



Analysis of First NEOWISE-R IOC Scan Rate Test

14 December 2013

Technical memo WSDC D-T043

1. Introduction

This was the first of what may be a series of experiments designed to determine the optimal scan rates for the NEOWISE-R mission. During this test, data were acquired at eleven different X scan rates (while holding the Y scan rate constant) and at eleven different Y scan rates (while holding the X scan rate constant). Near-standard pipeline processing was used to derive metrics on the resulting image quality for each discrete rate. Discussion and analysis are presented below. These metrics are hereby delivered to Ned Wright so that he can determine the best scan rates to target for the survey (or next set of tests).

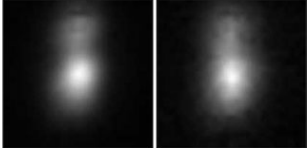
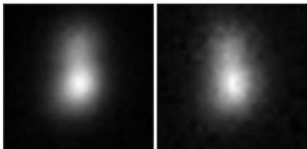
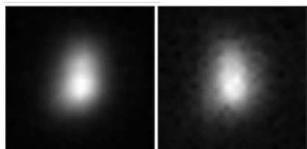
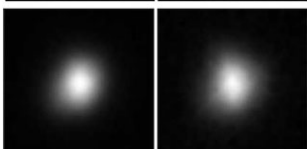
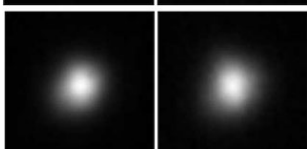
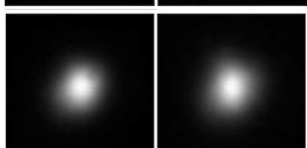
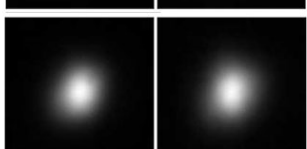
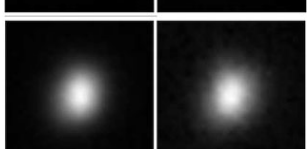
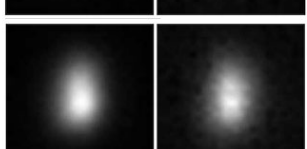
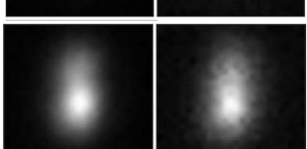
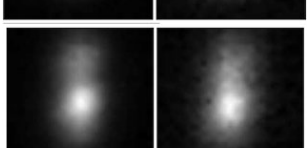
2. Analysis

A series of continuous framesets having similar scan rates were grouped into a "scan" for the purposes of data processing. Approximately 12-14 framesets were taken at each scan rate value.

a. Varying the Y -scan Rate

In the first set of eleven scans, the X scan rate was held near a commanded value of $+0.0125$ arcmin/sec while different values of the Y scan rate were used. Framesets for each of these discrete Y scan rates were assigned to scans 44210a through 44210k.

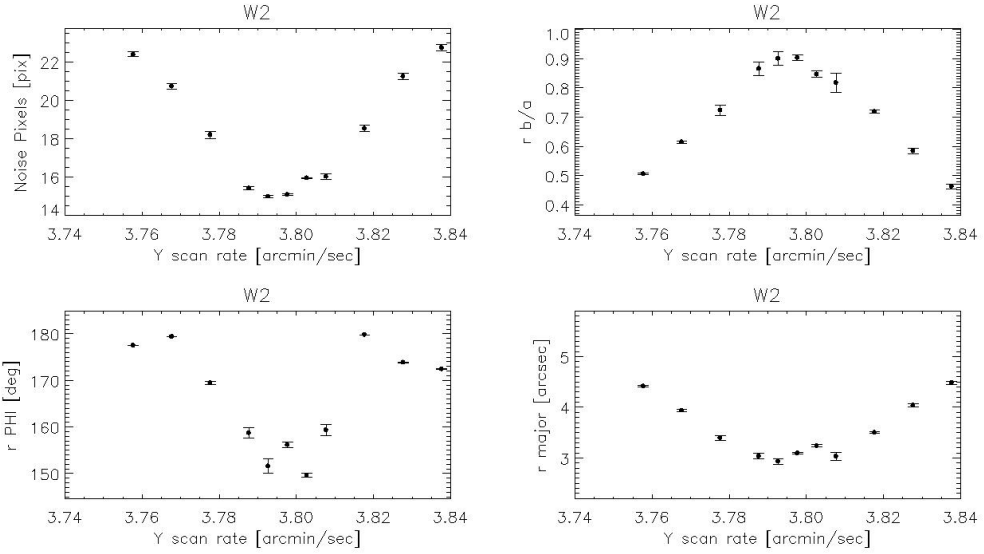
As input to *PSFmoments*, composite PSFs were generated for each scan using high-quality detections in the individual frames. The graphic below shows the composite PSFs for each of these scans. Shown from left to right in each row are the composite PSF for bands W1 and W2, the scan number, and the commanded Y scan rate.

	44210a	3.7577"/s
	44210d	3.7677"/s
	44210e	3.7777"/s
	44210h	3.7877"/s
	44210i	3.7927"/s
	44210k	3.7977"/s
	44210j	3.8027"/s
	44210g	3.8077"/s
	44210f	3.8177"/s
	44210c	3.8277"/s
	44210b	3.8377"/s

Using the composite PSFs, a number of image quality metrics were derived. These metrics, along with other parameters, are listed in the table below, and are

- *ScanDesc*: short description of scan
- *MedianScanRateX*: The commanded *X*-axis scan rate (in arcmin/s)
- *MedianScanRateY*: The commanded *Y*-axis scan rate (in arcmin/s)
- *MedianScanRateZ*: The commanded *Z*-axis scan rate (in arcmin/s)
- *x*: *x*-pixel location (in pixels)
- *y*: *y*-pixel location (in pixels)
- *mom1x*: 1st moment, *x*-axis (in pixels)
- *mom1y*: 1st moment, *y*-axis (in pixels)
- *mom2x*: 2nd moment, *x*-axis (i.e., the semi-major axis, in pixels)
- *mom2y*: 2nd moment, *y*-axis (i.e., the semi-minor axis, in pixels)
- *r_major*: Major axis (in pixels; for plotting purposes, we multiply this quantity by 2.75/3.00 to convert from binned pixels to arcsec)
- *rbovera*: Axis ratio
- *rPHI*: Position angle, measured east of north (in degrees)
- *r_05p*: Semi-major axis of the half-power points (in arcsec)
- *r_01p*: Semi-major axis of the 0.1-power points (in arcsec)
- *bovera*: Axis ratio from the 0.1-power points
- *PHI*: Position angle, measured east of north, from the 0.1-power points (in degrees)
- *NoisePix*: Effective number of noise pixels in the PRF (in pixels)
- *SigNSPix*: 1-sigma uncertainty of *NoisePix* (in pixels)
- *Sigmom1x*: 1-sigma uncertainty of *mom1x* (in pixels)
- *Sigmom1y*: 1-sigma uncertainty of *mom1y* (in pixels)
- *Sigmom2x*: 1-sigma uncertainty of *mom2x* (in pixels)
- *Sigmom2y*: 1-sigma uncertainty of *mom2y* (in pixels)
- *Sigrmajor*: 1-sigma uncertainty of *r_major* (in arcsec)
- *SigPHI*: 1-sigma uncertainty of *rPHI* (in degrees)
- *Sigbovera*: 1-sigma uncertainty of *rbovera*
- *ScanStartUTC*: Frame date/time at start of scan.
- *ScanEndUTC*: Frame date/time at end of scan.
- *Frames-in-SAA*: The percentage of frames in the scan impacted by a passage through the South Atlantic Anomaly.

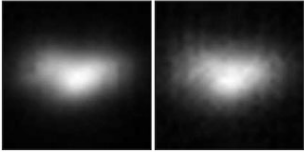
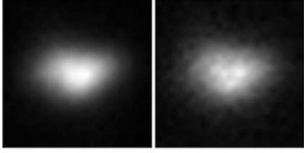
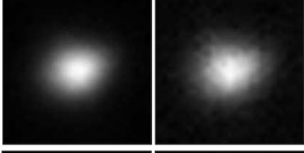
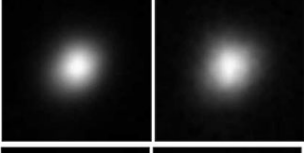
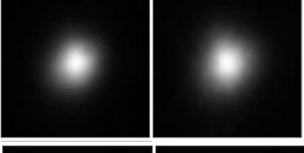
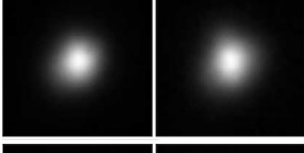
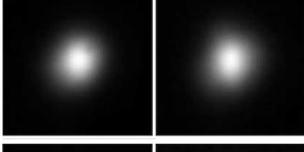
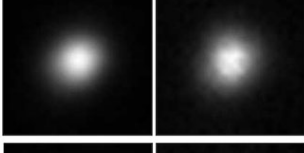
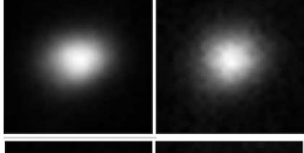
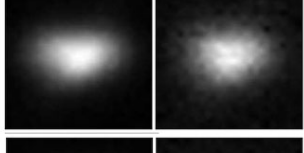
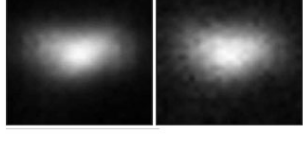
The most useful of these are *NoisePix*, *rbovera*, *rPHI*, *r_major*, and their associated errors, so it is on those metrics that we focus our attention in the subsequent discussion.



b. Varying the X-scan Rate

In the second set of eleven scans, the Y scan rate was held near a commanded value of 3.7977 arcmin/sec while the X scan rate was varied. Framesets for each of these discrete X scan rates were assigned to scans 44211a through 44211k.

The image below shows the composite PSFs for each of these scans.

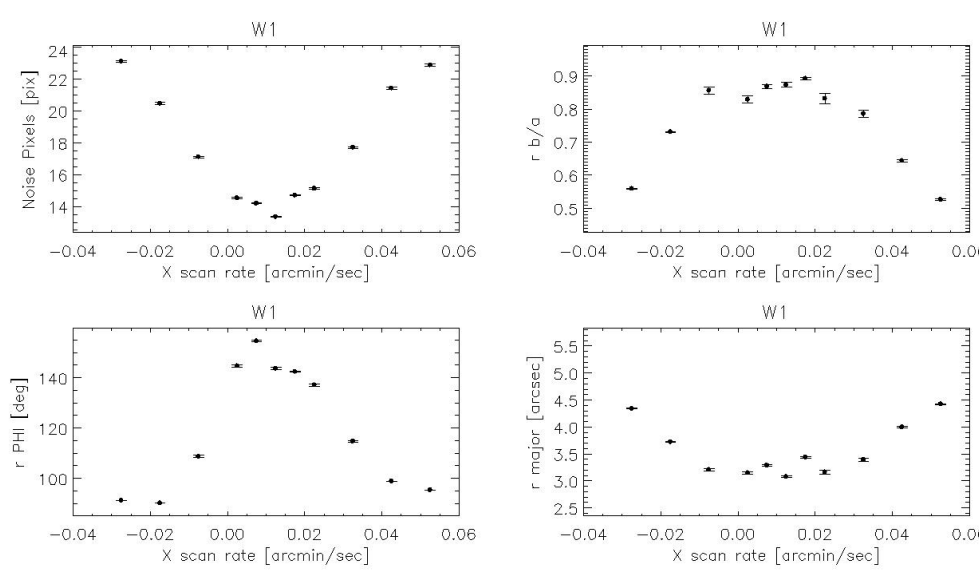
	44211a -0.0275'/s
	44211d -0.0175'/s
	44211e -0.0075'/s
	44211h +0.0025'/s
	44211i +0.0075'/s
	44211k +0.0125'/s
	44211j +0.0175'/s
	44211g +0.0225'/s
	44211f +0.0325'/s
	44211c +0.0425'/s
	44211b +0.0525'/s

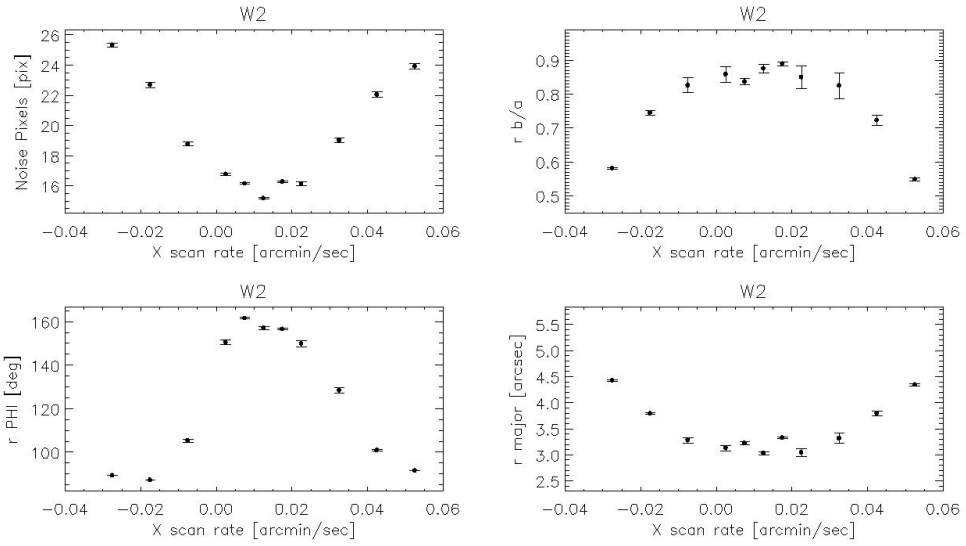
Summary tables for W1 (top) and W2 (bottom) are shown below. ASCII versions are included in the e-mail distribution:

ScanRate		MedianScanRate1	MedianScanRate2	x	y	wsk1	wsk2	wsk3	wsk4	r_ajor	rbovera	rPHI	r_rbp	r_rbovera	PHI	NoisePix	1sigmaPHI	1sigmaPHI	1sigmaPHI	1sigmaPHI	1sigmaPHI	1sigmaPHI	1sigmaPHI	1sigmaPHI	1sigmaPHI	ScanRateUTC	ScanRateUTC	ScanRateUTC	ScanRateUTC	Frames-in-Scan	Percentage
id	chr	pix	pix	pix	pix	pix	pix	pix	pix	pix	pix	pix	pix	pix	pix	deg	deg	deg	deg	deg	deg	deg	deg	deg	deg	id	chr	id	chr	id	chr
44215A/1	0.874999995980	3.776799232369	0.000000000000	13.20	13.86	13.8754	13.8754	4.7771	2.0965	4.7071	0.5591	91.20	5.1852	10.2532	6.5800	92.00	23.100	0.860	0.872	0.877	0.889	0.894	0.889	0.880	0.882	2013-347711758152.242	2013-34771197122.926	0.00	0.00		

ScanRate		MedianScanRate1	MedianScanRate2	x	y	wsk1	wsk2	wsk3	wsk4	r_ajor	rbovera	rPHI	r_rbp	r_rbovera	PHI	NoisePix	1sigmaPHI	1sigmaPHI	1sigmaPHI	1sigmaPHI	1sigmaPHI	1sigmaPHI	1sigmaPHI	1sigmaPHI	ScanRateUTC	ScanRateUTC	ScanRateUTC	ScanRateUTC	Frames-in-Scan	Percentage	
id	chr	pix	pix	pix	pix	pix	pix	pix	pix	pix	pix	pix	pix	pix	pix	deg	deg	deg	deg	deg	deg	deg	deg	deg	deg	id	chr	id	chr	id	chr
44215A/2	0.874999995980	3.776799232369	0.000000000000	13.20	13.86	13.8754	13.8754	4.7771	2.0965	4.7071	0.5591	91.20	5.1852	10.2532	6.5800	92.00	23.100	0.860	0.872	0.877	0.889	0.894	0.889	0.880	0.882	2013-347711758152.242	2013-34771197122.926	0.00	0.00		

In the graphics below, *W1 NoisePix*, *rbovera*, *rPHI*, and *r_major* and their associated 1-sigma uncertainties are plotted as a function of the X-axis scan rate for each scan group. The first plot shows W1, and the second shows W2.





3. Conclusions

a. Y-scan Rate

The composite PSFs for the varying Y scan rates are well behaved and the metrics derived from them are easily understood.

Our quick assessment, done by examining the W1 and W2 metrics, shows that the best Y -scan rate likely falls between 3.7927 and 3.7977 armin/s.

b. X-scan Rate

The composite PSFs for the varying X scan rates are also well behaved and the metrics derived from them are easily understood.

Our quick assessment, done by examining the W1 and W2 metrics, shows that the best X -scan rate is likely very close to +0.0125 arcmin/s.

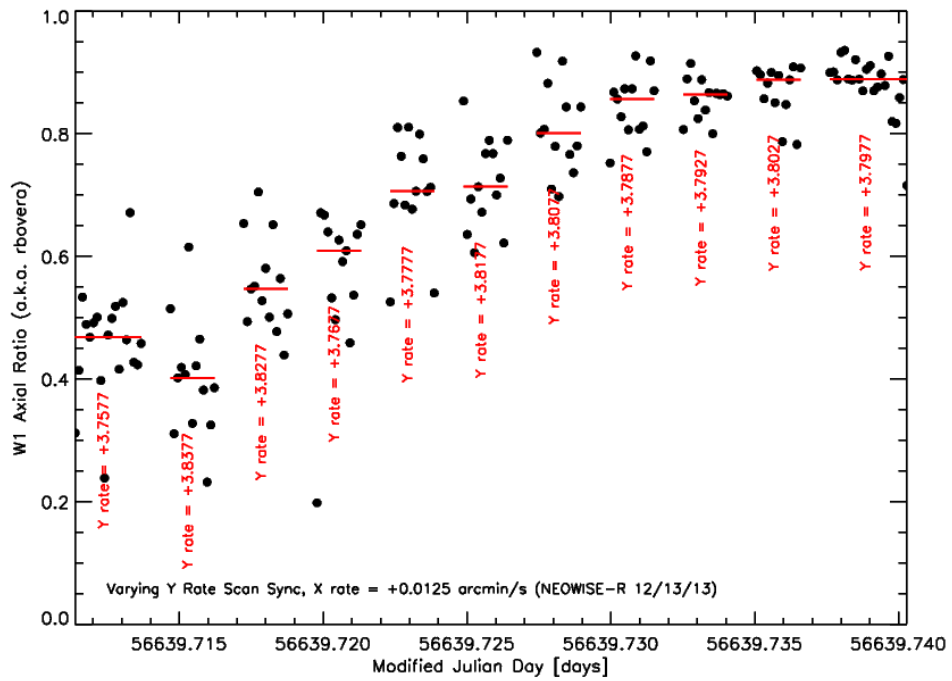
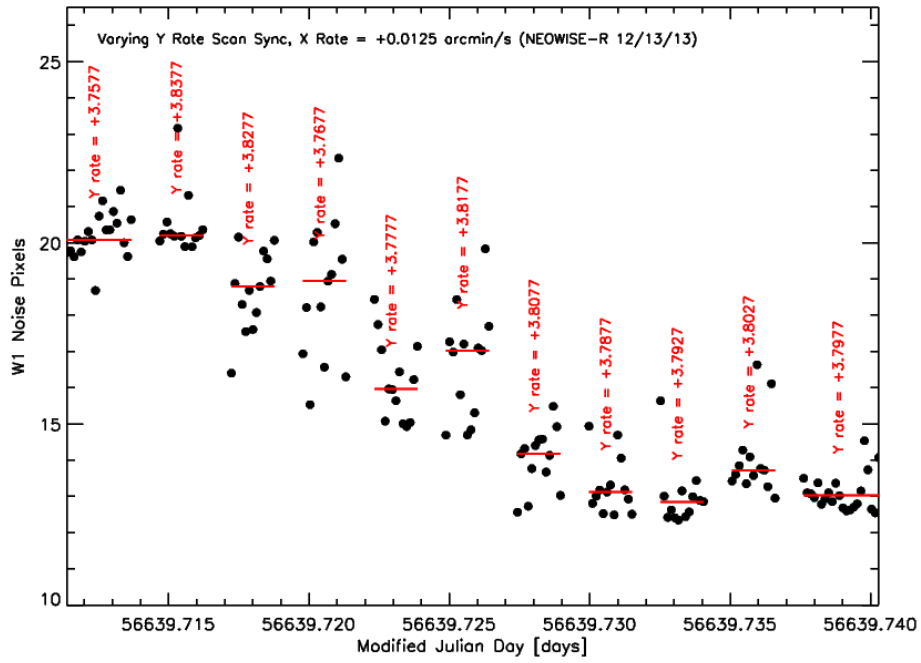
c. Summary

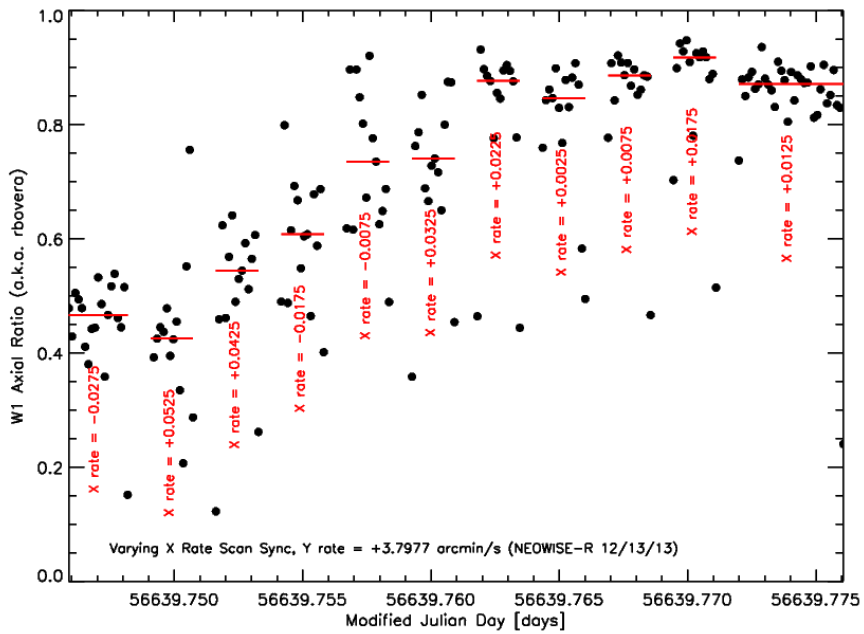
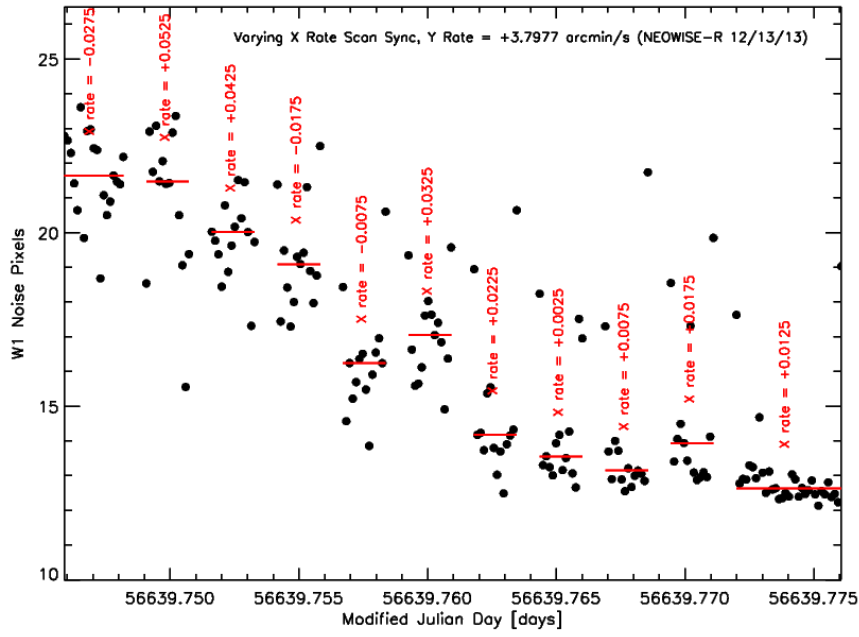
Ned Wright will use the data tabulated above to make a more rigorous determination of the best parameters to use in subsequent observations.

4. Appendix

As a check of scan-averaged image metrics, we include the following plots that show the frame-based *W1 NoisePix* values and the *W1 rbovera* values plotted as a function of time. The first pair of plots shows the Y-rate test, and the second pair shows the X-rate test. The red horizontal bars on each plot show the median value in each set of frames, and the extent of the bar is drawn to show the full time range of the scan over which this median value is computed.

There can be small amounts of image smearing at the beginning and end of each scan. These frames are not eliminated by *PSFmoments*, so they are included in the scan-averaged metrics. As an example, we checked all frames in scans 44211i and 44211j and found that only frames 001 and 015 (the first and last framesets in each) are smeared, as judged by the plot showing aperture *minus* PSF mag as a function of mag. (For brevity, these plots, which appear on the webQA pages, are not reproduced here.) Because affected frames are few in number, these do not adversely affect the scan-based metrics.





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