Transients and Variable LSST sky

federica b. bianco, NYU
The Transient and Variable Stars LSST Collaborations

@fedhere

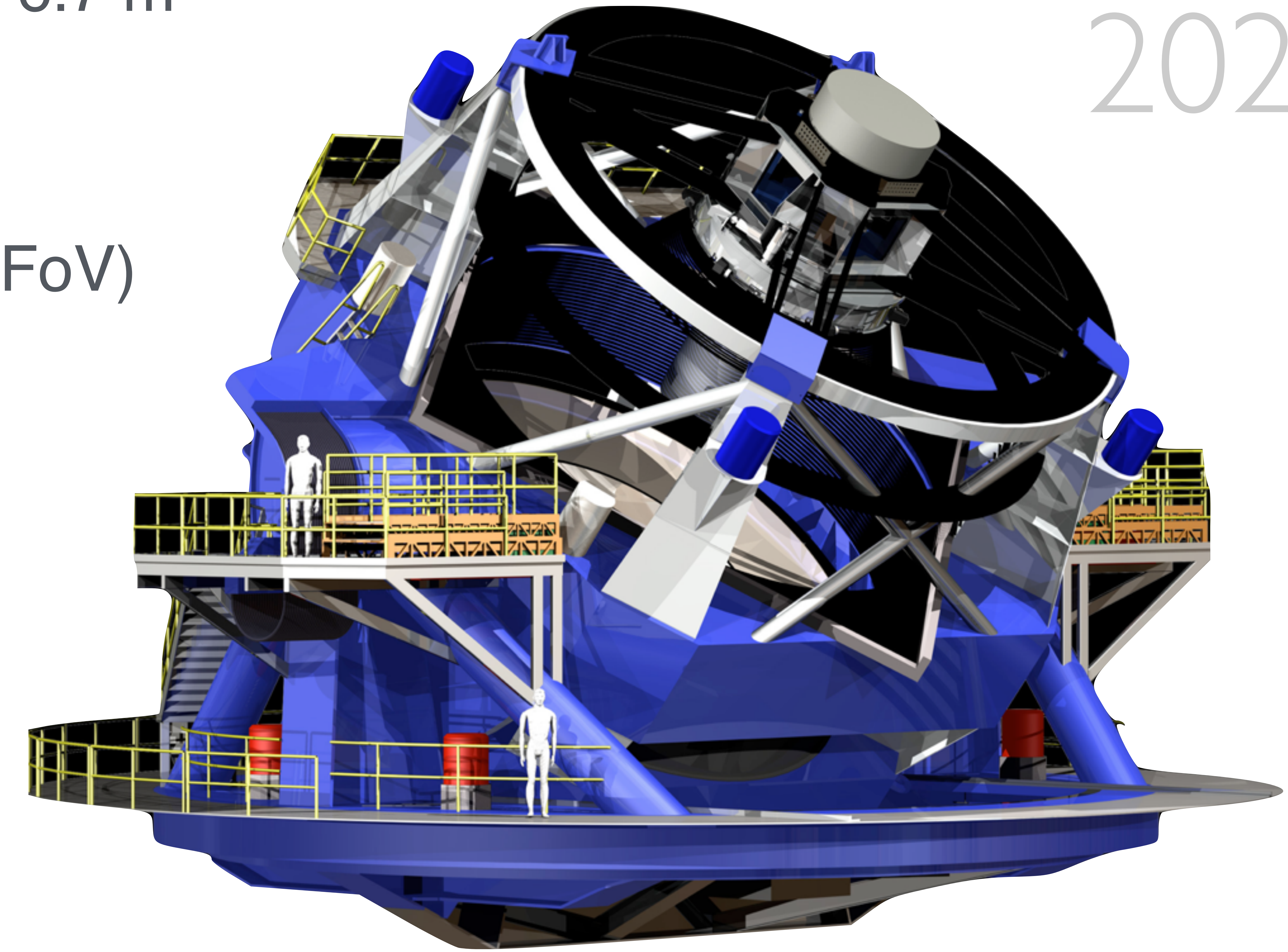
fedhere

Atacama Desert, Cerro Pachon

- effective aperture of 6.7 m
- FoV 9.6 deg^2
- large *etendue*

    (collecting area x FoV)

2022-2032



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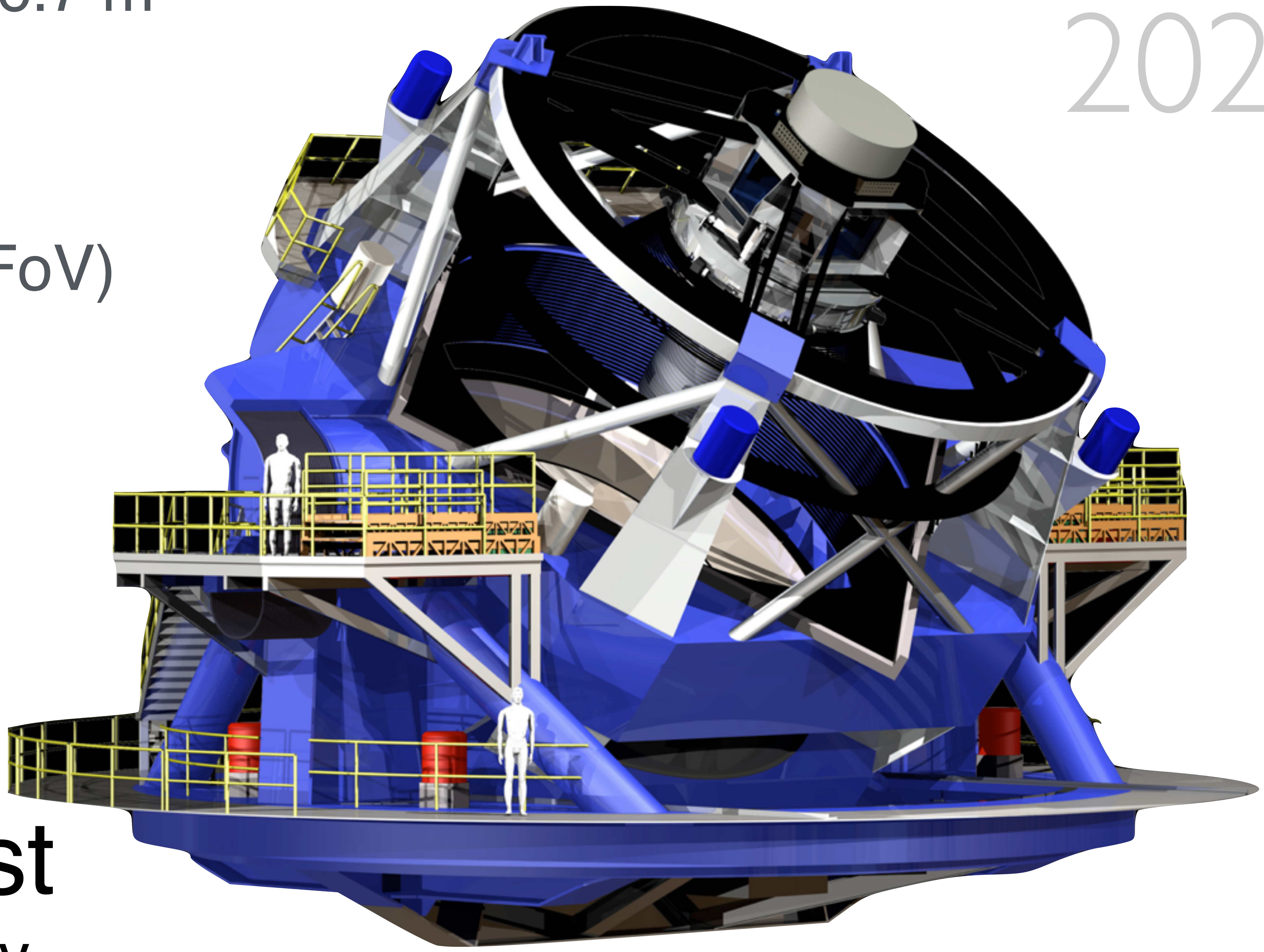

Wide-Deep-Fast

cover large swaths of sky

to faint magnitudes

in a short amount of time

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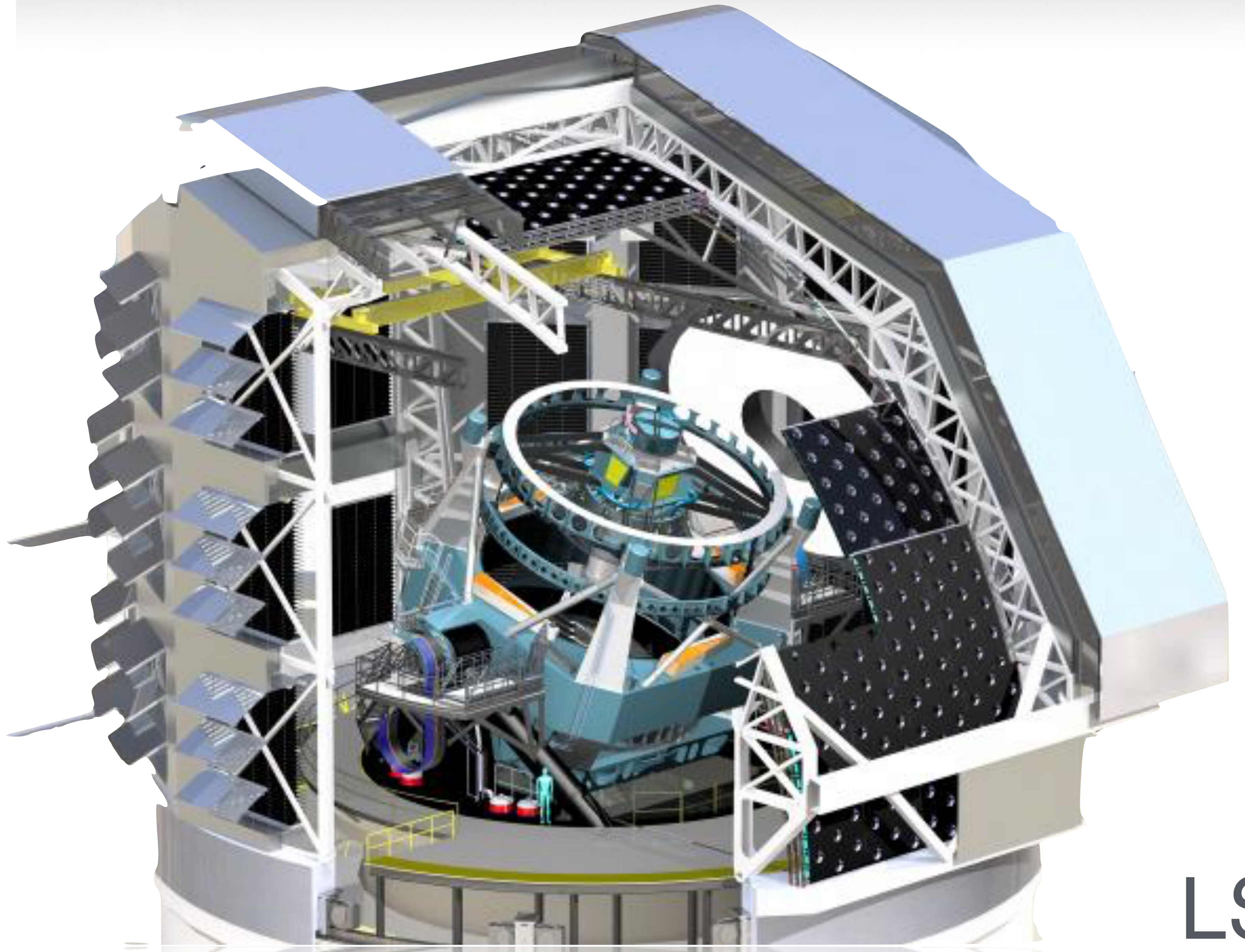
Innovative Optical Design

MIRROR:

8m diameter

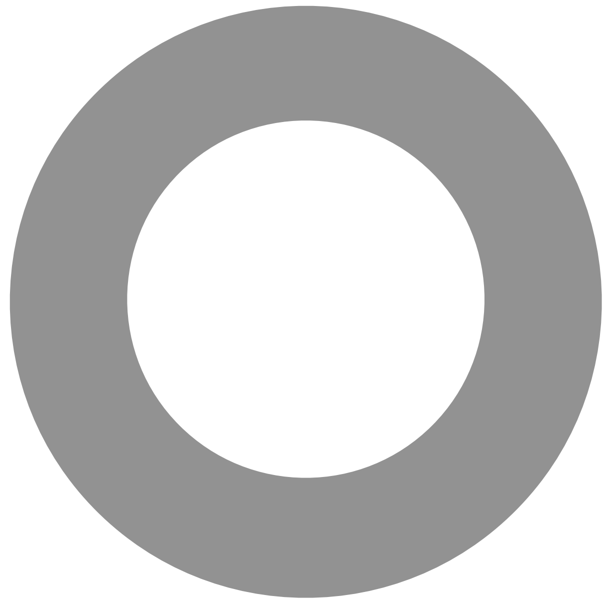
FIELD OF VIEW:

0.2 deg^2

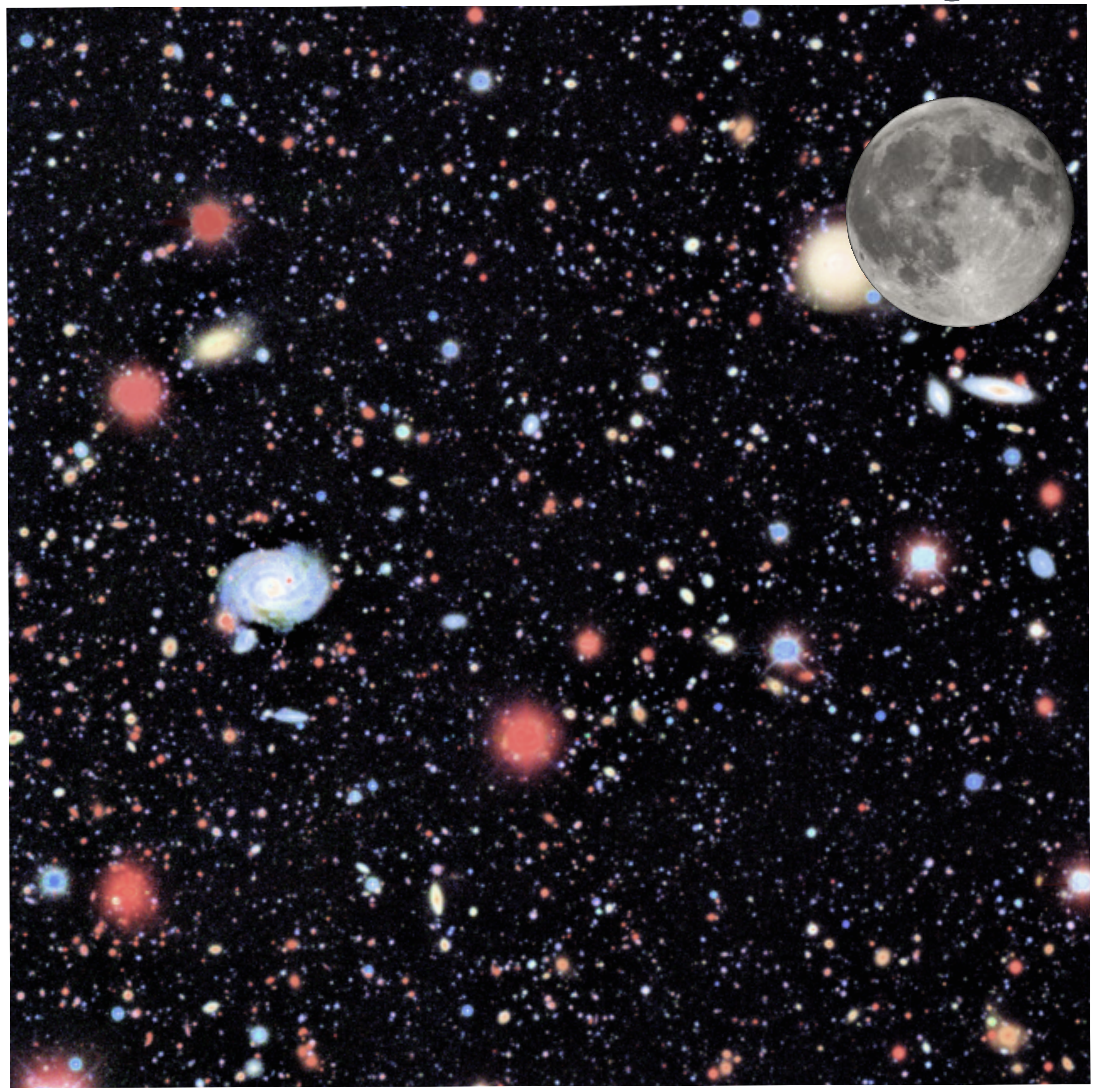


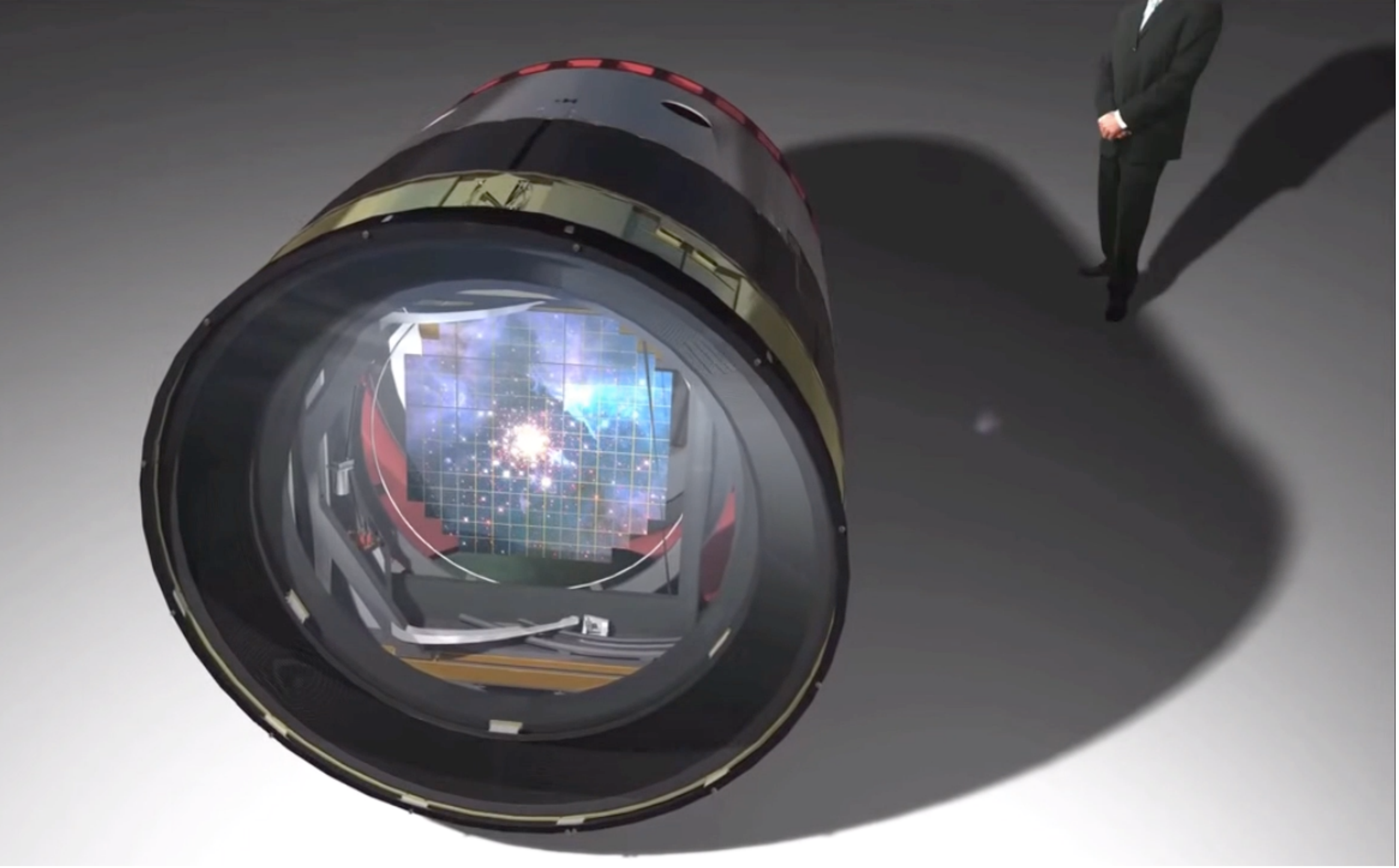
LSST

8.4m diameter



9.6 deg^2





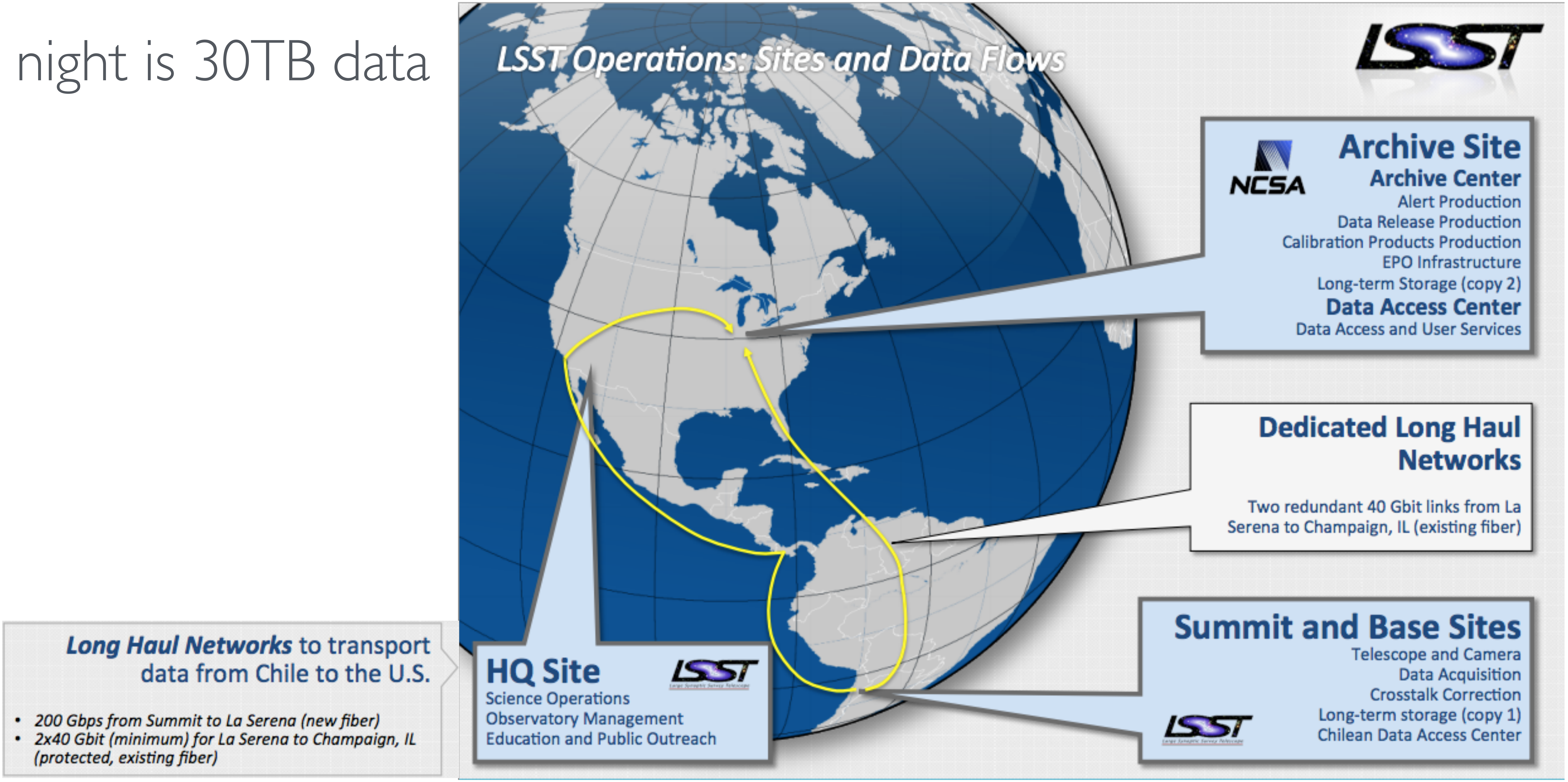
3.2 Gigapixels

The LSST Data Stream

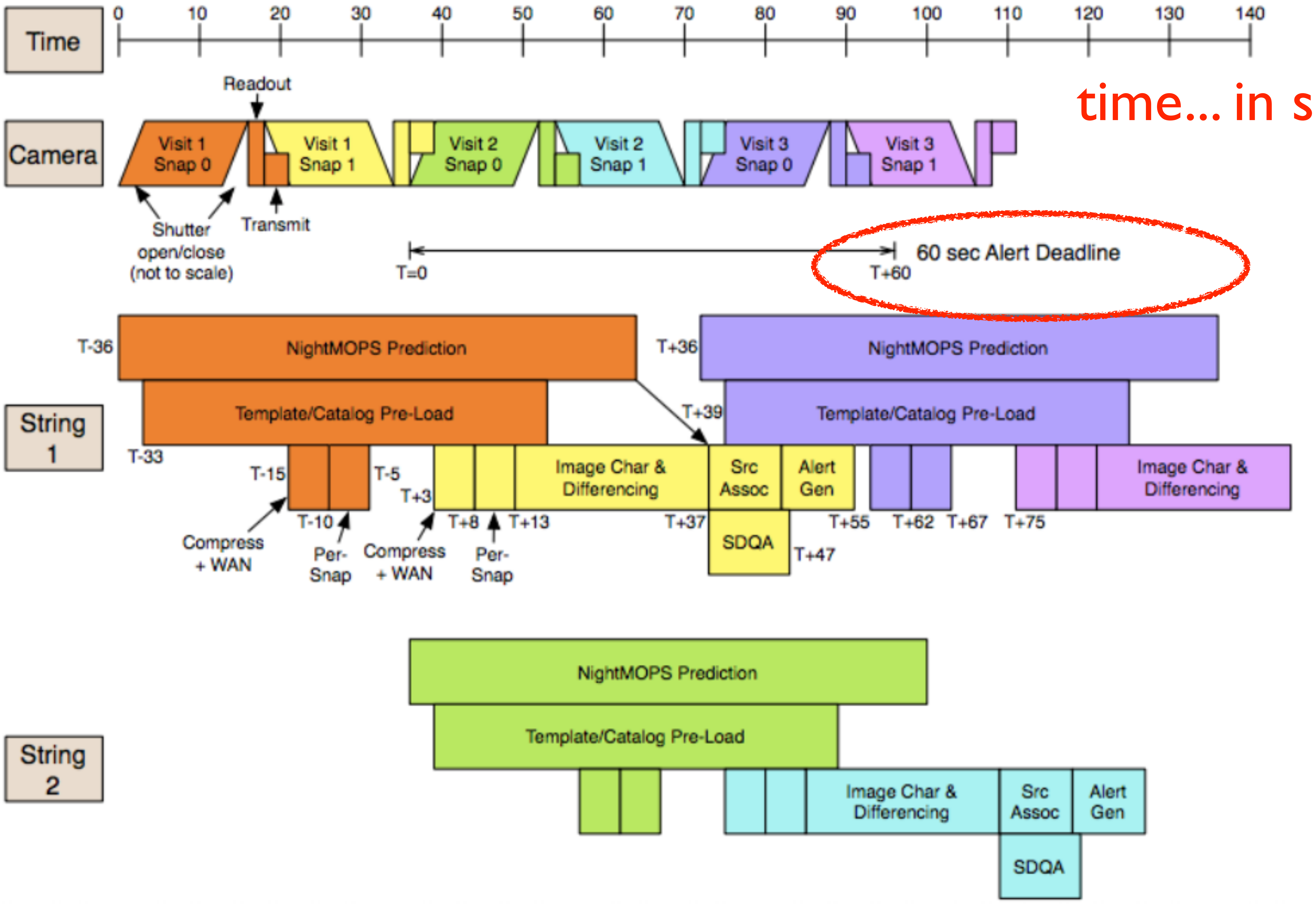
the LSST data

At 1Gbps, 30TB would take 67 hours to download

each night is 30TB data



Level 1 Processing: System Architecture



time... in seconds

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The LSST Science

- A stream of 1-10 million time-domain events per night, ***detected and transmitted <u>within 60 seconds of observation.</u>***

- A catalog of orbits for 6 million bodies in the Solar System.

- A catalog of 37 billion objects: 20B galaxies, 17B stars characterized in shape, color, and variability.

- High resolution deep stacks that will allow measure weak lensing.

Science Drivers

- Dark energy and dark matter (via measurements of strong and weak lensing, large-scale structure, clusters of galaxies, and supernovae)
- Exploring the transient and variable universe
- Studying the structure of the Milky Way galaxy and its neighbors via resolved stellar populations
- An inventory of the Solar System, including Near Earth Asteroids and Potential Hazardous Objects, Main Belt Asteroids, and Kuiper Belt Objects

Science Drivers

all relevant to trasients + variable Universe!

- Dark energy and dark matter (via measurements of strong and weak lensing, large-scale structure, clusters of galaxies, and ***supernovae***)

- Exploring the ***transient and variable universe***

- Studying the structure of the Milky Way galaxy and its neighbors via ***resolved stellar populations***

- An inventory of the Solar System, including Near Earth Asteroids and Potential Hazardous Objects, Main Belt Asteroids, and Kuiper Belt Objects ***moving objects***

LSST Science Collaborations

There are currently ten LSST Science Collaborations. Additional information about their work and membership can be found at the links below or by contacting the individual chairs, or the LSSTC Science Collaborations Coordinator (LSSTCSCC), Lucianne Walkowicz.

Galaxies

Michael Cooper (UC Irvine); Brant Robertson (University of California, Santa Cruz);

Stars, Milky Way, and Local Volume

John Bochanski (Rider University); John Gizis (University of Delaware); Nitya Jacob Kallivayalil (University of Virginia);

Solar System

Lynne Jones (University of Washington); David Trilling (Northern Arizona University);

Dark Energy

Rachel Bean (Cornell University); Jeffrey Newman (University of Pittsburgh);

Active Galactic Nuclei

Niel Brandt (Pennsylvania State University);

Transients/variable stars

Federica Bianco (New York University); Ashish Mahabal (Caltech);

Large-scale structure/baryon oscillations

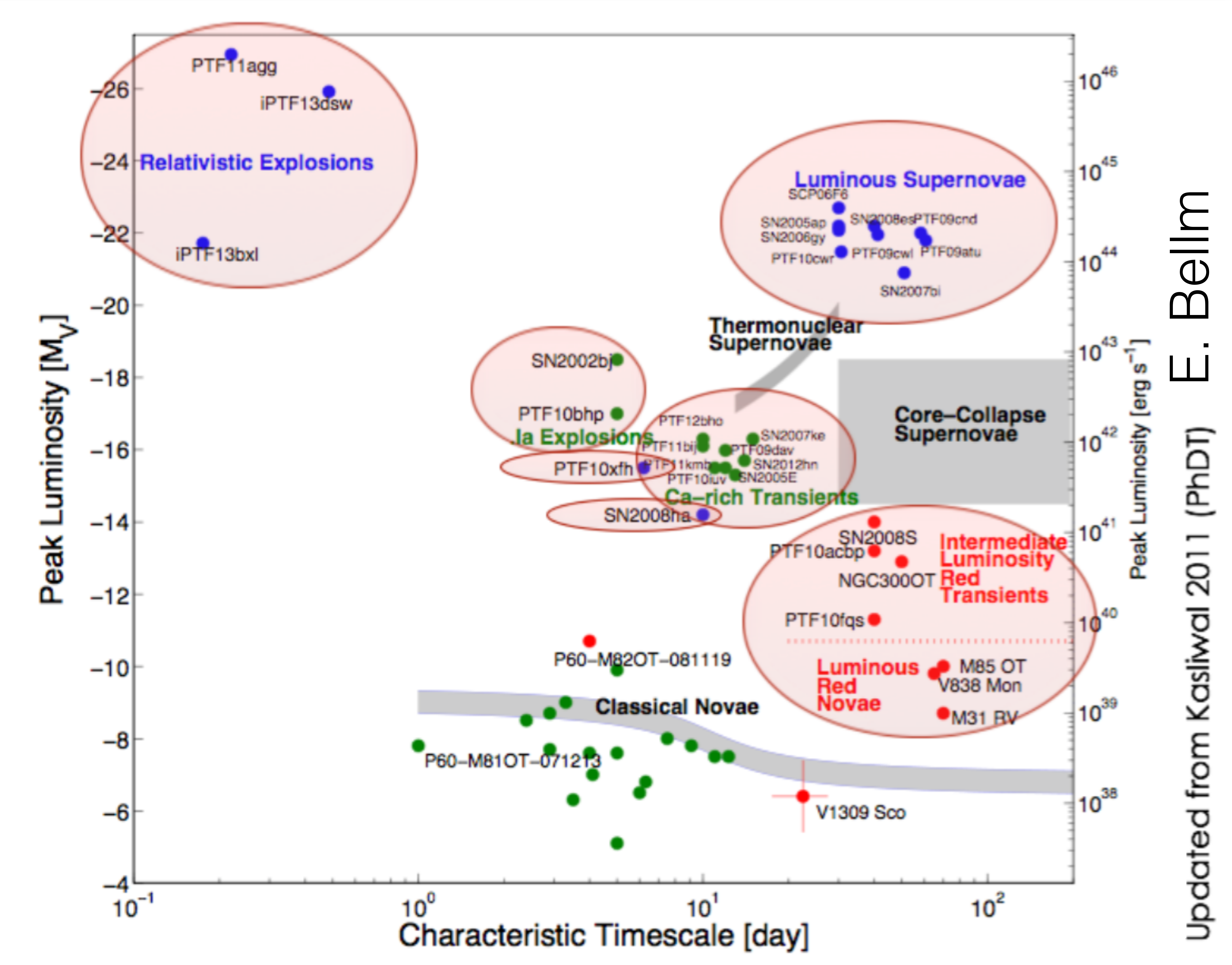
Eric Gawiser (Rutgers The State University of New Jersey); Shirley Ho (Carnegie Mellon University);

Strong Lensing

Phil Marshall (KIPAC);

Informatics and Statistics

Tom Loredo (Cornell University); Chad Schafer (Carnegie Mellon University);



Updated from Kasliwal 2011 (PhDT) E. Bellm

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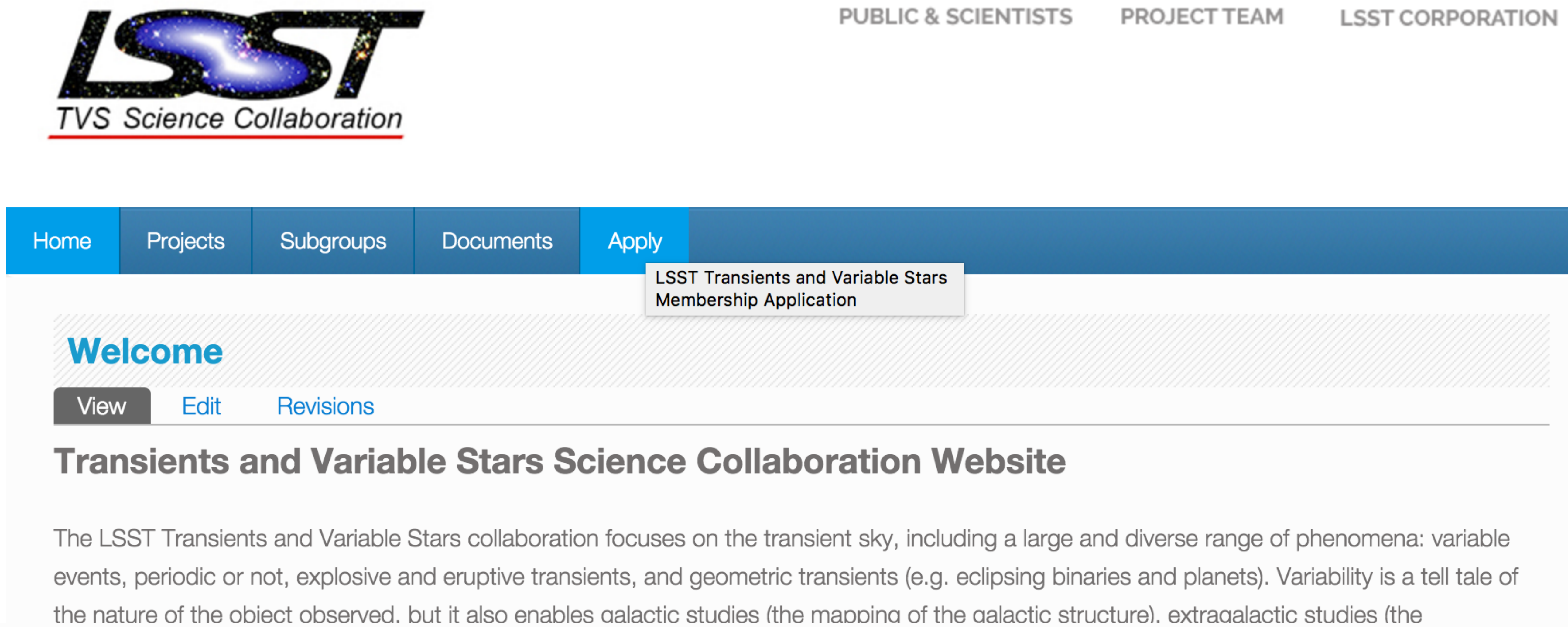
Transients & Variable Stars collaboration co-chairs

Federica Bianco   Rachel Street

https://tvs.science.lsst.org/home



The LSST Transients and Variable Stars collaboration focuses on the transient sky, including a large and diverse range of phenomena: variable events, periodic or not, explosive and eruptive transients, and geometric transients (e.g. eclipsing binaries and planets). Variability is a tell tale of the nature of the object observed, but it also enables galactic studies (the mapping of the galactic structure), extragalactic studies (the characterization of the intracluster medium), and cosmological studies. Because of their physical and phenomenological diversity, the object we study span a wide range of timescales, and present themselves in a range of brightnesses, and colors. LSST also holds great potential for discovery of new transient phenomena, especially at the very short and very long time scales.

TVS Science Collaboration

Transients & Variable Stars collaboration co-chairs


Federica Bianco   Rachel Street

Nearly 160 members!

Each member declares a *primary* affiliation and up to 3 *secondary* affiliations

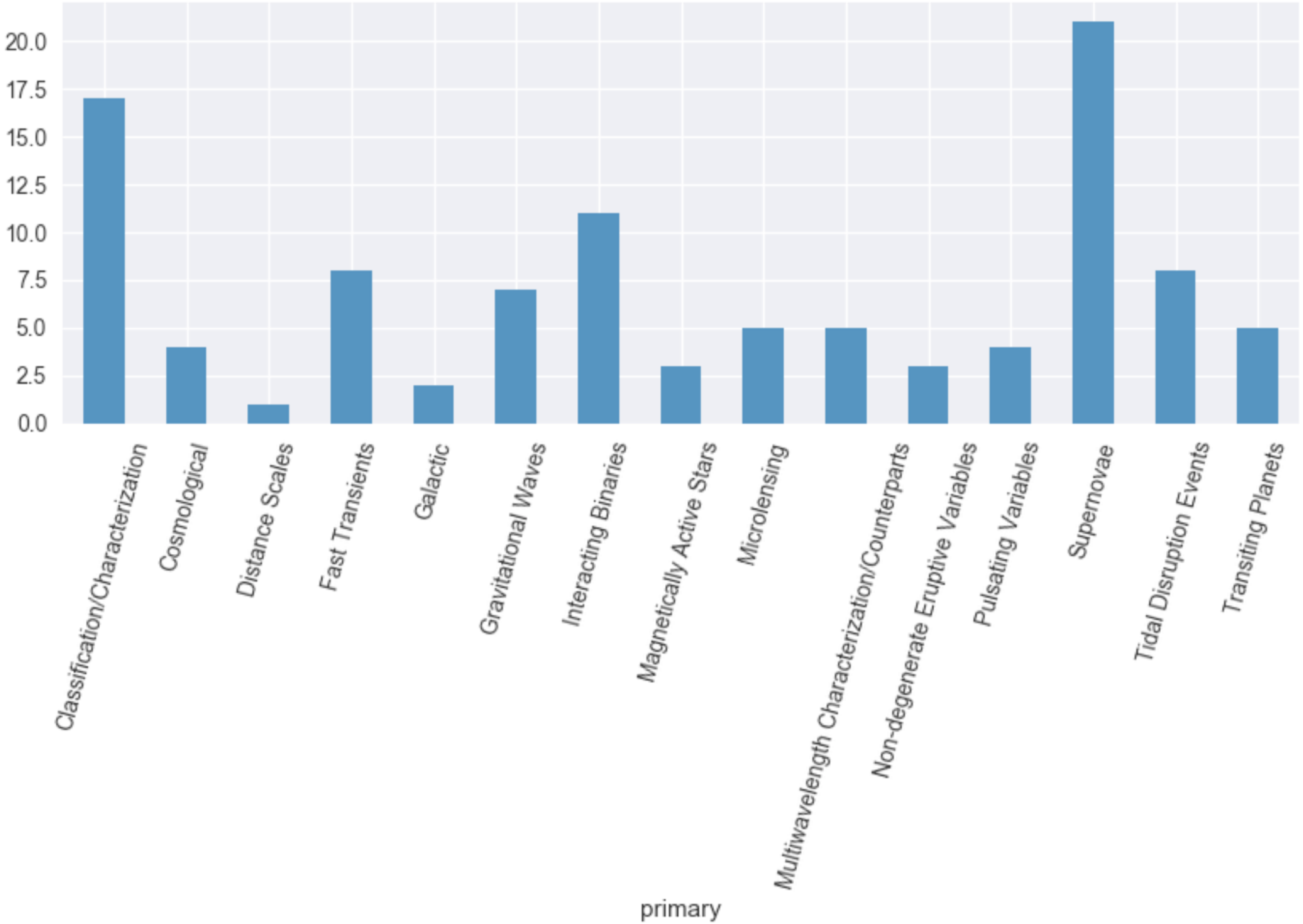
Home | Projects | Subgroups | Documents | Apply

Home » Subgroups

Subgroups

View | Edit | Revisions

- Cosmological
- Classification/Characterization
- Distance Scale
- Fast Transients
- Galactic
- Gravitational Waves
- Interacting Binaries
- Magnetically Active Stars
- Microlensing Subgroup
- Multiwavelength Characterization/Counterparts
- Non-degenerate Eruptive Variables
- Pulsating Variables
- Supernovae Subgroup
- Tidal Disruption Events
- Transiting Planets



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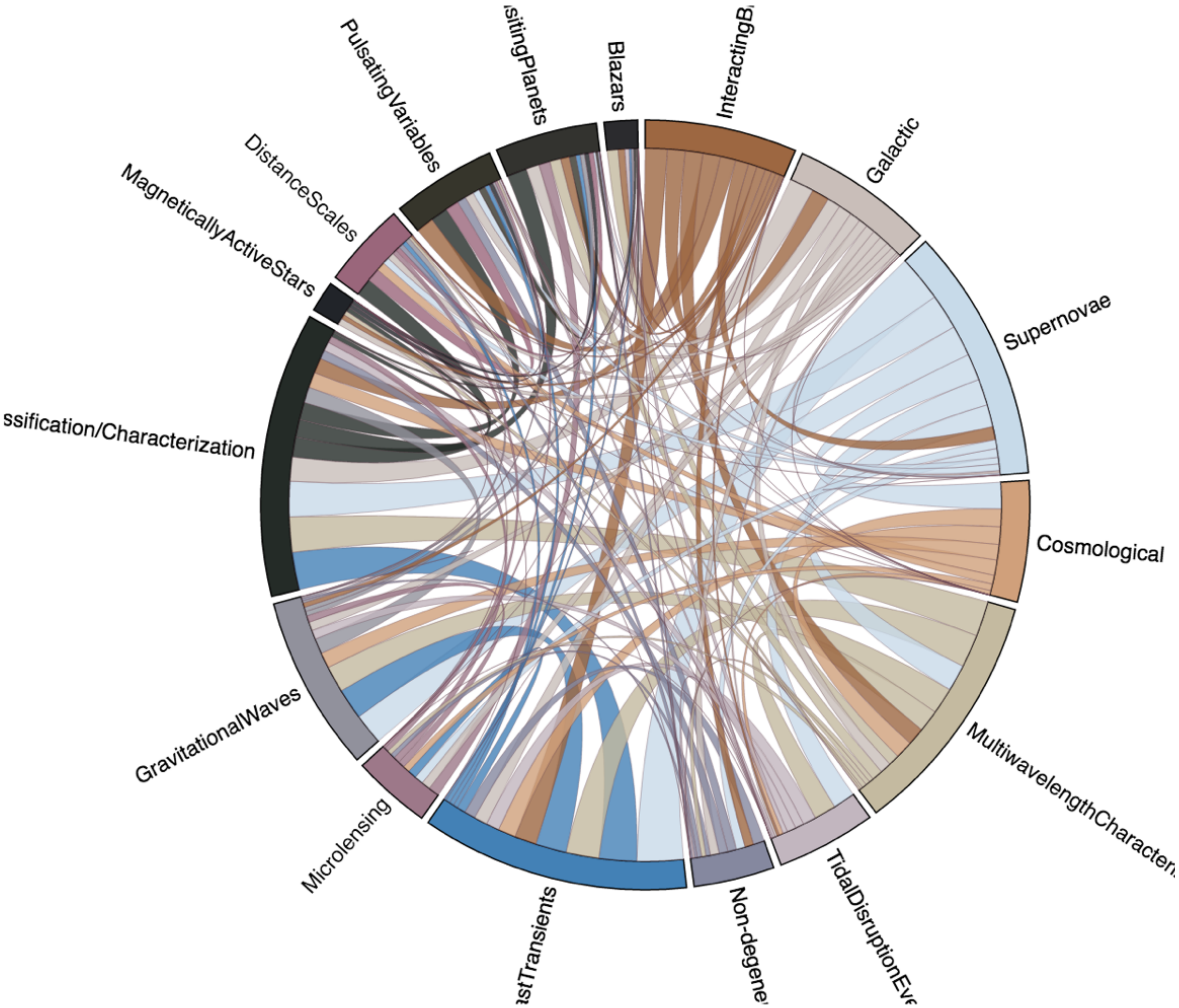

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The success of TRANSIENTS & VARIABLES related science

is tied to cadence choices

TVS ROADMAPPING MEETING

LSST Transients Working Group Workshop

24-25 March 2016
Argonne National Laboratory
US/Central timezone

- Overview
- Timetable
- Registration
  - Registration Form
- List of registrants
- Argonne Visitor Registration Form
- Accommodations
- Getting to Argonne

Support

lraino@anl.gov

We are no longer accepting requests for financial travel assistance.

Important Information

All meeting attendees must register using the registration form in the left menu. Non-US citizens must complete the Argonne Visitor Registration form **in addition** to the meeting registration form. This is mandatory in order to guarantee site access.

A room block has been set up with the Argonne Guest House, please visit the accomodations tab for more information on reserving a room.

The workshop will be held in Argonne's Theory and Computational Sciences (TCS) conference center in building 240.

Meeting Overview

This meeting is designed as a small collaborative workshop to shape the ongoing roadmap contributions into a coherent vision for the LSST TVS path to science, integrating the individual subgroup contributions into a comprehensive plan for the collaboration. At this time it is critical to discuss the impact of LSST strategic decisions on the diverse range of phenomena that our group studies, and consolidate common goals.

MEETING MATERIAL https://indico.hep.anl.gov/indico/conferenceDisplay.py?ovw=True&confId=968

Starts 24 Mar 2016 01:30
Ends 25 Mar 2016 17:00
US/Central

Argonne National Laboratory
Conference Room 1404
Building 240
9700 South Cass Avenue
Lemont, IL 60439
USA

Dr. Mahabal, Ashish
Dr. Bianco, Federica B.

OBSERVING STRATEGY WHITE PAPER

Science-Driven Optimization

of the LSST Observing Strategy

Prepared by the LSST Science Collaborations,

with contributions from the LSST Project.

Contributing Authors

Phil Marshall,[1] Scott Anderson,[2] Timo Anguita,[3] Iair Arcavi,[4] Humna Awan,[5] Federica B. Bianco,[6] Rahul Biswas,[7] Keaton J. Bell,[8] Eric C. Bellm,[9] David Bennett,[10] Niel Brandt,[11] Chris Britt,[12] Dana I. Casetti-Dinescu,[13] Laura Chomiuk,[14] Will Clarkson,[15] Chuck Claver,[16] Andy Connolly,[17] Kem Cook,[18] Victor Debattista,[19] Seth Digel,[20] Zoheyr Doctor,[21] Wen-fai Fong,[22] Eric Gawiser,[23] John E. Gizis,[24] Carl Grillmair,[25] Zoltan Haiman,[26] Patrick Hartigan,[27] Željko Ivezić,[28] C. Johns-Krull,[29] Peter Kurczynski,[30] Lynne Jones,[31] Shashi Kanbur,[32] Vassiliki Kalogera,[33] Vishal Kasliwal,[34] Michael C. Liu,[35] Michelle Lochner,[36] Michael B. Lund,[37] Ashish Mahabal,[38] Raffaella Margutti,[39] Peregrine McGehee,[40] Tom Matheson,[41] Josh Meyers,[42] Dave Monet,[43] David Nidever,[44] Knut Olsen,[45] Eric Neilsen,[46] Matthew T. Penny,[47] Christina Peters,[48] Gordon Richards,[49] Stephen Ridgway,[50] Jeonghee Rho,[51] Jason Rhodes,[52] David Rubin,[53] Ohad Shemmer,[54] Avi Shporer,[55] Colin Slater,[56] Nathan Smith,[57] Marcelles Soares-Santos,[58] Jay Strader,[59] Michael Strauss,[60] Rachel Street,[61] Christopher Stubbs,[62] Paula Szkody,[63] David Trilling,[64] Virginia Trimble,[65] Miguel de Val-Borro,[66] Stefano Valenti,[67] Kathy Vivas,[68] Robert Wagoner,[69] Lucianne Walkowicz,[70] Beth Willman,[71] Peter Yoachim,[72] Bevin Ashley Zauderer,[73]

http://www.slac.stanford.edu/~digel/ObservingStrategy/whitepaper/LSST_Observing_Strategy_White_Paper.pdf

https://github.com/LSSTScienceCollaborations/ObservingStrategy

how to contribute

we need a *science based evalution*
of the baseline LSST observing strategy and its variants

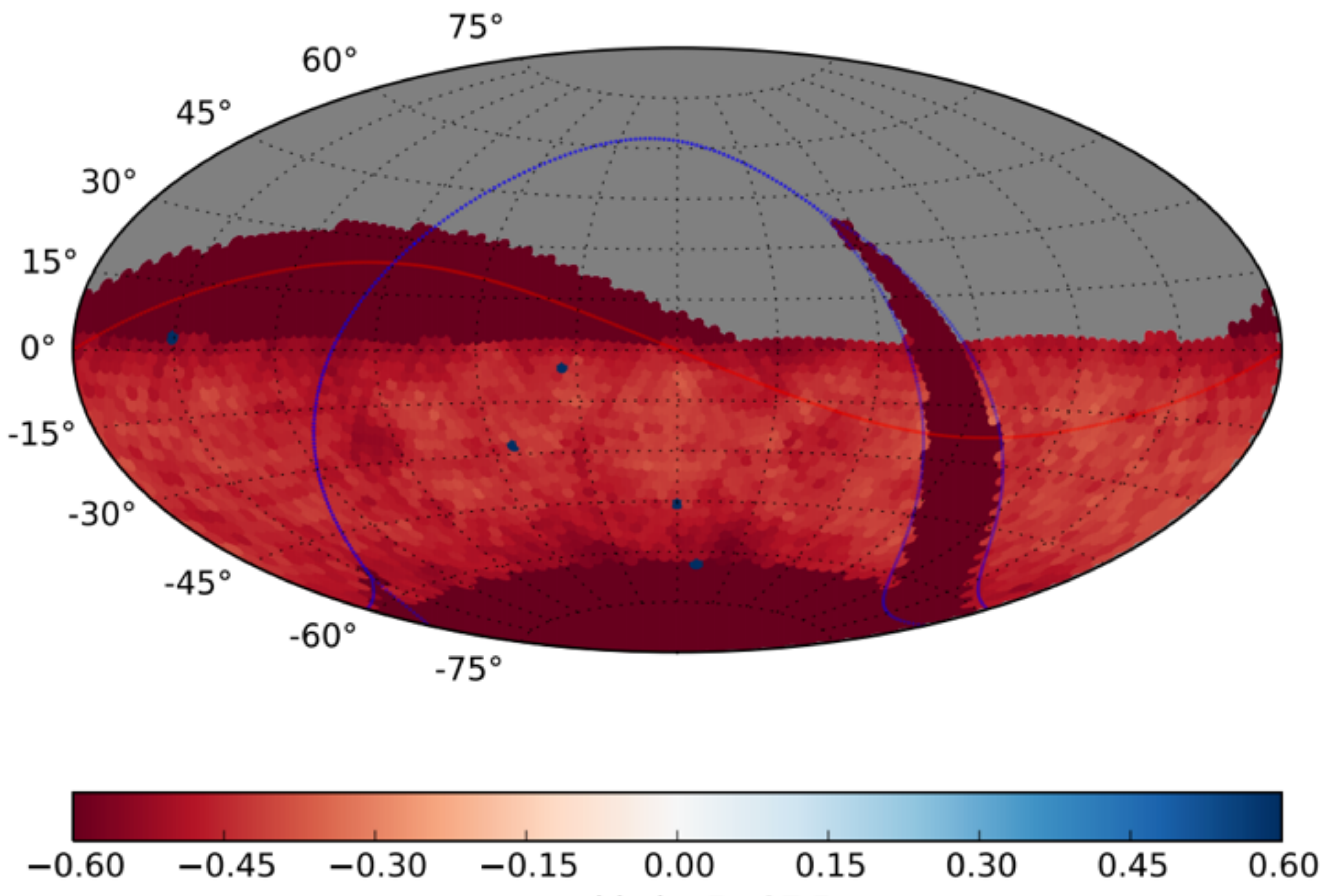
Observing Strategy White Paper Secion 1.2

OpSim

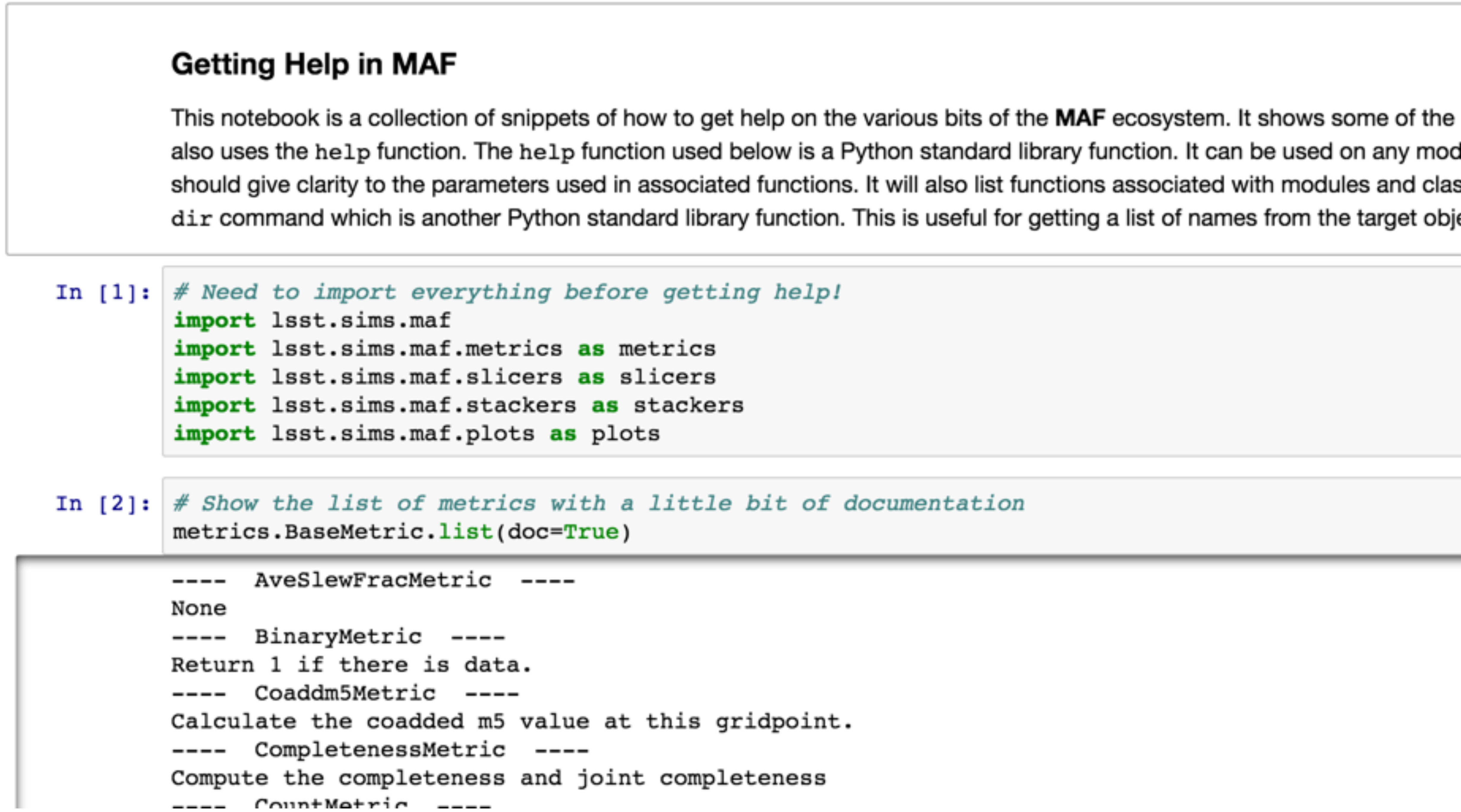
LSST developed operation simulations
(A. Connoly)

MAF API

Metric Analysis Framework
(Peter Yoachim, Lynne Jones)



LSST simulates Observing Strategies



Getting Help in MAF

This notebook is a collection of snippets of how to get help on the various bits of the **MAF** ecosystem. It shows some of the
also uses the `help` function. The `help` function used below is a Python standard library function. It can be used on any mod
should give clarity to the parameters used in associated functions. It will also list functions associated with modules and clas
`dir` command which is another Python standard library function. This is useful for getting a list of names from the target obj

In [1]:
```
# Need to import everything before getting help!
import lsst.sims.maf
import lsst.sims.maf.metrics as metrics
import lsst.sims.maf.slicers as slicers
import lsst.sims.maf.stackers as stackers
import lsst.sims.maf.plots as plots
```

In [2]:
```
# Show the list of metrics with a little bit of documentation
metrics.BaseMetric.list(doc=True)
```

```
---- AveSlewFracMetric ----
None
---- BinaryMetric ----
Return 1 if there is data.
---- Coaddm5Metric ----
Calculate the coadded m5 value at this gridpoint.
---- CompletenessMetric ----
Compute the completeness and joint completeness
---- CountMetric ----
```

https://github.com/LSST-nonproject/

we need a *science based evalution*
of the baseline LSST observing strategy and its variants

1. Describe your science case

2. Design a Figure of Merit (FOM) to quantify LSST's cadences performance with a single number

2a. Design a MAF if needed
(but so many are already available!)

3. Run MAF on the available ObSim Cadences

4. Recommend a new cadence

OpSim

LSST developed operation simulations
(A. Connoly)

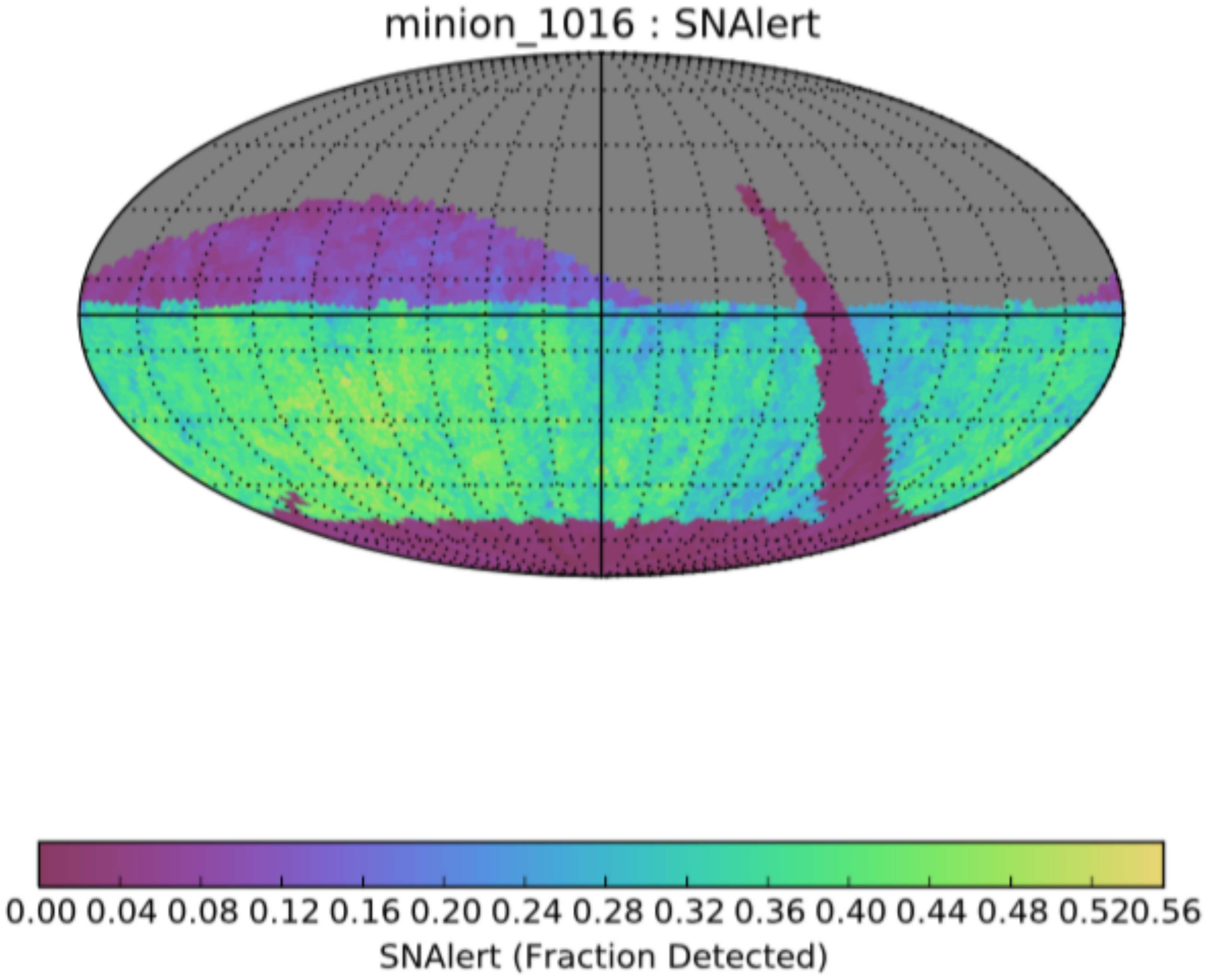
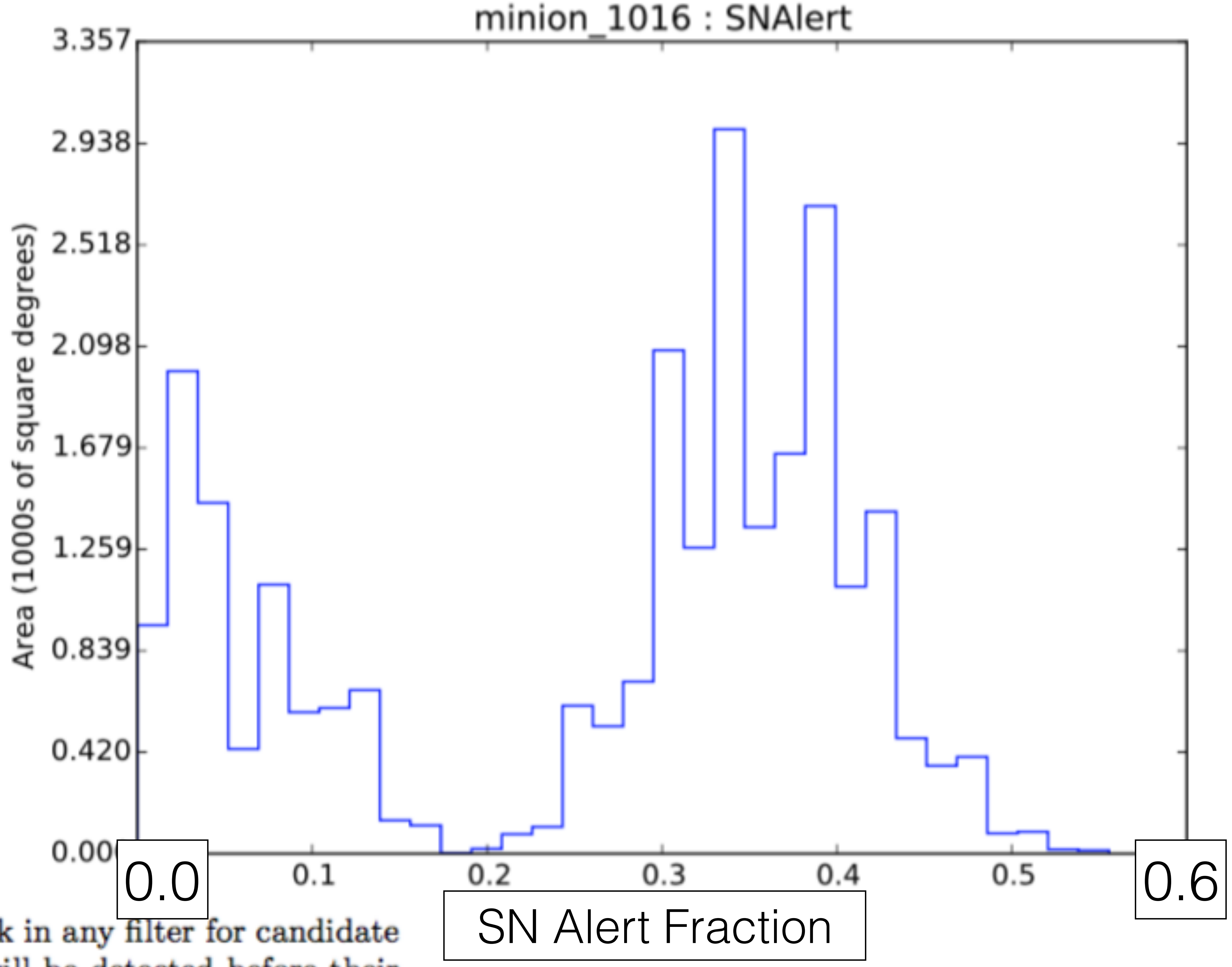


Figure 2.10: The fraction of simulated Type Ia SNe at a redshift of 0.5 detected pre-peak in any filter for candidate Baseline Cadence minion_1016. About 40% of all such SNe from the main survey will be detected before their maximum brightness.

MAF API

Metric Analysis Framework
(Peter Yoachim, Lynne Jones)



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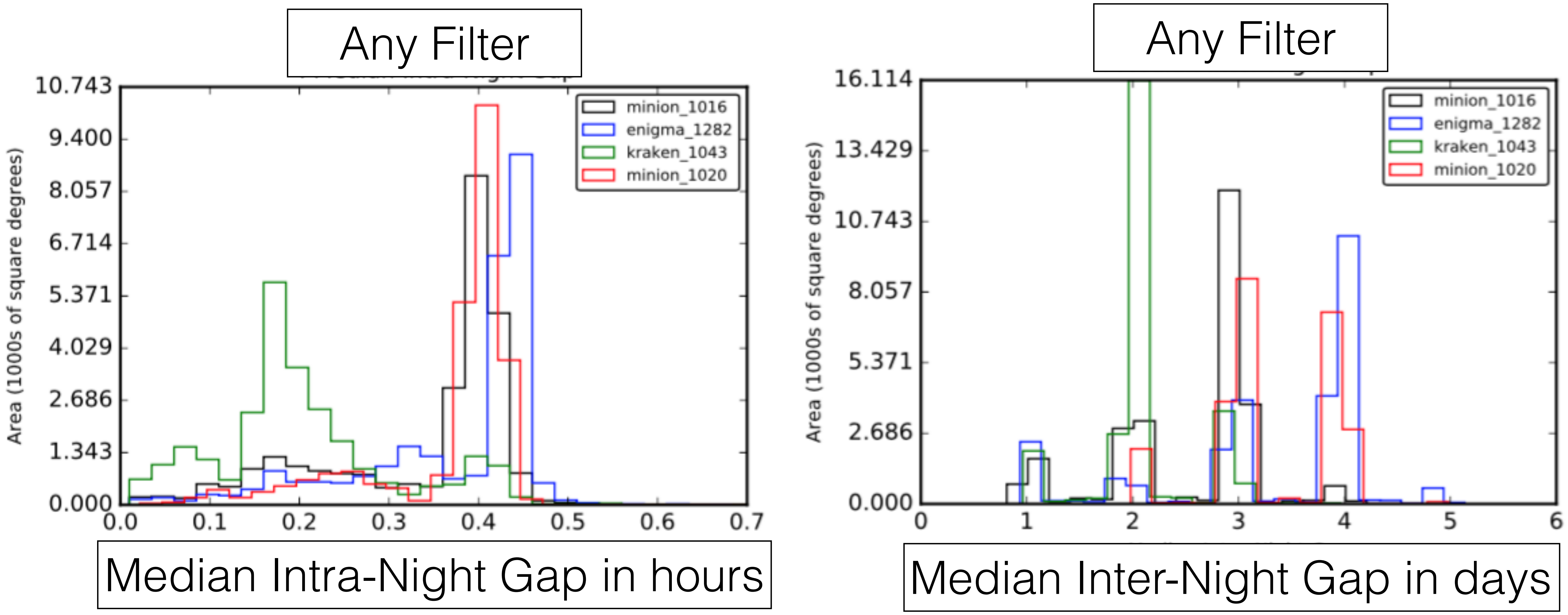

Figure 6.2: Histograms of median intra- (left) and inter- (right) night visit gaps for any band for several OpSim runs.

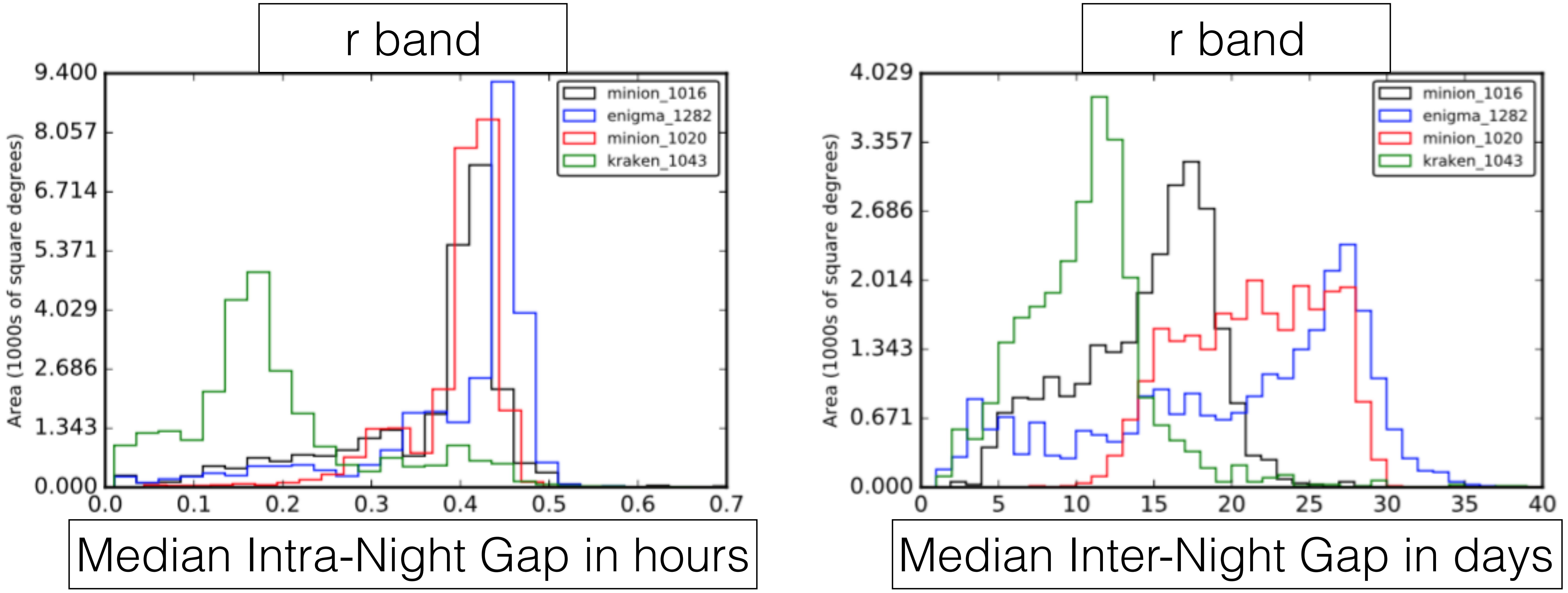

Figure 6.3: Histograms of median r-band intra- (left) and inter- (right) night visit gaps for several OpSim runs.

different variable and transient phenomena benefit from different observing strategies

our group is working to reconcile the differences & understand the existing tensions & overlap

Tensions:

color or sampling? (SN/GW vs GRB)

dense sampling or duration? (SN vs TDE)

Rolling cadence?

ToO?

Transients Classification challenge

Publications of the Astronomical Society of the Pacific, **122**:1415–1431, 2010 December

Results from the Supernova Photometric Classification Challenge

Richard Kessler,[1,2] Bruce Bassett,[3,4,5] Pavel Belov,[6] Vasudha Bhatnagar,[7] Heather Campbell,[8]

SNLS, SDSSII CSP

TABLE 2
Non-Ia Subtype Fractions and Template Statistics

Non-Ia subtype	Fraction	No. of measured templates	No. of composite templates
Ibc	0.29	16	1
II-P	0.59	23	1
II-L	0.08	0	1
IIn	0.04	2	1

Time for a NEW TRANSIENT CHALLENGE!

with more data and
incorporating recent advances in ML
and this is one of the TVS projects