DARK ENERGY
SURVEY

# PreCam's Progress

Douglas L. Tucker
for the PreCam Team

FCPA Chalk Talk Notes

Fermilab, 10 February 2011

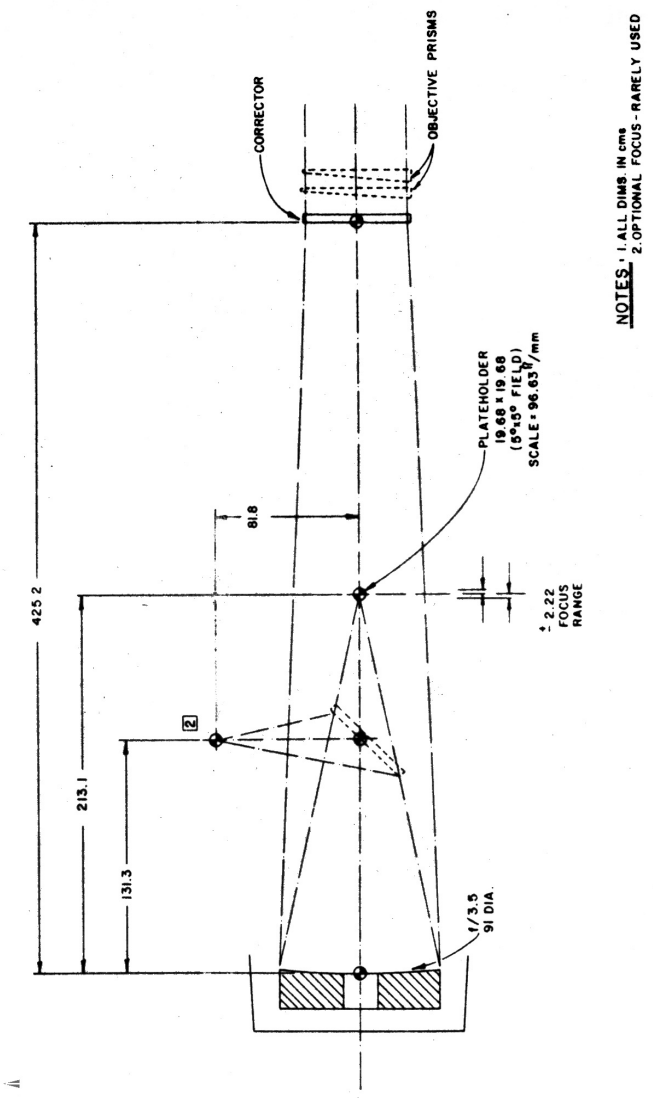
DARK ENERGY SURVEY

# Overview

1. The PreCam Survey is quick, bright imaging survey in the DES footprint…
    a. Using 4kx4k camera (the "PreCam") composed of 2 DECam CCDs ("1/32nd-scale DECam")
    b. Mounted on the UM-Astro Curtis-Schmidt telescope at CTIO (~50m from the Blanco 4m telescope, which will be used for DES)
    c. Using a set of small (100mmx100mm DES *grizy* filters)
2. The PreCam has two main purposes:
    a. Serve as a test-bed for DECam hardware and software
    b. Provide calibration stars for DES.

# The Curtis-Schmidt Telescope

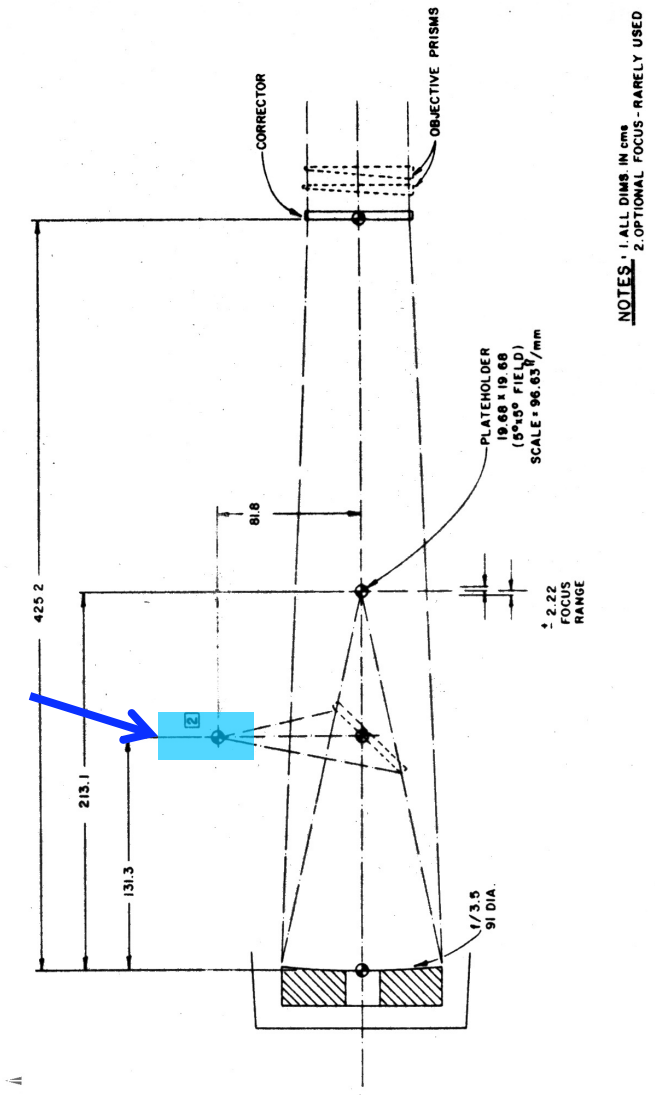
DARK ENERGY SURVEY




- 0.9m Primary Mirror + 0.6m Corrector Plate
- PreCam-related upgrades (TAMU):
  - New secondary mirror + mount
  - New flat-field screen and LED-based dome flat field lamps
- Agreement with University of Michigan Department of Astronomy granted the PreCam Survey 100 nights between Aug 2010 and January 2011 (which includes commissioning time).

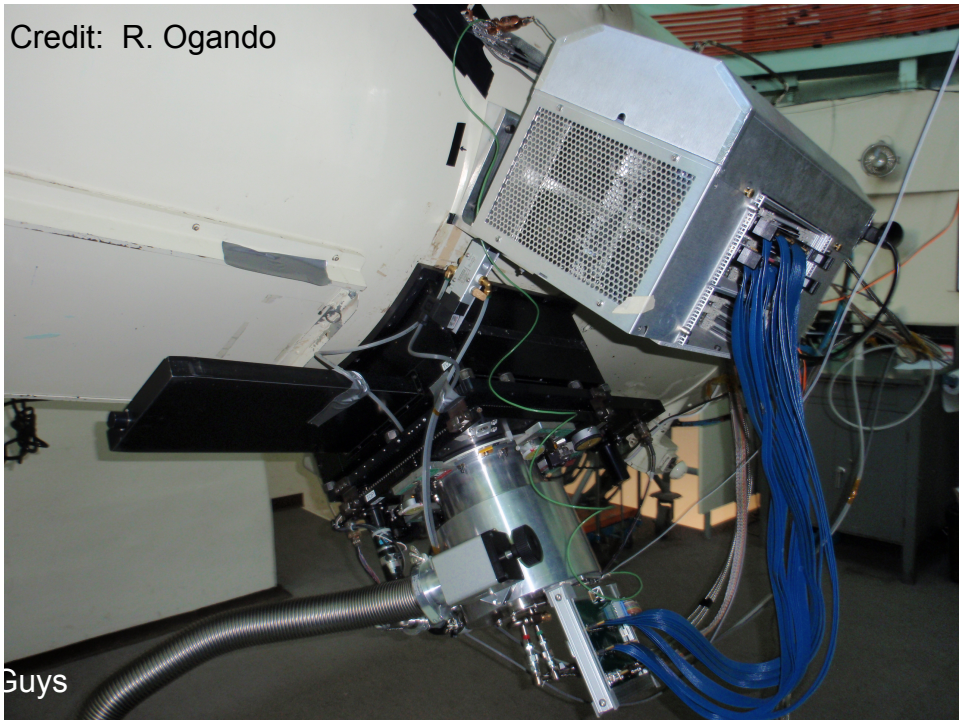
# The PreCam Camera

DARK ENERGY SURVEY




Precam

- Built by Argonne group (Kyler Kuehn, Steve Kuhlmann).
- PreCam FOV on C-S with TAMU secondary is 1.6°x1.6°.



DARK ENERGY SURVEY

# The PreCam Survey Exposure Times

**Baseline PreCam Survey Point-Source Magnitude Limits (optimized to achieve S/N=50 at DES saturation + 1.5mag)**

| Band | Exposure time [seconds] | PreCam saturation limit | PreCam mag limit S/N=50 | Number of usable stars per sq deg (SGP) |
|---|---|---|---|---|
| g | 36 | 12.8 | 17.8 | 186 |
| r | 51 | 13.2 | 17.8 | 265 |
| i | 65 | 13.4 | 17.7 | 344 |
| z | 162 | 14.1 | 17.5 | 317 |
| y | 73 | 11.6 | 14.3 | 150 |

- Mag limits provide a good set of photometric calibration stars for DES.

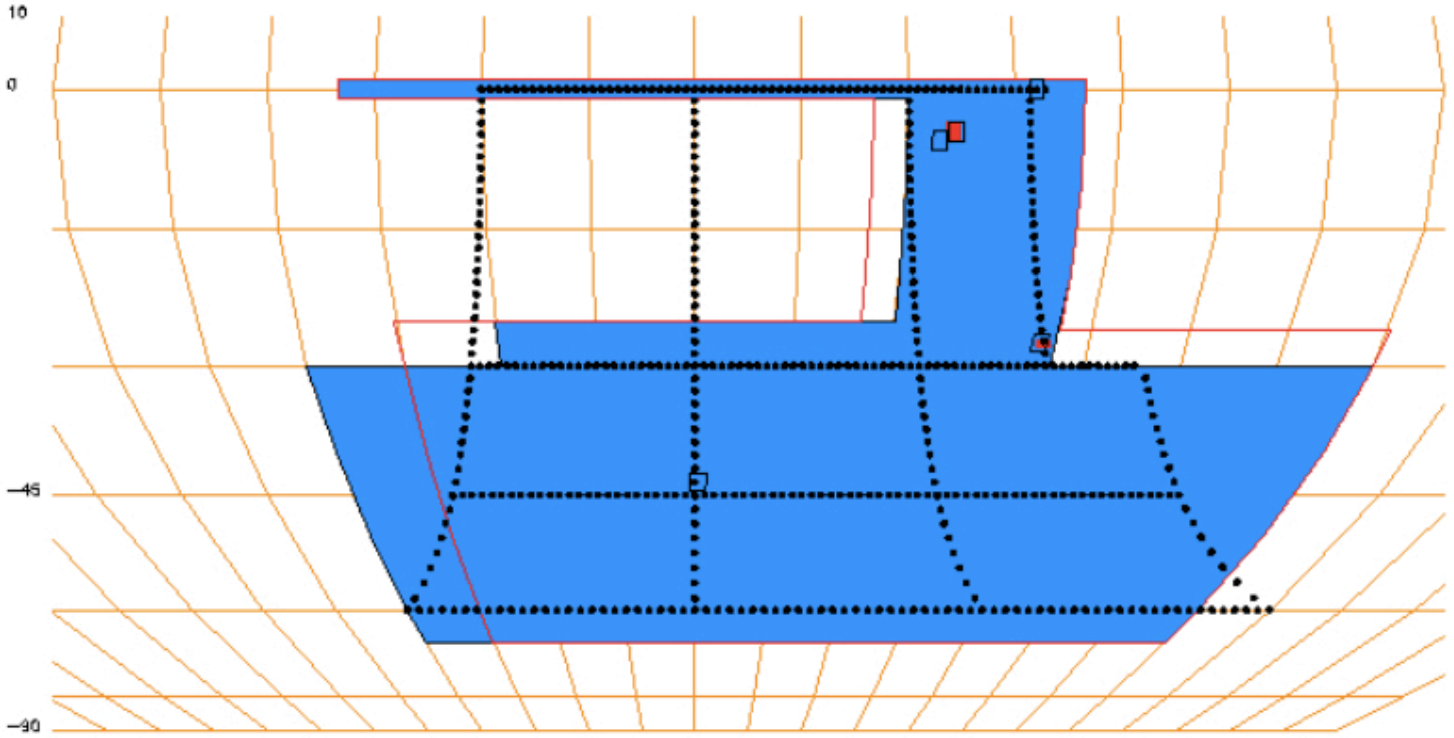
# Planned PreCam Survey Strategy

(Jim Annis, des-doc#4559-v9)

DARK ENERGY SURVEY

I. Aug 11-31: h/w install. and commiss.; Sept 1-15: on-sky commissioning

II. Sept 15-Sept 27, Nov 16-30, Dec 9-Jan 24 is devoted to observing 30° grid




version 5
modified 30° grid
454 hexes
~6 tilings

**Rigid grid of calibration stars throughout DES footprint**

# Aug-Sept Problems

DARK ENERGY SURVEY

## Poorly Manufactured 2ndary Mirror

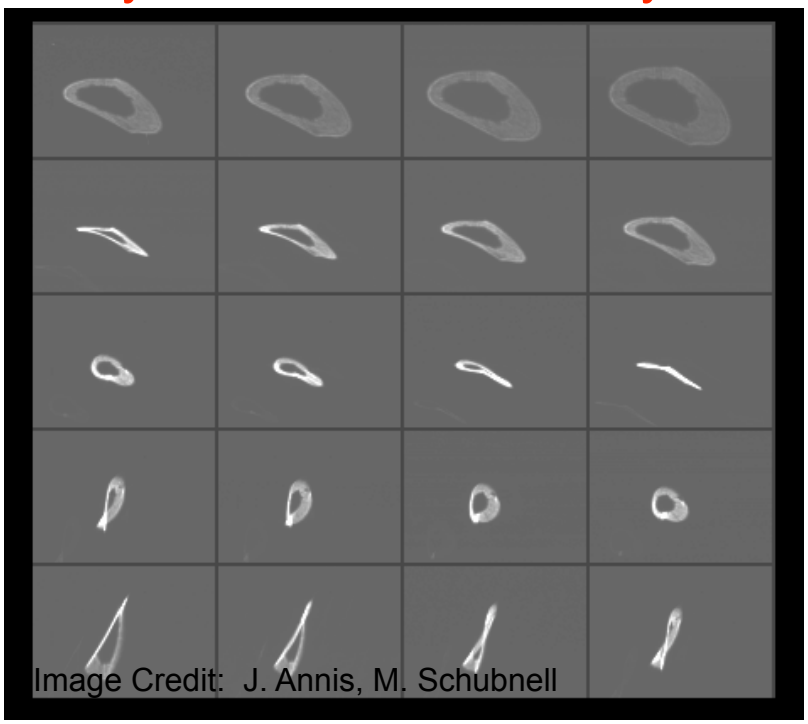


Image Credit: J. Annis, M. Schubnell

## Broken Shutter

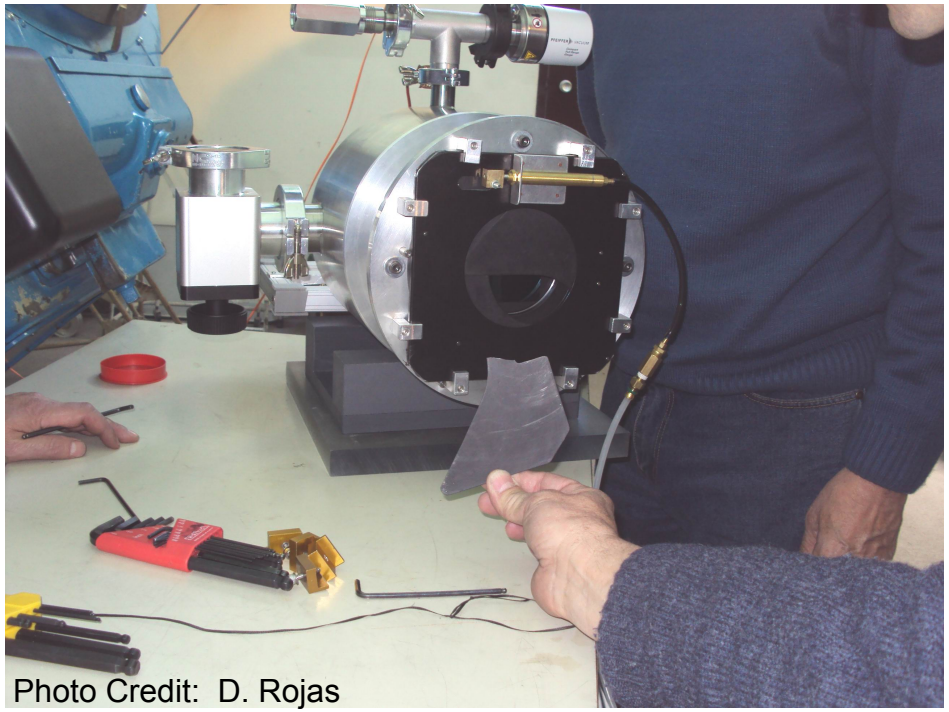


Photo Credit: D. Rojas

## FITS header problems,

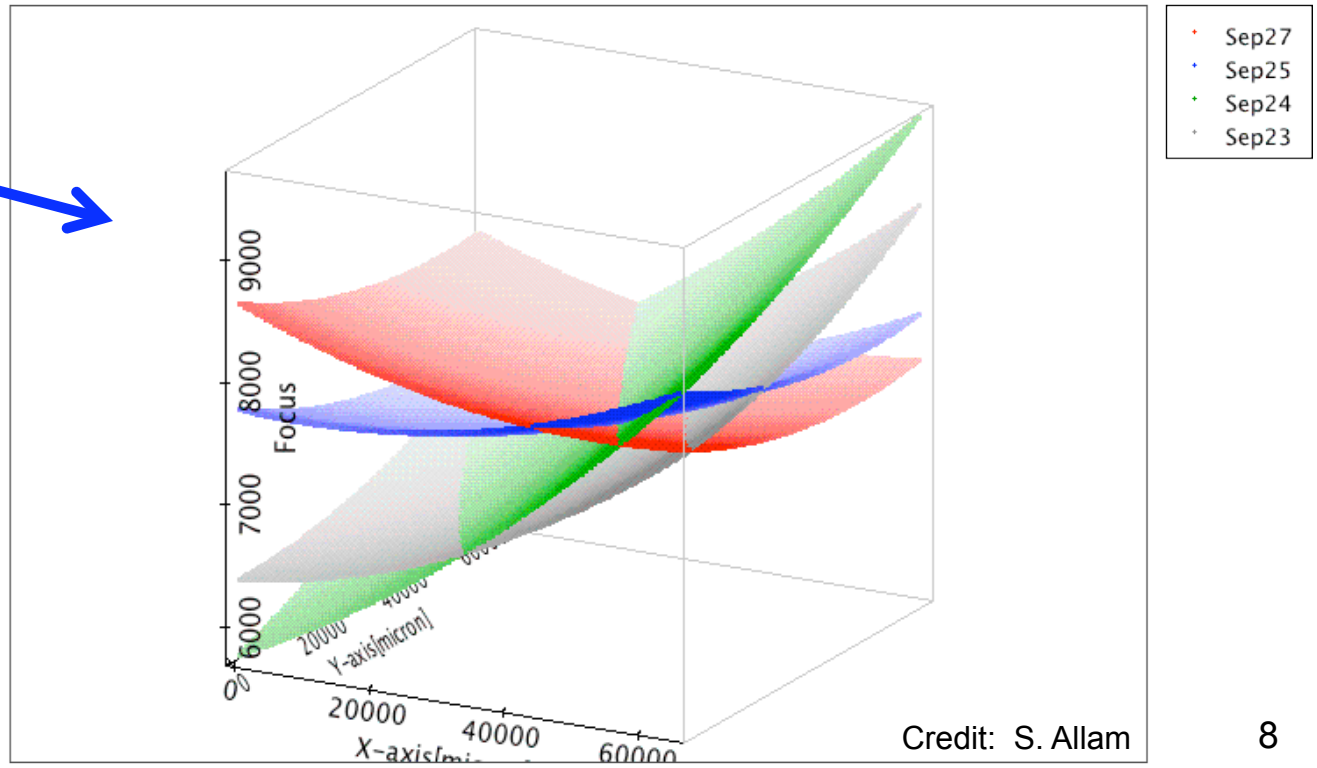
(esp. w.r.t. adding RA,DEC from Curtis-Schmidt TCS)

```
SIMPLE  =                    T / conforms to FITS standard
BITPIX  =                   16 / array data type
NAXIS   =                    0 / number of array dimensions
EXTEND  =                    T
…
RA      = '25:0:0.0'         / [HH:mm:ss.ss] RA for center of this detector
DEC     = '91:0:0.0'         / [DD:mm:ss.ss] Dec for center of this detector
…
```

# Aug-Nov Successes

DARK ENERGY SURVEY

1. Safely shipped PreCam, PreCam computers, PreCam CCDs, and auxiliary equipment to CTIO and mounted on C-S.
2. Hardware upgrades to C-S, including new TAMU dome flat system.
3. Quick Reduce and data transfer installed on PreCam computers
4. Preliminary observing scripts written.
5. Realigned optics with powerful new quantitative technique.
6. Identified problems to be fixed.
7. **PreCam on sky!**
8. **Built successful PreCam team!**




Credit: S. Allam

DARK ENERGY SURVEY

# Revised Nov-Jan Plan: Context (Spoken)

1. It was unlikely that the replacement flat mirror for the TAMU secondary will be available until after January.
2. Until the TAMU secondary mirror is replaced, PreCam observing must rely on the original Curtis-Schmidt secondary mirror and mount.
3. The TAMU secondary flat would have had an unvignetted field-of-view of 1.6°x1.6° (the field-of-view of the PreCam camera focal plane)
4. The original Curtis-Schmidt secondary has noticeable (~25%) vignetting in the corners of a 1.3°x1.3° field-of-view.
5. Vignetting can be flat-fielded out, but it reduces the S/N of stars where vignetting is significant.
6. With the original Curtis-Schmidt secondary, the PreCam camera's field-of-view is effectively reduced nearly in half (in area).
7. The MOU granted PreCam 100 nights (including the nights from this past August and September), but there was a possibility of negotiating for a few nights more.

# Final PreCam Survey Strategy

## Rigid grid of calibration stars throughout DES footprint

DARK ENERGY SURVEY

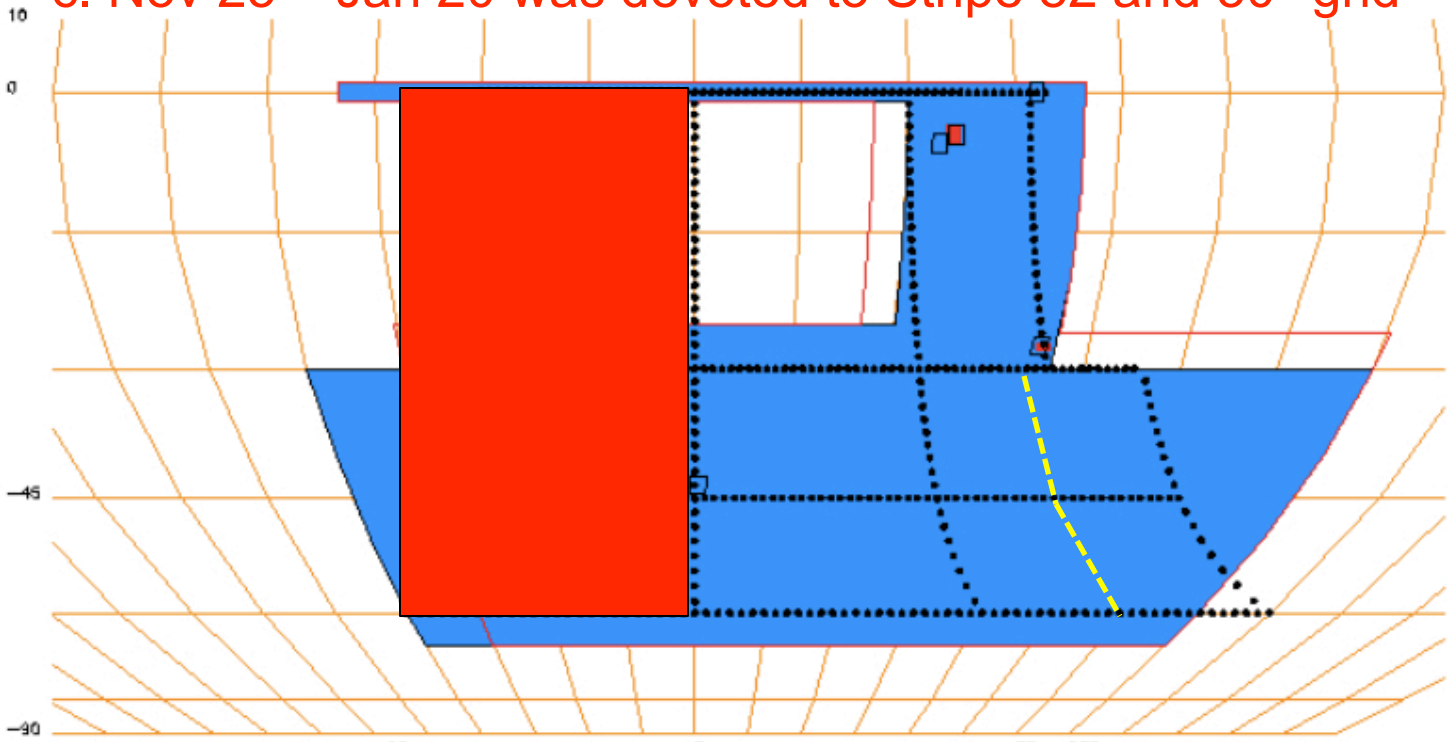
I. Aug 11-31: h/w install. and commiss.; ~~Sept 1-15: on-sky commissioning~~

II. ~~Sept 15-Sept 27, Nov 16-30, Dec 9-Jan 24 is devoted to observing 30° grid~~

Sept 1-2 was devoted on-sky commissioning and debugging of h/w

Nov 16-c. Nov 24 was devoted s/w commissioning and on-sky tests.

c. Nov 25 – Jan 20 was devoted to Stripe 82 and 30° grid




Stripe 82:
10x in grizy

30° grid:
6x in gri

**Rigid grid of calibration stars throughout DES footprint**

DARK ENERGY SURVEY

# Nov-Jan: The Data

- 64 nights allocated (Nov 16-Jan 20 minus Dec 24-25)
  - 1 night lost to weather
  - 2 nights lost to software meltdown on original DAQ computer
  - 2 nights lost to shutter breaking
  - 4 nights devoted to engineering due to shutter-sticking
  - 1 night lost due to venting dewar to ambient atmospheric pressure
  - 1 night lost due to problems with installing new 12-channel DAQ card
  - 2 nights devoted to end-of-run engineering tests
- 51 nights on sky (c. 80% of the 64 nights allocated)
- ~24,000 images

DARK ENERGY SURVEY

# What's Next?

- Data Processing (DES-Brazil)
  - Identifying issues with the data and how to correct them
  - Processing the data to astrometrically calibrated single-epoch cat's
- Data Analysis
  - Measuring nightly extinctions, etc.
  - Photometric calibration of the cat's
  - Tying together single-epoch cat's to create grid of standard stars
  - Determining quality of final catalogs
- Review
  - How well did this PreCam observing season succeed?
  - What are the benefits/costs of another PreCam observing season?


# Lessons Learned (Also Useful for DECam Commissioning)

1. Don't rush commissioning.

2. Test hardware thoroughly before observers arrive.

3. Expect that problems will arise.

4. Don't skimp on human resources.

   a. Plan on having 1.5x - 2x more people on site during commissioning than you plan to have during operations.

   b. At least one of the extra persons would be in charge of debugging software.

5. Daily telecons are extremely useful, especially during the commissioning period. Videocons, if available -- especially in the dome -- would be even more useful.

DARK ENERGY
SURVEY

# Extra Slides

DARK ENERGY SURVEY

# The Options

(Credit: Dave Burke and Jim Annis)

Using the original Curtis-Schmidt secondary, here are four viable options for PreCam Survey Strategy in November 2010 – January 2011:

1. Cover the same footprint with half the tilings.
2. Cover the same footprint without z- or y-band.
3. Cover half the footprint.
4. Cover the same footprint without z- or y-band but cover the SDSS Stripe 82 region in z and y.

These options were discussed at the Oct. 15 DES Survey Strategy Meeting.

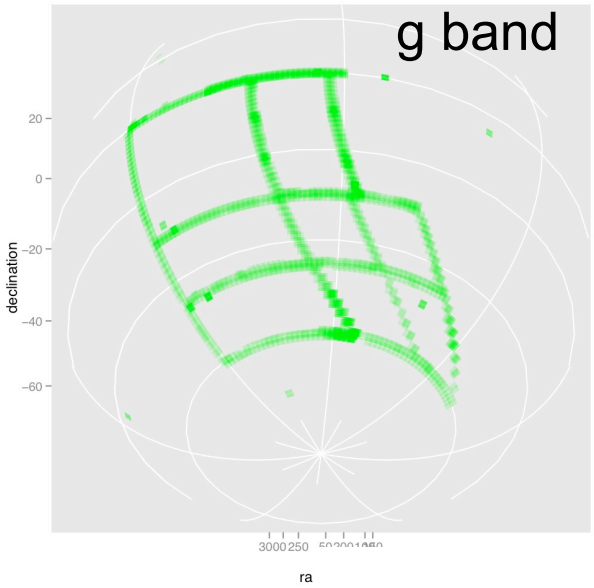
DARK ENERGY SURVEY

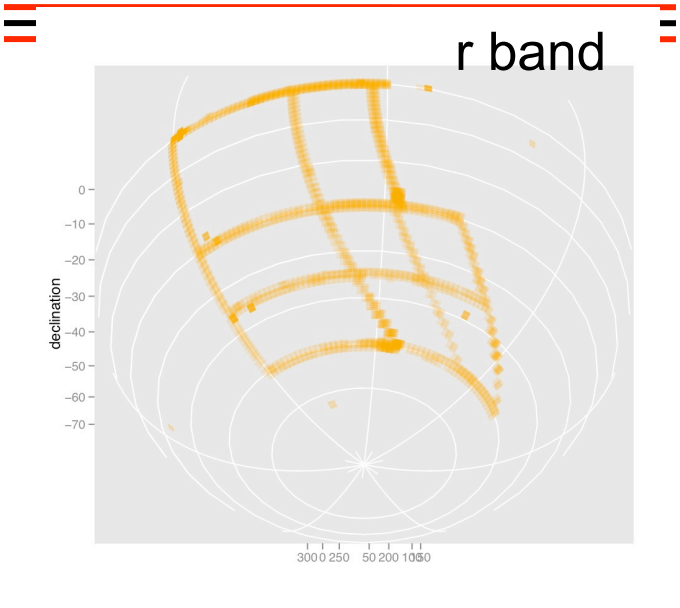
# Results from the Oct. 15 SSM Meeting

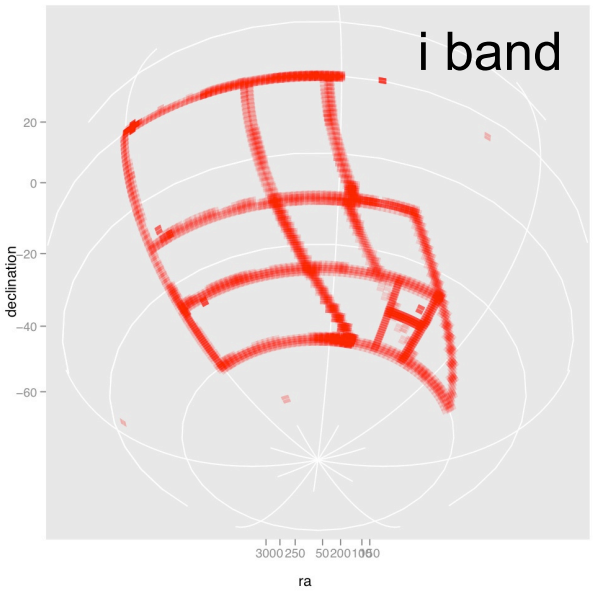
(from Jim Annis's notes)

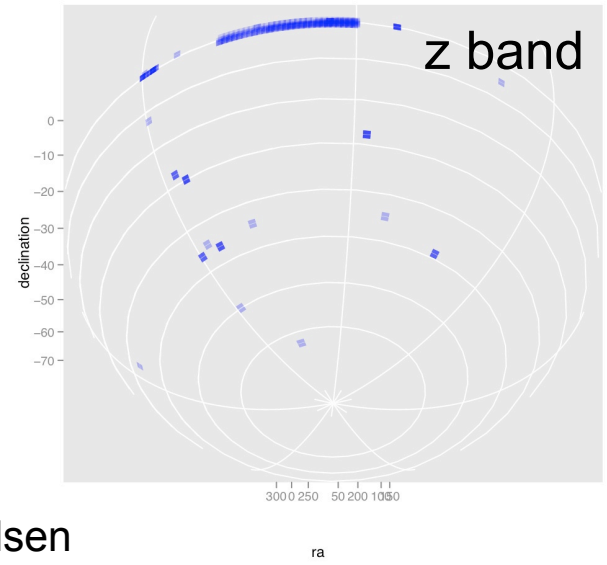
- Our new strategy is to ensure that we can demonstrate that the PreCam program will succeed so that in the next observing season we can pursue the program (assuming another observing season). This can be done by:
  a. performing the 5-filter, 10-tile, 30-degree stripe 82 test, which demonstrates that sqrt(N) can reach 1%, or alternatively what the root(N) floor is, and
  b. performing a test of the grid work approach. This will likely be 4 boxes of the "year 1 footprint", observing in just g,r,i (so that the test using the stellar locus can proceed), while performing standard star observations in all five filters (so that z & y standards can be developed).

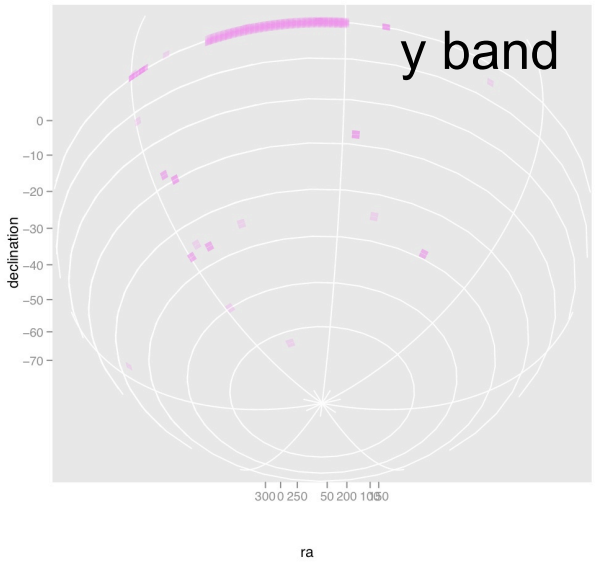
# PreCam ObsTac Coverage



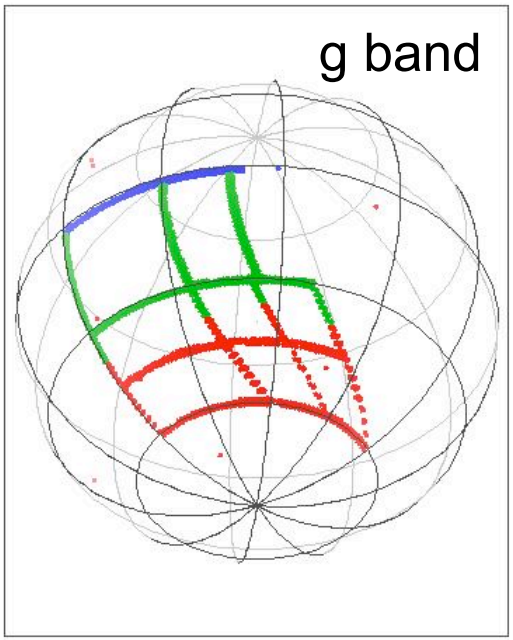



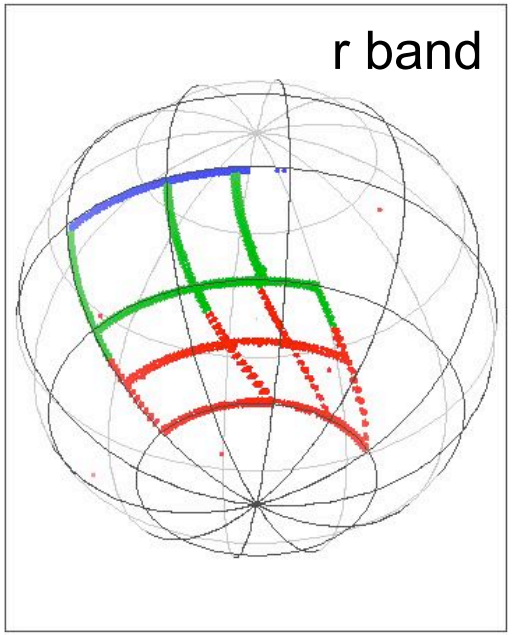



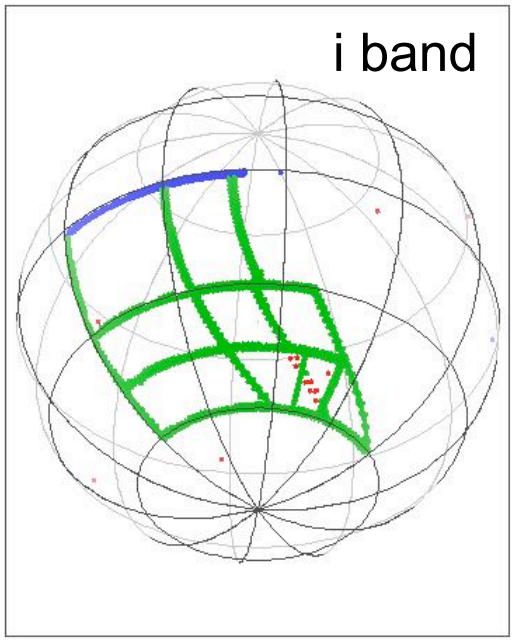

Credit: Eric Neilsen

# PreCam ObsTac Linkage: Friends-of-Friends Algorithm

DARK ENERGY SURVEY




- Stripe 82 (Calibrated/Reference)
- Connected by overlaps to Stripe 82 (Calibrateable)
- Isolated from Stripe 82 (Not calibrateable… at least not directly via overlaps from Stripe 82)