

# NGAO Two-Telescope AM2 + Narrow FoV Relay Architecture

Concept Summary	
Narrow-field	Narrow-field optimized small relay on Keck 1 feeding NIR Imager & IFS, Vis Imager & IFS, possible High-contrast instrument & AM2 on Keck 2 feeding d-NIRI, possibly a NIR GLAO camera, possibly legacy instruments

Interferometer Support	
Repackage the existing AO systems into a new Nasmyth basement on each of Keck 1 and Keck 2	

Lasers	
Single laser lab with 8 20 W CW Na D2 line lasers (supports up to 6 d-NIRI IFU channels) Switchable inputs to either Keck 1 or Keck 2 BTO fiber runs	

Laser Launch Telescopes	2 (one per Keck)
Narrow-field	On-axis projection 50 cm diameter
Wide-field	On-axis RC telescope design Two-mirror transmission > 0.85 Asterism counter-rotates on the sky to negate field rotation

Beam Transfer System	
Narrow-field	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	
Narrow-field	Single Tomograph RTC Must handle 6 x 64 x 64 HOWFS input and 4 x 64 x 64 DM cmd outputs
Wide-field	One independent RTC per d-NIRI channel Each must handle 1 x 32 x 32 HOWFS input and 1 x 32 x 32 DM cmd output

PSF Calibration System	
Narrow-field	Identical copy of science relay 5" unvignetted FoV Spatial pick-off in Nas focal plane in annulus 10" < radius < 90" (could be part of LOWFS subsystem) Detectors TBD
Wide-field	Patrolling camera(s) Spatial pick-off in Nas focal plane (some field blocking okay) Detectors TBD

Field Rotation	
Lots of 'barrel rotators', for each sensor package & instrument (EI bearing flange to focus distance ~1.767 m helps packaging)	

Optics	
Narrow-field	Refractive Relay 20" unvignetted FoV Maintained at -5C relative to ambient temperature
Wide-field	AM2

Laser Guide Star Asterism	
Narrow-field	6 Na beacon sci asterism 1 @ field center 5 on fixed pentagon of radius 12" and 2 Na beacons for 1 TT, 1 TTFA LOWFS LGS pointed toward LOWFS stars
Wide-field	1 Na beacon per d-NIRI target + 2 Na beacons for 2 TT Each LGS pointed directly at d-NIRI science target LOWFS LGS pointed toward LOWFS stars

Deformable Mirrors	
Narrow-field	1 x 64 x 64 actuator MEMS DM 25.2 mm pupil diameter 400 micron pitch Hermetic seal DM window
Wide-field	AM2 N = 32 actuators across telescope pupil Diameter ~ 1.456 m Final focal ratio = 15.41 (to provide M3 - focus distance of 8 m)
Narrow-field	and N x 32 x 32 d-NIRI MEMS
Modest stroke requirement - only handling isoplanatic component of wavefront	

Tip/Tilt Correction	
Narrow-field	Fast tip/tilt mirror 25 mm pupil diameter
Wide-field	AM2 tip/tilt & 2nd-stage tip/tilt embedded within each fed instrument (if needed)

HO Wavefront Sensors	
Narrow-field	6 LGS asterism sensor package Full-field dichroic pick-off before relay Full atmospheric linear range or Go-to MEMS correction in HOWFS
Wide-field	8 LGS sensors Full-field dichroic pickoff before instruments

LO Wavefront Sensors	
Narrow-field	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)
Wide-field	1 TT + TWFS Spatial pick-off in Nas focal plane (some field blocking okay) NIR TT Tracker 32 x 32 MEMS correction in TT WFS 8 x 8 subap (slow) visible S-H Truth WFS (20 sec exposure)

Wavefront Sensor ACQ	
Narrow-field	2k x 2k NIR camera and 2k x 2k CCD Calibrated offset to sci instruments allow use of same cameras for sci acquisition
Wide-field	2k x 2k NIR camera and 2k x 2k CCD Calibrated offset to sci instruments allow use of same cameras for sci acquisition and dNIRI metrology system