

LSST:UK Long-Term Plan

Bob Mann
Project Leader

Release 2.1: 2020-03-31

1. Introduction

This Long-Term Plan (LTP) is the principal, top-level planning document for UK participation in the *Legacy Survey of Space and Time* (LSST) to be conducted at the *Vera C. Rubin Observatory*. Its primary focus is the grant-funded effort of the LSST:UK Science Centre (LUSC), but, where appropriate, it may include other activities, such as preparatory or follow-up observations with other telescopes, that are conducted on behalf of the LSST:UK Consortium, but funded from other sources.

The LTP is a living document, to be maintained by the Project Leader, and updated periodically. The current version will be available from the LSST:UK wiki site at the following URL:

<https://lsst-uk.atlassian.net/wiki/display/BOAR/Long-Term+Plan>.

The LTP contains an outline plan for the full project period from 2015 to 2033, with additional information added to sections as they approach and removed once they have passed. Each version of the LTP will be approved by the LSST:UK Consortium Board, to confirm that the plan it outlines reflects the collective wishes of the Consortium, and, hence, the UK community.

2. Applicable Documents

This document implicitly assumes familiarity with the following documents:

- [AD1]: *UK Involvement in the Large Synoptic Survey Telescope* (Phase A proposal to PPRP)
<https://lsst-uk.atlassian.net/wiki/display/BOAR/Phase+A+Proposal>
- [AD2]: *Memorandum of Agreement regarding collaboration in the scientific exploitation of data acquired with LSST by the UK Astronomical Community*
<https://lsst-uk.atlassian.net/wiki/display/BOAR/UK+MoA+with+LSSTC>
- [AD3]: *LSST:UK Science Requirements Document*
(linked from <https://lsst-uk.atlassian.net/wiki/spaces/LUSC/overview>)
- [AD4]: *UK Involvement in the Large Synoptic Survey Telescope: Phase B – Resubmission* (resubmitted Phase B proposal to PPRP) (linked from <https://lsst-uk.atlassian.net/wiki/spaces/LUSC/overview>)
- [AD5]: *LSST:UK Science Centre Phase B Project Management Plan*
<https://lsst-uk.atlassian.net/wiki/spaces/LUSC/pages/580222977/LSST+UK+Science+Centre+Phase+B+Project+Management+Plan>

3. UK participation in LSST

The objectives for UK participation in LSST are two-fold:

1. To obtain for the whole UK community the data access required for scientific participation in the LSST survey programme and for enhancing the scientific return from other facilities in the UK astronomy programme through incorporation of LSST data;
2. To secure intellectual leadership of the UK community's top priority LSST science areas, by targeting investment in the software and DAC services needed for their success.

The first part of Objective 1 was initially to be met through *AD2*, signed by LSSTC and STFC (acting on behalf of the LSST:UK Consortium, through which the UK community engages with the Rubin Observatory and the LSST programme), with its cost covered by the £15M that STFC set aside at the time of the Phase A grant awards to meet the UK contribution to LSST operations. At the time of writing¹, the Consortium is in the midst of negotiations with the Rubin Observatory operations management team (and, through them, with the US funding agencies) to agree the in-kind contribution that the UK shall make to Rubin Observatory operations under the new operations model, which will see the *AD2* lapse. Objective 2 is the focus of the funded LUSC programme, which also, thereby, addresses the second part of Objective 1.

4. The LUSC Programme

AD1 defines the LUSC programme as comprising four activities:

- **LUSC-DAC** will operate the UK Data Access Centre (DAC), curating data releases and supporting their analysis;
- **LUSC-DEV** will develop the software needed for User-Generated Products, to help secure UK leadership in the community's highest priority science areas;
- **LUSC-TRN** will train young researchers in the statistical and computational techniques needed to exploit the vast LSST dataset; and
- **LUSC-EPO** will create a Citizen Science platform to enable the public to engage in LSST science and interface to the comprehensive education and outreach programme being planned by the LSST project in the US.

Funding for LUSC-DAC and LUSC-DEV will be provided by STFC through the PPRP process, while STFC Science Board has directed us to seek support for LUSC-EPO from STFC public engagement grants schemes. It has been expected that LUSC-TRN would target EU support, but, due to the lack of appropriate funding opportunities, this part of the LUSC programme has not started.

¹ A new release of this document will be made once the UK's in-kind contribution to Rubin Observatory operations has been agreed.

5. The timeline for LSST and LUSC

The LSST project schedule is available at <http://www.lsst.org/about/timeline> and the salient dates are as follows:

- August 2014: Start of NSF-funded construction project
- October 2019 – August 2020: *Early Integration and Test* (with ComCam)
- August 2020 – February 2021: *Full System Integration and Test*
- February 2021 – August 2021: *Science Verification*
- August 2021 – October 2022: *Schedule Contingency*
- October 2022 – September 2033: *Operations*

This remains the official schedule, but, at the time of writing, it is expected that changes will be made to the Commissioning programme (see below), which runs up to the Operations Readiness Review in mid-2022.

The LUSC Baseline Programme outlined in AD1 runs from 1 July (originally 1 April) 2015 to a date intended to be after the final LSST data release; AD1 listed that end date as 31 March 2033, but the correct date will, clearly, need to be confirmed nearer the time. The Baseline Programme is divided into four phases, as follows:

- **Phase A: Development** (July 2015 - March 2019).
- **Phase B: Commissioning** (July 2019² - March 2023).
- **Phase C: Early Operations** (April 2023 - March 2027).
- **Phase D: Standard Operations** (April 2027 - March 2033).

Table 1 presents the division of DI staff effort (in FTE) for LUSC-DAC and LUSC-DEV activities across the four Phases of the LUSC programme; for Phases A and B, the figures represent the effort awarded, while the figures for Phases C and D are those specified in AD1. (N.B. agreement of the UK's in-kind contribution to Rubin Observatory operations may change these numbers for Phases B-D).

	Phase A				Phase B				Phase C				Phase D					
Year	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	2032/33
Project Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
DAC	1.5	1.5	1.5	1.5	3.0	3.0	3.0	3.0	4	4	4	4	4	4	4	4	4	4
DEV	4	4	4	4	4.9	4.9	4.9	4.9	8	8	6	6	3	3	0	0	0	0
Total	5.5	5.5	5.5	5.5	7.9	7.9	7.9	7.9	12	12	10	10	7	7	4	4	4	4

Table 1: DI staff allocations (in FTE) for LUSC-DAC and LUSC-DEV. For Phases A and B we show the awarded effort as a flat profile, while the figures for Phases C and D are those for the Baseline Programme presented in AD1. All Project Years begin on 1 April, with the exception of Years 1 and 5, which both started on 1 July.

² Phase B was originally intended to start on 1 April 2019, but a delay with the PPRP process led to its being reduced in length from 48 to 45 months, with a new start date of 1 July 2019; bridging across the period April-July 2019 ensured continuity of those activities present in both Phases A and B.

In addition to the DAC and DEV DI staff effort, the LUSC programme also provides management effort. In both Phases A and B, PPRP awarded 0.1 FTE of Work Package leader effort per FTE of DI staff effort, plus 0.2 FTE for the Project Leader and Project Scientist roles. The Project Manager post was funded at 0.5 FTE in Phase A and 1.0 FTE in Phase B, while the Commissioning Coordinator role was funded for Phase B at a level of 0.2 FTE.

6. Phase A: July 2015 - March 2019

The principal goals of this phase were to attain full technical and scientific engagement with the LSST Project and the Science Collaborations, and, thereby, to secure for UK astronomers access to the LSST commissioning data.

The Phase A programme was divided into three Work Packages, namely:

- WP1: Management
- WP2: LUSC-DAC
- WP3: LUSC-DEV

with WP3 subdivided into six sub-packages:

- WP3.1: Weak Lensing
- WP3.2: Milky Way
- WP3.3: Transient Server and Supernova Photometric Classification
- WP3.4: Galaxies, Clusters and Active Galactic Nuclei
- WP3.5: Solar System
- WP3.6: Sensor Characterisation

of which five (WP3.1, WP3.2, WP3.3, WP3.5 and WP3.6) were awarded effort by PPRP through the Phase A grants.

The rules for access to commissioning data are still to be confirmed by the Project, but, otherwise, Phase A was generally successful, with the UK becoming established as one of the top International Contributors in terms of leadership in Science Collaborations and technical preparation. More details of the outputs of the Phase A programme – both the formal Deliverables and Technical Reports produced during Phase A – can be found at <https://lsst-uk.atlassian.net/wiki/spaces/LUSC/overview>. An underspend on WP2 allowed WP3.3 work on the Lasair event broker and the WP3.6 sensor characterization work to be bridged through to the delayed start of Phase B on 1 July 2019, along with continuation of the DAC programme, so there was no loss of continuity for those Phase A activities extending into Phase B. A no-cost extension of one year was awarded to enable the completion of the WP3.2 deliverables, which had been delayed by the departure of the funded PDRA.

7. Phase B: July 2019 – March 2023

This phase covers commissioning of the full Rubin Observatory, from the telescope and camera through to the data management system. As noted in Section 5 above, the official LSST timeline remains that published a number of years ago, but it is expected that the actual Commissioning programme will differ in detail from that originally planned, which has a knock-on effect for LUSC plans. Similarly, agreement of the UK in-kind contribution may affect some of the Phase

B WPs, so the plan outlined below is subject to revision, and it is expected that a further release of this document will be made in late 2020, after the UK in-kind contribution has been agreed.

The UK in-kind proposal is intended to secure for the UK community a stronger role in LSST than would have been provided by the original Memorandum of Agreement (AD2). It comprises four components, which include cost-offsetting and value-adding activities, namely:

1. undertaking a fraction of the annual Data Release Processing workload;
2. supporting the maintenance by the Zooniverse team of software that they have provided to the Rubin Observatory Education and Public Outreach programme;
3. operation of the UK DAC as part of an international DAC network; and
4. performance of the DEV programme, delivering software and User-Generated Products aligned with the priorities of the Science Collaborations.

This in-kind package will be specified in terms of a set of agreed workplans, which may involve the slight refocussing of some of the Work Packages described below, and is expected to influence the selection of DEV WPs in Phases C and D.

7.1 LUSC Phase B Work Packages

The LUSC Phase B programme is divided into three top-level Work Packages, namely:

- WP1: Management
- WP2: LUSC-DAC
- WP3: LUSC-DEV

which, in turn, are divided into the following subpackages:

- WP1: Management
 - WP1.1: Maintenance of Long-Term Plan
 - WP1.2: Maintenance of Science Requirements Document
 - WP1.3: Management of the DEV and DAC Staff Effort
 - WP1.4: Coordinating of LSST:UK Contributions to Commissioning
 - WP1.5: External Liaison
 - WP1.6: Reporting to STFC
- WP2: LUSC-DAC
 - WP2.1: DAC Management
 - WP2.2: Data Ingestion and Publication
 - WP2.3: Alert Handling Infrastructure
 - WP2.4: Provision of the DAC Platform
 - WP2.5: Science Support
- WP3: LUSC-DEV
 - WP3.2: LASAIR—the UK transient broker for LSST
 - WP3.5: LSST and near infra-red data fusion
 - WP3.7: Low-surface-brightness science using LSST
 - WP3.9: LSST Point Spread Function, sensor characterisation and modelling
 - WP3.10: UK Contributions to DESC Operations

- WP3.11: Cross matching and astrometry at LSST depths

Detailed descriptions of each of these are presented on the LUSC wiki – see <https://lsst-uk.atlassian.net/wiki/spaces/LUSC/overview> – with each sub-WP having a Project Brief, plus lists of Deliverables and Milestones, which are also collected in *AD5*. Each sub-WP will also have a series of six-month plans, each of which has a number of interim deliverables and milestones, against which progress can be monitored on a regular basis.

7.2 Other Phase B activities

The Phase B award from STFC included travel and subsistence funding for UK researchers to participate in Commissioning activities in either Tucson or Chile. At the time of writing, we are still awaiting confirmation from the Project as to what expertise they are seeking from external participants in Commissioning, so this activity remains to be planned. Consortium members continue to play significant roles in a number of the Science Collaborations; at the time of writing, a quarter of the Science Collaboration co-chairs are UK-based, and a much larger number of UK researchers are engaged in Science Collaboration activities.

8. Phase C: April 2023 – March 2027

The first few LSST Data Releases will be used to shake down LUSC-DAC operations and complete the large-scale development of analysis software within the LUSC-DEV programme. LUSC-DAC activities for Phase C will, therefore, focus on supporting UK astronomers in their analysis of these data products and in their further development of software for User-Generated Products. The LUSC-EPO programme will have started to deploy in the UK tailored versions of the education and public outreach resources developed by the Project EPO team.

9. Phase D: April 2027 – March 2033

LUSC-DEV development work will wind down early in Phase D, transitioning to scientific exploitation funded through the Astronomy Grants Panel, while LUSC-DAC should be entering routine operations, and LUSC-EPO will be fully operational. The main funded LUSC activity will, therefore, be the continuing support for UK astronomers analyzing LSST data products using the DAC, but it will be important to ensure that the final stages of DEV funding will support preparation for those science applications that require the full integrated depth or the full set of epochs.