

# Closeout Presentation for the DES Council of Directors' Operational Readiness Review of the Dark Energy Survey

March 20-21, 2013 @ Fermilab

# The Review Team:

- Tim Axelrod (U of Arizona & LSST) – Chairperson
- Fernanda Garcia (Fermilab Accelerator Division)
- Mario Juric (AURA – LSST)
- Eric McHugh (Fermilab Particle Physics Div. – ESH)
- Constance Rockosi (UCSD & Lick Observatory)
- Larry Stepp (Thirty Meter Telescope)
- David Wittman (UCSD)

# Executive Summary

- The DES has made major progress since the last review. SV data has been obtained using DECam and the upgraded Blanco telescope, and processed through DESDM. By the completion of Extended SV, the majority of the data met the data quality requirements for the survey. Both the telescope and camera systems are very well instrumented, and this has laid the groundwork for continued future improvement in the system performance. The entire DES team is to be congratulated for this achievement.
- The Committee believes that DES is largely ready to begin gathering survey quality data and doing the necessary time-critical processing to enable the supernova science. Some tasks still need to be completed to reach this goal, but they are likely to be completed prior to September 2013. In that sense DES is operationally ready. The largest risk to successful start of operations is that the under-resourcing of DESDM will result in a system that is insufficiently reliable to meet the needs of the Survey.
- While we think it likely that DES will also be ready for science with the first season of survey data in early 2014, there are significant risks that it will not. Again, the principal risk is the under-resourcing of DESDM. Longer term, there is a risk that the longer than planned interval between exposures will require lengthening the survey period, but we think it likely that this risk will largely be mitigated by continuing improvements in performance of the telescope.
- Acceptance of the Community Pipeline is a precondition for beginning the survey. The Committee is generally happy with the progress made in implementation of the CP, and understands that there is widespread agreement that it is acceptable. We recommend, however, that a current set of requirements for the CP be generated prior to formal acceptance.

# Charge Questions

- **Assess whether DES has a viable plan to be ready for the start of survey operations by September 1, 2013.**
- 1. The panel should focus on the status and plans for technical readiness of the major components that are critical for operational success. Does the project have well-defined criteria for readiness, an executable plan to reach readiness for the critical operational components, and appropriate resources to carry out the plan? Those critical components include (A-K):**

## **A. survey observing plan (including survey strategy) and on-mountain software system to execute the observing plan**

- Primary Writer: C. Rockosi
- Contributors:
- Findings:
  - There is a design for survey strategy that achieves the required area, number of filters and depth, and which considers strategy for achieving the required photometric calibration accuracy.
  - The ObsTac survey planning software exists and has the required basic functionality. It has been tested in simulation and was successfully used during Science Verification.
- Comments:
  - The argument that the supernova observations make more productive use of bad-seeing time than main survey observations is broadly convincing. However, no information about the scientific usefulness vs. maximum or average time between observations was presented to evaluate whether the particular 7-day maximum delay selected by the project was a good choice.

## **A. survey observing plan (including survey strategy) and on-mountain software system to execute the observing plan**

- Primary Writer: C. Rockosi
- Contributors:
- Recommendations:
  - Confirm that, given the DES strategy of 1 degree dithers of the hex centers between tilings, that a minimum of four tilings will result in a photometric calibration that meets the DES requirements. Then consider survey strategies that will achieve that in each survey year and evaluate the risk of not getting a complete calibration each year.
  - Consider taking extra calibration data, at least in the first year or two, to make sure that there is enough. For example, observations of dense stellar fields or many tilings of a small area dithered as with the DES observing plan.
  - Develop a metric for when repeated observations of the supernova fields provide diminishing returns and consider using that extra bad-seeing time for calibration or other supporting data.

## **B. telescope + instrument + ancillary on-mountain systems with capability to acquire survey-quality data with sufficient efficiency to meet survey science goals**

- Primary Writer: Larry Stepp
- Contributors:

### **Telescope & Mountain Systems**

- Comments:
  - CTIO is completing a major rebuild of the Blanco Telescope, which added 8 tons of mass and a new Telescope Control System. A number of hardware, software and procedural problems were found during integration and commissioning, but most have been remedied during the 7 months of effort.
- Findings:
  - CTIO has made good progress rebuilding and recommissioning the Blanco Telescope
  - CTIO has a good system of telemetry to help diagnose problems with the Blanco
  - Improvements have been made in system robustness in response to risk assessment/failure modes analysis
  - 3% telescope downtime during first 260 hours of DECam operation is good reliability under the circumstances
  - Cooperation between the CTIO and DECam teams has been excellent

## **B. telescope + instrument + ancillary on-mountain systems with capability to acquire survey-quality data with sufficient efficiency to meet survey science goals**

- Primary Writer: Larry Stepp
- Contributors:

### **Telescope & Mountain Systems (2)**

- Findings:
  - Failure to meet inter-exposure time limits is a significant risk to survey efficiency and achievement of the survey area science goals; more improvement is needed
  - The team working on analysis of the BCAM and optical "donut" is making good progress in understanding the flexure and alignment issues, but more work is needed
  - Although not all requirements are currently met, it appears the work is on track to complete the needed improvements to get to acceptable telescope performance by the start of the survey
- Recommendations
  - Further work is needed to understand telescope flexure and reconcile BCAM and optical "donut" measurements, to improve image quality and pointing performance
  - CTIO should proceed with plans to repair the DIMM before the start of the survey
  - Further improvements in inter-exposure time are needed to ensure science goals can be met

## **B. telescope + instrument + ancillary on-mountain systems with capability to acquire survey-quality data with sufficient efficiency to meet survey science goals**

- Primary Writer: Larry Stepp
- Contributors:

### **Instrument**

- Findings:
  - DECam performance has generally been excellent
  - There are some issues with CCD linearity, bad column features, etc., but these are being worked
  - Instrument reliability of 1% downtime in first 260 hours of operation is excellent
  - Problems with ghost images and stray light have been analyzed and are being dealt with
  - Maintenance of the detector lab at FNAL to continue learning about CCD properties is an excellent approach
- Comments:
  - D. Silva reports DECam has already been a very successful facility instrument, with much interest from community observers

## **B. telescope + instrument + ancillary on-mountain systems with capability to acquire survey-quality data with sufficient efficiency to meet survey science goals**

- Primary Writer: Larry Stepp
- Contributors:

### **Instrument**

- Recommendations
  - It is important to carry through with plans to reduce the risk of exposing the CCDs to excessive light conditions
  - Add monitoring procedures to track any changes in CCD performance with time (fullwell level, etc.)

## C. reliable data transport system from mountain to off-mountain data archives

- Primary Writer: Mario Juric
- Contributors:
- Findings:
  - The transport mechanisms were exercised in Commissioning, Science Verification, and Extended Science Verification. They performed well in transferring the data from Chile to NCSA, and NCSA to NOAO, and storing them at NCSA. The DESDM file store experienced some problems, including complete filesystem loss. The team has successfully recovered from remote archives. The pending switch to centralized and better supported file store at NCSA is expected to reduce the probability of similar issues in the future.
- Comments:
  - The transport system to the data archive (at NCSA) appears to be working well. The handling of data at the archive is of greater concern. While the proximate cause of the data loss incident was hardware failure, the ultimate cause seems to have been human error that was allowed to persist due to insufficient processes in place to monitor system operations and data reliability.

## C. reliable data transport system from mountain to off-mountain data archives

- Primary Writer: Mario Juric
- Contributors:
- Recommendations
  - Complete the data store move to the “condo”.
  - Clearly designate the person responsible for data integrity, and have them report directly to DESDM PI.
  - Develop a clear disaster recovery plan. Solidify estimates on how long it would take to recover from a data loss incident, if reprocessing from raw data was needed.
  - Implement recommendation #12 from the May 2012 review and checksum all files.

## **D. data management system for operations-critical data processing, archiving of reduced data, and to efficiently serve data products to the collaboration**

- Primary Writer: Mario Juric
- Contributors:
- Findings:
  - The DESDM system is generally capable of receiving, archiving, and processing data through the “First Cut” pipeline to provide feedback on basic image quality metrics that are needed to track data quality and the progress of the survey.
  - The image differencing pipelines perform acceptably well for the envisioned time-domain science.
  - The processed data are stored and provided to the collaboration via an Oracle database (catalogs) and http (images/files). The database supports bulk downloads of catalogs.
  - The DESDM team is to be congratulated on delivering such a complex system given the extremely limited resources and tight schedules. However, given DESDM staffing levels, operations are at risk if the Supplemental Funding proposal to NSF is unsuccessful.

## **D. data management system for operations-critical data processing, archiving of reduced data, and to efficiently serve data products to the collaboration**

- Primary Writer: Mario Juric
- Contributors:
- Comments:
  - Going forward, DESDM should distinguish between tasks and products that are required to produce the final DES science products, and those required to ensure that DES is ready to begin and sustain operations. We define the latter as a) being able to sustain nightly operations and time-domain science, b) ensuring the data being taken are of sufficient quality to support DES science goals, and c) ensuring that all necessary data is being taken (eg., calibration frames), and d) ensuring the acceptance of the Community Pipeline. Given the limited resources, issues that do not fall into these categories should be de-prioritized.
  - Existing DESDM code base has been pushed to its limits, and future improvements are contingent on completing the refactoring effort. Establishment of clear processes and responsibilities lag behind the coding efforts; to enter operations, this should be remedied.

## **D. data management system for operations-critical data processing, archiving of reduced data, and to efficiently serve data products to the collaboration**

- Primary Writer: Mario Juric
- Contributors:
- Recommendations
  - Distinguish between requirements for start of operations, and science readiness. Prioritize the former. Develop a schedule integrated with the rest of the project.
  - Complete the code refactoring and ensure the refactored pipeline is ready for start of operations.
  - Formalize the acceptance criteria for the Community Pipeline, have all stakeholders formally agree to it. Develop a schedule for delivery.
  - Assess de-scope options in case the Supplemental Funding request to the NSF is unsuccessful. If it is impossible to de-scope w/o endangering the operations or the science goals of the survey, clearly explain and document why that is so.
  - Assign clear responsibilities for maintaining nightly pipeline operations and data integrity, and develop reporting processes.

## **E. Quality Assurance systems for data-quality monitoring on- and off-mountain (to enable survey operations decisions)**

- Primary Writer: C. Rockosi
- Contributors:
- Findings:
  - There is a version of the DESDM First Cut pipeline that can process the data in 24 hours and provides reductions sufficient to assess survey quality.
  - The code for data quality analysis on the First Cut reductions also exists and was run on the Science Verification data, though there is a desire to upgrade to the improved image quality metrics used to evaluate the SV data, and there remains a manual step to evaluate the QA analysis and uploaded information to the operations Survey Table.
  - There is also a set of Quick-Reduce and Image Health tools available for same-night feedback on data quality for the observer at CTIO.
- Comments:
  - The fact that a version of First Cut was used for the Science Verification analysis supports the assertion that First Cut can provide useful information for monitoring the survey data quality.

## **E. Quality Assurance systems for data-quality monitoring on- and off-mountain (to enable survey operations decisions)**

- Primary Writer: C. Rockosi
- Contributors:
- Comments:
  - The DESDM infrastructure that existed at the start of SV is adequate to keep up running the First Cut analysis during survey data-taking. However, not having the re-factored version of DESDM would be a significant risk to data integrity and the continued ability to keep up with data flow.
- Recommendations:
  - Before the start of Survey Operations, automate the photometric calibration and DQ assessment from the First Cut reductions and be able to upload of the DQ assessment to the Survey Table before the start of the next night's preparation. This will enable the Run Manager to function as intended in the survey operations plan.
  - Implement the proposed new image quality metric from the SV analysis in the First Cut analysis.
  - Deploy re-factored DESDM in time for the start of Survey Operations.

## F. survey-progress monitoring systems and metrics

- Primary Writer: David Wittman
- Contributors:
- Findings:
  - Survey-progress monitoring is tightly coupled with data-quality monitoring. DES has multiple systems for monitoring data quality, and these appear to be working well (see Charge E). In addition, mountaintop staffing plans and logging tools are more than sufficient to provide a layer of human backup to these automated tools. Each image's quality success/failure status is logged in a database which resides on the mountain and is queried by ObsTAC (the software which decides what to observe next). Thus, the survey-progress monitoring systems are robust against failures in the workflow downstream. However, downstream information (eg, that a particular image failed additional quality checks during processing at NCSA) is relatively easily propagated into the mountaintop database.
  - Survey progress can then be gauged with a database query. Tools for visualizing the progress are under development. In addition, extensive human-friendly nightly summaries are compiled by scraping various data sources. These nightly summaries will be very useful in tracing back any problems encountered during data processing.

## F. survey-progress monitoring systems and metrics

- Primary Writer: David Wittman
- Contributors:
- Comments:
  - There is not yet a well-defined procedure for propagating information about failed quality checks during firstcut or later processing, but the team have indicated that they will settle on such a procedure by Sep. 1. Doing so is much more a matter of agreeing on what constitutes bad data rather than a matter of software implementation. With respect to survey-progress monitoring systems and metrics, DES is very close to operational readiness, and can easily be at operational readiness by Sep. 1.
- Recommendations:
  - The team must define a procedure for propagating information about failed quality checks back into the survey table. This procedure should assign responsibility to a clearly identified person, perhaps the run manager, to ensure that this is done daily. The current reviewers do not consider this a risky item.

## **G. data management system to deliver data products that meet DESDM/DES requirements (and a DESDM acceptance testing plan to verify that)**

- Primary Writer: Mario Juric
- Contributors:
- Findings:
  - The Project has an Acceptance Testing Task Force that is charged with assessing the readiness of DESDM to deliver science grade images and catalogs to the whole Collaboration (coadds and fully processed single epoch images and catalogs). Each science working group has compiled the tests relevant to their science and created a team to facilitate their execution. A test requirements matrix exists and is being maintained. No standard test framework exists at the moment, but the Science Portal is planned to be used in the future. The team has presented tests performed on simulated data.

## **G. data management system to deliver data products that meet DESDM/DES requirements (and a DESDM acceptance testing plan to verify that)**

- Primary Writer: Mario Juric
- Contributors:
- Comments:
  - While assurances were made that the DESDM system delivers data products of sufficient quality to begin the SNe search mission, it does not yet satisfy all DES SRD requirements. The Committee believes this is something that can be improved upon in Operations, and is not considered a showstopper at the moment.
  - The acceptance test plan, developed by a team external to DESDM, is impressive. DESDM should develop in-house science expertise (an astronomer) to support communication with this team.
- Recommendations
  - Continue to develop the acceptance test suite, integrate it with the Science Portal
  - Plan for hiring additional staff with astronomical expertise to help with the acceptance tests and integration of science codes

## H. calibration plan and systems for early DES data

- Primary Writer: Tim Axelrod
- Contributors:
- Finding:
  - The photometric calibration plan is state of the art for wide field surveys. The instrumentation for probing the state of the atmosphere in particular is very well developed. The DECal system for generating monochromatic dome flats is complete, and is functioning well. The actual way this data will be used in the calibration process is not yet fully developed. Nonetheless, the calibration system is ready for operation.
- Recommendation:
  - The plan for making full utilization of the various calibration system data products should be completed by the end of the first survey season, and implemented prior to beginning of the second.
- Finding:
  - The calibration plan will need to respond to discrete changes in the telescope and DECam system, for example if a detector needs to be replaced. The procedure for doing so is not yet fully thought out.
- Recommendation:
  - The plan for dealing with discrete changes in the telescope/camera system should be formalized prior to beginning operations.

## H. calibration plan and systems for early DES data

- Primary Writer: Tim Axelrod
- Contributors:
- Finding:
  - The PreCam program to observe a set of photometric standards for the DES is incomplete. This incompleteness is likely to limit the accuracy of calibration, particularly in the y-band.
- Recommendation:
  - Completion of the PreCam program should be vigorously pursued, and if possible completed prior to the beginning of the second year of operations.

# I. plans for early science results

- Primary Writer: David Wittman
- Contributors:
- Findings:
  - The supernova team have already found and confirmed multiple supernovae, and made plans for many nights of spectroscopic followup this fall. Supernova science is the only time-critical component in the DES suite, and they appear to be operationally ready. We saw evidence that other science teams were engaged, eg a weak-lensing mass map of a galaxy cluster in SV data, but it is not clear that they are ready for data processing and analysis on a massive scale this fall.
  - A science analysis software framework is under development.
- Comments:
  - Because supernova science is time-critical, future review panels might appreciate more information about operational readiness of the supernova team: do they have enough people to inspect all the candidates? How are those people scheduled? We saw that the number of candidates per night has decreased by several orders of magnitude; is this enough or is further progress desired or to be expected? We suspect that the team is more than ready, but we felt that in an operational readiness review this type of information should feature prominently.

# I. plans for early science results

- Primary Writer: David Wittman
- Contributors:
- Comments:
  - If other science teams are indeed not ready for data processing and analysis on a massive scale this fall, we do not view this as an impediment to starting operations. However, DES is not in a state of science readiness (apart from supernovae). The other working groups are engaged, but we were not presented with a great deal of evidence that they are science-ready. They are currently (appropriately) engaged with relatively basic debugging of SV data. The presentations in these review contained only sparse information about activities of science teams beyond this task.
  - The science analysis framework seems to be a promising development.
  - If it really fosters joint analyses using multiple probes, that could become a real strength of the survey.
- Recommendations:
  - In future reviews, DES presenters should very clearly separate operational readiness issues from science readiness issues. When science readiness becomes a major focus, brief reports directly from the people trying to do the science would be helpful.

**J. Schedule and Resources – Does DES have an overall schedule including milestones for the delivery of components necessary to be in place for survey operations to begin in September? Has the DES project team identified and secured sufficient resources to accomplish these goals?**

- Primary Writer: Fernanda G. Garcia
- Contributors:
- Findings:
  - CTIO facility infrastructure has been completed and the DECam and subsystems have been successfully installed, tested and commissioned at Cerro Tololo. SV & Extended SV observing are complete.
  - SV period used “old” DESDM system. The completion for DESDEM refactoring project is now expected to occur at the end of FY13Q3.
  - Support for DECam equipment and associate subsystems are defined

**J. Schedule and Resources – Does DES have an overall schedule including milestones for the delivery of components necessary to be in place for survey operations to begin in September? Has the DES project team identified and secured sufficient resources to accomplish these goals?**

- Primary Writer: Fernanda G. Garcia
- Contributors:
- Comments:
  - The installation and commissioning of the DECam and its subsystems at Cerro Tololo are complete. Training materials and procedures have been written and available for DES experimenters and CTIO technical staff who will maintain DECam for DES. Congratulations!
  - DESDM funding constraints are a big concern on the overall project progress.
    - Additional fund was requested late Cal2012 (\$835K).
  - It was clear through all the review period that some level of confusion in regards of what is necessary for operations readiness and science readiness.
  - Despite the fact there are “ToDoLists” on each of the DESDM categories it was unclear which items were essential for the start of operations and which ones would impact science readiness

**J. Schedule and Resources – Does DES have an overall schedule including milestones for the delivery of components necessary to be in place for survey operations to begin in September? Has the DES project team identified and secured sufficient resources to accomplish these goals?**

- Primary Writer: Fernanda G. Garcia
- Contributors:
- Recommendations:
  - Identify the essential tasks that need to be complete for both operations readiness and science readiness.
  - An Integrated schedule needs to be put in place and track. This schedule should include the science code and the calibration.
  - In the scenario no additional DESDM funding from NSF is granted, another revenues need to be explore within collaboration institutions.

## **K. Have the appropriate level of ES&H (Environmental, Safety, and Health) aspects been implemented to assure personnel safety and reliable operation of the DES systems?**

- Primary Writer: Eric McHugh
- Contributors:
- Findings:
  - The project is cognizant of risks and vulnerabilities to the CTIO and DECam mission critical systems.
  - The project is "hardening the CTIO systems" making them more robust and redundant.
  - The project has also obtained spares of critical components with moderate to high probability of failures.
  - The project continues to review systems and has staged critical equipment at CTIO that is not readily accessible.

## **K. Have the appropriate level of ES&H (Environmental, Safety, and Health) aspects been implemented to assure personnel safety and reliable operation of the DES systems?**

- Primary Writer: Eric McHugh
- Contributors:
- Comments:
  - The committee believes that the project has implemented the appropriate level of ES&H aspects to ensure personnel safety. There is evidence that the project has formally evaluated some mission critical system risks for reliability. It is not readily apparent that all mission critical system risks for reliability have been evaluated. Documents such as the "DECam Installation and Related CTIO Infrastructure" and the "DECam Systems Operations & Maintenance Plan" attempt to outline the critical infrastructure risks and vulnerabilities, but do not formally list and evaluate the risks and vulnerabilities.
- Recommendations
  - Create a formal mission critical risk/vulnerabilities register. Evaluate each risk/vulnerability and respond with the understanding of the risk or mitigation efforts.

## **2. Assess whether the DES has adequately identified risks in its operational readiness plan and formulated a strategy for mitigating the major risk factors.**

- Primary Writer: Larry Stepp
- Contributors:
- Findings:
  - DES and CTIO have done risk analyses, including a risk audit of the CTIO facility, and have formulated strategies for mitigating the risks (but see recommendation in response to question 1.K about implementing a formal risk register to ensure visibility to management).

### **3. Provide recommendations if necessary on how the operational readiness plan should be improved, including additional resources.**

- Primary Writer: Tim Axelrod
- Contributors:
- Finding:
  - There is not a complete set of operational readiness requirements, and those that exist are not always clearly separated from science readiness requirements.
- Recommendation:
  - Separate sets of requirements should be generated for operational readiness and science readiness, and committed to by DES management.
- Finding:
  - While every group within the project has a planned set of tasks leading to operational readiness, there is not an integrated plan for the project as a whole.
- Comment:
  - The lack of an integrated plan increases the likeliness that necessary items will be overlooked, particularly those at the boundaries of group responsibilities.
- Recommendation:
  - The project should create an integrated operational readiness plan, showing the sequencing, durations, and resources of the required tasks. To be effective, this should be completed no later than June, 2013.

## 4. Assess whether the project has adequately responded to the previous review recommendations.

- Primary Writer: Eric McHugh
- Contributors: Tim Axelrod
- Findings:
  - The committee believes that most recommendations have been responded to and addressed adequately, with actions completed or in progress. The following need further action:
  - Recommendations 2.1.1 and 6.1 (project response refers to 2.1.1) have not been addressed adequately. The recommendation states, "Formalize the risk analysis with likelihood, consequences, and mitigation measures to capture the large-picture failures that could result in major program delays." The committee was not presented with a formal risk analysis that would satisfy this recommendation.
  - Recommendation 7.1a: An integrated plan for operations and science is still needed.
  - Recommendation 7.1d: The previous review called for identification of descopes to fall within the expected funding envelope, with a scientific assessment of the impacts. This still needs to be addressed for DESDM, considering the uncertainty of obtaining the requested additional funding.

# End of Presentation