Retroreflector array for a satellite in an eccentric orbit

by David Arnold
Smithsonian Astrophysical Observatory

An eccentric orbit presents problems for laser tracking because of large variation in range, velocity aberration, and incidence angle on the array. This paper presents a design that should be able to accommodate the variation in these quantities and provide millimeter range accuracy.

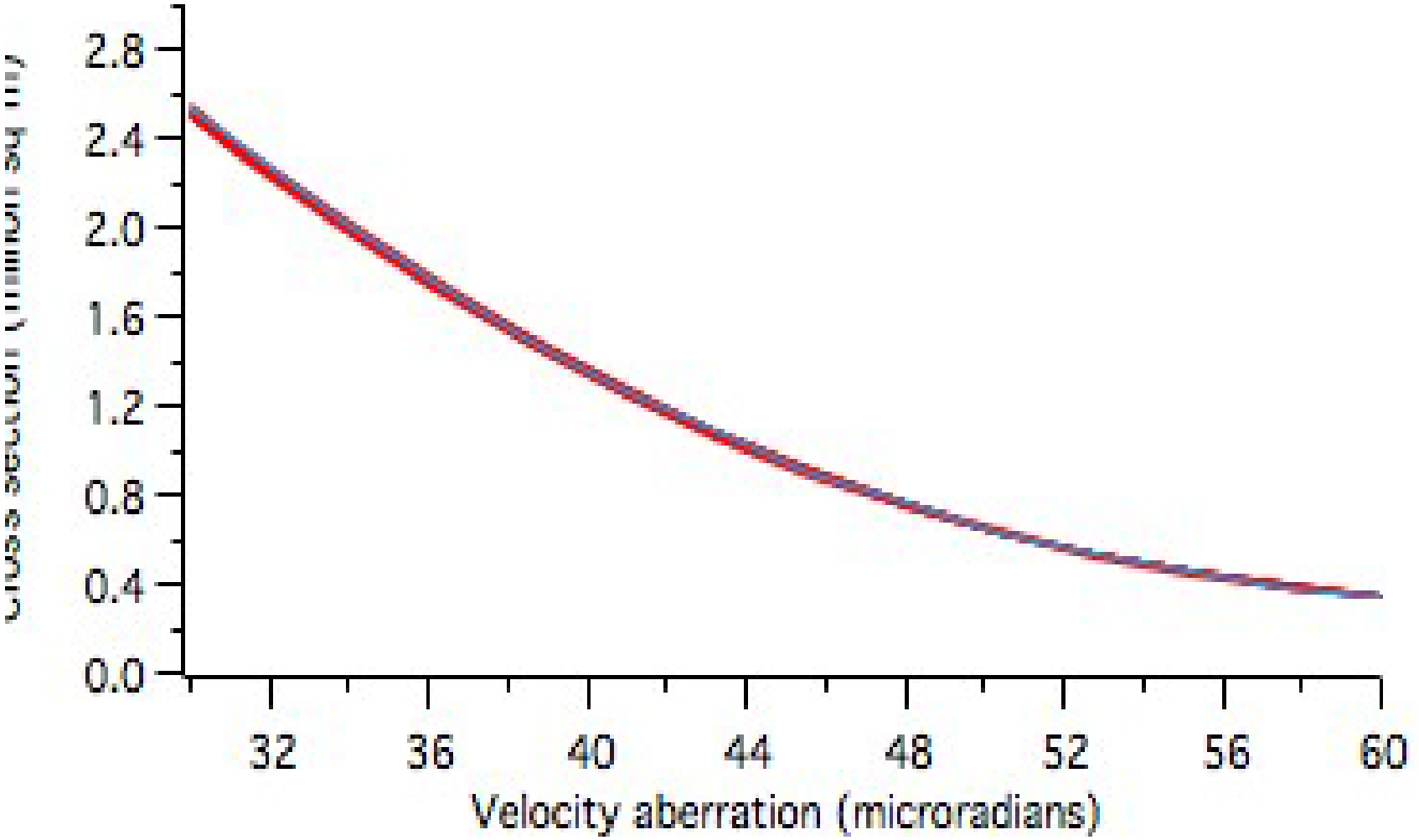
Array design

- The array is a minature LAGEOS of radius 10 cm using 245 half inch coated cubes with no intentional dihedral angle offset. There are 10 rings of cubes in the top hemisphere and one ring from the lower hemisphere. Ring 11 is needed to maintain a constant range correction out to 60 incidence angle on the array.

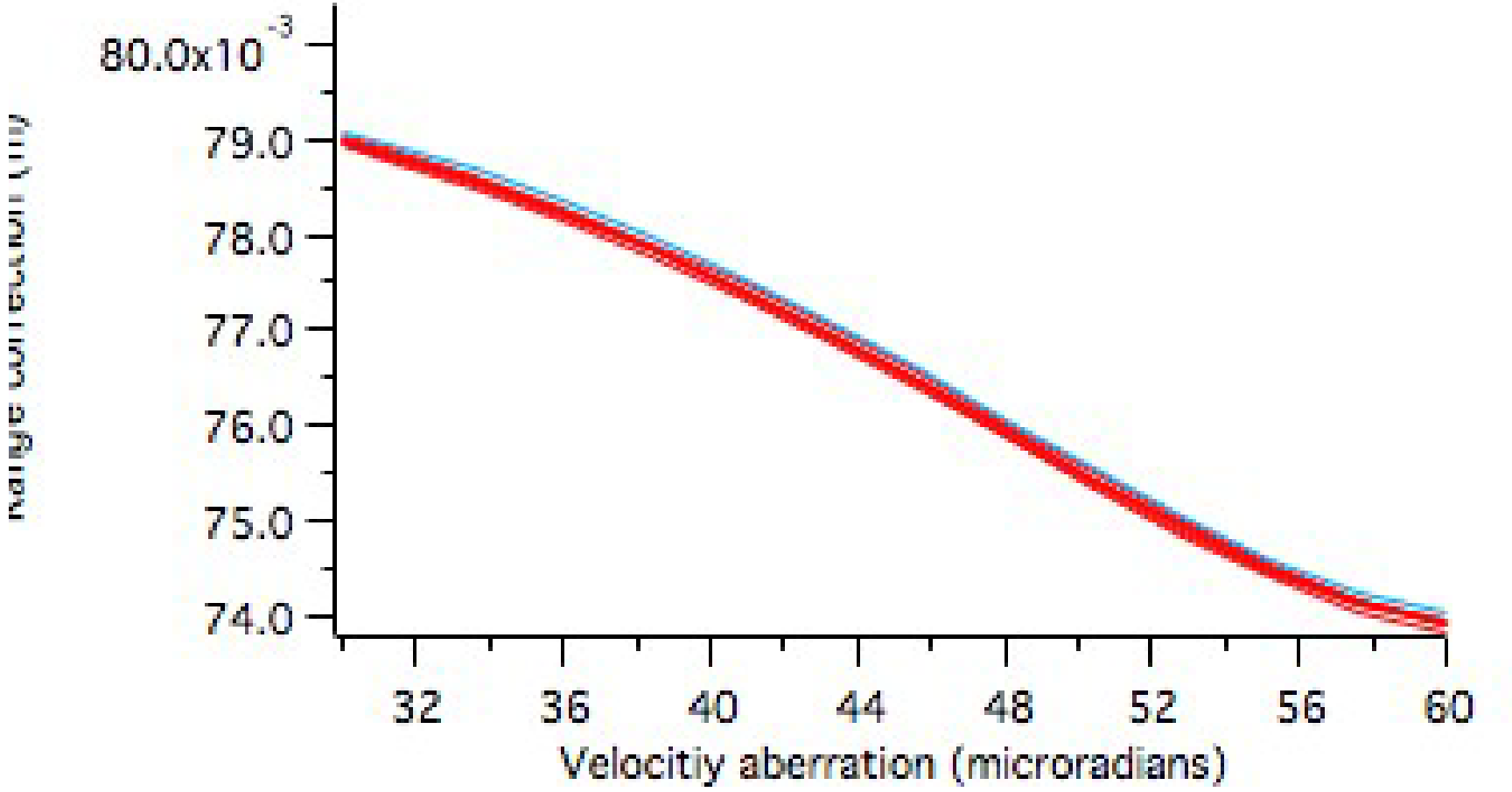
Parameters of the rings of cubes

Ring	# cubes	Latitude (deg)
1	1	90.000
2	6	79.882
3	12	70.152
4	18	60.421
5	23	50.691
6	27	40.961
7	31	31.231
8	31	22.982
9	32	13.252
10	32	4.865
11	32	-4.865

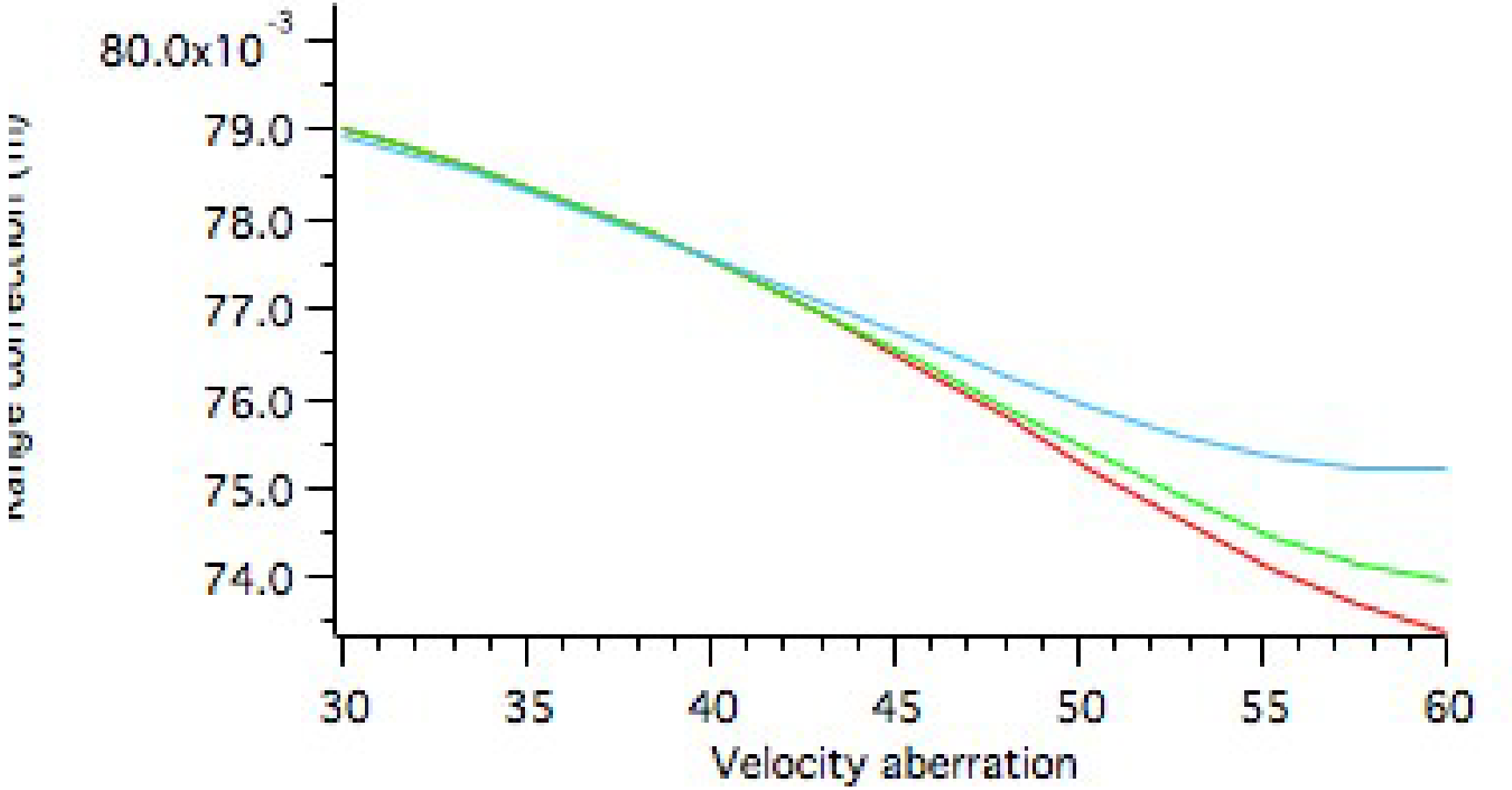
Cross section (million sq m) vs velocity aberration for incidence angles 0,10,20,30,40,50 deg (red), 60 deg (blue)



Range correction (meters) vs velocity aberration for incidence angles 0,10,20,30,40,50 deg (red), 60 deg (blue)



Range correction (m) vs velocity aberration at incidence angle 60 deg for dihedral angle offset 0 (red), .5 (green), 1.0 (blue) arcsec



Discussion

- In an eccentric orbit the velocity aberration is low at apogee where the range is highest. High velocity aberration occurs at perigee where the range is shortest. This design gives a cross section that is high for low velocity aberration and low for high velocity aberration. Correcting for velocity aberration gives submillimeter range accuracy.

Required cross section

- Suppose a satellite has an apogee of 7000 km and perigee below 1000 km. The velocity aberration at apogee is around 30 – 35 microradians. COMPASS has an altitude of 21,500 km and cross section of 80 million sq m. This is a factor of 89 in the fourth power of the range at apogee. The required cross section at apogee would be 80/89 which is less than one million sq m.