

### Short note on orbital manoeuvres in LEO with TriaXOrbital

For both cases below, assume drag. Ram area = 0.03 m<sup>2</sup>, CD = 2.5. Assume 10,000 sec ISP.

1) **Case BOB4** Starting orbit: 350 km circular orbit.

Burn for 20 minutes at 350 km until perigee = 170 km

Thrust = 5.5 mN

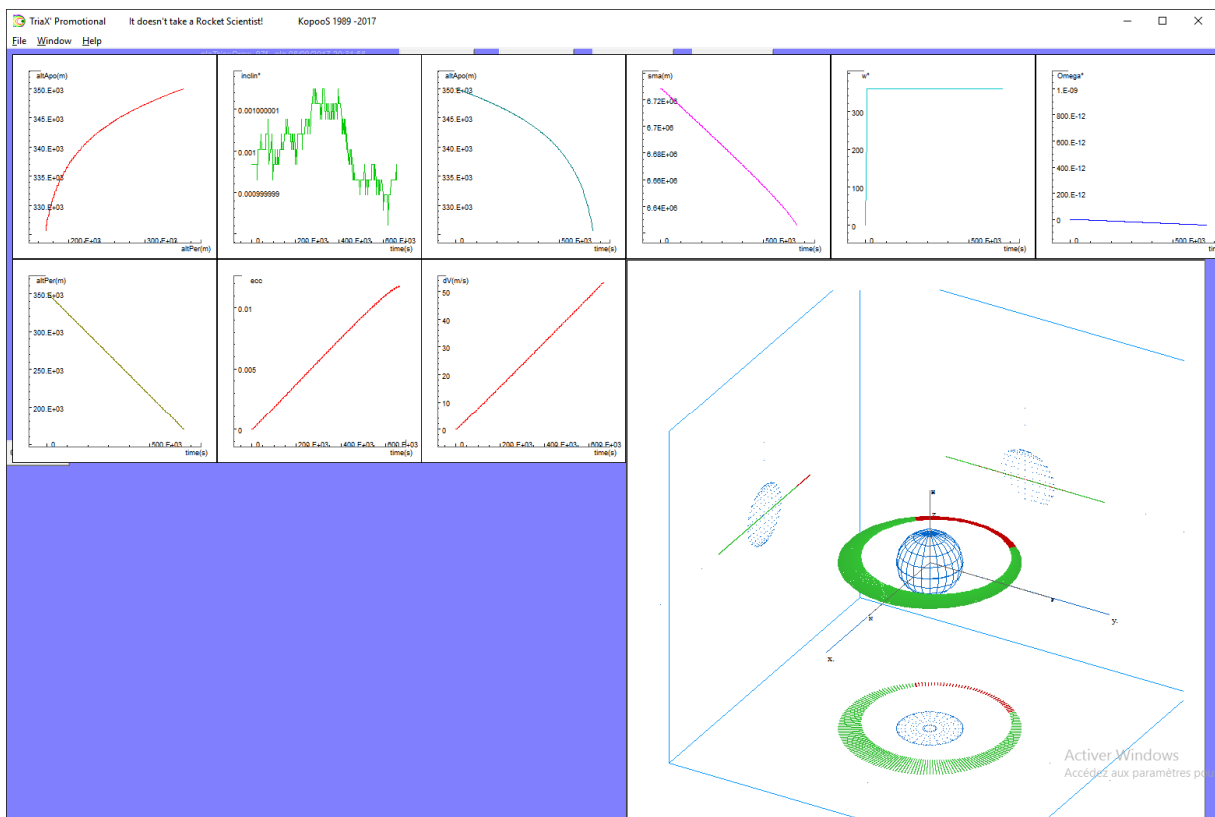
Spacecraft mass = 15 kg

Final orbit = 170 km perigee, apogee = 350 km. I know the apogee won't remain at 350 km. What is the new apogee?

What is the time to go from 350km circular to 350 km apogee, 170 km perigee. Number of orbits, total burn time?

### Run Case BOB4

121 pulses of 20 minutes are needed to lower perigee from 350 down to 170 km. Time to go is 7.6 days. Apogee (with help of the drag at perigee) decreases from 350 to 325 km (aerodynamic forces are "moderate", not high, not "low"). Total burn time 121 x 20 minutes. DeltaV =53.2 m/s (thrust orientation during the burn: in the horizontal --i.e. perpendicular to the radius vector to Earth-- opposite to the velocity).

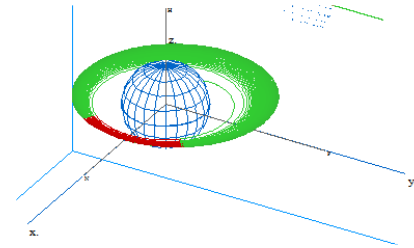


### Result table for traceability:

time(s)	ecc	ecc	altPer(m)	altApo(m)	inclin°	Omega°	w°	phi°	O+w+p°	w+p°	period	dt(s)	mass(kg)	thrust(N)	halfArc-t°	beta-t°	moon°	AnoExc°	n°Arc
0	0	0	350000	350001	0.001	0	0	0	0	0	5492.3	0	15	0	0	0	0	0	0
7638.8	0.000001	0.000001	349977	349985	0.001	0	256.923	243.777	140.7	140.7	5492.3	30.6	15	0.006	39.3	90	0	243.777	1
8838	0.000106	0.000106	348498	349921	0.001	0	359.178	220.122	219.3	219.3	5491.3	30	15	0	0	0	0	220.126	1
663646.5	0.011746	0.011746	170000	325663	0.001	0	359.516	51.849	51.4	51.4	5367.7	29.5	14.992	0	0	90	0	51.321	121

O+w°	mid-t°	alpha-t°	Eclips(s)	sma(m)	dV(m/s)	Lo°	ra_sma°	d_sma°	e_x	e_y	i_x°	i_y°	TimeID	MeanLo°	HourDN	ActAlt(m)	ActV(m/s)	Focus
0	180	0	0	6730000	0	91.094	180	0	0	0	0.001	0	2458655.5	91.094	18	350000	7697.001	Earth
256.9	180	270	0	6730000	0	-160.121	76.923	0.001	0	-0.000001	0.001	0	2458655.59	-160.121	18	349982.586	7697.009	Earth
359.2	180	0	0	6730000	0.4	-86.532	179.178	0	0.000106	-0.000002	0.001	0	2458655.6	-86.524	18	349753.35	7696.83	Earth
359.5	180	270	0	6630000	53.2	-109.47	179.516	0	0.011746	-0.000099	0.001	0	2458663.18	-110.528	18	199190.316	7813.263	Earth

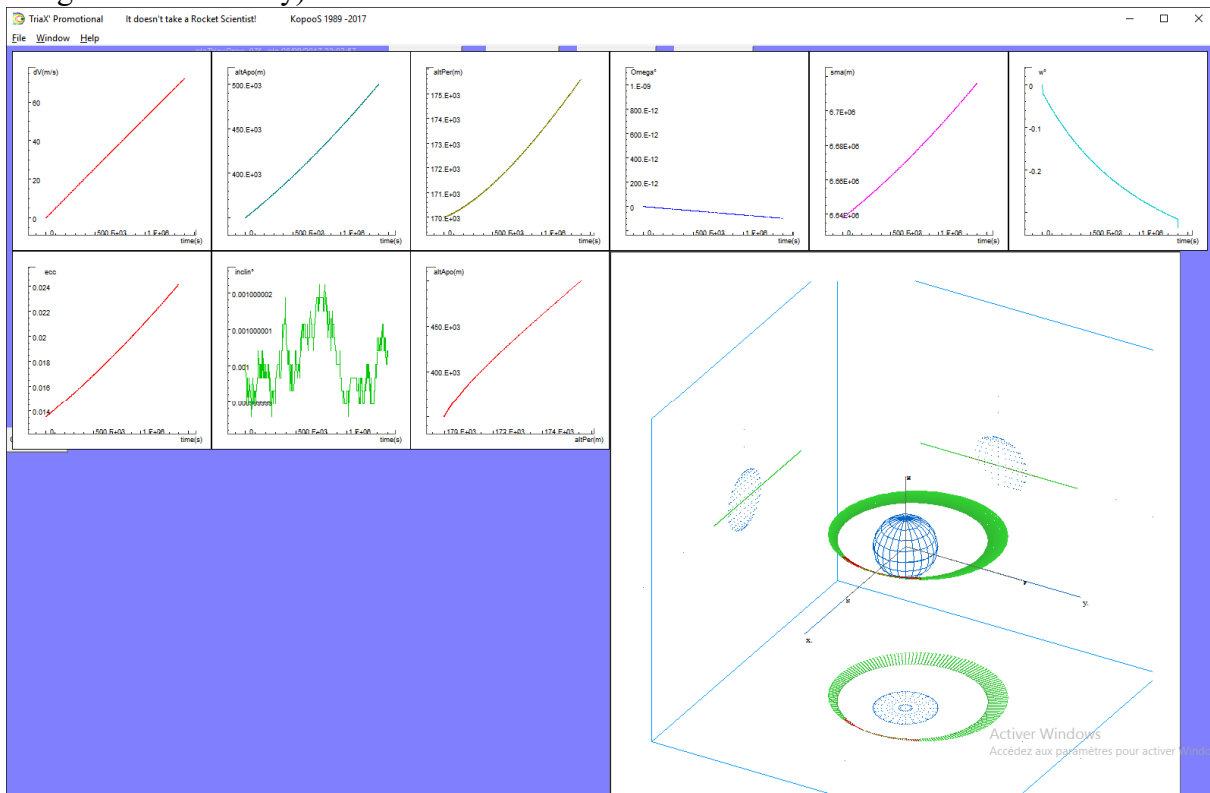
2) **Case BOB5** At an orbit of 170 km perigee, 350 km apogee, start burning for 20 minutes at perigee on each orbit.  
 Thrust = 3.5 mN  
 Just thrust at perigee.  
 Raise apogee to 500km.  
 What is the time to go from 170 km perigee, 350 km apogee to 170 km perigee to 500 km apogee. Need number of orbits, total burn time and total transfer time. Of course, the perigee will change during this operation. What is the final perigee?



**Run Case BOB5**

With aerodynamic forces "moderate", the thrust 3.5 mN is not enough for enabling perigee raising, the apogee slowly drop then both apsides decrease and deorbit occurs fast (13 days).

With aerodynamic forces "low", the thrust 3.5 mN is enough: 258 pulses of 20 minutes are needed to raise apogee from 170 up to 500 km. Time to go is 16.2 days. Perigee increases a bit from 170 to 175 km. Total burn time 258 x 20 minutes. DeltaV =72.1 m/s (thrust orientation during the burn: in the horizontal --i.e. perpendicular to the radius vector to Earth-- along with the velocity).



**Result table for traceability:**

time(s)	ecc	altPer(m)	altApo(m)	inclin°	Omega°	w°	phi°	O+w+p°	w+p°	period	dt(s)	mass(kg)	thrust(N)	halfArc-t°	beta-t°	moon°	AnoExc°	n°Arc
0	0.013558	170000	350001	0.001	0	0	0	0	0	5382.5	0	15	0	0	0	0	0	0
4781.6	0.013541	169976	349742	0.001	0	-0.018	-41.172	-41.2	-41.2	5382.3	30.1	15	0.004	41.19	90	0	319.336	1
5983	0.013577	170003	350258	0.001	0	-0.02	41.21	41.2	41.2	5382.6	29.3	15	0	0	0	0	40.7	1
1399728.5	0.024152	175588	500000	0.001	0	-0.337	-18.047	-18.4	-18.4	5477.3	29.2	14.989	0.004	41.19	90	0	342.377	258

O+w°	mid-t°	alpha-t°	Eclip(s)	sma(m)	dV(m/s)	Lo°	ra_sma°	d_sma°	e_x	e_y	i_x°	i_y°	TimeID	MeanLo°	HourDN	ActAlt(m)	ActV(m/s)	Focus
0	0	0	0	6640000	0	91.094	180	0	0.013558	0	0.001	0	2458655.5	91.094	18	170000	7854.786	Earth
360	0	90	0	6640000	0	29.926	179.982	0	0.013541	-0.000004	0.001	0	2458655.56	30.947	18	191678.298	7829.091	Earth
360	0	0	0	6640000	0.3	107.287	179.98	0	0.013577	-0.000005	0.001	0	2458655.57	106.262	18	191802.576	7829.102	Earth
359.7	0	90	0	6720000	72.1	-14.239	179.663	0	0.024152	-0.000142	0.001	0	2458671.7	-13.382	18	183200.806	7883.418	Earth