EUROPA LANDER MISSION CONCEPT TRAJECTORY DESIGN: CASE STUDIES FOR THE DIRECT-TO-EARTH ARCHITECTURE

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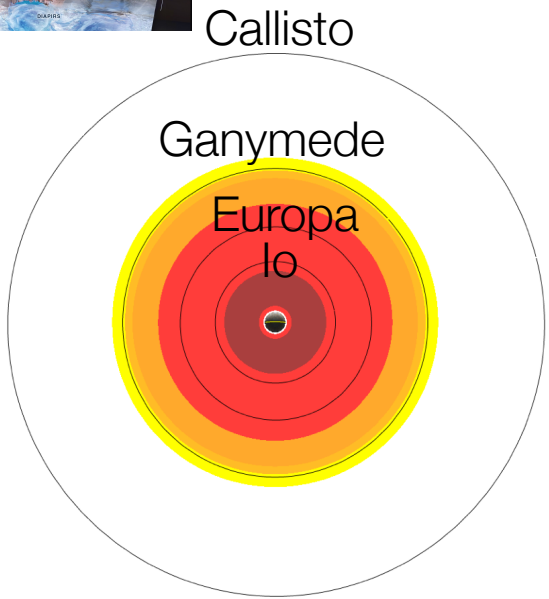
A Mission to Europa

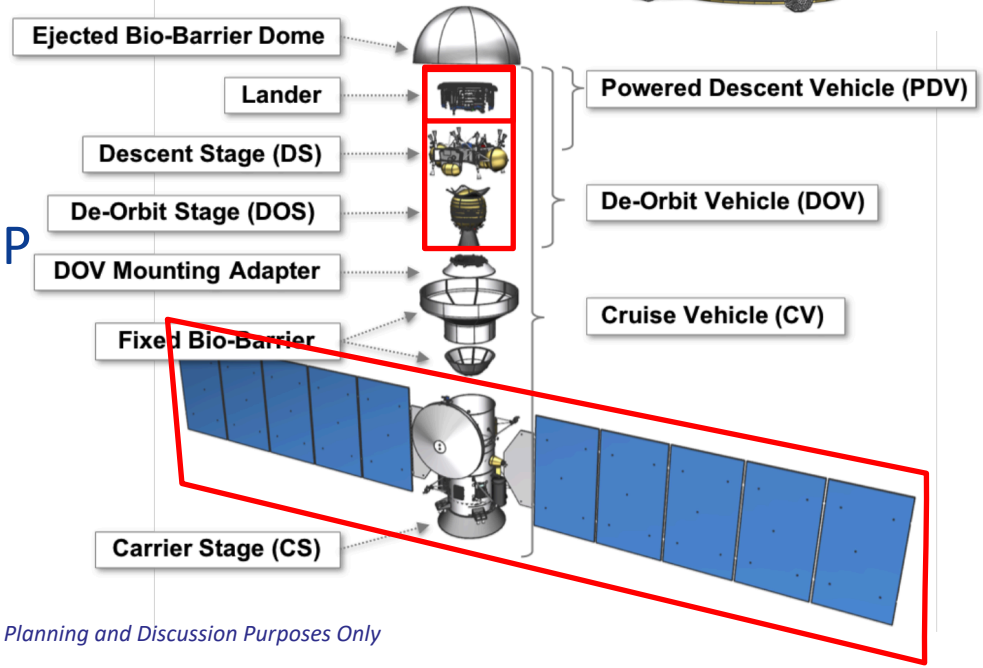
- Is there life on Europa?
  - Flybys, Orbiter, **Lander**
- Challenging mission
  - Deep inside gravity well, high Δv
  - Total Ionizing Dose TID(MRad), large shielding mass
  - Avoid contamination



Europa Lander Mission Concept

- Direct-to-Earth architecture
  - Lander direct telecom with Earth
- De-Orbit Vehicle (DOV) sterilized bef. launch, performs De-orbit, Descent, & Landing with SR
- Carrier (CS) makes all mnvs of the IP transfer, tour, and EOI.
  - After DOV separation enter a stable orbit around Europa. No orbit control capabilities!

Th.@11AM Zimmer et al. LANDING ON EUROPA: KEY CHALLENGES AND ARCHITECTURE CONCEPT (AAS 19-223)



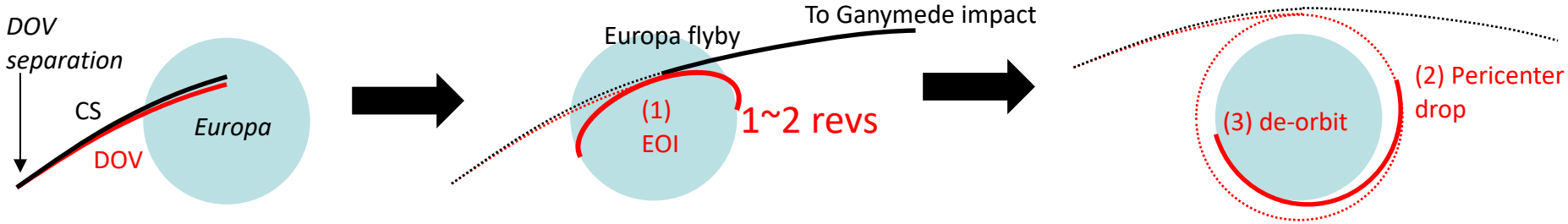
Two Case Studies

- This paper presents interesting phasing problems that came in support of DTE trade studies
  - Concurrent design of trajectories with coupled constraints

1. Case Study: Use Clipper as a data-relay spacecraft during Europa landing. Requires concurrent design of Clipper extended tour and Lander endgame.
   - Key challenge is exact timing. See also AAS19-366 today at 2:30PM!
2. Case Study Ultra-low radiation endgame strategy enabled by bi-prop architecture
   - CS disposal into Ganymede impact. Topic of this presentation

A bi-prop enabled strategy

- Re-starting capability of bi-prop architecture enables a new strategy
  - the Carrier would flyby Europa and hit Ganymede . Carrier does not perform EOI!



- Carrier's post-flyby orbit impacts Ganymede and is robust to error
- DOV's approach velocity is minimized for low EOI DV
- For global coverage, we need many approach flybys, covering the surface

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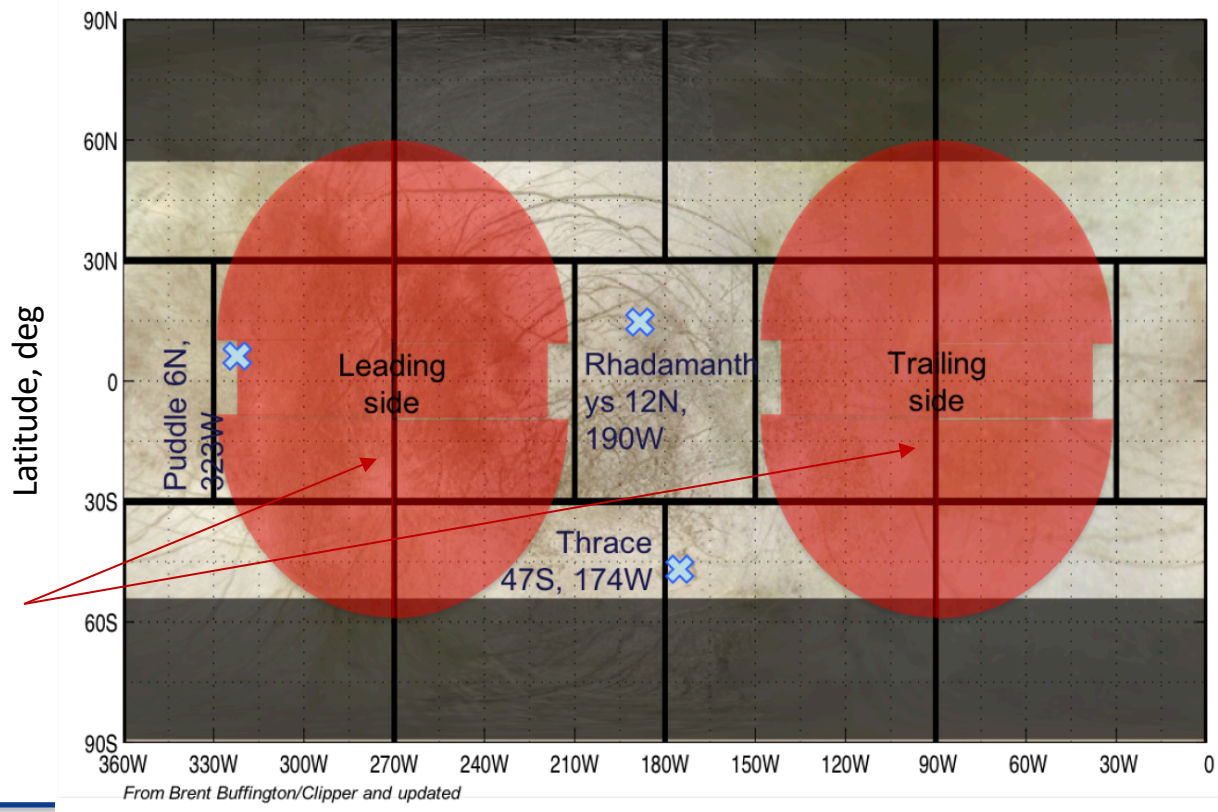
Required landing regions



No High-Res images from Clipper

High-phase (no landing)

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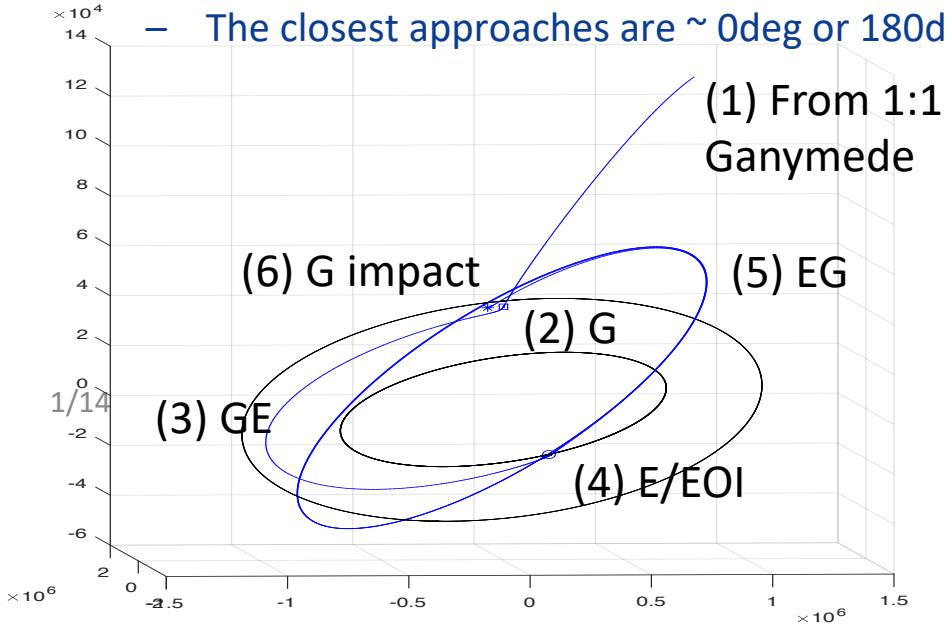
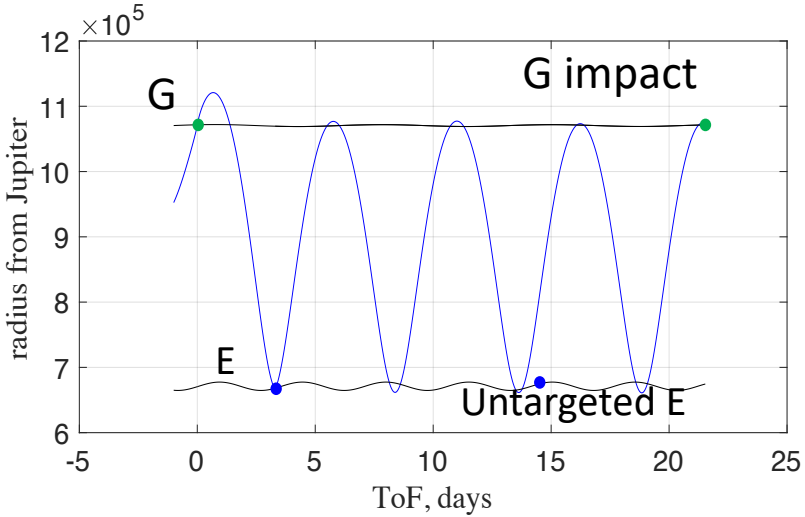
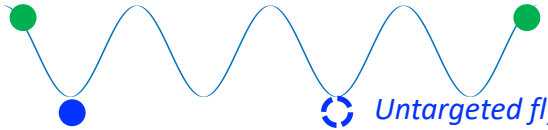
Ganymede-Europa-Ganymede (GEG)

- EG leg is quasi-Hohmann transfers (with N revs, N = 0,1,2,3) to minimize EOI
- GE leg is also quasi-Hohmann, with 4-N leg, for phasing (4 H = 3 Ga = 6 Eu revs)
- **Period-preserving flyby, so it shadows Clipper's recon flybys**
  - The closest approaches are ~ 0deg or 180deg long



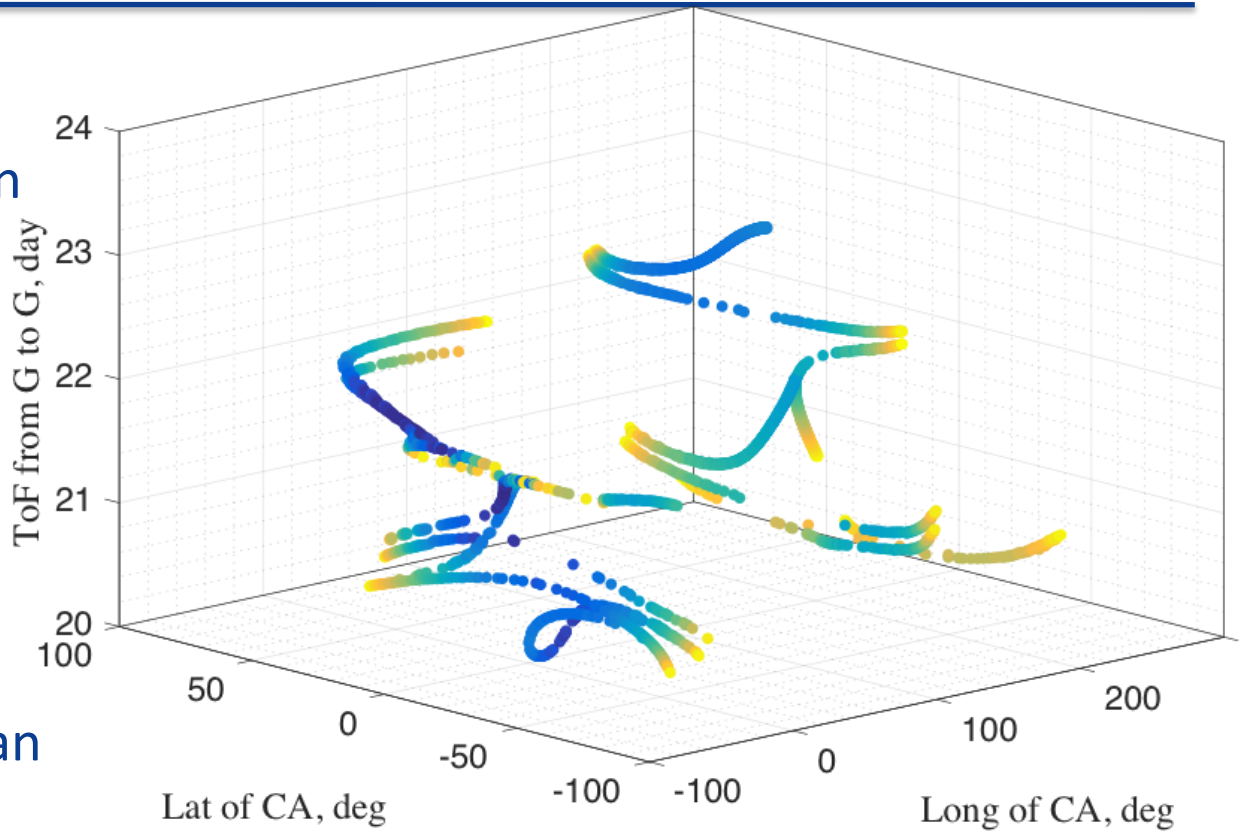


Classes of GEG

N	TYPE	TID to EOI	NOTES
0		~40	**Few solutions (no control in GE arc), and many of them are non-robust because 3.5 revs and untargeted Europa flyby**

1-D families (1-GEG example)

- Mathematical model can be reduced to 2 Eqs in 3 unknown
- Families represented as 1-D curves
- Closest approaches CA clustered around prime meridian or anti-meridian



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1-GEG solutions in full model

One trajectory per row

		CASE:			altitutde (km) after 5 km (3s) E1 error	DV cost (m/s)					untarg. flyby alt (km)	Ganymede flyby 1							G-E Dlong (deg)	Europa flyby / EOI							E-G2 Dlong (deg)	Ganymede flyby 2						
		0/180 crossing										vinf	alt (km	Incomig(deg)		Outgoing (deg)		long		vinf	alt (km	Incoming (deg)		Outgoing (deg)		long		vinf	alt (km)	Incoming (deg)		Outgoing (deg)		long	
Comm	ID	Long	Lat	Fam		DVtot	TCM	EOI	V rot.	EOI + DDV		(km/s)		pump	crank	pump	crank	wrt Sun		(km/s)		pump	crank	pump	crank	wrt Sun		(km/s)		pump	crank	pump	crank	wrt Sun	
	1	0	-60	A	-494	1265	9	1240	16	1256	162311	2.28	2214	97	25	120	0	5	130	1.75	48	18	-26	33	104	135	177	1.45	-1670	153	-87	83	146	-48	
NOM	2	0	-50	A	-1708	1249	0	1228	21	1249	61465	2.09	927	91	34	124	1	13	132	1.73	48	22	-20	30	109	144	175	1.43	-1881	155	-90	81	122	-41	
NOM	3	0	-40	A	-1792	1233	0	1208	25	1233	67466	2.01	849	90	37	126	1	15	134	1.7	48	21	-24	29	129	149	174	1.41	-1879	158	-69	80	128	-37	
NOM	4	0	-30	A	-1446	1228	0	1199	29	1228	86868	1.97	820	90	38	127	2	16	136	1.68	48	20	-28	29	148	152	173	1.41	-1877	159	-46	80	135	-35	
NOM	5	0	-20	A	-1560	1229	0	1198	31	1228	82665	1.94	814	90	40	128	3	17	137	1.68	48	21	-29	29	166	154	172	1.39	-1854	162	-30	77	136	-34	
NOM	6	0	-10	A	-1602	1235	0	1203	32	1235	54963	1.93	660	86	38	129	3	17	136	1.69	48	22	-27	29	-178	154	168	1.31	-2012	173	-26	58	131	-38	
BKUP	7	0	0	A	-1570	1245	0	1213	32	1245	124320	2	1429	91	31	127	3	16	135	1.7	48	21	-28	31	-163	151	169	1.36	-1666	167	13	63	103	-40	
	8	0	5	A	-1583	1258	20	1206	32	1238	97671	1.92	265	97	57	129	3	17	135	1.69	48	25	-25	29	-151	151	172	1.37	-1631	165	25	64	113	-36	
	9	0	10	A	-1588	1278	20	1226	31	1257	88852	1.87	1168	97	47	130	4	17	135	1.72	48	26	-27	31	-141	152	173	1.39	-1631	162	36	64	124	-35	
	10	0	20	A	-1796	1272	0	1243	30	1272	111975	2.01	1253	91	33	127	3	16	132	1.75	48	26	-23	33	-130	148	175	1.4	-1976	160	48	55	144	-37	
	11	0	30	A	-981	1265	2	1235	28	1263	137573	2.08	1763	97	-31	125	1	14	131	1.74	48	23	-9	32	-125	145	176	1.39	-1636	159	50	75	169	-39	
	12	0	40	A	-1230	1285	1	1260	24	1284	174628	2.21	1957	97	-27	122	1	9	128	1.78	48	23	-9	35	-113	137	174	1.37	-1631	159	80	63	168	-48	
	13	0	50	A	-1281	1314	4	1290	20	1310	183685	2.31	2147	97	-24	120	0	6	125	1.82	48	25	-7	37	-99	131	175	1.38	-1631	155	102	62	-172	-54	
	14	0	60	A	-1324	1363	3	1345	15	1360	158445	2.39	2512	97	-21	119	0	4	121	1.9	48	30	-5	39	-81	125	176	1.46	-1631	149	123	67	-144	-59	
NOM	15	180	-60	B	-429	1220	0	1236	-16	1220	394557	1.51	379	74	49	145	40	19	167	1.74	48	36	-100	19	14	-174	152	2.33	-1688	120	-176	107	-85	-21	
NOM	16	180	-50	B	-84	1205	0	1226	-21	1205	395369	1.61	627	76	43	140	27	22	165	1.72	48	34	-114	18	16	-173	152	2.33	-1689	120	-176	108	-84	-21	
	17	180	-40	B	209	1198	0	1223	-25	1197	386342	1.75	894	80	39	134	17	22	163	1.72	48	31	-127	19	17	-175	153	2.3	-1678	121	-175	107	-84	-23	
	18	180	-30	B	467	1195	0	1224	-28	1195	363436	1.92	742	80	31	128	10	19	159	1.72	48	28	-140	21	16	177	155	2.24	-1673	122	-175	105	-82	-27	
	19	180	-20	B	763	1204	0	1235	-31	1204	295791	2.2	54	75	26	122	3	9	150	1.74	48	22	-151	25	12	160	161	2.09	-1652	125	-174	103	-76	-39	
	20	180	-10	B	525	1217	0	1249	-32	1217	157925	2.45	3835	94	-1	117	1	1	144	1.76	48	18	-160	29	4	145	166	1.97	-2193	127	-175	90	-51	-49	
	21	180	0	B	185	1228	0	1261	-33	1228	66873	2.56	3614	94	-7	115	0	-5	141	1.78	48	15	-165	31	-7	136	167	1.98	-2559	127	-179	62	-30	-57	
	22	180	10	B	1634	1238	0	1270	-32	1238	23129	2.61	3392	93	-6	115	0	-8	140	1.79	48	14	-164	33	-20	131	163	2.22	-2527	121	177	60	-45	-65	
	23	180	20	B	18	1246	0	1276	-31	1246	17076	2.61	3334	93	-7	115	0	-8	140	1.8	48	15	-164	34	-34	132	162	2.21	-2439	121	174	61	-62	-66	
DVI	24	180	30	B	14041	1251	0	1279	-28	1251	7224	2.56	3053	94	-11	115	0	-6	142	1.8	48	17	-165	35	-49	137	154	2.23	-2438	121	175	50	-64	-69	
	25	180	40	B	338678	1270	0	1294	-24	1270	3725	2.56	3128	94	-11	116	1	-4	144	1.83	48	19	-166	36	-64	140	146	2.53	-2521	116	178	42	-48	-74	
	26	180	50	B	439474	1299	0	1319	-20	1299	2507	2.6	3095	94	-10	115	1	-6	144	1.86	48	21	-166	38	-77	138	145	2.65	-2502	114	179	35	-51	-76	
	27	180	60	B	371163	1329	0	1345	-15	1329	1782	2.67	2589	94	-14	114	0	-9	143	1.9	48	21	-169	40	-87	134	150	2.59	-2476	115	178	26	-51	-76	
	28	180	20	C	1865	1195	0	1225	-31	1195	18746	2.04	205	87	144	129	-178	-83	142	1.72	50	21	-176	29	-37	135	159	2.22	-1679	121	175	78	98	-66	
BKUP	29	180	20	D	-737	1203	0	1233	-30	1203	450187	1.42	2964	96	-44	151	-34	25	177	1.73	50	37	144	16	26	-153	146	2.5	-2320	117	-175	77	75	-6	
ISame	*30*	*180*	*20*	E	*-538*	*1205*	*0*	*1236*	*-30*	*1205*	*436011*	*1.5*	*912*	*94*	*-88*	*152*	*-36*	*20*	*179*	*1.7*	*50*	*36*	*142*	*18*	*25*	*-159*	*148*	*2.5*	*-2574*	*118*	*-174*	*45*	*36*	*-11*	
	31	180	-45	F	143	1245	0	1266	-22	1245	283099	1.59	2553	96	64	142	38	18	165	1.79	50	38	-100	28	-12	-176	134	2.13	-2130	129	2	42	-72	50	
	32	180	-20	G	1219	1205	0	1235	-31	1205	328379	2.09	531	88	42	124	6	13	154	1.74	50	25	-143	24	2	166	159	2.18	-2066	123	-177	38	115	-35	
NOM	33	0	0	H	-1550	1220	0	1187	32	1220	82437	1.54	199	91	-135	153	173	-22	174	1.66	50	26	-22	27	-159	152	173	1.36	-1644	165	12	71	128	-35	
NOM	34	0	10	H	-1438	1226	0	1195	32	1226	124588	1.6	318	91	-134	149	177	-28	176	1.68	50	26	-17	28	-146	148	173	1.36	-1703	164	30	67	136	-39	
NOM	35	0	20	H	-1636	1247	0	1217	30	1247	147738	1.65	453	92	-138	146	177	-34	177	1.71	50	28	-17	31	-128	143	174	1.36	-1934	163	55	58	158	-43	
NOM	36	0	30	H	-1691	1227	0	1199	28	1227	134901	1.65	950	90	-145	146	-173	-35	178	1.68	50	26	2	29	-125	143	176	1.36	-2053	163	52	57	167	-41	
NOM	37	0	40	H	-1793	1213	0	1188	25	1213	110972	1.65	1234	89	-151	146	-164	-35	179	1.67	50	25	21	27	-123	145	177	1.36	-2118	163	47	56	168	-38	

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1-GEG solutions in full model

		CASE:		
		0/180 crossing		
Comm	ID	Long	Lat	Fam
	1	0	-60	A
NOM	2	0	-50	A
NOM	3	0	-40	A
NOM	4	0	-30	A
NOM	5	0	-20	A
NOM	6	0	-10	A
BKUP	7	0	0	A
	8	0	5	A
	9	0	10	A
	10	0	20	A
	11	0	30	A
	12	0	40	A
	13	0	50	A
	14	0	60	A
NOM	15	180	-60	B
NOM	16	180	-50	B
	17	180	-40	B
	18	180	-30	B
	19	180	-20	B
	20	180	-10	B
	21	180	0	B
	22	180	10	B
	23	180	20	B
DVI	24	180	30	B
	25	180	40	B
	26	180	50	B
	27	180	60	B
	28	180	20	C
BKUP	29	180	20	D
ISame	*30*	*180*	*20*	E
	31	180	-45	F
	32	180	-20	G
NOM	33	0	0	H
NOM	34	0	10	H
NOM	35	0	20	H
NOM	36	0	30	H
NOM	37	0	40	H

Sub-Jovian EOI

Anti-Jovian EOI

Sub-Jovian EOI

Prime Meridian Crossing/
Anti-Meridian Crossing

Family
(A,B,C…)

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1-GEG solutions in full model

		CASE:			DV cost (m/s)				
		0/180 crossing							
Comm	ID	Long	Lat	Fam	DVtot	TCM	EOI	V rot.	EOI+DDV
	1	0	-60	A	126	9	1240	16	1256
NOM	2	0	-50	A	124	0	1228	21	1249
NOM	3	0	-40	A	123	0	1208	25	1233
NOM	4	0	-30	A	122	0	1199	29	1228
NOM	5	0	-20	A	122	0	1198	31	1228
NOM	6	0	-10	A	123	0	1203	32	1235
BKUP	7	0	0	A	124	0	1213	32	1245
	8	0	5	A	125	20	1206	32	1238
	9	0	10	A	127	20	1226	31	1257
	10	0	20	A	127	0	1243	30	1272
	11	0	30	A	126	2	1235	28	1263
	12	0	40	A	128	1	1260	24	1284
	13	0	50	A	131	4	1290	20	1310
	14	0	60	A	136	3	1345	15	1360
NOM	15	180	-60	B	122	0	1236	-16	1220
NOM	16	180	-50	B	120	0	1226	-21	1205
	17	180	-40	B	119	0	1223	-25	1197
	18	180	-30	B	119	0	1224	-28	1195
	19	180	-20	B	120	0	1235	-31	1204
	20	180	-10	B	121	0	1249	-32	1217
	21	180	0	B	122	0	1261	-33	1228
	22	180	10	B	123	0	1270	-32	1238
	23	180	20	B	124	0	1276	-31	1246
DVI	24	180	30	B	125	0	1279	-28	1251
	25	180	40	B	127	0	1294	-24	1270
	26	180	50	B	129	0	1319	-20	1299
	27	180	60	B	132	0	1345	-15	1329
	28	180	20	C	119	0	1225	-31	1195
BKUP	29	180	20	D	120	0	1233	-30	1203
!Same	*30*	*180*	*20*	E	*120*	*0*	*1236*	*-30*	*1205*
	31	180	-45	F	124	0	1266	-22	1245
	32	180	-20	G	120	0	1235	-31	1205
NOM	33	0	0	H	122	0	1187	32	1220
NOM	34	0	10	H	122	0	1195	32	1226
NOM	35	0	20	H	124	0	1217	30	1247
NOM	36	0	30	H	122	0	1199	28	1227
NOM	37	0	40	H	121	0	1188	25	1213

Large ΔV

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1-GEG solutions in full model

Not Robust to 5 km altitude delivery errors

(all Anti-Jovian, direct flyby)

		CASE:			altitude (km) after 5 km (3s) E1 error	DV cost (m/s)					untarg. flyby alt (km)
		0/180 crossing				DVtot	TCM	EOI	V rot.	EOI + DDV	
Comm	ID	Long	Lat	Fam							
	1	0	-60	A	-494	1265	9	1240	16	1256	162311
NOM	2	0	-50	A	-1708	1249	0	1228	21	1249	61465
NOM	3	0	-40	A	-1792	1233	0	1208	25	1233	67466
NOM	4	0	-30	A	-1446	1228	0	1199	29	1228	86868
NOM	5	0	-20	A	-1560	1229	0	1198	31	1228	82665
NOM	6	0	-10	A	-1602	1235	0	1203	32	1235	54963
BKUP	7	0	0	A	-1570	1245	0	1213	32	1245	124320
	8	0	5	A	-1583	1258	20	1206	32	1238	97671
	9	0	10	A	-1588	1278	20	1226	31	1257	88852
	10	0	20	A	-1796	1272	0	1243	30	1272	111975
	11	0	30	A	-981	1265	2	1235	28	1263	137573
	12	0	40	A	-1230	1285	1	1260	24	1284	174628
	13	0	50	A	-1281	1314	4	1290	20	1310	183685
	14	0	60	A	-1324	1363	3	1345	15	1360	158445
NOM	15	180	-60	B	-429	1220	0	1236	-16	1220	394557
NOM	16	180	-50	B	-84	1205	0	1226	-21	1205	395369
	17	180	-40	B	209	1198	0	1223	-25	1197	386342
	18	180	-30	B	467	1195	0	1224	-28	1195	363436
	19	180	-20	B	763	1204	0	1235	-31	1204	295791
	20	180	-10	B	525	1217	0	1249	-32	1217	157925
	21	180	0	B	185	1228	0	1261	-33	1228	66873
	22	180	10	B	1634	1238	0	1270	-32	1238	23129
	23	180	20	B	18	1246	0	1276	-31	1246	17076
DVI	24	180	30	B	14041	1251	0	1279	-28	1251	7224
	25	180	40	B	338678	1270	0	1294	-24	1270	3725
	26	180	50	B	439474	1299	0	1319	-20	1299	2507
	27	180	60	B	371163	1329	0	1345	-15	1329	1782
	28	180	20	C	1865	1195	0	1225	-31	1195	18746
BKUP	29	180	20	D	-737	1203	0	1233	-30	1203	450187
ISame	*30*	*180*	*20*	E	*-538*	*1205*	*0*	*1236*	*-30*	*1205*	*436011*
	31	180	-45	F	143	1245	0	1266	-22	1245	283099
	32	180	-20	G	1219	1205	0	1235	-31	1205	328379
NOM	33	0	0	H	-1550	1220	0	1187	32	1220	82437
NOM	34	0	10	H	-1438	1226	0	1195	32	1226	124588
NOM	35	0	20	H	-1636	1247	0	1217	30	1247	147738
NOM	36	0	30	H	-1691	1227	0	1199	28	1227	134901
NOM	37	0	40	H	-1793	1213	0	1188	25	1213	110972

	Ganymede flyby 2						
vin	alt (km)	Incoming (deg)		Outgoing (deg)		long	
(km/		pump	crank	pump	crank	wrt Sun	
1.4	-1670	153	-87	83	146	-48	
1.4	-1881	155	-90	81	122	-41	
1.4	-1879	158	-69	80	128	-37	
1.4	-1877	159	-46	80	135	-35	
1.3	-1854	162	-30	77	136	-34	
1.3	-2012	173	-26	58	131	-38	
1.3	-1666	167	13	63	103	-40	
1.3	-1631	165	25	64	113	-36	
1.3	-1631	162	36	64	124	-35	
1.1	-1976	160	48	55	144	-37	
1.3	-1636	159	50	75	169	-39	
1.3	-1631	159	80	63	168	-48	
1.3	-1631	155	102	62	-172	-54	
1.4	-1631	149	123	67	-144	-59	
2.3	-1688	120	-176	107	-85	-21	
2.3	-1689	120	-176	108	-84	-21	
2.1	-1678	121	-175	107	-84	-23	
2.2	-1673	122	-175	105	-82	-27	
2.0	-1652	125	-174	103	-76	-39	
1.9	-2193	127	-175	90	-51	-49	
1.9	-2559	127	-179	62	-30	-57	
2.2	-2527	121	177	60	-45	-65	
2.2	-2439	121	174	61	-62	-66	
2.2	-2438	121	175	50	-64	-69	
2.5	-2521	116	178	42	-48	-74	
2.6	-2502	114	179	35	-51	-76	
2.5	-2476	115	178	26	-51	-76	
2.2	-1679	121	175	78	98	-66	
2.1	-2320	117	-175	77	75	-6	
2.1	*-2574*	*118*	*-174*	*45*	*36*	*-11*	
2.1	-2130	129	2	42	-72	50	
2.1	-2066	123	-177	38	115	-35	
1.3	-1644	165	12	71	128	-35	
1.3	-1703	164	30	67	136	-39	
1.3	-1934	163	55	58	158	-43	
1.3	-2053	163	52	57	167	-41	
1.3	-2118	163	47	56	168	-38	

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1-GEG solutions in full model

Low ΔV, Robust solutions

		CASE:			altitutde (km) after 5 km (3s) E1 error	DV cost (m/s)					untarg. flyby alt (km)	Ganymede flyby 1							G-E Dlong (deg)	Europa flyby / EOI							E-G2 Dlong (deg)	Ganymede flyby 2						
		0/180 crossing										vinf	alt (km	Incomig(deg)		Outgoing (deg)		long		vinf	alt (km	Incoming (deg)		Outgoing (deg)		long		vinf	alt (km)	Incoming (deg)		Outgoing (deg)		long	
Comm	ID	Long	Lat	Fam		DVtot	TCM	EOI	V rot.	EOI + DDV		(km/s)		pump	crank	pump	crank	wrt Sun		(km/s)		pump	crank	pump	crank	wrt Sun		(km/s)		pump	crank	pump	crank	wrt Sun	
NOM	2	0	-50	A	-1708	1249	0	1228	21	1249	61465	2.09	927	91	34	124	1	13	132	1.73	48	22	-20	30	109	144	175	1.43	-1881	155	-90	81	122	-41
NOM	3	0	-40	A	-1792	1233	0	1208	25	1233	67466	2.01	849	90	37	126	1	15	134	1.7	48	21	-24	29	129	149	174	1.41	-1879	158	-69	80	128	-37
NOM	4	0	-30	A	-1446	1228	0	1199	29	1228	86868	1.97	820	90	38	127	2	16	136	1.68	48	20	-28	29	148	152	173	1.41	-1877	159	-46	80	135	-35
NOM	5	0	-20	A	-1560	1229	0	1198	31	1228	82665	1.94	814	90	40	128	3	17	137	1.68	48	21	-29	29	166	154	172	1.39	-1854	162	-30	77	136	-34
NOM	6	0	-10	A	-1602	1235	0	1203	32	1235	54963	1.93	660	86	38	129	3	17	136	1.69	48	22	-27	29	-178	154	168	1.31	-2012	173	-26	58	131	-38
BKUP	7	0	0	A	-1570	1245	0	1213	32	1245	124320	2	1429	91	31	127	3	16	135	1.7	48	21	-28	31	-163	151	169	1.36	-1666	167	13	63	103	-40
BKUP	29	180	20	D	-737	1203	0	1233	-30	1203	450187	1.42	2964	96	-44	151	-34	25	177	1.73	50	37	144	16	26	-153	146	2.5	-2320	117	-175	77	75	-6
NOM	33	0	0	H	-1550	1220	0	1187	32	1220	82437	1.54	199	91	-135	153	173	-22	174	1.66	50	26	-22	27	-159	152	173	1.36	-1644	165	12	71	128	-35
NOM	34	0	10	H	-1438	1226	0	1195	32	1226	124588	1.6	318	91	-134	149	177	-28	176	1.68	50	26	-17	28	-146	148	173	1.36	-1703	164	30	67	136	-39
NOM	35	0	20	H	-1636	1247	0	1217	30	1247	147738	1.65	453	92	-138	146	177	-34	177	1.71	50	28	-17	31	-128	143	174	1.36	-1934	163	55	58	158	-43
NOM	36	0	30	H	-1691	1227	0	1199	28	1227	134901	1.65	950	90	-145	146	-173	-35	178	1.68	50	26	2	29	-125	143	176	1.36	-2053	163	52	57	167	-41
NOM	37	0	40	H	-1793	1213	0	1188	25	1213	110972	1.65	1234	89	-151	146	-164	-35	179	1.67	50	25	21	27	-123	145	177	1.36	-2118	163	47	56	168	-38

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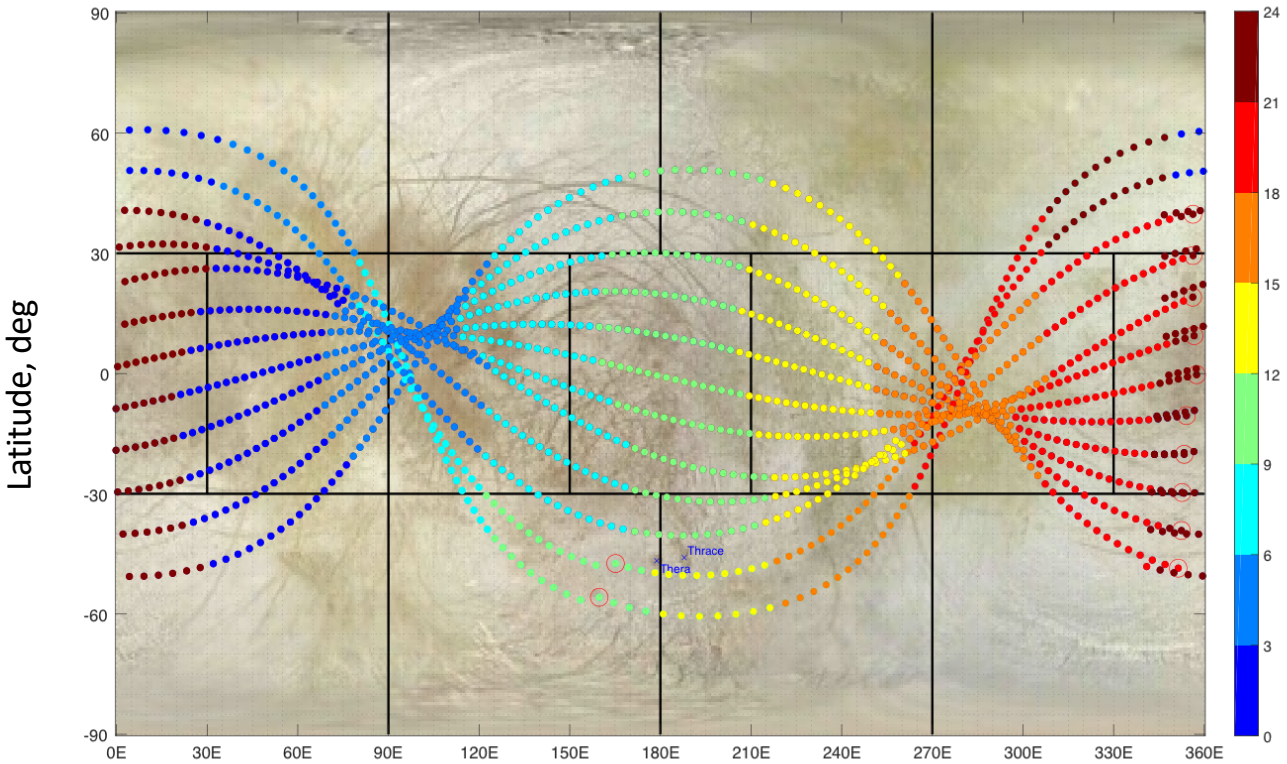
1-GEG attainable landing sites



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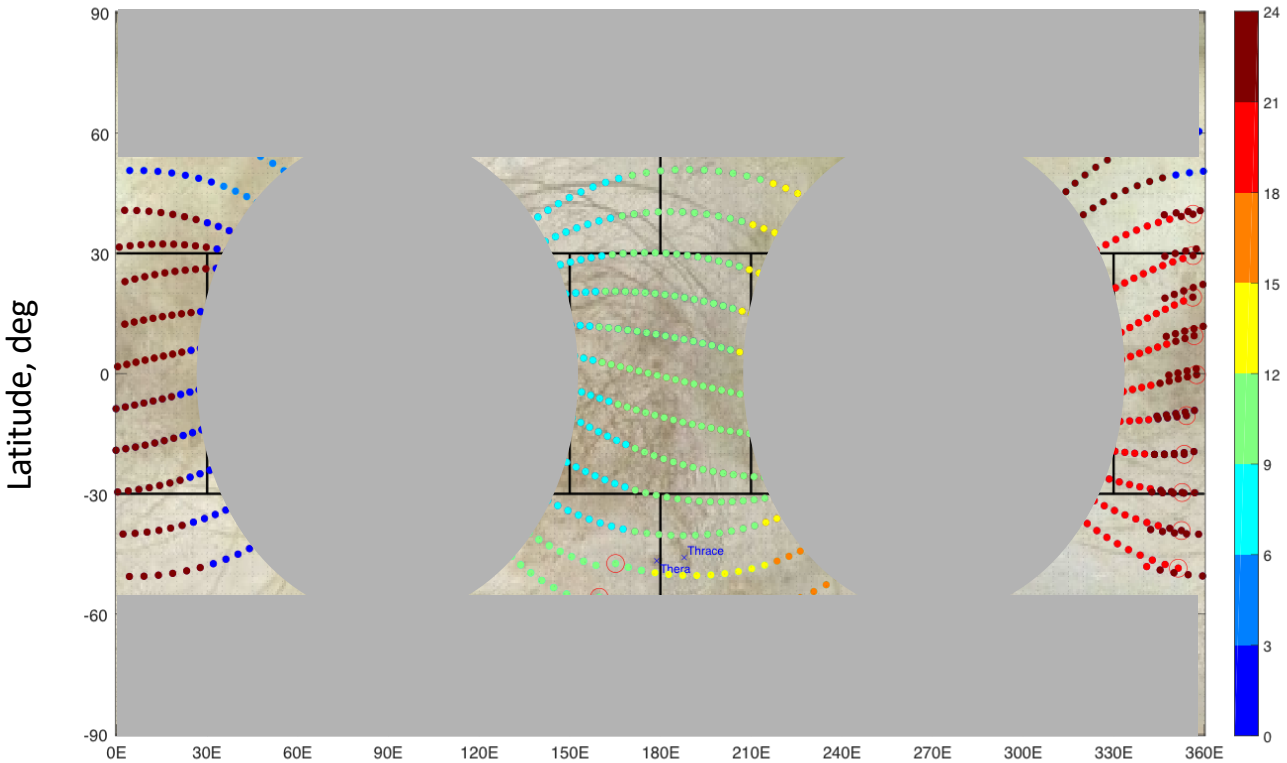
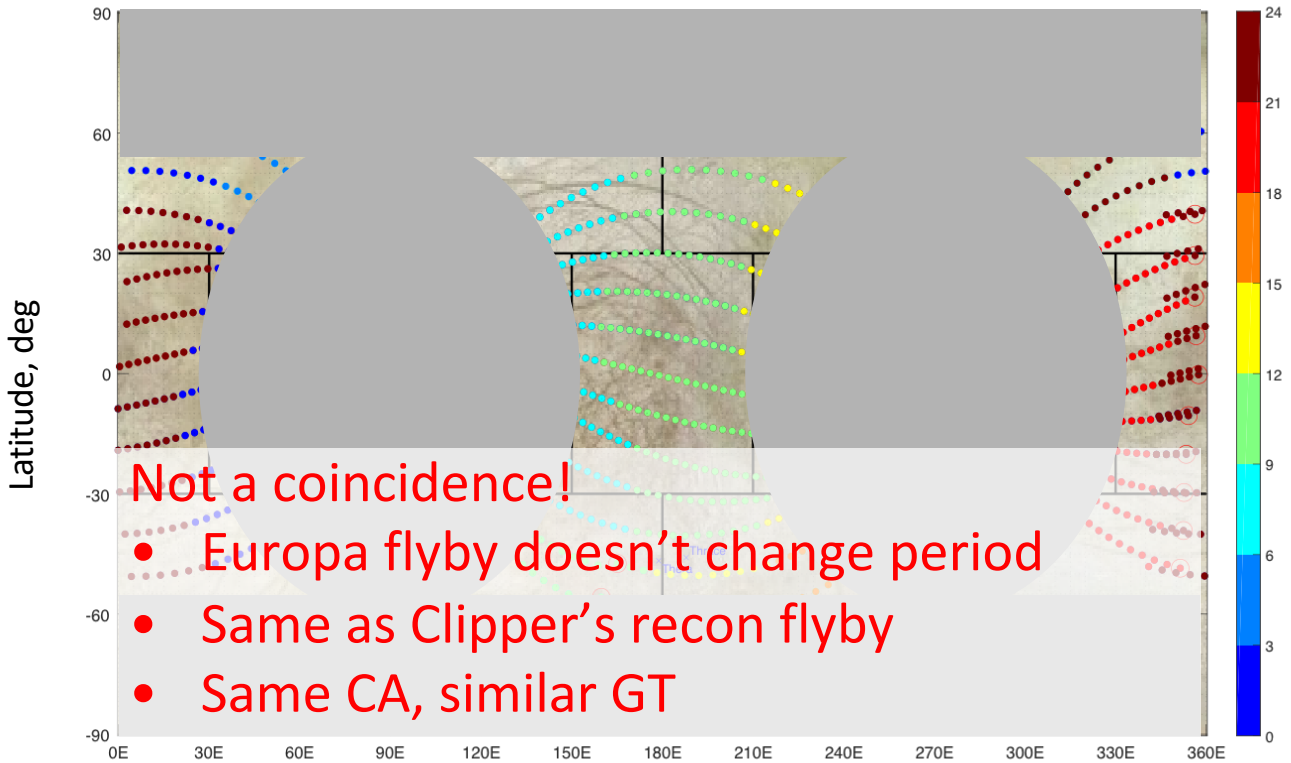
1-GEG attainable landing sites



East Longitude, deg

1-GEG attainable landing sites



Not a coincidence!

- Europa flyby doesn't change period
- Same as Clipper's recon flyby
- Same CA, similar GT

Conclusion

- Europa Lander Mission Concepts require large mass of propellant and radiation shielding. The current incarnation is a Direct-To-Earth TE architecture, where the Carrier Spacecraft has no orbit control capabilities after De-Orbit Vehicle separation
- The paper discuss two trajectory problems for the DTE architecture, that required concurrent design of multiple spacecraft trajectories with coupled constraints.
- The first problem required designing Clipper and Lander tours concurrently, so that Clipper can act as data-relay during landing operations
- The second problem is a an alternative endgame strategy where the DOV executes EOI and De-Orbit mnvr at different times, so that multiple landing site can be reached from the same orbit.
- Carrier does not execute EOI, however, it must impact Ganymede after delivery.
  - GEG strategies provide low TID and low EOI (1250 m/s);
  - GEG mimics Clipper's groundtrack so LS access is similar