Preliminary Design Phase – Activities, Priorities and Opportunities

Massively multiplexed spectroscopy with MSE: Science, Project and Vision

Kei Szeto
MSE Project Office

28 February, 2019
Overview plan for the Preliminary Design Phase and beyond

- Review of current participants and management structure
- Priority activities underway to ensure MSE’s success
- Look ahead to science operations
  - Project Timeline
  - Project Cost
- Opportunities for technical contributions starting in the PDP
The PDP starts in 2019 with participants:

- **Australian Astronomical Optics (AAO) Macquarie**
- **National Research Council (NRC) of Canada**
- **National Astronomical Observatories (NAOC), Chinese Academy of Sciences**
- **Centre National de la Recherche Scientifique (CNRS) of France**
- **Institute for Astronomy, University of Hawaii**
- **India Institute of Astrophysics**
- **National Optical Astronomy Observatory, USA and Texas A&M University participate as observers**
**PDP Management Structure**

- Management Group
  - Representatives from these six organizations form the MG
  - Precursor of the formal MSE governing board
  - Representatives for NOAO and Texas A&M University are observers
    - Exploring the possibility of becoming participants

- Governance Agreement for the PDP is defined in the Statement of Understanding (SoU)
  - SoU tasks the MG to set the direction of the Project in the Preliminary Design Phase and the subsequent Construction Phase
  - SoU empowers the MG to define the partnership model for science operations
Management Group

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Early participants play critical part in the decision process that shapes the MSE partnership.
PDP Priority Activities

In my Project Overview talk, I introduced the activities currently underway supported by the members of the Science Team, Project Office and Management Group:

- Promoting MES’s science merits to encourage community engagement in their national strategic planning processes with a goal to attain high rankings in order to secure national funding supports
  - Australia: Mid-term review
  - Canada: Long Range Plan
  - France: Prospective Process
  - US: Decadal Plan
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  • Australia: Mid-term review
  • Canada: Long Range Plan
  • France: Prospective
  • US: Decadal Plan
• Expanding and reinforcing partnership
  • Plan and enable Construction Phase
  • Define an operation model appropriate for an effective science platform
  • Build synergy with partners’ national aspirations by sharing technology development
    • Large data platform in the era of large surveys such as LSST
    • China’s 12 m Large Optical Telescope project
    • India’s 10 m National Large Optical Telescope project

Summary

MSE has completed successfully the Conceptual Design Phase and is starting Preliminary Design Phase.
• A total of $9M has been invested in the CoDP.
• MSE is starting Preliminary Design Phase.
• Support for half of the PDP cost, $13M out of $25M, has been identified.
• PDP participants are national astronomy institutes from Australia, Canada, China, France, India, and Hawaii.
• NOAO and Texas A&M University are participating as observers on the management board of MSE.
• As the only large aperture WFI-MOS facility under development in the world, MSE presents many opportunities and is at the cusp of transitions with the Maunakea Observatories.
• Development phase timing matches funding opportunities from participants’ national strategic planning for MSE.
• Partnership opportunities to join MSE will be presented by Andrew Hopkins, MSE MG chair, at the next ESO.
• Funding: European ESF, support from the US and Canada, and funding from the UK, France, India, and internationally.
• Plans for MSE, public outreach and STEM education from Mary Beth Lopatka, Outreach Manager of CFHT, and co-chair of the MSE Education and Public Outreach committee.
• Progress of the land-use authorization application for the MSE Science Reserve from Doug Simons, Executive Director of CFHT.
In my Project Overview talk, I introduced the activities currently underway supported by the members of the Science Team, Project Office and Management Group:

- Reaffirming access to the Mauna Kea Science Reserve for astronomy activities
- Establishing a new Master Lease for the MK Observatories and securing a construction permit for MSE
PDP Priority Activities

In my Project Overview talk, I introduced the activities currently underway supported by the members of the Science Team, Project Office and Management Group:

- Reaffirming access to the Mauna Kea Science Reserve for astronomy activities
- Establishing a new Master Lease for the MK Observatories and securing a construction permit for MSE
- Instituting a comprehensive outreach and education program for the international MSE community
Science Commission will begin in 2029

- Based on a technically paced schedule with no constraints on resources and cash flow

The project timeline is organized in four major overlapping phases with three milestones:

- Preliminary Design Phase - 2 yrs
- Construction Phase - 6.5 yrs duration
- System-Level Assembly, Integration and Verification (AIV) Phase - 5.5 yrs
- Science Commission - 2 yrs

Timeline to Science Operations
Science Commission will begin in 2029

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- Science Commission - 2 yrs

Received Construction Permit from the State

Construction Phase start approved

Received New Master Lease

Preliminary Design Phase

Detailed Design Phase / Industrial Systems AIV / Science Instrument Package AIV

Subsystem Manufacturing & Testing

Science Commission
Science Commission will begin in 2029

- Based on a technically paced schedule with no constraints on resources and cash flow

The project timeline is organized in four major overlapping phases with three milestones:

- Preliminary Design Phase - 2 yrs
- Construction Phase - 6.5 yrs duration
  - Detailed Design Phase
  - Subsystem Manufacturing and Testing Phase
- System-Level Assembly, Integration and Verification (AIV) Phase - 5.5 yrs
  - Industrial systems: enclosure and telescope
  - Science instrument package
- Science Commission - 2 yrs
Project schedule

- Technically paced
- Milestones driven
  - Land Use Authorization, a.k.a. new Master Lease
  - Construction Phase Start approved by Management Board
  - Received construction permit from the State
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- Tasks and their durations are bottom-up estimates provided by subsystems as their CoDP deliverables
- Divided into PDP, DDP and M&T phase
- Link-logic applied to execute tasks in parallel where possible to optimize the schedule

### Project Schedule – Basis of Estimate

<table>
<thead>
<tr>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
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<tbody>
<tr>
<td>MSE Timeline</td>
<td>154.55 mns</td>
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<td>Nov 5 '20</td>
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<td>Jun 27 '23</td>
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<tr>
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<tr>
<td>Production Readiness</td>
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<td>Deconst. IP &amp; OB</td>
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<td>Summit AIV - Inst</td>
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<td>Jun 19 '29</td>
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<tr>
<td>Science Commission</td>
<td>24 mns</td>
<td>Jan 3 '29</td>
<td>Nov 5 '30</td>
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• Divided into PDP, DDP and M&T phase
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- System-Level Assemble, Integration and Verification sequence of Science Instrument Package is based on the draft AIV storyboard
Basis of Estimate:

• Based on the detailed WBS
  • Detailed WBS dictionary describes included & excluded work in each element
  • Divided into PDP, DDP and M&T phase
  • Separated into labor and non-labor components
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  - Level of Effort (LOE) costs are linked to the project schedule duration
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  • Extensive PO WBS elements
  • Level of Effort (LOE) costs are linked to the project schedule duration
  • Risk Adjusted Costs are estimated bottom-up by subsystems in CoDP including uncertainties in their estimates.

• RAC = Base Cost + Risk Cost, where RC is assessed by standard formula based on:
  • Technical maturity
  • Work complexity
  • Schedule impact if delayed
  • Possible range - 4% to 98% of BC
Project Cost Estimate

- **Total Risk Adjusted Cost**
  - $424M*
  - *Base year 2017
- **Base Cost**
  - $338M (80%)
- **Risk Cost**
  - $86M (20%)
- **Overall risk ratio**
  - 25%

**Risk Cost/Base Cost**

### MSE Risk Adjusted Cost - Dec 2018

- **Telescope M1**, 21.6%
- **Enclosure**, 12.4%
- **Telescope Structure**, 7.2%
- **Telescope top end**, 2.6%
- **Fibre Transmission**, 2.0%
- **Science Calibration**, 1.0%
- **Positioner System**, 1.5%
- **Telescope Optical Feedback**, 6.1%
- **LM Spectrographs**, 13.9%
- **HR Spectrographs**, 8.2%
- **Observing Software**, 1.2%
- **Program Software**, 5.9%
- **Project Office**, 10.0%
- **Building and Facilities**, 6.0%
- **Deconstruction costs not included**, 0.3%
Status of PDP Contributions

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- Science Instrument Package
  - Organizations who led the Conceptual Design Phase will continue to lead the development
  - Collaboration in shared design and technology development with other participants are encouraged
    - Design cost and risk reductions
    - Shared construction costs
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  • Commitments identified for high level control systems
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• Program Execution System Architecture
  • Interest on the software elements and commitments are under discussion
For PDP, the PO will continue to coordinate with the Science Team and oversee the work of the international design team but need additional staff.

- Opportunities for PO staffing
  - On-site secondment or work remotely
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- Opportunities for OBF, ENCL and TEL
- Cash contributions for industrial contracts or equivalent engineering support
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  - On-site secondment or work remotely
- Opportunities for OBF, ENCL and TEL
- Cash contributions for industrial contracts or equivalent engineering support
- In-kind contributions for TEL TOFS and Top End Assembly
  - Acquisition and guide cameras system with analysis software
  - Segment phasing and alignment camera system with analysis software
  - Precision mechanisms
  - Opto-mechanical system
Leadership in OESA design

- Maintain and refine the OESA system conceptual design architecture

- Set common software interface definitions

- Set global safety system interface definitions
• Leadership in OESA design
• Maintain and refine the OESA system conceptual design architecture
• Set common software interface definitions
• Set global safety system interface definitions
• Leadership in PESA design
• Set PESA system architecture
• Based on the Operations concept
• Working with the Science Team to define scope of PESA elements based on the science products envisioned
• Queue Service Observing
• Data Reduction and Pipelines
• Data Archives and Distribution
• We will continue to advance the MSE vision and to realize science operations.
  • Actively seeking new contributors to expand the international partnership
    • Through providing scientific and technical opportunities to lead subsystem designs
    • In the US context, there are plenty of technical expertise and relevant experience in areas directly applicable to MSE
      • Survey planning, data pipeline, archive and distribution
      • Precision structures, opto-mechanics and instrumentation
  • Proactively promoting MSE scientifically to secure public and private funding
    • Welcome suggestions to engage potential funders
Acknowledgement

The Maunakea Spectroscopic Explorer (MSE) conceptual design phase was conducted by the MSE Project Office, which is hosted by the Canada-France-Hawaii Telescope (CFHT). MSE partner organizations in Canada, France, Hawaii, Australia, China, India, and Spain all contributed to the conceptual design. The authors and the MSE collaboration recognize the cultural importance of the summit of Maunakea to a broad cross section of the Native Hawaiian community.