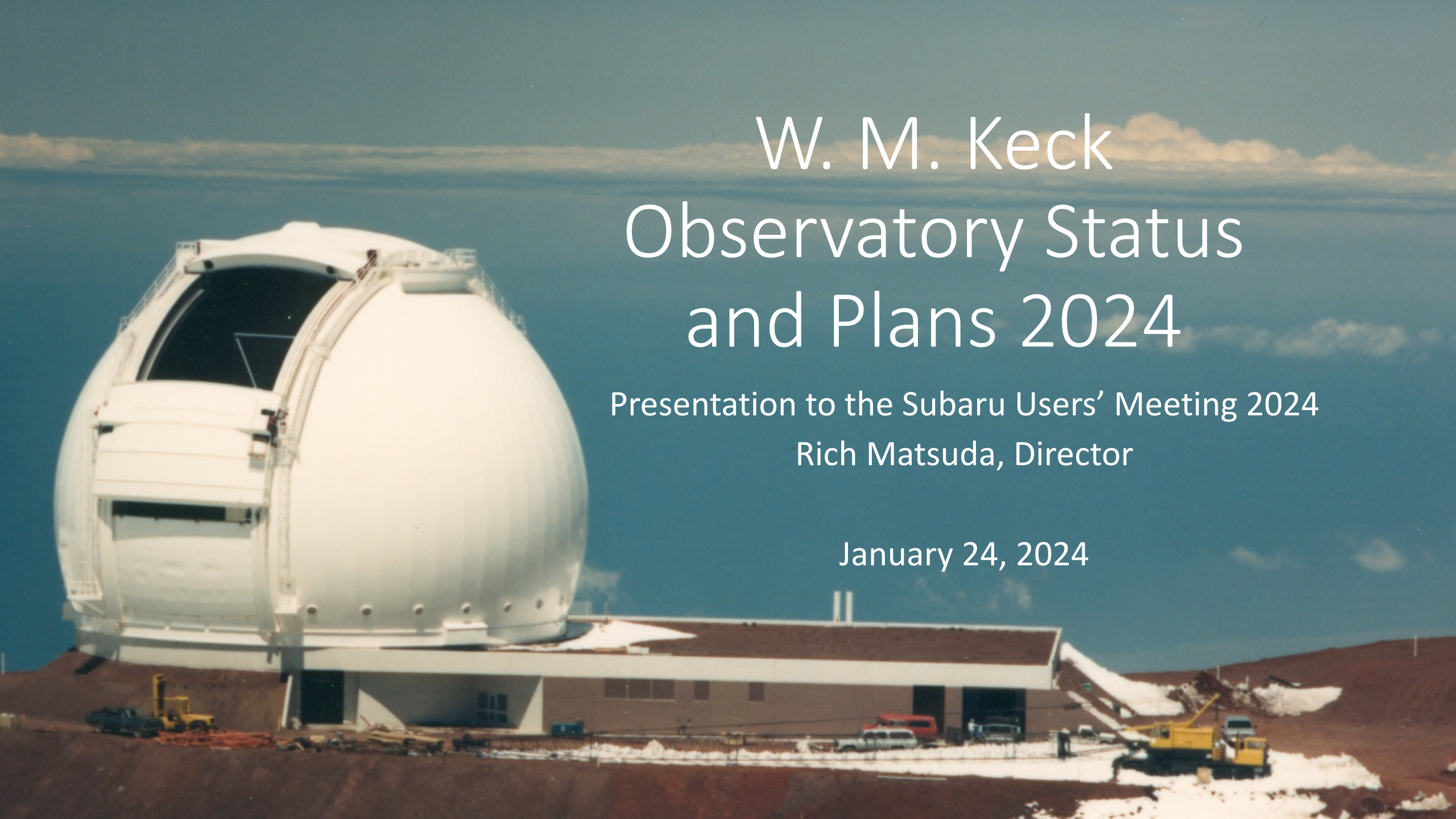


W. M. Keck Observatory Status and Plans 2024

Presentation to the Subaru Users' Meeting 2024

Rich Matsuda, Director

January 24, 2024

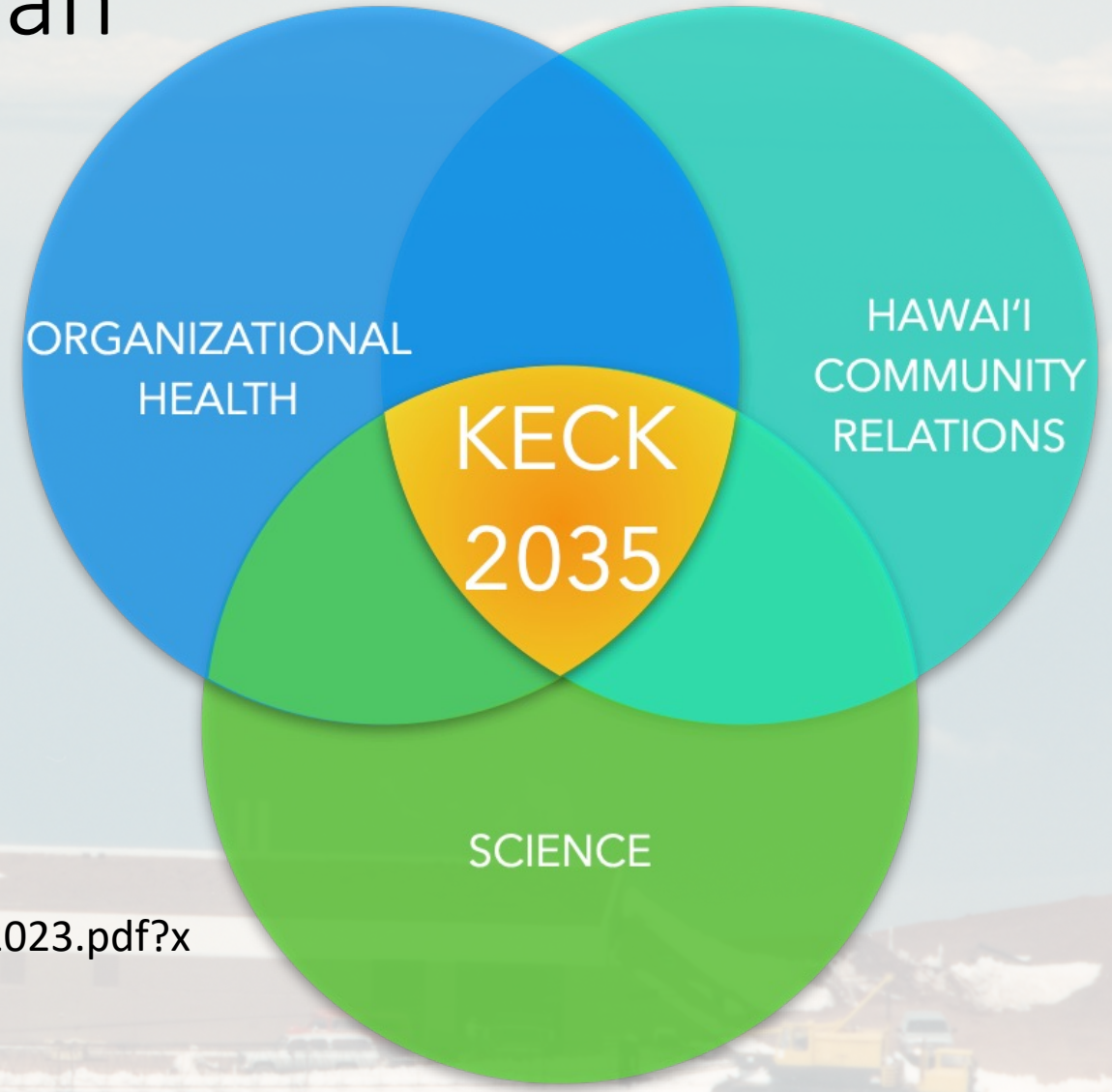
Deputy Director and Chief Scientist

Dr. John O’Meara

30th Anniversary of Keck Science

Keck 2035 Strategic Plan

https://keckobservatory.org/wp-content/uploads/2023/10/Keck2035_StratPlan_Oct2023.pdf?x28797&x60674



Keck 2035: Organizational Effectiveness

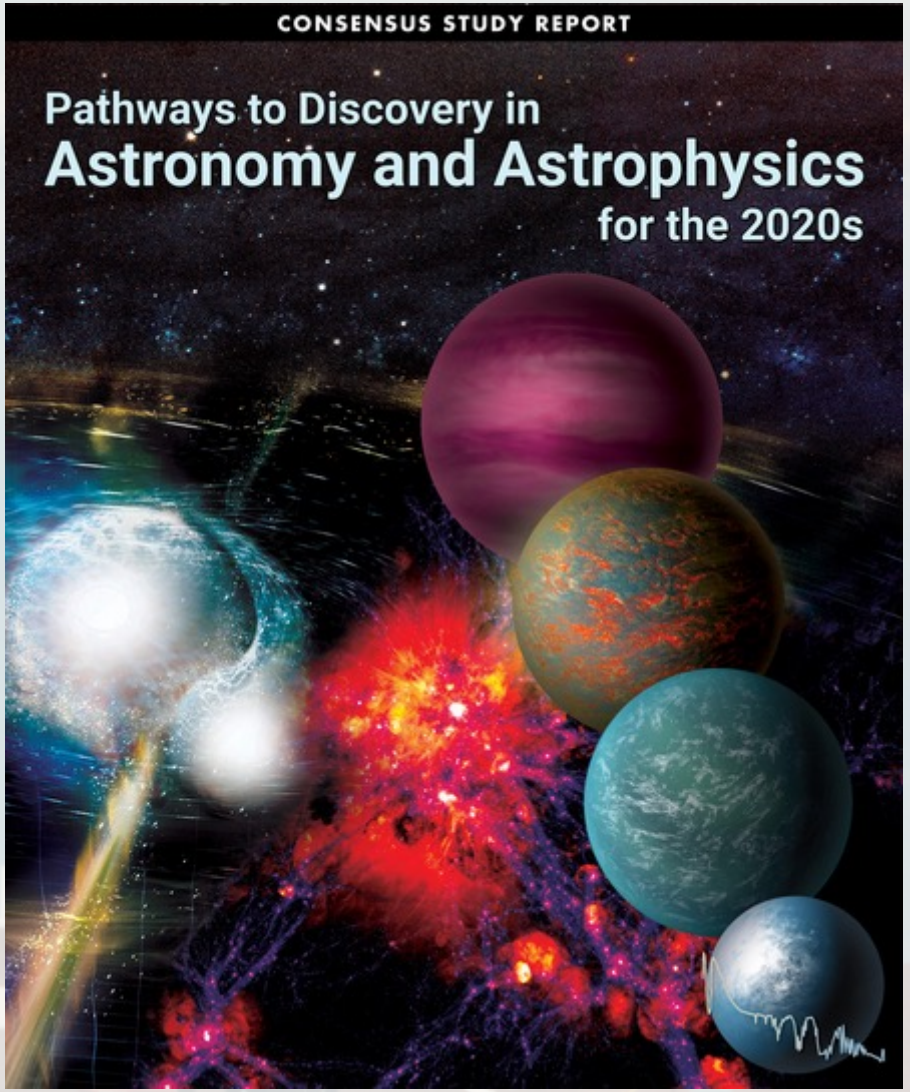
- **Be an Employer of Choice**: retain and recruit the best from Hawai‘i and beyond (comp/benefits, career development, flex work)
- **Be a Leader in Organizational Health:** foster an inclusive, effective organization that empowers staff at all levels (DEIA, communication, supervisory training/mentoring, leadership dev, eliminate barriers)
- **Operate Sustainably**: Focus on economic, technical, and environmental sustainability (technical, economic, environmental)
- **Build our Workforce:** Focus on strength in areas of critical need and drive to be Hawai‘i -centered (partner with UH+, workforce pipeline, internships, STEM curriculum, STEM outreach)

Keck 2035: Hawai‘i Community Relations

- **Reciprocal Relationships**: Prioritize relationships, serve as a community resource
- **Maunakea Governance**: Support the MKSOA, and secure a new lease
- **Environmental Stewardship**: Stewardship of Maunakea above and beyond compliance
- **Hawai‘i-Grounded**: Strengthen WMKO’s Hawaiian foundation
- **Leadership**: Lead adaptive change, tell our stories
- **Science Engagement**: Build stronger astronomy interest in Hawai‘i

Astro 2020 Community Astronomy Model

- **Listen and Empower** – Assure all stakeholders are heard. Empower the local community with at least partial control. Give community a seat at the table.
- **Aim to do Good for All** – Adopt a higher standard than minimum legal compliance. Beyond scientific benefits, add human value – educational, cultural, economic. Make difficult choices, be open to alternative solutions that optimize more than science alone.
- **Invest in the Future Together** – Cannot change past but can make effort to work in partnership with communities to create long-lasting mutual benefit and respect for diverse ways of knowing.



Mauna Kea Stewardship and Oversight Authority (MKSOA)

- In 2022, State of Hawaii created MKSOA – community-based management of Maunakea. MKSOA will determine future observatory leases.
- Per Act 255: "Astronomy is a policy of the state" (i.e., a priority)
- 12-person board includes 8 Native Hawaiians including Cultural Practitioner and Lineal Descendant (*Astro2020 – Listen and Empower*)
- 7 board members are residents of Hawaii Island
- 1 board member represents astronomy – WMKO director Rich Matsuda
- Five-year transition to shift authority from University of Hawaii to MKSOA

Community Relations Approach

Respect for Maunakea

- We prioritize and exceed regulatory compliance, and we are gradually and respectfully incorporating observance of Hawaiian culture into our conduct on Maunakea.
- Examples shown: WMKO staff volunteerism on Invasive Species Removal and Native Forest Restoration on Maunakea, Orientation video for workers on Maunakea.

Building Relationships

- We prioritize building healthy relationships, mutual understanding and collaboration, regardless of one's perspectives about astronomy on Maunakea. We work shoulder-to-shoulder with community to uplift the community.
- Examples shown: Assisting with Food Insecurity; Solar System Walk; Monthly Family Foodtruck Friday's at WMKO Headquarters campus;

Operating in a Hawai‘i-Rooted Way

- We align our values and conduct in harmony with Hawai‘i. The staff reflects the community we live in. We integrate Hawaiian knowledge, culture and customs into how we conduct astronomy, and we share our approach with the world.
- Examples shown: ‘Oli protocol to open Keck Science Meeting; Kama‘āina Connections Program leadership development program; UH College of Engineering Career Fair

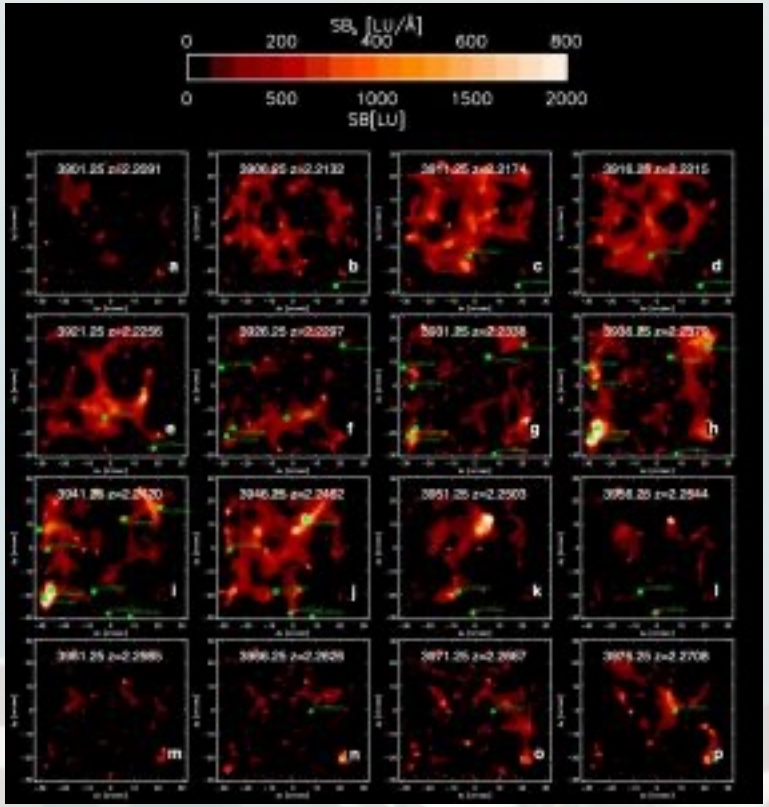
Keck 2035: Strategic Plan for Science

- Leverage the landscape
  - Update instrumentation and data infrastructure to match the evolving ground & space landscape
  - Incorporate new observation modes
- Grow Scientific Leadership
  - Bring state of the art new instrumentation online
  - GLAO and visible AO development and implementation
- Harvest Innovation
  - Partner w/ ELT and NASA missions on technology maturation w/ Keck use
  - Invest in early-phase development of AO and instrumentation robustly

Science Highlights

The Cosmic Web Revealed

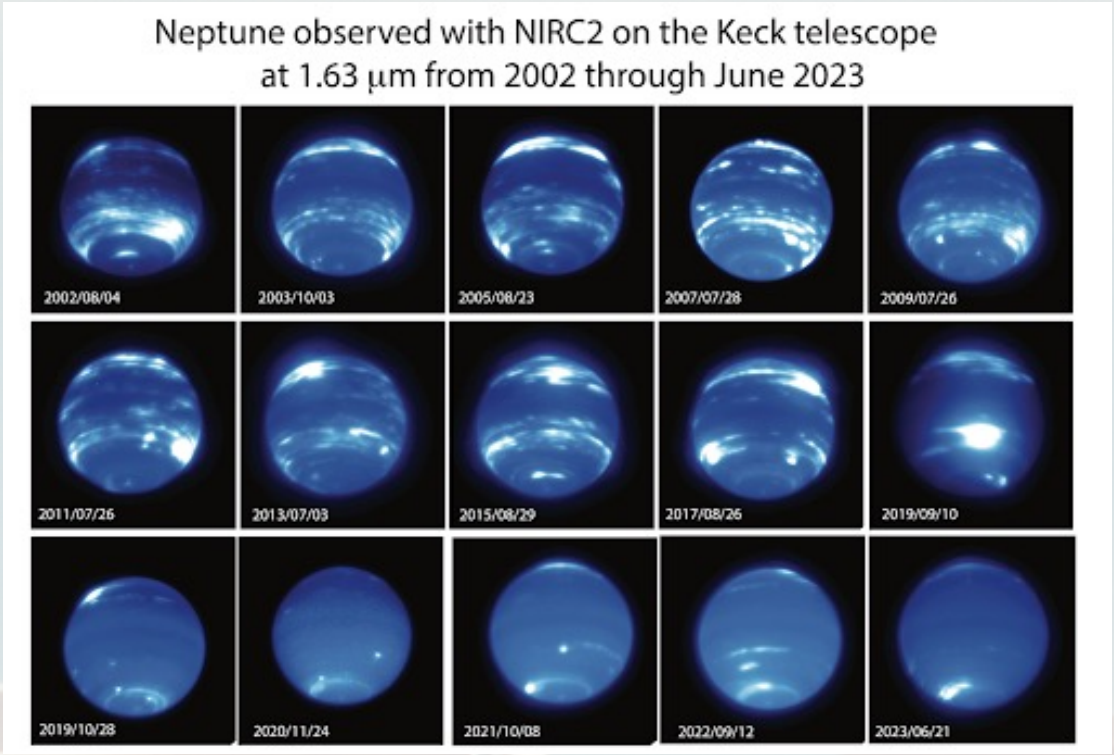
- For the first time, a direct observation of the cosmic web has been made with the KCWI instrument by the KCWI PI Chris Martin (CIT)
- Previously only studied indirectly, or in concert with simulations
- Very delicate (and long) observation requiring a large aperture, precise instrument, and pristine conditions



Neptune's Cloud Cycle

- 20 years of AO-enhanced observations of Neptune with NIRC2 showing extreme variability over time in clouds

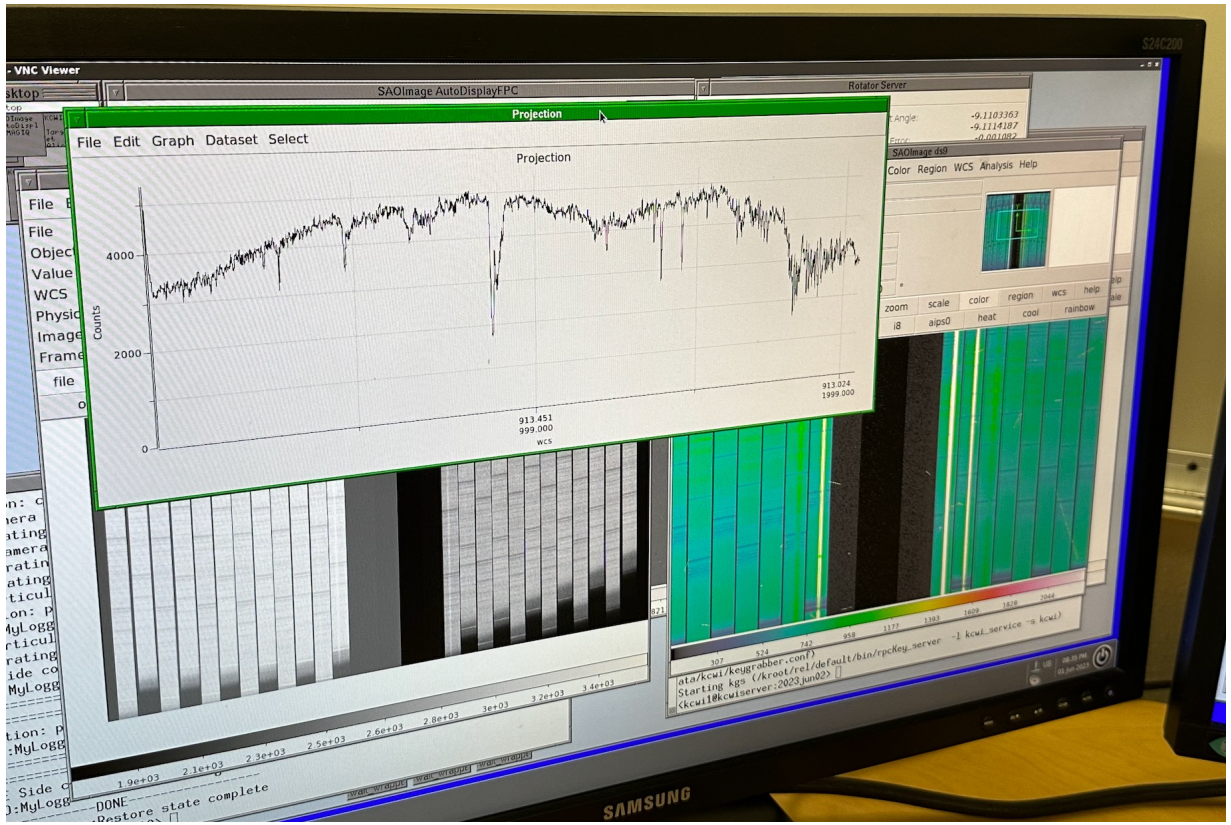
- When combined with HST, origins linked to variability in UV light from the Sun with the solar cycle



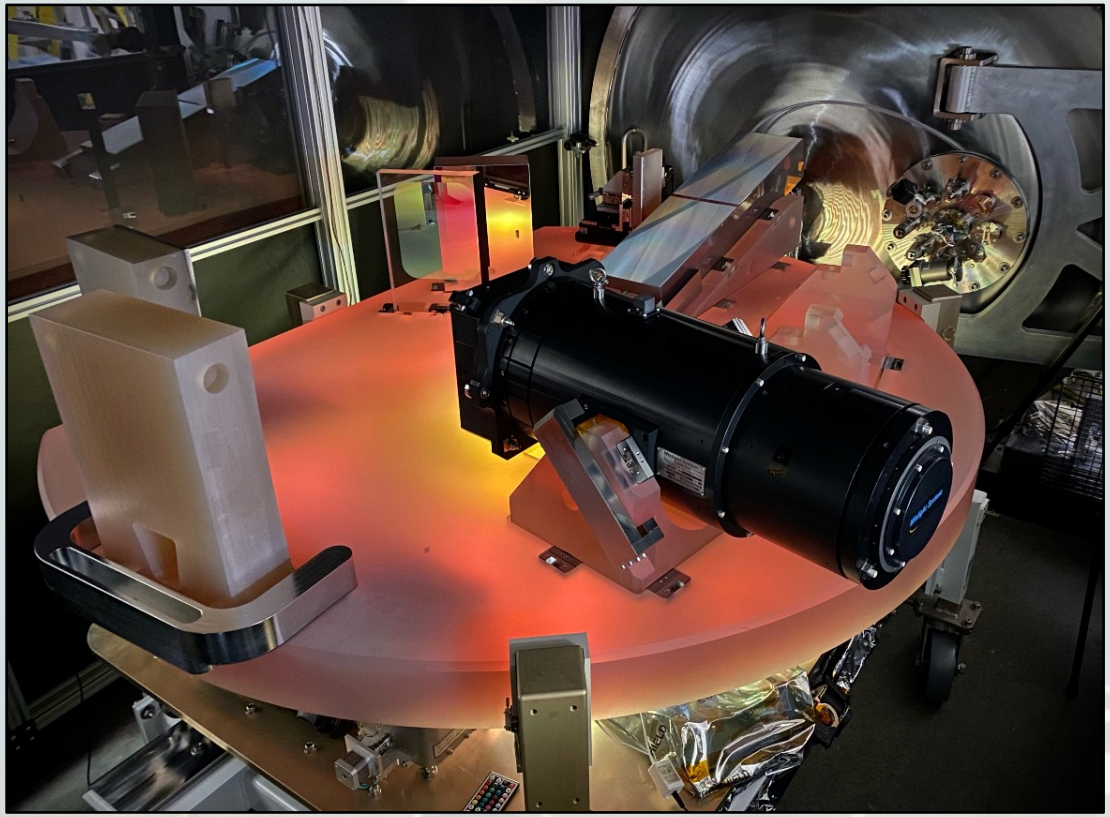
Instrumentation

KCRM first light!

First light of the red arm of the KCWI instrument



Keck Planet Finder Delivered!



NIRC2 detector electronics upgrade

- Hardware:
  - Archon controller
  - Modern Linux host computer
  - Direct fiber communication

- Software:
  - Low-level based on camerad
  - High-level new alad keyword service
  - New UTR and video modes
  - Records “unprocessed” images
  - Richer FITS headers
  - Can abort exposures

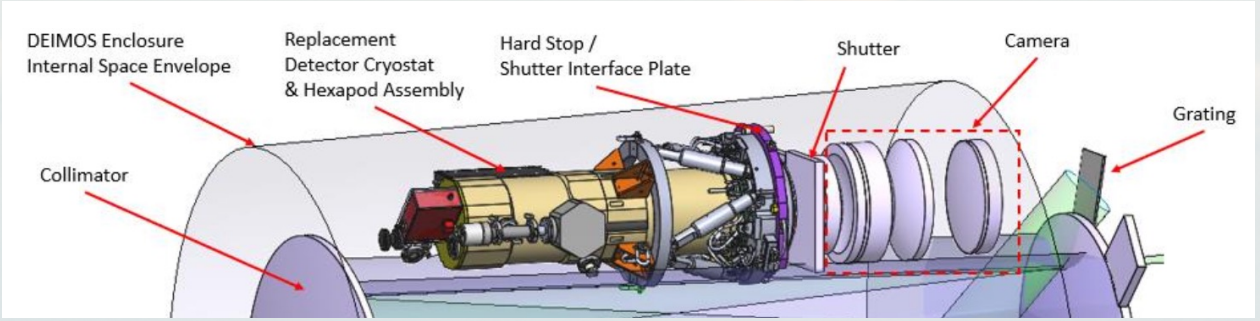
Summit installation(Feb 2023)

Archon installed

Host computer

DEIMOS

- Design maturity at detailed design phase
- Ready to cut metal



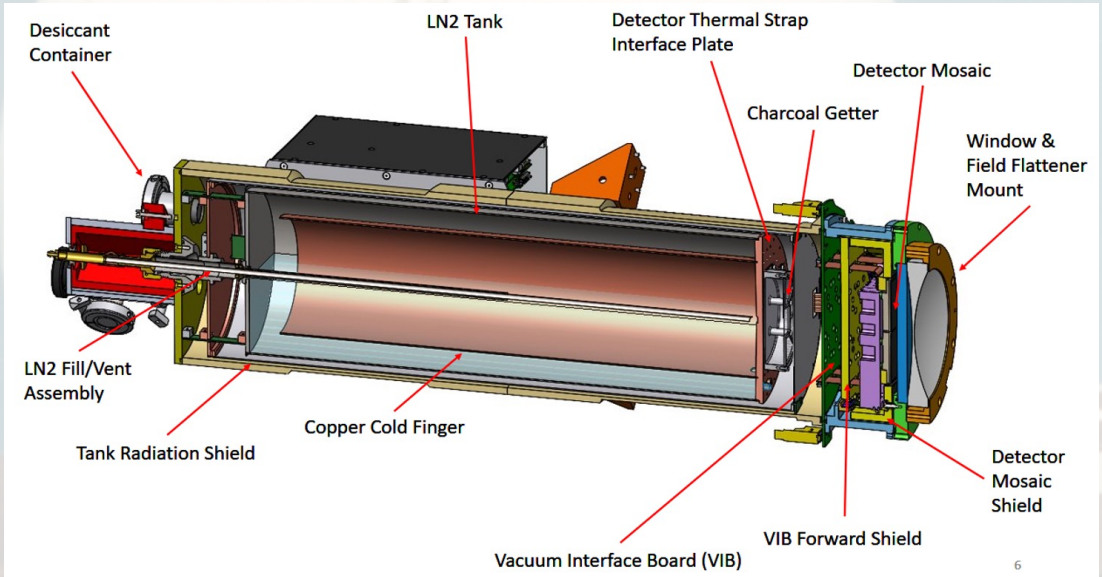
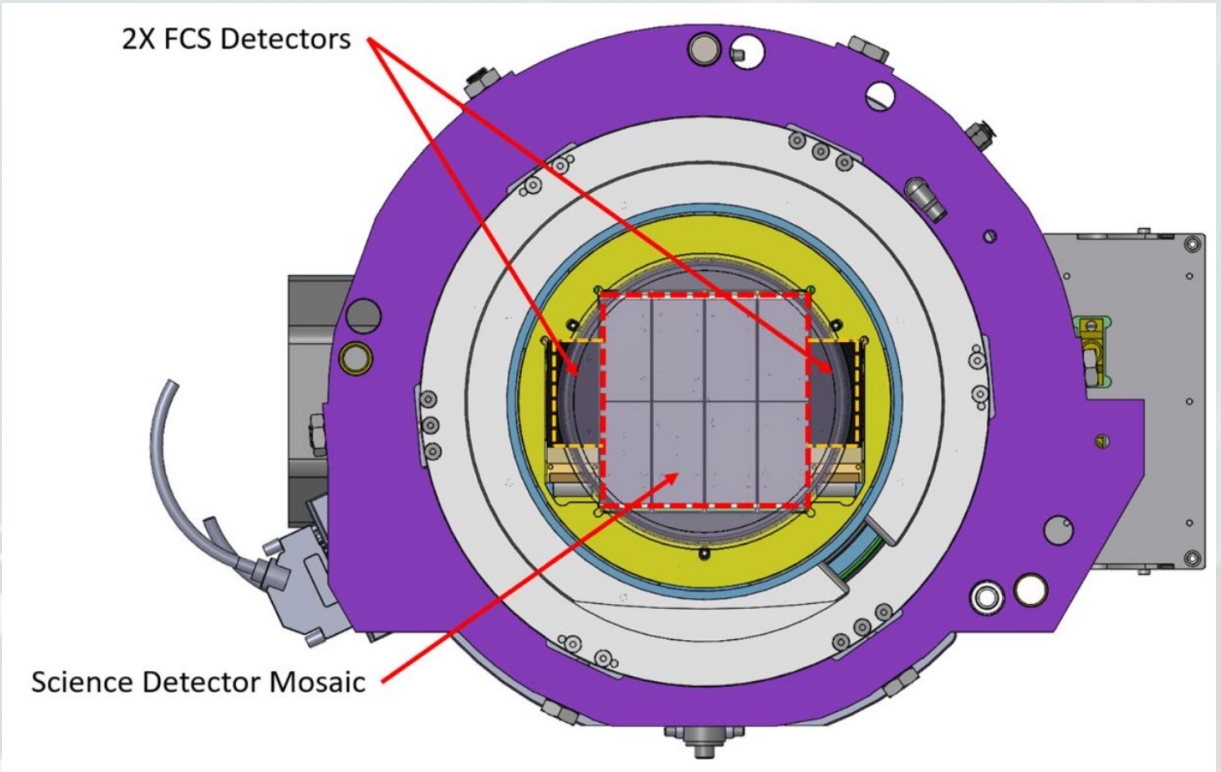


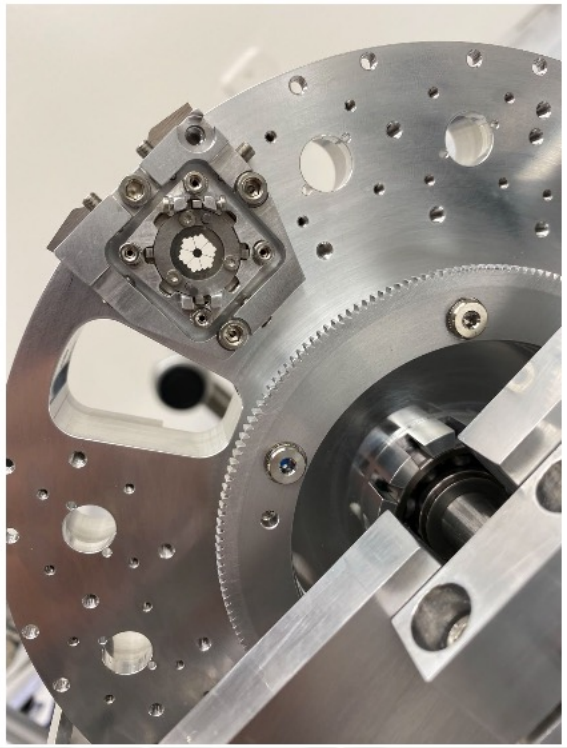
Figure 4: Cross-section of the Detector Cryostat.

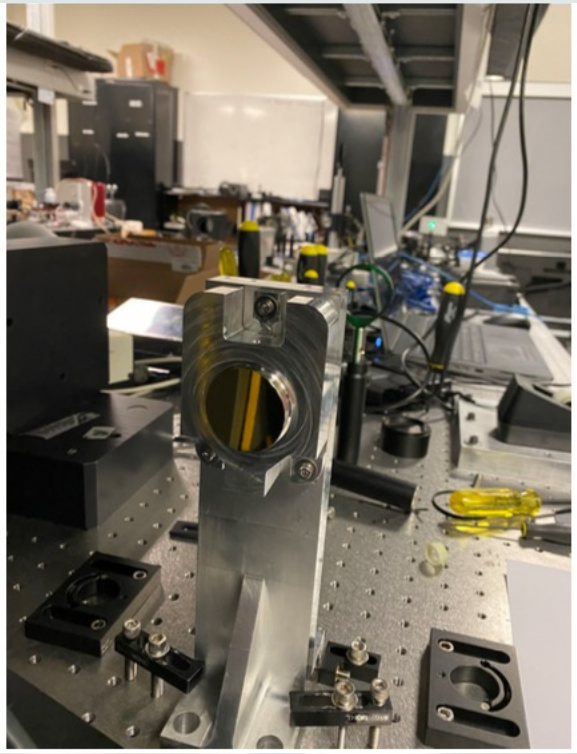


Infrared Laser Frequency Comb

- New IR laser frequency comb for NIRSPEC (and eventually HISPEC) installed at summit
- Commissioning with KPIC underway in 2024

SCALES: Thermal IR integral field spectrograph behind AO.

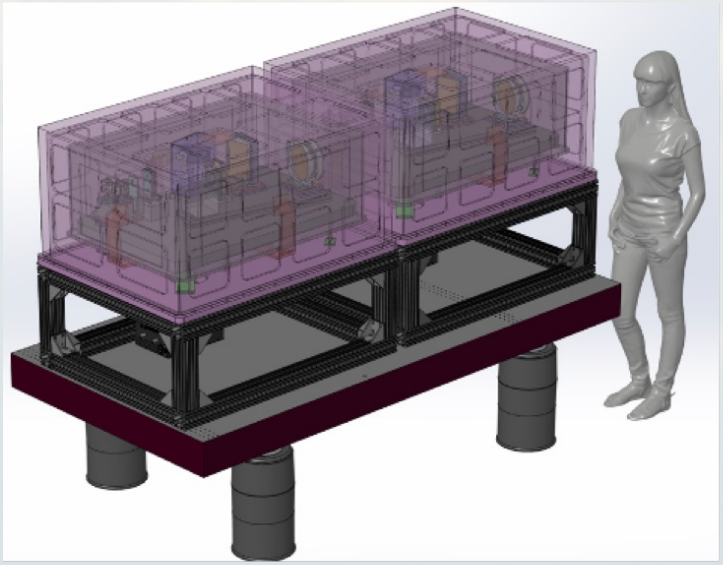




Will deliver in 2025, with major subsystems in full fabrication.

HISPEC

- High Resolution IR spectrograph
- Fiber-fed from Keck II AO
- Will obtain spectra of exoplanet host stars and many of the exoplanets themselves
- Delivers in 2026



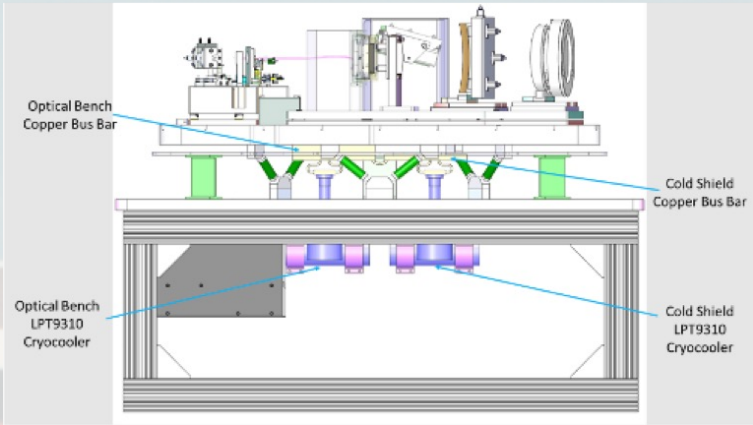


Figure 108: Side View showing dedicated copper bus bar locations for cooling of optical bench and cold shield separately with their corresponding cryocoolers.

Adaptive Optics

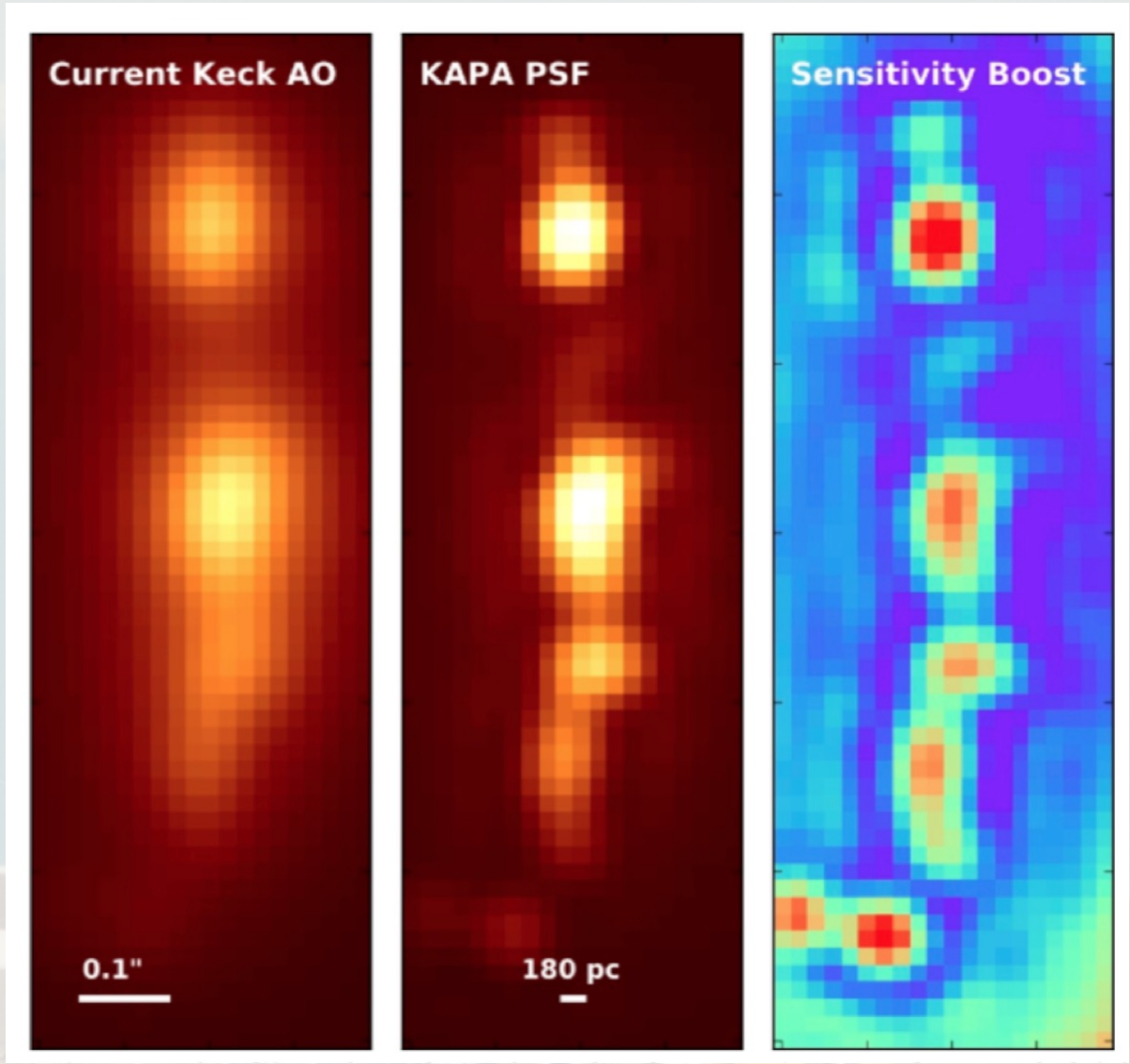
AO Leadership at WMKO

Peter Wizinowich

Antonin Bouchez

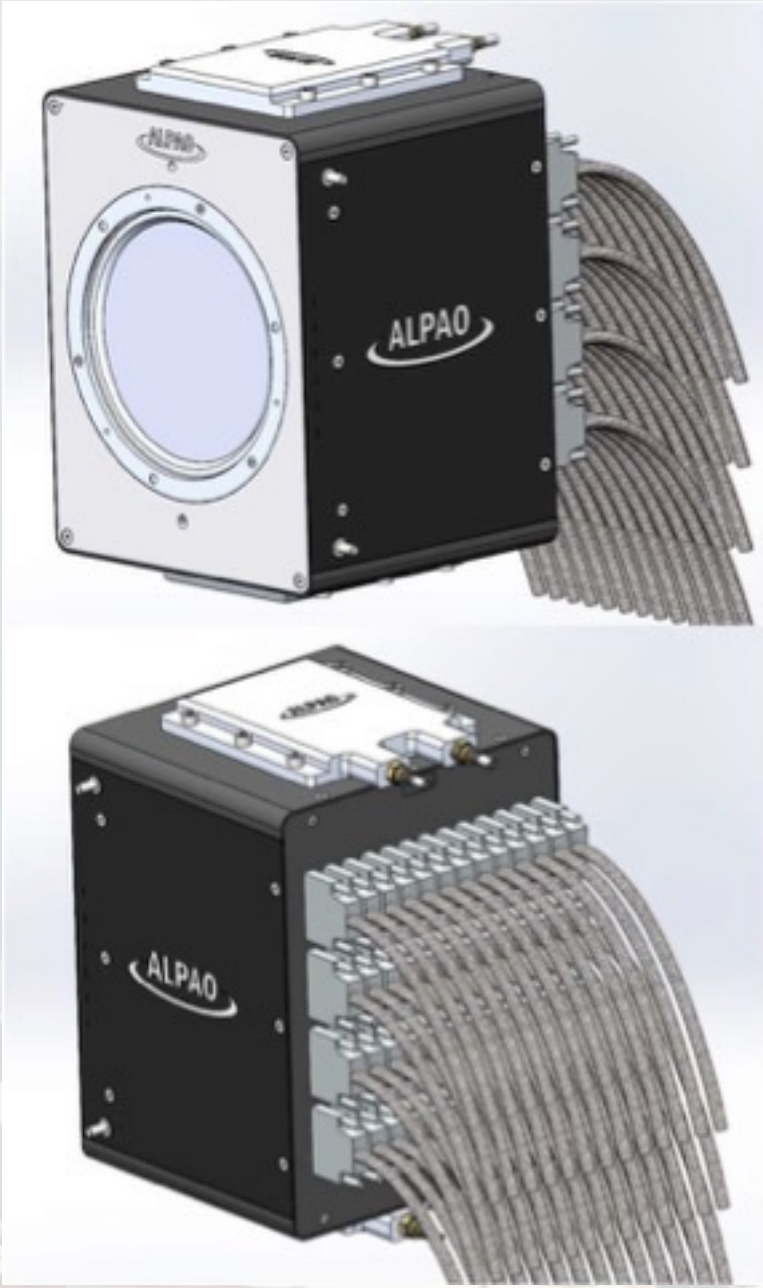
KAPA

- Laser tomographic system for Keck I
- Significant upgrade to AO capabilities
- Subsystems installing throughout the year



HAKA

- High-order DM
- Replaces ~20 year old DM on Keck II and offers significant increase in wavelength range accessible and correction speed
- First light in 2025



Thank you!