

# Overview of SLR2000 Tracking Mount Performance Testing

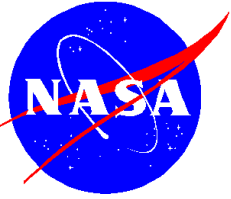
Don Patterson HTSI

Jan McGarry NASA GSFC

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## SLR2000 Mount System Built to the Following Specifications:

### •Mount Specifications:

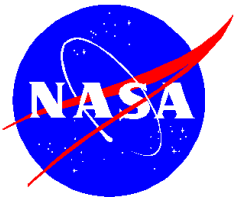
Configuration	EL over Az
Payload	~245 pounds
Travel in Azimuth	Continuous
Travel in Elevation	-5 degrees to 185 degrees
Angle resolution	0.0000215 degrees (24 bits/0.077 arc seconds)
Azimuth Slew Speed	$\geq 30$ degrees/second
Elevation Slew Speed	$\geq 20$ degrees/second
Azimuth Acceleration	$\geq 5$ degrees/second <sup>2</sup>
Elevation Acceleration	$\geq 5$ degrees/second <sup>2</sup>
Tracking Rates	From Sidereal to $\geq 5$ degrees/second (Both Axes)
Dynamic Tracking Error	1 arc seconds RMS (Both Axes)
Axis Wobble	3 arc seconds maximum repeatable error
Axis Orthogonality	5 arc seconds maximum repeatable error

### •Optical Path Specifications:

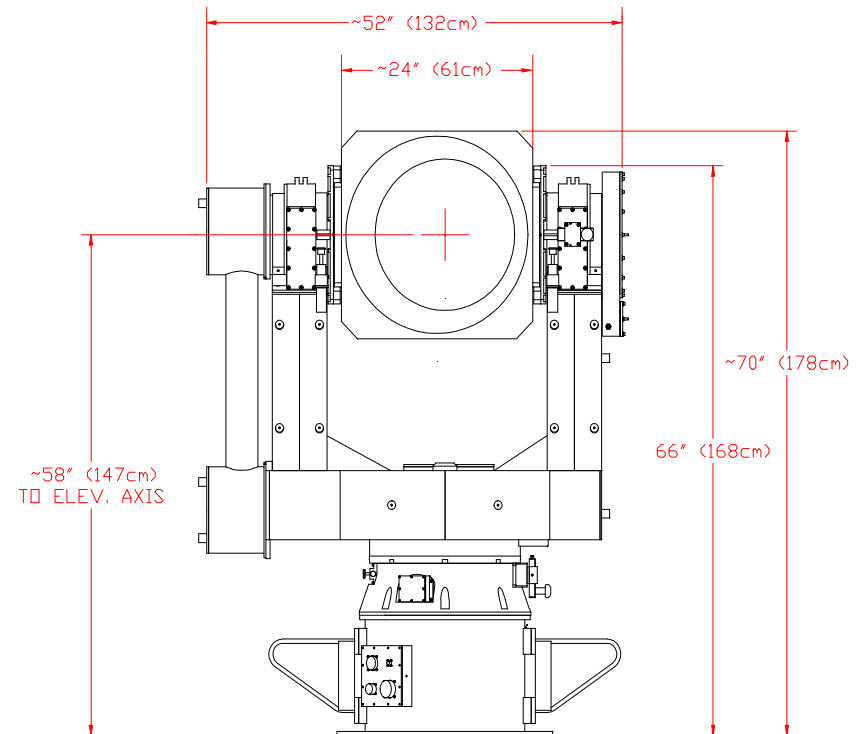
- Minimum centered 3-inch clear aperture
- Environmentally sealed volume for optics (enclosed coude path)
- Total beam deviation less than +/- 6 arcseconds under dynamic tracking operation

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**Mount with the Mass Simulator**  
(Duplicates telescope size, weight, inertia)

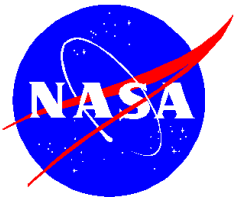


**Overall Mount Dimensions**

**SLR2000 Mount Model SPS-4275 built by Xybion Corporation**

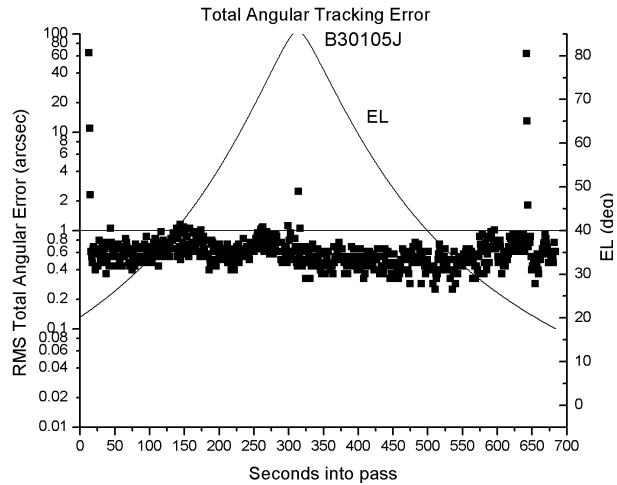
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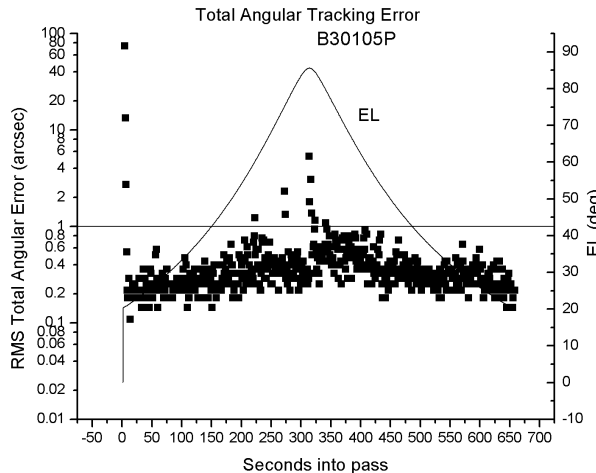
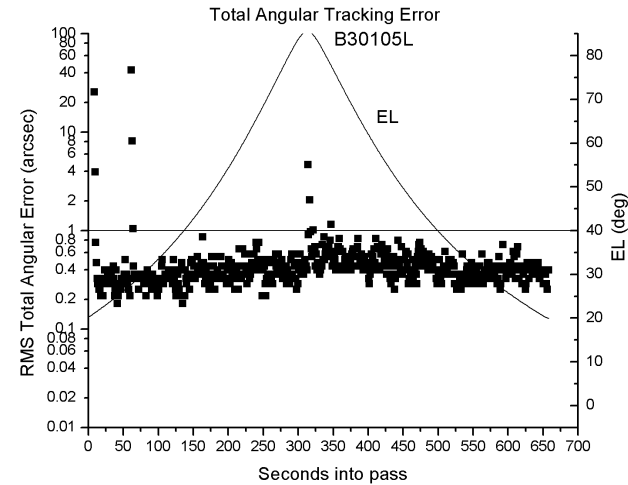


## Test Data Results – Total Tracking Error

November – Mass Simulator



January – Mass Simulator



Satellite BEC 950 Km Altitude

Maximum Elevation 85 degrees

Maximum Velocity in Azimuth 4.5 degrees/second

Maximum Velocity in Elevation 0.3 degrees/second

Maximum Acceleration in Azimuth 0.2 degrees/second<sup>2</sup>

Maximum Acceleration in Elevation 0.03 degrees/second<sup>2</sup>

### Plot Calculation

Compute the difference between the actual mount position & the command angle

Correct the azimuth error by the cosine of the elevation angle

Compute the RMS for each axis

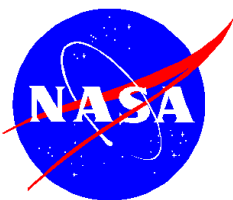
The total angular tracking error is the combination of the azimuth & elevation RMS values.

1 second bins (2000 angular differences equal one RMS point)

February – Telescope

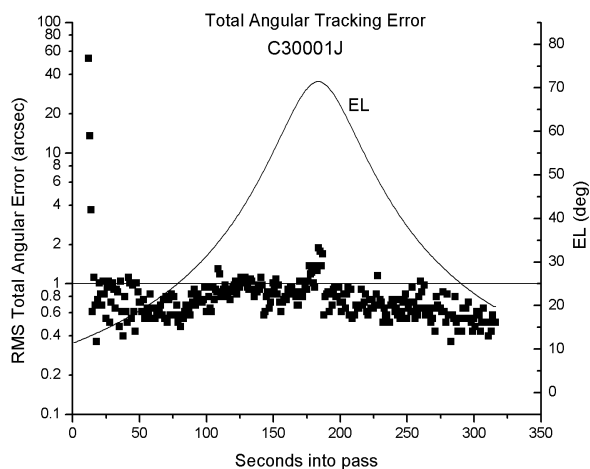
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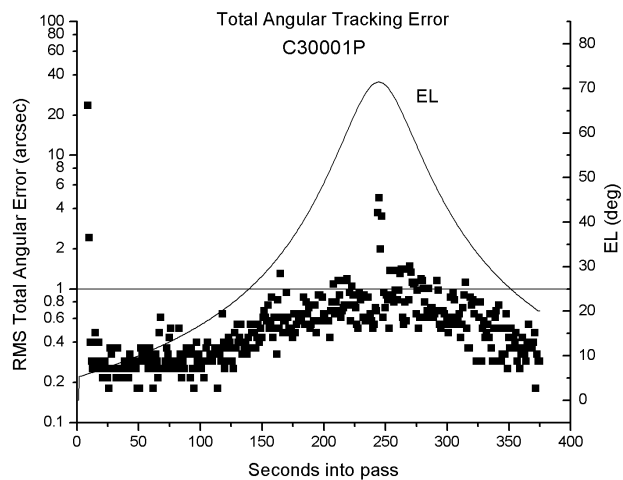
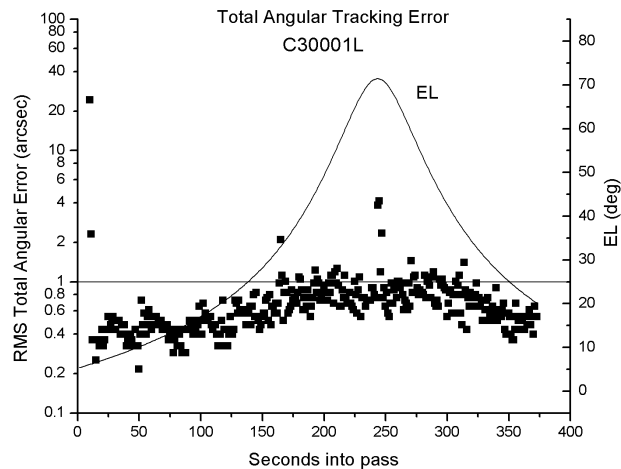


## Test Data Results – Total Tracking Error

### November – Mass Simulator



### January – Mass Simulator



**Satellite Champ** 470 Km Altitude

Maximum Elevation 71 degrees

Maximum Velocity in Azimuth 5.1 degrees/second

Maximum Velocity in Elevation 0.3 degrees/second

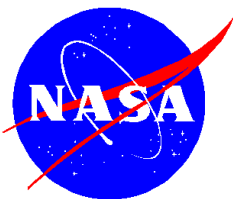
Maximum Acceleration in Azimuth 0.2 degrees/second<sup>2</sup>

Maximum Acceleration in Elevation 0.03 degrees/second<sup>2</sup>

### February – Telescope

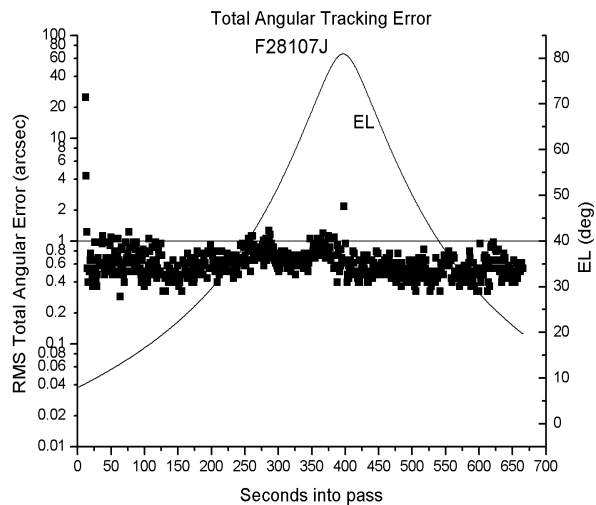
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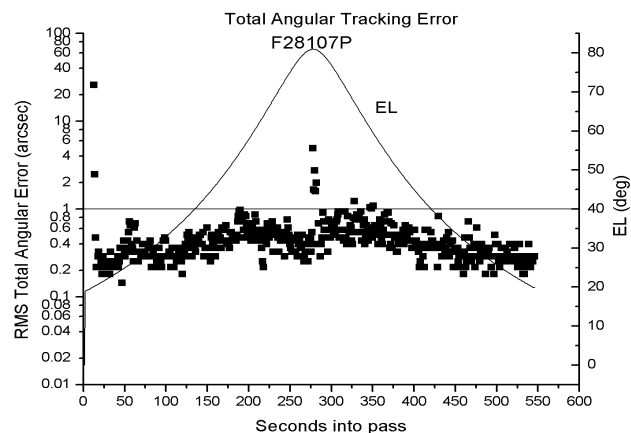
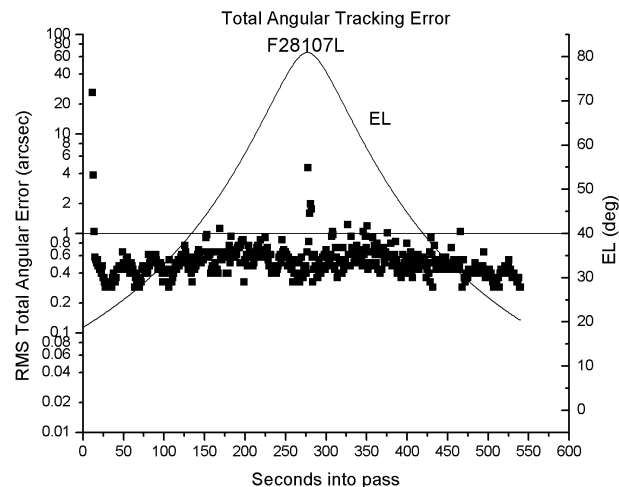


## Test Data Results – Total Tracking Error

### November – Mass Simulator



### January – Mass Simulator



Satellite Fizeau 950 Km Altitude

Maximum Elevation 80 degrees

Maximum Velocity in Azimuth 2.7 degrees/second

Maximum Velocity in Elevation 0.3 degrees/second

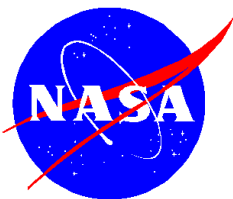
Maximum Acceleration in Azimuth 0.08 degrees/second<sup>2</sup>

Maximum Acceleration in Elevation 0.02 degrees/second<sup>2</sup>

### February – Telescope

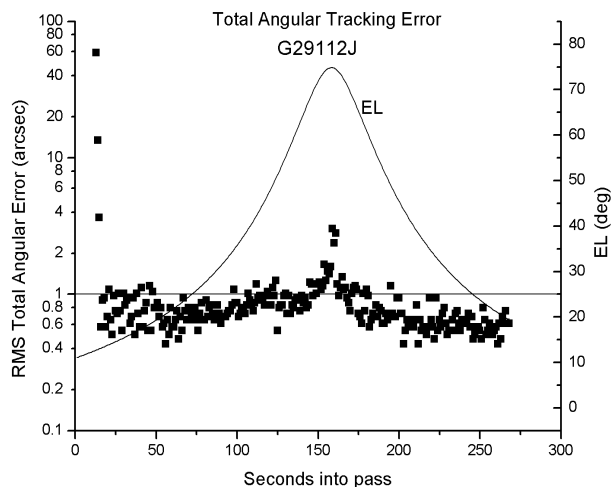
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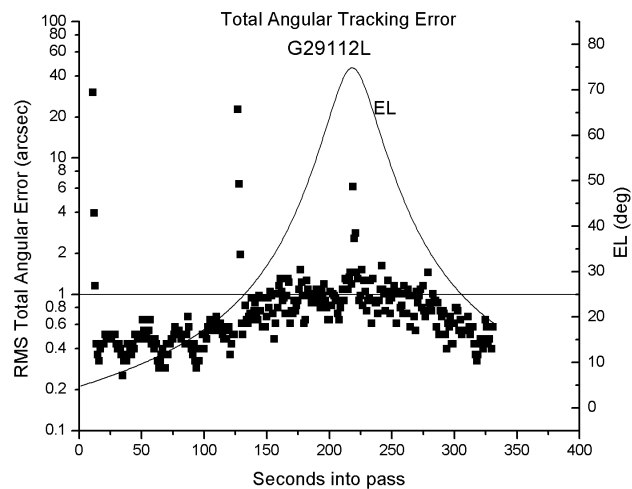


## Test Data Results – Total Tracking Error

November – Mass Simulator



January – Mass Simulator



Satellite GFZ 320 Km Altitude

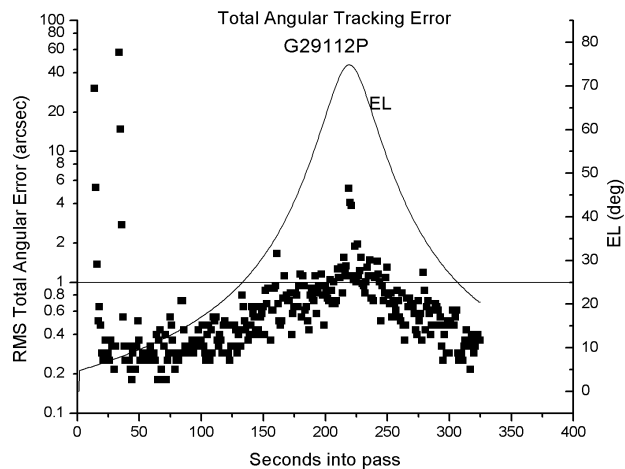
Maximum Elevation 70 degrees

Maximum Velocity in Azimuth 4.6 degrees/second

Maximum Velocity in Elevation 0.9 degrees/second

Maximum Acceleration in Azimuth 0.2 degrees/second<sup>2</sup>

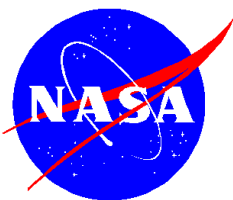
Maximum Acceleration in Elevation 0.09 degrees/second<sup>2</sup>



February – Telescope

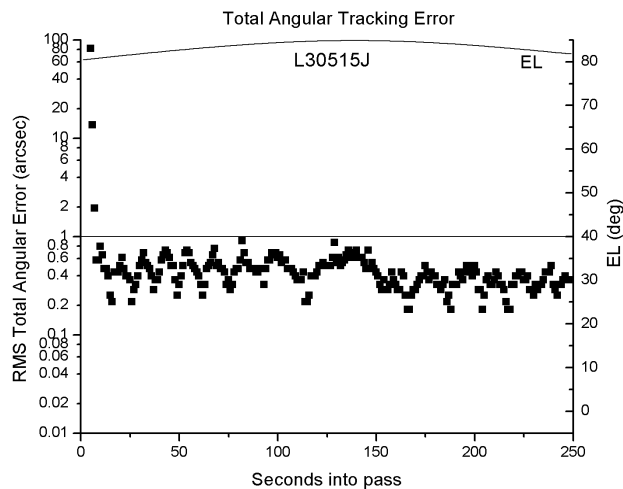
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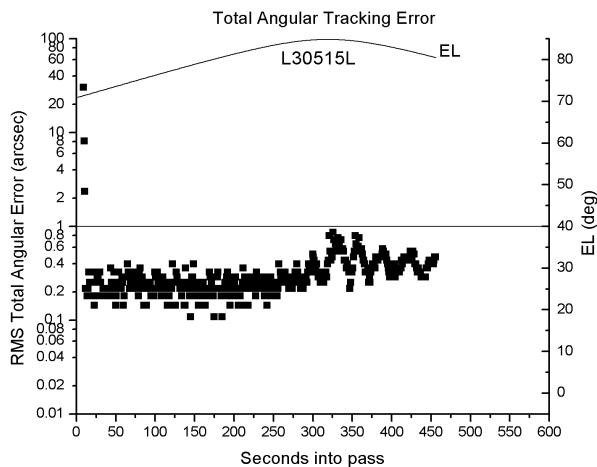


## Test Data Results – Total Tracking Error

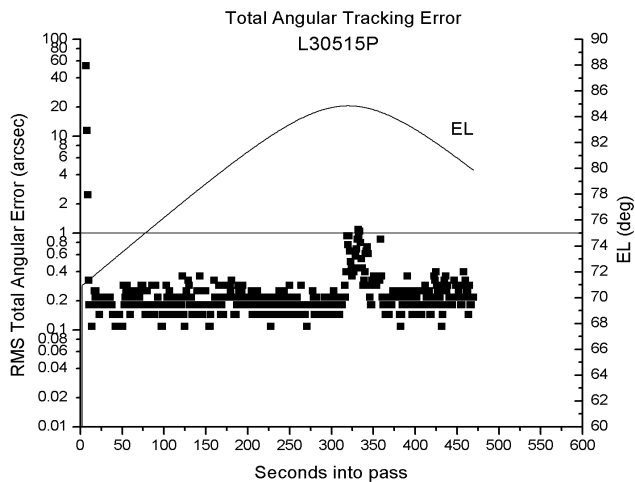
November – Mass Simulator



January – Mass Simulator



Satellite LAGEOS 6000 Km Altitude  
 Maximum Elevation 85 degrees  
 Maximum Velocity in Azimuth 0.6 degrees/second  
 Maximum Velocity in Elevation 0.05 degrees/second  
 Maximum Acceleration in Azimuth 0.005 degrees/second<sup>2</sup>  
 Maximum Acceleration in Elevation 0.001 degrees/second<sup>2</sup>

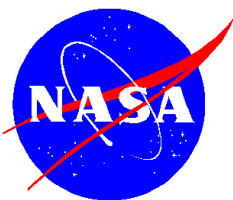


February – Telescope

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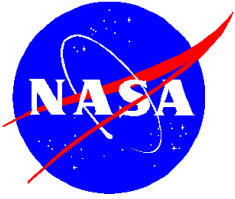
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## Test Summary – Average RMS Error in Arc Seconds

Type Track	<u>November</u>	<u>January</u>	<u>February</u>
Satellite B30105.cof	0.61 AZ/ 0.54 El.	0.57 AZ/ 0.47 El.	<b>0.50 AZ/ 0.47 El.</b>
Satellite C30001.cof	0.68 AZ/ 0.65 El.	<b>0.65 AZ/ 0.65 El.</b>	0.72 AZ/ 0.72 El.
Satellite F28107.cof	0.54 AZ/ 0.57 El.	0.57 AZ/ 0.54 El.	<b>0.54 AZ/ 0.50 El.</b>
Satellite G29112.cof	<b>0.79 AZ/ 0.75 El.</b>	0.93 AZ/ 0.90 El.	0.90 AZ/ 0.79 El.
Satellite I30515.cof	0.65 AZ/ 0.47 El.	0.65 AZ/ 0.32 El.	<b>0.57 AZ/ 0.25 El.</b>
Star Z0010881	0.53 AZ/ 0.61 El.	0.18 AZ/ 0.25 El.	<b>0.14 AZ/ 0.18 El.</b>
Az. Velocity 5°/Sec.	No Data	<b>1.18</b>	1.19
Az. Velocity - 5°/Sec.	“	<b>1.29</b>	1.29
Az. Velocity 2°/Sec.	“	<b>0.79</b>	0.83
Az. Velocity – 2°/Sec.	“	<b>0.79</b>	0.90
Az. Velocity 1°/Sec.	“	<b>0.75</b>	0.79
Az. Velocity - 1°/Sec.	“	<b>0.68</b>	0.68
El. Velocity 5°/Sec.	No Data	<b>0.89</b>	0.97
El. Velocity - 5°/Sec.	“	<b>1.40</b>	1.80
El. Velocity 2°/Sec.	“	0.97	<b>0.86</b>
El. Velocity – 2°/Sec.	“	<b>1.29</b>	1.83
El. Velocity 1°/Sec.	“	<b>0.61</b>	0.65
El. Velocity - 1°/Sec.	“	<b>0.75</b>	1.22



## Summary

### Overall Specifications Met

- Note:**
- Includes bearing wobble, orthogonality, and beam deviation measurements that were made at the factory.
  - Tracking errors near 5 degrees/second velocities slightly above 1 arc seconds RMS

### Servo System Incorporates Software Corrections for:

Encoder Error Compensation

Bearing Wobble

Servo Loop Compensation

Motor Cog Torque Effects (brushless motors used)

Motor Commutation Effects

**Note:** Software corrections will allow for possible performance improvements in the future and/or payload changes

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