Annex 3
Design of the Maunakea Spectroscopic Explorer

For questions, please contact
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1 Introduction

The Maunakea Spectroscopic Explorer (MSE) is a massively multiplexed optical/near-infrared spectroscopic facility that will repurpose the existing CFHT site within the next decade while maintaining the current observatory footprint (Figure 1). MSE's objective is to conduct million+ target level surveys of stars and galaxies fainter than can be achieved by existing and near-term massively multiplexed wide-field spectroscopic survey facilities.

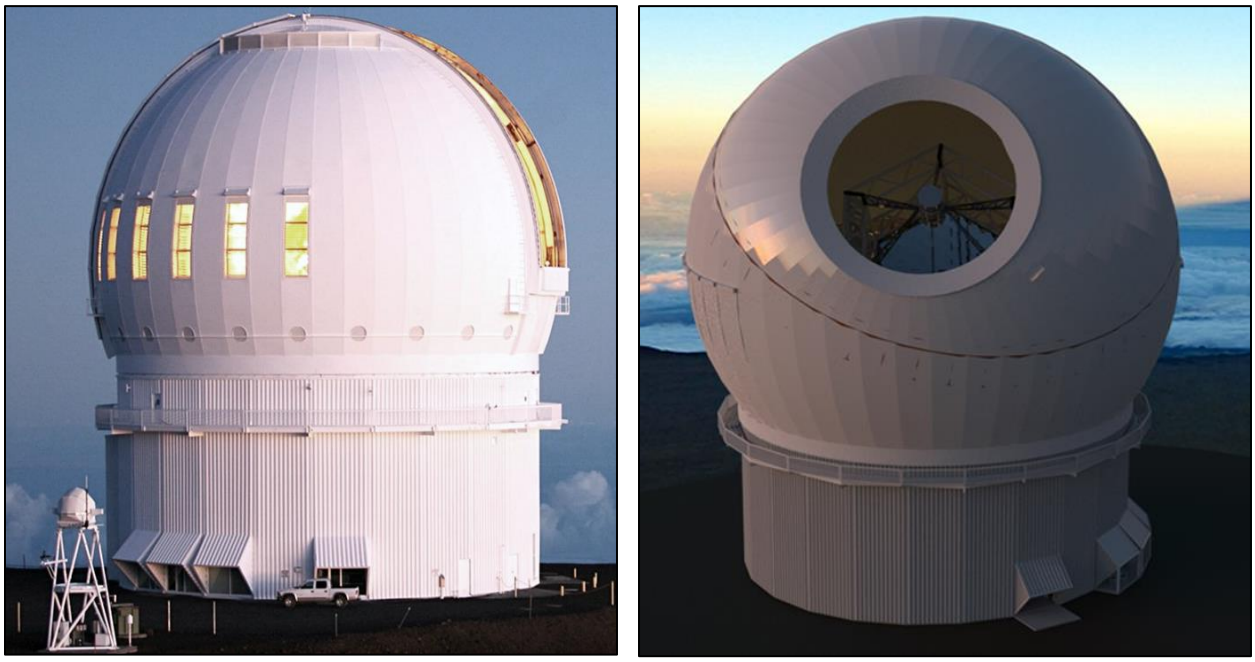

Figure 1: The Maunakea Spectroscopic Explorer (MSE), shown on the right, will repurpose the existing CFHT site while maintaining the current observatory footprint shown on the left.

The project team completed MSE's conceptual design in 2018, and the project is currently exploring an alternate telescope design: the Quad-Mirror (Q-M) concept. The Q-M design affords significant gains in multiplexing and telescope versatility, illustrated in Figure 2. The project looks to advance the design through the preliminary and detailed design phases so that the facility is "shovel ready" by the start of the next decade.

This call for Letters of Interest is to identify potential partners for joining the MSE-Design study and MSE's existing partnership for the study phases leading to construction.

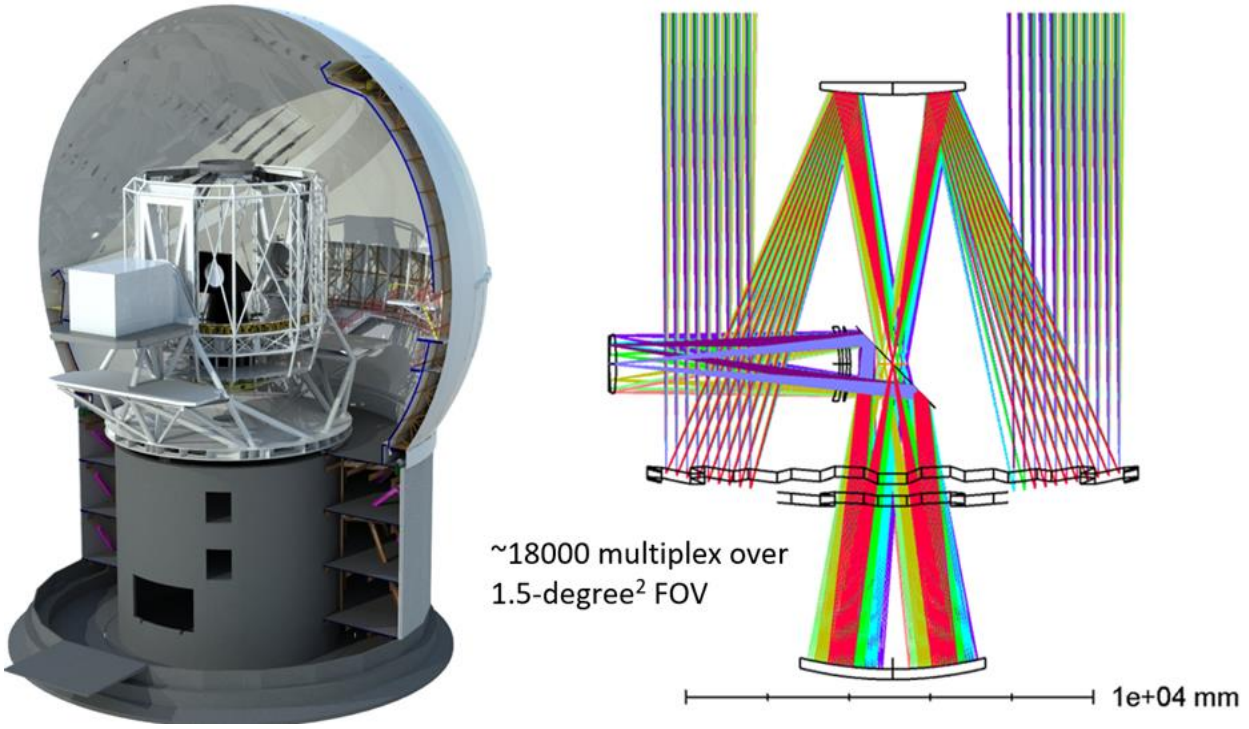

Figure 2: The Quad-Mirror (Q-M) MSE concept ray trace (right) and 3D CAD model (left)

The study includes, but is not limited to:

- Advancing the Q-M telescope design from the feasibility phase through the detailed design phase
- Researching and developing technology readiness
- Conducting detailed sustainability studies of the project from construction to operations
- Advancing MSE as a model for Indigenous- and community-based astronomy
- Producing a construction proposal respecting the timeline and process for summit lease renewal developed by the Mauna Kea Stewardship and Oversight Authority (MKSOA), including a responsible and sustainable summit decommissioning plan mindful of Maunakea's cultural significance

Figure 3 shows the proposed timeline of the major design phases preceding construction in the 2030s.

2 MSE Top-Level Design Requirements

MSE is anticipated to be the mid-21st century premier facility for wide field, optical/near-infrared spectroscopic surveys ideal for follow-up of Gaia, Euclid, Pan-STARRS, Rubin, Roman, and other deep imaging surveys. MSE must perform well at limiting magnitudes of at least 24th magnitude at low spectral resolution. Table 1 shows the envisaged spectral ranges and limiting magnitudes in typical conditions for the low-resolution (LR), moderate-resolution (MR), and

high-resolution (HR) modes. Low-resolution optical spectroscopy may be achieved with spectral binning of spectra taken at moderate-resolution.

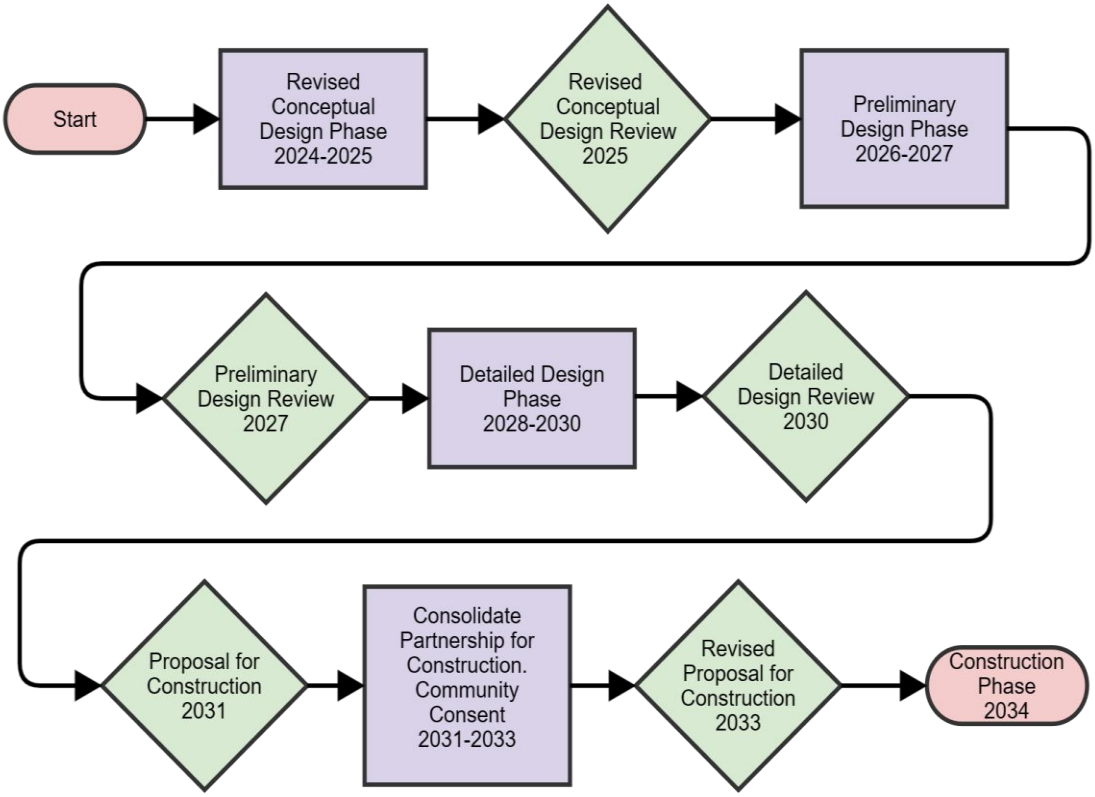

Figure 3: MSE-Design Study development phases and timeline

The MSE website contains a robust collection of documents and additional information pertinent to the previous design. The MSE-Design Study will leverage this considerable set of work in exploring the Q-M design. For instance, a full set of detailed and formal science requirements pertaining to the previous design are available in the MSE Science Requirements Document (SRD). This includes requirements on sky subtraction, radial velocity, and spectrophotometry as well as sky coverage and multiplexing. The SRD will be revised to match the capabilities of the Q-M design.

	LR	MR	HR
R ($\lambda/\Delta\lambda$) Per resolution element	2,000 to 3,000	4,500 to 7,000	R > 25,000, average 30,000
Spectral Range	360-1800 nm	360-1800 nm	Reconfigurable bands from 360 to 900 nm
Point-like Limiting Magnitude (AB)	24 (3σ, 2-hr, dark time)	23.5 (3σ, 4-hr)	20 (10σ, 1-hr)

Table 1: Baseline MSE spectral and sensitivity requirements

3 MSE-Design Study Work Breakdown Structure

As shown in Figure 4, the MSE-Design study has seven top-level Work Breakdown Structure (WBS) branches. The project seeks collaborators for all.

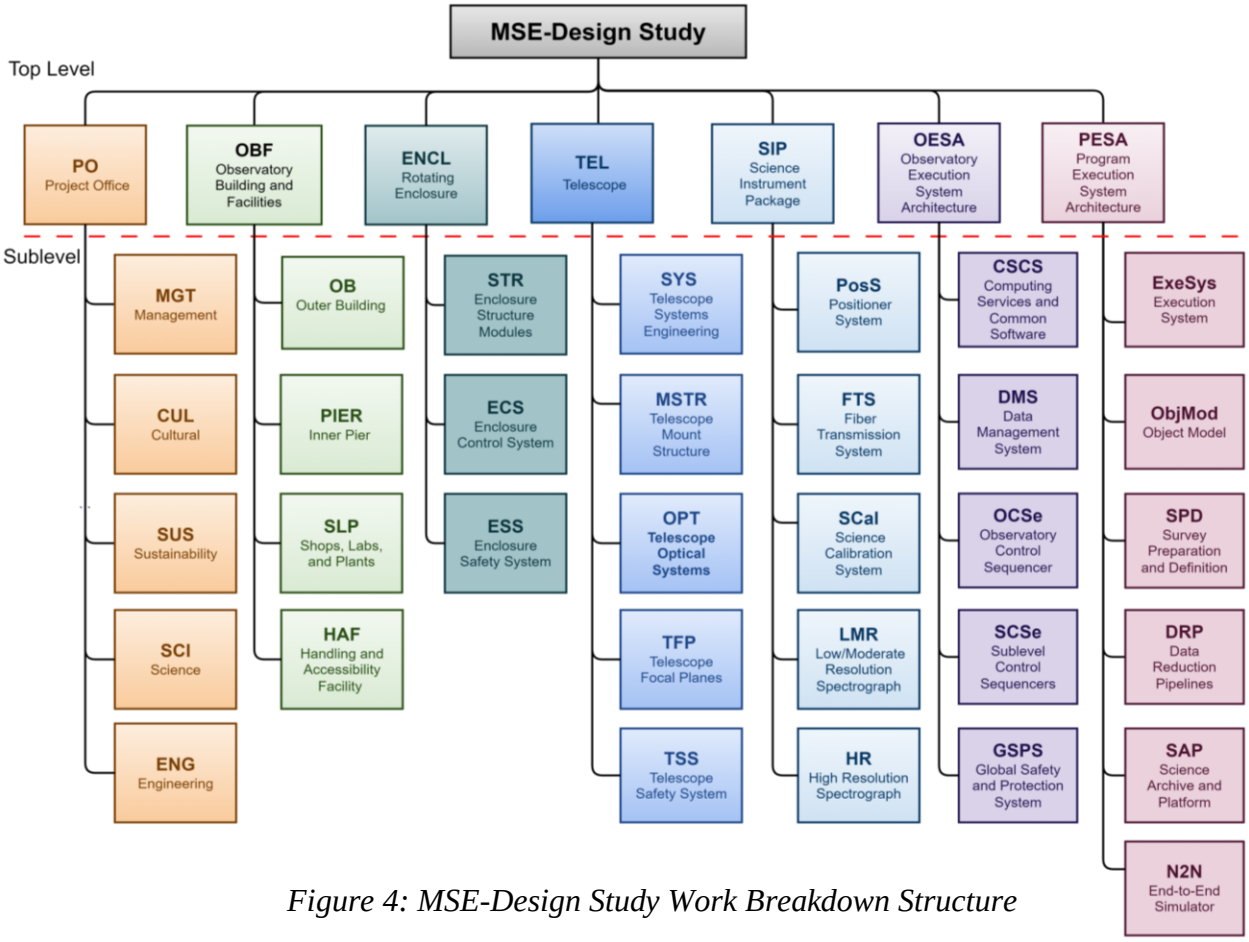

Figure 4: MSE-Design Study Work Breakdown Structure

4 MSE-Design Study Project Organization

Representatives from the MSE partners will form the MSE Collaborative Board (CB). The MSE-Design Study governance will evolve according to the contributed funding sources for each phase. Figure 5 contains the proposed MSE-Design Study organizational chart.

The CFHT Executive Director (ED) is an ex-officio member of the CB. The MSE Program Director (PD) oversees the MSE-Design Study and is the point of contact. The Project Scientist / Spokesperson is MSE's external scientific representative and leads the Science Team, a network of contributing scientists. The CB advises the CFHT Board and Executive Director.

Working in collaboration with the Systems Engineer (SE), the Project Engineer (PE) enforces the system performance budgets and implements the system-level requirements. Aided by four Deputy Project Engineers (DPEs), the PE is also responsible for the design work of contributed design teams and contractors.

CFHT's Director of Strategic Communications oversees the community-based astronomy model and engagement and coordinates national outreach programs within the partnership. The Cultural Practitioner/Liaison and the Sustainability Officer provide guidance throughout the project phases to ensure MSE's design is rooted in Hawaiian cultural values and best practices in sustainability.

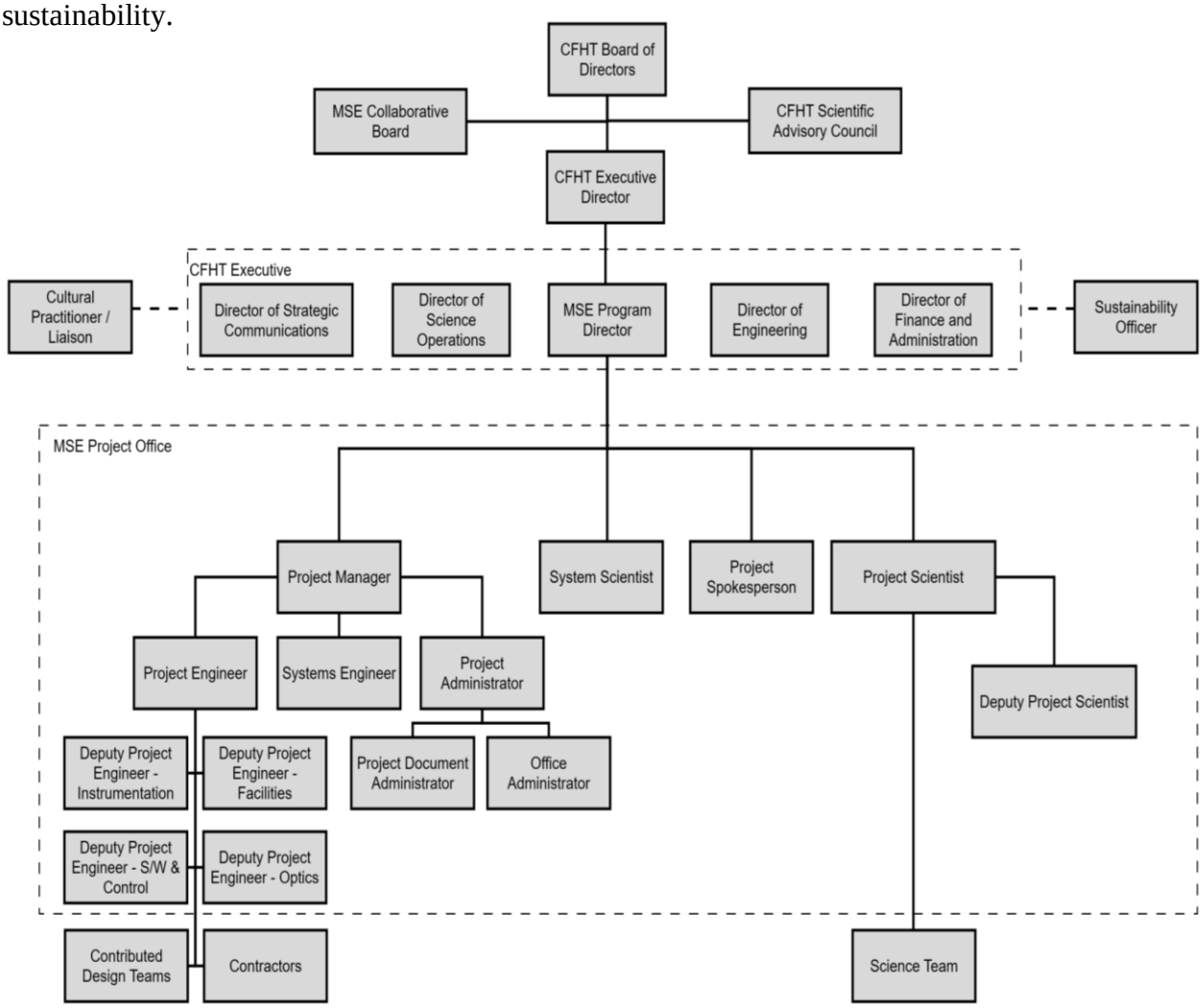

Figure 5: Proposed MSE-Design Study Organizational Chart