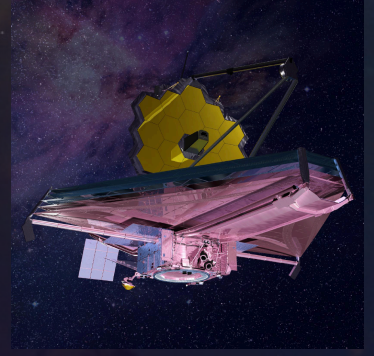

STScI | SPACE TELESCOPE SCIENCE INSTITUTE

EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

Probing the high-z TDE population with WFIRST and JWST

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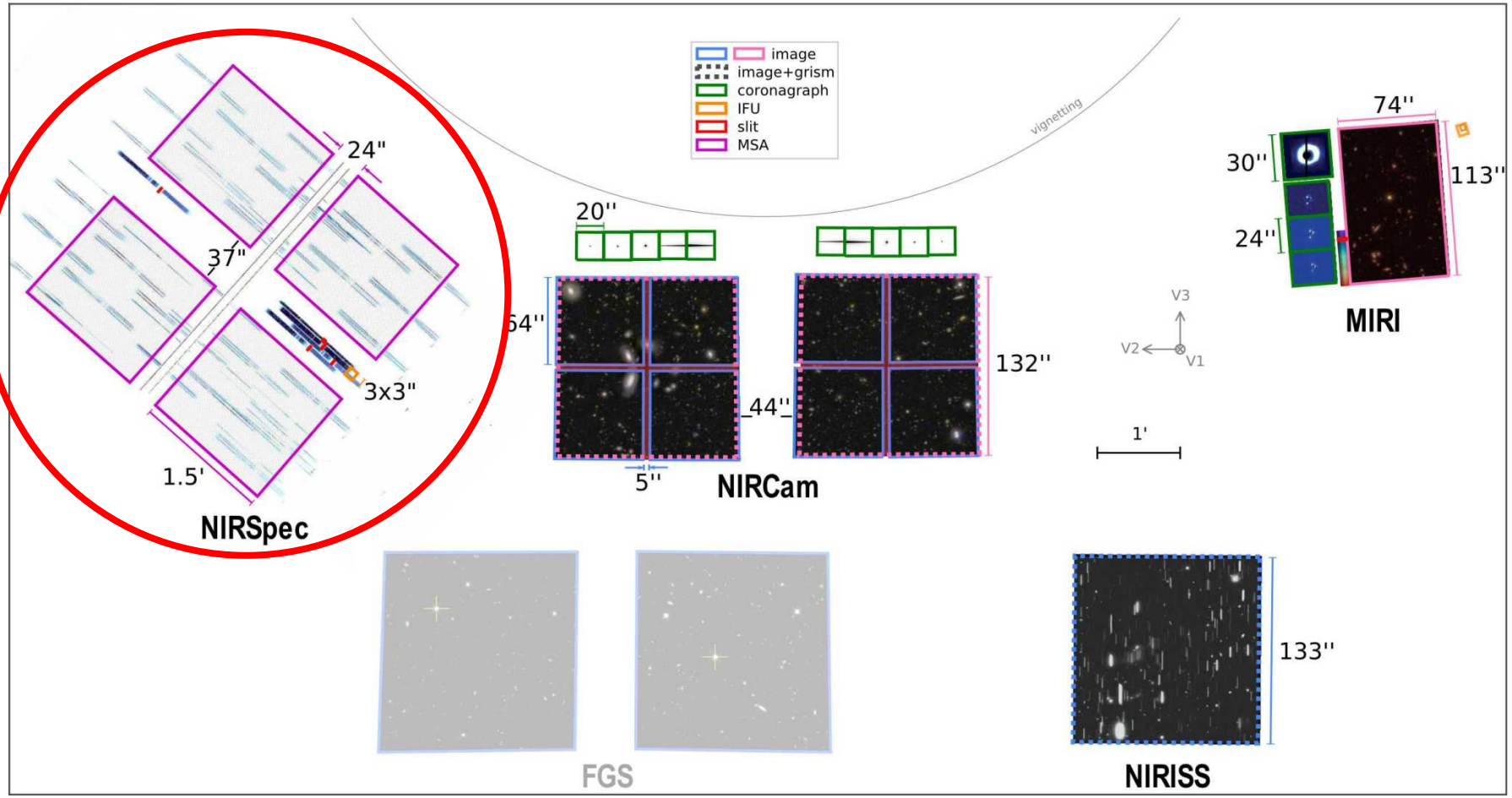
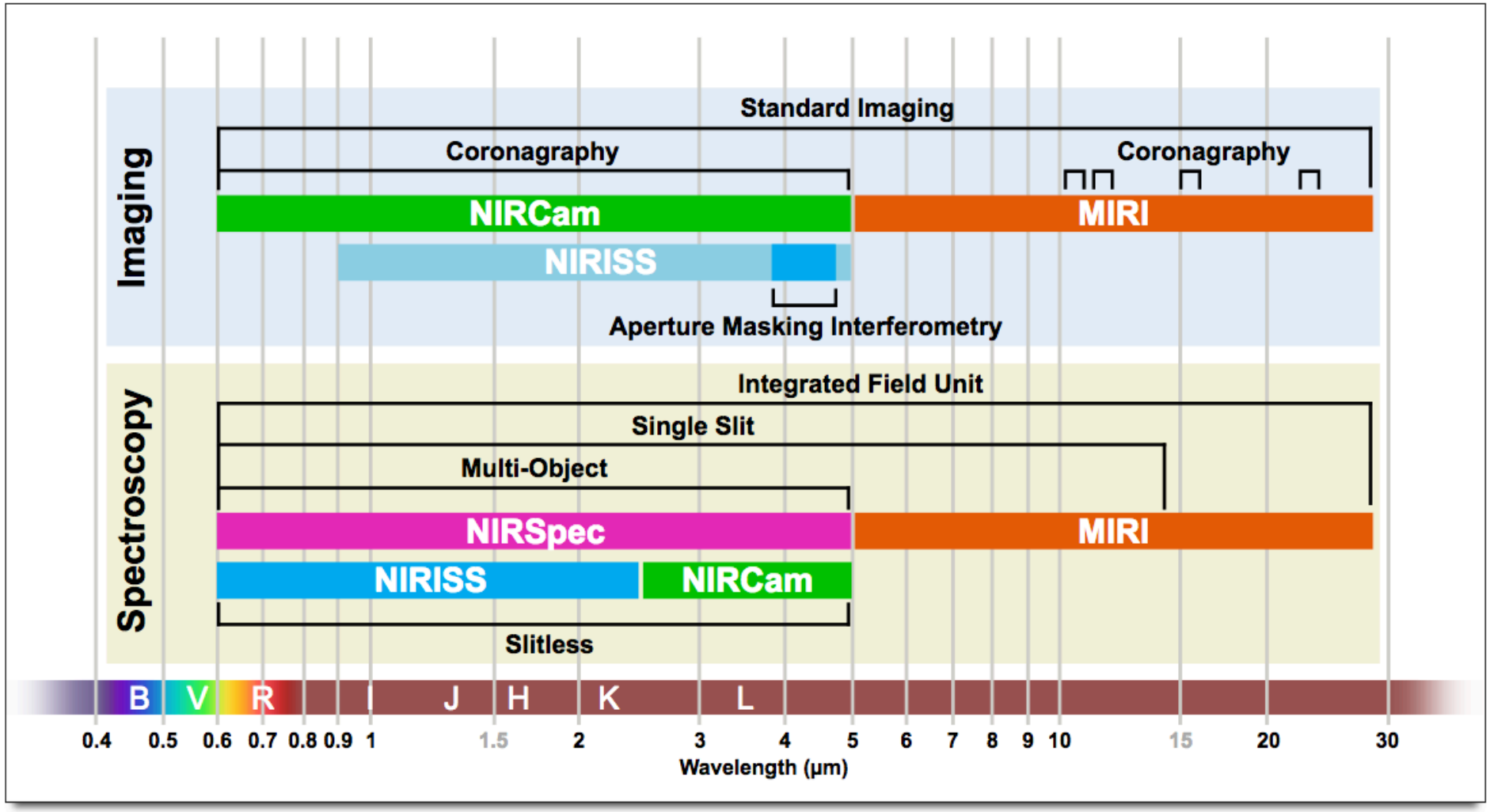
B. R. Hounsell (UCSC), D. Scolnic (KICP), R. Chornock (UO)

Unveiling the Physics Behind Extreme AGN Variability conference, UVI July 14th 2017

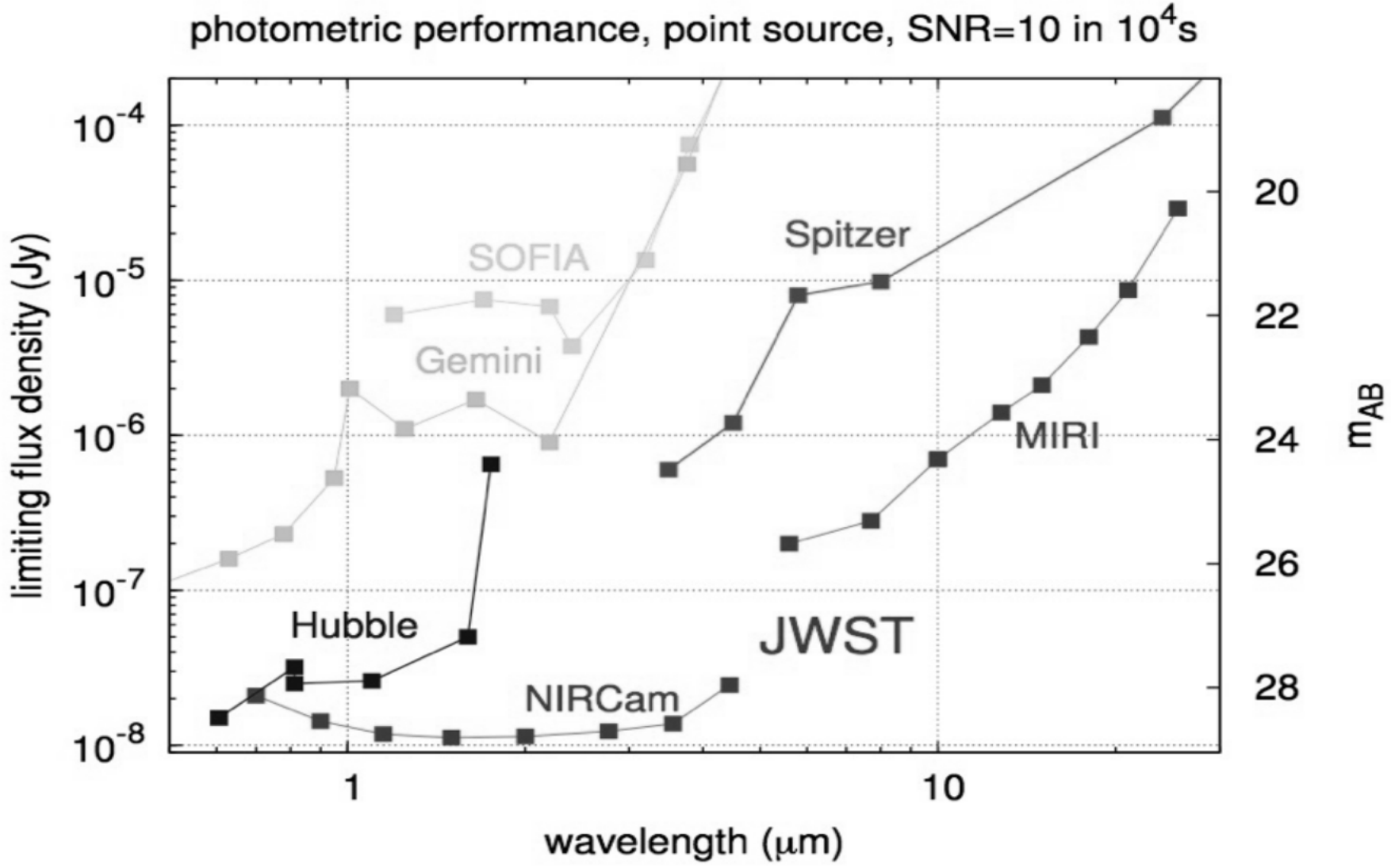
JWST Instruments



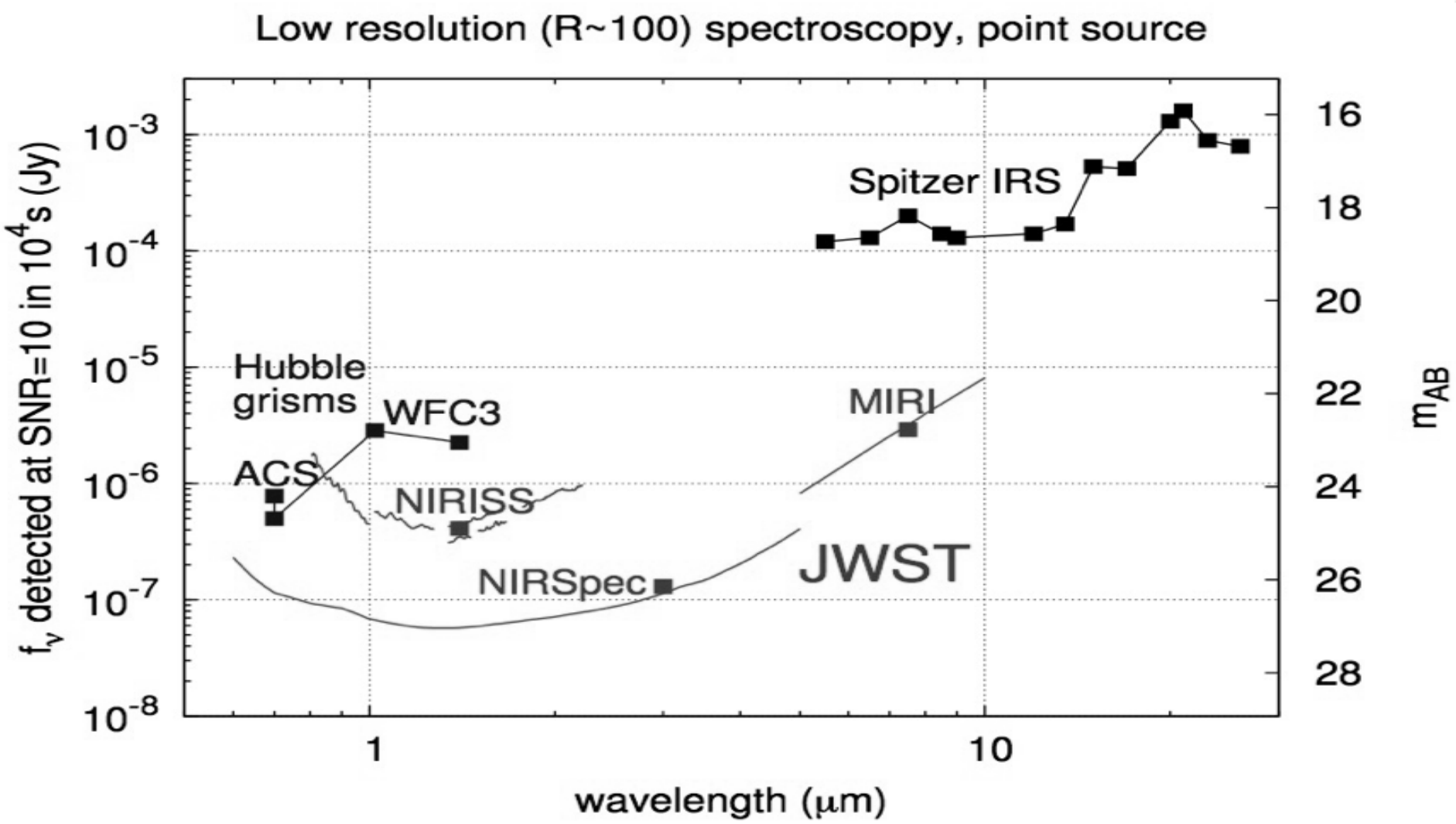
JWST: wavelength coverage



JWST: Photometric Sensitivity

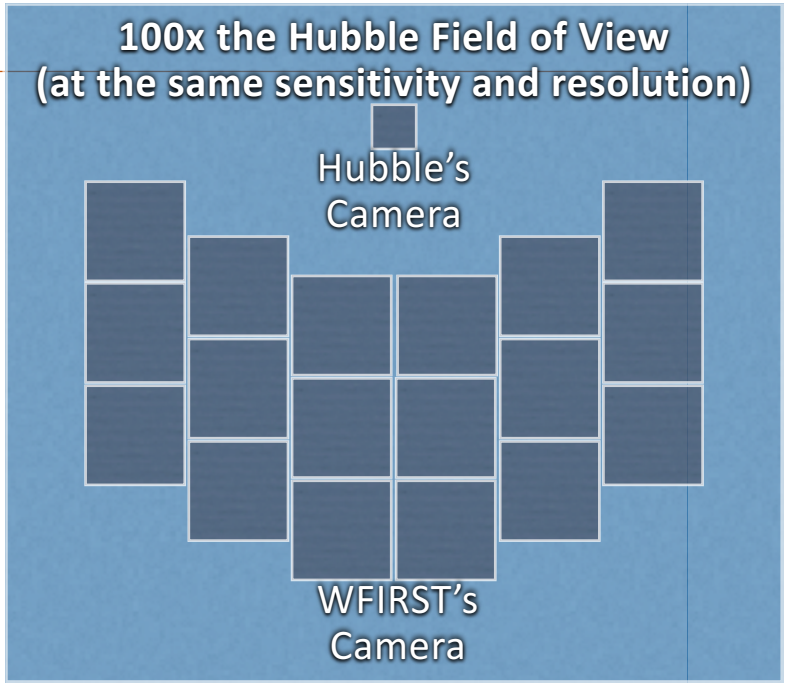


JWST: Spectroscopic Sensitivity



WFIRST summary

WFIRST Imaging Capabilities							
Telescope Aperture (2.4 meter)		**Field of View** (45'x23'; 0.28 sq deg)		**Pixel Scale** (0.11 arcsec)		**Wavelength Range** (0.5-2.0 μm)	
Filters	**R062**	**Z087**	**Y106**	**J129**	**H158**	**F184**	**W146**
Wavelength (μm)	0.48-0.76	0.76-0.98	0.93-1.19	1.13-1.45	1.38-1.77	1.68-2.00	0.93-2.00
Sensitivity (5σ AB mag in 1 hr)	28.50	28.02	27.95	27.87	27.81	27.32	28.33



Possible Survey Implementations

High Latitude Survey (2000 sq deg at 27th mag in YJHF184 + spectra)
Dark Energy — Cosmic Lensing — High-z Galaxies — Galactic Halo Substructure

Deep Field Surveys (~10 deg^2 fields at 28-29th mag, with high cadence)
Supernova Discovery — First Light — Galaxy Evolution

Guest Observer Surveys (user specified instrument, depth, area, …)
Broad astrophysics from Solar System exploration to cosmology

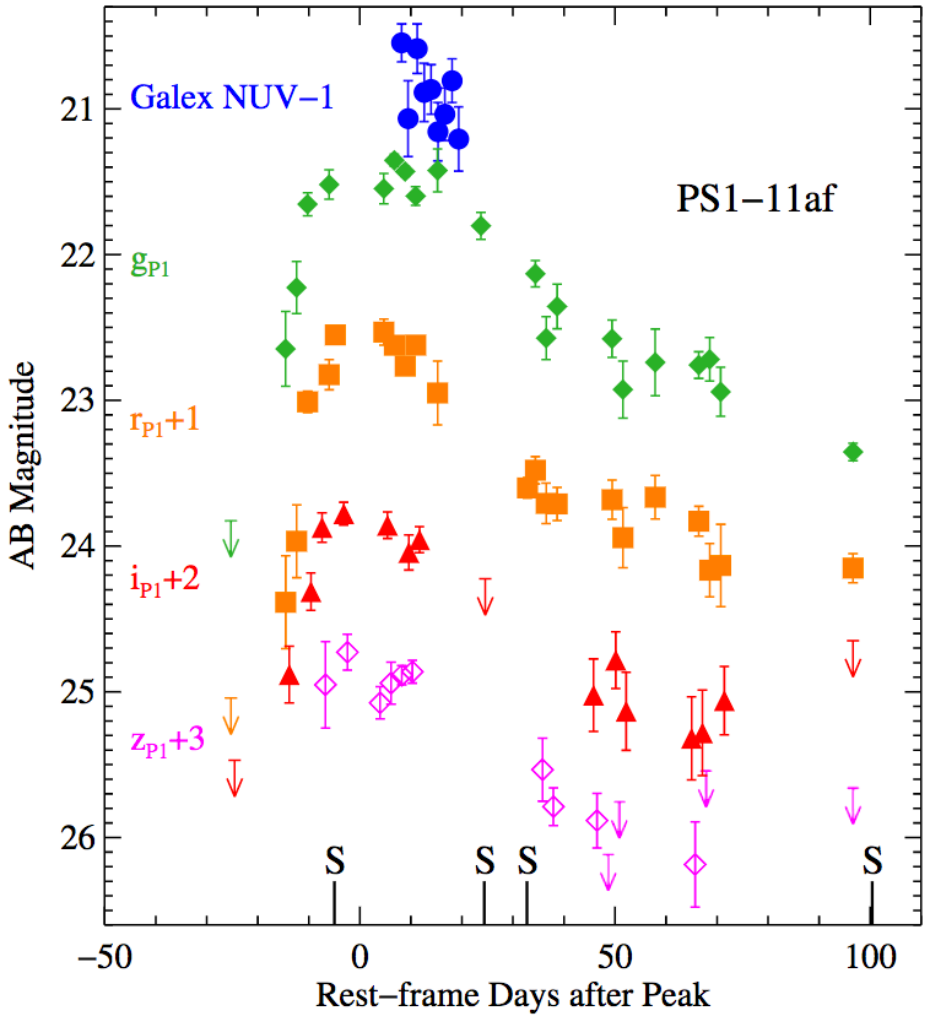
Galactic Bulge Survey (2.2 sq deg at high cadence)
Exoplanet Census — Free Floating Planets — Stellar Pops — Galactic Structure

Exoplanet (+ Other Objects) Imaging Survey (10^9 contrast ratio direct imaging)
Exoplanet Discovery and Characterization — Disks — Massive Star Atmospheres

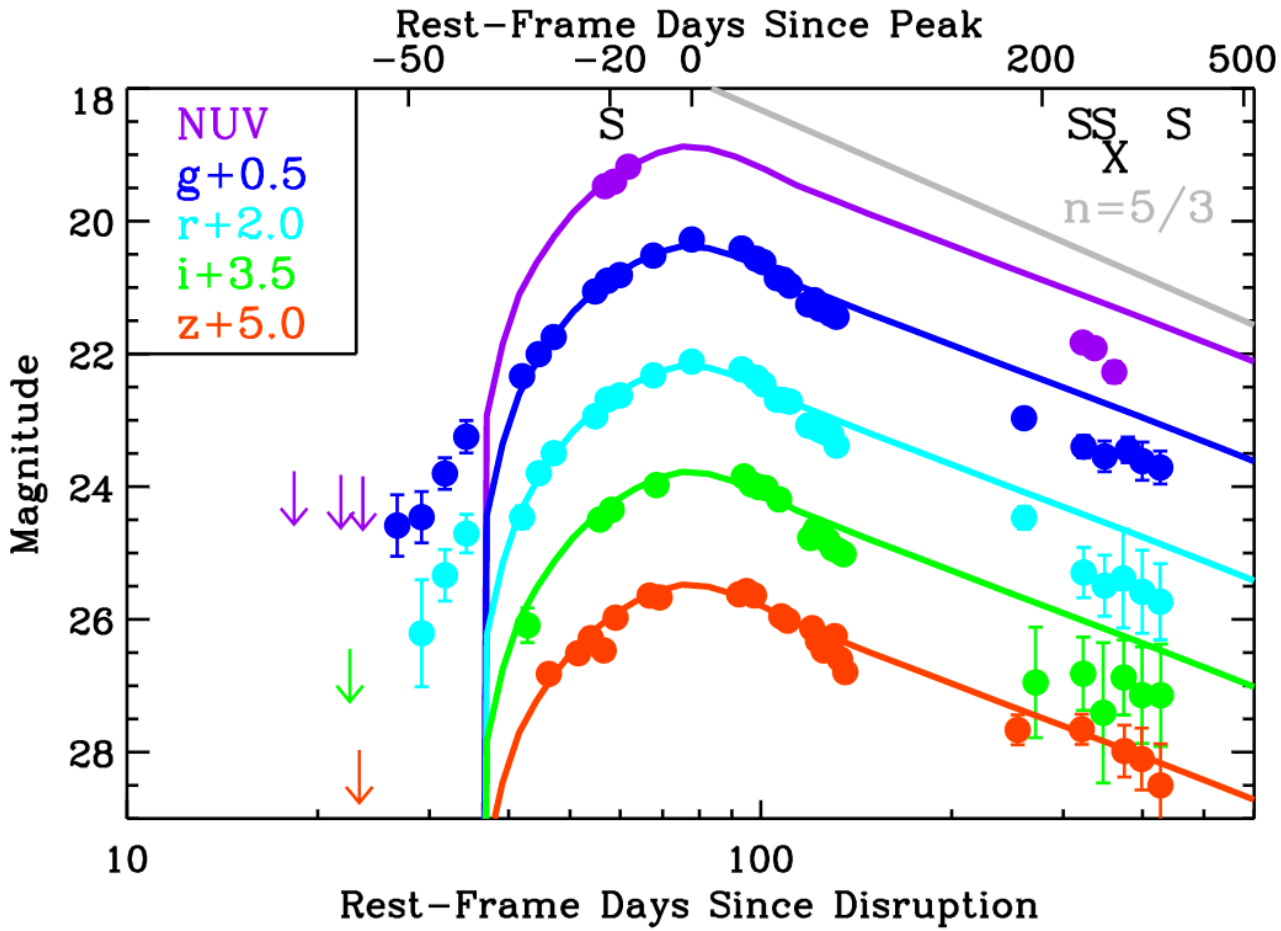
Guest Investigator Surveys (funded archival research from survey data)
Broad astrophysics from Solar System exploration to cosmology

TDE Examples for Simulations: PS1-11af and PS1-10jh

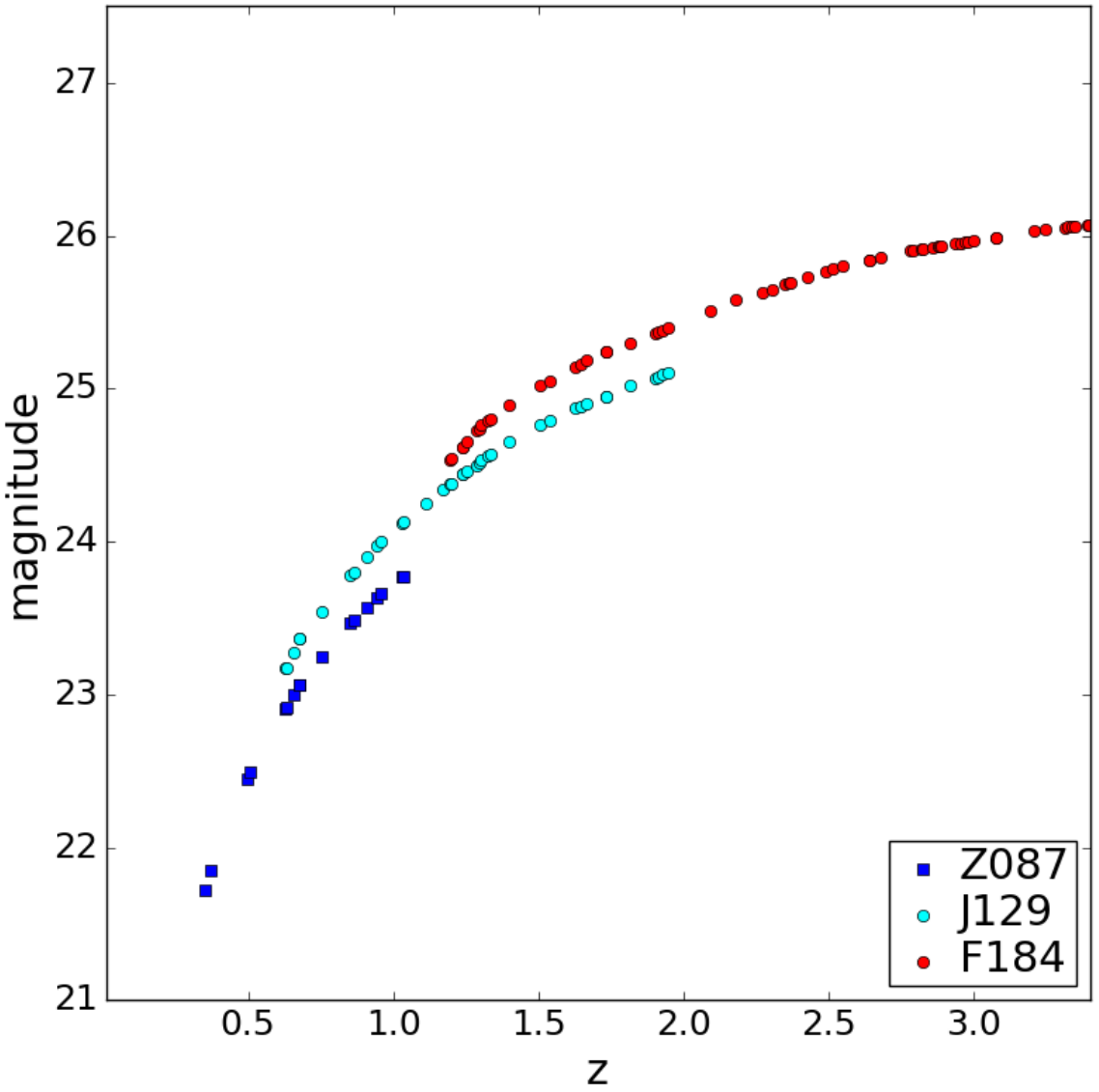
Chornock+14, PS1-11af, z=0.4



Gezari+12, PS1-10jh, z=0.16

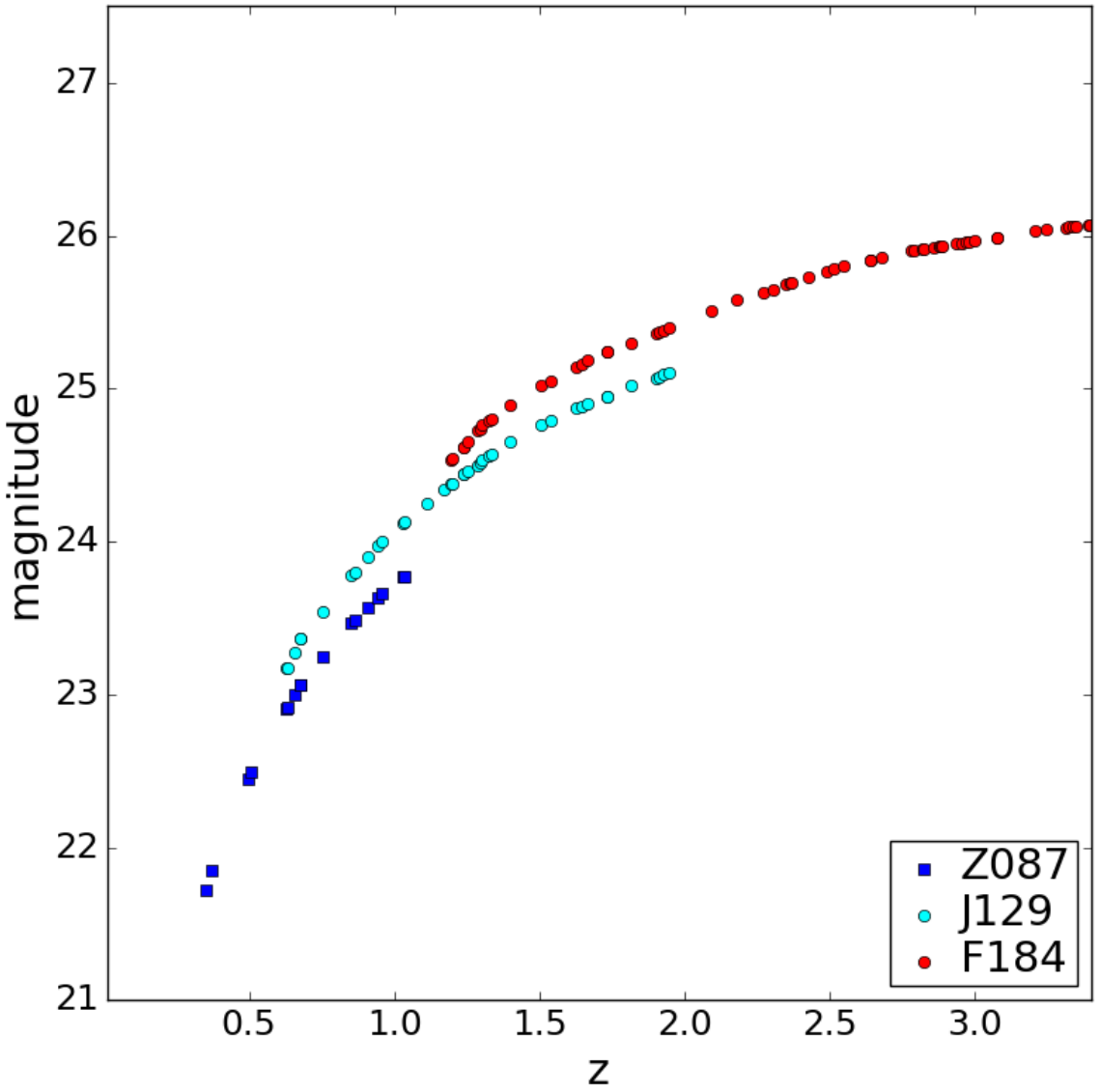


Simulating WFIRST magnitudes for PS1-11af and PS1-10jh

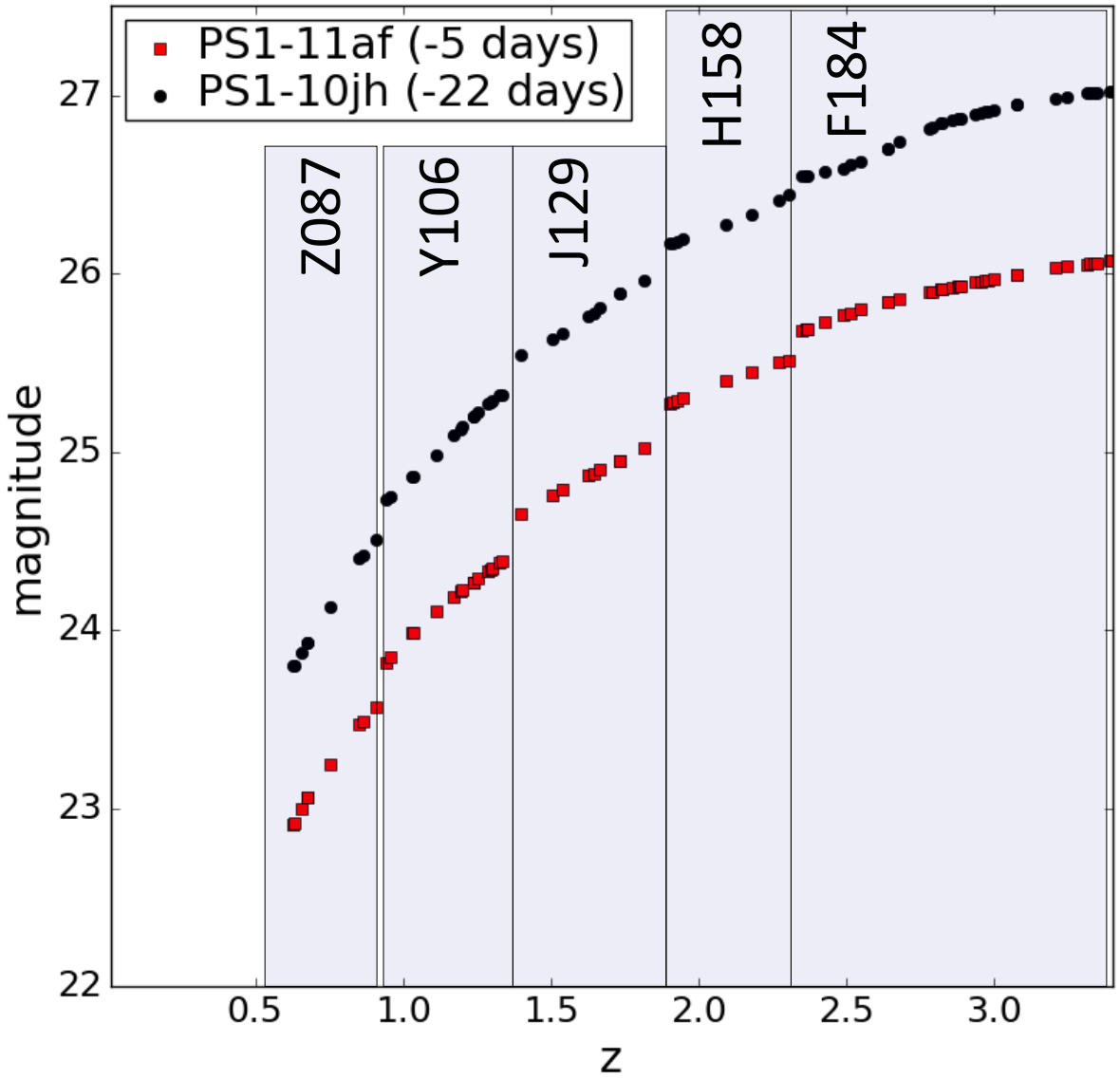


- SALT2
- z from 0.2 to 3.5
- Mags for given WFIRST filter

Simulating WFIRST magnitudes for PS1-11af and PS1-10jh

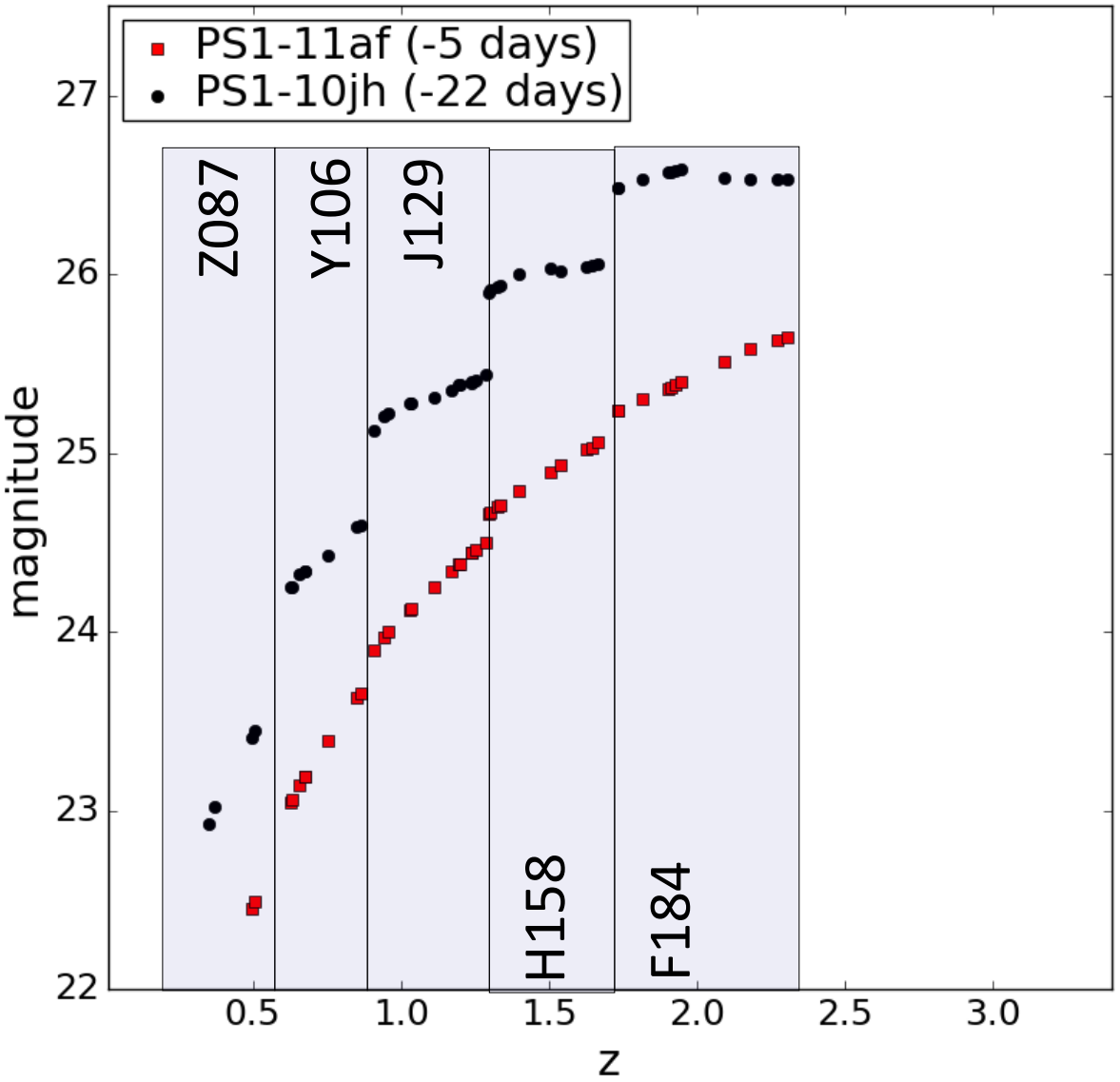


Mag in band closest to restframe g

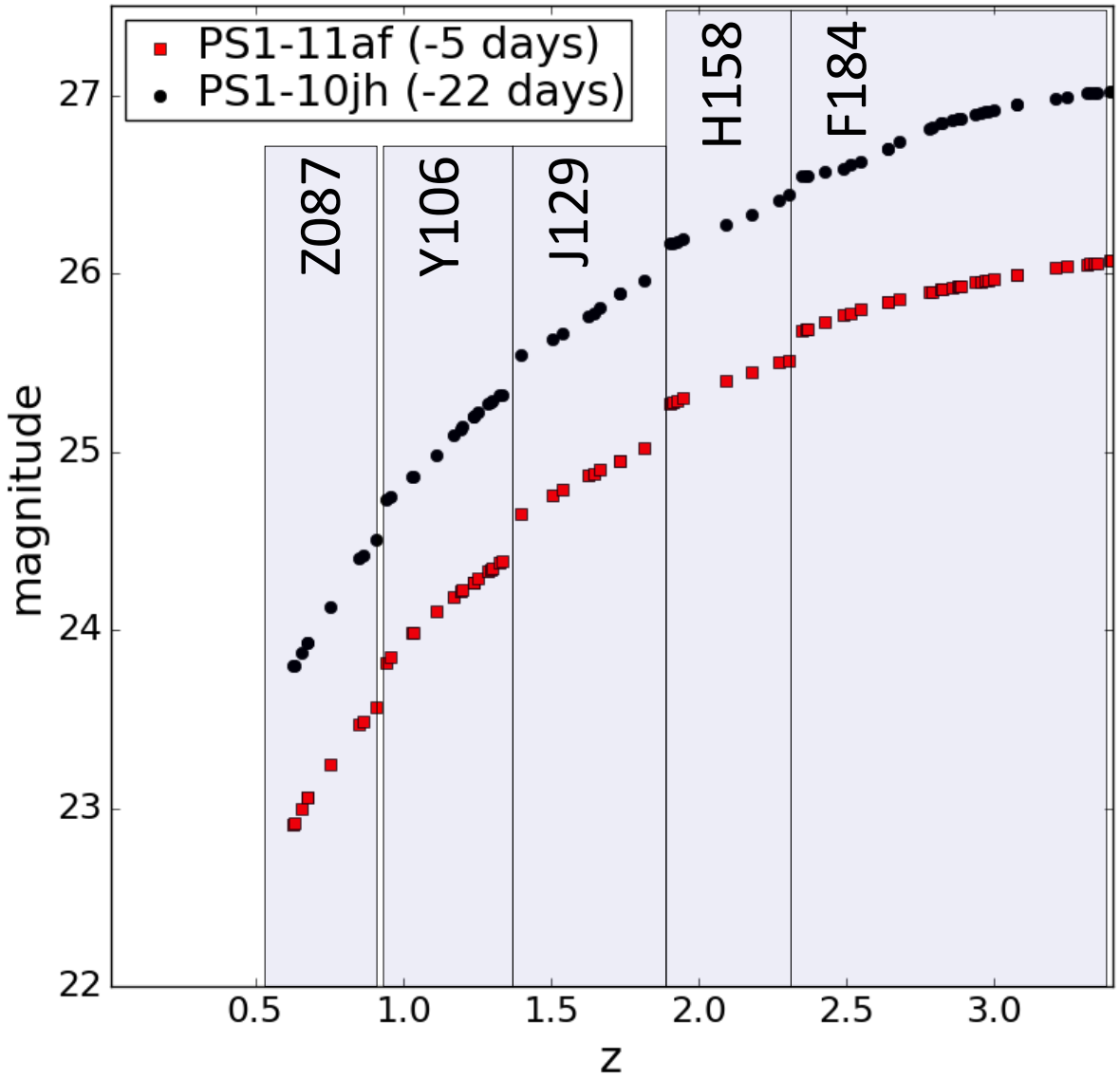


Simulating WFIRST magnitudes for PS1-11af and PS1-10jh

Mag in band closest to restframe r



Mag in band closest to restframe g



WFIRST: Survey strategies

Hounsell+17, arXiv::1702.01747

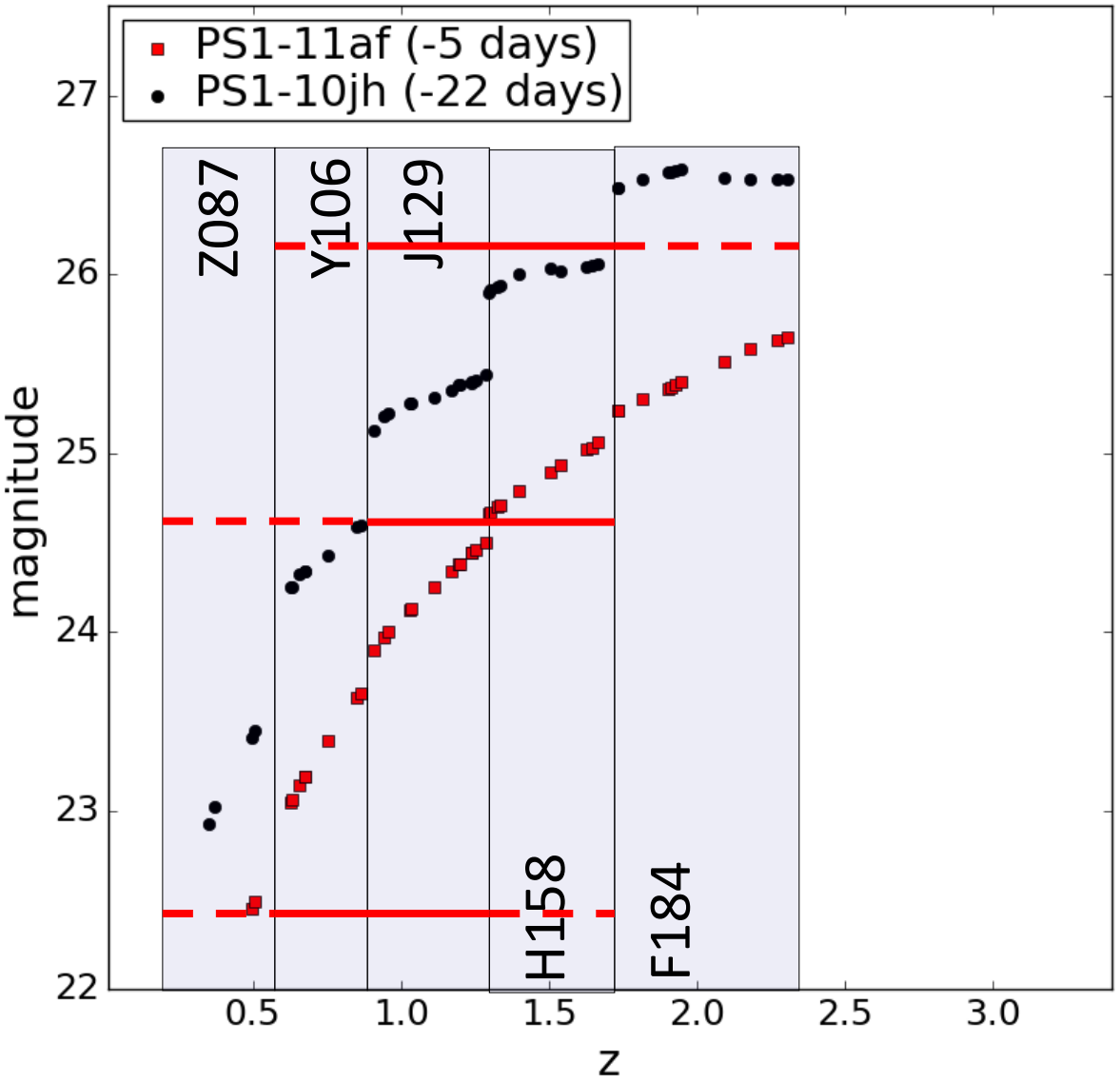
Table 2. Description of the three-tier SN survey as outlined in the SDT report.

Survey Tier	Redshift Range	Area (deg^2)	Discovery Filters	Depth per Exposure (mag)	Total Depth (mag)
Shallow	$0.1 \leq z < 0.4$	27.44	Y, J	22.3, 22.4	25.0, 25.1
Medium	$0.4 \leq z < 0.8$	8.96	J, H	24.6, 24.5	27.3, 27.2
Deep	$0.8 \leq z \leq 1.7$	5.04	J, H	26.2, 26.1	28.9, 28.8

	Redshift Range			Filter Set Used			Area (deg^2)			Number of SN Ia Selected		
Name	Shallow	Medium	Deep	Shallow	Medium	Deep	Shallow	Medium	Deep	Shallow	Medium	Deep
SDT	0.10–0.39	0.40–0.79	0.80–1.70	IFC-S, YJ	IFC-S, JH	IFC-S, JH	27.44	8.96	5.04	12	364	1204
SDT*	0.10–0.39	0.40–0.79	0.80–1.70	IFC-S, YJ	IFC-S, JH	IFC-S, JH	27.44	8.96	5.04	149	647	1224
SDT* Highz	···	0.10–0.79	0.80–1.70	···	IFC-S, JH	IFC-S, JH	···	22.80	5.04	···	1271	1224
Imaging:Allz	0.01–2.99	0.01–2.99	0.01–2.99	$RZYJ$	$RZYJ$	$YJHF$	48.82	19.75	8.87	557	4807	5892
Imaging:Lowz	0.01–2.99	0.01–2.99	···	YJ	JH	···	142.30	66.91	···	0	1797	···
Imaging:Lowz*	0.01–2.99	0.01–2.99	···	$RZYJ$	$RZYJ$	···	73.57	32.24	···	822	8117	···
Imaging:Lowz+	0.01–2.99	0.01–2.99	···	$RZYJHF$	$RZYJHF$	···	50.66	20.68	···	588	5167	···
Imaging:Lowz-Blue	0.01–2.99	0.01–2.99	···	$BVRIYJ$	$BVRIYJ$	···	50.66	20.68	···	347	4894	···
Imaging:Highz*	···	0.01–2.99	0.01–2.99	···	$RZYJ$	$YJHF$	···	32.06	13.24	···	7990	8881
Imaging:Highz+	···	0.01–2.99	0.01–2.99	···	$RZYJHF$	$RZYJHF$	···	20.50	9.14	···	5211	6289

TDEs with WFIRST: survey depths

Mag in band closest to restframe r

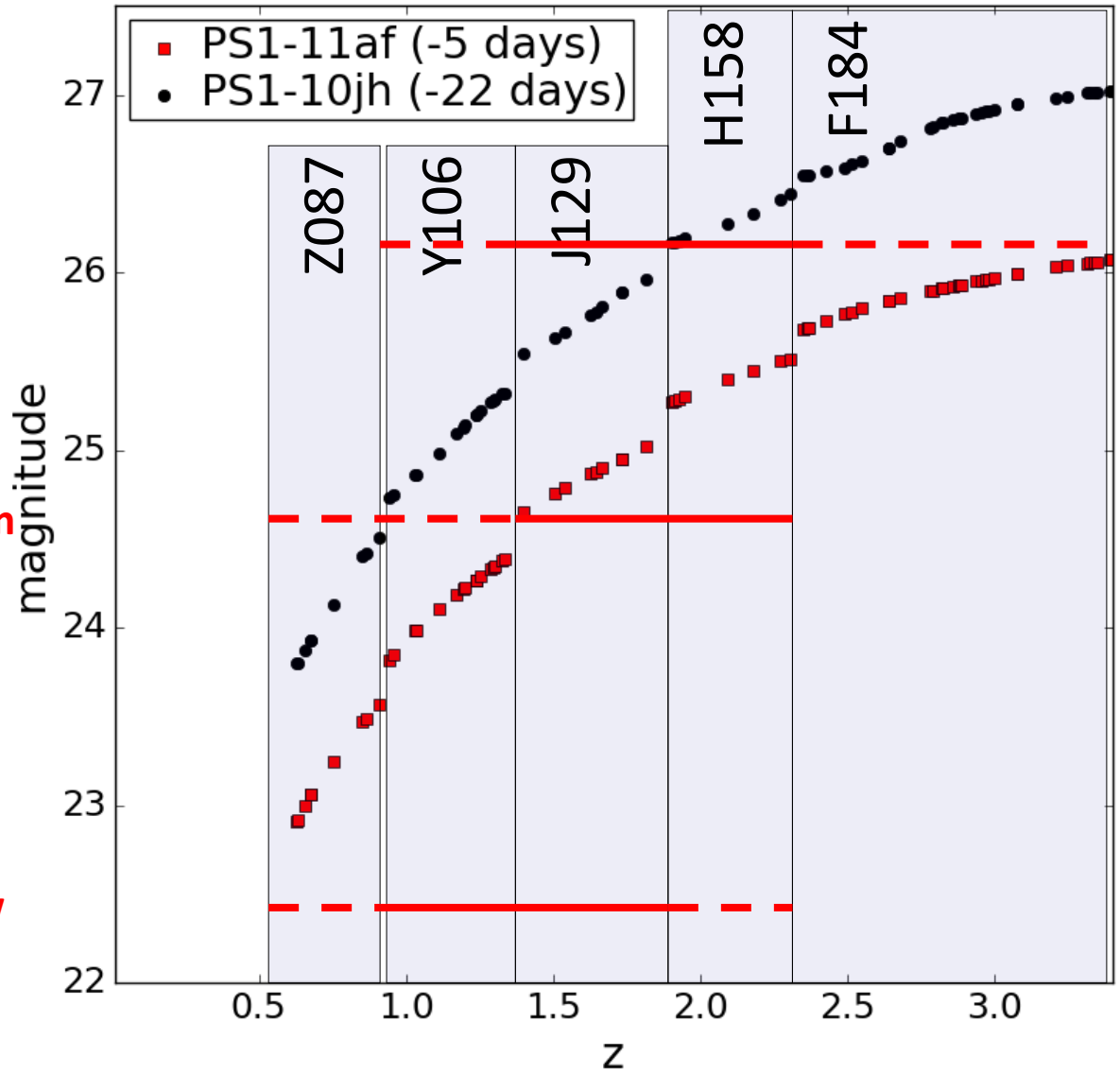


Deep

Medium

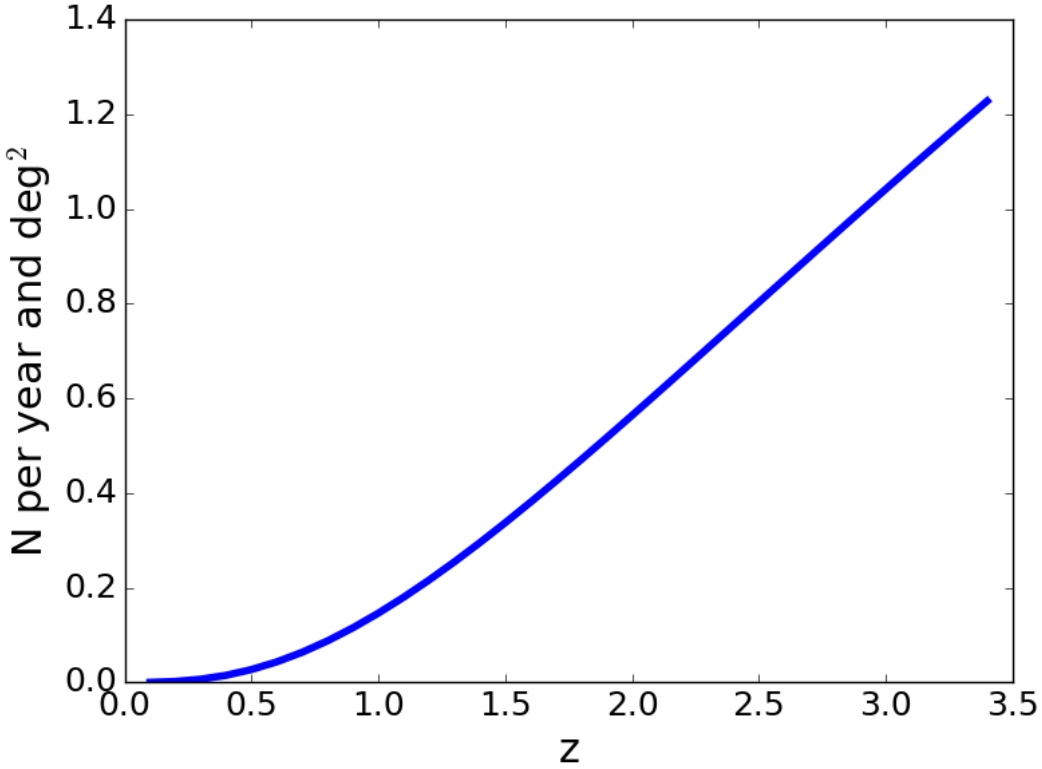
Shallow

Mag in band closest to restframe g



TDEs with WFIRST: Rates (Assuming 4×10^{-8} TDEs Mpc^{-3} yr^{-1} (van Velzen+14)

Survey name	Survey Area Range (deg^2)	z max	N TDE (yr^{-1})
Shallow	25 - 50	<0.5	?
Medium	10 - 20	<1.5	3 - 6
Deep	5 - 10	<3.0	2 - 8

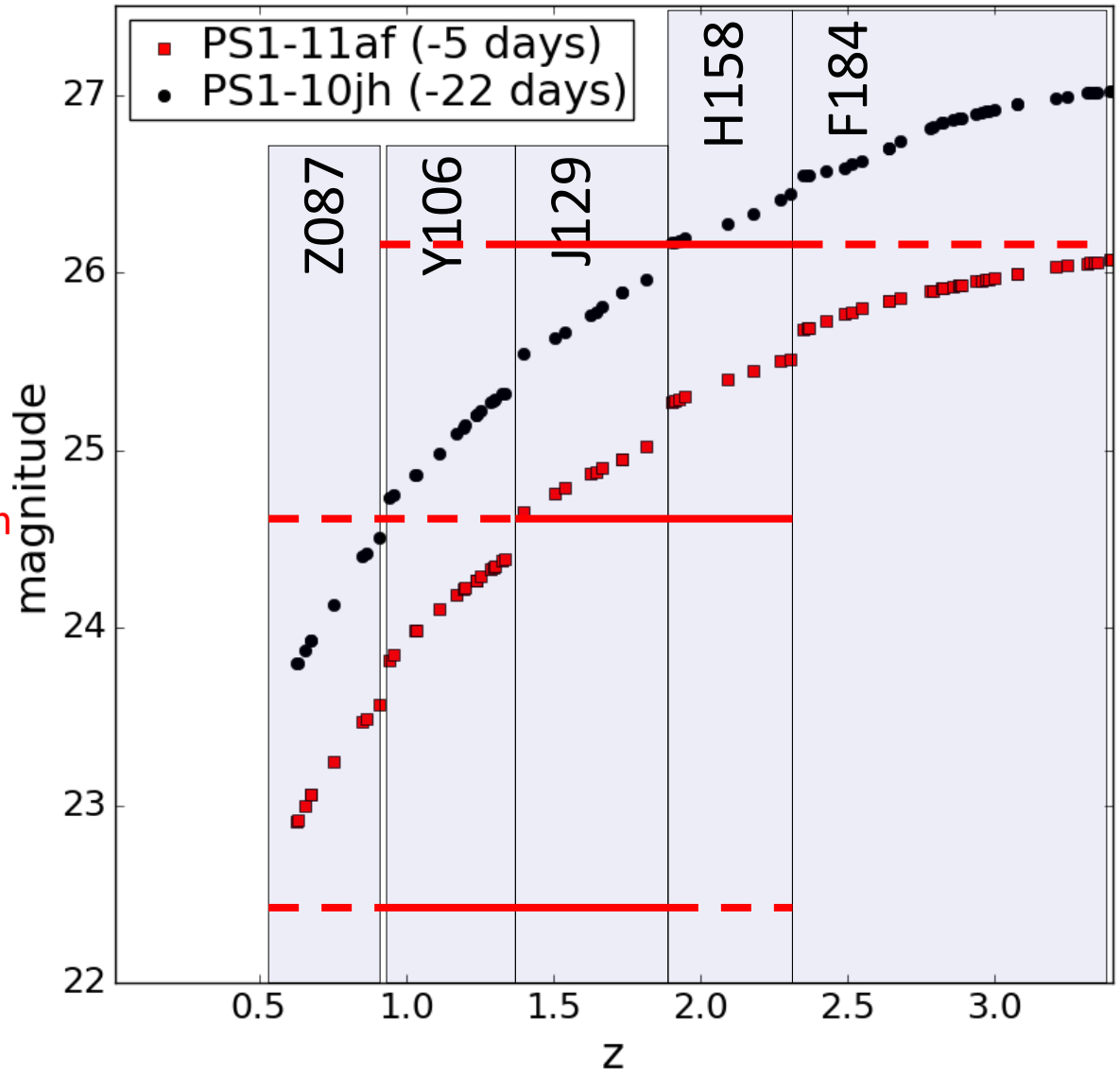


Deep

Medium

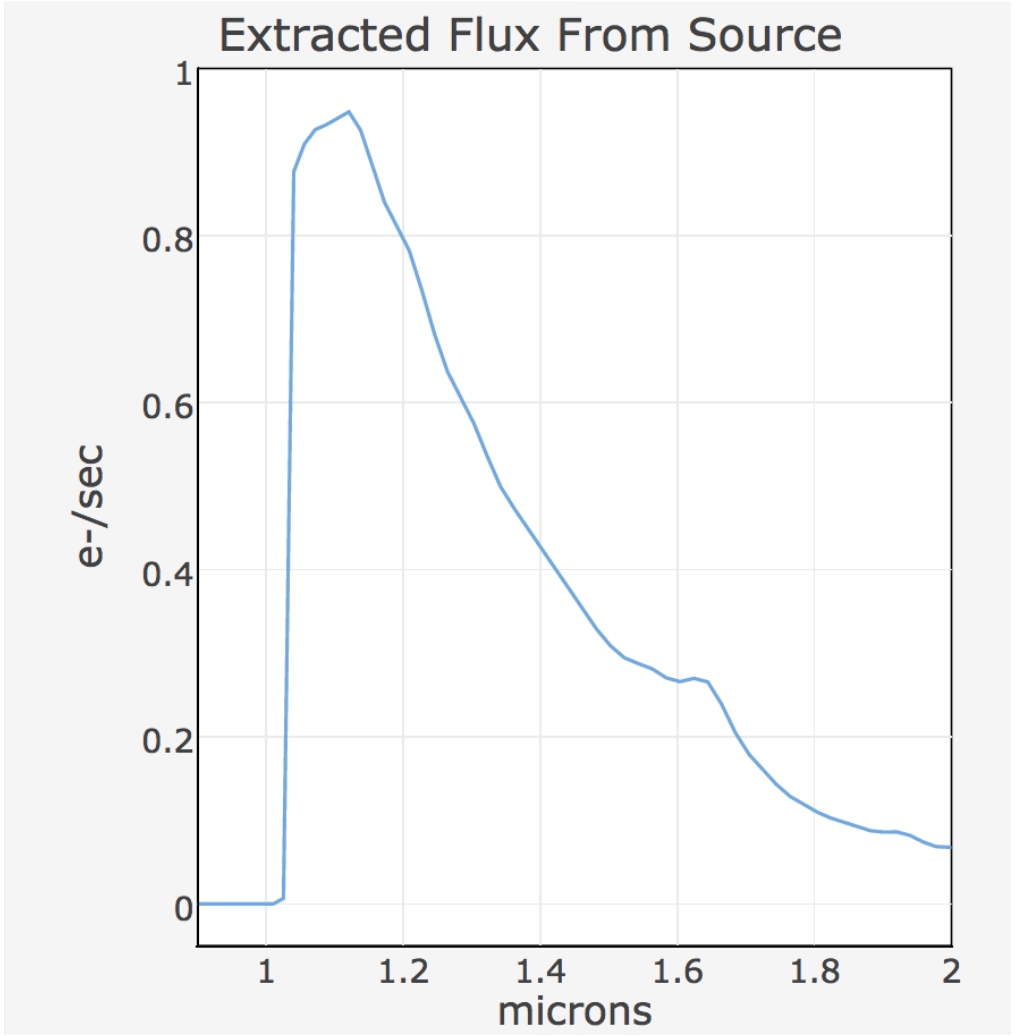
Shallow

Mag in band closest to restframe g



TDEs at high redshift: Spectroscopy with JWST NIRSpec

- JWST Exposure time calculator
- PS1-10jh, phase=-22 spectrum
- Normalization
  - z=2.5
  - F150W=25.7
  - 6000 seconds exposure time
- PRISM/CLEAR
- S200 A1 (0.2” x 3.3”)
- 0.6 - 5.3 microns
- R=100
- CAVEAT: Does not include host galaxy!



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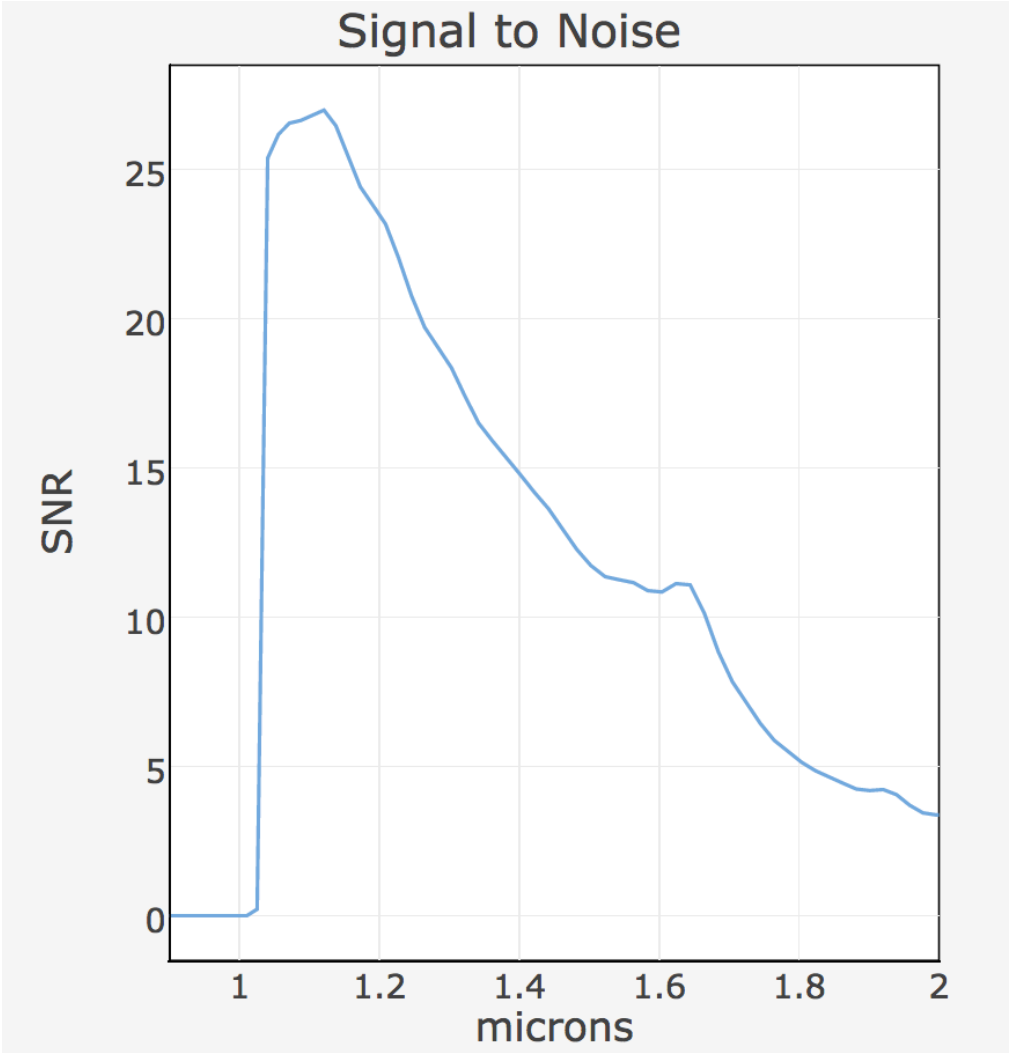

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- R~1000
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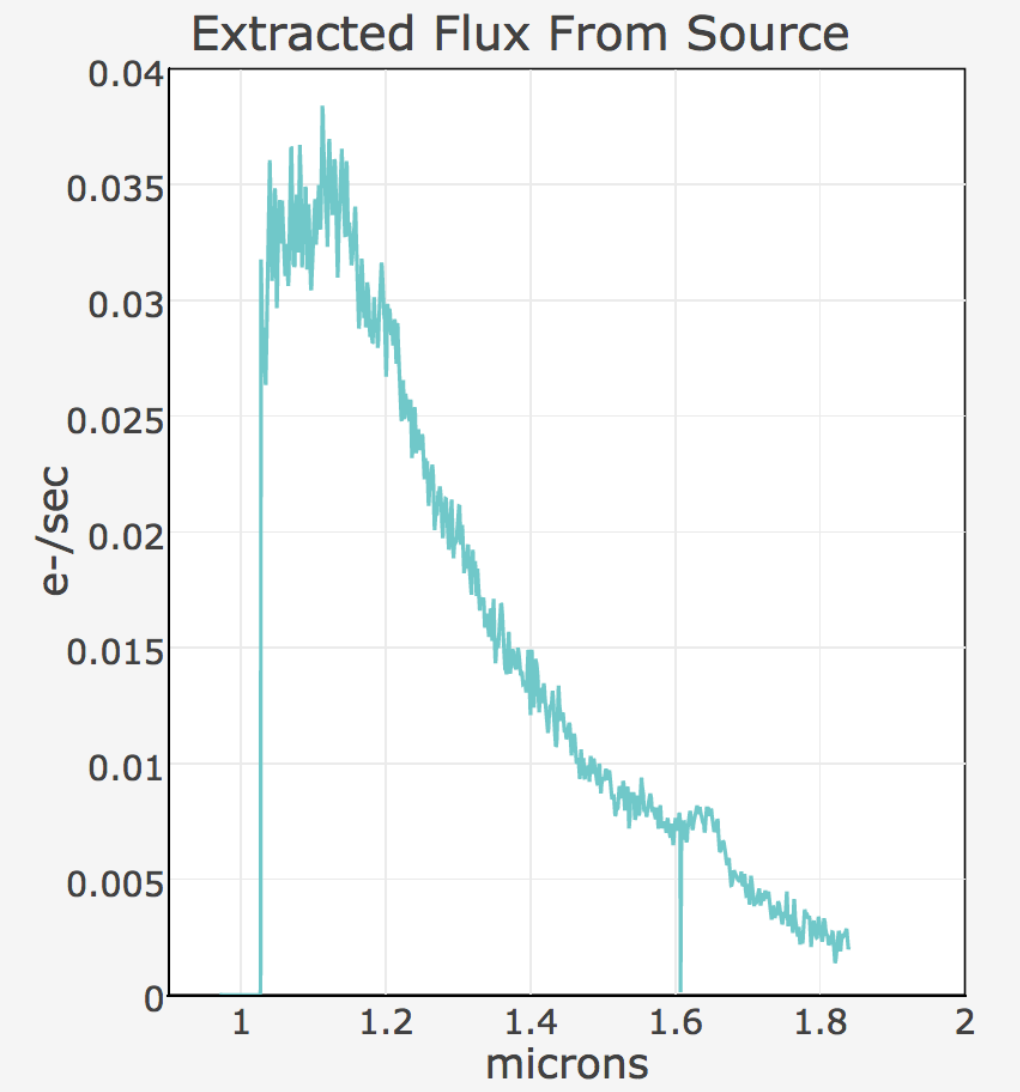

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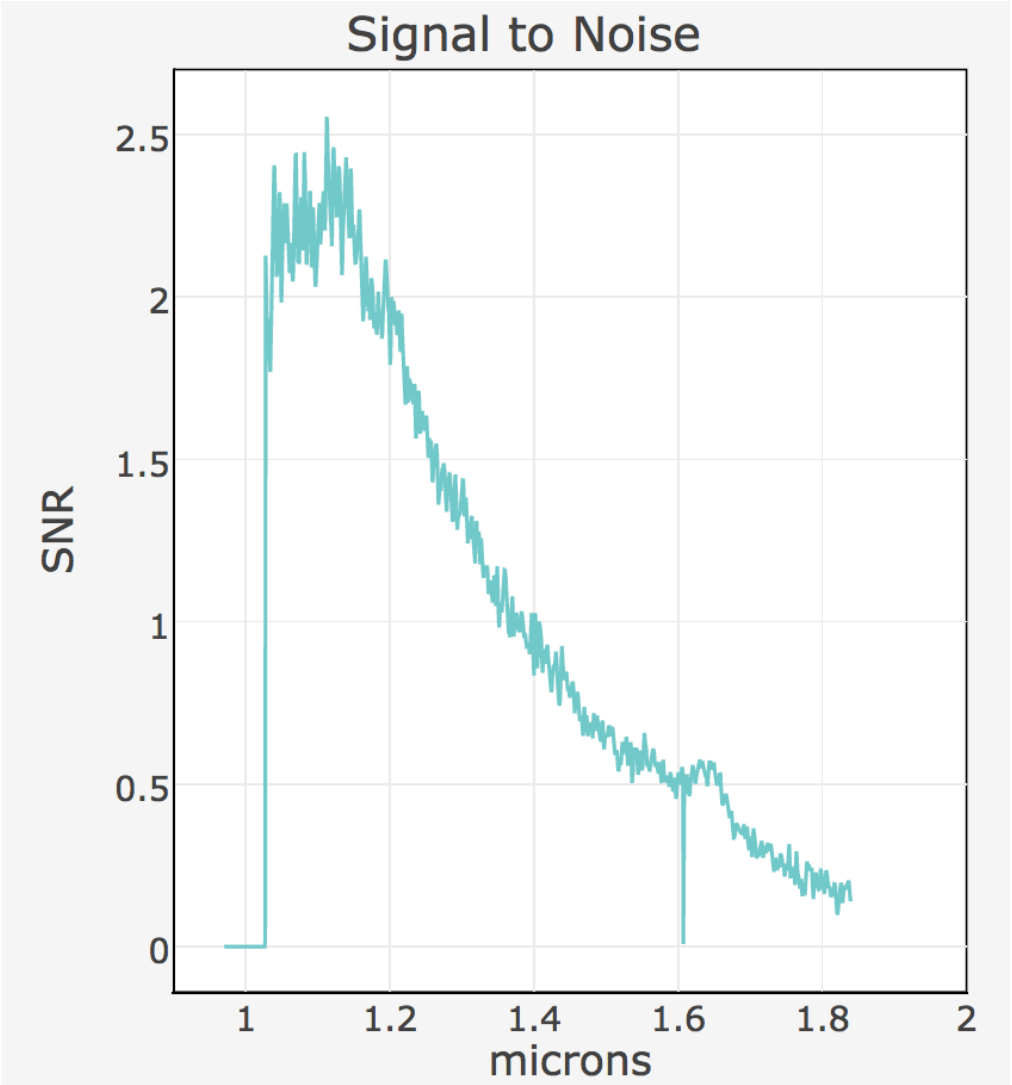

Summary

- Low-z TDE sample will grow from 10s to hundreds (ZTF) and thousands (LSST)
- Simulation: Use PS1-10jh and PS1-11af as examples
- High-z TDE sample with WFIRST:
  - Restframe g observable up z=3.5 with F184
  - SN survey: 5-10 TDE within z=3.5 per year (Efficiency? Constant rate with redshift?)
- JWST:
  - R=100 spectroscopy easily achievable for all discovered TDEs
  - R=1000: also possible!
- Work in progress, paper planned for late summer:
  - TDEs
  - SN Ia
  - SN IIP
  - SN Ib/c
  - SLSN