Grannus Expansion Pack - Delta V

Interstellar Transfer - Gael to Grannus

Time of Flight		
	40 years (379)	Ejection Δv: 2940 m/s Capture Δv (Pe = 2.5 Gm): 140 m/s Capture Δv (Pe = 11.9 Gm): 305 m/s Circularization & plane change (2.5 Gm): 7830 m/s Circularization & plane change (11.9 Gm): 3490 m/s
	30 years (284)	Ejection Δv: 3130 m/s Capture Δv (Pe = 2.5 Gm): 310 m/s Capture Δv (Pe = 11.9 Gm): 665 m/s Circularization & plane change (2.5 Gm): 7440 m/s Circularization & plane change (11.9 Gm): 3310 m/s
	20 years (189)	Ejection Δv: 3820 m/s Capture Δv (Pe = 2.5 Gm): 825 m/s Capture Δv (Pe = 11.9 Gm): 1710 m/s Circularization & plane change (2.5 Gm): 7290 m/s Circularization & plane change (11.9 Gm): 3240 m/s

Interstellar Transfer - Nodens to Ciro

Time of Flight		
	40 years (379)	Ejection Δv: 5600 m/s Capture Δv (Pe = 14 Gm): 250 m/s Circularization & plane change (14 Gm): 3830 m/s
	30 years (284)	Ejection Δv: 5610 m/s Capture Δv (Pe = 14 Gm): 540 m/s Circularization & plane change (14 Gm): 3850 m/s
	20 years (189)	Ejection Δv: 6050 m/s Capture Δv (Pe = 14 Gm): 1390 m/s Circularization & plane change (14 Gm): 3850 m/s

Launch Δv

Nodens	4100 m/s (SL) 3900 m/s (4 km)
Epona	2330 m/s
Brovo	1510 m/s
Belisama	960 m/s
Taranis	700 m/s
Airmed	570 m/s
Cernunnos	310 m/s
Damona	275 m/s
Rosmerta	160 m/s
RAB-58E	50 m/s

NOTES

1. Interstellar transfers are computed for year 10; transfers in other years will vary.
2. Time of flight is given in Gael-years (2556 hours); numbers in () are Nodens-years (270 hours).
3. Ejection occurs from low orbit around departure planet; includes plane change for direct transfer.
4. Capture Δv is minimum required, with apoapsis at SOI.
5. Circularization burn includes plane change to match ecliptic plane of destination star.
6. Launch Δv is for eastward launch from equator, sea level elevation unless noted otherwise.

Grannus Expansion Pack - Interplanetary Transfer Orbits

Departure Planet	Arrival Planet: Taranis	Nodens	Sirona	Epona	Cernunnos
Taranis		Escape/Injection: 17100-17600 m/s Plane change: 0-1720 m/s Flight time: 54-57 hours Orbit matching: 8900-9230 m/s Capture/circ. (82 km): 1080 m/s Entry speed: 9630-9930 m/s	Escape/Injection: 19700-20300 m/s Plane change: 0-1200 m/s Flight time: 490-550 hours Capture: 1980-2260 m/s Circularization (550 km): 2030 m/s Entry speed: 9000-9280 m/s	Escape/Injection: 20100-20700 m/s Plane change: 0-1350 m/s Flight time: 1290-1540 hours Capture: 2470-2940 m/s Circularization (51 km): 670 m/s Entry speed: 4770-5250 m/s	Escape/Injection: 20200-20800 m/s Plane change: 0-3340 m/s Flight time: 2110-3580 hours Capture: 2700-3990 m/s Circularization (20 km): 110 m/s Impact speed: 3070-4370 m/s
Nodens	Escape/Injection: 9960-10300 m/s Plane change: 0-1720 m/s Flight time: 54-57 hours Orbit matching: 16900-17400 m/s Capture/circ. (20 km): 250 m/s Impact speed: 16900-17500 m/s		Ejection: 3250-3330 m/s Plane change: 0-190 m/s Flight time: 635-695 hours Capture: 615-700 m/s Circularization (550 km): 2030 m/s Entry speed: 7630-7710 m/s	Ejection: 3990-4100 m/s Plane change: 0-435 m/s Flight time: 1490-1750 hours Capture: 1300-1570 m/s Circularization (51 km): 670 m/s Entry speed: 3600-3870 m/s	Ejection: 4210-4510 m/s Plane change: 0-1460 m/s Flight time: 2340-3850 hours Capture: 1870-2840 m/s Circularization (20 km): 110 m/s Impact speed: 2250-3220 m/s
Sirona	Ejection: 4010-4290 m/s Plane change: 0-1200 m/s Flight time: 490-550 hours Orbit matching: 19500-20000 m/s Capture/circ. (20 km): 250 m/s Impact speed: 19500-20000 m/s	Ejection: 2640-2730 m/s Plane change: 0-190 m/s Flight time: 635-695 hours Capture: 2240-2320 m/s Circularization (82 km): 1020 m/s Entry speed: 5860-5930 m/s		Ejection: 2140-2170 m/s Plane change: 0-150 m/s Flight time: 2410-2730 hours Capture: 155-245 m/s Circularization (51 km): 670 m/s Entry speed: 2460-2550 m/s	Ejection: 2210-2320 m/s Plane change: 0-725 m/s Flight time: 3360-5140 hours Capture: 665-1320 m/s Circularization (20 km): 110 m/s Impact speed: 1050-1700 m/s
Epona	Ejection: 3140-3620 m/s Plane change: 0-1350 m/s Flight time: 1290-1540 hours Orbit matching: 19900-20500 m/s Capture/circ. (20 km): 250 m/s Impact speed: 19900-20500 m/s	Ejection: 1970-2240 m/s Plane change: 0-435 m/s Flight time: 1490-1750 hours Capture: 2980-3110 m/s Circularization (82 km): 1020 m/s Entry speed: 6590-6720 m/s	Ejection: 825-910 m/s Plane change: 0-150 m/s Flight time: 2410-2730 hours Capture: 115-145 m/s Circularization (550 km): 2030 m/s Entry speed: 7130-7160 m/s		Ejection: 720-805 m/s Plane change: 0-625 m/s Flight time: 4930-6660 hours Capture: 210-725 m/s Circularization (20 km): 110 m/s Impact speed: 605-1110 m/s
Cernunnos	Ejection: 2800-4100 m/s Plane change: 0-3340 m/s Flight time: 2110-3580 hours Orbit matching: 20100-21300 m/s Capture/circ. (20 km): 250 m/s Impact speed: 20100-21300 m/s	Ejection: 1980-2940 m/s Plane change: 0-1460 m/s Flight time: 2340-3850 hours Capture: 3270-3840 m/s Circularization (82 km): 1020 m/s Entry speed: 6880-7450 m/s	Ejection: 745-1370 m/s Plane change: 0-725 m/s Flight time: 3360-5140 hours Capture: 195-345 m/s Circularization (550 km): 2030 m/s Entry speed: 7210-7360 m/s	Ejection: 220-730 m/s Plane change: 0-625 m/s Flight time: 4930-6660 hours Capture: 55-240 m/s Circularization (51 km): 670 m/s Entry speed: 2360-2540 m/s	

Departure Planet	Arrival Planet: Belisama
Nodens	Plane change: 25* m/s Ejection: 1005 m/s Flight time: 9-14 hours Capture: 60 m/s Circularization (20 km): 295 m/s Impact speed: 1180 m/s

* 0.56° plane change prior to ejection, assuming optimal launch from KSC.

NOTES

1. To use, select the departure planet on the right of the table, and the arrival planet at the top of the table. Data for the transfer orbit between the selected planets is in the cell where the row and column intersects.
2. All transfers orbits are computed as Hohmann type with a mid-course plane change. Initial injection is in the orbital plane of the departure planet. Plane change is performed 90-degrees from target intercept.
3. Ejection is the Δv required to eject the spacecraft from a low orbit around the departure planet, and placing it in a transfer orbit that intercepts the arrival planet 180-degrees from the ejection point.
4. Escape/Injection is the Δv required to perform a two-burn technique, consisting of escape to solar orbit followed by injection into transfer orbit. Might be needed when very long burn times prohibit one-burn ejection.
5. Plane change is the Δv required to alter the spaecraft's transfer orbit from being coplanar with the departure planet to having an inclination that will intercept the target.
6. Flight time is the time in hours required to travel from the departure planet to the arrival planet. It is one-half the orbital period of the transfer orbit.
7. Capture is the Δv required to slow the spacecraft just enough that it is captured by the arrival planet, resulting in an orbit with a periapsis near the planet and an apoapsis near the sphere of influence.
8. Circularization is the Δv required to alter the spacecraft's orbit from its initial elliptical capture orbit to a low circular orbit around the planet. The altitude of the circular orbit is indicated.
9. Orbit matching is the Δv required to match the solar orbit of the arrival planet, allowing for a subsequent low speed encounter with target. Might be needed when extremely long burn times prohibit direct capture.
10. Capture/circularization is the minimum Δv required to insert the spacecraft into a low circular orbit around the arrival planet, presuming a low speed encounter setup by previous orbit matching.
11. Entry and/or impact speed is the speed of the speedcraft when making contact with the arrival planet's upper atmopshere and/or surface, presuming it is on a direct impact trajectory.
12. The altitude of circular orbits, or the periapsides of ellipitcal and hyperbolic orbits, is assumed to be 20 km above the planet's surface, or 10 km above the atmosphere, whichever is greater.
13. Where a range of numbers is indicated, these are the minumum and maximum values. Actual requirements will vary within this range depending on the particular launch window selected.
14. Hohmann transfer orbits are only one possibility. If another type of transfer is used, then the values can vary significantly from those indicated.
15. Transfer orbits designed to reduce flight time will require greater Δv.