



Vera C. Rubin Observatory
Data Management

Characterization Metric Report: Science Pipelines Version 23.0.0

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Abstract

This brief report describes measurements of data quality metrics that were carried out for release v23.0.0 of the LSST Science Pipelines. The report for the previous version can be found in [DMTR-311].

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Characterization Metric Report: Science Pipelines Version 23.0.0

In this Report, we characterize the performance of the Rubin Observatory Science Pipelines Version 23.0.0. We illustrate the performance via metrics that are measured on the HSC-RC2 dataset. RC2 consists of 3 tracts of data taken from the HSC-SSP survey, and selected to provide a means of testing various “pathological” cases (e.g., difficult astrometric solutions, extremely good seeing that does not provide a well-sampled PSF, difficult fields for deblending, and large galaxies, among others). These three tracts each contain between 112–149 visits split between the HSC-G, HSC-R, HSC-I, HSC-Z, and HSC-Y (*grizy*) filters.

Version 23.0.0 represents the first data release production pipeline that relies entirely on Gen3 middleware; Gen2 middleware is now deprecated as of this release.

All metrics reported here were calculated using the *faro* metric calculation package, which is part of the standard pipeline builds. All of the underlying algorithms to calculate metrics within *faro* are the same as they were in v22.0.0 of the Science Pipelines, so most metrics are expected to show similar results between v22 and v23 releases.

The metric calculation pipelines from *faro* were run on the RC2 tracts to derive the photometric, astrometric, and shape metrics that are reported here. We exclude the two astrometry metrics (AM3 and AF3) that concern residuals on 200-arcminute scales, since the individual tracts of RC2 do not span large enough spatial scales to enable these measurements.

For comparison, we provide the [SRD](#) required “design” value of each metric as defined in the Science Requirements Document [LPM-17]. For context, the [SRD](#) does not place any constraints on *y*-band for these Key Performance Metrics (KPMs). For the photometric metrics, there are only specifications for *g*, *r*, and *i*. In the case of the ellipticity correlation metrics, there are specs only for *r* and *i*. The *y*-band measurements are of interest primarily for historical tracking.

Some KPMs (e.g., PF1, AF1, AF2) involve thresholds that are different for “design”, “minimum”, and “stretch” specifications. Metrics in this report are all compared to the “design” thresholds. The assessment of these KPMs would be different if evaluated against different thresholds.

1 Note about sky backgrounds

In the v23.0.0 release of the Science Pipelines, the application of `skyCorr` (the global full focal plane background estimation) has been disabled for HSC data due to a bug in the pipelines that was being investigated at the time of the release (see DM-32827 for details). This will be fixed before release v23.0.1. The absence of the `skyCorr` background corrections has a minor effect on coadd images, but all data products produced before the coaddition steps are unaffected. Of the metrics reported in this document, only the ellipticity correlations (Section 6) TE1 and TE2 are measured on coadds.

2 Metric monitoring dashboard

Since the previous Science Pipelines release, we have created a new dataset called `rc2_subset`, which is a small selection of data from the RC2 dataset that includes only the 6 central detectors from 8 randomly chosen visits in each of the 5 filters *grizy*. This dataset was created with the goal of covering a large enough area and including an ample number of sources for data quality monitoring in all five available HSC filters, but that is a small enough dataset that it can be reprocessed in its entirety in a nightly continuous integration (CI) job. This job has been dubbed `verify_drp_metrics`, and is automatically executed in Jenkins CI nightly. Data quality metrics calculated by `faro` are dispatched to SQuaSH (Science Quality System Harness; described in [SQR-009]) and a dashboard displaying time-series plots of the metrics is updated daily to enable monitoring of data quality. Figure 1 shows a snapshot of the SQuaSH dashboard.

3 Summary of performance metrics

Because there have been no major changes in the data processing algorithms in the Science Pipelines between versions 22.0.0 and 23.0.0, the data quality metrics should be similar. Indeed, the astrometry metrics (Section 5) are nearly identical (19 are unchanged, 10 changed by $< 2.5\%$, and 9 changed by 6 – 16%; the median change was 1.2%) between the previous (v22) and current (v23) Science Pipelines releases. The photometry metrics (Section 4) and ellipticity correlation metrics (Section 6) show small differences between Release 22 and 23, most of which represent minor improvements in the metric values. A likely explanation for these minor improvements is the work done on ticket DM-31505, which updated the FGM photo-

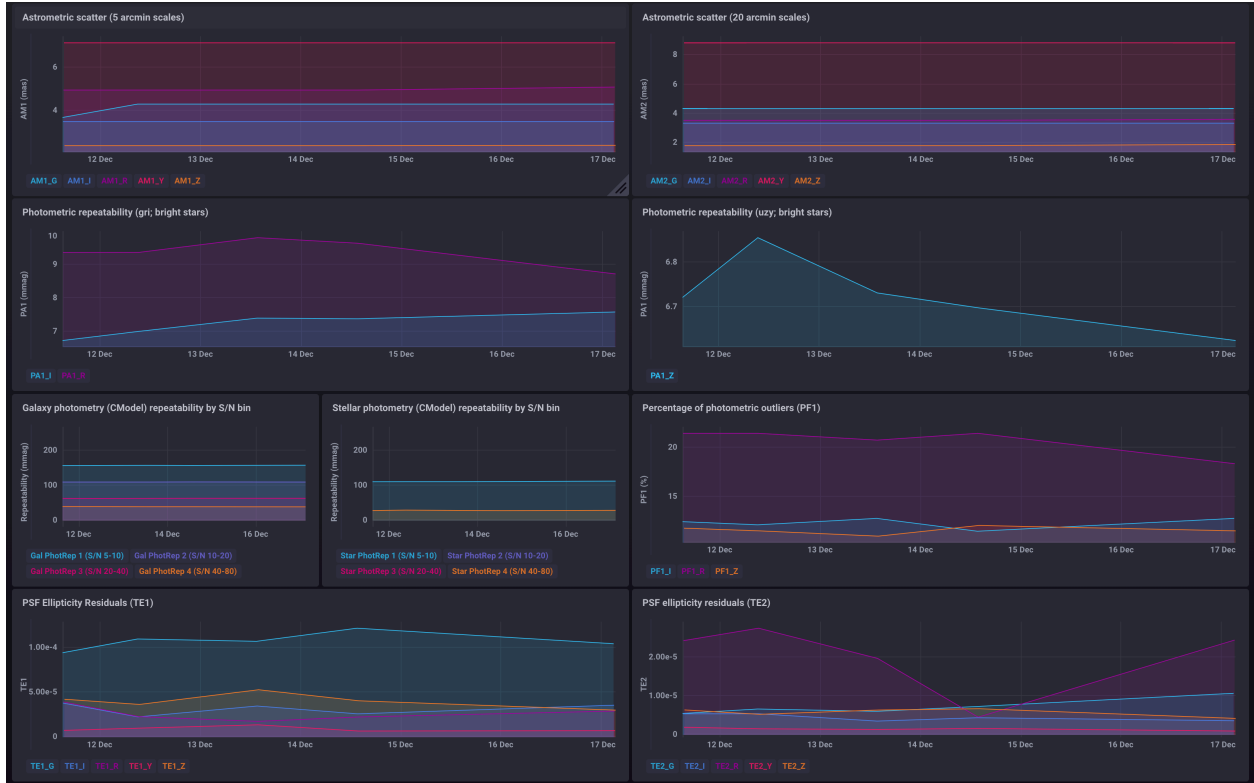


FIGURE 1: A portion of the “DRP metrics nightly CI Gen3 (rc2_subset)” dashboard on SQuaSH. This was recently created for daily tracking of metrics calculated on the rc2_subset dataset via the nightly verify_drp_metrics CI job. The view shown here tracks metrics calculated each day for the past week. Although no changes in the science pipelines over the week displayed should contribute to changes in data quality, there are small fluctuations seen in many metrics. This is under investigation, but is likely due to small changes in data products brought about by non-deterministic behavior in some calibration algorithms.

metric calibration algorithms to better handle fields of view near the spatial edges of survey footprints. This likely affects RC2 data, because they consist of three distinct, isolated tracts, and thus have a relatively large fraction of “edge” data. It is obvious that improvements to the photometric *calibration* will improve the measured photometry; the effects on ellipticity correlations likely arise due to the slightly different photometric calibrations altering the weights that are applied to individual frames during coaddition.

4 Photometric Performance

These photometric performance metrics are defined in LSS-REQ-0093 (LSE-29) and Table 14 of LPM-17. Values in this table represent the mean of the results reported by faro for the

three tracts in RC2.

Any entries left blank are those for which we do not have data in the given filter for that dataset.

Metric	Unit	SRD Re-requirement - Design	Release 22 Value (RC2)	Release 23 Value (RC2)	Comments
PA1: <i>u</i>	mmag	≤ 7.5	—	—	No data
PA1: <i>g</i>	mmag	≤ 5.0	7.6	7.1	
PA1: <i>r</i>	mmag	≤ 5.0	8.5	8.4	
PA1: <i>i</i>	mmag	≤ 5.0	9.2	8.7	
PA1: <i>z</i>	mmag	≤ 7.5	7.0	6.7	
PA1: <i>y</i>	mmag	≤ 7.5	8.0	7.9	
PF1: <i>u</i>	%	≤ 20	—	—	No data
PF1: <i>g</i>	%	≤ 20	12.0	10.7	
PF1: <i>r</i>	%	≤ 10	14.5	14.0	
PF1: <i>i</i>	%	≤ 10	16.0	14.5	
PF1: <i>z</i>	%	≤ 20	8.7	8.1	
PF1: <i>y</i>	%	≤ 10	12.0	11.5	

5 Astrometric Performance

The following metrics are defined following LSR-REQ-0094 [LSE-29] and Table 18 of LPM-17. Values in this table represent the mean of the results reported by *faro* for the three tracts in RC2.

Any entries left blank are those for which we do not have data in the given filter for that dataset.

Metric	Unit	SRD Re-requirement - Design	Release 22 Value (RC2)	Release 23 Value (RC2)	Comments
AM1: <i>u</i>	mas	≤ 10	—	—	No data
AM1: <i>g</i>	mas	≤ 10	5.3	5.3	

Metric	Unit	SRD Re- quirement - Design	Release 22 Value (RC2)	Release 23 Value (RC2)	Comments
AM1: <i>r</i>	mas	≤ 10	5.0	4.9	
AM1: <i>i</i>	mas	≤ 10	4.3	4.4	
AM1: <i>z</i>	mas	≤ 10	5.1	5.1	
AM1: <i>y</i>	mas	≤ 10	6.7	6.7	
AF1: <i>u</i>	%	≤ 10	—	—	No data
AF1: <i>g</i>	%	≤ 10	0.8	0.8	
AF1: <i>r</i>	%	≤ 10	1.6	1.5	
AF1: <i>i</i>	%	≤ 10	0.6	0.5	
AF1: <i>z</i>	%	≤ 10	0.9	0.8	
AF1: <i>y</i>	%	≤ 10	2.7	2.5	
AD1: <i>u</i>	mas	≤ 20	—	—	No data
AD1: <i>g</i>	mas	≤ 20	7.6	7.5	
AD1: <i>r</i>	mas	≤ 20	7.6	7.6	
AD1: <i>i</i>	mas	≤ 20	6.4	6.4	
AD1: <i>z</i>	mas	≤ 20	7.8	7.8	
AD1: <i>y</i>	mas	≤ 20	10.1	10.0	
AM2: <i>u</i>	mas	≤ 10	—	—	No data
AM2: <i>g</i>	mas	≤ 10	5.2	5.2	
AM2: <i>r</i>	mas	≤ 10	4.8	4.8	
AM2: <i>i</i>	mas	≤ 10	4.3	4.4	
AM2: <i>z</i>	mas	≤ 10	5.2	5.2	
AM2: <i>y</i>	mas	≤ 10	6.5	6.5	
AF2: <i>u</i>	%	≤ 10	—	—	No data
AF2: <i>g</i>	%	≤ 10	0.9	0.8	
AF2: <i>r</i>	%	≤ 10	1.2	1.0	
AF2: <i>i</i>	%	≤ 10	0.7	0.6	
AF2: <i>z</i>	%	≤ 10	0.9	0.8	
AF2: <i>y</i>	%	≤ 10	3.5	3.2	
AD2: <i>u</i>	mas	≤ 20	—	—	No data
AD2: <i>g</i>	mas	≤ 20	7.7	7.7	
AD2: <i>r</i>	mas	≤ 20	7.4	7.4	
AD2: <i>i</i>	mas	≤ 20	6.4	6.5	

Metric	Unit	SRD Requirement - Design	Release 22 Value (RC2)	Release 23 Value (RC2)	Comments
AD2: <i>z</i>	mas	≤ 20	7.9	7.8	
AD2: <i>y</i>	mas	≤ 20	11.0	10.8	
AB1: <i>u</i>	mas	≤ 10	—	—	No data
AB1: <i>g</i>	mas	≤ 10	8.4	8.5	
AB1: <i>r</i>	mas	≤ 10	4.6	4.6	
AB1: <i>i</i>	mas	≤ 10	5.2	5.1	
AB1: <i>z</i>	mas	≤ 10	4.4	4.4	
AB1: <i>y</i>	mas	≤ 10	6.1	6.1	

6 Ellipticity Correlations

The following metrics are defined following LSR-REQ-0097 [LSE-29] and Table 27 of LPM-17. Values in this table represent the mean of the results reported by *faro* for the three tracts in RC2.

Any entries left blank are those for which we do not have data in the given filter for that dataset.

Metric	Unit	SRD Requirement - Design	Release 22 Value (RC2)	Release 23 Value (RC2)	Comments
TE1: <i>u</i>	—	$\leq 2 \times 10^{-5}$	—	—	No data
TE1: <i>g</i>	—	$\leq 2 \times 10^{-5}$	1.5×10^{-5}	1.8×10^{-5}	
TE1: <i>r</i>	—	$\leq 2 \times 10^{-5}$	2.6×10^{-4}	3.0×10^{-5}	
TE1: <i>i</i>	—	$\leq 2 \times 10^{-5}$	1.9×10^{-5}	1.0×10^{-5}	
TE1: <i>z</i>	—	$\leq 2 \times 10^{-5}$	9.4×10^{-6}	7.9×10^{-6}	
TE1: <i>y</i>	—	$\leq 2 \times 10^{-5}$	4.8×10^{-5}	1.3×10^{-5}	
TE2: <i>u</i>	—	$\leq 1 \times 10^{-7}$	—	—	No data
TE2: <i>g</i>	—	$\leq 1 \times 10^{-7}$	1.1×10^{-6}	9.7×10^{-7}	
TE2: <i>r</i>	—	$\leq 1 \times 10^{-7}$	2.0×10^{-6}	1.1×10^{-6}	
TE2: <i>i</i>	—	$\leq 1 \times 10^{-7}$	1.5×10^{-6}	1.5×10^{-6}	

Metric	Unit	SRD Requirement - Design	Release 22 Value (RC2)	Release 23 Value (RC2)	Comments
TE2: z	—	$\leq 1 \times 10^{-7}$	8.4×10^{-7}	8.2×10^{-7}	
TE2: y	—	$\leq 1 \times 10^{-7}$	1.4×10^{-6}	1.4×10^{-6}	

7 Computational Performance

Computational performance metrics were not measured for this release.

A References

- [1] **[DMTR-311]**, Carlin, J., 2021, *Characterization Metric Report: Science Pipelines Version 22.0.0*, DMTR-311, URL <http://DMTR-311.lsst.io>
- [2] **[LSE-29]**, Claver, C.F., The LSST Systems Engineering Integrated Project Team, 2017, *LSST System Requirements (LSR)*, LSE-29, URL <https://ls.st/LSE-29>
- [3] **[SQR-009]**, Fausti, A., 2017, *The SQuaSH metrics dashboard*, SQR-009, URL <https://sqr-009.lsst.io>
- [4] **[LPM-17]**, Ivezić, Ž., The LSST Science Collaboration, 2018, *LSST Science Requirements Document*, LPM-17, URL <https://ls.st/LPM-17>

B Acronyms

Acronym	Description
CI	Continuous Integration
DM	Data Management
DMTR	DM Test Report

DRP	Data Release Production
FGCM	Forward Global Calibration Model
HSC	Hyper Suprime-Cam
LPM	LSST Project Management (Document Handle)
LSE	LSST Systems Engineering (Document Handle)
LSR	LSST System Requirements; LSE-29
LSST	Legacy Survey of Space and Time (formerly Large Synoptic Survey Telescope)
PSF	Point Spread Function
SQuaSH	Science Quality Analysis Harness
SRD	LSST Science Requirements; LPM-17