

Hohmann Transfers

Calculations	LEO to GEO	LEO to D.Moon	LEO to 4Mkm	Lunar capture to LLO	D.Moon to 4Mkm
Ra (km)	6788.140	6788.140	6788.140	1838.000	384401.000
Rb (km)	42164.000	384401.000	4000000.000	66000.000	4000000.000
Vai (km/s)	7.663	7.663	7.663	1.633	1.018
Vbf (km/s)	3.075	1.018	0.316	0.273	0.316
a.transfer (km)	24476.070	195594.570	2003394.070	33919.000	2192200.500
Dva (km/s)	2.395	3.080	3.165	0.645	0.357
Dvb (km/s)	1.455	0.829	0.297	0.209	0.183
Dv.total (km/s)	3.850	3.908	3.462	0.854	0.541
Dv.spiral total (?) (km/s)	4.588	6.645	7.347	1.361	0.703

Scenarios

Hohmann LEO to LLO	4.7623534 km/s	(=(LEO to D.Moon)+(Lunar capture to LLO)) [Need to take out some delta-v from capture at Moon]
Hohmann LEO to 4Mkm	3.462195 km/s	(=(LEO to 4Mkm))
Hohmann LEO to LLO to 4Mkm	6.1571669 km/s	(=(LEO to D.Moon)+(Lunar capture to LLO)+(Lunar capture to LLO)+(D.Moon to 4Mkm))
Hohmann LEO to 4Mkm to LLO	4.8570085 km/s	(=(LEO to 4Mkm)+(4Mkm to D.Moon)+(Lunar capture to LLO))
Weak Stability Boundary LEO to LLO	3.5717651 km/s	"25% reduction in delta-v to LLO" http://astrogatorsguild.com/wp-content/papers/0800_wsb.pdf

Constants

Earth grav const (GM = μ)	398600.5 [km ³ /s ²]	
(GM) ^{0.5} = $\mu^{0.5}$	631.34816 [km ^{1.5} /s]	
Radius of Earth (R.E)	6378.14 km	
Altitude of ISS LEO (H.ISS)	410 km	(ISS can be at 330 to 435 km altitude)
Radius GEO (R.GEO)	42164 km	
Earth-Moon distance (ave) (D.Mo)	384401 km	
Target distance (4Mkm) (D.T)	4000000 km	
Moon grav const (GM.m)	4902.794 [km ³ /s ²]	
(GM.m) ^{0.5}	70.019954 [km ^{1.5} /s]	
Radius of Moon (R.M)	1738 km	
Altitude of LLO (H.LLO)	100 km	
Distance of Lunar capture	66000 km	('Sphere of influence' for Moon)

Note: NASA Cube Quest rules allow a "Lunar Orbit" to be 10,000 km x 300 km altitude

Bi-Elliptic Transfer

Calculations	LEO to 4Mkm to D.Moon							
Ra	6788.14	km						
Rb	384401	km						
R*	4000000	km						
Rb/Ra	56.62832528							
Dv_1	3.164896098	km/s	a_1	2003394.07 km	t_1	14110114.21	sec	163.3115071 days
Dv_2	0.113812539	km/s	a_2	2192200.5 km	t_2	16151072.32	sec	186.9337074 days
Dv_3	-0.357216621	km/s			Total Flight Time	30261186.53	sec	350.2452145 days

Scenarios

Bi-Elliptic LEO to
4Mkm to D.Moon 3.635925257 km/s (=Bi-Elliptic((LEO to 4Mkm)+(4Mkm to D.Moon))

Bi-Elliptic LEO to
4Mkm to LLO 4.490035784 km/s (=Bi-Elliptic((LEO to 4Mkm)+(4Mkm to D.Moon))+Hohmann(Lunar capture to LLO))

Chemical Propulsion

Scenarios	Propellant Mass		Propellant Mass Percentage	Vehicle Dry Mass		Vehicle Dry Mass Percentage
Hohmann LEO to LLO	14	kg	1	0	kg	0.00%
Hohmann LEO to 4Mkm	11.60393183	kg	0.828852273	2.396068175	kg	17.11%
Hohmann LEO to LLO to 4Mkm	13.39360528	kg	0.956686091	0.606394723	kg	4.33%
Hohmann LEO to 4Mkm to LLO	12.82334914	kg	0.91595351	1.17665086	kg	8.40%
Bi-Elliptic LEO to 4Mkm to LLO	12.58125002	kg	0.898660716	1.418749978	kg	10.13%
Weak Stability Boundary LEO to LLO	11.73411829	kg	0.838151306	2.265881714	kg	16.18%

Constants		
Standard Gravity (g_0)	9.80665	m/s^2
1U Cubesat Standard Mass	1.33	kg
Cubesat Units	6	Units
Cubesat Starting Mass (m_0)	14	kg
Chemical Propulsion I_sp	200	seconds
Electric Propulsion I_sp	3000	seconds

DeltaV		
Hohmann LEO to LLO	4762.353409	m/s
Hohmann LEO to 4Mkm	3462.195018	m/s
Hohmann LEO to LLO to 4Mkm	6157.166938	m/s
Hohmann LEO to 4Mkm to LLO	4857.008547	m/s
Bi-Elliptic LEO to 4Mkm to LLO	4490.035784	m/s
Weak Stability Boundary LEO to LLO	3571.765057	m/s

Dahlstrom Trajectory 2-Stage Co

Segmented Trajectory

Total Delta_V	4100 m/s
Leg 1/Stage 1	
Delta_V	3100 m/s
Initial Total Mass of Stack (Stage 1 & 2)	14 kg
Chemical Propulsion I_sp	350 s
Propellant Mass	11.1179634 kg
Stage 1 Propellant Mass Fraction of Total Stack Mass	0.79414024
Leg 2-3/Stage 2	
Delta_V	1000 m/s
Initial Total Mass of Stage 2	1.88203661 kg
Chemical Propulsion I_sp	350 s
Propellant Mass	0.47567352
Stage 2 Propellant Mass Fraction	0.25274403
Payload Mass	1.40636309 kg
Payload Mass Fraction Of Stage 2	0.74725597
Payload Mass Fraction Of Total Stack Mass	0.10045451
Stage 1 Constants	
Standard Gravity (g_0)	9.80665 m/s^2
1U Cubesat Standard Mass	1.33 kg
Cubesat Units	6 Units
Cubesat Starting Mass (m_0)	14 kg
Chemical Propulsion I_sp	200 seconds

5/3/15 – SEC: In all staging calculations, assumed stage mass dropped is 1 kg.

Single Stage Baseline

Dahlstrom Trajectory 2-Stage Co

Propellant Mass	12.2691042 kg
Propellant Mass Fraction	0.87636458
Payload Mass	1.73089583 kg
Payload Mass Fraction	0.12363542

Dahlstrom Trajectory 2-Stage Co

Dahlstrom Trajectory 2-Stage Co

Trade Chart, Isp vs Propellant Mass Fraction

I_sp Stage 1 (s)	Stage 1 PM (kg)	Stage 1 PMF	m_o Stage 2 (kg)	I_sp Stage 2 (s)	Stage 2 PM (kg)	Stage 2 PMF	Payload Mass (kg)
150	12.29827265	0.878448047	0.701727349	150	0.346153085	0.493287151	0.355574264
				200	0.280283382	0.399419209	0.421443966
				250	0.23504051	0.334945632	0.466686839
				300	0.202211397	0.288162344	0.499515951
				350	0.177357399	0.252744031	0.52436995
				400	0.157908668	0.225028522	0.543818681
				450	0.142284523	0.202763258	0.559442825
				500	0.129462622	0.184491344	0.572264727
			m_o Stage 2 (kg)	I_sp Stage 2 (s)	Stage 2 PM (kg)	Stage 2 PMF	Payload Mass (kg)
200	11.11796339	0.794140242	1.882036607	150	0.928384476	0.493287151	0.953652131
				200	0.751721572	0.399419209	1.130315035
				250	0.630379941	0.334945632	1.251656666
				300	0.54233208	0.288162344	1.339704528
				350	0.475673518	0.252744031	1.406363089
				400	0.423511917	0.225028522	1.458524691
				450	0.381607874	0.202763258	1.500428733
				500	0.347219463	0.184491344	1.534817144
			m_o Stage 2 (kg)	I_sp Stage 2 (s)	Stage 2 PM (kg)	Stage 2 PMF	Payload Mass (kg)
250	10.04646852	0.717604894	2.953531482	150	1.45693913	0.493287151	1.496592352
				200	1.179697207	0.399419209	1.773834274
				250	0.989272469	0.334945632	1.964259013
				300	0.851096554	0.288162344	2.102434928
				350	0.746487451	0.252744031	2.20704403
				400	0.664628825	0.225028522	2.288902657
				450	0.598867666	0.202763258	2.354663816
				500	0.544900993	0.184491344	2.408630489

Dahlstrom Trajectory 2-Stage Co

			m_o Stage 2 (kg)	I_sp Stage 2 (s)	Stage 2 PM (kg)	Stage 2 PMF	Payload Mass (kg)
300	9.118997758	0.651356983	3.881002242	150	1.914448539	0.493287151	1.966553703
				200	1.550146844	0.399419209	2.330855397
				250	1.299924748	0.334945632	2.581077493
				300	1.118358702	0.288162344	2.76264354
				350	0.98090015	0.252744031	2.900102092
				400	0.873336199	0.225028522	3.007666042
				450	0.786924659	0.202763258	3.094077583
				500	0.71601132	0.184491344	3.164990922

			m_o Stage 2 (kg)	I_sp Stage 2 (s)	Stage 2 PM (kg)	Stage 2 PMF	Payload Mass (kg)
350	8.326080706	0.59472005	4.673919294	150	2.305584332	0.493287151	2.368334961
				200	1.866853146	0.399419209	2.807066148
				250	1.565508851	0.334945632	3.108410442
				300	1.346847538	0.288162344	3.327071756
				350	1.181305201	0.252744031	3.492614092
				400	1.051765152	0.225028522	3.622154142
				450	0.947699104	0.202763258	3.72622019
				500	0.862297652	0.184491344	3.811621642

			m_o Stage 2 (kg)	I_sp Stage 2 (s)	Stage 2 PM (kg)	Stage 2 PMF	Payload Mass (kg)
400	7.647952102	0.546282293	5.352047898	150	2.64009646	0.493287151	2.711951438
				200	2.137710736	0.399419209	3.214337162
				250	1.792645065	0.334945632	3.559402833
				300	1.542258666	0.288162344	3.809789232
				350	1.352698158	0.252744031	3.99934974
				400	1.20436343	0.225028522	4.147684468
				450	1.085198669	0.202763258	4.266849229
				500	0.98740651	0.184491344	4.364641388

			m_o Stage 2 (kg)	I_sp Stage 2 (s)	Stage 2 PM (kg)	Stage 2 PMF	Payload Mass (kg)
450	7.064964584	0.504640327	5.935035416	150	2.927676712	0.493287151	3.007358705

Dahlstrom Trajectory 2-Stage Co

200	2.37056715	0.399419209	3.564468267
250	1.987914188	0.334945632	3.947121228
300	1.710253715	0.288162344	4.224781701
350	1.500044773	0.252744031	4.434990643
400	1.335552249	0.225028522	4.599483167
450	1.203407117	0.202763258	4.731628299
500	1.094962661	0.184491344	4.840072756

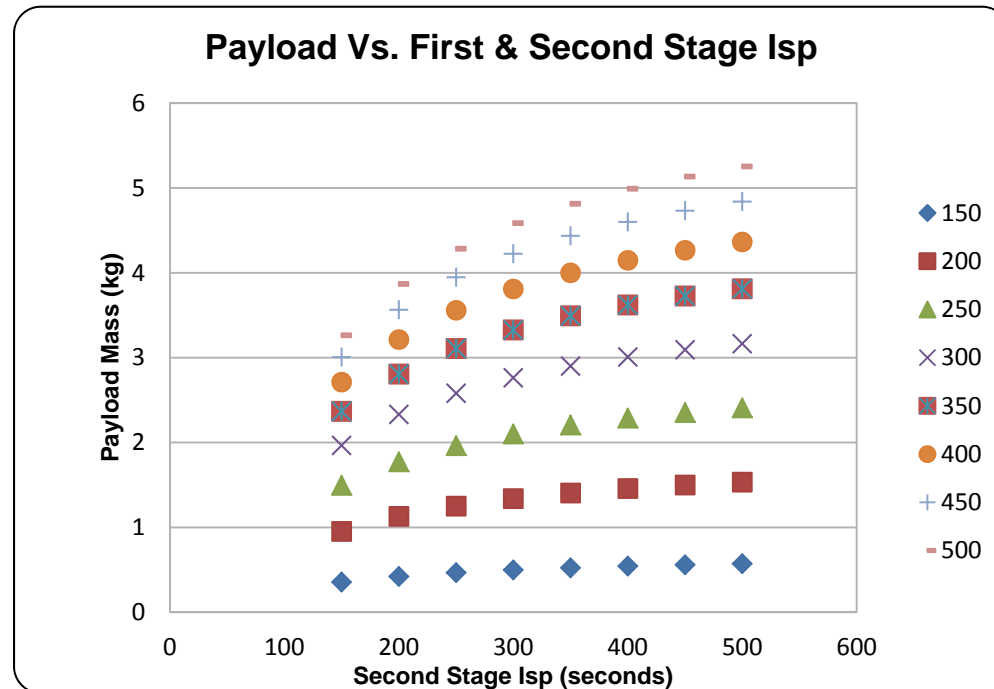
			m_o Stage 2 (kg)	I_sp Stage 2 (s)	Stage 2 PM (kg)	Stage 2 PMF	Payload Mass (kg)
500	6.560279525	0.468591395	6.439720475	150	3.176631366	0.493287151	3.263089109
				200	2.572148056	0.399419209	3.867572418
				250	2.156956244	0.334945632	4.282764231
				300	1.855684945	0.288162344	4.58403553
				350	1.627600909	0.252744031	4.812119566
				400	1.449120782	0.225028522	4.990599693
				450	1.305738704	0.202763258	5.133981771
				500	1.188072685	0.184491344	5.25164779

Dahlstrom Trajectory 2-Stage Co

Payload	Charting								
Stage 2\Stage 1 Isp		150	200	250	300	350	400	450	500
150	0.355574264	0.95365213	1.49659235	1.9665537	2.36833496	2.71195144	3.0073587	3.26308911	
200	0.421443966	1.13031503	1.77383427	2.3308554	2.80706615	3.21433716	3.56446827	3.86757242	
250	0.466686839	1.25165667	1.96425901	2.58107749	3.10841044	3.55940283	3.94712123	4.28276423	
300	0.499515951	1.33970453	2.10243493	2.76264354	3.32707176	3.80978923	4.2247817	4.58403553	
350	0.52436995	1.40636309	2.20704403	2.90010209	3.49261409	3.99934974	4.43499064	4.81211957	
400	0.543818681	1.45852469	2.28890266	3.00766604	3.62215414	4.14768447	4.59948317	4.99059969	
450	0.559442825	1.50042873	2.35466382	3.09407758	3.72622019	4.26684923	4.7316283	5.13398177	
500	0.572264727	1.53481714	2.40863049	3.16499092	3.81162164	4.36464139	4.84007276	5.25164779	

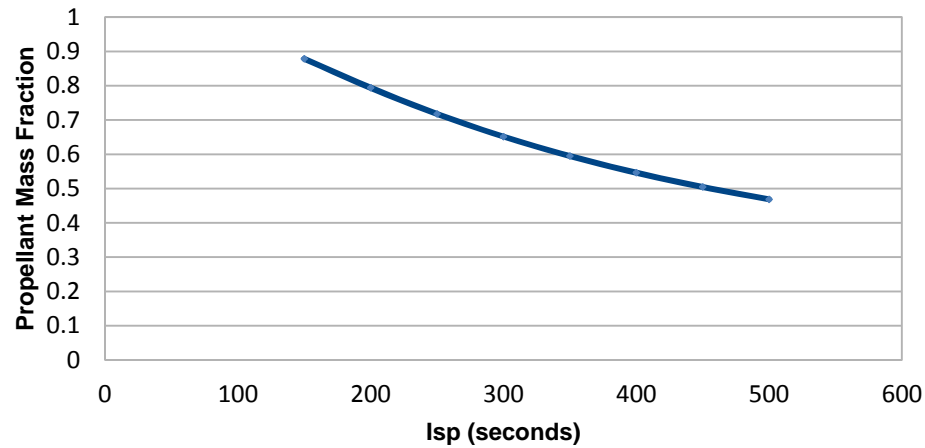
Stage 1 Isp	1st Stage PMF
150	0.878448047
200	0.794140242
250	0.717604894
300	0.651356983
350	0.59472005
400	0.546282293
450	0.504640327
500	0.468591395

Stage 2\Stage 1 Isp	2 nd Stage PMF
150	0.493287151
200	0.399419209
250	0.334945632
300	0.288162344
350	0.252744031
400	0.225028522
450	0.202763258
500	0.184491344

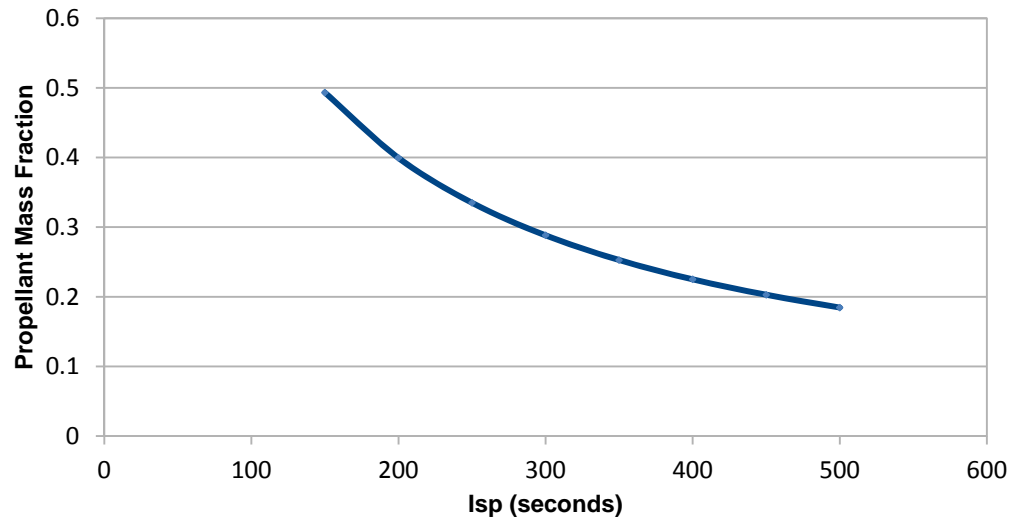


Dahlstrom Trajectory 2-Stage Co

First Stage: Propellant Mass Fraction Vs. Isp



Second Stage: Propellant Mass Fraction Vs. Isp



Mass & Volume Limited Motor Ana

Single Stage Chemical Kick Motor Analysis – Volume & Mass Limit

Total Initial Mass	14 kg	
Kick Motor System Volume Limit	3 U	1 U
Non-Propellant Volume	0.75 U	0.001 m^3
Propellant Volume	2.25 U	
Kick Motor System Mass Limit	10 kg	
Kick Motor System Dry Mass	3 kg	
Kick Motor Propellant Mass	7 kg	
Standard Gravity (g_0)	9.80665 m/s^2	

	N2O-40% Aluminized Paraffin	N2O-Asphalt	90% H2O2-95% LiAl- Hydride/5% CH2
I_sp	200	200	319 seconds
Density N2O	1222	1222	1365 kg/m^3
Density 40% Al-Paraffin	1250	1010.316496	866.380995 kg/m^3
O/F Ratio	3	4.882352941	1.25
Maximum Mass Oxidizer	5.25	5.81	3.888888889 kg
Maximum Mass Fuel	1.75	1.19	3.111111111 kg
Volume Oxidizer	4.296235679	4.754500818	2.849002849 U
Volume Fuel	1.4	1.177848728	3.590927235 U
Total Propellant Volume	5.696235679	5.932349547	6.439930084 U
Total System Mass	10	10	10 kg
Total System Volume	6.446235679	6.682349547	7.189930084 U
Mass-Limited DeltaV	1359.49036	1359.49036	2168.387124 m/s
Maximum Volume Oxidizer	1.6875	1.8675	1.25 U
Maximum Volume Fuel	0.5625	0.3825	1 U
Mass Oxidizer	2.062125	2.282085	1.70625 kg
Mass Fuel	0.703125	0.38644606	0.866380995 kg
Total Propellant Mass	2.76525	2.66853106	2.572630995 kg

Mass & Volume Limited Motor Ana

Total System Mass	5.76525	5.66853106	5.572630995 kg
Total System Volume	3	3	3 U
Volume-Limited DeltaV	431.5821859	414.7695403	635.1933295 m/s

Single Stage Electric Long-Endurance Motor Analysis – Volume & Mass Limit

Electric Motor System Volume	1.5 U
Non-Propellant Volume	0.5 U
Propellant Volume	1 U
Electric Motor System Mass Limit	2 kg
Electric Motor System Dry Mass	0.5 kg
Electric Motor Propellant Mass	1.5 kg

Solid Iodine

I _{sp}	1200 seconds
Density Solid Iodine	4933 kg/m ³
Maximum Mass Propellant	1.5 kg
Volume Propellant	0.3040746 U
Total System Mass	2 kg
Total System Volume	0.8040746 U
Mass-Limited DeltaV	1333.649702 m/s

Maximum Volume Propellant	1 U
Mass Propellant	4.933 kg
Total System Mass	5.433 kg
Total System Volume	1.5 U
Volume-Limited DeltaV	5112.197399 m/s

Mission Requirements

SLS Launch		ISS Launch	
EP Delta_V	1166.252128 m/s	EP Delta_V	8401.369951 m/s
CP Delta_V	95.91006883 m/s		

Mass & Volume Limited Motor Ana

SLS Propulsion System		Single Stage Electric Long-Endurance Motor Analysis – Volume & Mass Limit	
Kick Motor System Volume Limit	2 U	Electric Motor System Vo	2 U
Non-Propellant Volume	0.75 U	Non-Propellant Volume	0.5 U
Propellant Volume	1.25 U	Propellant Volume	1.5 U
Kick Motor System Mass Limit	5 kg	Electric Motor System Ma	3 kg
Kick Motor System Dry Mass	3 kg	Electric Motor System Dry	0.5 kg
Kick Motor Propellant Mass	2 kg	Electric Motor Propellant	2.5 kg
N2O-40% Aluminized Paraffin		Solid Iodine	
Maximum Mass Oxidizer	1.5 kg	Maximum Mass Propellar	2.5 kg
Maximum Mass Fuel	0.5 kg	Volume Propellant	0.506790999 U
Volume Oxidizer	1.227495908 U	Total System Mass	3 kg
Volume Fuel	0.5 U	Total System Volume	1.006790999 U
Total Propellant Volume	1.727495908 U	Mass-Limited DeltaV	2314.882808 m/s
Total System Mass	5 kg	Maximum Volume Propel	1.5 U
Total System Volume	2.477495908 U	Mass Propellant	7.3995 kg
Mass-Limited DeltaV	302.3403529 m/s	Total System Mass	7.8995 kg
Maximum Volume Oxidizer	0.9375 U	Total System Volume	2 U
Maximum Volume Fuel	0.3125 U	Volume-Limited DeltaV	8848.484505 m/s
Mass Oxidizer	1.145625 kg		
Mass Fuel	0.390625 kg		
Total Propellant Mass	1.53625 kg		
Total System Mass	4.53625 kg		
Total System Volume	2 U		
Volume-Limited DeltaV	431.5821859 m/s		
Single Stage Electric Long-Endurance Motor Analysis – Volume & Mass Limit			
Electric Motor System Volume	1.5 U		

Mass & Volume Limited Motor Ana

Non-Propellant Volume	0.5 U
Propellant Volume	1 U
Electric Motor System Mass Limit	2 kg
Electric Motor System Dry Mass	0.5 kg
Electric Motor Propellant Mass	1.5 kg

Solid Iodine

Maximum Mass Propellant	1.5 kg
Volume Propellant	0.3040746 U
Total System Mass	2 kg
Total System Volume	0.8040746 U
Mass-Limited DeltaV	1333.649702 m/s

Maximum Volume Propellant	1 U
Mass Propellant	4.933 kg
Total System Mass	5.433 kg
Total System Volume	1.5 U
Volume-Limited DeltaV	5112.197399 m/s

Mass & Volume Limited Motor Ana

Mass & Volume Limited Motor Ana

SLS & ISS-Based Trajectory Anal

Earth Standard Gravitational Parameter	398600.4418 km ³ /s ²			
SLS Initial Secondary Payload Trajectory				
a (Semimajor Axis)	205954.7723 km	b (Semiminor Axis)	52700.13 km	
e (Eccentricity)	0.966708003	Apogee	405052.90 km	
i (Inclination)	28.6065478 deg	Perigee	6856.65 km	
Right Ascension of the Ascending Node	65.95689659 deg	Orbital Period	930183.80 seconds	10.8 days
w (Argument of Perigee)	47.91616744 deg	v_apo_0	0.18 km/s	
f (True Anomaly)	122.4710759 deg	Total Transit Time	10.77 days	
SHORT-DURATION, HIGH-THRUST CALCULATION				
First Delta V (Initial SLS Ellipse Perigee to Apogee 4M km)				
v_per_0	10.69259161 km/s	v_apo_1	0.02 km/s	
Apogee Target	4000000 km	Orbital Period	28220954.22 seconds	326.6 days
Common Perigee	6856.645584 km	Total Transit Time	163.32 days	
a	2003428.323 km			
e	0.996577544			
v_per_1	10.77348294 km/s			

SLS & ISS-Based Trajectory Anal

Delta_V_1_SLS 0.080891331 km/s

First Delta V (Initial ISS LEO to 4M km
Apogee Elliptic)

v_CLEOISS 7.668145961 km/s
Apogee Target 4000000 km
Common Perigee 6778.86576 km
a 2003389.433 km
e 0.996616302
v_per_1 10.83521859 km/s
Delta_V_1_ISS 3.167072631 km/s

v_apo_1 0.02 km/s
Orbital Period 28220132.50 seconds 326.6 days
Total Transit Time 163.31 days

Pure Inclination Change (At 4M km
Apogee SLS to LO)

v_4MApogee 0.018467489 km/s
i_0 28.6065478 deg
Delta_V_PC_SLS 0.007509369 km/s

Pure Inclination Change (At 4M km
Apogee ISS to LO)

v_4MApogee 0.018362623 km/s
Delta_i 46.57181 deg
Delta_V_PC_ISS 0.014518208 km/s

Second Delta V (4M km Apogee Elliptic to
Lunar Orbit-Intercepting Elliptic)

SLS & ISS-Based Trajectory Anal

Common Apogee	4000000 km	v_per_2	1.989375585 km/s	
Perigee Target	192199.5 km	Orbital Period	30201526.87 seconds	349.6 days
a	2096099.75 km	Total Transit Time	174.7773546 days	
e	0.908306129			
v_apo_2	0.095589248 km/s			
Delta_V_2_SLS	0.07712176 km/s			
Delta_V_2_ISS	0.077226625 km/s			

Third Delta V (Circularization of Orbit to be Co-Orbiting with Moon)

a	384399 km
v_LO	1.018304735 km/s
Delta_V_3	-0.97107085 km/s

Fourth Delta V (Capture into LLO)

Delta_V_CapLLO	0.854110526 km/s
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SLS-Based Trajectory ISS-Based Trajectory

Impulsive Delta_V_Total	1.990703836	5.0839988 km/s
Approximate Total Transit Time	348.8590781	338.08831 days

LONG-DURATION LOW-THRUST
APPROXIMATE CALCULATION

v_CLEOISS	7.668145961 km/s
v_CLO	1.018304735 km/s
v_C4M	0.315674057 km/s
Delta_i	46.57181 deg

Delta_V_Spiral_ISS-4Mkm-2/3PC	7.463866644 km/s
Delta_V_Spiral_4Mkm-LO-1/3PC	0.742322029 km/s
Delta_V_Spiral_LO-LLO	0.195181278 km/s

SLS & ISS-Based Trajectory Anal

ISS-Based Trajectory

Low-Thrust Delta_V_Total 8.401369951 km/s

COMBINATION CHEMICAL & ELECTRIC TRAJECTORY

From SLS

Chemical Phases

Delta_V_1_SLS 0.080891331 km/s

Delta_V_PC_SLS 0.007509369 km/s

Delta_V_2_SLS 0.07712176 km/s

Impulsive Delta_V_Total 0.095910069 km/s

Approximate Total Transit Time 338.0930619 days

Electric Phases

Incremental_Delta_V_3 -0.97107085 km/s

Delta_V_Spiral_LO-LLO 0.195181278 km/s

EP Delta_V_Total 1.166252128 km/s

From ISS

Electric Phase

All Delta_Vs Total 8.401369951 km/s

SLS & ISS-Based Trajectory Anal

Lunar Orbit Parameters

a	384399 km
e	0.0549006
i	5.145 deg
Right Ascension of the Ascending Node	(Dependant on time of launch) deg
w	(Dependant on time of launch) deg
f	(Dependant on position of body in orbit) deg

ISS LEO Parameters

a	6778.86576 km
e	0.0013981
i	51.71681 deg
Right Ascensic	11.18203 deg
w	103.09233 deg
f	303.89993 deg

Lunar System Parameters

Moon grav const (GM.m)	4902.794 [km ³ /s ²]
(GM.m) ^{0.5}	70.0199543 [km ^{1.5} /s]

Lunar capture to LLO

Radius of Moon (R.M)	1738 km	Ra	1838
Altitude of LLO (H.LLO)	100 km	Rb	66000
		Vai	0.195181278 km
		Vbf	0.032571589 km
		a.transfer	33919 km/s
Distance of Lunar capture	66000 km	('Sphere of influence' for Moon)	
		Dva	0.645003763 km/s
		Dvb	0.209106764 km

SLS & ISS-Based Trajectory Anal

Note: NASA Cube Quest
rules allow a "Lunar
Orbit" to be 10,000 km x
300 km altitude

Dv.total	0.854110526 km/s
	km/s
	km/s

SLS & ISS-Based Trajectory Anal