Rubin Observatory

Vera C. Rubin Observatory
Data Management

Characterization Metric Report: Science Pipelines Version 21.0.0

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DMTR-281

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Abstract

This brief report describes measurements of interest that were carried out for release v21.0.0 of the Science Pipelines. The report for the previous version can be found in [DMTR-251].

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Characterization Metric Report: Science Pipelines Version 21.0.0

In this Report, we characterize the performance of the Rubin Observatory Science Pipelines Version 21.0.0. 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, seeing too small to 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. The validate_drp scripts were run on these tracts to derive the photometric, astrometric, and shape metrics that are reported here. We exclude the three astrometry metrics (AM3, AD3, and AF3) that concern residuals on 200-arcminute scales, since neither the handful of CCDs in the validation_data_hsc dataset nor the individual tracts of RC2 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 (AF1, AD1) involve thresholds that are different for "design", "minimum", and "stretch" specifications. The 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 Summary of performance metrics

Metrics are typically monitored on a dashboard hosted by SQuaSH (Science Quality System Harness; described in [SQR-009]). Here we show an example of this dashboard displaying ~ 6 months of measurements for a few metrics. These measurements are for tract 9813, as measured in the *r*-band filter (HSC-R). The astrometry (two upper panels) and ellipticity (lower right plot) metrics have remained roughly the same since the Version 20.0.0 release in late June, 2020. Likewise, all of the astrometry metrics summarized in Section 3 are similar to, or

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slightly better than, the Version 20.0.0 values. Note, however, that there is a large increase in the photometric repeatability metric in late June – this can also be seen in the photometric KPMs summarized in Section 2. This happened because shortly after the release of version 20.0, we began using FGCM [1] for photometric calibration instead of jointcal. In general, FGCM is optimized for survey self-calibration with multiple exposures overlapping in space and time, and is not optimized for individual isolated tracts as in the RC2 dataset. Thus, while FGCM is likely to enable much better overall survey calibration, at RC2 scales it may offer little improvement compared to jointcal. Nonetheless, we expect the photometry metrics to continue to improve as we understand the effects of implementing FGCM in the Science Pipelines.

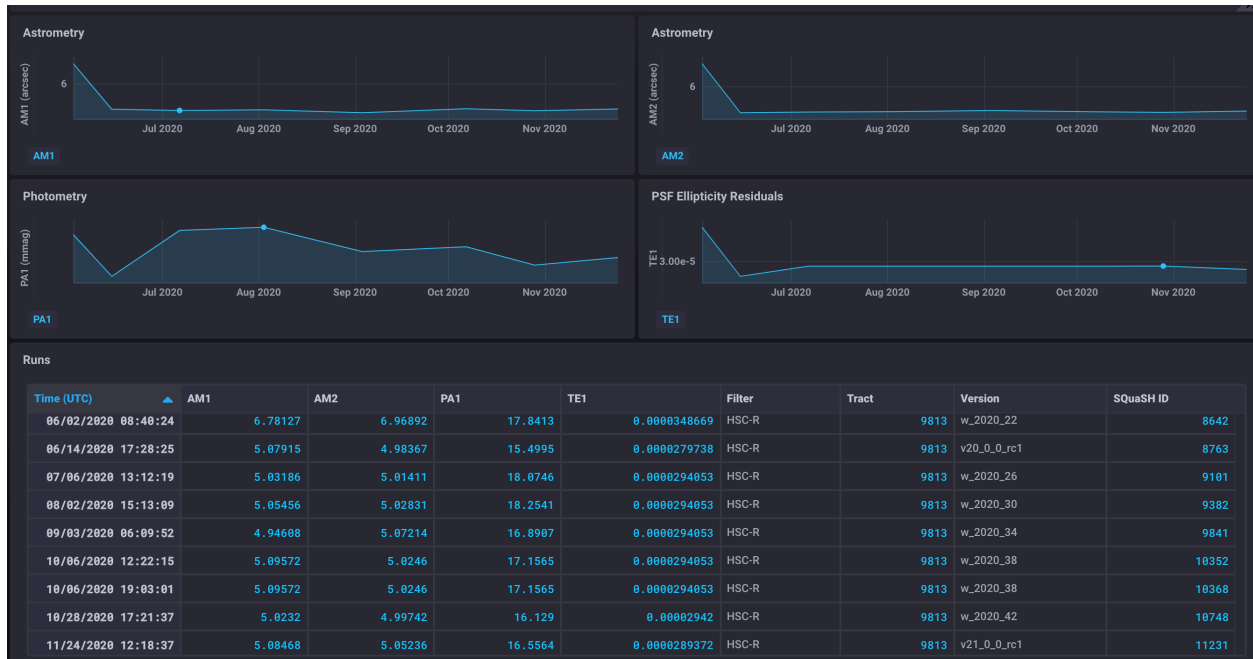| Time (UTC)	AM1	AM2	PA1	TE1	Filter	Tract	Version	SQuaSH ID
06/02/2020 08:40:24	6.78127	6.96892	17.8413	0.0000348669	HSC-R	9813	w_2020_22	8642
06/14/2020 17:28:25	5.07915	4.98367	15.4995	0.0000279738	HSC-R	9813	v20_0_0_rc1	8763
07/06/2020 13:12:19	5.03186	5.01411	18.0746	0.0000294053	HSC-R	9813	w_2020_26	9101
08/02/2020 15:13:09	5.05456	5.02831	18.2541	0.0000294053	HSC-R	9813	w_2020_30	9382
09/03/2020 06:09:52	4.94608	5.07214	16.8907	0.0000294053	HSC-R	9813	w_2020_34	9841
10/06/2020 12:22:15	5.09572	5.0246	17.1565	0.0000294053	HSC-R	9813	w_2020_38	10352
10/06/2020 19:03:01	5.09572	5.0246	17.1565	0.0000294053	HSC-R	9813	w_2020_38	10368
10/28/2020 17:21:37	5.0232	4.99742	16.129	0.00002942	HSC-R	9813	w_2020_42	10748
11/24/2020 12:18:37	5.08468	5.05236	16.5564	0.0000289372	HSC-R	9813	v21_0_0_rc1	11231

FIGURE 1: SQuaSH dashboard showing the past four months of metric measurements from the RC2 dataset. This view shows the metrics for tract 9813 in the HSC-R filter. The degraded performance in the photometry metrics after late June was due to the introduction of a new photometric calibration method known as FGCM, replacing jointcal. The metrics have continued to improve since the introduction of FGCM (but are still slightly worse than previous results using jointcal), as our understanding of FGCM's effects on the pipeline outputs evolves.

2   Photometric Performance

These photometric performance metrics are defined in LSS-REQ-0093 (LSE-29) and Table 14 of LPM-17.

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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 20 Value (RC2)	Release 21 Value (RC2)	Comments
PA1: u	mmag	≤ 7.5	—	—	No data
PA1: g	mmag	≤ 5.0	12.7	13.8	
PA1: r	mmag	≤ 5.0	14.1	14.7	
PA1: i	mmag	≤ 5.0	14.0	14.7	
PA1: z	mmag	≤ 7.5	11.6	11.8	
PA1: y	mmag	≤ 7.5	13.5	14.3	
PF1: u	%	≤ 20	—	—	No data
PF1: g	%	≤ 20	28.6	31.1	
PF1: r	%	≤ 10	31.1	33.0	
PF1: i	%	≤ 10	31.7	33.7	
PF1: z	%	≤ 20	13.2	14.1	
PF1: y	%	≤ 10	16.6	17.6	
PA2: u	%	≤ 22.5	—	—	No data
PA2: g	%	≤ 15	27.9	29.0	
PA2: r	%	≤ 15	29.8	30.1	
PA2: i	%	≤ 15	29.7	31.6	
PA2: z	%	≤ 22.5	25.5	26.4	
PA2: y	%	≤ 22.5	29.6	29.2	

3 Astrometric Performance

The following metrics are defined following LSR-REQ-0094 [LSE-29] and Table 18 of LPM-17.

Metric	Unit	SRD Requirement – Design	Release 20 Value (RC2)	Release 21 Value (RC2)	Comments
AM1: u	mas	≤ 10	—	—	No data
AM1: g	mas	≤ 10	4.9	4.8	

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Metric	Unit	SRD Requirement – Design	Release 20 Value (RC2)	Release 21 Value (RC2)	Comments
AM1: r	mas	≤ 10	5.2	5.2	
AM1: i	mas	≤ 10	4.5	4.4	
AM1: z	mas	≤ 10	4.8	4.9	
AM1: y	mas	≤ 10	6.7	6.6	
AF1: u	%	≤ 10	—	—	No data
AF1: g	%	≤ 10	0.4	0.5	
AF1: r	%	≤ 10	1.4	1.3	
AF1: i	%	≤ 10	0.5	0.5	
AF1: z	%	≤ 10	0.5	0.4	
AF1: y	%	≤ 10	2.8	3.1	
AD1: u	mas	≤ 20	—	—	No data
AD1: g	mas	≤ 20	5.9	6.0	
AD1: r	mas	≤ 20	7.4	7.4	
AD1: i	mas	≤ 20	5.7	5.8	
AD1: z	mas	≤ 20	6.7	6.6	
AD1: y	mas	≤ 20	11.3	10.8	
AM2: u	mas	≤ 10	—	—	No data
AM2: g	mas	≤ 10	5.0	5.0	
AM2: r	mas	≤ 10	6.4	5.0	
AM2: i	mas	≤ 10	4.4	4.4	
AM2: z	mas	≤ 10	5.0	5.0	
AM2: y	mas	≤ 10	6.8	6.8	
AF2: u	%	≤ 10	—	—	No data
AF2: g	%	≤ 10	0.5	0.6	
AF2: r	%	≤ 10	1.1	1.1	
AF2: i	%	≤ 10	0.7	0.6	
AF2: z	%	≤ 10	0.5	0.4	
AF2: y	%	≤ 10	2.7	2.8	
AD2: u	mas	≤ 20	—	—	No data
AD2: g	mas	≤ 20	5.7	6.0	
AD2: r	mas	≤ 20	6.8	6.9	
AD2: i	mas	≤ 20	5.7	5.8	

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Metric	Unit	SRD Requirement – Design	Release 20 Value (RC2)	Release 21 Value (RC2)	Comments
AD2: z	mas	≤ 20	6.0	5.9	
AD2: y	mas	≤ 20	10.6	10.5	

4 Ellipticity Correlations

The following metrics are defined following LSR-REQ-0097 [LSE-29] and Table 27 of LPM-17.

Metric	Unit	SRD Requirement – Design	Release 20 Value (RC2)	Release 21 Value (RC2)	Comments
TE1: u	—	$\leq 2 \times 10^{-5}$	—	—	No data
TE1: g	—	$\leq 2 \times 10^{-5}$	1.4×10^{-5}	1.3×10^{-5}	
TE1: r	—	$\leq 2 \times 10^{-5}$	2.0×10^{-5}	2.1×10^{-5}	
TE1: i	—	$\leq 2 \times 10^{-5}$	1.1×10^{-5}	9.2×10^{-6}	
TE1: z	—	$\leq 2 \times 10^{-5}$	1.6×10^{-5}	1.7×10^{-5}	
TE1: y	—	$\leq 2 \times 10^{-5}$	9.3×10^{-6}	9.2×10^{-6}	
TE2: u	—	$\leq 1 \times 10^{-7}$	—	—	No data
TE2: g	—	$\leq 1 \times 10^{-7}$	3.7×10^{-7}	3.6×10^{-7}	
TE2: r	—	$\leq 1 \times 10^{-7}$	1.0×10^{-6}	9.5×10^{-7}	
TE2: i	—	$\leq 1 \times 10^{-7}$	2.5×10^{-6}	1.8×10^{-6}	
TE2: z	—	$\leq 1 \times 10^{-7}$	5.0×10^{-7}	5.4×10^{-7}	
TE2: y	—	$\leq 1 \times 10^{-7}$	$1,2 \times 10^{-6}$	1.1×10^{-6}	

5 Computational Performance

Computational performance metrics were not re-measured for this release.

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[1] Burke, D.L., Rykoff, E.S., Allam, S., et al., 2018, AJ, 155, 41 (`arXiv:1706.01542`), doi:10.3847/1538-3881/aa9f22, ADS Link

[2] **[DMTR-251]**, Carlin, J., 2020, *Characterization Metric Report: Science Pipelines Version 20.0.0*, DMTR-251, URL `http://dmtr-251.lsst.io`

[3] **[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`

[4] **[SQR-009]**, Fausti, A., 2017, *The SQuaSH metrics dashboard*, SQR-009, URL `https://sqr-009.lsst.io`

[5] **[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
DM	Data Management
DMTR	DM Test Report
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
PSF	Point Spread Function
SQuaSH	Science Quality Analysis Harness
SRD	LSST Science Requirements; LPM-17