



12053 - Hubble Investigation of the Unusual Object P/2010 A2

Cycle: 17, Proposal Category: GO/DD

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) P2010-A2	WFC3/UVIS	1	21-Jan-2010 21:03:41.0	yes
11	(1) P2010-A2	WFC3/UVIS	1	21-Jan-2010 21:03:45.0	yes
12	(1) P2010-A2	WFC3/UVIS	1	21-Jan-2010 21:03:48.0	yes
13	(1) P2010-A2	WFC3/UVIS	1	21-Jan-2010 21:03:51.0	yes

4 Total Orbits Used

ABSTRACT

On 2010 January 6, the LINEAR survey telescope detected an extremely unusual-looking object (P/2010 A2) that appears to be either: (1) the most remarkable member of a new dynamical class known as the main-belt comets (MBCs), or (2) a manifestation of a collision between two asteroids in the

Flora family. In either case, this discovery could have profound implications for planetary science. We propose a 5-orbit Hubble investigation of P/2010 A2, executed within the next week if possible, to determine the nature of this strange, quickly-evolving object. Deep WFC3 (or ACS/WFC) images taken over a 6 hr period will be used to measure the size, shape, and rotational period of the nucleus, to characterize the near-nucleus environment, and to perform a deep search for any decameter-sized fragments. We will also measure the color of the nucleus in 3 different bands for comparison with asteroids and other cometary nuclei. With its high spatial resolution and high sensitivity, Hubble is uniquely suited to this investigation.

OBSERVING DESCRIPTION

At its declination of +28 , P/2010 A2 will have an HST visibility window of 54 min per orbit. We are working closely with the JPL Horizons group to ensure we have knowledge of the object's ephemeris to an accuracy of 10, or better, for the HST observations, which is more than adequate for planning these imaging observations. (The WFC3 has a field-of-view of 162×162 , and the ACS/WFC has a field-of-view of 202×202 .) At the time of the Hubble observations, the object's heliocentric distance will be 1.9 AU, the geocentric distance will be 1 AU (corresponding to 29 km/pixel at the comet for the WFC3), the solar elongation angle will be 160, the solar phase angle will be 10, and the galactic latitude (which affects the level of background star contamination) will be 13. All of these geometric parameters are currently favorable for Hubble observations, but the conditions get progressively worse over time. The target's apparent rate of motion is 35/hr, which is easily within Hubble's tracking capabilities. This rate of motion is also slow enough to keep a single pair of guide stars within the FGS pickles for an entire visibility window.

This program requires both high spatial resolution and high sensitivity. The former drives us to the WFC3 (0.4/pix vs 0.5/pix), but the latter argues for use of the ACS/WFC3 (with 2x the throughput at visible wavelengths). We have tentatively selected WFC3 for this submission (partly because of its higher spatial resolution and partly because we figure the degraded CTE and increased noise of the ACS/WFC might negate some of its perceived advantage in sensitivity), but we plan to consult with the relevant STScI experts before making a final decision on which camera to use for this investigation.

We request 5 consecutive orbits utilizing the newly commissioned WFC3. Our choice of 5 orbits is a compromise between the desire to characterize the temporal evolution of the object and the need to minimize the impact on Hubble's observing schedule. Our planned observations would cover a clock time of 6 hours, which should be sufficient to include an entire sinusoid of a dual-peaked light curve for a "typical" rotational period of 12 hours.

During orbits #1, #3, and #5, we tentatively plan to take images in 3 different filters (here we assume WFC3): F390W (or possibly F475W), F606W, and F814W. Orbits #2 and #4 will be used entirely for F606W. This strategy balances our attempt to go as deep as possible, yet also obtain some color information for comparison with previously observed asteroids and cometary nuclei.

Our nominal observing strategy will be to use a standard 2-point dither, taking a series of images (e.g., 1-2 long F606W images and 1 long exposure each using F390W and F814W) at one location near the center of one of the CCD chips, and an identical series at the second dither location. Dithering mitigates the effects of bad pixels and cosmic ray events. We will shift and add the resultant images, reaching a limiting magnitude (S/N5) of V 27.5 for the F606W images, as determined from the WFC3 ETC assuming a total exposure time of 2000 sec and a solar-type spectrum. This latter limit corresponds to an object having a diameter of 25-30 m, assuming an albedo of 10% and a phase law of 0.04 mag/deg. For the F390W and F814W filters, we only require reaching S/N10 for V 24, which can be

accomplished using exposure times of 320 sec and 120 sec, respectively. We expect to use exposure times of at least 347 sec for all of our images to “hide” the overhead associated with dumping the data storage buffer.

We understand that we will have essentially no control over the spacecraft roll angle, which means we won't be able to optimize the orientation of the dust tail on the CCD (i.e., to orient the tail along the longest dimension of the detector). The field-of-view of the camera is large enough that we should obtain excellent data on a portion of the tail, no matter what spacecraft roll angle is used.

The proposed observing plan features the following properties:

We will probe the spectral properties of the main component; these include the spectral slope between the F390W and F606W bands, and the prominent silicate absorption band in F814W – a signature of S-type asteroids. A sensitive search for fragments in F606W. Mitigation of the brightness modulation from the body rotation; this effect will be largely averaged-out if we change filters in the suggested manner.

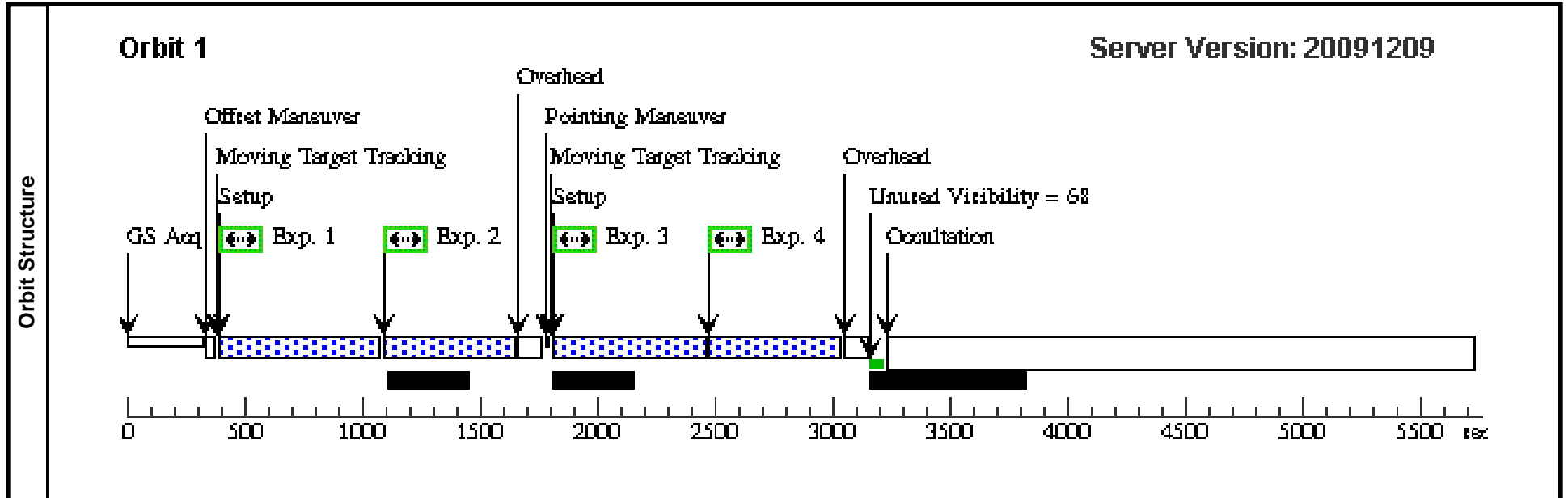
ADDITIONAL COMMENTS

Observations at the earliest opportunity, possibly next week, are highly desired, since material in P/2010 A2 is dispersing and fading. We request that observations be taken no later than the end of January in order to connect the HST-observed morphology with the initial morphology obtained from the ground (albeit at 10 times poorer resolution).

Proposal 12053 - Visit 01 - Hubble Investigation of the Unusual Object P/2010 A2

Fri Jan 22 02:03:55 GMT 2010

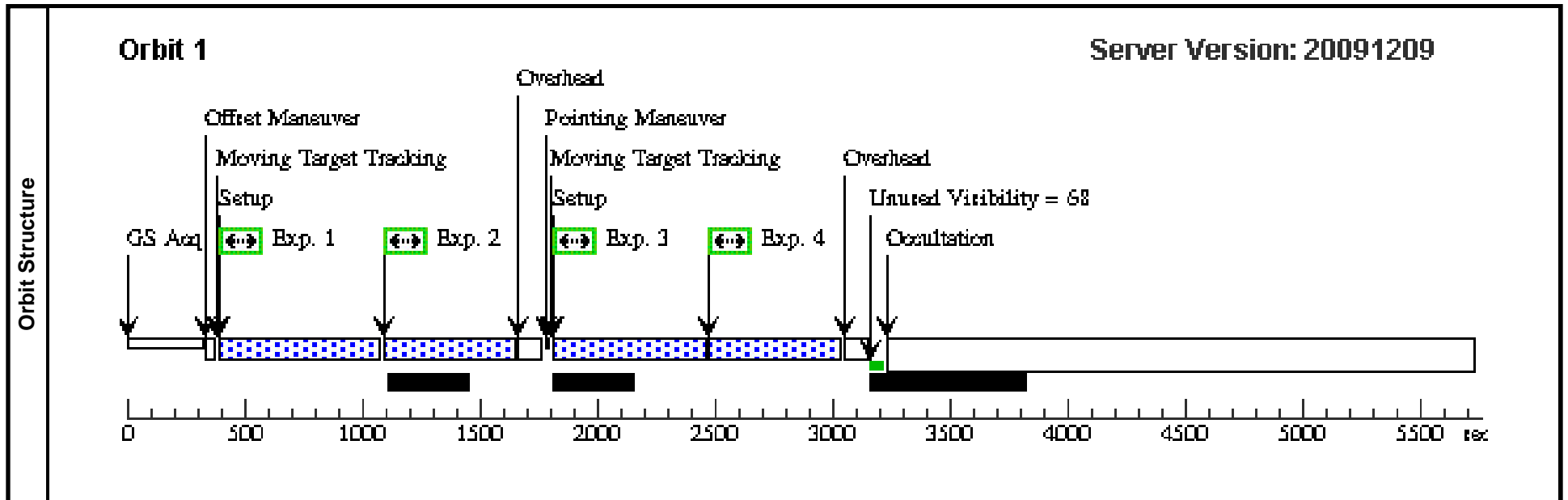
Visit	Proposal 12053, Visit 01, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none) <i>Comments: duplicate of visit 11 to see if it can go earlier than day 29.</i>									
	Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center		
	(1)	P2010-A2	TYPE=COMET,Q=2.0112975,E=0.12 31870,I=5.28995,O=320.13138,W=13 3.28380,T=04-DEC- 2009:07:05:09,EQUINOX=J2000,EPO CH=25-NOV-2009:00:00:00					EARTH		
	<i>Comments:</i> Acquisition Uncertainty: 10 Arcsec Ephemeris Uncertainty: 7250 Kilometers									
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	(1) P2010-A2		WFC3/UVIS, ACCUM, UVIS1-FIX	F606W	CR-SPLIT=NO	REQ EPHEM CORR PA2V01		537 Secs [==>]	[1]
	2	(1) P2010-A2		WFC3/UVIS, ACCUM, UVIS1-FIX	F814W	CR-SPLIT=NO	REQ EPHEM CORR PA2V01		537 Secs [==>]	[1]
	3	(1) P2010-A2		WFC3/UVIS, ACCUM, UVIS1-FIX	F814W	CR-SPLIT=NO	POS TARG 0.2,0.2; REQ EPHEM CORR PA2V01		537 Secs [==>]	[1]
	4	(1) P2010-A2		WFC3/UVIS, ACCUM, UVIS1-FIX	F606W	CR-SPLIT=NO	POS TARG 0.2,0.2; REQ EPHEM CORR PA2V01		537 Secs [==>]	[1]



Proposal 12053 - Visit 11 - Hubble Investigation of the Unusual Object P/2010 A2

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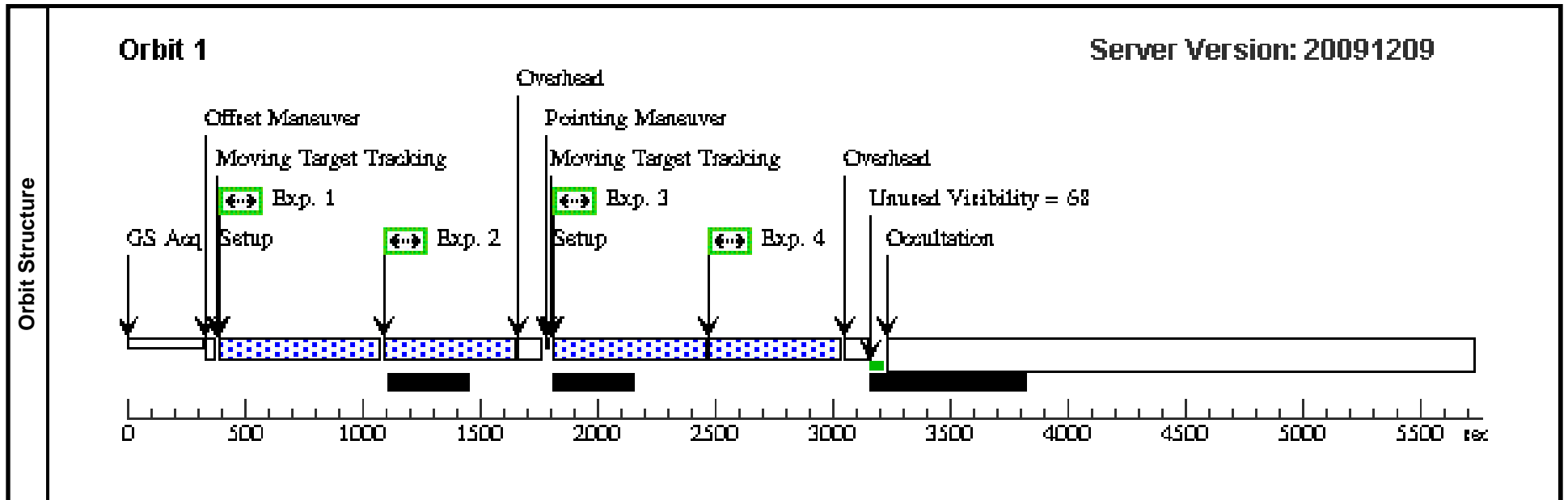
Visit	Proposal 12053, Visit 11, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none)									
	Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center		
	(1)	P2010-A2	TYPE=COMET,Q=2.0112975,E=0.12 31870,I=5.28995,O=320.13138,W=13 3.28380,T=04-DEC- 2009:07:05:09,EQUINOX=J2000,EPO CH=25-NOV-2009:00:00:00					EARTH		
	<i>Comments:</i> Acquisition Uncertainty: 10 Arcsec Ephemeris Uncertainty: 7250 Kilometers									
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	(1) P2010-A2		WFC3/UVIS, ACCUM, UVIS1-FIX	F606W	CR-SPLIT=NO	REQ EPHEM CORR PA2V11		537 Secs [==>]	[1]
	2	(1) P2010-A2		WFC3/UVIS, ACCUM, UVIS1-FIX	F814W	CR-SPLIT=NO	REQ EPHEM CORR PA2V11		537 Secs [==>]	[1]
	3	(1) P2010-A2		WFC3/UVIS, ACCUM, UVIS1-FIX	F814W	CR-SPLIT=NO	POS TARG 0.2,0.2; REQ EPHEM CORR PA2V11		537 Secs [==>]	[1]
	4	(1) P2010-A2		WFC3/UVIS, ACCUM, UVIS1-FIX	F606W	CR-SPLIT=NO	POS TARG 0.2,0.2; REQ EPHEM CORR PA2V11		537 Secs [==>]	[1]



Proposal 12053 - Visit 12 - Hubble Investigation of the Unusual Object P/2010 A2

Fri Jan 22 02:03:56 GMT 2010

Visit	Proposal 12053, Visit 12, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none)									
	Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center		
	(1)	P2010-A2	TYPE=COMET,Q=2.0112975,E=0.12 31870,I=5.28995,O=320.13138,W=13 3.28380,T=04-DEC- 2009:07:05:09,EQUINOX=J2000,EPO CH=25-NOV-2009:00:00:00					EARTH		
	<i>Comments:</i> Acquisition Uncertainty: 10 Arcsec Ephemeris Uncertainty: 7250 Kilometers									
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	(1) P2010-A2		WFC3/UVIS, ACCUM, UVIS1-FIX	F606W	CR-SPLIT=NO	REQ EPHEM CORR PA2V12		537 Secs [==>]	[1]
	2	(1) P2010-A2		WFC3/UVIS, ACCUM, UVIS1-FIX	F814W	CR-SPLIT=NO	REQ EPHEM CORR PA2V12		537 Secs [==>]	[1]
	3	(1) P2010-A2		WFC3/UVIS, ACCUM, UVIS1-FIX	F814W	CR-SPLIT=NO	POS TARG 0.2,0.2; REQ EPHEM CORR PA2V12		537 Secs [==>]	[1]
	4	(1) P2010-A2		WFC3/UVIS, ACCUM, UVIS1-FIX	F606W	CR-SPLIT=NO	POS TARG 0.2,0.2; REQ EPHEM CORR PA2V12		537 Secs [==>]	[1]



Proposal 12053 - Visit 13 - Hubble Investigation of the Unusual Object P/2010 A2

Fri Jan 22 02:03:56 GMT 2010

Visit	Proposal 12053, Visit 13, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none)									
	Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center		
	(1)	P2010-A2	TYPE=COMET,Q=2.0112975,E=0.12 31870,I=5.28995,O=320.13138,W=13 3.28380,T=04-DEC- 2009:07:05:09,EQUINOX=J2000,EPO CH=25-NOV-2009:00:00:00					EARTH		
	<i>Comments:</i> Acquisition Uncertainty: 10 Arcsec Ephemeris Uncertainty: 7250 Kilometers									
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	(1) P2010-A2	WFC3/UVIS, ACCUM, UVIS1-FIX	F606W	CR-SPLIT=NO	REQ EPHEM CORR PA2V13			537 Secs [==>]	[1]
	2	(1) P2010-A2	WFC3/UVIS, ACCUM, UVIS1-FIX	F814W	CR-SPLIT=NO	REQ EPHEM CORR PA2V13			537 Secs [==>]	[1]
	3	(1) P2010-A2	WFC3/UVIS, ACCUM, UVIS1-FIX	F814W	CR-SPLIT=NO	POS TARG 0.2,0.2; REQ EPHEM CORR PA2V13			537 Secs [==>]	[1]
	4	(1) P2010-A2	WFC3/UVIS, ACCUM, UVIS1-FIX	F606W	CR-SPLIT=NO	POS TARG 0.2,0.2; REQ EPHEM CORR PA2V13			537 Secs [==>]	[1]

