W. M. Keck Observatory

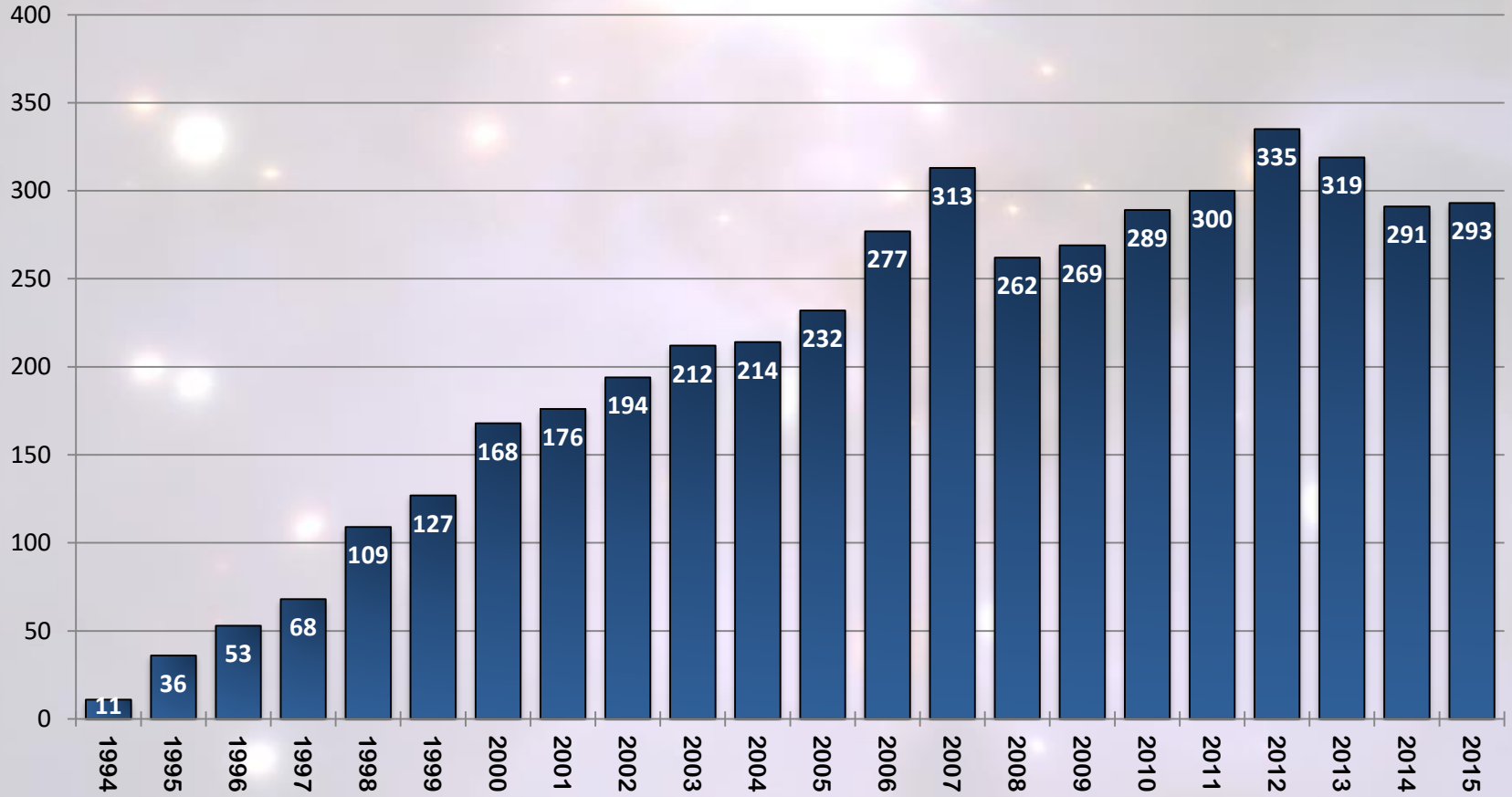
Andrew Richard Hara Photography

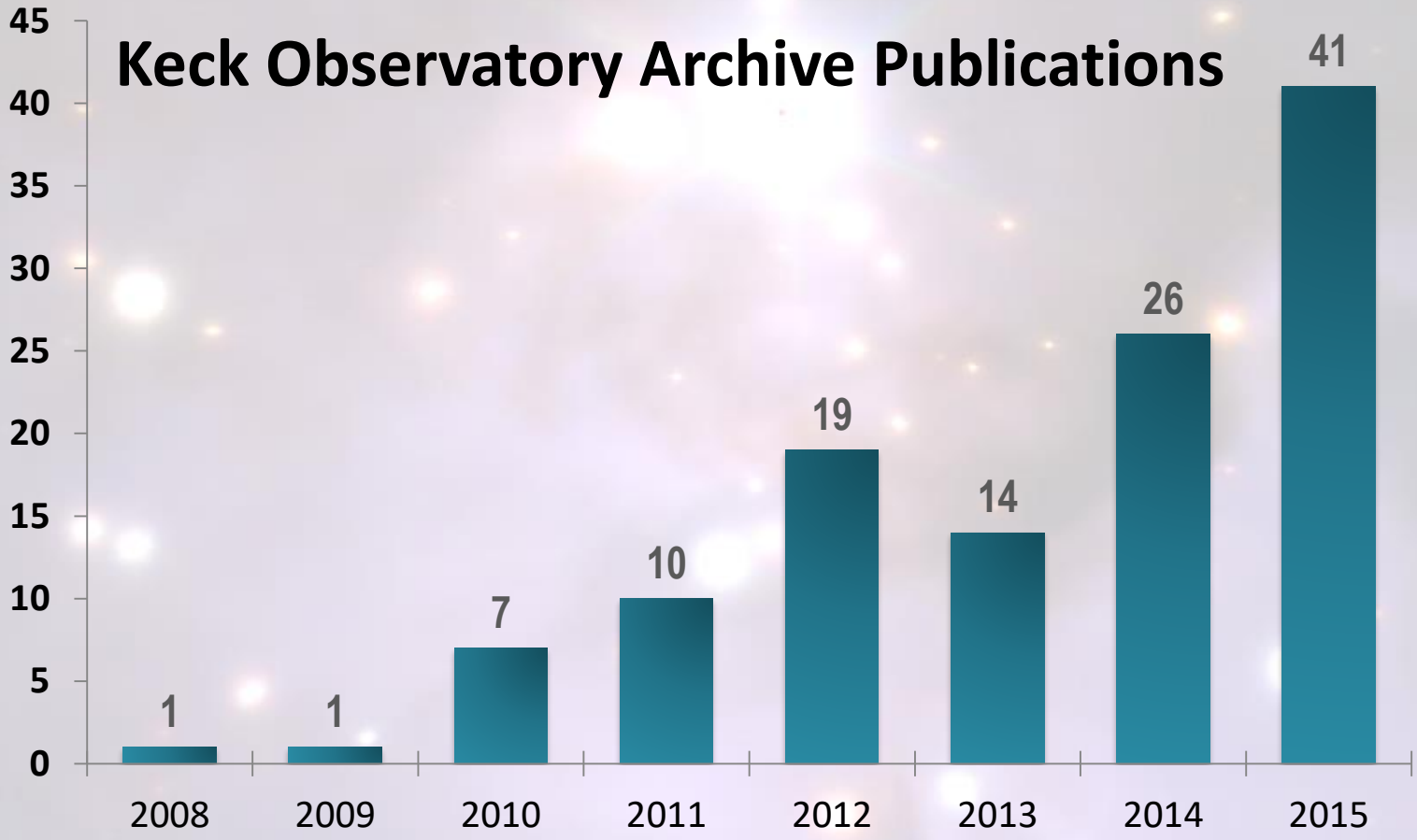
Hilton Lewis

Subaru Users Meeting

10 January 2017

Refereed Articles: based on WMKO data




Keck Observatory Archive Publications
45
40
35
30
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7
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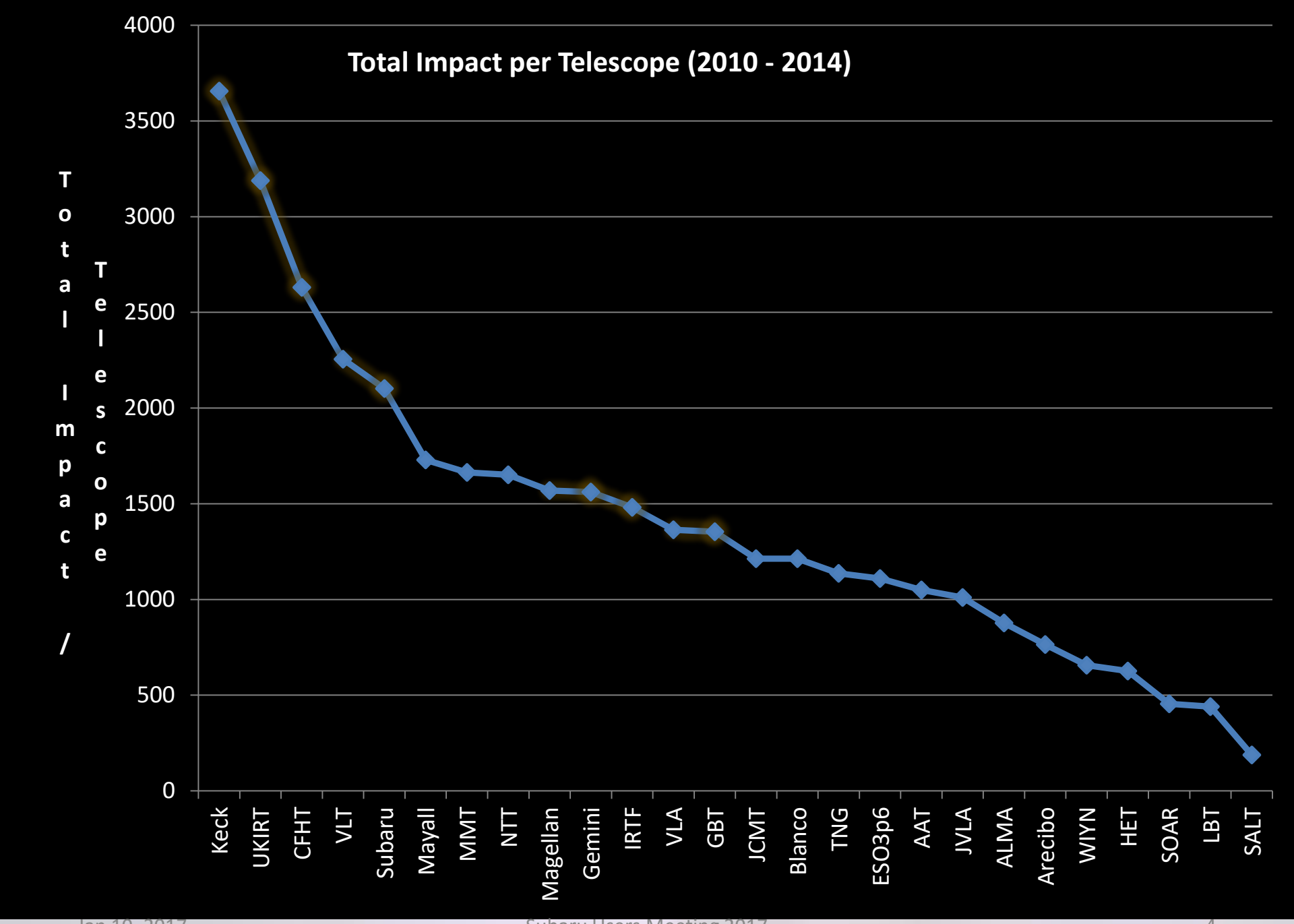
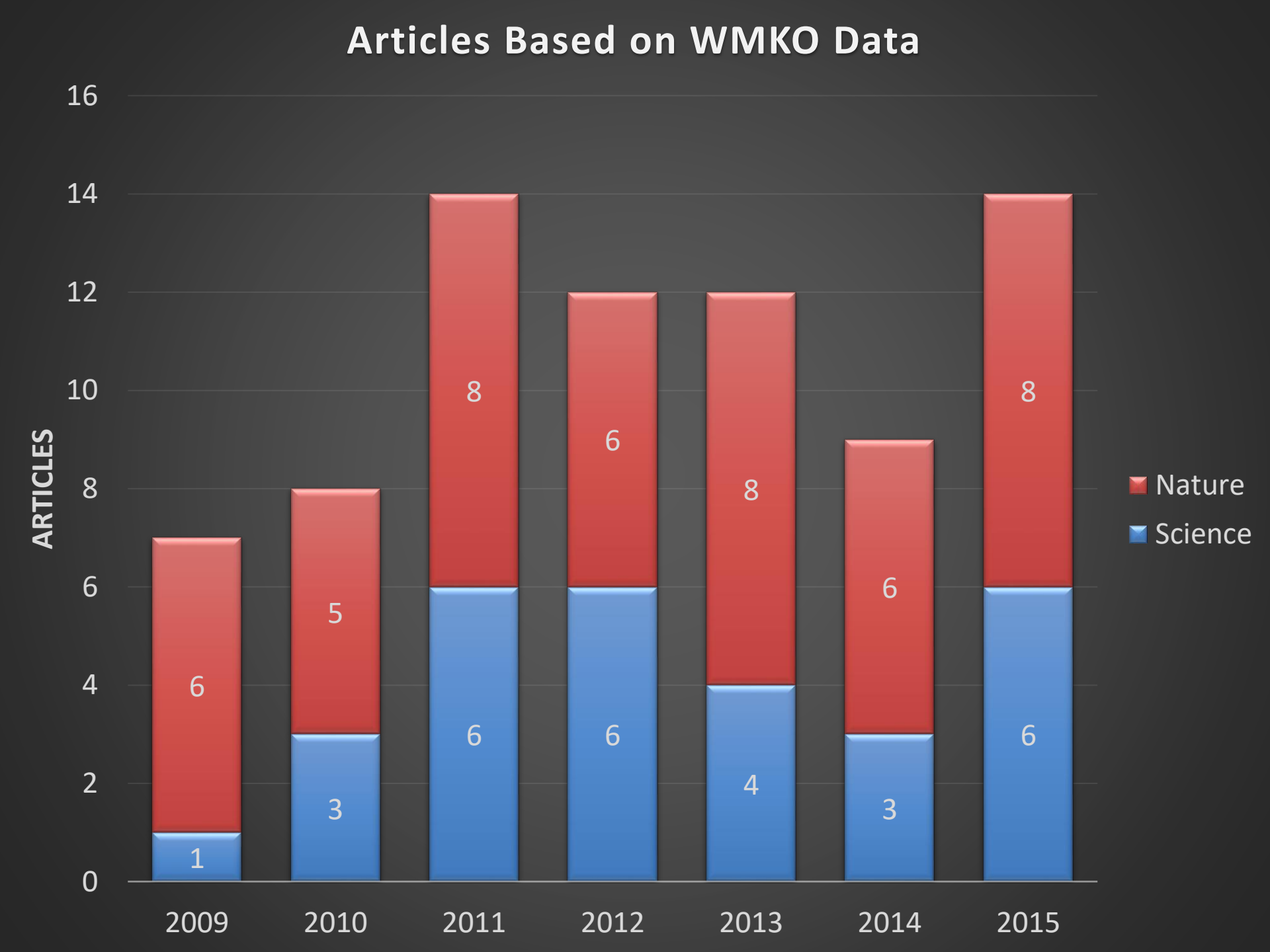
19
14
26
41
2008
2009
2010
2011
2012
2013
2014
2015


Total Impact per Telescope (2010 - 2014)
Total Impact / Telescope
4000
3500
3000
2500
2000
1500
1000
500
0
Keck
UKIRT
CFHT
VLT
Subaru
Mayall
MMT
NTT
Magellan
Gemini
IRTF
VLA
GBT
JCMT
Blanco
TNG
ESO3p6
AAT
JVLA
ALMA
Arecibo
WIYN
HET
SOAR
LBT
SALT


Articles Based on WMKO Data
ARTICLES
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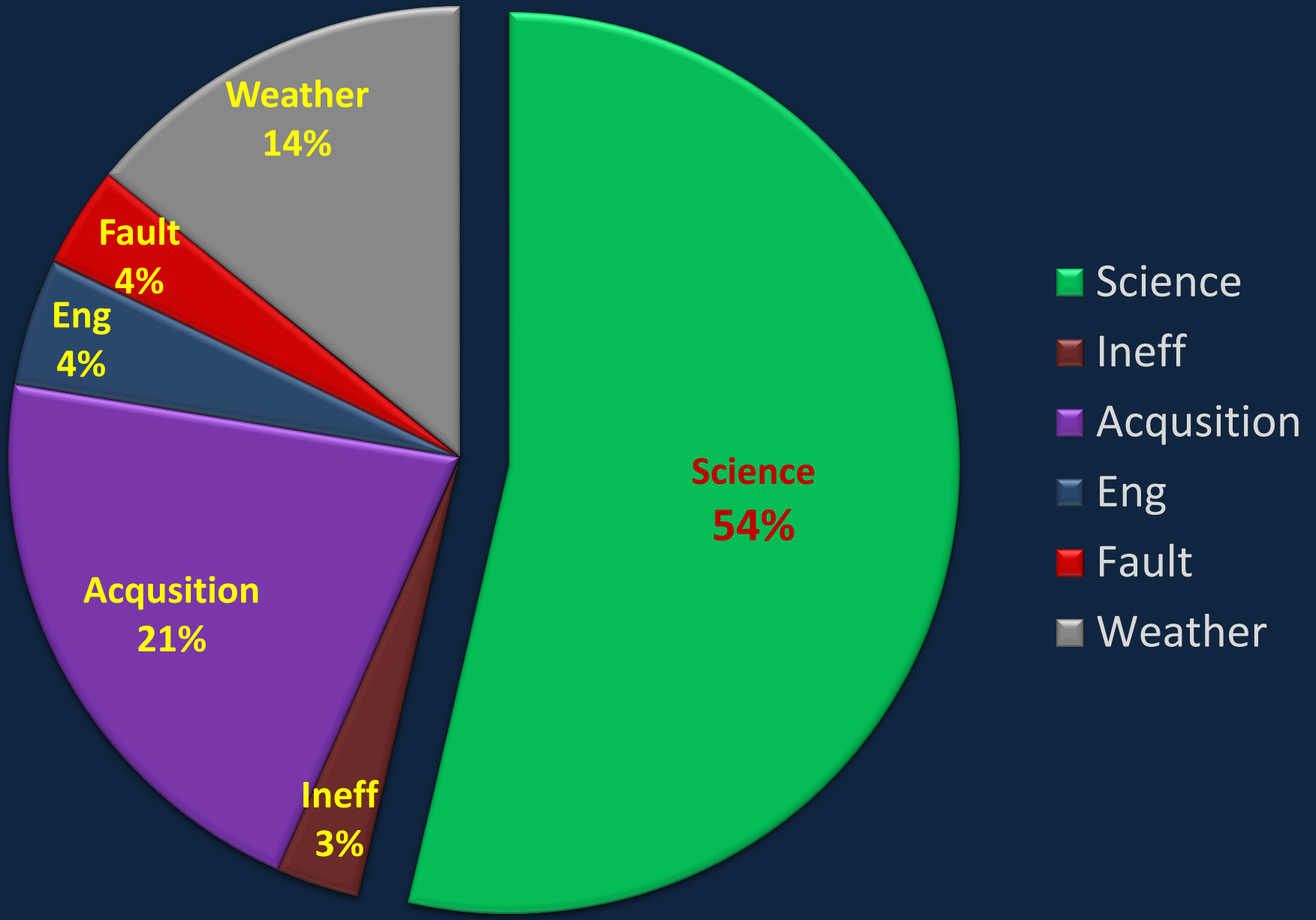
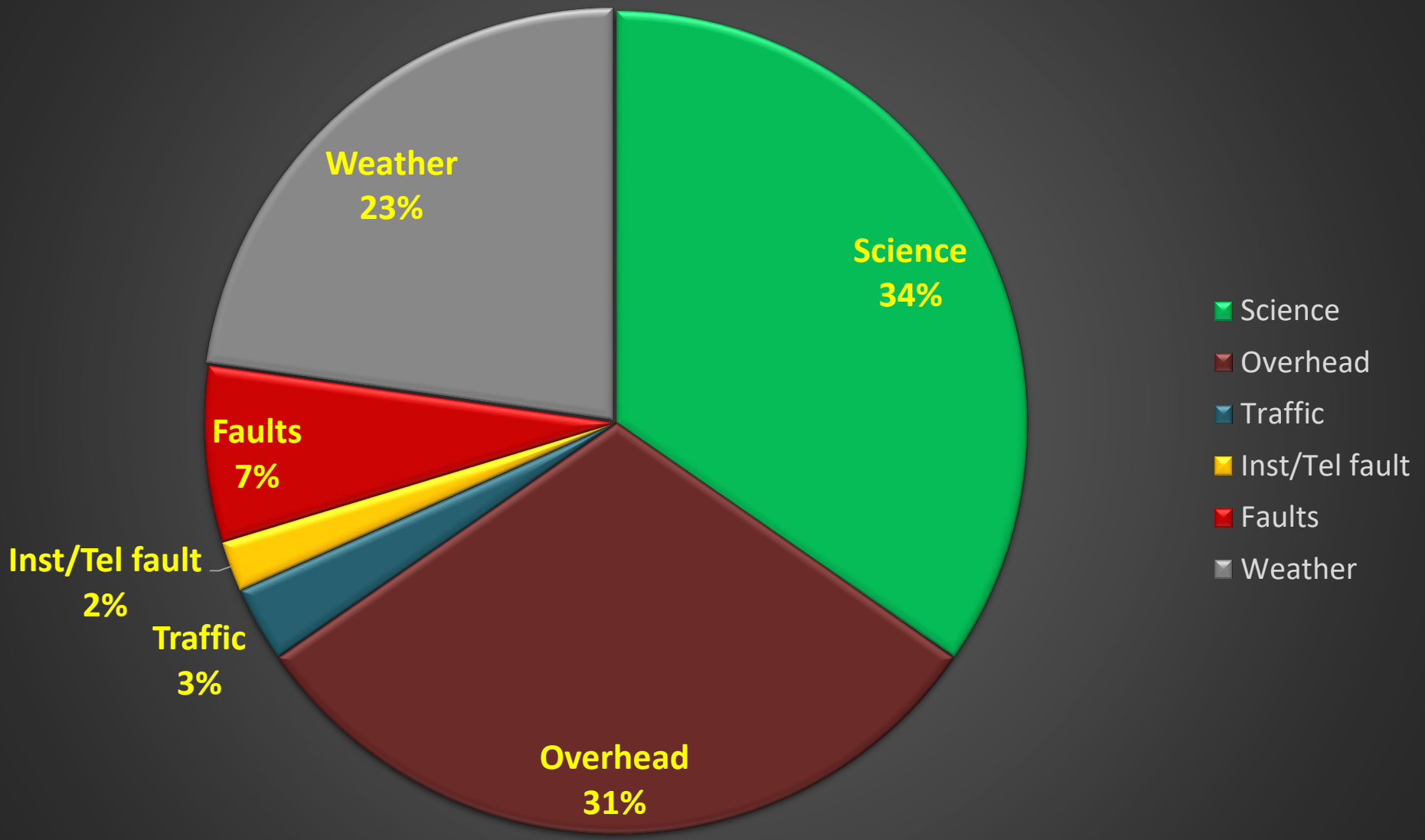
14
12
10
8
6
4
2
0
2009
2010
2011
2012
2013
2014
2015
6
1
5
3
8
6
6
6
8
4
6
3
8
6
Nature
Science


OPERATIONS

Observing Time Breakdown: FY16, Both Telescopes

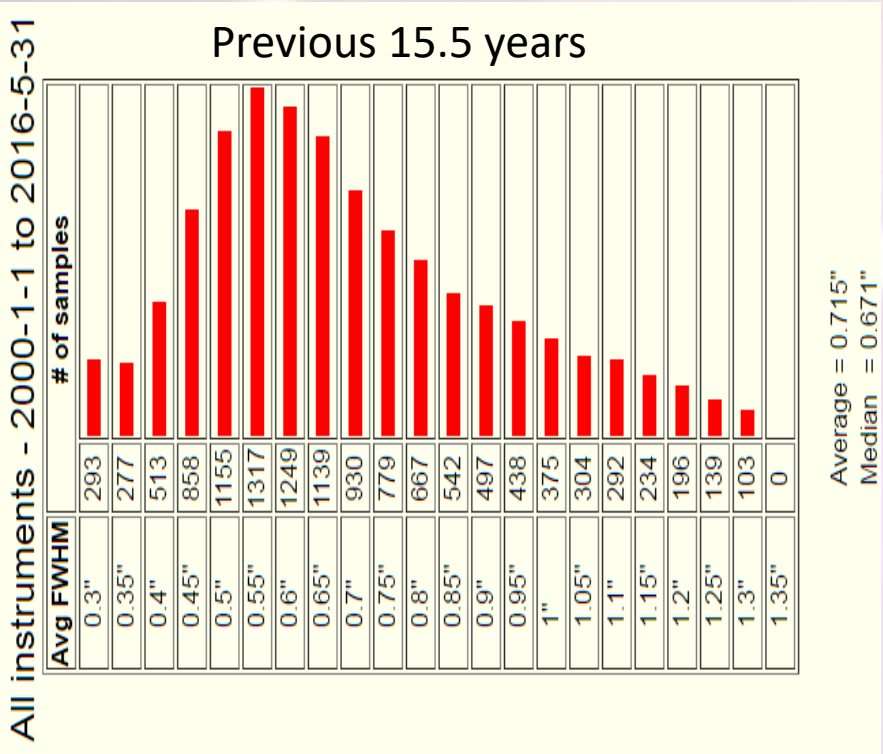


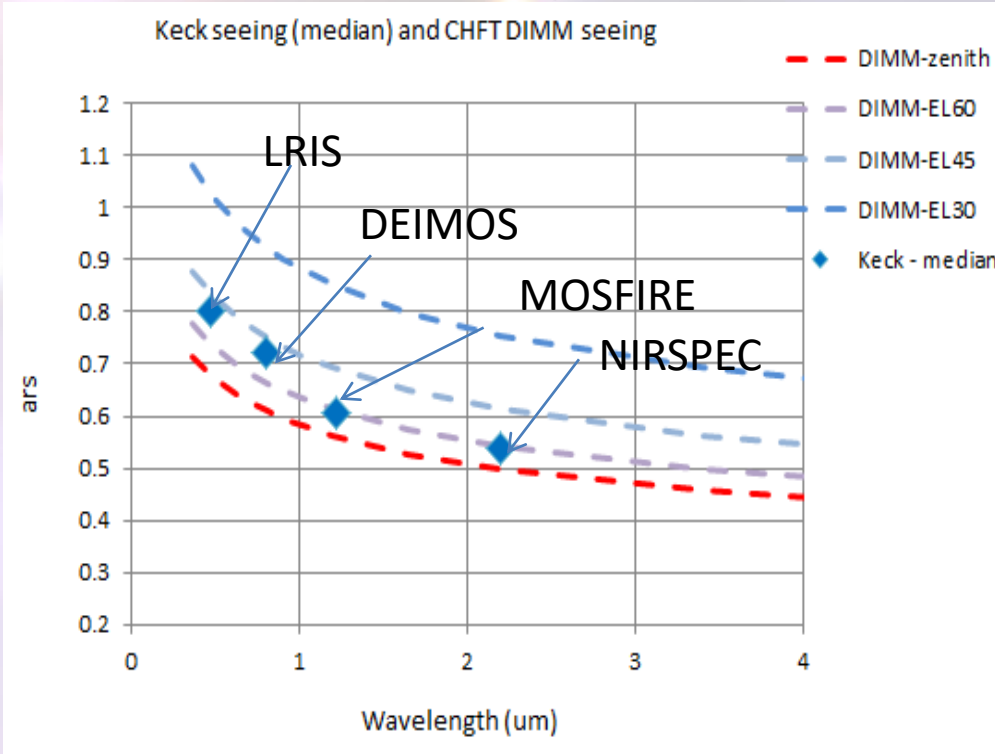
LGS AO Time Breakdown (Past 11 Years)



Excellent Dome Seeing Conditions At Keck

- Image FWHM from MIRA vs. CFHT DIMM Seeing
- All instruments, all operating conditions, past 15.5 years
  - 0.55” peak of distribution; 0.67” median
- Median FWHM consistent with DIMM seeing from CFHT

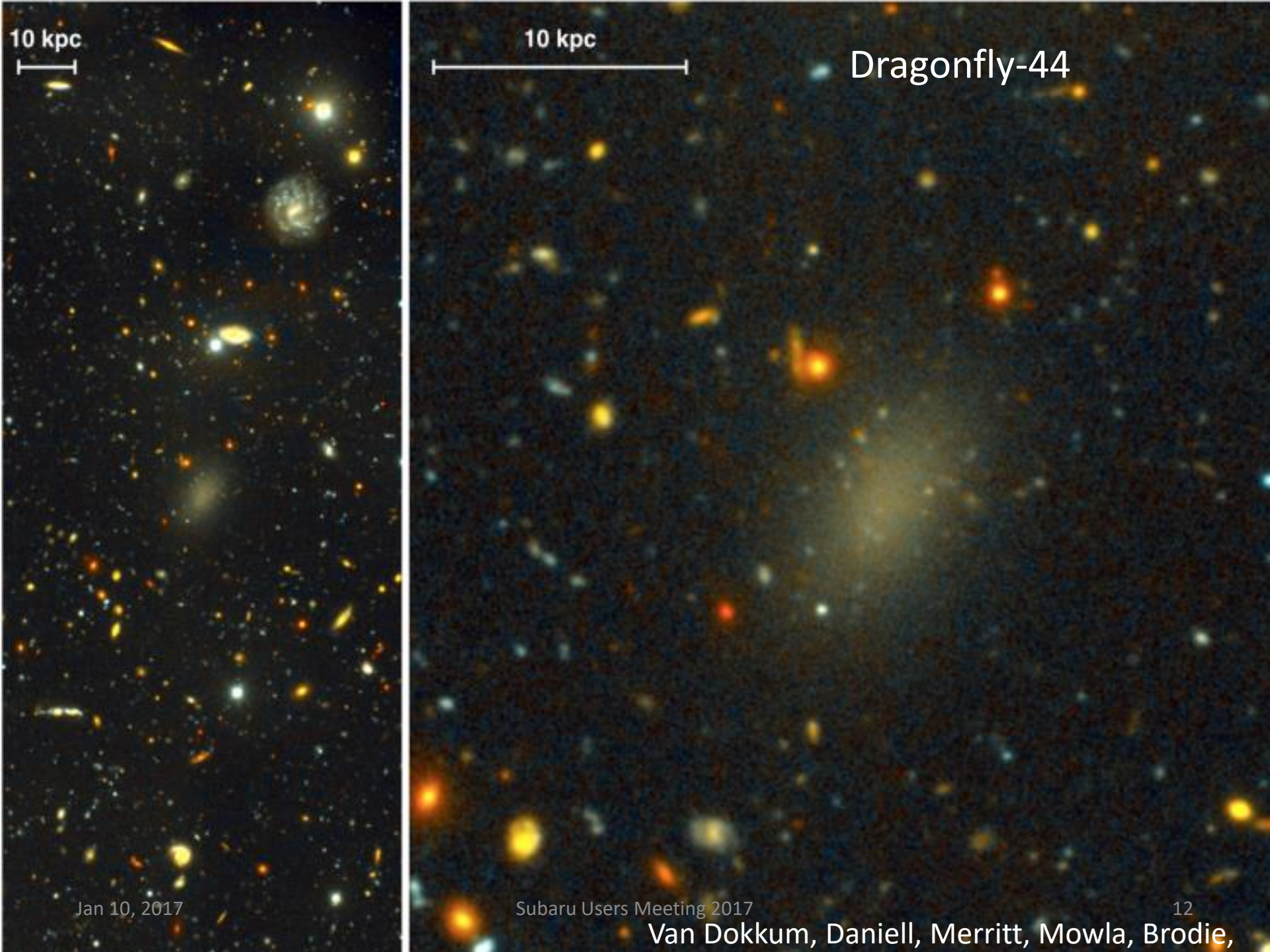




Time Domain Astronomy

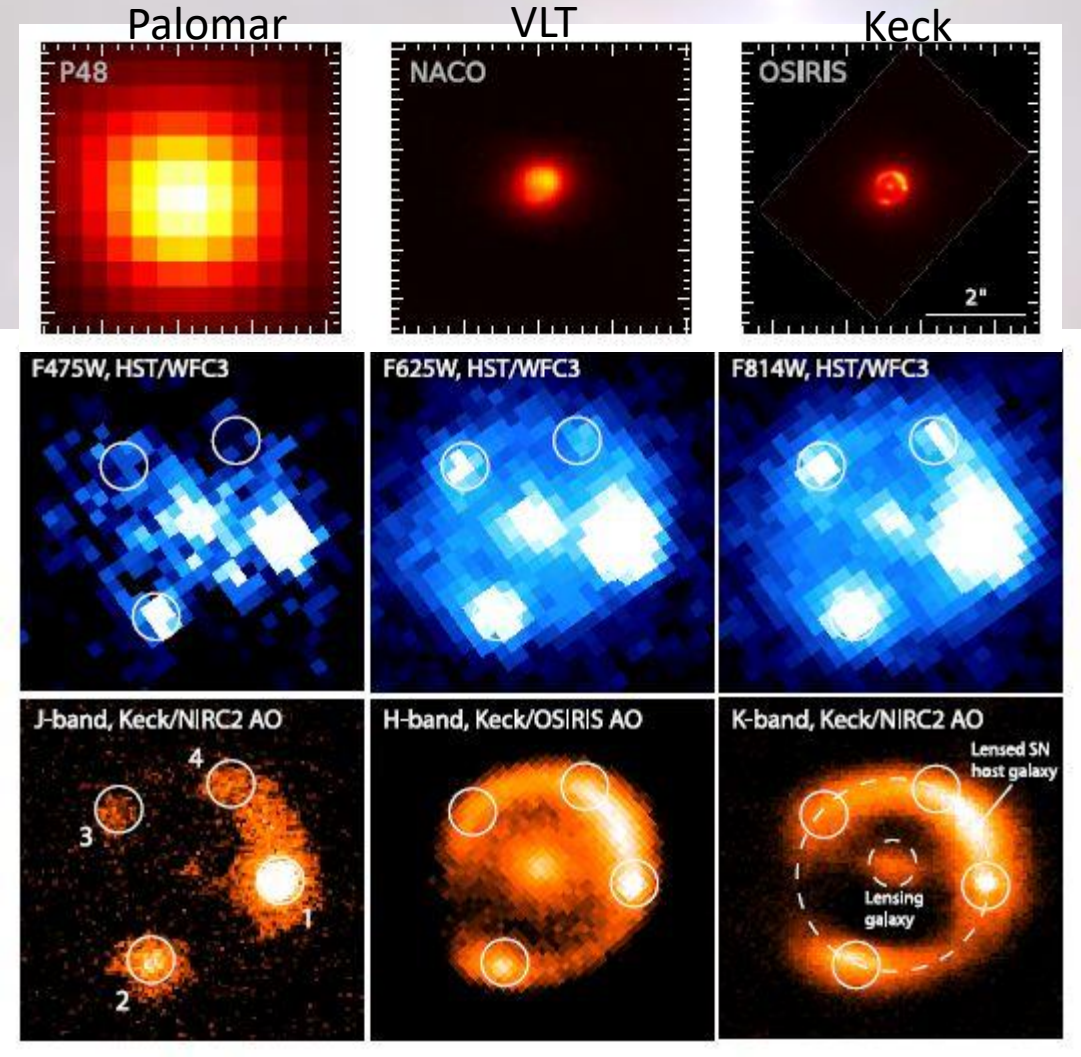
- New rules adopted for time domain astronomy scheduling to accommodate cadence and targets of opportunity
  - 2 year evaluation
- Needed for effective use of deployable tertiary
- Rules apply across the board to all partners
- Designed to minimize impact on short programs (1/2 night or smaller)

SCIENCE



Van Dokkum, Daniell, Merritt, Mowla, Brodie,

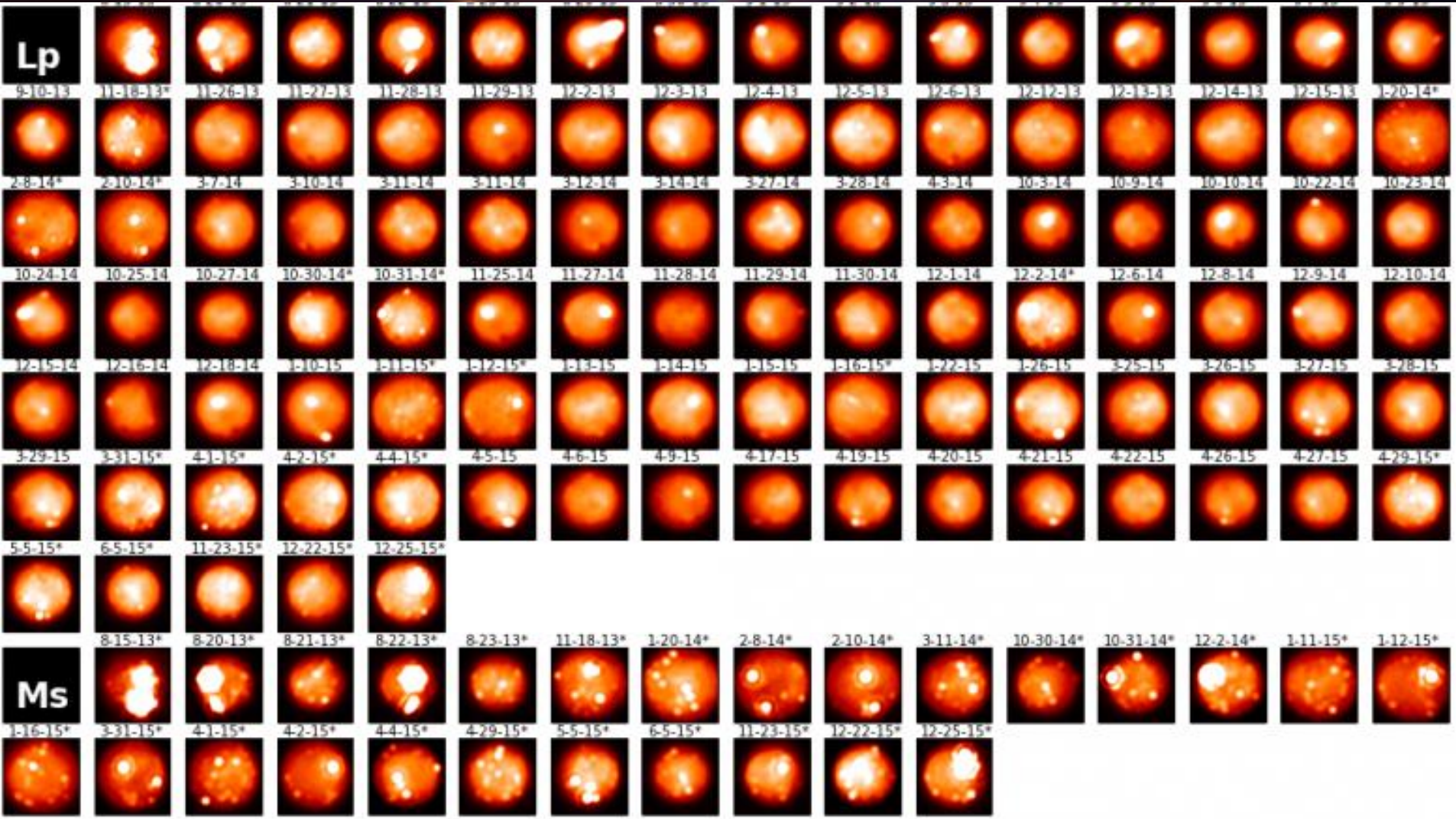
Lensed Type Ia Supernova: iPTFgeu



- iPTF-discovered
  - Too bright for distance
  - Suggested lensed
- $Z_{sn} = 0.4$; $z_i = 0.2$
- Fit multi-color lightcurve of SN
  - Measure magnification ~4.4 magnitudes
- First time multiple images of a SN1a have been observed
- Resolved lensing galaxy
  - Small scale clumping

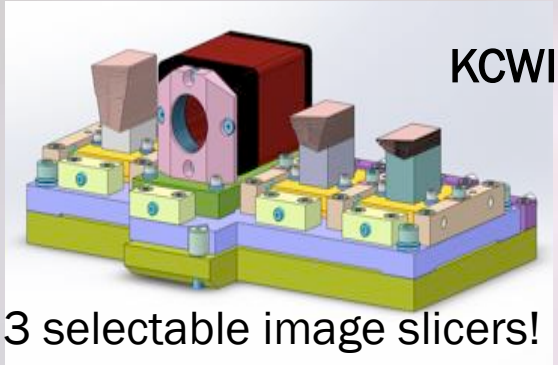
Goobar, A. et al., 2016, astro-ph

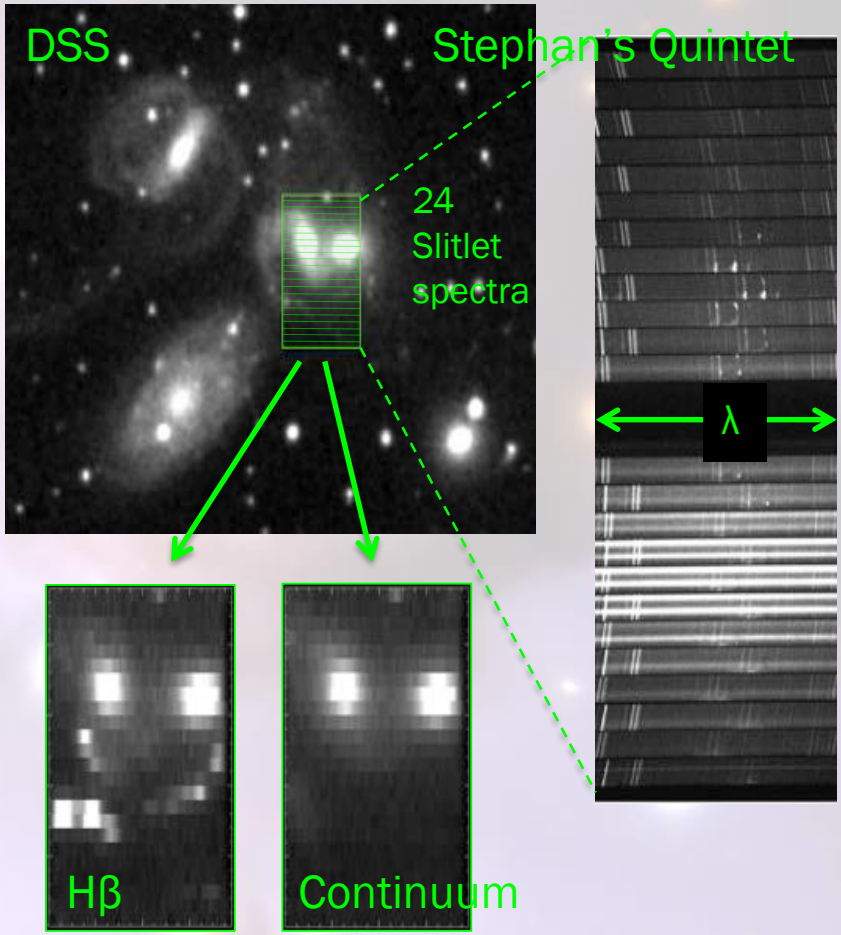
EVOLUTION OF VOLCANIC ERUPTIONS ON IO



FY16 UPDATE

KCWI Flexible & Powerful 2D Spectroscopy





Strengths

- Blue coverage (3500-6000Å)
- Red coverage (5600-10500Å)
- Precision Sky Subtraction
- Flexible observing modes
- High Resolution (R~20,000)

Slicer	Field of View	Spatial Resolution	Spectral Resolution
Small	20" x 8"	0.6" x 0.35"	0.23 Å (R 20,000)
Medium	20" x 16"	0.6" x 0.7"	0.45 Å (R 10,000)
Large	20" x 32"	0.6" x 1.4"	0.90 Å (R 5,000)

Keck Cosmic Web Imager-Blue

- Instrument completed, packed and ready for shipping
- Preliminary results from testing meet / exceed specifications
- Installation between Jan 2017 and Mar 2017
- Commissioning and science verification starts in Mar 2017
- Available for scheduled observing in 2018A

Detector assembly

Front view

Electronics cabinet

Segment Repair Project Progress

- Phase II Lab delayed but now complete
- First segments transported to HQ and repair underway
- Schedule
  - Production repairs started Dec 2017 spring 2017
  - Planning to complete 27 segments by end of FY17
  - Project expected to complete late 2019

OSIRIS Upgrade

- Spectrograph detector system upgraded
  - Hawaii-2 replaced with Hawaii-2RG
  - Added focus stage to optimize detector alignment
  - Replaced detector readout system
  - Updated spectrograph computer
  - Successfully commissioned and in routine service
- Preparing to commission new imager detector system in early 2017

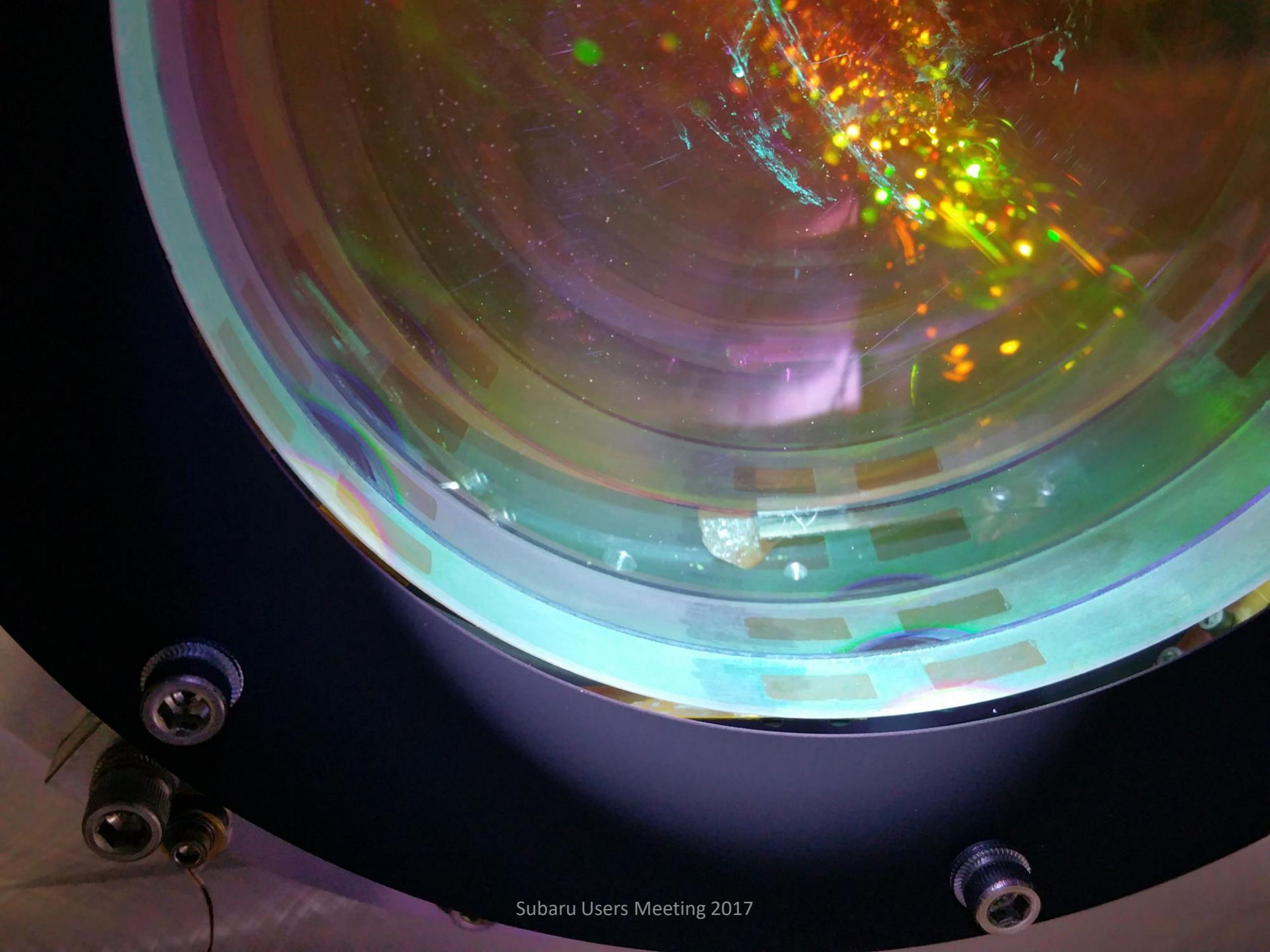
Telescope Control System Upgrade

- **Keck 2**
  - First successful science demonstration June 2016.
  - Excellent pointing achieved, far superior to old system. Conservative estimate of time saved through improved pointing is 5 nights/year, modeled using 1 years' worth of actual acquisitions.
  - Blind on-sky performance is 1.2" RMS from 7 months' pointing tests, refitting encoder zero points only.
  - Tracking closer to keyhole with improved wind-shake rejection.
- **Keck 1**
  - Excellent pointing much better than old system, though not as good as K2. Suspect due to nature of azimuth journal tilt variations.
  - Best model fit ~1.25" RMS

But Then…

On the point of completion with full transition to science when rotator accident occurred, damaging MOSFIRE

- Reverted all science operations to old control system
- Reviewed rotator subsystem design and servo approach following mishap (with expert outside help)
- Implementing additional safety precautions to prevent the possibility of future incidents
- Completion date dependent on available commissioning time in 2017A



Mishaps are like knives, that either serve us or cut us, as we grasp them by the blade or the handle.

James Russell Lowell
American Romantic poet
1819 - 1891

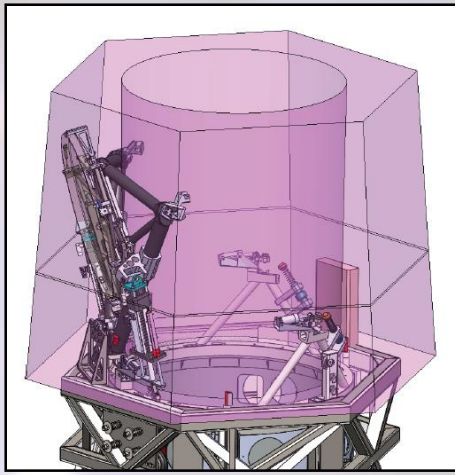
QUOTEHD.COM

Unattended Night-Time Operations at Summit

- **Rationale:**
  - Cost savings, reliability improvements, efficiency gains
- **Scope:**
  - 1/3rd : New tools to support night staff unattended operations needs
  - 2/3rd : Efficiency and reliability improvements to eliminate need for summit presence for fault detection/recovery
- **Milestones:**
  - Design reviews: Oct. 2016 (concept), May 2017 (preliminary) and Sep. 2017 (final)
  - Efficiency and reliability improvements to existing equipment starting in 2017 and continuing through 2019
  - Start of fully unattended operations no sooner than 2019

Keck I Deployable Tertiary (K1DM3)

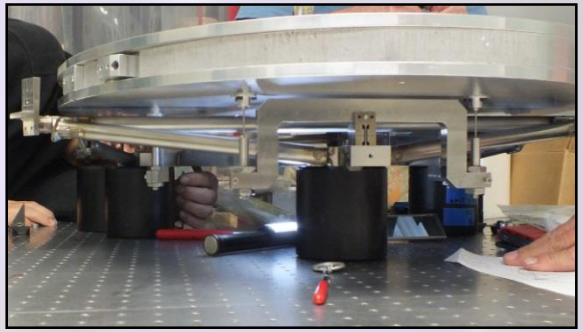
- Mechanized Tertiary that can be swung in and out in place
- Rapid switch between Nas and Cass instruments (~120 sec)
- Module will remain inside the Tertiary Tower
  - Module and Mirror will be removed for recoating in similar manner as existing tertiary
- Installation and Commissioning scheduled for August 2017
  - Module will be shipped here between June and August
- Key to enabling time-domain astronomy on Keck 1 telescope



Outer and Inner Drums

Swingarm

Mirror Support Flexure



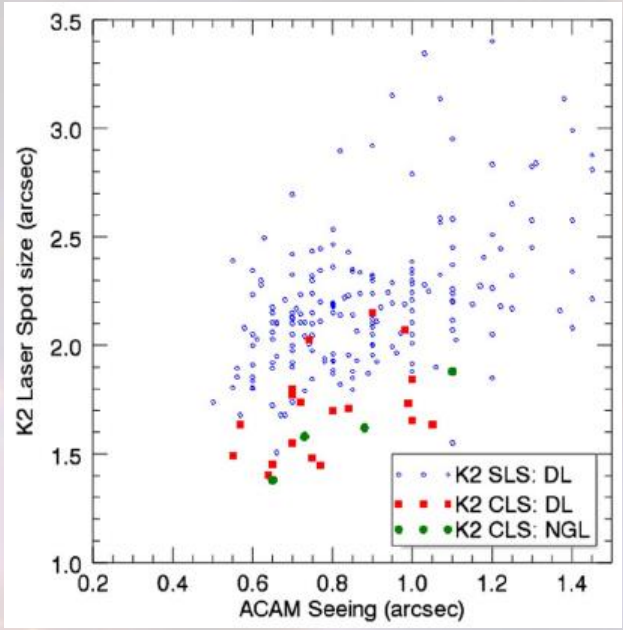
Whiffle Tree and Dummy Mirror

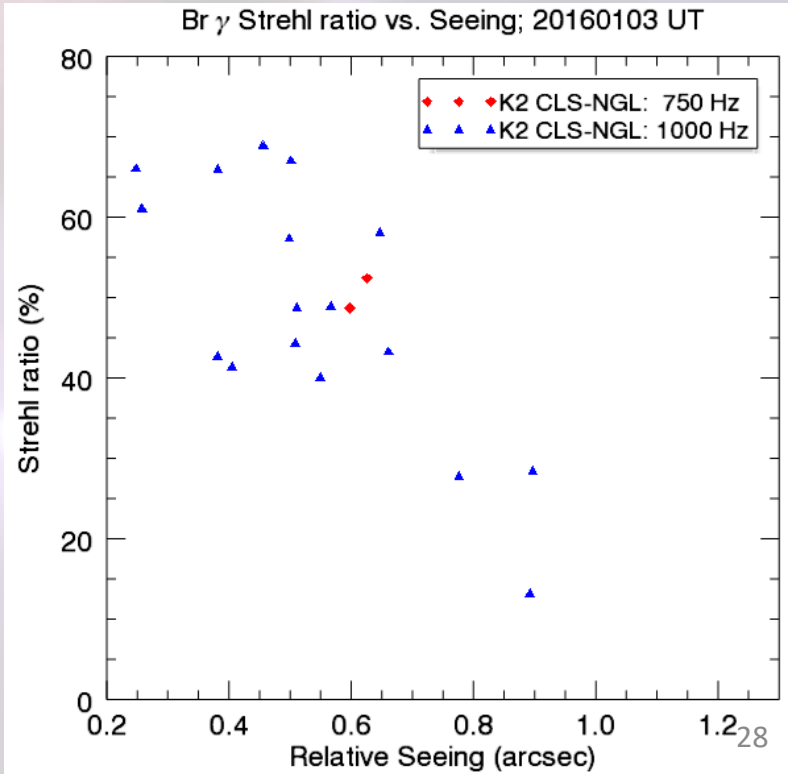
Keck II Laser Status

- Upgraded old dye laser in use since 2002 to new Toptica fiber laser
- LGS AO science resumed April 2016.
- ~10x signal return but using just 5% input power (3kW).
- Project completed on schedule and under budget!

K2 Laser Status

- Predicted laser return achieved: R = 7.5 (19x old dye laser)
- Laser spot size ~24% reduced
- Best Strehl ~65% vs. ~53% with dye laser
  - Performance limited by wavefront controller bandwidth; no noticeable improvements operating between 14W and 20W





DEIMOS Service Mission II

- Completed March 2016
- No belt breaks since then
- Can clamp gratings at any rotator angle
- Flexure reduced to historically “good” levels
- No time lost due to mechanical failures since repair. Previously, 50% of DEIMOS problems were due to the grating system

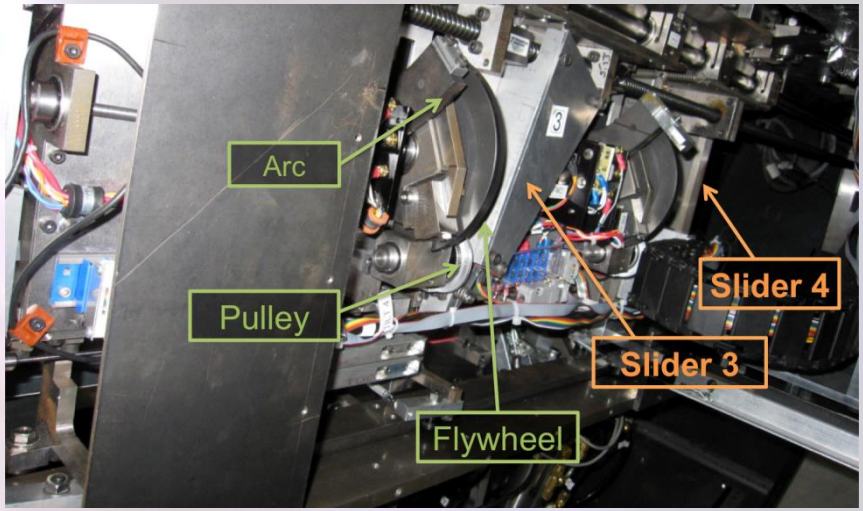
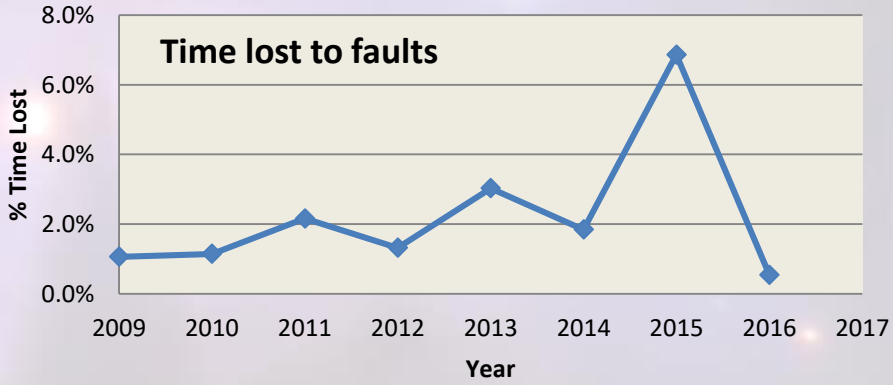


Photo of the DEIMOS grating sub system. Parts labeled green were replaced. There is one set of components for each slider.



Segment Warping

- Direct slope algorithm for determining warping forces is fully operational
  - Manually tested during 2015 K1 exchange
  - Fully implemented for 2016 K2 exchange
    - Matlab warping GUI, direct interface to PEAS-PCS database, & a new warping fixture with a Python GUI
- Result: $\theta_{80} = 0.32''$ for both exchanges
  - 15% improvement over previous years


2017 PLANS

Programs in Progress

Project	Status	First light	Shared Risk
Enhanced TRICK	Testing on sky	June 2015	2017A
TCS Upgrade	Facility rotator re-commissioning	Apr 2015	2017A
OSIRIS imager upgrade	Preparing for integration	Jan 2017	2017B
KCWI-Blue	Delivery to observatory	Jan 2017	2018A
NIRES	Final I&T in lab	Oct 2017	2018A
K1 Deployable Tertiary	Detailed design	Jul 2017	2018A
NIRSPEC upgrade	Preliminary design	Feb 2018	2019A
K2 AO IR wavefront sensor	Preliminary design	Mar 2018	2019A
KCWI-Red	Preliminary design	Mar 2019	2019B
Unattended Night Ops	Preliminary design	June 2019	2019B
Keck Planet Finder	Preliminary design	Oct 2019	2020A

Major Deliverables in FY17

<table>
<tr><th>Month</th><th colspan="2">Keck I</th><th>Keck I & II</th><th colspan="2">Keck II</th></tr>
<tr><td>Oct</td><td rowspan="3">MOSFIRE Repair</td><td></td><td rowspan="6"></td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>Nov</td><td></td></tr>
<tr><td>Dec</td><td></td></tr>
<tr><td>Jan</td><td rowspan="2">MOSFIRE Recommissioning</td><td></td><td rowspan="2">KCWI Install</td><td rowspan="2"></td></tr>
<tr><td>Feb</td><td>OSIRIS Imager Install</td><td rowspan="4">TCSU Commissioning</td></tr>
<tr><td>Mar</td><td></td><td rowspan="3">OSIRIS Imager Commissioning</td><td rowspan="4">KCWI Commissioning</td><td></td></tr>
<tr><td>Apr</td><td>Segment Exchange</td><td rowspan="2">PCS Camera Upgrade</td></tr>
<tr><td>May</td><td></td></tr>
<tr><td>Jun</td><td rowspan="2">Segment Exchange</td><td></td><td rowspan="2">ACS Upgrade Install & Test</td></tr>
<tr><td>Jul</td><td>K1DM3 Install/Test</td><td rowspan="3"></td><td rowspan="3">NIRES Install & Daytime Testing</td></tr>
<tr><td>Aug</td><td rowspan="2">Segment Exchange</td><td>K1DM3 Commissioned</td><td rowspan="2">ACS Upgrade Install & Test</td></tr>
<tr><td>Sep</td><td></td></tr>
<tr><td>Oct</td><td>Segment Exchange</td><td></td><td></td><td colspan="2" rowspan="2">NIRSPEC Upgrade Install, DEIMOS Grating Install, NIRES Commissioning</td></tr>
<tr><td>Nov</td><td></td><td></td><td></td></tr>
</table>

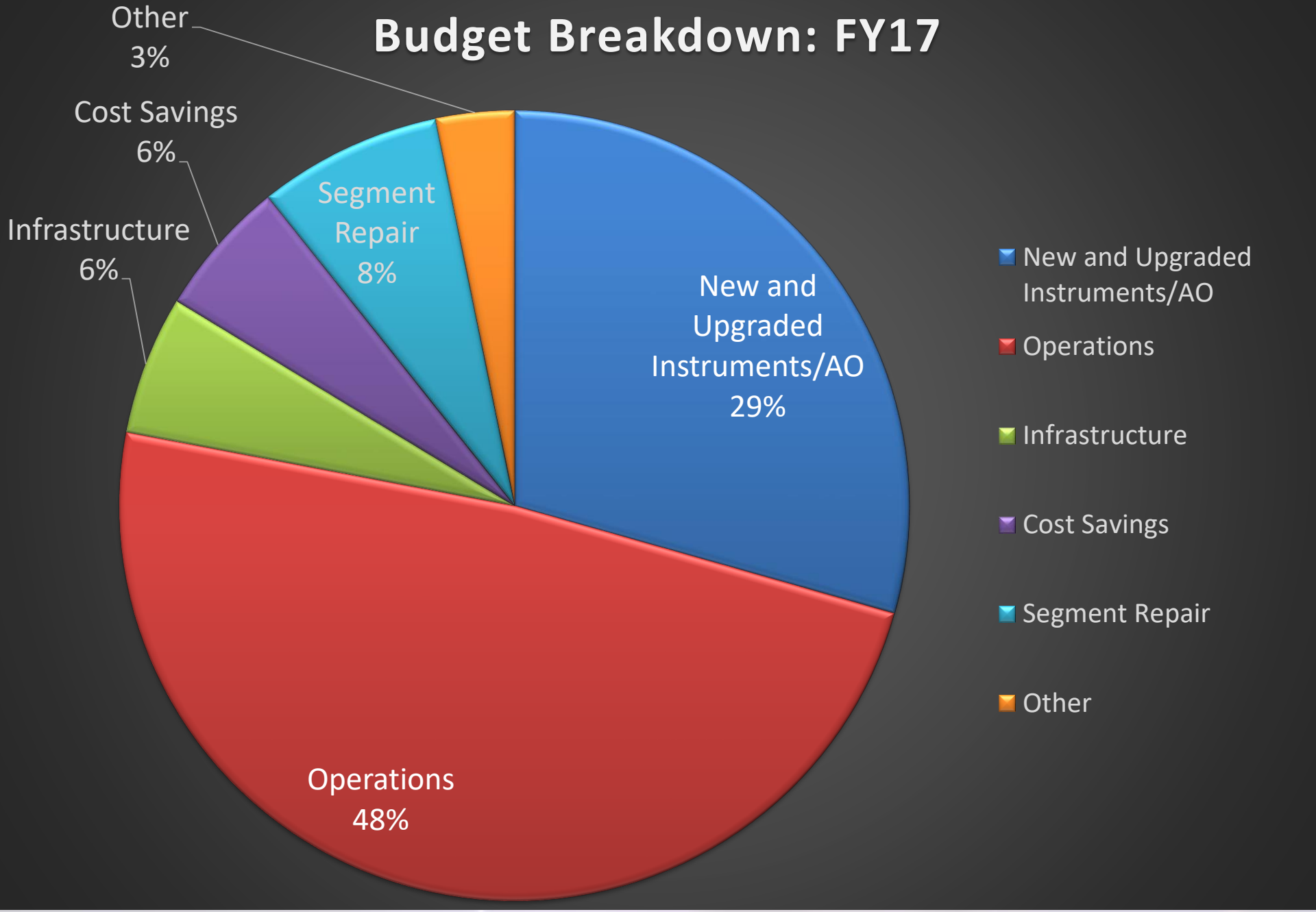
Observing Semester

FY Boundary

FY17 Highest Priority Projects and 'Must Wins'

Prio	Project	FY17 Deliverables
1	**MOSFIRE**	**Recommission for 17A science & complete Investigation**
2	**Segment Repair**	**Complete first 27 segments**
3	**TCSU**	**Commission tertiary by Feb. & all before 17B**
4	**KCWI-B**	**Commission for 17B science**
5	**OSIRIS Imager Upgrade**	**Commission for 17B science**
6	**K1DM3 Deployable Tertiary**	**Commission for 17B science**
7	KCWI-R	**Complete delta PDR** + good progress on DDR
8	**OSIRIS Spectrograph DRP Fix**	**DRP release that reduces legacy & current data**
9	PCS camera Upgrade	**New K2 camera** & motor controller operational
10	Un-attended Night Ops	**ROSI PDR** & start biggest reliability subprojects
11	Spare Secondary	Complete replan based on bids. Place polishing contract
12	Summit PV	**Resolve insurance issue** & install if approved
13	Enhanced Tip-Tilt Sensor	**Commission TRICK for 17A science** & E-TRICK for 17B science
14	NIRSPEC Upgrade	**Complete design review. Procure & test both detectors at UCLA**
15	ACAM Guider Upgrade	Commission for 17B science
16	K2 Laser (NGL)	**Service contract in place**. Complete spares procurement
17	ACS Upgrade	**Final design**. In final testing after replacement of all nodeboxes on 1 tel.

Budget Breakdown: FY17



Maunakea Update

- Focus: Develop trusting relationships, educating leaders about astronomy's role in Hawaii and to building astronomy's image
- Message:
  - We seek to engage in a helpful, constructive manner towards a positive future for Astronomy that benefits Hawaii
- Some important findings so far:
  - There is a still a lack of basic knowledge about the astronomy sector in Hawaii among some decision makers
  - The messenger and the approach are as important, sometimes more important, than the message itself.
- Two themes resonate most:
  - Educational and work opportunities for future generations
  - Explaining the advantages for the community