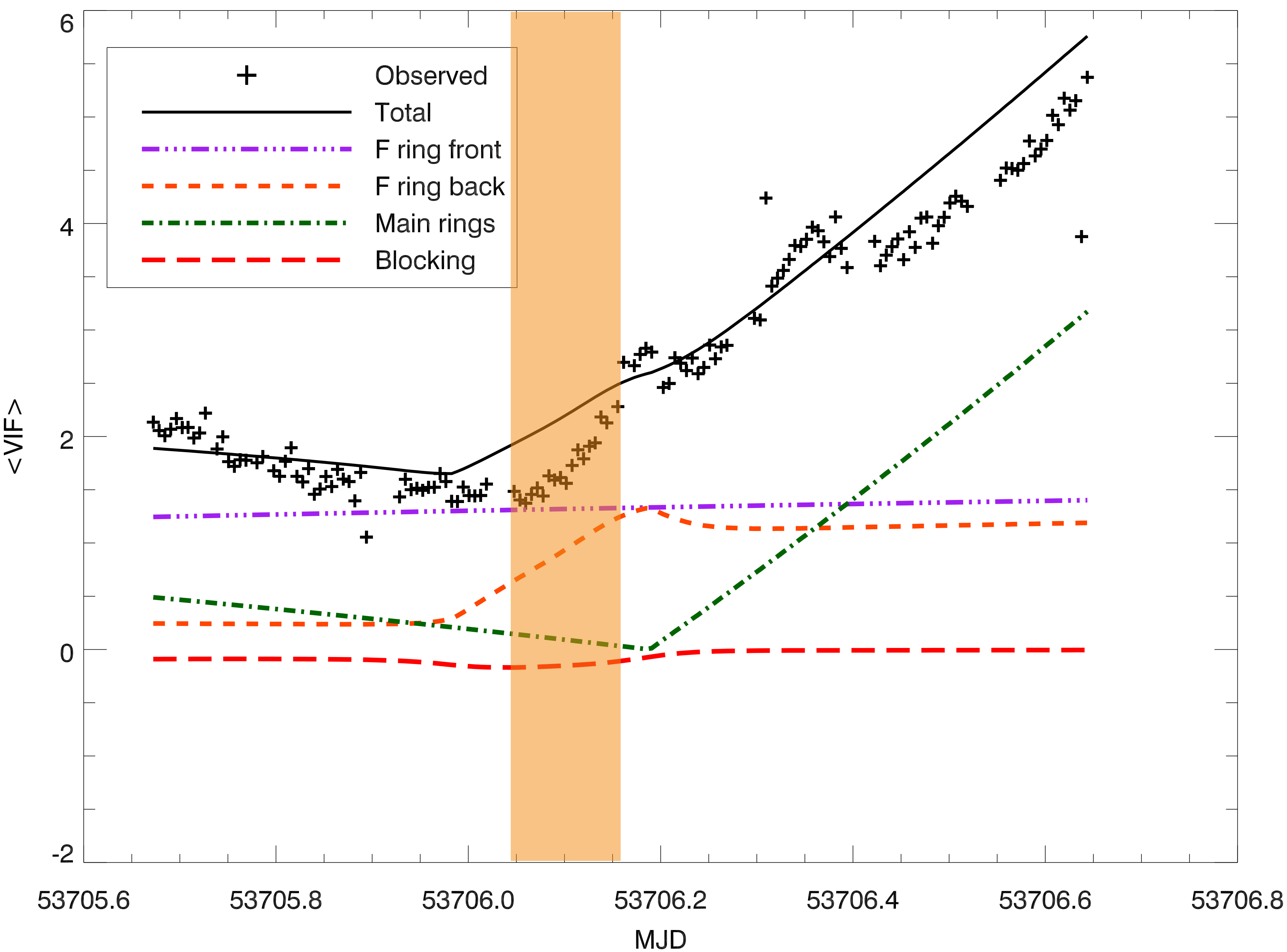




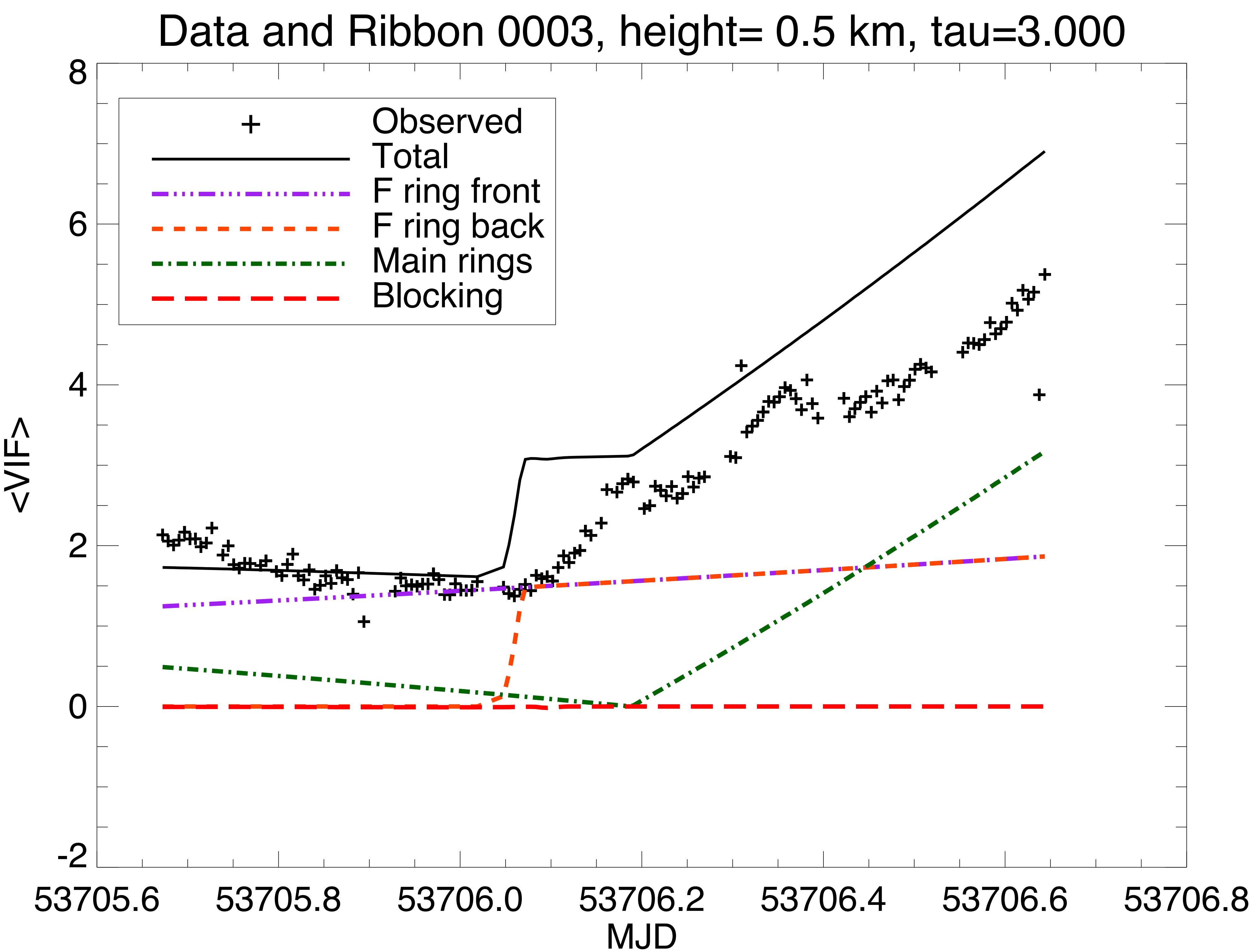
Scharringhausen (2007) Gaussian F ring: FWHM: 13 km, τ_{peak}=0.7



Scharringhausen (2007) Gaussian F ring: FWHM: 13 km, τ_{peak}=0.7

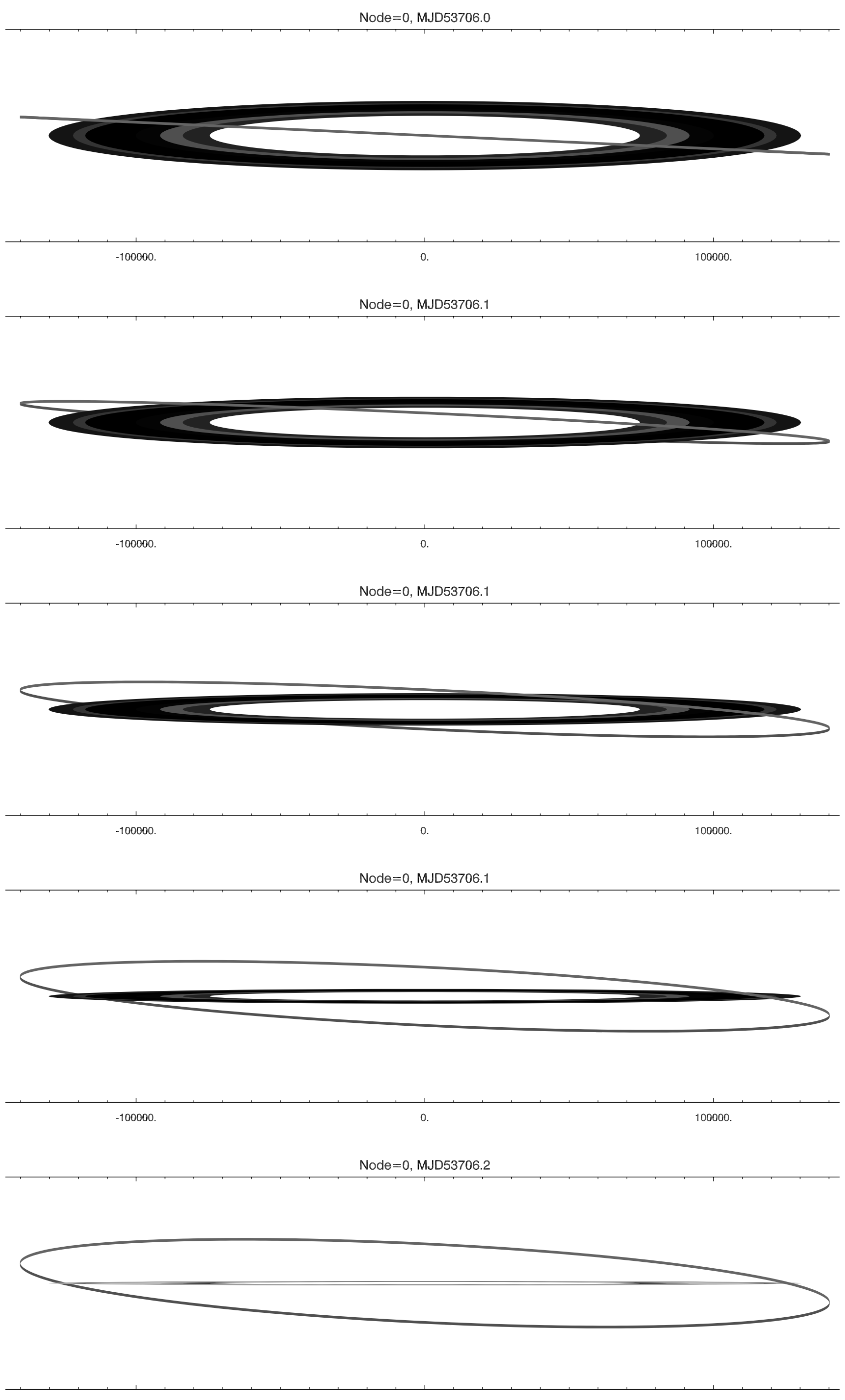


Ring model with F-ring orbit of Albers, et al. 2012

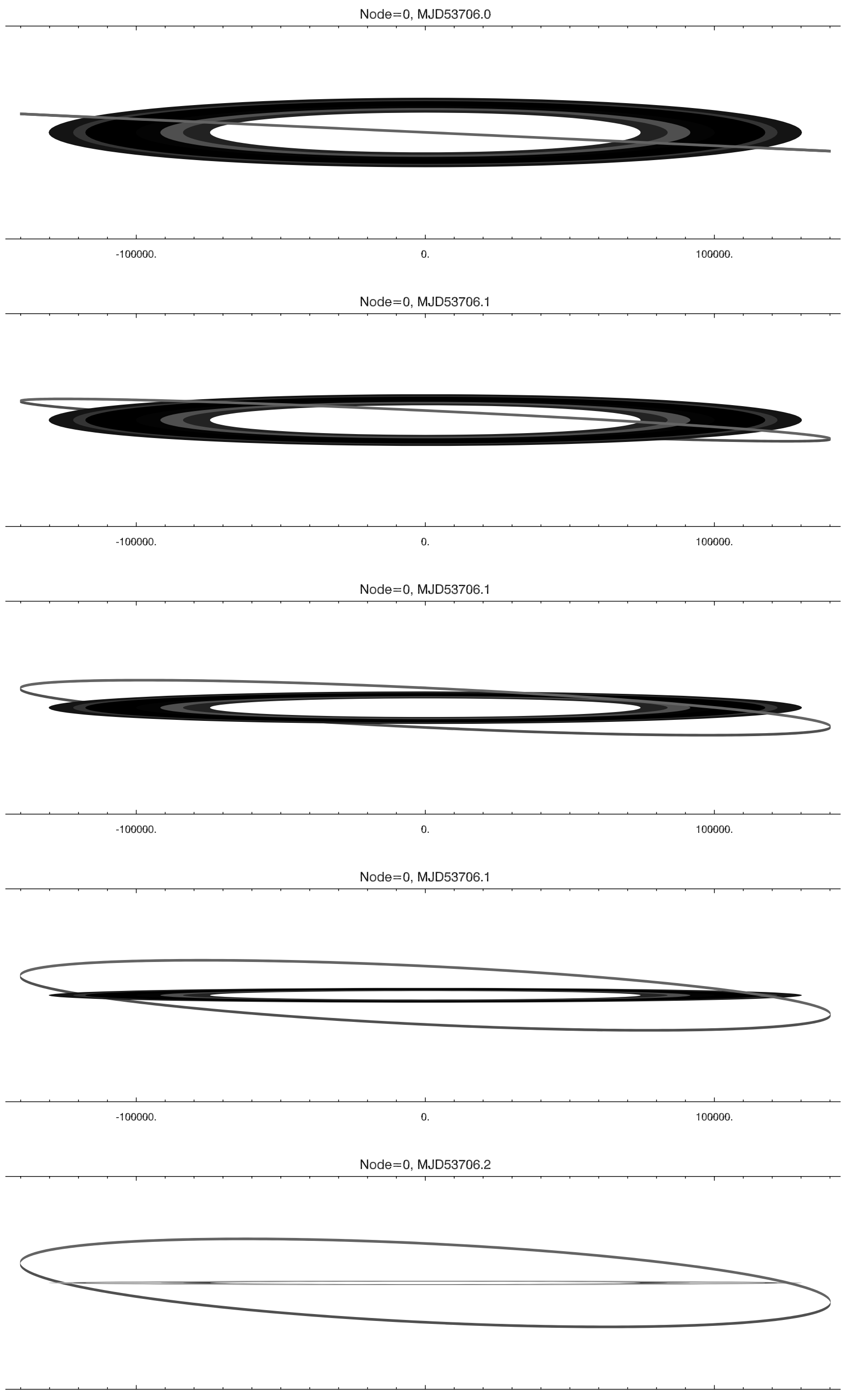


Ascending Node

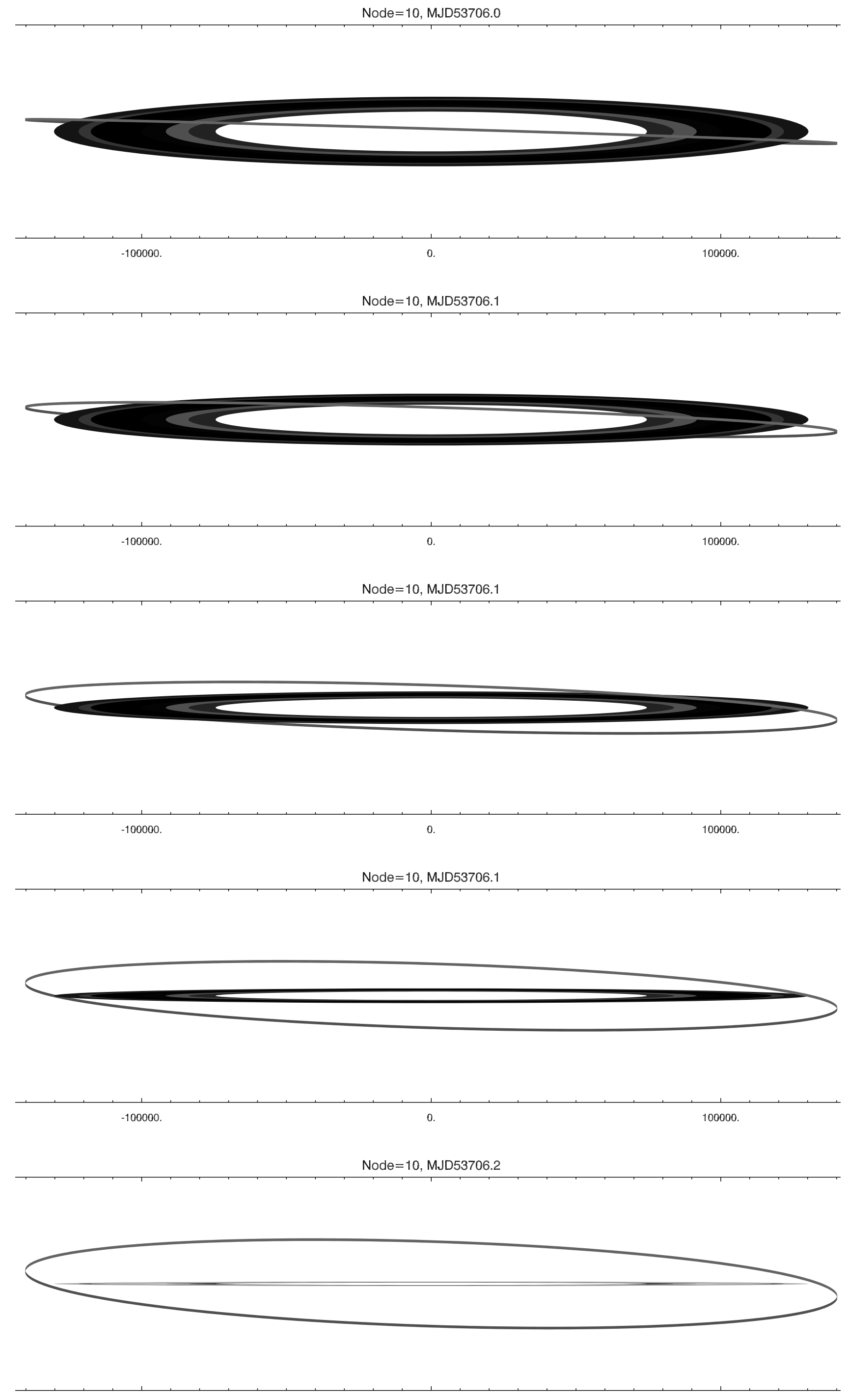
Publication	Observations	Ω	Precession Rate
Bosh *et al.*, 2002	Pre-Cassini occultations	17.3±3.9°	-2.6877°/day
Albers *et al.*, 2012	UVIS occultations	15.0±1.4°	-2.68779°/day
Cooper *et al.*, 2013	ISS images	5.3 ± 0.6°	Not fit
		7 ± 2°	Not fit


Node=0, MJD53706.0
-100000.
0.
100000.
Node=0, MJD53706.1
-100000.
0.
100000.
Node=0, MJD53706.1
-100000.
0.
100000.
Node=0, MJD53706.1
-100000.
0.
100000.
Node=0, MJD53706.2
-100000.
0.
100000.

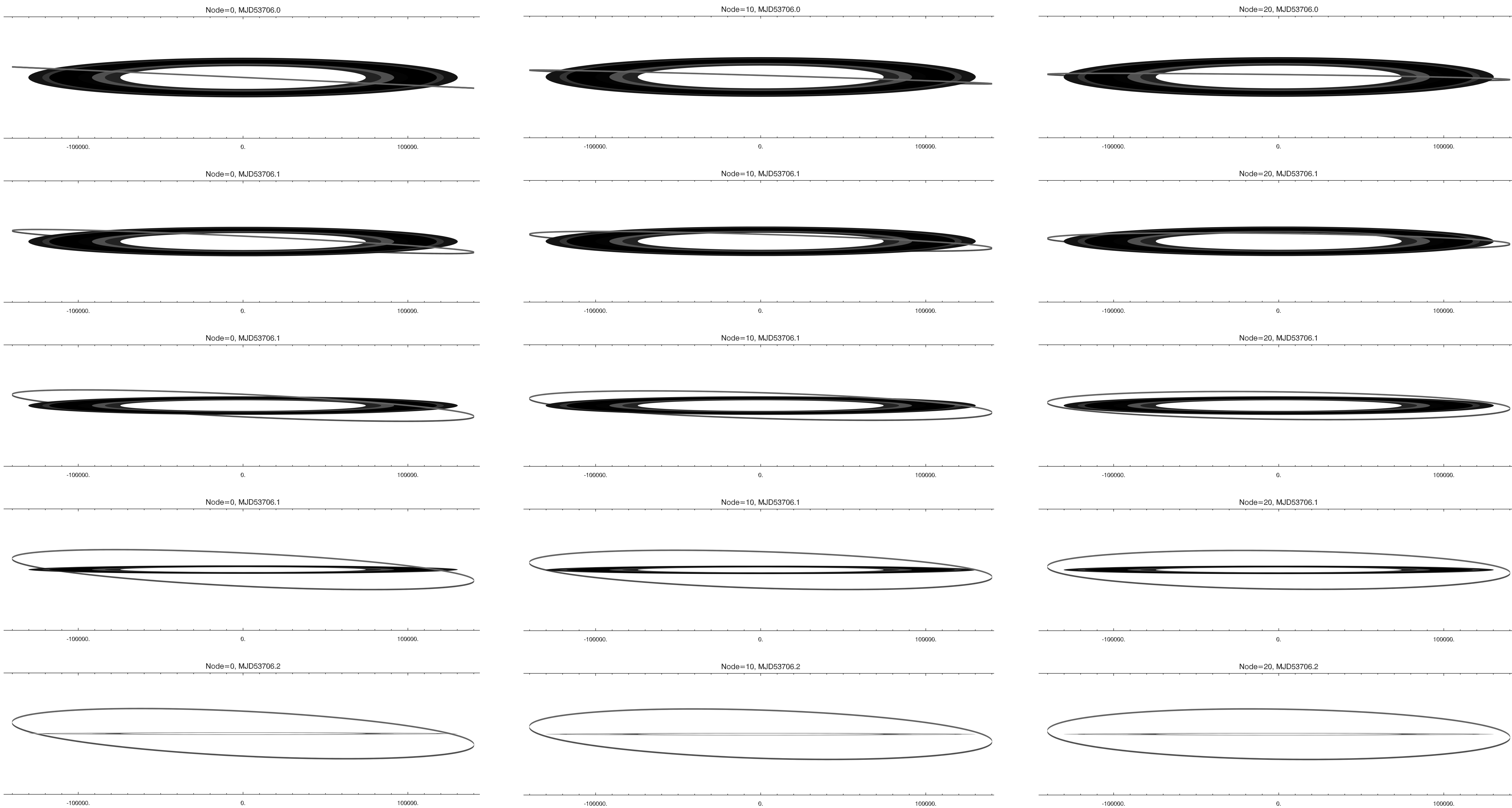
$\Omega_0 = 0°$



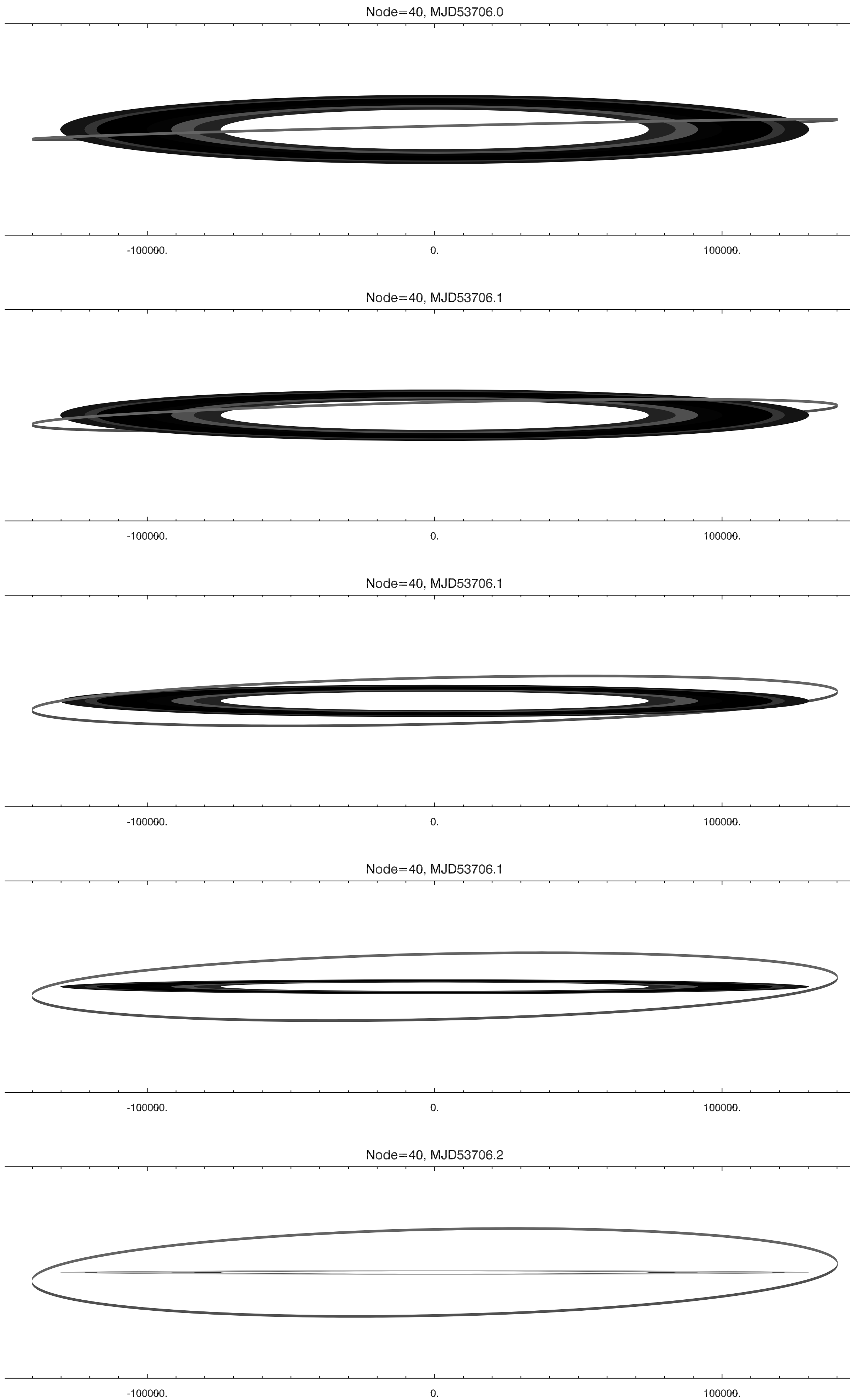
$\Omega_0 = 0°$



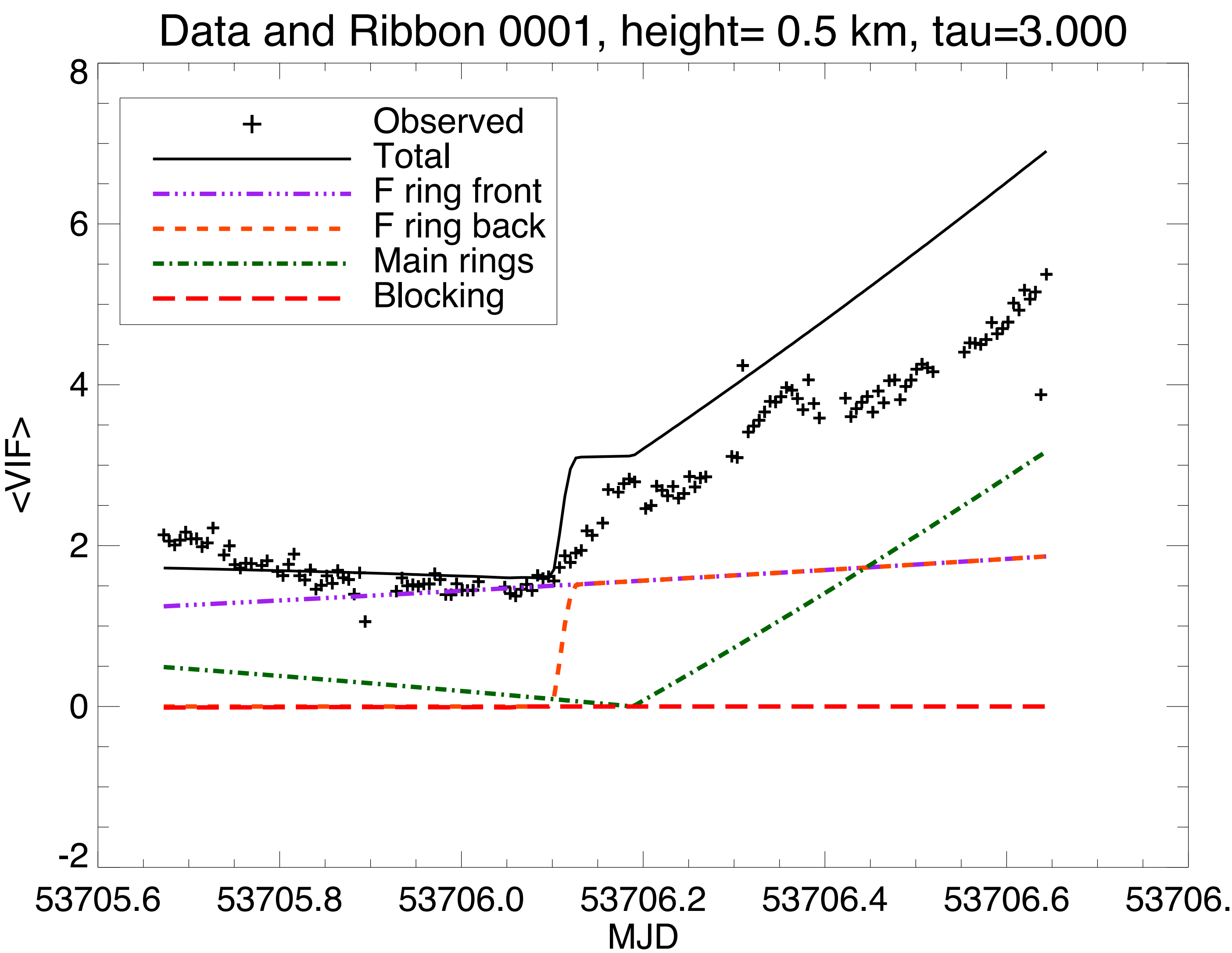
$\Omega_0 = 10°$



Ω_0=0° Ω_0=10° Ω_0=20°

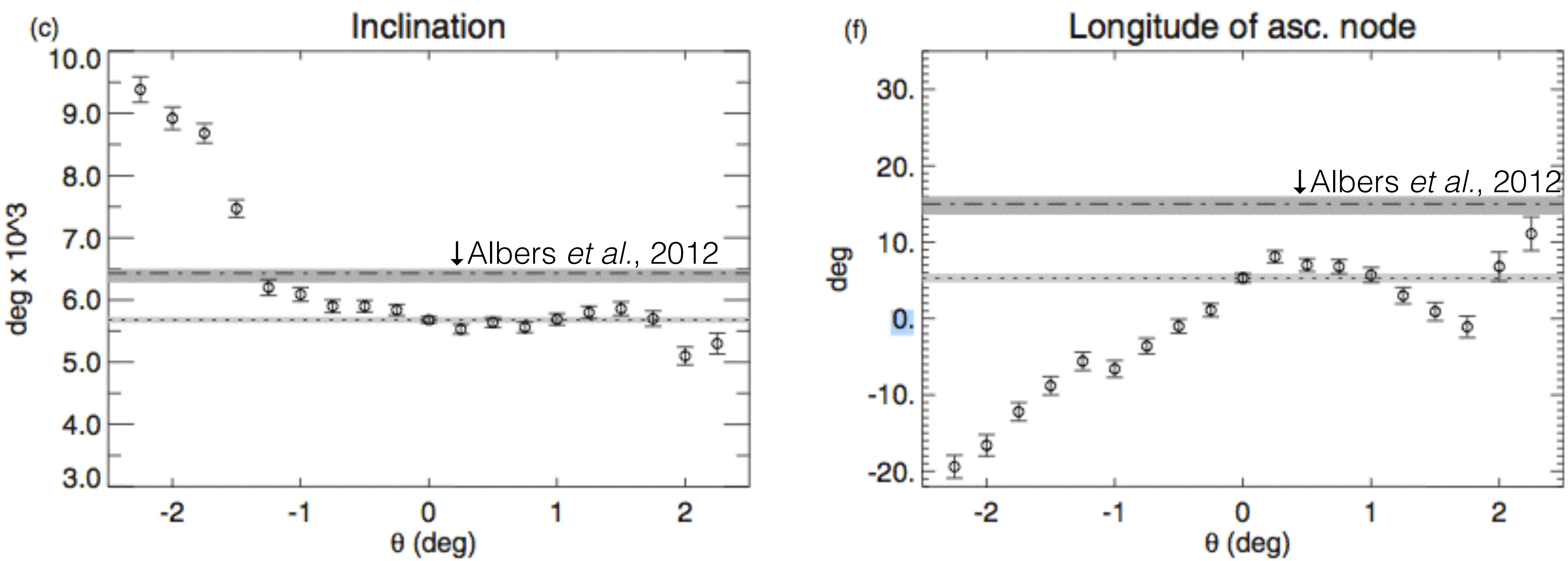

Node=40, MJD53706.0
-100000.
0.
100000.
Node=40, MJD53706.1
Node=40, MJD53706.1
Node=40, MJD53706.1
Node=40, MJD53706.2

Ω_0=40°


Data and Ribbon 0001, height= 0.5 km, tau=3.000
Observed
Total
F ring front
F ring back
Main rings
Blocking
<VIF>
MJD
53705.6
53705.8
53706.0
53706.2
53706.4
53706.6

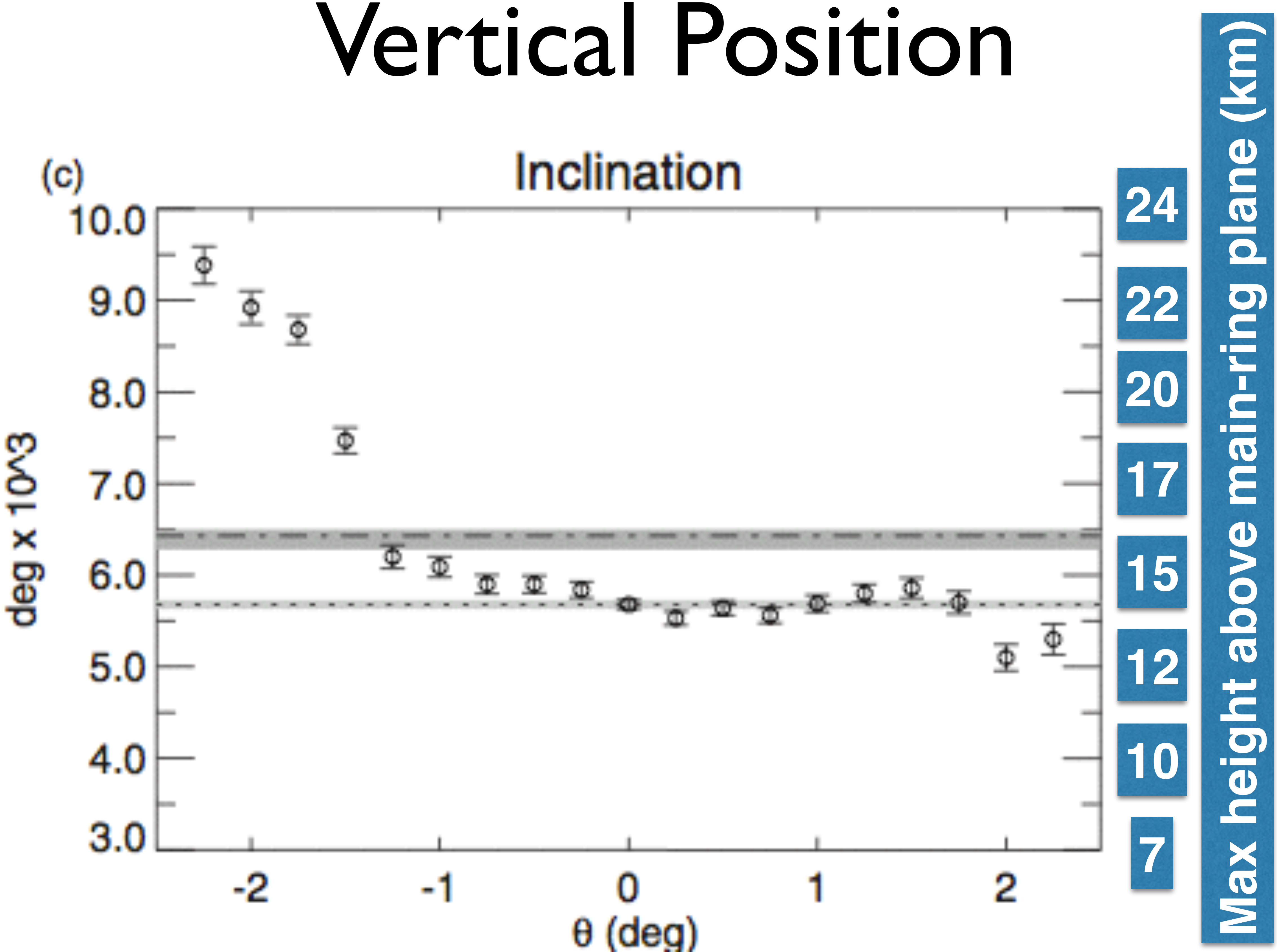
i and Ω_0 near Prometheus (Cooper *et al.*, 2013)

Cooper et al. (2013) fit 9805 ISS STREAMER/CHANNEL images, in 10 sequences, each following a piece of the F ring *near Prometheus* for one orbit.

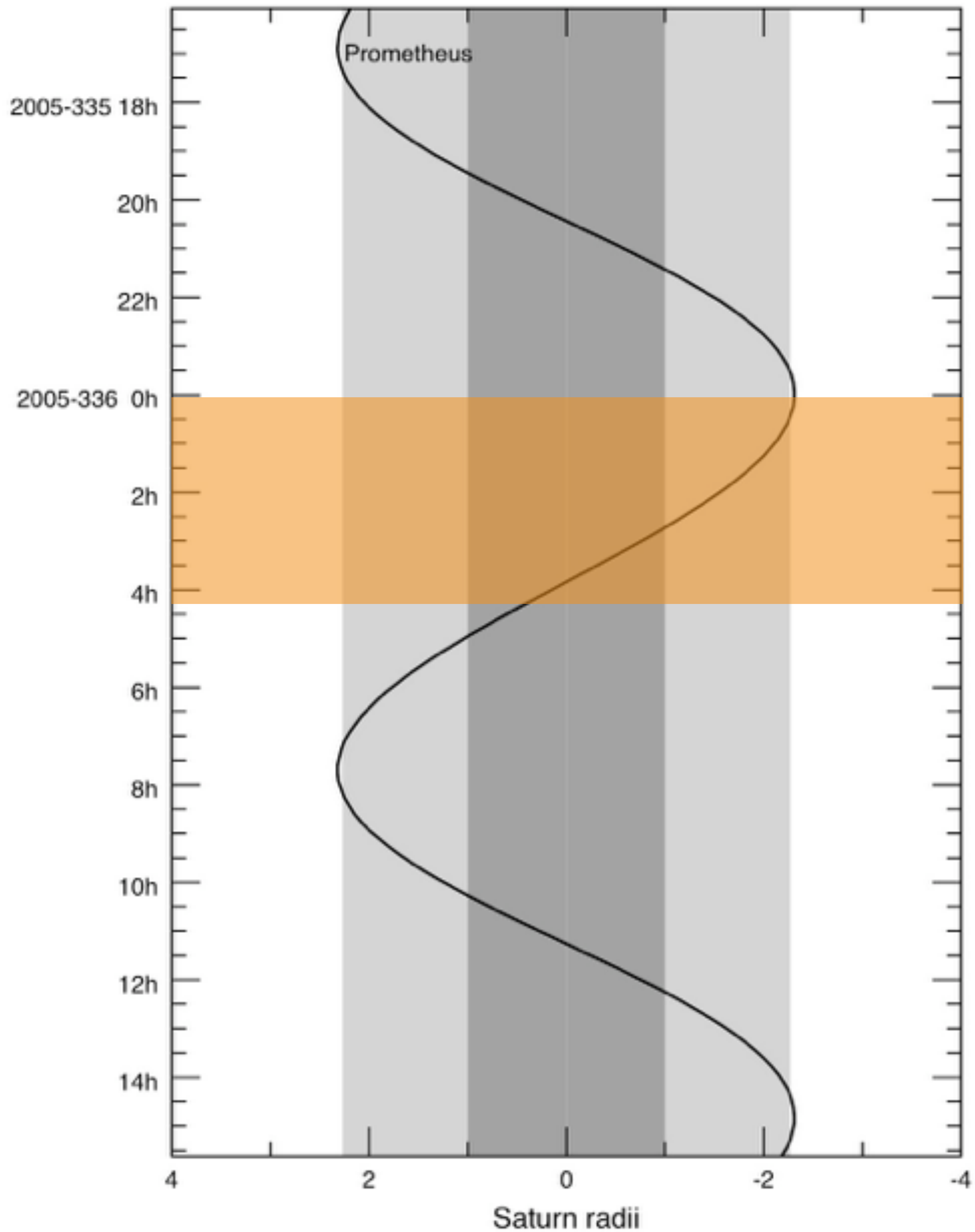


Images closer than θ to Prometheus excluded from fit.

Inclination and Vertical Position



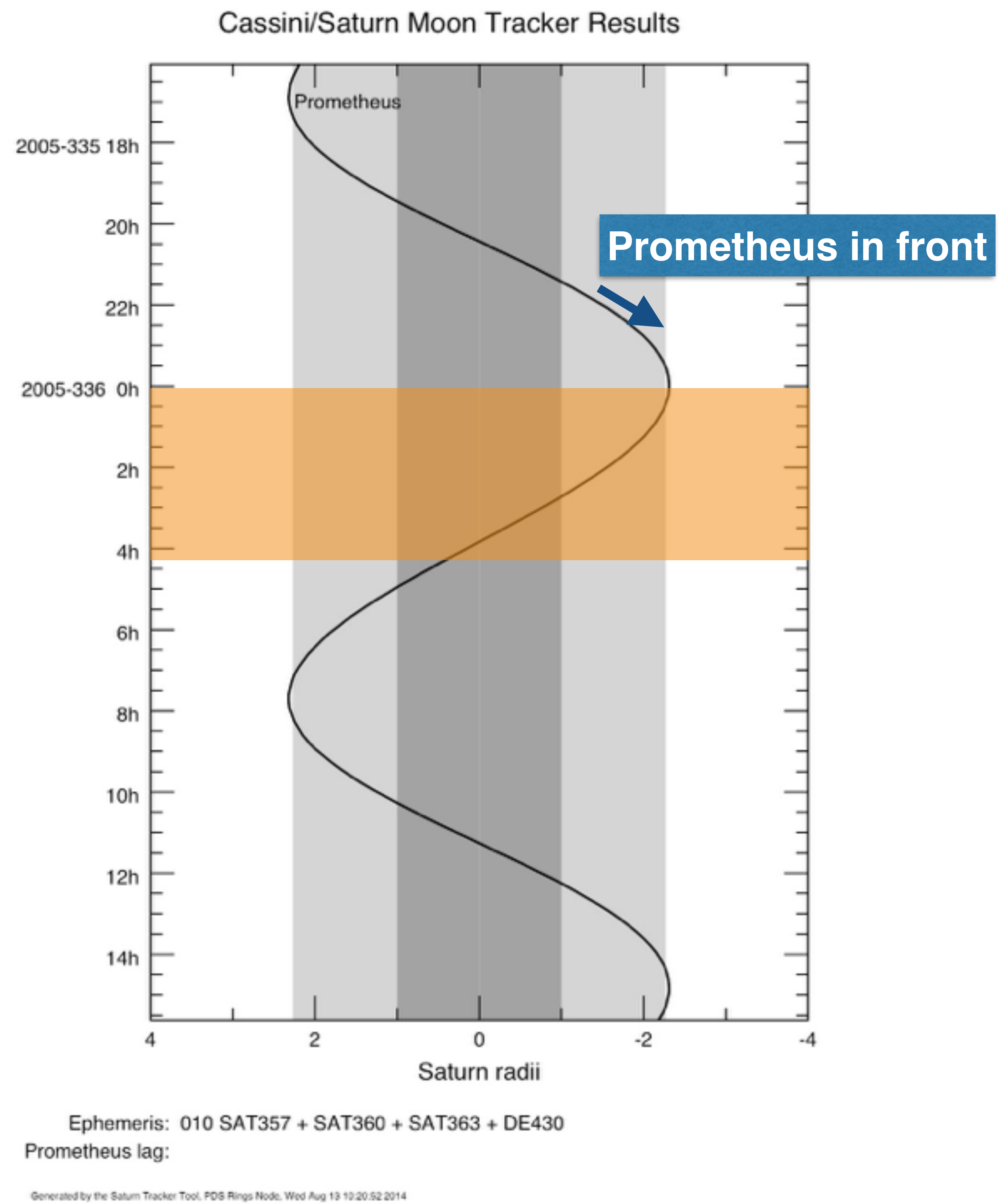
Cassini/Saturn Moon Tracker Results

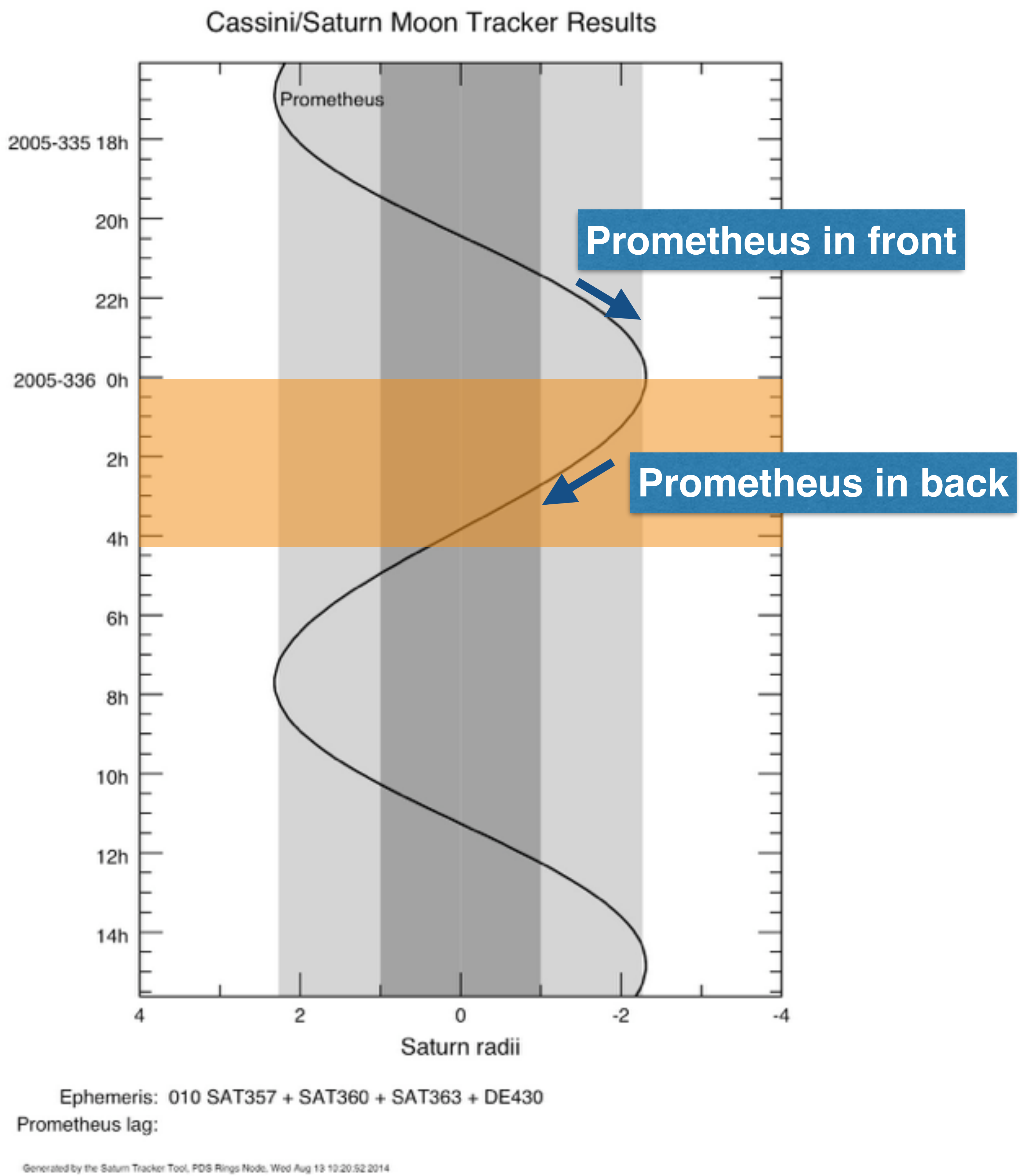


Ephemeris: 010 SAT357 + SAT360 + SAT363 + DE430

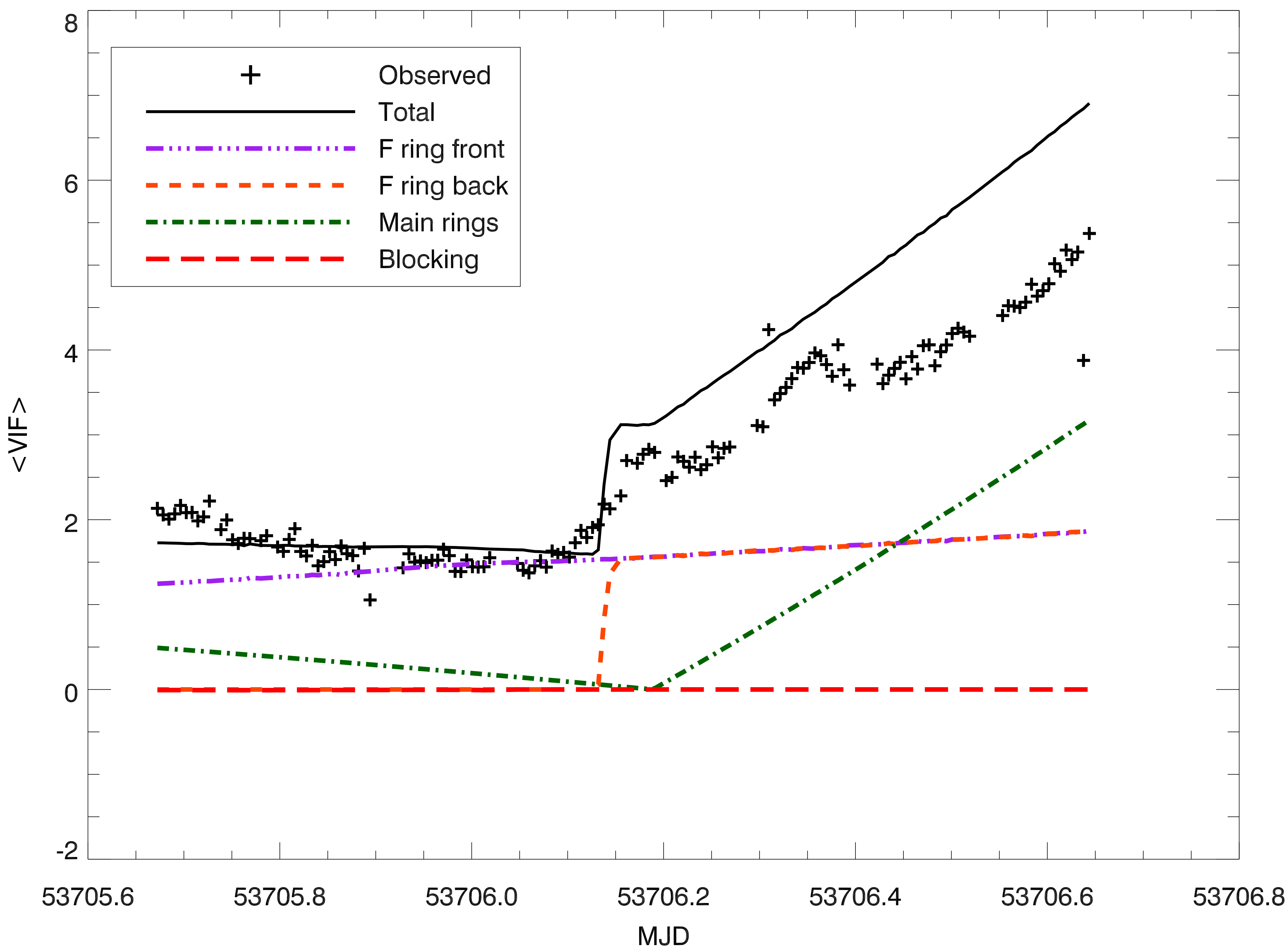
Prometheus lag:

Generated by the Saturn Tracker Tool, PDS Rings Node, Wed Aug 13 10:20:52 2014

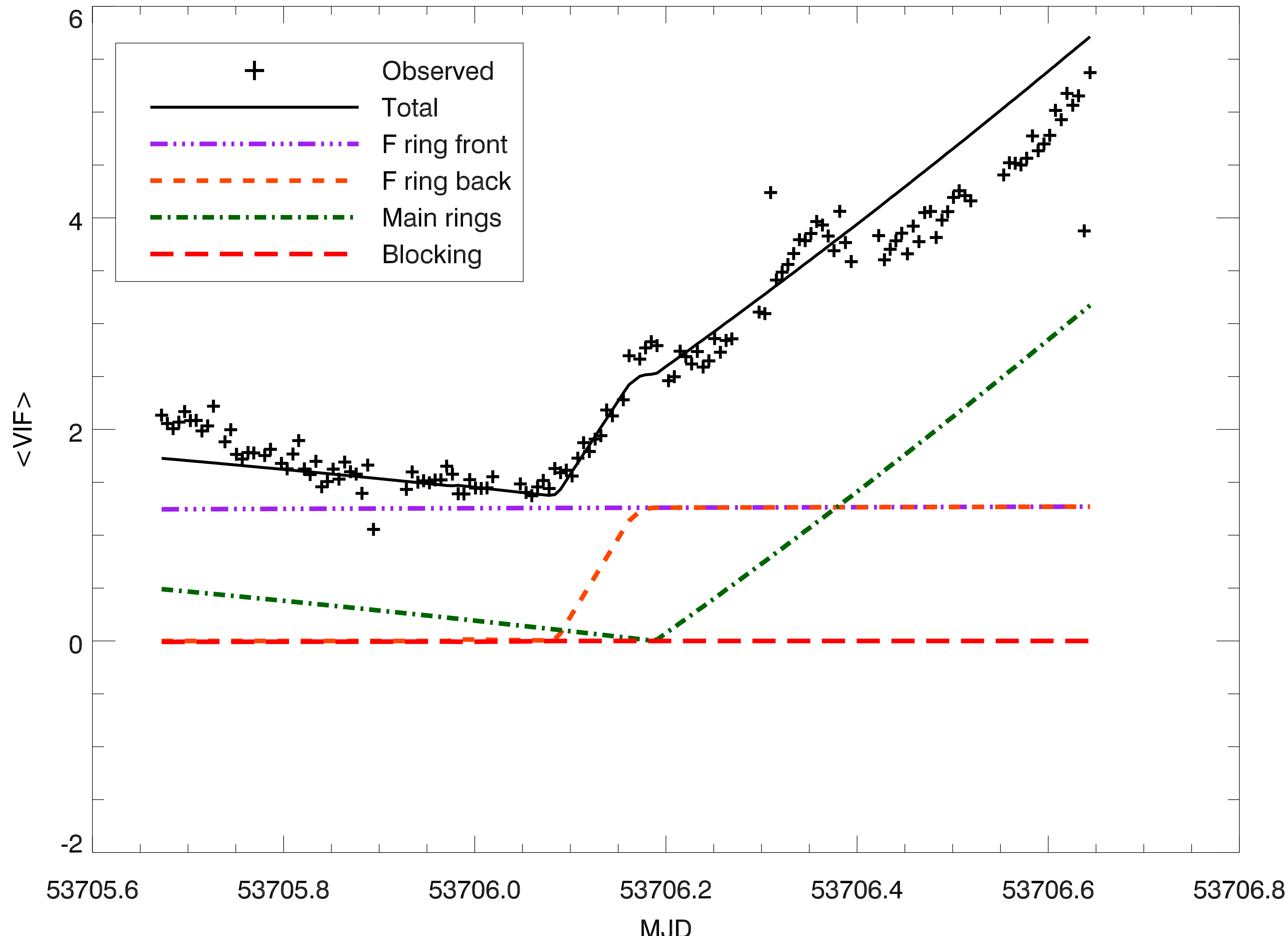

Cassini/Saturn Moon Tracker Results
Prometheus
Prometheus in front
2005-335 18h
20h
22h
2005-336 0h
2h
4h
6h
8h
10h
12h
14h
4
2
0
-2
-4
Saturn radii
Ephemeris: 010 SAT357 + SAT360 + SAT363 + DE430
Prometheus lag:
Generated by the Saturn Tracker Tool, PDS Rings Node, Wed Aug 13 10:20:52 2014


Cassini/Saturn Moon Tracker Results
Prometheus
Prometheus in front
Prometheus in back
2005-335 18h
20h
22h
2005-336 0h
2h
4h
6h
8h
10h
12h
14h
4
2
0
-2
-4
Saturn radii
Ephemeris: 010 SAT357 + SAT360 + SAT363 + DE430
Prometheus lag:
Generated by the Saturn Tracker Tool, PDS Rings Node, Wed Aug 13 10:20:52 2014

Shifting the F ring up 8 km



Optically thin ribbon F ring with a thickness of 8.5 km & a vertical displacement of +7 km



Summary

- The back of the F ring is revealed from behind the main rings at RPX, causing a ramp-up of brightness.
- The timing of the ramp up is strongly affected by the vertical position of the F ring, which is affected by:
  - The F ring's inclination and ascending node.
  - Any vertical displacement of the F ring core (or other strands or clumps present in the averaging region at RPX).
- … which are affected *locally* by perturbations from Prometheus, so perhaps we cannot model the F ring with one single i and one single Ω_0.

To Do

- Ignoring the ramp-up near RPX, fit to the linear portions of the lightcurve where the brightness is not as sensitive to the vertical position of the F ring.

- Then apply a vertical displacement to the F ring near RPX???

- Get local: Examine data profiles of VIF vs. *r* to determine *at what radius* the brightness is increasing in the ramp-up. Initial analysis seems to that the ramp-up is faster at smaller *r*. Compare model profiles (which are decomposed into model layers).

F-ring Ansa Lightcurves