

**Rubin Observatory Science Advisory Council Meeting**  
***Friday, October 30, 2020***

*SAC members attending:* Michael Strauss, Charles Liu, Mansi Kasliwal, Marcio Catelan, David Kirkby, Meg Schwamb, Niel Brandt, Steve Smart, Josh Simon, Risa Wechsler, Rachel Bean

*Rubin personnel attending:* Leanne Guy, Eric Bellm, Amanda Bauer, Bob Blum, Zeljko Ivezic

*Regrets:* Federica Bianco

The theme of the meeting was the plans for early science with the Rubin Observatory. The funding agencies, in particular the National Science Foundation, want to see science (in the form of papers and discoveries from the community) start to flow in the first six months to a year after full operations start. To do so requires that data be delivered to the community earlier than the Data Release 1, planned for a year after the start of operations. The Project is now planning for three Data Previews (DP)'s, delivered to the Project and community using the Rubin Science Platform/Science User Interface:

**DP0** will use simulated data of several hundred square degrees, produced by the Dark Energy Science Collaboration and processed through the Rubin pipelines. Given the compute capabilities available at the time, the number of people who could access DP0 would have to be kept small (of order 300). It is not yet decided who would get that access; in practice, it is likely to be limited largely to project personnel, and its principal purpose will be to learn how to stand up the Science Platform.

Having said that, the Data Previews are an opportunity for the science community to become familiar with, and proficient in, using the Science Platform. In that context, the limited access to DP0 will be a source of frustration for some, and managing community expectations will be challenging. Moreover, the DESC simulations are great, but they do not contain everything of interest to the full Rubin community. For example, they do not simulate asteroids, meaning that this release is unlikely to be of broad interest to the solar system community.

We discussed whether it would be possible to use data from

existing surveys (e.g., DES, HSC) for this purpose. It is not impossible, but given that the main purpose of DP0 is to exercise the Science Platform, rather than do science per se, it may not be an ideal choice. As this will be a question on a lot of peoples' minds, it will be important for the Project to articulate the reasons for using simulated rather than real data.

**DP1** will use data taken by the Commissioning Camera (ComCam). This would be available to more people than DP0, although perhaps still not to the full Rubin community. The majority of the ConCam data is likely to be engineering data; it is unclear how much will be scientifically useful.

**DP2** will use data taken by the full Rubin camera during the Science Verification stage of commissioning, and during the first months of full operations. Given that this would be released after the start of full operations, the system supporting the Science Platform should be at full strength, and thus adequate to allow access to the full Rubin science community.

The Project has stated that the data products made available in each of DP0,1,2, may be a subset of those included in a full normal data release. This subset will be determined by what the data in hand will allow (e.g., DP1 from ConCam data is unlikely to include alerts), and what the Data Processing team can produce at that time (e.g., from DP0, it may include processed images and per-visit catalogs, but perhaps not yet deep stacks). The SAC would like to understand better what the limitations are likely to be. That is, we would like to see further examples of the data products that couldn't be produced in a DP, and the reasons why not.

The planning for Early Science depends on the schedule for completing construction, which of course has been slowed down by the ongoing pandemic. The Project is in discussions with the funding agencies for a rebaselining, which will redefine the schedule for construction, commissioning, and the start of operations. Until that rebaselining planning is done (and the decision will not be finalized until the pandemic situation becomes clearer; nobody

wants to have to redo the planning and budgeting if there are additional delays), one cannot make specific plans about exactly when and for how long the science verification phase of commissioning will take place, and exactly when full operations will start. Indeed, the rebaselining (which will respect the original scope and plans for commissioning and operations) will leave both schedule and budget contingency in place, so even with it, there is quite a bit of uncertainty about exactly how much and what sort of science verification data we will have at the end of commissioning.

Having said that, there is a quite solid Systems Integration, Testing, and Commissioning (SITCom) plan in place, which includes 2 months of Science Verification, where the full Rubin Observatory will be used to gather science-quality data in various focussed mini-surveys designed to exercise all aspects of the system. Moreover, before the pandemic shutdown, there was 4.5 months of contingency remaining in the schedule. As indicated above, the plan is for the rebaselining to respect that, and retain those 4.5 months. However, in the happy situation in which the Project does not need to use any of that contingency and has finished the baseline commissioning 4.5 months before the scheduled start of full operations, they will probably go ahead to start the survey rather than do an extended set of science verification activities.

A key aspect of early science, and a significant concern of the SAC, is the ability to generate alerts. Doing so requires having imaging templates that can be subtracted to identify variable objects, and a big question is how quickly those templates can be generated over how much of the sky. The Project is planning to speed up the process of generating templates in two ways:

1. The default for most of the survey is that templates must be generated from the coaddition of at least five visits in a given filter. During the first year, this requirement could be reduced to three high-quality visits, and thus the templates would have slightly lower S/N than later in the survey. (It is worth remembering that the templates will continue to be updated through the full ten years of the survey with each data release, and the alert stream will be correspondingly updated after the fact as part of the data release.) But there is a clear community consensus that

they would prefer early alerts generated with less than perfect templates (i.e., of lower S/N) than not having alerts at all in the first year of the survey. The decision to generate these so-called incremental templates in the first months of operations has not yet been formally made, but the DM team has demonstrated the ability to do so.

-The default through most of the survey will be that the templates will be generated as part of the annual data releases. This process will be sped up for the first year of operations, allowing templates to be generated on a significantly shorter cadence.

The Project is planning for Early Science under various scenarios:

-Most optimistic: the commissioning goes extremely well, and a great deal of time is available for generating templates and carrying out science verification.

-Modestly optimistic: some science verification is done, but there is little time for generating imaging templates before full operations start.

-Less optimistic: there are still significant science verification/commissioning activities to be done at the start of full operations.

The aim is to have a completed plan in the next six months, and the Project will be looking for feedback on this plan from the SAC among others. The Early Science plan which will be delivered to the funding agencies will explicitly state the plans for generation of the incremental templates for identification of alerts.

Bob emphasized that Science Verification during commissioning and Early Science operations could include some specialized observing modes, perhaps distinct from the main survey. One such example would be intensively observing in one of the Deep Drilling fields to get to 10-year or 20-year depth in one or more filters over a few nights. A big question going forward is how ideas for such observing modes would be solicited from the community, and how the decision would be made. Moreover, to the extent that these programs are carried out in full operations, they will impact the 10-year planning of survey cadence that the SCOC is undertaking, so such decisions will need to

be coordinated with the SCOC. The SAC agreed that it is important that the integrity of DR1 and DR2 (the first two data releases from full operations) not be compromised. In particular, DR2 (based on roughly the first year of data) should be the first data release with coverage in all six filters over the full Wide-Fast-Deep footprint, a milestone that the community will be very much looking forward to.

The SAC felt that if alerts are being generated in the first six months of operations, even over a limited area of the sky (e.g., in one or more Deep Drilling Fields), science results are sure to follow. The Science Collaborations are primed to start exploring those data (but will be even more likely to produce science results if they have access to funding!). Several science collaborations have already written papers describing some of the science projects that can be done right away during an early data release. However, there has been less thought about what science can be done early from the static sky, and how that might impact the decision about operations in the first months of the survey.

The SAC asked the Project to articulate specific questions concerning the plans for early science operations. The SAC is interested in the generation of templates early, even over limited areas of sky, to allow alerts to be generated early. There is a considerable interest in observations in Deep Drilling Fields, to allow both deep imaging and alert generation. The SAC supports the idea of a community call for ideas for specialized surveys done in commissioning and the start of operations (perhaps totaling of order a month of telescope time), but expectations have to be managed carefully, given everything described above:

- We don't know how much time we will have in practice to carry out such surveys, given the uncertainties in the rebaselining plans;

- Time used for specialized observing modes will necessarily eat into the time for the main survey, and thus must be coordinated with the SCOC planning exercise.

To summarize the above, here are some of the key questions, suggestions, and concerns that the SAC has for the Project when thinking about early science:

1. Access to DP0 and DP1 is likely to be limited, and the data products available at the time will be limited as well, both in ways that cannot be fully articulated at this point. Explaining this clearly to the Rubin Community will be challenging, but necessary.
2. The Project, with guidance from the SAC and the SCOC, will come up with a mechanism to solicit proposals or ideas from the Rubin community for observing programs to be carried out early in full operations, using the unique capabilities of the Observatory and designed to allow science results to come out quickly. These programs need not be in the same observing mode as the full ten-year survey, but ideally will contribute to the full 10-year survey goals. In particular, it is important that the integrity of the first two data releases (and the goal of having observed the full Wide-Fast-Deep footprint in all six filters for DR2) be respected.
3. The SAC feels that if alerts are generated in the first months of the survey, even over fairly limited areas of sky, science is likely to come out quickly, especially if funds are made available to the Science Collaborations. The SAC will think further about static science opportunities that can be done in the first month of operations. Observations of Deep Drilling Fields will allow both transient/variable and static science to be done early (albeit over relatively small fields).
4. Given that the Rubin science community is building its plans for early science now, and are preparing funding proposals to support Year I science over the next six months to a year, the SAC encourages the Project to come up with a timeline on the decision about the templates, and communicate this timeline to the community soon.