

Briefing the UK community on commissioning the Vera Rubin Observatory

This document briefs the UK astronomy community on the commissioning of the Rubin Observatory, and thus aims to assist colleagues in preparing for and contributing to commissioning. This is in the context of the current pause in Rubin construction, and the ongoing negotiations of the UK's in-kind contributions to the Rubin Observatory and LSST Science Collaborations. Nevertheless, engagement with commissioning is timely, as we anticipate the in-kind negotiations reaching a positive conclusion in late 2020, and we all hope that the covid-19 pandemic eases in the coming months. Graham Smith's role as LSST:UK Commissioning Coordinator is to coordinate UK contributions to Rubin commissioning in collaboration with UK colleagues and the Rubin Project Team. A recent kick-off discussion with Chuck Claver (Systems Scientist & Commissioning Manager) and Phil Marshall (Deputy Director of Operations), indicates that the UK has a significant opportunity to contribute to commissioning spanning the full spectrum from support of physical activities through to examining and possibly processing commissioning data. We therefore intend to publish a call for expressions of interest in UK Contributions to Rubin Commissioning August 2020. Funding is already in place to support travel and subsistence relating to UK commissioning activities, as part of the LSST:UK Phase B grant. New funding to support salary is also not out of the question, depending on how the in-kind process plays out.

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1 Introduction

The UK is well placed to contribute and add value to Rubin commissioning notwithstanding the prevailing uncertainties. For example, the US agencies' shift from a cash subscription model to an in-kind cost off-setting model plays to LSST:UK's strengths as a large national consortium funded to create a Data Access Centre (DAC), and to develop relevant scientific software (DEV). Both DAC and DEV aspects of funded UK effort therefore feature prominently in the in-kind negotiations. A more intimate role for the UK in the Rubin project is therefore inevitable, at some level. Allied with project delays, the in-kind negotiations are therefore helping to crystallise opportunities for UK contributions to commissioning. UK contributions will be supported by a dedicated travel and subsistence fund of £27k within the Phase B funding. These funds will enable UK colleagues that get involved in commissioning to make extended visits to LSST locations, namely Tucson, Champaign-Urbana, Cerro Pachón, and La Serena.

A broad range of preparatory work is required before Rubin survey observations begin, ranging from work that enables the observatory to pass its Operations Readiness Review (ORR), through commissioning computing infrastructure spanning the US and international partners, to testing and running DEV and non-DEV software on early data products. The scope of this briefing paper is preparatory work that is integrated with / done on behalf of the Rubin Project Team as it works towards a successful ORR. Thus defined, "commissioning" should not be regarded as a direct path to achieving and publishing early science results. Nevertheless, expertise gained and lessons learned in commissioning will support the achievement of early science. With that in mind, lessons learned will be disseminated broadly to UK colleagues at each stage of commissioning.

2 Rubin commissioning plans

This section summarizes the status of commissioning plans as we understood them in early 2020. These plans are likely to change in the second half of 2020, as the covid-19 pandemic hopefully eases and re-planning is possible. Nevertheless, the issues and questions outlined in this summary will remain live and important questions regardless of alterations to the scope and timing of commissioning.

2.1 On-sky commissioning observations

The [Rubin Project Teams's December 2019 presentation](#) to the newly appointed Science Collaboration Commissioning Liaisons concentrated on plans to reduce the amount of on-sky commissioning observations. Whilst these planned reductions were described as pending a final decision, it was clear that they were the default planning assumptions at that time.

In general, commissioning observations will be performed with ComCam in the first instance, and then with LSSTCam. ComCam comprises a single raft of CCDs, with a field of view of 0.45 degree^2 , and three filters loaded on any given night. LSSTCam comprises the full complement of CCDs and is the camera that will be used for the survey observations, with the full 9.6 degree^2 field of view, and five filters loaded on any given night. Planned commissioning observations with each camera are summarized below:

ComCam: Observations with ComCam are planned to commence in June 2021 and to last for 3-4 months. These observations will concentrate on engineering tasks, and thus only include opportunistic

science observation. The originally planned 12 weeks of “sustained observing” with ComCam has been removed from the schedule. Unless sustained observing is reinstated, colleagues would be unwise to rely on ComCam to deliver any scientifically useful/informative data. That said, the Rubin Project Team appear to attach increased importance to opportunistic science observations during this 3-4 months of ComCam engineering time, in light of the expected cancellation of sustained observing. In general, the Project Team look to the Science Collaborations for input on suitable targets.

LSSTCam: Observations with LSSTCam are planned to commence in December 2021, with an initial 3-4 month period of engineering time similar to that for ComCam, during which opportunistic science observations might be possible. A two month period of sustained observing will then follow, commencing February 2022. This is significantly reduced from the original plan of five months of sustained observing. During these two months the intention is to conduct two Science Validation surveys: a Wide Area survey and Full Depth survey. However, note that the Operations Readiness Review (ORR) only requires the Project Team to complete “at least one Science (Validation) survey that ... will last at least 30 days”. One possible scenario is that one Science Validation survey be completed prior to the ORR, and the other in the early months of survey operations.

The increased importance of opportunistic observations with both ComCam and LSSTCam, and the compressed timescales for the SV surveys together motivate the following questions (paraphrasing from the December 2019 presentation):

- what can be achieved with 1-hour ($\sim 75 - 90$ visits), half a night (~ 300 visits, assuming an 8 hour night and 85% efficiency), and a full night of observations with ComCam and LSSTCam?
- what constitutes a “broadly useful” dataset, in terms of bands, cadences, exposures, and fields? (bear in mind that 1-year survey depth in *riz*-bands is equivalent to ~ 18 visits)
- what is the minimum viable (defined as completable in 30 days and thus able to satisfy ORR requirements) set of on-sky LSSTCam SV observations?
- what can be achieved beyond the minimal viable scenario if a total of two or three months of sustained observing is possible with LSSTCam?

In their December 2019 presentation, the Project Team outlined a nominal minimum set of viable observations for SV surveys, as follows: (1) a 20-year depth survey in *ugrizy*-bands that overlaps with at least one external reference field (presumably a Deep Drilling Field; DDF), and (2) a 1600 degree² wide-area survey in *gi*-bands to a depth equivalent to 1-year survey depth, repeated in two phases to enable production of templates from the first phase. Possible extensions to this nominal scenario if two months of SV observing is possible were suggested to be: add *urzy*-bands to the wide-area survey and add a second deep field to the full depth survey. If a third month of sustained observing is possible it was suggested by the Project Team to add a 10-year depth ~ 200 degree² survey in all six filters.

The Rubin Project Team sought input from the Science Collaborations in several areas, of which some are obviously relevant to UK colleagues: (1) feedback on the minimum viable on-sky observations plan and priorities if more time is available, (2) suggested observing fields for opportunistic 1-hour observations, 1-year equivalent exposures with limited band coverage, and 10-year equivalent exposure in most bands, (3) relevant external datasets including those with deep multi-band imaging. For example, the Commissioning Working Group in the Dark Energy Science Collaboration (DESC) have written a white paper on recommended commissioning fields, that they envisage posting to the arXiv.

2.2 Access to commissioning data

Three pre-survey data previews are envisaged: DP0, DP1, and DP2. The details of these previews including data access are still being discussed, with input from Science Collaborations. These discussions are important, because the Rubin Project Team are cautious as to how widely to release commissioning data. This underlines the importance of UK colleagues fully engaging with their Science Collaboration(s) if they aspire to access commissioning data. Additional key points, including content and timing of DP0-DP2 are summarized from information presented at the 2019 Project and Community Workshop below:

DP0 will comprise simulated and/or precursor survey data. For example data from DESC’s second data challenge (DC2; simulated 300 degree² LSST WFD survey, and 1 degree² DDF survey at ≥ 5 -year depth), and data from the Hyper-SuprimeCam survey (possibly their DR2 *grizy*-bands covering 300 degree²). Possible timescale for release of pixels and catalogues via the US Science Platform is Autumn 2021, with release via the UK DAC a few months thereafter. These timescales were tentative, even before covid-19 happened.

DP1 relates to ComCam data, with possible release of pixels autumn 2021, and catalogues (and thus official DP1) spring 2022. Given that scientifically interesting ComCam observations are likely descoped to opportunistic observations only, the size and scientific utility of DP1 is likely to be much less significant than envisaged. It is also possible that DP1 will not happen at all.

DP2 relates to LSSTCam data, and appears to include both opportunistic engineering observations and the two SV surveys. Pixels are provisionally slated for release spring 2022, with catalogues following autumn 2022. The alert stream from the wide-field SV survey will not necessarily be released in real time.

The Project Team are looking for input from Science Collaborations on the content of DP0 (re-processed HSC data, deep fields, DESC DC2, and/or something else), what data types will be needed as a high priority by the community in each DP, and the level of community interest in using DP0,1,2 data. Colleagues are strongly encouraged to give their input via their respective Science Collaboration Commissioning Liaisons.

3 UK Contributions to Rubin Commissioning

Bob Mann (LSST:UK Project Lead) and Graham Smith (LSST:UK Commissioning Coordinator) met with Chuck Claver (Systems Scientist & Commissioning Manager) and Phil Marshall (Deputy Director of Operations) via zoom on July 9, 2020. In part, this discussion was framed by the in-kind contribution process, and also built on the growing interactions between the Project Team and the scientific community on the subject of commissioning (e.g. through [Science Collaboration Chairs](#), and [Science Collaboration Commissioning Liaisons](#)).

Key messages include that the Project Team are looking to international partners for help with commissioning, and the process of defining what that help looks like will iterate between what Rubin colleagues need and what we as an international partner can offer. Therefore, whilst Chuck articulated known needs, he doesn’t exclude new value added ideas from coming forward. Indeed, contributions spanning the full spectrum from “direct physical support” in Chile through to “extra eyeballs on the data” are within scope. Such access to commissioning data will help build expertise and knowledge that will be valuable for early scientific exploitation of the survey data. However, it is important to

understand that involvement in commissioning is about helping the project and not about getting hands on data early to do science.

One clearly articulated need is for people with relevant scientific and technical expertise to cross-correlate the properties of commissioning data with data stored in the Engineering Facilities Database. This database stores technical data on the operational parameters of the telescope, instrument and their environment whilst observations are being performed. For example, running prototype data analysis algorithms on commissioning data, and correlating the resulting measurements with technical data will be very instructive from both engineering and scientific points of view. Conversely, identifying anomalies in the technical data, and correlating them with the properties of the observational data will also be important. These tasks could be opportunities for colleagues with machine learning and computer science expertise.

It's important to stress that the Project Team's interests in receiving help are broader than tasks that are adjacent to science, such as that outlined above. Therefore colleagues with expertise in detectors, instrumentation, commissioning of telescopes, and data management are all encouraged to think about and discuss with us how they could get involved. For example, there could be opportunities for colleagues to contribute to the preparation of commissioning data for release to the community via the Data Previews.

Finally, a few practical points came up, including the availability of training (via existing boot-camps) to help colleagues climb the steep learning curve required to contribute in a timely manner to commissioning tasks. Also, there is a desire to take advantage of timezone differences such that colleagues in different timezones can analyze and learn from newly acquired commissioning data while colleagues in Chile sleep.

A call for expressions of interest in commissioning will be published to the UK community in August 2020. This call will invite a "bottom up" contribution of ideas and expertise that can form the basis of discussions between us in the UK, and then further discussion with US colleagues.