DRAFT IN PROGRESS

# Solar Oscillation Investigation
# Michelson Doppler Imager
# Mission Operations Plan

**DRAFT Version 1.3**
**SOI-RD-018**
**10 March 1994**

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## Revision History

| | | |
|---|---|---|
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| 4/23/93 | V1.0-draft | Included comments from Jake Wolfson on Draft 4/19/93 |
| 4/23/93 | V1.0-draft | Included comments from Rock Bush on Draft 4/15/93 |
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| 6/16/93 | V1.1-draft | Updated per Ted Tarbel comments |
| 10/27/93 | V1.2-draft | Updated per St. Cyr comments |
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| 3/10/94 | V1.3-draft | Updated to match EOM V2.4-draft and include CJW comments |

## Table of Contents

# 1.0 MISSION OPERATIONS PLAN INTRODUCTION

## 1.1 Purpose

This SOI-MDI Mission Operations Plan describes the concept and methodology for MDI operations and planning at the SOHO Experimenters' Operations Facility at Goddard Space Flight Center. It defines the roles, responsibilities and staffing requirements for the MDI mission operations team at the EOF and defines the means for mission planning and instrument commanding. It addresses coordinated operations and data analysis with other SOHO investigations and will be a reference for the operation of the MDI experiment.

## 1.2 Overview

The operation of the MDI instrument is a joint activity involving Stanford University and Lockheed Palo Alto Research Laboratory personnel. The MDI instrument is designed to be self-sufficient; daily commanding requirements will be limited, requiring only signals to indicate telemetry rate and consequent operating mode changes as well as changes from one observing campaign mode to another. During normal operation there will a be small SOI-MDI staff at the Experimenters' Operations Facility (EOF) at Goddard Space Flight Center who will support the day-to-day operation of the instrument. These functions include manning the MDI Command Workstation in the EOF, verifying instrument health and safety, generating command loads, making the MDI data available to other instrument teams as requested, and representing SOI-MDI in the mission planning process. In addition, there will be facilities for the support of scientific studies including joint studies with other SOHO experiment groups. Personnel at the SOI Science Support Center located at Stanford University will be responsible for science planning including setting observational priorities and developing observing campaigns; data management, archive and distribution; and much of the data analysis. Additional engineering support will be provided by LPARL.

# 2.0 MISSION OPERATIONS AND PLANNING

## 2.1 Experimenters' Operations Facility (EOF)

The SOHO Experimenters' Operations Facility (EOF) and Experimenters' Analysis Facility (EAF) are part of the GSFC ground support system and serve as the focal point for instrument operations, mission planning and science data analysis related to SOHO operations. The EOF is colocated with the spacecraft Flight Operations Team (FOT) facilities and supports the day to day science operations. The EAF is linked to the EOF by highspeed ethernet and provides additional space to support science planning and data analysis. The EOF Core System (ECS) is a network of computers located in the EOF which support the SOHO Science Operations Coordinator (SOC) and provide communications between the instrument workstations and the other elements of the SOHO ground system. The ECS is the single entity responsible for telemetry acquisition, data transfer, and instrument commanding. The ECS acquires telemetry from the IPD Packet Processor (PACOR) for rebroadcast to the instrument workstations, maintains an archive of the most recent 7 days of SOHO telemtry, transmits command requests to the SOHO Mission Operations Control Center (SMOCC) Command Management System (CMS) and provides access to the archived key parameters data from all ISTP spacecraft in the ISTP Central Data Handling Facility (CDHF). The ECS maintains a database of mission support data including activity plans, orbit and attitude data, archived telemetry, command history, summary data products and the Project Data Base (PDB).

The SOI-MDI operations group based in the EOF at GSFC will have the primary responsibility for day to day operations and support of the MDI instrument. This will include the conversion of observing requirements and priorities as defined by the science team into the MDI observing plan and the commanding and memory uploads required to implement it. The EOF based group will represent MDI in the SOHO mission planning effort and will be responsible for coordinating the MDI observing plan with the constraints imposed by DSN access, SOHO spacecraft operations and other experiments. The MDI operations group will also develop and provide summary data to the other SOHO/ISTP teams, command MDI and monitor its performance, and coordinate with other experiments.

## 2.2 SOI Science Support Center (SSSC)

The SOI Science Support Center manages the development of MDI science data and is the center for SOI science planning and coordination. The Team Science working groups responsible for the development of observing sequences and data analysis procedures will be coordinated from the SSSC. The SOI science team will hold planning meetings once per quarter to allocate observing resources and develop observing priorities based on the requests developed by the Team Science working groups and Investigator collaborations. Weekly meetings will be held at the SSSC which will direct MDI operations through the development of the MDI observing priorities and definition of observing campaigns in support of the science requirements. The SSSC will also provide support in the development of observing sequences and performing science data analysis. It is the site of the SOI-MDI Data Storage and Distribution System (DSDS) which performs the primary archiving of MDI data. It houses the SOI data processing system for the generation of standard science data products and it provides the central site for data analysis in support of SOI team science and the Stanford investigators data analysis efforts.

## 2.3 LPARL Engineering Support

LPARL has the primary responsibility for supporting the engineering requirements of the MDI instrument. These requirements include providing support in the EOF for MDI operation and maintaining an engineering support function at the Palo Alto labs location. The MDI Simulator System will be maintained for development and test of new and modified observing sequences and MDI Image Processor (IP) tables as well as for use in resolving any anomalies.

# 3.0 EOF MISSION SUPPORT FUNCTIONS

The SOI-MDI Operations and Planning activity in the SOHO Experimenters' Operations Facility (EOF) will be performed by the MDI Observer and the MDI Operator. The Observer will be generally responsible for developing the MDI Observing Plan and monitoring the acquisition of science data. The Operator will have the responsibility for implementing the MDI Observation Plan and monitoring the health and status of the instrument.

## 3.1 MDI Observer Functions

### 3.1.1 Coordinate Mission Planning

The Observer is responsible for coordinating schedule, resource and science priorities in developing the Observing Plan. Observing priorities are set at the SOI Science Support Center based on inputs from the SOI science team. The Observer will participate in the development of these priorities to ensure that they are consistent with operational constraints and schedules. The MDI Observer will be the day to day representative for the MDI science team in the EOF. The Observer will represent MDI in the SOHO mission planning process including attending planning meetings as required and communicating MDI observing priorities and requirements in support of developing the SOHO EOF Activities Plan. Similarly, the Observer will communicate SOHO operations requirements, constraints and plans in SOI-MDI science team meetings in support of developing MDI observing priorities and coordinating MDI operations with the SSSC. The Observer will use these inputs and the DSN contact and FOT spacecraft activities schedules to derive the MDI Observing Plan. The MDI Observing Plan will be developed from the observing priorities and will be coordinated with the SOHO Science Operations Coordinator.

### 3.1.2 Monitor Science Data

The Observer will also be responsible for monitoring the status and quality of the science data available in the EOF including performing instrument trend analysis, assessing quicklook data and producing summaries of successfully acquired data.

### 3.1.3 Develop and Distribute Summary Data

The Observer will ensure the proper distribution of science data in the EOF including SOHO summary images, GOLF and VIRGO collaborative data and magnetograms as required.

### 3.1.4 Support Sequence Development

The Observer will support the development of updated or new MDI sequences as required to satisfy the observing priorities in conjunction with the SSSC. He will be capable of operating the sequence and IP table building tools but will be principally charged with specifying and coordinating the new sequences, tables and parameters with the Operator.

### 3.1.5 Provide MDI Operator Backup

The Observer will also be trained as a backup MDI Operator.

## 3.2 MDI Operator Functions

### 3.2.1 Commanding MDI

The MDI Operator is responsible for transforming the MDI Observing Plan and sequence, parameter and table updates into the MDI Command Plan. The Command Plan coordinates and distributes MDI commanding among the various methods supported by the SOHO Mission Operations Control Center (SMOCC). The Operator will accept new or revised MDI Dedicated Experiment Processor (DEP) sequences, parameters or tables and develop DEP memory loads as required. The Operator will be responsible for coordinating the uplink of the DEP memory loads with the SMOCC to ensure they are available as required for the MDI Observing Plan. The Operator will develop new SMOCC command sequences and procedures as required to accommodate new or updated MDI observing campaigns or other coordinated instrument commanding. The Operator will monitor the command uplink and verify the successful implementation of the command plan. Should there be missed commands and resultant corrupted science data, the Operator will identify this in the command history.

### 3.2.2 Monitoring MDI Health and Status

The Operator is responsible for monitoring the health and status of the MDI instrument and the MDI EGSE in the EOF.

### 3.2.3 Manage MDI On-board Resources

The Operator will develop all memory loads and manage the MDI memory resource to meet the Observing Plan requirements. The Operator will maintain portions of the MDI EOF Database including those related to on-board resources.

### 3.2.4 Telemetry Acquisition in the EOF

The Operator will have the primary responsibility for ensuring successful MDI telemetry acquisition in the EOF.

### 3.2.5 Provide MDI Observer Backup

The Operator will also be trained as a backup MDI Observer.

## 3.3 Other EOF Functions

### 3.3.1 Sequence Building

DEP sequences will be developed in support of the observation requirements as established by the SSSC. In general terms, most sequence development will be performed at the SSSC and verified by LPARL while the SOI-MDI staff in the EOF will be responsible for coordinating the implementation of sequences for use in the flight instrument. New or modified sequences must be communicated to the MDI Operator in sufficient detail to allow the Operator to develop the required CMS control files and DEP/IP memory loads. A responsible engineer/scientist will be identified for each new sequence to be developed and may be resident at the EOF, SSSC or elsewhere. Such a sequence builder will coordinate and compile sequence definition requirements, build sequences with the sequence construction tools, create sequence resources, transmit new and modified sequences to the MDI Observer, develop supporting DEP and IP tables, and in conjunction with the MDI Operator, maintain the EOF database of sequences and tables for use in observing plan development.

### 3.3.2 Telemetry Acquisition

The telemetry acquisition function will be performed to support both the Observer and the Operator workstations. The telemetry function will acquire real-time low rate science and housekeeping telemetry for use in monitoring instrument health, status and science quality. In addition, the tape dump low rate science and housekeeping data will be acquired and archived in time recoverable series with the real-time data. This will permit review of “seamless” data for trend analysis and anomaly resolution. Summary and collaborative data products will be extracted from the seamless data and made available in the EOF as required. High rate magnetogram sequence data will be acquired and processed to develop magnetogram and continuum images for distribution in the EOF and to any other interested Investigators. Depending on the available downlink time, additional high rate science data may be available over the magnetogram virtual channel and these data products will be acquired and processed as appropriate.

### 3.3.3 EOF Database Function

The SOI-MDI EOF database will parallel the structure of the ECS SOHO database maintained at the EOF. It will consist of a catalog providing information about observation sequences (planned and executed), instrument housekeeping and science data, and telemetry definitions. The contents of the SOI-MDI EOF database will include items such as the telecommand and telemetry tables, Command History, Observing Plan, DEP sequences and DEP/IP memory map. The database will be maintained by the EOF functional elements as identified in Appendix D. In addition, the SOHO EOF database will be maintained and updated as required by the SOHO Science Operations Plan including documentation of the planned and as-run observations and summary data products.

### 3.3.4 DEP/IP Executable Code Maintenance

Linked sequences and other DEP and IP code will be maintained by engineering support personnel with a master copy in the EOF. All uplinked code segments and memory loads will be archived and their uplink and status tracked in the EOF database.

# 4.0 EXPERIMENT OPERATION INTERFACES

## 4.1 Facility Interfaces

### 4.1.1 MDI EOF Based Systems

The EOF is anticipated to have two separate SOI-MDI workstations, the MDI Command Workstation (CW) capable of performing real-time commanding, and the MDI Science Workstation (SW) for performing science analysis and data display and which has access to outside networks. Telemetry will be delivered to both workstations and they will be available on the same Local Area Network (LAN) in order to allow the Command Workstation access to data files developed on the Science Workstation. In addition, the two workstations provide complete functional redundancy for short periods of time. The Command Workstation will be one of the SGI workstations currently being used as the ground support interface to the instrument. The MDI Operator will be the principal user of the Command Workstation in line with the commanding responsibilities. This workstation will also be used as the principal engineering data monitor. The Science Workstation will be provided by Stanford in order to support the external network access and data processing requirements. The science data monitor, sequence builder, and MDI EOF Database functions will be performed from this workstation. Stanford will also provide two Xterminals for use in the Analysis Facility to help support these additional functions as well as to support science analysis and onsite collaborative research. The MDI systems in the EOF will use a commercial product supporting SQL for relational databases and will support TCP/IP for connections to the ECS and the NASA Science Internet.

### 4.1.2 EOF Core System

The MDI workstations will have access to the EOF Core System (ECS) which is the single entity responsible for telemetry acquisition, data transfer, and in the case of the CW, instrument commanding. The ECS will acquire telemetry from PACOR for rebroadcast to both MDI workstations, will transmit command requests received from the CW to the SMOCC/CMS and will provide access to archived data locally and in the ISTP CDHF. The ECS maintains a database of mission support data including activity plans, orbit and attitude data, archived telemetry, command history, summary data products and a copy of the current Project Data Base (PDB) which includes the lists of telecommands and telemetry items. The PDB is formally maintained by the Flight Operations Team (FOT) in the SMOCC.

## 4.2 Functional Interfaces

The primary documentation to be used as interface between the MDI EOF functions, the SSSC, the SOHO SOC and other experiments are described below.

**Table 4.2.1 MDI Operational Interfaces**

| | |
|---|---|
| Observing Priorities | SSSC |
| Observing Plan | Observer |
| Science Data | Observer |
| Weekly Summary | Observer |
| Command Plan | Operator |
| Command History | Operator |
| DEP/IP Status Summary | Operator |
| Sequence Definitions | Builder |

### 4.2.1 Observer Interfaces

The MDI Observer will coordinate efforts with the SSSC via the observing priorities list and the Observing Plan. The observing priorities list establishes the goals that MDI operations are to support and is developed by the science team at the SSSC. The Observing Plan will document the method of implementing those priorities based on the constraints of the spacecraft, DSN and other sources. The Observing Plan or a subset of it will be the primary interface to the SOHO SOC in defining MDI inputs to the SOHO planning process. It will also be the principal interface document to the MDI Operator to support the development of the MDI command plan and SMOCC Predefined Command Sequences (PCSs). The Observer will provide summary data products in electronic and hardcopy form to the SOHO SOC and other interested experimenters including the GOLF and VIRGO measurements identified below. The Observer will develop a weekly MDI Status report for the SSSC which includes summaries of the MDI observations for the previous week including a qualitative assessment of observation plan success and MDI science data quality. This report will also include summaries of instrument health and commanding provided by the MDI Operator. Finally, it will include a summary of the upcoming weeks activities and planning constraints.

### 4.2.2 Operator Interfaces

The MDI Operator will develop the MDI command plan based on the inputs contained in the MDI Observing Plan. The command plan will include all types of commanding and will identify the timing required to support the Observing Plan requirements. The plan will identify sequence initiation commands, CMS control file executions, direct instrument commands, and memory load commands. While the observing plan will only include the level of detail required to communicate the particular observing requirement (generic campaigns may be identified by single mnemonics for the CMS control file) the command plan will include the detail of every command to be uplinked. A command history will be developed by the MDI Operator in the same format as the command plan to document the as-run operations. The command history will differ from the command plan by including an identification of discrepancies from the planned operations. The MDI Operator will also maintain a database of on-board sequences and tables and the resultant memory map. A summary describing instrument health and status will be provided by the Operator on a weekly basis as inputs to the MDI weekly status report.

### 4.2.3 Other Interfaces

Each sequence submitted by the Sequence Builder will be documented to include a summary of the science goals, observables generated, required initial instrument status, duration, number of commands, derivation (if an update of or evolution from an existing sequence), any constraints on time of uplink, required DEP/IP tables or code, image buffer usage, and any other constraints. The exact sequence of DEP commands will then be listed.

# 5.0 NOMINAL MDI OPERATIONS AND MISSION PHASES

## 5.1 Mission Phases

MDI operations at the EOF will occur in four distinct phases: EOF integration and test, launch, transfer trajectory / instrument commissioning and on-station observing. Imaging and science operations will begin as early as possible in the transfer trajectory phase in order to verify and fine tune the imaging sequences and instrument performance.

### 5.1.1 EOF Integration and Test

During the EOF integration and test phase, the procedures required for the MDI mission operations phase will be developed and tested. To the maximum extent possible, these procedures will have companion procedures that are used to test the MDI instrument. The procedures used for integration and verification of the instrument operation will be as "mission-like" as is feasible, thereby providing a more direct transition to the operations phase. MDI Operations personnel will undergo familiarization training in the EOF prior to flight as part of the support of EOF development. Further description of development and integration for the MDI EOF is included in Appendix C.

### 5.1.2 Launch and Earth Orbit Phase

The MDI instrument will not be powered up during LEOP. Beginning several days pre-launch a launch and early operations team will arrive at the EOF.

### 5.1.3 Transfer Trajectory Phase

Following the initiation of the transfer trajectory and SOHO sunpointing attitude, the spacecraft heaters will be required to stabilize the MDI instrument temperature. As early as possible in the TTP, the MDI instrument will be powered-up, initialized and commissioned. Initial power up will be immediately after the solar array deployment, with commissioning tests with the front door closed taking about 2 weeks. This will provide adequate time for bakeout to avoid contamination of the CCD. As resources permit, all nominal procedures will be verified, the command link will be exercised, and data will be taken in every operating mode. As commanding requirements permit, the IP Processor Table will be uploaded. After the high rate telemetry link has been verified, the MDI front door will be opened, a preliminary alignment will be performed and calibration and sequence verification will begin. This will include running the dynamics, structure, and a variety of campaign observing sequences, as well as telecommand calibration tests. As verification is completed, the instrument will be used for measurements that cannot operate with the background structure program. This phase will also be the best time to roll the spacecraft to allow for calibration of the instrument for absolute limb figure measurements and to perform detailed assessment of spacecraft and other payload induced jitter. Following the checkout of the instrument and operational sequences, TTP operations and MDI configurations and modes are the same as in Halo Orbit Phase. As spacecraft resources permit, the instrument will be operated in the same fashion as it will after reaching final halo orbit. These initial instrument operations are detailed in reference 6, MDI Experiment Operations Manual. Once the instrument performance is verified and nominal science operations are underway the EOF staffing will be reduced to the nominal halo orbit phase levels.

### 5.1.4 Halo Orbit Phase

Nominal operations will begin with the initiation of on-station halo orbit by SOHO. This phase will begin with a two month period of high rate data acquisition in support of the MDI Dynamics Program. The remainder of this document serves to define the operations during HOP.

## 5.2 Telemetry Channels

The telemetry coverage determines which observing programs are used. There are two science data telemetry rates: 5 kbps and 160 kbps. The 160 kbps telemetry rate is sufficient to send down full disk arrays of 2 arc-sec compressed velocity and intensity data each minute. The 5 kbps coverage is expected to be continuous. The nominal telemetry coverage schedule is shown in Figure 5.2.1. For a 2 month period each year, the 160 kbps telemetry channel will be available to MDI 24 hours/day, and there will be no data saved to the tape recorder. During the remaining 10 months per year, the 160 kbps telemetry channel will be available to MDI about 8 hours per day, and the tape recorder playback will use the 160 kbps telemetry channel about 5 hours per day.

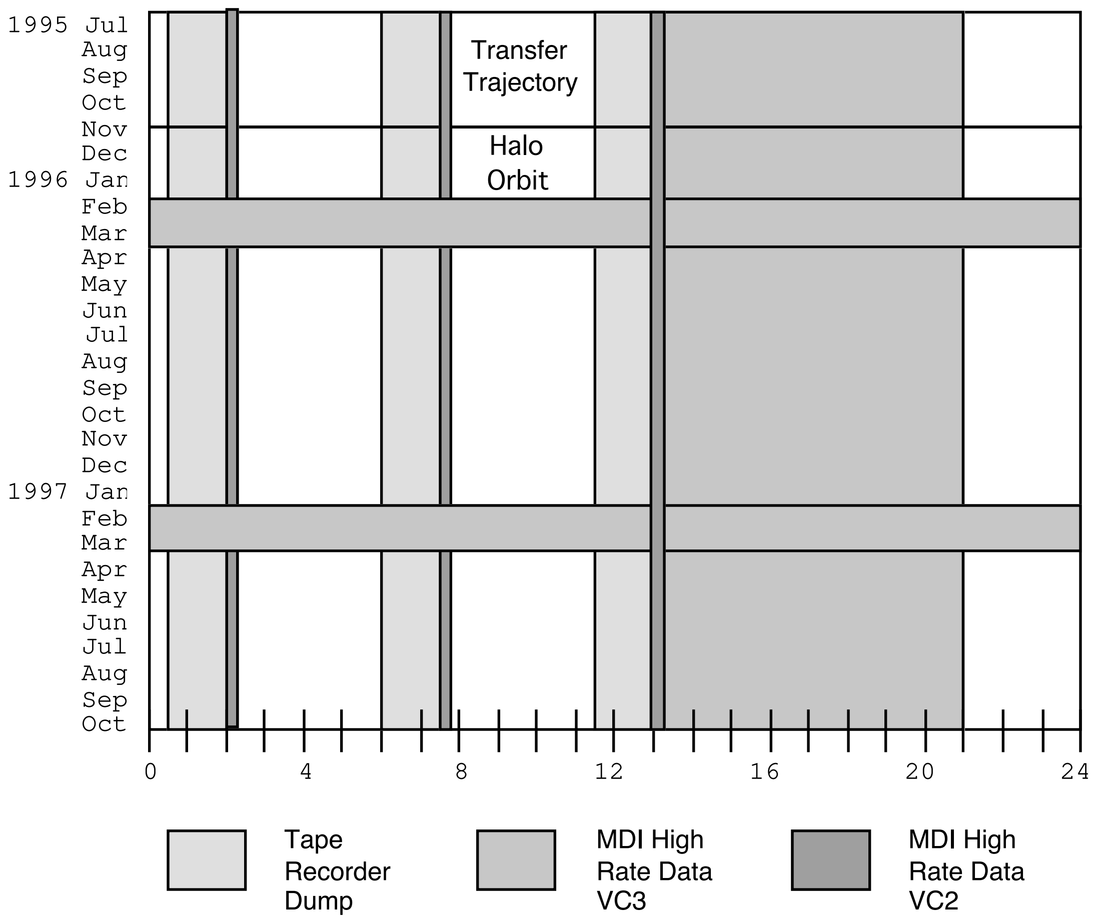


Figure 5.2.1 Telemetry Coverage

There are five virtual channels through which MDI telemetry will be managed onboard the SOHO spacecraft and in the EOF. The telemetry will be acquired in the EOF from the ECS via ethernet packets. Each packet will include a header record defining the virtual channel and packet contents. The low rate housekeeping data is transmitted as part of the 5 kbps telemetry stream in virtual channel VC0. The low rate science data is transmitted as the majority portion of the 5 kbps telemetry stream in virtual channel VC1. The low rate data is recorded onboard the spacecraft during periods of no DSN support. This tape recorded data will be downlinked in high rate channel VC4 during the realtime contact following each LOS (loss of signal) period. Following each tape dump, five minutes of high rate data will be allocated to MDI for the downlink of magnetograms in channel VC2. Channel VC2 data will be available in the EOF in near real time. For eight hours each day during the Campaign Program and for 24 hours per day during the Dynamics Program high rate MDI data will be downlinked in channel VC3. Channel VC3 data will be delivered to the SSSC on CDROM or 8mm tape and will not be available in the EOF.

## 5.3 Observing Programs

There are several observing programs for the MDI instrument, each of which requires a series of filtergrams. A filtergram is one exposure and readout of the CCD camera, with a particular wavelength setting of the Michelson filters, orientation of the polarization wheel, and magnification. The basic cadence of observation for the MDI instrument is to complete two separate measurements in one minute. The one minute period of observation is required to observe solar signals having an oscillation period of around 5 minutes.

The observing programs that have been defined are the Structure, Dynamics, Campaign, Magnetic Field, and Calibration Programs. The Structure Program proceeds at all times and collects data in the first 30 seconds of each minute. All other programs normally run in the remaining 30 seconds. The Structure Program may occasionally be interrupted for Calibrations and Magnetic Field measurements. Each observing program is described below.

### 5.3.1 Structure Program

MDI runs the Structure Program of scientific observations almost continuously during HOP. This involves nearly continuous operation of the instrument to measure full disk solar velocities, process them on-board to extract an interesting subset of parameters, and downlink an unbroken time series of these data in the 5 kbps medium rate science channel. The Structure Program requires eight filtergrams to make two 4 point dopplergrams which are then averaged, and a continuum observation. The series of 9 filtergrams should take no longer than 30 seconds. Dopplergrams are computed and then processed on board to determine about 20,000 binned medium-l velocity averages which are then downlinked. Limb data will be processed to determine centering information and the limb figure. The limb information, a magnetic proxy average, compressed intensity sum and LOI mask velocity and intensity images will also be included in the medium rate science downlink .

### 5.3.2 Dynamics Program

The Dynamics Program runs each year during the 2-month period of extended high rate telemetry format. The Dynamics Program uses the same data obtained for the structure program analysis. Both 1024 x 1024 dopplergrams and intensity images are compressed and transmitted. When the 160 kbps channel is available continuously, the Dynamics Program is initiated. The Structure Program will continue as usual, but the same full disk images will also be compressed (by encoding) and downlinked in the 160 kbps channel. Occasionally, one or more cycles will be devoted to magnetic field measurements or calibrations, but these will be scheduled carefully to ensure the minimum disruption of the long time series. During the dynamics program, the structure program will be interupted 3 times per day to support the magnetic field program.

### 5.3.3 Campaign Program

The Campaign Programs are performed when the MDI high rate science data channel is available for periods of 8 hours to 3 days. The Campaign Programs will be a mixture of other observing modes, with the accent on high resolution observing. One program might consist of continuous high resolution magnetograms. Another program might consist of continuous high resolution line and continuum intensities. When the 160 kbps telemetry channel is available for any period between a few hours and a few days (high rate telemetry format), MDI will run Campaign Programs. The Structure Program will continue, occupying the instrument for about 50% of its duty cycle and filling the 5 kbps channel as usual, and other observations will use the remainder of the duty cycle and fill the 160 kbps channel. The other observations will often involve images in high magnification mode, images at different wavelength settings in the line or continuum, and/or magnetograms, depending on the scientific program selected.

### 5.3.4 Magnetic Field Program

The Magnetic Field Program will run three times each day during both the campaign and dynamics program telemetry schedules. The program is an interleaved set of right and left circularly polarized dopplergrams, averaged over several minutes. It will be telemetered in the five minutes following each scheduled 160 kbps tape dump. The magnetograms will be telemetered on Virtual Channel 2 (VC2) which will enable the direct receipt at the Experiment Operations Facility (EOF).

### 5.3.5 Calibration Program

The Calibration Program consists of cycling the calibration lenses into the main light path and making dopplergrams of the resultant defocused solar light. The Calibration Program runs during the high telemetry rate intervals, and uses calibration lenses to provide defocused sunlight through the optics system. The Calibration Program should be run every few hours (if possible) early in mission and perhaps once to several times per day later on after instrument time constants are shown to be very long; some random variation in scheduling is desirable. The sun-source provides calibration of the intensity flat field and velocity flat field at each magnification and does not interrupt the structure program.

# 6.0 MISSION PLANNING

The SOI-MDI operations and planning activity in the EOF is performed by the MDI Observer and the MDI Operator. The Observer is responsible for developing the MDI Observing Plan and monitoring the acquisition of science data. The Operator has responsibility for implementing the MDI Observation Plan and monitoring the health and status of the instrument. The EOF will be staffed by two fulltime personnel five days per week and eight hours per day. Weekend and evening coverage will be provided on an on-call basis. This implies that no unscheduled command uploads or three day campaigns will be performed over the weekends.

## 6.1 Planning Schedule

### 6.1.1 Quarterly

SOI-MDI Science Team planning meetings will be held quarterly to assess performance, science progress, and to set priorities for the next quarter.

### 6.1.2 Monthly

The MDI Observer will support the monthly SOHO science goals planning meetings as the representative of MDI science in conjunction with any EOF resident MDI Science Investigators.

### 6.1.3 Weekly

SSSC Observation Priorities planning meetings will be held weekly, phased to precede the EOF weekly planning meetings. The MDI Observer will acquire planning data updates including: attitude and trajectory data from the CDHF and DSN Schedules, Spacecraft and FOT activities from SMOCC. The output of these meetings will be the MDI Observing Priorities for the next week from which the MDI Observer will develop the weekly Observing Plan.

Instrument commanding schedule requests will then be developed to support the observing plan and submitted by the MDI Operator with MDI Observer approval in support of the weekly planning cycle.

The MDI Observer will represent MDI in the SOHO weekly planning meetings and will coordinate the implementation of the MDI Observing plan with the SOC. The Observer will support the SOC in merging commanding requests into the SOHO weekly schedule.

### 6.1.4 Daily

Daily internal planning will be performed via short staff meetings and electronic mail in the EOF as required. Electronic mail, teleconferences and data file exchange between the SSSC staff and the MDI Observer will be used for daily EOF/SSSC coordination. Any changes for next day operations will be provided to the SSSC by the MDI Observer by the close of business in the EOF following the completion of the next day's final schedule by the SOHO Science Operations Coordinator. In addition, a daily assessment will be made of opportunities for collaborative studies of developing solar features. Such opportunities will be communicated to the SSSC for consideration as they arise.

## 6.2 Telemetry Schedule

SOHO will be operated during each year in one of two telemetry schedules. For ten months each year high rate data will be provided for eight hours per day during the Campaign Program. For two months in every year high rate data will be provided continuously during the Dynamics Program. The actual DSN contact schedule will be made available on a weekly basis and may vary from these plans due to other requirements, or lack thereof, on its use. Changes in DSN support will likely be forecast with up to several weeks of notice. The availability of near continuous 5 kb science data coverage is very important to the key SOI science goals.

### 6.2.1 Campaign Program Telemetry Schedule

The Campaign Program will run for ten months of every year with eight hours of MDI high rate data scheduled during daylight hours at GSFC. The nominal telemetry schedule for the Campaign Program is as follows:

> Three 3.6 hour periods per day of no telemetry (Loss of Signal - LOS) with tape storage of low rate VC0 housekeeping and VC1 science onboard the spacecraft.
>
> Three 1.6 hour realtime periods per day of low rate VC0, VC1 and high rate tape dump on VC4 of VC0 and VC1 as stored during preceding LOS period.
>
> Three 0.1 hour realtime periods per day Magnetic Field / Synoptic Program data on VC2 following each VC4 tape dump in addition to low rate data.
>
> One 8 hour realtime period per day of high rate Campaign / Structure Program on VC3 in addition to low rate data on VC0 and VC1.

The nominal telemetry schedule for the Campaign Program is as shown in Figure 6.2.1.1.

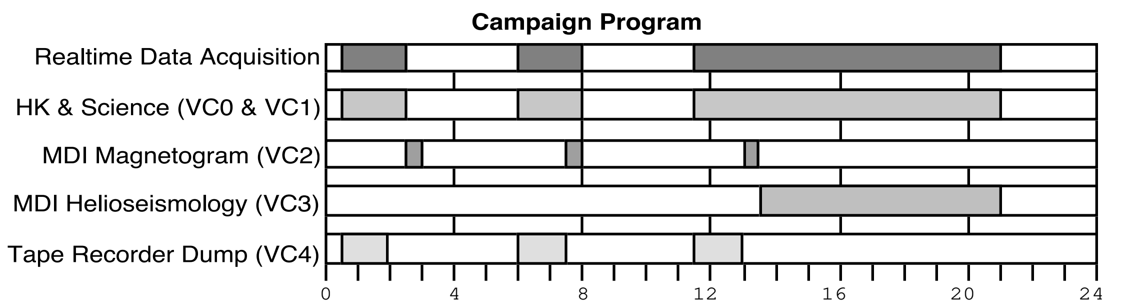


Figure 6.2.1.1 Campaign Program Schedule

### 6.2.2 Dynamics Program Telemetry Schedule

For two months of each year the Dynamics Program provides continuous high rate telemetry, 24 hours per day on VC3. This will be interrupted once per day to provide magnetograms on the high rate VC2 channel for use in developing summary data at the EOF. Several times per day additional magnetograms will be included in VC3. This schedule is shown in Figure 6.2.2.1.

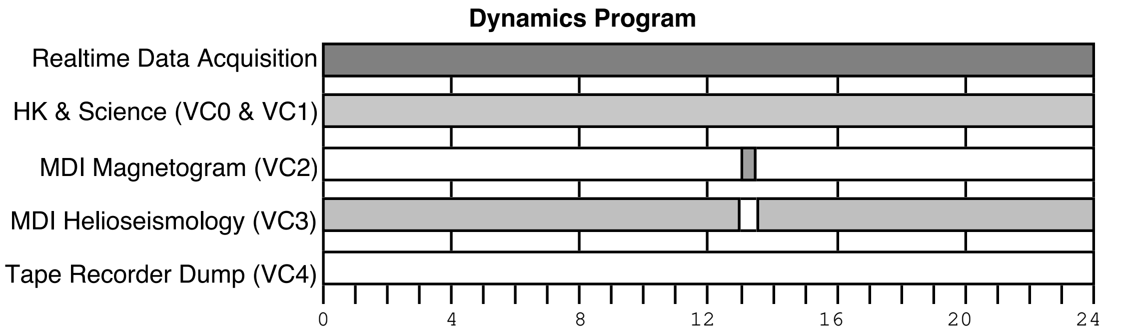


Figure 6.2.2.1 Dynamics Program Schedule

## 6.3 Routine Operations

Science operations are planned on a monthly basis well in advance of use. The preliminary MDI Observing Plan will be derived from the monthly science requirements planning meetings and will be developed weekly. The principal mode of MDI operations will be delayed commanding via an established command plan. The MDI Operator will develop the command plan based on the schedule of activities described in the MDI Observing Plan. The command plan will list the commanding requirements and identify the files containing the combination of direct instrument commands, DEP sequence initiation commands, DEP sequence loads, SMOCC Predefined Command Sequences (PCS) or SMOCC STOL Procedures to be used in its implementation The preliminary command plan will also be built on a weekly basis. The development of the final version will be coordinated with the SOC and the SMOCC Flight Operations Team and reviewed by the MDI Observer. The principal activity for the EOF beyond the development of these plans will be to monitor the performance of the instrument and the quality of the science data through monitoring the housekeeping data and developing the summary science products.

### 6.3.1 Campaign Program Update

The campaign observing mode of the MDI, which is used during the daily periods of high data rate, will be changed periodically. These changes will occur every few days, and will require TBD bytes of uplink.

### 6.3.2 IP Data Table Update

In addition, commands will be issued periodically (typically once every few months) to change which image components are downlinked in the low data rate channel as part of the Primary Structure Program. This operation will require a maximum of 2 megabytes of uplink and is described further in section 7.2. Such changes will be within the scope of the Observing Plan, and will be specified well in advance.

### 6.3.3 DEP Imaging Sequence Uplink

On occasion, updates to the onboard data tables and imaging sequences may be required. These updates will be developed with sufficient lead time prior to needed use to allow for review, uplink and operational test. Uplink and operational test of new or significantly modified sequences will typically be performed during periods of high rate data support. The data will be routed to the EOF by switching to VC2 for a short period to support the sequence testing and performance evaluation. This data support period will be scheduled to coincide with a period of reserved, Near Real Time commanding to allow for instrument commanding in the advent of anomalies in the sequence performance.

#### 6.3.4 Non-Observing Operations

On occasion MDI may require operation in non-observing modes. These modes are most commonly driven by spacecraft operations. In particular, the firing of orbit adjust thrusters will probably require that the outer door on MDI be closed. During these short periods of non-observing operations the MDI Operator will be enabled for Near Real Time commanding as possible and close coordination with the FOT will be maintained.

#### 6.3.5 Coordinated Campaigns

Coordinated campaigns will be arranged with the SOHO SOC and will be identified in the Instrument Activity Requests (IAPs) of all participants.

### 6.4 MDI Observing Plan

The MDI Observing Plan will fully specify the activities of the MDI instrument. It will consist of an ASCII file of UTC time-tagged operations that will identify significant parameters such as DSN contact times, mode changes in the MDI instrument, science and campaign programs, and specify SMOCC PCS/STOLs or other commanding requirements. Where appropriate it will identify the requirement for new DEP sequences, parameters and/or IP tables. The MDI inputs to the ECS activity plan (EAP) will be directly derivable from the MDI Observing Plan. The MDI Observing plan will be developed on a weekly basis corresponding with the availability of the DSN contact schedule. The Observing Plan will be updated prior to each days operations based on the final EAP. An example of the MDI Observing Plan is included in Appendix D.

### 6.5 MDI Command Plan and Command History

The MDI command plan will be developed based on the Observing Plan. A preliminary command plan will be developed on a weekly basis to allow for the scheduling of any Near Real Time commanding and the development of any new or modified PCSs, STOLs, Delayed Commanding Files or Background Queue Command Files. The command plan will include a list of all anticipated MDI commands and will identify the source and expected time of transmission.

# 7.0 COMMANDING

During nominal operations minimal commanding will be required to operate MDI. The MDI instrument is designed to be self-sufficient; daily commanding requirements will be minimal, perhaps requiring only signals to indicate data rate and consequent operating mode changes and changes from one preset campaign mode to another.

## 7.1 Instrument Commanding Methods

The methods available for commanding include Near Real Time (NRT) commanding, Delayed Command Files, Background Queue Command Files, Remote Command Requests for SMOCC Predefined Command Sequences (PCS) and Remote Procedure Requests for FOT executed STOL Procedures.

### 7.1.1 Delayed Commanding

The principal mode of MDI operations will be delayed commands via an established command plan. The command plan will consist of a set of files containing a combination of direct instrument commands, DEP sequence initiation commands or DEP sequence loads. The files will contain headers with the targeted uplink time and will be submitted the day before the operations take place. The CMS will validate the commands in each file and the FOT will then uplink them within the time windows specified.

### 7.1.2 Background Queue Commanding

Commands and memory loads not requiring specific uplink time will be submitted to the SMOCC background commanding queue. These submissions will consist of logically segmented load files and will be primarily memory loads consisting of IP Tables, non-time critical DEP sequences and imaging parameters. These command files will be submitted at least two days prior to needed uplink time. The FOT will uplink the individual command groups in order by interleaving them into the real-time command stream on a space available basis.

### 7.1.3 Near Real Time Commanding

Near realtime commanding will be used to support checkout of new or modified imaging sequences and IP tables and for recovery and resolution of anomalies. For NRT commanding, the MDI Command Workstation will be enabled for direct submission of commands via the ECS to the SMOCC/CMS for uplink with a latency of less than 60 seconds. For preplanned NRT commanding such as uploading and checking out a new sequence, a MDI only commanding window can be reserved at least one day in advance. This mode allows the MDI Command Workstation to run locally resident control files similar to the SMOCC PCS and STOL procedures.

### 7.1.4 Flight Operations Team Coordinated Commands

Commanding that involves the spacecraft or other critical commands or that requires coordination with the FOT can be arranged and will be originated from the POCC terminals in the EOF or from the MDI Command Workstation. The MDI Operator can request FOT commanding support via Remote Command Requests (RCRs) for Predefined Command Sequences (PCSs) or Remote Procedure Requests (RPRs) for STOL Procedures. When originating from the CW, these requests are transmitted by the ECS to the SMOCC similar to the method used for the NRT commanding. RCRs contain one or more Predefined Command Sequences (PCSs) which will be automatically initiated if valid. STOL Procedures contain time-tagged sequences of MDI and possibly other spacecraft commands that will be implemented by the FOT. Examples of this type of commanding are MDI initial power-up and checkout.

## 7.2 IP Data Table Upload

The MDI image processor uses look-up table parameters to calculate observables of various types. It is estimated that MDI will use about 2 megabytes of these look-up-tables, which will be stored in error correcting memory in the MDI image processor. It is planned to uplink the entire set of look-up-tables at the start of the mission (and after any complete power failure including IP memory keep alive power). This table uplink would require approximately 10 hours of uplink time, assuming that 2 megabytes of mask look-up tables is uplinked at 500 bits/second. This table uplink will be performed over several weeks early in the transfer phase from the background queue. In addition to the initial uplink, the look-up-tables will occasionally be updated to provide information about other solar oscillation modes. The extent of these updates is still to be established.

The look-up-tables are stored in hamming error correcting memory which will correct single bit errors and detect double bit errors. Multiple bit errors will be corrected from the ground. To reduce the telemetry requirements and improve the instrument operation after a non-catastrophic power outage, use of the keep alive power is planned to maintain the look-up-table memory.

# 8.0 TELEMETRY ACQUISITION

## 8.1 Description

There are three spacecraft telemetry format data rates (not including Reed-Solomon encoding): a low rate of 1.18 kbps, a medium rate of 47.35 kbps and a high rate of 2,112 kbps. The spacecraft low rate telemetry format is transmitted to ground from launch until the deployment of the high gain antennae, and in contingency operations when the high gain antenna is not available. The spacecraft medium rate telemetry format is transmitted to ground for the period between the high gain antenna deployment and the first midcourse correction, and during orbit correction maneuvers. In addition, the medium rate telemetry format is recorded on the SOHO tape recorders when the spacecraft is not in DSN contact. The spacecraft high rate telemetry format can only be used during nominal real time contacts, and cannot be recorded on board.

The low and medium rate telemetry data are transmitted as a stream of packets that are identified and sorted on the ground. The high rate telemetry consists of the medium rate telemetry packets plus a 160 kbps data stream that can be used by only the tape recorder for dumping recorded data or by MDI for a high data rate channel available during real-time contacts. As a result of real-time transmission and tape recorder operations, the goal is to have complete continuity of the medium rate telemetry.

The MDI instrument has been allocated portions of all the spacecraft telemetry formats, and the data have been separated into housekeeping (or engineering) information and science measurements. A small number of MDI voltages, temperatures, and digital status indicators are monitored by the spacecraft and are transmitted in spacecraft telemetry packets, and are available whether or not MDI is powered on. The majority of the MDI housekeeping information is collected by the MDI DEP (when it is powered on), and transmitted in separate MDI housekeeping packets. The MDI instrument has two science data channels which can operate simultaneously, one with a data rate of 5 kbps (typically called MDI low or medium rate science) and the second with a data rate of 160 kbps (typically called MDI high rate science). The MDI 5 kbps science data are observables computed by the Image Processor, transferred to the DEP and sent on to the spacecraft data handling system in packet format. The MDI 160 kbps science data stream is sent directly from the Image Processor through a dedicated MDI/tape recorder data channel.

Medium rate science and housekeeping telemetry will be acquired from the ECS during all periods of realtime support. The medium rate housekeeping will be monitored on the MDI Command Workstation in the EOF. The medium rate science data will be monitored and subjected to quick-look analysis on the MDI Science Workstation in the EOF as well as at the SSSC and other supporting institutions via an electronic pickup. The SOI-MDI staff at the EOF in conjunction with Stanford and LPARL support will verify that the data being received are consistent with the expectations of the current observing mode. The telemetry will be acquired in the EOF from PACOR by the ECS and rebroadcast on the EOF LAN as ethernet packets. Each packet will include a header record defining the virtual channel and packet contents. Further detail on the data acquisition is included in section 9.

## 8.2 Telemetry Channels

There are five virtual telemetry channels through which MDI data will be managed onboard the SOHO spacecraft and in the EOF.

### 8.2.1 Medium Rate Housekeeping

The medium rate housekeeping data is transmitted as part of the 5 kbps telemetry stream in virtual channel VC0 and consists of two packets containing the same parameters every 15 seconds. The contents of these packets will be instrument status including temperatures, voltages, currents, mechanism encoder values and relay talkbacks.

### 8.2.2 Medium Rate Science

The medium rate science data is transmitted as the majority portion of the 5 kbps telemetry stream in virtual channel VC1.

### 8.2.3 Tape Dump

During periods of no DSN support, presently scheduled as three 3.6 hour periods per day, VC0 and VC1 will be recorded onboard the spacecraft. During the three 1.6 hour daily contacts this data will be downlinked at 160 kbps in the tape dump virtual channel, VC4. This data will be made available as files on the ECS within two hours of its receipt.

### 8.2.3 High Rate Science - Magnetogram

A small number of full resolution frames will be retrieved each day at GSFC via the magnetogram virtual data channel, VC2 following the tape dumps on VC4. This allows the production of magnetograms required for use by other SOHO instruments. This will also provide an opportunity to verify certain functions of the instrument.

### 8.2.4 High Rate Science - Helioseismology

The MDI instrument is allocated approximately 8 hours of high-rate telemetry per day. In addition, two months of continuous high-rate (160 kbps) telemetry are provided during each year of operations. This data is handled in the helioseismology virtual channel, VC3, and is not available in the EOF. High rate science data will be delivered to the SSSC on tape within 2 weeks of receipt at GSFC. This data will be subjected to some quick look evaluation at the SSSC and other supporting institutions; however, because of the delays in receiving these data, their use in terms of determining day to day operations will be limited to revisions to the long term observing plan.

### 8.2.5 Extended High Rate - Synoptic Data

Presently, 5 to 10 minutes of MDI high rate downlink telemetry will be acquired on VC2 following the high rate tape dumps three times per day. Depending on the length of the post tape dump high rate support, additional telemetry beyond the magnetograms may be obtained. This additional synoptic data will permit significantly higher cadence for some important observable quantities, including full disk magnetograms, full disk dopplergrams, full disk intensity images and several lower resolution time averages. For scientific purposes the data may be taken in either the magnetogram virtual channel or the helioseismology virtual channel. For operational purposes, monitoring the status of the instrument and providing higher cadence to other experiments, the magnetogram virtual channel, VC2, is required so that the data is available in the EOF.

### 8.2.6 Additional High Rate

It is highly desirable for the study of supergranule convection cell evolution to obtain high rate data for at least 50 hours of continuous Deep Space Network time several times over the 2 year mission. This time is in addition to the 2 months continuous and the 8 hours per day of DSN time presently provided. Because the 2-month continuous telemetry interval is near the lower limit acceptable for studying the largest scales of convective motion (2 rotations of structures with comparable lifetimes), it would be very advantageous to have several intervals of continuous 160 kbps coverage lasting 3 days centered on 27 day centers at either end of the 2 month interval.

## 8.3 Magnetogram Virtual Data Channel

The magnetic program has been structured so that MDI is enabled in the 160 kbps magnetic channel mode for about 5 minutes at the end of each tape dump. This allows 3 or 4 magnetograms to be acquired in the EOF per day and results in more complete monitoring of the MDI health and status as well as providing timely magnetograms to the coronal experiments. During the two month high telemetry rate intervals, full resolution magnetograms will also be telemetered and incorporated into the quick look data stream once per day. The magnetograms are critical for SOI-MDI data analysis and for monitoring the health of the instrument. They will be very useful for the operation of several of the other experiments on SOHO and instruments associated with the ISTP in general. The near real-time recovery of the magnetogram data is accomplished using virtual data channel, VC2. This virtual data channel does not require additional telemetry, but rather is a change in the way the data is labeled on the spacecraft and handled on the ground. Essentially a very small number of full 1024 x 1024 resolution data frames are added to the data transmitted from the DSN to the EOF at GSFC in near realtime. This will involve approximately 5 minutes of data at the 160 kbps rate. This is done by enabling virtual data channel VC2 to be intercepted by the ground system. Instead of routing all the high data rate telemetry to a local archive via VC3, the DSN and PACOR will transmit several frames directly to the EOF.

## 8.4 Data Recovery

Because of the requirement for uninterrupted data, particularly in MDI scientific objectives that depend on the low transmission rate data, the possibility that there is no back-up of the 5 kbps channel during MDI high data rate transmission intervals is of concern. An investigation of the possibility of storing the low data rate data during the high data rate time to minimize losses due to lack of tracking continuity is recommended. In addition, MDI may buffer some of this data onboard and transmit it redundently.

# 9.0 DATA MANAGEMENT

## 9.1 Data Acquisition

The ECS receives, stores and rebroadcasts real-time telemetry data in channels VC0, VC1 and VC2 when available. The ECS also receives and stores "quicklook" data consisting of the VC0 and VC1 packets from the tape recorder playback data and any retransmissions of VC0, VC1 and VC2 based on problems with the original transmissions from DSN. The realtime data is distributed to the instrument workstations based on instrumenter submitted requests.

Quicklook Data acquired by the ECS as well as the realtime data is available via network retrieval from ECS archive. The tape dump data is available within two hours of downlink. Telemetry is kept online in the EOF for 7 days and offline for 28 days.

High rate science data from both VC2 and VC3 is delivered by CDROM or 8 mm tape to the SSSC within 2 weeks of downlink.

## 9.2 Summary and Collaborative Data Products

Several summary and collaborative MDI data products will be developed and distributed from the EOF by the MDI operations team.

### 9.2.1 VIRGO-LOI Low-l P-modes

Average low intensity images (64 elements) of the velocity and flat fielded continuum intensity will be computed each minute for the Luminosity Oscillations Imager (LOI) on VIRGO.

### 9.2.2 GOLF Magnetic Proxy

Medium resolution magnetic proxy are developed for 32x32 element spatial averages and are provided once per minute for GOLF.

### 9.2.3 Full disk Magnetogram

A full disk Magnetogram will be generated and downlinked following each tape dump three times per day in the magnetogram virtual channel VC2 during the 10 months of Campaign Program. During the 2 months of Dynamics Program the VC2 magnetogram will be available only once per day.

## 9.3 Data Distribution

### 9.3.1 Mission Support Summary Data

MDI will provide summary data in the form of magnetograms, dopplergrams and intensity maps to the ECS on a daily basis.

### 9.3.2 Collaborative Data Products

Virgo and Golf data will be made available directly to the respective investigators in electronic form.

## 9.4 Data Formats

Data formats for use in the EOF are described in reference 6.

## Appendix A: REFERENCES


1 SOI-MDI Data Management Plan

Revision 2, 6/10/91

2 SOHO EID Part B1, MDI General Description

Issue 1, Revision 2, 1/6/92

3 SOI-MDI Instrument Performance Specification

Revision 2, MDI330016, 1/14/91

4 SOI-MDI Image Processor Functional Requirements

Draft Version 3.2, SOI-RD-013, 1/20/94

5 SOHO Science Operations Plan

Issue 1.1, 6/93

Spacecraft Timing

Key Parameters

Coordinate Systems

6 MDI Experiment Operations Manual

Revision 2.4, SOI-RD-019, 3/9/94

Telemetry Monitors

Telecommands

7 ICD SOHO EOF Core System (ECS) to SOHO Instrumenters

514-3ICD/0193, Initial Release, 7/93

EOF Telemetry Interface

EOF Command Interface

EOF Core System Database

8 SOHO EOF Core System Functional Requirements Document

Initial Release 4/92

9 SOHO EOF Core System System Requirements Document

514-4SRD/0492, Initial Release 2/92

# Appendix B: DEFINITIONS

## B.1 SOI-MDI Definitions

| | |
|---|---|
| Campaign | Observation program custom tailored to achieve specific science objectives using the 8 hours of high rate data during the Campaign Program |
| Command Plan | Plan defining commands to be sent to MDI |
| Continuum | Single filtergram taken away from line center |
| CW | Command Workstation - MDI workstation in the EOF dedicated to supporting the MDI Operator for commanding and housekeeping telemetry display |
| DEP | MDI onboard Dedicated Experiment Processor |
| Dopplergram | A map of velocity generated from four filtergrams taken at slightly different filter positions |
| DSDS | SOI-MDI Data Storage and Distribution System located in the SSSC |
| Filtergram | Single MDI image |
| IP | MDI onboard Image Processor |
| LPARL | Lockheed Palo Alto Research Laboratory |
| Magnetogram | A map of magnetic field intensity generated from an interleaved set of right and left circularly polarized dopplergrams |
| MDI | Michelson Doppler Imager |
| Observing Plan | Plan defining observations for MDI to make |
| Program | Period of MDI observations dedicated to general science goals: Dynamics, Structure, Magnetic Field, Campaign or Calibration |
| SOI | Solar Oscillations Investigation |
| SSSC | SOI Science Support Center |
| SW | Science Workstation - MDI workstation in the EOF dedicated to supporting the MDI Observer for mission planning and science data analysis and display |

## B.2 SOHO Definitions

| | |
|---|---|
| CDHF | ISTP Central Data Handling Facility |
| CMS | Command Management System |
| DSN | Deep Space Network |
| EAP | ECS Activity Plan |
| ECS | EOF Core System |
| EID | Experiment Interface Document |
| EOF | SOHO Experimenter Operations Facility |
| FOT | Flight Operations Team, NASA staff for the POCC |
| HOP | Halo Orbit Phase |
| IAP | Instrument Activity Plan, instrumenter input to EAP |
| ISTP | International Solar-Terrestrial Physics program |
| LAN | Local Area Network |
| LEOP | Launch and Earth Orbit Phase |
| LOS | Loss Of Signal |
| NRT | Near Real Time commanding |
| Operational Day | 24 hour period beginning at 00:00 GMT |
| PACOR | IPD Packet Processor |
| PCS | Predefined Command Sequence, a list of commands stored in the SMOCC |
| PDB | Project Data Base, a database of defined commands, telemetry formats, page displays, procedures and other mission related datasets which is delivered to the POCC and maintained by the FOT. |
| POCC | Payload Operations and Control Center |
| RCR | Remote Command Request, electronic request for execution of a PCS |
| RPR | Remote Procedure Request, electronic request for FOT to execute a STOL procedure |
| SAF | Science Analysis Facility |
| SMOCC | SOHO Mission Operations Control Center |
| SOC | Science Operations Coordinator |
| SQL | Source Query Language - database query language |
| STOL | Systems Test and Operations Language, language used for spacecraft command procedures |
| TTP | Trajectory Transfer Phase |
| UTC | Universal Time Code |
| VC | Virtual Data Channel |

## Appendix C: DEVELOPMENT RESPONSIBILITIES

During the integration and test phase, the procedures required for the MDI mission operations phase will be developed and tested. To the maximum extent possible, these procedures will have companion procedures that are used to test the MDI instrument. The procedures used for integration and verification of the instrument operation will be as "mission-like" as is feasible, thereby providing an easier transition to the operations phase.

### C.1 Stanford

Stanford is responsible for developing the SOI Science Support Center including the SOI-MDI Data Storage and Distribution System (DSDS). As part of this development effort, Stanford will generate the processing software required to support the science data analysis functions for the EOF including the development of summary data for distribution. In addition, Stanford will develop the sequence construction tools and the MDI EOF Database.

### C.2 LPARL

Lockheed is responsible for engineering development and support for the flight instrument. Lockheed will develop the Command Workstation interface, tools to support DEP and IP executable development and telemetry acquisition.

# Appendix D: MDI OBSERVING PLAN

## D.2 Description

The MDI Observing Plan will fully specify the activities of the MDI instrument. It will consist of an ASCII file of UTC time-tagged operations that will identify significant parameters such as DSN contact times, mode changes in the MDI instrument, science and campaign programs, and specify SMOCC PCS/STOLs or other commanding requirements. Where appropriate it will identify the requirement for new DEP sequences, parameters and/or IP tables. The MDI inputs to the ECS Activity Plan (EAP) will be directly derivable from the MDI Observing Plan. The MDI Observing Plan will be developed on a weekly basis corresponding with the availability of the DSN contact schedule. The Observing Plan will be updated prior to each day's operations based on the final EAP. An example of the MDI Observing Plan is attached.

## D.1 Definition

### D.1.1 Header

The MDI Observing Plan will be developed as a separate plan for each day of operations. The listing of the day's planned activities will be preceded by a header identifying the author and date for the plan. The contents of the header are as follows:

| | |
|---|---|
| DATATYPE: | MDI Observing Plan |
| FILENAME: | MDIyymmdd.MOP |
| OBSERVER: | Author |
| DATE-CREATED: | yyyy/mm/dd hh:mm:ss |
| STARTIME: | yyyy/mm/dd hh:mm:ss |
| ENDTIME: | yyyy/mm/dd hh:mm:ss |
| COMMENT: | Description of important features and issues for the day as planned |

### D.1.2 Content

The listing of each day's activities will include DSN contact, FOT, spacecraft and any other MDI operation planning constraints. It will list all mode changes, commanding, verification activity and activity coordinated with the FOT or other experiments. Each entry will include the following items:

| | |
|---|---|
| Activity | Mnemonic characterizing entry content |
| UTC Startime | The anticipated start time for the activity |
| Duration | The anticipated duration of the activity |
| Instrument Mode | The mode of activity with respect to MDI or the resulting change in MDI mode |
| Program | Observing program: campaign, structure, dynamics, magnetic, calibration or test. |
| Command Type | Source of commanding: Near Real Time (NRT), Delayed Command File (DCF), Background Queue Command File (BQF), |

| | |
|---|---|
| | Remote Command Request (RCR) for SMOCC Prestored Command Sequence, or Remote Procedure Request (RPR) for SMOCC STOL Procedure. |
| Command File | Command mnemonic or command sequence file name for NRT, name of command file for DCF or BQF, name of PCS for RCR, or name of STOL for RPR. |
| DEP Sequences | DEP sequence being initiated, terminated or whose operational characteristics are being changed. |
| Description | Description of activity. Should include detail on requirements for DEP/IP memory loads for new sequences, DEP code, IP tables or IP firmware |

## D.3 Observing Plan Example

The example MDI Observing Plan is for Campaign Program telemetry acquistion and includes the coordinated uplink and testing of a new IP sequence.

See attachment

## Appendix E: EOF DATABASE

The SOI-MDI EOF database will parallel the structure of the ECS SOHO database maintained at the EOF. It will consist of a catalog providing information about observation sequences (planned and executed), instrument housekeeping and science data, and telemetry definitions. The contents of the SOI-MDI EOF database will include items and be maintained by the EOF functional elements as identified in the following table:

**Table E.1 EOF Database**

| | |
|---|---|
| DSN Schedule | Observer |
| Trajectory Plan/As-Flown | Observer |
| Spacecraft Activities | Observer |
| Weekly Summaries | Observer |
| MDI Observing Requirements | Observer |
| MDI Observing Plan | Observer |
| SOHO EOF Activities Plan | Observer |
| Command History | Observer |
| Summary Science Data | Observer |
| Telecommand Definitions | Operator |
| CMS Control Files | Operator |
| Instrument Memory Map | Operator |
| DEP/IP Code Managment | Operator |
| IP Firmware / DEP Code | Operator |
| CCD Header Definition | Operator |
| Command Plan | Operator |
| Summary Housekeeping Data | Operator |
| DEP Sequence Development Status | Builder |
| DEP / IP Parameter Table Development | Builder |
| Telemetry Acquired | Telemetry |
| Telemetry Definitions | Telemetry |