```
***************************************************************************
NSSDC Note: The energy ranges for helium fluxes have been changed from MeV
            to MeV/nucleon for consistency with the Voyager 2 CRS document.
            J. F. Cooper 6/15/95

***************************************************************************

Header for NSSDC submission for Voyager-1 Cruise Archive
  Applies to the TEXT datasets formed by program DCFLUX from
  the original BINARY IBM mainframe datasets.

VOL_CREATION_DATE:      1994-10-07

MEDIUM_DESCRIPTION:     1/2 inch, 9-track, 6250 bpi magnetic tape

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PREV_VOLS:              None



DATA_SET_NAME:          Voyager-1 Cruise Mode Data Archive

DATA_SOURCE:            Voyager-1  Cosmic Ray Subsystem

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SPACECRAFT_CHARACTERISTICS:  Voyager-1 was launched on September 5,
1977, encountered Jupiter on March 5, 1979, and Saturn on November
12, 1980. After passing Saturn the spacecraft trajectory is taking
it generally toward the nose of the terminator shock of the sun's
heliosphere. At the end of 1992 it was about 50 AU from the sun,
and above the ecliptic plane near 33 degrees N heliolatitude.
The spacecraft is instrumented with a full suite of
magnetic field, plasma and energetic particle and cosmic ray
sensors. The Imaging experiment has sent back wonderful pictures of
the planets and their moons and rings.



INVESTIGATION_OBJECTIVES: This instrument is designed to exploit to
the fullest practical degree the proposed trajectories of
Voyagers-1 and -2. The significance of these measurements will be
greatly enhanced by concurrent measurements with similar particle
telescopes on satellites such as the Pioneers, IMPs, and similar
series in near-earth orbits. similar series in near-earth orbits.
The principle scientific objectives of this experiment are:

    1.) To measure the flow patterns of energetic solar and
        galactic particles separately in the inter-planetary field.
        To interpret this measurement, simultaneous determination
```

```
        of the energy spectrum, radial gradient,  distribution, and
        streaming parameters is required for each nuclear species
        and over as wide an energy range as is practicable.

    2.) To measure the energy spectra, and isotopic composition of
        galactic and solar cosmic rays from the lowest practical
        energies up to ~800 MeV/nucleon  and (by use of objective
        1) to unfold the primary flare and interstellar spectrum.

    3.) To measure the time variations of the differential energy
        spectra of electrons, hydrogen and helium nuclei over the
        corresponding energy intervals. During flare events, to
        obtain time histories; during quiet times, to relate gross
        time variations to those near earth thus deducing a
        spatial gradient for galactic cosmic rays.

    4.) To study the energy spectra, time variations and spatial
        gradients associated with recurrent and non-flare
        associated interplanetary proton and helium streams and to
        define the related solar or inter-planetary acceleration
        processes.

    5.) To provide information on the energetic particle
        distribution surrounding Jupiter and Saturn.

    6.) To try to determine the extent of the solar cavity, the
        energetic particle phenomena occurring at this interface
        and the cosmic ray density in nearby interstellar space.


INSTRUMENT_ATTRIBUTES: The California Institute of Technology (CIT)/
Goddard Space Flight Center(GSFC) experiment on Voyager-1 and -2
(CRS) consists of three types of solid state detector telescopes,
the High Energy Telescopes (HET-I and II), the Low Energy dE/dx vs.
E Telescopes (LET A,B,C, and D) and The Electron Telescope (TET).
The HETs and LETs are redundant and are designed to complement each
other and to cover a broad range in energy, intensity, and charge
spectra. Charged particle spectra are measured over energy
intervals as follows:

       Particle Component       Energy Range
   Galactic cosmic ray protons  1.8 - 200 MeV
     and Solar protons
   Galactic cosmic ray helium   1.8 - 500 MeV/nucleon
     and Solar helium
   Galactic and Solar electrons 0.2- 13.0 MeV
   Li,Be,B,C,N,O,F,Ne and
    their isotopic composition  6 MeV/nuc - 200 MeV/nuc
   Integral flux of IONS > 70 MeV



               Geometrical Factors
            HET       Varies from about .74 - 1.7 depending
                      if the event is A or B Stopping or
                      Penetrating
            LET       0.440 cm2-ster.   (nominal)
            TET       Varies from about .66 - 3.12 depending
                      upon depth of penetration into the Di stack.

High Energy Telescope:  The HET consists of a multi-element stack
of solid state detectors. Particles can enter this telescope from
both ends of this stack. The Two "A" elements (see diagram below)
are single lithium drift detectors, 8 cm2 area and .15 mm thick.
The "C1" element is a surface barrier detector 8 cm2 and 3 mm
thick. Next is an array of six "C" surface barrier detectors each
8 cm2 and 6 mm thick and finally two curved 8 cm2 and 2 mm thick
"B" detectors are stacked to form a two-ended telescope.

For particles which come to rest within this stack (4 - 70 MeV/
nucleon) three measurements are made:  energy loss (dE/dx), total
```

energy, and range. For particles which penetrate completely through the stack of solid state detectors three separate dE/dx measurements are made. This multiparameter analysis reduces the back-ground level of spurious events to a negligible level. Charge resolution for penetrating particles is possible up to about 200 MeV/nucleon. It is estimated that the absolute uncertainty in the helium flux is about 7% at 400 MeV and about 5% at energies below 200 MeV.

Low Energy Telescope. This detector was designed to measure low-energy solar flare particles in the interplanetary space and trapped particles in the Jovian and Saturnian magnetospheres. Its geometry factor (4.4E-01 cm**2.sr) allows measurement of fluxes as high as 5.0E+05/(cm**2.s.sr). The LET is a double dE/dx vs. E solid state detector. To enter this telescope a particle must pass through a 4 uM Aluminum collimator which helps define the geometry. Then two thin (35 microns thickness and 2.8 cm2 area) surface barrier detectors provide a double dE/dx measurement. Two thick (450 uM thickness and 4.5 cm2 area) lithium drift detectors provide another dE/dx and a total energy measurement. The LET covers the energy range 1.8 to 22 MeV/nucleon with charge resolution from Z=1 to 8.

The Electron Telescope.   Eight solid state detectors, each 3 mm thick and 4.5 cm2 in area are used individually and in coincidence as total absorption spectrometers. Varying depths of tungsten absorber are between each Di element.

For more information, refer to the document:

D.E.Stillwell, W.D.Davis, R.M.Joyce, F.B.McDonald, J.H.Trainor, W.E.Althouse, A.C.Cummings, T.L.Garrard, E.C.Stone, and R.E.Vogt, "The Voyager Cosmic Ray Instrument", ISEE Transactions on Nuclear Science, Vol. 26, 1979, pp. 513

DATA_SET_PARAMETERS:

Time of start of averaging interval in seconds from start of base year, TIME;

6 hour averages of the following fluxes, plus statistical errors units of particles/(cm**2.sec.ster.MeV/nuc) HELIUMFLUXi or PROTONFLUXi ;

6 hour averages of the following rates, plus statistical errors units of particles/second

The following diagrams are given to assist the user in understanding the meaning of the data quantities present.

Simplistic diagram of Voyager instruments:

```
                element
                mnemonic              area      thickness

Voyager HET        A1      ---------  8 cm**2   0.15 mm



                   A2      ---------  8 cm**2   0.15 mm
```

```
                C1      xxxxxxxxx  9.5 cm**2  3 mm
           G1
             |  C2a     xxxxxxxxx  9.5 cm**2  6 mm
             |  C2b     xxxxxxxxx
             |
             |  C3a     xxxxxxxxx  9.5 cm**2  6 mm
             |  C3b     xxxxxxxxx
             |
             |  C4a     xxxxxxxxx  9.5 cm**2  6 mm
             |  C4b     xxxxxxxxx
                          _______
                B2     //       \\ 8 cm**2    2 mm  curved

                B1     \\_______// 8 cm**2    2 mm  curved








             element
             mnemonic              area      thickness

Voyager LET         *****************   4uM AL collimator
                                          light baffle

               L1    ---------  2.8 cm**2 surface barrier 35 uM


               L2    ---------  2.8 cm**2 surface barrier 35 uM

               L3    xxxxxxxxx  4.5 cm**2 surface barrier 450 uM

               L4    xxxxxxxxx  4.5 cm**2 surface barrier 450 uM







Voyager TET     D1      xxxxxxxxx


                D2      xxxxxxxxx
                          .25 mm tungsten absorber
                D3      xxxxxxxxx
                          .56 mm tungsten absorber
                D4      xxxxxxxxx
                         1.12 mm tungsten absorber
                D5      xxxxxxxxx
                         1.60 mm tungsten absorber
                D6      xxxxxxxxx
                         2.03 mm tungsten absorber
                D7      xxxxxxxxx
                         2.34 mm tungsten absorber
                D8      xxxxxxxxx

                     Di detectors= 4.5 cm**2 Lithium drifted 3mm
                     tungsten absorbers are 18.0 g/cm**3

                where cm = centimeters
```

```
                          mm = millimeter
                    where uM = micrometer









Data present on our tape(s) :
   Time in seconds from start of base year, for start of averaging
   interval

   Particle fluxes are given in units  particles/(m**2.s.sr.Mev/n)
   Rates           are given in units  particles/s
                   where cm = centimeters
                         s  = second
                         sr = steradian
   Underneath the flux designations, HELIUMFLUX1, for example,
      is a mnemonic code, such as M IIA2, indicating from which
      calibration response table this data came from.  It is for
      documenting purposes only.

In the following, the phrases "2 dimensional analysis" or
"3 dimensional analysis" refer to events whose analysis
utilized pulse height data from either 2 or 3 pulse height values
associated with the particular event type (detector element
coincidence requirement) being measured at the time. As an example,
for A side events, particles enter the HET telescope from
the A end, and 1) stop in A1 or A2 for 2-dimensional A stopping
                  events
               2) stop in the C123 stack for 3-dimensional
                  A stopping events
               3) pass entirely through the SumC stack and
                  have a B1 or B2 pulse height as well and are called
                  3-dimensional A penetrating events.



----------------------------------
HET fluxes :
----------------------------------
HELIUMFLUX1             Helium4 flux in particles/cm**2.s.sr.Mev/n
M IIA2                  A-stopping 2 dimensional analysis, high
                        gain data from HET-II
                        4.2 - 6.0 MeV/nucleon energy range
----------------------------------
HELIUMFLUX2             Helium4 flux as above, A-stopping,
M IIA3                  3 dimensional analysis, high gain data
                        from HET-II
                        6.0 - 42.0 MeV/nucleon energy range,
----------------------------------
HELIUMFLUX3             B-stopping 2 dimensional analysis, low
M IIL2                  gain HET-II
                        17.0 - 27.0 MeV/nucleon
----------------------------------
HELIUMFLUX4             B-stopping 3 dimensional analysis, low
M IIL3                  gain HET-II
                        30.0 -  69.0 MeV/nucleon
----------------------------------
HELIUMFLUX5             B-stopping 2 dimensional analysis, high
M IIB2                  gain HET-II
                        17.0 - 27.0 MeV/nucleon

HELIUMFLUX6             B-stopping 3 dimensional analysis, high
M IIB3                  gain data from HET-II
                        30.0 - 69.0 MeV/nucleon
----------------------------------
```

```
HELIUMFLUX7            B-penetrating 3 dimensional analysis, low
M IIP                  gain penetrating data from HET-II
                       193.125 - 480.486 MeV/nucleon
----------------------------------
HELIUMFLUX8            B-penetrating 3 dimensional analysis, high
M IIPH                 gain penetrating data from HET-II
                       191.925 - 475.705 MeV/nucleon energy range
----------------------------------
PROTONFLUX1            Proton  flux in particles/cm**2.s.sr.MeV/n
M IIA2                 A-stopping 2 dimensional analysis, high
                       gain data from HET-II
                       4.2 - 6.0 MeV energy range
----------------------------------
PROTONFLUX2            Proton  flux in particles/cm**2.s.sr.MeV/n
M IIA3                 3 dimensional analysis, high gain data from
                       HET-II
                       6.0 - 42.0 MeV energy range,
----------------------------------
PROTONFLUX3            B-stopping 2 dimensional analysis, high
M IIB2                 gain data from HET-II
                       17.0 - 27.0 energy range
----------------------------------
PROTONFLUX4            B-stopping 3 dimensional analysis, high
M IIB3                 gain data from HET-II
                       30.0 - 69.0 energy range
----------------------------------
PROTONFLUX5            B-penetrating 3 dimensional analysis, high
M IIPH                 gain penetrating data from HET-II
                       132.834 - 241.963 energy range
----------------------------------
LET fluxes :   (all stopping particle events)
----------------------------------
P PROTON
* M LC2                   NO LC2 RESPONSE FOR V1 is AVAILABLE
* B    1.800     3.300
----------------------------------
PROTONFLUX6             Proton 2-dimensional analysis from LET-D
M LD2                     energy range of 1.8 - 3.3 MeV
----------------------------------
PROTONFLUX7             Proton 3-dimensional analysis from LET-C
M LC3                     energy range of 3.25 - 8.1 MeV
----------------------------------
PROTONFLUX8             Proton 3-dimensional analysis from LET-D
M LD3                     energy range of 3.25 - 8.1 MeV
----------------------------------
P ALPHA
* M LC2                       NO LC2 RESPONSE FOR V1 is AVAILABLE
* B    1.800     2.800
----------------------------------
HELIUMFLUX9              Helium4 2-dimensional analysis from LET-D
M LD2                    1.800 - 2.800 MeV/nucleon energy range
----------------------------------
HELIUMFLUX10             Helium4 3-dimensional analysis from LET-C
M LC3                    2.800 - 8.000 MeV/nucleon energy range
----------------------------------
HELIUMFLUX11             Helium4 3-dimensional analysis from LET-D
M LD3                    2.800 - 8.000 MeV/nucleon energy range
----------------------------------
----------------------------------
HET   event type RATES (for flux calculations) :
----------------------------------
*   NOMINAL COINCIDENCE CONDITION status
*   exists unless otherwise noted.
*   To interpret the LOGIC EQUATIONS (refer to simplistic telescope
*   diagrams above) :  EXAMPLE:  BRIBSP (the BR pre-mnemonic
*   indicates to our system a rate bin request and is left here for
*   documentation purposes only)
*              B1.B2.^SB.^C1.^G1.^A2
*   The above LOGIC EQUATION means: a particle entered the
*   telescope from the B end, and met the coincidence condition of
*   passing through B1, stopping in either B2 or the C432 stack,
```

```
*   but NOT (= ^ ) tripping the Slant threshold condition SB,
*   NOT going into C1, Guard G1, or A2.
*
----------------------------------
HET-I event type rates (for flux calculations) :
----------------------------------
BRIAS                        A-Stopping High Gain
  A1.A2.^C4.^G1.^B2

BRIASZ3                      A-Stopping Low Gain  Atomic Number
                                  Z >= 3
  A1.A2.SA.^C4.^G3.^B2

BRIBSE                       B-Stopping electron event
  B1.B2.C4.^SB.^C1.^G1.^A2

BRIBSP                       B-Stopping High Gain
  B1.B2.SB.^C1.^G1.^A2

BRIBSZ2                      B-Stopping Low Gain  Atomic Number
                                              Z >= 2
  B1.B2.SB.^C1.^G3.^A2

BRIPENH                      B-Penetrating High Gain
  B1.B2.C1

BRIPENL                      B-Penetrating Low Gain
  B1.B2.C1

BRIPGH                       Guard High Gain
  B1.B2.C1.^G1

BRIPGL                       Guard Low Gain
  B1.B2.C1.^G1

BRIBS4E
  B1.B2.C4.^C3.^SB.^G1       Stop in C4, did NOT get into C3

BRIBS4P
  B1.B2.C4.^C3.SB.^G1              "                        , High
                                                              Gain

BRIBS4
  B1.B2.C4.^C3.^SB.^G1             "

BRIBS4Z2
  B1.B2.C4.^C3.SB.^G1              "                        , Low
                                                              Gain

BRIBS3E
  B1.B2.C4.C3.^C2.^SB.^G1    Stop in C3, did NOT get into C2, High
                                                              Gain

BRIBS3P
  B1.B2.C4.C3.^C2.SB.^G1           "

BRIBS3
  B1.B2.C4.C3.^C2.^SB.^G1          "

BRIBS3Z2
  B1.B2.C4.C3.^C2.SB.^G1           "                         , Low
                                                              Gain

BRIBS2E
  B1.B2.C4.C3.C2.^C1.^SB.^G1  Stop in C2, did NOT get into C1, High
                                                               Gain

BRIBS2P
  B1.B2.C4.C3.C2.^C1.SB.^G1        "

BRIBS2
```

```
    B1.B2.C4.C3.C2.^C1.^SB.^G1       "

  BRIBS2Z2
    B1.B2.C4.C3.C2.^C1.SB.^G1        "                         , Low
                                                                 Gain

  ----------------------------------
  HET-II event type RATES (for flux calculations) :
    interpreted analagously to HET-I
  ----------------------------------
  BRIIAS
    A1.A2.^C4.^G1.^B2

  BRIIASZ3
    A1.A2.SA.^C4.^G3.^B2

  BRIIBSE
    B1.B2.C4.^SB.^C1.^G1.^A2

  BRIIBSP
    B1.B2.SB.^C1.^G1.^A2

  BRIIBSZ2
    B1.B2.SB.^C1.^G3.^A2

  BRIIPENH
    B1.B2.C1

  BRIIPENL
    B1.B2.C1

  BRIIPGH
    B1.B2.C1.^G1

  BRIIPGL
    B1.B2.C1.^G1

  BRIIBS4E
    B1.B2.C4.^C3.^SB.^G1

  BRIIBS4P
    B1.B2.C4.^C3.SB.^G1

  BRIIBS4
    B1.B2.C4.^C3.^SB.^G1

  BRIIBS4Z2
    B1.B2.C4.^C3.SB.^G1

  BRIIBS3E
    B1.B2.C4.C3.^C2.^SB.^G1

  BRIIBS3P
    B1.B2.C4.C3.^C2.SB.^G1

  BRIIBS3
    B1.B2.C4.C3.^C2.^SB.^G1

  BRIIBS3Z2
    B1.B2.C4.C3.^C2.SB.^G1

  BRIIBS2E
    B1.B2.C4.C3.C2.^C1.^SB.^G1

  BRIIBS2P
    B1.B2.C4.C3.C2.^C1.SB.^G1

  BRIIBS2
    B1.B2.C4.C3.C2.^C1.^SB.^G1

  BRIIBS2Z2
```

```
    B1.B2.C4.C3.C2.^C1.SB.^G1

  ----------------------------------
  HET-I singles rates
  ----------------------------------
  BRIA1H                    Singles rate, high gain, for the A1
    A1                         element
                            below are all high gain until noted
  BRIA2H
    A2

  BRIC1H
    C1

  BRIC2H
    C2

  BRIB1H
    B1

  BRISBH
    SB

  BRIC3H
    C3

  BRIC4H
    C4

  BRIB2H
    B2

  BRIG1
    G1

  BRIA1L                  begin low gain singles here
    A1

  BRIA2L
    A2

  BRIC1L
    C1

  BRIC2L
    C2

  BRIB1L
    B1

  BRISA1
    SA

  BRISA2
    SA

  BRISBL
    SB

  BRIC3L
    C3

  BRIC4L
    C4



  BRIB2L
    B2
```

```
----------------------------------
HET-II singles rates
  Interpreted the same as HET-I singles rates
----------------------------------
BRIIA1H
  A1

BRIIA2H
  A2

BRIIC1H
  C1

BRIIC2H
  C2

BRIIB1H
  B1

BRIISBH
  SB

BRIIC3H
  C3

BRIIC4H
  C4

BRIIB2H
  B2

BRIIG1
  G1

BRIIA1L                      begin low gain singles here
  A1

BRIIA2L
  A2
BRIIC1L
  C1

BRIIC2L
  C2

BRIIB1L
  B1



BRIISA1
  SA

BRIISA2
  SA

BRIISBL
  SB

BRIIC3L
  C3

BRIIC4L
  C4

BRIIB2L
  B2

----------------------------------
LET singles rates  in high gain
```

```
----------------------------------
BRLA1
  L1

BRLA2
  L2

BRLA3
  L3

BRLA4
  L4

BRSLA
  SL

BRSLB
  SL

BRLB1
  L1

BRLB2
  L2

BRLB3
  L3

BRLB4
  L4

BRLC1
  L1

BRLC2
  L2

BRLC3
  L3

BRLC4
  L4


BRSLD
  SL

BRLD1
  L1

BRLD2
  L2

BRLD3
  L3

BRLD4
  L4

----------------------------------
TET singles rates  H or L at end of rate indicates High or Low Gain
----------------------------------
BRD6L
  D6

BRGA+GB
  GA.GB

BRD5H
  D5
```

```
BRD7L
  D7

BRD6H
  D6
BRD7H
  D7

BRD5L
  D5

BRD8L
  D8

BRD1H
  D1

BRD4H
  D4

BRD2L
  D2

BRD3L
  D3

BRD1L
  D1

BRD3H
  D3

BRD2H
  D2

BRD4L
  D4

*  MAJOR STATUS CHANGE CONFIGURATIONS IN CRUISE AFFECT THESE
----------------------------------
LET event type rates (for flux calculations) :
----------------------------------
BRLATRP
  L1.L2.^L4

BRLBTRP
  L1.L2.^L4

BRLCTRP
  L1.L2.L3.^L4

BRLCTRP
  L1.L2.^L4

BRLDTRP
  L1.L2.^L4

BRLC                     High Gain  (typical mnemonic)
  L1.L2.L3.^SL.^L4
BRLC
  L1.L2.^SL.^L4

BRLCZ3                   Low Gain  Atomic Number Z >= 3
  L1.L2.L3.SL.^L4             (typical mnemonic)

BRLCZ3
  L1.L2.SL.^L4

* LD                       NOMINAL DEFINITION IS PRESENT
*                   near launch FOR LA, LB, LD SERIES
* L1.L2.L3.^SL.^L4
```

```
BRLD
  L1.L2.^SL.^L4

* LDZ3                     NOMINAL DEFINITION IS PRESENT
*                   near launch FOR LA, LB, LD SERIES
* L1.L2.L3.SL.^L4

BRLDZ3
  L1.L2.SL.^L4

BRLA
  L1.L2.^SL.^L4

BRLAZ3
  L1.L2.SL.^L4

BRLB
  L1.L2.^SL.^L4

BRLBZ3
  L1.L2.SL.^L4

----------------------------------
TET event type rates (for flux calculations) :
----------------------------------
BRTAN
  W1.W2.D3.^D8.^GA.^GB

BRTAN
  W1.W2.^D8.^GA.^GB

BRTLO
  W1.W2.D3.D5.^D6.^GA.^GB.^UT

BRTLO
  W1.W2.D5.^D6.^GA.^GB.^UT

BRTHI
  W1.W2.D3.D7.^D8.^GA.^GB.^UT

BRTHI
  W1.W2.D7.^D8.^GA.^GB.^UT



Description of DATA

Files of data are in ASCII text format, variable length formatted
records, readable by the example program given below. The
records of these datasets contain words with information on start time,
data quantities are present, the averaging interval , and ASCII
character data descriptions of the specific coincidence logic
condition which gives rise to the data quantity being presented.

If the Error value is -1.0, data for this item is not available. If
the Flux and Error are 0.0 no events occurred during the collection
time.

   The format of the text data is generally as follows:

        Record #:    general length   description

              1        C*12        Satellite name
              2        C*n         Start time of first 6 hour average
                                   present
              3        C*n         Stop  time of last 6 hour average
                                   present
              4        C*3         Number of bins (data quantities
                                   present)
```

```
        Records 5-(N+4) (where N = number of bins): Bin Label
                          Records
                       C*3         bin number
                       C*n         Character data label description

        Records N+4- ...  Data records:

                       C*19        Start time as yy-mm-ddThh:mm:ss
                       C*15        Value of data quantity 1
                       c*15        Error in data quantity 1
                       .           .
                       .           .
                       C*15        Value of data quantity N
                       C*15        Error in data quantity N
```

This program will list the contents of the data for one quantity.

```
C       EXTRACTS SPECIFIED ITEM FROM A VOYAGER NSSDC FORMATTED FILE
         IMPLICIT NONE
         CHARACTER*12 SATID
         CHARACTER*19 START,END,T
         CHARACTER*132 LABEL
         CHARACTER*100 FMTSTRING
         CHARACTER*40 FNAME
         INTEGER I,IBIN,NOBINS
         REAL FLUX,ERROR
         WRITE (6,*) 'FILE:'
         READ(5,'((A))') FNAME
         OPEN(UNIT=1,FILE=FNAME,STATUS='OLD')
         READ(1,'((A))') SATID
         WRITE(6,'((A))') SATID
         READ(1,'((A))') START
         WRITE(6,'((A))') START
         READ(1,'((A))') END
         WRITE(6,'((A))') END
         READ(1,*) NOBINS
         WRITE(6,*) 'BIN NUMBER:'
         READ(5,*) IBIN
         IF ((IBIN .LT. 1) .OR. (IBIN .GT. NOBINS)) THEN
              WRITE(6,*) 'BIN # ',IBIN,' NOT IN RANGE (1,',NOBINS,').'
                   STOP
         ENDIF
         WRITE(FMTSTRING,1) 2*(IBIN-1)*15
1        FORMAT('((A),',I5,'X,2E15.5)')
         DO 10 I=1,IBIN-1
            READ(1,'((A))') LABEL
10       CONTINUE

         READ(1,'((A))') LABEL
         WRITE(6,*) LABEL

         DO 20 I=IBIN+1,NOBINS
            READ(1,'((A))') LABEL
20       CONTINUE

         DO 30 I=1,1000000
            READ(1,FMTSTRING,END=100) T,FLUX,ERROR
            WRITE(6,25) T,FLUX,ERROR
25          FORMAT(1X,A19,1X,2E15.5)
30       CONTINUE
         STOP
100      WRITE(6,*) 'END OF FILE'
         STOP
         END
```

DATA_SET_QUALITY/INSTRUMENT_PERFORMANCE:

Three status configurations have been used in the CRUISE portions of the mission (see below).

The LET and TET are in non-nominal status states for much of the CRUISE portion of the mission. To access non-nominal rate data in our system requires input to our FLUXPLOT program (which makes data summaries) of the exact COINCIDENCE LOGIC EQUATION described by the non-nominal instrument status. To handle both nominal and non-nominal times we have requested both states for the lifetime cruise periods. Therefore, users of this NSSDC data need to be aware of the correct status condition for times of interest, and look at the corresponding data quantity for our submission, in order not to be confused by thinking there is no data for those quantities affected.

The exact order of data on our tapes is listed after the REFERENCES section of this header information.

VOYAGER-1 CRUISE PERIODS (NON-ENCOUNTER) STATUS SUMMARIES

```
VOLUME time
------ ----
24832  9/16/77 15:45: 0   IN STATUS CONFIG (1)
 STATUS CONFIG (1) = NOMINAL + 0020 0580 0680 0780 0880      0D0A
60948  9/27/78 20:45:0    IN STATUS CONFIG (2)
 STATUS CONFIG (2) = NOMINAL + 0020 0580 0600 0780 0880 0A04 0D0A
287502 3/14/85 19:15:0    IN STATUS CONFIG (3)
 STATUS CONFIG (3) = NOMINAL + 0020 0580 0600 0780 0880 0A00 0D0A
```

Telescope nominal conditions are indicated by a 00 in the right-most byte of each status word for words 5 - 10 (05 - 0A in the left byte of each status word).

```
 status byte meanings:
   0020    High Volt. enable indicator
   0580    delete LA3 terms
   0600    nominal
   0680    delete LC3 terms
   0780    delete LB3 terms
   0880    delete LD3 terms
   0A00    nominal
   0A04    delete  D3 terms
   0D0A    Het 1 and Het 2 auto gain flag on

 other status byte values sometimes used:
   OD05    Het 1 and Het 2 gain set high
```

excluded data times (localized and non-localized data blips):
These times have been excluded from our NSSDC data:

```
SE        77/09/18 00:00:00 77/10/03 00:00:00
SE        77/10/12 00:00:00 77/10/15 00:00:00
SE        77/11/10 00:00:00 77/12/01 20:00:00
SE        78/04/08 00:00:00 78/06/07 00:00:00
SE  *     78/05/23 05:30:00 78/05/23 06:00:00
SE        78/06/23 00:00:00 78/06/29 00:00:00
SE  *     78/07/01 03:30:00 78/07/01 04:00:00
SE        78/07/02 00:00:00 78/07/06 00:00:00
SE        78/07/08 00:00:00 78/07/21 00:00:00
SE  *     78/09/27 13:30:00 78/09/27 20:45:00
SE  *     78/11/21 18:45:00 78/11/21 19:00:00
SE  *     78/12/18 08:45:00 78/12/18 09:00:00
SE  *     78/12/28 08:15:00 78/12/28 08:30:00
SE  JUP   79/02/15 00:00:00 79/03/22 00:00:00
SE  *     79/03/19 00:00:00 79/03/21 23:15:00
```

```
 SE  *     79/08/15 02:15:00 79/08/15 03:00:00
 SE        80/03/14 00:00:00 80/03/15 00:00:00
 SE  *     80/10/25 15:45:00 80/10/26 02:15:00
 SE  SAT   80/11/12 00:00:00 80/11/23 00:00:00
 SE        81/10/13 00:00:00 81/11/14 00:00:00
 SE  *     81/10/30 18:00:00 81/10/31 01:30:00
 SE  *     81/11/06 04:00:00 81/11/06 04:30:00
 SE        83/08/15 00:00:00 83/08/16 00:00:00
 SE        83/08/23 00:00:00 83/08/24 00:00:00
 SE        86/12/05 08:00:00 86/12/05 12:00:00
 SE        87/03/04 07:00:00 87/03/04 10:00:00
 SE        87/03/16 05:00:00 87/03/16 10:00:00
 SE        87/07/21 00:00:00 87/07/22 00:00:00
 SE        87/07/22 07:00:00 87/07/22 10:00:00
 SE        87/10/11 06:00:00 87/10/11 07:00:00
 SE  *     88/02/06 20:30:00 88/02/06 23:45:00
 SE        88/05/26 09:00:00 88/05/26 10:00:00
 SE  *     88/11/02 05:00:00 88/22/02 05:15:00
 SE  *     89/12/12 17:15:00 89/12/12 17:45:00

      Whole single exclude days are probably data blips which
      were never localized.

  *  indicates time derived from status listings


 Voyater-1 Encounter times:
    Jupiter   5Mar79  for exclude use 2/15/79 - 3/22/79
                           VOLUMEs    74401   - 77758
    Saturn   12Nov80                11/02/80 - 11/23/80
                           VOLUMEs   134497   - 136513



 Year timeline summary
 Instrument condition /general health observations:

    2/8/82 PHA BLOCK for LETA,B, HET I partial failure

    TAN event type rates need special coincidence equations
    during part of cruise:  for TAN,  TLO,  THI
     delete the D3 term from
     9/27/78 20:45 -  3/14/85  19:15

    LET event type rates need special coincidence equations
    during cruise: for LA,LB,LD  high and low gains
     delete the L3 term throughout the mission
     For LC set, delete L3 from launch - 9/27/78 20:45;
        then LC set is nominal

 1977   Status Configuration 0 essentially nominal at launch
        Status Configuration 1 begins at 9/16/77 15:45

 1978          day 100 - 160 bad times; (day 190-200 bad data/gap He
              ASTP)
              Status Configuration 2 begins at 9/27/78 20:45

 1979  day 45 - 80  Jupiter; (day 100 - 112 bad data? He IA2,IIA2)

 1980                                        day 316 - 323 Saturn

 1981

 1982   2/8/82 PHA BLOCK for LETA,B, HET I partial failure
      -et IPH, IP; IB3 electron ; all gone
      -et LA2,3  LB2,3 H  data there, but la2, lb2 drop 10+1
           other H  data have calib discrepancy from then on;
           He is present everywhere, but with sparse periods and
           no notes on calibration discrepancy
      -HET I,II calibration discrepancy IA2,IA3  H, HE from then on,
           and sparseness in data after day 300 of 1985; flux
```

```
          discrepancy disappears after day 140 of 1989 (a)

 1983

 1984

 1985                                          day 300 -> (a)
                                                   ----------
       Status Configuration 3 begins at 3/14/85 19:15

 1986 ----------------(a)----------------------------------------

 1987 ----------------(a)----------------------------------------

 1988 ----------------(a)----------------------------------------

 1989 ---(a)------~day 140.

 1990

 1991

 1992


 (a) After day 40 of 1982, our group uses only HET II for fluxes
    The gap of day 315-335, 1977  where indicated was caused by an
    exclude card,  added to prevent FLUXPLOT from
    returning invalid fluxes related to a data exception
    it did not handle properly.


 HE IB2,IIB2 all ok, but H IB2,IIB2 has flux discrepancy after ~day
 160 of 1982




 -----------------------------------------------------------------
 -----------------------------------------------------------------
 Dr. A. Cummings (Principle Investigator, CIT) has provided the
 following information from the theses indicated, to summarize
 instrument health and experiment problems.

 START OF THESIS INFORMATION  ----------------------------------------
 From the Rick Cook thesis-

 Appendix B   Problems

 B.1 LET B of Voyager-1

   The response of this telescope was unusual in that (1) the HE
 mass measurement, M1, showed a relatively large energy and time
 dependence, (2) a relatively large 'background' of events was
 present in the charge range near fluorine, and (3) the L1 versus
 L2+L3 element tracks had an uncharacteristically blurred appear-
 ance.  The problem may be electronic instability, but was not
 investigated in detail; instead the data from this telescope
 were excluded from use in the measurements presented in Chapter
 4, Tables 4.1 through 4.12.

 B.2 LET C of Voyager-2

   On April 1, 1978 the L1 detector of this telescope experienced
 a simultaneous shift in energy calibration and increase in count
 rate, perhaps as the result of a light leak in the thin AL entrance
 window.  Subsequent data from this telescope were not used in the
 measurements of Chapter 4, Tables 4.1 through 4.12.

 B.3 Pulse Height Multiplication in the LET 35 um Detectors
```

A background effect specific to the iron group nuclei was identified in Sections 3.3 and 3.5 and necessitated the further study and special handling which is discussed here. The affected PHA events were clearly seen in Figure 3.7, a plot of the charge measurements Z1 versus Z2, as a clump of points near (Z1=26, Z2=28). Inspection of the L1, L2 and L3 pulse heights of the events in this clump revealed a very specific signature:

(1) The events lie directly on the L1 versus L3 track for iron, but lie just above the L2 versus L3 iron track, indicating that the L1 and L3 pulse heights are normal, but that the L2 pulse height is abnormally large.

(2) The events have relatively small L3 pulse heights (E{L3} less than about 170 MeV), indicating that the nuclei responsible for the events just barely penetrated detector L2.

The effect also occurs for a fraction of the iron nuclei which barely penetrate the L1 detectors. In this case, the affected events may be seen as the unusual clump of points near Z1=28 in Figure 3.6.

The above signature suggests a pulse height multiplication effect in the LET 35 um surface barrier detectors that is very similar to one observed earlier in the response of such detectors to fission fragments. The effect (discussed by Walter 1969) occurs for nuclei which deposit a large ionization charge density in the depleted silicon near the gold electrode. The large ionization charge density is thought to induce tunneling of additional carriers (electrons) from the electrode through the thin oxide layer which separates the electrode frm the depleted bulk silicon. The orientation of the LET 35 um detectors is consistent with this multiplication hypothesis: The gold electrodes face toward the L3 detector, such that the ionization charge density near a gold electrode is largest for nuclei which just barely penetrate the detector, as in (2) above.

To further stydy the problem, three detector PHA events with charge measurements Z1> 24 were re-analyzed. For each event the L1 and L3 energy measurements (E{L1} and E{L3}) were used to calculate a new charge measurement Z' and obtain an estimate E'{L2} of the energy deposited in detector L2 by solving:

```
    T{L1} = R(E{L1} + E'{L2} + E{L3}, Z', M) -
                R(E'{L2} + E{L3}, Z', M)
    T{L2} = R(E'{L2} + E{L3}, Z', M) =
                R(E{L3}, Z', M)

      taking  M = 2.132 * Z'
```

R is the generalized range-energy function discussed in Section 3.4. T{L1} and T{L2} are the mean pathlengths for the L1 and L2 detectors respectively. The results are illustrated in Figure B.1, a plot of E{L2} (the measured L2 energy) versus E'{L2} (the L2 energy inferred from the L1 and L3 energy measurements). Normal events lie along the diagonal, while events with abnormally large L2 energy measurements lie above the diagonal. (Events below the diagonal may be due to L2 edge effects and other processes discussed in Section 3.5.2) The abnormal events occur predominantly at large values of E'{L2} which can only be obtained by nuclei which barely penetrate L2, consistent with observation (2) above. Figure B.2 shows two histograms of E{L2}/E'{L2} ; one histogram for events which barely penetrate L2 (E{L3} < 170 MeV) and one for the remaining events (E{L3} > 170 MeV). These histograms are summed over all the LETs used on both Voyagers and indicate that (1) about 15 percent of the events with E{L3} less than 170 MeV have L2 energy measurements which are abnormally large by an average of about 12 percent and (2) the L2 energy measurements are essentially normal for events with E{L3} greater than 170 MeV.

B.3.1 Three Parameter Analysis for Iron Nuclei

The results for iron nuclei presented in Table 4.2 (8.7-15.0 MeV/nucleon) are based on PHA events selected as follows:

(1) Normal iron events (i.e. those with normal L2 pulse height) were selected using the charge consistency requirement and charge boundaries discussed in Section 3.5, and were counted if the total energy measurement, E{L1}+E{L2}+E{L3}, was appropriate to the 8.7 - 15.0 MeV/nucleon interval.

(2) Iron PHA events having abnormally large L2 pulse heights were identified as those events with charge measurements near (Z1=26, Z2=28). (Specifically, the requirement was (Z1+Z2)/2 > 25 and (Z1-Z2) < -0.85.) For each of the PHA events the L2 energy measurement was divided by 1.125 (the mean shift of the abnormal L2 energy measurements; see Figure B.2) to obtain a corrected value E*{L2}. Then the event was counted if E{L1}+E*{L2}+E{L3} was within the total energy interval corresponding to 8.7 - 15.0 MeV/nucleon.

PHA events with abnormal L2 pulse heights constitute about 15 percent of the iron nuclei counts presented in Table 4.2. Any additional systematic error (beyond that discussed in Section 4.4.1) in the iron nuclei counts due to the abnormal L2 pulse heights should be small. For example, if no corrections at all are applied to the abnormal L2 energy measurements (as was the case for the iron abundances reported earlier in Cook et. al. 1979 and Cook, Stone and Vogt 1980), the resulting iron abundance measurements differ from those of Table 4.2 by less than 5 percent.

B.3.2 Two Parameter Analysis for Iron Nuclei

In the two parameter analysis of iron (for the fluence measurements of Tables 4.4 through 4.11) the multiplication effect in the L1 detectors was taken into account as follows:

(1) Iron PHA events with normal L1 pulse heights were identified as those events with charge measurement Z1 in the range 24.8 to 27.2 and were binned according to energy/nucleon as described in Section 3.4.

(2) PHA events with charge Z1 in the range 27.2 to 32.0 and L2+L3 energy measurements of less than 170 MeV are primarily due to iron nuclei with abnormally large L1 pulse heights, rather than nickel or other nuclei. Therefore, the L1 energy measurements of these events were divided by 1.125 before energy/nucleon binning. The remaining events with Z1 in the range 27.2 to 32.0 (i.e. those with E{L2}+E{L3} > 170 MeV) are mainly nickel nuclei an were included with no L1 energy adjustment. All PHA events were sorted into energy/nucleon binns as if they were due to iron nuclei, exactly as in (1) above.

In the two parameter iron analysis, no special treatment was applied to account for multiplication effects in the L2 detectors. They do not significantly affect the Z1 charge measurement and at most shift a small fraction (about 5 percent) of the PHA events which should fall in th 7.8-8.7 MeV/nucleon interval into the 8.7 - 10.6 MeV/nucleon interval.

The inclusion of nickel and other nuclei (27 <= Z <= 32) increases the fluence measurements over measurements of pure iron by roughly the combined abundance of these elements relative to iron, or about 10 percent. However, the inclusion of these nuclei probably has only a negligible effect on the spectral index(gamma, see Section 4.5), since the energy spectra of the various elements of the iron group are likely to be similar. (Spectral index variations among the elements appear to be roughly ordered by nuclear charge Z, such that, in a given flare event, neighboring elements have similar spectral indices; see Section 5.2. Further, the nickel to iron ratio {8.7 -15 MeV/nucleon, Table 4.2} is nearly constant from flare to flare.)

The multiplication effect in the L1 detectors is potentially an additional source of systematic error (beyond those discussed in

Section 4.5) in the iron fluence measurements of Tables 4.4 through 4.11 and the iron spectral index measurements of Tabl 4.12. Upper limits to these possible additional errors were obtained by re-computing the fluences and spectral indices without the L1 energy corrections discussed in (2) above. The changes in the iron fluence measurements were typically less than 10 percent for energy bins in the range 5.0-8.7 MeV/nucleon, and wer zero for the other higher energy bins. The iron spectral indices changed by less than 5 percent. Since the actual systematic error induced in the iron spectral indices is probably much less than 5 percent (and therefore is small compared to statistical error and the possible systematic error from other sources discussed in Section 4.5) this error is negligible.

HH Breneman Thesis. Flare analysis treated differently from interplanetary data.

Appendix G Instrumental Anomalies and Other Problems

The analysis of data form the Voyager CRS LET and HET telescopes was complicated by several instrumental problems. These are described in detail elsewhere (Breneman 1984); they are summarized here.

G.1. Pulse Height 'Multiplicaton' Effect

This effect has been observed many times in numerous surface-barrier detectors, both in flight and in the laboratory (Cook 1981, Breneman 1982). Particles passing completely through a detector sometimes yield pulse heights that are anomalously high By about 10 - 30 %). It occurs most often for particles with high dI/dx in the detector in question, and therefore at a given initial energy, the errect occurs more often for elements higher on the charge scale; in the data it is most prominent for Fe. On a delta E versus E' plot, the effect appears as a more or less diffuse 'track' above and roughly parallel to the nominal track for the element, since delta E is anomalously high for the affected particles (Fig. G.1). A charge determination of such an event will of course be high, generally by ~2-3 charge units at Fe. Since the effect is strongly dependent on dE/dx, it is usually evident only in the delta E detector immediately before the E' detector. When z is calculated for 3-parameter events involving such anomalous pulse heights, Z2 is more strongly affected than Z1, since the anomalous pulse height has the role of delta E for Z2, while for Z1 the same detector PHA usually makes only a modest contribution to E' with delta E normal. On a Z1 versus Z2 plot (e.e., Fig. 3.1), the effect takes the form of a cluster fo events to the right of, and slightly above, the main cluster along the diagonal. All of the Voyager LETs show the effect for Fe; although its rate of occurrence varies somewhat between the different telescopes, it is generally in the range of ~5 - 10 % of all the 3-parameter Fe SEP events in a given telescope. The fraction of 2-parameter events affected is larger, since the E' detector is thinner and therefore a larger fraction of the data has high dE/dx in the delta E detector. At least one LET (Voyager 1 LET A) shows evidence for the effect at charges as low as 20.

In the HETs the problem is worse in several respects. Its rate of occurrence at Fe, as a percentage of the total Fe event ample, is generally much larger than in the LETs (~40 % for Voayger 1 HET 2); it is clearly seen for elements as low on the charge scale as Mg in some telescopes (Voyager 1 HET 2 and Voyager 2 HET 2); and for 3-parameter events it can sometimes be seen occurring in either (or both) delta E detectors, rather than just the last one, resulting in several displaced clusters of events in those telescopes (Voyager 1 HET 1 and Voayger 2 HET 2).

Two actions were necessary to deal with this problem. For abundant elements affected by the problem, mainly Fe and Ni, the 3-parameter charge consistency requirement was made lenient enough to include the particles affected by pulse height multiplication. The rate of occurrence in LET for elements lower than Fe was negligible compared to other sources of uncertainty in the abundance determination, and no correction was made for these elements. Based on the observed rates in some HET telescopes for the abundant elements (e.e., Fig. G.2 for Voayger 1 HET 2), the rate of occurrence in these thelscopes for elements in the Z = 17-25 charge range was significant even though limited statistics make it less apparent and less quantifiable. However, HET data were not used for these elements for the reasons given in Section 3.3.

In addition, the energy loss in the delta E detector had to be corrected in an approximate way for affected events, so that the total incident energy, which is required for constructing energy spectra, would be accurate.

For 2-parameter events, there is no second independent determination fo Z to permit unambiguous separation of normal and abnormal events. This is not a serious problem for abundant elements, since the only abundant element significantly affected is Fe, which has no other elements of comparable abundance near it on the charge scale with which it could be confused. For rare elements the situation would be more serious, but as noted in Section 3.3, 2-parameter data were not used for rare element abundances due to excessive background contamination from other sources.

G.2. LET Telescope ID Tag Bit Errors at High Counting Rates

For each Block I or Block II LET event, there is a single tag bit which specifies from whih LET telescope in that Block the event originated. A near coincidence in the triggering of LETs A and B, as is possible during periods of very high count rates, can result in the bit being set for a LET A event, causing that event to be read out as a LET B event (similarly for C and D). Since the bit is ordinarily set only for LET B events and is otherwise not set, LET A events can be misidentified as LET B events but never the reverse.

The telescope identification bit is used in all subsequent data analysis to determine the appropriate detector thicknessess and gains to use in calculating energy losses in the detectors and, ultimately, the charge of the particle. If the telescope identification is erroneous, incorrect thick= nesses and gains are used in the calculations, resulting in incorrect determinations of Z. The magnitude and sign of the discrepancy in Z depends only on the (coincidental) relationship between the thicknesses of the detectors in the paired telescopes, and, to a lesser degree, differences in the energy calibrations fo the respective detectors.

On a Z1 versus Z2 plot of 3-parameter Voyager data, this effect has the appearance of small clusters of events displaced slightly from the main clusters along the diagonal for all the more abundant elements. It appears only in plots of the B and D telescopes, sine it is events with these identifications which contain some misidentified particles. In the Voyager flight data the effect is noticeable only during flare period 7, for which the peak LET B singles rate is ~ 5 * 10**3 /sec, the highest seen during the Voayger mission through August 1984. Its rate of occurrence is about 3 % at this peak rate, an average of about 1 % for flare period 7 as a whole, and is the same for all elements for which statistics permit a measurement. On delta E versus E' plots of both 2- and 3-parameter data, these effects have the appearance of 'ghost' tracks falling between or partially overlapping the real tracks of nearby elements (Fig. G.3).

Later laboratory work using the backup GRS and pulse generators (Martin 1983) was able to reproduce the effect with greatly improved statistics, and verified the magnitude of the time constant (~6 us) implied by the flight data while extending coverage to event rates more than an order of magnitude above the highest seen in the flight data.

The impact of this problm on the data analysis is relatively minor. For 3-parameter data, the previously chosen charge-consistency requirement is restrictive enough to easily exclude the misidentified events; the amount of data lost is an insignificant 0.2% of the total, and the remaining data set is as 'clean' as that from the other telescopes. The problem is more serious for the 2-parameter data, since there is no second determination of Z to permit separation of the normal and abnormal events; it is an unremovable source of background in the data. For abundant elements this is unimportant, since the error introduced by this background is on the order of 1 % or less. But the problem would be serious for rare elements in cases where the 'ghost' trakc of an abundant element overlaps the true location fo a rare element, since even 1 % of an abundant element could seriously contaminate a much rarer element. However, as noted previously, the 2-parameter LET data are not useful in obtaining rare element abundances on account of other background contributions.

G.3. LET L1 Detector Jupiter Encounter Radiation Damage
and Post-Encounter Annealing

As a result of their exposure to intense charged particle fluxes in the inner Jovian magnetosphere during the 1979 Jupiter encounters, the L1 detectors of the LETs experienced radiation damage which can be modeled as a reduction in the 'effective thickness' of the detectors. It is thought to be due to the implantation of energetic oxygen and sulfur ions known to be present in the inner Jovain magnetosphere (Gehrels 1982). Although all LETs on both spacecraft were affected to some degree, the Voayger 1 LETs were affected much worse than those on Voyager 2, since the former spacecraft passed closer to Jupiter and experienced a more intense radiation environment. On each spacecraft, LET C was by far the most seriously affected; this telescope was sparially oriented so as to receive the most intense radiation exposure during the Jupiter encounters. (LET B on Voyager 2 experienced unrelated types of radiation damage during the Jovian encounter and has returned no data since tha encounter.) The front detectors of the HETs, being much thicker than those of the LETs and protected by a thiker window, showed no detectable effective thichness reduction.

The impact of the radiation damage on the post-Jupiter data is apparent as a shift in the location fo the element tracks on a delta E versus E' plot of data from flares 16 and 17, the first large post-Jupiter flares, relative to their location in plots of pre-Jupiter flares. Similarly, Z1 versus Z2 plots of flares 16 and 17 show Z values shifted from their proper values when Z is calculated using the detector thicknesses measured before launch, which served adequately for all pre-Jupiter flares. The change in effective thickness appears to be somewhat dependent on Z, with the magnitude of the reduction increasing with Z for any given detector. Furthermore, with the passage of time the radiation damage seems to gradually undergo a partial reversal. This 'annealing' effect is evident in data from the later large flares, 20 and 24, which show less shift in Z than do the flares immediately following Jupiter encounter.

In the analysis of post-Jupiter data, this problem was dealt with by adjusting the L1 detector thicknesses used in the calculation of Z so as to make the calculated charges fall in the proper places on the charge scale. Flares 16 and 17 were used to define the required shift for the more abundant elements; a linear or weakly quadratic function of Z was fit to these to define the Z dependence for all Z. Data from flare periods 20 and 24 were used in conjunction with the flare 16/17 data to mathematically characterize the time-dependence of the annealing effect, by fitting to a decaying-exponential function of time. This procedure, repeated for each LET, defined the L1 thickness to be used in analyzing any given post-Jupiter event. The adjustment of the L1 thickness was then incorporated into the iterative cycle for calculating Z. The radiation damage did not have a noiceable effect on the inherent charge resolution of the telescopes, so with the above modifications the post-Jupiter flare data could be treated the same way as the pre-Jupiter data.

Table G.1 lists the adjustment made to the thickness for each L1 detector cor carbon and iron at two different times during the post-Jupiter phase. The actual expression for the thickness L(Z,t) of each L1 detector was given by

$$L(Z,t) = L0 - deltaL0(Z) + K \exp(delta\ t / 562.56)$$

where K is a constant, L0 is the pre-Jupiter thickness, delta t is the time since the Jupiter encounter in days, and deltaL0(z) is the linear or quadratic function of Z that closely fits the required thickness changes for the first post-Jupiter flares.

G.4. Voyager 2 LET C Temporary Gain Shift

During the time period 1978 APR 3 - June 9, the L1 detector of LET C on Voayger 2 experienced, for unknown reasons, a temporary gain shift (~ 47 % decrease) and an associated excessively high L1 count rate (~ 9* 10**3 /sec). The gain shift and excessive count rate set in abruptly, remained nearly constant until about May 29, and then gradually reverted to their former levels; a very slight decline during the central phase was consistent with the decrease in the intensity of sunlight during the smae time period and suggests the possibility of a light leak in the telescope's aluminum window.

The effect on the data was to shift the locations of the element tracks on a delta E versus E' plot, and yield shifted charge estimates when nominal gain factors were used in the analysis. The only flares occurring duting this time period were the three large events of flare period 7. Since the gain was constant at the shifted value during these flares, the data could be analyzed by generating the appropriate gain factors by fitting the oxygen flight data from flare period 7 in the manner described in Appendix A. The resulting values are included in Table A.1.

This anomaly was previously noted (Cook 1981), and the telescope was rejected for analysis because of the problem. However, since the energy calibration used in the analysis is easily adjusted to compensate for the problem, since the charge resolution and background of the telescope do not seem to be affected by the problem and since the three 7 flares include a major fraction of all SEP data, it was decided to inlude Voayger 2 LET C in the analysis with the special treatment described above.

G.5 CRS Instrument Configuration Changes

At certain times during the Voayger mission, the configuation of the CRS instruments was changed in ways that

```
influence data analysis.  At the beginning of each flight
the LETs were configured to require triggering of the L3
detector for pulse height analysis;  that is, only 3-
parameter events were analyzed.  About 12 days after launch
the L3 coincidence requirement was removed, permitting
both 2- and 3-parameter events to be analyzed.  For Voyager
2 this occurred before the first flares were seen, but on
Voyager 1 flares 1a and 1b occurred before the configuration
was changed, so no 2-parameter events were obtained from
these flares.   A similar situation occurred on 17 Jun 1978
when Voyager 1 LET C was switched back to requiring L3
coincidence.  Thus for all flares from 8 onward there are no
2-parameter events from this telescope.  These situations
required changes in the weightings of 2-parameter relative
to 3-parameter events for the affected spacecraft and
flares.  There could still be a residual abundance bias in
flares 1a dna 1b if the particle composition was energy-
dependent and if the two spacecraft saw particles with
different spectra, but the possibility of a bias comparable
to the statistical uncertainty in the abundances is very
unlikely.

 Another important configuration change is the HET gain state.
Normally the instrument cycles between high and low gain
modes, but after Jupiter encounter HET 1 on Voyager 2 was
switched to a high-gain-only mode, so no post-Jupiter SEP
heavy ion data were obtained from this telescope.  This
required changes in the partile wwighting factors of HET
relative to LET for Voyager 2 for all post-Jupiter flares.

  The event weighting factors tabulated in Table 3.8 include
the effects of all instrument configuration changes.

G.6. Voyager 1 Block I PHA Problem

  On 1982 Feb 8, the Voayger 1 CRS experienced a failure
affecting the readout of PHA information from the Block I
telescopes (LETs A and B and HET 1).  The result of the
failure is that in place of PHA2, the instrument reads out
whichever of the three PHAs has the largest numerical value.
If PHA2 happens to be numerically the largest pulse height,
as is true over some energy ranges, the event is read out
normally; otherwise some information si lost.  The effect
of this problem is that some of the 2-parameter events are
lost completely, and that some of the 3-parameter events
are degraded to 2-parameter events.

  The effect of this problem on the data analysis was minimal
because it occurred very late in the time span included in the
SEP data set, and thus affected only two relatively small
flares.  The problem was dealt with by simply discarding
the data on these flares from the three telescopes affected.


END OF THESIS INFORMATION  ------------------------------------------


Summary of Voyager-1 LET L1 thickness and delta Z correction
from Dr. Cummings:

  LET L1 Thickness before VOLUME 94465
           = 37.91 um   LET A
             30.91 um   LET B
             37.07 um   LET C
             35.45 um   LET D
                        um = micrometers

  LET L1 Thickness after  VOLUME 94465
           = 37.09 um + 0.82 {1 - exp{-(boi-94465)/943693} }  LET A
             27.97 um + 0.94 {1 - exp{-(boi-94465)/943693} }  LET B
             30.81 um + 6.26 {1 - exp{-(boi-94465)/943693} }  LET C
```

```
             34.68 um + 0.77 {1 - exp{-(boi-94465)/943693} }  LET D
                        um = micrometers

  Z1 is computed from L1 vs L2+L3  energies
  After VOLUME 94465 Z1 is corrected as follows if Z1 > 9,
             rho{123} = (E{L1}+E{L2}+E{L3}) / 2Z1   <   25

  Z1'  =  Z1 + delta Z  where

  delta Z{A} = (Z1/26)**2 x (1.0461- 0.0418(rho{123})) x
                             {1 - exp{-(boi-94465)/943693} }

  delta Z{B} = (Z1/26)**2 x (0.9254- 0.0370(rho{123})) x
                             {1 - exp{-(boi-94465)/943693} }

  delta Z{C} = (Z1/26)**2 x (1.5190- 0.0608(rho{123})) x
                             {1 - exp{-(boi-94465)/943693} }

  delta Z{D} = (Z1/26)**2 x (0.8730- 0.0349(rho{123})) x
                             {1 - exp{-(boi-94465)/943693} }
```

Summary of Voyager-2 LET C L1 thickness and delta Z correction
(post-Jupiter) from Dr. Cummings:

```
  LET C L1 Thickness before VOLUME 93985
           = 35.33 um   LET C
                        um = micrometers

  LET C L1 Thickness after  VOLUME 93985
           = 32.43 um + 2.90 {1 - exp{-(boi-93985)/943693} }
                        um = micrometers

  Z1 is computed from L1 vs L2+L3 energies
  After VOLUME 93985 Z1 is corrected as follows if Z1 > 9,
             rho{123} = (E{L1}+E{L2}+E{L3}) / 2Z1   <   25 ,
             and if LET = C or D :

  Z1'  =  Z1 + delta Z  where

  delta Z{C} = (Z1/26)**2 x (1.8530- 0.0741(rho{123})) x
                             {1 - exp{-(boi-93985)/943693} }

  delta Z{D} = (Z1/26)**2 x (0.6970- 0.0279(rho{123})) x
                             {1 - exp{-(boi-93985)/943693} }
```


DATA_PROCESSING_OVERVIEW: Four generic types of data are sent back by the cosmic ray telescopes: rates data, pulse height data, internal calibration data and engineering housekeeping data. All are preserved in the reduction steps described below.

A time-ordered dataset containing fifteen minute data blocks (VOLUMEs) of PHA and RATE data is created from the experimenter data records. The data are decompressed and reorganized while preserving the time order. Each VOLUME contains summarized counts and accumulation times for RATES. In addition, the PHA data is sorted and organized by event types. Time tags of individual particles are lost in this process. This database is called the ENCYCLOPEDIA Database.

Using the instrument response matrices and the ENCY database, rates and particle fluxes averaged over multiples of fifteen minutes can be derived. The desired count rates and fluxes are computed on demand, and the NSSDC data is produced in this manner. We have submitted encounter data at 15 minute resolution and the rest of the data at 6 hour time resolution. The interplanetary dataset submitted to NSSDC may be periodically updated, and the new submission will supercede the previous data.

```
ENCY database volumes for Voyager-1 and Voyager-2 are approximately
5 Gbytes each.  All permanent databases reside on magnetic tape
volumes in the library at the NCCS IBM 9021.


This data set is not intended to be used as an encounter data set.


LIT_REFERENCES:



                               INSTRUMENTATION


D.E.Stillwell, W.D.Davis, R.M.Joyce, F.B.McDonald, J.H.Trainor,
W.E.Althouse, A.C.Cummings, T.L.Garrard, E.C.Stone, and R.E.Vogt,
"The Voyager Cosmic Ray Instrument", ISEE
Transactions on Nuclear Science, Vol. 26, 1979, pp. 513



                              SCIENTIFIC PAPERS

    See file VOYAGER-REFERENCES in the data directory

VOL_TIME_COVERAGE:      1977-09-07 to 1992-12-31


FILE_NAMING_CONVENTION: CRS files are named according to the start
time of the data contained in the file as follows: V1xx.NSSDC .
Here the xx stands for the two digits of the year of
the data contained in the file.

FILE_TIME_COVERAGE:
   Data appear as one file for each year from 1977 - 1992.

   V177.NSSDC              1977 launch - 78/01/01 00:00:00

   Other similarly named file sets contain each year's data
   starting from January 1.


/* EOF  */
/* list of data quantities in order on the files follows */

SUBM_NAME:    Dr. Nand Lal
SUBM_ADDR:    Goddard Space Flight Center
              Code 935
              Greenbelt, MD 20771

              Electronic mail:  nand@voyager.gsfc.nasa.gov
                                LHEAVX::LAL
SUBM_DATE:    1994-10-07
TITLE:        Format for Voyager-1 CRS Cruise Data Archive Data Set
DESCR:        Format description of the Voyager-1 Cosmic Ray
              Subsystem cruise phase energetic particle data
              measurements archive data set, September 7, 1977
              through 1993.
REL_DATE:     1994-10-07


RECORD_FIELD_MNEMONICS:  See above in the DATA_SET_PARAMETERS for
basic description of quantities.
                        TIME,
                        HELIUMFLUX1,
                        HELIUMFLUX2,
                        HELIUMFLUX3,
                        HELIUMFLUX4,
                        HELIUMFLUX5,
```

```
                          HELIUMFLUX6,
                          HELIUMFLUX7,
                          HELIUMFLUX8,
                          PROTONFLUX1,
                          PROTONFLUX2,
                          PROTONFLUX3,
                          PROTONFLUX4,
                          PROTONFLUX5,
                          PROTONFLUX6,
                          PROTONFLUX7,
                          PROTONFLUX8,
                          HELIUMFLUX9,
                          HELIUMFLUX10,
                          HELIUMFLUX11,

 BRIAS        .
 BRIASZ3      .
 BRIBSE       .
 BRIBSP       .
 BRIBSZ2      .
 BRIPENL      .
 BRIPENH      .
 BRIPGL       .
 BRIPGH       .
 BRIBS4E      .
 BRIBS4P      .
 BRIBS4       .
 BRIBS4Z2     .
 BRIBS2E      .
 BRIBS2P      .
 BRIBS2       .
 BRIBS2Z2     .
 BRIBS3E      .
 BRIBS3P      .
 BRIBS3       .
 BRIBS3Z2     .
 BRISA1       .
 BRISA2       .
 BRIG1        .
 BRIISA1      .
 BRIISA2      .
 BRIIG1       .
 BRIIAS       .
 BRIIASZ3     .
 BRIIBSE      .
 BRIIBSP      .
 BRIIBSZ2     .
 BRIIPENL     .
 BRIIPENH     .
 BRIIPGL      .
 BRIIPGH      .
 BRIIBS4E     .
 BRIIBS4P     .
 BRIIBS4      .
 BRIIBS4Z2    .
 BRIIBS2E     .
 BRIIBS2P     .
 BRIIBS2      .
 BRIIBS2Z2    .
 BRIIBS3E     .
 BRIIBS3P     .
 BRIIBS3      .
 BRIIBS3Z2    .
 BRIA1H       .
 BRIA2H       .
 BRIB1H       .
 BRIB2H       .
 BRIC1H       .
 BRIC2H       .
 BRIC3H       .
 BRIC4H       .
```

```
 BRISBH       .
 BRIA1L       .
 BRIA2L       .
 BRIB1L       .
 BRIB2L       .
 BRIC1L       .
 BRIC2L       .
 BRIC3L       .
 BRIC4L       .
 BRISBL       .
 BRIIA1H      .
 BRIIA2H      .
 BRIIB1H      .
 BRIIB2H      .
 BRIIC1H      .
 BRIIC2H      .
 BRIIC3H      .
 BRIIC4H      .
 BRIISBH      .
 BRIIA1L      .
 BRIIA2L      .
 BRIIB1L      .
 BRIIB2L      .
 BRIIC1L      .
 BRIIC2L      .
 BRIIC3L      .
 BRIIC4L      .
 BRIISBL      .
 BRLA1        .
 BRLB1        .
 BRLC1        .
 BRLD1        .
 BRLA2        .
 BRLB2        .
 BRLC2        .
 BRLD2        .
 BRLA3        .
 BRLB3        .
 BRLC3        .
 BRLD3        .
 BRLA4        .
 BRLB4        .
 BRLC4        .
 BRLD4        .
 BRSLA        .
 BRSLB        .
 BRSLC        .
 BRSLD        .
 BRLATRP      .
 BRLBTRP      .
 BRLCTRP      .
 BRLDTRP      .
 BRD1L        .
 BRD2L        .
 BRD3L        .
 BRD4L        .
 BRD5L        .
 BRD6L        .
 BRD7L        .
 BRD8L        .
 BRGA+GB      .
 BRD1H        .
 BRD2H        .
 BRD3H        .
 BRD4H        .
 BRD5H        .
 BRD6H        .
 BRD7H        .
 *  MAJOR STATUS CHANGE CONFIGURATIONS IN CRUISE AFFECT THESE
 BRLC         .           Y Y
     X
```

```
    X
  L1.L2.L3.^SL.^L4
BRLC         .
    X

    X
  L1.L2.^SL.^L4
BRLCZ3       .
    X

    X
  L1.L2.L3.SL.^L4
BRLCZ3       .
    X

    X
  L1.L2.SL.^L4
BRLD         .
    X

    X
  L1.L2.L3.^SL.^L4
BRLD         .
    X

    X
  L1.L2.^SL.^L4
BRLDZ3       .
    X

    X
  L1.L2.L3.SL.^L4
BRLDZ3       .
    X

    X
  L1.L2.SL.^L4
BRLA         .
    X

    X
  L1.L2.L3.^SL.^L4
BRLA         .
    X

    X
  L1.L2.^SL.^L4
BRLAZ3       .
    X

    X
  L1.L2.L3.SL.^L4
BRLAZ3       .
    X

    X
  L1.L2.SL.^L4
BRLB         .
    X

    X
  L1.L2.L3.^SL.^L4
BRLB         .
    X

    X
  L1.L2.^SL.^L4
BRLBZ3       .
    X
```

```
     X
   L1.L2.L3.SL.^L4
 BRLBZ3       .
     X

     X
   L1.L2.SL.^L4
 BRTAN        .
     X

     X
   W1.W2.D3.^D8.^GA.^GB
 BRTAN        .
     X

     X
   W1.W2.^D8.^GA.^GB
 BRTLO        .
 BRTLO        .
     X

     X
   W1.W2.D5.^D6.^GA.^GB.^UT
 BRTHI        .
 BRTHI        .
     X

     X
   W1.W2.D7.^D8.^GA.^GB.^UT


 DATA_RECORD_SYNTAX:  See the Description of Data segment of the
 DATA_SET_PARAMETER section.
 Each record has terminators of the \n form.


 /* EOF */
```