



# The NOAO Science Archive

Mark Dickinson  
for NOAO Science Data Management



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# NOAO Science Archive

- **Raw data from:**
  - 11 telescopes (KPNO, CTIO, SOAR, WIYN)
  - 48 telescope+instrument combinations
- **Data from 2004B to the present**
  - Earlier raw data are stored on tape
- **Three geographically dispersed copies of raw data**
- **Pipeline-reduced data from NOAO wide-field imagers:**
  - Mosaic (1, 1.1, 2, at KPNO 4m+0.9m and CTIO 4m)
  - NEWFIRM (KPNO 4m + CTIO 4m)
  - DECam (CTIO 4m)
- **Delivered, reduced survey data products**
  - Older survey data currently in separate (older) Survey Archive
  - New DECam survey data (including DES) go into main Science Archive

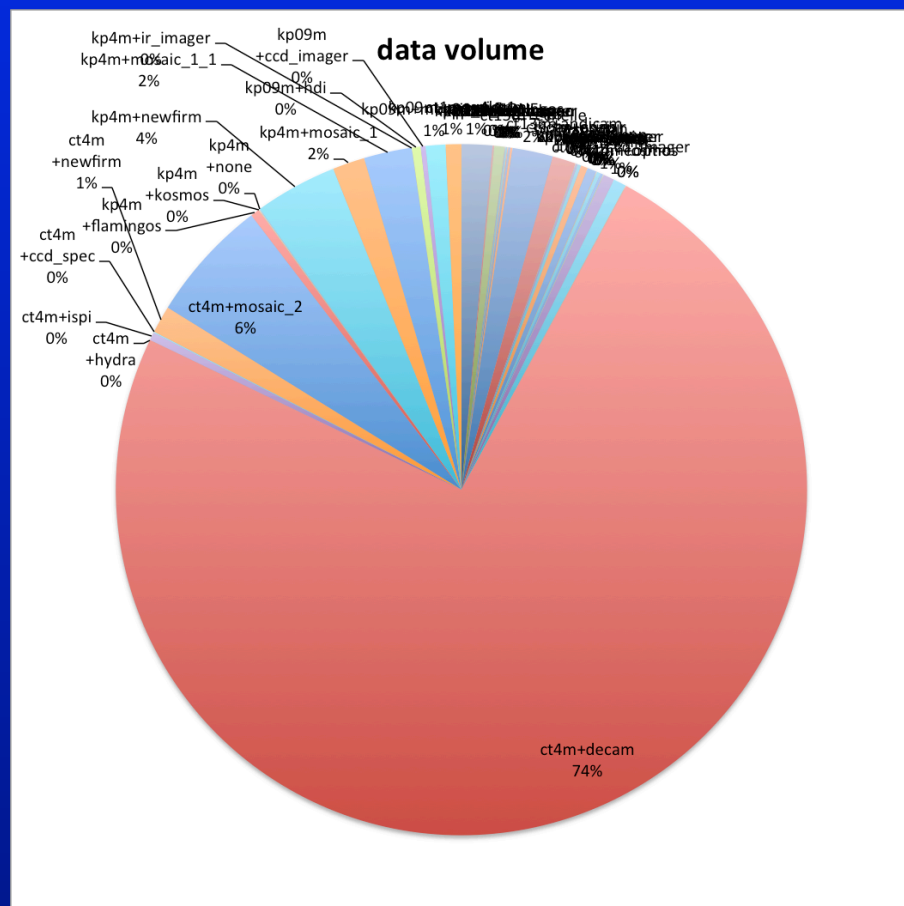




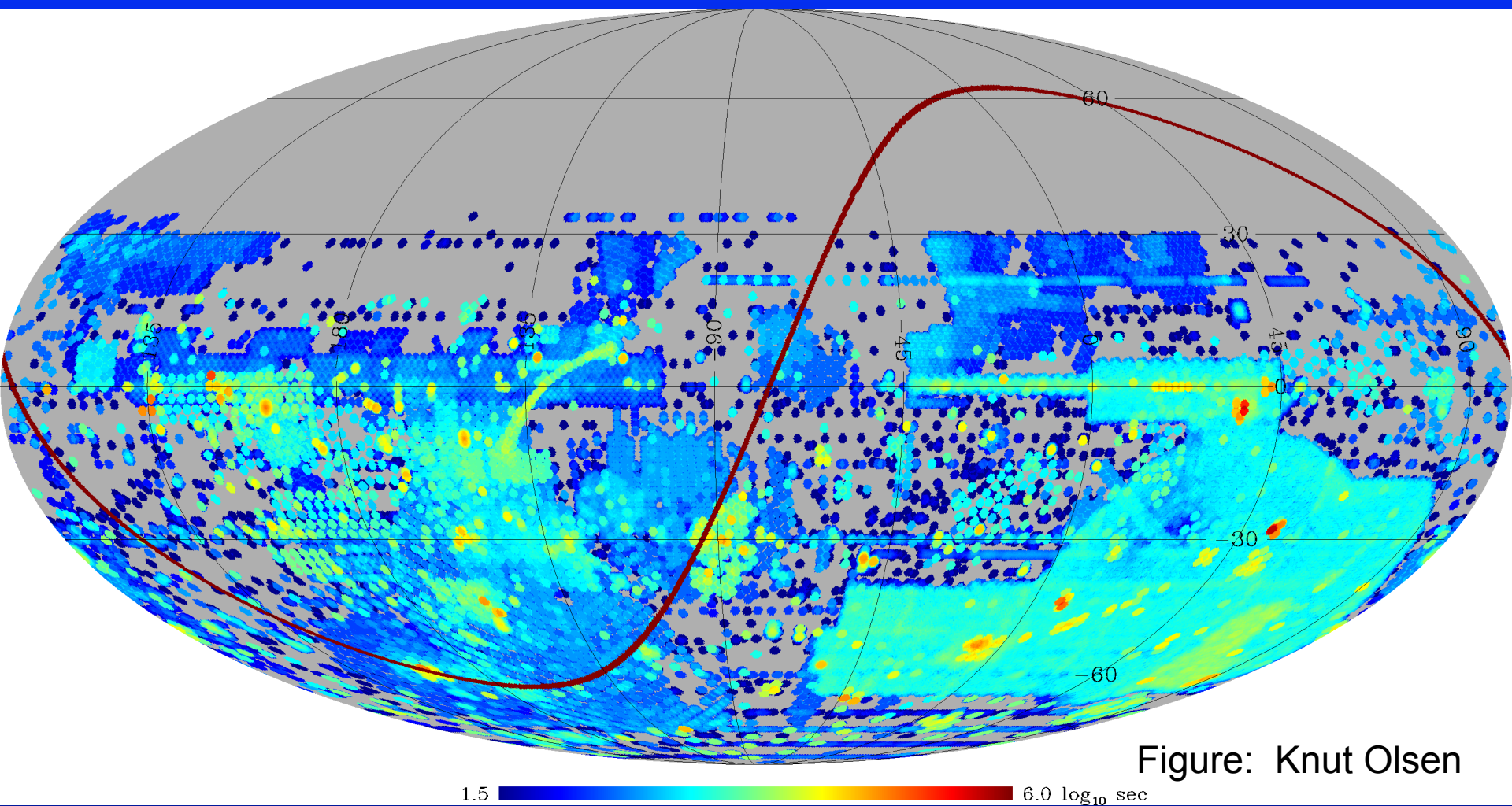
6,661,685 raw files (184.7 TB, compressed)

2,773,750 reduced files (149.6 TB, compressed)

## Raw data by telescope + instrument:



# Current DECam data holdings



# Incoming wide-field survey data

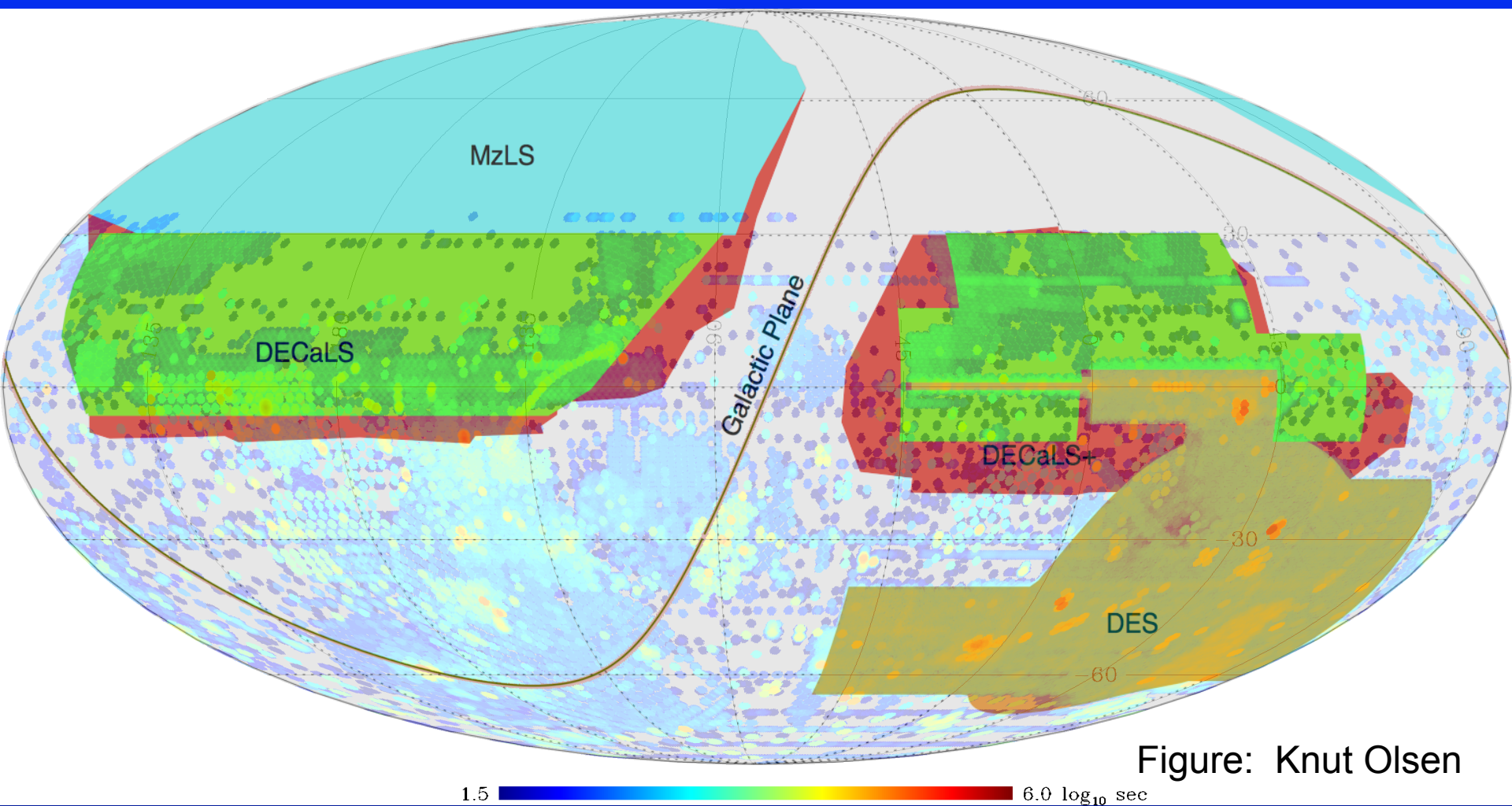


Figure: Knut Olsen





Rapidly growing  
hoard of NOAO  
wide-field imaging is  
a rich trove.

NOAO Archive is  
transitioning from  
being mainly a  
storage & distribution  
service (PI-oriented)  
to a data resource  
(archival users).

# Mining the NOAO Archive

arXiv.org > astro-ph > arXiv:1503.02079

Search or A

Astrophysics > Astrophysics of Galaxies

## Beasts of the Southern Wild. Discovery of a large number of Ultra Faint satellites in the vicinity of the Magellanic Clouds

Sergey E. Koposov, Vasily Belokurov, Gabriel Torrealba, N. Wyn Evans

(Submitted on 6 Mar 2015 (v1), last revised 10 Mar 2015 (this version, v2))

We have used the publicly released Dark Energy Survey data to hunt for new satellites of the Milky Way in the Southern hemisphere. Our search yielded a large number of promising candidates. In this paper, we announce the discovery of 9 new unambiguous ultra-faint objects, whose authenticity can be established with the DES data alone. Based on the morphological properties, three of the new satellites are dwarf galaxies, one of which is located at the very outskirts of the Milky Way, at a distance of 380 kpc. The remaining 6 objects have sizes and luminosities comparable to the Segue 1 satellite and can not be classified straightforwardly without follow-up spectroscopic observations. The satellites we have discovered cluster around the LMC and the SMC. We show that such spatial distribution is unlikely under the assumption of isotropy, and, therefore, conclude that at least some of the new satellites must have been associated with the Magellanic Clouds in the past.

arXiv.org > astro-ph > arXiv:1503.02584

Search or

Astrophysics > Astrophysics of Galaxies

## Eight New Milky Way Companions Discovered in First-Year Dark Energy Survey Data

The DES Collaboration, K. Bechtol, A. Drlica-Wagner, E. Balbinot, A. Pieres, J. D. Simon, B. Yanny, B. Santiago, R. H. Wechsler, J. Frieman, A. R. Walker, P. Williams, E. Rozo, E. S. Rykoff, A. Queiroz, E. Luque, A. Benoit-Levy, R. A. Bernstein, D. Tucker, I. Sevilla, R. A. Gruendl, L. N. da Costa, A. Fausti Neto, M. A. G. Maia, T. Abbott, S. Allam, R. Armstrong, A. H. Bauer, G. M. Bernstein, E. Bertin, D. Brooks, E. Buckley-Geer, D. L. Burke, A. Carnero Rosell, F. J. Castander, C. B. D'Andrea, D. L. DePoy, S. Desai, H. T. Diehl, T. F. Eifler, J. Estrada, A. E. Evrard, E. Fernandez, D. A. Finley, B. Flaugher, E. Gaztanaga, D. Gerdes, L. Girardi, M. Gladders, D. Gruen, G. Gutierrez, J. Hao, K. Honscheid, B. Jain, D. James, S. Kent, R. Kron, K. Kuehn, N. Kuropatkin, O. Lahav, T. S. Li, et al. (32 additional authors not shown)

(Submitted on 9 Mar 2015)

We report the discovery of eight new Milky Way companions in  $\sim 1,800 \text{ deg}^2$  of optical imaging data collected during the first year of the Dark Energy Survey (DES). Each system is identified as a statistically significant over-density of individual stars consistent with the expected isochrone and luminosity function of an old and metal-poor stellar population. The objects span a wide range of absolute magnitudes ( $M_V$  from  $-2.2 \text{ mag}$  to  $-7.4 \text{ mag}$ ), physical sizes (10 pc to 170 pc), and heliocentric distances (30 kpc to 330 kpc). Based on the low surface brightnesses, large physical sizes, and/or large Galactocentric distances of these objects, several are likely to be new ultra-faint satellite galaxies of the Milky Way and/or Magellanic Clouds. We introduce a likelihood-based algorithm to search for and characterize stellar over-densities, as well as identify stars with high satellite membership probabilities. We also present completeness estimates for detecting ultra-faint galaxies of varying luminosities, sizes, and heliocentric distances in the first-year DES data.



# Raw DECam data in Archive

(as of today)

- 273,886 raw DECam files (139.5 TB)
  - DECam already makes up 75% of the total raw data volume in the Archive
  - *As many DECam exposures taken since December 2012 as with the CTIO+KPNO Mosaic cameras combined since 2004B !!*
  - 192,258 public (as of today) (70%)
  - 173,446 “object” exposures (62%; the rest are calibration, etc.)
  - 75,931 exposures come from DES (28%)
    - 51,816 DES frames are public (68% of total DES)

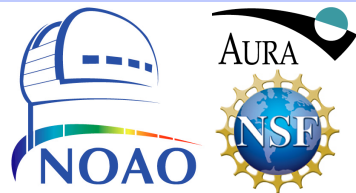


# Pipeline-reduced DECam data in Archive

(as of today)


- 782,929 reduced DECam data files
  - *Note:* CP produces several reduced files for each raw exposure
  - 387,456 reduced public (49%)
- Reduced single-frame “object” images:  
(PROCTYPE = InstCal, PRODTYPE = image)
  - 129,188 exposures
    - 12,027 are delivered products from DES-Y1 (9%; all public)
    - 117,161 from CP (90%)
      - 58,253 CP public (50%)
- Reduced coadds:  
(PROCTYPE = Stacked, PRODTYPE = image)
  - 16,415 stacks
    - 8,304 public (51%)





# NOAO Science Archive

<http://portal-nvo.noao.edu>



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### Latest News

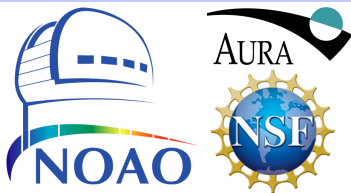
*February 2015*  
**Dark Energy Survey (DES) reduced data products available.**  
Reduced data from the Dark Energy Survey (DES) Year 1 public data release are now available in the NOAO Science Archive. The data release consists of a large number of DECam images in several sky areas, individually reduced and calibrated (photometrically and astrometrically) by the DES science team. The Simple Query Form now includes buttons that simplify searches for both raw and reduced DES images. Observations have a 12 month proprietary period; by February 2015, all data will be public. See the **DES Year 1 data release notes** for full documentation.

*September 2013*  
**New username and login system.**  
The NOAO Archive has a new login and security system, which provides easier and quicker sign-on for accessing proprietary data. PIs and co-Is of NOAO observing programs will automatically be assigned new archive usernames and passwords. If you have previously used an NVO username to sign in to the Archive, you may continue to do so, or switch to your new NOAO Archive username. You do not need to log in to query or retrieve public, non-proprietary data.

The NOAO Science Archive provides access to data from more than 25 **NOAO** telescope + instrument combinations, including those operated in partnership with the **WIYN**, **SOAR**, and **SMARTS** consortia. Pipeline-reduced data products from the DECam, Mosaic and NEWFIRM imagers on the **KPNO** and **CTIO 4m** telescopes are available.

[Proprietary data access \(login required\)](#) [General search for NOAO data \(all users\)](#)

[Search NOAO Survey Program high-level data products](#)



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**PIs and co-Is of NOAO programs log in to access their proprietary data**

# Simple Query Form



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Enter parameter constraints in the Query Form, then click "Search". To find data from your own NOAO programs, choose "Search My Data" under Search Type. Data from the Results may be staged and retrieved from the Staging Area.

[Reset](#)
Search Type: [Search All Data](#)
[Search](#)

### Target

**Object name**

[Resolve](#)

**Coordinates**
RA:   
Dec:

**Search box size (arcmin)**

### Observation

**Program number**

**Principal Investigator**

**Observing calendar date**

**Original Filename**

**Archive Filename**

### Telescope & Instrument

**Telescope & Instrument**

- KPNO 4m + Mosaic Imager
- KPNO 4m + NEWFIRM IR Imager
- KPNO 4m + FLAMINGOS IR Imager,
- KPNO 4m + KOSMOS
- KPNO 4m + Miscellaneous instrum
- WIYN 3.5m + Mini-Mosaic Imager
- WIYN 3.5m + WHIRC IR Imager
- WIYN 3.5m + Bench Spectrograph
- KPNO 2.1m + CCD Imager
- KPNO 2.1m + GoldCam Spectrogra
- KPNO 2.1m + FLAMINGOS IR Image
- KPNO 2.1m + SQUID IR Imager
- KPNO Coude Feed Spectrograph
- WIYN 0.9m + Mosaic Imager
- WIYN 0.9m + S2KB Imager
- CTIO 4m + Mosaic-2 Imager
- CTIO 4m + NEWFIRM IR Imager
- CTIO 4m + ISPI IR Imager
- CTIO 4m + CCD Spectrograph
- CTIO 4m + DECam
- SOAR 4m + Goodman Spectrograp
- SOAR 4m + OSIRIS IR Imager/Spect
- SOAR 4m + SOAR Optical Imager
- SOAR 4m + Spartan IR Imager
- CTIO 1.5m + Cassegrain Spectrogr
- CTIO 1.5m + Fiber Echelle Spectro
- CTIO 1.3m + ANDICAM Imager
- CTIO 1m + Y4KCam Imager
- CTIO 0.9m + Cassegrain Imager

### Data products

**Public release date**

**All instruments**
☐ Raw

**Mosaic, NEWFIRM and DECam**

- ☐ Calibrated images
- ☐ Reprojected images
- ☐ Stacked images
- ☐ Master calibration files

**NEWFIRM only**
☐ Sky subtracted images

**Dark Energy Survey (DES) public data**
[Raw data](#)
[Reduced data](#)

# Simple Query Form

Reset    Search Type: Search All Data    Search

Observation	Telescope & Instrument	Data products
<div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 10px;"> <b>Program number</b>  <input style="width: 100%;" type="text"/> </div> <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 10px;"> <b>Principal Investigator</b>  <input style="width: 100%;" type="text"/> </div> <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 10px;"> <b>Observing calendar date</b>  <div style="display: flex; align-items: center;"> <span style="border: 1px solid #ccc; padding: 2px 5px;">=</span> <span style="border: 1px solid #ccc; padding: 2px 5px; margin-left: 5px;">▼</span> </div> <input style="width: 100%;" type="text"/> </div> <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 10px;"> <b>Original Filename</b>  <input style="width: 100%;" type="text"/> </div> <div style="border: 1px solid #ccc; padding: 5px;"> <b>Archive Filename</b>  <input style="width: 100%;" type="text"/> </div>	<div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 10px;"> <b>Telescope &amp; Instrument</b> </div> <div style="border: 1px solid #ccc; padding: 5px;"> <p>             KPNO 4m + Mosaic Imager              KPNO 4m + NEWFIRM IR Imager              KPNO 4m + FLAMINGOS IR Imager,              KPNO 4m + KOSMOS              KPNO 4m + Miscellaneous instrum              WIYN 3.5m + Mini-Mosaic Imager              WIYN 3.5m + WHIRC IR Imager              WIYN 3.5m + Bench Spectrograph              KPNO 2.1m + CCD Imager              KPNO 2.1m + GoldCam Spectrogra              KPNO 2.1m + FLAMINGOS IR Image              KPNO 2.1m + SQUID IR Imager              KPNO Coude Feed Spectrograph              WIYN 0.9m + Mosaic Imager              WIYN 0.9m + S2KB Imager              CTIO 4m + Mosaic-2 Imager              CTIO 4m + NEWFIRM IR Imager              CTIO 4m + ISPI IR Imager              CTIO 4m + CCD Spectrograph              CTIO 4m + DECam              SOAR 4m + Goodman Spectrograp              SOAR 4m + OSIRIS IR Imager/Spect              SOAR 4m + SOAR Optical Imager              SOAR 4m + Spartan IR Imager              CTIO 1.5m + Cassegrain Spectrogr              CTIO 1.5m + Fiber Echelle Spectro              CTIO 1.3m + ANDICAM Imager              CTIO 1m + Y4KCam Imager              CTIO 0.9m + Cassegrain Imager           </p> </div>	<div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 10px;"> <b>Public release date</b>  <div style="display: flex; align-items: center;"> <span style="border: 1px solid #ccc; padding: 2px 5px;">=</span> <span style="border: 1px solid #ccc; padding: 2px 5px; margin-left: 5px;">▼</span> </div> <input style="width: 100%;" type="text"/> </div> <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 10px;"> <b>All instruments</b>  <input type="checkbox"/> Raw         </div> <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 10px;"> <b>Mosaic, NEWFIRM and DECam</b>  <div style="display: flex; flex-direction: column; gap: 5px;"> <input type="checkbox"/> Calibrated images  <input type="checkbox"/> Reprojected images  <input type="checkbox"/> Stacked images  <input type="checkbox"/> Master calibration files         </div> </div> <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 10px;"> <b>NEWFIRM only</b>  <input type="checkbox"/> Sky subtracted images         </div> <div style="border: 1px solid #ccc; padding: 5px;"> <b>Dark Energy Survey (DES) public data</b>  <div style="display: flex; justify-content: space-around; margin-top: 5px;"> <span style="border: 1px solid #ccc; padding: 2px 10px;">Raw data</span> <span style="border: 1px solid #ccc; padding: 2px 10px;">Reduced data</span> </div> </div>





# Simple Query Form

Search Type:

**Observation**

Program number

Principal Investigator

Observing calendar date

=

Original Filename

Archive Filename

**Telescope & Instrument**

Telescope & Instrument

KPNO 4m + Mosaic Imager

KPNO 4m + NEWFIRM IR Imager

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Public release date

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NEWFIRM only

☐ Sky subtracted images

Dark Energy Survey (DES) public data



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Enter your SQL into the Query Text Area, then click "Search". Data from the Results may be staged and retrieved from the Staging Area. You may enter parameters into the Simple Query Form, then switch to the Advanced Query Form to see the equivalent SQL. This can provide useful examples that you can modify to form your own custom queries.

There are a few required columns that you must include in your SELECT clause, these are: **reference**, **release\_date**, **start\_date**, **filesize**, **dtpropid**, and **md5sum**. Only **voisiap** and **voiskyimage** tables are allowed.

For further information about the schema of the tables **voisiap** and **voiskyimage**, please click [here](#). Also, if you want to know more about SQL please click [here](#) or [here](#) for advanced users.

*Warning: Queries by default will return data for which you are PI, and/or public data. To obtain data for which you are co-I, see the SQL example below. Observing mode is only applicable to KOSMOS instruments. The Advanced Query functionality is a new feature and will be improved in future versions of the archive.*

**Error trying to send your query.**

Reset
Search

```
SELECT reference, dtpropid, surveyid, release_date, start_date, date_obs, dtpi, ra, dec, telescope, instrument, filter, exposure, obstype, obsmode, proctype, prodtype, seeing, depth, dtacqnam, reference AS archive_file, filesize, md5sum FROM voisiap WHERE (release_date <= '2015-03-11' AND (proctype = 'InstCal') AND (prodtype IS NULL OR prodtype <> 'png')) AND (dtpropid ILIKE '%DES%' OR surveyid ILIKE '%DES%') ORDER BY date_obs ASC LIMIT 20000
```


### Examples of valid SQL queries

- This selects the first 100 rows from the voisiap table within a box bounded by ra (10.352, 11.017) and dec (41.019, 41.519). Note that position constraints must be in the same units (here, degrees). Tip: LIMIT 100 or some other small number is useful for testing without getting a very large data set back.

```
SELECT * FROM voisiap WHERE ((ra >= 10.352 AND ra <= 11.017) AND (dec >= 41.019 AND dec <= 41.519)) LIMIT 100
```
- This selects the first 100 rows from the voisiap table for a specified NOAO proposal ID (here, noao) using a wildcard match. A wildcard may be specified by constructing a condition using the operator "LIKE" or "ILIKE" (the later is case insensitive) followed by a string which may contain one or more "%" characters which are the wildcards.

```
SELECT * FROM voisiap WHERE dtpropid ILIKE '%noao%' LIMIT 100
```





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### Display

Displaying images **1 - 50** of **36081** in total  
1 2 3 4 5 6 7 8 9 ... 721 722 Next Last  
Current coordinate format: decimal degrees


### Refine

Categorize by:

Filter by:

### Download

0 rows selected	Access	Proposal ID	Survey ID	Release date	Observing date	UT ▲	PI	RA	Dec	Telescope	Instrument	Filter	Exposure	Observation type	Observing mode	Processing	Pr
<input type="checkbox"/>	Retrieve	2013A-9999	Dark Energy Survey (DES)	2013-08-14	2013-08-15	2013-08-16 04:35:10.815	Walker	306.179813	-50.937992	ct4m	decam	z DECam SDSS c0004 9260.0 1520.0	90.0	object	imaging	InstCal	dq
<input type="checkbox"/>	Retrieve	2013A-9999	Dark Energy Survey (DES)	2013-08-14	2013-08-15	2013-08-16 04:35:10.815	Walker	306.174792	-50.942111	ct4m	decam	z DECam SDSS c0004 9260.0 1520.0	90.0	object	imaging	InstCal	ir
<input type="checkbox"/>	Retrieve	2013A-9999	Dark Energy Survey (DES)	2013-08-14	2013-08-15	2013-08-16 04:35:10.815	Walker	306.179813	-50.937992	ct4m	decam	z DECam SDSS c0004 9260.0 1520.0	90.0	object	imaging	InstCal	w
<input type="checkbox"/>	Retrieve	2013A-9999	Dark Energy Survey (DES)	2013-08-14	2013-08-15	2013-08-16 04:37:29.148	Walker	308.664550	-51.952492	ct4m	decam	z DECam SDSS c0004 9260.0 1520.0	90.0	object	imaging	InstCal	w
<input type="checkbox"/>	Retrieve	2013A-9999	Dark Energy Survey (DES)	2013-08-14	2013-08-15	2013-08-16 04:37:29.148	Walker	308.660708	-51.956556	ct4m	decam	z DECam SDSS c0004 9260.0 1520.0	90.0	object	imaging	InstCal	ir



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**Display**  
 Displaying images **1 - 50** of **7284** in total  
 1 2 3 4 5 6 7 8 9 ... 145 146 Next Last  
 Current coordinate format: decimal degrees


**Refine**  
 Categorize by:    
 Filter by:

**Download**

50 rows selected
 

Access	Proposal ID	Survey ID	Release date	Observing date	UT	Telescope	Instrument	Filter	Exposure	Observation type	Observing mode	Processing			
<input checked="" type="checkbox"/>	Retrieve	2013A-9999	Dark Energy Survey (DES)	2013-08-14	2013-08-15	2013-08-16 04:35:10.815	Walker	306.174792 -50.942111	ct4m	decam	z DECam SDSS c0004 9260.0 1520.0	90.0	object	imaging	InstCal
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<input checked="" type="checkbox"/>	Retrieve	2013A-9999	Dark Energy Survey (DES)	2013-08-14	2013-08-15	2013-08-16 04:37:29.148	Walker	308.660708 -51.956556	ct4m	decam	z DECam SDSS c0004 9260.0 1520.0	90.0	object	imaging	InstCal
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Proposal ID  
 Survey ID  
 PI  
 Telescope  
 Instrument  
 Filter  
 Observation type  
 Observing mode  
 Processing  
 Product



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Staging process is completed.

[Restart staging](#)
[Stop staging](#)
[Clear staging area](#)
[Launch download manager](#)

### Imaging staging status

**Not Enqueued:** 0 images  
**Enqueued:** 0 images  
**Staging:** 0 images  
**Staged:** 60 images  
**Canceled:** 0 images  
**Timeout:** 0 images  
**Error:** 0 images

### Retrieval information

**FTP site:** portal-nvo.noao.edu  
**Username:** anonymous  
**Password:** not required  
**Staging directory:** user\_131019  
**Total files from your list:** 60 files  
**Total estimated size from your list:** 9.665 [GB]

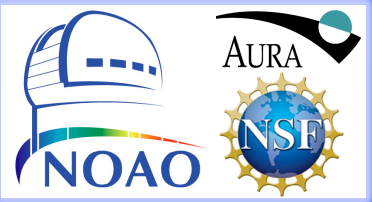
### Download tips (click for details)

- ▶ [NOAO Archive Download Manager](#)
- ▶ [Command line lftp \(fast parallel transfer\)](#)
- ▶ [Command line ftp \(simple file transfer\)](#)
- ▶ [Other data transfer tools \(e.g., for Windows, Mac, etc.\)](#)

Please report any problems to [sdmhelp@noao.edu](mailto:sdmhelp@noao.edu)

Displaying images 1 - 20 of 60 in total  
[1](#) [2](#) [3](#) [Next](#) [Last](#) →

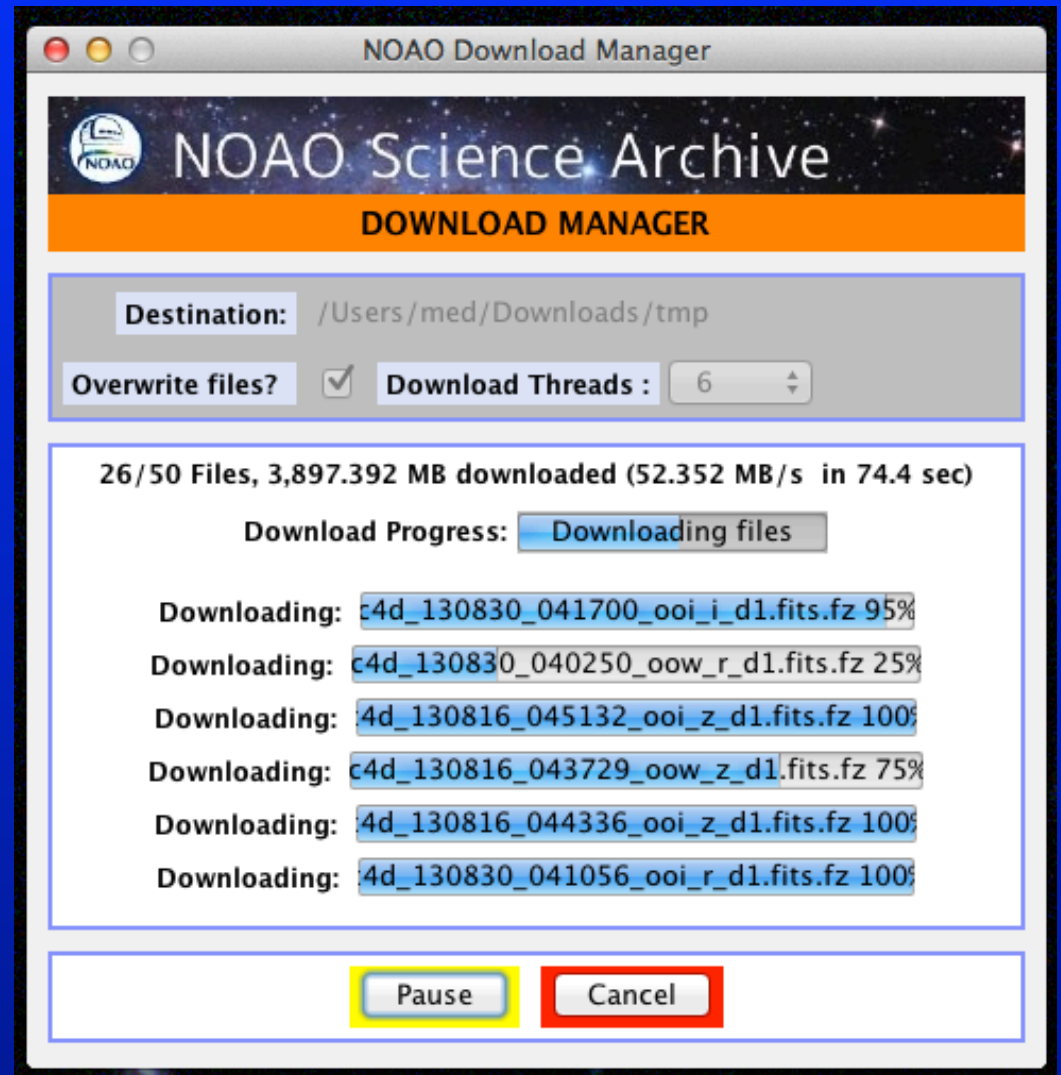
File name	File size	Stage status
c4d_130816_043510_oow_z_d1.fits.fz	162.608 [MB]	Staged
c4d_130816_043510_ooi_z_d1.fits.fz	318.453 [MB]	Staged
c4d_130816_043510_ood_z_d1.fits.fz	9.521 [MB]	Staged
c4d_130816_043729_ooi_z_d1.fits.fz	318.246 [MB]	Staged
c4d_130816_043729_oow_z_d1.fits.fz	162.181 [MB]	Staged
c4d_130816_043729_ood_z_d1.fits.fz	8.772 [MB]	Staged
c4d_130816_043930_ood_z_d1.fits.fz	8.787 [MB]	Staged
c4d_130816_043930_ooi_z_d1.fits.fz	318.067 [MB]	Staged
c4d_130816_043930_oow_z_d1.fits.fz	161.980 [MB]	Staged
c4d_130816_044136_ood_z_d1.fits.fz	8.289 [MB]	Staged
c4d_130816_044136_ooi_z_d1.fits.fz	317.716 [MB]	Staged
c4d_130816_044136_oow_z_d1.fits.fz	161.839 [MB]	Staged
c4d_130816_044336_oow_z_d1.fits.fz	162.475 [MB]	Staged
c4d_130816_044336_ood_z_d1.fits.fz	8.925 [MB]	Staged
c4d_130816_044336_ooi_z_d1.fits.fz	317.650 [MB]	Staged
c4d_130816_044541_ood_z_d1.fits.fz	9.046 [MB]	Staged
c4d_130816_044541_oow_z_d1.fits.fz	161.663 [MB]	Staged
c4d_130816_044541_ooi_z_d1.fits.fz	317.929 [MB]	Staged
c4d_130816_044831_ooi_z_d1.fits.fz	318.905 [MB]	Staged
c4d_130816_044831_oow_z_d1.fits.fz	162.547 [MB]	Staged




# Download Manager

- Fast parallel transfer
- Easy restart if needed

Next release will automatically pull files from mass storage in North or South depending on user location.







## NOAO Science Archive: Tutorials

[Return To Portal](#)   [Search and Retrieve NOAO Data](#)   [PI & Co-I Data Access](#)   [Data compression](#)   [Archive file names](#)

### Search and Retrieve NOAO Data

The **Query page** lets you search for data in the NOAO Science Archive. The Archive holds data from many different combinations of telescopes and instruments, including the NOAO facilities at **KPNO** and **CTIO**, and NOAO data from consortium facilities such as **WIYN**, **SOAR** and **SMARTS**. All raw data from these telescopes and instruments are archived, as well as pipeline-reduced data products from the DECam, Mosaic and NEWFIRM imagers on the NOAO 4m telescopes. Principal Investigators and authorized co-investigators of NOAO observing programs who have registered with the NOAO Archive can retrieve their proprietary data using the Query form. Any user (registered or not) can search for and retrieve non-proprietary data as well.

The process of finding and accessing NOAO data follows several basic steps:

- **Searching for data using the query form**
  - Search for data from your own NOAO observing programs
  - Search for any data in the NOAO Archive
  - Search form parameters
- **Search results**
  - Sorting, filtering, and categorizing search results
  - Selecting data for retrieval
- **Staging data for ftp retrieval**
  - The Staging Area
  - Retrieving your data
  - Problems with staging data
  - Cleaning up your ftp staging area
- **Retrieving data directly from the Archive using cURL**
- **Working with your downloaded data**
  - Data compression
  - Archive filenames and renaming

Also, send email to:  
[sdmhelp@noao.edu](mailto:sdmhelp@noao.edu)

## The Search Form

Search NOAO data »
Log in

Simple Query Form
Advanced Query Form
Results
Staging Area

Enter parameter constraints in the Query Form; then click "Search". To find data from your own NOAO programs, choose "Search My Data" under Search Type. Data from the Results may be staged and retrieved from the Staging Area.

  Search Type: Search All Data ▾  

Target	Observation	Telescope & Instrument	Data products
Object name	Program number	Telescope & Instrument	All instruments

- At top left (under **Search NOAO data**), there are four tabs marked **Query Form**, **Advanced Query Form**, **Results**, and **Staging Area**. These let you switch back and forth between the search form (or the advanced query form), the search results, and the place where you will stage selected data for ftp retrieval.



# NOAO Data Handbook

## NOAO DATA HANDBOOK

VERSION 2.0, FEBRUARY 2015

*Newly revised!*  
R. Shaw, editor

- Intro to NOAO data and archives
- Mosaic cameras
- NEWFIRM
- **DECam**







# Archive Usage

- Download statistics for CY2014 (approximate):
  - 717,000 files downloaded
  - 76 TB downloaded
  - average of 150 FTP users per month



# What's next for the NOAO Archive?

- **Features in upcoming archive releases:**
  - Larger staging volumes (up to 250,000 files)
  - Better performance
- **New survey data:**
  - DECam Legacy Survey (DECaLS) DR1 – this month!
  - Other DECam data from NOAO Survey Programs
  - Eventually: migrate pre-DECam surveys from old (obsolete) Survey Archive to NOAO Science Archive
- **Behind the scenes:**
  - Major overhaul of 3<sup>rd</sup>-party software systems & infrastructure
- **On my long-term wish-list:**
  - Uniform reprocessing of all Mosaic, NEWFIRM and DECam data



# Big images lead to big catalogs

- **NOAO imaging data is growing to ~petabyte scale:**
  - Dark Energy Survey
  - DECaLS and DESI Targeting Survey
  - Community DECam programs and surveys
- **NOAO Science Archive serves images, not catalogs**
- **But...Large catalogs are coming:**
  - Dark Energy Survey – 45 TB
  - DESI Targeting Survey – ~5 TB
  - Community programs and surveys – up to several TB each



# The NOAO Data Lab

Enable efficient exploration and analysis of the large datasets being generated by instruments on NOAO wide-field 4-m telescopes:

- Science with large catalogs
- Easy interplay between catalog objects & associated image data
- Combine services into custom workflows to derive scientific results from catalogs + pixels
- Collaboration tools for distributed research teams working on large data sets

The Data Lab team (so far):

- Project scientist: Knut Olsen
- System architect & lead developer: Mike Fitzpatrick
- In the trenches: Matthew Graham, Ken Mighell, Betty Stobie, Pat Norris, Stephen Ridgway



# The 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



# NOAO Data Lab

- Data Lab will benefit from and build off existing tools and systems where possible
  - SDSS CasJobs, MAST, IRSA, CANFAR, NERSC, VAO, community-led projects
- Timeline:
  - Conceptual design review next week!
  - Science demonstration at AAS January 2016
    - Functional prototypes of various subsystems
  - First public release in January 2017





## Discussion session

*Friday, 10:45 – 11:45*

Round-table discussion 7b: NOAO Science Archive

- What is good?
- What should the NOAO Archive be doing better?
- What isn't the NOAO Archive doing at all?

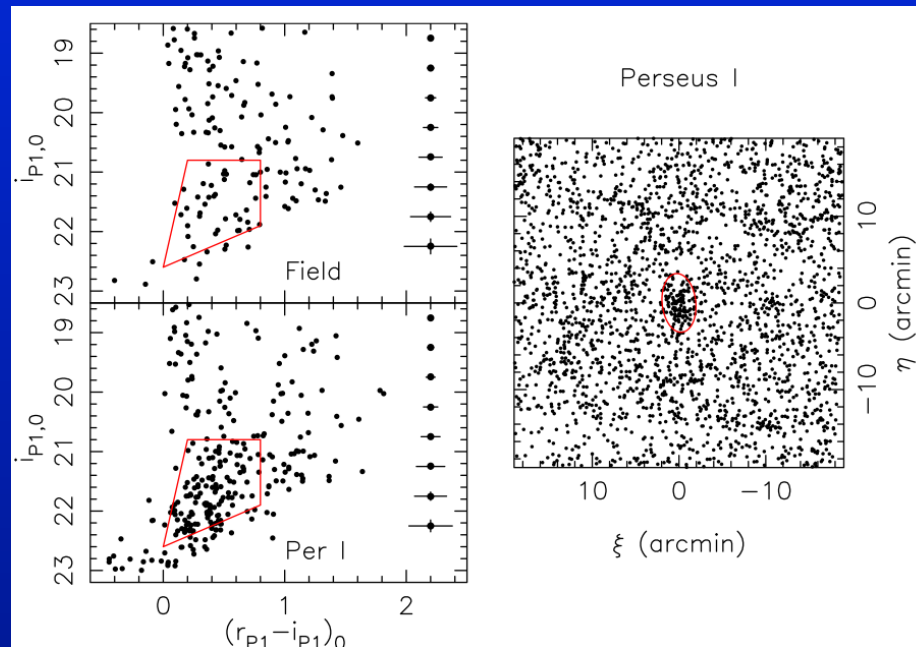


Extra slides

# Scientific Approaches Using the Data Lab

- Catalog science

- Example: search for Galactic substructure through photometric selection of candidate populations
- Data Lab will provide access to large catalog databases, query interface, personal storage, and visualization capability

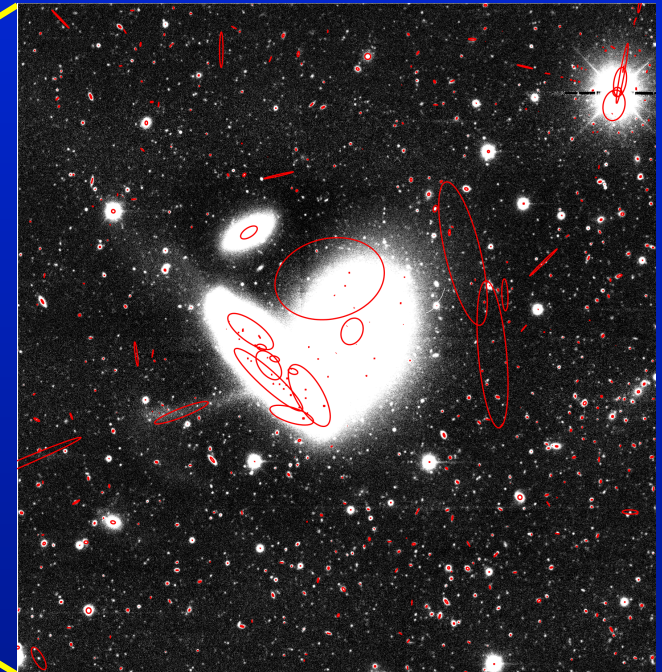
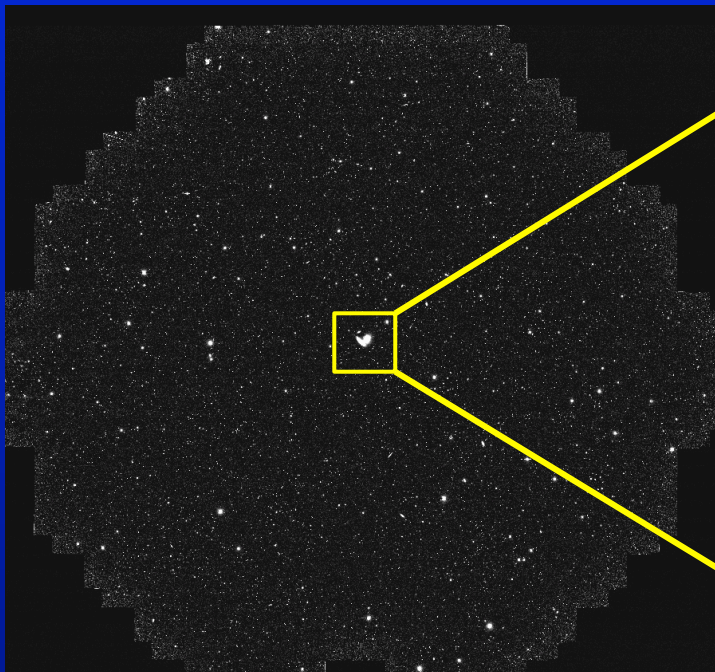


# Scientific Approaches Using the Data Lab

- Exploration

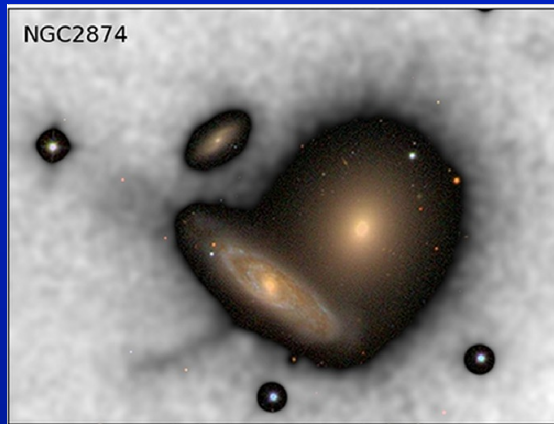
- Example: selection of a sample of large galaxies from a catalog, retrieving image cutouts, overlaying with catalog measurements
- Data Lab will provide a fast image cutout service, visualization capability, cross-match service

NGC 2874  
*Sweet et al.*  
DECam  
program

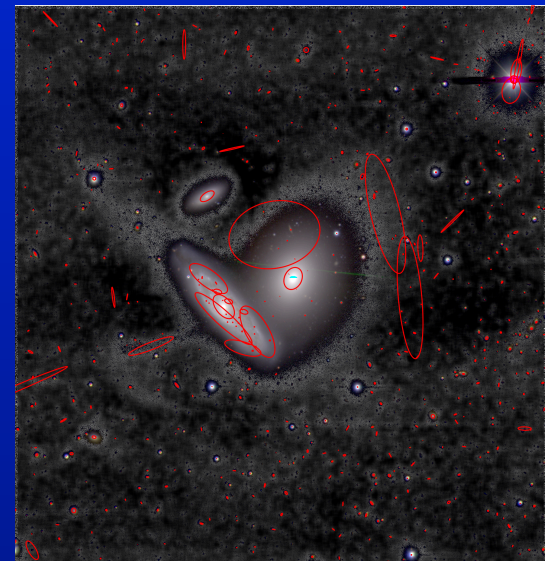


# Scientific Approaches Using the Data Lab

- Custom workflows
  - Example: Use a large sample of galaxies to determine frequency of minor mergers, obtaining image cutouts and performing custom pixel analysis (e.g. PSF subtraction, image filtering, automated feature detection)
  - Data Lab will provide ability to string previous services into a workflow, interface to legacy software, compute service



*Miskolczi et al. (2011)*



*NGC 2874 Sweet et al.  
DECam program*

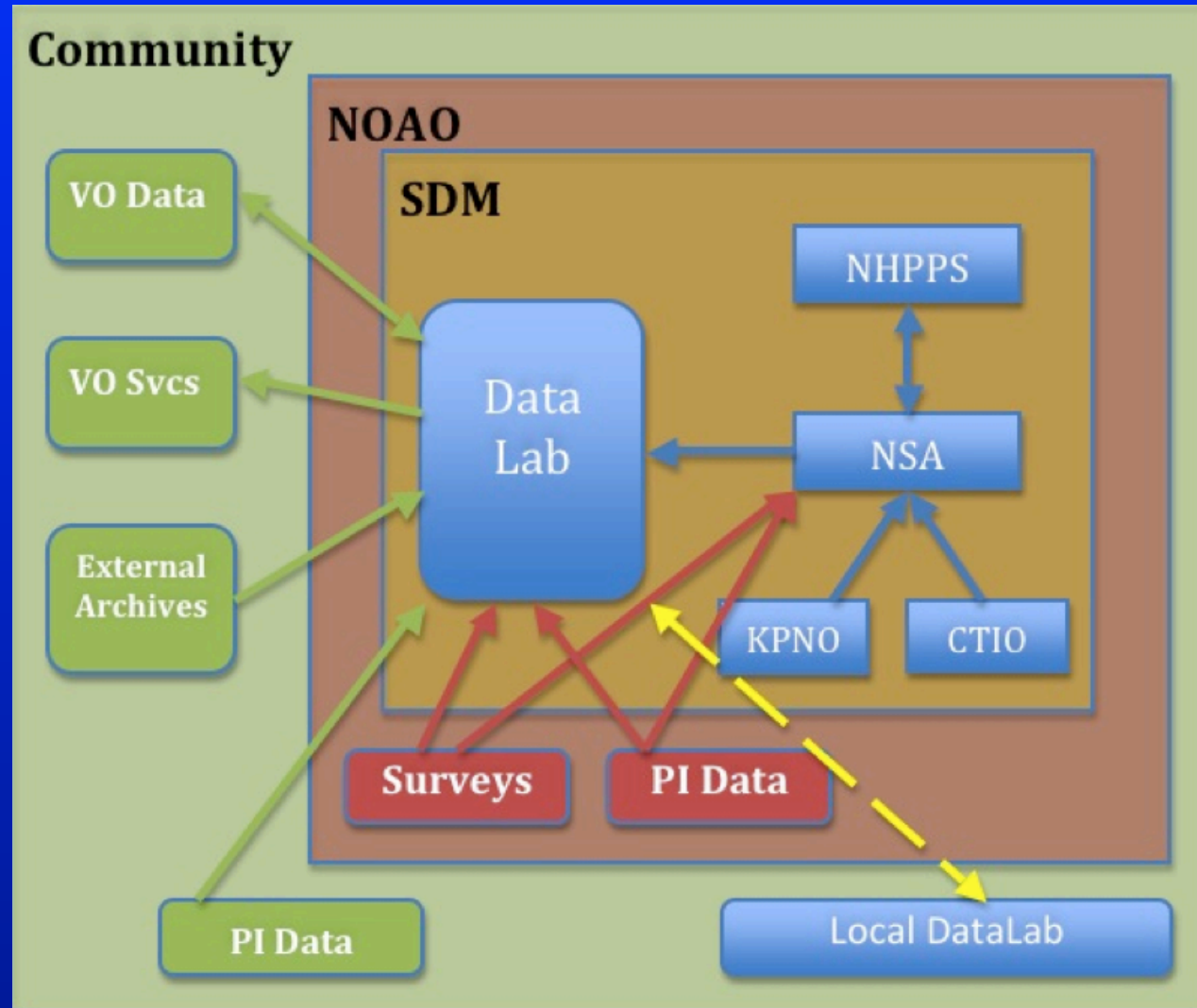




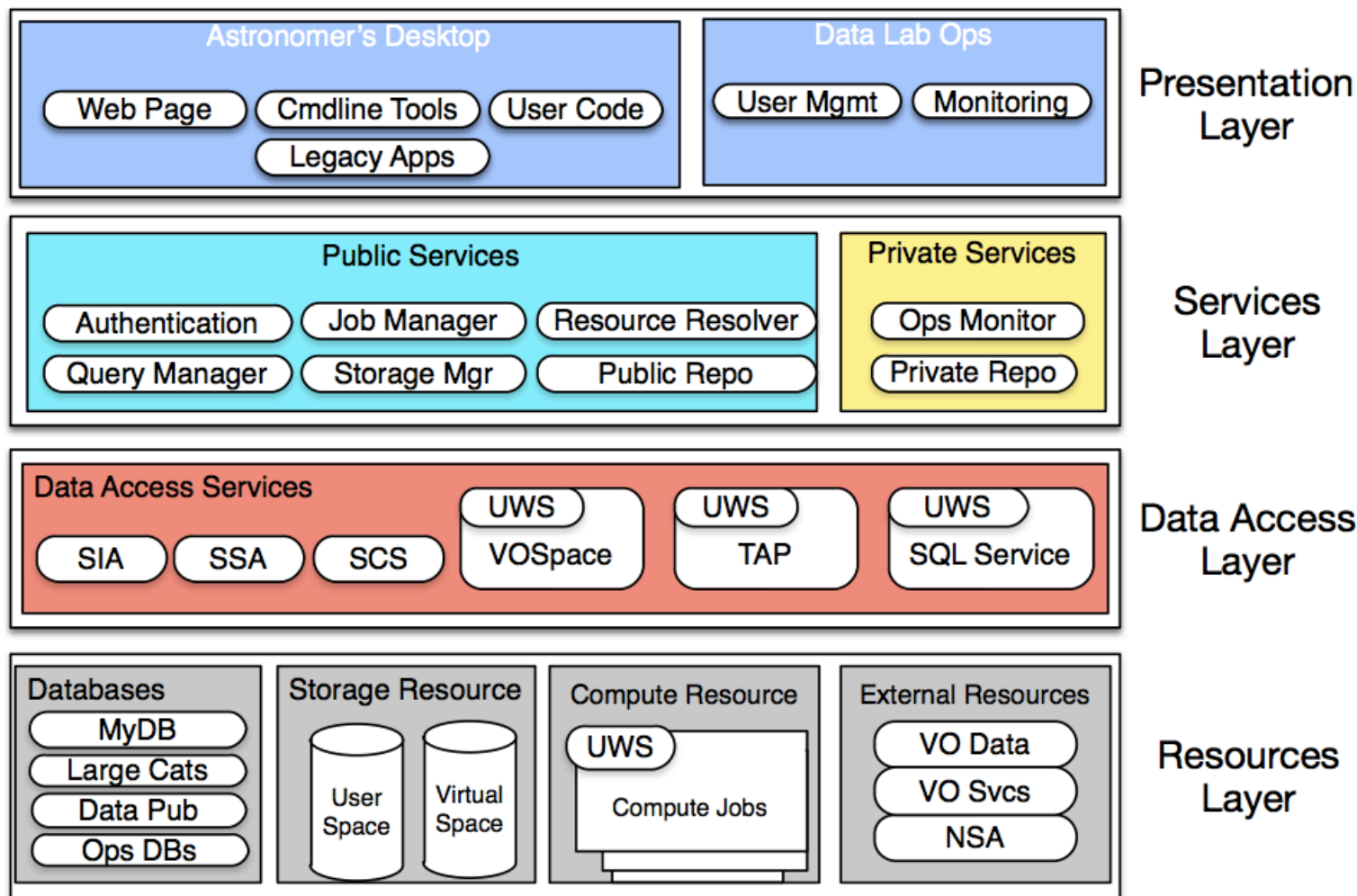
# Scientific Approaches Using the Data Lab

- Collaborative research
  - Example: SMASH collaboration has 30 investigators working on many aspects of search for Magellanic Cloud populations all over the sky. Data products include reduced images and photometry from three different approaches; tasks include star/galaxy separation, foreground modeling, population detection, population analysis, and simulations, divided over different people
  - Data Lab will provide access to a shared storage space, shareable containers for software tasks, and a customizable virtual machine

# Data Lab Context



# Data Lab Architecture



# Data Lab System Architecture

Example Flow  
of Use Case  
through  
System  
Architecture

