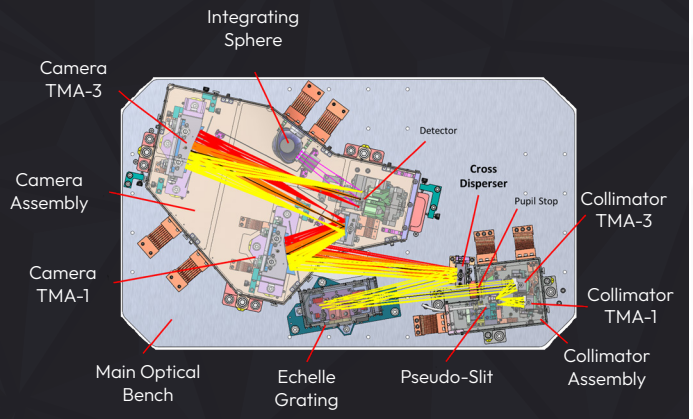
MODHIS

MULTI-OBJECT DIFFRACTION-LIMITED HIGH - RESOLUTION INFRARED SPECTROGRAPH

- Combines TMT aperture, adaptive optics, and single mode fibers for ultra-stable spectroscopy
- Light is AO-corrected by NFIRAOS and injected into fibers at the Front-End Instrument (FEI)
- Fibers deliver light to a dual-arm cryogenic spectrograph on the Nasmyth platform
- Red and blue channels cover the 0.98–2.45 μm range with high thermal stability
- Calibrated with a laser comb, etalon, and gas cells to achieve very high RV precision

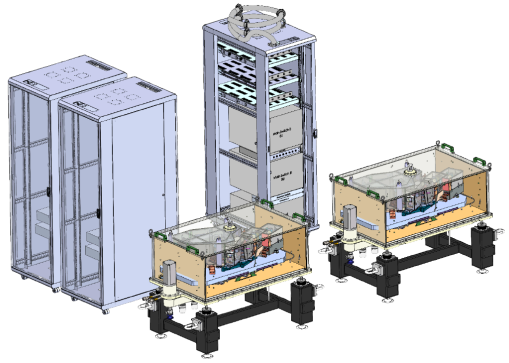


The optical layout of the Red Channel Spectrograph

MODHIS

Design Status

MODHIS entered the Preliminary Design Phase in the fall of 2025. The MODHIS spectrograph is identical in design to **Keck Observatory's HISPEC** which is in fabrication now, and will build on its heritage and reduce risk and cost. MODHIS is targeted for early science with TMT, delivering transformative capabilities from day one.



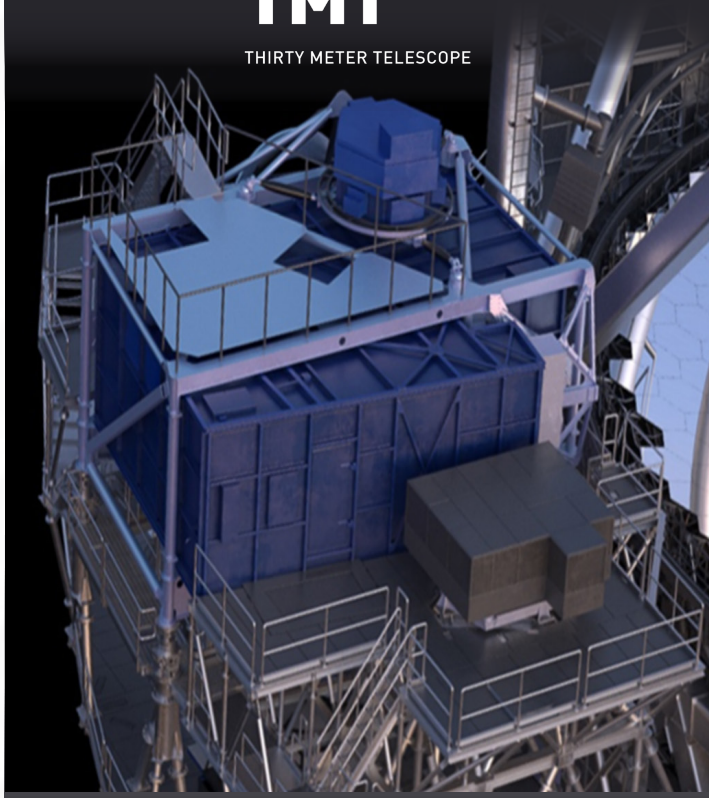
The fiber-fed red and blue MODHIS spectrographs will sit on TMT Nasmyth platform close to NFIRAOS and MODHIS top end instrument.

- Principal Investigator: Dimitri Mawet
- Co-PI: Michael Fitzgerald
- Project Scientist: Quinn Konopacky
- Project Manager: Mojtaba Taheri

Learn More About
TMT Instruments

Caltech | UNIVERSITY OF CALIFORNIA

TMT
THIRTY METER TELESCOPE



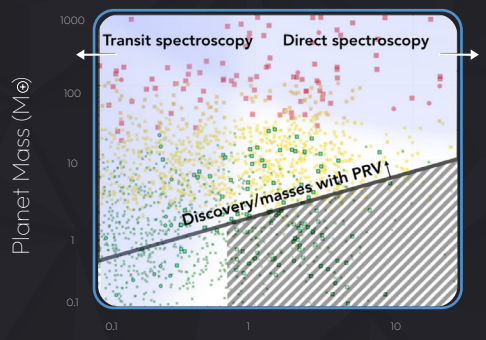
MODHIS

Unraveling the Chemistry and Motion of Distant Worlds

Canada NRC·CNRC | UNIVERSITY OF CALIFORNIA | Department of Science & Technology, Government of India | NINS National Institutes of Natural Sciences 自然科学研究機構 | Caltech

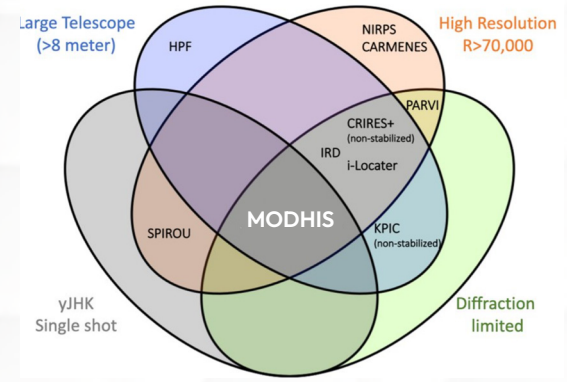
MODHIS
Science Highlights

- Characterizes Exoplanet Atmospheres by detecting faint molecular fingerprints (e.g., H_2O, CH_4, CO_2)
- Analyzes Directly Imaged Exoplanets, measuring winds, rotation, and atmospheric structure
- Detects Protoplanets using fiber-based starlight suppression at the diffraction limit
- Maps Solar System Bodies, resolving molecular species and isotopic ratios in atmospheres and icy surfaces
- Measures Stellar Orbits around the Galactic Center black hole to probe extreme gravity
- Enables Earth-mass planet detection with radial velocity precision down to ~30 cm/s



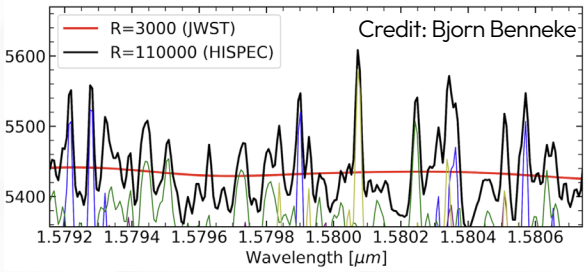
Semi-Major Axis (AU)

MODHIS potential exoplanet discovery and characterization space. Points are marked red for giant planets, orange for Neptunes, yellow for mini - Neptunes, and dark and light green for super-Earth and Earth-size planets.



MODHIS has a unique combination of instrument capabilities.

- **Brown Dwarf Characterization:**
  Analyze atmospheric compositions, temperatures, and dynamics of brown dwarf
- **Stellar Physics and Chemistry:**
  Investigate stellar compositions and magnetic activities, providing insights into stellar life cycles



Simulated transmission spectra of a typical 500 K sub-Neptune exoplanet at MODHIS's native spectral resolution. At the comparatively coarse resolution of JWST-NIRSpec (red curve), the spectral lines of H_2O (blue), NH_3 (green), and H_2S (yellow) are all blurred. MODHIS's high resolving power (black curve) will reveal their individual contributions and relative abundances.

MODHIS
Driving Requirements

Spectral Resolution	R ≥ 100,000
Wavelength Coverage	0.98 – 2.45 μm (Y–K bands)
MODHIS Throughput	>25% in Y-J channel >15% in H-K channel
Radial Velocity Precision	≤ 30 cm/s (internal)
Limiting Magnitude (1 hr, S/N ~10)	H ~ 19 mag
Adaptive Optics Feed	NFIRAOS (Laser and Natural Guide Star compatible)
Fiber Injection	Single-mode; >50% coupling efficiency
Calibration	Laser frequency comb, etalon, gas cell
Detectors	Two H4RG NIR arrays (4k × 4k)
Sky Coverage	>50% at high galactic latitudes