

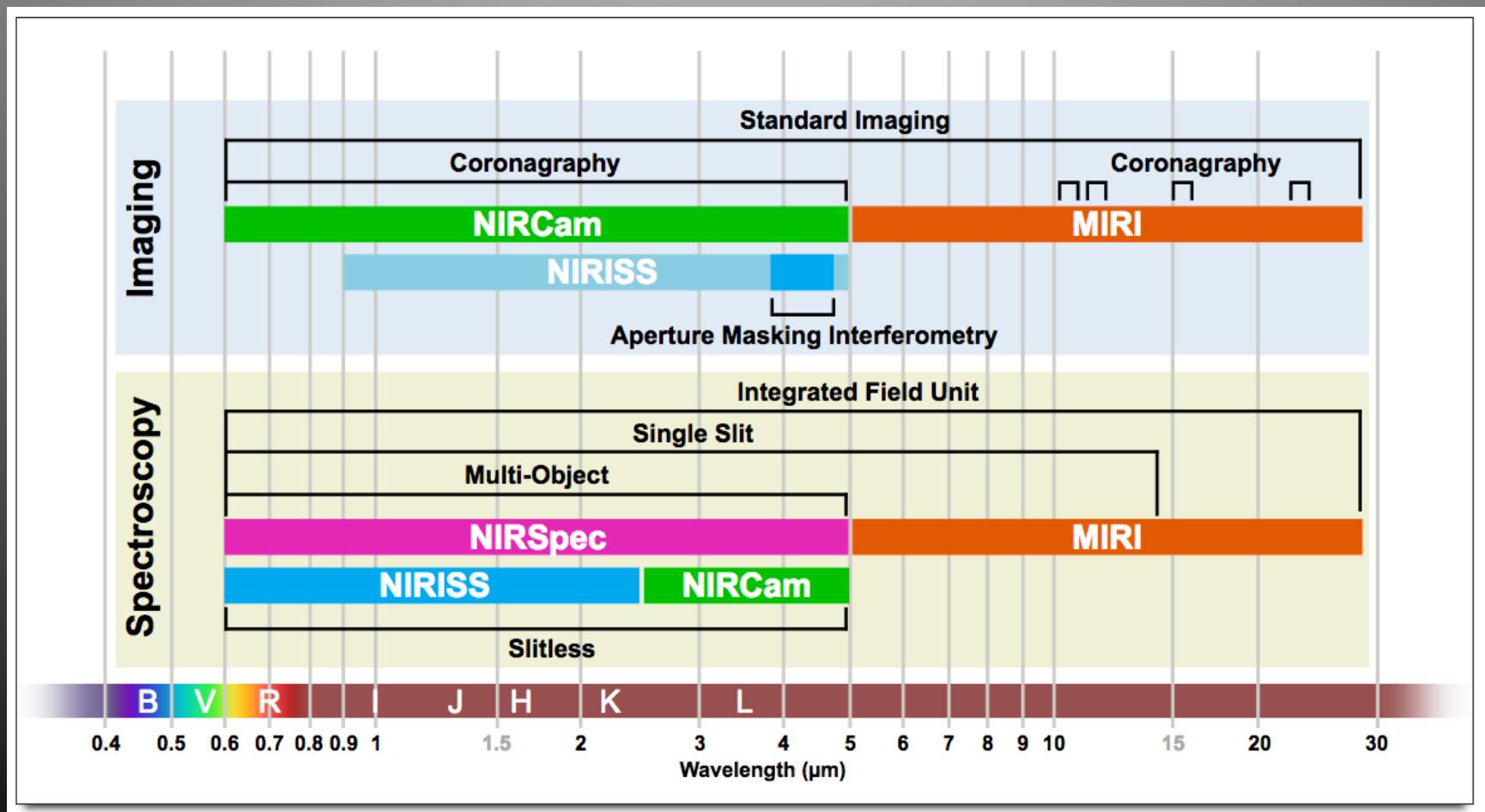
SN Ia (and TDEs) with JWST in the NIR

Armin Rest
(STScI)

A. Canipe (STScI),
G. Narayan (STScI),
R. Hounsell (UCSC),
D. Scolnic (KICP),
R. Kessler (U of Chicago)
R. Chornock (UO)



JWST Imaging and Spectroscopy

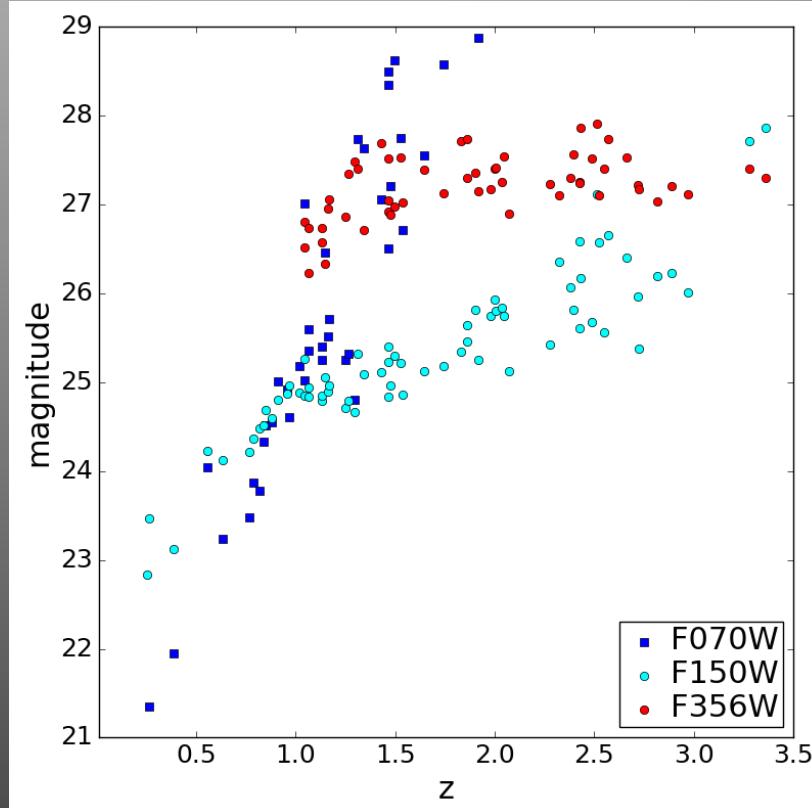


NIRSpec: Available filter/grating combinations

- For R~100, CLEAR/PRISM delivers full spectral range (0.6-5.3 μm) in a single exposure
- For R~1000, require 3-4 exposures to cover full wavelength range:
 - F100LP/G140M: 0.97 – 1.89 μm
 - F170LP/G235M: 1.66 – 3.17 μm
 - F290LP/G395M: 2.87 – 5.27 μm
 - (F070LP/G140M: 0.70 – 1.27 μm)
- For R~2700, require 3-4 exposures to cover full wavelength range:
 - F100LP/G140H: 0.97 – 1.89 μm
 - F170LP/G235H: 1.66 – 3.17 μm
 - F290LP/G395H: 2.87 – 5.27 μm
 - (F070LP/G140H: 0.70 – 1.27 μm)

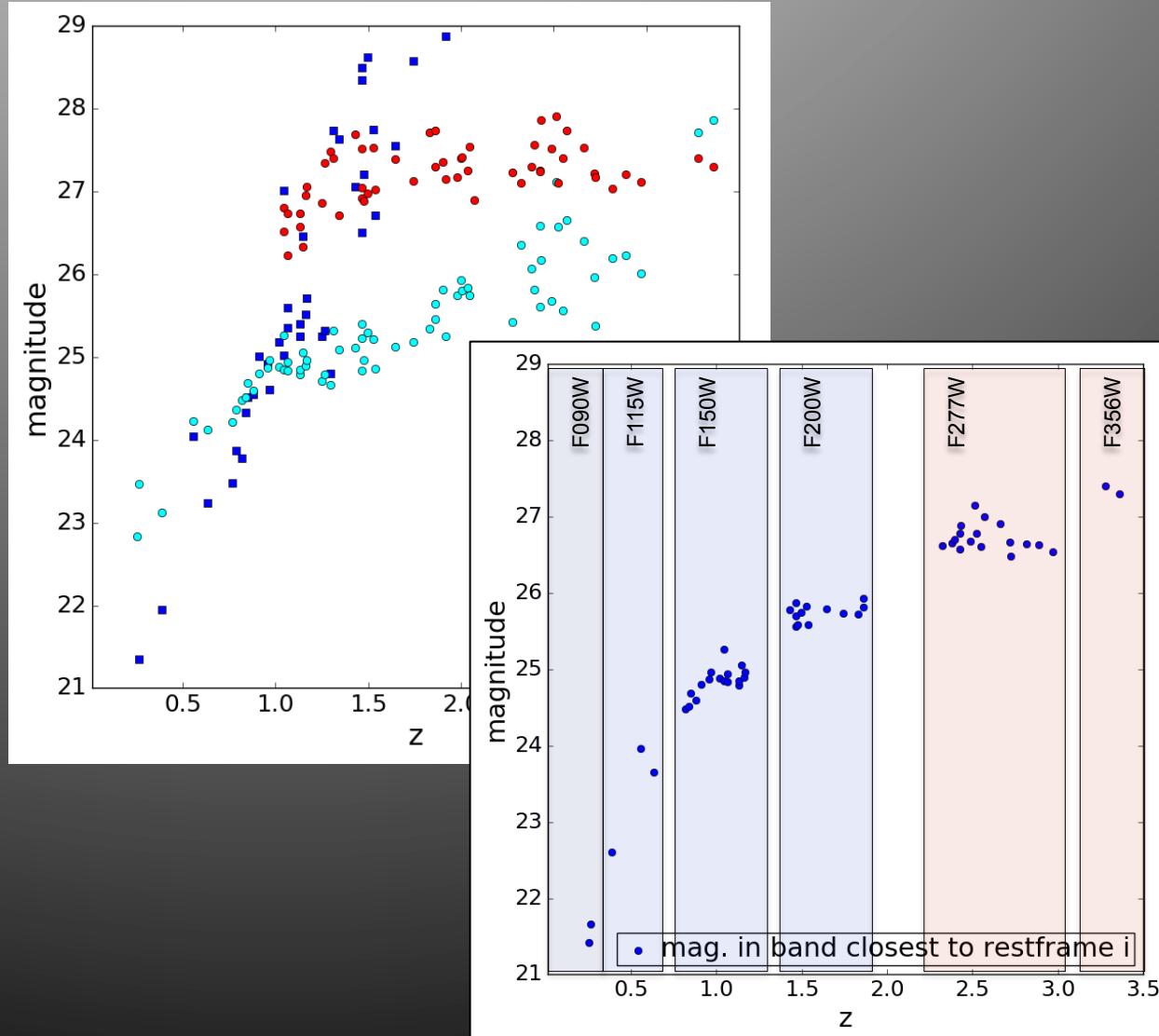
SN Ia cosmology: Magnitudes at different redshifts

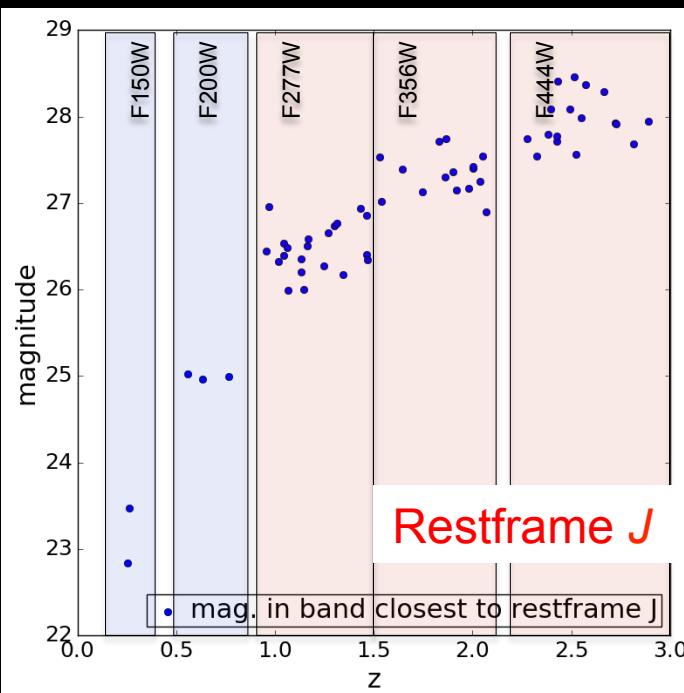
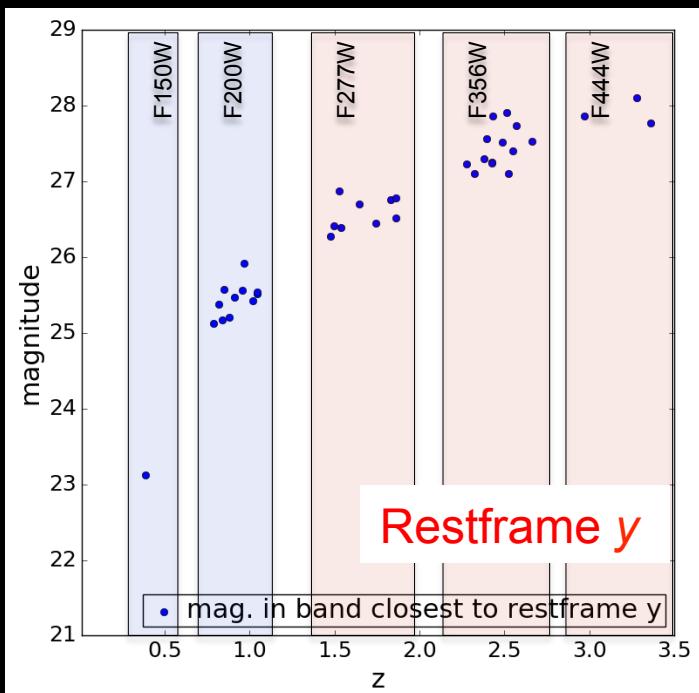
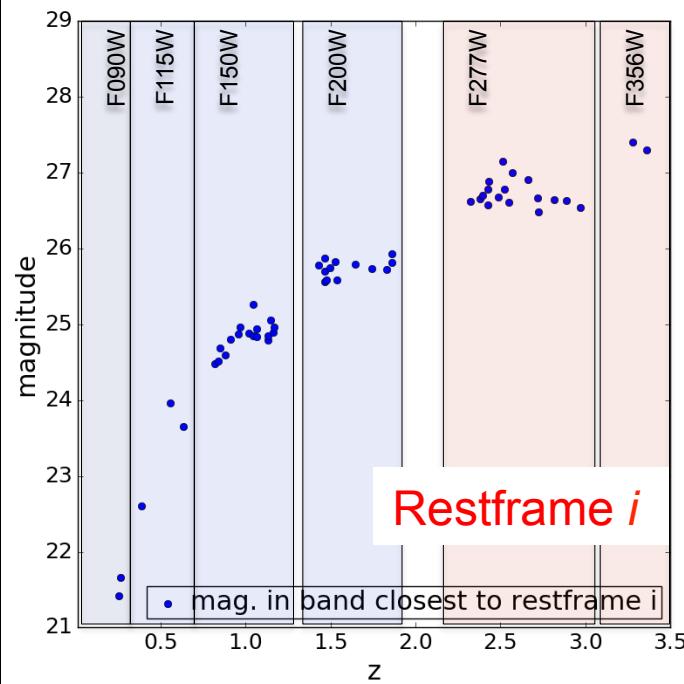
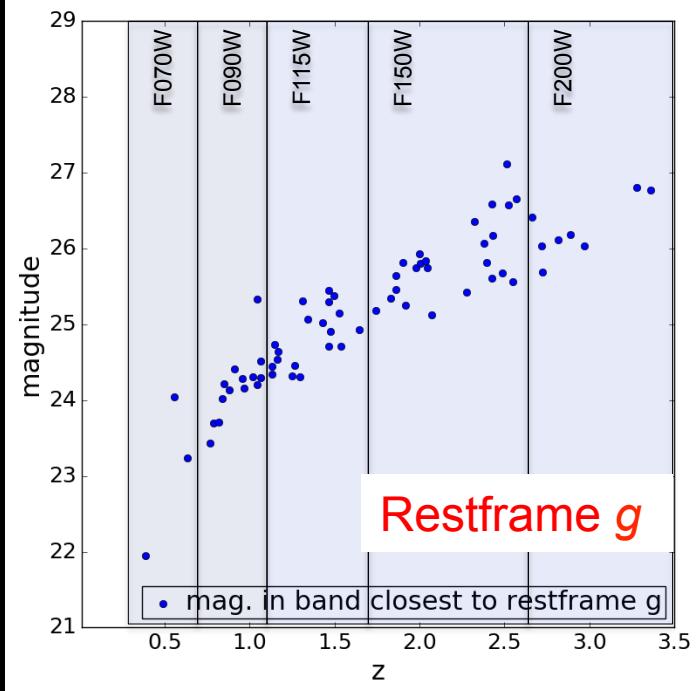
- Simulated SN Ia
 - SNANA
(Hounsell,
Scolnic, Kessler)
 - Realistic stretch
and color
distribution
 - z from 0.2 to 3.5
 - Mags for given
JWST filter



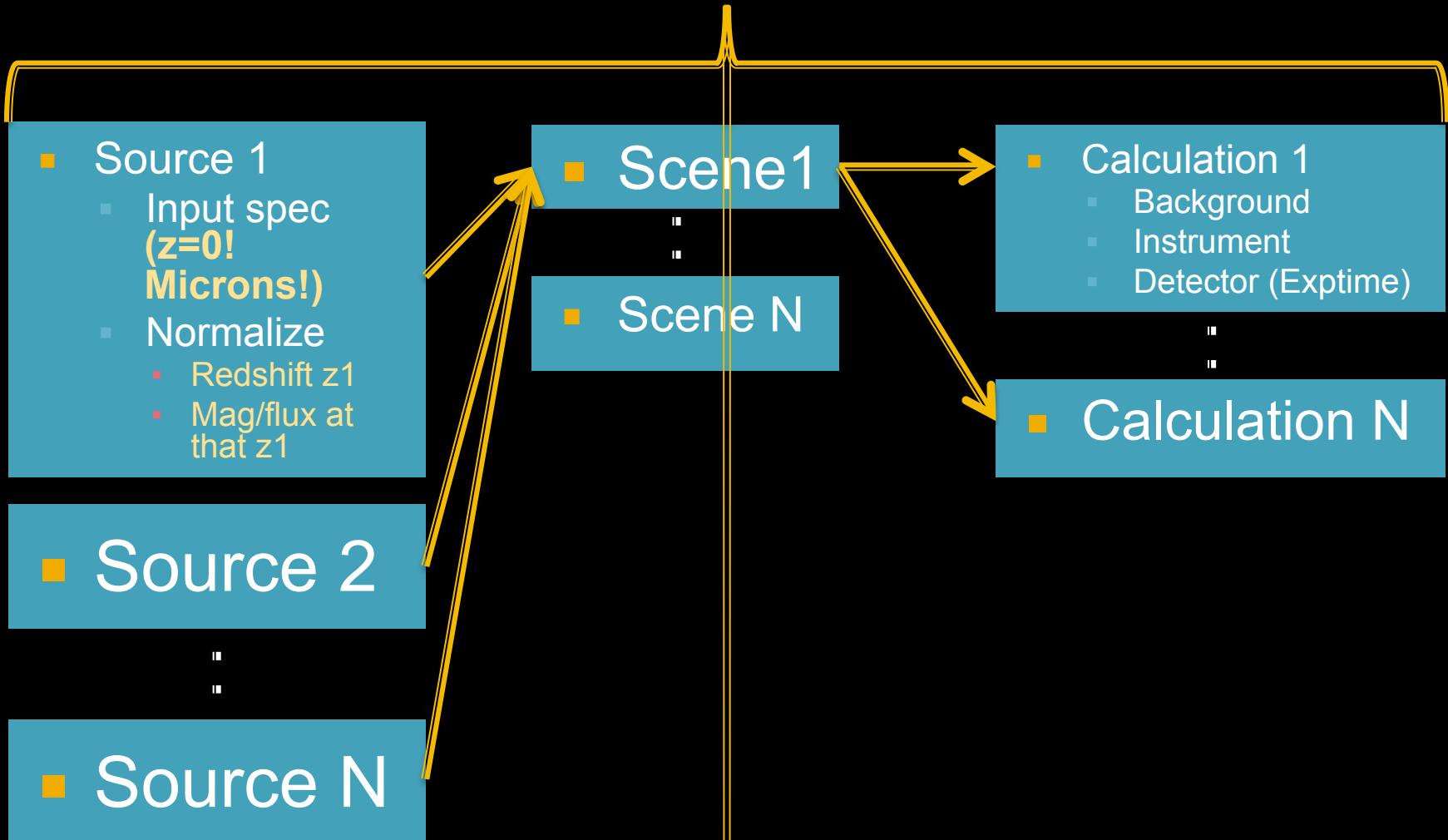
SN Ia cosmology: magnitudes at different redshifts (in coll. with Scolnic and Kessler)

- Simulated SN Ia
 - SNANA
 - Realistic stretch and color distribution
 - z from 0.2 to 3.5
 - Mags for given JWST filter
- What we really want: Mags for given restframe





ETC Worksheet



ETC Worksheet

- Source 1
 - Input spec (z=0! Microns!)
 - Normalize
 - Redshift z1
 - Mag/flux at that z1
- Source 2
- Source N

Source Editor

ID Continuum Renorm Lines Shape Offset

Spec
Upload salt

Upload salt

Select

Bl

at Tef

400

No Co

Source

Source selected: 1

Reset

Source Editor

ID Continuum Renorm Lines Shape Offset

Normalize Source Flux Density

Renormalization applied after redshift

Normalize at wavelength

0 abmag lambda 2 μm

Normalize in bandpass

24.8 abmag at

JWST NIRCAM/SW_IMAGING F150W

HST WFC3/IR F098M

ETC Worksheet

- Source 1
 - Input spec ($z=0!$
Microns!)
 - Normalize
 - Redshift z_1
 - Mag/flux at that z_1

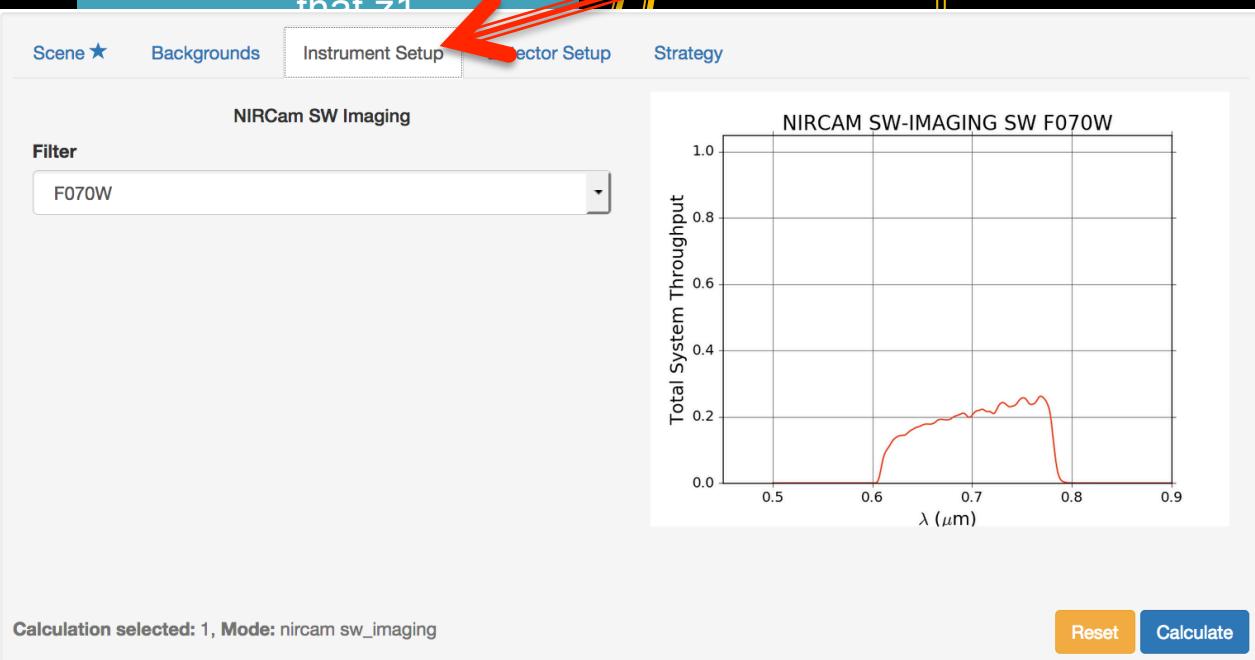
■ Scene 1

■ Scene N

■ Calculation 1

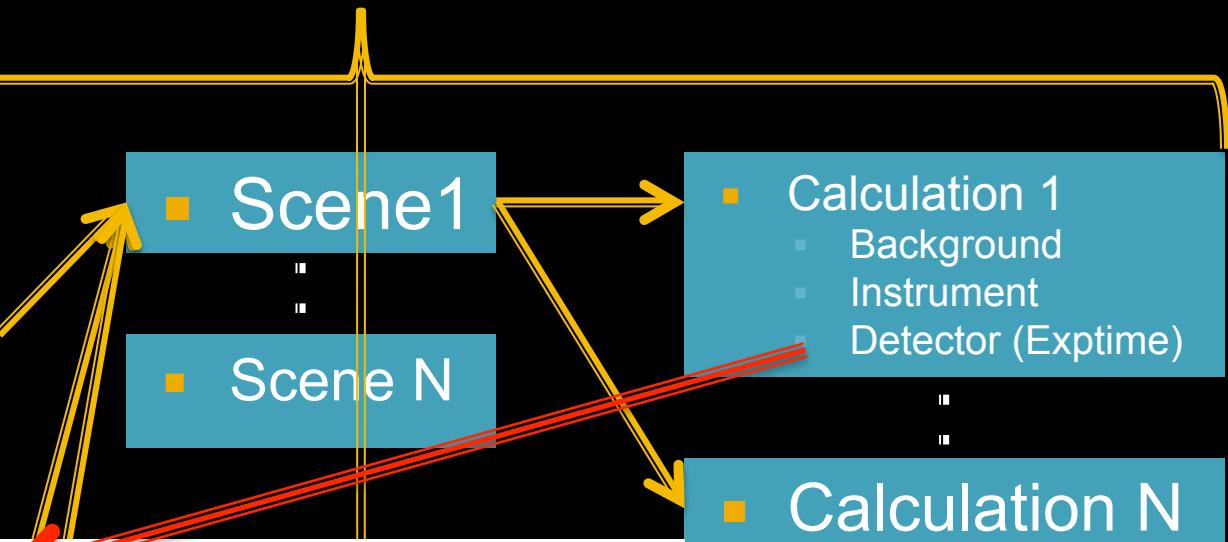
- Background
- Instrument
- Detector (Exptime)

■ Calculation N



ETC Worksheet

- Source 1
 - Input spec ($z=0!$
Microns!)
 - Normalize
 - Redshift z_1
 - Mag/flux at that z_1



Scene ★ Backgrounds Instrument Setup **Detector Setup** Strategy

Subarrays Readout patterns

FULL BRIGHT2

Groups Integrations Exposures

10 1 1

Exposure time: 00:03:45 (225.54 s)

Calculation selected: 1, Mode: nircam sw_imaging **Reset** **Calculate**

SN Ia @ z=1.0, F150W=24.8

	MIRI	NIRCam	NIRISS	NIRSpec	ID	Plot	Mode -	Scene -	(s) -	SNR -	⚠
F444W					8	<input checked="" type="checkbox"/>	nircam lw_imaging	1	4113.42	2.82	!
F356W					7	<input type="checkbox"/>	nircam lw_imaging	1	2137.26	7.14	
F277W					6	<input type="checkbox"/>	nircam lw_imaging	1	1063.26	9.49	✓
F200W					5	<input type="checkbox"/>	nircam sw_imaging	1	1965.42	47.31	✓
F150W					4	<input type="checkbox"/>	nircam sw_imaging	1	537.00	49.32	✓
F115W					3	<input type="checkbox"/>	nircam sw_imaging	1	268.50	59.83	✓
F090W					2	<input type="checkbox"/>	nircam sw_imaging	1	225.54	67.87	✓
F070W					1	<input type="checkbox"/>	nircam sw_imaging	1	225.54	45.90	✓
	-	-	---		-	-	---	-	---	-	-

Restframe g - J

SN Ia @ z=2.0, F150W=25.7

	MIRI	NIRCam	NIRISS	NIRSpec			
ID	Plot	Mode	-	Scene	(s)	-	SNR
F444W	8	<input type="checkbox"/>	nircam lw_imaging	1	8355.72	1.26	⚠
F356W	7	<input checked="" type="checkbox"/>	nircam lw_imaging	1	8355.72	5.61	✓
F277W	6	<input type="checkbox"/>	nircam lw_imaging	1	2029.86	9.37	✓
F200W	5	<input type="checkbox"/>	nircam sw_imaging	1	1965.42	29.83	✓
F150W	4	<input type="checkbox"/>	nircam sw_imaging	1	537.00	25.44	✓
F115W	3	<input type="checkbox"/>	nircam sw_imaging	1	268.50	18.08	✓
F090W	2	<input type="checkbox"/>	nircam sw_imaging	1	225.54	5.44	✓
F070W	1	<input type="checkbox"/>	nircam sw_imaging	1	225.54	0.37	!
-	-	-	---	-	--.-	--.-	-

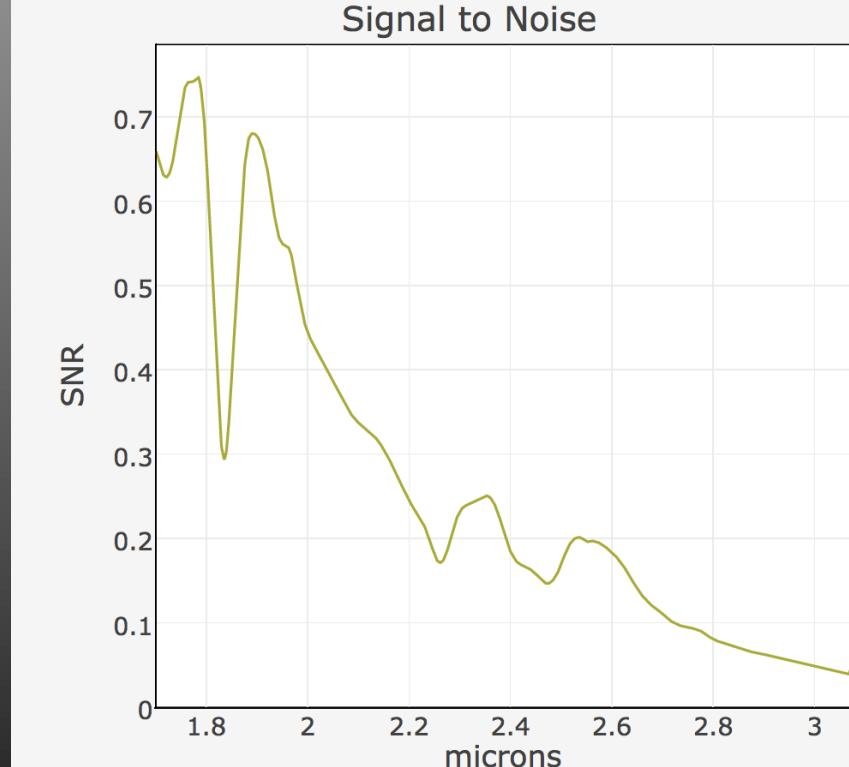
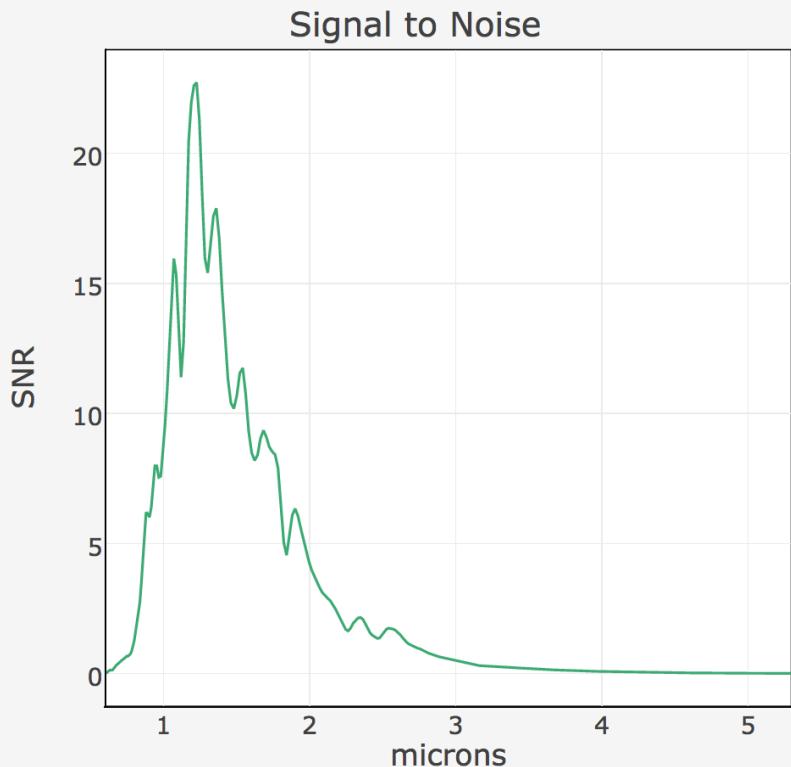
Restframe g - J

SN Ia @ z=3.0, F277W=26.8

	MIRI	NIRCam	NIRISS	NIRSpec			Restframe g - J
ID	Plot	Mode	-	Scene	(s)	-	SNR
F444W	8	<input type="checkbox"/>	nircam lw_imaging	1	8355.72	4.24	
F356W	7	<input checked="" type="checkbox"/>	nircam lw_imaging	1	8355.72	21.21	
F277W	6	<input type="checkbox"/>	nircam lw_imaging	1	2029.86	25.32	
F200W	5	<input type="checkbox"/>	nircam sw_imaging	1	1965.42	58.10	
F150W	4	<input type="checkbox"/>	nircam sw_imaging	1	537.00	33.60	
F115W	3	<input type="checkbox"/>	nircam sw_imaging	1	268.50	6.22	
F090W	2	<input type="checkbox"/>	nircam sw_imaging	1	225.54	0.44	
F070W	1	<input type="checkbox"/>	nircam sw_imaging	1	225.54	-0.00	
-	-	-	---	-	--.-	--.-	-

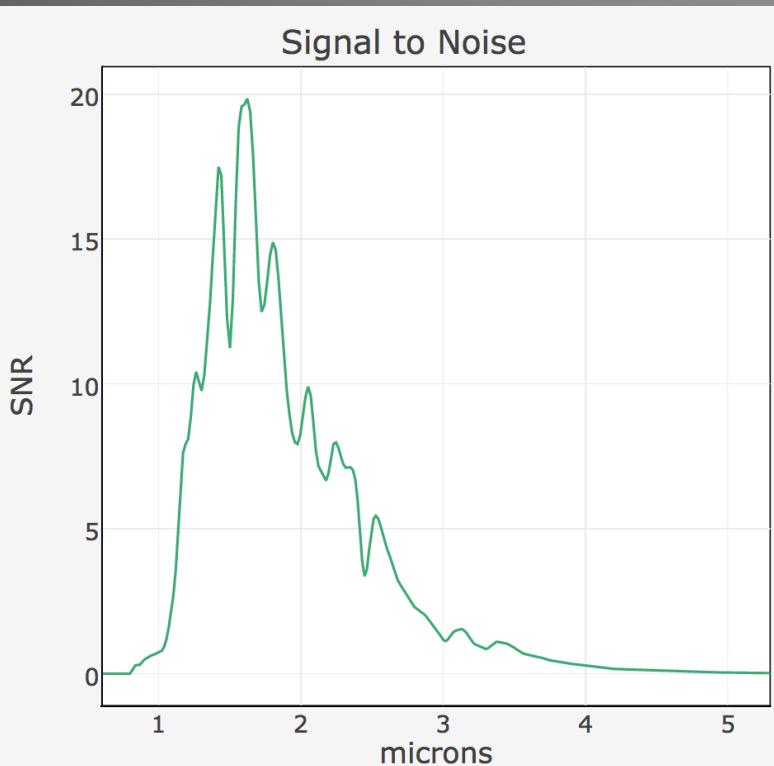
NIRSpec single slit, SN Ia @ $z=2.0$, F150W=25.7

- Clear/Prism
- R=100
- 6300 seconds
- G235M/F170LP
- R=1000
- 12600 seconds



NIRSpec single slit, SN Ia @ $z=3.0$, F277W=26.8

- Clear/Prism
- R=100
- 6300 seconds



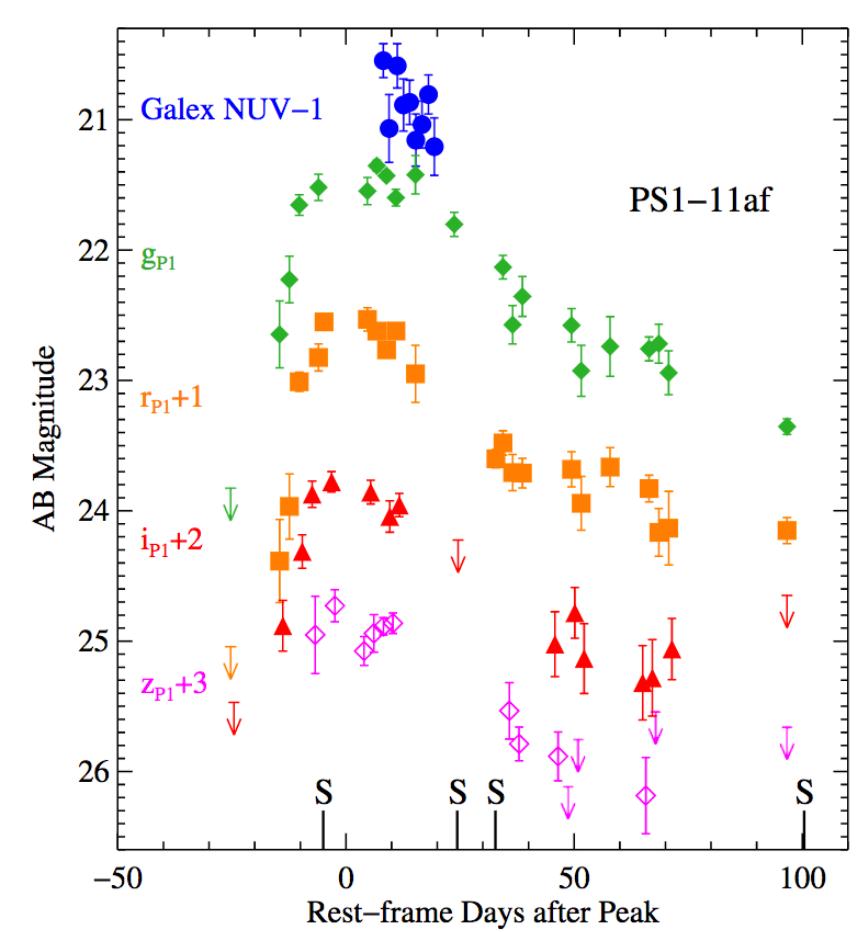
Tidal disruption events with WFIRST and JWST

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

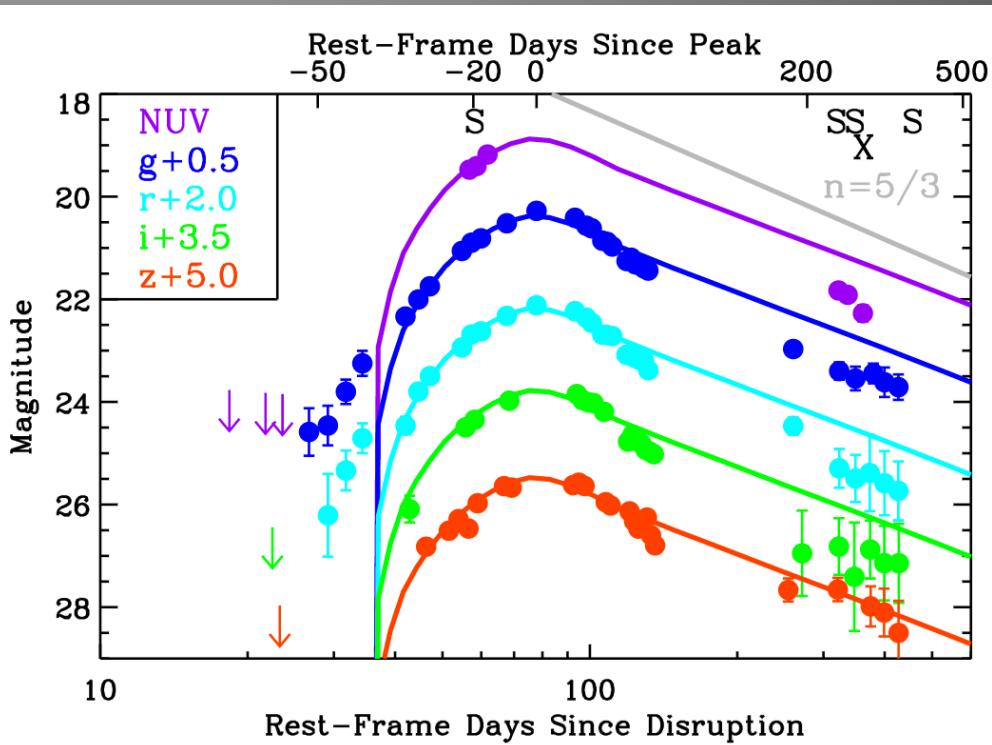
Survey	Redshift	Area	Discovery	Depth per	Total Depth
Tier	Range	(deg ²)	Filters	Exposure (mag)	(mag)
Shallow	$0.1 \leq z < 0.4$	27.44	Y, J	22.3, 22.4	25.0, 25.1
Medium	$0.4 \leq z < 0.8$	8.96	J, H	24.6, 24.5	27.3, 27.2
Deep	$0.8 \leq z \leq 1.7$	5.04	J, H	26.2, 26.1	28.9, 28.8

Tidal disruption event: PS1-10jh and PS1-11af

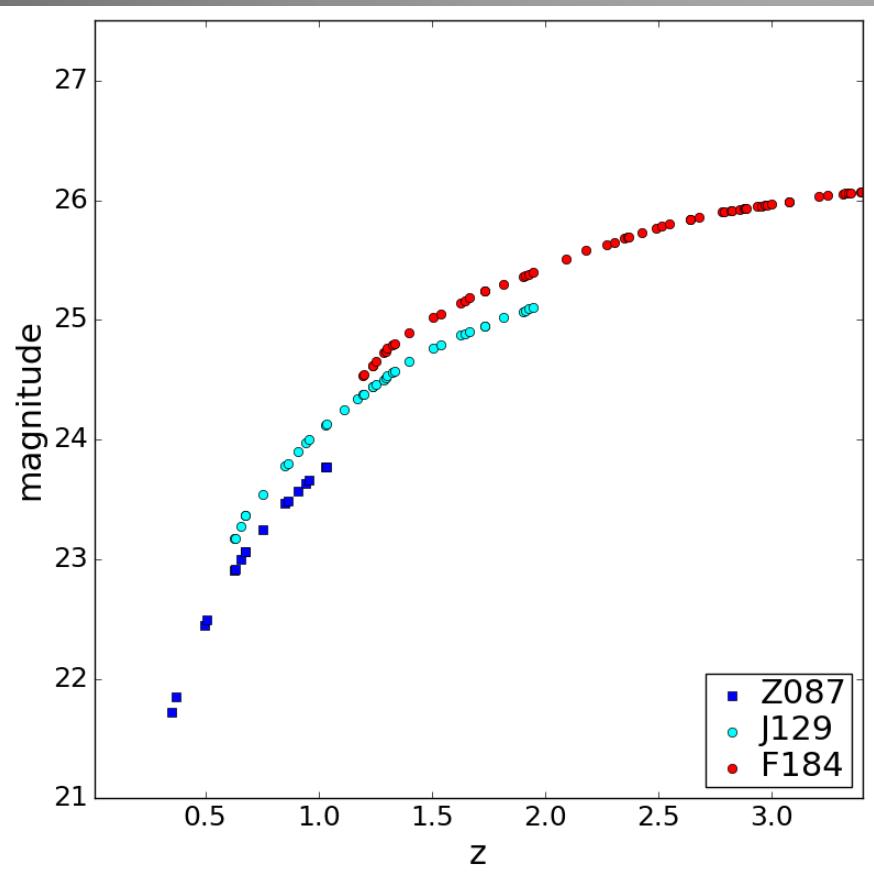
Chornock+14, PS1-11af, $z=0.4$



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

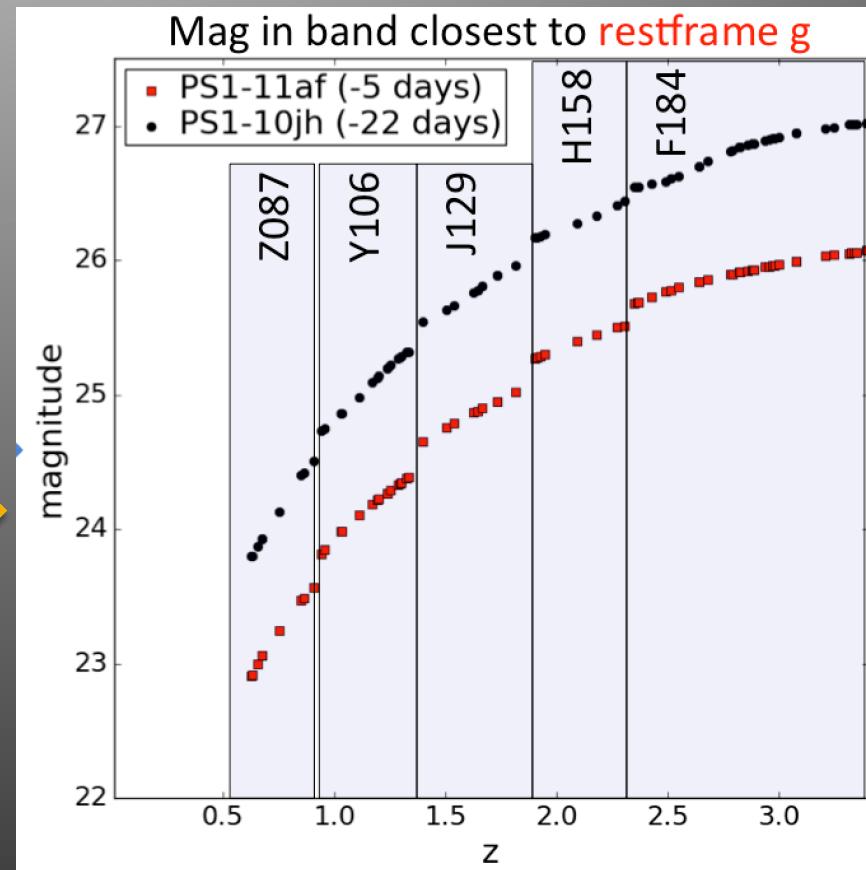
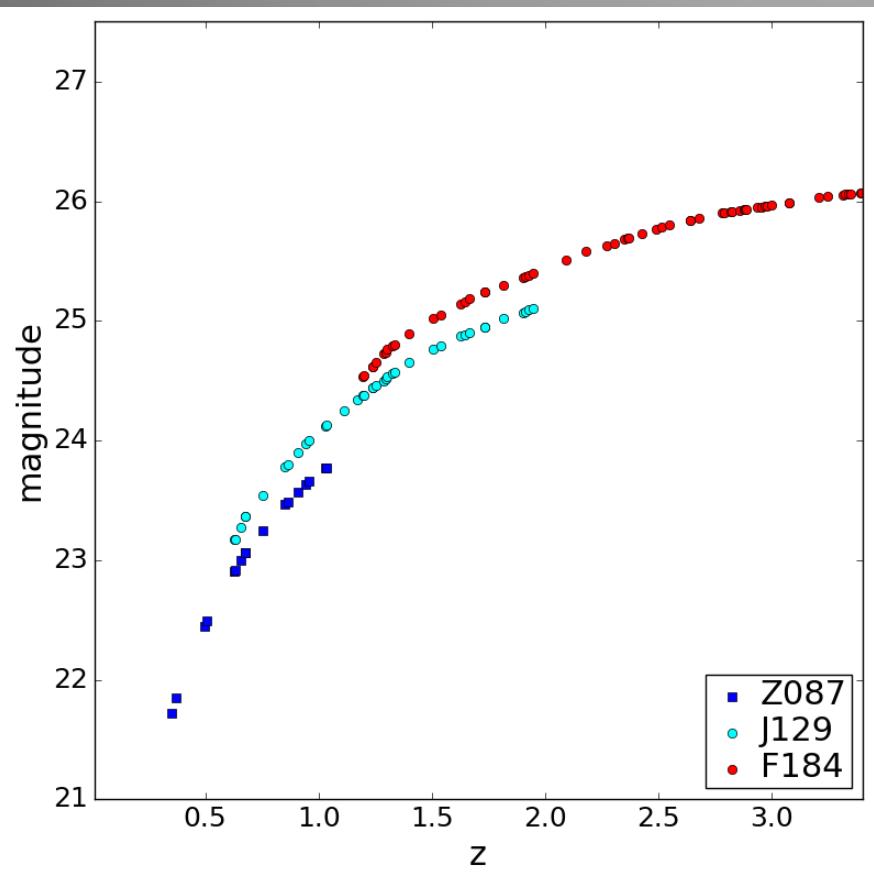


Simulating WFIRST magnitudes for PS1-11af and PS1-10jh

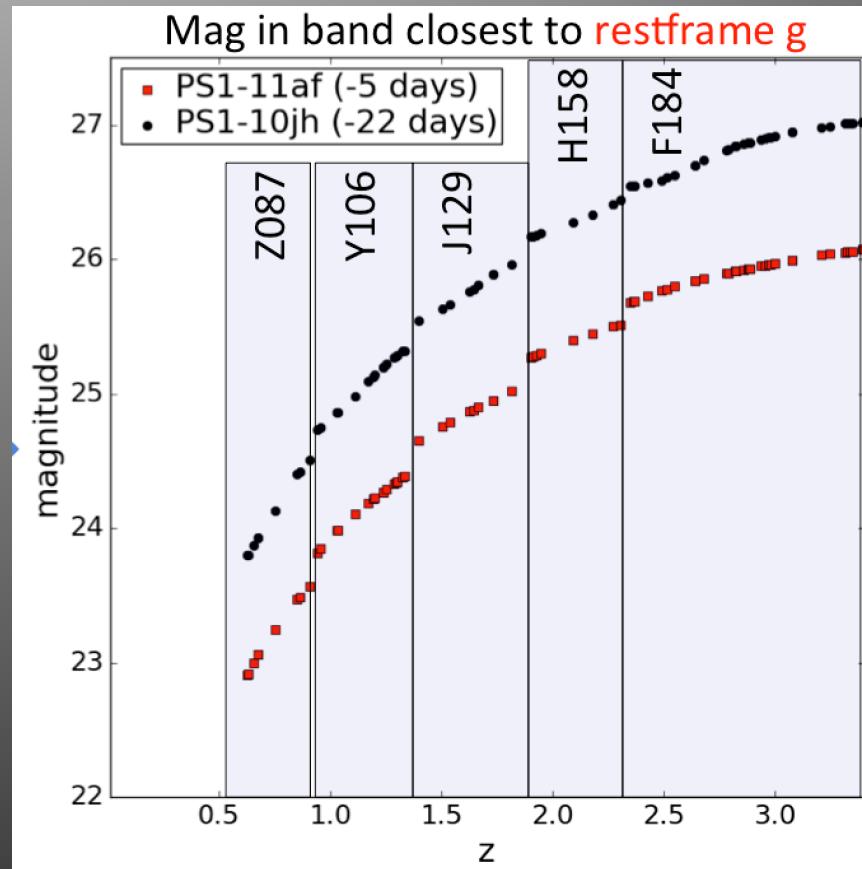
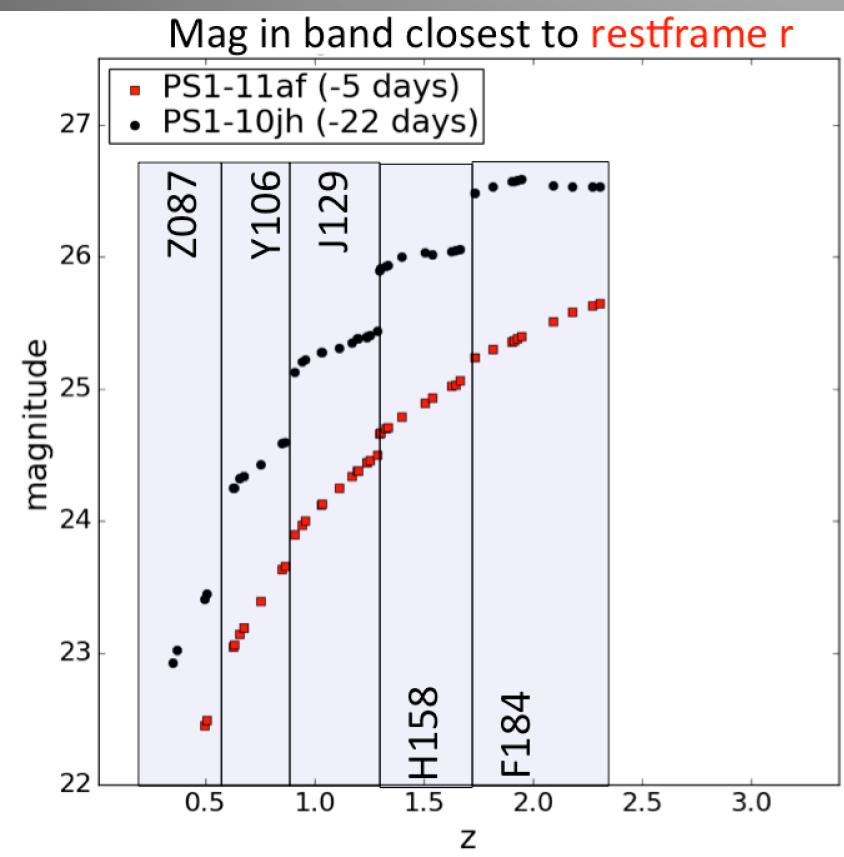


- SALT2
- z from 0.2 to 3.5
- Mags for given WFIRST filter

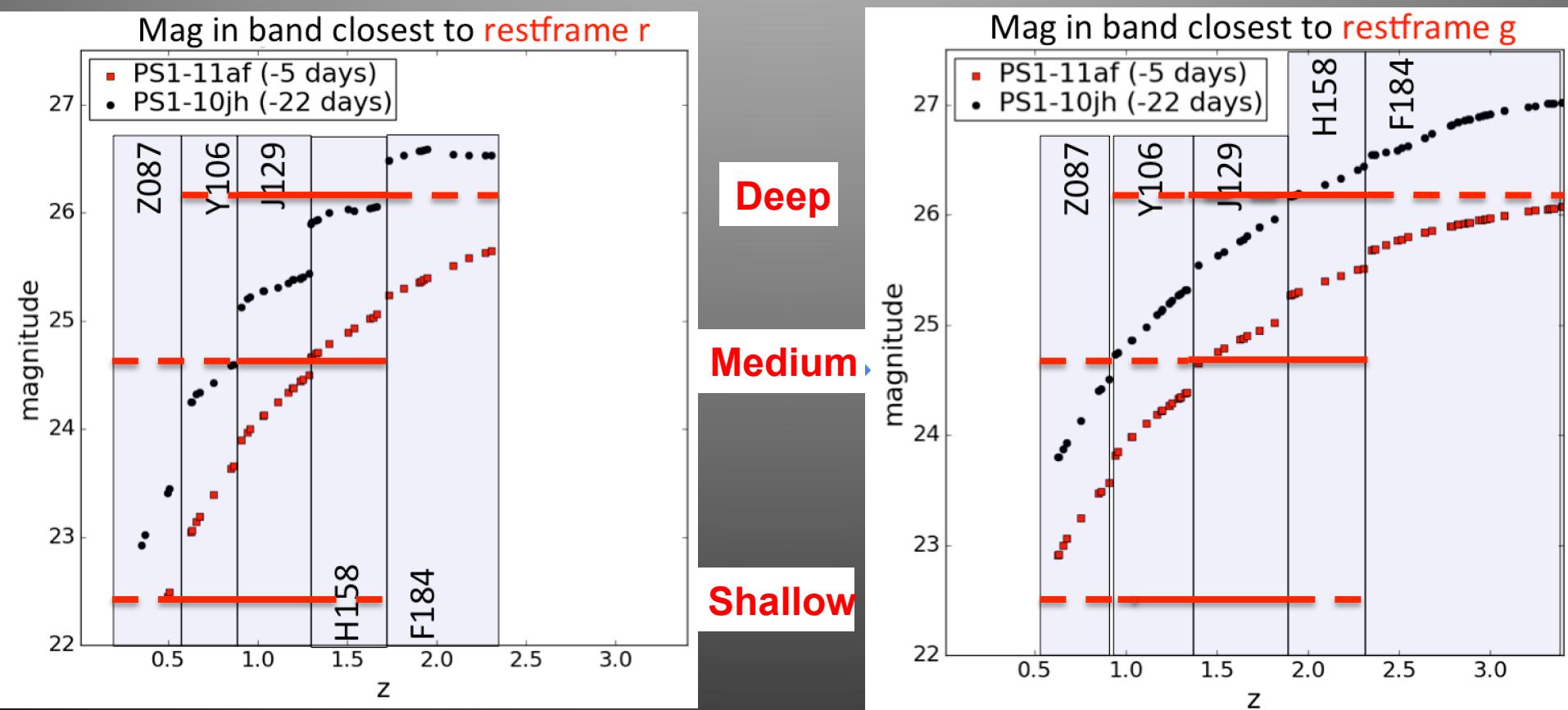
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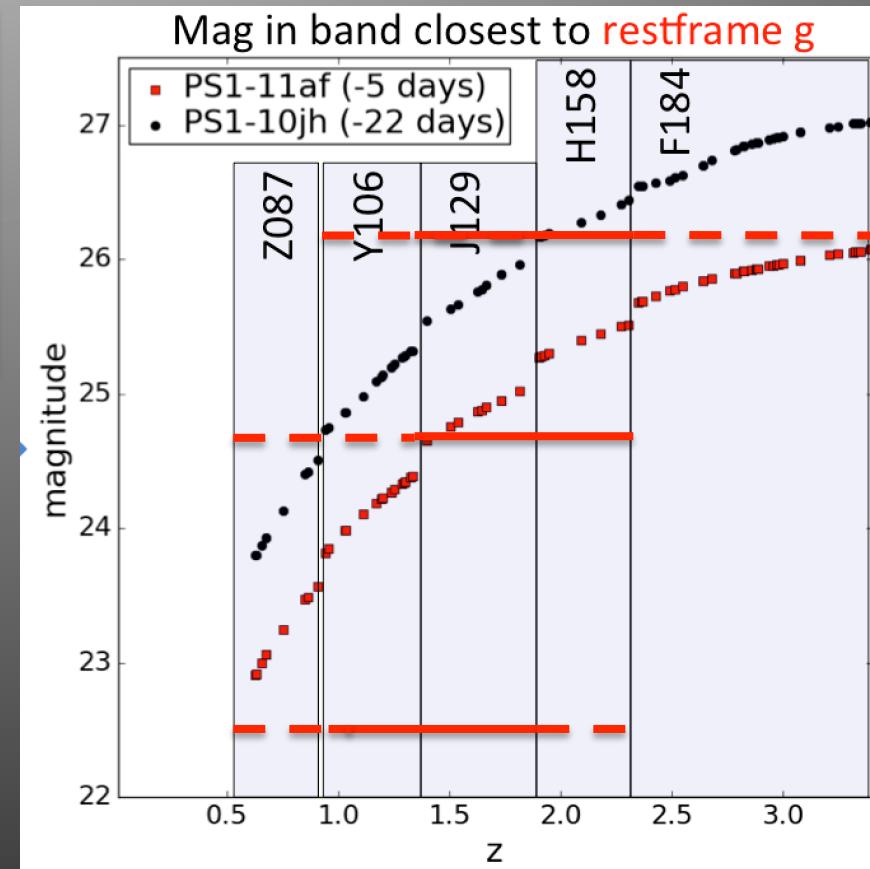
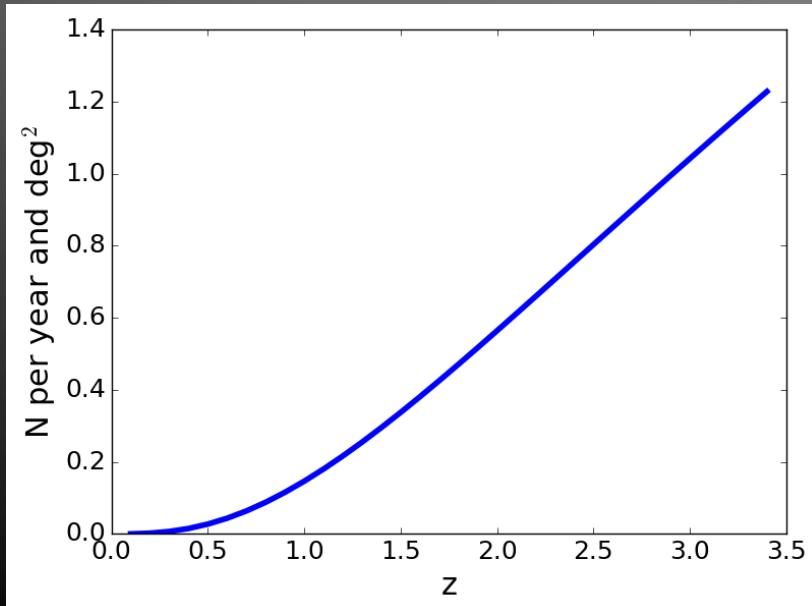


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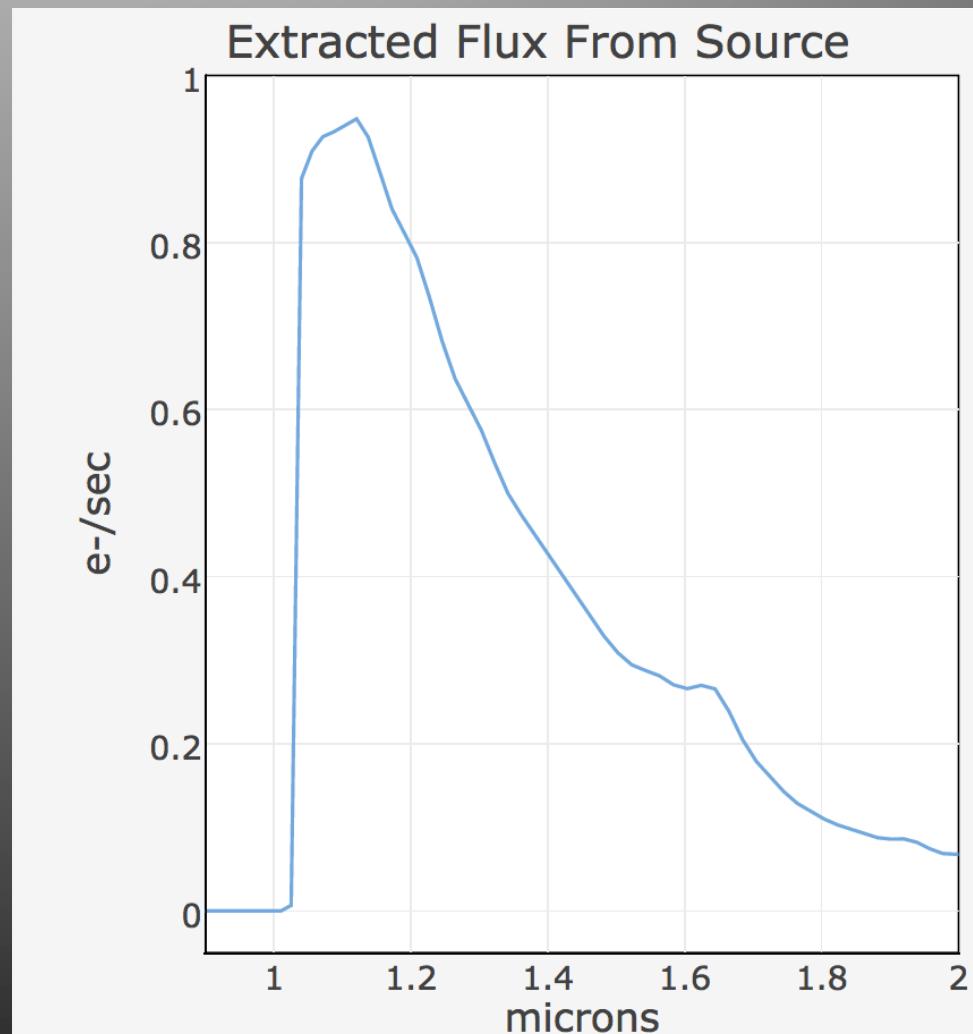
Simulating WFIRST magnitudes for PS1-11af and PS1-10jh

Survey name	Survey Area (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



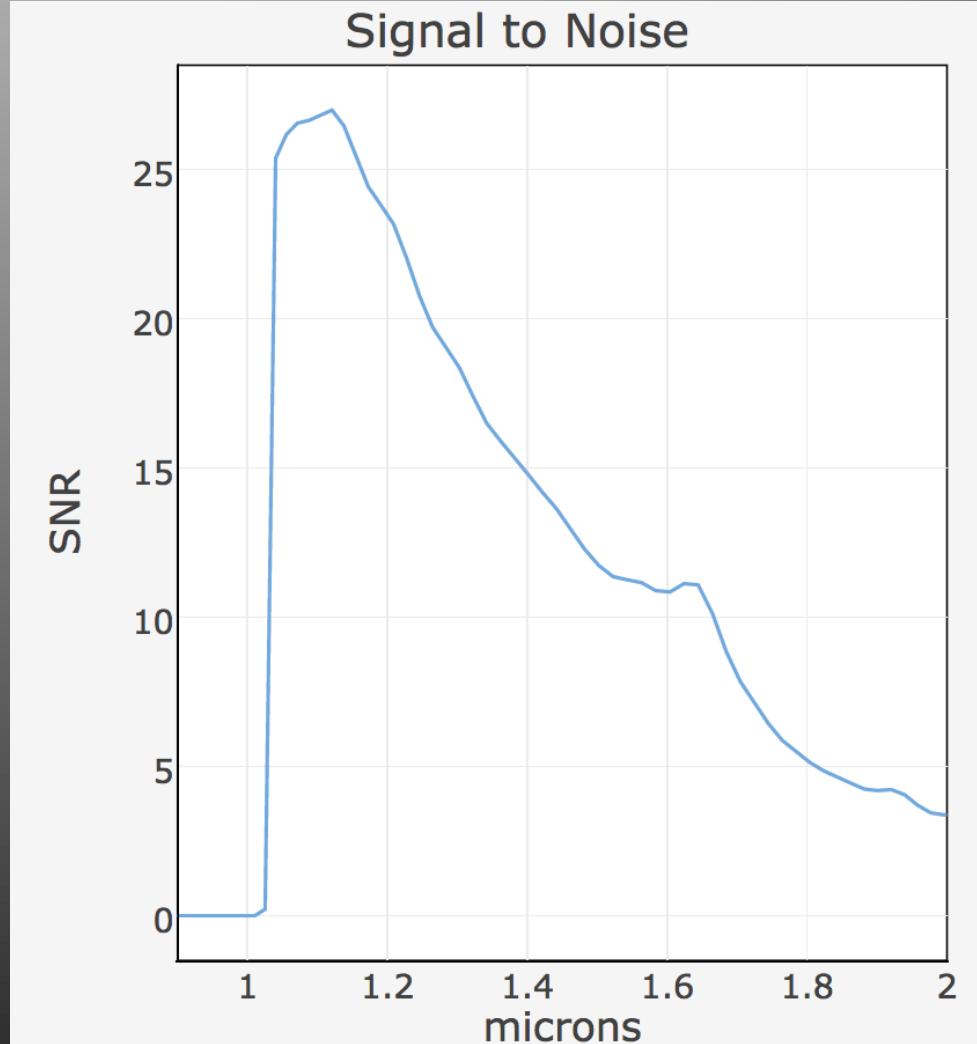
TDEs at high redshift: Spectroscopy with JWST NIRSpec

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



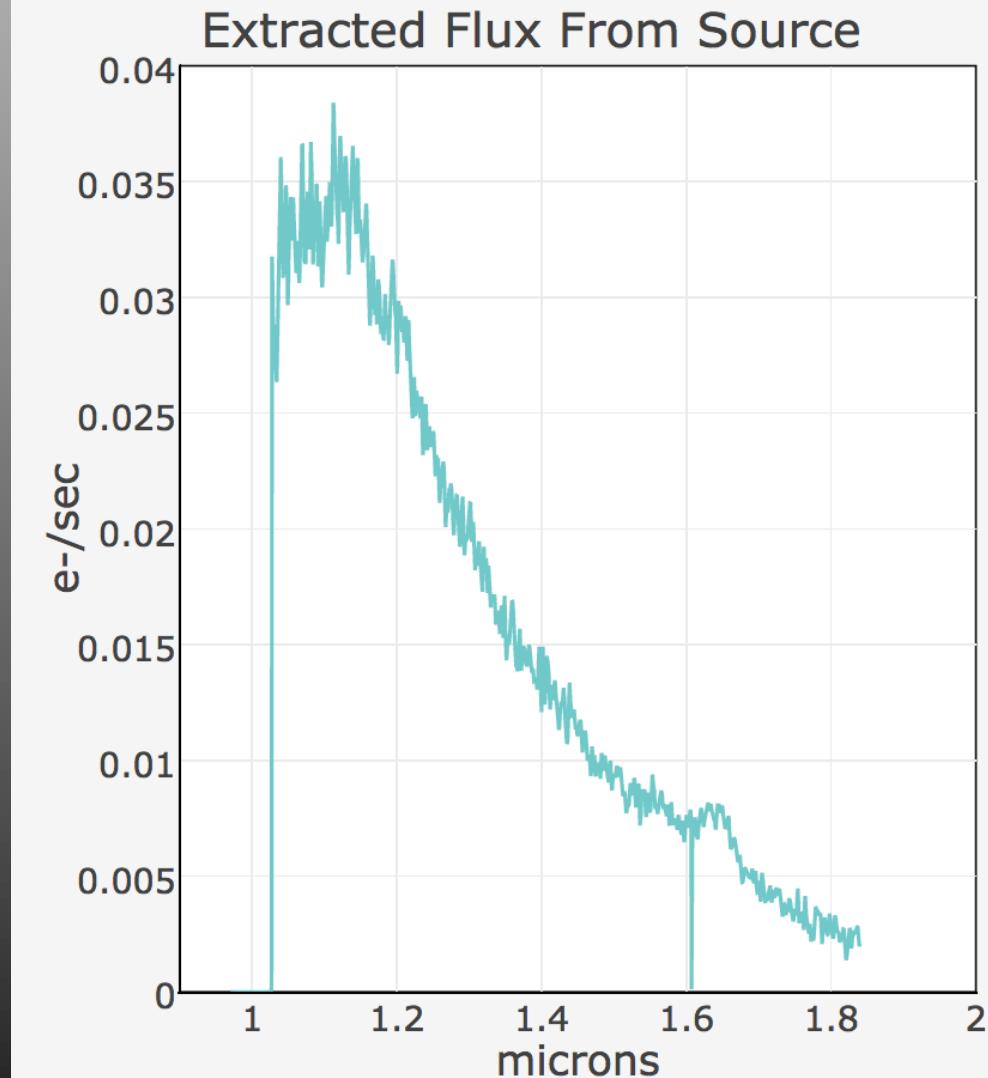
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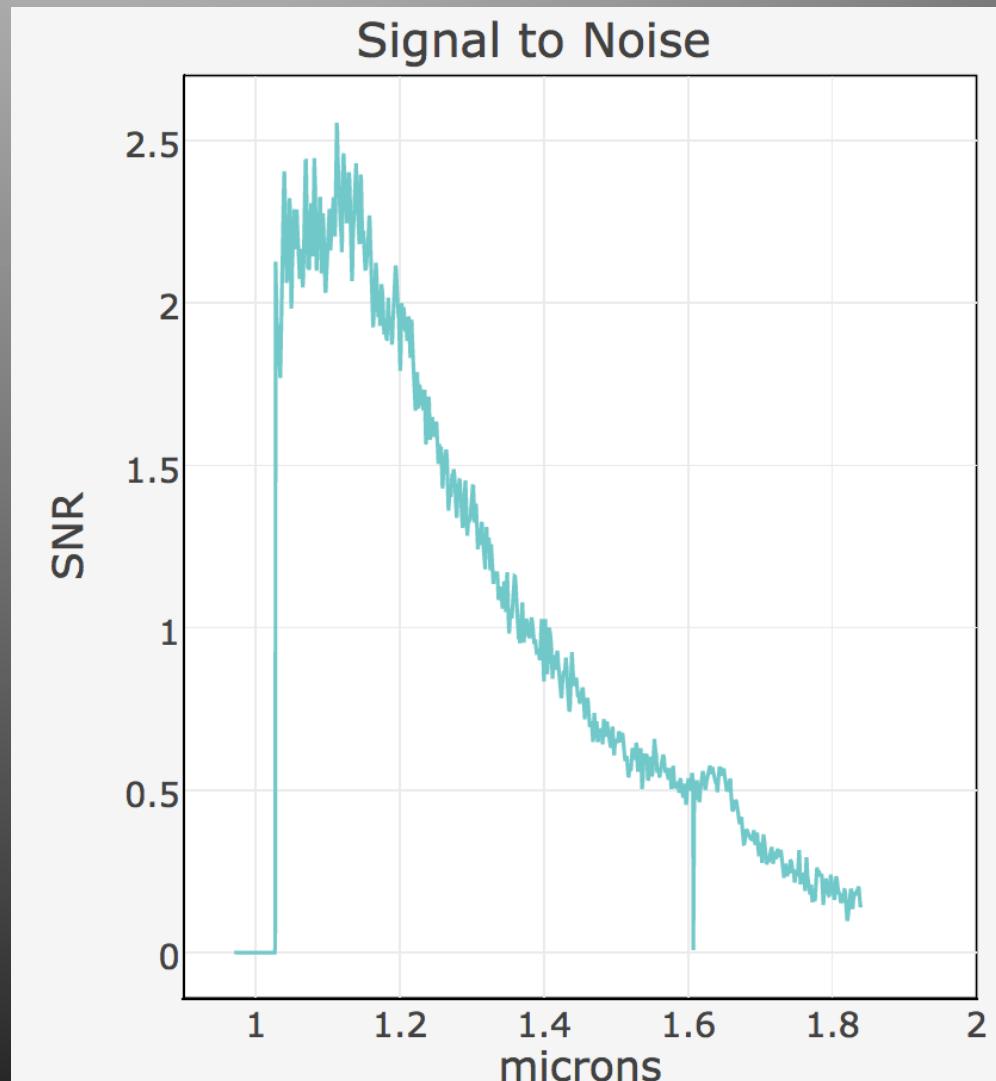
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 - 6000 seconds exposure time
- G140M/F100LP
- S200 A1 ($0.2'' \times 3.3''$)
- 0.6 - 5.3 microns
- R~1000
- CAVEAT: Does not include host galaxy!



TDEs at high redshift: Spectroscopy with JWST NIRSpec

- JWST Exposure time calculator
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- G140M/F100LP
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- 0.6 - 5.3 microns
- R~1000
- CAVEAT: Does not include host galaxy!



Summary

- JWST has amazing capabilities in both imaging and spectroscopy in the NIR
- Simulating SN Ia as test case:
 - ETC lots of great features, still needs some improvement in ease of use.
 - Imaging to $z=3$ in restframe g – J
 - Spectroscopy to $z=3$
- WFIRST + JWST: the full package...