#153

APOLLO 11, 14 AND 15

69-059C-04C

71-008C-09A

71-063C-08A

LUNAR LASER PHOTO DETECTION

FILTERED AND UNFILTERED

APOLLO 11, 14 AND 15

LUNAR LASER PHOTO DETECTION

FILTERED AND UNFILTERED

69-0590-04C

71-0080-09A

71-0630-08A

THESE DATA SETS HAVE BEEN RESTORED. ORIGINALLY THERE WERE 19 7-TRACK, 800 BPI TAPES WRITTEN IN BINARY CONTAINING VARIABLE DATA FILES. THERE ARE TWO DIFFERENT KINDS OF DATA, RUN DATA WHICH ARE DESIGNED BY A 'Z' IN THE BEGINNING OF EVERY 80 CHARACTER LOGICAL RECORD AND SHOT DATA WHICH ARE DESIGNATED BY A 'P' IN THE BEGINNING OF EVERY 80 CHARACTER LOGICAL RECORD. THE ORIGINAL TAPES WERE BLOCKED AT 64 LOGICAL RECORDS PER PHYSICAL RECORD. EACH PHYSICAL RECORD HAS AN ADDITIONAL FOUR (4) CHARACTERS AFTER BEING DUPED ON THE 7094 COMPUTER.

THERE IS ONE RESTORED TAPE. THE DR TAPE IS A 3480 CARTRIDGE AND THE DS TAPES IS 9-TRACK, 6250 BPI. THE ORIGINAL TAPES WERE CREATED ON A CDC 6600 COMPUTER.

DR#	DS#	D#	FILES		TIME SPAN	
DR02906	DS02906	D10058	1	F	08/20/69 - 12/17/70	AP11.14
			2-5	U	07/21/69 - 06/30/71	
		D11361	6	F	01/09/71 - 06/16/71	AP11,14
			7	U	07/04/71 - 12/30/71	
		D12605	8	F	07/07/71 - 12/27/71	AP11,14,15
			9	U	01/01/72 - 06/30/72	
		D14249	10	F	01/05/72 - 06/30/72	AP11,14,15
			11	U	07/01/72 - 12/29/72	

DR#	DS#	D#	FILES		TIME SPAN	
DR02906 CONT.	D302906	D16161	12	P	07/01/73 - 12/29/72	AP11,14,15
			13	U	01/12/73 - 06/26/73	
		D17752	14	P	01/12/73 - 06/26/73	
			15	U	07/05/73 - 12/30/73	
		D20494	16	P	07/07/73 - 12/30/73	
			17	U	01/01/74 - 06/30/74	
		D23015	18	P	01/04/74 - 06/30/74	
			19	U	07/01/74 - 12/23/74	
		D24011	20	P	09/04/69 - 03/24/76	
			21	P	07/01/74 - 03/24/76	
			22	U	01/04/75 - 03/24/76	
		D29193	23	P	03/10/76 - 09/28/76	
			24	P	03/10/76 - 09/28/76	
			25	U	03/08/76 - 09/30/76	
		D30416	26	P	10/03/76 - 03/31/77	
			27	P	10/03/76 - 03/31/77	
			28	U	10/03/76 - 03/31/77	
		D30960	29	P	04/01/77 - 09/30/77	
			30	P	04/01/77 - 09/30/77	
			31	U	04/01/77 - 09/30/77	
		D32370	32	P	10/01/77 - 06/27/78	
			33	P	10/01/77 - 06/27/78	
			34	U	10/01/77 - 06/27/78	
		D33870	35	P	07/10/78 - 12/20/78	
			36	P	07/10/78 - 12/20/78	
			37	U	07/10/78 - 12/20/78	
		D35139	38	P	01/05/79 - 06/28/79	
			39	P	01/05/79 - 06/28/79	
			40	U	01/05/79 - 06/30/79	
		D39137	41	P	07/06/79 - 12/31/79	
			42	P	07/06/79 - 12/31/79	
			43	U	07/03/79 - 12/31/79	
		D42431	44	P	01/01/79 - 06/30/79	
			45	P	01/01/79 - 06/30/79	
			46	U	01/01/79 - 06/30/79	
		D44016	47	P	07/03/80 - 12/31/80	
			48	P	07/03/80 - 12/31/80	
			49	U	07/03/80 - 12/31/80	
		D46762	50	P	01/21/80 - 06/22/81	
			51	P	01/21/81 - 06/22/81	
			52	U	01/26/81 - 06/24/81	

P = POINTS F = FILTERED U = UNFILTERED

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Run Card

Read a run card with, for example, the FØRTRAN statements

```
      READ (x,1)  (A(J),J=1,22)
    1 FØRMAT(A1,3I,D10.3,1X,I7,I3,3I2,3X,I3,I5,5I3,A5,2I3,2I4,2I2)
```

ignoring for the moment that we have mixed our variable modes.

Then the variables A will contain the following information:

A(1)	=Z
A(2)	=711 (3-digit observatory code)
A(3)	Julian date of beginning of run
A(4)	Clock epoch error, sec x 10^6
A(5)	Ambient temperature, °C
A(6)	Ambient relative humidity, % saturation
A(7)	Wind speed, km/hr
A(8)	Atmospheric seeing, arc sec x 10
A(9)	laser energy, joules x 10
A(10)	laser frequency, Hz x 10^{10}
A(11)	pulse length, sec x 10^{10}
A(12)	observational resolution, sec x 10^{10}
A(13)	photomultiplier dark count, kHz
A(14)	Moon count rate, kHz (Gross)
A(15)	Star count rate, kHz (Net)
A(16)	Calibration star identification
A(17)	Filter spectral width, A° x 10
A(18)	Filter spatial width, arc sec x 10
A(19)	Number of shots fired this run
A(20)	Year
A(21)	Month
A(22)	Day

The sense of the clock error is that it is to be subtracted from the clock time to give the true UTC time. This correction has not been applied to the observation epochs on the shot cards.

Shot Card

Similarly, again ignoring variable mode questions for the sake of illustration, read a shot card with

```
      READ(X,2)  (B(J),J=1,17)
    2 FØRMAT(A1,I3,D17.10,I5,1X,I1,A1,I1,D12.10,I5,I6,I5,3X,I5,I1,
             I5,I4,2I2)
```

Then the variables B will contain the following information:

B(1)	=P
B(2)	=011 (body identifier)
B(3)	Julian date of observation
B(4)	=71110 (observatory code)
B(5)	=0 (reflector code for Tranquility)
B(6)	=L (observation type)
B(7)	=1 (epoch time base is UTC)
B(8)	Observed time delay, seconds
B(9)	Observational uncertainty, seconds x 10^{10}
B(10)	Electronic calibration delay, seconds x 10^{10}
B(11)	Geometric delay, seconds x 10^{10}
B(12)	Clock frequency offset from UTC, parts in 10^{11}
B(13)	=1 (time delay time base is UTC)
B(14)	Ambient pressure, mbar x 10
B(15)	Year
B(16)	Month
B(17)	Day

The electronic and geometric delays refer to the equipment response times and the reduction to the geometric fixed point, respectively, and are to be subtracted from the observed time delay.

A word of warning is in order to the unwary users. During the report interval, many of the specified data items discussed above are not available. In the card images, a blank field is a "no information" indicator. Actual null values will be represented by zero punches. This is particularly important for clock epoch error. No clock data are presently available, although Currie (1970) estimates that the "actual epoch should be known to the order of 10 μsec or better."

IV. Acknowledgements

The data described herein were generated at the McDonald Observatory through the collective efforts of the LURE Team and numerous supporting personnel at their several institutions.

69-059A-04C
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5. COSPAR WORKING GROUPS

PROPOSED STANDARDS FOR DISTRIBUTION AND DOCUMENTATION OF LUNAR LASER RANGING DATA

A Report prepared for COSPAR Working Group 1

by J. Derral Mulholland, University of Texas at Austin, McDonald Observatory

1971 September

1. Prefatory Note

Laser ranging to the moon promises to provide the means for investigating a number of lunar and terrestrial phenomena to a much higher precision than has been heretofore possible. The interesting lunar problems can be pursued with data from any one or more observatories, although restriction to a single facility does introduce the hazard of local bias in the solutions due to unrecognized systematic errors in the observations. In contrast, very little can be accomplished in earth physics studies using range data from a single observatory. It is imperative to the effective use of these data that there exist a viable means for their distribution or exchange in a sufficiently complete and readily usable form.

This problem was first addressed during COSPAR XIII, when the Chairman of Working Group 1 directed that the present report be prepared. At the same time, a Working Party on Lunar Laser Ranging was formed within the Working Group. Subsequently, the Working Party was endorsed by both IAU and IUGG, and the membership was enlarged to include their representatives.

In an unrelated sequence of events beginning in 1964, IAU Commission 4 established a Working Group on Ephemerides for Space Research. This body served as the inspiration for an informal working group, founded in 1967, which provided working-level communication and coordination in ephemeris research within the USA. This latter group met on numerous occasions during 1967–1969. In addition to providing for standard test cases for areas of desirable duplication of effort, and direct exchange of data and software to reduce unnecessary duplication, this informal group produced two results of some interest to the present discussion. First, the transmission of data was facilitated by adoption by the participants of standard 80-column punched card formats[1]. Second, the three US members of the IAU Working Group were asked to carry back to that body certain recommendations concerning international exchange of astrometric and ephemeral data. This was at least a contributing factor in the establishment last year of the IAU Information Bureau on Astronomical Ephemerides, to provide information on the existence and availability of such data. COSPAR Working Group 1 will be represented in the membership of the Bureau.

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[1] O'Handley, D. A. "Card Format for Optical and Radar Planetary Data" Jet Propulsion Laboratory Tech. Rpt. 32-1296, Pasadena, 1968.

This report is based on the premise that these two lines of development towards international cooperation and exchange represent two convergent aspects of the same problem, and must be treated as complementary.

The author is pleased to acknowledge the helpful suggestions of many of his colleagues in the preparation of this report. This effort was funded by the National Aeronautics and Space Administration, under Grant No. NGR 44-012-219.

2. Philosophy of the Proposed Standards

We desire to establish some minimum criteria for the permanent recording, cataloguing, and transmission of the laser ranging data. This requires a somewhat different, more comprehensive approach to data recording and preservation than has frequently been the case in the past. The signal generation and detection devices, combined with the level of precision attainable in the observations, dictate that more parameters be preserved. It is also important to avoid crucial ambiguities. For example, the observations are time delays. Does the time delay clock run at the same rate as the clock that measures the epoch of observation? Both rates are necessary for application of the data. By presenting standards for data documentation, we do not propose to specify exactly what information is to be recorded, nor in what way to do the recording, but rather to state *minimum* guidelines for what data seem to be required to insure that the laser measures can be made to satisfy their enormous potential.

In addition to the general documentation criteria, we propose some very specific standards for the transmission of data between institutions or their deposition in public data centers. The need for machine-readable formats seems self-evident. Efficient use of machine-readable data from various sources requires the establishment of uniform standards insofar as this is possible. Since a similar exercise has been undertaken for optical and radar observations, it seems unreasonable to pursue the present goal *ab initio*. We propose, therefore, to maximize the compatibility of our data transmission formats with those of O'Handley [2]. It is to be hoped that these formats will provide the basis for a more comprehensive codification by the Information Bureau on Astronomical Ephemerides.

We have already implied that there should exist multiple classifications of data standards, since complete archival documentation is not customarily necessary to or desired by the user of astrometric data. It seems to be convenient to discriminate three categories, to be described in detail in subsequent sections of this report. The categories can be considered as approximating the functions of journal publication, public deposition, and archive data, respectively. These represent three levels of detail, corresponding to different purposes to which the data may be applied.

In their present form, these proposals are intended as first-order approximations, evolved from experience within the laser program and from the discussions held within Working Group 1 during the 14th Plenary Meeting. As further experience is gained, some modifications will surely follow.

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[2] op. cit.

3. Reduced Data Set

The "reduced data set" will consist of sufficient information to satisfy the requirements of non-critical application, such data as one might publish in a scientific journal. The items recommended for inclusion are:

Epoch of observation, and its meaning;
Observed time delay, modified by corrections for geometric and electronic calibration delays and for the atmospheric refraction delay;
System time delay resolution;
Telescope and reflector identification;
Time base identification for both epoch and time delay.

These data, which are certainly adequate for many purposes, are easily accommodated on a standard 80-column punched card. A proposed card format is specified in Appendix C.

4. Astrometric Data Set

This category is of most critical interest from the standpoint of serious application of the data, and it represents those data which we propose should constitute the standard grouping for deposition in a public data center or publication comparable to observatory annals. Here we must distinguish between data provided for each observation and other data recorded at most once for each run, but which are needed for high-confidence use of the data:

Each observation
- Epoch of observation, and its meaning;
- Observed time delay, unaffected by any corrections;
- Observational uncertainty, with a description of its basis;
- Gravimetric data (*)
- Telescope and reflector identification;
- Time base identification for both epoch and time delay.

Each run
- Clock calibration data;
- Electronic and geometric calibration delays to be subtracted from the observation;
- Atmospheric data (temperature, pressure, humidity, seeing, wind speed);
- Laser parameters (energy, pulse length, frequency);
- Detector parameters (count rates, inherent resolution, range gate structure);
- Number of shots per run.

Once
- Station description;
- Nominal telescope coordinates;
- Precise separations between transmitter and receiver, if appropriate;
- Relation of primary mirror position to fixed reference point.

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* The measurement of relative gravimetric data is considered desirable for those locations for which a simple analytic model is not adequate to account for solid earth tides.

A separation can be based on considerations of application. Customarily, use of the data to nanosecond accuracy requires only certain of these data. A conventional card format is proposed for these data in Appendix C. The other items permit either finer-scale reduction of the observations or re-evaluation of confidence levels and uncertainty estimates. A second machine-readable format is proposed for these data. The principal virtue claimed for these formats is that we propose immediately to begin using them in transmissions of lunar ranging data from the McDonald Observatory.

5. System Data Set

Each of the data-taking organizations will wish to maintain its own archive files, basically observatory logs, which will contain all of the information contained in the "astrometric data set" for that observatory, but also such additional items as might be useful in evaluating system performance. This might include such parameters as laser beam divergence, spatial and spectral filter width, filter/laser wavelength matching, etc. This seems to be a purely local matter of little impact on the astrometric use of the time delays, and thus this category does not lie within the scope of the present report. One will note that the McDonald formats (Appendix C) will include some of these items.

6. Distribution Mechanisms

Central to the entire purpose of this report is the precept that full utilization of these astrometric data of unprecedented precision can only occur if the data are made conveniently available outside the originating organization, indeed outside the country of origin. It may be admitted that each observing group may wish to restrict access to their own data for some specified time. It is further understood that, particularly in the early stages of an observational program, the observational identification problem (noise filtering) may not permit adherence to intended distribution schedules. Nonetheless, it seems unambiguous and unarguable that some mechanism for general and open distribution of the data need be endorsed in principle and, insofar as possible, adhered to in practice.

COSPAR has provided for open repositories of space science data in the network of World Data Centers, whose charter includes the handling of "precise positional observations... of great scientific value." There can be no question that the laser observations satisfy this description. We propose that Working Group 1 urge the WDC's to accept the responsibility of serving as a focal point for the dissemination of these data. We further propose that all lunar laser ranging facilities in countries whose National Scientific Institutions adhere to COSPAR be urged to agree to submit their observations, in the form of astrometric data sets, either to the WDC's directly or to national data centers that exercise free exchange with the WDC's (e.g. the US National Space Science Data Center). Each group should also be free to make other distribution arrangements as well, including acces to reduced data sets or system data sets as they see fit.

In addition to making explicit distribution arrangements, the observing organizations should be urged to register these arrangements with the IAU Information Bureau on Astronomical Ephemerides, for the convenience of those scientists unfamiliar with the COSPAR organization. It is presumed that the COSPAR representatives in the Information Bureau organization will provide coordination between the function of the Bureau and the wishes of COSPAR Working Group 1. Dr. Veis has also suggested that the COSPAR/IUGG Central Bureau for Satellite Geodesy be kept informed of available data.

Appendix A

Notes on Selected Data Items

Epoch of observation

Systems may be designed with either the transmission time or the reception time as the epoch reference. In every case, the appropriate option must be explicitly available. In addition, if reception time is used, this must be *observed* reception time, rather than predicted.

Observational uncertainty

This parameter is somewhat subjective and, for a given observation, may be revised *ex post facto*. Its minimum value is the shot-by-shot resolution, but may be much higher if electronic or other operating problems exist in the observing system.

Electronic delay

Thie represents the time delay in the detection circuitry, which does not relate to a distance.

Geometric delay

The observations will need to be reduced to a point in the light path fixed relative to the telescope pier. The geometric calibration delay represents the total light path from that point to the front face of the laser, plus the total light path from the fixed point to the detector. For bistatic operation, a fixed point reference is required separately for receiver and transmitter.

Nominal telescope coordinates

These should refer to the fixed point(s) described above. The nominal coordinates should be (as nearly as practical) the best available estimate of the coordinates relative to the Earth's center of mass, along with a description of the method of determination. Spherical coordinates are to be preferred to rectangular. Astronomical coordinates (including radial distance) may be given if more appropriate data are not available.

Primary mirror

Some telescope designs require the primary mirror to describe some space path relative to a fixed point such as the intersection of the rotation axes. High-accuracy discussion of observations from such telescopes will require that such motion be taken into account.

Appendix B

Proposed Standard Codes and Units

Epoch of observation

The standard unit is the Julian Date, with decimal fraction.

Observed time delay

The standard unit is the second.

Observational uncertainty

The standard unit is the nanosecond.

Electronic and geometric delays

The standard unit is the nanosecond.

Telescope identification

This will consist of three distinct codes: one for the observatory, one to indicate whether the system uses a single telescope or separate transmitter and receiver, and a third to identify distinct telescope locations in case different arrangements have been used at a single site. The total code requires five digits.

For the basic observatory code, we propose adherence to the established three-digit code used by the IAU Minor Planet Center. The center is willing to assign codes to presently unlisted observatories in a fashion consistent with past practice.

The number of telescopes used could serve as a one-digit code by itself, but we find it convenient from external considerations to propose that a one-digit code distinguish two characteristics. The fourth digit of the observatory code specifies either a single telescope (monostatic) operation or separate transmitter and receiver (bistatic) operation, and it also specifies if the epoch refers to transmission or reception time, according to the following table:

	Monostatic	Bistatic
Transmit	1	2
Receive	3	4

Finally, each observatory will be responsible for assigning a one-digit code (0–9), the fifth digit of the observatory code, specifying distinct sites on the premises. One may note that a changeover from monostatic to bistatic operations need not affect this digit, as that change may be accommodated unambiguously by the preceding digit code.

Reflector identification

A one-digit code should suffice for this parameter, with the digits assigned in the order of emplacement, as follows

0 – Apollo 11 (Tranquility Base)
1 – Luna 17 (Imbrium)
2 – Apollo 14 (Fra Mauro)
3 – Apollo 15 (Hadley)

Other numbers will be assigned as new reflectors are activated.

Time base identification

We assume that observation epoch will always be referred to a time base available in real time, regardless of the nature of the observation. The system UTO is included for the sake of generality, even though one does not expect it to be used for laser observations. The time delay will always be based on an oscillator frequency, but we must allow for the possibility of a non-standard frequency. The proposed codes are

0 – UTO
1 – UTC
2 – A.1 (USNO)
3 – A^T (BIH)
4 – USSR atomic time
9 – non-standard frequency

Clock calibration

The standard units are microseconds (epoch) and hertz (frequency)

Atmospheric data

The standard units are: for temperature, Celsius degrees
for pressure, millibars
for humidity, % saturation
for seeing, arc seconds
for wind speed, km/hour

For the present purpose, no distinction need be made between 99 % and 100 % humidity.

Laser parameters

The standard units are joules (energy) and nanoseconds (pulse length) full width between the half-power points.

Telescope coordinates

The standard units are: for radial distance, km
for longitude, degrees *east*
for latitude, degrees north
for rectangular coordinates, km

Appendix C
Proposed Standard Punched Card Formats

Standard formats are presented below for the transmission of reduced and astrometric laser data via 80-column punched cards. Some of the details of the formatting were chosen for compatibility with present usage of other data familiar to the author. This is particularly true of the placement and field size of certain data, such as body identifier, epoch, and observatory code.

Reduced data card

Col. 1: = P (11-7 punch)
2–4: = 011 (Body identifier)
5–21: Epoch of observation (Julian date with 10 decimal digit fraction, decimal implied following col. 11)
22–26: Observatory code
27: Blank (not used)
28: Reflector code
29: = L (11-3 punch, observation type)
30: Epoch time base
31–42: Two-way time delay (seconds, decimal implied following col. 32, 10 decimal digit fraction)
43–47: Observational precision estimate (nanoseconds, decimal implied following col. 46)
48–53: Refraction delay removed from observation
54–56: Blank (not used)
57–58: = -1 (identifies reduced data)
59–62: Blank (not used)
62–66: Frequency offset of time delay clock from nominal rate. If Col. 67 = 9, offset is from A^T (parts in $10''$)
67: Time delay time base
68–72: Blank (not used)
73–80: Year, month, day

Astrometric data card

Col. 1–47: Identical with reduced format
48–53: Electronic delay (nanoseconds, decimal implied following col. 52)
54–58: Geometric delay (nanoseconds, decimal implied following col. 57)
59–67: Identical with reduced format
68–72: Atmospheric pressure (mbars, decimal implied after col. 71)
73–80: Identical with reduced format

Operational environment data card

Col. 1: = Z (0–9 punch)
2–4: Observatory code (first 3 digits)
5–14: Julian date beginning run (truncated to 3 decimal digits, decimal implied following col. 11)
15: Blank (not used)
16–22: Clock epoch offset (μsec) to be added to clock reading
23–25: Temperature (°C)
26–27: Humidity (% saturation)
28–29: Wind speed (km/hr)
30–31: Seeing (0.1 arc sec)
32–34: Blank (not used)
35–37: laser energy (0.1 joule)

Col. 38–42: laser frequency (10^{10} Hz)
43–45: pulse length (0.1 nanosec)
46–48: resolution (0.1 nanosec)
49–51: photomultiplier dark count (kHz)
52–54: Moon count rate (kHz)
55–57: Star count rate (kHz)
58–62: Calibration star identification
63–65: Filter spectral width (0.1 Å)
66–68: Filter spatial width (0.1 arc sec)
69–72: Number of shots this run
73–80: Year, month, day

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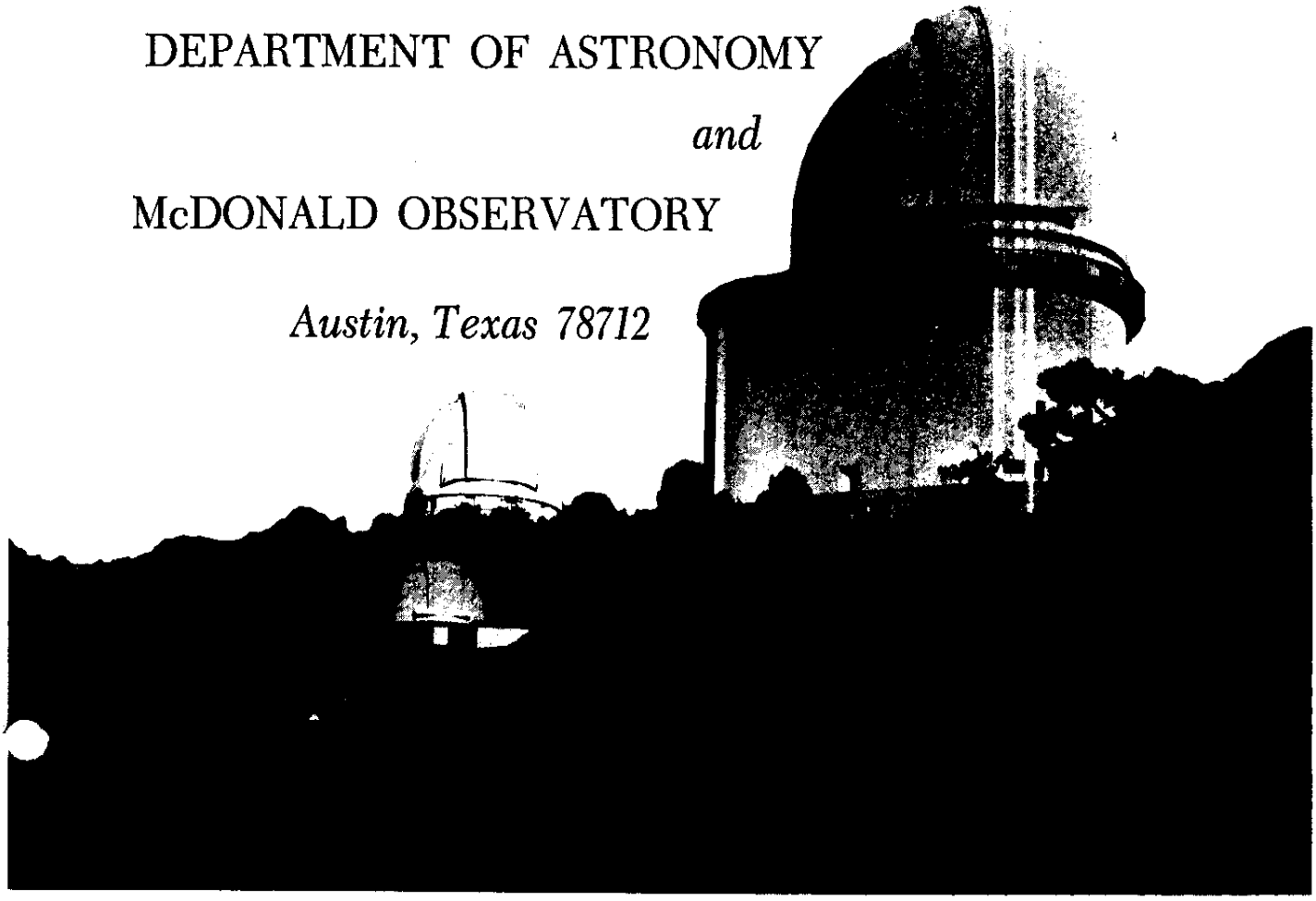
THE UNIVERSITY OF TEXAS AT AUSTIN

DEPARTMENT OF ASTRONOMY

and

McDONALD OBSERVATORY

Austin, Texas 78712



LUNAR LASER RANGING DATA DEPOSITED IN THE NATIONAL SPACE SCIENCE DATA CENTER NORMAL POINTS, FILTERED OBSERVATIONS, AND UNFILTERED PHOTON DETECTIONS FOR 1 JANUARY 1981 THROUGH 30 JUNE 1981

Peter J. Shelus

University of Texas at Austin

Research Memorandum in Astronomy

1981 October

I. Introduction

Not only is the laser ranging experiment capable of rendering significant improvements to a large number of fundamental physical constants and solar system parameters, it is also possible to apply the data to study the Earth itself. However, in order that lunar laser ranging data be used to its fullest capacity it is necessary that it be made available to the scientific community in a standard, useable form with sufficient environmental and systemic description included to assure proper reduction of that data. It is unreasonable to assume that all observing stations will be identical in their hardware and software configurations; further, it is impossible to assess and reduce in real-time all relevent environmental and systemic parameters during routine observing. Thus it has been assumed that such observatory-unique "raw" data be transmitted to a central agency in order to filter signal photons from the noise, form normal points from logical sub-sets of signal returns, and, perhaps most importantly, consolidate range, environmental, and systemic information into a standard form to be made available to the general scientific community.

In August of 1980 the McDonald Observatory Lunar Laser Ranging Station completed eleven years of operations using the 2.7m reflector. During that entire period of time LLR observations were obtained in a routine manner. The University of Texas at Austin has been responsible for the routine filtering, compression, and distribution of that data since mid-1971. Archival deposits of those data have been made periodically into the National Space Science Data Center (and the World Data Center) which is maintained at the NASA Goddard Space Flight Center in Greenbelt, Maryland (USA). These Mcdonald observations now comprise the bulk of all available LLR information. As we continue with our second decade of activity in this experiment, we have continued and will continue to maintain a steady and timely flow of data into the general scientific community. The present report comprises the documentation to be used in conjunction with the 1981 October deposit into the NSSDC which

contains normal points, filtered observations and unfiltered photon stops for the months January through June, 1981. Note that data deposits in this series continue to be made semi-annually in the spring and fall and consist of 6-month blocks of data which end three months before the deposit date, i.e., January-June or July-December.

A microfiche copy of the January-June, 1981 McDonald Observatory LLR data set has been included at the back of this report. Also, the interested reader is referred to Appendices C and D. Appendix C is entitled "Lunar Laser Calibration Data"; Appendix D is entitled "McDonald Lunar Laser Operations Log". Both of these appendices include information in a format similar to that which had been included in the tri-annual reports issued by E. C. Silverberg under NASA Grant NGR 44-012-165. With the demise of that grant and because of the different report requirements of the present McDonald Observatory Laser Operations Contract, this type of information is presently being included in our semi-annual NSSDC LLR data deposits.

A detailed overview of the equipment used to acquire the data described in this document has been provided by E. Silverberg (1974) and the precise role played by telescope mirror geometry and its effect upon the proper reduction of the data is discussed by Shelus et al (1975). New, definitive geometric calibration information for the entire McDonald 2.7m LLR data set can be found in Appendix A of this document. The interested user is also directed to papers by Mulholland (1980a, 1980b) and by Ferrari et al (1980) for current information and a near-exhaustive bibliography regarding most phases of the LLR experiment. Finally, a summary of the statistics concerning the first ten years of McDonald Observatory LLR operations has been compiled by Shelus (1980) and can be obtained from the author upon request.

II. Observational Statistics

The 119 McDonald Observatory LLR normal points contained in this data deposit represent some 957 individual photon returns from the moon. The distribution of the data with respect to month and to reflector is presented

1981	REFLECTOR 0		REFLECTOR 2		REFLECTOR 3		REFLECTOR 4		TOTALS	
	Normal points	# of photons	Normal points	# of photons	Normal points	# of photons	Normal points	# of photons	Normal points	# of photon
Jan	1	9	1	7	5	38	0	0	7	54
Feb	4	34	5	42	17	179	0	0	26	255
Mar	2	17	2	14	15	133	0	0	19	164
Apr	3	20	6	47	15	132	3	26	27	225
May	4	19	4	19	19	109	2	10	29	157
Jun	0	0	0	0	11	102	0	0	11	102
TTL	14	99	18	129	82	693	5	36	119	957

Table I. Summary of filtered observations by month and by reflector.

in Table 1. The statistics on the number of photons per normal point can be found in Figure 1. Figure 2 presents the current normal point distribution with respect to the classical fundamental arguments of the lunar motion. Figure 3 gives similar information with respect to the lunar declination and the local hour angle. Finally, Figure 4 presents statistics on uncertainty estimates for this data set. It should be noted that the various statistical information for the present data is essentially identical to earlier deposits in this series.

III. Data Description

The data are contained on three files of a binary magnetic tape written in card-image format, using a CDC Dual Cyber 170/750. It is written with odd parity at 800 bpi. Three types of cards are present, distinguished by an alphabet character in column 1. The letter "Z" designates a "RUN" card, giving environmental and operational parameters for a series of shots. Except for clock epoch offset, these will not customarily be required for application of the range data, but serve to provide information on the observing conditions and the state of the equipment. The letter "P" in column 1 represents a "SHOT" card, containing the result of a single laser firing. The letter "N" in column 1 represents a "NORMAL POINT" card containing the information compressed from an entire "RUN". A word of warning is in order to the unwary user. Some of the specified data may not be available. In the card images, <u>a blank field is a "no information" indicator</u>. Actual null values will be represented by zero punches. The complete "Z", "P", and "N" card formats are as follows:

```
  INTEGER ZIN(23)
  READ(5,1)ZIN
1 FORMAT(A1,I3,I10,I8,I3,3I2,A1,2X,I3,I5,5I3,A5,2I3,2I4,2I2)
where ZIN(1) = Card identifier (=Z)
         (2) = Observatory code* (=711)
         (3) = Julian date x 1000
         (4) = Clock epoch offset (microseconds)
         (5) = Atmospheric temperature (Celsius)
         (6) = Humidity (% saturation)
         (7) = Wind speed (km/hr)
         (8) = Seeing (0.1 arc sec)
         (9) = Electronic calibration accuracy code
               (see Appendix A)
        (10) = Energy (0.1 joule)
        (11) = Laser Frequency (10 gigahertz)
        (12) = Pulse length (100 picoseconds)
        (13) = Shot-by-shot resolution (100 picoseconds)
        (14) = Dark count (kHz)
        (15) = Moon count (kHz)
        (16) = Star count (kHz)
        (17) = Star identification
        (18) = Spectral filter width (0.1 angstrom)
        (19) = Spatial filter width (0.1 arc sec)
        (20) = Number of shots in run
        (21) = Calendar year
        (22) = Month
        (23) = Day

  INTEGER PIN(17)
  READ(5,2)PIN
2 FORMAT(A1,I3,I17,I5,I2,A1,I1,I12,I5,I6,I5,3X,I5,I1,I5,I4,2I2)
where: PIN(1) = Card identifier (=P)
          (2) = Body identifier (Moon = 011)
          (3) = Observation epoch
          (4) = Observatory code* (=71110)
          (5) = Reflector code*
          (6) = Observation type (=L)
          (7) = Epoch time base*
          (8) = Observed time delay (100 psec)
          (9) = Uncertainty estimate (100 psec)
         (10) = Electronic delay (100 psec)
         (11) = Geometric delay (100 psec)
         (12) = Frequency offset (parts in 10**11),
                  subtract effect from range
         (13) = Delay time base*
         (14) = Atmospheric pressure (0.1 mb)
         (15) = Calendar year
         (16) = Month
         (17) = Day
```

(*) For additional explanation see also Mulholland (1972).

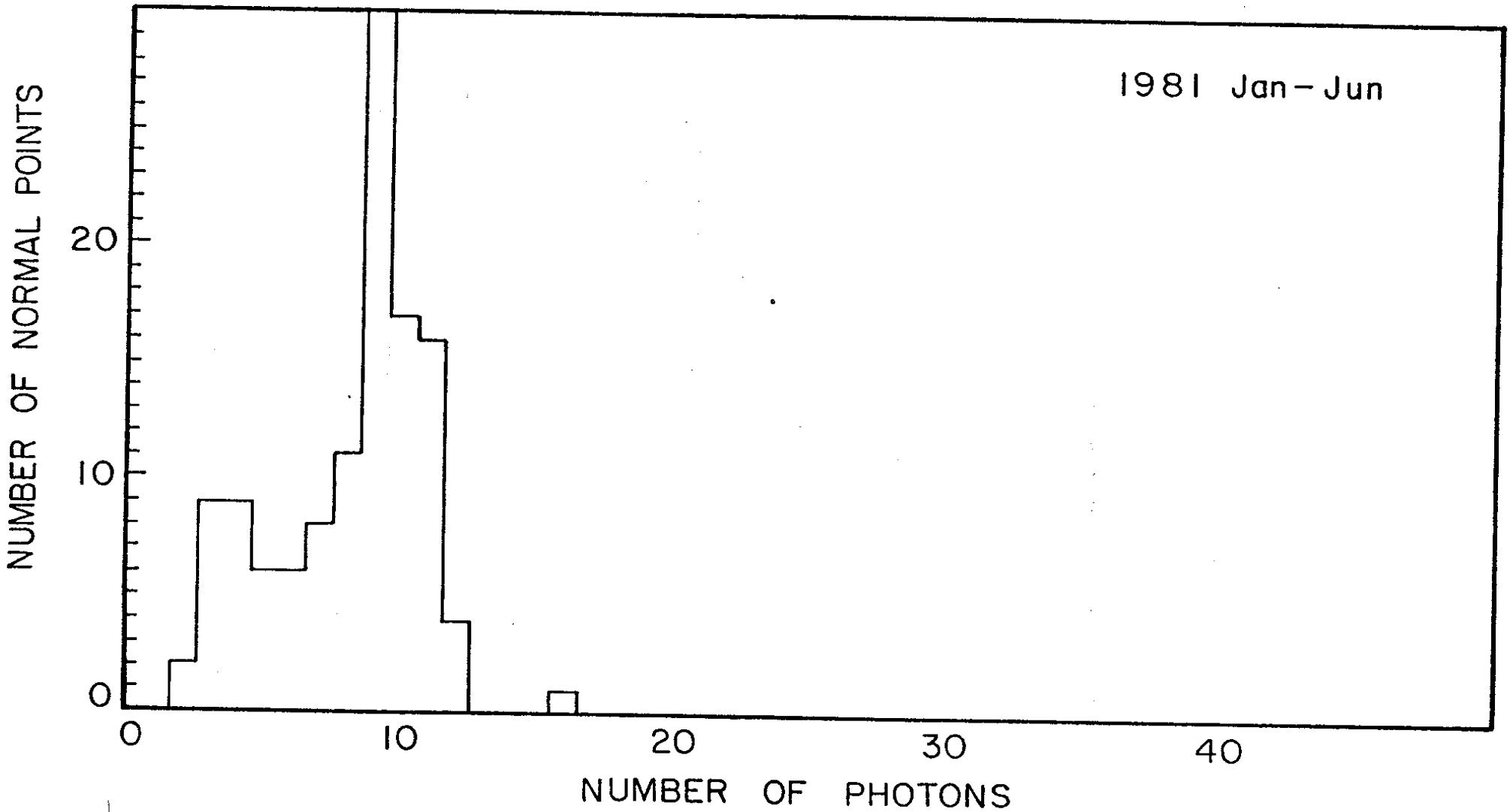


Figure 1: Distribution of signal photons per normal point for 1981.0 - 1981.5

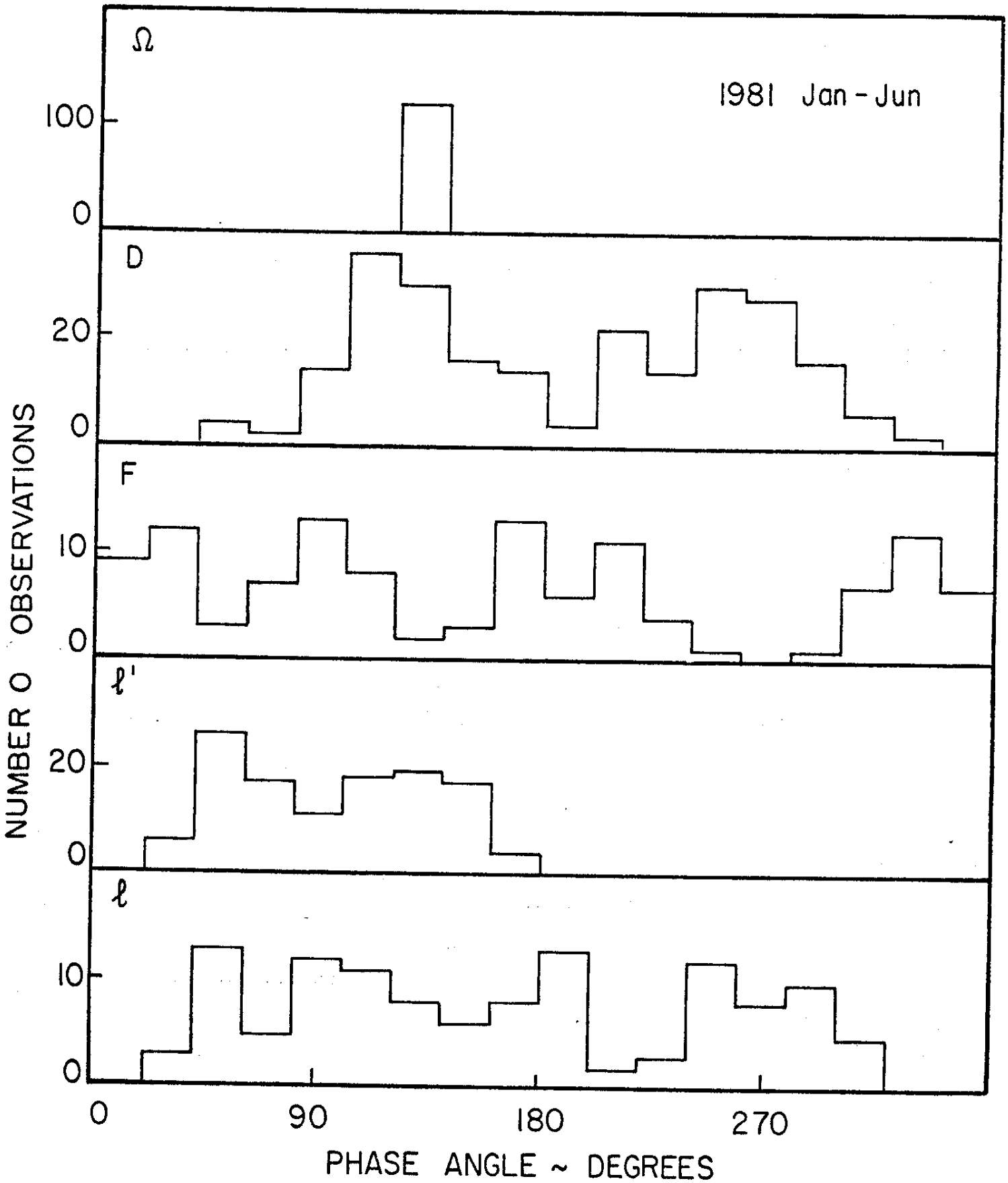


Figure 2: Histograms of the 1981.0 - 1981.5 observation distributions with respect to the phase of each of the fundamental arguments of the lunar motion. The sampling interval is 20°.

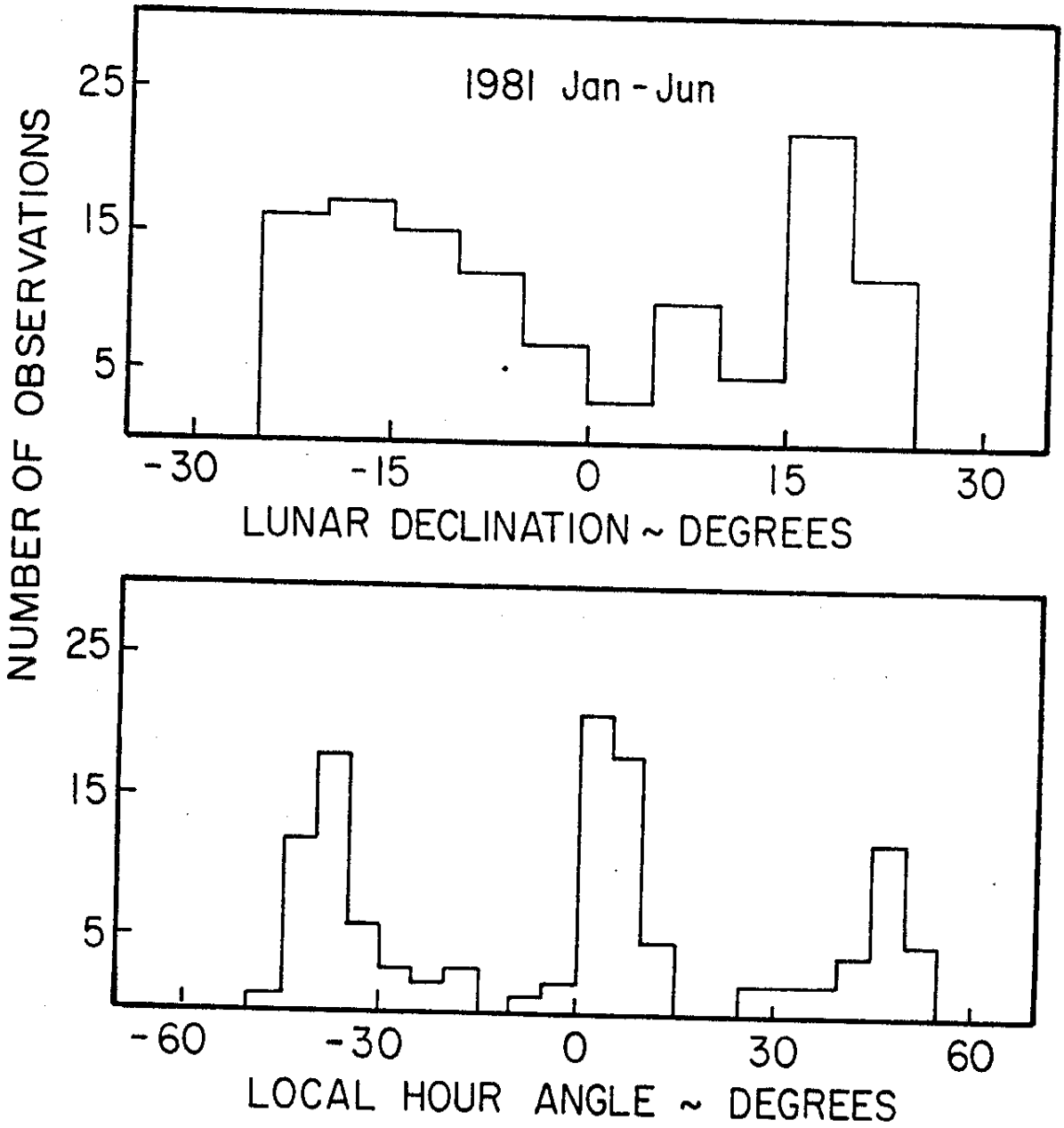


Figure 3: Histograms of the 1981.0 - 1981.5 observation distributions with respect to the lunar declination and local hour angle. The sampling interval is 5°.

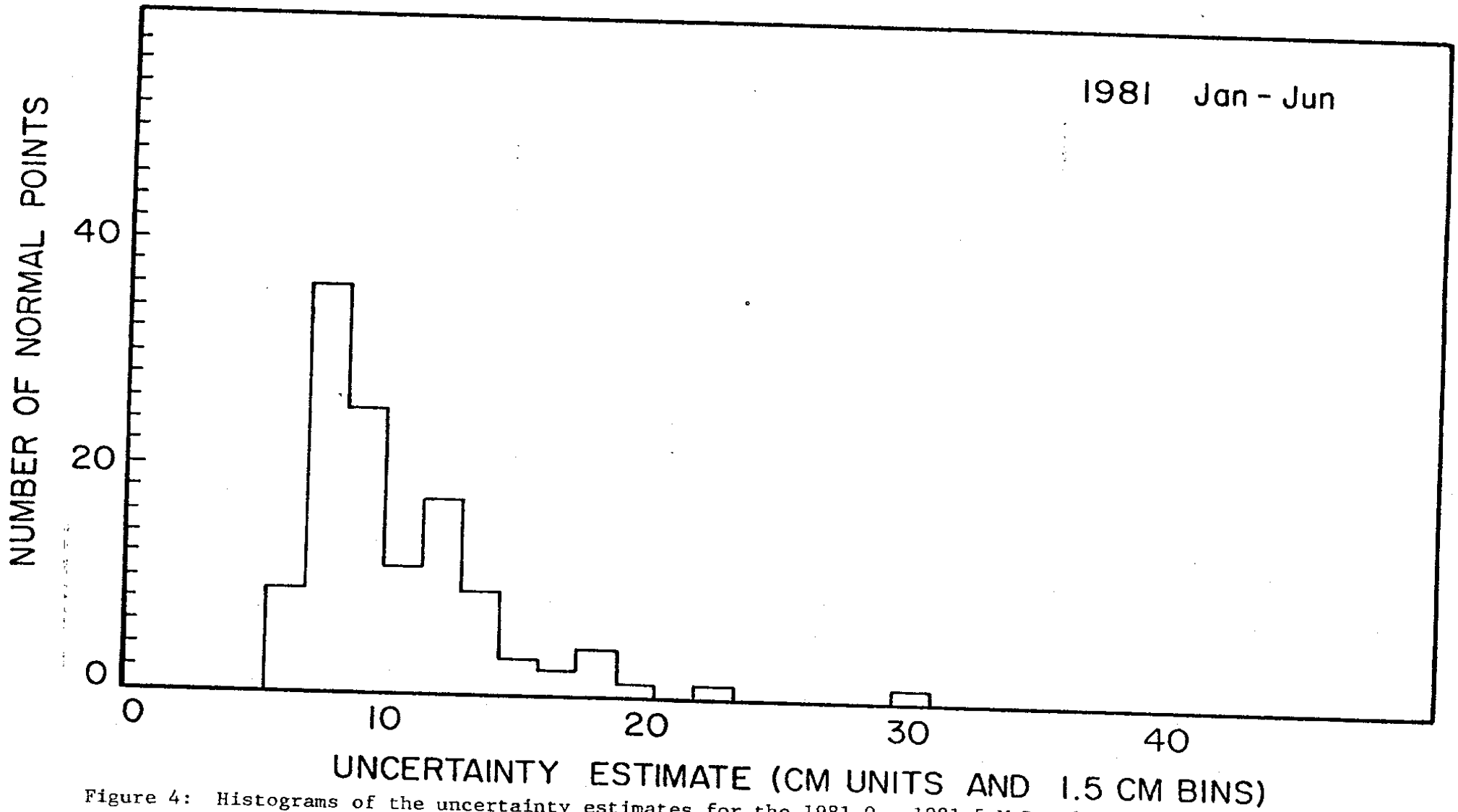


Figure 4: Histograms of the uncertainty estimates for the 1981.0 - 1981.5 McDonald Observatory LLR observation set.

```
  INTEGER NIN(18)
  READ(5,3)NIN
3 FORMAT(A1,I3,I17,I5,I2,A1,I1,I12,I5,I6,I5,I3,I5,I1,I5,I4,2I2)
where: NIN(1) = Card identifier (=N)
         (i) = PIN(I) for I=2,3,. . .,11 (see P-card above)
        (12) = Number of photon stops in normal point
         (J) = PIN(J-1) for J=13,14,. . .,18 (see P-card above)
```

For illustrative purposes and in order to define terminology to be used later we shall herein cite our treatment of McDonald Observatory lunar laser ranging data. Due to the fact that the McDonald Observatory obtains its lunar laser ranging observations with the 2.7 m telescope atop Mt. Locke, an instrument which is in regular and continuous use as a normal astronomical telescope, it is necessary that laser runs be scheduled in amongst other projects on-going through any lunar <u>day</u>. Note that by lunar day we refer to that period of time when the Moon is above the horizon at a given observatory, a definition quite analogous to the definition of a solar day. Such a scheduling has resulted in the formation of three laser observing <u>sessions</u> during the course of a lunar day. These three sessions at McDonald are each typically 45^m in length and are held nominally when the Moon is 3^h east of, on, and 3^h west of, the meridian. Of course day to day weather, equipment, and scheduling problems result in varying the length of such sessions and the location of the Moon with respect to the meridian during those sessions.

In the present format, during an observing session, consecutive laser firings are first made at the most favorably placed lunar surface retro-reflector until a sufficient number of returns are obtained to produce a normal point of the desired accuracy. For example, with its present configuration, the McDonald system can produce data to form a normal point with an accuracy of 7-10 cm with about 15 signal returns. Under good conditions these returns can be accumulated with 300-500 laser firings. Such consecutive laser firings at the same reflector, to form a single normal point, are referred to as a <u>run</u>. The observing crew will then set up on the next most favorably placed reflector and repeat the normal point formation

process. Ideally an observing session will produce a normal point for each available lunar retroreflector and then obtain a second normal point of the most favorably placed reflector to complete the cycle. The nominal 45^m observing session is completed by the taking and recording of all relevant environmental and systemic parameters.

The laser observing process does not result in directly useable range data, because the detection system cannot discriminate the source of an arriving photon. It is only the high potential accuracy of the laser system which permits the isolation of the observation from the noise. This requires elaborate computer processing incorporating a statistical filter (see Abbot et al. 1973). To emphasize the need for normal point development, note that through the present epoch, we have formed about 3,000 normal points from McDonald observations alone. Since, on the average, 10-15 photons go into each normal point we are dealing with in excess of 30,000 individual photons. Doing rigorous analysis with this sort of data at the individual photon level would increase computing and analysis costs by a factor of 10 with no significant increase in information content.

The first data file of this deposit contains the signal photon detections which have been compressed into normal points by the procedure referred to above developed at the University of Texas at Austin (Abbot et al, 1973). Each normal point represents the information content of an entire run. Such a normal point observation is comprised of a single pair of "Z" and "N" punched cards.

The second data file contains the photon detections which have been obtained by a data filtering procedure also developed at the University of Texas at Austin (Abbot et al, 1973). This process is based on the assumption of the linearity of (O-C) residuals over a relatively short interval of time and relies on Poisson statistics for establishing a level of confidence in a collection identified by the filter. Application of the process results in the identification of the observations during the subject interval. The

potential user should be aware that the laser cannot be relied upon to produce a simple pulse shape. There sometimes is a complex and/or biased structure within the pulse. Therefore, residuals derived from the signal photons are not necessarily expected to show a Gaussian distribution. The uncertainties assigned are based on the sum of the 1-sigma pulse-width and the measured uncertainty in calibrating the electronic system. Beginning with the April-May, 1972 lunation, a letter code appears in column 32 (formerly unused) of the "Z" card image which provides an estimate for the accuracy of the electronic calibration correction (see Appendix B). The data comprising an observation run consists of a single "z" card and several "p" cards (1 per identified observation).

The third data file contains the unfiltered photon stops. It is most important that the potential user observe the designation "unfiltered". By this, we mean that the real data are heavily interspersed with noise photons from any of the various sources of stray light. Any attempt to use these data in a simple Gaussian application would probably result in a solution closely adhering to the predition ephemeris which was used to control the detector range gating. Some filtering process needs to be applied to these data before effective use can be made of them. The unfiltered data may be of direct utility or interest to those potential users who may wish to replace our filter criteria with their own. Similar to the shot-by-shot information the data comprising an observation run consists of a single "z" card and several "p" cards (1 per photomultiplier stop).

IV. Acknowledgements

This report and the data tape described herein were prepared at the University of Texas at Austin under NASA Contract NAS5-25948. The observations are obtained at McDonald Observatory under the same contract using predictions computed at the Jet Propulsion Laboratory.

V. References

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Appendix A

At the present time the geometric calibration constant for the McDonald Observatory Lunar Laser Ranging Data set is usually applied in two stages by most LLR data analysts. The first phase is the 117.2 ns or the 100.4 ns which is contained on the actual data card image. The second phase is the 120.6 ns which was presented by Shelus et al (1975) to account for the 2.7 meter telescope folded light path. Definitive calibration measurements have recently been made (Silverberg memo follows). As the Silverberg memo states "... All laser range measurements should be referred to that range which would be observed if you used an infinitesimally small instrument placed at the first non-moving point along the receive path ... All McDonald data should be uniformly corrected by the difference between the constants you are using and these newer values ...".

For the sake of consistancy we are continuing to provide the geometrical calibration constant for the McDonald 2.7 meter system as 100.4 ns and are making the user responsible for applying the proper correction from the Silverberg memo. A suggestion to the user is to simply apply a "telescope" correction of 121.8 ns instead of the 120.6 ns value which is quoted in the referenced Astronomical Journal paper, i.e., Shelus et al (1975). That a proper geometrical calibration constant be applied to the McDonald LLR data set is especially important when multi-station and multi-technique experiments are being attempted.

At this time we also draw attention to paragraph 3 of the Silverberg memo which presents the measured offsets from the 2.7 meter telescope axis intersection to the NGS survey marker on the dome floor.

THE UNIVERSITY OF TEXAS
McDONALD OBSERVATORY AT MOUNT LOCKE
Robert Lee Moore Hall
Austin, Texas 78712

Date: 26 Feb 1980

MEMORANDUM

To: All Lunar Range Users, c/o Peter Shelus

From: E.C. Silverberg

Subject: McDonald Calibration Data

With the help of an NGS Field Team we have finally determined definitive calibrations for the McDonald lunar range data. Since 1973 we have been using a geometrically constant system; but one which was uncertain by as much as 2-3 nanoseconds in the overall range bias. This uncertainty has been greatly reduced by our recent work. Additional data has also been added to relate the 2.7 meter axes to the NGS survey mark on the telescope pier.

All laser range measurements should be referred to that range which would be observed if you used an infinitesimally small instrument placed at the first non-moving point along the receive path. The latter is usually the intersection of the telescope axes. Thus, a dynamical solution for station site coordinates will determine the geocentric position of a point on the #4 mirror in the 2.7 meter reflector. The relevant dimensions are given on the next page. A raw McDonald range measurement can be corrected to these conditions by <u>subtracting</u> a value equal to K - K' + 70.573 meters or K - K' + 235.4 nanoseconds. (The estimated error is about ± 1 cm.) K and K' are observed shot by shot by the feedback calibration system. In the past we have divided this calibration correction into an electrical component, ELCOR = K - K' + 13.19 nanosceonds and a geometric component (including the finite telescope size) of GEOC = 222.2 nanoseconds (66.621 meters) but the division is somewhat arbitrary. <u>All</u> McDonald data should be uniformly corrected by the difference between the constants you are using and these newer values. (We have always been certain of the relative biases of the various older systems, so any implied change in the last setup pertains to the entire eleven years.)

In addition to determining the system calibration constants we have accurately determined the offset of the 2.7 meter axes from the NGS survey mark on the dome floor. The survey marker is 5.304 meters down, .739 meters north and 0.143 meters east from the 2.7 meter calibration point.

Barring any further discoveries, this should be the last calibration work on the 2.7 meter system. I trust these calculations will lay this area to rest prior to abandoning the instrument sometime next year.

Eric C. Silverberg

Relevant Dimensions Used for the Calculations

Primary to Secondary Mirror	= 7.513 meters
Secondary to #3 Mirror	= 6.309 meters
#3 Mirror to #4 Mirror	= 3.039 meters
#4 Mirror to #6 Mirror	= 12.250 meters
#6 Mirror to PMT along the receive path	= 240.875"
#6 Mirror to the start diode behind #6	= 5 "
#6 Mirror to the feedback beam splitter along the receive path	= 195.75"
Feedback beam splitter to PMT along the feedback path	= 45.125"

Therefore: ELCOR, the difference measured if light hits the start diode and PMT simultaneously,

= K - K' (feedback calibration values)
+ 13.19 nanoseconds

and

GEOC, the correction to the intersection of telescope axes plus the correction for finite telescope size

= 30.491 meters + 36.130 meters (respectively)
or 222.2 nanoseconds

Appendix B

Code for the accuracy of the McDonald Observatory electronic calibration correct ion:

A - better than (+/-)200 picoseconds
B - (+/-)200 to (+/-)400 picoseconds
C - (+/-)400 to (+/-)600 picoseconds
D - (+/-)600 to (+/-)1000 picoseconds
E - (+/-)1.0 to (+/-)1.5 nanoseconds
F - (+/-)1.5 to (+/-)2.0 nanoseconds
G - (+/-)2.0 to (+/-)4.0 nanoseconds
H - worse than (+/-)4.0 nanoseconds

These calibration codes were established by E. C. Silverberg.

Appendix C

The Lunar Laser Calibration Data

from

1 January 1981 to 30 June 1981

EXPLANATION OF THE CALIBRATION DATA

The following pages contain the calibration constants for the six lunations covered by the present report. Pertinent information concerning the photodetectors and related timing discriminators is presented above the columnar data. The columnar categories are explained below.

A (pulser): This column contains the uncorrected calibration constant for the entire lunar ranging system as measured by an electronic start and a light emitting diode-PMT stop of the TDC-100 timer. Due to differing cable lengths of the start and stop paths in the system, this number is not the magnitude of the actual system calibration value. It is, however, a measure of the relative shift in the calibration value on a day-to-day basis. The units are nanoseconds.

B (laser pulse): This column shows the single shot uncertainty as keyed to the following code: (all values are in nanoseconds) A = ±0.4, B = ±0.5, C = ±0.6, D = ±0.7, E = ±0.8, F = ±1.0, G = ±1.2, H = ±1.4, I = ±1.7, J = ±2.0, K = ±2.4, L = ±2.9, M = ±3.5, N = ±4.2. The absence of a letter will indicate the single shot uncertainty of J.

C (feedback): This column gives the arithmetic mean in nanoseconds of the "feedback calibration returns" through the entire ranging system as recorded by the system teletype during actual ranging. A "feedback calibration return" is produced by a start-diode start and a PMT stop of the TDC-100 timer. The uncertainty gives the standard deviation of data points within 5 nsec of the mean.

D (ELCOR): This column shows the value of ELCOR which has been determined by subtracting the nominal value of K' (15.3 nsec) and adding 13.9 nanoseconds (geometrical delay) to the average in column C. The units are tenths-of-nanoseconds. The minus sign was added to coincide with how this additive constant appears on the preliminary data cards. Letters following the numerical value indicate the uncertainty in the determination of ELCOR based on the feedback uncertainty according to the code (all values are in picoseconds):

$$0 \leq A \leq \pm 200$$
$$\pm 200 \leq B \leq \pm 400$$
$$\pm 400 \leq C \leq \pm 600$$
$$\pm 600 \leq D \leq \pm 1000$$
$$\pm 1000 \leq E \leq \pm 1500.$$

NOTE: It should be remembered that ELCOR values, as given by these publications, are preliminary estimates determined at the ranging site using simple algorithms. As of March 1976, the final calibration constants, incorporating formal derivations of the calculation uncertainties, have been determined by the data reduction group in Austin, headed by P. Shelus.

SYSTEM CALIBRATION DATA
January 1981

PMT type: 30034

PMT voltage: 1630V

PMT gain: (Ortec 454) course: 5, fine: 2.
Differentiate time constant: 5 nanoseconds.
Integrate time constant: out nanoseconds.
PMT discriminator: (Ortec 453) lower level disc.: 2.5, fraction: 0.5.
Start Diode discriminator: (Ortec 453) 1.1.disc.: 9.0, fraction: 0.4.

UTC	A (pulser)	B (laser pulse)	C (feedback)	D (ELCOR)
012	50.2	--	---------	-----
013	50.5	--	---------	-----
014	53.2	--	---------	-----
015	53.5	I	75.7±0.16	-742B
016	----	--	---------	-----
017	52.0	--	---------	-----
018	----	--	---------	-----
019	----	--	---------	-----
020	54.2	--	---------	-----
021	53.4	H	76.1±0.14	-746A
022	52.8	--	---------	-----
023	54.0	I	75.6±0.10	-741A
024	53.4	--	---------	-----
025	53.3	--	---------	-----
026	53.2	--	---------	-----
027	55.1	--	---------	-----
028	54.0	H	75.4±0.10	-739A
029	52.8	--	---------	-----
030	51.5	--	---------	-----
031	53.3	--	---------	-----

SYSTEM CALIBRATION DATA

FEBRUARY 1981

PMT type: 31034 .
PMT voltage: 1630 .
PMT gain: (Ortec 454) course: 5, fine: 2.
Differentiate time constant: 5 nanoseconds.
Integrate time constant: out nanoseconds.
PMT discriminator: (Ortec 453) lower level disc.: 2.5, fraction: 0.5.
Start Diode discriminator: (Ortec 453) 1.1.disc.: 9.0, fraction: 0.4.

	UTC DAY	A (pulser)	B (laser pulse)	C (feedback)	D (ELCOR)
	042	-	-	-	-
	043	53.5	-	-	-
	044	52.8	J	75.2±0.23	-737B
	045	53.7	H	75.7±0.10	-742A
	046	53.8	I	75.4±0.12	-739A
	047	53.9	-	-	-
MT=1600V	048	53.3	I	75.1±0.21	-736B
MT= 1610V	049	55.3	I	75.8±0.18	-743A
	050	-	-	-	-
	051	-	-	-	-
	052	-	-	-	-
MT=1630V	053	54.7	-	-	-
	054	54.6	-	-	-
	055	54.3	I	74.8±0.15	-733A
	056	54.1	I	75.5±0.11	-740A
	057	53.6	-	-	-
	058	53.2	-	-	-
	059	51.7	-	-	-
	060	-	-	-	-
	061	-	-	-	-

SYSTEM CALIBRATION DATA
March 1981

PMT type: 31034

PMT voltage: 1630

PMT gain: (Ortec 454) course: 5, fine: 2.
Differentiate time constant: 5 nanoseconds.
Integrate time constant: out nanoseconds.
PMT discriminator: (Ortec 453) lower level disc.: 2.5, fraction: 0.5.
Start Diode discriminator: (Ortec 453) 1.1.disc.: 9.0, fraction: 0.4.

UTC	A (pulser)	B (laser pulse)	C (feedback)	D (ELCOR)
070	55.0	--	---------	-----
071	54.4	--	---------	-----
072	54.4	--	---------	-----
073	55.0	I	96.1+0.23	-746B
074	----	I	76.8±0.20	-753B
075	52.6	--	---------	-----
076	53.6	H	76.2+0.18	-747A
077	54.2	H	76.1±0.25	-746B
078	54.4	H	76.1±0.17	-746A
079	54.5	H	76.2±0.21	-746B
080	53.2	--	---------	-----
081	53.2	--	---------	-----
082	54.1	H	75.4+0.13	-739A
083	NO LASER RUN DUE TO SUPER NOVA OBSERVATION			
087	53.1	--	---------	-----
088	----	--	---------	-----
089	53.5	--	---------	-----
090	----	I	75.2+0.18	-737A
091	54.8	I	75.2±0.20	-737B

SYSTEM CALIBRATION DATA
April 1981

PMT type: 31034

PMT voltage: 1630

PMT gain: (Ortec 454) course: 5, fine: 2.
Differentiate time constant: 5 nanoseconds.
Integrate time constant: out nanoseconds.
PMT discriminator: (Ortec 453) lower level disc.: 2.5, fraction: 0.5.
Start Diode discriminator: (Ortec 453) 1.1.: 9.0, fraction: 0.4.

UTC	A (pulser)	B (laser pulse)	C (feedback)	D (ELCOR)
098				
099	----	I	75.6±.18	-741A
100	53.4	--	---------	-----
101	53.0	I	75.6±.13	-741A
102	54.1	I	75.8±.23	-743B
103	54.0	I	75.9±.24	-744B
104	53.0	--	---------	-----
105	53.8	--	---------	-----
106	54.4	--	---------	-----
107	53.6	--	---------	-----
108	53.5	--	---------	-----
109	----	--	---------	-----
110	----	--	---------	-----
111	----	I	75.4±.27	-739B
112	54.4	--	---------	-----
113	53.1	--	---------	-----
114	53.3	--	---------	-----
115	53.5	I	75.6±.11	-741A
116	53.6	I	75.5±.12	-740A
117	53.6	I	75.5±.17	-740A
118	53.6	H	76.3±.22	-748B
119	52.8	I	76.1±.16	-746A
120	----	--	---------	-----

SYSTEM CALIBRATION DATA
May 1981

PMT: type: 31034

PMT voltage: 1630

PMT gain: (Ortec 454) course: 5, fine: 2.
Differentiate time constant: 5 nanoseconds.
Integrate time constant: out nanoseconds.
PMT discriminator: (Ortec 453) lower level disc.: 2.5, fraction: 0.5.
Start Diode discriminator: (Ortec 453) 1.1.disc.: 9.0, fraction 0.4.

UTC	A (pulser)	B (laser pulse)	C (feedback)	D (ELCOR)
128	54.7	--	---------	-----
129	53.4	--	---------	-----
130	53.3	--	---------	-----
131	54.3	--	---------	-----
132	52.7	I	75.9+0.11	-744A
133	52.8	I	75.3∓0.12	-738A
134	53.2	I	75.1∓0.14	-736A
135	53.6	I	75.8∓0.14	-743A
136	----	J	74.0∓0.37	-725B
137	----	--	---------	-----
138	53.0	I	76.0+0.19	-745A
139	55.1	I	76.2∓0.26	-747B
140	54.8	I	75.3∓0.18	-738A
141	54.2	--	---------	-----
142	53.4	I	74.7+0.11	-732A
143	54.4	I	74.8∓0.11	-733A
144	----	--	---------	-----
145	53.5	I	75.1+0.12	-736A
146	----	I	74.7∓0.12	-732A
147	52.4	I	74.3∓0.13	-728A
148	----	I	75.3∓0.20	-738A

SYSTEM CALIBRATION DATA

June 1981

PMT type: 31034

PMT voltagé: 1630

PMT gain: (Ortec 454) course: 5, fine: 2.
Differentiate time constant: 5 nanoseconds.
Integrate time constant: out nanoseconds.
PMT discriminator: (Ortec 453) lower level disc.: 2.5, fraction: 0.5.
Start Diode discriminator: (Ortec 453) 1.1.disc.: 9.0, fraction 0.4.

UTC	A (pulser)	B (laser pulse)	C (feedback)	D (ELCOR)
159	----	--	---------	-----
160	52.2	--	---------	-----
161	----	--	---------	-----
162	53.8	H	74.8±0.16	-733A
163	53.9	I	74.9±0.16	-734A
164	53.9	I	75.0±0.14	-735A
165	54.4	--	---------	-----
166	51.2	J	74.6±0.36	-731B
167	53.8	--	---------	-----
168	----	--	---------	-----
169	----	--	---------	-----
170	----	--	---------	-----
171	----	--	---------	-----
172	53.4	J	---------	-----
173	53.0	I	74.9±0.17	-734A
174	53.2	--	---------	-----
175	52.7	J	---------	-734B
176	53.6	--	---------	-----
177	----	--	---------	-----
178	----	--	---------	-----

Appendix D

The McDonald Lunar Laser Operations Log

from

1 January 1981 to 30 June 1981

EXPLANATION OF THE OPERATIONS LOG

The information presented in the McDonald Lunar Laser Operations Log is as follows:

DATE (column 1): The local calendar date at the start of the day's ranging operation.

LUNAR DAY (column 2): The approximate number of days which have elapsed since the previous new moon. This estimate comes from the American Ephemeris and Nautical Almanac: Ephemeris for Physical Observations of the Moon.

UTC DAY (column 3): The Universal Coordinated Time day of the calendar year as read from the McDonald station clock at the beginning of a range attempt.

TIME (column 4): The UTC hour and minute as read from the station clock at the beginning of a range attempt.

REFL. NO (column 5): The lunar reflector site: 0 = Apollo 11, 1 = Luna 17, 2 = Apollo 14, 3 = Apollo 15, 4 = Luna 21.

RETURNS/SHOT (column 6): The number of lunar returns divided by the number of laser shots fired. Returns are as identified by the laser crew.

SIGNAL LEVEL (column 7): The number of lunar photoelectrons per laser shot for the range attempt. Double photoelectrons are counted as single photoelectron events.

DOUBLES (column 8): The number of returns which were greater than single photoelectron events. Lunar return doubles are presented without parenthesis; noise doubles are presented within parenthesis.

WEATHER (column 9): The general weather conditions at the time of the range attempt.

SEEING (column 10): The guider's estimate of the general seeing conditions in arcseconds, based on stellar or lunar observations.

COMMENTS (column 11): Comments which seem pertinent to the laser crew at the time of ranging.

STATION LOG - JANUARY 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
Jan. 7	1	007	1545	-	-	-			Started MCD 148 Changed Laron Content from 72476 to 7254 30014 to 30028
Jan. 9	3	009	2315						
Jan. 10	4	010	-				Cloudy		No runs. No cage change Clouds, fog
Jan. 11	5	011	-				Cloudy		No runs. No cage change Clouds, fog
Jan. 12	6	012	2130	-	-	-	Cloudy		Cancelled Clouds, Fog
			0030	-	-	-	Cloudy		Cancelled Clouds, Fog
			0330	-	-	-	Cloudy		Cancelled Clouds, Fog
Jan. 13	7	013	2230	-	-	-	Cloudy		Cancelled Clouds, Fog, Rain
			0130	-	-	-	Cloudy		Cancelled Clouds, Fog, Rain
			0433	-	-	-	Cloudy		Cancelled Clouds, Fog, Rain
Jan. 14	8	014	2200						TPHC2 & TPHC2 repaired - Start & Stop Tunnels Aged #1 Installed
Jan. 14	8	014	2330	-	-	-	Clear	6-8	Cancelled Poor Seeing Good Image Motion
			0230	-	-	-	Clear	7-10	Cancelled Poor Seeing Good Image Motion
			0530	-	-	-	Clear	6-7	Cancelled Poor Seeing

STATION LOG - JANUARY 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
Jan. 15	9	015	0000	-	-	-	Cloudy	-	Cancelled Clouds
			0300	3	0/266	-	Cloudy	3-5	Heavy Cirrus
			0600	-	-	-	Cloudy	-	Cancelled Clouds
Jan. 16	10	017	0100	-	-	-	Cloudy	-	Cancelled Clouds Snow
			0400	-	-	-	Cloudy	-	Cancelled Clouds Snow
			0700	-	-	-	Cloudy	-	Cancelled Clouds Snow
Jan. 17	11	018	0200	-	-	-	Cloudy	-	Cancelled Snow
			0500	-	-	-	Cloudy	-	Cancelled Snow
			0800	-	-	-	Cloudy	-	Cancelled Snow
Jan. 18	12	019	0300	-	-	-	Cloudy	-	Cancelled Clouds Snow
			0600	-	-	-	Cloudy	-	Cancelled Clouds Snow
			0900	-	-	-	Cloudy	-	Cancelled Clouds Snow
Jan. 20	14	020	0401	-	-	-			Reset Loran C
			0400	-	-	-	Hazy	-	Cancelled High Humidity
			0700	-	-	-	Clear	-	Cancelled High Humidity
			1000	-	-	-	Clear	-	Cancelled High Humidity
Jan. 21	15	021	0500	3	7/278	-	Ptly. Cldy.	4	
			0800	0	3/328	-	Ptly. Cldy.	5-6	Poor Contrast
			1100	-	-	-	Clear	8	Cancelled Seeing
Jan. 22	16	022	0600	-	-	-	Clear	-	Cancelled Air Conditioning Problem 3 Glycol Unit
			0900	-	-	-	Clear	-	Cancelled Air Conditioning Problem 3 Glycol Unit
			1200	-	-	-	Clear	-	Cancelled Air Conditioning Problem 3 Glycol Unit

STATION LOG - JANUARY 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
Jan. 23	17	023	0630	-	-	-	Clear	5-7	Cancelled seeing, image, motion
			0930	3	10/089	4	Clear	4	Slight image motion
				2	10/306	1	Clear	5	Slight image motion
			1230	0	13/236	1	Clear	4	
				2	4?/280	0	Clear	4-5	
Jan. 24	18	024	0730	-	-	-	Cloudy	5-8	Cancelled by clouds, bad image motion
			1030	-	-	-	Cirrus	7-10	Cancelled good seeing, terrible image motion
			1330	-	-	-	Cirrus	7-10	Cancelled good seeing, terrible image motion
Jan. 25	19	025	0800	-	-	-	Clouds	-	Cancelled clouds
			1100	-	-	-	Clouds	-	Cancelled clouds
			1400	-	-	-	Clouds	-	Cancelled clouds
Jan. 26	20	026	0830	-	-	-	Cloudy	-	Cancelled clouds
			1130	-	-	-	Cloudy	-	Cancelled clouds
			1430	-	-	-	Cloudy	-	Cancelled clouds
Jan. 27	21	027	0930	-	-	-	Clear	9-12	Cancelled terrible seeing
			1230	-	-	-	Clear	9-12	Cancelled terrible seeing
			1530	-	-	-	Clear	9-12	Cancelled terrible seeing
Jan. 28	22	028	1000	3	12/203	4	Light Cirrus	4-7	Chiller problems
			1300	3	5/357	1	Lt-Hvy Cirrus	4-8	Stopped by seeing (Carlini, unrecognizable)
			1600	3	8/350	2	Light Cirrus	3-6	Poor contrast (seeing variable)
Jan. 29	23	029	1100	-	-	-	Clear	7-10	Cancelled Bad Seeing Image Motion
			1400	-	-	-	Cloudy	-	Cancelled
			1700	-	-	-	Cirrus	7-10	Cancelled Seeing Contrast

STATION LOG - JANUARY 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
Jan. 30	24	030	1130	-	-	-	Cloudy	-	Cancelled Clouds
			1430	-	-	-	Cloudy	-	Cancelled Clouds
			1730	-	-	-	Cloudy	-	Cancelled Clouds
Jan. 31	25	031	1230	-	-	-	Ptly. Cldy.	10-15	No Cage change seeing bad cold at 82"
		031	1530	-	-	-	Ptly. Cldy.	10-15	Cancelled No Cage change seeing contrast
			1700	-	-	-	Ptly. Cldy.	10-15	Cancelled No Cage change seeing contrast

STATION LOG - FEBRUARY 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
Feb. 1	26	032	1330	-	-	-	Clear	15-20	No cage change bad seeing contrast
			1600	-	-	-	Clear	15-20	No cage change bad seeing contrast
			1800	-	-	-	Clear	15-20	No cage change bad seeing contrast
		032	1500	-	-	-	-	-	Copied MCD 148

STATION LOG - FEBRUARY 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
Feb. 2	27	033	1430	-	-	-			Started MCD 149
Feb. 2	27	042	2200	-	-	-	Cirrus	6-8	Cancelled Poor Seeing Contrast Bad Image Motion
Feb. 2	27		0100	3	0/29	-	Cirrus	5-7	Stopped TDG Problems - Flip Mirror Changing El Wrong Time
Feb. 2			0400	-	-	-	Cloudy		Cancelled Clouds. TDG Problem (2 Second Card Bad)
Feb. 12	7	043	0830						TDG, Card ?, Q7 Replaced to get 2 Sec. Delay to Work
Feb. 12	7	043	2300	3	12/162	2	Light Cirrus	3-4	Poor Contrast
			0200	-	-	-	Clouds	-	Cancelled Clouds
			0500	-	-	-	Clouds	-	Cancelled Clouds
Feb. 13	8	045	0000	3	14/138	3	Clear	3-6	Very Variable Seeing, (Should be 376 on log)
				2	8/143	3	Clear	3-6	Very Variable Seeing
			0300	3	17/147	3			
				0	11/129	1	Clear	3-4	
			0600	3	12/135	2	Clear	3-4	
Feb. 14	9	046	0100	3	9/44	4	Clear	3	
				0	8/142	2	Clear	3	
				2	11/186	4	Clear	3	
			0400	3	10/45	3	Clear	1-2	
			0700	3	12/60	3	Clear	1-2	
Feb. 15	10	047	0200	-	-	-	Cloudy	-	Cancelled

STATION LOG - FEBRUARY 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
Feb. 15	10	047	0500	-	-	-	Cloudy	-	Cancelled
			0800	-	-	-	Cloudy	-	Cancelled
Feb. 16	11	048	0230	3	11/92	1	Clear	1-2	V=1630 PMT
				3	12/129	1	Clear	1-2	V=1600 PMT
				0	10/190	2	Clear	1-2	
				2	9/96	-	Clear	1-2	
				3	9/338	1	Clear	3	Poor Contrast Full Moon
Feb. 17	12	049	0330	3	8/374	-	Clear	2-3	Poor Contrast Full Moon (PMT= V=1610)
				3	8/234	1	Clear	2-3	Poor Contrast Full Moon (PMT = V=1610)
				2	8/192	-	Clear	2-3	Poor Contrast Full Moon (PMT = V=1610)
				3	0/235	-	Clear	3	Poor Contrast Full Moon (PMT =V=1610)
Feb. 22	17	053	0630	-	-	-	Clear	10-12	Cancelled Bad Seeing PMT=1630V
			0930	-	-	-	Clear	9-11	Cancelled Bad Seeing
			1230	-	-	-	Clear	8-10	Cancelled Bad Seeing
Feb. 23	18	054	0730	3	0/?	-	Clear	4-6	Cancelled TDG Problems Seconds Board Bad
			1030	3	-	-	Clear	5-7	Cancelled TDG Problems Seconds Board Bad
			1320	-	-	-	Clear	5-7	Cancelled TDG Problems Seconds Board Bad
Feb. 23	18	054	2200						Replaced Q7 & Q9 On Seconds Board In TDG
Feb. 24	19	055	0800	3	11/119	1	Cirrus	1-2	Light to Heavy Cirrus
			1000	-	-	-	Clouds		Cancelled
			1400	3	10/83	2	Partly Cldy.	3-4	
				0	0/241	-	Partly Cldy.	3-4	Poor Contrast

STATION LOG - FEBRUARY 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
Feb. 25	20	056	0900	3	11/116	1	Ptly.Cloudy	2	Clouds
			1200	3	10/57	4	Clear	2	
			1200	2	9/274	-	-	2	
			1200	0	9/143	-	-	2	
			1500	3	11/203	1	Clear	4-5	Poor Contrast
Feb. 26	21	057	0930	-	-	-	Cloudy	3-5	Cancelled Clouds
			1230	-	-	-	Cloudy	-	Cancelled Clouds
			1530	-	-	-	Cloudy	-	Cancelled Clouds
Feb. 27	22	057	1000	-	-	-	Cloudy	-	Clouds Cancelled
			1300	-	-	-	Cloudy	-	Clouds Cancelled
			1600	-	-	-	Cloudy	-	Clouds Cancelled
Feb. 28	23	059	1100	-	-	-	Clouds	-	Cancelled Clouds Rain
			1400	-	-	-	Clouds	-	Cancelled Clouds Rain
			1700	-	-	-	Clouds	-	Cancelled Clouds Rain
Mar. 1	24	060	1200	-	-	-	Ptly.Cloudy	6-8	Cancelled Seeing Clouds
			1500	-	-	-	Cloudy		Cancelled
			1800	-	-	-	Clear	6-8	Cancelled Seeing Contrast
Mar. 2	25	061	1300	-	-	-	Cloudy		Cancelled Clouds
			1500	-	-	-	Cloudy		Cancelled Clouds
Mar. 2			1524						Copied MCD 149

STATION LOG - MARCH 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
Mar 2	25	061	1632	-	-	-		-	Started MCD 150
Mar 11	5	070	2100	-	-	-	Cloudy	-	Cancelled Clouds Fog Rain
		071	0000	-	-	-	Cloudy	-	Cancelled Clouds Fog Rain
			0010	-	-	-	-		Recopied MCD 149
			0300	-	-	-	Cloudy		Cancelled Clouds, Fog
Mar 12	6	071	2130	-	-	-	Cloudy	-	Cancelled Clouds Fog
		072	0030	-	-	-	Cloudy	-	Cancelled Clouds Fog
			0330	-	-	-	Cloudy	-	Cancelled Clouds Fog
Mar 13	7	072	2300	-	-	-	Cloudy		Cancelled Clouds
		073	0200	3	10/63	2	Clear	3-4	
				0	0/160	-	Clear	4	
			0500	3	12/175	1	Hazy	4	
Mar 14	8	074	0000	3	7/355	-	Cirrus	4-8	Varying Seeing (Bad Image Motion)
			0300	3	12/142	3	Clear	4-6	
			0600	-	-	-	Cloudy	-	Cancelled Clouds Wind Gusts to 50 MPH West
Mar 15	9	075	0100	-	-	-	Cloudy	-	Cancelled Clouds
			0400	-	-	-	Cloudy	-	Cancelled Clouds
			0700	-	-	-	Cloudy	-	Cancelled Clouds
Mar 16	10	076	0130	3	10/78	1	Clear	4-6	Hazy Variable Seeing
			0430	3	10/111	3	Clear	4-6	Hazy Variable Seeing
				0	8/237	2	Clear	4-6	
			0730	-	-	-	Cloudy	-	Cancelled Clouds
Mar 17	11	077	0230	0	0	0	Cirrus	-	Cancelled Wind 61MPH Unable to Open Dome
			0530	-	-	-	Clear	7-9	Cancelled Bad Seeing Wind 48MPH
			0830	3	13/184	2	Clear	4-6	Image Motion
Mar 18	12	078	0300	3	11/87	2	Clear	4-5	
			0600	3	11/266	3	Lt. Cirrus	4-6	Variable Seeing
			0900	3	10/273	4	Clear	4	

STATION L - MARCH 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
Mar 19	13	079	0400	3	8/366	2	Ptly.Cldy.	4-6	Lt.to Heavy Cirrus (Poor Contra
			0700	-	-	-	Cloudy	-	Cancelled Clouds
			1000	-	-	-	Cloudy	-	Cancelled Clouds
Mar 20	14	080	0430	-	-	-	Cloudy	-	Cancelled Clouds
			0730	-	-	-	Cloudy	-	Cancelled Clouds
			1030	-	-	-	Cloudy	-	Cancelled Clouds
Mar 21	15	081	0530	-	-	-	Dsty.&Wndy.	6	Cancelled Seeing
			0830	-	-	-	Dsty.&Wndy.	8	Cancelled Seeing
			1130	-	-	-	Dsty.&Wndy.	8	Cancelled Seeing
Mar 22	16	082	0600	3	11/041	2	Clear	2	PMT = 1630
				0	11/174	-	Clear	2	
				2	7/331	1	Clear	2	
			0900	3	10/111	3	Ptly.Cldy.	3	Light Cirrus
			1200	3	11/59	3	Ptly.Cldy.	3	
Mar 23-27			-	-	-	-	-		No Laser Runs/Telescope In Cass Observing Super NOVA.
Mar 28	22	087	1000	-	-		Cloudy	8	Cancelled Seeing
			1300	-	-		Clear	10+	Cancelled Seeing
			1600	-	-		Clear	?	Cancelled, High Winds
Mar 29	23	088	1017	-	-	-	Windy	8-10	Cancelled Run for Occultation
			1200	-	-	-	Windy		Cancelled High Winds
			1500	-	-	-	Windy		Cancelled High Winds
Mar 30	24	089	1130	-	-	-	Clear	4-9	Cancelled Bad Seeing
			1400	-	-	-	Clear	4-9	Cancelled Bad Seeing
			1630	-	-	-	Clear	4-9	Cancelled Bad Seeing
Mar 31	25	090	1330	2	10/220	2	Ptly.Cldy.	3	Cooler Problems
				3	8/249	0	Ptly.Cldy.	3	Cooler Problems
			1600	-		-	Clear	4-5	Cancelled Bad Contrast
Apr 1	26	091	1330	2	10/152	1	Clear	3	
			1630	-	-	-	-		Cancelled for Dome Repairs
			1649						Copied MCD 150

STATION LOG - APRIL 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
Apr 1	26	091	1737						Laser 32768 Freq 1955 to 1950
Apr 8	3	098	2017						Started MCD 151
Apr 8	3	098	2030	-	-	-	-	-	Cancelled Clouds
			2300	-	-	-	-	5-7	Cancelled Seeing
		099	0130	4	10/083	3	Clear	4	
				3	11/077	2	Clear	4	
				0	0/144	0	Clear	4	
Apr 9	4	099	2130	-	-	-	Clouds	-	Cancelled
		100	0030	-	-	-	Cloudy	-	Cancelled
			0330	-	-	-	Cloudy	-	Cancelled
Apr 10	5	100	2200	-	-	-	Ptly.Cldy	4-8	Cancelled, Seeing, Contrast
		101	0100	3	10/79	4	Clear	4	
				0	7/263	3	Clear	4	
			0400	3	9/226	1	Clear	4-5	Seeing was 4 at beginning & 9 At End
Apr 11	6	101	2300	-	-	-	Cloudy	-	Cancelled Clouds
		102	0100	-	-	-	Cloudy	-	Cancelled Clouds
			0430	3	10/180	2	Ptly.Cldy.	4-6	Problem with DEC Track at Beginning of Run
Apr 12	7	102	2330	-	-	-	-	-	Cloudy
		108	0145	-	-	-	Clear	4	Cancelled DEC Track problems
			0415	3	11/63	2	Cirrus	4	
				0	6/95	1	Cirrus	4	Stopped by Clouds
Apr 13	8	104	2030	0	0	0	Cloudy	-	Cancelled Clouds
			0330	-	-	-	Cldy.Rain	-	Cancelled, Clouds
			0630	-	-	-	Cldy.Rain	-	Cancelled, Rain
Apr 14	9	105	0100	-	-	-	Cloudy	-	Cancelled Rain Fog
			0400	-	-	-	Cloudy	-	Cancelled Rain Fog
			0700	-	-	-	Cloudy	-	Cancelled Rain Fog
Apr 15	10	106	0200	-	-	-	Clouds		Cancelled Clouds Rain
			0500	-	-	-	Clouds		Cancelled Clouds Rain
			0800	-	-	-	Clouds		Cancelled Clouds Ra

STATION LC - APRIL 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
Apr 16	11	106	0230	-	-	-	Cloudy		Cancelled Clouds
			0530	-	-	-	Cloudy		Cancelled Clouds
			0830	-	-	-	Cloudy		Cancelled Clouds
Apr 17	12	108	0300	-	-	-	Cloudy	-	Cancelled, Clouds
			0600	-	-	-	Cloudy	-	Cancelled, Clouds
			0900	-	-	-	Cloudy		Cancelled, Clouds
Apr 20	15	111	0530	3	12/134	4	Cirrus	2-3	
			0830	-	-	-	Cloudy	-	Cancelled Clouds
			1130	-	-	-	Cloudy	-	Cancelled Clouds
Apr 22	17	112	0600	-	-	-	Cloudy	-	Cancelled Clouds
			0900	3	9/152	3	Clear	3-5	
				0	9/191	1	Clear	3-5	
			1200	-	-	-	Cloudy	-	Cancelled Clouds
Apr 23	18	113	0700	-	-	-	Cloudy	-	Cancelled Clds Rain
			1000	-	-	-	Cloudy	-	Cancelled Clds Rain
			1300	-	-	-	Cloudy	-	Cancelled Clds Rain
Apr 24	19	114	0730	-	-	-	Cloudy	-	Cancelled, Clouds
			1100	-	-	-	Hazy	9+	Cancelled, Seeing
			1330	-	-	-	Cloudy	-	Cancelled, Clouds
Apr 25	20	115	0830	3	10/175	4	Clear	3-5	
			1130	3	10/75	2	Clear	3	
				2	9/260	2			
				4	10/180	1			
			1400	3	9/92	4	Clear	3	
Apr 26	21	116	0930	3	11/039	2	Clear	3	
			1230	3	11/058	4	Clear	3	
				2	10/251	1	Clear	3	
				4	7/284	1	Clear	3	
			1500	-	-	-	Clear	4-6	Cancelled, Seeing, Contrast
Apr 27	22	117	1030	2	10/146	1	Clear	4	
				3	4/213	0	Cirrus	4	
			1300	2	6/316	0	Cirrus	3-4	Clouds - Cirrus (no logs, just shots)
			1630	-	-	-	Cirrus	4-6	Cancelled, Seeing & Contrast

STATION LOG - APRIL 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
Apr 28	23	118	1100	-	-	-	Hvy.Cirrus	4-6	Cancelled Clouds
			1230	3	9/91	3	Clear	3	
				2	7/143	0			
			1630	-			Cloudy		Cancelled Clouds
Apr 29	24	119	1200	3	4/453	1	Ptly.Cldy.	2-3	In and Out of Clouds
			1430	-	-	-	Cldy	-	Cancelled Clouds
			1830	-	-	-	Clear	4-6	Cancelled Poor Contrast Seeing
Apr 30	25	120	1230	-	-	-	Cloudy	-	Cancelled Clouds
			1530	-	-	-	Cloudy	-	Cancelled Clouds
			1830	-	-	-	Cloudy		Cancelled Clouds
Apr 30		120	1330						Copied MCD 151

STATION LOG - MAY 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
May 7	3	127	1930	-	-	-	Cloudy	-	Cancelled Clouds Rain No Cage Change
			2230	-	-	-	Cloudy		Cancelled Clouds Rain No Cage Change
		126	0130	-	-	-	Cloudy		Cancelled Clouds Rain No Cage Change
May 8	4	128	2000	-	-	-	Clear	7-9	Cancelled Very Poor Contrast Seeing Checked at 82" No CageChn
			2300	-	-	-	Clear	7-9	Cancelled Bad Seeing No Cage Chn
		128	0200	-	-	-	Clear	7-9	Cancelled Bad Seeing No Cage Chn
May 9	5	129	2100	-	-	-	Clear	7-10	Cancelled Poor Contrast, Bad Seeing Yes Cage Change
			2330	-	-	-	Clear	7-10	Cancelled Bad Seeing No Cage Chn
		130	0230	-	-	-	Clear	7-10	Cancelled Bad Seeing No Cage Chn
May 10	6	130	2200	-	-	-	Clear	7-8	Cancelled Bad Seeing No Cage Chn
		131	0000	-	-	-	Clear	6-7	Cancelled Bad Seeing No Cage Chn
			0300	-	-	-	Clear	6-7	Cancelled Bad Seeing No Cage Chn
May 11	7	131	2300	-	-	-	Cloudy	-	Cancelled Clouds
			0200	3	010/116	1	Cirrus	2	Cirrus
				0	08/210	2	Cirrus	2	Cirrus
			0500	3	10/83	2	Pt.Cldy.	1-2	Partly Cloudy
				4	10/162	2	Pt.Cldy.	1-2	Partly Cloudy
				2	0/177	-	Pt.Cldy.	3-4	Partly Cloudy
May 12	8	133	0000	3	9/42	1	Cirrus	2-4	Partly Cloudy
				2	9/144	-	Cirrus	2-4	Partly Cloudy
				0	8/194	-	Cirrus	2-4	Partly Cloudy
				4	8/142	1	Cirrus	2-4	Partly Cloudy
			0300	3	10/187	3	Pt.Cldy.	3	Partly Cloudy
			0600	3	9/95	5	Clear	4-5	Clear
		134	0015	3	12/82	4	Clear	4	
				2	9/96	1	Clear	4	
				0	9/190	1	Clear	4	
				3	10/47	2	Clear	2-3	
				3	11/50	1	Clear	2	

STATION LOG - MAY 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
May 14	10	135	0130	-	-	-	-	-	Cancelled Clouds
			0430	3	10/138	1	Hazy	2-3	
				2	9/47	0	Hazy	2-3	
				0	7/237	2	Pt.Cldy	2-3	
			0730	-	-	-	Cloudy	-	Cancelled Clouds
May 15	11	136	0700	3	10/176	2	Cloudy	3-4	
			0500	-	-	-	Cloudy	-	Cancelled Clouds
			0800	-	-	-	Cloudy	4-6	Cancelled Clouds
May 16	12	137	0300	-	-	-	Clear	-	Cancelled Crew Sick
			0600	-	-	-	Clear	-	Cancelled Crew Sick
			0900	-	-	-	Clear	-	Cancelled Crew Sick
May 17	13	138	0330	3	3/216	-	Clear	2-4	Variable Seeing Full Moon V = 1660 PMT
				2	4/206	-	Clear	2-4	Variable Seeing Full Moon V = 1660 PMT
			0630	-	-	-	Very Hazy	5-7	Cancelled Seeing Image Motion Poor Contrast
			0930	-	-	-	Very Hazy	7-10	Cancelled Seeing Image Motion Poor Contrast
May 18	14	139	0400	3	3/249	0	Clear	2-3	1 Day Past Full Moon V=156
				2	0/106	0	Clear	2-3	
			0700	3	7/325	0	Clear	2-3	
			1000	-	-	-	Clear	10-15	Cancelled Bad Seeing
May 19	15	140	0800	3	5/329	1	Clear	4-6	PMT =1630
			2800	-	-	-	Cloudy	-	Cancelled Clouds
			1100	-	-	-	Cloudy	-	Cancelled Clouds
May 21	17	141	0530	-	-	-	Cloudy	-	Cancelled Clouds
			0830	-	-	-	Clear	8-10	Cancelled Seeing
			1130	-	-	-	Cloudy	-	Cancelled Clouds
May 22	18	142	0630	3	10/93	2	Pt.Cldy.	4	
				2	0/188	-	Pt.Cldy.	4	
			0930	3	12/79	3	Pt.Cldy.	3	
				0	7/322	3	Pt.Cldy.	3	
			1230	-	-	-	Cloudy	-	Cancelled Clouds

STATION 1 - MAY 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
May 23	19	143	0730	3	10/85	1	Clear	4-6	Variable Seeing
				0	9/259	1	Clear	4-6	Variable Seeing
			1030	3	10/211	2	Clear	5	Variable Seeing
				2	0/79	-	Clear	5	Too Much Variation in Seeing
			1300	3	10/199	-	Clear	4-5	
May 24	20	144	0800	-	-	-	Cloudy	-	Cancelled Clouds
			1100	-	-	-	Cloudy	-	Cancelled Clouds
			1400	-	-	-	Cloudy	-	Cancelled Clouds
May 25	21	145	0900	3	8/232	1	Clear	4-8	Variable Seeing
			1200	3	9/137	4	Clear	3-4	
				2	9/233	3	Clear	3-4	
			1400	3	5/279	-	Clear	5	Stopped by Seeing Contrast
May 26	22	146	1000	2	3/369	1	Clear	4-5	
				3	3/248	-	Clear	4-5	
			1300	3	10/144	-	Cirrus	4-5	Variable Seeing
				2	6/255	1	Cirrus	4-5	Variable Seeing
			1600	-	-	-	Cloudy	-	Cancelled Clouds
May 27	23	147	1100	2	5/258	1	Ptly.Cldy	3-8	
				3	6/190	1	Ptly.Cldy	3-8	
			1330	3	10/279	1	Clear	3-4	
			1530	3	9/173	1	Clear	3-4	Poor Contrast
May 28	24	148	1130	-	-	-	Cloudy		Cancelled Clouds
			1430	3	6/350	-	Clear	3	
			1730	-	-	-	Cloudy	-	Cancelled Clouds

STATION LOG - JUNE 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
May 29	25	149	1400	-	-	-	-	-	Started McD 153
June 5	3	156	2000						Changed 200 Cap in-2V P.S.
June 7	5	158	2100	-	-	-	Cloudy	-	Cancelled Clouds No Cage Chng
		158	2200	-	-	-	Cloudy	-	Cancelled Clouds No Cage Chng
		158	2300	-	-	-		-	Cancelled Clouds No Cage Chng
June 8	6	159	2130	-	-	-	Cloudy	-	Cancelled Clouds No Cage Chng
		160	0130	-	-	-	Cloudy	-	Cancelled Clouds No Cage Chng
			0400	-	-	-	Cloudy	-	Cancelled Clouds No Cage Chng
June 9	7	160	2230	-	-	-	Cloudy	-	Cancelled Clouds No Cage Chng
		161	0230	-	-	-	Cloudy	-	Cancelled Clouds No Cage Chng
June 10	8	161	2030	-	-	-	-		Started McD L153 (Lower Deck)
		161	2330				Cldy.Rain	-	Cancelled, Rain, Clouds
June 11	9	162	0230	3	11/66	1	Cirrus	-	
			0530	3	10/131	2	Hazy	4-6	Seeing Variable Image Motion
				0	0/136	0	Hazy	4-6	Seeing Variable, Image Motion
June 12	10	163	0100	3	10/080	2	Cloudy	3-4	
			0300	0	0	0	Cloudy	-	Cancelled Clouds
			0500	3	10/108	2	Ptly.Cldy.	4-5	
				2	0/178	0	Ptly.Cldy.	5	Stopped by Seeing
Jan 13	11	164	0130	3	10/166	2	Ptly.Cldy.	4	Poor Contrast
			0330	3	11/180	4	Ptly.Cldy.	3-5	Varying Seeing
				2	?/71	-	Cloudy	3-5	Stopped By Clouds
			0630	3	6/253	3	Ptly.Cldy.	4-6	Seeing Worse at End of Run
June 14	12	165	0130	-	-	-	Cloudy		Cancelled, Clouds
			0430	-	-	-	Cloudy		Cancelled, Clouds
			0730	-	-	-	Cloudy		Cancelled, Clouds
June 15	13	166	0200	3	9/203	1	Clear	3	
		166	0500	-	-	-	Cirrus	5-7	Cancelled seeing
			0800	-	-	-	Cloudy		Cancelled, cloud

STATION LOG - JUNE 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
June 16	14	167	0300	-	-	-	Cloudy	-	Cancelled Clouds
			0600	-	-	-	Cloudy	-	Cancelled Clouds
			0900	-	-	-	Cloudy	-	Cancelled Clouds
June 17-19	-	-	-	-	-	-	-	-	No ranging Full Moon
June 19	17	170	1930	-	-	-	-	-	Copied McD L153- McD 153
June 20	18	171	-	-	-	-	-	-	No ranging Full Moon
June 21	19	172	0700	3	2/252	-	Clear	5-8	Bad Image Motion Hazy (Flip Cage) Windy
			1000	-	-	-	Clear	6-8	Cancelled Poor Seeing, Bad Image Motion, Hazy,Windy
			1300	-	-	-	Clear	6-8	Cancelled Poor Seeing, Bad Image Motion, Contrast Windy
June 22	20	173	0800	3	9/92	1	Ptly.Cldy	4-6	Seeing Variable, Image Motic (Windy)
			1110	3	10/140	2	Cirrus	4-7	Bad Image Motion Seeing Variable (Flip Cage)Windy
			1340	3	9/238	2	Ptly.Cldy	4-5	Poor Contrast
June 23	21	174	0900	-	-	-	Hvy.Cirrus	8-10	Cancelled Clouds Poor Seein
			1200	-	-	-	Fog		Cancelled fog
			1500	-	-	-	Cloudy	-	Cancelled Clouds
Jan 24	22	175	0930	3	0/208	0	Clear	5-6	
			1230	-	-	-	Clear	6-8	Cancelled Poor Seeing
			1500	-	-	-	Clear	8-10	Cancelled Seeing Poor Contra
June 25	23	176	1030	-	-	-	Cloudy	3-5	Stopped by Clouds
			1300	-	-	-	Cloudy	-	Cancelled Clouds
			1600	-	-	-	Cloudy	-	Cancelled Clouds
June 26	24	177	1100	-	-	-	Cloudy	-	Cancelled Clouds
			1400	-	-	-	Cloudy	-	Cancelled Clouds
			1700	-	-	-	Cloudy	-	Cancelled Clouds

STATION LOG - JUNE 1981

DATE	LUNAR DAY	UTC DAY	TIME	REFL. NO.	RETURNS/ SHOT	DOUBLES	WEATHER	IMAGE QUALITY	COMMENTS
June 27	25	178	1200-1600	-	-	-	Cloudy	-	Cancelled Clouds No Cage Change
June 27	25	178	1811	-	-	-	-	-	Copied McD L153 - and - McD 133

DUMP OF TAPE CN1123

DR02906

INPUT TAPE CN1123 ON FT
DATA INPUT CS NF=52 SR=1=1=2 SR=52=1=2

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(2784)	[illegible]	203334343537	373337404341	363637423535	353535423434	343355331434	553536433435	373534333533
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(4032)	344441445544	553700000000	000000000000	203334343537	373337414343	444134343434	343434423434	343355331434
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(4128)	553700000000	000000000000	203334343537	373337414343	444233433636	363636423434	343355331434	553541373640
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(4272)	343333333355	555537373755	343442355555	555555555555	345542443733	344441445544	553700000000	000000000000
(4320)	203334343537	373337414344	343334364343	434343423434	343355331434	553541373441	443442333533	343333333355
(4368)	555537373755	343442355555	555555555555	345542443733	344441445544	553700000000	000000000000	203334343537
(4416)	373337414344	403637333542	424242423434	343355331434	553541364140	423442403533	343333333355	555537373755
(4464)	343442355555	555555555555	345542443733	344441445544	553700000000	000000000000	203334343537	373337414344
(4512)	404040404040	404040423434	343355331434	553541364136	413343403533	343333333355	555537373755	343442355555
(4560)	555555555555	345542443733	344441445544	553700000000	000000000000	203334343537	373337414344	404042413643
(4608)	434343423434	343355331434	553541364136	373341403533	343333333355	555537373755	343442355555	555555555555
(4656)	345542443733	344441445544	553700000000	000000000000	324234343537	373337434241	444055555555	555555555555
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(4752)	344441443344	353600000000	000000000000	203334343537	373337434242	354436423744	444444423434	343355331434
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(4848)	353600000000	000000000000	203334343537	373337434242	354440343643	434343423434	343355331434	553537334337
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(4944)	[illegible]	203334343537	373337434242	354440343636	363636423434	343355331434	553537334337	344334403333
(4992)	343333333355	555555553355	555555335555	555555555555	345542443733	344441445544	353600000000	000000000000
(5040)	203334343537	373337434242	354442353535	353535423434	343355331434	553537334337	353744333333	343333333355
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FILE 1 RECORD 2 LENGTH 512 BYTES

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(240)	555533555555	553355555555	555555553455	424437333444	414455443536	000000000000	000000002033	343435373733
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(336)	553355555555	555555553455	424437333444	414455443536	000000000000	000000002033	343435373733	374342423635
(384)	344035424242	424234343433	553314345535	373343403741	423333333433	333333555555	555533555555	553355555555
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(1392)	373344344037	424033333433	333333555555	555533555555	553355555555	555555553455	424437333444	414455443536
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(2112)	374 34334233	414135333433	333333555555	373737553434	423555555555	555555553455	424437333444	414455443541
(2160)	[illegible]	[illegible]3242	343435373733	404235404236	555555555555	555555555555	555555553455	555555555537
(2208)	363442435537	335535335555	555555555555	555555555555	555555555533	553436373444	414434353442	000000000000
(2256)	[illegible]2033	343435373733	404235404237	374433423733	424234343433	553314345535	374434343341	373333333433
(2304)	333333555555	555533555555	553355555555	555555553455	555555333444	414434353442	000000000000	000000002033
(2352)	343435373733	414235404424	414437373737	374234343433	553314345535	374434344033	424033333433	333333555555
(2400)	555533555555	553355555555	555555553455	424437363444	414434353442	000000000000	000000002033	343435373733
(2448)	404235404243	403443403443	404234343433	553314345535	374434354135	413333333433	333333555555	555533555555
(2496)	553355555555	555555553455	424437363444	414434353442	000000000000	000000002033	343435373733	404235404244
(2544)	414244 44354[illegible]	444234343433	553314345535	374434363434	413333333433	333333555555	555533555555	553355555555
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(2640)	444234343433	553314345535	374434364334	353333333433	333333555555	555533555555	553355555555	555555553455
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(2832)	413640433633	423440375555	553642555555	374234553434	423555555555	555555553455	424340403444	423355363441
(2880)	[illegible]	[illegible]2033	343435373733	414134414241	343434343434	344234343433	553314345535	413640443740
(2928)	344140335555	553642555555	374234553434	423555555555	555555553455	424335343444	423355363441	000000000000
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(3600)	[illegible]	[illegible]2033	343435373733	414134414437	424143403443	404234343433	553314345535	413643373635
(3648)	363533375555	553642555555	374234553434	423555555555	555555553455	424335343444	423355363441	000000000000
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(3744)	553642555555	374234553434	423555555555	555555553455	424335343444	423355363441	000000000000	000000002033
(3792)	343435373733	414134423341	433340[illegible]	404234343433	553314345535	413733353434	364440375555	553642555555
(3840)	374234553434	423555555555	555555553455	424335343444	423355363441	000000000000	000000002033	343435373733

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(4512)	343435373733	414134423342	433537334237	334234343433	553314345535	413733364142	434244345555	553642555555
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FILE	INPUT RECS.	DATA RECORDS INPUT	MAX. SIZE	READ ERROR SUMMARY PERM	ZERO B	SHORT	UNDEF.	INPUT RETRIES #RECS.	TOTAL#
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FILE 52 RECORD 1 LENGTH 5120 BYTES

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(1296)	333635362444	555555344055	555542373455	343333375555	555555554637	345542444044	344443345534	344100000000
(1344)	[illegible]	203334343537	373741353341	373641424137	333435423434	343355361434	553537344134	334137444441
(1392)	555555344055	555542373455	343333375555	555555554637	345542444044	344443345534	344100000000	000000000000
(1440)	203334343537	373741353341	373641374043	374037423434	343355361434	553537344134	334240343641	555555344055
(1488)	555542373455	343333375555	555555554637	345542444044	344443345534	344100000000	000000000000	203334343537
(1536)	373741353341	373643434344	333435423434	343355361434	553537344134	343342344240	555555344055	555542373455
(1584)	343333375555	555555554637	345542444044	344443345534	344100000000	000000000000	203334343537	373741353341

(2736)	553614345535	4 3436334433	343644365555	55344 555555	423735553433	333755555555	555546363455	424440443444
(2784)	433455343534	[illegible]	[illegible]2033	343435373737	413540423537	434440433740	444234343433	553614345535
(2832)	4 3436334244	354240435555	553440555555	423735553433	333755555555	555546363455	424440443444	433455343534
(2880)	[illegible]	[illegible]2733	343435373737	413540423542	354434414244	334234343433	553614345535	403435433733
(2928)	3441434 5555	553440555555	423735553433	333755555555	555546363455	424440443444	433455343534	[illegible]
(2976)	[illegible]2033	343435373737	413540423542	374146354433	364234343433	553614345535	403435433536	353744435555
(3024)	553440555555	423735553433	333755555555	555546363455	424440443444	433455343534	000000000000	000000002033
(3072)	343435373737	413540423542	413333333435	4 423434343433	553614345535	403435433444	413341335555	553440555555
(3120)	423735553433	333755555555	555546363455	424440443444	433455343534	[illegible]	[illegible]2033	343435373737
(3168)	413540423542	403637423637	404234343433	553614345535	403435433441	404341405555	553440555555	423735553433
(3216)	333755555555	555546363455	424440443444	433455343534	000000000000	000000002033	343435373737	413540423542
(3264)	4 4144374142	334234343433	553614345535	413435433435	434444375555	553440555555	423735553433	333755555555
(3312)	555546363455	424440443444	433455343534	[illegible]	[illegible]2033	343435373737	413540423542	413337344244
(3360)	354234343433	553614345535	403435433344	403342415555	553440555555	423735553433	333755555555	555546363455
(3408)	42444 443444	433455343534	000000000000	000000002033	343435373737	413540423542	423343363740	424234343433
(3456)	553614345535	4 3435424444	423636375555	553440555555	423735553433	333755555555	555546363455	424440443444
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(3552)	403435424441	364241415555	553440555555	423735553433	333755555555	555546363455	424440443444	433455343534
(3600)	[illegible]	[illegible]2033	343435373737	413540423542	433742353637	434234343433	553614345535	403435424340
(3648)	413434445555	553440555555	423735553433	333755555555	555546363455	424440443444	433455343534	000000000000
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(3744)	553440555555	423735553433	333755555555	555546363455	424440443444	433455343534	000000000000	000000002033
(3792)	343435373737	413540423542	444034373334	374234343433	553614345555	553633363335	344443355555	553440555555
(3840)	423735553433	333755555555	555546363455	424440443444	433455343534	000000000000	000000002033	343435373737
(3888)	413540423543	333533433740	444234343433	553614345535	403435424144	333542445555	553440555555	423735553433
(3936)	333755555555	555546363455	424440443444	433455343534	000000000000	000000002033	343435373737	413540423543
(3984)	334 434 4142	444234343433	553614345535	4 3343542414	363537405555	553440555555	423735553433	333755555555
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(4080)	344234343433	553614345535	403435424135	373337335555	553440555555	423735553433	333755555555	555546363455
(4128)	42444 443444	433455343534	[illegible]	[illegible]2033	343435373737	413540423543	344437374041	434234343433
(4176)	553614345535	4 3435424 35	4 3542345555	553440555555	423735553433	333755555555	555546363455	424440443444
(4224)	433455343534	000000000000	000000002033	343435373737	413540423543	353544344244	354234343433	553614345555
(4272)	554 37374144	404143445555	553440555555	423735553433	333755555555	555546363455	424440443444	433455343534
(4320)	[illegible]	[illegible]2 33	343435373737	413540423543	354136443334	374234343433	553614345535	403435423737
(4368)	443733435555	553440555555	423735553433	333755555555	555546363455	424440443444	433455343534	000000000000
(4416)	000000002033	343435373737	413540423543	354443413536	424234343433	553614345535	403435423734	374342335555
(4464)	553440555555	423735553433	333755555555	555546363455	424440443444	433455343534	000000000000	000000002033
(4512)	343435373737	413540423543	374235353637	424234343433	553614345555	344143423736	364442415555	553440555555
(4560)	423735553433	333755555555	555546363455	424440443444	433455343534	000000000000	000000002033	343435373737
(4608)	413540423543	413734414244	354234343433	553614345535	403435423443	354040405555	553440555555	423735553433
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(4704)	4 4241373334	374234343433	553614345535	403435423437	423540375555	553440555555	423735553433	333755555555
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(4800)	374234343433	553614345535	403435423434	404436335555	553440555555	423735553433	333755555555	555546363455
(4848)	42444 443444	433455343534	[illegible]	[illegible]2733	343435373737	413540423543	414333434143	344234343433
(4896)	553614345535	403435423337	364134375555	553440555555	423735553433	333755555555	555546363455	424440443444
(4944)	433455343534	000000000000	000000002033	343435373737	413540423543	424033333435	364234343433	553614345535
(4992)	4 3435414442	414241415555	553441555555	423735553433	333755555555	555546363455	424440443444	433455343534
(5040)	[illegible]	[illegible]2 33	343435373737	413540423543	433444374041	434234343433	553614345555	343640434341
(5088)	363341375555	553440555555	423735553433	333755555555	555546363455	4244		

FILE	INPUT RECS.	DATA RECORDS INPUT	MAX. SIZE	READ ERROR SUMMARY PERM	ZERO B	SHORT	UNDEF.	INPUT RETRIES #RECS.	TOTAL#
52	1 2	1 2	3840	0	0	0	0	0	0

EOJ DUMP STOPPED AFTER FILE 52 # OF PERMANENT READ ERRORS 0

START TIME 12/18/91 10:30:05 STOP TIME 12/18/91 10:32:26

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D 46762 File 1 1/21/81 - 6/22/81
2 1/21/81 - 6/22/81
3 1/26/81 - 6/24/81

DUMP OF TAPE X443

INPUT TAPE X443 [illegible] BYTES
DATA INPUT 07 NF 3 FL 3 1 1

FILE	1 RECORD	1 LENGTH	72 BYTES					
(0)	252433413311	333333341524	353555552524	364115343757	377557334157	553524553125	[illegible]	161126152223
(48)	112431551706	552445330123	553442335342	403302552524	350446353540	00106760		

FILE	1 RECORD	6 LENGTH	9408 BYTES		19 81 6 1 2			
(0)	423640553433	333755343455	554641443455	424437413444	433455413436	000000000000	000000003242	343435373737
(48)	424143424334	555555554644	433655353435	375543373311	555555353337	363442435536	3555344[illegible]3336	355674335555
(96)	555555555555	553435334433	553543363444	433455413436	000000000000	000000001633	343435373737	424143424337
(144)	354343353341	354234343433	553614345535	414236344044	364134335555	555541555555	423636553433	333755554155
(192)	554641443455	424437413444	433455413436	000000000000	000000003242	343435373737	424233404334	555555554643
(240)	413555354134	443441363302	555555363337	363442435536	445534443336	353735345555	551155021717	553435334133
(288)	553533363444	433455413440	000000000000	000000001633	343435373737	424233404343	374434403537	344234343433
(336)	553614345535	414237374035	333540335555	555442555555	423633553433	333755554155	354541373453	424437413444
(384)	433455413440	000000000000	000000003242	343435373737	424242433742	555555554637	354355335536	333441373303
(432)	555555363337	363442435536	405534433333	423442443437	350155012114	553435334433	553344353444	433455413535
(480)	000000000000	000000001633	343435373737	424242433744	434343343543	444254343435	555614345535	413644433544
(528)	344437355555	555543555555	423643553433	333755554455	554541423455	424442353444	433455413535	000000000000
(576)	000000003242	343435373737	424242444141	555555554637	353455353535	403441403302	555555363337	363442435540
(624)	355535413336	403535345555	555555555555	553435334433	553437333444	433455413535	000000000000	000000001633
(672)	343435373737	424242444144	444344404437	444234343433	553614345535	413544424447	443333341555	555544555555
(720)	423736553433	333755343355	554641423455	424442353444	433455413535	000000000000	000000003242	343435373737
(768)	424243334142	555555554637	344055354234	405533423302	555555363337	363442435537	343555333334	333743433555
(816)	555555555555	553435334433	553536433444	433455413535	[illegible]	[illegible]	[illegible]	343435373737
(864)	443641413736	414234343433	553614345535	413642434136	343444425555	555543555555	423635553433	333755554355
(912)	554641423455	424442353441	433455413535	000000000000	000000			

19 81 5 6 2 2

FILE	INPUT RECS.	DATA RECORDS INPUT	MAX. SIZE	READ ERRORS SUMMARY PERM	ZERO	SHORT	COMPR.	INPUT RETRIES RECS.	TOTAL
1	6	7	5120	0		0		0	

FILE	2 RECORD	1 LENGTH	5120 BYTES		19 81 6 1 2 1				
(0)	324234343537	373741354242	353455555546	344342375133	334240344337	331155555536	333733343243	355541553436	
(48)	333435404136	433655015514	051755343533	413355354143	344443345534	353400000000	000000000000	203334343537	
(96)	373741354042	353444373737	404233423434	343355361434	553540343636	433435337437	555555554155	555542373555	
(144)	343333375555	555555554636	345542444044	344443345534	353400000000	000000000000	203334343537	373741354042	
(192)	353542334336	374044423434	343355361434	553540343636	333533364441	555555344555	555542373555	343333375555	
(240)	555555554636	345542444044	344443345534	353400000000	000000000000	203334343537	373741354042	353542373533	
(288)	413333423434	343355361434	553540343635	444340413636	555555344555	555542373555	343333375555	555555554636	
(336)	345542444044	344443345534	353400000000	000000000000	203334343537	373741354042	353533335536	374041423434	
(384)	343355361434	553540343536	433343343333	555555344555	555542373555	343333375555	555555554636	345542444044	
(432)	344443345534	353400000000	000000000000	324234343537	373741354244	343335555546	344443345534	333633363537	
(480)	330155555536	333736344243	553540553435	333441363740	555555555555	555555345553	413540333344	344443345534	
(528)	353600000000	000000000000	203334343537	373741354244	343336433444	414144423434	343355361434	553540423544	
(576)	404144334037	555555343755	555542364355	343333375555	555555555533	345542444235	344443345534	353600000000	
(624)	000000000000	203334343537	373741354244	343337344141	424433423434	343355361434	553540423544	404337333643	
(672)	555555343755	555542364355	343333375555	555555555533	345542444235	344443345534	353600000000	[illegible]	
(720)	203334343537	373741354244	343336443335	443336423434	343355361434	553540423544	414144423434	555555343755	
(768)	555542364355	343333375555	555555555533	345542444235	344443345534	353600000000	000000000000	203334343537	
(816)	373741354244	343341443737	404142423434	343355361434	553540423544	423337354236	555555343755	555542364355	
(864)	343333375555	555555555533	345542444235	344443345534	353600000000	000000000000	203334343537	373741354244	
(912)	343342413644	333437423434	343355361434	553540423544	423637374043	555555343755	555542364355	343333375555	
(960)	555555555533	345542444235	344443345534	353600000000	000000000000	203334343537	373741354244	343433424137	
(1008)	333437423434	343355361434	553540423544	434234354235	555555343755	555542364355	343333375555	555555555533	
(1056)	345542444235	344443345534	353600000000	000000000000	203334343537	373741354244	343433424137	414033423434	
(1104)	343355361434	553540423544	444243424141	555555343755	555542364355	343333375555	555555555533	345542444235	
(1152)	344443345534	353600000000	000000000000	203334343537	373741354244	343335374144	414144423434	343355361434	
(1200)	553540423633	364444443742	555555343755	555542364355	343333375555	555555555533	345542444235	344443345534	
(1248)	353600000000	000000000000	203334343537	373741354244	343540333333	343336423434	343355361434	553540423633	
(1296)	403434343634	555555343755	555542364355	343333375555	555555555533	345542444235	344443345534	353600000000	

(2448)	424335423434	343355361434	553540364442	444041363437	555555353755	555542364355	343423375555	555555464142
(2496)	345542444235	344443345541	353500000000	000000000000	203334343537	373742424243	403344323542	353541423434
(2544)	343355361434	553540364442	433743374434	555555353755	555542364355	343333375555	555555464142	345542444235
(2592)	344443345541	353500000000	000000000000	203334343537	373742424243	403344323542	434436423434	343355361434
(2640)	553540364441	423444423741	555555353755	555542364355	343333375555	555555464142	345542444235	344443345541
(2688)	353500000000	000000000000	203334343537	373742424243	423344423533	353542423434	343355361434	553540364441
(2736)	413435403543	555555353755	555542364355	343333375555	555555464142	345542444235	344443345541	353500000000
(2784)	000000000000	203334343537	373742424243	423437443033	414143423434	343355361434	[illegible]	434433343440
(2832)	555555353755	555542364355	343333375555	555555464142	345542444235	344443345541	[illegible]	[illegible]
(2880)	324234343537	373742424244	414135555555	463735345535	353540344140	332255555536	333736344243	554635553541
(2928)	333640353534	555555555555	555555347533	443355347733	344443345541	353500000000	[illegible]	203334343537
(2976)	373742424244	414234344333	414234423434	343355361434	553540354443	344337363341	555553363355	355542373655
(3024)	343333375555	555555464142	345542444235	344443345541	353500000000	000000000000	203334343537	373742424244
(3072)	414235353535	363640423434	343355361434	553540354443	344236434334	555555363355	555542373655	343333375555
(3120)	555555464142	345542444235	344443345541	353500000000	000000000000	203334343537	373742424244	414340373441
(3168)	424335423434	343355361434	553540354443	334037334342	555555363355	555542373655	343333375555	555555464142
(3216)	345542444235	344443345541	353500000000	000000000000	203334343537	373742424244	414436373535	434436423434
(3264)	343355361434	553540354442	444435423443	555555363355	555542373655	343333375555	555555464142	345542444235
(3312)	344443345541	353500000000	000000000000	203334343537	373742424244	423343353343	373743433434	343355361434
(3360)	553540354442	443442363441	555555363355	555542373655	343333375555	555555464142	345542444235	344443345541
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(3456)	434436364337	555555363355	555542373655	343333375555	555555464142	345542444235	344443345541	353500000000
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(3552)	555555363355	555542373655	343333375555	555555464142	345542444235	344443345541	353500000000	000000000000
(3600)	203334343537	373742424244	423436434344	333337423434	343355361434	553540354442	434236414337	555555363355
(3648)	555542373655	343333375555	555555464142	345542444235	344443345541	353500000000	[illegible]	203334343537
(3696)	373742424244	423442423343	373744423434	343355361434	553540354442	434042434134	555555363355	555542373655
(3744)	343333375555	555555464142	345542444235	344443345541	353500000000	000000000000	203334343537	373742424244
(3792)	423444424434	424337423434	343355361434	553540354442	433744413543	555555363355	555542373655	343333375555
(3840)	555555464142	345542444235	344443345541	353500000000	000000000000	324234343537	373742424244	414255555555
(3888)	463734405535	423440553441	332255555536	333736344243	553734553533	333533374343	555555555555	555553435333
(3936)	443355353643	344443345541	353500000000	000000000000	203334343537	373742424355	414435364134	353544423434
(3984)	343355361434	553540364036	353676344235	555555353755	555542363555	343333375555	555555464142	345542444235
(4032)	344443345541	353500000000	000000000000	203334343537	373742424355	423334364344	333341423434	343355361434
(4080)	553540364037	324235434236	555555353755	555542363555	343333375555	555555464142	345542444235	344443345541
(4128)	353500000000	000000000000	203334343537	373742424355	423335424242	434436423434	343355361434	553540364037
(4176)	373433403535	555555353755	555542363555	343333375555	555555464142	345542444235	344443345541	[illegible]
(4224)	000000000000	203334343537	373742424355	424334423641	353542423434	343355361434	[illegible]	353542433733
(4272)	555555353755	555542363555	343333375555	555555464142	345542444235	344443345541	[illegible]	[illegible]
(4320)	203334343537	373742424355	424042354434	424337423434	343355361434	553540364133	423741443737	555555353755
(4368)	555542363555	343333375555	555555464142	345542444235	344443345541	[illegible]	[illegible]	203334343537
(4416)	373742424355	424133424137	333341423434	343355361434	553540364134	344133364037	555555353755	555542363555
(4464)	343333375555	555555464142	345542444235	344443345541	[illegible]	[illegible]	203334343537	373742424355
(4512)	424143373335	434440423434	343355361434	553540364135	334276444141	555555353755	555542363555	343333375555
(4560)	555555464142	345542444235	344443345541	353500000000	000000000000	203334343537	373742424355	424333373555
(4608)	374034423434	343355361434	553540364136	374441444444	555555353755	555542363555	343333375555	555555464142
(4656)	345542444235	344443345541	353500000000	[illegible]				

198156 22

FILE	INPUT RECS.	DATA RECORDS INPUT	MAX. SIZE	READ ERROR SUMMARY			INPUT ENTRIES RECS.	TOTAL
2	19	20	5120	0	0	0	0	0

FILE 3 RECORD 1 LENGTH 5120 BYTES

198151 26

(0)	324234343537	373741353341	364235555546	344344345533	364137554337	332155555536	333736344243	553542553436
(48)	333443353443	353333015524	012555343533	443355354141	344443345541	[illegible]	[illegible]	203334343537
(96)	373741353341	364335413644	333436423434	343355361434	553537344133	434235433536	555555344155	555542373455
(144)	343333375555	555555554637	345542444044	344443345534	344100000000	000000000000	203334343537	373741353341
(192)	364337333542	443333423434	343355361434	553537344133	434242423743	555555344155	555542373455	343333375555
(240)	555555554637	345542444044	344443345534	344100000000	000000000000	203334343537	373741353341	364341374443
(288)	374042423434	343355361434	553537344133	434443363634	555555344155	555542373455	343333375555	555555554637
(336)	345542444044	344443345534	344100000000	000000000000	203334343537	373741353341	364433354342	443324423434
(384)	343355361434	553537344133	413443363634	555555344155	555542373455	343333375555	555555554637	345542444044
(432)	344443345534	344100000000	000000000000	203334343537	373741353341	364434363444	414143423434	343355361434
(480)	553537344133	413541363344	555555344155	555542373455	343333375555	555555554637	345542444044	344443345534
(528)	344100000000	000000000000	203334343537	373741353341	344344141141	424343423434	343355361434	553537344133
(576)	413537413742	555555344155	555542373455	343333375555	555555554637	345542444044	344443345534	344100000000

(1728)	000020333434	353737374242	435542403433	373442433742	343434335536	143455354036	413333334333	364155555535
(1776)	375555554236	355534333337	555555555546	414234554244	423534444334	554135350000	000000000000	000020333434
(1824)	353737374242	435542403442	364135354242	343434335536	143455354036	413333434343	375555555535	375555554236
(1872)	355534333337	555555555546	414234554244	423534444334	554135350000	000000000000	000020333434	353737374242
(1920)	435542403634	354034344342	343434335536	143455354036	413335434042	413555555535	375555554236	355534333337
(1968)	555555555546	414234554244	423534444334	554135350000	000000000000	000020333434	353737374242	435542404140
(2016)	444236364342	343434335536	143455354036	413341413540	343455555535	375555554236	355534333337	555555555546
(2064)	414234554244	423534444334	554135350000	000000000000	000020333434	353737374242	435542404144	373743413342
(2112)	343434335536	143455354036	413342334036	374155555535	375555554236	355534333337	555555555546	414234554244
(2160)	423534444334	554135350000	000000000000	000020333434	353737374242	435542404235	443442433742	343434335536
(2208)	143455354036	413342374144	373755555535	375555554236	355534333337	555555555546	414234554244	423534444334
(2256)	554135350000	000000000000	000020333434	353737374242	435542404244	434135354442	343434335536	143455354036
(2304)	413343354234	333555555535	375555554236	355534333337	555555555546	414234554244	423534444334	554135350000
(2352)	000000000000	000020333434	353737374242	435542404433	354234344042	343434335536	143455354036	413344404143
(2400)	433755555535	375555554236	355534333337	555555555546	414234554244	423534444334	554135350000	000000000000
(2448)	000020333434	353737374242	435542413342	413733334142	343434335536	143455354036	413434413336	403755555535
(2496)	375555554236	355534333337	555555555546	414234554244	423534444334	554135350000	000000000000	000020333434
(2544)	353737374242	435542414041	354034344342	343434335536	143455354036	413442373336	403455555535	375555554236
(2592)	355534333337	555555555546	414234554244	423534444334	554135350000	000000000000	000020333434	353737374242
(2640)	435542414141	414142434042	343434335536	143455354036	413443414344	403455555535	375555554236	355534333337
(2688)	555555555546	414234554244	423534444334	554135350000	000000000000	000020333434	353737374242	435542414233
(2736)	343733334142	343434335536	143455354036	413444333741	433455555535	375555554236	355534333337	555555555546
(2784)	414234554244	423534444334	554135350000	000000000000	000020333434	353737374242	435542414337	333543444042
(2832)	343434335536	143455354036	413533423644	414155555535	375555554236	355534333337	555555555546	414234554244
(2880)	423534444334	554135350000	000000000000	000020333434	353737374242	435542414342	403334344042	343434335536
(2928)	143455354036	413534353342	444055555535	375555554236	355534333337	555555555546	414234554244	423534444334
(2976)	554135350000	000000000000	000020333434	353737374242	435542433335	334337403442	343434335536	143455354036
(3024)	413637444144	444455555535	375555554236	355534333337	555555555546	414234554244	423534444334	554135350000
(3072)	000000000000	000020333434	353737374242	435542433340	403434143642	343434335536	143455354036	417640373333
(3120)	363555555535	375555554236	355534333337	555555555546	414234554244	423534444334	554135350000	000000000000
(3168)	000020333434	353737374242	435542433435	403334344042	343434335536	143455354036	413641354035	403355555535
(3216)	375555554236	355534333337	555555555546	414234554244	423534444334	554135350000	000000000000	000020333434
(3264)	353737374242	435542433440	444236364342	343434335536	143455354036	413641414335	413455555535	375555554236
(3312)	355534333337	555555555546	414234554244	423534444334	554135350000	000000000000	000020333434	353737374242
(3360)	435542433444	373740413342	343434335536	143455354036	413642334442	343755555535	375555554236	355534333337
(3408)	555555555546	414234554244	423534444334	554135350000	000000000000	000020333434	353737374242	435542433535
(3456)	443442433542	343434335536	143455354036	413642403537	373555555535	375555554236	355534333337	555555555546
(3504)	414234554244	423534444334	554135350000	000000000000	000032423434	353737374242	444433415535	555544363343
(3552)	553437433655	434333015555	553633373634	423355354053	343633334233	344343437712	352150875334	353344335535
(3600)	334334444334	554135370000	000000000000	000020333434	353737374242	444434333634	354034343442	343434335536
(3648)	143455353743	334235353341	414055555534	405555554237	405534333337	555555555546	414334554436	344434444334
(3696)	554135370000	000000000000	000020333434	353737374242	444435344442	443442424342	343434335536	143455353742
(3744)	434334343736	354355555534	405555554237	405534333337	555555555546	414334554436	344434444334	554135370000
(3792)	000000000000	000020333434	353737374242	444435353644	403437374142	343434375536	143455353742	434237413341
(3840)	403755555534	405555554237	405534333337	555555555546	414334554436	344434444334	554135370000	000000000000
(3888)	0000							

1981 8624

FILE	INPUT RECS.	DATA RECORDS INPUT	MAX. SIZE	READ ERROR SUMMARY PERM	ZERO P	SHORT	UNREC.	INPUT RECORDS RECS.	TOTAL
3	132	133	5120	0	0	0	0	0	0

EOJ DUMP STOPPED AFTER FILE 3 # OF PERMANENT READ ERRORS 0

START TIME 11/21/81 00:36:49 STOP TIME 11/21/81 00:37:16

$$
$PASS XXX SCA
$EXE XFER PS