

Rubin/LSST & KOR-KAS Program Status

Narae Hwang
CfLAT, KASI

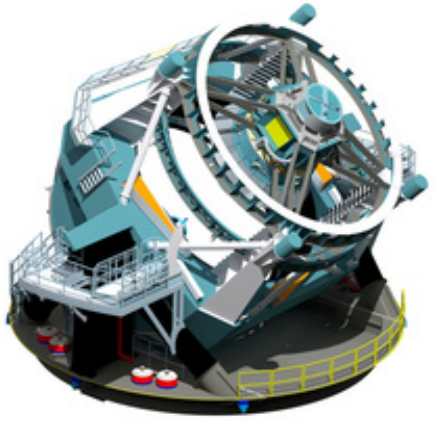
2023. 01. 17.
Survey Science Group Workshop 2023

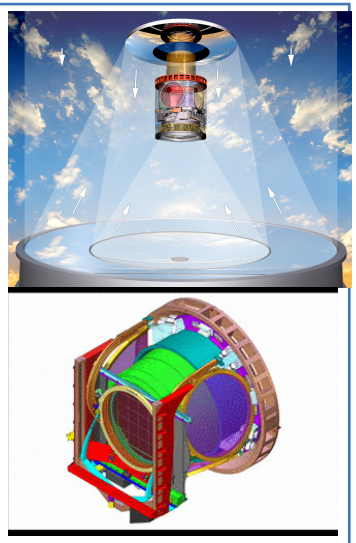
1. LSST Overview

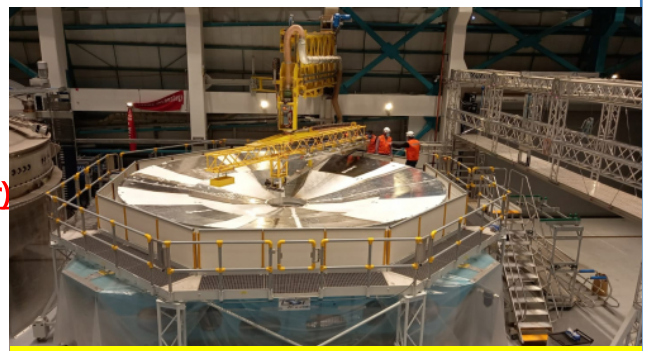
Based on Materials prepared by BG Park

LSST : Legacy Survey of Space & Time by Vera C. Rubin Observatory

- **Telescope (Simonyi Survey Telescope)**
  - ✓ 8.4 m 3-Mirror Telescope (equiv. aperture 6.5 m)
  - ✓ FOV = 3.5 degree in diameter
- **Camera**
  - ✓ 3.2 Gpx CCD Camera (10um pixel, 0.2 arcsec/px)
  - ✓ Filter Set = ugrizy
- **Observation**
  - ✓ Data = 20 TB/nt (20 PB for 10 yrs; 60PB raw data)
  - ✓ Nightly Pipeline = Alert transient events within 60 seconds of image readout
  - ✓ Data Release Pipeline = release completely analyzed data set once per year
- **Site**
  - ✓ Cerro Pachon, Chile
- **Schedule**
  - ✓ **First lights was planned in late 2023 but delayed to Oct. 2024 (or later)**
  - ✓ Project Period = 10 years after commissioning







Cleaning Test of M1M3 in Apr. 2022 at Summit

2. Korean Participation in LSST Project

11+ Years Efforts Since the First Contact from LSST

- **2011**
  - ✓ Nov. 07. : Tony Tyson sent email to KASI President to invite Korea to participate in the LSST Project
- **2012**
  - ✓ Jan. 31. : Official LOI with a list of 10 Korean PI's sent to LSST (formed KPG)
- **2013**
  - ✓ May 16. : LSST requested to convert LOI into MOA
    - ➢ International participants must pay USD 20k/PI/yr for 10 years to get the data access right
- **2015**
  - ✓ Nov 11. : Draft MOA for KPG joining LSST project sent to LSSTC
- **2016**
  - ✓ Apr. 13. : MOA for KPG joining LSST project signed
- **2018**
  - ✓ Oct. 01. : LSST Pre-Operation began (planned 4 years)
- **2019**
  - ✓ Mar. 01. : New policy on data rights for the international participants announced
  - ✓ Oct. 31. : LOI invitation for in-kind contribution released
  - ✓ Nov. 21. : KASI LOI for in-kind contribution sent
- **2020**
  - ✓ Oct. 02. : Formal proposal for KASI In-kind contribution submitted
- **2021**
  - ✓ Jan. 08. : Data Preview 0 (DP0.1) registration announcement released (300 slots closed on Apr. 30)
  - ✓ Mar. 02. : Feedback from LSST in-kind contribution evaluation committee received
- **2022**
  - ✓ Mar. 01. : Data Preview 0 (DP0.2) registration announcement released (300 slots closed on Apr. 30)
- ✓ **2023**
  - ✓ Current : Negotiation for detailed implementation plan for accepted contribution proposals in progress

← No fault termination of MOA w/ LSST Corp. in July 2022

← Negotiation began w/ Rubin regarding KASI's contribution to Operational Offsets in Aug. 2019.

3. Data Access Rights

Policy Changes for the International Participants

- **Original Policy**
  - ✓ LSST observation data was supposed to be open to the world without any condition on the next day of the observation

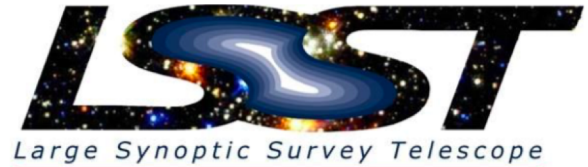
- **Policy Change after submitting NSF Construction funding proposal in 2011**
  - ✓ NSF requested LSST to secure 25% of the operation funds from international partners
  - ✓ Data shall be open to US and Chilean astronomers without limitation
  - ✓ Astronomers in the international partner institutions will have equal rights as US and Chilean astronomers by paying $20k(in 2013 value) per PI per year. (plus incremental costs for data system $1.5k per year)

  ※ Definition of 'PI' : PI = 1 faculty + up to 4 junior researchers (postdocs and/or students)

- **Policy Change in 2019**
  - ✓ International participants will have the same data rights as US/Chile scientists in exchange for in-kind contributions
  - ✓ In-kind contribution may be added-value to the construction, facility operations, related astrophysical resources, and anything agreed by the agencies (NSF and DOE)

  ← The reason behind to formulate KOR-KAS in-kind proposal team

LSST In-Kind Contribution Request



950 N. Cherry Avenue, T

October 31, 2019

Lett

We have already contacted several groups directly about specific contributions they could make that would offset the cost of constructing, commissioning, or operating the LSST facility to the US funding agencies, NSF and DOE: further contributions of this kind are not sought here.

Dear Colleagues,

LSST is not expecting or planning to accept money from international partners for the purposes of establishing data rights. As such, we are inviting you to submit a letter of intent to make in-kind contributions to the overall LSST enterprise, as a first formal step towards an agreement establishing long-term LSST data rights for your community's PIs.

In this invitation, we seek contributions that will expand the resources available to the US astronomical and high energy physics communities. We have already contacted several groups directly about specific contributions they could make that would offset the cost of constructing, commissioning, or operating the LSST facility to the US funding agencies, NSF and DOE: further contributions of this kind are not sought here.

Various categories of acceptable in-kind contributions are described below. Your letter of intent should provide a brief, and approximate, outline of the in-kind contributions you would like to (or could) make and comment on the number of PIs (each with up to 4 junior associates) for whom you

4. KASI In-Kind Contribution Proposal

KOR-KASI Team and Elements of the Proposed In-kind Contribution

- **KOR-KASI Team**
  - ✓ Proposal Lead (PL) : Byeong-Gon Park
  - ✓ Program Manager (PM) : Narae Hwang
  - ✓ Contribution Leaders : Min-Su Shin, Myungshin Im, Yong-Seon Song, Chang Hee Ree

- **In-kind Contribution Elements and Contribution Leads (CLs)**
  - S1 (CL: Narae Hwang) : KASI Observing Specialist Support for Rubin Commissioning and Operations
    → This covers the Operational Cost Offset
  - S2 (CL: Min-Su Shin) : KMTNet Observing Time
  - S3 (CL: Myungshin Im) : KMTNet Synoptic Survey of Southern Sky (KS4)
  - S4 (CL: Yong-Seon Song) : Science Pipeline Development in the Large Scale Structure Science Collaboration
  - S5 (CL: Chang Hee Ree) : Independent Data Access Center (IDAC)

4. KASI In-Kind Contribution Proposal

Feedback from LSST Contribution Evaluation Committee

No.	CL	Title	No. PI (requested)	CEC response	No. PI (expected†)
S1	Narae Hwang	Observing Specialist for Rubin Commissioning and Operations	3	Accept with modification	5 → 6
S2	Min-Su Shin	KMTNet Observing Time	6	Accept with modification	6
S3	Myungshin Im	KMTNet Synoptic Survey of Southern Sky (KS4)	3	Reject	0
S4	Yong-Seon Song	Science Pipeline Development in the Large Scale Structure Science Collaboration	2	Reject	0
S5	Chang Hee Ree	Independent Data Access Center (IDAC)	1	Accept with modification	1
Sum			15		13

† Expected number of PI's is not the original number at the time of CEC evaluation, and is changing according to negotiation currently under progress.

KASI In-Kind Contribution Progress Summary

No.	CL	Title	Status
S1	Narae Hwang	Observing Specialist for Rubin Commissioning and Operations	Negotiation is in progress/weekly meeting Engaging in SITCom Team activities (monthly telecon, etc.)
S2	Min-Su Shin	KMTNet Observing Time	Expect to begin in 2024 (prep to begin in June 2023)
S5	Chang Hee Ree	Independent Data Access Center (IDAC)	Prep. began in Sep. 2022. 1st stage is almost finished (IDAC facilities) 2nd stage for IDAC operation and maintenance will begin in 2024+

5. Contents and Status of Each Accepted Proposal

S1: Observing Specialist for Rubin Commissioning and Operations

- **Deliverables**
  - ✓ One experienced KASI staff for developing and commissioning wide-field CCD camera
  - ✓ One postdoc for joining commissioning & night time operation of the observatory
  - ✓ One postdoc for carrying out night time operation of the observatory

- **Invested Resources:**
  1 staff x 2 years (1 PI right) + 2 PD x 4 (+2@KASI) years (2.5 x2 PI rights)
  - ✓ 0.5 FTE of one staff scientist based in Chile for two years (1 FTE year) → 0.5 x 2 year = 1 PI right
  - ✓ 1 FTE of one postdoc (**TBH**) for commissioning & night time operation for two years (2 FTE year) + LSST-related research for two years → 1.0 x 2 years or 0.5 x 4 years = 2 PI rights → 2.5 PI rights
  - ✓ 1 FTE of one postdoc (**TBH**) for night time operation for two years (2 FTE year) + LSST-related research for two years → 1.0 x 2 years or 0.5 x 4 years = 2 PI rights → 2.5 PI rights

- **Expected number of PIs from this contribution**
  - ✓ 5 → **6 Pis (recent increase from negotiation)**

- **Source of fund to support this contribution**
  - ✓ International Optical Observatory Project (국제광학천문대 건설 및 운영)

5. Contents and Status of Each Accepted Proposal

S1: Observing Specialist for Rubin Commissioning and Operations

- **Status**
  - ✓ **KASI-AURA MOU** Regarding KASI Research Staff at AURA Sites in Chile
    - ➢ Office space lease for a KASI staff and postdoc in AURA building in La Serena
    - ➢ About to send KASI staff (Moo-Young Chun) in Feb. 2023 (0.5 FTE x 2 years for Rubin Commissionin)
  - ✓ **KASI-KIPAC MOU** Regarding **1st KASI-KIPAC Fellowship for Rubin Operation (4+2 years)**
    - ➢ Negotiation is in progress with KIPAC/SLAC and AURA
    - ➢ PLAN: 1st 2 years with Rubin, 2nd 2 years at KIPAC, and 3rd 2 years at KASI (upon successful evaluation)
    - ➢ Aim to have similar one to KASI-Arizona fellowship program but details to be finalized
      - 1st Fellow: 4+2 year contract, 2-year for Rubin operation in Chile, 2 year mostly for personal research using LSST data at SLAC/KIPAC, and final 2 years at KASI
  - ✓ **KASI-NOIRLab Fellowship MoU** will commence soon after the recruitment of 1st fellow.

- **Timeline (updated in Jan 2023)**
  - ✓ Rubin hope to have KASI staff join the commissioning/operation team ASAP, not later than late 2024
  - ✓ (ideally) KASI-KIPAC fellowship job post as early as Apr-Sept. 2023, actual joining in Sep. 2024

5. Contents and Status of Each Accepted Proposal

S2: KMTNet Observing Time – Active LSST Follow-up Observation Conforming to the AEON Standards

- **Deliverables**
  - ✓ Active and immediate follow-up of the LSST objects in the AEON mode support in two ways for the observation programs granted by the NOIRLab AEON TAC.
    - ➢ Beginning or ending 30 minutes of every night at all three sites
    - ➢ Full AEON mode available for pre-allocated nights equally distributed over lunar phases
  - ✓ KMTNet will equip LSST band g, r, i filters at all three sites in addition to existing BVRI set.
  - ✓ KMTNet telescope operator executes the AEON queue mode observation, and the processed data and catalogs will be delivered.

- **Invested Resources**
  - ✓ 2 PhD scientists (0.2 FTE each) – Min-Su Shin & Jae-Woo Kim
  - ✓ **Total time contributed : 300 hours per site per year for 5 years (~ 10% of total KMTNet time)**
  - ✓ Procurement of LSST band g, r, i filters for all three sites
  - ✓ Development work to adopt AEON mode and relevant interfaces with user support

- **Expected number of PIs from this contribution**
  - ✓ 6 PIs (5 for the telescope time, and 1 for filters & AEON development)

- **Source of fund to support this contribution**
  - ✓ TBD for 2024, working to get funding in 2023
  - ✓ 신규과제 (PI: 신윤경, funding TBC 2024- or 2025-)

※ AEON : Astronomical Event Observatory Network (currently SOAR, Gemini, LCOGT, +Blanco)

5. Contents and Status of Each Accepted Proposal

S2: KMTNet Observing Time – Active LSST Follow-up Observation Conforming to the AEON Standards

- **Timeline**
  - ✓ In the proposal, this contribution is to start in FY25, and until FY29. (subject to be delayed due to delayed commissioning of the Rubin observatory
  - ✓ **KMTNet-AEON – from 2024B for 5 years**
  - ✓ Data reduction & photometric pipeline + AEON-compatible system on cloud environment – by the end of 2023
  - ✓ Operation of the KMTNet-AEON system: starting from Jan. 2024.
  - ✓ Opening the KMTNet-AEON system to the US community: starting from the 2024B semester.

5. Contents and Status of Each Accepted Proposal

S5: Independent Data Access Center (IDAC)

- **Deliverables**
  - ✓ International Light IDAC interconnected to the major US data centers via high-bandwidth network
  - ✓ Computing resources for (1) access to catalog data and (2) wider distribution of LSST coadded image data

- **Invested Resources**
  - ✓ **Dedicated IDAC hardware of 500 TB storage plus 200 CPU cores**
  - ✓ 20M CPU-Hours
  - ✓ High-bandwidth (100Gbps) network environment
  - ✓ ~~Two dedicated~~ support staff (2 x 0.5 FTE) responsible for the oversight, maintenance, and data curation of the LSST data at KASI, data analysis support for the Rubin Science Platform (RSP) users

- **Expected number of PIs from this contribution**
  - ✓ 1 PI

- **Status**
  - ✓ 2020. 12. KASI Science Cloud : 192 vCPU + 240 TB storage constructed
  - ✓ 2022. 04. Expansion of KASI Science Cloud finished (total 672 vCPU + 480 TB storage and High density cloud storage : total 1,080 TB)

5. Contents and Status of Each Accepted Proposal

S5: Independent Data Access Center (IDAC)

- **Timeline**
  - ✓ IDAC will be operated during the full lifetime of the LSST project.

- **Considerations required:**
  - ✓ LSST demands refreshment of hardware at least twice during the project lifetime for stable operation of the IDAC, which will cost about 350M KRW each time.

- **Source of fund to support this contribution**
  - ✓ 천문우주 빅데이터 공유활용 플랫폼 구축 (~2023) – Confirmed, Existing.
  - ✓ 2024년 신규과제(PI: 신윤경) – TBC
    - ➢ 사업 기간 : 2024년 ~ 2032년 (9년) -- TBD
    - ➢ Rubin IDAC 운영비 연간 1억원 포함

Data Right Agreement (DRA) Status

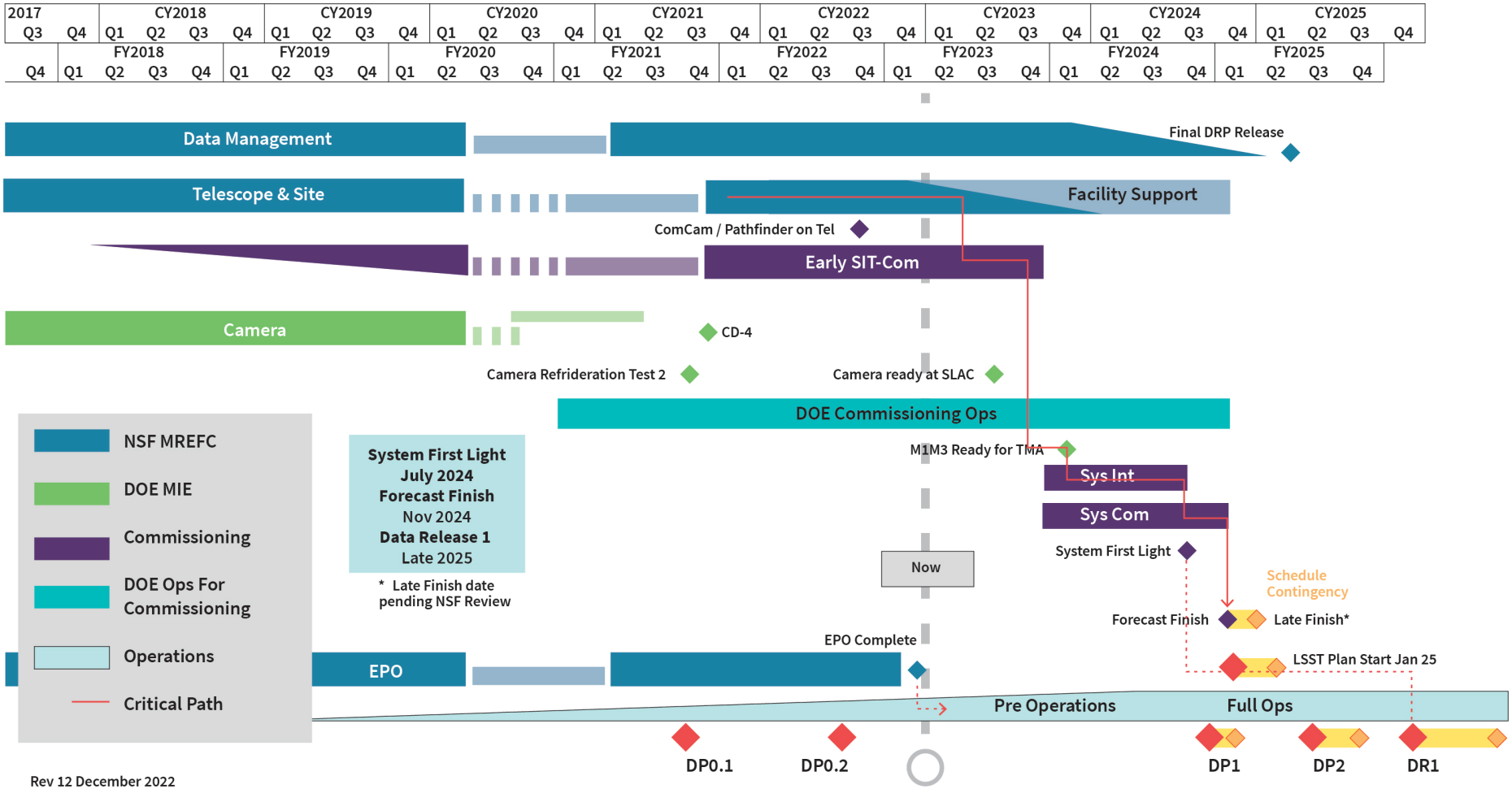
- DRA dictates # of PI data rights per KASI in-kind contribution in writing
- KASI is going to have two DRAs
  - DRA w/ SLAC/DOE: covers S1 & S5 (template CRADA)
  - DRA w/ AURA/NSF: covers S2 (template ICDRA)
- 1st DRA w/ SLAC/DOE is expected in late Feb or early Mar 2023
- 2nd DRA w/ AURA/NSF will follow
- Caveat:
  - "There will be regular reviews of the progress of the contribution with at most annual frequency, organized by Rubin Observatory."
    - PI data rights depend on successful delivery of the committed contribution

Data Right Holder (DRH) list

- Eligibility of DRH (based on DRA SOW)
  - PI's are KASI affiliated scientists
  - JA's can be affiliated with different institutes
- List is available from https://www.lsst.org/scientists/international-drh-list
- Regular update on DRH -- once per year, but update may happen as needed
  - Last update to KOR-KAS DRH list in September 2022
- The KOR-KAS DRH Policy is still in progress and under discussion with concerned parties.
- c.f.) Rubin Policy: PI data right holders can be changed and updated at the discretion of each In-kind contribution team

Rubin Project Schedule

❖ Rubin/LSST Project Schedule (rev. Dec 2022)

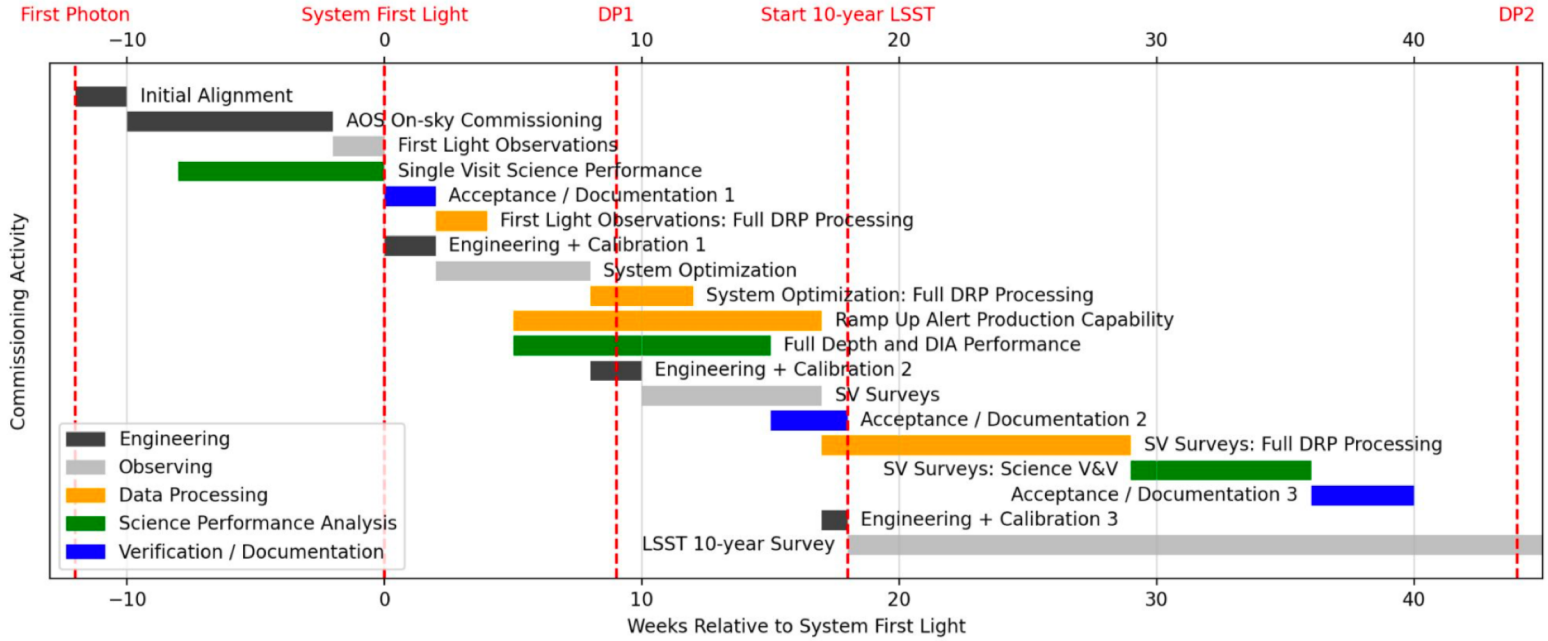


Update on Rubin Construction Schedule

- LSSTCam will be installed earlier than scheduled – C2024Q2
- ComCam will not see the night sky (but kept as a spare)
- System first light in July 2024 (exp. as of Jan. 2023)
- Science operation w/ LSSTCam is expected to begin in Oct-Dec. 2024 (still subject to change…)

VERA C. RUBIN OBSERVATORY

On-sky Commissioning Forecast Relative to System First Light



How to Engage in LSST Science Now

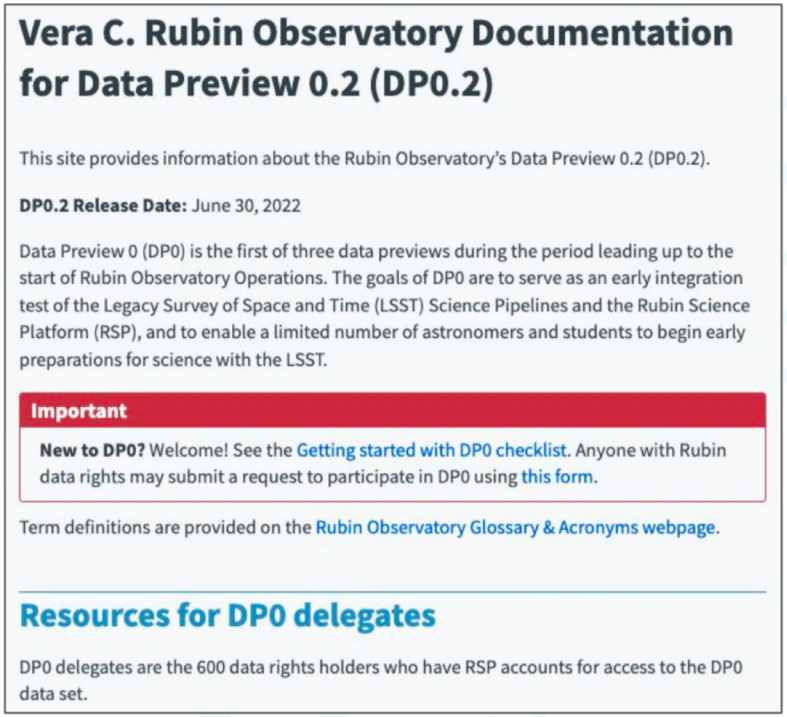
speaker: Melissa Graham

Engage in Rubin LSST Science in 2023

Data Preview 0

- **Simulated** "LSST-like" images over 300 deg^2 include galaxies, clusters, SNIa, and stars (some variable) created by the LSST Dark Energy Science Collaboration (DESC; arXiv:2010.05926).
- **Processed** by Rubin staff using the LSST Science Pipelines (with difference image analysis), images and catalogs are available in the same format as will be used for future data releases.
- **Data products** are available in the Rubin Science Platform via the same query and analysis tools as will be used for future (real) data releases.
- **Documentation, tutorials, and support** are all available now to accelerate learning and preparation for LSST early science.

Get started anytime at dp0-2.lsst.io



Vera C. Rubin Observatory Documentation for Data Preview 0.2 (DP0.2)

This site provides information about the Rubin Observatory's Data Preview 0.2 (DP0.2).

DP0.2 Release Date: June 30, 2022

Data Preview 0 (DP0) is the first of three data previews during the period leading up to the start of Rubin Observatory Operations. The goals of DP0 are to serve as an early integration test of the Legacy Survey of Space and Time (LSST) Science Pipelines and the Rubin Science Platform (RSP), and to enable a limited number of astronomers and students to begin early preparations for science with the LSST.

Important

New to DP0? Welcome! See the Getting started with DP0 checklist. Anyone with Rubin data rights may submit a request to participate in DP0 using this form.

Term definitions are provided on the Rubin Observatory Glossary & Acronyms webpage.

Resources for DP0 delegates

DP0 delegates are the 600 data rights holders who have RSP accounts for access to the DP0 data set.

How to Engage in LSST Science Now

speaker: Federica Bianco

VERA C. RUBIN OBSERVATORY

Growing the Rubin Community via the SC's

The LSST SCs aspire to be an inclusive and supportive environment for anyone interested in pursuing science with Rubin LSST.

No membership fees. No requirements on organizational affiliation. No minimum time commitment for basic membership. Most SCs do not require Rubin Data holder status

Community growth and inclusion

SC driven programs

- Pan-SC's DEI council, with involvement from AURA/NSF, NOIRLAB, SLAC/DoE
- HSF-funded* 35 "Kickstarter" projects ($10-20k) with a focus on meaningful partnerships with newcomers and underserved communities
  - Partnerships with faculty-student teams from minority-serving institutions;
  - Improving data accessibility through sonification and 3D prints;
  - Collaboration visits to involve new international LSST research groups;
- HSF-funded* access to professional training in software development

Partnering with Rubin and LSSTC (e.g. LINCC framework and Catalyst fellowship, DP0)

HEISING-SIMONS FOUNDATION

*Multi-SC program "Preparing for Astrophysics with LSST" PI Rachel Street

AGN	Niel Brandt (Penn State), Gordon Richards (Drexel)
Dark Energy	Katrin Heitmann (Argonne), Renee Hlozek (Toronto)
Galaxies	Sugata Kaviraj (Herts), Simona Mei (Obs. Paris)
Informatics & Statistics	Tom Loredo (Cornell), Francois Lanusse (CNRS)
Strong Lensing	Timo Anguita (UNAB), Graham Smith (Birmingham)
Stars, Milky Way & Local Volume	Peregrine McGehee (SLAC), Will Clarkson (UMich-Dearborn)
Solar System	Meg Schwamb (QUB), Colin Orion Chandler (UW)
Transients & Variable Stars	Sara Bonito (INAF), Igor Andreoni (U. Maryland)

For more information, including how to join: https://www.lsstcorporation.org/science-collaborations

Future of (Ground-based) Survey Science

- Threat#1
  - ALAN (Artificial Light at Night)
    - Can avoid (in principle) by choosing 'Dark Sites'
    - However, Dark Site area is decreasing

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY

MNRAS **519,** 26–33 (2023) https://doi.org/10.1093/mnras/stac2929

Light pollution indicators for all the major astronomical observatories

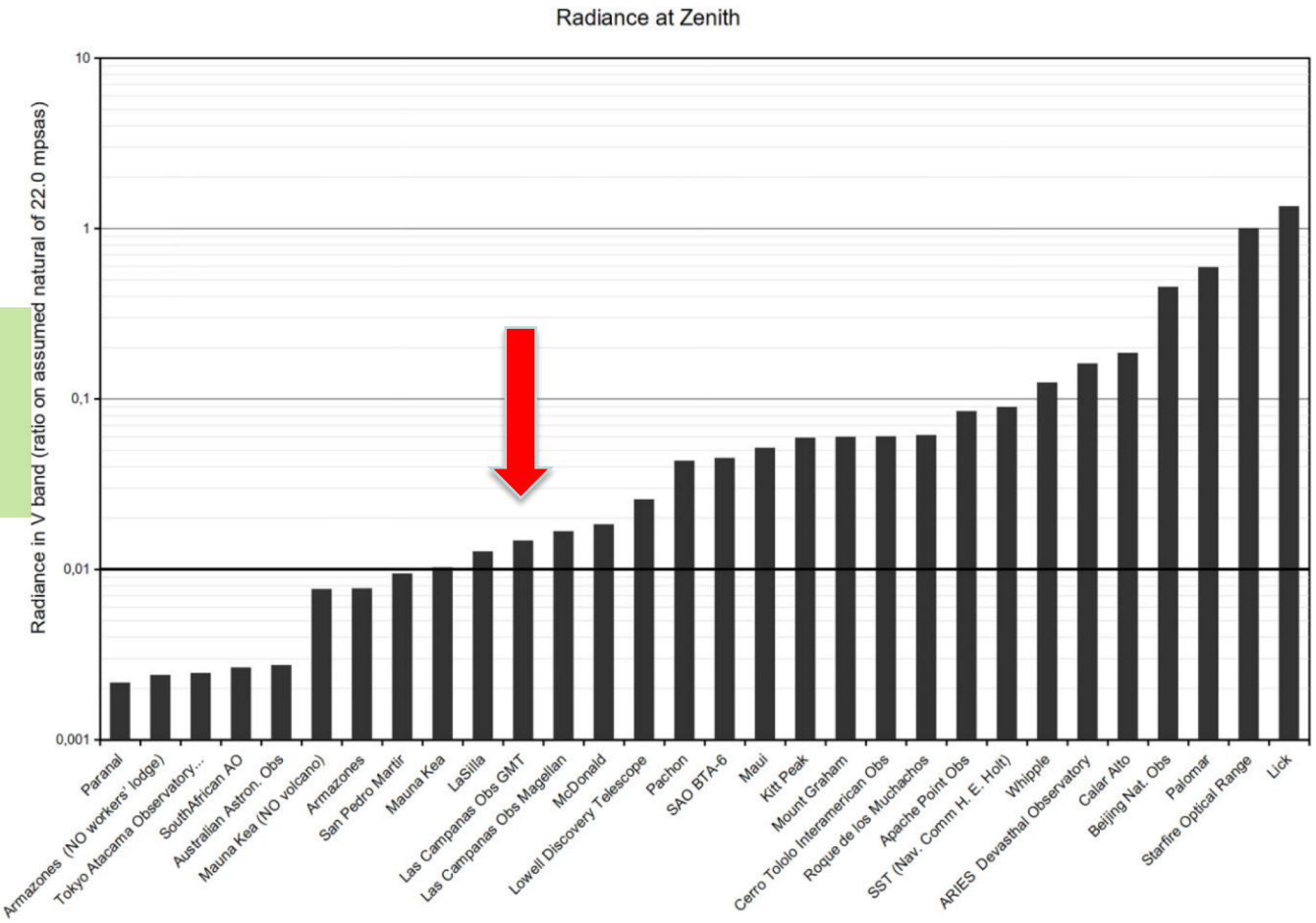
Fabio Falchi,[1,2★] Felipe Ramos,[3] Salvador Bará,[4] Pedro Sanhueza,[5] Marcelo Jaque Arancibia,[6] Guillermo Damke[7] and Pierantonio Cinzano[2]

[1]*Departamento de Física Aplicada, Universidade de Santiago de Compostela, Santiago de Compostela, 15782 Galicia, Spain*
[2]*ISTIL Istituto di Scienza e Tecnologia dell'Inquinamento Luminoso – Light Pollution Science and Technology Institute, I-36016 Thiene, Italy*
[3]*Instituto de Investigación Multidisciplinar en Ciencia y Tecnología, Universidad de La Serena, 1720170 La Serena, Chile*
[4]*Independent scholar, Santiago de Compostela, Galicia, Spain*
[5]*OPCC Oficina de Protección de la Calidad del Cielo del Norte de Chile, 1700000 La Serena, Chile*
[6]*Departamento de Física y Astronomía, Universidad de La Serena, 1720236 La Serena, Chile*
[7]*Cerro Tololo Inter-American Observatory/NSF's NOIRLab, 1700000 La Serena, Chile*

Future of (Ground-based) Survey Science

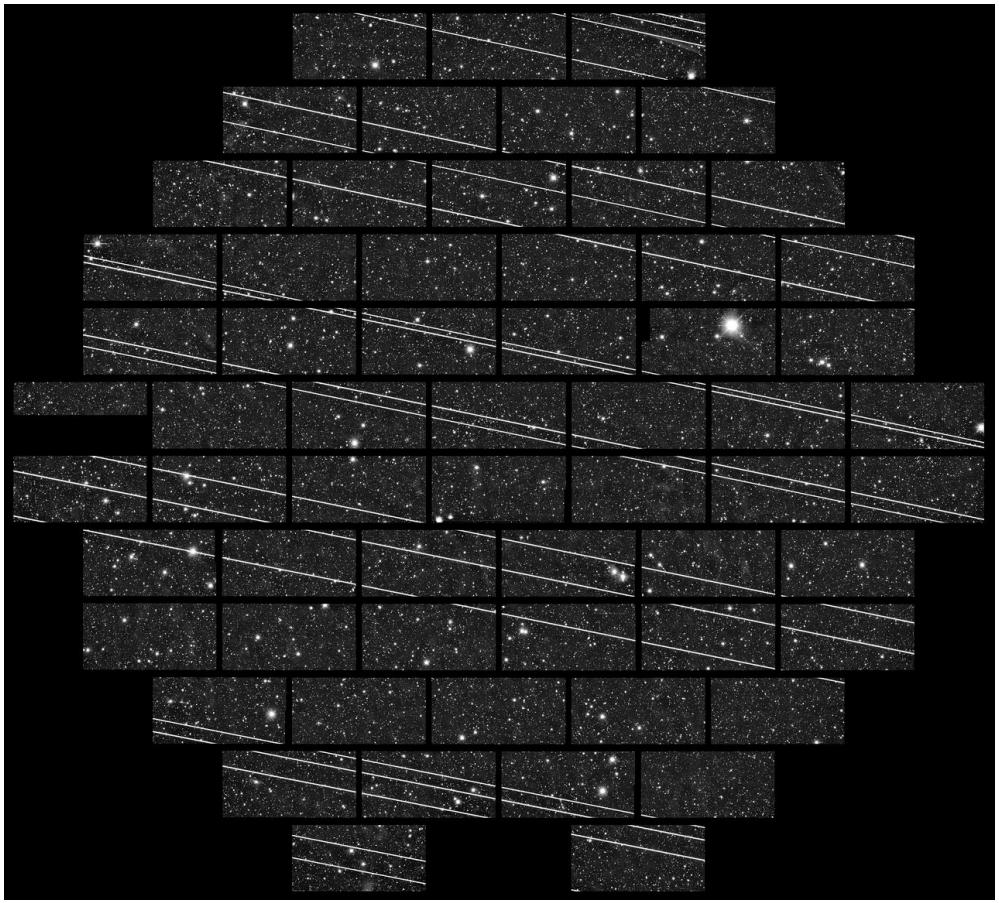
❖ Falchi et al. (2023)

International Union for Conservation of Nature (IUCN) Dark Skies Advisory Group (DSAG) Class 1 for Astronomy Site



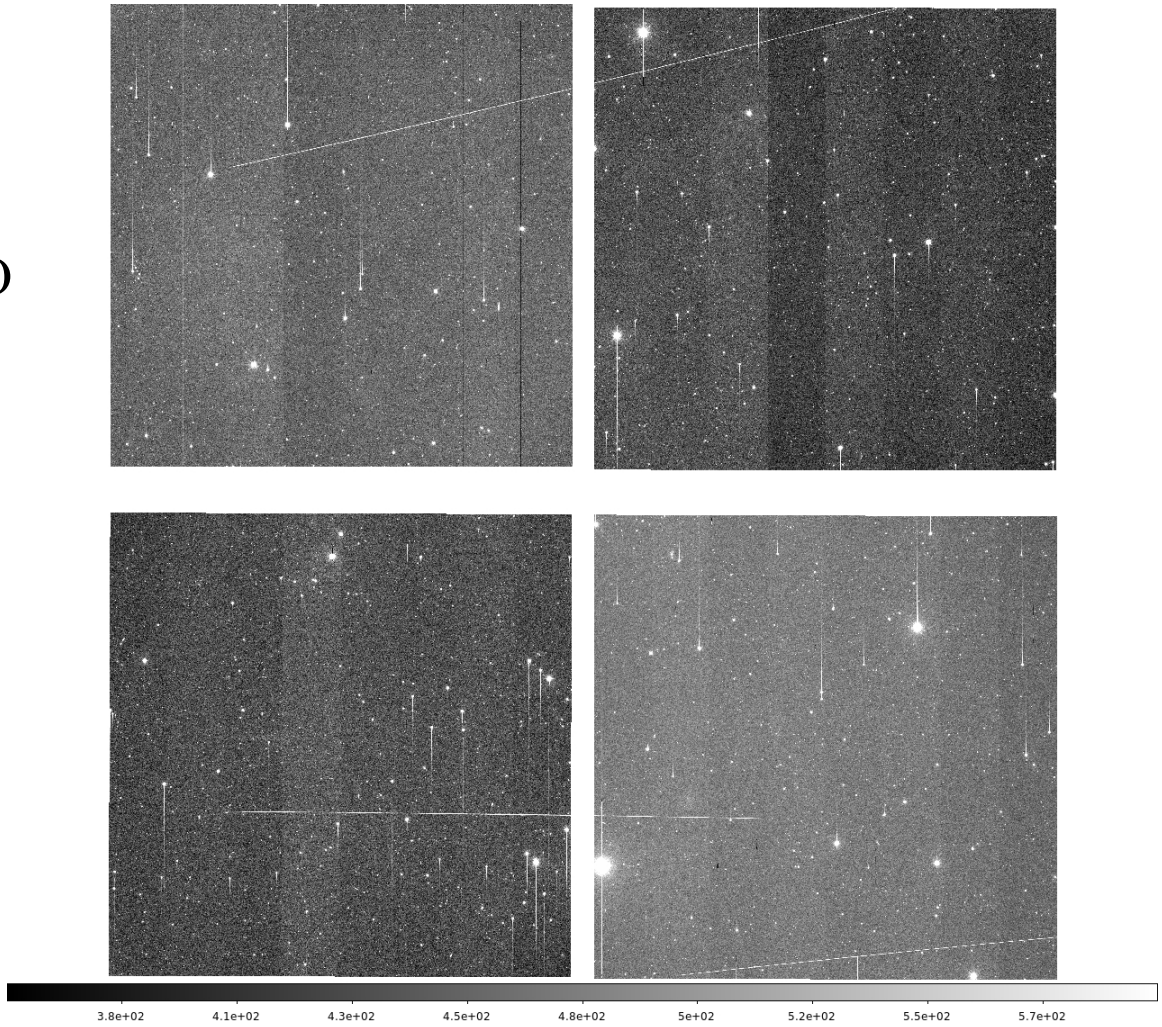
Future of (Ground-based) Survey Science

- Threat#2 – Satellite Constellation
  - No Way Out!
  - E.g.) DECam on Blanco 4m



Future of (Ground-based) Survey Science

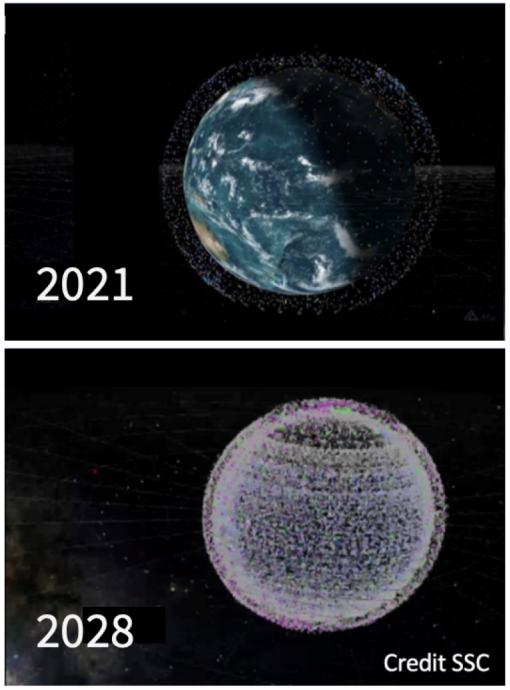
- Threat#2 – Satellite Constellation
  - No Way Out!
  - E.g.) KMTNet @ SSO



Impact to Rubin/LSST

This is a new era for Earth's orbital space environment

VERA C. RUBIN OBSERVATORY



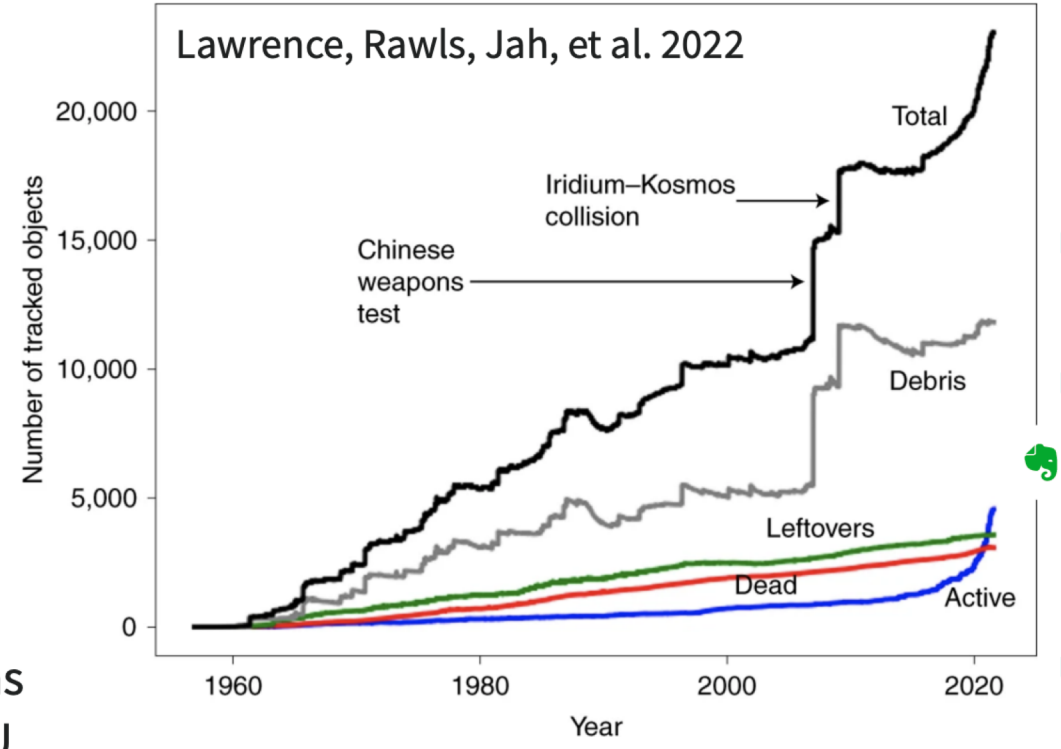


Illustration based on applications filed with the US FCC and the ITU

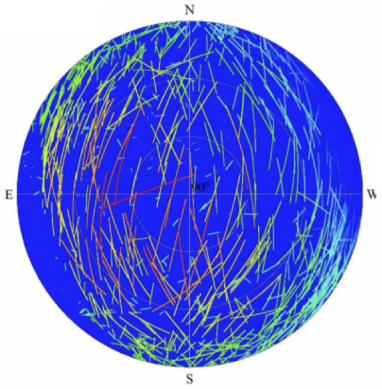
Meredith Rawls | Rubin PCW Satellite Constellations | August 9, 2022

LSST Legacy Survey of Space and Time

Impact to Rubin/LSST

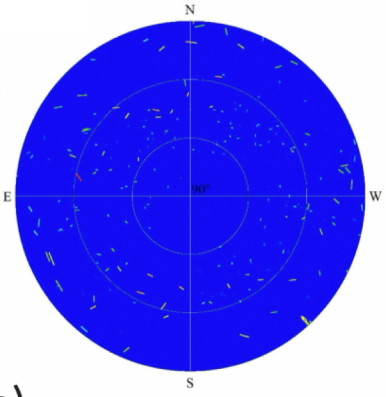
Rubin's potential for discovery is also its vulnerability to LEO satellites

VERA C. RUBIN OBSERVATORY

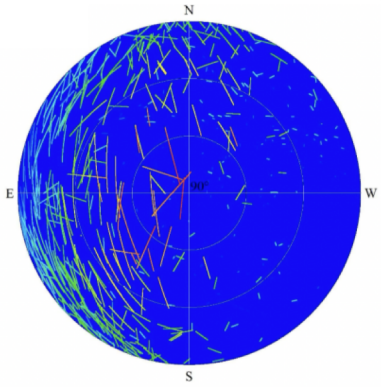


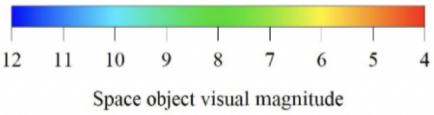
Evening twilight from Rubin site (July 2020 sat pop)

Middle of night



Nearing sunrise





Simulation: Moriba Jah



- Wide field of view
- Sensitive to faint things
- Looking for "bumps in the night"
- Imaging subtle cosmic structures

Meredith Rawls | Rubin PCW Satellite Constellations | August 9, 2022

LSST Legacy Survey of Space and Time

IAU CPS activities

- IAU CPS is being hosted by NOIRLab and SKAO
- IAU CPS Policy Hub is leading efforts such as…
  - Bring this issue to UN COPUOS, STSC
  - Adding "Dark & Quiet Skies (D&QS)" agenda to COPUOUS STSC meeting in Feb 2023

- 한국천문학회 광학천문분과
  - 운영세칙 제2조(활동사항)
  - "4. 밤하늘의 보호 및 광공해 대책"

- 제4차 우주개발진행기본계획
  - Korea is aiming to become a major space faring nation

ann2304 — Announcement

NSF and SpaceX Sign Agreement to Mitigate Impact of Starlink Satellites on Ground-Based Astronomy

NSF and SpaceX continue to explore methods to further protect ground-based astronomy with new coordination agreement

10 January 2023



The National Science Foundation (NSF) and SpaceX have finalized a coordination agreement to mitigate the impact of the company's Starlink satellites on ground-based radio-, optical-, and infrared-astronomy facilities. The NSF's public statement is here.

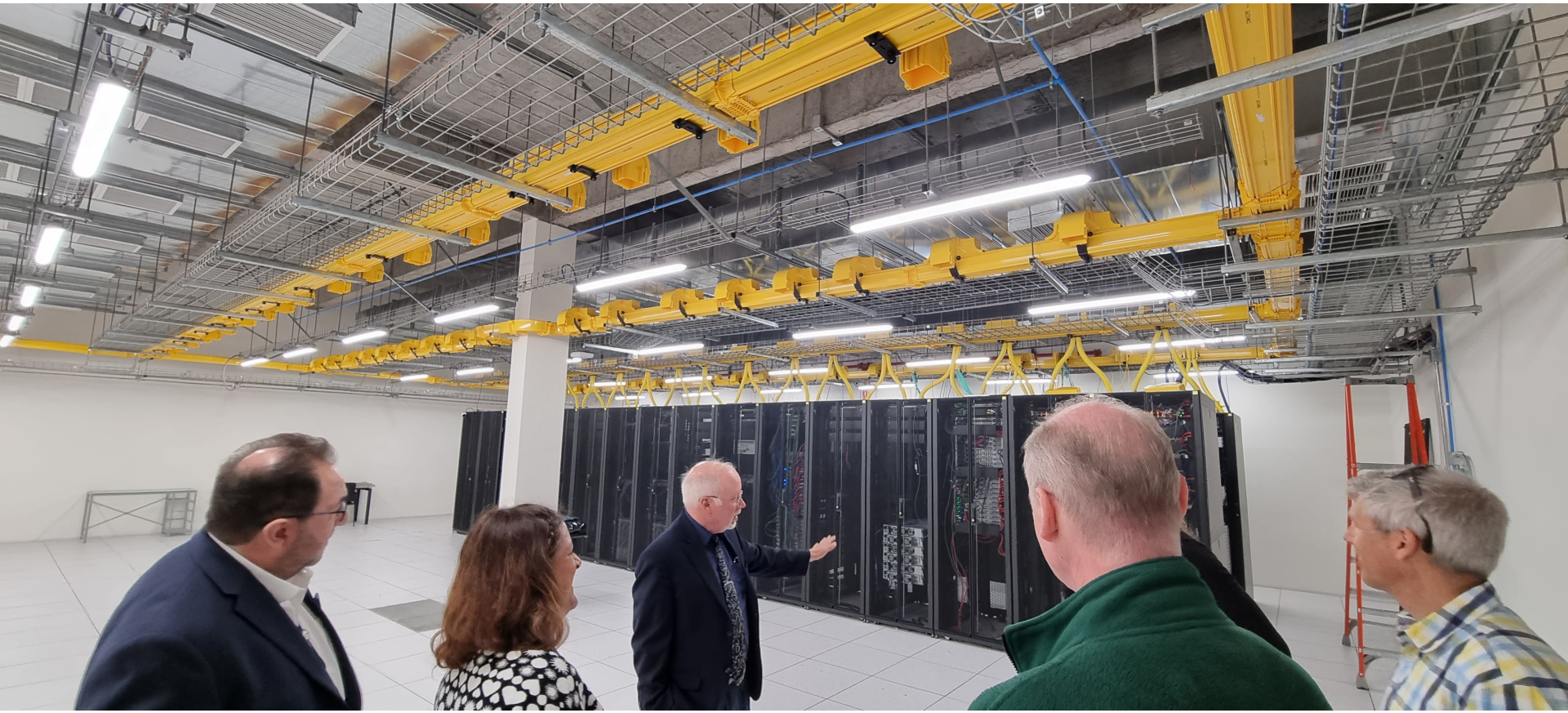
Some recent photos





Some recent photos

❖ Data Center at La Serena



Some recent photos

❖ SOAR, Gemini-South, and Rubin (from Left to Right)



Some recent photos

❖ AuxTel (Auxiliary Telescope)



Some recent photos

❖ Rubin Observatory (under construction)



Some recent photos

- Rubin Observatory (under construction)



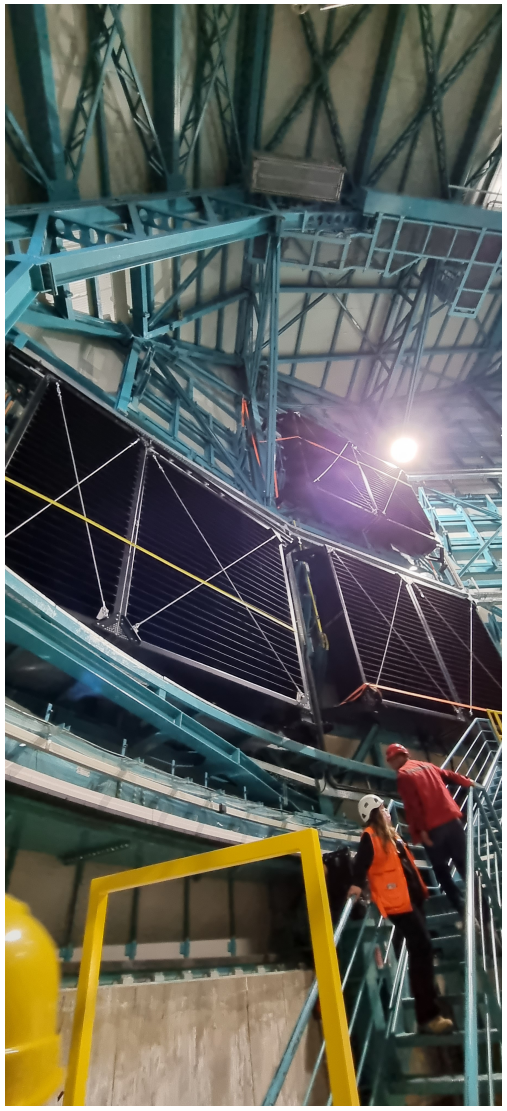
Some recent photos

❖ Rubin Observatory – M1M3 & Coating Facility

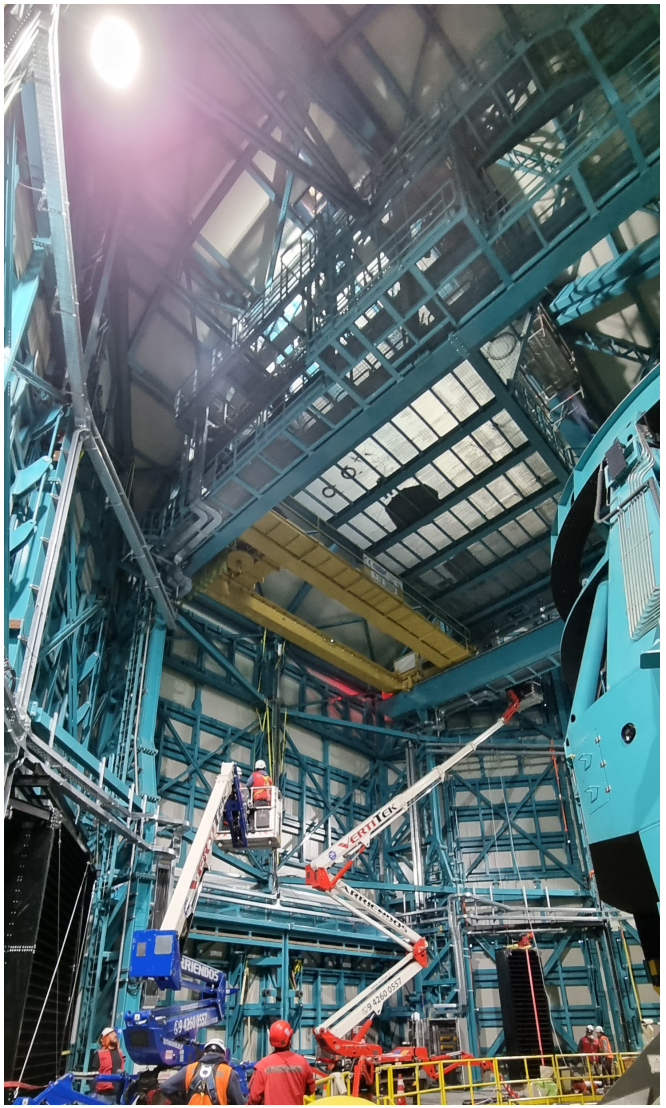


Some recent photos

❖ Rubin Observatory – Inside the Dome







Some recent photos

❖ Rubin Observatory – Observing & Control Room



Thank you

- Upcoming Rubin event:
  - PCW2023 – Aug 7 -11, 2023 at Tucson, AZ

- Any questions?