

NGAO Keck 1 Upgrade Path Architecture

Concept Summary
Reuse existing Keck 1 AO system feeding NIR Imager & IFS, Vis Imager & IFS, possible High-contrast instrument, and d-NIRI as exchangable scheduled instruments (current instrument switch model)

Interferometer Support
Keep current AO systems in place for KI

Lasers
Single laser lab with 9 20 W CW Na D2 line lasers (w/ arbitrary # of d-NIRI IFU channels)

Laser Launch Telescopes
Reuse existing K1 on-axis LLT (as modified for multiple LGS broadcast)

Beam Transfer System
1 Hollow-core photonic crystal fiber per laser beam Bundle run of 15 fibers (w/ spares) Approx. 30 m run Transmission (589 nm) > 0.71 Top-end laser diagnostics package

Real-Time Controller
Single Tomograph RTC Must handle up to 9 x 64 x 64 HOWFS input and (4+N) x 64 x 64 DM cmd outputs (more if HOWFS have MEMS DM's)

PSF Calibration System
Patrolling camera(s) Spatial pick-off in Nas focal plane (some field blocking okay) Detectors TBD or could be Built into dNIRI as d-Imager Detectors TBD

Field Rotation
Large out-front K-mirror derotates field Pupil allowed to rotate, reconstructor updated continuously

Optics
Relay passes has unvignetted FoV of at least 120" (TBC) Pupil size 140 mm diameter Space for WFS packages and certain instruments (e.g. dNIRI) may be a strong restriction on the design

Laser Guide Star Asterism
Narrow-field 6 Na beacon asterism 1 @ field center, 5 on fixed pentagon of radius 12" and 3 Na beacons for 2 TT, 1 TTFA LOWFS LGS pointed toward LOWFS stars Wide-field 9 Na beacon asterism Evenly distributed over 120" diameter FoR

Deformable Mirrors
Keck 1 1 x 48 x 48 actuator MEMS DM 140 mm pupil diameter (same as current K1 AO) 2.97 mm pitch (can we achieve 4um surface stroke with this pitch?) dNIRI N x 32 x 32 d-NIRI MEMS Modest stroke requirement - only handling isoplanatic component of wavefront

Tip/Tilt Correction
Keck 1 Existing SiC tip/tilt mirror dNIRI Tip/tilt control within each d-IFU channel

HO Wavefront Sensors
Narrow-field 6 LGS asterism sensor package Full-field dichroic pick-off after K1 relay Anisoplanatic linear range or Go-to MEMS correction in HOWFS dNIRI 9 LGS asterism sensor package Full-field dichroic pickoff after K1 relay

LO Wavefront Sensors
Narrow-field or dNIRI 2 TT + 1 TTFA + TWFS Spatial pick-off in Nas focal plane in annulus 10" < radius < 90" NIR TT ROI Trackers NIR 2x2 subap Pyramid 64 x 64 MEMS correction in TT, TTFA WFS 8 x 8 subap (slow) visible S-H Truth WFS (20 sec exposure)

Wavefront Sensor ACQ
General 2k x 2k NIR camera and 2k x 2k CCD Calibrated offset to sci instruments allow use of same cameras for sci acquisition dNIRI Above, plus dNIRI metrology system