Software Interface Specification (SIS) for the Lunar Prospector Spectrometer Planetary Data System Files, Version V002.2

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This document describes the file formats and data processing used for the version 2.2 submission of Lunar Prospector Gamma-Ray Spectrometer (GRS), Neutron Spectrometer (NS) and Alpha Particle Spectrometer (APS) data to the Planetary Data System (PDS). The complete Version 2 submission will be described in a future SIS document.

1. Gamma-Ray Spectrometer (GRS) Calibration Data

1.1 Calibration Set up

Four isotopic sources of gamma rays were used for the calibration. These sources, their strengths on the day of calibration (6 Nov., 1996), their distance to the center of the BGO crystal, and the rate of gamma-rays incident on the crystal (area = A_d) are given in Table I.

Table I
Gamma-Ray Sources used for Calibration of the LPGRS on 11/6/96

Source	**Source Strength (S)**	**Distance (d)**	**$Sa_d/(4\pi d^2)$**
Co-60	3.695×10^5 s^{-1}	100 cm	8.57 s^{-1}
Cs-137	3.928×10^5 s^{-1}	100 cm	9.11 s^{-1}
Yt-88	1.30×10^4 s^{-1}	50 cm	0.302 s^{-1}
Na-22	2.875×10^5 s^{-1}	100 cm	6.67 s^{-1}

The calibrations using the Co-60 and Yt-88 sources were conducted with the GRS symmetry axis oriented perpendicular to the source direction, and those using Cs-137 and Na-22 were oriented at angles spanning -90^o to +90^o to the perpendicular at 15^o intervals.

1.2 Calibration Data Files

There are 32 data files in ASCII column format which contain the LP GRS calibration data. The column format is as follows:

column 1: channel number (0 – 511)
column 2: calibrated energy in MeV
column 3: number of *accepted* counts normalized to counts per 32 seconds
column 4: number of *rejected* counts normalized to counts per 32 seconds

Definitions of *accepted* and *rejected* are given in references [1] and[2].

The file names have the following format: run#_source_##_deg.dat, where

run#: designating run number
source: signifies which radioactive source was used
##_deg: ## gives the angle of the source location—this angle ranges from -90° to +90°.

2. Neutron Spectrometer (NS)

The Version 2.2 NS data contains one primary data file: *NS_high2_V001.cdf*. This NS data file contains counting rate data for thermal and epithermal neutrons from Oct. 7, 1998 to Dec. 19, 1998. This file is the completion of the high altitude NS data and contains data from the post-flip portion of the mission. Descriptions of the NS data format, processing, and mission phase are given in the previous Version 1 and Version 2 SIS documents (references [3] and[4]).

3. Alpha Particle Spectrometer (APS)

3.1 APS Data Contents

Since one purpose of the APS is to look for time variable lunar gas release events, the APS data is sorted by time instead of averaging into lunar latitude/longitude pixels. The number of records is therefore not fixed, but is determined by the number of measured alpha particle counts. Table 4 lists the contents of the APS data. A description of each variable is given below.

sf: The *sf* variable is an integer variable. *sf* give the face number that was triggered by each alpha particle. Figure 1 shows a diagram of how each APS face is orientated relative to the LP spacecraft.

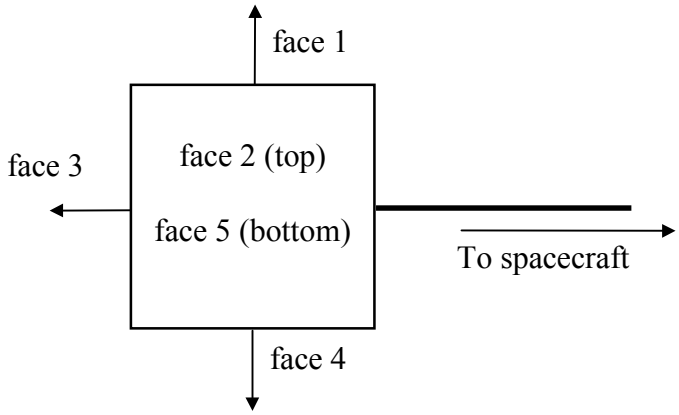

Figure 1: APS Detector view from top spin axis of the Lunar Prospector spacecraft.

lat: Spacecraft longitude to the nearest 32-seconds.

lon: Spacecraft height to the nearest 32-seconds.

hgt: Spacecraft height to the nearest 32-seconds.

Variable	Type	Unit	Description
sf	integer	<none>	APS face number having values from 1 to 5
lat	float	degrees	Spacecraft latitude for nearest 32-seconds.
lon	float	degrees	Spacecraft longitude for nearest 32-seconds.
hgt	float	kilometers	Spacecraft height for nearest 32-seconds.
ERT	float	seconds since Jan 1, 1970	Earth receive time for each alpha particle count.
ph	integer	channel	Pulse height value for each alpha particle count.
phi	float	degrees	Look angle from the orbital plane for each alpha particle count.
aps_acc	float	counts per 32-seconds	Number of accepted counts between *ph* channels 1 – 126
aps_buffer	float	counts per 32-seconds	Number of counts in the event mode buffer for faces 1 – 5.
APS_scalar	integer	counts per 32-seconds	APS counting rate for the nearest 32-seconds.

Table 4: Contents of the APS.cdf file.

ERT: Earth receive time for to the nearest 0.5 second for each of the alpha particle counts. *ERT* is measured in seconds since January 1, 1970.

ph: Pulse height value of each alpha particle count. The *ph* variable is measured as a channel number having values from 0 to 127. The channels cover an alpha particle energy range of roughly 4.5 – 6.6 MeV.

phi: The *phi* variable gives the de-spinned phase angle of each face for each alpha particle count. This angle is defined as the angle between normal of each face and the orbital plane.

aps_acc: The *aps_acc* variable gives the number of counts, regardless of face, that occur for *ph* values of 1 – 126.

aps_buffer: The *aps_buffer* variable gives the number of counts that are measured in the APS event buffer. Since the event buffer can only measure up to 294 counts (see [2]), *aps_buffer* is never any larger than 294.

aps_scalar: The *aps_scalar* variable gives the total number of APS events in the nearest 32-second data frame.

3.2 APS Data Processing

The main processing carried out with the APS data is to correct for the spacecraft spin using sunpulse and ephemeris data. The result is a time series data set consisting of data for each alpha particle count. These data include: the pulse height value for each count (*ph*), the face where the count occurred (*sf*), and the direction the face was pointing (*phi*) relative to the plane of the spacecraft orbit. Note, the top and bottom faces (faces 2 and 5) do not have a changing *phi* angle. The orientation of these faces change with respect to the Moon only as a function of latitude. These faces are therefore given *phi* angles of +1 (top face 2) and –1 (bottom face 5). A description of the APS instrument can be found in reference [2].

3.3 APS Data Format

The APS data are stored as one file per day. The naming convention for each file is as follows:

$$aps\_YY\_DOY_{start}\_HHMM_{start}\_DOY_{end}\_HHMM_{end}.cdf$$

where

YY = two digit year designation (i.e. 1998 = 98)
DOY_{start} = three digit day of year for the start time of the file
$HHMM_{start}$ = four digit hours/minutes for the start time of the file
DOY_{end} = three digit day of year for the end time of the file
$HHMM_{end}$ = four digit hours/minutes for the end time of the file.

The APS data is currently stored in Common Data Format (CDF). This format has been described in a previous SIS [1]. A listing of the file contents is given *aps-info.txt*. While the files have different lengths, each file contains the same variables. CDF data files can be read from a variety of platforms using a variety of software languages. The Interactive Data Language (IDL) procedure called *load_cdf.pro* (written by the LP spectrometer team and submitted to the PDS) can read the APS data files inside the IDL environment. For example, to read the *ph* and *phi* CDF variables into the PH and PHI IDL variables from the file *aps_98_180_0000_98_181_0000.cdf*, do the following commands:

```
IDL> load_cdf,'aps_98_180_0000_98_181_0000.cdf','ph',PH
IDL> load_cdf,'aps_98_180_0000_98_181_0000.cdf','phi',PHI
```

4. References

[1] W. C. Feldman, B. L. Barraclough, K. R. Fuller, D. J. Lawrence, S. Maurice, M. C. Miller, T. H. Prettyman, and A. B. Binder, The Lunar Prospector Gamma-Ray and Neutron Spectrometers, *Nuclear Instruments and Methods in Physics Research A*, 422, 562 – 566, 1999.

[2] W. C. Feldman, D. J. Lawrence, S. Maurice, B. L. Barraclough, K. R. Fuller, R. Belian, Lunar Prospector Spectrometers Instrument Description Document, Los Alamos National Laboratory Report, LAUR-99-2752, 1999.

[3] D. J. Lawrence, S. Maurice, and W. C. Feldman, Software Interface Specification (SIS) for the Lunar Prospector Spectrometer Planetary Data System Files, Version V001, Los Alamos National Laboratory Report LAUR-99-2753, 1999.

[4] D. J. Lawrence, S. Maurice, and W. C. Feldman, Software Interface Specification (SIS) for the Lunar Prospector Spectrometer Planetary Data System Files, Version V002, Los Alamos National Laboratory Report LAUR-99-2754, 1999.