



# 16167 - Confirming the binarity of Kuiper Belt Object 2015 RR245: a test of the streaming instability

Cycle: 28, Proposal Category: GO  
(Availability Mode: SUPPORTED)

## INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
<b>Dr. Wesley C Fraser (PI) (CSA Member) (Contact)</b>	<b>Dominion Astrophysical Observatory</b>	<b>wesley.fraser@nrc.ca</b>
Dr. Michael Marsset (CoI) (AdminUSPI)	Massachusetts Institute of Technology	mmarsset@mit.edu
Dr. J. J. Kavelaars (CoI) (CSA Member)	National Research Council of Canada	jj.kavelaars@nrc-cnrc.gc.ca
Dr. Susan D. Benecchi (CoI)	Planetary Science Institute	susank@psi.edu
James Robinson (CoI) (ESA Member)	The Queen's University of Belfast	jrobinson72@qub.ac.uk
Richard Smith (CoI) (ESA Member)	The Queen's University of Belfast	rsmith2003@qub.ac.uk

## 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) 2015RR245	WFC3/UVIS	1	19-Oct-2020 16:00:52.0	yes
02	(1) 2015RR245	WFC3/UVIS	1	19-Oct-2020 16:00:53.0	yes

2 Total Orbits Used

## ABSTRACT

Binary systems are prevalent throughout the Kuiper Belt, with roughly 110 systems known to date. The question of how these binary systems formed is of great interest, as each proposed mechanism has its own implications for the conditions in the early Solar System during planetesimal growth. The favoured mechanism - streaming instability in a gaseous dusty disc followed by gravitational collapse of a pebble cloud (SI-GC) - naturally

produces many of the observed features of Kuiper Belt binaries. This mechanism also predicts the presence of a class of relatively massive systems with nearly equal sized primary and secondary components. Such systems are virtually absent from the observed sample, with the exception of the Varda-Ilume system. Here we propose observations of the KBO 2015 RR245, the ground-based observations of which hint at a barely resolved binary. The inferred brightnesses and locations of the primary and secondary are consistent from image to image, and imply a system with mass and mass ratio very similar to the Varda system. If binarity is confirmed, RR245 and Varda together would reveal the presence of a class of binary that has simply gone unnoticed, and would solve one of the current tensions between observations and formation simulation of SI-GC. We propose a simple two orbit WFC3 program, with an aim to confirm the binarity of RR245. Observations will be tuned to avoid non-detection in the case of overlapping binary components, and will enable measure of both component's colors and relative sizes, properties that are necessary to confirm consistency with formation via SI-GC.

## **OBSERVING DESCRIPTION**

To time our pair of observations to minimize the chances that the secondary and primary are unresolvable during both sequences, we request observations separated by roughly 15 days, or  $\sim 1/4$  of our estimated orbital period. We require no special timing for the first sequence though we would like to check the proposed scheduling timing windows to make sure that we avoid bright star and foreground sources that would otherwise compromise the data. Once scheduling windows are determined, Benecchi will do this field check.

Both visits to RR245 are identical. We make use of the WFC3's fast filter change capabilities, to gather three UVIS exposures each in the F606w and F814w filters, with 3" dithers between three different positions. This affords us some protection against cosmic ray strikes and hot pixels.

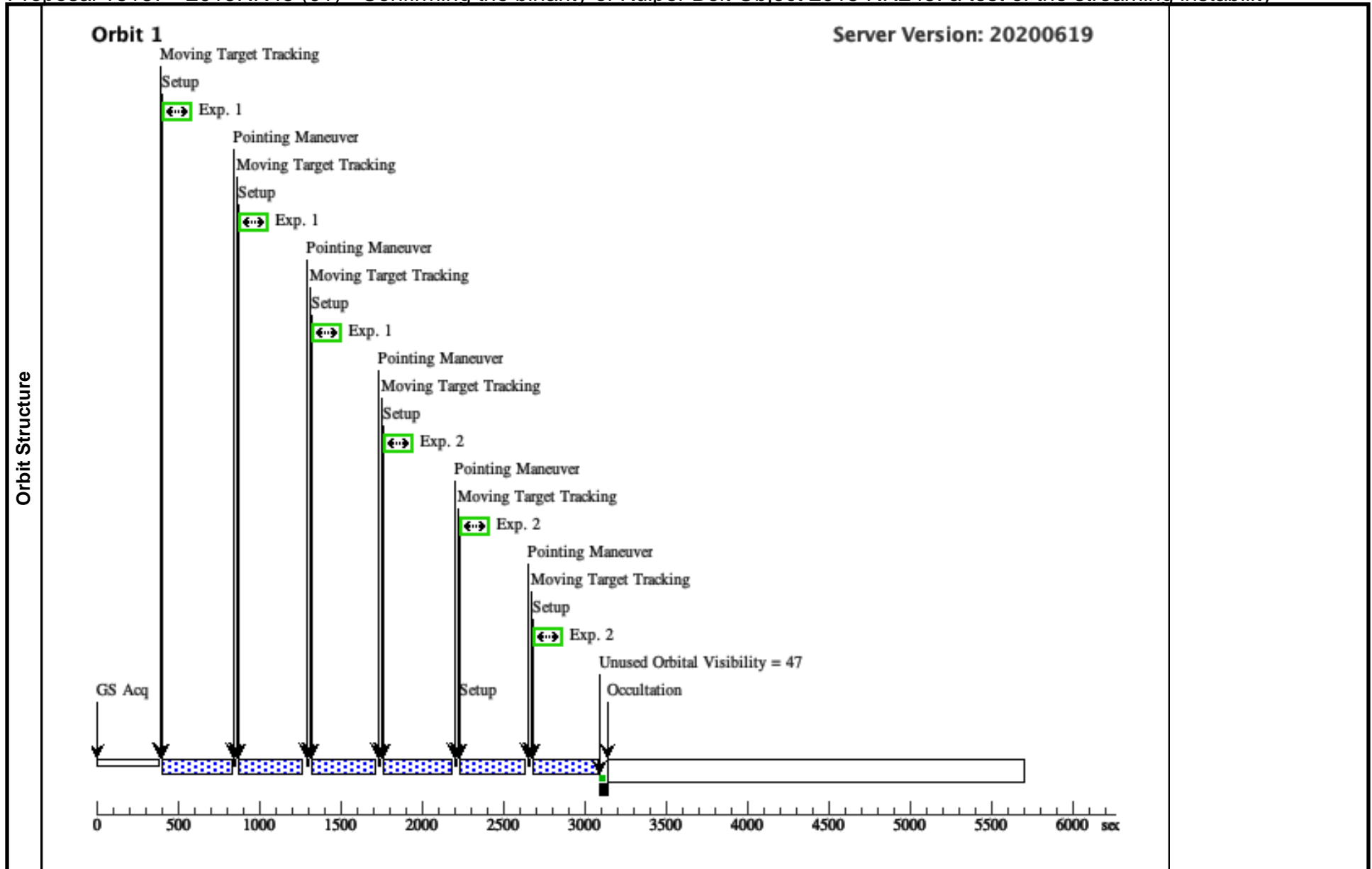
Observations are to be acquired in FGS fine lock mode, slewing at the very-well known rate of motion (at most 3"/hr) of the target during each visit to preserve maximum spatial resolution. The 3-sigma ephemeris uncertainty is sub-arcsecond. We will use 358-s and 358-s exposure times for the F606w and F814w filters, respectively and have placed them in a non-interruptable sequence to avoid any rotation curve complications on the object. These exposure times have been chosen to provide high SNR while minimizing the time wasted to buffer downlinks and optimized to fit the orbit. The WFC3 UVIS imaging ETC provides an estimated  $\text{SNR} > 100$  in each filter, or  $\sim 90$  and  $\sim 50$  for the primary and secondary, respectively. Images will be acquired in the UVIS2-C512C-SUB sub-aperture to prevent any time lost due to mid-orbit buffer dumps.

We have also put in Flash values such the total background for each filter is about 20 electrons/pixel.

Proposal 16167 - 2015RR45 (01) - Confirming the binarity of Kuiper Belt Object 2015 RR245: a test of the streaming instability

Mon Oct 19 20:00:53 GMT 2020

Visit	<b>Proposal 16167, 2015RR45 (01), implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: WFC3/UVIS Special Requirements: (none)									
	Patterns	#	Primary Pattern	Secondary Pattern	Exposures					
		(1)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1), (2)				
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center			
	(1)	2015RR245	TYPE=ASTEROID,A=82.0388477362 8791,E=0.5882820992739525,I=7.551 163366915228 ,O=211.769513212333,W=260.917968 2697775,M=322.1638134145541,EQU INOX=J2000,EPOCH=05-JUL- 2014:00:00:00,EpochTimeScale=TDB  <i>Comments: Description=KBO Binary                      Extended=NO</i>				EARTH			
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	F606W Dither Line	(1) 2015RR245	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F606W		POS TARG 3,null	Sequence 1-2 Non-Int in 2015RR45 (01) Pattern 1, Exps 1-1 in Sequence 1-2 Non-Int in 2015RR45 (01) (1)	358 Secs (1074 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)]	[1]
	2	F814W Dither Line	(1) 2015RR245	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F814W	FLASH=5	POS TARG 3,null	Sequence 1-2 Non-Int in 2015RR45 (01) Pattern 1, Exps 2-2 in Sequence 1-2 Non-Int in 2015RR45 (01) (1)	358 Secs (1074 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)]	[1]



Proposal 16167 - 2015RR45 (02) - Confirming the binarity of Kuiper Belt Object 2015 RR245: a test of the streaming instability

Mon Oct 19 20:00:53 GMT 2020

Visit	<b>Proposal 16167, 2015RR45 (02), implementation</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: WFC3/UVIS Special Requirements: AFTER 01 BY 14 D TO 16 D									
	Patterns	#	Primary Pattern	Secondary Pattern	Exposures					
		(1)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1), (2)				
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center			
	(1)	2015RR245	TYPE=ASTEROID,A=82.0388477362 8791,E=0.5882820992739525,I=7.551 163366915228 ,O=211.769513212333,W=260.917968 2697775,M=322.1638134145541,EQU INOX=J2000,EPOCH=05-JUL- 2014:00:00:00,EpochTimeScale=TDB  <i>Comments: Description=KBO Binary                      Extended=NO</i>				EARTH			
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	F606W Dither Line	(1) 2015RR245	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F606W		POS TARG 3,null	Sequence 1-2 Non-Int in 2015RR45 (02) Pattern 1, Exps 1-1 in Sequence 1-2 Non-Int in 2015RR45 (02) (1)	358 Secs (1074 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)]	[1]
2	F814W Dither Line	(1) 2015RR245	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F814W	FLASH=5	POS TARG 3,null	Sequence 1-2 Non-Int in 2015RR45 (02) Pattern 1, Exps 2-2 in Sequence 1-2 Non-Int in 2015RR45 (02) (1)	358 Secs (1074 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)]	[1]	

