Towards an NOAO Expertise Center for LSST

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LSSTC Board Meeting

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Executive summary

- Establish a center of LSST expertise at NOAO to support the astronomy community
  - Enabling science now
  - Preparing community for scale of LSST
- Build on scientific and technical expertise of NOAO and its connection to community
  - Stellar populations and transient and variable science
  - DECam as a pre-LSST science platform
  - Community organization
- Current projects as prototypes for LSST activity
  - Transient event broker
  - Data Lab as platform for data experimentation
  - Guidance for cadence exploration
- Partner with SLAC to expand scope of user support
- Coordinate with LSSTPO to strengthen support for the community

Towards an LSST Expertise Center
Guiding concepts

- Goal
  - Create the LSST expertise center for the astronomy community
  - SLAC will support Dark Energy Science Collaboration (DESC)
- Method
  - Enable “big survey” research now
  - Build on DECam-based NOAO programs and Surveys
  - Extend to LSST
- Collaborate
  - LSST PO for various software tools
  - SLAC for common user support interests
  - NCSA for computing environment (eventually)

Towards an LSST Expertise Center
Topical areas

- Research area foci
  - Stellar populations in the Local Volume (SMWLV collaboration)
  - The time-variable Universe (Transients and Variables collaboration)
- Community organization
  - Organize workshops on topics general interest
  - Encourage visits to Expertise Center
  - Center scientific staff who are actively engaged in LSST community
- Big Data and the Community
  - Deploy collaborative spaces
  - Deploy tools for visualization and analysis
- Parsing the variable sky
  - Characterize alert streams
  - Identify the rarest of the rare

Build on existing scientific and technical expertise within NOAO science staff

Community organization
Current projects

- Staff participation in LSST Science Collaborations
  - LSST Transients and Variables
  - LSST Supernovae (NOAO Co-Chair)
  - LSST Stars, Milky Way, and Local Volume (NOAO subgroup leader)
  - Also LSST Galaxies and LSST AGN
- Workshops
  - Spectroscopy in Era of LSST (April 2013, completed, published report)
  - LSST Observing Cadences I. Science Metrics (August 2014)
  - Practical Big Data (working title, under development for 2015)
  - DECam Community Science and Lessons for LSST (working title, under development for 2015)
- Work with observatories and community groups on groundwork for LSST follow-up observations
  - Initial focus: Gemini South and SOAR
  - Have started dialogue with Gemini Director

Big Data and the Community
Challenges & approaches

- How do astronomers effectively share large imaging datasets and object catalogs with the broader community?
- How do large teams coordinate their data analysis activity of massive datasets?
- How do astronomers efficiently access, explore, and visualize datasets that are too big to fit on desktop computers?

- NOAO is developing a Data Lab concept to address these challenges; to be used as a tool by LSST SCs
- DECam-based NOAO programs and Surveys are natural starting point
  - A few existing NOAO Surveys may also help, e.g., NOAO Deep Wide
- Intermediate step is DES catalogs (coming in 2016+)
- As much as possible, adopt-adapt-deploy, not develop

NOAO Data Lab
Key objectives

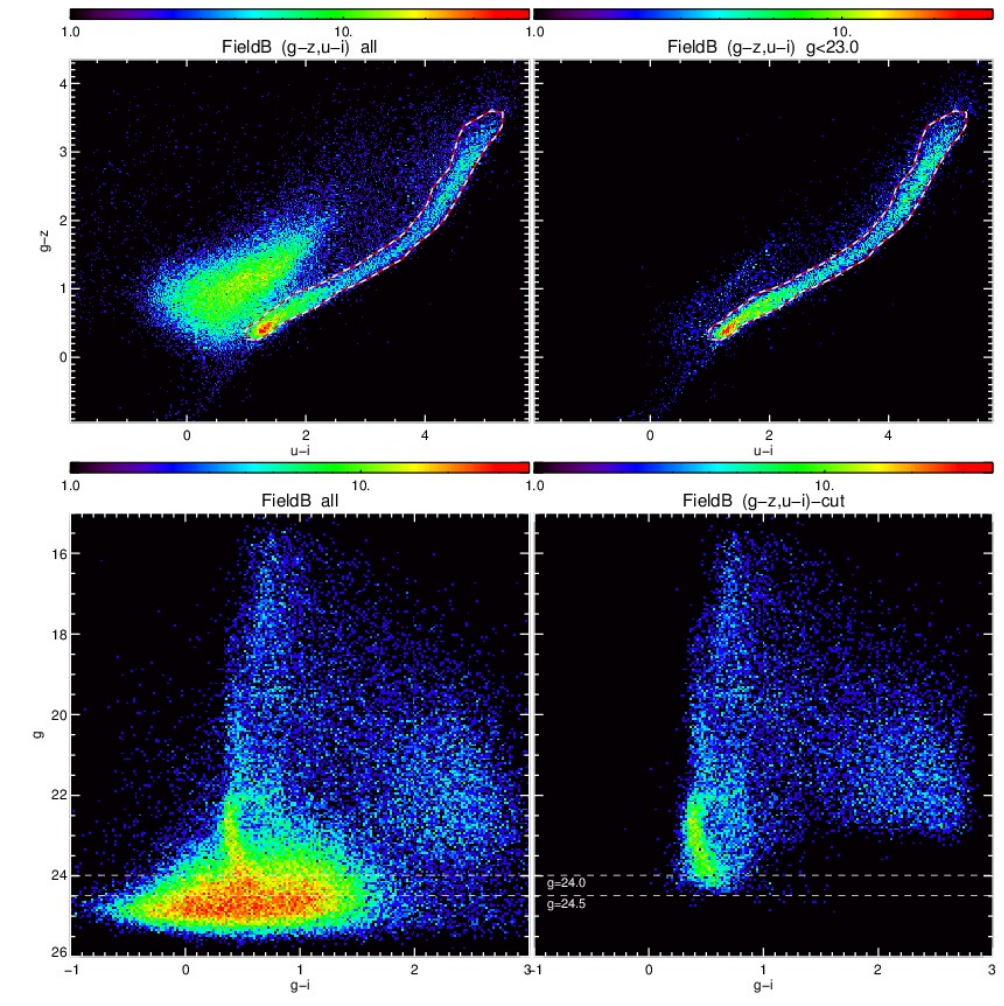
- Centralized facility for data analysis, visualization, sharing, and publication amongst project teams using NOAO facilities
- Services to filter, explore, and access large catalogs and associated data generated from NOAO facilities
- Gateway to related catalogs, images, or spectra
  - Tools for sub-selecting or cross-matching catalogs and data
- Incorporate existing analysis tools and science workflows
- Add as test bed for new tools and workflows

NOAO Data Lab: Science Case

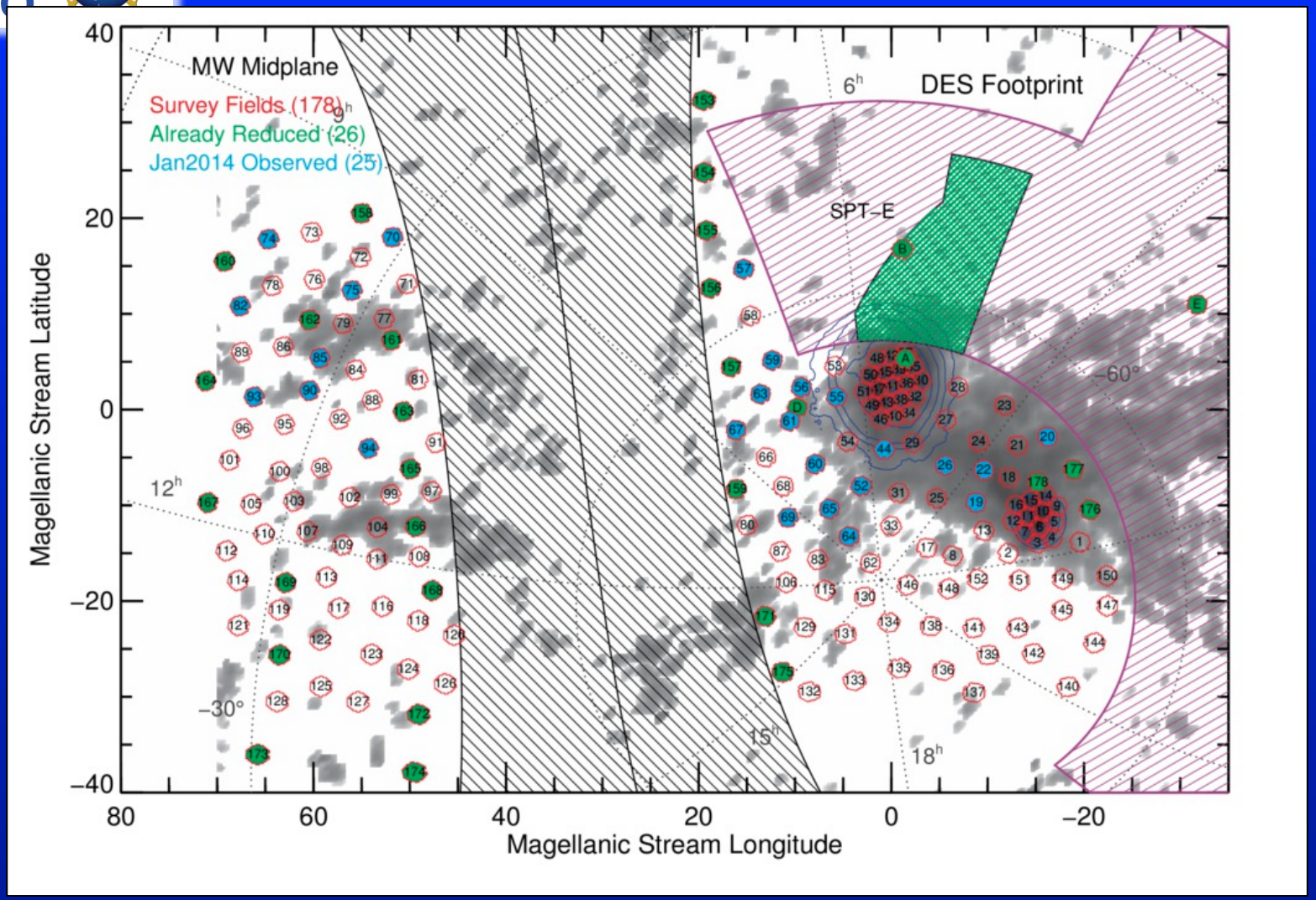
- Data Lab development focused on DECam community programs, in anticipation of DES data release in ~2017
- Two initial prototype programs
  - SMASH (Survey of the Magellanic Stellar History; PI Nidever)
  - A Synoptic DECam survey of the Galactic Bulge (PI Saha)
- Both programs have heavy NOAO staff involvement, providing efficient interface to development team
- Initial development will be focused on making Data Lab a useful resource to the teams themselves (audience of ~30 people); building on VO tools and services
- Both programs are also of strong interest to LSST Stars, Milky Way, and Local Volume Science Collaboration (audience of ~90 people); also Transients collaboration (~85 people)

Prototyping the Data Lab
Using SMASH

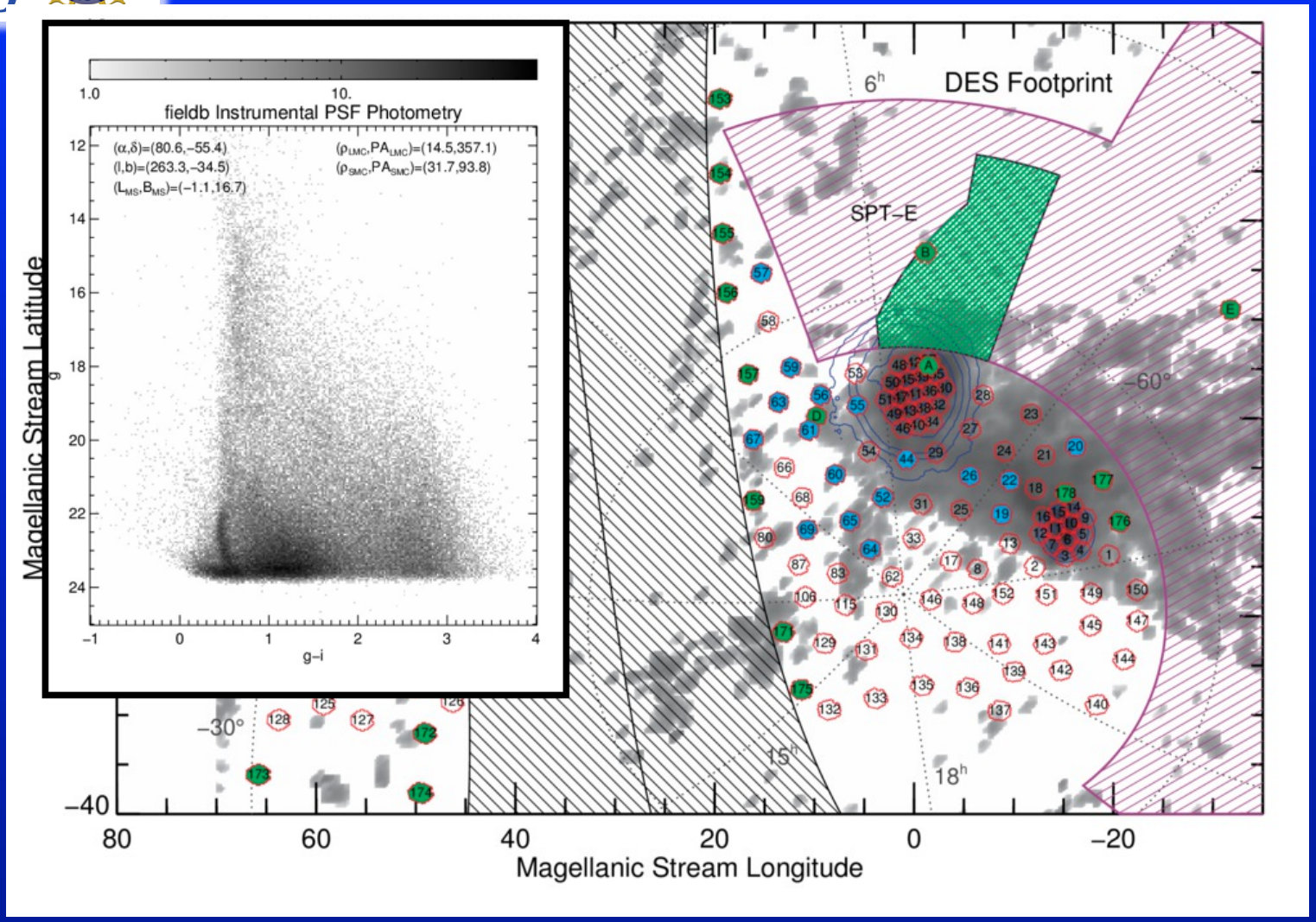
- Applied stellar locus color-color cut to remove unresolved galaxies
- LMC well-detected at *R*=14° with main sequence stars
- Analysis of background galaxy-dominated field (using stellar locus cuts in ugriz) shows that our LMC population surface brightness limit is ~35.5 mag/arcsec^2



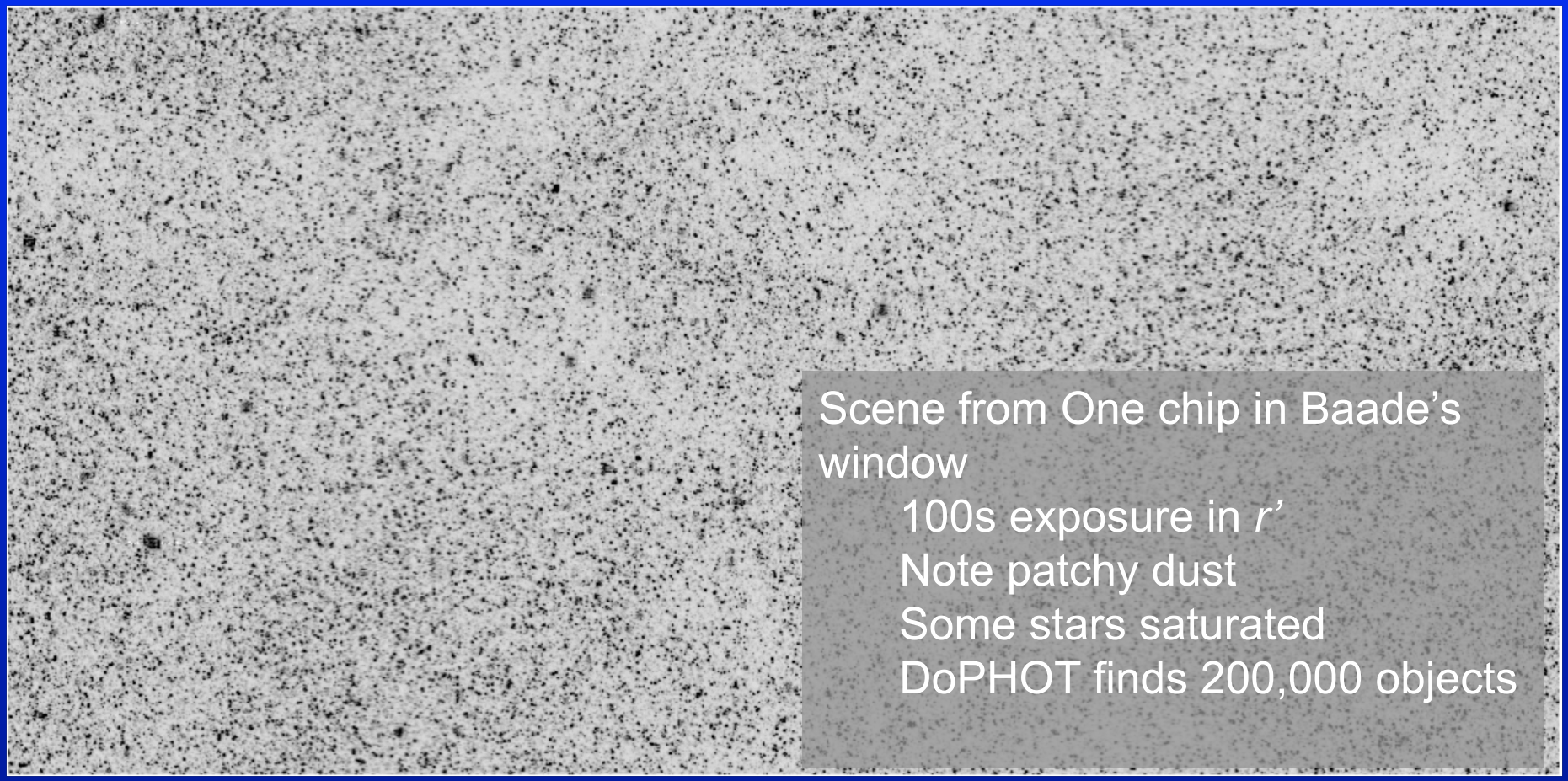
SMASH data visualization



SMASH data visualization



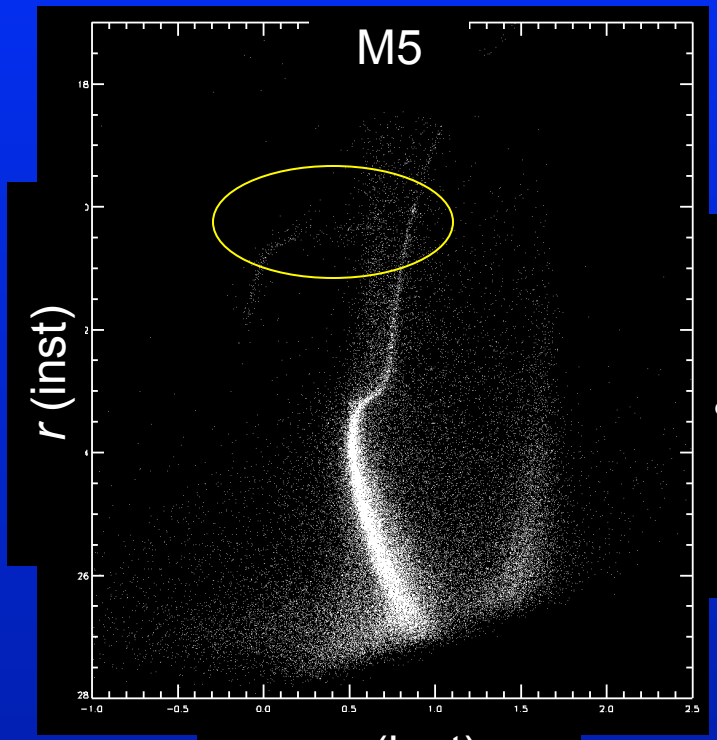
Prototyping the Data Lab
Using Galactic Bulge Variable project

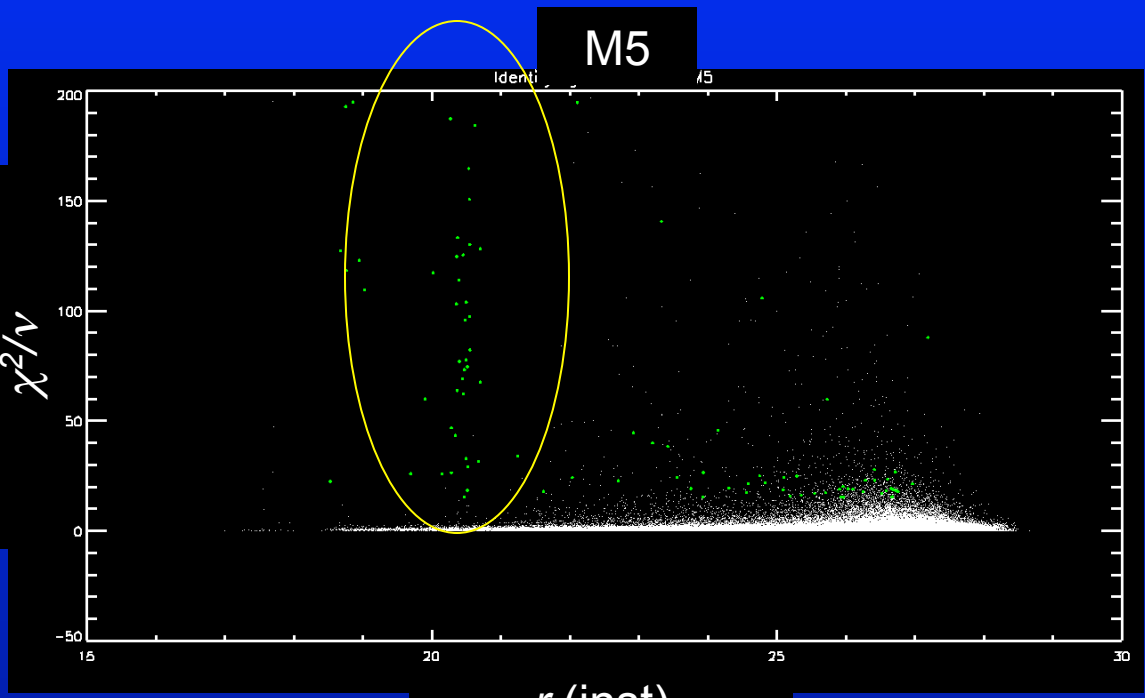


Scene from One chip in Baade's window

- 100s exposure in *r'*
- Note patchy dust
- Some stars saturated
- DoPHOT finds 200,000 objects

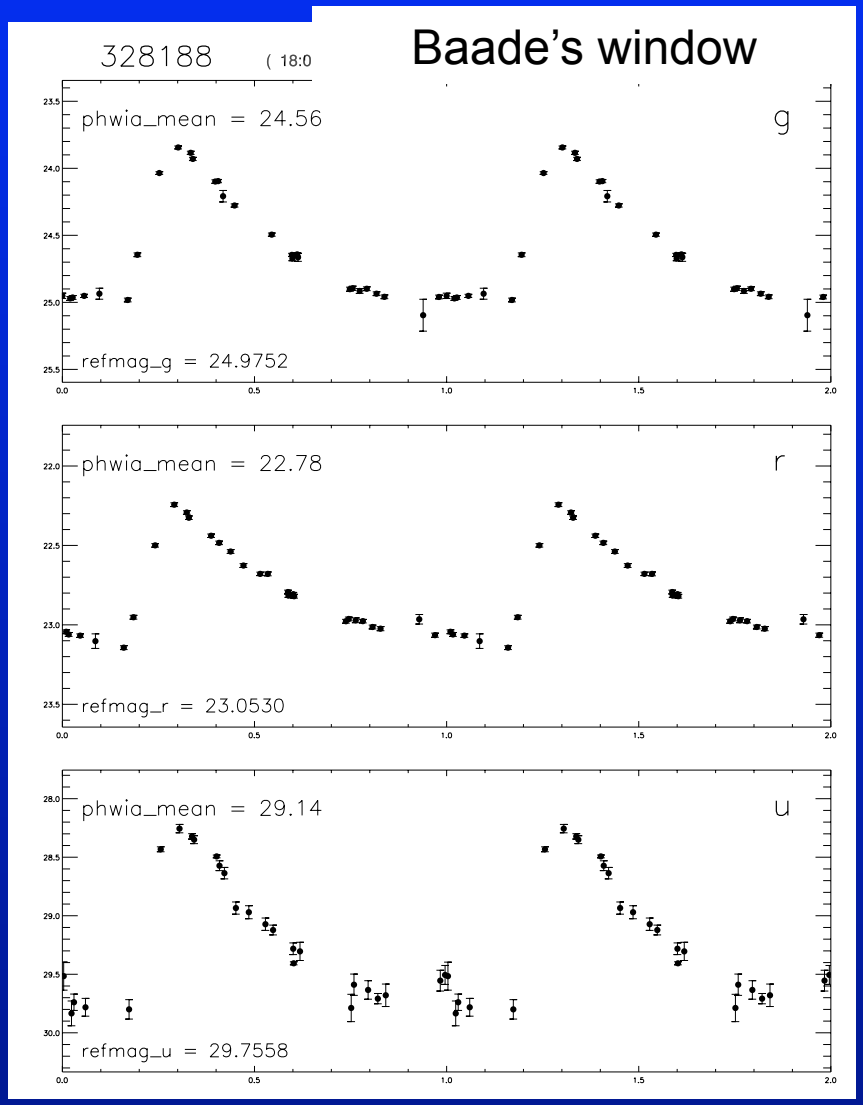
Prototyping the Data Lab
Using Galactic Bulge Variable project

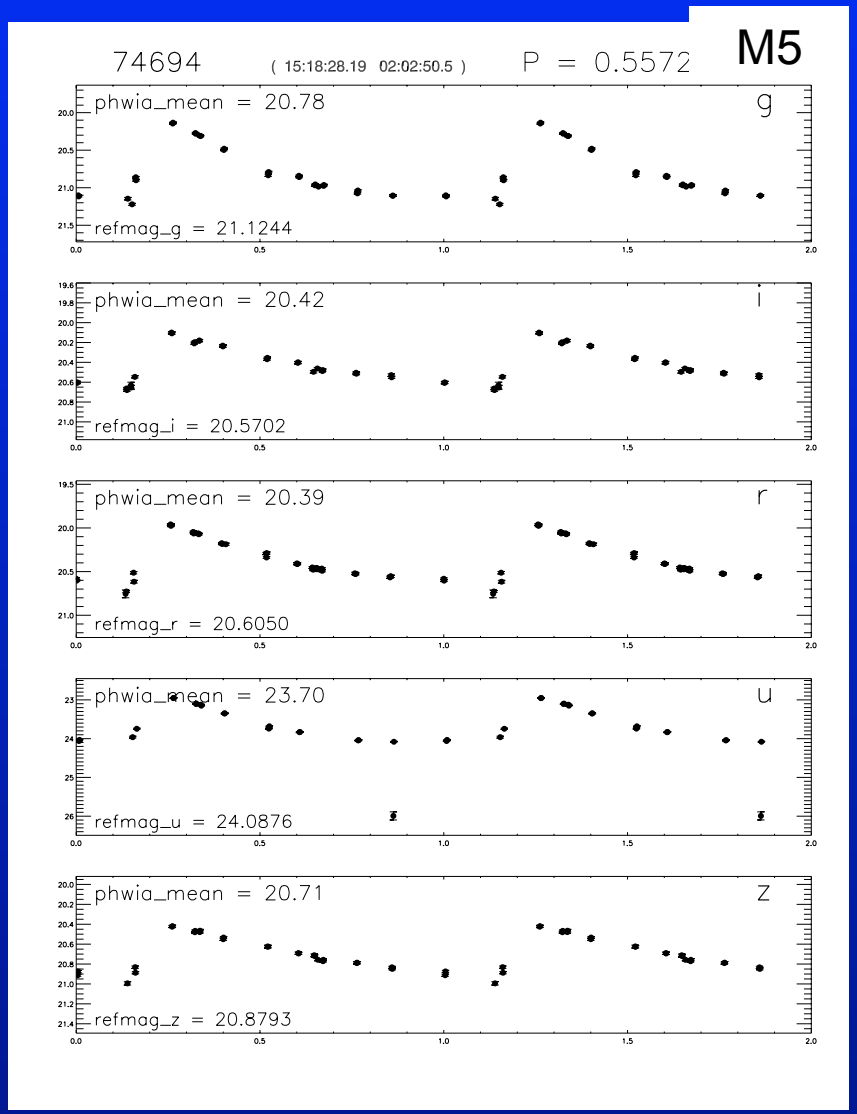




- DoPHOT-based photometric pipeline
- >5×10^6 objects measured in Baade's Window field
- Developed variable identification technique on M5 calibration cluster

Prototyping the Data Lab
Using Galactic Bulge Variable project





Parsing the variable sky
Challenges & approaches

- From LSE-163, a DIASource is a source detected from a difference image with S/N≥5. For each detected DIASource, an alert is transmitted within 60 seconds.
- The system is scaled to issue ~10^7 alerts per night
- Over time, most alerts will come from objects known previously to vary
- Will still need to filter full alert stream to find objects of interest

Parsing the variable sky
Challenges & approaches

Questions:

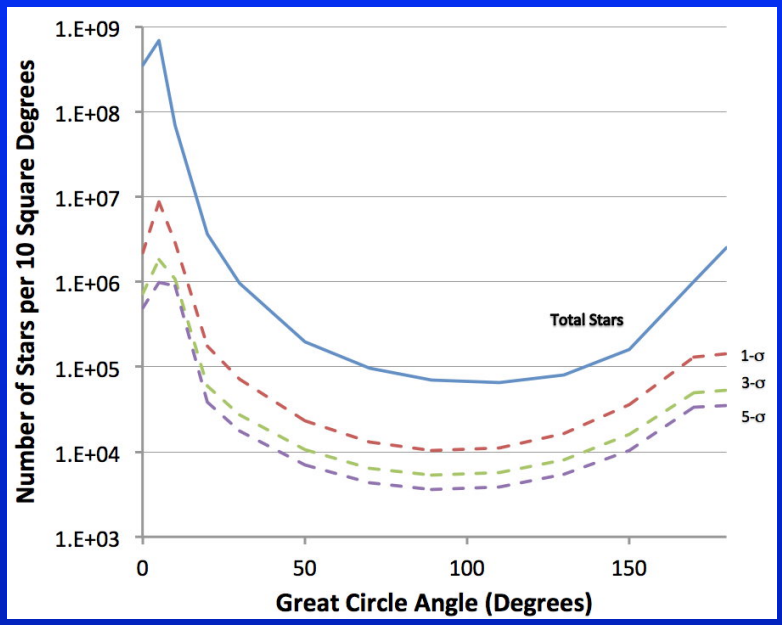
- How many alerts per night should we expect from prior experience?
- How many alerts from new objects per night?
- How to design a broker to serve broad filtering needs?

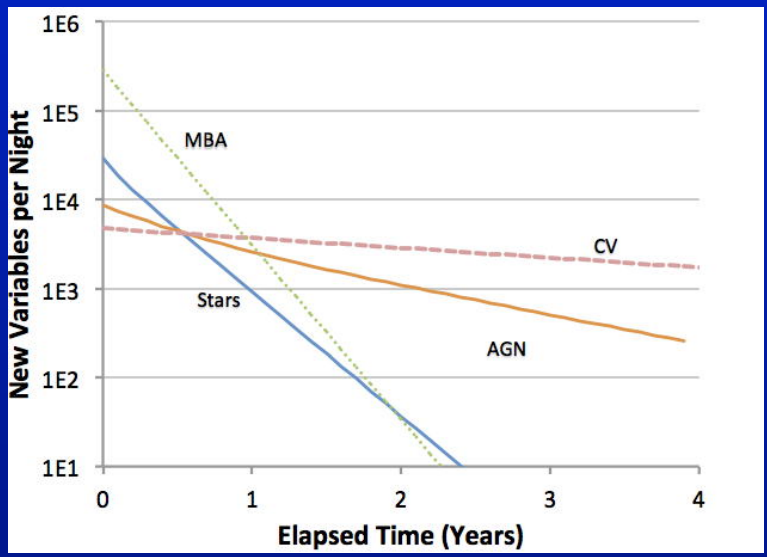
Approaches:

- Use an empirical data set (Kepler variability) to establish numbers
- Look at individual object classes to establish new object alert rate
- Collaboration with U.A. CS Dept. to design LSST-scale broker

Parsing the variable sky
A simulation

- Empirical study of statistics of stellar variability based on Kepler Quarter 13 data
- Statistics for stars mapped to whole sky through match of Kepler variabiity rate to Besançon Galaxy model
- Predicts alert rate as function of location for LSST and for GAIA
- Analysis includes treatment of variable AGN and moving objects
- While number of alerts on new objects for LSST and GAIA will be very large at first, drops by orders of magnitude after 2-3 years
- Critical to handle moving objects, as they dwarf other types of new alerts at start of survey
- Paper (Ridgway et al. 2014) submitted, presented at Hotwired III
- Next step: basis for alert stream simulator

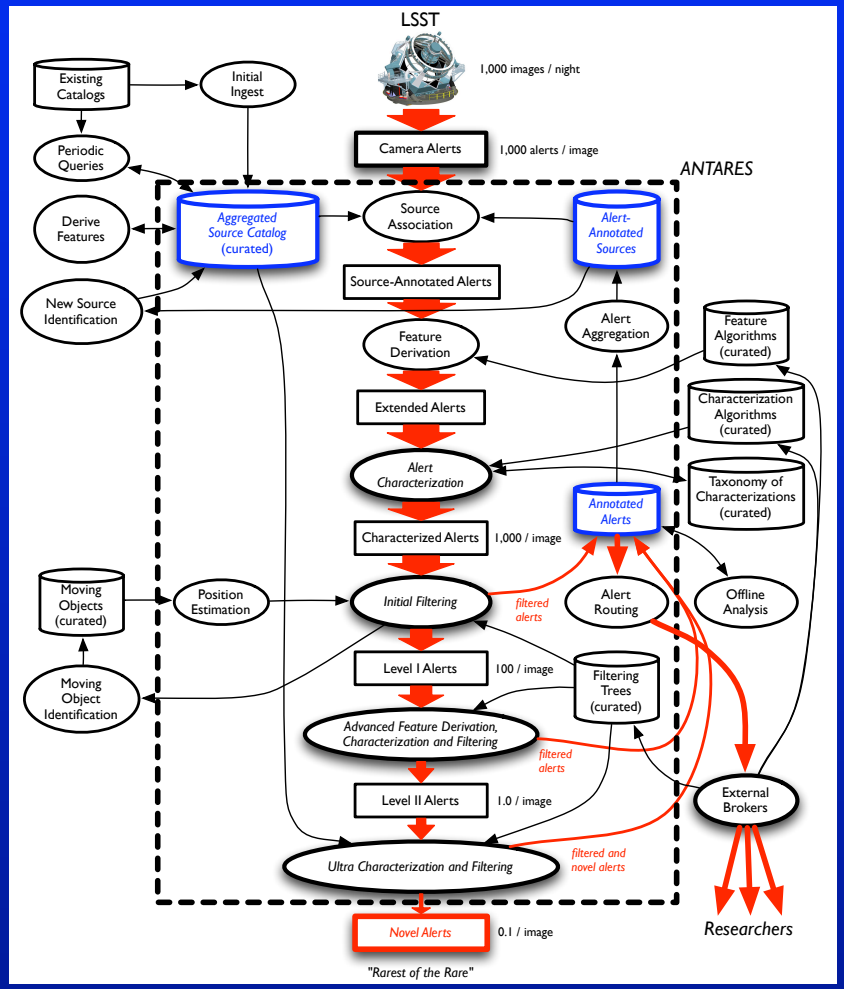




ANTARES

Arizona/NOAO Transient Alert & Response System

- Funded 3-year initial project
- Collaboration with U.A. Computer Science Department
- NOAO Co-Is: T Matheson, Abi Saha
- Prototype focused on finding "rarest of the rare"
- Will test core flow of system
- Open source/open access
- No alerts will be lost
- Future versions can expand to accommodate multiple filtering paths to address many goals



Parsing the time domain
Towards LSST

- Prototype being built around the alert streams of existing projects as well as simulated streams
  - Stripe 82, PanSTARRS, CRTSS
- By end of current project, scale to larger streams
  - e.g. DECam/DES
- Ultimate goal: deploy LSST-scale version for LSST Commissioning
  - Possible collaboration with NCSA

SLAC/NOAO collaboration
Areas of common interest

- SLAC and NOAO together provide a larger pool of expertise
- In area of LSST software and simulation tools, NOAO (OpSim) and SLAC (PhoSim, DM development) have complementary expertise
- SLAC has expertise in large-scale computing and Dark Energy science, NOAO has broad astronomical experience and connection to astronomy community
  - Discussing analyzing precursor data at scale, OpSim on large-scale computing platform
- Joint meetings and reciprocal visits to strengthen ties
- Organize workshops on LSST topics (Cadence workshop first example)
- Work together to lead “First Byte” pre-LSST dry run, driven by SC members in DESC and e.g. SMWLV, Transients and Variables
- Collaborate on commissioning activity

Summary

- Want to establish a center of LSST expertise at NOAO to support the astronomy community
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