



17081 - Mass Measurement of a Candidate Balck Hole Microlens with Systematic Error Control

Cycle: 30, Proposal Category: GO

(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) MOA-2019-BLG-284	WFC3/UVIS	2	14-Jul-2022 16:00:55.0	yes

<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>
02	(1) MOA-2019-BLG-284	WFC3/UVIS	2	14-Jul-2022 16:01:00.0	yes

4 Total Orbits Used

ABSTRACT

We propose Hubble imaging of the black hole candidate microlens system MOA-2019-BLG-284 in order to measure the astrometric microlensing signal and determine the lens system mass. Microlensing is the only method that can detect black holes that are isolated or in stable, non-accreting binary systems, so routine detection of black hole astrometric microlensing will provide a significant advance in our understanding of the formation of stellar mass black holes. Our proposed observations will determine if the MOA-2019-BLG-284 lens system is a rare stable binary system with a black hole primary or an isolated stellar mass black hole. This observing program is designed to address possible systematic errors in the astrometric measurements. We will also use the Hubble data to correct systematic errors in the ground-based photometry that determines the microlensing parallax. Since both astrometric microlensing and microlensing parallax measurements are needed to determine black hole masses, an understanding of systematic errors in both quantities is needed for reliable mass measurements. The novel systematic error correction methods that we propose may be used to increase the sensitivity of future black hole mass measurements from astrometric and photometric microlensing.

OBSERVING DESCRIPTION

We request two visits per year of two orbits each, with one orbit to observe in each of the F814W and F606W passbands. This is 4 orbits per year for a total of 12 orbits over 3 years. We require a time series of data in both the F814W and F606W passbands for two reasons. First, we can get redundant astrometry measurements with two passband, and this will help to understand possible systematic astrometry errors. The two passbands will also provide a critical test of the possibility of models with binary source stars, since astrometric microlensing of binary source stars is generally color dependent. The spring and fall data are necessary in order to obtain a time series of observations with roll angles changing by 180 degrees every ~ 6 months. This will provide yearly imaging with PSF distortions due to CTE losses in nearly opposite directions in alternate visits. The roll angles used will be the same as two previous observing programs for this target (Bennett et al. 2020, Terry et al. 2021) in order to provide two long duration, independent data sets with nearly opposite directions of CCD charge transfer. The strongest astrometric microlensing signals are expected at twice the Einstein radius crossing time (~ 570 days) after the event peak, which will be in mid-2023 for MB19284. However, as Dominik & Sahu (2002) point out, it is necessary to make astrometric microlensing observations for a longer duration (at least 3 Einstein radius crossing times) to separate the astrometric microlensing signal from the linear proper motion of the source star. We propose observations over 3 cycles to obtain the last observation at 3.6 Einstein radius crossing times after the light curve peak. We request 18 exposures per orbit in the WFC3/UVIS F814W and F606W passbands

to get good spatial sampling of the effective PSFs (Anderson and King 2000) and to avoid saturation. So, we select the UVIS2-C1K1C-SUB subarray to minimize PSF distortions due to the effects of CTE degradation.

We require observations within two weeks of one of our May and September 2020 and 2021 observations in order to minimize the effect of parallax motion of our astrometric reference stars between visits in different years.

Proposal 17081 - Visit 01 - Mass Measurement of a Candidate Balck Hole Microlens with Systematic Error Control

Visit	Proposal 17081, Visit 01 Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: ORIENT 89D TO 89 D; BETWEEN 01-SEP-2022:00:00:00 AND 13-OCT-2022:00:00:00					Thu Jul 14 20:01:01 GMT 2022
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(1)	MOA-2019-BLG-284	RA: 18 05 55.0600 (271.4794167d) Dec: -30 20 12.94 (-30.33693d) Equinox: J2000		V=17.65+/-0.05 I = 15.97 +- 0.05	Reference Frame: ICRS
Comments: Category=STAR Description=[BULGE, GRAVITATIONAL LENS, K V-IV]						

Proposal 17081 - Visit 01 - Mass Measurement of a Candidate Balck Hole Microlens with Systematic Error Control

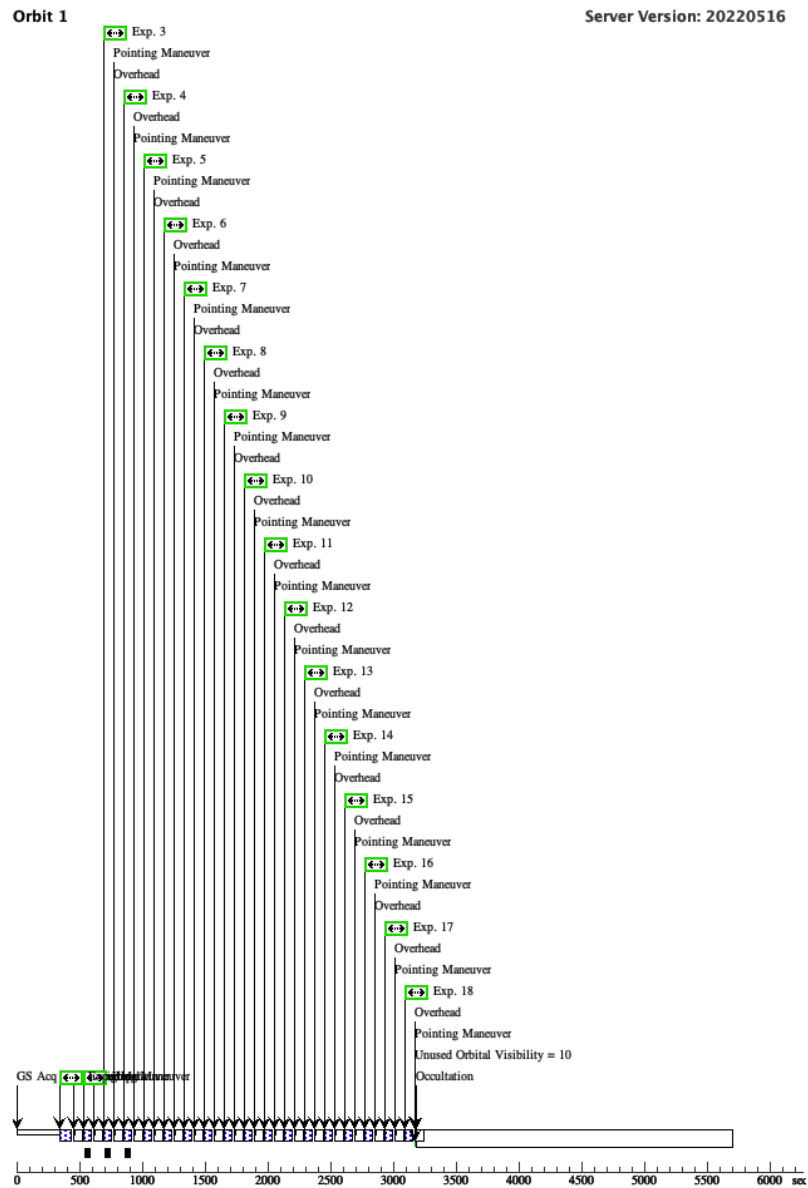
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.0,0.0		59 Secs (59 Secs)	
									[==>]	[1]
	2		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.39965, 0.07586		59 Secs (59 Secs)	
									[==>]	[1]
	3		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.08431, 0.10751		59 Secs (59 Secs)	
									[==>]	[1]
	4		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.48396, 0.18337		59 Secs (59 Secs)	
									[==>]	[1]
	5		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.16845, 0.17497		59 Secs (59 Secs)	
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	6		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.56810, 0.25084		59 Secs (59 Secs)	
									[==>]	[1]
	7		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.25276, 0.28248		59 Secs (59 Secs)	
									[==>]	[1]
	8		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.65241, 0.35835		59 Secs (59 Secs)	
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	9		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.33689, 0.34995		59 Secs (59 Secs)	
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	10		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.37904, 0.40370		59 Secs (59 Secs)	
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	11		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.06372, 0.43533		59 Secs (59 Secs)	
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	12		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.46318, 0.47117		59 Secs (59 Secs)	
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	13		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.14564, 0.50266		59 Secs (59 Secs)	
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	14		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.54749, 0.57867		59 Secs (59 Secs)	
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	15		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.23216, 0.61030		59 Secs (59 Secs)	
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	16		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.63162, 0.64614		59 Secs (59 Secs)	
									[==>]	[1]
	17		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.31629, 0.67777		59 Secs (59 Secs)	
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	18		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.71592, 0.75364		59 Secs (59 Secs)	
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	19		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.0,0.0		59 Secs (59 Secs)	
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	20		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.39965, 0.07586		59 Secs (59 Secs)	
									[==>]	[2]
	21		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.08431, 0.10751		59 Secs (59 Secs)	
									[==>]	[2]
	22		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.48396, 0.18337		59 Secs (59 Secs)	
									[==>]	[2]

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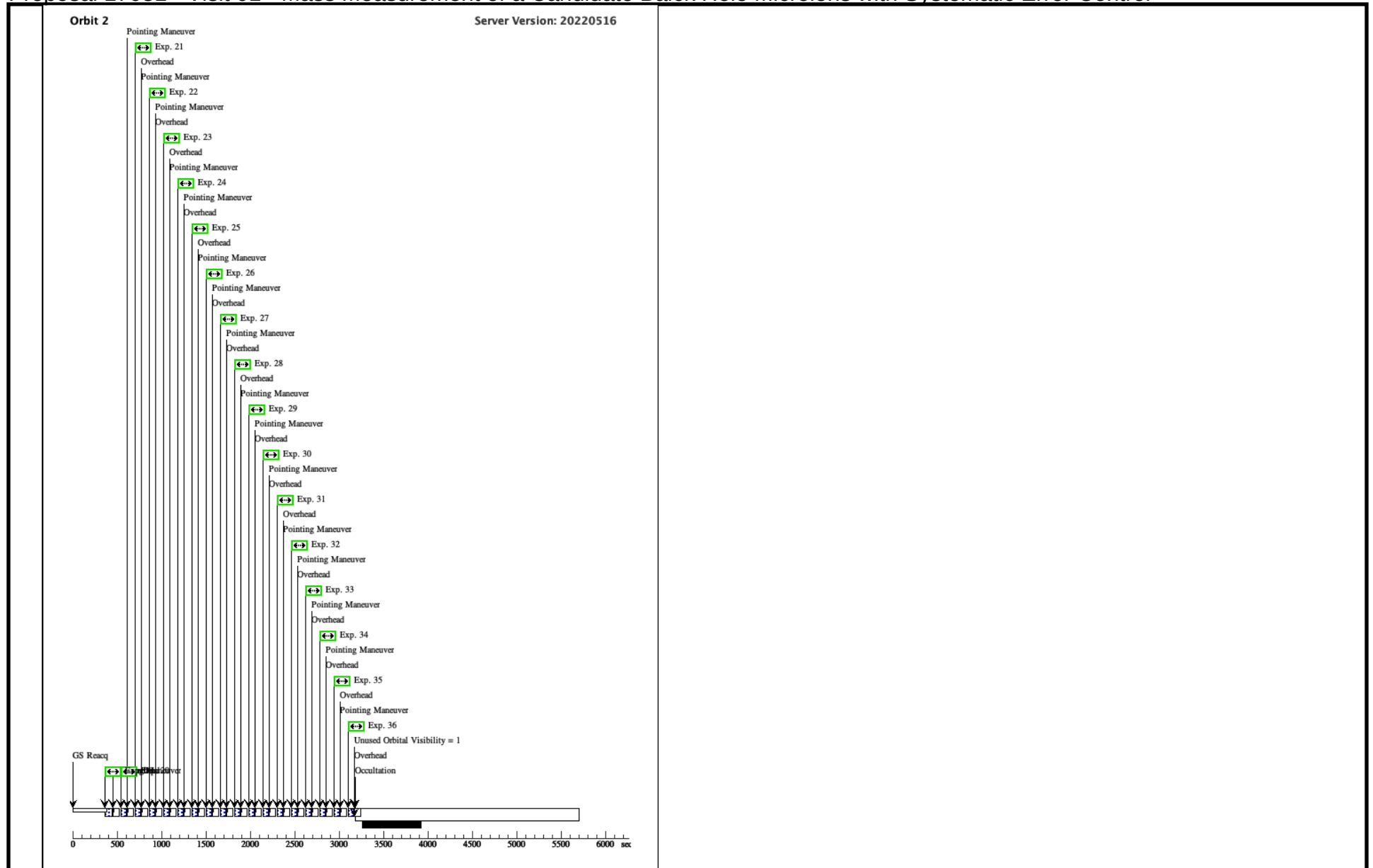
23	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.16845, 0.17497	59 Secs (59 Secs)	
						[==>]	[2]
24	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.56810, 0.25084	59 Secs (59 Secs)	
						[==>]	[2]
25	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.25276, 0.28248	59 Secs (59 Secs)	
						[==>]	[2]
26	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.65241, 0.35835	59 Secs (59 Secs)	
						[==>]	[2]
27	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.33689, 0.34995	59 Secs (59 Secs)	
						[==>]	[2]
28	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.37904, 0.40370	59 Secs (59 Secs)	
						[==>]	[2]
29	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.06372, 0.43533	59 Secs (59 Secs)	
						[==>]	[2]
30	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.46318, 0.47117	59 Secs (59 Secs)	
						[==>]	[2]
31	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.14564, 0.50266	59 Secs (59 Secs)	
						[==>]	[2]
32	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.54749, 0.57867	59 Secs (59 Secs)	
						[==>]	[2]
33	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.23216, 0.61030	59 Secs (59 Secs)	
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34	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.63162, 0.64614	59 Secs (59 Secs)	
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35	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.31629, 0.67777	59 Secs (59 Secs)	
						[==>]	[2]
36	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.71592, 0.75364	59 Secs (59 Secs)	
						[==>]	[2]

Proposal 17081 - Visit 01 - Mass Measurement of a Candidate Balck Hole Microlens with Systematic Error Control

Orbit Structure



Proposal 17081 - Visit 01 - Mass Measurement of a Candidate Balck Hole Microlens with Systematic Error Control



Proposal 17081 - Visit 02 - Mass Measurement of a Candidate Balck Hole Microlens with Systematic Error Control

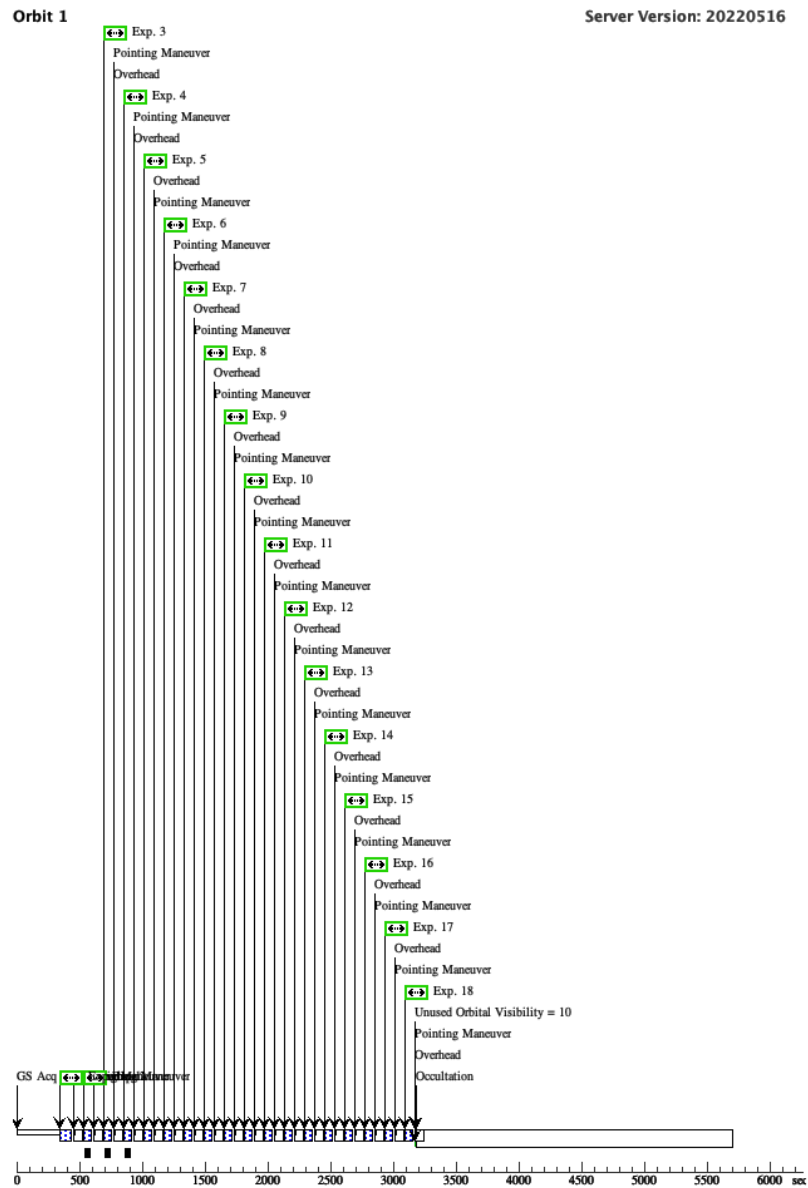
Visit	Proposal 17081, Visit 02 Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: ORIENT 269D TO 269 D; BETWEEN 04-MAY-2023:00:00:00 AND 08-JUN-2023:00:00:00					Thu Jul 14 20:01:02 GMT 2022
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
	(1)	MOA-2019-BLG-284	RA: 18 05 55.0600 (271.4794167d) Dec: -30 20 12.94 (-30.33693d) Equinox: J2000		V=17.65+/-0.05 I = 15.97 +- 0.05	Reference Frame: ICRS
Comments: Category=STAR Description=[BULGE, GRAVITATIONAL LENS, K V-IV]						

Proposal 17081 - Visit 02 - Mass Measurement of a Candidate Balck Hole Microlens with Systematic Error Control

Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.0,0.0		59 Secs (59 Secs)	
									[==>]	[1]
	2		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.39965, 0.07586		59 Secs (59 Secs)	
									[==>]	[1]
	3		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.08431, 0.10751		59 Secs (59 Secs)	
									[==>]	[1]
	4		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.48396, 0.18337		59 Secs (59 Secs)	
									[==>]	[1]
	5		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.16845, 0.17497		59 Secs (59 Secs)	
									[==>]	[1]
	6		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.56810, 0.25084		59 Secs (59 Secs)	
									[==>]	[1]
	7		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.25276, 0.28248		59 Secs (59 Secs)	
									[==>]	[1]
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	11		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.06372, 0.43533		59 Secs (59 Secs)	
									[==>]	[1]
	12		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.46318, 0.47117		59 Secs (59 Secs)	
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	13		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.14564, 0.50266		59 Secs (59 Secs)	
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	14		(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=20	POS TARG 0.54749, 0.57867		59 Secs (59 Secs)	
									[==>]	[1]
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Proposal 17081 - Visit 02 - Mass Measurement of a Candidate Balck Hole Microlens with Systematic Error Control

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24	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.56810, 0.25084	59 Secs (59 Secs)	
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32	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.54749, 0.57867	59 Secs (59 Secs)	
						[==>]	[2]
33	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.23216, 0.61030	59 Secs (59 Secs)	
						[==>]	[2]
34	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.63162, 0.64614	59 Secs (59 Secs)	
						[==>]	[2]
35	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.31629, 0.67777	59 Secs (59 Secs)	
						[==>]	[2]
36	(1) MOA-2019-BLG-284	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	FLASH=20	POS TARG 0.71592, 0.75364	59 Secs (59 Secs)	
						[==>]	[2]



Proposal 17081 - Visit 02 - Mass Measurement of a Candidate Balck Hole Microlens with Systematic Error Control

