

Keck SSC Meeting Notes

2021 May 21

Meeting held via Zoom

Announcements and Review of Actions

- SSC welcomes its new members:
 - Jessica Lu from UC Berkeley
 - Vicky Kalogera from Northwestern

Observatory Report

- Keck is planning “full” (~90%) staff returning to site on June 1, with COVID safety mitigations and IT infrastructure upgrades in place
- Expect Full VSQ availability in 2021B; developing testing & vaccination rules
- Anticipate lifting ToO restrictions (currently the live instrument only) in 2021B
- Instrument issues being watched:
 - DEIMOS CCD5B alive but noisy; KCWI dewar leak; NIRSPEC coadd and SCAM L'M' ghost issues, occasional LRIS grism and grating move faults
- LRIS Red CCD upgrade has been commissioned on-sky; available as of 5/7
- Keck Science meeting Sep 9 – 10 at UCSD + hybrid format (zoom + slack)
 - <https://kecksciencemeeting.org>
- KAPA LGS project is moving forward well; RTC I&T this year
- LFC (laser frequency comb) for NIRSPEC/HISPEC going well; funding in-hand
- SCALES PDR in Fall 2021, detectors from JWST, most funding is in-hand
- Data Services Initiative work ongoing, with new hardware capabilities
 - DRP work on DEIMOS quicklook first. MOSFIRE and NIRES to follow DEIMOS
 - KCWI python pipeline released
 - KOA interface and data transfer time improvements
- Keck DEI efforts expanded to outreach and internships for Hawaii college students; also leadership development for under-represented employee groups; DEI committee looking at other efforts

LRIS

- **Hardware:**
 - Replaced mosaic of 2k by 4k of red-sensitive CCDs with one 4x by 4k CCD.
 - Thicker, 60% QE at 1 μm , less fringing. Purchased along with CCD for KCRM, installed in existing cryostat from original LRIS red upgrade. New mount.
 - New Archon CCD controller from STA. No more RTC, interface board, bus. Same controller is being used for KCRM and KPF.
 - Preamp and cabling shared development and testing with KCRM.
- **Software:**
 - New LRIS Archon CCD controller code. New KTL dispatcher. Functionality to change readout configuration (binning) without reloading Archon config file (power cycling CCD). Significant development.
- **Operations:**
 - New keywords, commonality with new KCRM. New observing/support scripts. LRIS now uses a mix of Solaris and Linux. System functional but not yet optimized. Some modes need additional development.
- **Status:**
 - System delivered was usable, but not yet stable, in order to meet April installation window. Installed in LRIS 4/20-22. 3x half nights of engineering time, on-sky for observing since May 7.
 - Peak-to-valley focus is 63 μm , FWHM at best focus 3.6 pix = 0.44 arcsec. P-V focus range adds 0.16 arcsec to FWHM.
 - Read noise $\sim 3.5 e^-$. Gain $\sim 1. e^-/\text{ADU}$. Read times 45 sec (1x1 binning 4 amp, 2x1 binning 2 amp), 23 sec (bin 2x2, 2 amp)
 - Dark current $\sim 4 e^-/\text{pix}/\text{hr}$, likely contaminated and will re-measure. Expect $\sim 1 e^-/\text{pix}/\text{hr}$
 - Cosmic ray rate similar to previous array, needs more testing.
 - Flat fields show no fringing
- **Work in progress:**
 - CCD control improvements, robustness between Archon and KTL dispatch, saturation recovery. All software improvements.
- **Longer term:**
 - Optimize read noise, speed, tuning charge diffusion, "fast" mode, flexible window mode, sparing
- SSC thanks and congratulates the team for their hard work on this project

KPIC

- Dimitri Mawet presented (KPIC=Keck Planet Imager and Characterizer)
- $R > 30,000$ is goal (instrument paper Delorme et al 2021)
- K-L wavelength range
- System throughput $\sim 3\%$, with $\sim 40\%$ injection/propagation efficiency
- DRP built from scratch for the KPIC mode of NIRSPEC, making good progress.
- Data for HR7672 B look very nice
- Also HR 8799 bcde detections - many more substellar companions observed successfully.
- KPIC phase II coming end of 2021/early 2022 - adds ADC, high order deformable mirror (1k), beam shaping apodizers, fiber nulling coronagraph, using LFC
- Details of software facilitization given by Tobias Schofield

KPF

- Overall status update
 - Expected first light summer 2022.
 - Many large procurements complete; nearly all subsystems in procurement. Some COVID impacts, being tracked.
 - Assembly, Integration, Testing started April 2021. COVID impacts tracked.
 - Detailed planning on-going
 - Assembly+Integration: late primary collimator; Testing at SSL and commissioning; Detector testing: accommodate busy UCO detector lab (LRIS/KCRM), switch to STA/CIT; Community cadence meetings bi-weekly: expected SSC presentation in Nov.; Operations: planning for WMKO ops, calibration sequences, data flow, KOA integration, etc.
- Progress on individual subsystems
 - Vacuum chamber received, preliminary pump verification complete; cleanroom assembly ~75% complete; fit check of double scramblers with vacuum flanges complete
 - Zerodur bench received at UCB/SSL in April, very few defects (non-critical), zerodur echelle mount received, camera mounts shipping in June, waiting for mechanical fixtures.
 - Fiber system nearing completion; reformatter block #1 complete, good performance; most fibers fabbed; agitator assembled; scramblers assembled and fit-checked, performance testing ongoing.
 - Fiber injection unit Delta PDR on redesign in 2020. Mechanical peer review in April. New optical layout is coplanar; K1 or cal light feed science path, Ca H+K path, guide camera path.
 - Optics and ancillary systems: cal unit opt-mech assembled, alignment soon; exposure meter assembled; primary collimator polishing ongoing; secondary collimator received; progress on coatings for major optics; dichroic received, did not meet crossover wavelength spec, but accepted after science impact assessment (2% reduction in photon-limited Doppler precision) and consideration of cost/schedule impacts.
 - Cameras and reformatter: Winlight, schedule concern. Developed alignment plan for late delivery. Reformatter block #2 manufacturer re-work. Camera assembly proceeding at Winlight. Grism assemblies inspected at SSL and shipped to Winlight for camera integration.
 - Detectors: Red CCD received by STA. Green CCD expected by end of month. Initial testing of Red shows excellent cosmetics, other performance tests promising and ongoing. Additional testing at Caltech (Roger Smith) in ~weeks. Thermal/mechanical cryostat cold testing.
 - Laser Frequency Comb: Menlo systems on schedule, milestone #2 reached, on-track for shipment end of July.
 - Ca H+K spectrometer: optical design review in Feb. 3x improvement over PDR design; mechanical design review held April 2021. Procurements underway.
 - Solar calibrator: baselined for testing at SSL, under consideration for ops at WMKO. Feeds KPF with sunlight for investigation/calibration of stellar variability.
 - DRP: passed v1 milestone (~20 cm/s). NEID spectral analysis. Held bootcamp. Developing V2 testing on simulated KPF data. Expect to analyze real images in summer.
- I&T schedule, four critical paths: 1) reformatter delivery, 2) CCD deliveries, 3) coating of secondary collimator and red fold, 4) primary collimator polishing/coating.
- Risks actively tracked monthly, presented leading risks and mitigations.

KCRM

- Adding red channel and new guider to KCWI
- 8 subsystems: 5 developed at COO (Flat mounts, grating exchanger, articulation stage, optics, software), 3 by partners (guider- WMKO/OMP, Camera- Winlight, Detector- UCO)
- Status: nearing end of full-scale development phase and entering AIT. All major purchases received.
- Remaining technical risks: lens coatings, cryostat design, nod & shuffle
- On track for commissioning in July 2022 (5 months behind baseline target due to COVID-19)
 - Delivery of camera and detector system on critical path
 - Decision when to take KCWI off sky for KCRM integration to be made by August 4, 2021
- Guider subsystem: completed at OMP and in transit. Successful pre-ship review in March. Guider flange was checked at observatory.
- Camera subsystem (Winlight): scheduled to arrive at Caltech in October
 - Field flattener coatings were below spec. Stripped and recoated one lens.
 - Worked with Winlight to improve coating and testing processes.
- Detector subsystem (UCO): scheduled for October delivery.
 - Focus stage being tested. Nod & shuffle assembly nearly complete.
 - Cryostat: fabricated at Universal Cryogenics, delivered to UCO
 - Redesign effort completed to fix a leak that could have allowed charcoal particles to reach detector
 - Cryostat being reassembled in Santa Cruz
- AIT is commencing in Caltech Synchrotron building

KCRM

- Detector subsystem:
 - Spare detector array was used for LRIS red channel upgrade
 - Reduced risk to KCRM thanks to LRIS upgrade
- Red grating exchanger (REX) subsystem: passed thermal testing at Caltech. Scheduled for delivery to AIT in June.
- Gratings: all 7 VPH gratings have been received and approved, staged for bonding
- Red articulation subsystem (ART): passed module-level testing at Caltech, being handed off to AIT
- Fold mirror: bonded to frame at Caltech. FM2 subsystem will be delivered to AIT after final inspection.
- Dichroic: received and approved at Caltech. Preparing for bonding with dummy optic. Dichroic subsystem to be delivered to AIT in June.
- Clean tent prepared in Caltech synchrotron building. Proxy bench assembled.
- COVID impacts: restrictions began March 2020. Resulted in about 5 months in project delays, loss in efficiency, some unplanned purchases. Current situation rapidly improving.
 - Winlight is in early stages of relaxing restrictions in France.

Adaptive Secondary Mirror for Keck

- ASM can broaden use of AO for observatory:
 - GLAO (FOV ~ 4-10')
 - Higher order AO (~40 actuators across the diameter)
 - Low background AO for thermal IR (e.g. exoplanet studies with SCALES)
 - MCAO (FOV ~ 1', need 2nd DM conjugate at ~15 km)
 - Potential image quality improvement for all instruments
- On-sky GLAO demonstrations at UH88, VLT & LBT show image improvement
- GLAO requires large subsystems: {ASM} + {laser projector & WFS for wide FOV} + {suitable instrument (MOSFIRE? LRIS2? FOBOS(-IR)?)}
- Standard ASM design based on voice coils attached to glass shell (e.g. LBT)
- New design by TNO (Dutch company): hybrid variable reluctance design
 - linear response, ~75x less power needed & ~10x max force compared to standard design
 - easier to cool, easier to fabricate, no need for high-speed positional sensing.
 - hoping for lower cost & easier operation - studies underway at UH (0.6m mirror for UH88) and UCSC (0.15m prototype in lab).
 - UH88 planned to be on-sky in summer 2022, then integrate with GLAO system `imaka.
- Current trade study for Keck: f/25 secondary top end
 - Mounted on hexapod to allow for telescope focal plane adjustment
 - Decided on 2000 actuators (balance of weight, sheet thickness, fitting error, etc.)
- Completing ASM concept study, planning for Phase A study

Keck AO Future Study Group Report

- AO Future Study Group (FSG) has been interfacing with Adaptive Secondary group.
- FSG Viewpoint: ASM should be driven by GLAO science, and not so much by diffraction-limited AO science, though it offers lower thermal background if instrument at direct focus. Costs should include ASM asterism, WFSs per/inst.
- Need to compile and assess GLAO science case for ASM. In addition to FSG input, this will require other science and instrument expertise for instruments that might be used with GLAO.
- AO strategic planning: looking for SSC input on FSG role.
Questions: Landscape, science/technology in 2035?

ORCAS - Orbiting Configurable Artificial Star

- Idea: satellite points laser at Maunakea for use by AO systems at WMKO
- Push AO down to shorter wavelengths; fully sky guide star availability; 29th mag (10-sigma) in 1 hr; high resolution (13 mas @0.5 um) -- beats Webb, HST, Roman; photometric calibration to 0.1%.
- Visible AO can beat space sensitivity because aperture advantage beats ~5X increased background from ground.
- Instrument: Mag 0 star at 532 nm or 1064 nm. LEDs for photometric calib.
- Highly elliptical orbit (P=5 days); stationary for 0.6-4 hr
- Need new AO system at Keck: Strehl ~0.5 at 0.5um (goal)
- Feasible now because: commercial spacecraft buses available, commercial laser beacons, ride share possibility, high altitude GPS.
- ORCAS team has carried out detailed planning on how to model orbits and target visibility, and to optimize long-term scheduling efficiently
- Science team desires: diff-limited camera (0.45-1um), FOV=10x10 arcsec; IFU (0.5-2um and low-res) and IFU (0.4-0.9um and higher-res)
- Timeline: completed engineering study; report was due June 21; Keck teams to study instrument concepts; gain Goddard support for proposing; propose to SMEX in 2023?; launch readiness (2029?) followed by science.

White Paper / Phase A Proposal Call Discussion

- Marc will prepare Q&A spreadsheets to SSC members and PI/team prior to July/7 meeting. Google forms for ranking and discussion being prepared. The forms will permit providing endorsements (\$ and nights) for each project.
- Types of proposal for the white paper call: Concept studies (~75K), Phase A design (~250K), Mini grants, proposal developments
- Call on May/24, SSC review on July/6-7 2021 - Draft call already drafted.
- A WP template has been developed to assist proposers in providing all the needed and important information required for the review.

Instrument Risk Metrics driven by NASA IKUG

- Use instrument age as a proxy for risk
- LRIS/HIRES are 28 years old
- KII: mid- to young-generation instruments
- Marc Kassis proposed a risk matrix of costs vs age (or likelihood vs severity)
 - Costs represents day crew time
 - Night-time science loss is not included in the matrix
 - Highest-risk instruments are DEIMOS, OSIRIS, NIRSPEC, and LRIS (high likelihood & high severity)
 - Global instrument risk difficult to address. HIRES has highest severity but lowest probability.
- Important to incorporate this information in instrument retirement planning
- November SSC meeting will include risk assessment for each instrument
- Also should include KI and KII AO systems on the risk matrix
- Could try to get information on detector failure risk for specific detector fabrication runs

Strategic Planning Update

- Envisioning a multi-step process with a relatively short timeline.
- Step 1 (mid-June): Definition of categories (science and capability driven) and of scope. O'Meara to provide perspective on key questions. SSC participants to make recommendations on community engagement. 1-day meeting.
- Step 2 (late-June⇒ Aug): Solicit community involvement (via surveys, short white papers, workshops). WMKO organization. Participants defined in Step 1.
- Step 3 (Aug⇒ Sep): Refinement by SSC of community input. Determine common themes, explore interesting edges, understand spectrum of inputs. Deliverables are topics and writing assignments for WPs to deliver to WMKO
- Step 4 (Sep⇒ Oct): Writing, beginning with the WPs but combined with other stakeholder inputs to draft strategic plan text. Deliver draft strategic plan text.
- Step 5 (Nov): Review and endorsement at regular SSC.
- Note that this process describes only the Scientific part of the SP. Other parts will come from WMKO staff and from consideration of external issues.
- SSC (and WMKO) should be cognizant of any boundary conditions.

Keck AO Users Community Workshop

- June 4 virtual workshop: focus is on current Keck AO operations & performance (only - no future AO items).
- Open to the whole community. Invitation sent to all the Keck AO users and scientists/engineers working on AO telemetry.
- A report / summary / white paper will be prepared and submitted to the Keck SSC.