



17748 - HST Observations of the Most Energetic and Luminous Optical Transient AT 2021lwx aka Scary Barbie

Cycle: 32, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>
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Prof. Paul Duffell (CoI)	Purdue University
Ms. Danielle Dickinson (CoI)	Purdue University
Mr. Braden - Garretson (CoI)	Purdue University

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) AT2021LWX	WFC3/UVIS	2	11-Dec-2024 13:00:12.0	yes
02	(1) AT2021LWX (2) STAR-OFFSET	STIS/CCD STIS/NUV-MAMA	1	11-Dec-2024 13:00:13.0	yes

ABSTRACT

AT 2021lwx (aka "Scary Barbie") is an ultraluminous, long-duration (500 days in rest frame), energetic transient of unclear origin at a redshift of 0.9945. With an estimated pseudo-bolometric peak luminosity of $\log(L/[\text{erg/s}]) = 45.7$ and a radiative energy of over 10^{53} erg, AT 2021lwx represents one of the most energetic and luminous transients ever observed, and, impressively, is still evolving. Modeling of AT 2021lwx suggests that it is associated with the tidal disruption of a 14-15 solar mass star by a supermassive black hole (SMBH) of order 10^8 solar masses, or accretion of a giant molecular cloud (GMC) onto a dormant 10^8 to 10^9 solar mass SMBH. AT 2021lwx is an excellent laboratory to understand extreme accretion scenarios associated with SMBHs, yet intriguingly no host galaxy has been detected. We request two orbits of HST/WFC3 observations and one orbit of NUV spectroscopy with STIS, to image AT 2021lwx, search for its host galaxy, and map signatures of outflows. These observations will resolve any extended galaxy structure surrounding the transient, further enabling characterization of its properties. Pinpointing the location of AT 2021lwx relative to its host galaxy is a fundamental test of current interpretations. Our time-sensitive observations are necessary during Cycle 32 because the transient is fading consistently. The NUV spectroscopy will provide much needed diagnostics of outflowing material from accretion processes. Extending coverage to rest-frame Ly alpha is especially important, since the total power emitted at this line can significantly constrain radiative transfer models.

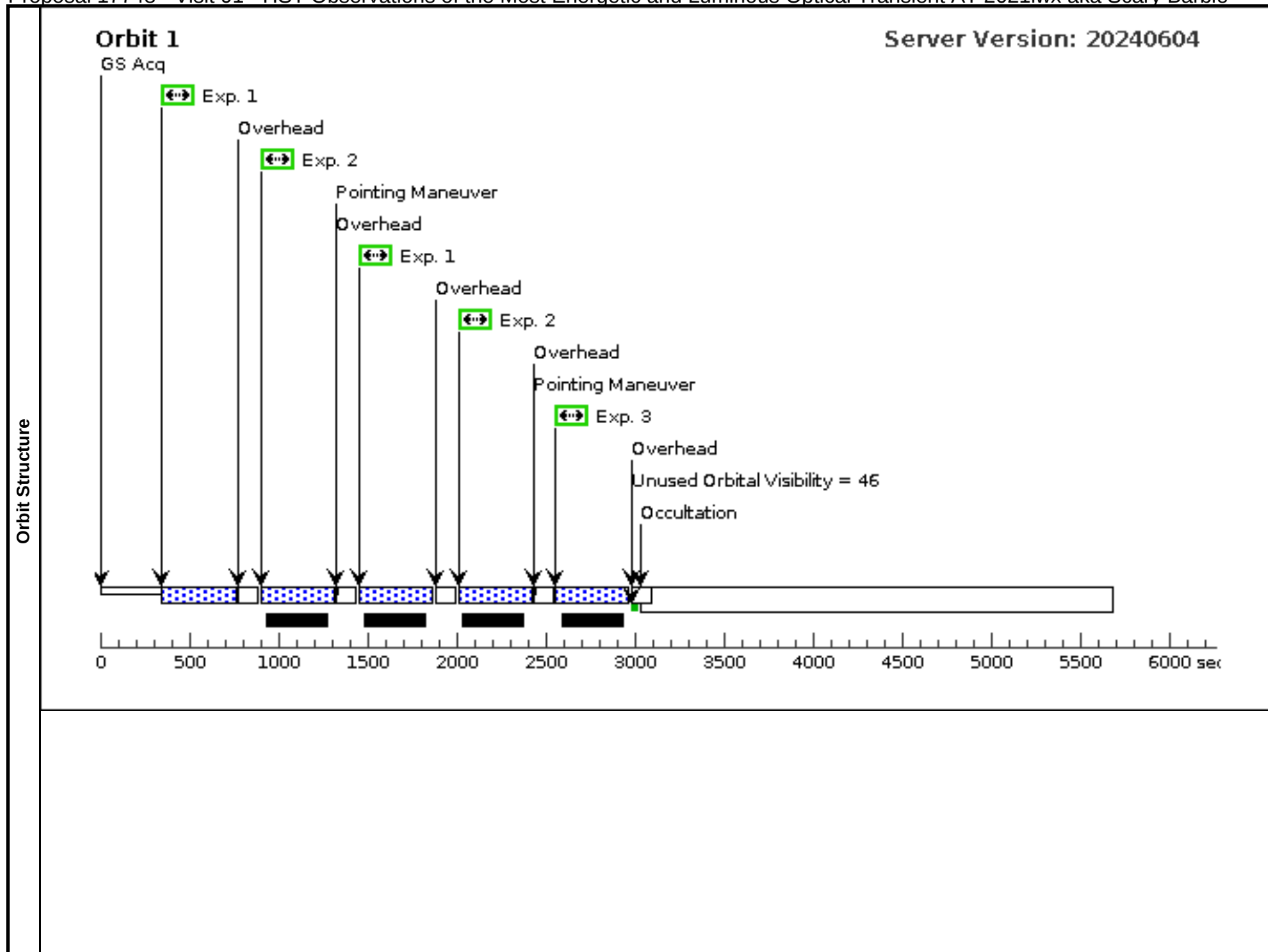
OBSERVING DESCRIPTION

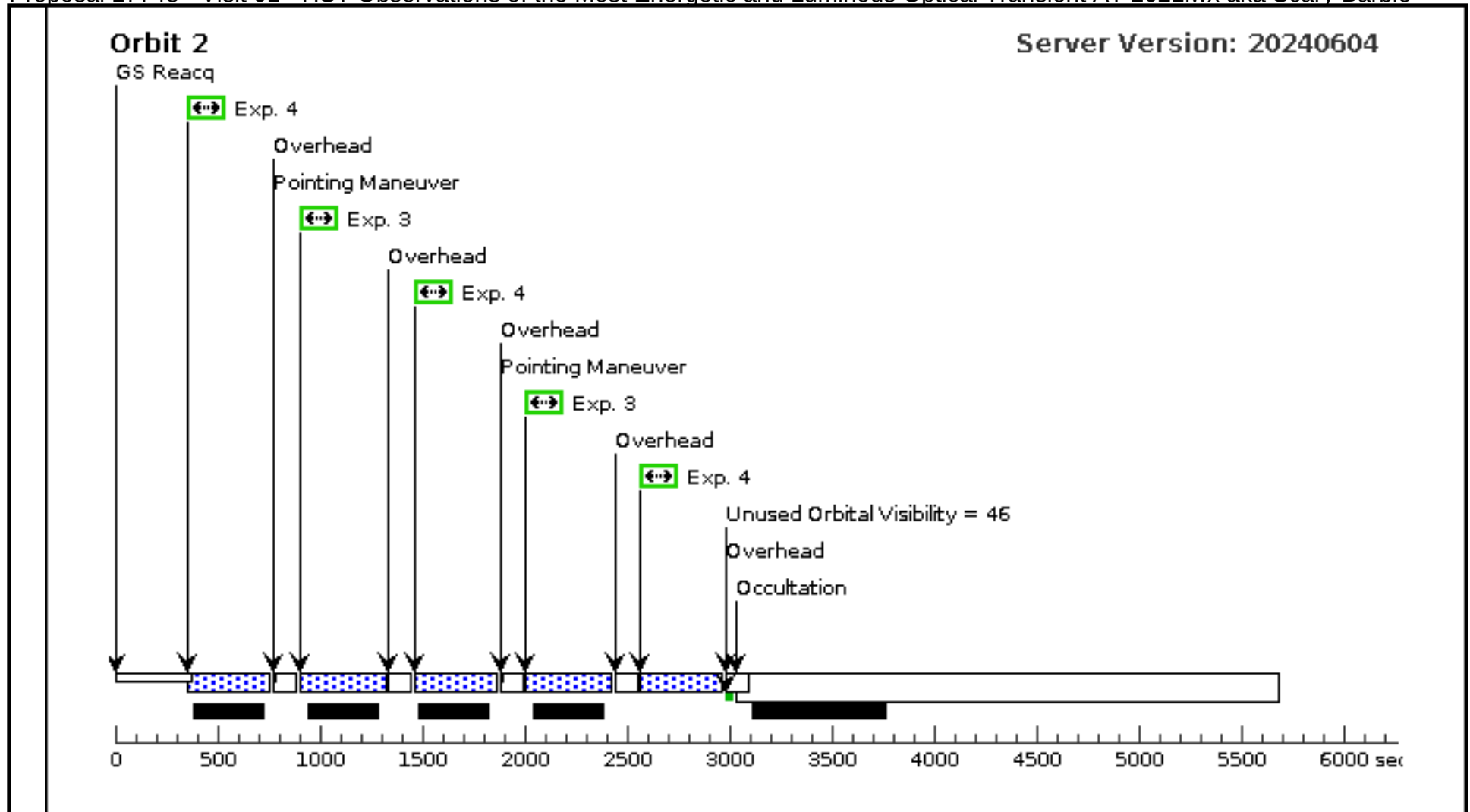
WFC3/UVIS Imaging (2 Orbits): Using two dithered exposures in UVIS/F275W and UVIS/F775W and three dithered exposures in UVIS/F390W and UVIS/F850LP filters, we will measure UV-optical emission to constrain the SED model of AT 2021lwx as well as determine the existence of any underlying host galaxy of the transient using the high spatial resolving power of HST observations. These exposures fit within 2 orbits, including overheads.

NUV Spectroscopy with STIS (1 Orbit): STIS/G230L spectra will cover 1570-3180 angstrom, targeting redshifted Lyman alpha, NV, Si IV, and C IV emissions from AT 2021lwx. An exposure for target acquisition with STIS CCD is included.

Proposal 17748 - Visit 01 - HST Observations of the Most Energetic and Luminous Optical Transient AT 2021lwx aka Scary Barbie

Visit	Proposal 17748, Visit 01, implementation					Wed Dec 11 18:00:13 GMT 2024					
	Diagnostic Status: No Diagnostics										
	Scientific Instruments: WFC3/UVIS										
	Special Requirements: BETWEEN 2025.128 AND 2025.154										
Patterns	#	Primary Pattern				Secondary Pattern				Exposures	
	(1)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=		Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false						(1-2)	
	(3)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=		Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false						(3-4)	
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous		
	(1)	AT2021LWX Alt Name1: ZTF20ABRBEIE Alt Name2: SCARYBARBIE	RA: 21 13 48.4080 (318.4517000d) Dec: +27 25 50.48 (27.43069d) Equinox: J2000		Epoch of Position: 2000 Redshift: 0.9945		V=22.00+/-0.05		Reference Frame: ICRS		
	Comments: Category=UNIDENTIFIED Description=[ACCRETION DISK, OPTICAL EMITTER, TIDAL TAIL, ULTRAVIOLET EMITTER]										
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1	(1934122)	(1) AT2021LWX	WFC3/UVIS, ACCUM, UVIS2	F275W	FLASH=22		Pattern 1, Exps 1-2 i n Visit 01 (1)	390 Secs (780 Secs) [==>(Pattern 1)] [==>(Pattern 2)]		[1]
	2	(1934129)	(1) AT2021LWX	WFC3/UVIS, ACCUM, UVIS2	F775W	FLASH=17		Pattern 1, Exps 1-2 i n Visit 01 (1)	390 Secs (780 Secs) [==>(Pattern 1)] [==>(Pattern 2)]		[1]
	3	(1934127)	(1) AT2021LWX	WFC3/UVIS, ACCUM, UVIS2	F390W	FLASH=20		Pattern 3, Exps 3-4 i n Visit 01 (3)	390 Secs (1170 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)]		[1] [2]
	4	(1934130)	(1) AT2021LWX	WFC3/UVIS, ACCUM, UVIS2	F850LP	FLASH=20		Pattern 3, Exps 3-4 i n Visit 01 (3)	390 Secs (1170 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)]		[2]





Proposal 17748 - Visit 02 - HST Observations of the Most Energetic and Luminous Optical Transient AT 2021lw aka Scary Barbie

Visit	Proposal 17748, Visit 02, implementation						Wed Dec 11 18:00:13 GMT 2024			
	Diagnostic Status: No Diagnostics									
	Scientific Instruments: STIS/NUV-MAMA, STIS/CCD									
	Special Requirements: BETWEEN 2025.128 AND 2025.154									
Patterns	#	Primary Pattern			Secondary Pattern			Exposures		
	(2)	Pattern Type=STIS-ALONG-SLIT Purpose=DITHER Number Of Points=3 Point Spacing=0.3 Line Spacing=		Coordinate Frame=POS-TARG Pattern Orientation=90.0 Angle Between Sides= Center Pattern=false		(2)				
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	AT2021LWX Alt Name1: ZTF20ABRBEIE Alt Name2: SCARYBARBIE Comments: Category=UNIDENTIFIED Description=[ACCRETION DISK, OPTICAL EMITTER, TIDAL TAIL, ULTRAVIOLET EMITTER]	RA: 21 13 48.4080 (318.4517000d) Dec: +27 25 50.48 (27.43069d) Equinox: J2000	Epoch of Position: 2000 Redshift: 0.9945	V=22.00+/-0.05	Reference Frame: ICRS				
	(2)	STAR-OFFSET	RA: 21 13 49.3858 (318.4557742d) Dec: +27 25 41.11 (27.42809d) Equinox: J2000	Proper Motion RA: -2.283149 mas/yr Proper Motion Dec: -7.061812 mas/yr Epoch of Position: 2000	V=13+/-0.5	Reference Frame: ICRS				
	Comments: Category=STAR Description=[OF] Extended=NO									
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(1937005)	(2) STAR-OFFSET	STIS/CCD, ACQ, F28X50LP	MIRROR				0.5 Secs (0.5 Secs)	
									[==>]	[1]
	2	(1938975)	(1) AT2021LWX	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A			Pattern 2, Exps 2-2 i n Visit 02 (2)	644 Secs (1932 Secs)	
									[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)]	[1]

