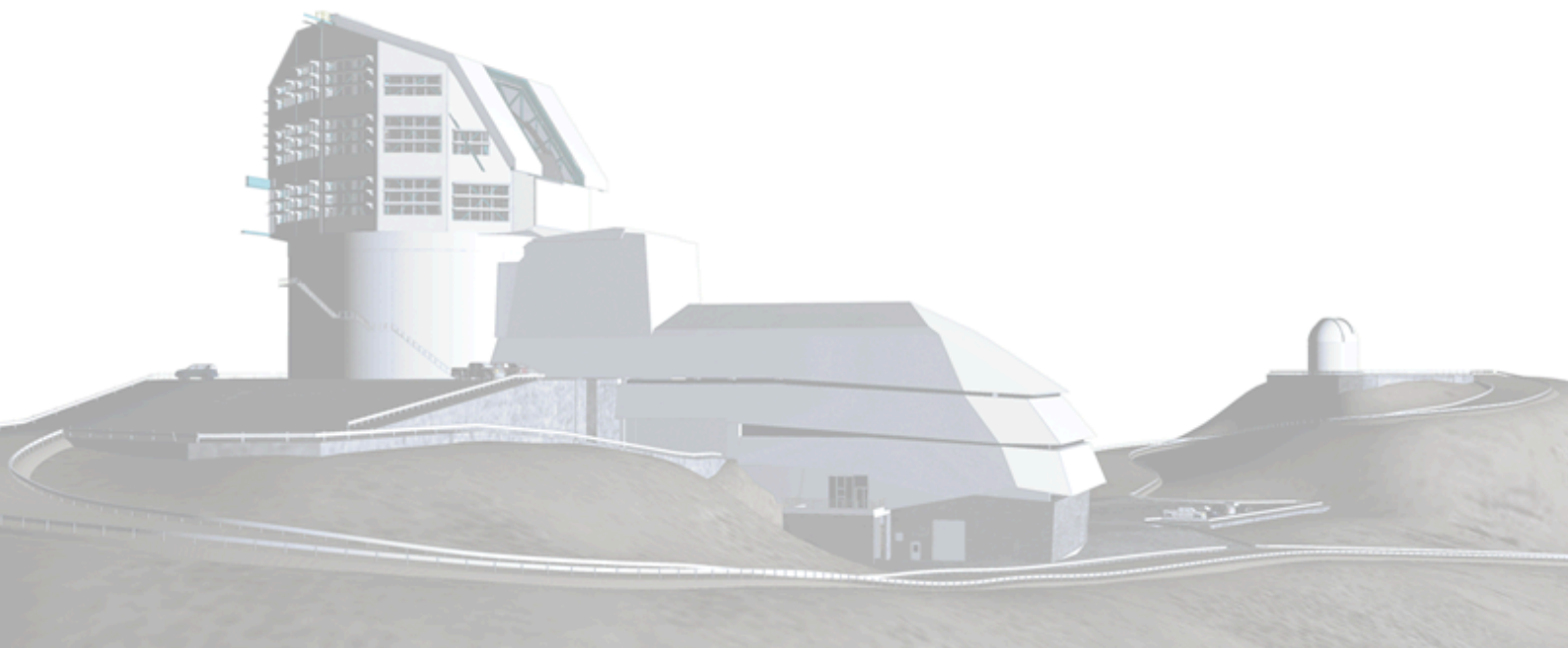# Vera C. Rubin Observatory

In-Kind Contribution Program
Handbook for Proposal Teams

Phil Marshall, Bob Blum, Rachel Mandelbaum, Rachel Street, Matthew Graham, Xiaohui Fan, Sugata Kaviraj, Aprajita Verma, Peregrine McGehee, Meg Schwamb, Federica Bianco, Will Clarkson, Ray O'Neal, Patricia Arevalo, Paulina Lira, Francisco Förster, Sebastian Hoenig, Pat Burchat, Richard Dubois, Harry Ferguson, Chad Schafer, Timo Anguita, John Gizis, David Trilling, Paula Szkody, Greg Madejski, Knut Olsen, Heather Shaugnnessy, Leanne Guy, Steve Ridgway, Verne Smith

RDO-031

Latest Revision Date: September 14, 2020

Change Record

Version	Date	Description	Owner name
0.1	2020-07-09	Draft guidelines for agency review	Phil Marshall
0.2	2020-07-27	Revised following Management Board and Agency requests for modification	Phil Marshall
1.0	2020-07-31	Version distributed to Proposal Teams via their feedback letters.	Phil Marshall
1.1	2020-09-14	Endorsement guidelines, extra software examples, telescope & dataset evaluation and contribution tracking/reporting clarifications. Adjusted proposal schedule, exceptions.	Phil Marshall

Rubin Observatory

Table of Contents

Rubin Observatory

Rubin Observatory

Rubin Observatory

Rubin Observatory

Rubin Observatory

Rubin Observatory

Rubin LSST International In-Kind Contribution Program

Handbook for Proposal Teams

1 Introduction

What are you being asked to do?

Now that your Letter of Intent has been approved for further development by the US funding agencies and evaluated by the Rubin LSST International In-kind Contribution Evaluation Committee (CEC), the next step is for you to **submit a full proposal to make specific in-kind contributions of labor, computing resources, equipment, telescope time or synergistic datasets, to the Rubin Observatory or the Rubin Observatory Legacy Survey of Space and Time (LSST) science program, in return for the same LSST data rights and access as enjoyed by US and Chilean scientists**.

You can submit your proposal by simply notifying Bob Blum and Phil Marshall by email that your proposal is complete and ready for formal review by the CEC. Please make sure your submission is made by **1700 PDT on Friday September 25, 2020.**

Exceptions to this deadline for specific contributions may be requested, for up to 6 weeks beyond September 25. If one or more of your proposal sections needs additional time to be completed, please clearly mark it in your proposal (directly under the section title) with **"Exception requested: please begin review on <date>"** where <date> is when you will complete the section by. After November 6, all proposals will be considered complete.[1]

You should view this proposal as a big step towards establishing an LSST data rights agreement, but recognize that that process is a negotiation between your team and Rubin Observatory, leading to a recommendation made by Rubin to the Observatory's managing organizations (AURA and SLAC) and then the US agencies, for approval. What your proposal will do is provide enough information for that negotiation to proceed in earnest.

What will happen to your proposal?

The content of your proposal will be programmatically rearranged into the initial drafts of two needed documents. The first is a Statement of Work (SOW), for input to a draft data rights agreement (DRA). This DRA is the document specifying the responsibilities of your team and the DRA's other signatory, which will be one of either NSF, DOE, AURA or SLAC (the Rubin Observatory US funding agencies and management organizations). The second document is a Detailed Plan that will lay out what you will contribute (and when) in more detail than in the SOW, to enable oversight of your contributions by the Rubin managing organizations and NSF and DOE's Rubin Observatory

---

[1] Please include a section in your September 25 proposal for every contribution you intend to propose, so that we can plan the review. It is better to include a contribution that you think you might be able to propose and then remove it later if you have to, than surprise us with extra contributions in November! Proposal sections appended after the September 25 deadline and before November 6, will be reviewed, we'd just like to know about them as soon as possible, please.

Rubin Observatory

Resource Board.

Your proposal, thus transformed, will be reviewed by Rubin staff in October and then the CEC between November and February. During the period September 26 through November 6, the Rubin International Program Coordinators will carry out some basic checks for compliance with the Handbook, and carry out a technical review of the proposed contributions. The CEC's scientific review will begin on November 10.

The CEC is advisory to the Rubin Observatory Director of Operations. The CEC will make their recommendations to the Rubin Operations Director for acceptance, acceptance with modification, or rejection of your proposal by February 26. At this point we will send you the CEC's review report, and any modifications needed to your SOW and Detailed Plan. At minimum these modifications will include listing of the agents who will participate in the reporting on, and evaluation of, the performance of your contributions, so as to embed your contributions in the Rubin LSST enterprise and ensure that they expand the resources available to the US science community, as required. We will then make, for each proposal received, a recommendation to the Rubin Management Board, and then, by around the end of March, to the US funding agencies, in order to move ahead with negotiating a data rights agreement based on the draft Statement of Work and Detailed Plan derived from that proposal.

Following this agency approval, final negotiations over your Statement of Work and Detailed Plan will then take place between the Rubin Observatory Director of Operations and your team from April 2021 onwards. Since this is only 3 months from the June 2021 deadline (when currently all existing international data rights expire, as per the May 2019 talking points), the, NSF and DOE have agreed that the approval they provide in Spring 2021 will be "approval to Rubin to establish a data rights agreement and grant interim data access" for each proposal. The idea is that as soon as this approval is obtained, your PIs and JAs will have affirmed data rights that extend beyond the June 2021 deadline and through to the signing of the DRA, and that in that interim pre-signing period we will be able to give Rubin user accounts for data rights holders looking to use the Data Preview Zero data. The agency approvals will also allow us to write letters of intent as needed (e.g. for your funding purposes).

Negotiation of the final DRAs would begin right after the agencies grant these approvals, based on the solid frameworks that SLAC, AURA and the agencies will be putting together over the next 9 months.

For a more in-depth description of how the transformation between proposals and DRA SOWs will work, please see Sections 4 through 8 of this Handbook, in which we walk you through a worked example. SLAC, AURA, NSF and DOE will all have different instruments for the DRAs, and which of those institutions would sign your particular DRA will be decided as we go forward; however, the content needed from your proposal for the Statement of Work will be the same in each case.

In-kind Proposal Review Timeline, 2020

Friday September 25, 2020	Proposal deadline, CEC/Rubin review begins
Friday November 6, 2020 (6 weeks after proposal deadline)	Proposals considered complete (including contributions with exceptions)

Rubin Observatory

Friday February 26, 2021	CEC/Rubin proposal reviews due
March 2021	Management Board review and approval
April 2021	Agency decisions on *"approval to Rubin to establish data rights agreements and grant interim data access"*
Summer 2021	Final DRA negotiations and signing

What is in this document?

The next two sections contain a detailed set of guidelines derived by the CEC and Rubin Observatory and NOIRLab staff, that are designed to help you prepare a proposal that contains enough information to support a meaningful review as well as providing us and you with the initial draft of a detailed plan to to follow as you get started on your successful proposed contributions.

After that, in Sections 4 through 8 we provide a worked example. After defining the basic properties of the data rights agreements and associated detailed plans in Section 4, we give a short example proposal in Section 5, the corresponding statement of work (extracted from the proposal) to be inserted into a DRA in Section 6, and finally the detailed plan (also extracted from the proposal) in Section 7. This worked example should be considered to provide sufficiently accurate guidance for this round of proposals, in support of the production of an initial draft DRA and detailed plan. Proposal teams should expect those initial drafts to be modified as a result of CEC proposal review, and then further edited during the final negotiation of the agreement. What we are aiming for with your proposal is to construct the best possible starting point for your data rights agreement. Finally, Section 8 contains a larger library of example proposal sections, to illustrate the guidelines in Sections 2 and 3.

How should we respond to the feedback you sent us?

The letter you received will have referred you to this Handbook, so you're already off to a good start. The feedback should have provided some keywords for you to use when consulting this Handbook, too: directable software development effort, active follow-up programs, Lite IDACs and so on.

As well as consulting this Handbook, you'll benefit from reaching out to the primary point of contact for the "recipient" group for each of the possible contributions you mentioned in your LOI. The table in your feedback letter contains pointers to these groups; you can get the name and email address of the primary contact for each group from the table below. When you have digested the guidelines in this Handbook, and collected your thoughts, please do get in touch and ask for any help you need. (You may also want to wait until after the Rubin 2020 In-Kind Proposal Workshop, where some of your questions may already get answered.) Even if you know other individuals within the recipient group, ***please do start with the primary point(s) of contact*** below: their most important task is coordinating the response to the 40-odd proposal teams, so that we protect the time of the Rubin staff and Science Collaboration members while getting you the information you need.

Rubin Observatory

Bob Blum and Phil Marshall remain your overall primary contacts at Rubin, and can help you get connected as well as handling general questions about the in-kind program and proposal process. If in doubt, ask them.

Rubin LSST In-Kind Program Directory
Please get in touch with the Primary Contact(s) first, they will redirect you from there as needed.

Contribution Recipients	Primary Contact(s)	Secondary Contacts
AEON network	Steve Ridgway <ridgway@noao.edu>, Rachel Street <rstreet@lco.global>	
LSST AGN Science Collaboration	Xiaohui Fan <fan@as.arizona.edu>, Sebastian Hoenig <S.Hoenig@soton.ac.uk>	
LSST Dark Energy Science Collaboration	Rachel Mandelbaum <rmandelb@andrew.cmu.edu>, Richard Dubois <dubois@stanford.edu>	
LSST Galaxies Science Collaboration	Sugata Kaviraj <s.kaviraj@herts.ac.uk>, Harry Ferguson <ferguson@stsci.edu>	
LSST ISSC	Chad Schafer <cschafer@cmu.edu>, Matthew Graham <mjg@caltech.edu>	
LSST Science Collaborations	Federica Bianco <fbianco@udel.edu>	
LSST Solar System Science Collaboration	Meg Schwamb <mschwamb.astro@gmail.com>, David Trilling <david.trilling@nau.edu>	
LSST Stars Milky Way and Local Volume Science Collaboration	Peregrine McGehee <peregrine.mcgehee@gmail.com>	
LSST Strong Lensing Science Collaboration	Aprajita Verma <aprajita.verma@physics.ox.ac.uk>, Timo Anguita <tanguita@gmail.com>	
LSST Transients and Variable Stars Science Collaboration	Rachel Street <rstreet@lco.global>, Paula Szkody <szkody@uw.edu>	
NOIRLab CSDC	Knut Olsen <kolsen@noao.edu>	
NOIRLab Observatories	Steve Ridgway <ridgway@noao.edu>	
Rubin Alert Production Group	Phil Marshall <pjm@slac.stanford.edu>	Eric Bellm, John Swinbank
Rubin Algorithms & Pipelines Team	Phil Marshall <pjm@slac.stanford.edu>	Yusra Alsayyad, Wil O'Mullane
Rubin Commissioning Team	Phil Marshall <pjm@slac.stanford.edu>	Chuck Claver, Kevin Reil
Rubin Communications Team	Phil Marshall <pjm@slac.stanford.edu>	Ranpal Gill
Rubin Community Engagement Team	Phil Marshall <pjm@slac.stanford.edu>	Melissa Graham, Leane Guy

Rubin Observatory

Rubin Crowded Field Coordination Group	Phil Marshall <pjm@slac.stanford.edu>	Colin Slater
Rubin Data Production Dept.	Phil Marshall <pjm@slac.stanford.edu>	Wil O'Mullane, Yusra Alsayyad
Rubin EPO Dept.	Phil Marshall <pjm@slac.stanford.edu>	Lauren Corlies
Rubin IDACs Coordination Group	Greg Madejski <madejski@slac.stanford.edu>, Knut Olsen <kolsen@noao.edu>	Wil O'Mullane, Leanne Guy
Rubin International Program Coordinator (Software Development)	Phil Marshall <pjm@slac.stanford.edu>, Greg Madejski <madejski@slac.stanford.edu>	
Rubin Middleware Team	Phil Marshall <pjm@slac.stanford.edu>	Tim Jenness, Wil O'Mullane
Rubin Observatory Science Team	Phil Marshall <pjm@slac.stanford.edu>	Kevin Reil
Rubin Photo-z Coordination Group	Phil Marshall <pjm@slac.stanford.edu>	Melissa Graham
Rubin SPaRE Team	Phil Marshall <pjm@slac.stanford.edu>	Frossie Economou, Wil O'Mullane
Rubin System Performance Dept.	Phil Marshall <pjm@slac.stanford.edu>	Leanne Guy
Rubin Telescope & Site Team	Phil Marshall <pjm@slac.stanford.edu>	Chuck Claver, Wil O'Mullane

[Back to the top]

---

2 Defining Your In-kind Contributions - CEC Guidelines

In this section we provide an extensive update to the guidance that was given to proposal teams in the Fall of 2019, in the invitation to submit Letters of Intent. That guidance was designed to enable the proposal teams to make an initial estimate of the kinds of in-kind contributions they could make and that would likely be acceptable, and to start estimating the local resources they would need in order to deliver at a level commensurate with the previous funding model. It also indicated that the "exchange rate" between in-kind contributions and the number of PIs to be granted data rights would not be a fixed one, but instead that the Contribution Evaluation Committee would be asked to weigh in on the scientific value of each contribution, and that that would be taken into account. The promise of the Rubin Observatory and the discoveries that the LSST data will generate is not only near term, but greater than ever: the proposals should match that promise.

The aim of this guidelines section is to provide additional indications of how your proposed contributions will be valued, so that you can judge the appropriate level of resources to put forward

Rubin Observatory

for consideration. The same guidelines will be followed by the CEC through the proposal review period in Fall 2020, and by Rubin Observatory when evaluating the numbers of PIs appropriate to be granted in return for each proposed contribution. For some, but not all, contributions referred to in the LOIs, Rubin will have been able to suggest an appropriate number of PIs. In other cases, Rubin will be able to advise on the appropriate number of PIs to put in your proposal as you develop it. By early 2021, it should be possible to converge on the appropriate level of resources offered in-kind and the corresponding number of PIs.

To get started, and for reference, the following initial guidance covering in-kind contributions was given to the proposal teams when they were invited to submit their Letters of Intent (LOIs) in Fall 2019, and also posted publicly on community.lsst.org:

"Examples of the type of in-kind contribution that are likely to be acceptable following a positive CEC evaluation include:

- *Observing time, dedicated to proposals led by US PIs, at key non-US facilities. (Observing time contributed only to subsets of the US community will not be accepted by the US agencies.)*
- *Access to surveys or proprietary datasets of high value to the US community, including (but not restricted to) datasets complementary to the LSST survey and which enable high priority LSST science.*
- *Dedicated software development effort, to be either embedded in one or more LSST Science Collaborations and assigned to a needed analysis pipeline, or focused on a particular enhancement to the LSST system.*
- *Dedicated and appropriately supported computing resources, made available to one or more LSST Science Collaborations for their analyses.*

As a rough guide, and in order to achieve "comparable commitments to the ones that were made in the original MOAs," we'll assume that 1 FTE year of dedicated effort (at the appropriate skill level) will be approximately sufficient to obtain data rights for 1 PI for the duration of the survey (13 years, US FY22 through FY34). The equivalent cost of the US agencies providing the same 1 FTE year of effort is about $300k; we can use that number as a rough guide when considering the value of other resources, including observing time, again using US prices. For example, computing resources purchased in the US cost roughly $10k per million CPU hours, and $200k per Pb of disk storage, and so 30M CPU hrs, or 1.5 PB of disk space, would be approximately sufficient to obtain data rights for 1 PI for the duration of the survey (modulo CEC evaluation of their location and distribution in time). All these "exchange rates" are only approximate: we'll ask the CEC to weigh in on the value of each contribution being proposed."

The guidelines for proposal teams laid out in this section were developed by the CEC during its evaluation of the Letters of Intent, and aim to flesh out the details of what a high value in-kind contribution would look like. In doing so, they adhered to the May 2019 US agency talking points, and in particular focused on the principle that proposed in-kind contributions should "expand the resources available to the U.S. astrophysical and high energy physics communities." Any in-kind contribution comes with management overhead: the CEC guidelines seek to minimize that overhead by discouraging contributions that do not represent a high net gain in available resources. As expected, the devil is in the details: please read carefully the sub-sections below that pertain to your own team's proposed contributions.

These guidelines are intended to supplement the feedback given by the CEC on your particular LOI

Rubin Observatory

ideas, which should guide your decision-making as to which resources to include in your proposal, and in what proportions. The guidelines should help you write the text of your proposal so as to craft a set of in-kind commitments that will be successful, both in expanding the resources available to the US community, and in strengthening the LSST science program in which you will be participating. While the LOIs were by construction brief, high-level, and free-form, the goal in this section is to guide the development of proposals that contain the information needed to allow meaningful evaluation by the CEC against a uniform set of criteria. The example proposal sections, and the proposal template itself, provide additional illustration of the guidelines below.

The guidelines are divided by contribution category into three technical subsections, plus a short management subsection, linked to via the following shortcuts:

- Telescope Time, Datasets and Active Follow-Up Programs
- Software Development
- Independent Data Access Centers (IDACs) and Other Computing Resources
- In-Kind Contribution Tracking and Program Management

Following this, the next section briefly covers in-kind contributions to Rubin Observatory Construction, Commissioning and Operations. These contributions will be evaluated by Rubin Observatory rather than the Contribution Evaluation Committee, but similar "exchange rates" apply. Indeed, contributions of development effort to enhance the Rubin Observatory's software should follow the software development guidelines in the current section.

2.1 Telescope Time, Datasets and Active Follow-Up Programs

In this section we lay out the CEC's approach to estimating the value of a telescope time or dataset contribution, following and extending the Fall 2019 initial guidance.

2.1.1 Assessment of Telescope Time Contributions

Contributions of telescope time to enable observations that are complementary to LSST are highly valued as in-kind contributions. The guidelines below provide an overview of how proposals of time from different facilities will be evaluated, and the factors that will be taken into account. The intention is for these guidelines to help you first propose an appropriate amount of telescope time to cover the number of PIs' data rights you wish to obtain, and then understand any requested modifications to your proposal that arise during your proposal's review.

Proposers are strongly encouraged to consider the Astrophysical Events Observatories Network (AEON) as a framework for contributing time on their facility in a way that is highly flexible and accessible for the US/Chilean communities. Telescopes with apertures smaller than 4-m will be expected by Rubin to join AEON. Any **AEON-compatible facilities will receive preferential weighting in the evaluation of contributions.** More information on AEON can be found in the supplementary materials below.

The relative value, in PIs, of telescope time be assessed as follows. The value of one night of telescope time in USD will be determined by combining the average nightly operating cost of the observatory multiplied by a weighting factor (computed as the product of a *"telescope value"* factor based on telescope aperture and location, and a "capability value" factor based on site, instrumentation and operation mode offered at the facility). **These weighting factors range between 0.25 and 1 or a little more, such that 8-m telescopes at Southern sites offering spectroscopic**

Rubin Observatory

capability receive a combined weight of around 1. The resulting dollar amount will then be divided by the fiducial $300k per PI to estimate the approximate number of PIs' worth of data rights that observing nights will earn.

Proposals should include a breakdown of the nightly operating cost for each proposed facility, which should be calculated following the model of the OPTICON network. Proposers should use the template provided in the supplementary material on evaluating telescope operating costs below.

The total value of the proposed telescope time can then be computed. Rubin can provide, based on the above CEC guidelines, an estimate of your facility's combined weighting on request, based on information you provide via the Telescope & Dataset Evaluation Form. We note that the Telescope & Dataset Evaluation Form is a work in progress and still changing from time to time.

Further details:

- Telescope/Site values scale strongly with LSST sky access, weather, and image quality.

- Capability values will be scored quantitatively where sensible or semi-subjectively according to pre-established criteria where that is more reasonable.

- Combined values can be constructed with a weighted combination of the telescope value and the capability value. Note that the algorithm for the combined weight of a contribution is likely to evolve based on experience with actual proposals. It is intended as a guide for Rubin negotiations, which are likely to be more interactive than suggested by a spreadsheet.

In order for the CEC to evaluate the proposed time during review of each proposal, it should provide a concise summary of:

- Telescope characteristics, including effective aperture or collecting area, latitude, longitude and altitude above mean sea level

- Radio facilities should provide their simultaneous field of view (for a mode with angular resolution ~3" FWHM or better), simultaneous bandwidth (e.g. fraction of 21-42 cm covered in one setting) and angular resolution.

- Site characteristics, including clear night fraction, seeing statistics, telescope down time statistics

- Instrument suite, including all instruments to be offered as part of in-kind contribution, and their basic characteristics such as wavelength range, spectral resolution, multiplexity, field of view. Each instrument should be entered as a separate row in the Telescope & Dataset Evaluation Form.

- Time domain capability, including abilities for fast followup observations and instrument change, cadence for observations

- Available observing and operation modes, such classic vs. remote vs. queue observing, abilities to change targets, TAC/scheduling process and constraints, ToO capabilities or AEON compatibility. Any additional constraints on providing access to the telescope time allocation (e.g. limits on when it can begin) should be fully described in the proposal. If a facility envisions joining AEON, the proposal should outline their plan for interfacing with, and participating in, that network.

- Data reduction and data management, such as availabilities of data pipeline and data archive and general user support

Rubin Observatory

- Future plan for upgrades of facilities

In addition, the proposal team should highlight:

- Instruments or capabilities that are unique to the facility or network, or facilities that US and Chilean astronomers currently have limited access to
- For telescopes that are still not fully operational, a detailed timeline of construction and commissioning

This material will form the bulk of this contribution's Detailed Plan, and support ongoing evaluation of the contribution's performance as well as initial assessment of its value in PIs.

If proposed contributions require reassignment or transfer of telescope privileges on a facility belonging to a third party, the approval of the third party should be obtained and any related limitations of special conditions documented in the proposal.

2.1.2 Assessment of Contributed Datasets

The guidelines below offer guidance for international contributions which involve datasets comprised of data products that complement LSST but which were not acquired specifically in response to LSST alerts or other measurements. (Data acquired in response to LSST alerts or measurements, whether in support of time domain or static sky science, are referred to as "Active follow-up programs", and are discussed in the section below.) Proposers should provide brief, representative use cases that demonstrate how their dataset could be used for science by members of the LSST community. They should also provide details about the timeline for dataset delivery and how the dataset will be made accessible ("distributed") by all LSST data rights holders.

The value (in PIs) of a proposed dataset is typically not straightforward to estimate, but a reasonable starting point is the equivalent value of the telescope time used to generate that data. (This valuation is discussed in detail in the previous section). The work needed to process the raw data, and develop the software tools needed to produce the final dataset product, is considered a necessary investment that the contributor would have made anyway, for their own purposes, and so should not count towards LSST data rights. Beyond this, a number of factors that could lead to adjustments to the value of the dataset are recognized and outlined below.

In most cases, each weight will be calculated as a numerical grade (e.g. out of 5) assigned by the CEC to represent how well the dataset fulfils the criteria, based on the description provided in the proposal. Those grades will then be combined to yield an overall factor between 0.25 and 1.0, such that a dataset that meets all the weighting criteria below would achieve a combined weight of 1.0. This factor will then be applied to the operating costs of the observatory taking the data (as described in the section above), and the resulting product divided by the nominal $300k per PI to get the value of the dataset in PIs.

The high priority weights indicate characteristics that datasets must satisfy to be successful. Secondary and tertiary weights indicate how datasets will be weighted relative to each other and are considered of higher and lower importance, respectively.

High priority weights:

- The dataset should be made available either via a Rubin data access center (including NOIRLab), or a similar data center maintained by the proposer. Such data centers must offer secure access, longevity of data and routine backups to ensure uninterrupted data access to the LSST community.

Rubin Observatory

- The dataset should be easy to access and have high useability for the main science use cases that the proposers have described. If specific tools are required for exploitation, then these should be provided and maintained by the proposer.

- If a dataset is public or due to become public shortly after LSST data rights are conferred to the proposer, then the contribution must provide significant added value to the public dataset. For example, this could involve providing enhanced data products that cannot easily be produced from the raw dataset. Proposals should explain clearly the scientific goals of any proposed reanalysis of LSST data and outline how they will access large sections of the data if required.

Secondary priority weights:

- Earlier availability of datasets is preferred: higher value is given to datasets readily available by the start of Rubin operations.

- Dataset value scales in proportion to the number and diversity of science goals it enables/enhances.

- Dataset value scales in inverse proportion to their amount of redundancy with observations already available to the Rubin community.

- Wide-area, faint limiting magnitude datasets are generally preferred versus narrow-field (with the possible exception of "mini-surveys").

- "Full target catalog" datasets are valued higher than pre-selected subsets, as they are more generally useful to more science cases and as training data.

Tertiary priority weights:

- Value is given proportional to the LSST survey footprint intersection (with possible exceptions for specific science cases). If the survey footprint is not yet finalized, a realistic expected footprint should be included.

- Spectroscopy is considered a more valuable contribution than broad-band photometry in general.

- Higher value is given to datasets from complementary spectral ranges (wavelength regimes).

Any team looking to propose a dataset contribution will be provided with, and asked to complete, a Telescope & Dataset Evaluation form during the proposal development phase, which will enable the CEC to calculate the above weights.

Note on "Value-Added Catalogs"

Note that the above considerations can also be applied to "value added catalogs", in which the LSST catalogs themselves are enhanced in some way. Simply making new versions of the measurements in the LSST catalogs, or adding new derived quantities (such as photometric redshifts, stellar mass estimates etc), with alternative software pipelines and no new observational data, will be considered a software development contribution, and should follow the software guidelines in this handbook. The resource being contributed in such programs is the developer effort: serving the resulting value-added catalog product costs, rather than adds, resources. Adding value to the LSST catalog by federating it with a complementary (survey) dataset is different: there, the resource being added is primarily the telescope time that was used to take that complementary data. The labor needed to build the catalog will not be considered as part of such an in-kind contribution, following the logic of

the previous section. And, if the dataset in question is already public, the value of the telescope time used to make it should (and will) be discounted accordingly. If you plan to make, using your earned LSST data rights, value-added catalogs of either kind, and share them with the rest of the LSST science community via the IDAC network, please do mention this in your proposal under the "Activity Description" so that the CEC can take this into account in its review, but when estimating the requested numbers of PIs you should follow the guidelines above.

2.1.3 Distribution of Datasets

These guidelines describe two possible ways by which an in-kind contributed dataset might be delivered to the US and Chilean astronomical communities for scientific use: 1) through Rubin Observatory's data access centers (including NOIRLab's data services), or 2) from the contributing team directly. The choice of distribution is up to the proposal team, but should follow naturally from the representative science use cases.

Guidelines for Datasets hosted at the Rubin Data Access Centers

Rubin Observatory will operate two data access centers (DACs), one in the US (at the Rubin Data Facility doing the prompt and annual release image processing) and one in Chile. It will also support a network of Independent Data Access Centers (IDACs), that will allow the LSST data to be queried and analyzed by anyone with LSST data rights (using the same access controls as the US and Chilean DACs). The Rubin DACs have been designed to support individual users and groups of users ingesting user-generated (previously known as "level 3") datasets for use at that DAC; we expect that the IDACs will also support this activity.

In line with its mission, we expect NOIRLab's Community Science and Data Center (CSDC) to host a subset of the proprietary LSST data and federate them with a range of complementary datasets, and provide access to those federated datasets to the LSST data rights community in the process. This makes NOIRLab a particularly interesting choice of dataset host IDAC, as we describe in the next subsection. We also follow CSDC's experience in defining guidelines, in the subsequent subsection, for teams proposing to contribute datasets to be hosted at Rubin DACs and IDACs more generally.

Specific Guidelines for Datasets hosted by NOIRLab

The NOIRLab CSDC maintains a number of data platforms and services that might make it a good fit to serve as host of a proposed in-kind contributed dataset. Besides the LSST Science Platform itself, current services include:

- The Astro Data Archive (https://astroarchive.noao.edu), which serves ~2 PB of pixel data from >40 telescope and instrument combinations from NOIRLab's CTIO and KPNO mountaintops. It features a web front-end, API access, and provides access control to datasets.

- The Astro Data Lab (https://datalab.noao.edu), which serves ~100 TB of catalog data through a searchable database, provides a crossmatch service for catalog data, exposes ~1 PB of file-based data products through a Python client to a file service, and provides an image cutout service for all of the Astro Data Archive's pixel holdings and the image tiles from a number of major DECam-based surveys. Astro Data Lab hosts a Jupyter Notebook server that provides programmatic access to all of its services and documentation and examples.

- The ANTARES transient alert broker (https://antares.noirlab.edu/), which currently provides

Rubin Observatory

filtering of the ZTF alert stream, and is planned to scale to the alert stream from LSST.

The development path for these services includes:

- Ability to ingest additional pixel datasets into the Astro Data Archive
- Faster parallelized image cutouts
- Additional spectroscopic data services
- Integration and unification of services for concurrent usage and cross-data analysis
- Scaling of ANTARES to LSST alert stream
- Establishment of an IDAC at NOIRLab that incorporates CSDC's data services alongside the LSST Science Platform

If a proposal team wishes to use NOIRLab as host for its contributed dataset, the proposal should address:

- Why the representative science use cases would be best accomplished with the NOIRLab IDAC as host
- Which of NOIRLab's existing data platforms and services would be needed to enable the science use cases
- Which of NOIRLab's planned developments would be needed to enable the science use cases
- How the contributor will provide user support and documentation for the dataset, including addressing problems with the dataset itself should they be discovered during the course of use

General Guidelines for Datasets hosted at a Rubin DAC or IDAC

For a Rubin DAC or IDAC (including NOIRLab) to be able to host and serve a contributed dataset, some preparation work on the part of the proposal team will be required. Proposal teams are encouraged to contact NOIRLab to identify the preparatory work needed. Examples of preparation include:

- Schema design for catalog tables
- Population of required metadata
- Documentation of catalog columns and metadata fields
- Creation of web documentation summarizing the datasets
- Development of example uses in the form of Jupyter notebooks

The effort by Rubin and NOIRLab staff, and the computing resources at the relevant center needed to ingest and host a contributed dataset will depend strongly on the complexity, volume, and nature of that dataset, as well as the lead time granted to perform the work. The cost of hosting the dataset, as well as the lead time provided, will be taken into account when evaluating your proposal: datasets that are expensive to host or required on short timescales may be assigned a discounted value (in terms of PIs) to reflect this additional burden on the Rubin system; likewise, proposal review may lead to you being asked to increase the level of support provided.

If a proposal includes a dataset to be hosted by a particular planned or proposed IDAC, a written statement from that IDAC's lead confirming this arrangement should be included in the proposal,

outlining the terms and lifetime of the agreement.

Guidelines for Datasets hosted by the Contributor

In general, we encourage contributed datasets to be ingested and curated at one or more of the Rubin data access centers (including NOIRLab). However, a proposal team might choose to host a contributed dataset themselves for a number of good reasons, including:

- The representative science use cases all use the dataset in a standalone way, without need to bring other data into the analyses
- The science use cases require comparison of the dataset with other data hosted by the proposing partner
- The science use cases rely on services or tools provided by the proposing partner.

These reasons should be justified in the proposal.

If a proposing partner chooses to serve as host for the contributed dataset, the contribution will be evaluated on:

- Provision of access control to the dataset for US and Chilean LSST community users, which is a fundamental requirement for the contribution;
- Ease of access and useability for the representative science use cases;
- The tools and services provided to the US and Chilean community for exploiting the dataset;
- The commitment of the proposal team to the long-term curation of the dataset, at minimum for the length of the LSST survey, but preferably beyond.

The reason(s) for not requesting Rubin / NOIRLab dataset hosting, and a brief description of the four evaluation considerations given above, should be summarized in the proposal text.

2.1.4 Assessment of Active Follow-up Programs

The term "active follow-up program" refers to a proposal component that offers to deliver observations or reduced data products in response to requests for observations of specific targets during the LSST survey, as opposed to simply offering "open telescope time" for allocation to US PIs.

To ensure broad and fair access to proposed follow-up programs, it is envisioned that the allocation of this resource will proceed in terms of equivalent hours of observing time, managed through a NOIRLab TAC process. US/Chilean astronomers will be able to apply for access to these programs by competitive proposal, and have their observation request carried out in a service observing mode. It is not expected that members of the international consortia would be part of those allocated proposals, except by optional collaborations with proposal PIs, and it is expected that the proposal PIs would have proprietary access to the resulting data products for a defined period, agreed in advance with NOIRLab. The NOIRLab TAC will provide a ranked list of accepted programs in priority order. Proposals may describe alternative options for enabling access to the proposed observing resource other than this TAC process (provided that they meet all other requirements), but teams should be aware that as a result this proposed contribution may be disfavored for logistical or policy reasons, and/or they may be asked to modify their program to fit into the NOIRLab TAC model (if appropriate). Note that long-term "legacy" datasets taken by complementary survey facilities during LSST are encouraged, even within this TAC model. Roughly speaking, we expect that active follow-up of target lists of manageable size will be handled by a semester-based TAC process, while

Rubin Observatory

complementary survey datasets would be handled by a large programs process.

Proposals for LSST data rights will need to provide a clear, detailed description of how users will request targets for observation, how the observations and all calibration observations (including biases, flat fields, arc spectra etc) will be made (and/or requested by the user), how data will be delivered, and on what timescale.   Preference will be given for programs that provide the means to programmatically submit targets for observation and receive data products. The proposal should also include a full description of the facilities and instrumentation available through the program, providing the information described in the section for [contributions of telescope time](#). This information should be provided via the Telescope & Dataset Evaluation Form.

A key question to address is how will the follow-up program manage cases where multiple observation requests are submitted for the same target? The CEC recommends the adoption of the Gemini/NOIRLab policy for competing ToOs, which respects the priority assigned to proposals by the TAC process and time of receipt of request. No targets should be off-limits.

Rubin Observatory will favor proposals which provide access to instruments and telescope facilities that will benefit the widest number of science cases, and we encourage proposers to outline science use cases that extend beyond the science interest of the proposing team.

Proposals should describe how quickly they can respond to a request for observations, especially for those that are intended to support time domain science. It is expected that different science programs will require a range of different scheduling constraints including:

- urgent target of opportunity requests,

- monitoring of a target at intervals over an extended period,

- intensive observations over a limited period,

- flexible single-shot observations which may be scheduled at any time within a specified window,

- requests to be executed under specific observing conditions (e.g. seeing, weather), and

- complementary surveys undertaken over several semesters.

Preference will be given to proposals that offer the greatest flexibility of scheduling.

Proposals should describe the timescale on which data products will be delivered, and the nature of the data products provided, their degree of processing and data quality verification. Preference will be given to proposals that deliver data products (and in particular, reduced data products) within 24hrs of observations being acquired. In all cases, users should be able to access the raw data products. While such prompt delivery is desirable for any data product, it is especially needed for data products intended to support time domain science.

Proposals should also describe their user support plan. This should include:

- Documentation of the proposals process

- Documentation of the instruments and facilities offered and survey and instrument status

- Documentation of the scheduling process

- Documentation regarding data access and data products

- Helpdesk support for user inquiries

Note that it is expected that all documentation will be kept up to date from at least the start of

Rubin Observatory

operation of the active program until it ceases operation, and archived for the lifetime of the LSST. It should be expanded as necessary to accommodate new instrumentation, functionality, etc.

If a contributing team proposes access to a facility for which all proposals must by policy be reviewed by another TAC, the following points should be noted:

1) The process of undergoing a second review should be transparent to the proposal PI, who will not be required to prepare a second proposal.
2) The contributing team will not automatically earn authorship in the science program by virtue of managing the second proposal.
3) Proposals should not be subject to rejection due to competing with "local" proposals. It may be possible to satisfy this condition by having agreed science areas which are fully open. However, a restriction of science areas will probably reduce the weight of a contribution.
4. For time critical proposals, a second review in series may be unreasonable. An alternate may be for the contributing team to work their TAC for pre-assignment of ToO time for certain science areas, and then populate the observing schedule in response to alerts.

Supporting Information for Telescope Time or Dataset Proposers

Some additional notes to help you define and cost out your proposed contributions.

The Astrophysical Events Observatories Network (AEON)

The goal of AEON[2] is to provide flexible, queue-scheduled, programmable access to a range of telescope facilities, in order to facilitate modern astronomical observing programs.

Almost all observations fall into one of five main categories:

- Urgent target of opportunity requests,
- Monitoring of a target at intervals over an extended period,
- Intensive observations over a limited period,
- Flexible single-shot observations which may be scheduled at any time within a specified window,
- Requests to be executed under specific observing conditions (e.g. seeing, weather)

Queue-scheduling observations on any telescope facility offers an efficient mechanism to enable all five categories, and AEON partners are encouraged to support as many scheduling options as possible. Flexibility is particularly appropriate for LSST follow-up, where some of the science return is expected to derive from the characterization of real-time alerts. It should be noted that AEON partner facilities do not have to be queue-scheduled all the time, but should offer this mode of observation at regular intervals.

The other key capability of AEON is to make it possible to submit *requests for observations* through a programmatically accessible interface. The requests can then be carried out robotically or by observatory operators, rather than by an astronomer having to operate the facility themselves, either in person or via remote access. AEON provides an observation request language for fully

---

[2] https://lco.global/aeon/

Rubin Observatory

describing these requests, and can extend this language to accommodate new instrumentation as required.

AEON welcomes new facility partners, and can offer a number of resources.

Facilities may choose to make use of the LCO scheduler while in AEON mode, taking advantage of its existing infrastructure for observation requests and to provide automated queue scheduling. The SOAR 4m telescope currently operates in this mode for selected AEON nights.

Interfaces to AEON-compatible facilities are also provided in the TOM Toolkit[3], a software package designed to help astronomers manage observing programs. Compatibility with this package would provide added value to proposed in-kind contributions.

Proposers are encouraged to contact AEON in advance of submitting their proposal for advice on participating in the network.

Technical Requirements for a Facility Joining AEON

- Scheduling

Observatories participating in the AEON network shall make at least some of their time available in a queue-scheduled mode where the observatory is responsible for carrying out observation requests submitted by users. This time shall be distributed at intervals throughout a given semester in order to support time series monitoring observations. The observatory may support requests for rapid response or Target of Opportunity observations that may override previously scheduled observations at short (~minutes) notice. The observatory is free to optimize the sequence of submitted observations conducted at its facility on a nightly basis as it feels is most appropriate. Observatories may also contact the Las Cumbres Observatory if they are interested in using the LCO scheduling system to optimize their nightly observing sequence when the participating facility is in AEON-mode.

Calibration observations may be scheduled by direct request from the users or may be obtained as part of an observatory's regular functions.

- Observation requests

Observatories shall make it possible for users with active time allocations to submit requests for observations that will be executed at the participating facility. The observations may be carried out manually (by observatory staff) or robotically.

Observation requests shall include sufficient information to enable all necessary calibration data to be obtained for the data to be properly reduced.

- Online user interface

The observatory shall provide a secure, online webservice where users can fully describe the observations they require through a browser-based form and submit those requests.

- Programmable user interface

The observatory shall provide a secure Application Programmable Interface where users can fully describe the observations they require and submit those requests. Ideally, this interface will use the AEON request language. The AEON Partners will work with facilities joining AEON to ensure that their instruments can be fully supported within this language, and extend it where necessary. Alternatively, observatories can develop their own plugin for the TOM Toolkit which enables users to

---

[3] https://lco.global/tomtoolkit/

Rubin Observatory

submit programmatic requests.

- Data distribution

The observatory shall provide the users with timely access to all appropriate data products pertaining to their observations, and shall respect any pre-agreed proprietary period. Typically, the data products should be made available to the user within 24hrs of observations being made. Ideally, users should be able to access their data programmatically.

- Calibration Data and Data processing

Observatories are encouraged but not required to provide reduced data products. If no reduced data products are generated, then the observatory shall provide access to all appropriate raw and calibration data such that the data can be processed by the user in a timely way. Typically, the data products should be made available to the user within 24hrs of observations being made.

- Documentation

The observatory shall maintain, and make publicly available, complete and accurate documentation of its instrument capabilities and overheads, necessary calibrations, scheduling, observation request specifications and interfaces as well as describing its data products and how users should access them.

Applicants are strongly encouraged to answer the AEON technical questionnaire which is designed to review all aspects of the operation of a facility and help the operators decide which approach to partnership will be most suitable.

Evaluating Telescope Operational Costs

Proposals should include an accounting of the nightly operating costs for each proposed telescope facility. We are trying to capture what the cost to NOIRLab would be if we were buying time and did not have to cover construction costs. Costs should be calculated following the guidelines below, which are based on the OPTICON model, and documented using this template. The template has two panels. The first panel is for an accounting of the facility operations costs. The second panel is for accounting of contributor expenses which are incurred in direct support for the InKind access, and are in addition to expenses accounted in the first panel.

Estimates of nightly operating direct costs may only include:

- Personnel costs associated with the operation of the facility
- Maintenance and repair costs associated with the functioning of the installation (if not capitalised)
- Consumables specifically used for the operation of the facility
- Costs associated with the management of the facility, for example providing security, insurance, quality control and any certifications specifically required for the operation of the facility
- Costs of energy and water utilities for the facility
- Costs of software licence, internet connection or other electronic services for data management and computing required for the installation to provide virtual access services
- Costs of specific scientific services included in the access provided or needed for the provision of virtual access for the facility

Operating costs should be estimated based on the most recent two years of operation, except in exceptional cases. If a different period is proposed, justification should be provided, and agreed with

24

Rubin Observatory

the Rubin Observatory.

If operating costs are not available for any reason, estimates may be proposed, with supporting evidence, such as the documented operating costs of similar facilities.

If a contributor has access via a buy-in, either one-time or incremental, that includes development costs, that buy-in fee may not be used as the operating cost. If the contributor pays an access/use fee that does not cover development, that fee may be used as an alternative to an operations cost analysis.

Proposals that include development of their facilities *specifically needed in order to be able to make their proposed contribution* (e.g. in order to join AEON when you otherwise would not have done) should provide both estimated operating costs, and the additional cost needed for the facility development.

Personnel costs for the provision of access can only include costs of administrative, technical and scientific staff directly assigned to the functioning of the facility and to the generic support of users.

2.2 Software Development

2.2.1 Definition of in-kind software development effort

The Fall 2019 [guidance](#) to teams writing LOIs described "*[d]edicated software development effort, to be either embedded in one or more LSST Science Collaborations and assigned to a needed analysis pipeline, or focused on a particular enhancement to the LSST system*" as one type of in-kind contribution that would be likely to be considered acceptable following a positive CEC evaluation.

Here we define contributions involving software. In all cases, we consider the contributions as being made to develop the essential software infrastructure of one or more Rubin Observatory LSST Science Collaborations (SCs) or of some subsystem within Rubin Observatory. For brevity, we'll call this group the *recipient SC/subsystem(s) (or just the "recipients"),* assuming some reasonable coordination between multiple recipients, if any. We refer to the group of software developers making the contribution as *the contributors*.

Software contributions may take two forms:

Dedicated and directable software development effort ("directable effort") assigned to some recipient SC/subsystem(s) or working groups within them, with the intention that efforts will be prioritized and planned via mutual agreement based on the needs of the recipients at the time the effort is being contributed and the effort and skill level offered by the contributors. Directable effort may be particularly important to ensure a high return from in-kind contributions to be provided more than a few years from now, as it is challenging at this time to anticipate what infrastructure development activities will be the highest priority in the future.

In practice, "software development effort" may include any of the following activities: designing, writing, optimizing, validating performance (e.g. unit testing or developing end-to-end validation suites), documenting (with documents or demos), and/or maintaining key analysis software; tailoring existing, proven algorithms and analysis methods to LSST challenges at LSST-scale; providing user support; or running that software at scale on data or simulations to produce value-added products deemed essential scientific infrastructure.

The CEC should provide the SCs with guidance for what is needed from the SCs that wish to accept directable software development effort in practice. The flexibility of directable effort can add great

Rubin Observatory

value, when appropriate support structures are available to guide it, and so it is the preferred mode for offering software development effort.

Non-directable software development effort ("non-directable effort") is specifically dedicated to some task(s) selected by the proposers, from amongst those software development tasks listed in the previous paragraph. Some non-directable contributions may not be intended to result in delivery of a specific product, e.g., it could be effort that *must* be used to optimize, validate, or maintain a specific software pipeline. While not directable as in the original guidelines, we recognize some contributors may have inflexible funding sources or other constraints that prevent the provision of directable effort, yet their non-directable effort can still provide substantial value to the community. The basis for prioritization of these contributions is that the intended software or value-added catalog should be evaluated as high-priority infrastructure by the recipient. For SCs that have software development road maps, this evaluation may be provided by the SC with respect to that road map, while allowing for some flexibility, e.g., to accept contributions that constitute new high-value opportunities. For those SCs without road maps, the SC evaluation may be based on the degree to which the proposed product enables key analyses the SC envisions carrying out. Due to the need to assess value for specific deliverables anticipated by groups with non-directable effort, there is a section below about how proposing teams offering non-directable effort should request endorsement for their proposals before submitting them.

Proposal teams should clearly indicate which of the above options they are taking, and may switch from what they described in their LOI as they use these guidelines to identify which option best matches their available effort.

All efforts should be embedded. To ensure the intended broad benefit from in-kind contributions, both directable and non-directable effort should be *embedded* within the recipient SC/subsystem(s), i.e., the contributors should carry out their work within the recipient SC/subsystem(s), through whatever informal discussion and reporting methods are provided for those developing the recipients') infrastructure to report updates. While proposing teams may be well-placed to make high-value embedded contributions as a consequence of their general-purpose effort (e.g., developing software, simulations, and models that are broadly of use for many survey collaborations), it is the LSST-specific embedded effort that counts towards data rights.

Value for data rights is based on effort level. For all such contributions deemed acceptable, the basis for estimating the value for data rights is the level of effort rather than some characteristic of the intended product. For non-directable effort aimed at producing some specific product, proposing teams should provide a short budget synopsis with an estimate of the FTE level connected to the key development milestones and provide some indication of what they would do to ensure a valuable contribution in cases where delays prevent the full scope of work from being carried out, so that Rubin and/or the CEC can evaluate the risk associated with this proposal. **1 FTE-yr of software development effort that is provided in compliance with the CEC software guidelines should earn data rights for 1 PI for the duration of the survey -- unless that effort is provided to the [General Pool of fully directable effort](#) (defined below), for which the exchange is 0.75 FTE-yr per PI.** This incentive is motivated by the fact that the general pool of fully directable effort will enable the CEC to advise the Rubin Director to deploy effort (via the International Program Coordinators) to SCs with significant unmet software development needs, thereby providing more effective coverage of the needs of the community. Rubin still reserves the right to adjust the exchange rate further based on the skills and experience of the staff proposed, and the perceived impact of the contribution (e.g. comparing directable effort with a non-directable contribution focused on a narrow area).

Minimum effort level: to maximize chances of success and reduce management overhead, those

Rubin Observatory

providing software development effort should have a minimum effort commitment of at least the 50% level. Smaller contributions of time in support of a larger one may also be impactful, and will be considered as in-kind contributions wherever those smaller contributions are *similarly dedicated to the development work* (i.e., they are as directable as the primary effort contribution). If dedicated software development effort is provided by a postdoc, the faculty effort to oversee, mentor, and provide consultancy advice to that postdoc will be assumed to simply be provided as necessary (and welcome) local support, and hence not considered part of the in-kind contribution. (Examples of acceptable in-kind contributions include: 20% effort from a software developer to consult on code design and optimize code written by a postdoc who is contributing 75% effort; or 50% effort from a research scientist dedicated to developing software for 2 years, followed by 20% effort dedicated to maintenance in subsequent years.)

Requirements to maximize value: To maximize the chances that in-kind contributions will add value as intended, all providers of software development effort (of both types) must consult with the recipient(s) on requirements, design, and validation. This statement applies when initial plans are being developed, and then throughout the execution of the work (by embedding the effort within the recipient SC/subsystem(s)). In addition, to ensure some uniformity of standards, improve the quality of the resulting software, and reduce responsibility on individual SCs to separately carry out processes of defining basic requirements in parallel, a uniform set of basic requirements for software development effort and acceptance criteria for products should be produced by Rubin Observatory in consultation with the CEC, with proposing teams being told their effort must adhere to those requirements (unless an exception is explicitly granted) along with any additional requirements imposed by the recipient(s). Examples of basic requirements might be use of version control, existence of documentation and demos in jupyter notebooks at key milestones according to the specifications of the recipient(s), existence of unit tests or end-to-end validation tests, or some degree of compatibility / interoperability with the DM stack or the LSST Science Platform at the US Data Facility and/or IDACs. These basic requirements will be developed during the coming year and prior to any data rights agreements being signed. Developing SC-specific requirements, and organizing code reviews etc., will undoubtedly provide long-term benefits to the SCs (particularly if those requirements can enable improved software efforts even from those whose effort is not provided as international in-kind) -- but these tasks involve significant provision of unfunded managerial effort from the SCs, and the existence of these basic requirements will help reduce the level of early investment SCs must provide.

Depending on the nature of the task addressed by the provided software, minimum performance standards may be a component of the agreed upon requirements. For example, software to implement a classifier can be required to achieve a specified figure of merit. Nevertheless, in an effort to encourage the utilization of leading-edge analysis methods and algorithms, and hence enable approaches that push well beyond minimum standards, the CEC recognizes that effort devoted to software development can include time spent adapting existing tools to LSST challenges. For example, if recent, published research demonstrates the efficacy of a new approach to estimation/regression, the effort required to tailor that method to a meaningful LSST problem will be counted as effort for the purposes of granting data rights. In all cases the final product must be software that meets the requirements of the recipient, i.e., the implementation is ultimately crucial.

While it is understood that proposers may be best-placed to contribute effectively to software infrastructure development connected to their own scientific interests, the above guidelines are essential to ensure that in-kind contributions serve the broader goal of adding resources to the US scientific community (via their impact on Rubin Observatory and/or the SCs).

In the spirit of ensuring the value of these in-kind contributions, the CEC may, as part of its proposal

Rubin Observatory

review, impose a standard based on usability to some minimum audience within the SC (e.g., for non-directable effort aimed at a specific product, the audience for that product within the SC should not be just a few scientists mostly in the proposing group, comprising a small subsection of an SC). This could involve the CEC suggesting ways to broaden the audience of a product, or identifying potential other SCs that may be interested in a software contribution initially aimed at a single SC.

2.2.2 Appropriate skill level and types of personnel

The guidance to the community in fall 2019 referred to "dedicated effort (at the appropriate skill level)". Here we discuss the question of skill level and, more generally, types of personnel who may provide software development effort.

By default, the expectation is that in-kind contributions will be provided through professional effort (computing professionals or PhD scientists) rather than graduate students. This is for several reasons: average skill levels, and concern over monetization of student effort being incompatible with the responsibility that supervisors take towards their graduate students. Exceptions to this default may be requested in the proposal, with justification. Of course, graduate students whose thesis work relies upon the software can and should be engaged with the development process, provided that it furthers their education and professional development. Their involvement should not be required for the successful completion of the software, however.

In cases where the individuals providing effort are not known, proposal teams should describe their expectation for type of personnel (e.g., permanent staff scientist, term postdoc) and hiring considerations (e.g., skill sets they intend to emphasize) so as to enable an assessment of the chance of success of a given contribution. We strongly encourage the use of equitable hiring practices when hiring into these roles; proposing teams should incorporate this information into their detailed plan. For cases where the individuals are known, information about skill sets should be provided. For non-directable effort, this information may factor directly into the prioritization or acceptance of a given contribution. For directable effort, this information will enable the proposing team and the recipient(s) to ensure a reasonable match between tasks and skill sets when developing a work plan. Some tasks will require strong computing skills, some may require strong domain skills, and others may require both.

Finally, depending on the funding model in the proposing country/institute, it may be more or less possible to identify permanent staff to provide a long-term stable contribution of effort. While long-term stable sources of effort may in some cases be easier to manage or more impactful due to the sustained effort they provide, due to the diverse conditions of proposing groups and funding sources we do not distinguish between permanent staff or temporary staff in the "exchange rate".

2.2.3 Tracking effort

The model for tracking in-kind software development effort that has been discussed is as follows:

- The international program coordinator (IPC, at Rubin Observatory) is the person to whom those contributing software development effort administratively report. The IPC should be aware of the key stakeholders for each contribution - those providing oversight within the recipient SC/subsystem(s) - and be prepared to work with them and those providing effort. Having a single person with broad oversight brings efficiencies in infrastructure across SCs, ensures some level of homogeneity in how effort is tracked, and may enable identification of synergies/opportunities that would not be visible to somebody within a single SC.

- Those contributors providing software development effort will develop work plans outlining

key activities and milestones and (where appropriate) deliverables in consultation with their recipient SC/subsystem(s). To enable flexibility to account for changes in status, those work plans should be revisited on some regular cadence (set by Rubin Observatory). Those providing effort then self-report on their progress towards their work plan, using a template provided by the IPC to ensure a consistent set of questions are asked regardless of the recipient SC/subsystem. The proposal team's Program Manager (see below) will be responsible for coordinating the timely production of these reports to the IPC. Rubin will request informal quarterly reports to the IPCs, and a more formal annual report.

● The IPC solicits feedback on progress by sharing the self-reported status with the key stakeholders for review; again, a template should be given to enable feedback to be provided in a reasonably homogeneous fashion, especially as those from whom feedback will be solicited (e.g., a working group lead within an SC) may have a wide variety of management skill sets.

At the proposal review stage we will revisit feasibility of tracking all software contributions using the above method, and communicate any changes needed.

2.2.4 Proprietary versus public software

In accordance with the US funding agencies' approach to open science, and to ensure that the benefits brought by in-kind contributions are felt by as broad a swathe of the US astronomical community as possible, the delivered software resulting from in-kind software development effort should become publicly available (to the world) no later than the time of the first publication using it — whether a method paper or a paper describing its first application — to ensure the software expands the resources available to the whole US community. However, some software packages may better, or even exclusively, benefit the recipient SC/subsystem(s) if they are not publicly available. Exceptions to this rule may be permitted in these cases via the recipient SC/subsystem(s) petitioning Rubin Director, who will then take the CEC's advice on the requested exception. (The Rubin Director may delegate this function to a Rubin data policy committee or publication board.)

Since the software development is being carried out as embedded effort within the recipient SCs/subsystems, the software should be accessible to those recipients, including during its development, and the initial publication should be written with the recipients in accordance with the relevant publication policy/policies. Proposing teams who are developing software should work with their recipients according to the SC/subsystem's standard for code visibility: for example 1. adopting fully world-public code development, versus 2. closed development (but still visible to members of the recipient SC/subsystem) followed by a code release at the time of the first publication[4] using the software. The decision should be codified in the detailed plan that accompanies the data rights agreement, though with the option to modify in case of evolution in software development and release policies in the coming decade. Contributed software must be sufficiently well-documented that it can be used by the intended community (i.e., open source software must be meaningfully open-source).

In principle, code that is developed with some proprietary dependency (either proprietary LSST data or proprietary software) may still be considered to have been released publicly if it is world-visible, even if the code cannot in practice be used to reproduce published results by those without access to

---

[4] At least a methods paper should be produced before the end of the in-kind contribution period. If this is not possible for some reason, the contributing group should request an extension to fulfill this requirement.

Rubin Observatory

the proprietary dependency.

Proposing teams should include a software delivery and release plan in their proposal, though modifications may be requested at a later stage based on feedback from the recipient(s), the CEC, or Rubin Observatory.

2.2.5 Special cases

Proposal endorsement for non-directable software development effort

Where possible, we encourage proposing groups to convert their contributions to directable effort. However, for cases where they are unable to do so, the process for developing a non-directable contribution is as follows:

1. The proposing team should consult the intended recipient SC/subsystem(s) *in advance of the proposal deadline* to initiate a discussion of the non-directable software development effort they intend to propose, and its intended outcome (what product they would produce, with what effort and on what timeline). They should provide enough information so that the intended recipient(s) can assess the potential benefits (does it meet one of their needs or add value?) and costs to them (how much effort might it take to support and track this development as an embedded contribution?).
2. The recipients should then follow the guidance below when considering whether or not to endorse the contribution and then communicating their endorsement (or lack thereof). If the recipient SC/subsystem(s) wishes to endorse the non-directable contribution, they should supply the proposing team, via the contribution's Primary Contact, with an emailed endorsement statement to be submitted with their proposal.

This process is intended to streamline the evaluation process by the CEC and reduce the number of iterations between the CEC and multiple recipient SC/subsystem(s).

In the case of non-directable effort aimed at implementing alternate or additional algorithms for aspects of image processing handled by the Project, proposing teams should describe the alternate approach they will take and the potential added scientific value (i.e., what analyses will this contribution enable that would not be possible with what is produced by Rubin Observatory). You should request endorsement from Rubin Observatory and any SCs expected to substantially benefit from this effort.

Guidance for Recipient Groups and Contribution Leads

When evaluating a proposed non-directable software contribution for endorsement, the recipient group leaders should first discuss the proposal with the Contribution Lead in order to understand what is being proposed, and how it can add value. Secondly, the recipient group leaders should consider the contribution more holistically, in the context of other proposed contributions or ongoing efforts in that area, and take into account the following specific criteria:

A. Is the proposed contribution a work package that you would choose to directed one of the collaboration's developers to undertake, both in terms of content and timeline, assuming you had such a developer?

B. Is the proposed contribution likely to be successful, in terms of either its likelihood of use (either by your group, the wider organization it is part of, or the wider LSST science community) and/or its fitness for purpose?

The recipients should then formulate a very brief endorsement statement and send it to the Primary

Rubin Observatory

Contact (see the Directory), for them to email it to the Contribution Lead for use in their proposal text. (The Primary Contact will typically be a Science Collaboration chair, or at Rubin Observatory, the Deputy Director of Operations. The recipient group will typically be an SC or a working group within an SC, or one of the Rubin teams).

When the Primary Contact communicates the endorsement to the Proposal Team, they should cc Phil Marshall (CEC Chair, and coordinator of the proposal review). If the recipients decline to endorse the proposed contribution, that should be communicated in the same way. Note that proposed contributions of non-directable software development effort that are submitted for CEC review without endorsement are likely to be rejected during the review.

Example endorsement statements are given below, for copying and pasting into email. Recipient group leaders should replace the content in angle brackets <> with suitable context-specific text.

> 1. The <recipient group> endorses this contribution.

> 2. The <recipient group> endorses this contribution on condition that <X happens>.

In case 1, the Contribution Lead would simply include the sentence in their proposal, in the Activities sub-section.

In case 2, the Contribution Lead should decide whether or not the condition can be met, and either adjust the contribution design accordingly and submit using statement 1, or decide whether or not to submit the proposed contribution without an endorsement. The CEC recommends that proposal teams do not propose contributions of non-directable software development effort without endorsement.

If the recipient group declines to endorse the contribution they should provide the Primary Contact with a very brief explanation, based on criteria A and B above.

General pool of fully directable effort

In most cases, directable effort still comes with some constraints, e.g. dedicated work for a particular SC. There is, however, room for an even more directable pool of effort that comes with no constraints on the recipient SC/subsys *recipient by the Rubin International Program Coordinators, following the recommendations of the CEC. In response to the full proposals received, Rubin and the CEC will establish a fully general and directable pool of software development effort, whose members would be software developers or data scientists with the technical skills that would enable them to contribute to software development tasks within *any* of the LSST SCs or the Rubin operations teams, and that share a willingness/interest to do so. Proposal teams are encouraged to consider contributions of effort in this category, and, as above, should note that such flexible contributions will receive a more favorable exchange rate of 0.75 FTE-yr per PI.

Some analysis tools require extensive domain knowledge for their development, so the tasks for the members of this general pool will still need to be selected effectively. (For example: assisting in the design of an analysis tool in consultation with a domain expert who understands needs/use cases; optimizing a software tool developed for some science case so it works at scale.)

The management structure envisioned for this directable general pool is that the Rubin and SC representatives on the CEC will work together to identify areas with software development needs that are not well-covered through other means. Once the recipient has been selected, the work will be carried out and managed the same as any other directable in-kind software development

Rubin Observatory

contribution.

Maintenance responsibility for delivered software products

Maintenance of delivered software is important to ensure its long-term value. Requiring software to be developed by a team embedded within the recipient SC/subsystem is a first important step to ensure that the proposing team does not deliver a system that nobody else can understand well enough to maintain. However, in recognition of the importance of maintaining software (addressing bug reports, dealing with changes in dependencies, adapting to changes in programming languages over time, …), software maintenance effort is considered in the same category as software development effort, as noted above.

For software development effort aimed at producing a well-defined software product (as opposed to, say, providing effort towards validating or documenting or optimizing some existing piece of software with some broader development team), by default the responsibility for maintaining that software product lies with the group delivering the software, rather than with the recipient SC/subsystem(s). In this context, maintenance responsibility involves addressing factors that affect usability of the software within the recipient SC/subsystem(s) (examples: changes in dependencies that require updates for compatibility) rather than full user support from anybody with access to world-public software.

Proposing teams should specify whether they plan to deliver a particular software product and if so, they should be asked to explain their maintenance plan, which may have a variable duration (if the code's intended lifetime is roughly N years, N may lie in the range from ~2 to ~10; they may wish to consult with the recipient(s) about expected lifetimes). The effort dedicated to maintenance should be counted towards data rights. They may request an exception to this responsibility for maintenance, in which case an alternative maintenance plan handing over to e.g. the recipient SC/subsystem(s) should be demonstrated in order for the CEC to endorse the contribution.

Duplication of effort

When it comes to duplication of effort, the recipients should consider which infrastructure would benefit from having parallel activities (e.g., two pipelines based on algorithms with distinct assumptions and/or independent development) versus really just needing one such activity. For such cases where the recipients specifically endorse the need for duplication, approving similar/duplicative contributions is a reasonable choice. This choice should be made transparent to proposing teams, who are intended to be working towards common goals within the recipient SC/subsystem(s).

For those groups contributing non-directable effort who wish to produce duplicative products, that transparency would occur at the time the proposals are accepted, while for those groups providing directable effort, it would happen when developing work plans that specify how their effort is to be directed. In these cases, regardless of which pipeline eventually gets used for science, when a deliberate choice is made to duplicate, both groups should get data rights in accordance with the amount of effort they contribute, as the parallel development and comparison was an essential part of developing the recipients' infrastructure.

Rubin and the CEC may not be aware of all funded efforts and, while endorsement of proposed in-kind contributions should include an attempt to take stock of duplication with other funded efforts, there may nonetheless be some unexpected duplication.

While the groups involved in an agreement to provide parallel software development efforts towards

Rubin Observatory

the same goal will still receive data rights in exchange for their effort, the CEC cannot guarantee that (a) the software will be chosen for use by the recipients for its scientific efforts in the end or (b) there is no hidden duplicative effort within or outside the recipient SC/subsystem(s).

Software effort associated with follow-up telescope time and datasets

Some follow-up telescope/dataset contributions may involve software development effort (for example, development of the facility interface to AEON). As explained in the relevant section above, this will be counted as additional operating costs and taken into account. Non-observatory-specific software development efforts that enable the follow-up telescope/dataset contribution to benefit the LSST science community may be proposed as an in-kind contribution in the same manner as any other software development effort. (Example: software that would enable any telescope to target classes of LSST transients according to the specifications of one or more SCs, to produce a spectroscopic follow-up dataset; or a data reduction pipeline of sufficient generality that it is applicable to data from many observatories.) See also the note above on "value added catalogs" and how to propose them.

Past software development effort

The original guidance to proposing teams says that "*Past contributions by PIs (and their groups) that would fit into one of the categories outlined above will also be taken into account.*" In practice, this statement applies to contributions of effort that are consistent with the basic guidelines for approval of future software contributions, such that the CEC would approve a comparable contribution now. (Note that it does not matter if the software may eventually be superseded by something done later, as long as it constitutes an essential contribution to the SC infrastructure for some period of time.) Proposal teams looking to include past software effort in their proposals, whether as part of a long term program extending from the past to the future, or simply to be recognized for the infrastructure work they have already done, should go ahead and do so; Handbook compliance will be evaluated early on in the proposal review, and will include verification with the recipient SC/subsystem.

If a group offers software that was previously developed *not* for Rubin Observatory and/or one of the LSST SCs, by definition that software does not conform to the guidelines for in-kind contributions, which specify that in-kind software development effort should be "embedded" within one of those groups, and hence the effort would not be accepted. However, that past effort from other contexts would set the group up to make a contribution involving further development/adaptation of the software for LSST, to be carried out within the recipient SC/subsystem. The effort on further development/adaptation to bring the software up to the necessary standard (testing, validation, documentation, etc.) would count as an in-kind contribution.

Note that past or planned community service or research contributions to LSST Science Collaborations (SCs) are *not* eligible as in-kind contributions. SC service work may instead be rewarded with additional publication rights by the collaboration being served. In addition, Rubin is exploring the possibility of defining an "LSST Community Builder" status, that would confer data rights on individuals (rather than proposal teams) in return for their service to the LSST science community (including the LSST Science Collaborations). However, such a scheme, if it can be realized, will be separate from the in-kind program.

Rubin Observatory

2.3 Independent Data Access Centers (IDACs) and Other Computing Resources

The ideas in the Fall 2019 LOIs can be placed into two categories of computing resource that would each make desirable in-kind contributions: Independent Data Access Centers (IDACs) and Scientific Processing Centers. In this section we define these two categories, and provide guidelines to teams proposing contributions in each. We also provide some guidance as to the likely value of such proposed contributions.

2.3.1 IDACs

Rubin Observatory will operate two Data Access Centers (DACs), one associated with the US Data Facility (that will carry out the prompt processing and a significant fraction of the annual data release processing), and a Chilean DAC at the Base Facility in La Serena. Beyond this, a network of Independent Data Access Centers is envisioned, that provides additional places to query the LSST databases, and in some cases, carry out analysis of the LSST data via the Rubin Science Platform or otherwise. The intent is to provide access to proprietary LSST data to anyone with LSST data rights at any of the Rubin DACs or IDACs, using a common authentication system. Different levels of IDAC have been defined, corresponding to different quantities and complexities of data being served, and consequently different levels of user support being provided. These definitions, and the requirements for being an IDAC of each class, are given in the Rubin technical note RTN-003, which is required reading for teams proposing computing resources.

Proposal teams looking to make computing resources one of their in-kind contributions are strongly encouraged to investigate the possibility of hosting an IDAC. This is to provide the broadest possible benefit to the US scientific community: IDACs can help reduce the demand on the US DAC's user resources, freeing up more storage space, bandwidth and compute cycles for other US users to use. Also, we expect large requests for user resources at the IDACs to be allocated by the Rubin Resource Allocation Committee, which provides a fair way to apportion computing resources among the LSST science community.

Proposal teams should refer extensively to RTN-003 when developing their proposal, and provide the following information in order to enable the Rubin Operations team to assess technical risk:

- The type of IDAC being proposed ("Full", "Catalog Server" or "Object Lite").
- The technical specifications of the IDAC, including: disk storage, database system, user compute cycles (preferably in units of both CPU hours and FLOPS, per year), and network bandwidth, demonstrating that the planned resources meet the requirements in the tech note.
- The level of dedicated support staff effort, with a very brief description of their planned activities, again demonstrating that the planned resources meet the requirements in the tech note.
- Confirmation of the intent to maintain, develop and support the IDAC for the lifetime of the survey (or otherwise), and when they propose to bring their IDAC online.
- Confirmation that the IDAC will support the common Rubin authentication system, and provide data access to all data rights holders.

See the checklists in Appendix C of RTN-003 for the full list of specifications that proposals will be evaluated against. Note that these checklists imply a minimum level of resources needed to qualify as an IDAC.

The Activity Description should contain qualitative information about the above, while the

34

quantitative information should go in the Deliverables Description, and should be formatted according to the RTN-003 checklist in order to provide a crisp and trackable summary of what will be delivered.

In addition, the proposal should include brief references to any specific user-generated datasets that the team proposes to host at the IDAC as part of its (or any other) in-kind proposal.

Rubin expects to coordinate a network of IDACs that operate in collaboration with each other, solving common problems and sharing solutions.

2.3.2 Scientific Processing Centers

In a few cases proposal teams may want to offer computing resources for use by the LSST science community as in-kind contributions. These resources could be used for "bulk analysis" of LSST data, following a negotiated "bulk download," in order to provide a needed user-generated data product, or to enable large calculations (such as N-body simulations). In general such "scientific processing centers" are significantly less valuable than an IDAC with comparable resources, because they would not provide the same broad, uniform, and guaranteed access to all LSST users, and because neither the center or its users would be able to be supported as efficiently as the IDACs would.

If any such scientific processing centers are proposed, their proposal teams should provide the following information in their proposal:

- A brief outline of the intended science case(s) and the corresponding target user community (i.e. the relevant LSST science collaborations), or state that the resources may be allocated by the Rubin Resource Allocation Committee following an open call for proposals by LSST data rights holders.
- The model for enabling user access, and also protecting any proprietary LSST data that is downloaded, as per the Rubin Data Policy [RDO-013](RDO-013).
- The computing resources to be provided: disk storage, database system, user compute cycles, and network bandwidth.
- The level of dedicated support staff effort, with a very brief description of their planned activities, to demonstrate that the science is achievable with acceptably low burden on the user community.

If the resources are to be targeted at one or more LSST Science Collaborations, the proposal team should provide a letter of endorsement from the Chair of that Science Collaboration, confirming the value of the resources offered and a commitment to actually using them.

2.3.3 Valuation of Computing Resources

In assessing the value of a proposed IDAC or Scientific Processing Center, we need to estimate the degree to which it expands the resources available to the US science community and offsets Rubin operations costs. The combined PI value of the average storage level and total CPU time provided using the formula in the Fall 2019 guidance is the starting point: "*computing resources purchased in the US cost roughly $10k per million CPU hours, and $200k per Pb of disk storage, and so 30M CPU hrs, or 1.5 PB of disk space, would be approximately sufficient to obtain data rights for 1 PI for the duration of the survey. … These "exchange rates" are only approximate: we'll ask the CEC to weigh in on the value of each contribution being proposed.*" We assume that computing resources must be accompanied by the appropriate level of support staff effort in order for the resources to be usable, and hence do not include them in the valuation.

As indicated above, the CEC considers IDAC contributions more valuable than Scientific Processing Centers, and will factor this into their value calculation accordingly. Indeed, as part of their proposal

Rubin Observatory

review, the CEC may recommend additional up- or down-weighting factors to capture the additional scientific value of the contributed resources. For now, proposal teams should assume these factors to all be unity when estimating the PI return on their proposed contribution.

As an example, a "Lite" (Catalog Server) IDAC with 10PB of storage (maintained and averaged over the survey lifetime) and 20MCPU-hrs per year for 13 years, and that provides very good user support including hosting of external datasets, should be roughly estimated to have a value of (10/1.5 + 20*13/30) = 15 PIs. Resources deemed more or less valuable than this would be recommended to earn greater or fewer PIs, by up to +/-50%. The CEC can provide an estimated weight factor on request.

2.4 In-Kind Contribution Tracking and Program Management

To help ensure that the proposal teams' in-kind contributions are successful, and to enable problems to be quickly surfaced and addressed, the following reporting structure is envisioned.

Each in-kind contribution will have a named individual (the "Contribution Lead") who is responsible for the successful delivery of the contribution, and who will produce regular annual reports on progress (as well as informal quarterly updates). For software development contributions, the lead would be the single developer, or the development team leader. For telescope time and dataset contributions, it would be a designated member of the contributing observatory staff. For computing resources, it would be the technical lead of the relevant computing center.

The Contribution Leads will provide these reports to the Rubin Observatory International Program Coordinator (IPC), who will orchestrate a simple review of them by the key stakeholders in each contribution. Those stakeholders will be the leads of each contribution's "recipient" group or their designates. For software development contributions, the recipients would be the relevant technical leads of the Science Collaboration or Rubin Observatory team in which that development effort is embedded. For telescope time and dataset contributions, the recipients would be the relevant NOIRLab staff. For computing resources, the recipients would be the Rubin Observatory Resource Allocation Committee.

The IPC will then present the results of this reporting process to the CEC, so that they can analyze the problems arising and make recommendations for solutions.

We anticipate the IPC and Rubin Director reporting regularly to the Rubin Management Board (SLAC and AURA) and to NSF and DOE's Rubin Observatory Resource Board. Those reports will include the CEC's recommendations for any problems that need addressing.

To provide needed assistance with the above reporting process, we request that each proposal team commit a small amount of staff effort to ensuring that the reporting on their program of in-kind contributions is carried out in a timely manner. First, we assume that the leads of each contribution will spend about 5% of their time preparing progress reports. Then, **we require that you designate a Program Manager, whose task it is to coordinate the production and collection of the contribution leads' reports, and who works with the IPC to understand the issues.** This Program Manager would also be responsible for reporting on contribution progress to the program's leadership, and we anticipate them also playing an important role in briefing the relevant representative on the Resource Board. We envision the Program Manager working to implement any needed changes to the in-kind program (including amendments to their DRA). In particular, a mid-term assessment of each in-kind program will provide an opportunity for both the Program Manager and the CEC to

Rubin Observatory

propose larger changes to the program than would typically emerge in the regular reports, in response to the evolving needs of the Observatory, the LSST Science Community, and the contributors. This Program Manager role will likely require between 0.1 and 0.5 FTE, depending on the size of the program in question.

In return, each participant group will receive 1 PI's worth of data rights for this program management effort.

[Back to the top]

---

3 Contributions to Rubin Construction, Commissioning and Operations

The majority of proposed in-kind contributions fall under the broad category of "added value", and are directly covered by the CEC guidelines in the previous section. Here, for completeness, we explain the guidance given to teams proposing contributions to Rubin Observatory construction, commissioning and operations. These contributions either offset operations costs, or directly enhance the Rubin facility by increasing its available staffing.

In most cases these contributions were specifically invited by, and subsequently evaluated by, the Rubin project or operations teams without consulting the CEC, which is only charged with evaluating those contributions which expand the resources available to the US science community. **Those teams proposing these contributions should work directly with Rubin staff to develop these parts of their proposals.** A notable exception is software development effort on the Rubin science pipeline or science platform, which is considered a resource-expanding contribution (since the Rubin science pipelines are intended to be developed in collaboration with the LSST science community). Such software development contributions are covered in the Software Development section above, and teams proposing them should follow the guidelines there.

[Back to the top]

---

4 Data Rights Agreement Components

In this section we outline the information needed for an LSST data rights agreement, namely a very brief statement of work (with prescribed subsectioning) and a "detailed plan" that could be either attached as an annex or held by Rubin in support of the contribution tracking process. These were derived following the model of DOE's International Cooperative Research and Development Agreement (ICRADA) that would be executed by SLAC, but similar agreements executed by AURA, NSF or DOE itself would have very similar components containing the same information. In the two sections following this one, we do not provide an example of the main body of the agreement, but instead focus on the Statement of Work and Detailed Plan, where your proposal content will end up.

In brief, the agreement itself will cover the exchange of proprietary information (the LSST data) in return for various forms of cooperation as mutually agreed, where the details of that cooperation are

all given in the statement of work annex.

Annex: Statement of Work

For each proposed in-kind contribution, this annex will need to:

1) Provide the title of the contribution.
2) Summarize in one sentence the participant's relevant experience and expertise. This will be absorbed into the "Background" section.
3) Provide a one sentence description of the activity that has been proposed. This will be absorbed into an "Expected Accomplishments" section.
4) State, in one sentence, the measurable goal of the activity: what will the participant take responsibility for delivering, and when? This will be absorbed into a "Technical Objectives and Deliverables" section.

It's the one sentence summaries listed above that lead to the proposal template's unusual format: we ask you to describe your proposed activities, but then also summarize them in one sentence because we will need those one-sentence summaries in order to construct your statement of work.

Supplement: Detailed Plan

This is not part of the DRA, but is a supplement that will be needed to support oversight of the in-kind contributions involved. This plan document should contain, for each proposed in-kind contribution, text in support of the three sentence summary given in the Statement of Work, describing the participants plans in more detail. In particular, this document should specify the trackable goals for each contribution, the responsible person for the achievement of those goals, who should provide information regarding performance to the CEC when they evaluate progress, and the timeline for the contribution. This is the motivation for the longer-form subsections of the proposal template.

[Back to the top]

---

5 Example Proposal

Below we give an example proposal, using the template distributed to the proposal teams. The template is designed so as to make it straightforward to extract, programmatically, the content needed for the DRA Statement of Work, while also being in a form that the international groups (primarily scientists) will find natural to write. You can see the pro forma instructions provided in the proposal template in violet italics: in the actual proposals, this would be stripped out by the proposal team before submission, and/or ignored by the script that rearranges the proposal content into the SOW and Detailed Plan. The SOW and Detailed Plan that would correspond to the Example Proposal in this section are given in Sections 6 and 7 respectively; to be clear, these documents will not need to be provided by the proposal team , but will be generated from the proposal by the Rubin staff. We provide them here just as an illustration of what will happen to your proposal after it is submitted.

Note that proposal writers are asked (via the template) to give one-sentence summaries as well as longer paragraphs, describing the proposed activities, deliverables, team background, and so on: these one-sentence summaries will be combined into the DRA Statement of Work (which is typically quite terse), while the longer-form descriptions will be combined into the supplementary Detailed

Plan. NB. We envision both the DRAs and the Detailed Plans existing as shared documents in highly homogeneous format, to enable the efficient management of the contribution tracking and review process.

To facilitate efficient review of your proposal, we require that each of the Abstract, Background, Activities Description, and Deliverables Description sections do not exceed 400 words maximum.

Note that in the DRA SOW, and hence in this proposal, a "deliverable" does not have to be a tangible product such as a telescope time allocation or dataset: it can also be a quantity of full time equivalent (FTE) effort by a member of staff. The "deliverables" in this context are the things being exchanged in return for LSST data rights.

Proposal Title: NAOB's In-kind Contributions to the Vera C. Rubin Observatory Legacy Survey of Space and Time

Instructions: Please edit the following so that it gives the correct personnel and institute. The Institute should be the single legal body that would sign the eventual data rights agreement. The program code has been assigned to you and should not be edited: it will be used to track the evolution of your LOI ideas into proposed in-kind contributions.

Participating Institution: National Astronomical Observatories of Bulgediskia

Program Code: BUL-NAO

Key Personnel:

Proposal Lead: Prof. Jane Doe, NAOB

Email: jane.doe@naob.edu.bd

Address: 1 Bulge Avenue, Disk City, Bulgediskia

Program Manager: Dr. Gabriella Da Vinci, NAOB

Email: gabi@naob.edu.bd

Address: 1 Bulge Avenue, Disk City, Bulgediskia

Contribution Lead: Dr. Richard Arago, NAOB

Email: arago@naob.edu.bd

Address: 3 Bulge Avenue, Disk City, Bulgediskia

Contribution Lead: Dr. Juan Cortez

Email: juan@naob.edu.bd

Address: 3 Bulge Avenue, Disk City, Bulgediskia

Abstract

Instructions: Please provide a brief overview of your proposal, to help the reviewers easily understand its contents.

We propose a two-fold contribution to the Rubin Observatory Legacy Survey of Space and Time. The first will be spectroscopic and/or active follow-up observations of transient objects discovered in the LSST observations (including in particular those located in drilling fields of COSMOS and XMM), using the prime-focus spectrograph on the Lenticular 8 meter telescope. This contribution is intended to fully conform to the Astronomical Events Observatory Network (AEON) standards. The second will be

Rubin Observatory

the delivery of the NAOB's 1000 square Degree Spectroscopic Survey to NOIR. We propose to make these contributions in return for LSST data rights and access for 6 NAOB PIs. We are submitting this proposal in response to your solicitation of a letter of intent (LOI) issued in October 2019 - to which we responded - and which was followed by your request for NAOB to submit the full proposal. We are convinced that LSST is an exciting opportunity for the entire astronomy / cosmology community in Bulgediskia, and we are enthusiastic about working with the LSST science community in the area of wide-field/time-domain astronomy and cosmology. Dr. Jane Doe will be the point of contact and our representative of the NAOB for this purpose. We are now having discussions with a group of interested scientists in Bulgediskia, including representatives of the NAOB, with an aim to form a consortium, tentatively called LSST Bulgediskia Participation Group, to make a coherent and synergetic collaboration with the LSST. However, there is a general agreement in Bulgediskia that NAOB should be the key institution and will be responsible for coordinating and submitting the proposal.

Instructions: a Telescope & Datasets Evaluation Form will be provided for you to give the parameters referred to in the Handbook, that are needed to assess the value of your proposed contribution. This form will be provided in mid-August.

- *Telescope & Datasets Evaluation Form (link to be provided)*

Instructions: now propose your various in-kind contributions, one in each numbered section, copying and pasting from the examples below (and also the Handbook). Further examples are available in Section 8 of the Handbook. In the end you will have one section for each proposed contribution numbered S1...SN, where N is the total number of contributions you propose.

S1. Statement of Work and Detailed Plan for Proposed Contribution 1

Instructions: this is a proposal section for a Telescope Time *contribution.*

S1.1 TITLE: Spectroscopic and/or active follow-up of transient objects discovered by the LSST conforming to the AEON standards

Instructions: Telescope time contributions to the Rubin Observatory can be made either as "open time" made available for allocation to US PIs, or as an "active follow-up program" that provides observation data products to US PIs on request. In most cases the recipients of these types of in-kind contribution will be NOIRLab Observatories and/or the AEON network, who will coordinate the time allocation and observation requests. Please read the violet pro forma "instructions" text in this template, and the guidelines for telescope time contributions in the Handbook for Proposal Teams before completing this form.

Instructions: if this contribution is based on one of the ideas in your Letter of Intent, please note its "LOI Code" from your feedback letter. If this contribution is a new idea, use "None". If it is based on several LOI ideas, please list the LOI Codes separated by commas (to support machine readability). This is all to help the CEC place this contribution in context during their review.

LOI Code: BUL-NAO-1

S1.2 BACKGROUND: RELEVANT EXPERTISE AND EXPERIENCE

S1.2.1 Background: Description

Instructions: Please outline your relevant experience and expertise for this proposed contribution, including your connection to the observing facility whose time will be offered, its ability to provide time in the way that is required, and your existing connections to Rubin Observatory, NOIRLab Observatories, AEON, and the LSST Science Collaborations. Include a brief overview of the relevant capabilities of the facility. You will be asked to provide specific parameters of the facility in the Telescope & Dataset Evaluation Form, so this description text can be kept high level. We encourage proposers to outline some science use cases, and in particular those that extend beyond the science interest of the proposing team.

Instructions: 400 words or fewer.

Rubin Observatory

The Lenticular 8-meter telescope has multiple focal-plane instruments, both imaging and spectroscopic. LSST will discover many transient and variable sources, and studying the nature of those sources will require spectroscopic follow-up. In some cases, the transient nature of those objects will require active and prompt follow-up. In particular, the instrument envisioned by us as providing the best synergy with LSST is the Prime Focus Spectrograph, developed by the team from Belmopan University, and loosely based on the design of the Subaru Telescope PFS. The instrument will have 2000 robotically-actuated fibers, with resolution of 3000, over the bandpass of 4000 Angstrom to 9000 Angstrom. The details of the Lenticular's and PFS's characteristics (longitude, latitude, fraction of clear nights, etc) are given in the Telescope & Datasets Evaluation Form linked to above. For an example of the spectroscopic results obtained with the Lenticular spectrograph, see Arago et al. (2018, MNRAS 900, 900) for a survey of V-19 and fainter quasars, deriving their luminosity function at the faint end, and a discussion of contribution of quasar light to reionization. We anticipate science use cases similar to this: large spectroscopic surveys of LSST objects. The Prime Focus Spectrograph on the Lenticular telescope is a particularly well-suited instrument for such follow-up. This is because in a 20 minute exposure, it can provide a relatively high signal-to-noise spectrum of a 19 V mag object. As an example, this translates to an ability to determine the spectrum of a supernova at a redshift $z \sim 0.8$ in such a short exposure, illustrating the potential synergy with the LSST. Another area where the Lenticular Telescope spectroscopy will be valuable is the measurements of spectroscopic redshifts of galaxies, in particular those that are at appreciable redshifts ($z > 1$). The particular use cases will be best developed once the LSST commissioning starts: we envision that the LSST science community and the NAOB would discuss, at community workshops, the optimal use of Lenticular towards a successful synergistic program. We note that the Lenticular Telescope is fully staffed, and no travel to the facility is necessary: essentially all observing is done remotely.

S1.2.2 Background: One Sentence Summary

Instructions: Focus on any unique or particularly valuable aspected of the facility for this contribution.

The Lenticular telescope operated by the NAOB has the world-class, very sensitive spectroscopic capability which is very likely to be of great use for following up transients discovered by the LSST.

S1.3 PLANNED ACTIVITIES

S1.3.1 Activity: Description

Instructions: Please give a high level summary of the mode of access proposed (open time, active follow-up, or otherwise), and outline what you will do to enable that, following the guidelines in the Handbook. Most contributions are expected to be made through a NOIRLab TAC or the AEON network: if proposing an exception that, please provide justification here. Please comment on the flexibility of scheduling at your facility.

Instructions: 400 words or fewer.

NAOB will make it possible for users with active time allocations to submit requests for observations that will be executed at the Lenticular Telescope. We intend to have the submission of requests for observations through a programmatically accessible interface conforming to the AEON standards: the work to upgrade the facility to integrate with AEON is already underway. In particular, whenever possible, we envision to employ queue scheduling with observations carried out by observatory staff. NOAB will fully reduce the raw data to provide calibrated spectra and thus the data processing is NAOB's responsibility, but NAOB will provide the access to data pipelines at NAOB, necessary for the observer to reduce the data on their own. Whenever possible, the raw data will be available within 24 hours of data taking, and fully reduced and calibrated data will be available within one week of data taking (in most cases, within 48 hours of data taking). NAOB already has excellent

documentation for the instrument as well as for the data pipelines. Regarding the time allocation, the LSST Science Community will have 8 dark time nights, and 8 bright time nights per year. To ensure broad and fair access to proposed follow-up programs, it is envisioned that the allocation of this resource will proceed in terms of equivalent hours of observing time, managed through a semester-based NOIRLab TAC process.

S1.3.2 Activity: One Sentence Summary

The spectroscopic follow-up, conforming to the AEON standards, will proceed in terms of equivalent hours of observing time, managed through a semester-based NOIRLab TAC process.

S1.4 TECHNICAL OBJECTIVES AND DELIVERABLES

S1.4.1 Deliverables: Description

Instructions: Please provide a clear, detailed description of how users will request targets for observation, how the observations and all calibration observations (including biases, flat fields, arc spectra etc) will be made (and/or requested by the user), how data will be delivered, and on what timescale. Please describe the timescale on which data products will be delivered, and also the nature of the data products provided, their degree of processing and data quality verification, and the user support the facility will provide.

Instructions: 400 words or fewer.

The technical objective is to deliver high quality optical spectra for a variety of uses aimed to complement the LSST data. Our preliminary discussions with the Lenticular Telescope Time Allocation Committee suggests that the Lenticular telescope can devote at least approximately 5% of observing time to such follow-up, which translates to roughly 8 nights in dark time and 8 nights in bright time per year (proportions consistent with the Lenticular TAC's general approach to large programs), starting during the year when the LSST survey starts. The details of the program are given in the Telescope & Datasets Evaluation Form linked to above. NAOB anticipates that, if the proposal is accepted, NAOB will establish procedures for securing the observations with the Lenticular Telescope to conform to the AEON standards. The observations will be done in a queue manner, so no travel of LSST collaborators to the telescope will be required. The raw data will be available within 24 hours of data-taking, and the fully reduced and calibrated data will be available in less than one week. Lenticular Telescope staff provide user support for all data taken, including documentation of the reduction pipelines and a helpdesk. If the synergy proves fruitful, upon the agreement from both sides, NAOB would be willing to double the commitment, to 10% of Lenticular time, in order to grow its contingent of astronomers with LSST data rights during the survey.

S1.4.2 Deliverables: One Sentence Summary

Instructions: Focus on the telescope time provided and data products delivered.

The NAOB team will deliver reduced spectra obtained via spectroscopic observations of targets corresponding to data obtained over 8 dark time nights, and 8 bright time nights per year on the telescope, equivalent to about 5% of the "on-sky" telescope time, for the duration of the 10 year LSST survey, for a total of 160 nights.

S1.4.3 Deliverables: Timeline

Instructions: On a separate line for each academic/US fiscal year (eg "FY22", which is October 1, 2021 through September 30, 2022), summarize the expected total amount of telescope time to be contributed, in nights.

FY24 - FY33: 16 nights of observing time on the Lenticular Telescope per year following up the LSST-discovered transients.

Rubin Observatory

S1.5 EXPECTED RIGHTS TO THE LSST DATA

S1.5.1 Data Rights: Description

Instructions: Please provide an estimate of the number of PIs you expect to be covered by the total delivered telescope time given in the previous section, citing the Handbook for the approximate exchange rate used. Please explain your estimate, outlining the operational costs of the facility and any facility development that will be specifically needed in order to be able to make the proposed contribution - see the Handbook for details. Note that the scientific value, and logistical burden, of your proposed contribution will be weighed during proposal review, potentially leading to revision of your estimate.

In return for the time on the Lenticular telescope, NAOB is requesting LSST data rights for 26 PIs. This estimate is based on the approximate total operational cost of the Lenticular Telescope, which is, according to the guidelines in the Handbook), approximately $50,000 per night, on average: see the filled-out OPTICON form for the Lenticular Telescope <here>. We assume the basic exchange rate given in the Handbook, but recognize that this may be revised on review, leading to an adjustment in the number of data rights awarded. Development costs to integrate with the AEON network will be covered separately. If the extension of the Lenticular time (from 5% to 10%) is exercised, NAOB would envision a commensurate increase in the number of PIs granted data rights.

S1.5.2: Data Rights: One Sentence Summary

Instructions: LSST data rights for N PIs.

LSST data rights for 26 NAOB PIs.

S1.6 KEY PERSONNEL

Instructions: please name one individual from your team who will take responsibility for delivering and reporting on the performance of the contribution (the "Lead"), and then name the recipient group for this contribution. Members of the recipient group will participate in the performance tracking as well as providing functional direction and support. The Contribution Lead should also be named in the table at the top of the proposal.

Contribution Lead: Dr. Richard Arago

Contribution Recipients: NOIRLab Observatories

S2. Statement of Work and Detailed Plan for Proposed Contribution 2

S2.1 TITLE: Access to the NAOB 1000 square degree spectroscopic survey

LOI Code(s): None

S2.2 BACKGROUND: RELEVANT EXPERTISE AND EXPERIENCE

S2.2.1 Background: Description

Over the last several years, NAOB's Lenticular 8-meter telescope has been involved in a spectroscopic survey of celestial objects (with the focus on quasars) in a 1000 square degree field. The survey has been conducted using the Prime Focus Spectrograph, developed by the team from Belmopan University, and loosely based on the design of the Subaru Telescope PFS. The instrument features 2000 robotically-actuated fibers, with a resolution of 3000, over the bandpass of 4000 to 9000 Angstroms. Among other results, the survey provided the luminosity function of V=19 and fainter quasars and it has been described in Arago et al. (2018, MNRAS 900, 900). Perhaps the most widely known result is the discussion of the contribution of quasar light to reionization. The full survey data

- including over a million spectra of a broad variety of sources, not just quasars - exist with NAOB, and importantly, since the data were assembled using standard formats, are easily accessible. We propose to contribute the calibrated survey data, to be hosted in a NOIRLab repository, for access by the LSST science community.

S2.2.2 Background: One Sentence Summary

The NAOB conducted a spectroscopic survey of a 1000 square degree region of the sky using the Prime Focus Spectrograph, and is proposing to provide the survey data to the LSST science community in exchange for data rights for two PIs in the LSST Science Community.

S2.3 PLANNED ACTIVITIES

S2.3.1 Activity: Description

The 1000 degree survey obtained with the Prime Focus Spectrograph on the Lenticular telescope contains, among others, spectra of over a half million galaxies, down to V magnitudes of 22, and at appreciable redshifts, going to z ~ 1.8 . The detailed specifications of the dataset are given in the Telescope & Datasets Evaluation Form linked to above. The planned activity would be to work with the NOIRLab team to ingest the data into the NOIRLab facility. One specific activity envisioned to perform jointly between the NAOB and LSST Science Community would be to use the spectroscopic data for training of photo-z estimates for galaxies from LSST photometry, in particular those that are at appreciable redshifts (z > 1).

S2.3.2 Activity: One Sentence Summary

The activity offered by NAOB would involve installation of the Lenticular Spectroscopy Survey data at NOIRLab, and subsequently, joint work with the LSST Science Collaborations in training photo-z as well as user support for the LSST Science Community to facilitate the use of the Survey data.

S2.4 TECHNICAL OBJECTIVES AND DELIVERABLES

S2.4.1 Deliverables: Description

Technical objectives are, as mentioned above, to contribute the full NAOB Lenticular Telescope Spectroscopic Survey to the NOIR, for the use of the LSST Science Community. The timeline of the activity would be to have the dataset available not later than 6 months of the start of the LSST survey. A part of the deliverable would be close collaboration of the NAOB team with the NOIRLab personnel to perform verification and validation of the data. The NAOB team will deliver the NAOB Lenticular Telescope Spectroscopic Survey to NOIRLab, and work closely with the NOIRLab team to assure successful and timely integration into its data repository.

S2.4.2 Deliverables: One Sentence Summary

NAOB will deliver the data from the NAOB's 1000 degree spectroscopic survey, to be ingested by NOIRLab.

S2.4.3 Deliverables: Timeline

4Q of FY23: delivery of the survey data to NOIRLab

2Q of FY24: verification of the complete calibrated dataset

Year 2 - 10, starting in FY 2025: User support for analysis and interpretation of the NAOB Lenticular Spectroscopic data.

Rubin Observatory

S2.5 EXPECTED RIGHTS TO THE LSST DATA

S2.5.1 Data Rights: Description

In return for the survey data, NAOB is requesting LSST data rights for 17 PIs.

S2.5.2: Data Rights: One Sentence Summary

LSST data rights for 17 NAOB PIs.

S2.6 KEY PERSONNEL

Contribution Lead: Dr. Juan Cortez

Contribution Recipients: NOIRLab Community Science and Data Center

[Back to the top]

---

6 Example Statement of Work

In this section we take the content of the [Example Proposal](#), and extract its summary sentences into a generically applicable Statement of Work, that would be attached to a DRA as an annex. This is done to illustrate the process of generating the initial draft of a data rights agreement from your proposal content, to enable Rubin to begin the negotiation.

DRA No:	XX-XXXX XXXX
Date:	July 1, 2021
Participant:	National Astronomical Observatories of Bulgediskia
Title:	In-kind Contributions to the Rubin Observatory Legacy Survey of Space and Time
Participant's Program Manager:	Dr. Gabriella Da Vinci, NAOB
Rubin International Program Coordinator:	Dr. John Doe, SLAC

Purpose

Parties

- The Board of Trustees of the Leland Stanford Junior University (Stanford) and SLAC National Accelerator Center (SLAC), Stanford, CA 94305 USA

Rubin Observatory

- National Astronomical Observatories of Bulgediskia, 1 Bulge Avenue, Disk City, Bulgediskia

Relationships

- NAOB is the national institution of Bulgediska responsible for operating and maintaining all national astronomical facilities. It has very strong expertise in designing, developing and deploying astronomical instruments. Currently it operates the premier national facility, the 8M Lenticular Telescope, featuring superb instruments capable of taking high quality spectra.
- SLAC is a national laboratory operated for the US Department of Energy by Stanford University. SLAC is one of the managing organizations for the Vera C. Rubin Observatory.

Background and Reason for Cooperation

Rubin Observatory is a wide-field astronomical survey facility that will repeatedly image the Southern sky in 6 optical and near infra-red filters over its 10 year Legacy Survey of Space and Time (LSST). The LSST Science Community spans scientists in many countries. The NAOB team proposes to make two distinct in-kind contributions to the Rubin/LSST enterprise. (1) The Lenticular telescope operated by the NAOB has world-class, very sensitive spectroscopic capability and NAOB proposes the use of that capability for following up transients discovered in the LSST. The spectroscopic follow-up would be for targets and observing parameters to be decided jointly between the LSST Science Community and NAOB teams, and will conform to the AEON standards. (2) The NAOB will deliver a 1000 square degree spectroscopic survey dataset for use by the LSST Science Community.

Agreement Schedule

The collaboration under this agreement will commence at the time of approval by the agencies, and will continue for the duration of the LSST Survey. It is anticipated that there will be regular reviews of the progress of the contribution with at most annual frequency, organized by the Rubin Observatory International Program Coordinators and overseen by the Rubin Observatory Contribution Evaluation Committee. The Key Personnel will coordinate on this reporting process as described in the Detailed Plan.

Project Agreement: Contribution 1

Phases, Tasks, and Division of Responsibilities

This contribution will take place when Rubin Observatory is taking data. NAOB will provide observing time on the 8 meter Lenticular Telescope, primarily to spectroscopically follow-up transient astronomical objects detected by the LSST.

Deliverables

The NAOB team will deliver spectra obtained via spectroscopic observations of targets corresponding to data obtained over 8 dark time nights, and 8 bright time nights per year on the telescope, equivalent to about 5% of the "on-sky" telescope time, for the duration of the 10 year LSST survey, for a total of 160 nights.

In return, the proposed SLAC commitment is to provide LSST data rights for 13 NAOB PIs.

Timeline and Goals

Year 1, starting in FY 2024: First set of Lenticular spectra of LSST-discovered transients.

Rubin Observatory

Year 2 - 10, starting in FY 2025: Follow-up of the LSST transients with the Lenticular Telescope. Success metric: delivery of the equivalent of 8 nights per year of Lenticular Telescope spectra (or equivalent) to the LSST science community.

Key Personnel

Contribution Lead: Dr. Richard Arago, richard.arago@naob.edu.bd; NAOB, 3 Bulge Avenue, Disk City, Bulgediskia

Program Manager: Dr. Gabriella Da Vinci, gabriella@naob.edu.bd; NAOB, 1 Bulge Avenue, Disk City, Bulgediskia

IPC: Dr. John Doe, Rubin Observatory International Program Coordinator, SLAC; 2575 Sand Hill Road, Menlo Park, CA 94025, USA

Contribution Recipients: NOIRLab Observatories

Project Agreement: Contribution 2

Phases, Tasks, and Division of Responsibilities

This contribution will take place shortly after the start of Rubin Observatory data-taking, and no later than six months of the beginning of the survey.

Deliverables

NAOB will deliver the data from the NAOB's 1000 degree spectroscopic survey, to be ingested by NOIRLab.

In return, the proposed SLAC commitment is to provide LSST data rights for 17 NAOB scientists.

Timeline and Goals

Year 1, starting in FY 2024: Delivery of the NAOB 1000 square degree spectroscopic survey to Rubin.

Year 2 - 10, starting in FY 2025: Joint work with the LSST Science Collaborations in training photo-z as well as user support for the LSST Science Community to facilitate the use of the Survey data.

Key Personnel

Contribution Lead: Dr. Juan Cortez, richard.arago@naob.edu.bd; NAOB, 3 Bulge Avenue, Disk City, Bulgediskia

Program Manager: Dr. Gabriella Da Vinci, gabriella@naob.edu.bd; NAOB, 1 Bulge Avenue, Disk City, Bulgediskia

IPC: Dr. John Doe, Rubin Observatory International Program Coordinator, SLAC; 2575 Sand Hill Road, Menlo Park, CA 94025, USA

Contributions Recipients: NOIRLab Community Science and Data Center

Rubin Observatory

7 Example Detailed Plan

In this section, we extract and then rearrange the more extensive parts of the [Example Proposal](#) above (beyond the one-sentence summaries that were used in the Statement of Work) to make a trackable detailed plan. This plan document would not be attached to the DRA, but instead would be used by the Rubin Observatory International Program Coordinators when monitoring the progress of the work and reporting to the funding agencies via the Resource Board. The most important part of this plan is the set of goals, which should be specific, measurable, attainable, relevant and time-bound. It also specifies the responsibilities of the named project (contribution) manager(s), and also those of an assigned set of external reviewers (who would be nominated by Rubin Observatory or the CEC).

Title: NAOB In-kind Contributions to the Rubin Observatory Legacy Survey of Space and Time: Detailed Plan

Participating Institution: National Astronomical Observatories of Bulgediskia

Key Personnel: Prof. Dr. Jane Doe, NAOB, Proposal Lead

      Dr. Gabriella Da Vinci, NAOB, Program Manager

      Dr. Richard Arago, NAOB, Contribution Lead

      Dr. Juan Cortez, NAOB, Contribution Lead

NAOB makes two in-kind contributions in return for LSST data rights: follow-up observations of transient sources with the 8 meter Lenticular Telescope, and provision of a 1000 square degree survey dataset. In this document the goals for these contributions are defined, and justified, in order to provide a trackable plan for the work.

- Telescope & Datasets Evaluation Form

Contribution 1: Spectroscopic and/or active follow-up of transient objects discovered by the LSST conforming to the AEON standards

In this contribution, the NAOB scientists would be involved in spectroscopic follow-up of transient sources discovered in the LSST. The Prime Focus Spectrograph on the 8 meter Lenticular telescope is a particularly well-suited instrument for such follow-up. The instrument will have 2000 robotically-actuated fibers, with resolution of 3000, over the bandpass of 4000 Angstrom to 9000 Angstrom. In a 20 minute exposure, it can provide a relatively high signal-to-noise spectrum of a 19 V mag object. As an example, this translates to an ability to determine the spectrum of a supernova at a redshift $z \sim 0.8$ in such a short exposure, illustrating the potential synergy with the LSST. Another area where the 8 meter Lenticular Telescope spectroscopy will be valuable is the measurements of spectroscopic redshifts of galaxies, in particular those that are at appreciable redshifts ($z > 1$).

NAOB proposes to deliver high quality optical spectra for a variety of targets / uses aimed to complement the LSST data. The particular use cases can be decided once the LSST commissioning starts: we envision that the LSST team and the NAOB would form a joint team to discuss the optimal use of Lenticular towards a successful synergistic program, which is planned to conform to the AEON

Rubin Observatory

standards. The Lenticular telescope can devote at least approximately 5% of observing time to such follow-up, which translates to roughly 8 nights in dark time and 8 nights in"bright time" a year, starting during the year when the LSST survey starts. However, if the synergy proves fruitful, upon the agreement from both sides, NAOB would be willing to double the commitment, to 5% of Lenticular time. The proposed timeline would start in FY 2024, with a pilot program aimed towards a feasibility study of such follow-up, with the subsequent years (initially FY 2025 and 2026, but most likely to be extended until 2034), pending the successful review of the project.

Deliverables

The commitment from the NAOB team is to deliver spectra obtained via spectroscopic observations of targets corresponding to data obtained over 8 dark time nights, and 8 bright time nights on the telescope per year, equivalent to about 5% of the "on-sky" telescope time.

Timeline and Goals

Year 1, starting in FY 2024: First set of Lenticular Telescope spectra of LSST-discovered transients.

Year 2 - 10, starting in FY 2025: Follow-up of the LSST transients with the Lenticular Telescope. Success metric: delivery of the equivalent of 8 dark and 8 bright nights of Lenticular Telescope spectra per year to the LSST Science Community.

Responsibilities

Execution: Contribution Lead: Dr. Richard Arago and Program Manager: Gabriella Da Vinci

> *Will provide annual report and informal quarterly progress updates to the Rubin International Program Coordinator for transmission to the CEC and Resource Board.*

Review: NOIRLab AEON Network Coordinator, TVS Science Collaboration Follow-up Working Group Conveners

> *Will review NAOB reports and evaluate progress, provide annual report to the Rubin International Program Coordinator for transmission to the CEC and Resource Board.*

Contribution 2: Access to the NAOB 1000 square degree spectroscopic survey

In this contribution, NAOB will provide the LSST Science Community with access to the data from the 1000 degree survey obtained with the Prime Focus Spectrograph on the Lenticular telescope. The survey data contain, among others, spectra of over a half million galaxies, down to V magnitudes of 22, and at appreciable redshifts, going to z ~ 1.8. This survey was carried out using 100 nights of Lenticular telescope time The planned activity would be to work with the NOIRLab team to ingest the data into the NOIRLab facility. One specific activity, envisioned to be performed jointly between the NAOB and LSST Science Community, would be to use the spectroscopic data for training of photo-z estimates for galaxies from LSST photometry, in particular those that are at appreciable redshifts (z > 1).

Deliverables

Here, the proposed commitment from the NAOB team is to deliver the calibrated survey data to NOIRLab, and to provide the validation and verification of the data.

Rubin Observatory

Timeline and Goals

4Q of FY23: delivery of the survey data and associated documentation to NOIRLab

2Q of FY24: verification of the complete calibrated dataset

Year 2 - 10, starting in FY 2025: Low levels user support for the LSST Science Community to facilitate the use of the Lenticular Survey data. During this period, NAOB scientists plan to use the LSST data in conjunction with the Lenticular Survey data, and are keen to collaborate with others in the LSST Science Community on this.

Responsibilities

Execution: Contribution Lead: Dr. Juan Cortez and Program Manager: Gabriella Da Vinci

> *Will provide annual report and informal quarterly progress updates to the Rubin International Program Coordinator for transmission to the CEC and Resource Board.*

Review: NOIRLab CSDC

> *Will review NAOB reports and evaluate progress, provide annual report to the Rubin International Program Coordinator for transmission to the CEC and Resource Board.*

[Back to the top]

---

8 Library of Example Contributions

In this section we provide a set of additional example in-kind contributions to help illustrate the guidelines given in Section 2. These all follow same template proposal format, so can be copied and pasted into a proposal and then edited from there. The template itself, in the form of a set of section headings with no instructions, is provided at the end of this library section.

Example Contribution: Serving LSST Catalogs from a Lite IDAC

Instructions: this is a proposal section for an Independent Data Access Centers (IDACs) and Other Computing Resources *contribution.*

SX.1 TITLE: Serving LSST Catalogs from the Bulgediskia Lite IDAC

Instructions: Contributions of computing resources may be in one of two forms, an Independent Data Access Center (IDAC) or a Scientific Processing Center (SPC). IDACs are strongly encouraged over SPCs, because they provide the broadest possible benefit to the US scientific community.

Instructions: if this contribution is based on one of the ideas in your Letter of Intent, please note its "LOI Code" from your feedback letter. If this contribution is a new idea, use "None". If it is based on several LOI ideas, please list the LOI Codes separated by commas (to support machine readability). This is all to help the CEC place this contribution in context during their review.

LOI Code: BUL-NAO-4

Rubin Observatory

SX.2 BACKGROUND: RELEVANT EXPERTISE AND EXPERIENCE

Instructions: Please outline your relevant experience and expertise for this proposed contribution, including your team's history of supporting large scale scientific computing, your experience with working with large astronomical surveys, the high-level properties of your computing center, and any existing relevant connections to Rubin Observatory and the LSST Science Collaborations that you may have. Please also comment on the current and projected status of the funding for the resources to be provided.

Instructions: 250 words or fewer.

National Astronomical Observatory of Bulgediskia (NAOB) is the umbrella organization coordinating the astronomical research in Bulgediskia. It is funded directly from BNSF (Bulgediskia National Science Foundation), and its charge is development, construction, and operation of ground-based astronomical telescopes and focal plane instruments. Importantly, it also provides a repository of astronomical data obtained from NAOB's facilities but also hosts local copies of large public astronomical datasets which are available freely from a variety of international sources. This is via a contemporary data center - Bulgediskia Astronomical Data Center, or BADC - featuring modern, fast and efficient supercomputer center, located in The Bulgediskia Institute of Technology, in Bulgeroo, but directly funded by NAOB. The center has excellent and very fast internet connection, and currently serves (on average) 100 Terabytes of data per day. It also houses 5,000 CPU cores, which can be used for astronomical data reduction and analysis. BADC has provided computing resources for Bulgediskia astronomers for over a decade, hosting the LRGLRG survey data, federating it with a number of other large surveys (including the SDSS catalog) and supporting its analysis.

SX.2.2 Background: One Sentence Summary

Instructions: Focus on capabilities essential for this contribution.

National Astronomical Observatory of Bulgediskia manages and operates a supercomputer center which holds a number of large astronomical databases, and believes that hosting a "Light-weight" IDAC would be a valuable addition to the currently planned set of data centers.

SX.3 PLANNED ACTIVITIES

SX.3.1 Activity: Description

Instructions: For IDACs, referring extensively to RTN-003 and the IDACs section of the Handbook, please provide a high-level, primarily qualitative summary of the computing resources being proposed. In particular, please include the type of IDAC being proposed, an overview of the technical specifications of the resources being offered, a brief description of how you will support the LSST user community in the use of those resources, a commitment to supporting the Rubin authentication system and maintaining data access for the lifetime of the survey.

Instructions: For SPCs , please provide the equivalent information, but noting your model for enabling user access and protecting the proprietary LSST data as per the Rubin Data Policy. Then, please also provide a brief outline of the intended science case(s) and the corresponding target user community (i.e. the relevant LSST science collaborations), and note explicitly the endorsements of your proposed contribution that have been made. (Please see the Handbook for details.) Alternatively, please state that the resources may be allocated by the Rubin Resource Allocation Committee following an open call for proposals by LSST data rights holders.

Instructions: If you propose to host any specific user-generated or external datasets at your computing center for use by the LSST science community, e.g. as part of this (or any other) in-kind proposal, please include brief references to them.

Instructions: 400 words or fewer.

If selected, NAOB would secure funding to purchase additional hardware necessary to store the LSST data. Since this would involve only catalog data, we believe that we would need only approx. 500 Terabytes of storage. We also believe that LSST users will need to do some basic data reduction and correlation with other data sets, and we intend to provide an additional 4.5PB of storage and 500 CPU cores, guaranteed for LSST researchers' use. We also believe that NAOB would need to devote

approx. 0.25 FTE time of an individual who would be the liaison between NOIRLab and NAOB (specifically, the BADC data center). This individual would be responsible for ingesting and maintenance / curation of the LSST data, and the coordination of the local software effort as well as synchronization of the data sets with the LSST Science Community, presumably via NOIRLab. They would be responsible to assure that software updates (in particular, those relevant to the LSST data) are installed and implemented in a timely manner. A second individual, also at 0.25 FTE, would provide technical support for the researchers and act as go-between to the BADC support staff. While this is not required under the Lite IDAC definition, we do intend to attempt to run and support the LSST Science Platform, while fully conforming to all other Guidelines for Rubin Independent Data Access Centers as specified in the https://rtn-003.lsst.io/ . Finally, we envision that the Lite IDAC at NAOB would facilitate the correlative studies of the LSST catalog data with other data sets available from that facility. In particular, NAOB envisions that the proposed data center, now with the inclusion of the LSST catalogs, would become a world-class facility in the area of quasar research, which has been the long-standing strength of the institution.

SX.3.2 Activity: One Sentence Summary

Instructions: Focus on the type of IDAC (or state SPC), and its target user community.

NOAB proposes to establish a "light-weight IDAC" at the site of its computing center, aimed at providing the LSST catalog data to the scientific community in Bulgediskia; this would be via a dedicated facility, conforming to the guidelines specified in https://rtn-003.lsst.io/ with an oversight by a dedicated scientist, responsible for the coordination with NOIRLab.

SX.4 TECHNICAL OBJECTIVES AND DELIVERABLES

SX.4.1 Deliverables: Description

Instructions: The checklists in Appendix C of RTN-003 provide the full list of specifications that proposals will be evaluated against. Note that these checklists imply a minimum level of resources needed to qualify as an IDAC. This section should include a copy of the relevant checklist, with confirmation that each criterion will be met (plus any additional commentary needed). SPC contributions shoudl provide a comparable quantitative listing of the technical specifications.

The technical objectives of this contribution are two-fold. One is to purchase and deploy sufficient hardware to provide for hosting of the local "Light-weight" IDAC, serving only the catalog data (rather than the full set of pixel data). This effort is currently envisioned to require a purchase of additional 500 CPU cores and 5 Petabytes of storage, to be included in the hardware pool of the BADC facility. NAOB will maintain the provision of these resources for the period FY23-FY35, including two complete storage refreshes, such that 5 PB continuous storage and a final total of 56M CPU-hrs are provided. Regarding the details, we intend to be fully compliant with the requirements spelled out in https://rtn-003.lsst.io/, and we propose, as listed in that document, to provide:

- Authentication/Authorization system inline with Rubin Observatory Access
- Agreement to make broadly accessible to all Data Rights holders
- Database system capable of handling 4^{10} rows
- Assure that it is compliant with IVOA TAP interface, MyDB and Table Upload, CAOM support
- Secure the availability of about 500TB of disk for catalogs + MyDBs
- Professional support staff: 0.25 FTE
- Sufficient connectivity to support users

The second part is the robust and effective communication with NOIRLab and the other IDACs in the Rubin IDAC network, to assure the software compatibility, and synchronization of the LSST catalog data releases. This would require a dedicated computer professional, at a 0.25 FTE level, and additional oversight of scientific personnel, who, presumably, would participate in this effort via

Rubin Observatory

pursuing their own scientific projects which involve the LSST data. This person could be an advanced graduate student or a post-doctoral fellow.

SX.4.2 Deliverables: One Sentence Summary

Instructions: Focus on a confirmation that you will meet the relevant criteria, plus a summary of the storage and compute you will deliver.

NAOB proposes to deliver hardware upgrade to their Data Center (BADC) at the level of 500 dedicated CPU cores and 5 Petabytes of storage - conforming to the guidelines specified in https://rtn-003.lsst.io/ - plus provide 0.25 FTE of a software professional who would be responsible for the oversight, maintenance and data curation of the LSST data at BADC, for the duration of the LSST survey.

SX.4.3 Deliverables: Timeline

Instructions: On a separate line for each academic/US fiscal year (eg "FY22", which is October 1, 2021 through September 30, 2022), give the total amount of computing resources to be contributed. This could include past years; see the "Past software development effort" section of the handbook for more detail.

If selected, the timeline is as follows:

FY23, 1st half: Procurement and installation of all computing hardware by and at the BADC facility; installation of the server software in coordination with NOIRLab and the other IDACs

FY23: 0.25 FTE of a software professional, responsible for the initial installation of the software and coordination with NOIRLab and the other IDACs regarding data updates etc.

FY24-FY35: 0.25 FTE of a software professional responsible for ingestion of the LSST data into BADC, curation of the datasets, synchronization of the data with NOIRLab and the other IDACs, and updates to computer software. Two hardware refreshes to maintain continuity of storage and compute resources.

SX.5 EXPECTED RIGHTS TO THE LSST DATA

SX.5.1 Data Rights: Description

Instructions: Please provide an estimate of the number of PIs you expect to be covered by the total delivered computing resources given in the previous section, citing the Handbook for the exchange rate used. Note that SPCs are likely to be less highly valued than IDACs, and that the scientific value of the proposed contribution will be weighed during proposal review, potentially leading to revision of your estimate.

In return for the NAOB's providing of the "Lite" IDAC (including hardware and necessary support staff), NAOB is requesting LSST data rights for 5 PIs. This estimate is based on the provision of 5PB of storage throughout the IDAC's 13-year lifetime, plus an estimated total of 56 MCPU-hrs over that period. The basic exchange rates given in the Handbook were assumed, so as to arrive at an estimated value of $(5/1.5 + 56/30) = 5$ PIs.

SX.5.2: Data Rights: One Sentence Summary

Instructions: LSST data rights for N PIs.

LSST data rights for 5 NAOB PIs.

SX.6 KEY PERSONNEL

Instructions: please name one individual from your team who will take responsibility for delivering and reporting on the performance of the contribution (the "Lead"), and then name the recipient group for this contribution. Members of the recipient group will participate in the performance tracking as well as providing functional direction and support. The Contribution Lead should also be named in the table at the top of the proposal.

Rubin Observatory

Contribution Lead: Mr. Xavier Romero

Contribution Recipients: Rubin IDACs Coordination Group

Xavier Romero is a software engineer at BADC, and the assistant director for astronomical data curation at the Center.

[Back to the Start of the Examples Library]

Example Contribution: Near-term Directable Software Development Effort in an LSST Science Collaboration

Instructions: this is a proposal section for a Software Development *contribution.*

SX.1 TITLE: Science Pipeline Development in the LSST AGN Science Collaboration

Instructions: Software contributions to the Rubin Observatory include dedicated software development effort, to be either embedded in one or more LSST Science Collaborations and assigned to a needed analysis pipeline, or focused on a particular enhancement to the Rubin Observatory software for the benefit of the US/Chilean LSST community. The Science Collaboration or Rubin Observatory operations team in which the contribution is embedded is referred to as the "recipient SC/subsystem(s)" (or just the "recipients"). Please read the violet pro forma "instructions" text in this template, and the guidelines for software development contributions in the Handbook for Proposal Teams before completing this form.

Instructions: if this contribution is based on one of the ideas in your Letter of Intent, please note its "LOI Code" from your feedback letter. If this contribution is a new idea, use "None". If it is based on several LOI ideas, please list the LOI Codes separated by commas (to support machine readability). This is all to help the CEC place this contribution in context during their review.

LOI Code: BUL-NAO-3

SX.2 BACKGROUND: RELEVANT EXPERTISE AND EXPERIENCE

SX.2.1 Background: Description

Instructions: Please outline your relevant experience and expertise for this proposed contribution, including previous software packages developed, and any existing connections to Rubin Observatory and the LSST Science Collaborations that you may have.

Instructions: 250 words or fewer.

NAOB staff have two decades of experience in developing software for use in astronomy, primarily in the area of AGN detection and characterization. This includes critical contributions to the Messier project's object detection pipeline, and the LRGLRG survey's automated AGN variability characterization code. Contribution Lead Leila Caraway is an active member of the LSST AGN Science Collaboration (AGN SC), and has been involved in developing that group's roadmap.

SX.2.2 Background: One Sentence Summary

Instructions: Focus on experience essential for this contribution.

NAOB has long-standing experience in developing software for astronomical surveys and key NAOB staff are active members of the AGN science Collaboration.

SX.3 PLANNED ACTIVITIES

SX.3.1 Activity: Description

Instructions: Please give a high level summary of the work proposed, specify the recipients of this contributed effort, and indicate the type of software development effort that you are proposing to contribute, using the definitions in the Handbook: directable, non-directable, or general pooled. Directable and general pooled efforts are preferred. If you are proposing to provide non-directable effort, please cite the endorsement of the recipient group(s) (and submit the endorsement letter along with your proposal).

Instructions: Please provide information on any additional investments you anticipate needing in order to provide the proposed contribution (e.g. significant GPU time on a supercomputing center to train deep learning models), and outline your plan for securing those resources. Include whether these are already available, or need to be applied for via national/local funding and on what timescale. If the work is based on existing development already funded by other grants/sources (possibly for other purposes) please declare those sources here. Please also list the major risks associated with the proposed work. Contributions of past software development may skip this section.

Instructions: 400 words or fewer.

NAOB will contribute directable software development effort in the general area of LSST AGN science analysis, including detection and measurement of AGN from the LSST data products (primarily the Object catalogs and time series, but potentially also the images). NAOB staff will work with the AGN SC to define needed software development tasks, and then carry out those tasks as an integral part of the collaboration, reporting regularly on progress, taking input from the rest of the collaboration, and supporting the collaboration's members in the use of the code.

We anticipate needing modest amounts of local computing to support this work, and focus on using Rubin-provided user computing resources as they become available to ensure the code functions at the needed scale. The aforementioned local computing resources are already available at NAOB, and we will work to secure additional local resources if needed. The primary risk associated with this work is in gaining the needed expertise in the Rubin tools and data products: to mitigate this, the NAOB staff will engage early with any Rubin tutorials provided, and look to be active participants in events associated with the Rubin "Data Previews", all within the context of the AGN SC.

SX.3.2 Activity: One Sentence Summary

Instructions: Focus on the type of effort, the topic area or general goal, and the contribution's recipients.

NAOB will provide directable software development effort to the LSST AGN Science Collaboration in the general area of LSST AGN science analysis, including detection and measurement of AGN from the LSST data products.

SX.4 TECHNICAL OBJECTIVES AND DELIVERABLES

SX.4.1 Deliverables: Description

Instructions: Budget justification. The deliverables are the amounts of Full-Time Equivalent (FTE) effort to be contributed to the recipient group. Please provide a high level description of the effort planned, including the seniority, staff category, and skill level of the people foreseen (e.g senior postdoc with survey experience and software carpentry training, software engineer from named observatory who built named package, etc). (Program management [i.e. reporting] overhead should be assumed to be covered separately, while only the technical effort level should be quoted here. Program management effort will be accounted for separately in the data rights agreements via an additional PI of data rights per team, as per the Program Management section of the Handbook). Please indicate whether recruitment will be necessary and whether funding is already secured to support this effort.

Instructions: Delivery. Please include a brief delivery plan that specifies how the software development work will be embedded within the recipient SC/subsystem and made public on the appropriate timescale. Please refer to the Handbook for Proposal Teams, follow the guidelines therein, and note any exceptions that will likely be required to execute the work. For general pooled effort, the embedding is achieved by committing to work with the Rubin International Program Coordinator to identify the appropriate recipients, and then deploy the effort.

Rubin Observatory

Instructions: Maintenance. Please describe the timescale over which it is foreseen that the software package(s) will be maintained, and outline the plan for that maintenance (e.g. whether it will be conducted by you, or whether there is a standing agreement between you and the recipients that covers the handover and subsequent upkeep of the developed software). Please consult the Handbook section "Maintenance responsibility for delivered software products" for more information. This part is only relevant for groups that plan to deliver a piece of software, not for those that are engaging as partners in a broader software development effort.

Instructions: 400 words or fewer.

NAOB plans to provide effort, using already-secured funding, at the level of 0.6 FTE per year for 5 years, starting in FY22. This effort will initially come from a senior postdoc (Dr. Leila Caraway) who has 5 years survey experience (with the LRGLRG survey) and software carpentry skills, supported by an experienced software engineer at lower (but still dedicated) effort level.

In terms of a delivery plan, both staff members will meet regularly with the relevant working group within the collaboration to present progress and garner domain input, and also be active participants in the collaboration's ongoing "roadmap realization" effort where they will take functional direction from collaboration leadership. NAOB expects to make all software developed as part of this contribution public at or before the time of the publication of the collaboration papers that first present the software and its application. Software will be developed in shared repositories accessible to AGN SC members throughout the development phase.

The 0.6 FTE per year will include effort developing, documenting, and maintaining software, with the split to be agreed upon with the LSST AGN Science Collaboration. Towards the end of the term of this contribution, the responsibility of maintaining any software built as part of this contribution will be negotiated with the collaboration: for any code that is still in active use, NAOB staff will (as part of their contribution) train other collaboration members in further evolving and supporting that code. The AGN SC has endorsed this approach.

NAOB will seek to replace Dr. Caraway in FY24 with an astronomer of comparable skills and experience to take over this in-kind contribution role. NAOB may propose for additional funds to maintain this support for the duration of the survey, beyond the currently funded FY22-FY26, and would welcome the opportunity to add further PIs at that time (as interest in the LSST data in Bulgediskia increases).

SX.4.2 Deliverables: One Sentence Summary

Instructions: Focus on the total effort contributed, by which kind of staff.

NAOB plans to provide skilled software development effort, using already-secured funding, at the level of 0.6 FTE per year for 5 years, starting in FY22.

SX.4.3 Deliverables: Timeline

Instructions: On a separate line for each academic/US fiscal year (eg "FY22", which is October 1, 2021 through September 30, 2022), give the total amount of FTE effort to be contributed. This could include past years; see the "Past software development effort" section of the Handbook for more detail, and note the need for SC endorsement of the effort provided.

FY22: Dr. Leila Caraway (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY23: Dr. Leila Caraway (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY24: New hire (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY25: New hire (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY26: New hire (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY27-FY35: potential continued contribution of development effort.

Rubin Observatory

SX.5 EXPECTED RIGHTS TO THE LSST DATA

SX.5.1 Data Rights: Description

Instructions: Please provide an estimate of the number of PIs you expect to be covered by the total delivered effort given in the previous section, citing the Handbook for the exchange rate used. Note that general pooled software development effort has a more favorable exchange rate, and that the scientific value of the proposed contribution will be weighed during proposal review, potentially leading to revision of your estimate.

Given the directable and skilled nature of the staff effort provided, NAOB considers 0.6 FTE for 5 years to be worth approximately 3 PIs.

SX.5.2: Data Rights: One Sentence Summary

Instructions: LSST data rights for N PIs.

LSST data rights for 3 PIs.

SX.6 KEY PERSONNEL

Instructions: please name one individual from your team who will take responsibility for delivering and reporting on the performance of the contribution (the "Lead"), and then name the recipient group for this contribution. Members of the recipient group will participate in the performance tracking as well as providing functional direction and support. The Contribution Lead should also be named in the table at the top of the proposal.

Contribution Lead: Dr. Leila Caraway

Contribution Recipients: LSST AGN Science Collaboration

[Back to the Start of the Examples Library]

Example Contribution: Non-Directable Software Development Effort in an LSST Science Collaboration

Instructions: this is a proposal section for a Software Development contribution. Changes relative to the directable SW dev example above are highlighted in **bold black font.**

SX.1 TITLE: AGN Variability Measurement Infrastructure in the LSST AGN Science Collaboration

Instructions: Software contributions to the Rubin Observatory include dedicated software development effort, to be either embedded in one or more LSST Science Collaborations and assigned to a needed analysis pipeline, or focused on a particular enhancement to the Rubin Observatory software for the benefit of the US/Chilean LSST community. The Science Collaboration or Rubin Observatory operations team in which the contribution is embedded is referred to as the "recipient SC/subsystem(s)" (or just the "recipients"). Please read the violet pro forma "instructions" text in this template, and the guidelines for software development contributions in the Handbook for Proposal Teams before completing this form.

Instructions: if this contribution is based on one of the ideas in your Letter of Intent, please note its "LOI Code" from your feedback letter. If this contribution is a new idea, use "None". If it is based on several LOI ideas, please list the LOI Codes separated by commas (to support machine readability). This is all to help the CEC place this contribution in context during their review.

LOI Code: BUL-NAO-3

SX.2 BACKGROUND: RELEVANT EXPERTISE AND EXPERIENCE

SX.2.1 Background: Description

Instructions: Please outline your relevant experience and expertise for this proposed contribution, including previous

Rubin Observatory

software packages developed, and any existing connections to Rubin Observatory and the LSST Science Collaborations that you may have.

Instructions: 250 words or fewer.

NAOB staff have two decades of experience in developing software for use in astronomy, primarily in the area of AGN detection and characterization. This includes critical contributions to the Messier project's object detection pipeline, and the LRGLRG survey's automated AGN variability characterization code. Contribution Lead Leila Caraway is an active member of the LSST AGN Science Collaboration (AGN SC), and has been involved in developing that group's roadmap.

SX.2.2 Background: One Sentence Summary

Instructions: Focus on experience essential for this contribution.

NAOB has long-standing experience in developing software for astronomical surveys and key NAOB staff are active members of the AGN science Collaboration.

SX.3 PLANNED ACTIVITIES

SX.3.1 Activity: Description

Instructions: Please give a high level summary of the work proposed, specify the recipients of this contributed effort, and indicate the type of software development effort that you are proposing to contribute, using the definitions in the Handbook: directable, non-directable, or general pooled. Directable and general pooled efforts are preferred. If you are proposing to provide non-directable effort, please cite the endorsement of the recipient group(s) (and submit the endorsement letter along with your proposal).

Instructions: Please provide information on any additional investments you anticipate needing in order to provide the proposed contribution (e.g. significant GPU time on a supercomputing center to train deep learning models), and outline your plan for securing those resources. Include whether these are already available, or need to be applied for via national/local funding and on what timescale. If the work is based on existing development already funded by other grants/sources (possibly for other purposes) please declare those sources here. Please also list the major risks associated with the proposed work. Contributions of past software development may skip this section.

Instructions: 400 words or fewer.

NAOB will contribute **non-directable software development effort** in the **specific** area of LSST AGN **variability measurement** from the LSST data products (primarily the Object, Source and DIASource catalogs). NAOB staff will adapt and extend the VARYIT package for this purpose (Smith et al 2019). **VARYIT uses a range of machine learning methods to extract advanced summary statistics of the light curves that have been shown to capture most of the physical information available in a fraction of the time of traditional time series analysis. The VARYIT developers will work closely with the AGN SC in this software development task, carrying out the work** as an integral part of the collaboration, reporting regularly on progress, taking input from the rest of the collaboration, and supporting the collaboration's members in the use of the code.

We anticipate needing modest amounts of local computing to support this work, and focus on using Rubin-provided user computing resources as they become available to ensure the code functions at the needed scale. The aforementioned local computing resources are already available at NAOB, and we will work to secure additional local resources if needed. The primary risk associated with this work is in gaining the needed expertise in the Rubin tools and data products: to mitigate this, the NAOB staff will engage early with any Rubin tutorials provided, and look to be active participants in events associated with the Rubin "Data Previews", all within the context of the AGN SC.

The AGN SC has endorsed this proposed contribution.

Rubin Observatory

SX.3.2 Activity: One Sentence Summary

Instructions: Focus on the type of effort, the topic area or general goal, and the contribution's recipients.

NAOB will provide **non-directable** software development effort to the LSST AGN Science Collaboration in the specific area of LSST AGN **variability measurement** analysis.

SX.4 TECHNICAL OBJECTIVES AND DELIVERABLES

SX.4.1 Deliverables: Description

Instructions: Budget justification. The deliverables are the amounts of Full-Time Equivalent (FTE) effort to be contributed to the recipient group. Please provide a high level description of the effort planned, including the seniority, staff category, and skill level of the people foreseen (e.g senior postdoc with survey experience and software carpentry training, software engineer from named observatory who built named package, etc). (Program management [i.e. reporting] overhead should be assumed to be covered separately, while only the technical effort level should be quoted here. Program management effort will be accounted for separately in the data rights agreements via an additional PI of data rights per team, as per the Program Management section of the Handbook). Please indicate whether recruitment will be necessary and whether funding is already secured to support this effort.

Instructions: Delivery. Please include a brief delivery plan that specifies how the software development work will be embedded within the recipient SC/subsystem and made public on the appropriate timescale. Please refer to the Handbook for Proposal Teams, follow the guidelines therein, and note any exceptions that will likely be required to execute the work. For general pooled effort, the embedding is achieved by committing to work with the Rubin International Program Coordinator to identify the appropriate recipients, and then deploy the effort.

Instructions: Maintenance. Please describe the timescale over which it is foreseen that the software package(s) will be maintained, and outline the plan for that maintenance (e.g. whether it will be conducted by you, or whether there is a standing agreement between you and the recipients that covers the handover and subsequent upkeep of the developed software). Please consult the Handbook section "Maintenance responsibility for delivered software products" for more information. This part is only relevant for groups that plan to deliver a piece of software, not for those that are engaging as partners in a broader software development effort.

Instructions: 400 words or fewer.

NAOB plans to provide effort, using already-secured funding, at the level of 0.6 FTE per year for 5 years, starting in FY22. This effort will initially come from a senior postdoc (Dr. Leila Caraway) who has 5 years survey experience (with the LRGLRG survey) and software carpentry skills, supported by an experienced software engineer at lower (but still dedicated) effort level.

In terms of a delivery plan, both staff members will meet regularly with the relevant working group within the collaboration to present progress **on the VARYIT package** and garner domain input, and also be active participants in the collaboration's ongoing "roadmap realization" effort. NAOB expects to make the **VARYIT package** developed as part of this contribution public at or before the time of the publication of the collaboration papers that first present the software and its application. Software will be developed in the **VARYIT public GitHub repository** accessible to AGN SC members throughout the development phase.

The 0.6 FTE per year will include effort developing, documenting, and maintaining **the VARYIT** software. **The responsibility of maintaining any software built as part of this contribution will be borne by NAOB staff (as part of their contribution), and they will train other collaboration members in further evolving and supporting that code as in any open source project. The AGN SC has endorsed this approach.**

NAOB will seek to replace Dr. Caraway in FY24 with an astronomer of comparable skills and experience to take over this in-kind contribution role. NAOB may propose for additional funds to maintain this support for the duration of the survey, beyond the currently funded FY22-FY26, and would welcome the opportunity to add further PIs at that time (as interest in the LSST data in Bulgediskia increases).

Rubin Observatory

SX.4.2 Deliverables: One Sentence Summary

Instructions: Focus on the total effort contributed, by which kind of staff.

NAOB plans to provide skilled software development effort, using already-secured funding, at the level of 0.6 FTE per year for 5 years, starting in FY22.

SX.4.3 Deliverables: Timeline

Instructions: On a separate line for each academic/US fiscal year (eg "FY22", which is October 1, 2021 through September 30, 2022), give the total amount of FTE effort to be contributed. This could include past years; see the "Past software development effort" section of the Handbook for more detail, and note the need for SC endorsement of the effort provided.

FY22: Dr. Leila Caraway (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY23: Dr. Leila Caraway (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY24: New hire (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY25: New hire (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY26: New hire (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY27-FY35: potential continued contribution of development effort.

SX.5 EXPECTED RIGHTS TO THE LSST DATA

SX.5.1 Data Rights: Description

Instructions: Please provide an estimate of the number of PIs you expect to be covered by the total delivered effort given in the previous section, citing the Handbook for the exchange rate used. Note that general pooled software development effort has a more favorable exchange rate, and that the scientific value of the proposed contribution will be weighed during proposal review, potentially leading to revision of your estimate.

Given the directable and skilled nature of the staff effort provided, NAOB considers 0.6 FTE for 5 years to be worth approximately 3 PIs.

SX.5.2: Data Rights: One Sentence Summary

Instructions: LSST data rights for N PIs.

LSST data rights for 3 PIs.

SX.6 KEY PERSONNEL

Instructions: please name one individual from your team who will take responsibility for delivering and reporting on the performance of the contribution (the "Lead"), and then name the recipient group for this contribution. Members of the recipient group will participate in the performance tracking as well as providing functional direction and support. The Contribution Lead should also be named in the table at the top of the proposal.

Contribution Lead: Dr. Leila Caraway

Contribution Recipients: LSST AGN Science Collaboration

[Back to the Start of the Examples Library]

Rubin Observatory

Example Contribution: Past Directable Software Development Effort in an LSST Science Collaboration

Instructions: this is a proposal section for a Software Development contribution.

SX.1 TITLE: Past Science Pipeline Development in the LSST AGN Science Collaboration

Instructions: Software contributions to the Rubin Observatory include dedicated software development effort, to be either embedded in one or more LSST Science Collaborations and assigned to a needed analysis pipeline, or focused on a particular enhancement to the Rubin Observatory software for the benefit of the US/Chilean LSST community. The Science Collaboration or Rubin Observatory operations team in which the contribution is embedded is referred to as the "recipient SC/subsystem(s)" (or just the "recipients"). Please read the violet pro forma "instructions" text in this template, and the guidelines for software development contributions in the Handbook for Proposal Teams before completing this form.

Instructions: if this contribution is based on one of the ideas in your Letter of Intent, please note its "LOI Code" from your feedback letter. If this contribution is a new idea, use "None". If it is based on several LOI ideas, please list the LOI Codes separated by commas (to support machine readability). This is all to help the CEC place this contribution in context during their review.

LOI Code: BUL-NAO-3

SX.2 BACKGROUND: RELEVANT EXPERTISE AND EXPERIENCE

SX.2.1 Background: Description

Instructions: Please outline your relevant experience and expertise for this proposed contribution, including previous software packages developed, and any existing connections to Rubin Observatory and the LSST Science Collaborations that you may have.

Instructions: 250 words or fewer.

NAOB staff have two decades of experience in developing software for use in astronomy, primarily in the area of AGN detection and characterization. This includes critical contributions to the Messier project's object detection pipeline, and the LRGLRG survey's automated AGN variability characterization code. Contribution Lead Leila Caraway is an active member of the LSST AGN Science Collaboration (AGN SC), and has been involved in developing that group's roadmap.

SX.2.2 Background: One Sentence Summary

Instructions: Focus on experience essential for this contribution.

NAOB has long-standing experience in developing software for astronomical surveys and key NAOB staff are active members of the AGN science Collaboration.

SX.3 PLANNED ACTIVITIES

SX.3.1 Activity: Description

Instructions: Please give a high level summary of the work proposed, specify the recipients of this contributed effort, and indicate the type of software development effort that you are proposing to contribute, using the definitions in the Handbook: directable, non-directable, or general pooled. Directable and general pooled efforts are preferred. If you are proposing to provide non-directable effort, please cite the endorsement of the recipient group(s) (and submit the endorsement letter along with your proposal).

Instructions: Please provide information on any additional investments you anticipate needing in order to provide the proposed contribution (e.g. significant GPU time on a supercomputing center to train deep learning models), and outline your plan for securing those resources. Include whether these are already available, or need to be applied for via national/local funding and on what timescale. If the work is based on existing development already funded by other grants/sources (possibly for other purposes) please declare those sources here. Please also list the major risks associated with the proposed work. Contributions of past software development may skip this section.

Rubin Observatory

Instructions: 400 words or fewer.

NAOB **contributed** directable software development effort in the general area of LSST AGN science analysis, including detection and measurement of AGN from the LSST data products (primarily the Object catalogs and time series, but potentially also the images). NAOB staff **worked** with the AGN SC to define needed software development tasks, and then **carried** out those tasks as an integral part of the collaboration, reporting regularly on progress, taking input from the rest of the collaboration, and supporting the collaboration's members in the use of the code.

SX.3.2 Activity: One Sentence Summary

Instructions: Focus on the type of effort, the topic area or general goal, and the contribution's recipients.

NAOB **provided** directable software development effort to the LSST AGN Science Collaboration in the general area of LSST AGN science analysis, including detection and measurement of AGN from the LSST data products.

SX.4 TECHNICAL OBJECTIVES AND DELIVERABLES

SX.4.1 Deliverables: Description

Instructions: Budget justification. The deliverables are the amounts of Full-Time Equivalent (FTE) effort to be contributed to the recipient group. Please provide a high level description of the effort planned, including the seniority, staff category, and skill level of the people foreseen (e.g senior postdoc with survey experience and software carpentry training, software engineer from named observatory who built named package, etc). (Program management [i.e. reporting] overhead should be assumed to be covered separately, while only the technical effort level should be quoted here. Program management effort will be accounted for separately in the data rights agreements via an additional PI of data rights per team, as per the [Program Management section of the Handbook](#)). Please indicate whether recruitment will be necessary and whether funding is already secured to support this effort.

Instructions: Delivery. Please include a brief delivery plan that specifies how the software development work will be embedded within the recipient SC/subsystem and made public on the appropriate timescale. Please refer to the Handbook for Proposal Teams, follow the guidelines therein, and note any exceptions that will likely be required to execute the work. For general pooled effort, the embedding is achieved by committing to work with the Rubin International Program Coordinator to identify the appropriate recipients, and then deploy the effort.

Instructions: Maintenance. Please describe the timescale over which it is foreseen that the software package(s) will be maintained, and outline the plan for that maintenance (e.g. whether it will be conducted by you, or whether there is a standing agreement between you and the recipients that covers the handover and subsequent upkeep of the developed software). Please consult the Handbook section ["Maintenance responsibility for delivered software products"](#) for more information. This part is only relevant for groups that plan to deliver a piece of software, not for those that are engaging as partners in a broader software development effort.

Instructions: 400 words or fewer.

NAOB provided effort at the level of 0.5 FTE per year for 2 years, starting in FY18. This effort **came** from a senior postdoc (Dr. Leila Caraway) who **had** 5 years survey experience (with the LRGLRG survey) and software carpentry skills, supported by an experienced software engineer at lower (but still dedicated) effort level.

In terms of a delivery plan, both staff members **met** regularly with the relevant working group within the collaboration to present progress and garner domain input, and **were** active participants in the collaboration's ongoing "roadmap realization" effort where they **took** functional direction from collaboration leadership. NAOB **made** all software developed as part of this contribution public at the time of the publication of the collaboration papers that first **presented** the software and its application. Software **was** developed in shared repositories accessible to AGN SC members throughout the development phase.

Rubin Observatory

The **0.5 FTE per year included** effort developing, documenting, and maintaining software, **with the split agreed upon** with the LSST AGN Science Collaboration. Towards the end of the term of this contribution, the responsibility of maintaining any software built as part of this contribution **was** negotiated with the collaboration: for any code that is still in active use, NAOB staff **trained** other collaboration members in further evolving and supporting that code.

SX.4.2 Deliverables: One Sentence Summary

Instructions: Focus on the total effort contributed, by which kind of staff.

NAOB provided skilled software development effort, at the level of 0.5 FTE per year for 2 years, starting in FY18.

SX.4.3 Deliverables: Timeline

Instructions: On a separate line for each academic/US fiscal year (eg "FY22", which is October 1, 2021 through September 30, 2022), give the total amount of FTE effort to be contributed. This could include past years; see the "Past software development effort" section of the Handbook for more detail, and note the need for SC endorsement of the effort provided.

FY18: Dr. Leila Caraway (postdoc, 0.4 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY19: Dr. Leila Caraway (postdoc, 0.4 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

SX.5 EXPECTED RIGHTS TO THE LSST DATA

SX.5.1 Data Rights: Description

Instructions: Please provide an estimate of the number of PIs you expect to be covered by the total delivered effort given in the previous section, citing the Handbook for the exchange rate used. Note that general pooled software development effort has a more favorable exchange rate, and that the scientific value of the proposed contribution will be weighed during proposal review, potentially leading to revision of your estimate.

Given the directable and skilled nature of the staff effort provided, NAOB considers 0.5 FTE for 2 years to be worth approximately 1 PI.

SX.5.2: Data Rights: One Sentence Summary

Instructions: LSST data rights for N PIs.

LSST data rights for 1 PI.

SX.6 KEY PERSONNEL

Instructions: please name one individual from your team who will take responsibility for delivering and reporting on the performance of the contribution (the "Lead"), and then name the recipient group for this contribution. Members of the recipient group will participate in the performance tracking as well as providing functional direction and support. The Contribution Lead should also be named in the table at the top of the proposal.

Contribution Lead: Dr. Leila Caraway

Contribution Recipients: LSST AGN Science Collaboration

Rubin Observatory

Example Contribution: General Pooled Software Development Effort

Instructions: this is a proposal section for a Software Development *contribution.*

SX.1 TITLE: General Pooled Software Development Effort

Instructions: Software contributions to the Rubin Observatory include dedicated software development effort, to be either embedded in one or more LSST Science Collaborations and assigned to a needed analysis pipeline, or focused on a particular enhancement to the Rubin Observatory software for the benefit of the US/Chilean LSST community. The Science Collaboration or Rubin Observatory operations team in which the contribution is embedded is referred to as the "recipient SC/subsystem(s)" (or just the "recipients"). Please read the violet pro forma "instructions" text in this template, and the guidelines for software development contributions in the Handbook for Proposal Teams before completing this form.

Instructions: if this contribution is based on one of the ideas in your Letter of Intent, please note its "LOI Code" from your feedback letter. If this contribution is a new idea, use "None". If it is based on several LOI ideas, please list the LOI Codes separated by commas (to support machine readability). This is all to help the CEC place this contribution in context during their review.

LOI Code: BUL-NAO-3

SX.2 BACKGROUND: RELEVANT EXPERTISE AND EXPERIENCE

SX.2.1 Background: Description

Instructions: Please outline your relevant experience and expertise for this proposed contribution, including previous software packages developed, and any existing connections to Rubin Observatory and the LSST Science Collaborations that you may have.

Instructions: 250 words or fewer.

NAOB staff have two decades of experience in developing software for use in astronomy, primarily in the area of AGN detection and characterization. This includes critical contributions to the Messier project's object detection pipeline, and the LRGLRG survey's automated AGN variability characterization code. Contribution Lead Leila Caraway is an active member of the LSST AGN Science Collaboration (AGN SC), and has been involved in developing that group's roadmap. **However, she has a broad range of science interests and widely applicable software development skills, including work on astronomy packages (VARYIT, astropy), general python coding (numpy, scipy, pytorch, tensorflow), and package development and maintenance (pypi, conda, git/GitHub, travis-ci).**

SX.2.2 Background: One Sentence Summary

Instructions: Focus on experience essential for this contribution.

NAOB has long-standing experience in developing software for astronomical surveys and **key NAOB staff are skilled in astronomical software package development.**

SX.3 PLANNED ACTIVITIES

SX.3.1 Activity: Description

Instructions: Please give a high level summary of the work proposed, specify the recipients of this contributed effort, and indicate the type of software development effort that you are proposing to contribute, using the definitions in the Handbook: directable, non-directable, or general pooled. Directable and general pooled efforts are preferred. If you are proposing to provide non-directable effort, please cite the endorsement of the recipient group(s) (and submit the endorsement letter along with your proposal).

Instructions: Please provide information on any additional investments you anticipate needing in order to provide the proposed contribution (e.g. significant GPU time on a supercomputing center to train deep learning models), and outline your plan for securing those resources. Include whether these are already available, or need to be applied for via national/local funding and on what timescale. If the work is based on existing development already funded by other grants/sources (possibly for other purposes) please declare those sources here. Please also list the major risks associated

Rubin Observatory

with the proposed work. Contributions of past software development may skip this section.

Instructions: 400 words or fewer.

NAOB will contribute general pooled software development effort to either the LSST science collaborations or Rubin Observatory teams as needed. NAOB staff will work with the Rubin International Program Coordinators (and through them, the CEC) to identify a suitable recipient group, work with that group to define needed software development tasks, and then carry out those tasks as an integral part of the group, reporting regularly on progress, taking input from the rest of the group, and supporting the group's members in the use of the code.

We anticipate needing modest amounts of local computing to support this work, and focus on using Rubin-provided user computing resources as they become available to ensure the code functions at the needed scale. The aforementioned local computing resources are already available at NAOB, and we will work to secure additional local resources if needed. The primary risk associated with this work is in gaining the needed expertise in the Rubin tools and data products: to mitigate this, the NAOB staff will engage early with any Rubin tutorials provided, and look to be active participants in events associated with the Rubin "Data Previews", all within the context of the AGN SC.

SX.3.2 Activity: One Sentence Summary

Instructions: Focus on the type of effort, the topic area or general goal, and the contribution's recipients.

NAOB will provide general pooled software development effort, to be deployed in either a Rubin Observatory team or an LSST Science Collaboration, as needed.

SX.4 TECHNICAL OBJECTIVES AND DELIVERABLES

SX.4.1 Deliverables: Description

Instructions: Budget justification. The deliverables are the amounts of Full-Time Equivalent (FTE) effort to be contributed to the recipient group. Please provide a high level description of the effort planned, including the seniority, staff category, and skill level of the people foreseen (e.g senior postdoc with survey experience and software carpentry training, software engineer from named observatory who built named package, etc). (Program management [i.e. reporting] overhead should be assumed to be covered separately, while only the technical effort level should be quoted here. Program management effort will be accounted for separately in the data rights agreements via an additional PI of data rights per team, as per the Program Management section of the Handbook). Please indicate whether recruitment will be necessary and whether funding is already secured to support this effort.

Instructions: Delivery. Please include a brief delivery plan that specifies how the software development work will be embedded within the recipient SC/subsystem and made public on the appropriate timescale. Please refer to the Handbook for Proposal Teams, follow the guidelines therein, and note any exceptions that will likely be required to execute the work. For general pooled effort, the embedding is achieved by committing to work with the Rubin International Program Coordinator to identify the appropriate recipients, and then deploy the effort.

Instructions: Maintenance. Please describe the timescale over which it is foreseen that the software package(s) will be maintained, and outline the plan for that maintenance (e.g. whether it will be conducted by you, or whether there is a standing agreement between you and the recipients that covers the handover and subsequent upkeep of the developed software). Please consult the Handbook section "Maintenance responsibility for delivered software products" for more information. This part is only relevant for groups that plan to deliver a piece of software, not for those that are engaging as partners in a broader software development effort.

Instructions: 400 words or fewer.

NAOB plans to provide effort, using already-secured funding, at the level of 0.6 FTE per year for 5 years, starting in FY22. This effort will initially come from a senior postdoc (Dr. Leila Caraway) who has 5 years survey experience (with the LRGLRG survey) and software carpentry skills, supported by an experienced software engineer at lower (but still dedicated) effort level.

In terms of a delivery plan, both staff members will meet regularly with the **identified recipient group** to present progress and garner domain input, and also be active participants **in the group's**

Rubin Observatory

ongoing planning, where they will take functional direction from the recipient group's leadership. NAOB expects to make all software developed as part of this contribution public at or before the time of the publication of the collaboration papers that first present the software and its application. Software will be developed in shared repositories accessible to **recipient group members** throughout the development phase.

The 0.6 FTE per year will include effort developing, documenting, and maintaining software, with the split to be agreed upon with the **recipient group**. Towards the end of the term of this contribution, the responsibility of maintaining any software built as part of this contribution will be negotiated with the **recipient group**: for any code that is still in active use, NAOB staff will (as part of their contribution) train other collaboration members in further evolving and supporting that code. The AGN SC has endorsed this approach.

NAOB will seek to replace Dr. Caraway in FY24 with an astronomer of comparable skills and experience to take over this in-kind contribution role. NAOB may propose for additional funds to maintain this support for the duration of the survey, beyond the currently funded FY22-FY26, and would welcome the opportunity to add further PIs at that time (as interest in the LSST data in Bulgediskia increases).

SX.4.2 Deliverables: One Sentence Summary

Instructions: Focus on the total effort contributed, by which kind of staff.

NAOB plans to provide skilled software development effort, using already-secured funding, at the level of 0.6 FTE per year for 5 years, starting in FY22.

SX.4.3 Deliverables: Timeline

Instructions: On a separate line for each academic/US fiscal year (eg "FY22", which is October 1, 2021 through September 30, 2022), give the total amount of FTE effort to be contributed. This could include past years; see the "Past software development effort" section of the Handbook for more detail, and note the need for SC endorsement of the effort provided.

FY22: Dr. Leila Caraway (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY23: Dr. Leila Caraway (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY24: New hire (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY25: New hire (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY26: New hire (postdoc, 0.5 FTE), Mr. Len Hutton (software engineer, 0.1 FTE)

FY27-FY35: potential continued contribution of development effort.

SX.5 EXPECTED RIGHTS TO THE LSST DATA

SX.5.1 Data Rights: Description

Instructions: Please provide an estimate of the number of PIs you expect to be covered by the total delivered effort given in the previous section, citing the Handbook for the exchange rate used. Note that general pooled software development effort has a more favorable exchange rate, and that the scientific value of the proposed contribution will be weighed during proposal review, potentially leading to revision of your estimate.

Given the **general pooled,** directable and skilled nature of the staff effort provided, NAOB considers 0.6 FTE for 5 years to be worth approximately **4 PIs (assuming an the general pooled SW exchange rate of 1.25 PIs per FTE-year).**

Rubin Observatory

SX.5.2: Data Rights: One Sentence Summary

Instructions: LSST data rights for N PIs.

LSST data rights for **4** PIs.

SX.6 KEY PERSONNEL

Instructions: please name one individual from your team who will take responsibility for delivering and reporting on the performance of the contribution (the "Lead"), and then name the recipient group for this contribution. Members of the recipient group will participate in the performance tracking as well as providing functional direction and support. The Contribution Lead should also be named in the table at the top of the proposal.

Contribution Lead: Dr. Leila Caraway

Contribution Recipients: Rubin International Program Coordination Team

[Back to the Start of the Examples Library]

Example Contribution: Blank Template Just With Section Headings

SX.1 TITLE: Your Contribution Title Goes Here

SX.2 BACKGROUND: RELEVANT EXPERTISE AND EXPERIENCE

SX.2.1 Background: Description

SX.2.2 Background: One Sentence Summary

SX.3 PLANNED ACTIVITIES

SX.3.1 Activity: Description

SX.3.2 Activity: One Sentence Summary

SX.4 TECHNICAL OBJECTIVES AND DELIVERABLES

SX.4.1 Deliverables: Description

SX.4.2 Deliverables: One Sentence Summary

SX.4.3 Deliverables: Timeline

SX.5 EXPECTED RIGHTS TO THE LSST DATA

SX.5.1 Data Rights: Description

SX.5.2: Data Rights: One Sentence Summary

SX.6 KEY PERSONNEL

[Back to the Start of the Examples Library]

[Back to the top]