13873 - The Intriguing Formation of Haumea's Satellites

Cycle: 22, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Prof. Darin Ragozzine (PI) (Contact)	**Florida Institute of Technology**	**dragozzine@fit.edu**
Dr. Michael E Brown (CoI)	California Institute of Technology	mbrown@caltech.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) HAUMEA	WFC3/UVIS	1	06-Nov-2014 21:08:10.0	yes
02	(1) HAUMEA	WFC3/UVIS	1	06-Nov-2014 21:08:13.0	yes
03	(1) HAUMEA	WFC3/UVIS	1	06-Nov-2014 21:08:16.0	yes

3 Total Orbits Used

ABSTRACT

The dwarf planet Haumea is arguably the most intriguing Kuiper Belt Object in the outer solar system. Orbited by two satellites, Haumea is also the progenitor of the only collisional family in the Kuiper belt and provides unique insights on the physics of KBO collisions, tides, surfaces, and interiors. A self-consistent theory for Haumea's formation remains elusive, but is clearly connected to unanswered questions about the outer solar system. Precise physical and orbital characteristics of Haumea's satellites can distinguish between several proposed histories. When 2010 HST data was added to the initial orbital solution from Ragozzine & Brown 2009 (RB09), degeneracies between the non-Keplerian effects from satellite masses and from Haumea's non-spherical gravity began to break (Cuk, Ragozzine, Nesvorny 2013). By obtaining three single-orbit visits in Cycle 22, HST will double its observational baseline, which provides very significant improvement in inference of the most interesting system properties. This small investment benefits multiple sicence goals: robust satellite mass and Haumea J2 measurements to distinguish between formation models;

crucial support for Haumea-inner-satellite mutual events through 2020; tying down the unusually rapid rotation of outer satellite; and providing context for New Horizons' visit to Pluto. Observations from the ground cannot reasonably provide the same scientific benefit since close-in (~0.25") resolved astrometry and photometry are required. This proposal provides low-risk, high-return scientific insight into the formation of this intriguing object with implications for understanding the outer solar system.

OBSERVING DESCRIPTION

Astrometric and photometric observations of the dwarf planet Haumea and its two satellites Hi'iaka and Namaka.

The goal is to obtain precise astrometry and high-cadence photometry of the satellites of Haumea. During the observing season, Haumea is located near 14h and +17d. The observing sequence will follow the successful observations of Program 12004.

The observations are designed to maximize overall signal-to-noise (by maximizing total exposure time), while taking multiple observations to produce a high-cadence light curve. We would like as many 40-second observations per orbit as possible. In order to minimize overheads, we're using the 512K subarray of WFC3/UVIS. The target should be centered in a region of good pixels near the center of the subarray.

The observations are time-sensitive: observing when the satellites are near Haumea, but definitely not within its PSF, contains the most information and has the highest scientific value. This limits the useful observation time to ~20% of the total time, spread over tens of observation periods. It turned out to be most straightforward to enter this in as a large number of BETWEEN requirements. We also require 30 days between each observation to obatin independent information. As necessary, we will interact directly with scheduling to make the observations both plausible and valuable.

Visit

Proposal 13873, Visit 1 (01), implementation Fri Nov 07 02:08:17 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 02-SEP-2014:14:00:00 AND 03-SEP-2014:14:00:00; BETWEEN 07-SEP-2014:14:00:00 AND 09-SEP-2014:19:00:00; BETWEEN 21-SEP-2014:09:00:00 AND 22-SEP-2014:09:00:00; BETWEEN 09-OCT-2014:14:00:00 AND 10-OCT-2014:19:00:00; BETWEEN 24-OCT-2014:19:00:00 AND 25-OCT-2014:09:00:00; BETWEEN 27-OCT-2014:09:00:00 AND 29-OCT-2014:00:00:00; BETWEEN 19-NOV-2014:19:00:00 AND 20-NOV-2014:04:00:00; BETWEEN 21-NOV-2014:14:00:00 AND 22-NOV-2014:09:00:00; BETWEEN 03-DEC-2014:14:00:00 AND 04-DEC-2014:14:00:00; BETWEEN 08-DEC-2014:00:00:00 AND 08-DEC-2014:09:00:00; BETWEEN 09-DEC-2014:09:00:00 AND 10-DEC-2014:19:00:00; BETWEEN 12-DEC-2014:14:00:00 AND 13-DEC-2014:00:00:00; BETWEEN 22-DEC-2014:00:00:00 AND 23-DEC-2014:00:00:00; BETWEEN 09-JAN-2015:04:00:00 AND 10-JAN-2015:04:00:00; BETWEEN 13-JAN-2015:14:00:00 AND 14-JAN-2015:09:00:00; BETWEEN 27-JAN-2015:00:00:00 AND 28-JAN-2015:14:00:00; BETWEEN 01-FEB-2015:00:00:00 AND 04-FEB-2015:09:00:00; BETWEEN 14-FEB-2015:19:00:00 AND 16-FEB-2015:00:00:00; BETWEEN 19-FEB-2015:04:00:00 AND 20-FEB-2015:04:00:00; BETWEEN 20-FEB-2015:19:00:00 AND 23-FEB-2015:09:00:00; BETWEEN 28-FEB-2015:00:00:00 AND 01-MAR-2015:04:00:00; BETWEEN 05-MAR-2015:00:00:00 AND 06-MAR-2015:04:00:00; BETWEEN 18-MAR-2015:04:00:00 AND 19-MAR-2015:04:00:00; BETWEEN 20-MAR-2015:14:00:00 AND 24-MAR-2015:14:00:00; BETWEEN 28-MAR-2015:00:00:00 AND 28-MAR-2015:14:00:00; BETWEEN 10-APR-2015:04:00:00 AND 12-APR-2015:00:00:00; BETWEEN 15-APR-2015:04:00:00 AND 16-APR-2015:09:00:00; BETWEEN 17-APR-2015:00:00:00 AND 19-APR-2015:04:00:00; BETWEEN 29-APR-2015:00:00:00 AND 30-APR-2015:04:00:00; BETWEEN 03-MAY-2015:14:00:00 AND 04-MAY-2015:09:00:00; BETWEEN 05-MAY-2015:19:00:00 AND 07-MAY-2015:04:00:00; BETWEEN 08-MAY-2015:19:00:00 AND 09-MAY-2015:19:00:00; BETWEEN 12-MAY-2015:04:00:00 AND 13-MAY-2015:19:00:00; BETWEEN 17-MAY-2015:09:00:00 AND 18-MAY-2015:14:00:00; BETWEEN 21-MAY-2015:19:00:00 AND 22-MAY-2015:09:00:00; BETWEEN 31-MAY-2015:14:00:00 AND 01-JUN-2015:04:00:00; BETWEEN 04-JUN-2015:09:00:00 AND 05-JUN-2015:19:00:00; BETWEEN 09-JUN-2015:04:00:00 AND 11-JUN-2015:14:00:00; BETWEEN 21-JUN-2015:19:00:00 AND 24-JUN-2015:04:00:00; BETWEEN 27-JUN-2015:14:00:00 AND 01-JUL-2015:09:00:00; BETWEEN 11-JUL-2015:04:00:00 AND 12-JUL-2015:09:00:00; BETWEEN 15-JUL-2015:19:00:00 AND 16-JUL-2015:19:00:00; BETWEEN 17-JUL-2015:04:00:00 AND 20-JUL-2015:00:00:00; BETWEEN 24-JUL-2015:19:00:00 AND 26-JUL-2015:04:00:00; BETWEEN 29-JUL-2015:04:00:00 AND 30-JUL-2015:19:00:00; BETWEEN 11-AUG-2015:19:00:00 AND 13-AUG-2015:00:00:00; BETWEEN 15-AUG-2015:00:00:00 AND 18-AUG-2015:00:00:00; BETWEEN 21-AUG-2015:09:00:00 AND 22-AUG-2015:00:00:00; BETWEEN 03-SEP-2015:14:00:00 AND 05-SEP-2015:09:00:00; BETWEEN 09-SEP-2015:19:00:00 AND 12-SEP-2015:19:00:00; BETWEEN 22-SEP-2015:09:00:00 AND 23-SEP-2015:14:00:00; BETWEEN 27-SEP-2015:00:00:00 AND 28-SEP-2015:00:00:00; BETWEEN 29-SEP-2015:14:00:00 AND 01-OCT-2015:00:00:00; BETWEEN 03-OCT-2015:00:00:00 AND 03-OCT-2015:09:00:00; BETWEEN 05-OCT-2015:19:00:00 AND 07-OCT-2015:14:00:00; BETWEEN 10-OCT-2015:19:00:00 AND 12-OCT-2015:00:00:00; BETWEEN 15-OCT-2015:09:00:00 AND 15-OCT-2015:19:00:00; BETWEEN 25-OCT-2015:04:00:00 AND 25-OCT-2015:19:00:00; BETWEEN 29-OCT-2015:00:00:00 AND 30-OCT-2015:04:00:00

Comments: Each visit is 1 orbit long with 4 sets of 7 observations each, with a dither in between, and each observation lasting about 40 seconds. The number of observations calls for the use of the 512x512 subarry on WFC3. The goal is precise astrometry and photometry of moving object Haumea.

To optimize the information content, I have identified when the satellites are visible and non-overlapping and current orbital solutions are weak. The easiest way to define this was as ~50 between requirements with 1-3 day durations. We can iterate with the schedulers to make this work.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	HAUMEA	STD=HAUMEA				EARTH

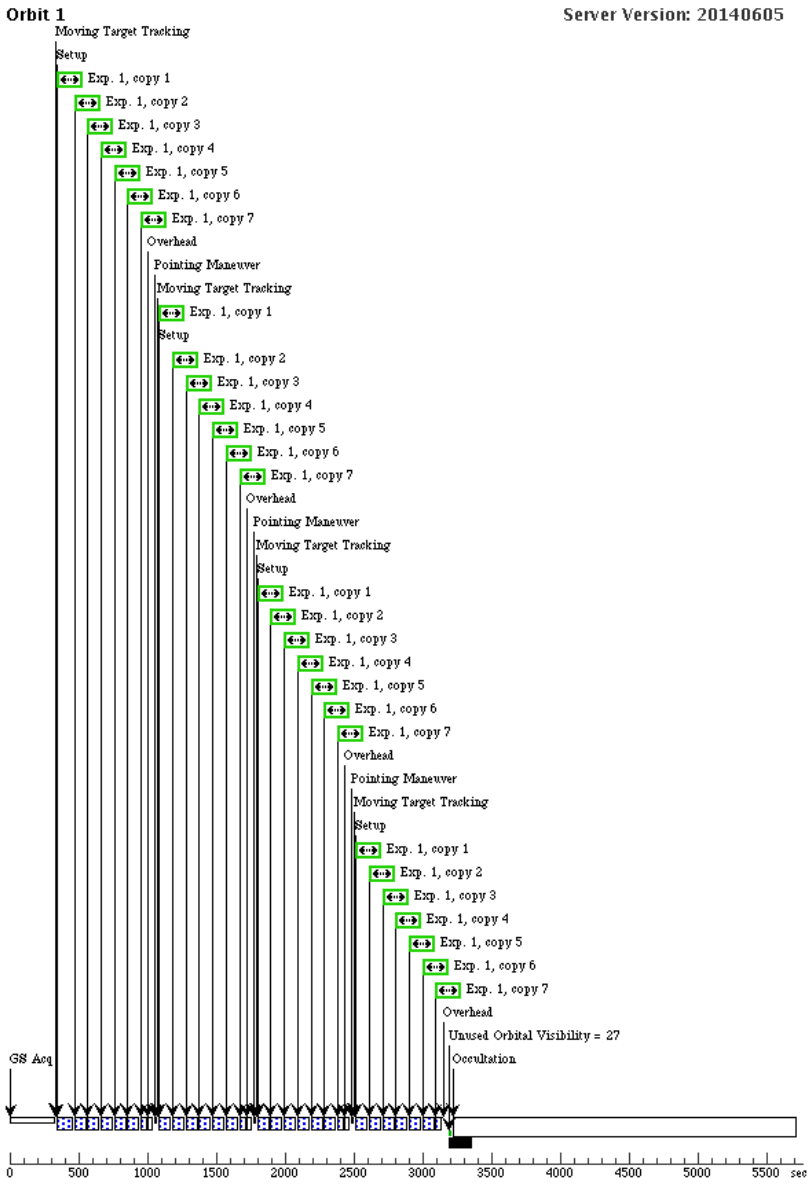
Comments: Using Haumea as a standard target.

During this cycle of observations, the rough RA and Dec are 14h and 17d.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	7 44 sec obs ervations	(1) HAUMEA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	CR-SPLIT=NO; FLASH=5		Sequence 1-1 Non-In t in Visit 1 (01) Pattern 1, Exps 1-1 i n Sequence 1-1 Non-Int in Visit 1 (01) (1)	39 Secs X 7 (1092 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 1, Copy 4)]* *[==>(Pattern 1, Copy 5)]* *[==>(Pattern 1, Copy 6)]* *[==>(Pattern 1, Copy 7)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]* *[==>(Pattern 2, Copy 4)]* *[==>(Pattern 2, Copy 5)]* *[==>(Pattern 2, Copy 6)]* *[==>(Pattern 2, Copy 7)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 3, Copy 3)]* *[==>(Pattern 3, Copy 4)]* *[==>(Pattern 3, Copy 5)]* *[==>(Pattern 3, Copy 6)]* *[==>(Pattern 3, Copy 7)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]* *[==>(Pattern 4, Copy 3)]* *[==>(Pattern 4, Copy 4)]* *[==>(Pattern 4, Copy 5)]* *[==>(Pattern 4, Copy 6)]* *[==>(Pattern 4, Copy 7)]*	***[1]***

Orbit Structure



Visit

Proposal 13873, Visit 2 (02) Fri Nov 07 02:08:18 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 02-SEP-2014:14:00:00 AND 03-SEP-2014:14:00:00; BETWEEN 07-SEP-2014:14:00:00 AND 09-SEP-2014:19:00:00; BETWEEN 21-SEP-2014:09:00:00 AND 22-SEP-2014:09:00:00; BETWEEN 09-OCT-2014:14:00:00 AND 10-OCT-2014:19:00:00; BETWEEN 24-OCT-2014:19:00:00 AND 25-OCT-2014:09:00:00; BETWEEN 27-OCT-2014:09:00:00 AND 29-OCT-2014:00:00:00; BETWEEN 19-NOV-2014:19:00:00 AND 20-NOV-2014:04:00:00; BETWEEN 21-NOV-2014:14:00:00 AND 22-NOV-2014:09:00:00; BETWEEN 03-DEC-2014:14:00:00 AND 04-DEC-2014:14:00:00; BETWEEN 08-DEC-2014:00:00:00 AND 08-DEC-2014:09:00:00; BETWEEN 09-DEC-2014:09:00:00 AND 10-DEC-2014:19:00:00; BETWEEN 12-DEC-2014:14:00:00 AND 13-DEC-2014:00:00:00; BETWEEN 22-DEC-2014:00:00:00 AND 23-DEC-2014:00:00:00; BETWEEN 09-JAN-2015:04:00:00 AND 10-JAN-2015:04:00:00; BETWEEN 13-JAN-2015:14:00:00 AND 14-JAN-2015:09:00:00; BETWEEN 27-JAN-2015:00:00:00 AND 28-JAN-2015:14:00:00; BETWEEN 01-FEB-2015:00:00:00 AND 04-FEB-2015:09:00:00; BETWEEN 14-FEB-2015:19:00:00 AND 16-FEB-2015:00:00:00; BETWEEN 19-FEB-2015:04:00:00 AND 20-FEB-2015:04:00:00; BETWEEN 20-FEB-2015:19:00:00 AND 23-FEB-2015:09:00:00; BETWEEN 28-FEB-2015:00:00:00 AND 01-MAR-2015:04:00:00; BETWEEN 05-MAR-2015:00:00:00 AND 06-MAR-2015:04:00:00; BETWEEN 18-MAR-2015:04:00:00 AND 19-MAR-2015:04:00:00; BETWEEN 20-MAR-2015:14:00:00 AND 24-MAR-2015:14:00:00; BETWEEN 28-MAR-2015:00:00:00 AND 28-MAR-2015:14:00:00; BETWEEN 10-APR-2015:04:00:00 AND 12-APR-2015:00:00:00; BETWEEN 15-APR-2015:04:00:00 AND 16-APR-2015:09:00:00; BETWEEN 17-APR-2015:00:00:00 AND 19-APR-2015:04:00:00; BETWEEN 29-APR-2015:00:00:00 AND 30-APR-2015:04:00:00; BETWEEN 03-MAY-2015:14:00:00 AND 04-MAY-2015:09:00:00; BETWEEN 05-MAY-2015:19:00:00 AND 07-MAY-2015:04:00:00; BETWEEN 08-MAY-2015:19:00:00 AND 09-MAY-2015:19:00:00; BETWEEN 12-MAY-2015:04:00:00 AND 13-MAY-2015:19:00:00; BETWEEN 17-MAY-2015:09:00:00 AND 18-MAY-2015:14:00:00; BETWEEN 21-MAY-2015:19:00:00 AND 22-MAY-2015:09:00:00; BETWEEN 31-MAY-2015:14:00:00 AND 01-JUN-2015:04:00:00; BETWEEN 04-JUN-2015:09:00:00 AND 05-JUN-2015:19:00:00; BETWEEN 09-JUN-2015:04:00:00 AND 11-JUN-2015:14:00:00; BETWEEN 21-JUN-2015:19:00:00 AND 24-JUN-2015:04:00:00; BETWEEN 27-JUN-2015:14:00:00 AND 01-JUL-2015:09:00:00; BETWEEN 11-JUL-2015:04:00:00 AND 12-JUL-2015:09:00:00; BETWEEN 15-JUL-2015:19:00:00 AND 16-JUL-2015:19:00:00; BETWEEN 17-JUL-2015:04:00:00 AND 20-JUL-2015:00:00:00; BETWEEN 24-JUL-2015:19:00:00 AND 26-JUL-2015:04:00:00; BETWEEN 29-JUL-2015:04:00:00 AND 30-JUL-2015:19:00:00; BETWEEN 11-AUG-2015:19:00:00 AND 13-AUG-2015:00:00:00; BETWEEN 15-AUG-2015:00:00:00 AND 18-AUG-2015:00:00:00; BETWEEN 21-AUG-2015:09:00:00 AND 22-AUG-2015:00:00:00; BETWEEN 03-SEP-2015:14:00:00 AND 05-SEP-2015:09:00:00; BETWEEN 09-SEP-2015:19:00:00 AND 12-SEP-2015:19:00:00; BETWEEN 22-SEP-2015:09:00:00 AND 23-SEP-2015:14:00:00; BETWEEN 27-SEP-2015:00:00:00 AND 28-SEP-2015:00:00:00; BETWEEN 29-SEP-2015:14:00:00 AND 01-OCT-2015:00:00:00; BETWEEN 03-OCT-2015:00:00:00 AND 03-OCT-2015:09:00:00; BETWEEN 05-OCT-2015:19:00:00 AND 07-OCT-2015:14:00:00; BETWEEN 10-OCT-2015:19:00:00 AND 12-OCT-2015:00:00:00; BETWEEN 15-OCT-2015:09:00:00 AND 15-OCT-2015:19:00:00; BETWEEN 25-OCT-2015:04:00:00 AND 25-OCT-2015:19:00:00; BETWEEN 29-OCT-2015:00:00:00 AND 30-OCT-2015:04:00:00

Comments: Each visit is 1 orbit long with 4 sets of 7 observations each, with a dither in between, and each observation lasting about 40 seconds. The number of observations calls for the use of the 512x512 subarry on WFC3. The goal is precise astrometry and photometry of moving object Haumea.

To optimize the information content, I have identified when the satellites are visible and non-overlapping and current orbital solutions are weak. The easiest way to define this was as ~50 between requirements with 1-3 day durations. We can iterate with the schedulers to make this work.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	HAUMEA	STD=HAUMEA				EARTH

Comments: Using Haumea as a standard target.

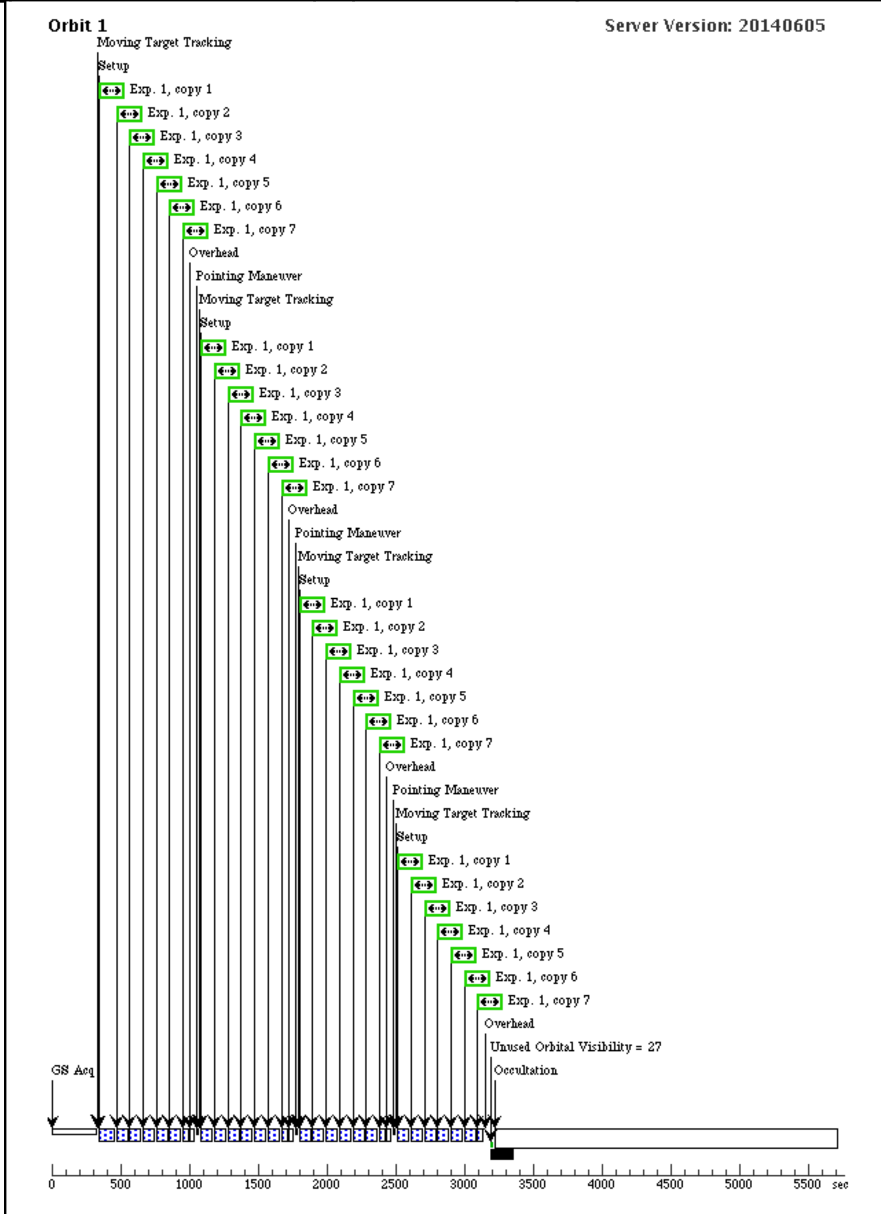
During this cycle of observations, the rough RA and Dec are 14h and 17d.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	7 44 sec obs ervations	(1) HAUMEA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	CR-SPLIT=NO; FLASH=5		Sequence 1-1 Non-In t in Visit 2 (02) Pattern 1, Exps 1-1 i n Sequence 1-1 Non-Int in Visit 2 (02) (1)	39 Secs X 7 (1092 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 1, Copy 4)]* *[==>(Pattern 1, Copy 5)]* *[==>(Pattern 1, Copy 6)]* *[==>(Pattern 1, Copy 7)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]* *[==>(Pattern 2, Copy 4)]* *[==>(Pattern 2, Copy 5)]* *[==>(Pattern 2, Copy 6)]* *[==>(Pattern 2, Copy 7)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 3, Copy 3)]* *[==>(Pattern 3, Copy 4)]* *[==>(Pattern 3, Copy 5)]* *[==>(Pattern 3, Copy 6)]* *[==>(Pattern 3, Copy 7)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]* *[==>(Pattern 4, Copy 3)]* *[==>(Pattern 4, Copy 4)]* *[==>(Pattern 4, Copy 5)]* *[==>(Pattern 4, Copy 6)]* *[==>(Pattern 4, Copy 7)]*	***[1]***

Proposal 13873 - Visit 2 (02) - The Intriguing Formation of Haumea's Satellites

Orbit Structure



Visit

Proposal 13873, Visit 3 (03) Fri Nov 07 02:08:18 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 02-SEP-2014:14:00:00 AND 03-SEP-2014:14:00:00; BETWEEN 07-SEP-2014:14:00:00 AND 09-SEP-2014:19:00:00; BETWEEN 21-SEP-2014:09:00:00 AND 22-SEP-2014:09:00:00; BETWEEN 09-OCT-2014:14:00:00 AND 10-OCT-2014:19:00:00; BETWEEN 24-OCT-2014:19:00:00 AND 25-OCT-2014:09:00:00; BETWEEN 27-OCT-2014:09:00:00 AND 29-OCT-2014:00:00:00; BETWEEN 19-NOV-2014:19:00:00 AND 20-NOV-2014:04:00:00; BETWEEN 21-NOV-2014:14:00:00 AND 22-NOV-2014:09:00:00; BETWEEN 03-DEC-2014:14:00:00 AND 04-DEC-2014:14:00:00; BETWEEN 08-DEC-2014:00:00:00 AND 08-DEC-2014:09:00:00; BETWEEN 09-DEC-2014:09:00:00 AND 10-DEC-2014:19:00:00; BETWEEN 12-DEC-2014:14:00:00 AND 13-DEC-2014:00:00:00; BETWEEN 22-DEC-2014:00:00:00 AND 23-DEC-2014:00:00:00; BETWEEN 09-JAN-2015:04:00:00 AND 10-JAN-2015:04:00:00; BETWEEN 13-JAN-2015:14:00:00 AND 14-JAN-2015:09:00:00; BETWEEN 27-JAN-2015:00:00:00 AND 28-JAN-2015:14:00:00; BETWEEN 01-FEB-2015:00:00:00 AND 04-FEB-2015:09:00:00; BETWEEN 14-FEB-2015:19:00:00 AND 16-FEB-2015:00:00:00; BETWEEN 19-FEB-2015:04:00:00 AND 20-FEB-2015:04:00:00; BETWEEN 20-FEB-2015:19:00:00 AND 23-FEB-2015:09:00:00; BETWEEN 28-FEB-2015:00:00:00 AND 01-MAR-2015:04:00:00; BETWEEN 05-MAR-2015:00:00:00 AND 06-MAR-2015:04:00:00; BETWEEN 18-MAR-2015:04:00:00 AND 19-MAR-2015:04:00:00; BETWEEN 20-MAR-2015:14:00:00 AND 24-MAR-2015:14:00:00; BETWEEN 28-MAR-2015:00:00:00 AND 28-MAR-2015:14:00:00; BETWEEN 10-APR-2015:04:00:00 AND 12-APR-2015:00:00:00; BETWEEN 15-APR-2015:04:00:00 AND 16-APR-2015:09:00:00; BETWEEN 17-APR-2015:00:00:00 AND 19-APR-2015:04:00:00; BETWEEN 29-APR-2015:00:00:00 AND 30-APR-2015:04:00:00; BETWEEN 03-MAY-2015:14:00:00 AND 04-MAY-2015:09:00:00; BETWEEN 05-MAY-2015:19:00:00 AND 07-MAY-2015:04:00:00; BETWEEN 08-MAY-2015:19:00:00 AND 09-MAY-2015:19:00:00; BETWEEN 12-MAY-2015:04:00:00 AND 13-MAY-2015:19:00:00; BETWEEN 17-MAY-2015:09:00:00 AND 18-MAY-2015:14:00:00; BETWEEN 21-MAY-2015:19:00:00 AND 22-MAY-2015:09:00:00; BETWEEN 31-MAY-2015:14:00:00 AND 01-JUN-2015:04:00:00; BETWEEN 04-JUN-2015:09:00:00 AND 05-JUN-2015:19:00:00; BETWEEN 09-JUN-2015:04:00:00 AND 11-JUN-2015:14:00:00; BETWEEN 21-JUN-2015:19:00:00 AND 24-JUN-2015:04:00:00; BETWEEN 27-JUN-2015:14:00:00 AND 01-JUL-2015:09:00:00; BETWEEN 11-JUL-2015:04:00:00 AND 12-JUL-2015:09:00:00; BETWEEN 15-JUL-2015:19:00:00 AND 16-JUL-2015:19:00:00; BETWEEN 17-JUL-2015:04:00:00 AND 20-JUL-2015:00:00:00; BETWEEN 24-JUL-2015:19:00:00 AND 26-JUL-2015:04:00:00; BETWEEN 29-JUL-2015:04:00:00 AND 30-JUL-2015:19:00:00; BETWEEN 11-AUG-2015:19:00:00 AND 13-AUG-2015:00:00:00; BETWEEN 15-AUG-2015:00:00:00 AND 18-AUG-2015:00:00:00; BETWEEN 21-AUG-2015:09:00:00 AND 22-AUG-2015:00:00:00; BETWEEN 03-SEP-2015:14:00:00 AND 05-SEP-2015:09:00:00; BETWEEN 09-SEP-2015:19:00:00 AND 12-SEP-2015:19:00:00; BETWEEN 22-SEP-2015:09:00:00 AND 23-SEP-2015:14:00:00; BETWEEN 27-SEP-2015:00:00:00 AND 28-SEP-2015:00:00:00; BETWEEN 29-SEP-2015:14:00:00 AND 01-OCT-2015:00:00:00; BETWEEN 03-OCT-2015:00:00:00 AND 03-OCT-2015:09:00:00; BETWEEN 05-OCT-2015:19:00:00 AND 07-OCT-2015:14:00:00; BETWEEN 10-OCT-2015:19:00:00 AND 12-OCT-2015:00:00:00; BETWEEN 15-OCT-2015:09:00:00 AND 15-OCT-2015:19:00:00; BETWEEN 25-OCT-2015:04:00:00 AND 25-OCT-2015:19:00:00; BETWEEN 29-OCT-2015:00:00:00 AND 30-OCT-2015:04:00:00

Comments: Each visit is 1 orbit long with 4 sets of 7 observations each, with a dither in between, and each observation lasting about 40 seconds. The number of observations calls for the use of the 512x512 subarry on WFC3. The goal is precise astrometry and photometry of moving object Haumea.

To optimize the information content, I have identified when the satellites are visible and non-overlapping and current orbital solutions are weak. The easiest way to define this was as ~50 between requirements with 1-3 day durations. We can iterate with the schedulers to make this work.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	HAUMEA	STD=HAUMEA				EARTH

Comments: Using Haumea as a standard target.

During this cycle of observations, the rough RA and Dec are 14h and 17d.

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	7 44 sec obs ervations	(1) HAUMEA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F350LP	CR-SPLIT=NO; FLASH=5		Sequence 1-1 Non-In t in Visit 3 (03) Pattern 1, Exps 1-1 i n Sequence 1-1 Non-Int in Visit 3 (03) (1)	39 Secs X 7 (1092 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 1, Copy 3)]* *[==>(Pattern 1, Copy 4)]* *[==>(Pattern 1, Copy 5)]* *[==>(Pattern 1, Copy 6)]* *[==>(Pattern 1, Copy 7)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 2, Copy 3)]* *[==>(Pattern 2, Copy 4)]* *[==>(Pattern 2, Copy 5)]* *[==>(Pattern 2, Copy 6)]* *[==>(Pattern 2, Copy 7)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 3, Copy 3)]* *[==>(Pattern 3, Copy 4)]* *[==>(Pattern 3, Copy 5)]* *[==>(Pattern 3, Copy 6)]* *[==>(Pattern 3, Copy 7)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]* *[==>(Pattern 4, Copy 3)]* *[==>(Pattern 4, Copy 4)]* *[==>(Pattern 4, Copy 5)]* *[==>(Pattern 4, Copy 6)]* *[==>(Pattern 4, Copy 7)]*	***[1]***

Orbit Structure