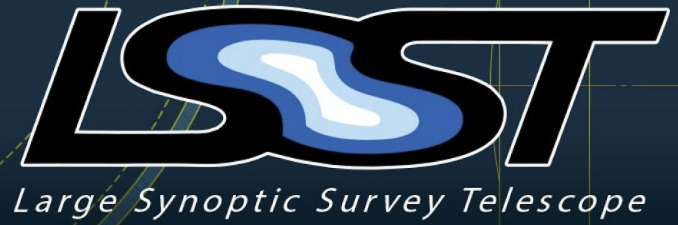
TVS metrics and survey cadence proposals

LSST Project and Community Workshop 2019

Presenter: Federica Bianco (University of Delaware)



TVS Task Forces 2019

Task-oriented groups that attract cross-disciplinary support from subgroups

MAF Task Force

Generating Metrics for the 14 TVS-led LSST Cadence White Papers

federica bianco
Supernovae
Sjoert van Velzen
Tidal Disruption Events

Stellar variability in crowded fields

Testing the LSST photometric pipeline in crowded and extremely crowded fields

Science Platform and Stack club

Catching up with stack club and testing the LSST science platform for TVS needs

Commissioning

Generating a commissioning plan for LSST

TVS Task Forces 2019

MAF Task Force

Generating Metrics for the 14 TVS-led LSST Cadence White Papers

federica bianco	Supernovae
Sjoert van Velzen	Tidal Disruption Events
Victoria Ashley Villar	Supernovae
Stephen Ridgway	Fast Transients
Katja Bricman	Tidal Disruption Events
Derek Fox	Fast Transients
Maria Teresa Botticella	Supernovae
Robert Szabo	Pulsating Variables
Martin Donachie	Microlensing
Fabio Ragosta	GW
Xiaolong Li	
Ming Lian	

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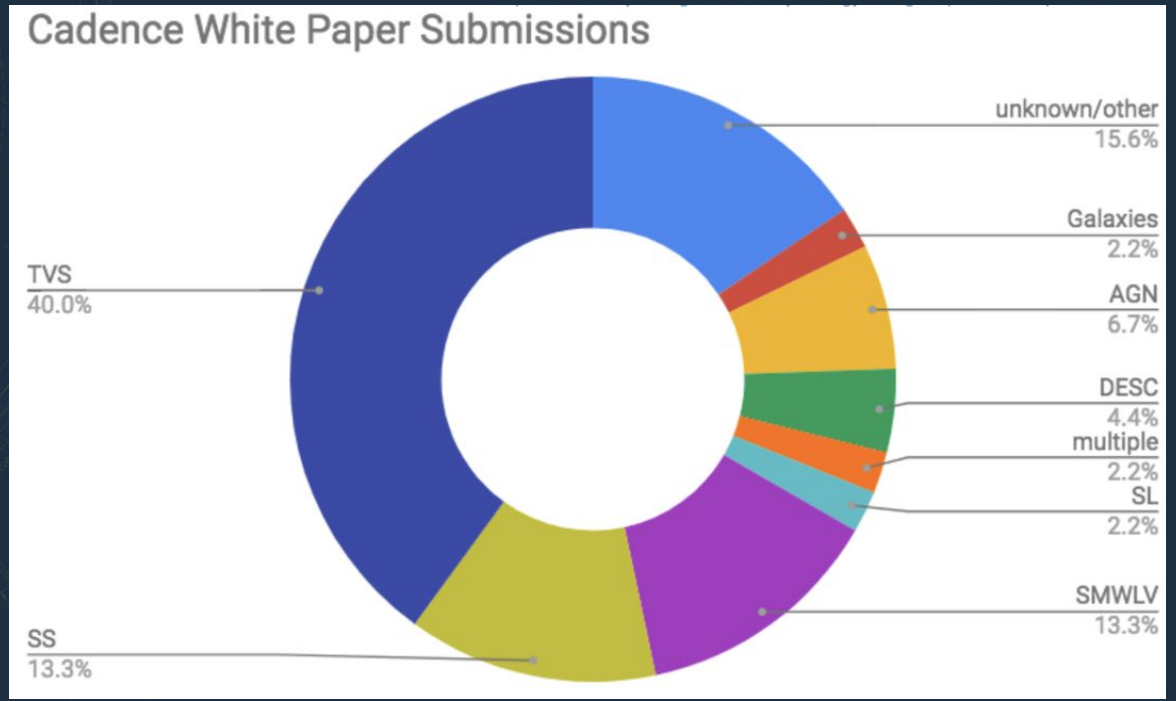
TVS submissions

Extremely sensitive to observing strategy

- Aliasing
- Coobserving (e.g. WFIRST)
- Colors information
- Filter selection
- Lightcurve density
- Lightcurve persistence
- Field selection (e.g. galactic plane)
- Exposure (e.g. inter-image time scales)



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TVS submissions

Extremely sensitive to observing strategy

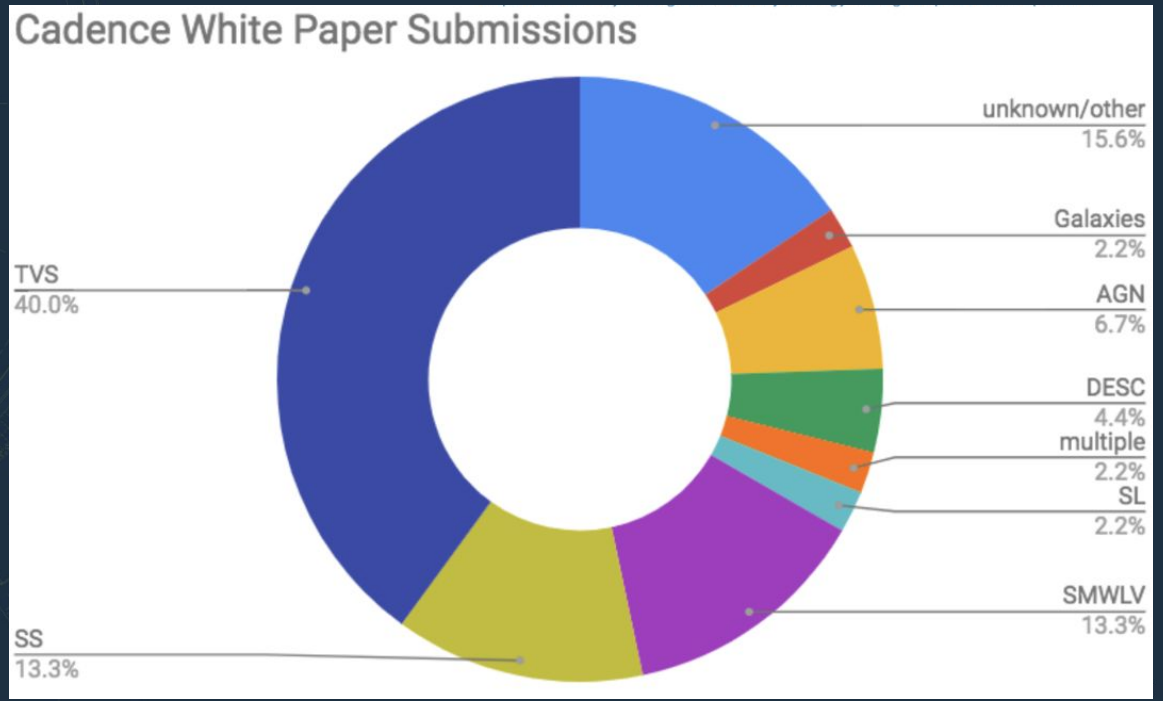
- ToO to follow up GW alerts (Margutti et al 2018)

Thursday 11AM

LSST-LIGO Synergy

T. Tyson

Coronado I



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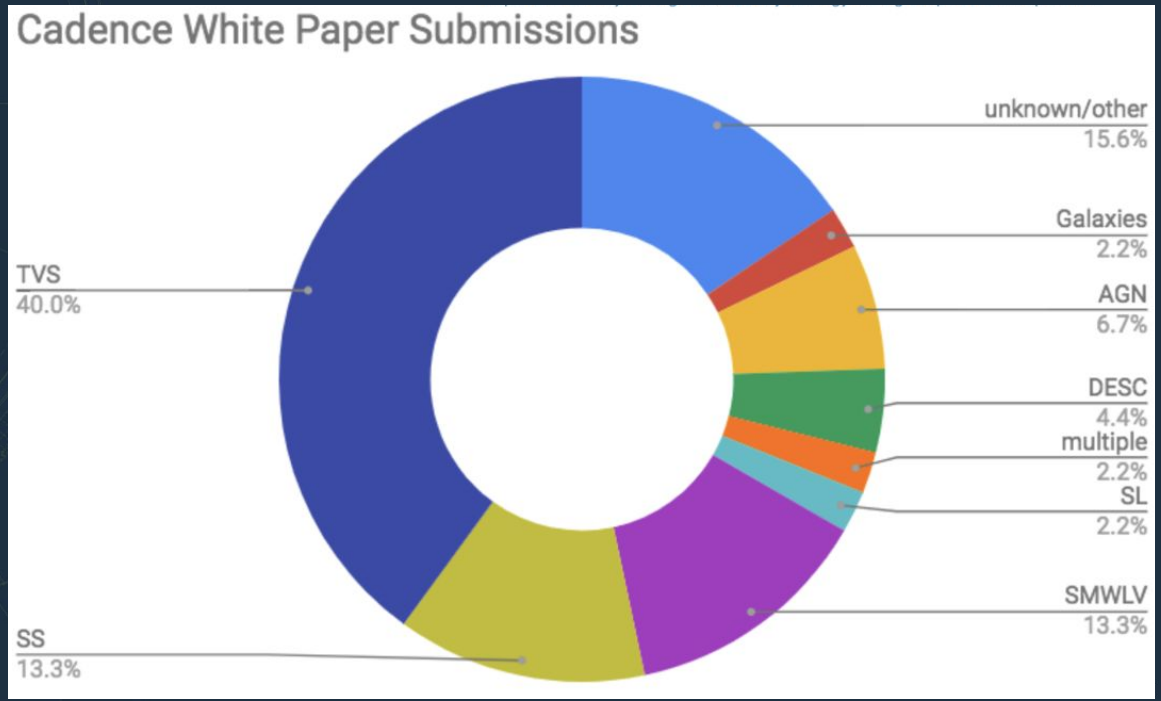

SAC RECOMMENDATIONS

https://project.lsst.org/groups/sac/sites/lsst.org.groups.sac/files/OpSim_experiments.pdf

The LSST Science Advisory Committee was charged with recommending simulation experiments to be done based on these white papers.

A Report from the LSST Science Advisory Committee: Recommendations for Operations Simulator Experiments Based on Submitted Cadence Optimization White Papers

The LSST Science Advisory Committee

April 2019

- The assumed footprint of the Wide-Fast-Deep survey; we suggest four footprints in § 4.1, defined by their North and South limits and the definition of what constitutes low latitude.
- The cadence of the WFD observations, which involves decisions about the nature of a single visit, and how the sky is covered on a nightly, monthly and yearly basis.
- The choice of mini-surveys, including those that push further North, further South, and to lower Galactic latitudes than the WFD survey;
- Deep Drilling fields and their cadence.
- Additional observing programs, such as Target of Opportunity and observations coordinated with other surveys.

SAC RECOMMENDATIONS

https://project.lsst.org/groups/sac/sites/lsst.org.groups.sac/files/OpSim_experiments.pdf

SAC RECOMMENDATIONS

1. OpSim involvement in MAF creation

A Report from the LSST Science Advisory Committee: Recommendations for Operations Simulator Experiments Based on Submitted Cadence Optimization White Papers

The LSST Science Advisory Committee

April 2019

A key tool in all this work will be the development of metrics to be run on OpSim outputs, to assess the scientific impact of each of these choices. Without quantitative metrics, it will not be possible to understand the tensions between different science programs as the survey strategy algorithms are modified. The OpSim team may need additional resources to write those metrics in the Metric Analysis Framework.

The SAC is concerned about how this work will be done; experience has shown that metrics are often only coded up when the OpSim team is closely involved in the effort. We recommend that the OpSim team be given the resources to code the metrics suggested in the white papers; the SAC is happy to work with them to identify those metrics we find most urgent.

SAC RECOMMENDATIONS

https://project.lsst.org/groups/sac/sites/lsst.org.groups.sac/files/OpSim_experiments.pdf

1. OpSim involvement in MAF creation
2. Use Community for communication

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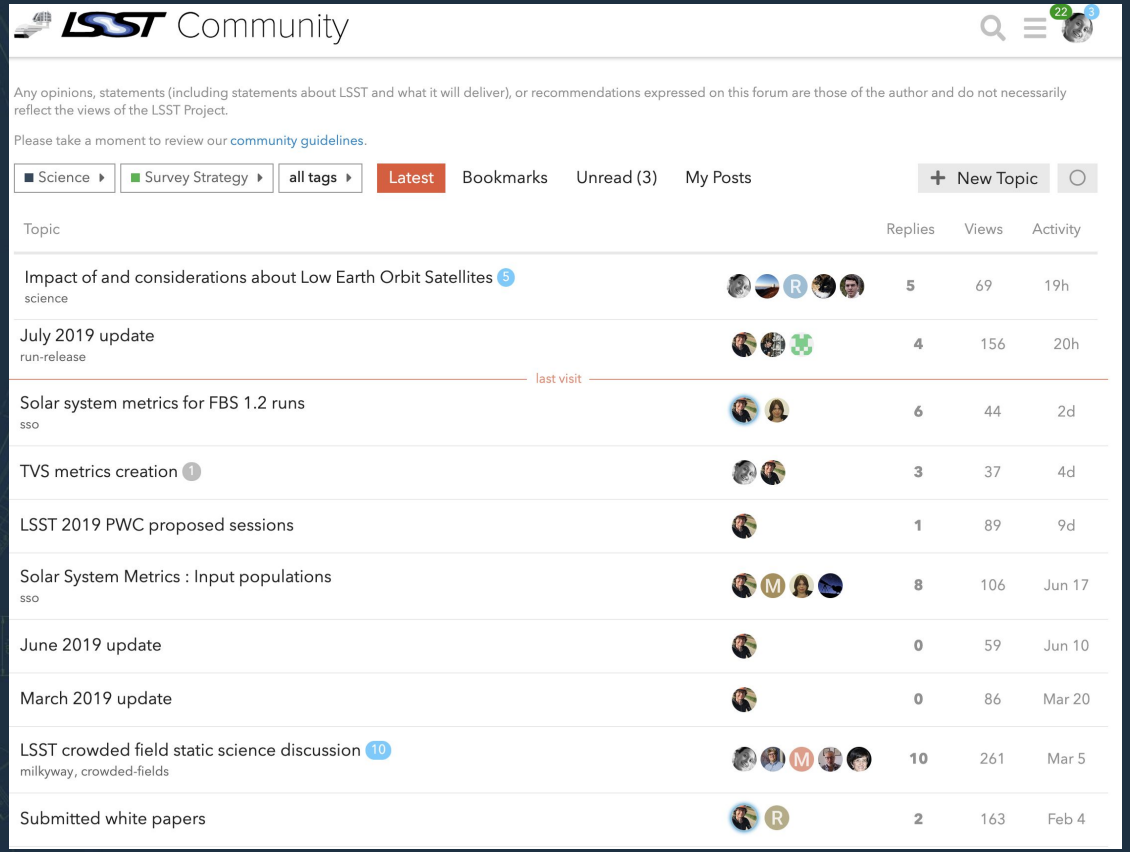
The SAC and the OpSim team are eager for feedback on all topics discussed above, especially as the OpSim outputs become available. As indicated earlier, we recommend that `https://community.lsst.org/c/sci/survey-strategy` be used for discussion, and specific recommendations via a google form at `https://tinyurl.com/OpSim-feedback`.

SAC RECOMMENDATIONS

https://community.lsst.org/c/sci/survey-strategy

1. OpSim involvement in MAF creation
2. Use Community for communication



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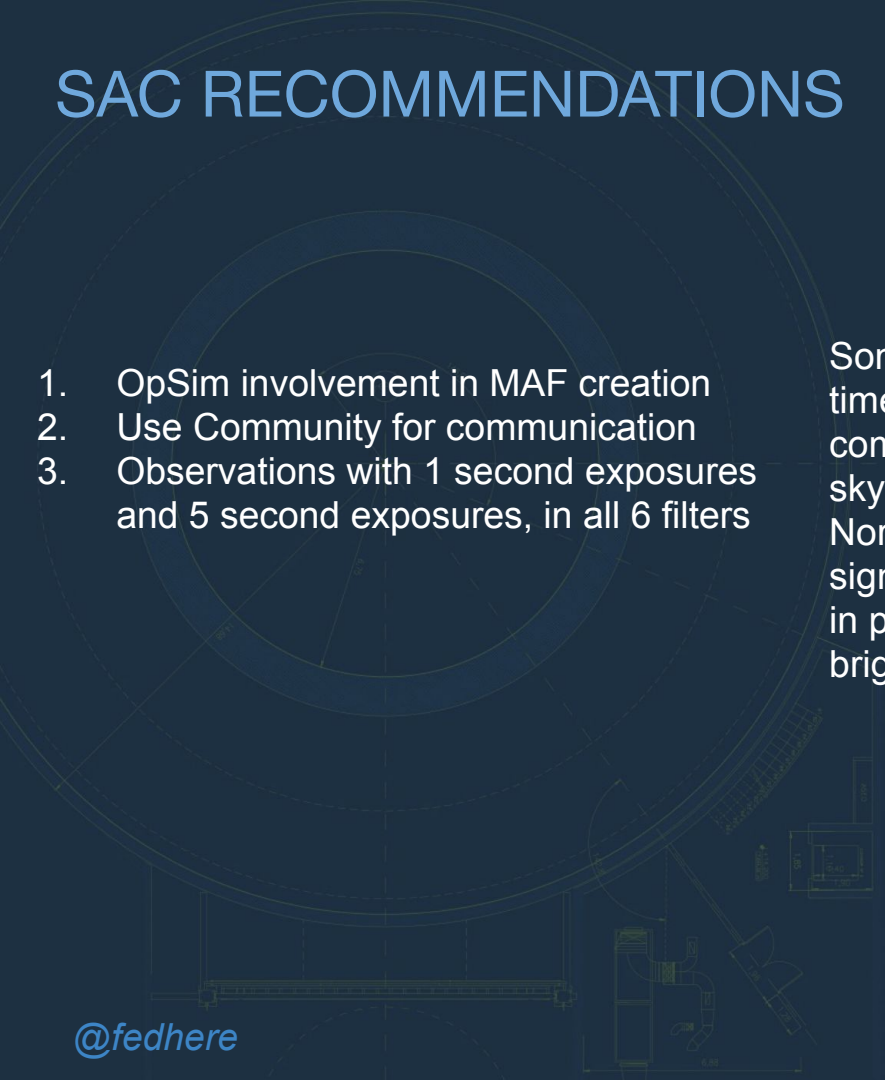
SAC RECOMMENDATIONS

https://project.lsst.org/groups/sac/sites/lsst.org.groups.sac/files/OpSim_experiments.pdf

1. OpSim involvement in MAF creation
2. Use Community for communication
3. Observations with 1 second exposures and 5 second exposures, in all 6 filters

Some of the white papers made suggestions for exposure times other than 30 seconds per visit. The most compelling of these were to do photometry over the entire sky that LSST would reach (including the extensions to the North, South, and at low Galactic latitudes) with significantly shorter exposures: 1 second and 5 seconds, in particular, to extend the LSST photometric system to brighter magnitudes.



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3. Observations with 1 second exposures and 5 second exposures, in all 6 filters
4. Experiments in which the u-band exposure time is varied

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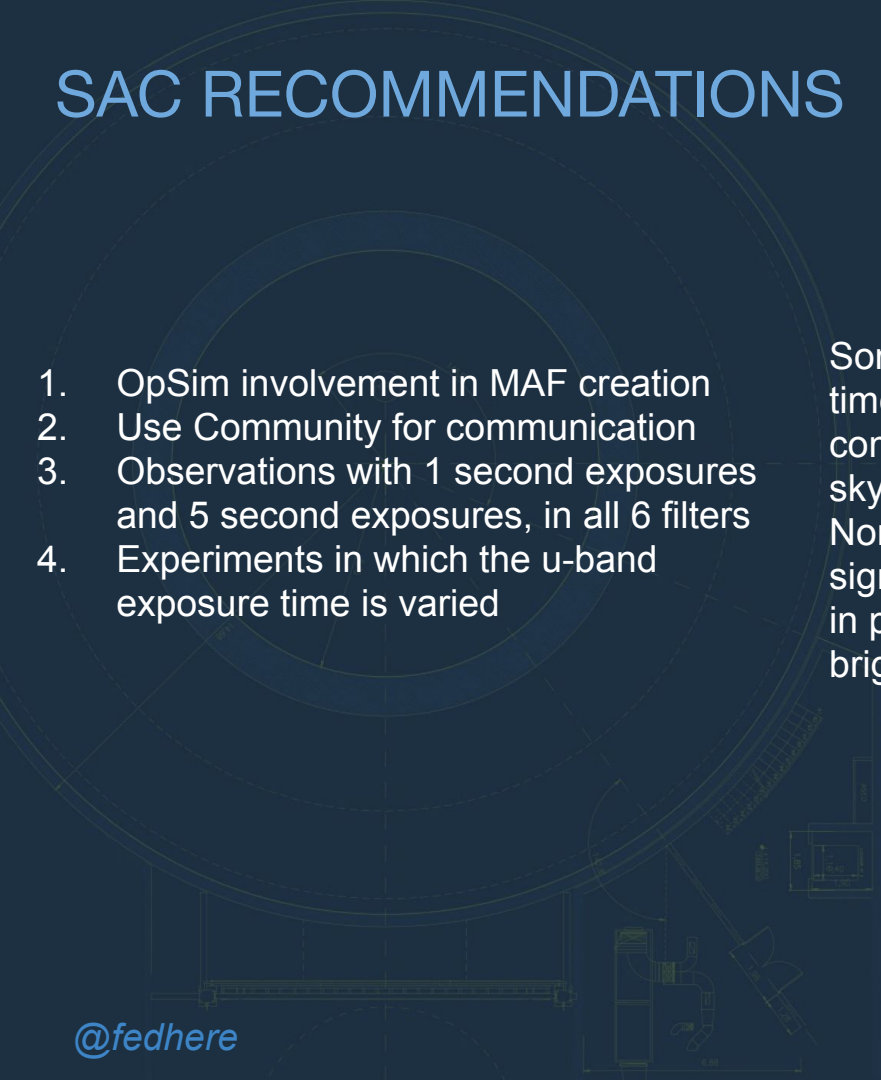

SAC RECOMMENDATIONS

https://project.lsst.org/groups/sac/sites/lsst.org.groups.sac/files/OpSim_experiments.pdf

1. OpSim involvement in MAF creation
2. Use Community for communication
3. Observations with 1 second exposures and 5 second exposures, in all 6 filters
4. Experiments in which the u-band exposure time is varied
5. There is no restriction on the filters in which the second visit happens.
6. The 2nd visit is forced to be in a different filter
7. r+r
8. g+i
9. g+i+g following night
10. The Presto-Color option
11. There were no strong requests for repeat observations in u or y.

The Choice of Fields and Filters on a Given Night, and in a Given Month

Some white papers requested that exposures in r be repeated in r (as this maximizes sensitivity to faint red Kuiper-Belt Objects) while others emphasized the need for pairs of g and i exposures on a given night, to optimize the detection of tidal disruption events around supermassive black holes in galaxy nuclei. A particularly interesting suggestion is made by Bianco et al, “Presto-Color: An LSST Cadence for Explosive Physics & Fast Transients”, which includes three observations per night in two different filters, as a way to identify and characterize fast transients. **No one of these observing modes need be carried out through the whole ten-year survey, and there is a strong argument for using different modes at different times.**

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SAC RECOMMENDATIONS

https://project.lsst.org/groups/sac/sites/lsst.org.groups.sac/files/OpSim_experiments.pdf

1. The universal cadence for all 10 years (which has defined the baseline cadence).
2. Split the WFD sky in two equal-area halves, separated by declination. Observe each half in alternate years, but obtain modest coverage over the remaining footprint.
3. As the above, but devoting the first and last years of the survey to full-footprint observations.
4. Split the sky into three equal parts, defined by declination.
5. Split the sky into six equal parts, and roll in the six years in between Years 1.5-7.5.

Rolling Cadence and the Length of a Season

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SAC RECOMMENDATIONS

https://project.lsst.org/groups/sac/sites/lsst.org.groups.sac/files/OpSim_experiments.pdf

1. A definition of the WFD footprint with no lowlatitude cut at all.
2. Olsen et al. “A Big Sky Approach to Cadence Diplomacy” white paper, both the bulge and the rest of the low-latitude region receive 250 visits over ten years.
3. WFD depth and cadence in the bulge, and up to 250 visits for the rest of the low-latitude sky
4. Gonzalez et al. WFD depth and cadence in the bulge, but doubling the number of i-band visits (and reducing the number of visits in the other bands) to study proper motions in the bulge
5. Street et al. a visit every 3 days in one of griz to every bulge field. This is inspired by the white paper by

Low Galactic latitudes

SAC RECOMMENDATIONS

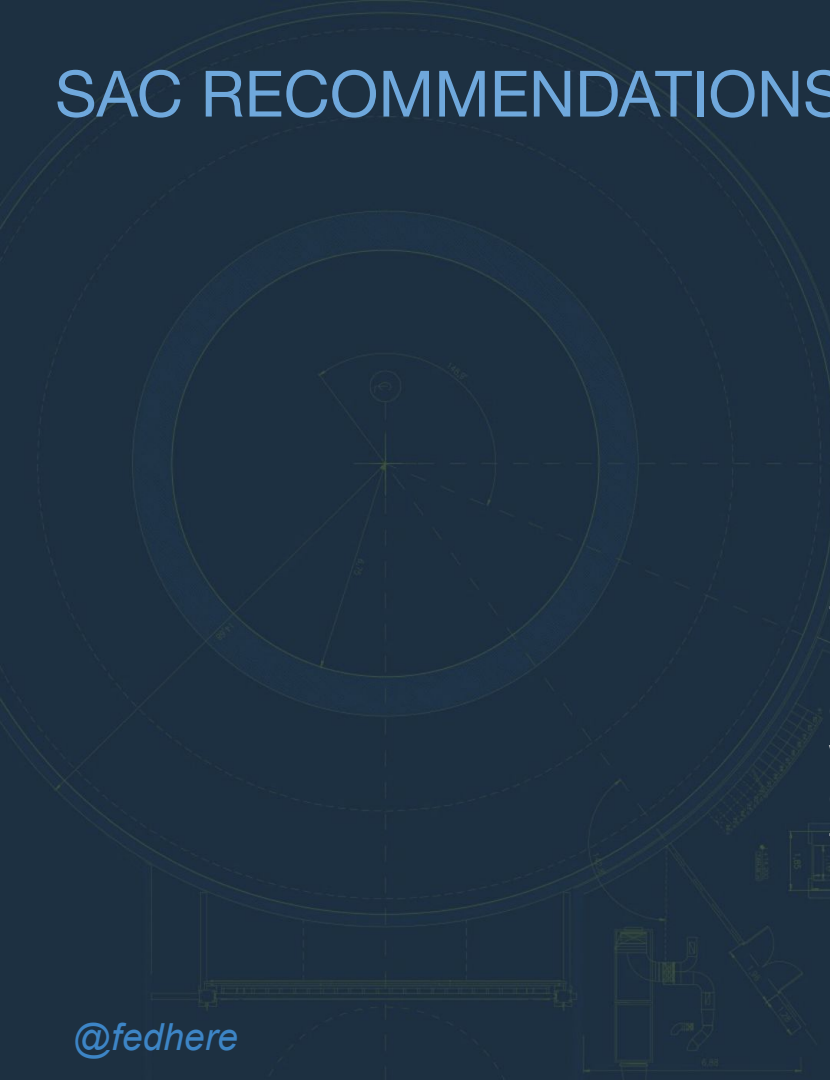
https://project.lsst.org/groups/sac/sites/lsst.org.groups.sac/files/OpSim_experiments.pdf

1. Margutti et al, “Target of Opportunity Observations of Gravitational Wave Events with LSST”. The SAC recommends that an OpSim experiment incorporate ToOs from gravitational wave triggers as outlined in Margutti et al. The SAC recommends re-visiting the assumptions made in this white paper in six to twelve months.
2. Thomas et al, “Unveiling the Rich and Diverse Universe of Subsecond Astrophysics through LSST Star Trails,” suggests a specific experiment in which images are trailed to look for very short timescale variability. This would take a small amount of time, and the resulting data will not contribute directly to the LSST main survey.

Specialized Observing Modes

SAC RECOMMENDATIONS

https://project.lsst.org/groups/sac/sites/lsst.org.groups.sac/files/OpSim_experiments.pdf



DDF

Only a few white papers made specific suggestions for cadence in the default DDFs. The two that should be experimented with are the following: DESC & AGN

There were other suggestions for DDFs selected in coordination with WFIRST, both at high latitudes (to observe supernovae) and low (for microlensing). These would require coordination with WFIRST both in position on the sky, and in time, to interleave the observations with the two facilities.

OPSIM RUNS

https://project.lsst.org/groups/sac/sites/lsst.org.groups.sac/files/OpSim_experiments.pdf

Pairs

- no pairs
- pairs in the same filter 2
- pairs in mixed filters 1
- pairs in the same filter, 2x15s visits
- pairs in mixed filters, 2x15s visits

Rolling

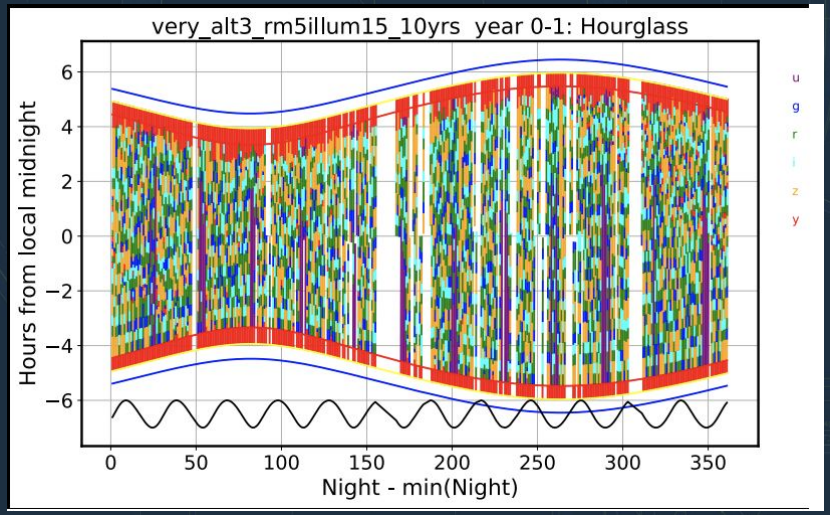
- Modified rolling, 2 bands, 5% background WFD 1
- Modified rolling, 2 bands, 10% background WFD
- Modified rolling, 2 bands, 20% background WFD
- Modified rolling 3 bands, 5% background WFD 1
- Modified rolling 3 bands, 10% background WFD
- Modified rolling 3 bands, 20% background WFD 1
- Modified rolling 6 bands, 5% background WFD 1
- Modified rolling 6 bands, 10% background WFD
- Modified rolling 6 bands, 20% background WFD
- Simple rolling 2 bands, 20% background WFD
- Simple rolling 3 bands, 20% background WFD
- Simple rolling 5 bands, 20% background WFD
- Simple rolling 10 bands, 20% background WFD

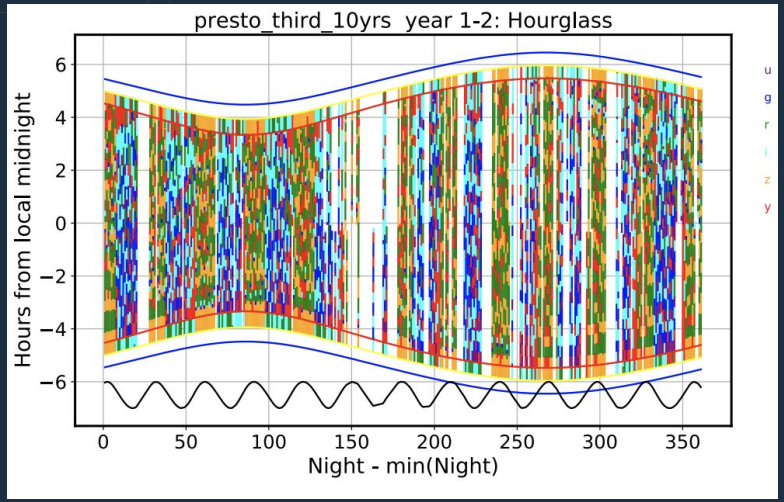
OPSIM RUNS

https://project.lsst.org/groups/sac/sites/lsst.org.groups.sac/files/OpSim_experiments.pdf

New visualizations!!

Hourglass plot





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OPSIM RUNS

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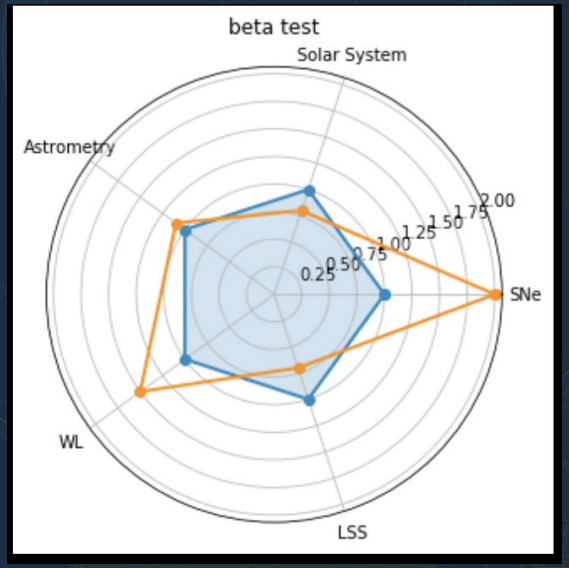
New visualizations!!

This is why you need a Figure of Merit!



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OPSIM RUNS

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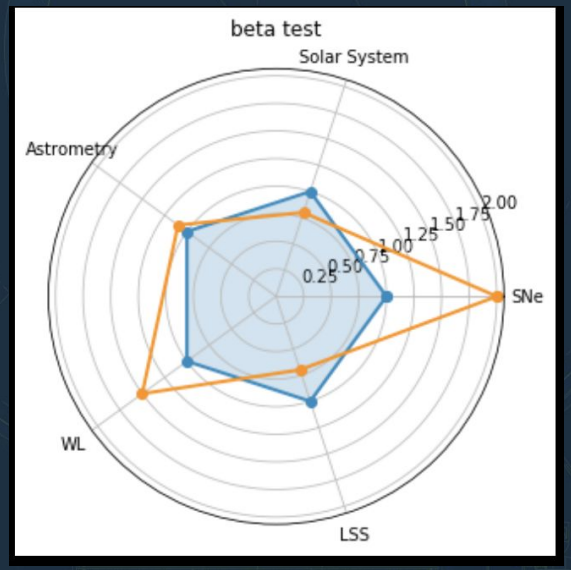
A new problem:
Sofie's choice? | Point of failuere for TVS?



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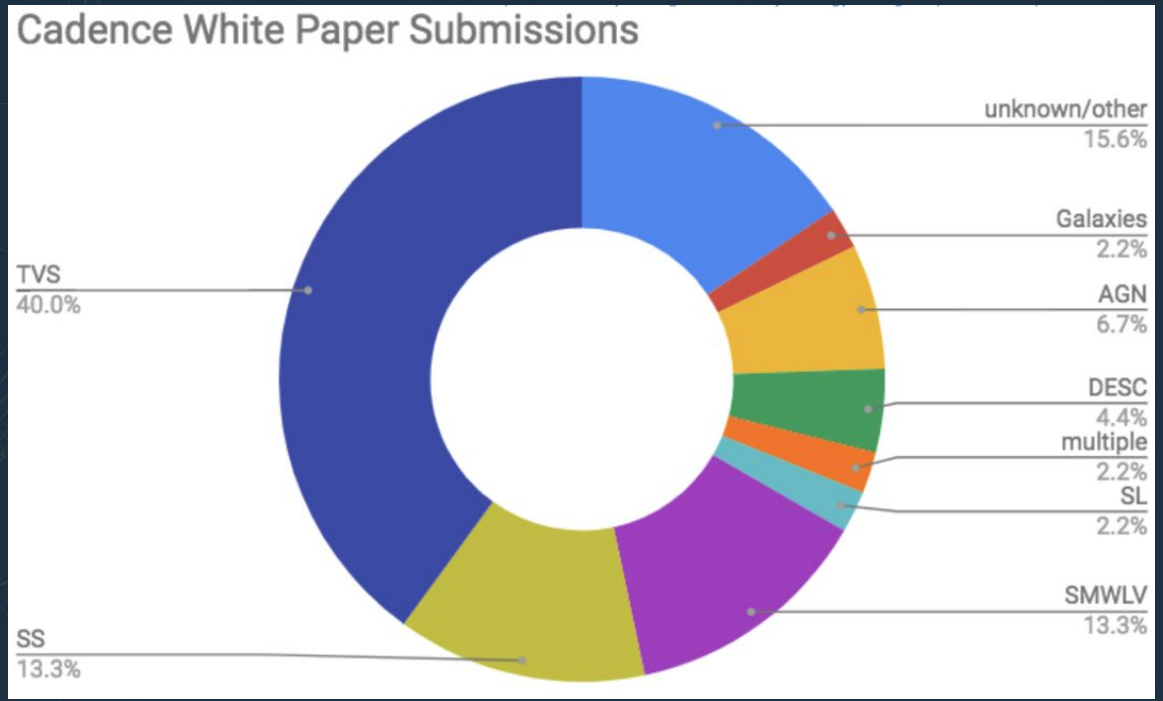

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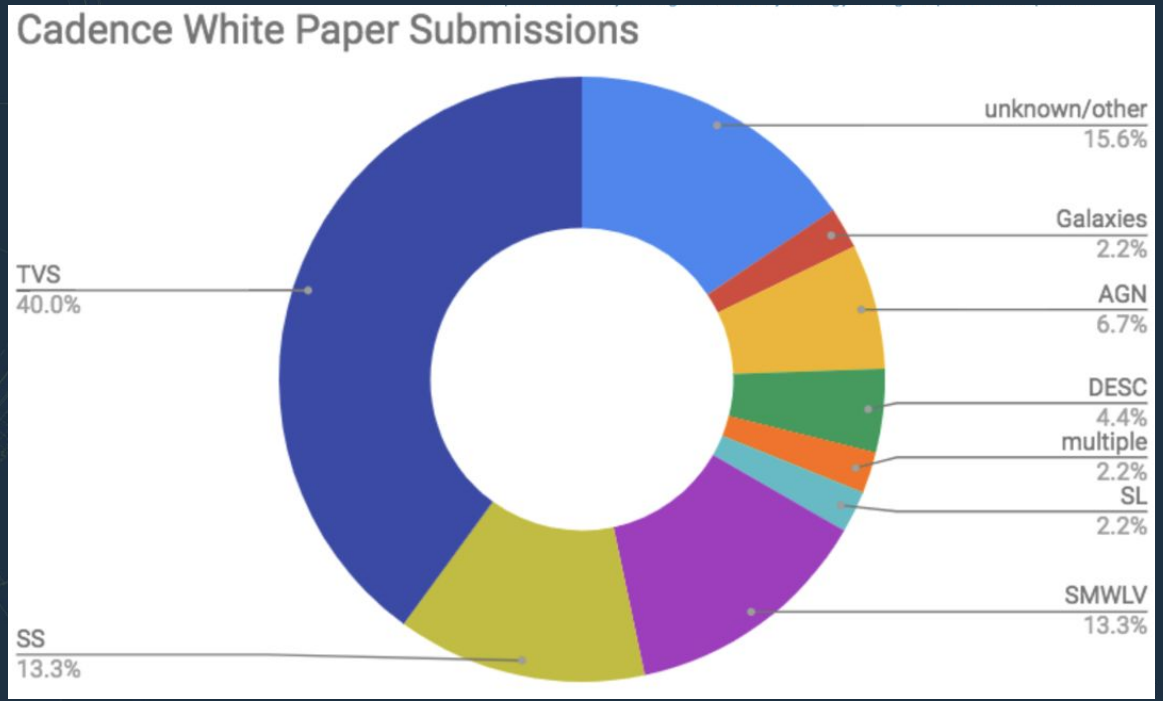

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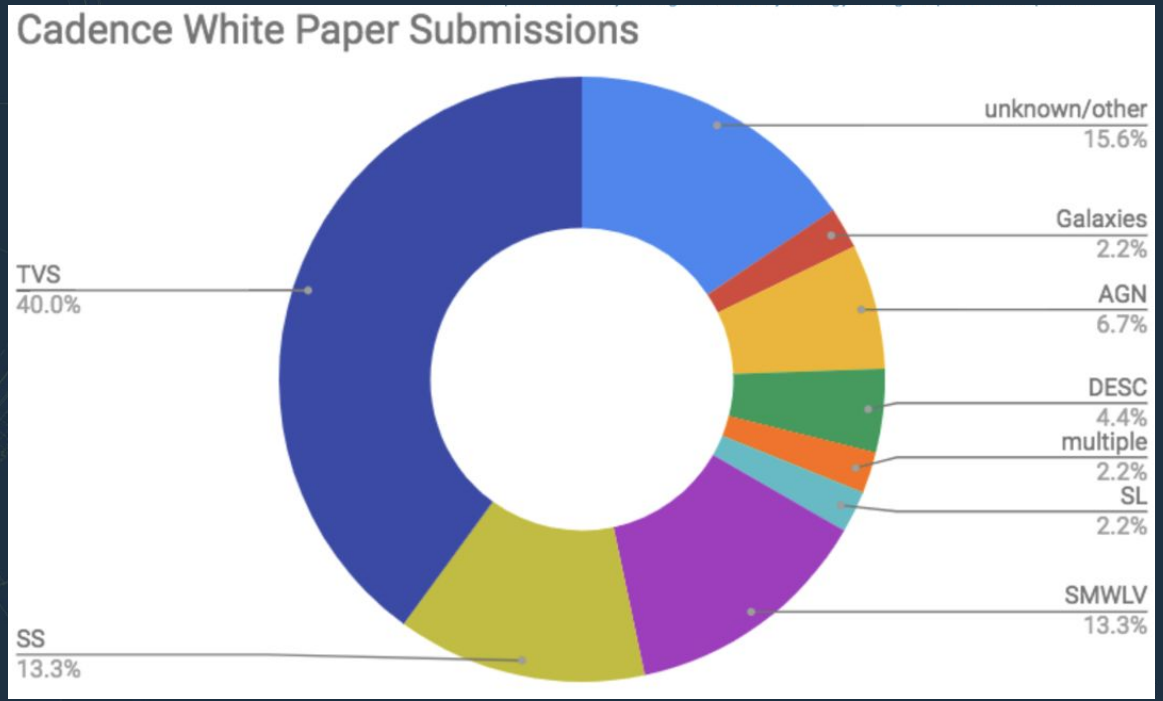
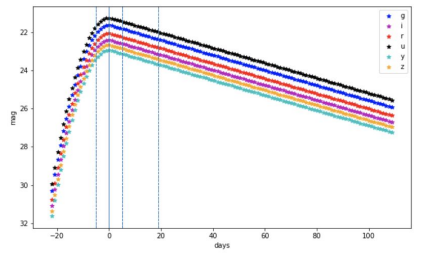


TF results so far

Xiaolong Li, Sjoert vanVelzen, Katja Bricman, Andreja Gomboc



- nObsTotal: Required total number of observations in each band.
- nObsPrePeak: Required Number of observations before peak.
- nObsNearPeak: Required number of observations in each band near peak.
- nFiltersNearPeak: Required number of filters near peak.
- nObsPostPeak: Required number of observations after peak.
- nFiltersPostPeak: Required number of number of filters after peak.

Minimum requirement for detection TDEs proposed by Sjoert van Velzen

- one detection before peak in any band to make sure we can roughly resolve the time/flux at peak, set nObsPrePeak=1;
- detections in three different bands within 10 days of peak to measure the color at peak, set nFiltersNearPeak=3, and nearPeakT=10;
- detections at least two bands post peak within two weeks to measure the change of color, set nFiltersPostPeak=2, and postPeakT=14.

TF results so far

Xiaolong Li, Sjoert vanVelzen,
Katja Bricman, Andreja Gomboc

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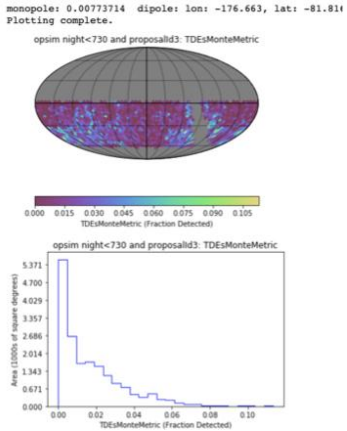
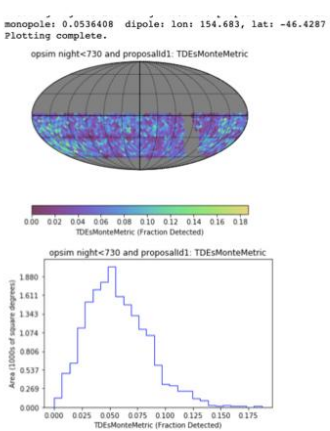
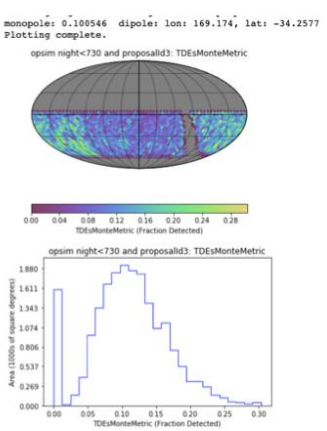


baseline2018



colossus_2667



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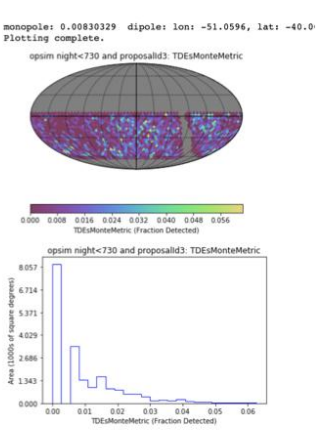

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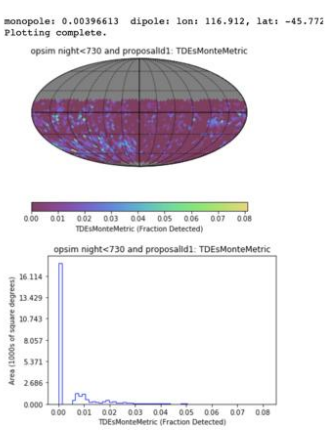
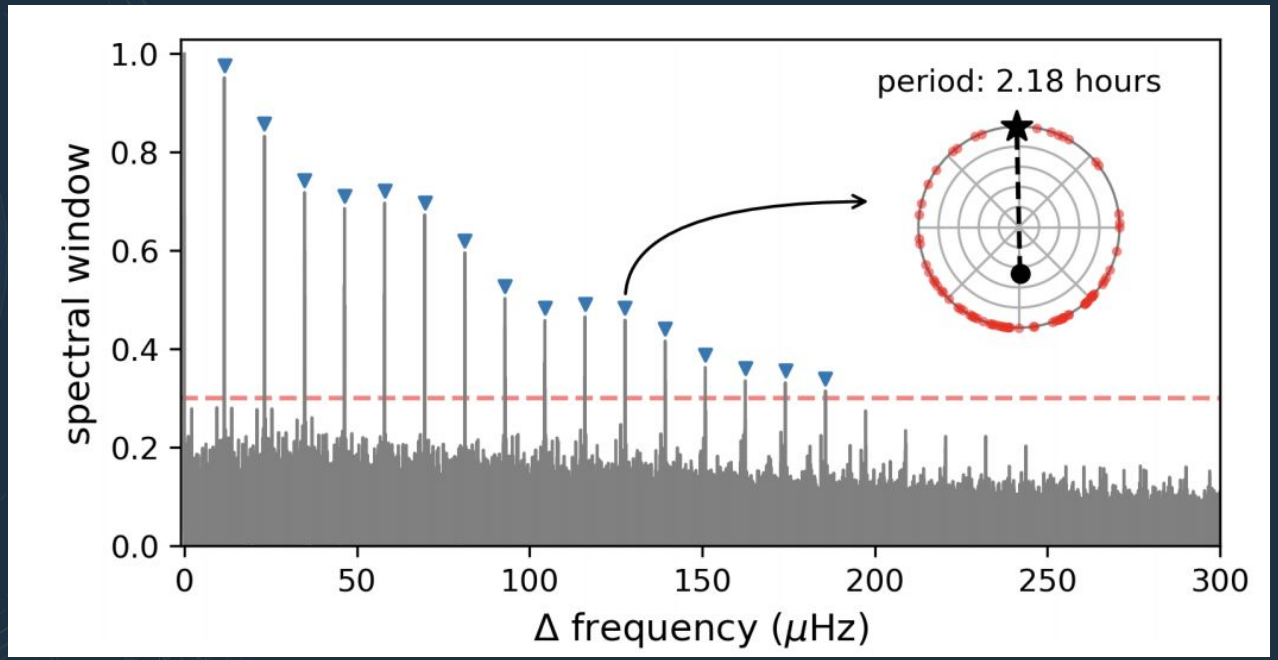


nexus_2097

TF results so far

Ming Li, Keaton Bell



TF results so far

Ming Li, Keaton Bell

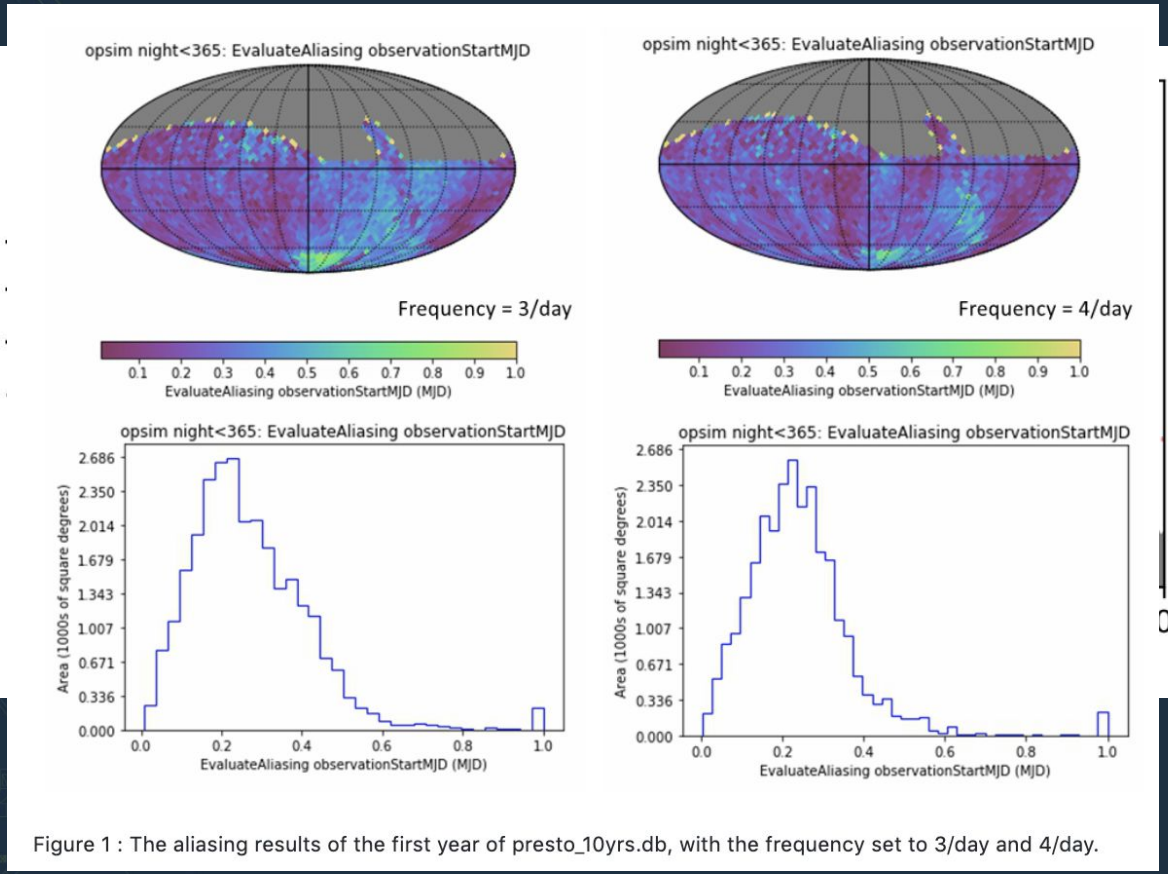


Figure 1 : The aliasing results of the first year of presto_10yrs.db, with the frequency set to 3/day and 4/day.

TF results so far

Ming Li, Keaton Bell

characterize their combined effect instead of just looking at the single worst peak at each pointing. Those worst peaks near one (sidereal or solar) day come from real physical limitations from our orbit that we won't be able to do much about. But the other aliases at higher frequencies (especially harmonics of the daily alias) should be more avoidable.

average strengths of the top n aliases