

Dark Energy Survey

Public Data Release Plan

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1. [Introduction](#)
2. [Release of Single Epoch Images](#)
 - 2.1. [Single-Epoch \(SE\) Raw Images](#)
 - 2.2. [Single Epoch Processed Images](#)
3. [Transient Alerts for Bright Sources](#)
4. [Data Release 1 \(DR1\)](#)
 - 4.1. [Data Products](#)
 - 4.1.1. [Coadd Images](#)
 - 4.1.2. [Coadd Catalogs](#)
 - 4.1.3. [Metadata/configuration files and masking](#)
 - 4.2. [Data Access Interfaces](#)
 - 4.2.1. [File Serving](#)
 - 4.2.2. [Database for Catalogs](#)
 - 4.2.3. [Database Access Tools](#)
 - 4.2.4. [Exposure Based Web Exploration](#)
 - 4.2.5. [Coadd Image Exploration](#)
 - 4.2.6. [Cutout server for SE/COADD API](#)
 - 4.2.7. [Landing Page for DR1](#)
 - 4.3. [Documentation](#)
 - 4.3.1. [General documentation](#)
 - 4.3.2. [DR1 Paper](#)
 - 4.4. [Software and Pipelines](#)
 - 4.5. [Support](#)
5. [Data Release 2 \(DR2\)](#)
6. [Summary of products and responsibilities](#)
7. [Long-Term Data Curation](#)
8. [Value-Added Catalogs](#)
9. [Attributions](#)
10. [Appendix](#)
 - 10.1. [Data Release language in the DES MOU](#)
 - 10.2. [Data Release language in the NSF AST Proposal for DESDM Operations](#)
 - 10.3. [Coadd Catalogs content \(example\)](#)

1. Introduction

Over five observing seasons that started in August 2013 (each season runs from August to February), the Dark Energy Survey (DES) Collaboration is surveying approximately 5000 sq. deg. of the southern sky in *grizY* and is carrying out a time-domain survey in *griz* over 30 sq. deg. Raw DECam images and associated metadata collected during DES observing are transferred via the National Optical Astronomy Observatory (NOAO) Data Transport System (DTS) both to the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign and to the NOAO Data Management Operations (DMO) at Tucson. NCSA operates the DES Data Management (DESDM) pipelines, which process the raw images and produce science-ready data products for the collaboration and the astronomy community.

This document lays out the plan for the public release of Dark Energy Survey (DES) data, drawing from earlier understandings and agreements (excerpted in the Appendix). In addition to the release of single-epoch images described in Sec. 2 and the transient alerts outlined in Sec. 3, there will be two major public releases of coadd data products: Data Release 1 (DR1), described in Sec. 4, will comprise data from the first three years (Y1-Y3) of the survey, while Data Release 2 (DR2), outlined in Sec. 5, will comprise the entire survey. Sec. 6 summarizes the DES data products, Sec. 7 outlines the plan for long-term data curation, Sec. 8 briefly discusses value-added catalogs, Sec. 9 describes the attribution for public DES data products, and the Appendices include data release language from previous DES documents as well as an example list of co-add catalog parameters.

This document primarily concerns DR1; it is anticipated that DR2 will be similar in scope but may include new features in addition to data obtained after Y3. We currently plan to release DR1 on December 15th, 2017, which should provide enough time to allow vetting of the associated data products by the Collaboration to assure their quality. Based on tests carried out to date, we have uncovered no issues in Y3A1 (which was internally released to the Collaboration on Dec. 10, 2016, and upon which DR1 will be based) that would require us to reprocess. Therefore, we expect to release vetted, high-quality data as DR1 on the above date. The planned release timeframe for DR2 is August 2020.

NCSA will be the principal institution responsible for the DR1 release and will work in close partnership with the NOAO DMO and Data Lab initiative (<http://datalab.noao.edu/>) as well as the the DES-Brazil consortium and Laboratório Interinstitucional de e-Astronomia (LIneA, <http://www.linea.gov.br/>). These partnerships are vital to the success of this data release plan. NOAO and LIneA are our data release partners, as referred to in this document.

The DES Data is the fundamental product and legacy of the most ambitious instrument and survey ever realized on an NOAO telescope. NOAO is committed to maximize the community-science value of this data and currently is deploying scalable and sustainable

infrastructure to serve this data alongside other major NOAO archival data holdings and to provide long-term stewardship of the DES public data releases.

As of this writing (mid-Dec. 2016), the following DES data products have already been made public: (i) all raw images from DES Science Verification and from Aug. 31, 2013 to mid-Dec. 2015 (Y1, Y2, and the first part of Y3); (ii) processed, calibrated single-epoch images from Y1; (iii) a variety of value-added catalogs (objects, weak lensing shear, photometric redshifts, red galaxies, clusters of galaxies) derived from co-added images from DES Science Verification; (iv) bright transient alerts from the 3rd and 4th seasons.

Several principles have guided the development of this plan:

1. No data products will be publicly released without first being vetted for scientific integrity by the DES Collaboration.
2. The coadd images released in DR1 will be based upon those contained in the internal (Y3A1) release to the DES Collaboration.
3. The coadd catalogs in DR1 will be based upon those in the internal (Y3A1) release to the Collaboration; they will include a vetted subset of the measured parameters in the Y3A1 catalogs.
4. No new internal DES tools will be developed specifically for DR1; rather, an effort will be made to adapt existing DES Collaboration tools and those from our data release partners to be used by the community.
5. Documentation and other support will take the form of published papers and web-based instructions for interfaces.

2. Release of Single Epoch Images

2.1. Single-Epoch (SE) Raw Images

The DES Collaboration has agreed to a 12-month proprietary period for raw DES images. NOAO manages access to DES raw data, making them automatically available to the general community on a rolling basis via the NOAO Science Data Archive (SDA) (<http://archive.noao.edu/>) 12 months after they are taken.

All raw DECam calibration data (flats, biases, etc.) taken by DES have no proprietary period and are immediately available to the community via the SDA, per NOAO policy. Moreover, any ancillary calibration files supplied by DES to NOAO are made immediately available to the general community via the SDA under the NOAO DMO.

All raw DECam data taken during DECam commissioning (Sept.-Oct. 2012) and during Science Verification (which included both DES and community observations and occurred during November 2012 to February 2013) have no proprietary period and were immediately available to the general community through NOAO SDA.

2.2. Single Epoch Processed Images

We interpret “processed data” to mean the data products (images and calibrations) produced by the DESDM Finalcut pipeline and global calibration module run on DES single-epoch images. This pipeline performs removal of instrumental artifacts, flat and bias calibration, masking, detrending, crosstalk correction, etc. The global calibration module performs a relative photometric calibration over the DES footprint. The transfer of these processed images to NOAO will include all calibrated Finalcut images that satisfy the DES criteria for inclusion in the annual internal release for the DES Collaboration, including both the wide-area survey and exposures in the supernova fields. The documentation for these products will be included in the DR1 documentation described below.

We plan to publicly release the processed, single-epoch images through NOAO via the SDA on May 15, 2017 for Y2 single-epoch images and on December 15, 2017 for Y3 single-epoch images. To prepare for the public release, these data products will be made available by NCSA to NOAO for internal (not public) use no later than 4 months prior to these respective dates.

Based on the experience of producing the Finalcut images for Y3, we plan to publicly release Y4 processed images no later than August 2018 and Y5 processed images no later than August 2019. As before, these data products will be made available to NOAO for internal (not public) use no later than 4 months prior to these respective dates.

For purposes of DR1, NCSA will also provide access to these images as well as the process information between the coadds and the Single Epoch images as detailed below.

3. Transient Alerts for Bright Sources

The Supernova Working Group publicly announces bright transients detected in the supernova pipeline via periodic astronomer’s telegrams (ATELs) for spectroscopically confirmed supernovae and in real time via a web-based tool for bright ($r < 21$) transients. The website <https://portal.nersc.gov/des-sn/> provides an updated list of these bright candidates, their positions, and properties, which will be provided only through the duration of survey operations.

In addition, a system called DESAlert¹ responds to gamma-ray bursts (GRBs) by generating a VOEvent if the source is contained within the area of sky that DES has observed. The DESAlert VOEvents, as well as the DESAlert online database (<https://www.aao.gov.au/DESAlert>), provide important information in near real-time to the

¹ Accepted for publication in the Publications of the Astronomical Society of Australia (see also arXiv:1504.02996)

transient astronomy community, such as magnitudes, colors, and redshifts of the nearest galaxies (i.e., those that may be the GRB hosts) and stars (particularly useful for calibration of follow-up observations). The DESAlert mechanism may be broadened to routinely generate VOEvents for other transients detected in the survey footprint, including fast radio bursts, galactic stellar flares, or disappearing red supergiant stars.

4. Data Release 1 (DR1)

4.1. Data Products

This section describes the data products in DR1, including coadd images, object catalogs, and other files. How these data will be served, stored, delivered, and maintained is described in the following sections. The DR1 data products will be based upon the Y3A1 outputs produced by the DES Data Management and Calibration pipelines and released to the DES collaboration on Dec. 10, 2016. NOAO will serve DR1 and DR2 data through the NOAO Data Lab and Science Data Archive concurrently with NCSA. To prepare for the public releases, NCSA will make the DR1 and DR2 data available to NOAO for internal (not public) use no later than 4 months prior to the respective public release dates.

4.1.1. Coadd Images

The depth and photometric calibration precision of DES data will increase from season to season as more images are accumulated and coadded together. For the DR1 release, the coadd images in each filter will be produced from the Finalcut, calibrated, single-epoch, wide-field survey exposures taken from years 1 through 3 (Y1-Y2-Y3 data).

4.1.2. Coadd Catalogs

Object catalogs derived from the DR1 co-add images will be included in DR1. The coadd catalogs will include detection, astrometric, and photometric parameters for all objects (point-source and extended) in each of the *grizY* bands in the wide-field survey.

Appendix 9.3 lists parameters from the COADD_OBJECT_SUMMARY table. This is the summary object table for the DES internal Y3A1 release, and we anticipate that these parameters will be the basis for the public DR1 release. As mentioned earlier, we do not plan to release parameters that have not been used by DES for science and for which we have no basis for assessing quality.

The DR1 catalogs will be provided to our data release partners, NOAO Data Lab and the Science Portal managed by LIneA, and will also be served from NCSA. File and path information linking the coadd catalogs and the

processed single-epoch images will also be available, providing a list of the images that were used in the coadd processing for a given sky coordinate.

4.1.3. Metadata/configuration files and masking

During the reduction, calibration, coaddition, and ingestion processes that generate the aforementioned data products, a series of metadata information and configuration files are produced. These ancillary data contain the values of the parameters used for the generation of each product in DR1. These files will document what went into the processing as a starting point for reproducing these results or for applying these results in a different scientific context. This information will be available in text files served at NCSA and as needed by our data release partners. In addition, DR1 will include basic footprint and masking region information to facilitate science analysis.

4.2. Data Access Interfaces

This section describes the interfaces and the data archive that will be operational to access and deliver the data presented in section 4.1. Most of these tools are currently being developed and tested, and the details described below regarding their implementation are illustrative. However, the core concepts will serve as guidelines to understand the mechanics of DR1. An overriding principle is to work synergistically with our data release partners to re-use available infrastructure, minimize cost, and maximize scientific value. The summary of science data products and partner responsibilities is enumerated in Section 6. The cost, schedule, and technical details for these developments are governed by the scope of work defined in the existing DESDM grant from the NSF and by mutual agreements with the data release partners, NOAO and LineA, and are subject to their available resources.

4.2.1. File Serving

The core of each data product mentioned in Secs. 2 and 4.1 are the flat files. All the image products will be served in flat files, and there will also be files for the catalogs (as backup) and metadata/configuration. We describe each type briefly below. These file types have a number of things in common: they are available through the web; each has a clear data model; and each will be validated with checksums. In some cases there will be more than one place serving the data, and backups will exist. Long-term curation is described in Section 7.

- Single-Epoch Raw Images: These files will be available through a file browser on the NOAO Science Data Archive (SDA).
- Single-Epoch Processed Images: These files will be also available through SDA, with copies at NCSA.
- Coadd Images: These images will be available through a file browser at NCSA, in partnership with NOAO, and through the Science Portal.

- **Catalogs:** Catalog files will contain all data in the catalogs generated and distributed in the database (see section 4.2.2). These files will be served from NCSA and available in NOAO Data Lab.
- **Ancillary Files:** Ancillary files, such as metadata and configuration files, will be served from NCSA and made available to our data partners as needed.

4.2.2. Database for Catalogs

A Relational SQL Database (DB) cluster at NCSA will host the catalogs in DR1. This DB will store the Coadd Catalogs as well as ancillary tables that provide a path to images and cross-information regarding all data products. This database will allow us to serve the catalogs and related services to our data release partners and the community. NOAO will also provide Server-side virtual storage and MyDB capabilities with synchronous and asynchronous catalog query services for discovery and exploration of image and catalog datasets.

4.2.3. Database Access Tools

In collaboration with our data release partners, we will provide data-discovery tools as well as efficient ways to access data that build on the specific strengths of existing infrastructure. Examples are included below:

- *Easyaccess*²: enhanced SQL command-line tools especially designed to access astronomical surveys. It is one of the main tools used by DES collaborators, and it is expected to evolve to provide general access to the DR1 DB.
- *NOAO Data Lab*: efficient discovery and exploration of astronomical data catalogs and large data sets.
- *Web UI*: As in many other surveys, and in collaboration with our data release partners, we expect to provide a simple online tool, similar to what CasJobs has been for the Sloan Digital Sky Survey (SDSS). With this tool, users will be able to connect to and have full access to the DB from a web browser.
- *Science Portal*: provides an online interface to the DR1 DB interconnected with the Coadd image exploration tool as well as the Cutout services described below.

4.2.4. Exposure Based Web Exploration

NOAO Data Lab will also provide web interfaces for discovery and exploration using the Single Exposures from not only DES but other surveys as well. These interfaces will be complementary to the catalog access provided by them and will allow to interact directly with the exposures map.

² <https://github.com/mgckind/easyaccess>

4.2.5. Coadd Image Exploration

LineA has developed image exploration tools for the DES collaboration and has made them available through the DES Science Portal. These tools have evolved from user experience and implementation of user requests for the internal DES Year 1 data release. LineA will provide a subset of these functionalities for DR1 and will have the opportunity to test these tools in advance with the internal DES Y3A1 release.

Figure 1 shows the Release Validation Viewer, one of the tools at the DES Science Portal for image exploration. It is based on the VisiOmatic viewer and uses the PTIF data format created during image processing at NCSA. It provides full control of the image display. Postage stamps for all the *grizY* bands for the selected tile are also available.



Figure 1. Release validation tool at the DES Science Portal.

Figure 2 shows the Sky Viewer, another tool available at the DES Science Portal showing the magnitude limit map in i-band for the DES Year 1 wide-field data.

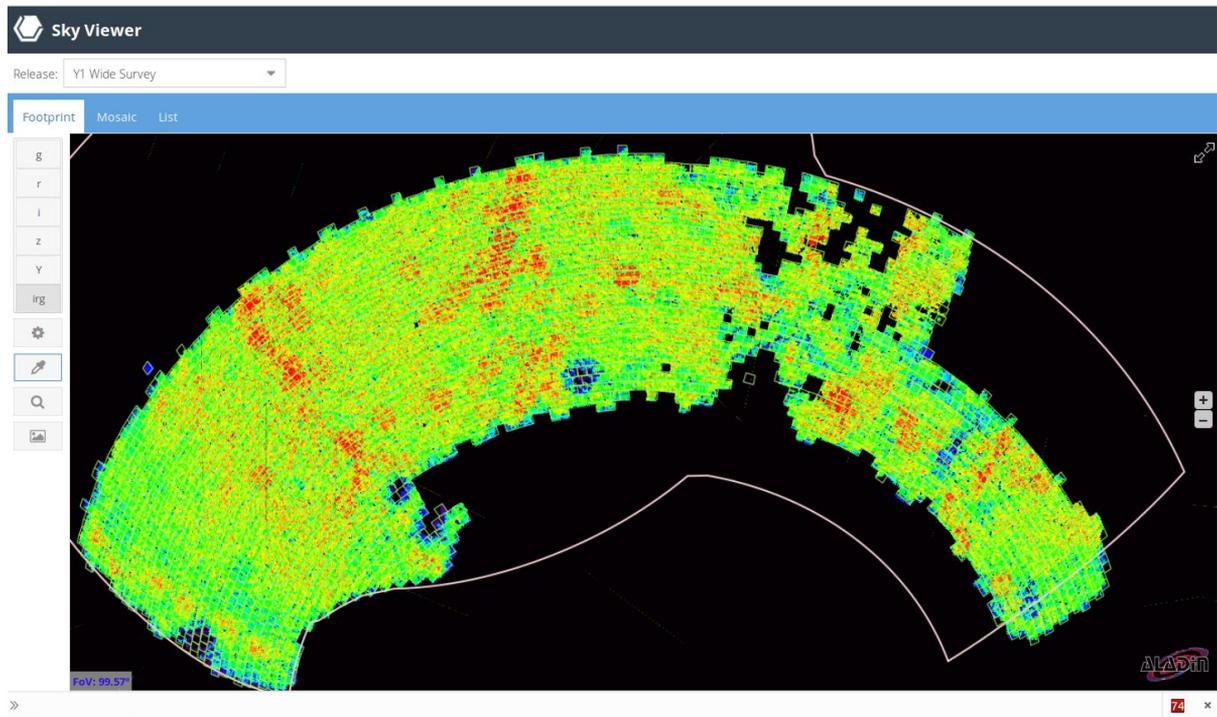


Figure 2. Sky Viewer tool available at the DES Science Portal.

For DR1, the image exploration will be focused on the co-added products with enhanced user capabilities.

4.2.6. Cutout server for SE/COADD API

One important tool for any photometric survey is the capability to generate cutouts around objects or regions of interest. Both false-color and band-by-band image cutouts are valuable. With help from NOAO, we will provide such tools and interfaces, which will allow users to create cutouts for both the coadd images and Single Exposure images. For DR1, we will make these tools publicly available with a web-based interface and REST API interface to allow creation of these cutouts from scripting tools.

The figures below show example screenshots from such tools. Cutout generation is controlled through a job manager and through queues which can be monitored and have different priority levels. Both services will be provided under the same website along with detailed documentation. This tool will also serve as a back-end server for other web applications that need to generate cutouts as part of their services.

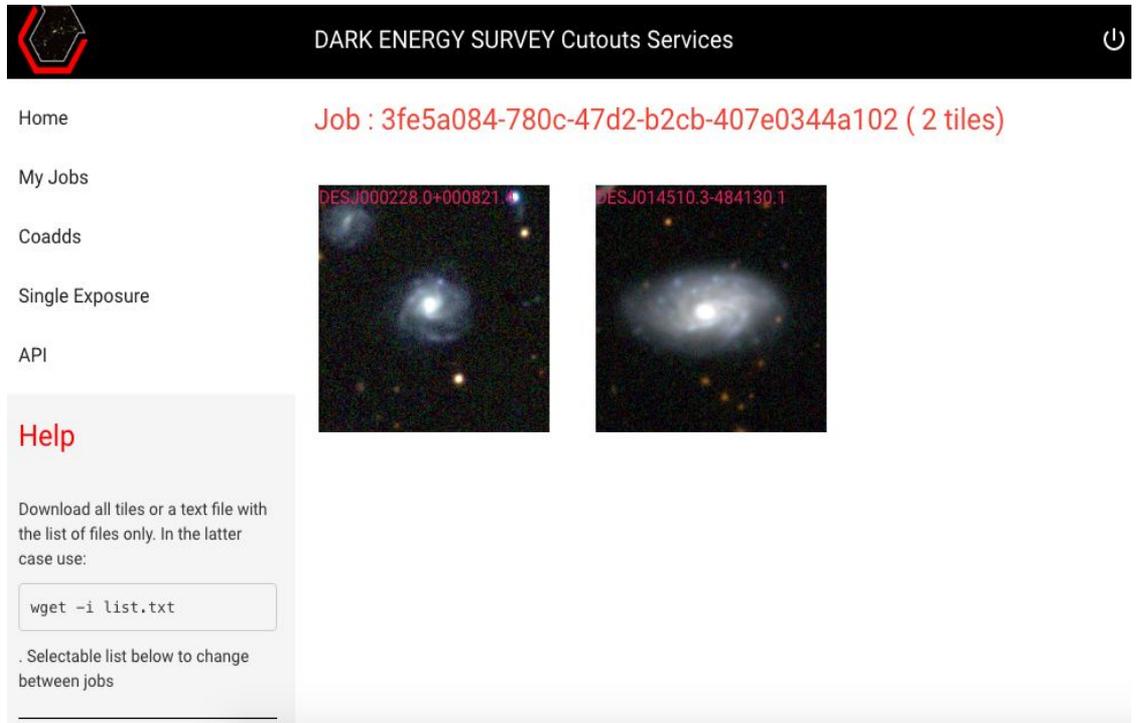


Figure 3. Example of coadd image cutout service

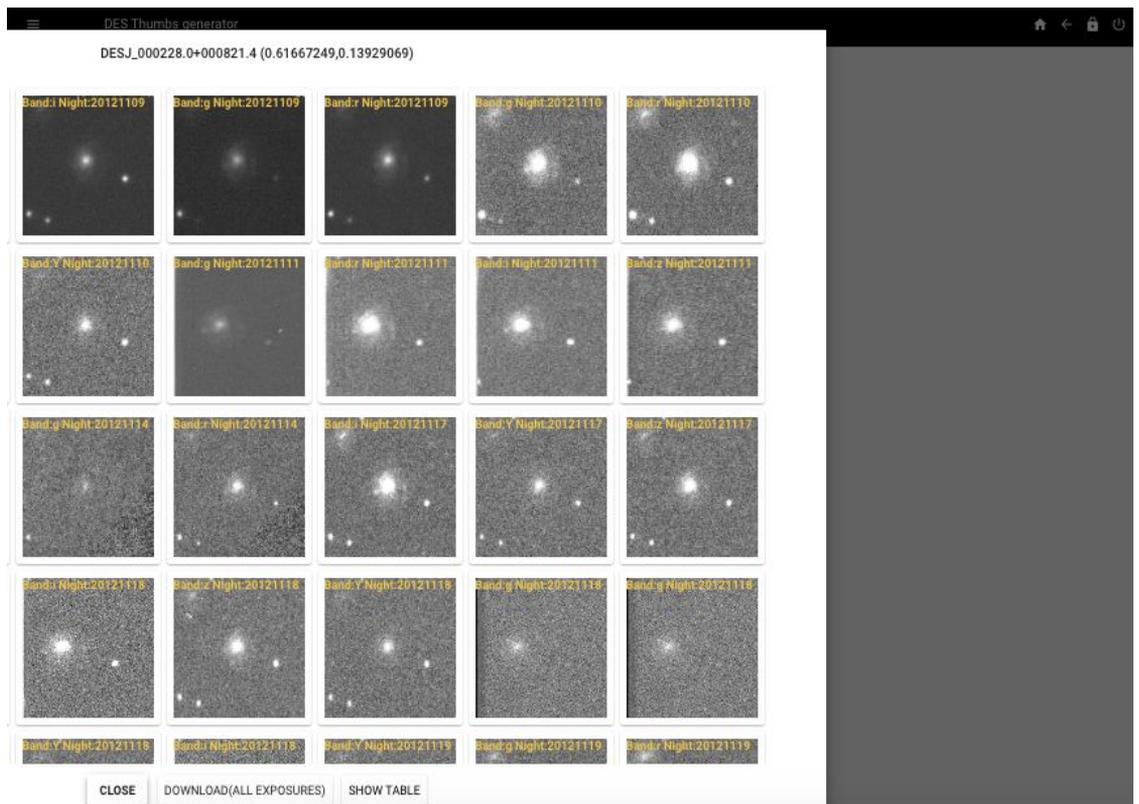


Figure 4. Example of Single-Epoch cutout server and exploration

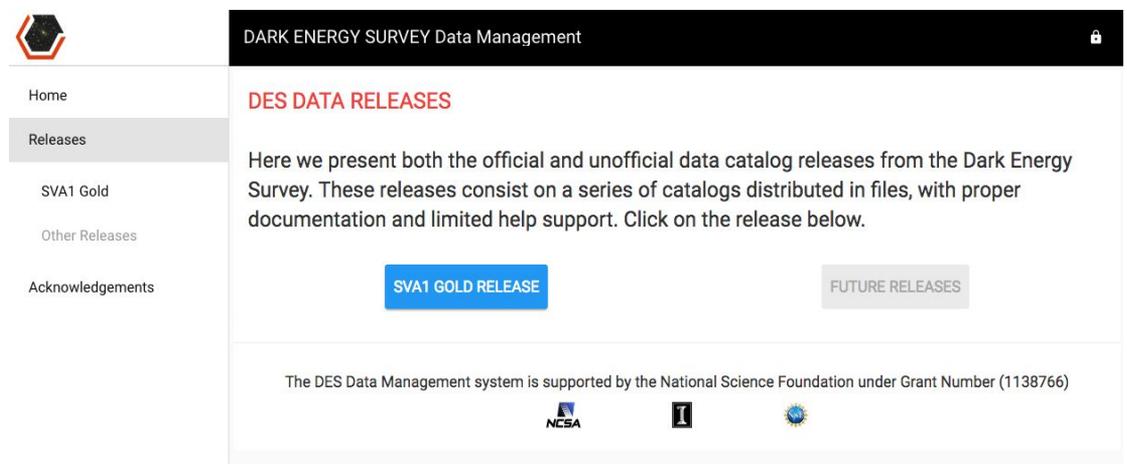
4.2.7. Landing Page for DR1

There will be a centralized place for DR1 linked off the DES main public page: <http://www.darkenergysurvey.org/>

We have also used another website to host the Science Verification Release, which can also serve this purpose: <https://des.ncsa.illinois.edu/releases>

Both of these pages will contain the information needed to explore and understand the release in terms of the data, the content, and the interfaces. The figure below shows the page hosting the first SV release.

We will provide links to data release partners sites, e.g., NOAO Data Lab.



4.3. Documentation

Documentation is an important part of each release as it contains all the relevant information to understand the content of the release, how to use the interfaces, and what went into the generation of the files and catalogs. This section describes what documentation will be part of the release in terms of support, and description of the products, software, and interfaces. Our release partners will also provide full documentation regarding their own infrastructure for the Data releases.

4.3.1. General documentation

This documentation will include detailed descriptions of all data products within the DR1 release, including description of the files generated, the data models, and all tables and columns in the generated catalogs.

The documentation will also include basic information regarding the procedures followed for calibration, coaddition, vetting and validation. This documentation will be available online through a website: see for example the SV release <https://des.ncsa.illinois.edu/releases>.

All the interfaces to the data described in Sec. 4.2 will be documented through tutorials and demonstrations to ease access to the content of the release.

4.3.2. DR1 Paper

There will be a companion paper to the DR1 release which we will describe in more detail the reduction process and each of the pipelines used during Y3A1 operation as well as some of the vetting and validation process and a deeper description of these products.

4.4. Software and Pipelines

All the software used in the DES Data Management System (including those for interfacing with the data) are already open sourced through a SVN server. We will provide links and information on how to access the source codes for the software used. In order to get more visibility, we will also mirror some of the main code on Github under the DES repository: <https://github.com/DarkEnergySurvey>

The source code for the pipelines and the metadata and configuration data described above will serve as a starting point for those wishing to reproduce some of the content of the release. Despite making the source code available, there is no plan to support or describe the details of running the software on raw data.

4.5. Support

There will be different means of communication to provide support regarding the data products, operational pipelines, as well as data interfaces. Options to be considered include: a general mailing list, a website with Frequently Asked Questions, Online Tutorials, etc. Detailed documentation and tutorials will reduce the need for staff-intensive support. Both NOAO and LIneA will provide general support for their infrastructures.

As an example on how we are planning to provide support, we have already implemented a Help Form for the SV release in which a user can ask a question by filling in a form which is then re-directed to a pool of experts suitable for that question, with the responses posted publicly as a knowledge database.

Individual interfaces will have some form of support either through a general interface or through their hosting institutions.

5. Data Release 2 (DR2)

The final DES public data release, DR2, will include DESDM-processed, co-add images and catalogs and associated data products for data taken during all DES observing seasons and the DES Science Verification period that satisfy the criteria for inclusion in the internal DESDM releases to the collaboration. Exposures included in DR1 will be reprocessed for DR2.

The end of DES observing is currently scheduled for February 2018. Assuming no problems with the pipeline processing, we expect to have an internal release of coadd images and catalogs available to the DES Collaboration within 18 months of this date. Experience suggests that it will take at least 12 months to validate the catalogs. Assuming the validation does not reveal serious problems with the processing, our intent is to release DR2 not later than August 2020.

DR2 will be served and maintained by NCSA in a similar manner to that described for DR1 for a period of at least 2 years after the public release. The data will be documented to the standards of a peer-reviewed data release paper.

The content, tools and interfaces described for DR1 will likely be extended for DR2; however, changes in the specifications for both releases are expected, and the description above serves as a guideline for DR2.

NOAO will also serve DR2 in a similar way to that planned for DR1. Through a collaboration with NCSA, and in advance of DR1 and DR2, an instance of the Data Lab will be available for developing and testing at NCSA infrastructure. This will allow a pre-release to the DES collaboration for testing and will allow developments for scale-up of the Data Lab workflows on high-performance computing resources at NCSA.

6. Summary of products and responsibilities

Product	Primary institutions	Other institutions	Comments
Data			
SE Raw Images	NOAO		Not officially DR1
SE Calibrated Images	NOAO	NCSA	Not officially DR1
Coadd Images	NCSA	LIneA, NOAO	~ 20-30 TB in total
Coadd Catalogs	NCSA	LIneA, NOAO	~ 1-2 TB in total
Metadata/config files	NCSA		< 1 GB
Alert of bright sources	NERSC	Fermilab	Updated website
Interfaces			
File Serving	NCSA/NOAO	LIneA	Web File Browser
DB for Catalogs	NCSA/NOAO	LIneA	Web accessible
DB access tools	NCSA/NOAO	LineA	Command line and web interfaces
Exposure based exploration	NOAO		Web based
Coadd image exploration	LIneA	NOAO	Web based
Cutout servers for SE/Coadd	NCSA/NOAO		Web based
Landing DR1 page	NCSA	Fermilab	
Documentation			
General Documentation	DES	NOAO/LIneA	Descriptions and tutorials
DR1 paper	DES		Peer reviewed
Software			
Source code	NCSA	Github	Open source
Support			
General support	DES	Release partners	Web based

7. Long-Term Data Curation

According to the DES MOU (see Appendix 9.1), “after the completion of the Survey, DESDM will deliver the final processed DES data to the NOAO Science Archive to ensure long-term preservation and curation of the DES data and data products.”

We interpret this to mean that the NOAO Science Archive, or currently NOAO DMO, will maintain indefinite public access to DES DR1 and DR2, following data transfer from NCSA as noted above. NCSA will ensure that the files are delivered to NOAO with adequate documentation.

8. Value-Added Catalogs

High-level data products produced by the Collaboration and used, e.g., for cosmological measurements will be made available to NOAO for long-term archiving at the time that the DES science working groups release those data products publicly. These value-added data products are produced in the course of DES science analyses, and the timing and content of their release will be determined by those analyses. It is expected that such products will be similar in scope to the value-added catalogs publicly released by the Collaboration for DES Science Verification in early 2016.

9. Attributions

Publications that use publicly released DES data must include an acknowledgement to the Dark Energy Survey and include any language required by funding agencies or other sponsors.

The language for such acknowledgement for single-epoch DES images made available through the SDA is available on the following NOAO site:

http://www.noao.edu/noao/library/NOAO_Publications_Acknowledgments.html

under Dark Energy Survey (DES) public archival data section.

The language for acknowledgement of DR1 and DR2 will be available on the sites where those data products are made available.

In addition, the following sentence must be included in attributions: "This material is based upon work supported by the National Science Foundation under Grant No. NSF AST 11-38766."

10. Appendix

10.1. Data Release language in the DES MOU

Section 9.3 of the [DES MOU](#) contains the following statement:

DES data products, including catalogs and co-added images, will be made available to the community through the VO-enabled DES Archive at NCSA. After the completion of the Survey, DESDM will deliver the final processed DES data to the NOAO Science Archive to ensure long-term preservation and curation of the DES data and data products. Raw DES data and associated metadata will be delivered automatically to the NOAO Science Archive through the NOAO DTS. NOAO will manage access to DES data during the proprietary period. The Collaboration and NOAO plan to make the raw data and the processed data accessible to the general community 12 months after the data have been obtained once DES operations become routine. At that time, the DESDM team will deliver the calibrated single images produced from the DES data to the NSA in order to facilitate community access and broad scientific use of the DES data.

10.2. Data Release language in the NSF AST Proposal for DESDM Operations

The proposal contains the following statements:

The plan for public access to the data includes effort at both NOAO and NCSA. NOAO will provide access to the raw images in the NOAO Science Archive (NSA) one year after the DES data were obtained. DESDM will enable access by NOAO to the processed and calibrated single-epoch images one year after the data were obtained, so that both the raw and the detrended image files will be accessible from the same source. DESDM will also create a coadd of all images after the first two observing seasons and enable public access to these images and derived catalogs directly from NCSA (via the VAO-enabled DES Archive); the target goal to accomplish this is before September 2015. Final coadded image files and the associated object catalogs will be made public after they are created and validated (target goal before September 2018). At the end of the DES project, NOAO will make a copy of all of the data being served by NCSA to the public and serve those data also in the NSA. The NSA will provide long-term curation for the DES data products.

(Note that the dates in the above paragraph assumed that DES survey operations would start Sept. 2012, so that the 2nd season would be completed in Feb. 2014 and the fifth season in Feb. 2017. The DES operations schedule has since slipped by a year. In addition, we have added another year prior to each public data release to

ensure that we will release only properly validated data products. Also note that “end of the DES project” does not mean the end of the DES observing period but rather the end of agency support for continued operations of DES, including data-serving operations.)

10.3. Coadd Catalogs content (example)

The list below provides a set of tables and columns that are being considered for the DR1 Catalogs. The detailed set of parameters may change.

Per Coadd Object

<u>Columns</u>	<u>Description</u>
COADD_OBJECT_ID	Unique Object identifier
OBJECT_NUMBER	Unique Object identifier within tile
PARENT_ID	For blended sources
PFW_ATTEMPT_ID	Identifier to recover the file path
ALPHA_J2000, DELTA_J2000	Positions from detection image, full precision
ALPHAERR_J2000, DELTAERR_J2000	Error in positions from detection image
RA, DEC	Positions, indexed
L, B	Galactic coordinates
TILENAME	Identifier for the tile
EBV	Reddening
HPIX	Healpix index
KRON_RADIUS	Luminosity weighted radius
AWIN_WORLD, BWIN_WORLD, THETAWIN_J2000	Shape parameters
ERRAWIN_WORLD, ERBWIN_WORLD, ERRTHETAWIN_J2000	Error in shape parameters
XWIN_IMAGE, YWIN_IMAGE	X, Y Pixel Position on image

Per Coadd Object and Band

<u>Columns</u>	<u>Description</u>
MAG_DETMODEL, MAGERR_DETMODEL	Magnitude measured from a fitted shape to the object in the detection image
<u>MAG_AUTO</u> , <u>MAGERR_AUTO</u>	Magnitude measured in an elliptical aperture and its error
WAVG_MAG_PSF, WAVG_MAGERR_PSF	Weighted average magnitude measured from the flux using the local PSF shape
MAG_APER_8, MAGERR_APER_8	Magnitude measured in a circular aperture of 6 arcseconds and its error
FLUX_DETMODEL,FLUXERR_DE TMODEL	Flux measured from a fitted shape to the object in the detection image
FLUX_AUTO,FLUXERR_AUTO	Flux measured in an elliptical aperture and its error
WAVG_FLUX_PSF,WAVG_FLUXE RR_PSF	Weighted average flux measured from the flux using the local PSF shape
FLUX_APER_8,FLUXERR_APER_ 8	Flux measured in a circular aperture of 6 arcseconds and its error
MU_EFF_MODEL, MU_MAX, MU_MAX_MODEL, MU_MEAN_MODEL, MU_THRESHOLD	Effective model surface brightness above background parameters.
AWIN_WORLD, BWIN_WORLD, THETAWIN_J2000	Shape parameters per band
ERRAWIN_WORLD, ERRBWIN_WORLD, ERRTHETAWIN_J2000	Error in shape parameters per band
SPREAD_MODEL, SPREADERR_MODEL	Morphology based star-galaxy classifier using PSF Model and its error
WAVG_SPREAD_MODEL, WAVG_SPREADERR_MODEL	SPREAD_MODEL using the weighted averaged values of the component single epoch objects and its error
CLASS_STAR	Morphology based star-galaxy classifier

FLUX_RADIUS	Radius of the circle centered around the barycenter of the object containing half of the object's flux
NITER_MODEL	Number of iterations needed to converge on the DETMODEL parameters
NEPOCHS	Number of single epoch detections of the coadd object in each band
FLAGS, IMAFLAG_ISO	Warning Flags
EXTINCTION	Extinction per band