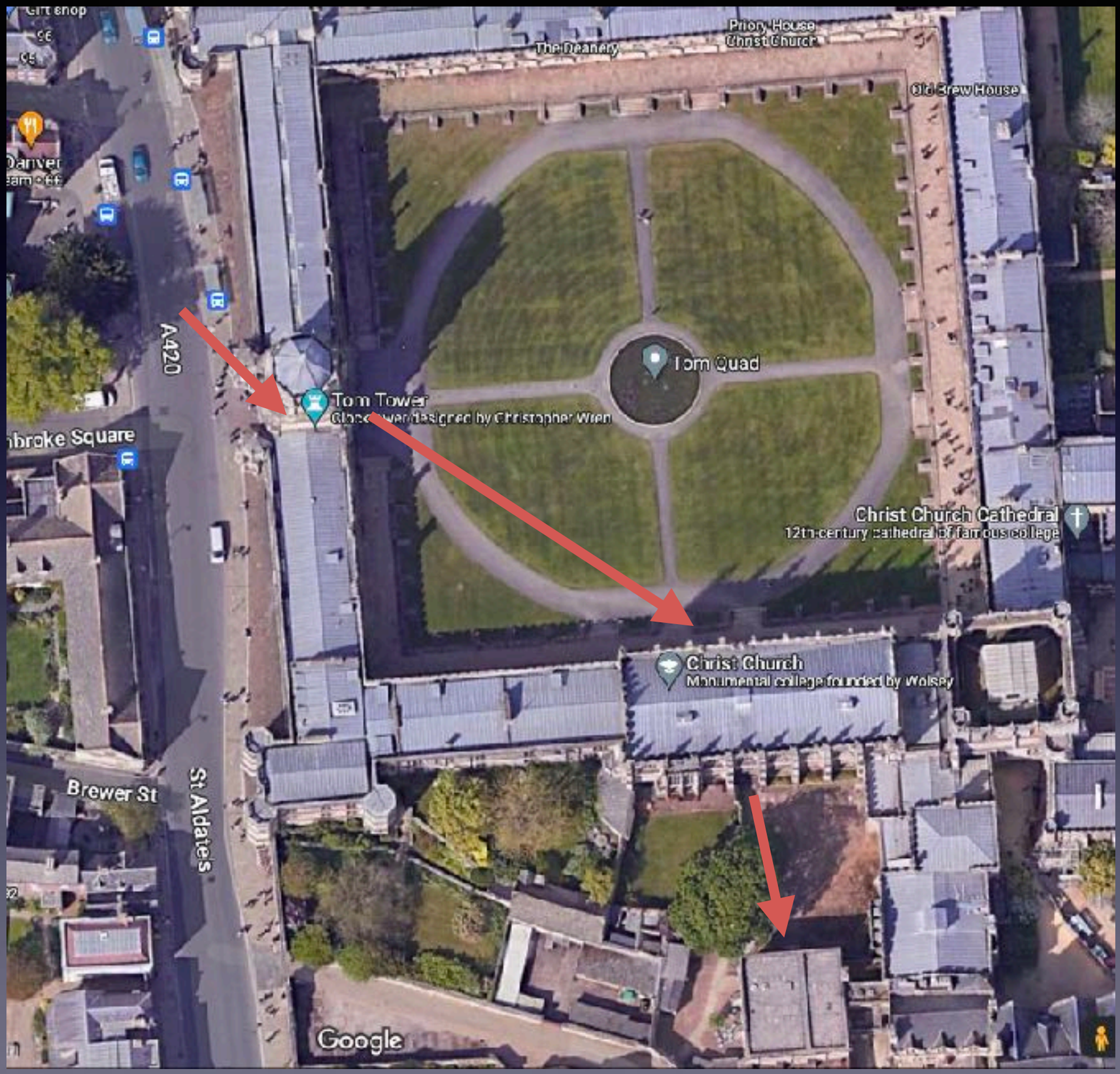
Arrive by 19:30 in the Freind Room



Freind Room, Lee Building

The Vera C. Rubin Observatory and the Legacy Survey of Space and Time (LSST)

Slides from LSST:UK consortium

Project scientist : Stephen Smartt (University of Oxford and Queen's University Belfast)
Project Lead : Bob Mann (University of Edinburgh)

Legacy Survey of Space and Time (LSST)

LSST:UK Consortium

Starting points :

https://www.lsst.org

https://www.lsst.ac.uk

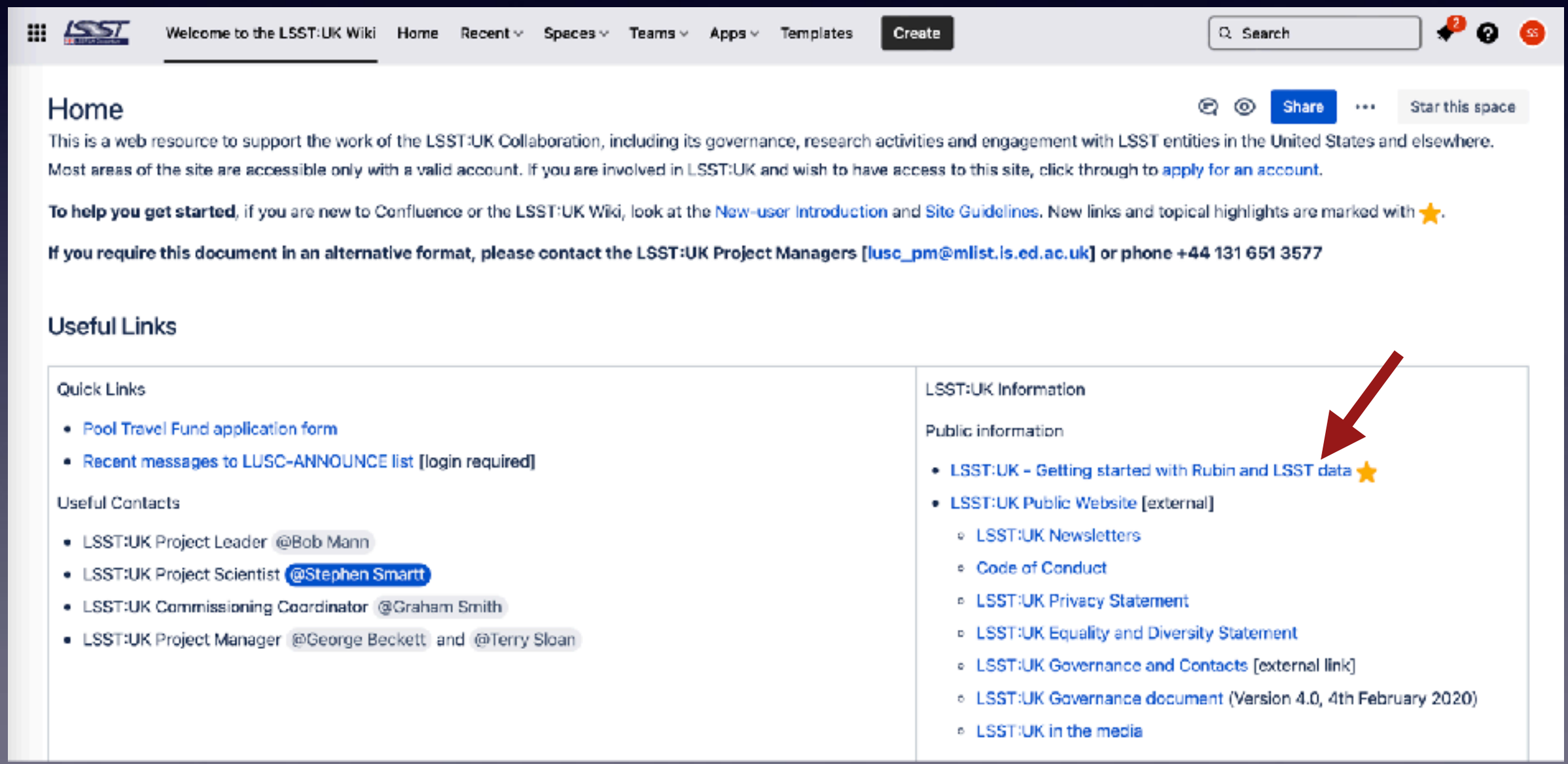
https://lsst-uk.atlassian.net

Timescales reviewed and last updated : 12th August 2023

Your (probable) first questions

- When will Rubin start science operations ?
- When will commissioning and science verification (or “early science”) start and will there be alerts ?
- What will be the cadence and survey strategy be ?
- What data will I get in the alerts ?
- How will I access the alert data ?

https://lsst-uk.atlassian.net



Construction progress : as of August 2023

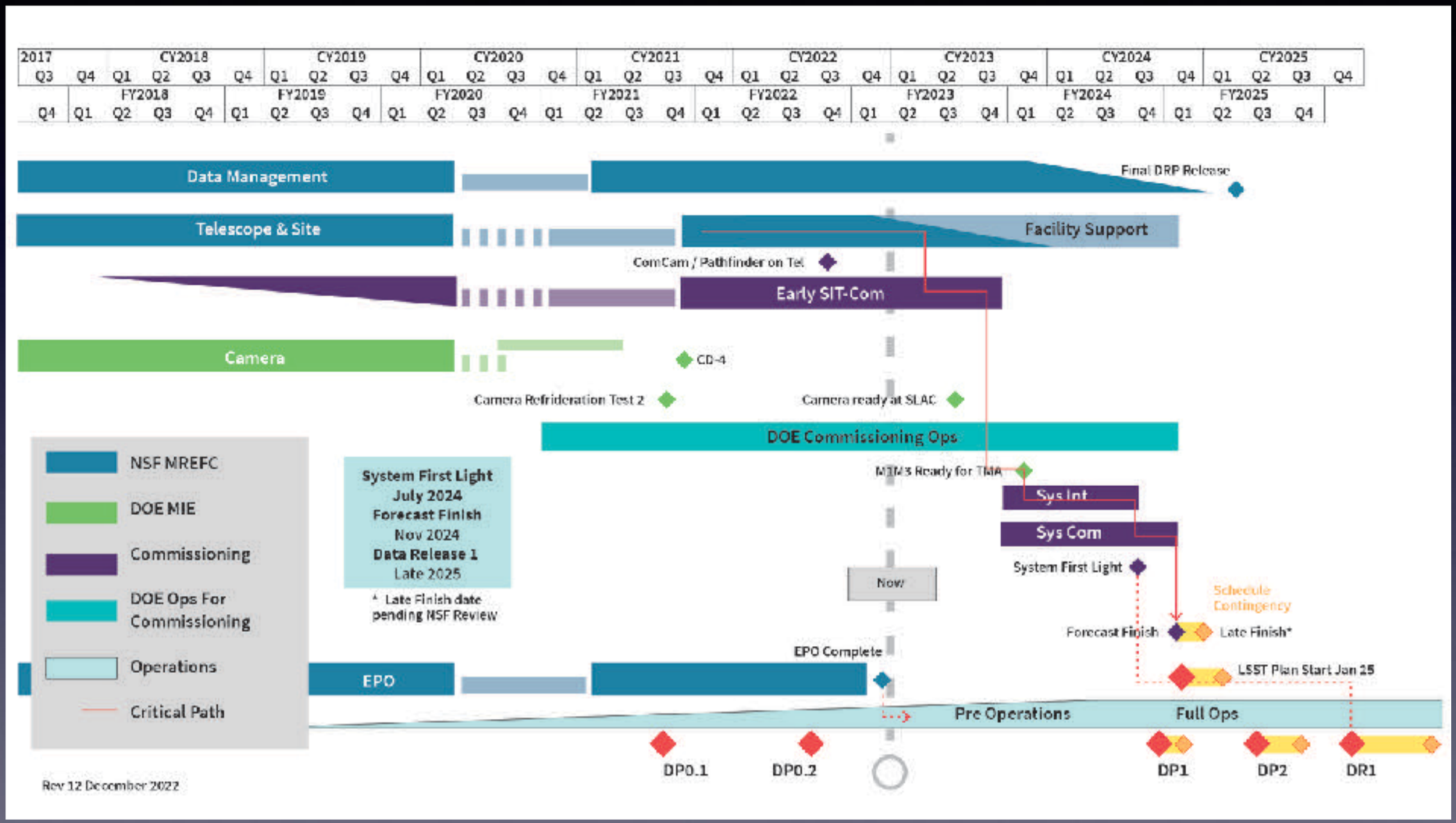
Projected start of science operations:
1st quarter 2025

Image credit: Rubin Observatory

Image taken 20th July 2023

Rubin schedule

Projected science operation start January 2025



Monthly updates (including diagram updates) :
https://www.lsst.org/about/project-status

Official timeline on Rubin webpages

Select Milestones

There are no changes to the Project completion forecast this month. The team has managed all emerging issues without schedule impacts to the overall Project.

Due	Name
30-Sep-2022	EPO Construction Finish (Completed 30-Sep-2022)
31-Mar-2023	TMA Handoff to Rubin (Completed 31-Mar-2023)
20-Oct-2023	COMP: Camera Pre-Ship Review at SLAC
29-Apr-2024	Dome Complete
30-Apr-2024	Camera Ready for Full System AI&T
13-Jun-2024	3-Mirror Optical System Ready for Testing
24-Jul-2024	LSSTCam Ready for On Sky (First Photon)
01-Nov-2024	System First Light with LSSTCam
27-Feb-2025	Test report: Final Pipelines Delivery
27-Feb-2025	COMP: Science Validation Surveys Complete
06-Mar-2025	Operation Readiness Review Complete

Using June 2023 project controls data.

Major Milestone : science validation follows

+4 months

+6 months later, survey starts

When will live alerts be released ?

- The first data preview release (DP1, for details see http://ls.st/rtn-011, which is currently under revision), based on a subset of images supporting the System First Light milestone: 2-3 months after System First Light
- The LSST Survey start: 4-7 months after System First Light. Some "near-live" alerts are planned around the time of the LSST Survey start, and then alert production is planned to increase smoothly to "live" during the early months of the LSST Survey, covering more regions over time as the static-sky templates are built up.
- Data Preview 2 (DP2): 9-12 months after System First Light
- Data Release 1 (DR1): 12-14 months after LSST Survey start

"Near-live" alerts 4-7 months after System First Light, which means Feb - June 2025.

When will data arrive ?

Two useful Rubin documents which are continually updated :

Release Scenarios for Rubin - LSST Commissioning and Survey data
Marshall et al. RDO-11
https://docushare.lsstcorp.org/docushare/dsweb/Get/RDO-11

Rubin Observatory Plans for an Early Science Program
Guy et al. RTN-11
https://rtn-011.lsst.io/

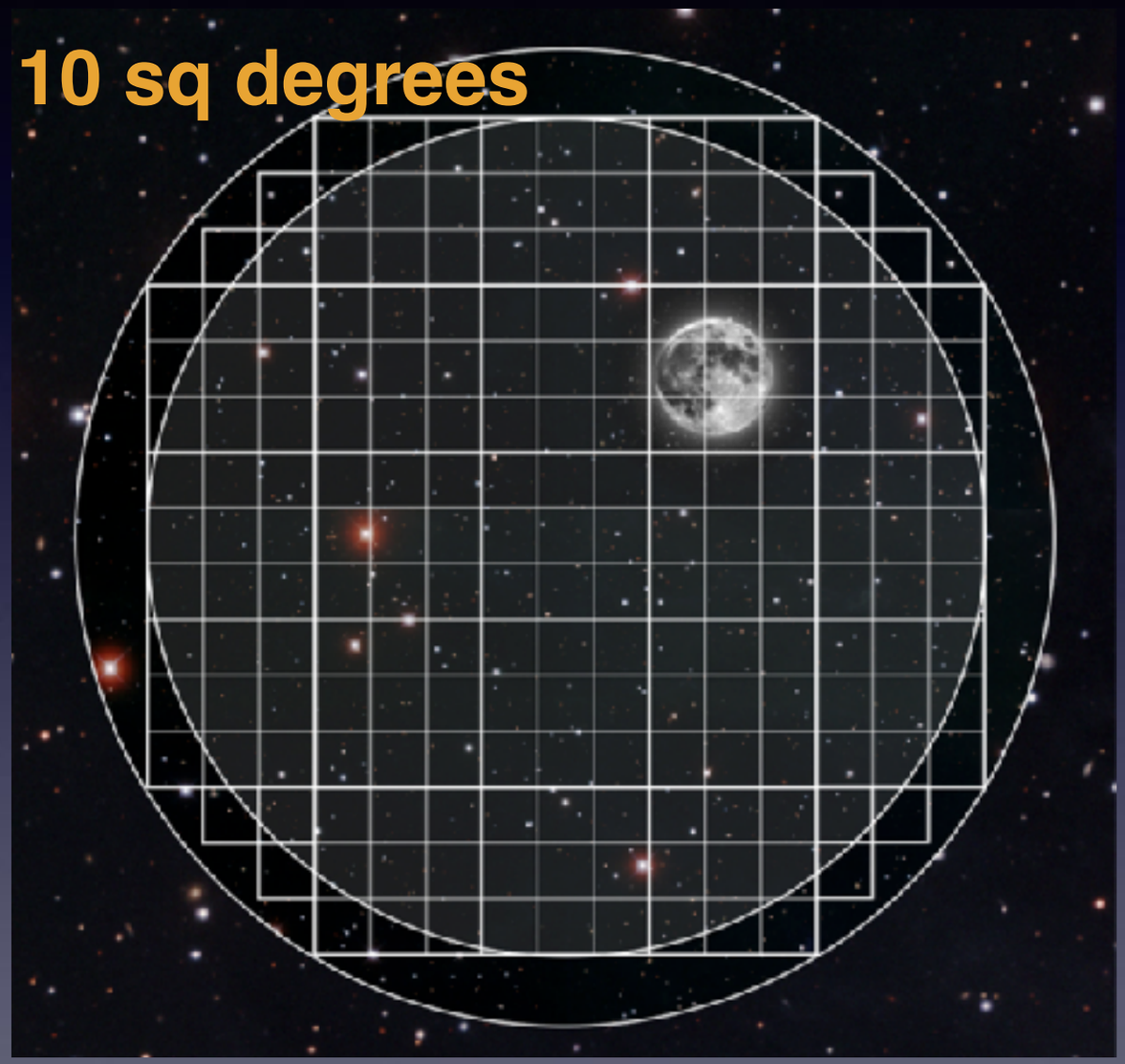
Live transients start

Guy et al. Table 1

Rubin Early Data Release Scenario	Jun 2021	Jun 2022	Jun 2023 - Sep 2023	Dec 2024 - Apr 2025	Aug 2025 - Mar 2026	Feb 2026 - Nov 2026	Feb 2027 - Nov 2027	Feb 2028 - Sep 2028	Feb 2029 - Sep 2029
	DP0.1	DP0.2	DP0.3	DP1	DP2	DR1	DR2	DR3	DR4
Data Product	DC2 Simulated Sky Survey	Reprocessed DC2 Survey	Solar System PPDB Simulation	First Light LSSTCam Data	LSSTCam Science Validation Data	LSST First 6 Months Data	LSST Year 1 Data	LSST Year 2 Data	LSST Year 3 Data
Raw images	✓	✓		✓	✓	✓	✓	✓	✓
DRP Processed Visit Images and Visit Catalogs	✓	✓		✓	✓	✓	✓	✓	✓
DRP Coadded Images	✓	✓			✓	✓	✓	✓	✓
DRP Object and ForcedSource Catalogs	✓	✓			✓	✓	✓	✓	✓
DRP Difference Images and DIASources		✓			✓	✓	✓	✓	✓
DRP ForcedSource Catalogs including DIA outputs		✓			✓	✓	✓	✓	✓
PP Processed Visit Images						✓	✓	✓	✓
PP Difference Images						✓	✓	✓	✓
PP Catalogs (DIASources, DIAObjects, DIAForcedSources)					✓	✓	✓	✓	✓
PP SSP Catalogs			✓		✓	✓	✓	✓	✓
DRP SSP Catalogs						✓	✓	✓	✓

Where to point and when ?

- Rubin Observatory
  - *8m telescope (6.5 m clear aperture) on Cerro Pachon, Chile*
  - *3.5 gigapixel camera, impressive detector quality*
  - *Real time alert stream and multi-colour deep image of the sky*



- ***Science Requirements***
  - *18,000 square degrees observed 825 times over 10 yrs*
  - *Multi-Colour deep image of southern sky*
  - *Parallax and proper motion precision requirements*
  - *Rapid revisit timescale requirements*

Cadence problem in a nutshell:
Can do all southern, visible sky once per night : but we need 2 visits and we have 6 filters
Average return time (in same filter) would be 2 x 6 = 12 days

Multi-colour and deep

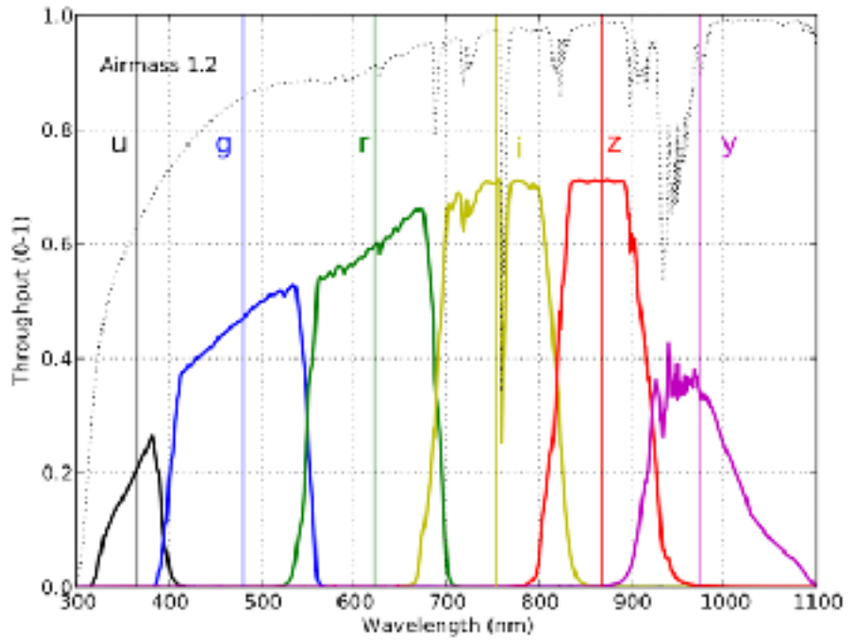


Figure 4. The LSST bandpasses. The vertical axis shows the total throughput. The computation includes the atmospheric transmission (assuming an airmass of 1.2, dotted line), optics, and the detector sensitivity.

	5σ single visit	10 yr depth
u	23.9	26.1
g	25.0	27.4
r	24.7	27.5
i	24.0	26.8
z	23.3	26.1
y	22.1	24.9

I think these are optimistic !
VLT r ~ 24 in 30 sec
0.5 moon, AM=1.3, IQ <1”

Ivezić et al: http://arxiv.org/pdf/0805.2366.pdf

LSST Alerts - Key numbers

Goal is 60 seconds to send an alert. Every 60 seconds the following tables give an idea of number of alerts and their types that will be released.

Alert numbers : per visit

Type	Extragalactic (80% of sky)	Galactic (20% of sky)
Movers	3000	3000
Stars	1800	30000
AGN	70	70
Supernovae and extragalactic transients	200	200

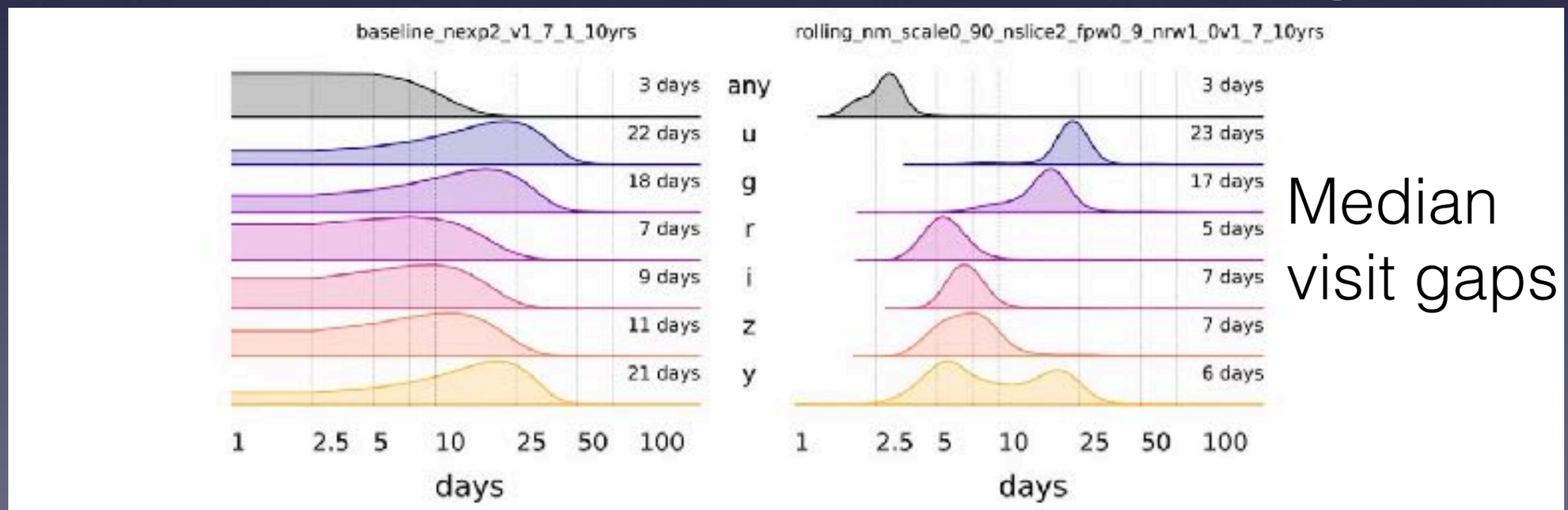
~80,000 extragalactic transient detections per night
~ 2,000 new discoveries per night
(Could be ~500 if I scale to measured VLT sensitivity)

Melissa Graham's "LSST Alerts - Key numbers" https://dmtn-102.lsst.io/DMTN-102.pdf
https://lsst-uk.atlassian.net/wiki/spaces/LUSC/pages/882409581/Summary+of+alert+data

LSST Observing sequence and cadence

- Observe a camera footprint with 2x15 second exposures, taken back-to-back (they are called “snaps”. They will be co-added automatically to make a 30 second image, allowing cosmic ray mitigation
- Come back on the same night, about 30mins later, and observe *exactly* the same footprint. Still to be decided if the 2nd visit will be in the same filter as the 1st or a suitable different pair (e.g. ***g+r, i+z*** …. ***u*** and ***y*** would not be paired of course*)*

When does LSST revisit this footprint again ?



Median visit gaps

Figure 2. Distribution of median internight visit gaps (the time elapsed between visits to the same field in different nights) at a given location in the sky for two simulated LSST OpSim strategies: `baseline_nexp2_v1.7.1_10yrs` (left) and `rolling_nm_scale0.90_nslice2_fpw0.9_nrw1.0v1.7_10yrs`

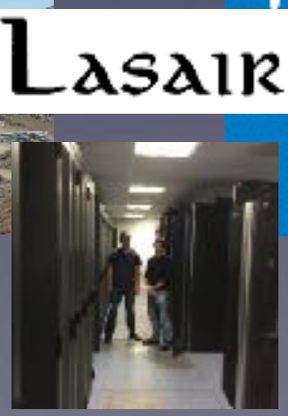
Bianco et al. 2022: Optimisation of the Observing Cadence for Rubin

Summary: Rubin and LSST for all

- Beginning 2025, the LSST by the Rubin observatory will change the landscape
- Very deep images of the sky, plus time domain survey of unprecedented depth

- Data are available to all with data rights - we hope for all UK scientists
- The alert data are world-wide public
- Scientists can work alone, in their own teams, or within Science Collaborations (everyone has equal data rights)

- LSST data combined with ESO follow-up puts UK in strong position



Lasair

4MOST

NTT+SOXS

VLT

ELT

Lasair scalable architecture