LSST:UK Newsletter 25 (August 2022)

Introduction

The 2022 Rubin Project and Community Workshop took during the week of 8-12 August. An item below summarises some of the highlights from the meeting, but one headline was an updated project schedule, which envisages full survey operations starting at some point in the period June-October 2024. This represents a slip of two months over the course of the past year, but that year has seen the passing of a number of major construction milestones without the introduction of a significant delay, so this should be viewed in a positive light, as indicating that planning for the start of the survey is firming up well.

Closer to home, progress with the evaluation of the LSST:UK Science Centre (LUSC) Phase C funding proposal continues, with the PPRP Visiting Panel meeting taking place on 18 August. The outcome of that meeting will have been a recommendation for the level of funding for Phase C, which will then be endorsed by a meeting of the full PPRP in September, and then submitted for approval by STFC Science Board in December. In parallel, STFC are developing a Business Case to elicit approval from BEIS for future funding of the LUSC programme - required because the cost of the full (2014-2036) LUSC programme exceeds STFC's delegated budgetary authority - and that passed its "Gateway Review", in which an expert panel assessed the current draft Business Case and provided useful pointers to areas that need further attention prior to submission to BEIS later this year.

Planning for the LSST@Europe4 meeting is taking shape, with a list of plenary speakers indicating the strength of support of the meeting by Rubin staff. Covid restrictions have limited in-person attendance to 100 people and those slots have now been filled, with a waiting list in case any become available. However, registration for virtual participation remains open until **15 September**.

Those with ideas for future newsletter items should contact the LSST:UK Project Managers (@ George Beckett and @ Terry Sloan lusc_pm @mlist.is.ed.ac.uk), while everyone is encouraged to subscribe to the Rubin Observatory Digest for more general news from the US observatory team.

@ Bob Mann

Highlights of the Project and Community Workshop 2022

The 2022 Rubin Project and Community Workshop took place in Tucson during the week of 8-12 August, with support for remote attendance; all plenary sessions were streamed live, as were some of the breakout sessions held in suitably-equipped rooms. Copies of slide sets from most of the sessions, plus video recordings where available, may now be accessed through the agenda page on the PCW2022 website.

In this item we summarise, and provide pointers to, some of the highlights from PCW2022, which, as usual, featured contributions from many LSST:UK members. These included a pair of breakouts (Part I, Part II) on low surface brightness science organised by @ aaron.watkins, a major session on the in-kind programme led by @ Aprajita Verma, and participation in meetings of several key committees - notably the Science Advisory Committee (@ Meg Schwamb, @ Stephen Smartt) and the Users Committee (Qingling Ni). In addition, @ Sugata Kaviraj represented the Galaxies Science Collaboration in the Wednesday plenary providing annual updates by each of the Science Collaborations, and @ George Beckett outlined plans for the UK's LSST DAC in the session on the network of Independent Data Access Centres.

For those new to the LSST community, Melissa Graham led a session to provide *An Introduction to Rubin Observatory: Systems, Jargon and Acronyms*, and its page on the workshop includes link to other introductory resources that have been prepared by Melissa and other members of the Community Engagement Team. Zeljko Ivezic, Director for Rubin Construction, led a major project progress update plenary, with Bob Blum, Director for Operations, providing a corresponding update on operations planning. Details of preparation for the start of operations were discussed in a series of sessions that covered on-boarding of staff contributing to commissioning, science verification and validation, survey strategy optimisation and planning for early science, which is taken to comprise science analysis up to, and including, Data Release 1. Further technical sessions addressed topics such as difference image analysis, deblending and photometric calibration, plus continuing efforts to mitigate the impact of satellite constellations, together with a general update on the science pipelines and more focussed updates on instrument signature removal and source injection. More science-focussed breakouts included those on photometric redshifts, multi-messenger astronomy, time domain follow-up and synergies with DESI, plus DESC's second time series classification challenge (ELAsTiCC).

The Rubin Observatory continues to prioritise the development a positive culture within its own staff and in the wider LSST community, and PCW2022 included a session on *Rubin-related initiatives toward diversity, equity and inclusion*, plus a more informal equity and inclusion workshop, and a discussion of how to foster trust in the workplace.

The workshop also included sessions aimed more specifically at Rubin staff, but there were fewer of those than in previous PCWs, reflecting the widening of the LSST community as the start of operations approaches. Rubin are considering the best way forward for the PCWs, informed in part by an exit survey completed by this year's attendees (in-person and remote). The PCW seems likely to evolve into a more science-focussed event, but no decision has been made as to its future frequency or location, or the balance between in-person and virtual activities. This transition is likely to take several years, and outline planning information about PCW2023 should be available within the next few months.

This is a necessarily incomplete summary of PCW2022 and those interested in a more complete picture are encouraged to watch the recording of the Friday plenary session, which features a one-minute summary of all of the breakout sessions that took place during the week.

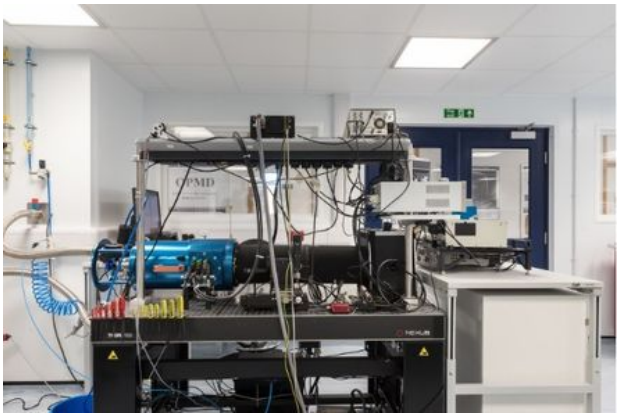
@ George Beckett and @ Bob Mann

Undergraduate Student Contributions to LSST:UK Camera Research at Oxford

Introduction

Our group have worked on the LSST camera since 2007, first in the U.S. at Purdue University and since 2013 at Oxford. Throughout that time many students have made important contributions to LSST research and launched their careers. From the early days in the US, undergraduate **Andy Bohn** went on to take a PhD at Cornell on numrerical relativity, while undergraduate **Joseph Clampitt** took a PhD at U. Penn on cosmology with the Dark Energy Survey. Andy is now a Senior Manager at Space-X, while Joseph became a post doc at Penn and LSST DESC member. PhD student **Bo Xin** joined Rubin Observatory in 2013 and worked his way up to Deputy System Scientist, and is now the Adaptive Optics Scientist for the Giant Magellan Telescope.

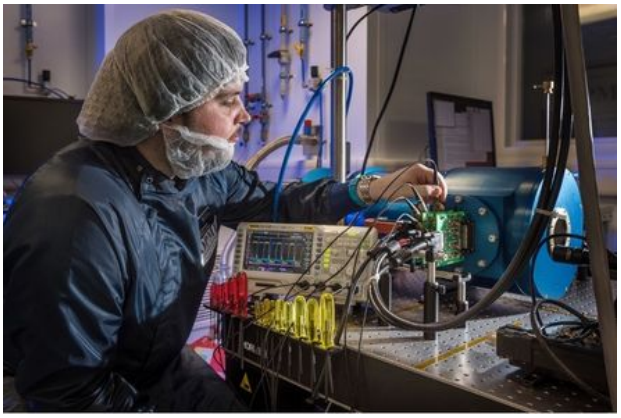
In 2015 we opened the Oxford Physics Microstructure Development Lab (OPMD), modelled on our earlier lab in the US. Like its predecessor, it specialises in developing, constructing, and exploiting silicon sensors mostly for particle physics, but also for astrophysics, atom interferometry and applied science. Oxford undergraduates take 3rd year research projects both experimental and computational with us, and summer research students have joined us too. In both cases, the students get to dedicate a period of a few months to LSST related work, though with differences in intensity. This article will summarize the projects we have offered in Oxford starting with the experimental projects, and highlight some of the major successes arising from them both in research and personally for the students involved.



The 3rd year experimental projects

The experimental projects involve students assisting with hardware tasks in the lab that are directly relevant to our work for LSST:UK. These projects vary from year to year depending on what would be most useful for us and also what we think would be achievable and rewarding for the students. In the 2019/20 year, we hosted two students, **Mingyu Liu** (subsequently took a MS in Statistics at University of Chicago 2021-22, and is now applying for a PhD at Chicago in econometrics) and **Esther Hung** (now taking a PhD at Oxford in condensed matter physics), who worked on aspects of calibration of the radiometry of our LSST sensor test stand. We discovered, characterised and corrected for several important problems during these projects, most particularly in the time stability of our mono-chromated tungsten light source, which was a fairly large source of error in long exposures. In the academic year 20/21 we were unable to offer an experimental project due to the COVID-19 pandemic.

However, we returned in great form in 2021/22 when **Fiona Zhang** helped us to develop our experimental new interferometric alignment technique for two cameras. She did great work in getting the test cases to work and understanding the systematic uncertainties in this measurement, and has greatly accelerated the progress for us to be able to demonstrate this technique on "real" LSST sensors. Some of the calibration graphs and charts on PSF interferometric alignment that **Dan Weatherill** has showed at recent LSST:UK progress meetings were contributed by Fiona. None of these students had particular experience in electronics or optics lab work, coding in the Python language, or using software development techniques like distributed version control before starting our projects, but learned them over the course of the project and have benefitted greatly from these skills and others acquired during the project.



The Summer Experimental Projects

We have offered 2 LSST related summer research internship projects to students, and in many ways these have been both the most useful directly to our LSST:UK work and the most profitable for the student. This is partly because, unlike the 3rd year projects for Oxford students, the summer student have no need to complete a detailed academic report based on the project, allowing us to be a little more speculative or utilitarian about the project content. Both of these possibilities are demonstrated by our two students. In the summer of 2018 we took on **Nicholas Demetriou** (Imperial College, now taking a PhD in quantum technology at TU Delft) to work on the noise calibration of LSST sensors. He previously had very little instrumentation experience, and no electronics experience, though he did have a good background in programming. It was during this summer project that Nicholas serendipitously discovered (by slightly mis-interpreting some instructions he had been given!) a deeply important aspect about the noise analysis power of digital Correlated Double Sampling (CDS) systems, as used in our lab to readout LSST sensors. This idea, along with ideas about how to optimise the timing of CDS readout to reduce noise and increase linearity that had been developed by **Dan Weatherill**, went on to form the core of our 2019 paper, “Automatic selection of correlated double sampling timing parameters” by Weatherill et al, on which Nicholas was named as a co-author for his core contribution to the work. Nicholas had to do a lot of detailed electronics characterisation work throughout the project, and his lack of prior experience only made his great success in this area all the more impressive.

In summer 2019, **Sergio Garcia** (now taking a PhD funded by a space technology company in Spain on satellite dynamics) joined the our team to work on the least interesting-sounding project, but also perhaps the most impactful to our LSST:UK work. Sergio had a background in electronics and computer engineering rather than physics, and this background gave him a great head start in tackling the engineering problems we asked him to work on. Those were, chiefly, to implement interfaces and calibration routines for all the motorised stage equipment on the LSST test bench in OPMD. This was absolutely vital preparatory work for all the spot based PSF measurements we have done since. Although the protocols for everything were documented, a requirement of our research group, we encountered several places where documentation differed from reality and Sergio had to do some significant reverse engineering to work out how exactly to make everything talk to each other. In OPMD we have a ~50,000 line codebase in our sensor test and analysis environment, which is a mixture of c++ and python. In recent years we have begun migrating more to LSST project provided tools for analysis, but in the early days when we began testing none of this was available. Sergio remains the only person in the git logs to touch the ~25000 line c++ codebase other than **Dan Weatherill**.

The 3rd year computational project

Simulation of detectors is an important part of our work, and we have great off the shelf commercial simulators available for this task. It has also long been of interest to build a simulator for the hydrodynamic model of a semiconductor somewhat “from scratch”. Very few free, high quality implementations exist (most of the high quality implementations are very expensive commercial products), and understanding exactly how to overcome some of the computational and numerical aspects of the problem is both challenging and highly illuminating. To that end, since 2019, we have been offering a 3rd year computational project which builds on top of each previous years work to try and implement the drift diffusion model in a CCD-like semiconductor structure. Our first students **Taavet Kalda** (now a PhD student at the Max Planck Institute for Astronomy) and **Theo Yoong (**subsequently took a MSc in Mathematical and Computational Finance at Oxford and is now a Quantitative Developer Associate at J.P. Morgan in London), under the supervision of **Dan Weatherill** did a great job in getting started, exploring the literature on the topic and coming up with the basic set of procedures that needed to be put together in order to solve a biased set of drift-diffusion equations via the so-called “Gummel method”. By the end of that year we had a basic, one-dimensional simulation of a pn-junction, the basic building block of nearly all modern semiconductor devices including CCDs. In the 2020/21 academic year, we continued running this project (it is easier to do a computational project under COVID restrictions), and **Xihan Deng** (starting a PhD in experimental cosmology at Caltech in September 2022) and **Mac Zhou** (whilst in his final year at Oxford, 2021-22 he served as Director of the OX1 Incubator) made progress over the previous year in several important areas, added new physical models for recombination and mobility, and made drastic performance improvements – both in space and time- and made many “quality of life” improvements to our simulator. In the 2021/22 academic year, **Megan Evans** began the very daunting task of extending the simulator to include other types of boundary conditions than just the Dirichlet conditions we had started with. This is the crucial step in going from something that can simulate a pn junction (i.e. a diode) to something that can also simulate MOS capacitor structures – once we have both, simulating a CCD pixel is possible. Though we have not fully solved all the issues related to this, we have made great progress

The Future

We are looking forward to welcoming several new students in the upcoming academic year and we hope to restart the summer programme in 2023. We are sure the new students will be as impressive as their predecessors. As soon as Dan is back from the summit we’ll get started.

@ Ian Shipsey and @ Daniel Philip Weatherill

Public Engagement Plans: Call for Input

The new Education and Public Outreach Coordinator, Chris Lintott, is working on a strategy for supporting LSST:UK institutions with public engagement and outreach plans during the lead up to first light, commissioning and survey science. A version will be circulated for comment by the end of September, but in the meantime, Chris is keen to talk to anyone, at any institution, who is especially keen to include LSST content in existing or new plans for public engagement or outreach. Whether it's taking transient science to schools, working with artists and musicians, online projects or community engagement, we'd like to make it as easy as possible for the whole collaboration to share the excitement of our project.

If you have ideas about what we should be doing, existing programs or projects which LSST content could enhance, or new ideas which could happen, please get in touch with Chris via chris.lintott@physics.ox.ac.uk, with 'LSST Engagement' in the subject line.

@ Chris Lintott

Recent LSST:UK Science Centre outputs

The LSST:UK Science Centre has recently produced the following technical reports.

Title	Author	Description
D1.2.3 Science Requirements Document (Mar '22)	S. Smartt	The LSST:UK Science Requirements Document, also known as the SRD, is maintained in a wiki page on the LSST:UK Science Centre's Confluence wiki. Deliverable D1.2.3 comprises the SRD as of March 2022. It lists the updates to the SRD from its deliverable D1.2.2 version. It also contains the PDF snapshot of the wiki that forms deliverable D1. 2.3 following its review and subsequent update.
D2.1.5 Data Facilities Transition Plan	G. Beckett, P Clarke	This describes the work that needs to be done within LSST:UK, to ensure that the UK Consortium can deliver effectively on the in-kind commitment to complete 25% of the Rubin Observatory Data Release Processing (DRP) workload. It also documents the required roles and resource levels, during Rubin Operations, based on guidance provided by the Rubin Data Management team, US and French Data Facilities Coordinators, and contacts within the IRIS programme. It begins by describing the context of this work and summarising initial activities that have been possible with in-kind effort from GridPP, working with peers in the USA and France, during the latter part of 2021. It then proposes a high-level work plan for DRP commissioning contributions that are needed, from LSST:UK, in the remaining 12 months or so of Phase B. The work plan is aligned with a Rubin Observatory in-preparation document [RTN-021] and assumes telescope operations from April 2024. Finally it describes the anticipated resource requirements (skills and effort levels) for during Rubin Operations (Phase C and D), plus the immediate resource requirements to complete the proposed Phase B work plan. (Note: This deliverable is available only to LSST:UK project members at this time.)
D2.2.3 Ingestion software for ancillary surveys	Mike Read, George Beckett, Craig Manzi	The UK-DAC has been tasked with hosting and serving datasets from external surveys and those produced by LSST:UK work packages. This document describes the initial investigations into ingesting survey catalogues and details the workflows and software required. Two tests of preparing and ingesting data are discussed together with the priorities and next steps for this work. Ancillary catalogues that need to be hosted alongside the LSST Data Releases will typically be hosted in Qserv, the bespoke, distributed, relational database being developed by the Rubin Observatory. While some archives provide a bulk-download facility, this is not universally the case. The DAC team is likely to need to collaborate with a small number of archive providers to obtain a copy of the ancillary catalogues they host.

		There are likely to be differences between the form and format of ancillary catalogues from different archives (for example, related to treatment of null values) and an understanding of these differences is required to successfully ingest and publish the data. Catalogue ingestion is a resource-intensive and time-consuming task, thus it is worthwhile to invest effort to carefully prepare each catalogue to reduce the risk of problems being encountered late on in the process. The Qserv administrator needs to make decisions regarding the partitioning of data and indexing of the catalogue which will have long-term implications on the utility of the data. At the time of writing, a strategy for making such decisions is still being developed, and we expect this to be informed by the Rubin Data Management team as they scale up their use of Qserv to LSST-scale datasets. At the time of writing, a catalogue needs to be available as (or converted to) a CSV/ TSV format, to be ingested, even though the CSV /TSV format is inefficient for transferring and handling substantial catalogues. This is related to a limitation in the underlying Qserv database architecture (MySQL). The ingestion process has the potential to consume twice as much storage as the catalogue itself (during ingestion), though tactics exist for reducing the storage requirement. The Rubin Data Management team is developing a suite of tools to help with ingestion of catalogues. These can simplify and automate the process. The UK DAC team has supplemented this suite with scripts to automate the preparation of ancillary datasets. The UK DAC team plans to ingest and publish a number of survey catalogues, over the coming months, including ancillary surveys and previous, user-generated products from DEV activities. This work will provide the prerequisite experience for managing LSST-scale catalogues during Operations.
D2.5.5 Interface Requirements for DAC-DEV interactions	George Beckett, Mike Read	A unique element of the LSST:UK programme, and a particular advantage for UK astronomy, is a portfolio of research and development activities (commonly referred to as DEV activities), which are funded as part of the Phase B programme and are working to enhance and extend the astronomy potential of the baseline Rubin Observatory software, services, and data products, for priority astronomy topics within the UK. Some of these DEV activities need to interface with the LSST:UK Data Access Centre (DAC), in order that their outputs can be made available to science users during operations. For example, a DEV activity may produce a piece of software that enables astronomers to analyse LSST data in a different way or may produce a User-generated Data Product (in Rubin Observatory nomenclature) to be co-hosted alongside official LSST Data Release products. A goal of the WP2.5 team has been to engage early with the affected DEV teams to develop, test and document how the DEV products will interact with the DAC and be supported by the DAC team. An important element of this activity is the production of a set of DAC-DEV Interface Definitions, which will define the interfaces between the DAC and the DEV products in sufficient detail to ensure seamless operation, and to document where the responsibility for different aspects of the interface will lie (that is, with the DAC team or the DEV team). The DAC team is working with these DEV activities to understand, agree and develop the required interfaces. The topical state of this work is captured in two documents: • WP3.11 DAC-DEV Interface Requirements • WP3.5 DAC-DEV Interface Requirements and are summarised in this report.

Forthcoming meetings of interest

Meetings of potential interest for the coming months include:

- 24–28 October 2022 – **Rubin Observatory LSST@Europe4**, at Accademia dei Lincei, Rome, Italy. The will be a hybrid meeting with a limited number of in-person spaces. Registration for virtual participation is open until **15th September**.
- 17–22 October 2022 – **DESC Sprint Week**, at University of Michigen, Ann Arbor. Details to be published on DESC members website (login required).

Members of the Consortium (not in receipt of travel funding through one of the Science Centre grants) may apply for travel support for meetings of this kind via the the LSST:UK Pool Travel Fund. Details are available at https://lsst-uk.atlassian.net/wiki/spaces/HOME/pages/25853997/LSST+UK+Pool+Travel+Fund .

Note that the current list of forthcoming meeting is always available on the Relevant Meetings page. You may also wish to check information held on the LSST organisation website LSST-organised events and the LSST Corporation website.

@ George Beckett

Announcements

If you have significant announcements that are directly relevant to LSST:UK and would like to share the announcement in a future newsletter, please contact the LSST:UK project managers.