GENESIS MISSION

Add-On for Orbiter2016 (v.160828)

REQUIREMENTS
Launch scenario requires "Delta2 and SLC17"
https://www.orbithangar.com/searchid.php?ID=7124

RECOMMENDED
InterplanetaryMFD 5.7 http://users.kymp.net/p501474a/Orbiter/Orbiter.html
LagrangeMFD https://www.orbithangar.com/searchid.php?ID=7070

INSTALLATION
Extract all files to the root of your Orbiter program directory. Be sure to preserve the folder structure. This should NOT overwrite anything in the standard Orbiter package.

WHAT'S IN THIS ADD-ON?
The Genesis spacecraft, AS350 recovery helicopter and heliport, "genesis_site" landing target base. Scenarios inc. Launch, post-launch, L1 halo-orbit, SRC release, AS350 recovery practice.

GENESIS MISSION OVERVIEW (text adapted from NSSDC)
The primary objective of the Genesis mission is to collect samples of solar wind particles and return them to Earth for detailed analysis.

Genesis launched successfully at 16:13:40 UTC on 8 August 2001 on a Delta 7326 (a Delta II Lite launch vehicle with three strap-on solid-rocket boosters and a Star 37FM third stage).

Approximately 1 hour later the spacecraft left low Earth orbit on a three month journey out towards the Sun-Earth L1 Lagrange point, 0.01 AU from Earth, to be inserted into a halo orbit about the L1 point. The L1 point is beyond the influences of the geomagnetic field and its trapped particles.

It completed 5 halo orbits over 30 months collecting samples. The samples were stowed and sealed in the contamination-tight canister within the Sample Return Capsule (SRC) which was returned to Earth. The spacecraft bus looped around Earth after the SRC was released and headed back out towards the L1 point.

Unfortunately, the SRC parachute never deployed and the capsule crashed in the Utah desert at a speed of 311 km/hr, severely damaging the capsule. The original plan was for a mid-air recovery of the SRC by helicopter.

MORE INFO HERE.....
http://nssdc.gsfc.nasa.gov/nmc/masterCatalog.do?sc=2001-034A
http://www.nasa.gov/mission_pages/genesis/main/
http://genesismission.jpl.nasa.gov/

SCENARIOS
Scenarios are in the "Genesis Mission" folder on the Orbiter Launchpad list.

1. Launch:	Delta287 carrying Genesis spacecraft is ready on the pad. Press V at T-10 for ascent autopilot to parking orbit.
2. Post-launch:	Leaving Earth, on the way to L1 halo-orbit.
3. L1 halo-orbit:	Station keeping on orbit around L1.
4. SRC Release:	Shortly before SRC Release for return to Earth.
5. AS350 SRC Recovery Practice:	Practice mid-air recovery of SRC by helicoopter

GENESIS SPACECRAFT DATA

Bus Empty Mass	289kg
SRC Mass	205kg
Propellant Mass	142kg
Main Engine/RCS ISP	3000Ns/kg
Main Engine Thrust	22N(each) x 4
RCS Thrust	1N(each) x 16

GENESIS BUS CONTROLS

Genesis_Bus has Rotational RCS (not balanced) for attitude control. Linear RCS in +Z direction only, for small dV course corrections. Main Engine also thrusts in +Z direction.
[G] = Deploy Solar Panels
[K] = Open/Close Particle Collectors
[J] = Jettison SRC (separation vel. 0.3m/s)
dV Capability is displayed on the HUD

GENESIS SRC

The SRC is spin-stabilised and flies on a ballistic trajectory once released. Drogue chute and parafoil deployment are automatic. At 100km alt. the SRC will spawn the two AS350 recovery helicopters at bases located near the "genesis_site" target base.
If "Damage and Failure Simulation" is enabled on your Orbiter launchpad, there is a small chance that the parachutes will fail during reentry, so you too can experience the disappointment and frustration of the mission scientists and engineers!

AS-350 CONTROLS

[K] = Start/Stop Engines (1min. warm-up time)
[L] = Night Lights On/Off
[G] = Deploy/Retract Grapple
[J] = Release Grappled Payload
[N]/[M] = +/- Rotor Thrust Tilt Angle
[Delete]/[Insert] = +/- Elevator Trim
[V] = Stop and Hover (auto pitch,bank,throttle - some pitch/bank user control for small adjustments)
[B] = Maintain Altitude (auto throttle for 0m/s climb rate)
[P] = Enter target name (Vessel or Base) Distance, bearing and rel.alt are displayed on the HUD.

AS-350 OPERATION NOTES

Once engines have been started [K], power can only be applied once engines are up to speed after about 1 minute (rotor animation goes blurry).
Default rotor thrust vector [N]/[M], can be tilted forward by up to 10°, for comfortable cruising.
Set elevator trim [Delete]/[Insert] for cruising attitude.
"Stop and Hover" [V] helicopter will kill ground speed and hover (some user authority over pitch and bank is maintained for fine adjustments while hovering).
"Maintain Altitude" [B] will adjust throttle automatically to maintain 0m/s climb rate.
SRC Parafoil will be captured if grapple hook comes within 5m of top of parafoil
It's much easier to fly with a joystick!

FLIGHT NOTES

Launch

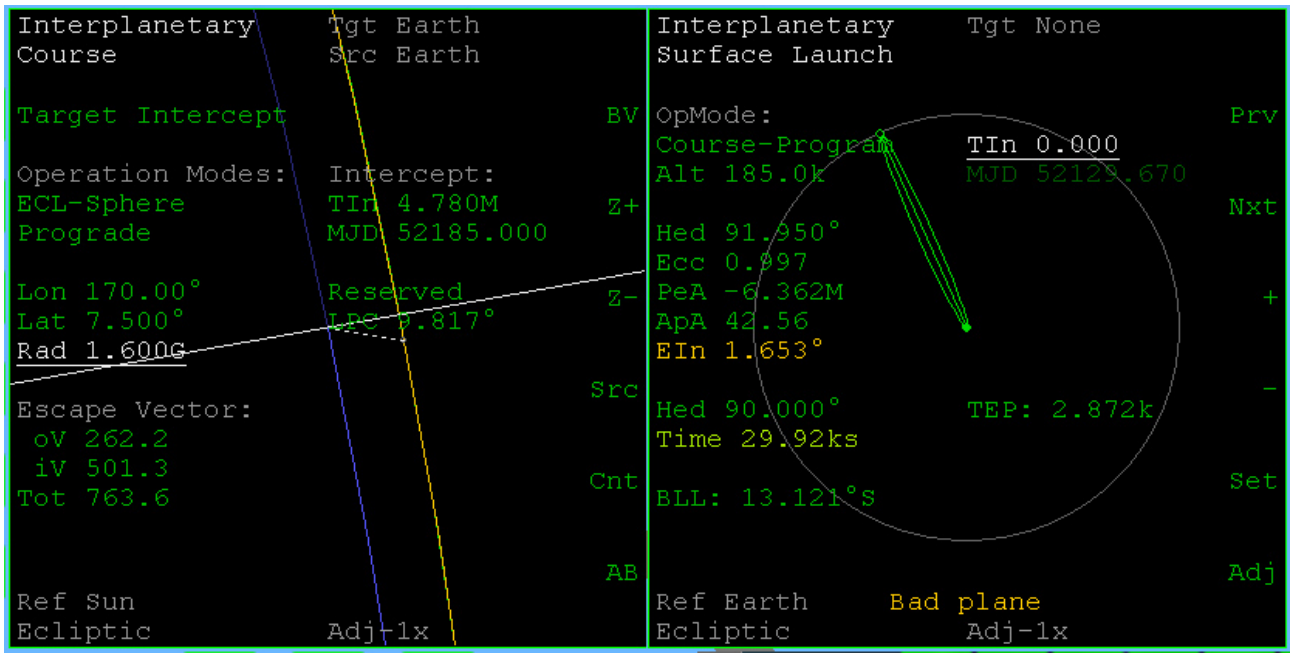
The Delta287 is set for launch to 185km parking orbit at 28.7°.inc.(92° launch azimuth).
You can choose to launch at the historical time of 16:13:40 UTC, or plan your own launch.

Although there are no tools within Orbiter to plan a launch to Lagrange Points, it is possible to get a usable solution using IMFD "Course - Target Intercept" and IMFD "Surface Launch".

IMFD "Course - Target Intercept" is used with "Offset" mode enabled. Target is set to Earth, flight time will be ~55 days, "Offset" distance is set to 1.5Gm. "Offset" Lat. and Long. are set to 1/2 the angular radius of the required "Halo Orbit".

(cont.)
In this case, the target "Halo Orbit" is 60° across (ecliptic plane) by 30° (perpendicular to ecliptic) when viewed from Earth. Angular radius is thus 15° x 30°.

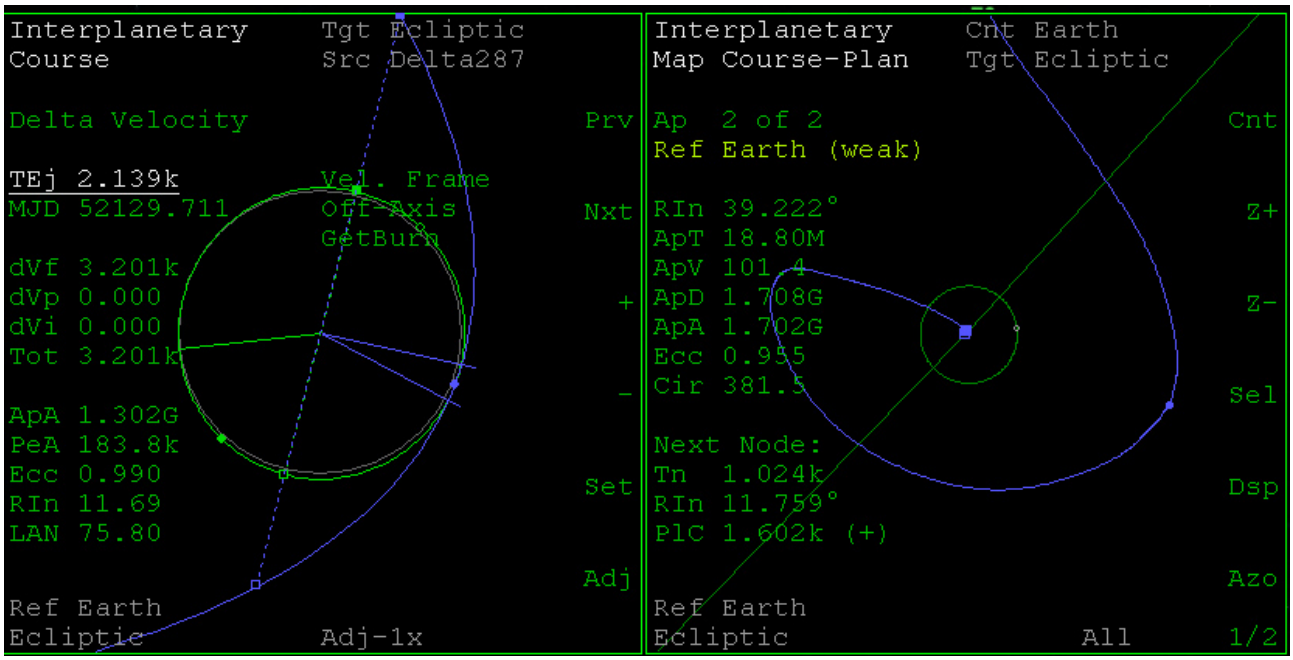
So "Offset" Lat. = +7.5°, and "Offset" Long. = Earth->Sun line – 15°



IMFD "Course - Target Intercept - Offset" and "Surface Launch" settings

Escape Burn

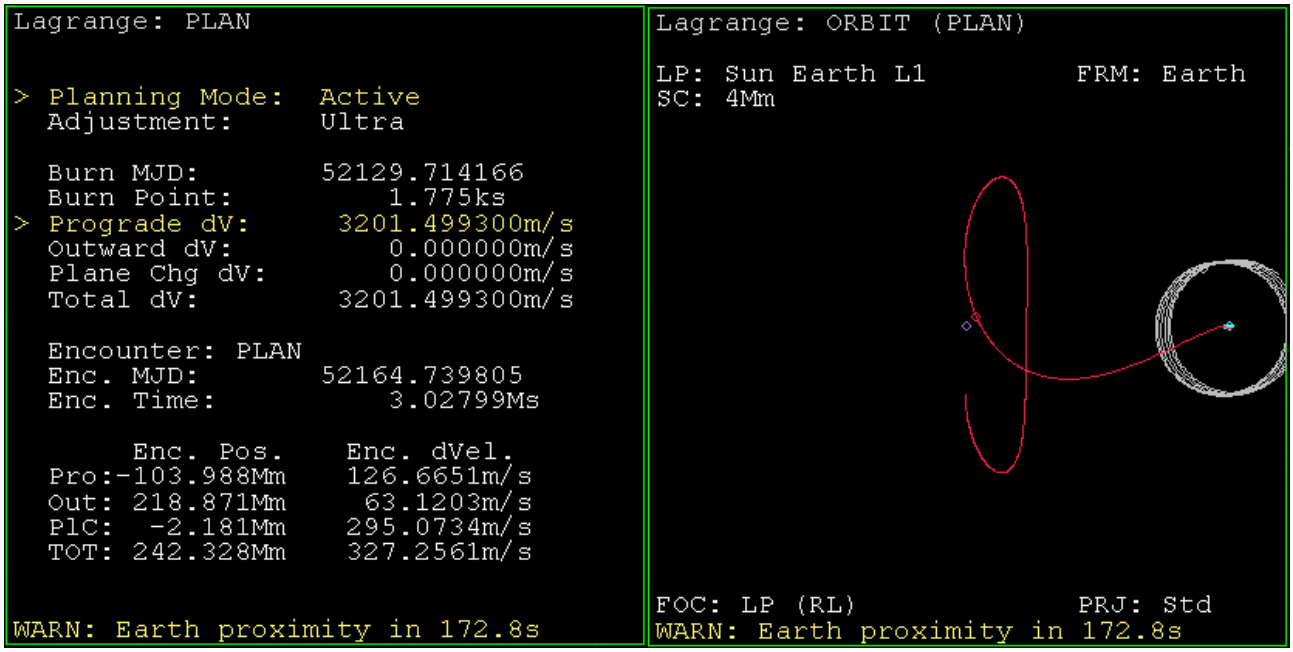
Once in parking orbit, you can use IMFD "Delta Velocity" + IMFD "Map - Plan View" to plan your escape burn. You will need ~3202m/s dV Prograde. Adjust the burn timing to achieve the distinctive "Rugby Ball" shape trajectory in IMFD "Map - Plan View".



IMFD "Course - Delta Velocity" and "Map - Plan View" escape burn planning

(Escape Burn cont.)

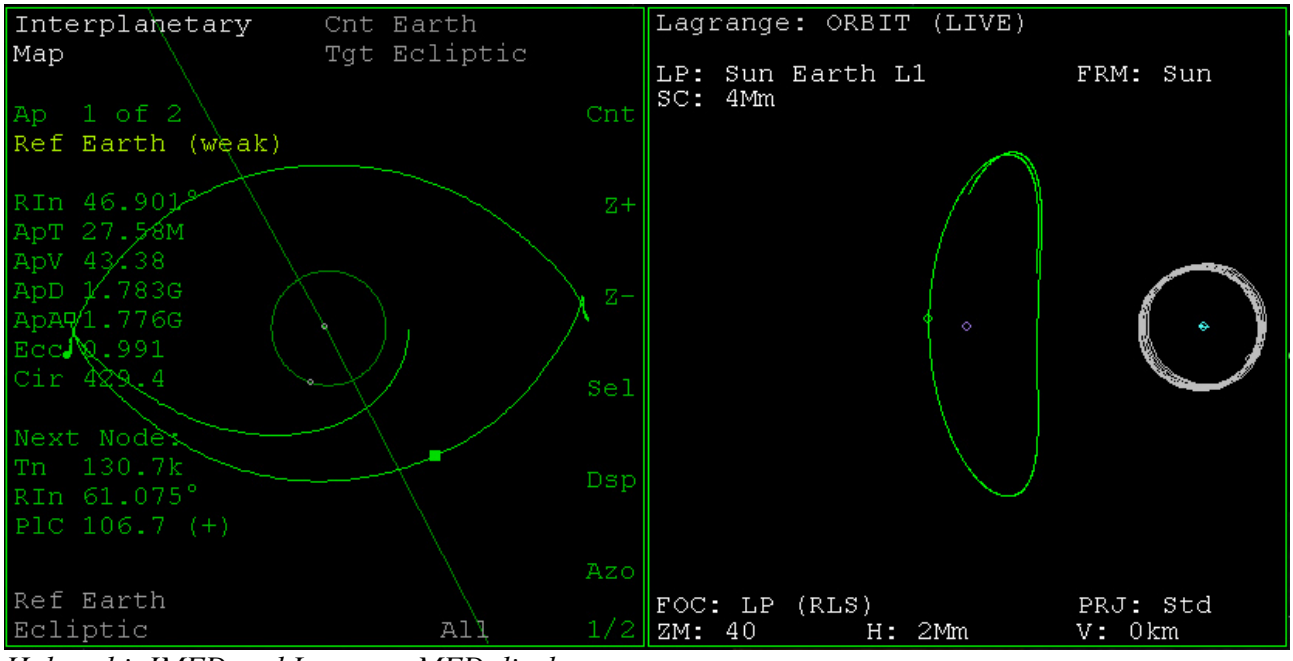
Alternatively, you can use LagrangeMFD. Adjust the burn timing to achieve the "Lasso" shape in the LagrangeMFD "Rotating Frame" view. I recommend transferring the burn data to TransX "Maneuver Mode" or IMFD "Delta Velocity" to implement the burn.



LagrangeMFD escape burn planning

Halo Orbit Station Keeping

Conveniently, at the general distance of the Lagrange Points, dV required for course corrections and station keeping is minimal. If the trajectory is tending towards Earth, make small burn directly towards Sun. If trajectory is tending to escape from Earth, burn directly away from Sun. Station keeping burns need to be made every one or two months, or at least at each apogee and perigee.



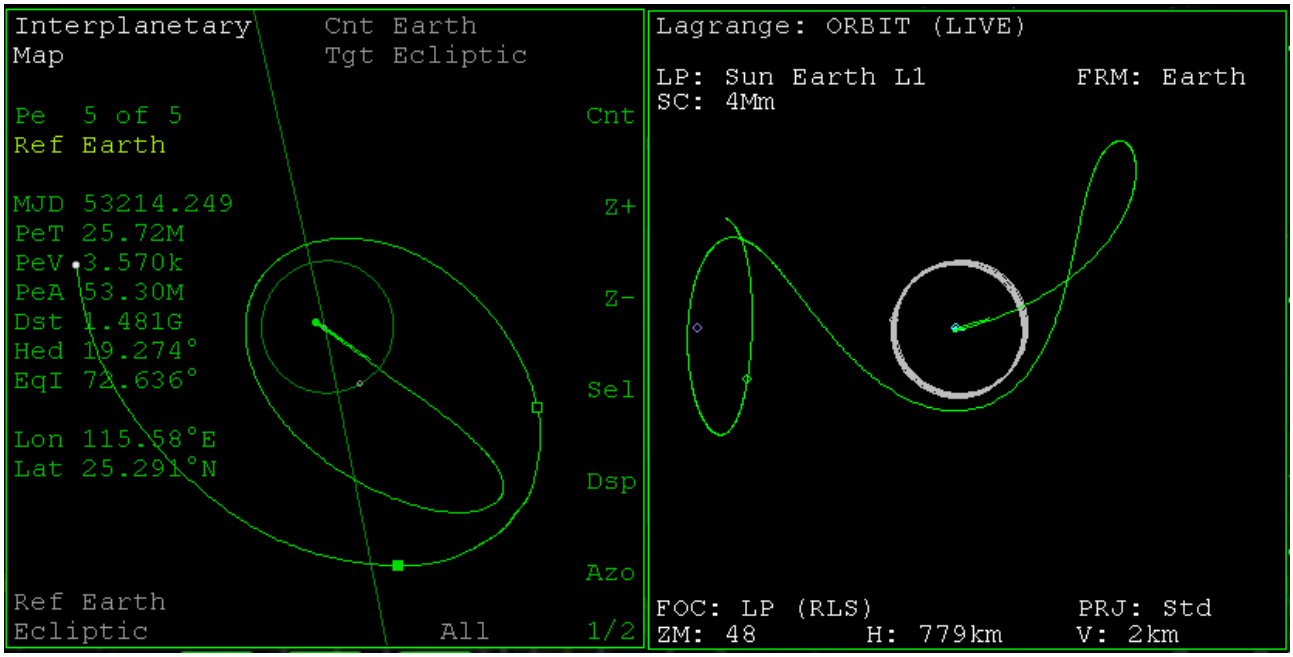
Halo orbit IMFD and LagrangeMFD displays

Return to Earth

Maintain Halo Orbit until apogee at October 2003, then you will need to set up the return to Earth by making small burn away from Sun.

To give a daylight SRC reentry over Utah, Genesis makes a flyby of Earth (just beyond Moon orbit) before looping back to Earth from the night-side.

Make small burns away from Sun and monitor the trajectory on IMFD "Map" and LagrangeMFD until you find a solution. Check your PeA, Lat. and Lng. at Earth on IMFD "Map".



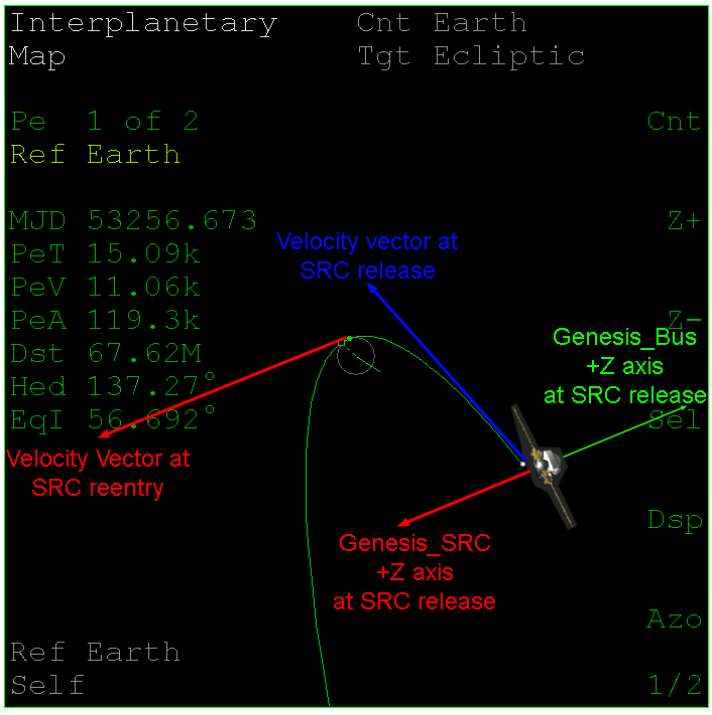
IMFD "Map" and LagrangeMFD display of Earth return solution

SRC Release

On your approach to Earth, try to set your PeA at 20km over the "genesis_site" target base in Utah, as far in advance as possible.

When setting Genesis_Bus attitude for SRC release, remember that the *SRC capsule faces the opposite direction from the Bus*. Release velocity is 0.3m/s .

Spin-up Genesis_Bus to 15rpm before SRC release, then de-spin and make burn to avoid Earth reentry.



IMFD "Base Approach" parameters

Target = genesis_site
Alt. = 120km
ReA. = 7.1°
Ant. = 7.9°

SRC Recovery
At 100km alt. the SRC will spawn the two AS350 helicopters at bases located near the "genesis_site" base. Select the nearest AS350 and make mid-air recovery of the SRC using the grapple pole beneath the helicopter. Return to base and deliver the SRC!

THANKS to....Dr.S, brainstorm, Adswnj, jarmonik, fred18, and all other Orbinauts and developers who made this simulation possible :-)

Happy Orbits!
BrianJ
October 2017

Genesis Trajectory