

# Closing Remarks on Opportunities for Engagement

Connie Walker, Co-Director,  
IAU Center for the Protection of the Dark & Quiet Sky from  
Satellite Constellation Interference (CPS)  
and Scientist at NSF's NOIRLab

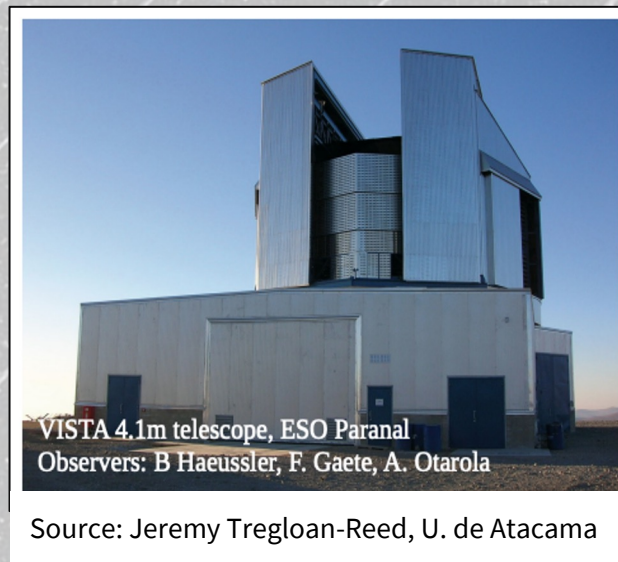
# Overview

- Opportunities for engagement in progress and planned as presented by several speakers
- Introduction to a vehicle for opportunities to engage, the IAU CPS or the International Astronomical Union's Center for the Protection of the Dark & Quiet Sky from Satellite Constellation Interference
- Specifically, the IAU CPS "Hub" to engage with: **the Industry Hub**, as well as future symposia.



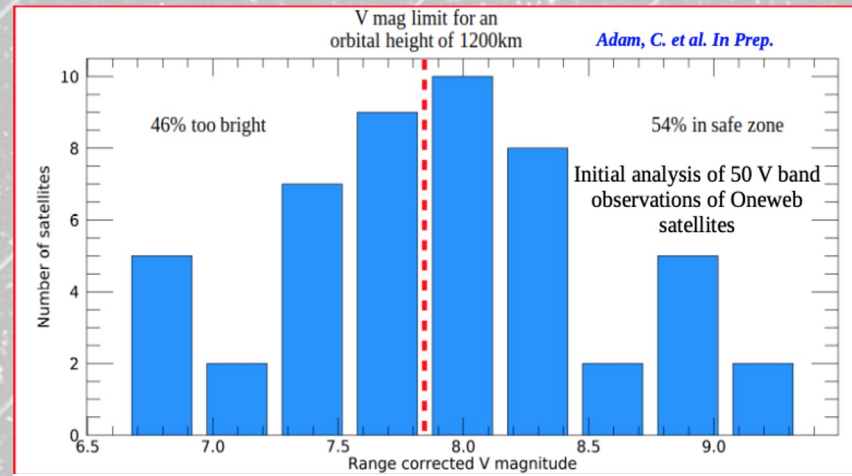
# Sharing the Sky

- Jeremy Tregloan-Reed, Chilean astronomical community
- Satellite constellations in LEO → services beneficial to society
- However, not at any cost → the sky is for all humanity
- Next Steps: through partnerships between satellite operators and astronomers, can converge on mitigation strategies that serve both communities
  - e.g., Through access to observing networks → test reflective brightness mitigation designs
  - Harness collective skills (without NDAs?)



# Being responsible by design

- OneWeb is actively working with the astronomical community (Ruth Prichard-Kelly)
- Observatories collecting data useful to the design of OneWeb's next generation
- Next Steps: Regulators around the world to require responsible behavior before licensing granted
- OneWeb considers the astronomy community a partner in the shared use of outer space.



Source: Jeremy Tregloan-Reed, U. de Atacama

# Predicting Bright Satellite Passes

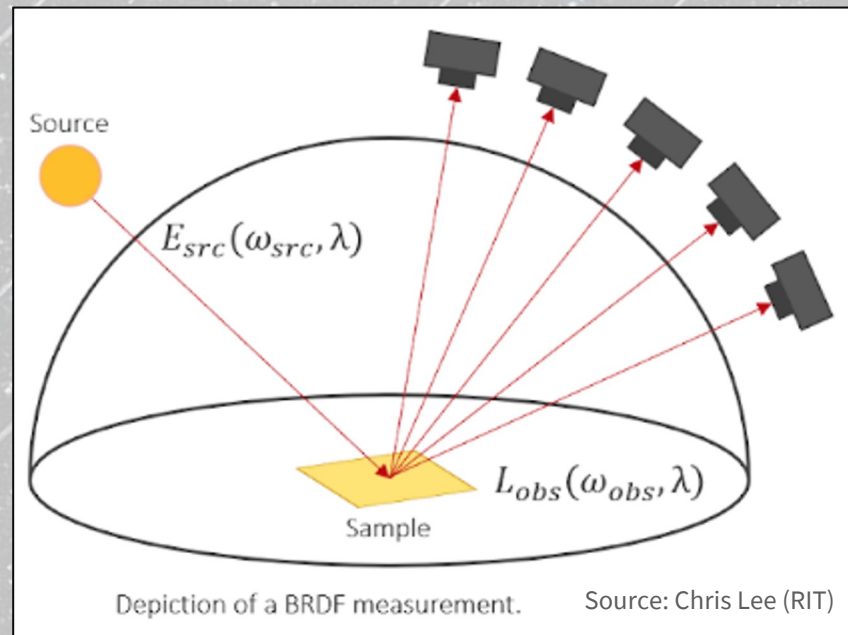


- Dept of Commerce, Office of Space Commerce & AeroSpace Corp (Mark Skinner)
- Open Architecture Data Repository (OADR) Prototype
- Rapid and accurate prediction of objects in space
- For space object collision avoidance
- Existing, demonstrated capability
- Next Steps: leverageable → passage predictions could be provided to astronomers & sat operators when satellite in the FOV of observatories



Source: NOAA

- Active collaboration between industry and astronomers is the most promising path to identifying and applying solutions. Industry is eager to include the scientific world in this effort (Chris Hofer, Amazon Kuiper)
- Next steps: Help from the NIST community on predictive tools, especially labs that could perform testing in advance.



# Mitigating Brightness

- Brightness mitigation requires accurate characterization of material reflectance across the solar spectrum
- NIST (Heather Patrick) stands ready
- Next Steps: Comparisons of lab vs observational measurements
- Follow-on workshops to raise awareness and continue exploring mitigation solutions.

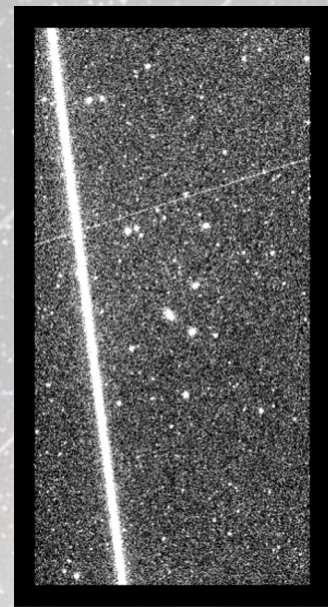


Goniometer of the Rochester Institute of Technology-Two (GRIT-T). Image Credit: C. Lee  
J. Harms, C. Bachmann, B. L. Ambeau, J. Faulring, A. Ruiz Torres, G. Badura, E. Myers,  
2017. "A fully-automated laboratory and field-portable goniometer used for performing  
accurate and precise multi-angular reflectance measurements," *Journal of Applied Remote  
Sensing*, 11(4): 046014-1-046014-15, <https://dx.doi.org/10.1117/1.JRS.11.046014>.

# Using a Multi-pronged Approach



- No combination of mitigations will eliminate impact on optical astronomy. (Richard Green, U. Arizona)
- Meeting targeted apparent brightness = minimum step to preclude substantial scientific loss & visual impact.
- This symposium → expanding the collegiality and spirit of partnership between our two communities
- Next Steps: to include more satellite operators and observatories in useful and productive engagement



Source: Pat Seitzer (U.MI)

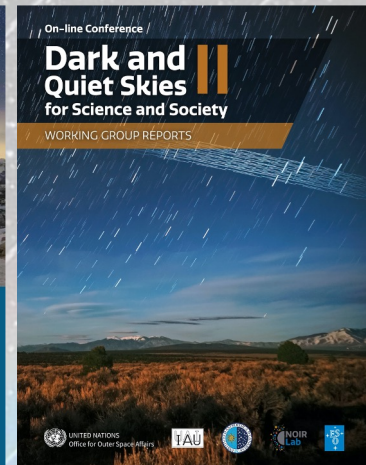
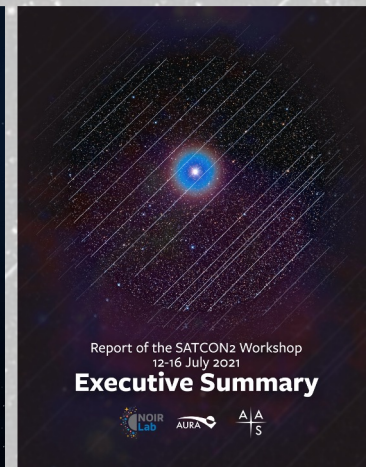




# Addressing the impact of satellite constellations on astronomy

- 2019:** First constellation of 60 Starlinks launched in May
- 2020:** Identify the issues; formulate recommendations for mitigation: [SATCON1](#), [Dark & Quiet Skies I](#)
- 2021:** Identify pathways to implement recommendations: [SATCON2](#), [Dark & Quiet Skies II](#)
- 2022:** Take the pathways to implement recommendations

 **IAU Center on the Protection of the Dark & Quiet Sky from Satellite Constellation Interference**





# Mitigation Recommendations from SatCon1



1. Software to mask satellite trails.
2. Software to predict satellite passes.
3. Detailed simulations of effects of trails.
4. Design to be faint prior to launch (BRDF studies).
5. Fainter than  $V \sim 7$ th mag.
6. Avoid flares and glints.
7. Clump satellites closely together after launch.
8. Coordinated observation campaigns of satellite brightness.
9. Updated ephemerides.
10. New standard for ephemerides.



# *A Pathway Forward: International Astronomical Union (IAU) Centre for the Protection of the Dark & Quiet Sky from Satellite Constellation Interference*



## Mission

- The Centre will **coordinate efforts and unify voices** of the global astronomical community
- The Centre will bring together astronomers, industry, policy experts and the wider community and **act as a bridge between all stakeholders**
- The Centre will **produce and disseminate information and resources**
- The Centre will **continue research** on the satellite constellation issues to arrive at feasible and implementable solutions in the areas of:
  - A hub for observations, software, etc. (SatHub)
  - Policy
  - Community Engagement
  - Industry and technology

**Apply for membership  
here: [cps.iau.org](https://cps.iau.org)**



# Industry Hub Objectives

Chris Hofer (Amazon Kuiper) & Tim Stevenson (SKAO)



- **Raise awareness** within satellite community that constellations and even smaller satellites have potential to adversely impact astronomy
- **Foster technical collaboration** across stakeholders - private satellite sector, government and astronomers
- **Promote development of tools** for satellite operators to predict and assess visibility of their systems, prior to launch and after
- **Further develop best practices and mitigations** to reduce visibility, and share lessons learned
- **Encourage satellite operators to commit to and adopt the known best practices and mitigation techniques** to reach the target brightness

Apply for membership  
here: [cps.iau.org](https://cps.iau.org)



# Industry Hub: Building the Collaboration between Satellite & Astronomy Communities

Chris Hofer (Amazon Kuiper) & Tim Stevenson (SKAO)



- Industry Hub established to engage the technical insights of both satellite stakeholders and astronomers to build the tools and resources to spur voluntary adoption of mitigations
- Most space operators are committed to being good stewards of space, but require familiarization with the effect on astronomy, and tools to assess their project and to evaluate mitigations
- Operators are more likely to voluntarily adopt best practices that are well-defined, with performance-based metrics that leave room for customization and innovation
- Mitigations are more likely to be incorporated if integrated early in the satellite project life-cycle, avoiding prohibitive delays and costs from retrofitting or change orders



# Industry Hub Leads



**Chris Hofer**

International Team Lead, with responsibility for spectrum policy and satellite coordination at Amazon Kuiper  
[chofer@amazon.com](mailto:chofer@amazon.com)



**Tim Stevenson**

Head of Assurance at the Square Kilometre Array Observatory  
[Tim.Stevenson@skao.int](mailto:Tim.Stevenson@skao.int)

Apply for membership here: [cps.iau.org](https://cps.iau.org)



# Thank you for joining us...

## CONTACT INFORMATION of the Steering Committee

**Dianne Poster**, U.S. Department of Commerce, Chair

dianne.poster@nist.gov

**Susana Deustua**, U.S. Department of Commerce, NIST, Chair

susana.deustua@nist.gov

**Julie Davis**, American Astronomy Society

julie.davis@aas.org

**Richard Green**, Steward Observatory, University of Arizona

rgreen@arizona.edu

**Therese Jones**, Satellite Industry Association

tjones@sia.org

**Mark Mulholland**, U.S. Department of Commerce

mark.mulholland@noaa.gov

**Ashley Vanderley**, National Science Foundation

bevander@nsf.gov

**Connie Walker**, International Astronomical Union's (IAU) Centre for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference (CPS) and National Science Foundation's (NSF) NOIRLab

connie.walker@cps.iau.org

