#294

APOLLO 15 & 17

LASER ALTIMETER INCIDENCE DATA

71-063A-05A

72-096A-09A

DCD 7-4

APOLLO 15 & 17

LASER ALTIMETER INCIDENCE DATA

71-063A-05A

72-096A-09A

THIS DATA SET HAS BEEN RESTORED. ORIGINALLY THERE WAS ONE 7-TRACK, 800 BPI TAPE WRITTEN IN BCD. THERE IS ONE RESTORED TAPE. THE DR TAPE IS A 3480 CARTRIDGE AND THE DS TAPE IS 9-TRACK, 6250 BPI WRITTEN IN ~~EBCDIC~~ ASCII. THE TAPE WAS CREATED ON A CDC 6600 COMPUTER. THE DR AND DS NUMBERS ALONG WITH THE CORRESPONDING D NUMBERS AND THE TIME SPAN IS AS FOLLOWS:

DR#	DS#	D#	FILES	TIME SPAN
DR03500	DS03500	D17180	3	07/30/71, 12/15/72

REQ. AGENT
VJP

RAND NO.
RC2488

ACQ. AGENT
RWV

APOLLO 15 & 17

LASER ALTIMETER INCIDENCE DATA

71-063A-05A

72-096A-09A

THis data set catalog consists of 1 Apollo 15 and 17 Laser Altimeter Incidence data tape. The tape is 800 BPI, 7 track, BCD with 3 files. The tape was created on a CDC-6400 computer. There are 10 logical records in each physical record and 195 characters in each logical record.

D#	C#	FILE	TIME SPAN
D-17180	C-13373	1 APOLLO 15	July 30, 1971
		2 APOLLO 15	July 30, 1971
		3 APOLLO 17	DECEMBER 15, 1972

UNIVERSITY OF VIRGINIA
SCHOOL OF ENGINEERING AND APPLIED SCIENCE
CHARLOTTESVILLE
22901

DEPARTMENT OF ENGINEERING SCIENCE
AND SYSTEMS
THORNTON HALL

October 29, 1974

Mr. Robert Vostreys
National Space Science Data Center
Code 601
Goddard Space Flight Center
Greenbelt, Maryland 20771

Dear Mr. Vostreys:

Per our recent telephone conversation, I am mailing, herewith, the following items:

1. one magnetic tape #T01651 containing Apollo laser altimeter incidence points and associated data from Missions 15 and 17,

2. a decimal dump of tape #T01651,

3. tape fromat information,

4. a brief description of the data on #T01651.

As I indicated during our discussion, I shall mail a copy of our final report which is now being prepared (it should be in your hands within a month).

Should there be questions or comments, please contact me.

Sincerely yours,

John L. Junkins
Associate Professor

JLJ:sw

Enclosures (4)

Enclosure (3)

TAPE CONTENTS/FORMAT INFORMATION
(Tape T01651)

Prepared on UVA's CDC 6400 Computer

UN LABELED

7 - Track

800
~~556~~ Characters per Inch (BPI)

195 Characters in each Record

10 Records (1950 Characters) in each Block

3 Files: Apollo 15: Revolution 15 Laser Incidence Points
Apollo 15: Revolution 21 Laser Incidence Points
Apollo 17: Revolution 65 Laser Incidence Points

Even Parity (Alpha, Coded)

Format of the Records in Each File:

Record 1: F 10.2 = Julian Date of Base
80A1 = Title
105X Blank "Filler"

All Subsequent Records:

E15.7 = Seconds Since Base Time
E15.7 = X True Selgnographic of Date Moon-
E15.7 = Y Fixed Coordinates of the Laser
E15.7 = Z Incidence Point

9 E15.7 3 x 3 Covarianie Matrix of the (X, Y, Z) Incidence Coordinates

Enclosure (4)

Description of Apollo Laser Incidence Coordinates' Determination

Missions 15, 16, and 17 carried an advanced mapping system which included

1. A laser altimeter to make discrete measurements of slant range from the Command Module (CM) to some point on the lunar surface. The distance measurements were good to ± 2 M.

2. A stellar camera which photographed stars simultaneous to the laser firings (± 0.001 sec timing tolerance); from which the laser firing direction could be deduced.

3. A metric mapping camera which took photographs of the lunar surface simultaneously with laser firings and exposure of the stellar camera.

4. A panoramic camera which took wide-angle photographs of the lunar surface.

The laser was fired in two modes; on the lighted side of the moon simultaneous with the mapping, panoramic and stellar camera exposures, and on the dark side with only the stellar camera operating. Given position estimates of the CM at laser firings, it is a straightforward calculation to determine laser incidence coordinates. CM position estimates were originally taken from NASA-determined orbit estimates using Doppler tracking. These estimates were refined using short-arc orbit fits to photogrammetric-determined CM positions at mapping camera exposure times. Various empirical processes were developed to compensate for the uncertainty introduced by unmodeled accelerations (gravity anomalies and vehicle process noise). The reductions include formal covariances propagations which are believed to provide reasonable uncertainty estimates for the determined coordinates. The details of our reduction processes are being documented in the final report on NASA contract NAS9-12752.

LASER INCIDENCE COORDINATES

JULIAN DATE OF "BASE
2441661.5

APOLLO 17
REV 1

Jan 0, 1975 = 2442413

TIME	X	Y	Z	PHI	LAMBDA	RADIUS
77985.114	-1257.263	-1046.031	-594.891	-19.974	219.814	1741.544
78005.117	-1274.667	-1022.999	-593.465	-19.956	218.749	1738.822
78025.109	-1293.536	-999.169	-592.650	-19.930	217.684	1738.622
78045.113	-1312.066	-975.010	-591.623	-19.896	216.616	1738.442
78067.034	-1334.876	-950.241	-592.263	-19.873	215.445	1742.304
78090.546	-1354.868	-920.243	-590.759	-19.834	214.185	1741.124
78115.943	-1375.002	-890.527	-589.324	-19.786	212.929	1740.969
78137.303	-1393.427	-859.822	-587.154	-19.728	211.677	1739.449
78160.650	-1413.587	-830.180	-585.688	-19.660	210.425	1740.621
78183.996	-1432.420	-799.639	-583.629	-19.584	209.172	1741.223
78207.335	-1450.157	-768.444	-581.064	-19.497	207.919	1741.005
78229.907	-1466.082	-737.596	-578.017	-19.402	206.707	1739.985
78254.412	-1482.461	-706.637	-574.444	-19.293	205.391	1738.615
78279.649	-1499.853	-668.882	-570.870	-19.168	204.035	1738.636
78304.749	-1516.256	-633.894	-566.920	-19.033	202.688	1738.463
78329.954	-1533.347	-598.908	-562.881	-18.877	201.335	1739.735
78355.202	-1547.754	-562.721	-557.559	-18.704	199.980	1738.698
78380.275	-1561.748	-526.651	-552.197	-18.523	198.635	1738.209
78405.521	-1575.112	-490.094	-546.485	-18.329	197.283	1737.762
78430.768	-1588.178	-453.392	-540.692	-18.127	195.933	1737.678
78456.002	-1600.757	-416.400	-535.190	-17.930	194.581	1738.460
78481.144	-1611.389	-379.025	-529.269	-17.731	193.236	1737.929
78506.378	-1621.803	-341.403	-523.413	-17.527	191.888	1738.034
78531.613	-1631.731	-303.642	-517.382	-17.314	190.541	1738.514
78556.847	-1643.169	-266.055	-511.776	-17.090	189.197	1741.466
78582.081	-1649.439	-227.534	-504.497	-16.856	187.854	1739.810
78607.316	-1655.784	-189.025	-497.199	-16.612	186.513	1739.126
78632.497	-1664.271	-150.836	-490.122	-16.346	185.179	1741.485
78657.696	-1668.479	-112.143	-481.731	-16.070	183.845	1740.248
78682.932	-1675.203	-73.528	-474.030	-15.785	182.513	1742.532
78708.170	-1676.048	-34.605	-464.678	-15.493	181.183	1739.615
78733.407	-1678.433	4.332	-455.715	-15.190	179.852	1739.204
78758.643	-1679.776	43.290	-446.502	-14.881	178.524	1738.845
[illegible]	-1684.782	82.374	-438.235	-14.564	177.201	1742.792
[illegible]	-1681.832	121.139	-427.856	-14.238	175.880	1739.625
[illegible]	-1680.991	159.977	-418.030	-13.905	174.564	1739.561
[illegible]	-1679.388	198.831	-408.157	-13.569	173.248	1739.675
[illegible]	-1677.983	237.906	-398.569	-13.234	171.930	1741.001
[illegible]	-1675.708	276.946	-388.743	-12.892	170.616	1742.360
[illegible]	-1668.681	315.151	-377.790	-12.542	169.305	1739.695
[illegible]	-1660.921	353.103	-366.688	-12.186	167.998	1737.182
[illegible]	-1653.775	391.142	-355.720	-11.823	166.693	1736.232
[illegible]	-1647.775	429.417	-344.986	-11.453	165.393	1737.405
[illegible]	-1644.660	468.600	-334.782	-11.076	164.097	1742.573
[illegible]	-1631.850	504.995	-322.623	-10.693	162.805	1738.402
[illegible]	-1620.951	541.643	-310.829	-10.307	161.517	1737.150
[illegible]	-1610.152	578.775	-299.038	-9.914	160.229	1736.950
[illegible]	-1600.174	616.108	-287.364	-9.514	158.942	1738.598
[illegible]	-1587.460	652.354	-275.187	-9.109	157.660	1738.213
[illegible]	-1575.150	688.759	-263.063	-8.700	156.382	1739.163
[illegible]	-1559.702	723.739	-250.431	-8.287	155.108	1737.583

LASER INCIDENCE COORDINATES

JULIAN DATE OF BASE
41153.5

APOLLO 15
REV 15

ELAPSED SEC SOURCE)	X (KM) Y (KM) Z (KM)	PHI (DEG) LAM (DEG) RAD (KM)	COVARIANCE X-Y-Z (KM X KM)		
2264.363	597.650	7.895	.431E-01	.449E-01	.237E-01
	-1612.387	290.338	.449E-01	.474E-01	.249E-01
(UVA)	238.468	1736.043	.237E-01	.249E-01	.142E-01
2287.933	566.774	7.408	.433E-01	.438E-01	.238E-01
	-1626.145	289.215	.438E-01	.448E-01	.242E-01
(UVA)	223.900	1736.580	.238E-01	.242E-01	.141E-01
2311.504	535.175	6.910	.435E-01	.426E-01	.238E-01
	-1638.046	288.093	.426E-01	.422E-01	.235E-01
(UVA)	208.852	1735.865	.238E-01	.235E-01	.141E-01
2334.684	504.672	6.393	.436E-01	.414E-01	.238E-01
	-1650.471	287.002	.414E-01	.398E-01	.228E-01
(UVA)	193.371	1736.704	.238E-01	.228E-01	.140E-01
2358.245	473.097	5.865	.437E-01	.402E-01	.238E-01
	-1661.085	285.898	.402E-01	.374E-01	.220E-01
(UVA)	177.416	1736.231	.238E-01	.220E-01	.139E-01
2381.805	441.497	5.334	.437E-01	.390E-01	.237E-01
	-1671.673	284.794	.390E-01	.352E-01	.213E-01
(UVA)	161.437	1736.511	.237E-01	.213E-01	.138E-01
[illegible].976	410.448	4.811	.436E-01	.378E-01	.236E-01
	-1682.432	283.710	.378E-01	.330E-01	.205E-01
(UVA)	145.746	1737.897	.236E-01	.205E-01	.137E-01
[illegible].526	378.139	4.277	.435E-01	.365E-01	.235E-01
	-1690.310	282.610	.365E-01	.310E-01	.198E-01
(UVA)	129.531	1736.927	.235E-01	.198E-01	.136E-01
[illegible].077	345.981	3.772	.434E-01	.352E-01	.234E-01
	-1699.807	281.505	.352E-01	.290E-01	.191E-01
(UVA)	114.369	1738.426	.234E-01	.191E-01	.134E-01
[illegible].248	313.986	3.277	.432E-01	.340E-01	.232E-01
	-1707.647	280.419	.340E-01	.271E-01	.183E-01
(UVA)	99.422	1739.117	.232E-01	.183E-01	.133E-01
[illegible].798	281.071	2.758	.429E-01	.328E-01	.230E-01
	-1712.567	279.320	.328E-01	.253E-01	.176E-01
(UVA)	83.600	1737.491	.230E-01	.176E-01	.131E-01

July 30, 1971

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046721E&03  -.1650471E&04   .1933710E&03   .4359099E-01   .4142493E-01   .2380732E-01   .4142493E-01
   .3980994E-01   .2275821E-01   .2380732E-01   .2275821E-01   .1401357E-01   .2358245E&04   .473097
4E&03  -.1661085E&04   .1774158E&03   .4365923E-01   .4020993E-01   .2378184E-01   .4020993E-01   .3
744713E-01   .2202117E-01   .2378184E-01   .2202117E-01   .1393153E-01   .2381805E&04   .4414972E&03
  -.1671673E&04   .1614375E&03   .4366570E-01   .3897808E-01   .2372127E-01   .3897808E-01   .351793
7E-01   .2127938E-01   .2372127E-01   .2127938E-01   .1382612E-01   .2404976E&04   .4104476E&03  -.1
682432E&04   .1457457E&03   .4360878E-01   .3775279E-01   .2362502E-01   .3775279E-01   .3304074E-01
   .2054624E-01   .2362502E-01   .2054624E-01   .1369634E-01   .2428526E&04   .3781389E&03  -.169031
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980910E-01   .2351783E-01   .1980910E-01   .1357540E-01   .2452077E&04   .3459806E&03  -.1699807E&04
   .1143692E&03   .4335482E-01   .3524775E-01   .2336489E-01   .3524775E-01   .2897326E-01   .190647
3E-01   .2336489E-01   .1906473E-01   .1342072E-01

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2E-01   .3401013E-01   .2710614E-01   .1833860E-01   .2319492E-01   .1833860E-01   .1326433E-01   .2
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   .3276118E-01   .2529979E-01   .1761277E-01   .2301519E-01   .1761277E-01   .1311302E-01   .252233
8E&04   .2485407E&03  -.1718412E&04   .6756460E&02   .4262281E-01   .3151425E-01   .2279629E-01   .3
151425E-01   .2358164E-01   .1689140E-01   .2279629E-01   .1689140E-01   .1292709E-01   .2545499E&04
   .2163722E&03  -.1723631E&04   .5179507E&02   .4228453E-01   .3029526E-01   .2255646E-01   .302952
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838142E&03  -.1728483E&04   .3585034E&02   .4189354E-01   .2906443E-01   .2228650E-01   .2906443E-01
   .2042584E-01   .1548549E-01   .2228650E-01   .1548549E-01   .1251764E-01   .2592580E&04   .151106
2E&03  -.1731985E&04   .1991809E&02   .4146732E-01   .2784907E-01   .2200029E-01   .2784907E-01   .1
896025E-01   .1479362E-01   .2200029E-01   .1479362E-01   .1230018E-01   .2615741E&04   .1188970E&03
  -.1734988E&04   .4220764E&01   .4100530E-01   .2666776E-01   .2169610E-01   .2666776E-01   .175961
4E-01   .1412463E-01   .2169610E-01   .1412463E-01   .1207332E-01   .2639281E&04   .8600119E&02  -.1
736097E&04  -.1176426E&02   .4051282E-01   .2548631E-01   .2137788E-01   .2548631E-01   .1628746E-01
   .1345923E-01   .2137788E-01   .1345923E-01   .1184554E-01   .2662812E&04   .5317199E&02  -.173804
9E&04  -.2777371E&02   .3996499E-01   .2432445E-01   .2102869E-01   .2432445E-01   .1505507E-01   .1
280821E-01   .2102869E-01   .1280821E-01   .1159403E-01   .2685972E&04   .2078535E&02  -.1737312E&04
  -.4353235E&02   .3941775E-01   .2320309E-01   .2068429E-01   .2320309E-01   .1391386E-01   .121830
6E-01   .2068429E-01   .1218306E-01   .1135670E-01

   .2709493E&04  -.1206134E&02  -.1738510E&04  -.5959509E&02   .3879576E-01   .2208779E-01   .202974  REC     3, LENGTH  1950
4E-01   .2208779E-01   .1282520E-01   .1156465E-01   .2029744E-01   .1156465E-01   .1108427E-01   .2
733023E&04  -.4494752E&02  -.1738455E&04  -.7565662E&02   .3815063E-01   .2099807E-01   .1990054E-01
   .2099807E-01   .1180454E-01   .1096350E-01   .1990054E-01   .1096350E-01   .1081064E-01   .275656
4E&04  -.7784294E&02  -.1736437E&04  -.9164074E&02   .3749418E-01   .1993435E-01   .1950004E-01   .1
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  -.1101088E&03  -.1733400E&04  -.1072270E&03   .3682911E-01   .1891537E-01   .1909713E-01   .189153
7E-01   .9972271E-02   .9822417E-02   .1909713E-01   .9822417E-02   .1027657E-01   .2803235E&04  -.1
427878E&03  -.1728417E&04  -.1229110E&03   .3614688E-01   .1790607E-01   .1868539E-01   .1790607E-01
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1E&03  -.1727914E&04  -.1388395E&03   .3537091E-01   .1693652E-01   .1822742E-01   .1693652E-01   .8
366888E-02   .8748810E-02   .1822742E-01   .8748810E-02   .9706873E-02   .2849896E&04  -.2077116E&03
  -.1720225E&04  -.1539007E&03   .3468069E-01   .1600047E-01   .1781428E-01   .1600047E-01   .766136
9E-02   .8243853E-02   .1781428E-01   .8243853E-02   .9450399E-02   .2873417E&04  -.2403863E&03  -.1
714922E&04  -.1693536E&03   .3391730E-01   .1508741E-01   .1736548E-01   .1508741E-01   .6995685E-02
   .7753992E-02   .1736548E-01   .7753992E-02   .9167432E-02   .2896937E&04  -.2729916E&03  -.170778
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.1151983E-02 .3356747E-03 .3464086E-02 .3356747E-03 .2187506E-02 .3785979E&04 -.129027
8E&04 -.9670777E&03 -.6538030E&03 .8327693E-02 .9366134E-03 .3256694E-02 .9366134E-03 .1

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162278E&04  -.1172561E&04   .5354116E&03   .4325035E-02   .6495211E-02   .5771481E-02   .6495211E-02
   .1521565E-01   .1605742E-01   .5771481E-02   .1605742E-01   .2273184E-01   .8878178E&04   .114005
8E&04  -.1199193E&04   .5241885E&03   .4612217E-02   .6658291E-02   .6226619E-02   .6658291E-02   .1
465667E-01   .1580632E-01   .6226619E-02   .1580632E-01   .2282778E-01   .8901588E&04   .1117239E&04
  -.1225197E&04   .5126990E&03   .4935175E-02   .6830959E-02   .6703081E-02   .6830959E-02   .141366
3E-01   .1558196E-01   .6703081E-02   .1558196E-01   .2297757E-01   .8924999E&04   .1093935E&04  -.1
250748E&04   .5009950E&03   .5260917E-02   .6971407E-02   .7154023E-02   .6971407E-02   .1360951E-01
   .1532700E-01   .7154023E-02   .1532700E-01   .2309990E-01   .8948399E&04   .1070219E&04  -.127575
4E&04   .4891317E&03   .5607360E-02   .7090911E-02   .7601024E-02   .7090911E-02   .1305452E-01   .1
502560E-01   .7601024E-02   .1502560E-01   .2318530E-01   .8981202E&04   .1036543E&04  -.1310379E&04
   .4723689E&03   .6050160E-02   .7129935E-02   .8105399E-02   .7129935E-02   .1212711E-01   .143697
3E-01   .8105399E-02   .1436973E-01   .2298526E-01

   .8981372E&04   .1036365E&04  -.1310551E&04   .4722809E&03   .6053482E-02   .7130883E-02   .810912  REC     2, LENGTH  1950
8E-02   .7130883E-02   .1212280E-01   .1436711E-01   .8109128E-02   .1436711E-01   .2298597E-01   .9
001195E&04   .1015280E&04  -.1330325E&04   .4618110E&03   .6446884E-02   .7253587E-02   .8555215E-02
   .7253587E-02   .1169531E-01   .1413942E-01   .8555215E-02   .1413942E-01   .2315595E-01   .902119
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6E&04   .3934356E&03   .8862254E-02   .7758499E-02   .1087314E-01   .7758499E-02   .9726211E-02   .1
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2E-01   .1127642E-01   .1243292E-01   .2318977E-01

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   .8625122E-02   .1385409E-01   .8625122E-02   .2241640E-01   .9341203E&04   .6119611E&03  -.160345
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