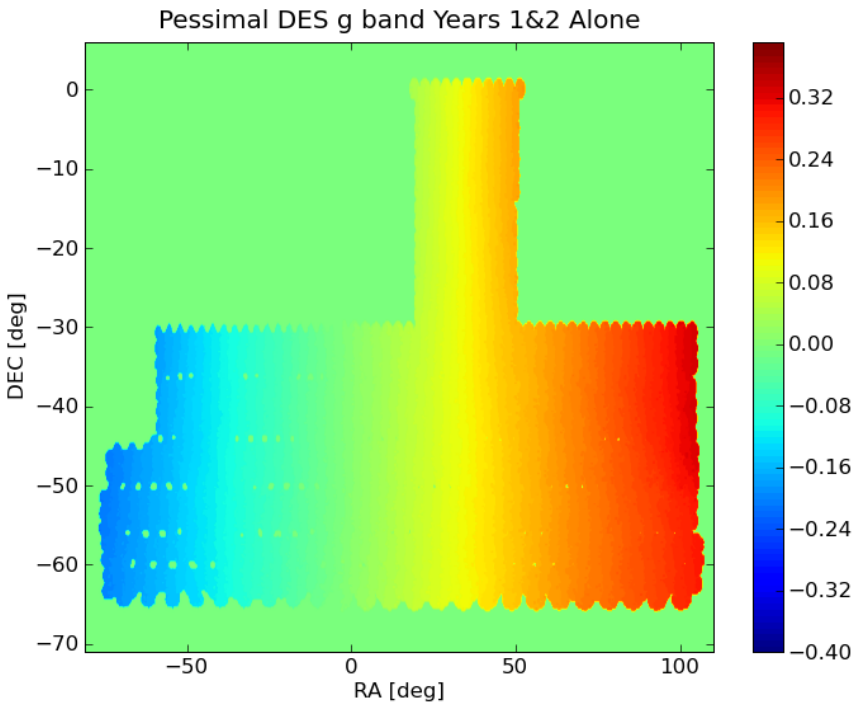
Recent Activities of the Dark Energy Survey Group at ANL (since the non-accelerator review)

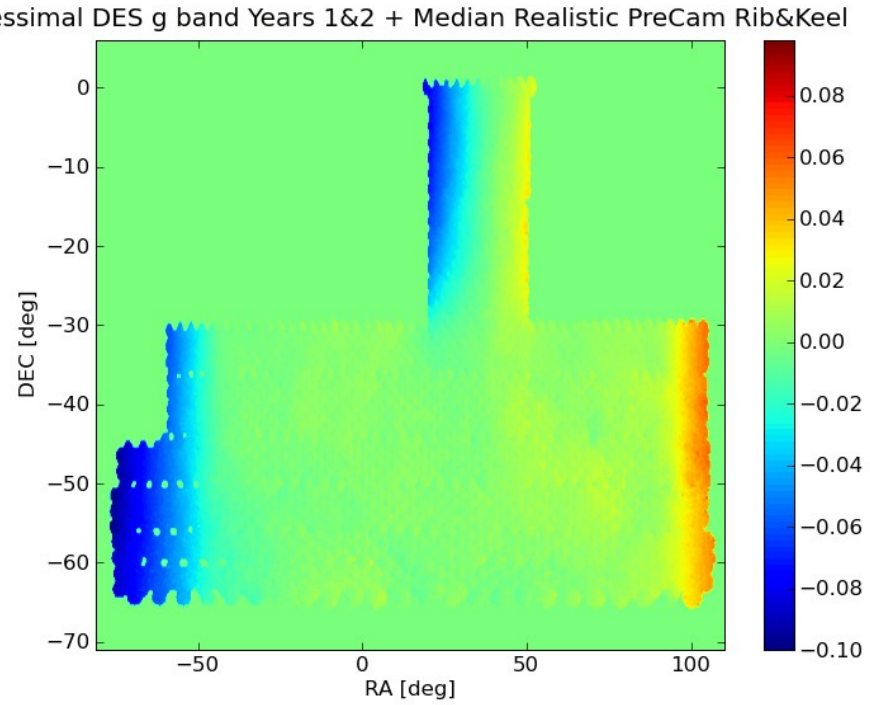
- PreCam Science Run and First Results
  - Camera designed and built by ANL
  - First tests of DECam-type Asahi filters
  - ANL leading standard-star calibrations
  - Preparing for summer review of future prospects

- DES Supernova Strategy Paper (35 2-column pages, 26 figures)
  - >3 year study coming to fruition
  - ANL-led draft under internal review
  - Blueprint for SN science without SN spectra
  - Cosmology forecasts including detailed systematics

- Important DECam mechanical roles in commissioning

Expected improvement in g band precision in first 2 DES years with PreCam (note x4 smaller color scale) D. Tucker FNAL

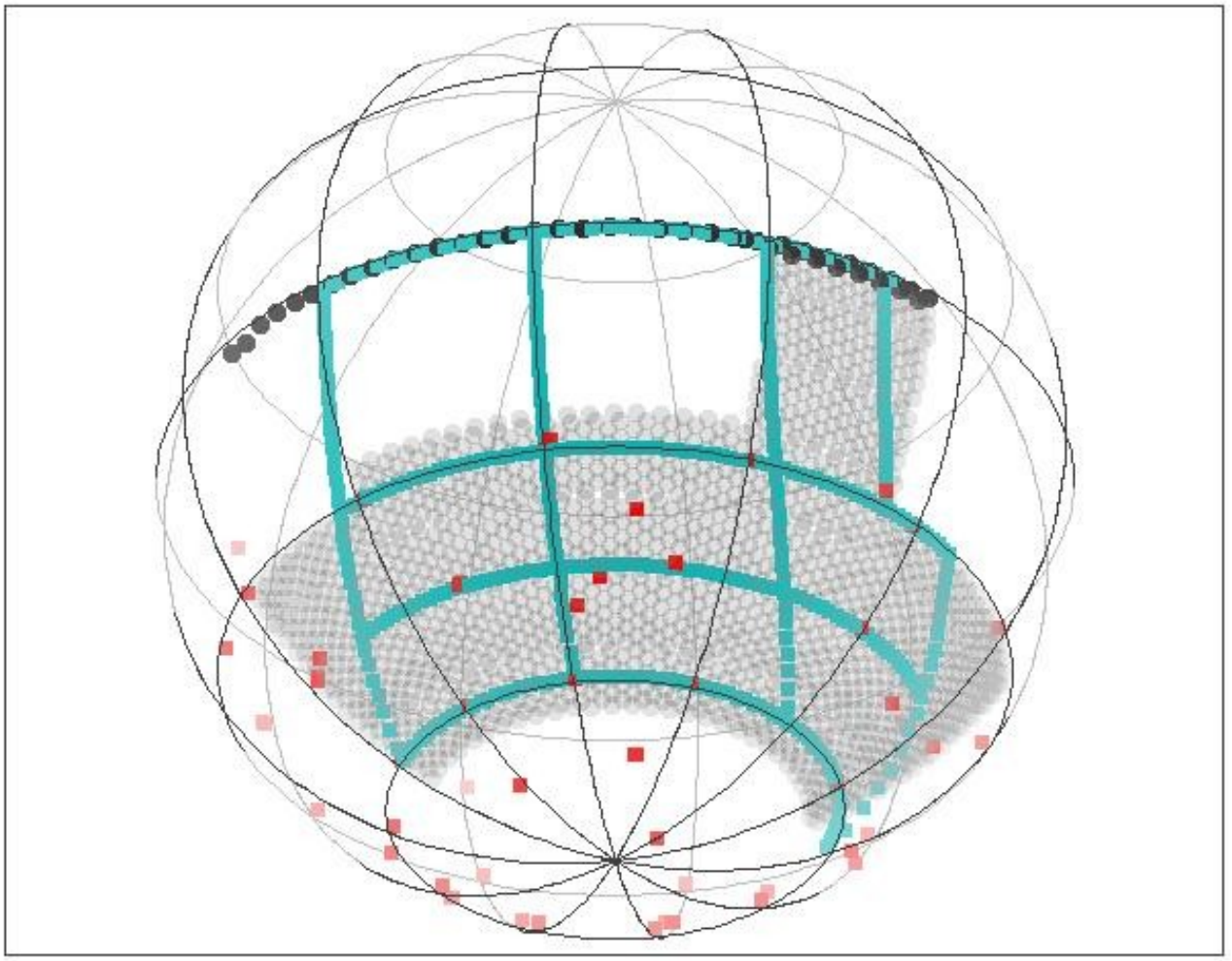




SDSS Stripe 82

PreCam Planned

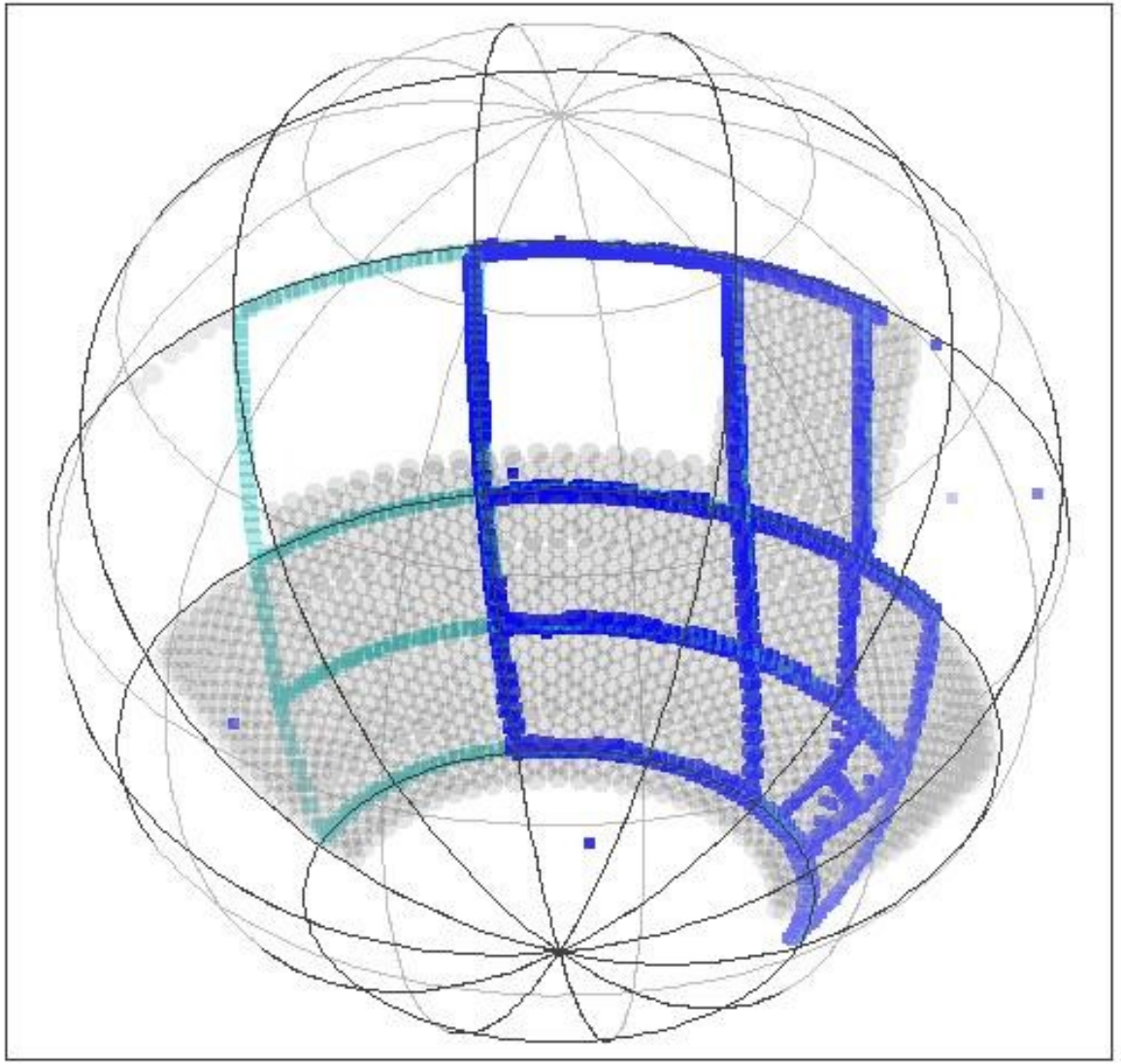
Southern Standards
(most saturate DECam)



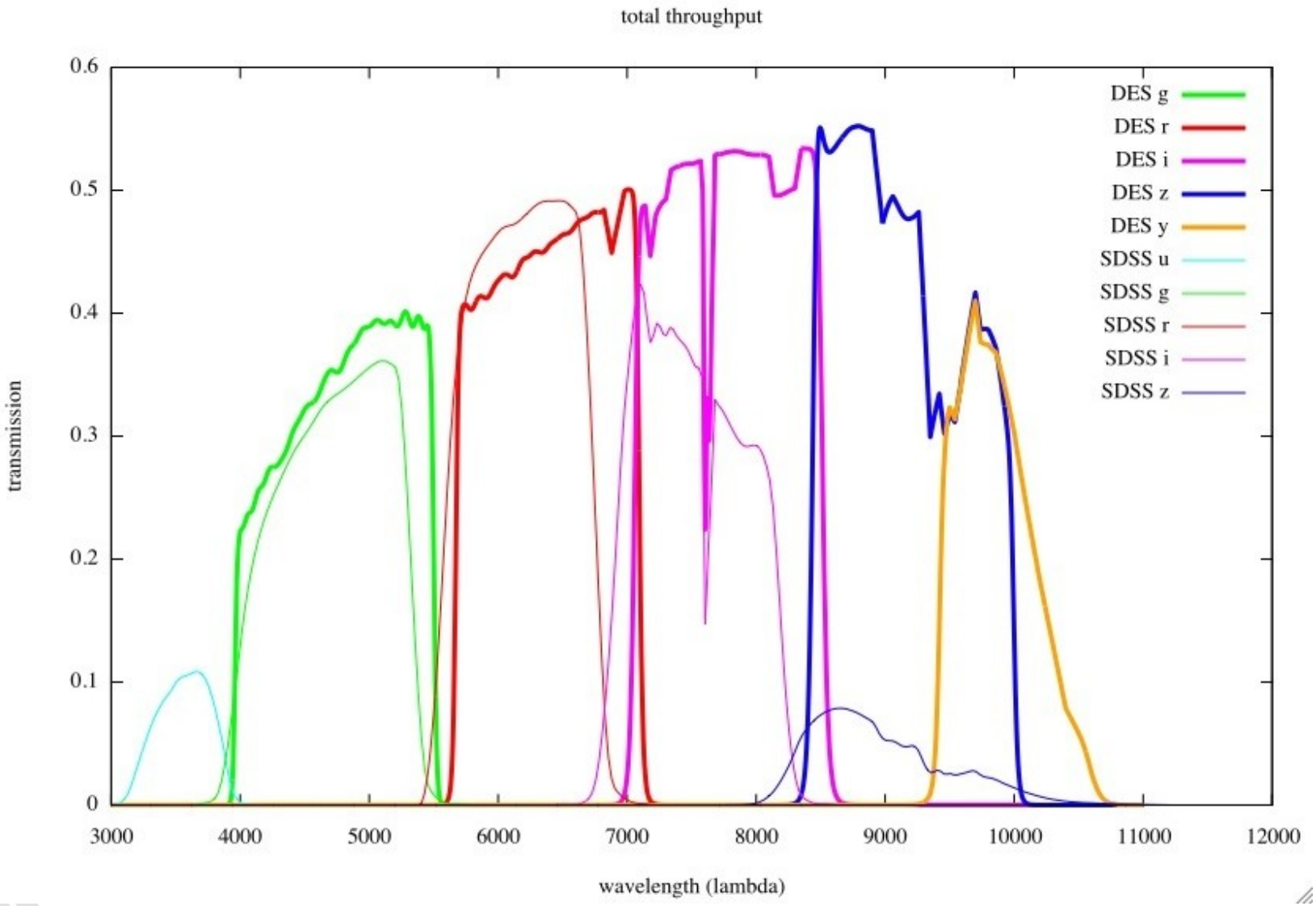
i-band coverage in Nov-Jan data.

~5 tilings in g,r,i in this partial grid

Western fields not visible at that time.



Asahi DECam filters used for PreCam (4"), first test of filter transmission and CCD QE compared to SDSS.

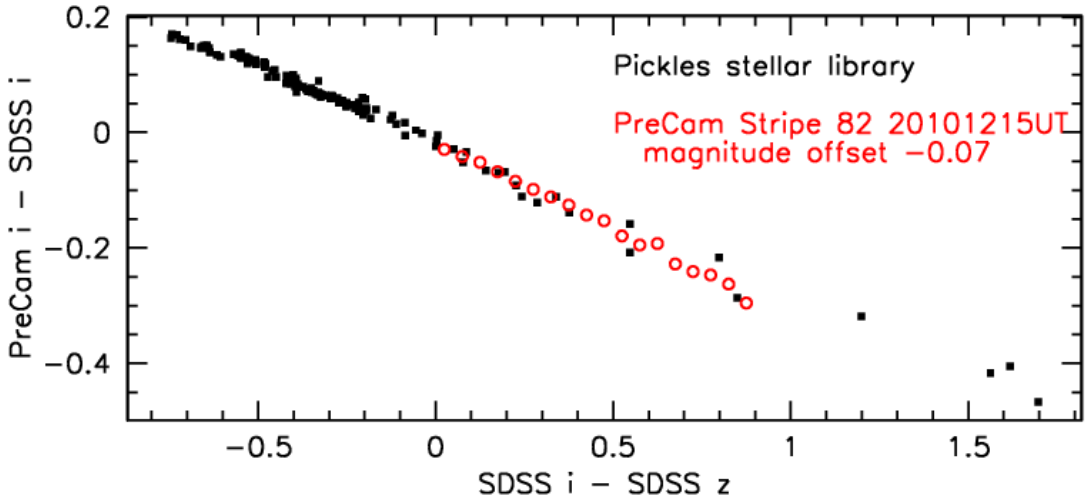


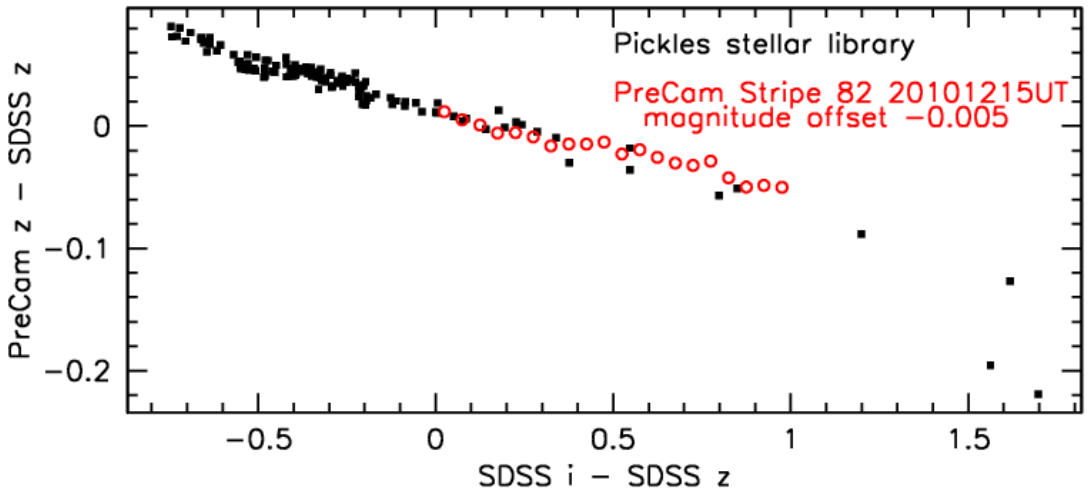
Asahi DECam filters used for PreCam, first test of filter transmission and CCD QE compared to SDSS.

Huan Lin (FNAL) analysis.

Black points are star spectra convoluted with expected PreCam and SDSS filters.

Red points are measured PreCam data compared to SDSS. Very good overlap with black points.



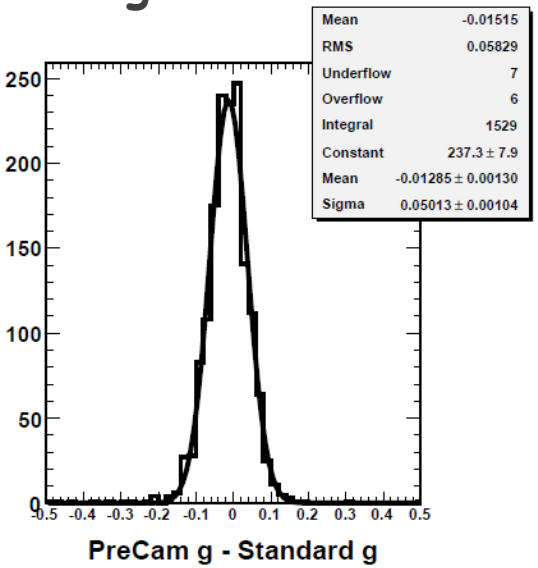


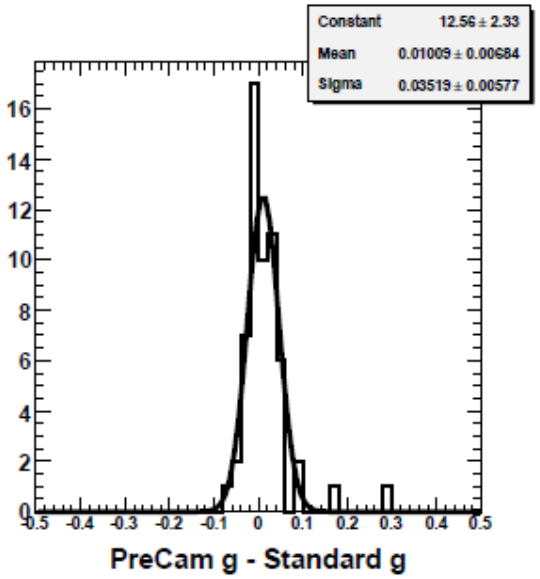
PreCam compared to Southern Standards, mostly mag<14. No corrections for color terms, vignetting, multiple tilings…

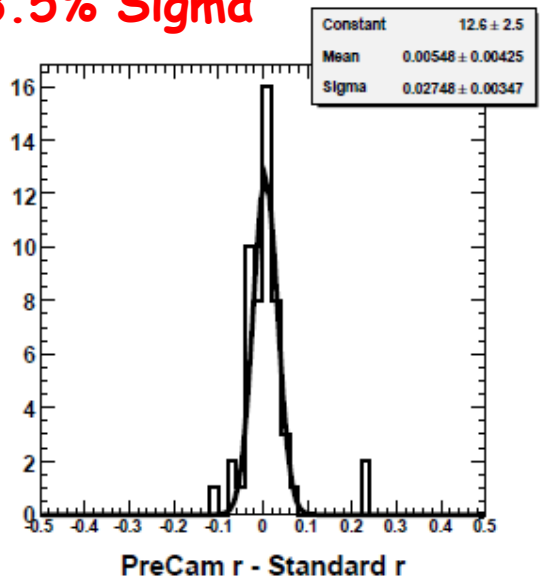
2-3.5% Sigma

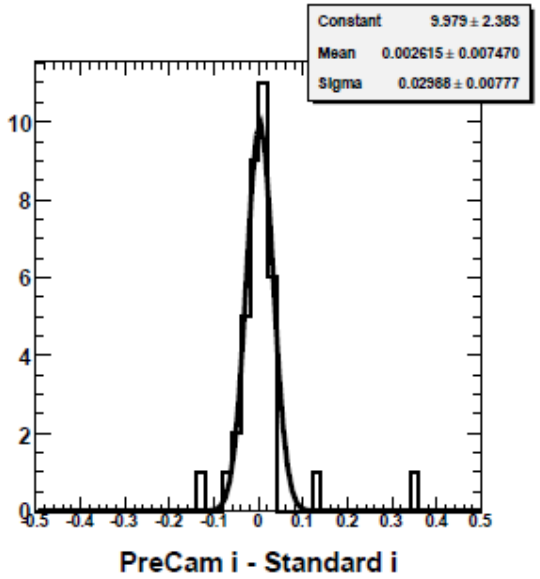
PreCam compared to SDSS Standards. Mag<16

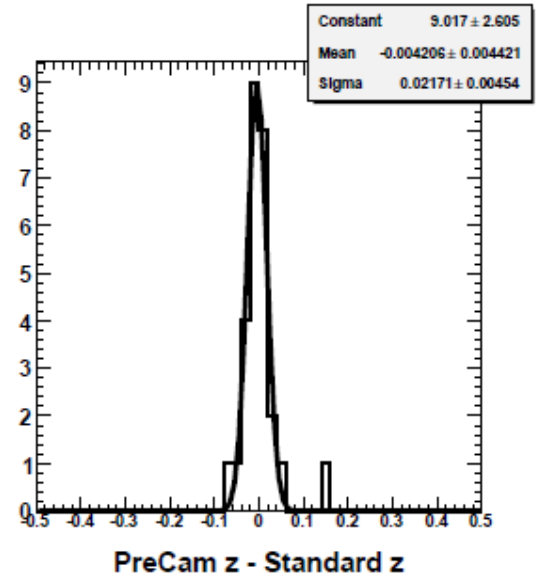
5% Sigma



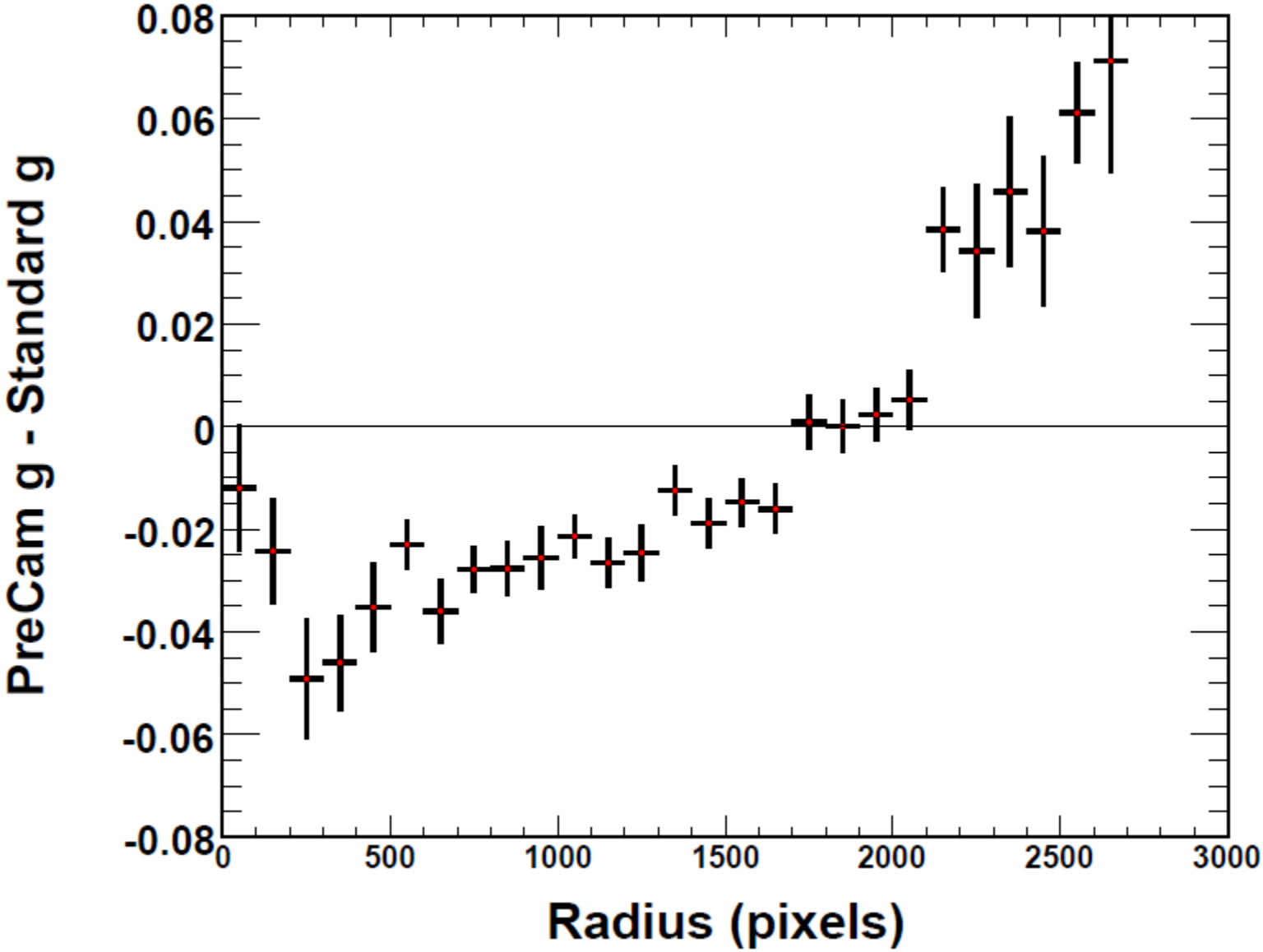








Expected vignetting due to small secondary mirror observed, future correction.



Plan is to improve precision with 1/sqrt(N-tiles).

~5 tiles in g,r,i over current coverage.

Questions for summer review:
1) How well did we calibrate PreCam?
2) What is the ultimate precision?
3) How well can we calibrate DES now?
4) How well could we do with the full survey?

Tile 1:

Tile 2:

Tile 3:

Tile 4:

Tile 5:

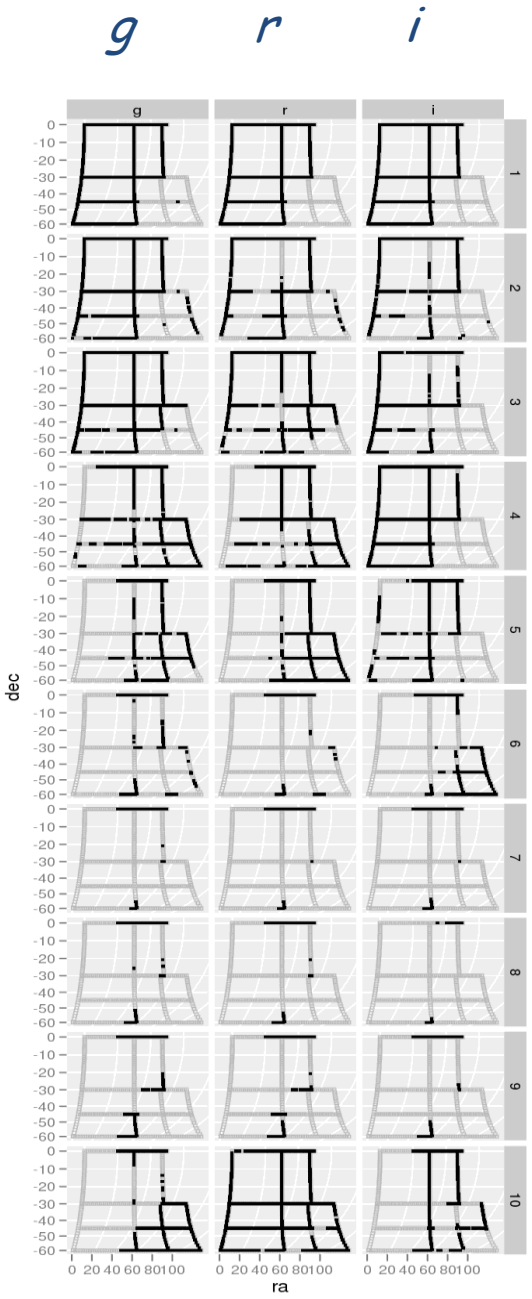
Tile 6:

Tile 7:

Tile 8:

Tile 9:

Tile 10:



Supernova Simulations and Strategies For the Dark Energy Survey

Draft: April 14, 2011, submitted for DES publication policy review (step Vi.B.5)

J. P. Bernstein[1], R. Kessler[2,3], S. Kuhlmann[1], R. Biswas[1], I. Crane[1,4], D. A. Finley[5], J. A. Frieman[2,3,5], T. Hufford[1], A. G. Kim[6], E. Kovacs[1], J. Marriner[5], P. Mukherjee[7], R. C. Nichol[8], P. Nugent[6], D. R. Parkinson[7], R. Reis[5], M. Sako[9], H. Spinka[1]. . .

ABSTRACT

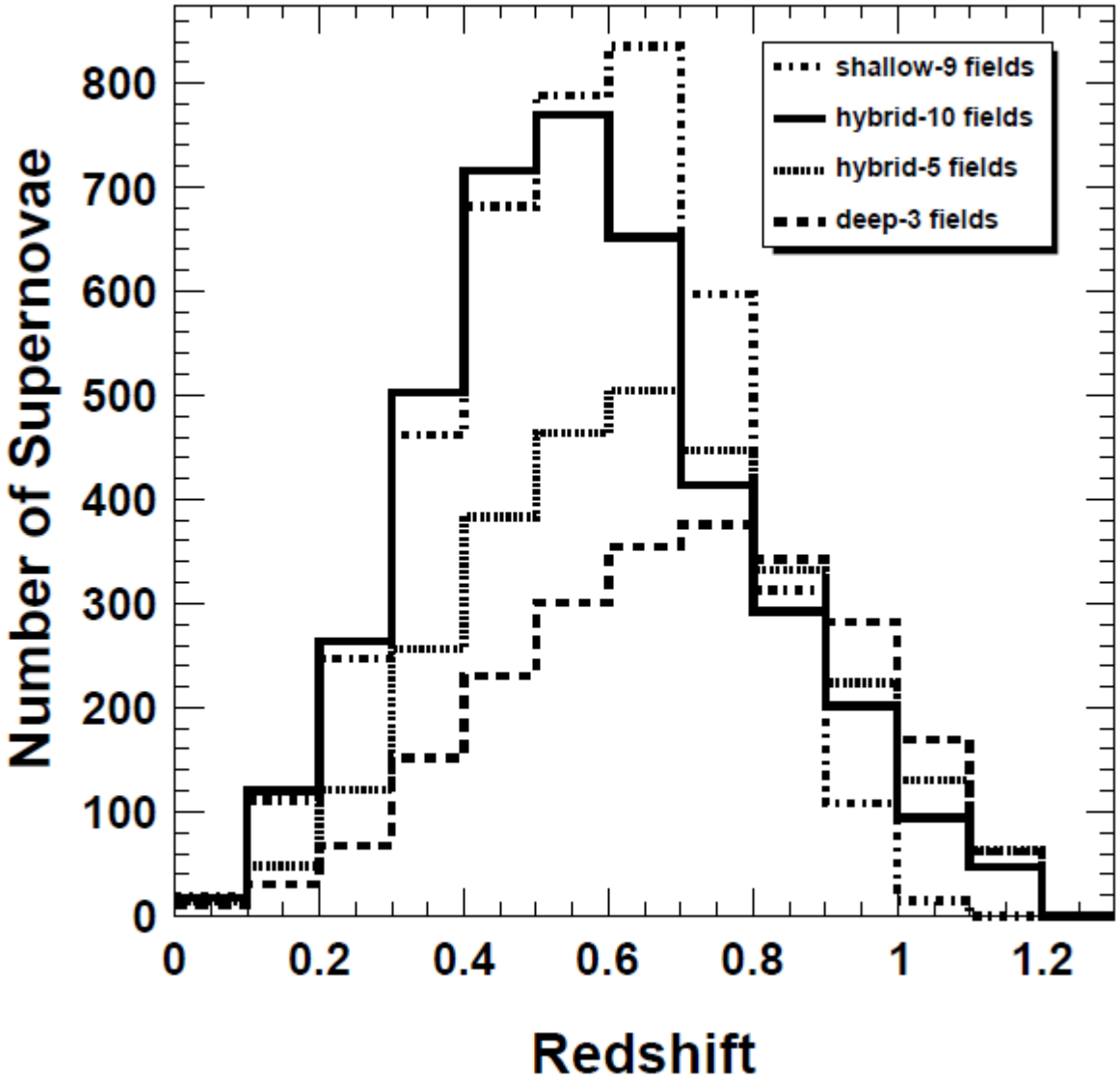
We present an analysis of supernova light curves simulated for the upcoming Dark Energy Survey (DES) supernova search. This survey will provide a homogeneous sample of up to ∼4000 supernovae in the redshift range 0.05-1.2. The heightened red efficiency of the DES camera will significantly improve z-band sensitivity relative to SNLS. The redshift of each supernova will be obtained either from spectral follow-up, i.e., the acquisition of a host galaxy or supernova spectrum, or from a combined host-supernova photometric redshift determination. The photometric redshifts of the host galaxies at the largest redshifts are measured with a deep co-add of more than 70 observing hours per season. The simulations employ a code suite that generates and fits realistic supernova light curves in order to obtain distance modulus/redshift pairs which are passed to a cosmology fitter. We harnessed the fit results to investigate several different survey strategies including field selection, supernova selection biases, and photometric redshift measurements. Our study also includes estimates of the systematic effects due to the Type Ia sample purity and dust extinction. We conclude by estimating the cosmological constraints that will be obtained from the DES supernova dataset.

Subject headings: supernovae – cosmology: simulations

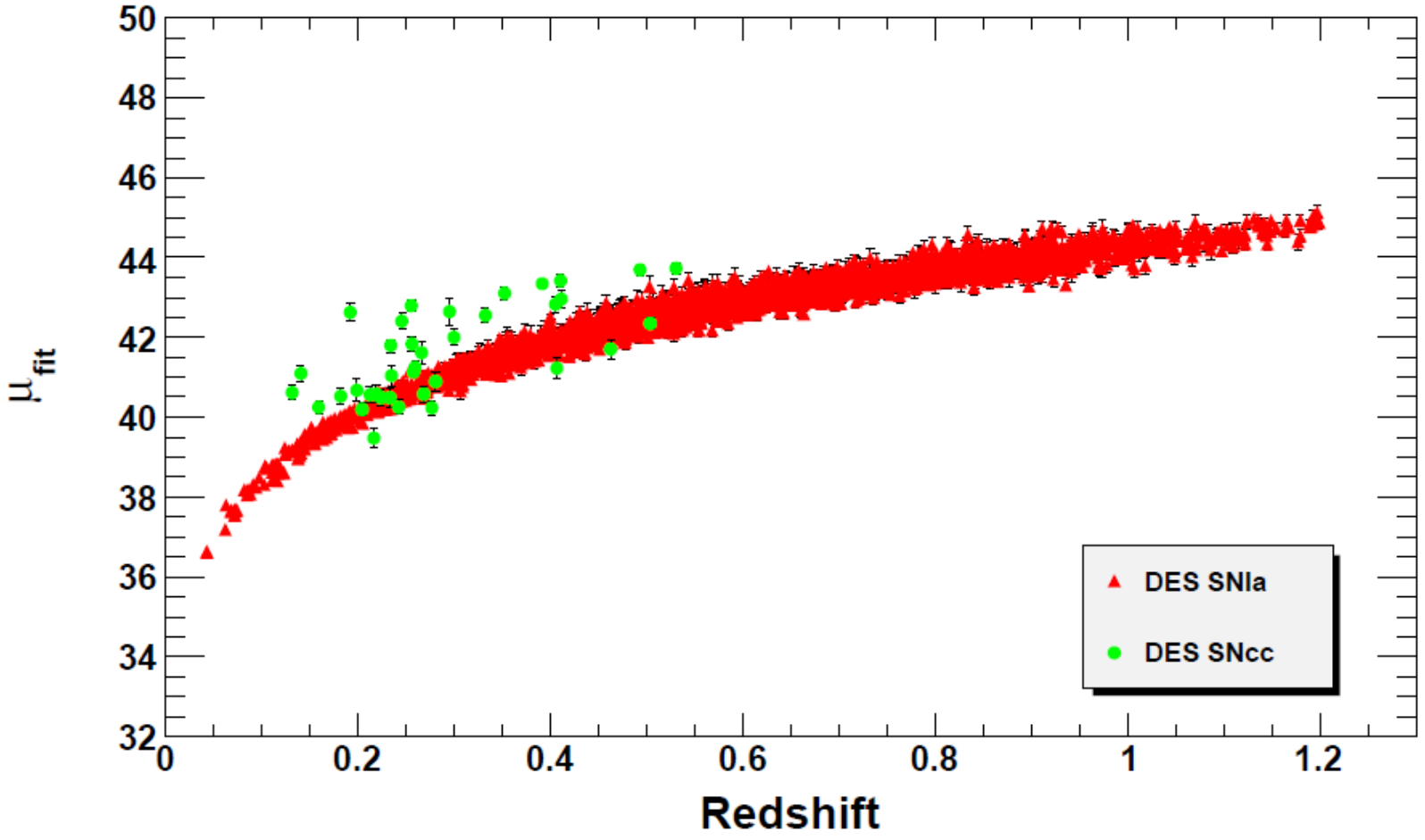
[1]Argonne National Laboratory, 9700 South Cass Avnue, Lemont, IL 60439, USA

Contents

Four possible surveys simulated…

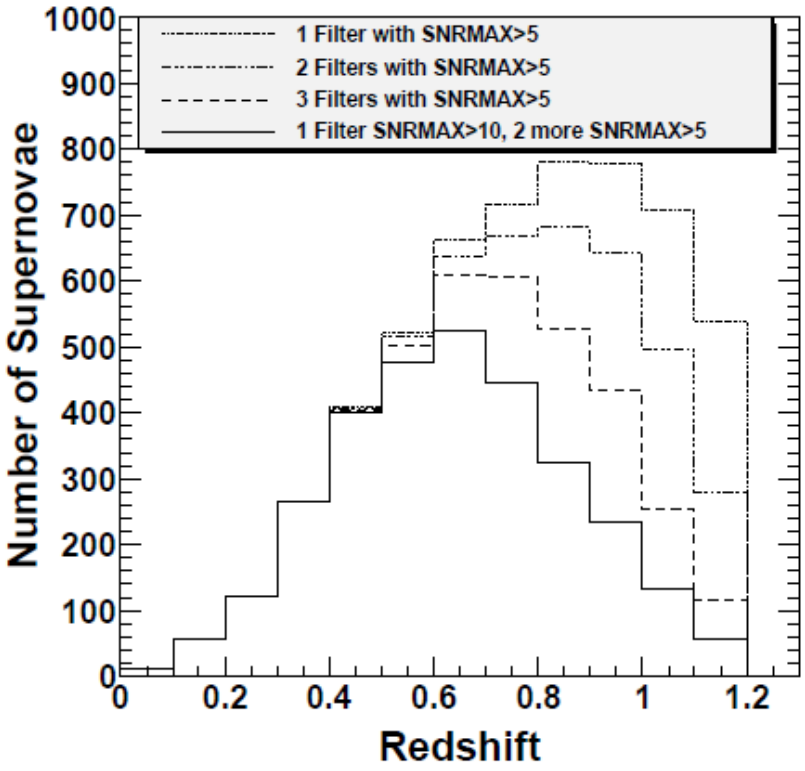


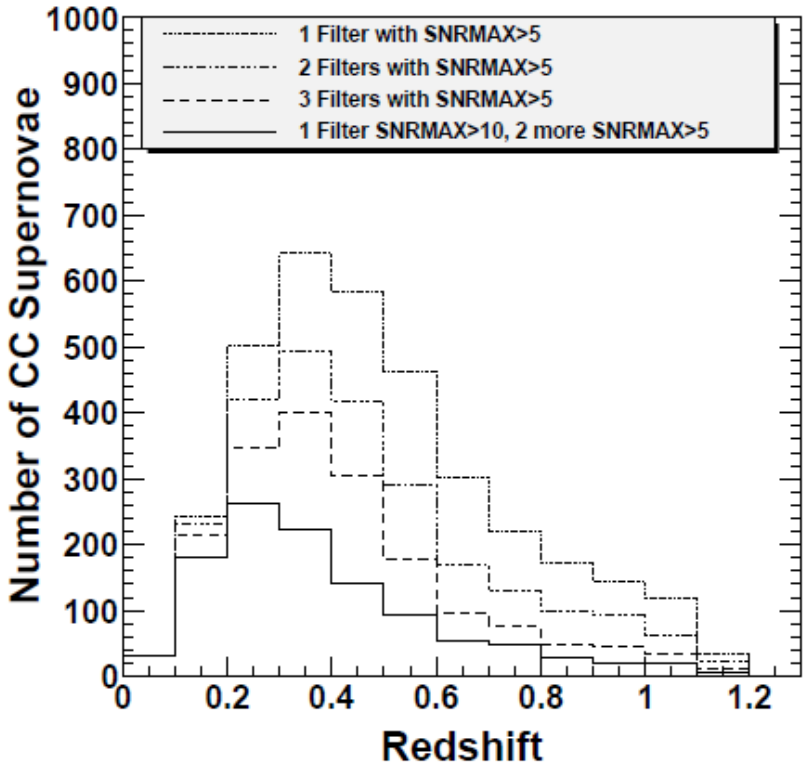
Hubble diagram for Type Ia (red), and Core Collapse (green).



(b) Hybrid 10-field survey.

Effects of varying Signal-to-Noise cuts on Ia and Core Collapse





Dark Energy Task Force Figure of Merit, and Systematics Considered

DES SNIa Data Set	DETF FoM (Stats.)
Hybrid 10-field	250
Hybrid 5-field (`MLCS2k2`)	241
Hybrid 5-field (`SALT2`)	222
Shallow 9-field	232
Deep 3-field	230

Table 1: Results for the Dark Energy Task Force Figure-of-Merit for the four DES SN survey strategies, evaluated using statistical uncertainties only. Each survey is augmented by a projected low-redshift SNIa anchor and a simulated 3-year SDSS SNIa data set.

Systematic Change	FoM without IC errors	FoM with IC errors
None	241	196
Filter zeropoint shift	153	137
Filter λ shift	189	161
Core collapse mis-id.	227	181
Dust prior R_V and τ_{A_V}	121	107
Total without dust prior	142	126
Total with dust prior	107	95

Table 2: DETF FOM results for the DES SNIa hybrid 5-field survey combined with a low-redshift anchor and a simulated SDSS sample. The effects of various systematic changes with and without including intercalibration (IC) errors are shown.

Dark Energy Forecasts

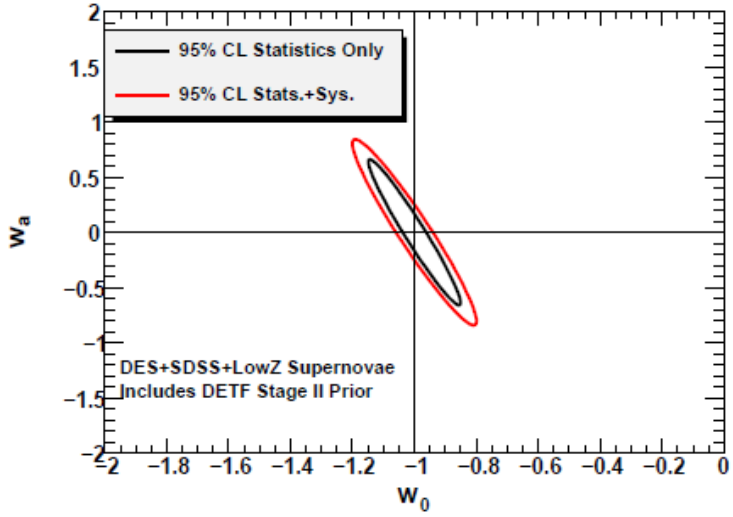


Fig. 25.—: Projected 95% limits on w_0 and w_a as a function of redshift, with and without systematic uncertainties.

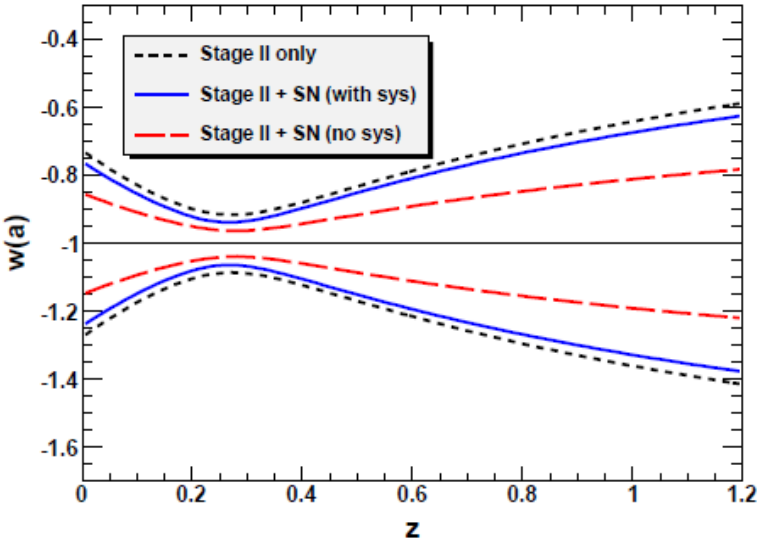


Fig. 26.—: Projected 95% limits on $w(a)$ as a function of redshift, with and without systematic uncertainties. Also shown is the DETF Stage II prior by itself.

Publication of this paper not the final answer. DES considering changes in the main survey ground rules that will affect SN. ANL has by far the best tools to evaluate survey changes and is leading this evaluation.

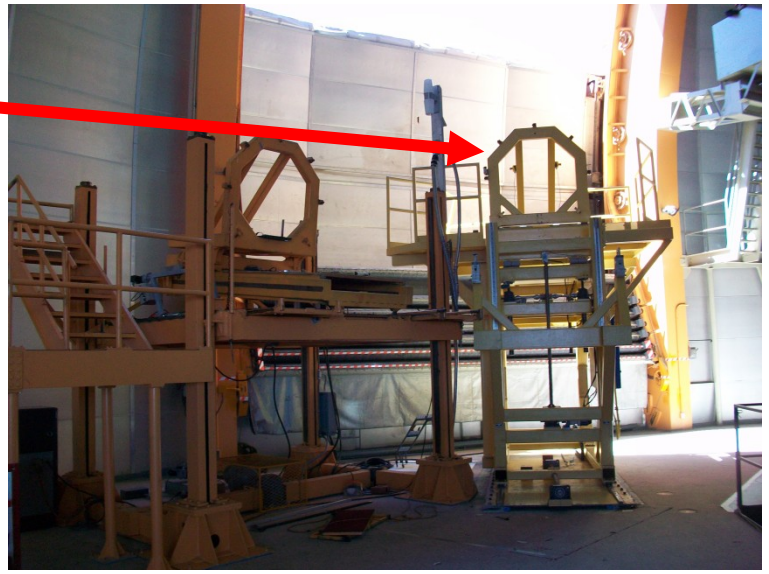
DECam Mechanical Commissioning

- f/8 Secondary Mirror Installation Platform
  - Designed and First assembly at ANL
  - Tested at FNAL
  - Now installed at CTIO
  - Engineer Allen Zhao working with CTIO staff

- Instrument Controls
  - Shutter Exposure Time, CCD Temp, Vacuum, LN2, …
  - ANL design, National Instruments Hardware due to low power dissipation (only choice at the time!).
  - Labview 80% written by Zhao (Level2 LV Certified)
  - Mostly finished last year, but focus this year on alarm systems to protect science-grade CCDs

f/8 Mirror Handling System

- Used to install and remove the f/8 secondary mirror from DECam
- Allen Zhao and the mechanical group led the design, procurement, assembly and testing at ANL.
- Platform installed at CTIO.
- Zhao working with CTIO staff on commissioning.



Extensive Interlock, Alarm, and Notification Systems (Email and Phone)

Alarm	Reason	Level	Actions Follow Automatically
CCD Temperature	>-10C or <-150C	Critical	Monsoon Vicor turned off, email
Imager Vacuum	>2.2E-4 Torr	Critical	Monsoon Vicor turned off, email, phone
Monsoon Vicor Fault	Overvoltage, etc.	Critical	Monsoon Vicor turned off, email
Monsoon Vicor Off	Other alarms, user error	Critical	Email
LN2 pump off	Four LN2 interlocks	Critical	Email msg “Turn on turbopump”, phone
Shutter	Shutter box error	Critical	Email
CCD Photodiode	Voltage>0.5	Critical	Monsoon Vicor turned off, email
LN2 Level	<45% or >95%	Alert	Email, phone
LN2 pressure	<50psi or >130psi	Alert	Email, phone
LN2 diff. pressure	>20psi	Alert	Email, phone
LN2 Heater	Heater off	Alert	Email, phone
Oxygen sensor	<15%	Alert	Shuts off LN2 valve and eventually pump, email
CCD Temp alert	>-85C or <-120C	Alert	Email
Vacuum alert	>1.0E-5 Torr	Alert	Email
Imager cRIO Heartbeat	Loss of Heartbeat	Alert	Email
LN2 cRIO Heartbeat	Loss of Heartbeat	Alert	Email
Fieldpoint Heartbeat	Loss of Heartbeat	Alert	Email
Vacuum Heartbeat	Loss of Heartbeat	Alert	Email
Ion Pump Heartbeat	Loss of Heartbeat	Alert	Email
Windows PC Heartbeat	Loss of Heartbeat	Alert	Email
Telemetry Script	Loss of Heartbeat	Alert	Email
Fake alarm	User generated	Warning	Email

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  - Camera designed and built by ANL
  - First tests of DECam-type Asahi filters
  - ANL leading standard-star calibrations
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  - >3 year study coming to fruition
  - ANL-led draft under internal review
  - Blueprint for SN science without SN spectra
  - Cosmology forecasts including detailed systematics

- Important DECam mechanical roles in commissioning

Backup Slides...

Cosmology and Dark Energy Group at Argonne

Dark Energy Survey group members:

Joe Bernstein (currently computational fellow)

Rahul Biswas (post-doc: Supernova)

Kyler Kuehn (post-doc: PreCam)

Steve Kuhlmann

Hal Spinka

Rich Talaga

Additional:

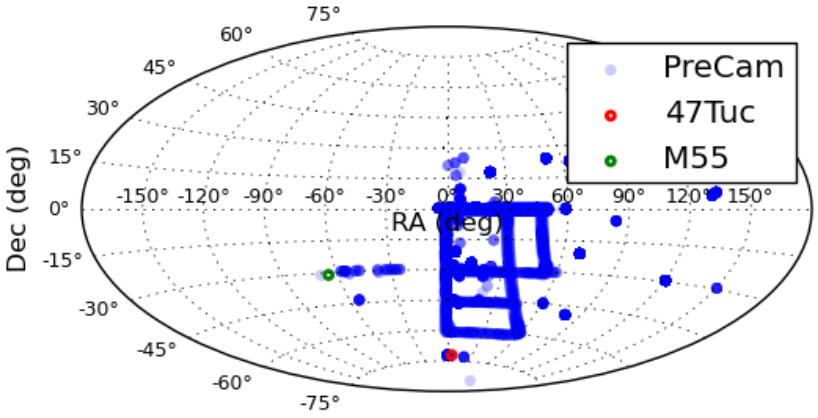
Eve Kovacs (supernova simulations)

John Cunningham + students (Loyola visitor)

** Salman Habib and Katrin Heitmann and post-docs… **

PreCam: a "mini-DECam," camera developed/built at ANL

- Science motivation for pre-survey observations with DECam hardware
  - 0.01 calibrated stars/image w/o PreCam, ~1000/image with PreCam
  - reach 2% photometry requirement faster, and better chance at 1% goal
  - possible 10% savings (~$1M!) in telescope time
- Test-bed for DECam hardware, software, and observing strategies
- First PreCam science run underway, ~500 images/night, each 30-120s



Grid of PreCam science observations in DES survey area

Kyler Kuehn (ANL) and Jorge Briones (CTIO) during Aug 30th camera installation.