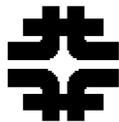


Memorandum of Understanding for the Dark Energy Survey



DARK ENERGY
SURVEY

The Dark Energy Survey Collaboration



Fermilab

Fermi National Accelerator Laboratory



National Center for Supercomputing Applications
at the
University of Illinois at Urbana-Champaign



National Optical Astronomy Observatory
Operated by the Association of Universities for Research in
Astronomy

Amended August 27, 2010

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Memorandum of Understanding for the Dark Energy Survey

I. Parties

- A. The Fermi Research Alliance (FRA), a LLC, operates Fermilab under contract DE-AC02-07CH11359 for the U.S. Department of Energy (DOE).
- B. The Board of Trustees of the University of Illinois, acting on behalf of its Urbana-Champaign campus (UIUC), is a body corporate and politic of the State of Illinois and an institution of higher education that is home to the National Center for Supercomputing Applications (NCSA) research center.
- C. The Association of Universities for Research in Astronomy, Inc. (AURA) is a non-profit corporation located in the United States of America, operates the National Optical Astronomy Observatory (NOAO) for the National Science Foundation (NSF) under NSF Cooperative Agreement, AST-0132798. The Cerro Tololo Inter-American Observatory (CTIO), which is located in Chile, is a division of NOAO.

The institutions herein shall collectively be referred to as the “Parties”.

II. Duration

The Memorandum of Understanding (the “Understanding”) is effective upon being signed by the Parties. The duration of the Understanding will be ten years. The Parties may, by amendment, choose (i) to extend the Understanding at any time during the term or (ii) no later than one year prior to the end of the duration of the Understanding, to shorten the duration of the Understanding.

III. The Understanding

A. Background

1. NOAO issued an Announcement of Opportunity (AO) in December 2003, The AO requested proposals for the development and delivery of a major new instrument for the Blanco 4-meter telescope at the CTIO. The AO offered up to 30% of the telescope time over a period of five years for a major science project.

In response, scientists from Fermilab, the UIUC, the University of Chicago and Lawrence Berkeley National Laboratory formed the Collaboration and submitted a proposal to Fermilab requesting permission to respond to the AO. A copy of the AO is in Appendix A.

2. The Fermilab Physics Advisory Committee reviewed the science and technical feasibility of the Collaboration’s DES proposal. Following this review, the Fermilab Director approved submission of a proposal responding to the AO. The Collaboration submitted “A Proposal for the Dark Energy Survey to NOAO on July 15, 2004

- (https://www.darkenergysurvey.org/the-project/main_documents), hereafter the Proposal. The Fermilab Director noted in a July 16, 2004, letter to the Director of NOAO that that the DES science was compelling and well-suited to Fermilab's scientific mission. The Fermilab Director noted further that Fermilab will serve as host laboratory for the Collaboration and for construction of the camera if the DES proposal is approved. This letter is in Appendix B.
3. UIUC reviewed the science positively and made institutional commitments to support the Proposal. UIUC sees the project as an important step in building its cosmological sciences initiative.
 4. The NOAO Director appointed the Blanco Instrumentation Review Panel (BIRP) to review the Proposal and make recommendations on whether it justified formation of a partnership with NOAO to carry out the scientific program in the Proposal. The NOAO Director wrote in his letter of September 27, 2004 to the Fermilab Director that "The panel declared that the science goals of the DES, steady tightening of the constraints on the dark energy equation of state and its possible evolution, are exciting and timely. The report recommends that NOAO and the Dark Energy Consortium (DEC) move forward with this partnership with the provision that certain conditions are met." He wrote further that "a number of these conditions relate to infrastructure whose provision would be incumbent on NOAO, for which the report recommends the DEC identify a prioritized list. I have asked Alistair Walker, Director of Cerro Tololo Interamerican Observatory, to consult with John Peoples about this. This would inform our drafting of a Memorandum of Understanding (MOU) regarding the conduct of the partnership." This letter is in Appendix C. Subsequently, the NOAO Director asked the CTIO Director and the DES Project Director (hereafter Project Director) to draft an MOU defining the goals and conduct of the partnership.

B. Goals and Deliverables

The Parties are committed to achieving two primary goals in this Understanding: (1) the successful deployment of DECam, a world class astronomical instrument, on the Blanco telescope, for the benefit of the entire astronomical community served by NOAO, and (2) the successful completion of the scientific goals of the Collaboration. These goals are of equal importance to the Parties and the Understanding has been drafted to reflect that principle. The Collaboration requested 525 scheduled nights on the Blanco 4-m telescope with DECam in order to carry out the Survey. In exchange for the telescope time, the Parties, with the contributions from the Collaboration that are described in the Addendum, will deliver the DECam System, which consists of the DECam instrument, the Community Pipeline and their interfaces to the Blanco and the E2E System, to NOAO for use by the NOAO Community and the Collaboration. The Goals and Deliverables, including the management, execution and oversight of the DES Projects are described in further detail in the Addendum.

C. Mutual Understanding Regarding Resources

1. Limitations to the Commitments of the Parties

The Parties recognize that Fermilab's ability to meet its commitments in this Understanding are subject to Department of Energy (DOE) approval of DES and the allocation of DOE funds to build and deploy DECam and to support the science and operations phases of DES. The Parties also recognize that NOAO's ability to meet its commitments in the Understanding depend on NSF allocating sufficient

NSF funding to NOAO for the support of CTIO Facilities Improvement Project (CFIP) and the commissioning, installation and operation of the DECam System. The Parties further recognize that UIUC/NCSA's ability to develop and deploy the DESDM System at NCSA is dependent on NSF's approval of DES and the award of sufficient funding by the NSF to UIUC to support the DES Project activities at NCSA and other participating UIUC departments.

2. Scope Reductions

When the ability of one of the Parties to meet its intended commitments is impaired or is likely to be impaired, that Party will inform the other Parties promptly. In such an event, the Parties will develop a practical plan within three months that would sustain the partnership, preserving the scientific goals of the Collaboration to the maximum extent possible, as defined in the Science Requirements Document, and minimize any additional costs that the Collaboration, AURA/NOAO, FRA/Fermilab, and UIUC/NCSA might incur if the Parties agreed to continue the partnership. If the Parties do not reach agreement they will promptly inform the Project Director in order that he can inform the DOE-NSF Joint Oversight Group (JOG) of the issue.

D. Delegation

FRA hereby delegates its responsibility for the management, execution and oversight of the DES Projects to the Fermilab Associate Director for Research. UIUC hereby delegates the responsibility for the management, execution and oversight of the DES Data Management (DESDM) Project to the Director of NCSA. AURA hereby delegates its responsibility for the management, execution and oversight of the CTIO Facilities Improvement Project and the installation, commissioning, and operation of the DECam System to the Director of NOAO. The management, execution, and oversight of the DES Projects are described in detail in the Addendum. The Parties, through their authorized delegates, shall review and approve the Addendum and appoint a Project Director. The Project Director has no authority to bind or commit the Parties to the terms of the Understanding, the terms in the Addendum, Collaboration Letters of Acknowledgment, or Project MOUs, and shall not make any representations related thereto on behalf of the Parties.

IV. The Application of AURA Policies to the Dark Energy Survey

The Parties agree that they will comply with the relevant AURA Policies as adapted to the DES. The implementation of these policies, including the exceptions granted to accommodate the DES, is described in the Addendum. These policies consist of the following.

A. Export and Import Policies for Equipment shipped to Chile for DES Projects

The Parties represent that in the performance of this Understanding they will fully comply with all governing export and import control laws and regulations.

Control of DECam and related equipment will be transferred to AURA for purposes of importing this equipment into Chile in order to obtain the importation benefits AURA receives from the Ministry of Finance in Chile. Such equipment shall be on loan to AURA for the

duration of the Understanding or until such time as agreed by the Parties. The procedure to develop a plan to ship DECam to CTIO is described in the Addendum.

B. Intellectual Property

The AURA Intellectual Property Policy, <http://www.aura-astronomy.org/a/pp/a8.pdf>, shall govern ownership of the rights, title to and interests in any patentable intellectual property and copyrightable works, including software, developed, conceived of or first reduced to practice solely by employees of AURA under this Understanding. Notwithstanding those policies:

1. AURA shall grant to each Collaborating Institution a royalty-free, nontransferable, nonassignable, irrevocable right and license to reproduce, distribute and display publicly, in print, electronic or digital formats, data or images obtained by the Collaborating Institutions during the DES Observations on the Blanco 4-meter Telescope for the DES observing program.
2. The policies of the Collaborating Institution(s) shall govern ownership of the rights, title to and interests in any patentable intellectual property and copyrightable works, including software, developed, conceived of, or first reduced to practice solely by one or more employees of such Collaborating Institution(s).
3. The Collaborating Institution(s) and AURA shall jointly own rights, title and interests in patentable intellectual property and copyrightable works, including software, that is developed, conceived of or first reduced to practice jointly by employee(s) of such Collaborating Institution(s) and employee(s) of AURA.

C. Data Rights

Rights to scientific images and data, including, but not limited to, images, databases, catalogs, and scientific works (but not scientific papers produced by researchers using NOAO facilities) will be determined in accordance with applicable AURA and NOAO data rights policies as follows:

1. AURA/NOAO Data Rights Policy
<http://www.noao.edu/noaoprop/help/datarights.html>
2. And NOAO/AURA Science Archive Conditions of Use
<http://archive.noao.edu/nsa/condOfUse.html>

Notwithstanding the policies specified above, AURA hereby grants each Collaborating Institution a royalty-free, nontransferable, nonassignable, irrevocable right and license to reproduce, distribute and display publicly, in print, electronic or digital formats, data or images obtained by the Collaboration during the DES Observations on the Blanco 4-meter Telescope for the observing program described in this Understanding.

D. Publications

The Parties will encourage the DES Members to publish scholarly articles and papers, individually or jointly, and to make presentations regarding the scientific and technical results of the Survey. DES Members will follow the NOAO policies on publications as described in the Addendum.

E. Policy Implementation

The Parties will require the Management Committee to inform all Members, Participants and their respective Collaborating Institutions of policies applicable to their participation in the DES Collaboration including, but not limited to, by posting applicable policies on the DES web site.

V. Amendments

Amendments to this Understanding may be made by a written document signed by an authorized representative of each Party. Each Party will transmit such amendments to its authorized delegates for action and the Addendum will be revised if required. In the event of any conflict between the Addendum and the Understanding, the terms of the Understanding will govern.

Addendum: The Management, Execution and Oversight of the DES Projects

1. Goals and Deliverables:

The Parties are committed to achieving the two primary goals in this Understanding; the successful deployment of DECam, a world class astronomical instrument, on the Blanco telescope, for the benefit of the entire astronomical community served by NOAO, and the successful completion of the scientific program of the Survey. These objectives are of equal importance to the Parties and the Understanding and the Addendum have been drafted to reflect that principle.

The Collaboration seeks sufficient telescope time on the Blanco 4m telescope with DECam in order to carry out the Survey. In exchange for the telescope time, NOAO expects the Collaboration to deliver the DECam System, which is defined as the DECam instrument, the Community Pipeline and their interfaces to the Blanco and the E2E System as follows:

1. The DECam instrument itself, a facility-class wide-field optical imager to be installed at the prime focus of the CTIO Blanco 4m telescope and integrated into both the telescope system and the standard operation of CTIO instrumentation, allowing for efficient community use.
2. A data processing pipeline, the Community Pipeline, which will remove the instrumental signatures and provide astrometric and rough photometric calibration for images taken under a broad, but well defined, set of observing modes. This pipeline will be integrated into E2E, the NOAO data management system, and it will comply with appropriate interfaces in that system, and be operational as part of that system.

The scientific program will explore the accelerating expansion of the Universe because this acceleration requires something new and strange--Dark Energy. The Collaboration plans to meet this challenge by measuring the dark energy equation of state parameter, w , through four complementary techniques in a single survey: (i) the redshift distribution and clustering evolution of galaxy clusters, (ii) weak gravitational lensing on large scales, (iii) the evolution of large-scale structure, and (iv) type Ia supernova distances. These four independent measurements of w , when taken together, will provide a measurement with substantially better precision than the precision that the current experiments will achieve when the Survey begins. The multiple, complementary techniques will allow DES to constrain systematic errors far more robustly than can be done with any single technique.

DES proposes to make this determination with an optical-near infrared multiband survey of 5000 sq. deg of the South Galactic Cap to $\sim 24^{\text{th}}$ magnitude in each band using DECam, mounted on the Blanco 4-m telescope. The Survey will also include a small number of fields that will be viewed repeatedly with high cadence within the 5000 sq. deg. area in order to obtain multi-band light curves for type Ia supernovae. The initial description of the scientific program is contained in the

Proposal (https://www.darkenergysurvey.org/the-project/main_documents) and it includes the Collaboration request for 525 scheduled nights. The current statement of the scientific program is contained in the Dark Energy Survey Science Program (DES-doc # 1204 in des-docdb.fnal.gov). The metrics for the successful achievement of the scientific program of the Survey will be the area and depth of the Survey and the quality of the images obtained with DECam. The Collaboration and the NOAO Director agree that these goals can be achieved with 525 scheduled nights with the typical weather conditions that are likely to be encountered at CTIO over a five year period.

The Parties agree that the data acquired with the DECam System through the Blanco Telescope time awarded to the Collaboration through the Addendum will be placed in the DES Science Archive at NCSA for use by the Collaboration and the astronomical community and in the NOAO Science Archive for use by the astronomical community. The Collaboration has chosen a 12 month proprietary period for the release of the raw data to the public, 6 months shorter than the default 18-month NOAO proprietary period. NOAO will give the astronomical community access to the DES data in the NOAO Science Archive after this proprietary period expires. During the intervening period the Collaboration has exclusive rights to these data. When these data are withdrawn from the NOAO Archive by parties other than the Members and Participants of the Collaboration, the AURA/NOAO Data Rights Policy <http://www.noao.edu/noaoprop/help/datarights.html> will apply to those parties. The AURA/NOAO Data Rights Policy will also apply to data acquired with the DECam System through the NOAO proposal procedures. Whenever appropriate, the policies for the use of the DECam System and the data produced with the DECam System and archived in the NOAO Archive will be consistent with these NOAO policies.

2. The Organization and Management of the DES Projects

The DES Projects include the DECam Project; the CTIO Facilities Improvements Project (CFIP); and the DES Data Management (DESDM) Project. The latter includes the DESDM System and the Community Pipeline. These three separate, coupled projects constitute the design, development and building phases of the Survey. In addition the DES Projects include the installation and commissioning of the DECam System at CTIO and the operation of the DECam System during the Survey. They also include the commissioning and operation of the DESDM System at NCSA and the scientific exploitation of the DES data and data products, which were produced with the DESDM System, by the Collaboration. Finally, the DES Projects include the additions to the DECam System that will make it possible for NOAO to successfully operate the DECam System for the community. The purpose and scope of the DES Projects are briefly described in subsequent sections of this addendum and are also described in detail in the DECam Technical Design Report (DES-doc # 1350 in des-docdb.fnal.gov), the DESDM Technical Design Report (DES-doc #1182 in des-docdb.fnal.gov), and the CFIP Technical Design Report (DES-doc #1388 in des-docdb.fnal.gov). The designs described in those reports flow from the technical content of NSF Proposal No: 0715596.

The authority to carry out the DECam Project, the DESDM Project and CFIP has been delegated to the DECam Project Manager, the DESDM Project Leader, and the CTIO Director

by the Directors of Fermilab, NCSA, and NOAO respectively. The NOAO Director has delegated the responsibility of the installation and commissioning to the CTIO Director.

The DECam Project, the DESDM Project, including the Community Pipeline, and the CFIP will proceed in parallel until they are ready to come together for installation and commissioning at CTIO. The CTIO Director will oversee the installation and commissioning of the DECam System. After the DECam System and the DESDM System have been commissioned and accepted, the CTIO Director will authorize the start of the operation phase of the Survey. NOAO will manage the operation of the DECam System as it manages all of its instruments.

2.1 The DES Projects Organization

The Figure shows the management structure that is being used by the Collaboration, Fermilab, UIUC/NCSA and NOAO to carry out the DES projects and by the Council to oversee the DES Projects, including their interfaces with NOAO facilities. Finally, it is being used to organize and coordinate the scientific work of the Collaboration.

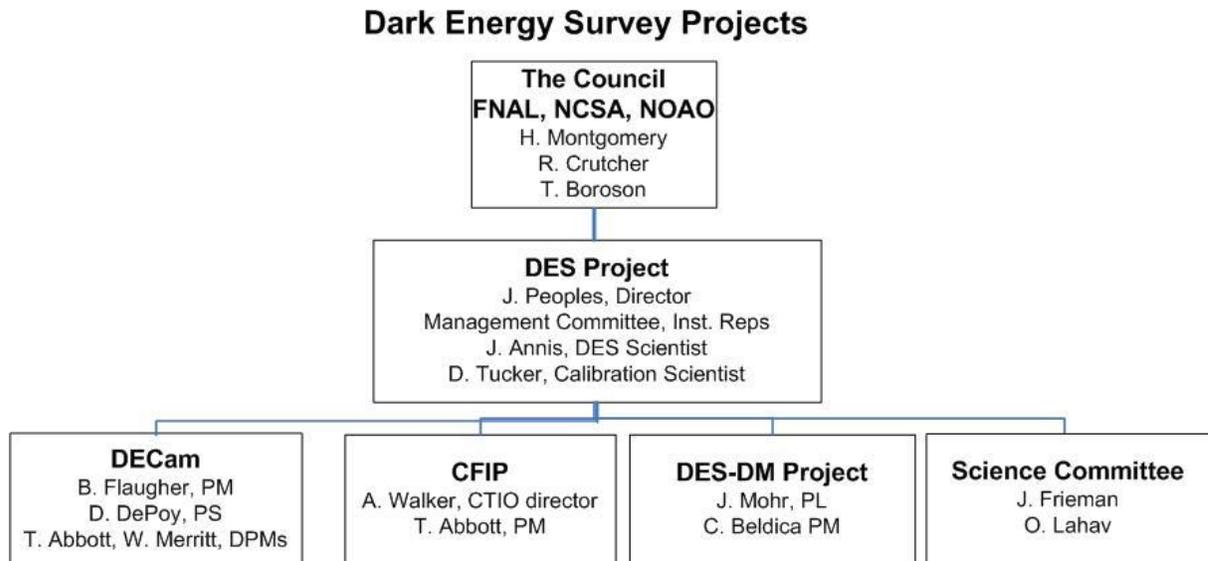


Figure: Organization Diagram of the Dark Energy Survey as May 1, 2008

2.2 The Council and its Oversight of the DES Projects

The Directors of Fermilab, NCSA, and NOAO have agreed to jointly oversee the DES Projects, including the installation, commissioning and operation of the Survey and they have further agreed to form the Council to carry out the oversight. Dr. Hugh Montgomery, Fermilab Associate Director of Research, has been designated by the Fermilab Director to represent him on the Council. The NCSA Director has designated Professor Richard Crutcher to represent him on the Council. The NOAO Director, currently Dr. Todd Boroson as interim Director, completes the Council membership.

The Council will conduct periodic reviews of the DECam Project; the DESDM Project; and the CFIP. The Council will examine the Community Pipeline, including the parts of the E2E

System relevant to the operation of the DECam System, as part of these reviews. These reviews are intended to assure the Directors that the Collaboration can achieve the DES scientific goals with the DECam System, the DESDM System and the CFIP, that the cost estimates for the three Projects are sound and have sufficient contingency to complete the DES Projects, that the unified schedule has a high probability of being met, that the funding plan is realistic and that the DES Projects teams are strong enough to design, build and execute the Survey. The Council will conduct readiness reviews of the DECam System, CFIP, DESDM System and the E2E System at times they deem appropriate. These reviews are also intended to assure the Directors that the DES and NOAO teams have developed and are carrying out a plan that will make the DECam System a successful community instrument.

2.3 The Collaboration

The Collaboration consists of senior scientists from Fermilab; the University of Illinois at Urbana-Champaign; the University of Chicago; the Lawrence Berkeley National Laboratory; the National Optical Astronomy Observatory; the UK-DES Collaboration, a consortium of the University College London, University of Cambridge, University of Edinburgh, University of Portsmouth and the University of Sussex; the Spain-DES Collaboration, a consortium of the Institut d'Estudis Espacials de Catalunya, Institut de Fisica d'Altes Energies, CIEMAT-Madrid; the University of Michigan; the University of Pennsylvania; DES-Brazil, a consortium of Brazilian scientists; Argonne National Laboratory and the Ohio State University.

The Management Committee admitted these senior scientists to the Collaboration as Members and designated the aforementioned institutions and consortia as Collaborating Institutions. The Management Committee treats each consortium as a single institution. In addition to Members there are Participants in the Collaboration and they are typically students and post-doctoral scholars from the Collaborating Institutions who are mentored or sponsored by Members. The responsibilities and privileges of Members, Participants and Collaborating Institutions are defined by the Membership Policy and their admission to the Collaboration is administered by the Management Committee in accordance with this Policy.

2.4 The Management Committee

The Management Committee (MC) represents the interests of the Collaboration in all phases of the Survey. The Members of each Collaborating Institution select their institutional representative to the MC. Each Collaborating Institution is represented by one Member and each consortium may have up to two Members. The DECam Project Manager, the DES Data Management Project Leader, the head of NOAO Data Products Program (DPP) and the CFIP Project Manager are ex-officio members of the MC.

The MC brings the skills and efforts of the Members and Participants into the Projects and assists the Project Managers and Leaders in coordinating the contributions of the Collaboration and the Collaborating Institutions. The contributions of the Members and the Collaborating Institution of those Members to the Projects are described in the application for admission to the Collaboration submitted to the MC by the Members of each Collaborating Institution. These Members are admitted after the application is accepted by the MC.

The MC does not enter into formal contracts with the Collaborating Institutions, including the Parties, in recognition of the fact that it does not have the legal power to enter into contracts.

2.5 Project Director

Overall responsibility for carrying out the DES is vested in the DES Project Director (Project Director). The current Project Director is Dr. John Peoples. He coordinates the activities at the systems interfaces of the DES Projects and the contributions of the Collaboration for the installation, commissioning and operation phases of the Survey; is the principle point of contact between the Collaboration and NOAO; chairs the Community Needs Working Group; serves as the principal point of contact between the MC and the Council; represents the Collaboration in interactions with the Council and the Collaborating Institutions; is advised by the MC on all matters relevant to the Collaboration; and is the Chair of the MC.

The Project Director, with the support of the MC, is responsible for the preparation of proposals for the in-kind contributions that are needed to build, commission and operate the Survey. These proposals will be submitted to the appropriate national funding agency or to a philanthropic institution by one of the Collaborating Institutions or one of the Consortia in accordance with the current practices of the Collaborating Institutions that agree to submit proposals. The Project Director will assist the Leaders/Managers of the DECam and DESDM Projects in the preparation of proposals for submission to the Department of Energy and the NSF by Fermilab and UIUC/NCSA respectively. The Project Director will prepare the *Funding Plan*, which will describe the cash and in-kind resources required to build, commission and operate the Survey and he will submit it to the Council for their review. The status of its implementation will be included in the DES quarterly reports that will be sent to the Council.

The Project Director will develop a unified schedule for the DES Projects from the individual project schedules in order to assure that these schedules are properly coordinated and he will submit it to the Council and the DOE-NSF Joint Organizing Group for their consideration.

The Project Director will maintain current lists of DES Members, Participants and Collaborating Institutions.

The Project Director has no authority to bind or commit the Parties to the terms of the Understanding, the terms in the Addendum, Collaboration Letters of Acknowledgment, or Project MOUs, and shall not make any representations related thereto on behalf of the Parties.

In the event the Project Director position becomes vacant, the MC will recommend a candidate to the Council, which will be responsible for appointing the successor Project Director.

2.6 The DECam Project

The DECam Project is described in the DECam Technical Design Report (DES-doc # 1350 in des-docdb.fnal.gov). Fermilab manages and oversees the DECam Project in accordance with the [DOE] "*Project Execution Plan for the Dark Energy Camera Project for the Dark Energy Experiment at Fermi National Accelerator Laboratory*" and the Fermilab *DECam Project Management Plan*, DES-doc # 1217 in des-docdb.fnal.gov. Dr. Brenna Flaugher was appointed as DECam Project Manager (Project Manager) by the Fermilab Director. The Project Manager provides the direct connections between the DECam Project, Project Director and the MC. She has the responsibility to complete the DECam Project to the specifications contained in the DES Science Requirements and DECam Technical Requirements and Specifications

documents (DES-doc # 806 in des-docdb.fnal.gov), within the cost and schedule agreed upon by the DOE and Fermilab.

The Project Manager is responsible for preparing and maintaining a full schedule and Work Breakdown Structure (WBS) for the DECam Project. It will contain sufficient milestones to allow the Project to be tracked from project initiation to completion. The milestones will include dates for the Directors' reviews of the Conceptual Design, Preliminary Design, Final Design and Project completion. These reviews will evaluate technical, cost and schedule performance of the Project, and will be organized by the Council.

The Project Manager is aided in the execution of all aspects of the Project by the DECam Project scientist, Dr. Darren DePoy; and two deputy Project managers, Dr. Wyatt Merritt of Fermilab, who focuses on activities at Fermilab and the preparation of the DOE documentation, and Dr. Tim Abbott of CTIO, who focuses on installation and integration of DECam with the Blanco and facilities at CTIO.

The Project Manager is responsible for preparing the monthly status report for DOE and these reports will be sent to the Project Director, who will transmit them to the Council as part of the DES Projects quarterly report.

2.7 CTIO Facilities Improvement Project

The CTIO Facilities Improvement Project (CFIP) is described in detail in the CFIP Technical Design Report (DES-doc #1388 in des-docdb.fnal.gov) and NOAO is responsible for upgrading these facilities as described in that report. The work at CTIO will be carried out in accordance with NOAO procedures under the direction and oversight of the CTIO Director. Dr. Tim Abbott, Blanco Scientist, is the current CFIP Project Manager, and he also serves as the DECam Deputy Project Manager.

The CFIP Project Manager is responsible for preparing and maintaining a full schedule and WBS structure for the CFIP, which will contain sufficient milestones to allow the Project to be tracked from Project initiation to completion. The milestones will include dates for the Directors' reviews of the Conceptual Design, Preliminary Design, Final Design and Project completion. These reviews will evaluate technical, cost and schedule performance of the CFIP and they will be organized by the Council. The Project Manager is responsible for preparing quarterly status reports of the project for the Project Director, who will transmit these reports to the Council as part of the DES quarterly report.

2.8 Dark Energy Survey Data Management Project

The DES Data Management Project (DESDM) is described in detail in the DES Data Management Technical Design Report (DES-doc# 1182 in des-docdb.fnal.gov). The Project will deliver the DESDM System to the Collaboration and the Community Pipeline to NOAO. These elements will be developed and commissioned primarily by personnel from NCSA and the Astronomy Department of UIUC, under the leadership of Professor Joseph Mohr as DESDM Project Leader. Dr. Cristina Beldica, who has been appointed as DESDM Project Manager, supports the DESDM Project Leader in the development and implementation of the management strategy for this Project.

The DESDM Project Leader, with the support of the DESDM Project Manager, is responsible for preparing and maintaining a full schedule and WBS structure for the project. It will contain sufficient milestones to allow the project to be tracked from initiation to completion. The milestones will include dates for the Directors' reviews of the Conceptual Design, Preliminary Design, Final Design and project completion. These reviews will cover technical, cost and schedule aspects of the DESDM Project, and they will be organized by the Council. The DESDM Project will include a series of annual Data Challenges that will allow the DESDM Management, the Project Director and the Council to track the degree to which the Project satisfies DESDM technical requirements and the Community Needs. The DESDM Project Manager is responsible for preparing quarterly status reports of the project for the Project Director, who will transmit these reports to the Council as part of the DES Projects quarterly report.

2.9 The Science Committee and its Working Groups

The DES Science Committee is responsible for the organization and direction of the Working Groups (WGs). The MC appointed Dr. Ofer Lahav and Dr. Josh Frieman as the Co-Chairs with the responsibilities of leading and organizing the Science Committee. The Co-Chairs are also responsible for proposing WGs for each critical science topic and nominating the WG co-coordinators to the MC. The WG co-coordinators are responsible for coordinating the activities of the WGs. The Science Committee consists of the Co-Chairs and the WG co-coordinators. The Science Committee, with input from the WGs, contributes to the preparation of the DES Science Requirements. It also coordinates the publication of the DES scientific work in journals and conference proceedings and assists in the preparation of funding proposals for DES.

The Co-Chairs report to the MC. They provide the coordination among the WGs and appoint the WG co-coordinators in consultation with the MC. Participation in all science WGs are open to all DES Members, and all Members of the Collaboration have access to all DES data and all scientific data products produced by the Collaboration.

The WGs are responsible for organizing the work on Clusters, Baryon Acoustic Oscillations, Weak Lensing and Type Ia supernovae, and the work on photometric redshifts and simulations. They will coordinate the development of these techniques to enable DES to explore and constrain the nature of Dark Energy. Additional WGs for science projects critical to the DES will be formed, and still others may be formed, depending on the interests and resources of the Collaboration.

The Co-Chairs are responsible for preparing quarterly status reports of the WG activities for the Project Director, who will transmit these reports to the Council and the Collaborating Institutions as part of the Project Director's quarterly report.

2.10 DES Project Scientist

Dr. James Annis, Fermilab, is the current DES Project Scientist. He is responsible for the preparation and maintenance of the DES Science Requirements Document, and for assuring that the individual technical requirements and specifications document for each of the three Projects and the Science Committee are compatible with the DES Science Requirements. The

Project Scientist folds the requirements that are developed by the Science Committee into the Science Requirements Document.

The DES Project Scientist is also responsible for coordinating tests to ensure that the three Projects and any software developed for the key science projects, which is intended to be used widely by the Collaboration, is constructed, commissioned and operated to meet the DES Science Requirements. The tests are intended to assure that the data quality will continue to meet the DES science goals after scientific commissioning is completed. He is also responsible for preparing the *Preliminary DES Observing Plan* and the *DES Observing Plan* and submitting these plans to the Project Director for consideration and approval by the MC.

2.11 Science Requirements

The initial DES Science Requirements were developed for the Proposal (https://www.darkenergysurvey.org/the-project/main_documents DES doc # 20 in des-docdb.fnal.gov) and since then the Science Requirements have been refined in response to Directors' Reviews of July 2006 and December 2007 and Joint DOE-NSF Reviews of May 2007 and January 2008. The revised requirements are contained in the DES Science Requirements. The Science Requirements will be placed under change control at the time DOE takes CD-2 for DES. The DES Science Requirements Document and the Change Control Process ensure that the scope of the project is controlled at the highest scientific level in the project.

2.12 Community Needs

The most stringent scientific requirements flow from the DES Science Requirements, because the Survey must strive to control and understand the detailed systematics of the data obtained with DECam in order to achieve its goals. There are also scientific requirements that are derived from the community use of the DECam and some will be truly distinct requirements. The community needs are captured in the document entitled "Community Needs for the Dark Energy Camera and Data Management System", henceforth the Community Needs (<http://www.noao.edu/dir/usercom/2006/DECam-Community-Use-v2.pdf> DES doc # 1354 in des-docdb.fnal.gov)).

NOAO defined the initial set of requirements that will make the DECam System useful to the broad astronomical community and they are contained in the Community Needs Document. At the request of NOAO Director this document was reviewed by the NOAO Users' Committee in October, 2007 and subsequently revised. Following the adoption of the Community Needs Document subsequent requests for changes to the Community Needs will be sent to the Project Director by the NOAO Director and the Project Director will convene the three Project Managers and the Head of NOAO DPP to determine if the request can be satisfied by one of the DES Projects or NOAO DPP. When that is possible the appropriate project team or NOAO DPP will develop a plan to implement the request. If NOAO and one of the DES Projects have to combine their efforts to analyze the request and develop an implementation plan, the request will be brought to the Community Needs Working Group and it will review the request and recommend how to implement it. The Project Director will bring the recommendation for implementation to the appropriate Project Managers for action. In the event that the Project Managers agree that the request can be implemented with the cost and schedule baselines of the DES Projects, the Technical Requirements and Specifications of the appropriate Project

will be revised. In the event the resources are not matched to the requirements, the Project Director will request the support of the Council to attempt to resolve the problem. The Community Needs Document will be updated periodically to reflect the final resolution of the proposed changes.

2.13 Project Technical Requirements and Specifications

The Technical Requirements and Specifications Documents of the DECam Project, the DESDM Project, and the CFIP flow from the DES Science Requirements, the Community Needs and the practical requirements imposed by the telescope and the operating environments at NOAO and NCSA. The practical requirements are derived from the documents that define the features of the telescope environment, the data management environment and Environment, Safety and Health (ES&H) requirements of the CTIO site. They in turn define the software and hardware interfaces within the DECam System and the DESDM system, and their interfaces with the telescope, the utilities and environmental control systems at the telescope, and the E2E System and the NCSA operating environments.

Each Project Manager is responsible for assuring that their Project meets the requirements contained in their Technical Requirements and Specifications documents and each of these documents is under change control in accordance with their Project Management Plan.

2.14 Community Needs Working Group

The Community Needs Working Group was established to review the requests contained in the Community Needs Document that require DES and NOAO to jointly allocate resources to implement the request. The Group will analyze each request and develop a plan for its implementation, which will be brought by the Project Director as a recommendation to the Project Managers of the three Projects and the head of NOAO DPP for action.

The leaders of the DES Projects and NOAO DPP anticipate that there may be requests for changes to the software for SISPI, the Telescope Controls System and the Community Pipeline in order to accommodate modes of operating DECam that have yet to be defined. The Community Needs Working Group has been charged to analyze such requests for changes.

As its first task, the Group will review the set of technical requirements for the Community Pipeline that are derived from the Community Needs and it will coordinate the implementation to ensure that the requirements will be met. The DESDM and NOAO DPP teams will each develop an implementation plan for their respective responsibilities for the Community Pipeline that can be accomplished within the resources available to each team. The plans will allow the Community Pipeline to be fully integrated into the E2E system before the DES Projects are ready for installation at CTIO. The plans will be submitted to the Project Director for approval. The Community Needs Working Group will track the implementation of the plan, and the Project Director will report its progress to the Council. In the event that the resources of one or both groups do not adequately support the plans, the Project Director will bring the issue to the Council for resolution.

2.15 Project Baselines and Change Control

Each Project shall have a set of baselines that will define the technical performance, cost estimate and schedule of each Project. Changes to those baselines will be subject to the formal change control process for each Project.

It is anticipated that the findings and recommendations from reviews chartered by the Council may lead to requests for changes to the technical requirements and specifications of one or more of the Projects. The Project Director and the Project Managers will develop plans to implement these requests. The findings and recommendations from reviews chartered by the DOE and NSF may also lead to requests for changes to the technical requirements and specifications that the Project Director and the Project Managers will be expected to implement.

Changes to the DECam Project, the CFIP and the DESDM Project that will affect the DES Science Requirements or the technical requirements and specifications, the total project cost or critical schedule milestones of one or more of the projects will be proposed by the appropriate Project Manager, evaluated with their respective change control process. It is expected that the Project Director would inform the Council as well as ensuring that the oversight bodies for the appropriate Projects are notified.

2.16 Management and Execution Plan Implementing Documents

Guided by and subject to the express terms in the Addendum to the DES Memorandum of Understanding, the management and execution of the DES Projects will be implemented in part by Collaboration Letters of Acknowledgment and Project MOUs.

Collaboration Letters of Acknowledgment document acceptance of and agreement to the terms of the DES Memorandum of Understanding, including the Addendum, by a Collaborating Institution and its Members and Participants. Said acceptance and agreement will be established through a letter from the Institutional Representative of the Collaborating Institution to the Project Director. The Project Director shall be responsible for disclosing to the authorized representatives of the proposed Collaborating Institution all terms and conditions contained in the Memorandum of Understanding, including the Addendum, together with any proposed amendments thereto.

Project MOUs plan the work of the DES projects and assign responsibility for execution of that work to a Collaborating Institution and a Party. The Fermi Research Alliance Delegate will sign Project MOUs with Collaborating Institutions for the DECam Project. The NOAO Director will sign Project MOUs with Collaborating Institutions for the CTIO Facilities Improvement Project and installation, commissioning and operation activities. The UIUC Delegate will coordinate the execution of Project MOUs with Collaborating Institutions for the DESDM Project.

3. Funding for the DES Projects

The DOE Office of High Energy Physics (OHEP) and Fermilab have developed a plan to execute the DECam Project that is described in the [DOE] "*Project Execution Plan for the*

Dark Energy Camera Project for the Dark Energy Experiment at Fermi National Accelerator Laboratory". Prior to approving this Plan DOE took a number of critical decisions on DES that are part of its process for executing a project. DOE established a mission need for a ground-based dark energy mission in November 2005 by taking Critical Decision-0. In October of 2007, DOE approved the Conceptual Design and the Acquisition Strategy for the Dark Energy Survey. The latter selected Fermilab to lead the fabrication of DECam and established the ranges for the cost and schedule. These actions were part of making Critical Decision-1. DOE approved the technical specifications, management plan, and the cost and schedule baselines for the DECam Project in April 2008 as part of taking Critical Decision-2. The approval of the expenditure of DOE funds for long lead procurements is being reviewed by DOE, and DOE intends to give full approval to the DECam Project in the first quarter of FY2009, should Congress appropriate the funds requested for FY2009. These actions are part of Critical Decision-3. Congress appropriated funds for DES in FY2008 and the DOE part of the FY2009 budget request is before Congress (April 2008). The funding proposed in the Project Execution Plan beyond FY2008 is dependent on Congress appropriating funds for the DECam Project.

The DECam project also includes in-kind contributions to several DECam subsystems, which are being funded through a grant to the University College London from the UK Science and Technology Facilities Council and a grant to the Spanish Collaborating Institutions from the Spanish Ministry of Education and Science. In addition, cash contributions from several of the Collaborating Institutions have been used to partially fund the in-kind contributions. The level and pace of the in-kind contributions are meeting the expectations of the Collaboration.

UIUC/NCSA submitted a proposal to the NSF for the development of the DESDM system at NCSA in January 2007. The proposal was funded by NSF for the period August 1, 2007 to September 30, 2008. UIUC/NCSA submitted a second proposal to the NSF for the period August 1, 2008 to January 31, 2012 in December 2007 and action on that proposal is pending. UIUC/NCSA will submit a third proposal to the NSF in early 2009 that will request the remainder of the funds required to complete the development and commissioning of the DESDM System and to initiate DES operations at NCSA. The DESDM project has also received significant support from the UIUC to support the initial phase of development, which began in 2004.

The Parties have developed a preliminary plan, which is contained in this Addendum, to execute the CFIP and install, commission and operate the DECam System. The funding required to execute the plan is expected to fit within the envelope of the planned budget for NOAO, which is provided by the NSF through its Cooperative Agreement with AURA to operate NOAO.

3.1 Scope Reductions

When the ability of one of the Parties to meet their intended commitments in this Addendum is impaired or is likely to be impaired, that Party will inform the other Parties promptly. When that is the case, the Parties agree to develop a practical plan within three months that will sustain the partnership, preserve the scientific goals of the Collaboration to the maximum extent possible, as defined in the DES Science Requirements, and minimize any additional costs that the Collaboration, NOAO, Fermilab, and UIUC/NCSA might incur if the Parties

agreed to continue the partnership. After consultation with the Council the Project Director will promptly inform the JOG of the issue in the event that agreement is not reached.

3.2 Resource Committee

In order to provide all of the parties contributing to the DES Projects an opportunity to monitor the progress of the Projects and to express their commitment to the Projects the Council will convene a Resource Committee to discuss the status of the Projects, the resources needed to carry out the Projects, the resources available to the Projects and the expectations for the near and far future. This committee would meet as needed and the venue for meetings would be expected to rotate. The Council members will chair the Resource Committee rotating as necessary.

3.3 Proposals for the exploitation of DES Data

DES Members are expected to prepare and submit individual investigator proposals for the scientific exploitation of the Survey Data to their national funding agencies or philanthropic institutions in accordance with the practices of their Collaborating Institutions. Prior to submitting a proposal that proposes to use DES data and/or the research products and analysis tools, which were developed by the Collaboration, the proposal PI will provide an abstract of the proposal to the Project Director. The abstract will be posted on the Project Website so that all DES Members and Participants may be aware of proposals submitted by Members.

4. The DECam Project

DECam is designed to cover a sky area of about three square degrees per pointing and will consist of a ~ 500 Mpixel CCD focal plane, including focus, alignment and guide star sensors, CCD readout electronics, a shutter, a filter mechanism containing five DES filters and three other filter positions, a wide field optical corrector and a new prime focus cage. DECam will be supported in the cage such that both focus and lateral alignment is possible between exposures. All systems which are essential for the operation of DECam such as the focal plane cooling system, the data acquisition system, diagnostic instrumentation and software to determine the state of the instrument and instrument control are part of DECam. The DECam Project is described in detail in the *DECam Technical Design Report*.

The DECam performance requirements are presented in *Dark Energy Camera Specifications and Technical Requirements* (DES-doc # 806 in des-docdb.fnal.gov). The requirements that DECam must meet to be a successful community instrument are contained in this document. The requirements for community use include: The DECam filter mechanism will allow easy daytime replacement of filter cartridges and the mount of the f/8 mirror will enable the change from observations at the prime focus to the Cassegrain focus to be done efficiently and safely during the daytime.

4.1 DECam Plans

DECam will be delivered with the *DECam Installation and Commissioning Plan* and the *DECam Operation and Maintenance Plan*. The CFIP Project Manager and the DECam Project Manager are jointly responsible for the preparation of these Plans.

The *DECam Installation and Commissioning Plan* will define the interfaces between the Blanco Telescope and DECcam, including utilities and services provided by NOAO and all off-telescope systems provided by the Collaboration as part of the DECcam Project. This Plan will define the assignment of responsibilities for the design and implementation of these interfaces. It will define and document the procedures for the initial installation of DECcam on the Blanco and the connection of DECcam to the Observatory utilities. It will also describe the responsibilities of the institutions that will carry out the installation and system testing at CTIO.

The *DECcam Operation and Maintenance Plan* will define and document the procedures for servicing DECcam. The Plan will include a description of the operations support from the DECcam team for the DECcam instrument, and it will include a description of the support of the off-prime-focus-cage equipment and services provided by CTIO. The Plan will include an operations manual that will describe its design, use, and maintenance. It will define the DECcam special spare parts and the maintenance support of the DECcam hardware and software that will be provided as part of the DECcam Project. The DECcam Project will provide the special spare parts that are required to ensure continuous operation of the DECcam instrument throughout the estimated ten-year lifetime. Fermilab and CTIO will be the custodians for the specialized spare parts.

4.2 The Shipment of DECcam to CTIO

Fermilab will ship DECcam to CTIO as part of the DECcam Project in accordance with the *DECcam Shipping Plan*, which will be prepared jointly by Fermilab and NOAO and approved by AURA. For the purpose of this section DECcam is defined to be all of the subsystems, special spare parts that will be needed for installation, commissioning and initial operation of the DECcam System on the Blanco and related calibration equipment for DECcam. The Parties agree that other than DECcam there is no currently recognized need to ship additional equipment to CTIO to complete the DES Deliverables. Should a need arise to ship additional equipment to CTIO in order to complete the DES deliverables the responsibility for handling the additional equipment will be described in an amendment to this Addendum.

The DECcam Shipping Plan will contain the following elements:

Import/Export Regulations Compliance: Fermilab and NOAO will represent that in the performance of the Shipping Plan they will fully comply with all U.S. export control laws and regulations

Importation of Property and/or Equipment by AURA: Fermilab and NOAO intend that DECcam will be imported into Chile by AURA. The Fermilab and NOAO agree to comply with any and all applicable Chilean import laws and regulations for the importation of DECcam into Chile. They will cooperate in lawfully importing DECcam.

Management of the importation of DECcam to CTIO: Fermilab and NOAO agree that DECcam will only be used on the Blanco for the purposes described in this Addendum and its importation and subsequent use will be subject to the following terms and conditions:

1. The Fermilab and NOAO will initiate all requests for AURA to export DECcam to Chile under this Addendum by contacting the AURA Export Control Administrator, as described in the DECcam Shipping Plan. The AURA Export Control Administrator will execute the necessary shipping documents for exporting the property to Chile. Such

shipping documents are required to obtain export licenses from the United States Government. Control of all such property and/or equipment shall be transferred to AURA for purposes of importing such property and/or equipment into Chile in order to obtain the importation benefits AURA receives from the Ministry of Finance in Chile. Such property and/or equipment shall be on loan to AURA for the purposes of the Addendum or until such time as agreed by the Parties.

2. Fermilab and the Collaborating Institutions are responsible for the costs of transportation, insurance and importation of DECcam to Chile and they will be defined in the DECcam Shipping Plan.
3. AURA assumes no responsibility for loss or damage to equipment shipped to Chile or maintained in Chile under this provision.

4.3 Integration of the DECcam Subsystems at CTIO

After the DECcam components have been delivered to CTIO they will be assembled and tested by the DECcam team in the Blanco Instrument Maintenance Facility, which is part of the CFIP, and on the dome floor of the Blanco. The DECcam Project will be complete when a series of verification tests are successfully passed. These tests, which will be described in the *DECcam Integration Plan*, will be executed before the installation of DECcam on the Blanco is begun. The DECcam Project Manager is responsible for preparing this plan.

4.4 DECcam Software and Software Licenses

The Survey Image System Process Integration (the data acquisition and instrument control system) will include the software required to operate DECcam, to interface it to the Blanco telescope controls system, the NOAO Data Transport System and other external systems at CTIO, and to efficiently enable the execution of the scientific programs that will be carried out with DECcam, including the Dark Energy Survey.

NOAO will acquire software licenses that will be needed to operate the DECcam System and fund their cost from the NOAO operations budget. The DECcam Project team and NOAO will make every effort to use software that NOAO is either currently using or plans to use to the extent that the performance of the DECcam System is not compromised.

4.5 Duration of Community Use of the DECcam Instrument

The Parties agree that DECcam will remain at CTIO as a community instrument for use on the Blanco for five years beyond the completion of the Survey unless the Parties make other arrangements before the completion of the Survey. During the five year period following the completion of the Survey there is no commitment on the part of the Collaborating Institutions, including Fermilab and UIUC/NCSA, to support the operations and maintenance of the DECcam System. The support of the DECcam System and its ultimate disposal will be the responsibility of NOAO upon the completion of the scientific goals and objectives described in this Addendum, including any amendments that the Parties make.

5. The CTIO Facilities Improvement Project

The CFIP will directly benefit the DES and DECcam as an NOAO facility instrument by improving telescope reliability and performance. A full description of the CFIP is presented in

the CFIP Technical Design Report and its essential features are summarized here. The technical specifications of the CFIP were developed by CTIO staff, in consultation with the DECam Project team and flow from the DES Science Requirements and the DECam Technical Requirements and Specifications.

Two major upgrades to the Blanco will be carried out prior to the arrival of DECam. These are the modification and/or replacement of the primary mirror radial supports and the replacement of the Blanco Telescope Control System (TCS). They will improve reliability and preserve the optical performance of the telescope, and are expected to lower the cost of maintenance. They will sustain efficient operation of the Blanco telescope for all of its observing programs.

In addition to the Blanco upgrades there are two significant infrastructure additions required for installation and operation of DECam at CTIO. These are the Blanco Instrument Maintenance Facility, a clean room that will be built in the Coudé room at the Blanco, and the installation of utilities and cryogenic Systems. The former is being designed to meet DECam requirements although it will be used to service all Blanco instruments. In addition CTIO will re-evaluate the present Telescope Environmental Control System and develop options for improving the thermal environment of the telescope as part of the CFIP Project.

6. DES Data Management Project

The DES Data Management (DESDM) Project consists of the DES Data Management (DESDM) System and the Community Pipeline. A full description of the Project is contained in the DESDM Technical Design Report (DES-doc # 1182 in des-docdb.fnal.gov).

6.1 The DES Data Management System (DESDMS)

The DESDM Project will design, develop, commission and operate the DESDM System, the data management system that will be used to process the DES data into science ready data products for the Collaboration. The DESDM System consists of (1) processing pipelines with built in quality assurance testing, (2) a distributed archive to support automated data processing and calibration within a high performance computing environment, (3) a catalog archive database to support science analyses, (4) web portals for control, monitoring, archive data access and scientific analyses, and (5) the hardware required to operate the system at UIUC/NCSA. The DESDM system is designed to enable automated dissemination of raw and reduced data products throughout the Collaboration.

The requirements for the DESDM system are detailed in the DESDM Technical Requirements and Specifications Document; these requirements flow from the DES Science Requirements and are informed by the need to control operating costs by deploying a highly automated, grid enabled system with built in quality assurance.

The DESDM Project will release all elements of the DESDM system to the public and provide a DECam Reduction portal at NCSA. The DESDM system will be available within a central software archive at NCSA, and updates to the software will be made as appropriate over the lifetime of the Survey.

One element of DES Commissioning and Operation lies at the intersection of DESDM, DECam and the NOAO Data Products Program responsibilities. This is the network transfer of DES data from DECam to the DES Archive at NCSA using the NOAO Data Transport System (DTS), which NOAO uses for retrieving and archiving data from its observatories. The DESDM Project Leader and the NOAO Data Products Program head will prepare a plan for integrating the NOAO DTS with the DESDM system at NCSA. This plan will be included in the *DESDM Commissioning and Integration Plan*.

The DESDM Project will prepare the plans for DES data management in the later phases of the Project. These plans will be described in two documents: (1) the *DESDM Commissioning and Integration Plan* and (2) the *DESDM Operation and Maintenance Plan*. Both Plans will contain a detailed description of quality assurance of the processing of the DES data.

6.2 The Community Pipeline

The DESDM Project will design, develop, test and deliver the Community Pipeline to NOAO DPP for installation in the E2E system. It will remove instrumental signatures from DECam data and provide astrometric and rough photometric calibration taken under a broad, but well defined, set of observing modes. The key elements of the Community Pipeline will include basic image reduction and astrometric calibration to produce science ready images to serve as input to higher level processing and analysis by either NOAO in its E2E system or the science analysis programs developed by the Principal Investigator (PI). This will provide the users of the DECam System, which consists of the DECam instrument, the Community Pipeline, and their interfaces to the Blanco and the E2E system, with level of functionality that is specified in *DECam Community Pipeline Technical Requirements and Specifications* (DES-doc # 1283 in des-docdb.fnal.gov). This document will guide the design and development of the Community Pipeline and the interfaces between this pipeline and the E2E system and this document is derived from the Community Needs document.

7. Installation and Commissioning

The installation of the DECam instrument on the Blanco telescope and its subsequent commissioning will bring the DECam system, the DESDM System, the CFIP, and the E2E System together with the Blanco for the first time and thus allow the entire DES system to be tested in its operational configuration. The Telescope Controls Upgrade and the Radial Supports upgrade will be completed before the start of the integration of the DECam instrument on the dome floor. The installation and commissioning period will extend from the completion of the three construction projects through the authorization of the start of observations with the DECam System. The CTIO Director will be in charge of these two phases, with responsibility for safe execution of all tasks, as detailed in *The DECam System Installation and Commissioning Plan*.

7.1 Pre-Installation Activities

After the delivery of the DECam to CTIO and the completion of CFIP and prior to its installation of DECam on the Blanco telescope all of the elements of the DECam System will be integrated with the NOAO and NCSA operating environments and tested in so far as this can be done off-telescope. The connections between DECam, the NOAO Data Transport

System and the DESDM System at NCSA will be verified by successfully transmitting mock data from the DECam Survey Image System Process Integration (SISPI), to La Serena and then to the DES Archive at NCSA and the location of the primary NOAO Science Archive. The successful completion of these tests will establish that the DECam System and the Blanco are ready for the installation of the DECam instrument and it will also define the end of the DECam Project. In addition, the Community Pipeline will have been integrated with the E2E System and successfully tested. Finally, the DESDM system at NCSA will be tested with artificial object and calibration frames as part of the development of the DESDM Project and it will have undergone acceptance testing that includes DES Science Working Group tests of the DESDM data products prior to the CTIO commissioning of DECam.

7.2 The Installation and Commissioning Plan

The DECam System Installation and Commissioning Plan will be prepared under the leadership of CTIO by merging the individual installation and commissioning plans provided by the DECam project team, the DESDM project team and NOAO DPP. The Plan will be presented to the DECam Project and DESDM Project readiness reviews one year prior to shipping the DECam instrument. It will define the responsibilities and the level of effort provided by each collaborating institution engaged in the installation and commissioning. It will contain an integrated schedule for all activities during the installation and commissioning period, it will include contingency and it will be sufficiently flexible to allow for real-time reconfiguration, if required.

The NOAO DPP Operations group, with support from the DESDM Project team, will develop the *DECam/E2E System Integration and Commissioning Plan*, which will define and document the procedures and tests for the installation and integration of the DECam System into the NOAO data management environment. This Plan will include integration of the DECam-SISPI data delivery function with the NOAO Data Transport System and the integration of the Community Pipeline with the NOAO Data Management System. It will also describe the ingestion of DECam raw and reduced data into the NOAO Science Archive and their subsequent delivery to both community PIs and archival users through the NOAO National Virtual Observatory (NVO) Portal (and other VO portals).

CTIO will lead the installation and commissioning. DECam Project personnel, DESDM Project personnel, CTIO staff, NOAO DPP staff, and other Collaboration Members and Participants will participate in the various tasks. The schedule outlined below is nominal since it predates preparation of *The DECam System Installation and Commissioning Plan*.

7.3 Installation of DECam on the Blanco telescope

The installation of DECam on the Blanco telescope is expected to take three weeks. Following the installation of DECam on the Blanco, a series of tests that will be defined in the *DECam System Installation and Commissioning Plan* will be conducted to verify correct operation of all aspects of the instrument and its data system. Many of these tests will be repeats of those carried out during the pre-installation activities, but others will be new, such as exercising interfaces with telescope systems and verifying operational procedures, including changing from prime focus to Cassegrain f/8 focus and changing filter cartridges. Particular attention will be paid to verifying that all procedures ensure the safety of the personnel and equipment involved, and to documenting procedures that will be used during operation and maintenance.

7.4 Commissioning of the DECam System and the DESDM System

Commissioning of the DECam System may begin immediately after the installation of the DECam instrument on the Blanco is complete and its interfaces with telescope and the NOAO Data Transport System have been verified. The DECam System will image the sky in this phase, thus allowing the critical on-sky optical performance tests to be conducted for the first time, and to thoroughly test SISPI for functionality and reliability. On-sky frames and calibration data frames will be moved from the DECam System through the Data Transport System to the DES Archive at NCSA and the NOAO Science Archive. Commissioning of the DESDM system commences with the ingestion and processing of the DECam commissioning data at NCSA. Commissioning of the E2E system with the Community Pipeline begins with the processing of the DECam commissioning data at NOAO. The data processing phases of the commissioning will enable the full end-to-end testing of the Collaboration deliverables to NOAO and mark the beginning of science analysis with real astronomical data.

Following successful completion of the on-sky phase of commissioning, acceptance by NOAO of the Collaboration deliverables, and recommendation by the CTIO Director, DES operation and/or community use can commence. The acceptance tests shall include relevant performance requirements that are derived from the Science Requirements and the Community Needs Document. If the tests are not successfully passed and further commissioning is required prior to NOAO authorizing the start of observations, the CTIO Director will work with the Project Director or his designate to optimally schedule extra day and/or night time tests that will facilitate the completion of commissioning. Time already scheduled for post-commissioning activities, as described below, will be re-programmed as necessary to accommodate extra commissioning.

7.5 Post Commissioning Activities

The activities that immediately follow the completion of commissioning will depend on the time of the year. NOAO intends to schedule two one-week on-sky runs post-commissioning for Community Science Verification. If these periods fall within the September-February DES observing window, then the Community Science Verification will be coordinated with DES observations, which will commence according to the Blanco telescope observing schedule. If these post-commissioning activities occur during March-August, then the Community Science Verification will consist of contiguous blocks of time. However, in that case time will be set aside, either as an adjunct to the Community Science Verification activities or as separate engineering time, to obtain data using DES protocols that can be processed using the DESDM system and subsequently analyzed by the DES science teams. The purpose of these extra observations will be to ensure that DECam and the DESDM system are completely ready to commence the Survey at the start of the subsequent DES observing period.

8. The Community Use of the DECam System and DECam Data

The DECam System will be available for use on the Blanco by the world-wide astronomical community. It will replace MOSAIC as the only wide field optical imager on the Blanco. NOAO will provide the technical support for all use of the DECam System as befitting a NOAO facility instrument. All data produced by DECam will flow directly into the NOAO Data Transport System, which serves all facility instruments. The data will be transported to

long-term storage sites, placed in the NOAO Science Archive, and processed by NOAO DPP using the Community Pipeline provided by the Collaboration. This mountain-to-archive support will enable broad community use through PI-directed science as well as archival use of the raw and processed DECam data.

The level of support provided by the Collaboration during the operation of the DECam System for both the Collaboration scientific program and community programs will be described in the *DECam System Operation and Maintenance Plan*. NOAO will integrate the *DECam Operation and Maintenance Plan* and the *DESDM Operation and Maintenance Plan* into the *DECam System Operation and Maintenance Plan* and this combined Plan will be reviewed by the Council prior to the start of commissioning. The combined Plan will be updated at the conclusion of the commissioning to reflect the experience gained during commissioning.

8.1 NOAO Support of the DECam System Operation and Maintenance

The DECam System will be operated as a standard NOAO facility instrument following the standard practices set by NOAO for other NOAO facility instruments used in its Observatories. CTIO will maintain the Blanco telescope and its infrastructure to enable efficient operation of the DECam System. NOAO will appoint an instrument scientist for the DECam System, who will become familiar with all phases of the operation of the System, and will be primarily tasked with providing scientific support for community users of the System.

CTIO and DPP staff, with support from the DES Projects team, will develop an operations model for the use of the DECam System, which will be part of the *DECam System Operation and Maintenance Plan*. This model will define the institutional responsibilities for the operational support of the DECam System by the NOAO staff, including CTIO staff, DPP staff, and the DES Projects Team, including the DECam Project staff, and DESDM Project staff. It will assume that most of the bugs have been worked out during commissioning and that the CTIO and DPP staffs have been well trained in the operation and maintenance of the DECam System. The model will also accommodate special operational features for the community use of DECam that have been adopted through the Community Needs process.

NOAO will manage and maintain network connectivity, interacting with providers where necessary, to enable efficient transfer of DECam data to NOAO archive sites and the DES archive at NCSA. This function will be provided by the NOAO Computer Infrastructure Services South (CISS) Group. General community use of the DECam System is projected to require a sustained bandwidth of 36 Mbps over 18 hours to transfer a single, typical night of compressed data. Dedicated bandwidth higher than this minimum of 36 Mbps would be required to enable rapid recovery from a single 24 hour period of international network outage. While the minimum required bandwidth of 36 Mbps is within the currently contracted bandwidth (45 Mbps internationally), this bandwidth may not be sufficient to simultaneously transport the data from all NOAO facility instruments through the NOAO Data Transport System (DTS). However, NOAO considers meeting the additional bandwidth needs a general site operation issue and plans to meet those needs within the standard Observatory operations budget by the time DECam operation begins.

8.2 NOAO DPP Management of DECam Data and Data Products

The E2E System supports all NOAO facility instruments at all NOAO sites and will support the acquisition and processing of DECam data. Key, high-level components of the E2E System include: the Data Transport System (DTS), the NOAO Science Archive (NSA), the NOAO NVO Portal (NVO), and the NOAO High-Performance Pipeline System (HPPS). The NSA ingests and tracks data and metadata in the system, and makes it available through VO interfaces. The HPPS is designed to remove instrumental signatures from NOAO's current suite of wide-field optical and infrared imagers (MOSAIC and NEWFIRM). The Community Pipeline provided by the Collaboration will be a "drop in" addition to the E2E system, alongside HPPS for MOSAIC and NEWFIRM, and will be fully integrated into E2E. It will enable the use of DECam data by the entire astronomical community, supporting both PIs and archival users of DECam data. Quality assurance on the DECam data processed with the Community Pipeline in the E2E system will be the responsibility of NOAO.

The raw data stream from the DECam System is being designed to meet the interface requirements for data entry into the E2E system, so that the data will flow out of DECam into the E2E system. Those requirements will be specified in the *NOAO E2E Interface Control Document (E2E ICD)*, which may evolve over the timescale of DECam development to meet the needs of a variety of new instruments, including DECam.

The NOAO DPP group will operate and maintain the Data Transport System (DTS), the automated system which will transfer the data from all NOAO facility instruments, including DECam, to the NOAO Science Archive (NSA) using the network infrastructure managed by CISS. NOAO will archive all DECam data for the community, including both community and DES data.

Initially the data stored in the NOAO Science Archive will be made available only to the Principle Investigator (PI) of the observing program that generated the data, including DES data obtained with DECam. PIs may choose to shorten or even eliminate the default eighteen month proprietary period. After the proprietary period has expired the public will have access to the raw data and the image data that have been processed by NOAO DPP to remove the instrument signature. When DECam data is obtained by observers that lack suitable calibration material or use observation procedures that are incompatible with the operation of the Community Pipeline in the E2E environment, then NOAO will archive only the raw data.

NOAO DPP will manage the public access to all DECam raw data, metadata and processed data after the proprietary periods for these data have expired, thereby providing uniform access to DECam data from both DES and non-DES observations. DECam data in the NSA will be accessible through the NOAO NVO portal. In addition, other VO services and portals may access the DECam data in the NSA through standard VO interfaces. As noted in Section 9.3, the DESDM System will provide a second avenue for community access to DES data and data products through the DES Archive after the Collaboration completes the quality assessment.

8.3 Collaboration Support of DECam System Operation and Maintenance

The DES Project Teams will support the training of CTIO staff in the operation of the DECam System, which will take place primarily before and during the commissioning phase. Although a high standard of operational reliability and performance should have been achieved prior to

commencement of community operation of the DECam System, the *DECam System Operation and Maintenance Plan* will take into account the possibility of technical problems that will need the attention and presence of DECam Project team members at CTIO during the initial year of DECam operation. The expertise of the full DES Projects team will be available remotely through video and phone meetings and via e-mail throughout the duration of the Survey. Members of the DECam Project team will also travel to CTIO to support special maintenance and the solution of problems requiring physical presence of team members. The DESDM Project team will support the operation and maintenance of the Community Pipeline throughout the duration of the period of the Survey as described in the *DECam System Operation and Maintenance Plan*.

8.4 Selection of Other Observers and Special Features of their Observing Programs

Other than the time given to Chilean astronomers through the agreement between AURA and the University of Chile, almost all (>95%) of the time allocated to observers is granted as a result of peer reviewed proposals. In principle, the Blanco time remaining after the nights scheduled for the Collaboration are taken into consideration could be awarded to the astronomical community for the use of DECam, although substantial time is likely to be scheduled on other instruments mounted at the f/8 focus through NOAO time allocation procedures. The AURA/NOAO Data Rights Policy shall be applied to science data obtained with time awarded to these other observers (non-DES) on the Blanco with DECam.

It is anticipated that the approved non-DES observing programs may have special requirements that are not included in the DES Science Requirements, the DECam Technical Requirements and Specifications or the Community Pipeline Technical Requirements and Specifications. These special requirements will be considered for incorporation into the Community Needs Document.

9. DES Operation

This section describes the elements of the Survey that the Collaboration executes during the operations phase of its scientific program. They include the support of Collaboration observations with the DECam System, the formulation and annual updating of the DES Observing Plan for consideration by NOAO, and the production and distribution of science ready data products to the Collaboration for use in the execution of its scientific program.

9.1 Collaboration Support of Observations with the DECam System

The operation of the DECam System will be supported and managed by NOAO as described in Section 8.1 and as noted there NOAO will appoint a scientist who will become familiar with all phases of the operation of the DECam System for both the Community and Collaboration. The regular telescope observatory staff will support the DECam System as a facility instrument during DES operations. The Collaboration will complement the NOAO support of the DECam System during DES operations by providing an on-site observing team and technical support of the Collaboration deliverables. Several members of the DECam Project team will be in residence throughout the first year of DES operations and the expertise of the full DES Projects Teams will be available remotely through video and phone meetings and via e-mail throughout

the Survey. The level of Collaboration support will be described in the *DECam System Operation and Maintenance Plan*.

9.2 The DES Observing Plan

The planning and execution of DES observations will be closely coordinated with NOAO in order to optimize the entire set of observing programs that NOAO schedules for the Blanco. The Collaboration has proposed a 5000 sq-degree deep multi-band imaging survey that can produce complete cluster catalogs to $z \sim 1.5$, with point spread functions stable enough for weak lensing measurements of large scale structure, photometric calibration with sufficient precision to allow wide angle galaxy angular correlation function measurements, and red sensitivity and system response function well enough known to allow study of a large number of supernovae with red shifts within the range between ~ 0.3 and ~ 1 . The Collaboration calculated that ~ 525 scheduled nights, distributed approximately uniformly over lunar phase, will be needed to carry out the Survey and presented its estimate in the Proposal to NOAO (https://www.darkenergysurvey.org/the-project/main_documents). The Collaboration assumed that the Blanco would deliver the same performance that it delivered with MOSAIC between 2000 and 2004. This estimate included an allowance for time lost due to weather that was based on the thirty year history weather at CTIO. A full description of that estimate is given in the Proposal. NOAO agreed to schedule 525 nights on the Blanco for the Survey on the basis of the Proposal, subject to satisfactory progress.

The DES Project Scientist with the support of the Survey Strategy Team will prepare a *DES Observing Plan* that will allow the DES science goals to be achieved with not more than 525 scheduled nights of observing on the Blanco telescope distributed over a period of about five years. The *Observing Plan* will describe the planned observation sequence, it will include the procedures for photometric and astrometric calibrations, and it will make reasonable allowances for weather and other factors that reduce the available observing time. The DES Project Scientist will submit it to the Project Director for review and comment by the MC prior to its submission to the CTIO Director.

The Project Director shall submit a *Preliminary DES Observing Plan* to the Council and the CTIO Director one year prior to the start of commissioning for their consideration. The Council will review this plan as part of their oversight process. The CTIO Director will review it in order to integrate this with other observing programs that will be using the Blanco during the commissioning periods. These periods will be scheduled by the CTIO Director in consultation with the Project Director.

After commissioning is complete, the NOAO Director in consultation with the Council will periodically review DECam operations to assess whether the expectations of the Collaboration and the Community are being met. The NOAO Director's periodic review will be conducted as follows:

Prior to the start of Survey observations the Project Director will submit the initial *DES Observing Plan* to the Council and to the NOAO Survey Time Allocation Committee (Survey TAC) for their consideration. Thereafter, the Project Director will submit an updated plan annually to the Council and to the Survey TAC. The Project Director will report the status of DES observations and scientific accomplishments, including a

comparison of actual DES observations to the forecast of observations in the *DES Observing Plan*.

The Survey TAC will be the venue for any requests for an extension of the DES observing time allocation that might, for instance, be precipitated by significant deviations in actual survey efficiency from that calculated in the DES Observing Plan. This venue will be used by DES to request an additional time allocation in order to extend the area of the Survey or expand the DES scientific goals. The Survey TAC will also advise the NOAO Director on the scientific merit of any additional project(s) or DES extensions proposed by DES to use the remaining survey time, in the situation where the DES is completed in less than 525 nights. Such a request would be submitted in response to a regular call by NOAO for new survey proposals. Prior to making such a request the Collaboration will request a commitment from the Council to support such an extension.

The Survey Strategy Team will coordinate the survey observing activities. It will also be responsible for tracking survey progress in terms of area covered and data quality, providing algorithms for night observations that optimize data quality while maintaining high observing efficiency, testing the calibrations obtained, and coordinating collaboration wide testing of the data. The nights will be scheduled within the period from September through February in order to efficiently observe the South Galactic Cap. Nominally in each year equal fractions of the total nights available for scheduling scientific observation by NOAO will be scheduled for DES observations. The nights assigned will be distributed approximately uniformly over lunar phase when averaged over the entire survey.

9.3 DESDM Operations

The operation and maintenance of the DESDM System is described in the *DESDM Operation and Maintenance Plan*. DESDM operation at NCSA is based on the transmission of the DES raw data over the NOAO DTS system described in Section 8.1 and estimates that the projected bandwidth requirement is 36 Mbps. This bandwidth is needed to maintain prompt processing of DES data for the follow up of time sensitive observations, but is the same as that required for community use of DECam, and so requires no special or dedicated allocation of Observatory resources. After the raw data, including instrument monitoring data, are delivered to the DES Archive at NCSA by the NOAO DTS, the DESDM team is responsible for all processing and distribution of data in the DES Archive. DESDM operations include processing, quality assurance, archiving and distribution of the DES survey data products. Processing includes ingestion into the DES archive at NCSA, removal of instrumental signatures, astrometric and photometric calibration, co-addition into deeper and more uniform sky images, and cataloguing and ingestion into the DES Archive database. The DES Archive will track all the survey data products, calibration data, instrument metadata and survey metadata required to enable automated operation. DESDM processing and archiving will be carried out primarily on computing platforms at NCSA.

The DESDM team is responsible for the quality assurance of the DES data at every stage from acquisition through processing and archiving, and it plans to carry out the full and final data quality assurance on the DES data, the science-ready data products, and the DES Archive at NCSA. UIUC/NCSA will lead the Collaboration Quality Assurance effort for the DES data. Quality assurance testing and logging occurs automatically in each stage of DESDM

processing, and this QA information along with nightly summaries will be available for review by the DESDM operators at NCSA and by DES scientists.

The DES data will be made available to the Collaboration through the DES Archive. A complete copy of DES data will be archived on the NCSA mass storage system for safe keeping. In addition, a full copy of the raw and processed data will be kept at the secondary DES Archive node at Fermilab, and the data products will be distributed to archive nodes throughout the Collaboration as desired by the teams at each DES institution.

The DESDM processing framework will be made available to DES scientists for science calculations that are of general interest to the Collaboration. DESDM operations also include periodic reprocessing of the full DES dataset. This computationally intensive task will engage the broader computing resources that are available to the Collaboration.

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.

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.

10. Education and Public Outreach

The Parties intend that an integrated Education and Public Outreach plan should be a part of the overall DES Project. It will build on the extensive public outreach and education efforts already underway at some of the Collaborating institutions. A website will be built that will evolve from serving the DES Projects during construction to serving the general public and astronomers during operations, a model that has proved very successful with the Sloan Digital Sky Survey.

11. Oversight and Reporting to DOE and NSF

The Associate Director for High Energy Physics in the Department of Energy Office of Science and the Head of the Astronomy Division of the National Science Foundation formed a Joint Oversight Group (the JOG) for the DES in response to the recommendation contained in the draft report of the joint DOE/NSF review of May 1-3, 2007. The JOG will act as the official contact point between the agencies and the Project Director, Dr John Peoples. All formal communications will be handled by the JOG and the Project Director: all other contacts should be considered unofficial. Current membership of the JOG is Dr Kathy Turner, DOE

(Kathy.Turner@science.doe.gov), Mr Paul Philp (paul.philp@ch.doe.gov) and Dr Nigel Sharp, NSF (nsharp@nsf.gov).

The day to day business of the DECam Project is conducted through the DOE Integrated Project Team and the Delegate of the Fermilab Director as described in the [DOE] "*Project Execution Plan for the Dark Energy Camera Project for the Dark Energy Experiment at Fermi National Accelerator Laboratory*". The day to day business of the DESDM Project is conducted through NCSA, and the day to day business of the CFIP and operations of DECam are conducted through NOAO as noted in Sections 7, 8 and 9.

DOE and NSF will jointly review the DES Projects. DOE and NSF reviewed the DES Projects in May 2007 and again in January 2008. The positive outcomes of the two reviews were the basis for the joint decision of both agencies to go forward with DES. Nevertheless there remains some risk that there could be a shortfall on the expected funding.

The Parties recognize that DOE and NSF expect the Project Director and the Project Managers to provide periodic status reports. These reports and the quarterly reports prepared by the Project Director will have the same content to the extent possible to avoid unnecessary duplication. The Parties also recognize that the DOE and NSF will conduct joint reviews of the DES Project. When such reviews are scheduled, the timing of the reviews conducted by the Directors will take the timing and content of the agency reviews into consideration.

In the event of a serious conflict among the Parties concerning the implementation of this Addendum, including the request by one of the Parties to withdraw from its commitments, the Project Director will inform the JOG of the conflict or request, after consultation with the Council.

12. The Application of AURA/NOAO Policies to DES Members

The ultimate responsibility for complying with AURA/NOAO policies lies with each Member or Participant except for applying the AURA policies to the shipment of DECam to CTIO, which is described in Section 4. The Collaboration will bring the AURA/NOAO policies listed below to the attention of its Members and Participants through the DES website, which will note the existence of the policies and the importance of complying with them. This website will provide specific references to these policies on the NOAO website. Each Institutional Representative is responsible for communicating the terms of the policies listed below to their Collaborating Institution and to acknowledge the commitment of his or her institution to comply with those policies. This will be done in a Collaboration Letter of Acknowledgement from the Institutional Representative to the Project Director.

The current list of Collaborating Institutions is contained in Section 2.3 of the Addendum. The Project Director will maintain an up-to-date list of Collaborating Institutions and display it on the Project website.

12.1 Shipment of Equipment to Chile by DES Members and Participants

Export and Property Control Policies: The Members and Participants represent that in the performance of this Addendum they will fully comply with all U.S. export control laws and regulations.

Importation of Property and/or Equipment by AURA: All foreign-manufactured (i.e. not manufactured in Chile) equipment that a Member wishes to use for his or her scientific work on the Survey in Chile, including scientific work carried out by a Participant mentored or sponsored by the Member, shall be imported into Chile by AURA. Each Member agrees to comply with any and all applicable Chilean import laws and regulations for the importation into Chile of any such equipment.

Management of Equipment Imported to Chile: Any property and/or equipment purchased or provided outside of Chile for use in the Survey by Members and the Participants that they mentor in Chile shall be subject to the following terms and conditions:

1. A [DES] Member shall initiate a request for AURA to export property and/or equipment to Chile for research associated with the Member's scientific work in DES, including the scientific work done by Participants mentored or sponsored by the Member, by contacting the AURA Export Control Administrator. The AURA Export Control Administrator shall execute the necessary shipping documents for exporting the property to Chile. Such shipping documents are required to obtain export licenses from the United States Government. Control of all such property and/or equipment shall be transferred to AURA for purposes of importing such property and/or equipment into Chile in order to obtain the importation benefits AURA receives from the Ministry of Finance in Chile. Such property and/or equipment shall be on loan to AURA until such time as agreed by the Member.
2. AURA assumes no costs for transportation, insurance and importation of items to Chile. The Member is responsible for these costs and they will be defined in an MOU between the Member's Collaborating Institution and AURA.
3. AURA assumes no responsibility for loss or damage to equipment shipped to Chile or maintained in Chile under this provision.

12.2 Intellectual Property and Data Rights

NOAO policies shall govern ownership of the rights, title to and interests in any patentable intellectual property and copyrightable works, including software, developed, conceived of or first reduced to practice solely by employees of AURA under this Memorandum of Understanding. Notwithstanding those policies,

1. AURA shall grant to each Collaborating Institution a royalty-free, nontransferable, nonassignable, irrevocable right and license to reproduce, distribute and display publicly, in print, electronic or digital formats, data or images obtained by the Collaborating Institutions during the DES Observations on the Blanco 4-meter Telescope for the DES observing program; and
2. The policies of the Collaborating Institution or Collaborating Institutions shall govern ownership of the rights, title to and interests in any patentable intellectual property and copyrightable works, including software, developed, conceived of or first reduced to

- practice solely by employees of the Collaborating Institution or Collaborating Institutions.
3. The Collaborating Institutions and AURA shall jointly own rights, title to and interests, including those under applicable intellectual property laws, in any patentable intellectual property and copyrightable works, including software that are developed, conceived of or first reduced to practice jointly by employees of the Collaborating Institutions and employees of AURA.

12.3 Publicity and Trademarks

1. Each Collaborating Institution may publicize the existence and nature of the Memorandum of Understanding, including the Addendum, without prior approval of any of the other Parties or other Collaborating Institutions.
2. Neither AURA nor any of the Collaborating Institutions shall have any right to use the name, trademark(s) or service marks of any other party participating in DES for any commercial purpose except upon prior written consent and approval of the other party.

12.4 Publications

The MC and the Council will encourage the DES Members to publish scholarly articles and papers, individually or jointly, and to make presentations regarding the scientific and technical results of the Survey. In connection with any such publication or presentation, the publishing party agrees to:

1. Include an acknowledgment of support from the Collaborating Institutions and the funding agencies. Currently the latter include the DOE Office of High Energy Physics, the NSF, the Science and Technology Facilities Council (UK) and the Ministry of Education and Science (Spain). The Project Director will maintain a current list of these contributing parties and post a sample acknowledgement on the project website
2. The support of the contributing parties will be orally acknowledged during all news media interviews, including popular media such as radio, television, and news magazines.
3. Except for papers published in scientific, technical or professional journals: the following disclaimer will appear in all publications (including Web pages) of material produced by the Collaboration or the Collaborating Institutions and based on or developed with the support of the contributing parties, whether copyrighted or not,

“Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the funding agencies or the institutions, laboratories or other organizations that supported or contributed to the Dark Energy Survey Project.”

13. Amendments

Except for the terms in Section 12, the Addendum may be amended by a written document signed by each Party’s delegate, subject to concurrence by the Project Director. Such amendments will be transmitted to the other Collaborating Institutions by the Project Director.

Signatures

IN WITNESS WHEREOF, the Project Director for the Collaboration has signed to confirm his concurrence with the understandings specified in the Addendum and the Parties hereto have caused it to be executed by their duly authorized delegates on the day and year specified below.

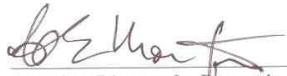
For the Dark Energy Survey Collaboration



DES Project Director, John Peoples

5 May 2008
Date

For Fermi National Accelerator Laboratory



Associate Director for Research,
Hugh Montgomery

5 May 2008
Date

For the National Center for Supercomputing Applications



Director, Thomas H. Dunning Jr.

05/09/2008
Date

For The National Optical Astronomy Observatory



NOAO Director, Todd Boroson

May 7, 2008
Date

Fully Executed Amendments to the Memorandum of Understanding for the Dark Energy Survey

Effective date of the Amendment

Each Amendment to the Understanding is effective upon being signed by the Parties and each Amendment to the Addendum is effective upon being signed by the Delegates.

List of fully executed Amendments

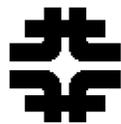
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Amendment #1 to the Memorandum of Understanding for the Dark Energy Survey



DARK ENERGY
SURVEY

The Dark Energy Survey Collaboration



Fermilab

Fermi National Accelerator Laboratory



National Center for Supercomputing Applications
at the
University of Illinois at Urbana-Champaign



National Optical Astronomy Observatory
Operated by the Association of Universities for Research in
Astronomy

Fully Executed August 27, 2010

Amendment #1 to the Understanding

Section I. Parties, subsection C: The sentence that reads “*The Association of Universities for Research in Astronomy, Inc. (AURA) is a non-profit corporation located in the United States of America, operates the National Optical Astronomy Observatory (NOAO) for the National Science Foundation (NSF) under NSF Cooperative Agreement, AST-0132798.*” is replaced by the following:

“The Association of Universities for Research in Astronomy, Inc. (AURA) is a non-profit corporation located in the United States of America, operates the National Optical Astronomy Observatory (NOAO) for the National Science Foundation (NSF) under NSF Cooperative Agreement, AST-0132798. After January 31, 2012 AURA will operate NOAO for the NSF under NSF Cooperative Agreement AST-0809409.”

Section IV, A, paragraph 2. The sentence that reads “*Such equipment shall be on loan to AURA for the duration of the Understanding or until such time as agreed by the Parties*” is deleted.

Amendment #1 to the Addendum

Section 4.2, **The Shipment of DECAM to CTIO**, paragraph 1:
Paragraph 1, which reads as follows:

“Fermilab will ship DECAM to CTIO as part of the DECAM Project in accordance with the DECAM Shipping Plan, which will be prepared jointly by Fermilab and NOAO and approved by AURA. For the purpose of this section DECAM is defined to be all of the subsystems, special spare parts that will be needed for installation, commissioning and initial operation of the DECAM System on the Blanco and related calibration equipment for DECAM. The Parties agree that other than DECAM there is no currently recognized need to ship additional equipment to CTIO to complete the DES Deliverables. Should a need arise to ship additional equipment to CTIO in order to complete the DES deliverables the responsibility for handling the additional equipment will be described in an amendment to this Addendum.” is replaced with the following text:

“Fermilab will ship DECAM to CTIO as part of the DECAM Project in accordance with the DECAM Shipping Plan, which will be prepared jointly by Fermilab and NOAO and approved by AURA. For the purpose of this section DECAM is defined to be all of the subsystems, installation fixtures, interfaces between the DECAM Instrument and the Blanco Telescope and interfaces between the DECAM instrument and the NOAO Data Transport System that are needed for installation and commissioning and initial operations on the Blanco. It also includes related equipment for such purposes as the calibration of DECAM.

The accountability of the DOE provided DECAM Property and related equipment, as described in the “Memorandum of Understanding between the U.S. Department of Energy and the National Science Foundation for transfer of Dark Energy Property and Related Equipment”, will be transferred to the NSF and NSF will transfer these items of equipment to AURA prior to shipment to CTIO for importation into Chile. Table 1, DOE DECAM Property, in Attachment 2 of this MOU defines the list of property and related equipment that will be transferred to the NSF under this MOU. The same list is included in the DECAM Shipping Plan. Should a need arise to add or subtract items from this list they will be recorded in a revision to the DOE-NSF MOU and the DECAM Shipping Plan.”

Section 4.2, **The Shipment of DECAM to CTIO**, item 1: The sentence that reads *“Such property and/or equipment shall be on loan to AURA for the purposes of this Addendum or until such time as agreed by the Parties”* is deleted.

Section 4.2, **The Shipment of DECAM to CTIO**, item 3: The sentence that reads *“AURA assumes no responsibility for loss or damage to equipment shipped to Chile or maintained in Chile under this provision.”* is replaced by the following:

“Except as otherwise specifically provided, neither NSF nor AURA (or its successor awardee) shall be liable for loss or destruction of or damage to the DECAM property and related equipment unless such loss, destruction, or damage results from the negligence, willful misconduct or lack of good faith on the part of any of AURA (or the successor awardee’s)

directors or officers, or on the part of any of the managers, superintendents, or other equivalent representatives, who have supervision or direction of (1) all or substantially all of the AURA business, or (2) all or substantially all of the AURA operations at any one facility or separate location in which this MOU is being performed.”

Section 4.5, Duration of Community Use of the DECam Instrument: The text that reads:

“The Parties agree that DECam will remain at CTIO as a community instrument for use on the Blanco for five years beyond the completion of the Survey unless the Parties make other arrangements before the completion of the Survey. During the five year period following the completion of the Survey there is no commitment on the part of the Collaborating Institutions, including Fermilab and UIUC/NCSA, to support the operations and maintenance of the DECam System. The support of the DECam System and its ultimate disposal will be the responsibility of NOAO upon the completion of the scientific goals and objectives described in this Addendum, including any amendments that the Parties make.” is replaced by the following text:

“The Parties agree that the DECam System will remain at CTIO as a community instrument for use on the Blanco for five years beyond the completion of the Survey unless the Parties make other arrangements before the completion of the Survey. During the five year period following the completion of the Survey there is no commitment on the part of the Collaborating Institutions, including Fermilab and UIUC/NCSA, to support the operations and maintenance of the DECam System. The support of the DECam System will be the responsibility of NOAO upon the completion of the scientific goals and objectives described in this Addendum, including any amendments that the Parties make. The disposition of DOE provided DECam equipment shall be done in accordance with the Memorandum of Understanding between the U.S. Department of Energy and the National Science Foundation for Transfer of Dark Energy Camera Property and Related Equipment.”

Section 12.1, Shipment of Equipment to Chile by DES Members and Participants

Export and Property Control Policies, item 1: The sentence that reads *“Such property and/or equipment shall be on loan to AURA until such time as agreed by the Member”* is deleted.

Section 12.1, Shipment of Equipment to Chile by DES Members and Participants

Export and Property Control Policies, item 2. The text that reads *“AURA assumes no costs for transportation, insurance and importation of items to Chile. The Member is responsible for these costs and they will be defined in an MOU between the Member’s Collaborating Institution and AURA.”* is replaced with the following text:

AURA assumes no costs for transportation, insurance and importation of items to Chile. The Member’s Institution is responsible for these costs, which will be defined in a written agreement with AURA.”

Section 12.1, Shipment of Equipment to Chile by DES Members and Participants

Export and Property Control Policies, item 3: The sentence that reads *“AURA assumes no responsibility for loss or damage to equipment shipped to Chile or maintained in Chile under this provision.”* is replaced by the following text:

“Except as otherwise specifically provided, neither NSF nor AURA (or its successor awardee) shall be liable for loss or destruction of or damage to the DECam property and related equipment unless such loss, destruction, or damage results from, negligence, the willful misconduct or lack of good faith on the part of any of AURA (or the successor awardee’s) directors or officers, or on the part of any of the managers, superintendents, or other equivalent representatives, who have supervision or direction of (1) all or substantially all of the AURA business, or (2) all or substantially all of the AURA operations at any one facility or separate location in which this MOU is being performed.”

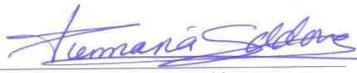
Signatures for Amendment #1 to the Addendum

IN WITNESS WHEREOF, the Project Director for the Collaboration has signed to confirm his concurrence with the understandings specified in the Amendment #1 to the Addendum and the Parties hereto have caused it to be executed by their duly authorized delegates on the day and year specified below.

For the Dark Energy Survey Collaboration


DES Project Director, Josh Frieman 8/25/10
Date

For Fermi National Accelerator Laboratory


Fermilab Director, Pier Oddone 8/18/10
Date

For the National Center for Supercomputing Applications


Director, Thomas H. Dunning, Jr. 08/26/2010
Date

For The National Optical Astronomy Observatory


NOAO Director, David Silva 8/23/10
Date

Appendices

- Appendix A. Announcement of Opportunity**
- Appendix B. Letter from M. Witherell to J. Mould dated July 16, 2004**
- Appendix C. Letter from J. Mould to M. Witherell dated September 27, 2004**
- Appendix D. List of Plans Defined in the Addendum**

Announcement of Opportunity for Blanco Instrumentation Partnership

NOAO announces a partnership opportunity to develop a major new instrument for the Blanco 4 meter telescope of Cerro Tololo Inter-American Observatory. Although there are no restrictions on the type of instrument that can be proposed, in order to build on the Blanco telescope's particular strengths we see a special opportunity to exploit the wide field capability of the prime or RC focus of the telescope. Additionally, any proposed instrument should be, consistent with a system-wide view of facilities available to the US community, in particular those in the southern hemisphere. Guidance on the US system can be obtained from the report on the first workshop on the ground-based O/IR system, see http://www.noao.edu/gateway/oir_workshop/

By the likely time of commissioning of the new instrument solicited here, we expect to have retired the RC and Echelle spectrographs since their capabilities will have been replaced by new instrumentation on SOAR and Gemini. We plan to begin sharing the wide-field IR imager NEWFIRM with the KPNO Mayall 4-m in 2006, NEWFIRM is described at <http://www.noao.edu/ets/newfirm/>. A technical description of the telescope will be accumulated [here](#).

Proposers will need to submit a science plan, a technical plan, and a management plan. The science plan should include a description of compelling science to be undertaken by the proposing team, which may be in partnership with NOAO, and also an outline of anticipated astronomy community use of the instrument through merit based proposals. The technical plan should present a conceptual design of the instrument in sufficient depth for peer reviewers to assess the feasibility of the project with the resources to be committed. The management plan should outline the proposed sharing of responsibilities for optomechanical, focal plane, data acquisition, and data management work packages between the proposer and NOAO. A general management structure along with a schedule of project reviews (PDR, CDR) and acceptance testing should be included. The management plan should include a plan for public and educational outreach and explain the broader impacts of the project.

Up to 30% of the Blanco telescope time for 5 years commencing in 2007 or 2008 is available for the science project. NOAO will contribute the operation of the telescope and an upgraded control system with a combined nominal annual value of \$4M at real year prices. NOAO would expect to partner with the successful proposer in developing a data management system, (including data acquisition) which is compatible with the National Virtual Observatory. The successful proposer can expect to work with an engineering interface at NOAO with optomechanical and other expertise.

Letters of intent are due at NOAO on March 15, 2004. At that time an NOAO contact person will be appointed to answer proposers' technical inquiries, and to give guidance on the form and scope of the proposal. Instructions and technical information will also be available via these WWW pages, and arrangements can be made for early appointment of the NOAO contact person, mentioned above, if appropriate. Full proposals are due August 15, 2004, and will be reviewed by an expert external panel. It is expected that results will be announced by October 15, 2004.

Potential proposers are encouraged to contact Alistair Walker at awalker@ctio.noao.edu , (56-51-205200).

Alistair Walker



Fermi National Accelerator Laboratory
P.O.Box 500 • Batavia, IL • 60510-0500
630-840-3211 FAX 630-840-2900

Director's Office

July 16, 2004

Dr. Jeremy Mould
Director
National Optical Astronomy Observatory
Tucson, AZ 85726-6732

Dear Jeremy,

The Dark Energy Survey (DES) project director, John Peoples, has asked me to write to you to describe the project approval process at Fermilab, the current status of the Dark Energy Survey within that process, and the steps required to begin construction of the project. I am pleased to do this and thus provide support for their proposal to NOAO.

I charged our Physics Advisory Committee with reviewing the science and technical feasibility of the DES proposal because Fermilab is the host laboratory for the collaboration and for the construction of the camera. In their report to me, they said, "The Committee finds the science provided by the DES to be exciting and well-worth the estimated costs of the project, assuming it can be carried out on the timescale of the new proposed schedule. The Committee therefore encourages the Director to approve the submission of the letter proposal to NOAO and to grant Stage I approval for the beginning of work on the DES at Fermilab, if the required funding can be found." In reaching this stage, we also conducted a [Director's] Preliminary Technical, Cost and Schedule Review, which involved a team of respected members of both particle physics and astronomy fields. The report of this review was one of the documents available to the PAC. The PAC report is attached. If you wish we can provide the complete reports from the Director's Preliminary Review.

I have accepted the recommendation from the PAC, granted Stage I approval to the DES proposal, and approved the collaboration's submission of the proposal to you for your consideration. Fermilab finds the science compelling and well-suited to our scientific mission.

If you find the proposal satisfies your requirements, the collaboration will work to obtain our Stage II approval. To do this they must develop a detailed technical design and prepare for a review of the cost, schedule, and management of the project. Since we currently expect that the overall project will be managed here we will conduct the review to see that the cost estimate is sound and has sufficient contingency to complete the project, that the schedule has a high probability of being met, and that the project management and collaboration are strong enough to complete the project.

In addition, the collaboration must obtain commitments for funding the total cost of the project. We will provide them guidance on what resources are available from Fermilab and will work with them to reach necessary agreements with funding sources external to Fermilab. We, along with the other collaborating institutions, will support the work required for them to meet the requirements of this review. When all of these requirements are met, we will be ready to give Stage II approval and begin construction of the project.

If you have any questions about the approval process, please contact me. We look forward to working with you to complete the Dark Energy Survey.

Sincerely,

Michael Witherell
Director

Cc: B. Flaugher
J. Annis
H. Montgomery
J. Peoples



National Optical Astronomy Observatory

Kitt Peak National Observatory • Cerro Tololo Inter-American Observatory • NOAO Gemini Science Center

Dr. Michael Witherell
Director
Fermilab National Accelerator Lab
PO Box 500
Batavia IL 60510-0500

September 27, 2004

Dear Michael,

Thank you for your letter of July 16 describing the project approval process at Fermilab for the Dark Energy Survey (DES). In that letter you also approved the collaboration's submission of the DES proposal to NOAO's Blanco Instrumentation Partnership Review.

A panel was asked to review the proposal and to advise me whether the proposal to build the Dark Energy Camera and conduct the DES should be accepted, and whether the proposal merits the award of up to 30% of the Blanco telescope time for 5 years. The panel employed the criteria advertised in the Announcement of Opportunity last year.

I am happy to inform you that I now have the report of the review panel, which I enclose for your information. The panel declared that the science goals of the DES, steady tightening of the constraints on the dark energy equation of state and its possible evolution, are exciting and timely. The report recommends that NOAO and the Dark Energy Consortium (DEC) move forward with this partnership with the provision that certain conditions are met.

A number of these conditions relate to infrastructure whose provision would be incumbent on NOAO, for which the report recommends the DEC identify a prioritized list. I have asked Alistair Walker, Director of Cerro Tololo Interamerican Observatory, to consult with John Peoples about this. This would inform our drafting of a Memorandum of Understanding (MOU) regarding the conduct of the partnership. The MOU would also take note of Fermilab's approval process going forward, including your Stage II approval. Fermilab, as lead institution in the DEC, and NOAO would, I assume, be the parties to the MOU. Such memoranda require AURA and NSF approval on our side. In these matters AURA is advised by its Observatories Council and NSF by its NOAO Program Review Panel. I am keeping these groups informed about the DES.

If you would like to discuss this process further, please contact me. We look forward to working with you on the Dark Energy Survey.

Sincerely,

Jeremy Mould
Director

cc: C. Foltz, J. Peoples,
A. Walker, W. Smith

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List of Plans Defined in the Addendum

The Funding Plan: Section 2.5

Preliminary DES Observing Plan and the DES Observing Plan: Section 9.2

These plans are prepared by the DES Project Scientist for the Project Director and subsequent consideration by NOAO. They allow the DES science goals to be achieved in a five year period with up to 525 scheduled nights of the Blanco time.

DECam Plans:

The DECam Project Management Plan: Section 2.6

This plan was prepared by the DECam Project Manager for Fermilab. It has been signed by the Fermilab Director and submitted to DOE as part of the Critical Decision-2 Process.

DECam Installation and Commissioning Plan: Section 4.1

The *DECam Installation and Commissioning Plan* will define and document the procedures for the initial installation of DECam, including the new prime focus cage, on the Blanco and the connection of DECam to the Observatory utilities. This plan will also define the institutional responsibilities of the DES Institutions, including NOAO, that will carry out the initial installation and commissioning. The plan will define the interfaces between the Blanco Telescope, including all Observatory systems that are needed to carry out the DES, and DECam, including all off-telescope systems provided by the Collaboration as part of DECam.

DECam Operation and Maintenance Plan: Section 4.1

DECam Operation and Maintenance Plan will define and document the procedures for operating and servicing DECam. The plan will include a description of the support of the off-prime-focus-cage equipment and services provided by the DES Institutions, including CTIO. It will define the DECam spares and the maintenance support of DECam that will be provided by the Collaboration.

DECam Shipping Plan: Section 4.2

DES [DOE] Project Execution Plan: Section 3 and 11

This is a document prepared by the Federal Project Director for DOE, with contributions from the DECam Project team. The full title is “Project Execution Plan for the Dark Energy Camera Project for the Dark Energy Experiment at Fermi National Accelerator Laboratory”. It is one of the documents required for [DOE] CD-2.

DESDM Plans:

DESDM Commissioning Plan and DESDM Operation and Maintenance Plan: Section 6.1

The DESDM Project will prepare the plans for DES data management in the later phases of the project. These plans will be described in two documents: (1) the *DESDM Commissioning Plan* and (2) the *DESDM Operation and Maintenance Plan*. Both the *Commissioning* and *Operation plans* will contain a detailed description of quality assurance of the processing of the DES data.

Plans Prepared Under the Leadership of the CTIO Director

The DECam System Installation and Commissioning Plan: Section 7.2

The DECam System Installation and Commissioning Plan will be prepared under the leadership of CTIO by merging the individual installation and commissioning plans provided by the DECam project team, the DESDM project team and NOAO DPP. The Plan will be presented to the DECam and DESDM readiness reviews one year prior to shipping DECam. The Plan will define the responsibilities and the level of effort provided by the DES Institutions, including NOAO, participating in the installation and commissioning. The Plan will contain an integrated schedule for all activities during the installation and commissioning period, it will include contingency and it will be sufficiently flexible to allow for real-time reconfiguration, if required.

DECam/E2E System Integration and Commissioning Plan: Section 7.2

The NOAO DPP Operations group, with support from the DESDM project team, will develop the *DECam/E2E System Integration and Commissioning Plan*, which will define and document the procedures and tests for the installation and integration of the complete DECam system into the NOAO data management environment. This plan will include integration of the DECam SISPI data delivery with the NOAO Data Transport System as well as installation and integration of the Community Pipeline, and also cover ingestion of DECam raw and reduced data into the NOAO Science Archive and through the NOAO National Virtual Observatory (NVO) Portal (and other VO portals) to both community PI and archival users.

The DECam System Operation and Maintenance Plan: Section 8

NOAO will integrate the *DECam Operation and Maintenance Plan* and the *DESDM Operation Plan* into the *DECam System Operation and Maintenance Plan* and this plan will be reviewed by the Council prior to the start of commissioning as noted in Section 2.2. The combined plan will be updated at the conclusion of the commissioning to reflect the experience gained during commissioning.