



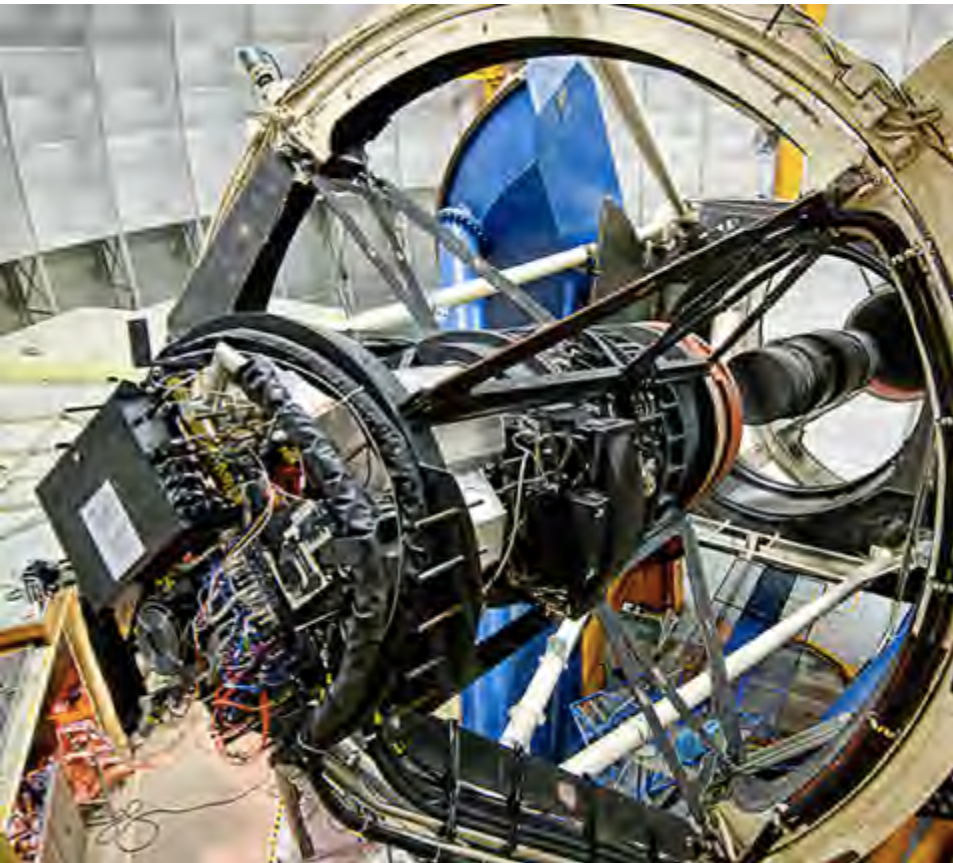
Picture credit Rongpu Zhou

CTIO & NOAO South

Steve Heathcote

Dark Energy Camera @ Blanco

Reliable & Performing Well



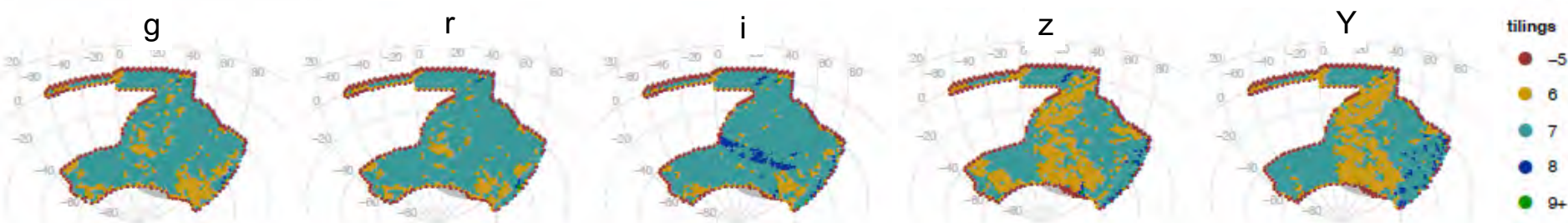
- Blanco+DECAM delivers excellent image quality
 - Median DIQ 0.94" @ riz
 - Best DIQ ~0.6" close to theoretical system floor
- Blanco+DECAM remains very reliable
 - Technical downtime 3% over last year
- Preparing for in-house support post DES including purchase of critical spares

See slide 36 for remote observing



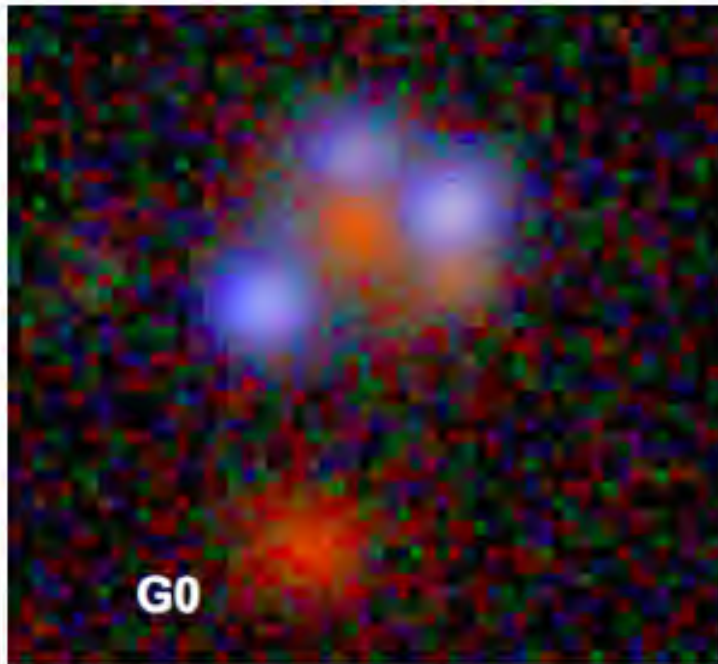
Dark Energy Survey (DES)

Y4 The Best Season So Far

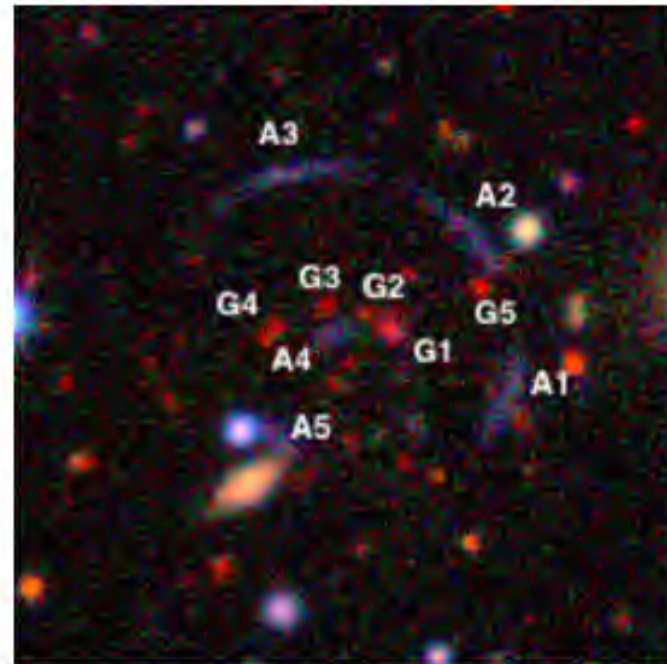


- Four of five DES seasons completed
 - 54712 survey-quality wide-field exposures obtained so far
 - 68% of planned total for survey, 15% behind target for this stage
- Y4 was the best season so far
 - Only 6.4% of time lost to weather versus 33% in Y3
 - Recovered some, but not all, ground lost in Y3
- New public data release schedule agreed (see slide 30)
 - Data products (calibrated, co-added images and catalogs) from Y123 available Dec 2017

- DES: 65 papers published, 32 more submitted
 - Mostly from SV, Y1 and Y2 data
 - First DES cosmology results from Y1 data products imminent
- Community: 55 papers (15 based on DES archival data)

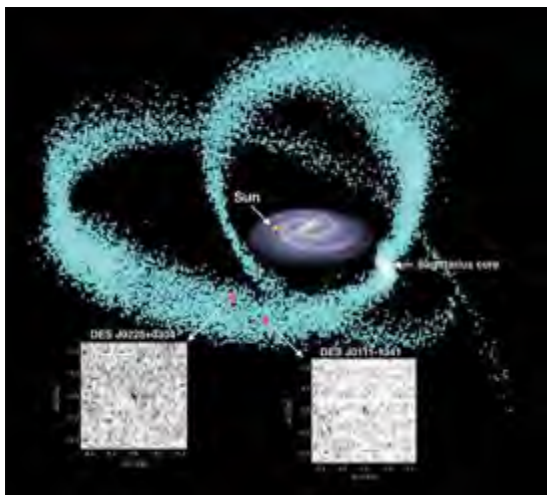


Lensed QSO system DES J0408-5324
Lin et al 2017 ApJ 838, L15



Z=1.06 lensing cluster SPT-CLJ2011-5288
Collett et al arXiv 1703.04810

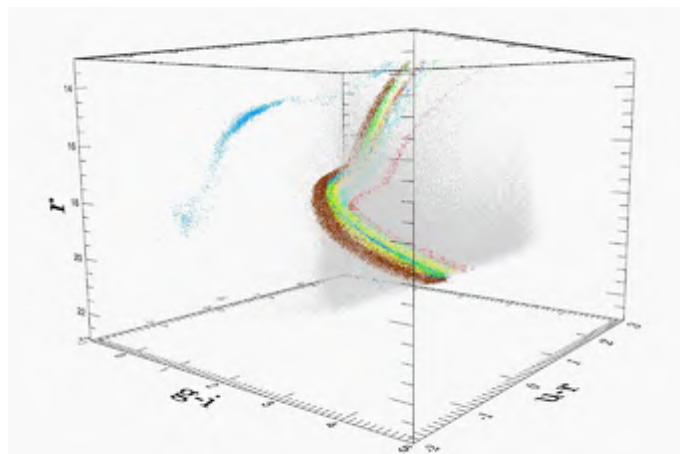
Dark Energy Camera Continues Producing High Impact Science



Faint stellar systems in the
Sagittarius stream

Luque et al 2017 MNRAS 468, 97

Discovery of 2nd most distant dwarf
planet 2014 UZ 224 “Dee Dee” through
image subtraction of DES survey data
Gerdes et al. 2016 ApJ 839, L35



The not so simple globular cluster ω Cen.
Spatial distribution of the multiple stellar
populations.

Calamida et al. 2017 AJ in press





Dark Energy Survey (DES)

The End Game – Year 5.5 ?

- DES have advocated for an additional partial year to complete the survey to the original plan
 - DES is in discussion with DOE over a potential extended program
- DOE and NOAO have agreed that any DES Y5.5 must not impact completion of the DESI targeting survey (DECaLs)
 - NOAO has committed ~30 nights for DECaLs in 2018B
 - NOAO has agreed to pre-allocate time for DECaLs and DES Y5.5
 - DECaLs will go forward, DES Y5.5 now only depends on DOE approval
- DECaLs and DES Y5.5 would together leave little community time in 2018B



Dark Energy Camera

Technical Support Beyond DES

- Per agreement DECcam remains at Blanco for 5 years after the end of the survey.
 - What happens after this is a matter for negotiation
 - There is no obligation on Fermi lab to provide support beyond DES and key staff will move onto other projects
- We envision a role for DECcam in LSST follow-up extending at least a decade beyond this planned life
 - We have in-house expertise in many areas and are well stocked with spares
 - Negotiating with Fermi lab and OSU regarding limited ongoing support in specific areas of concern
 - Software (SISPI)
 - Cooling system and refurbishment of LN2 pumps
 - Opening Dewar to address failed detectors under evaluation
- Will hold a post-DES operational readiness review in July



Dark Energy Camera Community Use Beyond DES

- Blanco+DECam are most suited to produce large homogenous data sets
 - Demand for “traditional surveys” remains high
 - Growing interest in “time -domain surveys” to sample the variable sky on a variety of cadences
- What is the right balance between
 - Large surveys ~ 100s of nights
 - Small surveys ~10s of nights
 - PI programs a few nights
- What new scheduling modes are needed?
 - Time domain surveys need support for specific cadences and long time series e.g. 1h every 3 nights
 - ToO mode for transient events, gravitational wave follow up
- Plan to poll community via currents and e-mail

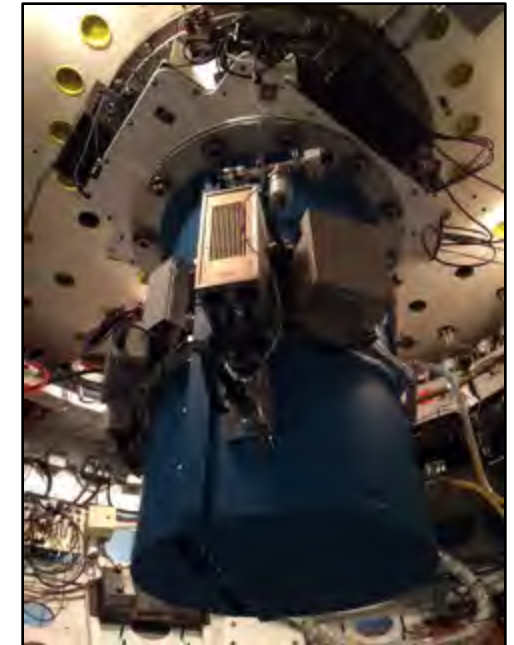
COSMOS



- Optical long-slit & multi-slit $R \leq 3000$ spectroscopy, plus imaging
- Peak Throughput $\sim 40\%$

ARCoIRIS

- Moderate resolution near IR spectrograph
- $0.9 < \lambda < 2.4 \mu\text{m}$ simultaneously in 5.5 cross-dispersed orders @ $R \sim 3000$
- Data reduction package available on first night
Many thanks to Dr. Katelyn Allers!!!
- Moving to SOAR to increase availability, good for LSST follow-up (see slide 55)





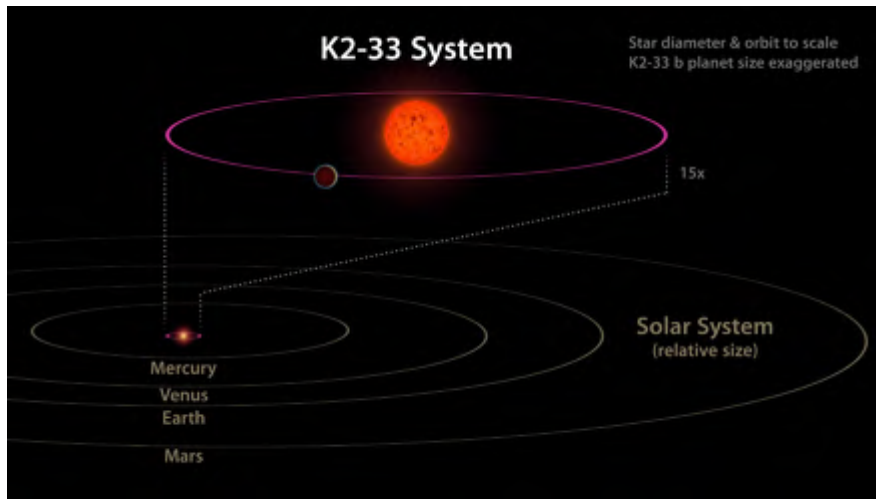
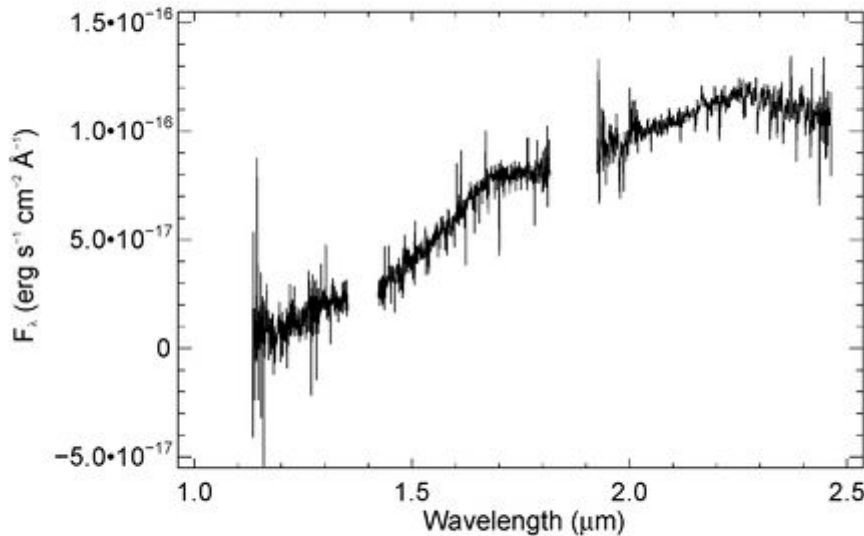
ARCoIRSIS @ Blanco

Early Science Results

Spectrum of J=19.1 YSO

- 8x180sec exposures
- Reduced at telescope within 10 min of readout.

Credit: Katelyn Allers



A short-period planet orbiting a pre-main sequence star in the upper Scorpius OB association
Mann et al 2016 ArXiv:1604.0615
Commissioning run data



Blanco Telescope

Preparing for recoating in July

- Coating plant refurbished
 - Coating tests underway
- Mirror lift repair
 - All purchased and fabricated parts ready
 - Installation nearing completion
 - 12 week program, 7 week contingency
- 4 week shutdown starts 10 July
 - Includes annual servicing of DECam





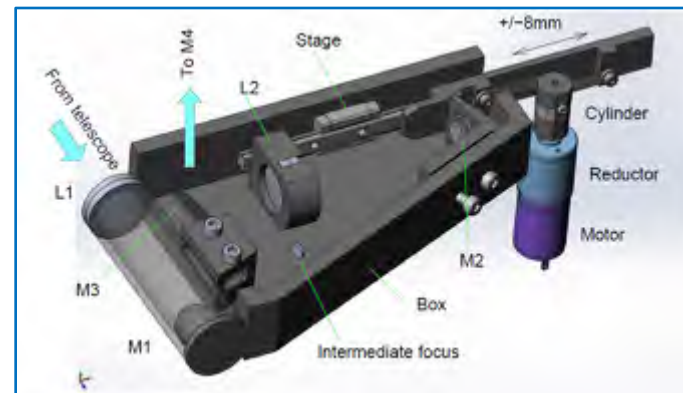
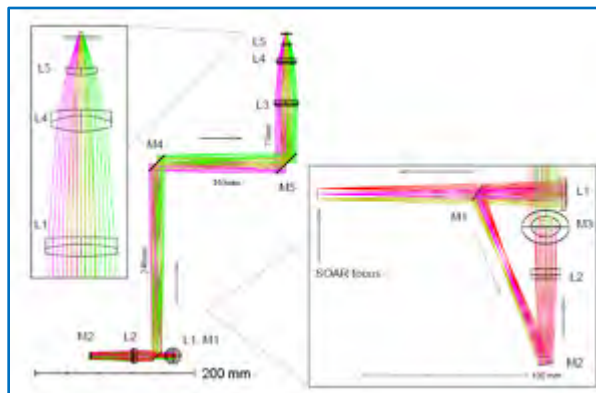
SOAR Telescope

Preparing for the future

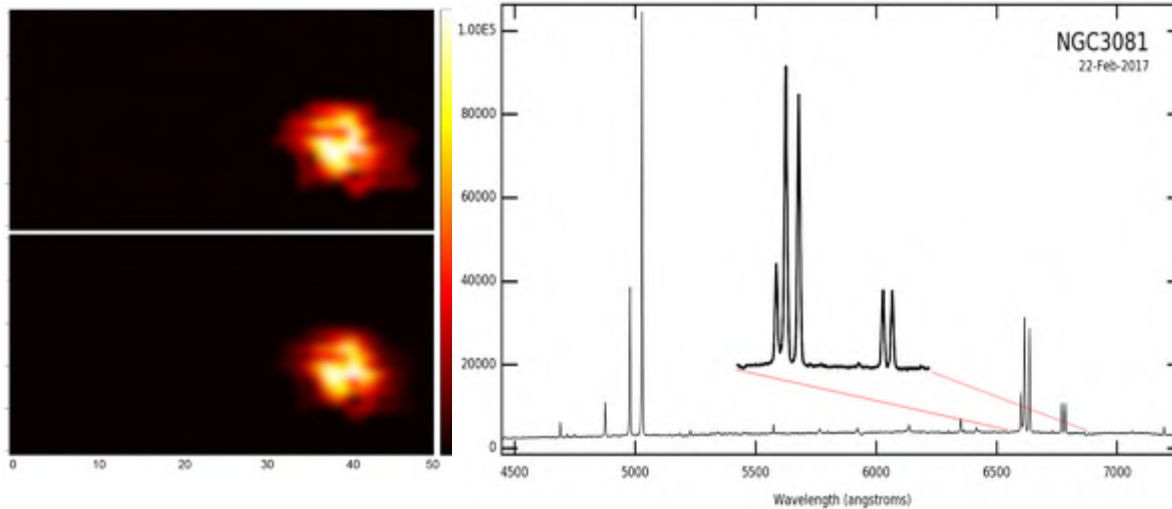
- SOAR partnership fully engaged in planning for the future beyond the end of the current agreement in 2020
 - SOAR 2020 workshop (March 2017) of science plans and priorities
 - Input to planning & assessment by SOAR Board in August
- Further progress as been made over the last year to improve observing efficiency and scientific productivity
- Community demand for SOAR remains strong
- NOAO considers SOAR to be a key component of the LSST follow up capability being developed in collaboration with Las Cumbres, Gemini and SOAR (See presentation by R. Blum)



- Preparing for recoating optics in Oct 2017
- Goodman spectrograph
 - New red camera in service, computer/software for blue camera upgraded to same version
 - Scripting capability being developed at UNC
 - Data reduction pipeline being developed at SOAR. Beta release expected in December
- Detailed opto-mechanical design of wave-front sensing guider underway. Will allow closed loop control of low order aberrations significantly improving observing efficiency



SOAR Telescope SIFS & STELES – Getting Close

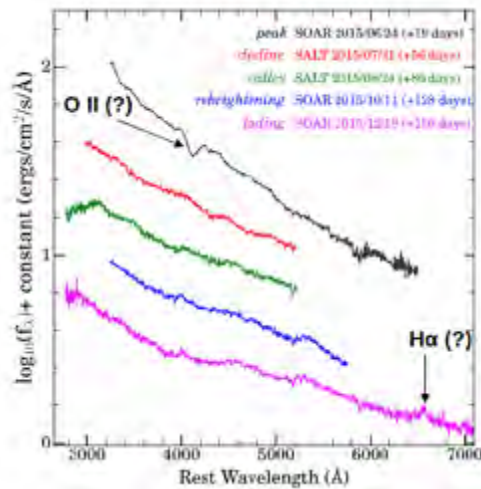


- First Science Verification run successful



- Post-ship test and fit check on telescope completed successfully
- Commissioning starts in July

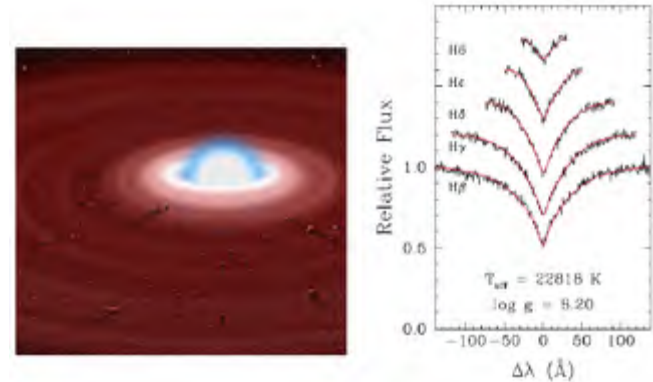
SOAR Telescope Science Highlights



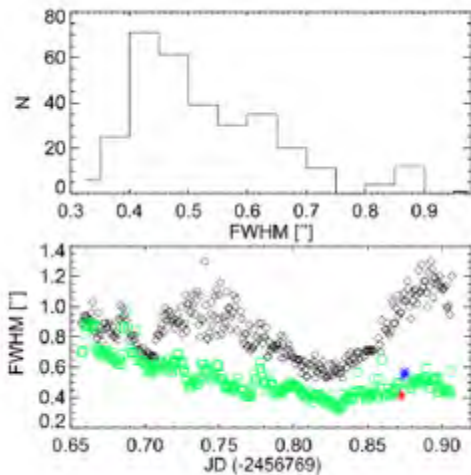
ASSN-151H

Godoy-Rivera et al MNRAS 466,1428

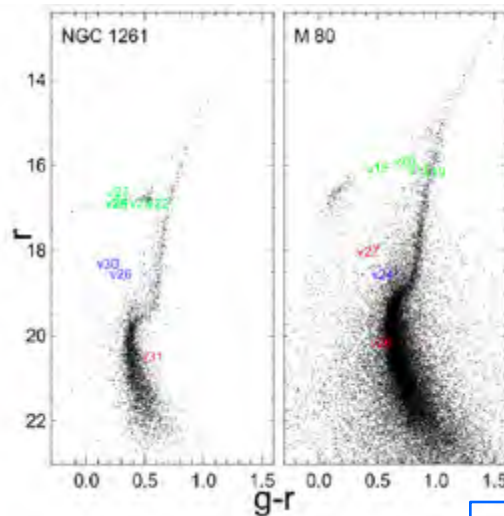
Survey: Next generation low-z SNIa sample for cosmology
PI R. Foley



A subtle IR excess associated with a young WD in the Edinburgh-Cape blue object survey
Dennihy et al 2016 ApJ 831,31



NOAO UC, Tucson, May 2017 (D1)



AO assisted variability study of four globular clusters.
Salinas et al 2016 AJ 152, 55

More on slides 65-74



NOAO-S Facilities Operations Improvements On Tololo & Pachón

Tololo Dining Dormitory



Remodeled Kitchen



Dormitory repainted inside & out, roof repaired

Pachón two-unit building conversion

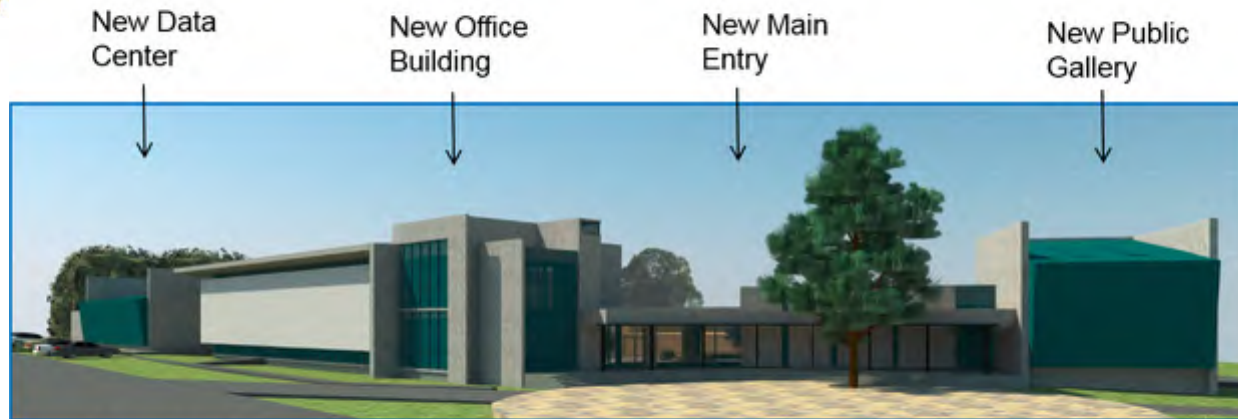


← New ambulance



New La Serena Office Building

LSST, NOAO, AURA Joint venture



New building North elevation (credit: Andes Architects group)

- Collaborative effort to construct new shared office building and data center & refurbish existing offices bringing them to similar standard
- Will provide an integrated facility for scientific and technical staff creating a collaborative environment
- Schedule:
 - Phase I (remodeling): Some preparatory work has already begun. Principal contractor started work Mar 15 2017
 - Phase II (new construction): Reviewing bids received, work expected to start in July 2017



New La Serena Office Building

A new look for new times



View from garage



View from Gemini lobby



View from "modulux"

Credit Andes Architects group



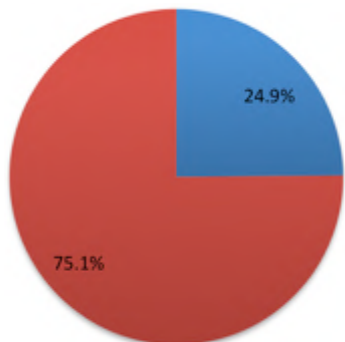
- Slides 20-22 Key Performance Indicators (KPI)
- Blanco
 - Slides 23-44 DECam
 - Slides 46-55 F/8 Instruments
 - Slides 56-59 Blanco improvement projects
- Slides 60-74 SOAR
- Slides 75-79 Small Telescopes
- Slides 80-88 Facilities Operations
- Slides 89-93 New headquarters building



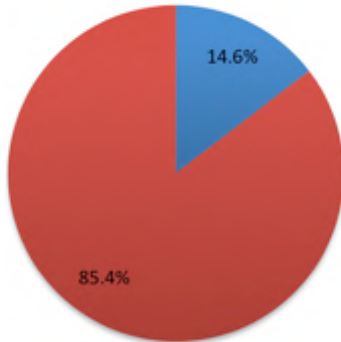
Key Performance Indicators

OA-01 Down Time, Blanco

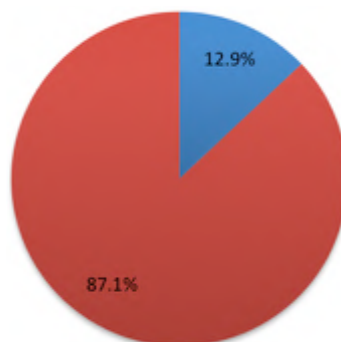
FY13



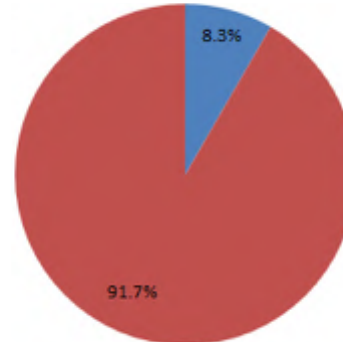
FY14



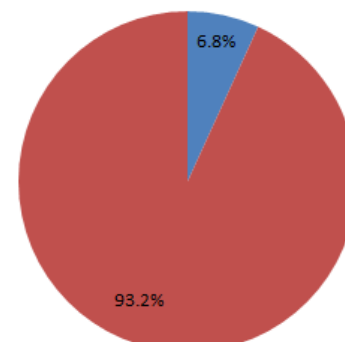
FY15



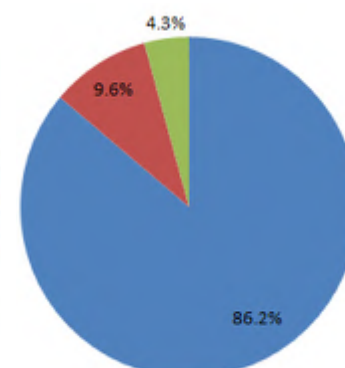
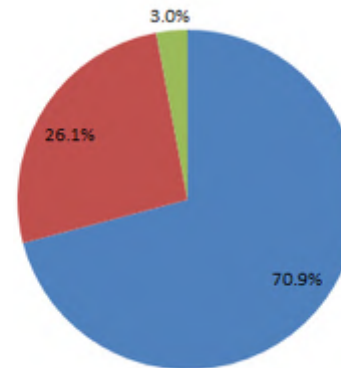
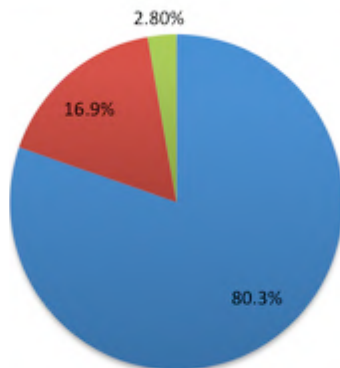
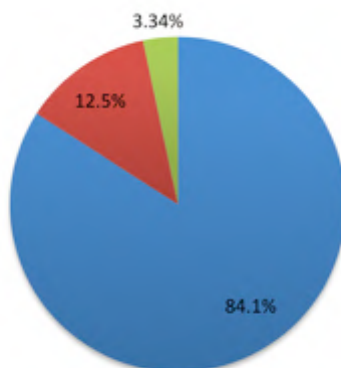
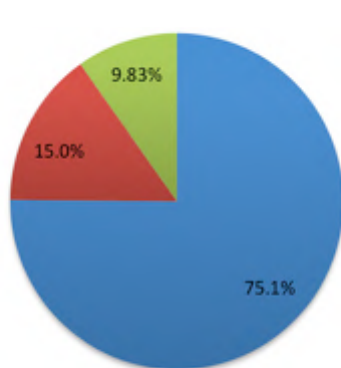
FY16



FY17



Top: % of ALL time scheduled for MT&E; % scheduled for science

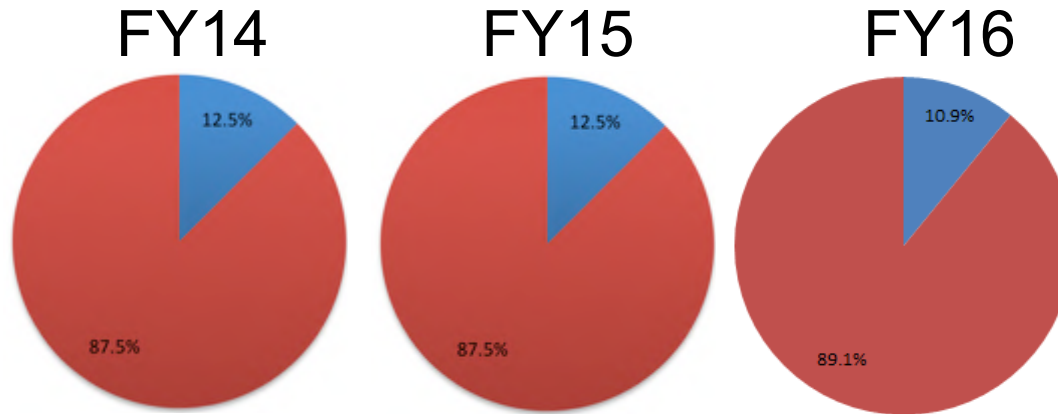


Bottom: % of scheduled science time used for science, lost to weather; lost to unscheduled technical downtime.

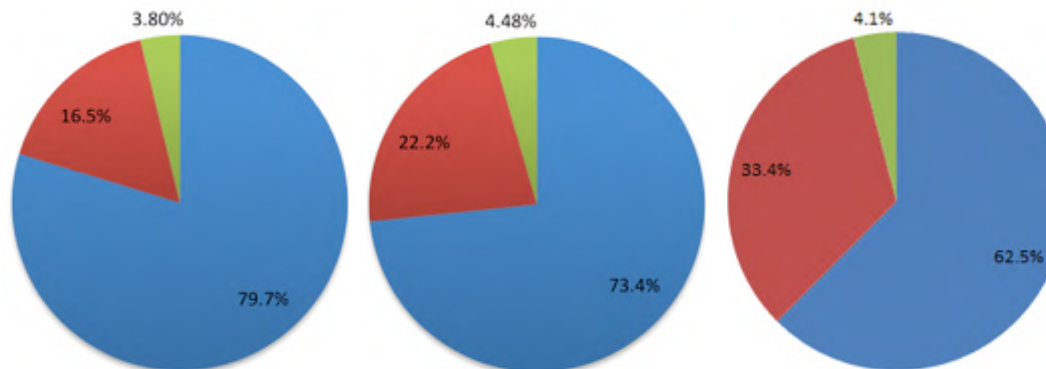


Key Performance Indicators

OA-01 Down Time, SOAR



Top: % of ALL time scheduled for MT&E; % scheduled for science

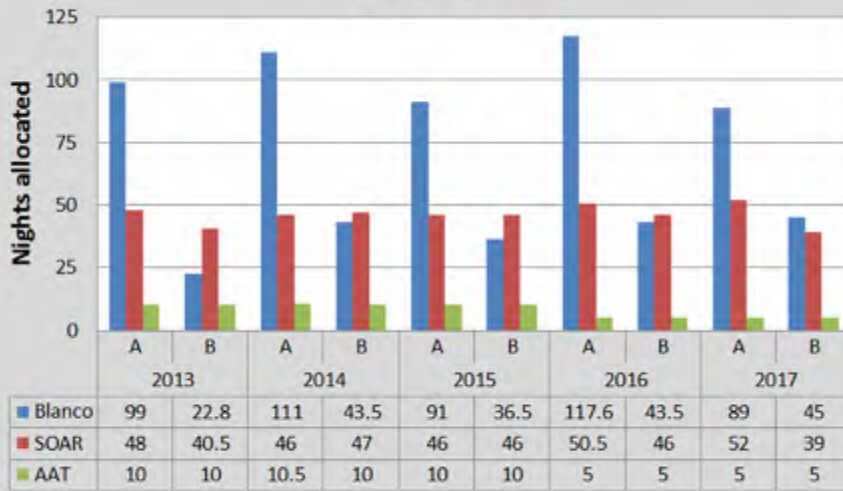


Bottom: % of scheduled science time used for science, lost to weather; lost to unscheduled technical downtime.

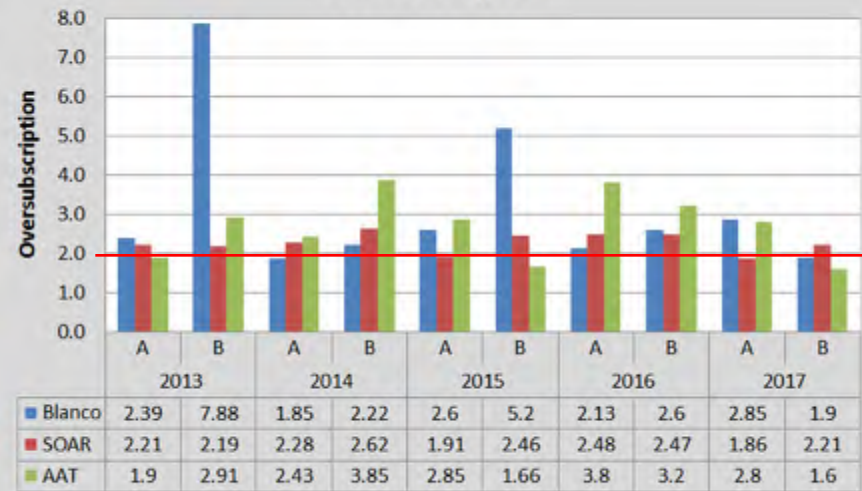


Key Performance Indicators Nights Available & Oversubscription

Nights Allocated



Oversubscription



- Time allocated by the NOAO TAC including standard, long term and survey proposals for a given semester



Blanco 4-meter



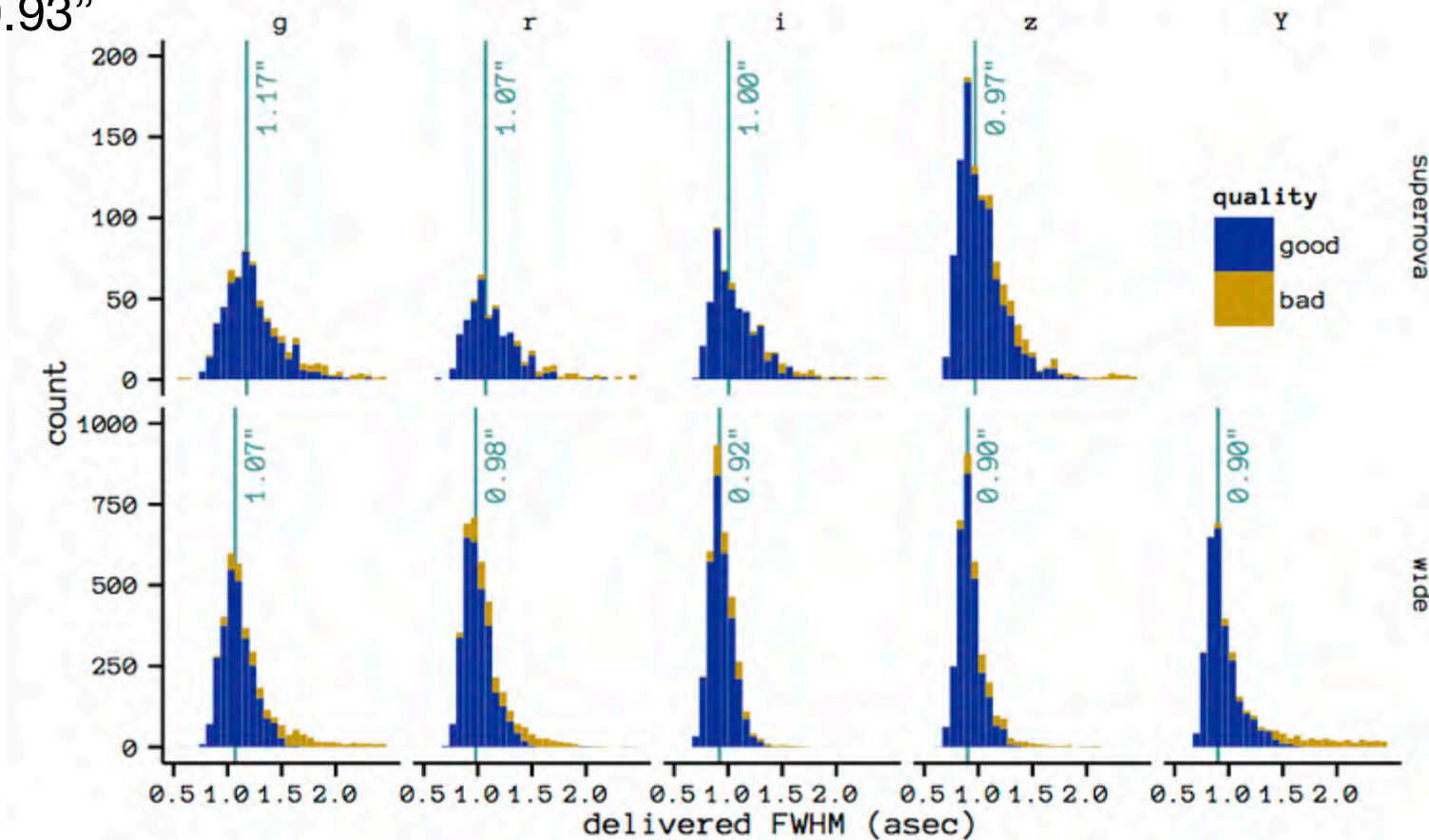


DECam @ Blanco

Delivered Image Quality Y2

Science requirement riz FWHM 0.9" (weak lensing)

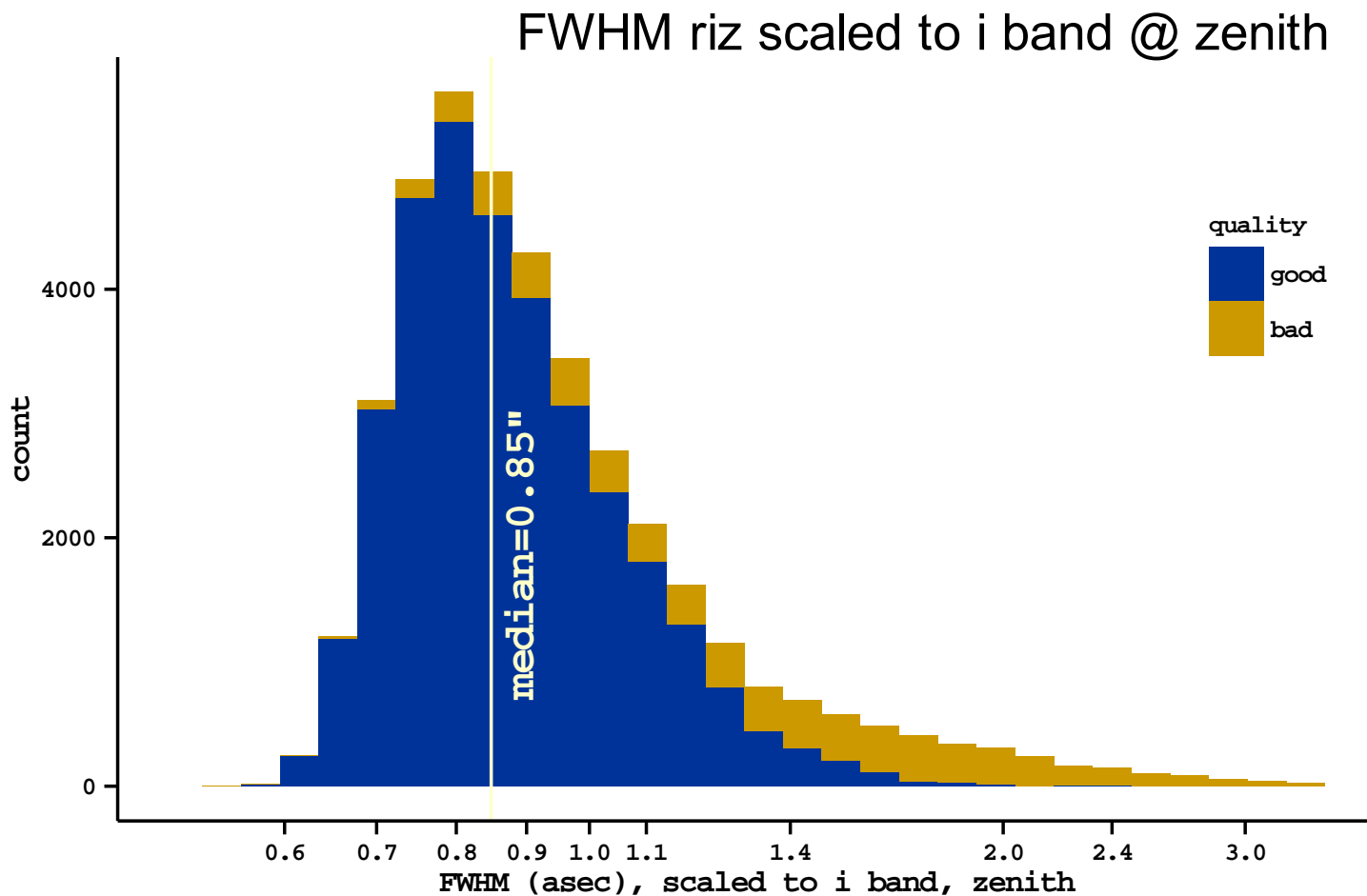
actual I band for "good" exposures Y2 = 0.92", Y3 = 0.94", Y4 = 0.93"





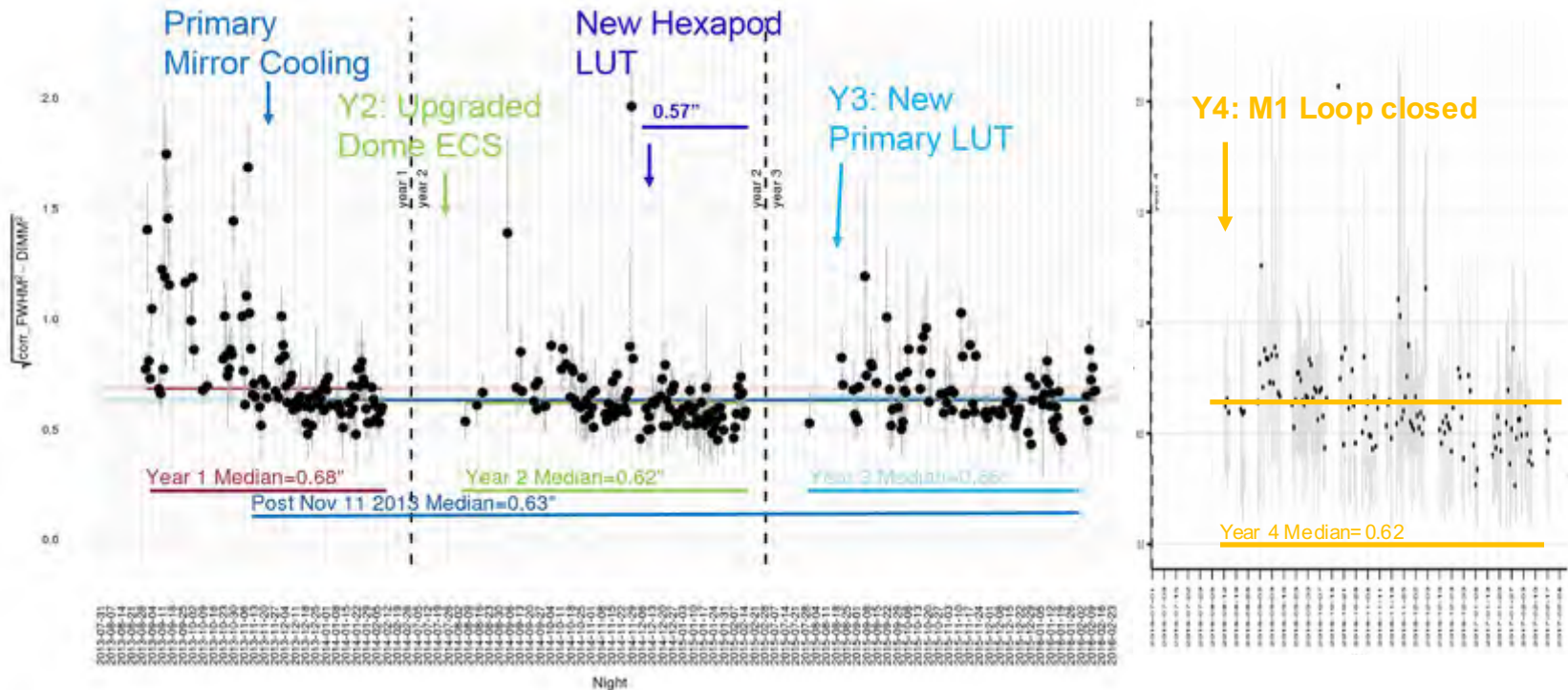
DECam @ Blanco

Delivered Image Quality Y2



Telescope improvements → Better DIQ

The plot shows measured image quality minus DIMM seeing, on a night by night basis (thanks to Eric Nielsen)

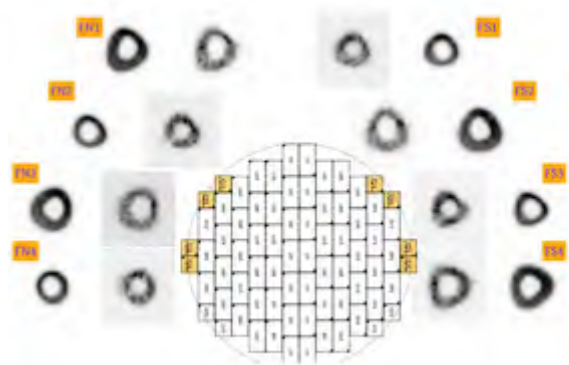


- Atmospheric seeing subtracted DIQ vs night for DES seasons 1 to 4
 - Dates of improvements & resulting median DIQ are marked
 - The calculated instrumental floor of 0.55" is now often achieved



DECam @ Blanco

Closing the M1 AO loop

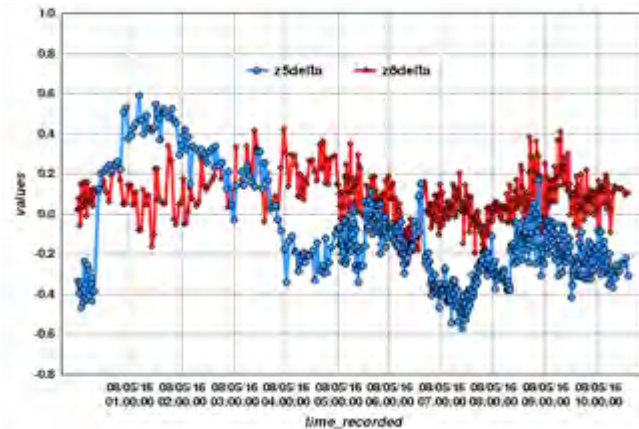


+

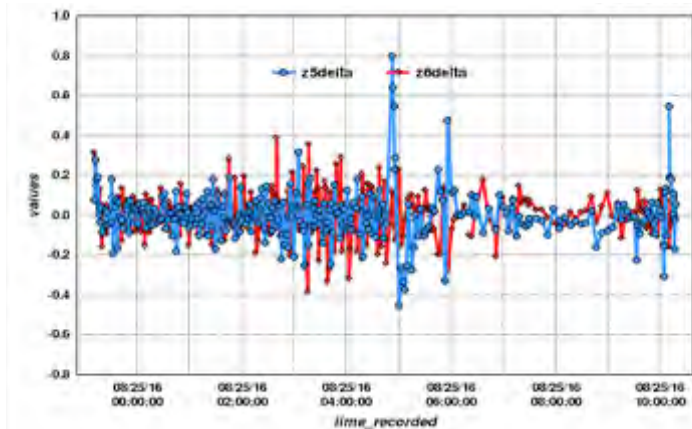


Wave front measurement using extra-focal images
A. Roodman & K. Riel (SLAC)

Higher precision control of M1 pneumatic actuators



→



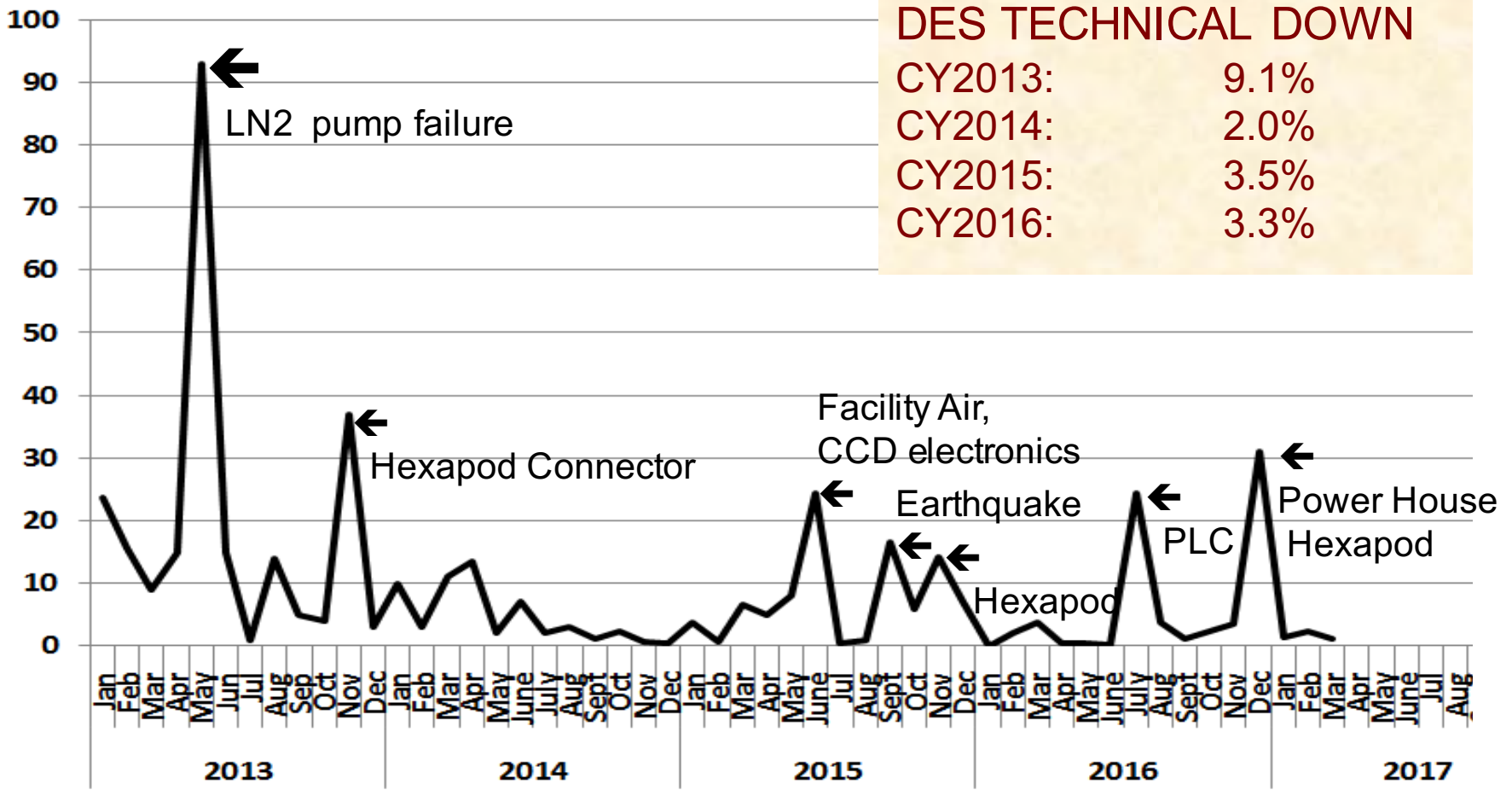
Look-up table based control of astigmatism

Closed loop control of astigmatism

- Closing M1 control loop around “donut” wave front measures
 - Builds on upgrade of M1 pneumatic actuator control
 - This is now the default mode of operation with DECcam



DECam @ Blanco Operating Very Reliably





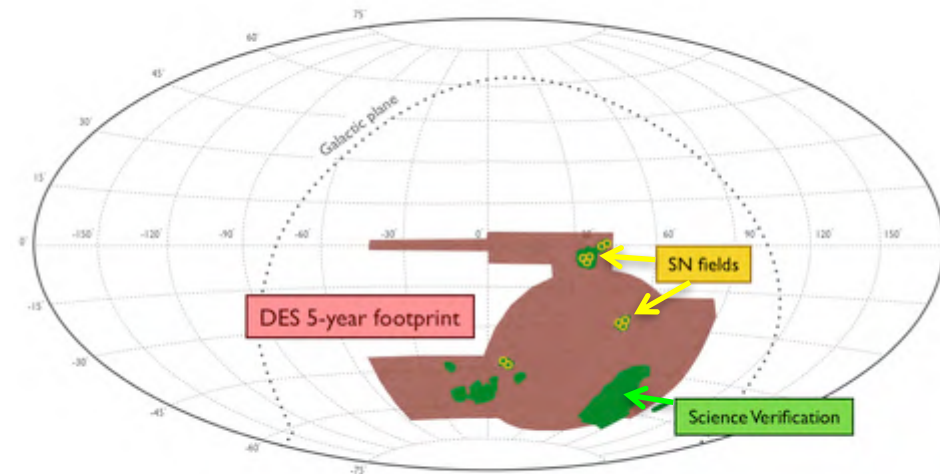
And keeping it that way

- Conservative schedule for replacement of the LN2 pump
 - Swap out every 8 months
 - Pump built with new bearing material was installed in Oct 2016. Lab tests suggest this will be good for >12 months
- LN2 supply/return lines continue to be a concern
 - Aug 2015: replaced 2 segments that had thermal shorts
 - Feb 2016: addressed vacuum leak in one segment
 - Oct 2016: found and fixed major leak through vacuum gauge
 - but continue to have leaks/poor vacuum needing attention
- “hot sparing” the SISPI data acquisition computer system
 - 4 hot spares allow replacement of any of the 30 computers with minimal reconfiguration of the system
 - Implementing plan for transfer of knowledge from OSU software creators to CTIO staff
- Procuring a complete set of key spares for all systems



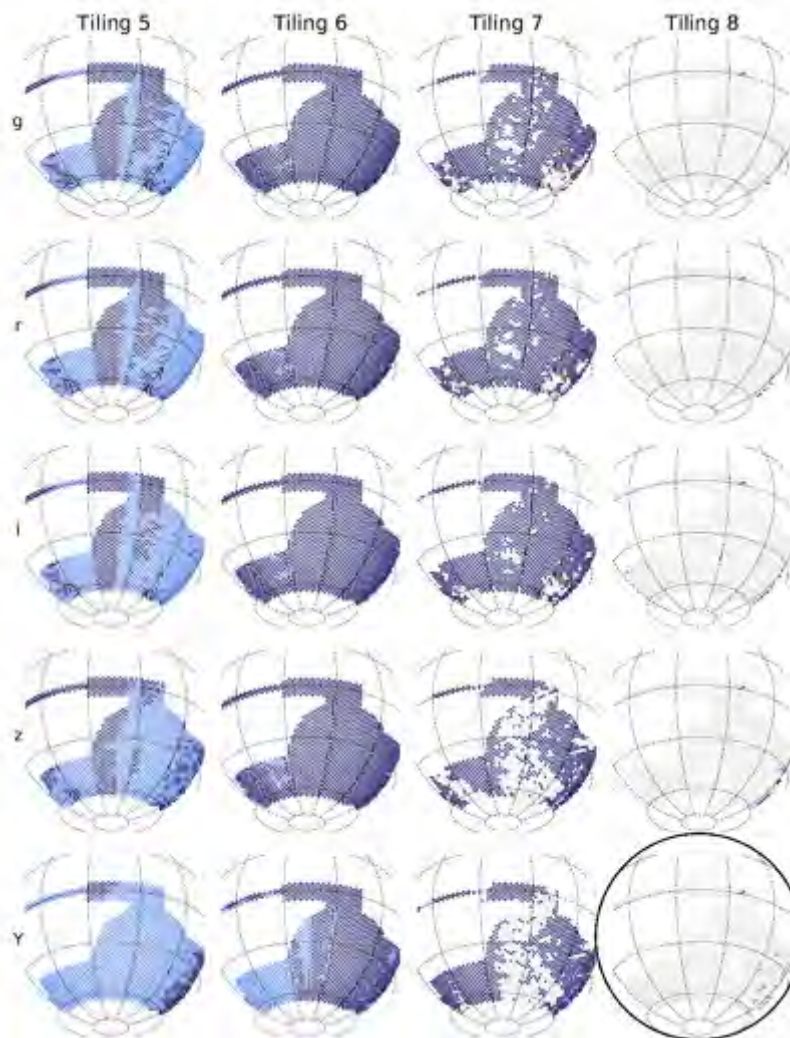
Dark Energy Survey (DES) Overview

- DES uses 4 complimentary techniques to probe cosmic acceleration
 - Clusters
 - Weak Lensing
 - Large-scale Structure (BAO)
 - Supernovae
- Two multiband imaging surveys:
 - 5000 deg² *grizY* to 24th mag
 - 30 deg² *griz* time-domain (SNe)
- Collaboration built & helps maintain:
 - DECam 3 deg² FOV imager
 - DESDM & Community pipelines
- Survey 105 nights/year 2013-2018



Dark Energy Survey (DES)

Status at end of Y4



Light blue Y1+Y2+Y3, Dark Blue Y4.

- DECam Commissioning Sep-Oct 2012
- DES Science Verification Dec 2012-Feb 2013
- The survey proper started in Aug 2013
- With 4 of 5 seasons completed
 - 54712 survey-quality wide-field exposures so far
 - 67.9% of survey total (~15% behind target)
 - A very good Y4 made up some but not all of the ground lost in a miserable Y3
- A possible Y6 is under discussion

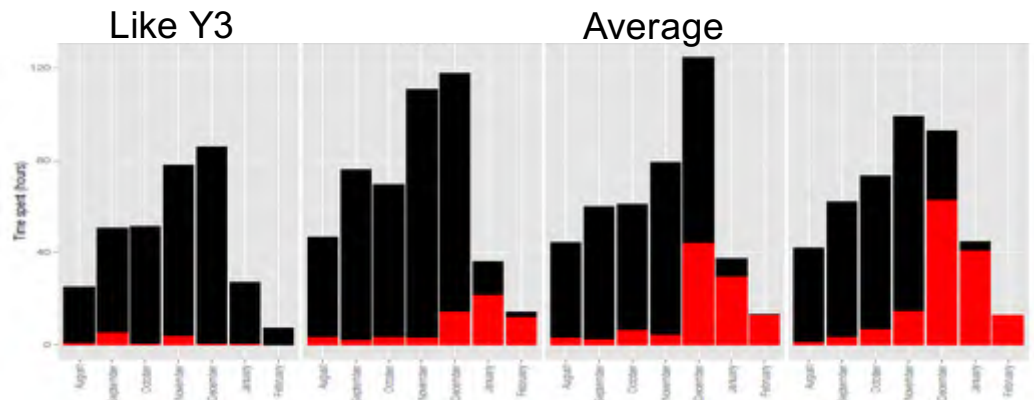


Dark Energy Survey (DES)

Year 5.5 ?

- DES have advocated for an additional partial year to complete the survey to the original plan
 - DES is in discussion with DOE over a potential extended program
 - DOE and NOAO have agreed that any DES Y5.5 must not DOE and NOAO have agreed that any DES Y5.5 must not impact completion of the DESI targeting survey (DECaLs)
 - DES, DECaLs and NOAO are working together to develop a joint observing strategy which could achieve the science goals of both projects should Y5.5 go ahead. Initial indications are that this is plausible

“Non DES” time in Y6 (red)
depending on weather in
Y4+Y5





Dark Energy Survey (DES)

Public Data Releases

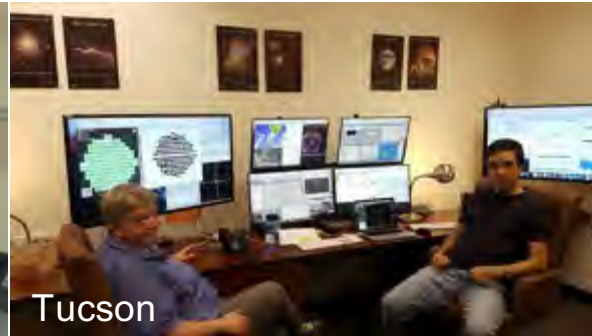
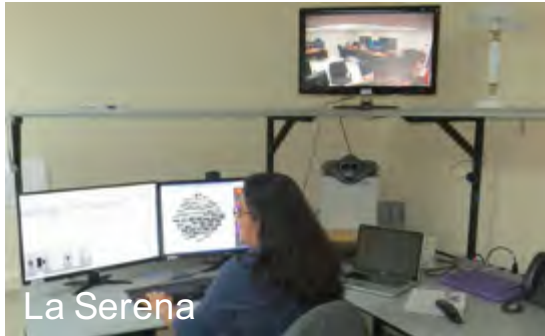
- New schedule for data release agreed with DES (See CSDC presentation by Bolton)
- DESDM-processed, calibrated single-epoch Y1 images released late 2014-early 2015
- SV value-added catalogs (galaxies, photo-z's, shear, etc.) released Jan. 2016
- Processed images for Y123 expected release May 2017
- DR1: Calibrated, co-add images and catalogs from Y123 to be released Dec 2017
- DR2: Calibrated, co-add images and catalogs from Y123, nominally 2020 (survey ends 2/2018)
- DR1, DR2 will be served initially by NCSA, with long-term curation by NOAO.



Community Use of DECam

Demand Remains High

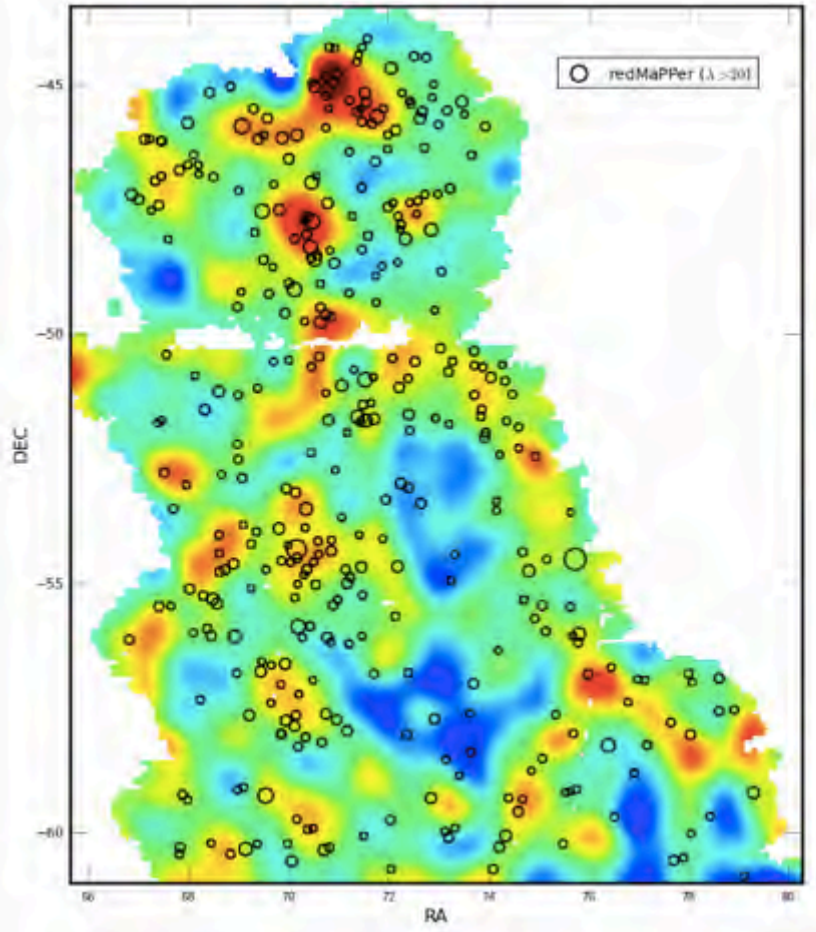
- Diverse science from NEOs, to crowded field photometry, to local group structure, to far universe
- Community Surveys
 - SMASH (PI D. Nidever): 30n over 3 years (done)
 - DECam NEO Survey (PI L. Allen): 30n in 3 “A” semesters (done)
 - DECaLS: (PI D. Schlegel): 64 nights over 3 years
- Many community PI programs
 - DECam accounts for ~81% of all Blanco requests
 - Blanco oversubscription: 15A 2.62; 15B 5.20; 16A 2.13; 16B 2.24; 17A 2.71; 17B 1.9
 - 125.5 nights for 26 programs scheduled in 2016B+2017A
 - B-semester scheduling remains challenging:
 - 77 nights requested for 24 DECam proposals in 2016B
 - Only 37.5 nights for 8 programs could be scheduled



- Remote observing from La Serena now in regular use by staff and visitors and successfully used from Tucson & Fermi lab
 - New tools recently added to facilitate remote assessment of data quality
 - Improved hardware for communication with telescope operators
- Will make more widely available starting in 2017B
 - From Tucson for general users – discussing practical aspects
 - From Fermilab as option for DES observers
 - Open to tests from other locations with required infrastructure
- Support for remote observing w/ COSMOS and ARCoIRIS will follow
 - Beta tested with both instruments in 2017A

Dark Energy Survey (DES)

Early Science Results

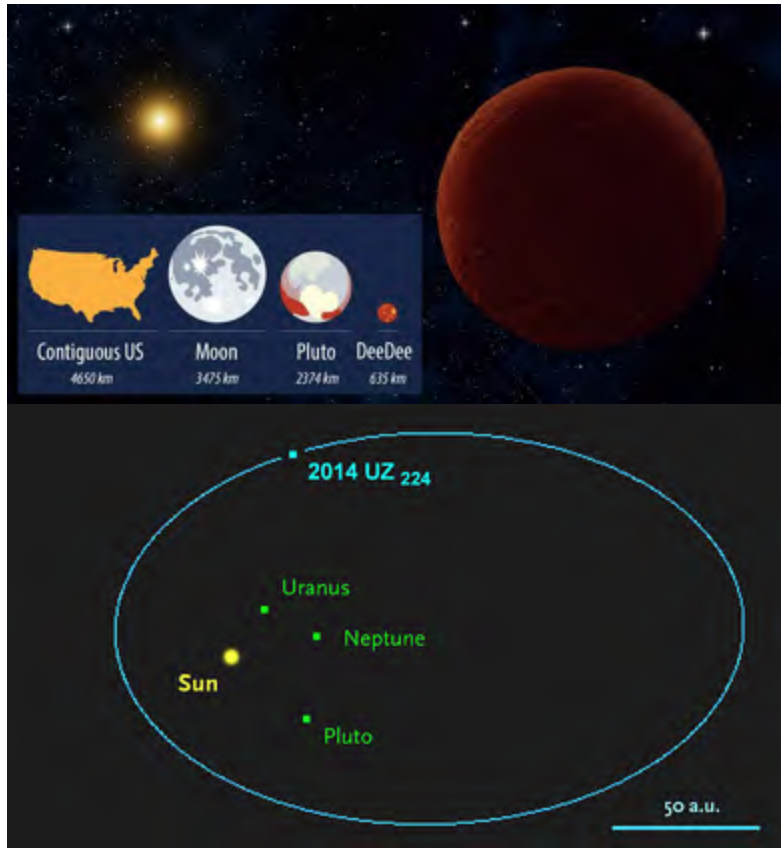


Large-scale Weak Lensing mass map
(Vikram, et al arXiv:1504.03002)

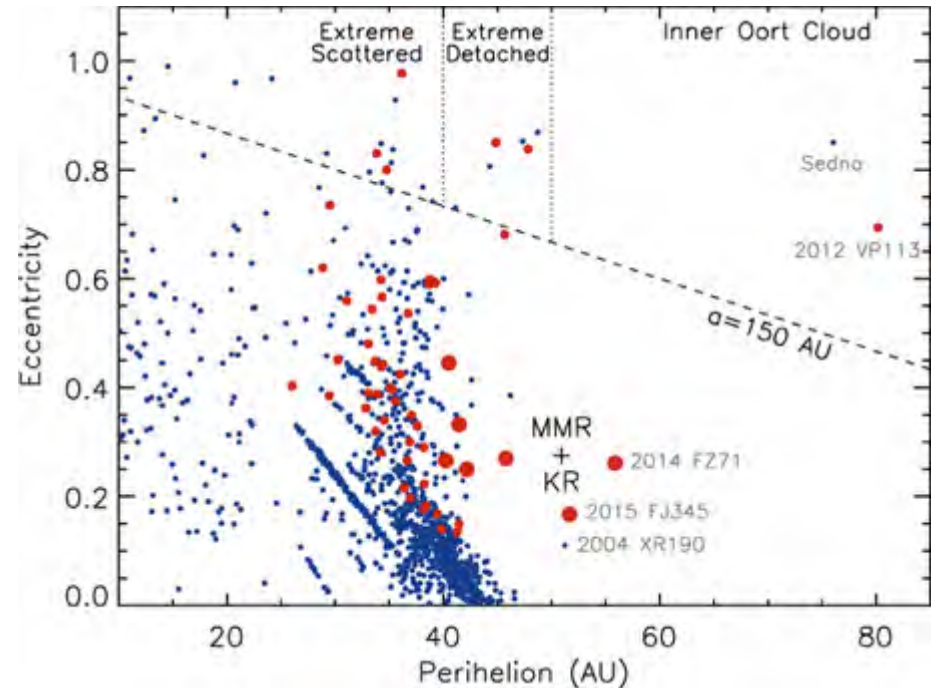
- 97 papers published or in press
 - New Milky Way dwarf satellites
 - Large-scale weak lensing mass map
 - Cluster weak
 - Photo-z catalogs
 - $Z > 6$ QSOs
 - ~ 1000 high-z SNe
 - Superluminous supernovae
 - Strong lenses
 - Cosmology from cosmic shear
 - Galaxy clustering
 - Properties of SZ-selected clusters
 - Cluster scaling relations
 - LMC structure
 - Two new L4 Neptune Trojans

DECam Science Highlights

Solar System



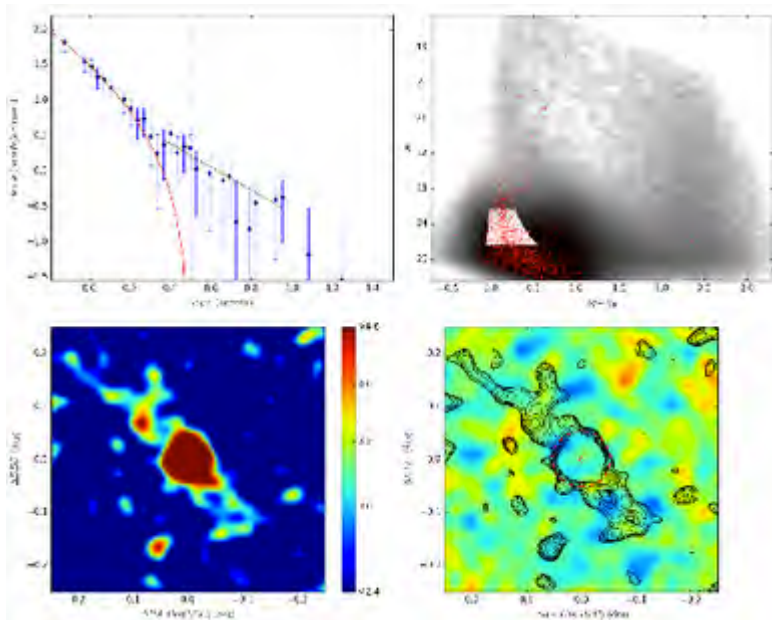
Discovery of 2nd most distant dwarf planet 2014 UZ 224 “Dee Dee” through image subtraction of DES survey data
Gerdes et al. (2016)



Discovery of two new TNOs beyond the Kuiper belt edge
Sheppard et al 2016 ApJ 825 L13

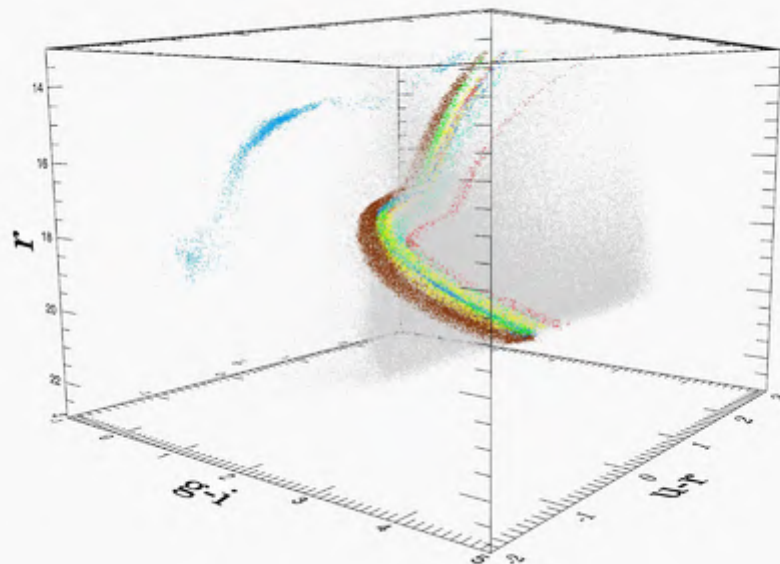
DECam Science Highlights

Globular Clusters



Tidal tails around the outer halo
globular clusters Eridanus and
Palomar 15

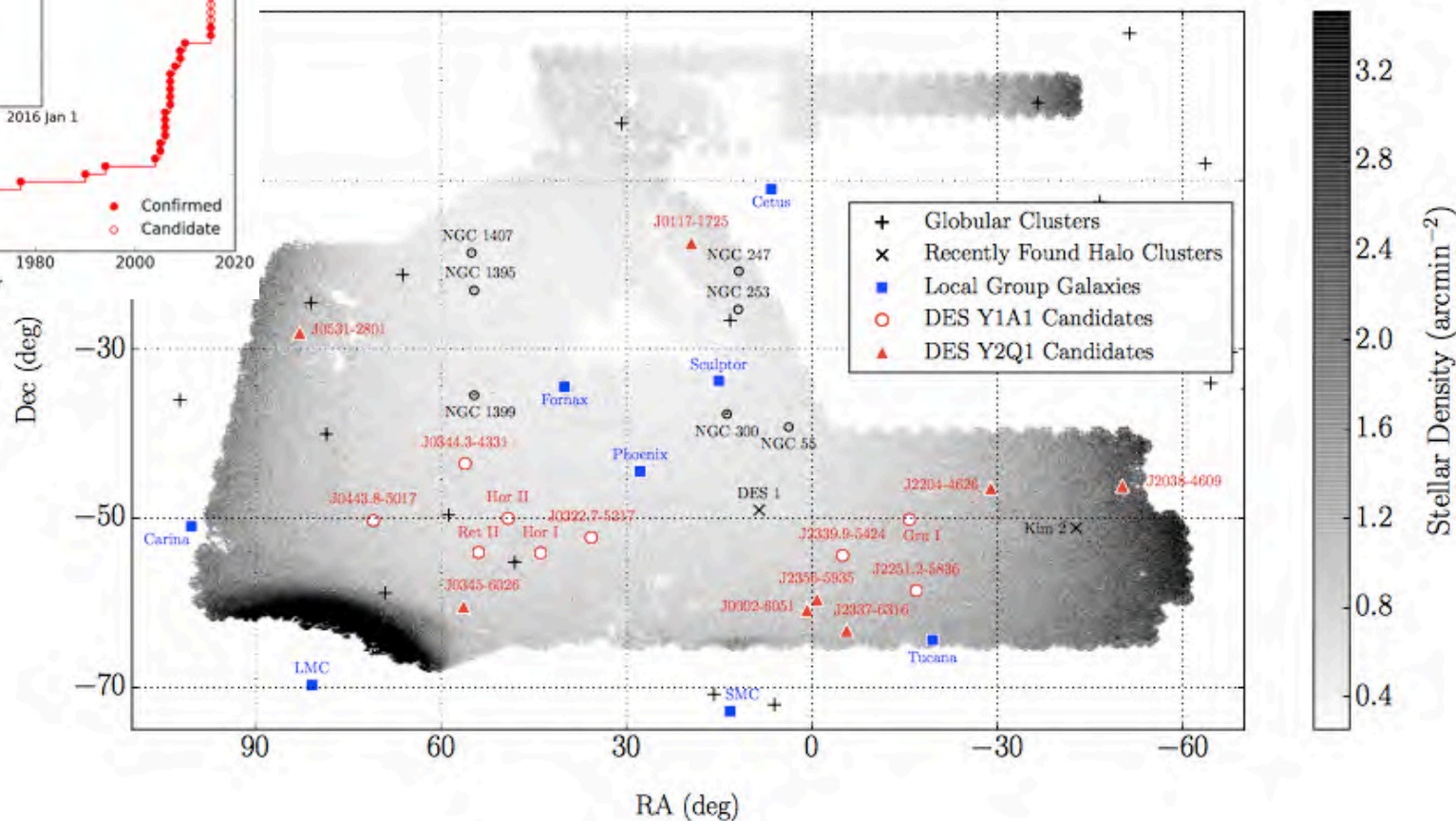
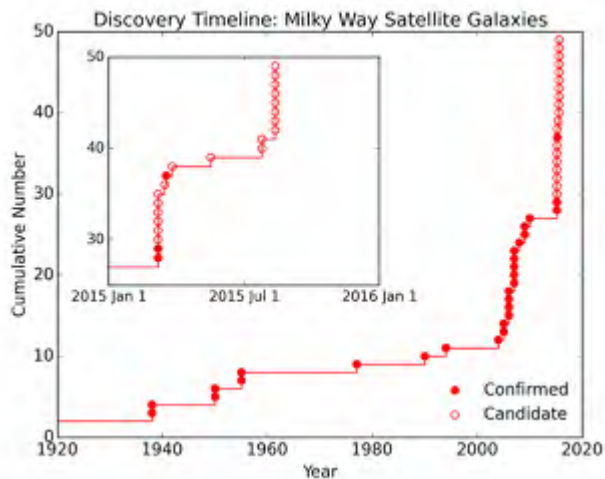
Myeong et al 2017 ArXiv 1704.07690



The not so simple globular cluster
 ω Cen. Spatial distribution of the
multiple stellar populations
Calamida et al. 2017 AJ in press

DECam Science Highlights

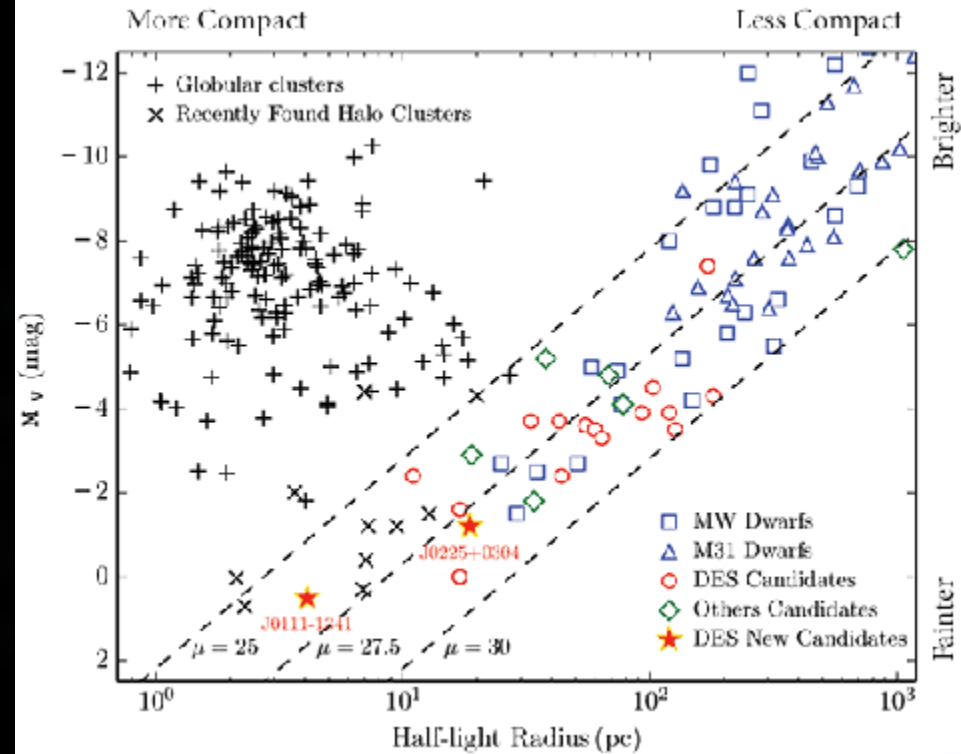
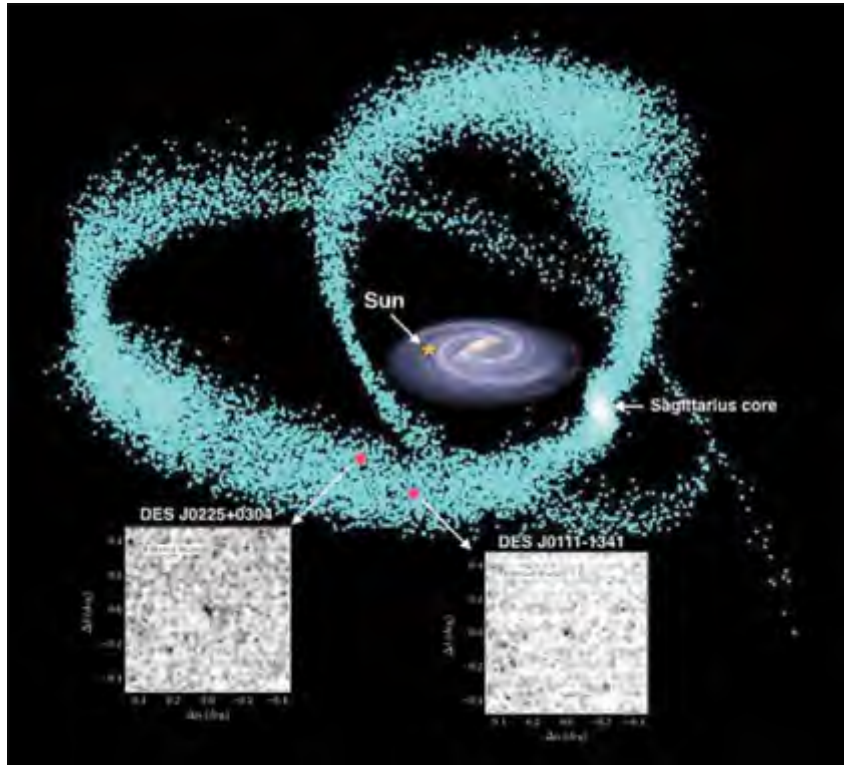
New Milky Way Satellite Galaxies



DECam discoveries almost double the number known

DECam Science Highlights

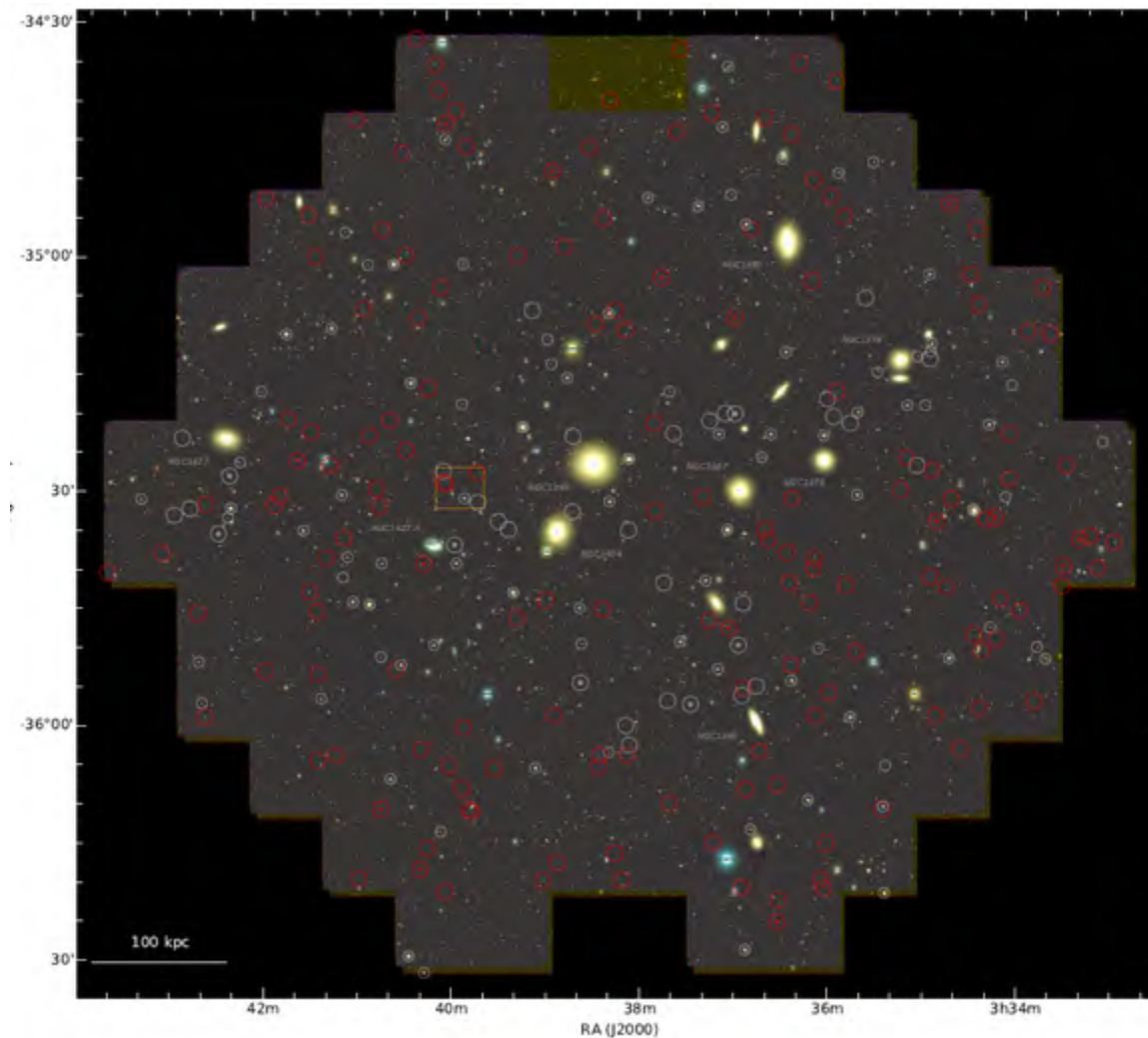
Milky Way Structure



Faint stellar systems in the Sagittarius stream
 Luque et al 2017 MNRAS 468, 97

DECam Science Highlights

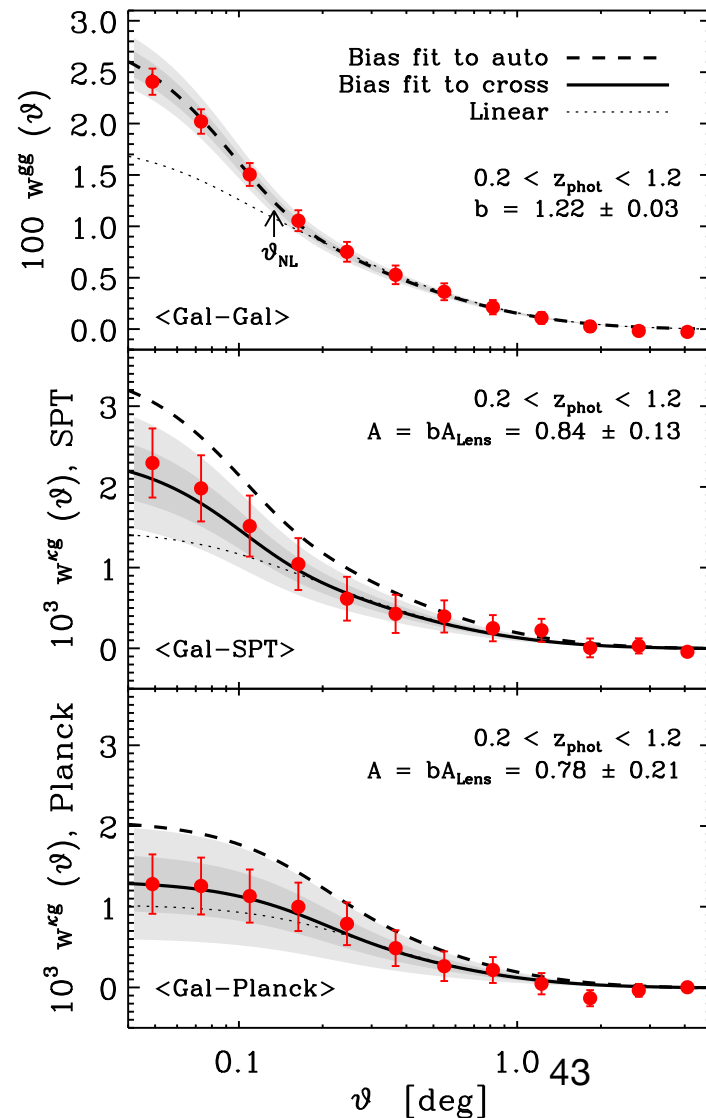
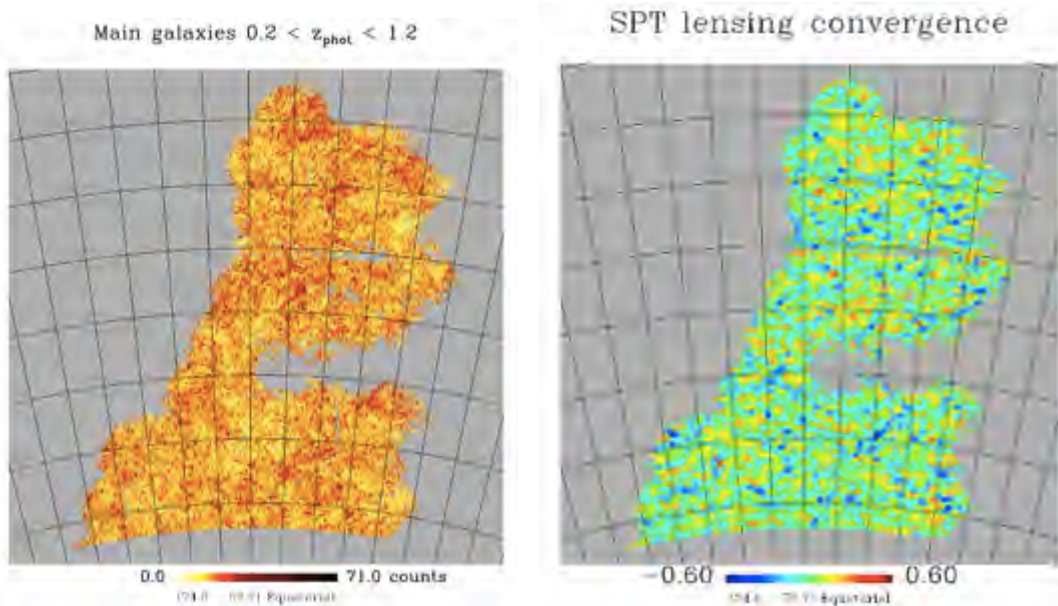
Next Generation Fornax Survey



Muñoz et al ApJ 813, L15

DECam Science Highlights)

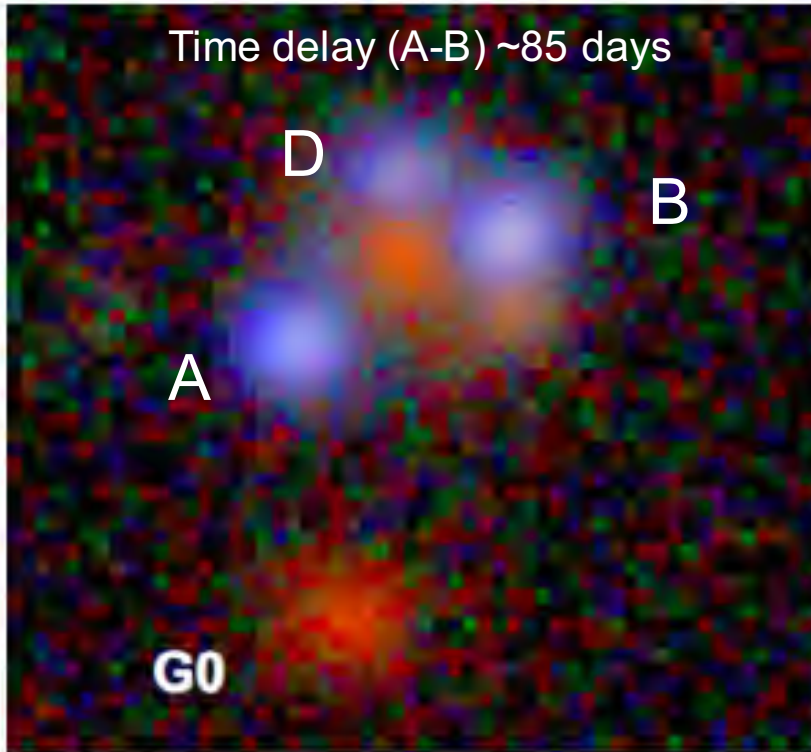
Galaxy-CMB Cross-Correlation



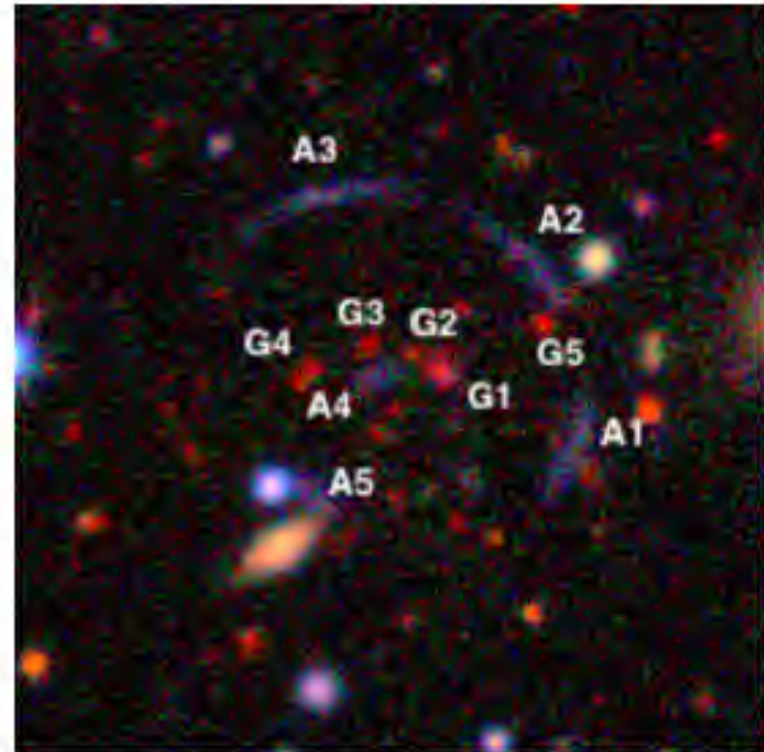
Giannantonio et al 2016 MNRAS 456, 3213

DECam Science Highlights

Strong Lensing



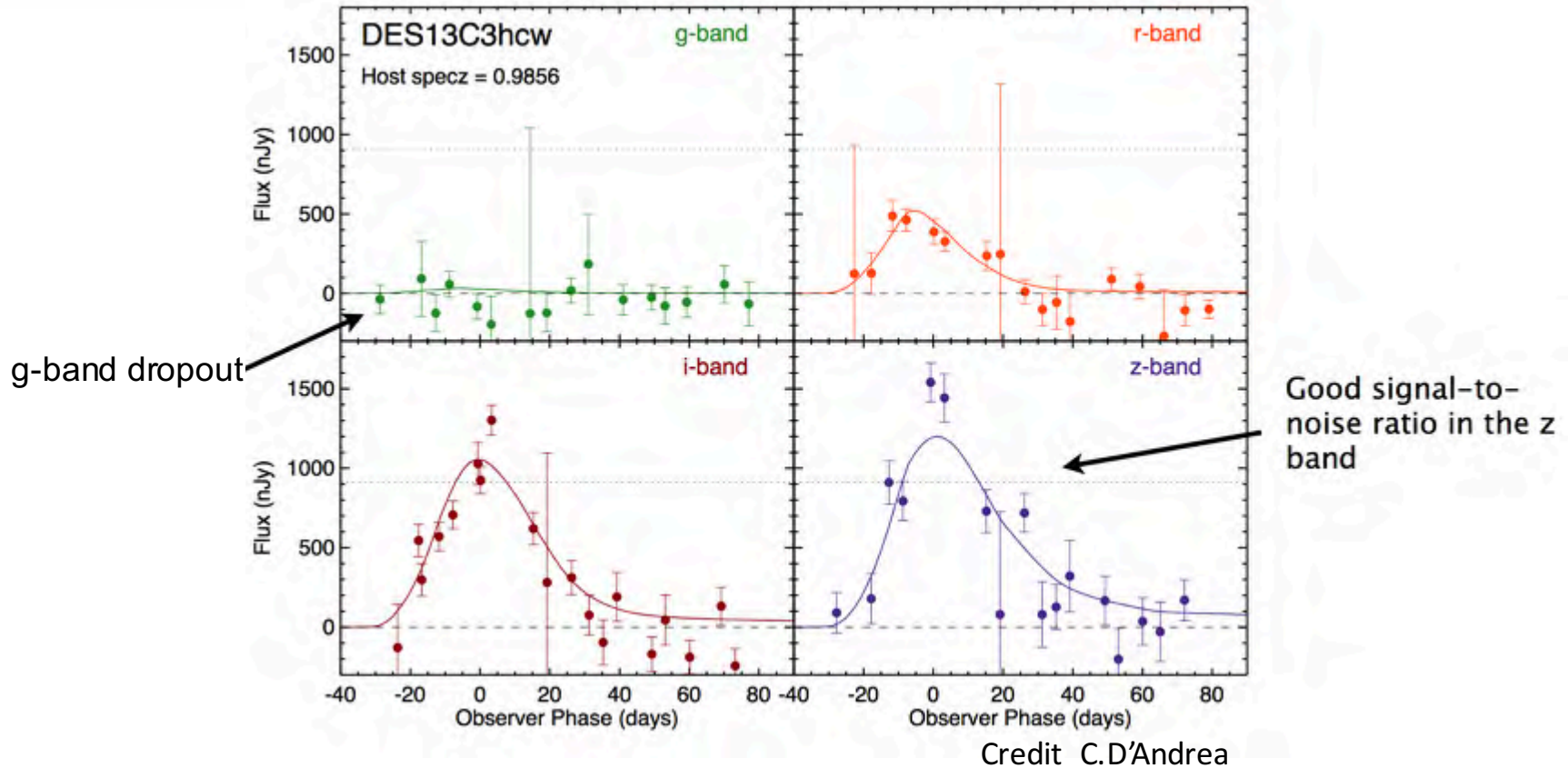
Discovery & modeling of lensed QSO system DES J0408-5324
Lin et al 2017 ApJ 838, L15
Agnelo et al 2017



Z=1.06 lensing cluster SPT-CLJ2011-5288
Collett et al arXiv 1703.04810

DECam Science Highlights

High-Z DES SN light curve $Z=1.0$



- ~200 spectrally confirmed SNIa
- 500+ SNIa with host galaxy redshifts from OzDEZ (AAT)





- COSMOS:
 - in regular science use since 2015A (~10% of requests)
 - 2016A: 18 nights for 7 programs scheduled
 - 2016B: 9 nights for 2 proposals requested, none scheduled
 - 2017A: 6.5 nights for 3 proposals scheduled
 - 2017B: 8 nights requested by 3 proposals
- ARCoIRIS:
 - Offered for community use starting in 2016A (9% of requests)
 - 2016A: 18 nights for 8 programs scheduled
 - 2016B: 13 nights for 6 programs scheduled
 - 2017A: 3.5 nights for 2 programs scheduled
 - 2017B: 12.6 nights requested by 5 proposals
- Time trade with AAO
 - Instruments: AAOmega, HERMES, IRIS2, UCLES, UHRF
 - From 2016A onward trade is 5 nights per semester
 - Oversubscription: 2016A 3.8; 2016B 3.2; 2017A 2.8; 2017B 1.6

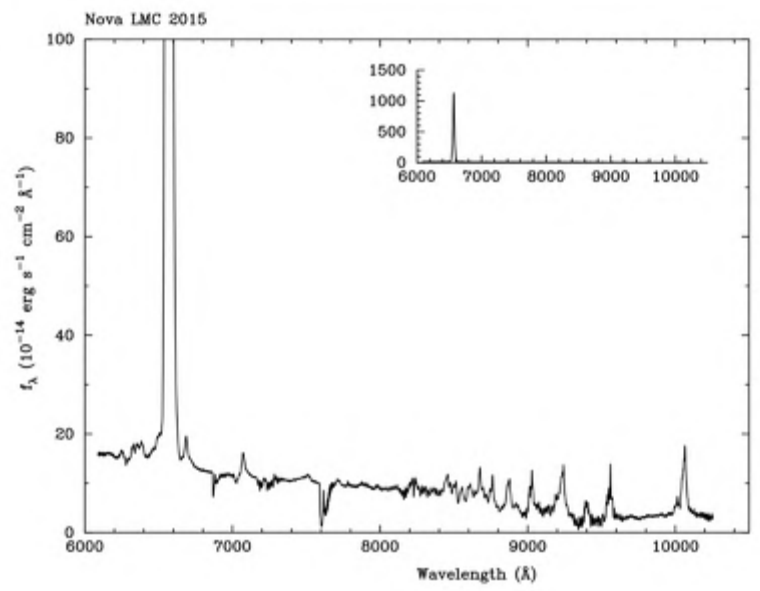
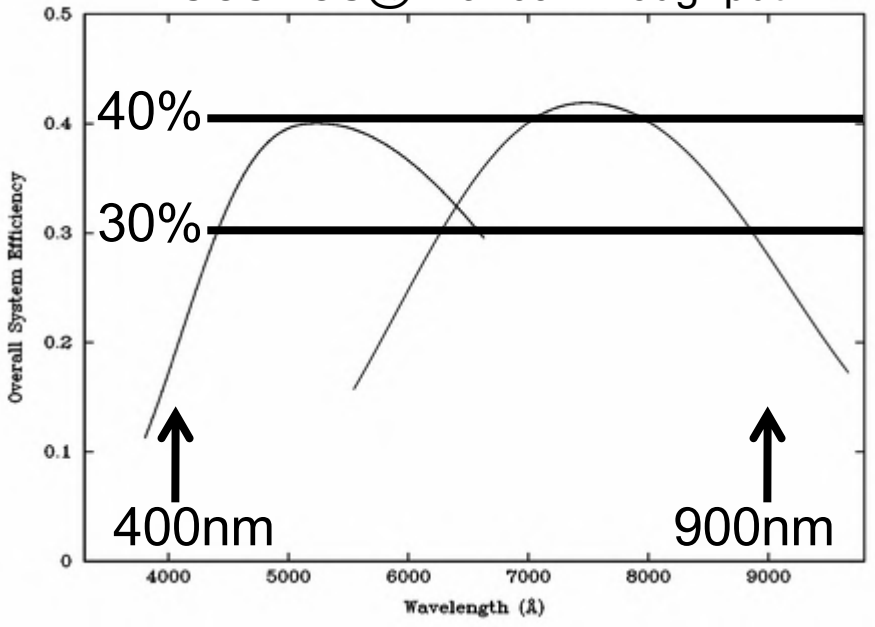


COSMOS @ Blanco In Regular Science Use



- Twin of KOSMOS @ Mayall
- Long-slit & multi-slit spec $R \leq 3000$ + imaging
- Peak throughput 40%
- All modes offered as of 2015A

COSMOS@ Blanco Throughput



Nova LMC 2015 F. Walter



COSMOS (4-m Blanco telescope)

KOSMOS (4-m Mayall telescope)

Identical high-throughput multi-object/longslit spectrometer/imagers

- Peak total system throughput ~40%

Currently available configurations:

- Spectroscopy, R~2200 w/ 0.9 arcsec slit; long-slit coverage options:
 - 3700-6200A
 - 3800-6600A
 - 4150-7050A
 - 5000-8900A
 - 5600-9600A
 - 6150-9800A
 - Also provides 0.6, 1.2, 1.5, 3.0 arcsec slits; resolution scales accordingly
- Multi-slit coverage similar; details depend on mask design
 - Recommended mask FOV ~5x10 arcmin
- Imaging: 10 arcmin diameter FOV, available filters comprise *most* KPNO and CTIO 4-inch filters.
 - Narrowband filter passbands shift to blue
 - Some filters aren't optically flat and degrade images
 - Consult manual for details on what's useful
- Detector is an e2v CCD: deep-depletion device with broadband coating
- *Check back for detector and grism upgrades!*



ReSTAR



ARCoIRIS @ Blanco

Commissioning Completed

- A collaborative project of NOAO with Cornell and U Va (PI. T. Hurter) funded through ReSTAR
 - Heritage from earlier versions on Palomar and ARC
- $0.9 < \lambda < 2.4 \mu\text{m}$ simultaneously in 5.5 cross-dispersed orders
- $R \sim 3000$ with 1.1 arcsec slit (no moving parts)
- Near-IR slit-viewing camera for guiding & acquisition, $\sim 30'' \times 30''$ FOV
- Hawaii-2RG 2kx2k HgCdTe detectors
- Delivered 4/24, First light 4/29
- Commissioning completed
- Performance meets requirements

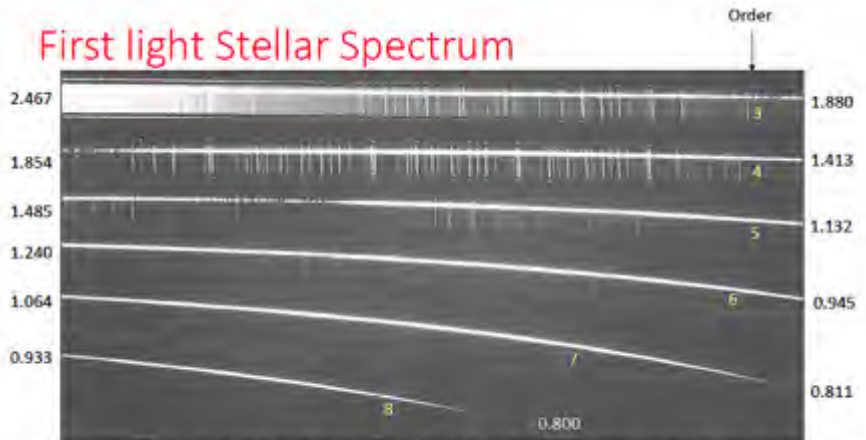


ARCoIRIS on Blanco



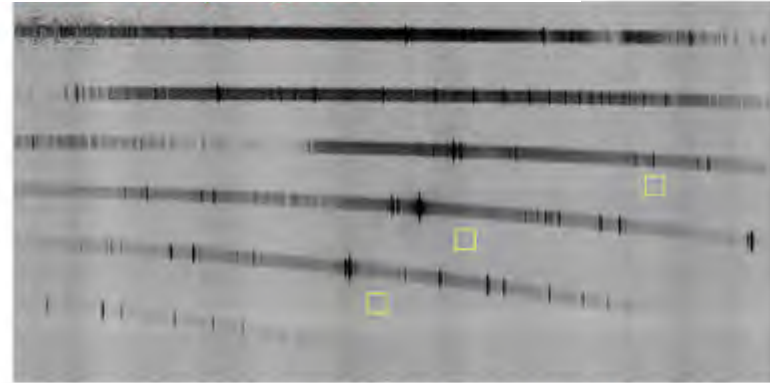
ARCoIRIS @ Blanco Performing to Specification

First light Stellar Spectrum



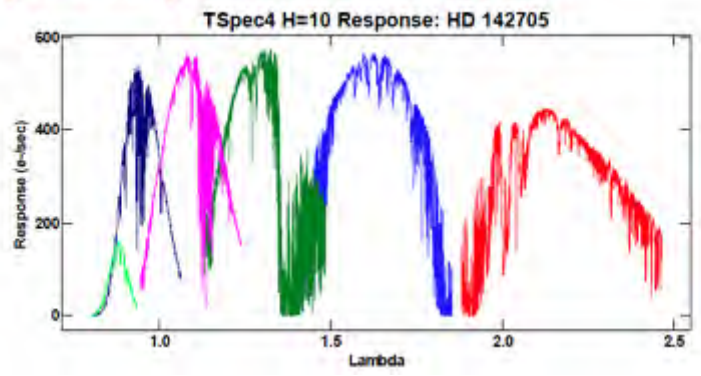
- Raw spectrum of HD 138295 A0V star, V = 8. Exposure time = 20 seconds. Night sky lines and OH spectrum are evident. Wavelength ranges and spectral orders (3 – 8) are indicated. Faint ghosts (< 1%) are seen near orders 6 and 7.

PNe NGC 3918

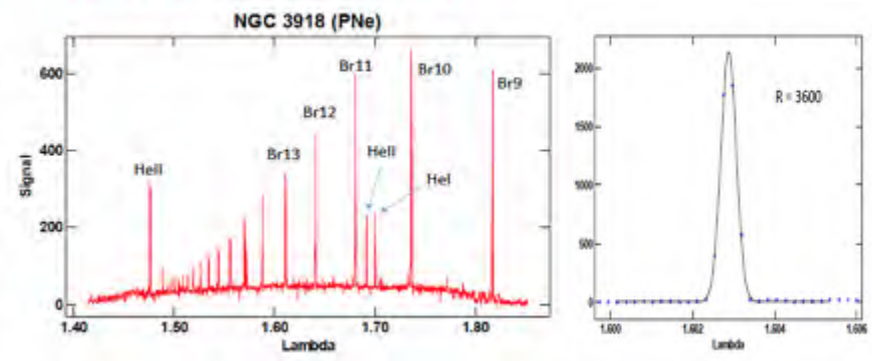


- Sky subtracted spectrum of PNe NGC 3918 obtained w/ 16 Fowler samples, exptime = 20.5 seconds. The nebular continuum and numerous spectral lines are seen. Boxes indicate the off-spectrum regions sampled for read noise.

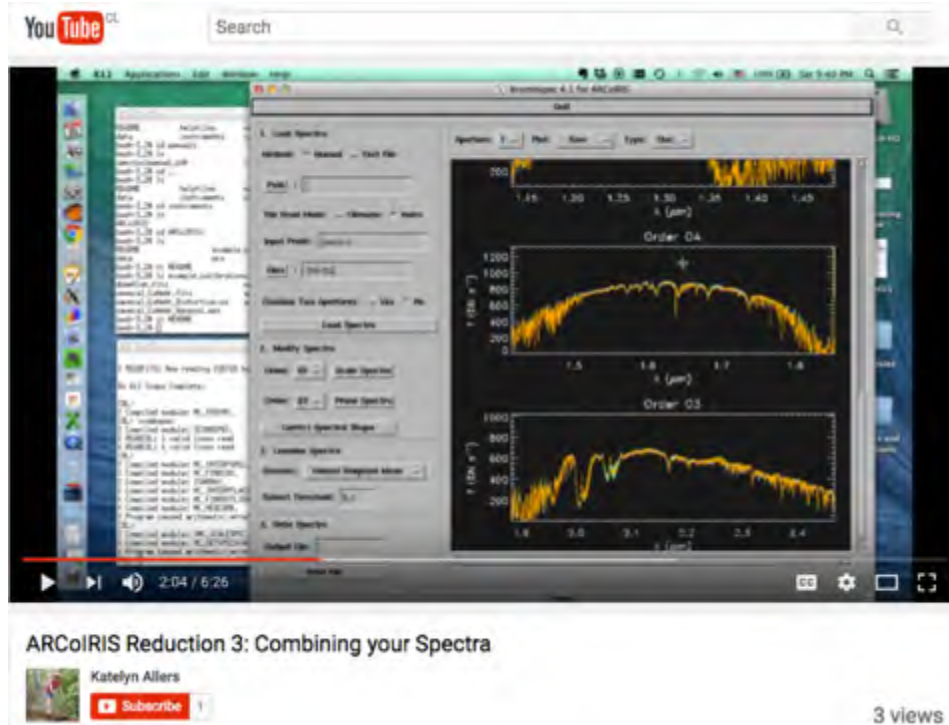
TSpec4 Response: HD 142705 A0V



Sample H-band spectrum



- Response comparable to TS1 @ Palomar in H & K, better in J
- Resolution ~3600 from night sky lines



- Data reduction package available on first night
- Many thanks to Dr. Katelyn Allers!!
 - Adaptation for ARCoIRIS of the IDL package Spextool
 - Complete with four video tutorials on YouTube
 - Available at the telescope and on a public machine in La Serena

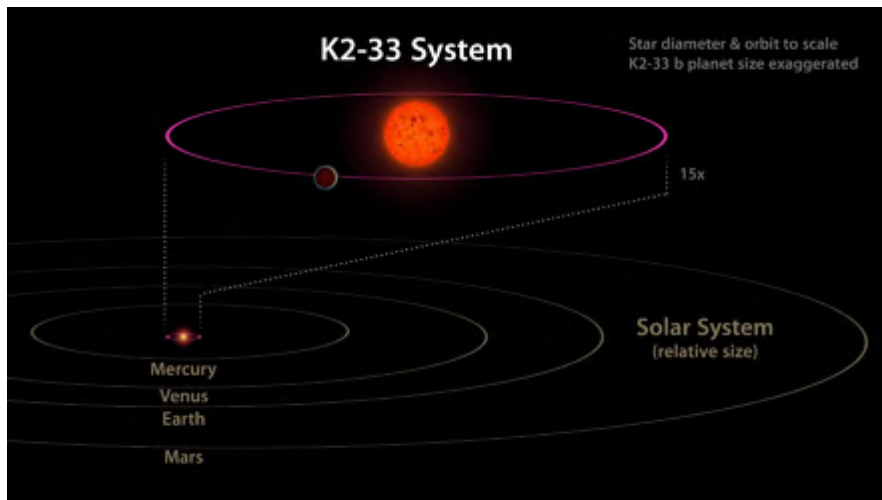
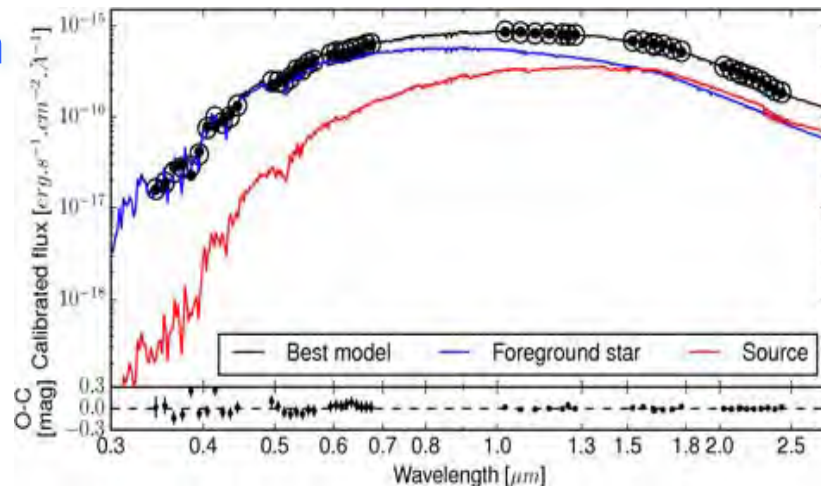


ARCoIRSIS @ Blanco

Early Science Results



Spectroscopic classification of microlensing events:
Towards a new interpretation of OGLE-2011-BLG-0417.
Santerne et al. (2016)



A short-period planet orbiting a pre-main sequence star in the upper Scorpius OB association
Mann et al 2016 ArXiv:1604.0615

A Successful Collaborative Effort



Team work by Cornell & NOAO staff during integration

- Results from a close collaboration of NOAO with Cornell & UVA
- Significant contributions by NOAO-S staff
 - Fabrication of detector test Dewar
 - Characterization and optimization of detectors
 - Detector control software
 - Full participation in integration and test at Cornell
 - Design and fabrication of telescope interface and handling cart



Instrument interface
& handling cart



- Instrument design contemplates simple fore-optics change to accommodate different telescope focal ratios
- Heavy use of DECam on Blanco leaves little time for anything else and this is unlikely to change soon
- SOAR equipped with modern near-IR and optical spectrographs would be an agile platform for follow-up of transients
- Moving forward with relocation of ARCoIRIS to SOAR
 - Encouraged by NSF
 - Agreement reached with SOAR Board on value of instrument and that this will be considered as an in-kind contribution towards NOAO's obligation to SOAR
 - Cornell have interest and availability in doing internal opto-mechanical changes. Final details under discussion preparatory to writing MOU
 - Work could start in May 2017 with duration ~9-12 months driven by lead time for procurement of optics



Blanco Improvements in FY16 & FY17

Focus on Robustness

- Prepare coating infrastructure for aluminizing in 2017
 - Automate coating plant following Mayall experience
 - Repair mirror lift. The implementation at Mayall suffered several problems with the vendor selected, so a different approach taken by AAO is being followed, but incorporating improvements from the Mayall design
 - New Cass cage cart to support increased weight
- Critical electric power infrastructure
 - Upgrade Tololo power house equipment for increased redundancy & robustness and ease of maintenance
- Dome & Shutter
 - Align dome trucks to increase bearing life
 - Beef up shutter drive mechanism following Mayall experience
 - Rework emergency brake using improved AAO design
 - Last two no longer fit within “No Cost Extension” funding box

Blanco Improvements

Coating infrastructure

- Goal is to be ready to recoat Blanco primary in July 2017



- Refurbish coating chamber & automate process, building on KPNO experience
 - Hardware already purchased (ARAA funds)
 - Hardware integration completed
 - Testing and process tuning has begun

- Build new cage handling cart
 - Fabrication complete
 - Assembly underway

Cage handling cart



- Repair mirror elevator
 - All purchased and fabricated parts ready
 - Installation nearing completion
 - 12 weeks program with 7 week contingency



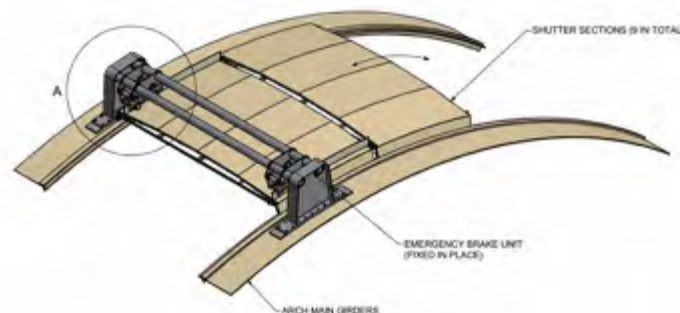
Blanco Improvements

Dome & Shutter

- Address issues with ageing hardware of Dome & Shutter
 - Remanufacture severely worn gears for reduction gear box of dome rotation drives (next slide)
 - Precise alignment of dome trucks to reduce frequency of bearing failures (next slide)
 - Replace aluminum foil on outside of dome
 - Upgrade shutter drive mechanism to increase safety factor
 - Replace current “centrifugal” emergency brake with external brake following AAO design



Current Brake



New AAO Brake

Blanco Improvements Dome & Shutter



Replacing failed bearings on dome trucks

Precise alignment of dome trucks to increase bearing life

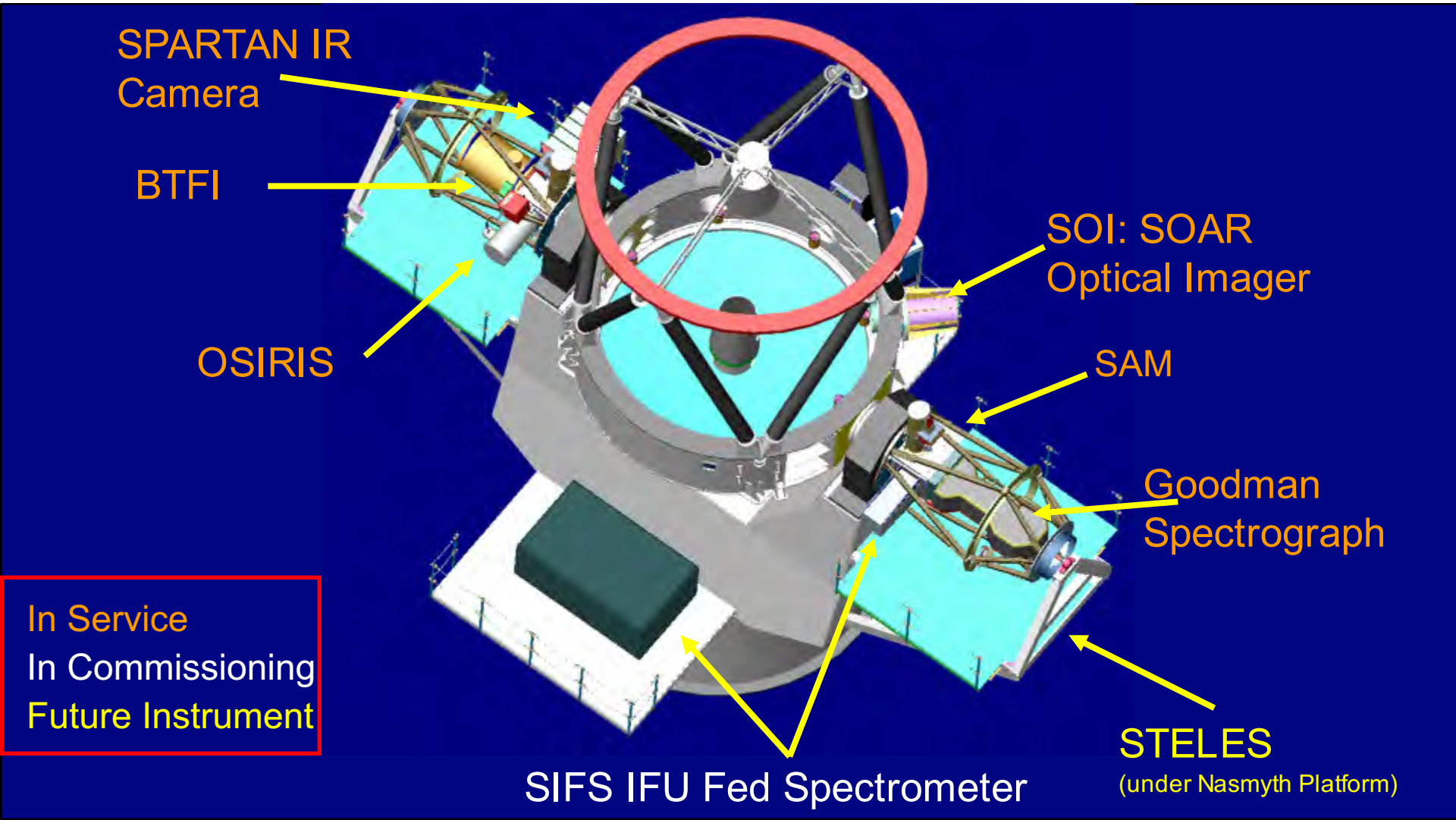
Dome drive gear box before & after refurbishment




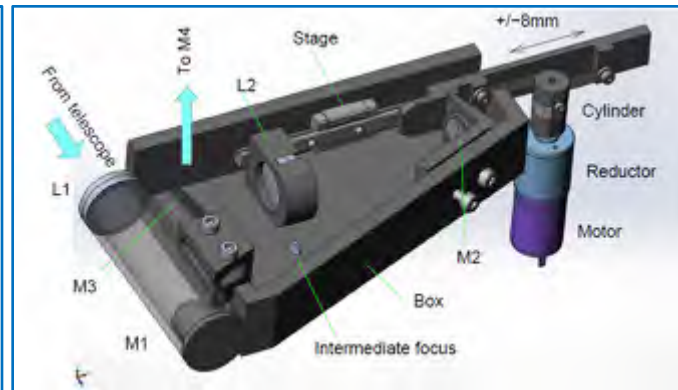
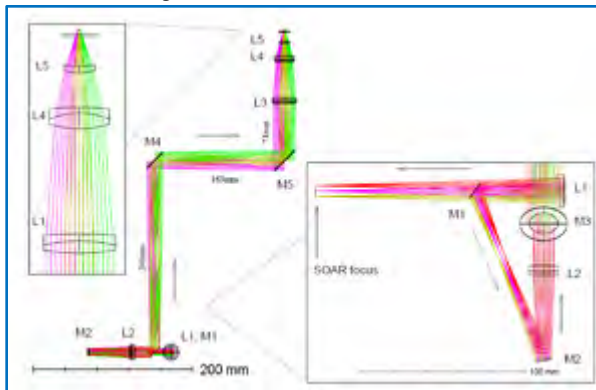


SOAR Telescope

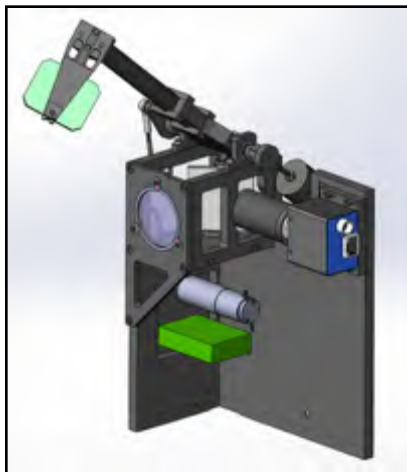




- Telescope improvements:
 - TCS software upgrade completed and in service
 - New “earthquake proof” read head mount  for Azimuth encoder
 - Automated control of focus and astigmatism using guide camera
 - Conceptual design & prototyping phase completed
 - Detail design in progress with goal of design review by end of CY2017

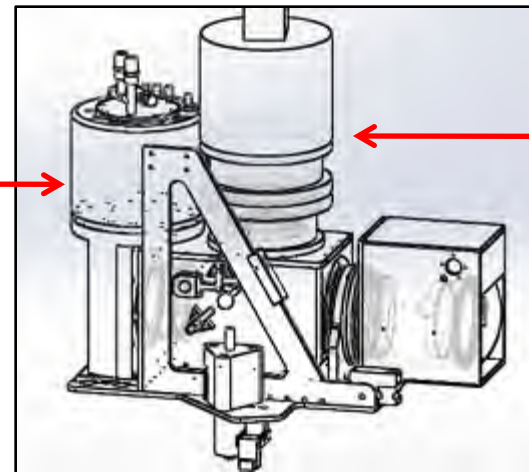


- Goodman Spectrograph
 - Multi-slit mode, fully commissioned & available since 2014B
 - Seeing significant use from all SOAR partners
 - Acquisition camera now in service greatly reducing overheads
 - New, red optimized CCD camera (SOAR funding) provides higher red sensitivity and less fringing
 - Commissioning completed offered for 2017A semester



Acquisition camera

Existing blue camera



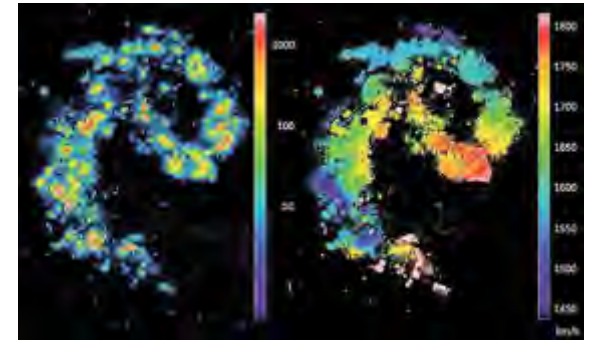
New red camera

Dual CCD Cameras



SOAR Telescope Improvement Projects

- **SAM (SOAR Adaptive Module)**
 - Increasingly in demand from all SOAR partners (24% of 16B requests for NOAO)
 - Successful tests with BTFI Fabry-Perot providing a spectral imaging mode.
 - Special calls for 2x4 night SV runs attracted 20 proposals from all partners
- **SIFS**
 - Recommissioning of instrument is underway
 - SV testing underway
- **STELES**
 - Post ship assembly & test complete
 - Fit checked on Telescope
 - Commissioning starts in June

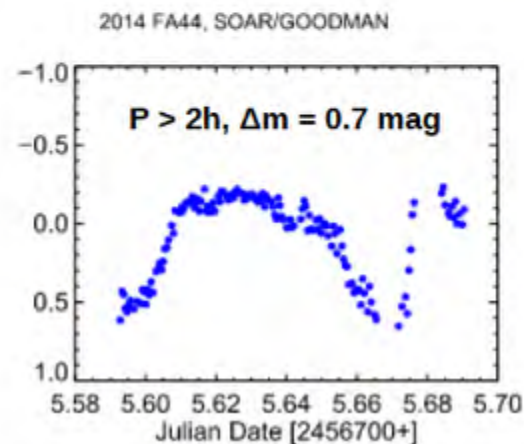
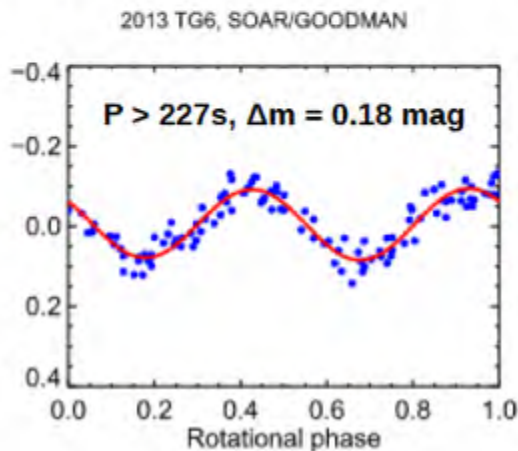




NOAO 2013B-0270 – PI: N. Moskovitz,
Lowell Observatory
Goodman imaging and spectroscopy

OBJECTIVE: Characterize sub-km NEOs.

Thirouin et al. 2016, AJ, 152, 163 → Rotational periods and light curves for 86 sub-km NEOs



Debris disks around WDs

“A Subtle Infrared Excess associated with a Young White Dwarf in the Edinburgh-Cape Blue Object Survey”, Dennihy, E. et al. 2016, ApJ, 831, 31 - **Goodman spectroscopy**

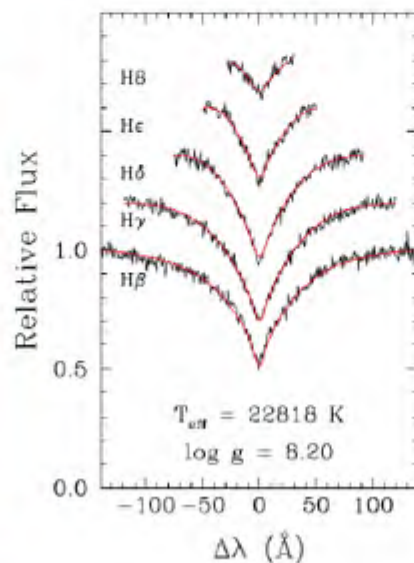
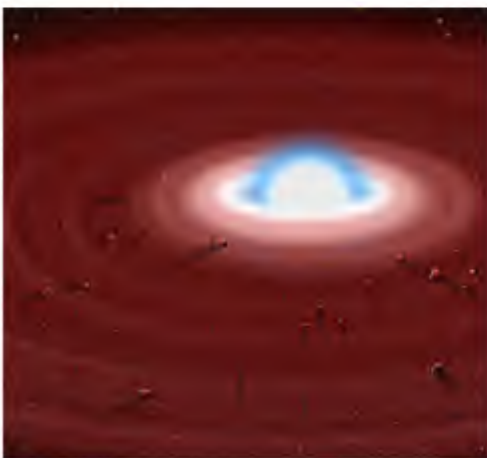
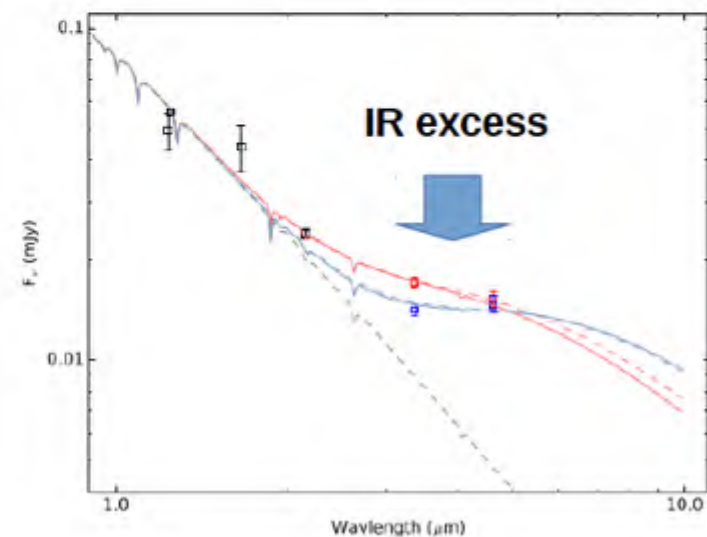


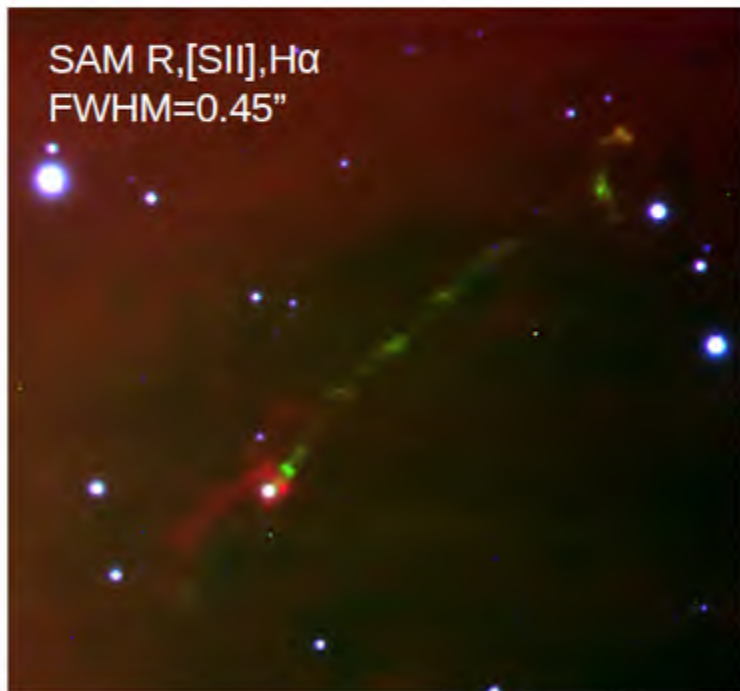
Table 3
Best-fitted Circular Dust Disk Parameters

Fixed i (deg)	T_{inner} (K)	T_{outer} (K)	R_{inner} (R_*)	R_{outer} (R_*)
Case 1 Contamination:				
45	1100	1030	34	37
80	1150	860	32	47
Case 2 Contamination:				
45	860	800	47	52
80	920	650	43	68

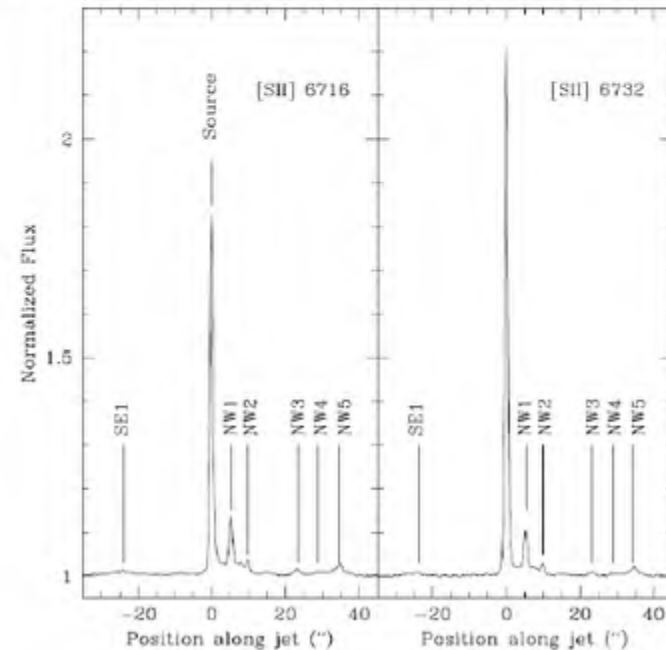


First parsec-scale jet in a Brown Dwarf

“First Large Scale Herbig-Haro Jet Driven by a Proto-brown Dwarf”, Riaz, B., Whelan, E., Briceño, C., Heathcote, S. 2017, AAS Journals, in press - **SAM + Goodman spectroscopy**



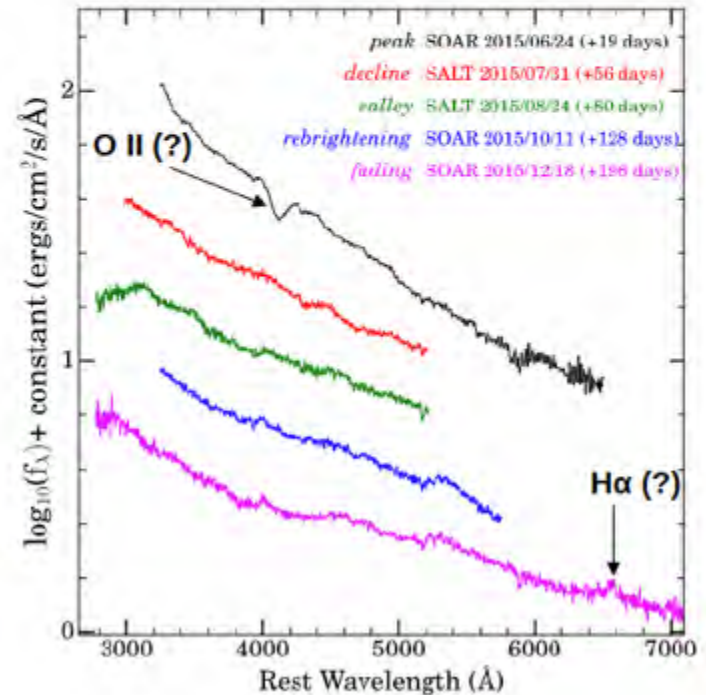
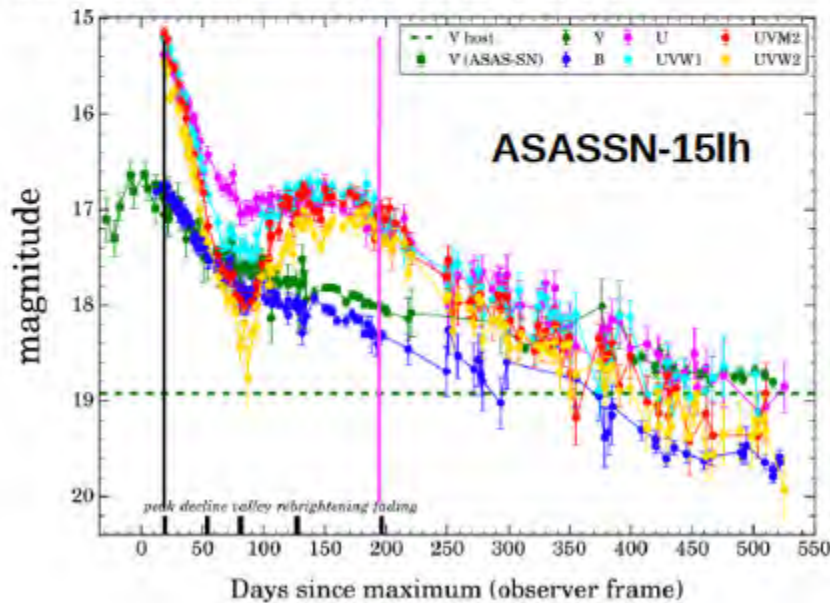
Spatial extent of [SII] 6716,6732 in Goodman spectrum



The Next Generation Low-z Type Ia SN Sample for Cosmology

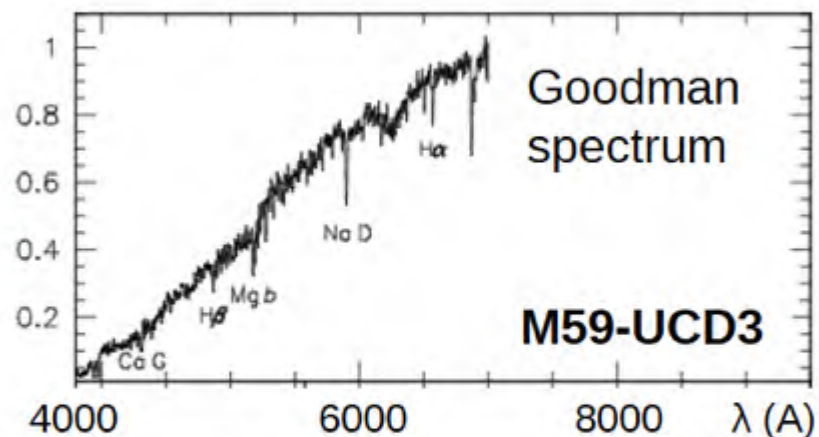
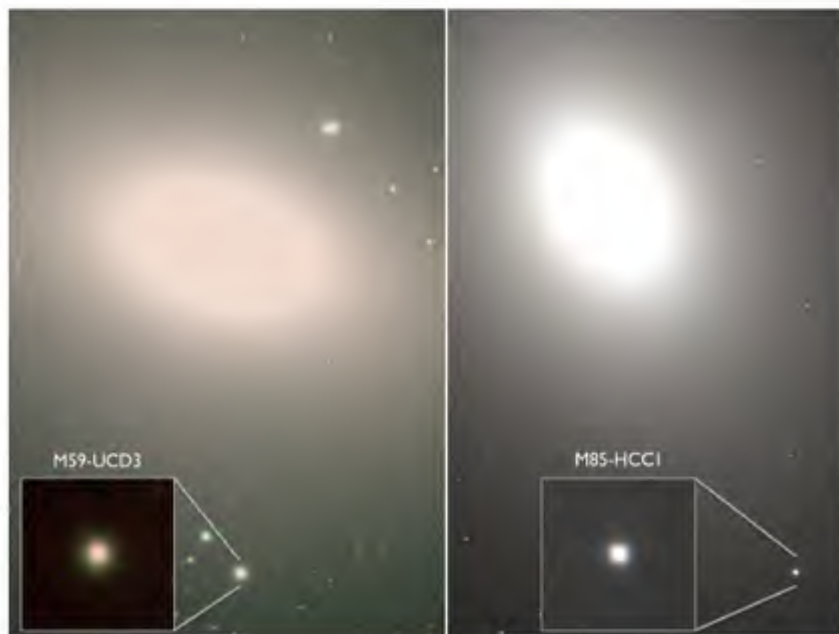
NOAO 2015B-0313 – PI: R. Foley, UC Santa Cruz - Goodman spectroscopy

Godoy-Rivera et al. 2017, MNRAS, 466, 1428



Discovery of the densest galaxy

“Hiding in plain sight: record-breaking compact stellar systems in the Sloan Digital Sky Survey”, Sandoval, M. et al. 2015, ApJ Letters, 808, 32 - **Goodman spectroscopy**



M59_UCD3: densest galaxy
 $M_v = -14.6$ ($g=16.81$, $r=16.00$)
 $r_h \sim 20 \text{ pc}$, $\sim 2 \times 10^8 M_\odot$, 9 Gyr

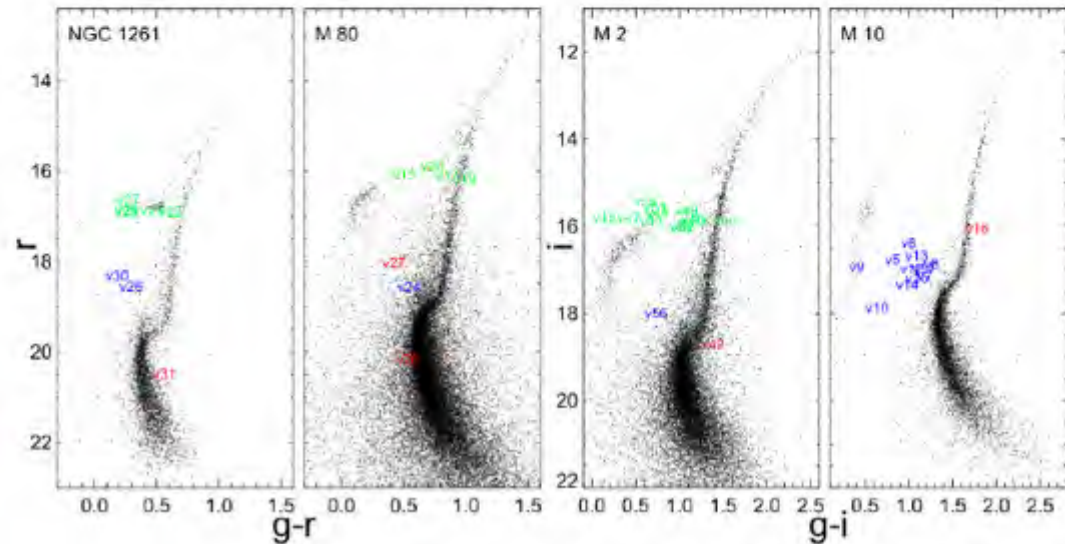
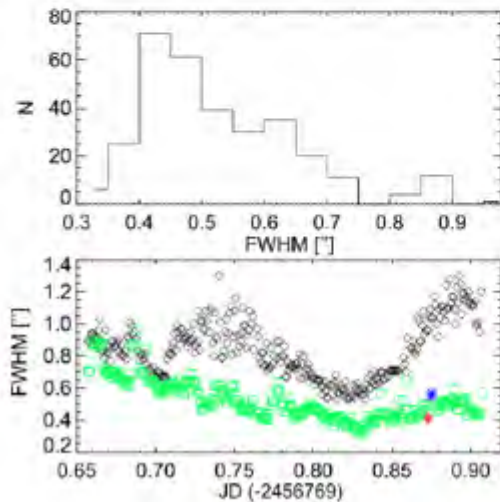
AO Time Series Photometry in Crowded Fields

"AO-Assisted Variability Study of Four Globular Clusters", Salinas, R. et al. 2016, AJ, 152, 55

SAM

High angular resolution by SAM => better photometry down to cluster cores

Discovery of 15 new variables in M 2 (12 RR Lyrae stars and 3 SX Phe stars), 12 new variables in M 10 (11 SX Phe and 1 long-period variable), and 1 new W UMa-type variable in NGC 1261



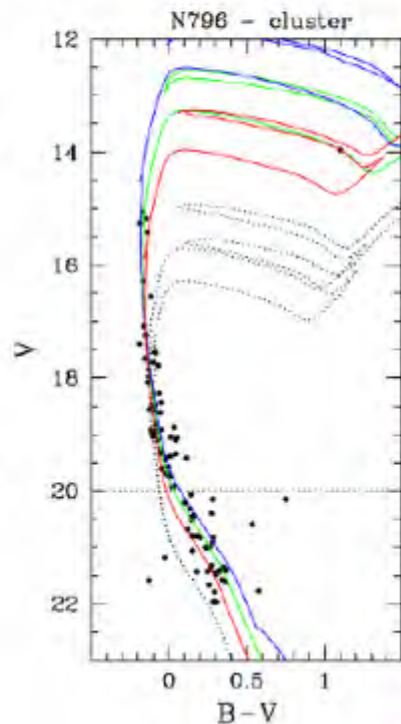
Clusters in the Bridge between the SMC and LMC

“Bridge over troubled gas: clusters and associations under the SMC and LMC tidal stresses”,
Bica, E. et al. 2015, MNRAS, 453, 3190 - **SOI imaging**

B, V photometry of 14 clusters and 2 OB assoc in tidal bridge connecting LMC and SMC

Clusters not coeval: ages ~1-5 to 100-200 Myr

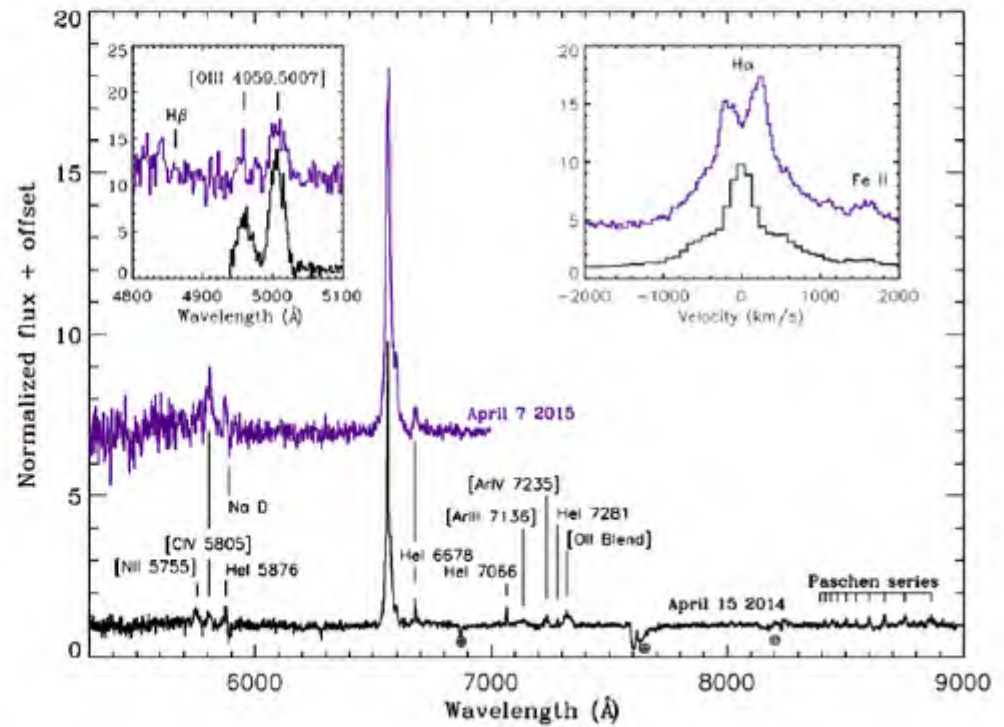
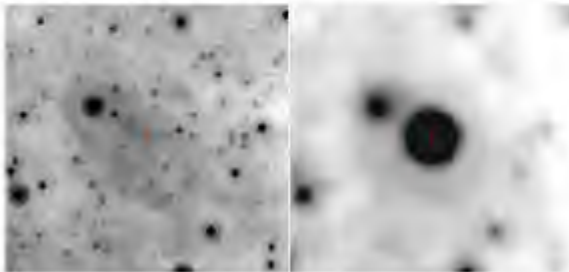
Find evidence that the studied part of the Bridge is evolving into a tidal dwarf galaxy, decoupling from the Bridge.



Characterizing unknown transients

"Discovery of a long-lived, high amplitude dusty infrared transient", Britt, C. T. et al. 2016, MNRAS, 460, 2822 - **Goodman spectroscopy**

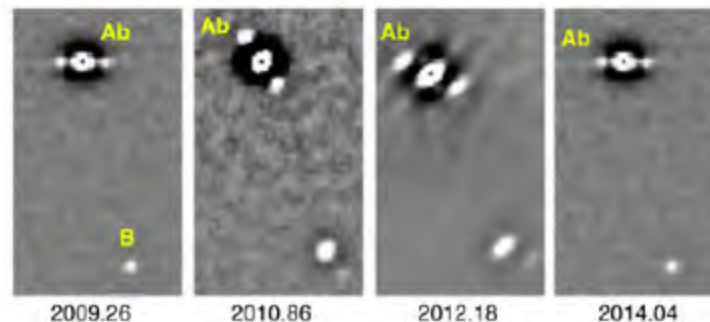
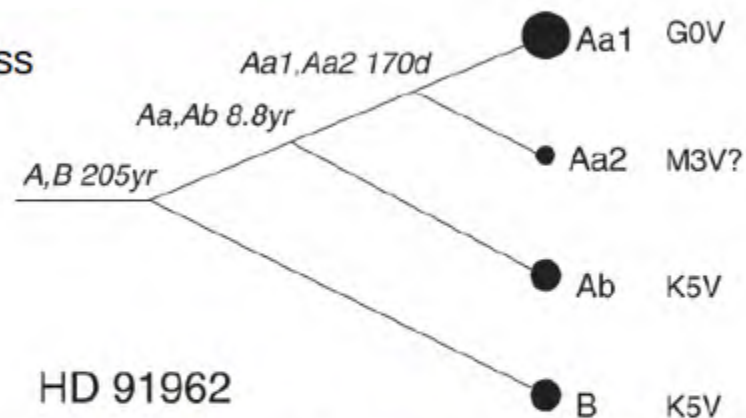
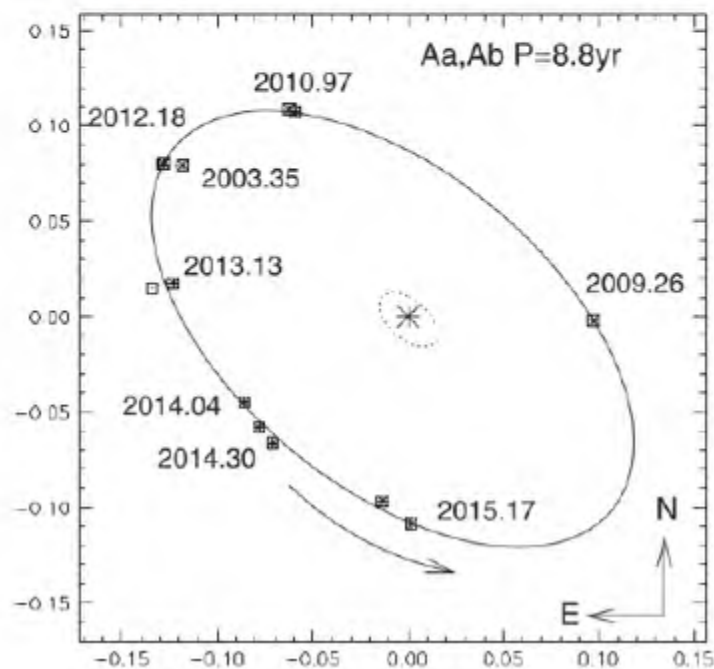
- IR-selected transient lasting ~5 yr
- Large mid-IR/optical outburst of faint X-ray source detected with Chandra
- Possibly a YSO ~1 Msun, but does not fit FU Ori outbursts



Stellar Multiplicity studies at SOAR: Field stars

"The Unusual Quadruple System HD 91962 with a "Planetary" Architecture", Tokovinin, A. et al. 2015, AJ, 149, 195 - HRCam

$d=36.5$ pc, Li I, H α emission, X-ray, no IR excess



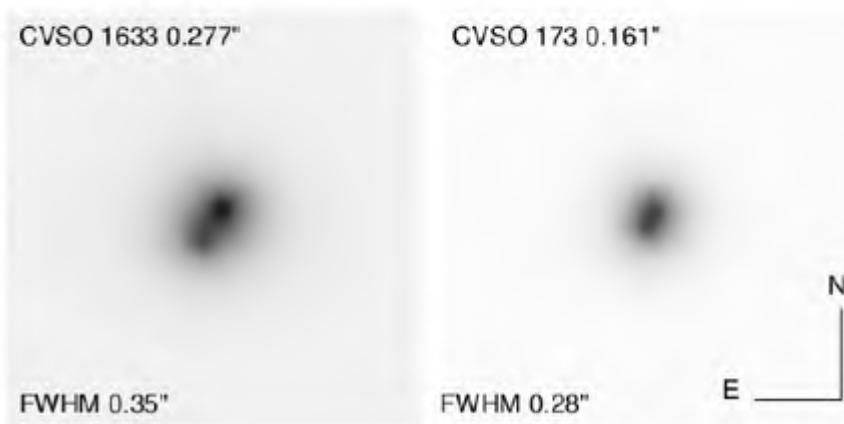
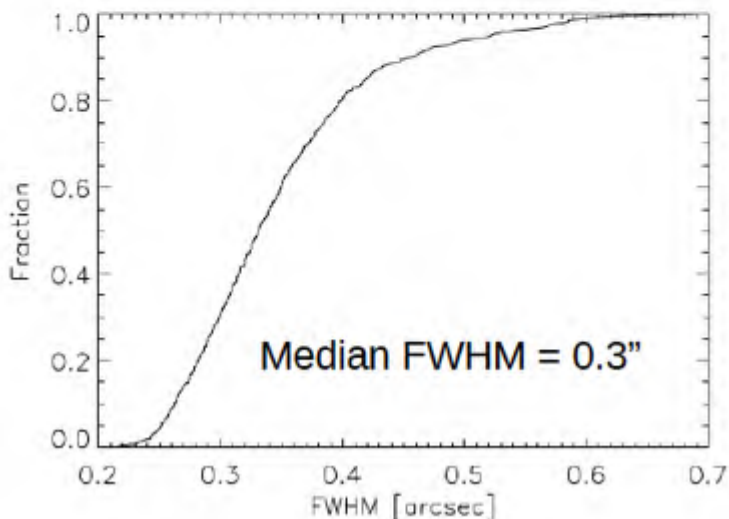
Stellar Multiplicity in Pre-main sequence stars in nearby SFRs

C. Briceño, A. Tokovinin, M. Petr, two papers in preparation - SAM+HRCam

SAM provides initial AO correction → go ~1-2 mag deeper

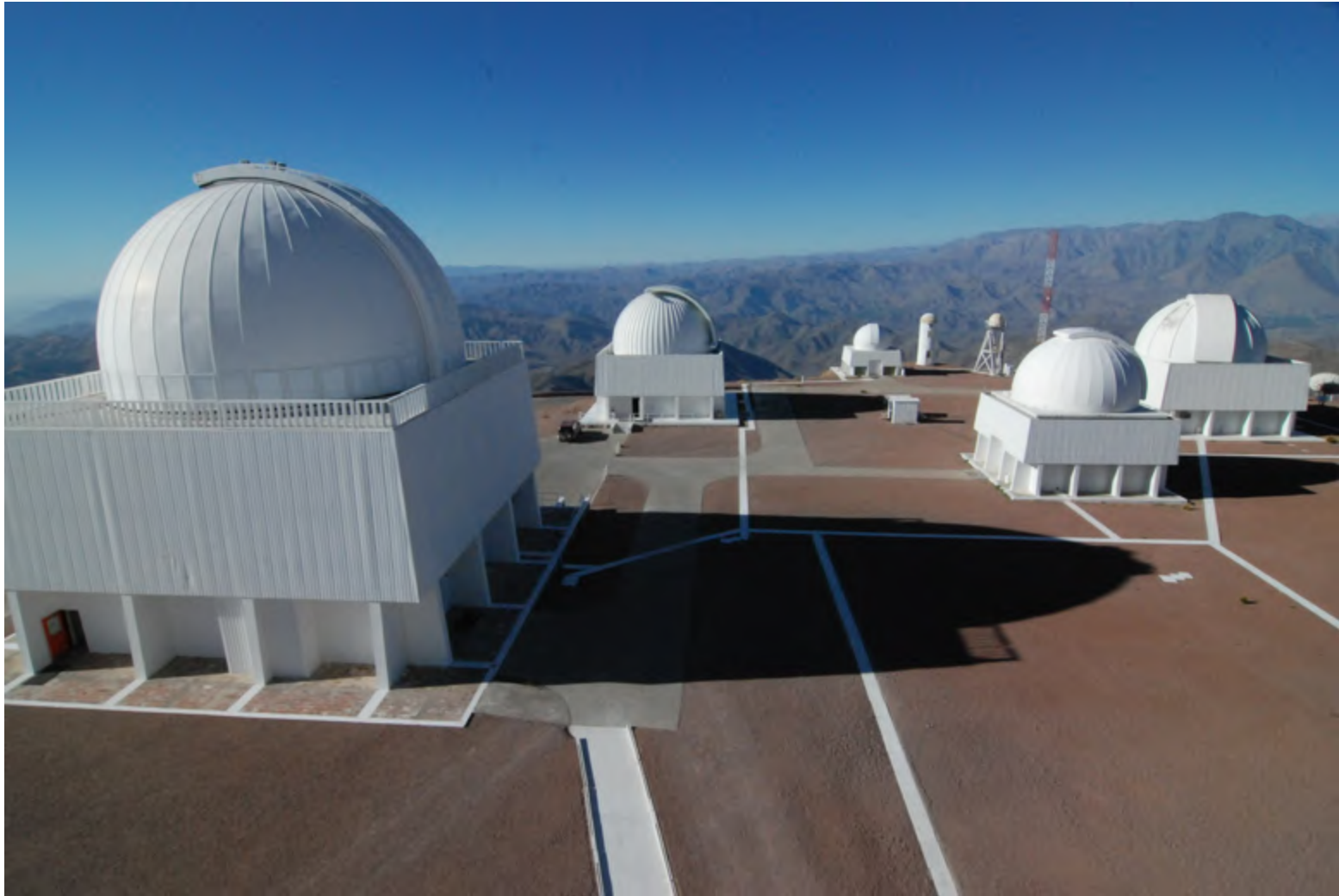
~100 T Tauri stars in the Orion OB1 association (d~400 pc; ~5-10 Myr)

~60 T Tauri stars in ϵ Cha (d~110 pc; 3-5 Myr) and η Cha (d~97 pc; 6-10 Myr)





Small Telescopes





- SMARTS MOU and Funding:
 - 1.3-m & 1.5-m administered by Yale
 - 0.9-m administered by GSU
 - Operation of the 1.3-m and 0.9-m is fully funded for FY16 and funding appears to be on track for FY17
 - 1.5-m closed for 2016B and 2017A due to funding limitations. Future funding situation under discussion within the SMARTS partnership
- Current mode of operation
 - 1.3-m service queue mode only, 0.9-m classical mode only
 - Day time support duties taken over by telescope observers, leaving fewer (work) hours for observations: 8hrs/night
- New CCD controller for 0.9m (funded by Georgia State): successfully commissioned in May 2016
 - Similar performance, but greatly improved reliability & maintainability
 - Exit the last Arcon & Sun SparcStation on Tololo

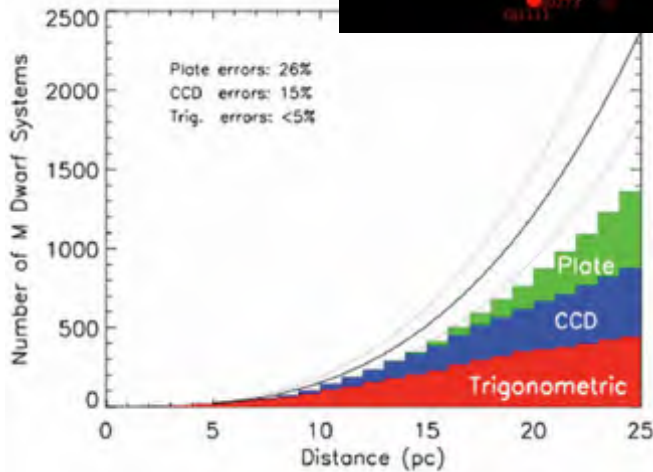
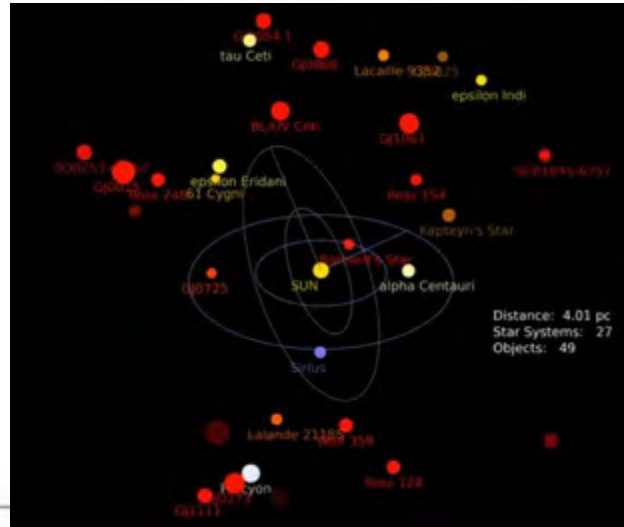




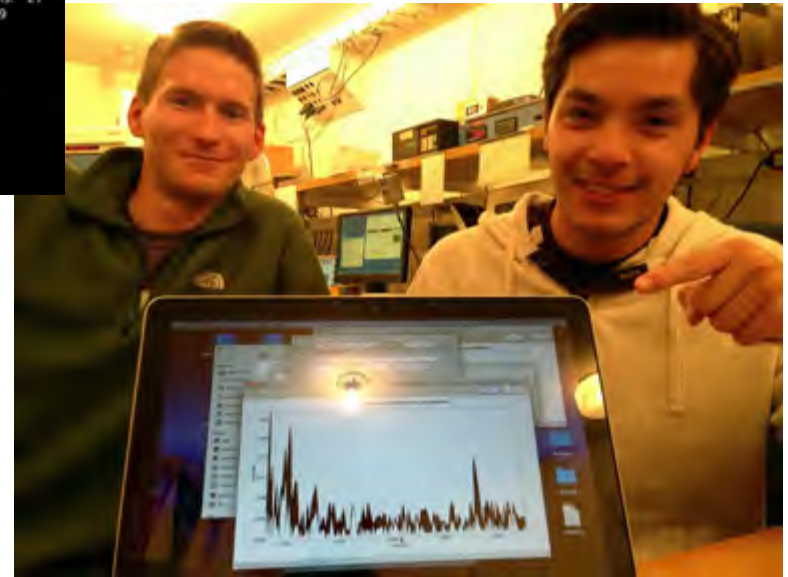
RECONS the Movie

https://www.youtube.com/watch?v=up_MqNBv0FE

SMARTS Science Highlights



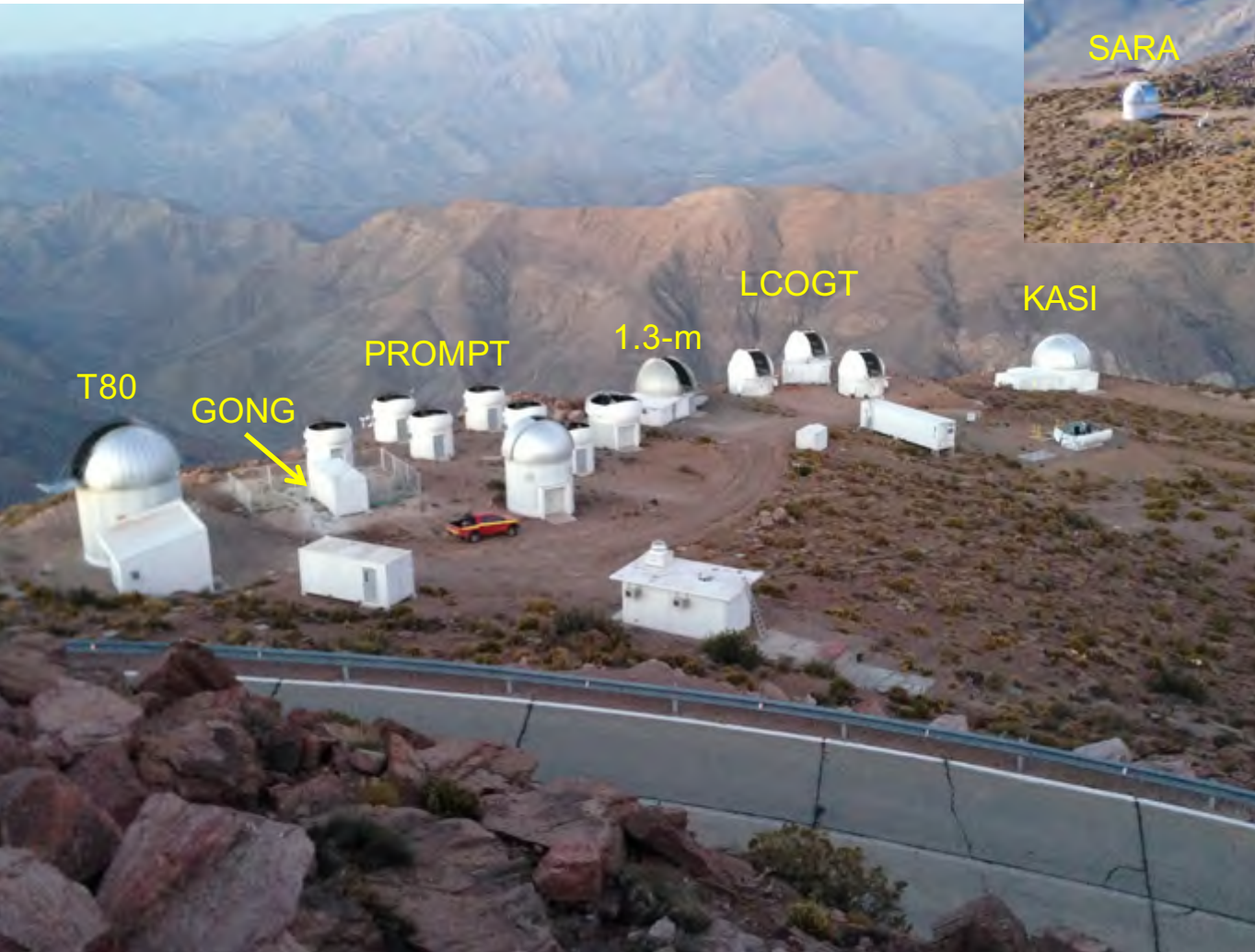
Cumulative number of southern single M dwarf systems from RECONS survey on 0.9-m Telescope (Winters et al 2015 AJ 149,12)



Students from High Point University discover new pulsating white dwarf using SMARTS 0.9-m (picture credit B. Barlow / High Point U. News)



Tololo Tenants





Tololo Tenants

- Ongoing: GONG, WHAM, etc.
- UM Schmidt – Continuing debris search with UM funding
- SARA (ex-Lowell) – Remote operations
- LCOGTN – 3x 1-m + 2x 0.4-m telescopes complete & functioning
- PROMPT – PROMPT 8 (Thai), telescope commissioned & operating
- Chilean 24” – Being commissioned
- MEarth (Charbonneau, Harvard) – 8x 0.4-m telescopes, commissioned and operating
- KASI (Korean Microlensing project)
 - Telescope installed & fully operational
 - CCD camera commissioned, science program underway
- T80 (Brazilian project)
 - Telescope installed & fully operational
 - CCD Camera delivered in April 2015
- USNO URAT astrometric survey begun Oct 2015



NOAO-S Facilities Operations



NOAO UC, Tucson, May 2017 (D1)



NOAO-S Facilities Operations

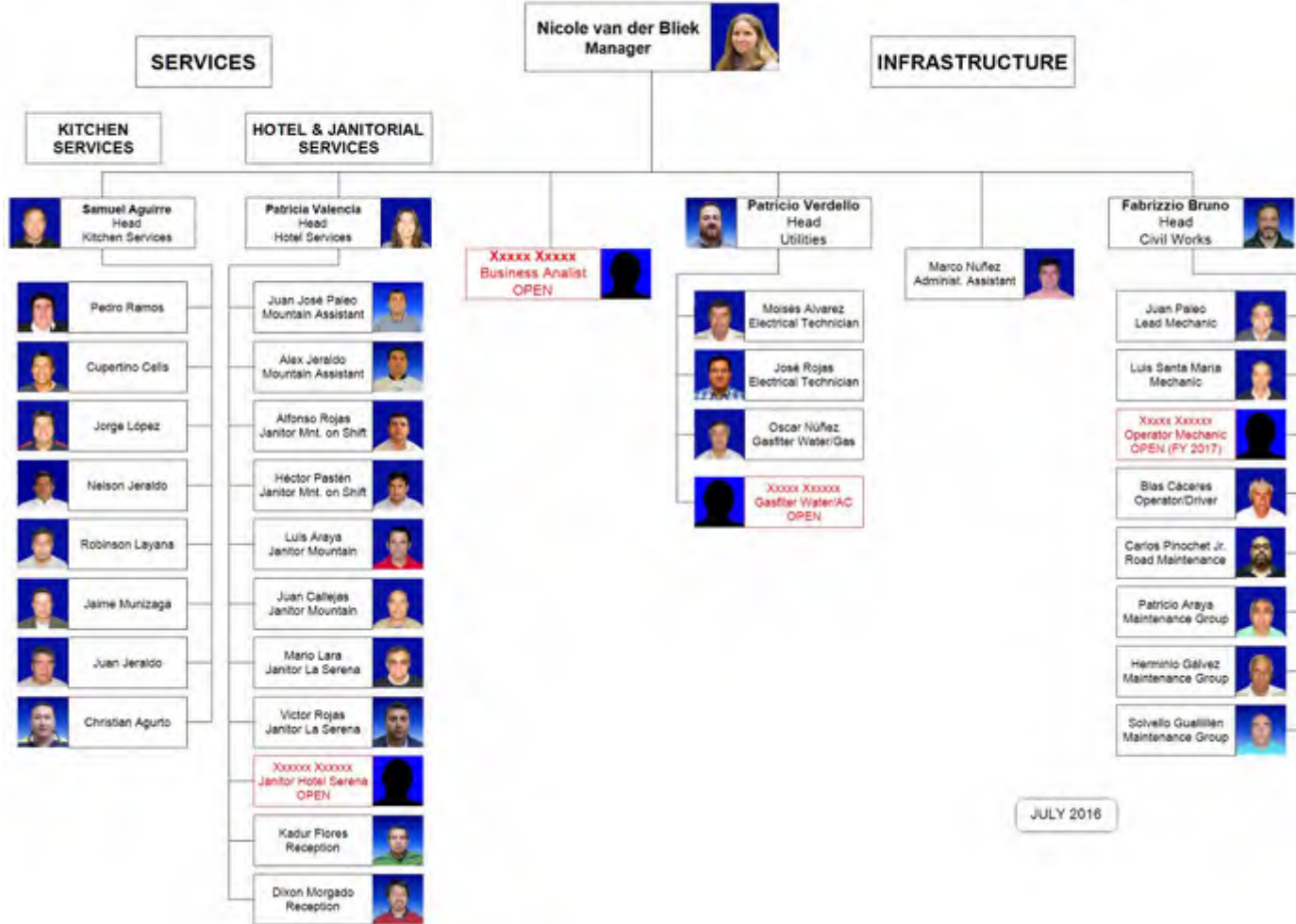
Recovering a Strong Basis

- Staffing – recover critical mass & fill gaps in expertise
 - Electrical & Civil engineer are both on board and fully engaged leading the efforts in their areas;
 - Financial analyst added to improve reporting
 - Recruiting 3rd heavy equipment operator, Janitor, & craftsman
- Restore damaged and decayed infrastructure
 - Near term priorities electrical power system, water system, roads
 - Developing 5-year infrastructure improvement plan & budget
- Maintain for the future
 - Reinforce preventative maintenance plan
 - Regular renewal of equipment and purchase of key spares
- Requires an increase in shared costs for all users
 - 16% increment to facilities budget in FY16 settling to 10% for FY18 onward
- Working to build/improve collaborative relations with clients

NOAO-S Facilities Operations Staffing



NOAO SOUTH - FACILITIES AND OPERATIONS



JULY 2016



NOAO-S Facilities Operations Infrastructure Investments Past & Planned

- Investments in critical infrastructure support tenants as well as NOAO's own facilities
 - FY10-FY14: US\$1.64M of ARRA funding during invested in upgrades of shared infrastructure
 - FY15: Base funding used for Repair of Tololo power house equipment and additional costs of generation
 - FY16: US\$1M NCE funding planned for upgrade of Tololo power house
 - FY16: ~US\$0.5M total for planned upgrade projects. This cost will be shared between all users, but NOAO will absorb part of the cost for the Tololo tenants
 - FY17 onward: plan to invest ~10% of annual facilities budget in maintenance and upgrade of shared infrastructure
- These investments are consistent with our NSF mandate and are made with AURA and NSF oversight and approval, through review of our ARRA and NCE proposals



NOAO-S Facilities Operations FY16 and FY17 Improvement Projects

- Electric Power infrastructure
 - Continue upgrade of Tololo power house equipment for increased redundancy, robustness and ease of maintenance
 - Circuit reclosers installed at key points on main HT power line
 - Refurbish medium tension distribution network on Tololo
 - Certification of electric substations
- Water system
 - Repair of earthquake damage to Tololo water tanks completed
 - Install additional tank(s) on Pachón to handle increased use
- Road
 - Critical repairs of storm/earthquake damaged sections including construction of a ford where the road washed out during FY16
 - Planning multi-year improvement/repair program starting in FY17
- Renovation/repairs of hotels & upgrade/certification of kitchens
 - Work on Tololo Kitchen completed in Jan, Pachón starting April



NOAO-S Facilities Operations

Tololo Power House Repair & Upgrade

- New Electrical Engineer started work in Dec 2015
- Commercial power finally restored on Jan 16 2016
 - Using original mechanical frequency converter – demonstrated to be in good condition
 - Dual redundant generators with automatic fail over operational
- Effort now focused on making a robust system for the future with built in redundancy
 - New transformer installed, spare on hand
 - Automatic installed on reconnectors in power line at entrance and at bifurcation on on line to each summit
 - Protection circuits at output from power house
 - Soft starter for frequency converter
 - Evaluating options for redundant frequency converter
- Cost of new equipment is being covered by NCE funding

NOAO-S Facilities Operations

New and Restored Electrical Infrastructure

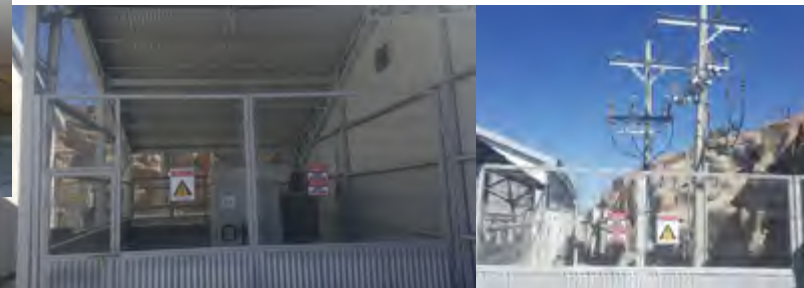
Tololo Power House



Larger capacity
Fuel tank



Dual redundant
generators



New main transformer and electrical yard

Pachón Substation



Pachón sub-station safety fences

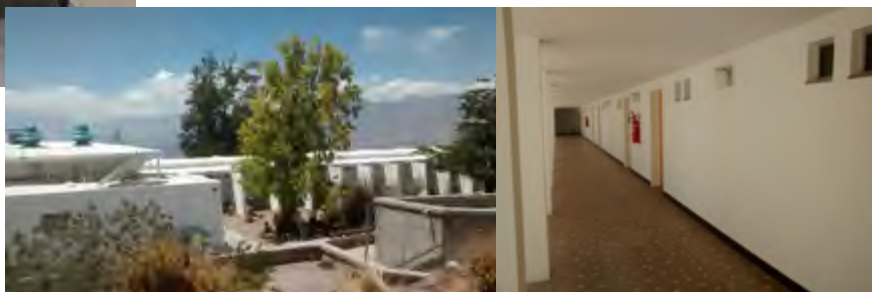


NOAO-S Facilities Operations Building Refurbishment & Remodeling

Tololo Dining Dormitory



Remodeled Kitchen



Dormitory repainted inside & out, roof repaired

Pachón two-unit building conversion





NOAO-S Facilities Operations

Building Improvements on Tololo

- Blanco: exterior refurbishment including replacement of aluminum foil on dome
 - Work starting in March
- Tololo visitor centre: handicap accessible public restrooms will be provided on the summit and at the entrance gate to the property
 - Bids solicited for design & construction work
- Costs covered by NCE funding



New La Serena Office Building



Credit Andes Architects group



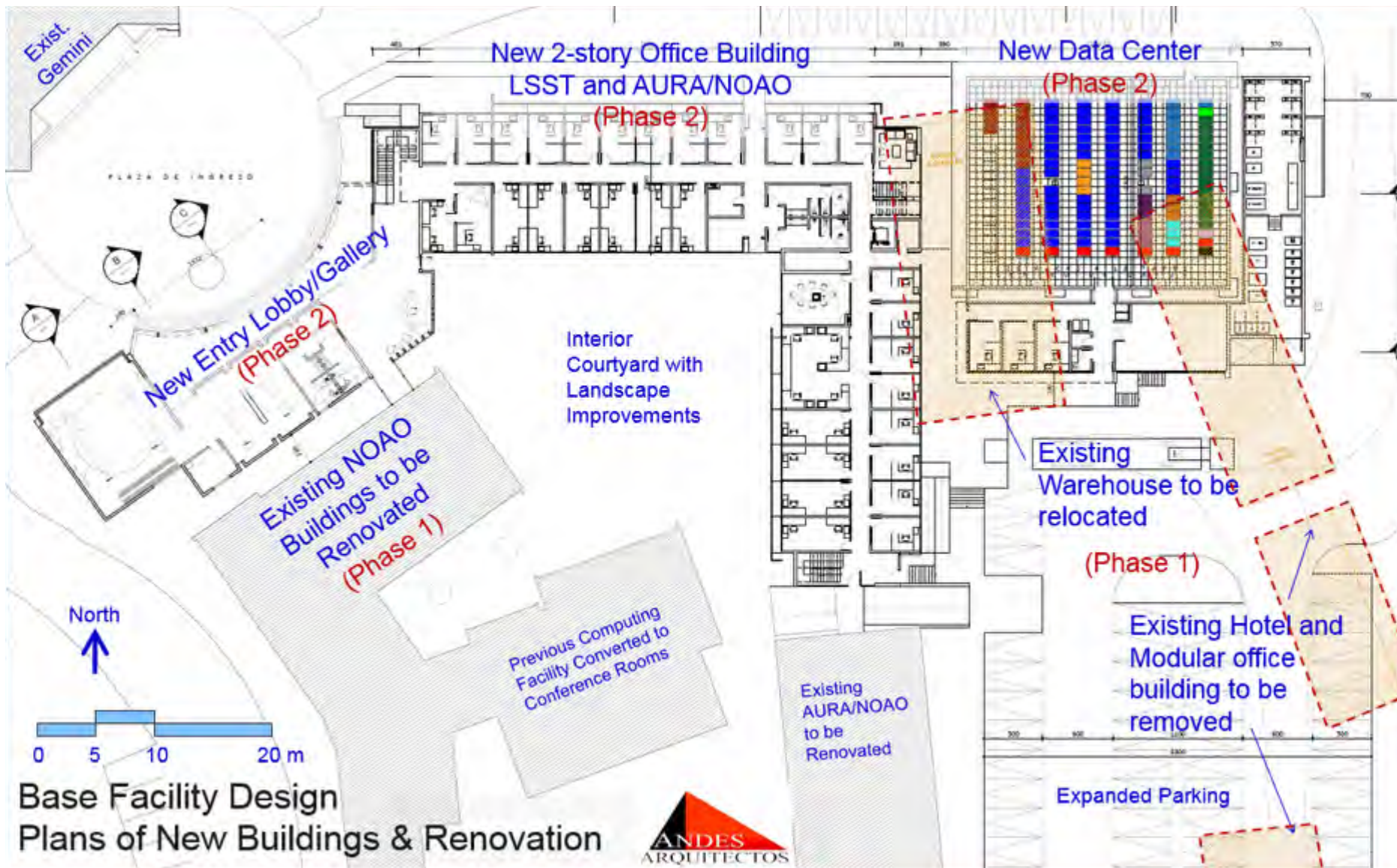
New La Serena Office Building

LSST, NOAO, AURA Joint venture

- Collaborative effort to construct new shared office building and data center and refurbish existing offices
- Will provide an integrated facility for scientific and technical staff creating a collaborative environment
- Phase I: preparing contract, work started Mar 15 2017
 - Remodel existing offices bringing them up to a similar standard
 - Includes new heating / AC system
 - Universally accessible entrances and bathrooms
 - Utility work in preparation for new construction
- Phase II: preparing bid process, work starts July 2017
 - New two story office building
 - Modern data center (one of largest in S. America)
 - Entrance lobby and visitor gallery



New La Serena Office Building Mix of Remodeling & New Construction



Base Facility Design
Plans of New Buildings & Renovation



New La Serena Office Building Phase I Work Plan & Schedule



- Work proceeds in stages with staff from each area moved to temporary accommodation leaving work area unoccupied
- Work starting ~now with each stage expected to take ~3 months



New La Serena Office Building

A new look for new times



View from garage



View from Gemini lobby



View from "modulux"



Thank you!

