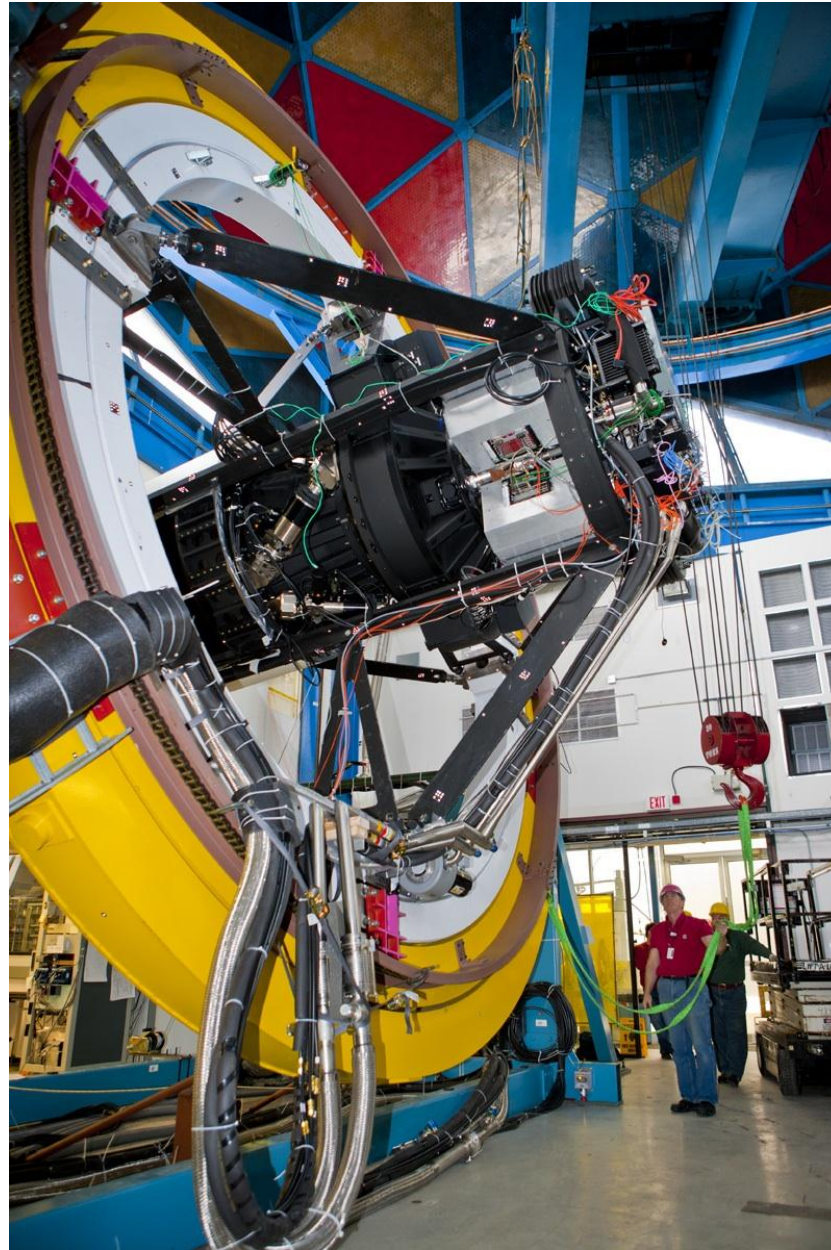
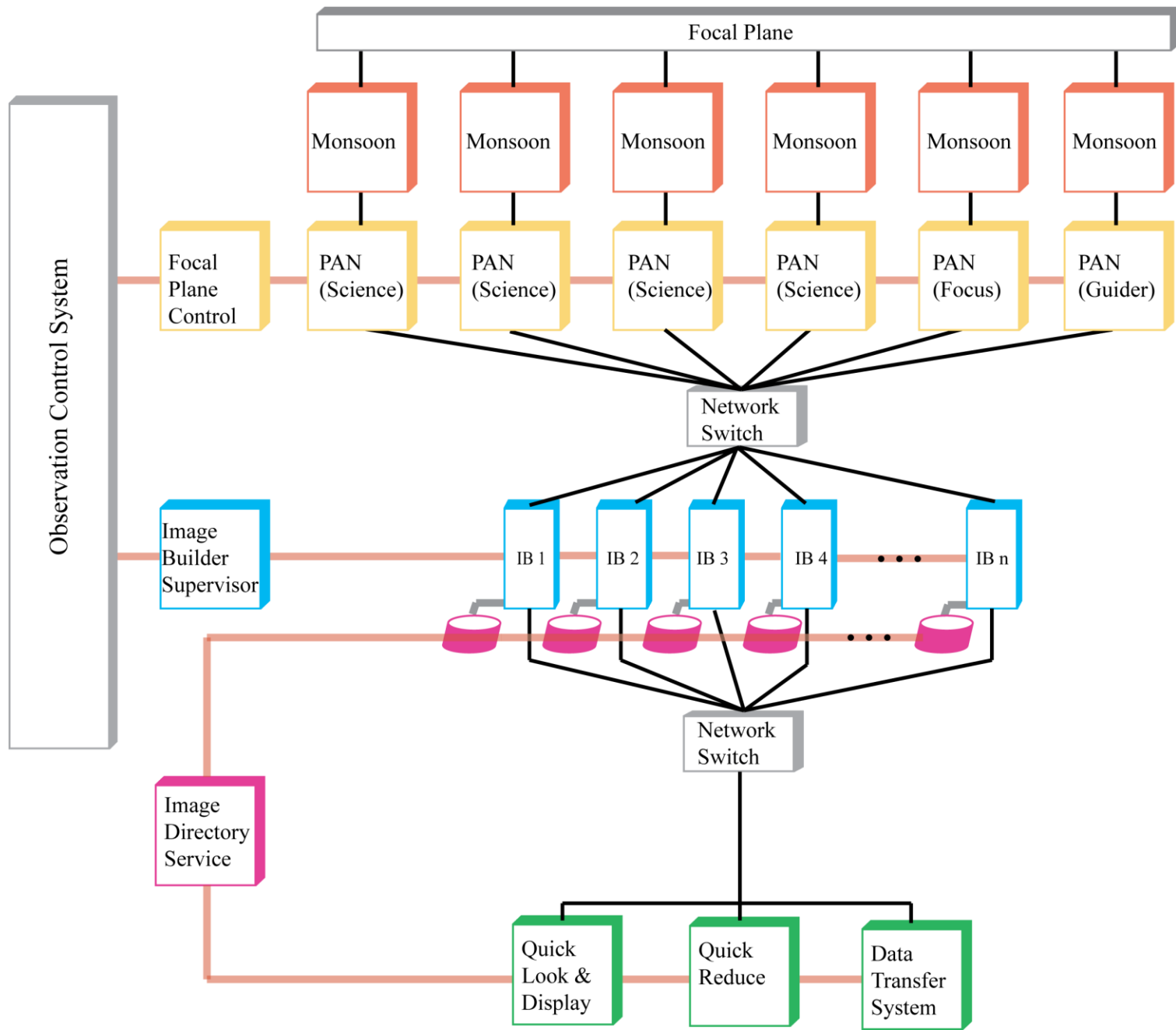


Observing with DECam

Klaus Honscheid
Dept. of Physics
Ohio State University



DECam Community
Workshop
Tucson, August 18, 2011



62 science CCDs (2kx4k)
 4 guide CCDs (2kx2k)
 8 focus CCDs (2kx2k)

3 Monsoon Crate with

**~ 20 seconds
 readout time**

S-Link (optical fiber)

100 Mbits/s input per PAN
 17 Mbits/s output per PAN
 (for a 100 s exposure)

Gigabit Ethernet

PC Farm with N nodes
 Processing time per node
 $t = N \times 17$ seconds

**1 GB Images
 (600 MB
 compressed)**

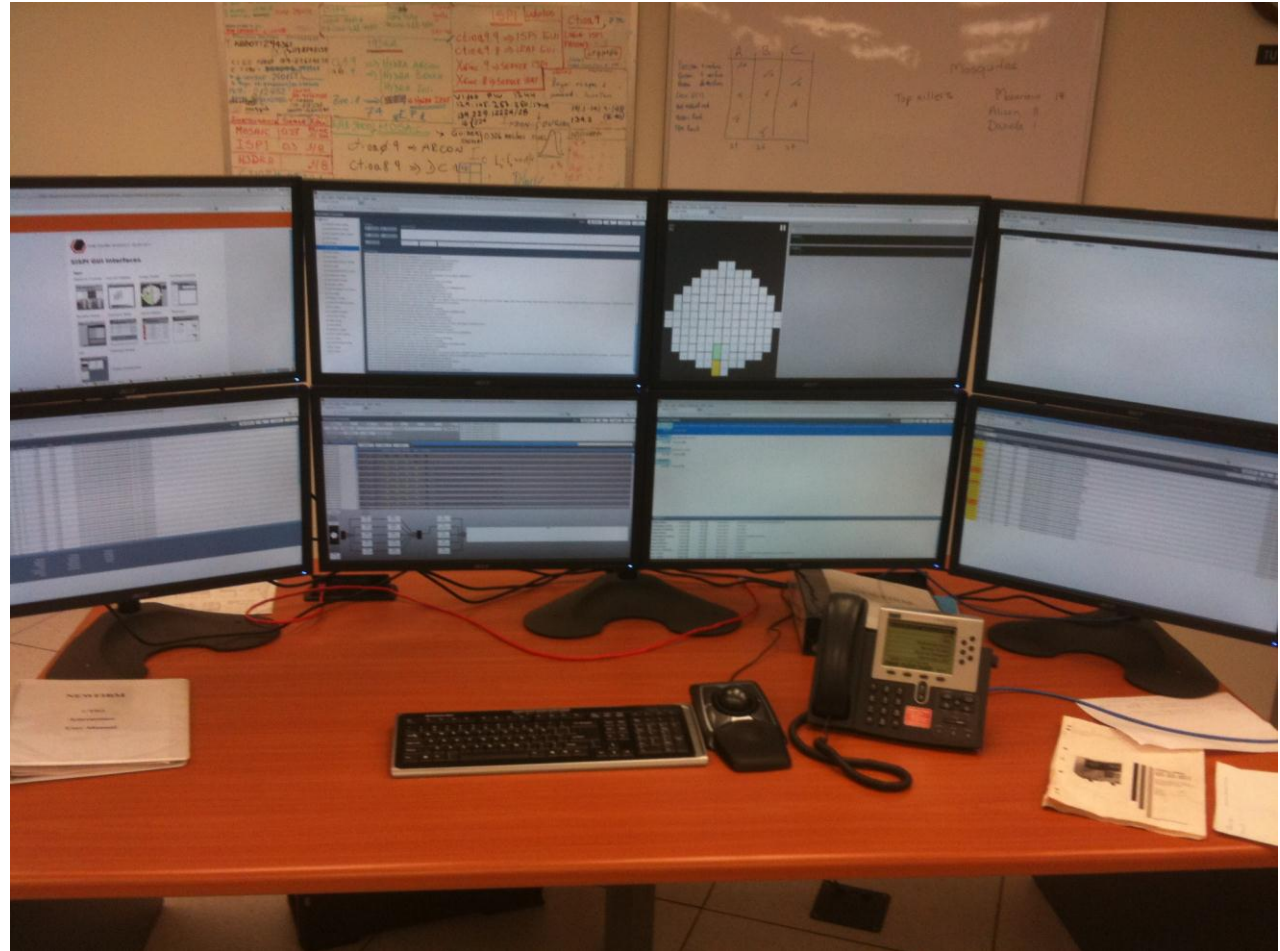
Directory service to
 locate DES images on
 distributed filesystem

**DTS (NOAO)
 Workstation**

DECam Observer Console

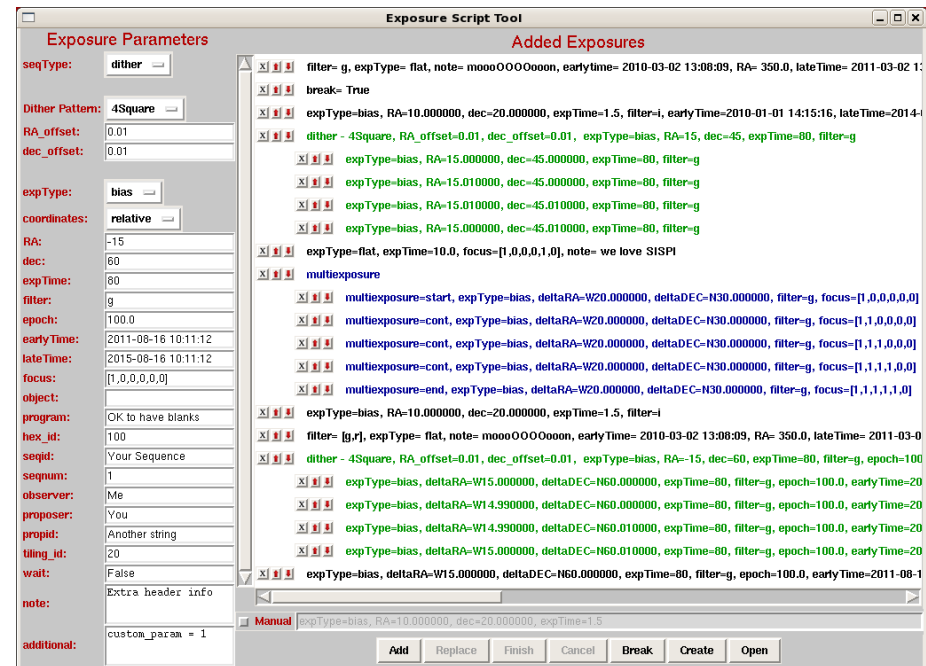
What to expect:

- Linux workstation
- DECam GUIs are web-based
- Some VNC
- 8 screens
- How-To's, Manuals, Procedures on Wiki
- Webcam with Skype:
DECamObserver
- Chat
- Gmail account:
decamobserver@gmail.com
- **Observer workstation**
(4 screens)



Observation Control (OCS) and Exposure Queue

- OCS orchestrates entire exposure sequence
- 2 exposure deep pipeline
- Exposure requests are submitted to Exposure Queue
 - Manual
 - Obstac (DES)
 - Script (Script Editor)



Exposure Parameters

seqType: **dither**

Dither Pattern: **4Square**

RA_offset: 0.01

dec_offset: 0.01

expType: **bias**

coordinates: **relative**

RA: -15

dec: 60

expTime: 80

filter: g

epoch: 100.0

earlyTime: 2011-08-16 10:11:12

lateTime: 2015-08-16 10:11:12

focus: [1,0,0,0,0,0]

object:

program: OK to have blanks

hex_id: 100

seqid: Your Sequence

seqnum: 1

observer: Me

proposer: You

propid: Another string

tiling_id: 20

wait: False

note: Extra header info

additional: custom_param = 1

Added Exposures

- X [↑][↓] filter= g, expType= flat, note= moooOOOOoon, earlytime= 2010-03-02 13:08:09, RA= 350.0, lateTime= 2011-03-02 13:08:09
- X [↑][↓] break= True
- X [↑][↓] expType=bias, RA=10.000000, dec=20.000000, expTime=1.5, filter=i, earlyTime=2010-01-01 14:15:16, lateTime=2014-01-01 14:15:16
- X [↑][↓] dither - 4Square, RA_offset=0.01, dec_offset=0.01, expType=bias, RA=15, dec=45, expTime=80, filter=g
- X [↑][↓] expType=bias, RA=15.000000, dec=45.000000, expTime=80, filter=g
- X [↑][↓] expType=bias, RA=15.010000, dec=45.000000, expTime=80, filter=g
- X [↑][↓] expType=bias, RA=15.010000, dec=45.010000, expTime=80, filter=g
- X [↑][↓] expType=bias, RA=15.000000, dec=45.010000, expTime=80, filter=g
- X [↑][↓] expType=flat, expTime=10.0, focus=[1,0,0,0,1,0], note= we love SISPI
- X [↑][↓] multiexposure
- X [↑][↓] multiexposure=start, expType=bias, deltaRA=W20.000000, deltaDEC=N30.000000, filter=g, focus=[1,0,0,0,0,0]
- X [↑][↓] multiexposure=cont, expType=bias, deltaRA=W20.000000, deltaDEC=N30.000000, filter=g, focus=[1,1,0,0,0,0]
- X [↑][↓] multiexposure=cont, expType=bias, deltaRA=W20.000000, deltaDEC=N30.000000, filter=g, focus=[1,1,1,0,0,0]
- X [↑][↓] multiexposure=cont, expType=bias, deltaRA=W20.000000, deltaDEC=N30.000000, filter=g, focus=[1,1,1,1,0,0]
- X [↑][↓] multiexposure=end, expType=bias, deltaRA=W20.000000, deltaDEC=N30.000000, filter=g, focus=[1,1,1,1,1,0]
- X [↑][↓] expType=bias, RA=10.000000, dec=20.000000, expTime=1.5, filter=i
- X [↑][↓] filter= [g,r], expType= flat, note= moooOOOOoon, earlyTime= 2010-03-02 13:08:09, RA= 350.0, lateTime= 2011-03-02 13:08:09
- X [↑][↓] dither - 4Square, RA_offset=0.01, dec_offset=0.01, expType=bias, RA=-15, dec=60, expTime=80, filter=g, epoch=100
- X [↑][↓] expType=bias, deltaRA=W15.000000, deltaDEC=N60.000000, expTime=80, filter=g, epoch=100.0, earlyTime=2011-08-16 10:11:12
- X [↑][↓] expType=bias, deltaRA=W14.990000, deltaDEC=N60.000000, expTime=80, filter=g, epoch=100.0, earlyTime=2011-08-16 10:11:12
- X [↑][↓] expType=bias, deltaRA=W14.990000, deltaDEC=N60.010000, expTime=80, filter=g, epoch=100.0, earlyTime=2011-08-16 10:11:12
- X [↑][↓] expType=bias, deltaRA=W15.000000, deltaDEC=N60.010000, expTime=80, filter=g, epoch=100.0, earlyTime=2011-08-16 10:11:12
- X [↑][↓] expType=bias, deltaRA=W15.000000, deltaDEC=N60.000000, expTime=80, filter=g, epoch=100.0, earlyTime=2011-08-16 10:11:12

☐ Manual expType=bias, RA=10.000000, dec=20.000000, expTime=1.5

Add

Replace

Finish

Cancel

Break

Create

Open

DECam Image Format

- Standard FITS Format
 - Multi-extensions
 - 62 4kx4k science CCDs
 - 8 2kx2k focus& alignment CCDs
 - 1 ccd = 2 amp per extension
 - 16 bits per pixel
- Tile compression

DECam Exposure Primary Header

Keyword	Data Type	Example	Comment
SIMPLE	Logical		T File does conform to FITS standard
BITPIX	Integer		8 Number of bits per data pixel
NAXIS	Integer		0 Number of data axes
EXTEND	Logical		T FITS dataset may contain extensions
NEXTEND	Integer		70 Number of extensions
FILENAME	String	Image_decam_00032144.fits	Filename
EXPNUM	Integer		32144 DECam exposure number
OBJECT	String	DES0550-2116A	Object name
OBSTYPE ⁽⁹⁾	String	object	Observation type
PROCTYPE	String	Raw	Data processing level
PRODTYPE	String	image	Data product type
OBSERVER	String	John Peoples, Brenna Flaugher	Observer Name(s)
PROGRAM	String	DES-SN	Current observing program
PROPOSER	String	John Peoples	Proposal Principal Investigator
PROPID	String	2006B-0569	Proposal ID
TELESCOP	String	CTIO 4.0-m telescope	Telescope Name
OBSERVAT	String	CTIO	Observatory Name
OBS-LAT	String	-30.1662500	[deg] Observatory latitude
OBS-LONG	String	-70.8151111	[deg] Observatory East longitude
OBS-ELEV	Float		2215.0 [m] Observatory Elevation
INSTRUME	String	DECam	Instrument used to obtain these data
DETSIZE	String	[1:29400,1:29050]	Detector size
PIXSCALE1	Float		0.27 [arcsec/pixel] Pixel scale, axis 1
PIXSCALE2	Float		0.27 [arcsec/pixel] Pixel scale, axis 2
CAMSHUT	String	Open	Camera shutter status at exposure start
FILTER	String	g	Filter name (serial number)
FILTID	String	DES-g	Unique filter identifier
FILTPOS	String	cassette_1	Filter position in FCM
RADESYS	String	FK5	Telescope coordinate system
TELEQUIN	Float		2000.0 Equinox of telescope coordinates
TELRA	String		23:48.5 [deg] Telescope RA
TELDEC	String		-30.1005 [deg] Telescope Dec
HA	String		02:09:18.7 Telescope hour angle (HH:mm:ss.s)
ZD	Float		30.7 [deg] Telescope zenith distance
AIRMASS	Float		1.162 Airmass
TELFOCUS	String	1.22, 145.3, 2.9, 4300.1, 0.2,0.0	DECam hexapod settings
TELSTAT	String	Track	Telescope tracking status
TIMESYS	String	UTC	Time system
DATE-OBS	String	2006-09-05T08:17:03.988	Date/Time of observation start
TIME-OBS	String	08:17:3.988	Time of observation start
MJD-OBS	Double		53983.34518505 MJD of observation start
EXPTIME	Float		100.02 [s] Exposure duration
EXPREQ	Float		100.00 [s] Requested Exposure duration
DARKTIME	Float		100.15 [s] Dark time
OPENSHUT	String	2006-09-05T08:17:04.012	Time when shutter opened
WINDSPD	Float		5.4 [m/s] Wind speed
WINDDIR	Float		24 [deg] Wind direction (from North)
AMBTMP	Float		11.9 [deg C] Ambient temperature (inside dome)
HUMIDITY	Float		16 [%] Ambient relative humidity
PRESSURE	Float		783 [Torr] Barometric pressure
UPTRTEMP	Float		11.45 [deg C] Upper truss temperature
MSURTEMP	Float		10.17 [deg C] Mirror surface temperature
OUTTEMP	Float		17 [deg C] Outside temperature
DIMMSEE	Float		0.7 DIMM seeing
SKYSTAT	Logical		T Cloud camera (RASICAM) available if true
GSKYPHOT ⁽²⁾	Logical		T RASICAM global sky clear flag
GSKYVAR ⁽²⁾	Float		0.21 RASICAM global sky standard deviation
GSKYPHOT ⁽²⁾	Float		0.51 RASICAM global sky fraction above threshold
LSKYPHOT ⁽²⁾	Logical		T RASICAM local sky clear flag
LSKYVAR ⁽²⁾	Float		0.21 RASICAM local sky standard deviation
LSKYPHOT ⁽²⁾	Float		0.51 RASICAM local sky fraction above threshold
LSKYPOW ⁽²⁾	Float		0.32 RASICAM local sky normalized power
SKYUPDAT ⁽²⁾	String	2006-09-05T08:17:02.890	Time of last RASICAM exposure
HEX ⁽⁴⁾	Integer		1654 DES hex number
TILING ⁽³⁾	Integer		3 DES tiling number
SISPIVER	String	ctio-09122012	SISPT software version
CONSTVER	String	NIGHT:22	SISPT constants version
INSTANCE	String	decam	SISPT instance name
ERRORS	String	None	SISPT readout errors
COMMENT	String	FITS (Flexible Image Transport System)	
CHECKSUM	String	OWDA3T940TA90T99	HDU checksum (incl. update time)
DATASUM	String	0	Data unit checksum (incl. update time)

70 extensions

Environment

Cloud Camera

DECam Exposure Extension Header

Keyword	Data Type	Example	Comment
XTENSION	String	IMAGE	Extension type
BITPIX	Integer		16 Number of bits per data pixel
NAXIS	Integer		2 Number of data axes
NAXIS1	Integer		2160 Length of axis 1
NAXIS2	Integer		4146 Length of axis 2
PCOUNT	Integer		0
GCOUNT	Integer		1 Number of arrays in this extension
INHERIT	Logical		T Inherits PHDU header
EXTNAME	String	S2	Name of this extension
BZERO	Integer		32768 Zero shift for unsigned short
BSCALE	Float		1.0 Scale factor for unsigned short
BUNIT	String	adu	Brightness units for pixel array
DETECTOR	String	PB2213	Detector identifier
CCDNUM	Integer		26 CCD Number
DETSEC	String	[12389,14586,4097:8192]	Location of this CCD on focal plane
TRIMSEC	String	[57:2104,51:4146]	Trim Section of CCD
	String	[57:2104,51:4146]	Data Section of CCD
	String	[1:2048,1:4096]	CCD section to display
	String	[2048:1025,4096:1]	CCD section in read order for amp A
	String	[1081:2104,51:4146]	Data section for amp A
	String	[2105:2154,51:4146]	Overscan section for amp A
	String	[1081:2104,51:4146]	Trim section for amp A
	String	[2155:2160,52:4146]	Prescan section for amp A
	String	[1081:2104,1:50]	Postscan section for amp A
POSTSECA	String		
GAINA	Float		1 [electrons/adu] Gain for amp A
RNOISEA	Float		8 [electrons] Read noise for amp A
SATURATA	Float		170000.0 [adu] Saturation for amp A
AMPSECB	String	[1:1024,4096:1]	CCD section in read order for amp B
DATASECB	String	[57:1080,51:4146]	Data section for amp B
BIASSECB	String	[7:56,51:4146]	Overscan section for amp B
TRIMSECB	String	[57:1080,51:4156]	Trim section for amp B
PRESSECB	String	[1:6,51:4146]	Prescan section for amp B
POSTSECB	String	[57:1080,1:50]	Postscan section for amp B
GAINB	Float		1 [electrons/adu] Gain for amp B
RNOISEB	Float		8 [electrons] Read noise for amp B
SATURATB	Float		170000.0 [adu] Saturation for amp B
DETSET	String	S2	Detector position id (old key)
DETPOS	String	S2	Detector position id
FPA	String	DECAM_BKP1	DECam focal plane name
CCDBIN1	Integer		1 Pixel binning, axis 1
CCDBIN2	Integer		1 Pixel binning, axis 2
DHEINF	String	MNSN simulated hardware	DHE hardware
DHEFIRM	String	demo305_bkp3p3ftt-uc	DHE firmware
RA	String		8.1 [deg] RA for center of the focal plane
DEC	String		-30.1 [deg] DEC for center of the focal plane
RADESYS	String	FK5	World coordinate reference frame
EQUINOX	Float		2000.0 [yr] Equinox of WCS
WCSEXAXES	Integer		2 WCS Dimensionality
CTYPE1	String	RA---TAN	Coordinate Type
CTYPE2	String	DEC---TAN	Coordinate Type
CRVAL1	Double		8.100 [deg] Center of focal plane (RA)
CRVAL2	Double		-30.100 [deg] Center of focal plane (DEC)
CRPIX1	Double		2129.667 [pixel] Reference pixel location along axis1
CRPIX2	Double		10652.800 [pixel] Reference pixel location along axis2
LTIM1_1	Float		1.0 Detector to image transformation
LTIM2_2	Float		1.0 Detector to image transformation
LTIM1_2	Float		1.0 Detector to image transformation
LTV1	Float		56.0 Detector to image transformation
LTV2	Float		0.0 Detector to image transformation
CD1_1	Float		0.0 World coordinate transformation matrix
CD1_2	Float		-7.500000E-05 World coordinate transformation matrix
CD2_1	Float		7.500000E-05 World coordinate transformation matrix
CD2_2	Float		0.0 World coordinate transformation matrix
PV1_0	Float		0.0 PV Distortion Coefficient
PV1_1	Float		1.0 PV Distortion Coefficient
PV1_2	Float		0.0 PV Distortion Coefficient
PV1_3	Float		0.0 PV Distortion Coefficient
PV1_4	Float		0.0 PV Distortion Coefficient
PV1_5	Float		0.0 PV Distortion Coefficient
PV1_6	Float		0.0 PV Distortion Coefficient
PV1_7	Float		0.002 PV Distortion Coefficient
PV1_8	Float		0.0 PV Distortion Coefficient
PV1_9	Float		0.002 PV Distortion Coefficient
PV1_10	Float		0.0 PV Distortion Coefficient
PV2_0	Float		0.0 PV Distortion Coefficient
PV2_1	Float		1.0 PV Distortion Coefficient
PV2_2	Float		0.0 PV Distortion Coefficient
PV2_3	Float		0.0 PV Distortion Coefficient
PV2_4	Float		0.0 PV Distortion Coefficient
PV2_5	Float		0.0 PV Distortion Coefficient
PV2_6	Float		0.0 PV Distortion Coefficient
PV2_7	Float		0.002 PV Distortion Coefficient
PV2_8	Float		0.0 PV Distortion Coefficient
PV2_9	Float		0.002 PV Distortion Coefficient
PV2_10	Float		0.0 PV Distortion Coefficient
CHECKSUM	String	914dCZ3Z9F3dCZ3Z	ASCII 1's complement checksum
DATASUM	String	1459267856	Data checksum for validation file
END			

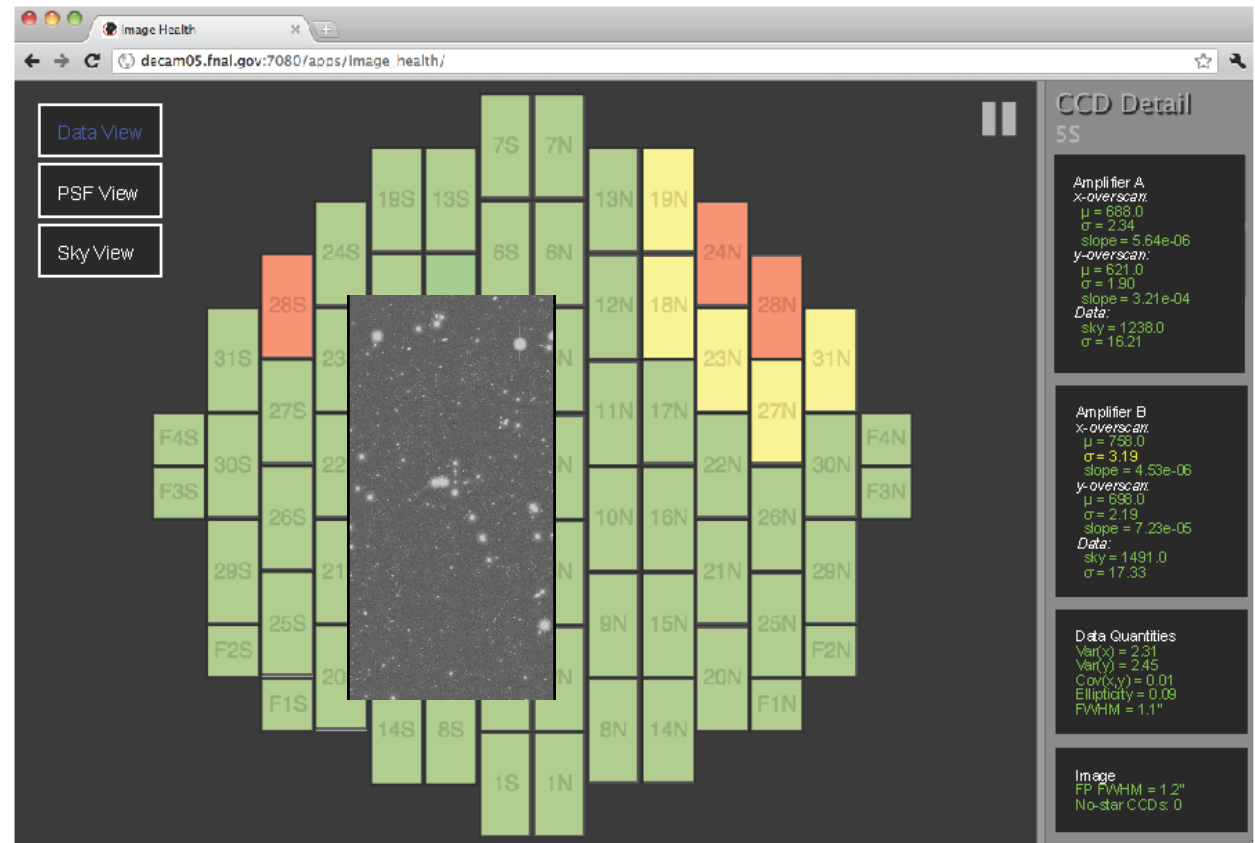
16 bit data

2 Amps per extension

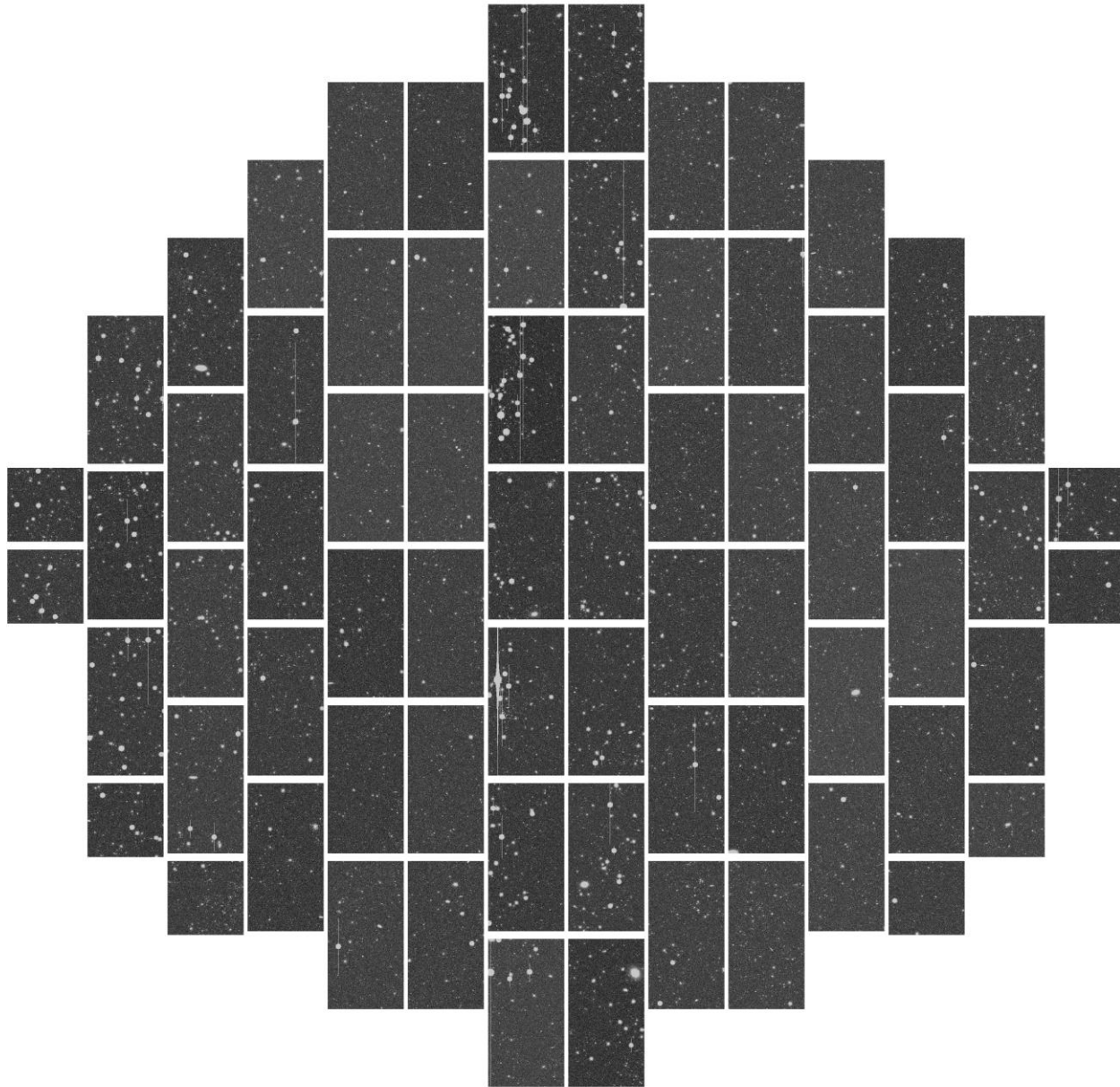
WCS

Quality Assurance: Image Health

- ImageHealth analyzes **every** image
- Algorithms include:
 - Seeing per CCD
 - Sky noise per CCD
 - Mean, variance per amps for overscan and data regions
- Graphical user interface to represent results with different views:
 - Data
 - PSF
 - Sky
 - CCD Image




Quality Assurance: Comfort Display



Quality Assurance: Quick Reduce

- Quick Reduce analyzes a **sample** of all image
- DESDM Astronomy codes, but:
 - No crosstalk correction
 - No bad pixel map
 - No illumination correction
 - (still in flux)
- Astrometry & Photometry
- Plots and Histograms:
 - Seeing
 - Distortions
 - Sky brightness
 - Magnitude limit
 - # of objects
 -
- DES CTIO Portal web interface
- Nightly Summaries
- different views:
 - Data
 - PSF
 - Sky
 - CCD Image



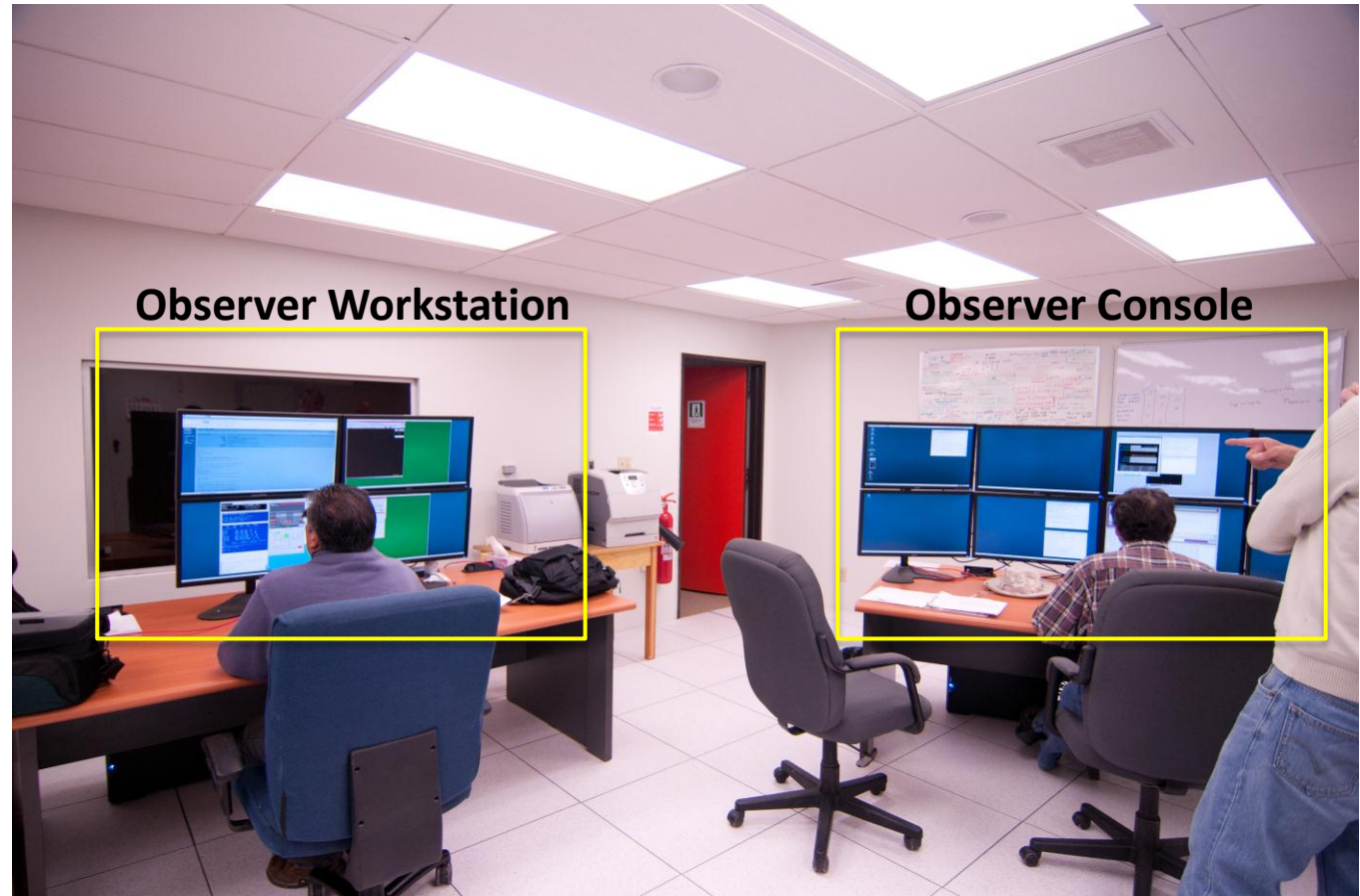
The screenshot shows the DES CTIO Portal web interface. At the top, there's a header with the title "DES CTIO Portal" and a "Logout" link. Below the header is a navigation bar with links: Home, PreCam, Data, Configuration, Documentation, and Help. Under the "Data" link, there are sub-links: Provenance, Search, and Selection. The main content area displays a table of astronomical data. Above the table, it says "You are in page 1. Found pages between 1 and 29" and provides navigation buttons: Choose Page, Previous Page, Next Page, and a dropdown for "Choose lines per page: 20". The table has columns: FILE NAME, DATE, TIME, MJD, RA, DEC, and FILTER. Each row starts with a checkbox. The data is as follows:

	FILE NAME	DATE	TIME	MJD	RA	DEC	FILTER
<input type="checkbox"/>	SA_95-d	2009-11-12	08:08:36.600000	55147.3393	58.749	0.000	z
<input type="checkbox"/>	SA_95-d	2009-11-12	08:07:09.800000	55147.3383	58.749	0.000	i
<input type="checkbox"/>	SA_95-d	2009-11-12	08:02:52.800000	55147.3353	58.749	0.000	u
<input type="checkbox"/>	SA_95-d	2009-11-12	08:00:40.600000	55147.3338	58.750	0.000	g
<input type="checkbox"/>	SA_95-d	2009-11-12	07:58:33.400000	55147.3323	58.750	0.000	r
<input type="checkbox"/>	SA_94-a_1a	2009-11-12	01:07:50.300000	55147.0471	43.888	0.000	i
<input type="checkbox"/>	SA_94-a_1a	2009-11-12	01:05:40.600000	55147.0456	43.888	0.000	i
<input type="checkbox"/>	SA_94-a_1a	2009-11-12	01:03:31.300000	55147.0441	43.888	0.000	i
<input type="checkbox"/>	SA_94-A_9a	2009-11-12	07:53:07.700000	55147.3286	44.715	0.000	i
<input type="checkbox"/>	SA_94-A_8b	2009-11-12	07:50:36.200000	55147.3268	44.674	0.000	i
<input type="checkbox"/>	SA_94-A_8a	2009-11-12	07:48:04.100000	55147.325	44.674	0.000	i
<input type="checkbox"/>	SA_94-A_7b	2009-11-12	07:45:32.100000	55147.3233	44.633	0.000	i
<input type="checkbox"/>	SA_94-A_7a	2009-11-12	07:43:01	55147.3215	44.633	0.000	i
<input type="checkbox"/>	SA_94-A_6b	2009-11-12	07:40:30.200000	55147.3198	44.592	0.000	i
<input type="checkbox"/>	SA_94-A_6a	2009-11-12	07:37:59	55147.318	44.593	0.000	i
<input type="checkbox"/>	SA_94-A_5b	2009-11-12	07:35:27	55147.3163	44.551	0.000	i
<input type="checkbox"/>	SA_94-A_5a	2009-11-12	07:32:55	55147.3145	44.551	0.000	i
<input type="checkbox"/>	SA_94-A_4b	2009-11-12	07:30:23.400000	55147.3128	44.510	0.000	i
<input type="checkbox"/>	SA_94-A_4a	2009-11-12	07:27:52.100000	55147.311	44.510	0.000	i
<input type="checkbox"/>	SA_94-A_3b	2009-11-12	07:25:21.100000	55147.3093	44.469	0.000	i

At the bottom of the page, it says "Release Date: Thu Jul 22 18:25:05 2010".

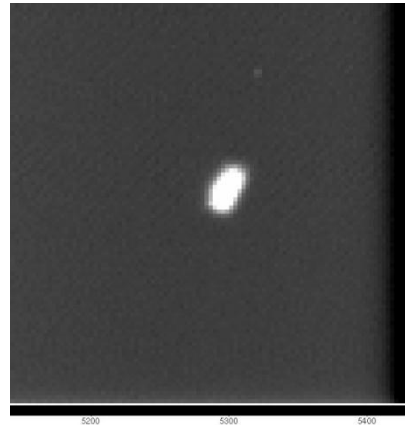
Quality Assurance: Observer Workstation

- **Every** image will be copied to local disk
- Uncompressed
- Standard astronomy software packages:
 - IRAF
 - DS9
 - IDL (is this needed?)
 - fv (is this needed?)
 - fitsutil (is this needed?)
 - SExtractor
- Run your own analysis and algorithms
- USB external disk

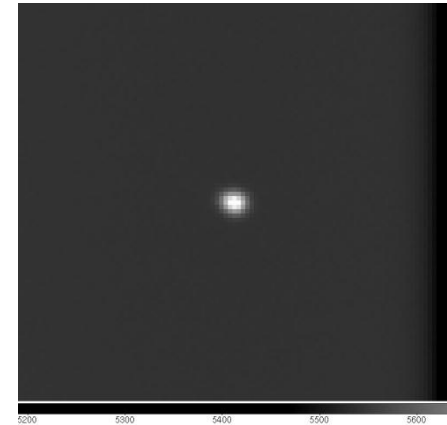


DECam Guider

- 4 2kx2k guide CCDs
- Behind the shutter
- 7 s full readout
<0.5 s in ROI mode
- 1 Hz update rate
- Modes supported:
 - AUTO (Catalog look up)
 - SELF
 - USER
- Tested with PreCAM



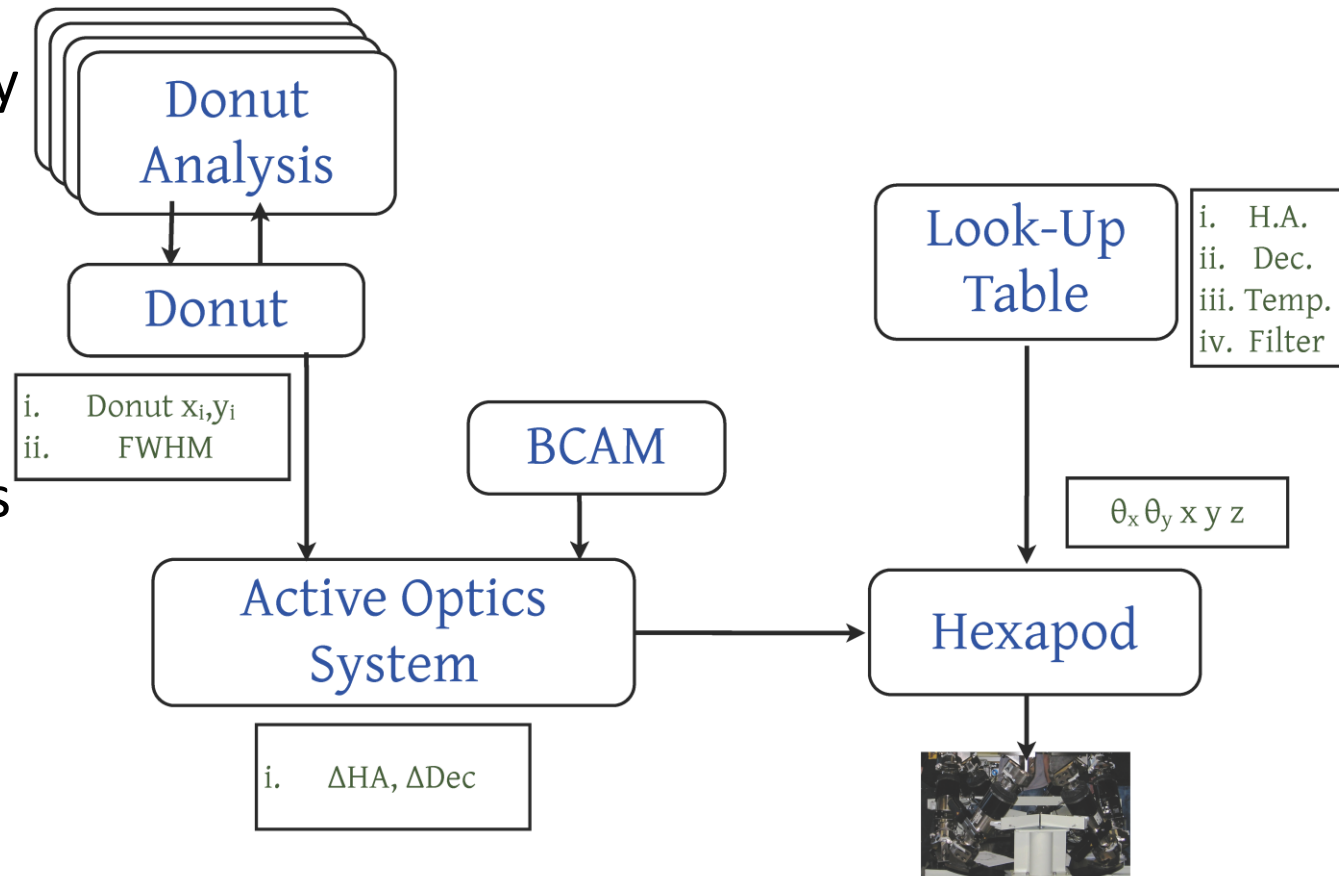
no guide



DES guide

DECam Hexapod, Focus

- Focus controlled by camera, not TCS
- DECam Hexapod
- Closed feedback loop (eventually) using 8 2kx2k CCDs
- Manual focus sequence



and much more...

- **Monitoring and Alarms**
 - Hardware is protected
 - Only experts have access to critical components (e.g. CCD substrate voltage)
 - Call list, paging system
 - Telemetry information archived in DECam DB
- **Remote Access (View information, No control)**
 - Exposure Browser
 - Telemetry, trend charts, correlations
- **Electronic Logbook**

Summary

- DECam readout time ~20 seconds
- DECam image size 1 GB (~600 MB compressed)
- Provided QA:
 - Image Health
 - Quick Reduce
 - Comfort Display
- Observer QA:
 - Observer Workstation
- Feedback, questions: kh@physics.osu.edu