



# Long-Term Plan

## *Work Package 1.1, Deliverable D1.1.3*

**Project Acronym** LUSC-B  
**Project Title** UK Involvement in the Legacy Survey of Space and Time  
**Document Number** LUSC-B-40

<b>Submission date</b>	29/MAR/23
<b>Version</b>	3.1
<b>Status</b>	Final
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<b>Dissemination level</b>	
Public	

## Version History

<b>Version</b>	<b>Date</b>	<b>Comments, Changes, Status</b>	<b>Authors, contributors, reviewers</b>
3.0	29/MAR/23	Revision of LTP for end of Phase B	RGM
3.1	23/MAY/23	Approved by LSST:UL Executive Group	

# LSST:UK Long-Term Plan

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Release 3.1: 2023-05-23

## 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 2036<sup>1</sup>, 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>)

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<sup>1</sup> This the end-date of the current LSST:UK plan, but it is subject to revision, given that the survey has not started yet. In practice, it will be some time after Data Release 11, as some mechanism (TBD) will have to be agreed to support long-term use of LSST dataset by the UK community. Successful review by the then Department of Business, Energy and Industrial Strategy of a Business Case submitted by STFC means that they have Government approval to continue funding the LUSC programme to 2036.

- [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>)
- [AD6]: *UK Involvement in the LSST: Phase C* (Proposal to PPRP)(linked from <https://lsst-uk.atlassian.net/wiki/spaces/LUSCSWG/overview>)

### 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 is now to be met through the UK’s Data Rights Agreement, which will be signed by STFC and the US Department of Energy, and which will enshrine the agreed manner in which members of the UK community will be able to access LSST data in return for UK contributions to Rubin operations. The Data Rights Agreement is expected to be signed during 2023, after which the next revision of this document will be produced.

The second part of Objective 1, together with Objective 2, are addressed through the LUSC programme. As discussed in AD1, it was initially planned specifically to address those objectives, but the adoption of the in-kind model for international data rights has enabled us to secure data rights through a set of contributions that also yield scientific benefits to the UK community.

### 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; an initial plan for doing that is being developed by the LSST:UK EPO Coordinator, Chris Lintott. It had been expected that LUSC-TRN would target EU support, but, due to the lack of appropriate funding opportunities, this now seems unlikely, at least for the foreseeable future. However, the Rubin Data Preview programme does provide a broad range of training opportunities, so it is now expected that it will provide the focus for training within LSST:UK.

## 5. The timeline for LSST and LUSC

The LSST project schedule is available at <http://www.lsst.org/about/timeline>. Needless to say, it has been significantly affected by the Covid-19 pandemic, which introduced a delay of almost two years into the completion of Rubin construction. Supplementing the current version of that schedule (dated December 2022) with those of the *Release Scenarios for Rubin LSST Commissioning and Survey Data* document ([RDO-11](#)) and of the Rubin Observatory Plans for an Early Science Program ([RTN-011](#)) yields the following major milestones for the Rubin LSST:

- July 2024: System First Light
- September/October 2024: Release of Data Preview 1
- November 2024: Forecast finish of Rubin construction project
- January 2025: Nominal start of survey operations
- May – August 2025: Release of Data Preview 2
- January 2026: Nominal release date for Data Release 1
- January 2027: Nominal release date for Data Release 2
- ...annual data releases will follow, until...
- February 2036: Nominal release date for Data Release 11

These dates remain subject to some uncertainty and are likely to remain so until survey operations have begun.

The LUSC Baseline Programme outlined in *AD1* ran from 1 July (originally 1 April) 2015 to 31 March 2033, which was after the originally-planned date for the final data release. The Baseline Programme was divided into four phases, as follows:

- **Phase A: Development** (July 2015 - March 2019).
- **Phase B: Commissioning** (July 2019<sup>2</sup> - March 2023).
- **Phase C: Early Operations** (April 2023 - March 2027).
- **Phase D: Standard Operations** (April 2027 - March 2033).

Phase D was originally specified as being longer than Phases A-C because of the likelihood of a delay to survey operations, with the intention that it could be split

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<sup>2</sup> 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.

into shorter Phases D and E once the operations schedule was finalised. The significant delay to the Rubin construction schedule by the Covid-19 pandemic makes this even more likely, although the dates for Phases D and E will have to be agreed with STFC

## 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.

In total, 5.6 staff-years of DI effort was awarded for LUSC-DAC and 11.3 staff-years for LUSC-DEV, while DA supervisory effort was provided at a level of 0.1 FTE per FTE of DI effort. In addition, the Project Leader and Project Scientist posts were funded at the level of 0.2 FTE, with the Project Manager at 0.5 FTE.

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.

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>.

## 7. Phase B: July 2019 – March 2023

The change to the in-kind model for international partners took place during Phase B, and that, coupled with the impact on the Rubin schedule of the Covid-19 pandemic, meant that significant changes were made to the Phase B plan after the initial grants were awarded by STFC.

## 7.1 The UK in-kind proposal

The proposal was developed in conjunction with the Rubin operations leadership between autumn 2019 and submission of the final proposal in November 2020. Its contents were endorsed by both the LSST:UK Consortium Board and the LSST:UK Oversight Committee, and both the initial Letter of Intent and the final proposal included a supporting statement from Colin Vincent for STFC.

The proposal contained 15 contributions, as follows:

<b>ID number</b>	<b>Title of contribution</b>
UKD-UKD-1	LSST:UK's contribution to Annual Data Processing
UKD-UKD-2	LSST:UK's contribution to Rubin's EPO software programme
UKD-UKD-3	LSST:UK's operation of an international Data Access Centre
UKD-UKD-4	Science Software development: Lasair Transient Broker
UKD-UKD-5	Science Software development: Near-infrared data fusion
UKD-UKD-6	Science Software development: Low surface brightness science
UKD-UKD-7	Science Software development: Sensor characterisation and PSF modelling
UKD-UKD-8	Science Software development: DESC operations
UKD-UKD-9	Science Software development: Cross-matching
UKD-UKD-10	Science Software development: spectroscopic classification of transients and 4MOST spectra
UKD-UKD-11	Science Software development: photometric redshift estimation and DESC related software development
UKD-UKD-12	Science Software development: Phases C and D
UKD-UKD-13	Commissioning Support
UKD-UKD-14	International Program Coordinator
UKD-UKD-15	Community Scientists (secondments)

This proposal can be thought of as comprising two categories of contribution:

1. Those contributions that comprise the DAC and DEV activities that we had already outlined in our Phase A proposal as constituting the baseline LUSC programme needed to enable full UK scientific exploitation of the data rights "subscription" envisaged in our original Memorandum of Agreement with the LSST Corporation (UKD-UKD-3 to UKD-UKD-12); and
2. Activities – primarily a 25% share in Data Release Processing (DRP, UKD-UKD-1), plus some specific staff roles (UKD-UKD-2, UKD-UKD-13 to UKD-UKD-15) – that we were asked to consider by the Rubin team and that will help integrate us into the operations consortium.

While most of these contributions mapped one-to-one to Work Packages in the original Phase B proposal, some of those needed to be expanded in scope to match the requirements agreed with the relevant Recipient Groups. That, and the funding of the new Work Packages, was accomplished through a combination of use of the Phase B Working Allowance, plus the award by STFC of some additional funding.

## 7.1 LUSC Phase B Work Packages

Following amendment as a result of adoption of the UK in-kind proposal, the LUSC Phase B programme was divided into four top-level Work Packages, namely:

- WP1: LUSC-MAN (Management)
- WP2: LUSC-DAC
- WP3: LUSC-DEV
- WP4: LUSC- DRP (Data Release Processing)

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

- WP1: LUSC-MAN
  - 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
  - WP1.7: International Program Coordinator
- 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
  - WP3.3: Spectroscopic classification of transients
  - WP3.5: LSST and near infra-red data fusion
  - WP3.6: Photometric Redshift Estimation
  - 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
  - WP3.12: Support of EPO software
- WP4: LUSC-DRP
  - WP4.1: DRP Preparations

In total, 11.75 staff-years of DI effort was awarded for LUSC-DAC, 26 staff-years for LUSC-DEV, and 3 staff-years for LUSC-DRP, with DA supervisory effort was provided at a level of 0.1 FTE per FTE of DI effort. In addition, 9.1 staff-years was awarded for LUSC-MAN, covering the Project Office (Project Leader, Project Scientist, Project Managers, Data Facility Coordinator), the contributions to Commissioning and the International Program Coordinator role. Several of the Phase B grants were awarded No-Cost Extensions, so some of the Phase B funding will be deployed after 31 March 2023.

Detailed descriptions of each of Work Packages 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, with the



former appearing on completion at <https://lsst-uk.atlassian.net/wiki/spaces/HOME/pages/752156697/LSST+UK+Technical+Reports+Phase+B>.

At the start of Phase B, STFC established an Oversight Committee, which has reviewed progress at six-monthly intervals, on the basis of the Project Assurance Report that we prepare for submission to STFC. On that basis, the project has been awarded a “Green” assessment at each review.

## 8. Phase C: April 2023 – March 2027

The Phase C proposal to PPRP (AD6) was written explicitly as the implementation of that portion of the UK in-kind programme that falls within its dates, plus provision of the management support needed for its success. The Work Package structure for Phase C again features four top-level Work Packages:

- WP1: LUSC-MAN
- WP2: LUSC-DAC
- WP3: LUSC-DEV
- WP4: LUSC-DRP

with the following set of sub-WPs:

- WP1: LUSC-MAN
  - WP1.1: Long-term Planning
  - WP1.2: Management of LUSC Staff Effort
  - WP1.3: Reporting to STFC and Oversight Committee
  - WP1.4: Liaison with Rubin Observatory
  - WP1.5: Data Facility Coordination
  - WP1.6: Community Scientist Programme
  - WP1.7: Support for Rubin Commissioning
  - WP1.8: In-Kind Program Coordination
  - WP1.9: Communications Officer
- WP2: LUSC-DAC
  - WP2.1: Catalogue Ingestion and Database Administration
  - WP2.2: Image Ingestion and Publication
  - WP2.3: Rubin Science Platform Tailoring and Support
  - WP2.4: DAC Service Development
  - WP2.5: DEV Activity Support
  - WP2.6: Science Support
- WP3: LUSC-DEV
  - WP3.1: Support for EPO Software
  - WP3.2: LSST-VISTA Fusion Dataset
  - WP3.3: Cross-matching at LSST Depths
  - WP3.4: Critical Infrastructure for Low Surface Brightness Science
  - WP3.5: Lasair – the UK’s Community Alert Broker
  - WP3.6: Adler – Solar System Transient Classification
  - WP3.7: Spectroscopic Classification of Transients and Lenses with 4MOST
  - WP3.8: UK Contributions to Dark Energy Science Collaboration
- WP4: LUSC-DRP
  - WP4.1: DRP Preparations

- WP4.2: DRP Data Management
- WP4.3: DRP Pipeline Operations
- WP4.4: Scientific Validation
- WP4.5: Infrastructure Support and Troubleshooting

The initial set of Phase C grants includes only DRP effort for WP4.1, which will run for the first year of Phase C, with the awards funding WP4.2-4.5 to be made once the detailed requirements of our DRP role – in terms of the mix of skills needed and the best set of people to undertake the work – have been agreed, but in time for those grants to support DRP work from 1 April 2024. Including those later DRP grants, the total staff effort awarded for Phase C is: (i) LUSC-MAN: 22.6 staff-years DI and 2.9 staff-years DA; (ii) LUSC-DAC: 20 s.y. DI and 2 s.y. DA; (iii) LUSC-DEV: 31.3 s.y. DI and 3.1 s.y. DA; and (iv) LUSC-DRP: 19 s.y. DI + 1.9 s.y. DA.

Phase C will also see the signing of the UK's Data Rights Agreement, and its implications for the UK community will be detailed in the next revision of this document, which will be produced once the DRA has been signed. Many of those on the current data rights list are already applying for LSST science exploitation funding from the Astronomy Grants Panel, and that will continue in future rounds. Letters were provided to AGP for the 2023 grants round to emphasise the distinction between the PPRP-funded LUSC programme and AGP proposals being submitted by individual LSST:UK Consortium members. This may be advisable for future rounds, but this is likely to be the extent to which LSST:UK gets involved in AGP proposals; LSST:UK obtains and manages data rights for UK researchers, but how they exercise those for science exploitation is a matter for themselves alone.

## **9. Phases D and E: April 2027 – March 2036(?)**

The end-point of the LUSC programme will be determined by the date of the final data release, which will itself be determined by the start date of survey operations. The division of the remaining time into Phase D and Phase E will have to be agreed with STFC, but it would be likely that Phase D will cover another four-year period (i.e. April 2027 – March 2031), and Phase E covering whatever time remains after 1 April 2031.

The current plan – consistent with both the UK in-kind programme and the whole-lifetime financial plan submitted to STFC and used by them as the basis of their Business Case to BEIS – sees LUSC-DAC and LUSC-DRP both continuing at a 5 FTE level until the release of the final LSST data release, and a total of 9 staff-years of additional effort being available for LUSC-DEV activities beyond the end of Phase C. This reflects the fact that most science analysis software should be in place and operational during Phase C, ready for the first few data releases, with only modest DEV effort needed therefore, primarily for the maintenance of DEV software, if that has not been handed over by then to the relevant Recipient Groups. The bulk of LSST-related STFC funding during Phases D and E is, therefore, likely to be provided by AGP for science exploitation.