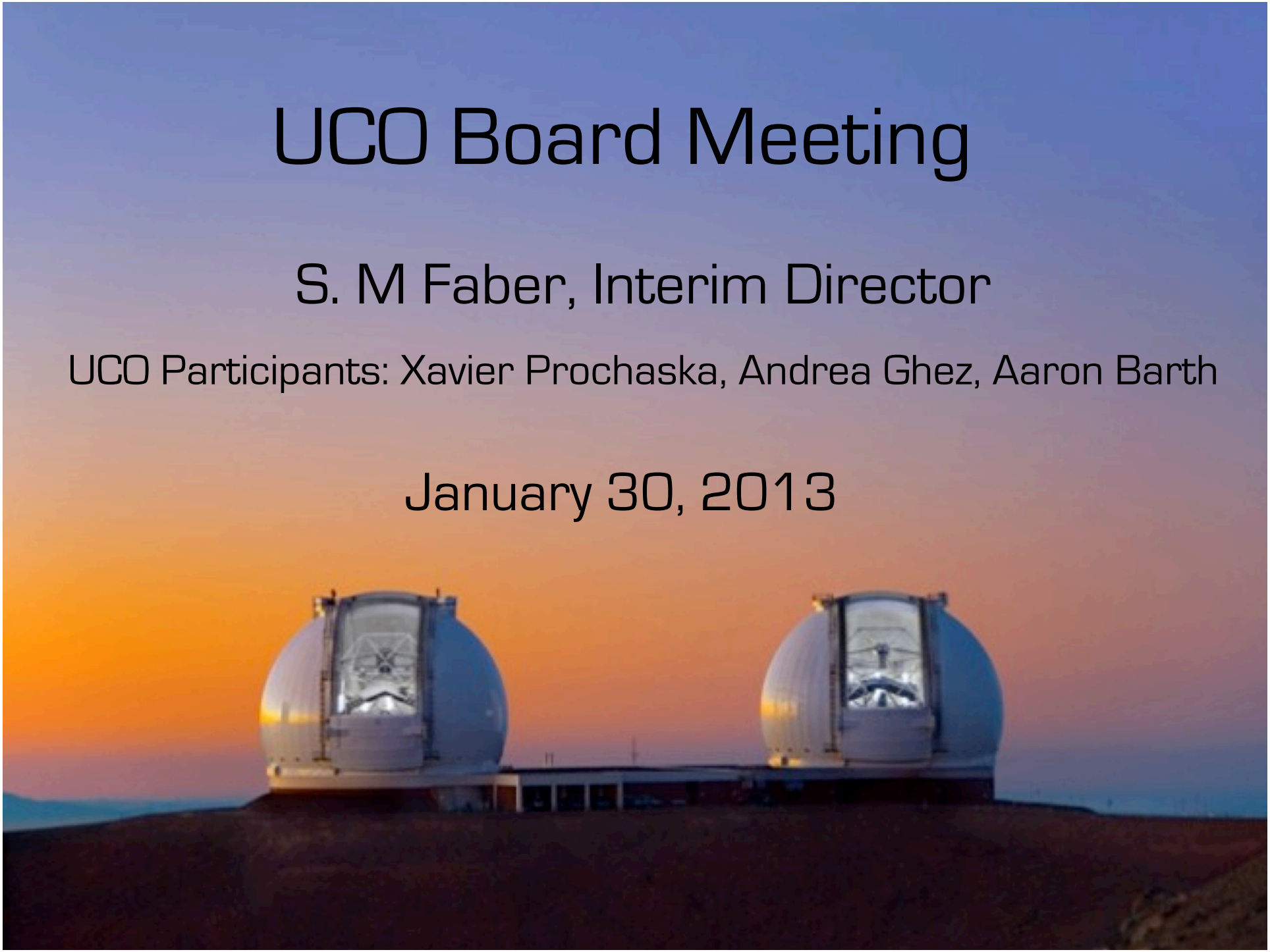
UCO Board Meeting

S. M Faber, Interim Director

UCO Participants: Xavier Prochaska, Andrea Ghez, Aaron Barth

January 30, 2013



Part I: UC OIR Astronomy – Long Term Vision, Context, and Strategic Plan

Long-term Vision for UC O/IR Astronomy

Lead the coming "golden age" of ground-based optical-IR astronomy via:

- Forefront observations with TMT and Keck,
- Pathbreaking innovations in telescope design and instrumentation,
- Adaptive optics systems that finally realize the full power of enormous telescopes that are possible only on the ground.

Summary Points on Vision, Context, and Plan

- UC leads in inventing telescopes of the future. TMT capitalizes on our expertise and investment in Keck and will maintain our leadership position in O/IR astronomy for the foreseeable future.

- UC's competitors are investing heavily in giant ground-based telescopes around the world; efforts are intense; the scientific payoff is huge.

- The Keck+TMT combination is affordable at little extra cost from UCOP funds.

- Major investments have been made at Lick that will return important science in five years and are technical steppingstones to Keck and TMT. We should continue to operate Lick for at least five years and review its status as we approach the Keck+TMT era.

Recommendations on Vision, Context, and Plan

- *Recommend 1:* Endorse UC's commitment to the Thirty-Meter Telescope and support ongoing negotiations with partner institutions.

- *Recommend 2:* Endorse plan to redirect Keck savings after 2018 to pay TMT operating costs.

- *Recommend 3:* Support Lick operations for 5 years at spartan level while plans are developed for 2018 and beyond.

Synergies

- Within UC: Astronomy uniquely embodies UC's "Power of Ten".

- TMT + Keck: Keck's capabilities complement TMT's, as Lick's complement Keck's now.

- With other planned major facilities:
  - Large-scale survey telescopes such as the Large Synoptic Survey Telescope (LSST)
  - ALMA + EVLA (radio), JWST (infrared *Hubble* follow-on)

These telescopes will all need **optical/IR spectra of faint objects**, for which UC capabilities will continue to be pre-eminent.

- With other TMT partners on Mauna Kea:
  - Subaru (Japan), Gemini-North (NSF), Canada-France-Hawaii (Canada)
  - Add India and China to create a "Pacific-Rim" consortium built on ESO model.

Mauna Kea "owns" the northern sky.

The UC Astronomical Task Force

The ATF was a survey commissioned by ORGS to determine priorities for future systemwide investment in Astronomy & Astrophysics. The committee was comprised of 14 astronomers including 9 regular users of UCO facilities and three theorists.

Members of the UC Astronomy Task Force:
Geoff Marcy, UC Berkeley, gmarcy@astro.berkeley.edu (Chair)
Joshua S. Bloom, UC Berkeley, jbloom@astro.berkeley.edu
James Bullock, UC Irvine, bullock@uci.edu
Steve Furlanetto, UC Los Angeles, sfurlane@astro.ucla.edu
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David Tytler, UC San Diego, dtytler@ucsd.edu

Priorities from the Astronomical Task Force

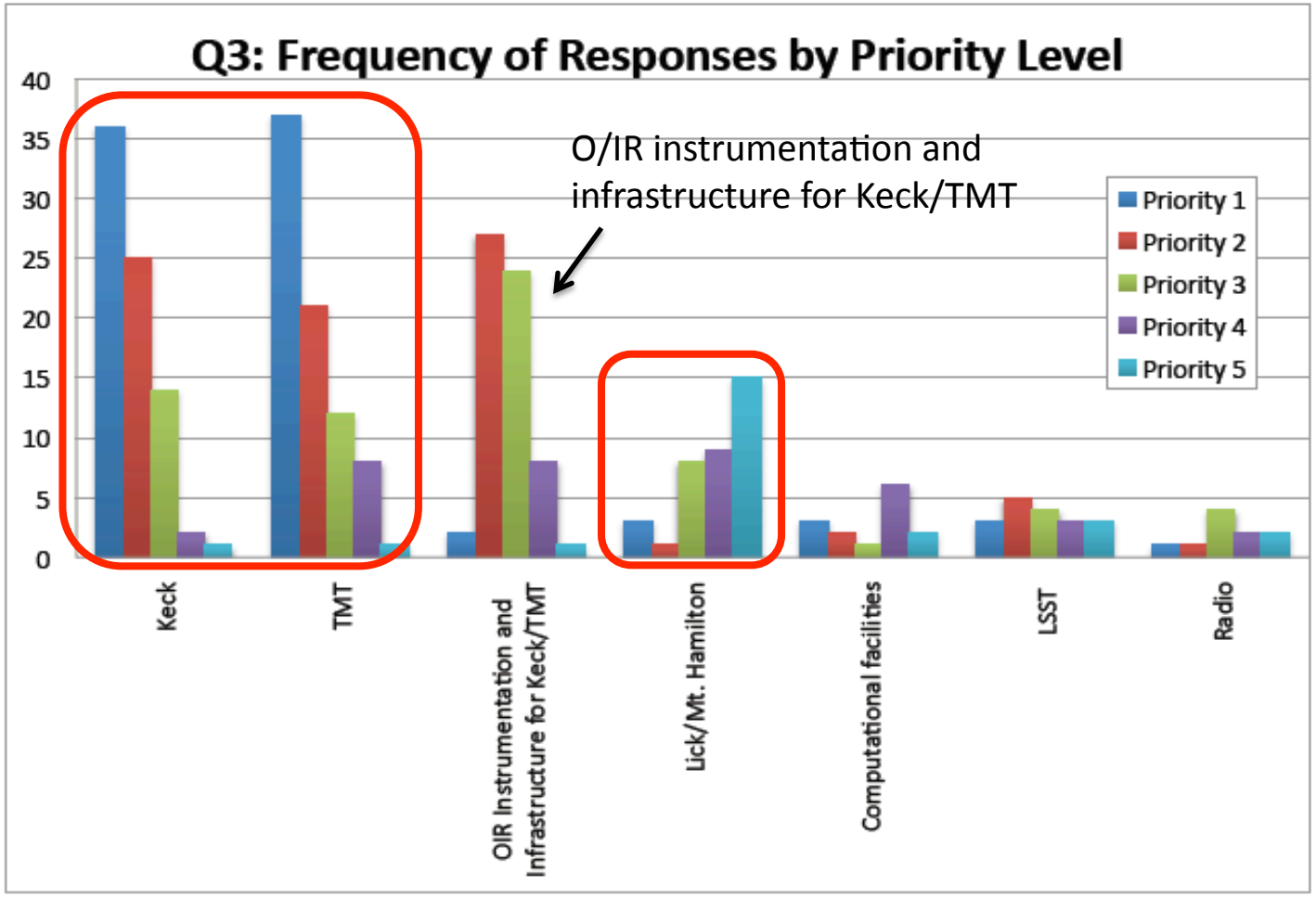
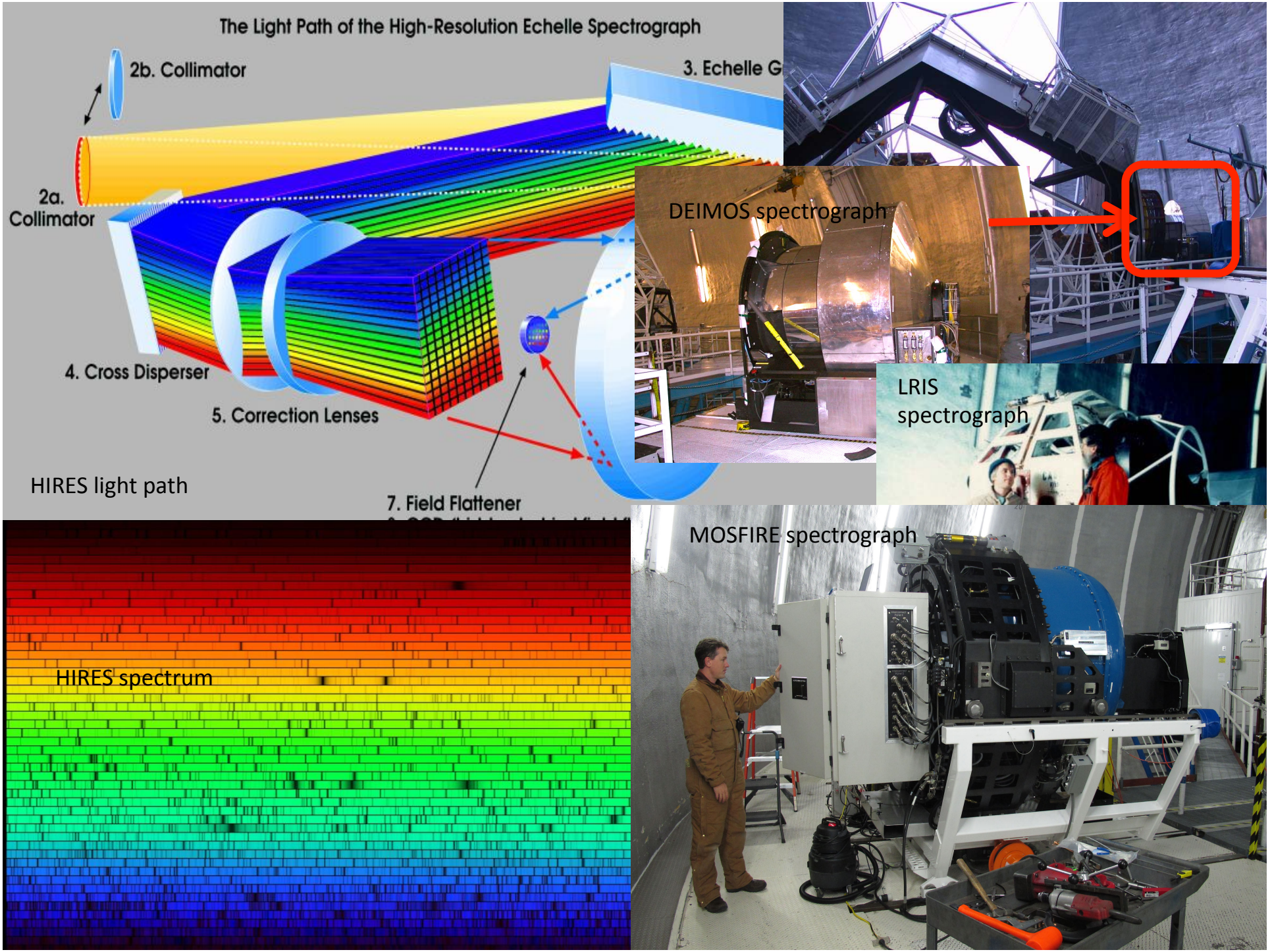
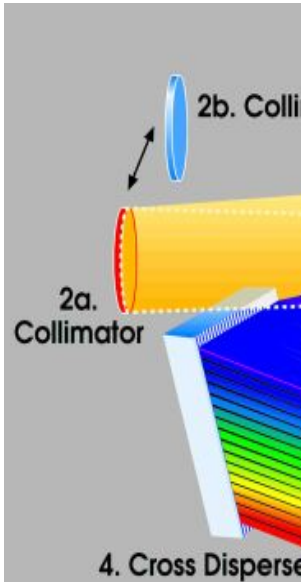
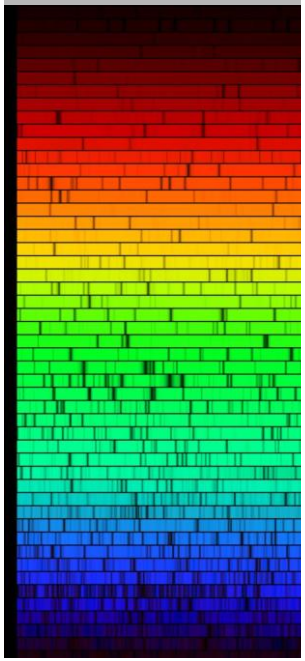


Figure 4. Distribution of priority rankings for each facility identified as a "Top 5" facility for UC system-wide investment by more than 10% of Survey respondents in Question 2 (see Figure 3). TMT and Keck are most often ranked as top priorities. Optical/Infrared Instrumentation and Infrastructure for Keck/TMT are most often listed as a second or third priority, and Lick Observatory has the next highest ranking.


The Light Path of the High-Resolution Echelle Spectrograph
2b. Collimator
3. Echelle G
2a.
Collimator
4. Cross Disperser
5. Correction Lenses
7. Field Flattener
HIRES light path
DEIMOS spectrograph
LRIS
spectrograph
HIRES spectrum
MOSFIRE spectrograph





Keck and TMT Instruments and Upgrades

Inverse chronological order by commissioning dates

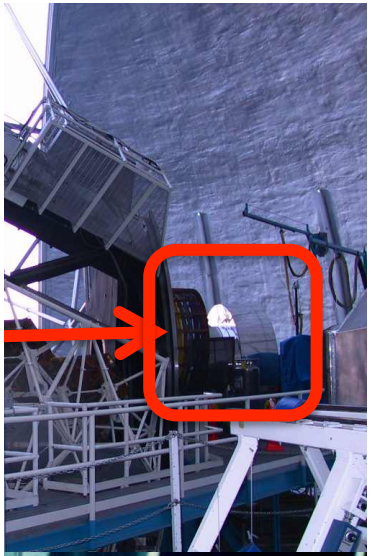
Keck instruments and optics delivered:

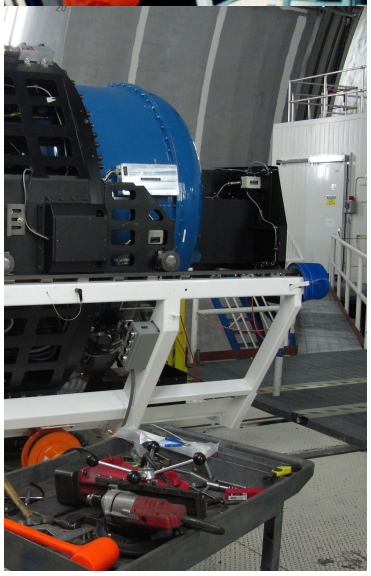
- MOSFIRE (2012): Caltech & UCLA/IR Co-PIs, UCSC/UCO (optics and guider)
- Keck-I laser guide star (2010): WMKO
- SHARC (2006): UCLA/IR PI (engineering camera; retired)
- OSIRIS (2005): UCLA/IR PI
- Keck-II laser guide star (2004): LLNL/UCSC PI, WMKO
- Interferometer (2004): JPL, MSC, WMKO Co-PIs
- DEIMOS (2002): UCSC/UCO PI
- NIRC-2 (2001): Caltech PI, UCLA/IR (electronics)
- LRIS-Blue side (2000): Caltech PI
- Keck-I natural guide star AO (2001): WMKO PI
- NIRSPEC (1999): UCLA/IR PI
- ESI (1999): UCSC/UCO PI
- Keck-II natural guide star AO (1999): WMKO & LLNL Co-PIs
- LWS (1996): UCSD PI
- Keck-II secondary (1995): UCSC/UCO PI
- HIRES (1994): UCSC/UCO PI
- NIRC (1994): Caltech PI
- LRIS-Red side (1993): Caltech PI, UCSC/UCO (optics)
- Keck-I secondary (1991): UCSC/UCO PI

UCO sites are in yellow

Keck instrument upgrades delivered:

- LRIS-Red detector upgrade (2010): UCSC/UCO PI
- Keck-I & II AO wavefront controller upgrade (2007): WMKO PI
- HIRES detector upgrade (2004): UCSC/UCO PI
- HIRES image rotator (1997): UCSD PI





Keck Instruments

- Typical cost: $5-15 M in 2012 dollars
- Typical team: 25 people
- Development/fabrication duration: 4-8 years

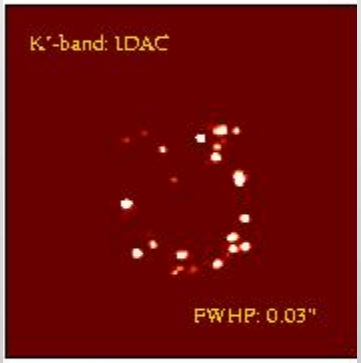
- Resources:
  - Original grant of $10 M as part of telescope construction.
  - Then, for first decade, 21.5% of UC/NASA operations funding was set aside for new instruments. As instrument suite grew, more was needed to pay running costs.
  - For last eight years, instruments and upgrades have been funded by NSF ATI and MRI programs, ~25 nights/yr at $100 K per night exchanged via TSIP, and private fund raising

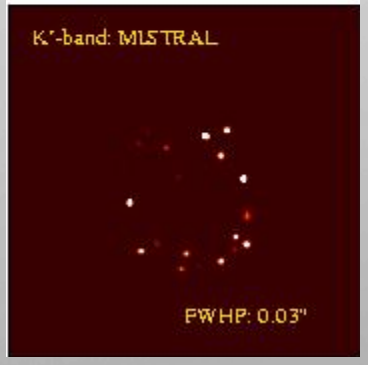
- TMT has a better plan.

UC and Adaptive Optics

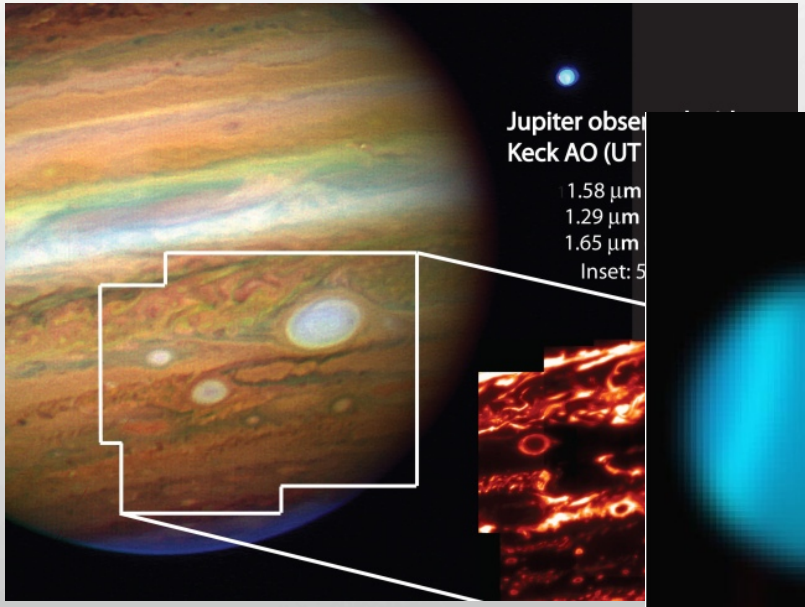
- Adaptive Optics is the “third technology revolution” in astronomy after telescopes and detectors
- UC and UCO have led the way in AO for astronomy
- 3-m laser-guide star AO first to be put in use
- Keck is (by far) the leader in AO science productivity; growing each year
- $9.3 M gift from the Moore Foundation for the Lab for Adaptive Optics at UCSC
- $40 M for Center for Adaptive Optics, NSF Science and Technology Center at UCSC

Adaptive Optics at Keck



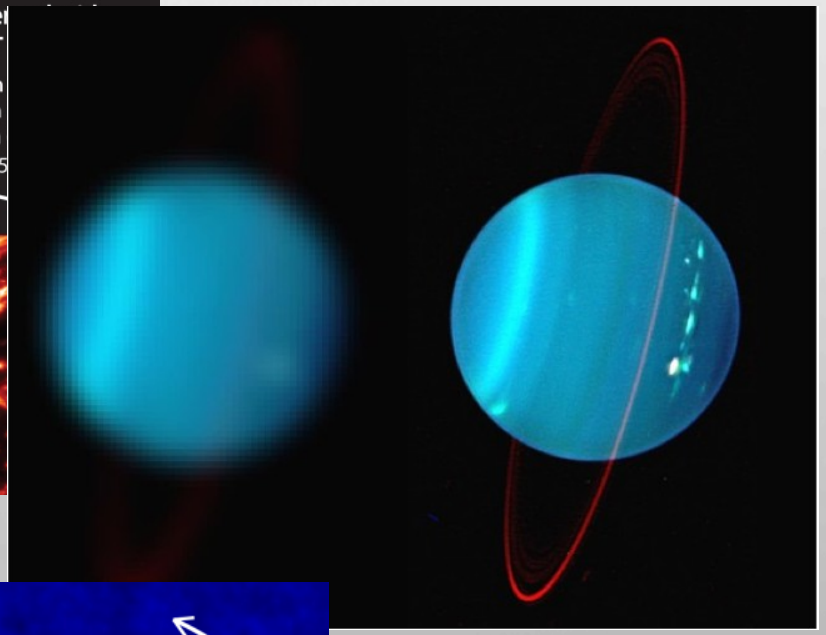


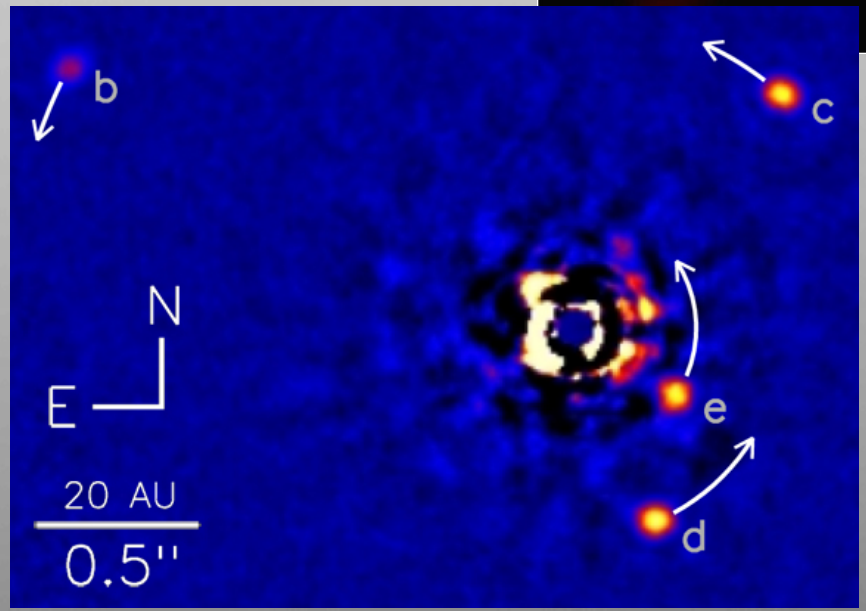
Io volcanoes



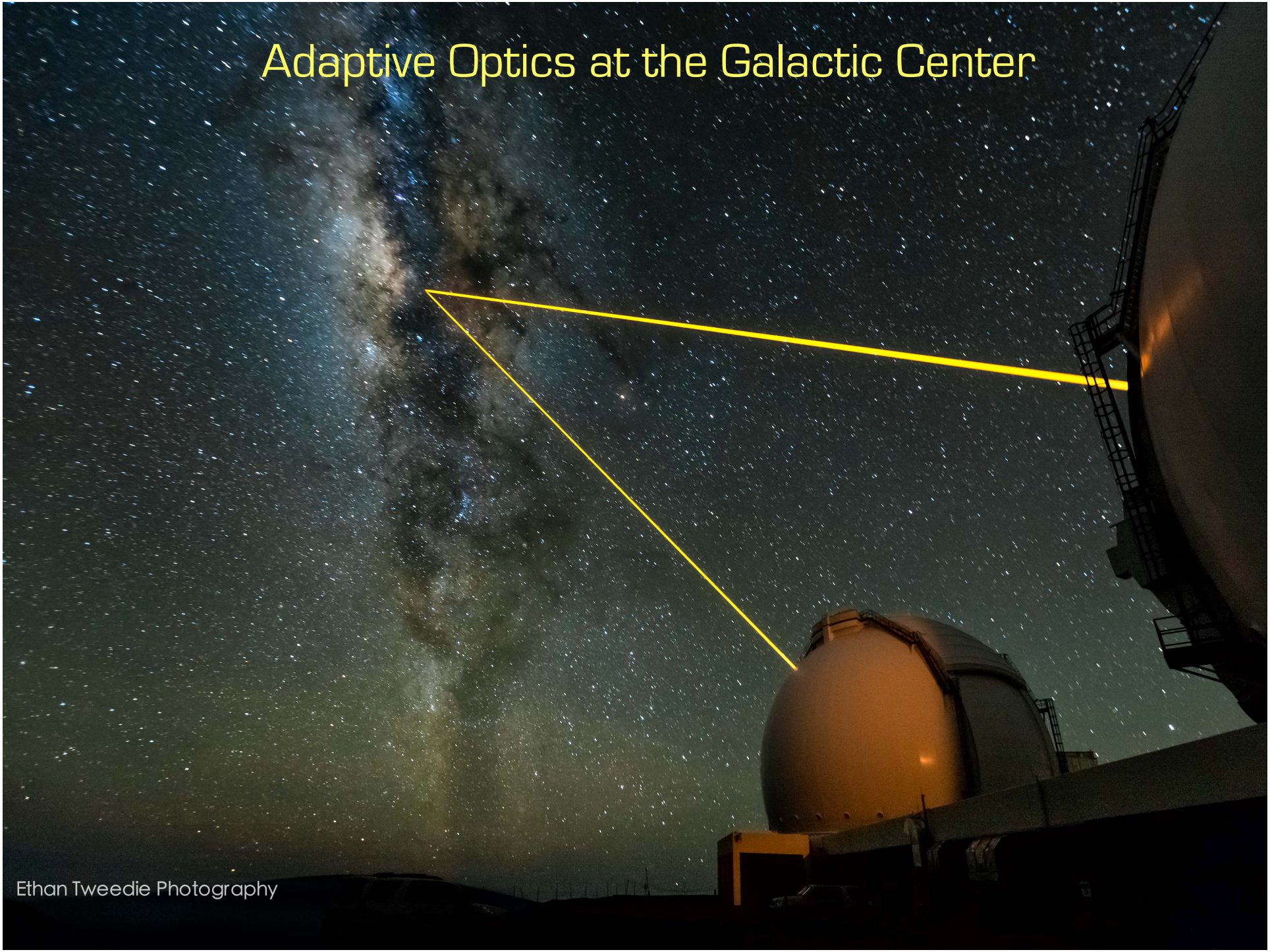
Jovian weather

Uranus w and w/o AO

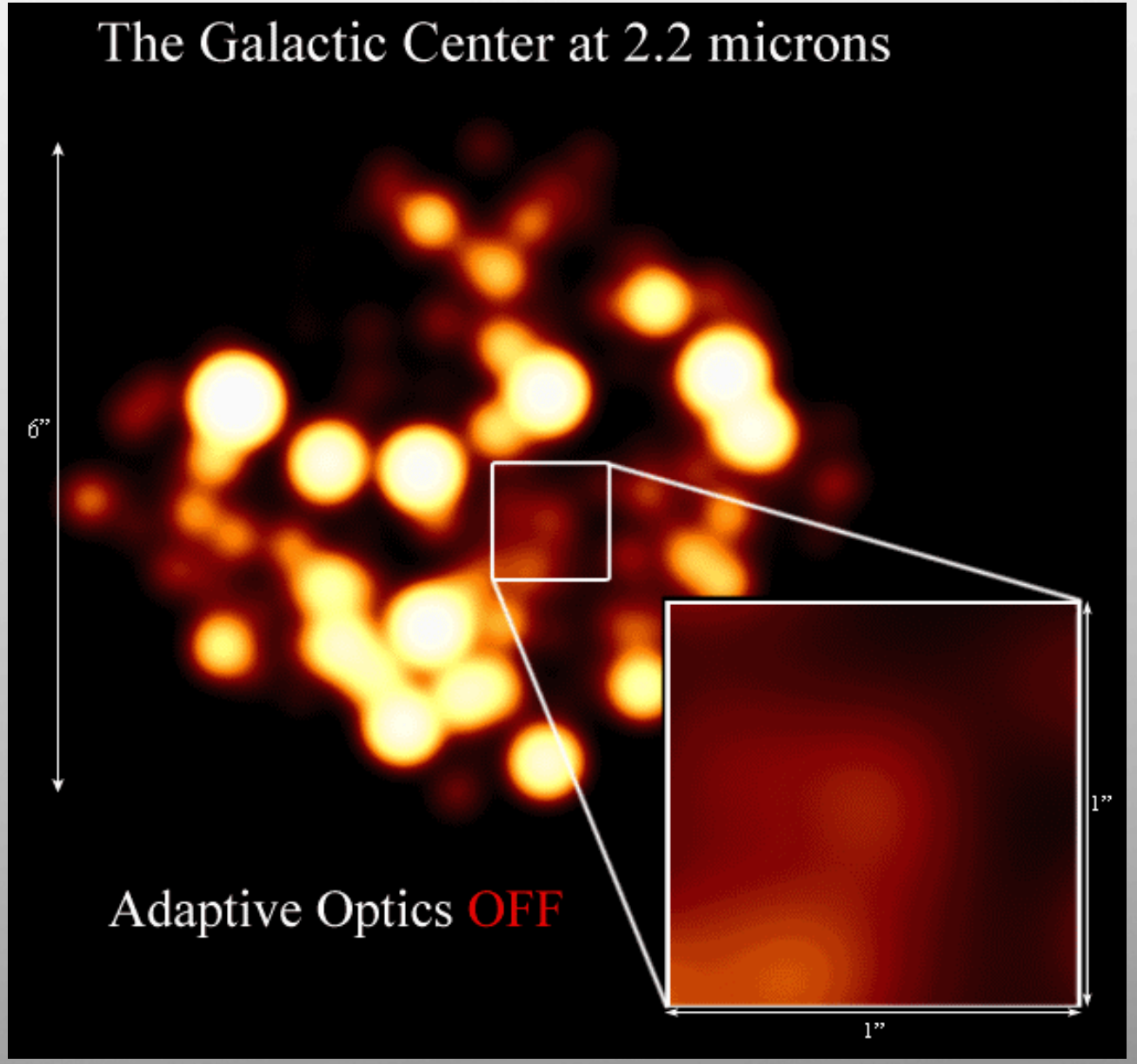




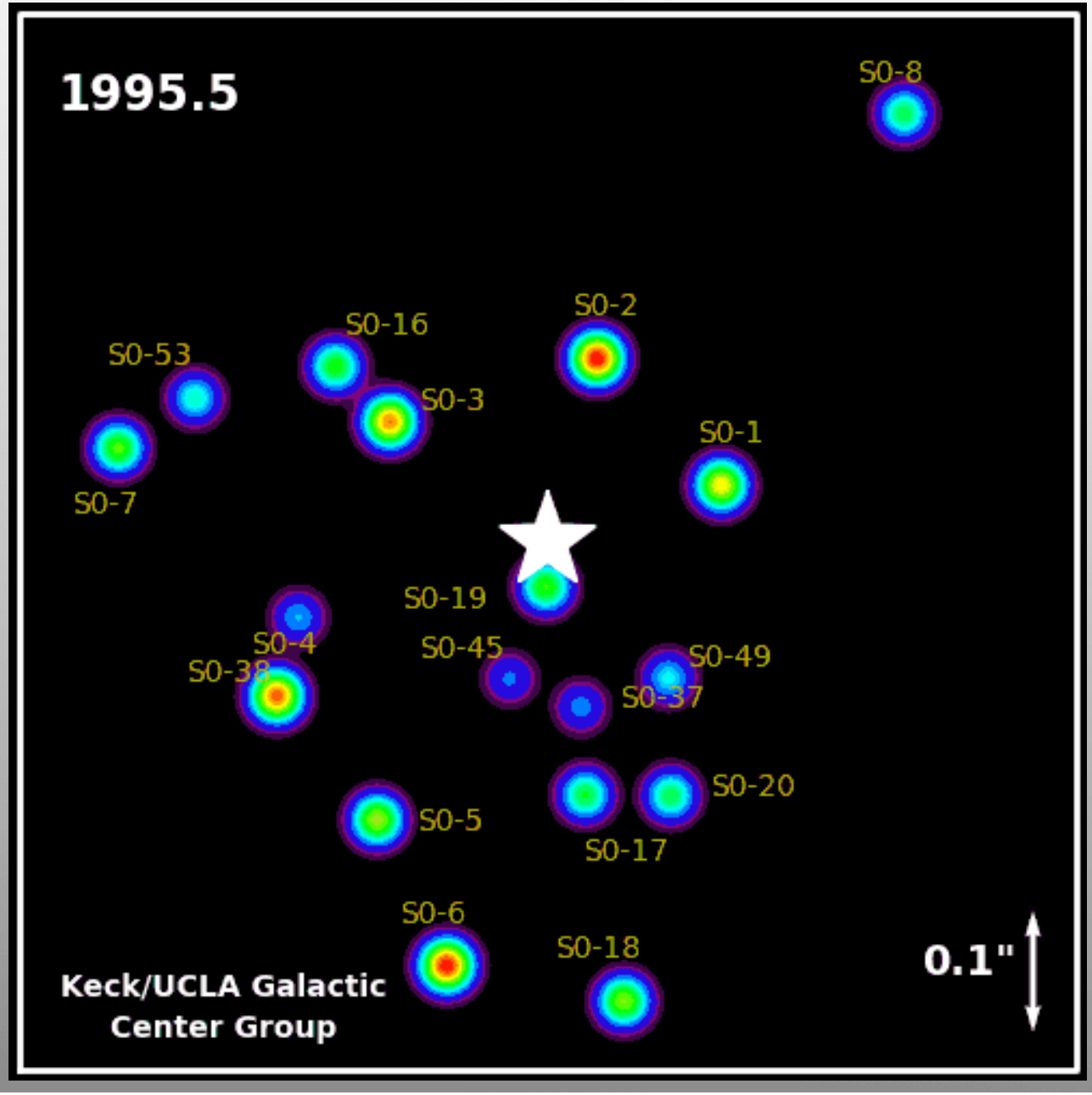
HR 8799: first direct image of a multiplanet system


Adaptive Optics at the Galactic Center
Ethan Tweedie Photography

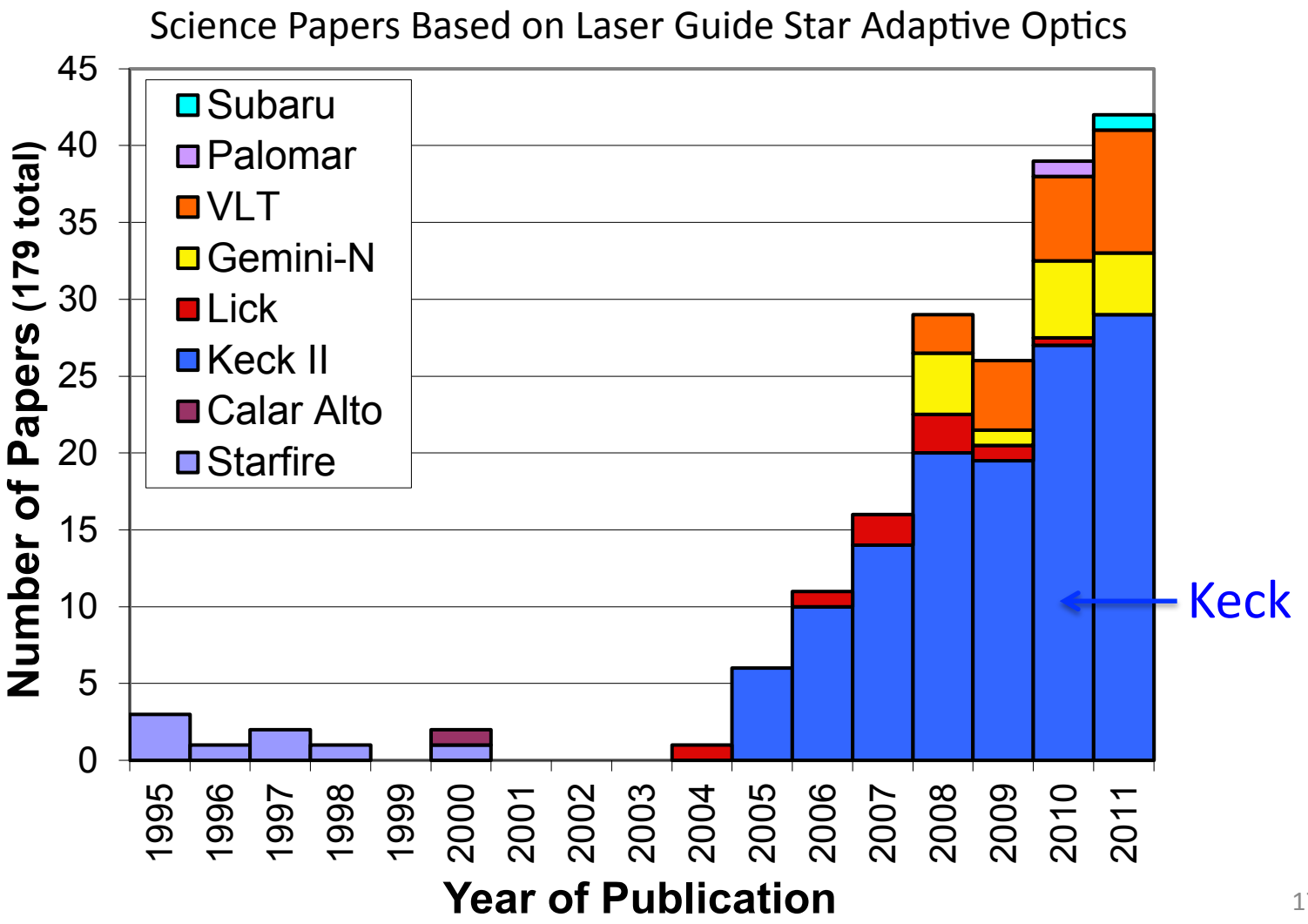
Adaptive Optics at the Galactic Center



Adaptive Optics at the Galactic Center

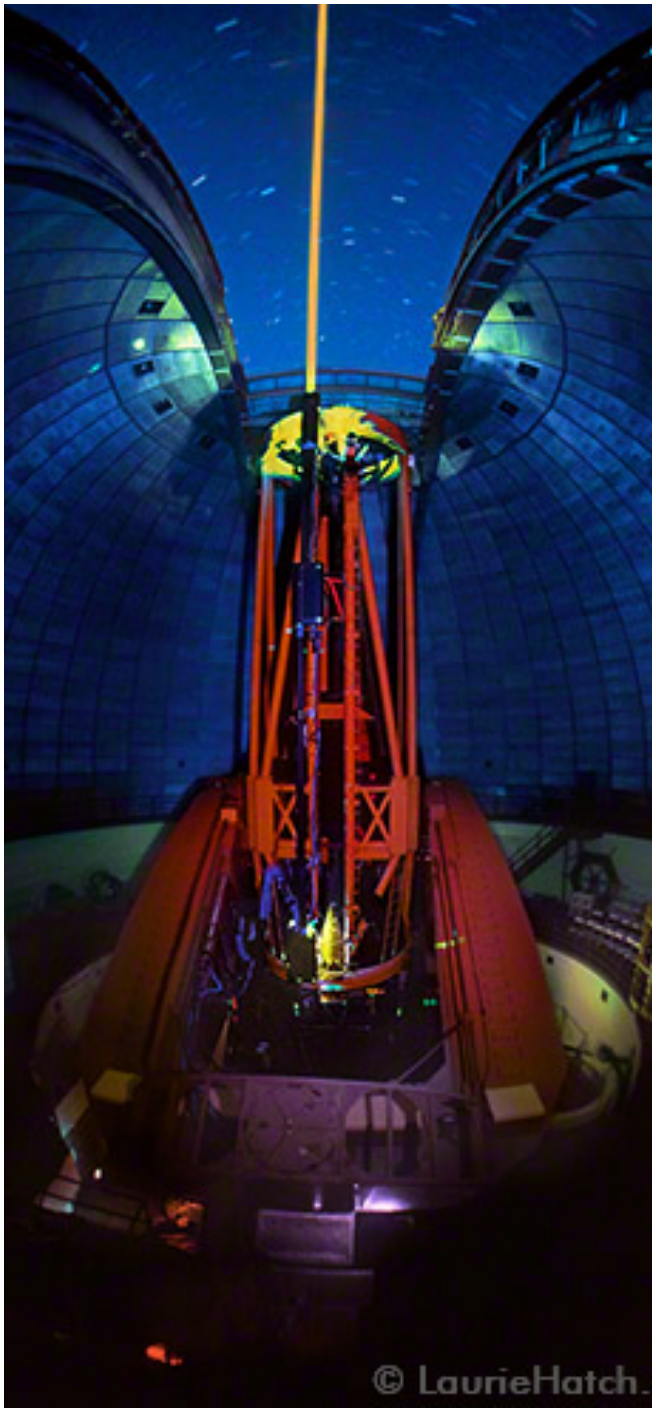


Keck Leads in the Field of Adaptive Optics



Shane Adaptive Optics at Lick

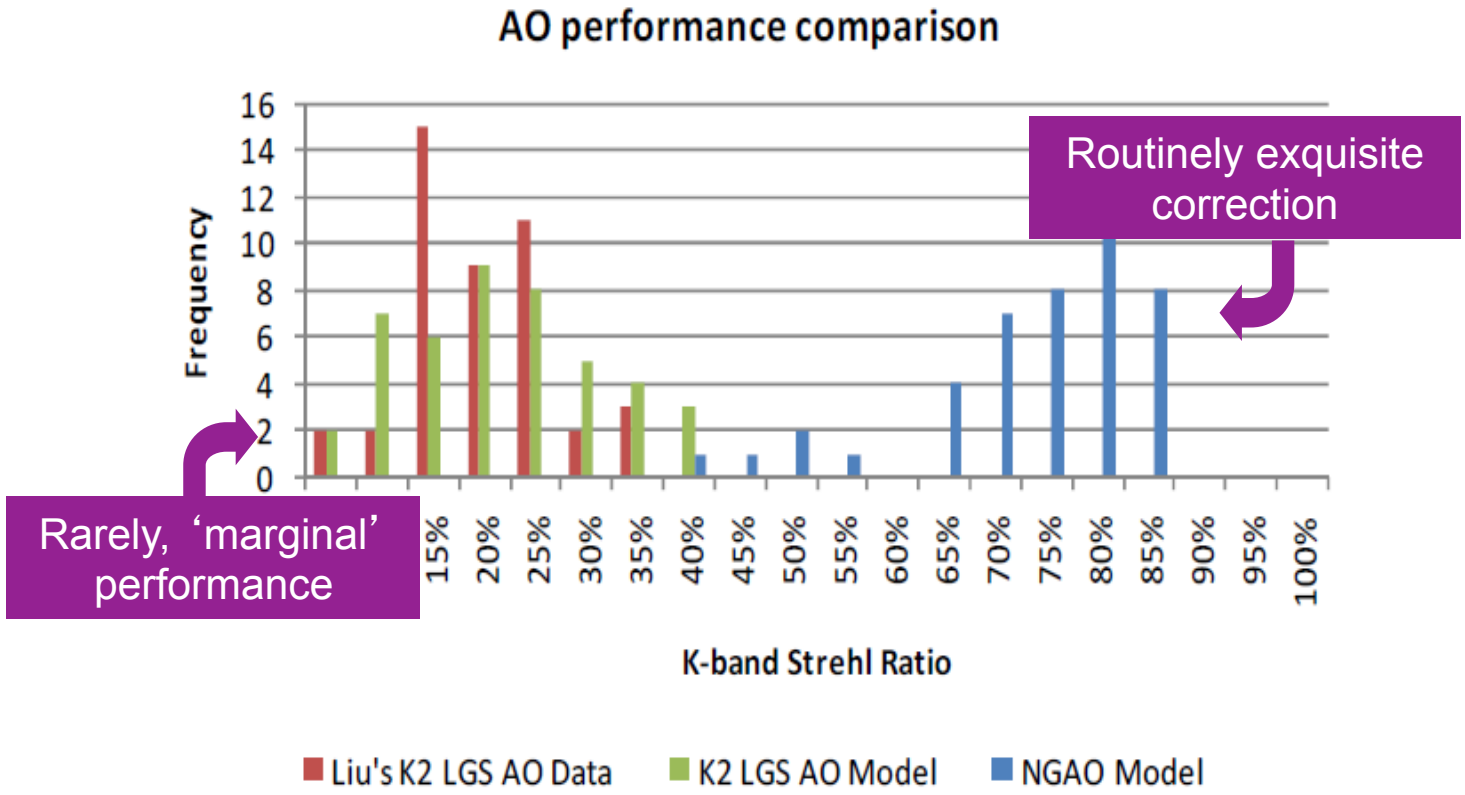
- Shane AO is a project led out of Santa Cruz to build a “next-generation” AO system for the 3-m telescope
  - MEMS-based system designed to provide much sharper correction and an order of magnitude improvement in sensitivity at the diffraction limit of the 3-m, plus extension to shorter wavelengths
  - New detector/camera mechanisms
  - New advanced format laser pumps sodium layer optimally (LNLL); brighter guide star
  - Excellent science case
  - Opportunity to implement and exercise a number of the Keck NGAO concepts
  - $2 M NSF MRI grant (sponsored out of UCSC) + $380 k grant from G&B Moore Foundation
- In fabrication and lab test phase, first light on telescope in Fall 2013



Next-Generation Adaptive Optics at Keck (NGAO)

* Passed Preliminary Design Review in June 2010
* Estimated remaining cost:
  AO = $37 M
  DAVINCI spectrograph = $13 M
* Work to be shared at UCSC, UCLA, Caltech
* CARA Board placed hold on until funding path clear

* New opportunities are on horizon
  - Mid-scale recommendation Astro2010 & NSF AST Portfolio Review (Aug 2012)
  - Keck 20th Anniversary celebration
  - UCLA Development office strongly engaged
* UCOAC and SSC endorsement: Fall 2012



Nearly All Leading US Universities Invest in O/IR Facilities

US institutions with their own observatory facilities with >2m apertures:

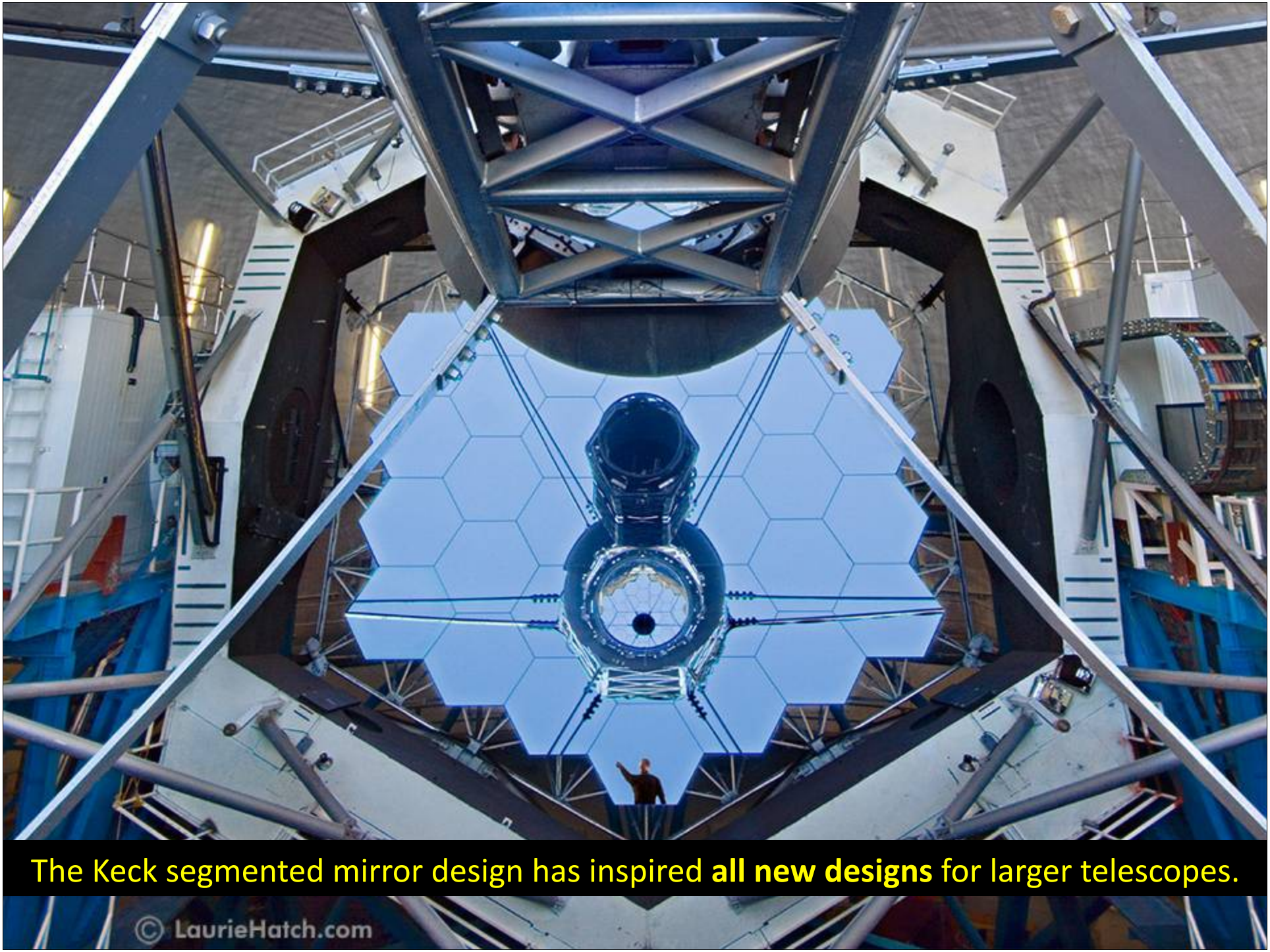
University of California Observatories	• Lick Observatory:
	  ◦ Shane 3m, Nickel 1m, CAT 0.6m
	  ◦ Private or semi-private: APF 2.4m, KAIT 0.8m
	• Keck partner
	• TMT partner

University of Arizona	• LBT 2x8.4m • MMT 6.5m • Magellan partner • GMT partner • VATT 1.8m • Mt. Lemmon 1.52m, 1.0m, others • Kitt Peak facilities: Bok 2.3m, others • Catalina Station (Mt. Bigelow) 1.55m, 0.7m
Caltech	• Palomar 5m, 1.5m, 1.2m, other small telescopes • Keck partner • TMT partner
University of Texas	McDonald Observatory: • HET 9.2m • Smith 2.7m, Struve 2.1m, 0.8m • GMT partner
University of Hawaii	Mauna Kea Observatories: • acceess to observing time on all MK facilities including Keck, Gemini-N, Subaru, TMT • UH 2.2m, CFHT 3.6m Haleakala Observatories: • Pan-STARRS 1.8m • Access to observing time at other telescopes including Faulkes 2m, AEOS 3.7m
Carnegie Observatories	Las Campanas Observatory: • Magellan 2x6.5m • Du Pont 2.5m • Swope 1m • GMT partner
Harvard-Smithsonian Center for Astrophysics	• Magellan partner • MMT partner • GMT partner • Whipple Observatory 1.5m, 1.3m, 1.2m
Lowell Observatory	• DCT 4.3m • Perkins 1.8m, 1.0m, other smaller telescopes
Las Cumbres Observatory	• Faulkes Telescopes (2x2m) • Network of 1m and 0.4m telescopes in development
University of Wyoming	• WIRO 2.3m

Other US institutions not having their own observatories but currently investing in optical telescope access, excluding survey projects such as SDSS or LSST:

American Museum of Natural History	SALT
Boston University	Lowell Perkins, DCT
Carnegie Mellon	SALT
Chicago	APO, Magellan, GMT
Columbia	MDM
Cornell	Palomar
Dartmouth	SALT, MDM
Georgia State	SMARTS, Lowell Perkins
Johns Hopkins	APO
Michigan State	SOAR
MIT	Magellan
New Mexico State	APO
Notre Dame	LBT, VATT
Ohio State	MDM, LBT, SMARTS
Ohio University	MDM
Penn State	HET
Princeton	APO
Rutgers	SALT
Stanford	HET
Stony Brook	Palomar, SMARTS
Texas A&M	GMT
University of Colorado	APO
University of Florida	GTC
University of Indiana	WIYN
University of Maryland	DCT
University of Michigan	Magellan, MDM
University of Minnesota	Steward Observatory, LBT
University of North Carolina	SOAR, SALT
University of Toledo	DCT
University of Virginia	LBT, VATT, APO, MMT, Magellan
University of Washington	APO
University of Wisconsin	WIYN, SALT
Yale	Keck, WIYN, SMARTS

Missing from top 20: Duke, U. Pennsylvania, Northwestern, Washington U., Brown, Rice, Emory

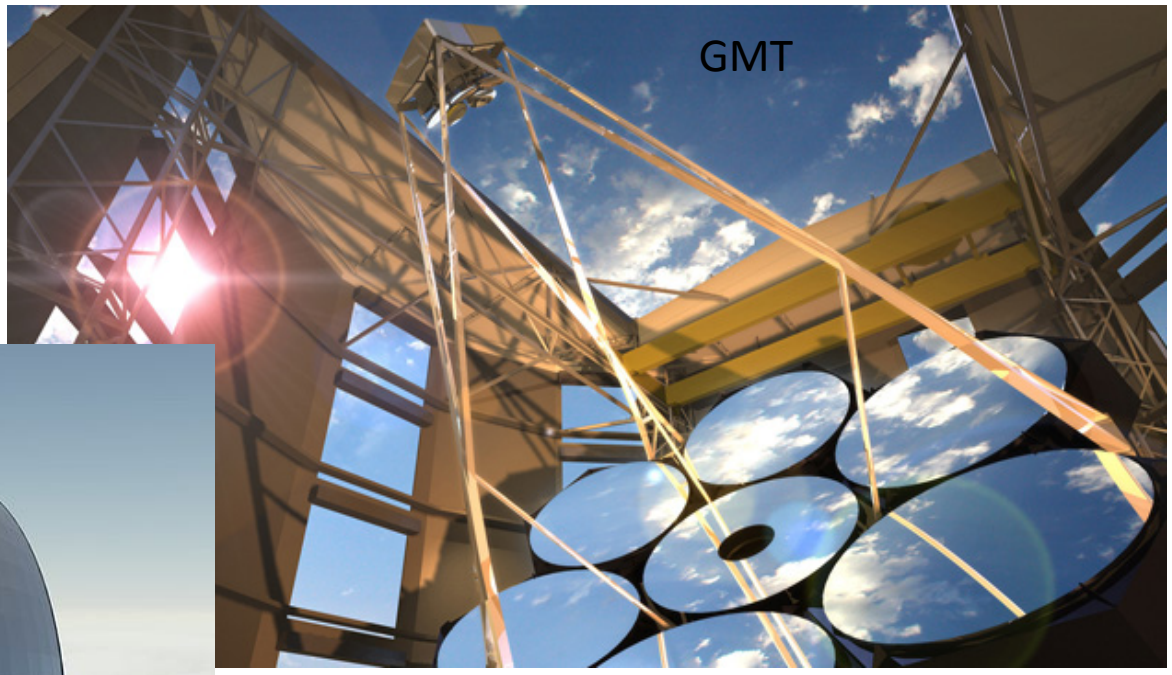


The Keck segmented mirror design has inspired **all new designs** for larger telescopes.

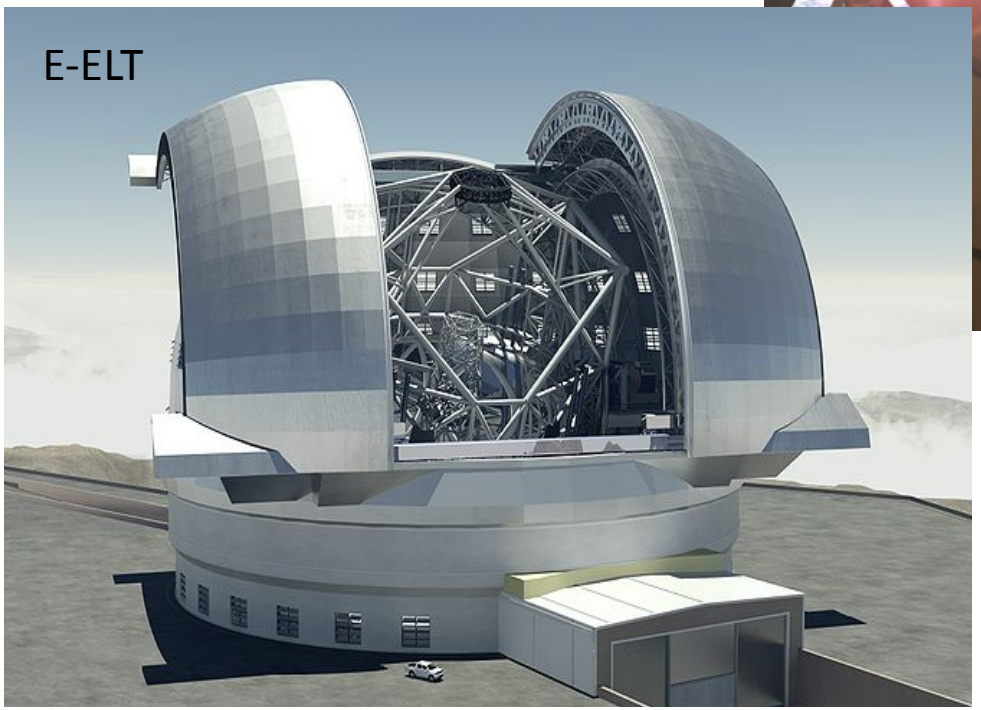
Developments in the O/IR World

Extremely Large Telescopes

GMT: 21.4 m primary (area); Carnegie, US univ., Australia, Korea; location Chile; cost $700 M; expected first light early 2020s

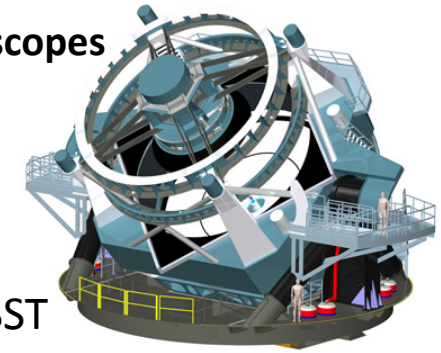


E-ELT: 39.3 m primary; ESO community; location Chile; cost 1 B euros; expected first light early 2020s



Giant Imaging Survey Telescopes

- LSST
- Pan-STARRS
- PTF+
- SDSS continuations



The Future of O/IR Astronomy in Space

* **James Webb Space Telescope** is Hubble's successor.
* Infrared telescope with 0.6 - 28 micron wavelength range
* 6.5 diameter segmented beryllium mirror (same concept as Keck).
* Diffraction-limited imaging quality for ≥2 micron
* Required design life is 5 years, expected to last ~10 years.
* Cost is $8 B to launch in fall 2018 on ESA Ariane 5 rocket.

JWST and TMT provide complementary and synergistic capabilities (cf. HST and Keck).

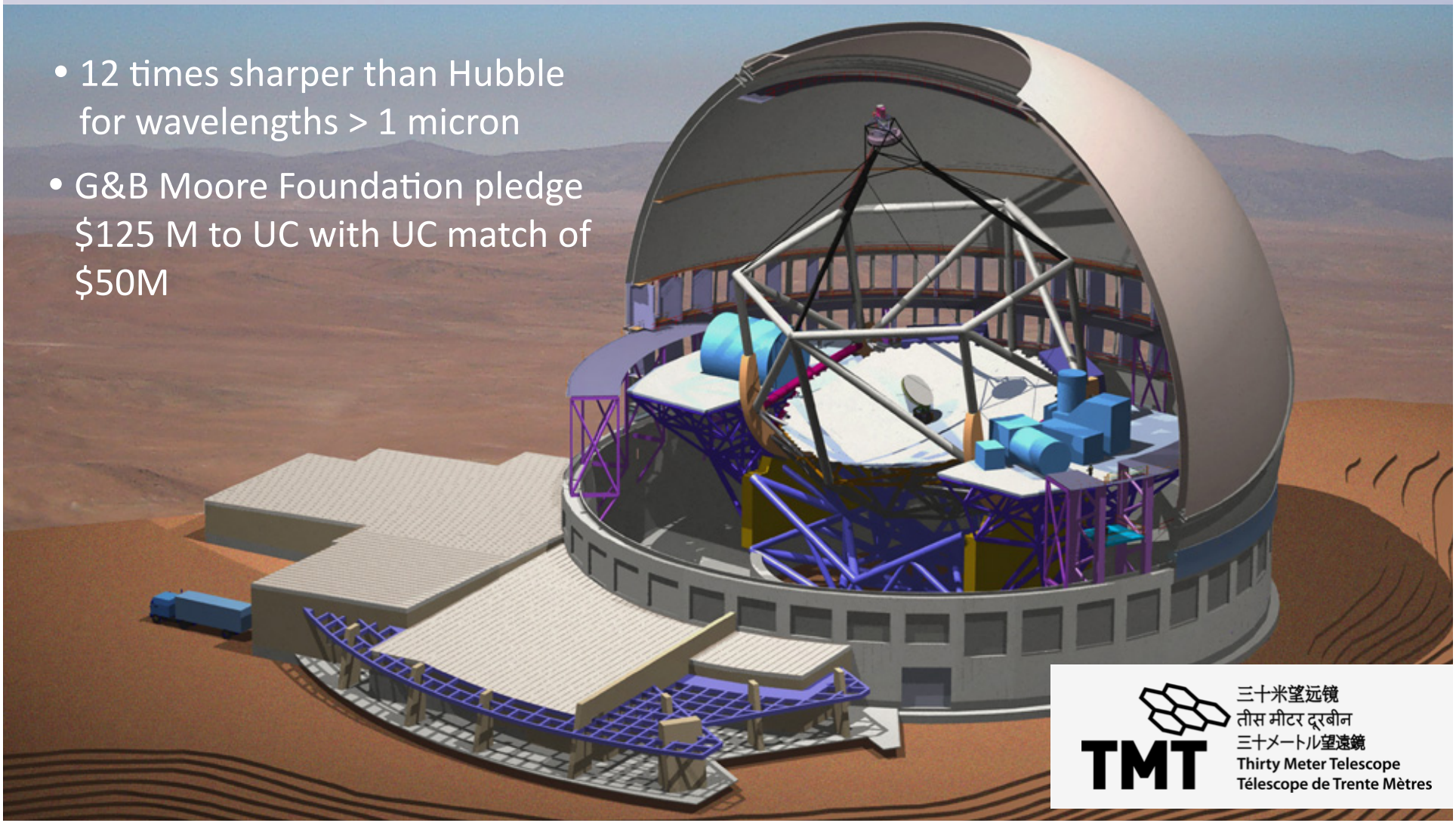
Key science goals are:

1) First light (stars and galaxies) just 200-300 million years after Big Bang,
2) Assembly of galaxies over all time (13.5 billion years),
3) Birth of stars and protoplanetary systems,
4) Planetary systems and origins of life.

And after JWST……????

Thirty-Meter Telescope Project (TMT)

30.0 m primary; partners UC, Caltech, Canada, Japan, China, India; location Mauna Kea; cost $1.15 B (2011); construction time 8 years; expected first light Dec. 2021



TMT Costs

- Capital cost: $1.152 B (FY2011)
  - 26.2% contingency
  - Includes Jan. 2011 Cost Review recommendations
- Operations (running) costs: $24.8M/yr
- New capabilities costs: $21M/yr

($12M/yr in ops budget) ← Permanent instrument $$$

  - Five more instruments planned after first-light suite of three
  - Also deformable secondary mirror for infrared AO
  - AO upgrade to reduce wavefront error from 120 nm to 85nm

UC's Share in TMT

- Current partnership principle regarding shares is based on:
  - Contributions to capital
  - Contributions to operations for first 20 years
  - Contributions to new capabilities for first 20 years
  - Early funding premium factor ("Founder's Shares")

- 15-19% is the current UC share for the first 20 years assuming:
  - $175 M capital contribution ($125 M from Moore, $50 M from UC)
  - $5.5-7.0 M/year operations (cf. Keck "savings" = $6.5 M/year)
  - 3-5% premium factor (this is not yet agreed to)

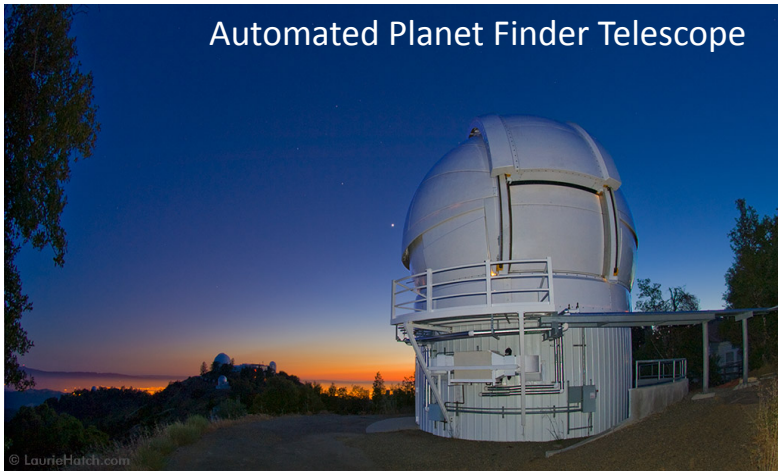
- May also have community access if NSF becomes a partner

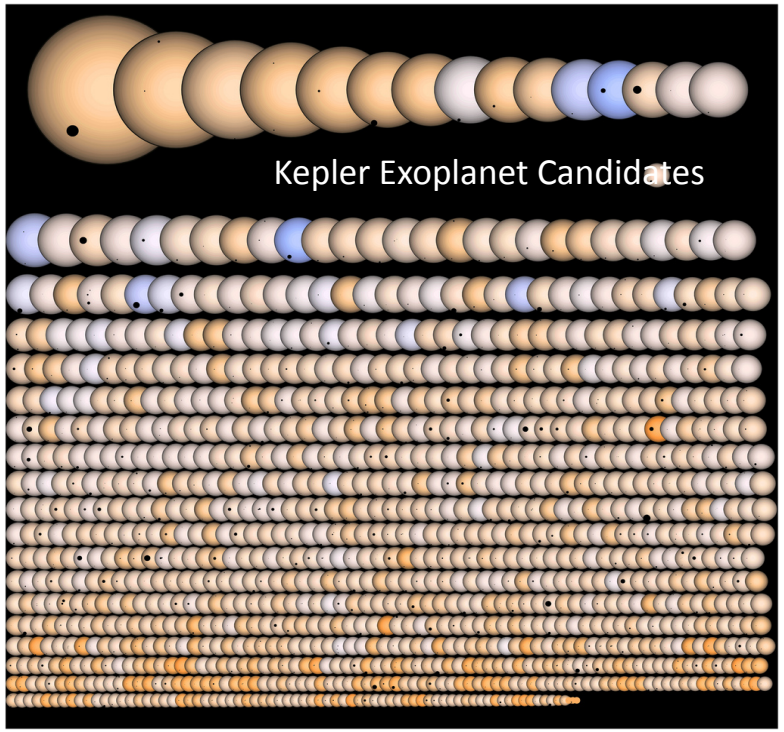
- Note: In buying into TMT we are really buying into a *SCIENTIFIC COMMUNITY* with the right to collaborate.

Lick Observatory Programs

- **Planning**
  - Lick Observatory Strategic Planning Committee: 2009
  - Lick Observatory EPO partnerships workshop: May 2012
  - Lick Community Workshop: September 2012
- **Projects**
  - Shane AO
  - Automated Planet-Finder Telescope
    - 2.4-m diameter on Mount Hamilton
    - Mission: to study nearest 1,000 stars for planets using Doppler motions to <1 meter/sec
    - $12 M from US Naval Observatory, private funds, NASA, UCO support
    - First robotic spectroscopic telescope at Lick
    - Marcy (UCB) and Vogt (UCSC) will split time; roughly half available for general observing
- **Potential Major Surveys**
  - Supernovae and transient spectroscopy
  - Active galaxy reverberation mapping
  - Exoplanet searches (transitioning to APF soon)
  - Shane AO surveys of galaxy gravitational lenses, etc.

MANY OF THESE ARE TIME-DOMAIN SCIENCE, WHERE SHANE REMAINS VERY COMPETITIVE.





Lick and Keck

- **Technology transfer from Lick to Keck: historical**
  - Shane Cassegrain focus: first remote TV guider and photo-counting detector in astronomy
    The "digital revolution" in astronomy started at Lick
  - Proof of laser guide-star concept for AO
  - Invention of iodine cell – opened the way to Doppler discovery of hundreds of exoplanets
  - Hamilton high-resolution spectrograph was prototype for Keck HIRES

- **Technology transfer from Lick to Keck: now**
  - Shane AO is proving new AO correction scheme and efficient laser pumping of sodium layer
  - APF is establishing Doppler accuracy needed for future Keck SHREK spectrograph

- **Lick as "science finder" for Keck**
  - Exoplanet candidates with Hamilton followed up at Keck
  - QSO candidates for measuring primoridal nucleosynthesis abundance are screened at Lick
  - Supernova calibration determined at Lick continues to provide foundation for accelerating universe measurement at Keck

Grad+Undergrad Systemwide Training

- Traditional training ground for graduate students; 15-20 from around system
- Have opened this up increasingly to undergraduate classes
- Remote observing stations have been key to undergraduate classes
- Almost 50% of 3-m time is allocated to student and postdoc PIs

Lick Observatory Public Outreach

- Open to visitors all year: ~ 30,000 per year
- New “Friends of Lick Observatory” donor group
- Special events (Transit of Venus)
- “Music of the Spheres” concerts with live music and viewing
- Summer Open House nights with lectures and viewing
- Center for Science Excellence: high school science teacher summer workshop
- Tech Museum of San Jose: exhibits, remote real-time telescope

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- UC's competitors are investing heavily in giant ground-based telescopes around the world; efforts are intense; the scientific payoff is huge.

- The Keck+TMT combination is affordable at little extra cost from UCOP funds.

- Major investments have been made at Lick that will return important science in five years and are technical steppingstones to Keck and TMT. We should continue to operate Lick for at least five years and review its status as we approach the Keck+TMT era.

Recommendations on Vision, Context, and Plan

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- *Recommend 2:* Endorse plan to redirect Keck savings after 2018 to pay TMT operating costs.

- *Recommend 3:* Support Lick operations for 5 years at spartan level while plans are developed for 2018 and beyond.

Part II: UCO in FY13

Summary Points on UCO in FY13

- The FY13 budget is in balance at $7.5 M.
- Cut in staff over last 8 years has been 30%. Same at UCLA.
- Current allocation of UCSC technical effort is weighted to Lick. Resources need to be redirected to reflect urgent instrument needs at Keck.
- A systemwide strategic planning process is now underway, first results will be available in March.
- *Recommend 4:* Redirect some fraction of technical effort from Lick to Keck instrumentation by operating Lick in spartan mode for next 5 years. Details in Feb.

Current Staff Roster: FY13

- UCSC labs: Total = 28.5 persons + 8 (soft money)

Research Scientists:	3(+2)
Instruments (14.5+4.5 persons):	1 Technical Mgr, 5 Engr, 1 Laser Engr, 4.5 Software Engr, 2 Opticians, AdminAsst (+ 4.5 techs)
Bus./Support (11+1.5 persons):	Asst Dir, Exec Asst, Financial Mgr, HR Mgr, 4 Analysts, Buyer, CompRes, AdminAsst (+ 1.5 admin)

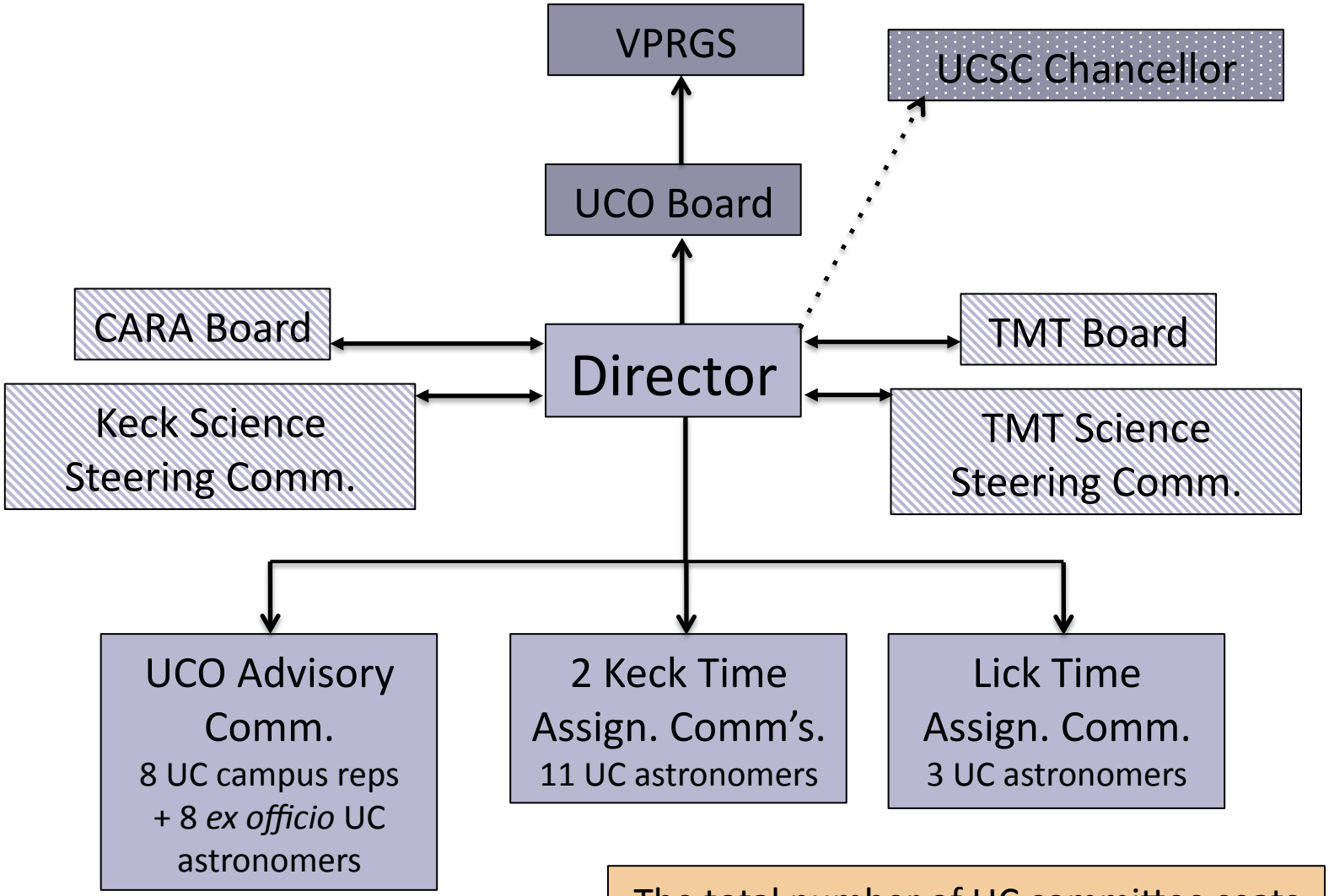
- UCLA labs: Total = 8 persons

Instrumentation (7 persons):	3 Engr, 2 Techs, 2 Software Engr
Business/Support (1 person):	AdminAsst(Purch,Acct,Trav,Sched)

- Lick Observatory: Total = 10 persons

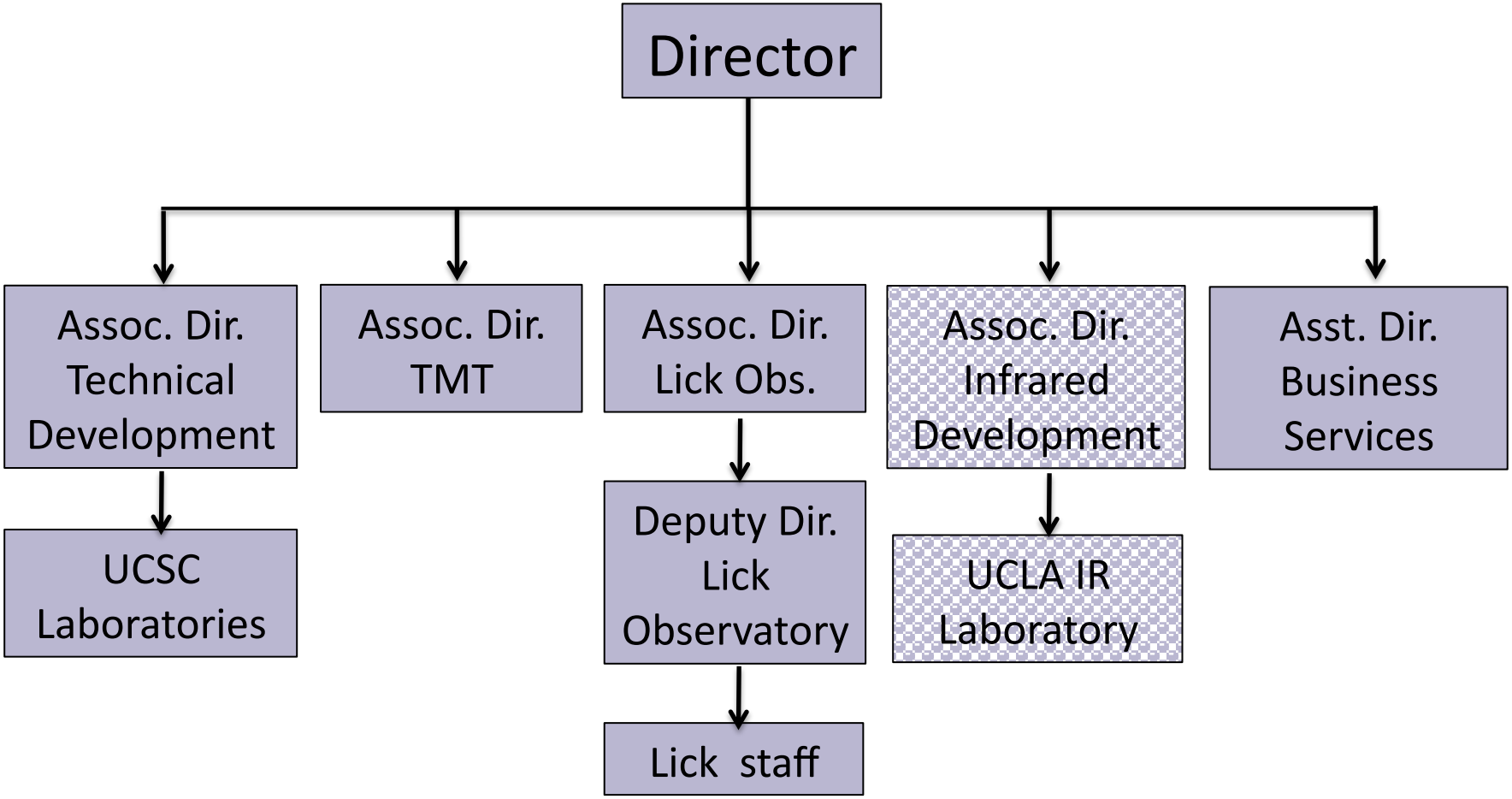
Operations:	1 TeleOps Mgr, 5 TeleOps, 1 Mechanician
Observing support:	1(+1) Support Astronomers
Business/Support:	Deputy Dir. (+0.3 AdminAsst)

Governance Structure



The total number of UC committee seats filled by faculty in TMT era is approx. 27!

Current Organization Chart



Projects at the UCSC Labs

Underway:

- Shane AO: Installation Fall 2013 followed by 3 years observing
- APF commissioning: regular operations start Fall 2013
- KCWI (blue side) camera for Keck: lens polishing, fabrication of lens mountings, assembly and test. Subcontract to Caltech. Complete early 2014.
- Advanced Coatings Laboratory: developing durable overcoated silver coating for Keck and TMT segments. Important for Keck, vital for TMT
- MOBIE spectrograph design: first-light instrument for TMT
- Planning for UCO Instrument Labs refurbishment project
- Numerous small projects for Lick Observatory, mostly software

Pending, awaiting funding:

- Deployable Keck 1 Tertiary mirror: $1.5 M proposal to NSF
- DEIMOS spectrograph detector upgrade for Keck
- Fabricate, assemble, test KCWI red camera for Keck
- GPI commissioning support – for Gemini-South, camera was assembled at UCSC; this would continue those efforts
- Kast spectrograph upgrade for Lick; donor contacted
- Next-generation Keck AO: $50 M project, major NSF proposal this summer

Projects at the UCLA Labs

Underway:

- FLITECAM (commissioning and science; IR camera for SOFIA Observatory)
- IRIS (continuing design work; first-light TMT instrument)
- Several exploratory studies that could yield bigger contracts later

Pending, awaiting funding:

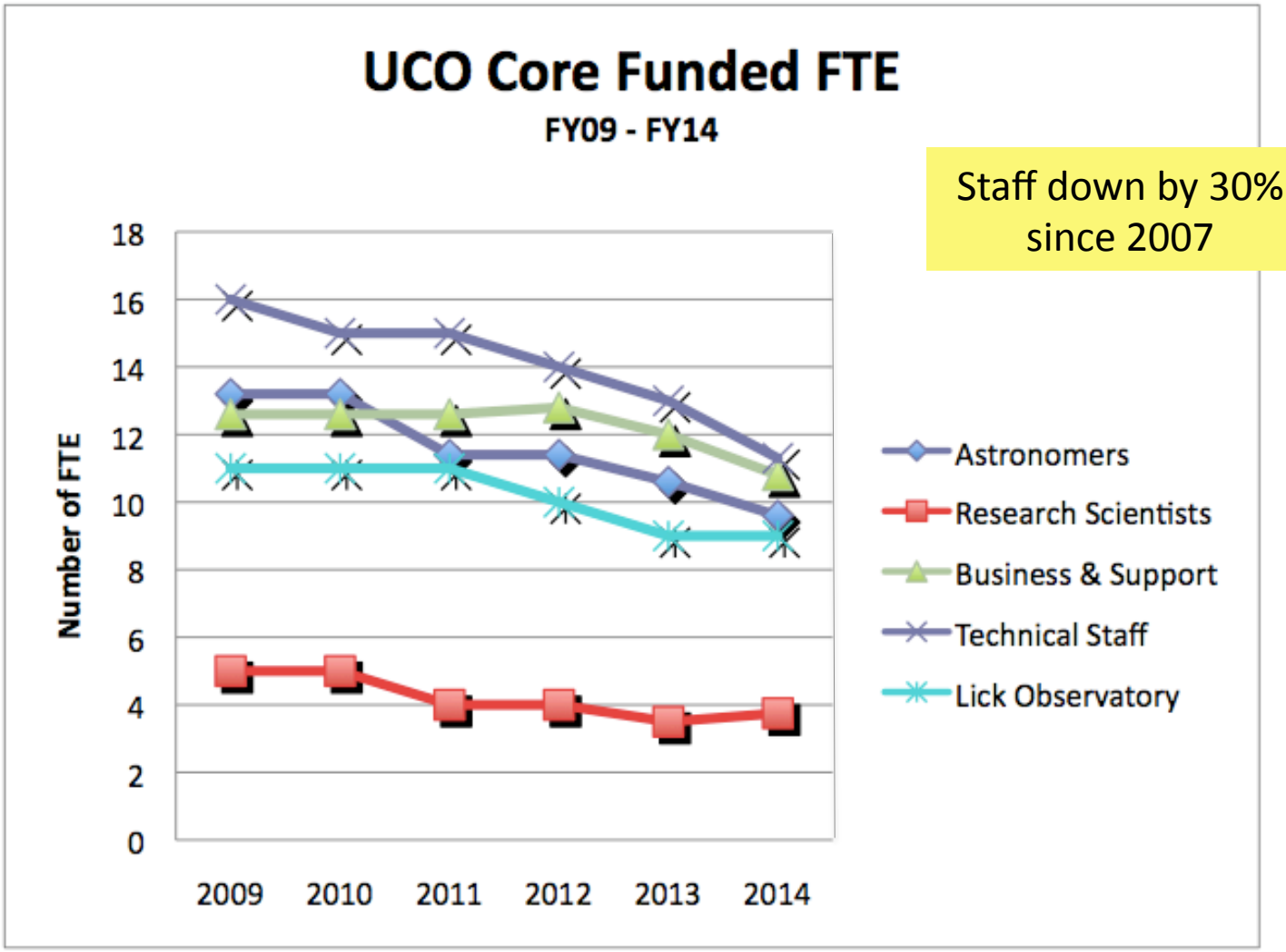
- KCWI-red side (software/electronics; KCWI-blue for Keck is already going)
- OSIRIS upgrade (existing IR spectrograph on Keck)
- NIRSPEC upgrade (existing IR spectrograph on Keck)
- DAVINCI (new near-IR spectrograph for Keck NGAO)

FY13 Budget

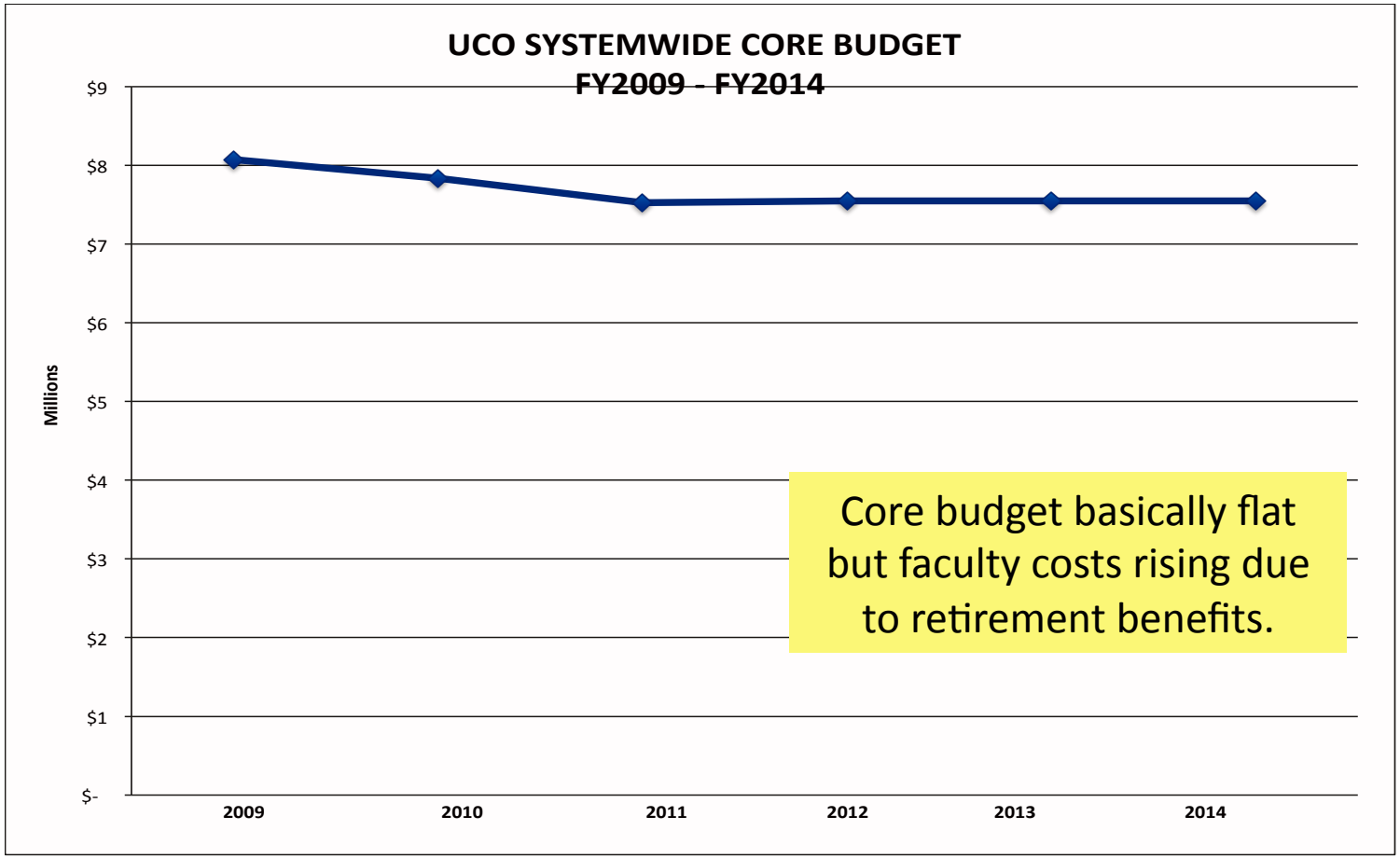
	FY13	
EXPENDITURES	FTE	$
Astronomers	11.40	2,552,313
Research Scientists	4.25	628,680
UCLA IR Lab		300,000
Technical Staff	14.25	2,085,311
Lick Staff	9.28	984,708
Admin & Business Staff	12.53	1,256,462
Non-Salary Expend		620,000
TOTAL CORE	51.71	8,427,473
Recharge Staff	5.00	476,625
UCO TOTAL	56.71	8,904,098
REVENUE		$
UCOP Base Budget		7,548,243
One-time funds (UCOP)		250,000
One-time funds (UCO)		300,000
Technical Recharge Revenue		842,476
		8,940,719
YEAR END PROJECTED BALANCE		36,621

One-time

FTEs vs Time


UCO Core Funded FTE
FY09 - FY14
Staff down by 30% since 2007
Number of FTE
18
16
14
12
10
8
6
4
2
0
2009
2010
2011
2012
2013
2014
Astronomers
Research Scientists
Business & Support
Technical Staff
Lick Observatory

Core Budget vs Time



Summary Points on UCO in FY13

- The FY13 budget is in balance at $7.5 M.
- Cut in staff over last 8 years has been 30%. Same at UCLA.
- Current allocation of UCSC technical effort is weighted to Lick. Resources need to be redirected to reflect urgent instrument needs at Keck.
- A systemwide strategic planning process is now underway, first results will be available in March.
- *Recommend 4:* Redirect some fraction of technical effort from Lick to Keck instrumentation by operating Lick in spartan mode for next 5 years. Details in Feb.

Part III: Governance Going Forward – UCO Faculty, Director, MRU

Summary Points on Future Governance

- Faculty positions are moving to UCSC with their funding, but UCOP will take back savings after TBD number of initial retirements.
- The future staffing plan envisions UCO faculty in Assoc. Director positions and as Instrument PIs; most are at UCSC, one is at UCLA, some are distributed around the system supported by Compensation for Service (CfS).
- "Glidepath" model for UCSC: 13 persons → 8 persons over 5 years. Nine potential retirements or transfers versus four new hires (Director + 3 faculty).
- Currently UCO has no operating MOU with UCOP.
- The Compendium describes both Multicampus Research Units (MRUs) and Multi-Campus Research Initiatives (MRPIs). Neither category fits the long time horizon, large facilities investment, and external-partner obligations of UCO. The definition of the Director position, who he reports to, and how he is appointed need to be defined as part of a new category definition and associated MOU for UCO.
- I am retiring July 1, 2013. An Interim Director is needed on that date.

Summary Points on Future Governance, cont'd

- *Recommend 5*: Set aside the first two retirement positions for the Director and an ***Assoc. Director of Adaptive Optics,*** with permission to start the hiring process immediately.

- *Recommend 6:* Advise UCOP that current MRU definition is unsuitable for UCO. Request a TBD committee to work with current UCO administration to craft new words and new MOU with completion date Jan. 1, 2014.

- *Recommend 7:* Advise UCOP that Director search should be initiated in Fall 2013 in anticipation of final MRU/MOU. Director should be appointed by UC President or designee with review and approval by the UCSC Chancellor. Request that UCO and UCSC administration draft a position description, compensation plan, and a performance review process for presentation at next Board meeting.

Current UCO Faculty Responsibilities List (FRL)

See full list at
http://www.ucolick.org/administration.html

RESPONSIBILITIES	FACULTY
Director	Faber
Associate Director, Lick Observatory (LO)	Prochaska
Associate Director, Instrumentation	Rockosi
Associate Director, UCLA InfraRed Lab (IR Lab)	McLean (UCLA Faculty)
Associate Director, Thirty-Meter Telescope (TMT)	Bolte
UCO Cabinet Member	Bolte (ex officio, Assoc Dir TMT) Brodie (ex officio, Commun Coord) Illingworth Koo (ex officio, Commun Coord) McLean (ex off, Assoc Dir UCLA IR Lab) Prochaska (ex officio, Assoc Dir LO) Rockosi (ex officio, Assoc Dir Instruments)
Provides advice to the Director, prompt response to emergencies, problem-solving, budget planning, policy development.	
UCO Representative to Systemwide Optical/InfraRed (OIR) Strategic Planning Committee	Prochaska
Internal Strategic Planning Committee Member	Bernstein Epps Gavel[a] Max McLean Rockosi Smith
The Internal Strategic Planning Committee is an ad hoc committee charged with developing internal UCO input to the systemwide OIR strategic plan. A major focus will be on UCO instrumentation efforts and the staff and infrastructure needed for that but the committee will also consider broader issues. Suggestions from this internal committee will be forwarded to the systemwide committee for discussion, incorporation, and/or modification. The internal committee will also act as a resource for the systemwide committee to provide factual data on UCO operations.	
TMT Board Member	Bolte
TMT Scientific Advisory Committee (SAC) Co-Chair	Illingworth
TMT SAC Member	Bolte (ex officio, TMT Board Member)
CARA Board Member	Faber
Keck Scientific Steering Committee (SSC) Co-Chair	Prochaska
Keck SSC Member	Faber (ex officio, UCO Director) Nelson (ex officio, WMKO Proj Scientist) Bernstein
Keck Adoptive Optics (AO) Planning Committee Member	Max
UCOAC Member	Faber (ex officio, UCO Director) Prochaska (ex officio, Keck SSC co-chair) Illingworth (ex offico, TMT SAC co-chair) Smith
The UCOAC is the systemwide advisory committee that advises the UCO Director on the UC OIR facilities and instrumentation program.	
Keck Extragalactic TAC Chair	Faber
Keck Extragalactic TAC Co-Chair	Guhathakurta

What UCO Faculty Do Now

Astronomical management and leadership, general:

* Director
* UCO faculty meetings
* UCO Advisory Committee
* Strategic planning activities
* Development activities: Lick and Keck
* Personnel actions/supervision
* External communications: publicity, website, newsletter, Annual Report
* Education and outreach programs
* Space management
* Computing facility management

Instrument management and leadership:

* Assoc. Director for Instrumentation
* Assoc. Director for UCLA IR Lab
* Moore Adaptive Optics Laboratory supervisor
* Scientific Programming group supervisor
* Center for Adaptive Optics supervisor

What UCO Faculty Do Now, cont'd

Thirty-Meter Telescope:

* Assoc. Director for Thirty-Meter Telescope
* TMT Board
* TMT Science Advisory Committee
* UCO Advanced Coatings Development Program faculty supervisor

Keck Observatory support:

* CARA Board
* Keck Science Steering Committee
* Keck Time Assignment Committees and telescope scheduling
* Keck policies and operational oversight
* Keck Next Generation Adaptive Optics Committee
* Keck Observatory technical support

Lick Observatory support:

* Assoc. Director for Lick Observatory
* Lick Observatory Time Assignment Committee and telescope scheduling
* Lick Observatory policies and management oversight
* Lick Observatory technical support
* San Jose lighting liaison

New instrumentation (Keck, TMT, Lick):

* Instrument PIs
* Leaders of instrument subsystems
* New instrument proposals

Fractional Effort Distribution at UCSC

Distribution of Core-funded FTE Supporting Systemwide Activities [1]

Effort in % of time

FY13 CORE BUDGET			Scientific Leadership			Support/Maintenance			New Instrumentation			
CATEGORY	FTE	$M	Astron Mgt	Instr. Mgt.	Research Admin	TMT	Keck	Lick	TMT	Keck	Lick	APF
UCO Faculty Astronomers	3.3	0.7	49%	3%		7%	9%	7%	6%	10%	8%	
Research Scientists	3.5	0.7				18%	11%	13%	5%	10%	44%	
Business & Support Staff	9.6	1.0	9%	5%	10%	3%	13%	26%	9%	19%	5%	1%
Technical Staff	13.0	2.1	2%			3%	8%	28%	5%	13%	29%	12%
Lick Observatory Technical Staff	9.0	1.0	10%					80%			10%	
UCLA IR Lab	2.8	0.3							28%	62%	10%	
Supplies & Equipment	0	0.6										
TOTAL	41.2	6.4	9%	1%	2%	4%	7%	34%	6%	14%	18%	4%

The administrative load on UCO faculty is substantial: interface with three communities plus UC administration, plus US community.

Total TMT	10%
Total Keck	21%
Total Lick	56%

[1] This table does not include individual UCO faculty science research grants and their associated administrative support. An additional 8 FTE at UCSC are supported by external funding on various instrumentation projects. Externally funded work that is separate from UCO includes: Gemini Planet Imager (UCO-$90K; UCLA-$55K) and SOFIA FLITECAM (UCLA-$180K).

UCOAC Desiderata for UCO Faculty

- Faculty-level experience, perspective, leadership, and stature
- Focus and commitment
- Clearly defined duties and expectations
- A staffing plan that reflects the needs of the organization and the responsibilities of each faculty
- Regular and effective review of the performance of UCO duties
- Opportunities for faculty on other campuses to serve, with appropriate support
- A critical mass of UCO faculty on one lead campus, UCSC

Structure and Location of New UCO Faculty (proposed)

At UCSC:

- Regular 9-month professor appointments augmented by 2 quarters of teaching relief and 1 quarter summer salary. Total effort for Observatory duties is approximately 0.25 FTE.
- Duration: 5 years with expectation of renewal.
- Current 11-month "Astronomer" position will probably disappear.

At UCLA:

- Similar, but flexible. Nominal 1 quarter teaching relief and 1 month summer salary. From annual UCLA lab allocation.

Systemwide:

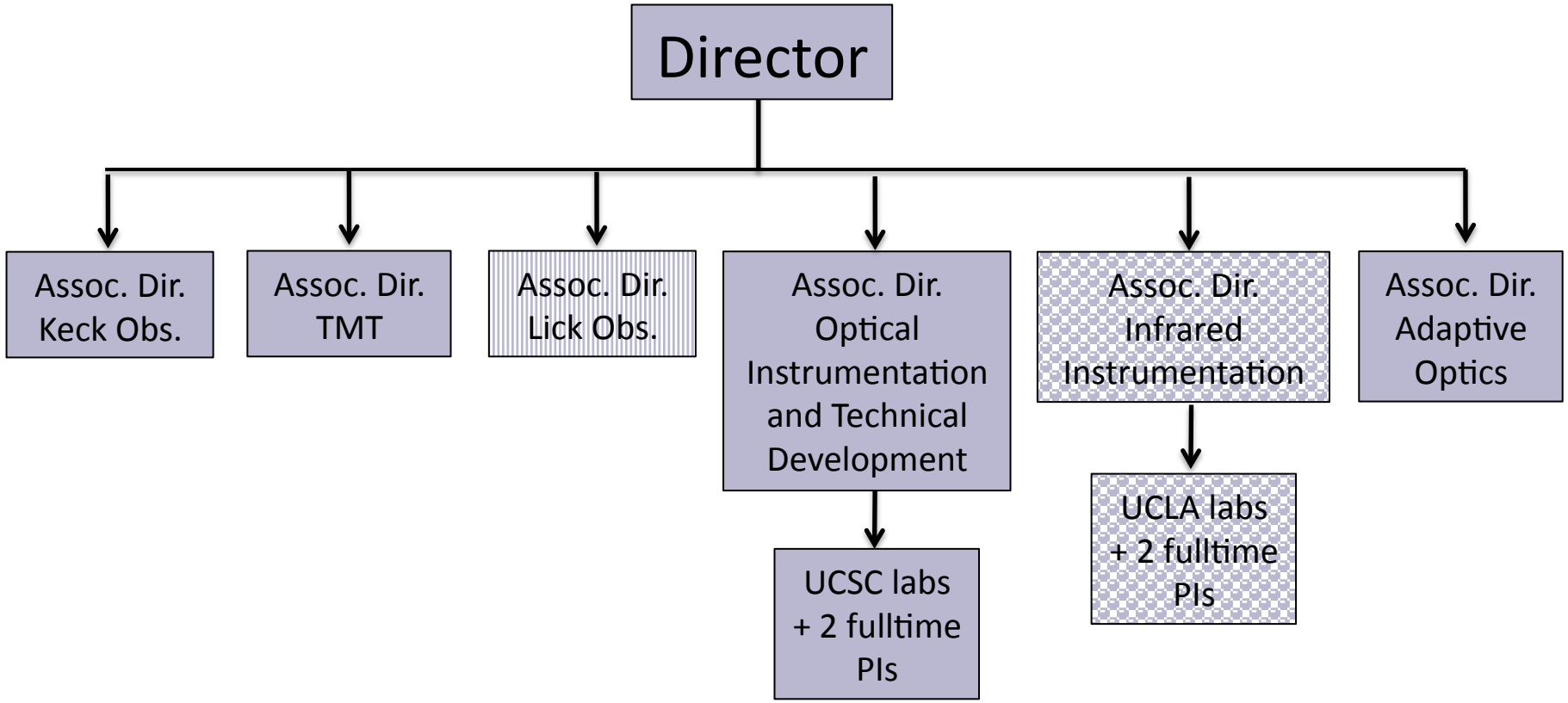
- 1 unfilled FTE at UCSC to use for distributed teaching relief and summer salary.

All:

- Personnel reviews will include appraisal letter by UCOAC.

Proposed Future Faculty Staffing Plan

- Total UCSC: Director + 6 faculty (+ Lick Assoc. Director) = 8 faculty
- Total UCLA: 3 faculty
- Distributed: Compensation for Service (CfS) for 6-8 faculty on other campuses
- Strategic Planning Committee will make recommendation in March



Outstanding Governance Issues

- An appropriate category in the Compendium that fits UCO.
- A new MOU.
- Interim Director, needed July 1, 2013.
- Search for the permanent Director.
- Time and location of next Board meeting.

Uncertainty and delay concerning the future of UCO are having a ***major impact*** on community perceptions, UCSC graduate applications (down 30% this year), and (in all likelihood) grant success.

REASSURANCE AND PROMPT ACTION ARE NEEDED.

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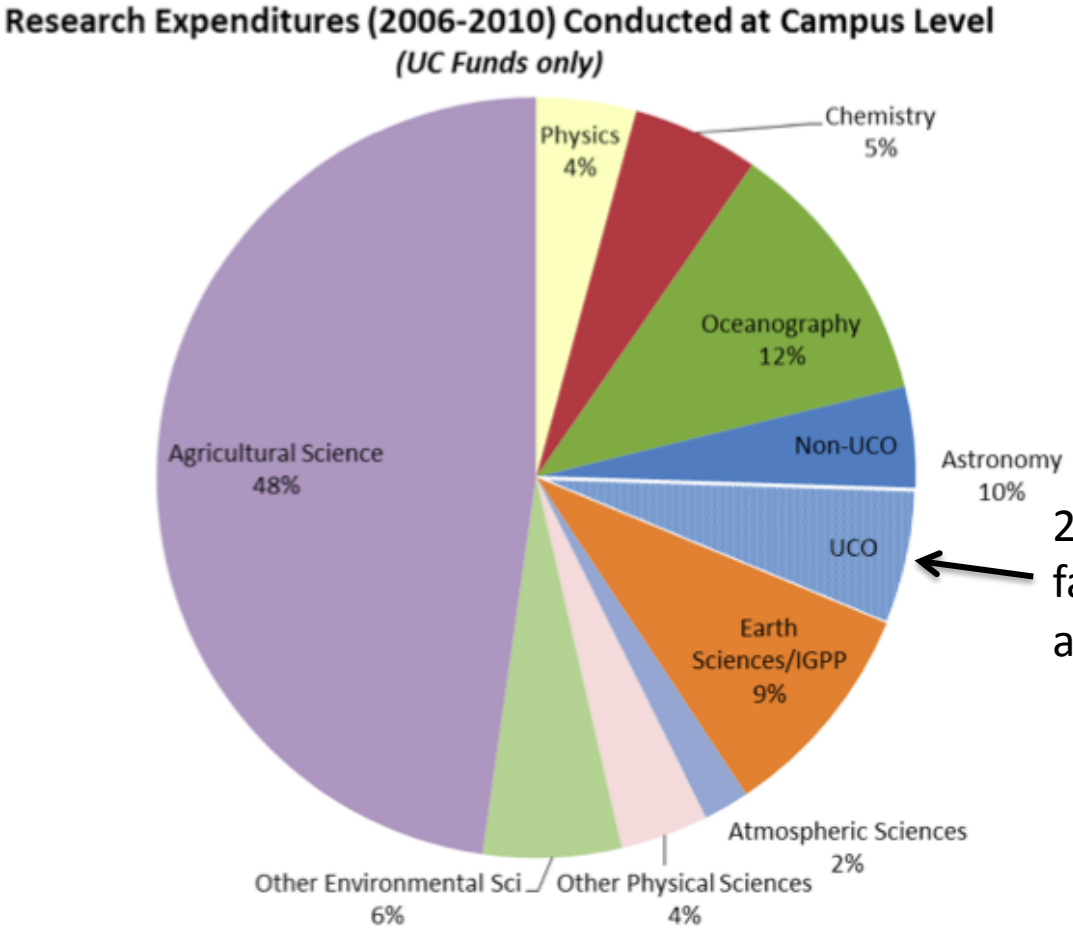
Part IV: The UCO Budget – Long-Term and Near-Term

Summary Points on FY14 Budget

- Astronomy is not expensive in terms of lifetime support per UC scientist. Grant income vs. investment is comparable to other UC sciences.
- Running costs at Keck and Lick are low compared to comparable sites.
- The optimum model puts ***TMT instrumentation into the Core***.
- FY14 budget is under study. UCOAC will recommend priorities on Feb 25. Request to postpone final report until next UCO Board meeting.
- Paying back debt at $0.65 M/year out of Core budget for next four years would be ***DISASTROUS***.
- *Recommend 8*: Apply faculty savings to repay the UCO debt.
- *Recommend 9:* Include TMT instrument-building in long-term Core model.

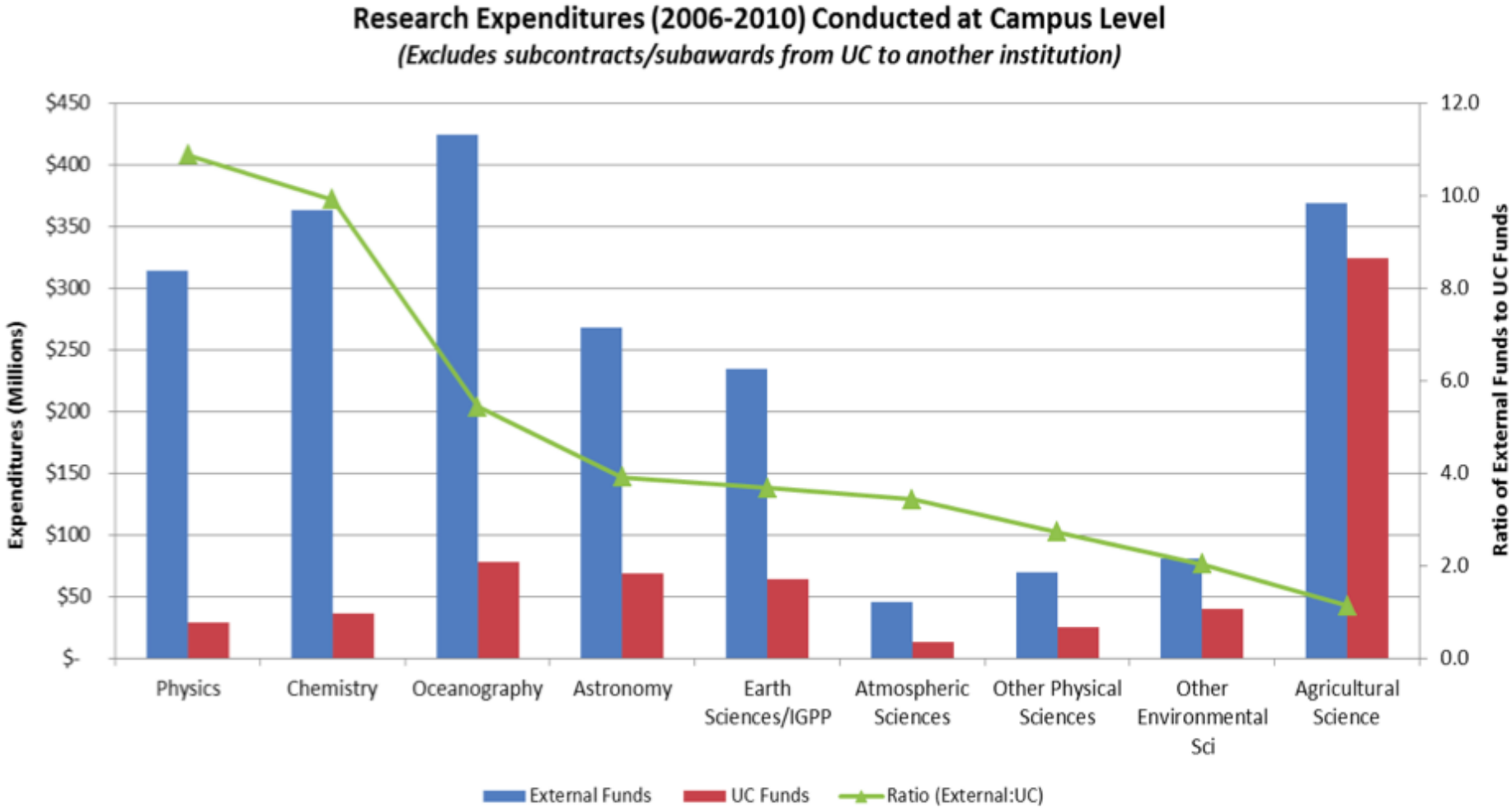
Astronomy as a Fraction of UC Research Expenditures



2/3 of UCO supports facilities at Lick, Keck, and TMT.

Head-to-head comparison of research expenditures from **all** UC funds, disregarding facilities costs (except for UCO). Non-facilities costs for astronomy are comparable to those of other fields.

External Revenue Returned per UC Investment



UC research expenditures from all sources (red) are compared to external funds generated from grants and contracts (blue) The ratio is plotted in green. Astronomy ratio is near the median. In preparing this graph it is important to capture grant income from astronomers in Physics departments. Only two campuses have astronomy departments (UCSC and UCB), and even those campuses also have astronomers in Physics.

Lifetime UC Research Expenditures per Scientist

Table 1
State Funds Invested per UC Scientist

	Astronomer	Laboratory Scientist
(a) Capital costs	$1.07 M	$1.64 M
(b) Start-up	0.39	1.63
(c) Annual operations	0.114	0.026
(d) Operations over 30 yr	3.41	0.78
Lifetime total (a+b+d)	$4.87 M	$4.05 M

Lifetime investment per research scientist **including facilities costs** (excluded from two previous slides). The "Astronomer" is a typical Keck observer. His/her share of Keck capital costs is calculated as the UC share of the original cost of the two Keck telescopes divided by the number of UC observers who use it. These are taken to be the current number of observers (65) times two, assuming that the useful life of a telescope is 60 years and the research career of a faculty member is 30 years. The "Laboratory Scientist" is a typical faculty member with a laboratory in one of two new research buildings at UCSC. Capital costs were assigned per faculty as a fraction of space devoted to research (57%). The buildings are assumed to last 60 years (serving two generations of faculty), but, unlike the telescopes, renovation and major maintenance double construction cost. Start-up costs are averages from UCLA and UCSC for astronomers and laboratory scientists over the last 8 years. With proper account taken of capital investment in facilities and startup costs, the difference in UC cost between astronomers and lab scientists is small.

Comparing Keck Observatory's Operations Costs to Peers

- Keck Observatory: two 10-m telescopes, Hawaii
  - $16.0M, Ops & Infrastructure FY2013 (does not include new instrumentation, segment repair, or Advancement)
- Gemini Observatory: two 8-m telescopes, Hawaii and Chile
  - $30.3M, Ops & Infrastructure (does not include new instrumentation costs; no Advancement program at Gemini)
- CFHT, one 3.6-m telescope, Hawaii
  - $10M, Ops & Infrastructure (does not include new instrumentation costs; no Advancement program at CFHT)

The Core and Layers of the UCO Onion

Each of these is an activity that adds to the scope and cost of a restructured UCO. Priority order is consistent with ATF report and has been vetted by UCO faculty but not by UCOAC or SPC.

1) Provide **access to observing facilities at Keck** Observatory by UC OIR observers and exercise effective **technical leadership** in the planning and operations of **Keck** Observatory

2) Play a central role as a leading **instrument-builder for Keck**

3) Play a major role in developing the new **astronomical technologies of the future**, at Keck and beyond

4) Provide access to **observing facilities on the Thirty-Meter Telescope** by UC OIR observers and exercise effective **technical leadership** in the planning and operations of the **Thirty-Meter Telescope**

---------- Core

5) Play a central role as a leading **instrument-builder for TMT**

---------- Level A

6) **Barebones operation of Mount Hamilton**

---------- Level B

7) **New instrumentation, new investment, new technology at Mount Hamilton**

---------- Level C

Core-Onion Model, Simplified

1) Observing at Keck, and some technical leadership

2) Instrument-building at Keck and active technical leadership

3) Development of future technologies

4) Observing at TMT, and some technical leadership — Core

5) Instrument-building at TMT and active technical leadership — Level A

6) Spartan operation of Lick Observatory (probably time-limited) — Level B

7) New investment, new technology at Lick Observatory — Level C

TMT Instrument Opportunities

- **Three first-light instruments:**
  - MOBIE optical spectrograph (UCSC leads)
  - IRIS IR infrared "integral field" spectrograph with AO (UCLA leads)
  - MOSFIRE "clone" infrared spectrograph (no lead yet)
  - All instruments are in practice multi-national consortia

UCO LABS LEAD TWO OUT OF THREE FIRST-LIGHT TMT INSTRUMENTS.

- Three times size, 20 times volume of Keck instruments (except MOSFIRE clone)
- Typical cost: $30-50 M

- Resources:
  - Original three first-light as part of telescope cost
  - After that, $21 M/yr as part of operations; estimated to cover half the cost
  - Instrument-building opportunity, *but matching funds may be advantageous*

- **Competition:**
  - Canada: Dominion Astrophysical Observatory: a major, capable group
  - Japan: NOAJ and other excellent groups

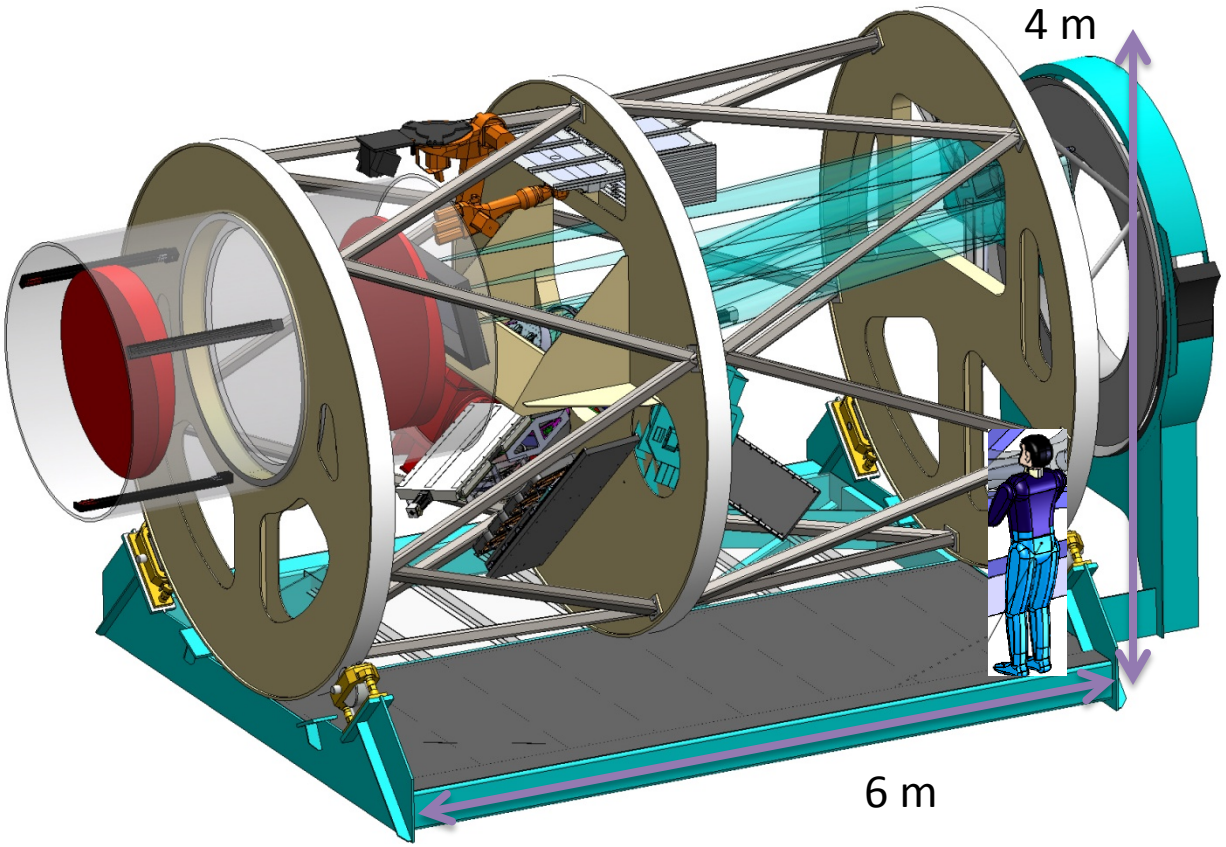
MOBIE – the Multi-Object Broadband Imaging Echellette

PI, Optical Designer: Prof. Rebecca Bernstein, UCSC
Project Manager: Dr. Bruce Bigelow, UCSC
Project Scientist: Prof. Chuck Steidel, Caltech

Cost: $45M + $9.5M contingency (2013 US$)
Current Status: Conceptual Design Phase (1/2012–9/2013)
Schedule: Preliminary design phase (2014)
Construction phase (2018)
Commissioning (2021)

Field of View: 25 sq. arcmin for spectroscopy & imaging
Wavelength: 300 – 1100 nm (full optical)
Spectral Resolution Modes: R=1000, 5000, &10,000

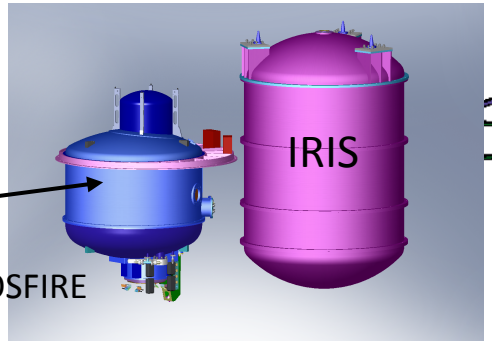
The MOBIE instrument uses a unique new cross-dispersed echellette optical design to provide full coverage of the optical spectrum in each exposure in all three of its possible spectral resolutions modes. This will allow unprecedented efficiency and flexibility in a single instrument — at least 6 times the efficiency of any spectrograph on Keck. It will also be the only spectrograph on the planet that provides this wide range of configurations AND the only one on an ELT that will provide wavelength coverage into the near-UV.

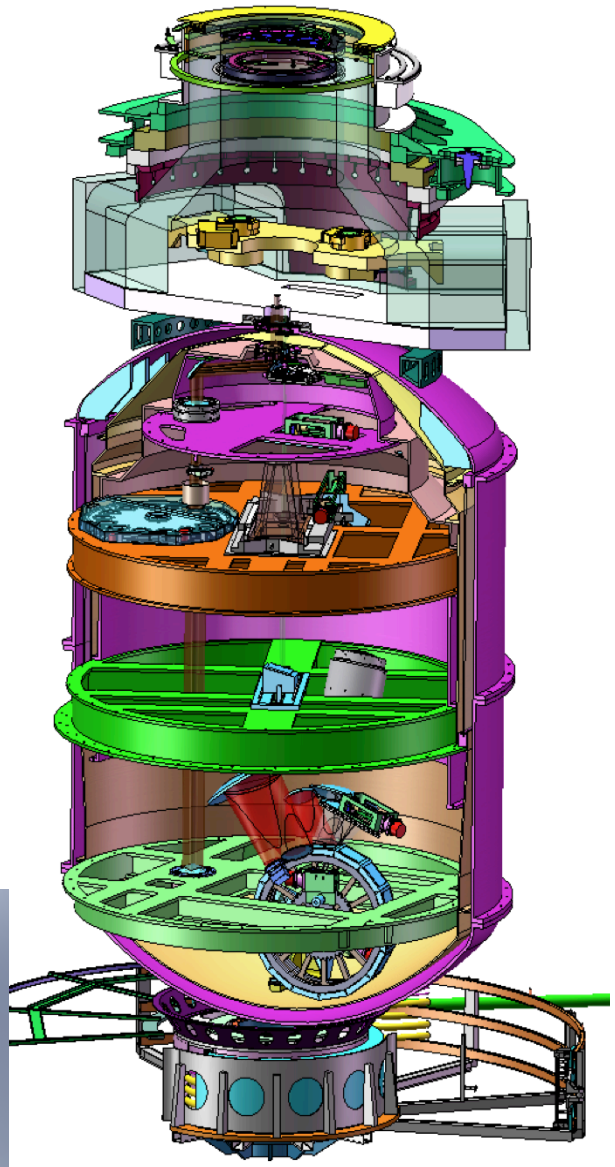


IRIS: The Ultimate High-Res AO Spectrograph and Imager for TMT

PI: Prof. James Larkin

- Infrared Spectrograph
  - Wavelength: **0.8-2.5** microns; 16 megapixels
  - *Spectral Resolution* R > 3500
  - *Plate Scales:* 0.004, 0.010, 0.025, 0.050 arcsec per sample
- Infrared Imager: down to 0.015 arcsec.
  - 15 arcsec field of view
  - 0.004 arcsec/pixel plate scale
  - Distortion correctable to 50 micro-arcsec.
    - Atmospheric dispersion correction < 1 mas
- Cost & Status
  - ~$40 M; early PDR phase; grating turret R&D
  - International team led by UCLA
- Size Facts
  - 3.5m long; 2x cryo surface of MOSFIRE on Keck





Changes in the Budget From FY13 to FY14

Rock bottom to operate Lick

	FY13		FY14		DIFFERENCE	
EXPENDITURES	FTE	$	FTE	$	FTE	$
Astronomers	11.40	2,552,313	10.60	2,554,656	0.80	(2,344)
Research Scientists	4.25	628,680	3.75	615,491	0.50	13,189
UCLA IR Lab		300,000		300,000		0
Technical Staff	14.25	2,085,311	11.75	1,970,363	2.50	114,947
Lick Staff	9.28	984,708	7.30	751,105	1.98	233,603
Admin & Business Staff	12.53	1,256,462	9.30	971,751	3.23	284,711
Non-Salary Expend		620,000		600,000		20,000
TOTAL CORE	51.71	8,427,473	42.70	7,763,367	9.01	664,106
Recharge Staff	5.00	476,625	5.00	465,594	0.00	11,031
UCO TOTAL	56.71	8,904,098	47.70	8,228,961	9.01	675,138
REVENUE		$		$		$
UCOP Base Budget		7,548,243		7,548,243		0
One-time funds (UCOP)		250,000		0		(250,000)
One-time funds (UCO)		300,000		0		(300,000)
Technical Recharge Revenue		842,476		782,318		(60,158)
		8,940,719		8,330,561		(610,158)
YEAR END PROJECTED BALANCE		36,621		101,600		

16% cut from FY13

Additional Negative Budget Impacts in FY14

Mandated Reductions		K$	
Loss of faculty turnover savings	$	535	*Perm*
Accumulated debt	$	650	*Four years*
FY14 staff salary & benefit 3% increase	$	143	*Perm*
Faculty support costs to campus (I&R)	$	100	*Perm*
Startup for new Director	$	400	*One-time*
	$	1,828	

Needed New Expenditures			
UCSC Instrumentation Facility: Detailed Project Plan	$	300	*One-time*
Startup for new hire Assoc Director of AO	$	400	*One-time*
UCLA augmentation	$	150	*Recurring*
Distributed systemwide faculty compensation	$	100	*Recurring*
Project management & accounting software	$	200	*One-time*
APF spares	$	150	*One-time*
	$	1,300	

Revenue Sources We Have Considered

1) Renting the Shane: $3000/night: NO TAKERS YET
2) Charge UC observers $500 for Shane/night: NO, PUSHBACK!
3) Charge the two APF PIs operating fees: YES
4) Charge for services of Support Scientists: YES
5) Revenue from Advanced Coatings Laboratory: EXPLORING
6) Price grants more competitively: YES
7) Write more grants, including Research Scientists: YES
8) Liberal interpretation of endowment funds: YES, but they are small
9) More development: YES -- Friends of Lick Observatory, KAST SPECTROGRAPH
10) Expand Summer Visitors program: YES
11) Corporate sponsor for Summer Visitors program: EXPLORING
12) VIP program for Summer Visitors: YES
13) Camping for Summer Visitors: EXPLORING
14) VIP B&B in Old Dorm: NO, dorm repairs too expensive
15) Commercial restaurant in MH diner: NO, not up to code
16) Facilities rental: NO, Main building too small, revenue not worth it
17) Charge visitors to have special night w/ Shane: EXPLORING
18) 125^{TH} anniversary gala: NOT THIS YEAR, Lick future too iffy

Summary Points on FY14 Budget

- Astronomy is not expensive in terms of lifetime support per UC scientist. Grant income vs. investment is comparable to other UC sciences.
- Running costs at Keck and Lick are low compared to comparable sites.
- The optimum model puts ***TMT instrumentation into the Core***.
- FY14 budget is under study. UCOAC will recommend priorities on Feb 25. Request to postpone final report until next UCO Board meeting.
- Paying back debt at $0.65 M/year out of Core budget for next four years would be ***DISASTROUS***.
- *Recommend 8*: Apply faculty savings to repay the UCO debt.
- *Recommend 9:* Include TMT instrument-building in long-term Core model.

Part IV: Summary of Recommendations

Summary of UCO Recommendations

- *Recommend 1:* Endorse UC's commitment to the Thirty-Meter Telescope and support ongoing negotiations with partner institutions.

- *Recommend 2:* Endorse plan to redirect Keck savings after 2018 to pay TMT operating costs.

- *Recommend 3:* Support Lick operations for 5 years at spartan levels while plans are developed for 2018 and beyond.

- *Recommend 4:* Redirect some fraction of technical effort from Lick to Keck instrumentation by operating Lick in spartan mode for next 5 years. Details in Feb.

- *Recommend 5*: Set aside the first two retirement positions for the Director and an ***Assoc. Director of Adaptive Optics,*** with permission to start the hiring process immediately.

Summary of UCO Recommendations, cont'd

- *Recommend 6:* Advise UCOP that current MRU definition is unsuitable for UCO. Request a TBD committee to work with current UCO administration to craft new words and new MOU with completion date Jan. 1, 2014.

- *Recommend 7:* Advise UCOP that Director search should be initiated in Fall 2013 in anticipation of final MRU/MOU. Director should be appointed by UC President or designee with review and approval by the UCSC Chancellor. Request that UCO and UCSC administration draft a position description, compensation plan, and a performance review process for presentation at next Board meeting.

- *Recommend 8*: Apply faculty savings to repay the UCO debt.

- *Recommend 9:* Include TMT instrument building in long-term Core model.

PRG Report:
Activities and Initiatives

Summary of PRG Activities

- **Activity 1: Ensure that the Keck Observatory provides world-class service to all UC observers.**
- **Activity 2: Design, build, and maintain state-of-the-art instrumentation to equip the telescopes at Keck.**
- **Activity 3: Develop new technologies of the future, for Keck and beyond.**
- **Activity 4: Support and promote graduate, undergraduate, and postdoctoral teaching and training.**
- **Activity 5: Provide a wide array of observing services at UC's Lick Observatory on Mount Hamilton.**
- **Activity 6: Design, build and maintain forefront telescopes and instrumentation at Lick Observatory.**
- **Activity 7: Conduct forefront research in astronomy and astrophysics.**
- **Activity 8: Support science, enrich the cultural life of the community, and share the wonders of astronomy with the citizens of California.**

Summary of PRG Initiatives

- **Initiative 1: Oversee the design and construction of the Thirty-Meter Telescope. Develop, design, and build TMT instrumentation. Represent UC's interests in the TMT community to ensure successful use by UC astronomers.**

- **Initiative 2: Lead construction of Next-Generation Adaptive Optics on the Keck telescopes.**

- **Initiative 3: Develop the foundations of on-line training for future science/ engineering faculty educators.**

- **Initiative 4: Piggyback on excellent technical facilities to expand and invigorate training programs in astronomical instrumentation**

- **Initiative 5: Institute new and more efficient ways of doing business.**