Photometric Calibration of the Dark Energy Survey (DES)

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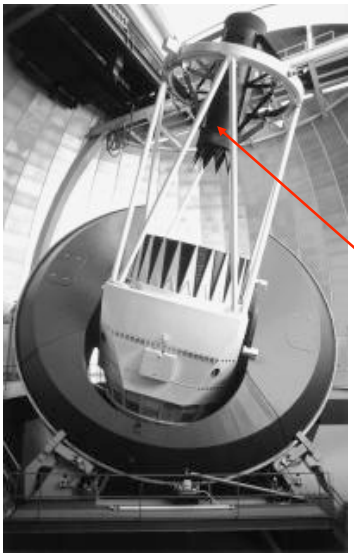


Purpose of the DES

Perform a 5000 sq deg *griZY* imaging survey of the Southern Galactic Cap down to ~24th mag (10σ, galaxies) in order to probe the nature of the Dark Energy by constraining its equation of state parameter *w* and its energy density.

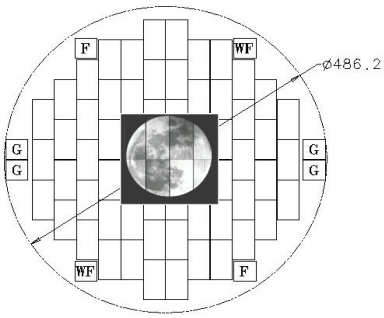
New Equipment

Replace the Prime Focus cage on the CTIO Blanco 4m telescope with a new 2.2 deg FOV optical CCD camera (DECam). (See Poster #160.09 by Kyler Kuehn).

Survey Period

30% of the telescope time (525 nights) from 2011-2016 (September - February)

DECam Focal Plane (a.k.a., "The Hex")



62 2k×4k imaging CCDs (520 Mpix)

0.27 arcsec/pix

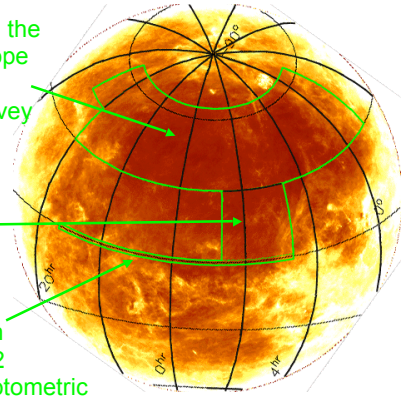
LBNL design (fully depleted, 250 micron thick, 17 sec readout time, QE > 50% at 1 micron).

Survey Area

Overlap region with the South Pole Telescope Sunyaev-Zeldovich Galaxy Cluster Survey (4000 sq deg)

Connector region (800 sq deg)

Overlap region with the SDSS Stripe 82 for redshift and photometric calibration (200 sq deg)



Schlegel et al (1998) dust map, southern sky, celestial coordinates

Observing Strategy

100 sec exposures (science fields)

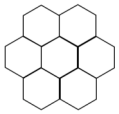
2 filters per pointing (typically)
- *gr* in dark time
- *iZ* in bright time
- *Y* in bright time

Image survey twice per year per filter
- Each full coverage of the survey area is called a "tiling"
- It takes ~1700 hexes to tile the whole survey area

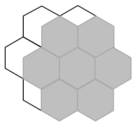
Multiple tilings with large overlaps to optimize photometric calibrations

All-sky photometric accuracy
- Requirement: 2%
- Goal: 1%

Zooming in on part of the survey area…



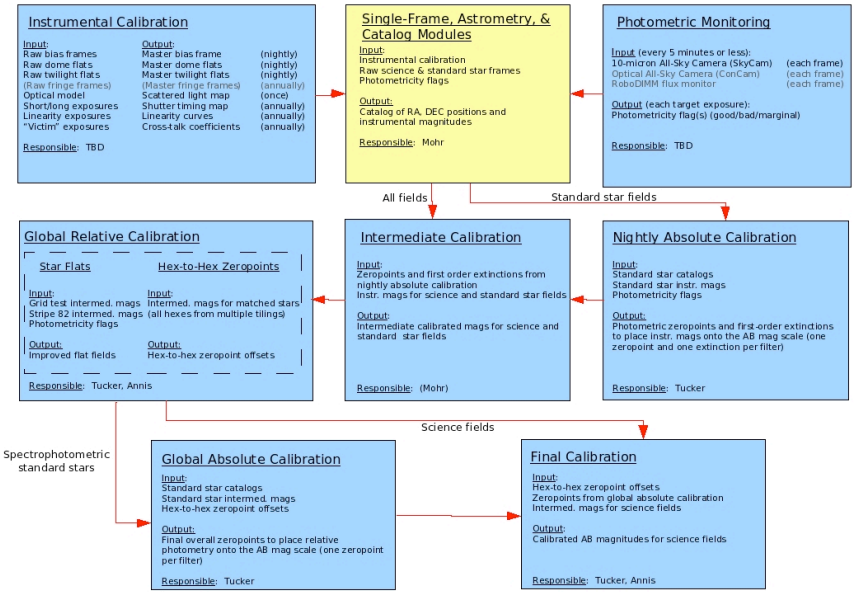
1 tiling



2 tilings

3 tilings

DES Photometric Calibrations Flow Diagram



Standard Stars

For Nightly (Intermediate) Absolute Calibration

- Observe nightly during nautical twilight and around the midpoint of the night
- Calibrate to the DES *griZY* "natural" system
- Use SDSS *u'g'r'i'z'* and ugriz standards transformed to DES *griZ* "natural" system
  - SDSS Stripe 82 tertiary standards (see, e.g., Ivezic et al. 2007)
  - Smith et al. *u'g'r'i'z'* Southern Standards
  - Skymapper and/or VST OmegaCam standards as supplement or as cross-check
- Use or create *Y*-band standards
  - UKIDSS observations in Stripe 82? VHS *Y*-band standards?
  - Synthetic magnitudes of hot white dwarfs in SDSS Stripe 82?

For Global (Final) Absolute Calibration

- LDS 749B
  - *r*=14.8 hot white dwarf in Stripe 82 and in STScI CALSPEC db
- Hot White Dwarfs in Stripe 82

The DES Collaboration: *US Institutions:* Fermilab, University of Illinois at Urbana-Champaign, University of Chicago, Lawrence Berkeley National Laboratory, CTIO, University of Michigan, University of Pennsylvania, Argonne National Laboratory, Ohio State University. *UK-DES Collaboration:* University College London, University of Cambridge, University of Edinburgh, University of Portsmouth, University of Sussex. *Spain-DES Collaboration:* Institut d'Estudis Espacials de Catalunya, Institut de Fisica d'Altes Energies, CIEMAT-Madrid. *Brazil-DES Consortium:* scientists from Observatorio Nacional, Centro Brasileiro de Pesquisas Fisicas, Universidade Federal do Rio de Janeiro and Universidade Federal do Rio Grande do Sul.