EXHIBIT D

Preliminary measurements of APF Telescope Pointing and Tracking

By: R. Kibrick, UCO/Lick Version 2.0, July 26, 2009

SUMMARY

Telescope engineering tests of the APF Telescope were conducted remotely from UC Santa Cruz on the nights of June 10, June 23, and July 16. These tests demonstrated that we could successfully operate both the telescope and dome remotely and that the telescope points and tracks adequately to routinely acquire and track stars in all parts of the sky. The telescope easily meets the specified pointing requirement, and meets the 10-minute open-loop tracking performance requirement in most parts of the sky tested so far. We have not yet had an opportunity to measure the 60-minute open-loop tracking performance.

Based on the measurements completed so far, we expect that the tracking performance requirements will be met once the final optical alignment of the telescope and the guide camera are completed later this year.

BACKGROUND

Although measurements of the telescope tracking performance were carried out on all 3 nights in an effort to check compliance with the specified requirements, the results of those tests are confounded by several factors:

1. Since the wind direction on all 3 nights was predominantly from NW to N, the results from tests performed on objects observed in the north include the effects of wind shake.

2. The dome thermal control system is not yet fully optimized, so there were significant differences between the temperature of the telescope and the outside air during the first part of all 3 engineering nights, resulting in degraded dome seeing.

3. The apparent center of field rotation changes depending upon where in the sky the telescope is pointed, and quite often falls outside of the unvignetted field of view of the guide camera. The resulting field rotation needs to be determined and subtracted out, thus complicating the measurement process and adding an additional potential source of error.

We expect all three of these factors to be significantly reduced as work continues on the telescope and its control systems:

1. Wind shake should be reduced once the dome shutters are engaged to track the telescope position so as to serve as a windscreen. Due to mechanical adjustments being made to the dome shutters and telescope during the weeks when the 3 engineering nights were conducted, this windscreen functionality was disabled during our tracking performance measurements. As a result, the dome shutters were left parked in the fully open position during observing, thereby leaving the telescope maximally exposed and thus subject to significant wind shake whenever the dome shutter was pointed into the wind. Also, during the week of July 20, vibration dampers were

installed on the primary mirror support system and these should further reduce the effects of wind shake (although that remains to be confirmed).

2. We will continue to collect and analyze temperature measurements from inside the telescope and dome and to adjust parameters of the dome thermal control system in an effort to better match those temperatures to the expected nighttime temperature of the outside air so as to improve the dome seeing.

3. We believe that the variations in the center of field rotation as observed in images from the guide camera are most likely due to a misalignment of the guide camera stage and/or one or more of the upstream optical elements. Final optical alignment has not yet been completed on either the telescope or the guide camera system. Once those alignments are completed, we expect these field rotation issues to be resolved.

POINTING ACCURACY

Pointing observations of 87 targets spaced across the sky were collected on-site on June 8 and used to generate a telescope pointing (or mount) model. Pre-fit residuals were 29.49 arcsec RMS in azimuth, 46.66 arcsec in elevation, and 55.19 overall. Post-fit residuals were 1.27 arcsec and 1.85 arcsec RMS, respectively, in az and el, and 2.24 arcsec overall. A list of observations, residuals, and pointing terms is attached to this report as Appendix A.

This pointing model was then installed and verified that night. This same pointing model was used for all three remote engineering nights (June 10, 23, and July 16) and the blind pointing was sufficiently good on the first two of those nights that all objects landed near the center of the guide camera on initial acquisition. The pointing accuracy achieved should be sufficient to support the APF planet search observing program.

The pointing accuracy was not quite as good (but still adequate) on the third engineering night (July 16), but this appears to be due to the installation of the atmospheric dispersion compensator (ADC) earlier in July; the ADC sits in the optical beam between the tertiary mirror and the pickoff mirror for the guide camera, and it appears to introduce a position offset in the image the guide camera sees. A new pointing model should be generated to account for the offset caused by the ADC.

TRACKING ACCURACY

<u>June 10 measurements</u>

In an attempt to satisfy Acceptance Test Reference Item 2.1, "10 minute Open-loop tracking test", a 10-minute-long open-loop tracking test with the APF Telescope was conducted on the night of Wednesday, June 10 over the 10-minute interval starting at 22:57:35 to 23:07:34 PDT. The telescope was tracking a 12th magnitude object at 12h 54m 34s and +14 52 11.6. The telescope elevation angle was about 53 degrees and the azimuth about 240 degrees. There was a 10-15 MPH wind at azimuth 255-260. The seeing estimate from the Shane 3-meter Telescope for optical wavelengths was 1.2 to 1.4 arcsec.

The object was acquired and the telescope offset slightly so as to position the image of the object at the center of the guide camera, i.e., at pixel coordinates (256,256). The guide camera exposure time was set to 1-s and full-frame (i.e., 512x512 pixel) images were being read out, so overall the frame rate was 0.912 Hz, or one 1-s exposure read every 1.097 seconds. This corresponds to 547 such images being recorded

during this 10-minute interval. For each such image, the centroid of the star position was computed, and the RMS tracking error derived from those measurements. A plot of tracking errors versus time is attached as Appendix B.

Because of blowing fog that started before sunset but which did not drop below the summit until well after 18-degree twilight, we did not have an opportunity to open up the dome to allow the telescope and mirror to reach thermal equilibrium prior to starting the observation sequence. Accordingly, overall seeing was likely significantly degraded by dome seeing.

Under these conditions, the measured RMS open-loop tracking error over this 10-minute interval was 0.312 arcsec for the X (or column) axis and 0.479 arcsec in the Y (or row) axis. Added in quadrature, these yield an overall tracking error of .572 arcsec, which exceeds by almost 15% the limit of 0.5 arcsec specified under under Acceptance Test 2.1: "< 0.5 arcseconds (over 0-70 degree zenith angle)".

However, given that a significant component of this measured error may be due to the other factors described earlier (i.e., unmitigated wind shake, dome seeing, and unexpected variations in the center of field rotation), the RMS tracking error itself may be within the specified requirement.

<u>June 23 measurement</u>

On the second telescope engineering night conducted 13 days later (June 23), further attempts were made to measure the telescope tracking accuracy. To reduce dome seeing effects, during the day the air conditioning system in the dome was turned on and the inside of the dome cooled to a temperature a few degrees colder than the predicted nighttime outside temperature. The dome shutters and vents were opened at twilight to enable the temperature inside the dome to equalize with that outside. However, despite these efforts, our prediction of the expected nighttime temperature was well off the mark, and there were still significant temperature gradients at the start of the night.

Since the APF Telescope is an alt-az mount and since there is no image de-rotator, the APF camera mounted at the Nasmyth focus sees a rotating field. As reported earlier, the center of that field rotation currently does not appear to fall on the APF guide camera CCD where expected (i.e., in the center of the CCD), presumably due to misalignment of the APF guide camera and/or one or more of the upstream optical elements. In addition, the center of field rotation currently lands in a different spot on the CCD (or, in most cases, completely outside the imaging area of the CCD) as you point to target objects in different parts of the sky. Presumably, these problems will be corrected once the various optical elements of the telescope and guide camera are properly aligned.

At present, because of the extreme difficulty (or impossibility) of simultaneously placing the image of target object at the center of field rotation AND onto the guide camera's CCD, if you position the image of a target object onto a specific pixel on the CCD (e.g., the pixel at the center of the CCD), in nearly all cases it will rotate away from that pixel as the telescope tracks that object across the sky. Accordingly, if one attempts (as we did on June 10) to measure the tracking performance of the telescope by simply measuring the drift (relative to that pixel) in the position of the image of that target object over a given time interval (e.g., 10 minutes), the dominant source of error typically will be due to field rotation rather than the telescope tracking errors that one is trying to measure.

Because of these problems, attempts to measure tracking performance during the June 23 engineering night were abandoned. Instead, images were obtained to characterize the behavior of the telescope secondary mirror focus.

July 16 measurements

To compensate for the variation in the center of field rotation observed when tracking star fields in different parts of the sky, software was developed to determine the apparent center of field rotation from a sequence of consecutive images obtained while tracking a given star field over an interval of time (typically 10 minutes). Once that determination is made, the field rotation effects can be subtracted out of the tracking error measurements to determine the residual tracking errors that would have been observed if the center of field rotation had been aligned with the CCD pixel on which the target object was initially positioned at the start of the observation.

On the July 16 engineering night, stars fields were observed in several parts of the sky and analyses performed (to subtract out the effects of field rotation where possible) on five of those fields as shown in Table 1 below. In three of those five fields, the 10-minute open-loop tracking performance requirement was clearly met. That requirement states the the RMS tracking error (i.e., the "RMS-R" column in Table 1 below) measured over that interval should be "<= 0.5 arcseconds".

The two fields in which the requirement was not met were both in the north and were observed during periods of time in which the dome shutter was pointing into the wind for much of the observation. As such, the tracking errors measured for these two fields likely include a significant wind shake component. In addition, both of these fields were observed at higher elevation angles and with the target object either transiting or close to transiting the meridian.

CONCLUSION

Based on the tracking performance measurements completed so far, we expect that the tracking performance requirements for the APF Telescope will be met over the required range of sky positions later this year, once the final optical alignment of the telescope and guide camera are completed and the windscreen-functionality of the dome shutters is fully operational. Already, the telescope appears to be meeting the 10-minute open loop tracking performance requirement over the majority of sky positions tested to date.

In the meantime, once EOS and EOST completes its current phase of adjustments on the dome and telescope, and releases them back to UCO/Lick for further engineering tests, a high priority should be to obtain tracking performance measurements of targets transiting the meridian at relatively high elevation angles but with targets selected such that they can be observed with the dome shutter opening pointed away from the wind so as to minimize wind shake. In addition, it will be instructive to determine whether the vibration dampers installed on the primary mirror support system during the week of July 20 will reduce the measured RMS tracking errors.

Table 1:

Summary of 10-minute open-loop tracking performance statistics for July 17, 2009

EL = Elevation in degrees at start of observation
HA = Hour Angle in minutes from meridian at start of observation
DEC = Declination in degrees
RMS-X = RMS tracking error as measured in guide camera's X axis
RMS-Y = RMS tracking error as measured in guide camera's Y axis
RMS-R = RMS tracking error in X and Y added in quadrature
PASS = does this observation meet the tracking performance requirement

Catalog	Filename Root	EL	HA	DEC	RMS-X	RMS-Y	RMS-R	PASS
5572F	20090717061920	83	-1m	+44.2	1.10	0.45	1.19	no
5698F	20090717072459	76	20m	+52.1	0.67	0.25	0.71	no
5781F	20090717083839	52	-2m	+0.14	0.31	0.25	0.40	yes
5781F	20090717083839	52	+8m	+0.14	0.19	0.21	0.28	yes
5490F	20090717093317	27	+262m	+12.5	0.31	0.31	0.44	yes
4188F	20090717095629	27	-273m	+17.7	0.26	0.35	0.44*	yes

* RMS tracking errors not corrected for field rotation because insufficient stars in observed field to accurately determine the center of field rotation.

Appendix A
Pointing Accuracy List

Star Observations
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	Region deg		Star	deg		Prefit Residuals arc sec			Postfit Residuals arc sec		
Obs	Azim	Elev	Catalog	Azim	Elev	Azim	Elev	Error	Azim	Elev	Error
1	148	64	5277F	150.13	64.72	-10.04	56.52	57.40	1.64	3.23	3.62
2	146	47	5341F	145.96	47.36	-8.72	59.69	60.32	0.01	3.53	3.53
3	147	27	5392F	146.94	26.94	-7.59	62.62	63.08	0.01	2.93	2.93
4	144	16	5432F	144.79	16.01	-8.91	67.80	68.38	0.15	1.86	1.87
5	166	15	5314F	166.04	15.50	-8.59	60.23	60.83	-1.13	0.88	1.43
6	166	34	5285F	165.97	33.56	-4.88	52.53	52.75	-0.06	0.96	0.97
7	170	59	5249F	170.05	59.26	-5.48	44.73	45.06	1.11	-1.96	2.25
8	163	73	5248F	163.90	73.46	-11.55	47.42	48.80	0.16	-0.52	0.54
9	164	81	5228F	165.16	81.02	-14.15	46.58	48.68	0.47	-0.40	0.62
10	168	65	5253F	168.11	64.79	-7.94	47.03	47.70	0.29	0.05	0.29
11	193	82	5207F	194.31	82.43	-12.97	35.24	37.55	0.42	-0.03	0.42
12	197	73	5184F	198.41	72.68	-8.48	35.40	36.40	1.24	1.11	1.67
13	202	76	5185F	202.61	76.10	-9.56	33.15	34.50	1.78	0.77	1.94
14	189	64	5197F	189.73	64.29	-5.12	39.33	39.66	1.64	0.91	1.88
15	186	52	5200F	186.95	52.19	-3.16	41.40	41.52	1.19	0.76	1.41
16	192	39	5171F	191.90	38.68	-3.55	41.57	41.73	0.11	1.16	1.16
17	190	18	5163F	190.27	18.31	-7.58	47.61	48.21	-1.24	-0.11	1.25
18	208	21	5081F	208.46	20.81	-9.29	36.77	37.92	-2.63	-2.35	3.53
19	205	43	5145F	205.01	42.48	-3.97	31.60	31.85	0.55	-3.03	3.08
20	208	51	5149F	208.73	50.57	-4.86	28.17	28.59	0.72	-4.01	4.07
21	232	64	5133F	232.10	63.92	-11.99	18.82	22.32	1.07	-4.08	4.22
22	243	73	5159F	243.60	73.33	-19.33	17.22	25.89	0.41	-1.88	1.92
23	245	87	5247F	246.33	86.95	-28.34	17.66	33.37	-1.70	0.16	1.71
24	258	81	5193F	257.95	80.60	-29.18	16.83	33.68	-1.24	0.99	1.59
25	265	64	5085F	264.85	63.60	-23.79	18.79	30.31	-0.09	2.47	2.47
26	257	42	4977F	257.38	42.25	-15.65	19.98	25.38	-0.53	0.37	0.65
27	263	28	4893F	263.46	27.63	-15.67	23.06	27.88	-1.46	1.11	1.84
28	269	18	4828F	268.97	17.60	-15.62	25.06	29.53	-1.51	-1.12	1.88
29	283	20	4795F	283.46	19.60	-17.67	26.56	31.90	-1.53	1.95	2.48
30	281	41	4923F	281.02	40.90	-21.24	17.91	27.78	-0.11	-0.32	0.34
31	286	63	5058F	285.57	62.48	-30.18	15.65	33.99	0.64	-0.25	0.68
32	284	78	5181F	284.10	77.79	-37.81	13.60	40.17	-0.61	-1.02	1.19
33	292	83	5224F	292.28	83.27	-43.89	16.53	46.89	-0.75	1.75	1.90
34	-60	77	5178F	-60.30	76.26	-41.93	18.79	45.94	0.64	2.62	2.69
35	-53	61	5055F	-53.25	61.18	-36.75	20.69	42.17	0.60	2.13	2.22
36	-59	42	4900F	-59.25	41.82	-25.82	22.23	34.07	0.61	2.49	2.56
37	-59	30	4813F	-59.21	30.34	-23.00	24.31	33.46	-1.22	2.29	2.60
38	-57	15	4711F	-57.21	14.45	-19.15	31.64	36.98	-2.42	1.09	2.65
39	-37	17	4634F	-37.17	17.05	-22.35	33.17	40.00	-3.41	0.51	3.45
40	-35	44	4905F	-34.98	43.86	-31.73	23.79	39.65	0.83	-1.09	1.38
41	-38	57	5045F	-37.91	56.80	-37.69	21.60	43.44	1.51	-0.97	1.79
42	-31	69	5179F	-31.94	69.14	-46.34	22.16	51.36	1.35	-1.11	1.74
43	-33	84	5265F	-33.87	84.35	-54.05	22.79	58.63	1.56	1.19	1.96
44	-8	80	5281F	-8.38	80.11	-58.99	31.15	66.68	-0.55	0.32	0.64
45	-11	64	5231F	-10.62	63.84	-47.68	31.62	57.20	0.80	0.49	0.94

46	-16	45	4974F	-16.12	44.65	-34.62	30.70	46.27	1.22	-0.32	1.26
47	-7	31	4503F	-7.13	30.66	-29.52	35.65	46.28	-1.47	-1.29	1.95
48	-15	17	4464F	-14.57	16.63	-22.78	38.51	44.74	-2.92	-1.85	3.46
49	8	16	4119F	7.97	15.76	-23.00	48.42	53.61	-3.01	-1.42	3.33
50	12	35	5889F	12.17	34.79	-32.11	41.23	52.26	-0.95	-2.45	2.63
51	12	60	5389F	11.63	59.79	-46.27	36.15	58.71	0.87	-4.18	4.27
52	12	73	5339F	11.84	73.21	-54.95	36.68	66.05	0.48	-2.74	2.78
53	7	81	5316F	6.71	80.74	-60.03	33.93	68.93	-0.20	-2.90	2.91
54	19	84	5321F	18.01	84.09	-62.46	40.30	74.29	-0.93	-0.91	1.30
55	40	78	5371F	39.57	77.65	-54.97	49.89	74.22	-0.03	0.08	0.08
56	30	54	5541F	29.47	54.00	-41.19	47.70	63.02	1.26	-0.18	1.28
57	31	34	5813F	31.45	34.15	-30.94	51.18	59.81	-0.81	-0.15	0.82
58	40	16	5956F	40.08	15.73	-22.99	60.50	64.72	-3.20	-1.59	3.57
59	55	13	5897F	55.33	13.49	-20.48	65.91	69.02	-2.23	-3.21	3.91
60	53	35	5757F	52.73	35.04	-28.48	56.33	63.12	-0.10	-1.94	1.94
61	57	51	5608F	56.53	51.20	-34.66	53.77	63.97	1.60	-3.35	3.71
62	55	66	5481F	55.24	66.32	-42.23	51.75	66.79	2.64	-3.76	4.60
63	49	75	5405F	48.61	75.40	-50.20	50.35	71.08	1.42	-2.60	2.96
64	62	89	5322F	59.80	88.81	-57.58	55.40	79.63	0.14	0.05	0.15
65	66	80	5387F	65.81	79.73	-48.76	57.45	75.33	0.05	0.14	0.15
66	81	80	5388F	80.91	80.20	-44.14	60.62	74.96	-0.65	0.70	0.96
67	77	63	5513F	77.36	63.04	-35.26	60.70	70.19	1.07	0.16	1.08
68	74	45	5638F	74.35	45.54	-28.05	61.19	67.31	0.97	-0.49	1.09
69	71	16	5835F	70.69	15.77	-18.74	69.35	71.84	-0.70	-1.04	1.25
70	86	13	5797F	85.78	12.99	-15.34	75.46	77.01	0.63	0.01	0.63
71	86	39	5656F	86.52	38.90	-21.88	64.35	67.97	1.24	0.21	1.25
72	86	51	5586F	85.89	51.43	-26.08	60.19	65.60	2.11	-2.34	3.15
73	93	86	5356F	93.15	86.16	-42.61	61.34	74.64	-0.71	0.77	1.05
74	104	82	5378F	103.83	82.02	-35.70	63.58	72.90	-0.65	2.75	2.83
75	107	69	5457F	107.20	69.48	-27.04	65.01	70.41	0.87	3.57	3.67
76	102	47	5583F	102.65	46.92	-19.64	65.59	68.46	1.49	2.04	2.52
77	99	16	5744F	99.10	16.41	-14.30	73.76	75.14	0.70	1.20	1.39
78	113	15	5695F	113.43	14.84	-13.52	75.38	76.59	-0.52	2.15	2.21
79	114	37	5601F	114.11	37.22	-14.47	66.85	68.39	0.79	2.71	2.82
80	128	55	5490F	128.50	55.25	-14.20	59.95	61.61	0.97	0.23	1.00
81	133	72	5409F	132.93	72.55	-18.60	57.90	60.81	0.90	0.42	1.00
82	147	81	5364F	147.17	81.44	-19.36	53.53	56.92	-0.48	0.43	0.64
83	176	82	5340F	177.34	81.61	-12.87	41.34	43.29	0.49	-0.87	1.00
84	160	66	5379F	160.41	66.47	-9.44	51.09	51.96	0.53	1.40	1.50
85	158	51	5411F	157.91	51.17	-6.47	53.47	53.86	0.41	1.58	1.63
86	152	33	5474F	152.58	32.78	-7.38	58.68	59.14	-0.86	2.28	2.43
87	148	16	5537F	148.29	15.83	-10.51	65.91	66.74	-1.78	0.85	1.97
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			Min:	-60.30	12.99	-62.46	13.60	22.32	-3.41	-4.18	0.08
			Max:	292.28	88.81	-3.16	75.46	79.63	2.64	3.57	4.60
			P-P:	352.57	75.81	59.30	61.87	57.31	6.05	7.75	4.51
			Avg:	110.41	52.07	-24.90	43.38	52.96	-0.00	-0.00	1.95
					RMS:	29.49	46.66	55.19	1.27	1.85	2.24

Mount Model Terms

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Term	Std Dev arc sec	Value arc sec	Name	Formula
01	0.41	-32081.59	Azimuth Encoder Offset	A=1
02	0.51	1051.71	Elevation Encoder Offset	E=1
03	0.19	-25.53	X Axis Tilt	A=tEcA;E=-sA
04	0.15	-1.02	Y Axis Tilt	A=tEsA;E=cA
05	0.16	176.61	Transverse Misalignment	S=1
06	----	----	Az-El Non-Orthogonality	A=tE
07	----	----	Sin(Azimuth) in Azimuth	A=sA
08	----	----	Cos(Azimuth) in Azimuth	A=cA
09	----	----	Sin(Elevation) in Elevation	E=sE
10	1.38	31.35	Cos(Elevation) in Elevation	E=cE
11	0.35	-1.78	Flexure	E=1/tE
12	----	----	Azimuth Encoder Scale	A=A/r360
13	----	----	Elevation Encoder Scale	E=E/r360
14	0.42	-1.72	Sin(2*Azimuth) in Azimuth	A=s(2A)
15	0.38	-4.49	Cos(2*Azimuth) in Azimuth	A=c(2A)
16	0.75	0.67	Sin(Azimuth) in Elevation	E=sA
17	----	----	Cos(Azimuth) in Elevation	E=cA
18	0.73	0.21	El Sin(Az) in Elevation	E=EsA
19	----	----	El Cos(Az) in Elevation	E=EcA

Covariance Matrix (arcseconds)
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Term	01	02	03	04	05	06	07	08	09	10	11	1
01	8.1e-007											
02	-1.1e-009	1.2e-006										
03	4.1e-008	5.1e-010	1.7e-007									
04	3.2e-008	-3.6e-009	-1.5e-008	1.1e-007								
05	-2.3e-007	8.2e-010	-2.0e-008	-2.4e-008	1.3e-007							
06	----	----	----	----	----	----						
07	----	----	----	----	----	----	----					
08	----	----	----	----	----	----	----	----				
09	----	----	----	----	----	----	----	----	----			
10	1.0e-008	-2.7e-006	-4.7e-009	3.4e-008	-7.5e-009	----	----	----	----	9.2e-006		
11	-3.3e-009	4.2e-007	1.5e-009	-1.1e-008	2.5e-009	----	----	----	----	-2.0e-006	5.9e-007	
12	----	----	----	----	----	----	----	----	----	----	----	--
13	----	----	----	----	----	----	----	----	----	----	----	--
14	1.1e-007	4.2e-010	-1.9e-008	-1.2e-008	-1.3e-008	----	----	----	----	-3.9e-009	1.3e-009	--
15	-8.5e-009	-1.5e-011	3.4e-008	4.5e-010	-8.2e-009	----	----	----	----	1.4e-010	-4.7e-011	--
16	4.9e-008	-3.9e-008	1.7e-007	1.1e-008	-2.6e-008	----	----	----	----	5.0e-007	-2.5e-007	--
17	----	----	----	----	----	----	----	----	----	----	----	--
18	-6.1e-009	-2.1e-008	2.8e-009	-2.0e-008	4.6e-009	----	----	----	----	-3.8e-007	2.2e-007	--
19	----	----	----	----	----	----	----	----	----	----	----	--

Correlation Matrix
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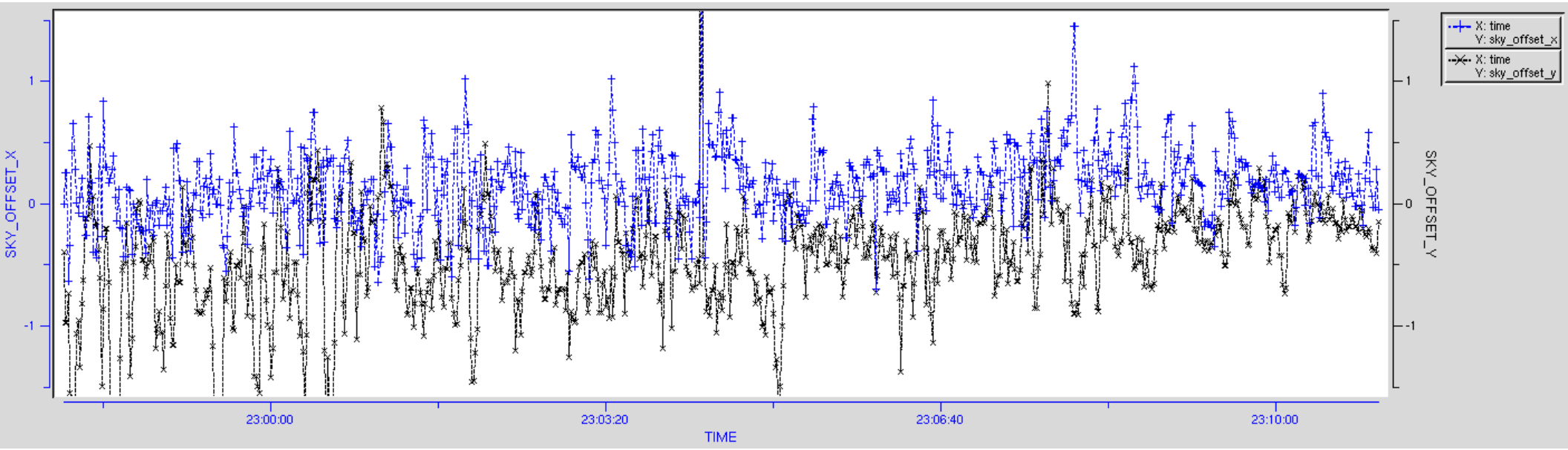
Term	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
01	1.00																	
02	-0.00	1.00																
03	0.11	0.00	1.00															
04	0.11	-0.01	-0.11	1.00														
05	-0.72*	0.00	-0.13	-0.20	1.00													
06	----	----	----	----	----	----												
07	----	----	----	----	----	----	----											
08	----	----	----	----	----	----	----	----										
09	----	----	----	----	----	----	----	----	----									
10	0.00	-0.81*	-0.00	0.03	-0.01	----	----	----	----	1.00								
11	-0.00	0.49	0.00	-0.04	0.01	----	----	----	----	-0.86*	1.00							
12	----	----	----	----	----	----	----	----	----	----	----	----						
13	----	----	----	----	----	----	----	----	----	----	----	----	----					
14	0.13	0.00	-0.05	-0.04	-0.04	----	----	----	----	-0.00	0.00	----	----	1.00				
15	-0.01	-0.00	0.10	0.00	-0.03	----	----	----	----	0.00	-0.00	----	----	0.02	1.00			
16	0.03	-0.02	0.24	0.02	-0.04	----	----	----	----	0.10	-0.20	----	----	-0.01	0.02	1.00		
17	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
18	-0.00	-0.01	0.00	-0.04	0.01	----	----	----	----	-0.08	0.18	----	----	0.00	-0.00	-0.88*	----	1.00
19	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

Appendix B
Tracking Errors vs Time