



Argonne
NATIONAL
LABORATORY

... for a brighter future

Dark Energy Survey Supernovae: a Study of Contamination and the Impact of Light Curve Extension to the Infrared

J. P. Bernstein¹, I. Crane¹, T. Hufford¹, R. Kessler^{2,3}, S. Kuhlmann¹, H. Spinka¹, Dark Energy Survey Collaboration

¹Argonne National Laboratory,

²KICP, U. Chicago

³Dept. of Astronomy & Astrophysics, U. Chicago



U.S. Department
of Energy

UChicago ►
Argonne_{LLC}



U.S. DEPARTMENT OF ENERGY

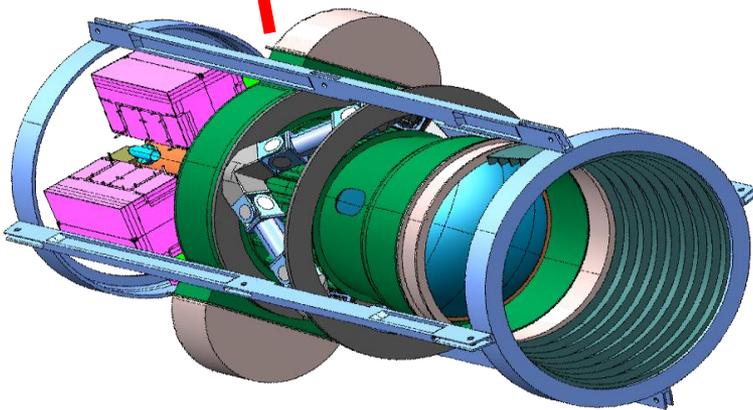
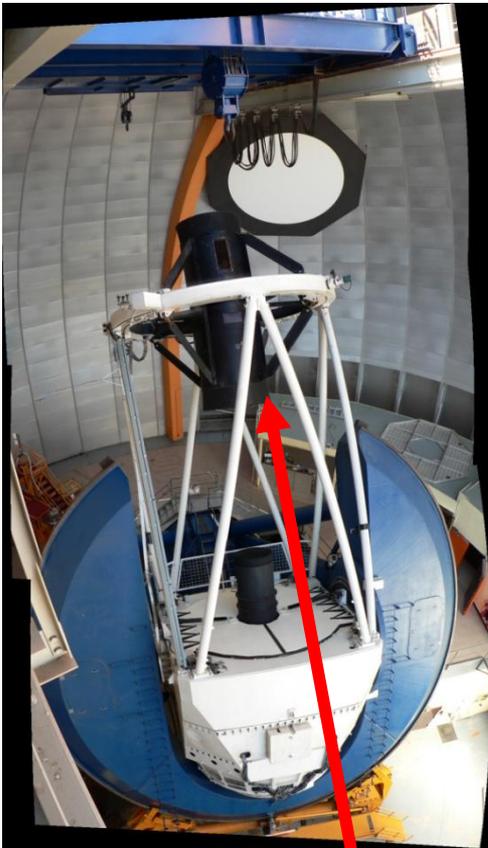
A U.S. Department of Energy laboratory
managed by UChicago Argonne, LLC

215th Meeting of the
American Astronomical Society
Washington, D.C. 2010/01/06

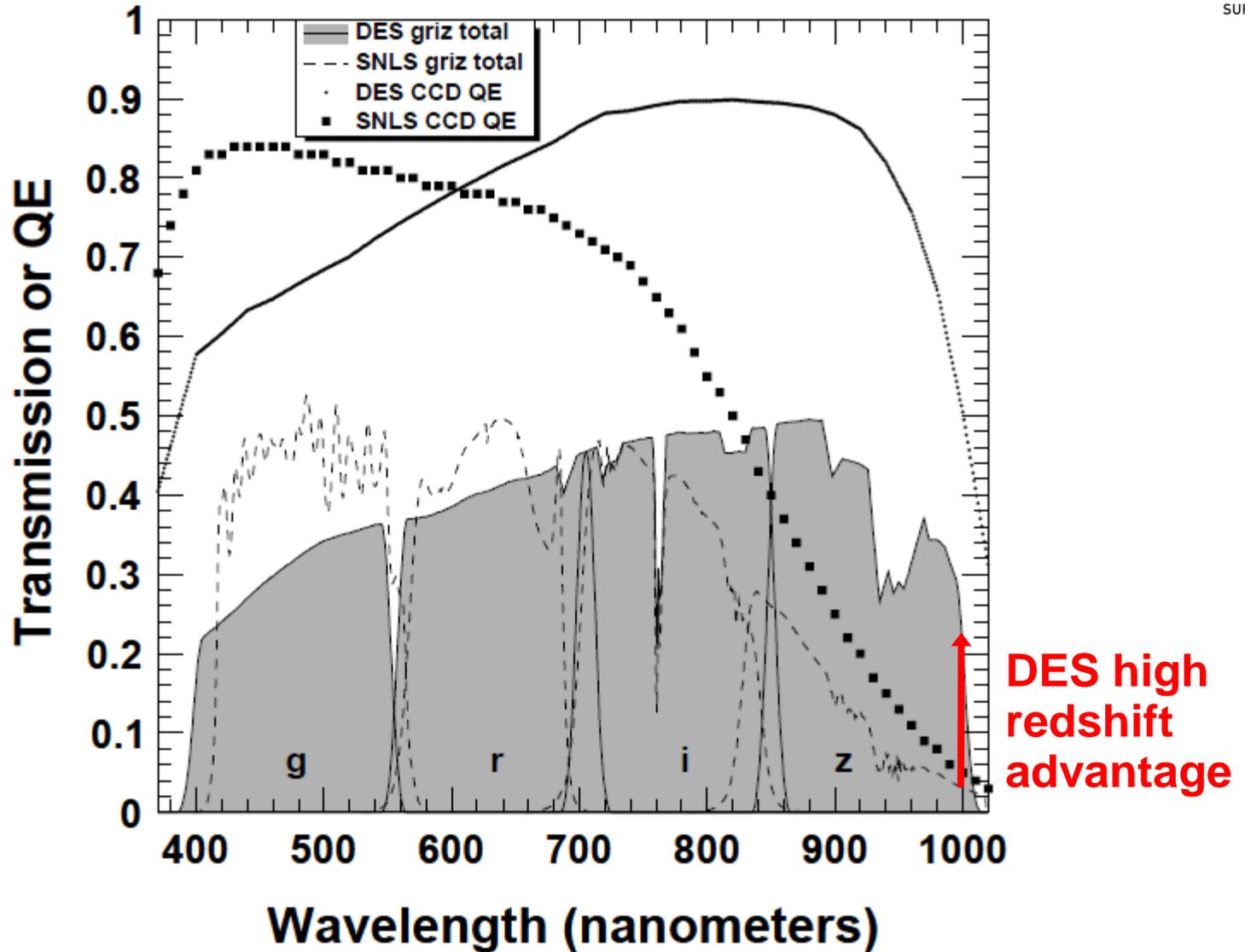
Dark Energy Survey (DES)

DES is providing a new 520Mpixel CCD camera (DECam) for the Blanco 4m telescope in Chile in exchange for 525 survey nights over 5 year period for a 5000 square degree survey starting in 2012

DES uses thicker charge coupled devices (CCDs) from Lawrence Berkeley National Laboratory with increased red sensitivity



DES/SNLS Comparison (SNLS data: Regnault et al. 2009, A&A, 506 999)



DES Supernovae (SNe)

- DES time allocation fixes total SN exposure time: 1260 hr planned over 5 years
 - maximal use of non-photometric time (~920 hr or 73%) planned
 - 10–25% spectroscopic follow-up (full host follow-up eventually)
- Goal: optimize observing time to maximize science & minimize systematic effects
- SNANA: **S**uper**N**ova **A**NALYSIS package for DES
 - R. Kessler (U. Chicago), J. P. Bernstein, S. Kuhlmann, H. Spinka (ANL)
 - public SNANA URL: <http://www.sdss.org/supernova/SNANA.html>
 - SNANA overview paper: Kessler et al. 2009, PASP, 121, 1028
 - also used by SDSS & LSST (utilized for two sections of Science Book)
- Currently favored fields
 - Chandra Deep Field South, Sloan Stripe 82, SNLS D1, XMM-Newton LSS, ELAIS S1 (from a study by Peter Nugent)
 - hybrid strategy of two “deep” and three “shallow” fields favored

Preliminary Core Collapse SN Simulation Inputs

- Literature parsed for estimates of
 - mean peak magnitudes
 - scatter in peak magnitudes
 - relative rates

SN Type	M_B	σ_{M_B}
IIP	-17.0	1.12
Bright Ib/c	-20.26	0.33
Normal Ib/c	-17.61	0.74
Bright IIL	-19.27	0.51
Normal IIL	-17.56	0.38
IIn	-19.15	0.92

Nugent templates fluctuated using Richardson et al. 2002, ApJ, 123, 745

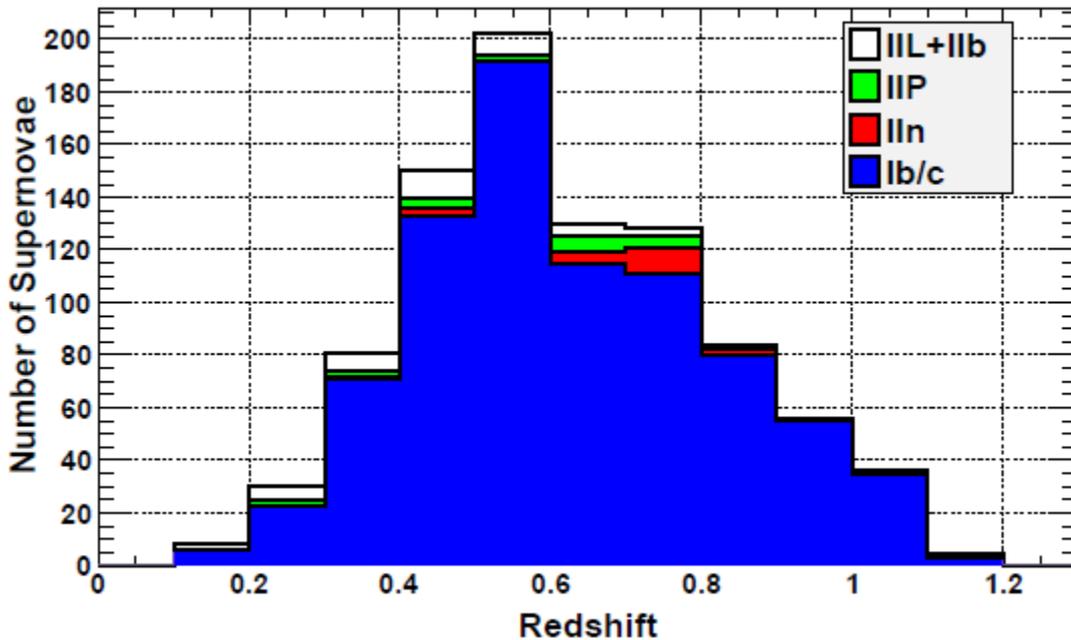
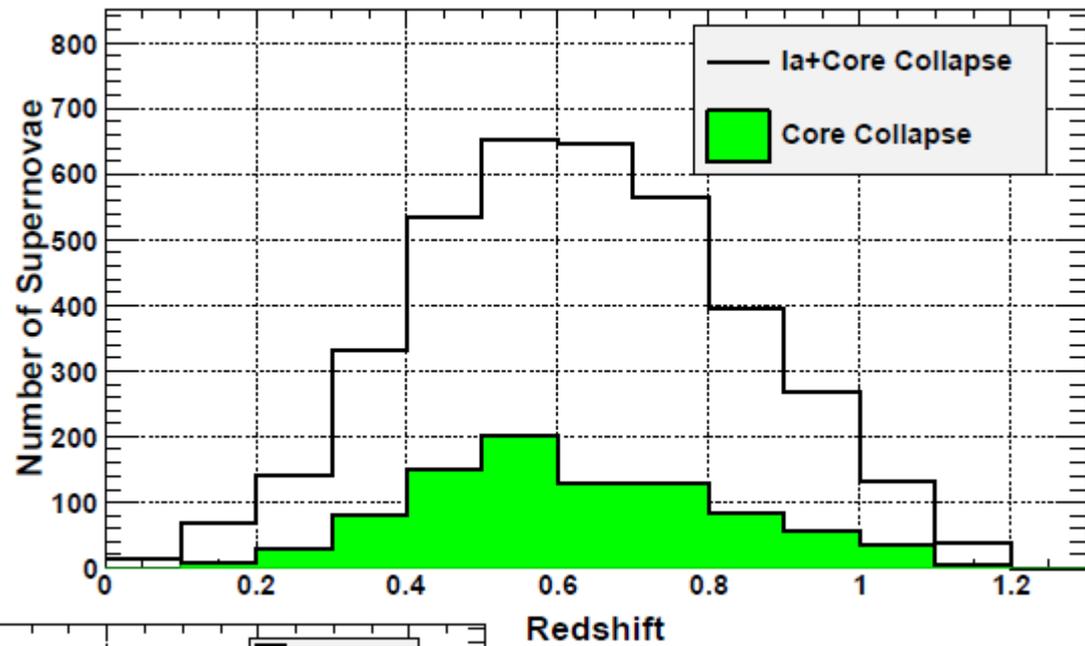
Reference	Ib/c fraction
Li et al. (2007)	$26.5 \pm 5.4\%$
van den Bergh et al. (2005)	$24.7 \pm 2.6\%$
Smartt et al. (2009)	$29.3 \pm 4.7\%$
Prieto et al. (2008)	$24.7 \pm 4.9\%$
Leaman et al. (2009)	$33.3 \pm 4.3\%$
Cappellaro et al. (1999)	15-22%

Relative fraction of Type Ib/c SNe

SN Type	Relative SNcc Fractions
IIP	0.47
Ib/c	0.28
IIL + Iib	0.16
IIn	0.09

Relative fractions used in this analysis

Projected DES SN Redshift Distributions (after cuts)



Simulated DES Core Collapse SN Contamination

f_p : fit probability

Sample	$f_p > 0.0$	$f_p > 0.1$	$f_p > 0.5$
Ia	2876	2777	2104
Ib/c	3301	824	137
IIn	2946	20	0
IIP	729	21	0
IIL	506	44	3
Contamination		23.8%	6.2%

Dominant component



Number of simulated SNe passing cuts

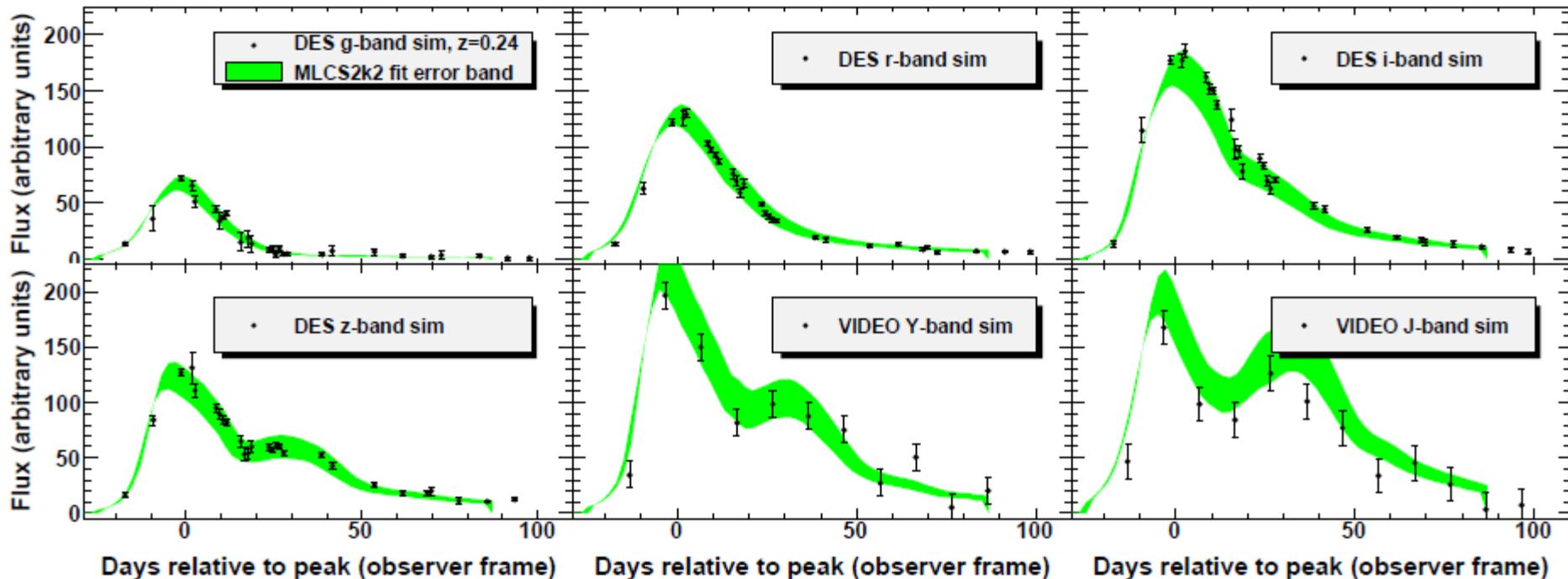
No. σ cut on μ	f_p cut	w_0
3	0.1	$-0.935^{+0.055}_{-0.050}$
3	0.5	$-0.951^{+0.056}_{-0.049}$
No μ cut	0.1	$-0.365^{+0.031}_{-0.034}$
No μ cut	0.5	$-0.845^{+0.049}_{-0.046}$

Contamination effect of cosmology fit

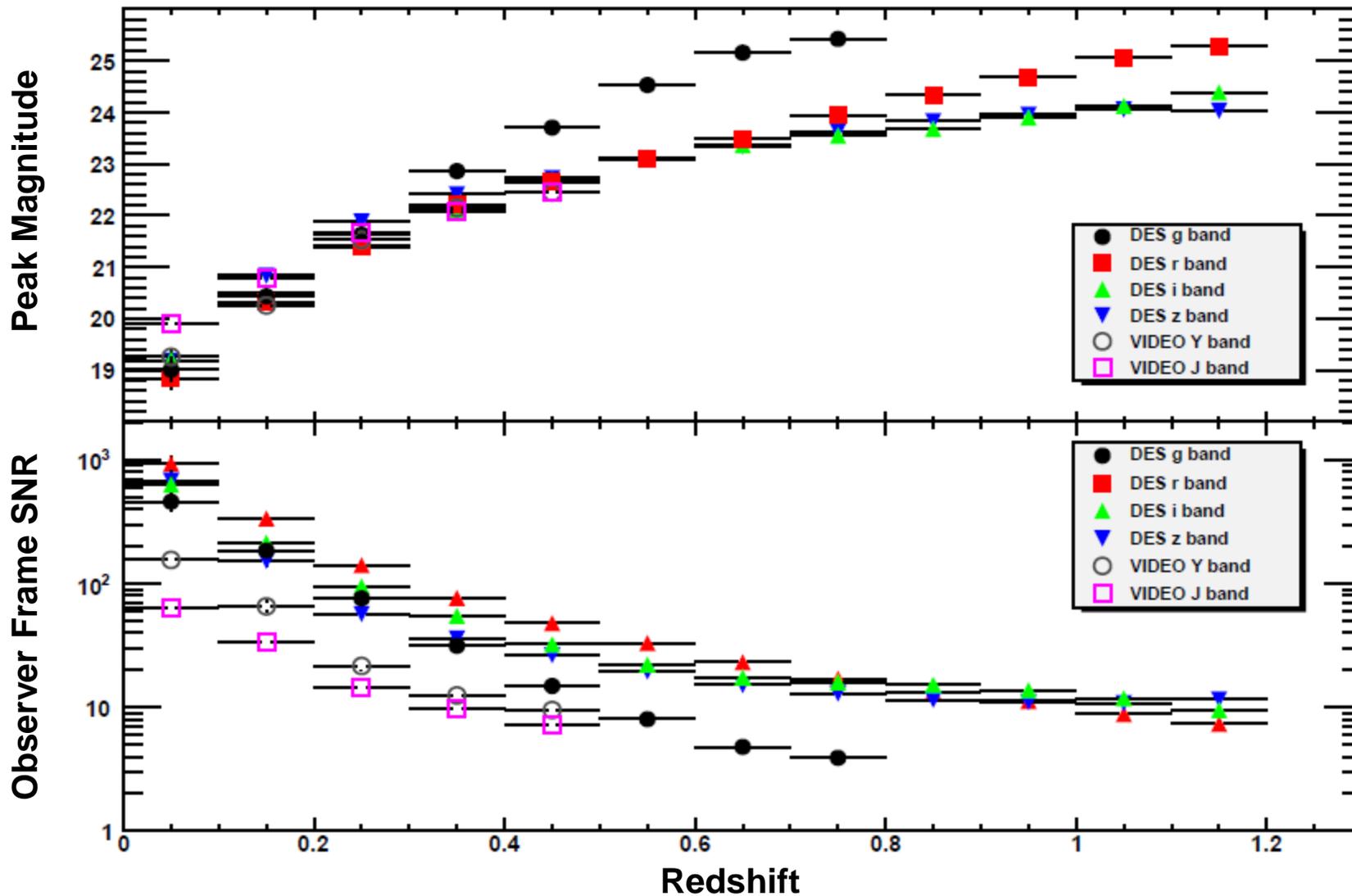
- Additional SN typing methods to be tested
- Further optimization to come

SNANA Optical+IR Sims (9 filter MLCS2k2 model developed)

- Motivation: unique DES/VIDEO overlap, infrared (IR) color advantage
 - VIDEO Survey: IR observations with recent first light
 - three year temporal DES overlap with three shared SN fields
 - will provide for an optical+IR sample of order 100 SNe



Peak Magnitudes & Signal-to-noise Ratios (SNR)



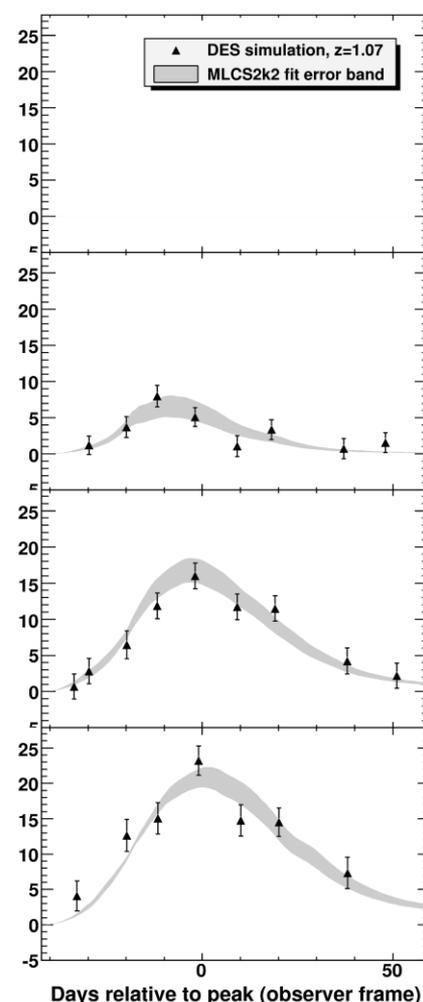
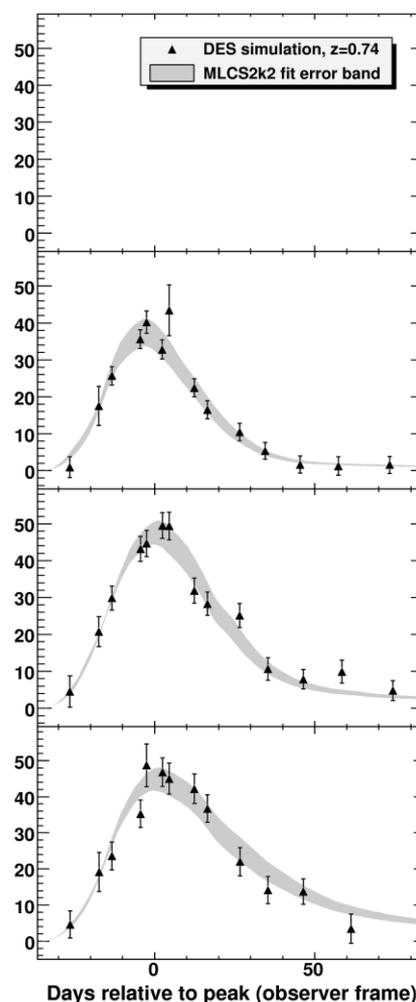
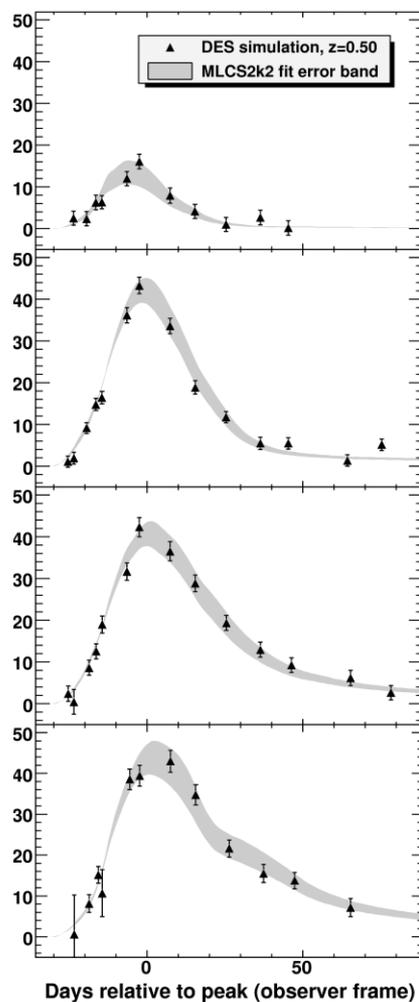
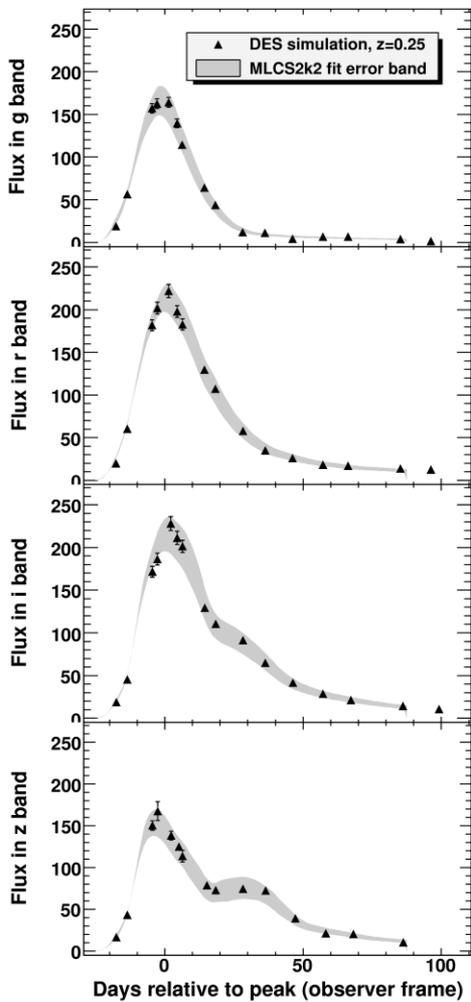
Summary & Conclusions

- DES will observe ~3000 well-measured Type Ia SNe out to $z \sim 1$
- Understanding of non-Ia contamination well developed
- DES+VIDEO Survey advantage under investigation
- Systematics studies underway
- DES-SN strategy simulation paper to be submitted soon
- Follow-on, detailed DES+VIDEO SN paper next

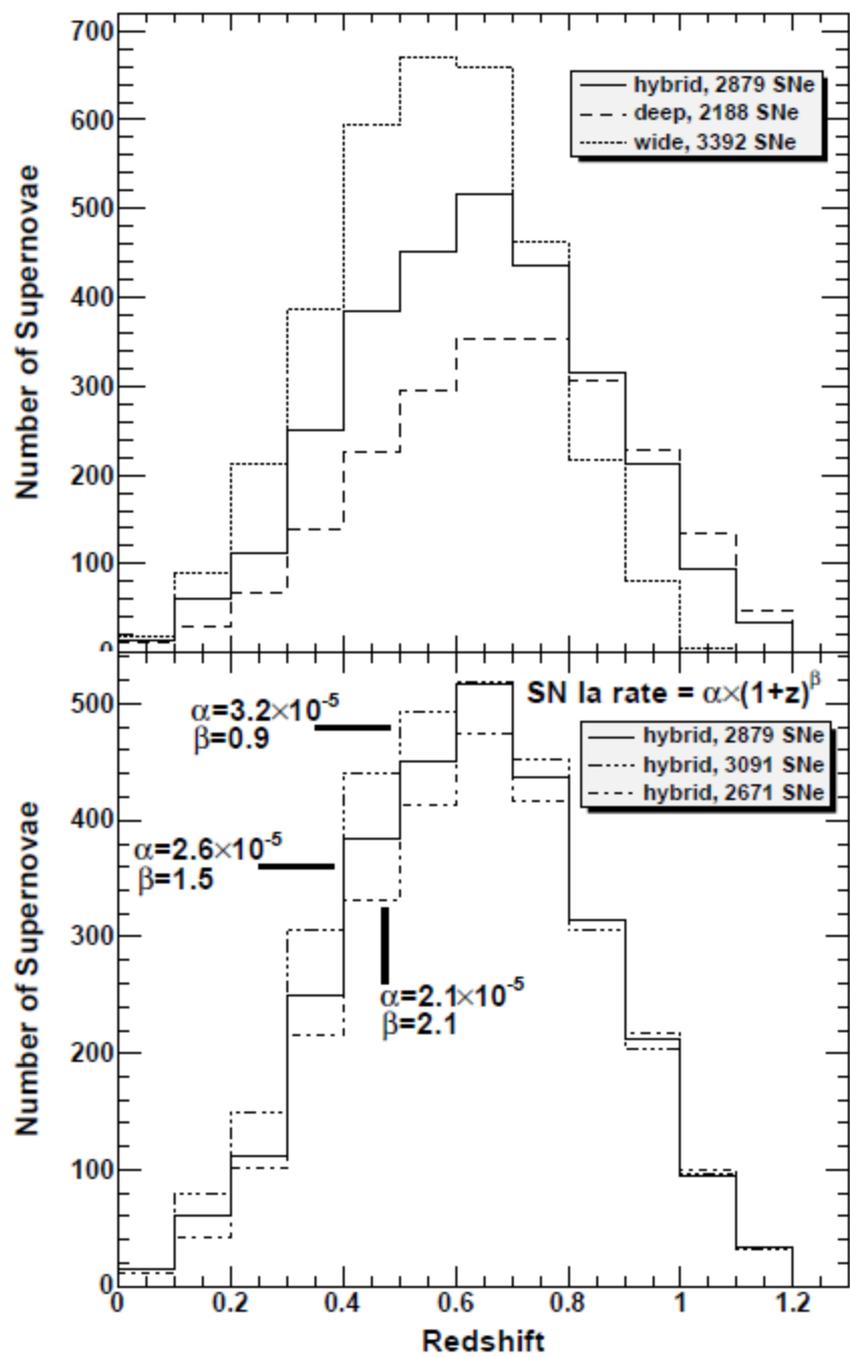
Backup



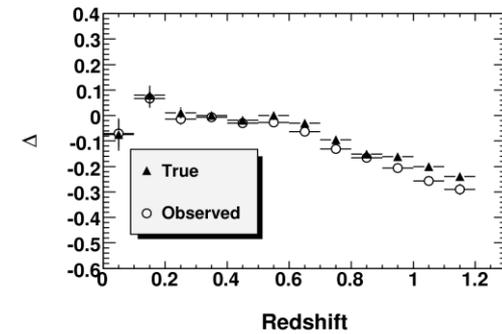
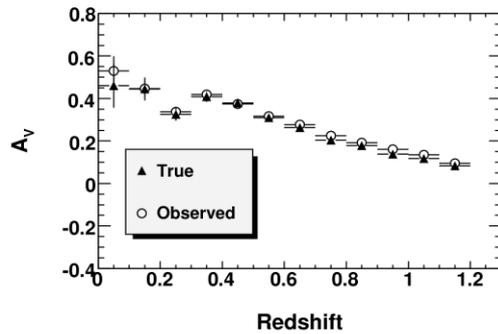
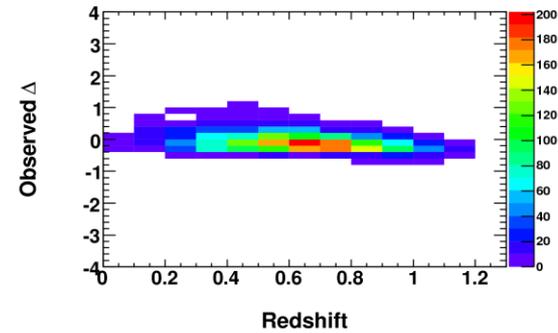
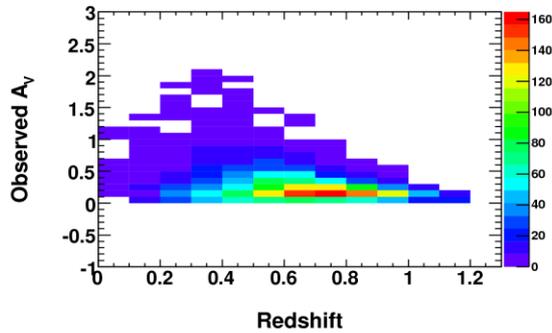
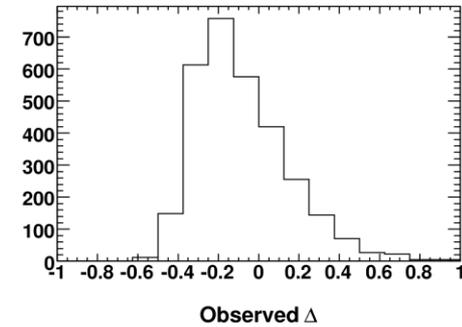
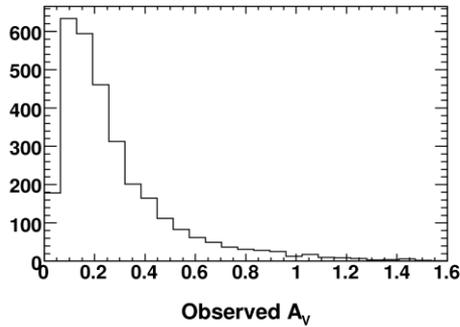
Example Simulated MLCS2k2 DES SN Ia Light Curves



Number Of Supernovae For Different Strategies



Extinction (A_V) and Light Curve Shape Parameter (Δ)



Photometric Redshifts

