

## Commissioning Science Data Quality Analysis Tools, Methods and Procedures

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(Dated: April 23, 2020)

### ABSTRACT

The Vera C. Rubin Observatory will conduct a 10-year survey of the night sky visible from Chile to address many questions at the frontier of astrophysics and cosmology research. The survey will collect many petabytes of image data, which will be processed to generate a diverse set of derived data products, each with stringent set of requirements flowed down from science drivers. Meanwhile, the observatory itself is a collection of complex subsystems that must function together to deliver high-quality scientific images. We describe here the systems engineering approach adopted by the Rubin Observatory construction project used to verify each step of the system integration, and to monitor the system performance over time. We focus on the application of these tools to science verification and validation during commissioning.

This paper has potential overlap / connections with several other Construction Papers, including the Alert Production (PSTN-038) and Data Release Production (PSTN-039) science verification papers based on commissioning data, as well as several of the Data Management papers, such as “LSST Data Management Quality Assurance and Reliability Engineering” (PSTN-023) and “LSST Data Management System Verification and Validation” (PSTN-024). In order to distinguish this paper from the others, the current draft outline takes more of a systems engineering approach, and focuses on technical aspects over scientific aspects. The two commissioning science verification papers are intended for a science user audience interested in the high-level science performance and data products of the as-built Rubin Observatory, and it is envisioned that those papers will focus on results, rather than methods. Meanwhile, based on current draft outlines, it seems that the Data Management papers are focusing on the testing methodologies and tools used when developing the science pipelines and Data Management system, with less emphasis on the commissioning and overall system integration specifically. Therefore, this paper would provide an overview of the systems engineering approach adopted by the project, using the science performance as a specific example of the application. It does not appear that the other construction papers cover this topic. One intended audience is the LSST Operations Team that would likely use much of the tooling to monitor system performance over time, and to help evaluate the science quality of data releases.

- Paragraph to introduce the LSST, emphasizing the size/richness/complexity of the dataset, multiple data processing steps, and stringent requirements on systematic uncertainty
- Paragraph to describe how the science drivers translate to high-level requirements on scientific performance of the survey and flow-down to observatory specifications, written for a systems engineering audience
- During commissioning, both the datasets and science pipelines are evolving rapidly, and we need a verification framework that will be functional at survey scale
- Paragraph to briefly describe the verification and validation framework used for commissioning
- Pointers to other relevant Rubin Observatory construction papers for context

## 2. VERIFICATION ARCHITECTURE AND TOOLS FOR SYSTEM INTEGRATION AND COMMISSIONING

(Austin, Gabriele)

- Integrated modeling approach
- Description of verification architecture, including concepts of Verification Elements, Test Plans, Test Cases, etc.
- Description of verification tooling, e.g., MagicDraw, Syndeia, and JIRA
- Description of verification workflow
- Description of visualization and status tooling

### 3. APPLICATION TO SCIENCE VERIFICATION AND VALIDATION FOR COMMISSIONING

(Keith, Andy, Jeff, Simon)

- Examples to illustrate use of verification architecture described above
- Description of science verification analysis framework used in commissioning
- Example results showing summary of verification status during commissioning

### 4. DISCUSSION

- Brief summary of the utility / effectiveness of the verification framework used in commissioning
- We intend to use this framework during LSST Operations, with the following suggestions for improvement
- We hope that these strategies might be useful for future projects

## APPENDIX

### **Initial paper list added here for reference.**

“Editor” is a responsible team leader but not necessarily the person who will do most of the required work, or who will eventually become the first author. Both issues will be handled by individual teams.

domain: Telescope & Site

editor: Jeff Barr

title: Overview of the LSST Telescope

domain: Telescope & Site

editor: Sandrine Thomas

title: Performance of the LSST Telescope

domain: Telescope & Site

editor: Lynne Jones

title: The LSST Scheduler Overview and Performance

domain: Telescope & Site

editor: Bo Xin

title: Performance of the LSST Active Optics System

domain: Telescope & Site

editor: Tiago Ribeiro

title: LSST Observing System Software Architecture

domain: Camera

editor: Justin Wolfe

title: LSST Camera Optics

domain: Camera

editor: Chris Stubbs

title: LSST Camera Rafts

domain: Camera

editor: Steve Ritz

title: LSST Camera Cryostat

domain: Camera

editor: Ralph Schindler

title: LSST Camera Refrigeration

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editor: Steve Ritz

title: LSST Camera Body and Mechanisms

domain: Camera

editor: Mark Huffer and Tony Johnson

title: LSST Camera Control System and DAQ

domain: Camera

editor: Tim Bond and Aaron Rodman

title: LSST Camera Integration and Tests

domain: Data Management

editor: Leanne Guy

title: Overview of LSST Data Management

domain: Data Management  
editor: Michelle Butler  
title: LSST Data Facility

domain: Data Management  
editor: Tim Jenness  
title: LSST Data Management Software System

domain: Data Management  
editor: Jim Bosch  
title: LSST Data Release Processing

domain: Data Management  
editor: Eric Bellm  
title: LSST Prompt Data Products

domain: Data Management  
editor: Gregory Dubois-Felsmann  
title: LSST Science Platform

domain: Data Management  
editor: Simon Krughoff  
title: LSST Data Management Quality Assurance and Reliability Engineering

domain: Data Management  
editor: Leanne Guy (with likely delegation to new DM V&V Scientist)  
title: LSST Data Management System Verification and Validation

domain: Data Management  
editor: Mario Juric  
title: LSST Moving Object Processing

domain: Data Management  
editor: Robert Lupton  
title: LSST Calibration Strategy and Pipelines

domain: Calibration  
editor: Patrick Ingraham  
title: Performance of the LSST Calibration Systems

domain: Calibration  
editor: Patrick Ingraham  
title: Atmospheric Properties with the LSST Auxiliary Telescope

domain: EPO  
editor: Amanda Bauer  
title: Overview of LSST Education and Public Outreach

domain: EPO  
editor: Ardis Herrold  
title: LSST Formal Education Program

domain: EPO  
editor: Amanda Bauer  
title: LSST EPO: The User Feedback

domain: Commissioning  
editor: Chuck Claver  
title: LSST Observatory System Operations Readiness Report

domain: Commissioning  
editor: Bo Xin  
title: Performance of Delivered LSST System

domain: Commissioning  
editor: Chuck Claver  
title: Active Optics Performance with LSST Commissioning Camera

domain: Commissioning  
editor: Chuck Claver  
title: LSST Active Optics Performance with the LSST Science Camera

domain: Commissioning  
editor: Brian Stalder  
title: Integration, Test and Commissioning Results from LSST Commissioning Camera

domain: Commissioning  
editor: Kevin Reil  
title: LSST Camera Instrumental Signature Characterization, Calibration and Removal

domain: Commissioning

editor: Patrick Hascal  
title: Installation and Performance of the LSST Camera Refrigeration System

domain: Commissioning  
editor: Andy Connolly  
title: Science Validation of LSST Alert Processing

domain: Commissioning  
editor: Keith Bechtol  
title: Science Validation of LSST Data Release Processing

domain: Commissioning  
editor: Michael Reuter  
title: Tracking of LSST System Performance with Continuous Integration Methods

domain: Commissioning  
editor: Chuck Claver  
title: The LSST Science Platform as a Commissioning Tool

domain: Commissioning  
editor: Chuck Claver  
title: Commissioning Science Data Quality Analysis Tools, Methods and Procedures

domain: Commissioning  
editor: Lynne Jones  
title: Performance Verification of the LSST Survey Scheduler

## A. REFERENCES

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## B. ACRONYMS

<b>Acronym</b>	<b>Description</b>
ADS	Astrophysics Data System
DAQ	Data Acquisition System
DM	Data Management
EPO	Education and Public Outreach
LPM	LSST Project Management (Document Handle)
LSE	LSST Systems Engineering (Document Handle)
LSST	Legacy Survey of Space and Time (formerly Large Synoptic Survey Telescope)
LaTeX	(Leslie) Lamport TeX (document markup language and document preparation system)
NEO	Near-Earth Object
OpSim	Operations Simulation
PSTN	Project Science Technical Note
TBD	To Be Defined (Determined)