

# Keck SSC Meeting Notes

2021 November 10-11  
Meeting held via Zoom

# Introduction and Review of Actions

- The SSC welcomes Doug Simons, who is joining the SSC as the new Director of the IfA.

# Observatory Report

- Keck performs well in paper impact (MIPP) vs collecting area. Magellan is strong in its class and competitive with larger observatories. Considering other metrics.
- >46% of time dedicated to science, 21% lost due to weather, with modest (1.1%) COVID impacts on operations. Fault times increased slightly.
- Keck/MKO acting intensely on further developing community relationships and engagement. Three elements:
  - Education: e.g., P-12 MKO curriculum development
  - AINA: environmental issues
  - Community resources: e.g., share Hale Pohaku with the community.
- Doug Simons move to UH IfA has significantly strengthened the community relationships.
- Akamai internship very successful, and with talks to be continued at UH.
- MKO supported several community needs, such as response to a large Waimea fire, and hosted a COVID vaccine drive at MKO HQ.

# Observatory Report (continued)

- **Diversity, equity and inclusion (DEI)** is being embraced strongly at Keck at all levels, as a positive way to attract, retain, motivate, and inspire staff.
- DEI is considered a pillar for future developments at Keck. Keck is reaching the partners (e.g., Caltech, NASA) to coordinate and develop common strategies.
- Importantly, the DEI is being expanded to capture the specific Hawaii issues, with the inclusion of accessibility (DEIA): "Providing broader access .. "
- **COVID update:** a) vaccination mandate for WMKO staff; b) bi-weekly testing, c) no new instances of positive cases, d) observers welcome at HQ if vaccinated, e) continue on normal operations yet some projects are being impacted.
- **Pier repair:**
  - K1 remove drywall and determined level of concrete damage, b) K2: 3 locations of deflections found, one repairable but small and of lower priority than K2.
  - Contracted outside expertise; although oil-saturated, strength is adequate. A grout-focused repair should be possible.
  - Will likely require downtime to repair (1-2 months; but very uncertain)

# Observatory Report (continued)

- Tertiary mirror repair:
  - Completely repaired the K1 tertiary and installed in K2, following segment repair knowledge.
  - Verified alignment using NIRC2 pupil image.
  - K2 tertiary mirror to be repaired as a spare (recall that K1 now has a deployable tertiary).
- Instrument watchlist
  - NIRC2: occasional server reboots, and a detector quadrant has improved
  - NIRSPEC: service mission planned for February 2022 to install new pupil.
  - KCWI: Dewar leak monitored and under control.
  - MOSFIRE: large offsets may be inaccurate at few x 0.1”.
- AO operations watchlist: Max Service has started as AO operation scientist. Sylvain Cetre (software) is departing.
- Remote observing evolving slowly back at remote campus sites, but "Pajama mode" is still the rule.

# Observatory Report (continued)

- Data Services Initiative (DSI) updates:
- DSI-DDOI: conceptual design review complete in September. Software design phase nearly complete, with night-time engineering in late 2022A.
- DSI-DRP (Data Reduction Pipeline): complete for KCWI and mostly complete for DEIMOS and MOSFIRE; discussions with KPF underway.
- DSI-KOA RTI (Real-Time Ingestion): framework developed and tests worked correctly and ready for all instruments to operate under RTI. The RTI process is quite fast, in the manner of seconds (<30 s) for the files to be ingested (mostly bandwidth limited and for most instruments). The reduced data (automatic DRP) are available within a few minutes once ingested.
- DSI-INF: a new portal is being developed for the observer – how astronomers operate and control the instruments and observatory settings.
- SSC emphasizes the importance of user community engagement in the design and testing of the DSI user interface.

# IGNIS status report

- Presenters: Emily Martin and Gregory Mace
- IGNIS would achieve considerable cost savings if instrument designs for GMT & Magellan are used as-is
  - GMT & Magellan instruments progressing with PDR in June 2023 with some hardware funding
  - Use of Si immersion gratings ( $n = 3.4$ ) allow  $\sim 10x$  reduction in volume over reflection gratings
- IGNIS is designed to be seeing-limited and planning to be AO-capable with adaptive secondary
- Solicited & received Keck community science input:
  - Assembled IGNIS science team, had a community workshop, developed science traceability matrix
- Completed initial fore-optics design with bent Cass location
  - Option for a longer slit (7" vs 4") with same post-slit optics) but would not satisfy all planetary science needs (NIRSPEC more efficient with its longer slit even with small wavelength range)
- Project will be led by UCSC, cover 1.07 - 5.45  $\mu\text{m}$ ,  $R \sim 45,000$ 
  - IGNIS plans to follow behind the GMT and Magellan instruments by 1-2 years
  - Notional IGNIS timeline (if not funding limited): 2022 - Phase A, 2024 - Proposal submission, 2025 - PDR, 2028 - shipped to Keck (cf. 2029 - NIRSPEC turns 30)

# MKIDS technology update (from Ben Mazin):

- MKIDs are superconducting detectors that resolve the wavelengths and arrival times of detected photons
- MKIDs have been used on-sky at Palomar and Subaru
  - Subaru MEC array is 140x146 pixels with ~85% pixel operability
  - Steiger+ (2021) AJ discovered new faint stellar companion (with SCExAO)
  - New papers on circumstellar disks and young brown dwarf companion in preparation
- Latest MKID detectors:
  - New layer to block phonons in MKIDs and new amplifiers to reduce noise and increase dynamic range: provides major improvement in spectral resolution
  - Single detector is  $R \sim 15$  in J band and linearly higher at shorter wavelengths
- UCSB is working with Lincoln Labs to fabricate high-quality MKIDs
  - Can improve pixel operability with cleaner facilities and potentially increase  $R$  via more controlled processing
- Considering high- $R$  wide-bandpass Keck spectrometer without cross-disperser:
  - Overlapping orders resolved by MKIDs in high aspect rectangular format
  - Developing lab testbed
- Also considering KRAKENS Prime  $\sim 1k \times 1k$  seeing-limited IFS with  $R \sim 50$ 
  - $R \sim 50$  would require successful detector development (Lincoln Labs)
  - Other modes could include dispersion and polarization, could work with GLAO or ORCAS AO

# SCALES imager capabilities

- Presenter: Andy Skemer
- Motivations for considering an imager:
  - Science: expands SCALES science case.
  - Practical: acts as a finder camera; aids in pupil alignment.
  - Strategic: provides a replacement in case of failure, and/or upgrade for NIRC2.
  - Programmatic: extra detector obtained and imager optics potentially available at no cost
- Need a decision on instrument design, most urgently for cryostat contracts, and on intended location (bent port / NIRSPA0 vs straight port / NIRC2).
- Discussion of saturation limits, given long read-times of the JWST-sourced H2RG. Projected to be J/H/K/L/M = 11.4, 10.8, 9.5, 7.4, 5.0 but can mitigate with subarrays and neutral density filters. Could be improved with future detector/SIDECAR mod.
- Compared to NIRC2 in narrow-field mode (see details in slides):
  - saturation is ~0.2–2 mag brighter.
  - approximately same sensitivity, with improvements in certain regimes.
  - studying a field of 12.3" x 12.3", which is 20% larger than NIRC2 narrow
  - FOV up to 20 arcsec may be feasible, pending community input
  - Pixel scale of 6 mas vs 10 mas for NIRC2.
  - lower wavefront error by 3x and better distortion.
  - will need to have fewer filters (20 filter slots available).

# Major projects update

- KCRM:

- projected costs under cap. NSF COVID relief supplement received.
- Will deliver in June 2022- 3 month slip since last reporting period
- TACs were notified of 22A availability of KCWI (Blue): not available in June/July
- Winlight on critical path for camera lens delivery
- Camera lenses polished and about to be coated
- Dichroic bonded in lab (world's largest). Major optics risks retired.
- Proxy bench populated with articulation stage, grating exchanger, FM2 mirror
- Full system integration by the March SSC meeting (grating bonding, detector system, camera optics, dichroic installed)
- Ship date slipped to May. Key decision point ahead of 2022B TAC call.
- Existing KCWI pipeline is being adapted for KCRM.

- KPF:

- Current costs are under cost cap. NSF COVID relief supplement received.
- Expect delivery in April 2022 - 3 month slip due to vendor delays.
- Green channel detector system completed, green camera optics arrived.
- Bench: rails aligned perfectly, moves easily in and out of chamber. Ready for optical assembly.
- By March SSC: end-to-end testing, instrument calibration, pre-ship review.
- DRP to be delivered ~6 months after instrument; DRP needs on-sky data

# Major projects update (2)

- Laser frequency comb:
  - Current costs are under cap.
  - Expected delivery in Feb 2022 (no change)
  - 70% of equipment is purchased or in queue
  - Scope changes being considered to better dovetail with KPIC
  - Basement location being prepared
  - KPIC DRP effort will include LFC
- SCALES:
  - PDR to be held Nov 15-16
  - Limited by engineering staff availability
  - Designs accommodate both AO ports
  - Anticipated ship to WMKO in 2025A assuming no funding lapses. WMKO efforts will start primarily in FY23.

# Major projects update (3)

- DEIMOS upgrade
  - Trigger for start of project will be the PO for detectors. Will be a ~2.5 year project.

# AO major projects

- Peter Wizinowich presented
- KAPA (2024) coming on Keck 1
- On Keck 2, HAKA (2026), SCALES (2025?), KPIC2, possible Vis IFS, HISPEC (2025), AO RTC (2022 completed)
- KAPA Hardware:
  - RTC and WFS on Keck 1 being implemented--
  - LGS tomography FY22/23 (4 LGS)
    - Laser tomography asterism generator assembled and to be shipped this month
    - Will be conducting daytime tests for functionality and calibration
  - Near-IR tip/tilt sensing
  - PSF reconstruction (2024)
  - KAPA science (2024)
  - Operations software is in detailed design and is being prototyped
- KAPA performance and science tools in development:
  - ETC, Strehl calculator, DRPs (non-DSI), distortion solution for OSIRIS, PSF-R (below)
  - PSF-Reconstruction has made good progress but not yet applied on sky
- KAPA education program:
  - Interns, visiting scholars, AstroTech students, and postdocs to broaden participation in instrumentation, especially women and underrepresented minorities
- TRICK tip-tilt sensor improves SNR  $\sim 2X$  (to SNR $\sim 50$ ) for GC observations
- KPIC is being expanded with PIAA lenses and FIU completed

# Wide Field Imager review discussion

- Proposal readiness review 8-9 Nov 2021
- Experienced review team: S Kent, H McGregor, V Riot, D Sprayberry
- WFI has completed Phase A design, Review assessed readiness for proposal
- Review recommended proceeding with proposal request after improving costing fidelity
- Major technical recommendations: Pursue widest possible FOV (1 deg), improve throughput budget/model, improve coatings in UV, trace requirements (including DRP) to science case better
- Major technical recommendations: Review optics, CCD, and labor cost estimates, review the risk register and cost impact with quantitative analysis
- Recommendations for progress to PDR: Review tolerancing and gravity impacts, better understand Keck mass limit, add instrument scientist position, complete missing requirements, improve definition of DRP

# AO strategic planning workshop results

- Held Keck AO workshops in enhanced seeing, exoplanets/high-contrast, and OIR universe at high resolution.
- Products: 1. White paper, 2. This presentation, 3. Science case / instrument requirement descriptions using templates.
- Known unknowns: dark matter/energy, compact objects, fundamental physics, solar system, exoplanets
- Unknown knowns: AO for gravitational wave science, time-domain imaging, 3-5x improvement in spatial resolution
- AO landscape: considered AO systems and their science results from Gemini-N, Gemini-S, LBT, Magellan, Palomar, Subaru, VLT, VLTI, ELT, GMT, TMT, JWST, NGRT (a detailed table was shown during the presentation)

# AO strategic planning workshop results (2)

- Enhanced seeing science: Especially noteworthy cases include galaxy evolution (near AGN, mergers, outflows, inflows), M31 and satellites, constraints on dark energy and galaxy evolution from deep spec-z datasets (GLAO/FOBOS).
- Enhanced Seeing Key Findings:
  - strive to be the most efficient facility, do large surveys, with a broad range of wavelength coverage.
  - Strive for complementarity with Roman/JWST.

# AO strategic planning workshop results (3)

- Exoplanet / high-contrast: Science case templates produced; especially noteworthy cases: EPRV discovery of Earth-analogs around Solar-type stars, direct characterization of planets from transits & combined light, worked towards smaller planets (high contrast in the visible/NIR), reflected light characterization of giant planets.
  - Strawman configuration of capabilities in 2035: AO-fed EPRV spectroscopy, high-performance optical AO, Keck playing role in tech development. Core facility: moderate FoV, low-R IFU 2-5  $\mu\text{m}$  & fiber-coupling capability.
- Exoplanet / high-contrast Key Findings:
  - Visible AO (especially post-HST) will enable new science
  - Keck can play a unique role in transit spectroscopy and ERPV with AO-coupled red-optical high-R ( $>\sim 200\text{k}$ ) spectrometer
  - High-performance LGS AO
  - Take a fresh look at interferometry (with fibers/photonics)
  - Have a technology-development platform
  - ASM can help in the 3-5  $\mu\text{m}$  regime

# AO strategic planning workshop results (4)

- OIR Universe Science Cases (especially noteworthy cases listed): SMBH mergers in the NANOGrav & LISA era, dark matter mass function determination from gravitational imaging. Origins, evolution, and demographics of hidden planets and compact objects in the Milky Way. Seasonal evolution and storm systems on gas giant planets (+Titan).
- OIR Universe key findings: cadence, time domain, and large samples are competitive advantages. Shorter wavelengths important. Needs: high coverage, modest corrected fields (~30" fields), new instrumentation (visible imager and IFU).
- Astro2020 report relevant AO highlights: US-ELT program (with AO). Tech development (AO called out). Augmentation of mid-scale investments (AO called out).
- Astro2020 OIR panel report also called out need for AO support
- Overall recommendations from AO workshop:
  - Use AO to enhance competitive advantages in cadence, time domain, and large samples
  - Use Keck AO to support ELT/space mission for risk reduction technology demonstrations
  - AO in the visible
  - Improve overall efficiency through GLAO-enhanced seeing

# March meeting logistics - planning for instrument reports

- The board would like an extra half/full day, moving the SSC meeting in Hawaii on March 8 and 9 2022. Final dates to be defined in the next days.
- The SAs will present the instrument status, risk status, DSI status.
- There is possibility for a summit site visit on March 7th - Logistics would need to be coordinated.

# KPF Cadence Discussion

- Presenter: Erik Petigura
- KPF Cadence working group was charged with developing recommendations to implement a cadence/queue strategy to optimize KPF science return.
- Report was delivered to the SSC in November.
- Points of discussion:
  - Need better estimates of impacts on (1) observatory, (2) non-KPF science and observers, (3) lost/gained observing time for other programs, (4) development costs of software.
  - Need to expand the “simulated semester” to include impact to other science programs/calibrations.
  - Current cost of CPS (in regular operations) is ~1 FTE + volunteer observers.
  - Impact to observatory operations (particularly OAs) needs to be explored.
- General interest and agreement that the science case for the cadence strategy is strong.
- WMKO will convene a modified working group to study implementation and costs, impacts on WMKO operations, and impacts on other non-KPF science programs.
- Strategic planning discussions should consider whether it would be advantageous to develop queue software in a way that could be used for other instruments in the future.

# Keck Strategic Plan: December meeting planning

- June meeting of SSC: discussed global strategy & community outreach
- Sept: presentation at Keck Science Meeting + half-day splinter session
- End of Nov: white paper deadline
- Dec 6-8: in-person strategic planning retreat of SSC and ~10 others
  - Consulting with Stylus Group about planning & outreach
- Mid-Jan. deadline for additional input from Keck community
- Feb 2022: major drafting of text
  - Exact process / people TBD. SSC recommends discussing this at December meeting.
- March 2022: presentation to SSC & Board of major points
- SSC should review the plan prior to submitting it to the Board
- July 2022: final written report done for Board approval
- Summer 2022: circulation to community