SDSS-II SN Survey

Peter Garnavich
Notre Dame

and the SDSS-II SN collaboration

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SDSS-II SN Collaboration

J. Frieman

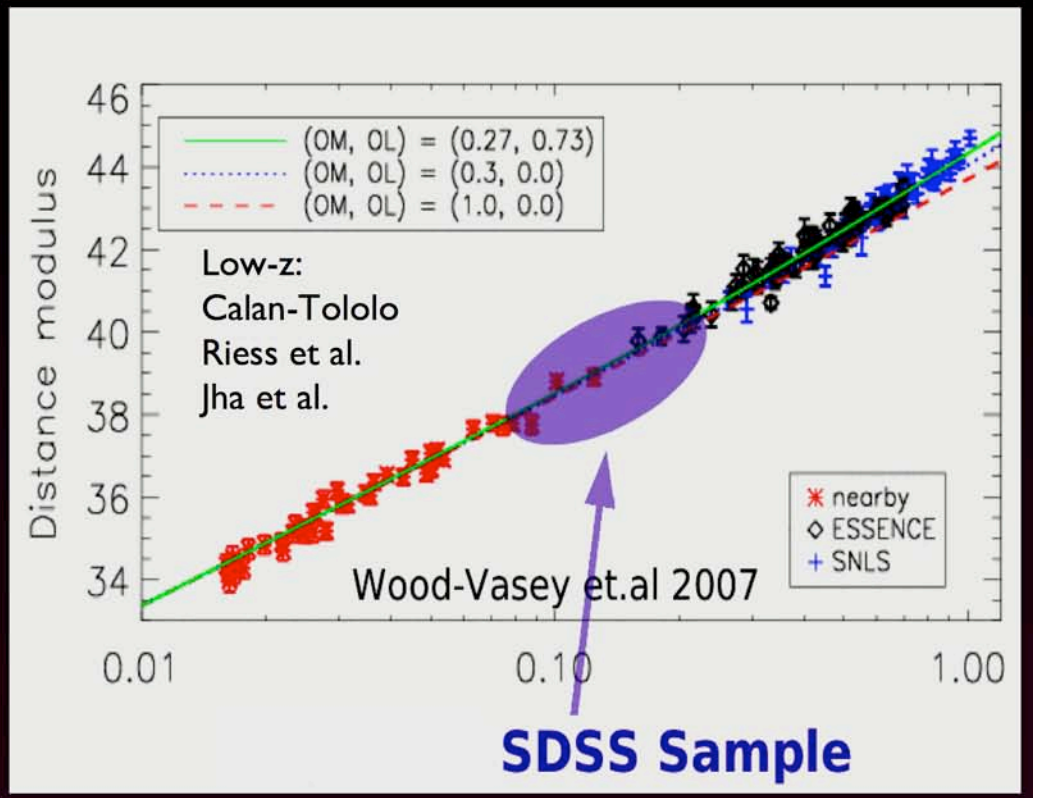
Fermilab	F. DeJongh, J. Marriner, D. McGinnis, G. Miknaitis
U. Chicago	B. Dilday, R. Kessler
APO	H. Brewington, J. Dembicky, M. Harvanek, J. Krzesinski, B. Ketzeback, D. Long, O. Malanushenko, V. Malanushenko, R. McMillan, K. Pan, G. Saurage, S. Snedden, S. Watters
SAAO	B. Bassett, K. van der Heyden
U. Washington	A. Becker, C. Hogan
U. Munich	R. Bender, U. Hopp
Seoul Natl. U.	C. Choi, M. Im
Wayne State U.	D. Cinabro
Ohio State U.	D. L. DePoy, J. L. Prieto
U. Tokyo	M. Doi, K. Konishi, T. Morokuma, N. Takanashi, K. Tokita, N. Yasuda
U. Notre Dame	P. Garnavich
NM State U.	J. Holtzman
KIPAC/Stanford	S. Jha, R. Romani, C. Zheng
U. Göttingen	W. Kollatschny
STScI	H. Lampeitl, A. Riess
U. Portsmouth	R. Nichol, M. Smith
Rochester IT	M. Richmond
U. Pennsylvania	M. Sako
Penn State U.	D. Schneider
U. Texas	C. Wheeler

with help from: J. Eastman, L. Watson, R. Assef, K. Schlesinger, A. Crotts, M. Stritzinger, J. Sollerman, A. Goobar, G. Leloudas, R. J. Foley, A. V. Filippenko, A. Aragon-Salamanca, M. Bremer, M. Turatto, P. Ruiz-Lapuente, F. Castander, A. Romer, C. Collins, J. Lucey, A. Edge, Y. Ihara

SN Ia Hubble Diagram

- Main goals of the SDSS SN survey:
- => fill in the SN Ia Hubble diagram at intermediate redshift, $0.1 \lesssim z \lesssim 0.3$
- => connect low-z with high-z
- => confirm concordance cosmology (or not!)
- => create a large, uniform sample of well-studied SNIa + hosts

- Challenges
  - =>peak magnitudes m ≃ 20-22
  - =>need to search hundreds of deg^2



→ SDSS 2.5m telescope + imager

http://sdssdp47.fnal.gov/sdsssn/sdsssn.html

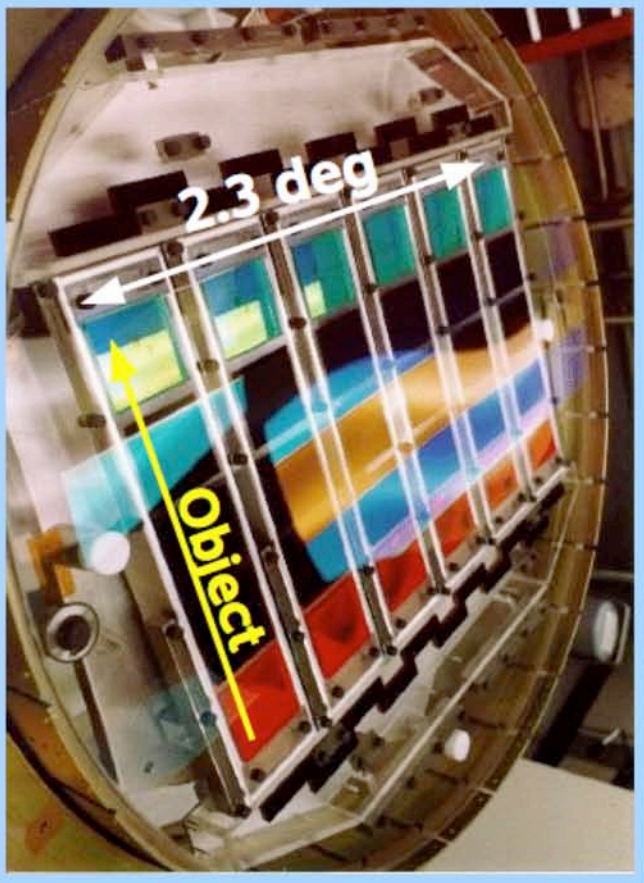
Apache Point Observatory
Southern New Mexico

2.5 m f/5 modified Ritchey-Chretien
- camera (u,g,r,i,z)
- spectrograph (640 fibers)

ARC-3.5m

NMSU-1m

0.5m photometric telescope (PT)

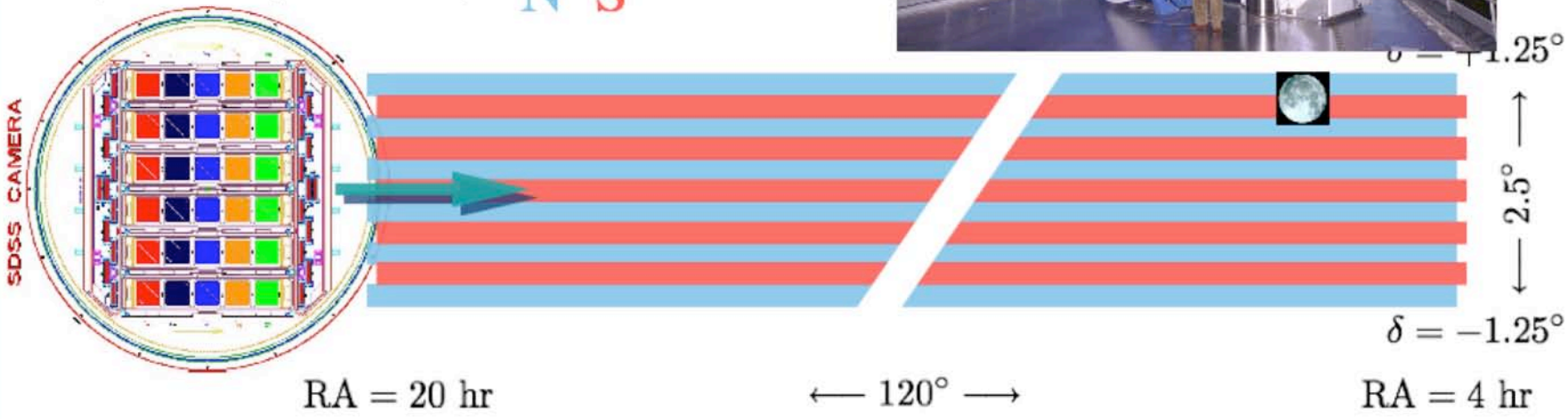


u	g	r	i	z
22.0	22.2	22.2	21.3	20.5

56 sec to cross a chip

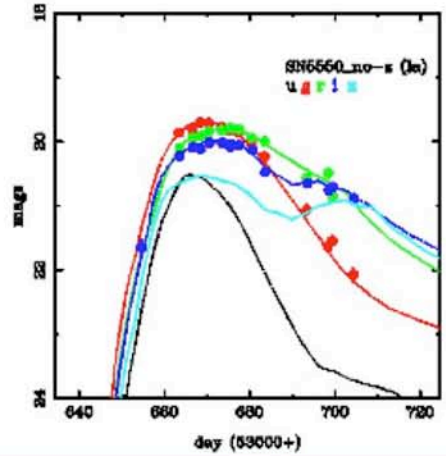
SNe Survey

September 1 – November 30 of 2005-2007
Scan 280 sq. degrees every 2 days
multi-color light curves
spectroscopic followup



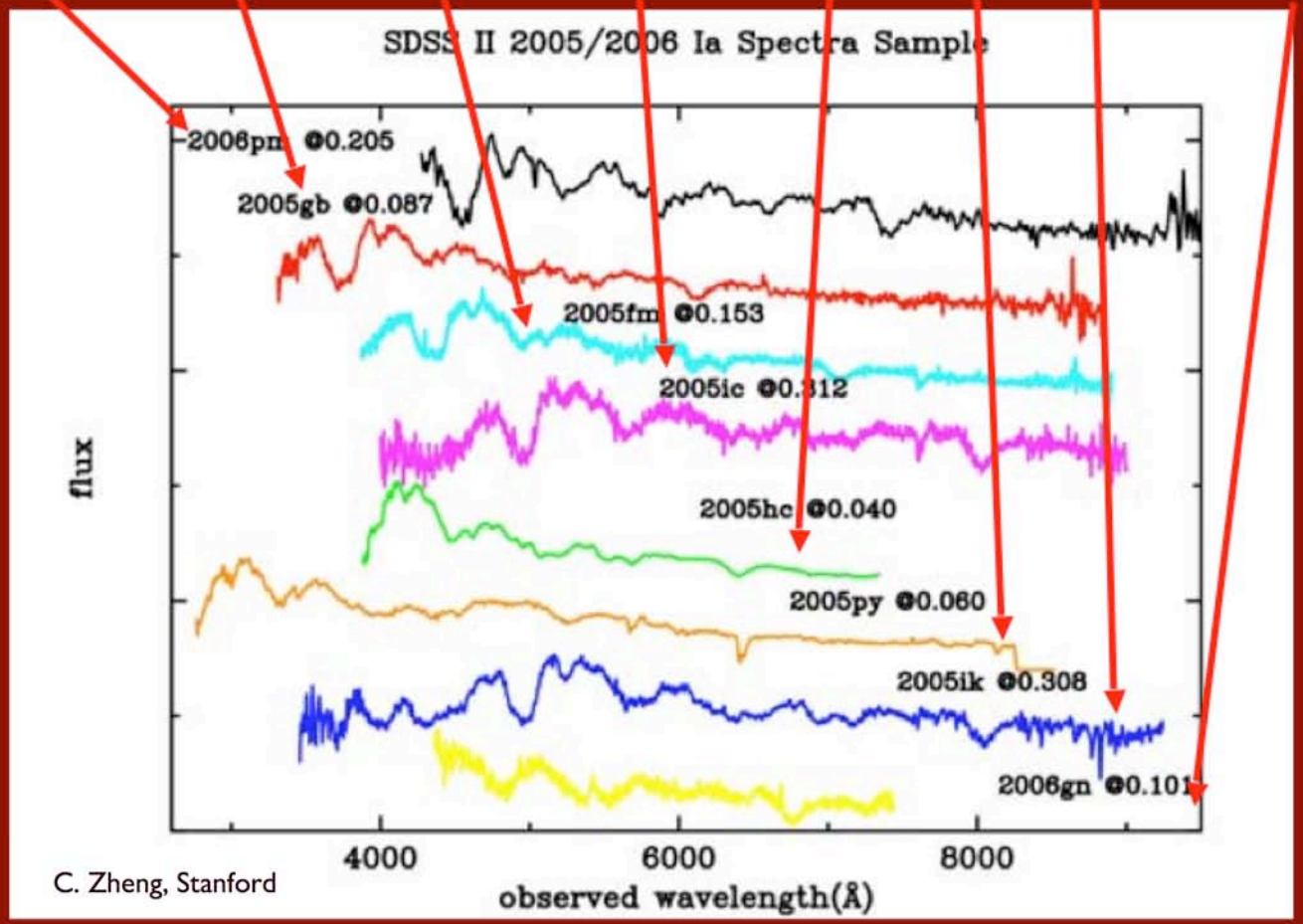
Drift scanning is very efficient: no readout time or filter changes.

SDSS scans at 20 square degrees/hour



SDSS SN Spectroscopy

HET ARC WHT Subaru MDM NTT KECK SALT



+KPNO 4m

After Two Full Innings…

Scans processed at APO during the day including template subtraction and initial residual identification.

Template is created from ~10 good seeing scans taken before 2004.

Hand-scan (humans) within 24 hours:

bad subtractions (dipoles)
asteroids (slow moving)
ghosts near bright stars

Number of bad candidates greatly reduced in 2006=> color filter on asteroids and wait for two epoch detection
(not great for transients)

	2005	2006
nights on 2.5m	59	60
runs	73	90
objects scanned	190,020	14,441
SN candidates	11,385	3694
confirmed SN Ia	**129**	**193**
probable SN Ia	**16**	**15**
SN Ia host z	**80**	**0**

improved "junk" filter; trained with 2005 data.

322 SN Ia in two seasons!

Expect ~500 spec confirmed total in 3 years

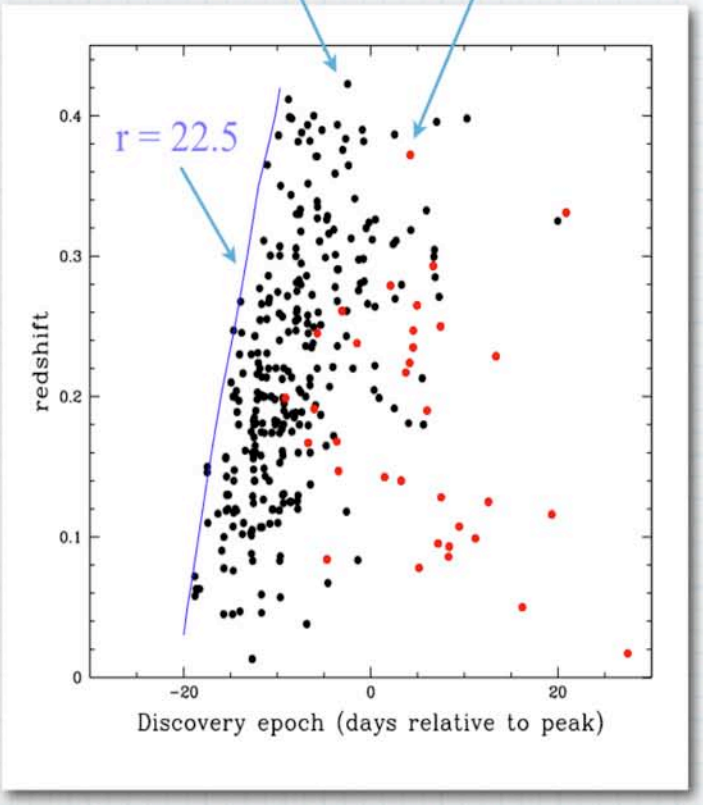
> 50% of 2005 frames are ***not*** survey quality.

2005 & 2006 Seasons

Detect transients to r=22.5

peaked after Sept. 7

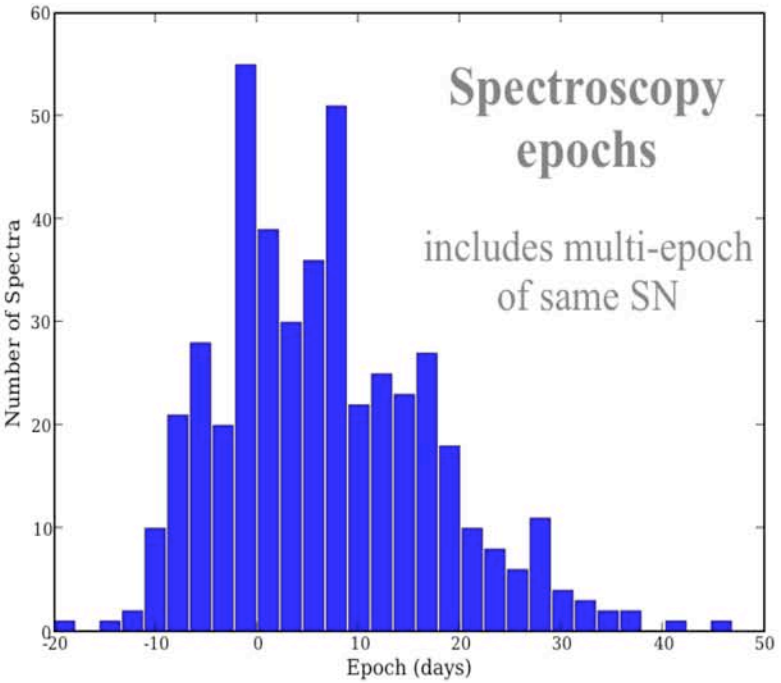
peaked before Sept. 7



J. Frieman

> 85% of SN Ia discovered before maximum light

Follow-up spectrum usually obtained after **~2 - 4 epochs** (~90% confirmation efficiency for SN Ia).

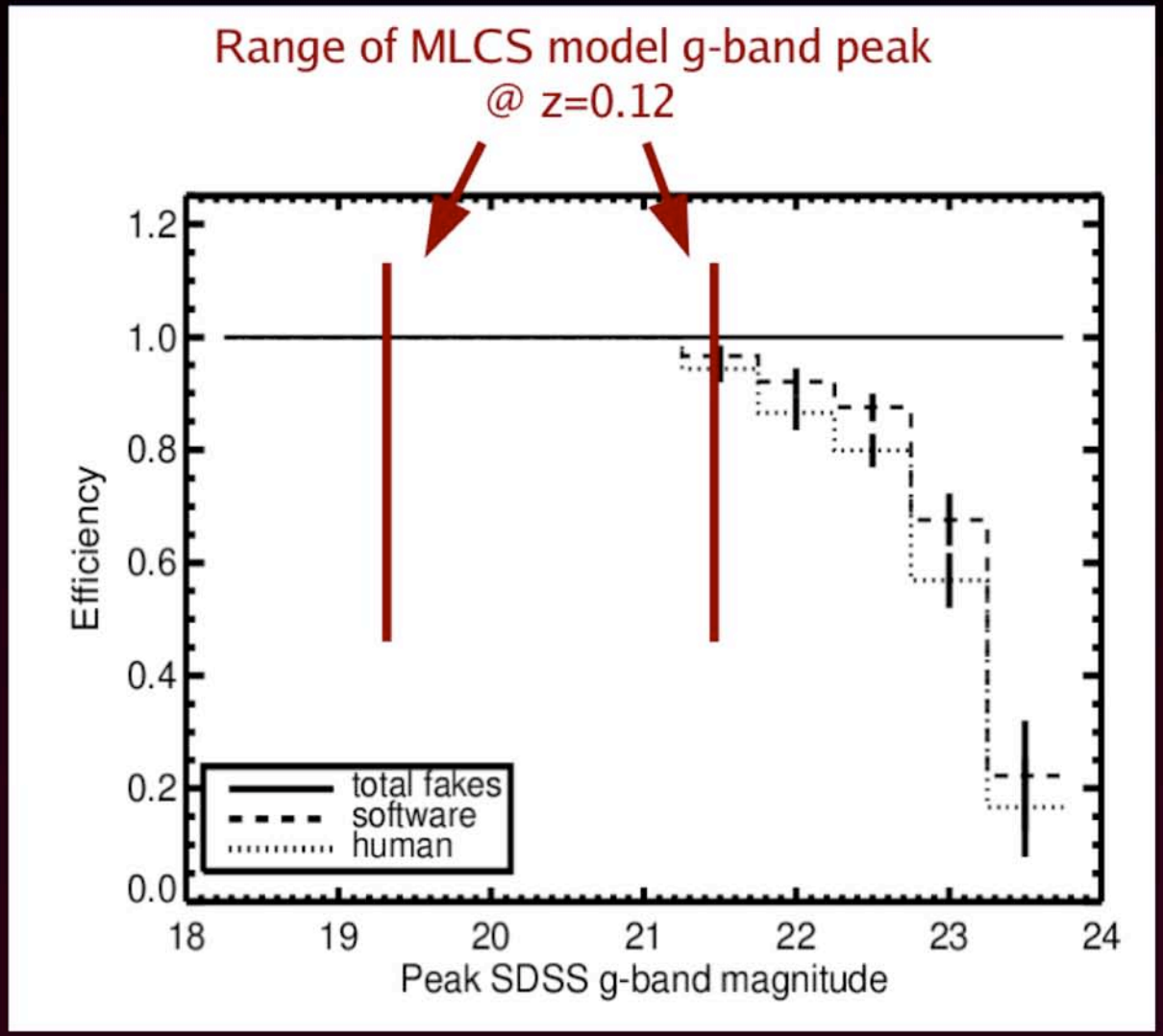


A. Becker

also attempted **20 single-epoch** candidates (**15** SNe, **1** galaxy, **2** noise, **2** asteroids)

Efficiency of Finding Fakes

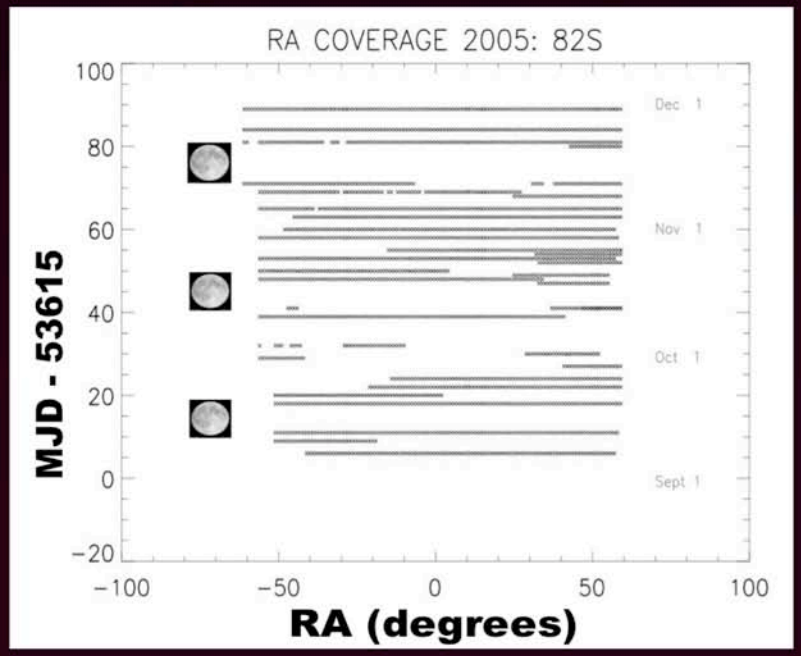
100% at g<21.3 50% at g=23.3 (includes fakes in host core)

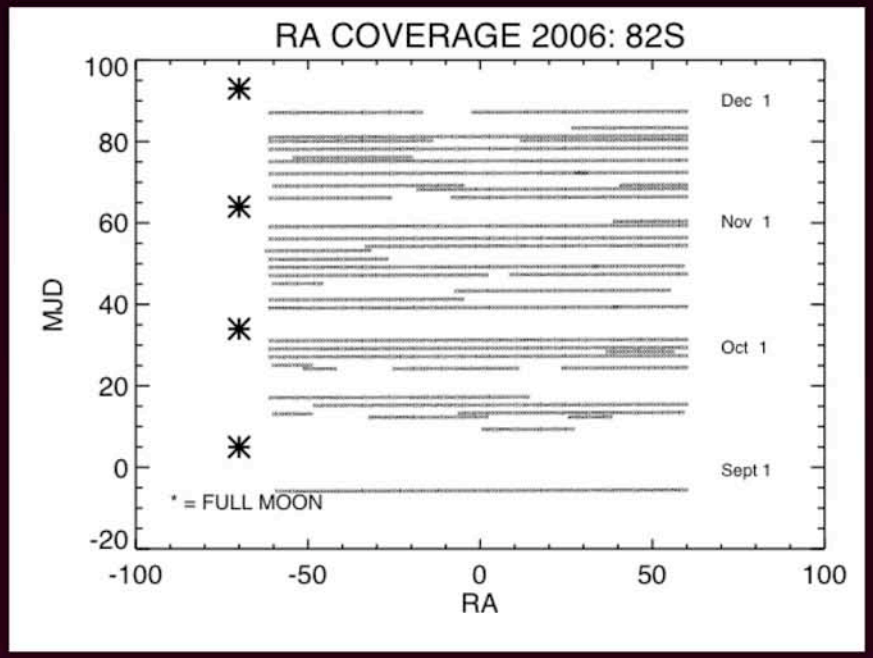


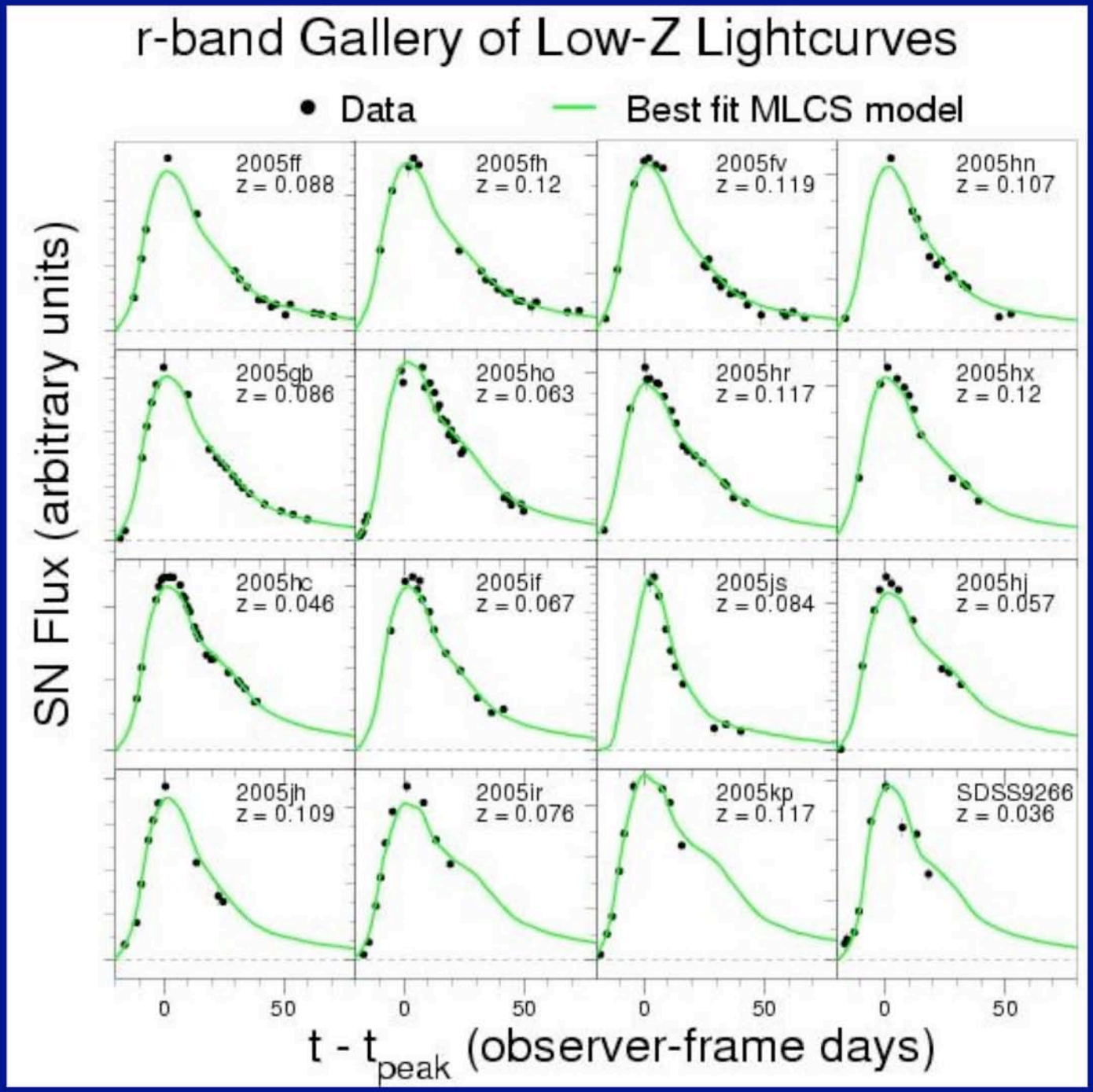
Ben Dilday

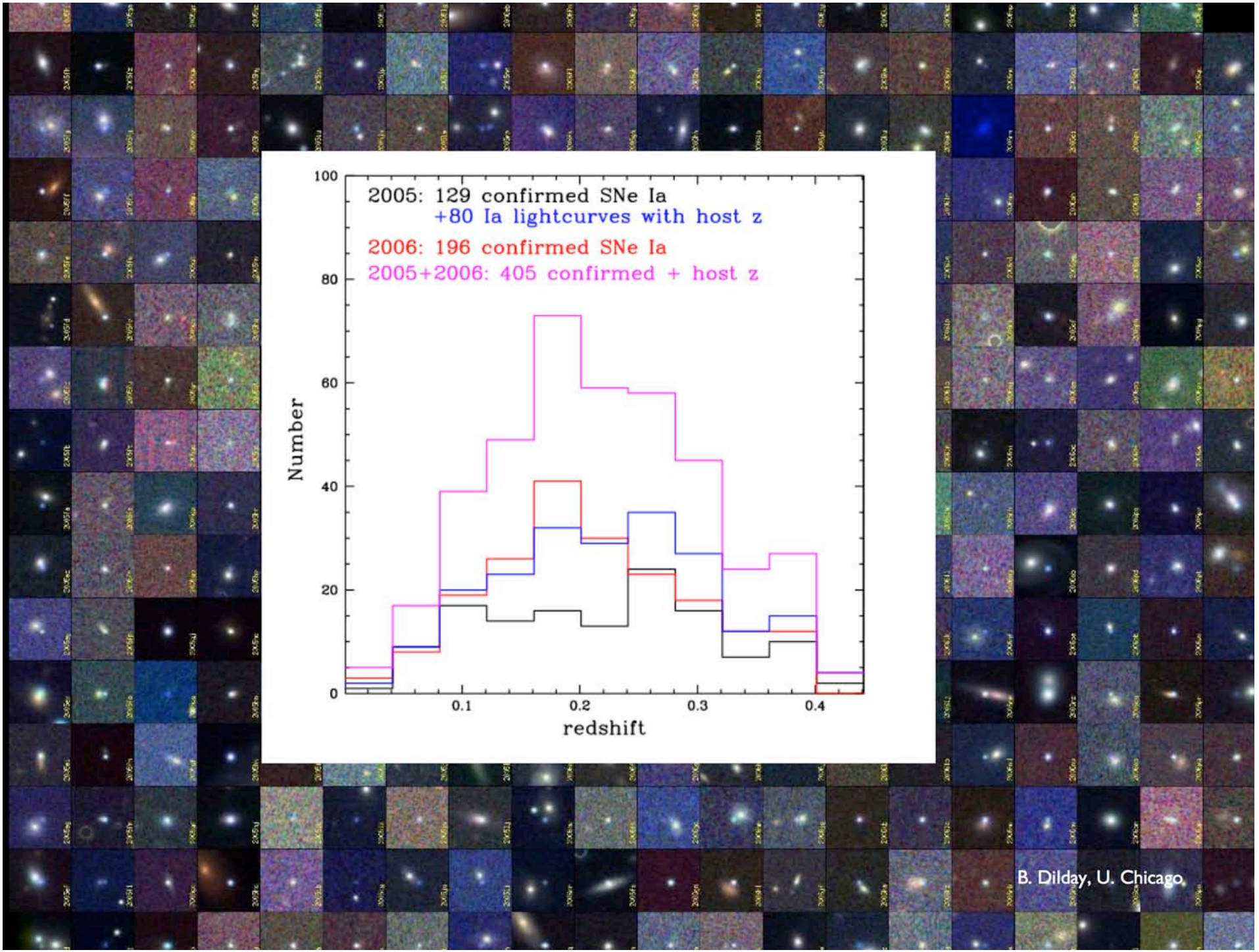
SDSS SN Search Properties

- 3 months/year for 3 years (two down, one to go)
- Pointless/democratic (volume) search
- 280 square degrees search area (stripe 82N + 82S)
- cadence: every other day
- ugriz simultaneously - but u and z only useful for bright Sne
- Excellent photometric calibration using SDSS natural system
- transient detection at r=22.5 mag
- galactic latitude > 30 deg
- image scale 0.4 arcsec/pix

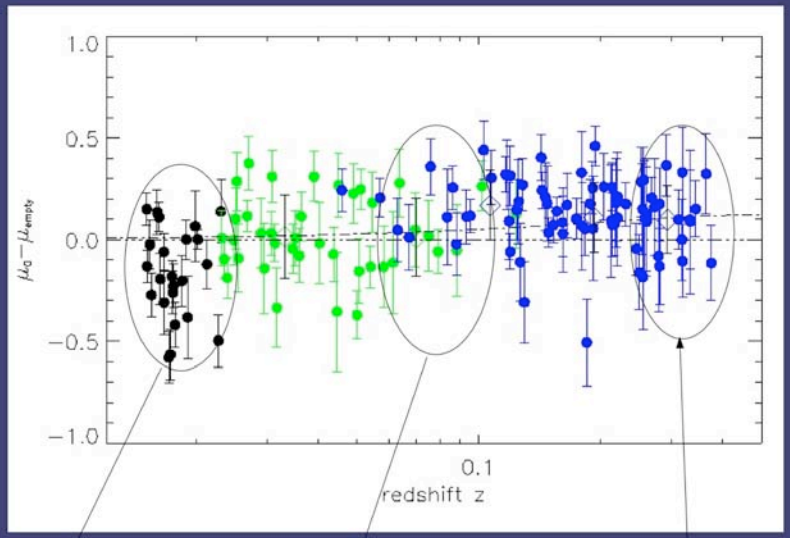





r-band Gallery of Low-Z Lightcurves
Data
Best fit MLCS model
SN Flux (arbitrary units)
2005ff
z = 0.088
2005fh
z = 0.12
2005fv
z = 0.119
2005hn
z = 0.107
2005qb
z = 0.086
2005ho
z = 0.063
2005hr
z = 0.117
2005hx
z = 0.12
2005hc
z = 0.046
2005if
z = 0.067
2005js
z = 0.084
2005hj
z = 0.057
2005jh
z = 0.109
2005ir
z = 0.076
2005kp
z = 0.117
SDSS9266
z = 0.036
0
50
t - t peak (observer-frame days)


2005: 129 confirmed SNe Ia
+80 Ia lightcurves with host z
2006: 196 confirmed SNe Ia
2005+2006: 405 confirmed + host z
Number
redshift
0
20
40
60
80
100
0.1
0.2
0.3
0.4
B. Dilday, U. Chicago

SDSS SN Hubble diagram
from fall 2005 data
129 SN Ia in all, 74 "clean"
SN Ia for cosmology
(cuts on number of epochs and
epochs around maximum)



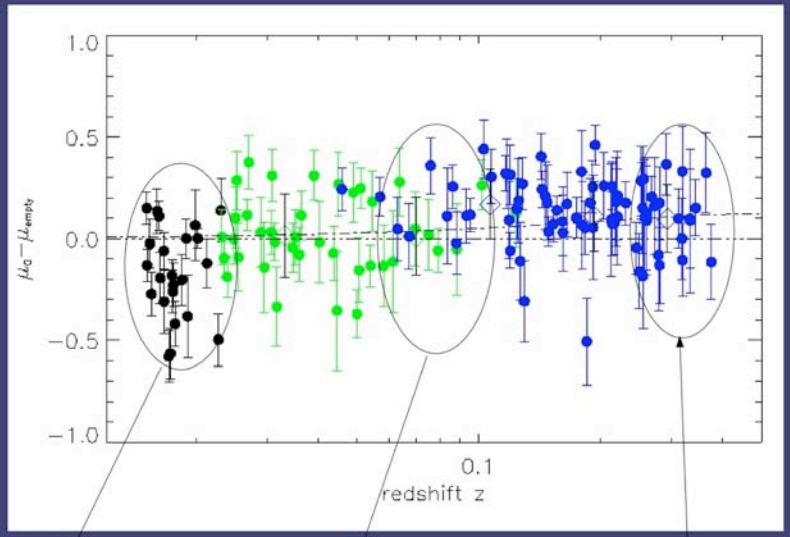
Hubble Bubble?
(Jha, 2006,
astro-ph/0612666)

zeropoints
passbands
k-corrections

Selection bias at
the faint end?

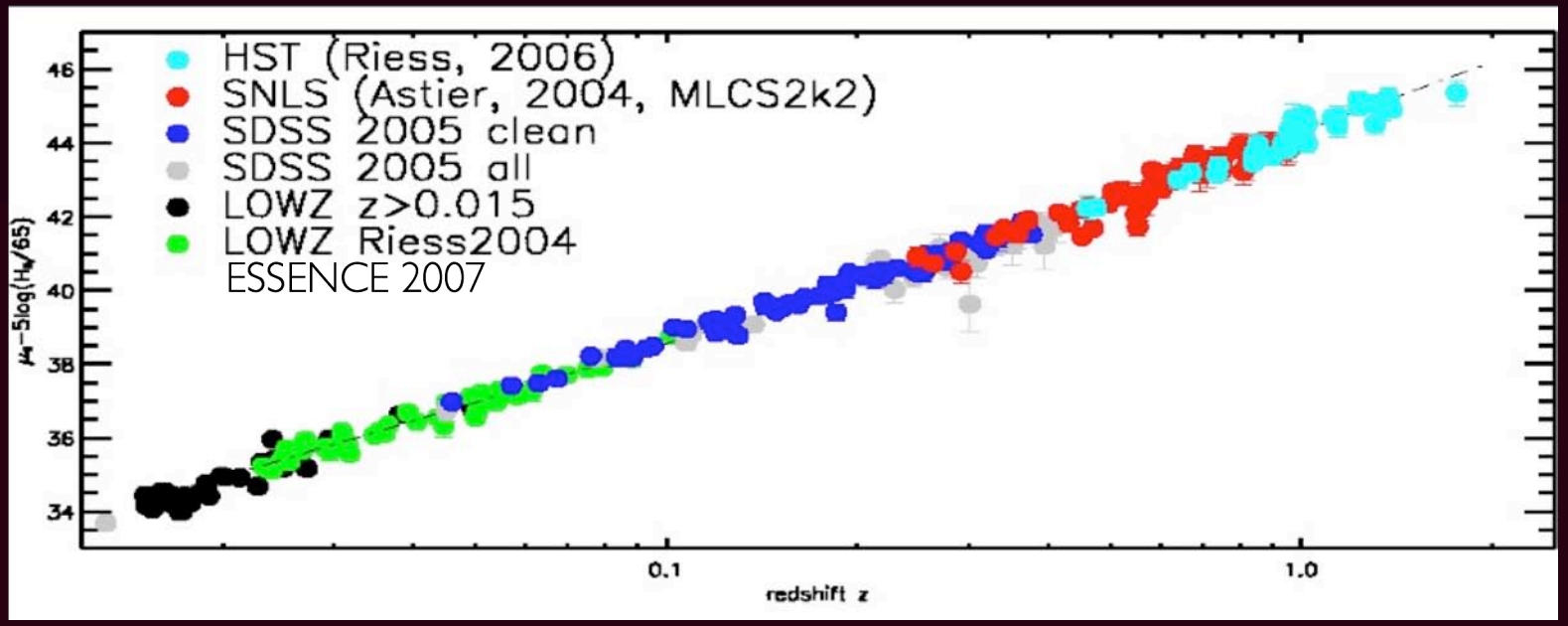
SDSS SN Hubble diagram
from fall 2005 data
129 SN Ia in all, 74 "clean"
SN Ia for cosmology
(cuts on number of epochs and
epochs around maximum)

for the first time we have a
continuous expansion history
measured from SN to z > 1



Lampeitl

209th AAS Meeting, Seattle, January 2007



SDSS SN Survey Status

- Preparing initial year papers on cosmology, rates, photometry, hosts…
- Extensive simulations to check for systematics
- Developing a new light curve fitting program - MLCS-like with flux fitting
- Simulate other surveys (SNLS, ESSENCE, Higher-Z) to check their systematics and make uniform Hubble diagram
- Preparing for final season in the fall

DARK ENERGY
SURVEY

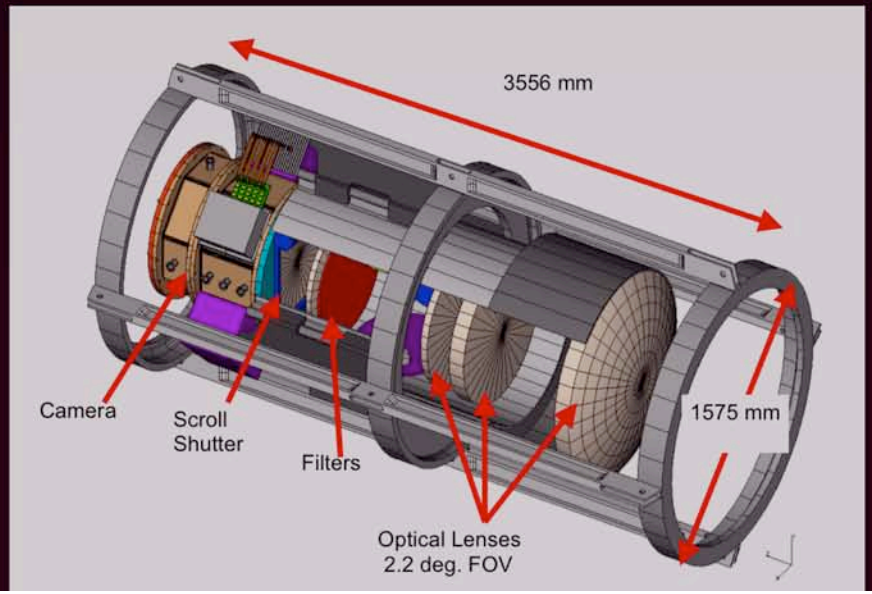
DES Supernova Survey

Masao Sako (Penn)
for the DES SN Working Group Team

FNAL - May 1, 2007

DES Outline

- Improved CTIO 4m
- 5000 square deg South Gal. Cap
- New camera with 3 sqr deg FOV
- griz filters
- Supernova search/ weak lensing cluster abundance/ clustering
- Observations begin fall 2010
- 5 year survey (525 nights total)



DECam

Blanco CTIO 4m

Dark Energy with Supernova

- Fundamental goals of DES SN Survey:
  - **Provide a large sample of high-redshift SN Ia** (redshift > 0.7) with good rest-frame *g*-band (observer-frame *z*-band) light curves.
    - possible with enhanced red sensitivity of DECam.
  - **Study and minimize systematic uncertainties -** dust extinction, photometric calibration, K-corrections
    - requires high-quality multi-band SN light curves on a well-understood photometric system.

low-dispersion

Present/Near-future Surveys

High-z

CFHT SNLS : 3.5m CFHT, *griz*
(2003 - 2007), 4 deg^2

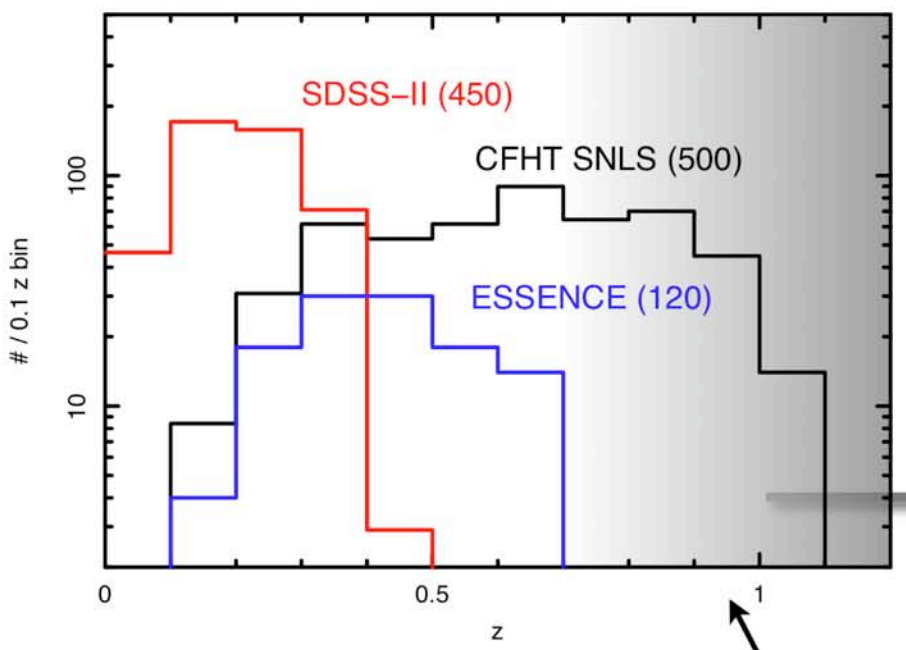
ESSENCE : 4m CTIO, *RI*
(2001 ~ 2006), XX deg^2

Mid-z

SDSS-II : 2.5m SDSS, *ugriz*
(2002 - 2007), 300 deg^2

Low-z

LOSS, SNFactory, CSP
~80 SN Ia per year



HST
(Space)

limited to rest-frame
u-band light curves

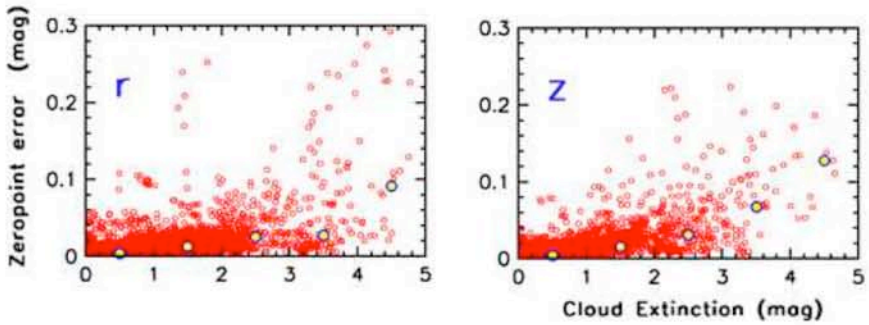
Pan-STARRS-1 (1.8m)
SkyMapper (1.4m)
to go online soon.

DARK ENERGY
SURVEY

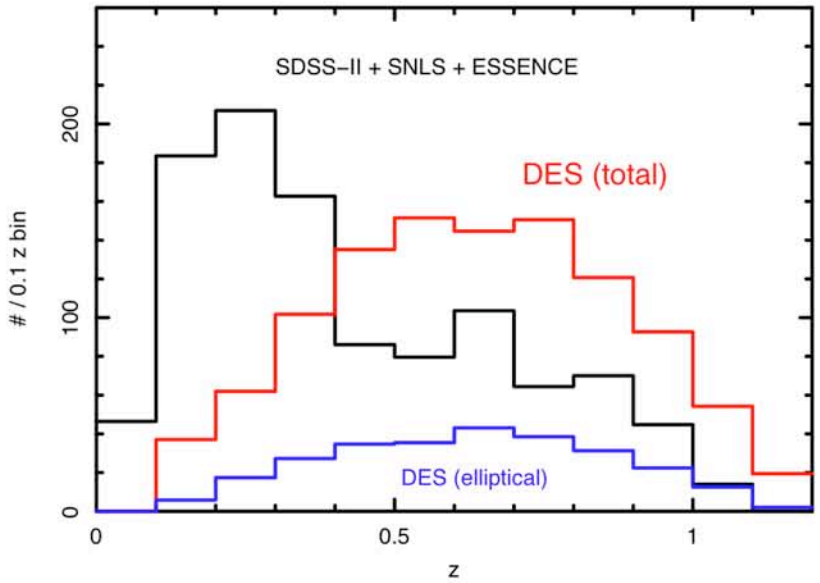
DARK ENERGY SURVEY

Current Strategy

- 6-month search seasons every year for 5 years.
- Use 750 hours of total DES observing time (e.g., 10% of photometric + 50% of non-photometric time).
  - robust point-source photometric accuracy in non-photometric conditions.



Ivezić et al. (2007) - SDSS southern stripe



- Cover 3 DES fields (9 deg^2) on a cadence of 4 - 6 days in *riz* filters (and possibly *Y-band*).
- Expect to discover ~1400 SN Ia at $0.2 < z < 1.0$.
  - ~1100 with "good" light curves

Spectroscopic Follow-up

- **Confirm SN type** and **measure redshifts**.
  - Most likely to be resource-limited.
- Public/institutional access time on 6 ~ 10 m class telescopes:
  - VLT, GTC (European DES collaborators), Gemini, Magellan, Keck, LBT (US DES collaborators)
- Realtime follow-up of a subsample of active SN Ia.
  - ~50 - 100 SN Ia per season is feasible (~300 Ia/season is ambitious).
  - possibly focus on SNe in ellipticals (purely Ia, low dust).

ALPACA Outline

- 8m Mirror (spinning Hg)
- Site selected in Chile
- Zenith pointing drift scan only
- Phase I camera => 1 deg field
- 15 sqr deg/hour
- grizy filters to r=24.5 each night
- 10000 SNIa/yr to z<0.8
- cadence => every night (duh)
- Phase I in 2011
- Phase II => 3 deg camera
- AΩ 40% of LSST at 0.1 cost

8m Spinning Mercury Mirror

Advanced Liquid-mirror Probe for Astrophysics, Cosmology and Asteroids

Crotts (Columbia) camera Hickson (UBC) telescope