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Maunakea Spectroscopic Explorer: the Status and Progress of a Major Site Redevelopment Project

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ABSTRACT

The Maunakea Spectroscopic Explorer (MSE) project is a collaboration designing the largest non-ELT optical/NIR astronomical telescope to date. MSE is unique as a major astronomical facility since it involves the redevelopment of an existing facility, that of the Canada France Hawai‘i Telescope (CFHT), with a newly expanded partnership. The project office is hosted at CFHT in Waimea HI, and includes new partners from Australia, China, India and Spain. The project is being developed by an international collaboration with design team membership distributed across four continents. In addition to a report on the progress and organization of design work, this paper describes the challenges of redeveloping a major astronomical site in Hawai‘i. We discuss the Project Office and engineering work from the aspects of meeting the Science Requirements while satisfying the unique conditions imposed by redevelopment on Maunakea.

Keywords: astronomical observatories maunakea multiobject spectroscopy

1. INTRODUCTION

MSE is the realization of the long-held ambition[1, 2, 3] of the international astronomy community for highly multiplexed, large aperture, optical and near-infrared spectroscopy on a dedicated facility. Such a facility is the most glaringly obvious and important missing capability in the international portfolio of astronomical facilities. MSE will realize this ambition in the form of a rebirth of the 3.6m CFHT as a dedicated, 11.25m, spectroscopic facility[12,13]. The project serves the science ambitions, and enjoys the technical expertise, of an expanded international partnership extending beyond the original CFHT membership. As importantly, developing and operating as an extension of CFHT’s science mission, MSE will provide continuity and stability to CFHT’s successful synergistic relationship with the local Hawaiian community. MSE will retain the current summit building and pier to reduce cost and environmental impact. The ground footprint will remain exactly the same, the visual “footprint” very nearly the same.

The MSE project is funded through a Design Phase, culminating in a Construction Proposal Review at which time the partnership will make a decision on readiness to proceed into the Construction Phase. Mid-2016 finds the MSE project moving through its conceptual design, leading to system-wide design review and cost review in early 2017. Preliminary design will follow the cost review, and lead to the Construction Proposal Review currently scheduled in 2018. If approved to move immediately into construction, MSE would begin full science operations in 2024.

2. PROJECT DEVELOPMENT STATUS

2.1 MSE Partnership, Funding and Distribution of Work

The general organization of the MSE Project Office and its relationship with CFHT was described by Simons[12]. This structure has thus far proven to be a successful and cost effective way to operate. The core dedicated Project Office staff remain small in number, well supported by CFHT regular staff, meanwhile interacting with much larger science and engineering teams in the MSE partnership. Interactions occur on three distinctly different planes. In the highest plane, science guidance is developed in the 150+ member MSE Science Team, distilled by and represented to the Project Office through the MSE Project Scientist. On a second plane, project-wide Level 1 engineering is performed through interaction among an MSE Engineering Team made up of the Project Office staff, assigned CFHT staff, contractors, and specialists from among the MSE partners. The MSE Engineering Team is coordinated by the MSE Project Engineer - not

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an envious task given the time zones involved in his daily contacts. One of the roles of the Project Office is to manage the third plane of interation: work packages for Level 2 design. These work packages, in the form of contracts or work package agreements, are assigned to organizations which, wherever possible, are within the MSE partnership.

Organizations are deemed MSE Design Phase partners when they make substantive contributions to the design phase of the project. At this time MSE enjoys engineering participation from

- Australian Astronomical Observatory (AAO), Australia
- Centre de Recherche Astrophysique de Lyon (CRAL), France
- Le Centre National de la Recherche Scientifique (CNRS, through Observatoire de Paris and Division Technique of the Institut National des Sciences de l'Universe), France
- Consejo Superior de Investigaciones Científicas (CSIC), Spain
- Indian Institute for Astrophysics (IIA), India
- National Institute for Astronomical Optics Technology (NIAOT), China
- National Research Council (NRC), Canada
- University of Science and Technology (USTC), China

In-kind contributions by the above organizations form one component of the design phase budget. In addition to the above organizations, CFHT staff are enthusiastic to participate in MSE and contribute in-kind to the limit of their necessary operational priority, together making up a second resource component. All in-kind contributions during the design phase accrue to that partner's total contribution to the project for design and construction. The third component of the budget is direct funding of the Project Office by CFHT Corporation, with which most of the Project Office staff costs and all the contracts and operating costs are paid.

2.2 Science Development

Understanding the science niche for MSE is critical to ensuring its ultimate scientific success. Doing so amidst the palette of capabilities available or under development at other projects and observatories, and in the context of the evolving way in which scientists work together to bring new knowledge to light, has been a relentless focus for the MSE Science Team. This effort resulted in three central and interlocking products that guide the project: the MSE Science Requirements Document[15] (SRD), the MSE Detailed Science Case[14] and the Science Reference Observations. The Detailed Science Case provides the science narrative describing the principal envisioned science goals of MSE and describes its impact on a broad range of science topics. Science Reference Observations describe in detail specific transformational observing programs for MSE that span the range of science described in the Detailed Science Case.

Accessible sky	30000 square degrees (airmass<1.55)						
Aperture (M1 in m)	11.25m						
Field of view (square degrees)	1.5						
Etendue = FoV x π (M1 / 2)²	149						
Modes	**Low**		**Moderate**	**High**			**IFU**
Wavelength range	0.36 - 1.8 μm		0.36 - 0.95 μm	0.36 - 0.95 μm ♯			IFU capable; anticipated second generation capability
	0.36 - 0.95 μm	J, H bands		0.36 - 0.45 μm	0.45 - 0.60 μm	0.60 - 0.95 μm	
Spectral resolutions	2500 *(3000)*	3000 *(5000)*	6000	40000	40000	20000	
Multiplexing	>3200		>3200	>1000			
Spectral windows	Full		≈Half	$\lambda_c/30$	$\lambda_c/30$	$\lambda_c/15$	
Sensitivity	m=24 *		m=23.5 *	m=20.0 ♮			
Velocity precision	20 km/s ♪		9 km/s ♪	< 100 m/s ★			
Spectrophotometic accuracy	< 3 % relative		< 3 % relative	N/A			

♯ Dichroic positions are approximate

* SNR/resolution element = 2 ♪ SNR/resolution element = 5

♮ SNR/resolution element = 10 ★ SNR/resolution element = 30

Table 1. A summary of the MSE Science Requirements.

The SRD is the formally controlled document that establishes the Level 0 design objectives for the project, at the top of the hierarchy of engineering design flowdown. Key requirements are summarized in Table 1. Science requirements described there are defined as the science capabilities required to conduct the Science Reference Observations. A comprehensive description of the structure of MSE science and operational requirements can be found in McConnachie[4], in these proceedings.

MSE builds on the success of the SDSS concept, but is realized on a facility with about 20 times larger aperture located at possibly the world's best telescope site. Defining science capabilities include:

- **Survey speed and sensitivity:** The etendue of MSE is more than twice as large as its closest 8m competitor (149 vs. 66 m^2deg^2 for Subaru/PFS). MSE's sensitivity allows efficient observation of sub-L* galaxies to high redshift, and high resolution analysis of stars in the distant Galaxy. The excellent site image quality is essential to observe efficiently the faintest objects and to ensure the spectrograph optics are a reasonable size given the multiplexing demands.
- **Dedicated and specialized operations:** MSE's specialized capabilities enable a vast range of new science. Specialized observing modes allow time domain programs such as transient targeting, quasar reverberation mapping and precision stellar radial velocity monitoring. These require well-calibrated and stable systems only possible with dedicated facilities.
- **Spectral performance:** The extensive wavelength coverage of MSE from the ultraviolet through the infrared H-band uniquely enables the same tracers to be used to study galaxy and black hole growth at all redshifts to beyond cosmic noon. Chemical tagging with MSE can be conducted across the full luminosity range of Gaia targets, and operation at R=40000 enables the identification of weak lines in the blue to access species sampling a diverse range of nucleosynthetic sites.

The combination of aperture, spectral resolution and multiplex advantage that are needed to achieve these capabilities already make MSE unique among contemporaneous facilities, but it is the dedication of the entire MSE system to this single mode of operation that sustainably enables its remarkable scientific grasp.

2.3 Level 1 work breakdown

For purposes of engineering management, the MSE product tree is distributed into 6 distinct Level 1 systems that are developed under the coordinated support of MSE Systems Engineering and within the framework of a work breakdown structure description. These systems, sketched in Figure 1, are:

1. Modifications to the existing CFHT facility building, including work to bring the building structure to current seismic code, to control the thermal environment at the telescope, and to modify the structure to meet a new interface with the telescope and the enclosure. Progress on this design work is described by Bauman[7] in these proceedings.
2. The telescope enclosure, which will replace the current CFHT telescope enclosure. The telescope enclosure is currently undergoing conceptual design at Dynamic Structures Limited, Canada, and seeks to mimic the silhouette and appearance of the CFHT enclosure to the maximum extent possible consistent with other engineering design objectives.
3. The telescope system, encompassing the telescope structure and drives, the guiding and wavefront sensing subsystem, the primary mirror together with segment support equipment, the 1.5 $degree^2$ wide field corrector and the prime focus hexapod and instrument rotator. MSE's primary mirror design seeks to reuse partner development made for the ELT projects, and has selected an 11.25m diameter mirror made of 60 1.44m hexagonal segments of the same format chosen by two of the ELT projects. See Szeto[16] for a description of the design process, and Saunders[8] for a description of the MSE optics.
4. The science instrument is the most extensive of the Level 1 systems. It is made of a number of important subsystems,
    a. The fibre positioner, comprising more than 3200 fibre positioner robots in the MSE optical focal plane, as well as the associated position optical metrology system,

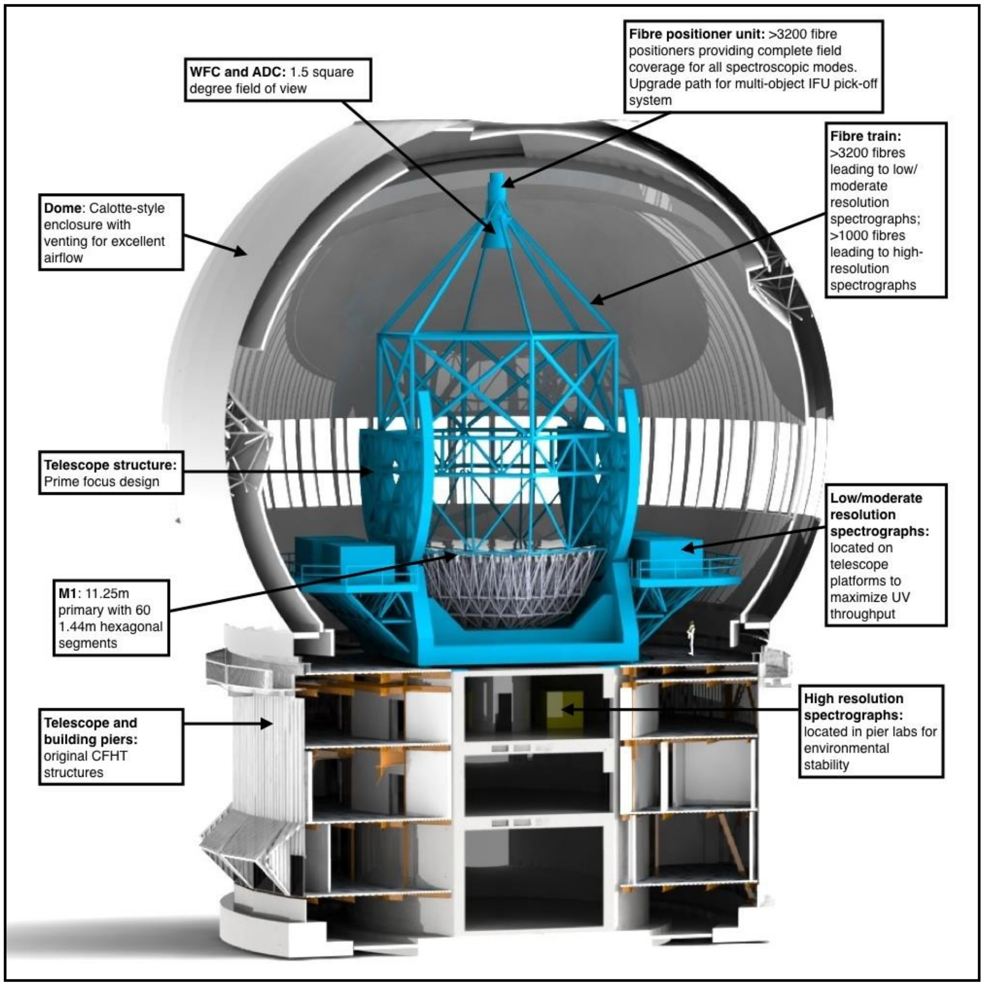

Figure 1 - MSE System Architecture

b. A bank of high resolution spectrographs located in the upper Coudé room within the concrete pier of the telescope, capable of 1000 spectral channels (see Zhang[17]),

c. A bank of low and moderate resolution spectrographs located on two instrument platforms that are part of the telescope azimuth structure, capable of more than 3200 spectral channels,

d. The fibre transmission system transferring science and calibration photons from the telescope focal plane to the two spectrograph banks.

e. The science calibration system (see Flagey[9]) providing wavelength and gain calibration.

One particular challenge presented through the SRD is the need for a mode in which one can select more than 3200 fibre positions for the low and moderate resolution spectrograph, and a mode in which one can select 1000 fibre positions for the high resolution spectrograph, each mode with complete field coverage over the MSE field of view. An engineering study[16] looked at a range of design solutions to this challenge, and recommended two additions to the science instrument work. These are: a) take both the AAO "echidna" positioner and the "rho-theta" style positioners through conceptual design phase before selecting a technical solution that best meets requirements, and b) investigate the feasibility of fibre optic switching with acceptable performance within the fibre transmission system. Informed by these studies, the Project will revise this science instrument system description to a single multiplexing architecture to take to preliminary design phase.

5. The control system provides integration and safe control of all the hardware systems that are part of the collection of science or engineering data during telescope operations. Described in more detail in Vermeulen[11], the main subsystems in the MSE control system are
    a. The Observatory Control Sequencer,
    b. The Telescope Control System – coordinated by the Telescope Control Sequencer,
    c. The Instrument Control System – coordinated by the Instrument Control Sequencer,
    d. The Telescope Feedback System – coordinated by the Telescope Feedback System Sequencer,
    e. The Facility Control System – coordinated by the Facility Control System,
    f. The Safety System, an independent system enforcing personnel and hardware safety.
6. Computing and IT provide the network and compute hardware infrastructure supporting the control system, as well as the observation preparation software and data reduction and data distribution software and services.

Understanding the engineering impact of the SRD, modeling performance, and then distributing and managing the level-1 performance objectives among the six principal systems are the métier of the MSE System Engineer and MSE System Scientist. Accompanying papers describe the technical budgeting process (Mignot[10]) and the modeling and optimization of system throughput (Flagey[5]).

3. PERMITTING STATUS

3.1 Historical Context and Processes

On 18 December 1975 Canada France Hawai‘i Telescope Corporation and the Hawai‘i Board of Land and Natural Resources (today the Department of Land and Natural Resources, DLNR) signed a sublease agreement granting CFHT permission to “erect and manage astronomical observatory facilities” on a particular site within the Mauna Kea Science Reserve. That sublease is pursuant to General Lease S-4191 between the State of Hawai‘i and the University of Hawai‘i (UH), conferring upon UH the right and obligations to operate in and to manage the Mauna Kea Science Reserve until 31 December 2033. All the Maunakea observatories operate within the terms of S-4191, popularly known as the “Master Lease”.

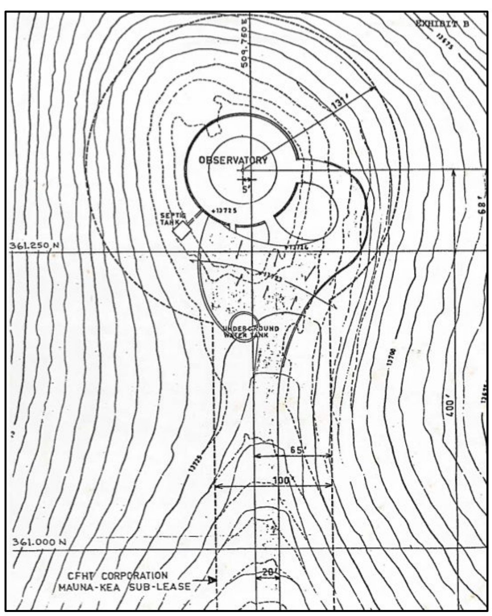

Figure 2 - CFHT Sublease to operate on Maunakea was granted in 1975.

UH has designated 10,760-acres of the Maunakea Science Reserve as a Natural/Cultural Preservation Area, with no development activity. The remaining 525 acres (5%) of the Science Reserve are designated as an Astronomy Precinct.

A lead document in the management of the lease-held lands is the Mauna Kea Science Reserve Master Plan[18]. The plan was updated and adopted by the UH Board of Regents in June 2000. Changes made in that release were to ensure it correctly addressed the Hawaiian community's concerns over impacts to cultural sites, cultural beliefs, and natural resources. There are four major aspects of the Master Plan:

1. On-island dedicated management under the auspices of the University of Hawai'i at Hilo,
2. New management structure including the Office of Mauna Kea Management (OMKM), the Mauna Kea Management Board (MKMB), and a native Hawaiian advisory council named Kahu Kū Mauna,
3. Restrictions on development within the astronomy precinct; and
4. A project review process.

In April 2009 UH released the Mauna Kea Comprehensive Management Plan[19], followed in 2010 by the Natural Resources Management Plan, Cultural Resources Management Plan, Public Access Plan, and Decommissioning Plan. These management plans, approved by DLNR, are the State's plans for managing Maunakea and provide a management framework for the UH to protect the cultural, natural, and scientific resources on UH-managed areas on Maunakea.

The OMKM, together with the MKMB and Kahu Kū Mauna Council share responsibility for implementing these plans. Since June 2000, management of Maunakea requires input and participation from the community regarding daily activities, development of policies and programs, and review of proposed projects.

The Master Plan explicitly recognizes CFHT on page IX-45 as one of the sites that will be redeveloped. Although planned changes for MSE are of much smaller impact than those categorized as "redevelopment" in the Master Plan, MSE remains subject to two separate approval processes.

The first is OMKM's process for evaluating new proposals. OMKM provides valuable and welcome guidance during the design process, to ensure that both the work, and the final results, of the project result in minimal impact to cultural and natural resources and the astronomical qualities of the Science Reserve. The process begins with a proposal to OMKM which triggers an initial classification of proposals as Major, Minor, or Minimal Impact. It also triggers the

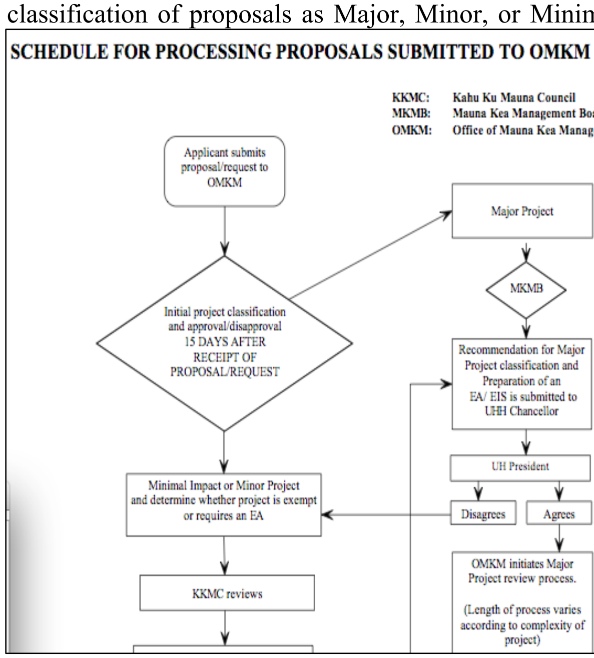

Figure 3 - An extract from the OMKM proposal process.

establishment of a review panel comprising state and local stakeholders, to review plans for conformance with established regulations and codes, as well as to recommend how to minimize any deleterious impact on the natural environment, the cultural environment, and the socioeconomic environment.

MSE had planned to enter this design review process in 2015, but due to external circumstances that are described in the next section, the Project continues to look forward to this important exchange with the local community. Meanwhile, MSE is pursuing design choices that demonstrate the intention to remain good stewards of the site and partners with the local community in the continuation of CFHT. These include constraining our enclosure design to mimic the visual silhouette of CFHT, designing for only remote Waimea-run observations to reduce traffic on the summit, reaffirming complete protection of the summit environment from chemical or biological pollutants, and working toward designs that reduce electrical power and water consumption during operations. While MSE remains in Conceptual Design phase, designs can be altered to accommodate the recommendations of this review panel to the Project.

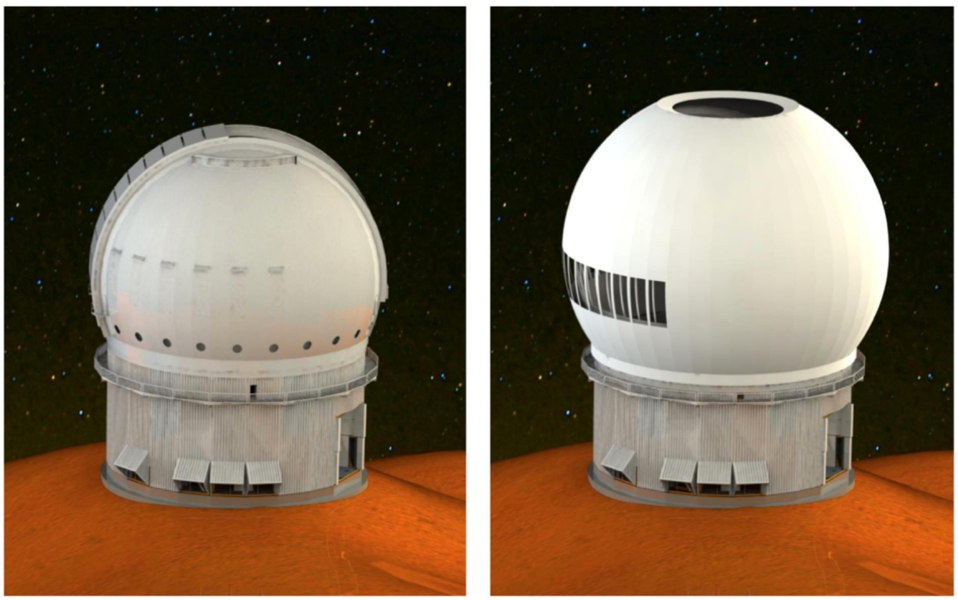

Figure 4 - Renderings of CFHT (left) and MSE (right). MSE will not disturb new soil on the summit, and strives to keep the external appearance of the observatory as similar as possible to that of the current CFHT.

A second approval process is the legal one through which the State, represented by DLNR, approves the planned work. The application and approval processes are described in Chapter 13-5 of the Hawai‘i Administrative Rules[20]. MSE is a category B-1 alteration of an existing structure and land use, and will be required to go through a site plan approval process.

While the above two processes would grant the Project permission to construct MSE on the summit of Maunakea, there is a third and equally important process that needs to reach a conclusion before construction can begin. The current Master Lease for all observatories will expire at the end of 2033, at which point MSE on its current schedule would have been in operation 9 years. For the science communities and funding agencies to realize a return on investment, MSE will need to operate for at least 30 years. Hence, a renewal of the Master Lease is a clear condition that needs to be satisfied before a construction proposal review leading to construction on Maunakea is held. UH began the public process that would lead to a renewal of the Master Lease in late 2014, but that process came to a premature halt and the ground rules changed during the turmoil on Maunakea in the spring of 2015.

3.2 Re-establishing a Partnership for Astronomy with the Community

When TMT selected Maunakea as the site for their facility nearly a decade ago, events were set in motion that required not only a technology revolution but an ability to adapt to Hawaiian societal challenges that nobody credibly predicted from the outset. Starting not long after the failed Keck outrigger project, TMT set out on an extensive community engagement process and parallel permitting process that was mostly characterized by a string of successes with the general community and State. The first publically obvious signs of trouble for TMT's engagement program occurred in October 2014, when their ground breaking ceremony was halted through protests and an impromptu summit roadblock, leading to a dramatic standoff and eventual termination of the groundbreaking program. In the process a number of new faces in the Hawaiian community emerged, and they were mostly young, passionate, and adept with social media. Emboldened by their initial success in 2014 with stopping TMT's groundbreaking ceremony, an even larger protest was organized in April 2015 which was intended to block the Maunakea Access Road for TMT's contractors. Though large scale arrests occurred, that protest also successfully blocked TMT's access to the summit for construction, effectively rendering TMT's summit construction contracts non-executable. TMT tried a third time to reach the summit in June 2015. That time a much larger crowd assembled up and down Maunakea Access Road between the Visitor Information Station and TMT summit site. Law enforcement was overwhelmed, the road was blocked in several areas with hastily built rock walls, trapping people on the summit, and the underground fiber optic cable used for critical communications and control of the Maunakea Observatories was cut, and nearly rendered useless. Finally, in November 2015 TMT prepared to try to reach the summit again, but due to a longstanding lawsuit the Hawaiʻi State Supreme Court remanded the Conservation District Use Permit (CDUP) for TMT, effectively bringing the project's construction activity on the summit of Maunakea to a halt. In the end, a trend of persistent escalation in the protest community was clear. Compounding matters, the protest community has scattered interests, ranging from cultural concerns about telescopes on the summit, to claims of not receiving adequate compensation for summit access, to a much larger sovereignty movement. These various calls to protest all combined, making the halt of TMT's construction a symbolic means of casting a spotlight on all of these interests, even though in some cases stopping TMT"s construction had no direct bearing on resolving major facets of the conflict.

In May 2015, under heavy pressure to take action, Governor Ige declared his support for TMT and proposed 10 actions intended to strike a balance between competing interests. Many of these were directed at UH and were predicated on an assertion that UH had been poor stewards of the summit, under their longstanding Master Lease arrangement. From the outset of constructing telescopes on Maunakea, UH has entered into scientific partnerships with observatories on Maunakea, being granted valuable observing time in exchange for observatory access to the summit. With Maunakea Observatory funding, UH also supports considerable infrastructure (road maintenance, power, fiber optics, mid-level facility for astronomers, etc.) that makes it possible for the Maunakea Observatories to function. Among the more noteworthy of Governor Ige's actions was the requirement that "the University must decommission as many telescopes as possible with one to begin this year and a least 25% of all telescopes gone by the time TMT is ready for operation." Today that requirement has mapped into CSO (which already declared their intent to decommission years before), Hoku Kea (the UH-Hilo educational 0.7 m telescope), and UKIRT being identified for removal from the summit. Another noteworthy provision was "the University substantially reduce the length of its request for a lease extension." As mentioned earlier, the current Master Lease expires in 2033, the point at which all telescopes would be removed from Maunakea if a new Master Lease is not granted. To date new Master Lease terms have not been negotiated, primarily because (1) the EIS underway to renew the Master Lease was halted by Governor Ige and (2) the Governor called for 10,000 acres from the Maunakea Science Reserve to be transferred back to DLNR as part of the conflict resolution. Before the Master Lease EIS can be restarted, the boundary of the property defined by the EIS needs to be set, and a cascade of complications with the land transfer have thus far lead to marginal progress.

Taken at face value, the conflict over Maunakea may seem intractable. It is the product of an unlikely confluence of events and circumstances, the details of which are too intricate and nuanced to convey in their entirety in this brief report. In practice resolution requires a multifaceted approach, not only to the administrative challenges summarized above, but more importantly aimed at the core of the community conflict. Political strategies can accelerate resolution of these societal conflicts, but they need popular support. A grass roots approach is needed and that is what CFHT, working closely with the other Maunakea Observatories, community leaders, UH, elected officials, and Hawaiian elders has helped bring to the table. This strategy includes amplified applications of existing outreach programs, new programs altogether, and a paradigm shift in community engagement of the Maunakea Observatories. Examples include –

- Increased media coverage of the existing astronomy outreach programs, building them into even larger programs in some cases.
- Improved government relations, through on-going dialog with legislators, the Governor's office, County officials, etc.

- An infusion of new community outreach programs that invert the paradigm, bringing the community into the observatories, rather than relying mostly on observatory staff going into the field (classrooms).
- Provision of innovative education, environmental, and cultural opportunities for the community through unprecedented and non-conditional philanthropy
- Focusing a positive message about the future of Maunakea with special emphasis on what the future of Hawaiʻi astronomy means to the keiki (children) of Hawaiʻi, who will in a real sense "inherit" these remarkable facilities as members of their technical, administrative, and scientific staffs
- Promoting community based management of Maunakea consistent with the Office of Maunakea Management, Maunakea Management Board, Kahu Kū Mauna, Comprehensive Management Plan, etc.
- Establishing a lasting community-based vision for the future of Maunakea, for the next 100 years, that informs policy and decision making about the summit of Maunakea in all respects.

CFHT has taken a leadership role with many of these initiatives, helping organize the Kamaʻāina Observatory Experience program (a monthly program in which the public receives cultural and environmental lessons before seeing up close 2 observatories), establishing the Maunakea Fund (which advances cultural, environmental, and scientific interests in Maunakea), creating the Maunakea Scholars program (making it possible for the first time for local high school students to use a Maunakea telescope to conduct their research), and most recently working closely with community leaders to establish the EnVision Maunakea (EM) program. EM is designed to support community conversations in safe and respectful settings, conducive for candid and well informed exchanges of ideas that combined lend to solutions. This program will solicit a wide range of perspectives about the future of Maunakea through a multitude of listening sessions, fact-finding, and ultimately extensive professionally conducted public surveys. The program has been endorsed by the UH-Hilo Chancellor, who has given assurances that future policy on Maunakea will be critically informed by the results of EM. The Office of Maunakea Management reports to the UH-Hilo Chancellor, who is also responsible for driving the Maunakea Master Lease renewal and has a central role in determining its terms and conditions, as well as driving the EIS needed by the new Master Lease.

Despite the challenges, elements of a resolution to the conflict are beginning to appear. Motivated by kupuna (Hawaiian elders), voices in favor of TMT and astronomy are now present in the Hawaiian community. This perspective was critically lacking for over a year, but now a more balanced perspective is being heard within the Hawaiian community. That perspective is in general aligned with the broader community, seeking a resolution that is inclusive of multiple interests. The renewal process for TMT's CDUP is underway, with a reasonable chance that it will be renewed by the end of 2016, when TMT has indicated it is needed for the project to remain in Hawaii. If the CDUP is renewed, that decision will doubtless be challenged in court, but a new law passed by Hawaii's legislature fast tracks such appeals straight to the Hawaii Supreme Court, vastly accelerating the appeal process. Taken together, it is likely that a final decision on TMT being built in Hawaii will be made during the first half of 2017.

How does all of this effect MSE? First, there is a large distinction between building an ELT on a new site on Maunakea and upgrading an existing facility on an established site. CFHT does not need a new CDUP and the cultural significance of an already "disturbed" site is reduced. The longer term issues for MSE are the need for a Master Lease renewal and finance challenges for Hawaiʻi astronomy in general if TMT does not go forward. For the former, though challenges lie ahead, the process and basis for a new Master Lease are very different from TMT's challenges. It is procedurally impossible to block a Master Lease renewal process through road blocks. More importantly, the discussion of a Master Lease renewal intimately involves over a thousand families, well established in Hawaii, that together provide a much deeper presence than a new telescope, with a project office based in California, possibly can. Having a vested presence is critical in an island community, and the Maunakea Observatories unquestionably have such a presence. The largest challenge to MSE is therefore lack of investor confidence in Hawaii astronomy in general if TMT does not go forward in Hawaiʻi. That lack of confidence will take time to restore and, in the interim, could impact not only major projects like MSE but even instrumentation development since the "cradle to grave" time for instruments now exceeds the time remaining in the current Master Lease. As a result, pursuing the Master Lease renewal on a rapid pace is important for not just MSE but Hawaiʻi astronomy in general.

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THE PULSE OF PARADISE

BIG ISLE SCOPES OPEN FOR TOURS

The 8-meter mirror of the Gemini Observatory's telescope was exposed and shown in action Tuesday at a preview of the Kamaaina Observatory Experience atop Mauna Kea on Hawaii island.

The Mauna Kea community hopes to "inspire a passion for astronomy" among kamaaina

By Timothy Hurley
thurley@staradvertiser.com

MAUNA KEA, HAWAII >> The astronomy community in Hawaii has taken its lumps over the past year, from the Native Hawaiian-led rebellion against the Thirty Meter Telescope to the state Supreme Court ruling invalidating the project's construction.

Now the observatory community on Mauna Kea is fighting back. And it begins Saturday.

For the first time in its 50-year history, the world-class telescopes on Hawaii's tallest mountain will be opening their doors to the public for tours.

The aim, according to a news release, is "to inspire a passion for astronomy and an appreciation for the cultural and environmental future of Mauna Kea among Hawaii residents."

Please see **TOUR,** *A12*

More photos at staradvertiser.com.

Photos by HOLLYN JOHNSON/Tribune-Herald

Joy Pollard, tour coordinator and graphic designer for the Gemini Observatory, guides a media group into the telescope chamber Tuesday afternoon during a media preview of The Kama'aina Observatory Experience.

QUITE AN 'EXPERIENCE'

Observatories tour gives visitors up-close look at Mauna Kea telescopes

By TOM CALLIS
Hawaii Tribune-Herald

The Mauna Kea observatories have spent nearly 50 years helping write the history of the universe, but now it's their story they want to tell.

This Saturday, a hui made of telescope operators and the 'Imiloa Astronomy Center will host the first official tour of the

See EXPERIENCE Page A7

Mary Beth Laychak, outreach program manager for the Canada-France-Hawaii Telescope, stands in the telescope's control room Tuesday during the tour.

DENNIS ODA / DODA@STARADVERTISER.COM

CHANCE OF A LIFETIME

A new program awards Kapolei students time at a powerful Mauna Kea telescope

By Rosemarie Bernardo
rbernardo@staradvertiser.com

In what one described as a "once-in-a-lifetime opportunity," four budding astronomers on Wednesday learned they had won time using one of the world's most powerful telescopes.

"It's like winning a Grammy," said Jamie Valdez, 18, after the announcement of the winners at the Kapolei High School library. "We were so surprised. Like, I was shaking the whole time."

Four Kapolei students were named the inaugural winners of the Maunakea Scholars Program, believed to be the first of its kind in the United States that gives aspiring astronomers an opportunity to spend time at a major international observatory. The pilot program is a partnership between the Canada-France-Hawaii Telescope, the Gemini International Observatory, both of which are atop Mauna Kea, and the state Department of Education.

Doug Simons, director of the Canada-France-Hawaii Telescope, announced two groups of winners from Kapolei High. Each two-member team will spend an hour to an hour-and-a-half at CFHT's control room to further their research.

"This is a breakthrough program," said Simons. "It's a quantum leap."

Please see **WINNERS,** *B3*

Jamie Valdez, left, reacted with surprise at being named to the Maunakea Scholars Program. Fellow Kapolei High students David Zerba, right, Ashley Cobbs, back left, and Nevyn Tyau, back middle, also were selected to participate in the program.

HOLLYN JOHNSON/Tribune-Herald

From left, Waiakea High School students Ramsey Goodale, Ana Bitter, Hannah Blue and Kylan Sakata react to being chosen to be Maunakea Scholars for their proposal called "Exploring Star Formation in the Host of Radio-Quiet Quasars" during a Maunakea Scholars Proposal Selection Program luncheon in the school's library.

'You're all astronomers today'

Waiakea High students win opportunity to use Mauna Kea telescope

By TOM CALLIS
Hawaii Tribune-Herald

Many students are encouraged to shoot for the stars, but few get an opportunity quite like this.

As part of the inaugural launch of the Maunakea Scholars program, four seniors at Waiakea High School were told Tuesday they were awarded observing time on the Canada-France-Hawaii Telescope atop the mountain.

SIMONS

The new program, which organizers say isn't replicated anywhere else, is meant to open up some of the world's most advanced telescopes to Hawaii students and inspire the next generation of scientists.

Based on the excitement on the students' faces, that probably won't be a difficult task.

One student, Ramsey Goodale, placed his

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A compilation of front page news stories appearing in Hawaii newspapers during early 2016 stemming from innovative new outreach programs. Above, the Kamaʻāina Observatory Experience yielded plenty of "wows" from an enthusiastic community. Below, the look of shock as high school students in Kapolei (left) and Waiakea (right) learn they have received CFHT observing time to conduct their own research is priceless.

Given the importance of Hawai‘i astronomy worldwide, as the premier site in the northern hemisphere, the stakes are high not only for TMT and MSE but for 21st century astronomy itself. The challenges ahead are serious but not impossible to overcome. The solution will be found through multilateral dialog, persistence, open minded and open hearted listening, and a community wide sense of ownership and pride in the future of Maunakea.

4. CONCLUSION

In the two years since it was first established, the MSE project has developed and published compelling reasons for the need for such a singular new capability among the next generation of ground- and space-based facilities. The design work of MSE's partnership-wide Engineering Team is proceeding effectively and apace, toward a decision in 2018 to enter the Construction Phase of the project. All of this has been achieved as a happy result of the willingness of a wide international partnership to participate in this great venture, both intellectually and financially.

Equal in importance to a successful international collaboration, MSE must succeed as a partner with the Hawaiian community that provides the cultural foundation upon which Maunakea astronomy has made such astounding progress over the past 50 years. CFHT/MSE, along with its partner Maunakea Observatories, are staunch supports of sustainable stewardship of Maunakea by balancing the cultural, environment, and scientific interests of the people of Hawai‘i in Maunakea. Synergies between Hawaiian culture and astronomy abound. The sea wayfarers of Polynesia, that would eventually be called Hawaiians, were arguably the finest astronomers of their age, able to pinpoint their location on a spinning sphere, revolving around our sun, without any landmarks, only the stars overhead. Ancient Hawaiian astronomers literally pinned their fate at sea on their knowledge of astronomy. Their connection to the heavens, both literal and through their remarkable cosmology, combined with the most powerful collection of observatories ever built, will define a path forward for not only MSE, but 21st century ground based astronomy.

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