Chapter 1 - Introduction

Contents

Introduction to the Revised Edition

This document was originally published by the NIMS team in August 1993 as a guide to the Galileo Encounter with the asteroid Ida. It has been revised and corrected for inclusion on the 4th CD-ROM of NIMS Experimental Data Records (EDRs). Some material in the original document has been omitted, and a chapter added describing the Ida data actually returned to the ground.

The aim of the revised guide is to provide detailed information on the various NIMS observations and calibrations. Also included is background information on the encounter. An overview of the guide is given below. Please refer to the beginning of each chapter for a detailed list of contents.

Chapter 1 gives an introduction to the Ida encounter as well as a discussion of various issues that went into the design of the Ida encounter sequence. Chapter 2 gives an overview of the entire Ida encounter using various timelines. Chapter 3 contains diagrams of various aspects of geometry for the Ida encounter. Chapter 4 summarizes the planned NIMS Ida observations by means of a comprehensize sequence summary, PA summary and Observation Table (OBSTAB). Chapter 5 is a collection of the Detailed Observation Designs made up of OAPEL forms and POINTER plots. Chapter 6 is a summary of the NIMS data return for the Ida Encounter.

For information on the NIMS instrument, please see the preprint of the NIMS instrument paper provided elsewhere on the CD-ROM, or refer to the published version: R.W. Carlson, P.R. Weissman, W.D. Smythe, J.C. Mahoney and the NIMS Science and Engineering Teams, "Near-infrared Mapping Spectrometer Experiment on Galileo", Space Science Reviews 60: 457-502, 1992.

ACKNOWLEDGEMENTS

The NIMS Ida observations in this guide were designed by Marcia Segura and Paul Weissman with the help of Bill Smythe and Bob Carlson. The calibrations were designed by Marcia Segura with help from Bill Smythe. John Hui prepared the original printed guide. Frank Leader subsequently retrieved most of the original material for the CD-ROM, edited the original Postscript files for consistency and clarity, recovered missing material by scanning parts of the original printed document and prepared the last chapter describing the data return. Some figures from the Galileo Ida Encounter Notebook prepared by the Galileo Mission Design Team were incorporated into this guide. Al Stevenson generated the sequence summary. Bob Mehlman oversaw production of this guide.

Introduction

On August 28, 1993, Galileo will attempt to record the best spatial and spectral information available on an asteroid. 243 Ida will be the target and will provide the second opportunity for an asteroid flyby by the Galileo spacecraft. This packet is provided to the NIMS team as a guide to the Galileo Ida Encounter. Within these pages, you will find information about the asteroid itself, the plans for obtaining the data, and the plans for the data return.

243 Ida - The Asteroid

Ida was discovered by Johann Palisa in Vienna on September 29, 1884. The asteroid was named for the nymph of Crete who nursed young Zeus. It is a faint object as viewed from Earth-based telescopes and little observing was done prior to Galileo's desire to 'fly by' a second asteroid.

Ida is an S-type asteroid and a member of the Koronis family which is in the outer belt between 2.8 and 2.9 AU. Ida itself is located at a semi-major axis of 2.86 AU. It is expected to be composed of olivine and pyroxene silicates and have a reddish color. Large light curve variations imply a very elongated shape with an approximate mean diameter of 28 km.

Ida's pre-encounter characteristics are summarized below. Gaspra's characteristics are also listed for comparison.

- Ida is almost twice as large in diameter and eight times as large in volume as Gaspra (Ida's triaxial ellispoid model is 53 x 23 x 18 km whereas Gaspra's is 19 x 12 x 11 km.)
- Ida is in the middle of the asteroid belt. (Gaspra is located in the inner edge.)
- Ida has a more rapid spin rate. (Ida's spin period = 4.63 hours; Gaspra's period = 7.04 hours.)
- Ida is thought to have a more irregular shape.
- Ida is a member of the Koronis family of asteroids. (Gaspra is in the Flora family.)
- Ida may be much younger that Gaspra. (10s of millions of years vs. 200 million years for Gaspra.)
- Ida is possibly an ordinary chondrite (most common meteorite) parent body. (Gaspra is posibly a stony-iron meteorite parent body.)

On the following three pages are: 1) a list of Ida's physical constants that was provided by the Galileo Mission Design Team, 2) a plot of a ground-based near-infrared spectrum of Ida that was presented by David Tholen at the Munich DPS of 1992 and 3) a plot in semi-major axis vs inclination of the known asteroids showing Ida and Gaspra and the asteroid families that they belong to.

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Asteroid 243 Ida - Physical Constants
Class S, Family 3 - Koronis Family

Diameter:  28 +/- 3 km

Shape:     assume tri-axial ellipsoidal with axis ratios
           a:b:c = 2.3 : 1.0 : 0.8
             +/-   0.4         0.2
           coupled with the assumed mean diameter yields:
           a:b:c = 53 km : 23 km : 18 km
           (28 km  = cube root of (a*b*c))

Synodic Period:
           0.1930680 +/- 0.0000005 day

Sense of Rotation:
           unknown, assume retrograde  (sigma result)

North Pole Position:  (IAU convention - equally likely, adopy #1)
           Solution 1:  260 deg ecliptic longitude, +50 deg ecliptic
                        latitude ( 263 RA, +27 Dec)
           Solution 2:  82 deg ecliptic longitude, +50 deg ecliptic
                        latitude ( 72 RA, +73 Dec)
           (uncertainites are +/- 15 deg in each direction)

Epoch:     (Direction of longest axis)
           1993 Aug 29.000 (JD 2449228.500)
           Solution 1:  120 deg ecl. long., +33 deg ecl. lat.
           Solution 2:  120 deg ecl. long., -34 deg ecl. lat.
           1993 Aug 30.000 (JD 2449229.500)
           Solution 1:   41 deg ecl. long., +33 deg ecl. lat.
           Solution 2:   41 deg ecl. long., -32 deg ecl. lat.

Albedo:    0.24 +/- 0.03 (IRAS)

Magnitudes:
           H   = 10.02      G   = 0.203
           U-B = 0.44       B-V = 0.81

Lightcurve Amplitude:
           0.45 - 0.95

Orbital Elements:  (Epoch 1993 nov 9.0 = 2449300.5)
           a = 2.862 AU          (semi-major axis)
           Q = 2.7388094 AU      (perihelion distance)
           e = 0.0434032         (eccentricity)
           sin i = 0.0197        (inclination, i=1.13126 deg)
           W = 113.21057 deg     (argument of perihelion)
           node = 323.66333 deg  (longitude of asc. node, from B1950.0)
           Wbar rate = 64.6      (sec/yr)
           node rate = -65.6     (sec/yr)
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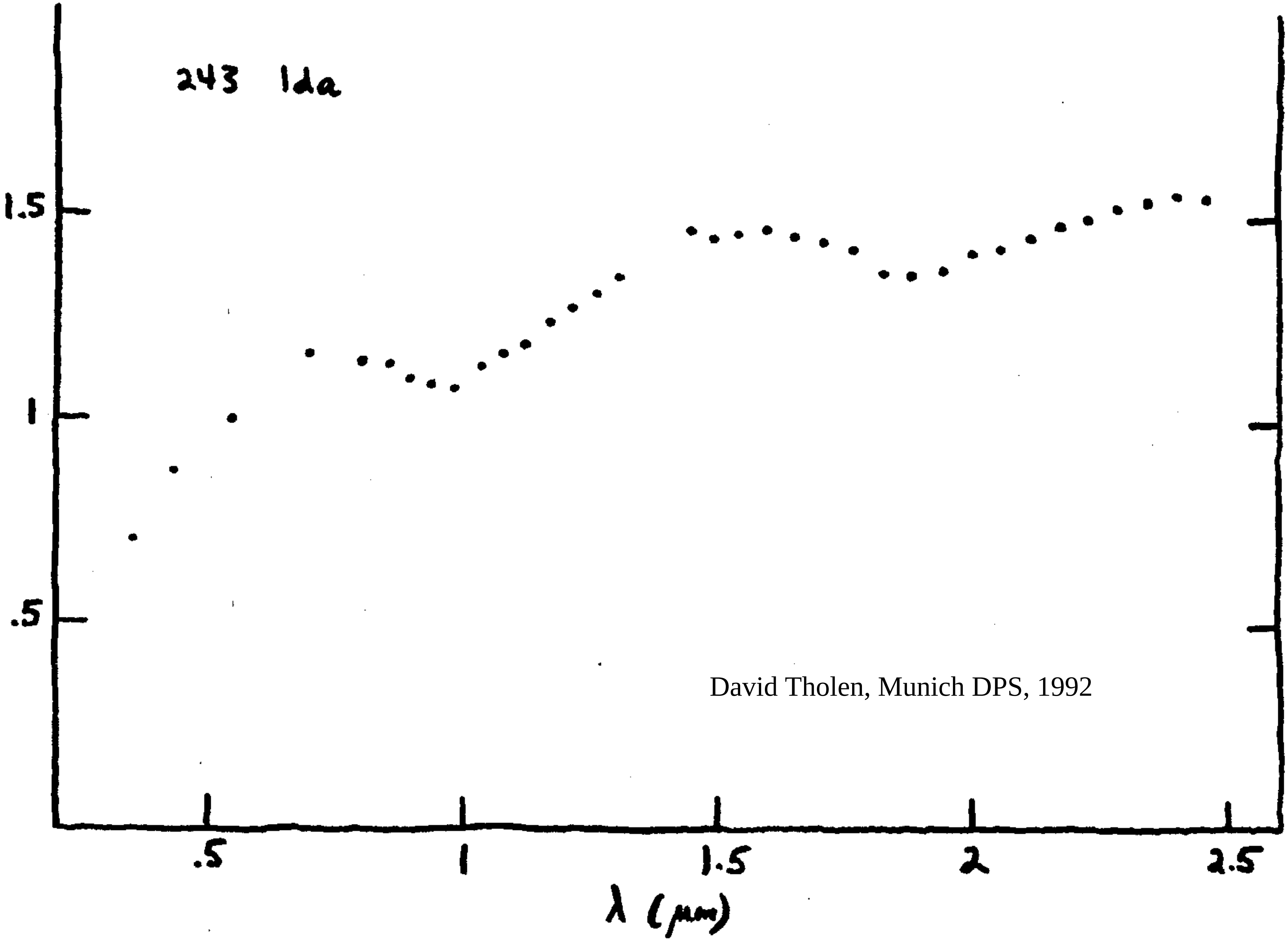
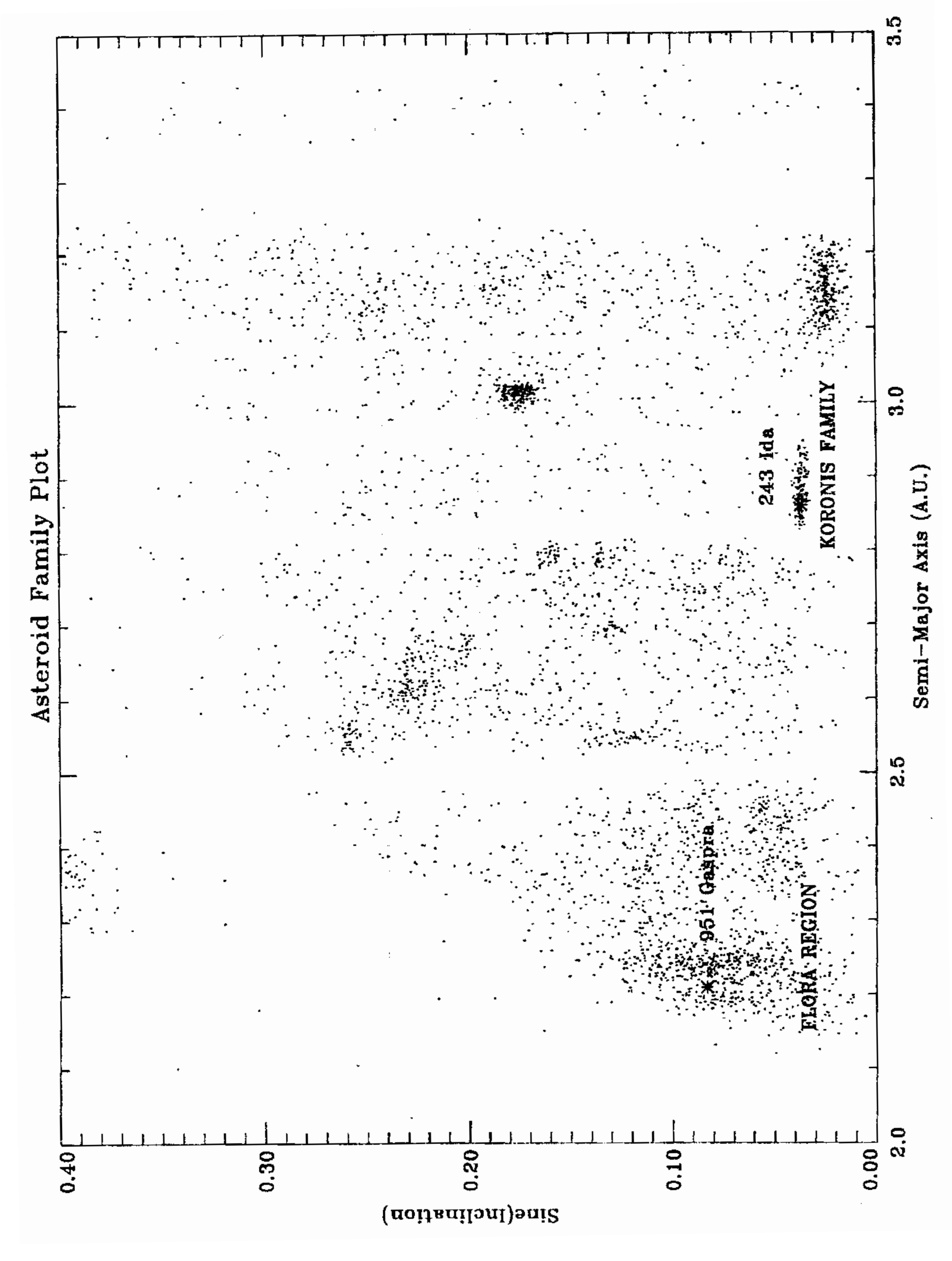

243 Ida
1.5
1
.5
.5
1
1.5
2
2.5
λ (μm)
David Tholen, Munich DPS, 1992


Asteroid Family Plot
Semi-Major Axis (A.U.)
Sine(Inclination)
2.0
2.5
3.0
3.5
0.00
0.10
0.20
0.30
0.40
951 Gaspra
FLORA REGION
243 Ida
KORONIS FAMILY

History of the Ida Sequence

The planning for Ida Encounter began in the early fall of 1992 with a series of aim point selection meetings. A dark side, 75 deg south ecliptic latitude, 2400 km range flyby was chosen. This aim point provided for the most illuminated surface area to be visible at closest approach and was a compromise of both NIMS and SSI observation requirements. The aim point itself impacted the sequence. It required that the spacecraft attitude be changed (18 degrees off-sun and 29 degrees off-earth) to insure the observations would not be in the cone pole region and to delay the time of boom obscuration. Downlink capability, due to both the spacecraft attitude and the HGA deployment failure, mandated that all science observations be stored on the tape recorder rather than be returned immediately. This requirement grew to include all engineering data taken during the telemetry gap caused by the turn to the off-Earth attitude, which amounted to approximately one half track of the DMS. The data return strategy overshadowed every other aspect of the sequence development. During the observation design phase, much thought was given to the return of Ida data. Observations that may have been collaborative efforts in previous encounters became standalone activities to reduce tape usage. Series of observations were repeated to accommodate easier tape positioning for return. NIMS fixed map observations were added after every absolute slew in the rotation study portion of the sequence to provide more exact Ida location for the return of subsequent NIMS/SSI data. This effort will reduce the amount of dark sky data return for pointing uncertainties and conserve both downlink capability and DMS start/stop cycles for actual asteroid data.

Spacecraft Orientation and Trajectory

Galileo off-sun angle:	~ 18 degrees
Radial distance:	darkside, 2400 km @ closest approach
Closest approach point:	75 degrees, south ecliptic latitude
Encounter time:	August 28, 1993; DOY 93-240/16:52:04 UTC

NIMS Science Priorities

Using the Asteroid Working Group's science objectives, Ida's physical characteristics, spacecraft range, and experience gained during Galileo's flyby of Gaspra, the NIMS Ida observations were sequenced accordingly ("Start" and "End" times are in rims prior to Ida closest approach.).

Priority	Start	End	Observation
1	-5	-1	Fixed Map, 0.8 mrad/sec, collaborative NIMS/SSI mosaic, 95% coverage of error ellipse.
2	-11	-5	Short Map, 0.11 mrad/sec, 2 swaths, full coverage of error ellipse
3	-22	-18	Long Map, 0.03 mrad/sec, 1 swath, full coverage of error ellipse
4	-322	-28	Fixed Map, 0.75 mrad/sec every 90 deg of rotation Full Map, 0.06 mrad/sec every 90 deg of rotation Short Map, 0.11 mrad/sec every 30 degrees between 90 degree samples Short Map, 0.11 mrad/sec every 15 degrees between 30 degree samples throughout 1 full Ida rotation.
5	After closest approach		PCT and RCT calibrations with durations of 6 rims each.

The NIMS Sequence

The NIMS Ida sequence uses four NIMS instrument modes for science observations: Long Map (LM), Full Map (FM), Short Map (SM) and Fixed Map (XM). The gain states chosen were 4 and 3; 4 being used during the distant observations when Ida is still sub-nimsel in size and 3 being used during the closest observations. The grating offset is the default: 4. The following grating offsets were used to allow sampling of the 1.05 micron absorption band. The 1.05 micron samples maximize the scene contrast and should provide the best information on the olivine/pyroxene band. These are the same grating offsets used in the Gaspra Encounter.

Mode	Grating Start Position
LM	0
FM	0
SM	2
XM	6

Observations:

The NIMS science observations are logically divided into two portions; the rotation observations and the "close-in" observations. The rotation portion covers approximate 390 degrees of Ida rotation starting at -322 rims from closest approach. NIMS acquires samples every 90 degrees (XM and FM), 30 degrees (SM), and 15 degrees (SM) of rotation. Note: The XM samples were included to aid in the reduction of pointing uncertainty and thus facilitate asteroid data return. The "close-in" portion covers from -28 rims prior to closest approach (the end of the rotation observations) to 1 rim after closest approach. At -28 rims and -22 rims, NIMS acquires two Long Map (LM) samples. These observations are at the best spectral resolution possible. At -11 rims before closest approach, NIMS observes Ida in Short Map (SM) mode to determine asteroid composition. This observation is done in the best spectral/spatial combination possible. From -5 rims to 1 rim, collaborative NIMS/SSI observations are taken; NIMS acquires data in Fixed Map (XM) mode at the highest spatial resolution possible for the Ida Encounter. NIMS rides along in Fixed Map on an additional SSI observation from -1 to +1 Rim to obtain the highest possible spatial resolution data on the asteroid.

Calibrations:

Bore-sight	-	NIMS, UVS, and PPR collaborative StarCal, at +30 rims
PCT Cal	-	NIMS Photometric Calibration at +661 rims
RCT Cal	-	NIMS Radiometric Calibration at +2984 rims

Activities Prior to Ida Encounter

Certain activities necessary to set the stage for Ida Encounter could not be placed in the EJ3-Ida sequence load due to time/load constraints. These tasks were placed in the EJ2 sequence prior to EJ3. Items of importance to NIMS are the OPNAV frames, instrument turn-on and heater configuration. Although all of the OPNAV images are important to the success of the Ida encounter, #4 and #5 provided NIMS with the opportunity to do two calibrations: Opcal and Ecal. Listed below are the activities of interest to NIMS:

Time	Activity
DOY 93-227/19:38:04	NIMS Shield Heater OFF
DOY 93-229/00:56:44	NIMS Replacement Heaters OFF
DOY 93-229/00:57:12	NIMS Power ON
DOY 93-229/20:25:05	PCT Heater 1 OFF
DOY 93-229/20:41:27	OPNAV 4/NIMS OPCAL recorded
DOY 93-230/04:25:10	OPNAV 4/NIMS OPCAL playback begins
DOY 93-232/06:06:23	OPNAV 4/NIMS OPCAL playback ends
DOY 93-233/14:52:55	OPNAV 5/NIMS ECAL recorded
DOY 93-233/15:05:10	OPNAV 5/NIMS ECAL playback begins
DOY 93-235/05:58:23	OPNAV 5/NIMS ECAL playback ends
DOY 93-237/23:05:10	PCT Heater 1 ON

Timeline Summary

The list below provides an overview of the Encounter events.

Time (UTC)		Event
08/17/93 (Tue., Day 229)	00:57:11	NIMS Turn On in EJ2 Sequence
08/17/93 (Tue., Day 229)	20:39:21	NIMS OPCAL in EJ2 Sequence
08/21/93 (Sat., Day 233)	14:50:50	NIMS ECAL in EJ2 Sequence
08/27/93 (Fri., Day 239)	11:00:00	Ida Sequence EJ3 Begins
08/28/93 (Sat., Day 240)	11:24:28	NIMS First Observation, Ida Rotation 1
08/28/93 (Sat., Day 240)	16:52:04	Ida Closest Approach
08/30/93 (Mon., Day 242)	19:19:03	NIMS Last Observation, PCT Calibration
08/30/93 (Mon., Day 242)	20:35:00	NIMS TURN Off
09/27/93 (Mon., Day 270)	16:00:00	Ida Sequence EJ3 Ends

Month of September, 1993	First Ida Data Return Playback
Months of March through June, 1994	Remainder of Ida Data Return Playback

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Meetings:

Tuesdays	Regular SROP meeting @ 9:00 a.m. in 264-784 NIMS Science Coordinators meeting @11:00 a.m. in 264-784
Wednesdays	Regular S&MD meeting @9:30 a.m. in 264-784
Thursdays	NIMS Team Meeting @ 12:00 p.m. in 183-343