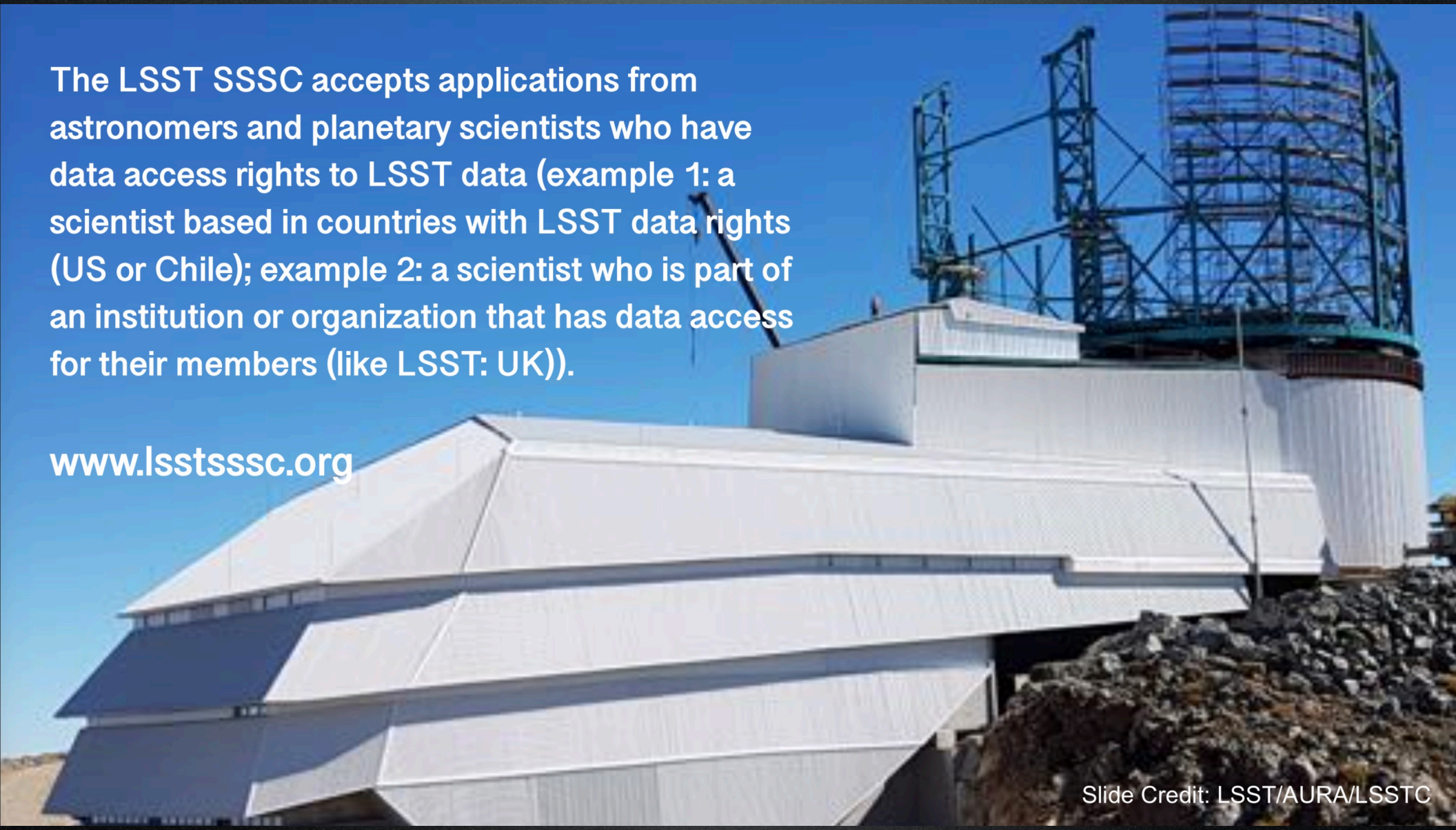
Preparing to Do Solar System Science with LSST

- Difference Imaging (Mario Jurić)
- SSSC Science Preparations Overview (Henry Hsieh)
- Science Update (Siegfried Eggl)
- General Discussion
  - Difference imaging needs/concerns
  - Other science efforts (Snodgrass? Jones?)
  - Software development needs
  - Funding proposals
  - Alerts and alert brokers (Hsieh, on behalf of Trilling et al.)
  - Starlink
  - The Community Observing Strategy Evaluation Paper (COSEP)
  - How SSSC members collaborate (or don't collaborate)



From DPS 2018 update (Schwamb & Trilling)

Revised Data Delivery Schedule

Data Production Milestone	Start Date
First calibration data from Auxiliary Telescope	November 2018
First on-sky and calibration images with ComCam	May 2020
Images from Camera re-verification at Summit Facility	July 2020
Sustained observing with ComCam	August 2020
First on-sky and calibration data from Camera+Telescope	February 2021
Sustained scheduler driven observing with Camera+Telescope	April 2021
Start Science Verification mini-Surveys	June 2021

Slide Credit: Chuck F Claver

From DPS 2018 update (Schwamb & Trilling)

LSST Solar System Science Collaboration (SSSC)

David Trilling & Meg Schwamb
SSSC Co-Chairs

Large Synoptic Survey Telescope
Solar System Science Collaboration

www.lsstsssc.org

Wes Fraser
LSST: UK Solar System POC

Active objects Working Group (Lead: Mike Kelley): broadly consisting of all categories of activity in the minor planet populations: short period comets, long period comets, main belt comets, impact- or rotationally-generated active asteroids,etc

Community software/infrastructure development Working Group (Lead: Henry Hsieh): broadly consisting of people interested in helping build databases, software packages, etc to be used by the Solar System community on LSST data

Inner Solar System Working Group (Lead: Cristina Thomas): broadly consisting of the main belt, Mars/Jupiter Trojans, and Jupiter irregular satellites

NEOs (Near Earth Objects) and Interstellar Objects Working Group (Lead: Steve Chesley): broadly consisting of objects on orbits inward of or diffusing inward from the main belt as well as interstellar objects temporarily residing in the Solar System

Outer Solar System Working Group (Lead: Darin Ragozzine and Matt Holman): broadly consisting of KBOs, Centaurs, Oort cloud, Saturn/Neptune/Uranus Trojans, and Saturn/Neptune/Uranus irregular satellites

From DPS 2018 update (Schwamb & Trilling)

First LSST Solar System Readiness Sprint

July 10-12, 2018

University of Washington, Seattle WA

LSST CORPORATION DiRAC B612 DEPARTMENT OF ASTRONOMY

From DPS 2018 update (Schwamb & Trilling)

From DPS 2018 update (Schwamb & Trilling)

A Software Roadmap for Solar System Science with the Large Synoptic Survey Telescope

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Research Notes of the AAS, Volume 3, Number 3

The 8.4 m Large Synoptic Survey Telescope (LSST) will provide an unprecedented view of the Solar System (Ivezić et al. 2008; LSST Science Collaboration et al. 2009). LSST will detect millions of asteroids and tens of thousands of distant Solar System bodies, within approximately 16 and 24.5 mag (in *r*-band). Over a ten year period, most of these minor planets will receive hundreds of observations divided between 6 filters (*ugrizy*). What specifically LSST project will deliver for Solar System detections will soon be updated in the LSST Data Products Definition Document (DPDD; Jurić et al. 2013). A preliminary version of the new LSST Solar System data products schema is available at http://ls.st/ssd and http://ls.st/oug.

The LSST Solar System Science Collaboration (SSSC; http://www.lsstsssc.org) produced a science roadmap (Schwamb et al. 2018) which outlines the collaboration's highest ranked research priorities utilizing LSST. To achieve these science goals, the SSSC has identified crucial software products and tools that will be required but will not be provided by the LSST project. These will have to be developed by the SSSC and the broader planetary community. To spur this effort, we present below this list of LSST community software development tasks.

1. Community Software Utilities Needed During Year 1 of LSST Operations

1. Tools to extract cutouts from raw, reduced, and deep-stacked LSST images at locations where a specified orbit is predicted to appear, accounting for the uncertainty in the orbital parameters.

Maximizing LSST Solar System Science: Approaches, Software Tools, and Infrastructure Needs

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Abstract. The Large Synoptic Survey Telescope (LSST) is expected to increase known small solar system object populations by an order of magnitude or more over the next decade, enabling a broad array of transformative solar system science investigations to be performed. In this white paper, we discuss software tools and infrastructure that we anticipate will be needed to conduct these investigations and outline possible approaches for implementing them. Feedback from the community or contributions to future updates of this work are welcome. Our aim is for this white paper to encourage further consideration of the software development needs of the LSST solar system science community, and also to be a call to action for working to meet those needs in advance of the expected start of the survey in late 2022.

Table 1: Summary of Software and Infrastructure Needs by Science Area

Software Task	Active[a]	NEOs[b]	ISS[c]	OSS[d]	Notes[e]
1. Orbital parameter computation (B.1)	✓	✓	✓	✓	❗ — 🗗
2. Orbital uncertainty characterization (B.2)	✓	✓	✓	✓	❗ — —
3. Extended object astrometry (B.3)	✓	—	—	—	❗ 📷 —
4. Faint precovery/recovery identification (B.4)	✓	✓	✓	✓	❗ — —
5. Extremely faint object detection (B.5)	✓	✓	✓	✓	🕒 📷 —
6. Advanced moving object detection (B.6)	—	✓	—	✓	❗ — —
7. Phase function characterization (B.7)	✓	✓	✓	✓	🕒 — 🗗
8. Compositional characterization (B.8)	✓	✓	✓	✓	🕒 — 🗗
9. Rotational characterization (B.9)	✓	✓	✓	✓	🕒 — 🗗
10. Multi-object system characterization (B.10)	✓	✓	✓	✓	🕒 📷 —
11. Activity detection (B.11)	✓	✓	✓	—	❗ 📷 —
12. Activity characterization (B.12)	✓	✓	✓	—	❗ 📷 —
13. Outburst and disruption detection (B.13)	✓	✓	✓	—	❗ 📷 —
14. Advanced dynamical characterization (B.14)	✓	—	—	✓	🕒 — —
15. Dynamical clustering identification (B.15)	✓	—	✓	—	🕒 — —
16. Occultation event prediction (B.16)	✓	—	✓	✓	🕒 📷 —
17. Physical property change detection (B.17)	✓	✓	✓	—	📅 — —
18. Dynamical property change detection (B.18)	✓	✓	✓	—	📅 — —
19. System validation (B.19)	✓	✓	✓	✓	🕒 — —
20. Survey debiasing (B.20)	✓	✓	✓	✓	📅 — —
21. Alert and follow-up management (B.21)	✓	✓	—	—	❗ 📷 —
22. External data incorporation (B.22)	✓	✓	✓	✓	❗ — —
23. Data access tools (B.23)	✓	✓	✓	✓	❗ 📷 —

[a] Science roadmap priorities identified for active objects (Appendix C.2)
[b] Science roadmap priorities identified for near-Earth objects (Appendix C.3)
[c] Science roadmap priorities identified for inner solar system objects (Appendix C.4)
[d] Science roadmap priorities identified for outer solar system objects (Appendix C.5)
[e] 📅: low time sensitivity; 🕒: moderate time sensitivity; ❗: high time sensitivity; 📷: requires image data; 🗗: requires ability to compute results from subsets of total LSST data set

Cadence White Papers

- Northern Ecliptic Spur (Schwamb)
  - https://arxiv.org/abs/1812.01149
- Filter Choice Impact on OSS Science (Volk)
  - https://arxiv.org/abs/1812.00937
- Twilight Survey (Seaman)
  - https://arxiv.org/abs/1812.00466
- KBO Deep Drilling Field Search (Trilling)
  - https://arxiv.org/abs/1812.09705
- Enabling Deep All-Sky Searches for OSS Objects (Jurić)
  - https://arxiv.org/abs/1901.08549
- LSST + Euclid (Snodgrass)
  - https://arxiv.org/abs/1812.00607