APPENDIX B: LANDER MISSION DATABOOK

Go to TOC

B.1 Lander Mission Database

LANDER MISSION DATABASE

12/20/96

SUMMARY

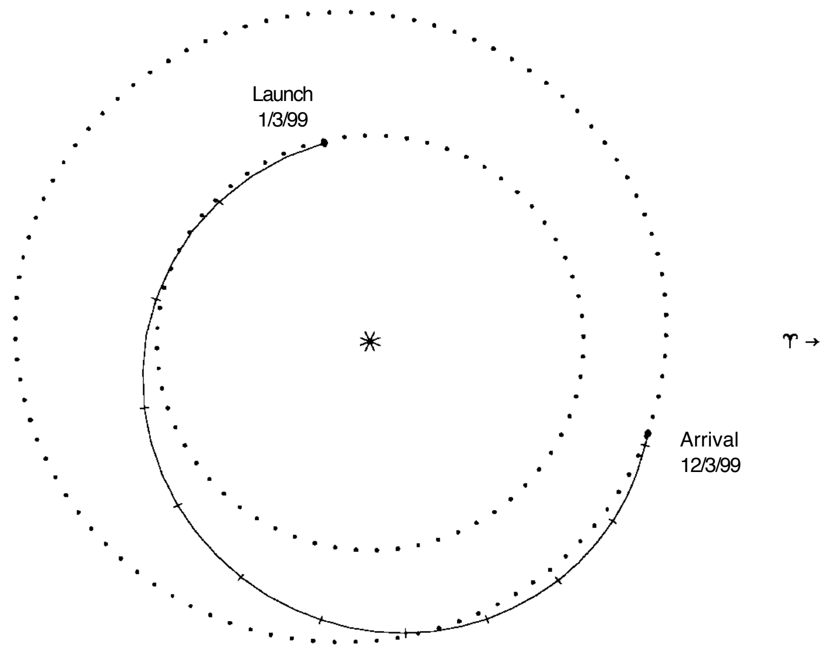
	Day in Launch Period	Launch Date	Arrival Date	Depart C3 [km^2/s^2]	Arrival Vinf [km/s]	Landing Ls [deg.]	Landing Sun angle [deg.]	Landing True Solar Time	Landing Latitude [deg.]
Open of Primary	1	1/3/99	12/3/99	11.17	4.84	256.3	18.3	4:14:33	76S
Close of Primary	8	1/10/99	12/3/99	9.76	4.76	256.3	17.5	4:10:10	75S
Close Contingency	14	1/16/99	12/15/99	9.71	5.08	263.5	16.5	3:36:35	~75S

DATABASE

	Start Primary Launch Period	End Primary Launch Period	End Conting. Launch Period
inj_date_utc	3-Jan-99	10-Jan-99	16-Jan-99
inj_time_utc	21:19:09	20:19:52	20:34:18
inj_date_et	**3-Jan-99**	**10-Jan-99**	**16-Jan-99**
inj_time_et	**21:20:10**	**20:20:53**	**20:35:19**
inj_c3	**11.165**	**9.76**	**9.71**
inj_dla	0.92	4.66	1.69
inj_rla	-124.65	-125.02	-120.91
arrival_date_utc	3-Dec-99	3-Dec-99	15-Dec-99
arrival_time_utc	20:51:15	20:46:46	3:35:33
arrival_date_et	**3-Dec-99**	**3-Dec-99**	**15-Dec-99**
arrival_time_et	**20:52:18**	**20:47:49**	**3:36:36**
arrival_dla	-29.85	-31.19	-30.20
arrival_rla	166.67	167.95	171.33
arrival_vhp	**4.84**	**4.76**	**5.08**
arrival_bdt	285.58	260.01	167.89
arrival_bdr	4883.84	4930.04	4773.70
arrival_radius	3522.20	3522.21	3522.20
arrival_lat	-62.57	-61.67	-61.31
arrival_lon	143.37	144.83	146.63
arrival_vel	6.91	6.85	7.08
arrival_fpa	-13.25	-13.25	-13.25
arrival_az	173.69	174.55	176.37
arrival_ltst	4:10:05	4:05:44	3:32:03
descent_time [s.]	273.41	272.90	278.68
landing_time_et	20:56:51	20:52:21	3:41:14
landing_ltst	**4:14:33**	**4:10:10**	**3:36:35**
landing_earth_angle	**18.5**	**18.3**	**19.0**
landing_sun_angle	**18.3**	**17.5**	**16.5**
Landing Ls [deg.]	**256.3**	**256.3**	**263.5**
Max N. Landing Lat [99%]	74.5S	73.5	~73.5S
Nominal Landing Lat	**76S**	**75S**	**~75S**
Max S. Landing Lat [99%]	77.7S	76.7S	~76.7S
Nominal Landing Lon	210W	210W	210W

Coordinate Systems: Earth Departure: Earth Mean Equator and Equinox of 2000
Mars Arrival: Mars Mean Equator and IAU node of date

LANDER TRAJECTORY
OPEN OF PRIMARY LAUNCH PERIOD



B.2 Lander DSN and Air Force Tracking Initial Acquisition Geometry

LANDER

JET PROPULSION LABORATORY **INTEROFFICE MEMORANDUM**

312/96.2-2010

Aug 21, 1996

TO: Phil Knocke

FROM: Steve Williams SW

SUBJECT: Mars 98 Tracking Station Initial Acquisition Geometry Update

This memo provides Mars 98 Initial acquisition geometries for a 2 hour period following stage 3 burnout for the 3 DSN stations and the 12 Air Force tracking stations given below. The burnout states used here were provided by you in a personal communication. The data is arranged in seven groups:

1) day 1 lander trajectories launching on 3 Jan 99 (short coast)
2) day 8 lander trajectories launching on 10 Jan 99 (short coast)
3) day 16 lander trajectories launching on 16 Jan 99 (short coast)
4) day 25 lander trajectories launching on 27 Jan 99 (short coast)
5) day 1 orbiter trajectories launching on 10 Dec 98 (short coast)
6) day 8 orbiter trajectories launching on 17 Dec 98 (short coast)
7) day 16 orbiter trajectories launching on 25 Dec 98 (short coast)

As before, four parameters are plotted for each station: range, range rate, elevation angle, and aspect angle between the S/C z-axis and the vector to the station (z-axis is assumed to be the S/C velocity vector at burnout as we discussed).

Stations shown in this memo are :

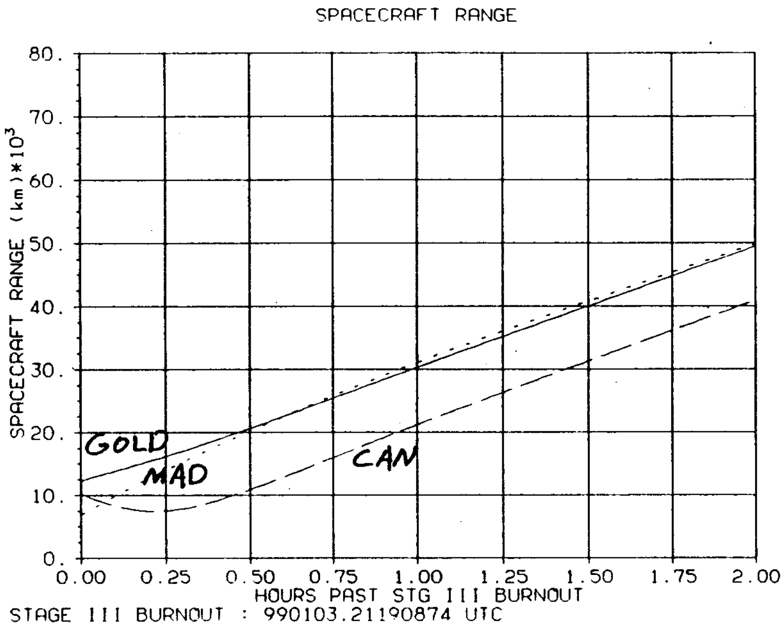
GOLD : Goldstone
MAD : Madrid
CAN : Canberra
ANT : Antigua
ASC : Ascension Island
DGS : Diego Garcia
LBV : Libreville, Gabon
IOS : Indian Ocean
KWAJ : Ennylabegan

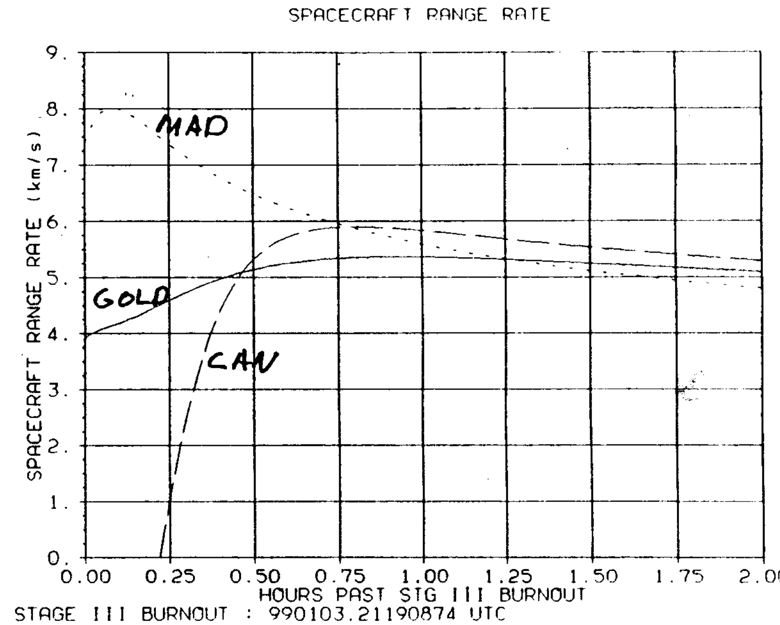
HTS : Hawaii
GTS : Guam
HBK : Hartebeesthoek, South Africa
TEL4 : Tel-4
VTS : Vandenberg
PRTH : Perth

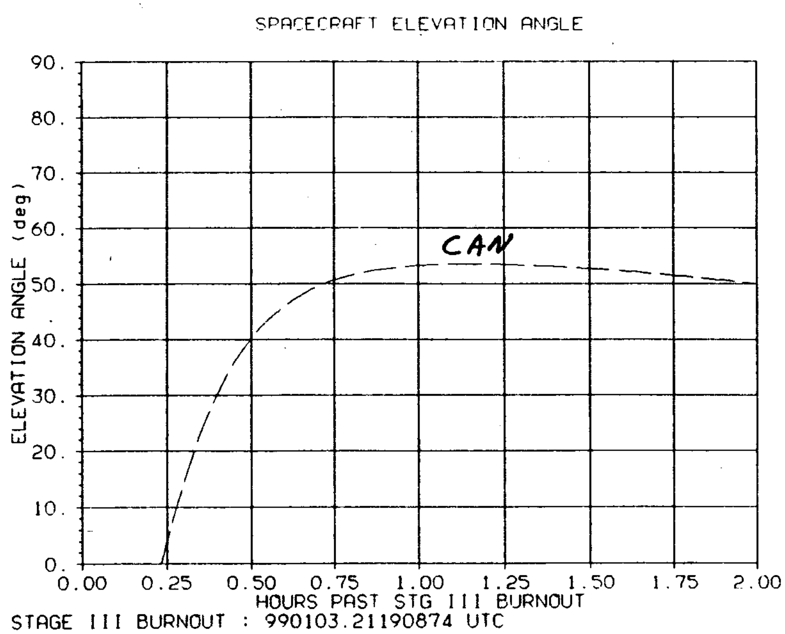
Distribution
D. Murrow
R. Roncoli

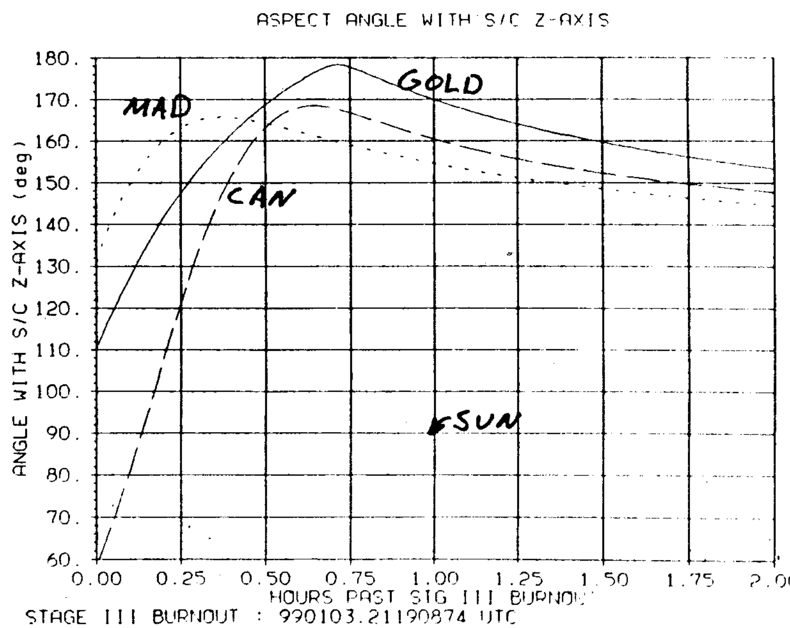
LANDER DAY 1 (1/3/99) SHORT COAST

TRACKING STATION GEOMETRY (LANDER) : DAY 1 SHORT COAST

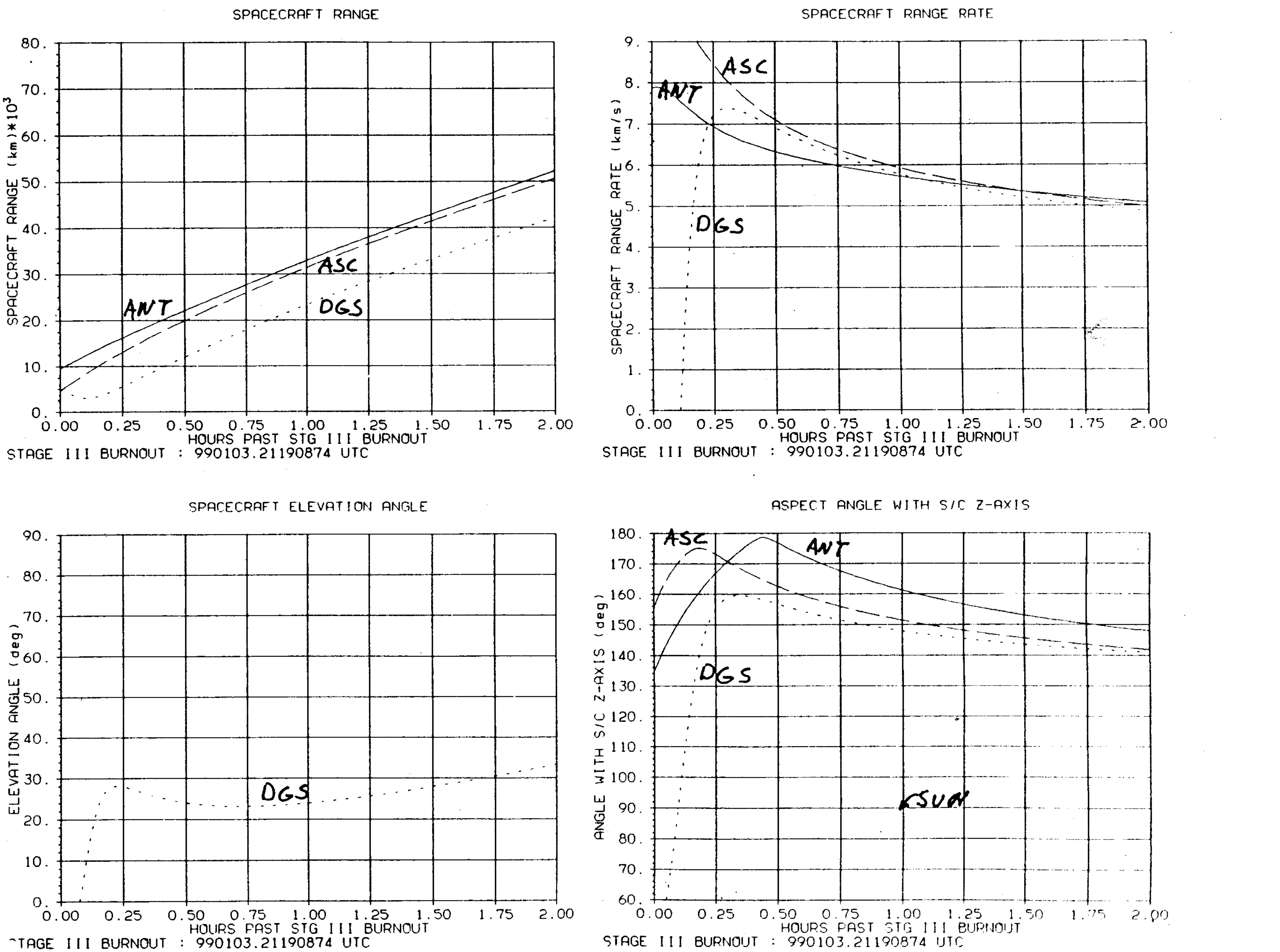






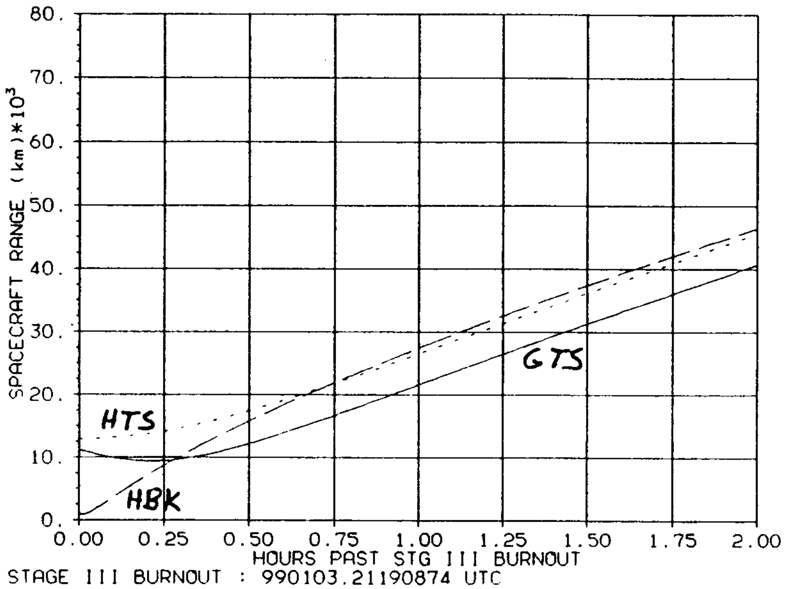


TRACKING STATION GEOMETRY (LANDER) : DAY 1 SHORT COAST

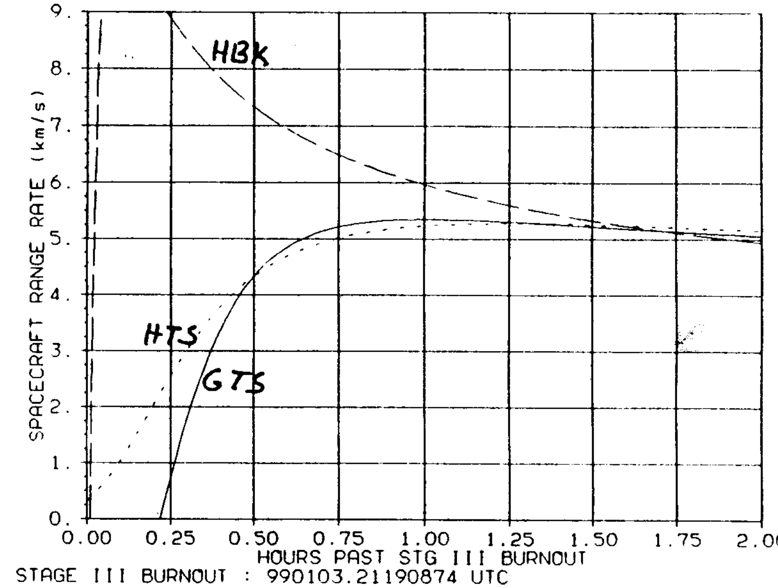


TRACKING STATION GEOMETRY (LANDER) : DAY 1 SHORT COAST

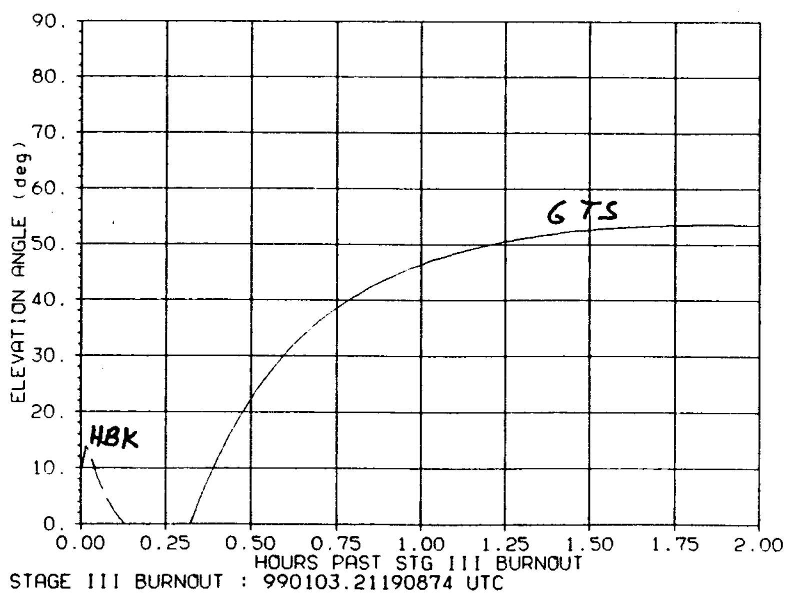
SPACECRAFT RANGE



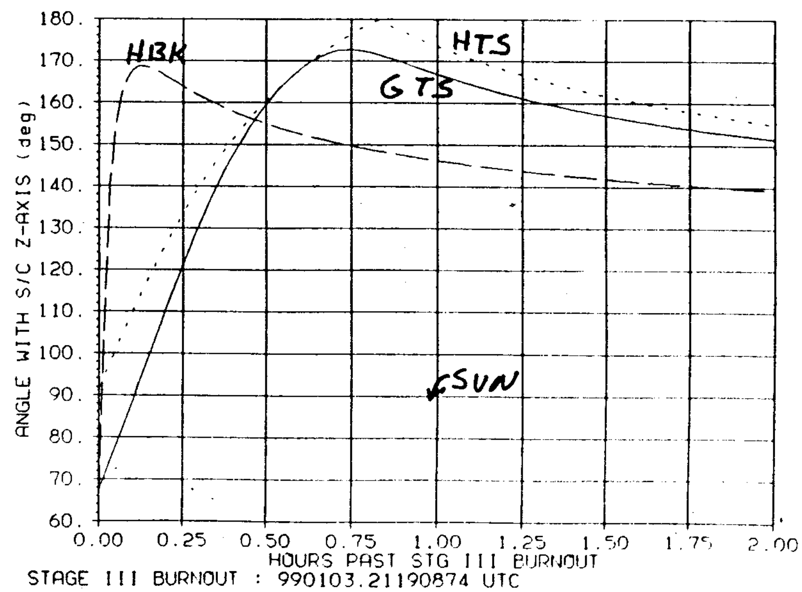
SPACECRAFT RANGE RATE



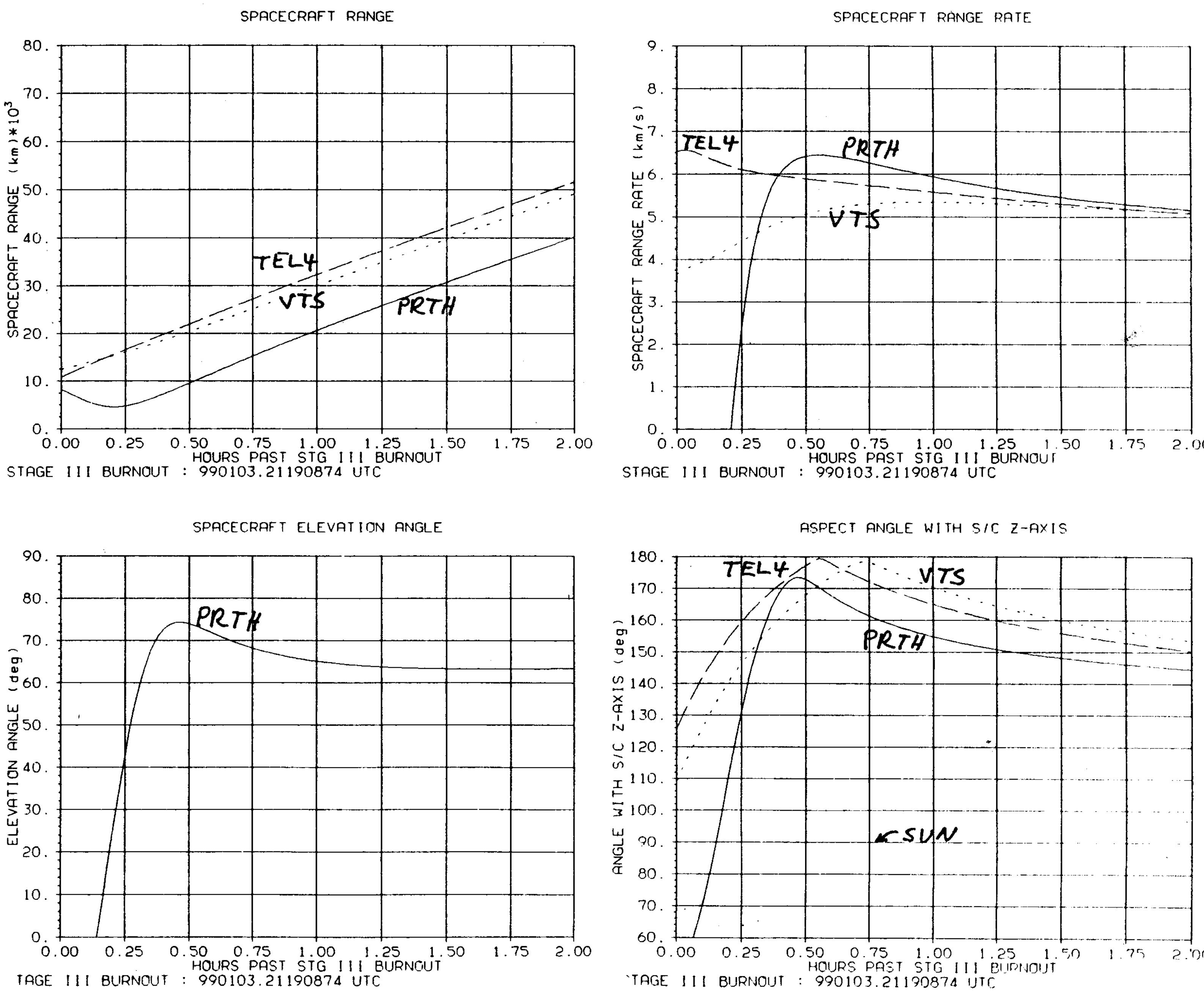
SPACECRAFT ELEVATION ANGLE



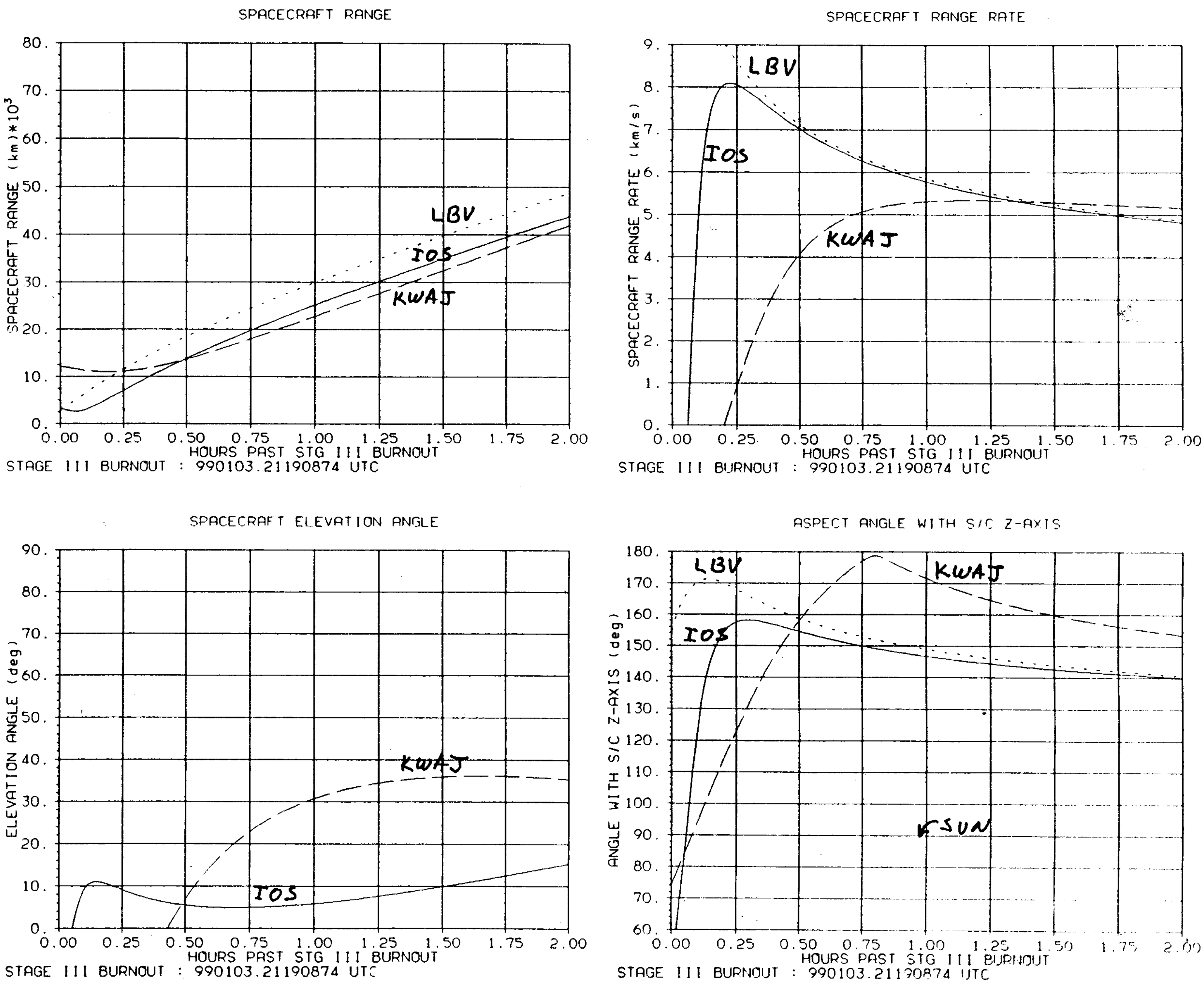
ASPECT ANGLE WITH S/C Z-AXIS



TRACKING STATION GEOMETRY (LANDER) : DAY 1 SHORT COAST



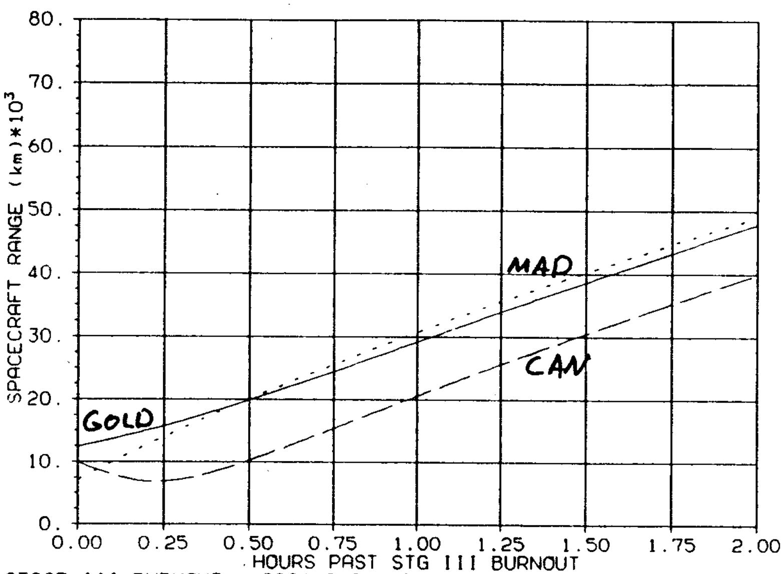
TRACKING STATION GEOMETRY (LANDER) : DAY 1 SHORT COAST



LANDER DAY 8 (1/10/99) SHORT COAST

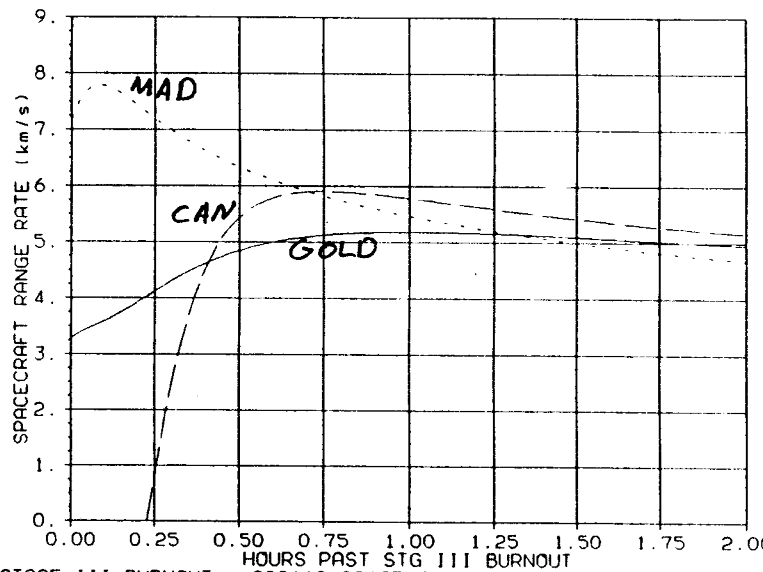
TRACKING STATION GEOMETRY (LANDER) : DAY 8 SHORT COAST

SPACECRAFT RANGE



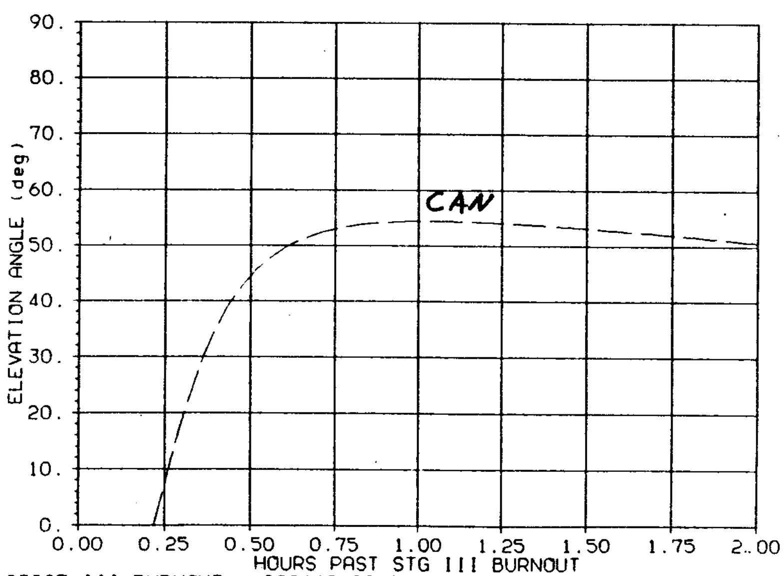
STAGE III BURNOUT : 990110.20195181 UTC

SPACECRAFT RANGE RATE



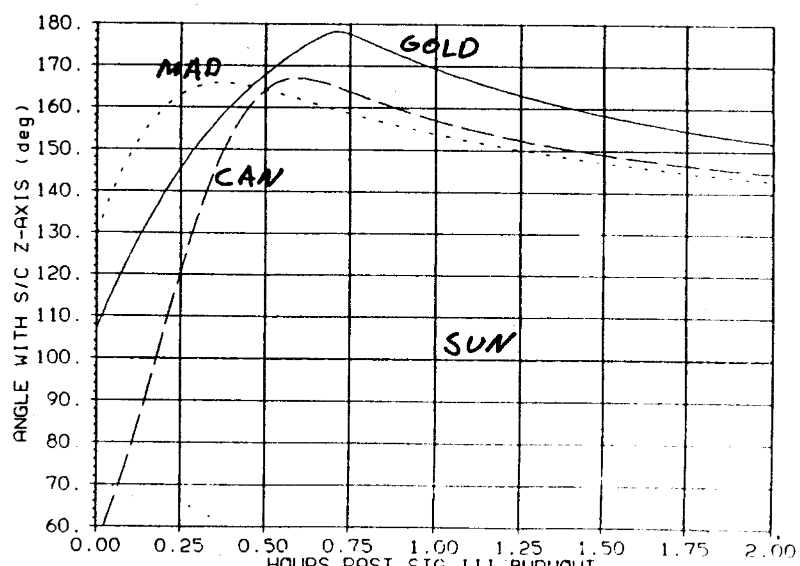
STAGE III BURNOUT : 990110.20195181 UTC

SPACECRAFT ELEVATION ANGLE



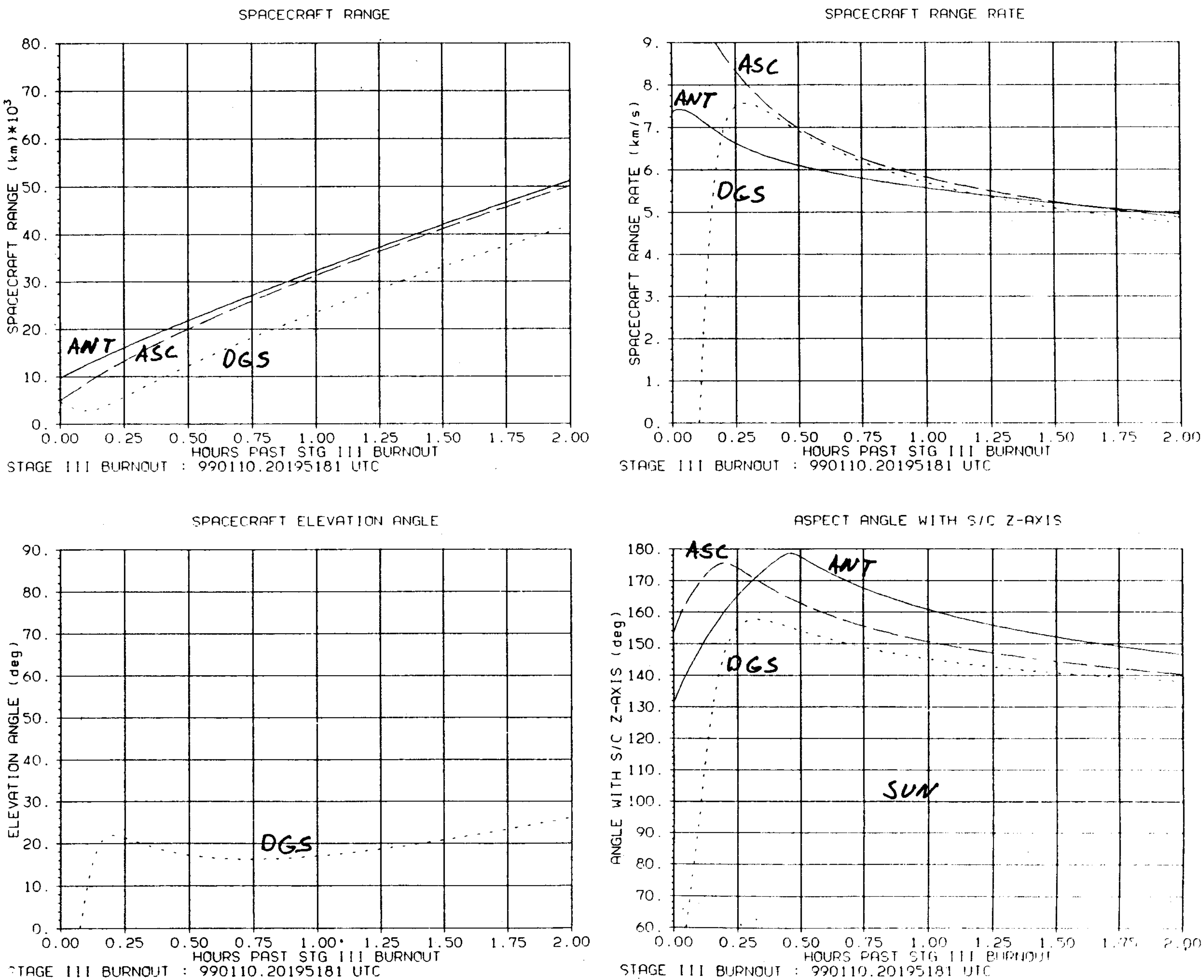
STAGE III BURNOUT : 990110.20195181 UTC

ASPECT ANGLE WITH S/C Z-AXIS

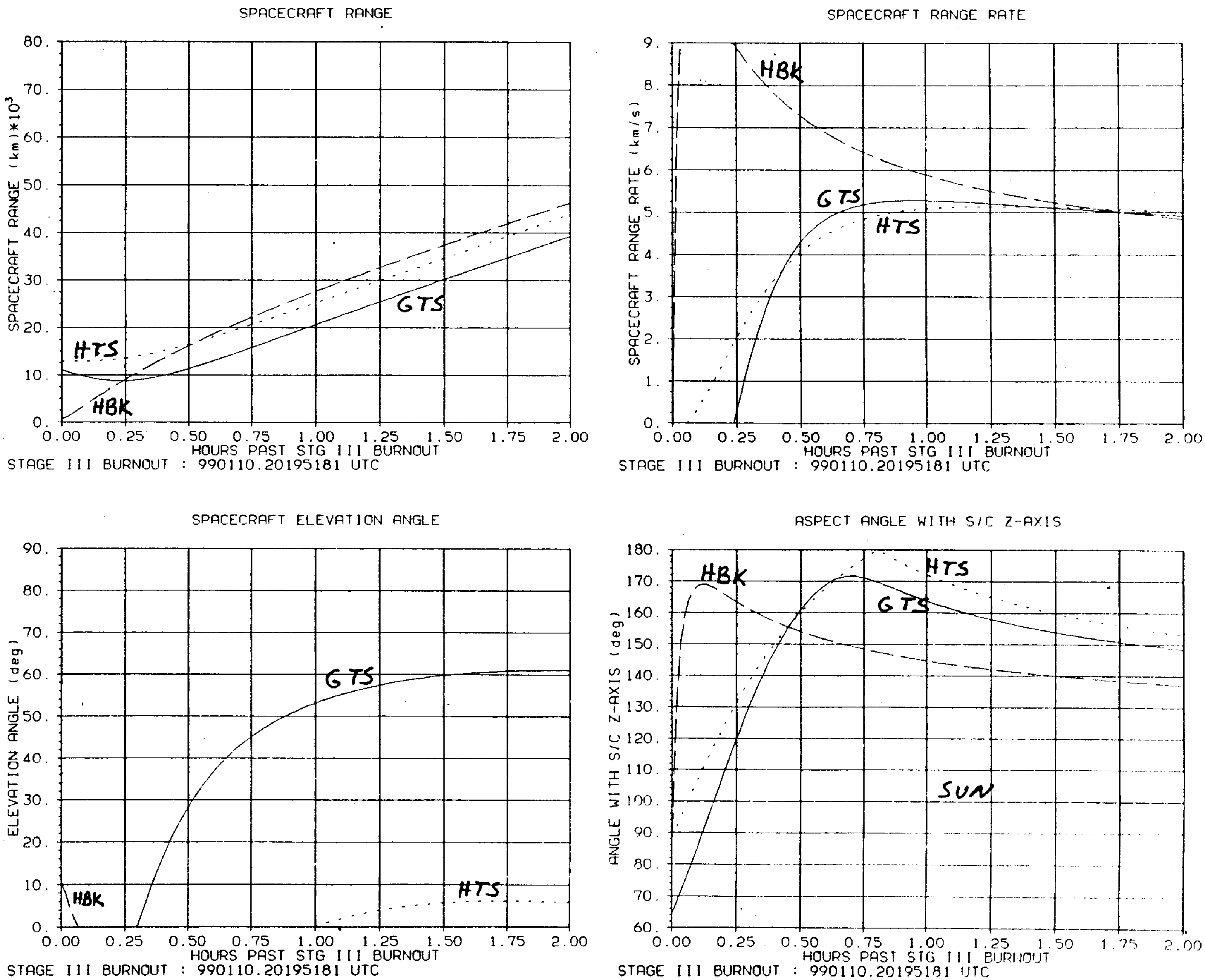


STAGE III BURNOUT : 990110.20195181 UTC

TRACKING STATION GEOMETRY (LANDER) : DAY 8 SHORT COAST

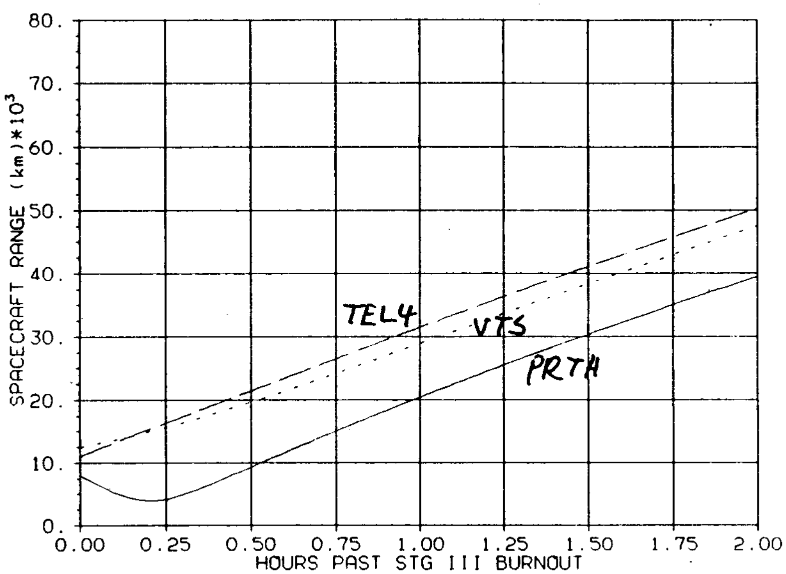


TRACKING STATION GEOMETRY (LANDER) : DAY 8 SHORT COAST



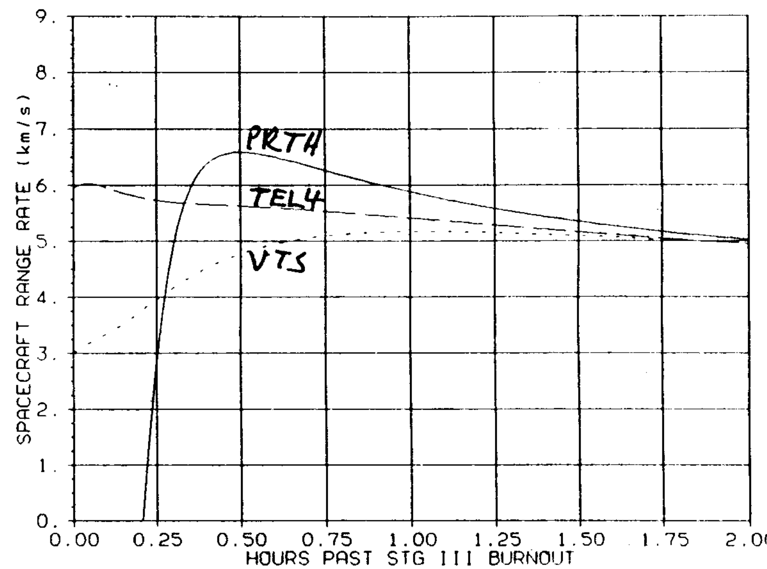
TRACKING STATION GEOMETRY (LANDER) : DAY 8 SHORT COAST

SPACECRAFT RANGE



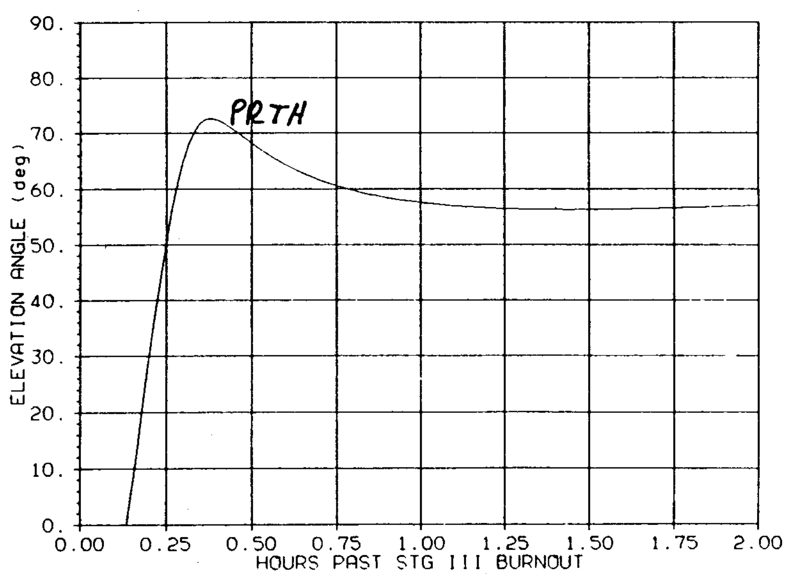
STAGE III BURNOUT : 990110.20195181 UTC

SPACECRAFT RANGE RATE



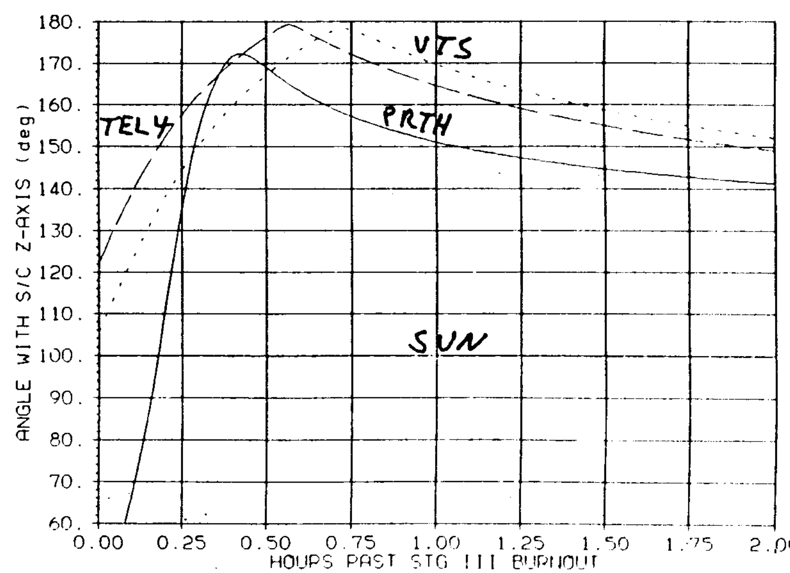
STAGE III BURNOUT : 990110.20195181 UTC

SPACECRAFT ELEVATION ANGLE



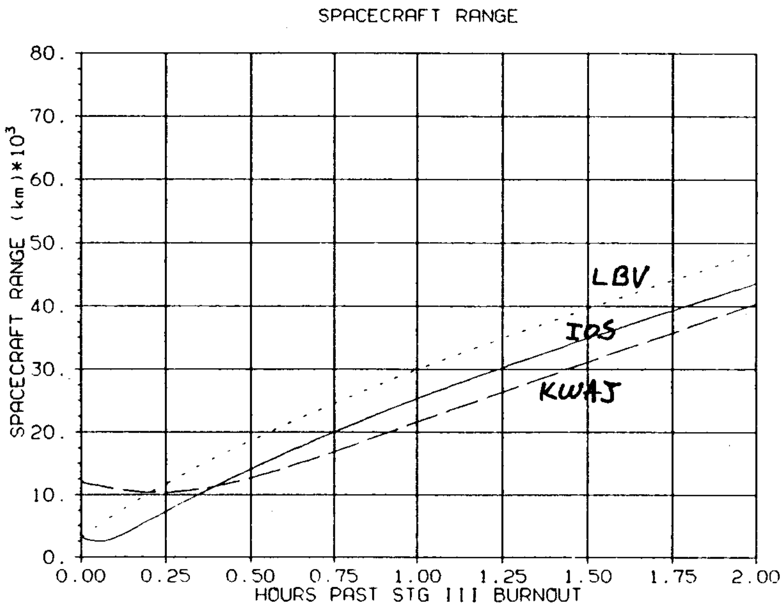
STAGE III BURNOUT : 990110.20195181 UTC

ASPECT ANGLE WITH S/C Z-AXIS

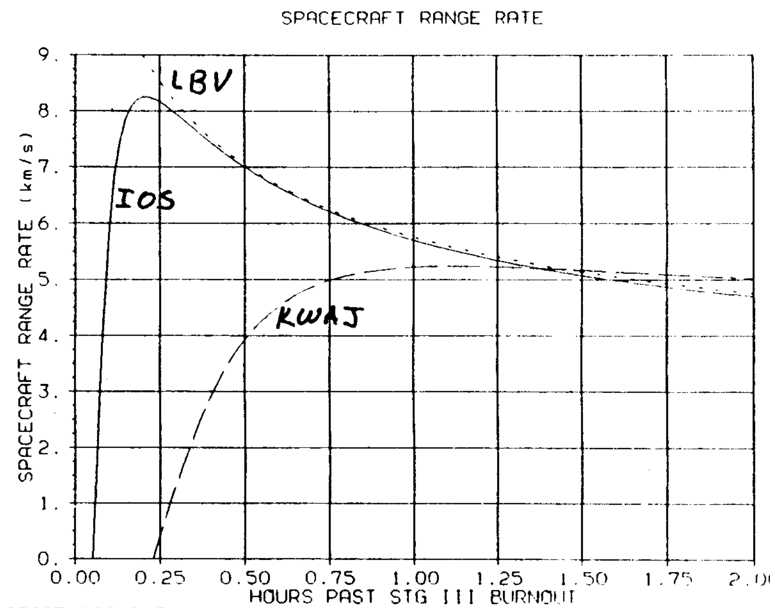


STAGE III BURNOUT : 990110.20195181 UTC

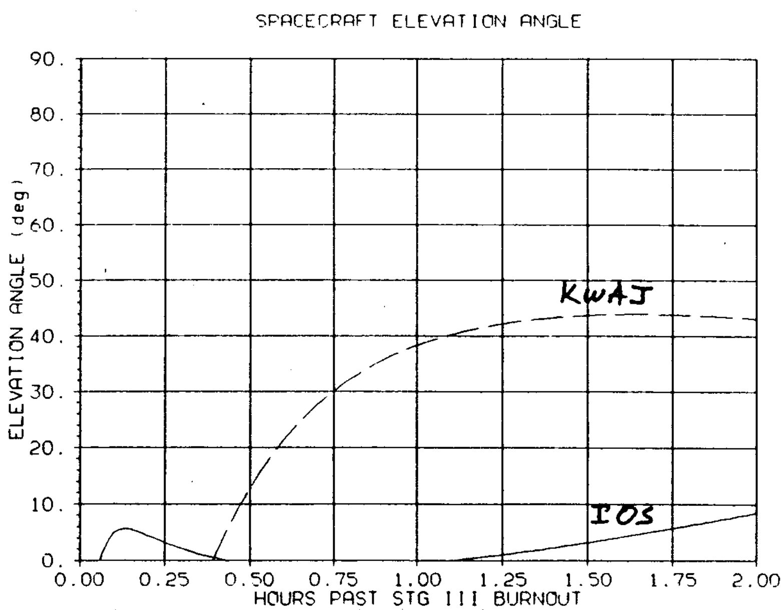
TRACKING STATION GEOMETRY (LANDER) : DAY 8 SHORT COAST



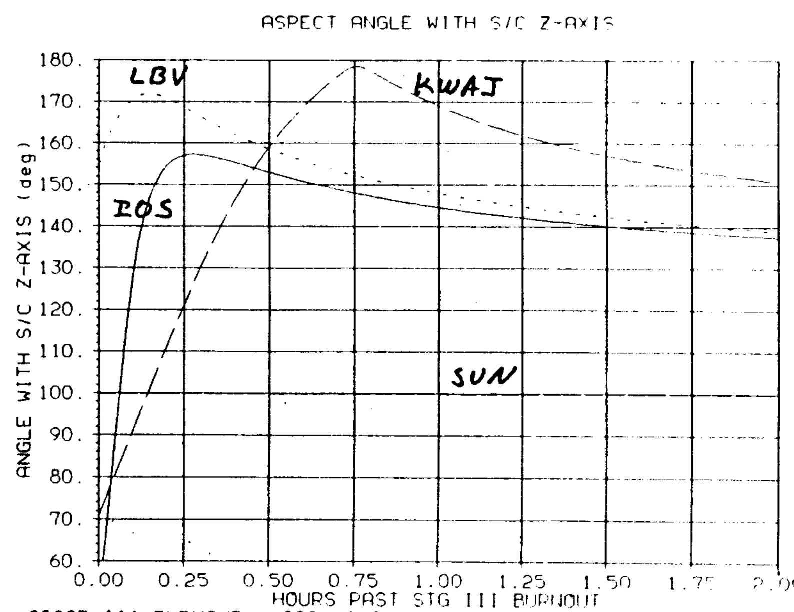
STAGE III BURNOUT : 990110.20195181 UTC



STAGE III BURNOUT : 990110.20195181 UTC



STAGE III BURNOUT : 990110.20195181 UTC

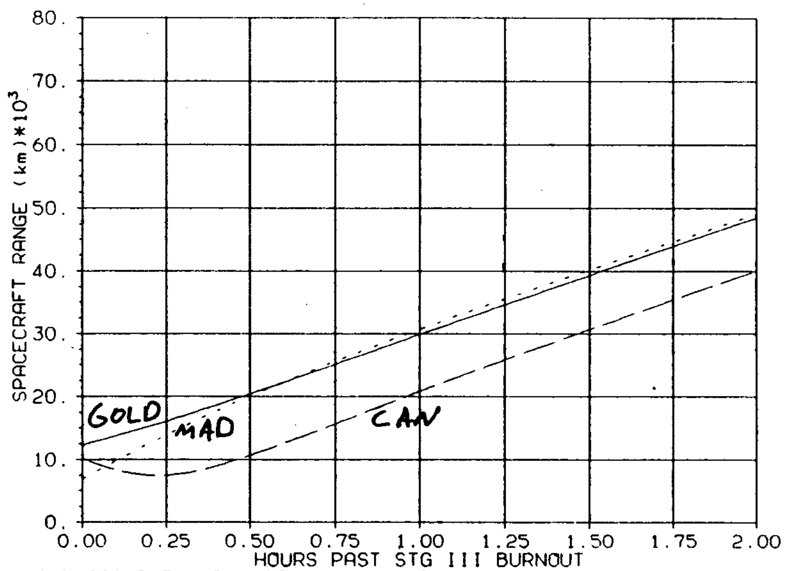


STAGE III BURNOUT : 990110.20195181 UTC

LANDER DAY 14 (1/16/99) SHORT COAST

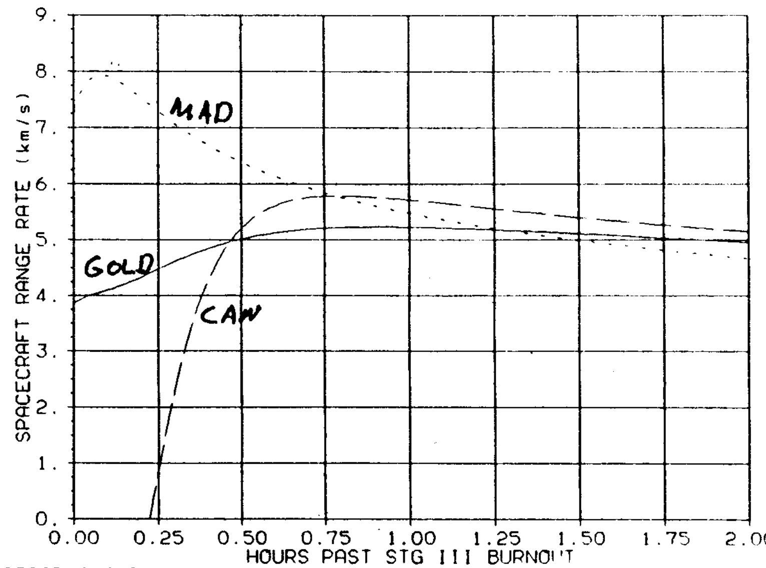
TRACKING STATION GEOMETRY (LANDER) : DAY 14 SHORT COAST

SPACECRAFT RANGE



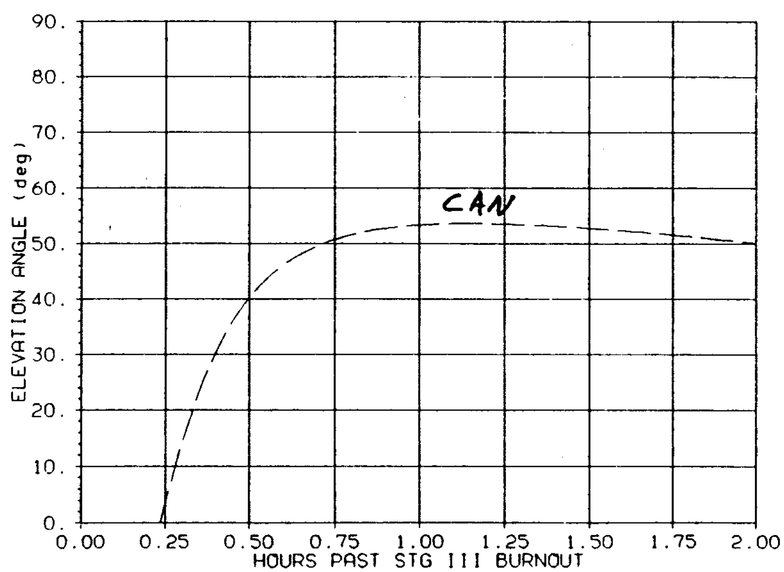
STAGE III BURNOUT : 990116.20341790 UTC

SPACECRAFT RANGE RATE



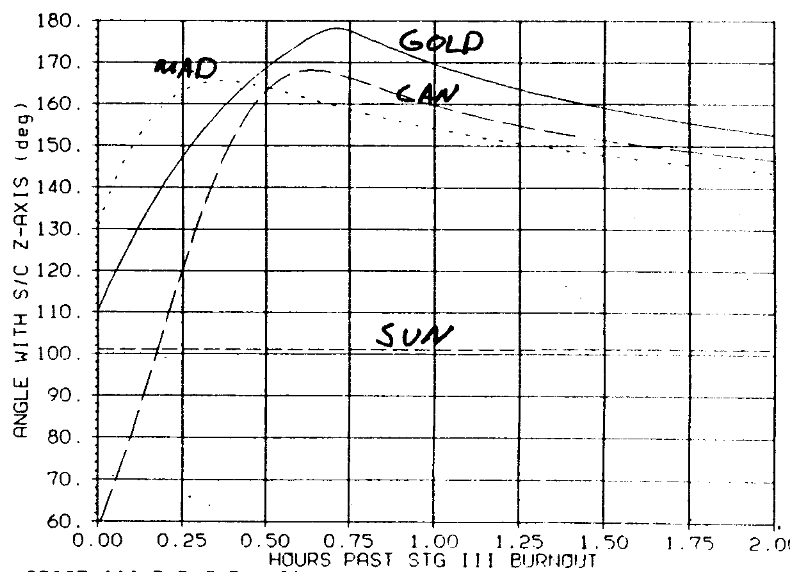
STAGE III BURNOUT : 990116.20341790 UTC

SPACECRAFT ELEVATION ANGLE



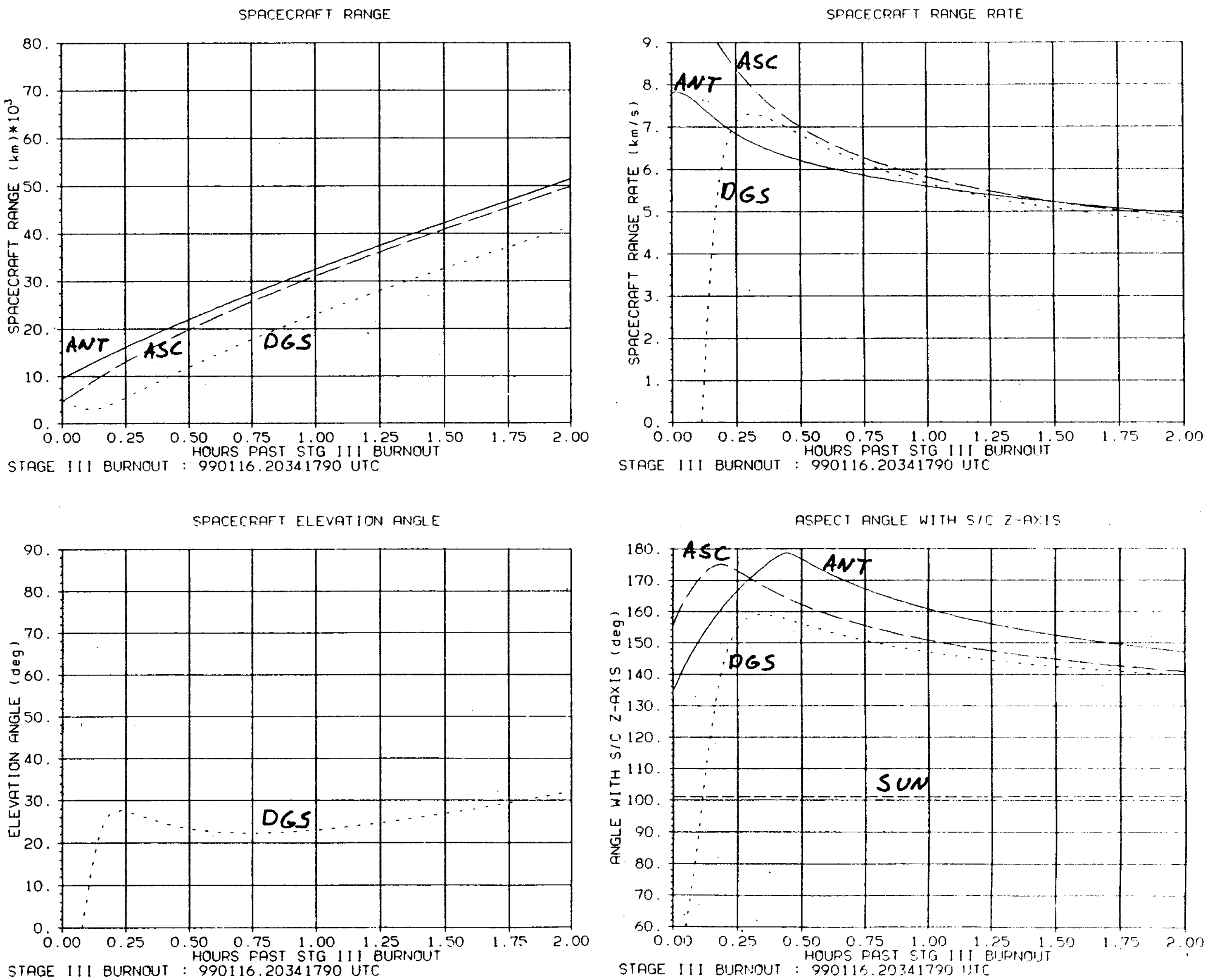
STAGE III BURNOUT : 990116.20341790 UTC

ASPECT ANGLE WITH S/C Z-AXIS

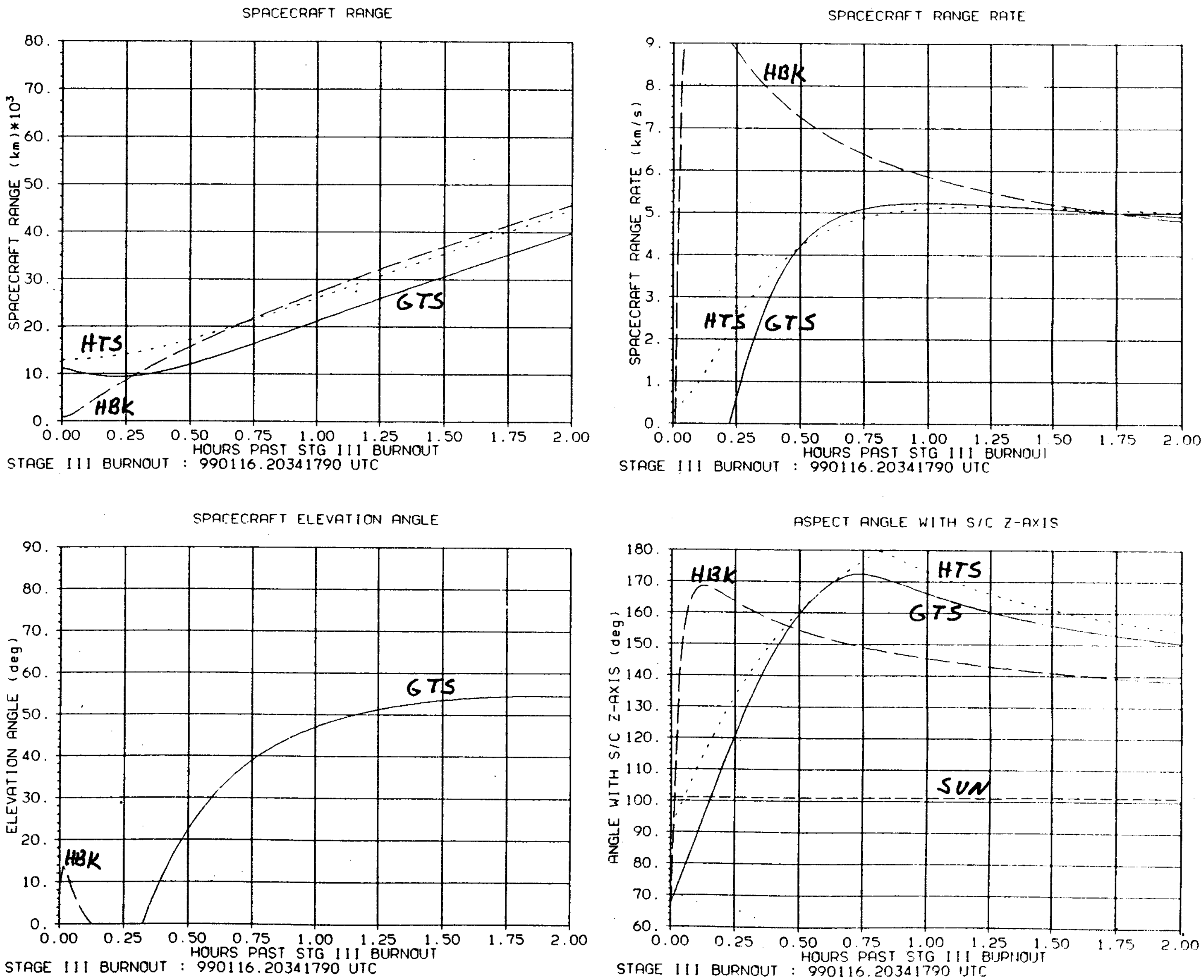


STAGE III BURNOUT : 990116.20341790 UTC

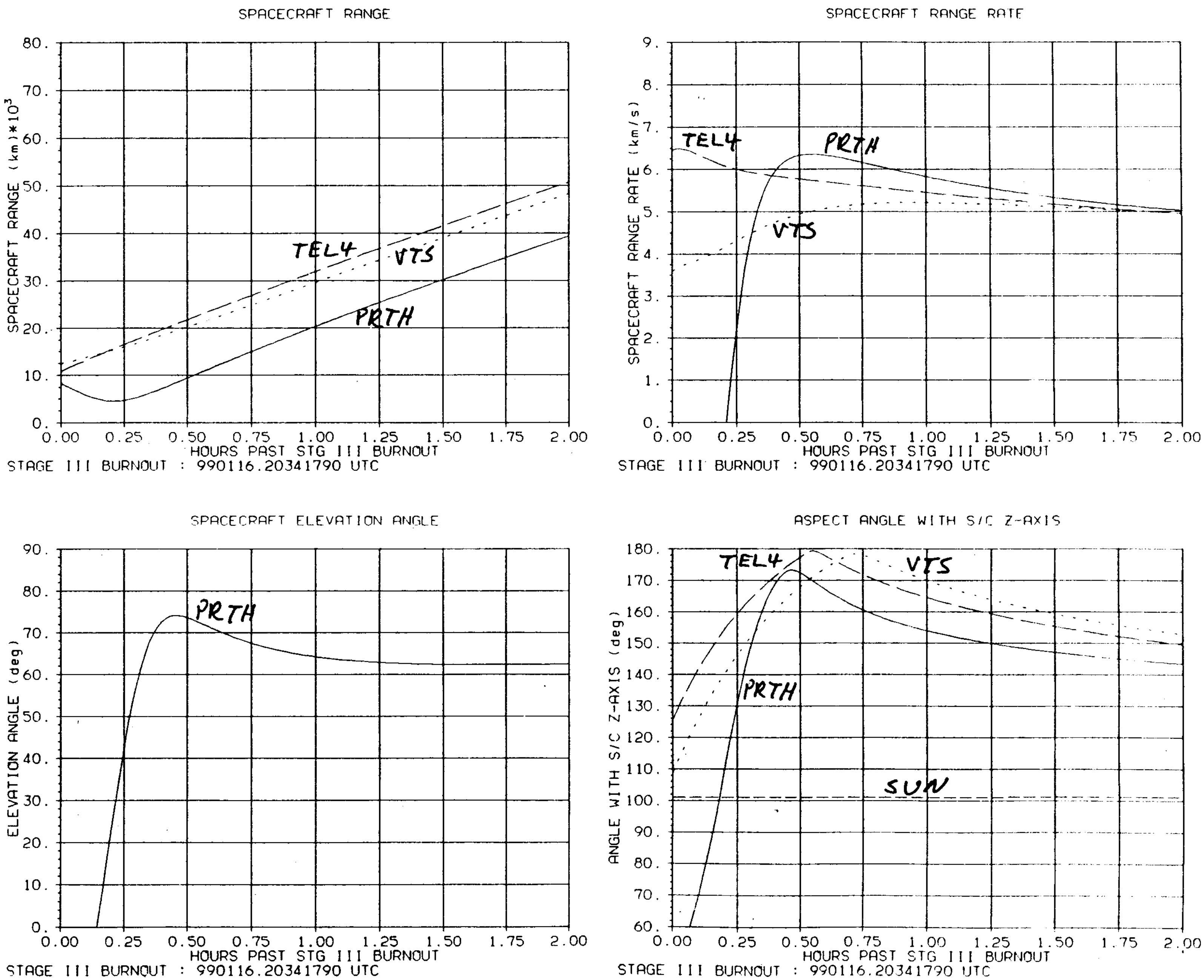
TRACKING STATION GEOMETRY (LANDER) : DAY 14 SHORT COAST



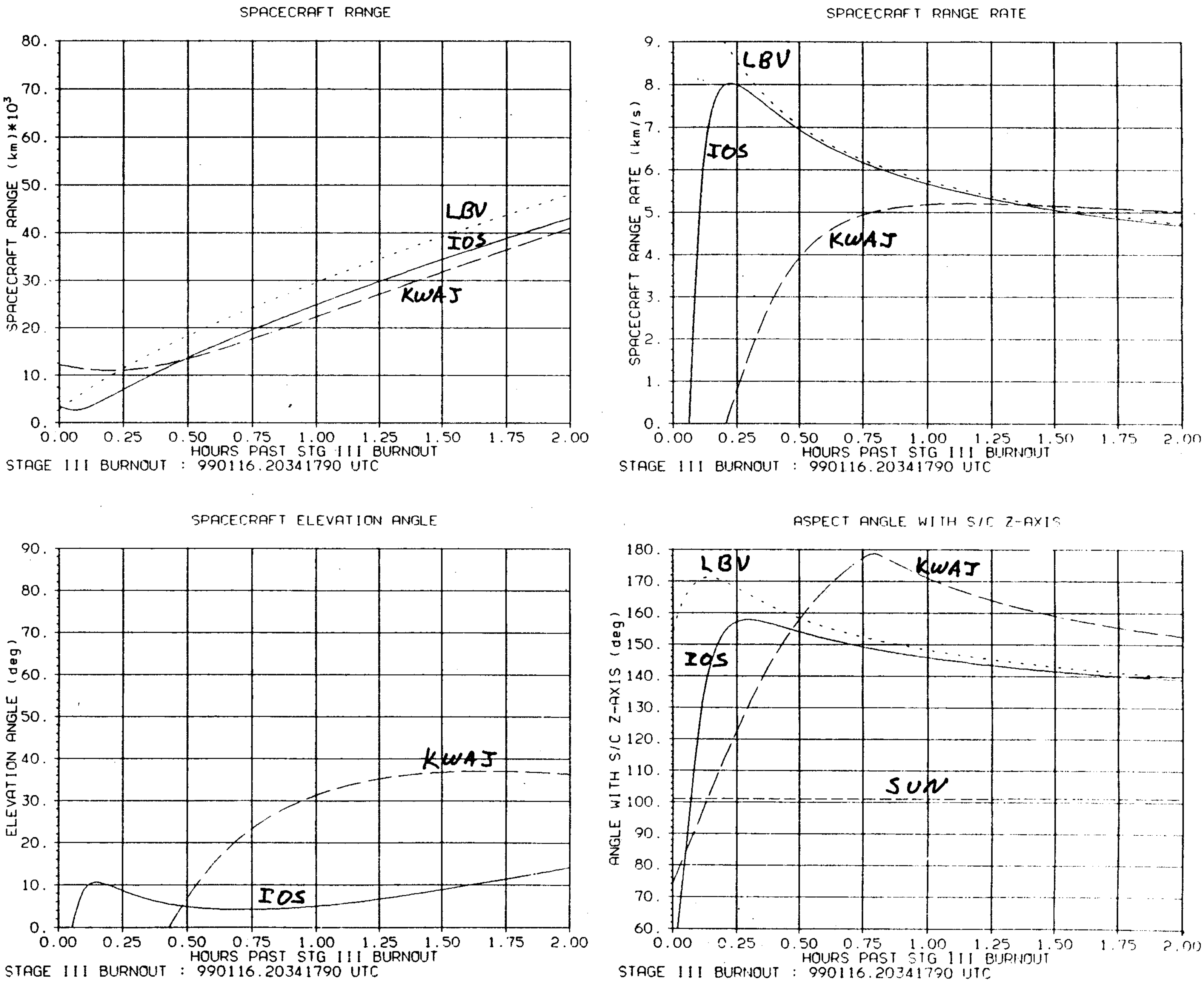
TRACKING STATION GEOMETRY (LANDER) : DAY 14 SHORT COAST



TRACKING STATION GEOMETRY (LANDER) : DAY 14 SHORT COAST



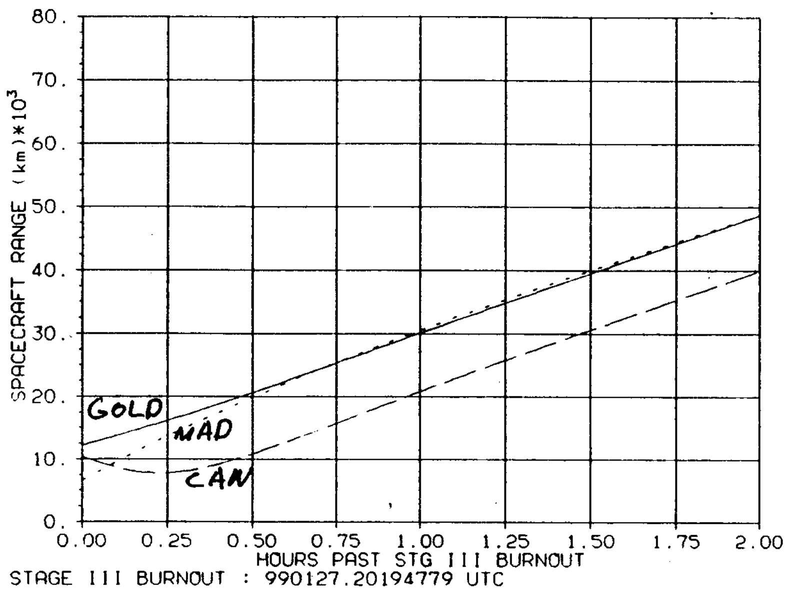
TRACKING STATION GEOMETRY (LANDER) : DAY 14 SHORT COAST



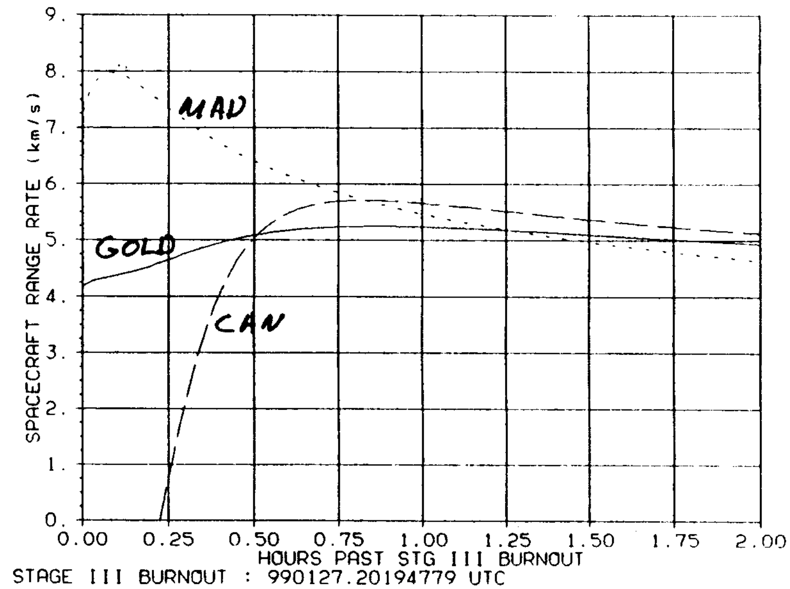
LANDER DAY 25 (1/27/99) SHORT COAST

TRACKING STATION GEOMETRY (LANDER) : DAY 25 SHORT COAST

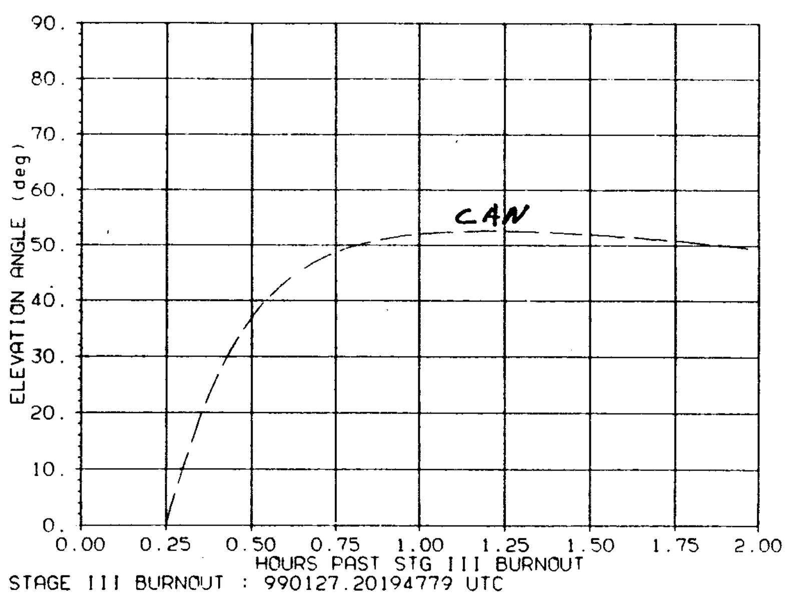
SPACECRAFT RANGE



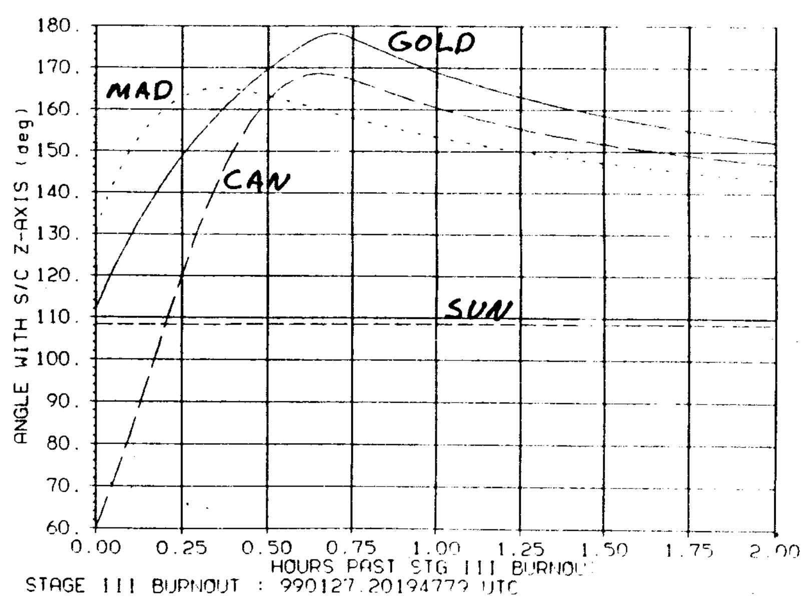
SPACECRAFT RANGE RATE



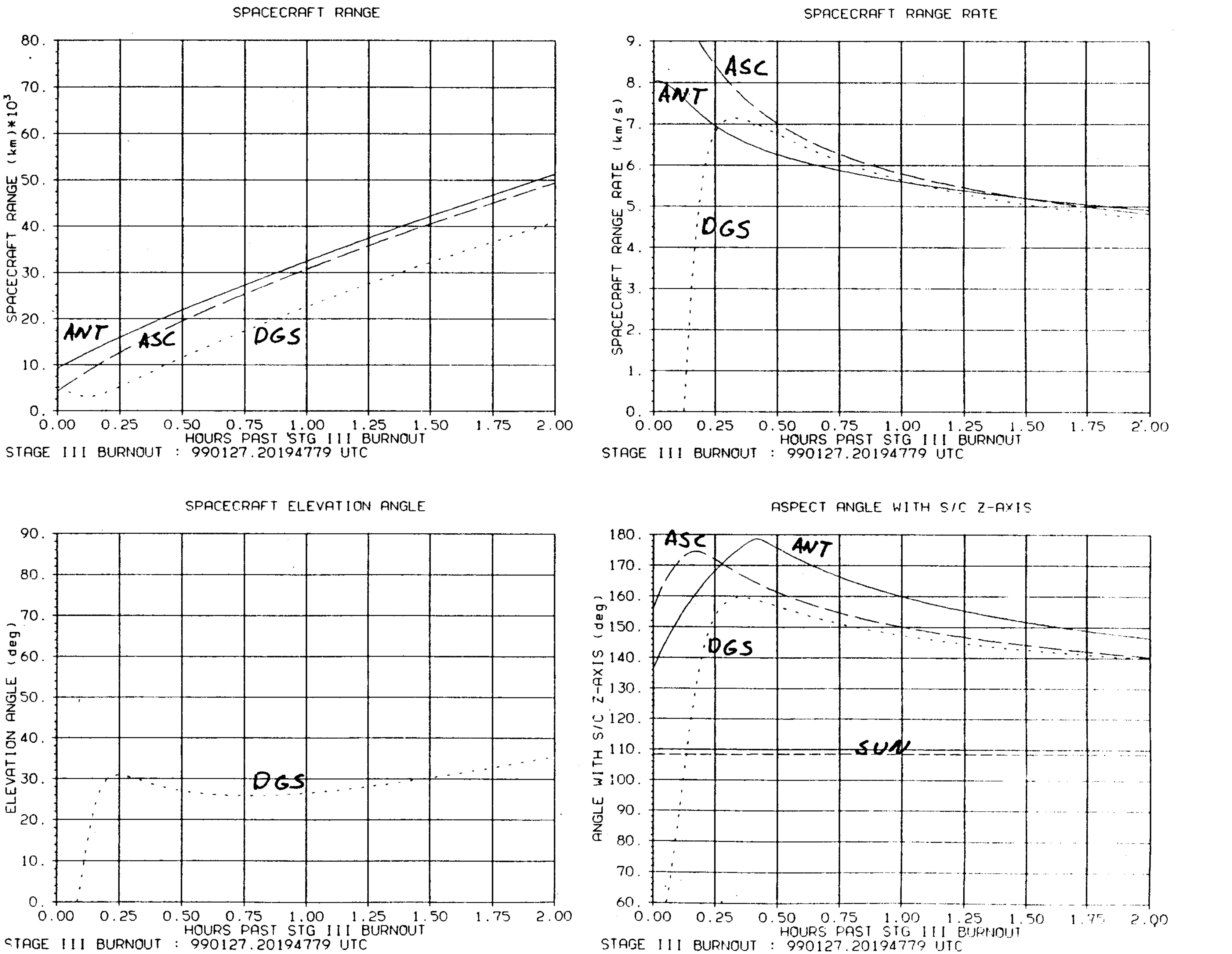
SPACECRAFT ELEVATION ANGLE



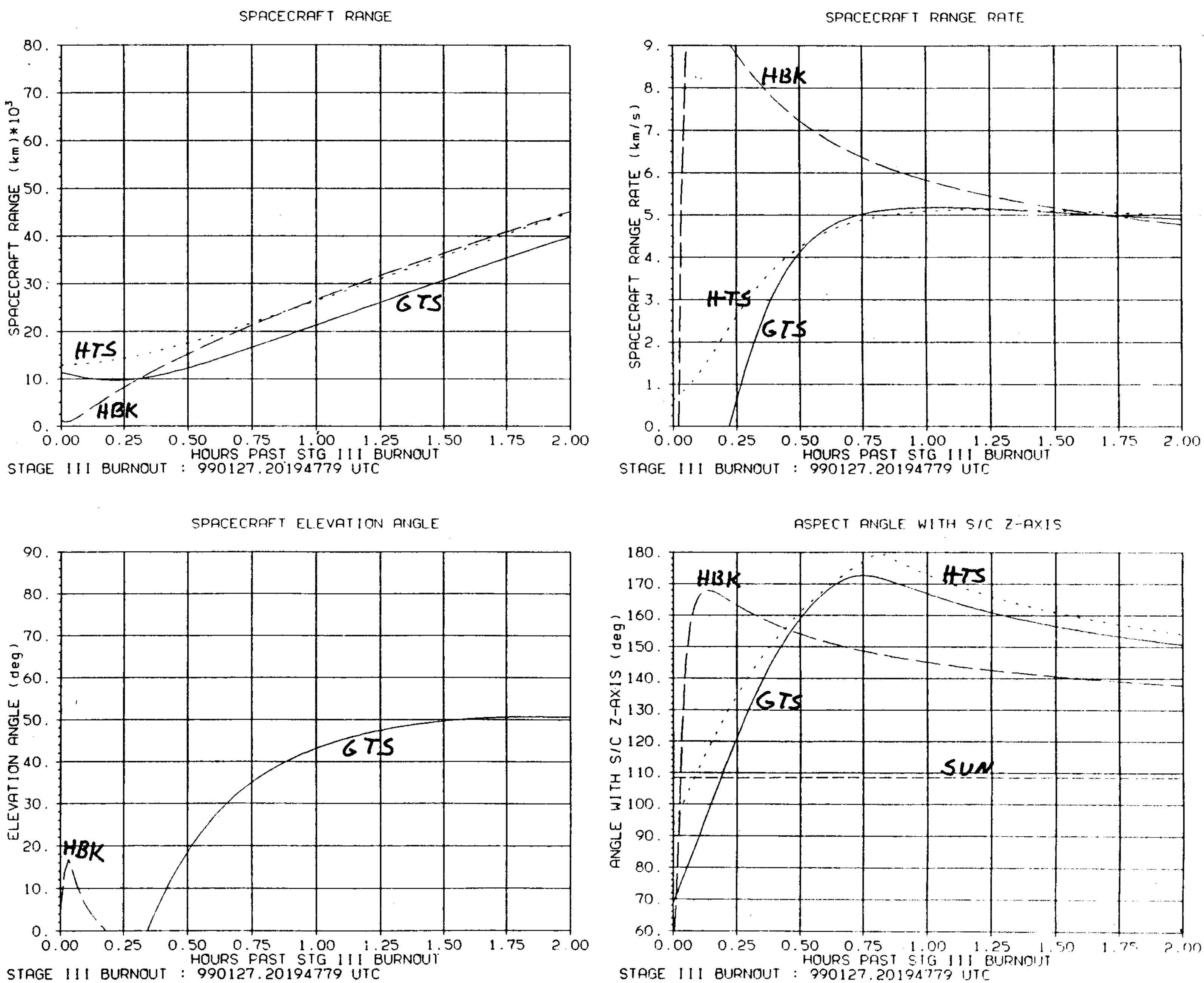
ASPECT ANGLE WITH S/C Z-AXIS



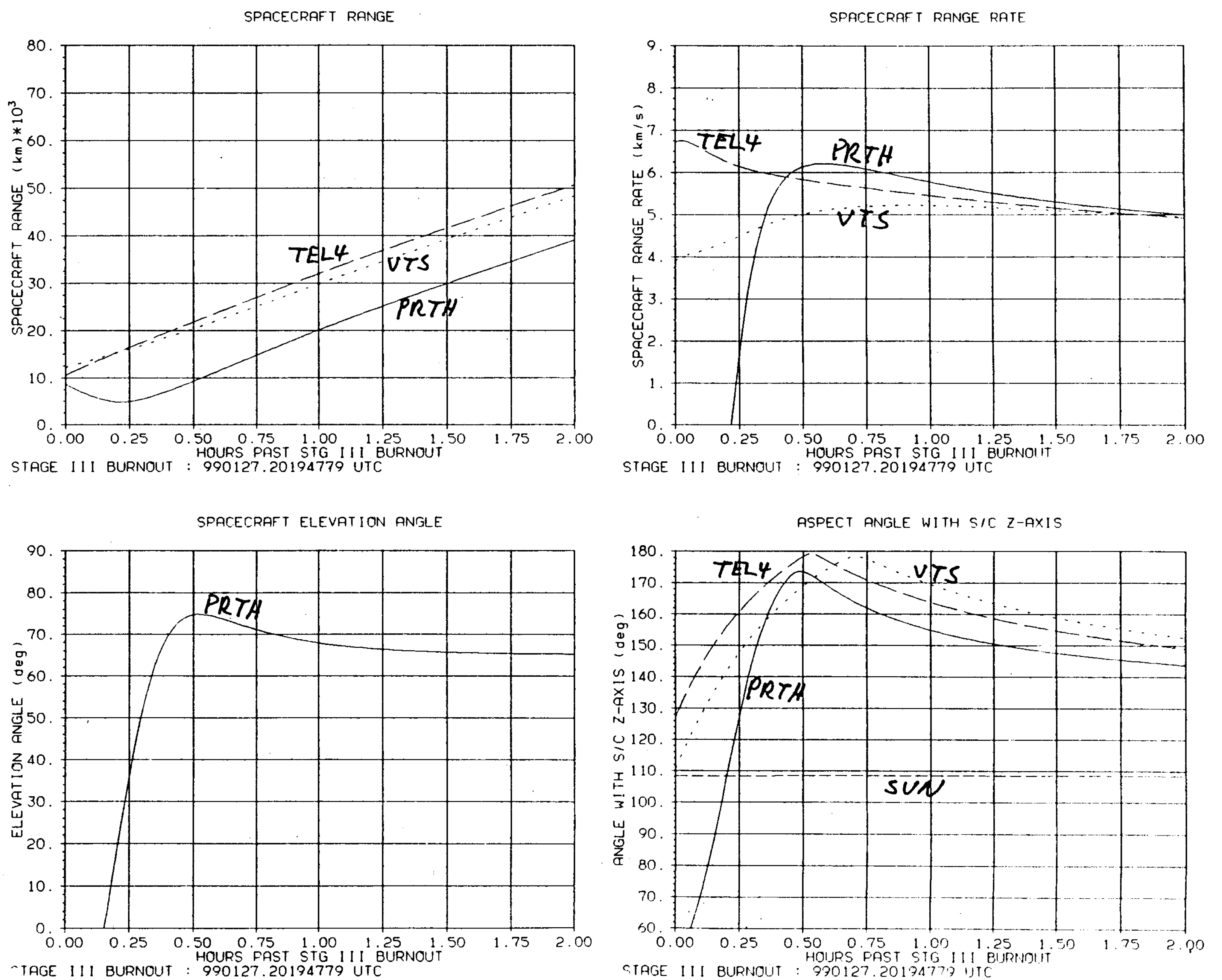
TRACKING STATION GEOMETRY (LANDER) : DAY 25 SHORT COAST



TRACKING STATION GEOMETRY (LANDER) : DAY 25 SHORT COAST

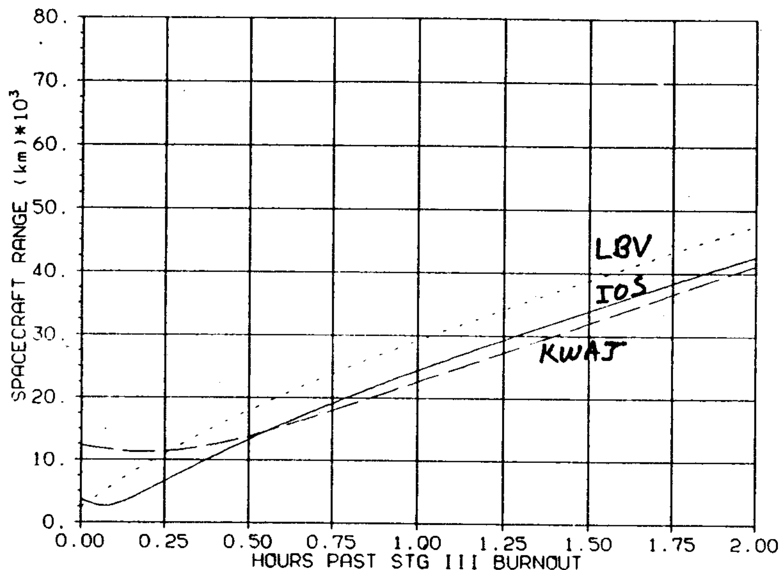


TRACKING STATION GEOMETRY (LANDER) : DAY 25 SHORT COAST



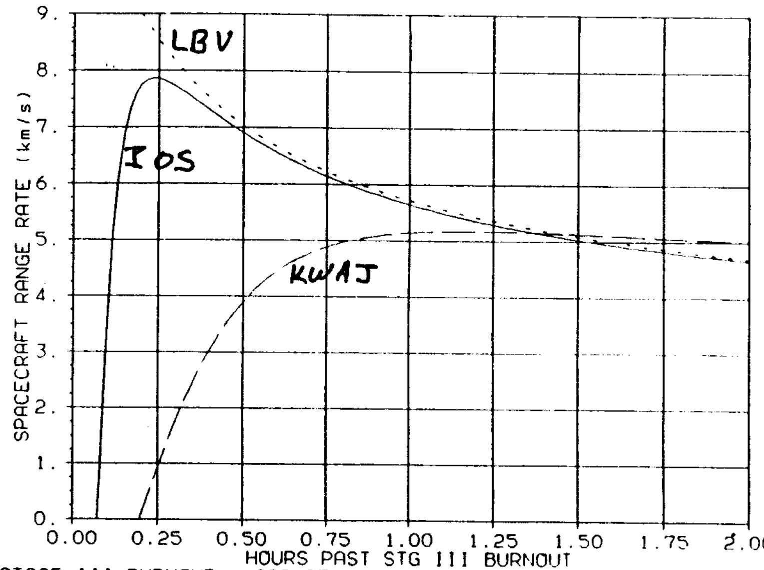
TRACKING STATION GEOMETRY (LANDER) : DAY 25 SHORT COAST

SPACECRAFT RANGE



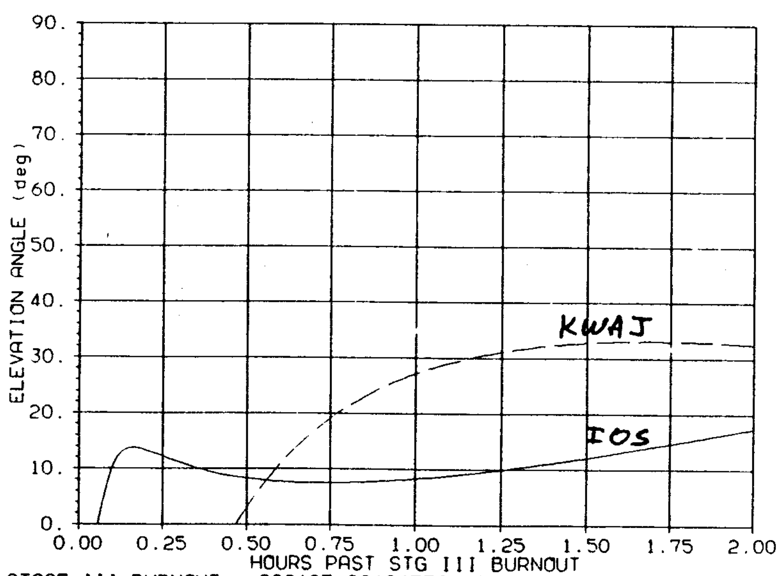
STAGE III BURNOUT : 990127.20194779 UTC

SPACECRAFT RANGE RATE



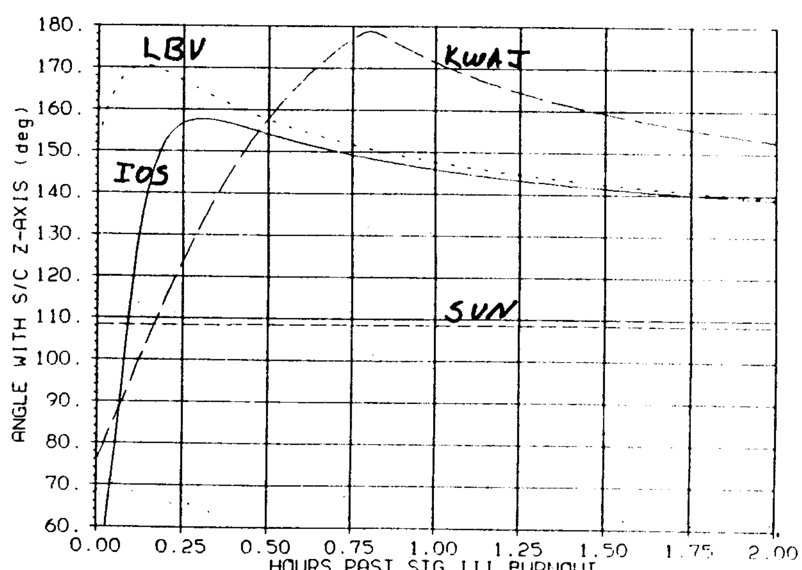
STAGE III BURNOUT : 990127.20194779 UTC

SPACECRAFT ELEVATION ANGLE



STAGE III BURNOUT : 990127.20194779 UTC

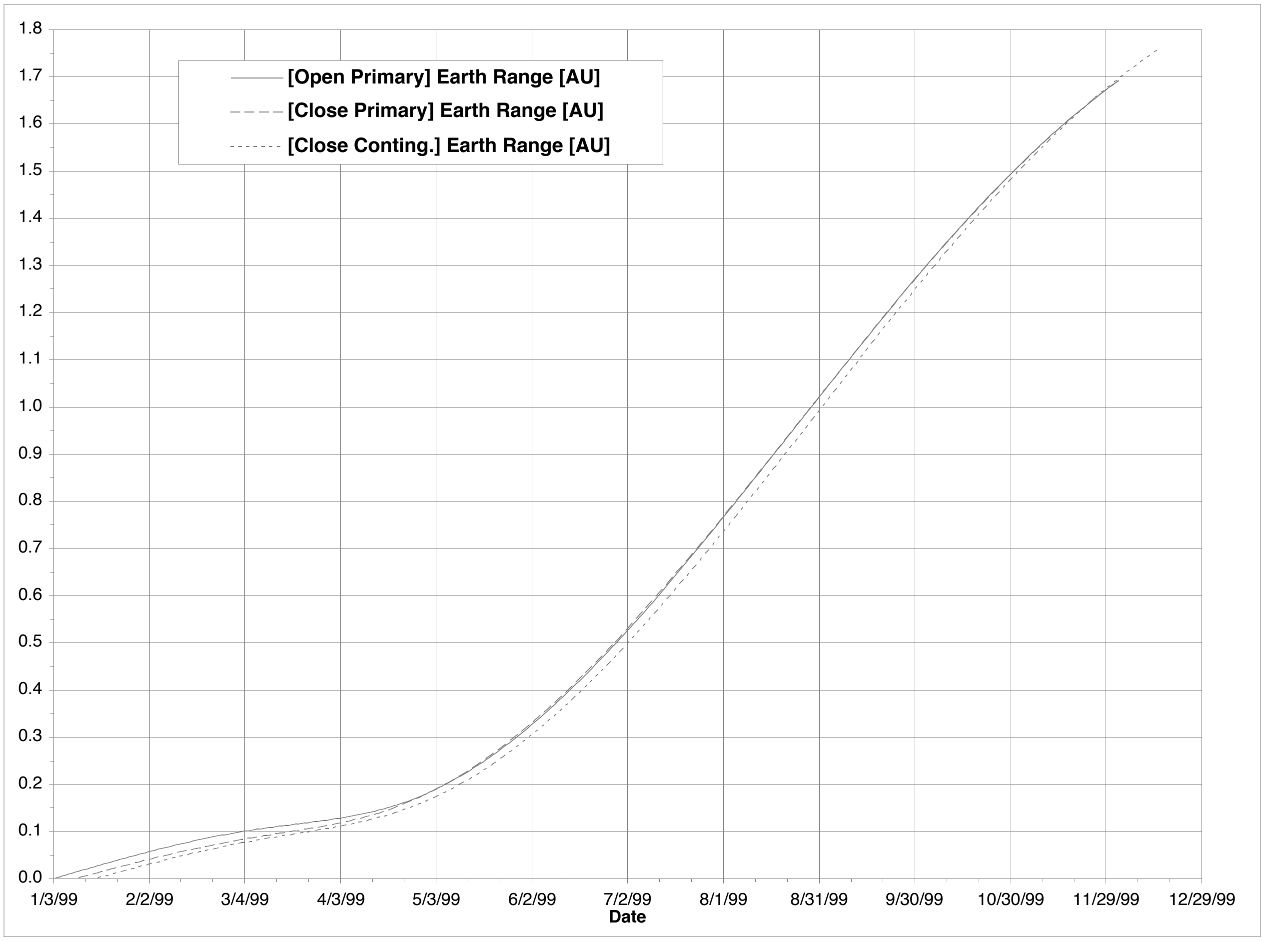
ASPECT ANGLE WITH S/C Z-AXIS

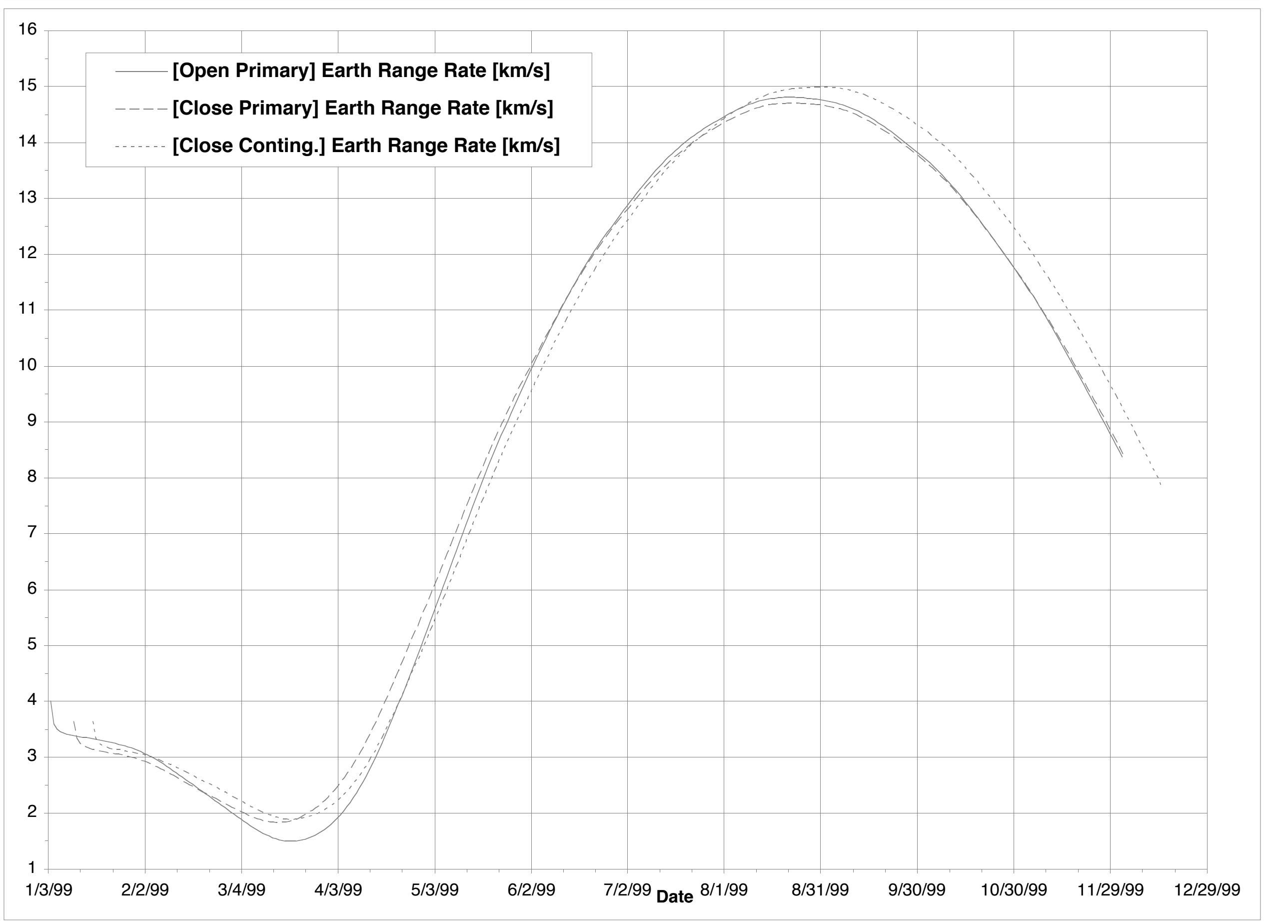


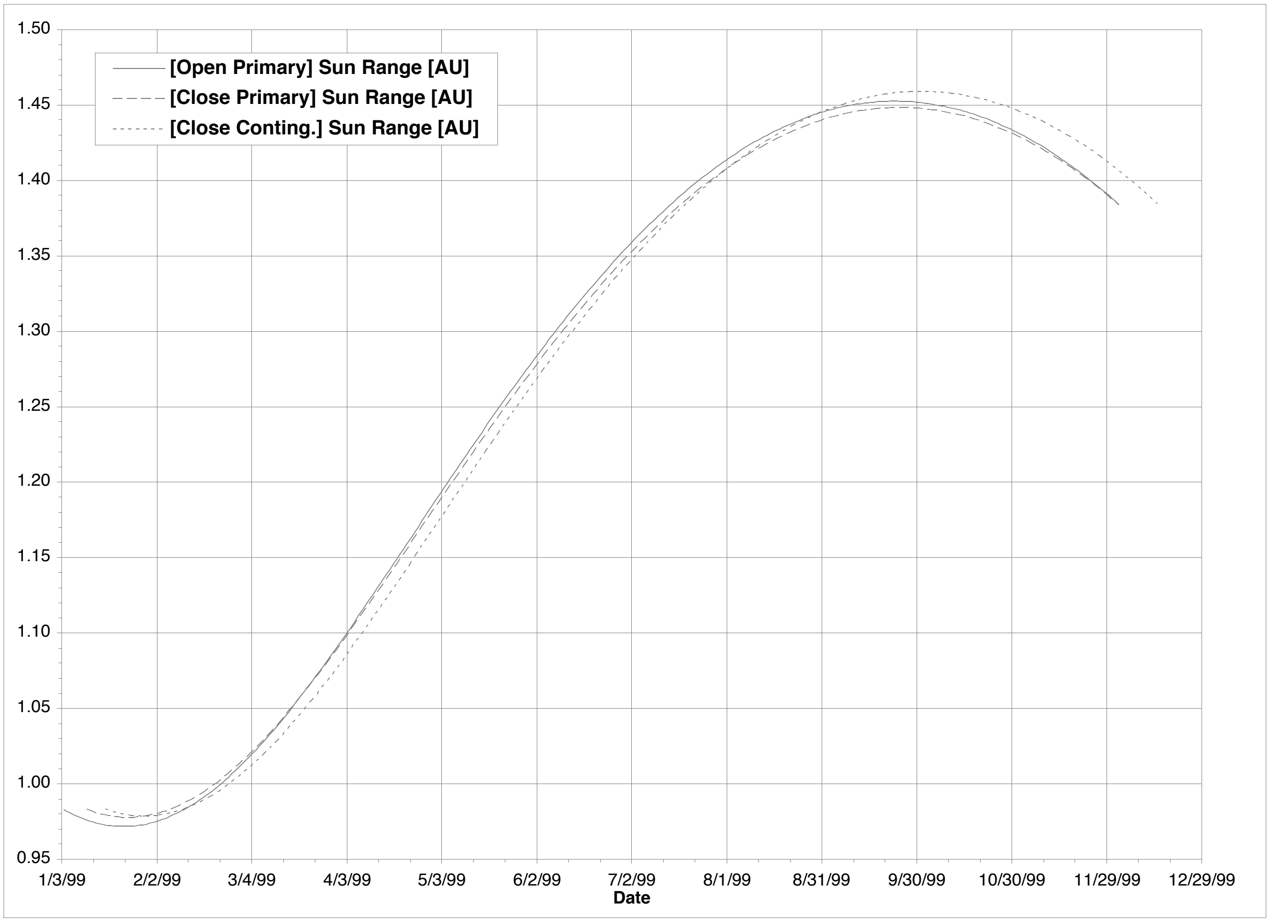
STAGE III BURNOUT : 990127.20194779 UTC

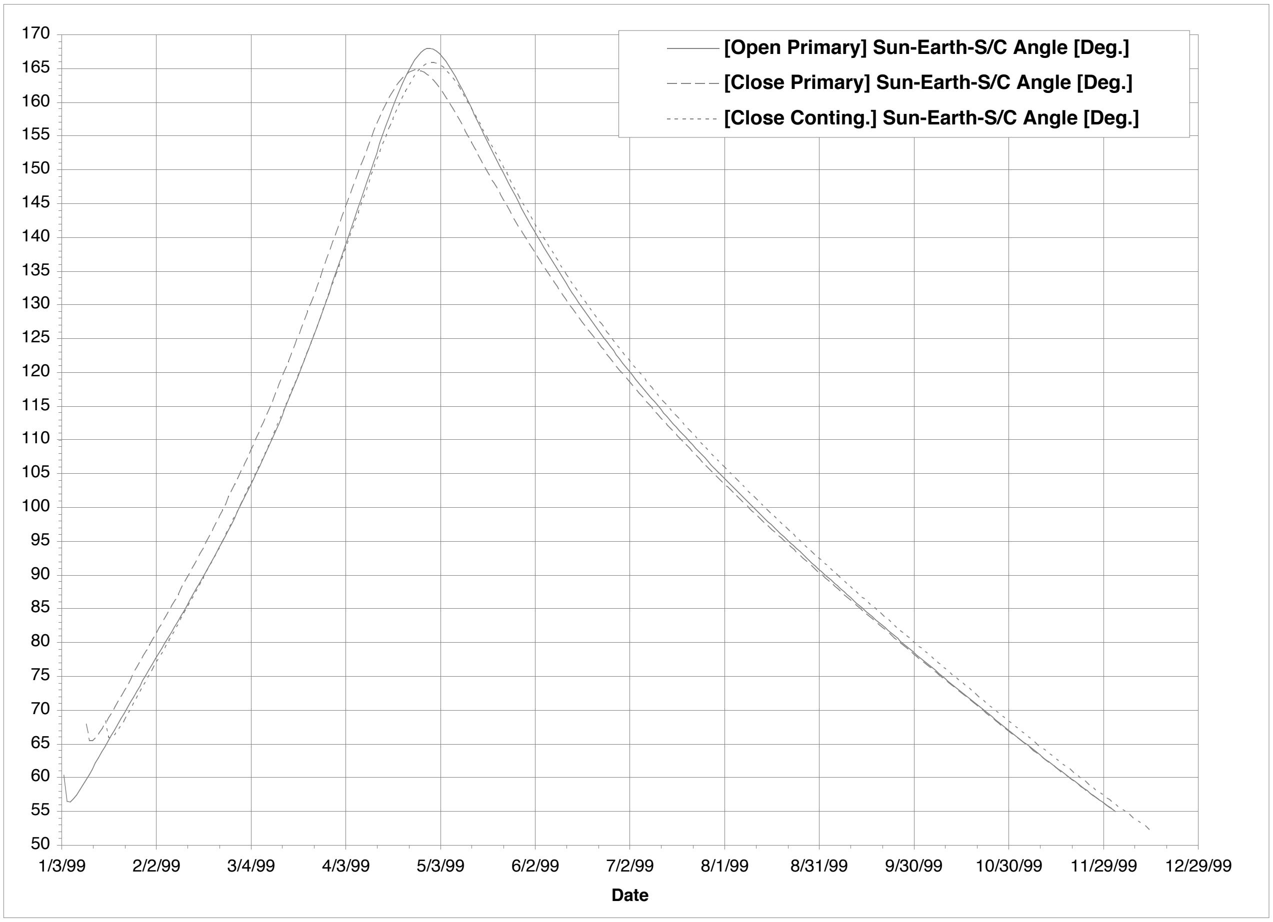
B.3 Lander Cruise Trajectory Characteristics

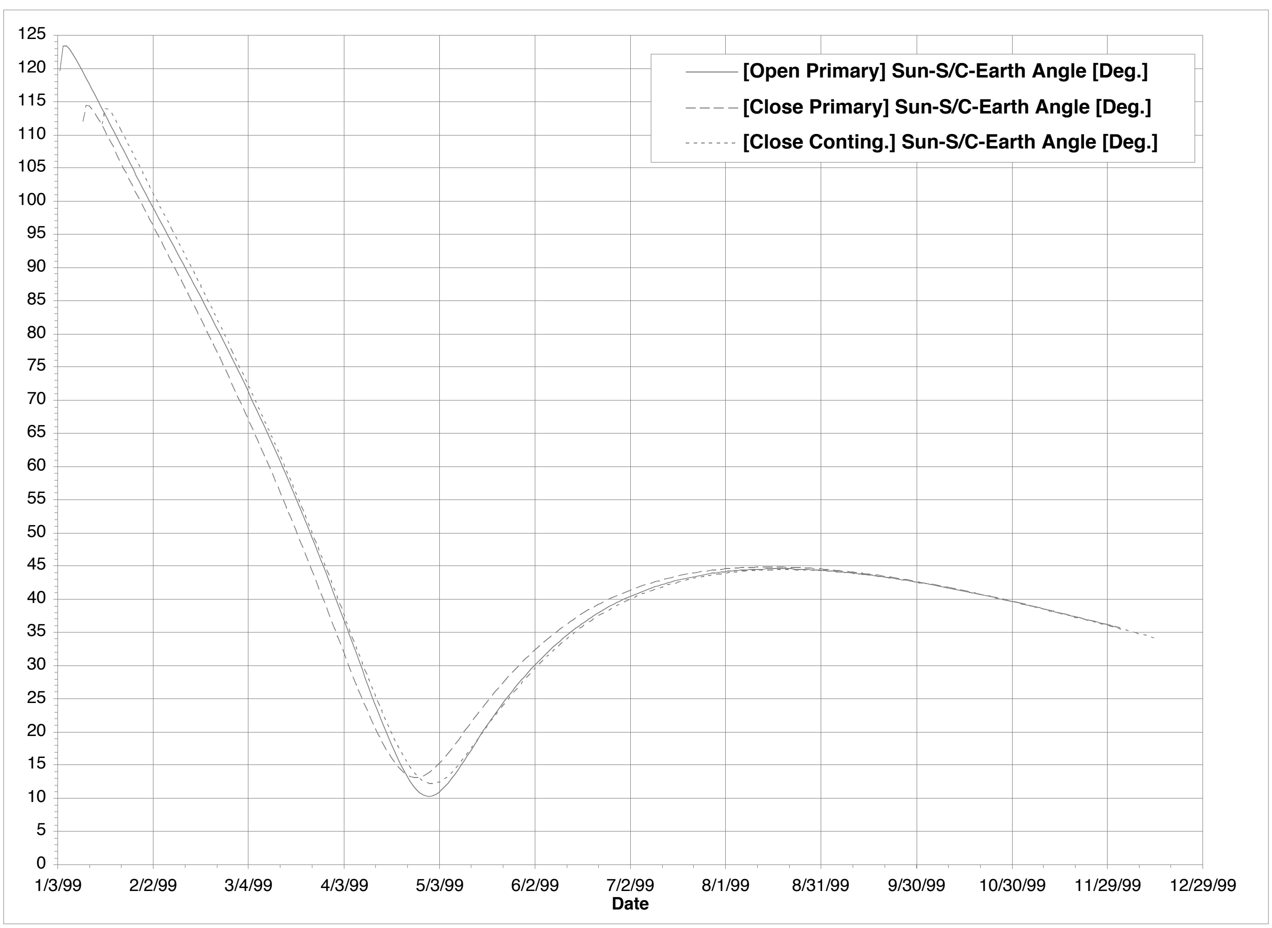
Data presented here are identical to the Lander cruise geometry data generated 5/8/96. The order of the plots has been changed to be consistent with the Orbiter cruise trajectory characteristics [Appendix A.3].

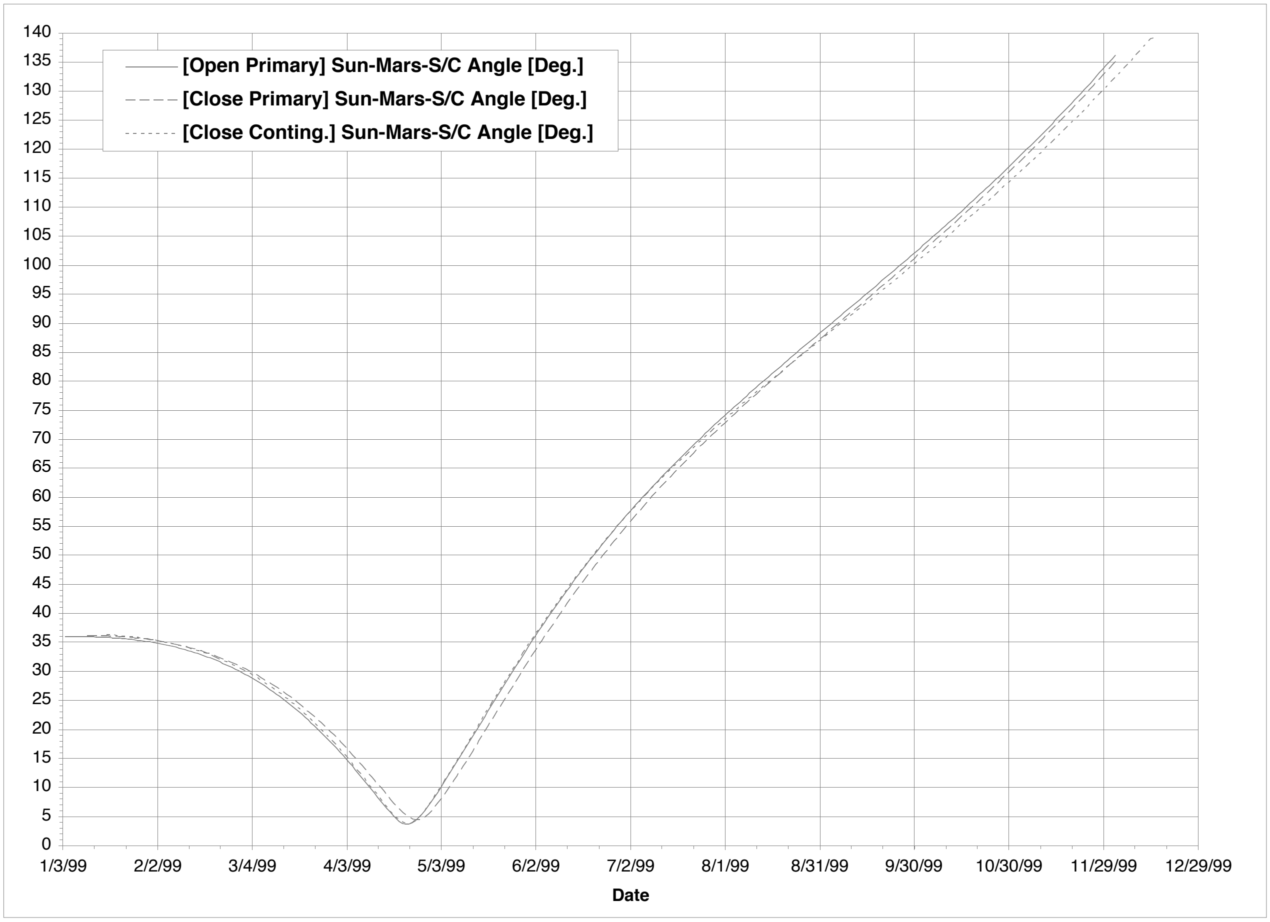

[Open Primary] Earth Range [AU]
[Close Primary] Earth Range [AU]
[Close Conting.] Earth Range [AU]
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1/3/99
2/2/99
3/4/99
4/3/99
5/3/99
6/2/99
7/2/99
8/1/99
8/31/99
9/30/99
10/30/99
11/29/99
12/29/99
Date

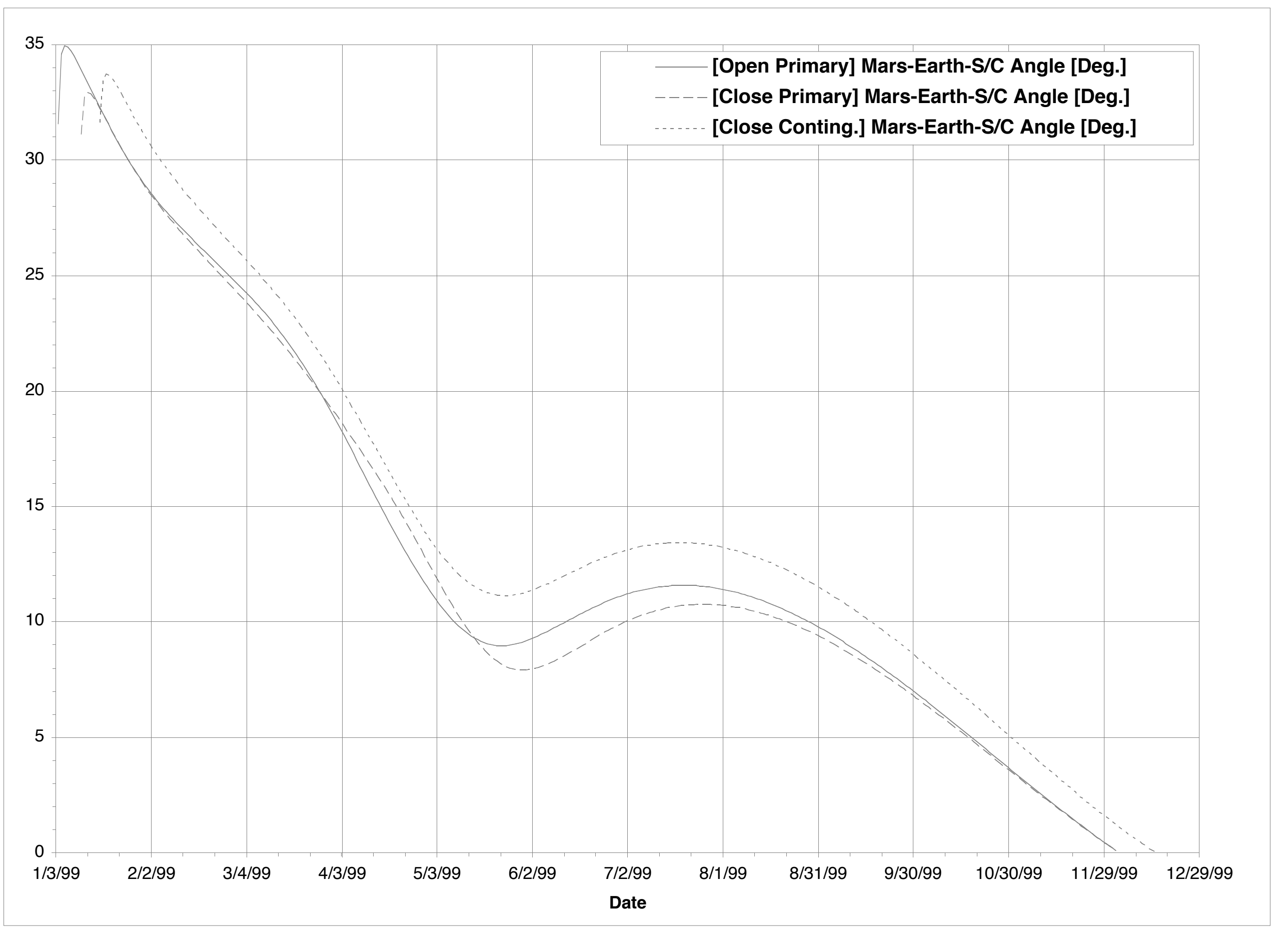

[Open Primary] Earth Range Rate [km/s]
[Close Primary] Earth Range Rate [km/s]
[Close Conting.] Earth Range Rate [km/s]
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1/3/99
2/2/99
3/4/99
4/3/99
5/3/99
6/2/99
7/2/99
8/1/99
8/31/99
9/30/99
10/30/99
11/29/99
12/29/99
Date

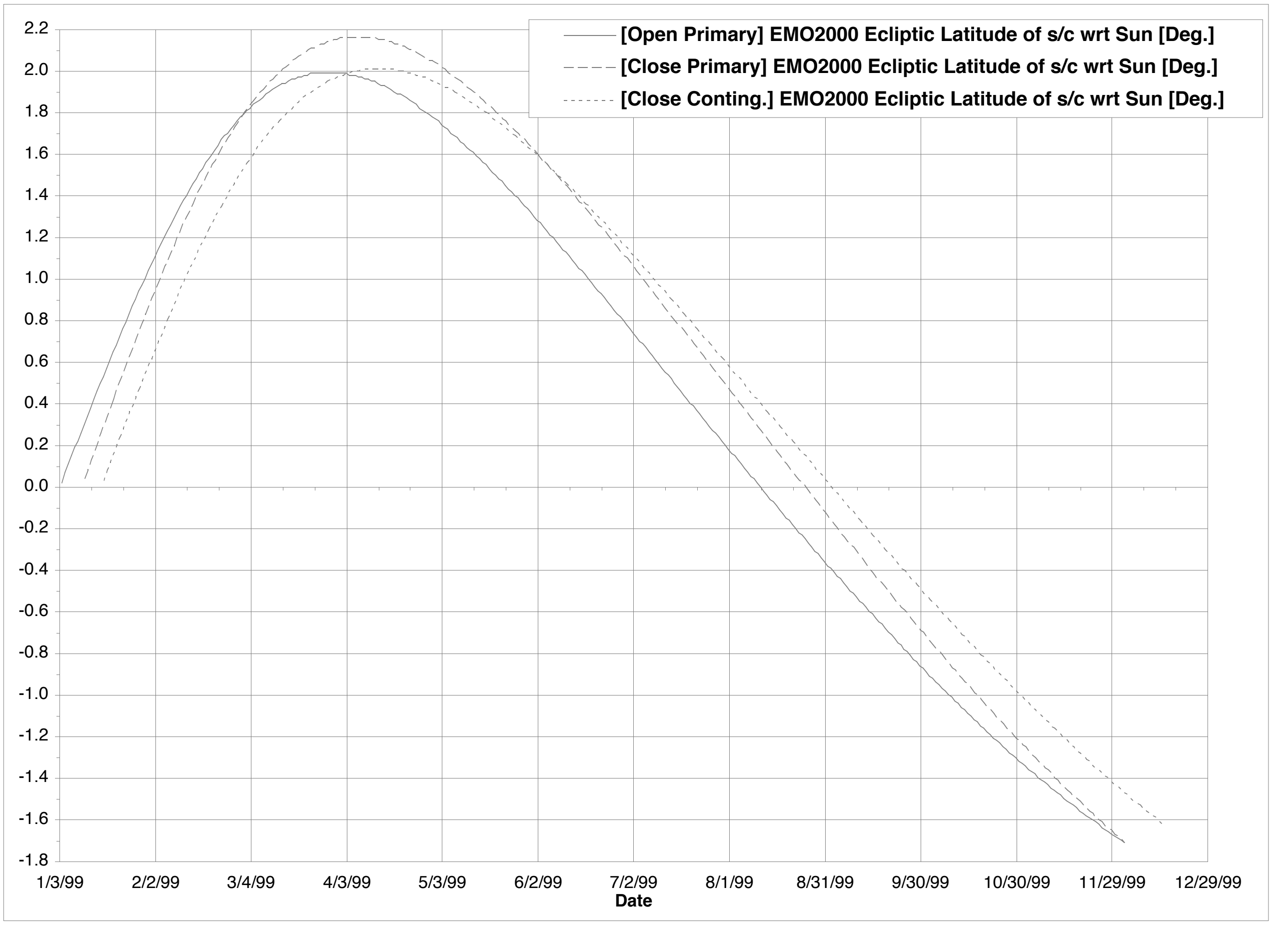

[Open Primary] Sun Range [AU]
[Close Primary] Sun Range [AU]
[Close Conting.] Sun Range [AU]
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
1/3/99
2/2/99
3/4/99
4/3/99
5/3/99
6/2/99
7/2/99
8/1/99
8/31/99
9/30/99
10/30/99
11/29/99
12/29/99
Date

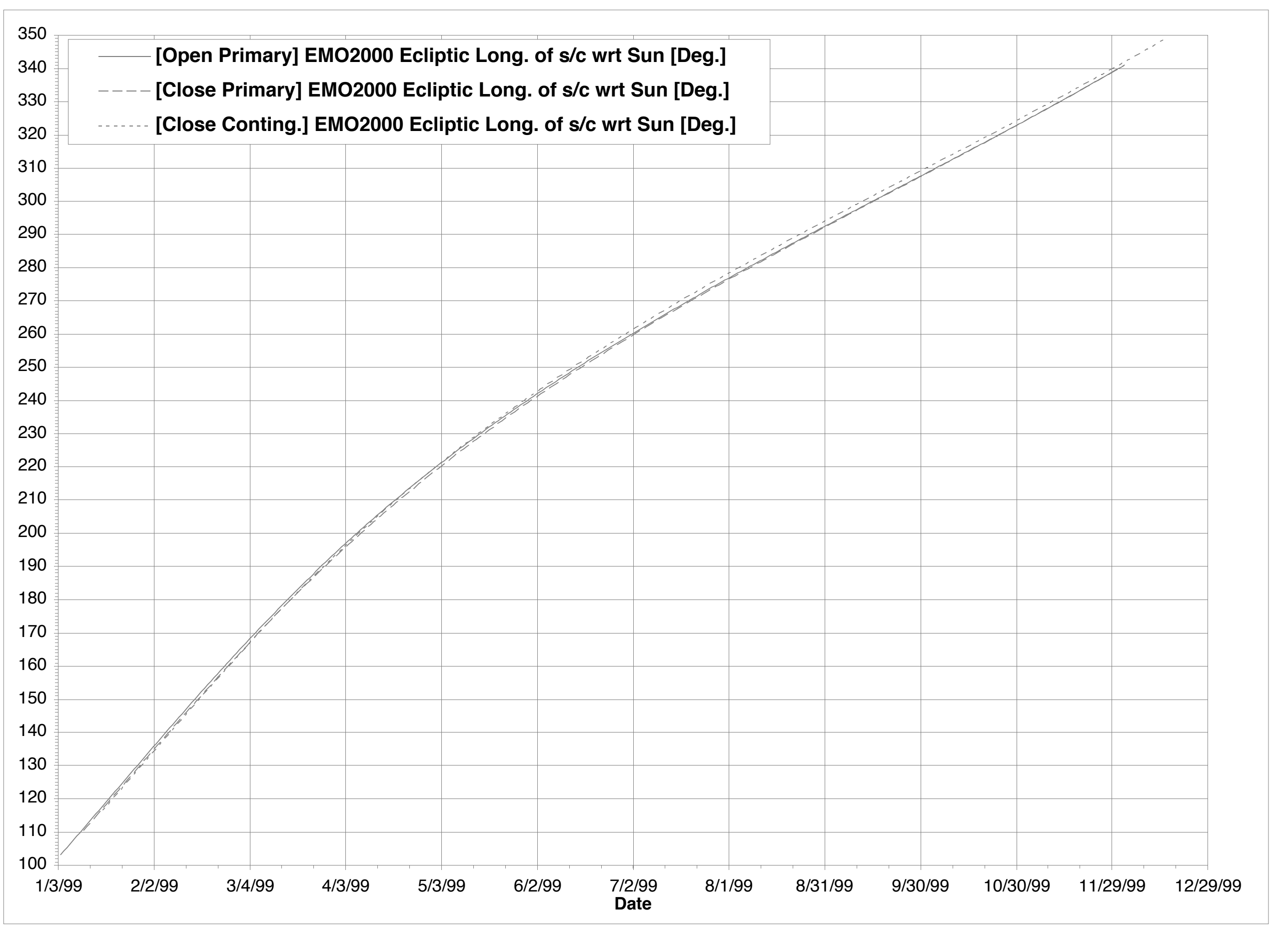

[Open Primary] Sun-Earth-S/C Angle [Deg.]
[Close Primary] Sun-Earth-S/C Angle [Deg.]
[Close Conting.] Sun-Earth-S/C Angle [Deg.]
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
1/3/99
2/2/99
3/4/99
4/3/99
5/3/99
6/2/99
7/2/99
8/1/99
8/31/99
9/30/99
10/30/99
11/29/99
12/29/99
Date

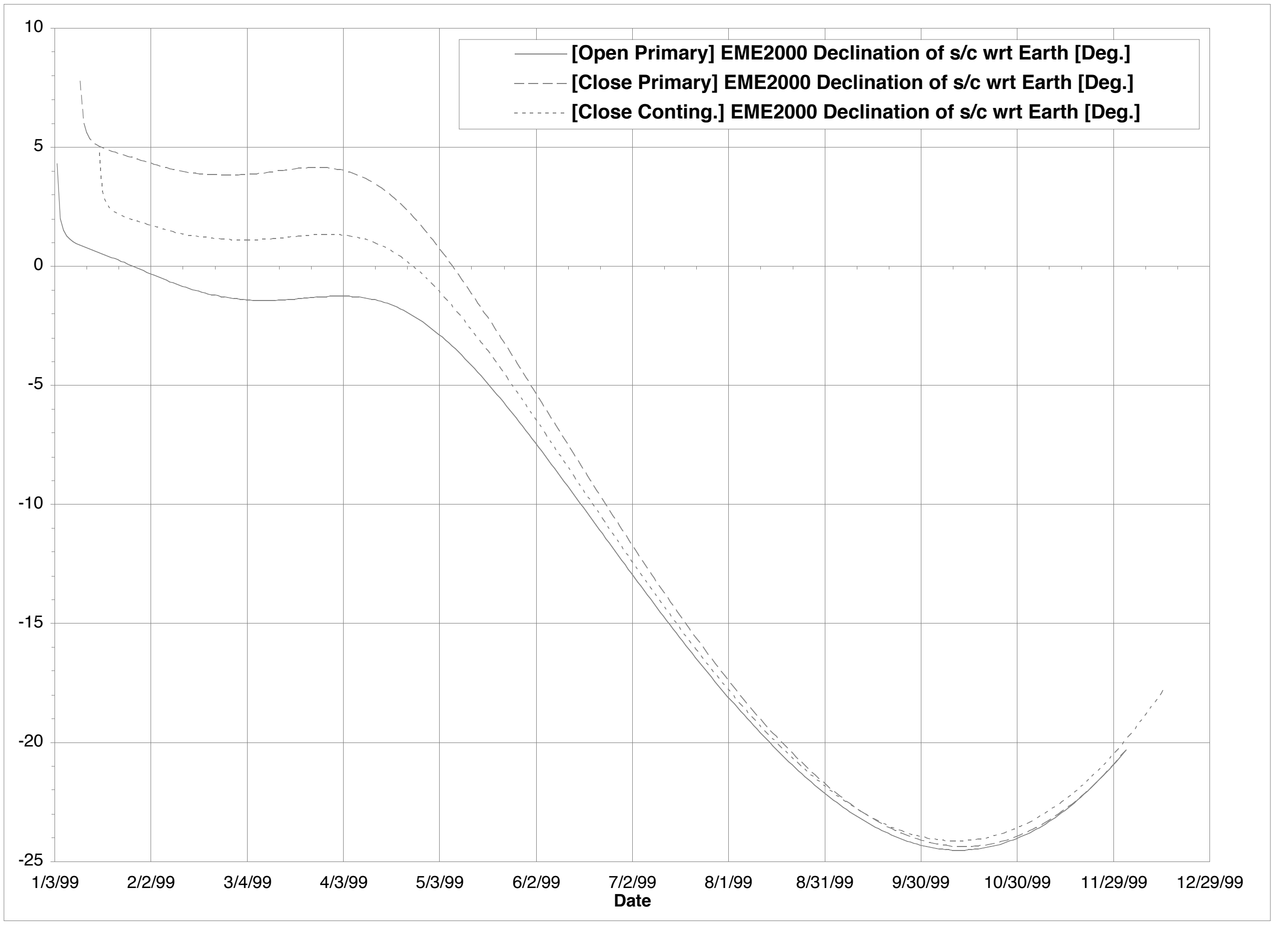

[Open Primary] Sun-S/C-Earth Angle [Deg.]
[Close Primary] Sun-S/C-Earth Angle [Deg.]
[Close Conting.] Sun-S/C-Earth Angle [Deg.]
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1/3/99
2/2/99
3/4/99
4/3/99
5/3/99
6/2/99
7/2/99
8/1/99
8/31/99
9/30/99
10/30/99
11/29/99
12/29/99
Date


[Open Primary] Sun-Mars-S/C Angle [Deg.]
[Close Primary] Sun-Mars-S/C Angle [Deg.]
[Close Conting.] Sun-Mars-S/C Angle [Deg.]
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
1/3/99
2/2/99
3/4/99
4/3/99
5/3/99
6/2/99
7/2/99
8/1/99
8/31/99
9/30/99
10/30/99
11/29/99
12/29/99
Date

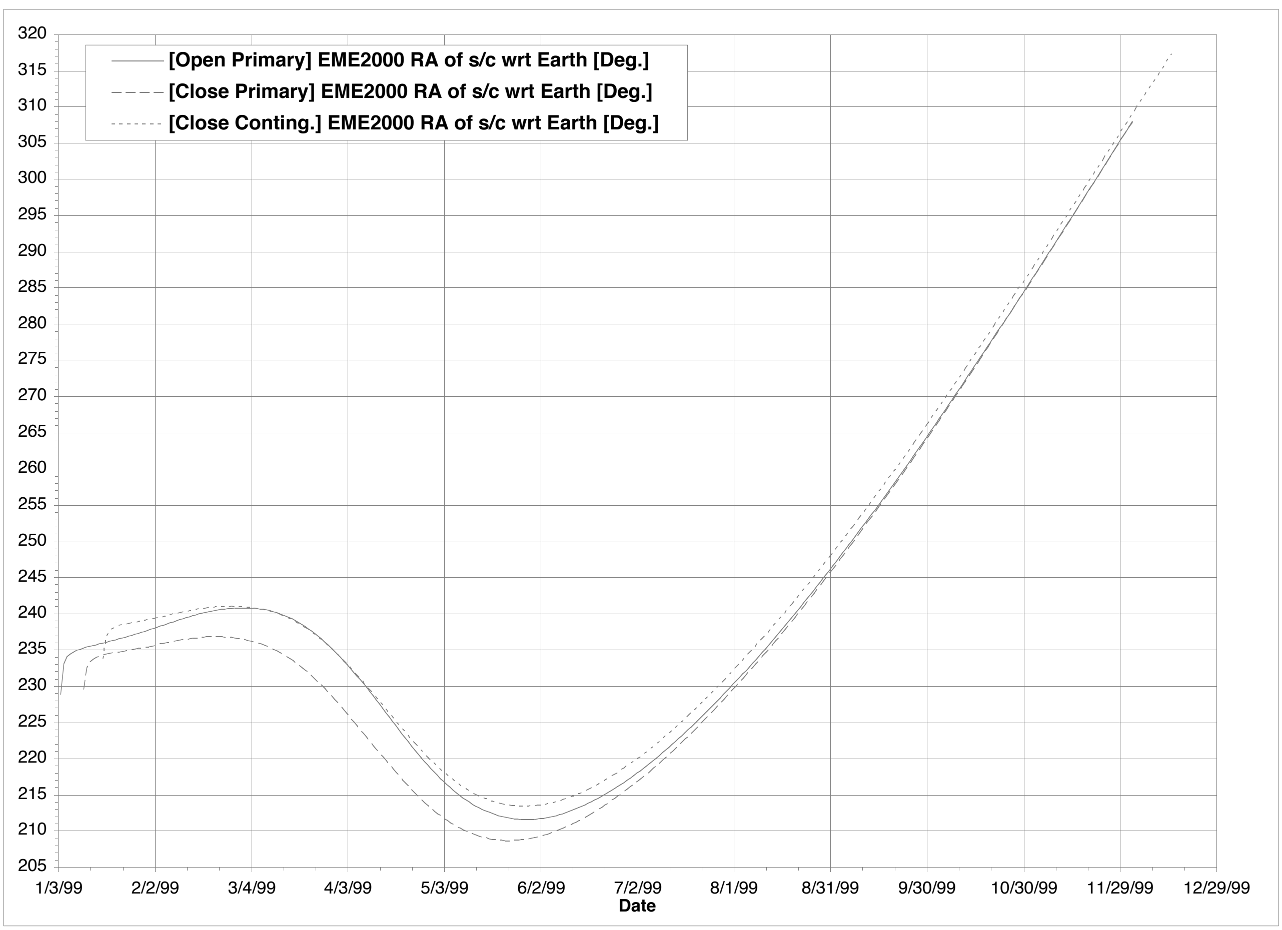

[Open Primary] Mars-Earth-S/C Angle [Deg.]
[Close Primary] Mars-Earth-S/C Angle [Deg.]
[Close Conting.] Mars-Earth-S/C Angle [Deg.]
35
30
25
20
15
10
5
0
1/3/99
2/2/99
3/4/99
4/3/99
5/3/99
6/2/99
7/2/99
8/1/99
8/31/99
9/30/99
10/30/99
11/29/99
12/29/99
Date


[Open Primary] EMO2000 Ecliptic Latitude of s/c wrt Sun [Deg.]
[Close Primary] EMO2000 Ecliptic Latitude of s/c wrt Sun [Deg.]
[Close Conting.] EMO2000 Ecliptic Latitude of s/c wrt Sun [Deg.]
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
1/3/99
2/2/99
3/4/99
4/3/99
5/3/99
6/2/99
7/2/99
8/1/99
8/31/99
9/30/99
10/30/99
11/29/99
12/29/99
Date


[Open Primary] EMO2000 Ecliptic Long. of s/c wrt Sun [Deg.]
[Close Primary] EMO2000 Ecliptic Long. of s/c wrt Sun [Deg.]
[Close Conting.] EMO2000 Ecliptic Long. of s/c wrt Sun [Deg.]
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
1/3/99
2/2/99
3/4/99
4/3/99
5/3/99
6/2/99
7/2/99
8/1/99
8/31/99
9/30/99
10/30/99
11/29/99
12/29/99
Date



10
5
0
-5
-10
-15
-20
-25
1/3/99
2/2/99
3/4/99
4/3/99
5/3/99
6/2/99
7/2/99
8/1/99
8/31/99
9/30/99
10/30/99
11/29/99
12/29/99
Date
[Open Primary] EME2000 Declination of s/c wrt Earth [Deg.]
[Close Primary] EME2000 Declination of s/c wrt Earth [Deg.]
[Close Conting.] EME2000 Declination of s/c wrt Earth [Deg.]



320
315
310
305
300
295
290
285
280
275
270
265
260
255
250
245
240
235
230
225
220
215
210
205
1/3/99
2/2/99
3/4/99
4/3/99
5/3/99
6/2/99
7/2/99
8/1/99
8/31/99
9/30/99
10/30/99
11/29/99
12/29/99
Date
[Open Primary] EME2000 RA of s/c wrt Earth [Deg.]
[Close Primary] EME2000 RA of s/c wrt Earth [Deg.]
[Close Conting.] EME2000 RA of s/c wrt Earth [Deg.]

B.4 Approach/Entry Illustrations

Entry Interface 12/3/99: View from N. Trajectory Pole

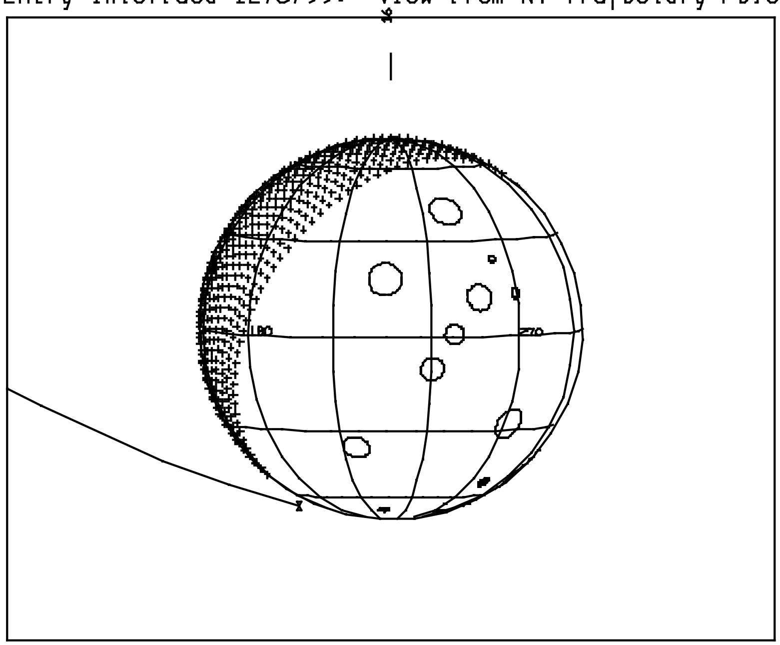


Fig 1

Entry Interface 12/3/99: View from Earth

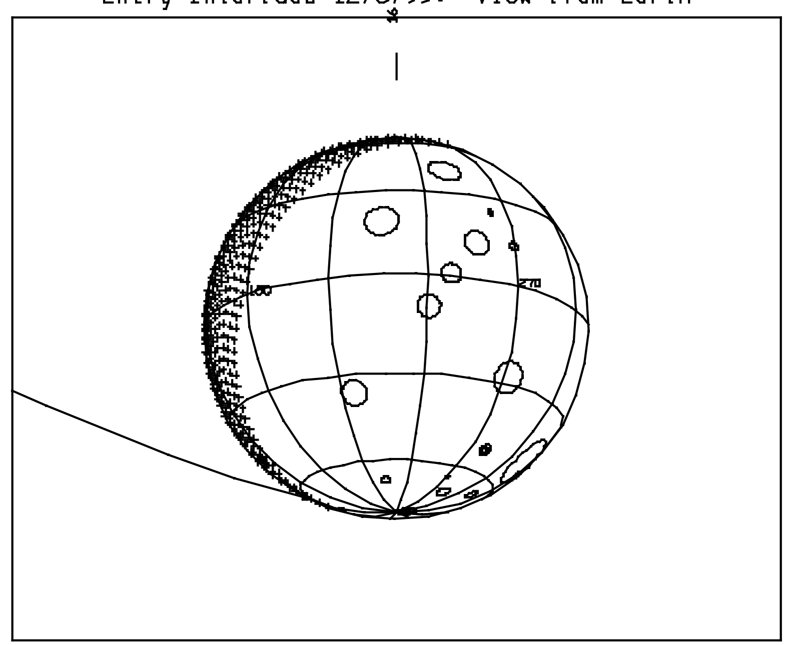


Fig 2

Entry Interface 12/3/99: View from Sun

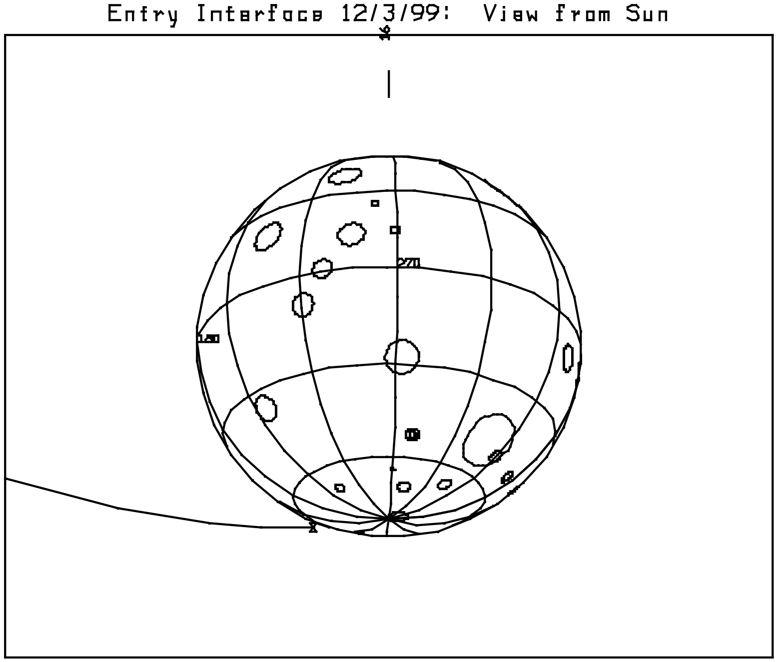


Fig 3

Entry Interface 12/3/99: View from Approach Asymptote

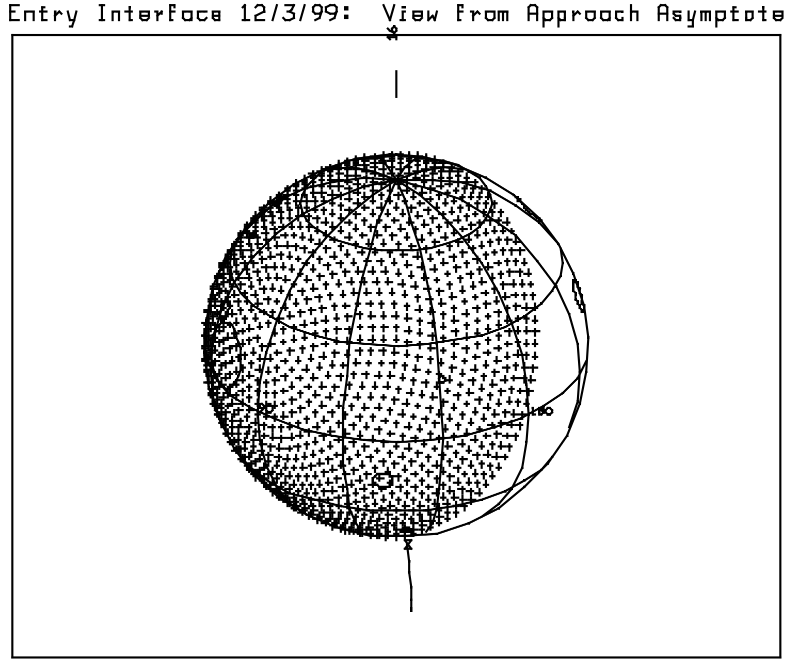


Fig 4

Entry Interface 12/3/99: View from South Pole

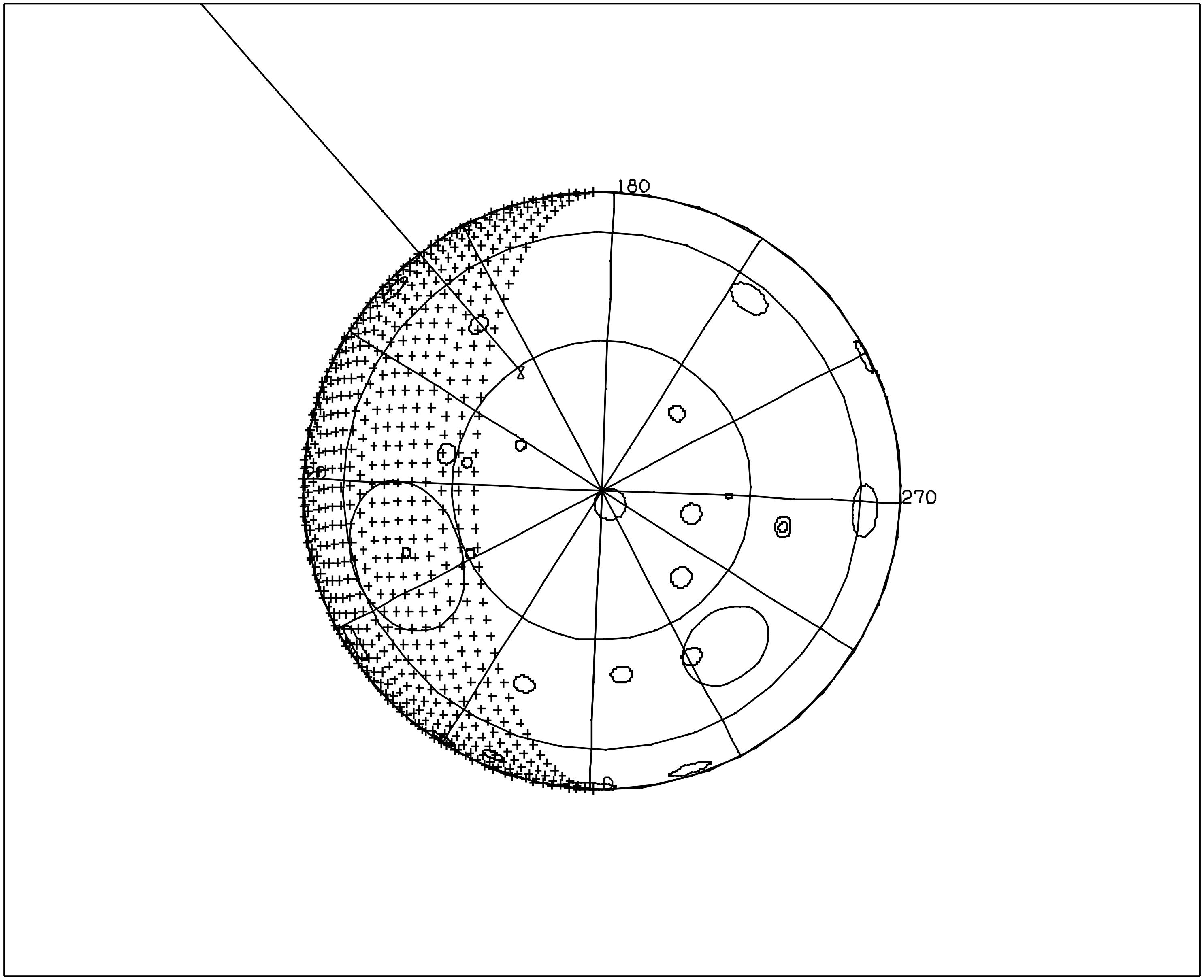


Fig 6

B.5 Post-Landing Data

B.5.1: First Pass after Landing - Variability with Landing Site and Orbiter Mean Anomaly

B.5.2: Orbiter/Lander Geometry Timelines

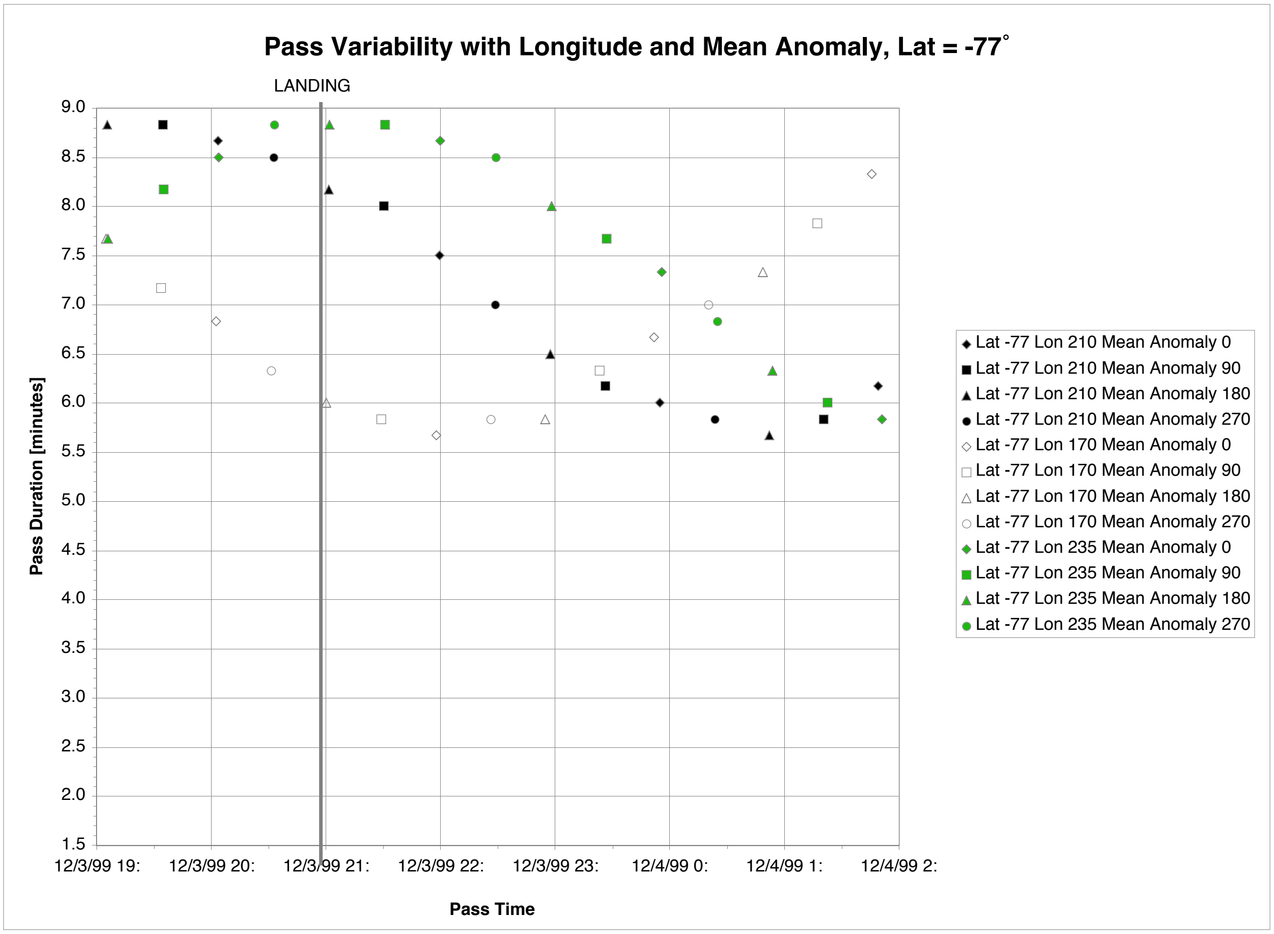
B.5.3: UHF Pass Information: Pass Durations, Data Volumes during Landed Science Mission

B.5.4: Earth and Sun Azimuth and Elevation during Landed Science Mission

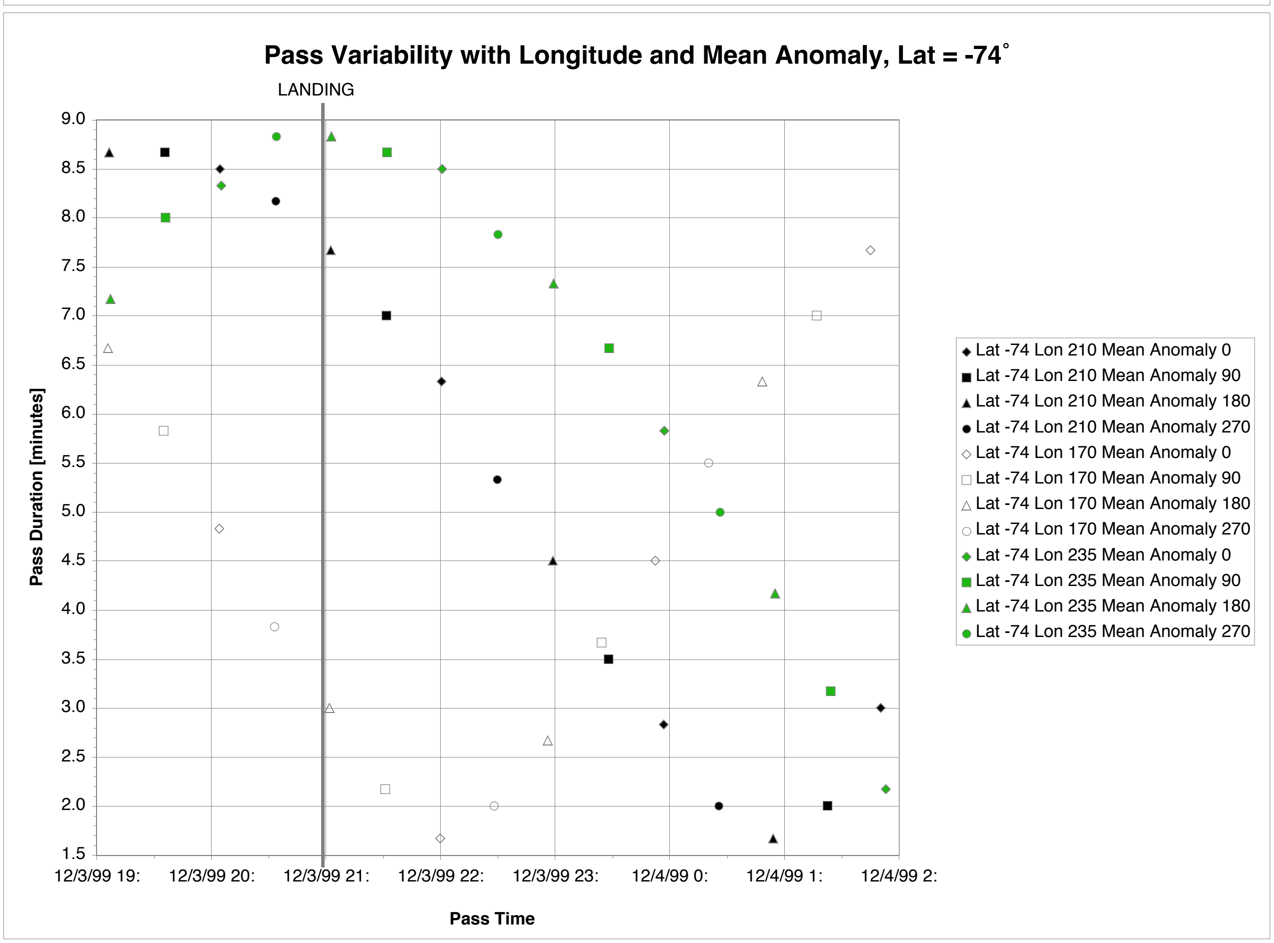
B.5.5: Sun and Earth Geometry with Respect to Mars

B.5.6: Design Reference Mission Power Profiles

B.5.7: Payload Scenarios



Pass Variability with Longitude and Mean Anomaly, Lat = -77°
LANDING
Pass Duration [minutes]
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
12/3/99 19:
12/3/99 20:
12/3/99 21:
12/3/99 22:
12/3/99 23:
12/4/99 0:
12/4/99 1:
12/4/99 2:
Pass Time
Lat -77 Lon 210 Mean Anomaly 0
Lat -77 Lon 210 Mean Anomaly 90
Lat -77 Lon 210 Mean Anomaly 180
Lat -77 Lon 210 Mean Anomaly 270
Lat -77 Lon 170 Mean Anomaly 0
Lat -77 Lon 170 Mean Anomaly 90
Lat -77 Lon 170 Mean Anomaly 180
Lat -77 Lon 170 Mean Anomaly 270
Lat -77 Lon 235 Mean Anomaly 0
Lat -77 Lon 235 Mean Anomaly 90
Lat -77 Lon 235 Mean Anomaly 180
Lat -77 Lon 235 Mean Anomaly 270



Pass Variability with Longitude and Mean Anomaly, Lat = -74°
LANDING
Pass Duration [minutes]
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
12/3/99 19:
12/3/99 20:
12/3/99 21:
12/3/99 22:
12/3/99 23:
12/4/99 0:
12/4/99 1:
12/4/99 2:
Pass Time
Lat -74 Lon 210 Mean Anomaly 0
Lat -74 Lon 210 Mean Anomaly 90
Lat -74 Lon 210 Mean Anomaly 180
Lat -74 Lon 210 Mean Anomaly 270
Lat -74 Lon 170 Mean Anomaly 0
Lat -74 Lon 170 Mean Anomaly 90
Lat -74 Lon 170 Mean Anomaly 180
Lat -74 Lon 170 Mean Anomaly 270
Lat -74 Lon 235 Mean Anomaly 0
Lat -74 Lon 235 Mean Anomaly 90
Lat -74 Lon 235 Mean Anomaly 180
Lat -74 Lon 235 Mean Anomaly 270

Orbiters/Lander Geometry Timelines

Shown below and on the next several pages are spacecraft timelines of geometric events during the Lander science period. Approximate timings of major events on both the MGS and Mars98 orbiters, and at the landing site are shown. For the orbiters, times of decending node passage, solar eclipse, earth occultation, and lander relay periods are indicated. For the Mars98 Orbiter, a candidate 10 hour Earth communication interval is shown for each sol. The DSN is requesting that Mars missions during this time share a common 10 hour Earth contact interval during operations at Mars. For this reason, and in order to facilitate orbiter support of Lander commanding and data relay, it is required that the 10 hour contact time be correlated with the lander operational day.

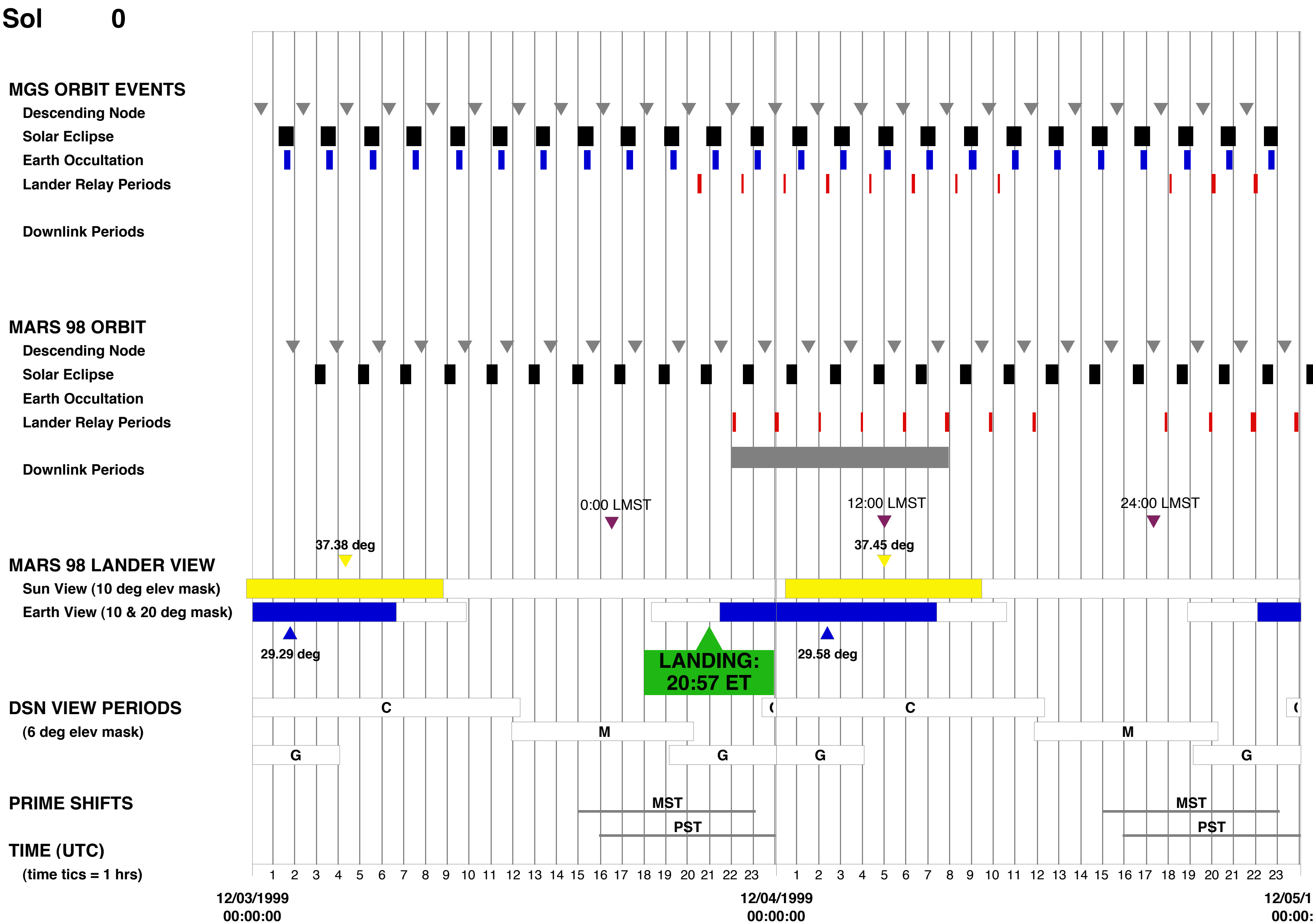
It is assumed the lander is located at the nominal landing site of 77S, 210W. Times when the Earth or Sun are above 10 degrees at this landing site are indicated by clear bars. Times when the Earth is above 20 degrees elevation are shown with a dark [or in color, blue] bar. Also indicated by the light gray [or yellow] bar is the Lander operational day, approximated in these graphics by intervals centered around local noon. [The duration of the Lander day is expected to shrink during the latter portion of the Landed science mission, as the Sun moves Northward and the maximum Solar elevation is reduced.] DSN view periods are also indicated, limited by 6 degree elevation masks at the DSN stations [G = Goldstone, C = Canberra, M = Madrid].

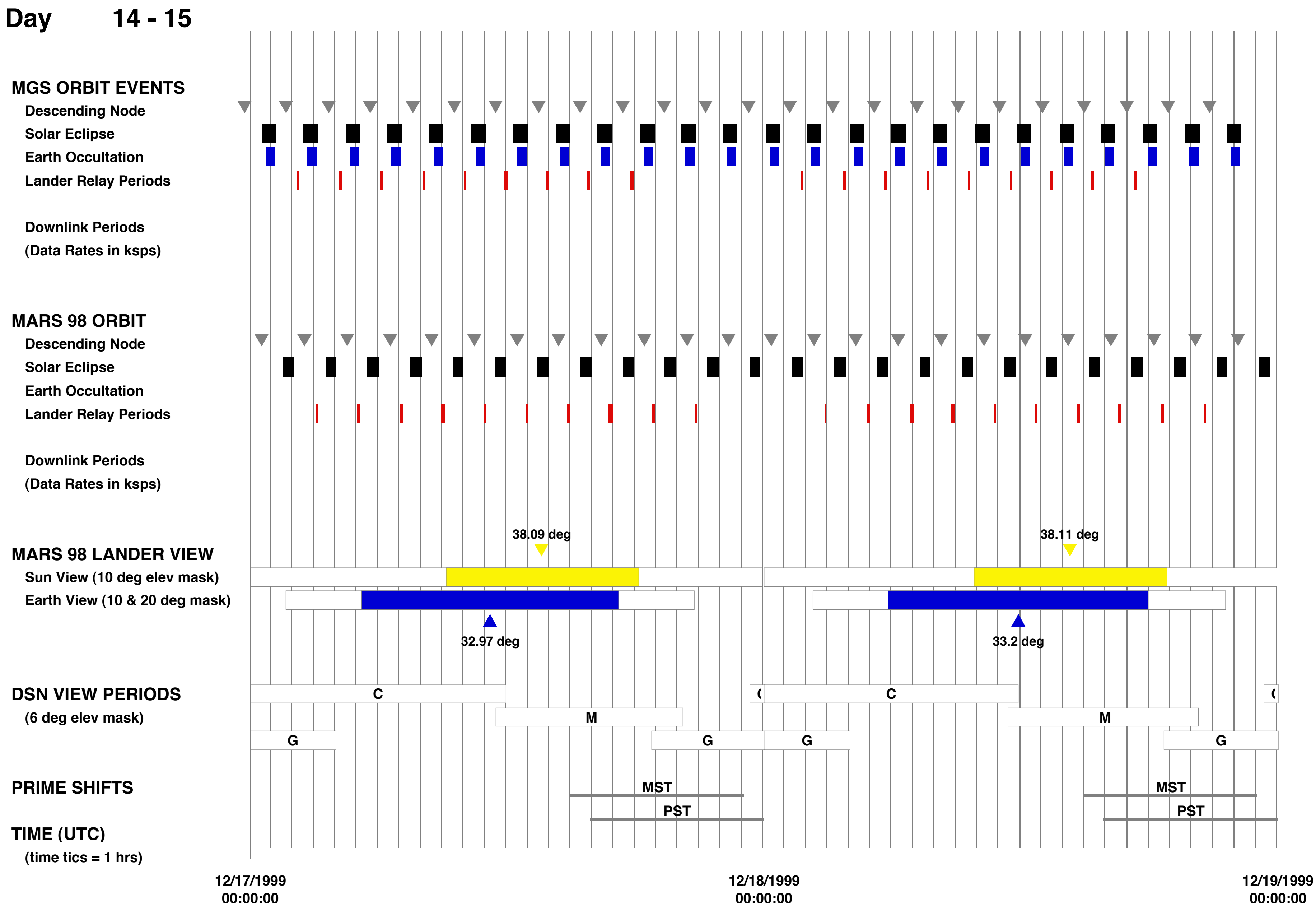
The absolute timing of events such as Sun and Earth rises and sets may differ from those presented below, depending on the actual landing site chosen. Also, at this point in time, the true anomalies of neither orbiter can be predicted, although their expected node locations are well established. As a result, the absolute timing of orbiter events, including lander relay periods, are uncertain to within one-half of the orbit period [i.e. approximately ±1 hr]. However, it is expected that there will be approximately 8 relay opportunities per orbiter per day

Sol 0 Geometry Timeline: Shown on this graph is are geometric events on the day of landing. Landing occurs at 20:57 ET [approximately 04:14 Local True Solar Time]. Both the Sun and Earth are more than 18˚ above the horizon at landing. The Earth will rise above 20˚ elevation approximately 30 minutes later. At least one orbiter relay opportunity is expected to exist within 2 hours of landing. See Appendix A.1 [Lander Mission Database] for other arrival dates and data. A 9 hour Lander "day" is shown, as is the fact that the Sun remains above 10˚ continuously during this time.

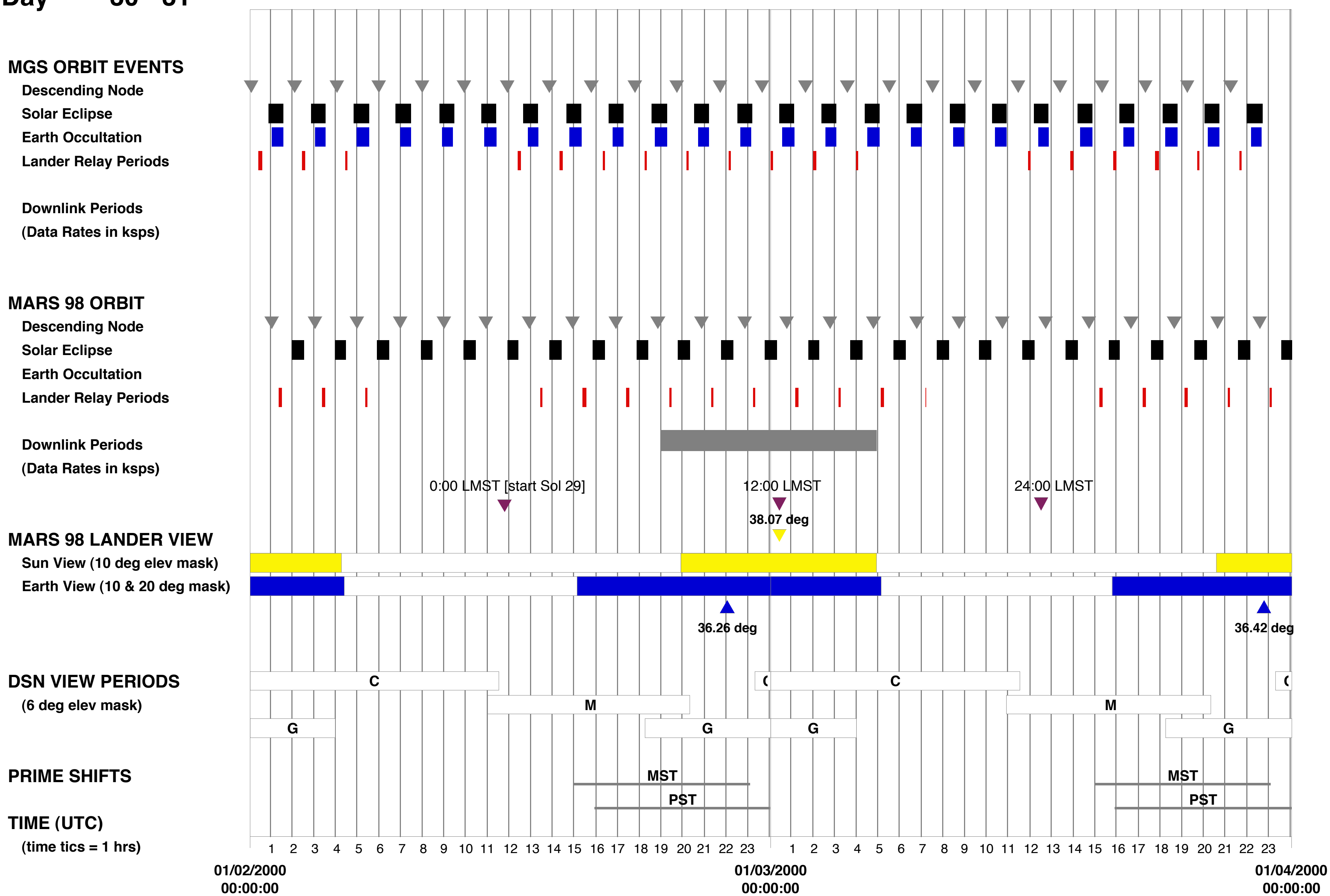
Day 45 - 46 Geometry Timeline: Forty-five days into the mission, the geometry is similar to that at landing, but local noon has shiftedbecause of the 40 minute difference in rotation rate between Earth and Mars.

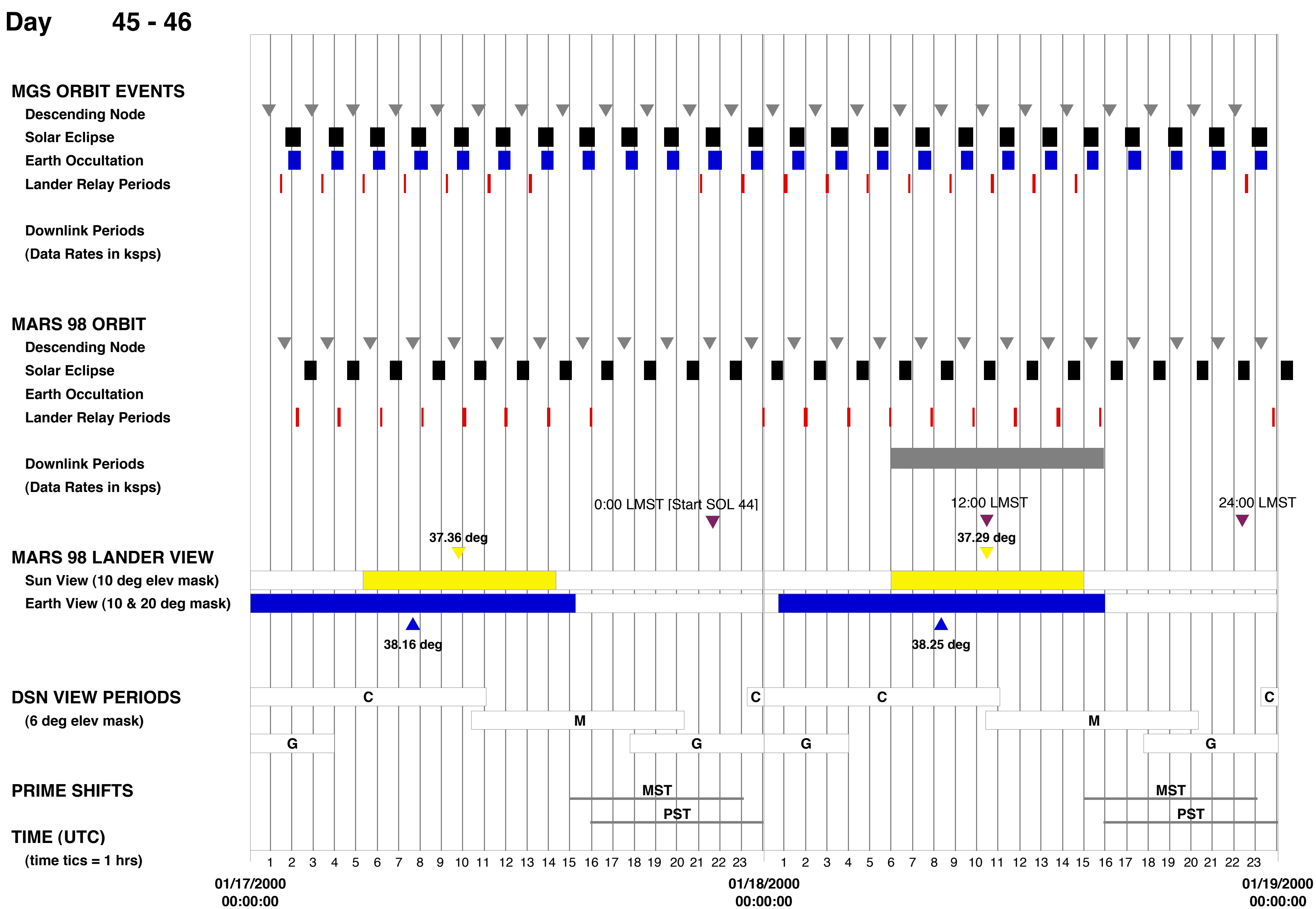
Day 84 - 85 Geometry Timeline: Towards the end of the Lander mission, the Sun has moved Northward, and no longer remains above 10˚ throughout the day. The Lander day is expected to be reduced as a result of lower solar array output. This will also mean that fewer relay opportunities will be available during the Lander day, as the end of the mission is approached.


Sol 0
MGS ORBIT EVENTS
Descending Node
Solar Eclipse
Earth Occultation
Lander Relay Periods
Downlink Periods
MARS 98 ORBIT
Descending Node
Solar Eclipse
Earth Occultation
Lander Relay Periods
Downlink Periods
0:00 LMST
12:00 LMST
24:00 LMST
37.38 deg
37.45 deg
MARS 98 LANDER VIEW
Sun View (10 deg elev mask)
Earth View (10 & 20 deg mask)
29.29 deg
29.58 deg
LANDING: 20:57 ET
DSN VIEW PERIODS
(6 deg elev mask)
C
M
G
PRIME SHIFTS
MST
PST
TIME (UTC)
(time tics = 1 hrs)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
12/03/1999 00:00:00
12/04/1999 00:00:00
12/05/1999 00:00:00


Day 14 - 15
MGS ORBIT EVENTS
Descending Node
Solar Eclipse
Earth Occultation
Lander Relay Periods
Downlink Periods
(Data Rates in ksps)
MARS 98 ORBIT
Descending Node
Solar Eclipse
Earth Occultation
Lander Relay Periods
Downlink Periods
(Data Rates in ksps)
MARS 98 LANDER VIEW
Sun View (10 deg elev mask)
Earth View (10 & 20 deg mask)
38.09 deg
38.11 deg
32.97 deg
33.2 deg
DSN VIEW PERIODS
(6 deg elev mask)
C
M
G
PRIME SHIFTS
MST
PST
TIME (UTC)
(time tics = 1 hrs)
12/17/1999 00:00:00
12/18/1999 00:00:00
12/19/1999 00:00:00

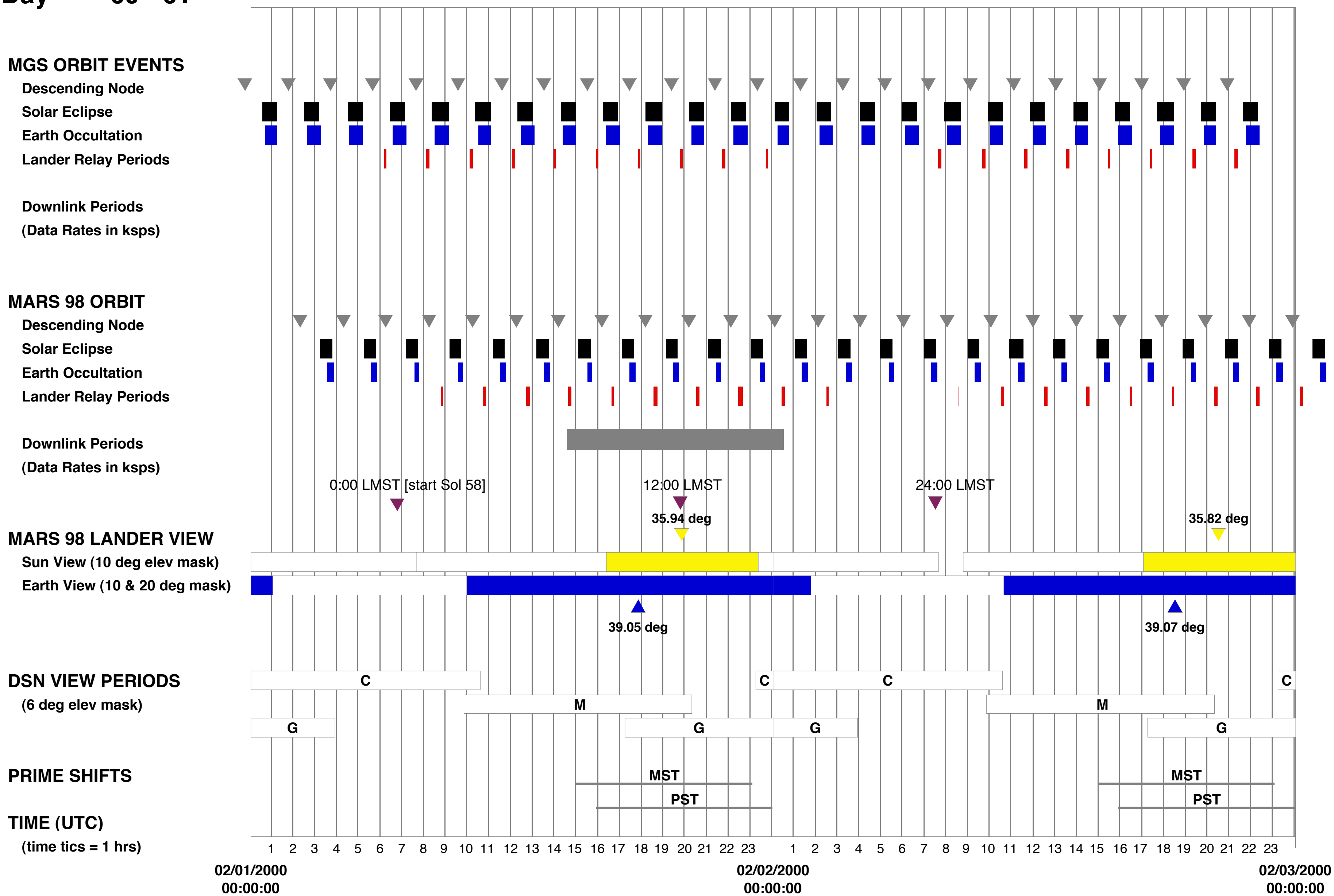
Day 30 - 31


MGS ORBIT EVENTS
Descending Node
Solar Eclipse
Earth Occultation
Lander Relay Periods
Downlink Periods
(Data Rates in ksps)
MARS 98 ORBIT
Descending Node
Solar Eclipse
Earth Occultation
Lander Relay Periods
Downlink Periods
(Data Rates in ksps)
0:00 LMST [start Sol 29]
12:00 LMST
24:00 LMST
38.07 deg
MARS 98 LANDER VIEW
Sun View (10 deg elev mask)
Earth View (10 & 20 deg mask)
36.26 deg
36.42 deg
DSN VIEW PERIODS
(6 deg elev mask)
C
M
G
G
G
C
M
G
PRIME SHIFTS
MST
PST
MST
PST
TIME (UTC)
(time tics = 1 hrs)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
01/02/2000
00:00:00
01/03/2000
00:00:00
01/04/2000
00:00:00



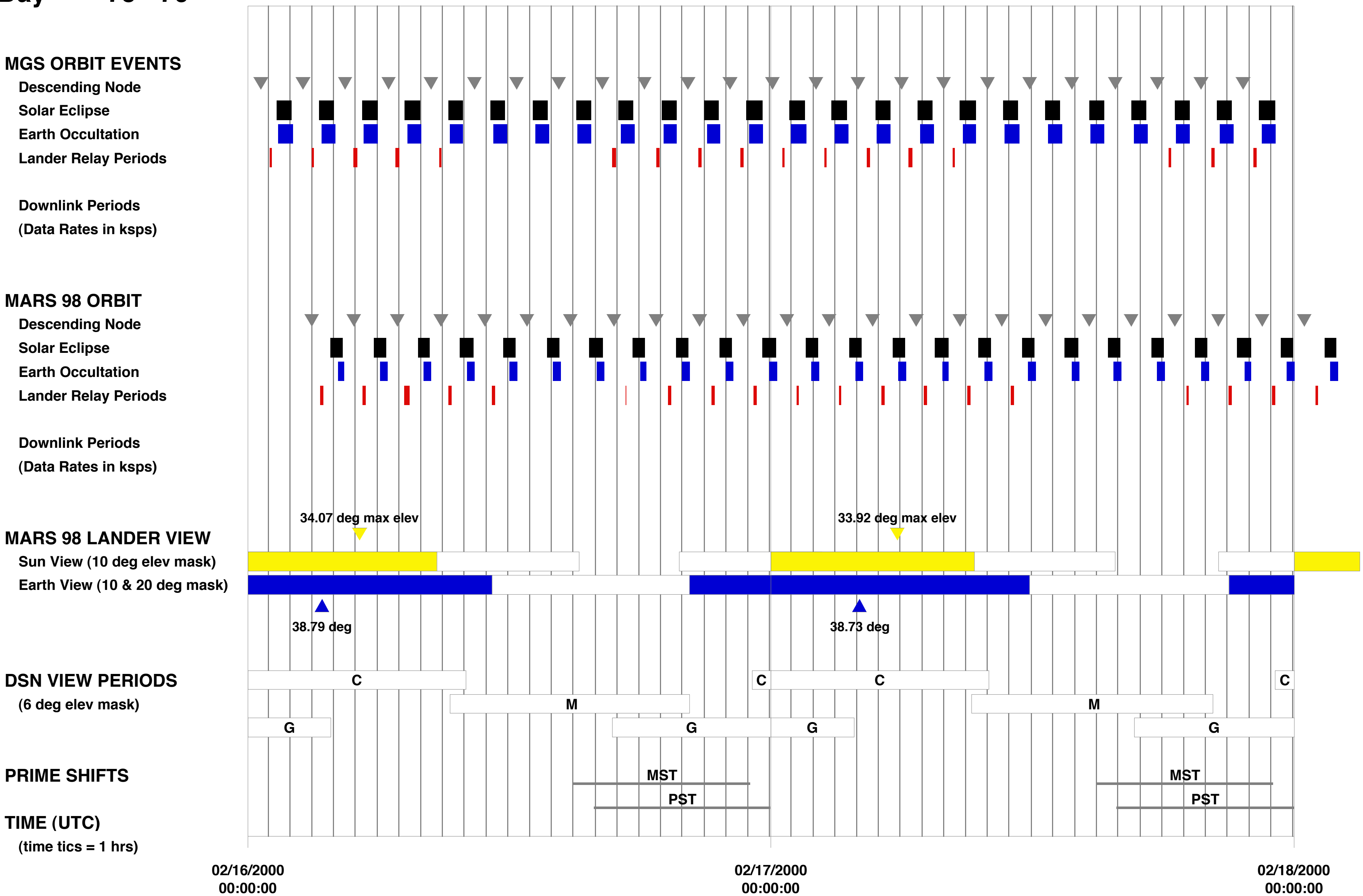
Day 45 - 46
MGS ORBIT EVENTS
Descending Node
Solar Eclipse
Earth Occultation
Lander Relay Periods
Downlink Periods
(Data Rates in ksps)
MARS 98 ORBIT
Descending Node
Solar Eclipse
Earth Occultation
Lander Relay Periods
Downlink Periods
(Data Rates in ksps)
0:00 LMST [Start SOL 44]
12:00 LMST
24:00 LMST
37.36 deg
37.29 deg
MARS 98 LANDER VIEW
Sun View (10 deg elev mask)
Earth View (10 & 20 deg mask)
38.16 deg
38.25 deg
DSN VIEW PERIODS
(6 deg elev mask)
C
C
C
C
M
M
G
G
G
G
PRIME SHIFTS
MST
PST
MST
PST
TIME (UTC)
(time tics = 1 hrs)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
01/17/2000 00:00:00
01/18/2000 00:00:00
01/19/2000 00:00:00

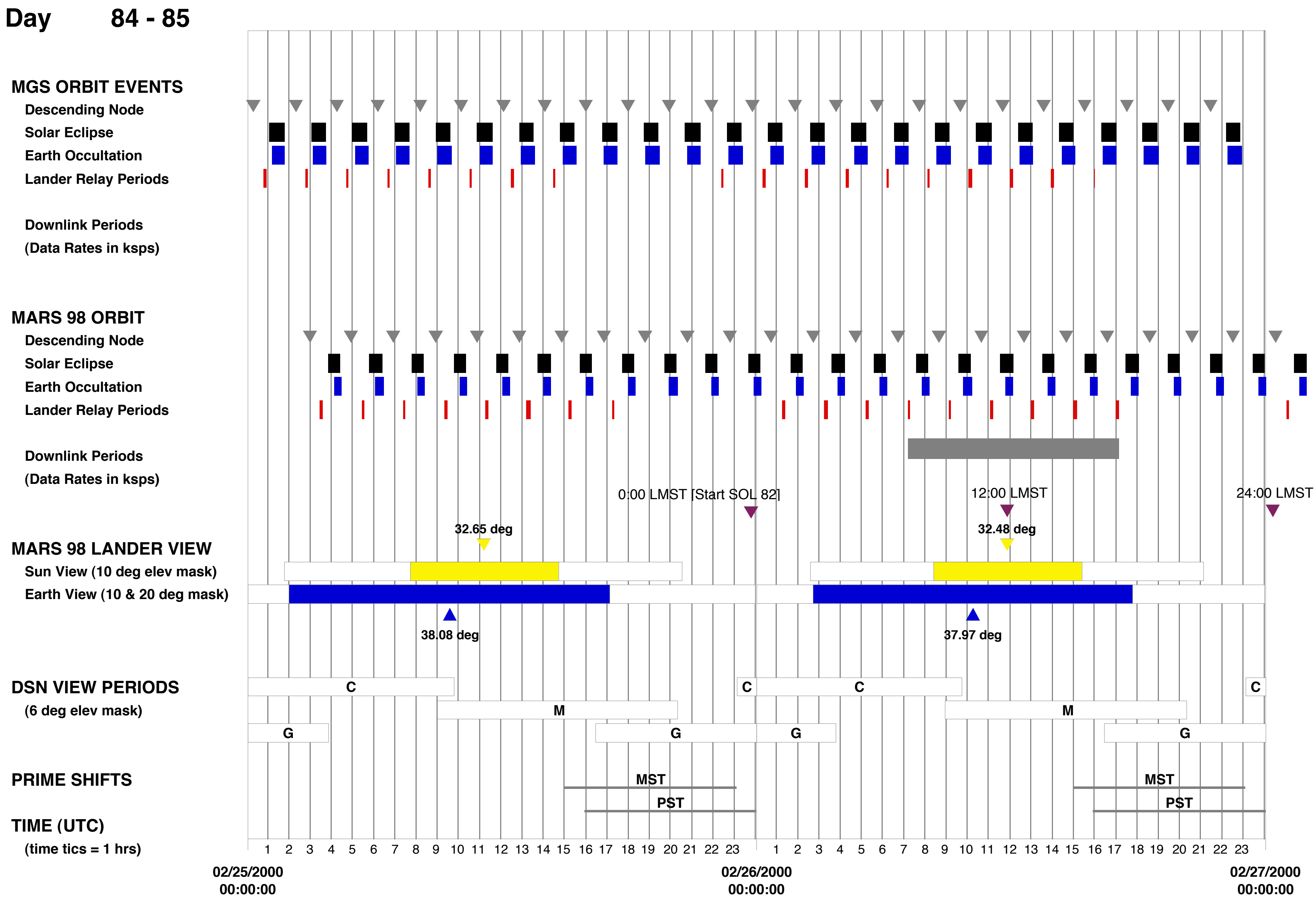
Day 60 - 61



MGS ORBIT EVENTS
Descending Node
Solar Eclipse
Earth Occultation
Lander Relay Periods
Downlink Periods
(Data Rates in ksps)
MARS 98 ORBIT
Descending Node
Solar Eclipse
Earth Occultation
Lander Relay Periods
Downlink Periods
(Data Rates in ksps)
0:00 LMST [start Sol 58]
12:00 LMST
24:00 LMST
35.94 deg
35.82 deg
MARS 98 LANDER VIEW
Sun View (10 deg elev mask)
Earth View (10 & 20 deg mask)
39.05 deg
39.07 deg
DSN VIEW PERIODS
(6 deg elev mask)
C
C
C
C
M
M
G
G
G
G
PRIME SHIFTS
MST
PST
MST
PST
TIME (UTC)
(time tics = 1 hrs)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
02/01/2000 00:00:00
02/02/2000 00:00:00
02/03/2000 00:00:00

Day 75 - 76

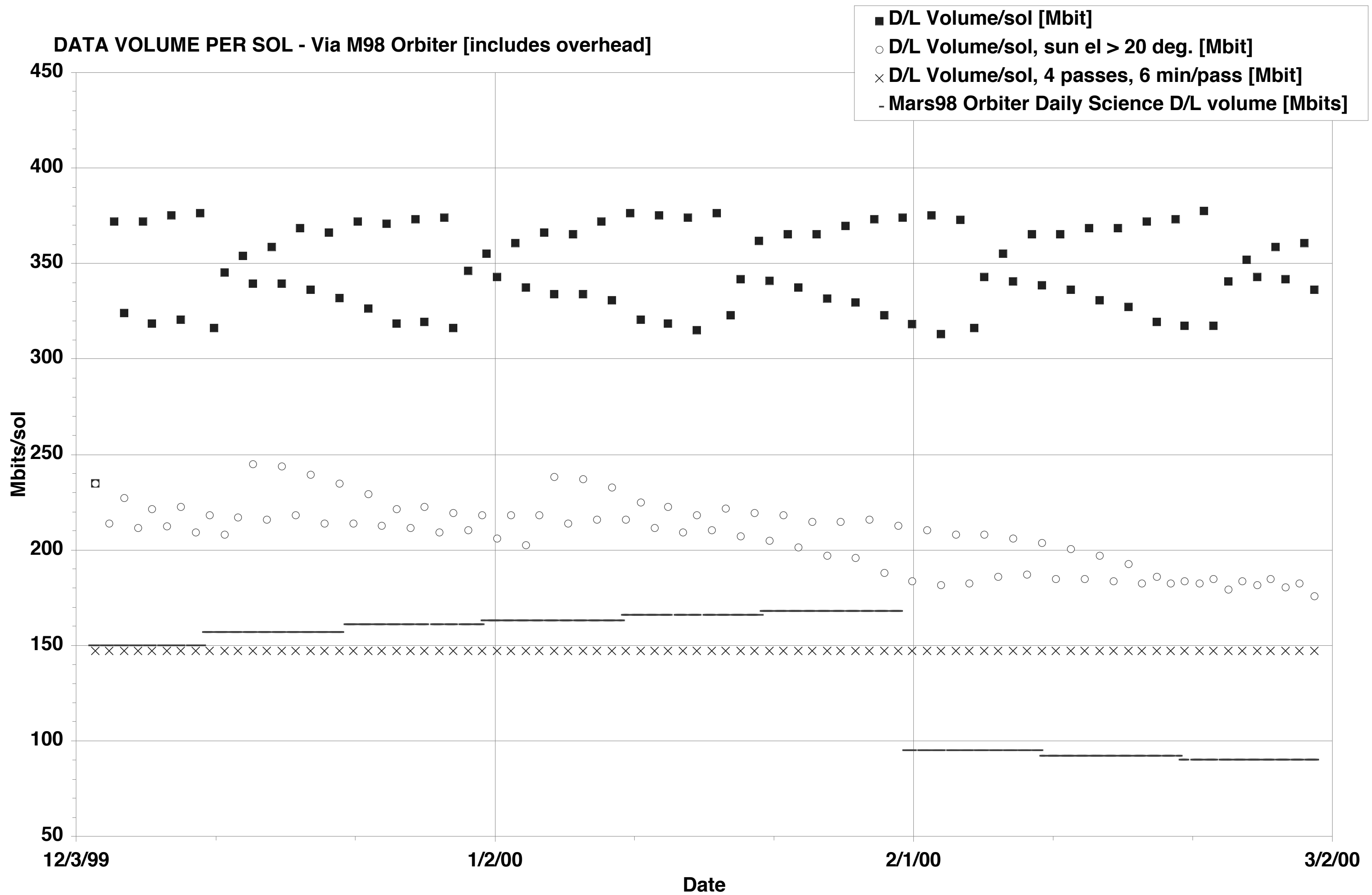

MGS ORBIT EVENTS
Descending Node
Solar Eclipse
Earth Occultation
Lander Relay Periods
Downlink Periods
(Data Rates in ksps)
MARS 98 ORBIT
Descending Node
Solar Eclipse
Earth Occultation
Lander Relay Periods
Downlink Periods
(Data Rates in ksps)
MARS 98 LANDER VIEW
Sun View (10 deg elev mask)
Earth View (10 & 20 deg mask)
34.07 deg max elev
33.92 deg max elev
38.79 deg
38.73 deg
DSN VIEW PERIODS
(6 deg elev mask)
C
C
C
C
M
M
G
G
G
G
PRIME SHIFTS
MST
PST
MST
PST
TIME (UTC)
(time tics = 1 hrs)
02/16/2000 00:00:00
02/17/2000 00:00:00
02/18/2000 00:00:00

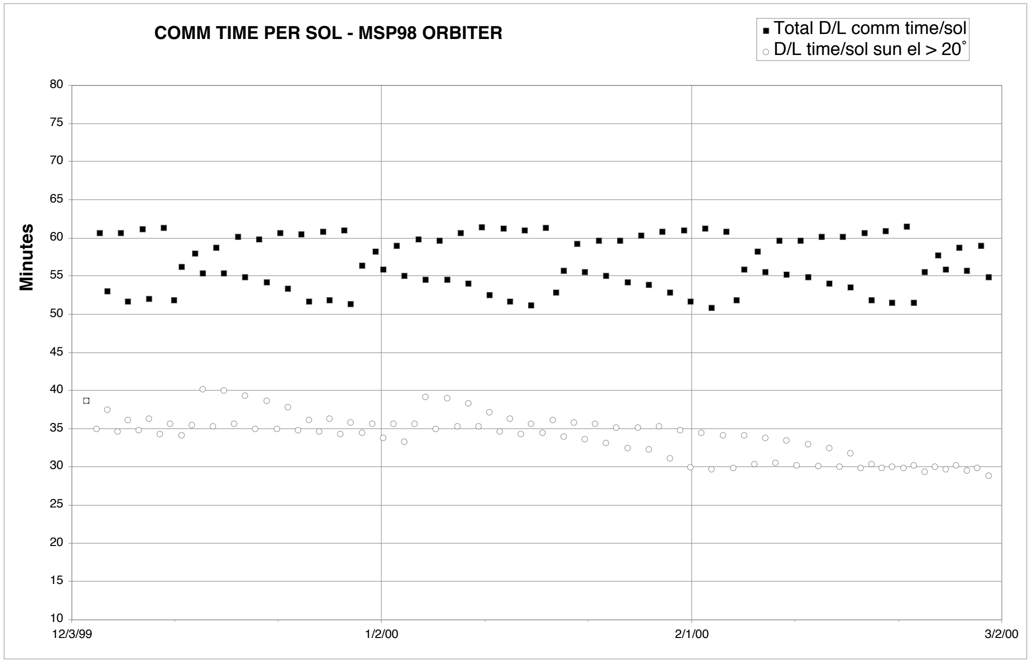

Day 84 - 85
MGS ORBIT EVENTS
Descending Node
Solar Eclipse
Earth Occultation
Lander Relay Periods
Downlink Periods
(Data Rates in ksps)
MARS 98 ORBIT
Descending Node
Solar Eclipse
Earth Occultation
Lander Relay Periods
Downlink Periods
(Data Rates in ksps)
0:00 LMST [Start SOL 82]
12:00 LMST
24:00 LMST
32.65 deg
32.48 deg
MARS 98 LANDER VIEW
Sun View (10 deg elev mask)
Earth View (10 & 20 deg mask)
38.08 deg
37.97 deg
DSN VIEW PERIODS
(6 deg elev mask)
C
M
G
PRIME SHIFTS
MST
PST
TIME (UTC)
(time tics = 1 hrs)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
02/25/2000
00:00:00
02/26/2000
00:00:00
02/27/2000
00:00:00

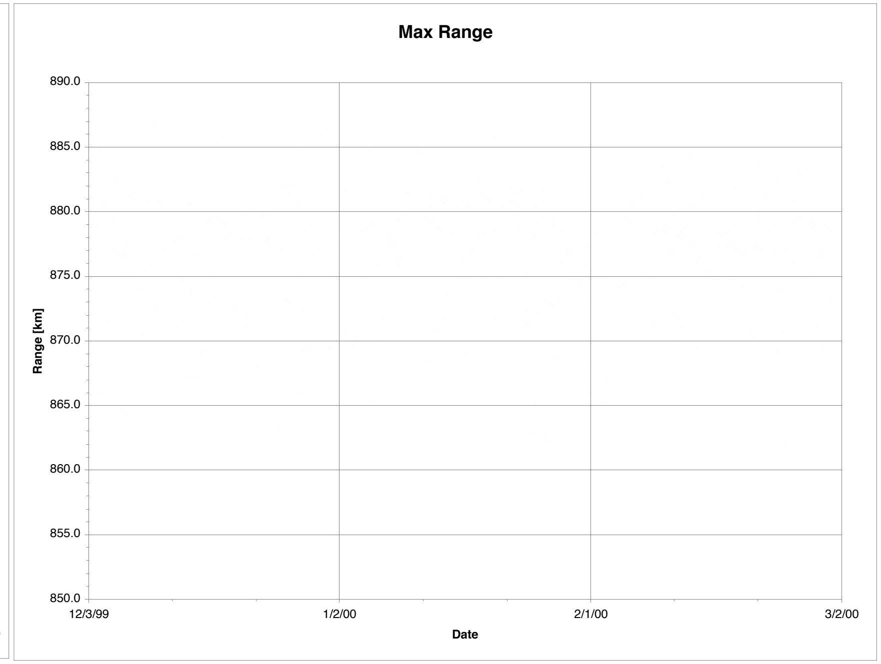
HYBRID PASSES

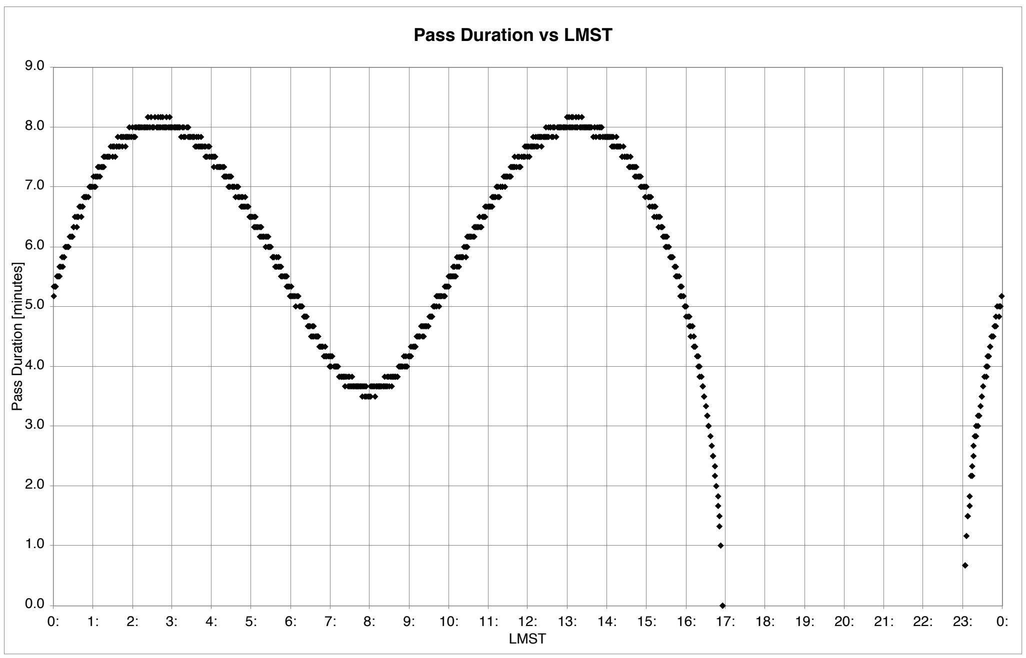
0.50 Minutes / pass for CMD

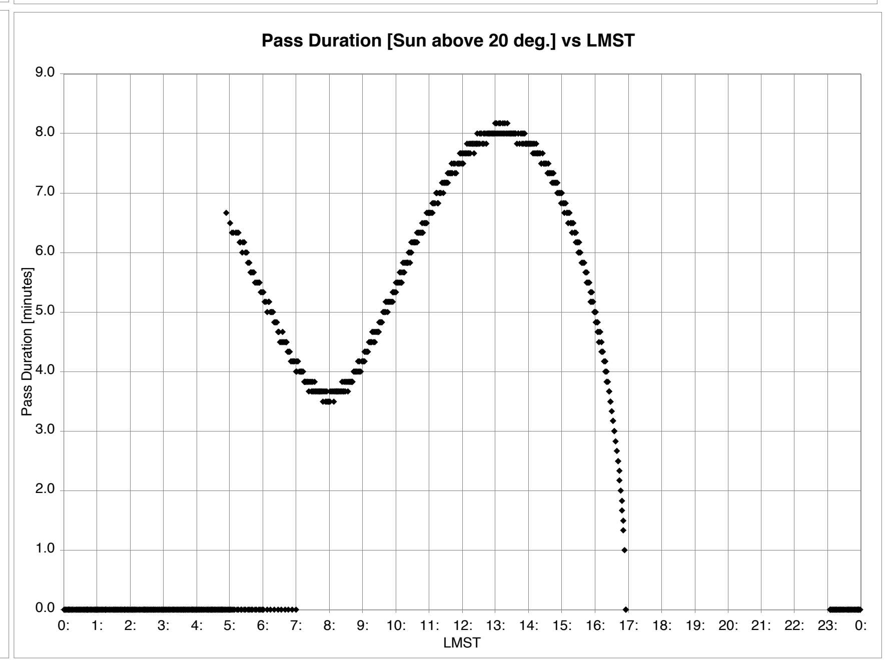
LANDER	UHF opportunities per day =	4	
GEOMETRY	Average length =	6	min.
CMD LANDER	Command load time [in UHF pass] =	0.50	min.
	CMD data rate [Orb -> Lander] =	8	kbps
	Average daily U/L to Lander =	67.8	kbits/pass actual commands
CMD ORBITER	Number of times sent =	2.00	
	U/L Data rate [Earth -> Orbiter]	0.5	kbps
	Overhead [Earth -> Orbiter]	1.77	
	Time for Command U/L to Orbiter	8	min.
TLM	Telemetry time =	5.5	min.
	TLM data rate =	128	kbps
	MSP Overhead [Lander -> Orbiter -> Earth]	1.15	
	Average daily D/L =	147	Megabits/day




COMM TIME PER SOL - MSP98 ORBITER
Total D/L comm time/sol
D/L time/sol sun el > 20˚
Minutes
12/3/99
1/2/00
2/1/00
3/2/00


Max Range
Range [km]
Date
12/3/99
1/2/00
2/1/00
3/2/00


Pass Duration vs LMST
Pass Duration [minutes]
LMST


Pass Duration [Sun above 20 deg.] vs LMST
Pass Duration [minutes]
LMST

Rise	Set	Pass Duration [min.]	Max.El at lander [deg.]	Max.Range [km]	MaxSun.El [de.g]	Day # [ET]	Sol #	LMST	Pass # that Sol	D/L Pass duration [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass	Max # passes that Sol	Cume D/L comm time that sol [min.]	Total D/L comm time/sol [min.]	D/L Volume/sol [Mbit]	Pass # sun el > 20°	Pass dur. sun el > 20° [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass [sun el > 20°]	Max # passes sun el > 20°	Cume D/L time sun el > 20° [min.]	D/L time/sol sun el > 20° [min.]	D/L Volume/sol, sun el > 20 deg. [Mbit]	D/L Volume/sol, 4 passes, 6 min/pass [Mbit]	Mars98 Orbiter Daily Science D/L volume [Mbits]
12/3/99 22:02	12/3/99 22:08	6.3	34.8	879.4	21.5	1	0	5:15:30	1	6.3	38.9		6.3			1	6.3	38.9		6.3				150
12/4/99 0:00	12/4/99 0:04	4.0	24.5	878.9	28.3	1	0	7:10:10	2	4.0	23.4		10.3			2	4.0	23.4		10.3				150
12/4/99 1:56	12/4/99 2:00	4.3	25.2	882.2	34.4	2	0	9:03:14	3	4.3	25.6		14.7			3	4.3	25.6		14.7				150
12/4/99 3:51	12/4/99 3:58	6.5	38.0	865.9	38.1	2	0	10:55:48	4	6.5	40.1		21.2			4	6.5	40.1		21.2				150
12/4/99 5:48	12/4/99 5:56	8.0	78.9	877.5	38.2	2	0	12:49:21	5	8.0	50.1		29.2			5	8.0	50.1		29.2				150
12/4/99 7:47	12/4/99 7:54	7.3	44.5	884.8	34.6	2	0	14:45:00	6	7.3	45.6		36.5			6	7.3	45.6		36.5				150
12/4/99 9:49	12/4/99 9:51	2.2	21.2	879.7	28.2	2	0	16:43:54	7	2.2	11.2	7	38.7	38.66	234.8	7	2.2	11.2	7	38.7	38.66	234.8	146.92	150
12/4/99 17:50	12/4/99 17:56	6.3	34.4	880.7	10.5	2	1	0:31:32	1	6.3	38.9		6.3			0								150
12/4/99 19:48	12/4/99 19:56	8.0	80.5	877.1	13.2	2	1	2:26:23	2	8.0	50.1		14.3			0								150
12/4/99 21:46	12/4/99 21:53	7.2	46.4	875.5	18.5	2	1	4:21:23	3	7.2	44.5		21.5			0				0.0				150
12/4/99 23:44	12/4/99 23:49	5.0	27.6	883.0	25.1	2	1	6:16:14	4	5.0	30.1		26.5			1	5.0	30.1		5.0				150
12/5/99 1:41	12/5/99 1:44	3.7	23.7	880.5	31.7	3	1	8:10:06	5	3.7	21.2		30.2			2	3.7	21.2		8.7				150
12/5/99 3:36	12/5/99 3:42	5.5	29.9	877.7	36.8	3	1	10:02:40	6	5.5	33.4		35.7			3	5.5	33.4		14.2				150
12/5/99 5:32	12/5/99 5:40	7.5	54.3	871.5	38.7	3	1	11:55:34	7	7.5	46.7		43.2			4	7.5	46.7		21.7				150
12/5/99 7:30	12/5/99 7:38	7.8	67.2	864.2	36.8	3	1	13:50:15	8	7.8	49.0		51.0			5	7.8	49.0		29.5				150
12/5/99 9:30	12/5/99 9:36	5.5	29.3	884.2	31.6	3	1	15:47:12	9	5.5	33.4		56.5			6	5.5	33.4	6	35.0	35	213.7	146.92	150
12/5/99 17:34	12/5/99 17:38	4.2	24.4	879.3	10.4	3	1	23:37:36	10	4.2	24.5	10	60.7	60.67	371.8	0				0.0				150
12/5/99 19:31	12/5/99 19:39	7.7	53.6	882.7	11.6	3	2	1:32:07	1	7.7	47.9		7.7			0								150
12/5/99 21:29	12/5/99 21:37	7.8	66.5	877.1	15.8	3	2	3:27:07	2	7.8	49.0		15.5			0				0.0				150
12/5/99 23:28	12/5/99 23:34	6.0	33.8	869.9	21.9	3	2	5:22:07	3	6.0	36.7		21.5			1	6.0	36.7		6.0				150
12/6/99 1:25	12/6/99 1:29	3.8	24.2	874.0	28.7	4	2	7:16:38	4	3.8	22.2		25.3			2	3.8	22.2		9.8				150
12/6/99 3:21	12/6/99 3:26	4.3	25.6	874.5	34.8	4	2	9:09:42	5	4.3	25.6		29.7			3	4.3	25.6		14.2				150
12/6/99 5:17	12/6/99 5:24	6.7	39.3	876.7	38.4	4	2	11:02:07	6	6.7	41.2		36.3			4	6.7	41.2		20.8				150
12/6/99 7:14	12/6/99 7:22	8.0	82.3	879.4	38.3	4	2	12:55:49	7	8.0	50.1		44.3			5	8.0	50.1		28.8				150
12/6/99 9:13	12/6/99 9:20	7.2	42.4	882.4	34.5	4	2	14:51:38	8	7.2	44.5		51.5			6	7.2	44.5		36.0				150
12/6/99 11:15	12/6/99 11:17	1.5	20.5	882.7	28.0	4	2	16:50:51	9	1.5	6.7	9	53.0	53	323.9	7	1.5	6.7	7	37.5	37.5	227.1	146.92	150
12/6/99 19:15	12/6/99 19:22	6.5	36.0	876.8	10.7	4	3	0:38:00	1	6.5	40.1		6.5			0								150
12/6/99 21:13	12/6/99 21:21	8.0	84.3	869.6	13.5	4	3	2:32:51	2	8.0	50.1		14.5			0				0.0				150
12/6/99 23:11	12/6/99 23:18	7.0	44.7	864.6	18.9	4	3	4:27:51	3	7.0	43.4		21.5			0				0.0				150
12/7/99 1:09	12/7/99 1:14	4.8	27.1	878.3	25.5	5	3	6:22:42	4	4.8	28.9		26.3			1	4.8	28.9		4.8				150
12/7/99 3:06	12/7/99 3:10	3.7	23.7	876.5	32.1	5	3	8:16:34	5	3.7	21.2		30.0			2	3.7	21.2		8.5				150
12/7/99 5:02	12/7/99 5:08	5.7	30.7	876.7	37.1	5	3	10:08:59	6	5.7	34.5		35.7			3	5.7	34.5		14.2				150
12/7/99 6:58	12/7/99 7:06	7.5	56.7	864.5	38.8	5	3	12:02:02	7	7.5	46.7		43.2			4	7.5	46.7		21.7				150
12/7/99 8:56	12/7/99 9:04	7.8	64.0	877.7	36.8	5	3	13:56:43	8	7.8	49.0		51.0			5	7.8	49.0		29.5				150
12/7/99 10:56	12/7/99 11:02	5.2	28.1	875.2	31.4	5	3	15:53:59	9	5.2	31.2		56.2			6	5.2	31.2	6	34.7	34.67	211.5	146.92	150
12/7/99 18:59	12/7/99 19:04	4.5	25.4	881.2	10.5	5	3	23:44:04	10	4.5	26.7	10	60.7	60.67	371.8	0				0.0				150
12/7/99 20:57	12/7/99 21:05	7.7	56.3	870.9	11.9	5	4	1:38:35	1	7.7	47.9		7.7			0								150
12/7/99 22:55	12/7/99 23:03	7.8	63.5	880.6	16.1	5	4	3:33:35	2	7.8	49.0		15.5			0				0.0				150
12/8/99 0:53	12/8/99 0:59	6.0	32.8	884.0	22.3	6	4	5:28:35	3	6.0	36.7		21.5			1	6.0	36.7		6.0				150
12/8/99 2:51	12/8/99 2:55	3.7	24.1	869.9	29.1	6	4	7:23:07	4	3.7	21.2		25.2			2	3.7	21.2		9.7				150
12/8/99 4:47	12/8/99 4:52	4.5	25.9	875.2	35.1	6	4	9:16:00	5	4.5	26.7		29.7			3	4.5	26.7		14.2				150
12/8/99 6:43	12/8/99 6:50	6.8	40.7	879.3	38.6	6	4	11:08:35	6	6.8	42.3		36.5			4	6.8	42.3		21.0				150
12/8/99 8:40	12/8/99 8:48	8.2	85.6	882.5	38.3	6	4	13:02:17	7	8.2	51.2		44.7			5	8.2	51.2		29.2				150
12/8/99 10:39	12/8/99 10:46	7.0	40.5	881.5	34.4	6	4	14:58:16	8	7.0	43.4	8	51.7	51.67	318.4	6	7.0	43.4	6	36.2	36.17	221.5	146.92	150
12/8/99 20:41	12/8/99 20:48	6.7	37.7	874.1	10.9	6	5	0:44:29	1	6.7	41.2		6.7			0								150
12/8/99 22:39	12/8/99 22:47	8.0	88.0	867.5	13.8	6	5	2:39:19	2	8.0	50.1		14.7			0				0.0				150
12/9/99 0:37	12/9/99 0:44	7.0	43.0	872.0	19.2	7	5	4:34:19	3	7.0	43.4		21.7			0				0.0				150
12/9/99 2:35	12/9/99 2:40	4.7	26.6	873.9	25.9	7	5	6:29:10	4	4.7	27.8		26.3			1	4.7	27.8		4.7				150
12/9/99 4:32	12/9/99 4:36	3.8	23.8	880.1	32.5	7	5	8:22:52	5	3.8	22.2		30.2			2	3.8	22.2		8.5				150
12/9/99 6:28	12/9/99 6:33	5.8	31.5	883.1	37.4	7	5	10:15:17	6	5.8	35.6		36.0			3	5.8	35.6		14.3				150
12/9/99 8:24	12/9/99 8:32	7.8	59.2	885.8	38.9	7	5	12:08:20	7	7.8	49.0		43.8			4	7.8	49.0		22.2				150
12/9/99 10:22	12/9/99 10:30	7.8	60.9	879.8	36.7	7	5	14:03:21	8	7.8	49.0		51.7			5	7.8	49.0		30.0				150
12/9/99 12:23	12/9/99 12:27	4.8	27.0	870.4	31.2	7	5	16:00:47	9	4.8	28.9		56.5			6	4.8	28.9	6	34.8	34.82	212.5	146.92	150
12/9/99 20:25	12/9/99 20:30	4.7	26.4	871.0	10.6	7	5	23:50:32	10	4.7	27.8	10	61.2	61.16	375.1	0				0.0				150
12/9/99 22:23	12/9/99 22:31	7.8	59.1	875.6	12.1	7	6	1:45:03	1	7.8	49.0		7.8			0								150
12/10/99 0:21	12/10/99 0:29	7.8	60.7	885.1	16.5	8	6	3:40:03	2	7.8	49.0		15.7			0				0.0				150
12/10/99 2:19	12/10/99 2:25	5.8	31.9	876.9	22.7	8	6	5:35:04	3	5.8	35.6		21.5			1	5.8	35.6		5.8				150
12/10/99 4:17	12/10/99 4:21	3.8	23.9	880.7	29.5	8	6	7:29:25	4	3.8	22.2		25.3			2	3.8	22.2		9.7				150
12/10/99 6:13	12/10/99 6:17	4.7	26.4	879.5	35.4	8	6	9:22:19	5	4.7	27.8		30.0			3	4.7	27.8		14.3				150
12/10/99 8:08	12/10/99 8:15	7.0	42.2	876.5	38.7	8	6	11:14:53	6	7.0	43.4		37.0			4	7.0	43.4		21.3				150
12/10/99 10:05	12/10/99 10:14	8.2	88.6	886.8	38.3	8	6	13:08:45	7	8.2	51.2		45.2			5	8.2	51.2		29.5				150
12/10/99 12:05	12/10/99 12:12	6.8	38.6	881.9	34.2	8	6	15:04:53	8	6.8	42.3	8	52.0	51.99	320.5	6	6.8	42.3	6	36.3	36.33	222.6	146.92	150
12/10/99 22:07	12/10/99 22:14	6.8	39.4	872.7	11.0	8	7	0:50:57	1	6.8	42.3		6.8			0								150
12/11/99 0:05	12/11/99 0:13	8.2	87.7	886.9	14.1	9	7	2:45:47	2	8.2	51.2		15.0			0				0.0				150
12/11/99 2:03	12/11/99 2:10	7.0	41.5	883.8	19.6	9	7	4:40:47	3	7.0	43.4		22.0			0				0.0				150
12/11/99 4:01	12/11/99 4:06	4.5	26.2	872.8	26.3	9	7	6:35:38	4	4.5	26.7		26.5			1	4.5	26.7		4.5				150
12/11/99 5:58	12/11/99 6:02	3.7	24.0	872.4	32.9	9	7	8:29:20	5	3.7	21.2		30.2			2	3.7	21.2		8.2				150
12/11/99 7:53	12/11/99 7:59	5.8	32.3	868.9	37.6	9	7	10:21:45	6	5.8	35.6		36.0			3	5.8	35.6		14.0				150
12/11/99 9:50	12/11/99 9:57	7.8	61.9	880.8	39.0	9	7	12:14:48	7	7.8	49.0		43.8			4	7.8	49.0		21.8				150
12/11/99 11:48	12/11/99 11:56	7.8	57.8	880.7	36.6	9	7	14:09:49	8	7.8	49.0		51.7			5	7.8	49.0		29.7				150
12/11/99 13:49	12/11/99 13:53	4.7	26.0	880.3	31.0	9	7	16:07:25	9	4.7	27.8		56.3			6	4.7	27.8	6	34.3	34.33	209.2	146.92	150
12/11/99 21:51	12/11/99 21:56	5.0	27.5	874.4	10.7	9	7	23:57:00	10	5.0	30.1	10	61.3	61.33	376.2	0				0.0				150
12/11/99 23:49	12/11/99 23:57	7.8	62.2	879.7	12.3	9	8	1:51:31	1	7.8	49.0		7.8			0								150
12/12/99 1:47	12/12/99 1:55	7.7	58.1	877.0	16.8	10	8	3:46:31	2	7.7	47.9		15.5			0				0.0				150
12/12/99 3:45	12/12/99 3:51	5.7	31.1	871.8	23.1	10	8	5:41:32	3	5.7	34.5		21.2			1	5.7	34.5		5.7				157
12/12/99 5:43	12/12/99 5:46	3.7	23.8	877.5	29.9	10	8	7:35:53	4	3.7	21.2		24.8			2	3.7	21.2		9.3				157
12/12/99 7:39	12/12/99 7:43	4.7	26.8	872.9	35.8	10	8	9:28:47	5	4.7	27.8		29.5			3	4.7	27.8		14.0				157
12/12/99 9:34	12/12/99 9:41	7.0	43.8	869.4	38.9	10	8	11:21:21	6	7.0	43.4		36.5			4	7.0	43.4		21.0				157
12/12/99 11:31	12/12/99 11:39	8.0	86.4	867.2	38.3	10	8	13:15:23	7	8.0	50.1		44.5			5	8.0	50.1		29.0				157
12/12/99 13:31	12/12/99 13:37	6.7	36.9	883.7	34.1	10	8	15:11:31	8	6.7	41.2		51.2			6	6.7	41.2	6	35.7	35.68	218.2	146.92	157

Rise	Set	Pass Duration [min.]	Max.El at lander [deg.]	Max.Range [km]	MaxSun.El [de.g]	Day # [ET]	Sol #	LMST	Pass # that Sol	D/L Pass duration [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass	Max # passes that Sol	Cume D/L comm time that sol [min.]	Total D/L comm time/sol [min.]	D/L Volume/sol [Mbit]	Pass # sun el > 20˚	Pass dur. sun el > 20˚ [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass [sun el > 20˚]	Max # passes sun el > 20˚	Cume D/L time sun el > 20˚ [min.]	D/L time/sol sun el > 20˚ [min.]	D/L Volume/sol, sun el > 20 deg. [Mbit]	D/L Volume/sol, 4 passes, 6 min/pass [Mbit]	Mars98 Orbiter Daily Science D/L volume [Mbits]
12/12/99 21:36	12/12/99 21:37	0.7	20.1	882.5	11.2	10	8	23:04:02	9	0.7	1.1	9	51.9	51.85	316.2	0				0.0				157
12/12/99 23:33	12/12/99 23:40	7.0	41.3	872.7	11.2	10	9	0:57:25	1	7.0	43.4		7.0			0								157
12/13/99 1:31	12/13/99 1:39	8.2	84.1	883.2	14.4	11	9	2:52:15	2	8.2	51.2		15.2			0				0.0				157
12/13/99 3:29	12/13/99 3:36	6.8	40.0	879.5	20.0	11	9	4:47:16	3	6.8	42.3		22.0			0				0.0				157
12/13/99 5:27	12/13/99 5:31	4.5	25.8	881.7	26.7	11	9	6:42:06	4	4.5	26.7		26.5			1	4.5	26.7		4.5				157
12/13/99 7:24	12/13/99 7:27	3.8	24.1	877.7	33.2	11	9	8:35:39	5	3.8	22.2		30.3			2	3.8	22.2		8.3				157
12/13/99 9:19	12/13/99 9:25	6.0	33.2	876.0	37.9	11	9	10:28:03	6	6.0	36.7		36.3			3	6.0	36.7		14.3				157
12/13/99 11:15	12/13/99 11:23	7.8	64.8	876.8	39.1	11	9	12:21:17	7	7.8	49.0		44.2			4	7.8	49.0		22.2				157
12/13/99 13:14	12/13/99 13:21	7.7	55.1	871.1	36.5	11	9	14:16:27	8	7.7	47.9		51.8			5	7.7	47.9		29.8				157
12/13/99 15:15	12/13/99 15:19	4.3	25.0	877.9	30.8	11	9	16:14:12	9	4.3	25.6	9	56.2	56.16	345.0	6	4.3	25.6	6	34.2	34.16	208.1	146.92	157
12/13/99 23:17	12/13/99 23:22	5.3	28.6	882.2	10.8	11	10	0:03:28	1	5.3	32.3		5.3			0								157
12/14/99 1:15	12/14/99 1:23	7.8	65.4	873.7	12.6	12	10	1:58:09	2	7.8	49.0		13.2			0				0.0				157
12/14/99 3:13	12/14/99 3:20	7.5	55.6	869.6	17.1	12	10	3:53:09	3	7.5	46.7		20.7			0				0.0				157
12/14/99 5:11	12/14/99 5:16	5.5	30.3	874.7	23.5	12	10	5:48:00	4	5.5	33.4		26.2			1	5.5	33.4		5.5				157
12/14/99 7:08	12/14/99 7:12	3.7	23.7	878.0	30.3	12	10	7:42:21	5	3.7	21.2		29.8			2	3.7	21.2		9.2				157
12/14/99 9:04	12/14/99 9:09	4.8	27.3	871.6	36.0	12	10	9:35:05	6	4.8	28.9		34.7			3	4.8	28.9		14.0				157
12/14/99 11:00	12/14/99 11:07	7.2	45.5	879.3	39.0	12	10	11:27:39	7	7.2	44.5		41.8			4	7.2	44.5		21.2				157
12/14/99 12:57	12/14/99 13:05	8.0	82.7	870.6	38.3	12	10	13:21:51	8	8.0	50.1		49.8			5	8.0	50.1		29.2				157
12/14/99 14:57	12/14/99 15:03	6.3	35.3	867.2	33.9	12	10	15:18:19	9	6.3	38.9		56.2			6	6.3	38.9	6	35.5	35.5	217.0	146.92	157
12/14/99 23:02	12/14/99 23:03	1.8	20.8	880.7	11.2	12	10	23:10:01	10	1.8	8.9	10	58.0	57.99	353.9	0				0.0				157
12/15/99 0:59	12/15/99 1:06	7.2	43.3	874.0	11.4	13	11	1:03:53	1	7.2	44.5		7.2			0								157
12/15/99 2:57	12/15/99 3:05	8.0	80.7	880.6	14.7	13	11	2:58:53	2	8.0	50.1		15.2			0				0.0				157
12/15/99 4:55	12/15/99 5:02	6.7	38.7	884.3	20.3	13	11	4:53:53	3	6.7	41.2		21.8			1	6.7	41.2		6.7				157
12/15/99 6:53	12/15/99 6:57	4.3	25.4	877.3	27.1	13	11	6:48:34	4	4.3	25.6		26.2			2	4.3	25.6		11.0				157
12/15/99 8:49	12/15/99 8:53	3.8	24.3	873.8	33.6	13	11	8:42:07	5	3.8	22.2		30.0			3	3.8	22.2		14.8				157
12/15/99 10:45	12/15/99 10:51	6.2	34.2	884.0	38.1	13	11	10:34:22	6	6.2	37.9		36.2			4	6.2	37.9		21.0				157
12/15/99 12:41	12/15/99 12:49	7.8	67.8	873.8	39.1	13	11	12:27:45	7	7.8	49.0		44.0			5	7.8	49.0		28.8				157
12/15/99 14:40	12/15/99 14:47	7.5	52.4	867.2	36.4	13	11	14:23:04	8	7.5	46.7		51.5			6	7.5	46.7		36.3				157
12/15/99 16:41	12/15/99 16:45	3.8	24.0	876.7	30.6	13	11	16:21:00	9	3.8	22.2	9	55.3	55.33	339.5	7	3.8	22.2	7	40.2	40.16	244.8	146.92	157
12/16/99 0:43	12/16/99 0:48	5.5	29.8	873.2	10.9	14	12	0:09:56	1	5.5	33.4		5.5			0								157
12/16/99 2:41	12/16/99 2:48	7.8	68.7	861.6	12.8	14	12	2:04:37	2	7.8	49.0		13.3			0				0.0				157
12/16/99 4:39	12/16/99 4:46	7.5	53.3	876.9	17.5	14	12	3:59:37	3	7.5	46.7		20.8			0				0.0				157
12/16/99 6:37	12/16/99 6:42	5.5	29.6	878.8	23.8	14	12	5:54:28	4	5.5	33.4		26.3			1	5.5	33.4		5.5				157
12/16/99 8:34	12/16/99 8:38	3.5	23.6	871.3	30.6	14	12	7:48:49	5	3.5	20.0		29.8			2	3.5	20.0		9.0				157
12/16/99 10:30	12/16/99 10:35	5.0	27.8	875.6	36.3	14	12	9:41:23	6	5.0	30.1		34.8			3	5.0	30.1		14.0				157
12/16/99 12:26	12/16/99 12:33	7.2	47.3	868.9	39.1	14	12	11:34:07	7	7.2	44.5		42.0			4	7.2	44.5		21.2				157
12/16/99 14:23	12/16/99 14:31	8.0	78.9	878.7	38.2	14	12	13:28:19	8	8.0	50.1		50.0			5	8.0	50.1		29.2				157
12/16/99 16:23	12/16/99 16:29	6.2	33.8	869.3	33.7	14	12	15:24:57	9	6.2	37.9		56.2			6	6.2	37.9	6	35.3	35.34	216.0	146.92	157
12/17/99 0:27	12/17/99 0:30	2.5	21.6	877.9	11.2	15	12	23:16:19	10	2.5	13.4	10	58.7	58.67	358.4	0				0.0				157
12/17/99 2:24	12/17/99 2:32	7.3	45.5	876.9	11.5	15	13	1:10:21	1	7.3	45.6		7.3			0								157
12/17/99 4:23	12/17/99 4:31	8.0	77.3	879.2	15.0	15	13	3:05:21	2	8.0	50.1		15.3			0				0.0				157
12/17/99 6:21	12/17/99 6:27	6.5	37.4	873.7	20.7	15	13	5:00:21	3	6.5	40.1		21.8			1	6.5	40.1		6.5				157
12/17/99 8:19	12/17/99 8:23	4.2	25.1	873.0	27.4	15	13	6:55:02	4	4.2	24.5		26.0			2	4.2	24.5		10.7				157
12/17/99 10:15	12/17/99 10:19	4.0	24.6	875.3	33.9	15	13	8:48:25	5	4.0	23.4		30.0			3	4.0	23.4		14.7				157
12/17/99 12:11	12/17/99 12:17	6.3	35.2	879.4	38.3	15	13	10:40:50	6	6.3	38.9		36.3			4	6.3	38.9		21.0				157
12/17/99 14:07	12/17/99 14:15	8.0	71.0	881.3	39.1	15	13	12:34:13	7	8.0	50.1		44.3			5	8.0	50.1		29.0				157
12/17/99 16:06	12/17/99 16:13	7.5	49.9	881.7	36.3	15	13	14:29:32	8	7.5	46.7		51.8			6	7.5	46.7		36.5				157
12/17/99 18:07	12/17/99 18:11	3.5	23.1	878.1	30.3	15	13	16:27:47	9	3.5	20.0	9	55.3	55.33	339.5	7	3.5	20.0	7	40.0	40	243.8	146.92	157
12/18/99 2:09	12/18/99 2:14	5.8	31.1	884.9	11.0	16	14	0:16:24	1	5.8	35.6		5.8			0								157
12/18/99 4:06	12/18/99 4:14	8.0	72.2	877.1	13.0	16	14	2:11:05	2	8.0	50.1		13.8			0				0.0				157
12/18/99 6:05	12/18/99 6:12	7.5	51.1	885.1	17.8	16	14	4:06:05	3	7.5	46.7		21.3			0				0.0				157
12/18/99 8:03	12/18/99 8:08	5.3	29.0	879.6	24.2	16	14	6:00:56	4	5.3	32.3		26.7			1	5.3	32.3		5.3				157
12/18/99 10:00	12/18/99 10:04	3.7	23.6	878.0	31.0	16	14	7:55:07	5	3.7	21.2		30.3			2	3.7	21.2		9.0				157
12/18/99 11:56	12/18/99 12:01	5.2	28.4	880.5	36.6	16	14	9:47:42	6	5.2	31.2		35.5			3	5.2	31.2		14.2				157
12/18/99 13:51	12/18/99 13:59	7.5	49.2	885.5	39.2	16	14	11:40:26	7	7.5	46.7		43.0			4	7.5	46.7		21.7				157
12/18/99 15:49	12/18/99 15:57	8.0	75.3	879.3	38.1	16	14	13:34:57	8	8.0	50.1		51.0			5	8.0	50.1		29.7				157
12/18/99 17:49	12/18/99 17:55	6.0	32.3	875.1	33.5	16	14	15:31:34	9	6.0	36.7		57.0			6	6.0	36.7	6	35.7	35.67	218.2	146.92	157
12/19/99 1:53	12/19/99 1:56	3.2	22.4	881.8	11.2	17	14	23:22:37	10	3.2	17.8	10	60.2	60.17	368.4	0				0.0				157
12/19/99 3:50	12/19/99 3:58	7.5	47.7	881.2	11.7	17	15	1:16:49	1	7.5	46.7		7.5			0								157
12/19/99 5:48	12/19/99 5:56	8.0	73.9	879.0	15.2	17	15	3:11:49	2	8.0	50.1		15.5			0				0.0				157
12/19/99 7:47	12/19/99 7:53	6.3	36.2	869.2	21.0	17	15	5:06:49	3	6.3	38.9		21.8			1	6.3	38.9		6.3				157
12/19/99 9:44	12/19/99 9:48	4.0	24.8	872.2	27.8	17	15	7:01:30	4	4.0	23.4		25.8			2	4.0	23.4		10.3				157
12/19/99 11:41	12/19/99 11:45	4.2	24.8	878.1	34.2	17	15	8:54:44	5	4.2	24.5		30.0			3	4.2	24.5		14.5				157
12/19/99 13:36	12/19/99 13:43	6.5	36.3	879.1	38.4	17	15	10:47:08	6	6.5	40.1		36.5			4	6.5	40.1		21.0				157
12/19/99 15:33	12/19/99 15:41	8.0	74.3	875.4	39.1	17	15	12:40:41	7	8.0	50.1		44.5			5	8.0	50.1		29.0				157
12/19/99 17:32	12/19/99 17:39	7.3	47.5	876.1	36.1	17	15	14:36:10	8	7.3	45.6		51.8			6	7.3	45.6		36.3				157
12/19/99 19:33	12/19/99 19:36	3.0	22.3	881.4	30.0	17	15	16:34:35	9	3.0	16.7	9	54.8	54.83	336.1	7	3.0	16.7	7	39.3	39.33	239.3	146.92	157
12/20/99 3:34	12/20/99 3:40	6.0	32.5	878.2	11.0	18	16	0:22:52	1	6.0	36.7		6.0			0								157
12/20/99 5:32	12/20/99 5:40	8.0	75.7	871.8	13.2	18	16	2:17:33	2	8.0	50.1		14.0			0				0.0				157
12/20/99 7:30	12/20/99 7:38	7.3	49.0	872.5	18.1	18	16	4:12:33	3	7.3	45.6		21.3			0				0.0				157
12/20/99 9:29	12/20/99 9:34	5.0	28.3	868.7	24.5	18	16	6:07:34	4	5.0	30.1		26.3			1	5.0	30.1		5.0				157
12/20/99 11:26	12/20/99 11:29	3.5	23.6	872.7	31.3	18	16	8:01:36	5	3.5	20.0		29.8			2	3.5	20.0		8.5				157
12/20/99 13:21	12/20/99 13:27	5.2	29.0	866.7	36.8	18	16	9:54:10	6	5.2	31.2		35.0			3	5.2	31.2		13.7				157
12/20/99 15:17	12/20/99 15:25	7.5	51.3	876.6	39.3	18	16	11:46:54	7	7.5	46.7		42.5			4	7.5	46.7		21.2				157
12/20/99 17:15	12/20/99 17:23	8.0	71.8	874.1	38.0	18	16	13:41:25	8	8.0	50.1		50.5			5	8.0	50.1		29.2				157
12/20/99 19:15	12/20/99 19:21	5.8	31.0	882.0	33.2	18	16	15:38:12	9	5.8	35.6		56.3			6	5.8	35.6	6	35.0	35	213.7	146.92	157
12/21/99 3:19	12/21/99 3:22	3.5	23.2	878.8	11.2	19	16	23:29:05	10	3.5	20.0	10	59.8	59.83	366.2	0				0.0				157
12/21/99 5:16	12/21/99 5:24	7.5	50.1	887.1	11.8	19	17	1:23:27	1	7.5	46.7		7.5			0								157
12/21/99 7:14	12/21/99 7:22	8.0	70.7	880.0	15.5	19	17	3:18:17	2	8.0	50.1		15.5			0				0.0				157
12/21/99 9:12	12/21/99 9:19	6.3	35.1	877.9	21.3	19	17	5:13:18	3	6.3	38.9		21.8			1	6.3	38.9		6.3				157

Rise	Set	Pass Duration [min.]	Max.El at lander [deg.]	Max.Range [km]	MaxSun.El [de.g]	Day # [ET]	Sol #	LMST	Pass # that Sol	D/L Pass duration [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass	Max # passes that Sol	Cume D/L comm time that sol [min.]	Total D/L comm time/sol [min.]	D/L Volume/sol [Mbit]	Pass # sun el > 20˚	Pass dur. sun el > 20˚ [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass [sun el > 20˚]	Max # passes sun el > 20˚	Cume D/L time sun el > 20˚ [min.]	D/L time/sol sun el > 20˚ [min.]	D/L Volume/sol, sun el > 20 deg. [Mbit]	D/L Volume/sol, 4 passes, 6 min/pass [Mbit]	Mars98 Orbiter Daily Science D/L volume [Mbits]
12/21/99 11:10	12/21/99 11:14	4.0	24.5	878.6	28.1	19	17	7:07:58	4	4.0	23.4		25.8			2	4.0	23.4		10.3				157
12/21/99 13:07	12/21/99 13:11	4.2	25.1	877.3	34.4	19	17	9:01:12	5	4.2	24.5		30.0			3	4.2	24.5		14.5				157
12/21/99 15:02	12/21/99 15:09	6.5	37.5	871.0	38.6	19	17	10:53:36	6	6.5	40.1		36.5			4	6.5	40.1		21.0				157
12/21/99 16:59	12/21/99 17:07	8.0	77.7	871.3	39.1	19	17	12:47:09	7	8.0	50.1		44.5			5	8.0	50.1		29.0				157
12/21/99 18:58	12/21/99 19:05	7.2	45.2	872.0	35.9	19	17	14:42:48	8	7.2	44.5		51.7			6	7.2	44.5		36.2				157
12/21/99 21:00	12/21/99 21:02	2.5	21.5	881.2	29.7	19	17	16:41:32	9	2.5	13.4	9	54.2	54.17	331.7	7	2.5	13.4	7	38.7	38.67	234.9	146.92	157
12/22/99 5:00	12/22/99 5:06	6.2	33.9	872.6	11.1	20	18	0:29:20	1	6.2	37.9		6.2			0								161
12/22/99 6:58	12/22/99 7:06	8.2	79.2	885.8	13.4	20	18	2:24:01	2	8.2	51.2		14.3			0				0.0				161
12/22/99 8:56	12/22/99 9:04	7.3	47.1	877.9	18.4	20	18	4:19:01	3	7.3	45.6		21.7			0				0.0				161
12/22/99 10:54	12/22/99 10:59	5.0	27.8	882.2	24.9	20	18	6:14:02	4	5.0	30.1		26.7			1	5.0	30.1		5.0				161
12/22/99 12:51	12/22/99 12:55	3.7	23.6	879.9	31.6	20	18	8:07:54	5	3.7	21.2		30.3			2	3.7	21.2		8.7				161
12/22/99 14:47	12/22/99 14:52	5.3	29.7	871.8	37.0	20	18	10:00:28	6	5.3	32.3		35.7			3	5.3	32.3		14.0				161
12/22/99 16:43	12/22/99 16:51	7.5	53.5	868.5	39.3	20	18	11:53:22	7	7.5	46.7		43.2			4	7.5	46.7		21.5				161
12/22/99 18:41	12/22/99 18:49	8.0	68.4	882.0	37.9	20	18	13:47:53	8	8.0	50.1		51.2			5	8.0	50.1		29.5				161
12/22/99 20:41	12/22/99 20:47	5.5	29.7	870.6	33.0	20	18	15:45:00	9	5.5	33.4		56.7			6	5.5	33.4	6	35.0	35	213.7	146.92	161
12/23/99 4:44	12/23/99 4:48	4.0	24.1	878.2	11.2	21	18	23:35:24	10	4.0	23.4	10	60.7	60.67	371.8	0				0.0				161
12/23/99 6:42	12/23/99 6:50	7.5	52.6	868.0	11.9	21	19	1:29:55	1	7.5	46.7		7.5			0								161
12/23/99 8:40	12/23/99 8:48	8.0	67.5	882.0	15.7	21	19	3:24:45	2	8.0	50.1		15.5			0				0.0				161
12/23/99 10:38	12/23/99 10:44	6.2	34.1	877.2	21.6	21	19	5:19:46	3	6.2	37.9		21.7			1	6.2	37.9		6.2				161
12/23/99 12:36	12/23/99 12:40	3.8	24.3	873.7	28.4	21	19	7:14:26	4	3.8	22.2		25.5			2	3.8	22.2		10.0				161
12/23/99 14:32	12/23/99 14:37	4.3	25.4	877.7	34.7	21	19	9:07:30	5	4.3	25.6		29.8			3	4.3	25.6		14.3				161
12/23/99 16:28	12/23/99 16:34	6.7	38.8	876.1	38.7	21	19	10:59:55	6	6.7	41.2		36.5			4	6.7	41.2		21.0				161
12/23/99 18:25	12/23/99 18:33	8.0	81.2	872.7	39.1	21	19	12:53:37	7	8.0	50.1		44.5			5	8.0	50.1		29.0				161
12/23/99 20:24	12/23/99 20:31	7.2	43.1	879.7	35.7	21	19	14:49:26	8	7.2	44.5		51.7			6	7.2	44.5		36.2				161
12/23/99 22:26	12/23/99 22:28	1.7	20.8	879.7	29.4	21	19	16:48:29	9	1.7	7.8	9	53.3	53.34	326.2	7	1.7	7.8	7	37.8	37.84	229.3	146.92	161
12/24/99 6:26	12/24/99 6:32	6.3	35.5	868.0	11.1	22	20	0:35:48	1	6.3	38.9		6.3			0								161
12/24/99 8:24	12/24/99 8:32	8.0	82.8	877.9	13.6	22	20	2:30:39	2	8.0	50.1		14.3			0				0.0				161
12/24/99 10:22	12/24/99 10:29	7.0	45.3	862.1	18.6	22	20	4:25:39	3	7.0	43.4		21.3			0				0.0				161
12/24/99 12:20	12/24/99 12:25	4.8	27.2	877.4	25.2	22	20	6:20:30	4	4.8	28.9		26.2			1	4.8	28.9		4.8				161
12/24/99 14:17	12/24/99 14:21	3.7	23.7	877.9	31.9	22	20	8:14:22	5	3.7	21.2		29.8			2	3.7	21.2		8.5				161
12/24/99 16:13	12/24/99 16:18	5.7	30.4	880.1	37.2	22	20	10:06:47	6	5.7	34.5		35.5			3	5.7	34.5		14.2				161
12/24/99 18:09	12/24/99 18:16	7.5	55.8	862.6	39.4	22	20	11:59:50	7	7.5	46.7		43.0			4	7.5	46.7		21.7				161
12/24/99 20:07	12/24/99 20:15	7.8	65.0	867.2	37.8	22	20	13:54:31	8	7.8	49.0		50.8			5	7.8	49.0		29.5				161
12/24/99 22:07	12/24/99 22:12	5.3	28.5	879.9	32.7	22	20	15:51:38	9	5.3	32.3		56.2			6	5.3	32.3	6	34.8	34.83	212.6	146.92	161
12/25/99 6:10	12/25/99 6:15	4.3	25.1	878.7	11.1	23	20	23:41:52	10	4.3	25.6	10	60.5	60.49	370.6	0				0.0				161
12/25/99 8:08	12/25/99 8:16	7.7	55.3	876.6	12.0	23	21	1:36:23	1	7.7	47.9		7.7			0								161
12/25/99 10:06	12/25/99 10:14	7.8	64.5	885.1	16.0	23	21	3:31:23	2	7.8	49.0		15.5			0				0.0				161
12/25/99 12:04	12/25/99 12:10	6.2	33.1	883.7	21.9	23	21	5:26:14	3	6.2	37.9		21.7			1	6.2	37.9		6.2				161
12/25/99 14:02	12/25/99 14:06	3.8	24.1	881.6	28.7	23	21	7:20:45	4	3.8	22.2		25.5			2	3.8	22.2		10.0				161
12/25/99 15:58	12/25/99 16:02	4.5	25.8	877.7	35.0	23	21	9:13:48	5	4.5	26.7		30.0			3	4.5	26.7		14.5				161
12/25/99 17:54	12/25/99 18:00	6.7	40.2	863.4	38.8	23	21	11:06:23	6	6.7	41.2		36.7			4	6.7	41.2		21.2				161
12/25/99 19:50	12/25/99 19:58	8.0	84.7	875.4	39.0	23	21	13:00:05	7	8.0	50.1		44.7			5	8.0	50.1		29.2				161
12/25/99 21:50	12/25/99 21:57	7.0	41.1	877.1	35.5	23	21	14:56:04	8	7.0	43.4		51.7			6	7.0	43.4		36.2				161
12/25/99 23:53	12/25/99 23:53	0.3	20.0	882.0	29.1	23	21	16:55:46	8	0.0	0.0	8	51.7	51.67	318.4	6	0.0	0.0	6	36.2	36.17	221.5	146.92	161
12/26/99 7:52	12/26/99 7:58	6.5	37.1	864.7	11.2	24	22	0:42:17	1	6.5	40.1		6.5			0								161
12/26/99 9:50	12/26/99 9:58	8.0	86.7	871.3	13.8	24	22	2:37:07	2	8.0	50.1		14.5			0				0.0				161
12/26/99 11:48	12/26/99 11:55	7.0	43.6	873.2	18.9	24	22	4:32:07	3	7.0	43.4		21.5			0				0.0				161
12/26/99 13:46	12/26/99 13:51	4.7	26.8	873.1	25.5	24	22	6:26:58	4	4.7	27.8		26.2			1	4.7	27.8		4.7				161
12/26/99 15:43	12/26/99 15:47	3.7	23.8	879.9	32.2	24	22	8:20:40	5	3.7	21.2		29.8			2	3.7	21.2		8.3				161
12/26/99 17:38	12/26/99 17:44	5.8	31.2	883.7	37.4	24	22	10:13:05	6	5.8	35.6		35.7			3	5.8	35.6		14.2				161
12/26/99 19:35	12/26/99 19:42	7.7	58.3	882.1	39.4	24	22	12:06:08	7	7.7	47.9		43.3			4	7.7	47.9		21.8				161
12/26/99 21:33	12/26/99 21:40	7.8	61.9	881.4	37.6	24	22	14:00:59	8	7.8	49.0		51.2			5	7.8	49.0		29.7				161
12/26/99 23:33	12/26/99 23:38	5.0	27.4	872.9	32.4	24	22	15:58:25	9	5.0	30.1		56.2			6	5.0	30.1	6	34.7	34.67	211.5	146.92	161
12/27/99 7:36	12/27/99 7:41	4.7	26.1	882.0	11.1	25	22	23:48:20	10	4.7	27.8	10	60.8	60.84	372.9	0				0.0				161
12/27/99 9:34	12/27/99 9:42	7.8	58.2	886.8	12.1	25	23	1:42:51	1	7.8	49.0		7.8			0								161
12/27/99 11:32	12/27/99 11:40	7.7	61.7	863.5	16.2	25	23	3:37:51	2	7.7	47.9		15.5			0				0.0				161
12/27/99 13:30	12/27/99 13:36	5.8	32.2	876.3	22.2	25	23	5:32:52	3	5.8	35.6		21.3			1	5.8	35.6		5.8				161
12/27/99 15:28	12/27/99 15:31	3.8	23.9	878.9	29.0	25	23	7:27:13	4	3.8	22.2		25.2			2	3.8	22.2		9.7				161
12/27/99 17:24	12/27/99 17:28	4.7	26.2	880.3	35.2	25	23	9:20:07	5	4.7	27.8		29.8			3	4.7	27.8		14.3				161
12/27/99 19:19	12/27/99 19:26	7.0	41.6	881.3	38.9	25	23	11:12:41	6	7.0	43.4		36.8			4	7.0	43.4		21.3				161
12/27/99 21:16	12/27/99 21:24	8.2	87.4	880.7	38.9	25	23	13:06:33	7	8.2	51.2		45.0			5	8.2	51.2		29.5				161
12/27/99 23:16	12/27/99 23:22	6.8	39.3	875.0	35.2	25	23	15:02:42	8	6.8	42.3	8	51.8	51.83	319.4	6	6.8	42.3	6	36.3	36.33	222.6	146.92	161
12/28/99 9:18	12/28/99 9:25	6.8	38.8	886.1	11.2	26	24	0:48:45	1	6.8	42.3		6.8			0								161
12/28/99 11:16	12/28/99 11:24	8.0	89.5	865.9	13.9	26	24	2:43:35	2	8.0	50.1		14.8			0				0.0				161
12/28/99 13:14	12/28/99 13:21	7.0	42.0	884.8	19.2	26	24	4:38:35	3	7.0	43.4		21.8			0				0.0				161
12/28/99 15:12	12/28/99 15:16	4.5	26.3	869.2	25.8	26	24	6:33:26	4	4.5	26.7		26.3			1	4.5	26.7		4.5				161
12/28/99 17:09	12/28/99 17:12	3.7	23.9	872.3	32.4	26	24	8:27:08	5	3.7	21.2		30.0			2	3.7	21.2		8.2				161
12/28/99 19:04	12/28/99 19:10	5.8	32.0	874.1	37.5	26	24	10:19:33	6	5.8	35.6		35.8			3	5.8	35.6		14.0				161
12/28/99 21:00	12/28/99 21:08	7.8	61.0	878.5	39.3	26	24	12:12:36	7	7.8	49.0		43.7			4	7.8	49.0		21.8				161
12/28/99 22:59	12/28/99 23:06	7.7	58.9	869.5	37.4	26	24	14:07:37	8	7.7	47.9		51.3			5	7.7	47.9		29.5				161
12/29/99 0:59	12/29/99 1:04	4.8	26.3	883.6	32.1	27	24	16:05:03	9	4.8	28.9		56.2			6	4.8	28.9	6	34.3	34.33	209.2	146.92	161
12/29/99 9:02	12/29/99 9:07	4.8	27.1	870.6	11.0	27	24	23:54:48	10	4.8	28.9	10	61.0	60.99	373.9	0				0.0				161
12/29/99 11:00	12/29/99 11:07	7.8	61.1	872.5	12.2	27	25	1:49:19	1	7.8	49.0		7.8			0								161
12/29/99 12:58	12/29/99 13:05	7.7	59.0	869.4	16.4	27	25	3:44:19	2	7.7	47.9		15.5			0				0.0				161
12/29/99 14:56	12/29/99 15:02	5.7	31.4	869.7	22.5	27	25	5:39:20	3	5.7	34.5		21.2			1	5.7	34.5		5.7				161
12/29/99 16:53	12/29/99 16:57	3.7	23.8	875.9	29.3	27	25	7:33:41	4	3.7	21.2		24.8			2	3.7	21.2		9.3				161
12/29/99 18:49	12/29/99 18:54	4.7	26.6	876.7	35.4	27	25	9:26:35	5	4.7	27.8		29.5			3	4.7	27.8		14.0				161
12/29/99 20:45	12/29/99 20:52	7.0	43.2	876.4	38.9	27	25	11:19:09	6	7.0	43.4		36.5			4	7.0	43.4		21.0				161
12/29/99 22:42	12/29/99 22:50	8.2	87.1	884.4	38.8	27	25	13:13:01	7	8.2	51.2		44.7			5	8.2	51.2		29.2				161
12/30/99 0:42	12/30/99 0:48	6.7	37.5	873.3	35.0	28	25	15:09:19	8	6.7	41.2	8	51.4	51.35	316.2	6	6.7	41.2	6	35.9	35.85	219.4	146.92	161

Rise	Set	Pass Duration [min.]	Max.El at lander [deg.]	Max.Range [km]	MaxSun.El [de.g]	Day # [ET]	Sol #	LMST	Pass # that Sol	D/L Pass duration [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass	Max # passes that Sol	Cume D/L comm time that sol [min.]	Total D/L comm time/sol [min.]	D/L Volume/sol [Mbit]	Pass # sun el > 20˚	Pass dur. sun el > 20˚ [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass [sun el > 20˚]	Max # passes sun el > 20˚	Cume D/L time sun el > 20˚ [min.]	D/L time/sol sun el > 20˚ [min.]	D/L Volume/sol, sun el > 20 deg. [Mbit]	D/L Volume/sol, 4 passes, 6 min/pass [Mbit]	Mars98 Orbiter Daily Science D/L volume [Mbits]
12/30/99 10:44	12/30/99 10:51	7.0	40.7	885.9	11.2	28	26	0:55:13	1	7.0	43.4		7.0			0								161
12/30/99 12:42	12/30/99 12:50	8.0	85.7	871.1	14.1	28	26	2:50:03	2	8.0	50.1		15.0			0				0.0				161
12/30/99 14:40	12/30/99 14:47	6.8	40.5	872.8	19.4	28	26	4:45:03	3	6.8	42.3		21.8			0				0.0				161
12/30/99 16:38	12/30/99 16:42	4.5	25.9	881.0	26.0	28	26	6:39:54	4	4.5	26.7		26.3			1	4.5	26.7		4.5				161
12/30/99 18:34	12/30/99 18:38	3.8	24.1	877.8	32.7	28	26	8:33:27	5	3.8	22.2		30.2			2	3.8	22.2		8.3				161
12/30/99 20:30	12/30/99 20:36	6.0	32.9	876.4	37.7	28	26	10:25:51	6	6.0	36.7		36.2			3	6.0	36.7		14.3				161
12/30/99 22:26	12/30/99 22:34	7.8	63.7	872.7	39.3	28	26	12:19:05	7	7.8	49.0		44.0			4	7.8	49.0		22.2				161
12/31/99 0:24	12/31/99 0:32	7.8	56.0	886.1	37.2	29	26	14:14:05	8	7.8	49.0		51.8			5	7.8	49.0		30.0				161
12/31/99 2:25	12/31/99 2:30	4.5	25.3	879.7	31.8	29	26	16:11:51	9	4.5	26.7	9	56.3	56.32	346.1	6	4.5	26.7	6	34.5	34.49	210.3	146.92	161
12/31/99 10:28	12/31/99 10:33	5.3	28.2	880.2	11.0	29	27	0:01:06	1	5.3	32.3		5.3			0								161
12/31/99 12:25	12/31/99 12:33	8.0	64.3	884.1	12.3	29	27	1:55:47	2	8.0	50.1		13.3			0				0.0				161
12/31/99 14:24	12/31/99 14:31	7.7	56.4	875.1	16.6	29	27	3:50:47	3	7.7	47.9		21.0			0				0.0				161
12/31/99 16:22	12/31/99 16:27	5.5	30.6	869.6	22.8	29	27	5:45:48	4	5.5	33.4		26.5			1	5.5	33.4		5.5				161
12/31/99 18:19	12/31/99 18:23	3.7	23.7	878.4	29.6	29	27	7:40:09	5	3.7	21.2		30.2			2	3.7	21.2		9.2				161
12/31/99 20:15	12/31/99 20:20	4.8	27.1	875.7	35.6	29	27	9:32:53	6	4.8	28.9		35.0			3	4.8	28.9		14.0				161
12/31/99 22:11	12/31/99 22:18	7.2	44.8	877.7	39.0	29	27	11:25:27	7	7.2	44.5		42.2			4	7.2	44.5		21.2				161
1/1/00 0:08	1/1/00 0:16	8.0	83.9	869.5	38.7	30	27	13:19:39	8	8.0	50.1		50.2			5	8.0	50.1		29.2				163
1/1/00 2:08	1/1/00 2:14	6.5	35.8	873.1	34.7	30	27	15:15:57	9	6.5	40.1		56.7			6	6.5	40.1	6	35.7	35.67	218.2	146.92	163
1/1/00 10:13	1/1/00 10:14	1.5	20.6	882.0	11.5	30	27	23:07:59	10	1.5	6.7	10	58.2	58.17	355.1	0				0.0				163
1/1/00 12:09	1/1/00 12:16	7.0	42.6	867.0	11.3	30	28	1:01:41	1	7.0	43.4		7.0			0								163
1/1/00 14:07	1/1/00 14:16	8.2	82.0	887.3	14.2	30	28	2:56:32	2	8.2	51.2		15.2			0				0.0				163
1/1/00 16:06	1/1/00 16:12	6.8	39.1	884.9	19.6	30	28	4:51:32	3	6.8	42.3		22.0			0				0.0				163
1/1/00 18:04	1/1/00 18:08	4.3	25.5	876.6	26.3	30	28	6:46:22	4	4.3	25.6		26.3			1	4.3	25.6		4.3				163
1/1/00 20:00	1/1/00 20:04	3.8	24.3	876.1	32.9	30	28	8:39:55	5	3.8	22.2		30.2			2	3.8	22.2		8.2				163
1/1/00 21:56	1/1/00 22:02	6.2	33.9	884.2	37.8	30	28	10:32:10	6	6.2	37.9		36.3			3	6.2	37.9		14.3				163
1/1/00 23:52	1/2/00 0:00	7.8	66.7	868.9	39.3	30	28	12:25:33	7	7.8	49.0		44.2			4	7.8	49.0		22.2				163
1/2/00 1:50	1/2/00 1:58	7.7	53.3	877.0	37.0	31	28	14:20:43	8	7.7	47.9		51.8			5	7.7	47.9		29.8				163
1/2/00 3:52	1/2/00 3:56	4.0	24.3	878.1	31.4	31	28	16:18:38	9	4.0	23.4	9	55.8	55.83	342.8	6	4.0	23.4	6	33.8	33.83	205.9	146.92	163
1/2/00 11:53	1/2/00 11:59	5.5	29.4	878.7	10.9	31	29	0:07:35	1	5.5	33.4		5.5			0								163
1/2/00 13:51	1/2/00 13:59	7.8	67.6	870.8	12.4	31	29	2:02:25	2	7.8	49.0		13.3			0				0.0				163
1/2/00 15:49	1/2/00 15:57	7.7	54.1	880.7	16.8	31	29	3:57:16	3	7.7	47.9		21.0			0				0.0				163
1/2/00 17:47	1/2/00 17:53	5.5	29.9	878.0	23.0	31	29	5:52:16	4	5.5	33.4		26.5			1	5.5	33.4		5.5				163
1/2/00 19:45	1/2/00 19:48	3.7	23.7	881.6	29.8	31	29	7:46:28	5	3.7	21.2		30.2			2	3.7	21.2		9.2				163
1/2/00 21:41	1/2/00 21:46	5.0	27.6	876.5	35.8	31	29	9:39:12	6	5.0	30.1		35.2			3	5.0	30.1		14.2				163
1/2/00 23:36	1/2/00 23:44	7.2	46.6	867.1	39.0	31	29	11:31:56	7	7.2	44.5		42.3			4	7.2	44.5		21.3				163
1/3/00 1:34	1/3/00 1:42	8.0	80.3	869.9	38.5	32	29	13:26:08	8	8.0	50.1		50.3			5	8.0	50.1		29.3				163
1/3/00 3:33	1/3/00 3:40	6.3	34.3	877.2	34.4	32	29	15:22:36	9	6.3	38.9		56.7			6	6.3	38.9	6	35.7	35.67	218.2	146.92	163
1/3/00 11:38	1/3/00 11:40	2.3	21.3	879.5	11.4	32	29	23:14:08	10	2.3	12.2	10	59.0	59	360.6	0				0.0				163
1/3/00 13:35	1/3/00 13:42	7.2	44.7	869.6	11.3	32	30	1:08:10	1	7.2	44.5		7.2			0								163
1/3/00 15:33	1/3/00 15:41	8.0	78.3	885.5	14.4	32	30	3:03:10	2	8.0	50.1		15.2			0				0.0				163
1/3/00 17:31	1/3/00 17:38	6.5	37.8	874.0	19.9	32	30	4:58:10	3	6.5	40.1		21.7			0				0.0				163
1/3/00 19:29	1/3/00 19:33	4.2	25.2	872.4	26.6	32	30	6:52:51	4	4.2	24.5		25.8			1	4.2	24.5		4.2				163
1/3/00 21:26	1/3/00 21:30	4.0	24.5	877.8	33.1	32	30	8:46:14	5	4.0	23.4		29.8			2	4.0	23.4		8.2				163
1/3/00 23:21	1/3/00 23:27	6.2	34.9	870.2	37.9	32	30	10:38:39	6	6.2	37.9		36.0			3	6.2	37.9		14.3				163
1/4/00 1:18	1/4/00 1:26	7.8	69.8	866.5	39.2	33	30	12:32:02	7	7.8	49.0		43.8			4	7.8	49.0		22.2				163
1/4/00 3:16	1/4/00 3:24	7.5	50.7	870.2	36.8	33	30	14:27:21	8	7.5	46.7		51.3			5	7.5	46.7		29.7				163
1/4/00 5:18	1/4/00 5:21	3.7	23.4	878.7	31.1	33	30	16:25:27	9	3.7	21.2	9	55.0	55.01	337.3	6	3.7	21.2	6	33.3	33.34	202.6	146.92	163
1/4/00 13:19	1/4/00 13:25	5.8	30.7	878.5	10.9	33	31	0:14:04	1	5.8	35.6		5.8			0								163
1/4/00 15:17	1/4/00 15:25	8.0	70.9	886.8	12.5	33	31	2:08:54	2	8.0	50.1		13.8			0				0.0				163
1/4/00 17:15	1/4/00 17:23	7.3	51.8	861.1	17.0	33	31	4:03:54	3	7.3	45.6		21.2			0				0.0				163
1/4/00 19:13	1/4/00 19:19	5.3	29.2	874.8	23.3	33	31	5:58:45	4	5.3	32.3		26.5			1	5.3	32.3		5.3				163
1/4/00 21:11	1/4/00 21:14	3.7	23.6	877.8	30.1	33	31	7:52:57	5	3.7	21.2		30.2			2	3.7	21.2		9.0				163
1/4/00 23:06	1/4/00 23:11	5.2	28.2	881.3	35.9	33	31	9:45:31	6	5.2	31.2		35.3			3	5.2	31.2		14.2				163
1/5/00 1:02	1/5/00 1:09	7.3	48.5	883.2	39.0	34	31	11:38:15	7	7.3	45.6		42.7			4	7.3	45.6		21.5				163
1/5/00 3:00	1/5/00 3:08	8.0	76.5	878.7	38.4	34	31	13:32:36	8	8.0	50.1		50.7			5	8.0	50.1		29.5				163
1/5/00 4:59	1/5/00 5:06	6.2	32.8	882.5	34.1	34	31	15:29:14	9	6.2	37.9		56.8			6	6.2	37.9	6	35.7	35.67	218.2	146.92	163
1/5/00 13:04	1/5/00 13:07	3.0	22.1	882.2	11.3	34	31	23:20:27	10	3.0	16.7	10	59.8	59.83	366.2	0				0.0				163
1/5/00 15:01	1/5/00 15:08	7.3	46.9	872.6	11.3	34	32	1:14:38	1	7.3	45.6		7.3			0								163
1/5/00 16:59	1/5/00 17:07	8.0	75.0	884.9	14.5	34	32	3:09:39	2	8.0	50.1		15.3			0				0.0				163
1/5/00 18:57	1/5/00 19:04	6.3	36.6	864.2	20.1	34	32	5:04:39	3	6.3	38.9		21.7			1	6.3	38.9		6.3				163
1/5/00 20:55	1/5/00 20:59	4.0	24.9	869.5	26.8	34	32	6:59:20	4	4.0	23.4		25.7			2	4.0	23.4		10.3				163
1/5/00 22:51	1/5/00 22:56	4.2	24.7	879.2	33.3	34	32	8:52:33	5	4.2	24.5		29.8			3	4.2	24.5		14.5				163
1/6/00 0:47	1/6/00 0:53	6.3	36.0	879.0	37.9	35	32	10:44:58	6	6.3	38.9		36.2			4	6.3	38.9		20.8				163
1/6/00 2:44	1/6/00 2:51	7.8	73.1	865.3	39.1	35	32	12:38:30	7	7.8	49.0		44.0			5	7.8	49.0		28.7				163
1/6/00 4:42	1/6/00 4:50	7.3	48.3	866.8	36.5	35	32	14:34:00	8	7.3	45.6		51.3			6	7.3	45.6		36.0				163
1/6/00 6:44	1/6/00 6:47	3.2	22.6	881.3	30.7	35	32	16:32:15	9	3.2	17.8	9	54.5	54.49	333.8	7	3.2	17.8	7	39.2	39.16	238.1	146.92	163
1/6/00 14:45	1/6/00 14:51	6.0	32.0	877.3	10.8	35	33	0:20:32	1	6.0	36.7		6.0			0								163
1/6/00 16:43	1/6/00 16:51	8.0	74.5	875.9	12.6	35	33	2:15:23	2	8.0	50.1		14.0			0				0.0				163
1/6/00 18:41	1/6/00 18:48	7.3	49.7	869.9	17.2	35	33	4:10:23	3	7.3	45.6		21.3			0				0.0				163
1/6/00 20:39	1/6/00 20:44	5.2	28.5	877.0	23.5	35	33	6:05:14	4	5.2	31.2		26.5			1	5.2	31.2		5.2				163
1/6/00 22:36	1/6/00 22:40	3.5	23.6	871.9	30.3	35	33	7:59:25	5	3.5	20.0		30.0			2	3.5	20.0		8.7				163
1/7/00 0:32	1/7/00 0:37	5.2	28.8	870.5	36.0	36	33	9:52:00	6	5.2	31.2		35.2			3	5.2	31.2		13.8				163
1/7/00 2:28	1/7/00 2:35	7.5	50.6	881.4	39.0	36	33	11:44:44	7	7.5	46.7		42.7			4	7.5	46.7		21.3				163
1/7/00 4:26	1/7/00 4:33	7.8	72.9	860.7	38.2	36	33	13:39:15	8	7.8	49.0		50.5			5	7.8	49.0		29.2				163
1/7/00 6:26	1/7/00 6:31	5.8	31.4	871.4	33.7	36	33	15:36:02	9	5.8	35.6		56.3			6	5.8	35.6	6	35.0	35	213.7	146.92	163
1/7/00 14:29	1/7/00 14:33	3.3	22.9	878.3	11.1	36	33	23:26:55	10	3.3	18.9	10	59.7	59.66	365.0	0				0.0				163
1/7/00 16:27	1/7/00 16:34	7.5	49.3	876.0	11.3	36	34	1:21:07	1	7.5	46.7		7.5			0								163
1/7/00 18:25	1/7/00 18:33	8.0	71.7	885.4	14.7	36	34	3:16:07	2	8.0	50.1		15.5			0				0.0				163
1/7/00 20:23	1/7/00 20:29	6.3	35.5	877.9	20.3	36	34	5:11:08	3	6.3	38.9		21.8			1	6.3	38.9		6.3				163
1/7/00 22:21	1/7/00 22:25	4.0	24.6	878.3	27.0	36	34	7:05:48	4	4.0	23.4		25.8			2	4.0	23.4		10.3				163

Rise	Set	Pass Duration [min.]	Max.El at lander [deg.]	Max.Range [km]	MaxSun.El [de.g]	Day # [ET]	Sol #	LMST	Pass # that Sol	D/L Pass duration [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass	Max # passes that Sol	Cume D/L comm time that sol [min.]	Total D/L comm time/sol [min.]	D/L Volume/sol [Mbit]	Pass # sun el > 20˚	Pass dur. sun el > 20˚ [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass [sun el > 20˚]	Max # passes sun el > 20˚	Cume D/L time sun el > 20˚ [min.]	D/L time/sol sun el > 20˚ [min.]	D/L Volume/sol, sun el > 20 deg. [Mbit]	D/L Volume/sol, 4 passes, 6 min/pass [Mbit]	Mars98 Orbiter Daily Science D/L volume [Mbits]
1/8/00 0:17	1/8/00 0:21	4.2	25.0	880.2	33.5	37	34	8:59:02	5	4.2	24.5		30.0			3	4.2	24.5		14.5				163
1/8/00 2:13	1/8/00 2:19	6.5	37.1	877.4	38.0	37	34	10:51:26	6	6.5	40.1		36.5			4	6.5	40.1		21.0				163
1/8/00 4:09	1/8/00 4:17	8.0	76.5	877.5	39.0	37	34	12:44:59	7	8.0	50.1		44.5			5	8.0	50.1		29.0				163
1/8/00 6:08	1/8/00 6:15	7.3	46.0	884.7	36.2	37	34	14:40:28	8	7.3	45.6		51.8			6	7.3	45.6		36.3				163
1/8/00 8:10	1/8/00 8:13	2.7	21.8	880.1	30.3	37	34	16:39:13	9	2.7	14.5	9	54.5	54.5	333.9	7	2.7	14.5	7	39.0	39	237.1	146.92	163
1/8/00 16:11	1/8/00 16:17	6.2	33.4	877.5	10.7	37	35	0:27:01	1	6.2	37.9		6.2			0								163
1/8/00 18:09	1/8/00 18:17	8.0	78.1	869.4	12.7	37	35	2:21:51	2	8.0	50.1		14.2			0				0.0				163
1/8/00 20:07	1/8/00 20:14	7.3	47.7	879.4	17.3	37	35	4:16:52	3	7.3	45.6		21.5			0				0.0				163
1/8/00 22:05	1/8/00 22:10	5.2	28.0	881.4	23.7	37	35	6:11:42	4	5.2	31.2		26.7			1	5.2	31.2		5.2				163
1/9/00 0:02	1/9/00 0:06	3.7	23.6	879.2	30.5	38	35	8:05:44	5	3.7	21.2		30.3			2	3.7	21.2		8.8				163
1/9/00 1:58	1/9/00 2:03	5.3	29.5	872.5	36.2	38	35	9:58:19	6	5.3	32.3		35.7			3	5.3	32.3		14.2				163
1/9/00 3:54	1/9/00 4:01	7.5	52.7	875.9	38.9	38	35	11:51:12	7	7.5	46.7		43.2			4	7.5	46.7		21.7				163
1/9/00 5:51	1/9/00 5:59	8.0	69.6	876.5	38.0	38	35	13:45:43	8	8.0	50.1		51.2			5	8.0	50.1		29.7				163
1/9/00 7:52	1/9/00 7:57	5.7	30.1	876.4	33.4	38	35	15:42:40	9	5.7	34.5		56.8			6	5.7	34.5	6	35.3	35.34	216.0	146.92	163
1/9/00 15:55	1/9/00 15:59	3.8	23.8	877.2	11.0	38	35	23:33:14	10	3.8	22.2	10	60.7	60.67	371.8	0				0.0				163
1/9/00 17:53	1/9/00 18:00	7.7	51.8	879.9	11.3	38	36	1:27:36	1	7.7	47.9		7.7			0								163
1/9/00 19:51	1/9/00 19:59	8.0	68.5	887.1	14.8	38	36	3:22:36	2	8.0	50.1		15.7			0				0.0				163
1/9/00 21:49	1/9/00 21:55	6.2	34.4	871.3	20.5	38	36	5:17:36	3	6.2	37.9		21.8			1	6.2	37.9		6.2				163
1/9/00 23:47	1/9/00 23:51	4.0	24.4	881.4	27.2	38	36	7:12:07	4	4.0	23.4		25.8			2	4.0	23.4		10.2				163
1/10/00 1:43	1/10/00 1:47	4.3	25.3	880.9	33.7	39	36	9:05:21	5	4.3	25.6		30.2			3	4.3	25.6		14.5				163
1/10/00 3:38	1/10/00 3:45	6.7	38.4	875.5	38.0	39	36	10:57:45	6	6.7	41.2		36.8			4	6.7	41.2		21.2				163
1/10/00 5:35	1/10/00 5:43	8.0	80.0	871.6	38.8	39	36	12:51:28	7	8.0	50.1		44.8			5	8.0	50.1		29.2				163
1/10/00 7:34	1/10/00 7:41	7.2	43.8	881.4	35.9	39	36	14:47:07	8	7.2	44.5		52.0			6	7.2	44.5		36.3				163
1/10/00 9:36	1/10/00 9:38	2.0	21.0	881.4	29.9	39	36	16:46:10	9	2.0	10.0	9	54.0	54.01	330.6	7	2.0	10.0	7	38.3	38.34	232.7	146.92	163
1/10/00 17:37	1/10/00 17:43	6.5	34.9	881.5	10.6	39	37	0:33:30	1	6.5	40.1		6.5			0								163
1/10/00 19:35	1/10/00 19:43	8.2	81.7	886.4	12.7	39	37	2:28:20	2	8.2	51.2		14.7			0				0.0				163
1/10/00 21:33	1/10/00 21:40	7.2	45.9	875.9	17.5	39	37	4:23:20	3	7.2	44.5		21.8			0				0.0				163
1/10/00 23:31	1/10/00 23:36	5.0	27.4	880.2	23.9	39	37	6:18:11	4	5.0	30.1		26.8			1	5.0	30.1		5.0				163
1/11/00 1:28	1/11/00 1:32	3.7	23.7	879.4	30.7	40	37	8:12:13	5	3.7	21.2		30.5			2	3.7	21.2		8.7				166
1/11/00 3:23	1/11/00 3:29	5.5	30.2	878.0	36.3	40	37	10:04:37	6	5.5	33.4		36.0			3	5.5	33.4		14.2				166
1/11/00 5:19	1/11/00 5:27	7.7	55.0	885.0	38.9	40	37	11:57:31	7	7.7	47.9		43.7			4	7.7	47.9		21.8				166
1/11/00 7:17	1/11/00 7:25	8.0	66.2	884.6	37.7	40	37	13:52:12	8	8.0	50.1		51.7			5	8.0	50.1		29.8				166
1/11/00 9:18	1/11/00 9:23	5.5	28.9	885.1	33.0	40	37	15:49:19	9	5.5	33.4		57.2			6	5.5	33.4	6	35.3	35.34	216.0	146.92	166
1/11/00 17:21	1/11/00 17:25	4.2	24.7	876.5	10.8	40	37	23:39:43	10	4.2	24.5	10	61.4	61.35	376.3	0				0.0				166
1/11/00 19:19	1/11/00 19:26	7.5	54.4	861.4	11.3	40	38	1:34:14	1	7.5	46.7		7.5			0								166
1/11/00 21:17	1/11/00 21:24	7.8	65.5	877.7	14.9	40	38	3:29:05	2	7.8	49.0		15.3			0				0.0				166
1/11/00 23:15	1/11/00 23:21	6.2	33.4	883.5	20.7	40	38	5:24:05	3	6.2	37.9		21.5			1	6.2	37.9		6.2				166
1/12/00 1:12	1/12/00 1:16	3.8	24.2	879.4	27.4	41	38	7:18:36	4	3.8	22.2		25.3			2	3.8	22.2		10.0				166
1/12/00 3:09	1/12/00 3:13	4.5	25.7	881.1	33.8	41	38	9:11:39	5	4.5	26.7		29.8			3	4.5	26.7		14.5				166
1/12/00 5:04	1/12/00 5:11	6.7	39.7	868.3	38.0	41	38	11:04:14	6	6.7	41.2		36.5			4	6.7	41.2		21.2				166
1/12/00 7:01	1/12/00 7:09	8.0	83.7	868.4	38.7	41	38	12:57:56	7	8.0	50.1		44.5			5	8.0	50.1		29.2				166
1/12/00 9:00	1/12/00 9:07	7.0	41.8	879.5	35.6	41	38	14:53:45	8	7.0	43.4		51.5			6	7.0	43.4		36.2				166
1/12/00 11:03	1/12/00 11:04	1.0	20.3	882.8	29.4	41	38	16:53:08	9	1.0	3.3	9	52.5	52.5	320.6	7	1.0	3.3	7	37.2	37.17	224.9	146.92	166
1/12/00 19:02	1/12/00 19:09	6.7	36.5	879.3	10.5	41	39	0:39:58	1	6.7	41.2		6.7			0								166
1/12/00 21:00	1/12/00 21:09	8.2	85.0	880.3	12.8	41	39	2:34:49	2	8.2	51.2		14.8			0				0.0				166
1/12/00 22:59	1/12/00 23:06	7.2	44.1	881.1	17.7	41	39	4:29:49	3	7.2	44.5		22.0			0				0.0				166
1/13/00 0:57	1/13/00 1:01	4.8	26.9	881.3	24.1	42	39	6:24:40	4	4.8	28.9		26.8			1	4.8	28.9		4.8				166
1/13/00 2:54	1/13/00 2:57	3.7	23.8	879.4	30.9	42	39	8:18:32	5	3.7	21.2		30.5			2	3.7	21.2		8.5				166
1/13/00 4:49	1/13/00 4:55	5.5	30.9	863.8	36.3	42	39	10:11:06	6	5.5	33.4		36.0			3	5.5	33.4		14.0				166
1/13/00 6:45	1/13/00 6:53	7.7	57.5	878.4	38.8	42	39	12:04:00	7	7.7	47.9		43.7			4	7.7	47.9		21.7				166
1/13/00 8:43	1/13/00 8:51	7.8	62.9	870.7	37.5	42	39	13:58:50	8	7.8	49.0		51.5			5	7.8	49.0		29.5				166
1/13/00 10:44	1/13/00 10:49	5.2	27.7	876.7	32.6	42	39	15:56:07	9	5.2	31.2		56.7			6	5.2	31.2	6	34.7	34.67	211.5	146.92	166
1/13/00 18:47	1/13/00 18:51	4.5	25.7	878.8	10.6	42	39	23:46:12	10	4.5	26.7	10	61.2	61.18	375.2	0				0.0				166
1/13/00 20:44	1/13/00 20:52	7.7	57.2	870.9	11.3	42	40	1:40:43	1	7.7	47.9		7.7			0								166
1/13/00 22:43	1/13/00 22:50	7.7	62.6	865.7	15.0	42	40	3:35:43	2	7.7	47.9		15.3			0				0.0				166
1/14/00 0:41	1/14/00 0:47	6.0	32.5	878.6	20.9	43	40	5:30:34	3	6.0	36.7		21.3			1	6.0	36.7		6.0				166
1/14/00 2:38	1/14/00 2:42	3.8	24.0	877.2	27.6	43	40	7:25:05	4	3.8	22.2		25.2			2	3.8	22.2		9.8				166
1/14/00 4:34	1/14/00 4:39	4.7	26.1	881.0	34.0	43	40	9:17:58	5	4.7	27.8		29.8			3	4.7	27.8		14.5				166
1/14/00 6:30	1/14/00 6:37	6.8	41.1	874.4	38.0	43	40	11:10:33	6	6.8	42.3		36.7			4	6.8	42.3		21.3				166
1/14/00 8:27	1/14/00 8:35	8.0	87.2	871.8	38.5	43	40	13:04:25	7	8.0	50.1		44.7			5	8.0	50.1		29.3				166
1/14/00 10:26	1/14/00 10:33	7.0	39.9	880.7	35.2	43	40	15:00:24	8	7.0	43.4	8	51.7	51.67	318.4	6	7.0	43.4	6	36.3	36.33	222.6	146.92	166
1/14/00 20:28	1/14/00 20:35	6.8	38.2	880.9	10.5	43	41	0:46:27	1	6.8	42.3		6.8			0								166
1/14/00 22:26	1/14/00 22:34	8.0	88.5	873.5	12.8	43	41	2:41:27	2	8.0	50.1		14.8			0				0.0				166
1/15/00 0:25	1/15/00 0:31	6.8	42.5	861.2	17.8	44	41	4:36:27	3	6.8	42.3		21.7			0				0.0				166
1/15/00 2:23	1/15/00 2:27	4.5	26.4	868.2	24.3	44	41	6:31:18	4	4.5	26.7		26.2			1	4.5	26.7		4.5				166
1/15/00 4:19	1/15/00 4:23	3.7	23.9	873.2	31.0	44	41	8:25:00	5	3.7	21.2		29.8			2	3.7	21.2		8.2				166
1/15/00 6:15	1/15/00 6:21	5.8	31.7	879.6	36.4	44	41	10:17:25	6	5.8	35.6		35.7			3	5.8	35.6		14.0				166
1/15/00 8:11	1/15/00 8:19	7.7	60.1	872.6	38.7	44	41	12:10:29	7	7.7	47.9		43.3			4	7.7	47.9		21.7				166
1/15/00 10:09	1/15/00 10:17	7.8	59.9	885.8	37.2	44	41	14:05:19	8	7.8	49.0		51.2			5	7.8	49.0		29.5				166
1/15/00 12:10	1/15/00 12:15	4.8	26.7	878.3	32.2	44	41	16:02:55	9	4.8	28.9		56.0			6	4.8	28.9	6	34.3	34.33	209.2	146.92	166
1/15/00 20:12	1/15/00 20:17	5.0	26.8	883.5	10.4	44	41	23:52:31	10	5.0	30.1	10	61.0	60.99	373.9	0				0.0				166
1/15/00 22:10	1/15/00 22:18	7.8	60.2	882.0	11.2	44	42	1:47:11	1	7.8	49.0		7.8			0								166
1/16/00 0:08	1/16/00 0:16	7.7	59.9	870.6	15.1	45	42	3:42:12	2	7.7	47.9		15.5			0				0.0				166
1/16/00 2:07	1/16/00 2:12	5.7	31.7	869.3	21.0	45	42	5:37:12	3	5.7	34.5		21.2			1	5.7	34.5		5.7				166
1/16/00 4:04	1/16/00 4:08	3.7	23.9	874.1	27.8	45	42	7:31:33	4	3.7	21.2		24.8			2	3.7	21.2		9.3				166
1/16/00 6:00	1/16/00 6:05	4.7	26.5	880.5	34.1	45	42	9:24:27	5	4.7	27.8		29.5			3	4.7	27.8		14.0				166
1/16/00 7:56	1/16/00 8:03	6.8	42.6	862.3	38.0	45	42	11:17:01	6	6.8	42.3		36.3			4	6.8	42.3		20.8				166
1/16/00 9:53	1/16/00 10:01	8.0	87.9	876.5	38.3	45	42	13:10:54	7	8.0	50.1		44.3			5	8.0	50.1		28.8				166
1/16/00 11:52	1/16/00 11:59	6.8	38.1	880.1	34.9	45	42	15:07:02	8	6.8	42.3	8	51.2	51.17	315.0	6	6.8	42.3	6	35.7	35.67	218.2	146.92	166
1/16/00 21:54	1/16/00 22:01	6.8	40.0	874.8	10.4	45	43	0:53:05	1	6.8	42.3		6.8			0								166

Rise	Set	Pass Duration [min.]	Max.El at lander [deg.]	Max.Range [km]	MaxSun.El [de.g]	Day # [ET]	Sol #	LMST	Pass # that Sol	D/L Pass duration [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass	Max # passes that Sol	Cume D/L comm time that sol [min.]	Total D/L comm time/sol [min.]	D/L Volume/sol [Mbit]	Pass # sun el > 20˚	Pass dur. sun el > 20˚ [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass [sun el > 20˚]	Max # passes sun el > 20˚	Cume D/L time sun el > 20˚ [min.]	D/L time/sol sun el > 20˚ [min.]	D/L Volume/sol, sun el > 20 deg. [Mbit]	D/L Volume/sol, 4 passes, 6 min/pass [Mbit]	Mars98 Orbiter Daily Science D/L volume [Mbits]
1/16/00 23:52	1/17/00 0:00	8.0	87.0	869.0	12.9	45	43	2:47:56	2	8.0	50.1		14.8			0				0.0				166
1/17/00 1:50	1/17/00 1:57	6.8	41.0	873.3	17.9	46	43	4:42:56	3	6.8	42.3		21.7			0				0.0				166
1/17/00 3:48	1/17/00 3:53	4.5	26.0	880.5	24.5	46	43	6:37:47	4	4.5	26.7		26.2			1	4.5	26.7		4.5				166
1/17/00 5:45	1/17/00 5:49	3.8	24.0	877.6	31.2	46	43	8:31:19	5	3.8	22.2		30.0			2	3.8	22.2		8.3				166
1/17/00 7:41	1/17/00 7:47	6.0	32.6	876.6	36.5	46	43	10:23:44	6	6.0	36.7		36.0			3	6.0	36.7		14.3				166
1/17/00 9:37	1/17/00 9:45	7.8	62.8	880.5	38.5	46	43	12:16:57	7	7.8	49.0		43.8			4	7.8	49.0		22.2				166
1/17/00 11:35	1/17/00 11:43	7.7	56.9	874.7	36.9	46	43	14:11:58	8	7.7	47.9		51.5			5	7.7	47.9		29.8				166
1/17/00 13:36	1/17/00 13:41	4.7	25.6	882.7	31.8	46	43	16:09:34	9	4.7	27.8		56.2			6	4.7	27.8	6	34.5	34.5	210.4	146.92	166
1/17/00 21:38	1/17/00 21:43	5.2	27.9	877.1	10.3	46	43	23:58:59	10	5.2	31.2	10	61.3	61.33	376.2	0				0.0				166
1/17/00 23:36	1/17/00 23:44	7.8	63.2	869.7	11.2	46	44	1:53:40	1	7.8	49.0		7.8			0								166
1/18/00 1:34	1/18/00 1:42	7.7	57.3	876.5	15.2	47	44	3:48:40	2	7.7	47.9		15.5			0				0.0				166
1/18/00 3:32	1/18/00 3:38	5.7	30.8	883.6	21.2	47	44	5:43:41	3	5.7	34.5		21.2			1	5.7	34.5		5.7				166
1/18/00 5:30	1/18/00 5:34	3.7	23.8	878.9	28.0	47	44	7:38:02	4	3.7	21.2		24.8			2	3.7	21.2		9.3				166
1/18/00 7:26	1/18/00 7:31	4.8	27.0	879.7	34.2	47	44	9:30:46	5	4.8	28.9		29.7			3	4.8	28.9		14.2				166
1/18/00 9:21	1/18/00 9:29	7.2	44.3	878.3	37.9	47	44	11:23:20	6	7.2	44.5		36.8			4	7.2	44.5		21.3				166
1/18/00 11:19	1/18/00 11:27	8.2	84.8	882.5	38.1	47	44	13:17:22	7	8.2	51.2		45.0			5	8.2	51.2		29.5				166
1/18/00 13:18	1/18/00 13:25	6.7	36.4	882.3	34.5	47	44	15:13:40	8	6.7	41.2		51.7			6	6.7	41.2	6	36.2	36.18	221.6	146.92	166
1/18/00 21:23	1/18/00 21:24	1.2	20.3	881.5	10.9	47	44	23:05:52	9	1.2	4.5	9	52.9	52.85	322.9	0				0.0				166
1/18/00 23:20	1/18/00 23:27	7.0	42.0	875.3	10.3	47	45	0:59:34	1	7.0	43.4		7.0			0								166
1/19/00 1:18	1/19/00 1:26	8.0	83.3	868.9	12.9	48	45	2:54:25	2	8.0	50.1		15.0			0				0.0				166
1/19/00 3:16	1/19/00 3:23	6.7	39.6	870.9	18.1	48	45	4:49:25	3	6.7	41.2		21.7			0				0.0				166
1/19/00 5:14	1/19/00 5:19	4.3	25.6	876.1	24.7	48	45	6:44:15	4	4.3	25.6		26.0			1	4.3	25.6		4.3				166
1/19/00 7:11	1/19/00 7:15	3.8	24.2	878.3	31.3	48	45	8:37:48	5	3.8	22.2		29.8			2	3.8	22.2		8.2				166
1/19/00 9:06	1/19/00 9:12	6.2	33.5	884.2	36.5	48	45	10:30:03	6	6.2	37.9		36.0			3	6.2	37.9		14.3				166
1/19/00 11:03	1/19/00 11:11	7.8	65.7	874.7	38.4	48	45	12:23:26	7	7.8	49.0		43.8			4	7.8	49.0		22.2				166
1/19/00 13:01	1/19/00 13:09	7.7	54.2	881.0	36.6	48	45	14:18:36	8	7.7	47.9		51.5			5	7.7	47.9		29.8				166
1/19/00 15:02	1/19/00 15:06	4.2	24.7	880.2	31.3	48	45	16:16:22	9	4.2	24.5	9	55.7	55.67	341.7	6	4.2	24.5	6	34.0	34	207.0	146.92	166
1/19/00 23:04	1/19/00 23:10	5.5	29.0	881.0	10.1	48	46	0:05:28	1	5.5	33.4		5.5			0								166
1/20/00 1:02	1/20/00 1:10	8.0	66.5	881.0	11.2	49	46	2:00:09	2	8.0	50.1		13.5			0				0.0				166
1/20/00 3:00	1/20/00 3:08	7.7	54.8	883.2	15.3	49	46	3:55:09	3	7.7	47.9		21.2			0				0.0				166
1/20/00 4:58	1/20/00 5:04	5.5	30.1	877.5	21.3	49	46	5:50:09	4	5.5	33.4		26.7			1	5.5	33.4		5.5				166
1/20/00 6:56	1/20/00 6:59	3.7	23.7	880.2	28.1	49	46	7:44:21	5	3.7	21.2		30.3			2	3.7	21.2		9.2				166
1/20/00 8:51	1/20/00 8:56	5.0	27.5	878.5	34.3	49	46	9:37:05	6	5.0	30.1		35.3			3	5.0	30.1		14.2				166
1/20/00 10:47	1/20/00 10:54	7.2	46.0	873.2	37.9	49	46	11:29:49	7	7.2	44.5		42.5			4	7.2	44.5		21.3				166
1/20/00 12:45	1/20/00 12:53	8.0	81.4	871.8	37.8	49	46	13:24:01	8	8.0	50.1		50.5			5	8.0	50.1		29.3				166
1/20/00 14:44	1/20/00 14:51	6.5	34.8	885.8	34.1	49	46	15:20:19	9	6.5	40.1		57.0			6	6.5	40.1	6	35.8	35.84	219.3	146.92	166
1/20/00 22:49	1/20/00 22:51	2.2	21.1	881.2	10.7	49	46	23:12:01	10	2.2	11.2	10	59.2	59.18	361.8	0				0.0				166
1/21/00 0:46	1/21/00 0:53	7.2	44.0	877.2	10.1	50	47	1:06:03	1	7.2	44.5		7.2			0								168
1/21/00 2:44	1/21/00 2:52	8.0	79.7	874.7	12.9	50	47	3:00:53	2	8.0	50.1		15.2			0				0.0				168
1/21/00 4:42	1/21/00 4:49	6.7	38.3	875.5	18.2	50	47	4:55:53	3	6.7	41.2		21.8			0				0.0				168
1/21/00 6:40	1/21/00 6:44	4.2	25.3	871.9	24.8	50	47	6:50:44	4	4.2	24.5		26.0			1	4.2	24.5		4.2				168
1/21/00 8:37	1/21/00 8:41	4.0	24.4	880.3	31.5	50	47	8:44:07	5	4.0	23.4		30.0			2	4.0	23.4		8.2				168
1/21/00 10:32	1/21/00 10:38	6.2	34.5	870.1	36.5	50	47	10:36:32	6	6.2	37.9		36.2			3	6.2	37.9		14.3				168
1/21/00 12:29	1/21/00 12:36	7.8	68.8	868.8	38.2	50	47	12:29:55	7	7.8	49.0		44.0			4	7.8	49.0		22.2				168
1/21/00 14:27	1/21/00 14:35	7.7	51.6	883.9	36.2	50	47	14:25:05	8	7.7	47.9		51.7			5	7.7	47.9		29.8				168
1/21/00 16:28	1/21/00 16:32	3.8	23.7	879.9	30.8	50	47	16:23:10	9	3.8	22.2	9	55.5	55.51	340.7	6	3.8	22.2	6	33.7	33.67	204.8	146.92	168
1/22/00 0:30	1/22/00 0:36	5.7	30.3	873.9	9.9	51	48	0:11:57	1	5.7	34.5		5.7			0								168
1/22/00 2:28	1/22/00 2:36	8.0	69.8	879.5	11.1	51	48	2:06:37	2	8.0	50.1		13.7			0				0.0				168
1/22/00 4:26	1/22/00 4:33	7.5	52.5	878.7	15.4	51	48	4:01:38	3	7.5	46.7		21.2			0				0.0				168
1/22/00 6:24	1/22/00 6:29	5.3	29.4	872.1	21.5	51	48	5:56:38	4	5.3	32.3		26.5			1	5.3	32.3		5.3				168
1/22/00 8:21	1/22/00 8:25	3.7	23.6	878.6	28.3	51	48	7:50:50	5	3.7	21.2		30.2			2	3.7	21.2		9.0				168
1/22/00 10:17	1/22/00 10:22	5.2	28.0	881.9	34.3	51	48	9:43:24	6	5.2	31.2		35.3			3	5.2	31.2		14.2				168
1/22/00 12:13	1/22/00 12:20	7.3	47.9	880.9	37.8	51	48	11:36:08	7	7.3	45.6		42.7			4	7.3	45.6		21.5				168
1/22/00 14:10	1/22/00 14:18	8.0	77.8	869.7	37.6	51	48	13:30:29	8	8.0	50.1		50.7			5	8.0	50.1		29.5				168
1/22/00 16:10	1/22/00 16:16	6.2	33.3	875.6	33.7	51	48	15:27:07	9	6.2	37.9		56.8			6	6.2	37.9	6	35.7	35.67	218.2	146.92	168
1/23/00 0:14	1/23/00 0:17	2.8	21.8	882.7	10.4	52	48	23:18:20	10	2.8	15.6	10	59.7	59.67	365.1	0				0.0				168
1/23/00 2:12	1/23/00 2:19	7.3	46.2	880.5	10.0	52	49	1:12:31	1	7.3	45.6		7.3			0								168
1/23/00 4:10	1/23/00 4:18	8.0	76.2	880.5	12.9	52	49	3:07:22	2	8.0	50.1		15.3			0				0.0				168
1/23/00 6:08	1/23/00 6:14	6.5	37.0	879.8	18.3	52	49	5:02:22	3	6.5	40.1		21.8			0				0.0				168
1/23/00 8:06	1/23/00 8:10	4.2	25.0	881.5	25.0	52	49	6:57:03	4	4.2	24.5		26.0			1	4.2	24.5		4.2				168
1/23/00 10:02	1/23/00 10:06	4.0	24.6	878.7	31.6	52	49	8:50:26	5	4.0	23.4		30.0			2	4.0	23.4		8.2				168
1/23/00 11:58	1/23/00 12:04	6.3	35.6	878.7	36.5	52	49	10:42:51	6	6.3	38.9		36.3			3	6.3	38.9		14.5				168
1/23/00 13:54	1/23/00 14:02	7.8	72.0	863.0	38.0	52	49	12:36:23	7	7.8	49.0		44.2			4	7.8	49.0		22.3				168
1/23/00 15:53	1/23/00 16:00	7.5	49.0	877.3	35.9	52	49	14:31:43	8	7.5	46.7		51.7			5	7.5	46.7		29.8				168
1/23/00 17:54	1/23/00 17:58	3.3	22.9	881.7	30.3	52	49	16:29:58	9	3.3	18.9	9	55.0	54.99	337.2	6	3.3	18.9	6	33.2	33.16	201.4	146.92	168
1/24/00 1:56	1/24/00 2:02	6.0	31.6	884.6	9.7	53	50	0:18:25	1	6.0	36.7		6.0			0								168
1/24/00 3:54	1/24/00 4:02	8.0	73.2	885.4	11.1	53	50	2:13:16	2	8.0	50.1		14.0			0				0.0				168
1/24/00 5:52	1/24/00 5:59	7.3	50.4	872.5	15.4	53	50	4:08:16	3	7.3	45.6		21.3			0				0.0				168
1/24/00 7:50	1/24/00 7:55	5.2	28.8	872.3	21.6	53	50	6:03:07	4	5.2	31.2		26.5			1	5.2	31.2		5.2				168
1/24/00 9:47	1/24/00 9:51	3.5	23.6	871.2	28.4	53	50	7:57:18	5	3.5	20.0		30.0			2	3.5	20.0		8.7				168
1/24/00 11:43	1/24/00 11:48	5.2	28.6	875.1	34.4	53	50	9:49:53	6	5.2	31.2		35.2			3	5.2	31.2		13.8				168
1/24/00 13:39	1/24/00 13:46	7.3	49.9	871.4	37.7	53	50	11:42:37	7	7.3	45.6		42.5			4	7.3	45.6		21.2				168
1/24/00 15:36	1/24/00 15:44	8.0	74.2	879.3	37.3	53	50	13:36:58	8	8.0	50.1		50.5			5	8.0	50.1		29.2				168
1/24/00 17:36	1/24/00 17:42	6.0	31.9	875.5	33.2	53	50	15:33:45	9	6.0	36.7		56.5			6	6.0	36.7	6	35.2	35.17	214.8	146.92	168
1/25/00 1:40	1/25/00 1:43	3.2	22.7	878.0	10.1	54	50	23:24:48	10	3.2	17.8	10	59.7	59.67	365.1	0				0.0				168
1/25/00 3:38	1/25/00 3:45	7.5	48.5	885.4	9.9	54	51	1:19:00	1	7.5	46.7		7.5			0								168
1/25/00 5:36	1/25/00 5:44	7.8	72.7	862.8	13.0	54	51	3:14:00	2	7.8	49.0		15.3			0				0.0				168
1/25/00 7:34	1/25/00 7:40	6.3	35.9	878.2	18.4	54	51	5:09:01	3	6.3	38.9		21.7			0				0.0				168
1/25/00 9:32	1/25/00 9:36	4.2	24.7	880.4	25.1	54	51	7:03:32	4	4.2	24.5		25.8			1	4.2	24.5		4.2				168
1/25/00 11:28	1/25/00 11:32	4.0	24.9	868.6	31.7	54	51	8:56:55	5	4.0	23.4		29.8			2	4.0	23.4		8.2				168

Rise	Set	Pass Duration [min.]	Max.El at lander [deg.]	Max.Range [km]	MaxSun.El [de.g]	Day # [ET]	Sol #	LMST	Pass # that Sol	D/L Pass duration [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass	Max # passes that Sol	Cume D/L comm time that sol [min.]	Total D/L comm time/sol [min.]	D/L Volume/sol [Mbit]	Pass # sun el > 20°	Pass dur. sun el > 20° [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass [sun el > 20°]	Max # passes sun el > 20°	Cume D/L time sun el > 20° [min.]	D/L time/sol sun el > 20° [min.]	D/L Volume/sol, sun el > 20 deg. [Mbit]	D/L Volume/sol, 4 passes, 6 min/pass [Mbit]	Mars98 Orbiter Daily Science D/L volume [Mbits]
1/25/00 13:24	1/25/00 13:30	6.3	36.7	865.0	36.4	54	51	10:49:19	6	6.3	38.9		36.2			3	6.3	38.9		14.5				168
1/25/00 15:20	1/25/00 15:28	7.8	75.2	859.1	37.8	54	51	12:42:52	7	7.8	49.0		44.0			4	7.8	49.0		22.3				168
1/25/00 17:19	1/25/00 17:26	7.3	46.7	872.2	35.5	54	51	14:38:21	8	7.3	45.6		51.3			5	7.3	45.6		29.7				168
1/25/00 19:21	1/25/00 19:24	2.8	22.0	879.3	29.8	54	51	16:36:56	9	2.8	15.6	9	54.2	54.15	331.6	6	2.8	15.6	6	32.5	32.49	196.9	146.92	168
1/26/00 3:22	1/26/00 3:28	6.2	32.9	878.2	9.5	55	52	0:24:54	1	6.2	37.9		6.2			0								168
1/26/00 5:20	1/26/00 5:28	8.0	76.9	875.4	11.1	55	52	2:19:44	2	8.0	50.1		14.2			0				0.0				168
1/26/00 7:18	1/26/00 7:25	7.3	48.4	881.7	15.5	55	52	4:14:45	3	7.3	45.6		21.5			0				0.0				168
1/26/00 9:16	1/26/00 9:21	5.2	28.1	880.8	21.8	55	52	6:09:35	4	5.2	31.2		26.7			1	5.2	31.2		5.2				168
1/26/00 11:13	1/26/00 11:17	3.7	23.6	878.4	28.6	55	52	8:03:37	5	3.7	21.2		30.3			2	3.7	21.2		8.8				168
1/26/00 13:09	1/26/00 13:14	5.3	29.2	873.1	34.4	55	52	9:56:12	6	5.3	32.3		35.7			3	5.3	32.3		14.2				168
1/26/00 15:05	1/26/00 15:12	7.3	52.0	862.7	37.6	55	52	11:49:05	7	7.3	45.6		43.0			4	7.3	45.6		21.5				168
1/26/00 17:02	1/26/00 17:10	7.8	70.6	862.2	37.0	55	52	13:43:36	8	7.8	49.0		50.8			5	7.8	49.0		29.3				168
1/26/00 19:02	1/26/00 19:08	5.8	30.6	882.7	32.8	55	52	15:40:24	9	5.8	35.6		56.7			6	5.8	35.6	6	35.2	35.16	214.8	146.92	168
1/27/00 3:06	1/27/00 3:10	3.7	23.5	876.5	9.8	56	52	23:31:07	10	3.7	21.2	10	60.3	60.33	369.5	0				0.0				168
1/27/00 5:03	1/27/00 5:11	7.5	50.9	872.9	9.8	56	53	1:25:29	1	7.5	46.7		7.5			0								168
1/27/00 7:02	1/27/00 7:09	7.8	69.5	864.2	13.0	56	53	3:20:29	2	7.8	49.0		15.3			0				0.0				168
1/27/00 9:00	1/27/00 9:06	6.2	34.8	869.4	18.5	56	53	5:15:29	3	6.2	37.9		21.5			0				0.0				168
1/27/00 10:57	1/27/00 11:01	4.0	24.5	879.0	25.2	56	53	7:10:00	4	4.0	23.4		25.5			1	4.0	23.4		4.0				168
1/27/00 12:54	1/27/00 12:58	4.2	25.2	872.7	31.8	56	53	9:03:14	5	4.2	24.5		29.7			2	4.2	24.5		8.2				168
1/27/00 14:49	1/27/00 14:56	6.7	38.0	879.5	36.4	56	53	10:55:38	6	6.7	41.2		36.3			3	6.7	41.2		14.8				168
1/27/00 16:46	1/27/00 16:54	8.0	78.7	879.6	37.6	56	53	12:49:21	7	8.0	50.1		44.3			4	8.0	50.1		22.8				168
1/27/00 18:45	1/27/00 18:52	7.2	44.5	868.7	35.1	56	53	14:45:00	8	7.2	44.5		51.5			5	7.2	44.5		30.0				168
1/27/00 20:47	1/27/00 20:49	2.3	21.3	882.3	29.3	56	53	16:43:44	9	2.3	12.2	9	53.8	53.84	329.5	6	2.3	12.2	6	32.3	32.34	195.9	146.92	168
1/28/00 4:47	1/28/00 4:54	6.3	34.4	873.3	9.3	57	54	0:31:23	1	6.3	38.9		6.3			0								168
1/28/00 6:45	1/28/00 6:53	8.0	80.6	867.0	11.0	57	54	2:26:13	2	8.0	50.1		14.3			0				0.0				168
1/28/00 8:44	1/28/00 8:51	7.2	46.5	868.7	15.6	57	54	4:21:13	3	7.2	44.5		21.5			0				0.0				168
1/28/00 10:42	1/28/00 10:47	5.0	27.6	876.1	21.9	57	54	6:16:04	4	5.0	30.1		26.5			1	5.0	30.1		5.0				168
1/28/00 12:39	1/28/00 12:42	3.7	23.7	880.8	28.7	57	54	8:10:06	5	3.7	21.2		30.2			2	3.7	21.2		8.7				168
1/28/00 14:34	1/28/00 14:40	5.5	29.9	878.5	34.4	57	54	10:02:30	6	5.5	33.4		35.7			3	5.5	33.4		14.2				168
1/28/00 16:30	1/28/00 16:38	7.7	54.3	881.7	37.4	57	54	11:55:24	7	7.7	47.9		43.3			4	7.7	47.9		21.8				168
1/28/00 18:28	1/28/00 18:36	8.0	67.3	879.1	36.7	57	54	13:50:05	8	8.0	50.1		51.3			5	8.0	50.1		29.8				168
1/28/00 20:28	1/28/00 20:34	5.5	29.3	877.1	32.3	57	54	15:47:12	9	5.5	33.4		56.8			6	5.5	33.4	6	35.3	35.34	216.0	146.92	168
1/29/00 4:32	1/29/00 4:36	4.0	24.4	874.5	9.6	58	54	23:37:36	10	4.0	23.4	10	60.8	60.84	372.9	0				0.0				168
1/29/00 6:29	1/29/00 6:37	7.7	53.5	876.7	9.7	58	55	1:31:57	1	7.7	47.9		7.7			0								168
1/29/00 8:27	1/29/00 8:35	7.8	66.4	869.8	13.0	58	55	3:26:58	2	7.8	49.0		15.5			0				0.0				168
1/29/00 10:26	1/29/00 10:32	6.2	33.8	883.5	18.6	58	55	5:21:58	3	6.2	37.9		21.7			0				0.0				168
1/29/00 12:23	1/29/00 12:27	3.8	24.2	877.1	25.3	58	55	7:16:29	4	3.8	22.2		25.5			1	3.8	22.2		3.8				168
1/29/00 14:19	1/29/00 14:24	4.3	25.6	877.0	31.8	58	55	9:09:33	5	4.3	25.6		29.8			2	4.3	25.6		8.2				168
1/29/00 16:15	1/29/00 16:22	6.7	39.3	875.0	36.3	58	55	11:02:07	6	6.7	41.2		36.5			3	6.7	41.2		14.8				168
1/29/00 18:12	1/29/00 18:20	8.0	82.4	873.8	37.4	58	55	12:55:49	7	8.0	50.1		44.5			4	8.0	50.1		22.8				168
1/29/00 20:11	1/29/00 20:18	7.0	42.4	866.6	34.7	58	55	14:51:38	8	7.0	43.4		51.5			5	7.0	43.4		29.8				168
1/29/00 22:13	1/29/00 22:15	1.3	20.5	879.4	28.8	58	55	16:50:52	9	1.3	5.5	9	52.8	52.83	322.8	6	1.3	5.5	6	31.2	31.16	188.1	146.92	168
1/30/00 6:13	1/30/00 6:20	6.5	36.0	874.1	9.1	59	56	0:37:51	1	6.5	40.1		6.5			0								168
1/30/00 8:11	1/30/00 8:19	8.0	84.2	872.5	11.0	59	56	2:32:42	2	8.0	50.1		14.5			0				0.0				168
1/30/00 10:09	1/30/00 10:17	7.2	44.7	876.4	15.6	59	56	4:27:42	3	7.2	44.5		21.7			0				0.0				168
1/30/00 12:07	1/30/00 12:12	4.8	27.1	877.3	22.0	59	56	6:22:33	4	4.8	28.9		26.5			1	4.8	28.9		4.8				168
1/30/00 14:04	1/30/00 14:08	3.7	23.7	878.9	28.8	59	56	8:16:25	5	3.7	21.2		30.2			2	3.7	21.2		8.5				168
1/30/00 16:00	1/30/00 16:06	5.5	30.7	867.5	34.4	59	56	10:08:59	6	5.5	33.4		35.7			3	5.5	33.4		14.0				168
1/30/00 17:56	1/30/00 18:04	7.7	56.7	874.7	37.2	59	56	12:01:53	7	7.7	47.9		43.3			4	7.7	47.9		21.7				168
1/30/00 19:54	1/30/00 20:02	7.8	64.0	874.3	36.3	59	56	13:56:43	8	7.8	49.0		51.2			5	7.8	49.0		29.5				168
1/30/00 21:54	1/30/00 22:00	5.3	28.1	881.5	31.8	59	56	15:53:50	9	5.3	32.3		56.5			6	5.3	32.3	6	34.8	34.83	212.6	146.92	168
1/31/00 5:57	1/31/00 6:02	4.5	25.4	880.5	9.3	60	56	23:43:55	10	4.5	26.7	10	61.0	61	374.0	0				0.0				95
1/31/00 7:55	1/31/00 8:03	7.8	56.2	882.2	9.6	60	57	1:38:26	1	7.8	49.0		7.8			0								95
1/31/00 9:53	1/31/00 10:01	7.8	63.5	875.7	13.0	60	57	3:33:26	2	7.8	49.0		15.7			0				0.0				95
1/31/00 11:51	1/31/00 11:57	6.0	32.8	875.8	18.7	60	57	5:28:27	3	6.0	36.7		21.7			0				0.0				95
1/31/00 13:49	1/31/00 13:53	3.8	24.1	877.3	25.5	60	57	7:22:58	4	3.8	22.2		25.5			1	3.8	22.2		3.8				95
1/31/00 15:45	1/31/00 15:50	4.5	25.9	881.4	31.9	60	57	9:15:51	5	4.5	26.7		30.0			2	4.5	26.7		8.3				95
1/31/00 17:41	1/31/00 17:48	6.8	40.6	873.3	36.2	60	57	11:08:26	6	6.8	42.3		36.8			3	6.8	42.3		15.2				95
1/31/00 19:38	1/31/00 19:46	8.0	86.1	868.0	37.1	60	57	13:02:18	7	8.0	50.1		44.8			4	8.0	50.1		23.2				95
1/31/00 21:37	1/31/00 21:44	6.8	40.5	866.0	34.2	60	57	14:58:17	8	6.8	42.3	8	51.7	51.65	318.2	5	6.8	42.3	5	30.0	29.99	183.6	146.92	95
2/1/00 7:39	2/1/00 7:46	6.7	37.7	875.4	8.9	61	58	0:44:20	1	6.7	41.2		6.7			0								95
2/1/00 9:37	2/1/00 9:45	8.2	87.0	881.4	10.9	61	58	2:39:10	2	8.2	51.2		14.8			0				0.0				95
2/1/00 11:35	2/1/00 11:42	7.0	43.0	879.0	15.7	61	58	4:34:11	3	7.0	43.4		21.8			0				0.0				95
2/1/00 13:33	2/1/00 13:38	4.7	26.6	878.3	22.1	61	58	6:29:01	4	4.7	27.8		26.5			1	4.7	27.8		4.7				95
2/1/00 15:30	2/1/00 15:34	3.7	23.8	875.0	28.9	61	58	8:22:53	5	3.7	21.2		30.2			2	3.7	21.2		8.3				95
2/1/00 17:26	2/1/00 17:31	5.7	31.5	870.3	34.4	61	58	10:15:18	6	5.7	34.5		35.9			3	5.7	34.5		14.0				95
2/1/00 19:22	2/1/00 19:30	7.7	59.2	868.6	37.0	61	58	12:08:22	7	7.7	47.9		43.5			4	7.7	47.9		21.7				95
2/1/00 21:20	2/1/00 21:28	7.8	60.8	874.8	36.0	61	58	14:03:12	8	7.8	49.0		51.4			5	7.8	49.0		29.5				95
2/1/00 23:21	2/1/00 23:26	5.0	27.0	881.0	31.3	61	58	16:00:38	9	5.0	30.1		56.4			6	5.0	30.1	6	34.5	34.51	210.4	146.92	95
2/2/00 7:23	2/2/00 7:28	4.8	26.4	879.6	9.0	62	58	23:50:24	10	4.8	28.9	10	61.2	61.18	375.2	0				0.0				95
2/2/00 9:21	2/2/00 9:29	7.7	59.2	865.7	9.4	62	59	1:45:04	1	7.7	47.9		7.7			0								95
2/2/00 11:19	2/2/00 11:27	7.7	60.7	874.7	13.0	62	59	3:40:05	2	7.7	47.9		15.3			0				0.0				95
2/2/00 13:17	2/2/00 13:23	5.8	31.9	876.3	18.8	62	59	5:34:55	3	5.8	35.6		21.2			0				0.0				95
2/2/00 15:15	2/2/00 15:19	3.7	23.9	872.3	25.6	62	59	7:29:26	4	3.7	21.2		24.8			1	3.7	21.2		3.7				95
2/2/00 17:11	2/2/00 17:15	4.5	26.3	869.2	31.9	62	59	9:22:20	5	4.5	26.7		29.3			2	4.5	26.7		8.2				95
2/2/00 19:07	2/2/00 19:13	6.8	42.1	865.3	36.1	62	59	11:14:54	6	6.8	42.3		36.2			3	6.8	42.3		15.0				95
2/2/00 21:04	2/2/00 21:12	8.0	89.5	868.8	36.8	62	59	13:08:47	7	8.0	50.1		44.2			4	8.0	50.1		23.0				95
2/2/00 23:03	2/2/00 23:10	6.7	38.7	866.9	33.8	62	59	15:04:55	8	6.7	41.2	8	50.8	50.84	312.8	5	6.7	41.2	5	29.7	29.67	181.4	146.92	95
2/3/00 9:05	2/3/00 9:12	6.8	39.4	877.2	8.6	63	60	0:50:49	1	6.8	42.3		6.8			0								95
2/3/00 11:03	2/3/00 11:11	8.0	87.5	876.4	10.8	63	60	2:45:49	2	8.0	50.1		14.8			0				0.0				95

Rise	Set	Pass Duration [min.]	Max.El at lander [deg.]	Max.Range [km]	MaxSun.El [de.g]	Day # [ET]	Sol #	LMST	Pass # that Sol	D/L Pass duration [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass	Max # passes that Sol	Cume D/L comm time that sol [min.]	Total D/L comm time/sol [min.]	D/L Volume/sol [Mbit]	Pass # sun el > 20°	Pass dur. sun el > 20° [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass [sun el > 20°]	Max # passes sun el > 20°	Cume D/L time sun el > 20° [min.]	D/L time/sol sun el > 20° [min.]	D/L Volume/sol, sun el > 20 deg. [Mbit]	D/L Volume/sol, 4 passes, 6 min/pass [Mbit]	Mars98 Orbiter Daily Science D/L volume [Mbits]
2/3/00 13:01	2/3/00 13:08	6.8	41.5	874.4	15.7	63	60	4:40:49	3	6.8	42.3		21.7			0				0.0				95
2/3/00 14:59	2/3/00 15:04	4.7	26.2	880.0	22.2	63	60	6:35:30	4	4.7	27.8		26.3			1	4.7	27.8		4.7				95
2/3/00 16:56	2/3/00 17:00	3.8	24.0	878.0	28.9	63	60	8:29:12	5	3.8	22.2		30.2			2	3.8	22.2		8.5				95
2/3/00 18:51	2/3/00 18:57	5.8	32.3	876.9	34.4	63	60	10:21:37	6	5.8	35.6		36.0			3	5.8	35.6		14.3				95
2/3/00 20:48	2/3/00 20:55	7.7	61.9	863.5	36.8	63	60	12:14:50	7	7.7	47.9		43.7			4	7.7	47.9		22.0				95
2/3/00 22:46	2/3/00 22:54	7.7	57.9	865.3	35.6	63	60	14:09:51	8	7.7	47.9		51.3			5	7.7	47.9		29.7				95
2/4/00 0:47	2/4/00 0:51	4.5	26.0	870.2	30.7	64	60	16:07:27	9	4.5	26.7		55.8			6	4.5	26.7	6	34.2	34.17	208.2	146.92	95
2/4/00 8:49	2/4/00 8:54	5.0	27.5	874.2	8.7	64	60	23:56:52	10	5.0	30.1	10	60.8	60.83	372.8	0				0.0				95
2/4/00 10:47	2/4/00 10:55	7.8	62.2	877.7	9.3	64	61	1:51:33	1	7.8	49.0		7.8			0								95
2/4/00 12:45	2/4/00 12:53	7.7	58.1	880.2	13.0	64	61	3:46:33	2	7.7	47.9		15.5			0				0.0				95
2/4/00 14:43	2/4/00 14:49	5.8	31.1	883.2	18.9	64	61	5:41:24	3	5.8	35.6		21.3			0				0.0				95
2/4/00 16:41	2/4/00 16:44	3.7	23.8	879.3	25.7	64	61	7:35:55	4	3.7	21.2		25.0			1	3.7	21.2		3.7				95
2/4/00 18:37	2/4/00 18:41	4.7	26.8	873.4	32.0	64	61	9:28:39	5	4.7	27.8		29.7			2	4.7	27.8		8.3				95
2/4/00 20:32	2/4/00 20:39	7.0	43.7	874.4	36.0	64	61	11:21:13	6	7.0	43.4		36.7			3	7.0	43.4		15.3				95
2/4/00 22:29	2/4/00 22:37	8.0	86.2	874.3	36.5	64	61	13:15:15	7	8.0	50.1		44.7			4	8.0	50.1		23.3				95
2/5/00 0:29	2/5/00 0:35	6.5	36.9	869.0	33.3	65	61	15:11:33	8	6.5	40.1		51.2			5	6.5	40.1	5	29.8	29.84	182.6	146.92	95
2/5/00 8:34	2/5/00 8:35	0.7	20.1	882.2	9.4	65	61	23:03:54	9	0.7	1.1	9	51.8	51.84	316.1	0				0.0				95
2/5/00 10:31	2/5/00 10:38	7.0	41.3	879.5	8.4	65	62	0:57:17	1	7.0	43.4		7.0			0								95
2/5/00 12:29	2/5/00 12:37	8.0	84.5	872.6	10.8	65	62	2:52:18	2	8.0	50.1		15.0			0				0.0				95
2/5/00 14:27	2/5/00 14:34	6.7	40.1	864.2	15.8	65	62	4:47:18	3	6.7	41.2		21.7			0				0.0				95
2/5/00 16:25	2/5/00 16:29	4.5	25.8	879.1	22.3	65	62	6:41:59	4	4.5	26.7		26.2			1	4.5	26.7		4.5				95
2/5/00 18:22	2/5/00 18:26	3.8	24.1	880.6	29.0	65	62	8:35:41	5	3.8	22.2		30.0			2	3.8	22.2		8.3				95
2/5/00 20:17	2/5/00 20:23	6.2	33.2	884.2	34.4	65	62	10:27:56	6	6.2	37.9		36.2			3	6.2	37.9		14.5				95
2/5/00 22:14	2/5/00 22:21	7.7	64.8	859.3	36.6	65	62	12:21:19	7	7.7	47.9		43.8			4	7.7	47.9		22.2				95
2/6/00 0:12	2/6/00 0:19	7.7	55.1	880.5	35.2	66	62	14:16:19	8	7.7	47.9		51.5			5	7.7	47.9		29.8				95
2/6/00 2:13	2/6/00 2:17	4.3	25.0	882.6	30.2	66	62	16:14:05	9	4.3	25.6	9	55.8	55.84	342.9	6	4.3	25.6	6	34.2	34.17	208.2	146.92	95
2/6/00 10:15	2/6/00 10:20	5.3	28.6	875.7	8.4	66	63	0:03:21	1	5.3	32.3		5.3			0								95
2/6/00 12:13	2/6/00 12:21	7.8	65.3	867.0	9.2	66	63	1:58:02	2	7.8	49.0		13.2			0				0.0				95
2/6/00 14:11	2/6/00 14:18	7.5	55.6	865.5	13.0	66	63	3:53:02	3	7.5	46.7		20.7			0				0.0				95
2/6/00 16:09	2/6/00 16:15	5.5	30.3	877.0	19.0	66	63	5:48:02	4	5.5	33.4		26.2			0				0.0				95
2/6/00 18:06	2/6/00 18:10	3.7	23.7	878.7	25.7	66	63	7:42:14	5	3.7	21.2		29.8			1	3.7	21.2		3.7				95
2/6/00 20:02	2/6/00 20:07	4.8	27.3	877.7	32.0	66	63	9:34:58	6	4.8	28.9		34.7			2	4.8	28.9		8.5				95
2/6/00 21:58	2/6/00 22:05	7.2	45.4	880.4	35.9	66	63	11:27:42	7	7.2	44.5		41.8			3	7.2	44.5		15.7				95
2/6/00 23:55	2/7/00 0:03	8.2	82.3	881.1	36.2	66	63	13:21:44	8	8.2	51.2		50.0			4	8.2	51.2		23.8				95
2/7/00 1:55	2/7/00 2:01	6.5	35.3	881.1	32.8	67	63	15:18:12	9	6.5	40.1		56.5			5	6.5	40.1	5	30.3	30.34	185.9	146.92	95
2/7/00 10:00	2/7/00 10:01	1.7	20.8	877.2	9.1	67	63	23:10:03	10	1.7	7.8	10	58.2	58.17	355.1	0				0.0				95
2/7/00 11:57	2/7/00 12:04	7.0	43.3	865.1	8.2	67	64	1:03:56	1	7.0	43.4		7.0			0								95
2/7/00 13:55	2/7/00 14:03	8.0	80.9	870.1	10.7	67	64	2:58:46	2	8.0	50.1		15.0			0				0.0				95
2/7/00 15:53	2/7/00 16:00	6.7	38.7	875.3	15.8	67	64	4:53:46	3	6.7	41.2		21.7			0				0.0				95
2/7/00 17:51	2/7/00 17:55	4.3	25.4	879.0	22.4	67	64	6:48:27	4	4.3	25.6		26.0			1	4.3	25.6		4.3				95
2/7/00 19:47	2/7/00 19:51	3.8	24.3	874.1	29.1	67	64	8:42:00	5	3.8	22.2		29.8			2	3.8	22.2		8.2				95
2/7/00 21:43	2/7/00 21:49	6.2	34.2	875.0	34.3	67	64	10:34:25	6	6.2	37.9		36.0			3	6.2	37.9		14.3				95
2/7/00 23:39	2/7/00 23:47	8.0	67.8	884.2	36.4	67	64	12:27:38	7	8.0	50.1		44.0			4	8.0	50.1		22.3				95
2/8/00 1:38	2/8/00 1:45	7.5	52.4	872.0	34.7	68	64	14:22:58	8	7.5	46.7		51.5			5	7.5	46.7		29.8				95
2/8/00 3:39	2/8/00 3:43	4.0	24.0	881.4	29.6	68	64	16:20:53	9	4.0	23.4	9	55.5	55.5	340.6	6	4.0	23.4	6	33.8	33.83	205.9	146.92	95
2/8/00 11:41	2/8/00 11:46	5.7	29.8	885.5	8.1	68	65	0:09:50	1	5.7	34.5		5.7			0								95
2/8/00 13:39	2/8/00 13:47	8.0	68.7	878.4	9.0	68	65	2:04:30	2	8.0	50.1		13.7			0				0.0				95
2/8/00 15:37	2/8/00 15:44	7.5	53.3	871.2	13.0	68	65	3:59:31	3	7.5	46.7		21.2			0				0.0				95
2/8/00 17:35	2/8/00 17:40	5.3	29.6	871.5	19.0	68	65	5:54:31	4	5.3	32.3		26.5			0				0.0				95
2/8/00 19:32	2/8/00 19:36	3.7	23.6	879.4	25.8	68	65	7:48:43	5	3.7	21.2		30.2			1	3.7	21.2		3.7				95
2/8/00 21:28	2/8/00 21:33	5.2	27.8	882.5	32.0	68	65	9:41:17	6	5.2	31.2		35.3			2	5.2	31.2		8.8				95
2/8/00 23:24	2/8/00 23:31	7.3	47.3	878.6	35.7	68	65	11:34:01	7	7.3	45.6		42.7			3	7.3	45.6		16.2				95
2/9/00 1:21	2/9/00 1:29	8.0	79.0	874.2	35.9	69	65	13:28:22	8	8.0	50.1		50.7			4	8.0	50.1		24.2				95
2/9/00 3:21	2/9/00 3:27	6.3	33.8	880.3	32.3	69	65	15:24:50	9	6.3	38.9		57.0			5	6.3	38.9	5	30.5	30.5	187.0	146.92	95
2/9/00 11:25	2/9/00 11:28	2.7	21.6	883.4	8.7	69	65	23:16:13	10	2.7	14.5	10	59.7	59.67	365.1	0				0.0				95
2/9/00 13:23	2/9/00 13:30	7.2	45.4	867.7	8.0	69	66	1:10:24	1	7.2	44.5		7.2			0								95
2/9/00 15:21	2/9/00 15:29	8.0	77.4	872.5	10.7	69	66	3:05:15	2	8.0	50.1		15.2			0				0.0				95
2/9/00 17:19	2/9/00 17:25	6.5	37.4	873.4	15.8	69	66	5:00:15	3	6.5	40.1		21.7			0				0.0				95
2/9/00 19:17	2/9/00 19:21	4.2	25.1	878.5	22.4	69	66	6:54:56	4	4.2	24.5		25.8			1	4.2	24.5		4.2				95
2/9/00 21:13	2/9/00 21:17	4.0	24.6	878.9	29.1	69	66	8:48:19	5	4.0	23.4		29.8			2	4.0	23.4		8.2				95
2/9/00 23:09	2/9/00 23:15	6.3	35.2	878.5	34.2	69	66	10:40:44	6	6.3	38.9		36.2			3	6.3	38.9		14.5				95
2/10/00 1:05	2/10/00 1:13	8.0	71.0	882.2	36.1	70	66	12:34:07	7	8.0	50.1		44.2			4	8.0	50.1		22.5				92
2/10/00 3:04	2/10/00 3:11	7.5	49.9	880.0	34.3	70	66	14:29:36	8	7.5	46.7		51.7			5	7.5	46.7		30.0				92
2/10/00 5:05	2/10/00 5:09	3.5	23.1	882.4	29.1	70	66	16:27:41	9	3.5	20.0	9	55.2	55.17	338.4	6	3.5	20.0	6	33.5	33.5	203.7	146.92	92
2/10/00 13:07	2/10/00 13:12	5.8	31.1	877.7	7.8	70	67	0:16:18	1	5.8	35.6		5.8			0								92
2/10/00 15:04	2/10/00 15:12	8.0	72.2	877.0	8.9	70	67	2:10:59	2	8.0	50.1		13.8			0				0.0				92
2/10/00 17:03	2/10/00 17:10	7.5	51.1	876.8	13.0	70	67	4:05:59	3	7.5	46.7		21.3			0				0.0				92
2/10/00 19:01	2/10/00 19:06	5.2	29.0	867.6	19.1	70	67	6:01:00	4	5.2	31.2		26.5			0				0.0				92
2/10/00 20:58	2/10/00 21:02	3.5	23.6	872.2	25.9	70	67	7:55:11	5	3.5	20.0		30.0			1	3.5	20.0		3.5				92
2/10/00 22:54	2/10/00 22:59	5.2	28.4	879.7	32.0	70	67	9:47:46	6	5.2	31.2		35.2			2	5.2	31.2		8.7				92
2/11/00 0:50	2/11/00 0:57	7.3	49.2	869.7	35.5	71	67	11:40:30	7	7.3	45.6		42.5			3	7.3	45.6		16.0				92
2/11/00 2:47	2/11/00 2:55	8.0	75.4	870.0	35.5	71	67	13:34:51	8	8.0	50.1		50.5			4	8.0	50.1		24.0				92
2/11/00 4:47	2/11/00 4:53	6.2	32.3	882.7	31.8	71	67	15:31:29	9	6.2	37.9		56.7			5	6.2	37.9	5	30.2	30.17	184.8	146.92	92
2/11/00 12:51	2/11/00 12:54	3.0	22.4	878.1	8.3	71	67	23:22:41	10	3.0	16.7	10	59.7	59.67	365.1	0				0.0				92
2/11/00 14:48	2/11/00 14:56	7.3	47.7	871.8	7.8	71	68	1:16:53	1	7.3	45.6		7.3			0								92
2/11/00 16:46	2/11/00 16:54	8.0	73.9	878.4	10.6	71	68	3:11:44	2	8.0	50.1		15.3			0				0.0				92
2/11/00 18:45	2/11/00 18:51	6.5	36.2	878.5	15.9	71	68	5:06:44	3	6.5	40.1		21.8			0				0.0				92
2/11/00 20:42	2/11/00 20:47	4.2	24.8	877.9	22.5	71	68	7:01:25	4	4.2	24.5		26.0			1	4.2	24.5		4.2				92
2/11/00 22:39	2/11/00 22:43	4.0	24.8	871.1	29.1	71	68	8:54:48	5	4.0	23.4		30.0			2	4.0	23.4		8.2				92
2/12/00 0:34	2/12/00 0:41	6.3	36.4	866.8	34.1	72	68	10:47:12	6	6.3	38.9		36.3			3	6.3	38.9		14.5				92

Rise	Set	Pass Duration [min.]	Max.El at lander [deg.]	Max.Range [km]	MaxSun.El [de.g]	Day # [ET]	Sol #	LMST	Pass # that Sol	D/L Pass duration [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass	Max # passes that Sol	Cume D/L comm time that sol [min.]	Total D/L comm time/sol [min.]	D/L Volume/sol [Mbit]	Pass # sun el > 20°	Pass dur. sun el > 20° [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass [sun el > 20°]	Max # passes sun el > 20°	Cume D/L time sun el > 20° [min.]	D/L time/sol sun el > 20° [min.]	D/L Volume/sol, sun el > 20 deg. [Mbit]	D/L Volume/sol, 4 passes, 6 min/pass [Mbit]	Mars98 Orbiter Daily Science D/L volume [Mbits]
2/12/00 2:31	2/12/00 2:39	8.0	74.2	881.4	35.8	72	68	12:40:35	7	8.0	50.1		44.3			4	8.0	50.1		22.5				92
2/12/00 4:30	2/12/00 4:37	7.5	47.5	885.5	33.8	72	68	14:36:05	8	7.5	46.7		51.8			5	7.5	46.7		30.0				92
2/12/00 6:31	2/12/00 6:34	3.0	22.3	878.8	28.5	72	68	16:34:39	9	3.0	16.7	9	54.8	54.83	336.1	6	3.0	16.7	6	33.0	33	200.3	146.92	92
2/12/00 14:32	2/12/00 14:38	6.0	32.5	870.7	7.5	72	69	0:22:47	1	6.0	36.7		6.0			0								92
2/12/00 16:30	2/12/00 16:38	8.0	75.5	884.5	8.7	72	69	2:17:37	2	8.0	50.1		14.0			0				0.0				92
2/12/00 18:29	2/12/00 18:36	7.3	49.0	884.2	13.0	72	69	4:12:38	3	7.3	45.6		21.3			0				0.0				92
2/12/00 20:27	2/12/00 20:32	5.2	28.3	880.2	19.1	72	69	6:07:28	4	5.2	31.2		26.5			0				0.0				92
2/12/00 22:24	2/12/00 22:27	3.7	23.6	877.5	26.0	72	69	8:01:30	5	3.7	21.2		30.2			1	3.7	21.2		3.7				92
2/13/00 0:19	2/13/00 0:25	5.3	29.0	877.7	31.9	73	69	9:54:05	6	5.3	32.3		35.5			2	5.3	32.3		9.0				92
2/13/00 2:15	2/13/00 2:23	7.3	51.3	864.2	35.4	73	69	11:46:58	7	7.3	45.6		42.8			3	7.3	45.6		16.3				92
2/13/00 4:13	2/13/00 4:21	8.0	71.8	880.5	35.1	73	69	13:41:20	8	8.0	50.1		50.8			4	8.0	50.1		24.3				92
2/13/00 6:13	2/13/00 6:19	5.8	31.0	880.0	31.2	73	69	15:38:17	9	5.8	35.6		56.7			5	5.8	35.6	5	30.2	30.16	184.7	146.92	92
2/13/00 14:17	2/13/00 14:20	3.5	23.2	876.0	7.9	73	69	23:29:00	10	3.5	20.0	10	60.2	60.16	368.4	0				0.0				92
2/13/00 16:14	2/13/00 16:22	7.5	50.1	877.5	7.6	73	70	1:23:22	1	7.5	46.7		7.5			0								92
2/13/00 18:12	2/13/00 18:20	7.8	70.6	869.6	10.5	73	70	3:18:22	2	7.8	49.0		15.3			0				0.0				92
2/13/00 20:11	2/13/00 20:17	6.2	35.1	869.5	15.9	73	70	5:13:22	3	6.2	37.9		21.5			0				0.0				92
2/13/00 22:08	2/13/00 22:12	4.0	24.5	876.4	22.6	73	70	7:07:53	4	4.0	23.4		25.5			1	4.0	23.4		4.0				92
2/14/00 0:05	2/14/00 0:09	4.2	25.1	873.2	29.2	74	70	9:01:07	5	4.2	24.5		29.7			2	4.2	24.5		8.2				92
2/14/00 2:00	2/14/00 2:07	6.5	37.5	874.3	34.0	74	70	10:53:31	6	6.5	40.1		36.2			3	6.5	40.1		14.7				92
2/14/00 3:57	2/14/00 4:05	8.0	77.6	881.7	35.5	74	70	12:47:04	7	8.0	50.1		44.2			4	8.0	50.1		22.7				92
2/14/00 5:56	2/14/00 6:03	7.3	45.2	881.2	33.4	74	70	14:42:43	8	7.3	45.6		51.5			5	7.3	45.6		30.0				92
2/14/00 7:58	2/14/00 8:00	2.5	21.5	880.9	27.8	74	70	16:41:27	9	2.5	13.4	9	54.0	54	330.6	6	2.5	13.4	6	32.5	32.5	197.0	146.92	92
2/14/00 15:58	2/14/00 16:04	6.2	33.9	868.6	7.1	74	71	0:29:16	1	6.2	37.9		6.2			0								92
2/14/00 17:56	2/14/00 18:04	8.0	79.3	875.4	8.6	74	71	2:24:06	2	8.0	50.1		14.2			0				0.0				92
2/14/00 19:54	2/14/00 20:02	7.2	47.1	867.8	13.0	74	71	4:19:06	3	7.2	44.5		21.3			0				0.0				92
2/14/00 21:52	2/14/00 21:57	5.0	27.8	875.4	19.2	74	71	6:13:57	4	5.0	30.1		26.3			0				0.0				92
2/14/00 23:50	2/14/00 23:53	3.5	23.6	871.7	26.0	74	71	8:07:59	5	3.5	20.0		29.8			1	3.5	20.0		3.5				92
2/15/00 1:45	2/15/00 1:51	5.5	29.7	879.0	31.9	75	71	10:00:23	6	5.5	33.4		35.3			2	5.5	33.4		9.0				92
2/15/00 3:41	2/15/00 3:49	7.5	53.5	878.4	35.1	75	71	11:53:17	7	7.5	46.7		42.8			3	7.5	46.7		16.5				92
2/15/00 5:39	2/15/00 5:47	7.8	68.3	864.3	34.7	75	71	13:47:58	8	7.8	49.0		50.7			4	7.8	49.0		24.3				92
2/15/00 7:39	2/15/00 7:45	5.7	29.7	880.7	30.7	75	71	15:44:55	9	5.7	34.5		56.3			5	5.7	34.5	5	30.0	30	183.7	146.92	92
2/15/00 15:43	2/15/00 15:46	3.8	24.1	872.9	7.5	75	71	23:35:29	10	3.8	22.2	10	60.2	60.17	368.4	0				0.0				92
2/15/00 17:40	2/15/00 17:48	7.7	52.6	884.8	7.4	75	72	1:29:50	1	7.7	47.9		7.7			0								92
2/15/00 19:38	2/15/00 19:46	7.8	67.5	871.7	10.5	75	72	3:24:51	2	7.8	49.0		15.5			0				0.0				92
2/15/00 21:36	2/15/00 21:43	6.2	34.1	883.5	15.9	75	72	5:19:51	3	6.2	37.9		21.7			0				0.0				92
2/15/00 23:34	2/15/00 23:38	3.8	24.3	874.8	22.6	75	72	7:14:22	4	3.8	22.2		25.5			1	3.8	22.2		3.8				92
2/16/00 1:30	2/16/00 1:35	4.3	25.4	877.5	29.2	76	72	9:07:26	5	4.3	25.6		29.8			2	4.3	25.6		8.2				92
2/16/00 3:26	2/16/00 3:32	6.7	38.8	885.0	33.9	76	72	10:59:50	6	6.7	41.2		36.5			3	6.7	41.2		14.8				92
2/16/00 5:23	2/16/00 5:31	8.0	80.9	883.2	35.2	76	72	12:53:33	7	8.0	50.1		44.5			4	8.0	50.1		22.8				92
2/16/00 7:22	2/16/00 7:29	7.2	43.1	878.4	32.9	76	72	14:49:21	8	7.2	44.5		51.7			5	7.2	44.5		30.0				92
2/16/00 9:24	2/16/00 9:26	1.8	20.8	881.8	27.2	76	72	16:48:25	9	1.8	8.9	9	53.5	53.5	327.2	6	1.8	8.9	6	31.8	31.83	192.5	146.92	92
2/16/00 17:24	2/16/00 17:31	6.5	35.5	882.1	6.8	76	73	0:35:44	1	6.5	40.1		6.5			0								92
2/16/00 19:22	2/16/00 19:30	8.0	83.1	867.5	8.5	76	73	2:30:35	2	8.0	50.1		14.5			0				0.0				92
2/16/00 21:20	2/16/00 21:27	7.2	45.3	878.2	13.0	76	73	4:25:35	3	7.2	44.5		21.7			0				0.0				92
2/16/00 23:18	2/16/00 23:23	4.8	27.2	873.2	19.2	76	73	6:20:26	4	4.8	28.9		26.5			0				0.0				92
2/17/00 1:15	2/17/00 1:19	3.7	23.7	878.4	26.0	77	73	8:14:18	5	3.7	21.2		30.2			1	3.7	21.2		3.7				92
2/17/00 3:11	2/17/00 3:16	5.5	30.4	872.7	31.8	77	73	10:06:52	6	5.5	33.4		35.7			2	5.5	33.4		9.2				92
2/17/00 5:07	2/17/00 5:15	7.7	55.8	879.8	34.9	77	73	11:59:46	7	7.7	47.9		43.3			3	7.7	47.9		16.8				92
2/17/00 7:05	2/17/00 7:13	7.8	65.1	877.4	34.3	77	73	13:54:27	8	7.8	49.0		51.2			4	7.8	49.0		24.7				92
2/17/00 9:05	2/17/00 9:10	5.2	28.5	868.4	30.1	77	73	15:51:43	9	5.2	31.2		56.3			5	5.2	31.2	5	29.8	29.84	182.6	146.92	92
2/17/00 17:08	2/17/00 17:13	4.3	25.1	878.7	7.2	77	73	23:41:48	10	4.3	25.6	10	60.7	60.67	371.8	0				0.0				92
2/17/00 19:06	2/17/00 19:14	7.7	55.3	873.7	7.1	77	74	1:36:19	1	7.7	47.9		7.7			0								92
2/17/00 21:04	2/17/00 21:12	7.8	64.5	874.8	10.4	77	74	3:31:19	2	7.8	49.0		15.5			0				0.0				92
2/17/00 23:02	2/17/00 23:08	6.0	33.1	875.7	16.0	77	74	5:26:20	3	6.0	36.7		21.5			0				0.0				92
2/18/00 1:00	2/18/00 1:04	3.8	24.1	877.4	22.7	78	74	7:20:51	4	3.8	22.2		25.3			1	3.8	22.2		3.8				92
2/18/00 2:56	2/18/00 3:00	4.5	25.8	881.9	29.2	78	74	9:13:44	5	4.5	26.7		29.8			2	4.5	26.7		8.3				92
2/18/00 4:52	2/18/00 4:58	6.8	40.2	877.0	33.7	78	74	11:06:19	6	6.8	42.3		36.7			3	6.8	42.3		15.2				92
2/18/00 6:48	2/18/00 6:57	8.2	84.6	885.9	34.9	78	74	13:00:01	7	8.2	51.2		44.8			4	8.2	51.2		23.3				92
2/18/00 8:48	2/18/00 8:55	7.0	41.1	877.1	32.4	78	74	14:56:00	8	7.0	43.4		51.8			5	7.0	43.4		30.3				92
2/18/00 10:51	2/18/00 10:51	0.3	20.0	882.5	26.5	78	74	16:55:42	8	0.0	0.0	8	51.8	51.83	319.4	5	0.0	0.0	5	30.3	30.33	185.9	146.92	92
2/18/00 18:50	2/18/00 18:57	6.7	37.1	879.1	6.5	78	75	0:42:13	1	6.7	41.2		6.7			0								92
2/18/00 20:48	2/18/00 20:56	8.0	86.7	870.2	8.3	78	75	2:37:03	2	8.0	50.1		14.7			0				0.0				92
2/18/00 22:46	2/18/00 22:53	7.0	43.6	872.0	12.9	78	75	4:32:04	3	7.0	43.4		21.7			0				0.0				92
2/19/00 0:44	2/19/00 0:49	4.7	26.8	874.4	19.3	79	75	6:26:54	4	4.7	27.8		26.3			0				0.0				92
2/19/00 2:41	2/19/00 2:45	3.7	23.8	876.7	26.1	79	75	8:20:47	5	3.7	21.2		30.0			1	3.7	21.2		3.7				92
2/19/00 4:37	2/19/00 4:42	5.7	31.2	870.7	31.8	79	75	10:13:11	6	5.7	34.5		35.7			2	5.7	34.5		9.3				92
2/19/00 6:33	2/19/00 6:40	7.7	58.3	874.1	34.7	79	75	12:06:15	7	7.7	47.9		43.4			3	7.7	47.9		17.0				92
2/19/00 8:31	2/19/00 8:39	7.8	61.9	877.0	33.9	79	75	14:01:05	8	7.8	49.0		51.2			4	7.8	49.0		24.8				92
2/19/00 10:31	2/19/00 10:36	5.0	27.4	878.7	29.5	79	75	15:58:22	9	5.0	30.1		56.2			5	5.0	30.1	5	29.8	29.84	182.6	146.92	92
2/19/00 18:34	2/19/00 18:39	4.7	26.1	876.1	6.8	79	75	23:48:17	10	4.7	27.8	10	60.9	60.85	373.0	0				0.0				92
2/19/00 20:32	2/19/00 20:40	7.8	58.1	878.0	6.9	79	76	1:42:48	1	7.8	49.0		7.8			0								92
2/19/00 22:30	2/19/00 22:38	7.8	61.6	879.0	10.3	79	76	3:37:48	2	7.8	49.0		15.7			0				0.0				92
2/20/00 0:28	2/20/00 0:34	5.8	32.2	870.7	16.0	80	76	5:32:48	3	5.8	35.6		21.5			0				0.0				90
2/20/00 2:26	2/20/00 2:29	3.7	24.0	872.1	22.7	80	76	7:27:19	4	3.7	21.2		25.2			1	3.7	21.2		3.7				90
2/20/00 4:22	2/20/00 4:26	4.5	26.2	871.4	29.2	80	76	9:20:13	5	4.5	26.7		29.7			2	4.5	26.7		8.2				90
2/20/00 6:17	2/20/00 6:24	7.0	41.6	884.6	33.6	80	76	11:12:38	6	7.0	43.4		36.7			3	7.0	43.4		15.2				90
2/20/00 8:14	2/20/00 8:22	8.0	88.3	870.2	34.6	80	76	13:06:40	7	8.0	50.1		44.7			4	8.0	50.1		23.2				90
2/20/00 10:14	2/20/00 10:20	6.8	39.3	877.2	31.8	80	76	15:02:38	8	6.8	42.3	8	51.5	51.49	317.2	5	6.8	42.3	5	30.0	30	183.7	146.92	90
2/20/00 20:16	2/20/00 20:23	6.8	38.8	877.4	6.2	80	77	0:48:42	1	6.8	42.3		6.8			0								90
2/20/00 22:14	2/20/00 22:22	8.2	88.0	883.9	8.2	80	77	2:43:32	2	8.2	51.2		15.0			0				0.0				90

Rise	Set	Pass Duration [min.]	Max.El at lander [deg.]	Max.Range [km]	MaxSun.El [de.g]	Day # [ET]	Sol #	LMST	Pass # that Sol	D/L Pass duration [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass	Max # passes that Sol	Cume D/L comm time that sol [min.]	Total D/L comm time/sol [min.]	D/L Volume/sol [Mbit]	Pass # sun el > 20°	Pass dur. sun el > 20° [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass [sun el > 20°]	Max # passes sun el > 20°	Cume D/L time sun el > 20° [min.]	D/L time/sol sun el > 20° [min.]	D/L Volume/sol, sun el > 20 deg. [Mbit]	D/L Volume/sol, 4 passes, 6 min/pass [Mbit]	Mars98 Orbiter Daily Science D/L volume [Mbits]
2/21/00 0:12	2/21/00 0:19	7.0	42.0	877.0	12.9	81	77	4:38:32	3	7.0	43.4		22.0			0				0.0				90
2/21/00 2:10	2/21/00 2:15	4.7	26.3	879.4	19.3	81	77	6:33:23	4	4.7	27.8		26.7			0				0.0				90
2/21/00 4:07	2/21/00 4:11	3.8	23.9	879.9	26.1	81	77	8:27:05	5	3.8	22.2		30.5			1	3.8	22.2		3.8				90
2/21/00 6:02	2/21/00 6:08	5.8	32.0	877.1	31.7	81	77	10:19:30	6	5.8	35.6		36.3			2	5.8	35.6		9.7				90
2/21/00 7:59	2/21/00 8:06	7.7	61.0	868.4	34.4	81	77	12:12:43	7	7.7	47.9		44.0			3	7.7	47.9		17.3				90
2/21/00 9:57	2/21/00 10:04	7.8	58.9	879.5	33.4	81	77	14:07:34	8	7.8	49.0		51.8			4	7.8	49.0		25.2				90
2/21/00 11:57	2/21/00 12:02	4.7	26.3	873.4	28.9	81	77	16:05:10	9	4.7	27.8		56.5			5	4.7	27.8	5	29.8	29.83	182.5	146.92	90
2/21/00 20:00	2/21/00 20:05	5.0	27.1	881.3	6.4	81	77	23:54:45	10	5.0	30.1	10	61.5	61.5	377.3	0				0.0				90
2/21/00 21:58	2/21/00 22:05	7.7	61.2	861.0	6.7	81	78	1:49:26	1	7.7	47.9		7.7			0								90
2/21/00 23:56	2/22/00 0:04	7.8	58.9	884.1	10.2	81	78	3:44:17	2	7.8	49.0		15.5			0				0.0				90
2/22/00 1:54	2/22/00 2:00	5.8	31.4	882.9	16.0	82	78	5:39:17	3	5.8	35.6		21.3			0				0.0				90
2/22/00 3:51	2/22/00 3:55	3.8	23.8	880.8	22.8	82	78	7:33:38	4	3.8	22.2		25.2			1	3.8	22.2		3.8				90
2/22/00 5:47	2/22/00 5:52	4.7	26.6	874.0	29.1	82	78	9:26:32	5	4.7	27.8		29.8			2	4.7	27.8		8.5				90
2/22/00 7:43	2/22/00 7:50	7.0	43.2	872.8	33.4	82	78	11:19:06	6	7.0	43.4		36.8			3	7.0	43.4		15.5				90
2/22/00 9:40	2/22/00 9:48	8.0	87.7	866.3	34.2	82	78	13:13:08	7	8.0	50.1		44.8			4	8.0	50.1		23.5				90
2/22/00 11:40	2/22/00 11:46	6.7	37.5	878.7	31.3	82	78	15:09:17	8	6.7	41.2	8	51.5	51.5	317.2	5	6.7	41.2	5	30.2	30.17	184.8	146.92	90
2/22/00 21:42	2/22/00 21:49	7.0	40.7	876.9	5.9	82	79	0:55:10	1	7.0	43.4		7.0			0								90
2/22/00 23:40	2/22/00 23:48	8.0	85.2	879.8	8.1	82	79	2:50:11	2	8.0	50.1		15.0			0				0.0				90
2/23/00 1:38	2/23/00 1:45	6.7	40.5	863.4	12.9	83	79	4:45:11	3	6.7	41.2		21.7			0				0.0				90
2/23/00 3:36	2/23/00 3:40	4.5	25.9	875.7	19.4	83	79	6:39:52	4	4.5	26.7		26.2			0				0.0				90
2/23/00 5:33	2/23/00 5:36	3.7	24.1	869.2	26.1	83	79	8:33:34	5	3.7	21.2		29.8			1	3.7	21.2		3.7				90
2/23/00 7:28	2/23/00 7:34	5.8	32.9	862.9	31.6	83	79	10:25:59	6	5.8	35.6		35.7			2	5.8	35.6		9.5				90
2/23/00 9:24	2/23/00 9:32	7.8	63.8	882.5	34.1	83	79	12:19:02	7	7.8	49.0		43.5			3	7.8	49.0		17.3				90
2/23/00 11:23	2/23/00 11:30	7.7	56.0	869.1	33.0	83	79	14:14:12	8	7.7	47.9		51.2			4	7.7	47.9		25.0				90
2/23/00 13:24	2/23/00 13:28	4.3	25.3	874.1	28.2	83	79	16:11:58	9	4.3	25.6	9	55.5	55.5	340.6	5	4.3	25.6	5	29.3	29.33	179.2	146.92	90
2/23/00 21:26	2/23/00 21:31	5.2	28.2	870.8	6.0	83	80	0:01:14	1	5.2	31.2		5.2			0								90
2/23/00 23:24	2/23/00 23:31	7.8	64.3	873.9	6.5	83	80	1:55:55	2	7.8	49.0		13.0			0				0.0				90
2/24/00 1:22	2/24/00 1:29	7.5	56.4	863.0	10.2	84	80	3:50:55	3	7.5	46.7		20.5			0				0.0				90
2/24/00 3:20	2/24/00 3:25	5.7	30.6	876.9	16.0	84	80	5:45:46	4	5.7	34.5		26.2			0				0.0				90
2/24/00 5:17	2/24/00 5:21	3.7	23.7	877.2	22.8	84	80	7:40:07	5	3.7	21.2		29.8			1	3.7	21.2		3.7				90
2/24/00 7:13	2/24/00 7:18	4.8	27.1	878.4	29.1	84	80	9:32:51	6	4.8	28.9		34.7			2	4.8	28.9		8.5				90
2/24/00 9:09	2/24/00 9:16	7.0	44.9	861.9	33.2	84	80	11:25:35	7	7.0	43.4		41.7			3	7.0	43.4		15.5				90
2/24/00 11:06	2/24/00 11:14	8.0	83.9	872.7	33.8	84	80	13:19:37	8	8.0	50.1		49.7			4	8.0	50.1		23.5				90
2/24/00 13:06	2/24/00 13:12	6.5	35.8	881.4	30.7	84	80	15:15:55	9	6.5	40.1		56.2			5	6.5	40.1	5	30.0	30	183.7	146.92	90
2/24/00 21:11	2/24/00 21:12	1.5	20.6	880.1	6.8	84	80	23:07:56	10	1.5	6.7	10	57.7	57.67	351.7	0				0.0				90
2/24/00 23:07	2/24/00 23:15	7.2	42.6	877.9	5.6	84	81	1:01:39	1	7.2	44.5		7.2			0								90
2/25/00 1:06	2/25/00 1:14	8.0	82.0	876.8	7.9	85	81	2:56:39	2	8.0	50.1		15.2			0				0.0				90
2/25/00 3:04	2/25/00 3:10	6.7	39.1	876.1	12.9	85	81	4:51:40	3	6.7	41.2		21.8			0				0.0				90
2/25/00 5:02	2/25/00 5:06	4.3	25.5	875.8	19.4	85	81	6:46:20	4	4.3	25.6		26.2			0				0.0				90
2/25/00 6:58	2/25/00 7:02	3.8	24.3	874.1	26.1	85	81	8:39:53	5	3.8	22.2		30.0			1	3.8	22.2		3.8				90
2/25/00 8:54	2/25/00 9:00	6.2	33.9	880.9	31.5	85	81	10:32:18	6	6.2	37.9		36.2			2	6.2	37.9		10.0				90
2/25/00 10:50	2/25/00 10:58	7.8	66.8	879.1	33.8	85	81	12:25:31	7	7.8	49.0		44.0			3	7.8	49.0		17.8				90
2/25/00 12:48	2/25/00 12:56	7.7	53.3	886.8	32.5	85	81	14:20:41	8	7.7	47.9		51.7			4	7.7	47.9		25.5				90
2/25/00 14:50	2/25/00 14:54	4.2	24.3	883.3	27.6	85	81	16:18:36	9	4.2	24.5	9	55.8	55.84	342.9	5	4.2	24.5	5	29.7	29.67	181.4	146.92	90
2/25/00 22:52	2/25/00 22:57	5.5	29.4	879.6	5.6	85	82	0:07:43	1	5.5	33.4		5.5			0								90
2/26/00 0:49	2/26/00 0:57	7.8	67.5	864.4	6.3	86	82	2:02:23	2	7.8	49.0		13.3			0				0.0				90
2/26/00 2:48	2/26/00 2:55	7.5	54.0	870.1	10.1	86	82	3:57:24	3	7.5	46.7		20.8			0				0.0				90
2/26/00 4:46	2/26/00 4:51	5.5	29.9	879.6	16.0	86	82	5:52:14	4	5.5	33.4		26.3			0				0.0				90
2/26/00 6:43	2/26/00 6:47	3.7	23.7	880.1	22.8	86	82	7:46:36	5	3.7	21.2		30.0			1	3.7	21.2		3.7				90
2/26/00 8:39	2/26/00 8:44	5.0	27.6	883.0	29.1	86	82	9:39:10	6	5.0	30.1		35.0			2	5.0	30.1		8.7				90
2/26/00 10:35	2/26/00 10:42	7.2	46.6	876.5	33.0	86	82	11:31:54	7	7.2	44.5		42.2			3	7.2	44.5		15.8				90
2/26/00 12:32	2/26/00 12:40	8.0	80.0	880.3	33.4	86	82	13:26:06	8	8.0	50.1		50.2			4	8.0	50.1		23.8				90
2/26/00 14:32	2/26/00 14:38	6.3	34.3	885.3	30.1	86	82	15:22:34	9	6.3	38.9		56.5			5	6.3	38.9	5	30.2	30.17	184.8	146.92	90
2/26/00 22:36	2/26/00 22:38	2.2	21.3	876.6	6.3	86	82	23:14:15	10	2.2	11.2	10	58.7	58.67	358.4	0				0.0				90
2/27/00 0:33	2/27/00 0:41	7.3	44.7	880.3	5.3	87	83	1:08:08	1	7.3	45.6		7.3			0								90
2/27/00 2:31	2/27/00 2:39	8.0	78.5	875.1	7.8	87	83	3:03:08	2	8.0	50.1		15.3			0				0.0				90
2/27/00 4:30	2/27/00 4:36	6.5	37.8	867.0	12.9	87	83	4:58:08	3	6.5	40.1		21.8			0				0.0				90
2/27/00 6:27	2/27/00 6:32	4.3	25.2	882.2	19.4	87	83	6:52:49	4	4.3	25.6		26.2			0				0.0				90
2/27/00 8:24	2/27/00 8:28	4.0	24.5	879.0	26.1	87	83	8:46:12	5	4.0	23.4		30.2			1	4.0	23.4		4.0				90
2/27/00 10:19	2/27/00 10:26	6.3	34.9	878.3	31.4	87	83	10:38:37	6	6.3	38.9		36.5			2	6.3	38.9		10.3				90
2/27/00 12:16	2/27/00 12:24	8.0	69.9	878.8	33.5	87	83	12:32:00	7	8.0	50.1		44.5			3	8.0	50.1		18.3				90
2/27/00 14:14	2/27/00 14:22	7.5	50.7	879.2	32.0	87	83	14:27:19	8	7.5	46.7		52.0			4	7.5	46.7		25.8				90
2/27/00 16:16	2/27/00 16:19	3.7	23.4	883.4	27.0	87	83	16:25:25	9	3.7	21.2	9	55.7	55.66	341.7	5	3.7	21.2	5	29.5	29.5	180.3	146.92	90
2/28/00 0:17	2/28/00 0:23	5.7	30.7	871.2	5.2	88	84	0:14:11	1	5.7	34.5		5.7			0								90
2/28/00 2:15	2/28/00 2:23	8.0	71.0	876.4	6.1	88	84	2:08:52	2	8.0	50.1		13.7			0				0.0				90
2/28/00 4:13	2/28/00 4:21	7.5	51.8	878.0	10.0	88	84	4:03:52	3	7.5	46.7		21.2			0				0.0				90
2/28/00 6:12	2/28/00 6:17	5.2	29.2	865.8	16.0	88	84	5:58:53	4	5.2	31.2		26.3			0				0.0				90
2/28/00 8:09	2/28/00 8:12	3.5	23.6	873.0	22.8	88	84	7:53:04	5	3.5	20.0		29.8			1	3.5	20.0		3.5				90
2/28/00 10:05	2/28/00 10:10	5.0	28.2	869.6	29.0	88	84	9:45:39	6	5.0	30.1		34.8			2	5.0	30.1		8.5				90
2/28/00 12:00	2/28/00 12:08	7.3	48.5	877.1	32.8	88	84	11:38:23	7	7.3	45.6		42.2			3	7.3	45.6		15.8				90
2/28/00 13:58	2/28/00 14:06	8.0	76.5	876.6	33.0	88	84	13:32:44	8	8.0	50.1		50.2			4	8.0	50.1		23.8				90
2/28/00 15:58	2/28/00 16:04	6.0	32.8	869.3	29.5	88	84	15:29:22	9	6.0	36.7		56.2			5	6.0	36.7	5	29.8	29.83	182.5	146.92	90
2/29/00 0:02	2/29/00 0:05	2.8	22.1	878.4	5.8	89	84	23:20:34	10	2.8	15.6	10	59.0	59	360.6	0				0.0				90
2/29/00 1:59	2/29/00 2:07	7.3	46.9	884.2	5.0	89	85	1:14:46	1	7.3	45.6		7.3			0								90
2/29/00 3:57	2/29/00 4:05	8.0	75.1	874.5	7.7	89	85	3:09:37	2	8.0	50.1		15.3			0				0.0				90
2/29/00 5:55	2/29/00 6:02	6.5	36.6	878.9	12.8	89	85	5:04:37	3	6.5	40.1		21.8			0				0.0				90
2/29/00 7:53	2/29/00 7:57	4.2	24.9	877.6	19.4	89	85	6:59:18	4	4.2	24.5		26.0			0				0.0				90
2/29/00 9:50	2/29/00 9:54	4.0	24.7	873.8	26.1	89	85	8:52:41	5	4.0	23.4		30.0			1	4.0	23.4		4.0				90
2/29/00 11:45	2/29/00 11:52	6.3	36.0	873.1	31.2	89	85	10:45:05	6	6.3	38.9		36.3			2	6.3	38.9		10.3				90
2/29/00 13:42	2/29/00 13:50	8.0	73.2	875.6	33.1	89	85	12:38:28	7	8.0	50.1		44.3			3	8.0	50.1		18.3				90

Rise	Set	Pass Duration [min.]	Max.El at lander [deg.]	Max.Range [km]	MaxSun.El [de.g]	Day # [ET]	Sol #	LMST	Pass # that Sol	D/L Pass duration [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass	Max # passes that Sol	Cume D/L comm time that sol [min.]	Total D/L comm time/sol [min.]	D/L Volume/sol [Mbit]	Pass # sun el > 20°	Pass dur. sun el > 20° [min.]	D/L Volume [Mbit]/pass w/ 0.50 min. CMD interval/pass [sun el > 20°]	Max # passes sun el > 20°	Cume D/L time sun el > 20° [min.]	D/L time/sol sun el > 20° [min.]	D/L Volume/sol, sun el > 20 deg. [Mbit]	D/L Volume/sol, 4 passes, 6 min/pass [Mbit]	Mars98 Orbiter Daily Science D/L volume [Mbits]
2/29/00 15:40	2/29/00 15:48	7.3	48.3	873.1	31.4	89	85	14:33:58	8	7.3	45.6		51.7			4	7.3	45.6		25.7				90
2/29/00 17:42	2/29/00 17:45	3.2	22.6	878.5	26.3	89	85	16:32:22	9	3.2	17.8	9	54.8	54.83	336.1	5	3.2	17.8	5	28.8	28.83	175.8	146.92	90
Totals										**4860.9**	**29791**	**800**		**4861**	**29791**		**2926**	**17851**	**506**		**2926**	**17851**	**12635.27**	

Statistics: TOTAL RELAY OPPORTUNITIES

9.3	av passes/sol	56.5	av comm time/sol
7.0	min passes/sol	38.7	min comm time/sol
10.0	max passes/sol	61.5	max comm time/sol

6.1	av pass length
0.3	min pass length
8.2	max pass length

Statistics: RELAY OPPORTUNITIES at Solar Elevations > 20°

5.9	av passes/sol	34.0	av comm time/sol
5.0	min passes/sol	28.8	min comm time/sol
7.0	max passes/sol	40.2	nax comm time/sol

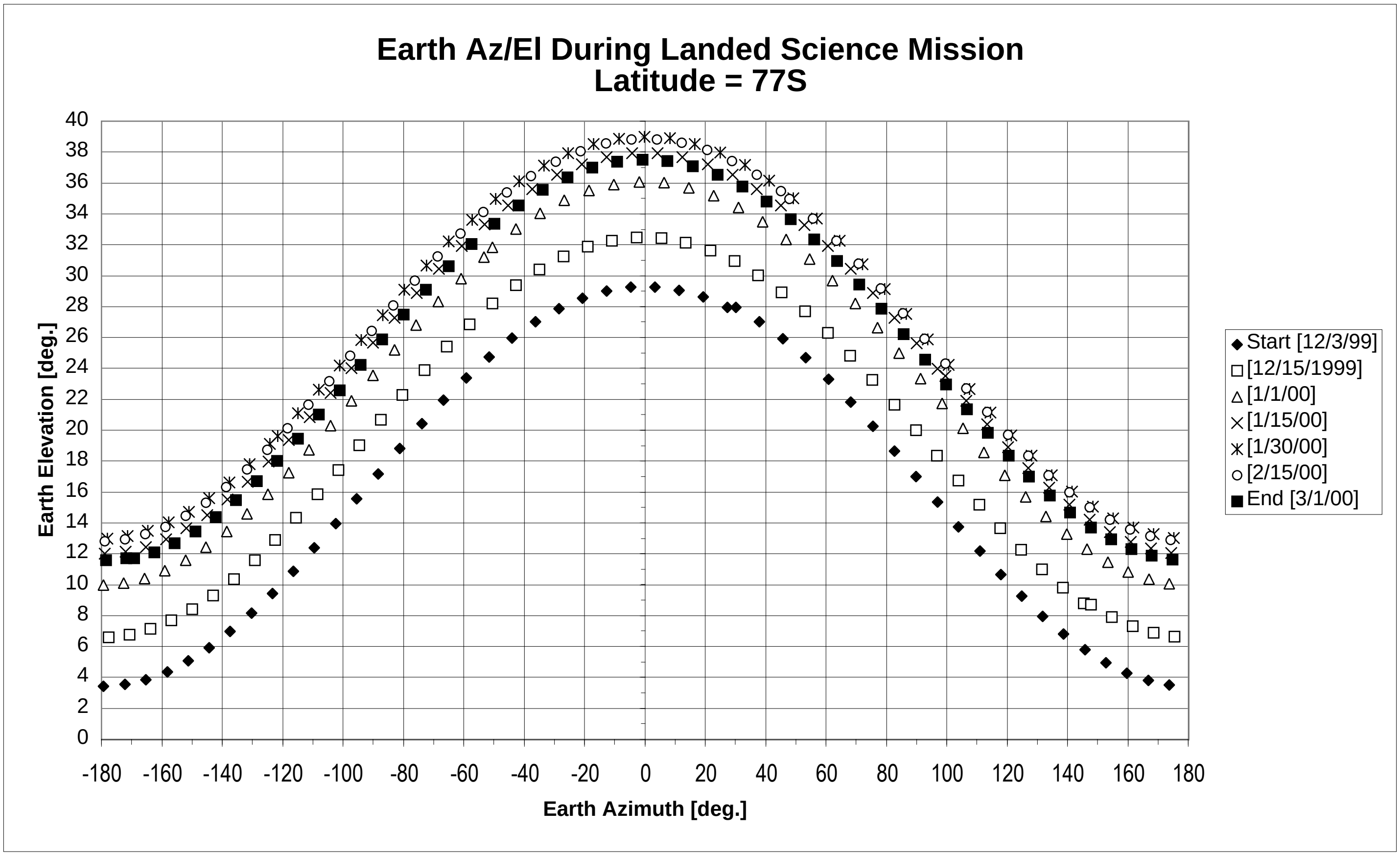
5.8	av pass length
175.8	min pass length
244.8	max pass length

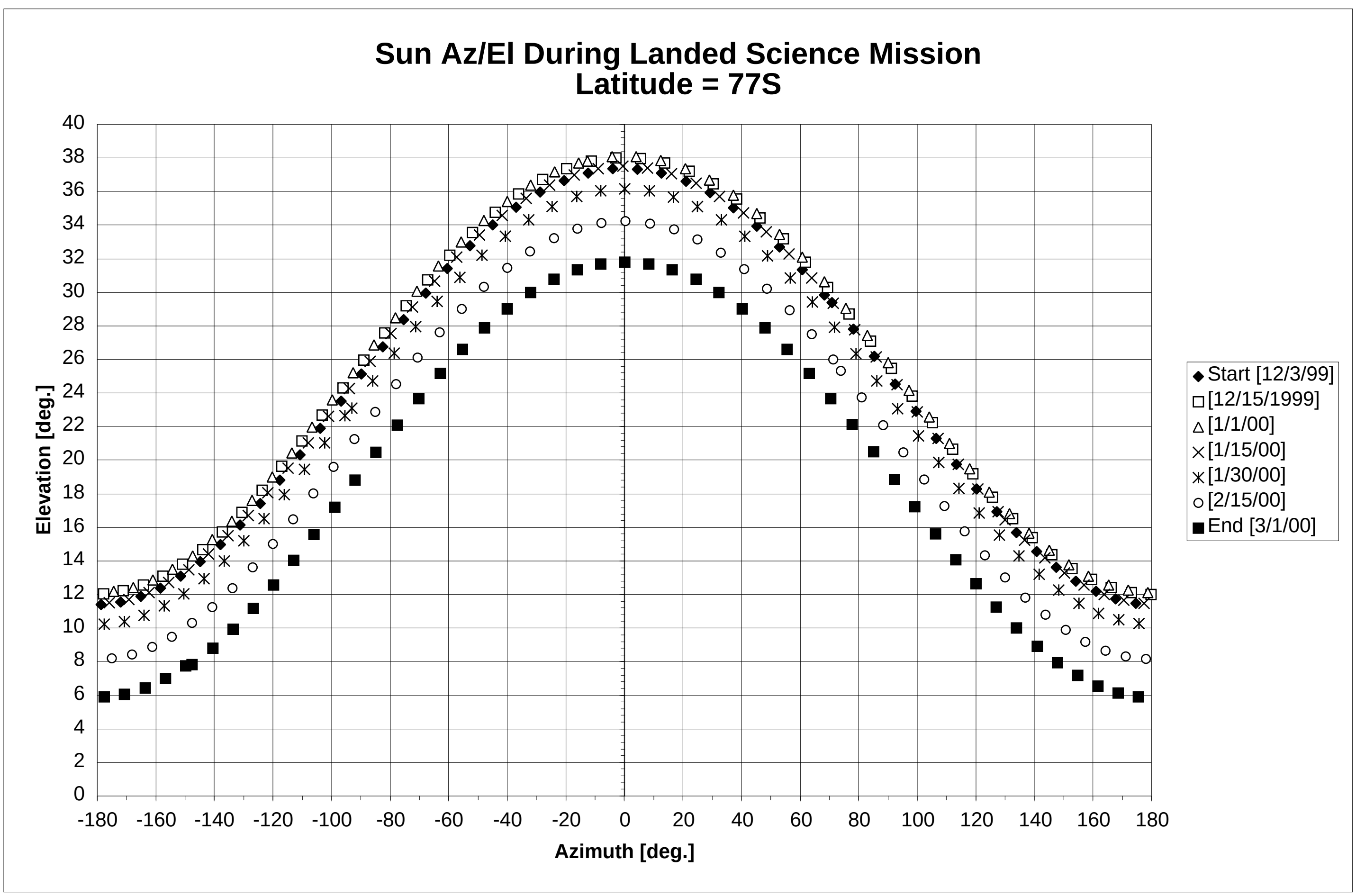
Solar and Earth Geometry for Lander at -76˚ [planetocentric], and 210˚W

Date	Lander Mission Day	Sun Range [AU]	Sun Decl. [deg.]	Min Sun Elev. [deg.]	Max Sun Elev. [deg.]	Earth Range [AU]	Earth Decl. [deg.]	Min Earth Elev. [deg.]	Max Earth Elev. [deg.]	Ls [deg.]
12/3/99	0	1.382	-24.4	10.4	38.4	1.691	-16.3	2.3	30.3	255.8
12/4/99	1	1.382	-24.4	10.4	38.4	1.696	-16.5	2.5	30.5	256.4
12/5/99	2	1.382	-24.5	10.5	38.5	1.702	-16.8	2.8	30.8	257.0
12/6/99	3	1.382	-24.6	10.6	38.6	1.707	-17.1	3.1	31.1	257.7
12/7/99	4	1.382	-24.6	10.6	38.6	1.712	-17.4	3.4	31.4	258.3
12/8/99	5	1.383	-24.7	10.7	38.7	1.718	-17.6	3.6	31.6	258.9
12/9/99	6	1.383	-24.7	10.7	38.7	1.723	-17.9	3.9	31.9	259.6
12/10/99	7	1.383	-24.8	10.8	38.8	1.728	-18.1	4.1	32.1	260.2
12/11/99	8	1.383	-24.8	10.8	38.8	1.734	-18.4	4.4	32.4	260.8
12/12/99	9	1.383	-24.9	10.9	38.9	1.739	-18.6	4.6	32.6	261.5
12/13/99	10	1.384	-24.9	10.9	38.9	1.744	-18.9	4.9	32.9	262.1
12/14/99	11	1.384	-25.0	11.0	39.0	1.750	-19.1	5.1	33.1	262.7
12/15/99	12	1.384	-25.0	11.0	39.0	1.755	-19.4	5.4	33.4	263.4
12/16/99	13	1.384	-25.0	11.0	39.0	1.761	-19.6	5.6	33.6	264.0
12/17/99	14	1.385	-25.1	11.1	39.1	1.766	-19.9	5.9	33.9	264.6
12/18/99	15	1.385	-25.1	11.1	39.1	1.771	-20.1	6.1	34.1	265.3
12/19/99	16	1.385	-25.1	11.1	39.1	1.777	-20.3	6.3	34.3	265.9
12/20/99	17	1.386	-25.1	11.1	39.1	1.782	-20.5	6.5	34.5	266.5
12/21/99	18	1.386	-25.2	11.2	39.2	1.787	-20.8	6.8	34.8	267.2
12/22/99	19	1.386	-25.2	11.2	39.2	1.793	-21.0	7.0	35.0	267.8
12/23/99	20	1.387	-25.2	11.2	39.2	1.798	-21.2	7.2	35.2	268.4
12/24/99	21	1.387	-25.2	11.2	39.2	1.804	-21.4	7.4	35.4	269.0
12/25/99	22	1.388	-25.2	11.2	39.2	1.809	-21.6	7.6	35.6	269.7
12/26/99	23	1.388	-25.2	11.2	39.2	1.814	-21.8	7.8	35.8	270.3
12/27/99	24	1.388	-25.2	11.2	39.2	1.820	-22.0	8.0	36.0	270.9
12/28/99	25	1.389	-25.2	11.2	39.2	1.825	-22.2	8.2	36.2	271.6
12/29/99	26	1.389	-25.2	11.2	39.2	1.831	-22.4	8.4	36.4	272.2
12/30/99	27	1.390	-25.2	11.2	39.2	1.836	-22.6	8.6	36.6	272.8
12/31/99	28	1.390	-25.1	11.1	39.1	1.841	-22.8	8.8	36.8	273.4
1/1/00	29	1.391	-25.1	11.1	39.1	1.847	-22.9	8.9	36.9	274.1
1/2/00	30	1.391	-25.1	11.1	39.1	1.852	-23.1	9.1	37.1	274.7
1/3/00	31	1.392	-25.1	11.1	39.1	1.858	-23.3	9.3	37.3	275.3
1/4/00	32	1.392	-25.0	11.0	39.0	1.863	-23.4	9.4	37.4	275.9
1/5/00	33	1.393	-25.0	11.0	39.0	1.869	-23.6	9.6	37.6	276.6
1/6/00	34	1.394	-25.0	11.0	39.0	1.874	-23.7	9.7	37.7	277.2
1/7/00	35	1.394	-24.9	10.9	38.9	1.879	-23.9	9.9	37.9	277.8
1/8/00	36	1.395	-24.9	10.9	38.9	1.885	-24.0	10.0	38.0	278.4
1/9/00	37	1.395	-24.9	10.9	38.9	1.890	-24.2	10.2	38.2	279.1
1/10/00	38	1.396	-24.8	10.8	38.8	1.896	-24.3	10.3	38.3	279.7
1/11/00	39	1.397	-24.8	10.8	38.8	1.901	-24.4	10.4	38.4	280.3
1/12/00	40	1.397	-24.7	10.7	38.7	1.907	-24.6	10.6	38.6	280.9
1/13/00	41	1.398	-24.6	10.6	38.6	1.912	-24.7	10.7	38.7	281.5
1/14/00	42	1.399	-24.6	10.6	38.6	1.917	-24.8	10.8	38.8	282.2
1/15/00	43	1.399	-24.5	10.5	38.5	1.923	-24.9	10.9	38.9	282.8
1/16/00	44	1.400	-24.5	10.5	38.5	1.928	-25.0	11.0	39.0	283.4
1/17/00	45	1.401	-24.4	10.4	38.4	1.934	-25.1	11.1	39.1	284.0
1/18/00	46	1.401	-24.3	10.3	38.3	1.939	-25.2	11.2	39.2	284.6
1/19/00	47	1.402	-24.2	10.2	38.2	1.945	-25.3	11.3	39.3	285.3
1/20/00	48	1.403	-24.2	10.2	38.2	1.950	-25.4	11.4	39.4	285.9
1/21/00	49	1.404	-24.1	10.1	38.1	1.955	-25.5	11.5	39.5	286.5
1/22/00	50	1.404	-24.0	10.0	38.0	1.961	-25.6	11.6	39.6	287.1
1/23/00	51	1.405	-23.9	9.9	37.9	1.966	-25.6	11.6	39.6	287.7
1/24/00	52	1.406	-23.8	9.8	37.8	1.972	-25.7	11.7	39.7	288.3
1/25/00	53	1.407	-23.7	9.7	37.7	1.977	-25.8	11.8	39.8	288.9
1/26/00	54	1.408	-23.6	9.6	37.6	1.983	-25.8	11.8	39.8	289.5
1/27/00	55	1.408	-23.6	9.6	37.6	1.988	-25.9	11.9	39.9	290.2
1/28/00	56	1.409	-23.5	9.5	37.5	1.993	-25.9	11.9	39.9	290.8
1/29/00	57	1.410	-23.4	9.4	37.4	1.999	-25.9	11.9	39.9	291.4
1/30/00	58	1.411	-23.2	9.2	37.2	2.004	-26.0	12.0	40.0	292.0
1/31/00	59	1.412	-23.1	9.1	37.1	2.010	-26.0	12.0	40.0	292.6
2/1/00	60	1.413	-23.0	9.0	37.0	2.015	-26.0	12.0	40.0	293.2
2/2/00	61	1.414	-22.9	8.9	36.9	2.021	-26.1	12.1	40.1	293.8
2/3/00	62	1.414	-22.8	8.8	36.8	2.026	-26.1	12.1	40.1	294.4

Solar and Earth Geometry for Lander at -76˚ [planetocentric], and 210˚W

Date	Lander Mission Day	Sun Range [AU]	Sun Decl. [deg.]	Min Sun Elev. [deg.]	Max Sun Elev. [deg.]	Earth Range [AU]	Earth Decl. [deg.]	Min Earth Elev. [deg.]	Max Earth Elev. [deg.]	Ls [deg.]
2/4/00	63	1.415	-22.7	8.7	36.7	2.031	-26.1	12.1	40.1	295.0
2/5/00	64	1.416	-22.6	8.6	36.6	2.037	-26.1	12.1	40.1	295.6
2/6/00	65	1.417	-22.4	8.4	36.4	2.042	-26.1	12.1	40.1	296.2
2/7/00	66	1.418	-22.3	8.3	36.3	2.048	-26.1	12.1	40.1	296.8
2/8/00	67	1.419	-22.2	8.2	36.2	2.053	-26.1	12.1	40.1	297.4
2/9/00	68	1.420	-22.1	8.1	36.1	2.058	-26.0	12.0	40.0	298.0
2/10/00	69	1.421	-21.9	7.9	35.9	2.064	-26.0	12.0	40.0	298.6
2/11/00	70	1.422	-21.8	7.8	35.8	2.069	-26.0	12.0	40.0	299.2
2/12/00	71	1.423	-21.7	7.7	35.7	2.074	-26.0	12.0	40.0	299.8
2/13/00	72	1.424	-21.5	7.5	35.5	2.080	-25.9	11.9	39.9	300.4
2/14/00	73	1.425	-21.4	7.4	35.4	2.085	-25.9	11.9	39.9	301.0
2/15/00	74	1.426	-21.3	7.3	35.3	2.091	-25.8	11.8	39.8	301.6
2/16/00	75	1.427	-21.1	7.1	35.1	2.096	-25.8	11.8	39.8	302.2
2/17/00	76	1.428	-21.0	7.0	35.0	2.101	-25.7	11.7	39.7	302.8
2/18/00	77	1.429	-20.8	6.8	34.8	2.107	-25.7	11.7	39.7	303.4
2/19/00	78	1.430	-20.7	6.7	34.7	2.112	-25.6	11.6	39.6	304.0
2/20/00	79	1.431	-20.5	6.5	34.5	2.117	-25.5	11.5	39.5	304.6
2/21/00	80	1.432	-20.4	6.4	34.4	2.123	-25.5	11.5	39.5	305.2
2/22/00	81	1.433	-20.2	6.2	34.2	2.128	-25.4	11.4	39.4	305.8
2/23/00	82	1.434	-20.0	6.0	34.0	2.133	-25.3	11.3	39.3	306.4
2/24/00	83	1.435	-19.9	5.9	33.9	2.138	-25.2	11.2	39.2	307.0
2/25/00	84	1.436	-19.7	5.7	33.7	2.144	-25.1	11.1	39.1	307.5
2/26/00	85	1.438	-19.6	5.6	33.6	2.149	-25.0	11.0	39.0	308.1
2/27/00	86	1.439	-19.4	5.4	33.4	2.154	-24.9	10.9	38.9	308.7
2/28/00	87	1.440	-19.2	5.2	33.2	2.159	-24.8	10.8	38.8	309.3
2/29/00	88	1.441	-19.1	5.1	33.1	2.165	-24.7	10.7	38.7	309.9
3/1/00	89	1.442	-18.9	4.9	32.9	2.170	-24.6	10.6	38.6	310.5
3/2/00	90	1.443	-18.7	4.7	32.7	2.175	-24.5	10.5	38.5	311.0
3/3/00	91	1.444	-18.6	4.6	32.6	2.180	-24.3	10.3	38.3	311.6
3/4/00	92	1.445	-18.4	4.4	32.4	2.185	-24.2	10.2	38.2	312.2
3/5/00	93	1.447	-18.2	4.2	32.2	2.191	-24.1	10.1	38.1	312.8
3/6/00	94	1.448	-18.0	4.0	32.0	2.196	-23.9	9.9	37.9	313.4
3/7/00	95	1.449	-17.8	3.8	31.8	2.201	-23.8	9.8	37.8	313.9
3/8/00	96	1.450	-17.7	3.7	31.7	2.206	-23.6	9.6	37.6	314.5
3/9/00	97	1.451	-17.5	3.5	31.5	2.211	-23.5	9.5	37.5	315.1
3/10/00	98	1.452	-17.3	3.3	31.3	2.216	-23.3	9.3	37.3	315.7
3/11/00	99	1.454	-17.1	3.1	31.1	2.221	-23.2	9.2	37.2	316.2
3/12/00	100	1.455	-16.9	2.9	30.9	2.226	-23.0	9.0	37.0	316.8
3/13/00	101	1.456	-16.7	2.7	30.7	2.231	-22.8	8.8	36.8	317.4
3/14/00	102	1.457	-16.6	2.6	30.6	2.236	-22.7	8.7	36.7	318.0
3/15/00	103	1.458	-16.4	2.4	30.4	2.241	-22.5	8.5	36.5	318.5
3/16/00	104	1.460	-16.2	2.2	30.2	2.246	-22.3	8.3	36.3	319.1
3/17/00	105	1.461	-16.0	2.0	30.0	2.251	-22.1	8.1	36.1	319.7
3/18/00	106	1.462	-15.8	1.8	29.8	2.256	-22.0	8.0	36.0	320.2
3/19/00	107	1.463	-15.6	1.6	29.6	2.261	-21.8	7.8	35.8	320.8
3/20/00	108	1.464	-15.4	1.4	29.4	2.266	-21.6	7.6	35.6	321.4
3/21/00	109	1.466	-15.2	1.2	29.2	2.271	-21.4	7.4	35.4	321.9
3/22/00	110	1.467	-15.0	1.0	29.0	2.276	-21.2	7.2	35.2	322.5
3/23/00	111	1.468	-14.8	0.8	28.8	2.281	-21.0	7.0	35.0	323.1
3/24/00	112	1.469	-14.6	0.6	28.6	2.286	-20.8	6.8	34.8	323.6
3/25/00	113	1.471	-14.4	0.4	28.4	2.291	-20.6	6.6	34.6	324.2
3/26/00	114	1.472	-14.2	0.2	28.2	2.295	-20.4	6.4	34.4	324.7
3/27/00	115	1.473	-14.0	0.0	28.0	2.300	-20.2	6.2	34.2	325.3
3/28/00	116	1.474	-13.8	0.0	27.8	2.305	-19.9	5.9	33.9	325.9
3/29/00	117	1.476	-13.6	0.0	27.6	2.310	-19.7	5.7	33.7	326.4
3/30/00	118	1.477	-13.4	0.0	27.4	2.314	-19.5	5.5	33.5	327.0
3/31/00	119	1.478	-13.2	0.0	27.2	2.319	-19.3	5.3	33.3	327.5
4/1/00	120	1.479	-13.0	0.0	27.0	2.324	-19.1	5.1	33.1	328.1


Earth Az/El During Landed Science Mission
Latitude = 77S
Earth Elevation [deg.]
Earth Azimuth [deg.]
Start [12/3/99]
[12/15/1999]
[1/1/00]
[1/15/00]
[1/30/00]
[2/15/00]
End [3/1/00]

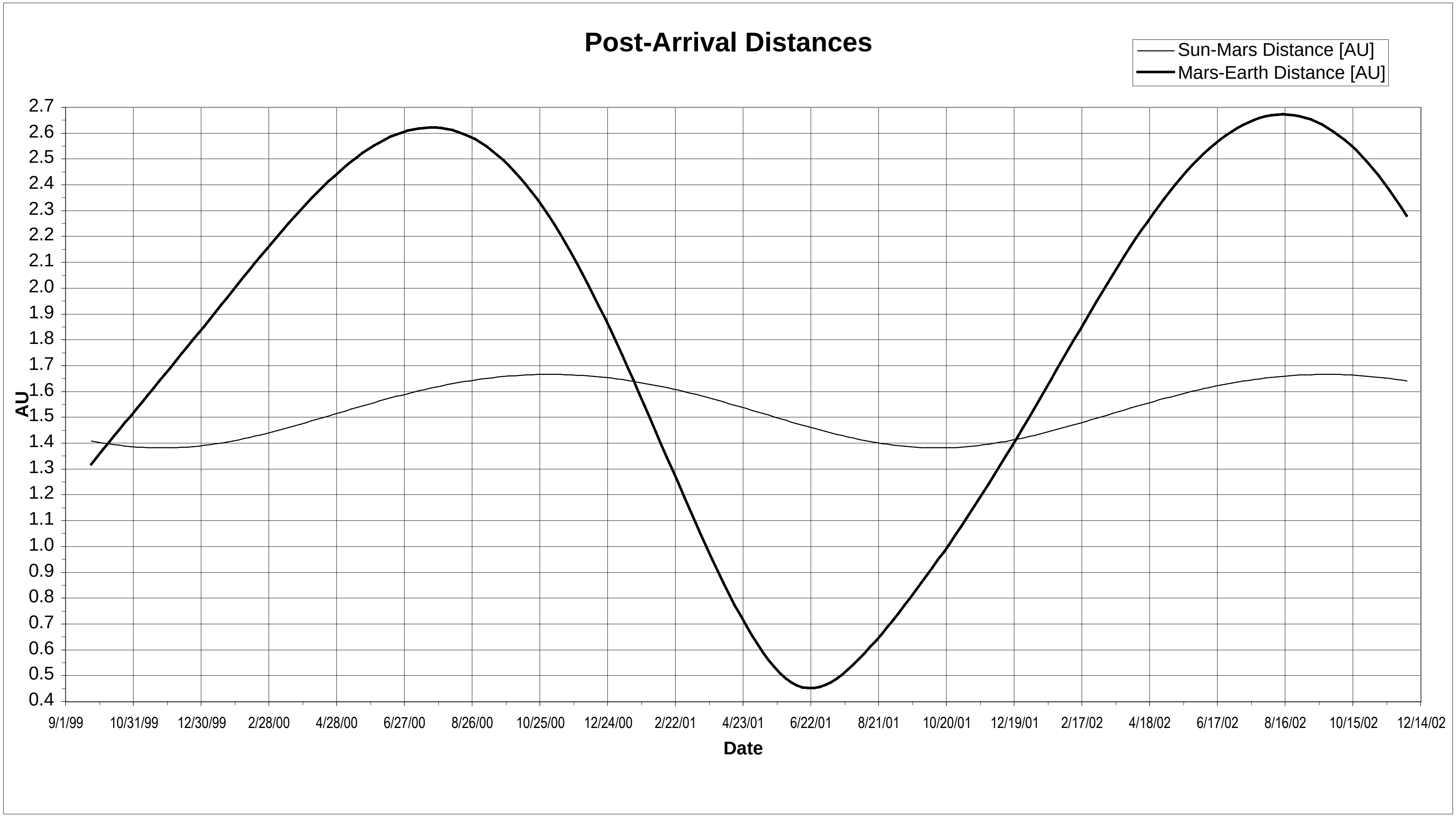

Sun Az/El During Landed Science Mission
Latitude = 77S
Elevation [deg.]
Azimuth [deg.]
Start [12/3/99]
[12/15/1999]
[1/1/00]
[1/15/00]
[1/30/00]
[2/15/00]
End [3/1/00]

Date	Days from Earliest MOI	Days from Start of Mapping	Sun-Mars Distance [AU]	Mars-Earth Distance [AU]	ESM [deg.]	SEM [deg.]	SME [deg.]	Events
9/24/99	1		1.4085	1.3173	63.6326	73.3347	43.0327	Orbiter MOI
9/29/99	6		1.4045	1.3447	65.4709	71.8521	42.6770	
10/4/99	11		1.4008	1.3718	67.3062	70.4061	42.2877	
10/9/99	16		1.3974	1.3988	69.1398	68.9929	41.8673	
10/14/99	21		1.3943	1.4256	70.9729	67.6092	41.4179	
10/19/99	26		1.3915	1.4523	72.8070	66.2519	40.9411	
10/24/99	31		1.3891	1.4789	74.6431	64.9181	40.4389	
10/29/99	36		1.3869	1.5055	76.4825	63.6049	39.9126	
11/3/99	41		1.3852	1.5320	78.3264	62.3100	39.3636	
11/8/99	46		1.3837	1.5584	80.1758	61.0309	38.7933	
11/13/99	51		1.3826	1.5849	82.0318	59.7654	38.2027	
11/18/99	56		1.3819	1.6114	83.8954	58.5115	37.5930	
11/23/99	61		1.3815	1.6379	85.7674	57.2674	36.9652	
11/28/99	66		1.3815	1.6644	87.6486	56.0312	36.3202	Perihelion
12/3/99	71		1.3819	1.6910	89.5398	54.8014	35.6588	Lander Arrival
12/8/99	76		1.3826	1.7177	91.4416	53.5765	34.9819	
12/13/99	81		1.3837	1.7445	93.3545	52.3552	34.2903	
12/18/99	86		1.3851	1.7713	95.2790	51.1363	33.5847	
12/23/99	91		1.3869	1.7983	97.2155	49.9187	32.8658	
12/28/99	96		1.3890	1.8253	99.1642	48.7015	32.1343	
1/2/00	101		1.3915	1.8523	101.1254	47.4837	31.3909	
1/7/00	106		1.3942	1.8794	103.0992	46.2647	30.6361	
1/12/00	111		1.3973	1.9066	105.0855	45.0438	29.8707	
1/17/00	116		1.4008	1.9338	107.0845	43.8204	29.0951	
1/22/00	121		1.4045	1.9609	109.0960	42.5941	28.3099	
1/27/00	126		1.4084	1.9881	111.1198	41.3644	27.5157	
2/1/00	131		1.4127	2.0152	113.1559	40.1311	26.7130	
2/6/00	136		1.4172	2.0422	115.2039	38.8938	25.9023	
2/11/00	141		1.4220	2.0692	117.2637	37.6524	25.0840	
2/16/00	146		1.4269	2.0959	119.3349	36.4066	24.2585	
2/21/00	151		1.4321	2.1225	121.4174	35.1562	23.4264	
2/26/00	156		1.4375	2.1489	123.5107	33.9013	22.5880	
3/2/00	161	1	1.4431	2.1750	125.6148	32.6415	21.7437	End Lander Mission; Start Mapping
3/7/00	166	6	1.4488	2.2008	127.7293	31.3770	20.8938	
3/12/00	171	11	1.4547	2.2263	129.8539	30.1074	20.0387	
3/17/00	176	16	1.4607	2.2514	131.9885	28.8328	19.1787	
3/22/00	181	21	1.4669	2.2760	134.1328	27.5531	18.3141	
3/27/00	186	26	1.4731	2.3002	136.2868	26.2680	17.4451	
4/1/00	191	31	1.4795	2.3239	138.4503	24.9776	16.5721	
4/6/00	196	36	1.4859	2.3469	140.6233	23.6816	15.6951	
4/11/00	201	41	1.4923	2.3694	142.8056	22.3798	14.8145	
4/16/00	206	46	1.4988	2.3912	144.9974	21.0721	13.9305	
4/21/00	211	51	1.5054	2.4123	147.1986	19.7583	13.0431	
4/26/00	216	56	1.5119	2.4327	149.4093	18.4381	12.1526	
5/1/00	221	61	1.5184	2.4522	151.6296	17.1112	11.2592	
5/6/00	226	66	1.5249	2.4709	153.8596	15.7775	10.3629	
5/11/00	231	71	1.5314	2.4887	156.0994	14.4366	9.4640	
5/16/00	236	76	1.5379	2.5056	158.3493	13.0882	8.5625	
5/21/00	241	81	1.5443	2.5215	160.6091	11.7322	7.6587	
5/26/00	246	86	1.5506	2.5364	162.8788	10.3683	6.7529	
5/31/00	251	91	1.5568	2.5502	165.1582	8.9965	5.8453	
6/5/00	256	96	1.5630	2.5629	167.4464	7.6172	4.9365	
6/10/00	261	101	1.5690	2.5744	169.7415	6.2311	4.0274	
6/15/00	266	106	1.5750	2.5848	172.0389	4.8410	3.1201	
6/20/00	271	111	1.5808	2.5939	174.3257	3.4544	2.2199	
6/25/00	276	116	1.5864	2.6018	176.5531	2.1010	1.3460	
6/30/00	281	121	1.5920	2.6084	178.3783	0.9897	0.6320	
7/5/00	286	126	1.5974	2.6137	177.8429	1.3181	0.8389	
7/10/00	291	131	1.6026	2.6175	175.7372	2.6084	1.6544	
7/15/00	296	136	1.6077	2.6200	173.4108	4.0377	2.5516	
7/20/00	301	141	1.6126	2.6211	171.0203	5.5105	3.4692	Max Earth Dist
7/25/00	306	146	1.6173	2.6207	168.5950	7.0094	4.3956	
7/30/00	311	151	1.6218	2.6188	166.1434	8.5294	5.3271	

Date	Days from Earliest MOI	Days from Start of Mapping	Sun-Mars Distance [AU]	Mars-Earth Distance [AU]	ESM [deg.]	SEM [deg.]	SME [deg.]	Events
8/4/00	316	156	1.6261	2.6154	163.6692	10.0687	6.2621	
8/9/00	321	161	1.6303	2.6104	161.1737	11.6267	7.1996	
8/14/00	326	166	1.6342	2.6039	158.6576	13.2033	8.1392	
8/19/00	331	171	1.6379	2.5959	156.1211	14.7986	9.0803	
8/24/00	336	176	1.6414	2.5862	153.5645	16.4130	10.0225	
8/29/00	341	181	1.6447	2.5749	150.9877	18.0468	10.9655	
9/3/00	346	186	1.6478	2.5620	148.3908	19.7002	11.9090	
9/8/00	351	191	1.6506	2.5474	145.7738	21.3737	12.8525	
9/13/00	356	196	1.6532	2.5312	143.1369	23.0675	13.7956	
9/18/00	361	201	1.6556	2.5134	140.4802	24.7819	14.7379	
9/23/00	366	206	1.6577	2.4939	137.8040	26.5172	15.6788	
9/28/00	371	211	1.6596	2.4727	135.1085	28.2736	16.6179	
10/3/00	376	216	1.6613	2.4499	132.3942	30.0513	17.5545	
10/8/00	381	221	1.6627	2.4255	129.6616	31.8505	18.4880	
10/13/00	386	226	1.6638	2.3995	126.9112	33.6711	19.4177	
10/18/00	391	231	1.6647	2.3718	124.1437	35.5134	20.3429	
10/23/00	396	236	1.6654	2.3426	121.3600	37.3773	21.2627	
10/28/00	401	241	1.6658	2.3118	118.5610	39.2628	22.1762	
11/2/00	406	246	1.6660	2.2795	115.7476	41.1699	23.0826	Aphelion
11/7/00	411	251	1.6659	2.2457	112.9210	43.0984	23.9806	
11/12/00	416	256	1.6656	2.2104	110.0824	45.0483	24.8693	
11/17/00	421	261	1.6650	2.1737	107.2331	47.0194	25.7475	
11/22/00	426	266	1.6642	2.1356	104.3747	49.0116	26.6137	
11/27/00	431	271	1.6631	2.0963	101.5086	51.0247	27.4667	
12/2/00	436	276	1.6618	2.0556	98.6364	53.0587	28.3049	
12/7/00	441	281	1.6602	2.0137	95.7598	55.1135	29.1268	
12/12/00	446	286	1.6584	1.9707	92.8806	57.1889	29.9305	
12/17/00	451	291	1.6564	1.9266	90.0006	59.2852	30.7142	
12/22/00	456	296	1.6541	1.8815	87.1218	61.4023	31.4759	
12/27/00	461	301	1.6516	1.8355	84.2460	63.5405	32.2135	
1/1/01	466	306	1.6488	1.7886	81.3751	65.7003	32.9246	
1/6/01	471	311	1.6458	1.7410	78.5113	67.8820	33.6067	
1/11/01	476	316	1.6426	1.6926	75.6565	70.0866	34.2570	
1/16/01	481	321	1.6392	1.6437	72.8125	72.3149	34.8726	
1/21/01	486	326	1.6356	1.5942	69.9815	74.5683	35.4502	
1/26/01	491	331	1.6317	1.5443	67.1653	76.8484	35.9863	
1/31/01	496	336	1.6277	1.4941	64.3658	79.1571	36.4771	
2/5/01	501	341	1.6234	1.4437	61.5849	81.4969	36.9182	
2/10/01	506	346	1.6189	1.3931	58.8242	83.8707	37.3051	
2/15/01	511	351	1.6143	1.3425	56.0855	86.2820	37.6324	
2/20/01	516	356	1.6095	1.2919	53.3705	88.7350	37.8945	
2/25/01	521	361	1.6045	1.2415	50.6805	91.2346	38.0849	
3/2/01	526	366	1.5993	1.1914	48.0171	93.7865	38.1964	
3/7/01	531	371	1.5940	1.1417	45.3816	96.3974	38.2211	
3/12/01	536	376	1.5885	1.0924	42.7751	99.0751	38.1498	
3/17/01	541	381	1.5828	1.0438	40.1987	101.8287	37.9726	
3/22/01	546	386	1.5771	0.9959	37.6535	104.6687	37.6778	
3/27/01	551	391	1.5712	0.9488	35.1403	107.6069	37.2529	
4/1/01	556	396	1.5652	0.9027	32.6598	110.6570	36.6832	
4/6/01	561	401	1.5591	0.8577	30.2126	113.8346	35.9528	
4/11/01	566	406	1.5529	0.8140	27.7994	117.1570	35.0436	
4/16/01	571	411	1.5466	0.7716	25.4205	120.6437	33.9358	
4/21/01	576	416	1.5402	0.7309	23.0761	124.3157	32.6081	
4/26/01	581	421	1.5338	0.6920	20.7666	128.1958	31.0376	
5/1/01	586	426	1.5273	0.6550	18.4921	132.3072	29.2008	
5/6/01	591	431	1.5208	0.6203	16.2526	136.6728	27.0746	
5/11/01	596	436	1.5143	0.5881	14.0484	141.3130	24.6386	
5/16/01	601	441	1.5077	0.5586	11.8796	146.2428	21.8775	
5/21/01	606	446	1.5012	0.5321	9.7470	151.4678	18.7852	
5/26/01	611	451	1.4947	0.5089	7.6521	156.9777	15.3702	
5/31/01	616	456	1.4882	0.4893	5.5998	162.7358	11.6644	
6/5/01	621	461	1.4818	0.4736	3.6065	168.6480	7.7455	
6/10/01	626	466	1.4754	0.4618	1.7651	174.3519	3.8830	

Date	Days from Earliest MOI	Days from Start of Mapping	Sun-Mars Distance [AU]	Mars-Earth Distance [AU]	ESM [deg.]	SEM [deg.]	SME [deg.]	Events
6/15/01	631	471	1.4692	0.4541	1.1472	176.2861	2.5667	
6/20/01	636	476	1.4630	0.4505	2.6948	171.2176	6.0876	Min Earth Dist
6/25/01	641	481	1.4569	0.4509	4.5420	165.1750	10.2830	
6/30/01	646	486	1.4510	0.4551	6.4124	159.1408	14.4468	
7/5/01	651	491	1.4452	0.4628	8.2737	153.2982	18.4281	
7/10/01	656	496	1.4395	0.4737	10.1186	147.7305	22.1508	
7/15/01	661	501	1.4341	0.4874	11.9454	142.4828	25.5719	
7/20/01	666	506	1.4288	0.5035	13.7541	137.5749	28.6711	
7/25/01	671	511	1.4237	0.5218	15.5457	133.0090	31.4454	
7/30/01	676	516	1.4189	0.5419	17.3215	128.7747	33.9038	
8/4/01	681	521	1.4143	0.5635	19.0830	124.8539	36.0631	
8/9/01	686	526	1.4099	0.5863	20.8319	121.2235	37.9446	
8/14/01	691	531	1.4058	0.6103	22.5702	117.8586	39.5712	
8/19/01	696	536	1.4020	0.6352	24.2995	114.7341	40.9663	
8/24/01	701	541	1.3985	0.6609	26.0221	111.8257	42.1522	
8/29/01	706	546	1.3953	0.6873	27.7397	109.1104	43.1499	
9/3/01	711	551	1.3924	0.7143	29.4545	106.5671	43.9784	
9/8/01	716	556	1.3898	0.7419	31.1686	104.1763	44.6551	
9/13/01	721	561	1.3876	0.7700	32.8839	101.9207	45.1953	
9/18/01	726	566	1.3857	0.7985	34.6026	99.7845	45.6129	
9/23/01	731	571	1.3841	0.8275	36.3266	97.7533	45.9200	
9/28/01	736	576	1.3829	0.8569	38.0580	95.8146	46.1274	
10/3/01	741	581	1.3820	0.8867	39.7986	93.9568	46.2446	
10/8/01	746	586	1.3815	0.9170	41.5502	92.1698	46.2800	
10/13/01	751	591	1.3814	0.9477	43.3148	90.4442	46.2410	Perihelion
10/18/01	756	596	1.3816	0.9788	45.0939	88.7719	46.1343	
10/23/01	761	601	1.3822	1.0103	46.8890	87.1454	45.9656	
10/28/01	766	606	1.3832	1.0423	48.7017	85.5580	45.7403	
11/2/01	771	611	1.3845	1.0747	50.5332	84.0039	45.4629	
11/7/01	776	616	1.3862	1.1075	52.3847	82.4776	45.1376	
11/12/01	781	621	1.3882	1.1408	54.2572	80.9745	44.7682	
11/17/01	786	626	1.3905	1.1745	56.1516	79.4903	44.3581	
11/22/01	791	631	1.3932	1.2087	58.0685	78.0212	43.9103	
11/27/01	796	636	1.3962	1.2432	60.0085	76.5640	43.4275	
12/2/01	801	641	1.3995	1.2782	61.9720	75.1158	42.9122	
12/7/01	806	646	1.4031	1.3136	63.9591	73.6741	42.3668	
12/12/01	811	651	1.4069	1.3493	65.9699	72.2368	41.7933	
12/17/01	816	656	1.4111	1.3854	68.0043	70.8020	41.1937	
12/22/01	821	661	1.4155	1.4219	70.0621	69.3682	40.5697	
12/27/01	826	666	1.4202	1.4586	72.1429	67.9342	39.9230	
1/1/02	831	671	1.4251	1.4956	74.2461	66.4989	39.2550	
1/6/02	836	676	1.4302	1.5329	76.3712	65.0616	38.5672	
1/11/02	841	681	1.4355	1.5703	78.5175	63.6216	37.8608	
1/16/02	846	686	1.4410	1.6079	80.6842	62.1786	37.1371	Orbiter end of Mapping
1/21/02	851	691	1.4467	1.6456	82.8704	60.7323	36.3973	
1/26/02	856	696	1.4526	1.6834	85.0752	59.2825	35.6423	
1/31/02	861	701	1.4585	1.7212	87.2977	57.8292	34.8732	
2/5/02	866	706	1.4646	1.7589	89.5368	56.3724	34.0908	
2/10/02	871	711	1.4709	1.7966	91.7916	54.9123	33.2961	
2/15/02	876	716	1.4771	1.8342	94.0611	53.4491	32.4898	
2/20/02	881	721	1.4835	1.8715	96.3443	51.9830	31.6727	
2/25/02	886	726	1.4900	1.9086	98.6403	50.5141	30.8456	
3/2/02	891	731	1.4964	1.9455	100.9482	49.0428	30.0090	
3/7/02	896	736	1.5030	1.9819	103.2670	47.5694	29.1636	
3/12/02	901	741	1.5095	2.0180	105.5960	46.0940	28.3100	
3/17/02	906	746	1.5160	2.0536	107.9345	44.6169	27.4486	
3/22/02	911	751	1.5225	2.0887	110.2817	43.1382	26.5801	
3/27/02	916	756	1.5290	2.1232	112.6370	41.6582	25.7047	
4/1/02	921	761	1.5355	2.1571	114.9999	40.1770	24.8230	
4/6/02	926	766	1.5419	2.1903	117.3700	38.6947	23.9354	
4/11/02	931	771	1.5482	2.2228	119.7467	37.2112	23.0421	
4/16/02	936	776	1.5545	2.2545	122.1298	35.7266	22.1436	
4/21/02	941	781	1.5607	2.2853	124.5190	34.2410	21.2400	

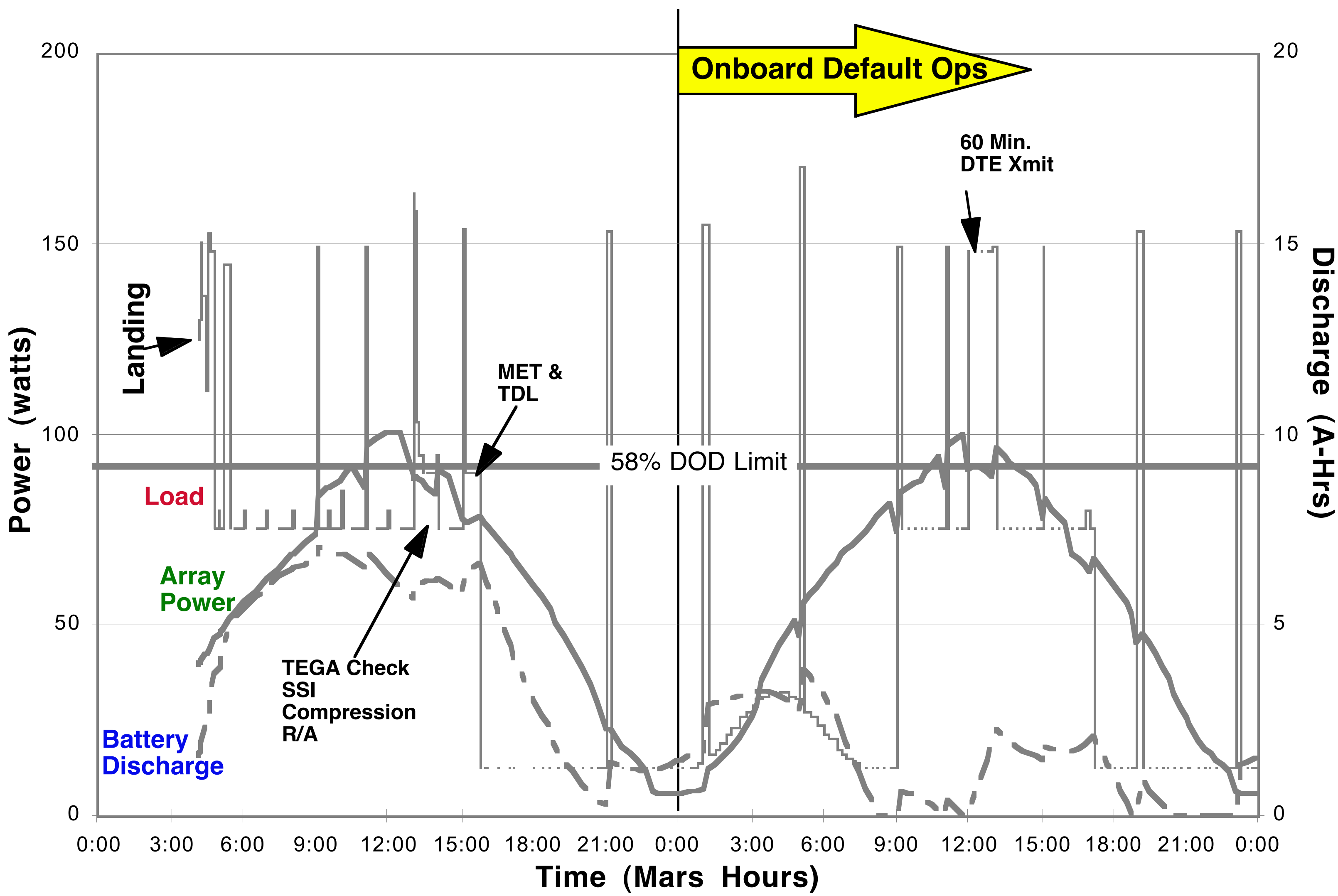
Date	Days from Earliest MOI	Days from Start of Mapping	Sun-Mars Distance [AU]	Mars-Earth Distance [AU]	ESM [deg.]	SEM [deg.]	SME [deg.]	Events
4/26/02	946	786	1.5668	2.3154	126.9143	32.7541	20.3317	
5/1/02	951	791	1.5727	2.3444	129.3153	31.2658	19.4189	
5/6/02	956	796	1.5786	2.3726	131.7222	29.7760	18.5018	
5/11/02	961	801	1.5843	2.3997	134.1350	28.2844	17.5806	
5/16/02	966	806	1.5899	2.4257	136.5536	26.7909	16.6555	
5/21/02	971	811	1.5954	2.4506	138.9783	25.2950	15.7266	
5/26/02	976	816	1.6007	2.4744	141.4093	23.7966	14.7941	
5/31/02	981	821	1.6058	2.4971	143.8466	22.2952	13.8582	
6/5/02	986	826	1.6107	2.5185	146.2906	20.7905	12.9189	
6/10/02	991	831	1.6155	2.5386	148.7416	19.2821	11.9763	
6/15/02	996	836	1.6201	2.5574	151.1997	17.7696	11.0307	
6/20/02	1001	841	1.6245	2.5750	153.6651	16.2528	10.0821	
6/25/02	1006	846	1.6287	2.5911	156.1381	14.7312	9.1307	
6/30/02	1011	851	1.6328	2.6059	158.6187	13.2046	8.1768	
7/5/02	1016	856	1.6366	2.6192	161.1066	11.6729	7.2205	
7/10/02	1021	861	1.6401	2.6311	163.6013	10.1362	6.2625	
7/15/02	1026	866	1.6435	2.6415	166.1015	8.5951	5.3033	
7/20/02	1031	871	1.6467	2.6504	168.6043	7.0512	4.3445	
7/25/02	1036	876	1.6496	2.6578	171.1028	5.5086	3.3887	
7/30/02	1041	881	1.6523	2.6636	173.5787	3.9782	2.4431	
8/4/02	1046	886	1.6548	2.6678	175.9677	2.4998	1.5324	
8/9/02	1051	891	1.6570	2.6704	177.8957	1.3055	0.7988	
8/14/02	1056	896	1.6590	2.6714	177.5634	1.5129	0.9237	Max Earth Distance
8/19/02	1061	901	1.6607	2.6708	175.4183	2.8471	1.7346	
8/24/02	1066	906	1.6622	2.6685	172.9427	4.3892	2.6681	
8/29/02	1071	911	1.6635	2.6646	170.3774	5.9900	3.6326	
9/3/02	1076	916	1.6645	2.6590	167.7698	7.6204	4.6098	
9/8/02	1081	921	1.6653	2.6518	165.1345	9.2715	5.5940	
9/13/02	1086	926	1.6658	2.6428	162.4778	10.9396	6.5826	
9/18/02	1091	931	1.6661	2.6322	159.8026	12.6231	7.5744	
9/23/02	1096	936	1.6661	2.6199	157.1106	14.3211	8.5683	Aphelion
9/28/02	1101	941	1.6659	2.6059	154.4032	16.0330	9.5638	
10/3/02	1106	946	1.6654	2.5902	151.6811	17.7585	10.5603	
10/8/02	1111	951	1.6647	2.5729	148.9454	19.4973	11.5574	
10/13/02	1116	956	1.6637	2.5540	146.1967	21.2489	12.5544	
10/18/02	1121	961	1.6625	2.5334	143.4360	23.0130	13.5510	
10/23/02	1126	966	1.6611	2.5112	140.6641	24.7893	14.5465	
10/28/02	1131	971	1.6594	2.4874	137.8821	26.5773	15.5406	
11/2/02	1136	976	1.6574	2.4620	135.0910	28.3764	16.5326	
11/7/02	1141	981	1.6552	2.4351	132.2920	30.1861	17.5219	
11/12/02	1146	986	1.6528	2.4068	129.4863	32.0058	18.5079	
11/17/02	1151	991	1.6502	2.3770	126.6752	33.8348	19.4900	
11/22/02	1156	996	1.6473	2.3457	123.8603	35.6722	20.4674	
11/27/02	1161	1001	1.6442	2.3131	121.0431	37.5174	21.4395	
12/2/02	1166	1006	1.6408	2.2792	118.2251	39.3694	22.4055	



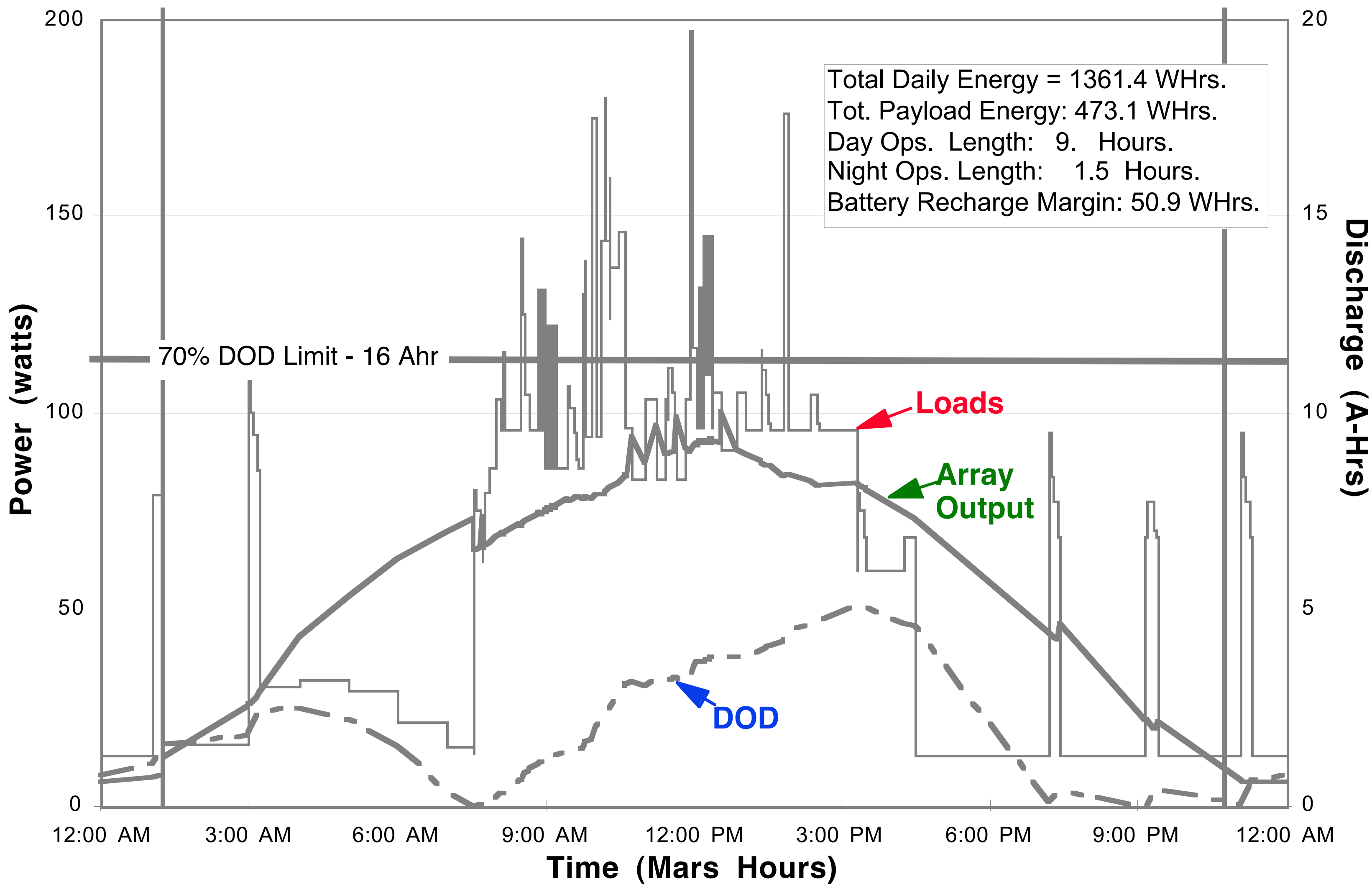
Post-Arrival Distances
Sun-Mars Distance [AU]
Mars-Earth Distance [AU]
AU
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
9/1/99
10/31/99
12/30/99
2/28/00
4/28/00
6/27/00
8/26/00
10/25/00
12/24/00
2/22/01
4/23/01
6/22/01
8/21/01
10/20/01
12/19/01
2/17/02
4/18/02
6/17/02
8/16/02
10/15/02
12/14/02
Date

B.5.6 DESIGN REFERENCE MISSION POWER PROFILES

SOL 0,1 POWER PROFILE



TEGA DAY 1 POWER PROFILE



B.5.7 Payload Scenarios

Observation scenarios have been sketched out in order to identify requirements for instrument and ground system capabilities. These scenarios are for nominal, not adverse, conditions. Example science scenarios are:

- **Nominal Sol 1 [TBD]:** The Sol 0,1 scenario shown in section 5.6.2 is a Design Reference Mission, based on conservative assumptions on power capabilities and spacecraft capabilities. Depending on s/c state, other activities may be commanded on Sol 1. The criteria and process for this transition are TBD.

- **Daily Weather [TBD]**

- **Panorama [TBD] -** **Undeployed**
Multispectral Mineralogy
Monitor site variability

- **Trench Layers, Workspace Close-up [TBD]**

- **TEGA Day 2 [TBD]**

Approximately 100 - 200 Mbits is budgeted for daily data volume. The actual daily D/L data volume will depend on the specific payload and s/c bus activities, the number of UHF passes supported, and D/L capability of the relaying orbiter or orbiters.

Daily Energy budgeted to MVACS and LIDAR instruments only =~225 W-hr (9 hrs x 24 W average) daytime, 156 W-hr (15.6 hrs x 10 W average) nighttime. Payload energy includes 6.5 W for higher processing rate when needed for image compression.

PAYLOAD SCENARIOS

- Observation scenarios developed in order to identify requirements for instrument and ground system capabilities.

- Scenarios are for nominal, not adverse, conditions. [Exception is TEGA Day 1 Design Reference Mission]. Example science scenarios are:

  - **Nominal Sol 1 [TBD]**
    - » Sol 0,1 scenario in section 5.6.2 is a Design Reference Mission, based on conservative assumptions
    - » Depending on s/c state, other activities may be commanded on Sol 1.
      - Criteria and process for this transition are TBD.

  - **Daily Weather [TBD]**

  - **Panorama [TBD]**
    - **Undeployed**
    - **Multispectral Mineralogy**
    - **Monitor site variability**

  - **Trench Layers, Workspace Close-up [TBD]**

  - **TEGA Day 2 [TBD]**

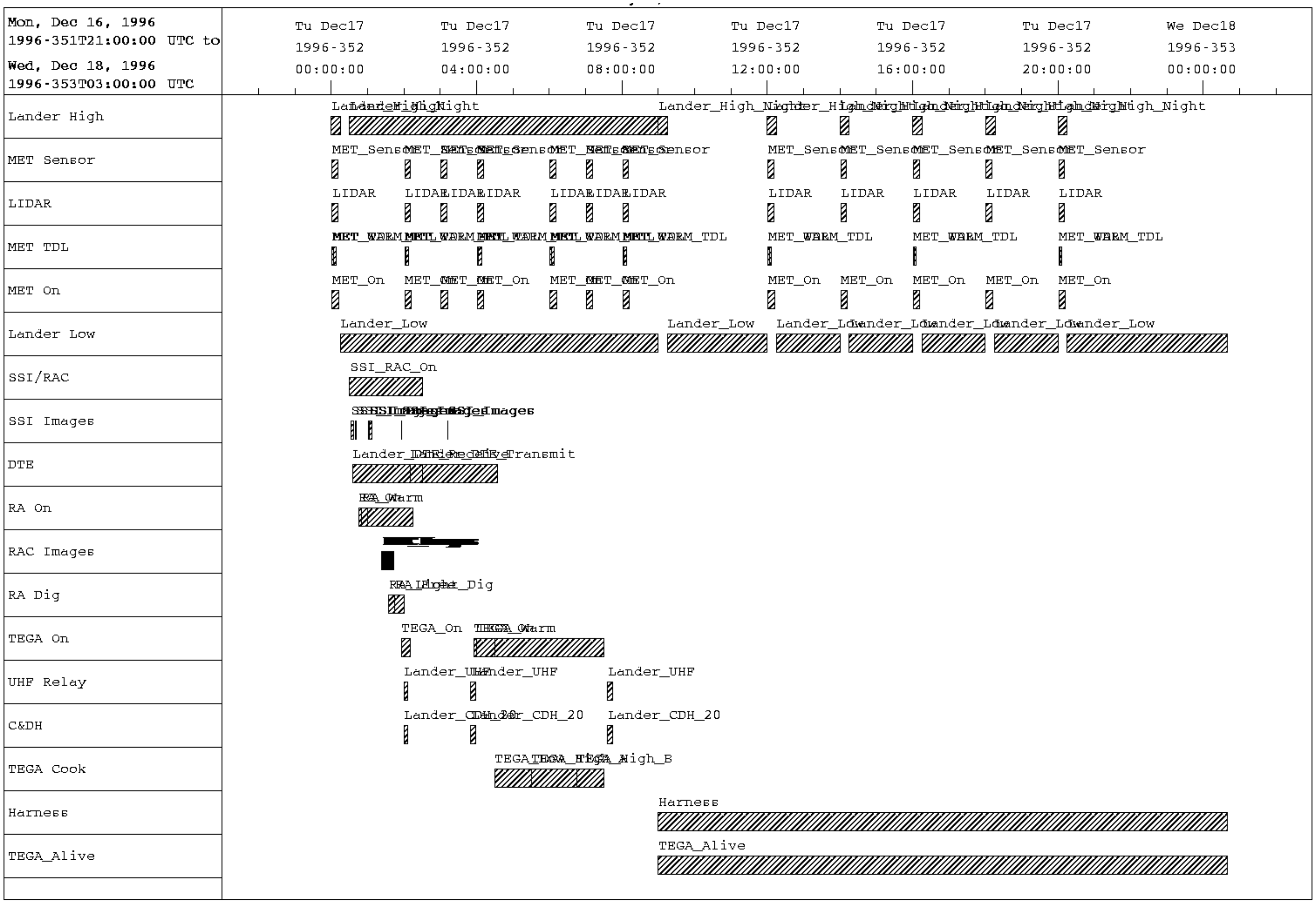
- **Daily Data Volume budgeted** = approximately 100 - 200 Mbits
  - Actual daily data volume will depend on payload and s/c bus activities, number of UHF passes, D/L capability of relaying orbiter or orbiters.

- **Daily Energy budgeted to MVACS and LIDAR instruments only:**
  - **Daytime:** 225 W-hr (9 hrs x 24 W average)
  - **Nighttime:** 156 W-hr (15.6 hrs x 10 W average)
  - Payload energy includes 6.5 W for higher processing rate when needed for image compression

Nominal Sol 1 Payload Scenario [TBD]

To be Supplied

NOMINAL SOL 1 PAYLOAD SCENARIO - TO BE UPDATED



Daily Weather Scenario [TBD]

Science Objectives: Investigate the diurnal temperature cycle, humidity, wind regime, and regional climate; monitor water exchange betwen the atmosphere, surface, and subsurface; measure atmospheric opacity and column-integrated water vapor abundance.

Payload Activity:

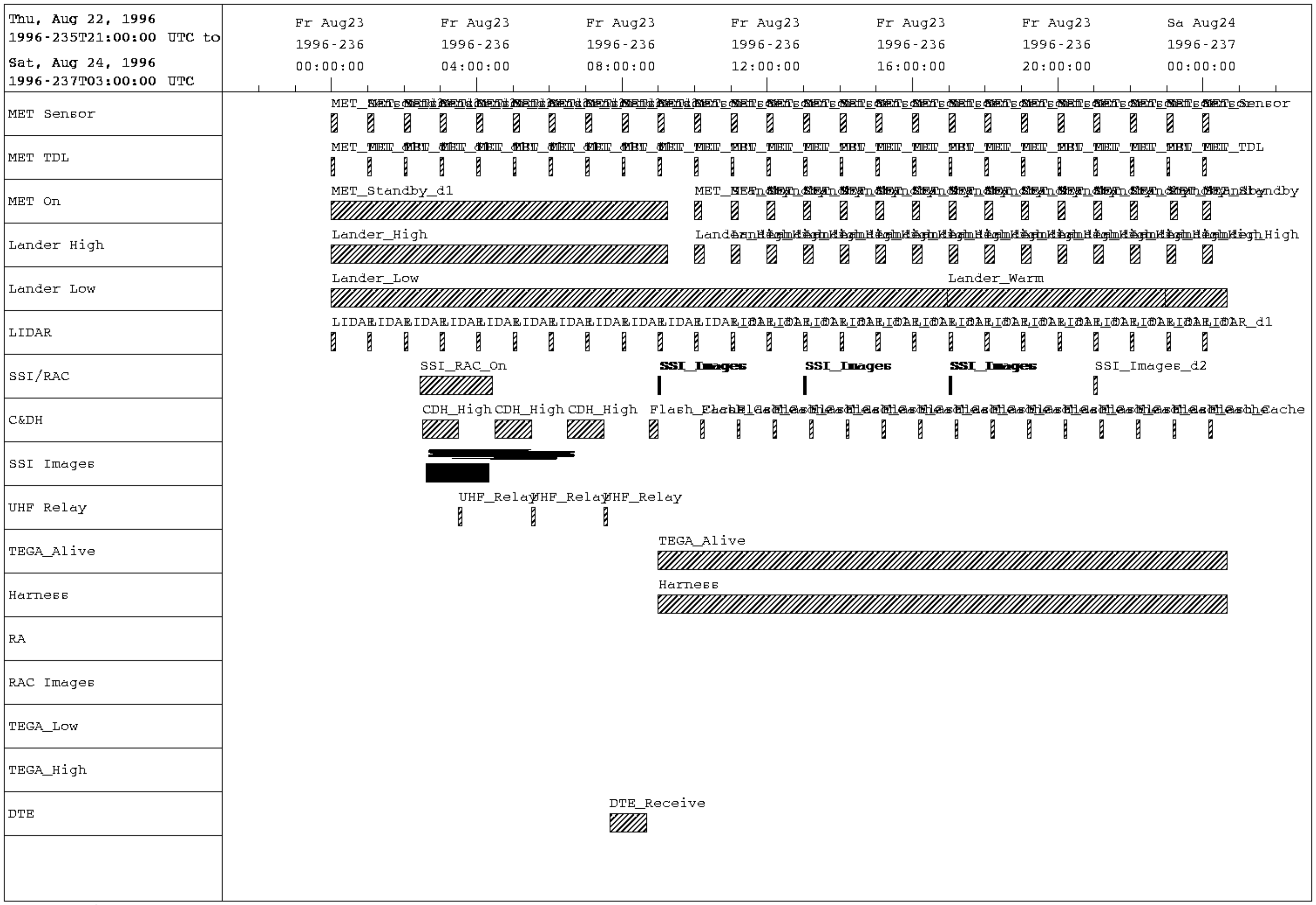
1. MET is on for full diurnal cycle, with sensors duty-cycled on once per hour for 10 minutes
2. Once per 4 hours through full diurnal cycle SSI acquires 4 images of the sun
3. Once per day SSI acquires 2 orthogonal sky swaths, compressed to the equivalent of 10 images (requires 1-2 hours to collect data set)
4. LIDAR is cycled on at the same time as MET

Frequency: Several times per week with MET + SSI, every day with at least MET

Total Energy: 141 W-hr

Daily Data Volume: 42 Mbits = 32 Mbits MET + 10 Mbits SSI (includes high rate processing for SSI)

DAILY WEATHER SCENARIO



Panorama Scenario [TBD]

Science Objectives: Study the geologic setting, topography, mineralogy, and short-time-scale variability of the lander landing site

Payload Activity:

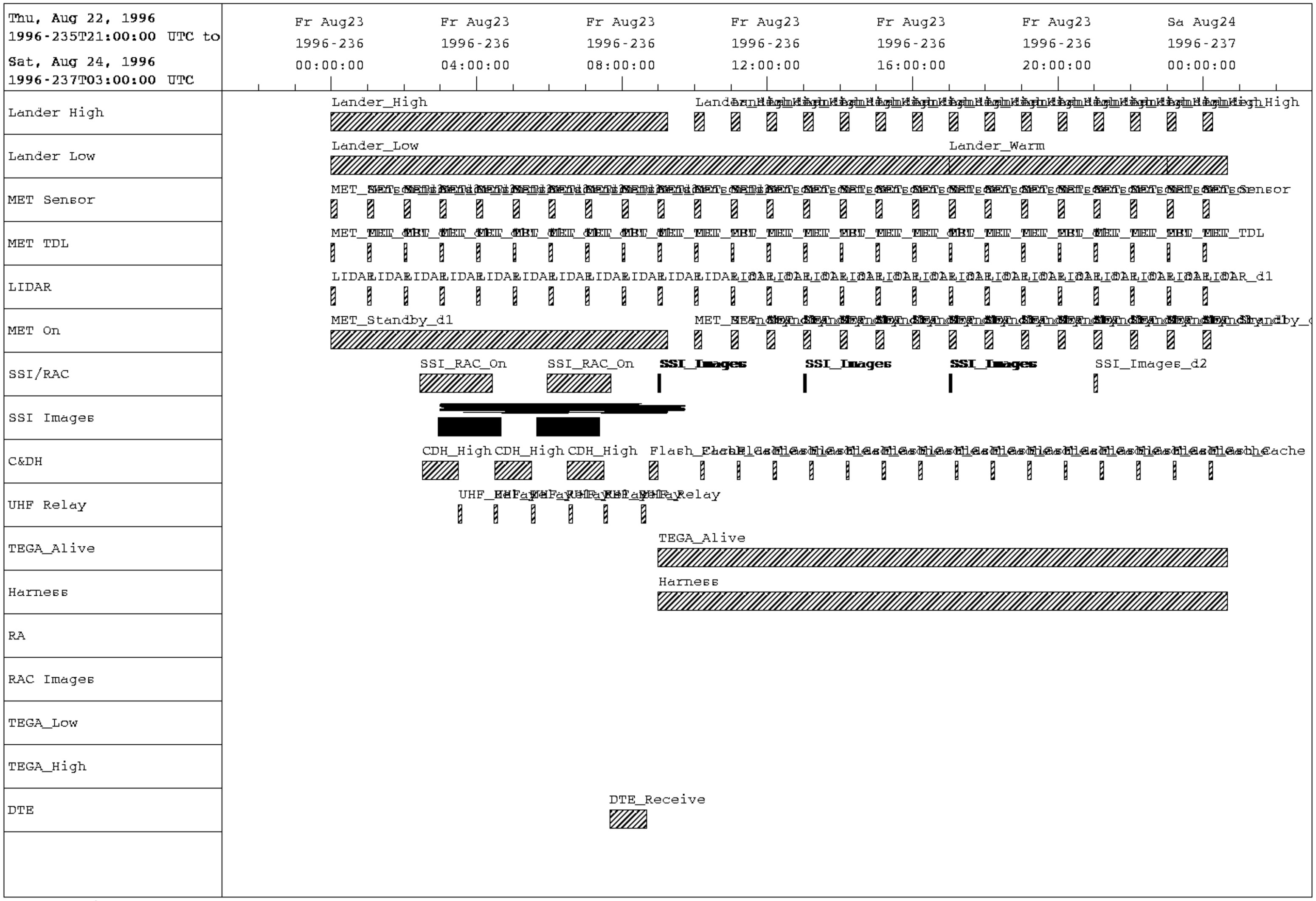
A. **Undeployed Panorama:** Execute a TBD-position monochromatic panorama of the landing site prior to mast deployment
Frequency: once

B. **Mineralogic Panorama:** Execute a 36x6 position mosaic through all mineralogic filters (8 filters per optical channel)
Playback over 3 - 7 days
Frequency: 3 times - beginning, middle, end of mission

C. **Site Variability:** Execute a 36x6 position mosaic through 4 filters per optical channel
Playback over 2 - 4 days
Frequency: once per week

	Total Daily Data Volume:	**Total Daily Energy:**
A:	48 images = 9.4 Mbits (assumes 4x compression)	3 W-hr
B:	3456 images = 679 Mbits / 7 days (assumes 2x compression)	161 W-hr [including daily weather]
C:	1728 images = 340 Mbits / 4 days (assumes 2x compression)	161 W-hr [including daily weather]

PANORAMA SCENARIO



APGEN Version E7.03 Page 1 of 1

Trench Scenario [TBD]

Science Objectives: Identify subsurface layering of soil; presence of ground ice; measure surface and subsurface soil temperatures;
characterize soil mechanical properties (hardness, cohesion, etc.)

Payload Activity:

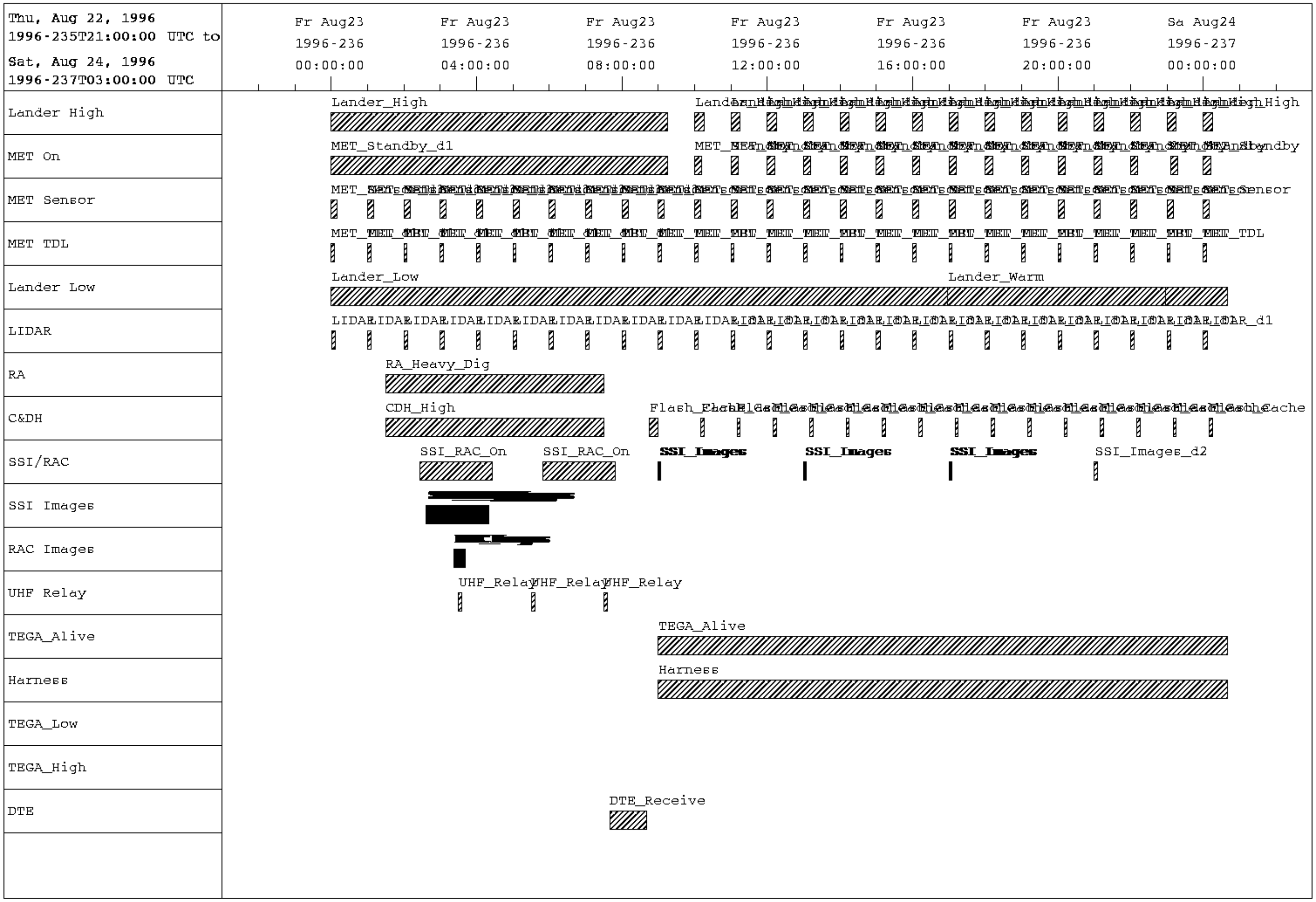
1. (After acquisition and analysis of panorama images of arm workspace) position RA scoop to desired trench start position.
2. Dig approx. 10 cm (6 hours?)
3. Use SSI and RAC to image sides and bottom of trench, 2-color, 5x4 strips, once per hour.
4. Repeat steps 2 to 4, for 5 or more days

Frequency: Four times during primary mission

Total Data Volume: 111 Mbits/day [assuming 2x compression] x 5 days (288 images per day)

Total Energy: 330 Whr/day [includes daily weather] x 5 days

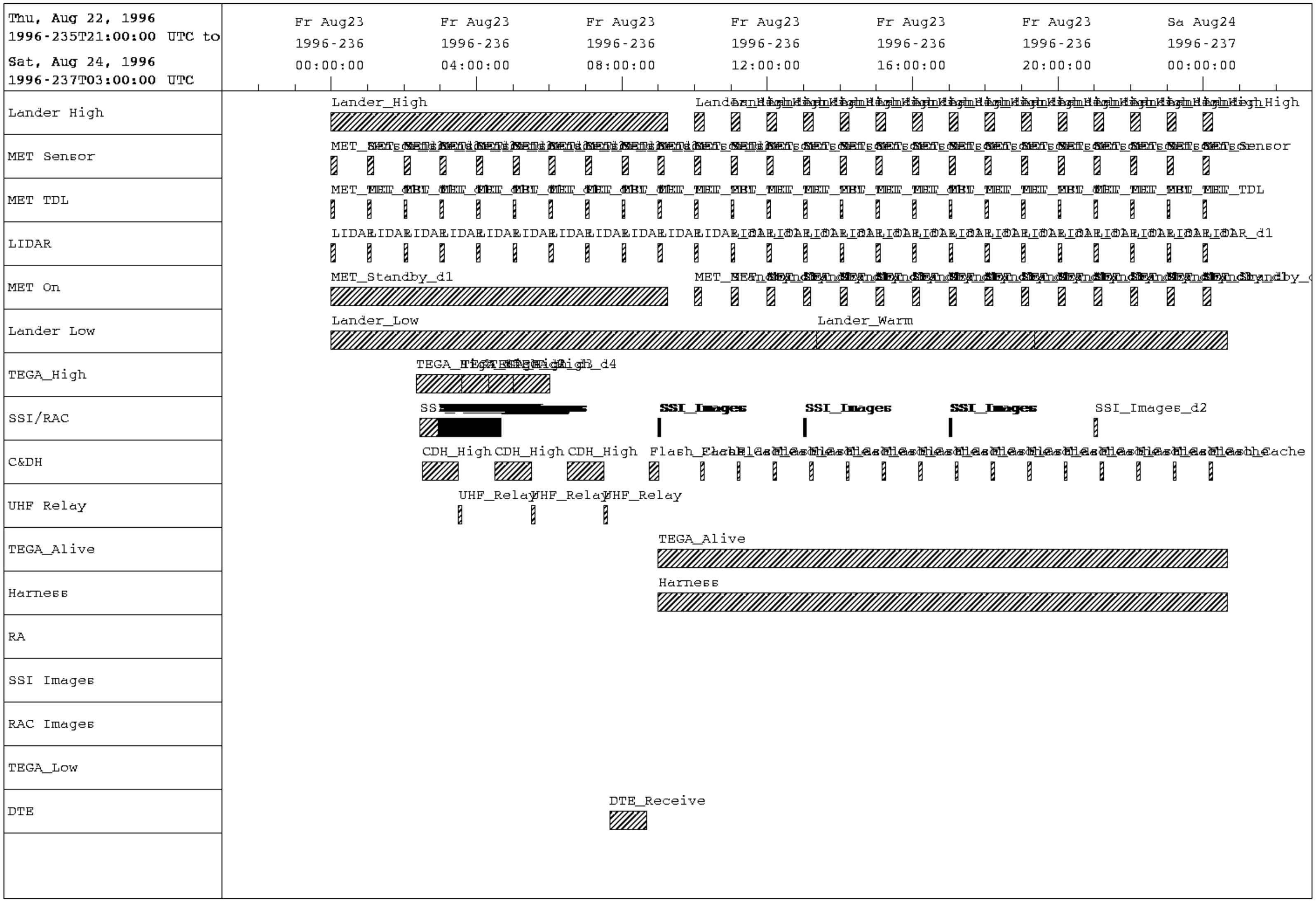
TRENCH SCENARIO



TEGA Day 2 Scenario [TBD]

This completes the TEGA activity started the previous day. After cooling overnight, the sample is cooked to 1300K in a programmed series of steps. In addition, a full daily weather scenario is carried out.

TEGA DAY 2 SCENARIO



B.6 Lander Configuration Drawings

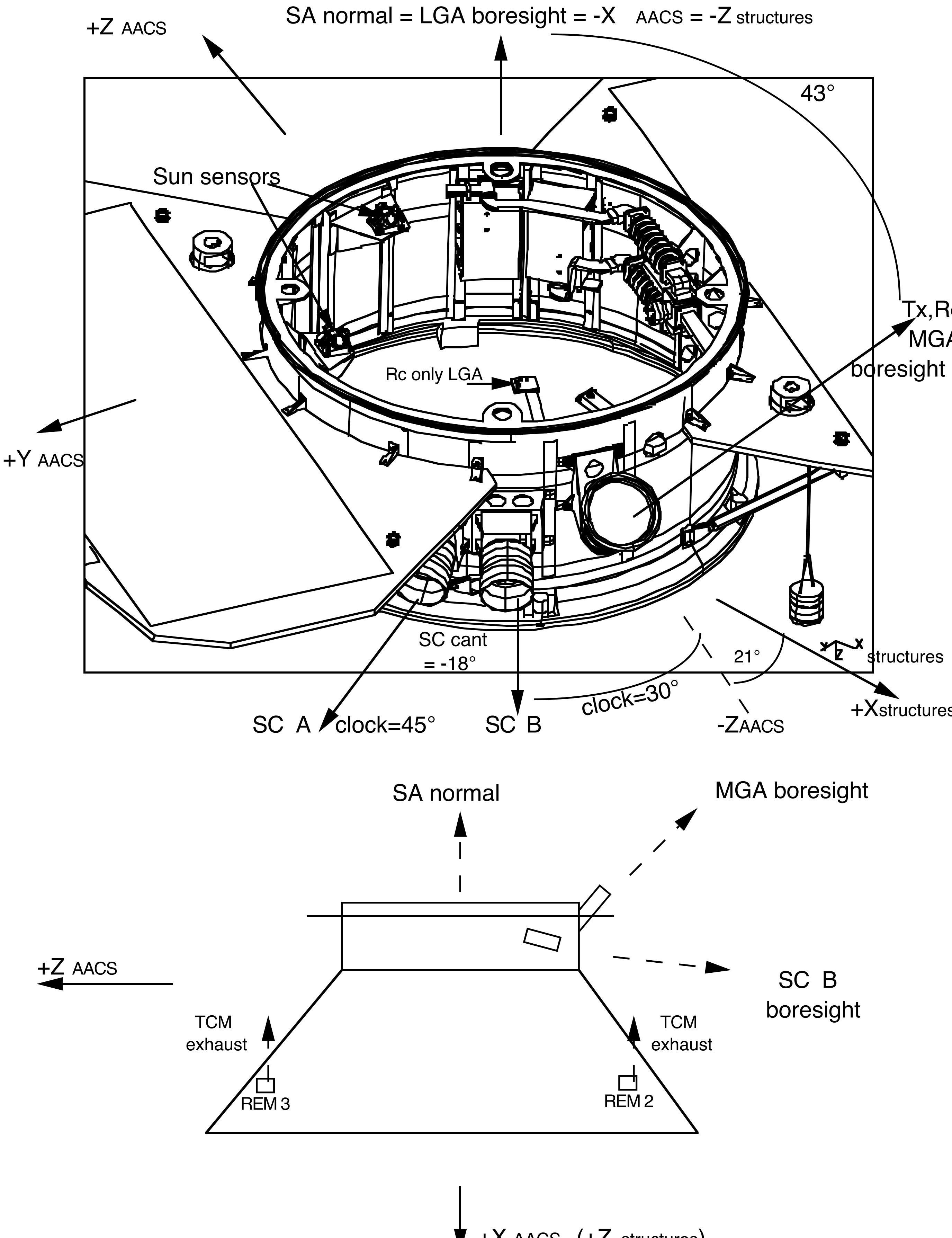
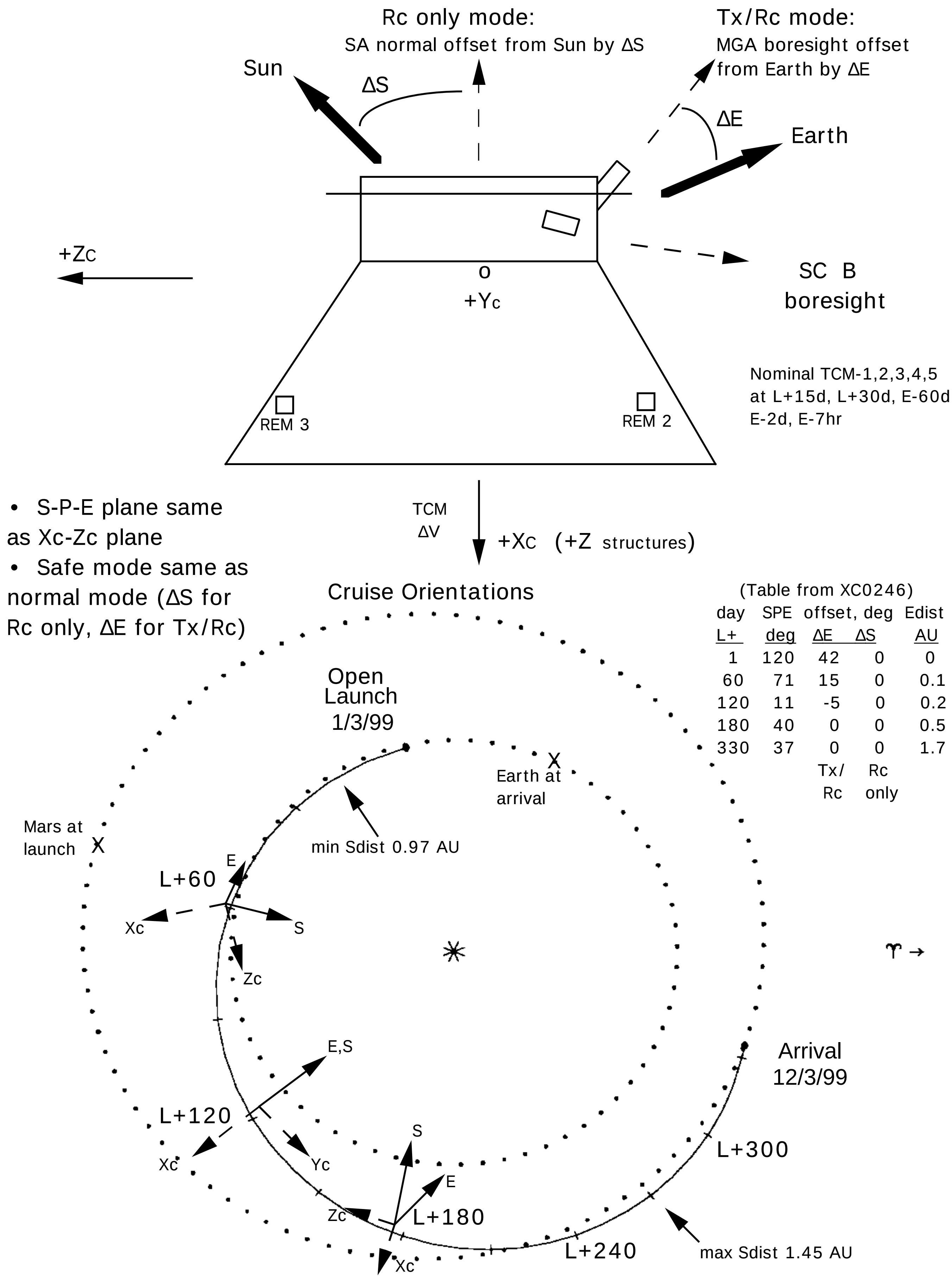


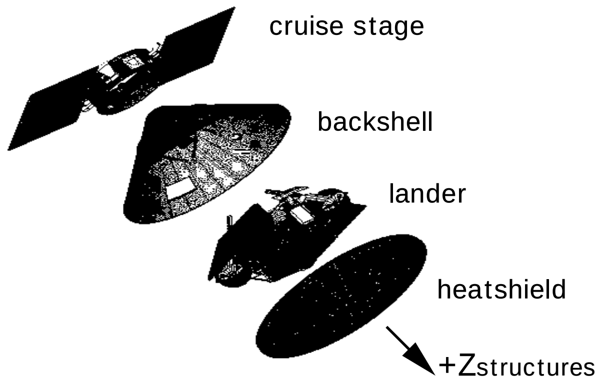
Figure 1.3.6.13.1-1 Lander Cruise Stage Configuration



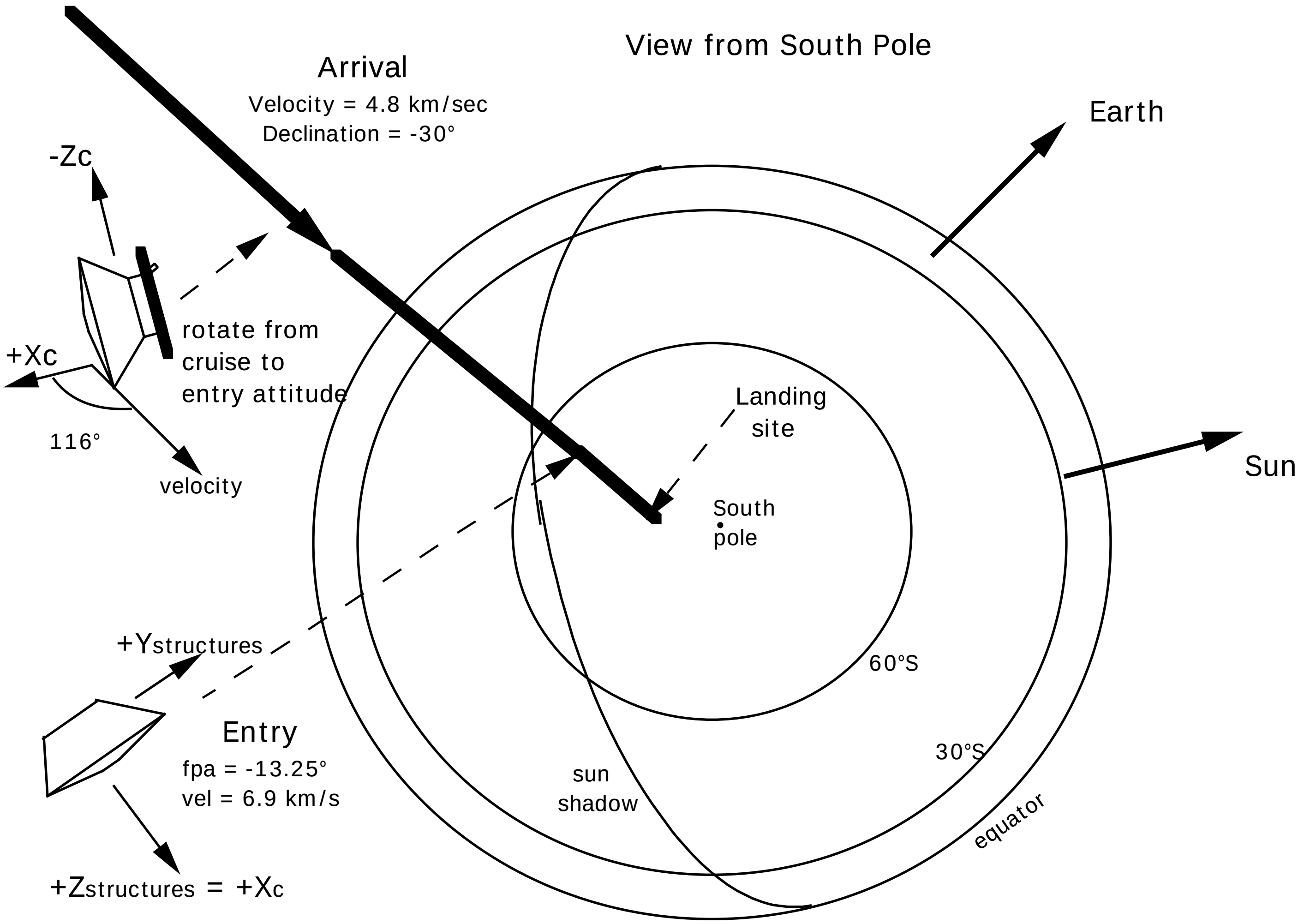
(Table from XC0246)

day	SPE	offset, deg		Edist
L+	deg	ΔE	ΔS	AU
1	120	42	0	0
60	71	15	0	0.1
120	11	-5	0	0.2
180	40	0	0	0.5
330	37	0	0	1.7
		Tx/Rc	Rc only	

Figure 1.3.6.13.1-2 Lander Cruise Geometry



Typical Arrival Timeline		
Event	Time	Altit,km
TCM-5	E-7 hr	125,000
Rotate to entry	E-7 m	1450
Cruise stage sep	E-5 m	950
Cruise probe sep	E-4:40	900
Entry	E	125
Parachute deploy	E+2:30	7
Desc engines start	E+4:00	2
Landing	E+4:40	0



launch period		arrival	landing	
day	date	date	latitude	LTST
open	1/3/99	12/3/99	76°S	4:14
close prim	1/10/99	12/3/99	75°S	4:10
close	1/16/99	12/15/99	75°S	3:37

Figure 1.3.6.13.1-3 Mars Approach to Landing

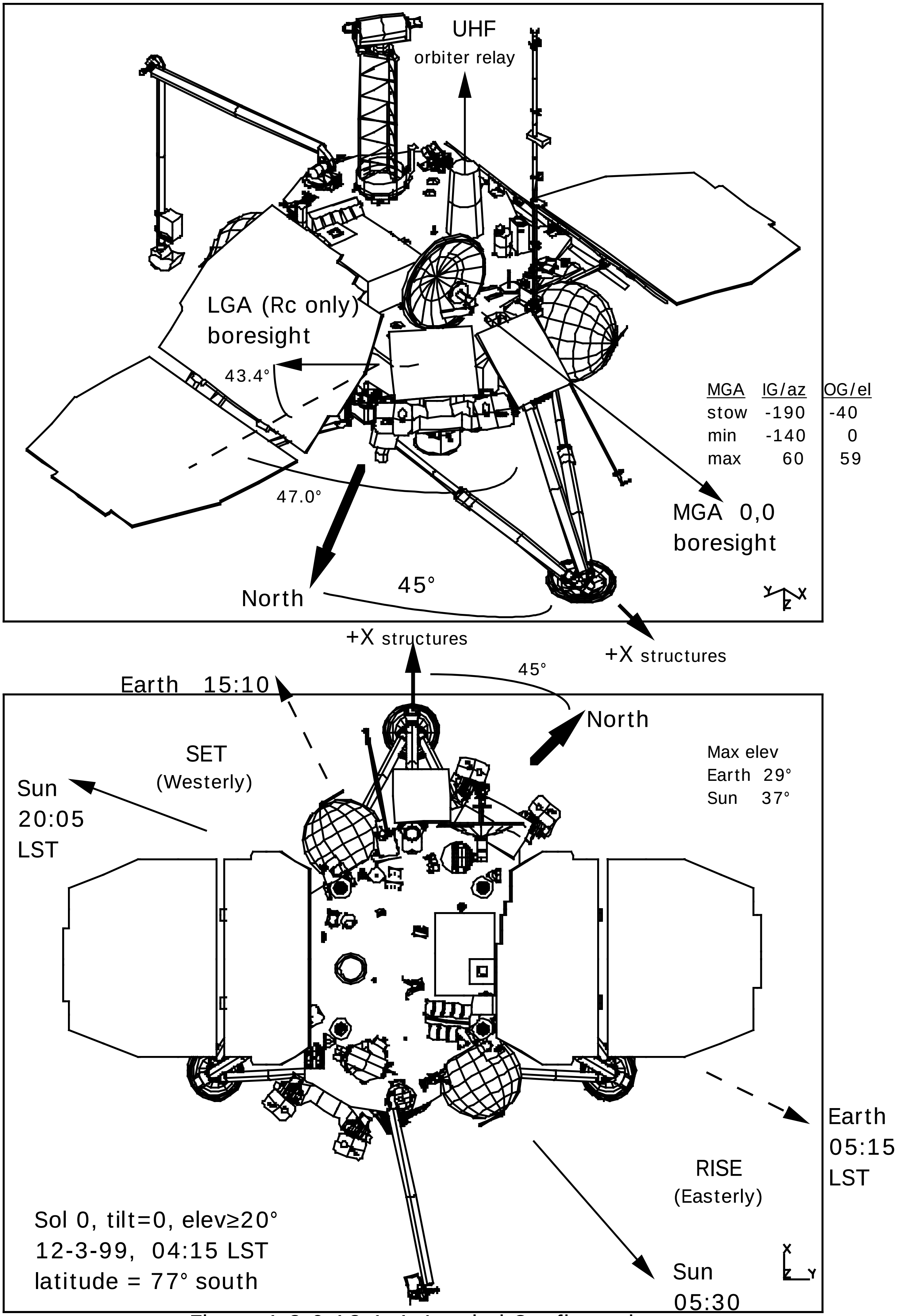


Figure 1.3.6.13.1-4 Landed Configuration

B.7 Lander Navigation Memo

This memo was last updated November 26, 1996, and should be used only as a general discussion of the navigation approach and assumptions used in the navigation analysis. Since the last update, there have been changes in approach deadbands and propulsion system characteristics, addition of DSN and other constraints, and additional navigation analyses have been undertaken. All of these changes will affect both ΔV estimates and approach control capabilities.

Jet Propulsion Laboratory

INTEROFFICE MEMORANDUM
IOM 312.3-96-027, Rev. A
November 26, 1996

To: Distribution
From: Pieter Kallemeyn
Subject: Navigation analysis report for the Mars Surveyor '98 Lander

SUMMARY

This memo details the work to date in characterizing the navigation capability for the Mars Surveyor '98 Lander mission. This report supersedes those results that were first presented in Reference [1].

Statistical information on the required ΔV for interplanetary TCM usage was calculated using the resulting OD error covariances, execution errors for the TCMs and an injection error covariance from McDonnell Douglas (received June 12, 1996). The total interplanetary ΔV required for 95% confidence is 61.2 m/sec. The 1σ B-plane guidance error ellipse for the last midcourse maneuver is 3.16 km by 0.13 km with an uncertainty in the linearized time of flight of 0.12 seconds. This guidance error is equivalent to a 3σ uncertainty in flight path angle at entry of 0.46°

INTERPLANETARY PHASE NAVIGATION ANALYSIS

Reference Trajectory

The reference trajectory used for this orbit determination and guidance analysis is a Type 2 Earth-Mars transfer corresponding to the first day of the MSP '98 lander primary launch period. The trajectory is shown in Figure 1 and summarized in Table 1.

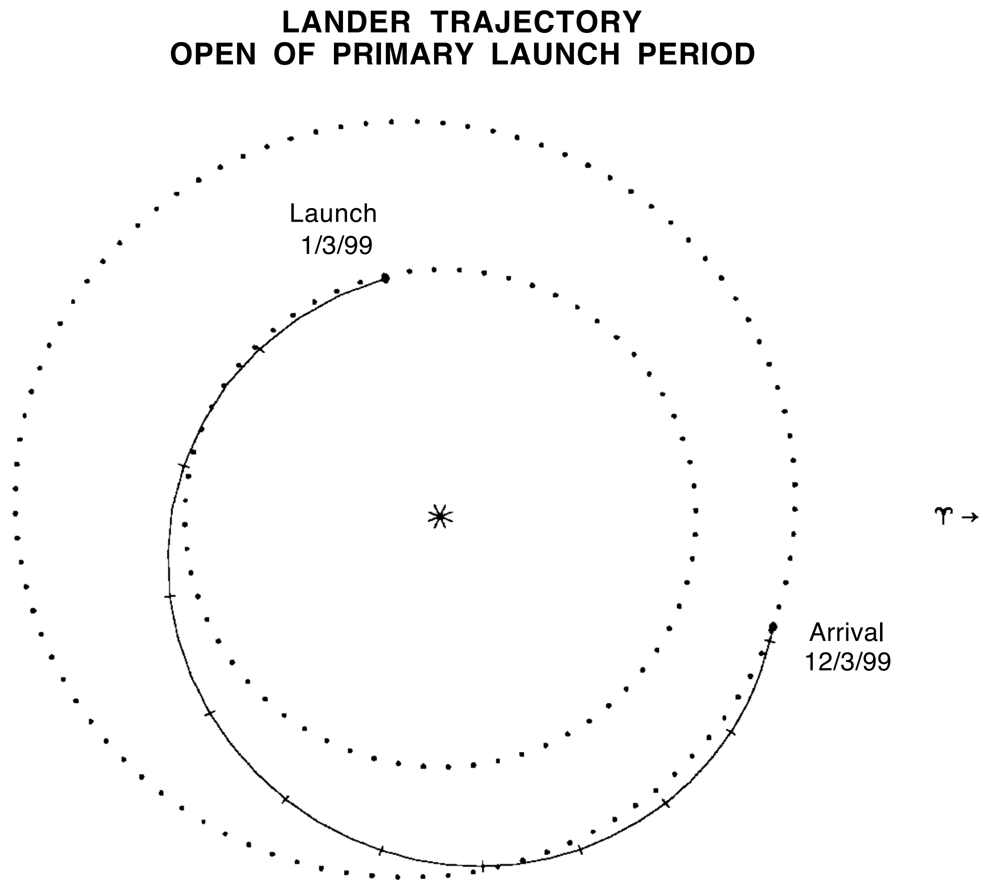


Figure 1: Mars '98 lander trajectory corresponding to a 1/3/1999 launch

Table 1: Lander reference trajectory characteristics

Injection Date	Arrival Date	Length	Arrival V_∞ (km/sec)
1/3/1999, 21:20	12/3/1999, 20:25	333 days 23 hours	4.84

Trajectory Correction Maneuvers

The five opportunities currently planned for interplanetary trajectory correction maneuvers (TCM's) are described in Table 2.

Table 2: Scheduled trajectory correction maneuvers

TCM #	Relative Date	Calendar Date	Comments
TCM-1	Launch+15 days	1/18/99	Corrects LV injection errors
TCM-2	Launch+30 days	2/17/99	Corrects NAV errors at TCM-1
TCM-3	Arrival-60 days	10/4/99	Targets to orbit insertion point
TCM-4	Arrival-2 days	12/1/99	Corrects errors from TCM-3
TCM-5	Arrival-8 hours	12/3/99	Final targetting maneuver

ORBIT DETERMINATION ASSUMPTIONS

Tracking Data

Table 3 shows the tracking coverage assumed for the orbit determination analysis. For the first 30 days of flight, there will be 1 pass (4 hours duration) per day. After 30 days of flight, the tracking schedule is decreased to 1 pass (4 hours duration) per DSN complex per week, giving a total of 3 passes per week.

Because it is important to reconstruct the TCM's, monitoring them will require more than 3 passes per week. Therefore, 3.5 days before a TCM, tracking coverage is increased to 1 pass (4 hours) per day, and is maintained until 3.5 days after the TCM is completed. For this OD study, it was assumed that tracking coverage could be increased to 3 passes per day during the 24-hour period centered on the maneuver time. It is expected, however, that a single 4-hr pass would be sufficient for this time. It is important that the entire TCM execution be monitored from a single DSN station.

Near-Simultaneous Tracking of the Lander and Orbiter

The final 45 days of flight is the most critical for navigation, therefore tracking coverage is increased from 3 passes per week to 3 passes per day. Starting 30 days before lander arrival, tracking data from the lander will be combined with tracking data from the MSP '98 Orbiter (which would be aerobraking during this time) or the Mars Global Surveyor. This technique, dubbed "near-simultaneous orbiter/lander tracking", reduces the effects of error sources that are common to both spacecraft. These error sources include station locations, Earth orientation, troposphere and ionosphere delay, Earth and Mars ephemeris, and solar plasma. By simultaneously reducing the tracking data from both spacecraft, a better estimate of the lander's trajectory (with respect to Mars) is possible.

For this OD study, tracking data from the lander for the final 45 days was simulated in a "4 hours ON-5 hours OFF" manner consistent with the current transmitter on-off cycle limits. For the final 30 days of flight, tracking data from the MSP '98 Orbiter was simulated such that there would be 4 hours of orbiter data during the 5-hour tracking data gap from the lander, and vice-versa (see figure 2). The actual schedule of tracking passes for the Orbiter and Lander during this time is yet to be finalized, and will depend on transmitter on-off times for each spacecraft as well as which orbiter (MSP '98 or MGS) is used.

Table 3: Tracking Data schedule for lander OD analysis

Period	Tracking Schedule
Launch to Launch + 30 days	One 4-hour pass of Doppler and range per day
Launch +30 to Arrival -45 days	one 4-hour pass per complex per week (3 passes/week) of Doppler and range
Arrival - 45 days to Arrival	Approx. 3 passes per day (4 h ON/5 h OFF) of Doppler and range.
Coverage for TCM-1, -2 and -3:	
TCM -/+ 3.5 days	One 4-hour pass per day of Doppler and range
TCM -/+ 12 hours	Three 4-hour passes of Doppler and range

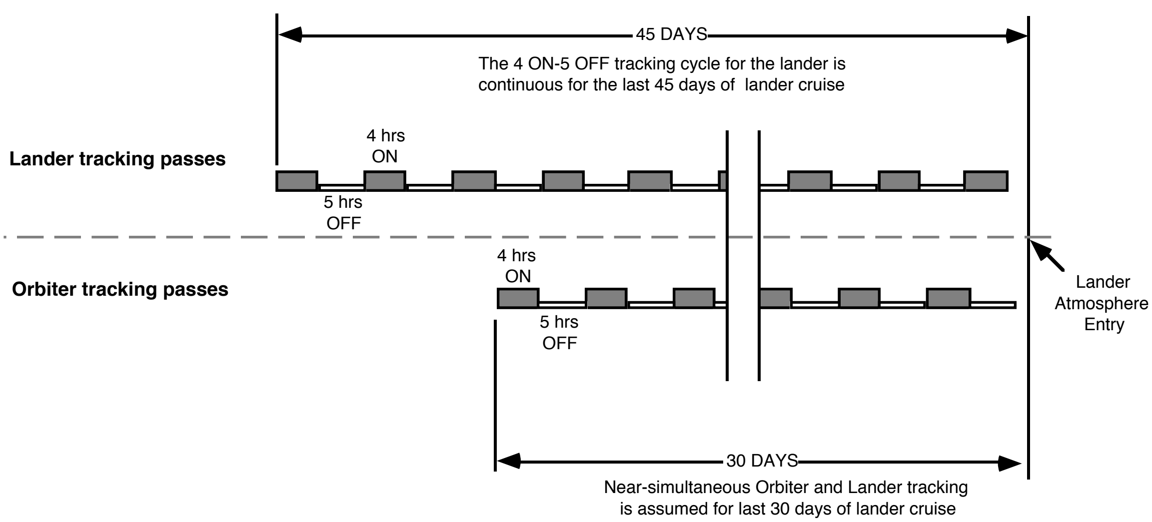


Figure 2: Near-Simultaneous Tracking Schedule used for OD study

Orbit Determination Error Sources

Table 4 gives a summary of the error sources included in the OD study, their nominal value, and level of assumed uncertainty. Many of the error sources (such as media, Earth motion, and non-gravitational accelerations) are assumed to be random in nature, and are therefore modeled as first-order Gauss-Markov processes. This model involves statistically correlated behavior, and is useful for describing these phenomena. Table 4 gives the steady-state uncertainty and the correlation time for the stochastic parameters. Parameters listed in Table 4 without these values, such as solar pressure, station locations, initial position and velocity, were assumed to be non-stochastic (bias) parameters. A complete description of these error source models can be found in References [2] through [6].

Modelling Non-Grav Errors Caused by Attitude Control

The Lander is three-axis stabilized, relying on star camera and ring-laser gyros for attitude determination and a set of eight thrusters for attitude control. During communication periods, the lander is assumed autonomously control its attitude with a deadband of 10.0°. In-between communication periods, this deadband is loosened to 60.0° [7]. The non-gravitational errors due to the unpredictability of thruster activity is the largest contributor to the overall guidance error. Therfore, considerable attention was paid toward the modelling of their effect for the orbit determination problem.

It was decided to use a stochastic acceleration model in the filter to model these nongrav effects. The direction of the accelerations was assumed fixed to the spacecraft coordinate frame, and the spacecraft frame was asssumed to be Sun pointed. When tracking data was available from the Lander, the acceleration solutions are updated every 20 minutes. while in-between tracking periods, the acceleration solutions are updated every 80 minutes. The relative size of the three components of the acceleration updates were adjusted to account for the relative placement of the ACS thrusters and the expected thruster firing frequency [7]. Table 5 gives the values of the stochastic acceleration model used for this study.

Table 4: Orbit Determination error assumptions for MSP '98 Lander interplanetary cruise

Error Source	Nominal value	Apriori uncertainty (1σ)	Corr. Time (days)	Steady-State Unc.	Comments
2-way Doppler noise	-	3 mHz	-	-	
SRA range noise	-	1.4 meters	-	-	
Initial Position (lander and orbiter)	variable	100 km	-	-	
Initial Velocity (lander and orbiter)	variable	1.0 km/s	-	-	
Solar Radiation Model for lander:					
entry vehicle: specular	0.15	0.15	-	-	2.4 m^2, Sun pointed
diffuse	0.09	0.09	-	-	
solar panels: specular	0.1	0.1	-	-	2.4 m^2 Sun pointed
diffuse	0.37	0.37	-	-	
S/C component area	100%	1%	-	-	error in sunlit area
self-induced delta-V from autonomous attitude control		variable	zero	variable	(see table ?? below)
TCM magnitude[1]	variable	0.33% (TCM1) 0.66% (TCM2-5)	-	-	from Exibit 1
TCM pointing	variable	0.33% (TCM1) 0.66% (TCM2-5)	-	-	
Station-induced range bias	0	1 meter	0.0 d	1 meter	independent across all three stations
S/C-induced range bias	-	7 meters (lander) 1 meter (orbiter)	zero	-	assumed constant for all of cruise
Troposphere calibrations	0	5 cm	0.1 d	5 cm	
Night Ionosphere calibrations	0	1 cm	1.0 d	1 cm	
Day Ionosphere calibrations	0	3 cm	0.2 d	3 cm	
Station locations	variable	10 cm	-	-	
Polar Motion calibrations	0	10 cm	2.0 d	10 cm	
UTC calibration	0	30 cm	1.0 d	30 cm	

[1] In addition to this proportional magnitude error, there is a fixed magnitude error (1σ) of .033 m/s when $\Delta V>2$ m/s (TCM-1) and 0.0033 m/s when $\Delta V<2$ m/s (TCMs 2-5) [Exhibit 1, requirement 3.C.2].

Table 5: Stochastic Acceleration Model Parameters for MSP '98 Lander

Time period	Solution updates	Process Noise (PSIGMA) Values (in km/s^2)		
		Sun-line (Radial)	Out-of-Plane (Normal)	In-Plane (Transverse)
During a tracking pass:	every 20 minutes	8.3E-13	7.6E-12	7.6E-12
Inbetween tracking passes	every 80 minutes	2.1E-13	1.9E-12	1.9E-12

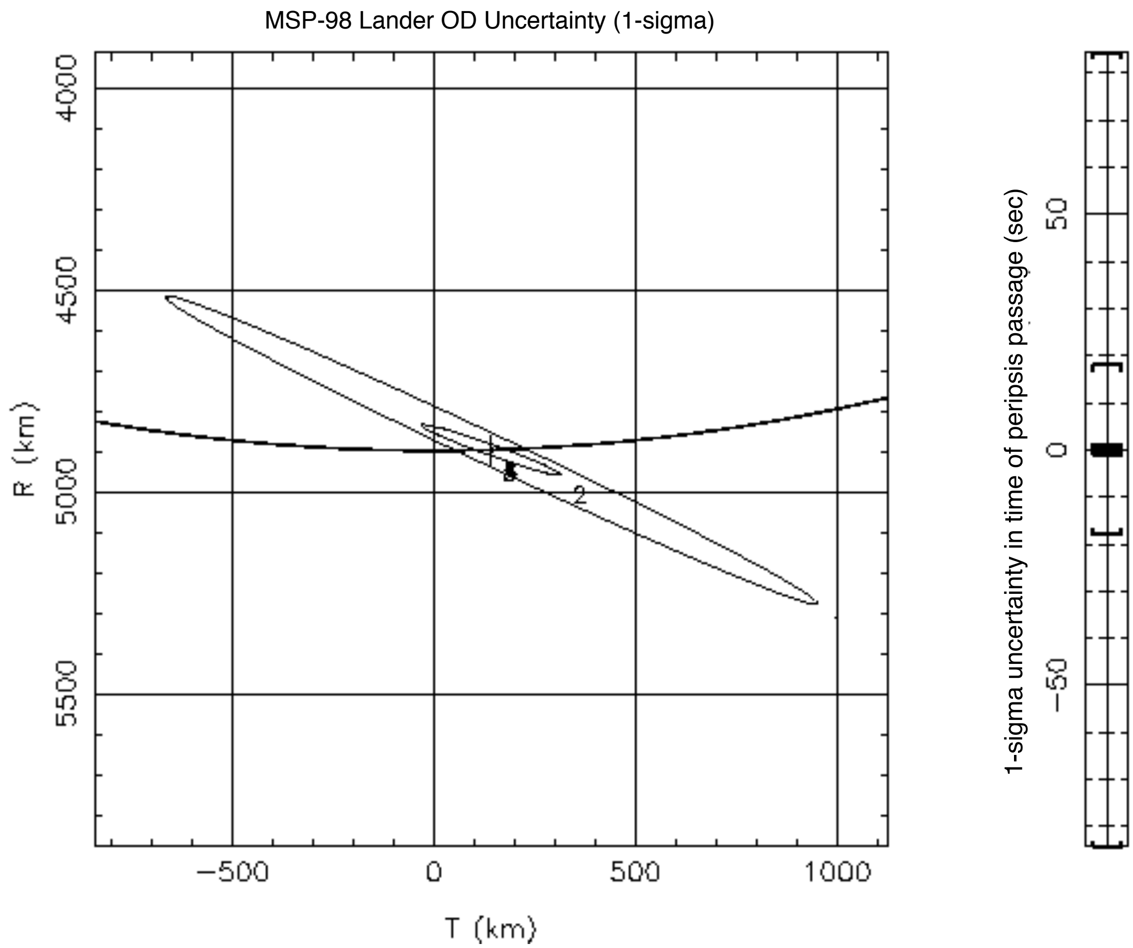
Orbit Determination Analysis Results

The Orbit Determination Program (ODP) coupled with the MIRAGE OD filter was used for this analysis [8]. MIRAGE employs a batch-sequential filtering method to a set of simulated Doppler and range data (scheduled according to Table 3). For maneuvers 1 through 4, tracking data up to 5 days before each TCM was reduced and fit to the reference trajectory. For TCM-5, tracking data up to 10 hours before entry was used, with TCM-5 occuring at Entry-8 hours (operational constraints may require this maneuver to be moved closer to entry). The orbit determination error covariance was mapped to the Mars-centered, Mars-Mean-Equator of Date *B*-plane at a time 1 hour before closest approach to Mars (A description of this coordinate frame is provided in Appendix A). The important results are the size, shape and orientation of the error ellipse in the two-dimensional B-plane and the linearized time of flight uncertainty. The orbit determination knowledge uncertainties for each of the five TCM's are described in Table 6 and illustrated in Figure 3.

Table 6: Lander orbit determination knowledge uncertainty (1σ) at the time of TCM design (TCM-5 days).

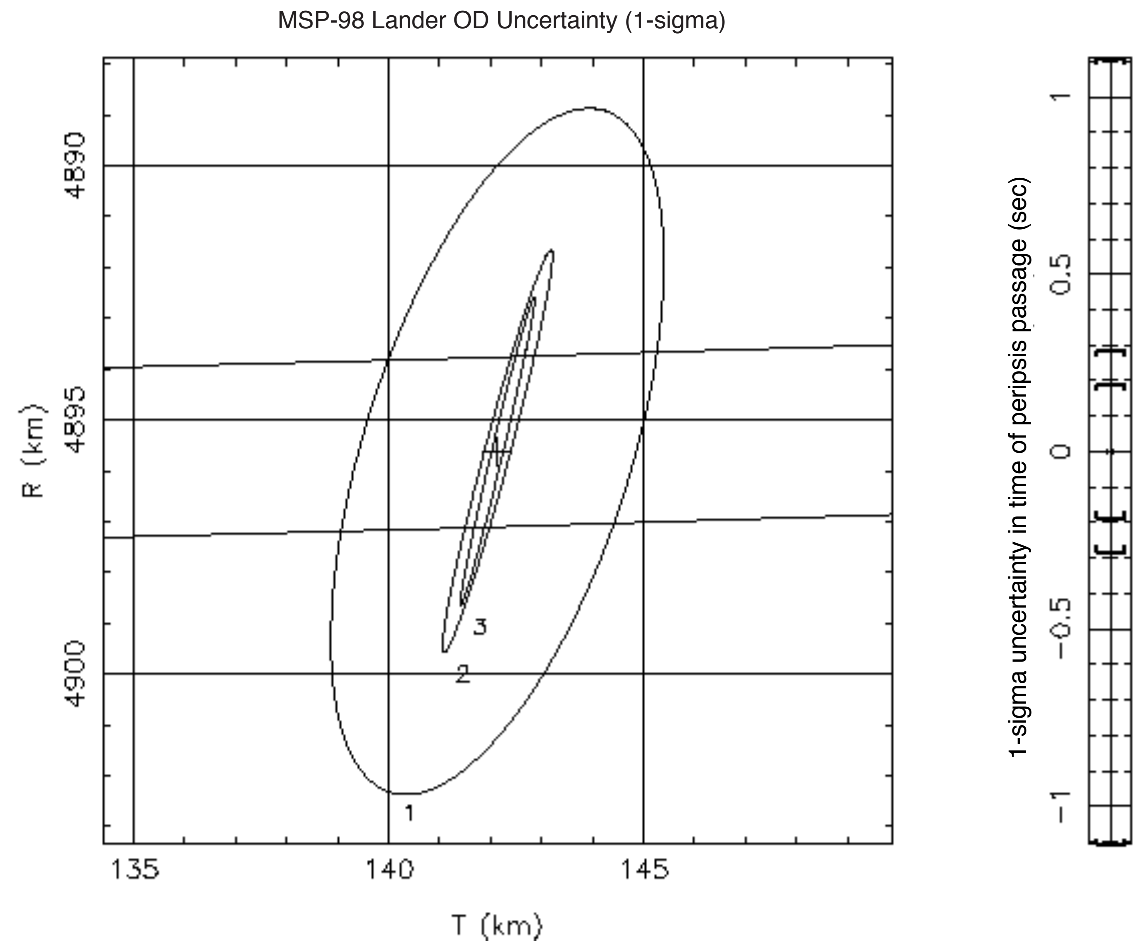
[The reference frame is the Mars-Centered, Mars Mean Equator of Date B-plane while the reference time is 1 hour prior to closest approach to Mars]

	Ellipse Semi-Major Axis (km)	Ellipse Semi-Minor Axis (km)	Ellipse orientation relative to T-axis	Linearized time of flight (seconds)
TCM-1	894	39	25°	57
TCM-2	182	14	20°	14
TCM-3	7.03	2.6	107°	1.1
TCM-4	4.10	0.25	105°	0.31
TCM-5	3.13	0.11	103°	0.12



1 - OD for design of TCM-1
2 - OD for design of TCM-2
3 - OD for design of TCM-3
4 - OD for design of TCM-4
5 - OD for design of TCM-5

Figure 3a: Orbit determination results for the Lander mapped in the B-plane



3 - OD for design of TCM-3
4 - OD for design of TCM-4
5 - OD for design of TCM-5

Figure 3b: Orbit determination results for the Lander mapped in the B-plane (for TCM3,TCM4 and TCM5)

Guidance Analysis Results

The OD results from Table 5 were combined with the maneuver execution assumptions described in Table 7 below to determine statistical data on the ΔV magnitude required for all four TCMs. The JPL programs INJCOV, LAMBIC, and PQ were used for this analysis [9].

Table 7: Trajectory correction maneuver assumptions for lander

Deterministic part of TCM-1	Fixed Magnitude Error (1-σ)	Proportional Magnitude Error (1-σ)	Proportional Pointing Error (1-σ)
13.8 m/s	0.033 m/s for TCM-1 0.0033 m/s for TCM 2-5	0.33% for TCM-1 0.66% for TCM 2-5	0.33% for TCM-1 0.66% for TCM 2-5

The launch vehicle injection errors were modeled with a covariance supplied by McDonnell-Douglas for the Delta-II 7425 launch vehicle received June 12, 1996. (see Appendix B). Using K-matrices for the nominal trajectory, this injection covariance was mapped to the

Mars B-plane at closest approach. The resulting 1-sigma uncertainty ellipse is shown in Figure 4 along. NASA planetary protection regulations requires the injection aimpoint to positioned so that the probability of the upper stage impacting Mars is less than 10^{-4}. Therefore the launch vehicle aimpoint was targeted to B•R=60,000 km, B•T=-20,000 km, as shown in Figure 4. Critical plane targetting of TCM-1 was not used in this analysis (as it was for the MSP '98 Orbiter analysis), because the lander needs to arrive at Mars at a pre-determined time in order to lander and the desired location.

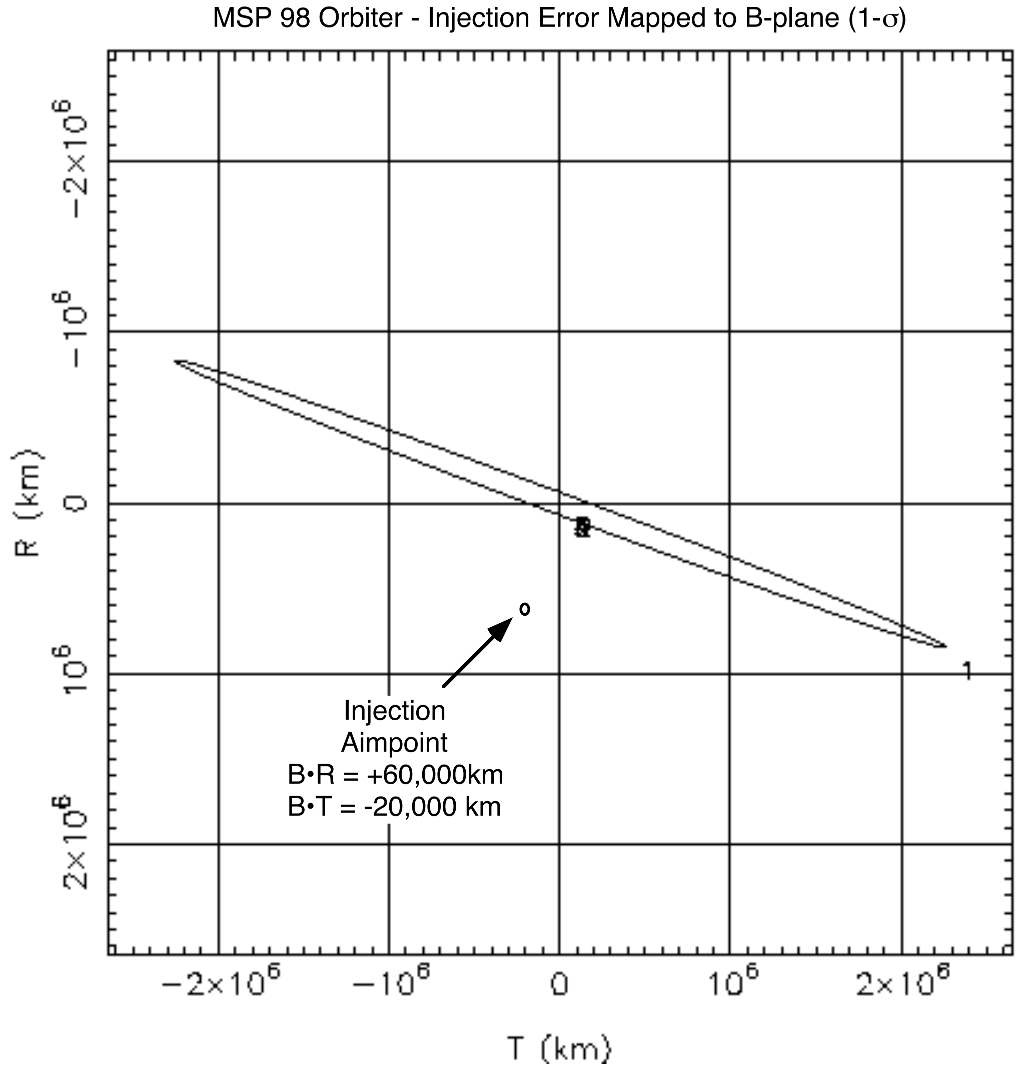


Figure 4: Injection error covariance mapped to the Mars B-plane, and injection aimpoint for P(impact)<1.0E-4

Table 8 gives the ΔV results from LAMBIC. Figure 5 is a histogram illustrating the statistical spread of required ΔV for the lander.

Table 8: Results of maneuver analysis (m/s) for lander

Maneuver	Mean	1σ	95%-low	95%-high
TCM-1	30.28	16.0	9.86	59.90
TCM-2	0.41	0.34	0.08	1.07
TCM-3	0.17	0.18	0.01	0.53
TCM-4	0.09	0.05	0.03	0.18
TCM-5	0.16	0.10	0.04	0.36
Mission Total	**31.10**	**16.25**	**10.29**	**61.20**

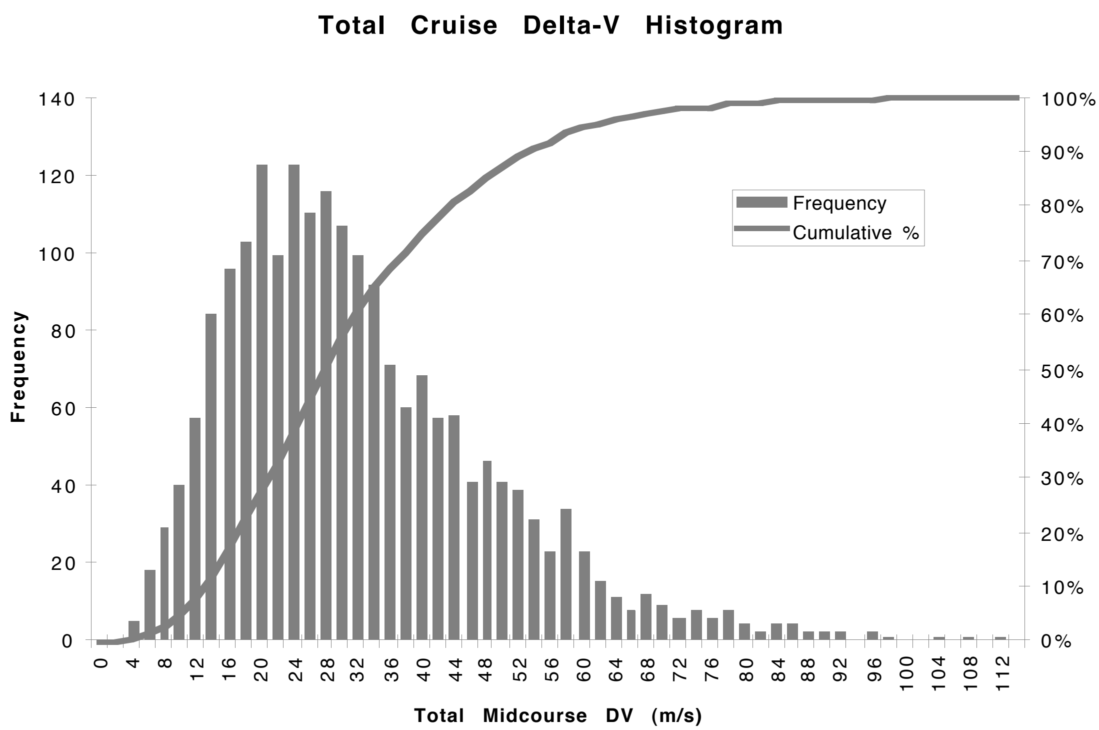


Figure 5: Histogram of maneuver ΔV (m/s) for interplanetary TCM usage

LAMBIC also provides the guidance error covariance, mapped to the Mars-Centered B-plane at closest approach (Table 9 and Figure 6). The guidance error is different than the OD error in that it includes maneuver execution errors. Guidance error from TCM-1 and TCM-2 are considerably larger than the corresponding OD error because these maneuvers are large and the resulting maneuver ΔV error is also large. Also, there is considerably more time between execution of these maneuvers and the arrival at Mars, so these errors propagate longer into a larger B-plane error. TCM-3 thru TCM-5 are much smaller maneuvers and they occur closer to Mars, therefore their resulting guidance errors are not significantly larger than their corresponding OD errors.

Table 8: Maneuver Delivery Uncertainty Ellipses (1-σ) for lander mapped in the Mars-centered, Mars Mean Equator of Date B-plane

	Semi-Major Axis (km)	Semi-Minor Axis (km)	Ellipse Orientation to T-axis	Linearized Time of Flight
TCM-1	12871	538	19°	1060
TCM-2	1209	38	19°	93.7
TCM-3	19.1	10.8	17°	2.55
TCM-4	4.1	0.63	105°	0.33
TCM-5	3.16	0.13	104°	0.12

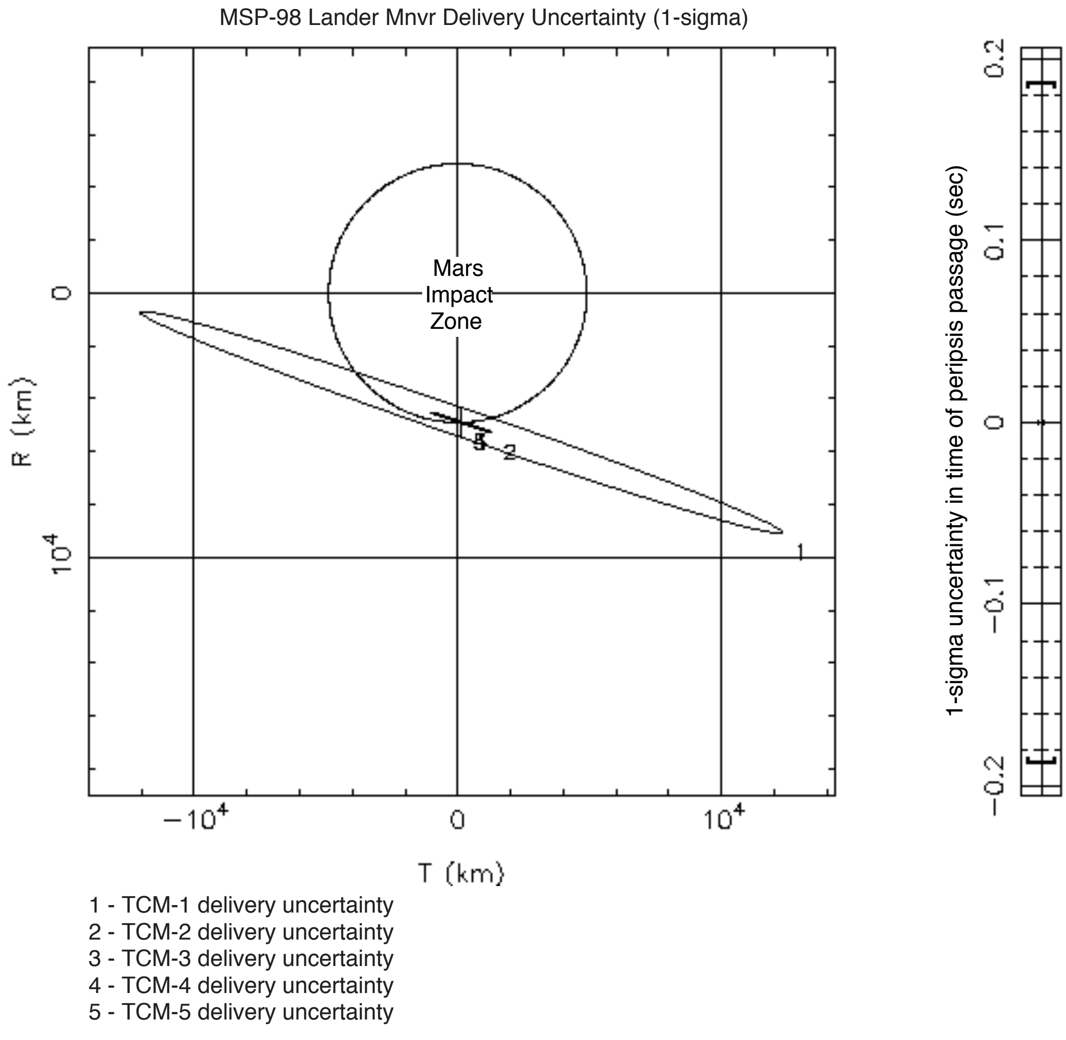


Figure 6a: Guidance error results (1-σ) for the lander, mapped in the Mars-centered, Mars Mean Equator of Date B-plane (TCM-1 and TCM-2)

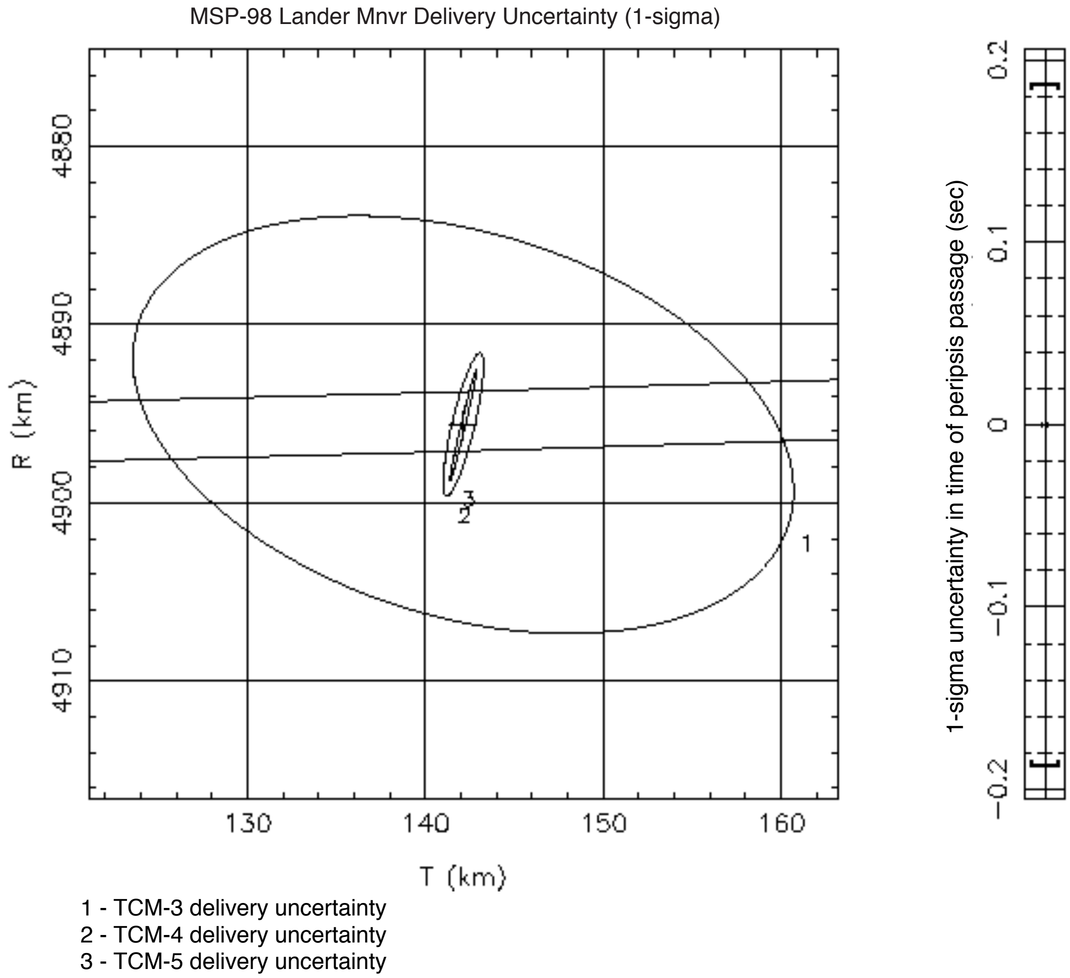


Figure 6b: Guidance error results (1-σ) for the lander, mapped in the Mars-centered, Mars Mean Equator of Date B-plane (TCM-3, TCM-4 and TCM-5)

Comments

1) **Nongrav modelling:** Although detailed, the nongrav model used in this study needs to be improved upon for flight operations. It will be necessary to establish a detailed interface from the Spacecraft Engineering group to the NAV group that provides an accurate history (time and ΔV direction/magnitude) of not only past thruster activity obtained from telemetry, but also the best estimate of predicted thruster activity. This thruster ΔV history will be used by the NAV team as *apriori* information both for flight path prediction as well as nongrav error estimation.

2) **Possible improvements to this baseline:** The largest single contributor to the guidance error budget is the nongrav effects arising from attitude control. If this effect can be minimized in the last few weeks before entry, it will certaintly improve the overall uncertainty. If you can't "minimize the errors", then "maxmize the data". It might be more practical to improve the data quality to achieve an overall guidance error improvement. For Mars '98, range is the primary data type, and for this OD study it was weighted at 1.4 meters (based on an

extrapolation of the current Mars Pathfinder capabilities). If it's possible to improve the ranging capability on both the spacecraft and station end, an improvement in the guidance errors will follow.

DISTRIBUTION

JPL:

Gene Bollman
Pat Esposito
Phil Knocke
Cliff Helfrich
Jim McDanell
David Spencer
Sam Thurman
Bobby Williams

LMA:

Lad Curtis
David Cwynar
Phil Hong
David Murrow
Bill Willcockson

REFERENCES

1. Kallemeyn, P., “Orbit Determination and Maneuver Analysis for Mars ‘98 Cruise Phase”, JPL IOM 312.3-95-009, July 21, 1995.

2. Moyer, T. D., “Mathematical Formulation of the Double-Precision Orbit Determination Program (DPODP)”, Technical Report 32-1527, Jet Propulsion Laboratory, Pasadena, California, 15 May 1971.

3. Spier, G. W., “Design and Implementation of Models for the Double Precision Trajectory Program (DPTRAJ)”, Technical Memorandum 33-451, Jet Propulsion Laboratory, Pasadena, California, 15 April 1971.

4. Mars Pathfinder Project Navigation Plan (Critical Design Review Version), JPL Document D-11349, July 1994.

5. Thurman, S. W., “Orbit Determination Filter and Modeling Assumptions for MESUR Pathfinder Guidance and Navigation Analysis”, Interoffice Memorandum 314.3-1075, Jet Propulsion Laboratory, Pasadena, California, 15 October 1993.

6. Deep Space Network System Functional Requirements and Design: Tracking System (1988 through 1993), DSN Document 821-19, Rev. C (JPL D-1662, Rev. C), Jet Propulsion Laboratory, Pasadena, California, 15 April 1993, pp. 3-27.

7. Wynn, J., Post TCM 4 Lander Limit Cycle Performance, Lockheed-Martin Interoffice Memorandum MSP-AC-96-0022, April 23, 1996.

8. DPTRAJ-ODP User's Reference Manual, Volumes 1-4, JPL Document D-9137, Jet Propulsion Laboratory, Pasadena, California, August 1991.

9. User's Guide for Navigation Subsystem Maneuver Operations Software (MOPS) , JPL Document D-9067, Jet Propulsion Laboratory, Pasadena, California, February 1992.

Appendix A

Definition of the Asymptotic Aiming Plane Coordinate System (B-plane)

The asymptotic aiming plane, or *B-plane*, coordinate system, is shown in Fig. 7. The orientation of this system in space is defined by the arrival asymptote direction, designated **S**, which is parallel to the velocity vector $\mathbf{V}_\infty$. The unit vectors **T** and **R** form an orthogonal triad with **S**; the direction of **T** is chosen to lie in the Martian equatorial plane, at a given date. The point of aim corresponding to the desired landing site is defined by the miss vector, **B**, in Fig. 7, which is oriented in the **T-R** plane, called the *B-plane*, by the angle ϕ, and has magnitude $|B|$. The miss vector specifies where the point of closest approach would be if the target body had no mass and did not deflect the flight path. Navigational uncertainty is characterized by a two-dimensional dispersion ellipse in the B-plane with semi-major axis *SMAA*, semi-minor axis *SMIA*, and orientation angle θ, and by the uncertainty in the time of arrival at the point of atmospheric entry, the time of arrival.

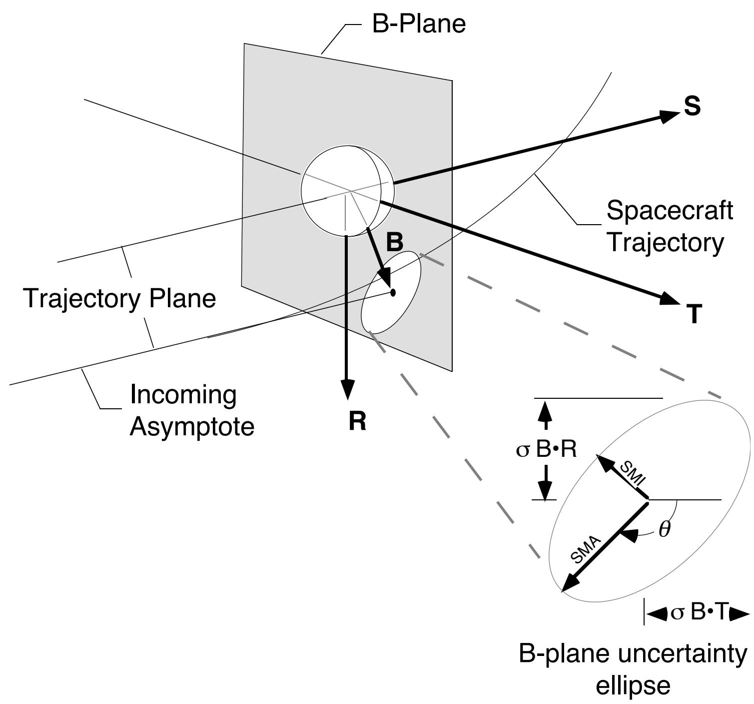


Figure 7: Target-centered aiming plane (B-plane) coordinate system.

Appendix B

Injection error covariance of the Delta II 7425 Launch Vehicle for the Mars Surveyor '98 lander mission

Delta 7425 MARS LANDER Mission - 1/3/99 Launch Date
Preliminary Orbit Injection Covariance Matrix without PCS Effects
Based on Updated Velocity Pointing Error and Coning Velocity loss

MSP LANDER - 1/3/99 --99.7% PCS -- 95 FLT AZ
COVARIANCE MATRIX OF TECO INJECTION CONDITIONS BASED ON -3 SIGMA SENSITIVITIES

		VELOCITY FT/SEC	GAMMA DEGREES	AZIMUTH DEGREES	LONG. + W DEGREES	LATITUDE DEGREES	RADIUS FEET
VELOCITY	FT/SEC	0.20481144E+03	-0.34414708E+00	0.24644275E+00	0.11585842E-01	0.65757311E-02	-0.14555668E+05
GAMMA	DEGREES	-0.34414708E+00	0.34200888E-01	-0.79730416E-03	-0.27300273E-02	-0.12506890E-02	0.55998423E+01
AZIMUTH	DEGREES	0.24644275E+00	-0.79730416E-03	0.33821900E-01	0.21692060E-02	0.99387262E-03	0.10299844E+02
LONG. + W	DEGREES	0.11585842E-01	-0.27300273E-02	0.21692060E-02	0.72944830E-02	0.33353893E-02	0.37684516E+02
LATITUDE	DEGREES	0.65757311E-02	-0.12506890E-02	0.99387262E-03	0.33353893E-02	0.15323557E-02	0.15713724E+02
RADIUS	FEET	-0.14555668E+05	0.55998423E+01	0.10299844E+02	0.37684516E+02	0.15713724E+02	0.18575764E+08
THETA LP	DEGREES	-0.10951174E+01	0.11077725E+00	-0.23624354E-02	-0.81764250E-02	-0.37420695E-02	-0.38567364E+02
PSI LP	DEGREES	0.79214216E+00	-0.76392393E-03	0.10848763E+00	0.21700173E-02	0.99264329E-03	0.10301716E+02

		THETA LP DEGREES	PSI LP DEGREES
VELOCITY	FT/SEC	-0.10951174E+01	0.79214216E+00
GAMMA	DEGREES	0.11077725E+00	-0.76392393E-03
AZIMUTH	DEGREES	-0.23624354E-02	0.10848763E+00
LONG. + W	DEGREES	-0.81764250E-02	0.21700173E-02
LATITUDE	DEGREES	-0.37420695E-02	0.99264329E-03
RADIUS	FEET	-0.38567364E+02	0.10301716E+02
THETA LP	DEGREES	0.35911889E+00	-0.22105251E-02
PSI LP	DEGREES	-0.22105251E-02	0.35121659E+00

Delta 7425 MARS LANDER Mission - 1/3/99 Launch Date
Preliminary Orbit Injection Covariance Matrix (NASA SYSTEM) without PCS Effects
Based on Updated Velocity Pointing Error and Coning Velocity loss

MSP LANDER - 1/3/99 --99.7% PCS -- 95 FLT AZ
COVARIANCE MATRIX OF TECO INJECTION CONDITIONS BASED ON -3 SIGMA SENSITIVITIES

		X (NASA) FEET	Y (NASA) FEET	Z (NASA) FEET	VX (NASA) FT/SEC	VY (NASA) FT/SEC	VZ (NASA) FT/SEC
X (NASA)	FEET	0.12955602E+10	-0.44595644E+06	-0.11353480E+08	0.20861946E+05	0.87340089E+01	-0.15132762E+07
Y (NASA)	FEET	-0.44595644E+06	0.81890678E+06	0.72748347E+04	-0.11564407E+02	-0.39518354E+03	0.52334715E+03
Z (NASA)	FEET	-0.11353480E+08	0.72748347E+04	0.18629851E+08	-0.15000721E+05	0.25932517E+00	0.25271242E+05
VX (NASA)	FT/SEC	0.20861946E+05	-0.11564407E+02	-0.15000721E+05	0.21395418E+03	-0.22743382E+03	-0.41093276E+03
VY (NASA)	FT/SEC	0.87340089E+01	-0.39518354E+03	0.25932517E+00	-0.22743382E+03	0.14425404E+05	-0.94326117E+01
VZ (NASA)	FT/SEC	-0.15132762E+07	0.52334715E+03	0.25271242E+05	-0.41093276E+03	-0.94326117E+01	0.16195217E+05
THETA LP	DEGREES	0.34462515E+04	-0.11851555E+01	-0.30232036E+02	-0.18426648E+01	-0.46291040E-01	0.67006008E+02
PSI LP	DEGREES	-0.91454712E+03	0.14727620E+00	0.80899712E+01	0.11069379E+01	-0.71110810E+02	0.11134903E+01

		THETA LP DEGREES	PSI LP DEGREES
X (NASA)	FEET	0.34462515E+04	-0.91454712E+03
Y (NASA)	FEET	-0.11851555E+01	0.14727620E+00
Z (NASA)	FEET	-0.30232036E+02	0.80899712E+01
VX (NASA)	FT/SEC	-0.18426648E+01	0.11069379E+01
VY (NASA)	FT/SEC	-0.46291040E-01	-0.71110810E+02
VZ (NASA)	FT/SEC	0.67006008E+02	0.11134903E+01
THETA LP	DEGREES	0.35911889E+00	-0.22105251E-02
PSI LP	DEGREES	-0.22105251E-02	0.35121659E+00

X, Y, Z (NASA) Coordinate System:
Positive x-axis is parallel to the projection of the instantaneous vehicle velocity vector onto a plane perpendicular to the radius vector. Z-ax positive away from the earth along the radius vector. Y-axis completes the right-handed orthogonal system. The origin is at the nominal vehicle position point and the system is inertial.

Delta 7425 MARS Lander Mission - 1/10/99 Launch Date

Preliminary Orbit Injection Covariance Matrix without PCS Effects

Based on Updated Velocity Pointing Error and Coning Velocity loss

MSP LANDER - 1/10/99 --99.7% PCS -- 95 FLT AZ

COVARIANCE MATRIX OF TECO INJECTION CONDITIONS BASED ON -3 SIGMA SENSITIVITIES

		VELOCITY FT/SEC	GAMMA DEGREES	AZIMUTH DEGREES	LONG. + W DEGREES	LATITUDE DEGREES	RADIUS FEET
VELOCITY	FT/SEC	0.23176285E+03	0.97154177E+00	0.21990679E+00	-0.10004462E+00	-0.41921734E-01	-0.16699383E+05
GAMMA	DEGREES	0.97154177E+00	0.34526204E-01	-0.85645106E-03	-0.25898198E-02	-0.11225974E-02	-0.75129331E+00
AZIMUTH	DEGREES	0.21990679E+00	-0.85645106E-03	0.34389507E-01	0.23375187E-02	0.10133142E-02	0.16541624E+02
LONG. + W	DEGREES	-0.10004462E+00	-0.25898198E-02	0.23375187E-02	0.72511665E-02	0.31370227E-02	0.54786821E+02
LATITUDE	DEGREES	-0.41921734E-01	-0.11225974E-02	0.10133142E-02	0.31370227E-02	0.13637945E-02	0.22080169E+02
RADIUS	FEET	-0.16699383E+05	-0.75129331E+00	0.16541624E+02	0.54786821E+02	0.22080169E+02	0.19838134E+08
THETA LP	DEGREES	0.32062229E+01	0.11126253E+00	-0.26623133E-02	-0.80003360E-02	-0.34642081E-02	-0.56371724E+02
PSI LP	DEGREES	0.78086637E+00	-0.89545751E-03	0.10935985E+00	0.23377992E-02	0.10112691E-02	0.16543005E+02

		THETA LP DEGREES	PSI LP DEGREES
VELOCITY	FT/SEC	0.32062229E+01	0.78086637E+00
GAMMA	DEGREES	0.11126253E+00	-0.89545751E-03
AZIMUTH	DEGREES	-0.26623133E-02	0.10935985E+00
LONG. + W	DEGREES	-0.80003360E-02	0.23377992E-02
LATITUDE	DEGREES	-0.34642081E-02	0.10112691E-02
RADIUS	FEET	-0.56371724E+02	0.16543005E+02
THETA LP	DEGREES	0.35878437E+00	-0.28244087E-02
PSI LP	DEGREES	-0.28244087E-02	0.35145700E+00

Delta 7425 MARS LANDER Mission - 1/10/99 Launch Date
Preliminary Orbit Injection Covariance Matrix (NASA SYSTEM) without PCS Effects
Based on Updated Velocity Pointing Error and Coning Velocity loss

MSP LANDER - 1/10/99 --99.7% PCS -- 95 FLT AZ
COVARIANCE MATRIX OF TECO INJECTION CONDITIONS BASED ON -3 SIGMA SENSITIVITIES

		X (NASA) FEET	Y (NASA) FEET	Z (NASA) FEET	VX (NASA) FT/SEC	VY (NASA) FT/SEC	VZ (NASA) FT/SEC
X (NASA)	FEET	0.12471384E+10	-0.64759778E+06	-0.18236751E+08	0.22970762E+05	0.10227128E+02	-0.14710695E+07
Y (NASA)	FEET	-0.64759778E+06	0.75999307E+06	0.12823007E+05	-0.16205728E+02	-0.44221693E+03	0.76465697E+03
Z (NASA)	FEET	-0.18236751E+08	0.12823007E+05	0.19874635E+08	-0.16197518E+05	0.31738532E+01	0.33266453E+05
VX (NASA)	FT/SEC	0.22970762E+05	-0.16205728E+02	-0.16197518E+05	0.25951160E+03	-0.23298055E+03	0.84254241E+03
VY (NASA)	FT/SEC	0.10227128E+02	-0.44221693E+03	0.31738532E+01	-0.23298055E+03	0.14454554E+05	0.10996707E+02
VZ (NASA)	FT/SEC	-0.14710695E+07	0.76465697E+03	0.33266453E+05	0.84254241E+03	0.10996707E+02	0.16147102E+05
THETA LP	DEGREES	0.33182855E+04	-0.17213248E+01	-0.48559863E+02	0.44352793E+01	0.54042157E-01	0.67080383E+02
PSI LP	DEGREES	-0.96948169E+03	0.15753084E+00	0.14260922E+02	0.11307599E+01	-0.71195772E+02	0.10936408E+01

		THETA LP DEGREES	PSI LP DEGREES
X (NASA)	FEET	0.33182855E+04	-0.96948169E+03
Y (NASA)	FEET	-0.17213248E+01	0.15753084E+00
Z (NASA)	FEET	-0.48559863E+02	0.14260922E+02
VX (NASA)	FT/SEC	0.44352793E+01	0.11307599E+01
VY (NASA)	FT/SEC	0.54042157E-01	-0.71195772E+02
VZ (NASA)	FT/SEC	0.67080383E+02	0.10936408E+01
THETA LP	DEGREES	0.35878437E+00	-0.28244087E-02
PSI LP	DEGREES	-0.28244087E-02	0.35145700E+00

X, Y, Z (NASA) Coordinate System:
Positive x-axis is parallel to the projection of the instantaneous vehicle velocity vector onto a plane perpendicular to the radius vector. Z-ax positive away from the earth along the radius vector. Y-axis completes the right-handed orthogonal system. The origin is at the nominal vehicle position point and the system is inertial.

Delta 7425 MARS Lander Mission - 1/16/99 Launch Date
Preliminary Orbit Injection Covariance Matrix without PCS Effects
Based on Updated Velocity Pointing Error and Coning Velocity loss

MSP LANDER - 1/16/99 --99.7% PCS -- 95 FLT AZ
COVARIANCE MATRIX OF TECO INJECTION CONDITIONS BASED ON -3 SIGMA SENSITIVITIES

		VELOCITY FT/SEC	GAMMA DEGREES	AZIMUTH DEGREES	LONG. + W DEGREES	LATITUDE DEGREES	RADIUS FEET
VELOCITY	FT/SEC	0.20332140E+03	-0.25490987E+00	0.24309051E+00	-0.41689121E-02	-0.62713315E-03	-0.14617355E+05
GAMMA	DEGREES	-0.25490987E+00	0.34517490E-01	-0.74095539E-03	-0.25349086E-02	-0.11631357E-02	0.30083521E+01
AZIMUTH	DEGREES	0.24309051E+00	-0.74095539E-03	0.34203457E-01	0.20745008E-02	0.95199156E-03	0.12526794E+02
LONG. + W	DEGREES	-0.41689121E-02	-0.25349086E-02	0.20745008E-02	0.69837143E-02	0.31979875E-02	0.45240938E+02
LATITUDE	DEGREES	-0.62713315E-03	-0.11631357E-02	0.95199156E-03	0.31979875E-02	0.14716626E-02	0.19191119E+02
RADIUS	FEET	-0.14617355E+05	0.30083521E+01	0.12526794E+02	0.45240938E+02	0.19191119E+02	0.18629072E+08
THETA LP	DEGREES	-0.79878258E+00	0.11123887E+00	-0.22714018E-02	-0.78343934E-02	-0.35909464E-02	-0.47054166E+02
PSI LP	DEGREES	0.78669454E+00	-0.71301128E-03	0.10909061E+00	0.20752840E-02	0.95067191E-03	0.12528598E+02

		THETA LP DEGREES	PSI LP DEGREES
VELOCITY	FT/SEC	-0.79878258E+00	0.78669454E+00
GAMMA	DEGREES	0.11123887E+00	-0.71301128E-03
AZIMUTH	DEGREES	-0.22714018E-02	0.10909061E+00
LONG. + W	DEGREES	-0.78343934E-02	0.20752840E-02
LATITUDE	DEGREES	-0.35909464E-02	0.95067191E-03
RADIUS	FEET	-0.47054166E+02	0.12528598E+02
THETA LP	DEGREES	0.35874288E+00	-0.21488519E-02
PSI LP	DEGREES	-0.21488519E-02	0.35097358E+00

Delta 7425 MARS LANDER Mission - 1/16/99 Launch Date
Preliminary Orbit Injection Covariance Matrix (NASA SYSTEM) without PCS Effects
Based on Updated Velocity Pointing Error and Coning Velocity loss

MSP LANDER - 1/16/99 --99.7% PCS -- 95 FLT AZ
COVARIANCE MATRIX OF TECO INJECTION CONDITIONS BASED ON -3 SIGMA SENSITIVITIES

		X (NASA) FEET	Y (NASA) FEET	Z (NASA) FEET	VX (NASA) FT/SEC	VY (NASA) FT/SEC	VZ (NASA) FT/SEC
X (NASA)	FEET	0.12420555E+10	-0.43909006E+06	-0.14737716E+08	0.20615450E+05	0.11842071E+02	-0.14643914E+07
Y (NASA)	FEET	-0.43909006E+06	0.81596426E+06	0.81353026E+04	-0.11394285E+02	-0.40431925E+03	0.51801484E+03
Z (NASA)	FEET	-0.14737716E+08	0.81353026E+04	0.18666579E+08	-0.14995076E+05	0.23469204E+00	0.29213427E+05
VX (NASA)	FT/SEC	0.20615450E+05	-0.11394285E+02	-0.14995076E+05	0.20874105E+03	-0.22780977E+03	-0.29628805E+03
VY (NASA)	FT/SEC	0.11842071E+02	-0.40431925E+03	0.23469204E+00	-0.22780977E+03	0.14426882E+05	-0.76091966E+01
VZ (NASA)	FT/SEC	-0.14643914E+07	0.51801484E+03	0.29213427E+05	-0.29628805E+03	-0.76091966E+01	0.16160632E+05
THETA LP	DEGREES	0.33043588E+04	-0.11670049E+01	-0.39240118E+02	-0.12719579E+01	-0.37309041E-01	0.67152201E+02
PSI LP	DEGREES	-0.87521139E+03	0.12525426E+00	0.10459152E+02	0.11085931E+01	-0.71092723E+02	0.10684595E+01

		THETA LP DEGREES	PSI LP DEGREES
X (NASA)	FEET	0.33043588E+04	-0.87521139E+03
Y (NASA)	FEET	-0.11670049E+01	0.12525426E+00
Z (NASA)	FEET	-0.39240118E+02	0.10459152E+02
VX (NASA)	FT/SEC	-0.12719579E+01	0.11085931E+01
VY (NASA)	FT/SEC	-0.37309041E-01	-0.71092723E+02
VZ (NASA)	FT/SEC	0.67152201E+02	0.10684595E+01
THETA LP	DEGREES	0.35874288E+00	-0.21488519E-02
PSI LP	DEGREES	-0.21488519E-02	0.35097358E+00

X, Y, Z (NASA) Coordinate System:
Positive x-axis is parallel to the projection of the instantaneous vehicle velocity vector onto a plane perpendicular to the radius vector. Z-ax positive away from the earth along the radius vector. Y-axis completes the right-handed orthogonal system. The origin is at the nominal vehicle position point and the system is inertial.

Delta 7425 MARS Lander Mission - 1/27/99 Launch Date
Preliminary Orbit Injection Covariance Matrix without PCS Effects
Based on Updated Velocity Pointing Error and Coning Velocity loss

MSP LANDER - 1/27/99 --99.7% PCS -- 95 FLT AZ
COVARIANCE MATRIX OF TECO INJECTION CONDITIONS BASED ON -3 SIGMA SENSITIVITIES

		VELOCITY FT/SEC	GAMMA DEGREES	AZIMUTH DEGREES	LONG. + W DEGREES	LATITUDE DEGREES	RADIUS FEET
VELOCITY	FT/SEC	0.20256164E+03	-0.28859402E+00	0.24192418E+00	0.38360094E-02	0.30274768E-02	-0.13310859E+05
GAMMA	DEGREES	-0.28859402E+00	0.34580531E-01	-0.64320840E-03	-0.24528963E-02	-0.11897673E-02	0.53652432E+01
AZIMUTH	DEGREES	0.24192418E+00	-0.64320840E-03	0.34147910E-01	0.17860617E-02	0.86637585E-03	0.93981719E+01
LONG. + W	DEGREES	0.38360094E-02	-0.24528963E-02	0.17860617E-02	0.66758205E-02	0.32314374E-02	0.37788209E+02
LATITUDE	DEGREES	0.30274768E-02	-0.11897673E-02	0.86637585E-03	0.32314374E-02	0.15720338E-02	0.16886651E+02
RADIUS	FEET	-0.13310859E+05	0.53652432E+01	0.93981719E+01	0.37788209E+02	0.16886651E+02	0.17295317E+08
THETA LP	DEGREES	-0.90849039E+00	0.11132532E+00	-0.19796028E-02	-0.76204979E-02	-0.36924877E-02	-0.39843735E+02
PSI LP	DEGREES	0.77721808E+00	-0.61319637E-03	0.10909417E+00	0.17867286E-02	0.86523677E-03	0.93973405E+01

		THETA LP DEGREES	PSI LP DEGREES
VELOCITY	FT/SEC	-0.90849039E+00	0.77721808E+00
GAMMA	DEGREES	0.11132532E+00	-0.61319637E-03
AZIMUTH	DEGREES	-0.19796028E-02	0.10909417E+00
LONG. + W	DEGREES	-0.76204979E-02	0.17867286E-02
LATITUDE	DEGREES	-0.36924877E-02	0.86523677E-03
RADIUS	FEET	-0.39843735E+02	0.93973405E+01
THETA LP	DEGREES	0.35865306E+00	-0.18491752E-02
PSI LP	DEGREES	-0.18491752E-02	0.35088671E+00

Delta 7425 MARS LANDER Mission - 1/27/99 Launch Date
Preliminary Orbit Injection Covariance Matrix (NASA SYSTEM) without PCS Effects
Based on Updated Velocity Pointing Error and Coning Velocity loss

MSP LANDER - 1/27/99 --99.7% PCS -- 95 FLT AZ
COVARIANCE MATRIX OF TECO INJECTION CONDITIONS BASED ON -3 SIGMA SENSITIVITIES

		X (NASA) FEET	Y (NASA) FEET	Z (NASA) FEET	VX (NASA) FT/SEC	VY (NASA) FT/SEC	VZ (NASA) FT/SEC
X (NASA)	FEET	0.12295151E+10	-0.33172880E+06	-0.12056630E+08	0.18181664E+05	0.11848384E+02	-0.14513680E+07
Y (NASA)	FEET	-0.33172880E+06	0.87211878E+06	0.58532559E+04	-0.89580692E+01	-0.35713073E+03	0.39123956E+03
Z (NASA)	FEET	-0.12056630E+08	0.58532559E+04	0.17329717E+08	-0.13670184E+05	-0.11993797E+01	0.26024879E+05
VX (NASA)	FT/SEC	0.18181664E+05	-0.89580692E+01	-0.13670184E+05	0.20859130E+03	-0.22555044E+03	-0.32316197E+03
VY (NASA)	FT/SEC	0.11848384E+02	-0.35713073E+03	-0.11993797E+01	-0.22555044E+03	0.14426108E+05	-0.80428342E+01
VZ (NASA)	FT/SEC	-0.14513680E+07	0.39123956E+03	0.26024879E+05	-0.32316197E+03	-0.80428342E+01	0.16145903E+05
THETA LP	DEGREES	0.32708142E+04	-0.88161565E+00	-0.32100727E+02	-0.14278825E+01	-0.39431966E-01	0.67182218E+02
PSI LP	DEGREES	-0.76679566E+03	0.34808165E-01	0.75822856E+01	0.11006229E+01	-0.71096270E+02	0.94399803E+00

		THETA LP DEGREES	PSI LP DEGREES
X (NASA)	FEET	0.32708142E+04	-0.76679566E+03
Y (NASA)	FEET	-0.88161565E+00	0.34808165E-01
Z (NASA)	FEET	-0.32100727E+02	0.75822856E+01
VX (NASA)	FT/SEC	-0.14278825E+01	0.11006229E+01
VY (NASA)	FT/SEC	-0.39431966E-01	-0.71096270E+02
VZ (NASA)	FT/SEC	0.67182218E+02	0.94399803E+00
THETA LP	DEGREES	0.35865306E+00	-0.18491752E-02
PSI LP	DEGREES	-0.18491752E-02	0.35088671E+00

X, Y, Z (NASA) Coordinate System:
Positive x-axis is parallel to the projection of the instantaneous vehicle velocity vector onto a plane perpendicular to the radius vector. Z-ax positive away from the earth along the radius vector. Y-axis completes the right-handed orthogonal system. The origin is at the nominal vehicle position point and the system is inertial.

Delta 7425 MARS Lander Mission

Preliminary 99.7 % PCS Effects on Injection Velocity

MSP LANDER - 1/3/99 --99.7% PCS -- 95 FLT AZ

VELOCITY DEFICIT VS. PROBABILITY

VELOCITY DEFICIT (FPS)	PROBABILITY LEVEL	VELOCITY DEFICIT (FPS)	PROBABILITY LEVEL
0.00	0.99760	25.27	0.99890
0.13	0.99770	26.36	0.99900
1.18	0.99780	28.75	0.99910
7.56	0.99790	30.74	0.99920
10.19	0.99800	33.20	0.99930
12.71	0.99810	40.21	0.99940
12.72	0.99820	41.82	0.99950
13.72	0.99830	57.57	0.99960
15.25	0.99840	68.55	0.99970
16.07	0.99850	104.94	0.99980
17.19	0.99860	115.44	0.99990
18.56	0.99870	164.98	1.00000
20.03	0.99880		

THE CORRESPONDING SENSITIVITIES TO THE ABOVE VELOCITY DEFICITS ARE:*

IN POLAR COORDINATES-

PARAMETER	SENSITIVITY
INERTIAL RADIUS	0.000966 (NMI/FPS)
INERTIAL VELOCITY	0.985352 (FPS/FPS)
INERTIAL FLIGHT PATH ANGLE	0.000416 (DEG/FPS)
AZIMUTH	-0.000102 (DEG/FPS)
LONGITUDE (+W)	-0.000361 (DEG/FPS)
GEOCENTRIC LATITUDE	-0.000154 (DEG/FPS)

* BASED ON A VELOCITY DEFICIT OF 17.19 FPS (0.99860 PROBABILITY LEVEL)

Delta 7425 MARS Lander Mission
Preliminary 99.865 % Probable Maximum and Minimum
Injection Condition Dispersions
Based on Updated Velocity Pointing Error and Coning Velocity Loss

McDonnell Douglas Aerospace-Space Transportation Division

Launch date:	1/3/99	1/10/99	1/16/99	1/25/99
PCS (%):	99.7	99.7	99.7	99.7
Parameter				
Injection altitude (nmi)	+2.1 -2.3	+2.2 -2.3	+2.1 -2.3	+2.1 -2.2
Injection Velocity (fps)	+41.8 -46.4	+41.0 -46.9	+41.0 -46.2	+40.9 -46.1
Elevation angle (deg)	+0.56 -0.55	+0.57 -0.55	+0.57 -0.55	+0.57 -0.55
Azimuth angle (deg)	+0.55 -0.55	+0.56 -0.56	+0.56 -0.56	+0.55 -0.56
Longitude (+w,deg)	+0.25 -0.26	+0.25 -0.25	+0.25 -0.25	+0.24 -0.24
Geocentric latitude (deg)	+0.11 -0.12	+0.11 -0.11	+0.11 -0.11	+0.12 -0.12

Note: Errors do not include launch time effects

Launch date:	1/3/99	1/10/99	1/16/99	1/25/99
PCS (%):	99.7	99.7	99.7	99.7
Parameter				
Inclination (deg)	+0.44 -0.45	+0.43 -0.43	+0.45 -0.45	+0.47 -0.47
Longitude of the ascending node (deg)	+0.66 -0.68	+0.72 -0.74	+0.66 -0.69	+0.59 -0.62
Argument of perigee (deg)	+1.14 -1.18	+1.18 -1.23	+1.15 -1.20	+1.12 -1.18
True anomaly (deg)	+1.04 -1.01	+1.06 -1.03	+1.06 -1.03	+1.06 -1.03
Perigee altitude (nmi)	+2.3 -2.5	+2.3 -2.5	+2.2 -2.4	+2.2 -2.3
V infinity magnitude (fps)	+132.8 -160.1	+145.8 -173.6	+141.7 -169.9	+144.0 -173.2
Right ascension of V infinity (deg)	+0.97 -0.88	+1.18 -1.08	+1.01 -0.90	+1.01 -0.91
Declination of V infinity (fps)	+0.58 -0.52	+0.66 -0.61	+0.59 -0.53	+0.60 -0.53

B.8 34m BWG Usage and Tracking Schedule Modifications

DSN coverage for the majority of the mission is via the 34m subnet and the 70m subnet. Use of the 34m HEF antennae has been maximized, but 34m BWG support is necessary for limited intervals, to accommodate DSN usage conflicts. In addition, some modification of the nominal tracking profile is required in order to accommodate conflicts with other missions using the same DSN assets. The following spreadsheet summarizes the use of BWG antennae and/or modifications to the tracking schedule required during the Lander mission.

Summary of Recommendations - DSN Resource Contention Resolution [Mars98]

PCK DRAFT - 4/29/97, updated 7/18/97

Contention Period	Recommendation (Source)	Dates	M98 Orbiter Action	Impact on M98 Orbiter	M98 Lander Action	Impact on M98 Lander	Comments
# 6 [1/4/99 - 3/7/99]	M98 Lander and Orbiter use BWG on days when MGS has continuous coverage. (RAP)	1/5/99 - 1/12/99	Use GLD & CAN HEF overlap [6 2-hr passes/week?]. Supplement with BWG to total 7 4-hr passes/week. Some coverage from all 3 stations required.	No Impact.	BWG: continuous coverage to 1/10/99 BWG: 7 4-hr passes/week 1/10/99 - 1/12/99	No Impact.	• GLD/CAN overlap pass duration of 2-hrs is an estimate, with pre&post-cal taken out.
		1/13/99 - 1/19/99	HEF: 6 4-hr passes/week	Reduced monitoring	BWG: 7 4-hr passes/week	No Impact.	
		1/20/99 - 1/27/99	Use GLD & CAN HEF overlap [6 2-hr passes/week?]. Supplement with BWG to total 7 4-hr passes/week. Some coverage from all 3 stations required.	No Impact.	BWG: 7 4-hr passes/week	No Impact.	
		1/28/99 - 2/2/99	HEF: 6 4-hr passes/week	Reduced monitoring	BWG: 7 4-hr passes/week	No Impact.	
		2/3/99 - 2/10/99	Use GLD & CAN HEF overlap [6 2-hr passes/week?]. Supplement with BWG to total 7 4-hr passes/week. Some coverage from all 3 stations required.	No Impact.	BWG: 7 4-hr passes/week	No Impact.	
		2/11/99 - 2/17/99	HEF [MAD only]: 7 4-hr passes/week	Reduced Nav accuracy	BWG: 7 4-hr passes/week	No Impact.	• MGS diametric occultations
		2/18/99 - 2/22/99	BWG: 7 4-hr passes/week	No Impact.	Use GLD & CAN HEF overlap [6 2-hr passes/week?].	Reduced monitoring, nav accuracy	
		2/23/99 - 3/5/99	BWG: 7 4-hr passes/week from GLD & CAN	Reduced Nav accuracy	HEF: GLD 4 hr/day, CAN 1 hr/day	Reduced nav accuracy	
# 8 [5/3/99 - 5/9/99]	M98 Lander and Orbiter use BWG (RAP)	5/3/99 - 5/9/99	BWG: 7 4-hr passes/week	No Impact.	Use GLD/CAN HEF overlap [7 3-hr passes/week?]. Supplement with BWG to total 7 4-hr passes/week. Some coverage from all 3 stations required.	No Impact.	• Lander 's use of BWG requires deadbands tightened to ±9°, leading to minimal propellant hit [<< 0.1 kg].
# 9 [6/21/99 - 7/25/99]	M98 Lander & Orbiter use BWG every 3rd day (RAP)	6/21/99 - 7/25/99	1 4-hr HEF pass/day* except every 3rd day, go to 1 4-hr BWG pass.	No Impact.	No action required.	No impact.	
#10 [7/26/99 - 8/15/99]	M98 Lander & Orbiter use BWG (RAP)	8/2/99 - 8/9/99	BWG: 7 4-hr passes/week	No Impact.	Use GLD/CAN HEF overlap [7 3-hr passes/week?]. Supplement with BWG to total 7 4-hr passes/week. Some coverage from all 3 stations required.	No Impact.	• Lander 's use of BWG may require deadbands tightened to ±TBD°, leading to propellant hit.
# 11 [8/16/99 - 10/16/99]	M98 Lander use BWG (RAP)	8/16/99 - 10/16/99	No action required. Orbiter receives needed HEF tracking during approach.	No Impact.	Lander uses HEF throughout. 1 4-hr pass/day* except every 3rd day, the Lander pass is truncated to fit within DSN capability.	Reduction in monitoring. Other impacts TBD [e.g. impact on TCM-3 10/4/99].	• Lander alternative: use BWG during 8/16-9/10/99 only, requiring deadbands tightened to ±2° for 25 days, leading to propellant hit of 0.1 kg. + TBD impacts.
# 12 [10/18/99 - 12/5/99]	Give Stardust 6 contiguous hrs/week of HEF time. (Stardust)	10/18/99 - 12/5/99	No action required. Orbiter receives needed HEF tracking during aerobraking.	No Impact.	Lander gets requisiteHEF tracking [near-simultaneous w/ Orbiter] except for Stardust tracks. Per 4/24/997 agreement, no Stardust tracks occur 11/26/99 - 12/5/99.	No impact.	
week 38-39, 1999	Accept 2-3 hr/day gap in continuous 70m coverage for Orbiter. (GLL)	9/21/99 - 9/25/99	Accept, per GLL memo 4/1/97, 2-3 hr gap in continuous 70m coverage.	No Impact	No action required.	No impact.	
week 48 - 49, 1999	Maximize use of Canberra 70m antenna for Lander D/L during Sol 0,1. (GLL)	12/1/99 - 12/5/99	Accept, per GLL memo 4/1/97, reduction in DSS-14 [Goldstone] coverage in favor of DSS-43 [Canberra].	No Impact	No action required.	No impact..	

* Baseline Coverage

Legend: GLD = Goldstone, MAD = Madrid, CAN = Canberra

B.9 Approach Tracking Schedule

Shown is a strawman tracking schedule for the Lander from Entry - 45 days to Entry - 30 days, and an integrated [Orbiter + Lander] schedule of tracks for the interval of near-simultaneous tracking starting 30 days from Entry. These tracks have not been edited to be consistent with Earth view periods, but are intended to show the approximate variation of lander track durations and timing as a function of date.

B.9.1: Entry - 45d to Entry - 30d

B.9.2: Near Simultaneous Tracking - Integrated Tracking Schedule

B.9.3: Lander Track Durations

Lander Tracks
E-45d to Entry

4on/5 off starting E-45
1h 24 m between tracks

Days from Entry	Start Track	SSPA on duration [hr]	End Track
-45.03	10/19/99 20:15	4.00	10/20/99 0:15
-44.65	10/20/99 5:15	4.00	10/20/99 9:15
-44.28	10/20/99 14:15	4.00	10/20/99 18:15
-43.90	10/20/99 23:15	4.00	10/21/99 3:15
-43.53	10/21/99 8:15	4.00	10/21/99 12:15
-43.15	10/21/99 17:15	4.00	10/21/99 21:15
-42.78	10/22/99 2:15	4.00	10/22/99 6:15
-42.40	10/22/99 11:15	4.00	10/22/99 15:15
-42.03	10/22/99 20:15	4.00	10/23/99 0:15
-41.65	10/23/99 5:15	4.00	10/23/99 9:15
-41.28	10/23/99 14:15	4.00	10/23/99 18:15
-40.90	10/23/99 23:15	4.00	10/24/99 3:15
-40.53	10/24/99 8:15	4.00	10/24/99 12:15
-40.15	10/24/99 17:15	4.00	10/24/99 21:15
-39.78	10/25/99 2:15	4.00	10/25/99 6:15
-39.40	10/25/99 11:15	4.00	10/25/99 15:15
-39.03	10/25/99 20:15	4.00	10/26/99 0:15
-38.65	10/26/99 5:15	4.00	10/26/99 9:15
-38.28	10/26/99 14:15	4.00	10/26/99 18:15
-37.90	10/26/99 23:15	4.00	10/27/99 3:15
-37.53	10/27/99 8:15	4.00	10/27/99 12:15
-37.15	10/27/99 17:15	4.00	10/27/99 21:15
-36.78	10/28/99 2:15	4.00	10/28/99 6:15
-36.40	10/28/99 11:15	4.00	10/28/99 15:15
-36.03	10/28/99 20:15	4.00	10/29/99 0:15
-35.65	10/29/99 5:15	4.00	10/29/99 9:15
-35.28	10/29/99 14:15	4.00	10/29/99 18:15
-34.90	10/29/99 23:15	4.00	10/30/99 3:15
-34.53	10/30/99 8:15	4.00	10/30/99 12:15
-34.15	10/30/99 17:15	4.00	10/30/99 21:15
-33.78	10/31/99 2:15	4.00	10/31/99 6:15
-33.40	10/31/99 11:15	4.00	10/31/99 15:15
-33.03	10/31/99 20:15	4.00	11/1/99 0:15
-32.65	11/1/99 5:15	4.00	11/1/99 9:15
-32.28	11/1/99 14:15	4.00	11/1/99 18:15
-31.90	11/1/99 23:15	4.00	11/2/99 3:15
-31.53	11/2/99 8:15	4.00	11/2/99 12:15
-31.15	11/2/99 17:15	4.00	11/2/99 21:15

Integrated Tracking Schedule
Near-Simultaneous Tracking
Open Primary [Starting E-30d]

Assumptions:
- Minimum 2 hr / lander track
- Minimum 1h 24 m between tracks
- 4 on/ 5 off or equivalent
- Use 0.5h Orbiter tracks and 4 on/5 off Lander tracks 2d before end of AB
- End near-simul tracking NLT Entry-30h

Days to Entry	s/c. antenna	Start Track	Track 1 duration h	End Track
-30.7	Orb.HEF	11/3/99 4:25	3.83	11/3/99 8:15
-30.5	Lander	11/3/99 9:39	2.05	11/3/99 11:42
-30.3	Orb.HEF	11/3/99 13:06	3.77	11/3/99 16:52
-30.1	Lander	11/3/99 18:16	4.00	11/3/99 22:16
-30.0	Orb.BWG	11/3/99 21:40	3.72	11/4/99 1:24
-29.6	Orb.HEF	11/4/99 6:06	3.68	11/4/99 9:46
-29.4	Lander	11/4/99 11:10	4.00	11/4/99 15:10
-29.3	Orb.BWG	11/4/99 14:26	3.62	11/4/99 18:03
-28.9	Orb.HEF	11/4/99 22:38	3.57	11/5/99 2:12
-28.7	Lander	11/5/99 3:36	4.00	11/5/99 7:36
-28.6	Orb.BWG	11/5/99 6:45	3.53	11/5/99 10:17
-28.3	Orb.HEF	11/5/99 14:44	3.47	11/5/99 18:13
-28.1	Lander	11/5/99 19:37	4.00	11/5/99 23:37
-27.9	Orb.BWG	11/5/99 22:37	3.43	11/6/99 2:03
-27.6	Orb.HEF	11/6/99 6:25	3.39	11/6/99 9:48
-27.4	Lander	11/6/99 11:12	4.00	11/6/99 15:12
-27.3	Orb.BWG	11/6/99 14:05	3.34	11/6/99 17:26
-27.0	Orb.HEF	11/6/99 21:40	3.30	11/7/99 0:59
-26.8	Lander	11/7/99 2:23	4.00	11/7/99 6:23
-26.7	Orb.BWG	11/7/99 5:10	3.25	11/7/99 8:25
-26.3	Orb.HEF	11/7/99 12:33	3.21	11/7/99 15:46
-26.2	Lander	11/7/99 17:10	4.00	11/7/99 21:10
-26.0	Orb.BWG	11/7/99 19:51	3.18	11/7/99 23:02
-25.7	Orb.HEF	11/8/99 3:03	3.13	11/8/99 6:11
-25.6	Lander	11/8/99 7:35	4.00	11/8/99 11:35
-25.4	Orb.BWG	11/8/99 10:09	3.10	11/8/99 13:15
-25.2	Orb.HEF	11/8/99 17:11	3.05	11/8/99 20:14
-25.0	Lander	11/8/99 21:38	4.00	11/9/99 1:38
-24.9	Orb.BWG	11/9/99 0:07	3.02	11/9/99 3:09
-24.6	Orb.HEF	11/9/99 6:58	2.98	11/9/99 9:57
-24.4	Lander	11/9/99 11:21	4.00	11/9/99 15:21
-24.3	Orb.BWG	11/9/99 13:44	2.94	11/9/99 16:41
-24.0	Orb.HEF	11/9/99 20:26	2.91	11/9/99 23:20
-23.8	Lander	11/10/99 0:44	4.00	11/10/99 4:44
-23.7	Orb.BWG	11/10/99 3:02	2.87	11/10/99 5:54
-23.5	Orb.HEF	11/10/99 9:33	2.84	11/10/99 12:24
-23.3	Lander	11/10/99 13:48	4.00	11/10/99 17:48
-23.2	Orb.BWG	11/10/99 15:59	2.81	11/10/99 18:48
-22.9	Orb.HEF	11/10/99 22:22	2.78	11/11/99 1:09
-22.8	Lander	11/11/99 2:33	4.00	11/11/99 6:33
-22.7	Orb.BWG	11/11/99 4:40	2.75	11/11/99 7:24
-22.4	Orb.HEF	11/11/99 10:54	2.72	11/11/99 13:37
-22.2	Lander	11/11/99 15:01	4.00	11/11/99 19:01
-22.2	Orb.BWG	11/11/99 17:04	2.68	11/11/99 19:45
-21.9	Orb.HEF	11/11/99 23:09	2.65	11/12/99 1:48
-21.7	Lander	11/12/99 3:12	4.00	11/12/99 7:12
-21.7	Orb.BWG	11/12/99 5:10	2.62	11/12/99 7:47
-21.4	Orb.HEF	11/12/99 11:06	2.59	11/12/99 13:41
-21.2	Lander	11/12/99 15:05	4.00	11/12/99 19:05
-21.2	Orb.BWG	11/12/99 16:59	2.56	11/12/99 19:32
-20.9	Orb.HEF	11/12/99 22:47	2.53	11/13/99 1:19
-20.8	Lander	11/13/99 2:43	4.00	11/13/99 6:43
-20.7	Orb.BWG	11/13/99 4:31	2.50	11/13/99 7:01
-20.4	Orb.HEF	11/13/99 10:11	2.47	11/13/99 12:39
-20.3	Lander	11/13/99 14:03	4.00	11/13/99 18:03
-20.2	Orb.BWG	11/13/99 15:47	2.44	11/13/99 18:13
-20.0	Orb.HEF	11/13/99 21:19	2.41	11/13/99 23:44
-19.8	Lander	11/14/99 1:08	4.00	11/14/99 5:08
-19.8	Orb.BWG	11/14/99 2:48	2.39	11/14/99 5:11
-19.5	Orb.HEF	11/14/99 8:13	2.36	11/14/99 10:35

Integrated Tracking Schedule
Near-Simultaneous Tracking
Open Primary [Starting E-30d]

Days to Entry	s/c. antenna	Start Track	Track 1 duration h	End Track
-19.4	Lander	11/14/99 11:59	4.00	11/14/99 15:59
-19.3	Orb.BWG	11/14/99 13:34	2.34	11/14/99 15:54
-19.1	Orb.HEF	11/14/99 18:52	2.31	11/14/99 21:11
-18.9	Lander	11/14/99 22:35	4.00	11/15/99 2:35
-18.9	Orb.BWG	11/15/99 0:06	2.28	11/15/99 2:23
-18.6	Orb.HEF	11/15/99 5:17	2.25	11/15/99 7:33
-18.5	Lander	11/15/99 8:57	4.00	11/15/99 12:57
-18.4	Orb.BWG	11/15/99 10:24	2.22	11/15/99 12:38
-18.2	Orb.HEF	11/15/99 15:28	2.20	11/15/99 17:40
-18.1	Lander	11/15/99 19:04	4.00	11/15/99 23:04
-18.0	Orb.BWG	11/15/99 20:28	2.17	11/15/99 22:38
-17.8	Orb.HEF	11/16/99 1:24	2.15	11/16/99 3:33
-17.7	Lander	11/16/99 4:57	4.00	11/16/99 8:57
-17.6	Orb.BWG	11/16/99 6:17	2.13	11/16/99 8:24
-17.4	Orb.HEF	11/16/99 11:06	2.10	11/16/99 13:12
-17.3	Lander	11/16/99 14:36	4.00	11/16/99 18:36
-17.2	Orb.BWG	11/16/99 15:53	2.08	11/16/99 17:58
-17.0	Orb.HEF	11/16/99 20:36	2.06	11/16/99 22:40
-16.9	Lander	11/17/99 0:04	4.00	11/17/99 4:04
-16.8	Orb.BWG	11/17/99 1:17	2.04	11/17/99 3:20
-16.6	Orb.HEF	11/17/99 5:55	2.02	11/17/99 7:56
-16.5	Lander	11/17/99 9:20	4.00	11/17/99 13:20
-16.4	Orb.BWG	11/17/99 10:31	2.00	11/17/99 12:31
-16.2	Orb.HEF	11/17/99 15:02	1.98	11/17/99 17:01
-16.1	Lander	11/17/99 18:25	3.95	11/17/99 22:22
-16.1	Orb.BWG	11/17/99 19:32	1.95	11/17/99 21:29
-15.9	Orb.HEF	11/17/99 23:58	1.93	11/18/99 1:54
-15.7	Lander	11/18/99 3:18	3.87	11/18/99 7:10
-15.7	Orb.BWG	11/18/99 4:21	1.91	11/18/99 6:16
-15.5	Orb.HEF	11/18/99 8:42	1.89	11/18/99 10:36
-15.4	Lander	11/18/99 12:00	3.78	11/18/99 15:46
-15.3	Orb.BWG	11/18/99 13:00	1.87	11/18/99 14:52
-15.2	Orb.HEF	11/18/99 17:15	1.85	11/18/99 19:06
-15.0	Lander	11/18/99 20:30	3.69	11/19/99 0:12
-15.0	Orb.BWG	11/18/99 21:27	1.83	11/18/99 23:17
-14.8	Orb.HEF	11/19/99 1:36	1.81	11/19/99 3:25
-14.7	Lander	11/19/99 4:49	3.57	11/19/99 8:23
-14.6	Orb.BWG	11/19/99 5:42	1.79	11/19/99 7:30
-14.5	Orb.HEF	11/19/99 9:47	1.77	11/19/99 11:33
-14.3	Lander	11/19/99 12:57	3.44	11/19/99 16:24
-14.3	Orb.BWG	11/19/99 13:49	1.75	11/19/99 15:34
-14.1	Orb.HEF	11/19/99 17:48	1.73	11/19/99 19:32
-14.0	Lander	11/19/99 20:56	3.29	11/20/99 0:14
-14.0	Orb.BWG	11/19/99 21:44	1.71	11/19/99 23:27
-13.8	Orb.HEF	11/20/99 1:38	1.70	11/20/99 3:19
-13.7	Lander	11/20/99 4:43	3.19	11/20/99 7:55
-13.6	Orb.BWG	11/20/99 5:30	1.68	11/20/99 7:10
-13.5	Orb.HEF	11/20/99 9:19	1.66	11/20/99 10:58
-13.4	Lander	11/20/99 12:22	3.05	11/20/99 15:25
-13.3	Orb.BWG	11/20/99 13:05	1.65	11/20/99 14:43
-13.2	Orb.HEF	11/20/99 16:49	1.63	11/20/99 18:27
-13.0	Lander	11/20/99 19:51	2.94	11/20/99 22:47
-13.0	Orb.BWG	11/20/99 20:31	1.61	11/20/99 22:08
-12.9	Orb.HEF	11/21/99 0:11	1.59	11/21/99 1:47
-12.7	Lander	11/21/99 3:11	2.81	11/21/99 6:00
-12.7	Orb.BWG	11/21/99 3:49	1.58	11/21/99 5:24
-12.6	Orb.HEF	11/21/99 7:24	1.56	11/21/99 8:57
-12.4	Lander	11/21/99 10:21	2.69	11/21/99 13:03
-12.4	Orb.BWG	11/21/99 10:57	1.55	11/21/99 12:30
-12.3	Orb.HEF	11/21/99 14:27	1.53	11/21/99 15:59

Integrated Tracking Schedule
Near-Simultaneous Tracking
Open Primary [Starting E-30d]

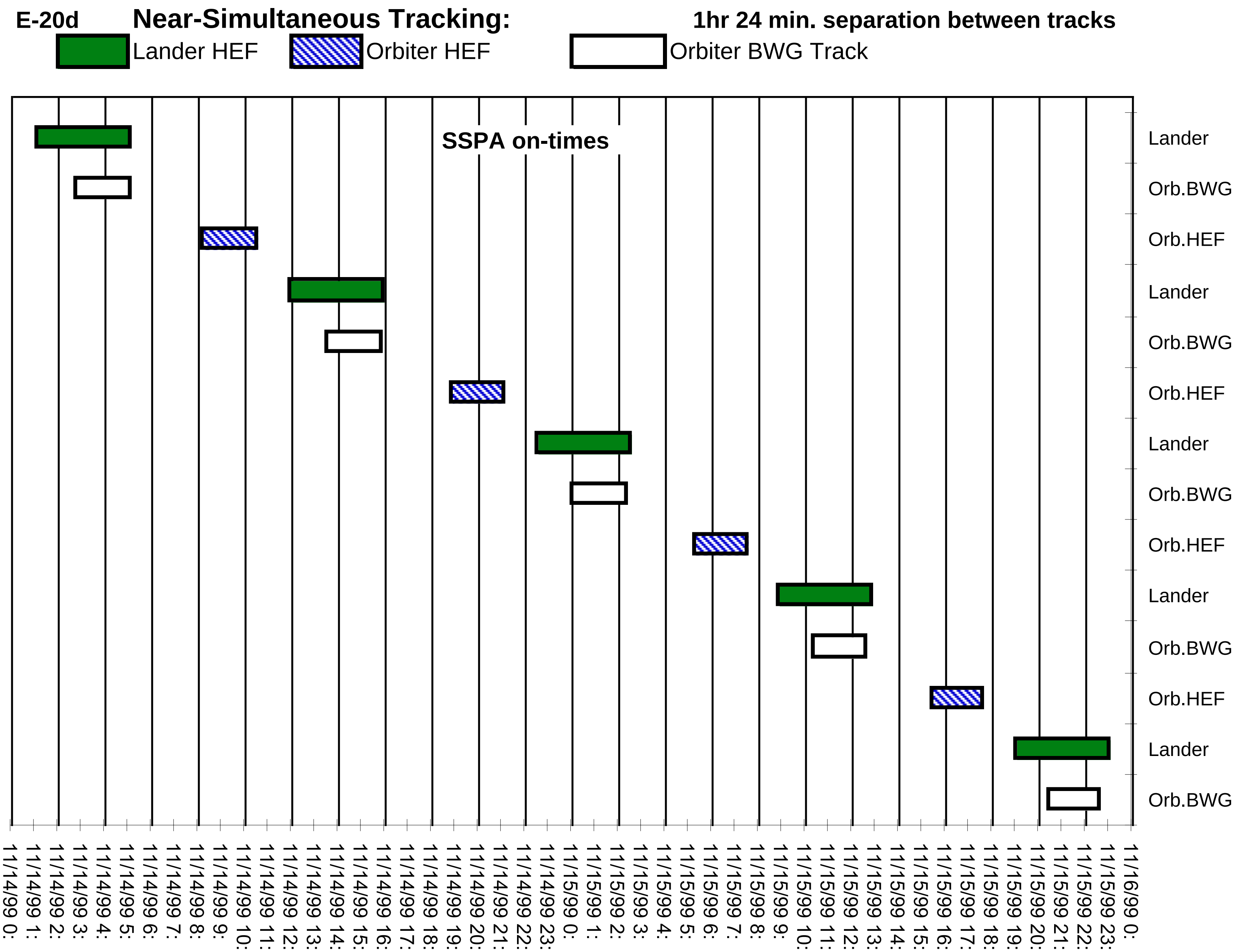
Days to Entry	s/c. antenna	Start Track	Track 1 duration h	End Track
-12.1	Lander	11/21/99 17:23	2.61	11/21/99 19:59
-12.1	Orb.BWG	11/21/99 17:56	1.52	11/21/99 19:27
-12.0	Orb.HEF	11/21/99 21:23	1.50	11/21/99 22:53
-11.9	Lander	11/22/99 0:17	2.47	11/22/99 2:45
-11.8	Orb.BWG	11/22/99 0:48	1.49	11/22/99 2:17
-11.7	Orb.HEF	11/22/99 4:09	1.48	11/22/99 5:38
-11.6	Lander	11/22/99 7:02	2.40	11/22/99 9:26
-11.6	Orb.BWG	11/22/99 7:31	1.47	11/22/99 8:59
-11.4	Orb.HEF	11/22/99 10:50	1.46	11/22/99 12:17
-11.3	Lander	11/22/99 13:41	2.36	11/22/99 16:03
-11.3	Orb.BWG	11/22/99 14:10	1.45	11/22/99 15:37
-11.1	Orb.HEF	11/22/99 17:27	1.45	11/22/99 18:54
-11.0	Lander	11/22/99 20:18	2.31	11/22/99 22:36
-11.0	Orb.BWG	11/22/99 20:44	1.44	11/22/99 22:11
-10.9	Orb.HEF	11/23/99 0:00	1.43	11/23/99 1:26
-10.8	Lander	11/23/99 2:50	2.23	11/23/99 5:04
-10.7	Orb.BWG	11/23/99 3:15	1.42	11/23/99 4:40
-10.6	Orb.HEF	11/23/99 6:28	1.41	11/23/99 7:52
-10.5	Lander	11/23/99 9:16	2.17	11/23/99 11:27
-10.5	Orb.BWG	11/23/99 9:39	1.40	11/23/99 11:03
-10.3	Orb.HEF	11/23/99 12:51	1.39	11/23/99 14:14
-10.2	Lander	11/23/99 15:38	2.08	11/23/99 17:43
-10.2	Orb.BWG	11/23/99 16:00	1.38	11/23/99 17:22
-10.1	Orb.HEF	11/23/99 19:07	1.37	11/23/99 20:29
-10.0	Lander	11/23/99 21:53	2.03	11/23/99 23:54
-9.9	Orb.BWG	11/23/99 22:14	1.36	11/23/99 23:35
-9.8	Orb.HEF	11/24/99 1:18	1.35	11/24/99 2:39
-9.7	Lander	11/24/99 4:03	4.00	11/24/99 8:03
-9.7	Orb.BWG	11/24/99 4:23	1.34	11/24/99 5:43
-9.6	Orb.BWG	11/24/99 7:24	1.33	11/24/99 8:44
-9.4	Orb.HEF	11/24/99 10:26	1.32	11/24/99 11:45
-9.3	Lander	11/24/99 13:09	3.96	11/24/99 17:06
-9.3	Orb.BWG	11/24/99 13:26	1.31	11/24/99 14:44
-9.2	Orb.BWG	11/24/99 16:24	1.30	11/24/99 17:42
-9.1	Orb.HEF	11/24/99 19:21	1.30	11/24/99 20:39
-9.0	Lander	11/24/99 22:03	3.88	11/25/99 1:56
-8.9	Orb.BWG	11/24/99 22:17	1.29	11/24/99 23:34
-8.8	Orb.BWG	11/25/99 1:13	1.28	11/25/99 2:30
-8.7	Orb.HEF	11/25/99 4:07	1.27	11/25/99 5:23
-8.6	Lander	11/25/99 6:47	3.82	11/25/99 10:37
-8.6	Orb.BWG	11/25/99 7:01	1.27	11/25/99 8:17
-8.5	Orb.BWG	11/25/99 9:53	1.26	11/25/99 11:08
-8.3	Orb.HEF	11/25/99 12:44	1.25	11/25/99 13:59
-8.2	Lander	11/25/99 15:23	3.76	11/25/99 19:09
-8.2	Orb.BWG	11/25/99 15:35	1.24	11/25/99 16:50
-8.1	Orb.BWG	11/25/99 18:24	1.24	11/25/99 19:38
-8.0	Orb.HEF	11/25/99 21:12	1.23	11/25/99 22:26
-7.9	Lander	11/25/99 23:50	3.69	11/26/99 3:32
-7.9	Orb.BWG	11/26/99 0:01	1.22	11/26/99 1:14
-7.8	Orb.BWG	11/26/99 2:47	1.21	11/26/99 3:59
-7.6	Orb.HEF	11/26/99 5:32	1.20	11/26/99 6:44
-7.5	Lander	11/26/99 8:08	3.59	11/26/99 11:44
-7.5	Orb.BWG	11/26/99 8:15	1.19	11/26/99 9:27
-7.4	Orb.BWG	11/26/99 10:58	1.18	11/26/99 12:09
-7.3	Orb.HEF	11/26/99 13:39	1.17	11/26/99 14:50
-7.2	Lander	11/26/99 16:14	3.52	11/26/99 19:45
-7.2	Orb.BWG	11/26/99 16:19	1.17	11/26/99 17:29
-7.1	Orb.BWG	11/26/99 18:57	1.16	11/26/99 20:07
-7.0	Orb.HEF	11/26/99 21:36	1.15	11/26/99 22:45
-6.9	Lander	11/27/99 0:09	3.45	11/27/99 3:36

Integrated Tracking Schedule
Near-Simultaneous Tracking
Open Primary [Starting E-30d]

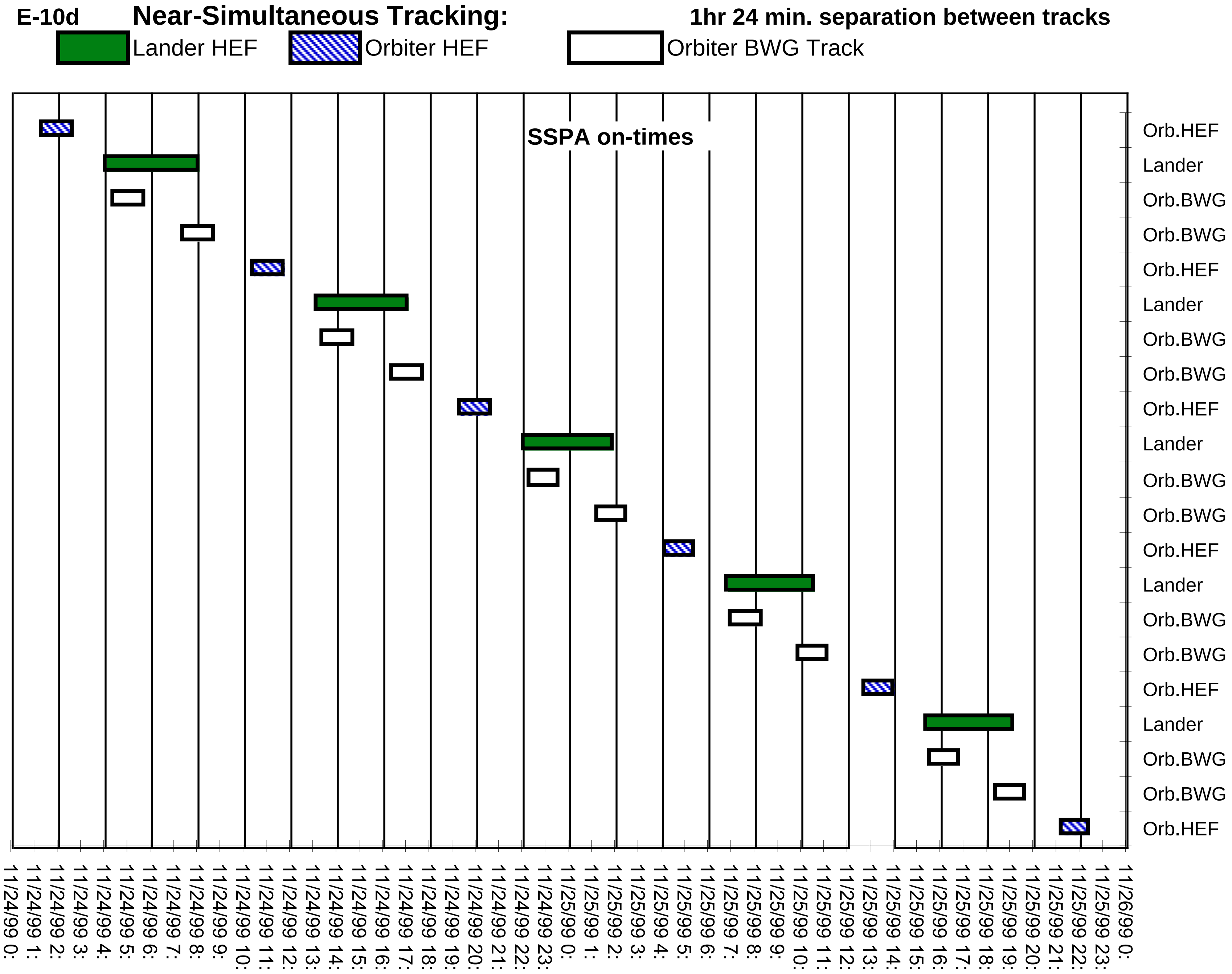
	Days to Entry	s/c. antenna	Start Track	Track 1 duration h	End Track
	-6.9	Orb.BWG	11/27/99 0:11	1.14	11/27/99 1:20
	-6.8	Orb.BWG	11/27/99 2:47	1.13	11/27/99 3:55
	-6.6	Orb.HEF	11/27/99 5:23	1.13	11/27/99 6:30
	-6.5	Lander	11/27/99 7:54	3.38	11/27/99 11:17
	-6.5	Orb.BWG	11/27/99 7:55	1.12	11/27/99 9:02
	-6.4	Orb.BWG	11/27/99 10:28	1.11	11/27/99 11:35
	-6.3	Orb.HEF	11/27/99 13:01	1.11	11/27/99 14:07
	-6.2	Orb.BWG	11/27/99 15:31	1.10	11/27/99 16:37
	-6.2	Lander	11/27/99 15:31	3.32	11/27/99 18:50
	-6.1	Orb.BWG	11/27/99 18:01	1.09	11/27/99 19:06
	-6.0	Orb.HEF	11/27/99 20:30	1.09	11/27/99 21:36
	-5.9	Orb.BWG	11/27/99 22:59	1.08	11/28/99 0:03
	-5.9	Lander	11/27/99 23:00	3.25	11/28/99 2:15
	-5.8	Orb.BWG	11/28/99 1:26	1.07	11/28/99 2:30
	-5.7	Orb.HEF	11/28/99 3:51	1.06	11/28/99 4:55
	-5.6	Orb.BWG	11/28/99 6:15	1.05	11/28/99 7:18
	-5.6	Lander	11/28/99 6:19	3.17	11/28/99 9:29
	-5.5	Orb.BWG	11/28/99 8:38	1.04	11/28/99 9:40
	-5.4	Orb.HEF	11/28/99 11:01	1.03	11/28/99 12:03
	-5.3	Orb.BWG	11/28/99 13:22	1.02	11/28/99 14:23
	-5.3	Lander	11/28/99 13:27	3.10	11/28/99 16:32
	-5.2	Orb.BWG	11/28/99 15:42	1.02	11/28/99 16:43
	-5.1	Orb.HEF	11/28/99 18:00	1.01	11/28/99 19:00
	-5.0	Orb.BWG	11/28/99 20:17	1.00	11/28/99 21:17
	-5.0	Lander	11/28/99 20:24	3.01	11/28/99 23:25
	-4.9	Orb.BWG	11/28/99 22:34	0.99	11/28/99 23:33
	-4.8	Orb.HEF	11/29/99 0:49	0.99	11/29/99 1:49
	-4.7	Orb.BWG	11/29/99 3:03	0.98	11/29/99 4:02
	-4.7	Lander	11/29/99 3:12	2.89	11/29/99 6:06
	-4.6	Orb.BWG	11/29/99 5:17	0.97	11/29/99 6:16
	-4.6	Orb.HEF	11/29/99 7:30	0.96	11/29/99 8:28
	-4.5	Orb.BWG	11/29/99 9:41	0.50	11/29/99 10:11
Start 30 minute Orbiter Tracks	-4.4	Orb.BWG	11/29/99 11:52	0.50	11/29/99 12:22
	-4.3	Lander	11/29/99 12:52	4.00	11/29/99 16:52
	-4.3	Orb.BWG	11/29/99 14:02	0.50	11/29/99 14:32
	-4.2	Orb.BWG	11/29/99 16:10	0.50	11/29/99 16:40
	-4.1	Orb.HEF	11/29/99 18:17	0.50	11/29/99 18:47
	-4.0	Orb.BWG	11/29/99 20:24	0.50	11/29/99 20:54
	-4.0	Lander	11/29/99 21:52	4.00	11/30/99 1:52
	-3.9	Orb.BWG	11/29/99 22:28	0.50	11/29/99 22:58
	-3.8	Orb.BWG	11/30/99 0:31	0.50	11/30/99 1:01
	-3.8	Orb.BWG	11/30/99 2:34	0.50	11/30/99 3:04
	-3.7	Orb.HEF	11/30/99 4:34	0.50	11/30/99 5:04
	-3.6	Orb.BWG	11/30/99 6:32	0.50	11/30/99 7:02
	-3.6	Lander	11/30/99 6:52	4.00	11/30/99 10:52
	-3.5	Orb.BWG	11/30/99 8:31	0.50	11/30/99 9:01
	-3.4	Orb.BWG	11/30/99 10:29	0.50	11/30/99 10:59
	-3.4	Orb.HEF	11/30/99 12:25	0.50	11/30/99 12:55
	-3.3	Orb.BWG	11/30/99 14:21	0.50	11/30/99 14:51
	-3.2	Lander	11/30/99 15:52	4.00	11/30/99 19:52
	-3.2	Orb.BWG	11/30/99 16:17	0.50	11/30/99 16:47
	-3.1	Orb.BWG	11/30/99 18:14	0.50	11/30/99 18:44
	-3.0	Orb.BWG	11/30/99 20:08	0.50	11/30/99 20:38
	-3.0	Orb.HEF	11/30/99 22:03	0.50	11/30/99 22:33
	-2.9	Orb.BWG	11/30/99 23:58	0.50	12/1/99 0:28
	-2.8	Lander	12/1/99 0:52	4.00	12/1/99 4:52
	-2.8	Orb.BWG	12/1/99 1:53	0.50	12/1/99 2:23
	-2.7	Orb.BWG	12/1/99 3:47	0.50	12/1/99 4:17
	-2.6	Orb.BWG	12/1/99 5:41	0.50	12/1/99 6:11
	-2.5	Orb.BWG	12/1/99 8:09	1.35	12/1/99 9:30

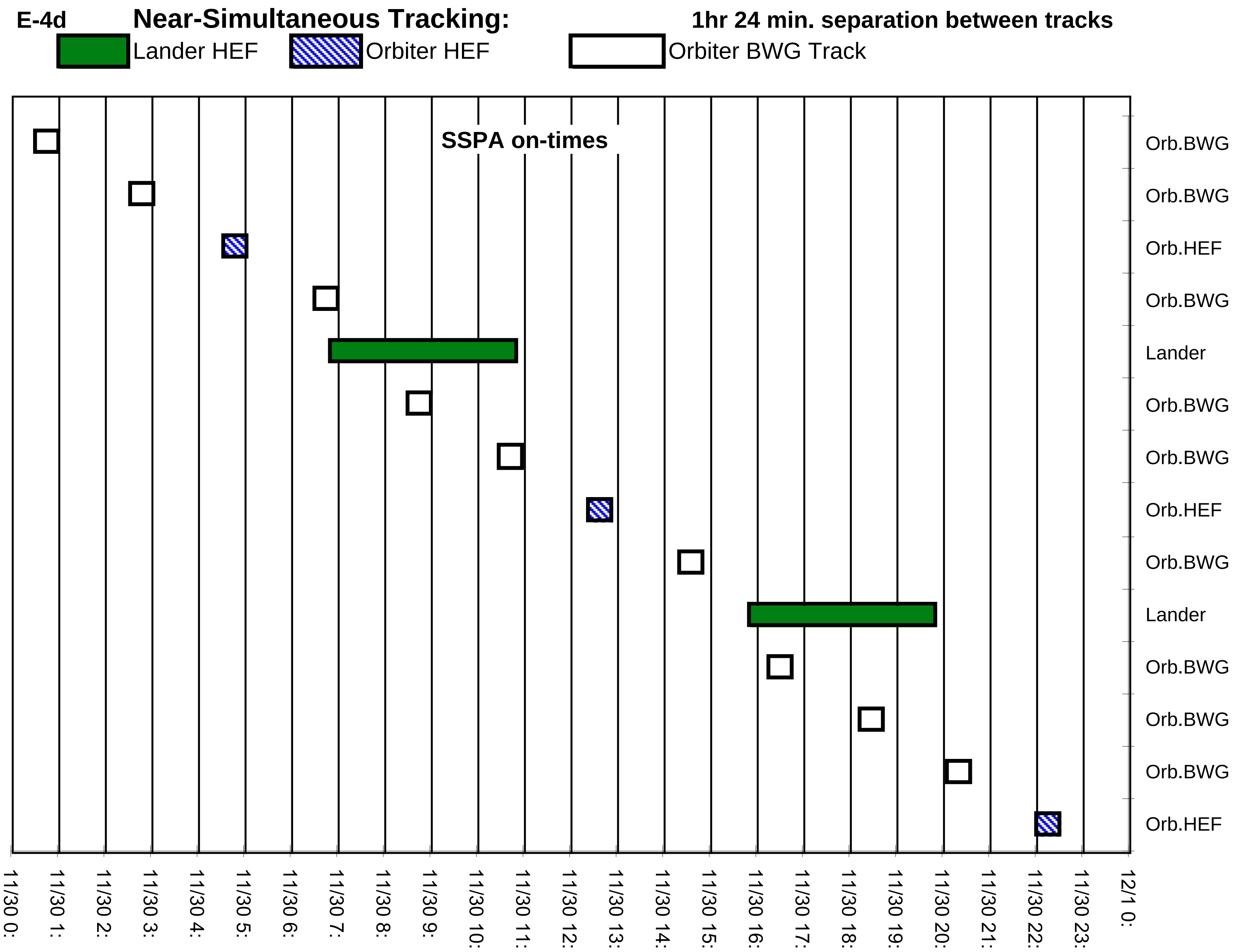
Integrated Tracking Schedule Near-Simultaneous Tracking Open Primary [Starting E-30d]	Days to Entry	s/c. antenna	Start Track	Track 1 duration h	End Track
Start Transfer to Map	-2.5	Lander	12/1/99 9:52	4.00	12/1/99 13:52
	-2.4	Orb.BWG	12/1/99 11:37	1.00	12/1/99 12:37
	-2.3	Orb.BWG	12/1/99 13:36	1.00	12/1/99 14:36
	-2.2	Orb.HEF	12/1/99 15:34	1.00	12/1/99 16:34
	-2.1	Orb.BWG	12/1/99 17:33	1.00	12/1/99 18:33
	-2.1	Lander	12/1/99 18:52	4.00	12/1/99 22:52
	-2.1	Orb.BWG	12/1/99 19:31	1.00	12/1/99 20:31
	-2.0	Orb.BWG	12/1/99 21:30	1.00	12/1/99 22:30
	-1.9	Orb.BWG	12/1/99 23:29	1.00	12/2/99 0:29
	-1.8	Orb.HEF	12/2/99 1:27	1.00	12/2/99 2:27
	-1.7	Orb.BWG	12/2/99 3:26	1.00	12/2/99 4:26
	-1.7	Lander	12/2/99 3:52	4.00	12/2/99 7:52
	-1.6	Orb.BWG	12/2/99 5:24	1.00	12/2/99 6:24
	-1.6	Orb.BWG	12/2/99 7:23	1.00	12/2/99 8:23
Last Near Simultaneous track	-1.5	Orb.HEF	12/2/99 9:22	1.00	12/2/99 10:22
	-1.4	Orb.BWG	12/2/99 11:20	1.00	12/2/99 12:20
	-1.3	Lander	12/2/99 12:52	4.00	12/2/99 16:52
	-1.3	Orb.BWG	12/2/99 13:19	1.00	12/2/99 14:19
	-1.2	Orb.BWG	12/2/99 15:18	1.00	12/2/99 16:18
	-1.1	Orb.BWG	12/2/99 17:16	1.00	12/2/99 18:16
	-1.1	Orb.BWG	12/2/99 19:15	1.00	12/2/99 20:15
	-1.0	Orb.BWG	12/2/99 21:13	1.00	12/2/99 22:13
	-1.0	Lander	12/2/99 21:52	4.00	12/3/99 1:52
	-0.9	Orb.BWG	12/2/99 23:12	1.00	12/3/99 0:12
	-0.8	Orb.BWG	12/3/99 1:11	1.00	12/3/99 2:11
	-0.7	Orb.BWG	12/3/99 3:09	1.00	12/3/99 4:09
	-0.7	Orb.BWG	12/3/99 5:08	1.00	12/3/99 6:08
	-0.6	Lander	12/3/99 6:52	4.00	12/3/99 10:52
Final Track pre TCM-5	-0.6	Orb.BWG	12/3/99 7:07	1.00	12/3/99 8:07
	-0.5	Orb.BWG	12/3/99 9:05	1.00	12/3/99 10:05
	-0.4	Orb.BWG	12/3/99 11:04	1.00	12/3/99 12:04
	-0.3	Lander	12/3/99 12:57	0.50	12/3/99 13:27
DSN-2	-0.3	Orb.BWG	12/3/99 13:02	1.00	12/3/99 14:02
	-0.3	TCM-5	12/3/99 13:32	0.58	12/3/99 14:07
TCM-5	-0.2	Orb.BWG	12/3/99 15:01	1.00	12/3/99 16:01
	-0.2	Lander	12/3/99 15:52	1.00	12/3/99 16:52
DSN-3	-0.2	Orb.BWG	12/3/99 17:00	1.00	12/3/99 18:00
	-0.1	Orb.BWG	12/3/99 18:58	1.00	12/3/99 19:58
	0.0	Lander	12/3/99 20:27	0.25	12/3/99 20:42
DSN-4	0.0	Landing	12/3/99 20:56	0.01	12/3/99 20:56
	0.0	Orb.BWG	12/3/99 20:57	1.00	12/3/99 21:57


E-30d
Near-Simultaneous Tracking:
1hr 24 min. separation between tracks
Lander HEF
Orbiter HEF
Orbiter BWG Track
SSPA on-times
Orb.BWG
Orb.HEF
Lander
Orb.BWG
Orb.HEF
Lander
Orb.BWG
Orb.HEF
Lander
Orb.BWG
11/4/99 0:
11/4/99 1:
11/4/99 2:
11/4/99 3:
11/4/99 4:
11/4/99 5:
11/4/99 6:
11/4/99 7:
11/4/99 8:
11/4/99 9:
11/4/99 10:
11/4/99 11:
11/4/99 12:
11/4/99 13:
11/4/99 14:
11/4/99 15:
11/4/99 16:
11/4/99 17:
11/4/99 18:
11/4/99 19:
11/4/99 20:
11/4/99 21:
11/4/99 22:
11/4/99 23:
11/5/99 0:
11/5/99 1:
11/5/99 2:
11/5/99 3:
11/5/99 4:
11/5/99 5:
11/5/99 6:
11/5/99 7:
11/5/99 8:
11/5/99 9:
11/5/99 10:
11/5/99 11:
11/5/99 12:
11/5/99 13:
11/5/99 14:
11/5/99 15:
11/5/99 16:
11/5/99 17:
11/5/99 18:
11/5/99 19:
11/5/99 20:
11/5/99 21:
11/5/99 22:
11/5/99 23:
11/6/99 0:

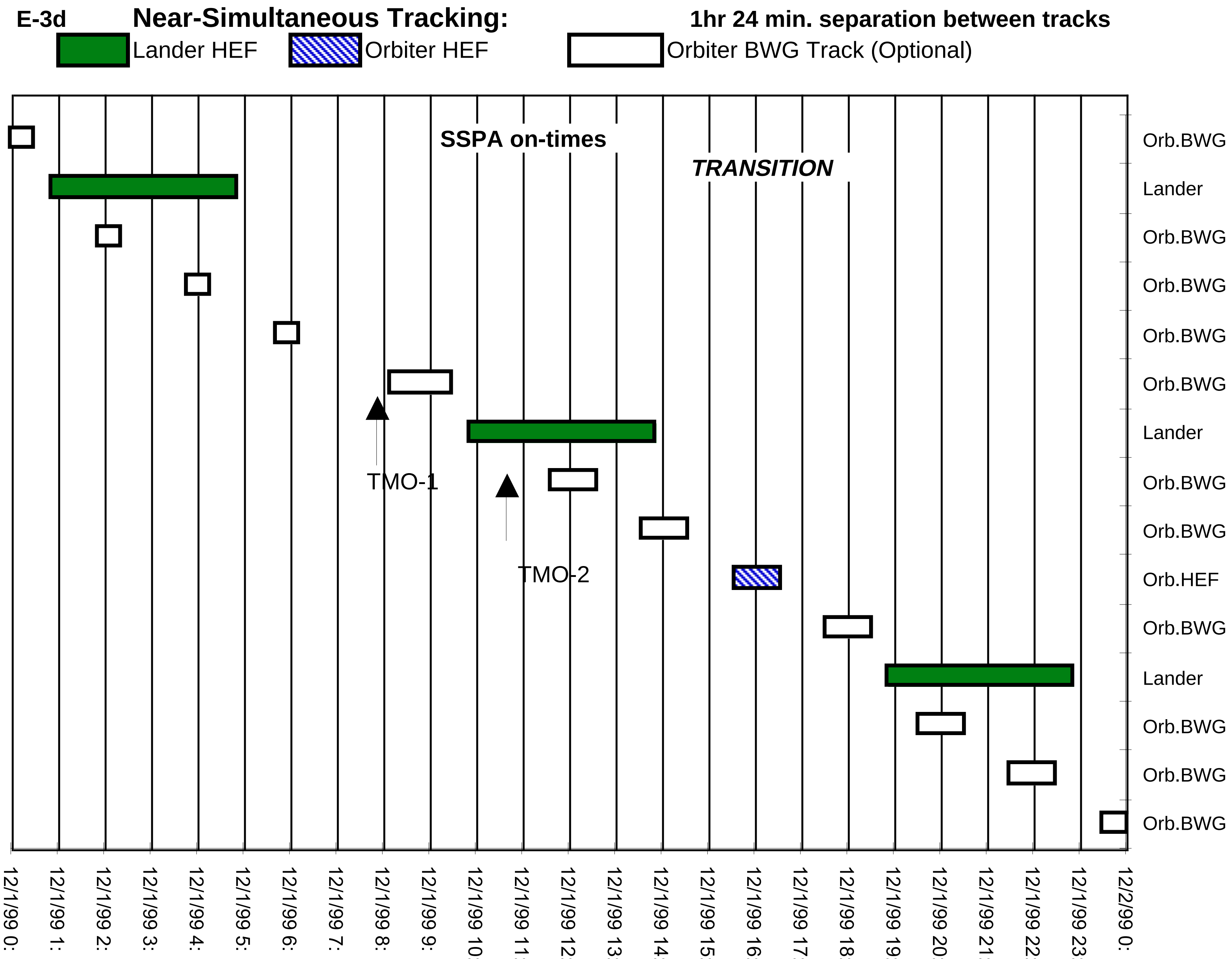


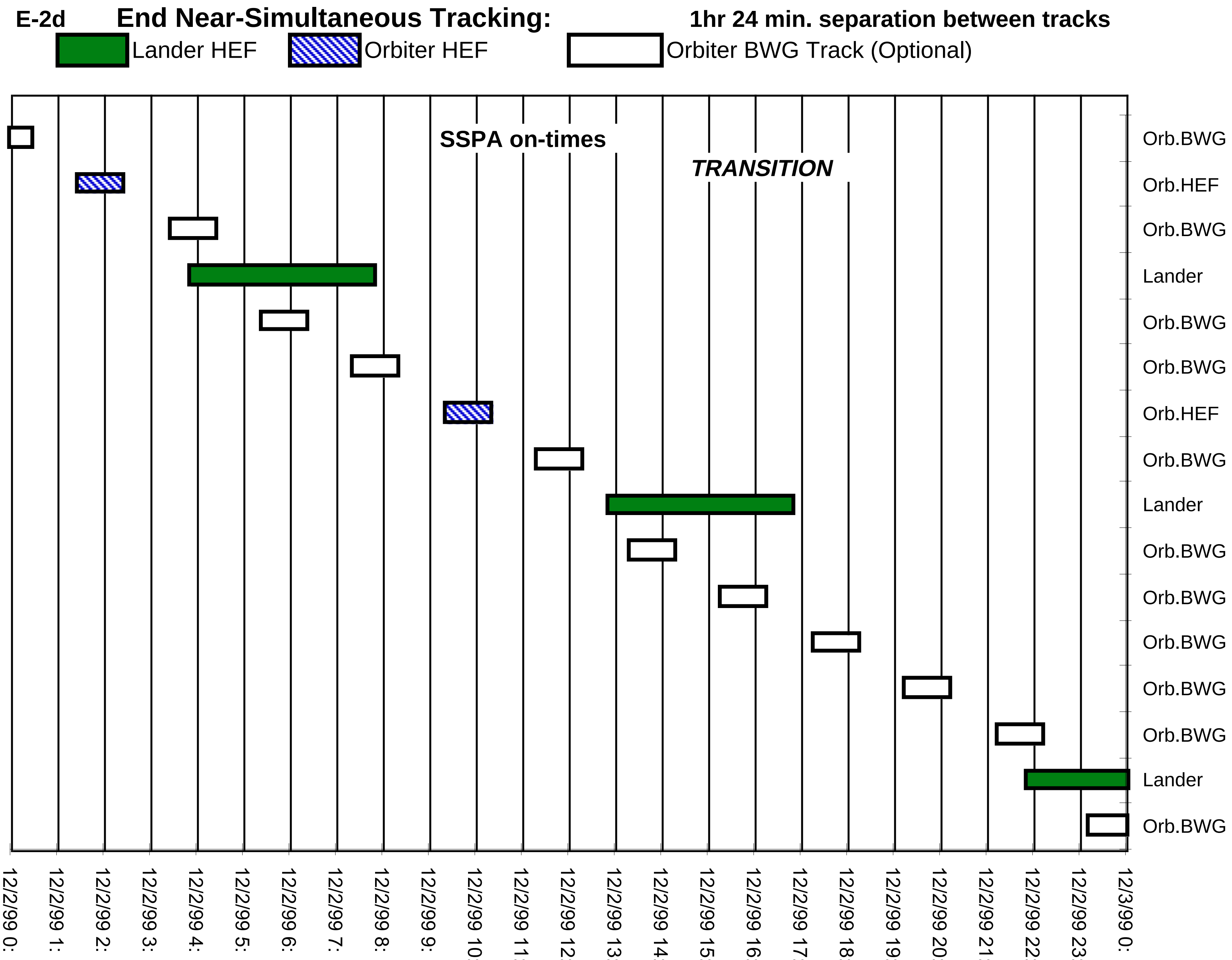
E-20d
Near-Simultaneous Tracking:
1hr 24 min. separation between tracks
Lander HEF
Orbiter HEF
Orbiter BWG Track
SSPA on-times
Lander
Orb.BWG
Orb.HEF
Lander
Orb.BWG
Orb.HEF
Lander
Orb.BWG
Orb.HEF
Lander
Orb.BWG
Orb.HEF
Lander
Orb.BWG
11/14/99 0:
11/14/99 1:
11/14/99 2:
11/14/99 3:
11/14/99 4:
11/14/99 5:
11/14/99 6:
11/14/99 7:
11/14/99 8:
11/14/99 9:
11/14/99 10:
11/14/99 11:
11/14/99 12:
11/14/99 13:
11/14/99 14:
11/14/99 15:
11/14/99 16:
11/14/99 17:
11/14/99 18:
11/14/99 19:
11/14/99 20:
11/14/99 21:
11/14/99 22:
11/14/99 23:
11/15/99 0:
11/15/99 1:
11/15/99 2:
11/15/99 3:
11/15/99 4:
11/15/99 5:
11/15/99 6:
11/15/99 7:
11/15/99 8:
11/15/99 9:
11/15/99 10:
11/15/99 11:
11/15/99 12:
11/15/99 13:
11/15/99 14:
11/15/99 15:
11/15/99 16:
11/15/99 17:
11/15/99 18:
11/15/99 19:
11/15/99 20:
11/15/99 21:
11/15/99 22:
11/15/99 23:
11/16/99 0:

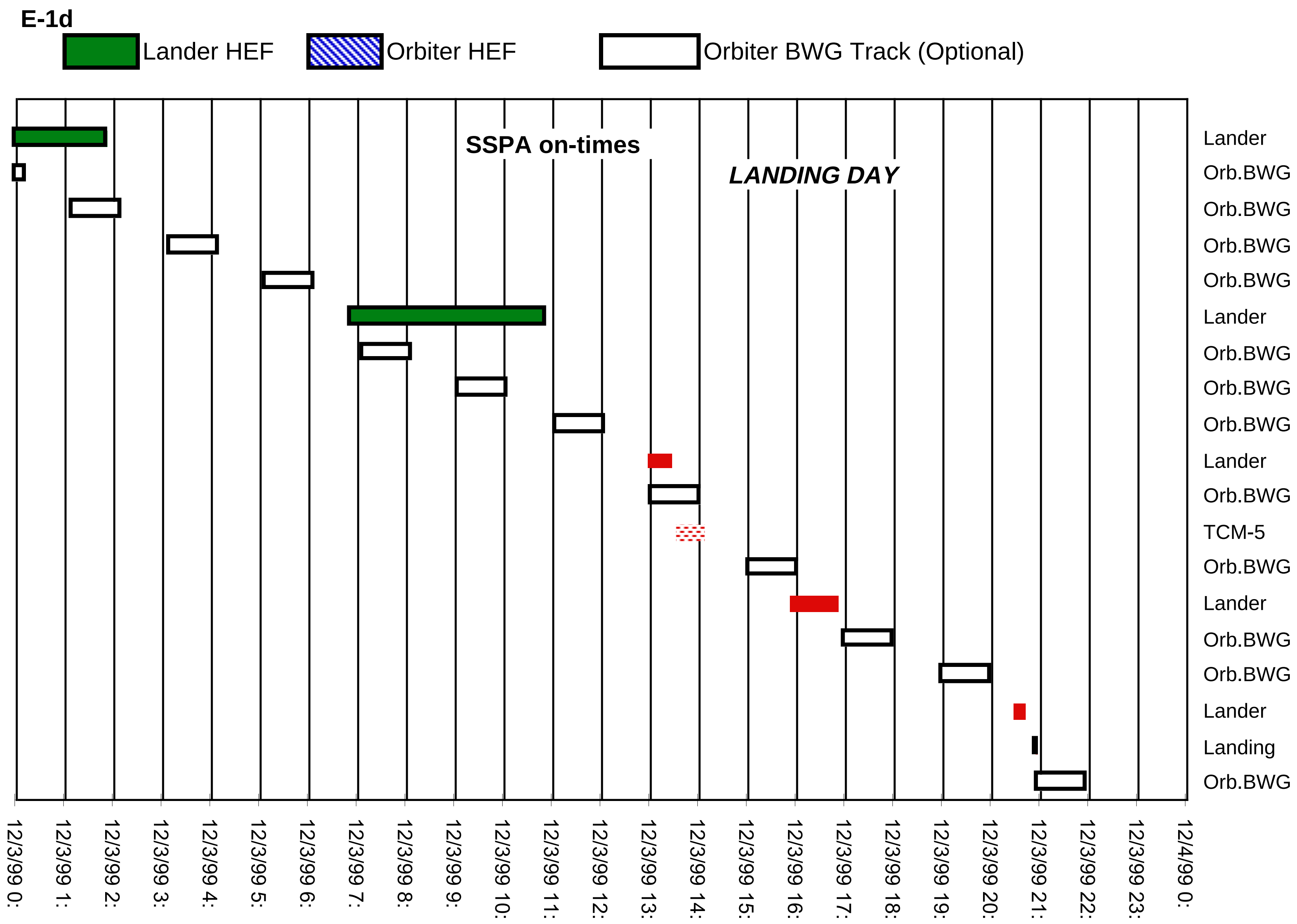

E-10d
Near-Simultaneous Tracking:
1hr 24 min. separation between tracks
Lander HEF
Orbiter HEF
Orbiter BWG Track
SSPA on-times
Orb.HEF
Lander
Orb.BWG
Orb.BWG
Orb.HEF
Lander
Orb.BWG
Orb.BWG
Orb.HEF
Lander
Orb.BWG
Orb.BWG
Orb.HEF
Lander
Orb.BWG
Orb.BWG
Orb.HEF
Lander
Orb.BWG
Orb.BWG
Orb.HEF
11/24/99 0:
11/24/99 1:
11/24/99 2:
11/24/99 3:
11/24/99 4:
11/24/99 5:
11/24/99 6:
11/24/99 7:
11/24/99 8:
11/24/99 9:
11/24/99 10:
11/24/99 11:
11/24/99 12:
11/24/99 13:
11/24/99 14:
11/24/99 15:
11/24/99 16:
11/24/99 17:
11/24/99 18:
11/24/99 19:
11/24/99 20:
11/24/99 21:
11/24/99 22:
11/24/99 23:
11/25/99 0:
11/25/99 1:
11/25/99 2:
11/25/99 3:
11/25/99 4:
11/25/99 5:
11/25/99 6:
11/25/99 7:
11/25/99 8:
11/25/99 9:
11/25/99 10:
11/25/99 11:
11/25/99 12:
11/25/99 13:
11/25/99 14:
11/25/99 15:
11/25/99 16:
11/25/99 17:
11/25/99 18:
11/25/99 19:
11/25/99 20:
11/25/99 21:
11/25/99 22:
11/25/99 23:
11/26/99 0:

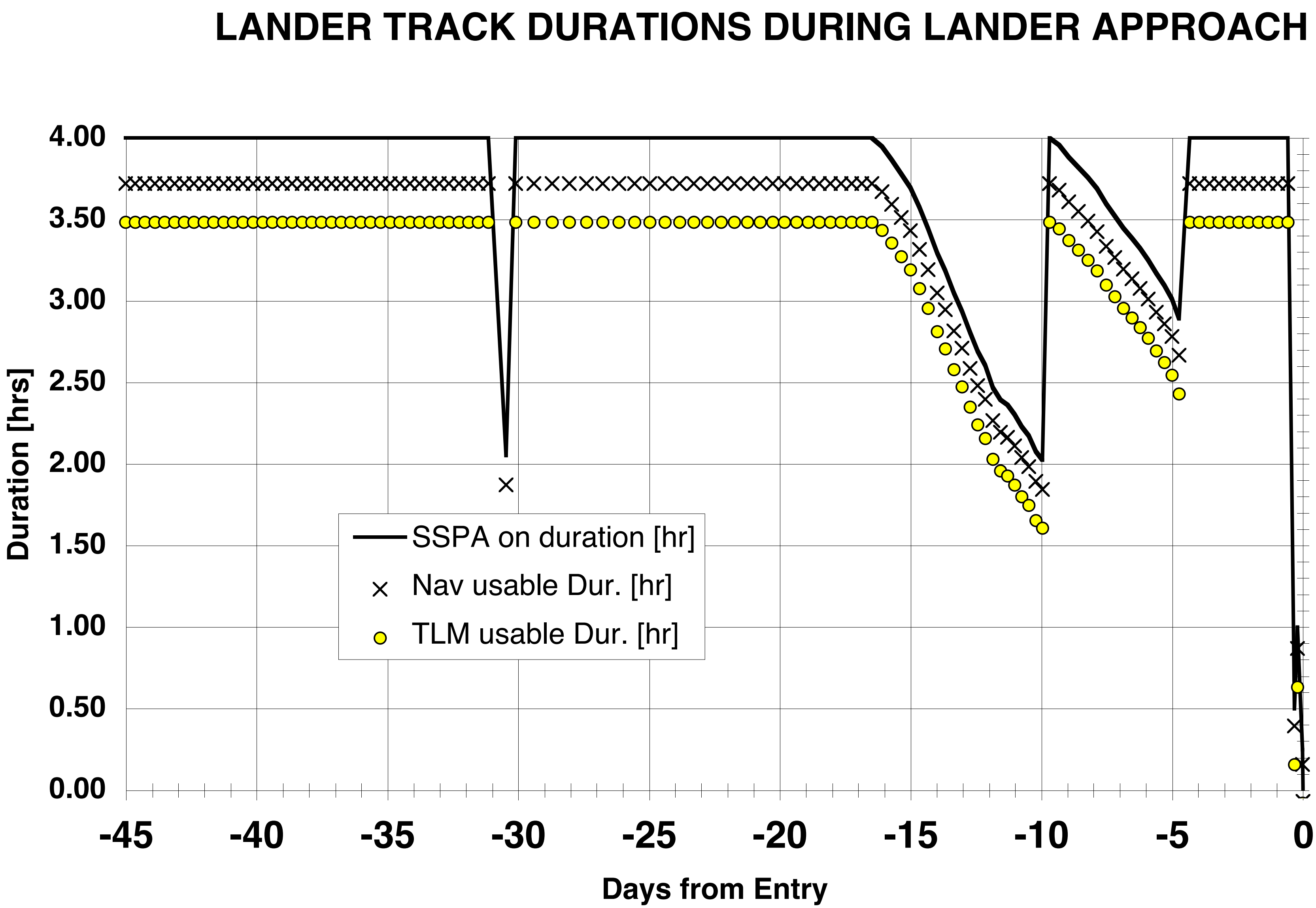


E-4d
Near-Simultaneous Tracking:
1hr 24 min. separation between tracks
Lander HEF
Orbiter HEF
Orbiter BWG Track
SSPA on-times
Orb.BWG
Orb.BWG
Orb.HEF
Orb.BWG
Lander
Orb.BWG
Orb.BWG
Orb.HEF
Orb.BWG
Lander
Orb.BWG
Orb.BWG
Orb.BWG
Orb.HEF
11/30 0:
11/30 1:
11/30 2:
11/30 3:
11/30 4:
11/30 5:
11/30 6:
11/30 7:
11/30 8:
11/30 9:
11/30 10:
11/30 11:
11/30 12:
11/30 13:
11/30 14:
11/30 15:
11/30 16:
11/30 17:
11/30 18:
11/30 19:
11/30 20:
11/30 21:
11/30 22:
11/30 23:
12/1 0:


E-3d
Near-Simultaneous Tracking:
1hr 24 min. separation between tracks
Lander HEF
Orbiter HEF
Orbiter BWG Track (Optional)
SSPA on-times
TRANSITION
TMO-1
TMO-2
Orb.BWG
Lander
Orb.BWG
Orb.BWG
Orb.BWG
Orb.BWG
Lander
Orb.BWG
Orb.BWG
Orb.HEF
Orb.BWG
Lander
Orb.BWG
Orb.BWG
Orb.BWG
12/1/99 0:
12/1/99 1:
12/1/99 2:
12/1/99 3:
12/1/99 4:
12/1/99 5:
12/1/99 6:
12/1/99 7:
12/1/99 8:
12/1/99 9:
12/1/99 10:
12/1/99 11:
12/1/99 12:
12/1/99 13:
12/1/99 14:
12/1/99 15:
12/1/99 16:
12/1/99 17:
12/1/99 18:
12/1/99 19:
12/1/99 20:
12/1/99 21:
12/1/99 22:
12/1/99 23:
12/2/99 0:


E-2d
End Near-Simultaneous Tracking:
1hr 24 min. separation between tracks
Lander HEF
Orbiter HEF
Orbiter BWG Track (Optional)
SSPA on-times
TRANSITION
Orb.BWG
Orb.HEF
Orb.BWG
Lander
Orb.BWG
Orb.BWG
Orb.HEF
Orb.BWG
Lander
Orb.BWG
Orb.BWG
Orb.BWG
Orb.BWG
Orb.BWG
Lander
Orb.BWG
12/2/99 0:
12/2/99 1:
12/2/99 2:
12/2/99 3:
12/2/99 4:
12/2/99 5:
12/2/99 6:
12/2/99 7:
12/2/99 8:
12/2/99 9:
12/2/99 10:
12/2/99 11:
12/2/99 12:
12/2/99 13:
12/2/99 14:
12/2/99 15:
12/2/99 16:
12/2/99 17:
12/2/99 18:
12/2/99 19:
12/2/99 20:
12/2/99 21:
12/2/99 22:
12/2/99 23:
12/3/99 0:


E-1d
Lander HEF
Orbiter HEF
Orbiter BWG Track (Optional)
SSPA on-times
LANDING DAY
Lander
Orb.BWG
Orb.BWG
Orb.BWG
Orb.BWG
Lander
Orb.BWG
Orb.BWG
Orb.BWG
Lander
Orb.BWG
TCM-5
Orb.BWG
Lander
Orb.BWG
Orb.BWG
Lander
Landing
Orb.BWG
12/3/99 0:
12/3/99 1:
12/3/99 2:
12/3/99 3:
12/3/99 4:
12/3/99 5:
12/3/99 6:
12/3/99 7:
12/3/99 8:
12/3/99 9:
12/3/99 10:
12/3/99 11:
12/3/99 12:
12/3/99 13:
12/3/99 14:
12/3/99 15:
12/3/99 16:
12/3/99 17:
12/3/99 18:
12/3/99 19:
12/3/99 20:
12/3/99 21:
12/3/99 22:
12/3/99 23:
12/4/99 0:



LANDER TRACK DURATIONS DURING LANDER APPROACH
Duration [hrs]
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
Days from Entry
SSPA on duration [hr]
Nav usable Dur. [hr]
TLM usable Dur. [hr]

B.10 Lander Data Rates

Orbiter and Lander Communication Strategy during the Mission [Memo MSP-SE-97-0162]

Interoffice Memo

LOCKHEED MARTIN

Memo No.: MSP-SE-97-0162

Date: 3/31/97

To: P. Knocke

cc: MSP

From: K. Nii

Subject: Orbiter and Lander Communication Strategy during Cruise
==

This memo documents the Mission Operations plan for communication strategies with the orbiter and lander during the Cruise portion of the mission.

Orbiter Cruise Comm Strategy Overview:

Each mission phase drives one or more subsystem performance parameter. After separation, key engineering data are broadcast to available X-band sites to support post-flight anomaly investigation. As the S/C approaches the first DSN station, the 34 m antenna will be used to acquire and track the Orbiter. Coherent two way ranging is key during daily telecommunication passes throughout all the phases. The Orbiter transmits 2.1 kbps on the MGA and receives 125 bps on the LGA during the S/C Init and Cruise Phases. Each DSN contact nominally lasts four hours. The Orbiter transfers from the MGA/LGA to the HGA at Launch + 80 days. During the rest of Cruise the Orbiter transmits at 2100 bps and receives at 125 bps. At MOI - 45 days, the orbiter will transition to a communicating strategy of 4 hours on and 5 hours off.

When not in planned communication with the ground the orbiter will be in receive mode on the LGA at 7.8125 bps.

Lander Cruise Comm Strategy Overview:

Each mission phase drives one or more subsystem performance parameter. After separation, key engineering data are broadcast to available X-band sites to support post-flight anomaly investigation. As the S/C approaches the first DSN station, the 34 m antenna will be used to acquire and track the Lander. Coherent two way ranging is key during daily telecommunication passes throughout the Cruise phase. The lander uses the cruise MGA to transmit and receive for the entire cruise phase. DSN contacts are planned to occur once/day for all of cruise until EDL-46 days. At this time the lander will transition to a four hours on five hours off communication strategy.

When not in planned communication with the ground the lander will be in receive mode on the LGA at 7.8125 bps.

Orbiter

Possible Transmit Rates: MGA/HGA 40, 2100, 5688, 9954, 33180, 71100, 110600 bps
8 kbps UHF

Possible Receive Rates: LGA 7.8125, 125 bps
HGA 7.8125, 125, 500, 1000* bps (* No ranging)
128 kbps UHF

Phase:	Nominal Transmit Rates:	Nominal Receive Rates:
Initial Acquisition	2.1K bits per second	125 bits per second
Cruise	2.1 kbps	125 bps

Lander

Possible Transmit Rates: Cruise MGA 40, 100, 2100 bits per second (bps)
Landed MGA 40, 395 (R=1/2), 700 (R=1/6), 1400 bps
8 kbps, 128 kbps UHF (nominal)

Possible Receive Rates: Cruise MGA 7.8125, 125, 500 bps
Landed MGA 7.8125, 125, 500 bps
8 kbps UHF (nominal) (128 kbps possible)

Phase:	Transmit	Receive
Initial Acquisition	2.1 kbits per second	125 bits per second
Cruise	100 bps	125 bps
Approach (EDL-46 days)	40 bps	7.8125 bps

Orbiter DSN Cruise Contact Plan (Open of Launch period):

# Days	Mission Day	Frequency	Antenna	Operations
80	1-80	1/day	LGA/MGA	Cruise (4 hours)
164	81-244	1/day	HGA	Cruise (4 hours)
45	245-289	3/day*	HGA	Approach (*4 hours on, 5 hours off) Includes TCM-4

Orbiter DSN Cruise Contact Plan (Close of Launch period):

# Days	Mission Day	Frequency	Antenna	Operations
80	1-80	1/day	LGA/MGA	Cruise (4 hours)
160	81-240	1/day	HGA	Cruise (4 hours)
45	241-285	3/day*	HGA	Approach (*4 hours on, 5 hours off) Includes TCM-4

Lander DSN Cruise Contact Plan (Open of Launch period):

# Days	Mission Day	Frequency	Antenna	Operations
301	1-302	1/day	MGA	Cruise (4 hours)
46	303-347	3/day*	MGA	Approach (*4 hours on, 5 hours off) Includes TCM-4

Lander DSN Cruise Contact Plan (Close of Launch period):

# Days	Mission Day	Frequency	Antenna	Operations
289	1-290	1/day	MGA	Cruise (4 hours)
46	291-335	3/day*	MGA	Approach (*4 hours on, 5 hours off) Includes TCM-4

original signed by

Kendall M. Nii

B.11 Lander Approach Targeting Data **This Section under Change Control**

[To be Supplied] This section contains approach data to be used for EDL analyses.