

Status update on the Maunakea Spectroscopic Explorer

Alan W. McConnachie, MSE Project Scientist, mconnachie@mse.cfht.hawaii.edu

Michael Balogh, John Blakeslee, Patrick Côté, David Crampton, Sara Ellison, Sarah Gallagher, Patrick Hall, Falk Herwig, Michael Hudson, Kimberley Venn, Ludovic Van Waerbeke

Background: ngCFHT, LRP2010 and the Feasibility Study

MSE is a project to replace CFHT with a 10m-class wide field facility dedicated to optical and near-infrared (OIR) multi-object spectroscopy at a range of spectral resolutions. It began life as the “Next Generation CFHT”, and was developed during the LRP2010 process. LRP2010 stated that ngCFHT would have a “transformative impact on a wide range of fields”, and that it would be a “unique resource for follow-up spectroscopy”. LRP2010 recognized that ngCFHT had some fundamental issues to address to be a viable project, rather than just a good idea. The official recommendation of LRP2010 was that “Canada develop the ngCFHT concept (science case, technical design, partnerships, timing).”

A Feasibility Study was conducted in 2011 – 2012 to investigate the key science drivers, major technical challenges, and international interest in ngCFHT. The study was led by Pat Côté and supported by NRC and CFHT. Two documents were submitted to the CFHT SAC and Board in November 2012¹, and a major international workshop was held in Hilo in March 2013². The documents and the meeting demonstrated that ngCFHT was technically feasible, scientifically compelling, and of substantial international interest. Subsequently, at the September 2013 SAC meeting, the SAC recommended to the Board that they support a proposal by the ngCFHT team for CFHT to set-up a Project Office to lead the ongoing development of the project³. The Project Office was officially launched in May 2014, and coincided with the rebranding of the project as MSE.

MSE is unique among future astronomy facilities due to its combination of (i) 10-m class aperture and superior sensitivity (ii) broad range of spectral resolutions (iii) dedicated mode of operation (iv) long lifetime. MSE will explore the faint Universe that is beyond the grasp of the many 4-m class instruments already under construction. Examples include in-situ analysis of the chemical evolution of the most metal-deficient halo stars at ~100kpc, and statistical analysis of the broad line regions of high-redshift quasar populations through systematic reverberation mapping surveys. Collaborative opportunities between MSE and other facilities – LSST, WFIRST, Euclid, the SKA, etc. – are numerous. No other facility comes near to providing the required follow-up capabilities for these projects; for example, Subaru/PFS does not have enough available telescope time, has reduced multiplexing and aperture relative to MSE, and a complete absence of high resolution capabilities. In contrast, MSE is technically and operationally optimized to excel at delivering high-quality spectra of faint targets. The scientific and collaborative opportunities available to MSE partners are a direct indicator of the strategic relevance of MSE to the future astronomy landscape.

¹ <http://mse.cfht.hawaii.edu/docs/>

² <http://ngcfht.cfht.hawaii.edu>

³ <http://mse.cfht.hawaii.edu/project/statements.php>

Project Office activities in 2014

The MSE Project Office (PO) is leading the Design Phase by producing a Construction Proposal by the end of 2017. This proposal provides the partners with the necessary information to decide to proceed with the construction of MSE. Specifically, the PO is leading the development of the science case, science requirements, operational concept, system architecture, and is coordinating the design of all major systems and subsystems to an advanced conceptual level. In addition to providing a detailed cost and schedule, the PO is leading the partnership development effort.

The MSE PO priorities for 2014 were to develop and establish support for the project, establish the functions and role of the PO, and progress the foundation documents toward a baseline design concept. Since May 2014, milestones include:

- The formation of an international Science Team⁴, currently consisting of 80 members from Australia, Canada, China, France, Germany, Rep. of Korea, Hawaii, Italy, India, Japan, Spain, Taiwan, the UK and the USA. The Science Team's governing body is the Science Executive⁵, with representatives from major MSE participants;
- The establishment of an Advisory Group with members from MSE participating countries, selected to provide strategic advice within their partner organization⁶;
- Successful efforts to secure prominence for MSE in national planning processes. In France, the Prospective awarded MSE development top priority and France is strongly represented on the Science Team (21 members); in Australia, early indications suggest that MSE is viewed very favorably in their Decadal Plan;
- The establishment of a new MOU between China and CFHT/MSE in which they commit to providing 1FTE/year to the PO⁷. Additionally, India (through the Indian Institute of Astrophysics, IIA) is identifying resources to contribute to MSE, and have sent an Expression of Interest in formally joining the MSE design phase⁸.

Work has commenced to develop the first draft of the Science Requirements by February 2015. Preliminary indications suggest that there may be departures from the original Feasibility Study design. It is possible that the NIR spectral range and the specific spectral resolution modes available will be modified. It is also expected that multi-object IFU capabilities will be introduced, although this may not be a first light capability.

MSE Plan of Work

MSE development will proceed very rapidly during the Design Phase. The work plan for 2015 describes work progressing in three broad areas: (i) Establish Baseline Design (ii) Design Development, and (iii) Permitting Process. Several important activities and milestones will occur during this period that may overlap with the MTR process:

⁴ <http://mse.cfht.hawaii.edu/science/sciteam.php>

⁵ <http://mse.cfht.hawaii.edu/science/sciexec.php>

⁶ <http://mse.cfht.hawaii.edu/project/MSEProjectOfficeAdvisoryGroupCharge.pdf>

⁷ <http://cfht.hawaii.edu/en/news/NAOC-CFHT/>

⁸ This document will be made available to the Panel after the CFHT Board Meeting (week of Dec. 8th).

- The Baseline Design will be established in early 2015 with first drafts of the Science Requirements, Observatory Architecture and Observatory Requirements. This will trigger an expansion in the engineering effort to last until 2018. PO staffing will expand significantly during this time;
- The PO has started preliminary investigations of the permitting process and has engaged with many of the stakeholders in this process, including the Office of Maunakea Management and the Kahu Ku Mauna council (representing local Hawaiian interests to OMKM). The work plan presumes we will conduct a full Environmental Impact Statement, and that MSE should seek a District Land Use Permit within the category “expansions and modifications”. This ~12 month process could be ready to begin in mid-2015; however, the process is uncertain in duration, and the best schedule-risk mitigation at this time is to start as soon as possible;
- A face-to-face meeting of the Science Team will occur in Spring 2015, prior to a full external review of the Science Case and Science Requirements in Aug./Sept. 2015;
- Engineering and science workshops will be organized across the partnership; the first of these will occur in March in Nanjing, China. In addition, MSE is planning to host a booth at the 2015 IAU meeting and to continue to have a strong presence at relevant national meetings and international conferences;
- The Australian Decadal Plan will be released, that will officially indicate the relative priority of MSE in this community.

Of particular note, a revised budget will be available in 2015⁹. MSE will then adopt a cost- and schedule-cap, to maintain a clear focus and allow for planning in partner communities. Figure 1 shows the current, project-driven schedule for MSE. For current planning purposes only, a reasonable estimate of the cost of MSE Construction is USD250M over 6 years, to be shared by ~6 major (equal) partners¹⁰. The Design Phase will undergo an external review in January 2018. Once the “decision to proceed” is made, there will be ~6 – 7 years of work prior to the start of MSE operations, including just over 4 years of construction activities at the summit. The greatest uncertainty in Figure 1 is the time between the completion of the Construction Proposal and the decision to proceed, including efforts to secure funding.

MTR Considerations

We ask the MTR Panel to consider the following points:

- Canada has a prominent leadership role in the emerging MSE collaboration, in part from leveraging its significant investments in CFHT over the past 35 years. This partnership includes major collaborators from TMT (China, India) with opportunities to engage others. MSE will consolidate these new and exciting collaborations, by providing further opportunity to engage with Pacific colleagues. Like Canada, TMT is the major priority for China and India. Both recognize the

⁹ The anticipated cost of MSE is similar to the Feasibility Study estimate (USD206M), adjusted for inflation.

¹⁰ Potentially Australia, Canada, China, France, India, plus one other (with Hawaii expected at a lower level).

potential of MSE as a “TMT feeder facility”¹¹. Operating MSE with its unique, in-demand, capabilities will entrench its partner communities as “collaborators of choice” not just for TMT but also for many other key future facilities. *The Panel should consider these scientific and leadership opportunities, and the strategic relevance of MSE in the portfolio of Canadian facilities;*

- The need for MSE is acute and getting sharper. LSST, Euclid, WFIRST and the SKA all begin operations in the 2020s, and the timely arrival of MSE is paramount to best exploit the many scientific synergies¹². Subaru/PFS comes closest to competing with MSE in this context, and we cannot expect others to stand still in pursuit of these capabilities. The schedule in Figure 1 is realistic and aggressive, but an aggressive schedule must be pursued if (i) MSE partners are to maintain their “head-start” over the rest of the community (ii) MSE is to best exploit the synergies with the new facilities of the next decade (iii) Canada is to make best use of the remarkable site and infrastructure that its investment in CFHT has produced (iv) the technical overlaps that exist between MSE and TMT are to be used effectively¹³ (v) the momentum that MSE has built since LRP2010, critical for success, is to be maintained. The degree to which a significant delay will hurt MSE will depend in part on what the rest of the world does to pursue this capability in the interim. Partners leading MSE must not squander their remarkable opportunity by being passive. *The Panel should consider the importance of pursuing an aggressive schedule for MSE, and the importance of MSE being on-sky in 2024 or as soon as possible thereafter;*
- *The Panel should consider the priority of MSE relative to other projects underway or planned at CFHT.* It is recognized that MSE is at an early stage; in our view, essential short and mid-term development activities at CFHT should be implemented and prioritized to allow redevelopment to proceed as rapidly as possible;
- The Design Phase is funded by CFHT Fund 5 (Development) and partner in-kind contributions. To complete this phase on schedule, it is essential that (i) the CFHT Board supports the annual PO budget request, projected to be an average of USD1200K/year for 2015 – 2017 (ii) partners contribute in-kind effort (for Canada, this is estimated at an average of ~2 – 3 FTEs/year for 2015 – 2017). *We ask the Panel to recognize the importance of the Construction Proposal finishing on time with strong Canadian support, both from the CFHT Board and through contributed effort;*
- The Construction Proposal will be reviewed in Jan. 2018. Therefore, the “decision-to-proceed” will be made prior to the next Canadian LRP (~2020). Canada must have a clear strategy in place to make this decision promptly, including securing of funding. *The MTR is the natural venue for laying the foundations for these strategies.*

All those involved in MSE development will welcome the opportunity to provide further updates to the Panel, and to discuss with the Panel any aspect of the project in more detail.

¹¹ e.g., see <http://cfht.hawaii.edu/en/news/NAOC-CFHT/>

¹² e.g., if only a few fibers every few pointings are allocated to recent LSST/SKA transients, MSE is expected to follow-up more transients than any other 10-m class telescope due to its dedicated operational mode.

¹³ e.g., India is leveraging its capabilities in segmented mirror technology, developed for TMT, for MSE.

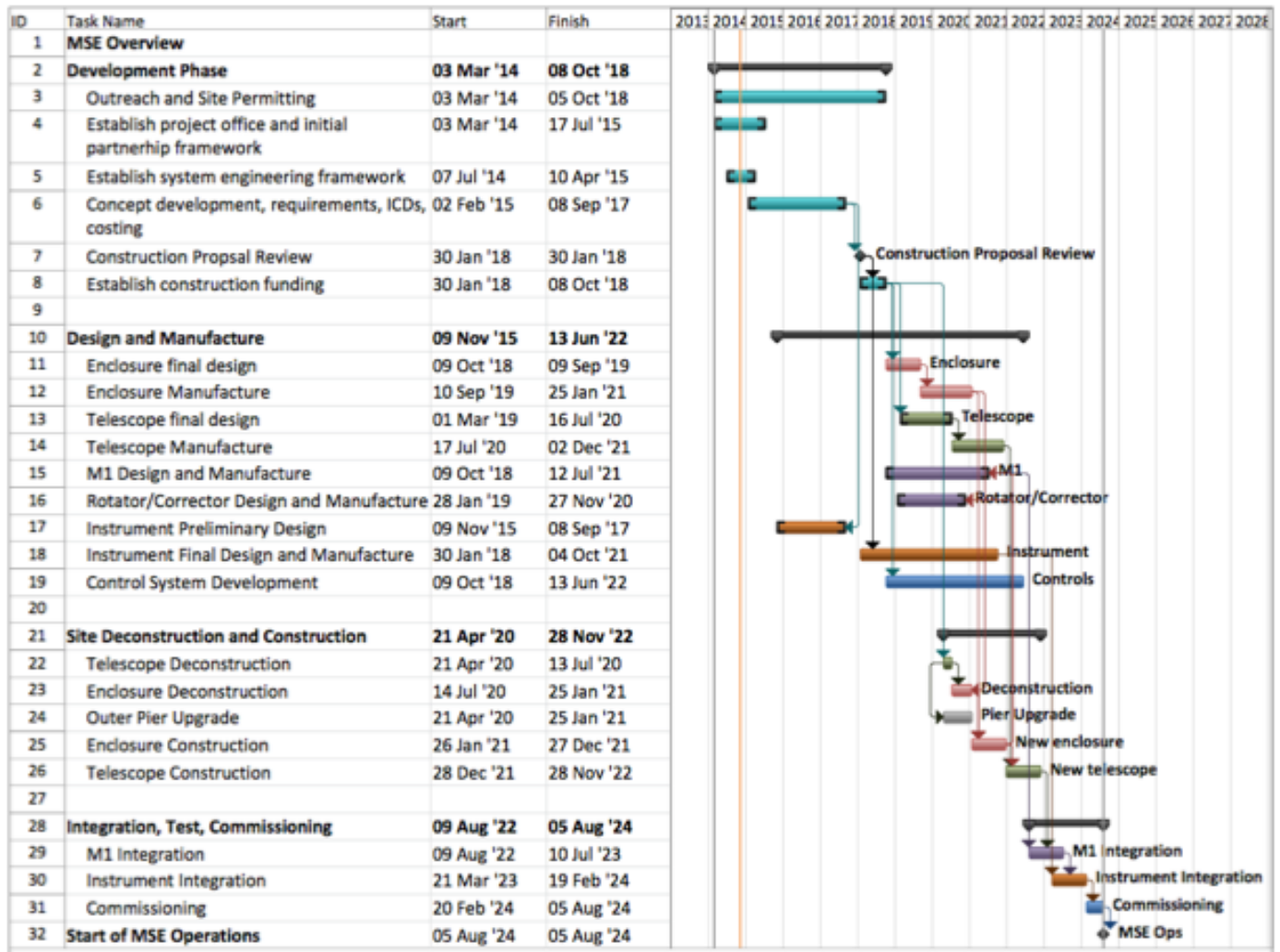


Figure 1: The fastest, realistic, schedule for MSE, from the start of the Design Phase to the start of MSE operations.