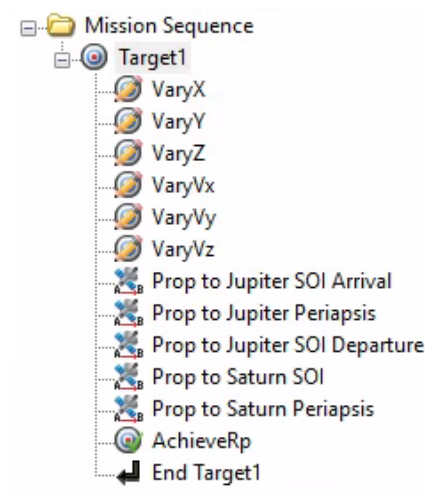
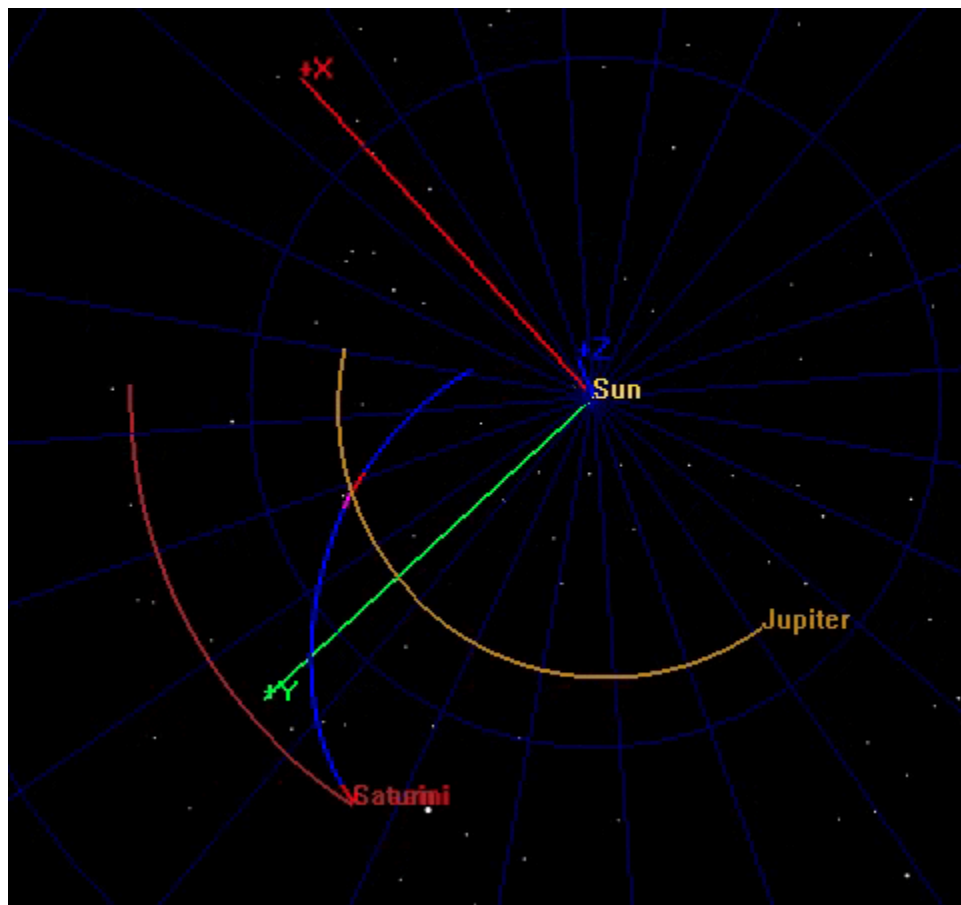


Problem 2

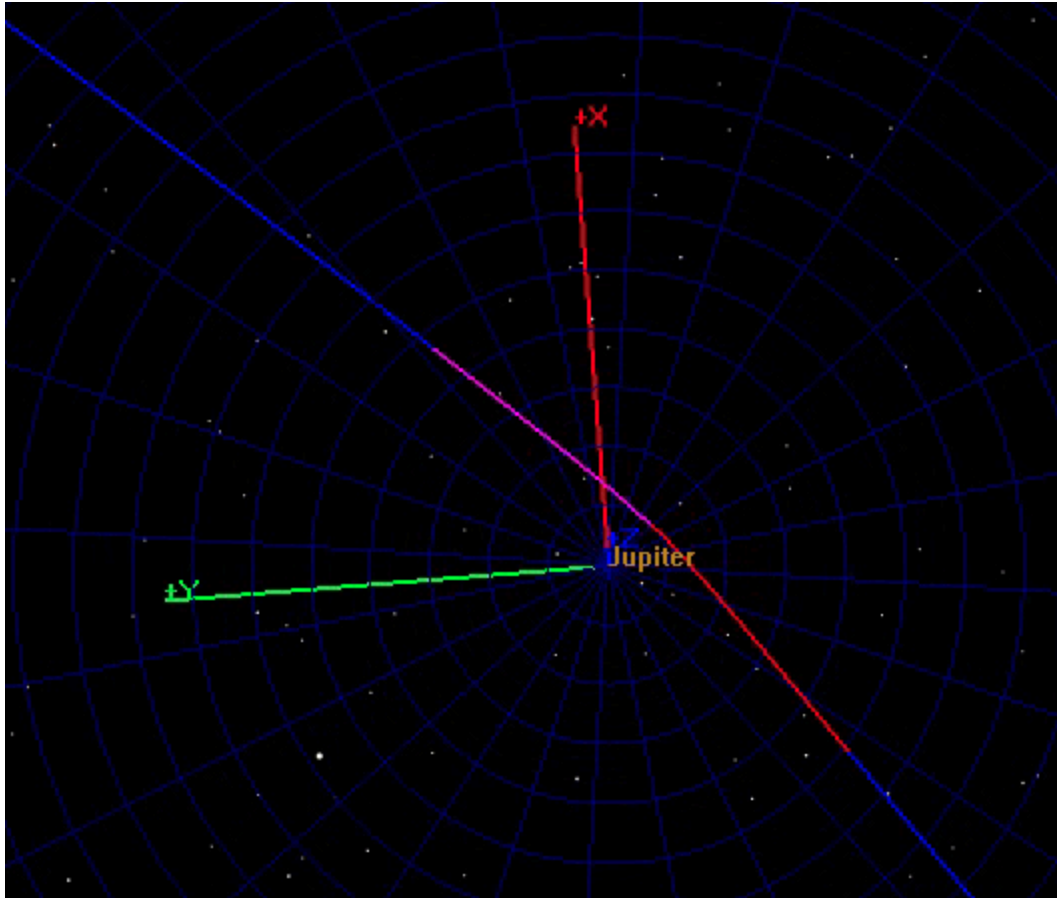
- Part a



Mission Sequence Screenshot



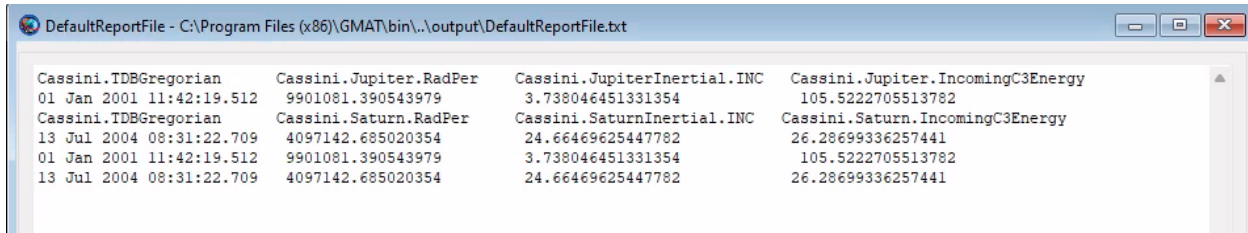
Heliocentric View of Trajectory (Blue)



Jupiter-Centered View of Trajectory (Blue)

- Part b
 - The report lists the radius of periapsis as 9,901,081.3905 km. It is given that the radius of Jupiter is 71,492 km. So, the altitude at periapsis is 9,829,589.3905 km
 - The epoch in Gregorian TDB date format is 01 Jan 2001 11:42:19.512.
 - The inclination is 3.7380 deg
 - The v-infinity along the hyperbola is square root of Incoming C3. v-infinity is 10.2724 km/s
- Part c
 - The report lists the radius of periapsis as 4,097,142.6850 km. It is given that the radius of Jupiter is 60,268 km. So, the altitude at periapsis is 4,036,874.685 km
 - The epoch in Gregorian TDB date format is 13 Jul 2004 08:31:22.709.

- The inclination is 24.6647 deg
- The v-infinity along the hyperbola is square root of Incoming C3.
v-infinity is 5.1271 km/s
- The report file is shown below



DefaultReportFile - C:\Program Files (x86)\GMAT\bin\..\output\DefaultReportFile.txt

Cassini.TDBGregorian	Cassini.Jupiter.RadPer	Cassini.JupiterInertial.INC	Cassini.Jupiter.IncomingC3Energy
01 Jan 2001 11:42:19.512	9901081.390543979	3.738046451331354	105.5222705513782
Cassini.TDBGregorian	Cassini.Saturn.RadPer	Cassini.SaturnInertial.INC	Cassini.Saturn.IncomingC3Energy
13 Jul 2004 08:31:22.709	4097142.685020354	24.66469625447782	26.28699336257441
01 Jan 2001 11:42:19.512	9901081.390543979	3.738046451331354	105.5222705513782
13 Jul 2004 08:31:22.709	4097142.685020354	24.66469625447782	26.28699336257441

- Part d
 - As seen above the radius of periapsis is not 81,000 km and the date of arrival is not July 1, 2004.
 - This may be because the GMAT simulation doesn't model any trajectory correction maneuvers that actual Cassini spacecraft may have conducted before it reached Saturn.
- Part e

```

*** Targeting Completed in 8 iterations.
*** The Targeter converged!
Final Variable values:
  Cassini.X = 298694286.772
  Cassini.Y = 201077211.165
  Cassini.Z = -4192849.59156
  Cassini.VX = 5.28832476238
  Cassini.VY = 22.0972626796
  Cassini.VZ = -0.262665585358

```

```

Mission run completed.
==> Total Run Time: 118.621 seconds|

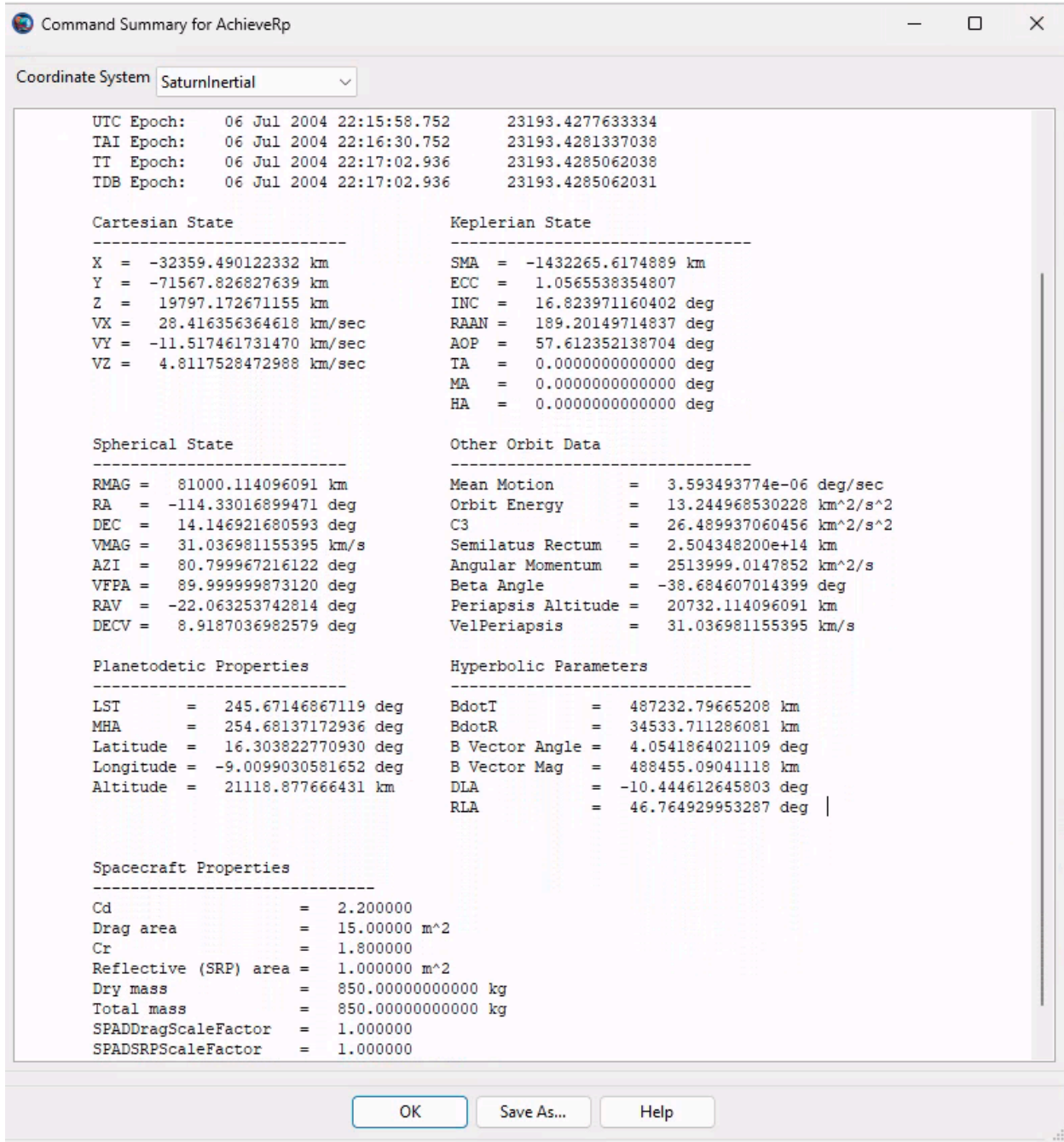
```

New Initial State Vector

- The targeter required 8 iterations to get to these values.
- Difference in state vector
 - X - 0.0000575 km
 - Y - 0.0001812 km
 - Z - 0.000004223 km
 - Vx - 0.00156924506263 km/s
 - Vy - 0.00436424588517 km/s
 - Vz - 0.00010459917061 km/s

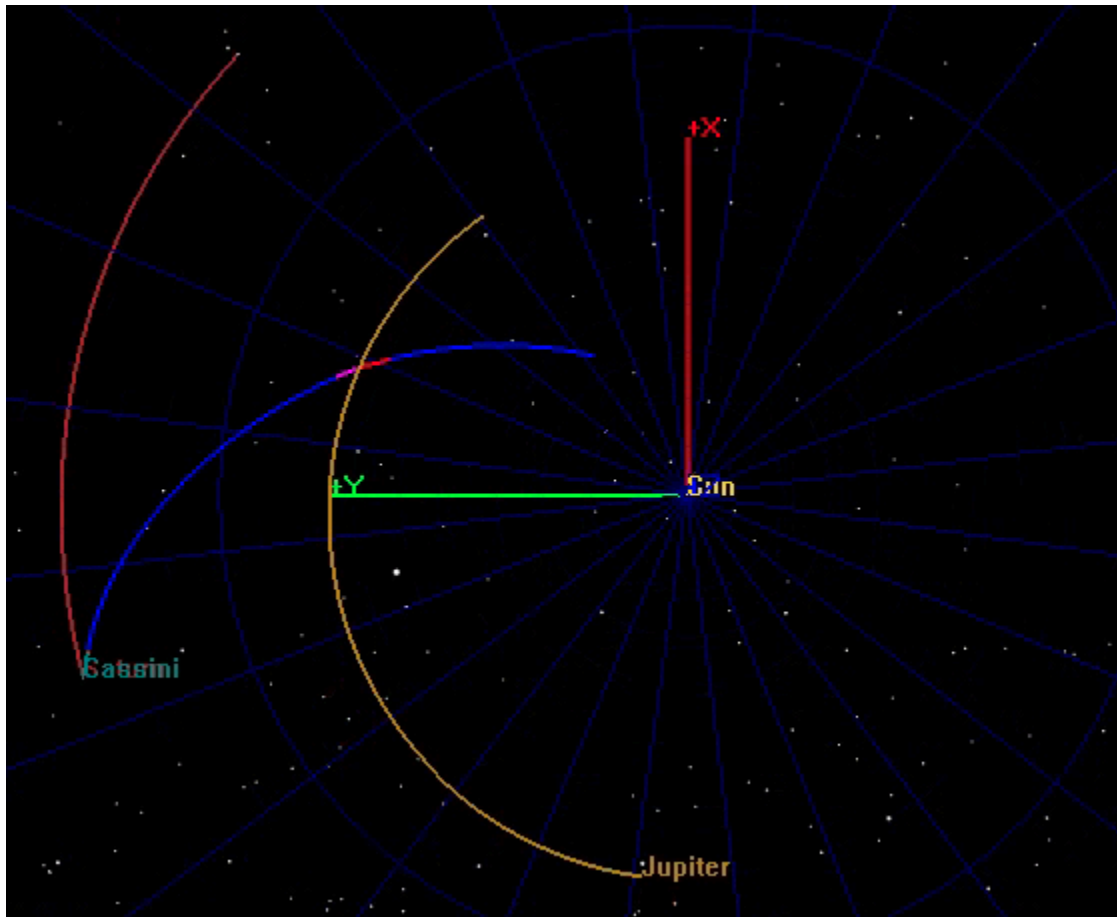
- Plot below shows the achieved radius of periapsis - 81000.114096 km. The plot below that also shows the radius of periapsis (RMAG)

Solver Window - Target DefaultDC {SolveMode = Solve, ExitMode = SaveAndContinue, ShowProgressWindow = true};			
Control Variable	Current Value	Last Value	Difference
Cassini.X	298694286.7720575	298694286.7720575	0
Cassini.Y	201077211.1651812	201077211.1651812	0
Cassini.Z	-4192849.591564223	-4192849.591564223	0
Cassini.VX	5.28832476237644	5.28832476237644	0
Cassini.VY	22.09726267962946	22.09726267962946	0
Cassini.VZ	-0.2626655853580731	-0.2626655853580731	0
Constraints	Desired	Achieved	Difference
(=) Cassini.Saturn.RadPer	81000	81000.11409609072	0.1140960907214321
CONVERGED			

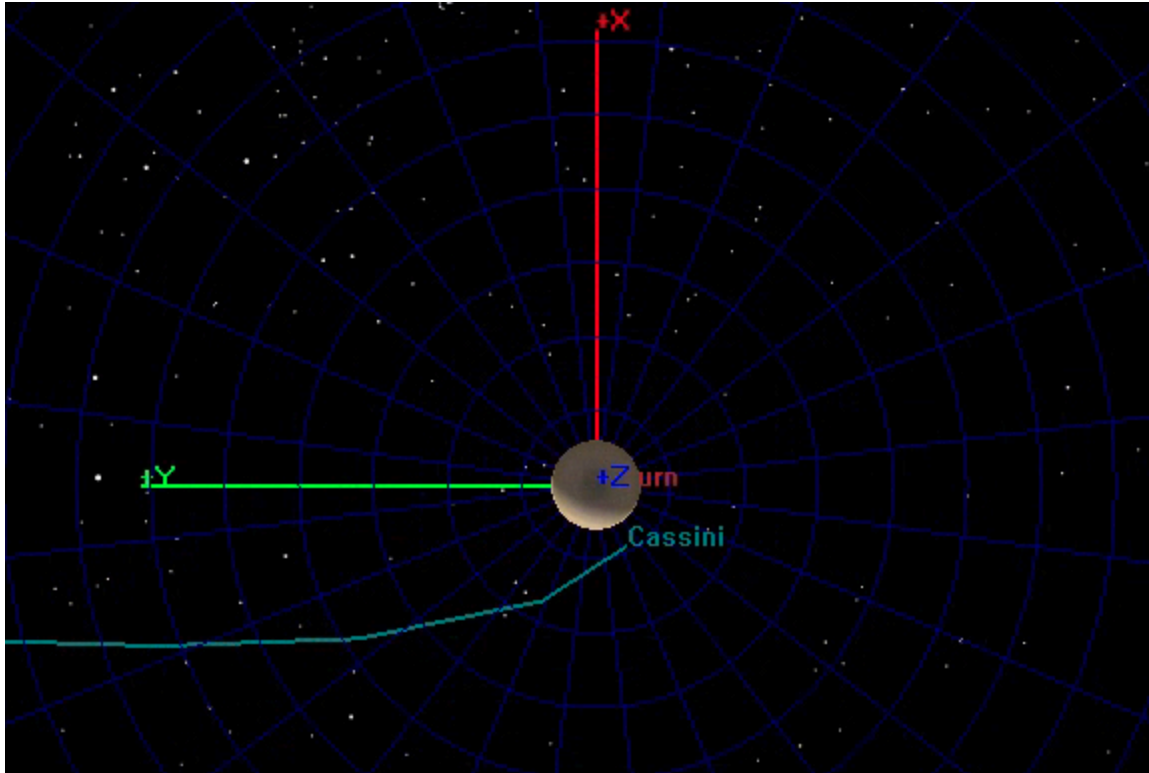


- Such a small change in the initial state vector caused such a big change because the change in initial positions changed the position of Jupiter and Saturn that provided the gravity assists. Their change in position changed the trajectory slightly, but at a solar system scale, even such a small change can drastically change the trajectory of the spacecraft. For perspective, the initial radius of periapsis (4e6 km in part c) is ~0.2% of Saturn's orbital radius. Hence, small initial changes cause big ripples.

- Part f



Heliocentric View of Trajectory (Blue)



Saturn-Centered View of Trajectory (Blue)