CM: SAMPEX-MGMT-018

SMALL EXPLORER (SMEX)

PROJECT DATA

MANAGEMENT PLAN (PDMP)

FOR

SOLAR ANOMALOUS

AND MAGNETOSPHERIC

PARTICLE EXPLORER

(SAMPEX)

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GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

National Aeronautics and
Space Administration

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER

PROJECT DATA MANAGEMENT PLAN (PDMP) FOR SOLAR, ANOMALOUS, AND MAGNETOSPHERIC PARTICLE EXPLORER (SAMPEX)

FOREWORD

The National Aeronautics and Space Administration (NASA) has initiated the Small Explorer (SMEX) Program to launch small and moderate sized space payloads to provide frequent opportunities for highly focused and relatively inexpensive space science missions. This program will also allow training opportunities for the next generation of scientists and engineers.

Dr. Lennard A. Fisk, then Associate Administrator for NASA's Office of Space Science and Applications (OSSA), announced on April 4, 1989, the selection of the first series of SMEX to study some of the most important questions in space physics, astrophysics, and upper atmosphere science. The Solar Anomalous and Magnetospheric Particle Explorer (SAMPEX) was one of the selected missions. SAMPEX was launched on July 3, 1992.

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1.0 PROJECT OVERVIEW

1.1 INTRODUCTION

The Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX) will carry out energetic particle studies of outstanding scientific questions in the fields of space plasma physics, solar physics, heliospheric physics, cosmic ray physics, and middle atmospheric physics. SAMPEX will determine the ionization state of the Anomalous Cosmic Ray component in order to identify the source of these mysterious cosmic rays, and the method of their energization in astrophysical plasmas. SAMPEX will provide new information on the composition of the solar atmosphere so that we may learn more about the origin of our solar system and about the relation between the material making up the sun with that of the planets. SAMPEX will make the first detailed survey of relativistic electrons which plunge from the radiation belts into our atmosphere and may decisively influence the chemistry of the atmospheric ozone. Finally, SAMPEX will provide unprecedented detail about the composition of cosmic rays entering the solar system from outside sources in order to determine whether cosmic rays originate in supernovae explosions or in other types of processes in the galaxy. SAMPEX will measure the particle flux and composition over a substantial portion of the solar cycle (Figure 1-1).

1.1.1 Scope

This document describes the SAMPEX mission Project Data Management Plan for the SMEX Project. Each SMEX mission will develop its own PDMP.

1.2 PROJECT DESCRIPTION

1.2.1 Project Objectives

SAMPEX will measure the electron and ion composition of energetic particle populations from ~0.4 MeV/nucleon to hundreds of MeV/nucleon from a zenith oriented satellite in near-polar orbit, using a coordinated set of detectors with excellent charge and mass resolution, and with much higher sensitivity than previously flown instruments. While over the Earth's magnetic poles, the instruments will study the composition of anomalous cosmic rays, solar energetic particles, and galactic cosmic rays. At lower magnetic latitudes, the properties of Earth's magnetic field will allow determination of the ionization state of three particles at energies much higher than can be studied from interplanetary spacecraft. At subauroral latitudes, SAMPEX will also observe precipitating relativistic magnetospheric electrons, which undergo crucial interactions within the middle atmosphere.

In the energy range below ~ 50 MeV/nucleon, there are at least six elements (He, C, N, O, Ne, and Ar) whose energy spectra show large increases in flux above the quite-time galactic cosmic ray spectrum. This "anomalous" cosmic ray (ACR) component is generally believed to represent neutral interstellar particles that drift into our solar system (i.e., the heliosphere), become ionized by solar wind interactions or solar UV radiation, and are than accelerated. This model makes a unique prediction: the ACR should be singly ionized, (an assertion for which there is only limited evidence). SAMPEX will make direct measurements of the ACR charge state by using the Earth's magnetic field as a giant charge-state spectrometer. Indeed, by organizing the particle fluxes by magnetic cutoff rigidity, SAMPEX measurements will be able to distinguish amongst a number of possible charge states for ACR nuclei. If the ACR are indeed singly ionized, then this component represents a direct sample of the local interstellar medium.

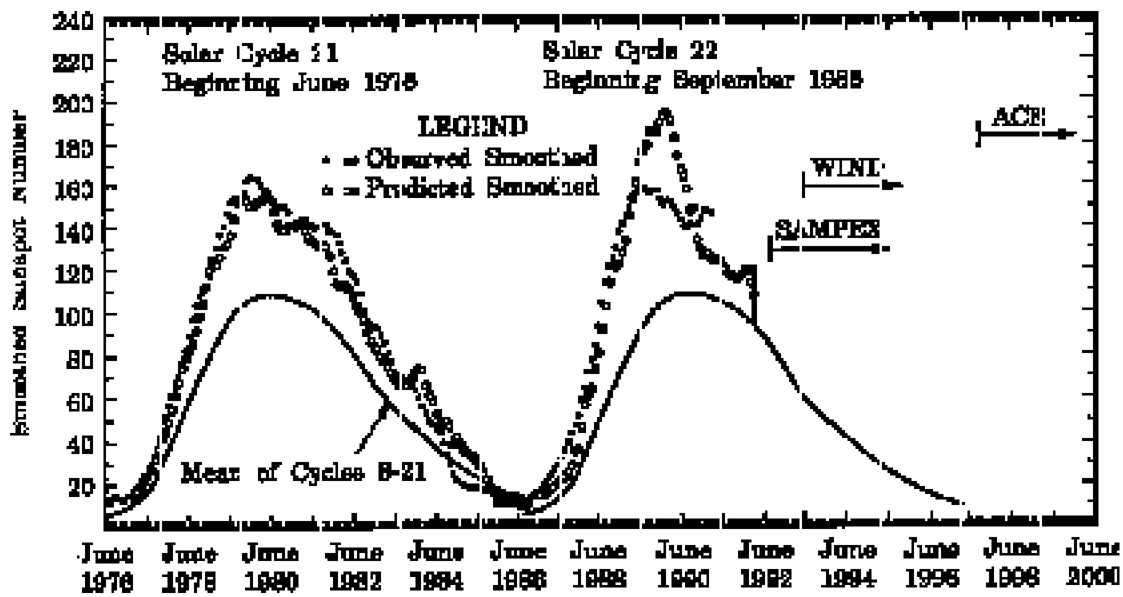

Figure 1-1

Solar flares frequently inject large populations of energetic heavy nuclei into the interplanetary medium. The elemental and isotopic composition of these particles provide crucial information for understanding the history of solar system material and to the study of solar flare acceleration and propagation processes. High sensitivity spectrometers on SAMPEX will have 1-2 orders of magnitude more collecting power than previous instruments.

The number of electrons stripped off solar energetic particle (SEP) nuclei within the sun's atmosphere is determined by plasma conditions at the acceleration site; thus, detailed determinations of the individual ionic species can be derived, in principle, from the charge state distribution measured far from the sun. Large solar flares show ionization states directly related to coronal temperatures, although it has not been possible to associate the observed distribution with a single equilibrium temperature. In addition to large solar flares, there is also a class of small, impulsive solar flares with enormous enhancements in the $^3He/^4He$ ratio (10^3 - 10^4) as well are large (~ 20) enrichments of heavy nuclei such as Fe.

Observations at geosynchronous orbit have found that relativistic ($\gtrsim$ 1 MeV) electron intensities can increase by orders of magnitude for periods of several days. These enhancements are related to the presence of recurrent high-speed solar wind streams, and show a strong solar cycle (11-year) dependence. Numerical modeling shows that when these electrons precipitate they can cause large energy depositions at 40-60 km altitude in the atmosphere, dominating other ionization sources at these heights.

Precipitating relativistic electrons may lead to substantial long-term increases in the levels of odd nitrogen compounds (NO_x) at these heights with an attendant impact on local ozone levels via the reactions $NO + O_3 \rightarrow NO_2 + O_2$, and $NO_2 + O \rightarrow NO + O_2$. Thus, relativistic electrons may provide a mechanism for coupling the 11-year solar activity cycle into the middle and lower atmosphere. It is therefore a critical problem to determine the actual intensity and spatial extent of relativistic electron precipitation, vital information that SAMPEX will provide.

Galactic cosmic rays are a directly accessible sample of matter from outside the solar system. A spectrometer on SAMPEX will carry out measurements of the isotopic composition of this sample of high energy matter, which contains a record of the nuclear history of cosmic rays. Cosmic ray isotope observations have already revolutionized our thinking about both cosmic ray origin and propagation. As an example, prior measurements have shown that ^{22}Ne is more than a factor of 3 times more abundant in cosmic ray source material than in the solar system. The abundances of ^{25}Mg, ^{26} Mg, ^{29}Si, and ^{30}Si are all enhanced by a factor of ~1.5. The exposure obtained on SAMPEX will make it possible to extend the search for isotopic differences between galactic and solar cosmic ray material to many other key elements.

SAMPEX will make measurements over energy, charge-state, and sensitivity ranges not planned for by any other cosmic ray mission. For example, by using the magnetic fields available in low-Earth orbit, it complements the Advanced Composition Explorer (ACE) that will be flown far upstream of the Earth's magnetosphere later in this decade. Moreover, in making measurements of particles directly penetrating the atmosphere, SAMPEX allows examination of crucial solar-terrestrial linkages. To achieve these diverse objectives, SAMPEX is slated for a minimum 3-year mission lifetime, with the objective of extending the mission to six years or more.

This broad range of inquiries can only be addressed using experimental measurements obtained on a low altitude near-polar orbiting spacecraft. The SAMPEX mission uses a single spacecraft developed by the Small Explorer (SMEX) Project at NASA/Goddard Space Flight Center. The spacecraft provides the total support (power, data, thermal, structural, etc.) to four scientific instruments. The spacecraft is designed as a single string system. Redundancy is almost non-existent. A system design has been selected that uses proven design concepts and flight qualified or readily available hardware wherever possible. A Class C Performance Assurance (PA) program was implemented for the SAMPEX payload.

Development of the instrument and spacecraft began immediately after the selection of SAMPEX by the Associate Administrator for Space Science and Applications in April

1989. The selection of SAMPEX completed the process begun with the release of NASA's Announcement of Opportunity OSSA 2-88.

1.2.2 Project Operations Summary

The SAMPEX spacecraft is operated through the Operations Control Center located at Goddard Space Flight Center. The mission is operated 24 hours a day, seven days a week. The data is transmitted to the ground twice per day through the Wallops Flight Facility. The data is transmitted as a series of CCSDS transfer frames. Commanding is performed once per day. Command data is also CCSDS compliant. SAMPEX is the first NASA mission to fully exercise the CCSDS data system recommendations for packetized command and telemetry.

1.2.3 Spacecraft Description

Due to the weight, power, and cost constraints the SAMPEX spacecraft was designed as a single string system. It was built in the "in house" mode by Code 700 personnel with support from Codes 300 and 500. The flow diagram of the data and electrical systems of the spacecraft are shown in Figure 1-2. The SAMPEX payload underwent a full test and verification program including an Engineering Test Unit (ETU).

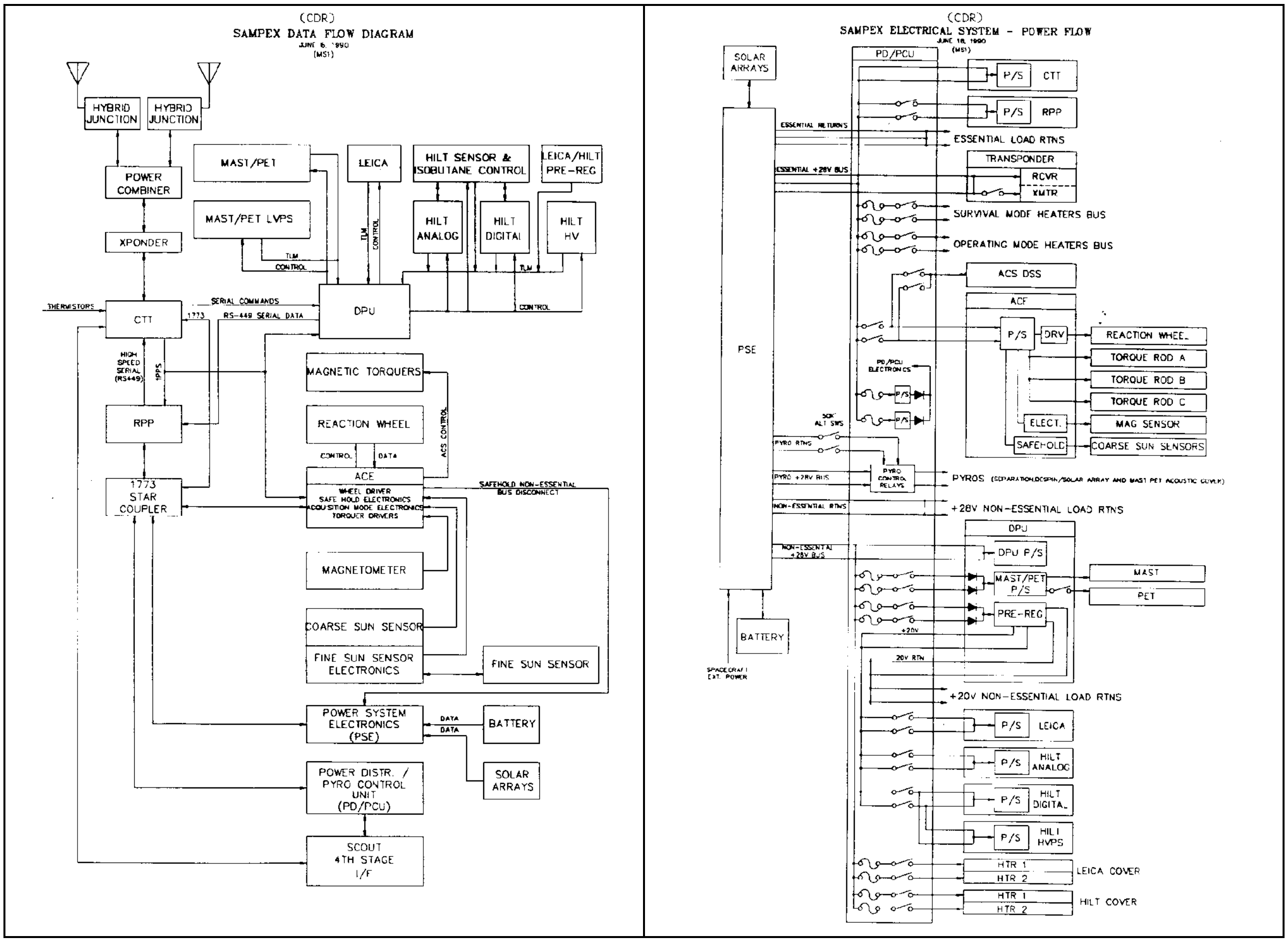

Figure 1-2
Spacecraft Electrical Diagrams

Structural/Mechanical

The SAMPEX mechanical subsystem supports the SAMPEX instruments and subsystem components and fit within the Scout small heat shield. The mechanical system consists of the primary structure, instrument support structure, isobutane tank, deployable solar arrays, and the yo-yo despin mechanism. The SAMPEX bus structure contains most of the subsystem components and provides the interface to the Scout 200-E adapter on the fourth stage of the Scout launch vehicle. The SAMPEX Spacecraft is shown in Figure 1-3.

Power System

The on-orbit average output power of the system is 102 watts using a Gallium Arsenide solar array with no shadowing and minimum solar intensity at end of minimum mission life (3 years). During the launch phase into a full sun orbit, the power system supplied 200 W-HR of energy. This is based on an 80 percent battery depth of discharge and a 9 A-HR battery.

Power Distribution/Pyro Control Unit (PD/PCU)

The primary function of the PD/PCU is to provide primary power distribution and fusing to other spacecraft subsystems, and control and power to spacecraft's separation and deployment pyrotechnic devices. Primary power from the power subsystem is received over the three power busses: essential, non-essential, and pyrotechnic. The PD/PCU distributes the power to the subsystems through appropriate relay and fuse circuits.

The PD/PCU electronics provides for receipt of power relay commands from the SEDS, monitoring of relay status, collection of internal housekeeping data, primary current sensing, and signal conditioning for the CTT, RPP, ACE, and transponder. The PD/PCU receives commands and transmits data via the 1773 data bus.

Small Explorer Data System (SEDS)

The Small Explorer Data System (SEDS) is comprised of a Recorder/Processor/Packetizer (RPP) and a Command and Telemetry Terminal (CTT).

SEDS (Figure 1-4) provides on-board computers that can be programmed to perform mission unique functions as required and provides autonomous operation of the spacecraft when it is not in contact with the ground. It controls the spacecraft attitude and provides primary command and control of experiments and spacecraft subsystems, and interfaces with the spacecraft communications system.

SEDS collects data from the different subsystems and instruments, stores the data, processes it, and sends it to the ground using recognized packet telemetry standards. The data system uses solid-state memory to record spacecraft telemetry data when the spacecraft is out of contact with the ground.

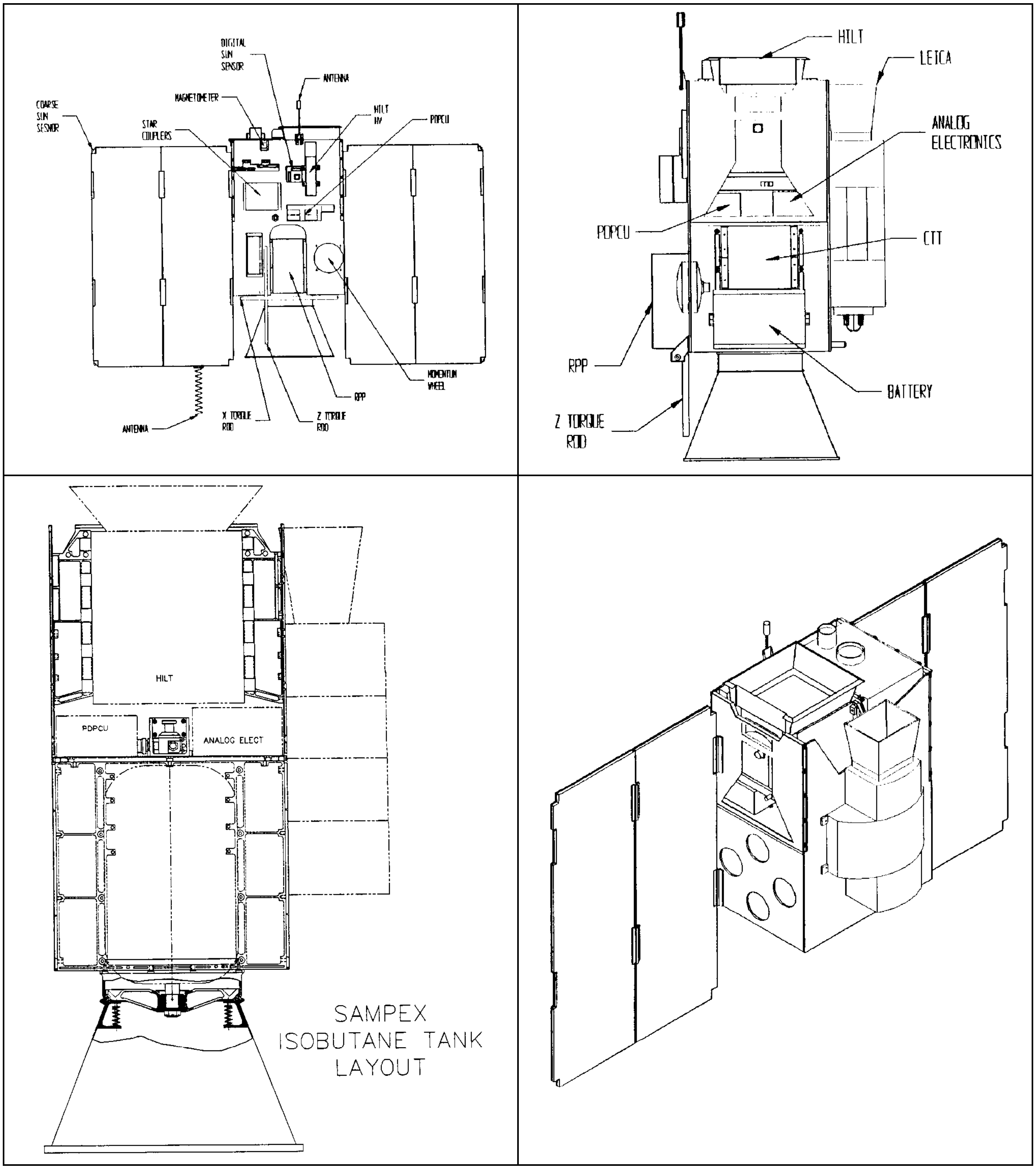

Figure 1-3
SAMPEX Spacecraft

Recorder/Processor/Packetizer (RPP)

The Recorder/Processor/Packetizer (RPP) provides storage for 26.5 Mbytes, packetizes commands and telemetry and is used as a general purpose processor.

The RPP supports general spacecraft control functions and specific control functions such as attitude control.

For general spacecraft control, the RPP monitors data to determine the general status of the spacecraft, instruments and the data system. The RPP checks critical parameters to determine if limit conditions have been exceeded. If they have, the RPP executes predefined stored command sequences. Working in conjunctions with safehold mechanisms, the RPP periodically performs a variety of self tests and reports its status to watchdog systems such as attitude control safehold system.

Command and Telemetry Terminal (CTT)

The Command and Telemetry Terminal (CTT) is a remote terminal that has been configured to connect the transponder to the rest of the data system.

The CTT provides:

- uplink command processing
- downlink telemetry encoding
- spacecraft time management
- local telemetry acquisition and command distribution
- system monitoring

The CTT provides processing for commands and telemetry and can acquire control of the spacecraft if the RPP fails.

CTT supports low rate (<100 kbps) communication requirements of instrument; provides telemetry data acquisition; provides command output distribution; and provides debug interfaces for integration and test (I&T) support.

CTT provides command interpretation, 1553/1773 depacketization, sensor read/condition, housekeeping, attitude determination, self diagnostics, etc.

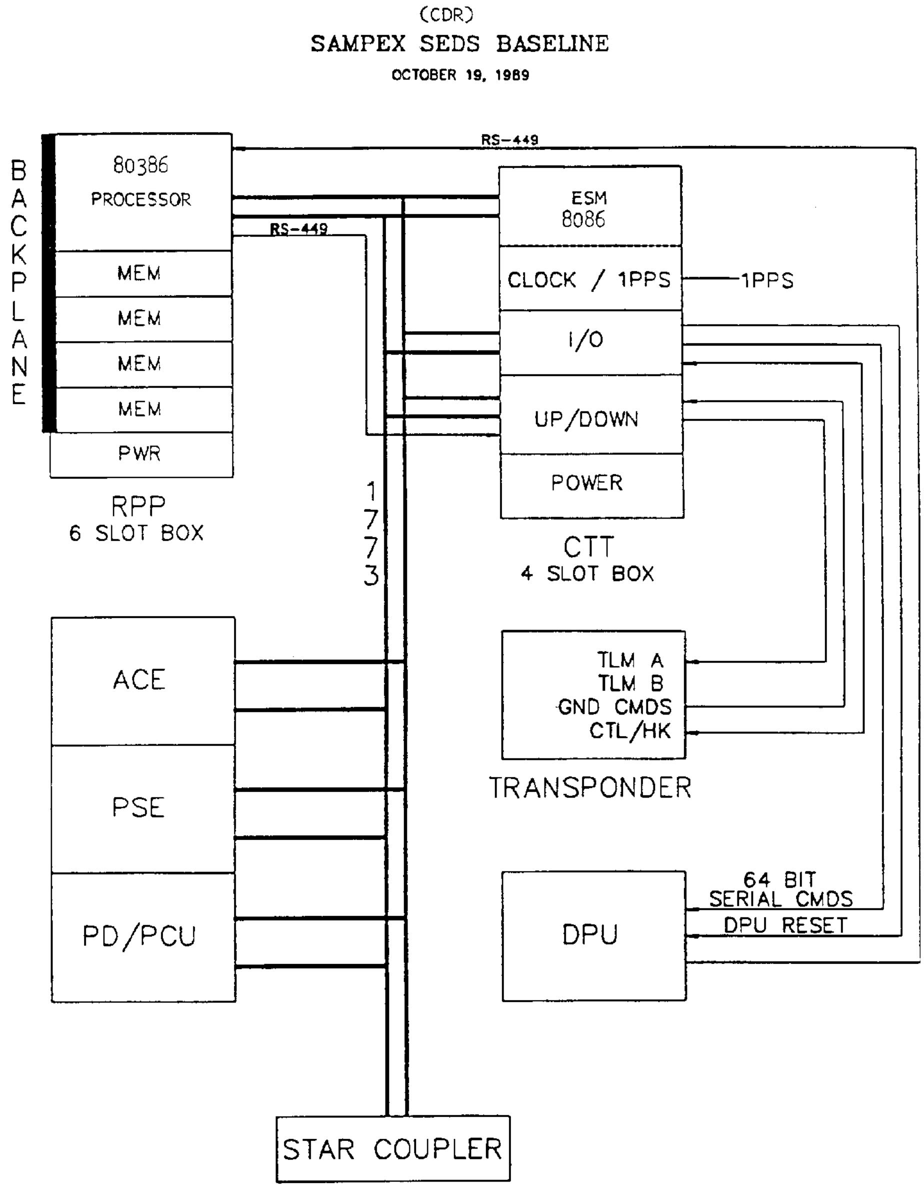

Figure 1-4
SEDS Block Diagram

Attitude Control System

The Attitude Control System (ACS) is designed as a solar pointed/momentum biased system using the momentum wheel to orient the experiment viewing axis about the sun vector. The sensor and actuator complement consists of one Fine Sun Sensor, five Coarse Sun Sensors, and Magnetometer, three Torque Rods, and one Momentum Wheel. The spacecraft pitch axis is kept within 5 degrees of sun line at all times. The spacecraft yaw axis (experiment boresight) should approach the zenith (local vertical) vector in the polar regions during science operations. The spacecraft yaw axis is maintained at an angle greater than 45 degrees from spacecraft velocity vector during science operations. Ground reconstruction of the spacecraft attitude is required to be less than 2 degrees.

An Attitude Control Electronics (ACE) Box which contains signal conditioning electronics and an independent analog safehold mode completes the ACS hardware manifest. SEDS performs closed loop real-time attitude determination and control processing. Three-axis attitude determination is provided by comparing the local measured sun vector and magnetic field vector with an on-board ephemeris model. Digital control of the spacecraft attitude is completed by sending appropriate command signals across the spacecraft data bus to the actuators.

Antenna System

The SAMPEX antenna system is composed of two quadrifilar helices, two 90° hybrid junctions, and a power divider. These omnidirectional antennas are located on the top of the spacecraft and on the bottom of a solar panel. The top antenna is a half-turn quadrifilar with a 150° beamwidth. The bottom antenna is a three-turn quadrifilar with a 210° beamwidth. (In this context, the beamwidth is defined as that view sector of a principle plane where the gain meets or exceeds -5 dBi as required). Each antenna is fed with a 90° hybrid junction to create the proper phasing between elements. A power divider feeds each hybrid junction to create the proper phasing between elements. A power divider feeds each hybrid junction with a single of equal amplitude and phase. This system is designed to operate over a 2025-2300 MHz frequency range.

Transponder

An S-Band transponder operating in full duplex mode provides the reception of uplinked commands, transmission of telemetry data and support of the Doppler tracking by the designated ground station. The received uplink is transmitted as Non-Return to Zero (NRZ) bi-phase modulated synchronously on a 16 Kilohertz (KHz) subcarrier. The command data rate is 2 kilobits/second (kbps). The telemetry output signal is modulated on the transmitter to produce the downlink signal. The transmitter modulation bandwidth is 3 Megahertz (MHz) and its output power is 5 watts. The S-band transponder interfaces with the S-band antenna and the SEDS CTT.

LAUNCH VEHICLE

The standard Scout launch vehicle is a solid-propellant, four-stage booster system providing an efficient means of boosting a spacecraft on a planned trajectory.

LAUNCH SITE

The launch site for the SAMPEX mission was located at the Western Test Range (WTR) at Vandenberg Air Force Base (VAFB), California. The Scout support facilities consist of the NASA Spacecraft Laboratory Ordnance Assembly Building (OAB) and Spin Test Facility (STF).

1.3 INSTRUMENT OVERVIEW

The four SAMPEX scientific sensors each address a subset of the required measurements with enough overlap in energy range and response to allow intercalibration and partial redundancy.

The four sensors, and the major institutional responsibilities are the Low Energy Ion Composition Analyzer (LEICA), the Heavy Ion Large Telescope (HILT), the Mass Spectrometer Telescope (MAST), and the Proton/Electron Telescope, (PET). LEICA is being provided by the University of Maryland, HILT by the Max-Planck-Institut fur Exterrestrische Physik, MAST/PET by Caltech and GSFC Codes 660/690, and the DPU by the Aerospace Corporation.

As shown in figure 1-5, the four sensors are serviced by a common Data Processing Unit (DPU), provided by the Aerospace Corporation. The DPU has the single data interface with the Small Explorer Data System (SEDS). Spacecraft housekeeping data is sampled through a 1773B fiber optic data bus. A one Hertz timing pulse is sent to the Attitude Control Electronics (ACE) box and the DPU, providing a fiducial from which the exact timing of each second is obtained.

The measurements made by these four instruments for electrons, and for typical ion species are summarized in the Table 1-1. The basic techniques used are time-of-flight vs. energy (LEICA), or dE/dx versus residual energy (HILT, MAST/PET).

More detailed descriptions of the SAMPEX mission, the four sensors, and the DPU may be found in a series of six articles in the May/June 1993 issue of IEEE Transactions on Geoscience and Remote Sensing (Vol. 31, No. 3).

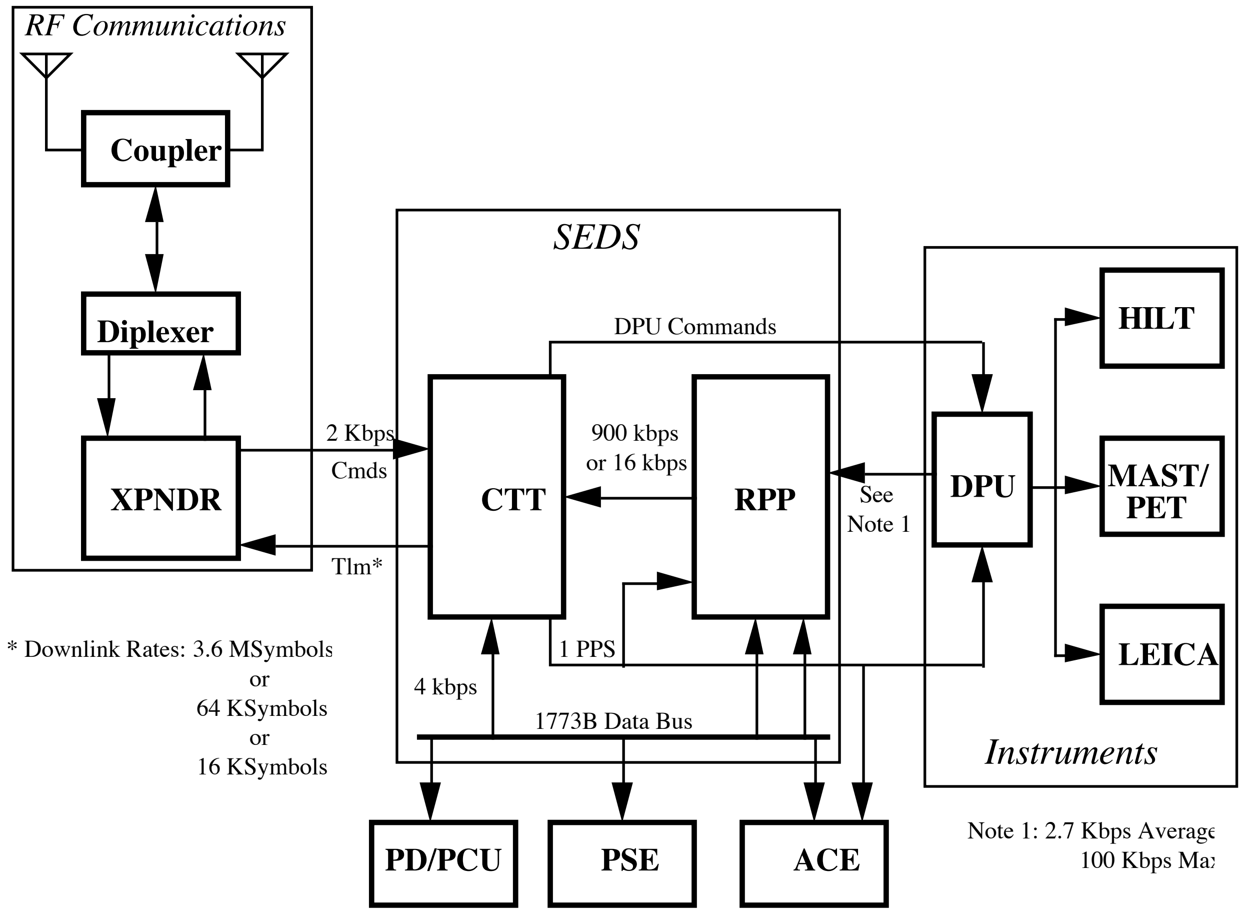

Figure 1-5
Instruments and Major Subsystems

1.3.1 Low Energy Ion Composition Analyzer (LEICA)

LEICA is provided by the University of Maryland. LEICA measures elemental and isotopic abundances over the range from about 0.35 to 10 MeV/nucleon. The instrument is a time-of-flight mass spectrometer that identifies incident ion mass M and energy by simultaneously measuring the time-of-flight and residual kinetic energy E of particles that enter the telescope and stop in one of the array of four Si solid state detectors. Figure 1-6 shows the basic construction of the LEICA instrument.

Low Energy Ion Composition Analyzer (LEICA)

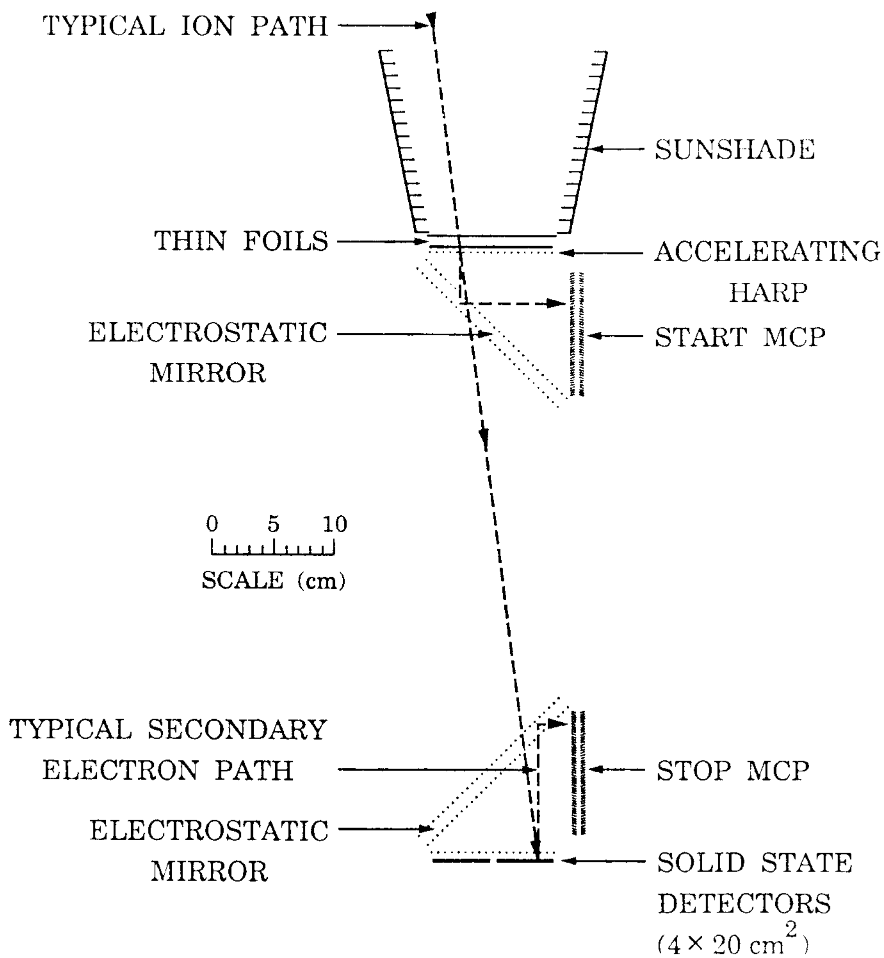

Figure 1-6
LEICA Instrument Diagram

1.3.2. Heavy Ion Large Telescope (HILT)

HILT is provided by the Max-Planck-Institut fur Extraterrestrische Physik and Aerospace Corporation. The HILT sensor is a large geometry factor (50 cm^2 sr) instrument designed to measure anomalous cosmic rays near the intensity maximum of their spectrum. This will allow statistically accurate heavy nuclei spectral and cutoff measurements required for determination of the ACR charge state, as well as the charge states of solar energetic particles. HILT determines particle type by the dE/dx vs. E method; particle trajectory angle is also determined allowing magnetic cutoff rigidity determination to be done by ground-based computers. Figure 1-7 shows the construction and major detector parts of HILT.

Heavy Ion Large Telescope (HILT)

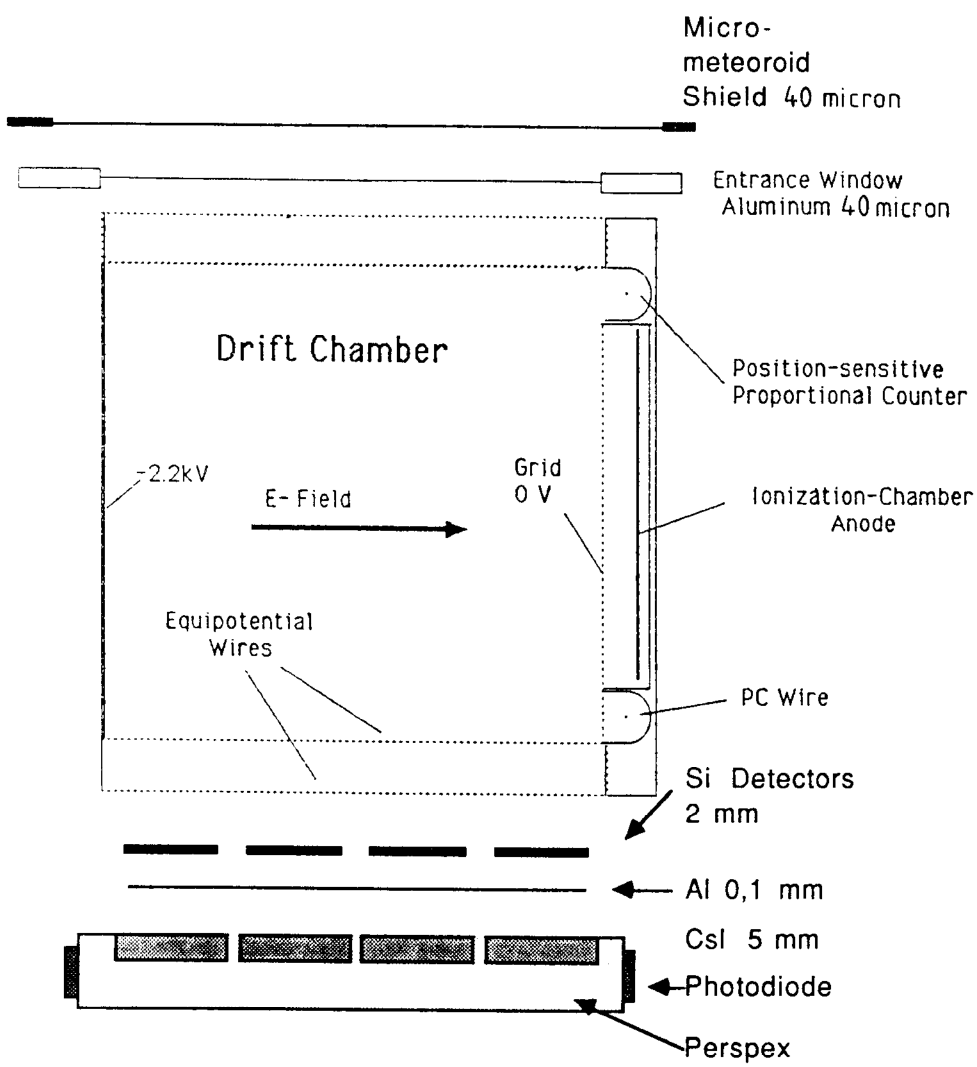

Figure 1-7
HILT Diagram

1.3.3 Mass Spectrometer Telescope (MAST)

MAST is provided by the California Institute of Technology, and Goddard Space Flight Center. MAST measures the isotopic composition of elements from Li to Ni in the range from ~ 10 MeV/nucleon to several hundred MeV/nucleon. MAST consists of a combination of surface barrier and lithium-drifted solid-state detectors. The first four detectors are one-dimensional position-sensitive detectors that accurately determine particle trajectories in order to permit corrections for path length and detector non-uniformities. Isotope identification is accomplished by the standard dE/dx vs. E technique and a resolution of s_m ~ 0.3 amu will be achieved, sufficient to resolve isotopes with abundance differences of ~ 100:1. The MAST detector layout is shown in figure 1-8.

Mass Spectrometer Telescope (MAST)

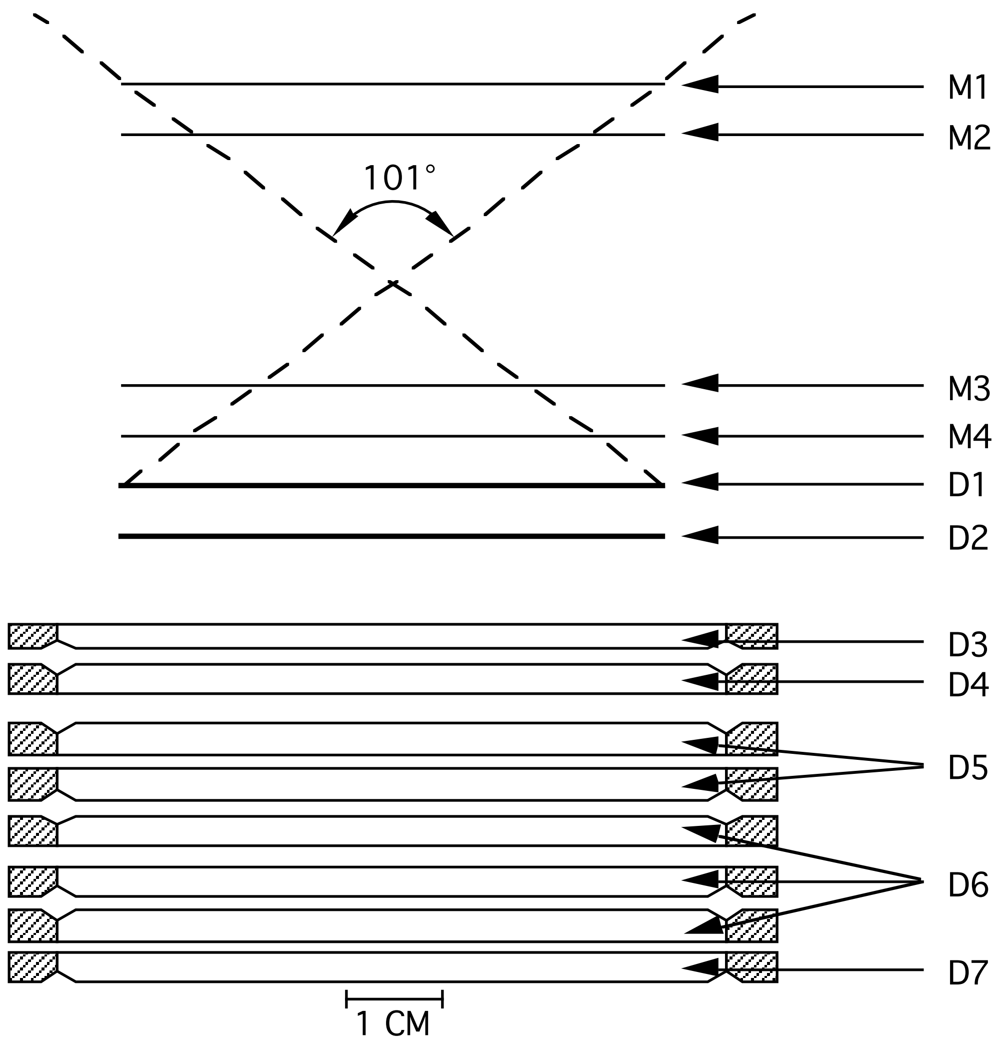

Figure 1-8
MAST Diagram

1.3.4 Proton/Electron Telescope (PET)

PET, the Proton/Electron Telescope, is provided by the California Institute of Technology and Goddard Space Flight Center. The PET system is an all-solid state detector telescope to allow the measurement of electron spectra from ~ 1-30 MeV and H and He spectra from ~20 to several hundred MeV/nucleon. As shown in Figure 1-9, PET has a field of view of 58°.

Proton/Electron Telescope (PET)

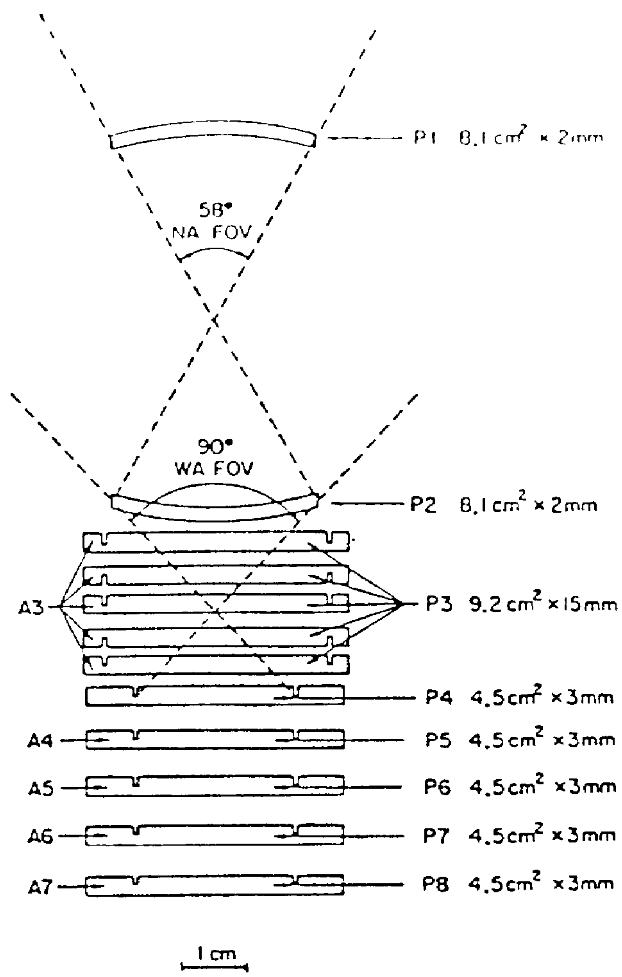

Figure 1-9
PET Diagram

Table 1-1.
SAMPEX SCIENTIFIC INSTRUMENTS

	LEICA	HILT	MAST	PET
Energy range for: electrons*	--	--	--	1-30 MeV
H*	0.75-8	--		18-250 MeV
He*	0.4-8	3.9-90	7-15	18-350 Mev/nuc
C*	0.35-12	7.2-160	12-140	
Si*	0.26-18	9.6-177	19-345	54-195 MeV/nuc
Fe*	0.16-25	11.0-90	24-470	
Charge range for elements*	1-28	2-28	2-28	1-28
Charge range for isotopes*	2-16	2	2-28	1-2
Geometry factor (cm2 sr)*	1.0	50	7-14	0.3-1.6
Field of View (deg full angle)	24 x 20	90 x 90	101	58
Mass (kg)	7.4	22.7	8.8	(incl. with MAST)
Power (W)	4.9	7.0	5.3	(incl. with MAST)
Telemetry (kbps)	1.3	0.9	1.3	0.4

*-Controlled, Level 1 requirement.

Total experiment mass: 38.9 kg (scientific sensors)
4.0 kg (DPU + LVPS)
Subtotal: 42.96 kg

Total experiment power: 17.2 W (from above) + 5.3 W (DPU) = 22.5 W

Isobutane Tank and 3 year gas supply for HILT sensor: 9.33 kg

2.0 PROJECT DATA MANAGEMENT REQUIREMENTS

2.1 END-TO-END DATA FLOW

2.1.1 Planning and Scheduling

Spacecraft planning and scheduling refer to the determination of spacecraft operations and the coordination of ground system elements to ensure successful science data collection. Science operations for the SAMPEX mission can be described as routine (as opposed to missions which have a campaign or an interactive style of operations). There is no daily interaction planned between instrument representatives and the spacecraft, and instrument command functions for routine operations will be performed by the onboard Data Processing Unit (DPU). The DPU is responsible for overall control of the science payload and controls the data acquisition from each instrument and packetizes science data for recording by the Small Explorer Data System (SEDS).

2.1.1.1 Planning

The scheduling of instrument observations is performed autonomously by the spacecraft. Routine instrument operations are performed by the onboard DPU. No additional instrument command activity occurs on a daily basis. HILT and LEICA in-flight calibrations are performed on a monthly basis. All other requests for instrument activities to be performed are on a special request basis. Requests for special operations originate from the instrument representatives and are transmitted to the Flight Operations Team (FOT) using the University of Maryland Science Operations Center (UMSOC) as intermediary. The UMSOC is the primary point of contact between the FOT and the experimenters; however, the UMSOC may instruct the FOT to accept requests for instrument commands directly from designated members of the individual instrument teams. Requests for special operations are transmitted to the FOT by means of the Space Physics Analysis Network (SPAN) or by means of fax transmission.

Science data are recorded onboard the spacecraft in the SEDS. The precise details of the data sampling and recording scheme is described in section 2.1.3, the Space Segment. With respect to planning and scheduling operations it is important to note that:

a. Science partition playbacks may only be done when the RPP is in normal mode and the downlink data rate is 900 Kbps.

b. The science partition is sized to nominally fill up every 12 hours.

The data are played back twice per day at the Wallops Island Orbital Tracking Station. Playback data quality statistics from ground system elements are compared against spacecraft telemetry to verify the quality of the downlink. Should the recorder dump quality be unacceptably low a Wallops support on the following orbit will be scheduled. Next-orbit playback opportunities occur approximately 40% of the time. If the science partition is not successfully dumped at Wallops on the primary or next-orbit opportunity, the partition will not be released. Additional science data will be recorded and playback will be attempted again at the next Wallops acquisition, approximately 12 hours later. Since only about one third of the science partition is filled during quiet periods, science return is maximized by not releasing the science partition. After October 1993, the DSN provides a secondary backup capability for science recorder operations.

2.1.2 Operational Data Flow

This section provides a high level definition of the flow of data from the instrument package to the University of Maryland Science Operation Center (UMSOC), the primary science data distribution center for SAMPEX. Figure 2-1 illustrates the operational data flow of the SAMPEX mission. The SAMPEX data transmission system includes a space segment and a ground segment.

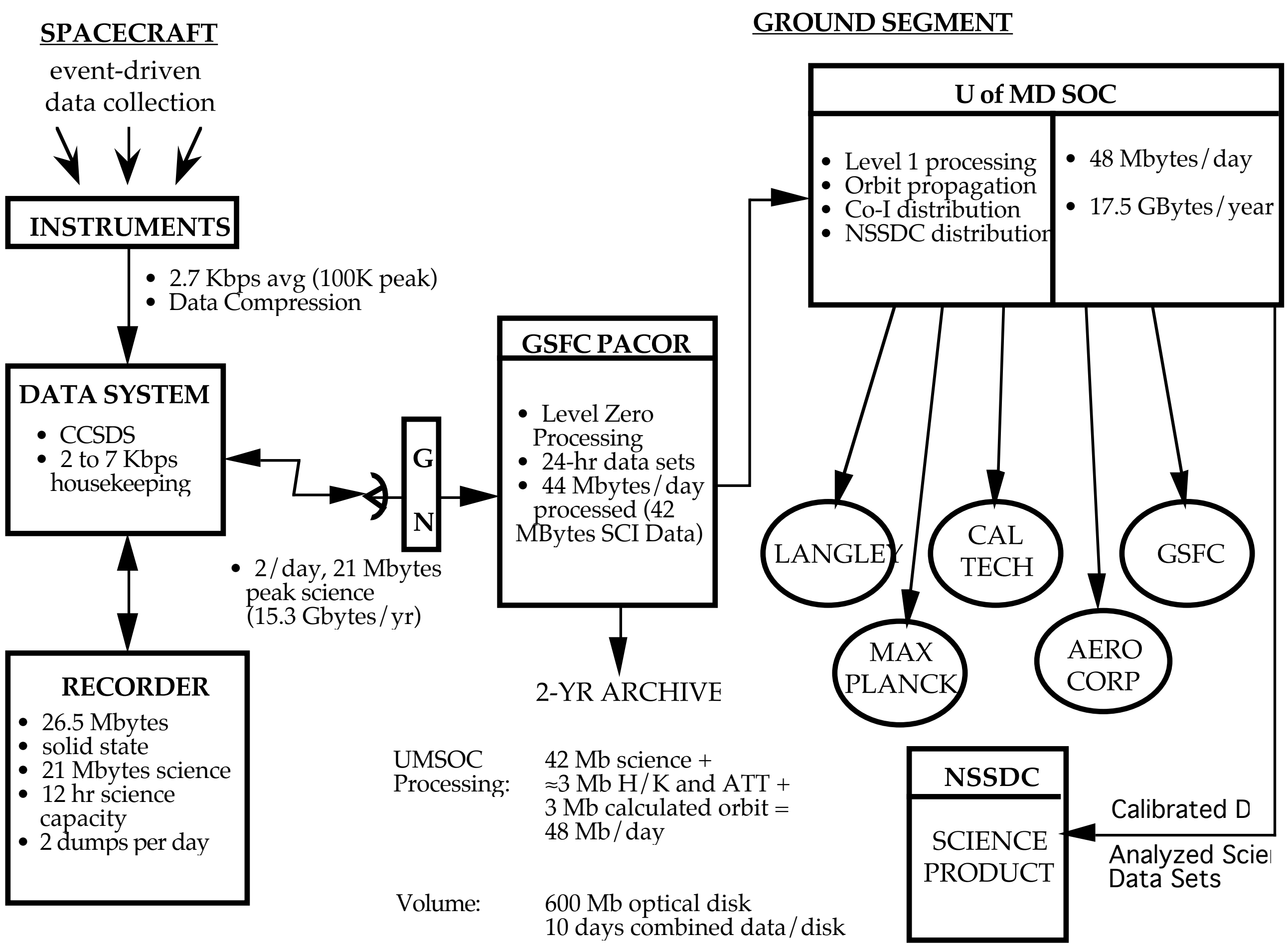

Figure 2-1
Operational Data Flow

The science payload is controlled by the Data Processing Unit (DPU). The DPU collects and packetizes science data for delivery to the spacecraft. The DPU routes appropriate data to the Small Explorer Data System (SEDS) for recording. A solid state recorder dump occurs twice per day at the Wallops Flight Facility (WFF). WFF transfers the data stream to the Goddard Space Flight Center (GSFC). The Packet Processor (PACOR) interfaces with the ground station via NASCOM, and records all incoming data. All data transfers to PACOR occur during real-time contacts with the spacecraft or by playback from the ground station.

PACOR performs level zero processing on the incoming telemetry, and extracts the science data. PACOR transmits the science data sets to the UMSOC in 24 hour blocks. The UMSOC is responsible for routing the science data to the various science investigators. UMSOC establishes the timeline for distribution of instrument specific data sets.

2.1.3 Space Segment

The SAMPEX spacecraft was placed by the SCOUT launch vehicle into an 82 degrees inclined, polar, elliptical orbit on July 3, 1992. The final spacecraft orbit was 512 x 685 km. This orbit is not sun-synchronous. The minimum anticipated mission duration is 3 years with a strong objective of achieving a six year mission. With the successful launch, the payload has a better than 98.5% probability of achieving 9 years in orbit. Table 2-1 describes various SAMPEX tracking and data acquisition parameters.

The space segment transports data from the instruments, through on-board data processing and communication systems, and through transmission to the ground. The spacecraft subsystems involved in the space segment data flow are the instruments, DPU, SEDS, and the transponder. The DPU collects data from the instrument package and transfers it to the SEDS for recording.

Table 2-1

Orbital Parameters	Apogee: 685 Km Perigee: 512 Inclination: 82°
Data Rate	Peak: Playback + R/T = 900 Kbps Average: R/T = 16 Kbps
Contact Frequency & Duration	4 contacts/day 8-14 min/contact Orbital Fraction: 2.7%
Contact Period Constraints	Limited by orbital period (ground station visibilities)

2.1.4 Ground Segment

The SAMPEX ground segment elements directly involved in the transmission and processing of science data are the ground stations, the POCC, PACOR and the UMSOC. Spacecraft telemetry data are downlinked to the receiving ground station, where the data are transferred via NASCOM to the POCC and PACOR. A high level diagram of the relationships and interfaces between these ground segment elements can be seen in Figure 2-2.

2.1.4.1 Data Handling

a) Level Zero Processing. The following list outlines the Level Zero Processing (LZP) and functions performed by PACOR:

- Data capture
- Transfer frame extraction from NASCOM blocks
- Checking of cyclical redundancy code (CRC)
- Separation of virtual channels, packet extraction and reassembly
- Logging of received playback transfer frames to magnetic media
- Grouping and time ordering of data sets by APID for users
- Deletion of redundant data (optional)
- Quality and accounting data generation
- Store and forward prepared data sets to users via electronic transfer

b) Data Quality Checks. Data transmission quality checks are performed during real-time and playback transmissions from WPS to the POCC and PACOR by each participating node. At a minimum, the transmission checks include the processing and data quality checks shown in Table 2-2.

Telemetry data are monitored as received to detect any data loss/problems. The POCC, PACOR and WPS uses voice nets to coordinate data quality and accounting information.

PACOR provides quality accounting information to UMSOC for the level zero processed data. The message trailer for each data set transmitted to UMSOC from PACOR includes a quality and accounting capsule (QAC) containing information on each packet in the data set for which an error was detected. The entry will identify the packet and error detected, such as:

- Application process ID incorrect
- Packet length code incorrect
- Mission ID incorrect
- Source sequence count discontinuity/error
- Detect frame errors during this packet

UMSOC provides PACOR with reports on transmission status and quality of data:

- A weekly summary of quality and quantity of data.

- UMSOC will provide timely response on suspected anomalous transmissions.

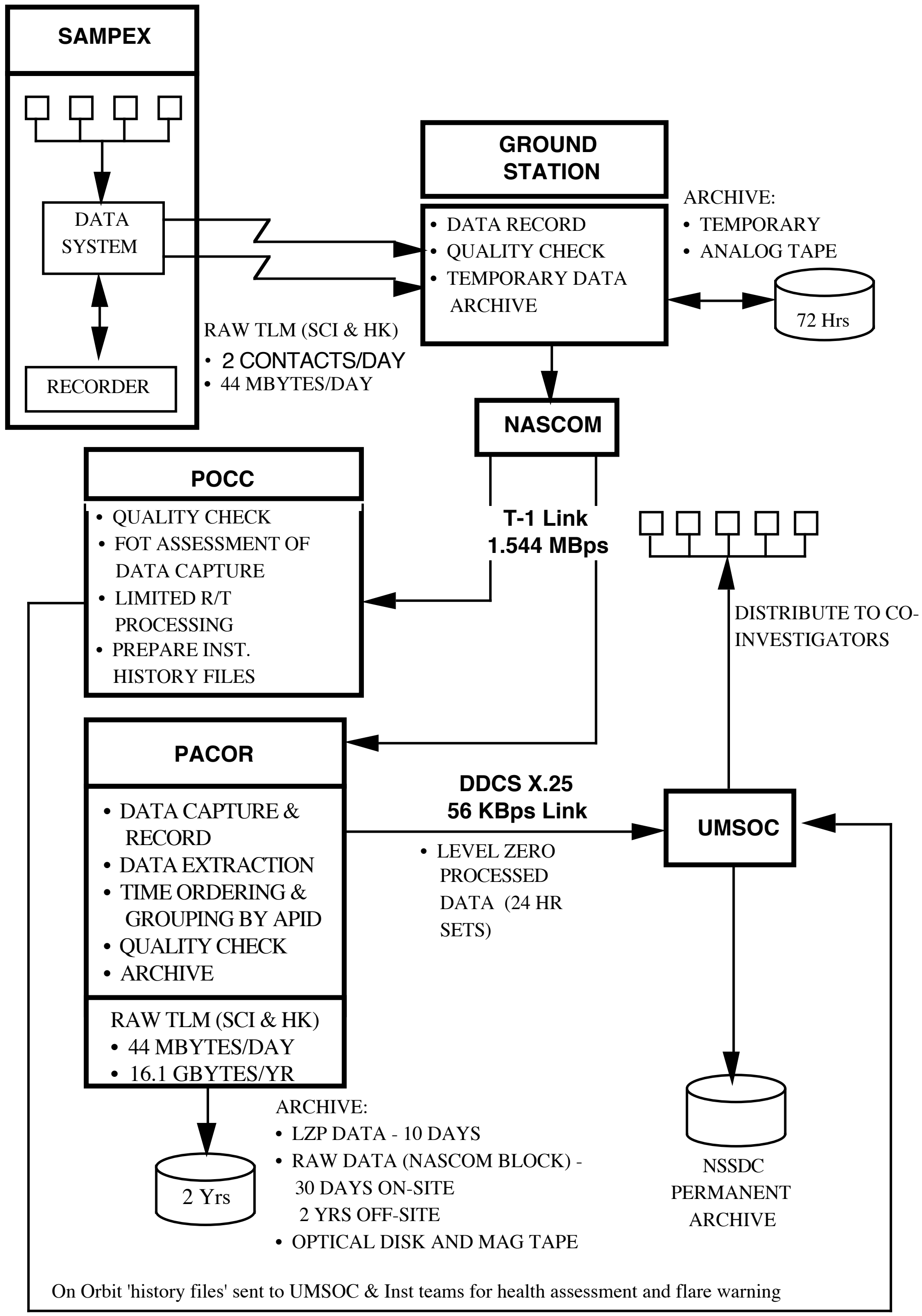

Figure 2-2
SAMPEX Ground Segment

If the data quality is determined to be inadequate, retransmission occurs:

- During real-time, PACOR provides data quality information to the FOT (in the POCC) in time to re-dump the spacecraft recorder if necessary.
- If the data recorded at the ground station are adequate, a post pass playback will be scheduled.
- For data transmitted from PACOR to the UMSOC:
  UMSOC can request data retransmission via phone call or FAX request
  For data ≤ 30 days old, retransmission will occur within 4-8 hours of the request.

For data > 30 days old, retransmission will occur within 3 working days of the request.

c) Physical Data Handling. Data are transmitted via electronic links between the ground station and the POCC, the ground station and PACOR, and PACOR and the UMSOC. The data are stored on analog tapes at the ground station and on optical disk (short term) and magnetic tape (long term) by PACOR. UMSOC distributes the science data on rewritable magneto-optical disks to all the co-investigators (Langley Research Center, Max Planck Institute, Caltech, Aerospace Corp. and Goddard Space Flight Center).

Table 2-2.

Quality Checks Performed at Various Ground System Elements

Data Quality Check	WPS	POCC	PACOR
Total # of NASCOM blocks sent/received	X	X	X
Total # of valid NASCOM blocks received		X	X
Total # of command echo blocks sent/received	X	X	
Total # of non-telemetry blocks sent/received	X	X	
Total # of CRC error blocks		X	X
Total # of sequential error blocks		X	X
Total # of telemetry transfer frames received	X	X	X
Total # of valid telemetry transfer frames received	X	X	X
Total # of valid telemetry transfer frames received for each virtual channel	X	X	X
Total # of CRC error frames for each virtual channel		X	X
Total # of sequential error frames for each virtual channel		X	X

2.1.4.2 Data Archives

Table 2-3 provides information regarding data archival parameters.

2.1.4.3 Network

a) Sites. SAMPEX is supported by the Wallops Island Orbital Tracking Station and the Deep Space Network (Madrid and Canberra ground stations). Wallops facilitates recorder dumps, spacecraft housekeeping data and attitude data twice per day. The DSN sites accommodate only the spacecraft housekeeping and attitude data. Spacecraft data from these sites are forwarded to the POCC and PACOR in parallel via NASCOM.

b) Data Types SAMPEX science and housekeeping data are downlinked as raw telemetry data in CCSDS format and transmitted to the POCC and PACOR in NASCOM blocks.

c) Required Capacity. WPS supports science data recorder dumps, and receives the 4K, 16K and 900 Kbps downlink telemetry rate. The DSN sites only receive the 4K and 16 Kbps downlink telemetry rate. The DSN anticipates station upgraded in October 1993, which will allow for the 900 Kbps telemetry rate. Note: Downlink rates stated are for spacecraft data prior to Bi-phase and Viterbi encoding.

The data are transmitted from the ground station to the POCC and PACOR on a 1.544 Mbps NASCOM T-1 link. Level Zero processed data are transmitted from PACOR to the UMSOC on a 56 Kbps NASCOM DDCS X.25 link

d) Standards and Protocol. All SAMPEX data will be in CCSDS format. Data are transmitted from the ground station to the POCC and PACOR in NASCOM blocks. Data are transmitted from PACOR to the UMSOC in NASCOM DDCS X.25 protocol.

Table 2-3
Data Archival Parameters

Location	Data Type	Data Volume*	Storage Duration	Storage Media
WPS	Raw Data (NASCOM blocks)	21 Mbytes/contact ~ 2 contacts/day	72 hours	Analog Tape
PACOR	Raw Data (NASCOM blocks)	44 Mbytes/day 16.1 Gbytes/year	30 days - on site 2 years - off site	Optical disk and magnetic tape
	LZP Data	42 Mbytes/day 15.3 Gbytes/year	10 days - on site	

* Does not include fill data or NASCOM overhead

2.2 DATA DESCRIPTION

The Instrument Data Processing Unit reads data from each of the four instruments, performs a selection algorithm on the sensor data, and forwards the approved data to the SEDS for storage. The selection algorithm provides efficient use of the solid-state memory aboard the spacecraft. The instruments can generate very high, event-driven data rates and the spacecraft can record only a small interval of data at the highest rates. The algorithms apportion the available data storage on a periodic basis and prevent the spacecraft recorder from filling up the full day's allocation of memory due to a unusually intense burst of radiation. Data storage allocation is based on a bytes per orbit allocation, where an orbit is loosely defined as 90 minutes. There are a total of 6 orbit-based memory quotas decremented when the associated data packet is output to the SEDS. Independent memory quotas are maintained for each of the four instrument's event packets, as well as the HILT and PET high resolution rate packets.

The DPU also generates orbital history data, which are comprised of 48 or 96 second averages of the selected counting rates and housekeeping parameters over the latest 96 minutes. These history data are downlinked in VC0 during each acquisition and serve as a quick check of instrument health and particle intensities over the latest orbit. Instrument housekeeping data are collected by the DPU. The data are packaged in the subcommed science packets and in the DPU housekeeping packets.

The SAMPEX spacecraft and instruments generate a variety of housekeeping telemetry and ancillary data, including voltage monitors, current monitors, thermistors, relay statuses, mode indications, and various counters. There is detailed information covering the behavior of the flight data system and software. The Attitude Control System also generates a large quantity of telemetry, including attitude quaternions, orbit propagator results, intermediate ACS algorithm results, actuator commands and ACS sensor data. The exact content of each SAMPEX packet can be found in the SAMPEX Telemetry and Command Handbook (GSFC-S-740-90-968). Additional information is contained in various subsystem telemetry and command descriptions and users' guides, including the SEDS Flight Software Users' Guide, the Telemetry Packet Description for the SAMPEX Data Processing Unit, the DPU and Sensor Command Description. The Instrument processing schemes and algorithms are presented in the Data Handling Strategy for the SAMPEX DPU.

Table 2-4 defines the packets generated by SAMPEX, with the packets to be delivered to the UMSOC identified by shading. The UMSOC ingests the level 0 data from PACOR via an X.25 network link. The incoming data are stored by a Vaxstation 3100, Model 72 onto a 426 Megabyte Winchester disk drive and later archived (for the duration of the mission) onto 600 Megabyte rewritable optical disks. Level 1 processing is performed by the University of Maryland to produce Master Data Files (MDF), which includes all the level 0 data plus calculated ephemeris and magnetic parameters. The Master Data Files are formatted using the "Tennis Standard" adopted by the SAMPEX Science Team. At approximately 10 day intervals, the UMSOC mails rewritable optical disks containing accumulated MDFs to the co-investigators and to the NSSDC. The UMSOC includes an additional Vaxstation 4000, Model 60, which is primarily used for Level 1 processing, the generation of standard rate plots, and the production of MDF copies, and a third Vaxstation 4000, Model 90, which is primarily used for LEICA science analysis (Figure 2-3). Access is provided via 8 terminal ports, and network logins. Bulk I/O devices include a streamer tape drive, a CD-ROM optical disk reader, two single rewritable optical disk drives, two rewritable optical disk jukeboxes (16 disk capacity) with single drives, an 8mm tape drive, and magnetic disks.

Table 2-4
SAMPEX Packet List

APID	VC	Size	Description	APID	VC	Size	Description
1	0,1	304	SEDS FSW Mode Independent Status Data	22	0,1	50	ACE Safehold Status
2	0,1	784	Normal Mode Status Packet	23	0,1	54	ACE Diagnostic Command Response
3	0,1	528	Launch Mode Status Packet	24	0,1	50	ACE Raw Sensor Data
4	0	80	Real-time Significant Event Packet	26	0,1	160	ACS Contamination & Calibration Matrices
5	0	80	Playback Significant Event Message Packet	30	0	144	CTT Memory Dwell Packet
6	0	228	RPP Table Dump Packet	31	0	144	RPP Memory Dwell Packet
7	0	228	RPP Memory Dump Packet	32	0,1	72	SEDS Data Type Diagnostic Packet
8	0	228	CTT Table Dump Packet	33	0	500	HILT History Packet
9	0	228	CTT Memory Dump Packet	34	0	500	LEICA History Packet
10	0,1	18	ACS Mode Status Message	35	0	512	MAST History Packet
11	0,1	42	ACS Attitude Determination	36	0	506	PET History Packet
12	0,1	100	ACS Command Status Message	37	0	380	DPU History Packet
13	0,1	132	ACS Orbit Data	38	0	96	Real Time DPU Housekeeping
14	0,1	224	ACS Statistics Diagnostics	39	0	122	Real Time Status
15	0,1	528	ACS Attitude Diagnostics	40	0	30	Real Time Command Error Echo
16	0,1	184	ACS Control Diagnostics	41	0	20	Real Time DPU State Change
17	0,1	320	ACS Configuration Diagnostics	42	2	var.	Subcommed Instrument Data
18	0,1	150	CTT I/O Card	43	0	278	EEPROM/LCA Memory Dump
19	0,1	66	PD/PCU Analog and Relay Status	44	0	276	DPU memory Dump
20	0,1	86	PSE Analog and Bilevel Telemetry Status	45	0	60	DPU Parameter Dump
21	0,1	60	ACE Housekeeping Data				

Note: Shaded packets are delivered to the UMSOC.

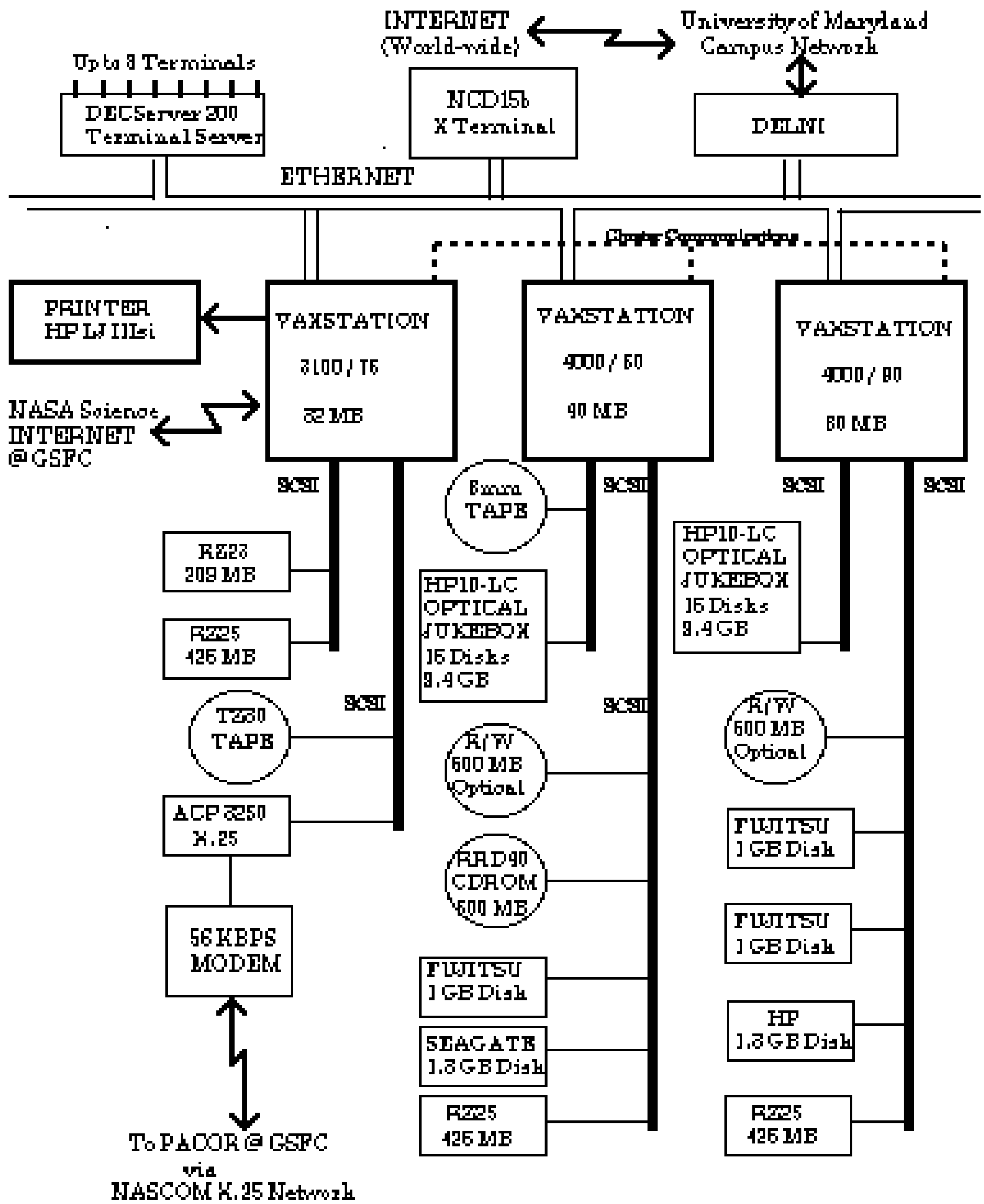

FIGURE 2-3
University of Maryland Science Operations Center

2.2.1 LEICA Data Overview

2.2.1.1 Raw Data

The Low Energy Ion Composition Spectrometer (LEICA) returns data of four types: rate data, event data, housekeeping data, and status data.

RATE DATA consist of counts of various LEICA detectors or combination of detectors accumulated over 6-second periods. The 12 LEICA counting rates are listed in Table 2-5.

The LEICA EVENTS return detailed information on a single ion including time-of-flight, energy signal, SSD ID, priority ID, and directional information. Since in general only a sample of detailed events can be accommodated by the telemetry, the instrument uses the priority ID to ensure a reasonable representation of light and heavy nuclei.

LEICA HOUSEKEEPING DATA include information on temperatures, low and high voltage monitors. The LEICA STATUS DATA include enable/disable information on the detectors and the high voltage and values specifying the slope of the slant discriminator. LEICA history data include a selection of rates and housekeeping values for use in quickly determining instrument health and general particle environment.

Table 2-5
LEICA Rate Data

Rate Acronym	Type	Response	Energy Range
D1	Single	All ions & electrons	>800 keV (P); >600 (e)
D2	Single	All ions & electrons	>800 keV (P); >600 (e)
D3	Single	All ions & electrons	>800 keV (P); >600 (e)
D4	Single	All ions & electrons	>800 keV (P); >600 (e)
START	Single	All ions & electrons	>250 keV(P);>30 keV(e)
STOP	Single	All ions & electrons	>250 keV(P);>30 keV(e)
DCR	Coincidence	All ions	>250 keV (P)
TCR	Coincidence	All ions	0.8-6.0 MeV (P)
Hi Priority	Coincidence	Z>2 ions	0.49-8.3 MeV/nuc
Lo Priority	Coincidence	He	0.5-6.6 MeV/nuc
Protons	Coincidence	H	0.8-6 MeV
IFC Counter	Not a particle rate		

2.2.1.2 Analyzed Science Data

LEICA is designed to measure the elemental abundances, energy spectra, and direction of incidence of ions from helium to iron in the approximate energy range 0.5 - 10 MeV/nucleon. The information from the LEICA Event Data determines the charge, kinetic energy, and direction of arrival of each analyzed event. Fluxes as a function of species, energy, and time are constructed by combining the Event Data with the Lo and Hi Priority normalizing rates. Solar energetic particles, anomalous cosmic rays, and magnetospheric particles are separated using their temporal and spatial variations.

2.2.2 HILT Data Overview

2.2.2.1 Raw Data

The Heavy Ion Large Telescope (HILT) returns four types of data: rate data, pulse-height event data, housekeeping data, and status data. The time resolution and characteristics of HILT rate data are summarized in Table 2-6.

The EVENT data provide the response of all sensor elements to individual ions. The 12 parameters measured for each event allow the determination of the ion's energy, nuclear charge, atomic mass (for light ions), and direction of incidence. The HILT event selection logic defines a total of 4 event types, corresponding to four coincidence rates (see Table 2-6). The maximum number of events per second of every event type can be defined by ground command, and the total number of HILT events per orbit is determined by the memory allocation algorithms of the DPU. This allows the optimization of the operation of the instrument under various conditions, e.g., in the magnetosphere and during solar flares.

Table 2-6
HILT Rate Data

Rate Acronym	Time Resolution(s)	Rate Type	Ion	Energy Range (MeV/nucleon)	
HE1	6	Coincidence	He	4.3 - 9.0	
HE2	6	Coincidence	He	9.0 - 38	
HZ1	6	Coincidence	Z>2	8.2 - 42	
HZ2	6	Coincidence	Z>2	42.0 - 220	
SSD1	24	Single	All ions	>5	(P)
SSD2	24	Single	All ions	>5	(P)
SSD3	24	Single	All ions	>5	(P)
SSD4	24	Single	All ions	>5	(P)
PCFE	48	Single	All ions	2.5 - 8	(P)
PCRE	48	Single	All ions	2.5 - 8	(P)
IK	48	Single	Z≥2	3.0 - 9	(He)
CsI	48	Single	All ions	>22	(P)
HSS1	0.1	Single	All ions	>4	(P)
HSS2	0.1	Single	All ions	>4	(P)
HSS3	0.1	Single	All ions	>4	(P)
HSS4	0.1	Single	All ions	>4	(P)
HPCRE	0.1	Single	All ions	2.5 - 21	(P)
HIK	0.1	Single	All ions	2.5 - 7	(P)

The DPU generates HOUSEKEEPING DATA of a number of HILT voltages and temperatures and thus provides a continuous record on health and safety of the experiment. A detailed description of all parameters monitored may be found in the

Telemetry Packet Description for the SAMPEX Data Processing Unit (DPU). The HILT STATUS DATA include information on the status of the HILT High Voltage, HILT Valve and Cover Motors, in-flight calibration, solid state detectors, and HILT EEPROM Memory and XILINX.

2.2.2.2 Analyzed Science Data

HILT is designed to measure heavy ion elemental abundances, energy spectra, and direction of incidence in the mass range from helium to iron and in the energy range 4 to 220 MeV/nucleon. From the pulse heights in the HILT Event Data it is possible to determine the nuclear charge (Z), the kinetic energy, and the direction of arrival of each analyzed event. The Event Data are combined with the Rate Date to produce fluxes of the various species over the instrument energy interval as a function of time. Distinctive spatial and temporal variations will permit the separate identification of particle populations of magnetospheric, solar, galactic, and interplanetary origin.

2.2.3 MAST Data Overview

2.2.3.1 Raw Data

The Mass Spectrometer Telescope (MAST) consists of a telescope composed of 11 silicon solid state detectors, including four position sensitive devices, and its associated electronics. There are several categories of raw data from MAST, as summarized below.

RATE DATA consist of scaled counting rates of various MAST signals, including coincidence rates involving various detector combinations, discriminator rates, and an instrument live time scaler. Some rates, best described as "engineering data", include individual detector count rates, while others provide "physics" measurements of the fluxes of interplanetary H, He, and Z>2 nuclei in several different energy ranges. All 75 rates are accumulated over a period of 6 seconds. Because some rates are subcommutated, it takes 96 seconds to sample them all. STATUS DATA, giving the status of the MAST internal calibrator, are contained in one byte appended to the Rate Data. The MAST History Packet includes 192 second samples of 38 of these rates as well as Housekeeping Data.

EVENT DATA consist mainly of energy loss measurements for individual nuclei that are analyzed by the instrument. The 184 bit format includes fourteen 12-bit pulse heights from detectors M1 to M4 and D1 to D6. The remainder of the Event Data is devoted to bits describing the event type (H, He, Z>2, etc.), 'range' in the telescope (last detector triggered), and various discriminators. Because the actual event rate in MAST is sometimes many thousand per second, only a prioritized sample of events is transmitted to the ground.

HOUSEKEEPING DATA include values for four thermistors located at various points within the MAST telescope and electronics.

2.2.3.2 Analyzed Science Data

MAST is designed to measure the elemental and isotopic composition of energetic nuclei from He to Ni (Z = 2 to 28). From the pulse heights in the MAST Event Data it is possible to determine the nuclear charge (Z), the mass (M), and the kinetic energy of each analyzed event. These data will be used to measure the composition of energetic nuclei from galactic, solar, and magnetospheric sources in the energy range from ~15 to 200 MeV/nuc. With the MAST Rate Data, the time history of various species will be plotted, thereby aiding in the identification of solar events and trapped particle populations. The Rate Data are also necessary to normalize the analyzed event data to obtain differential energy spectra.

2.2.4 PET Data Overview

2.2.4.1 Raw Data

The Proton-Electron Telescope (PET) consists of a telescope composed of 8 silicon solid state detectors and its associated electronics. The categories of raw data obtained from PET are listed below.

RATE DATA consist of scaled counting rates of various PET signals, including coincidence rates involving various detector combinations, discriminator count rates, and an instrument live time scaler. Some rate provide 'engineering data' such as individual detector count rates, while others provide 'physics' measurements of the fluxes of energetic electrons, protons, and heavier nuclei in several different energy ranges. The 32 PET rates are accumulated over periods of either 3 or 6 seconds. In addition there is a single rate with 0.1 sec time resolution. Some rates are subcommutated, and it takes 96 seconds to sample them all. STATUS DATA, giving the status of the PET internal calibrator are contained in one byte appended to the Rate Data. PET History Packets include 192 second samples of 25 of the rates as well as Housekeeping Data.

EVENT DATA consist mainly of energy loss measurements for individual electrons and nuclei that are analyzed by the instrument. The 56-bit format includes four 10-bit pulse heights from detectors P1 to P3, and the sum of P4 to P7. Most of the remaining bits describe the state of various discriminators. The PET bit rate allocation allows only a fraction of PET events to be telemetered, and a built-in priority system selects a representative sample of electron and nuclei events in different energy intervals.

HOUSEKEEPING DATA include values for two thermistors located in the PET telescope and on the analog electronics board.

2.2.4.2 Analyzed Science Data

PET is designed to measure the energy spectra of electrons from 0.3 to 30 MeV and of H and He isotopes from ~18 to 70 MeV/nuc. In addition a PET backup mode can identify elements from H to Ni (Z=1 to 28) with limited isotope resolution from Z = 1 to 10. These data are used to study the origin, acceleration, and transport of energetic particles from solar, galactic, and magnetospheric sources, including high energy electrons that may play a role in the chemistry of the upper atmosphere. Among the PET counting rates are electron and proton rates that will provide the time history of both solar and magnetospheric particle fluxes.

2.3 DATA ARCHIVING AND ACCESSIBILITY

The University of Maryland is the single point of delivery for Goddard Space Flight Center to the Science Working Group. The University of Maryland operates the Science Operations Center (UMSOC). Level 1 processing of the data is done at the UMSOC. The Level 0 data received from PACOR are archived at the UMSOC on rewritable optical disk. The Level 1 data product (Master Data Files) are archived at the UMSOC, and copies containing approximately 10 days of data are delivered to the Co-I institutions for further analysis and to the NSSDC for long-term archival. The Co-I institutions are located at Goddard Spaceflight Center, Aerospace Corporation, Langley Research Center, Max-Planck-Institut at Garching, and Caltech.

An advisory committee has been formed for SAMPEX for the purpose of establishing a coordinated data processing and archiving plan. The committee includes Project Scientist Daniel Baker, Project Software Manager Richard Hollenhorst, NSSDC Representative Raghaviyenga Parthasarathy, and Co-Investigators Douglas Hamilton, Richard Mewaldt, and Berndt Klecker.

2.3.1 Data and Software Archiving Plan

The SAMPEX Science Working Group plans to deliver one Level 1 data set and four Level 2 data sets to the NSSDC as listed in Table 2-7.

2.3.1.1 Master Data Files

The Level 1 Master Data Files will be supplied to the NSSDC on rewritable optical disk at the same time they are distributed to the co-investigator institutions. These daily data files are written with the VMS operating system using the Tennis Format. Currently, the NSSDC does not have the capability to read or copy these disks. Storage of this complete, basic SAMPEX science data set at the NSSDC is thus being undertaken to provide for the secure, long-term archiving of the data set and to provide eventual access to future users who may need more than the derived Level 2 products discussed below. A document describing the SAMPEX MDF files and a library of Tennis read routines will also be supplied. The Tennis Format is self documenting.

2.3.1.2 30-Second Rate and Flux Averages

A complete set of SAMPEX counting rates from the four sensors, typically averaged over 30 second periods, will be supplied. These averages will cover the complete orbit, although their interpretation may vary with location as the relative fluxes of ions and electrons vary. A subset of these counting rates, as listed in Table 2-8, will be converted to fluxes in physical units. Conversion factors appropriate to the polar cap regions (e.g., low background) will be used. The validity of these flux calculations at lower latitudes will depend on conditions, and at times (e.g., during South Atlantic

Anomaly passages) will be incorrect. The 30-s rate and flux average files will be accompanied by spacecraft position and attitude data, along with magnetic parameters derived from the IGRF 90 field model, which are necessary for proper interpretation of the data.

2.3.1.3 Polar Cap Rate and Flux Averages

In addition to the 30-second averages, a complete set of SAMPEX counting rates will be supplied, averaged over each polar cap pass. The subset of these counting rates given in Table 2-8 will be converted fluxes in physical units, which may be used as a monitor of interplanetary conditions.

2.3.1.4 Formats

The Level 2 data products will be delivered in Standard Formatted Data Units (SFDUs). The SFDU headers will uniquely indicate the format of the record. An SFDU format catalog will be delivered identifying each SFDU record format. Special unpacking software shall be delivered for all compressed data, subcommed data and the data field formats which do not comply with IEEE standard data types.

2.3.1.5 Caveats

The SAMPEX Science Working Group will make every effort to supply accurate fluxes to the NSSDC. However, considerable care must be taken in their interpretation because of the vastly differing particle environments encountered over an orbit. To facilitate the interpretation of the data supplied to the NSSDC, detailed descriptions of the various channels will be supplied with the Level 2 data. In addition the UMSOC will maintain a log containing the times or time intervals of significant S/C events (e.g. safehold periods), instrument status changes (e.g. changes in microchannel plate bias or periods of gradual gain change), and other instrument information which may be useful. Copies of this log will accompany Level 2 data submissions.

2.3.1.6 Period of Archival at the UMSOC

The UMSOC will archive the Level 0, Level 1 and Level 2 data products for a period of 10 years after receipt of the data.

Table 2-7
SAMPEX Data To Be Delivered to the NSSDC

	Data Type	Format/Media
LEVEL 1 DATA	MDF Files	Tennis Fmt, VMS written/ Rewritable Optical Disk
LEVEL 2 DATA	30-sec Rate Averages All Rate Channels	SFDU / 8mm tape or electronic
	30-sec Flux Averages Selected Channels	SFDU / 8mm tape or electronic
	Polar Cap Averaged Rates All Rate Channels	SFDU / 8mm tape or electronic
	Polar Cap Averaged Fluxes Selected Channels	SFDU / 8mm tape or electronic

Table 2-8
Selected SAMPEX Counting Rate Channels to Be Converted to Fluxes

Instrument	Channel	Energy Range	Dominant Particle Type
LEICA	SSD	> 0.8 MeV	Ions
		> 0.6 MeV	Electrons
	LoPriority	0.5-6.6 MeV/nuc	Z≥2 (mainly helium)
	HiPriority	0.49-8.3 MeV/nuc	Z>2
HILT	HE1	4-9 MeV/nuc	Helium
	HE2	9-38 MeV/nuc	Helium
	HZ1	8.2-42 MeV/nuc	Z>2
	HZ2	42-220 MeV/nuc	Z>2
MAST	M12	5-10 MeV	Z≥1 (mainly protons)
	Z2	8-15 MeV/nuc	Helium
	Hi-Z	18-50 MeV/nuc	Z>2
PET	ELO	2-6 MeV	Electrons
	EHI	4-15 MeV	Electrons
	PLO	19-28 MeV/nuc	Z≥1 (mainly protons)

Note: Z>2 energy ranges are for oxygen.

2.3.2 Schedule for Data Delivery

The Level 1 Master Data Files will be delivered to the NSSDC within approximately two months of receipt of data. The four Level 2 data products will be supplied to the NSSDC within two years of receipt data to allow for calibration verification and data validation.

2.3.3 Data Format Standards

The data format standards which apply to SAMPEX housekeeping data can be found in the SAMPEX Telemetry and Command Handbook (GSFC-S-740-90-968). Science packet standards, data formats and conventions are documented in the Telemetry Packet Description for the SAMPEX Data Processing Unit and the DPU and Sensor Command Description. The instrument processing schemes and algorithms are presented in the DATA Handling Strategy for the SAMPEX DPU.

2.3.4 Archive Media

The Level 2 data products will be delivered to the NSSDC on 8mm tape, or electronically, or on another medium acceptable to the NSSDC. The Level 1 Master Data Files will be delivered to the NSSDC on 5.25" rewritable optical disks.

2.3.5 Data Quality

Data quality is maintained at three levels: through the transfer frame and packet level processing provided by PACOR, through limit checks and continuity checks performed at the UMSOC and finally, through analysis of the science instrument data performed during the level 2 processing and analysis efforts.

2.3.6 Data Disposition

At the conclusion of the data archiving period, the SAMPEX data archives housed at the University of Maryland may be discarded at the discretion of the University of Maryland/Department of Physics. Disposition of data archived at NSSDC will be the prerogative of NSSDC and is outside the scope of this PDMP.

3.0 PDMP IMPLEMENTATION, MAINTENANCE AND MANAGEMENT

3.1 ROLES AND RESPONSIBILITIES

The Project Data Management Plan is a level 1 requirements document outlining the major data processing roles for the SMEX Project, the Principal Investigator's team and the Co-Investigator teams. The PDMP is developed as a joint effort between the Project Scientist, the Principal Investigator and the Software Manager. The Principal Investigator is responsible for defining the science data processing requirements, defining Analyzed Science Data Sets, and assigning the overall data analysis tasks. The Principal Investigator and the Project Scientist work with the Project Manager and headquarters personnel in defining delivery products, schedule and prelaunch budget data. The Software Manager assists in these activities and assists the SWG in development of practical approaches to meeting these goals.

3.2 CHANGE CONTROL

The PDMP should be baselined and placed under control of the SMEX Project Level 1 Configuration Control Board. Changes to the PDMP should be proposed through the SAMPEX Science Working Group and submitted to the SMEX Project through a Level 1 Change Control Request (available at the SMEX Project Office).

3.3 RELEVANT DOCUMENTATION

A complete list of SAMPEX mission documents can be obtained through the Small Explorer Project Configuration Management Office, Goddard Space Flight Center, Code 740.4, Greenbelt, MD, 20771. The SMEX Project office can be contacted by telephone during normal business hours at 301-286-7417 (Project office) or at 301-286-7599 (CM office).