

LSST Solar System Science Collaboration Update

Meg Schwamb

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@lsstssc



Credit: Gianluca Lombardi

It's Really Coming! Science Operations Start in ~2023
Next 3 years is the time to prepare!



LSST Science Advisory Committee provides a formal, and two-way, connection to the broader external science community served by LSST.

Solar System Representatives:
Meg Schwamb & Amy Mainzer



LSST Solar System Science Collaboration (SSSC)



Meg Schwamb & David Trilling
SSSC Co-Chairs



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: Bryce Bolin): broadly consisting of the main belt, Mars/Jupiter Trojans, and Jupiter irregular satellites



NEOs (Near Earth Objects) and Interstellar Objects Working Group (Lead: Sarah Greenstreet): 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: Michele Bannister): broadly consisting of KBOs, Centaurs, Oort cloud, Saturn/Neptune/Uranus Trojans, and Saturn/Neptune/Uranus irregular satellites



Darin Ragozzine & Gal Sarid
SSSC Publication Coordinators

Co-Chair Elections this Spring

Meg Schwamb re-elected for another 3 year term



Image credit: ratinasock (Carol Raabus) - flickr - <https://www.flickr.com/photos/ratinasock/4447403222/>



September 2019

SSSC Participating in LSST Project Workshop at EPSC-DPS

**Getting Ready for LSST: 5+ million
small bodies, 1+ billion observations**

**Thursday September 19, 2019 1:30–3:15pm, EPSC-
DPS Joint Meeting 2019 , Geneva, Switzerland -
Open to all EPSC-DPS attendees**

Last Year:

Identifying Software Development That Community Will Have To Do: SSSC LSST Software Roadmap

A SOFTWARE ROADMAP FOR SOLAR SYSTEM SCIENCE WITH THE LARGE SYNOPTIC SURVEY TELESCOPE

Megan E. Schwamb,¹ Henry Hsieh,² Michele T. Bannister,³ Dennis Bodewits,⁴ Steven R. Chesley,⁵ Wesley C. Fraser,³
Mikael Granvik,^{6,7} R. Lynne Jones,⁸ Mario Jurić,⁸ Michael S. P. Kelley,⁹ Darin Ragozzine,¹⁰ David E. Trilling,¹¹ and
Kathryn Volk¹²

on behalf of the LSST Solar System Science Collaboration

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<https://doi.org/10.3847/2515-5172/ab0e10>

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 magnitudes (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.

COMMUNITY SOFTWARE UTILITIES NEEDED DURING YEAR 1 OF LSST OPERATIONS

- 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

Henry H. Hsieh^{a,b}, Michele T. Bannister^c, Bryce T. Bolin^{d,e}, Josef Ďurech^f, Siegfried Eggl^d, Wesley C. Fraser^g, Mikael Granvik^{h,i}, Michael S. P. Kelley^j, Matthew M. Knight^j, Rodrigo Leiva^k, Marco Micheli^{l,m}, Joachim Moeyens^d, Michael Mommertⁿ, Darin Ragozzine^o, Cristina A. Thomas^p

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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.

Collaboration Publication Policy was accepted by unanimous vote in May 2019



http://lsst-sssc.github.io/publication_policy.html

Image credit: - flickr - <https://coffee-channel.com>

Publication Coordinators

- Guide manuscripts through the collaboration publication policy process
 - See: https://lsst-sssc.github.io/publication_policy.html
- Maintain SSSC lists:
 - Architects members and an accessible public version
 - Proprietary SSSC Community Products
 - Ensure SSSC has access and is kept updated
- Key points:
 - Anyone can work on any project, nothing is “owned”
 - Mandatory when proprietary SSSC Community Products are used; recommended otherwise
 - Architects and Builders can request co-authorship
 - 1-2 weeks review time required



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2020: SSSC Architects Form

SSSC Architects are members whose efforts are acknowledged to have laid the groundwork for LSST Solar System science and/or made notable contributions to the collaboration that significantly enhance or enable Solar System science with LSST.















Required:

- * Direct benefit to the SSSC.
- * 1-2 years of dedicated effort, or equivalently significant contribution.
- * Nomination (self or by other members) through this form.

Nomination form linked to: http://lsst-sssc.github.io/publication_policy.html

2020: Note Sent to Data Management about Template Generation in Rubin Observatory Year 1 Operations

Opportunities for High Impact Solar System Science During Year 1 of the Legacy Survey of Space and Time (LSST)

Megan E. Schwamb ¹ Mario Jurić ² Bryce T. Bolin ^{3,4} Luke Dones ⁵ Sarah Greenstreet ^{6,2} Henry H. Hsieh ^{7,8}
Laura Inno ⁹ R. Lynne Jones ^{10,11} Michael S. P. Kelley ¹² Matthew M. Knight ^{13,14} William T. Reach ¹⁵
Tom Seccul ¹⁶ Colin Snodgrass ¹⁷ And David E. Trilling ¹⁸
for the LSST Solar System Science Collaboration

2020: International In-Kind Contributions



The science collaborations are giving formal feedback to the Rubin Observatory with the CEC (in-kind Contribution Evaluation Committee)

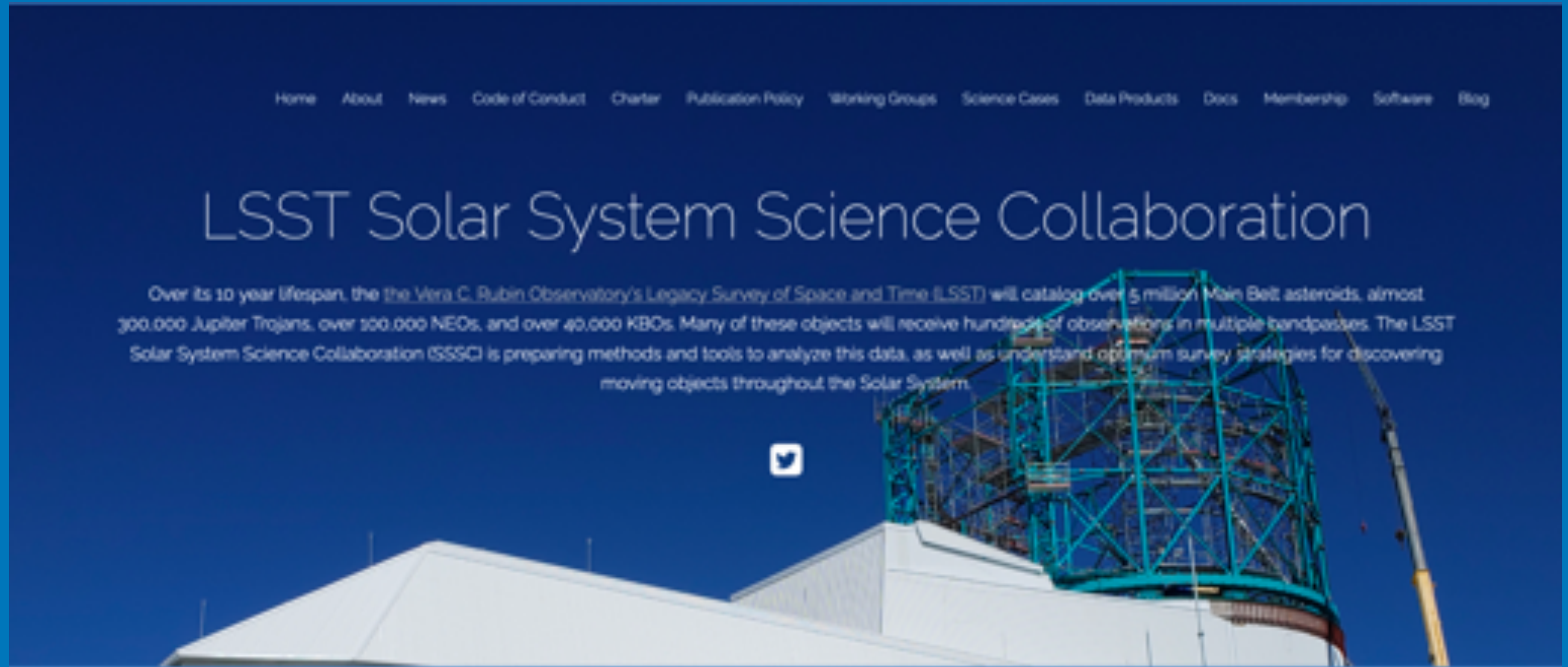
SSSC CEC Representative: Meg Schwamb
Alternate SSSC CEC Representative: David Trilling

International groups have contacted the SSSC for informal feedback on proposed in-kind contribution ideas (Organized by working group leads)

Image Credit: NASA/DISCOVER

<https://www.lsst.org/news/data-rights-and-funding-lsst-operations>

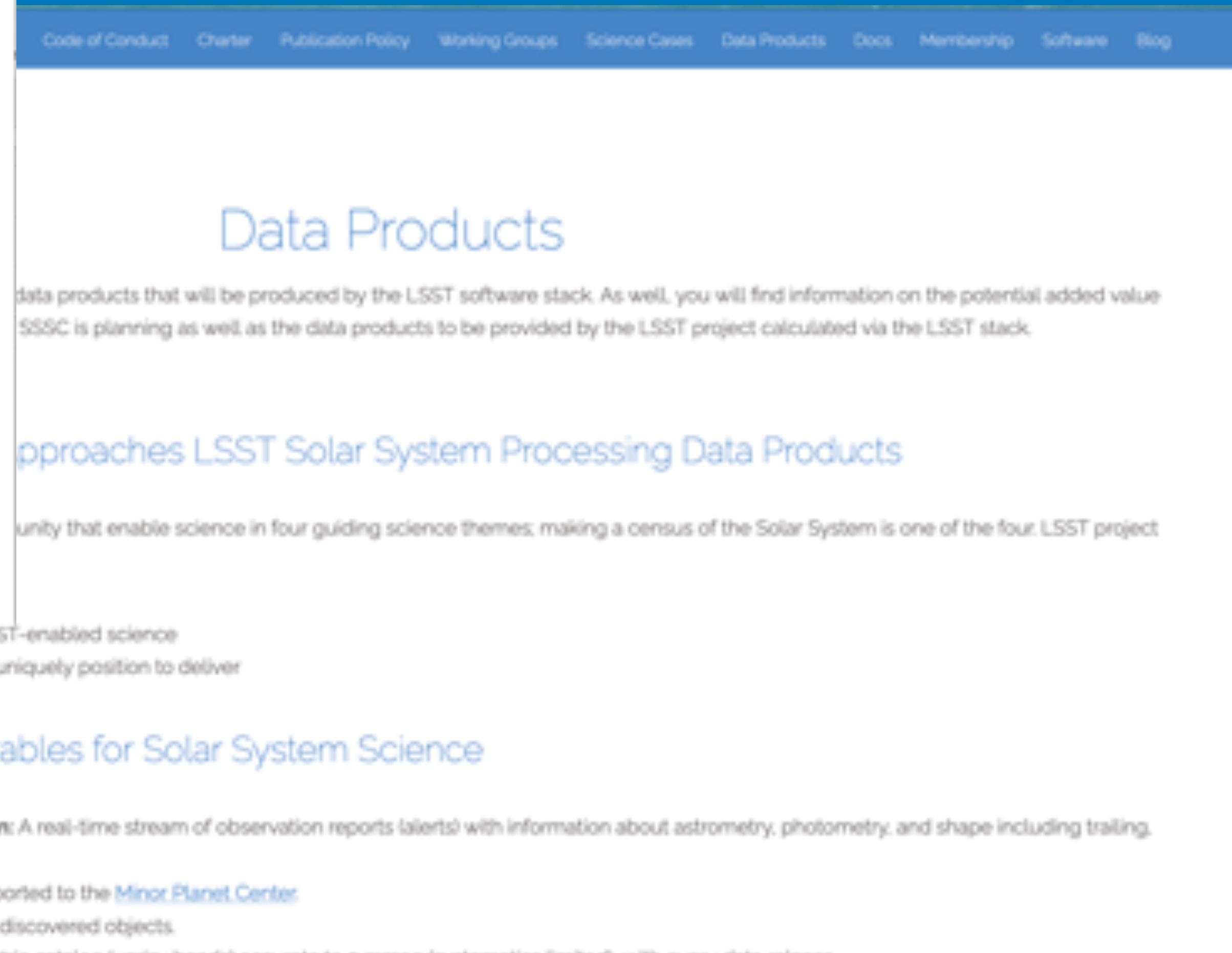
What is the SSSC doing for early career researchers?



www.lsstsssc.org

What is the SSSC doing for early career researchers?

Maintaining and updating the SSSC website with content



New About page,
Data Products page,
updated Software page

What is the SSSC doing for early career researchers?



2018 LSST Solar System Readiness Sprint in Seattle

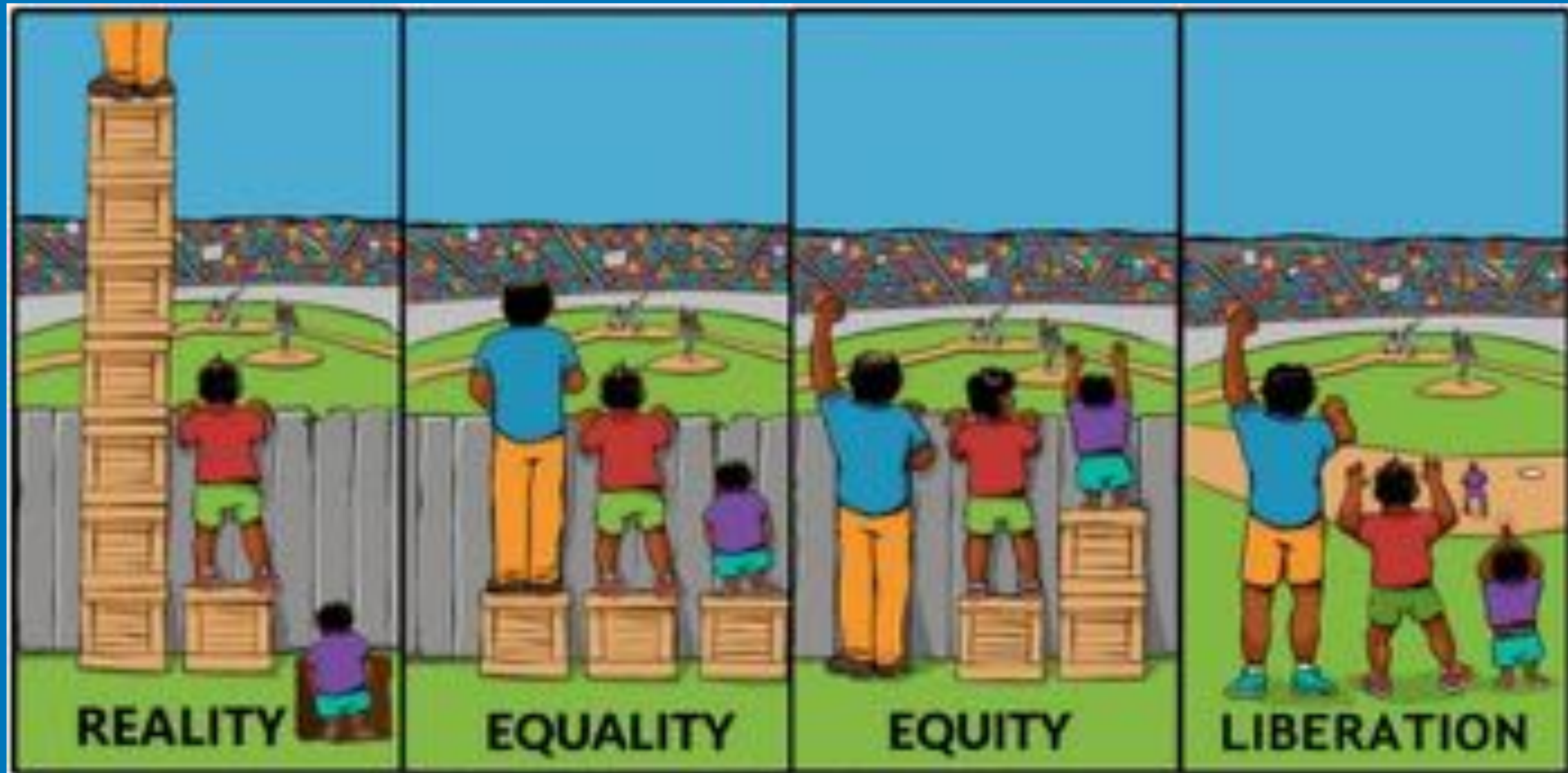
What is the SSSC doing for early career researchers?

In the future more virtual events + the yearly in-person readiness sprint

	# of Attendees	% women and gender minorities	% ethnic / race minorities within the SSSC	% early career
2018 Sprint (Seattle) LSSTC funding	25	20	12	36
2019 Sprint (Chicago)	14	14	7	21
2020 Sprint (Virtual)	53	27	11	38

Equity, Diversity, and Inclusion

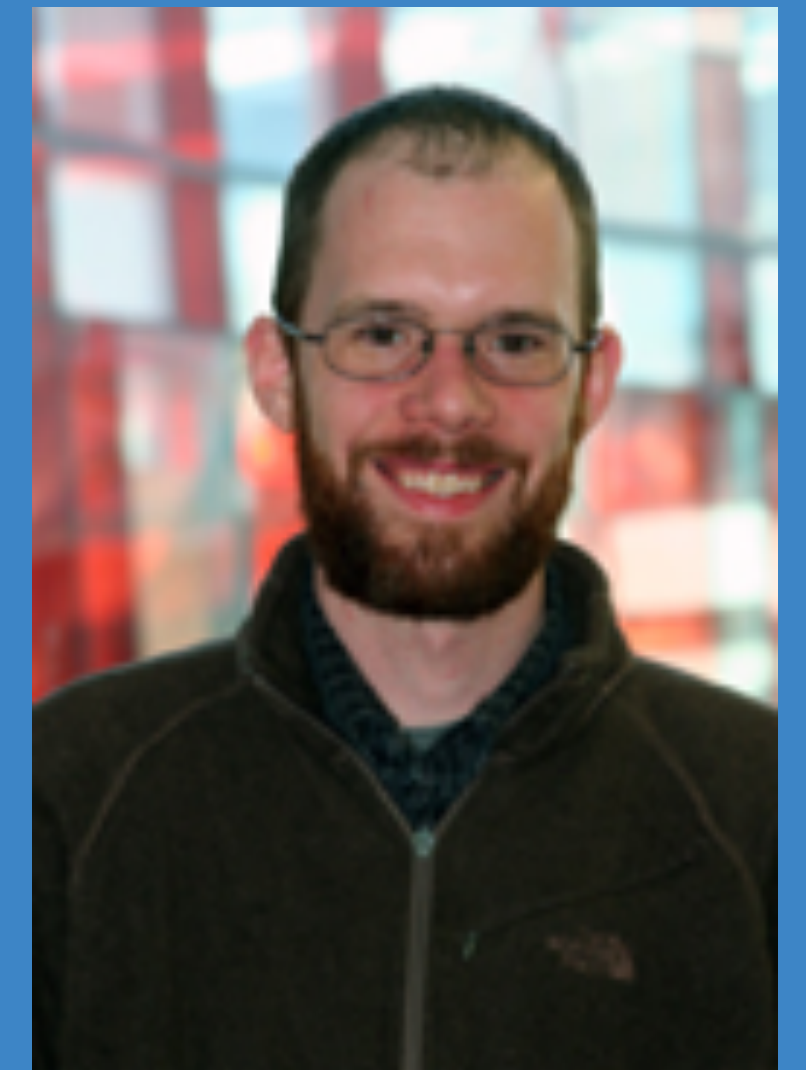
Meg will be planning a broader collaboration-wide virtual discussion in July/August



© Interaction Institute for Social Change | Artist: Angus Maguire

Active Objects Working Group

- Comet brightness model for MAF (M. Kelley, L. Jones).
- New post-doc (A. Rozek) to work on activity detection software (C. Snodgrass).
- LCO Outbursting Objects Key (LOOK) Project (Co-PIs T. Lister and M. Kelley):
 - Participation of several AOWG team members
 - ~2000 hr/3 years of Las Cumbres Observatory time to discover and follow-up cometary and asteroidal outbursts.
 - Developing an LSST-like workflow.



Mike Kelley, UMD
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Community Software/Infrastructure Development Working Group

- Detailed software white paper posted to arXiv in June 2019: <https://arxiv.org/abs/1906.11346>
 - Discusses needed software tools and current inventory, potential algorithmic approaches, timescale and dependency considerations, and infrastructure needs
 - Intended to be living document, so could be time for update
- Updates and Current Priorities:
 - Several LSST-related PDART proposals submitted this year
 - Some software development taking place as part of other projects
 - High-priority tasks listed in Schwamb et al. (2019, RNAAS, 3, 51)
 - Production of publicly available data products encouraged; will be credited per SSSC publication policy
 - Keeping a running inventory of software development efforts to identify gaps and overlaps; please contact Henry with updates
 - Decadal white paper(s?) in progress (contact Mike Kelley & Henry)



Henry Hsieh, PSI
hhsieh@psi.edu

Inner Solar System Working Group

- Inner Solar System site: <https://lsst-sssc.github.io/workinggroups.html>
- Key points:
 - Related to Main Belt asteroids, Jovian Trojans, Irregular Satellites of gas giants
 - Coordination between members of work on these topics
 - Interface with the MPC/AstDyS about data volume and discoveries
 - Coordination with groups computing proper elements
 - Connect with mission groups exploring inner Solar System
- Questions: working group leads



Bryce Bolin, Caltech/IPAC, bbolin@caltech.edu

NEOs (Near Earth Objects) and Interstellar Objects Working Group

- Objects on orbits inward of or diffusing inward from the asteroid main belt and objects on unbound orbits passing through the Solar System
- Main activities to date and continued work:
 - Establishing NEO & interstellar object science and hazard metrics
 - Implementing metrics in MAF
 - Evaluating various survey cadences with metrics and science drivers
 - Trying to understand how ZTF NEO discovery will translate to LSST NEO discovery
 - Contributing feedback to possible in-kind contributions to science
 - Cadence white papers

Sarah Greenstreet
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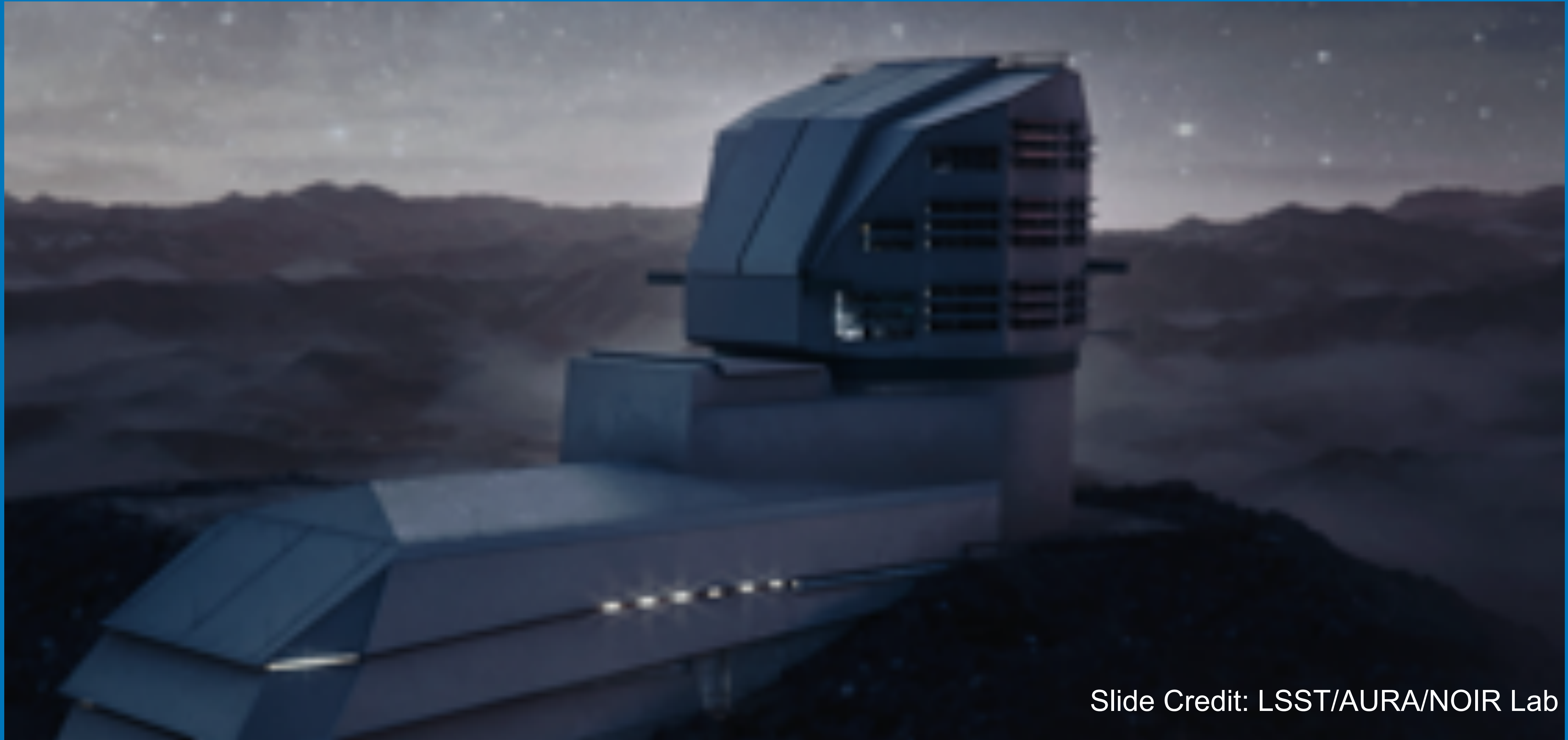
Outer Solar System Working Group

- Centaurs, irregular satellites & Trojans of planets beyond Jupiter, trans-Neptunian objects/Kuiper belt, potential distant planet, Oort cloud
- Primary activities thus far:
 - Supporting Software group (e.g. input for the Software white paper)
 - Cadence white papers
- Upcoming activities:
 - Satellite Constellations 1 Workshop (29 June - 2 July) bringing together the research community and industry to quantify the impact of satellite constellations on astronomy and find technical solutions (will produce a white paper)

Michele Bannister,
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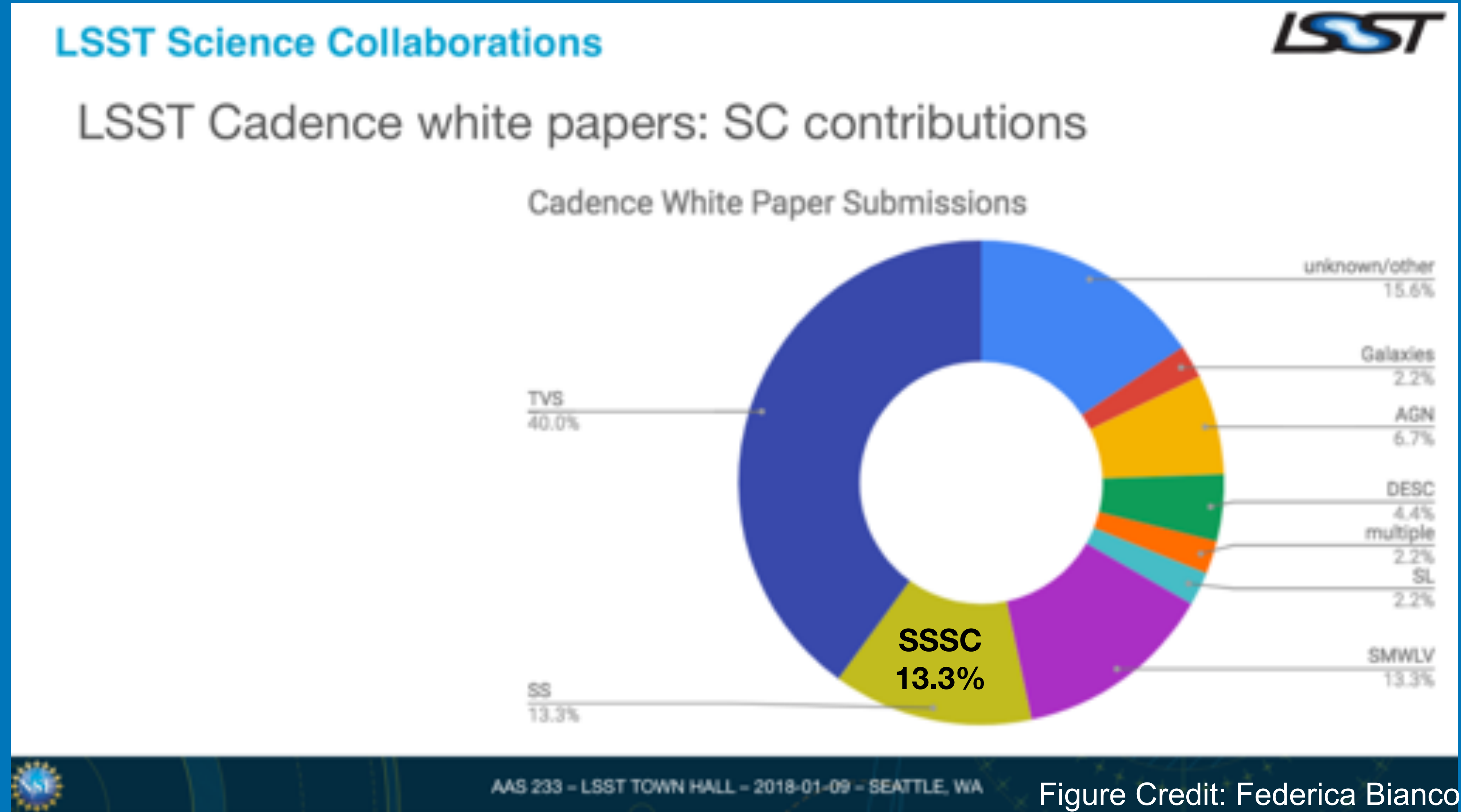
2020 Goals - Giving Feedback to the Rubin Observatory Survey Cadence Optimization Committee



Slide Credit: LSST/AURA/NOIR Lab

<https://www.lsst.org/content/charge-survey-cadence-optimization-committee-scoc>

Two Years Ago, We Were Focusing on LSST Cadence Optimization White Papers



http://lsst-sssc.github.io/cadence_white_papers.html

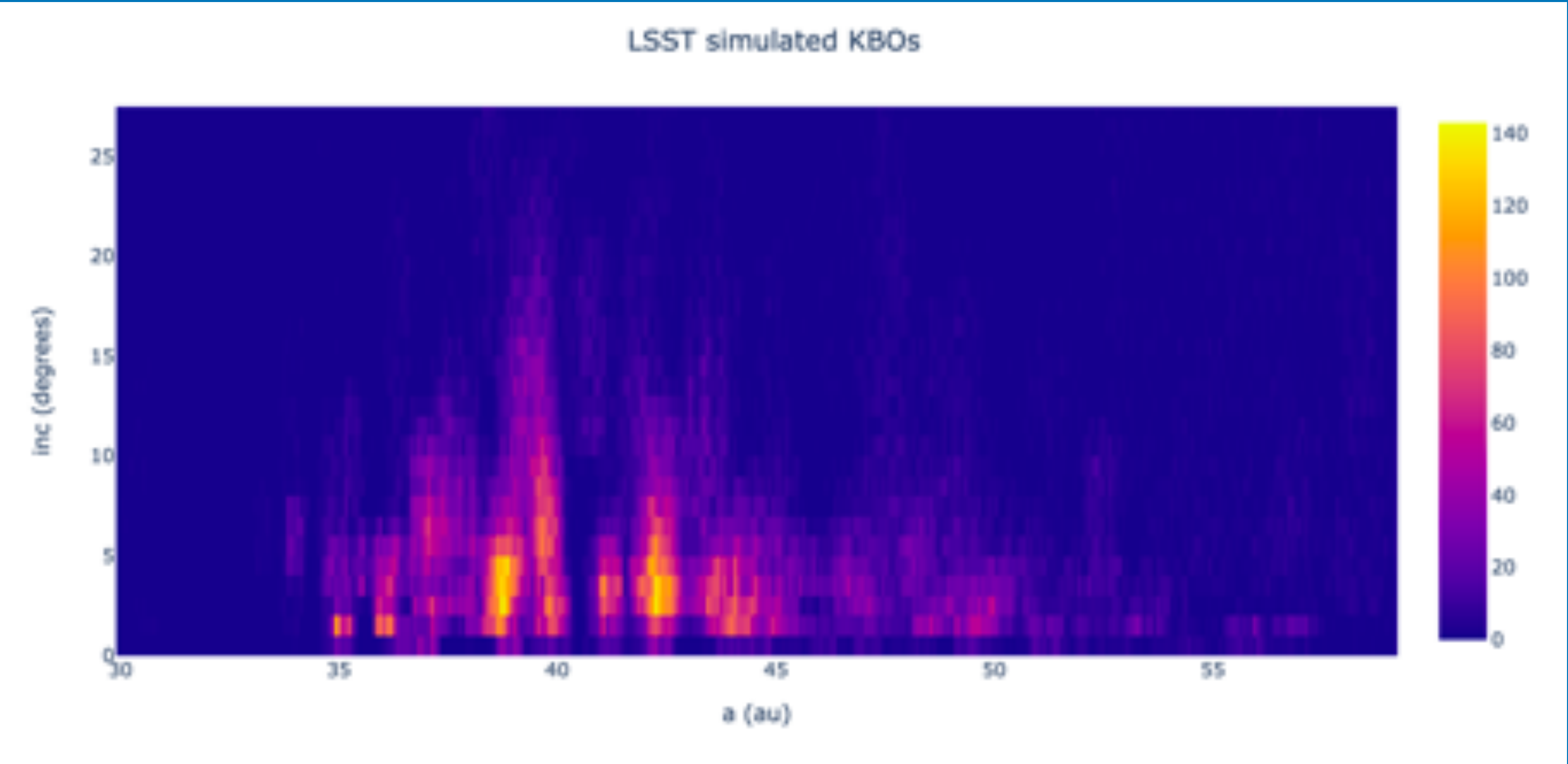
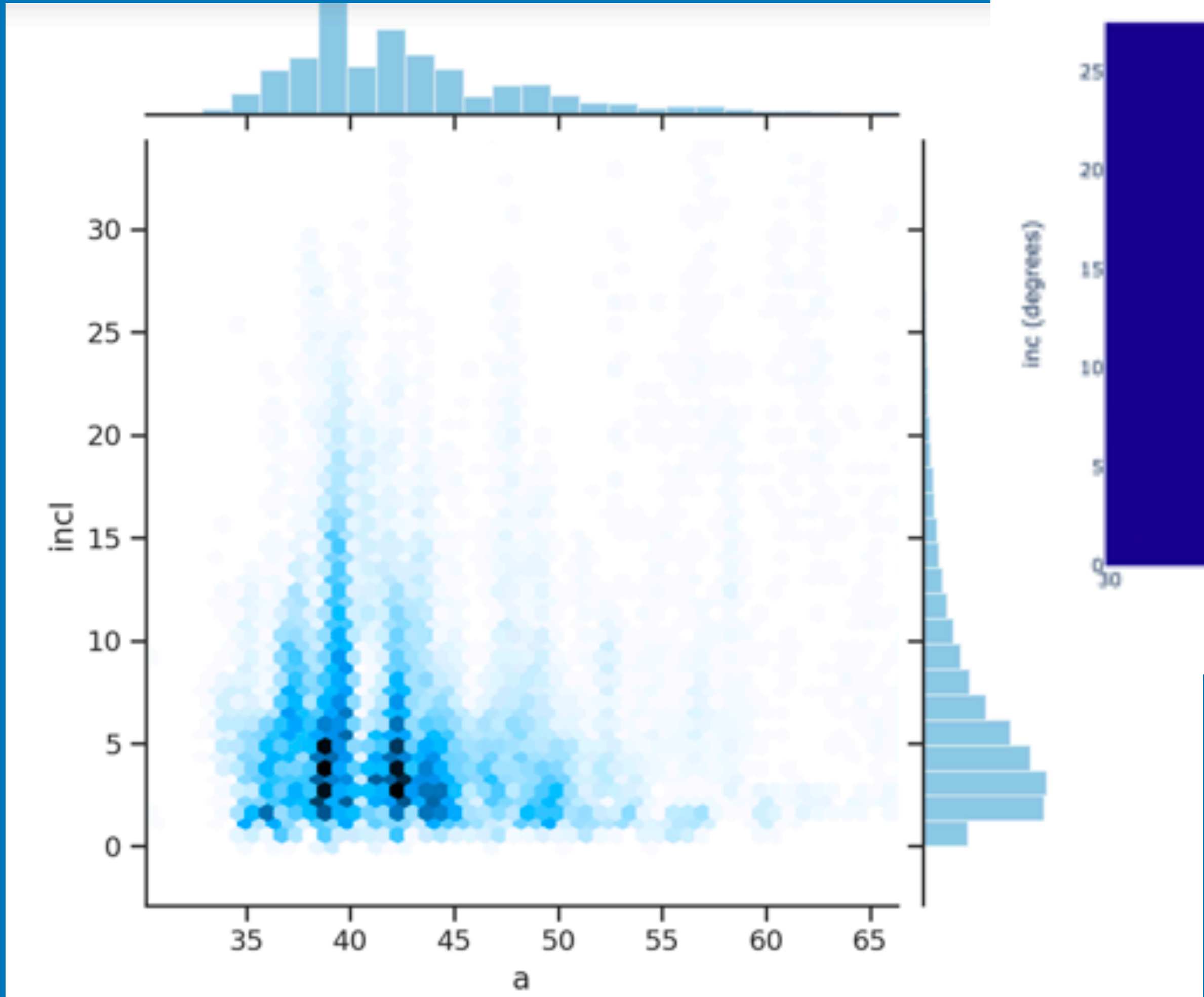
2020 Goals - Thinking about Observing Follow-up



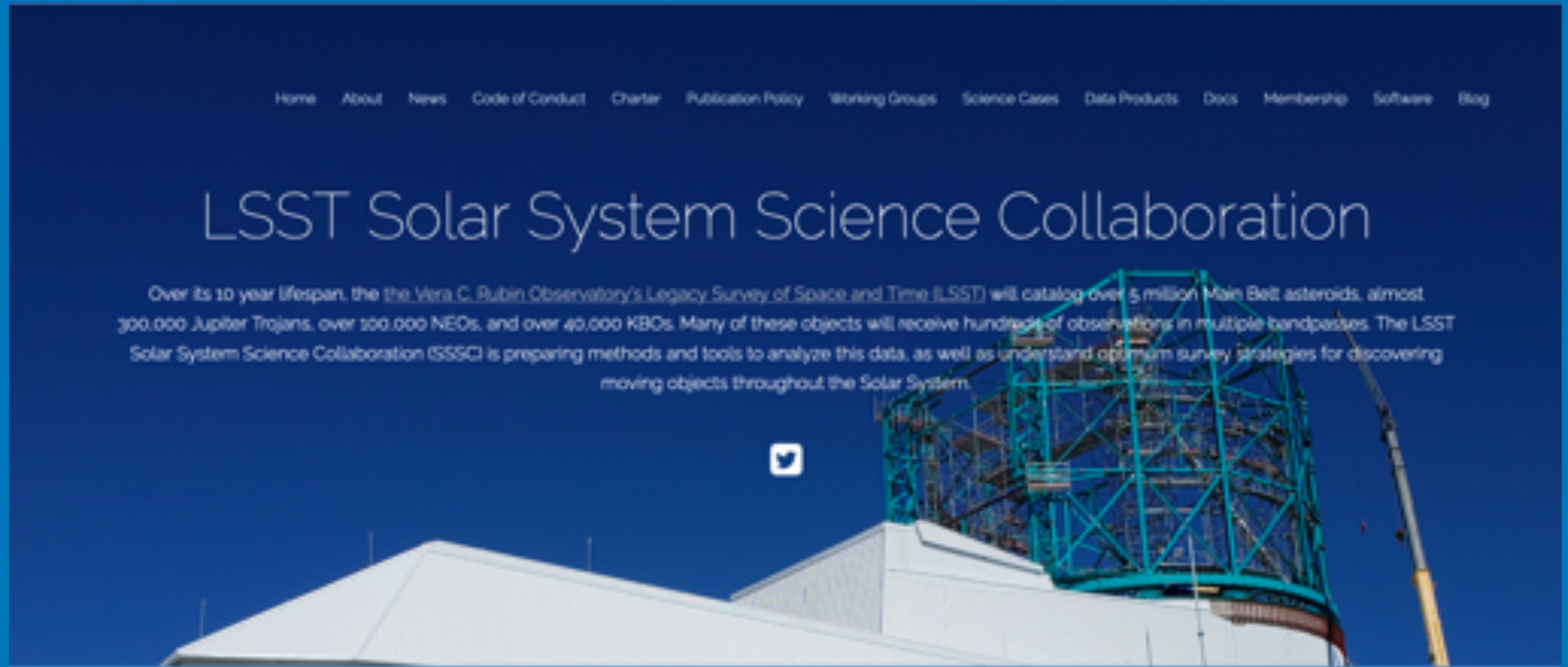
- How can the SSSC be most useful?
- Helping link interested proposers together?

Image Credit: Gemini Observatory/NSF/AURA

2020 Goals - Software Development with Simulated Solar System Data Products



More details can be found on the SSSC's webpage



www.lsstsssc.org