Laser Guide Star Operations at W. M. Keck Observatory

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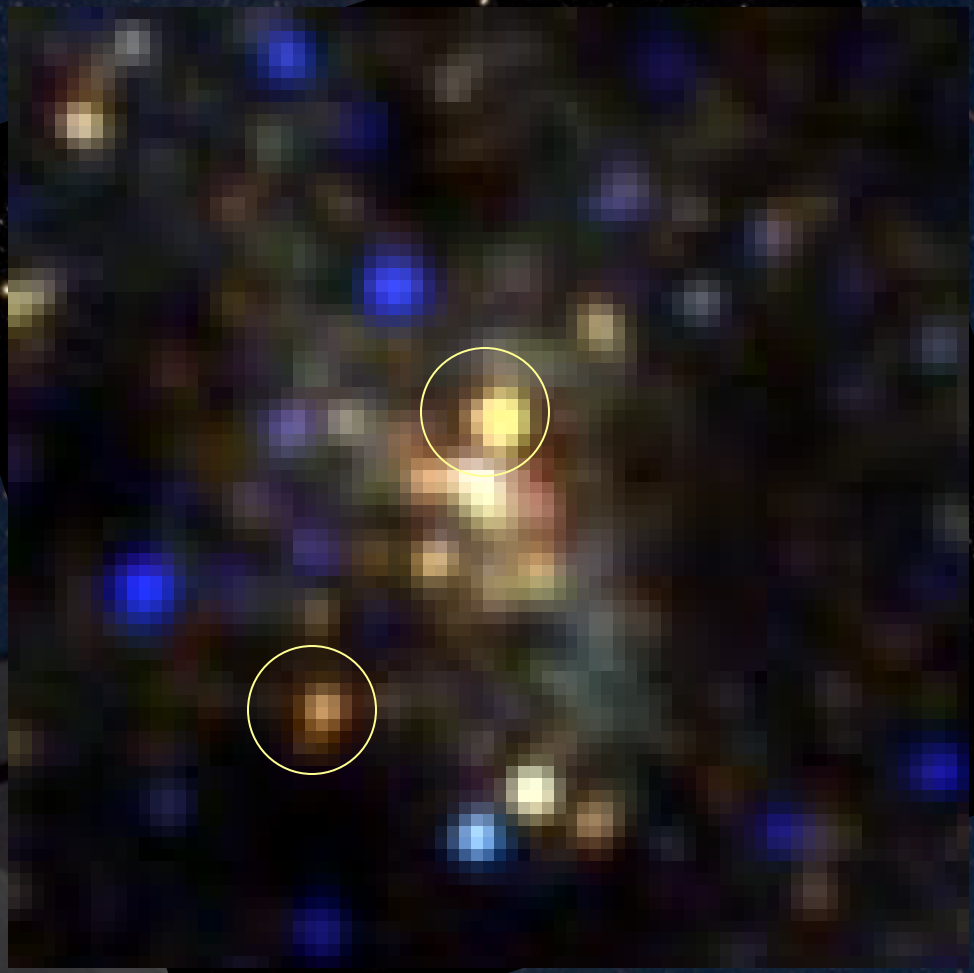
Introduction

- Background and history
- Organization
- Safety challenges
- Looking to the future

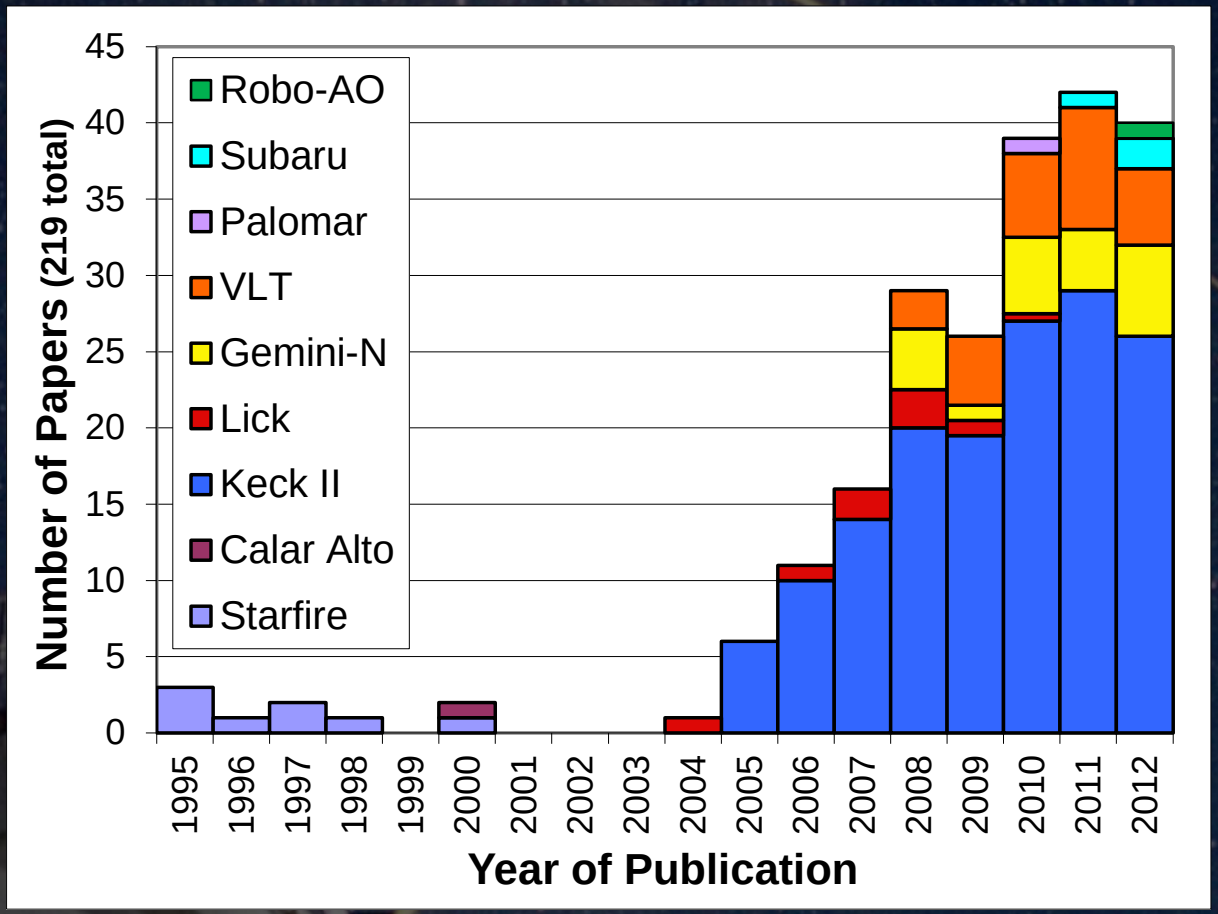
Laser Guide Stars

- Create an artificial "star" in the thin layer of sodium atoms 90 km above the Earth's surface
- Allows AO in 95% of the sky, rather than the 2% near a bright star.
- Converts IR astronomy to an active experiment; implies changes to operations.

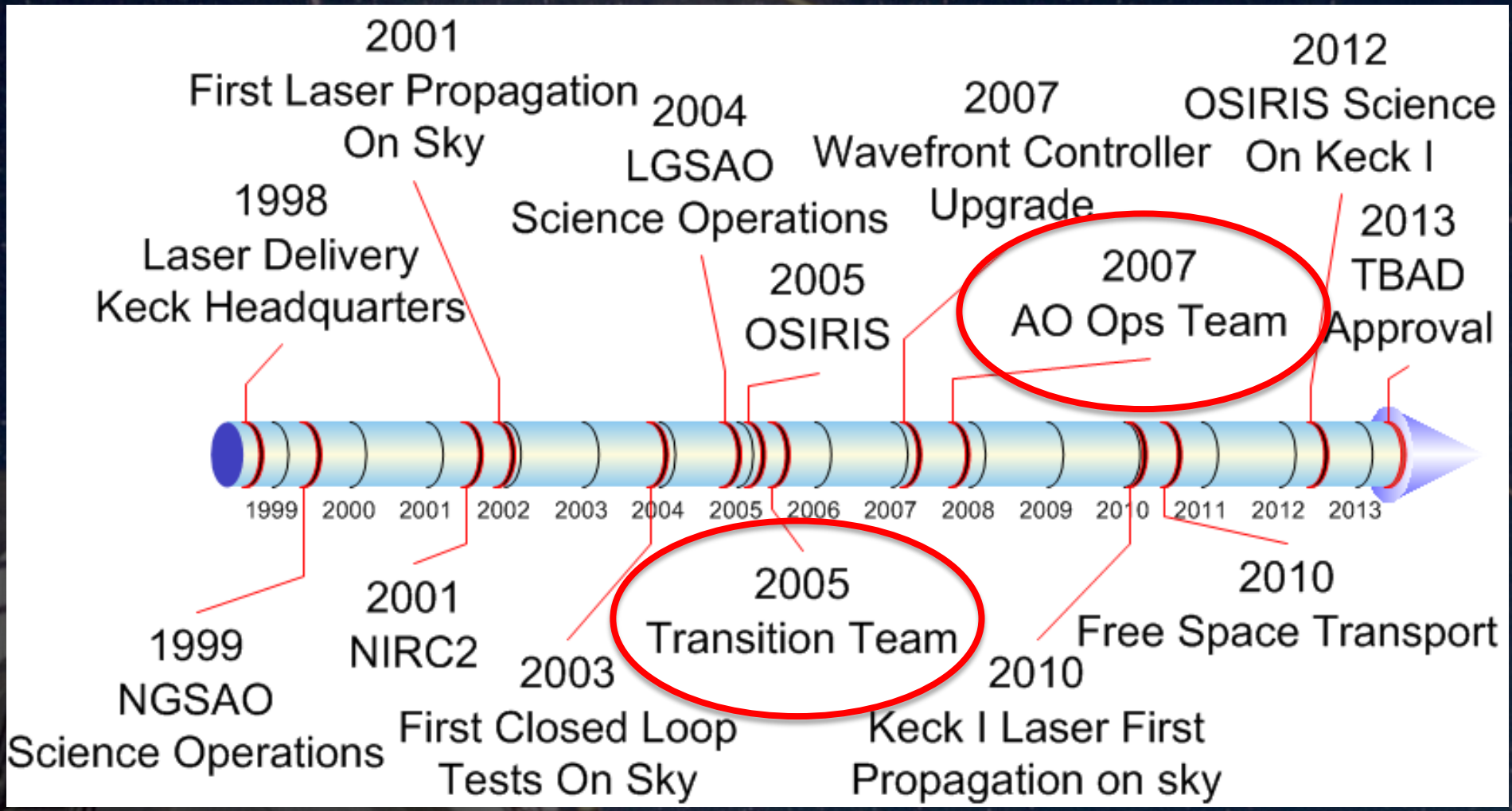
Center of Our Galaxy



Science Productivity



Keck AO Time Line



LGS-AO Transition Team

- Elements of operations and development groups
- Clear expectations for handover
- Clear training expectations
- Development team "service" after commissioning
- Operated strongly for one year, plus some cleanup in the second year

AO Operations Team

- Took over where the Transition Team ended
- Led by Randy Campbell, our most senior Support Astronomer
- Includes AO Support Astronomers, AO Specialists, and engineers
- AO development team mostly on-site
- Continual upgrades based on operational experience


Efficiency
Automation
Scripts
Flexibility
Observers
Feedback on observing experience
Advice on improvements
Help characterizing the system
Science Ops
Reliability
Closed-loop dye system
New lasers
Performance
Nightly system checkout
Advanced training

Coordination with External Agencies

- Other Mauna Kea observatories
- Civilian aircraft
- Military aircraft
- Satellites

Other Observatories

- Our laser beam can contaminate visible-light observations of other telescopes.
- LTCS (Laser Traffic Control System): calculates the geometry of participating telescopes to look for and predict "collisions"
- We are moving from "laser always gives way" to "first on target."

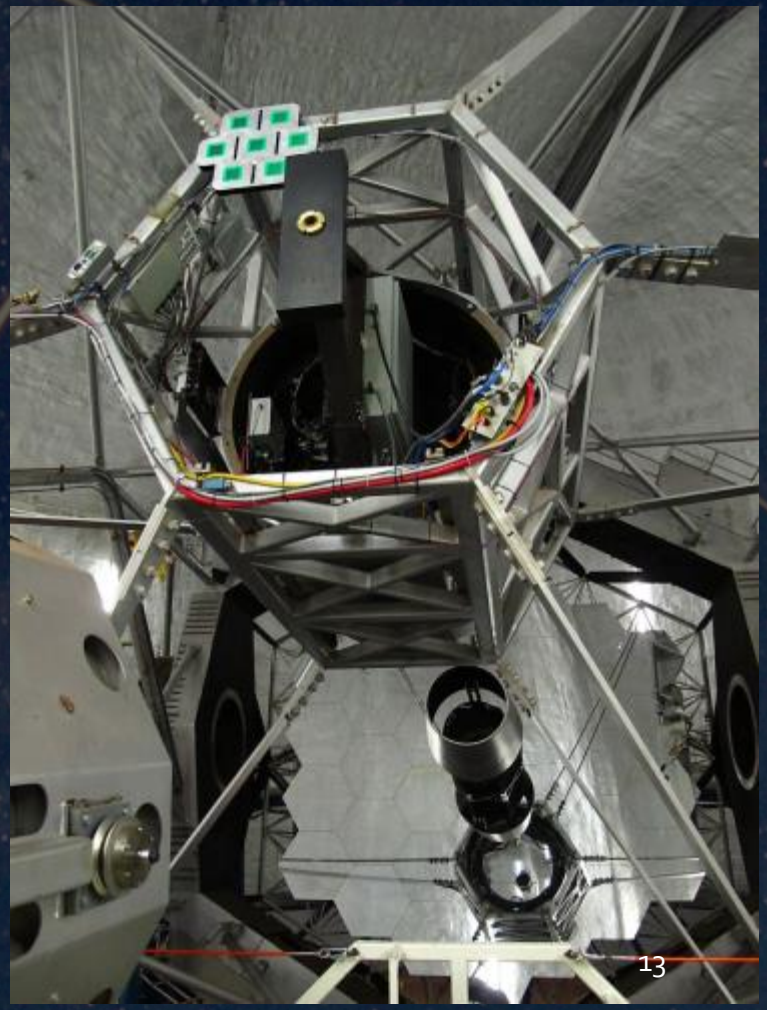
Civilian and Military Aircraft

- Coordinate with the U.S. FAA (Federal Aviation Administration)
  - Human aircraft spotters
  - Last month, we received "permission" to replace humans spotters with a transponder-based system. (see next slides)
  - Note: *no* all-sky camera
- Coordination with military flights
  - Local military training base sometimes hosts night-time flight operations
  - We provide details about our operational cone

TBAD: Transponder-Based Aircraft Detection

- Passive antennae (wide-field + narrow-field) listen for aircraft transponders
- The ratio of signal strength tells whether the aircraft is in the narrow beam.

- Advantages: never gets sleepy, always pointed the same as the laser, a sophisticated fail-safe configuration.



TBAD PI: Tom Murphy, UCSD

Satellites

- Laser can damage visible-light detectors on downward-looking satellites.
- Coordination with U. S. Strategic Command
  - We send them our list of targets, they tell us when during the night we are not allowed to lase at each target position (typically 10–30 seconds).
  - Excellent working relationship; processing highly automated on our end.
- Disadvantages
  - hard to add a target at the last minute
  - requires better tactical planning during the night
  - "blanket closures" prevent all LGS observing.

Time Domain Astronomy

- Currently only during scheduled LGS-AO nights
  - Scheduling human spotters
  - Coordination with U. S. Strategic Command
  - K2 laser warm-up and checkout, but…
- Enabling technologies for more flexibility
  - TBAD
  - New lasers
  - A deployable tertiary mirror on Keck I

Conclusions

- Complex, costly systems that benefit greatly from interaction between operations and development groups
- Transition and operations teams to optimize operational aspects
  - Tools developed specifically from operational experience
- Cooperation with external agencies is crucial