



US National Gemini Office (NGO)  
Program Update  
*Letizia Stanghellini*  
NGO



## NGO mission

- The US NGO supports Gemini users in the various phases of science program planning and execution, from proposal preparation to data analysis.
  - Support US users with telescope application
  - Support NOAO TAC with technical reviews as needed
  - Support TAC-approved programs
  - Liaise between Gemini and the US PIs in preparation for the ITAC to facilitate scheduling
  - Support post-data acquisition analysis
  - Inform the US community of Gemini opportunities



## NGO activities

NGO supports post-data acquisition activities

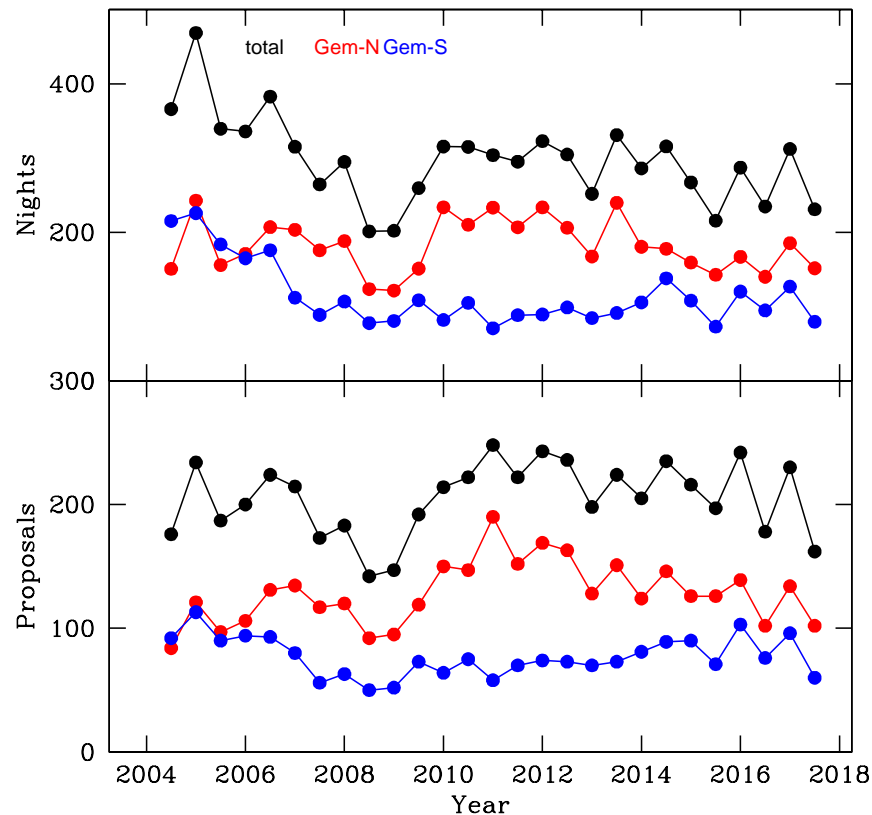
NGO does not provide Phase II support, which is done by Gemini

### Recent and current activities

- Update the GMOS Data Reduction Manual
- Update the NGO webpages with community-wide news, tools, and information useful for US Gemini users (and all users)
- A draft MIRI data reduction manual is now available
- AAS Mini-workshop series continues. January 2017 *Mining Data Archives* has been successful (see extra slides, including Gemini plans)
- 2018 AAS Mini-workshop is being planned at this time
- TAC support
- Supporting Phoenix as Gemini-S visitor instrument in 2017A/B



# Gemini submission to NOAO TAC



These numbers exclude NOAO Surveys, and LLP Gemini programs.

Submission has remained healthy at both telescopes.



# NGO webpage

The NGO webpage is a gateway for all Gemini users

It is updated bi-weekly

It includes links to all data analysis tools available to date

## US National Gemini Office



The US NGO main goal is to support US Gemini Users in the phases of the astronomical observing cycle, from proposal preparation through data analysis. This page is the main portal to all information needed in the different phases, explaining and connecting to specific [Gemini web pages](#), where users can find definitive contents on instruments and modes. In addition, this page contains tools for data reduction and analysis for the entire Gemini community. All Gemini Users are encouraged to contact us with questions and comments.

### News

- **OCTOCAM** has been selected as the Gan4#3 instrument. It is scheduled to be available at GS for LSST followup. The Feasibility Study (205 pages) is available [here](#).
- **Hamamatsu CCDs** have been installed at Gemini North. First use was March 26, 2017. Final characterization is underway. Users with Hamamatsu data should keep in touch with their contact scientist.
- Phase I/II driving you crazy? **Become proactive.** [A rewrite project has started.](#) Watch for opportunities to submit input or send email to Bryan Miller at Gemini.
- **PROGRAMS PAY OVERHEAD CHARGES IN 2017B.** Details can be found in the 2017B call for proposals. The PIT calculates the overhead charge.
- ITAC meets June 1. email concerning TAC decisions follows by a few weeks.

### Gemini Science Instruments and data reduction links

- [Overview](#) - general information and useful links
- [How to get your data - The Gemini Archive](#)
- [Gemini data format](#)
- [Gemini data processing software](#)
- [GMOS](#)
- [NIRI](#)
- [GNIRS](#)
- [NIFS](#)
- [GRACES](#)
- [GPI](#)
- [F2](#)
- [GSAOI](#)
- [Phoenix](#)
- [2015 AAS Mini-workshop "IR data reduction"](#)
- [2016 AAS Mini-workshop "AO data reduction"](#)
- [2017 AAS Mini-workshop "Mining data from the Public Archives"](#)

### Proposal preparation sites

- [Current NOAO Call for Proposals](#)
- [Current Gemini Call for Proposals](#)
- [Current Fast Turnaround Call](#)
- [Integration Time Calculator](#)
- [Gemini Helpdesk](#)
- [Guide for Planning GMOS Observations](#)

### Post-data acquisition sites

- [Gemini Science Archive](#)
- [Gemini Publications](#)

### Who We Are



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GMOS



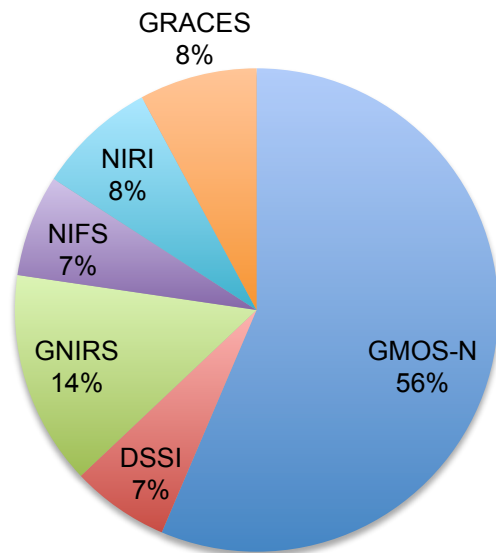
**Jane Price**  
([jprice@noao.edu](mailto:jprice@noao.edu))  
administration

Dave Bell at NOAO supports Phase I.



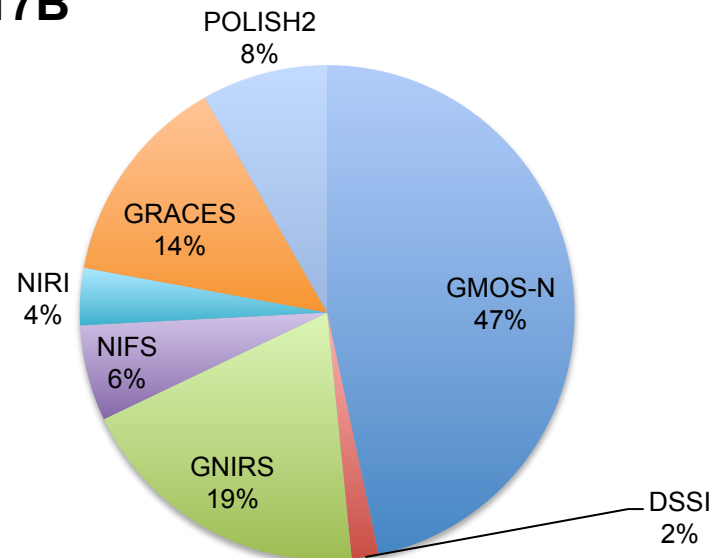
# Gemini-N Instrument requests (by nights)

**2017A**



Regular NOAO TAC  
New programs only  
(excluding Subaru exchange,  
LLP, surveys, FT, DD)

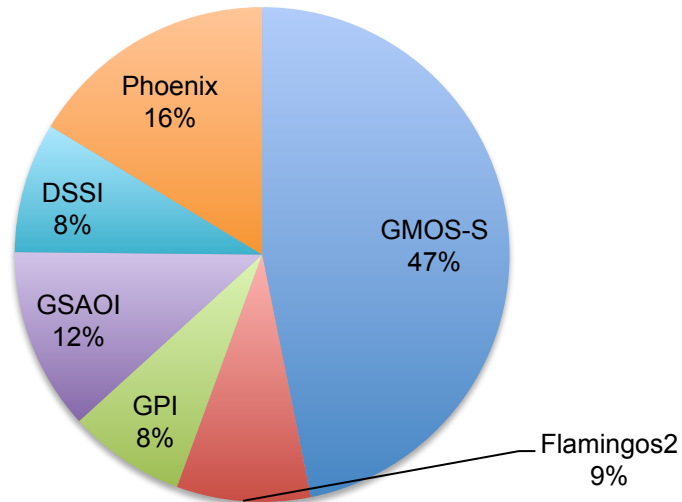
**2017B**





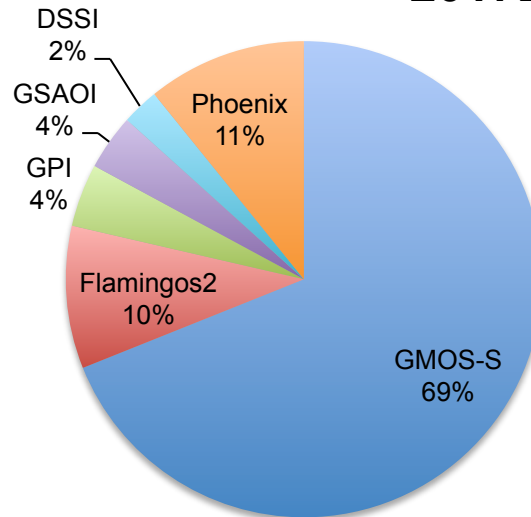
# Gemini-N Instrument requests (by nights)

**2017A**



Regular NOAO TAC  
New programs only (excluding  
LLP, surveys, FT, DD)

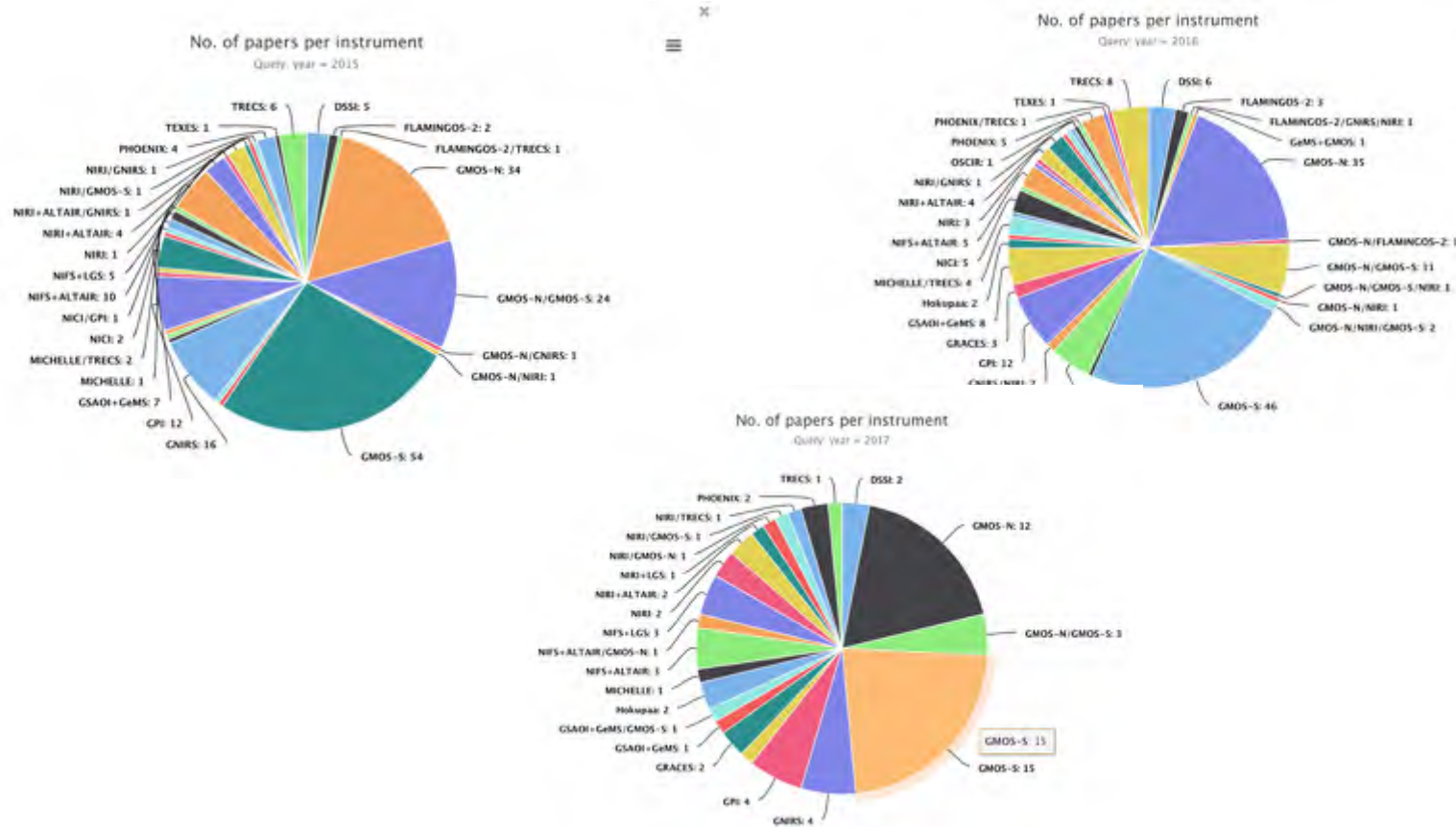
**2017B**





# Publications from NOAO TAC allocated programs

- The number of US Gemini refereed publications has remained constant though the last few years (2015: 103; 2016: 90; 2017: 29 so far)
- Graph shows paper by instrument in 2015, 2016, 2017







Backup slides

## 2017 AAS Mini-workshop on *Mining Data Archives*

- (1) Andy Adamson and Andre-Nicolas Chene: *Gemini Observatory Publications, Statistics, and Archive*
- (2) Harry Teplitz: *Astrophysics Archives at IPAC*
- (3) Scott Fleming: *Sailing the Archival Seas with MAST*
- (4) Knut Olsen: *The NOAO Data Lab Project*

# Gemini Observatory Publications, Statistics and Archive

A Adamson  
A-N Chené

# Abstract

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We describe the statistics of Gemini refereed publications, including relative productivity and impact of instruments and observing modes, and overall statistics such as the total publication count. We identify factors which may influence the probability of a publication emerging from a given observing program. At present, only a small fraction of publications arise purely from archival data. We present some of our plans for post-observing community support, and solicit input on various options for increased productivity in archival research.

*Notes in italics on each slide are the comments added to the information in the course of the talk.*

# Outline

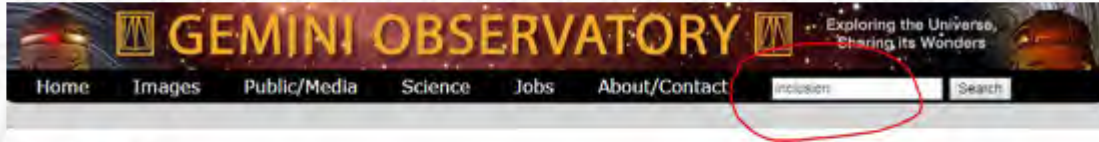
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Show some of the more interesting statistics relating to publications from Gemini observations - AJA

Show some of the ways in which we may be able to increase the publication rate, and solicit input on options - ANC

# Publication Statistics

# Overall Statistics



Publication count has now plateaued - about 200/yr, or a couple of papers per week at each telescope.

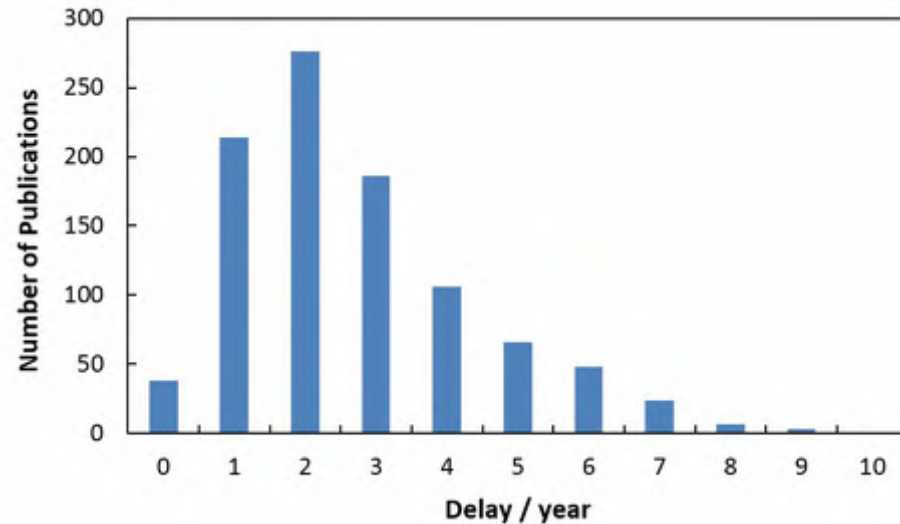
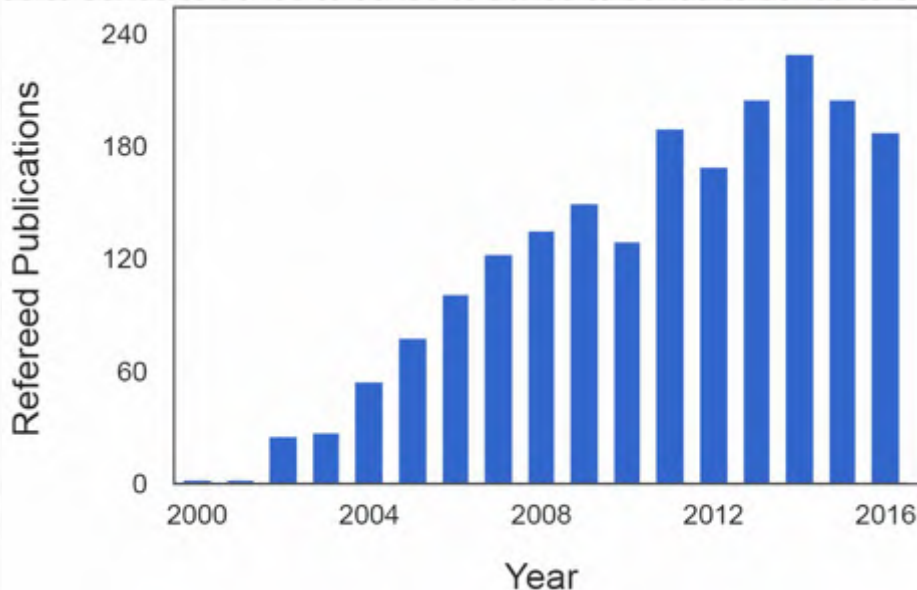
Lead time is about 2 years.

## Search Results

About 314 results (0.26 seconds)

### [Gemini Publication Inclusion Criteria](#)

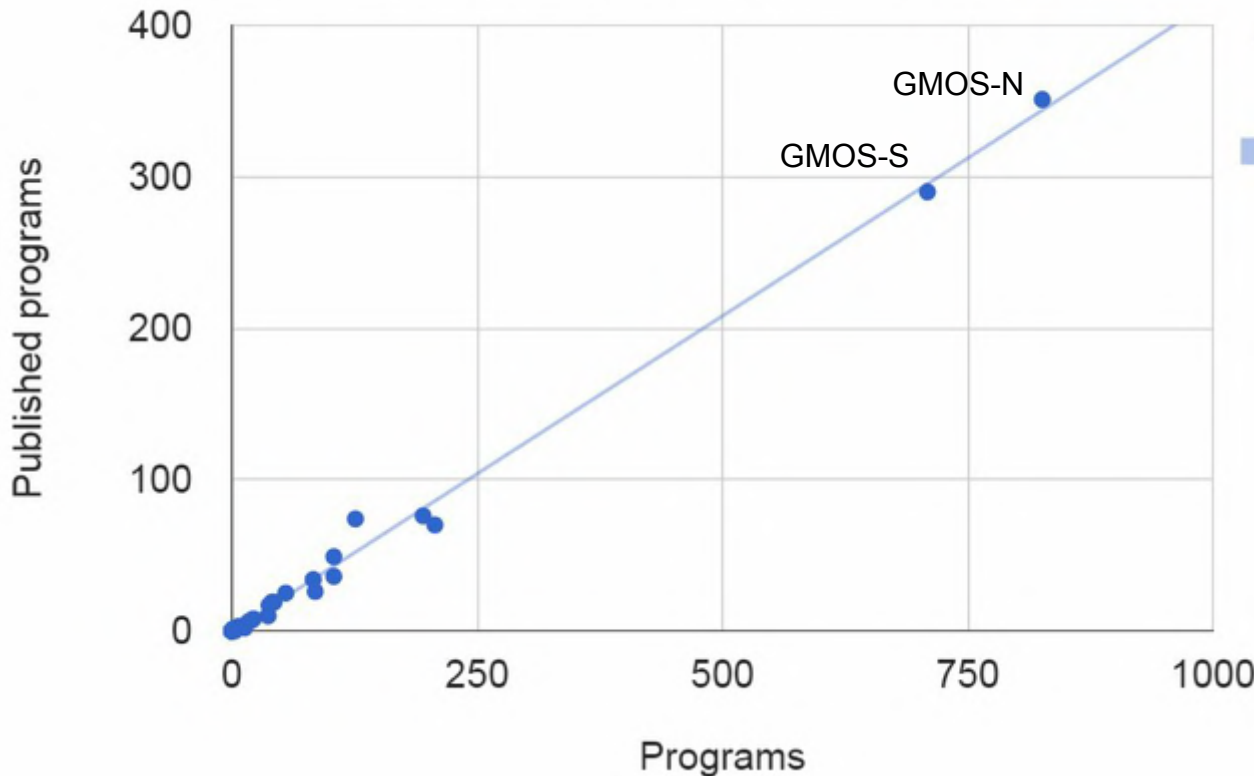
Gemini Publication Inclusion Criteria. by admin. To qualify as a Gemini publication, a paper must employ in an original way an image, spectrum, or data set.  
<https://www.gemini.edu/library/gemini-publication-inclusion-criteria>



*Noted in discussion: Gemini PIs across the whole partnership publish about two papers a week per telescope. Looks like we may now be at a plateau, and the influence of Large/Long programs is yet to be seen.*

# Publications vs Instrument

Publication/Completion per Instrument

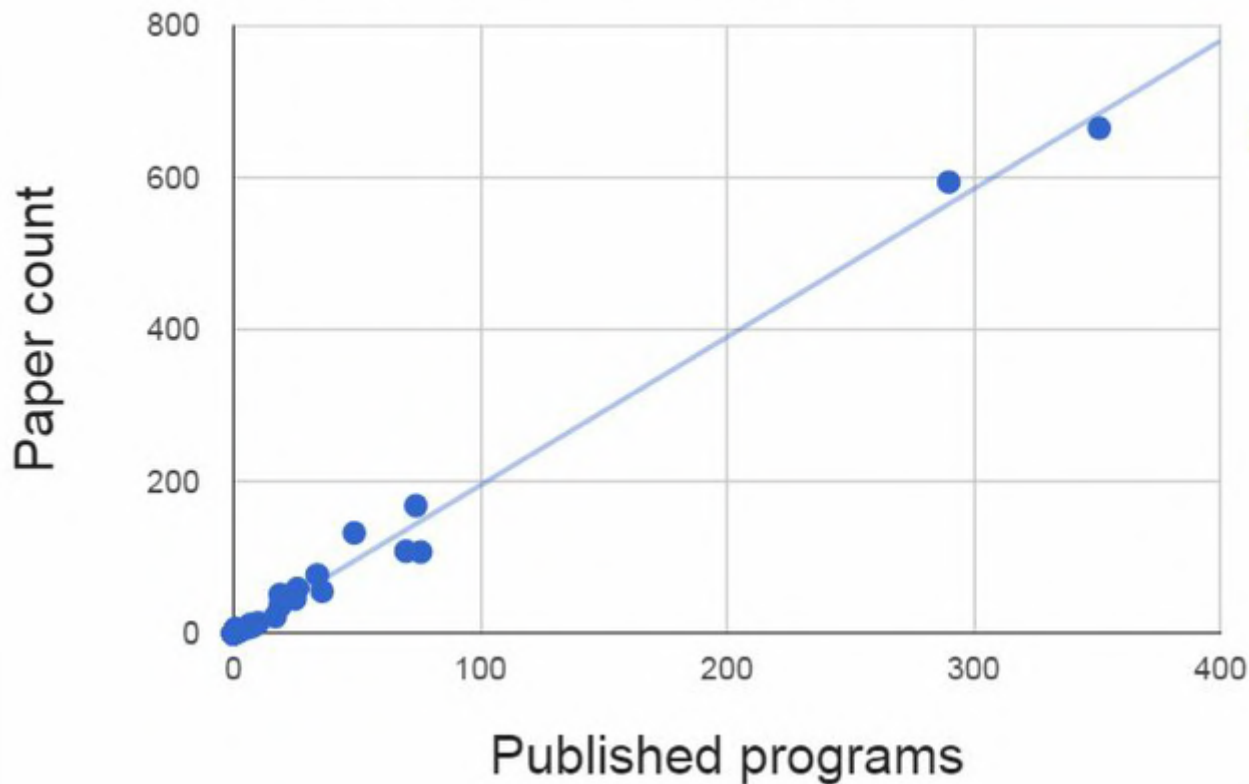


- >80% complete programs
- 2005-2014
- Each point is an instrument
- Single-instrument papers only

*Noted in discussion: There's really great variation between instruments. All lie on the same line, with a slope of about 40-50% (meaning there's room to grow in terms of publication count).*

# Multiple publications

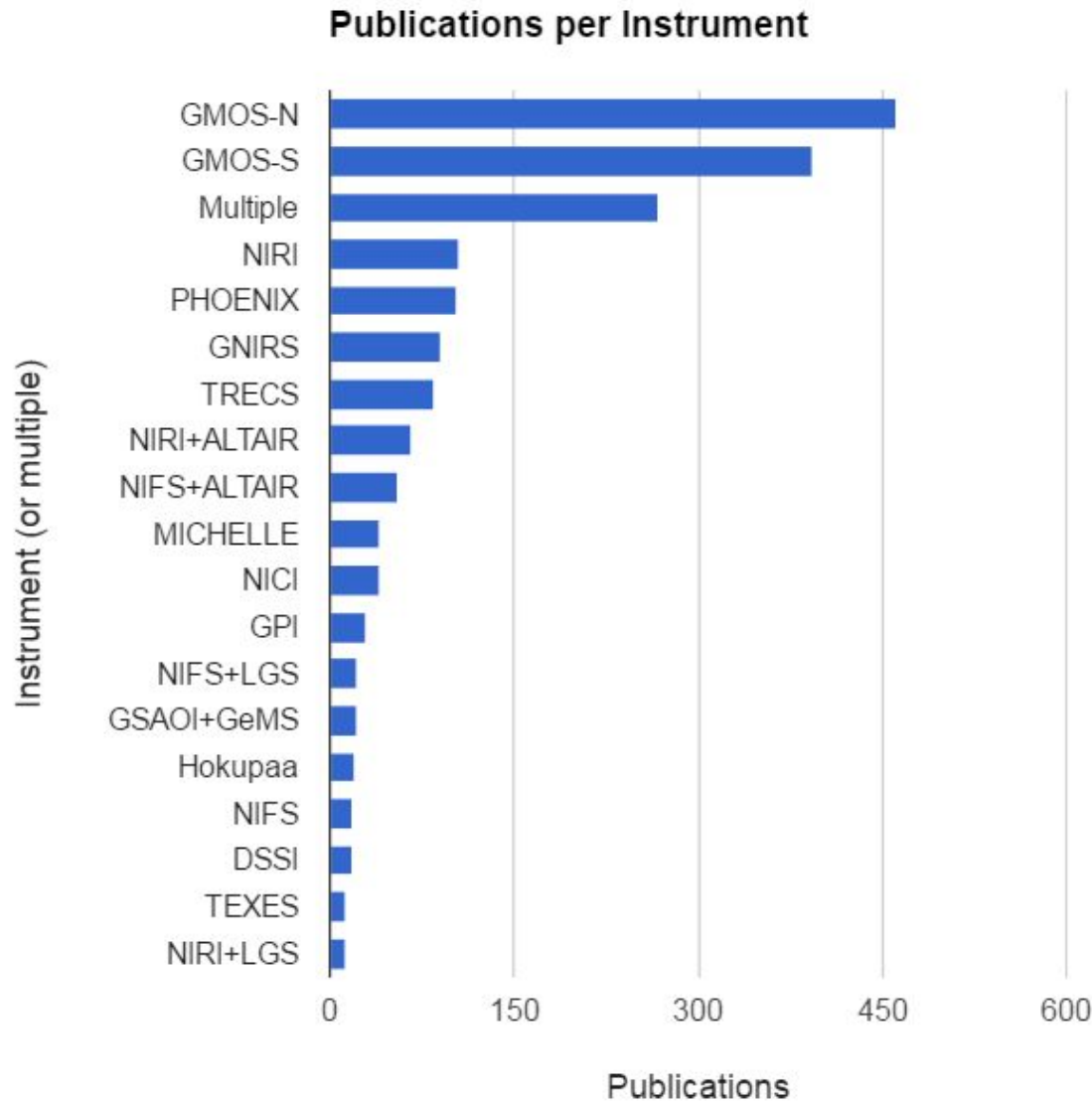
Paper count vs. Published programs



- A program that publishes, tends to publish twice
- Again, instrument-invariant



# Publications by instrument

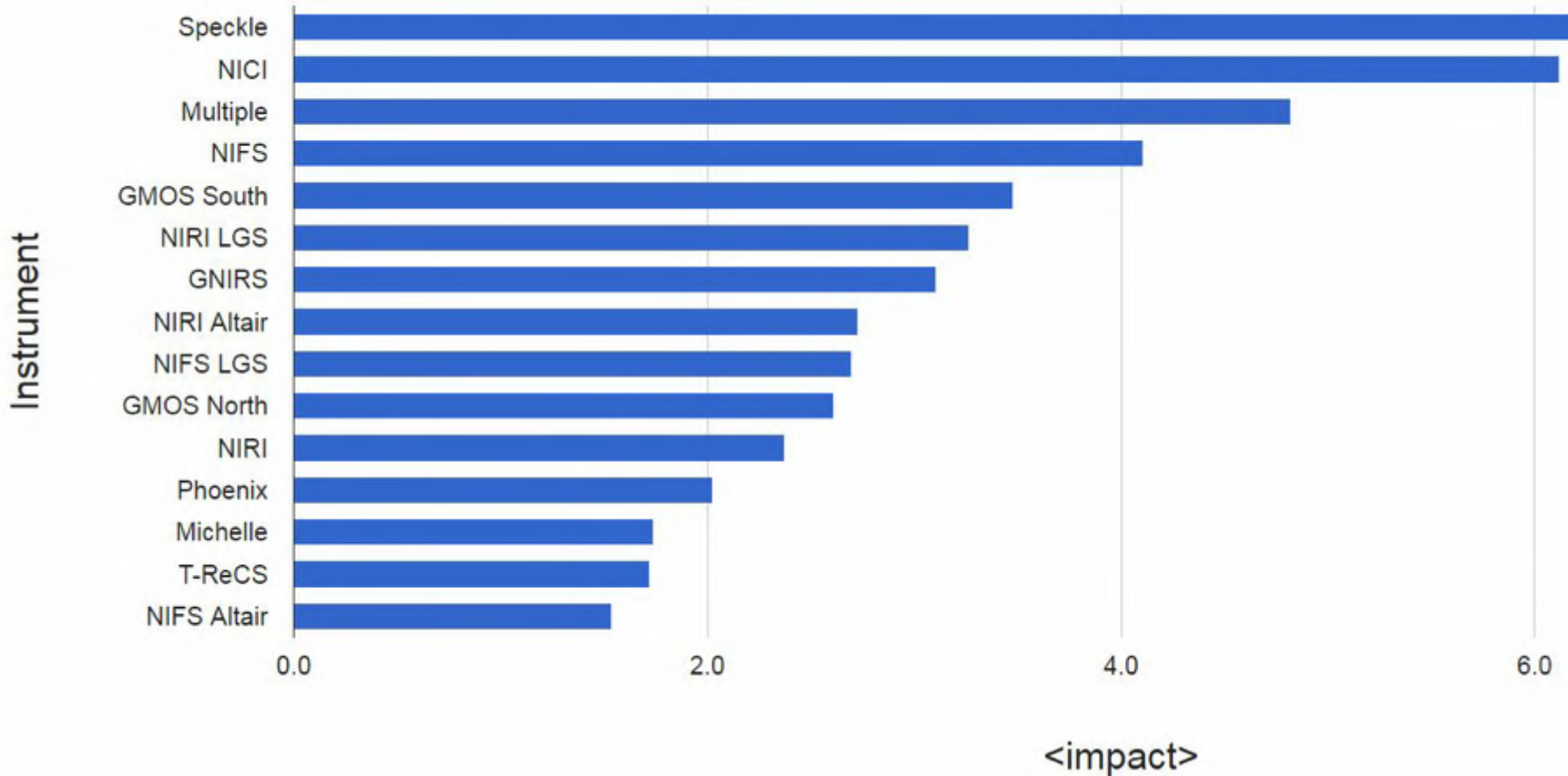


2005-2014

*Note added in discussion: GMOSs being at the top is not surprising (they dominate the program count). “Multiple” instrument publications coming just below that is more interesting, probably reflects the many possible combinations of more than one instrument, and programs over more than one semester contributing to a publication.*

# <Impact> per instrument

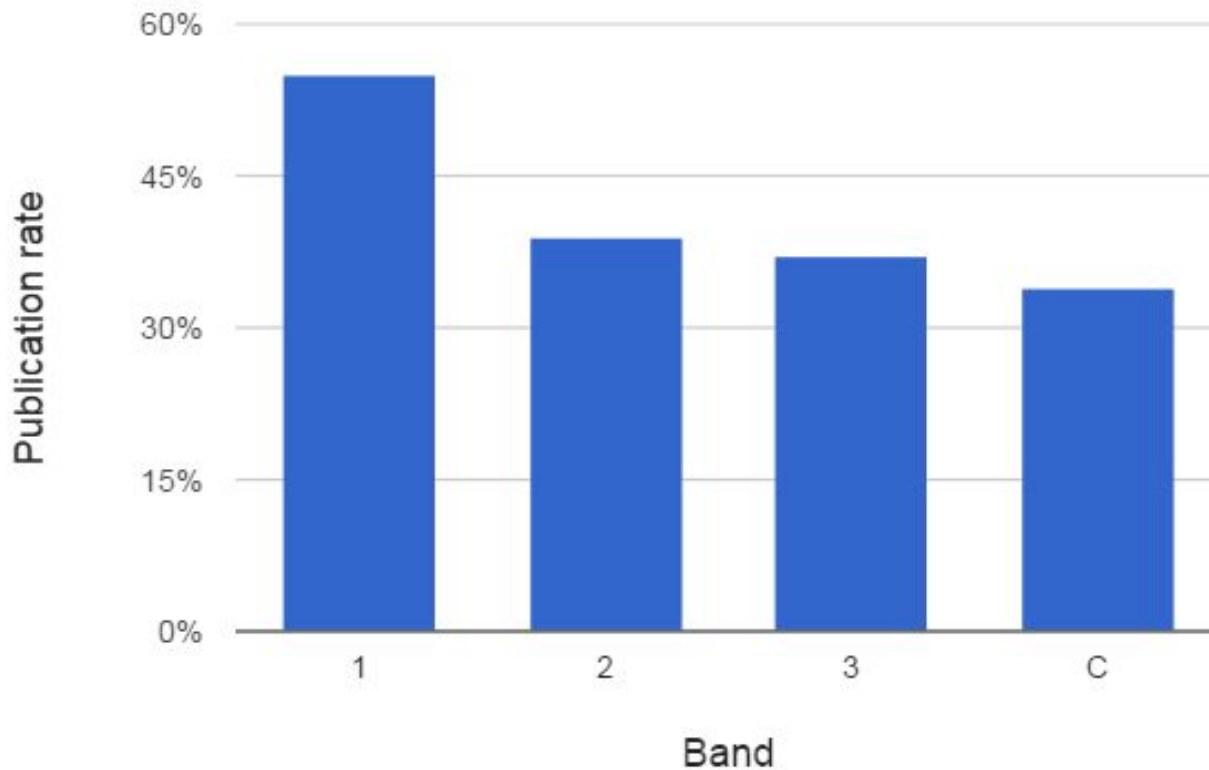
Average impact per instrument



*Note in discussion: interesting that the cheapest instrument ever on the telescope has the highest current impact (but remember this is a snapshot). Also the fact that NICI - another exoplanet instrument - comes second shows that this chart is about subject fields, not instruments per se.*

# Publications vs band

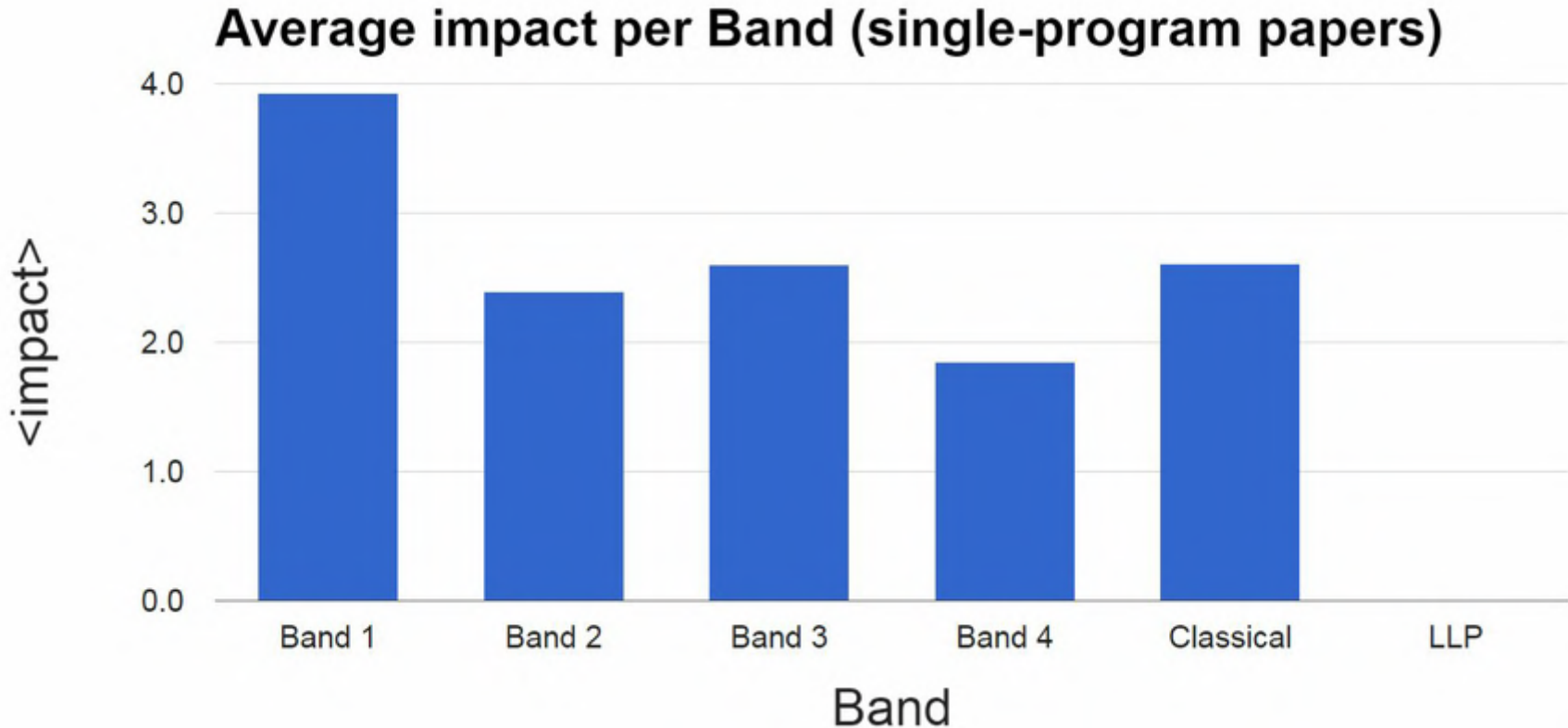
Publication rate vs. Band



- >80% complete programs
- 2005-2013

*Note added in discussion: since this is all to do with programs at the same minimum completion rate, the indication is that the TACs can spot a winner.*

# <Impact> vs band



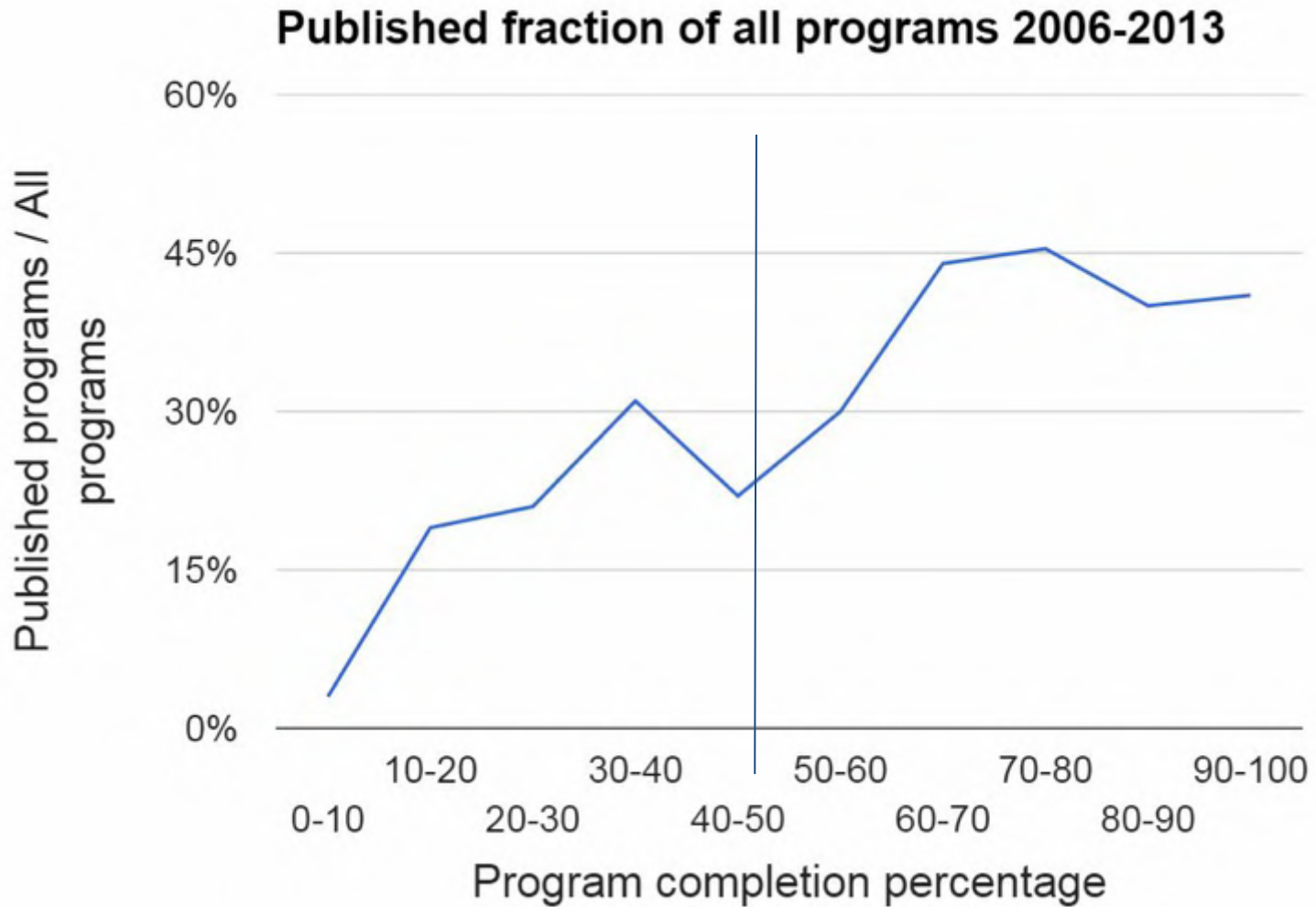
Single-program papers only, programs 2005-2015. Joints included.

Impact data from 2000-2014 publications. Updated Oct 2016

Nett coverage: publications between 2005 and 2013.

*In discussion: within Band 1, Joint programs have by far the highest impact when published.*

# Publication vs completion



*Note in discussion: once a program gets above 60-70% complete, the chance that its data will appear in the literature does not increase. This point has been discussed by Gemini and its Governance and has affected queue execution policy to some extent.*

## Data Gathering (NGOs):

2013-2015, with two-year lead time

## Main Themes (consistent across partnership):

- Low priority data set <- longer programs
- Circumstances changed <- fast turnaround
- Postdoc left <- fast turnaround
- Didn't detect the target

*Note in discussion: the most typical responses were not what had been expected. Changes in our offered observing modes may address some of these, as indicated in red.*

# Archive Publications

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Papers emerging from purely archival data amount to only a few percent of all Gemini publications.

# Gemini Science User Support, Data reduction and Archive possibilities

A-N Chené



- 4.6 FTE working on DR software
- 1 FTE focused on support

## Avenues:

- Helpdesk
- Contact Scientists
- DR Forum
- Contacts page
  - Sus\_inquiries
  - NGO contact info



So you have seen it at least once

<https://archive.gemini.edu/>

<b>Program ID:</b> <input type="text" value="(leave empty for Any)"/> (or Obs. ID / Data Label. Exact Match)	<b>Target Name:</b> <input type="text" value="(leave blank for Any)"/> (Name of Target)
<b>UTC Date:</b> <input type="text" value="(leave empty for Any)"/> (YYYYMMDD or start - end)	<b>Resolver:</b> <input type="text" value="None"/> <input type="button" value="Resolve"/> (Name Resolver)
<b>Instrument:</b> <input type="text" value="Any"/> : (Select GMOS for GMOS-N and GMOS-S)	<b>RA:</b> <input type="text" value="(leave blank for Any)"/> (HH:MM:SS.ss or decimal degrees)
<b>Obs. Class:</b> <input type="text" value="Any"/> : (help)	<b>Dec:</b> <input type="text" value="(leave blank for Any)"/> (J2000:MM:SS.ss or decimal degrees)
<b>Obs. Type:</b> <input type="text" value="Any"/> : (help)	<b>Search radius:</b> <input type="text" value="(leave blank for 180 arcsec)"/> (arcsecs or decimal degrees)
<b>Mode:</b> <input type="text" value="Any"/> : (Imaging / Spectroscopy etc)	<b>Raw / Reduced:</b> <input type="text" value="Any"/> : (Select data by processing state)
<b>Adaptive Optics:</b> <input type="text" value="Any"/> : (help)	<b>Advanced Options</b> ▾ (click to show / hide) <b>Column Selection</b> ▾ (click to show / hide)
<input type="button" value="Search"/> <input type="button" value="Reset to previous search"/> <input type="button" value="Start Over"/> <input type="button" value="Search ObsLogs Only"/> (help on buttons)	

Set at least one of the search criteria above to search for data. Mouse over the (text in brackets) to see more help for each item.

# Reducing archive data

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Two possible approaches:

- People can figure it out...

- Ain't nobody got time for that!!!

## Gemini reduction packages

- Gemini IRAF packages
- AstroConda!
  - set of astronomy-related packages for Anaconda
  - testing channel is now available
  - main Astroconda channel at STScI later this month

(One can contact James Turner from Gemini for any question about AstroConda.)

## Reduction cookbook

[http://ast.nao.edu/sites/default/files/GMOS\\_Cookbook/](http://ast.nao.edu/sites/default/files/GMOS_Cookbook/)



GMOS  
Cookbook

## But we could do more!!!

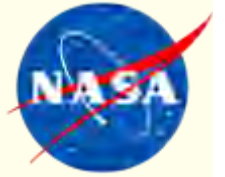
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- Publishing more cookbooks
  - That is on the way (F2)
- Adding reduced data to archive
  - Ready for GRACES and GNIRS XDmode!
  - Reduced data provided by PIs
- Making “pipelines”
  - Would require a tremendous additional effort

Thanks!

Questions?

Comments on priorities?



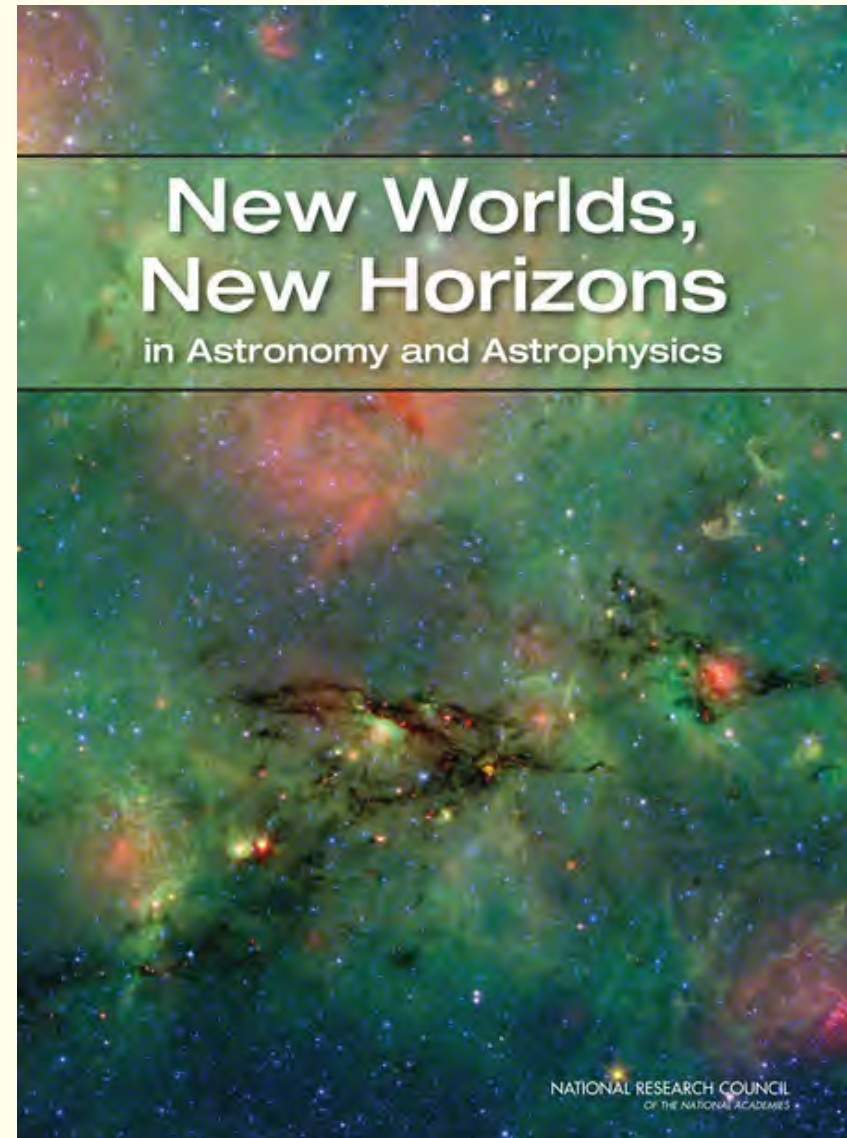
# Astrophysics Archives at IPAC

Harry Teplitz



## NASA's Commitment to Astrophysics Data Archives

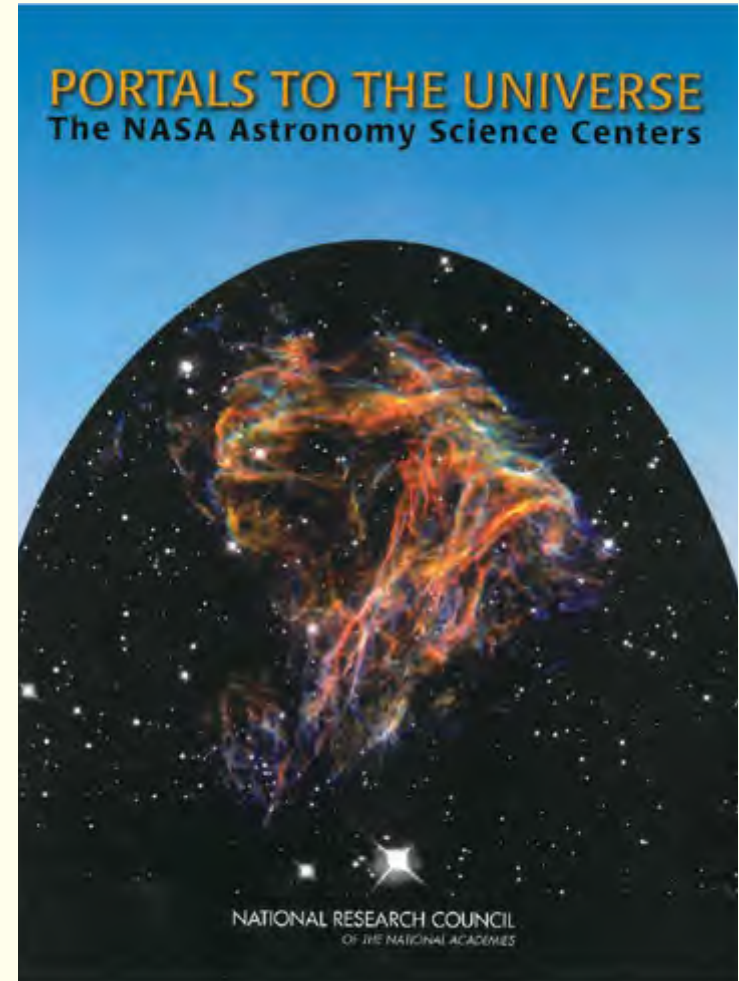
- ◆ "NASA has regarded data handling and archiving as an integral part of space missions."
- ◆ "This support now provides the major return on the considerable investment the agency made... over the past 20 years."





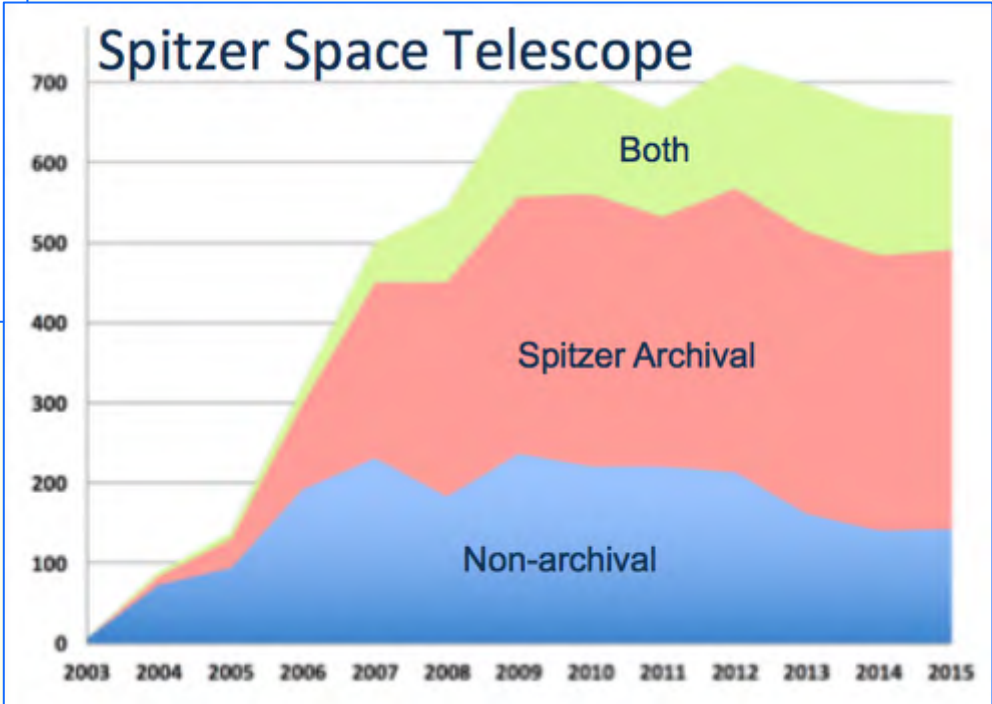
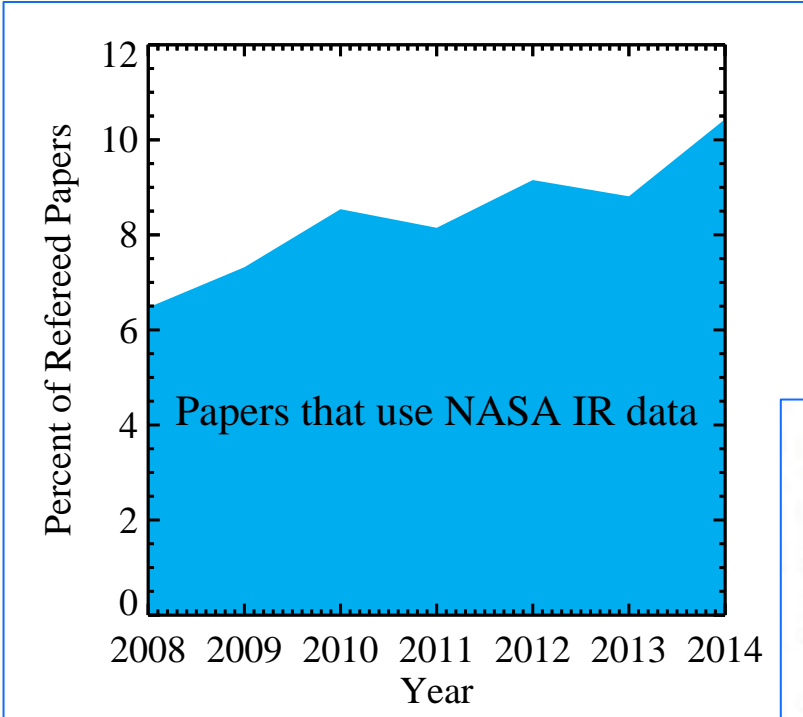
## “A Sustainable Archive”

- ◆ Continually facilitates production of new scientific results
- ◆ Has a strategic goal to enable more and better science
- ◆ Contains high-quality, reliable data
- ◆ Provides simple and useful tools to a broad community
- ◆ Provides user support to the novice as well as to the power user
- ◆ Has many diverse uses (and users)
- ◆ Adapts and evolves in response to community input





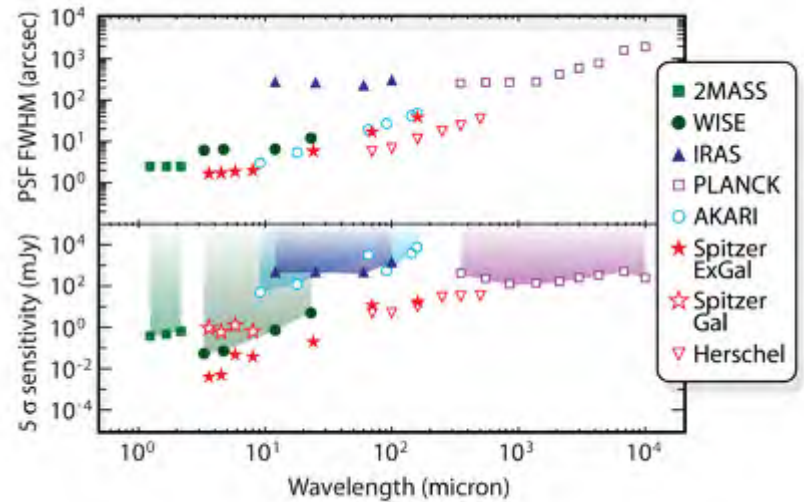
# Archives Double the Number of Papers from the Observatory





# IRSA : NASA's IR/sub-mm archive

- ◆ IRSA ensures the legacy of NASA's "golden age" of IR
  - ❖ Enable research that has not yet been envisioned.
  - ❖ Priorities set by missions and the community
  - ❖ Support future flight missions
  
- ◆ IRSA is continuing rapid expansion
  - ❖ Since 2011, holdings more than doubled (now > 1 PB);
  - ❖ # table rows increased by factor of 15 (>100 billion)
  - ❖ Almost 40 million queries in 2016



- All-sky 20 photometric bands from 1 micron to 1 cm
- About 40% of approved ADAP programs involve analysis of IR data sets



# NED : managing complex data sets



## Overview – NED in a Nutshell



**NED is where you find...**

- Objects with  $z > 2.0$  and available GALEX NUV flux
- Most precise  $z$ -independent distance measurement to M82
- SED, spanning gamma-rays through radio, for quasar 3C 279
- Spiral galaxies with stellar bars and Type 2 AGNs

**Published:**





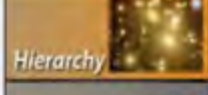
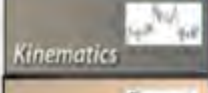
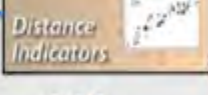
- Names
- $(\alpha, \delta)$
- Redshifts
- $D_{Mpc}$
- Fluxes
- Sizes
- Attributes
- References
- Notes

**Contributed:**

- Images
- Spectra

**Derived:**

- Distances
- Metric sizes
- Luminosities
- Velocity corrections
- Cosmological corrections
- SEDs
- $A_{\lambda}$

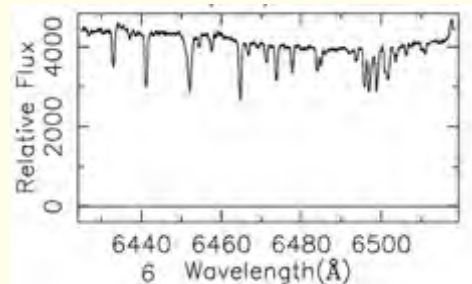
 Galaxy Morphology  
 Spectral Type (Activity)  
 Radio Morphology  
 Luminosity Class  
 Hierarchy  
 Kinematics  
 Distance Indicators

Extragalactic papers have grown to 3,500 per year, with unique measurements for millions of objects

## The Keck Observatory Archive




- ◆ NASA-funded collaboration between WMKO and IPAC/NExSci.
- ◆ Started with HIRES
- ◆ Systematic/automated capture of metadata ensures efficiency
- ◆ Now data from all ten instruments since their dates of commissioning
  - ❖ *decommissioned instruments Summer 2015.*
  - ❖ *proprietary period of at least 18 mo.*
- ◆ KOA creates browse products for three instruments by automating pipelines.



*KOA creates extracted HIRES browse spectra for every order of each object raw frame.  
Shown: T Tau. (PI: Reipurth).*






# NASA EXOPLANET ARCHIVE

A SERVICE OF NASA EXOPLANET SCIENCE INSTITUTE

FOR THE PUBLIC  
PLANETQUEST



Home
About the Archive
Data
Tools
User Guides & Help Desk

**3,375** Confirmed Planets  
08/25/2016 →

**570** Multi-Planet Systems  
08/25/2016 →

**4,696** Kepler Candidates  
09/18/2015 →

View more Planet and  
Candidate statistics →

### Explore the Archive

Search

? Advanced Search →

### Transit Surveys

21,853,310 Light Curves

The first space mission to search for Earth-sized and smaller planets in the habitable zone of other stars in our neighborhood of the galaxy.

Light Curves →	Objects of Interest (KOI) →
Threshold-Crossing Events →	Search Stellar Data →
Completeness and Reliability Products →	Documentation →

Kepler
K2
KELT
SuperWASP
More

### Tools & Services

Periodogram →	Predicted Observables for Exoplanets Service →
Transit and Ephemeris Service →	Build a Query (API) →
Search Interactive Tables →	Search Extended Planet Data →

### Meet the New Neighbor: Proxima Cen b

**August 25, 2016 • New Data**

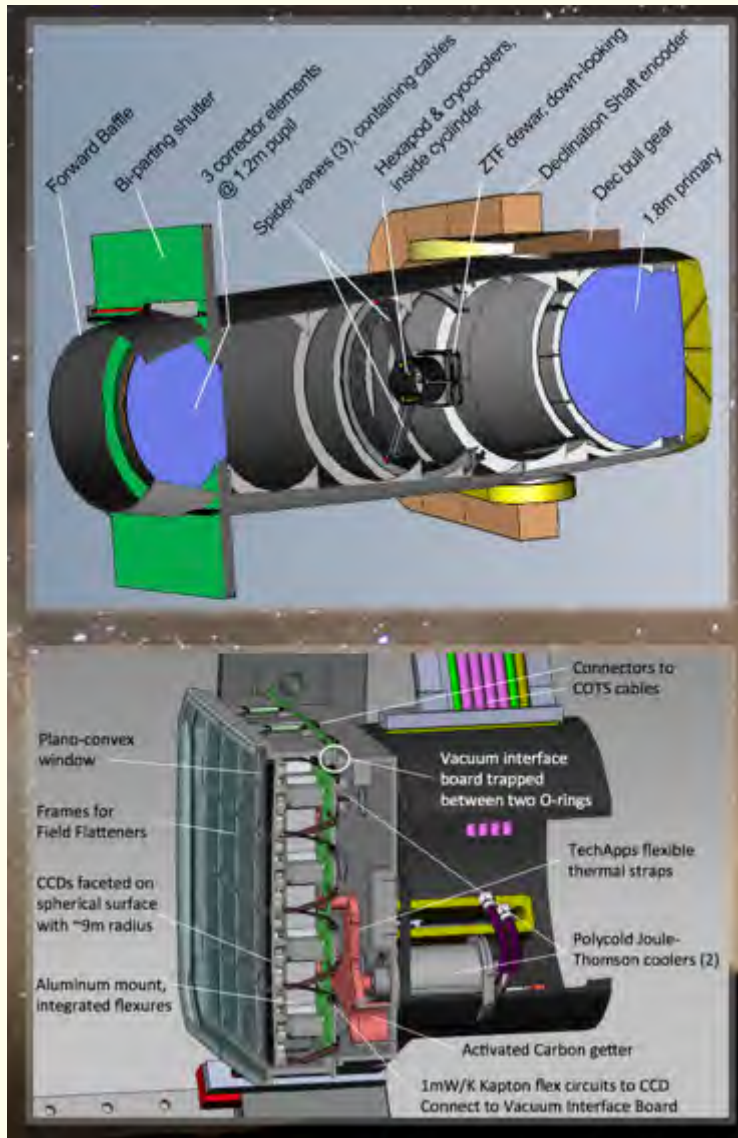
Proxima Centauri b, the new Earth-sized planet that has the astronomy world buzzing this week, is in the Archive. To view its parameters, click to see its Planet Overview page.

News →
1 2 3 4
Plots →
1 2 3 4

### Work with Data

Confirmed Planets Plotting Tool →	Confirmed Planets Table →
Search K2 Targets →	Bulk Download Service →
Transit Spectroscopy →	ExoFOP →

## Other IPAC Archives following the NASA model (non-NASA funded)



- ◆ **Palomar Observatory**
  - ❖ *Zwicky Transient Facility (2017+)*
  - ❖ *intermediate Palomar Transient Factory (iPTF; 2013-2016)*
  - ❖ *Palomar Transient Factory (2009-2012)*
- ◆ Fully automated wide-field survey with 1.2 m Oschin telescope
- ◆ Publicly accessible survey data products available at IPAC
  - ❖ *single frame exposures for selected regions of the sky,*
  - ❖ *source catalog files for those same regions.*



## An Archive's Job

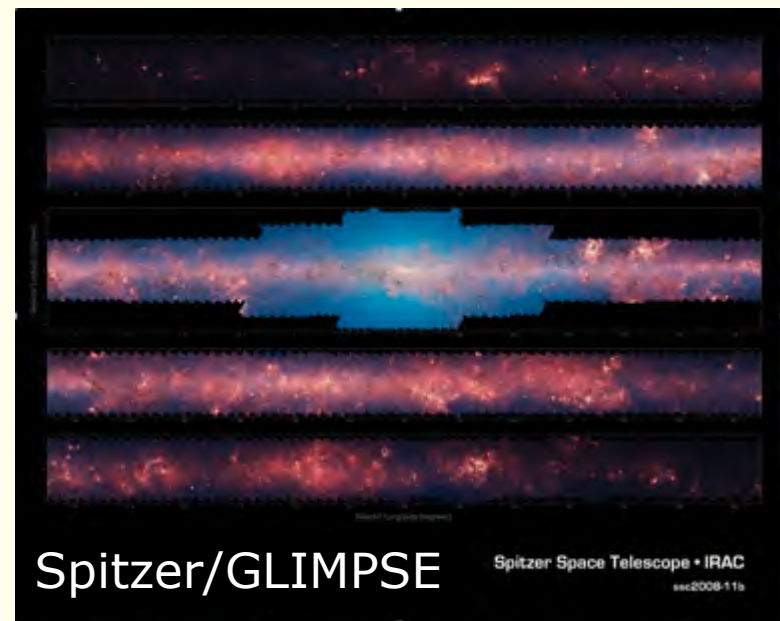
- ◆ Ingest new data
- ◆ Maintain/serve vital repository of irreplaceable data
  - ❖ *Support for observation planning*
  - ❖ *Resource for original science*
  - ❖ *High level science products*
- ◆ Enable cutting-edge research
  - ❖ *API and Virtual Observatory*
  - ❖ *User support by experts*
  - ❖ *New/enhanced services*



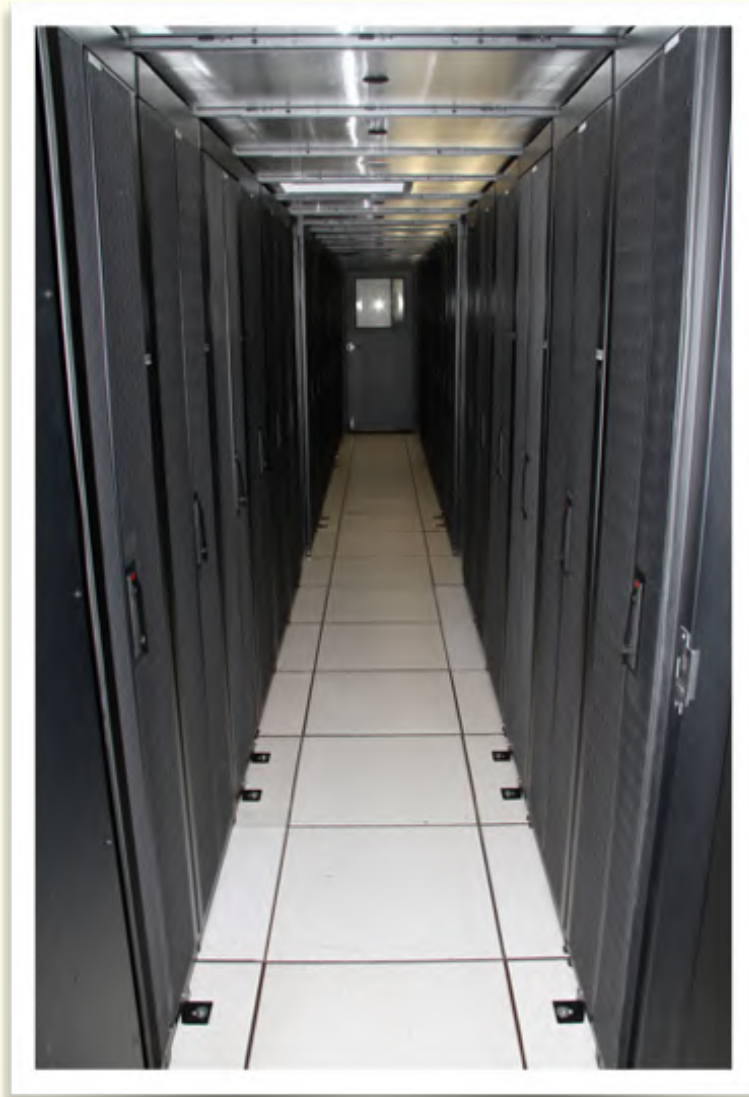


## High Level Science Products

- ◆ Greatly enhance the science return of the archives
  - ❖ *Hubble Legacy HLSP are used 10x as much as typical pipeline products*
- ◆ Make complex data sets accessible to a wider audience of researchers
- ◆ Expand the use of large, coherent projects
  - ❖ *Herschel Key Projects*
  - ❖ *Spitzer Legacy and Exploration Science*
- ◆ Generated by the community or by the archive



## Technical Synergy and Innovation



- ◆ IRSA implemented innovative indexing techniques for NEO/WISE, optimized to meet the required use cases for database queries
  - ❖ *single position spatial searches (using a recursively subdivided triangular mesh)*
  - ❖ *simultaneous matching of large user-supplied lists of positions (using a file-based index outside of the database).*
- ◆ Challenges presented by WISE were used as opportunities to extend IPAC's capabilities
  - ❖ *ZTF will require databases that are at least an order of magnitude larger*

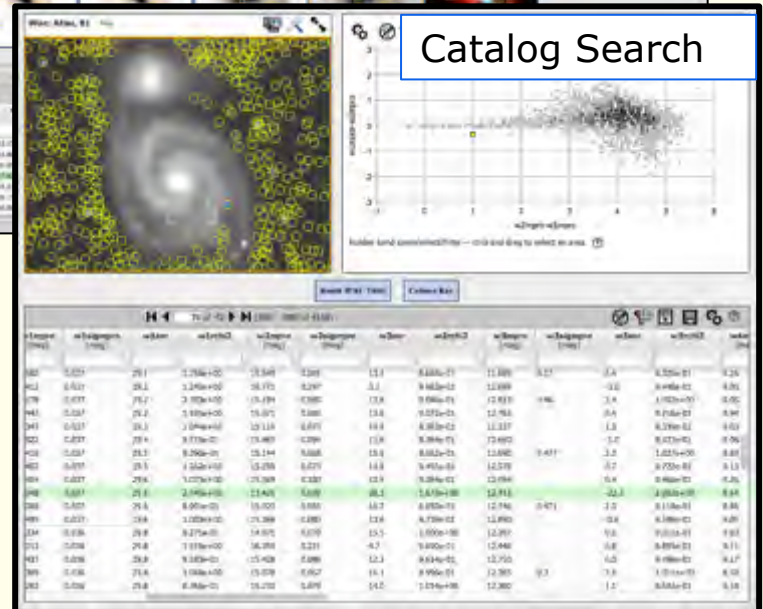
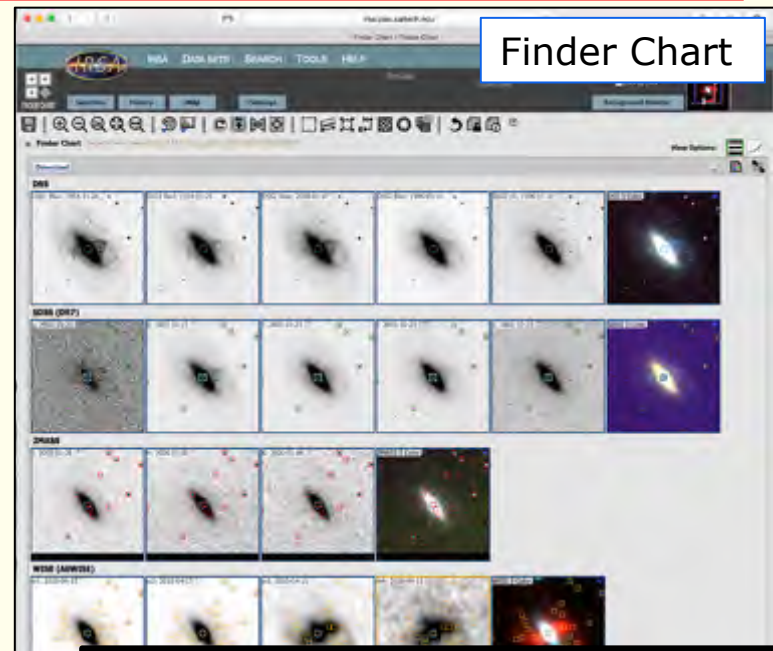
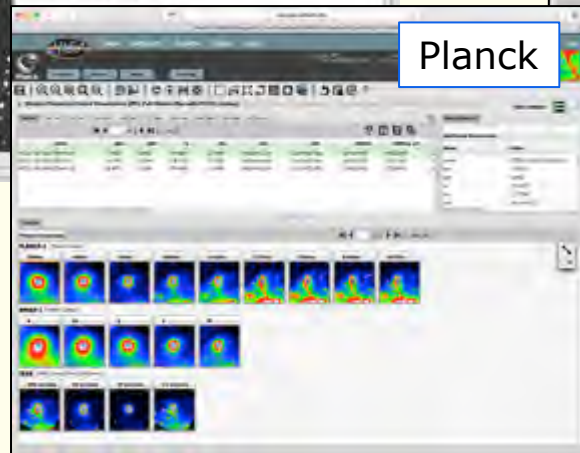
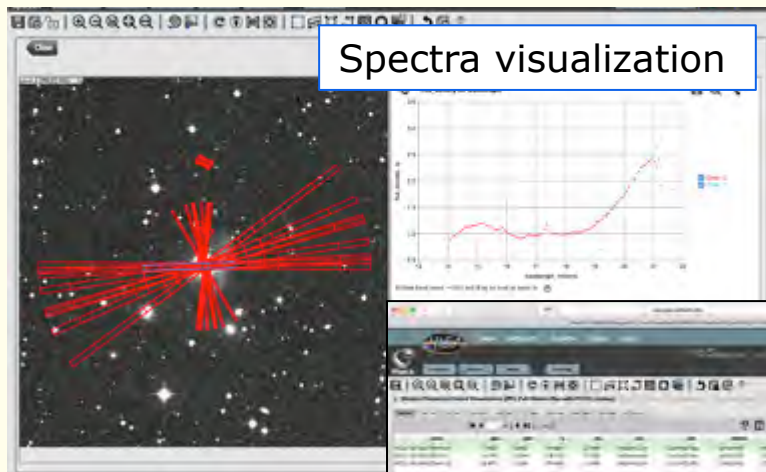


## Science User Support

- ◆ *Helpdesk* some tickets are simple, others extremely complex
- ◆ *Documentation*
  - ❖ *tools/data releases*
  - ❖ *updates in response to tickets*
  - ❖ *Handouts*
- ◆ *Demos*
  - ❖ *Live (AAS, ADASS, DPS)*
  - ❖ *Video tutorials (IRSA has > 60 videos)*
- ◆ The complexity of Science User needs increases with time.

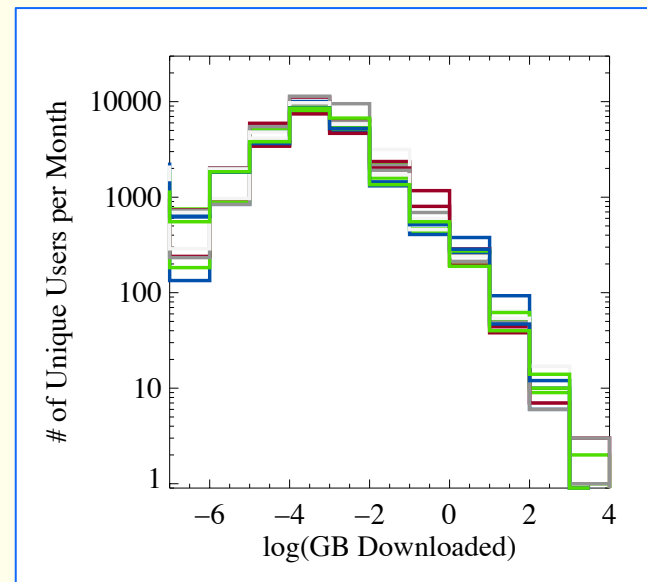
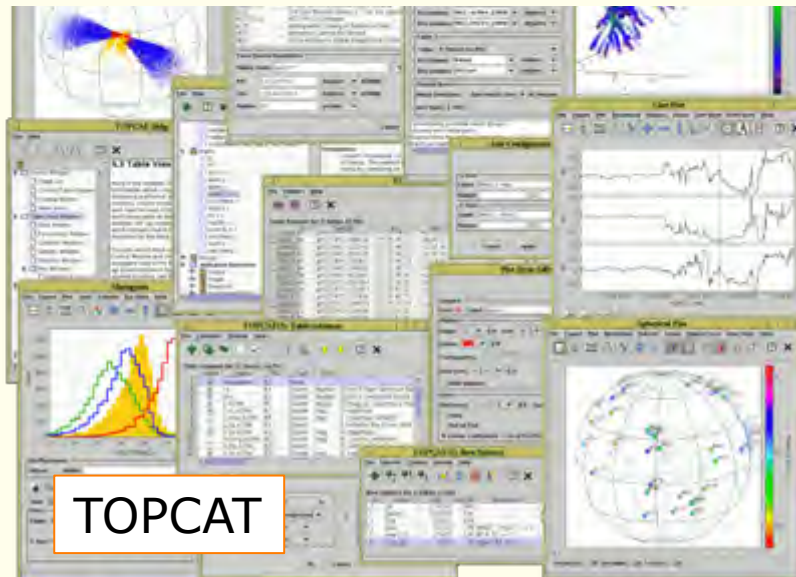
## Data Exploration and Visualization Services

- ◆ Search & display can be tailored to various instrument/science contexts, using reusable visualization components
- ◆ Combine images, plots, tables, spectra
- ◆ Supports observation planning
- ◆ **Firefly by IPAC**



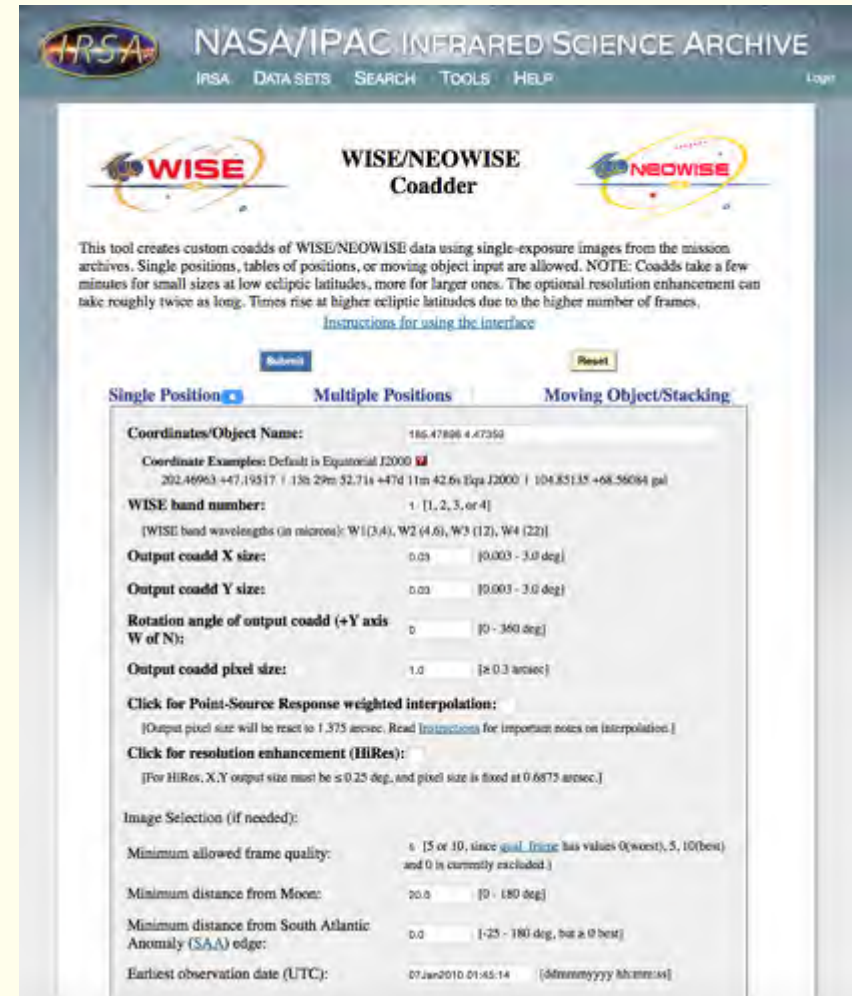
# VO broadens audience; API supports diverse users

- ◆ Virtual Observatory
  - ❖ *Standardized protocols for interoperability between archives*
  - ❖ *Data discovery*
  - ❖ *Independent Tools*
- ◆ Application Program Interface
  - ❖ *Allows scripted access to archive data*
  - ❖ *Enables complex projects*



## Data Analysis Tools

- ◆ Analysis “near the data”
  - ❖ *As data sets grow beyond local resources, researchers look to data centers to provide computing power and tools*
- ◆ Interactive tools
  - ❖ *WISE Coadder*
  - ❖ *Planck map making*
  - ❖ *IRAS tools*
  - ❖ *Spitzer imaging and spectra*
- ◆ Looking Forward
  - ❖ *“Big data means you can’t move it all”, suggesting the analysis must move to the data*



The screenshot shows the NASA/IPAC Infrared Science Archive (IRSA) website with the WISE/NEOWISE Coadder tool interface. The page title is "NASA/IPAC INFRARED SCIENCE ARCHIVE" and the tool is titled "WISE/NEOWISE Coadder". The interface includes a "Submit" button and a "Reset" button. Below these are three tabs: "Single Position" (selected), "Multiple Positions", and "Moving Object/Stacking". The form contains several input fields and checkboxes:

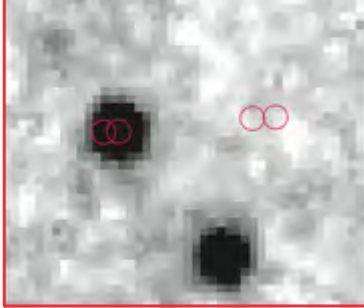
- Coordinates/Object Name:** 185.47896 4.47350
- Coordinate Examples:** Default is Equatorial J2000. Example: 202.46963 +47.19317 | 13h 29m 52.71s +47d 11m 42.6s Eqa J2000 | 104.85135 +68.56084 gal
- WISE band number:** 1 [1, 2, 3, or 4]
- Output coadd X size:** 0.03 [0.003 - 3.0 deg]
- Output coadd Y size:** 0.03 [0.003 - 3.0 deg]
- Rotation angle of output coadd (+Y axis W of N):** 0 [0 - 360 deg]
- Output coadd pixel size:** 1.0 [≥ 0.3 arcsec]
- Click for Point-Source Response weighted interpolation:** [Output pixel size will be react to 1.375 arcsec. Read Instructions for important notes on interpolation.]
- Click for resolution enhancement (HiRes):** [For HiRes, X,Y output size must be ≤ 0.25 deg, and pixel size is fixed at 0.6875 arcsec.]
- Image Selection (if needed):**
  - Minimum allowed frame quality:** 5 [5 or 10, since gal\_frame has values 0(worst), 5, 10(best) and 0 is currently excluded.]
  - Minimum distance from Moon:** 20.0 [0 - 180 deg]
  - Minimum distance from South Atlantic Anomaly (SAA) edge:** 0.0 [1-25 - 180 deg, but ≥ 0 best]
  - Earliest observation date (UTC):** 07-Jan-2010 01:45:14 [dformat:yyyy hh:mm:ss]



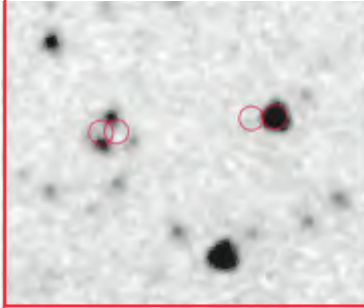
# IR Science Highlights

## Time domain

WISE 4.5 $\mu$ m (2010)



Spitzer 4.5 $\mu$ m (2014)

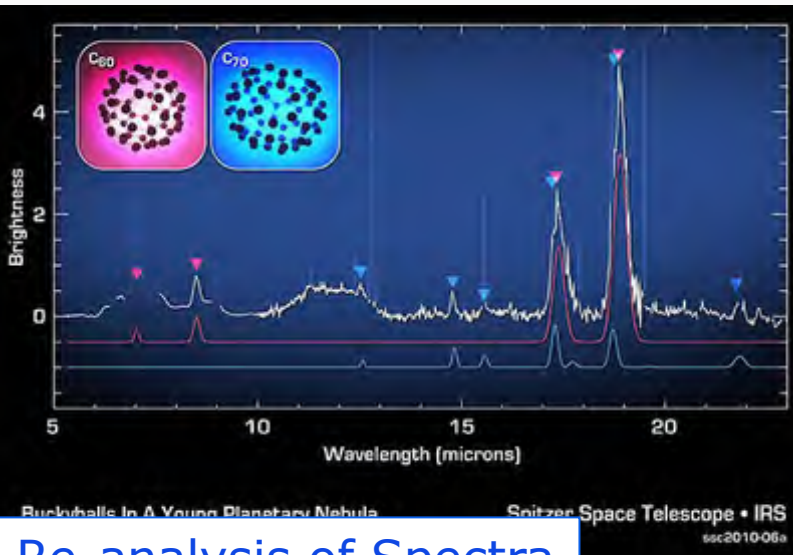


WISE+Spitzer discover the coldest brown dwarf (Luhman 2014, ApJL 786, L18)

## Follow-up Observations

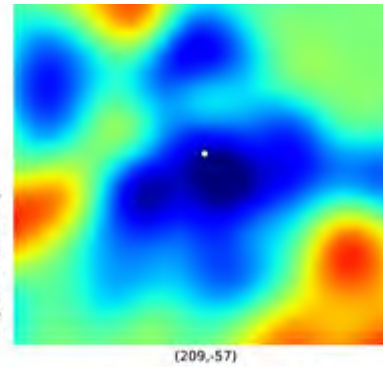


WISE morphological study of Wolf-Rayet nebulae, Toala et al. (A&A 2015, arXiv:1503.06878)

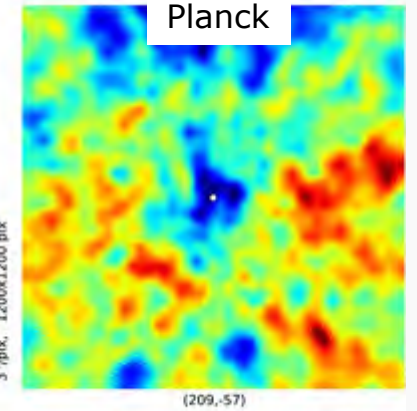


## Re-analysis of Spectra

WISE+2MASS galaxies



Planck



WISE+2MASS+PanSTARRS data may reveal super-void in CMB cold spot seen by Planck; (Szapudi et al. 2015, MNRAS, 450, 288)

## Combination of Surveys

## Lessons Learned

- ◆ Long-term, stable archives greatly increase the return on observatory investment
- ◆ Robust support for both expert and novice users pays off
- ◆ User support by instrument experts is crucial
- ◆ Standardization of tools within an archive increases efficiency
- ◆ Integrity of science data as obtained must be maintained
- ◆ Interoperability between archives benefits everyone
- ◆ High level data products can expand the reach of large data sets

Spitzer image of infrared dark clouds



# Sailing the Archival Seas with MAST



Scott W. Fleming

STScI

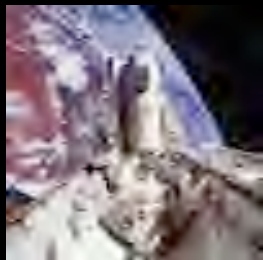
on behalf of the MAST team

# Outline – Mining Archival Data

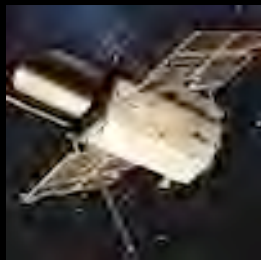
- Overview of MAST missions
- The MAST Discovery Portal
  - Cone Search
  - Advanced Search
  - Cross-Matching
  - Access to the Virtual Observatory
- MAST-led Enhanced Data Products
  - gPhoton: GALEX photon events
  - HSC: The Hubble Source Catalog

# MAST Missions: Past, Present and Future

## Legacy Missions



Astro



Copernicus



EPOCH



EUVE



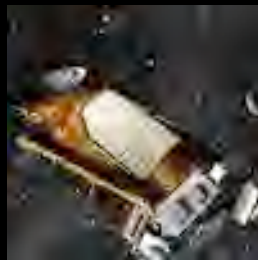
FUSE



GALEX



IUE



Kepler

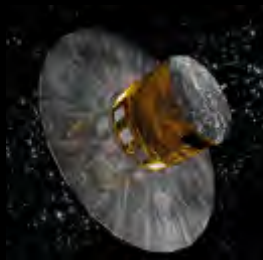


ORFEUS



VLA - FIRST

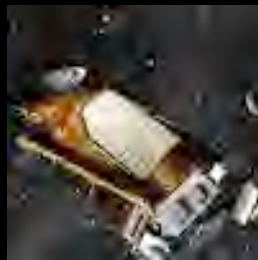
## Active Missions



Gaia



Hubble



K2



Pan-STARRS



Swift UVOT



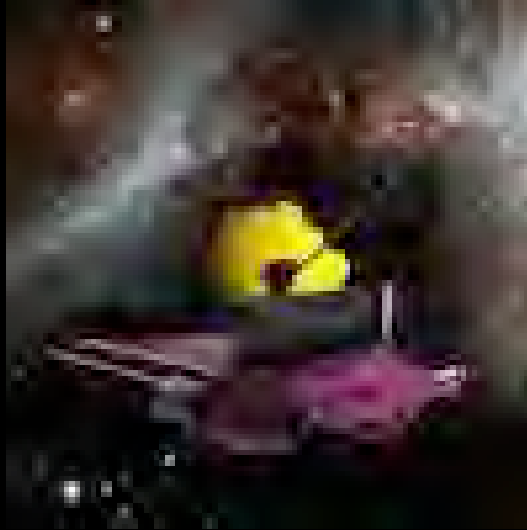
XMM OM

# MAST Missions: Past, Present and Future

## Upcoming Missions



TESS – Mar. 2018



James Webb – Oct. 2018



WFIRST – mid-2020s

# Cross-Mission Discovery

# MAST Portal: Cone Search

Select a collection... and enter target:

All MAST Observations M60 Search

Upload Target List

Home Page MAST: M60 MAST: M60 MAST: M60 MAST: M60

Displaying 30 of 316 Total Rows of Observations

MESSIER 060, radius: 0.06167°

Footprints: All

Filters

Mission

Name	Quantity
<input checked="" type="checkbox"/> HST	(30 of 283)
<input type="checkbox"/> STIS	(0 of 12)
<input type="checkbox"/> WFC3	(0 of 7)
<input type="checkbox"/> WFC3/IR	(0 of 7)
<input type="checkbox"/> WFC3/UVIS	(0 of 4)
<input type="checkbox"/> WFC3/VI	(0 of 3)

Instrument

Name	Quantity
<input type="checkbox"/> STIS/CCD	(0 of 146)
<input type="checkbox"/> WFPC2/PC	(0 of 39)
<input type="checkbox"/> WFPC2/WFC	(0 of 37)
<input checked="" type="checkbox"/> ACS/WFC	(30 of 30)
<input type="checkbox"/> WFC3	(0 of 12)

Show 10 More

Project

Name	Quantity
<input type="checkbox"/> HST	(12 of 181)
<input type="checkbox"/> HLA	(18 of 102)

List View Album View

Edit Columns... Table Display: All Show Preview: Show Cutout:

	Actions	Mission	Instrument	Project	Filters	Waveband	Target Name
1		HST	ACS/WFC	HLA	F475W	OPTICAL	VCC1971
2		HST	ACS/WFC	HLA	F850LP	OPTICAL	VCC1971
3		HST	ACS/WFC	HLA	DETEC...		VCC1971
4		HST	ACS/WFC	HST	F850LP	OPTICAL	VCC1971
5		HST	ACS/WFC	HST	F475W	OPTICAL	VCC1971
6		HST	ACS/WFC	HLA	F475W	OPTICAL	NGC464
7		HST	ACS/WFC	HLA	DETEC...		NGC464
8		HST	ACS/WFC	HLA	F850LP	OPTICAL	NGC464
9		HST	ACS/WFC	HST	F475W	OPTICAL	NGC464
10		HST	ACS/WFC	HST	F850LP	OPTICAL	NGC464
11		HST	ACS/WFC	HLA	F475W	OPTICAL	NGC464
12		HST	ACS/WFC	HLA	DETEC...		NGC464

AstroView

12:43:39.974 +11:33:09.76 RA DEC

12:43:39.974 +11:33:09.76 h/m/d:msec/deg



# MAST Portal: Advanced Search

Select a collection... All MAST Observations and enter target: M60

[About Collections...](#) [Show Examples...](#) [Random Search](#) [Advanced Search](#)

[Upload Target List](#) [User Manual/Help](#) [Leave Feedback](#) [About This Site](#)

Home Page MAST: M60 MAST: M60 MAST: M60 MAST: M60

Displaying 30 of 316 Total Rows of Observations MESSIER 060, radius: 0.06167° Footprints: All

**Filters** Clear Filters Edit Filters... Help...

**Mission**

Name	Quantity
<input checked="" type="checkbox"/> HST	(30 of 283)
<input type="checkbox"/> ...	(0 of 12)
<input type="checkbox"/> ...	(0 of 7)
<input type="checkbox"/> ...	(0 of 7)
<input type="checkbox"/> ...	(0 of 4)
<input type="checkbox"/> ...	(0 of 3)

**Instrument**

Name	Quantity
<input type="checkbox"/> STIS/CCD	(0 of 146)
<input type="checkbox"/> WFPC2/PC	(0 of 39)
<input type="checkbox"/> WFPC2/WFC	(0 of 37)
<input checked="" type="checkbox"/> ACS/WFC	(30 of 30)
<input type="checkbox"/> ...	(0 of 12)

**Project**

Name	Quantity
<input type="checkbox"/> HST	(12 of 181)
<input type="checkbox"/> HLA	(18 of 102)

Actions	Mission	Instrument	Project	Filters	Waveband	Target Name
1	HST	ACS/WFC	HLA	F475W	OPTICAL	VCC1971
2	HST	ACS/WFC	HLA	F850LP	OPTICAL	VCC1971
3	HST	ACS/WFC	HLA	DETEC...		VCC1971
4	HST	ACS/WFC	HST	F850LP	OPTICAL	VCC1971
5	HST	ACS/WFC	HST	F475W	OPTICAL	VCC1971
6	HST	ACS/WFC	HLA	F475W	OPTICAL	NGC464
7	HST	ACS/WFC	HLA	DETEC...		NGC464
8	HST	ACS/WFC	HLA	F850LP	OPTICAL	NGC464
9	HST	ACS/WFC	HST	F475W	OPTICAL	NGC464
10	HST	ACS/WFC	HST	F850LP	OPTICAL	NGC464
11	HST	ACS/WFC	HLA	F475W	OPTICAL	NGC464
12	HST	ACS/WFC	HLA	DETEC...		NGC464

**AstroView** 12:43:39.974 +11:33:09.76 RA DEC  
12:43:39.974 +11:33:09.76 h/m/d:msec/deg

# MAST Portal: Advanced Search

The screenshot displays the MAST Portal's Advanced Search interface. At the top, there is a search bar with the text "Select a collection..." and "and enter target:". Below this, the search results show "Records Found: 355" and a search query "Flame Nebula r=2d". A "Search" button is visible next to the query. To the right of the search bar, the resolved name "NAME Flame Nebula" and its coordinates "RA: 85.4279 Dec: -1.912" with a "Radius: 2 deg" are displayed. Below the search bar, the "Applied Filters" section shows several active filters: "Product Type: image", "Mission: HST", "Waveband: INFRARED", and "Position: 85.4279, -1.912, 2". The main content area is divided into two sections: "Columns" and "Filters". The "Columns" section on the left lists various filterable fields such as "Filters", "Waveband", "Target Name", "Target Classification", "Observation ID", "RA", "Dec", "Proposal ID", "Principal Investigator", "Calibration Level", "Start Time", and "End Time". The "Filters" section on the right contains five panels: "Proposal ID", "Principal Investigator", "Start Time", "End Time", and "Exposure Length". Each panel has a text input field and a description of how to search for that field. The "Start Time" and "End Time" panels also feature histograms and date range selectors. At the bottom of the interface, a status bar shows "HLA" and "(18 of 102)".



# MAST Portal: Advanced Search

Select a collection...  
All MAST Observations

and enter target:  
Orion B

[About Collections...](#) [Show Examples...](#) [Random Search](#) [Advanced Search](#)

[Upload Target List](#) [User Manual/Help](#) [Leave Feedback](#) [About This Site](#)

Home Page **MAST: Advanced Search 1**

355 Total Rows of Observations

Footprints: All

**Filters**

Clear Filters Edit Filters... Help...

**Keyword/Text Filter**

Filter All Columns

**Instrument**

Name	Quantity
<input type="checkbox"/> NICMOS/NIC1	(148 of 148)
<input type="checkbox"/> NICMOS/NIC2	(85 of 85)
<input type="checkbox"/> NICMOS/NIC3	(60 of 60)
<input type="checkbox"/> WFC3/IR	(60 of 60)
<input type="checkbox"/> WFPC2/WFC	(1 of 1)
<input type="checkbox"/> WFPC2/PC	(1 of 1)

**Project**

Name	Quantity
<input type="checkbox"/> HST	(281 of 281)
<input type="checkbox"/> HLA	(74 of 74)

**Filters**

Name	Quantity
<input type="checkbox"/> F187N	(74 of 74)
<input type="checkbox"/> F190N	(69 of 69)
<input type="checkbox"/> F212N	(57 of 57)

**List View** **Album View**


Edit Columns... Table Display: All Show Preview: Show Cutout:

	Actions	Mission	Instrument	Project	Filters
<input type="checkbox"/> 1	***	HST	NICMOS/NIC1	HST	F187N
<input type="checkbox"/> 2	***	HST	NICMOS/NIC1	HST	F190N
<input type="checkbox"/> 3	***	HST	NICMOS/NIC3	HST	F212N
<input type="checkbox"/> 4	***	HST	NICMOS/NIC1	HST	F187N
<input type="checkbox"/> 5	***	HST	WFC3/IR	HLA	F160W
<input type="checkbox"/> 6	***	HST	WFC3/IR	HLA	F160W
<input type="checkbox"/> 7	***	HST	NICMOS/NIC1	HST	F164N
<input type="checkbox"/> 8	***	HST	NICMOS/NIC1	HST	F164N
<input type="checkbox"/> 9	***	HST	NICMOS/NIC3	HST	F212N
<input type="checkbox"/> 10	***	HST	NICMOS/NIC1	HST	F187N
<input type="checkbox"/> 11	***	HST	NICMOS/NIC1	HST	F187N
<input type="checkbox"/> 12	***	HST	WFC3/IR	HST	F140W

**AstroView**

05:46:51.872 -02:19:38.90  
05:41:42.696 -01:54:43.20

RA DEC  
hhmmss/deg



# MAST Portal: Cross-Match

Select a collection...  
MAST Catalogs

and enter target:  
Enter object name or RA and Dec to cone search

Mission: TESS Input

**Upload Target List**

Home Page

## MAST: Barbara A. Mikulski Archive for Space Telescopes

The MAST Portal lets you search multiple collections of astronomical datasets all in one place. Use this tool to find astronomical data, publications, and images.

**Quick Start:**

1. Select a collection and enter a new search target OR upload an existing list of targets.
2. Use the filters and analysis tools to find the exact data you're looking for.
3. Add files to the download basket to control your download options.

See the [User's Guide](#) for more detailed documentation and [video tutorials](#).

**Currently available data collections:**

- MAST Observations: Millions of observations from Hubble, Kepler, GALEX, IUE, FUSE, and more.
- Virtual Observatory: Search thousands of astronomical data archives from around the world for images, spectra, and catalogs.
- Hubble Source Catalog: A master catalog with a hundred million measurements of objects in Hubble images.

**Featured tutorial:** Conducting a search

Positional Search

**AstroView**

11:45:45.361 +02:48:37.55  
11:45:42.290 +02:49:17.29

RA DEC  
hh:mm:ss/deg

# MAST Portal: Cross-Match

Select a collection... **MAST Catalogs** and enter target:  
Enter object name or RA and Dec to cone search  Search

[About Collections...](#) Mission: **TESS Input** [Show Examples...](#) [Random Search](#) [Advanced Search](#) [Flaring](#) [Account Info...](#)

**Upload Target List** [User Manual/Help](#) | [Leave Feedback](#) | [About This Site](#)

Home Page **kepler\_search.txt** **2330 Total Rows** **Footprints: All**

RA DEC  
19:59:18.632 +40:59:23.20  
19:29:03.098 +37:14:13.17

	Actions	Kepler ID	RA (J2000)	Dec (J2000)
<input type="checkbox"/>		757450	19:24:33.024	+36:34:38.57
<input type="checkbox"/>		1432789	19:25:59.861	+37:03:33.41
<input type="checkbox"/>		1718189	19:22:54.881	+37:15:09.54
<input type="checkbox"/>		1718189	19:22:54.881	+37:15:09.54
<input type="checkbox"/>		1724719	19:28:49.130	+37:13:16.38
<input type="checkbox"/>		1725016	19:29:03.098	+37:14:13.17
<input type="checkbox"/>		1865042	19:22:43.740	+37:21:18.40
<input type="checkbox"/>		1871056	19:28:10.709	+37:22:34.46
<input type="checkbox"/>		1871056	19:28:10.709	+37:22:34.46
<input type="checkbox"/>		1873513	19:30:19.166	+37:22:35.08
<input type="checkbox"/>		1995519	19:04:36.036	+37:24:40.93
<input type="checkbox"/>		1996180	19:05:22.632	+37:24:43.08
<input type="checkbox"/>		2142522	19:06:30.182	+37:32:14.28
<input type="checkbox"/>		2165002	19:20:57.747	+37:34:04.05

**AstroView**

# MAST Portal: Cross-Match

The screenshot displays the MAST Portal interface. At the top, there is a search bar with the text "Select a collection... and enter target:". Below this, a dropdown menu shows "MAST Catalogs". A "Cross-Match" dialog box is open in the center, titled "Cross-Match (Select catalog from list below)". The dialog has two columns: "Catalog" and "Description". The "Gaia" catalog is highlighted with a red circle and a red arrow pointing to it. Below the list, there is a "Catalog:" field with "None Selected" and a "Radius (arcseconds):" field with the value "3". The background shows a table of Kepler data with columns for "Kepler ID" and "RA (J2000)". A star field visualization is visible on the right side of the screen.

Kepler ID	RA (J2000)
757450	19:24:33.0
1432789	19:25:59.8
1718189	19:22:54.8
1718189	19:22:54.8
1724719	19:28:49.1
1725016	19:29:03.0
1865042	19:22:43.7
1871056	19:28:10.7
1871056	19:28:10.7
1873513	19:30:19.1
1995519	19:04:36.036 +37:24:40.93
1996180	19:05:22.632 +37:24:43.08
2142522	19:06:30.182 +37:32:14.28
2165003	19:06:57.747 +37:34:04.06

# MAST Portal: Cross-Match

Select a collection...  
MAST Catalogs

and enter target:  
Enter object name or RA and Dec to come search Search

Mission: TESS Input

Account Info...

Upload Target List

User Manual/Help | Leave Feedback | About This Site

Home Page | kepler\_cp\_search.txt | MAST Crossmatch [Gaia]

2385 Total Rows

Footprints: All

RA DEC  
54.349 +44:52:09.38  
55.466 +41:38:55.36

Filters

Clear Filters Edit Filters... Help...

Keyword/Text Filter

Filter All Columns

astrometric\_n\_obs\_ac

Name	Quantity
<input type="checkbox"/> 0	(2,015 of 2,015)
<input type="checkbox"/> 9	(42 of 42)
<input type="checkbox"/> 107	(15 of 15)
<input type="checkbox"/> 97	(13 of 13)
<input type="checkbox"/> 79	(12 of 12)

Show 68 More

astrometric\_n\_good\_obs\_ac

Name	Quantity
<input type="checkbox"/> 0	(2,016 of 2,016)
<input type="checkbox"/> 8	(29 of 29)
<input type="checkbox"/> 89	(17 of 17)
<input type="checkbox"/> 79	(10 of 10)
<input type="checkbox"/> 80	(10 of 10)

Show 78 More

Actions	Kepler ID	RA (J2000)	Dec (J2000)	MatchID	MatchRA	MatchDEC	distance
	6310636	19:53:55.466	+41:36:55.23	2075389014168396672	298.4811028...	41.61526284...	0.00
	6471021	19:56:29.386	+41:52:00.34	2075377675451477632	299.1224634...	41.86679402...	0.00
	6471021	19:56:29.386	+41:52:00.34	2075377675451477632	299.1224634...	41.86679402...	0.00
	7132798	19:43:47.138	+42:39:32.11	2077236709100409728	295.9463867...	42.65883482...	0.00
	6964929	19:44:55.877	+42:28:22.04	2077219048190581120	296.2328094...	42.47279662...	0.00
	7134976	19:45:56.023	+42:39:48.34	2077203723748146688	296.4834010...	42.66338211...	0.00
	7134976	19:45:56.023	+42:39:48.34	2077203723748146688	296.4834010...	42.66338211...	0.00
	7047824	19:42:56.484	+42:34:34.49	2077144487563291904	295.7353897...	42.57623231...	0.00
	6878240	19:43:34.584	+42:22:49.62	2077138410188489728	295.8940372...	42.38051560...	0.00
	6878240	19:43:34.584	+42:22:49.62	2077138410188489728	295.8940372...	42.38051560...	0.00
	4478168	19:40:46.414	+39:32:22.81	2076245950343273600	295.1931559...	39.54043869...	0.04
	4478168	19:40:46.414	+39:32:22.81	2076245946040887168	295.1933632...	39.53969399...	0.00
	8260902	19:59:51.761	+44:09:39.20	2076102631573024896	299.9656621...	44.16088155...	0.00

AstroView

# MAST Portal: Access to the Virtual Observatory

The screenshot shows the MAST Portal interface. At the top, there is a navigation bar with links like 'TESS Wiki', 'ARCH+', 'MAST', 'ASTRO', 'ESC', 'ST ScI Internal', 'YouTubeSub', and 'ADL Radio'. Below this is a search area with a dropdown menu labeled 'Select a collection...' (indicated by a red arrow) and a search box containing 'Abell 2744'. The search results show '216 Total Rows' and a table of data. The table has columns for 'Actions', 'Short Name', 'Type', 'Title', 'Waveband', 'Records Found', 'FITS Images', and 'Other Images'. The filters on the left include 'Keyword/Text Filter', 'Type' (Catalog, Image, Spectra), 'Waveband' (Optical, X-ray, Infrared, Radio, UV), and 'Publisher' (CDS, NASA/CFR/USCAPS).

Home Page | VO: Abell 2744

216 Total Rows

ABELL 2744, radius: 0.07500"

Filters

Clear Filters Edit Filters... Help...

Keyword/Text Filter

Filter All Columns

Type

Name	Quantity
Catalog	(165 of 165)
Image	(49 of 49)
Spectra	(2 of 2)

Waveband

Name	Quantity
Optical	(100 of 100)
X-ray	(74 of 74)
Infrared	(46 of 46)
Radio	(24 of 24)
UV	(17 of 17)

Show 4 More

Publisher

Name	Quantity
CDS	(98 of 98)
NASA/CFR/USCAPS	(68 of 68)

List View

Edit Columns...

Actions	Short Name	Type	Title	Waveband	Records Found	FITS Images	Other Images
	VIKING DR3		VIKING - VISTA Kilo-degree Infrared Galaxy survey Data...		13285	0	0
	II/343		VIKING catalogue data release 2 (Edge+, 2016)	Infrared	13284	0	0
	Spitzer Level 1		Spitzer Level 1 / Basic Calibrated Data	Infrared	5000	5000	0
	B/eso		ESO Science Archive Catalog (ESO, 1991-2016)		3933	0	0
	SuperCOSMOS		SuperCOSMOS Science Archive (SSA)	Optical	3155	0	0
	NED(sources)		The NASA/IPAC Extragalactic Database	Radio, Millim...	2170	0	0
	HSC		Hubble Source Catalog Detailed Search	UV,Visible	2000	0	0
	HSC_SUM		Hubble Source Catalog Summary Search	UV,Visible	2000	0	0
	NED/SED		The NASA/IPAC Extragalactic Database SED Data Discov...	Radio, Millim...	1443	0	0
	Simbad		The SIMBAD astronomical database	Radio, Millim...	1236	0	0
	J/A+A/389/787		VRI Photometry of Galaxies in AC118 Field (Busarello+, ...	Optical	1069	0	0
	EHST/HST/SIAP		European HST SIAP service		509	509	0
	HI A		Hubble Legacy Archive	Optical, Infra	433	433	0

AstroView

# Enhancing Data Products: gPhoton

# gPhoton: A 1.1 Trillion Row Database of GALEX Photon Events

## GALEX Overview

- Launched 28 April 2003
- FUV + NUV (simultaneously)
- FUV = 1350-1750 Å
- Phot. (5-6" resolution)
- Microchannel Plate Detector
- Retired 28 June 2013
- 1.2 deg. diameter FoV
- NUV = 1750-2750 Å
- Spec. (R ~ 100-250)
- 77% of the Sky at Diff. Depths

## gPhoton

- Database of 1.1 trillion photon events
- Open-source Python software: create cal. images and light curves
- Photon events meas. with 5 millisecond precision
- Light curves with few second sampling for any GALEX image

gPhoton page: <https://archive.stsci.edu/prepds/gphoton/>

Paper: Million, C; Fleming, S.W., Shiao, B., et al. 2016, *ApJ*, 833, 292



# gPhoton Design Considerations

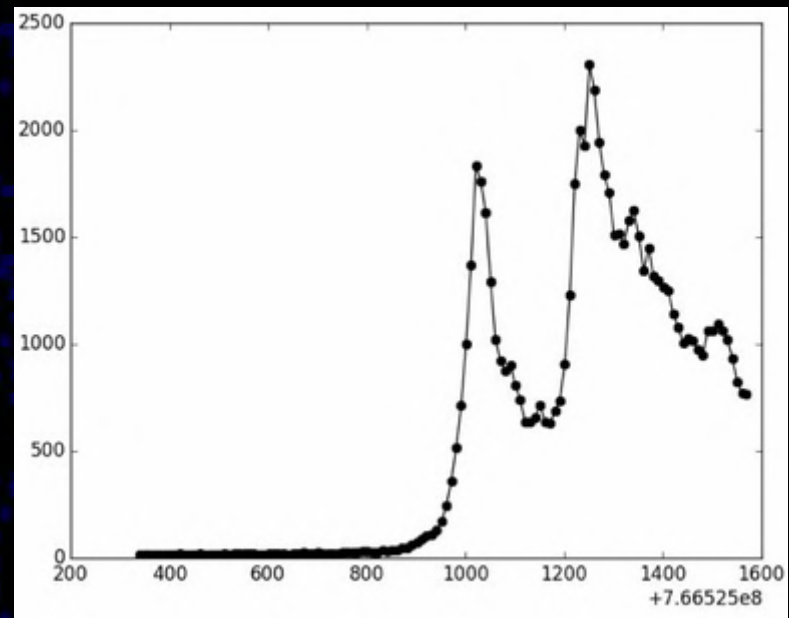
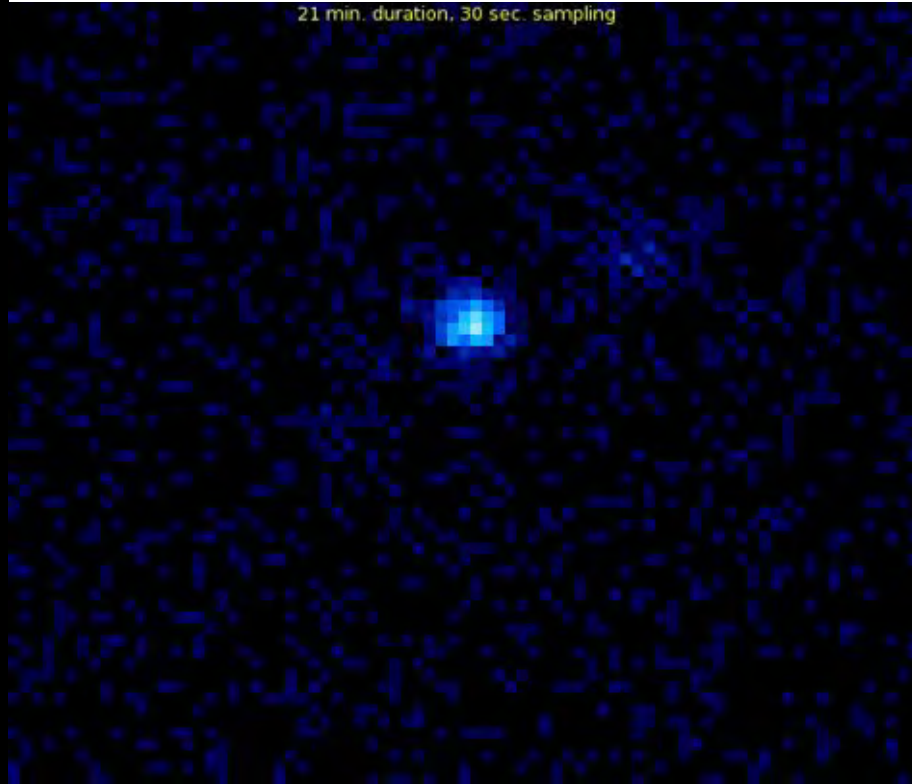
```
import gPhoton
```

```
def main():
```

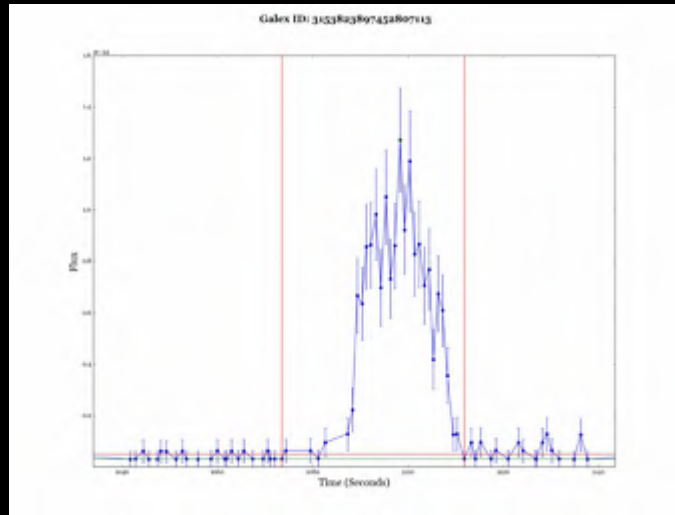
```
    gPhoton.gMap(band='NUV', skypos=[176.91975, 0.25561], stepsz=30., skyrange=[0.0333, 0.0333], cntfile='gj_3685a_movie.fits')
```

```
if __name__ == '__main__':  
    main()
```

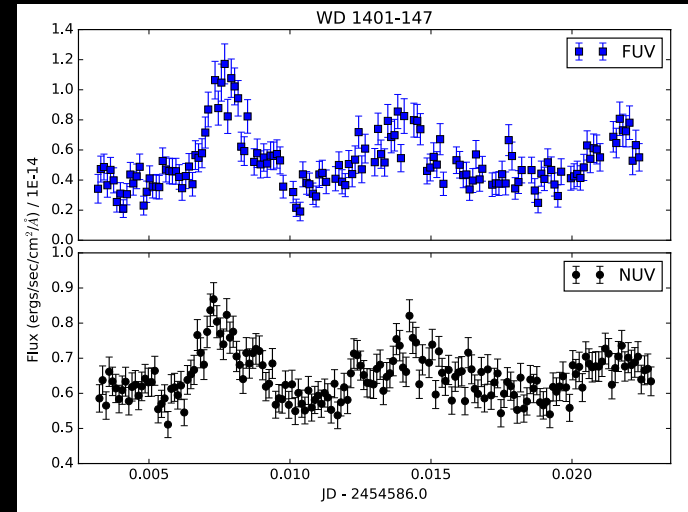
21 min. duration, 30 sec. sampling



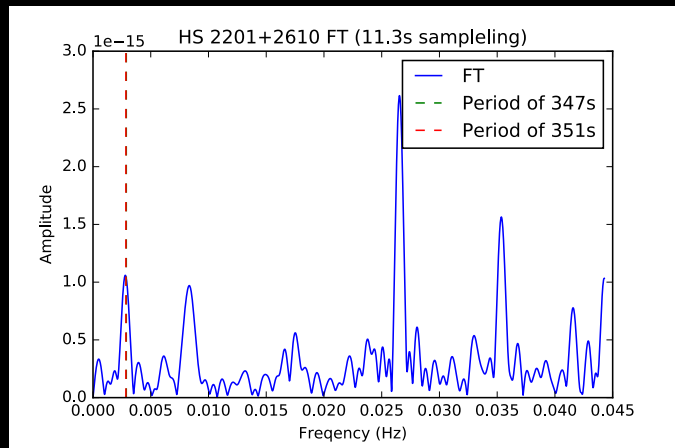
# gPhoton – Early Science Examples



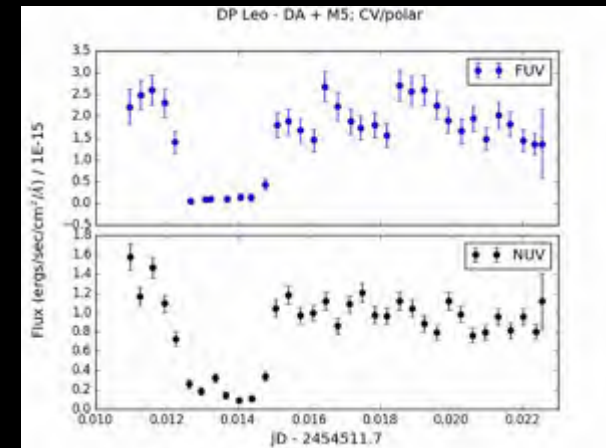
Stellar flares at low energies, w/  
Rachel Osten and Clara Brasseur



White dwarf pulsations, with  
Michael Tucker (2015 REU)



sdB pulsation survey, with  
Thomas Boudreaux (2016 REU)



Eclipsing objects, including  
polars and WD exoplanets

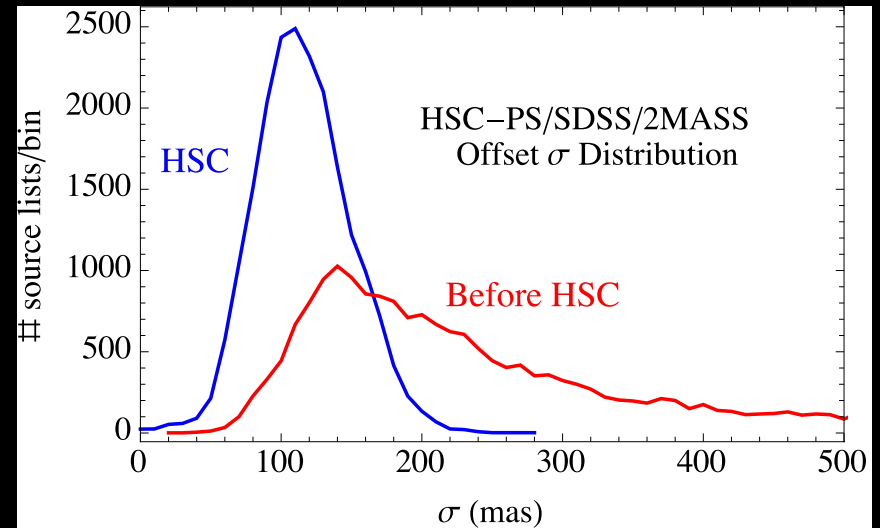
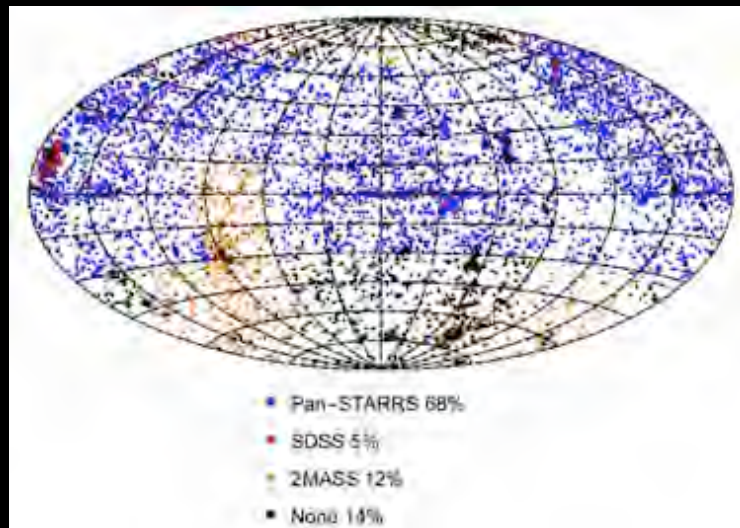
# Enhancing Data Products: Hubble Source Catalog

# The Hubble Source Catalog (HSC)

<https://archive.stsci.edu/hst/hsc/>

Paper: Whitmore, B.C, et al. 2016, *AJ*, 151, 134

1. Combines tens of thousands of SourceExtractor HLA source lists into a single master catalog. Uses matching algorithm from Budavari and Lubow 2012.
2. Includes WFPC2, ACS/WFC, and WFC3.
3. Absolute astrometry is good to  $\sim 100$  mas (calibrated using PanSTARRS and 2MASS). This can eventually be improved to  $\sim 10$  mas using Gaia observations).



# HSC: Science Use Case

There are several Science Use Cases with step-by-step instructions and screen shots on the HSC webpage.

## 2. Are there Use Cases available for the HSC?

Yes. We have a variety of Use Cases:

[HSC Use Case #1](#) - Using the Discovery Portal to Query the HSC - (Stellar Photometry in M31 - Brown et al. 2009)

[HSC Use Case #2](#) - Using CASJOBS to Query the HSC - (Globular Clusters in M87 and a Color Magnitude Diagram for the SMC)

[HSC Use Case #3](#) - Using the Discovery Portal to search for Variable Objects in the HSC - (Time Variability in the dwarf irregular galaxy IC 1613)

[HSC Use Case #4](#) - Using the Discovery Portal to perform cross-matching between an input catalog and the HSC - (Search for the Supernova 2005cs progenitor in the galaxy M51)

NOTE: This use case was made using version 1. However, most of the changes are relatively minor, hence it is still quite useful.

[HSC Use Case #5](#) - Using the Discovery Portal and CasJobs to search for Outlier Objects in the HSC - (White dwarfs in the Globular Cluster M4)

[HSC Use Case #6](#) - Using the Discovery Portal to study the Red Sequence in a Galaxy Cluster - (The Red Sequence in the Galaxy Cluster Abell 2390)

NOTE: This use case was made using version 1. However, most of the changes are relatively minor, hence it is still quite useful.

[HSC Use Case #7](#) - Comparing HSC "Sloan" filter magnitudes and SDSS magnitudes - (using the field around GRB110328A)

NOTE: This use case was made using version 1. However, most of the changes are relatively minor, hence it is still quite useful.

[HSC Use Case #8](#) - Combining HSC magnitudes and HST spectra to Investigate Objects in the HSC (using objects in the LMC Cluster R136)

[HSC Use Case #9](#) - Searching for Objects with both HST Imaging and Spectroscopic Data

# HSC: Science Use Case, Variables in IC 1613

Select a collection... Hubble Source Catalog (HSCv2) and enter target: 01:04:28 2:09:36 r=0.5m

Upload Target List

Home Page HSC: 01:04:28 2:09:36 r=0.5m HSC Matches: 87416231

2416 Total Rows of Objects Equatorial Coord 01:04:28 +2:09:36 J2000, radius: 0.00833°

Filters

Keyword/Text Filter

Match ID

Distance

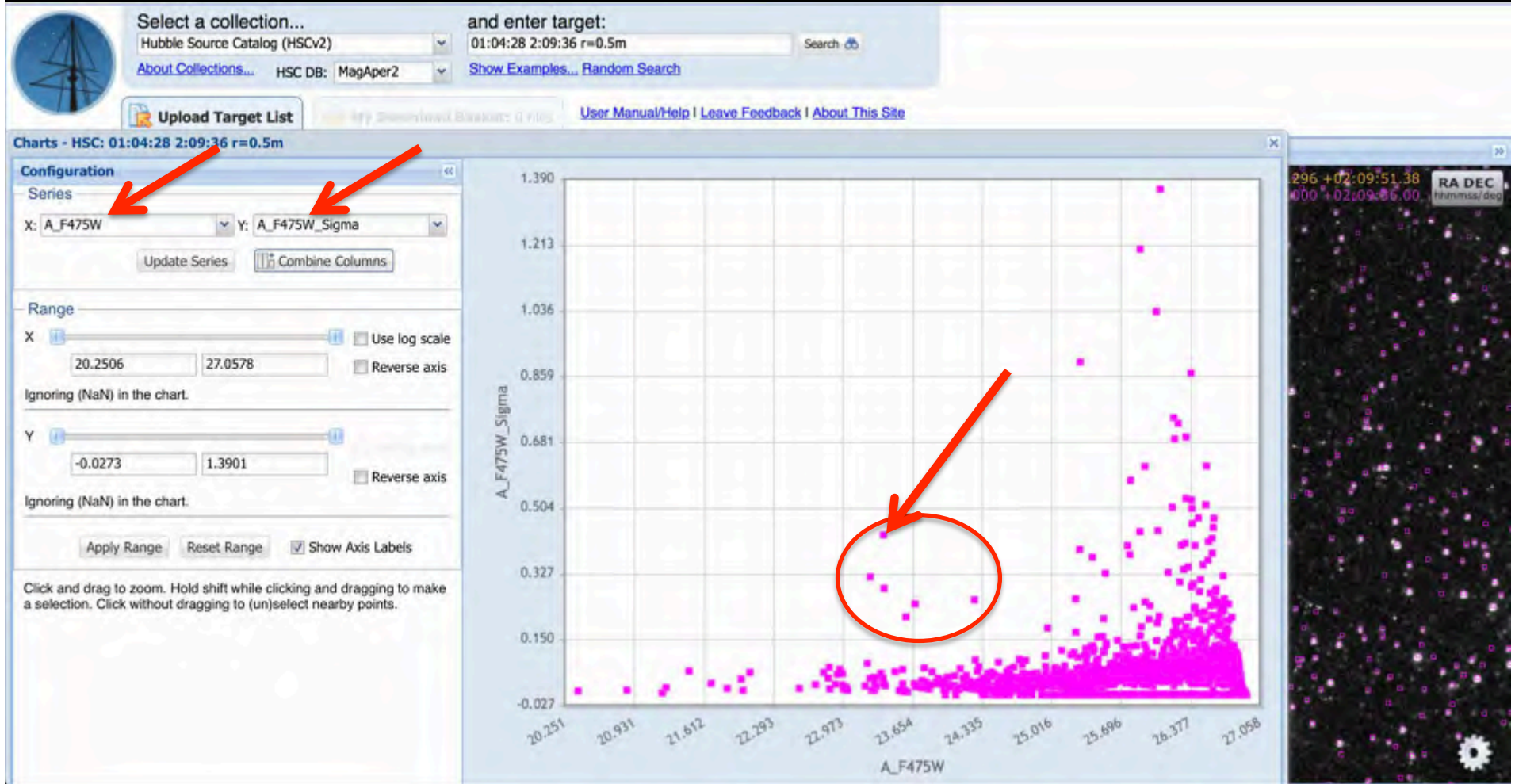
List View

	Actions	Match ID	Distance	Match RA	Match Dec
1		87416231	0.0209300446210454	01:04:27.958	+02:09:34.
2		87418391	0.0227336760824004	01:04:27.916	+02:09:35.
3		87416241	0.0379670283468321	01:04:27.897	+02:09:37.
4		87416171	0.0412776078346797	01:04:27.949	+02:09:33.
5		87428772	0.042604457732627	01:04:27.861	+02:09:34.
6		87415845	0.0441243272632123	01:04:27.973	+02:09:33.
7		87418399	0.0454911604334835	01:04:27.866	+02:09:34.
8		87416631	0.0459757290961777	01:04:27.910	+02:09:33.
9		87416173	0.0460838457631922	01:04:27.943	+02:09:33.
10		87595655	0.0505050289109621	01:04:27.816	+02:09:34.
11		87415859	0.0530502911429743	01:04:27.894	+02:09:33.
12		87417121	0.0553675651103514	01:04:27.809	+02:09:37.

AstroView

01:04:29.296 +02:09:51.38  
01:04:28.400 +02:09:36.00 RA DEC  
hh:mm:ss/deg

# HSC: Science Use Case, Variables in IC 1613



# HSC: Science Use Case, Variables in IC 1613

Select a collection... and enter target:  
Hubble Source Catalog (HSCv2) 01:04:28 2:09:36 r=0.5m Search

About Collections... HSC DB: MagAper2 Show Examples... Random Search

Upload Target List User Manual/Help | Leave Feedback | About This Site

Home Page HSC: 01:04:28 2:09:36 r=0.5m HSC Matches: 87416231

2416 Total Rows of Objects Equatorial Coord 01:04:28 2:09:36 J2000, radius: 0.00833°

Filters

Clear Filters Edit Filters... Help...

Keyword/Text Filter

Filter All Columns

Match ID

Distance

0.0209 0.5

List View

Edit Columns... Table Display: All

	Actions	Match ID	Distance	Match RA	Match Dec	DSigma	AbsCorr	Num Filters	Num Visits	Num Images
<input checked="" type="checkbox"/>		87413475	0.442471804533232	01:04:28.391	+02:09:10.11	5.353971479...	Y	2	12	24
<input type="checkbox"/>		87416231	0.0209300446210454	01:04:27.958	+02:09:34.91	3.040930984...	Y	2	10	20
<input type="checkbox"/>		87418391	0.0227336760824004	01:04:27.916	+02:09:35.46	0	Y	1	1	1
<input type="checkbox"/>		87416241	0.0379670283468321	01:04:27.897	+02:09:37.67	9.709568143...	Y	2	10	20
<input type="checkbox"/>		87416171	0.0412776078346797	01:04:27.949	+02:09:33.65	8.059347551...	Y	2	11	15
<input type="checkbox"/>		87428772	0.042604457732627	01:04:27.861	+02:09:34.51	0	Y	1	1	1
<input type="checkbox"/>		87415845	0.0441243272632123	01:04:27.973	+02:09:33.38	2.607678444...	Y	2	12	24
<input type="checkbox"/>		87418399	0.0454911604334835	01:04:27.866	+02:09:34.15	0	Y	1	1	1
<input type="checkbox"/>		87416631	0.0459757290961777	01:04:27.910	+02:09:33.59	8.218517325...	Y	2	12	15
<input type="checkbox"/>		87416173	0.0460838457631922	01:04:27.943	+02:09:33.37	4.558227625...	Y	2	12	24
<input type="checkbox"/>		87595655	0.0505050289109621	01:04:27.816	+02:09:34.75	3.949158426...	Y	2	12	24
<input type="checkbox"/>		87415859	0.0530502911429743	01:04:27.894	+02:09:33.24	0	Y	1	1	1



# HSC: Science Use Case, Variables in IC 1613

Select a collection...  
Hubble Source Catalog (HSCv2) and enter target:  
01:04:28 2:09:36 r=0.5m Search

About Collections... HSC DB: MagAper2 Show Examples... Random Search

Upload Target List

Home Page HSC: 01:04:28 2:09:36 r=0.5m HSC Matches: 87416231 HSC Matches: 87413475

24 Total Rows of Measurements

Filters

Clear Filters Edit Filters... Help...

Keyword/Text Filter

Filter All Columns

ImageName

Name	Quantity
<input type="checkbox"/> hst_10505_11_acs_wfc_f814w	(1 of 1)
<input type="checkbox"/> hst_10505_11_acs_wfc_f475w	(1 of 1)
<input type="checkbox"/> hst_10505_13_acs_wfc_f814w	(1 of 1)
<input type="checkbox"/> hst_10505_13_acs_wfc_f475w	(1 of 1)
<input type="checkbox"/> hst_10505_14_acs_wfc_f814w	(1 of 1)

Show 19 More

Filter

Name	Quantity
<input type="checkbox"/> F814W	(12 of 12)
<input type="checkbox"/> F475W	(12 of 12)

Flags

Name	Quantity
------	----------

List View Album View

Edit Columns... Table Display: All

Actions	CatID	MatchID	MemID	SourceID	ImageID	Det	Match RA	Match Dec	Sc
<input type="checkbox"/>	110543182	87413475	1	4000295011...	69741	Y	01:04:28.391	+02:09:10.11	
<input type="checkbox"/>	110543182	87413475	2	4000295011...	69741	Y	01:04:28.391	+02:09:10.11	
<input type="checkbox"/>	110745614	87413475	3	4000239603...	69735	Y	01:04:28.391	+02:09:10.11	
<input type="checkbox"/>	110742910	87413475	4	4000239603...	69735	Y	01:04:28.391	+02:09:10.11	
<input type="checkbox"/>	108267999	87413475	5	4000036377...	69810	Y	01:04:28.391	+02:09:10.11	
<input type="checkbox"/>	108268021	87413475	6	4000036377...	69810	Y	01:04:28.391	+02:09:10.11	
<input type="checkbox"/>	105523015	87413475	7	4000046499...	69789	Y	01:04:28.391	+02:09:10.11	
<input type="checkbox"/>	105523061	87413475	8	4000046499...	69789	Y	01:04:28.391	+02:09:10.11	
<input type="checkbox"/>	104261638	87413475	9	4000005716...	69796	Y	01:04:28.391	+02:09:10.11	
<input type="checkbox"/>	104261619	87413475	10	4000005716...	69796	Y	01:04:28.391	+02:09:10.11	
<input type="checkbox"/>	110732263	87413475	11	4000241633...	69755	Y	01:04:28.391	+02:09:10.11	
<input type="checkbox"/>	110733069	87413475	12	4000241633...	69755	Y	01:04:28.391	+02:09:10.11	

Footprints: All

AstroView

# HSC: Science Use Case, Variables in IC 1613

Select a collection...  
Hubble Source Catalog (HSCv2) and enter target:  
01:04:28 2:09:36 r=0.5m Search

About Collections... HSC DB: MagAper2 Show Examples... Random Search

Upload Target List User Manual/Help | Leave Feedback | About This Site

Home Page HSC: 01:04:28 2:09:36 r=0.5m HSC Matches: 87416231 HSC Matches: 87416231

24 Total Rows of Measurements

Filters

Clear Filters Edit Filters... Help...

Keyword/Text Filter

Filter All Columns

ImageName

Name	Quantity
<input type="checkbox"/> hst_10505_11_acs_wfc_f814w	(1 of 1)
<input type="checkbox"/> hst_10505_11_acs_wfc_f475w	(1 of 1)
<input type="checkbox"/> hst_10505_13_acs_wfc_f814w	(1 of 1)
<input type="checkbox"/> hst_10505_13_acs_wfc_f475w	(1 of 1)
<input type="checkbox"/> hst_10505_14_acs_wfc_f814w	(1 of 1)

Show 19 More

Filter

Name	Quantity
<input type="checkbox"/> F814W	(12 of 12)
<input type="checkbox"/> F475W	(12 of 12)

Flags

Name	Quantity
------	----------

List View Album View

Edit Columns... Table Display: All

Actions	CatID	MatchID	MemID	SourceID	ImageID	Det	Match RA	Match Dec	Sc
1	110543182	87413475	1	4000295011...	69741	Y	01:04:28.391	+02:09:10.11	
2	110543182	87413475	2	4000295011...	69741	Y	01:04:28.391	+02:09:10.11	
3	110745614	87413475	3	4000239603...	69735	Y	01:04:28.391	+02:09:10.11	
4	110742910	87413475	4	4000239603...	69735	Y	01:04:28.391	+02:09:10.11	
5	108267999	87413475	5	4000036377...	69810	Y	01:04:28.391	+02:09:10.11	
6	108268021	87413475	6	4000036377...	69810	Y	01:04:28.391	+02:09:10.11	
7	105523015	87413475	7	4000046499...	69789	Y	01:04:28.391	+02:09:10.11	
8	105523061	87413475	8	4000046499...	69789	Y	01:04:28.391	+02:09:10.11	
9	104261638	87413475	9	4000005716...	69796	Y	01:04:28.391	+02:09:10.11	
10	104261619	87413475	10	4000005716...	69796	Y	01:04:28.391	+02:09:10.11	
11	110732263	87413475	11	4000241633...	69755	Y	01:04:28.391	+02:09:10.11	
12	110733069	87413475	12	4000241633...	69755	Y	01:04:28.391	+02:09:10.11	

Footprints: All

AstroView

# HSC: Science Use Case, Variables in IC 1613

mast.stsci.edu

MAST Portal Variable Object Use Case

Select a collection... and enter target:  
Hubble Source Catalog (HSCv2) 01:04:28 2:09:36 r=0.5m Search

About Collections... HSC DB: MagAper2 Show Examples... Random Search

Upload Target List My Download Basket User Manual/Help | Leave Feedback | About This Site

Home Page HSC: 01:04:28 2:09:36 r=0.5m HSC Matches: 87416231 HSC Matches: 87413475

24 Total Rows of Measurements

Filters List View Album View

Clear Filters Edit Filters... Help... Table Display: All Page 1 of 2 Displaying 1 - 20 of 24

**Keyword/Text Filter**  
Filter All Columns

**ImageName**

Name	Quantity
<input type="checkbox"/> hst_10505_11_acs_wfc_f814w	(1 of 1)
<input type="checkbox"/> hst_10505_11_acs_wfc_f475w	(1 of 1)
<input type="checkbox"/> hst_10505_13_acs_wfc_f814w	(1 of 1)
<input type="checkbox"/> hst_10505_13_acs_wfc_f475w	(1 of 1)
<input type="checkbox"/> hst_10505_14_acs_wfc_f814w	(1 of 1)

Show 19 More

**Filter**

Name	Quantity
<input type="checkbox"/> F814W	(12 of 12)
<input type="checkbox"/> F475W	(12 of 12)

**Flags**

Name	Quantity
------	----------

4000295011782 Selected: [Icons] ...  
Source ID:4000295011782  
Target Name: IC1613  
ACS/ACS/WFC/F475W

4000295011782 Selected: [Icons] ...  
Source ID:4000295011782  
Target Name: IC1613  
ACS/ACS/WFC/F814W

4000239603209 Selected: [Icons] ...  
Source ID:4000239603209  
Target Name: IC1613  
ACS/ACS/WFC/F475W

4000239603209 4000036377404 4000036377404

# HSC: Science Use Case, Variables in IC 1613

Select a collection...  
Hubble Source Catalog (HSCv2) and enter target:  
01:04:28 2:09:36 r=0.5m Search

About Collections... HSC DB: MagAper2 Show Examples... Random Search

Upload Target List

Home Page HSC: 01:04:28 2:09:36 r=0.5m HSC Matches: 87416231 HSC Matches: 87413475

24 Total Rows of Measurements

Filters

Keyword/Text Filter

Filter All Columns

ImageName

Name	Quantity
<input type="checkbox"/> hst_10505_11_acs_wfc_f814w	(1 of 1)
<input type="checkbox"/> hst_10505_11_acs_wfc_f475w	(1 of 1)
<input type="checkbox"/> hst_10505_13_acs_wfc_f814w	(1 of 1)
<input type="checkbox"/> hst_10505_13_acs_wfc_f475w	(1 of 1)
<input type="checkbox"/> hst_10505_14_acs_wfc_f814w	(1 of 1)

Show 19 More

Filter

Name	Quantity
<input type="checkbox"/> F814W	(12 of 12)
<input type="checkbox"/> F475W	(12 of 12)

Flags

Name	Quantity
------	----------

List View Album View

Edit Columns... Table Display: All

Actions	CatID	MatchID	MemID	SourceID	ImageID	Det	Match RA	Match Dec
<input type="checkbox"/>	110543182	87413475	1	4000295011...	69741	Y	01:04:28.391	+02:09:10.11
<input type="checkbox"/>	110745614	87413475	2	4000239603...	69735	Y	01:04:28.391	+02:09:10.11
<input type="checkbox"/>	110742910	87413475	3	4000239603...	69735	Y	01:04:28.391	+02:09:10.11
<input type="checkbox"/>	108267999	87413475	4	4000036377...	69810	Y	01:04:28.391	+02:09:10.11
<input type="checkbox"/>	108268021	87413475	5	4000036377...	69810	Y	01:04:28.391	+02:09:10.11
<input type="checkbox"/>	105523015	87413475	6	4000046499...	69789	Y	01:04:28.391	+02:09:10.11
<input type="checkbox"/>	105523061	87413475	7	4000046499...	69789	Y	01:04:28.391	+02:09:10.11
<input type="checkbox"/>	104261638	87413475	8	4000005716...	69796	Y	01:04:28.391	+02:09:10.11
<input type="checkbox"/>	104261619	87413475	9	4000005716...	69796	Y	01:04:28.391	+02:09:10.11
<input type="checkbox"/>	110732263	87413475	10	4000241633...	69755	Y	01:04:28.391	+02:09:10.11
<input type="checkbox"/>	110733069	87413475	11	4000241633...	69755	Y	01:04:28.391	+02:09:10.11



# Summary

- MAST supports more than 20 missions: cross-mission discoverability is a key driver in our development efforts.
- The MAST Portal allows for searching across MAST missions and catalogs, the Virtual Observatory, and CDS catalogs.
- Beyond archiving mission data, MAST also creates enhanced data products that enable new science. Recent examples are:
  - gPhoton: A time-tagged database of 1.1 trillion GALEX photon events.
  - HSC: A master catalog of unique sources across all HST observations.
- Newly created STScI Data Mission Office, led by Arfon Smith, will begin to expand MAST capabilities into modern technological arenas, including cloud storage, “bring-code-to-the-data” environments, improved access to high performance computing resources, better support for API access to MAST resources.



# The NOAO Data Lab Project Introduction

Knut Olsen  
for the Data Lab team



# Data Lab Team



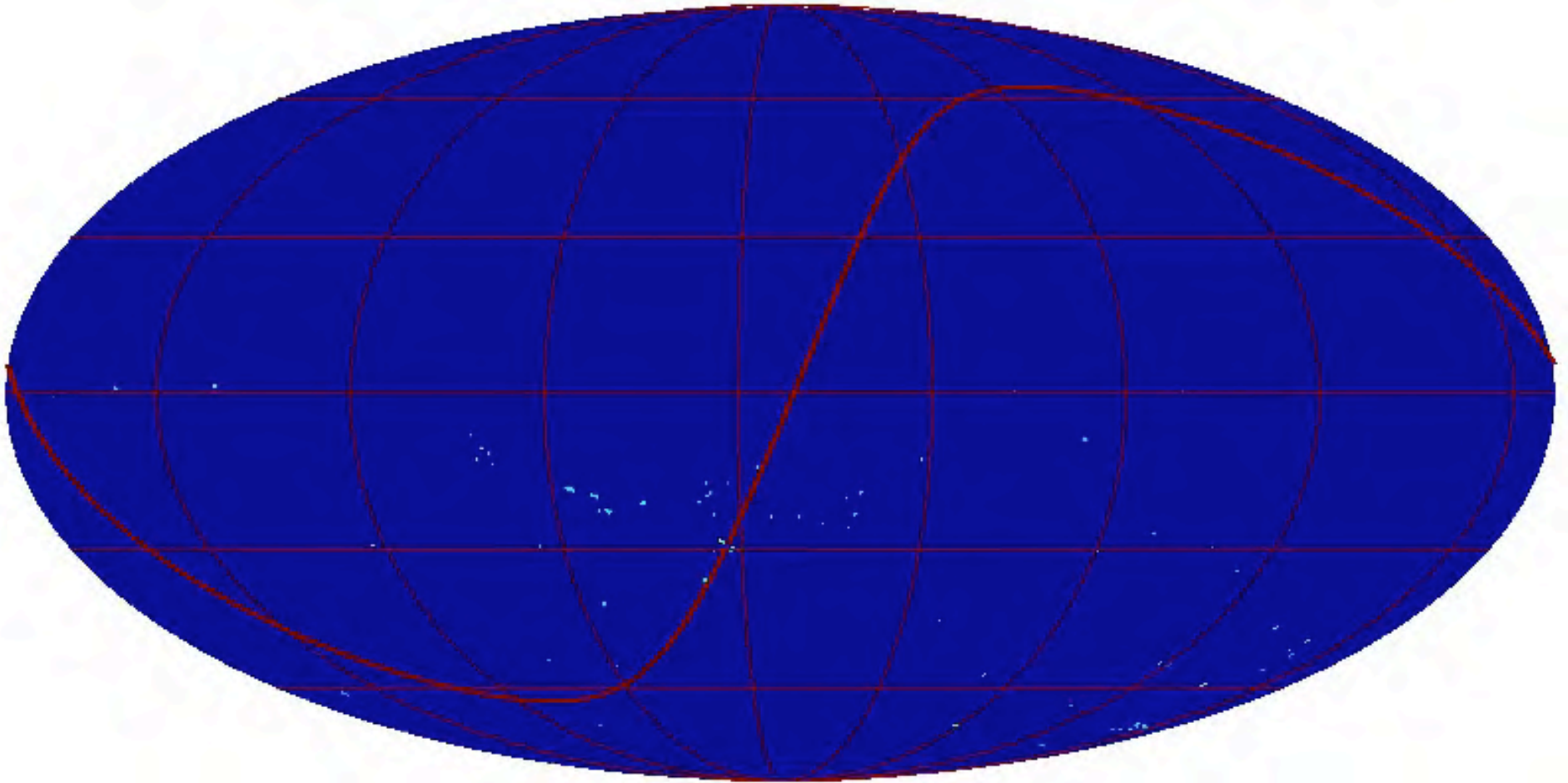
Current team:

- Mike Fitzpatrick, Lead Developer
- Matthew Graham, Scientist/Developer
- Wendy Huang, Software Engineer
- Stephanie Juneau, Data Scientist
- David Nidever, Data Scientist
- Robert Nikutta, Data Scientist
- Pat Norris, Test Engineer
- Knut Olsen, Project Scientist
- Steve Ridgway, Scientist
- Pete Wargo, System Administrator



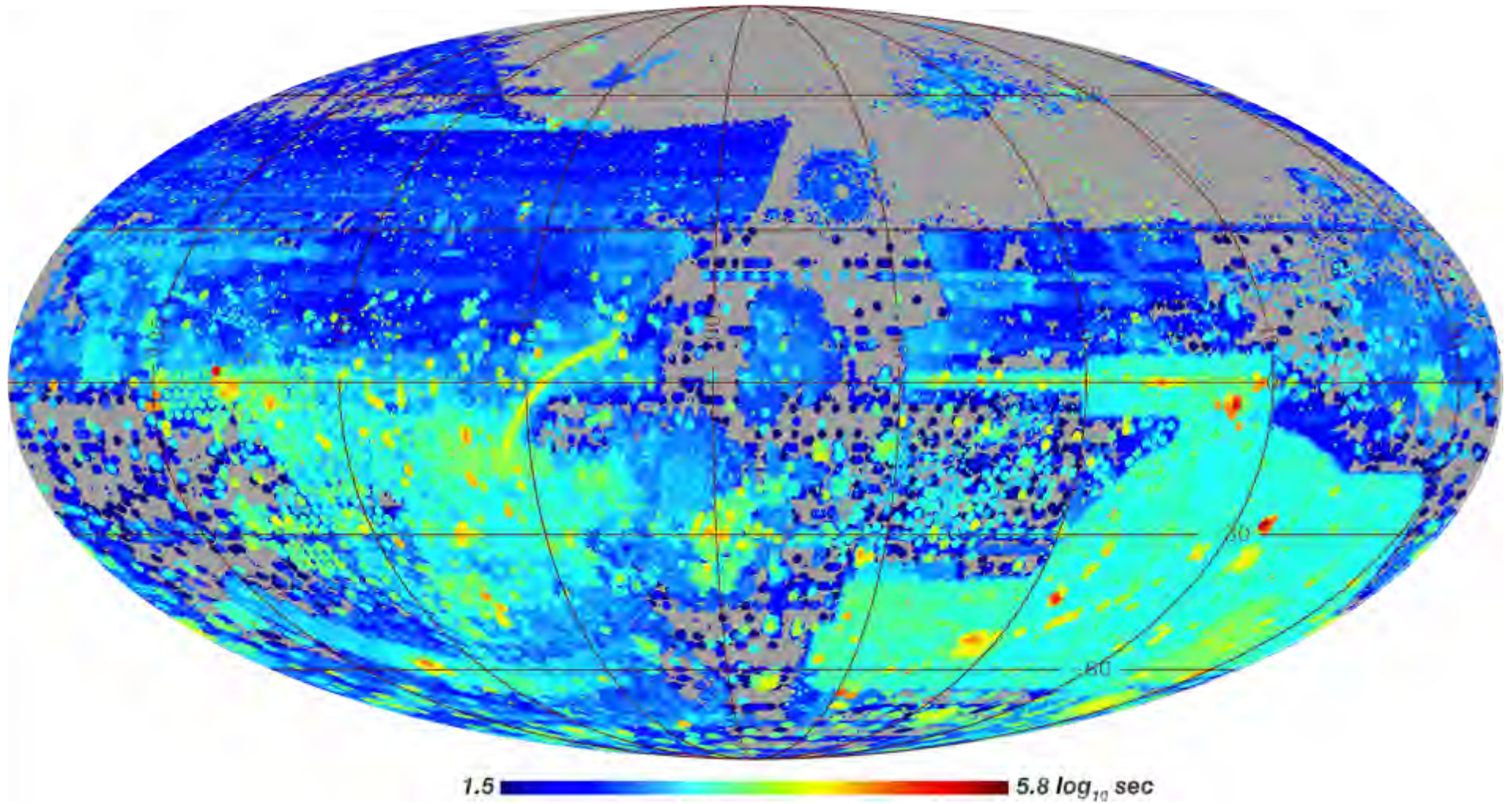


# NOAO wide field imaging data over time





# DECam and Mosaic data in May 2016





# Data Volume and Complexity

500 TB (January 2017) of on-target imaging data ( $t_{\text{exp}} > 30\text{s}$ ) currently from:

- Dark Energy Survey
- Legacy Surveys for DESI Targeting
- Community DECam and Mosaic programs and surveys

Hundreds of TB more coming

Total holdings of several PB

Large catalogs coming:

- Dark Energy Survey – 45 TB
- DESI Targeting Survey – ~5 TB
- Community programs and surveys – up to several TB each



- **Goal:**
- Efficient exploration and analysis of the large datasets being generated by instruments on NOAO wide-field 4-m telescopes
- **Approach:**
  - Catalogs and images linked to catalog objects
  - Data discovery
  - Developing intuition through interaction with selected catalog and image set of known objects
  - Automation of analysis to aid discovery of unknown objects

# Data Lab in a Nutshell



**Large Catalogs** – Data Lab will serve TB-scale databases

**Pixel Data** – Data Lab will connect users to images and spectra in NOAO Science Archive

**Virtual Storage** – Minimizes data transfer

**Visualization** – Data Lab will enable data exploration

**Compute Processing** – Data Lab will allow workflows to run close to the data

**Additional features** – Access to published datasets and external data services, data publication, exportable workflows, distributable software



## Timeline

- March 2015: Conceptual Design Review
  - Lisa Storrie-Lombardi (Chair), Severin Gaudet, Zeljko Ivezic, Connie Rockosi, Beth Willman reviewed Science Case & Requirements, System Architecture, Operations Concept & Requirements, and Schedule
- Fall 2015 hiring campaign
- June 2016 San Diego AAS Demo
- August 2016 Interim Review
  - Lisa Storrie-Lombardi (Chair), Severin Gaudet, Zeljko Ivezic, Ed Olszewski, Beth Willman, and Dennis Zaritsky reviewed progress and Year 2 plan
- January 2017 AAS SMASH DR1 and DECaLS DR3
- Summer 2017 first public release
- End 2017/Early 2018 DES DR1



**About the Data Lab**

Enabling efficient exploration and



**Discover Your Data**

Use our Discovery Tool (in alpha) to



**Interact with Your Data**

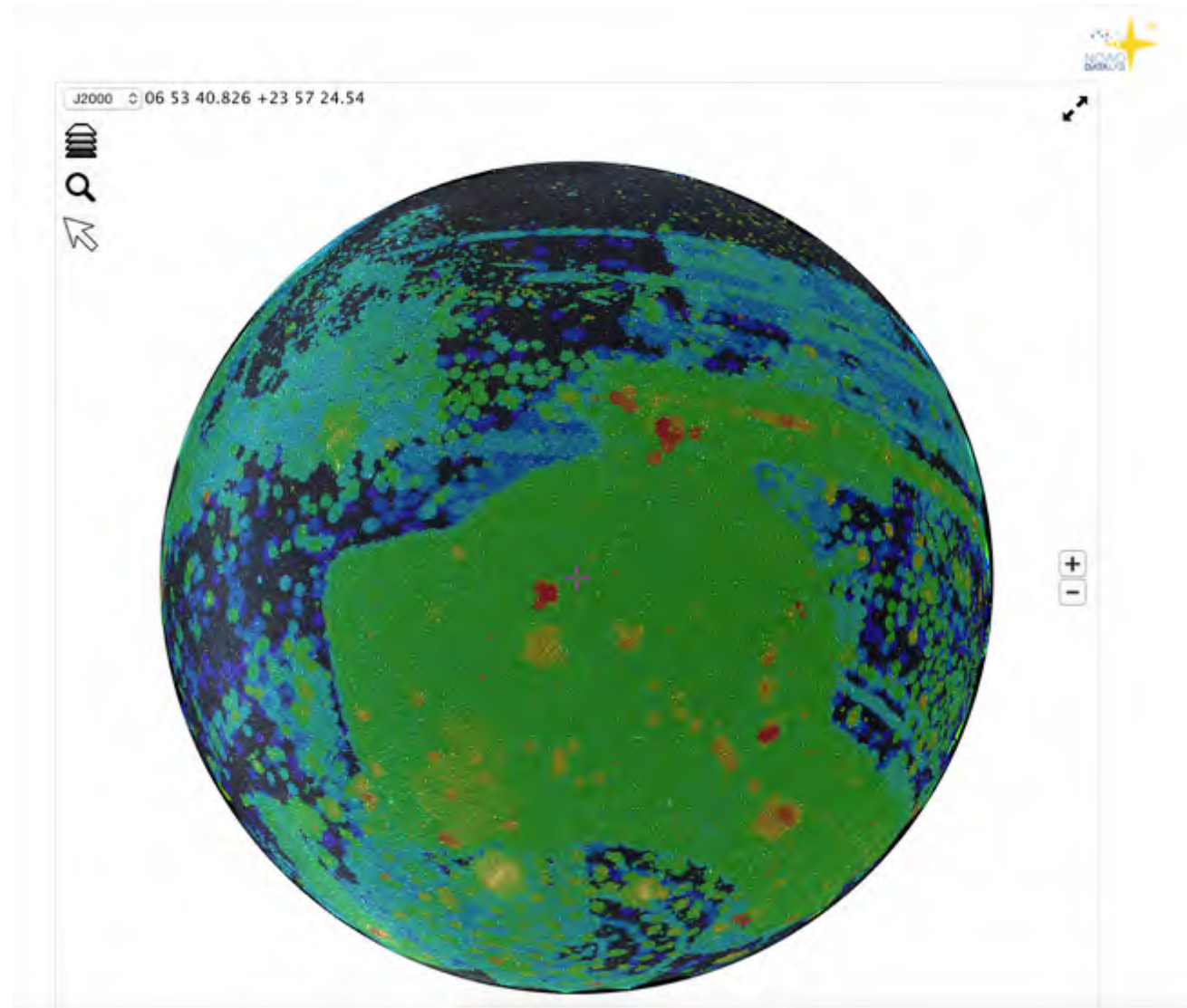
Learn about tools that you can use



**Script Your Analysis**

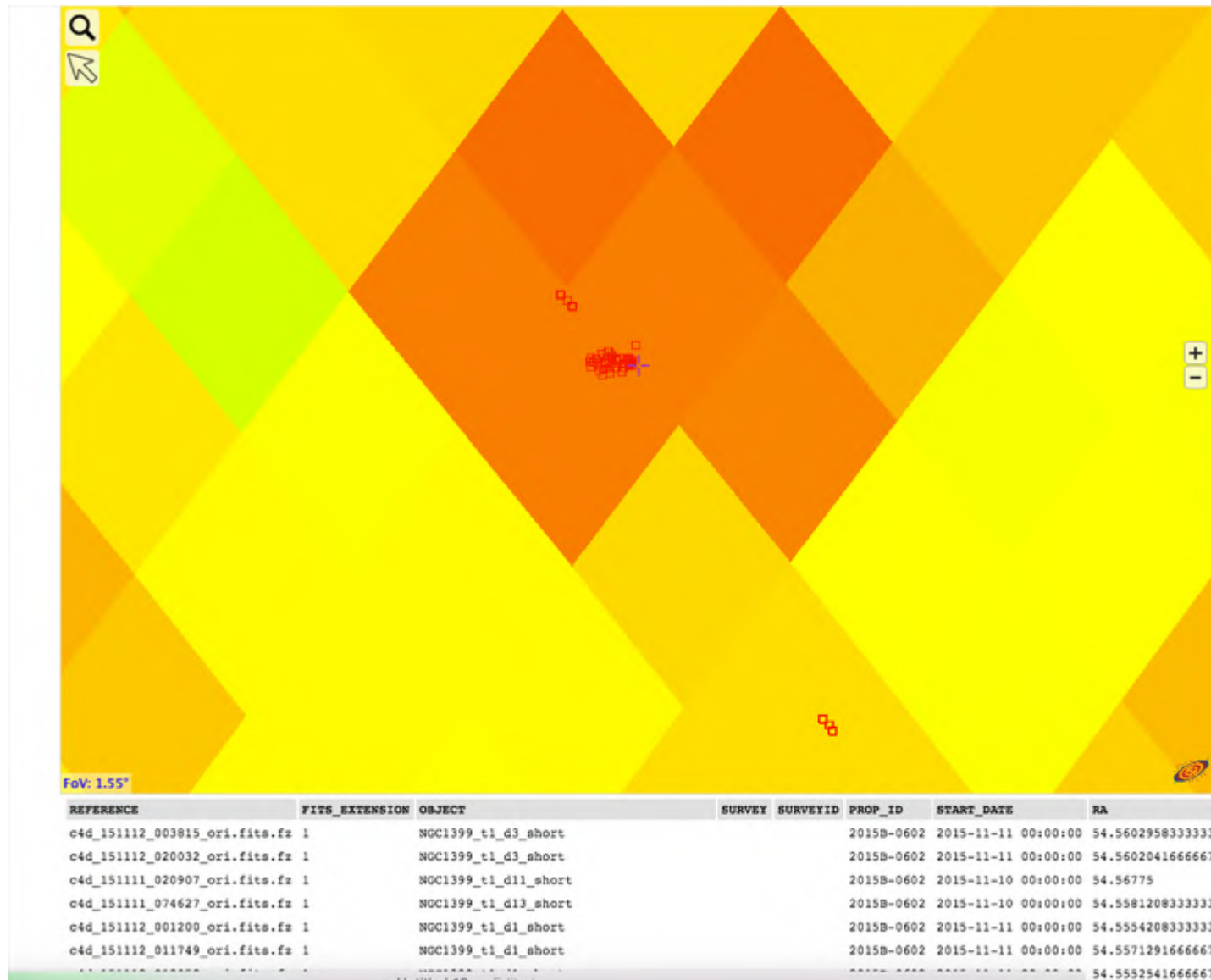
Learn how the Data Lab will

# Data discovery





# Data discovery



# Survey data



About Discover Interact Script **Survey Data** Feedback

SMASH

DECaLS

DES

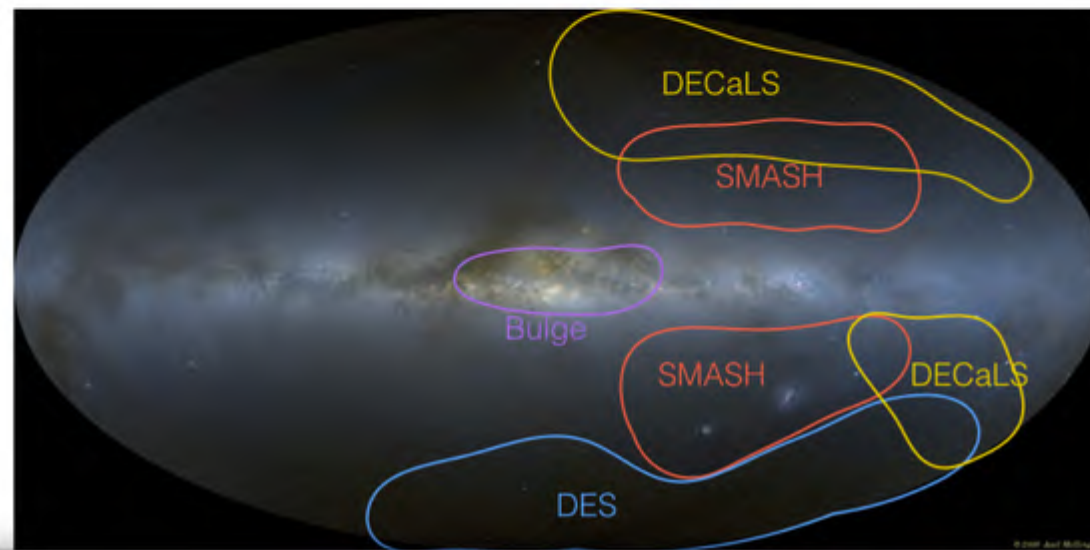
(coming soon)

Bulge

(coming soon)


## Survey Coverage

The map below shows the areas covered by surveys with catalog data currently available through the NOAO Data Lab (SMASH, DECaLS) and those expected within approximately a year (DES, Bulge). Hover over an outline to see the survey name or click on an outline or on the sidebar links to go to the page for that survey. For pure image data from these and other observing programs, visit the [NOAO Science Archive](#).



# SMASH DR1

## Survey of the Magellanic Stellar History (SMASH)

 [About](#) [Discover](#) [Interact](#) [Script](#) [Survey Data](#) [Feedback](#)

### Description


- [Overview](#)
- [Goals](#)
- [First Data Release](#)
- [Data Reduction and Calibration](#)

### Data Access

### Analysis

### Explore

### Results



## The SMASH Survey

### Overview

The Survey of the Magellanic Stellar History (SMASH) is using DECam to map 480 square degrees of sky to depths of  $ugriz-24$  with the goal of identifying broadly distributed, low surface brightness stellar populations associated with the stellar halos and tidal debris of the Magellanic Clouds. It will eventually contain measurements of approximately 250 million objects distributed in discrete fields spanning an area of about 2400 square degrees. The first data release (DR1) contains ~100 million objects from 61 observed fields. Browse these pages to learn more about SMASH and to access the data. The [SMASH overview paper](#) (Nidever et al. 2017) describes the survey in detail, including its goals, survey strategy, reduction, and calibration.

# SMASH DR1 Data Access

## Description

## Data Access

## Data Access

The SMASH data are accessible by a variety of means:

## Analysis

### Data Lab Table Access Protocol (TAP) service

TAP provides a convenient access layer to the SMASH catalog database. TAP-aware clients (such as [TOPCAT](#)) can point to <http://datalab.noaa.edu/tap>, select the *smash\_dr1* database, and see the database tables and descriptions. *smash\_dr1* contains six tables: *chip*, *exposure*, *field*, *object*, *source*, and *xmatch*. These are described in the [schema page](#).

## Explore

## Results

### Data Lab Query Manager

The Query Manager is available as part of the prototype Data Lab software distribution. The Query Manager client provides a Python API to Data Lab database services. For the SMASH DR1 release, these services include only anonymous access through synchronous queries of the catalog made directly to the database. The full public release of the Data Lab Query Manager in the summer of 2017 will include authenticated access, synchronous and asynchronous queries, TAP queries, personal database storage, and storage through the Data Lab VOSpace.

### Image cutouts

The Data Lab Simple Image Access (SIA) service provides a fast way to retrieve cutouts from SMASH images. For an example of how to use the SIA service, see [this Jupyter notebook](#).

### Jupyter Notebook Server

The Data Lab [Jupyter Notebook server](#) contains examples of how to access and visualize the SMASH catalog.

### FTP access



# SMASH DR1 Data Analysis

## Survey of the Magellanic Stellar History (SMASH)

[About](#)[Discover](#)[Interact](#)[Script](#)[Survey Data](#)[Feedback](#)[Description](#)[Data Access](#)[Analysis](#)[Explore](#)[Results](#)

## Analysis

### Jupyter Notebook Server

We have set up a public Jupyter Notebook server to allow anonymous access and exploration of the SMASH catalog and images. By clicking [this link](#), you will start an instance of this server running. You can make changes to the example notebooks, but note that these changes will disappear once you close the page or the browser.

### Example notebooks in the Data Lab Notebook server

You can view static versions of the example notebooks contained on the Jupyter Notebook server by selecting a notebook from the list below:

- [Basic access \(field list, avg. photometry of a field, single-source light curve\)](#)
- [Interactive filtering and plotting \(Hydra II dwarf galaxy discovery demonstration\)](#)
- [Making an interactive source density map](#)
- [Identifying ugr dropout candidates \(Simple Image Access search and retrieval\)](#)
- [Demonstrating criteria for separating stars and galaxies in the SMASH catalog \(visualization of millions of points\)](#)



# Identifying *r*-dropouts

## Catalog query

For our query, we will look for objects that are undetected or have large errors in u, g, and r, but are detected and have small errors in i and z. We will only keep objects that have a match in the ALLWISE catalog. Using subqueries to limit the object and xmatch tables using indexed columns makes the query run much faster than it would otherwise.

```
In [2]: %%time
db1='smash_dr1.object' # the SMASH object table with average magnitudes
db1sel='db1.fieldid,db1.id,db1.ra,db1.dec,db1.umag,db1.gmag,db1.rmag,db1.imag, '\
      'db1.zmag,db1.uerr,db1.gerr,db1.rerr,db1.ierr,db1.zerr,db1.depthflag' # select ID, coordinates, and mags
db2='smash_dr1.xmatch' # the SMASH cross-match table, which contains cross-matches to ALLWISE
db2sel='db2.wise_id,db2.wise_wlmag,db2.wise_wlerr,db2.wise_w2mag,db2.wise_w2err' # ALLWISE W1&W2 mags
db1where='(db1.ndetu=0 or db1.uerr>0.3) and '\
        '(db1.ndetg=0 or db1.gerr>0.3) and '\
        '(db1.ndetr=0 or db1.rerr>0.3) and '\
        '(db1.ndeti>0 and db1.ierr<0.1) and '\
        '(db1.ndetz>0 and db1.zerr<0.1)' # pick ugr dropouts
db2where='(db1.id=db2.id)' # only pick dropouts that are found in ALLWISE W1

# Create the query string.
query = 'SELECT '+db1sel+', '+db2sel+' FROM (SELECT * FROM '+db1+' WHERE depthflag > 1) AS db1, '\
      '{(SELECT * FROM '+db2+' WHERE wise_match=1) AS db2 '\
      'WHERE ('+db2where+' and '+db1where+')'

print "Your query is:", query
print "Making query"

# Call the Query Manager Service
response = queryClient.query(token, adql = query, fmt = 'csv')
df = pd.read_csv(StringIO(response))

print len(df), "objects found."

Your query is: SELECT db1.fieldid,db1.id,db1.ra,db1.dec,db1.umag,db1.gmag,db1.rmag,db1.imag,db1.zmag,db1.uerr,db1.gerr,db1.rerr,db1.ierr,db1.zerr,db1.depthflag,db2.wise_id,db2.wise_wlmag,db2.wise_wlerr,db2.wise_w2mag,db2.wise_w2err FROM (SELECT * FROM smash_dr1.object WHERE depthflag > 1) AS db1, (SELECT * FROM smash_dr1.xmatch WHERE wise_match=1) AS db2 WHERE ((db1.id=db2.id) and (db1.ndetu=0 or db1.uerr>0.3) and (db1.ndetg=0 or db1.gerr>0.3) and (db1.ndetr=0 or db1.rerr>0.3) and (db1.ndeti>0 and db1.ierr<0.1) and (db1.ndetz>0 and db1.zerr<0.1))
Making query
5769 objects found.
CPU times: user 52.3 ms, sys: 11.1 ms, total: 63.3 ms
Wall time: 39.2 s
```

# Identifying *r*-dropouts

## Displaying the cutouts

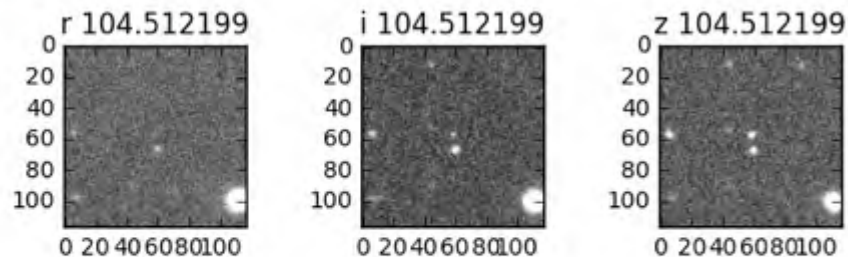
Now let's show the cutouts. The object in question is indeed invisible in the *r*-band image, but is visible in both *i* and *z*, and appears point-like.

```
In [12]: a1=plt.subplot2grid((2,8),(0,0),rowspan=2,colspan=2)
imgplot = plt.imshow(rimg)
a1.set_title('r '+idl.astype('string'))

a2=plt.subplot2grid((2,8),(0,3),rowspan=2,colspan=2)
imgplot = plt.imshow(iimg)
a2.set_title('i '+idl.astype('string'))

a3=plt.subplot2grid((2,8),(0,6),rowspan=2,colspan=2)
imgplot = plt.imshow(zimg)
a3.set_title('z '+idl.astype('string'))
```

```
Out[12]: <matplotlib.text.Text at 0x7fc06272fe90>
```



To go through the whole list of cutouts, the code from this notebook would be best put into a Python script and run from the command line, saving the images or making a figure showing all of the candidate objects at once.

# Discovering Hydra II dwarf

jupyter SMASH\_Hydrall\_interactive Last Checkpoint: Last Monday at 11:37 PM (autosaved) Control Panel Logout

File Edit View Insert Cell Kernel Widgets Help Python 2

```
+
```

### Query the SMASH DR1 database

We will query the averaged photometry table from the SMASH catalog and select Field 169, which we know contains the Hydra II dwarf.

```
In [2]: field = 169                # SMASH Field Number to query
        depth = 1                # minimum depth
        raname = 'ra'
        decname = 'dec'
        mags = 'gmag,rmag'
        dbase='smash_dr1.object'
        fid = 'fieldid'

        # Create the query string.
        query = ('select '+raname+', '+decname+', '+mags+',depthflag from '+dbase+ \
                ' where ('+fid+' = \''+str(field)+' AND' \
                '(depthflag > %d) and ' + \
                '(abs(sharp) < 0.5) and ' + \
                '(gmag is not null) and ' + \
                '(gmag between 9 and 25) and ' + \
                '((gmag-rmag) between -1.5 and 3.0))' % \
                (field, depth))

        print "Your query is:", query
```

Your query is: select ra,dec,gmag,rmag,depthflag from smash\_dr1.object where (fieldid = '169' AND (depthflag > 1) and (abs(sharp) < 0.5) and (gmag is not null) and (gmag between 9 and 25) and ((gmag-rmag) between -1.5 and 3.0))

We issue the query through the Query Manager, which connects directly to the database.

```
In [3]: %%time
        print "Making query"
        # Call the Query Manager Service
        response = queryClient.query(token, adql = query, fmt = 'csv')
        df = pd.read_csv(StringIO(response))

        print len(df), "objects found."
```

Making query  
297788 objects found.  
CPU times: user 307 ms, sys: 57.1 ms, total: 364 ms  
Wall time: 12.5 s

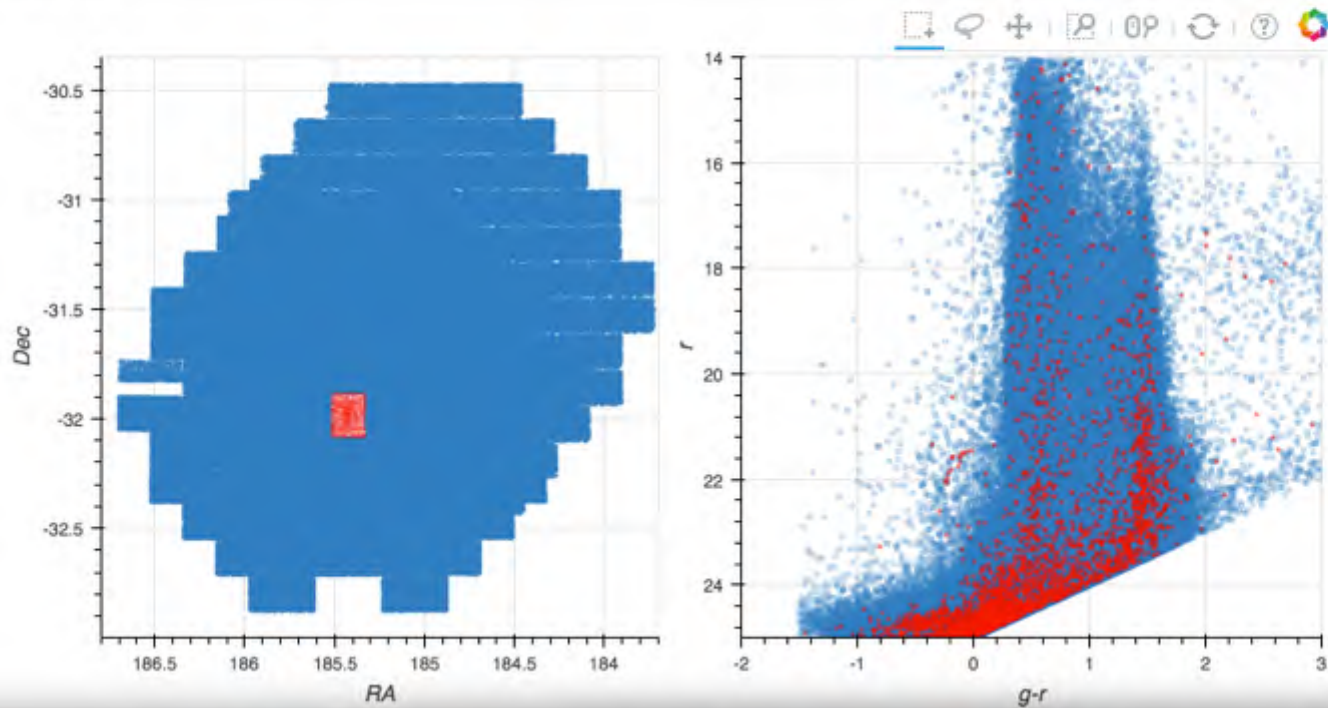


# Discovering Hydra II dwarf

## The plots

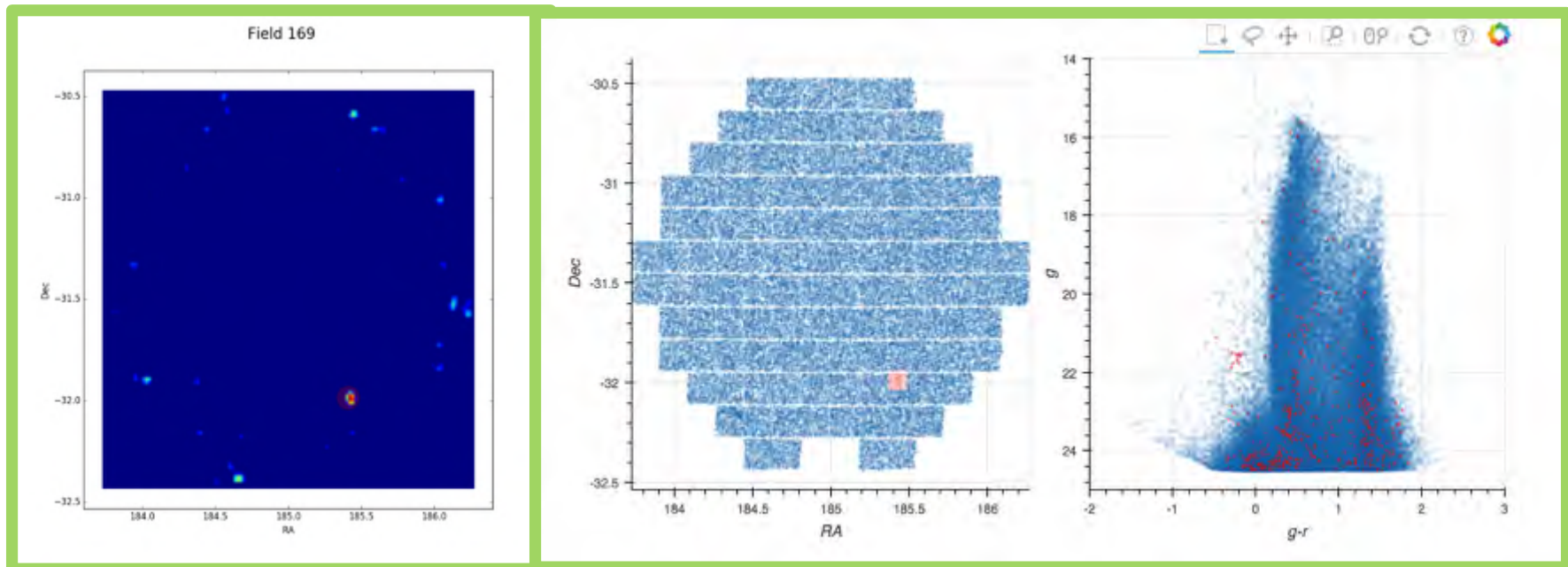
Finally, we render the plot. The figures are interactive, with ability to pan, zoom, and select samples of data that are then updated in the other plot. With the large number of points used here, the interaction can be a little slow, depending on browser and hardware. Try Box Select on the clump of points at lower left, where Hydra II is lurking.

```
In [12]: show(p)
```





# Automation of workflow



From Poster I54.25

## Coming in 2017

- Authentication
- Asynchronous queries and myDB through Query Manager
- Virtual storage and disk allocation
- Compute service
- Feedback? Visit [datalab.noao.edu](http://datalab.noao.edu) or contact us at [datalab@noao.edu](mailto:datalab@noao.edu)