Rubin Galaxies Science Collaboration

Simona Mei

LSST France June 2025

LSST Galaxies Science Collaboration

Scientific goals

Co-chairs: Simona Mei and Sugata Kaviraj

Number of members: ~370 (new members are very welcome, no requirements on time commitment)
Regular activities: monthly telecons, face-to-face meetings, LSB WG challenges
Core goal: perform extra-galactic science over ~90% of cosmic time

Main advances expected from LSST:

- **Revolutionary statistics** across full spectrum of extra-galactic studies
- Vast **discovery space in the 'low-surface-brightness' regime** (e.g. dwarfs outside local group, intra-cluster light, faint galaxy outskirts, tidal features)
- **Statistical studies of rare and/or extreme objects** (e.g. starbursts, massive high-z systems) especially when combined with IR surveys
- **Intersection with computer science** will drive **new technologies** (e.g. machine learning) for big data astrophysics: **galaxy classification, properties; large scale structure; cluster detection/environment**.

http://tinyurl.com/lsstgalaxies

https://tinyurl.com/lsstgalaxies

LSST Galaxies Science Collaboration

Roadmap

Large Synoptic Survey Telescope
Galaxies Science Roadmap

Robertson, Brant E.[1], Banerji, Manda[2], Cooper, Michael C.[3], Davies, Roger[4], Driver, Simon P.[5], Ferguson, Annette M. N.[6], Ferguson, Henry C.[7], Gawiser, Eric[8], Kaviraj, Sugata[9], Knapen, Johan H.[10,11], Lintott, Chris[4], Lotz, Jennifer[7], Newman, Jeffrey A.[12], Norman, Dara J.[13], Padilla, Nelson[14], Schmidt, Samuel J.[15], Smith, Graham P.,[16], Tyson, J. Anthony[15], Verma, Aprajita[4], Zehavi, Idit[17], Armus, Lee[18], Avestruz, Camille[19], Barrientos, L. Felipe[14], Bowler, Rebecca A. A.[4], Bremer, Malcolm N.[20], Conselice, Christopher J.[21], Davies, Jonathan[22], Demarco, Ricardo[23], Dickinson, Mark E.[13], Galaz, Gaspar[14], Grazian, Andrea[24], Holwerda, Benne W.[25], Jarvis, Matt J.[4,26], Kasliwal, Vishal[27,28,29], Lacerna, Ivan[30,14], Loveday, Jon[31], Marshall, Phil[32], Merlin, Emiliano[24], Napolitano, Nicola R.[33], Puzia, Thomas H.[14], Robotham, Aaron[5], Salim, Samir[34], Sereno, Mauro[35], Snyder, Gregory F.[7], Stott, John P.[36], Tissera, Patricia B.[37], Werner, Norbert[38,39,40], Yoachim, Peter[41], Borne, Kirk D.[42], and Members of the LSST Galaxies Science Collaboration

[1]*Department of Astronomy and Astrophysics, University of California, Santa Cruz, Santa Cruz, CA 96054, USA,* [2]*Institute of Astronomy, Kavli Institute for Cosmology, University of Cambridge, Madingley Road, Cambridge CB30HA, UK,* [3]*Department of Physics and Astronomy, University of California, Irvine, 4129 Frederick Reines Hall, Irvine, CA 92697, USA,* [4]*Department of Physics, University of Oxford, Denys Wilkinson Building, Keble Rd., Oxford, OX1 3RH, UK,* [5]*International Centre for Radio Astronomy Research (ICRAR), University of Western Australia, Perth, Australia, WA 6009, Australia,* [6]*Institute for Astronomy, University of Edinburgh, Royal Observatory, Blackford Hill, Edinburgh, EH9 3HJ, UK,* [7]*Space Telescope Science Institute, 3700 San Martin Drive, Baltimore MD 21218, USA,* [8]*Rutgers University, 136 Frelinghuysen Rd., Piscataway, NJ 08854-8019, USA,* [9]*Centre for Astrophysics Research, University of Hertfordshire, College Lane, Hatfield, Herts AL10 9AB, UK,* [10]*Instituto de Astrofísica de Canarias, E-38200 La Laguna, Spain,* [11]*Departamento de Astrofísica, Universidad de La Laguna, E-38206 La Laguna, Spain,* [12]*Department of Physics and Astronomy and PITT PACC, University of Pittsburgh, 3941 O'Hara St., Pittsburgh, PA 15260, USA,* [13]*NOAO, 950 N. Cherry Ave, Tucson, AZ 85719, USA,* [14] *Instituto de Astrofísica, Pontificia Universidad, Católica Chile, Vicuña Mackenna 4860, Santiago, Chile,* [15]*Department of Physics, University of California, Davis, One Shields Ave, Davis, CA, 95616, USA,* [16]*School of Physics and Astronomy, University of Birmingham, Edgbaston, B15 2TT, UK,* [17]*Department of Astronomy, Case Western Reserve University, 10900 Euclid Avenue, Cleveland, OH 44106, USA,* [18]*IPAC/Caltech, 1200 E. California Blvd. MS314-6, Pasadena, CA 91125, USA,* [19]*Kavli Institute for Cosmological Physics, University of Chicago, 5640 South Ellis Ave., Chicago, IL 60637, USA,* [20]*H.H. Wills Physics Laboratory, University of Bristol, Tyndall Avenue, Bristol, BS8 1TL, UK,* [21]*School of Physics and Astronomy, University of Nottingham, Nottingham, NG7 2RD, UK,* [22]*Cardiff University, School of Physics and Astronomy, The Parade, Cardiff, CF22 3AA, UK,* [23]*Departamento de Astronomía, Universidad de Concepción,Casilla 160-C, Concepción, Chile,* [24]*INAF - Osservatorio Astronomico di Roma, Via Frascati, 33, I-00078, Monte Porzio Catone (Roma), Italy,* [25]*Department of Physics and Astronomy, 102 Natural Science Building, University of Louisville, Louisville KY 40292, USA,* [26]*Department of Physics, University of the Western Cape, Bellville 7535, South Africa,* [27]*Colfax International, 750 Palomar Avenue, Sunnyvale, CA 94085, USA,* [28]*University of Pennsylvania, Department of Physics & Astronomy, 209 S 33rd St, Philadelphia, PA 19104, USA,* [29]*Princeton University, Department of Astrophysical Sciences, 4 Ivy Lane, Princeton, NJ 08544, USA,* [30]*Instituto Milenio de Astrofísica, Av. Vicuña Mackenna 4860, Macul, Santiago, Chile,* [31]*Astronomy Centre, University of Sussex, Falmer, Brighton, BN1 9QH,*

Robertson +17, ArXiv:1708.01617

Robertson +19, Nature Rev. Phys, 1, 450

https://tinyurl.com/lsstgalaxies

LSST Galaxies Science Collaboration

Organisational structure

Working groups

Active galactic nuclei (James Mullaney)

Galaxy environment (TBD)

Galaxy morphology (Garreth Martin and Jeyan Kartaltepe)

Low-surface-brightness science (Mireia Montes and Aaron Watkins)

SED-fitting and photometric techniques (Sam Schmidt and Rebecca Bowler)

Strong lensing (Aprajita Verma)

Survey strategy (H Ferguson, B Holwerda, B Robertson and D Burgarella)

Committee members and liaisons

In-kind operations managers - Brant Robertson and Pierre-Alain Duc

Contributions Evaluation Committee representatives - Manda Banerji and Brant Robertson

Survey cadence optimisation committee liaison – Louise Edwards

Rubin-Euclid WG - Manda Banerji

Data management liaison - Dan Taranu

Commissioning liaison - Lee Kelvin

DEI council – Manda Banerji

https://tinyurl.com/lsstgalaxies

LSST Galaxies Science Collaboration

CURRENT MAIN DISCUSSIONS

1. New proposition for the Science Validation coverage

2. The DP1 release on June 30th

LSST Galaxies Science Collaboration

SCIENCE VALIDATION

Pilot observations for the Science Validation (SV) surveys could begin as soon as mid-June 2025, and would continue through September. The project envision a "soft start" to SV surveys, beginning with pilot observations of a few hours per night interleaved with other engineering activities, and gradually increasing the duty cycle for SV survey observations

SITCOMTN-005 and Rubin Observatory Plans for an Early Science Program (RTN-011) describe a baseline SV survey concept, however we recently had a new coverage proposition

LSST Galaxies Science Collaboration

SCIENCE VALIDATION UPDATED PLANS

The Rubin Science Collaborations were solicited to give feedback on new propositions for the SV fields.

The project plans to release an updated version of Rubin Observatory Plans for an Early Science Program (RTN-011) that includes information on the recommended SV survey design. This plan may evolve over the course of the remainder of commissioning. The idea is to (1) verify construction completeness; (2) demonstrate operation readiness; (3) optimize early science and data management

LSST Galaxies Science Collaboration

BASELINE SV DESIGN

Interleave Deep and Wide survey components (minimum 30 nights) from SITCOMTN-005:

Deep: ~100 deg^2 *ugrizy* to 10 yr LSST Wide Fast Deep (WFD) equivalent depth → then increase depth

- Optimized for testing coadds at LSST 10-year survey full depth

Wide: ~1000 deg^2 *griz* to 1-2 yr LSST WFD equivalent depth → then increase area

- Optimized for testing alerts at survey scale, both infrastructure and science validation

LSST Galaxies Science Collaboration

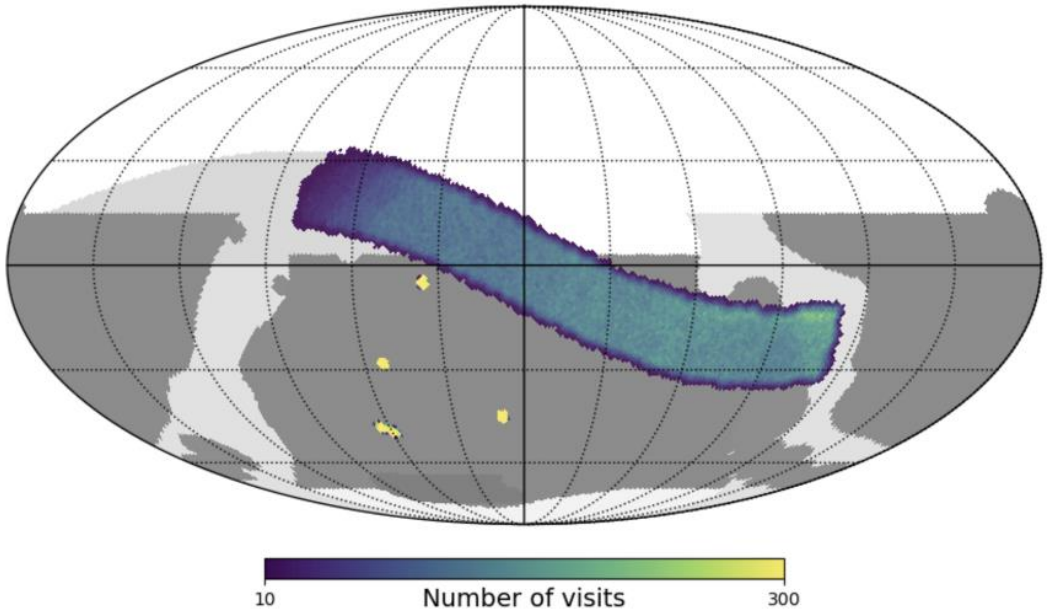
Enhanced SV Survey Design Candidate

Deep: LSST DDFs (total ~60 deg^2) in *ugrizy*

South Galactic cap DDFs visible in July-September (ELAIS_S1, XMM_LSS, ECDFS, and EDFSa + EDFSb)

Wide: LSST Year 1 WFD in *ugrizy* constrained to a region around the ecliptic, e.g., ±10 deg

The actual volume of delivered science-grade data from the SV surveys might be a fraction of the design



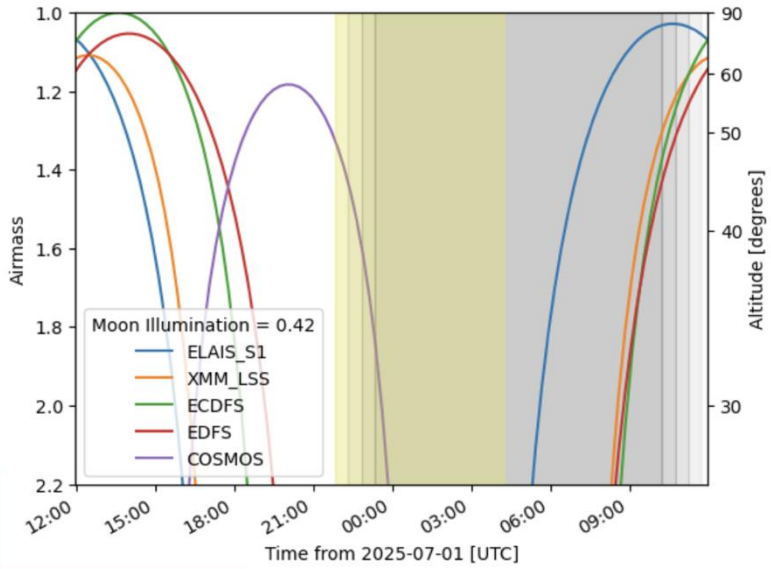
From Keith Bechtol's presentation to the SC chairs

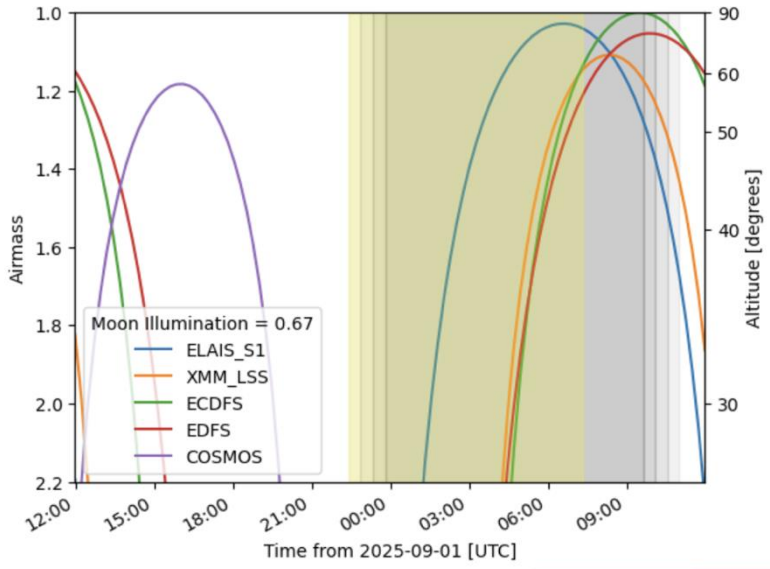
LSST Galaxies Science Collaboration

VISIBITY OF THE LSST Deep Drilling Fields

Visibility of LSST Deep Drilling Fields

Only one out of the four LSST DDFs located in the south Galactic cap is visible by early July. All four become visible for more of the night by September.





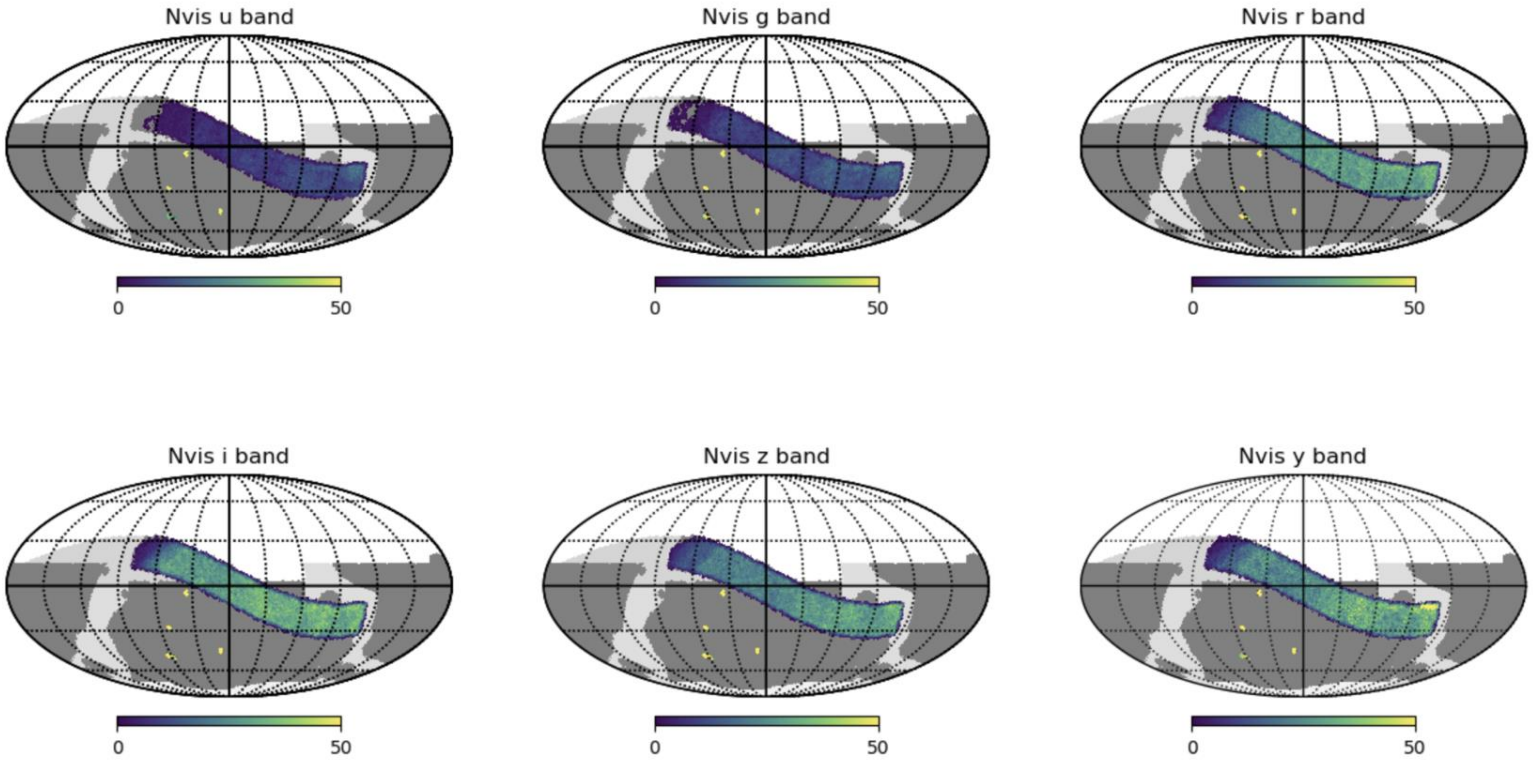
From Keith Bechtol's presentation to the SC chairs

LSST Galaxies Science Collaboration

Enhanced SV Survey Design visits

Median number visits per band
u 8
g 10
r 24
i 28
z 23
y 24

Comparable to LSST Year 1 in Wide component



From Keith Bechtol's presentation to the SC chairs

LSST Galaxies Science Collaboration

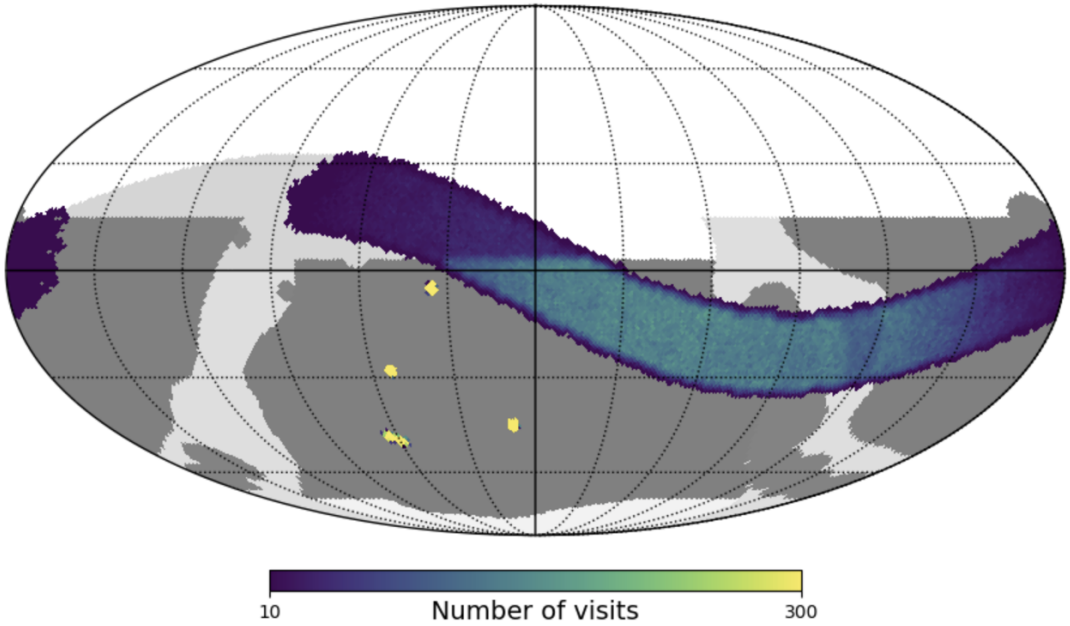
Enhanced SV Survey Design Variant

No constraint on RA for Wide component (i.e., would wrap around the sky if continued for a full year)

Baseline survey footprint, including *griz* only in North Ecliptic Spur and fewer visits in dusty Galactic plane

This variant yields wider area template coverage from Wide component, but has fewer visits per band

LSST DDFs are largely unchanged



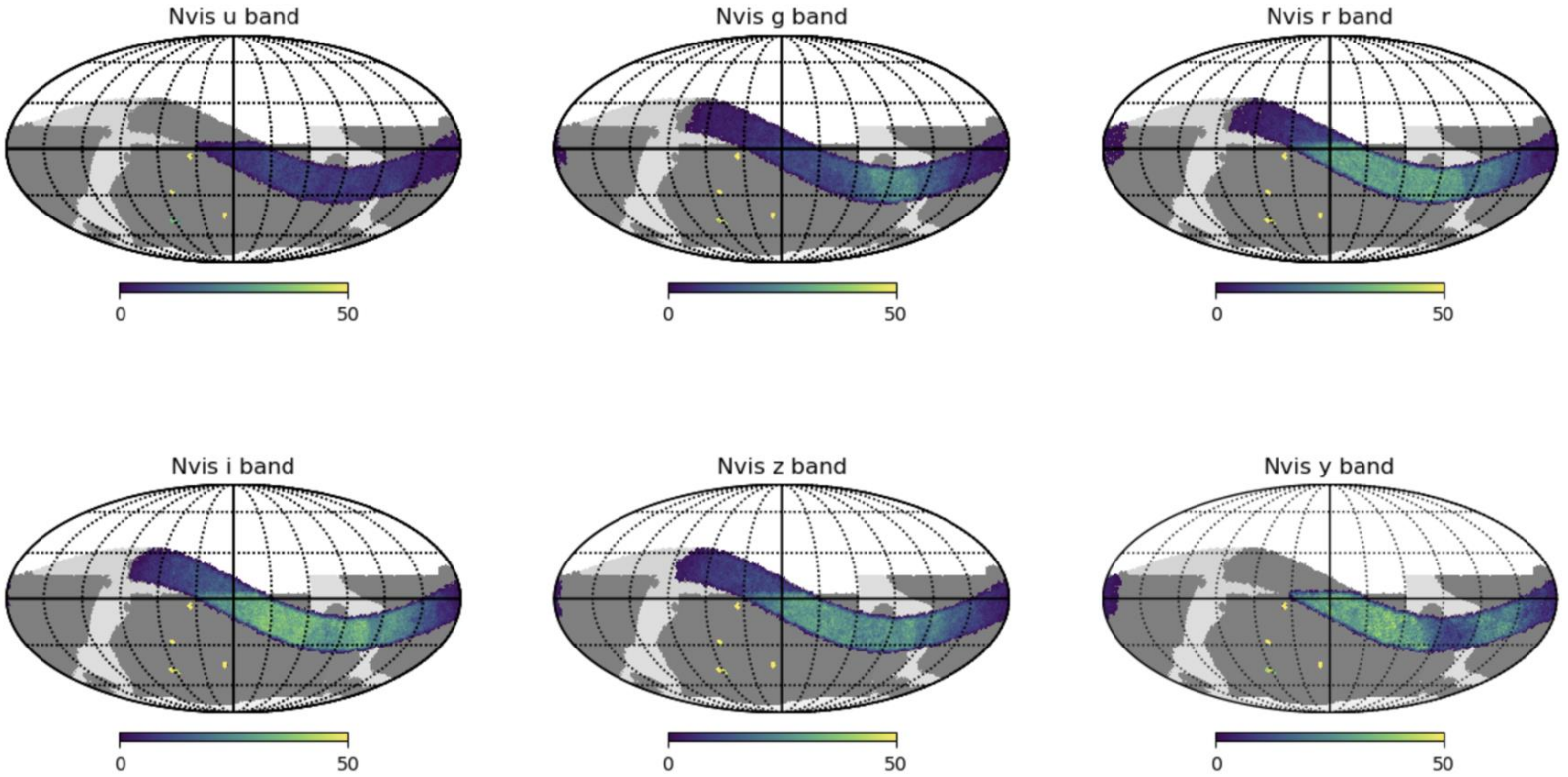
From Keith Bechtol's presentation to the SC chairs

LSST Galaxies Science Collaboration

Enhanced SV Survey Design Variant visit

Median number visits per band
u 7
g 7
r 12
i 17
z 13
y 18

Comparable to LSST Year 1 in Wide component



From Keith Bechtol's presentation to the SC chairs

LSST Galaxies Science Collaboration

OUR SC RECOMMENDATIONS

- In general, we strongly support the first proposition in your presentation: the "Enhanced SV Survey Design Candidate" compared to the other variants. We have a general preference for fewer visits on the Galactic plane, which is highly contaminated by dust (not ideal for extragalactic science), and a recommendation to increase depth in dust-free areas.

- We recommend observing all the Rubin Deep Drilling Fields to a ~10-year depth and in all bandpasses. Our top priorities are the Euclid Deep Field South, Cosmos, and XMM-LSS. The latter field is equatorial and has more than 100,000 redshifts available from DESI.

LSST Galaxies Science Collaboration

OUR SC RECOMMENDATIONS

- Low Surface Brightness (LSB) science is very important for our SC. The RA constraint works best for us to obtain observations of the Stripe 82 and the Abell 194 cluster in which already known LBS objects will permit us to optimize our algorithms. A key point for our collaboration is to maximize the dither size for both the DDF and the wide area, with the goal of preserving the signature of the extended LSB features after background subtraction.

LSST Galaxies Science Collaboration

DP1 release

- DP1 release on June 30th DP1 will contain approximately 2000 exposures in seven fields taken during the LSSTComCam on-sky commissioning campaign.

- We will have a presentation on the DP1 release at our next telecon on June 26th

- Participation to the Rubin DP1 Data Academy on June 30th - July 3rd - Interactive tutorials and networking sessions for an accelerated learning experience with the Rubin data products, pipelines, and services. Student participation is encouraged. Academy sessions are recorded and linked from the webpage. https://rubinobservatory.org/for-scientists/events-deadlines/events-rda

LSST Galaxies Science Collaboration

DP1 Fields

Table 2: ComCam target fields and pointing centers that are to be included in the DP1 dataset. ICRS coordinates are shared in units of decimal degrees.

Field Code	Field Name	Right Ascension	Declination
		deg	*deg*
47 Tuc	47 Tuc Globular Cluster	6.02	-72.08
Rubin SV 38 7	Low Ecliptic Latitude Field	37.86	6.98
Fornax dSph	Fornax Dwarf Spheroidal Galaxy	40.00	-34.45
ECDFS	Extended Chandra Deep Field South	53.13	-28.10
EDFS	Euclid Deep Field South	59.10	-48.73
Rubin SV 95 -25	Low Galactic Latitude Field	95.00	-25.00
Seagull	Seagull Nebula Seagull	106.23	-10.51

Thanks!