



# The ANTARES Event Broker and Robotic Followup

Tom Matheson

LOSS



CSS/CRTS



PTF/iPTF/ZTF



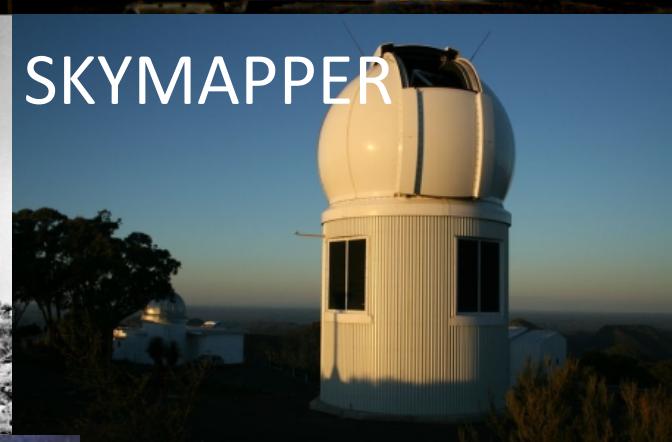
PAN STARRS



LA SILLA QUEST



SKYMAPPER



ASSASN

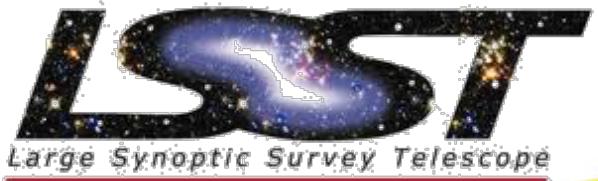


GAIA



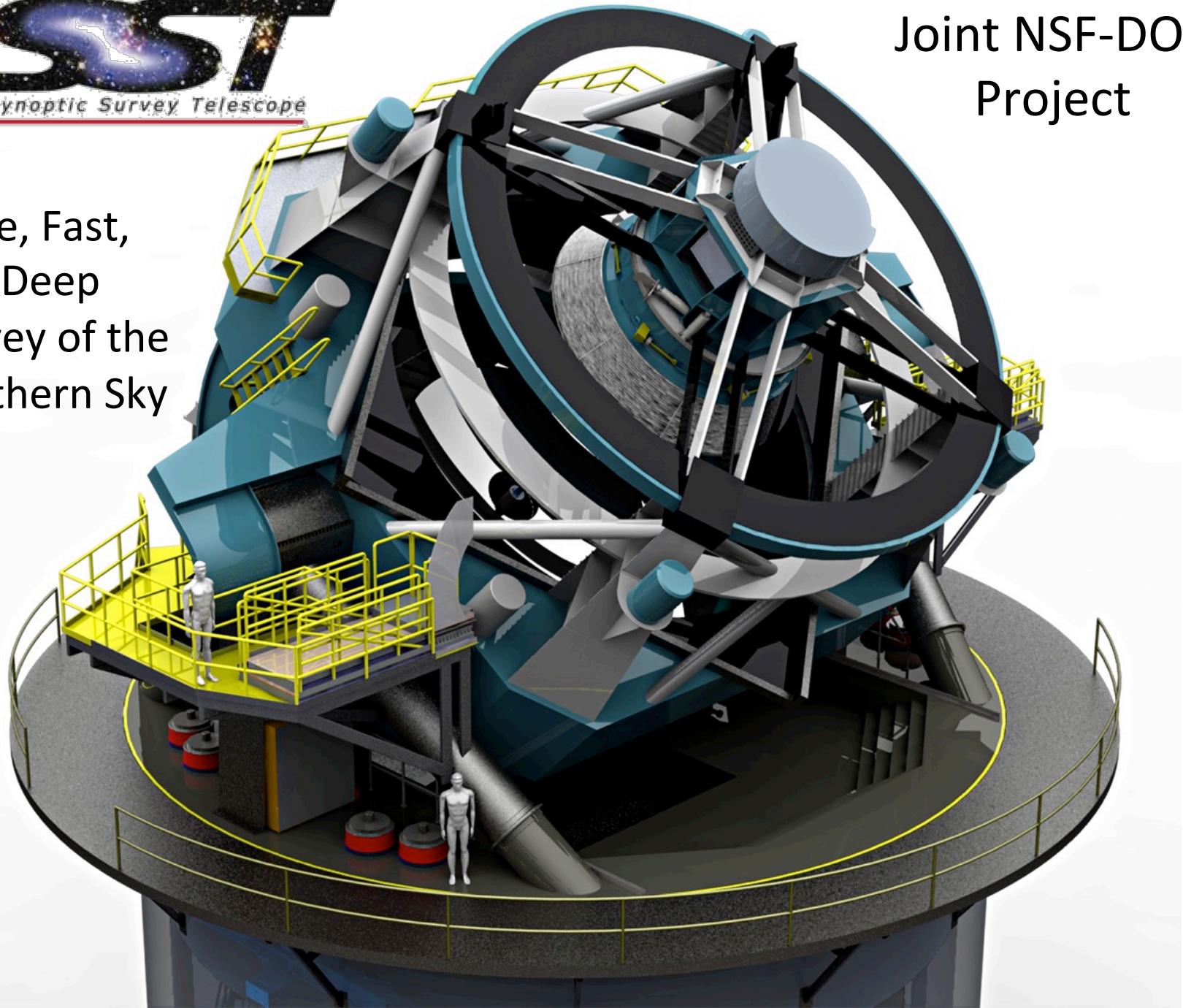
EVRYSCOPE





Joint NSF-DOE  
Project

Wide, Fast,  
and Deep  
Survey of the  
Southern Sky





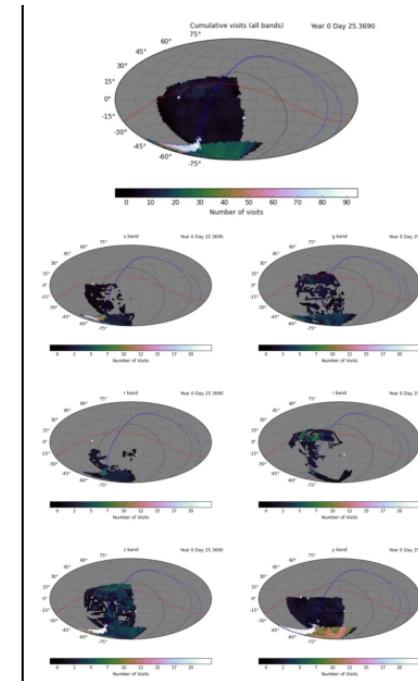
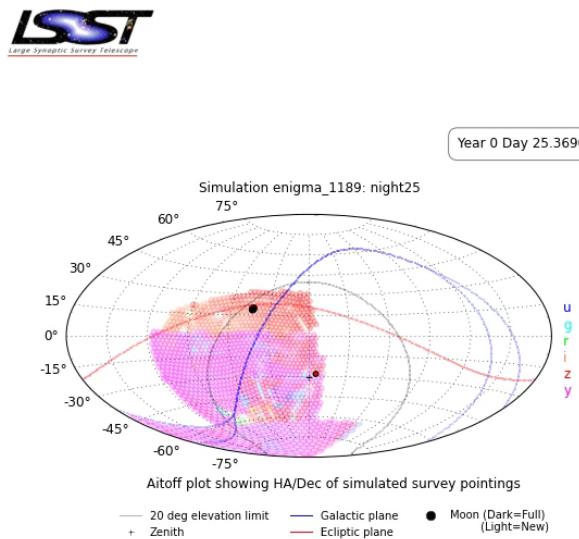
# LSST: Survey

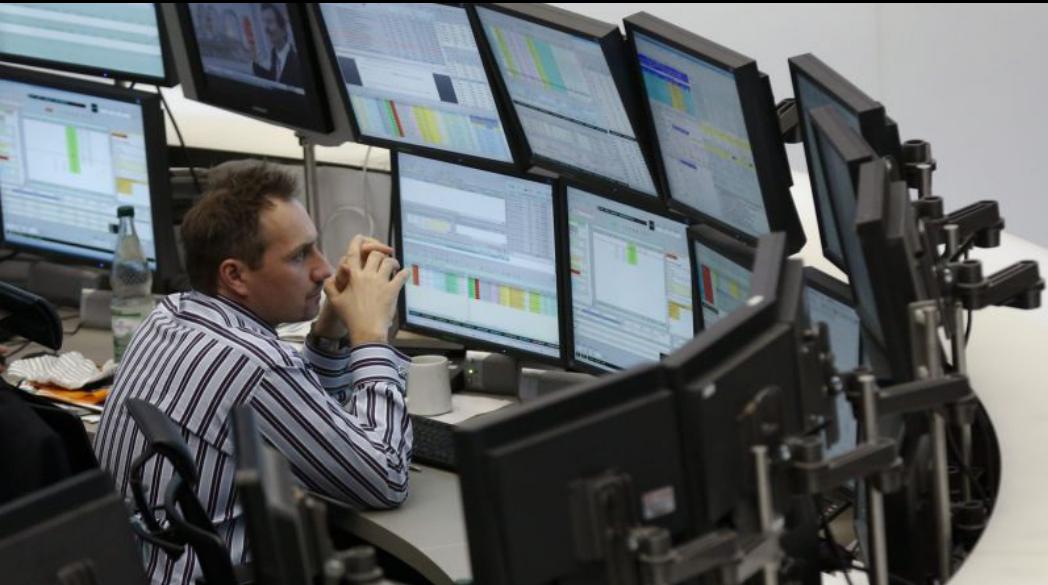
Wide: 18,000 square degrees (full sky ~40,000 square degrees)

**Fast:** Entire survey area every 3-4 days (10 sq. deg. per image)

Deep:  $r \sim 24.5$  per visit (30s), final depth  $u 26.1, g 27.4, r 27.5, i 26.8, z 26.1, y 24.9$  ( $\sim 1000$  visits per field)

Each field compared against a reference. All  $5\sigma$  differences reported as alerts. 10,000 per field, 10 million per night





What we need is often called a broker, an intermediary who sits between the source of the alerts and the consumers of the alerts while adding value

This system can be thought of as an instrument that looks at the data and not the sky. As such, it can be tuned for specific goals or treated like a generic work-horse instrument.

# ANTARES:

## The Arizona-NOAO Temporal Analysis and Response to Events System

Tom Matheson, NOAO

Abhijit Saha, NOAO

Gautham Narayan, STSci

Monika Soraisam, NOAO

Richard Snodgrass, University of Arizona, Computer Science

John Kececioglu, University of Arizona, Computer Science

Carlos Scheidegger, University of Arizona, Computer Science

Rob Maier, University of Arizona, Mathematics

Zhe Wang, University of Arizona, Computer Science

Navdeep Singh, University of Arizona, Computer Science

Zhenge Zhao, University of Arizona, Computer Science

Eric Evans, University of Arizona, Computer Science

Songzhe Zhu, University of Arizona, Computer Science

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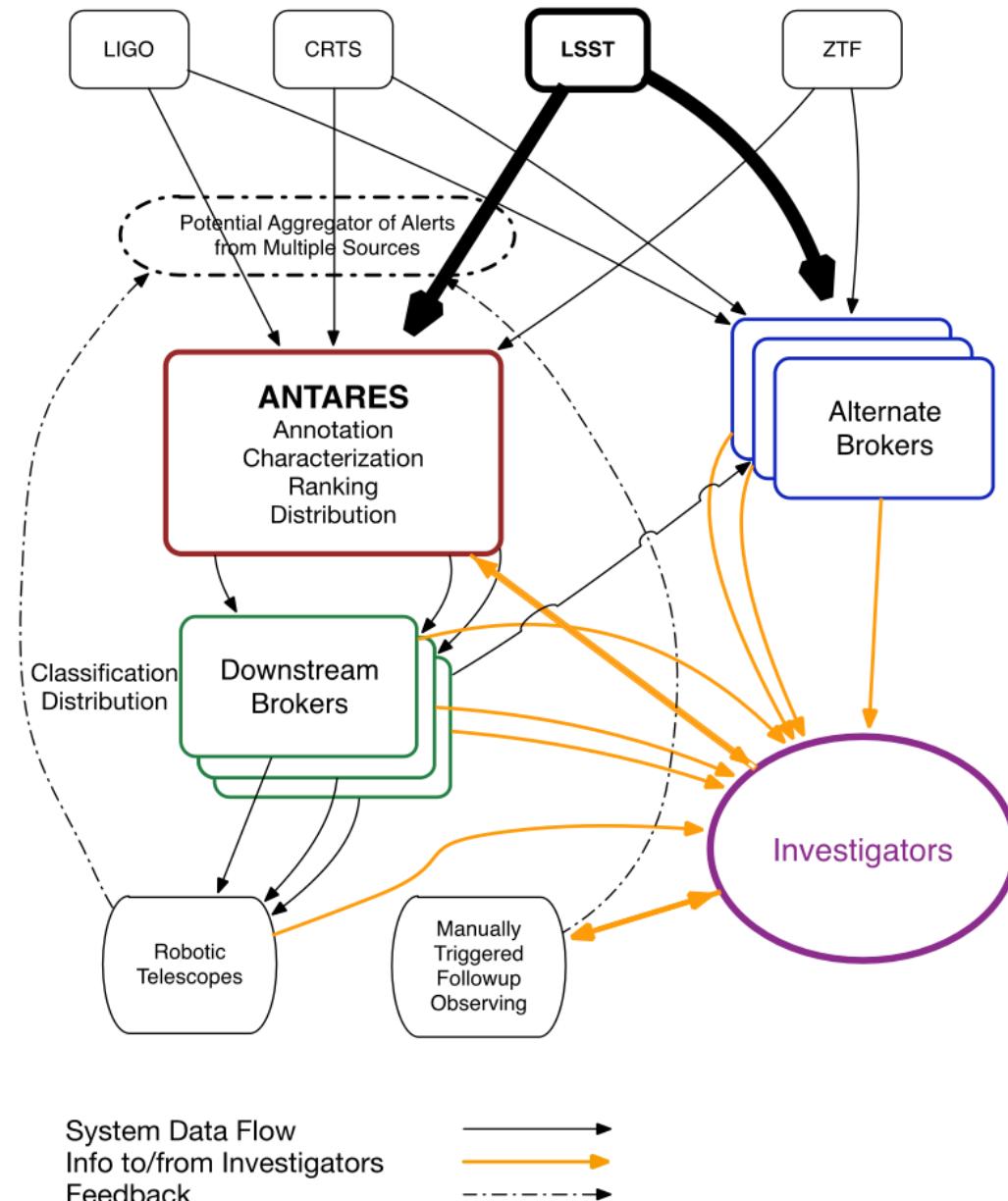
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# ANTARES Environment

ALERT GENERATORS: Difference Imaging, Real/Bogus & Moving Object Assessment



# ANTARES and the Time-Domain Ecosystem

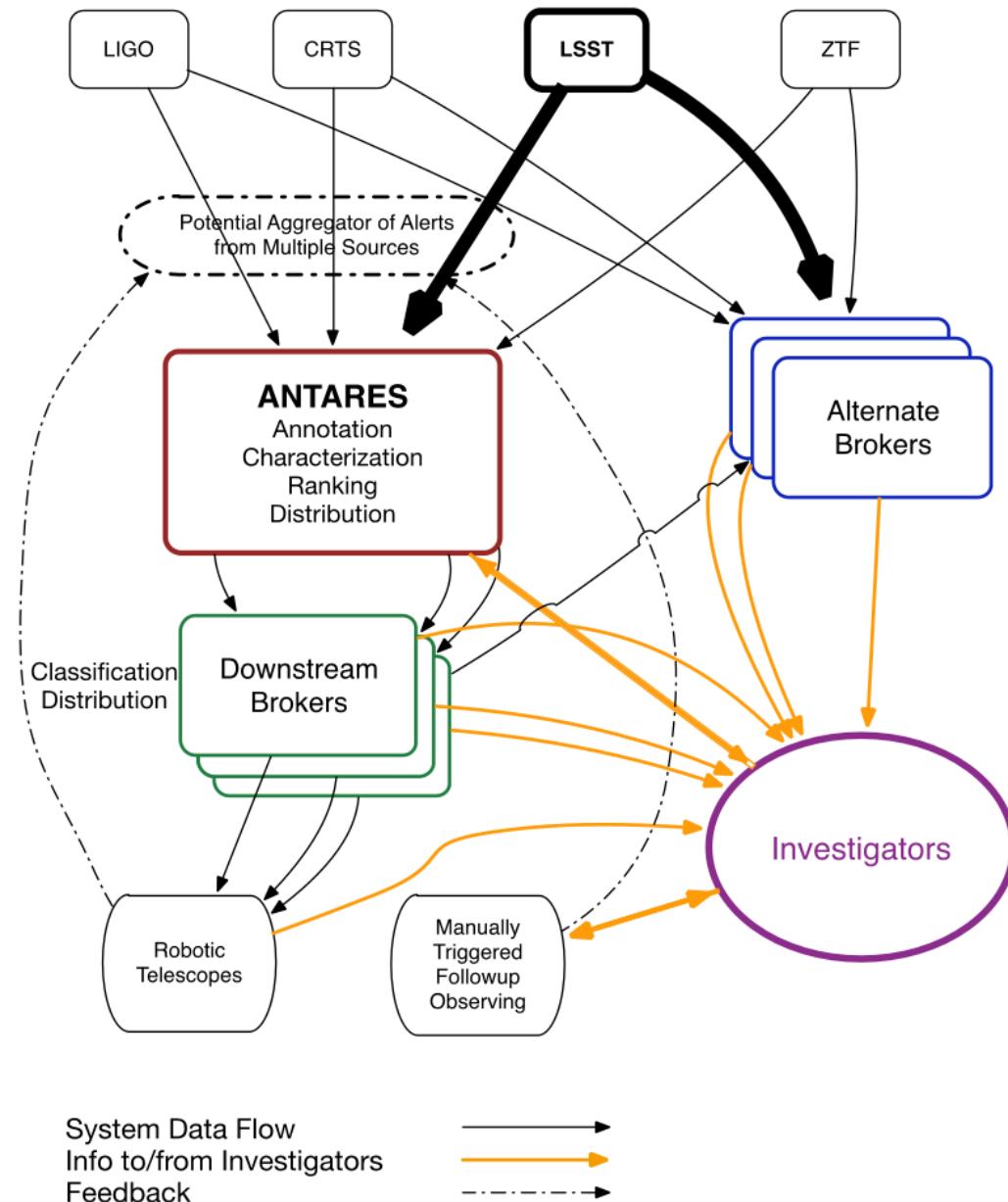
What it does, and does not, intend to do

## Does Not:

- Perform image differencing
- Identify sources on images
- Assess validity of source
- Identify moving objects
- Coordinate follow up

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# ANTARES and the Time-Domain Ecosystem

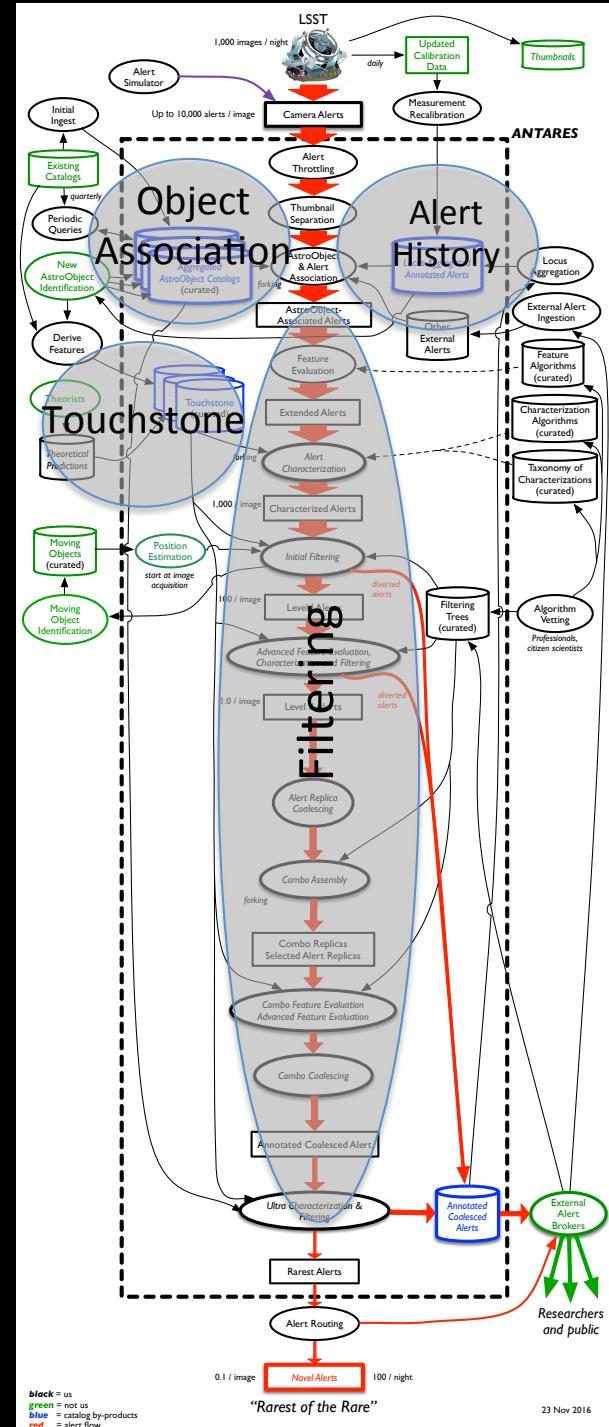
What it does, and does not, intend to do

Does (after receiving alerts):

- Annotates alerts
- Characterizes alerts
- Ranks alerts
- Stores value-added alerts
- Distributes alerts

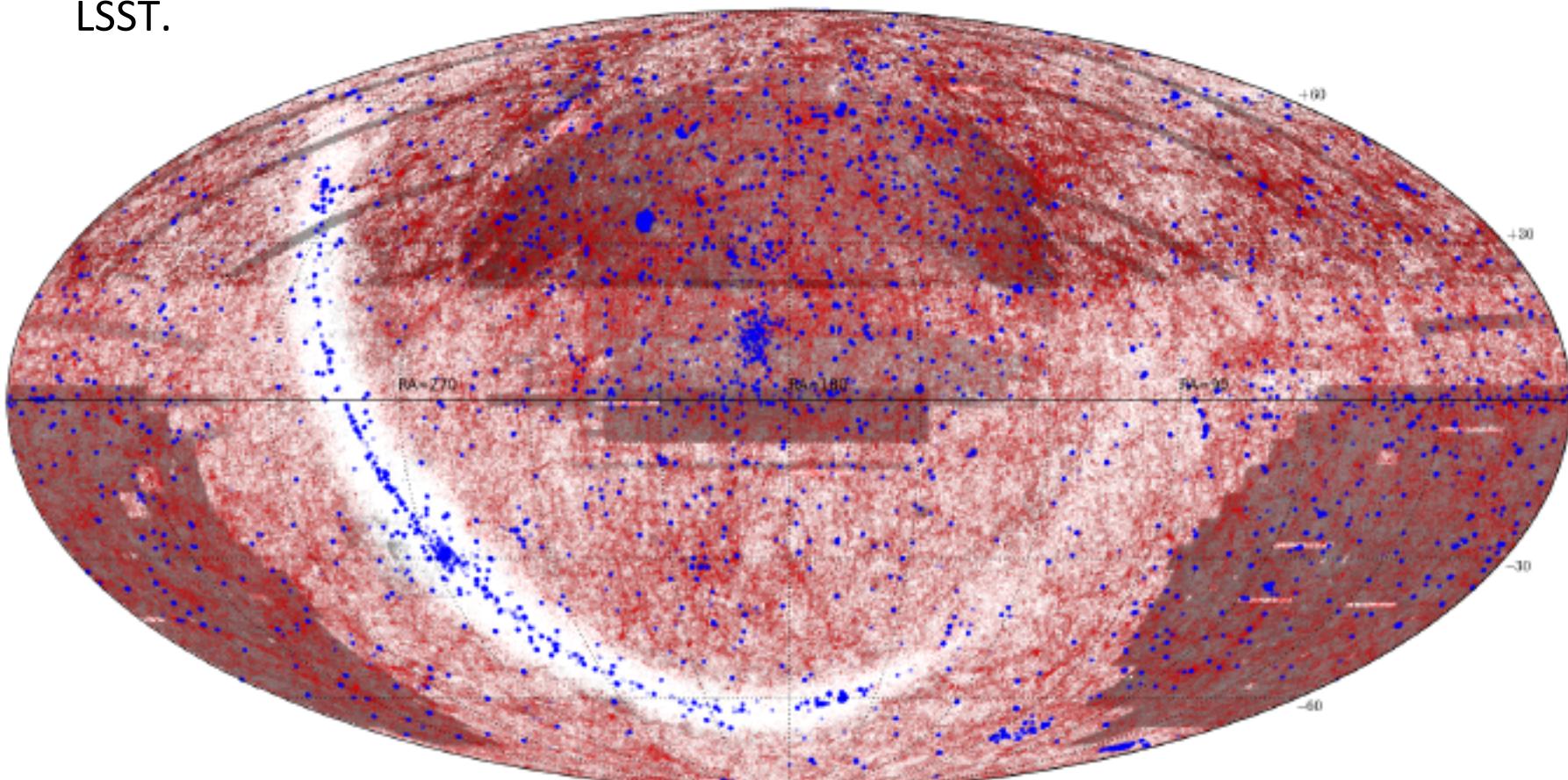
# ANTARES Philosophy

- Open source/open access
- Modular
- Community driven
- The prototype is focused on finding the ‘rarest of the rare’
- Nothing is lost: all alerts are archived
- Versions could accommodate multiple filtering paths to address many goals
- Volume and rate are key problems
- NSF INSPIRE grant (IIA-1344024)



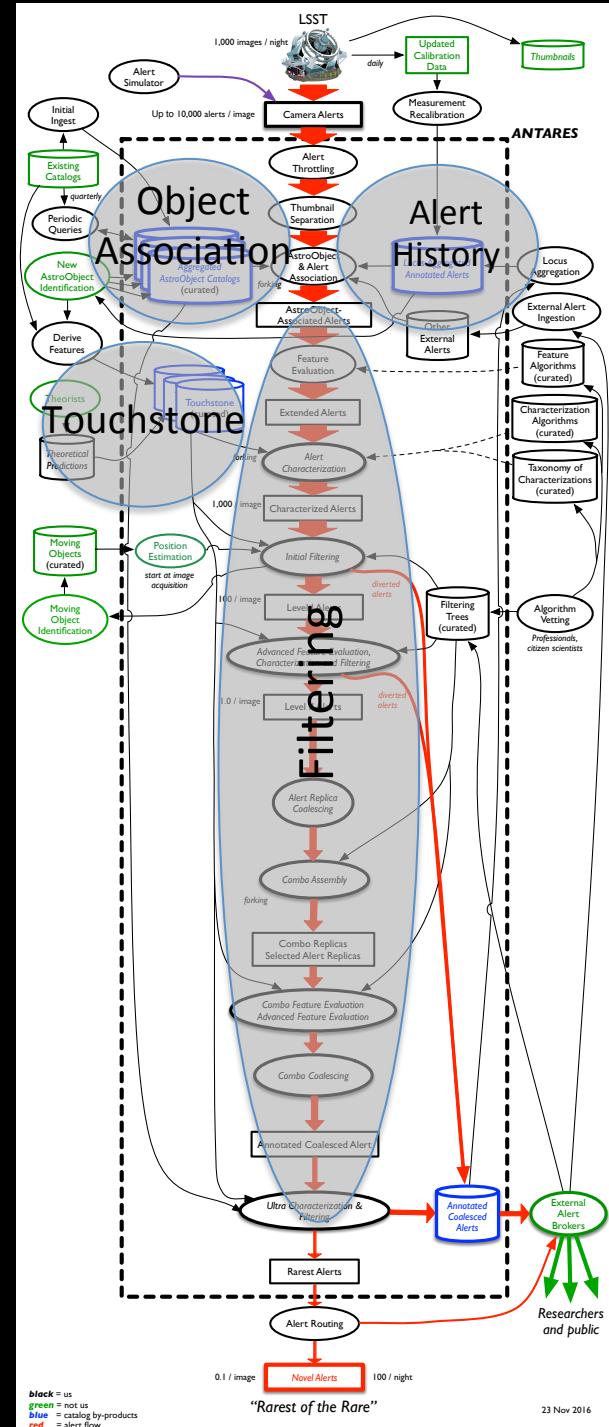
# Catalogs Already Have Large Number of Sources

- SDSS DR7 + NED\* (Grey density maps) + 2MASS XSC (Red, large-scale structure) + Chandra (Blue, high energy)
- This is an actual density map, not just a plot of SDSS stripes + NED fields – just under 190 million objects were parsed for this map. Expect few billion before LSST.



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  - Operating at UA’s UITS



# ANTARES: Where Do We Go From Here?

- Implementing guidance from expert external review
- Hiring software developer and scientist
- Broaden astronomical base—community involvement
- Test new algorithms
- Run on live streams—ZTF
- ARTN could serve as prototype for direct broker-telescope communication



<https://www.noao.edu/ANTARES/>