# The Maunakea Spectroscopic Explorer (MSE) status update

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MSE will be the only fully dedicated, 10-m class, wide field spectroscopic telescope at first light in ~2025. It will fill arguably the single biggest "missing link" in the international network of astronomical facilities. At optical wavelengths, LSST, WFIRST, Euclid, and Gaia will identify many millions of astrophysically interesting targets that otherwise lack the dedicated, large aperture, spectroscopic followup facilities required to probe their chemodynamical properties. Elsewhere, SKA, eRosita and others will provide a revolution in our understanding of the multiwavelength Universe. Among this capability, MSE will be an essential tool by providing the optical data that will otherwise be chronically absent.

MSE recognises that it is essential for the international astronomical community to consider the global suite of astronomical capabilities as a whole, and to develop ways in which to access key capabilities by using existing resources and infrastructure without compromising the science. MSE is a project to replace the current 3.6m CFHT with a 10m-class, segmented, wide-field telescope that will feed a dedicated suite of multi-object spectrographs, operating at resolutions from R=2000 to R>20000, and obtaining >3000 spectra per pointing (>> 5 million spectra/yr). It will use much of the existing infrastructure of the current CFHT, including the pier, and will closely approximate the envelope of the existing facility. A Feasibility Study, investigating the key science drivers and major technical challenges, was conducted in 2011 - 2012. This led to the submission of two documents[1] to the CFHT SAC and Board in November 2012, and a major international workshop in Hilo in March 2013[2]. MSE development is beyond the scope of the current CFHT partnership, and a major aspect of the development phase is the formation of a new international partnership that uses the existing CFHT organization as a nucleus.

The CFHT Board recently recommended the formation of a MSE Project Office at CFHT Headquarters. The Project Office is initially charged with leading the development of a "Construction Proposal", for completion and external review in 2017. The Proposal will develop the Science Case, Science Requirements, Operational Concept and design of all major systems and subsystems. Further, it will continue the partnership formation that started during the Feasibility Study. Project Office resources are being provided by CFHT and the burgeoning MSE partnership. By the end of this phase it is anticipated that the MSE partnership will have all the information necessary to decide about proceeding to construction. If approved for construction and sufficient funds are raised, MSE could see first light in ~2025 or earlier.

MSE will be a highly efficient spectroscopic machine that takes advantage of the superior location of CFHT on Maunakea. In concept, MSE could be considered a 10m-class version of SDSS at arguably the best site on the planet. However, there are four key aspects of its design and operations that collectively distinguish it from all other astronomical facilities, current or planned. These are:

[1] http://mse.cfht.hawaii.edu/documents.php
[2] http://ngcfht.cfht.hawaii.edu/

1. 10-m class aperture and superior sensitivity: MSE will utilize the full light-collecting power of a 10 m class primary mirror and will capitalize on the exceptional seeing of the site. MSE will complement the excellent projects underway or under development at smaller apertures on shorter timescales (e.g. DESI) by focusing on a scientific understanding of the *faint* Universe that is out-with the grasp of these less sensitive facilities.
2. Operation at a range of spectral resolution: MSE will enable a diverse range of scientific investigations from the Local Universe - where brighter targets may be better suited to higher resolution - to the Distant Universe - where fainter targets may require lower resolution. Further, operational efficiency is ensured by operating throughout the lunar cycle (high/low resolutions during bright/dark time), in contrast to instruments with more limited capabilities.
3. Dedicated operations: In comparison to instruments such as PFS, specialized facilities are more easily able to achieve a higher level of data consistency and homogeneity. For instruments that move on and off telescopes at regular intervals, data issues such as calibration, stability and reproducibility can be problematic since the instrument is not being left in a stable configuration. This is in contrast to the situation for MSE, where the *basic operational philosophy* enables high quality and stable data. Comparison to SDSS demonstrates the scientific power of this approach.
4. Long lifetime: MSE is not built to address a single science goal, and as such it is expected to have a long lifetime. Like all such facilities, it is important that upgrades occur and that it is able to adapt to the changing scientific landscape. Throughout its evolution, MSE is envisioned to remain a *spectroscopic facility*, and it will be the world's premier resource for exploitation of this important capability for frontier science. MSE should be viewed as *a specialized technical capability, and a general science-purpose facility*.

Located at an equatorial latitude, MSE allows complete access to the northern hemisphere and extensive access to the south (more than 50% of the LSST footprint can be accessed at an airmass better than 1.5). Synergies with LSST are numerous and obvious. For example, MSE will be the premier facility for spectroscopic follow-up of transients, even if only a small fraction of fibres per pointing are allocated to these events. On a given night, accessible fields could be cross-checked with a list of recently reported interesting transients (as recently as a few minutes ago). Pointings with one or more transients among their targets would be prioritized in the queue. Once the transient observation was completed, spectra could be reduced and released to the collaboration and/or the public immediately. Additionally, collaborations could be undertaken to monitor single-pointing deep spectroscopic fields during their MSE observing windows. Per night, LSST will image ~1500 square degrees accessible to MSE, in which there will be ~300 new SNe and >75,000 variable stars (Ridgway et al. arXiv:1409.3265). MSE will dominate a new regime of faint transients (probing very early or very late stages, as well as large distances and low luminosities), including fast transients. Indeed, MSE will be able to dedicate more of its time to transient spectroscopy than any other 10-m class telescope by sheer virtue of the fact that it is continually recording thousands of spectra of the faint Universe.

The Science Team currently consists of over 60 PhD astronomers from Australia, Canada, China, France, Italy, India, Japan, Republic of Korea, Spain, Taiwan, the UK and the USA. More details about MSE are available at http://mse.cfht.hawaii.edu. Please contact the Project Scientist, Alan McConnachie (mcconnachie@mse.cfht.hawaii.edu), for more information.