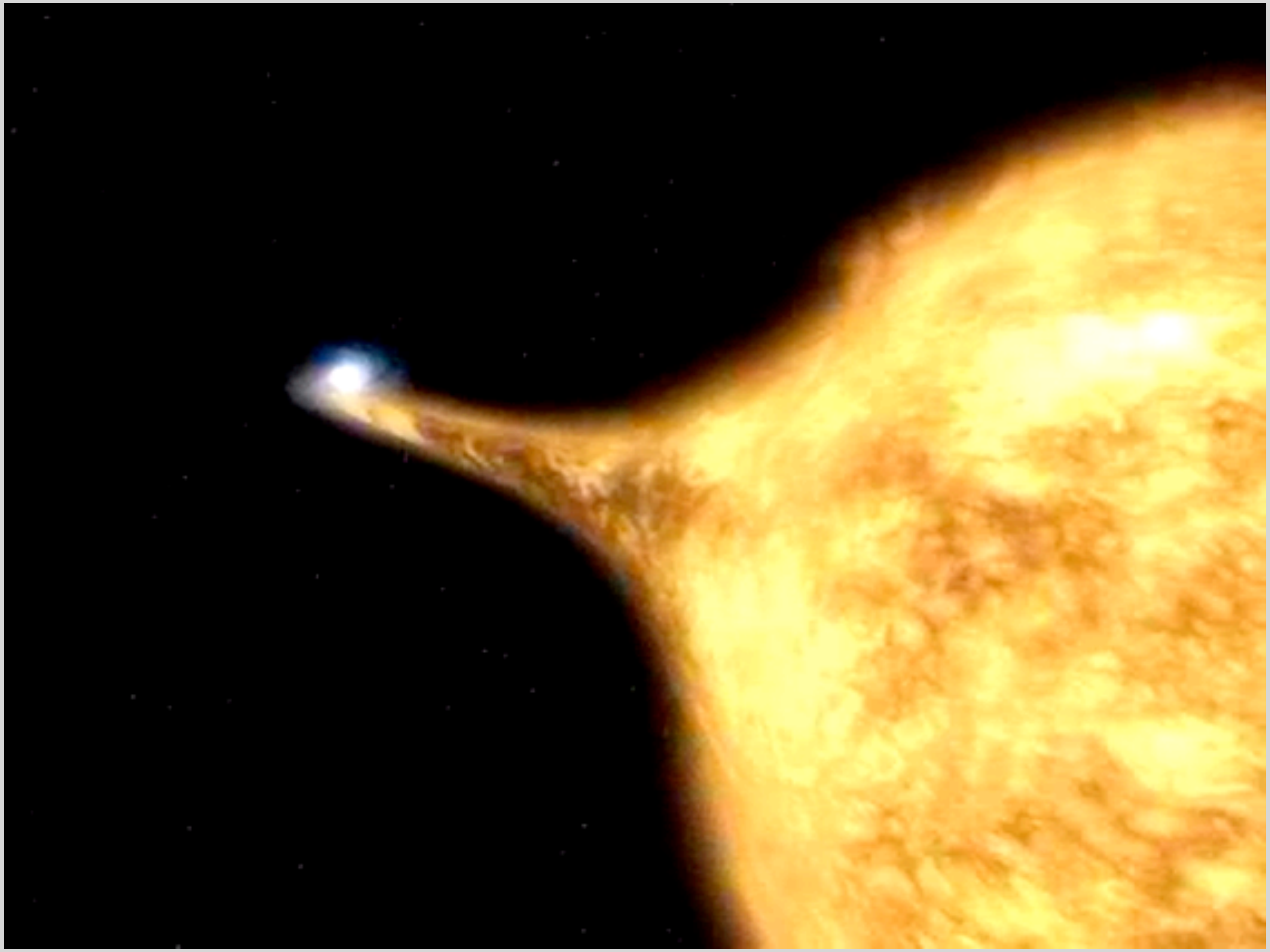
The WFIRST SN Survey: What the Community Needs to Know

Scolnic, Hounsell
Bohlin, Braganca, Dvorkin, Filippenko, Frieman, Jha, Kelly, Kessler, Kirshner, Lupton, Mandel, Riess, Rest, Rodney, Strolger

Ryan Foley
University of Illinois

SNe Ia Are Exploding White Dwarfs

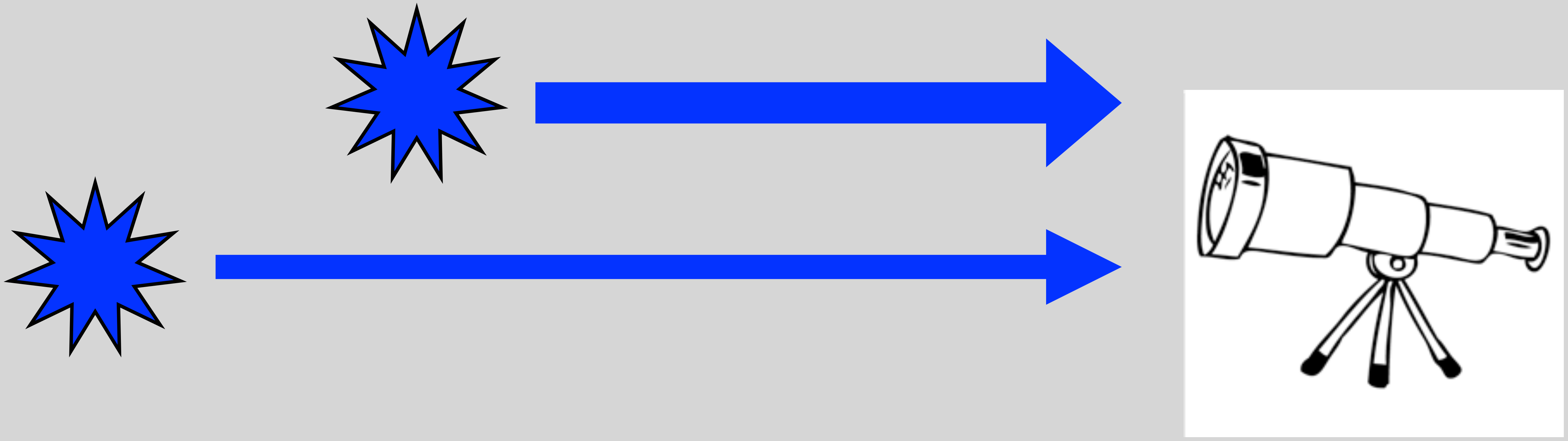


White Dwarf in Binary System

Accretes Matter Until ~1.4 times the Mass of the Sun

Explodes and is Very, Very Luminous

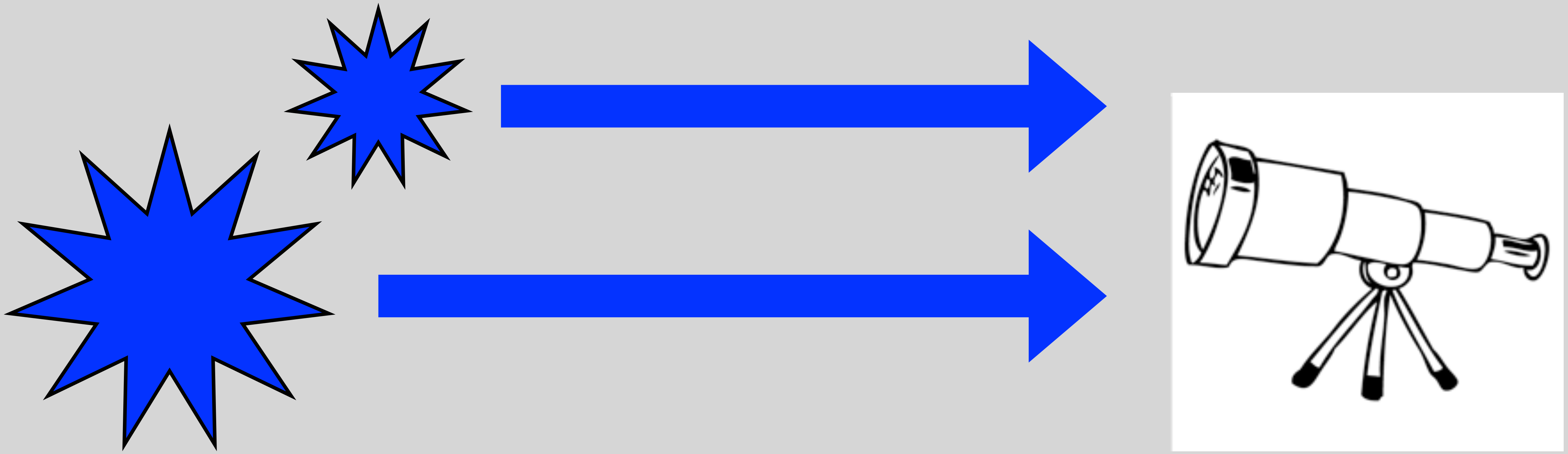
Standard Candles And Distances



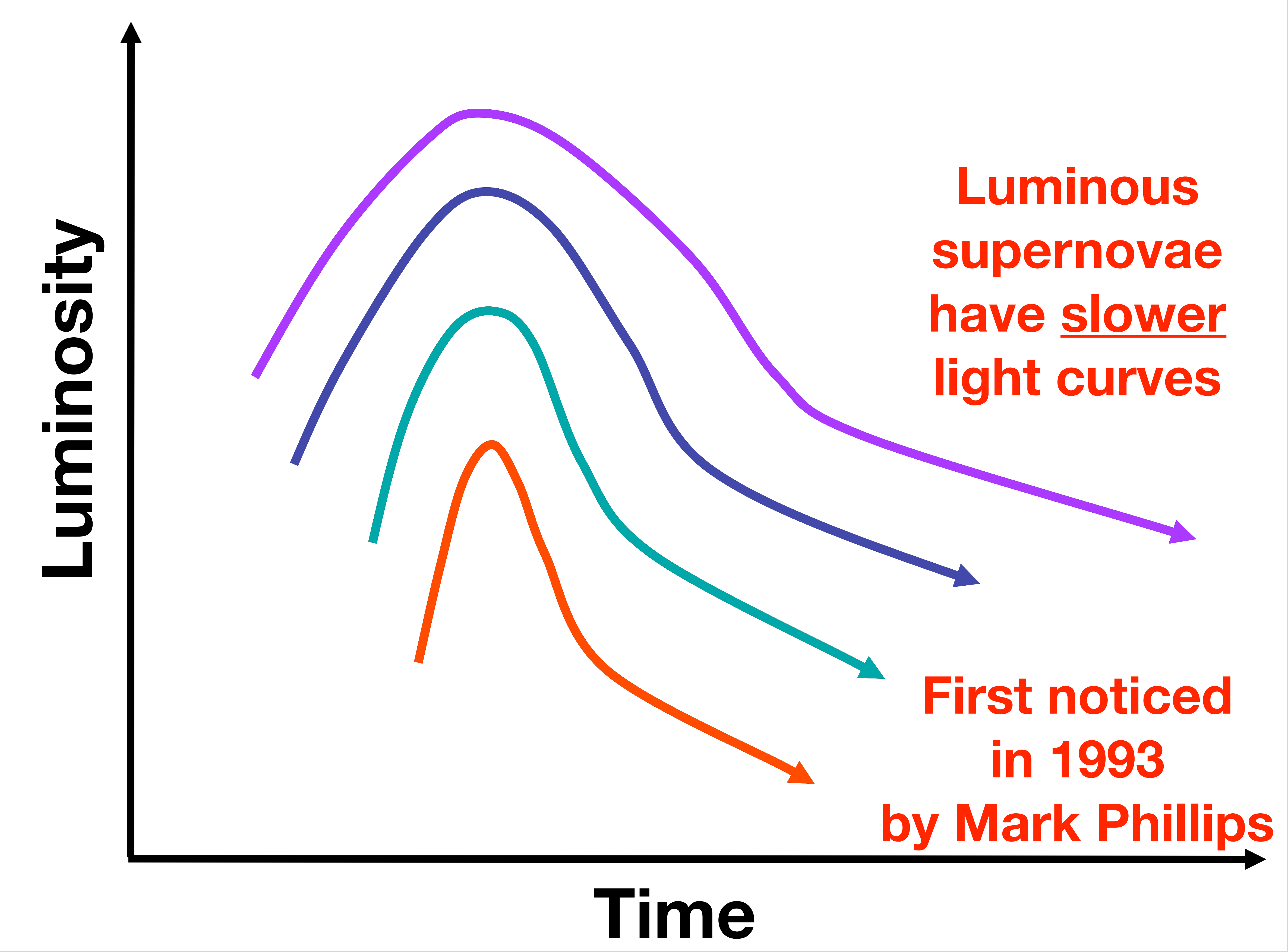
Obs: $D = (L/4\pi F)^{1/2}$

Theory: $D = f(z, \Omega, w(z), \text{etc})$

SNe Ia are NOT Standard Candles!



Calibrating the Nearly Standard Candle

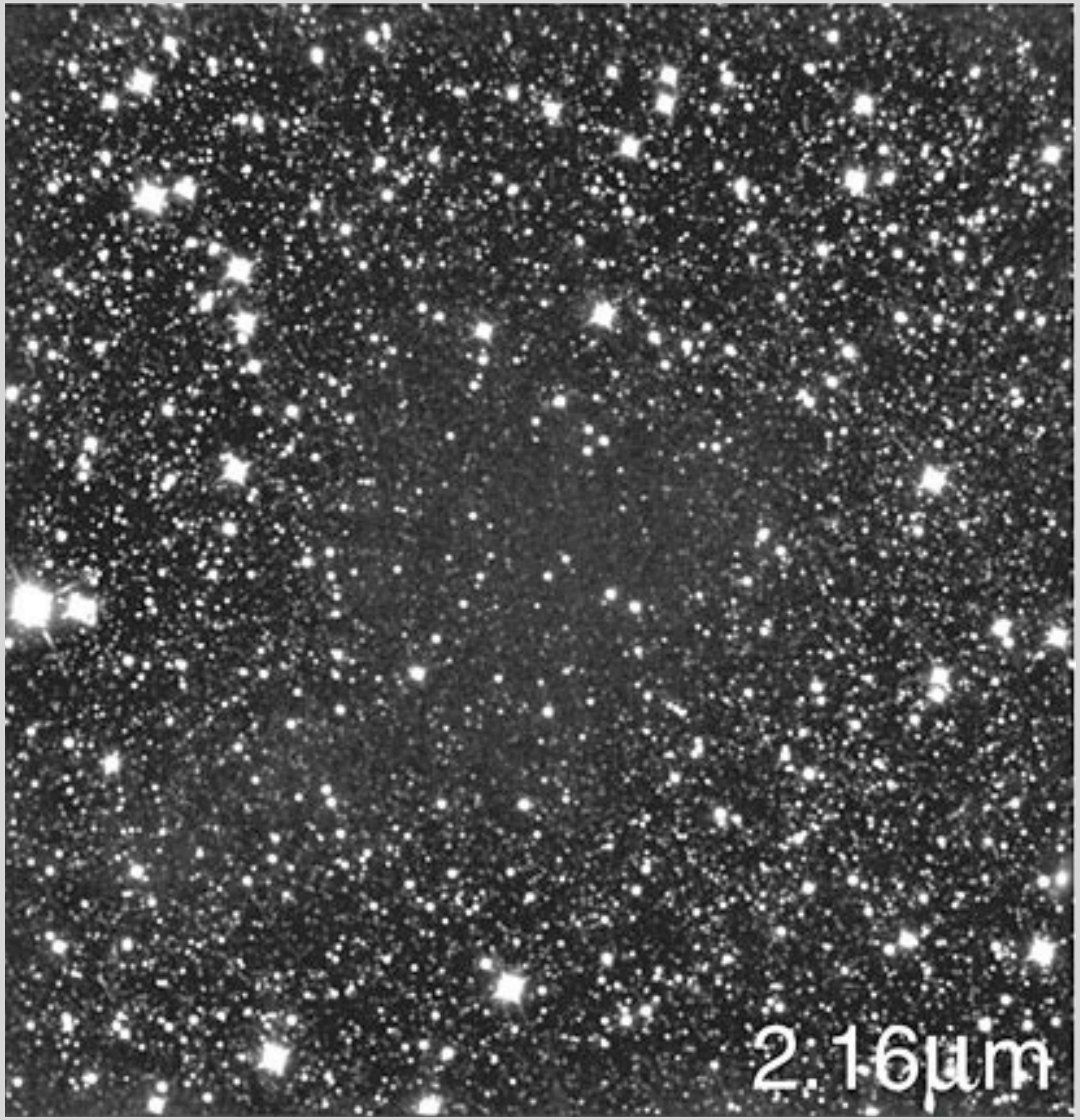


Systematics Dominate SN Cosmology

Source	dw
Total Uncertainty	**0.072**
Statistical Uncertainty	0.050
Systematic Uncertainty	**0.052**
Photometric calibration	**0.045**
SN color model	0.023
Host galaxy dependence	0.015
MW extinction	0.013
Selection Bias	0.012
Coherent Flows	0.007

Scolnic et al. 2014

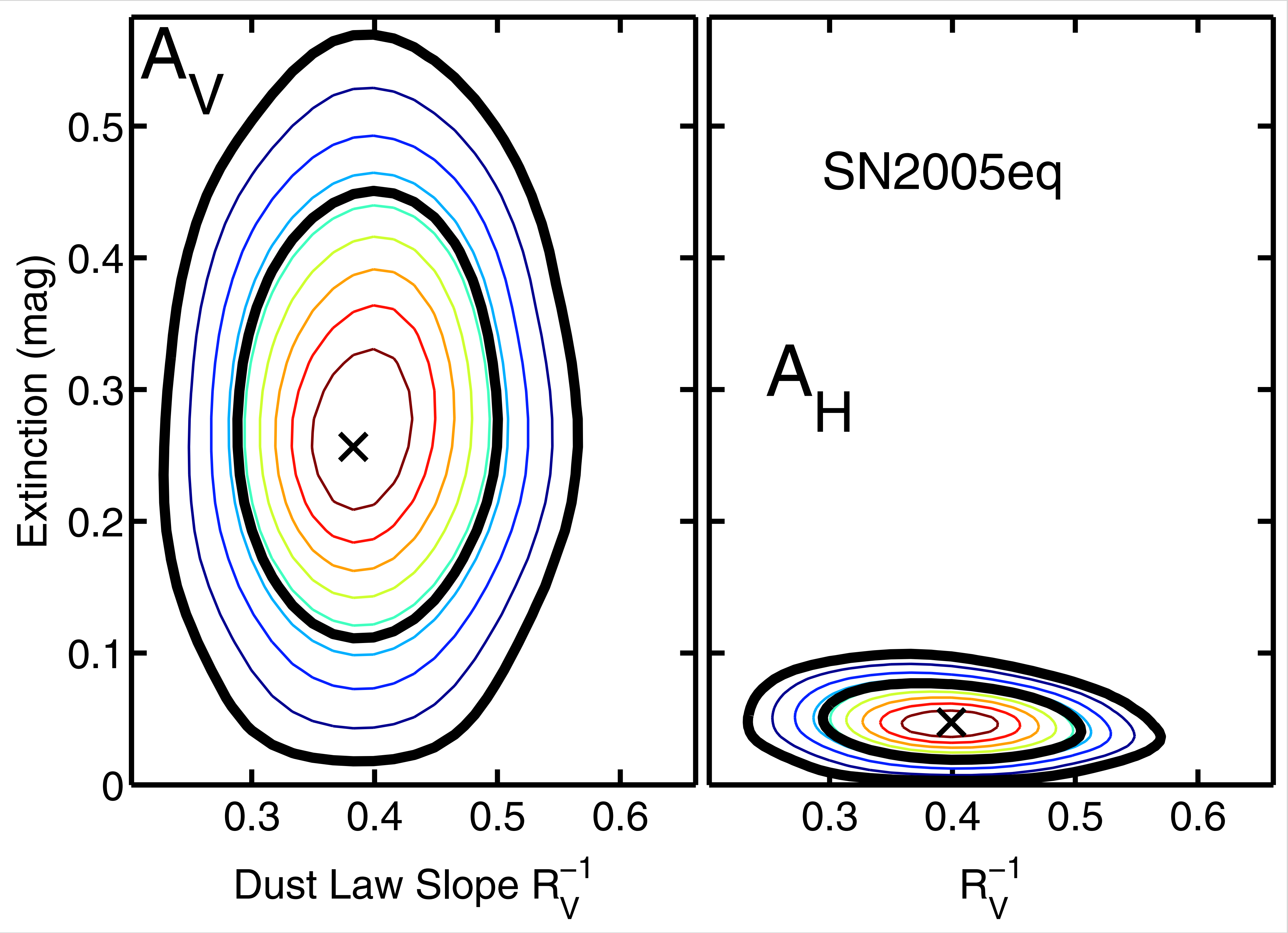
Seeing Through The Dirt in the NIR



Near Infrared

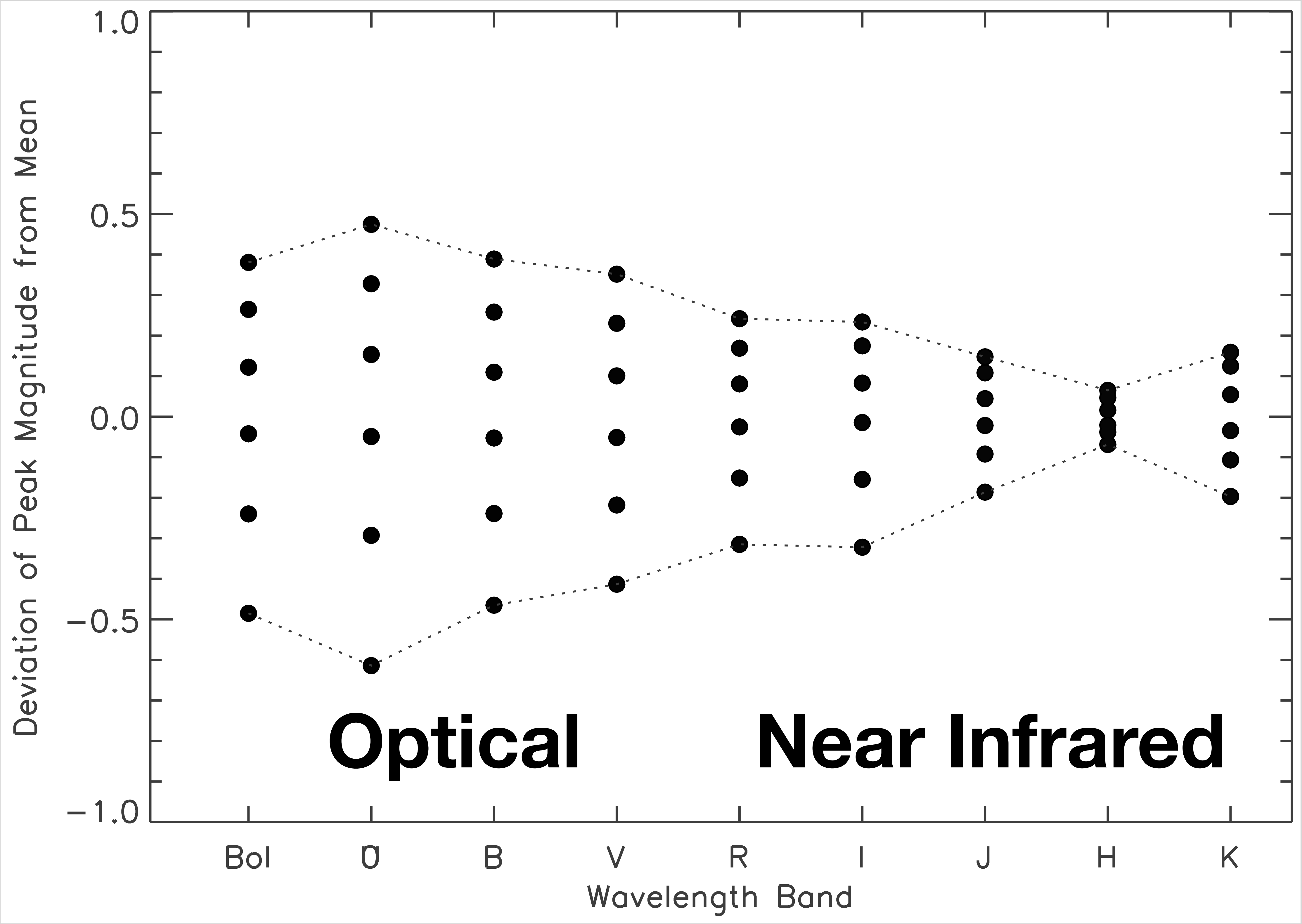
Optical

Smaller Extinction Errors in IR



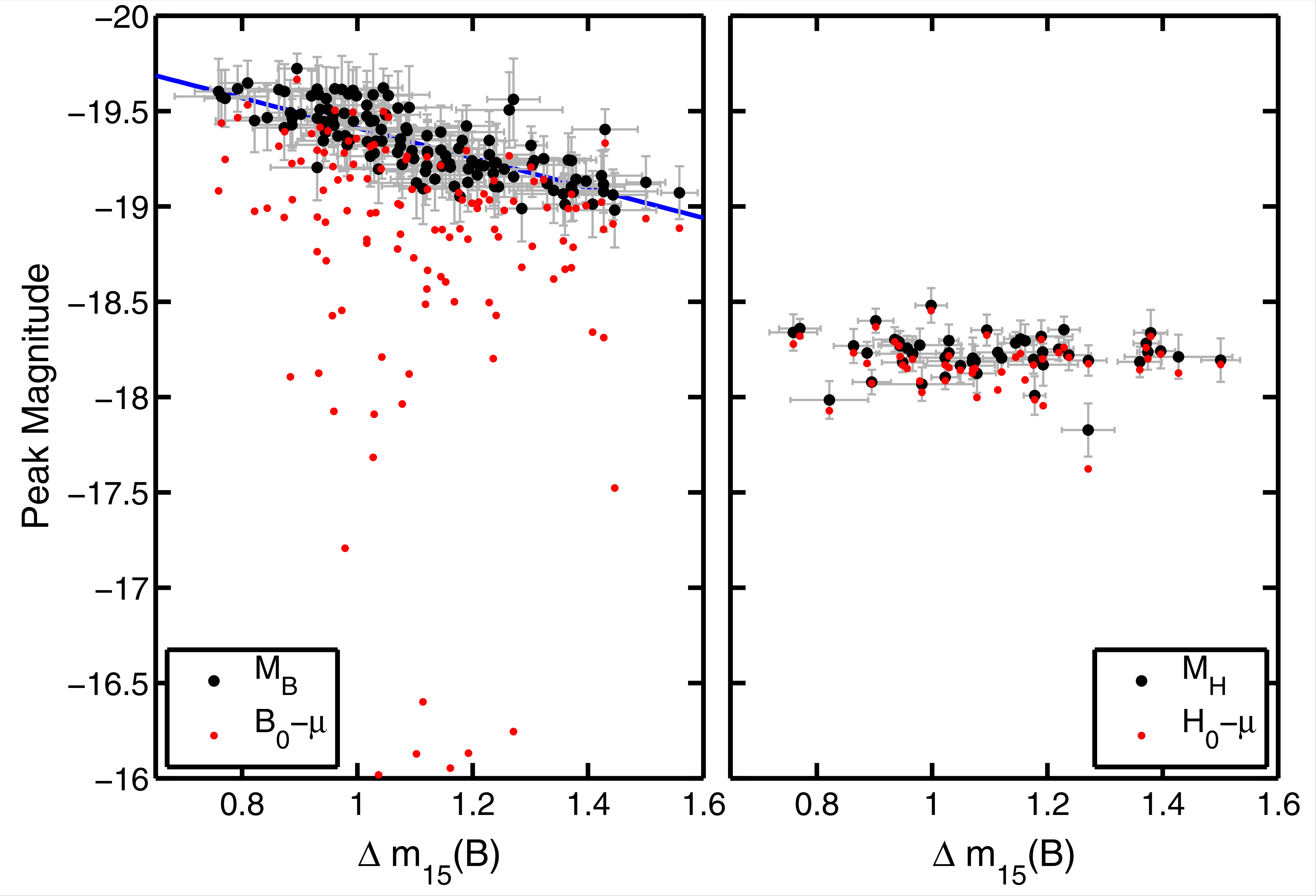
Mandel et al., 2011

Theory Points to the IR for Cosmology



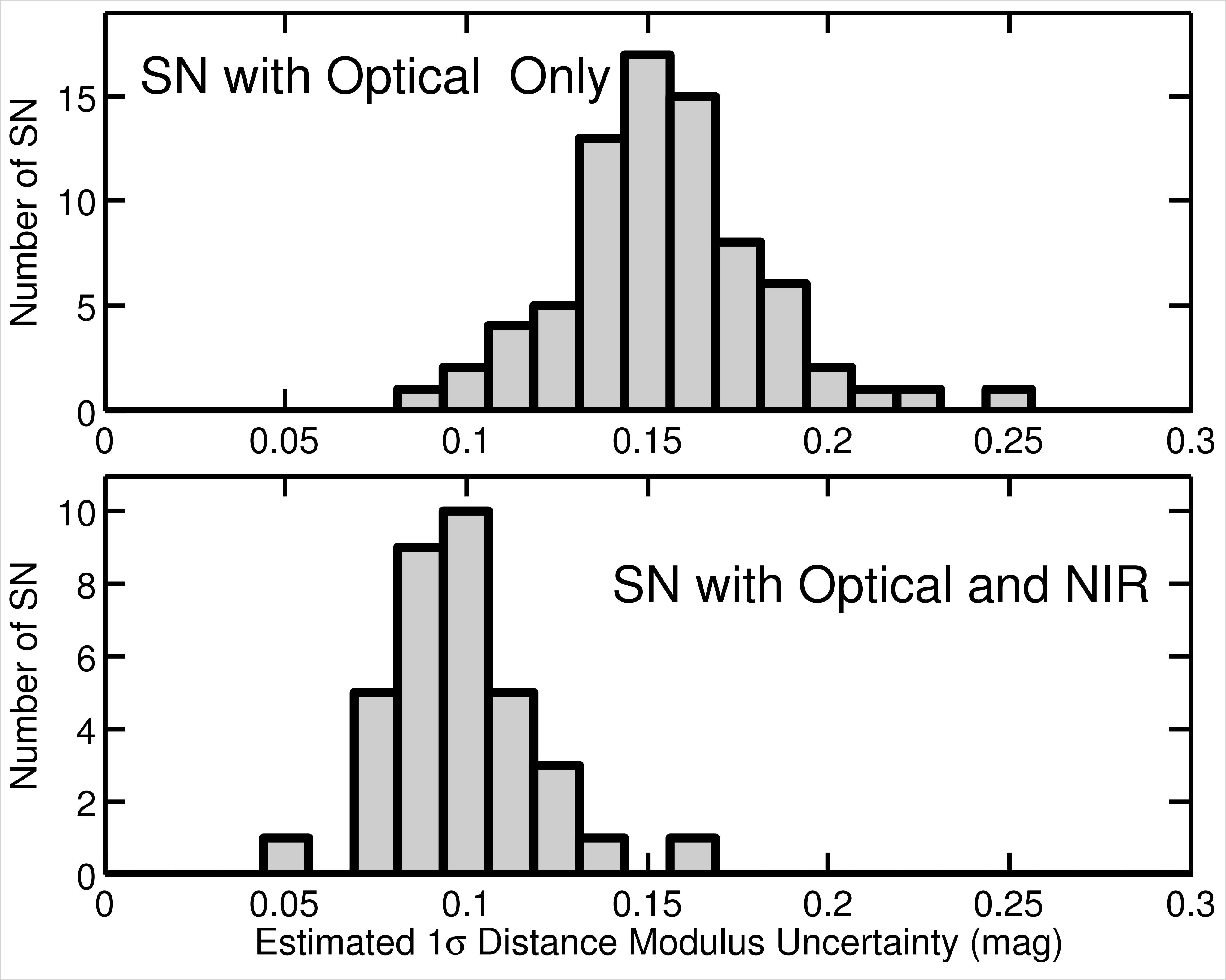
Kasen 2006

Smaller Light Curve Corrections in IR



Mandel et al., 2011

Smaller Total Errors in IR



Mandel et al., 2011

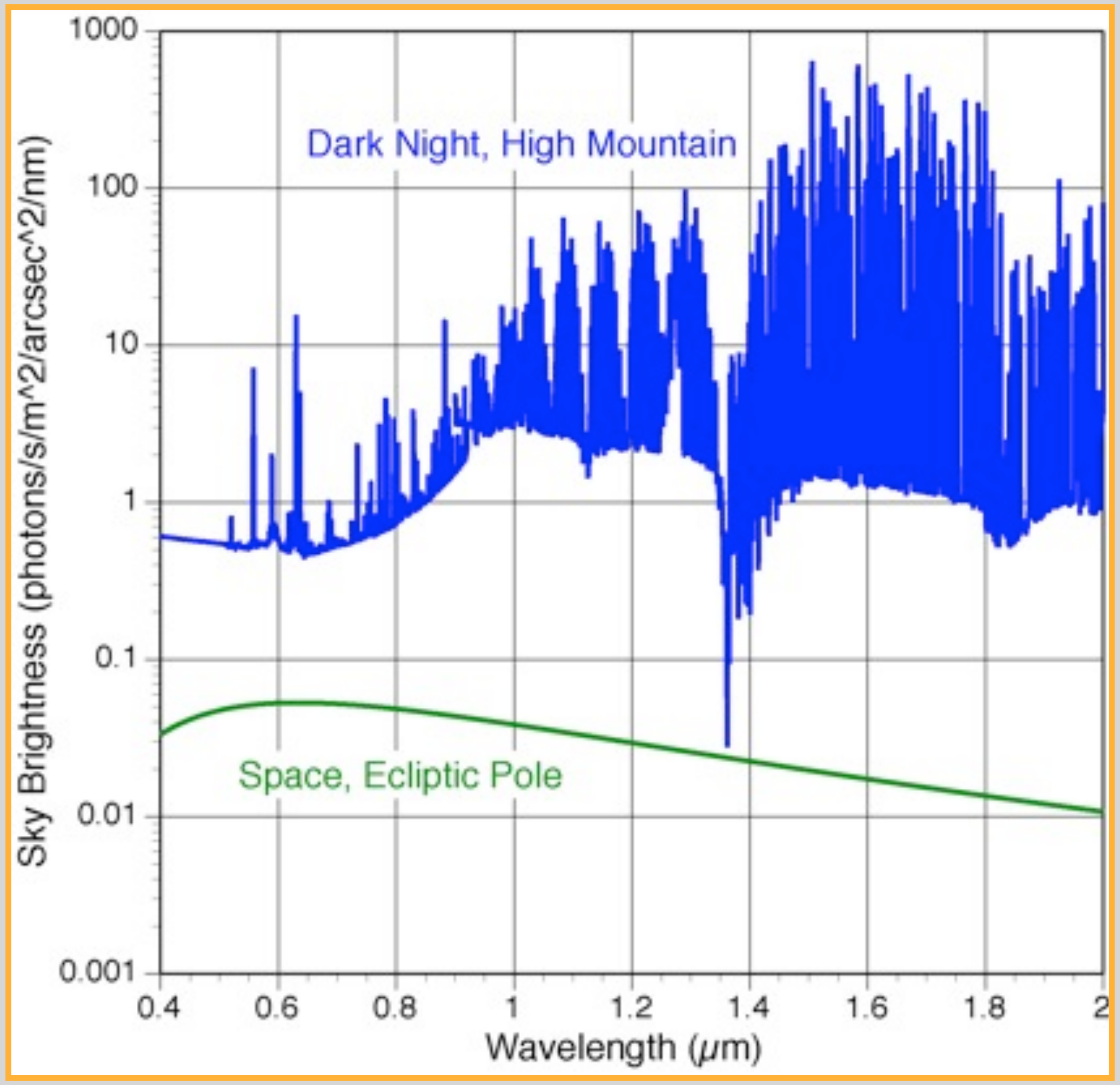
IR is Hard! (From the Ground)

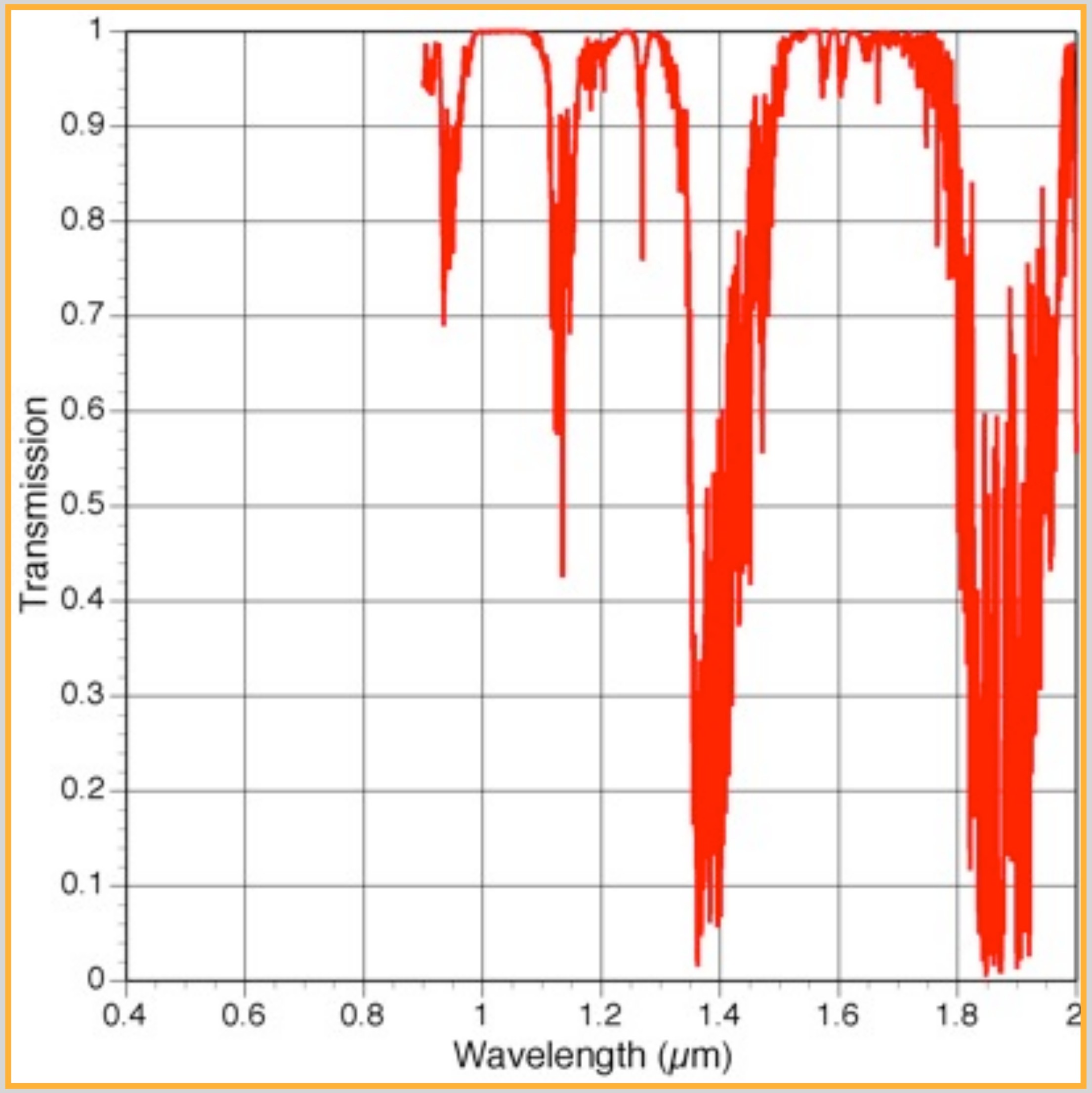
Rest frame IR measurements of z~1 supernovae are not possible from the ground

Go as far into the IR as technically feasible!

Sky is very bright in NIR: >100x brighter than in space

Sky is not transparent in NIR: absorption due to water is very strong and extremely variable






WFIRST

WFIRST SDT SN Survey Characteristics

Survey	Bandpass	Area (deg^2)	Depth	Duration	Cadence
SN Survey				0.5 years (in a 2-yr interval)	5 days
Wide	Y, J	27.44	Y = 27.1, J = 27.5		
Medium	J, H	8.96	J = 27.6, H = 28.1		
Deep	J, H	5.04	J = 29.3, H = 29.4		
IFU Spec	7 exposures with S/N=3/pix, 1 near peak with S/N=10/pix, 1 post-SN reference with S/N=6/pix Parallel imaging during deep tier IFU spectroscopy: Z, Y, J, H ~29.5, F184 ~29.0				

"WFIRST-2.4: What Every Astronomer Should Know"; arXiv:1305.5425

2 Components: Imaging and Spectroscopy

3 Tiers of Imaging

~30,000 IFU Spectra

WFIRST SDT SN Survey Characteristics

Survey	Bandpass	Area (deg^2)	Depth	Duration	Cadence
SN Survey				0.5 years (in a 2-yr interval)	5 days
Wide	Y, J	27.44	Y = 27.1, J = 27.5		
Medium	J, H	8.96	J = 27.6, H = 28.1		
Deep	J, H	5.04	J = 29.3, H = 29.4		
IFU Spec	7 exposures with S/N=3/pix, 1 near peak with S/N=10/pix, 1 post-SN reference with S/N=6/pix Parallel imaging during deep tier IFU spectroscopy: Z, Y, J, H ~29.5, F184 ~29.0				

"WFIRST-2.4: What Every Astronomer Should Know"; arXiv:1305.5425

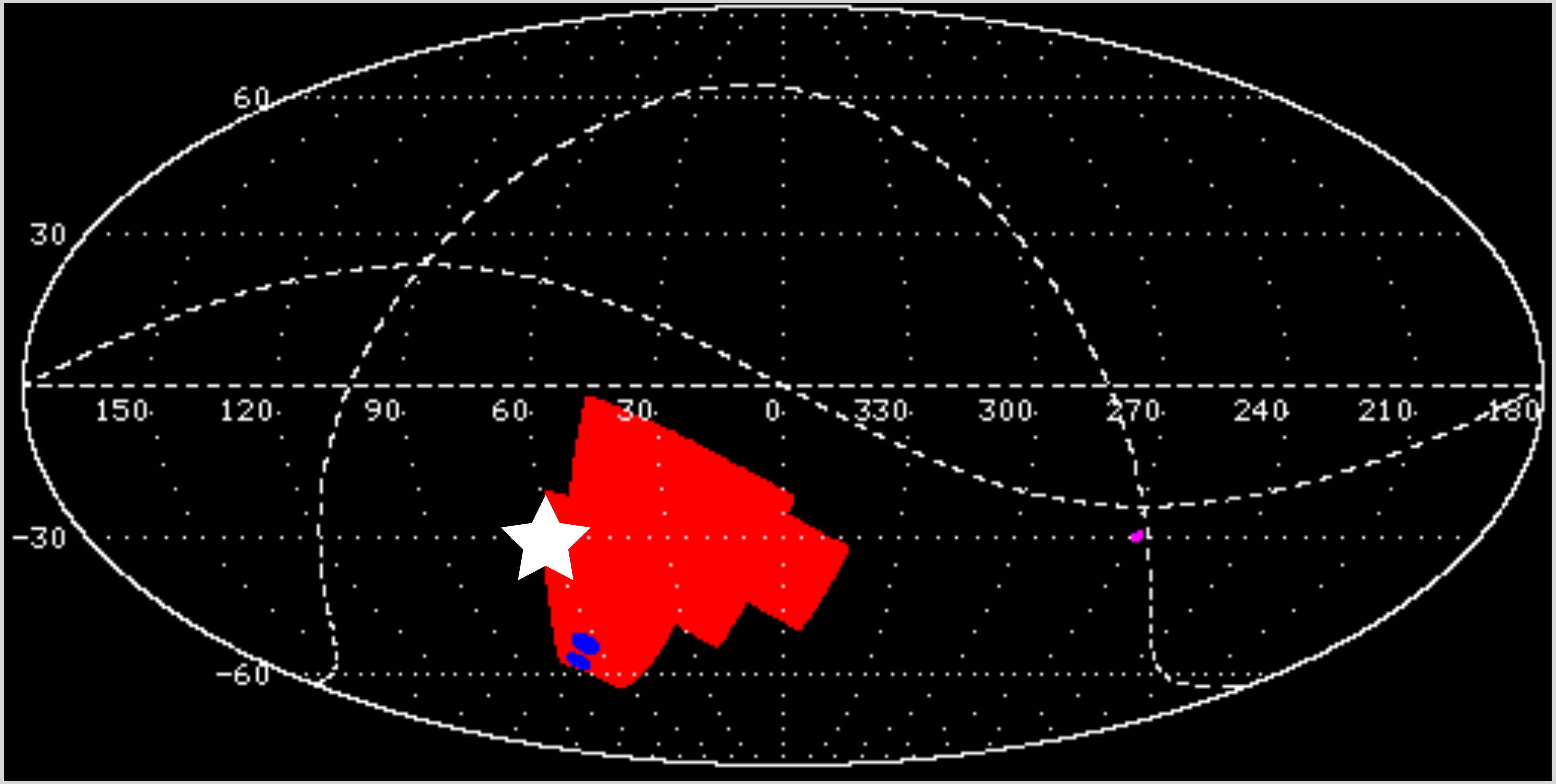
But Imaging Depths Did *NOT* Include Overheads

All Surveys (Single-Epoch and Stacked) Will be Shallower with Current Strategy

For Wide Survey, this is ~75% of Total Time

Unlikely There Will be a Wide Survey

WFIRST SDT SN Fields



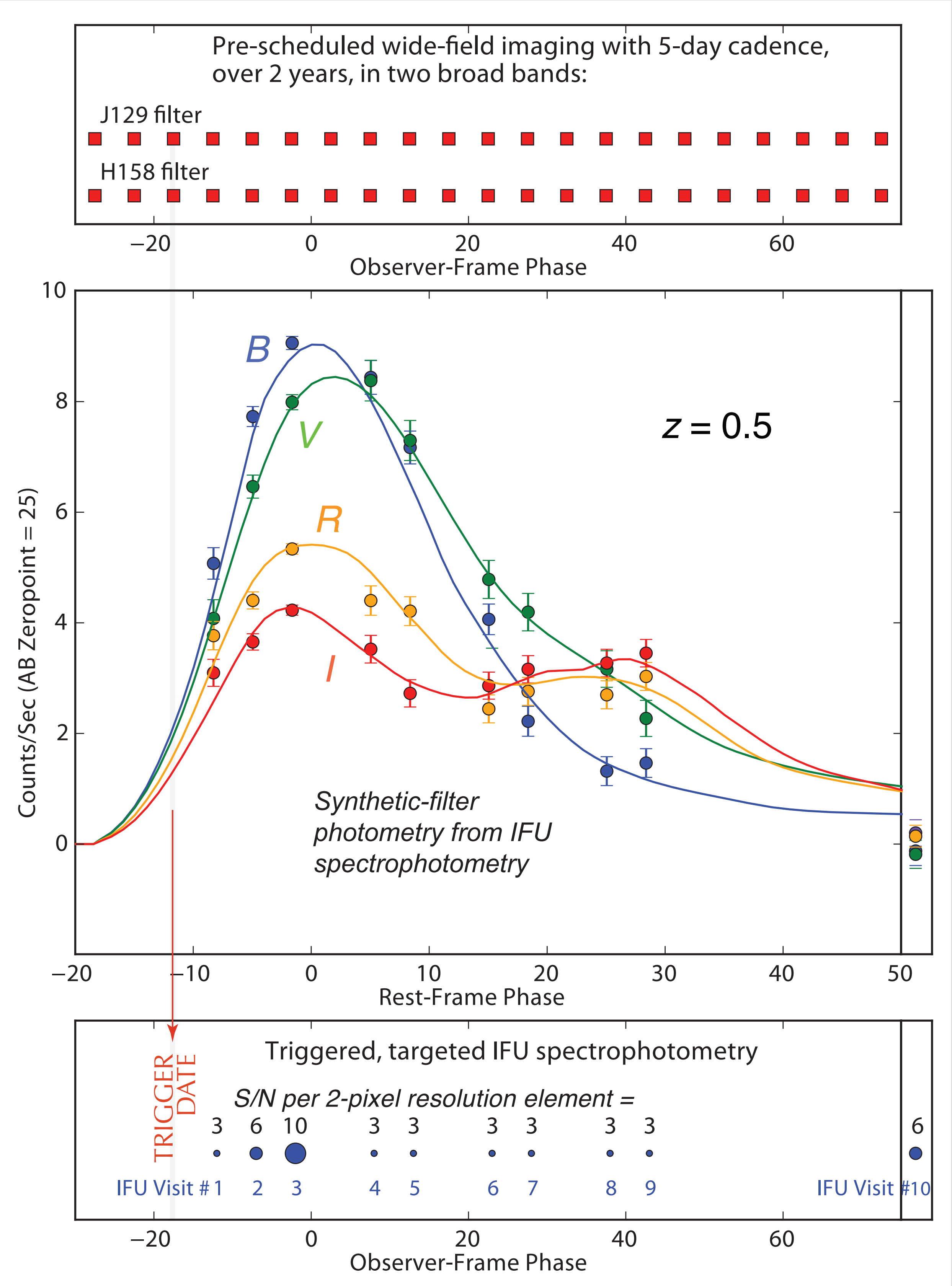
Imbedded in HLS

>30 deg from Galactic Plane

>55 deg from Ecliptic

Far Enough North for Ground-based Telescopes

WFIRST SDT SN Survey



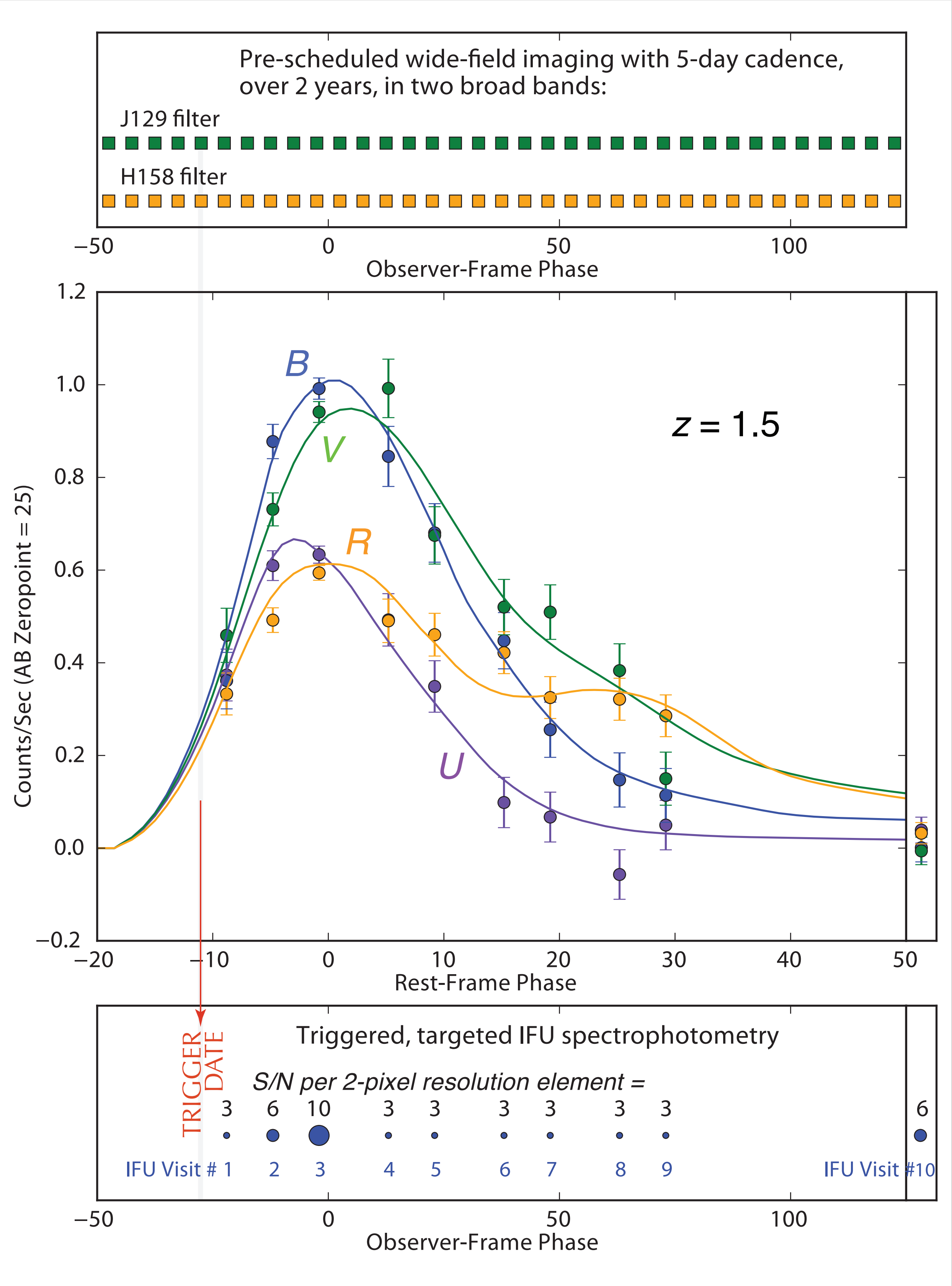
Requires Real-time Decisions

Uses Imager to Discover, IFU to get Photometry

Assumes Systematic Error:

$$\sigma_{\rm sys} = 0.01(1+z)/1.8 \text{ mag},$$

WFIRST SDT SN Survey



Requires Real-time Decisions

Uses Imager to Discover, IFU to get Photometry

Assumes Systematic Error:

$$\sigma_{\rm sys} = 0.01(1+z)/1.8 \text{ mag},$$

WFIRST SDT SN Survey Characteristics

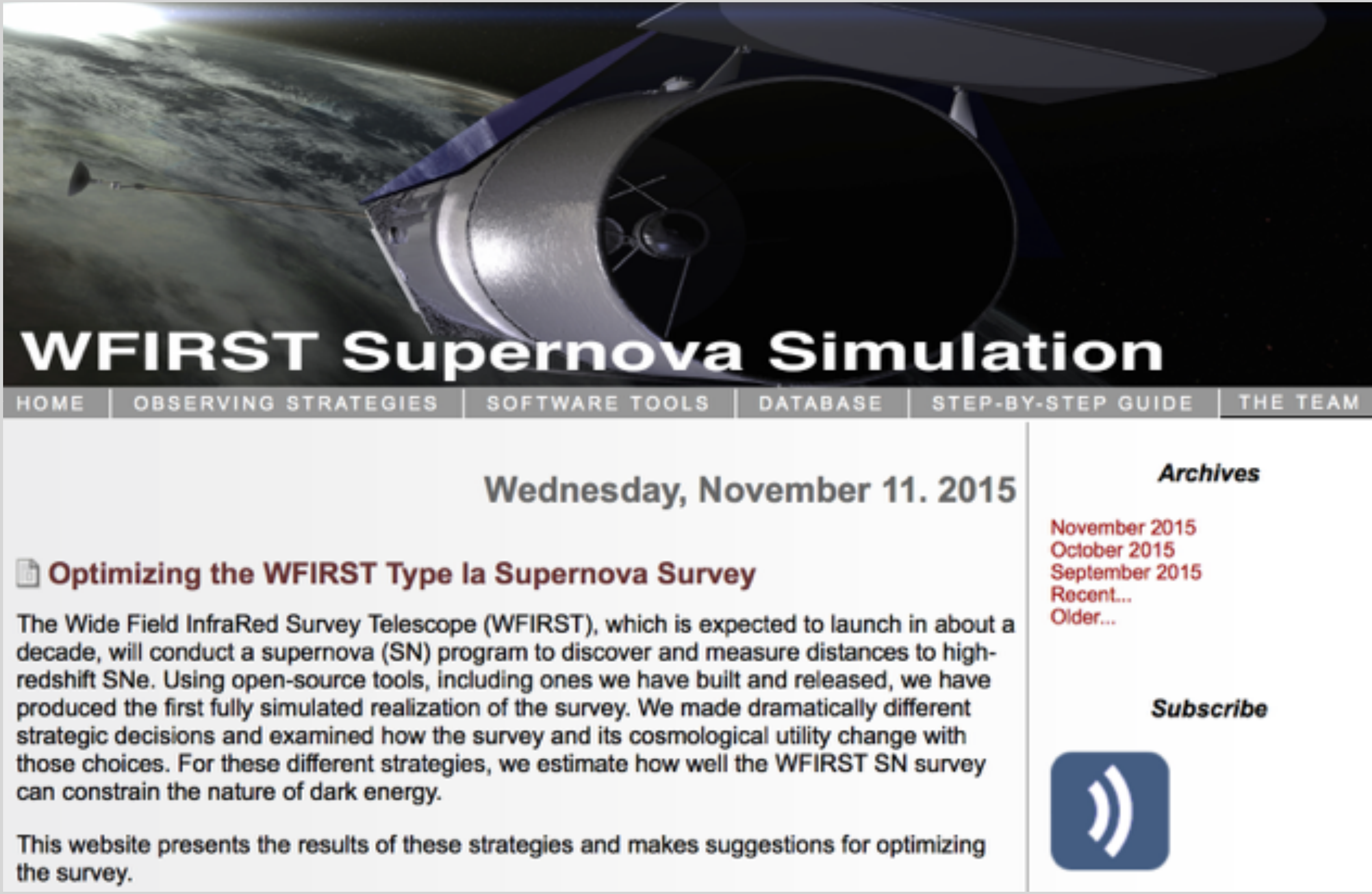
Survey	Bandpass	Area (deg^2)	Depth	Duration	Cadence
SN Survey				0.5 years (in a 2-yr interval)	5 days
Wide	Y, J	27.44	Y = 27.1, J = 27.5		
Medium	J, H	8.96	J = 27.6, H = 28.1		
Deep	J, H	5.04	J = 29.3, H = 29.4		
IFU Spec	7 exposures with S/N=3/pix, 1 near peak with S/N=10/pix, 1 post-SN reference with S/N=6/pix Parallel imaging during deep tier IFU spectroscopy: Z, Y, J, H ~29.5, F184 ~29.0				

“WFIRST-2.4: What Every Astronomer Should Know”; arXiv:1305.5425

5-Day Cadence is Overkill for Deep Survey

Will Likely Make Cadence Longer

Full, Public Simulations Complete



WFIRST Supernova Simulation

HOME | OBSERVING STRATEGIES | SOFTWARE TOOLS | DATABASE | STEP-BY-STEP GUIDE | THE TEAM

Wednesday, November 11. 2015

Optimizing the WFIRST Type Ia Supernova Survey

The Wide Field InfraRed Survey Telescope (WFIRST), which is expected to launch in about a decade, will conduct a supernova (SN) program to discover and measure distances to high-redshift SNe. Using open-source tools, including ones we have built and released, we have produced the first fully simulated realization of the survey. We made dramatically different strategic decisions and examined how the survey and its cosmological utility change with those choices. For these different strategies, we estimate how well the WFIRST SN survey can constrain the nature of dark energy.

This website presents the results of these strategies and makes suggestions for optimizing the survey.

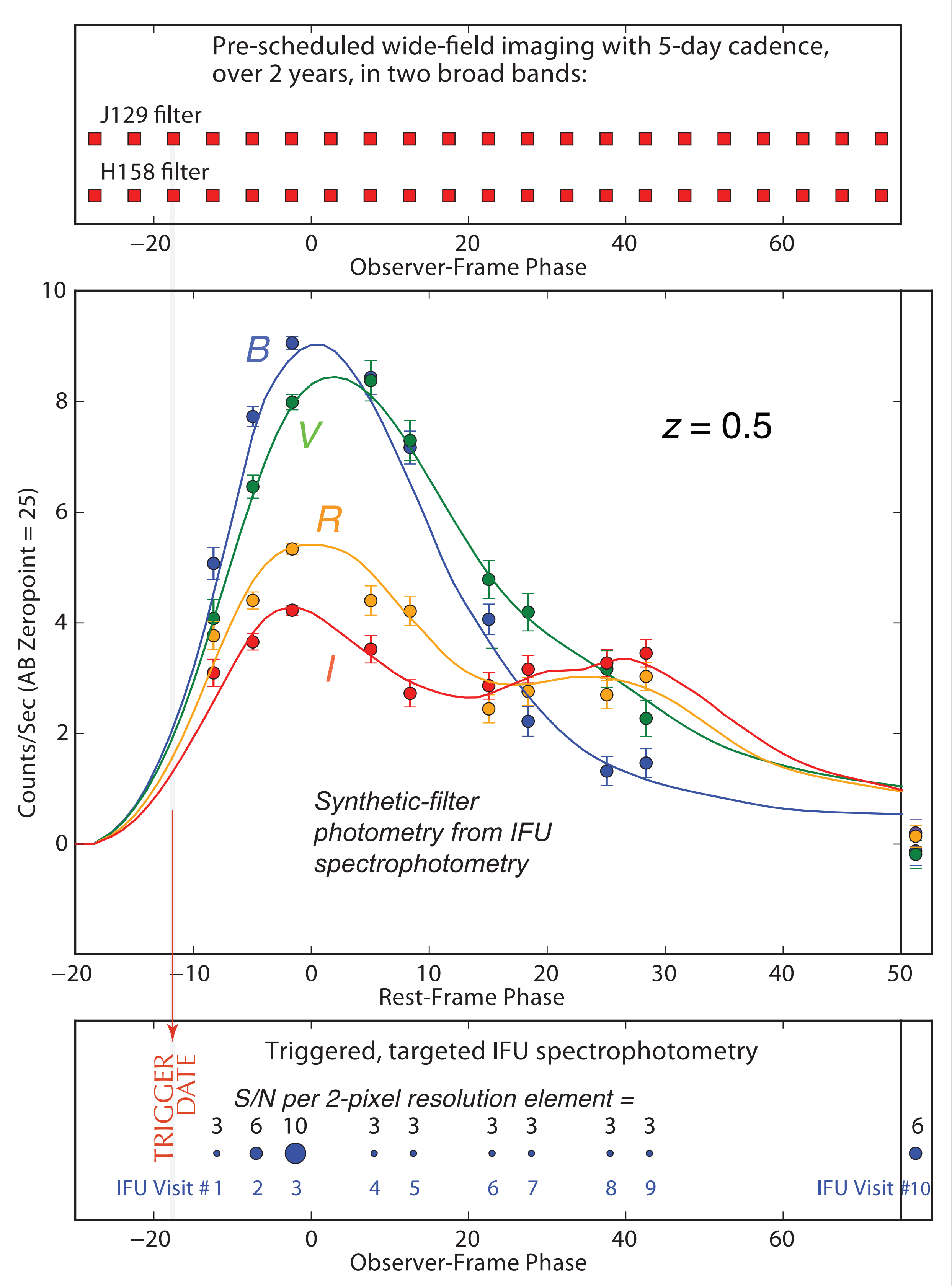
Archives

November 2015
October 2015
September 2015
Recent...
Older...

Subscribe

jet.uchicago.edu/blogs/WFIRST/

WFIRST SDT SN Survey



3 Tiered Imaging Survey (27, 9, 5 sq degrees)

Discover 24k SNe Ia and 14k CC SNe to z = 3

Simulated Background Galaxy Flux to Match CANDELS

Will Need to Re-run Simualtions and Re-evaluate Assumptions

WFIRST SDT SN Survey Characteristics

Survey	Bandpass	Area (deg^2)	Depth	Duration	Cadence
SN Survey				0.5 years (in a 2-yr interval)	5 days
Wide	Y, J	27.44	Y = 27.1, J = 27.5		
Medium	J, H	8.96	J = 27.6, H = 28.1		
Deep	J, H	5.04	J = 29.3, H = 29.4		
IFU Spec	7 exposures with S/N=3/pix, 1 near peak with S/N=10/pix, 1 post-SN reference with S/N=6/pix Parallel imaging during deep tier IFU spectroscopy: Z, Y, J, H ~29.5, F184 ~29.0				

"WFIRST-2.4: What Every Astronomer Should Know"; arXiv:1305.5425

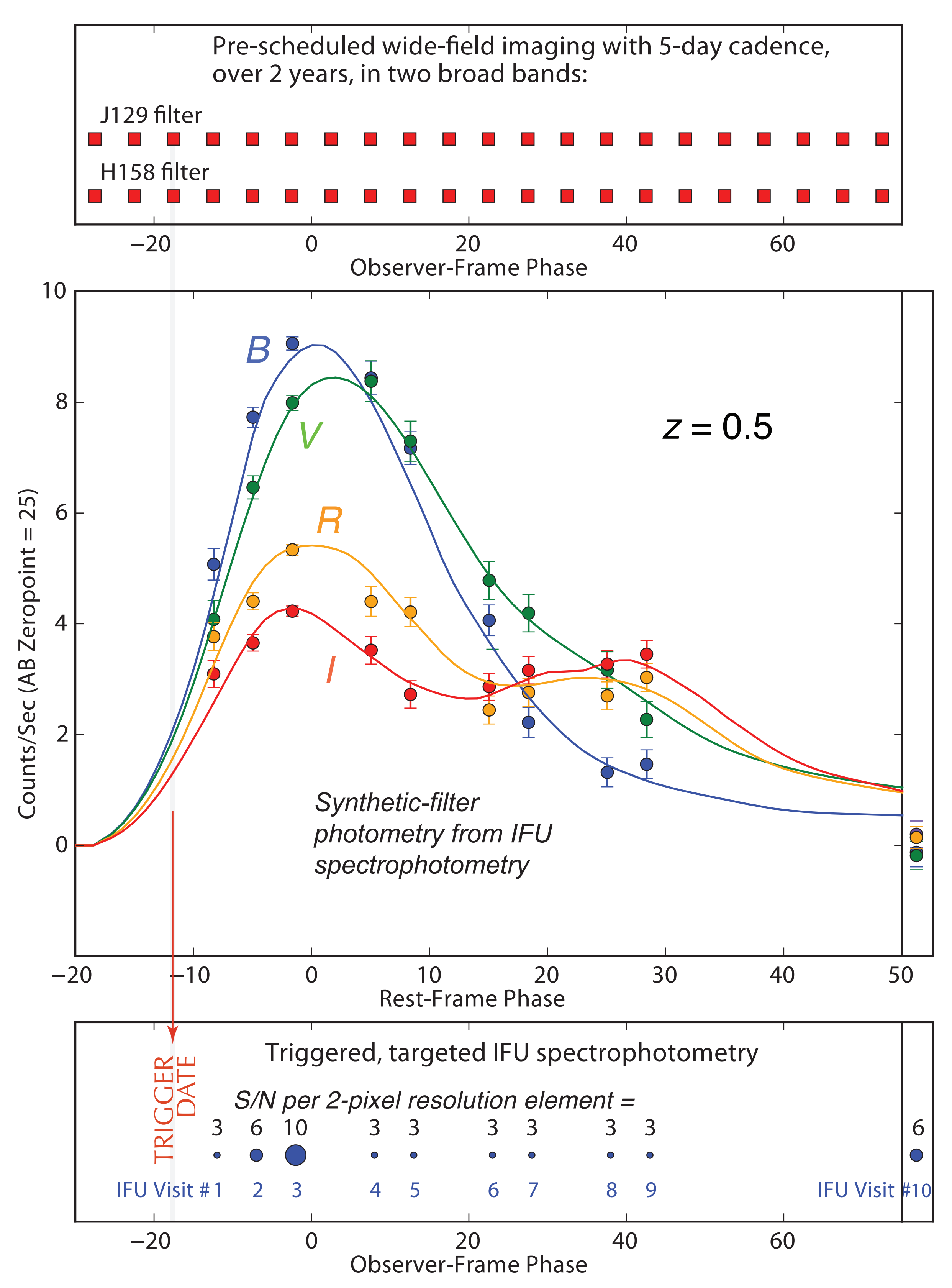
IFU S/N Is Really per Resolution Element (not pixel), for an unreddened SN Ia at peak with *NO* Galaxy Background or *ANY* Template Errors

Varying SN Flux with Time Means Lower S/N

Low S/N Template Means Lower S/N

Change SN SED Means Lower S/N

WFIRST SDT SN Survey Spectroscopy



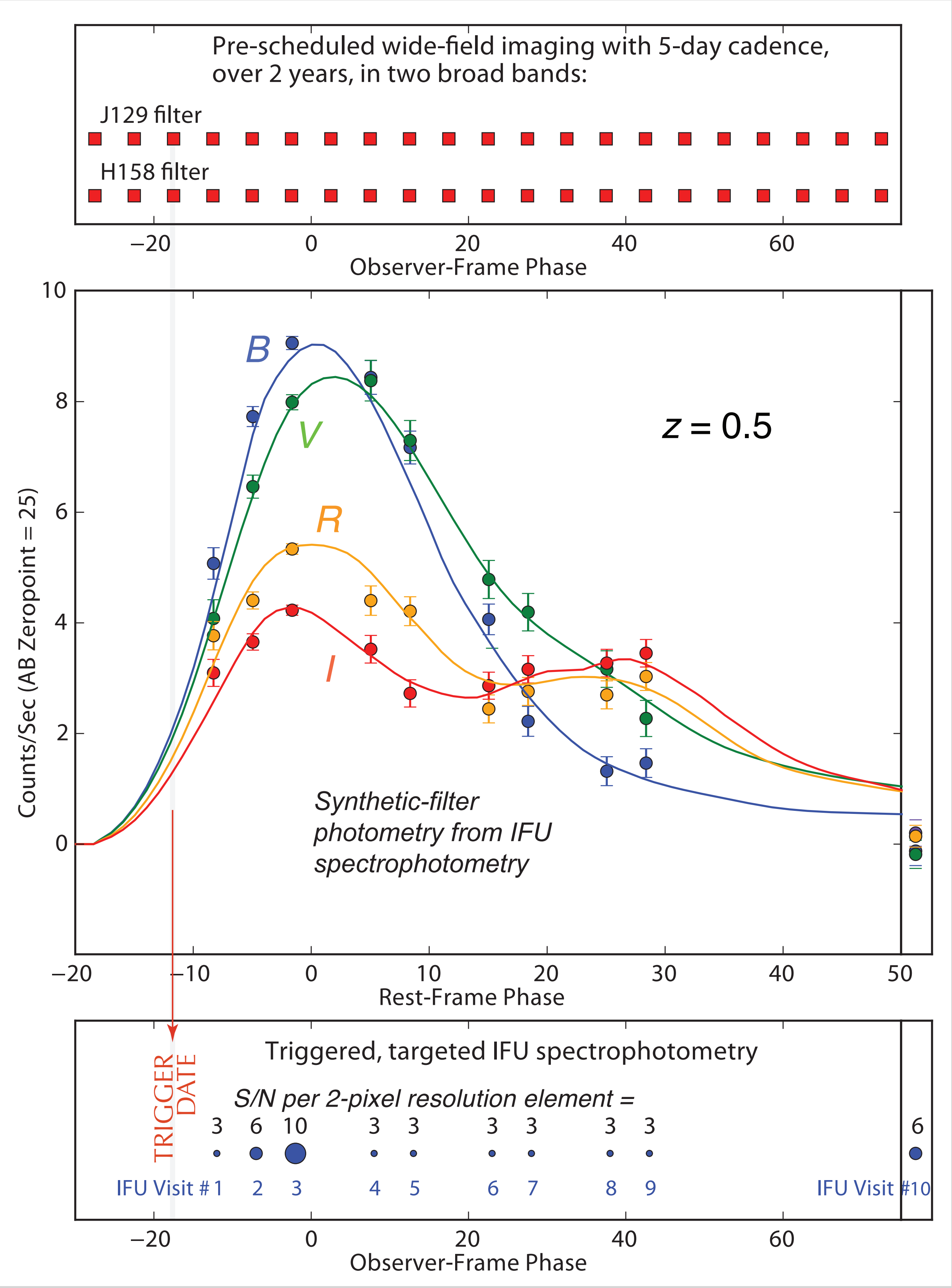
Three Kinds of IFU Exposures:

Typical
S/N = 3.5 (really 1.4)

Classification
S/N = 6 (really 4.0)

Deep
S/N = 10 (really 6.5)

WFIRST SDT SN Survey Selection

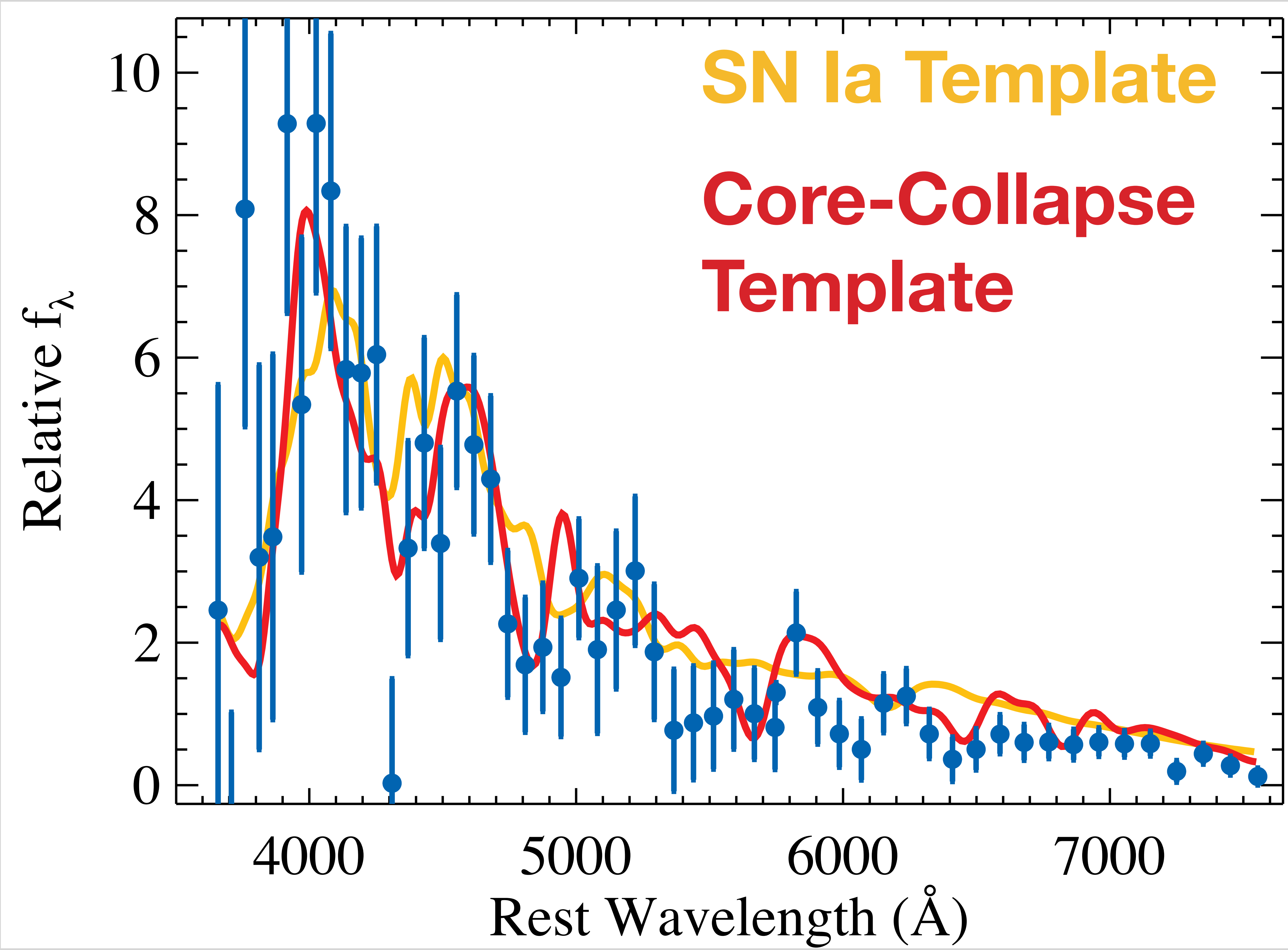


Rising Light Curve

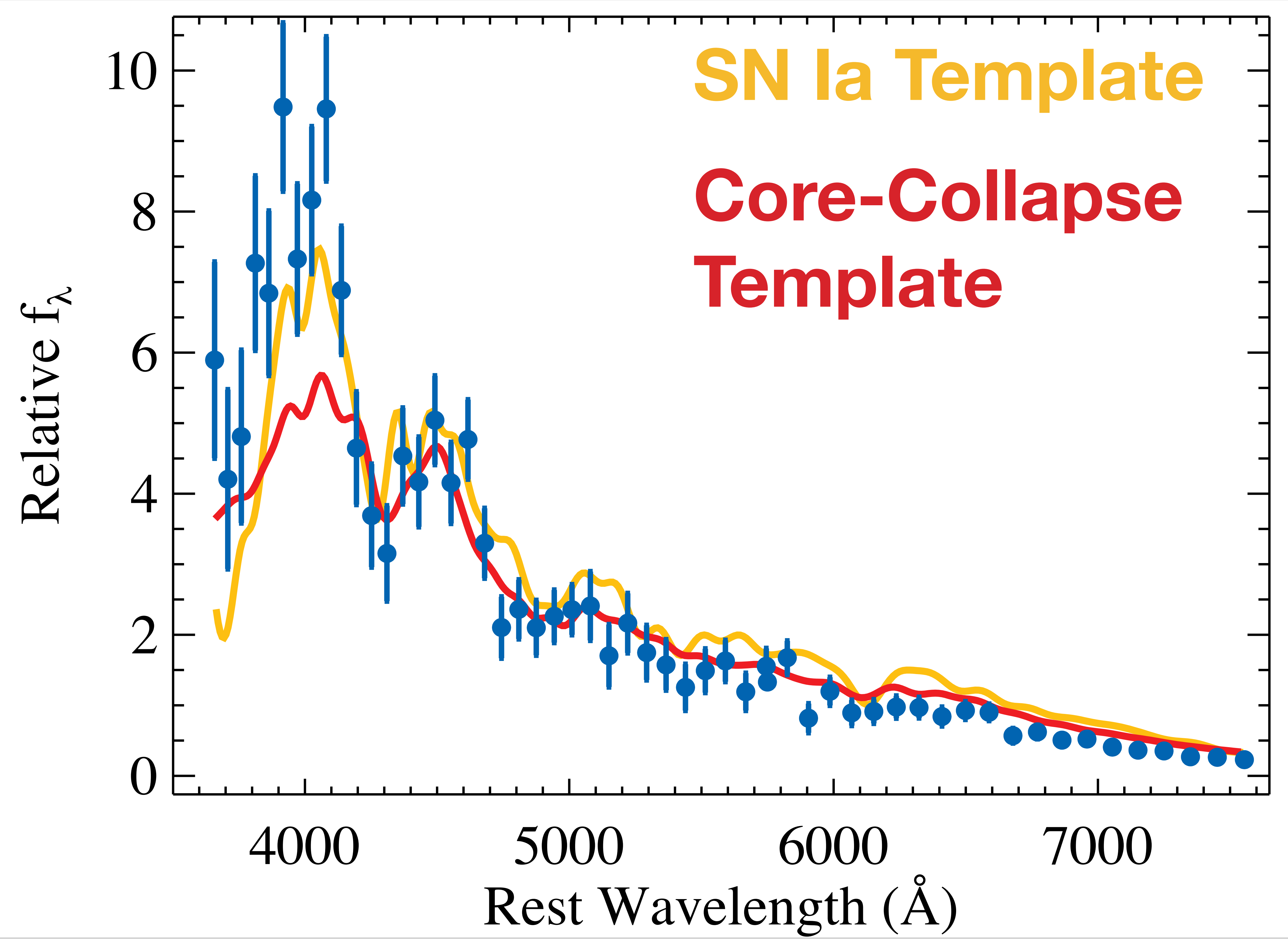
Colors Consistent with SN Ia

Spectra Consistent with SN Ia

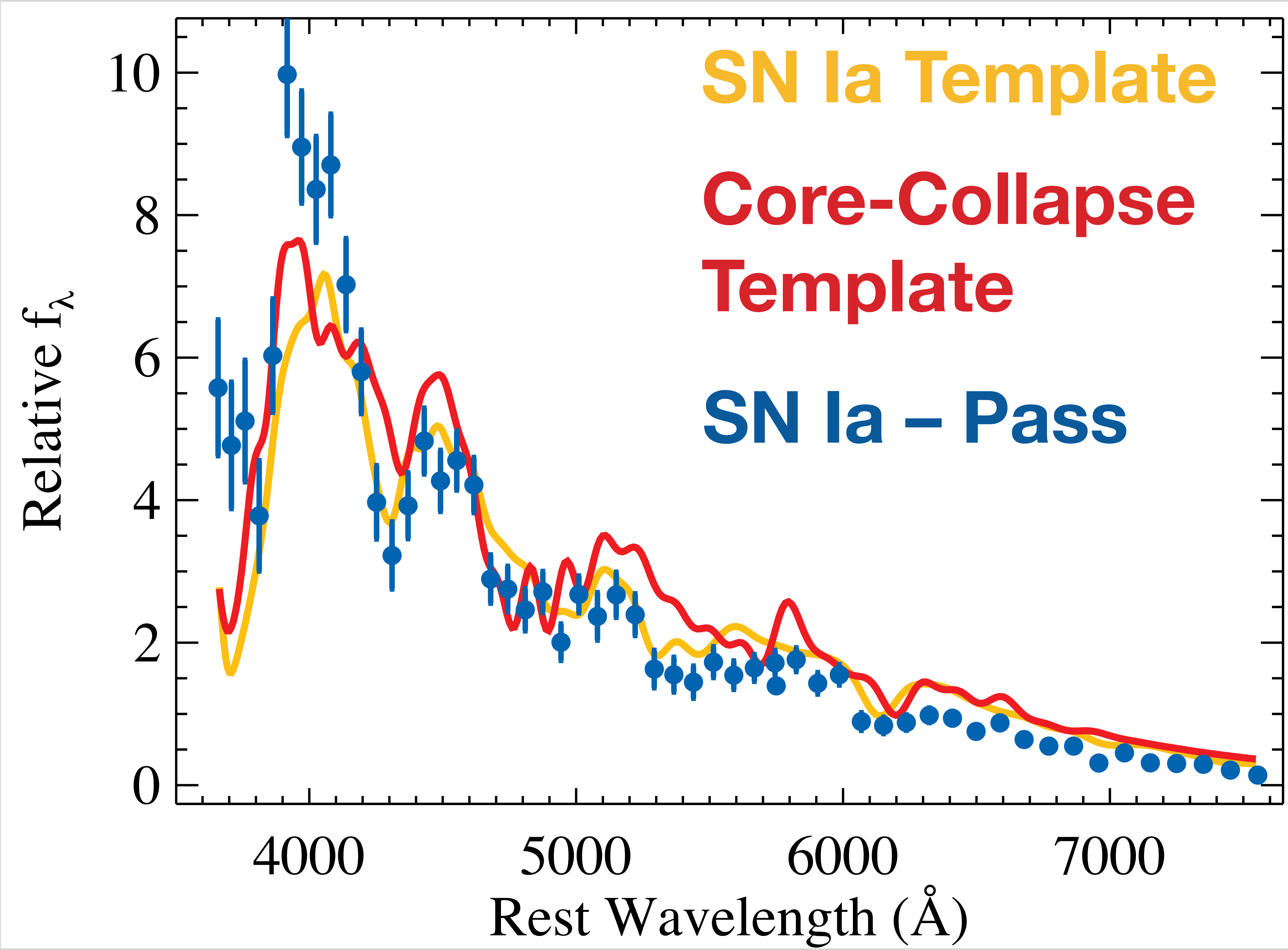
Simulated WFIRST Spectra



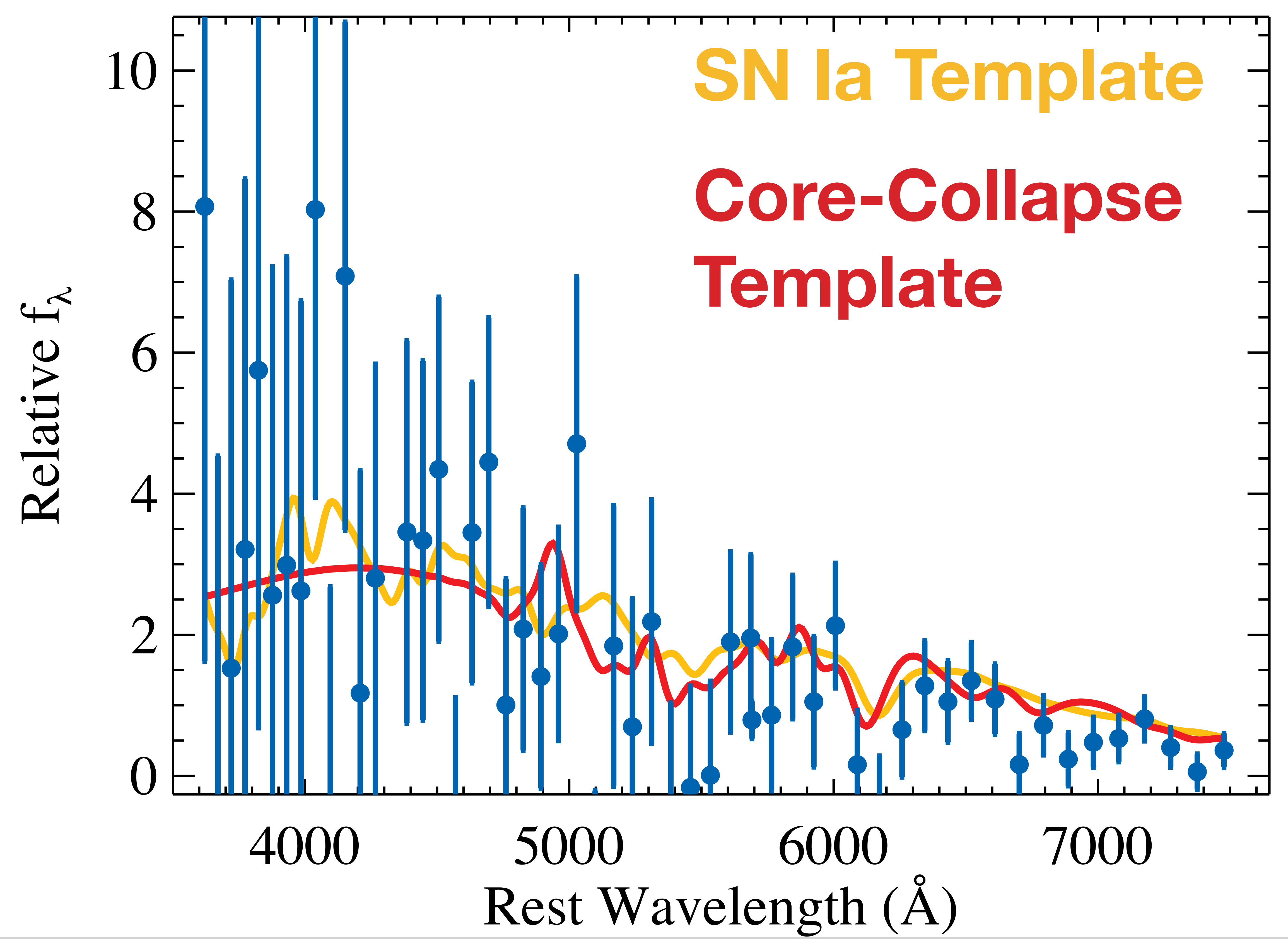
Simulated WFIRST Spectra



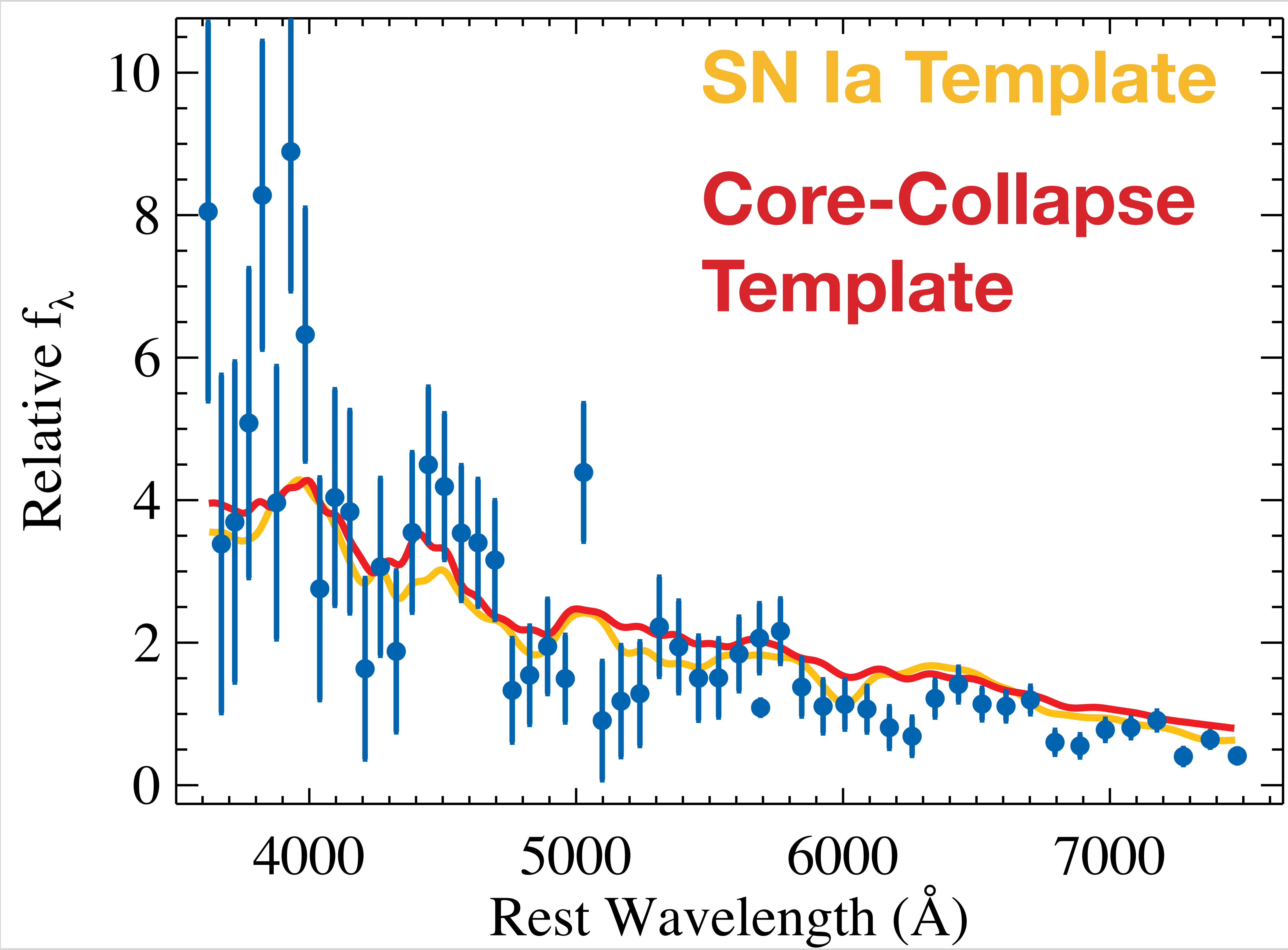
Simulated WFIRST Spectra



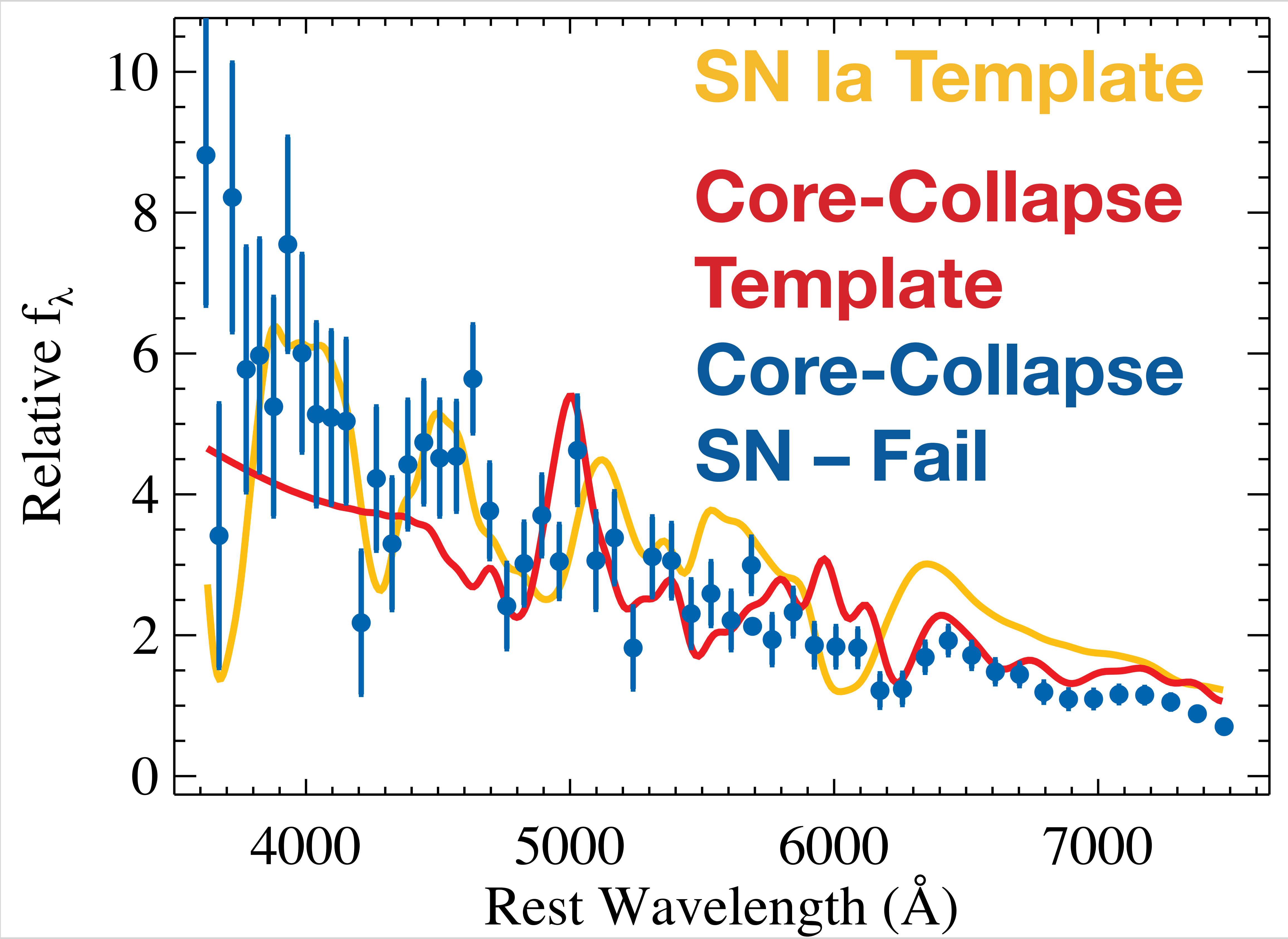
Simulated WFIRST Spectra



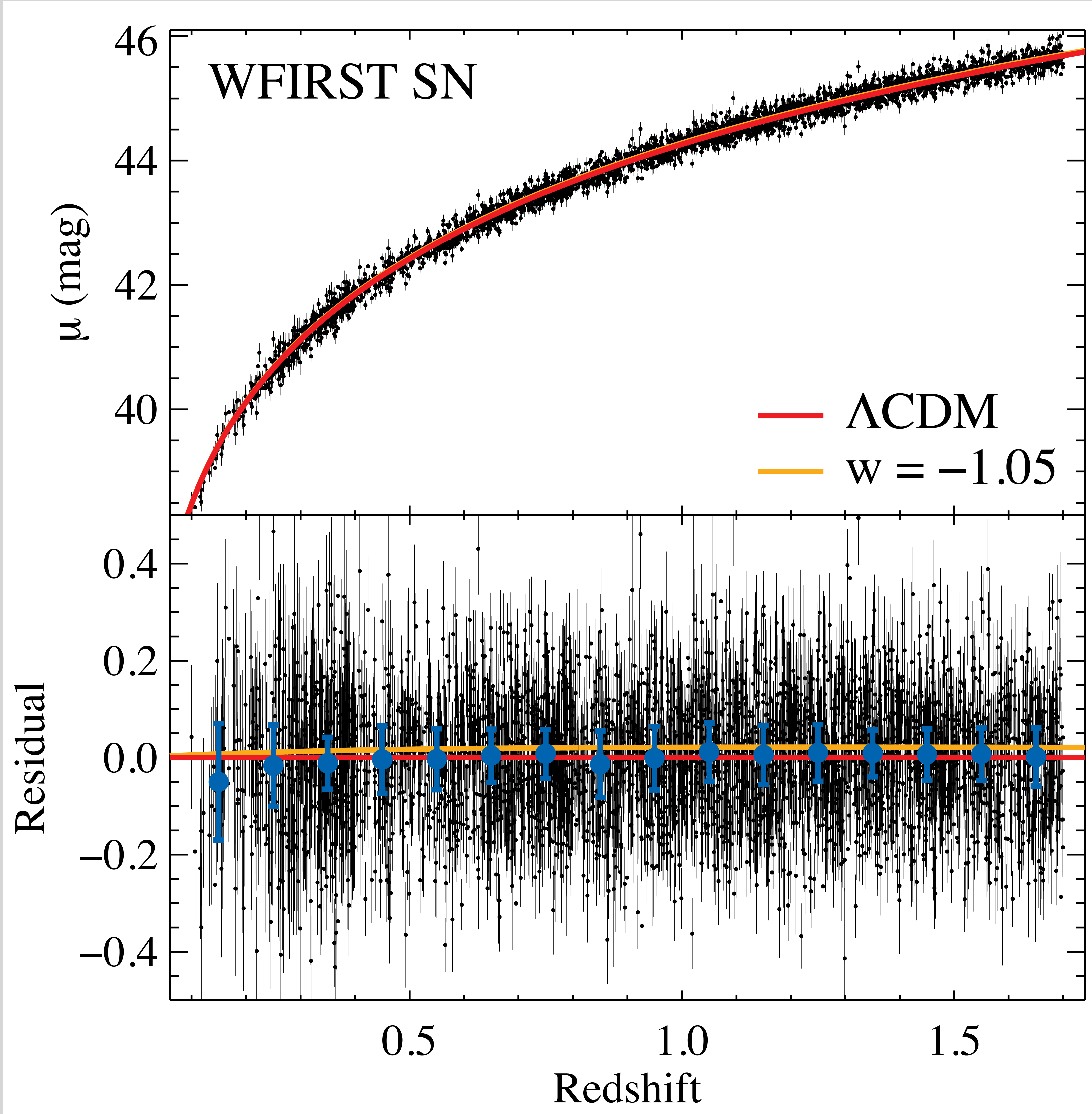
Simulated WFIRST Spectra



Simulated WFIRST Spectra

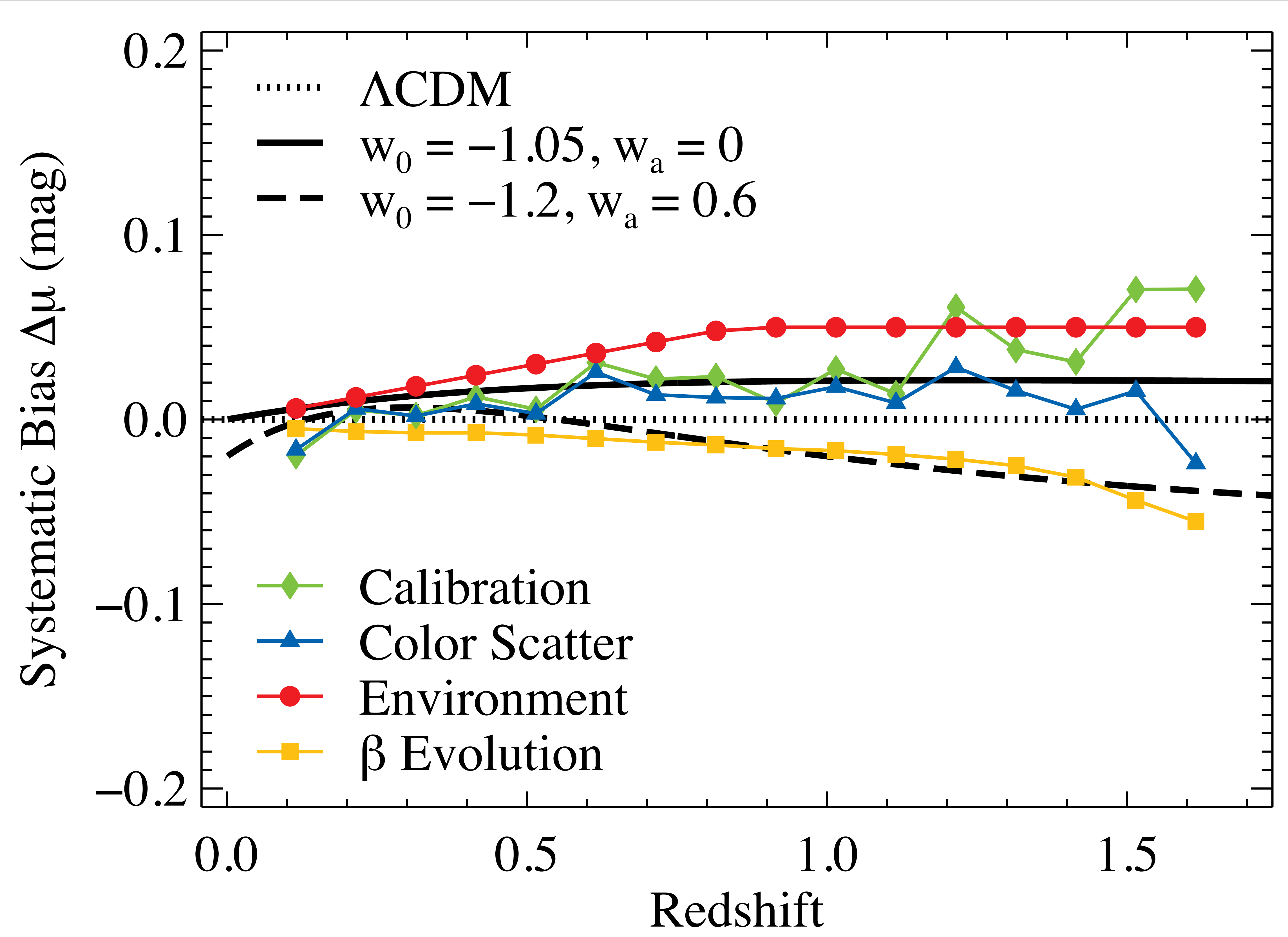


WFIRST Cosmology



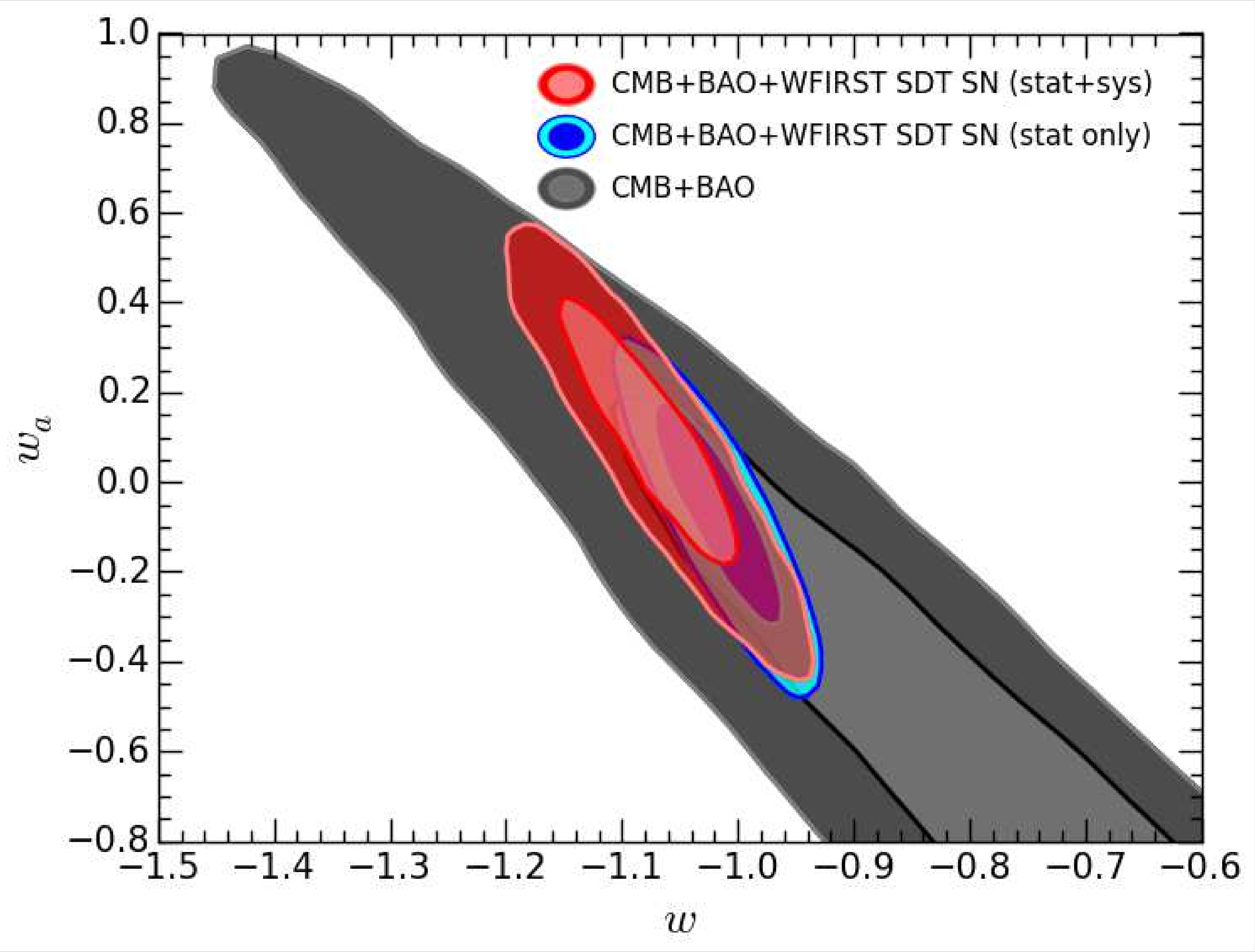
Hounsell et al., in prep.

WFIRST Systematics



Hounsell et al., in prep.

WFIRST Cosmology

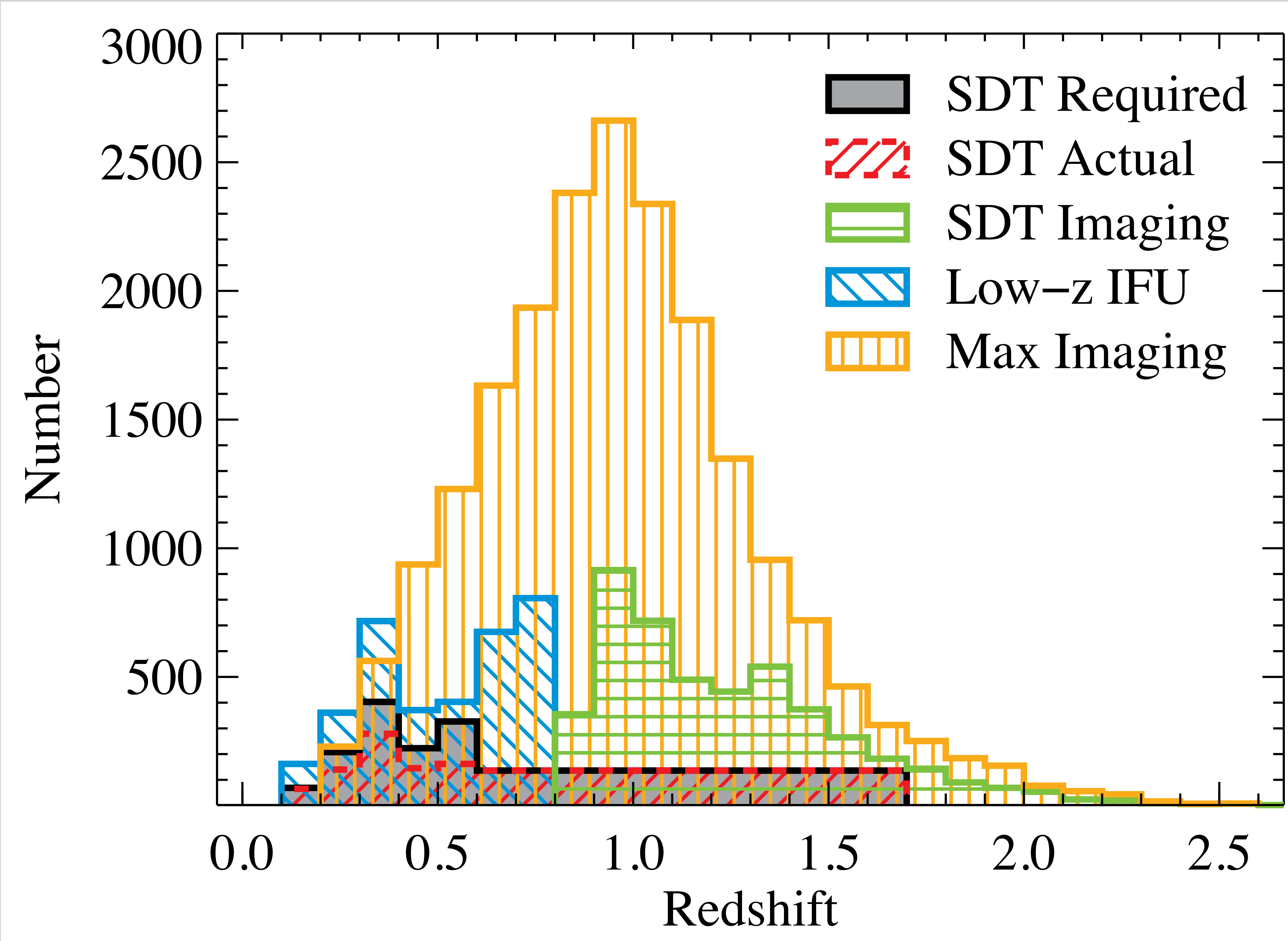


Hounsell et al., in prep.

Other WFIRST Strategies

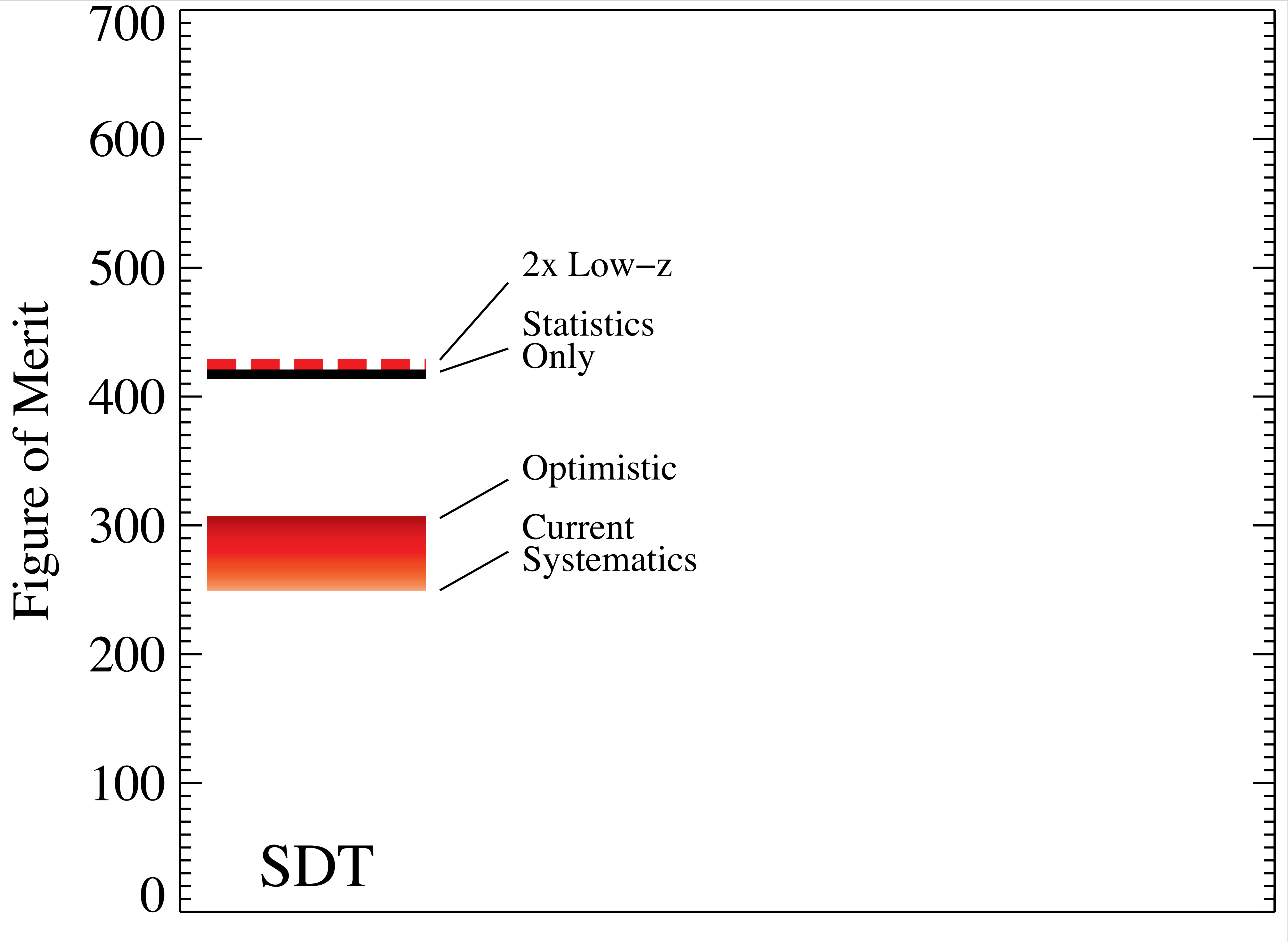
1. SDT
2. SDT + Higher S/N Galaxy Template
3. SDT Imaging Only (IFU breaks or can’t calibrate)
4. IFU Survey for z < 0.8
5. Imaging Only (using 4 bands)
6. Imaging + High S/N IFU/grism at peak
7. Imaging Only for z < 0.8
8. SDT + LSST

Other WFIRST Strategies



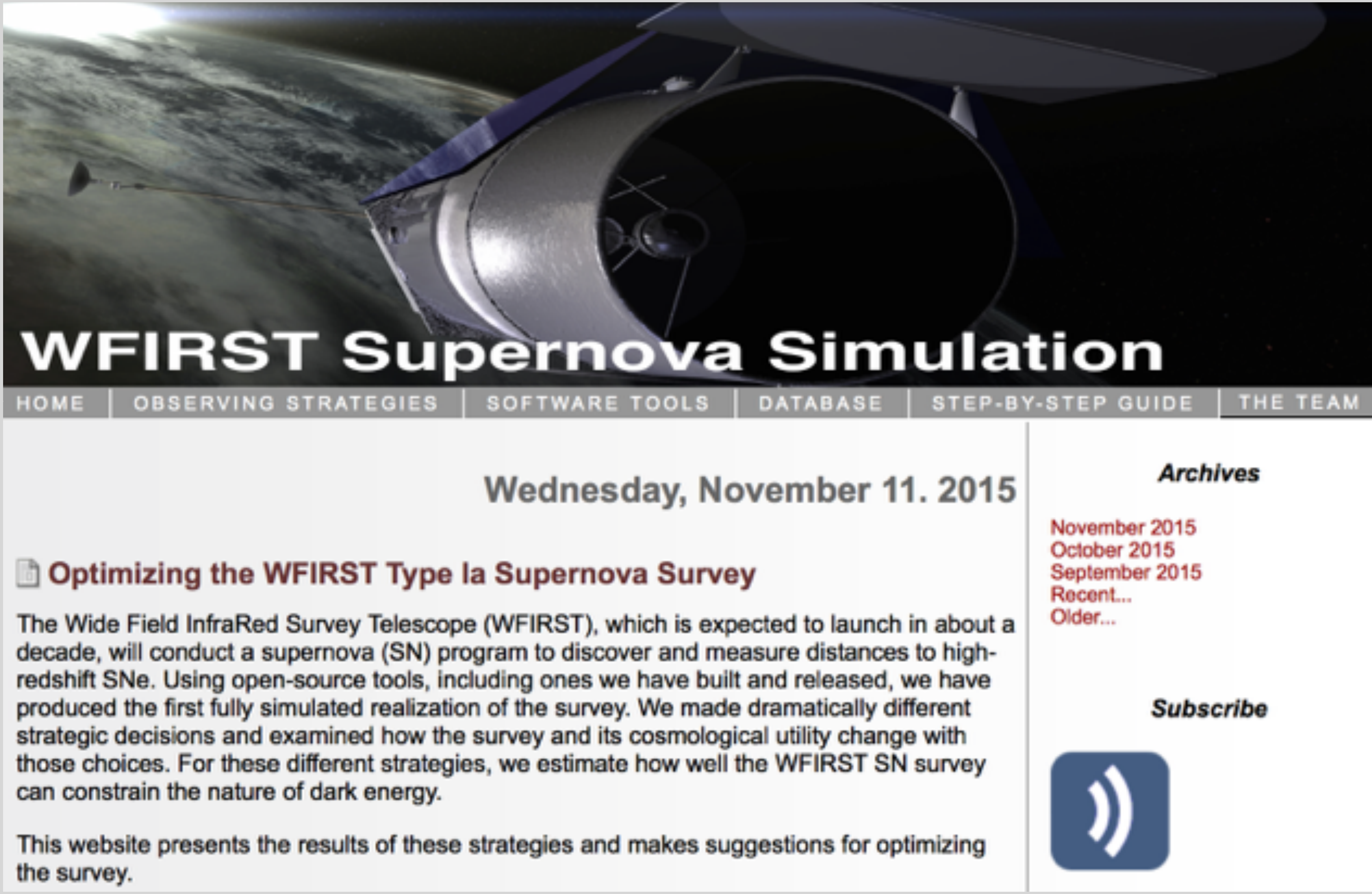
Hounsell et al., in prep.

Other WFIRST Strategies



Hounsell et al., in prep.

All Simulations Public



WFIRST Supernova Simulation

HOME | OBSERVING STRATEGIES | SOFTWARE TOOLS | DATABASE | STEP-BY-STEP GUIDE | THE TEAM

Wednesday, November 11. 2015

Optimizing the WFIRST Type Ia Supernova Survey

The Wide Field InfraRed Survey Telescope (WFIRST), which is expected to launch in about a decade, will conduct a supernova (SN) program to discover and measure distances to high-redshift SNe. Using open-source tools, including ones we have built and released, we have produced the first fully simulated realization of the survey. We made dramatically different strategic decisions and examined how the survey and its cosmological utility change with those choices. For these different strategies, we estimate how well the WFIRST SN survey can constrain the nature of dark energy.

This website presents the results of these strategies and makes suggestions for optimizing the survey.

Archives

November 2015
October 2015
September 2015
Recent...
Older...

Subscribe

jet.uchicago.edu/blogs/WFIRST/

What You Should Know about the WFIRST SN Survey

1. Take SDT Survey with Grain of Salt
2. All Images Shallower than Expected
3. Unlikely to Have Wide Survey
4. Will Try to Move SN Fields North
5. Cadence for Deep Survey Likely to Increase
6. All Spectra Lower S/N than Expected
7. Simulating Alternatives
8. All Simulations Public
9. More Input Wanted!