Refereed Articles: based on WMKO data
Keck Observatory Archive Publications

- 2008: 1 publication
- 2009: 1 publication
- 2010: 7 publications
- 2011: 10 publications
- 2012: 19 publications
- 2013: 14 publications
- 2014: 26 publications
- 2015: 41 publications
Total Impact = AIPP * # of Papers

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

Total Impact per Telescope (2010 - 2014)

Jan 10, 2017
Subaru Users Meeting 2017
Articles Based on WMKO Data

- **Nature**
- **Science**
OPERATIONS
Observing Time Breakdown: FY16, Both Telescopes

- Science: 54%
- Acquisition: 21%
- Ineff: 4%
- Fault: 4%
- Weather: 14%

Jan 10, 2017
Subaru Users Meeting 2017
LGS AO Time Breakdown (Past 11 Years)

- Science: 34%
- Overhead: 31%
- Traffic: 3%
- Inst/Tel fault: 2%
- Faults: 7%
- Weather: 23%
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

Previous 15.5 years

![Graph showing seeing conditions over 15.5 years]

Keck seeing (median) and CHFT DIMM seeing

- LRIS
- DEIMOS
- MOSFIRE
- NIRSPEC
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)
Dragonfly-44

Jan 10, 2017

Subaru Users Meeting 2017
Van Dokkum, Daniell, Merritt, Mowla, Brodie, Zhang
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 $\sim 4.4$ 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

3 selectable image slicers!

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

<table>
<thead>
<tr>
<th>Slicer</th>
<th>Field of View</th>
<th>Spatial Resolution</th>
<th>Spectral Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>20” x 8”</td>
<td>0.6” x 0.35”</td>
<td>0.23 Å (R 20,000)</td>
</tr>
<tr>
<td>Medium</td>
<td>20” x 16”</td>
<td>0.6” x 0.7”</td>
<td>0.45 Å (R 10,000)</td>
</tr>
<tr>
<td>Large</td>
<td>20” x 32”</td>
<td>0.6” x 1.4”</td>
<td>0.90 Å (R 5,000)</td>
</tr>
</tbody>
</table>
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
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
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
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 $\sim 24\%$ reduced
• Best Strehl $\sim 65\%$ vs. $\sim 53\%$ 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.

Time lost to faults

% Time Lost

Year

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
## Programs in Progress

<table>
<thead>
<tr>
<th>Project</th>
<th>Status</th>
<th>First light</th>
<th>Shared Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced TRICK</td>
<td>Testing on sky</td>
<td>June 2015</td>
<td>2017A</td>
</tr>
<tr>
<td>TCS Upgrade</td>
<td>Facility rotator re-commissioning</td>
<td>Apr 2015</td>
<td>2017A</td>
</tr>
<tr>
<td>OSIRIS imager upgrade</td>
<td>Preparing for integration</td>
<td>Jan 2017</td>
<td>2017B</td>
</tr>
<tr>
<td>KCWI-Blue</td>
<td>Delivery to observatory</td>
<td>Jan 2017</td>
<td>2018A</td>
</tr>
<tr>
<td>Nires</td>
<td>Final I&amp;T in lab</td>
<td>Oct 2017</td>
<td>2018A</td>
</tr>
<tr>
<td>K1 Deployable Tertiary</td>
<td>Detailed design</td>
<td>Jul 2017</td>
<td>2018A</td>
</tr>
<tr>
<td>NIRSPEC upgrade</td>
<td>Preliminary design</td>
<td>Feb 2018</td>
<td>2019A</td>
</tr>
<tr>
<td>K2 AO IR wavefront sensor</td>
<td>Preliminary design</td>
<td>Mar 2018</td>
<td>2019A</td>
</tr>
<tr>
<td>KCWI-Red</td>
<td>Preliminary design</td>
<td>Mar 2019</td>
<td>2019B</td>
</tr>
<tr>
<td>Unattended Night Ops</td>
<td>Preliminary design</td>
<td>June 2019</td>
<td>2019B</td>
</tr>
<tr>
<td>Keck Planet Finder</td>
<td>Preliminary design</td>
<td>Oct 2019</td>
<td>2020A</td>
</tr>
</tbody>
</table>
## Major Deliverables in FY17

<table>
<thead>
<tr>
<th>Month</th>
<th>Keck I</th>
<th>Keck I &amp; II</th>
<th>Keck II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct</td>
<td>MOSFIRE Repair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nov</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan</td>
<td>MOSFIRE</td>
<td></td>
<td>KCWI Install</td>
</tr>
<tr>
<td>Feb</td>
<td>Recommissioning</td>
<td>OSIRIS Imager</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Install</td>
<td></td>
</tr>
<tr>
<td>Mar</td>
<td></td>
<td>TCSU Commissioning</td>
<td></td>
</tr>
<tr>
<td>Apr</td>
<td>Segment Exchange</td>
<td>OSIRIS Imager</td>
<td>KCWI Commissioning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Commissioning</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>Segment Exchange</td>
<td></td>
<td>PCS Camera</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Upgrade</td>
</tr>
<tr>
<td>Jun</td>
<td>Segment Exchange</td>
<td></td>
<td>ACS Upgrade</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Install &amp; Test</td>
</tr>
<tr>
<td>Jul</td>
<td>Segment Exchange</td>
<td>K1DM3 Install/Test</td>
<td>NRES Install &amp;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>K1DM3 Commissioned</td>
<td>Daytime Testing</td>
</tr>
<tr>
<td>Aug</td>
<td>Segment Exchange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sep</td>
<td>Segment Exchange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct</td>
<td>Segment Exchange</td>
<td></td>
<td>NISPEC Upgrade</td>
</tr>
<tr>
<td>Nov</td>
<td></td>
<td></td>
<td>DEIMOS Grating</td>
</tr>
</tbody>
</table>

**Observing Semester**

- FY Boundary

### Notes

- MOSFIRE Repair
- OSIRIS Imager Install
- TCSU Commissioning
- KCWI Install
- PCS Camera Upgrade
- ACS Upgrade Install & Test
- NISPEC Upgrade Install, DEIMOS Grating Install, NIRES Commissioning
# FY17 Highest Priority Projects and ‘Must Wins’

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

- New and Upgraded Instruments/AO: 29%
- Operations: 48%
- Infrastructure: 6%
- Cost Savings: 6%
- Segment Repair: 8%
- Other: 3%

Jan 10, 2017
Subaru Users Meeting 2017
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