

**First pointing model for the 40m radiotelescope.  
Optical observations**

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## Change Record

<b>Version</b>	<b>Date</b>	<b>Author</b>	<b>Remarks</b>
1.0	21-Ago-2009	T. Alonso Albi	First version

## Remarks

The results in this document correspond to the first preliminary fit of a set of optical observations taken in November, 2007, using a refractor telescope attached to the subreflector of the 40m radiotelescope at Yebes. The original set of about 540 observations were selected and processed to eliminate those observations where no clear star was detected. An automatic star detection algorithm was used to produce a set of about 270 input points for the pointing model. All points were manually checked to reduce errors. However, there are some sources of errors that could produce some spurious points visible in the charts. For example, an important fraction of the images show the star saturated, producing large spots that reduce the precision/resolution in the detection of the central peak. Also, after taking the images and obtaining the first fit in 2007 a problem with the horizontal and vertical scale of the pixels in the ccd was found. This problem produces large errors in some stars located close to the right edge of the .fits images. Skipping a few points affected by this problem the global rms decrease to about 20 arcseconds, but in this document no point has been eliminated from the fit.

This document is an automatic output produced by the latest version of the model. The results produced by this version are slightly different from those obtained in November 2007, since some signs and terms ordering in the model implementation has changed.

Table 1: Model parameters.

Parameter	Value (")
P1	2566.086555957042
P2	-1436.63175950392
P3	-69.91463322848595
P4	-9.970128858282706
P5	23.55580502134719
P6	0.0
P7	2225.3937656214043
P8	-10.500377932123463
P9	1045.7053379862011

Residual = 57.22730994915117 ". Residual is defined as the square root of the sum of squares of each residual, for each parameter of the model, divided by the number of points ["]. It is a measure of the mean geometric variance of each parameter.

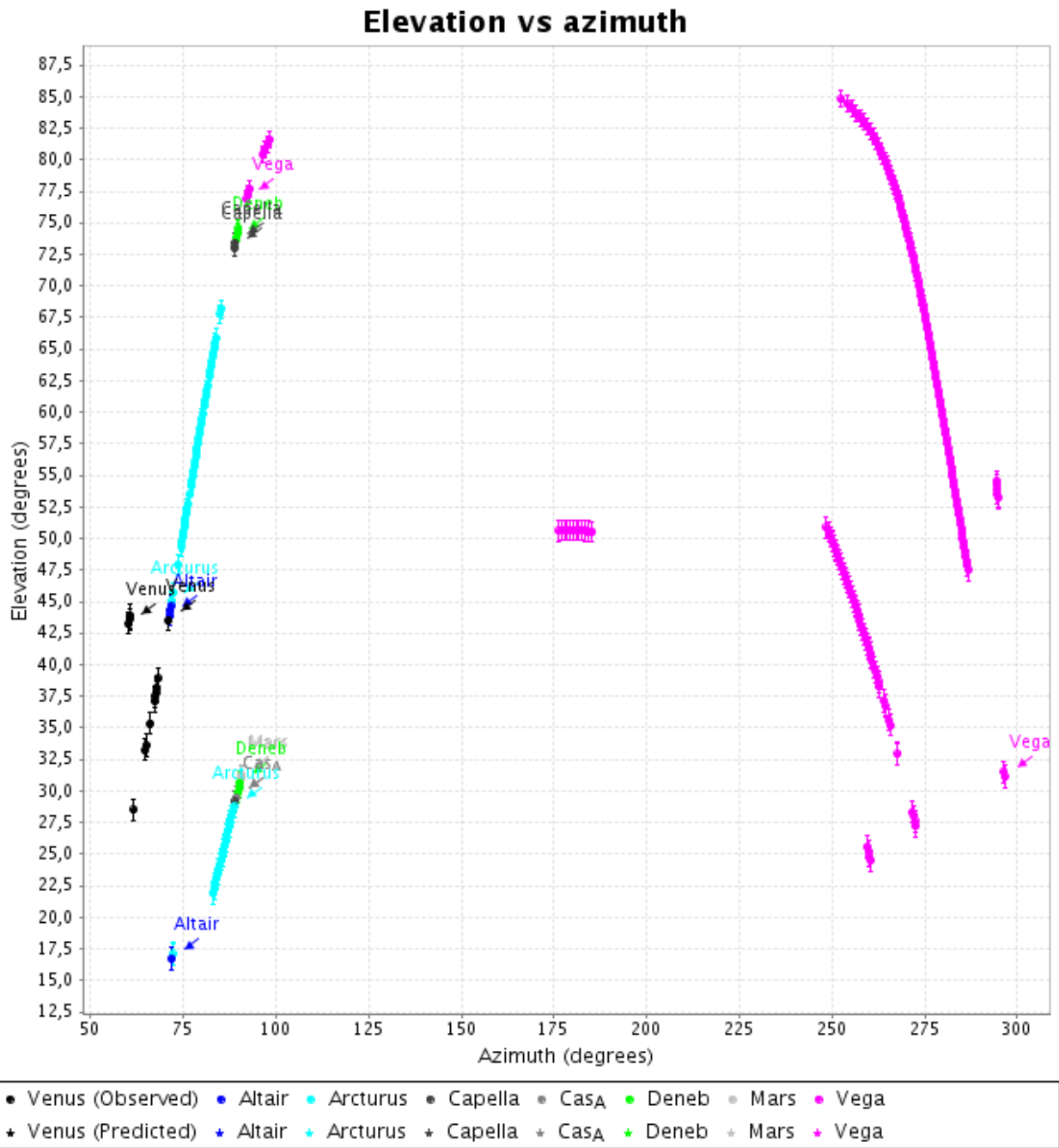


Figure 1: Elevation vs azimuth. Mean deviation, defined as the square root of squares of each error in the chart divided by the number of points, is 0.0 ”.

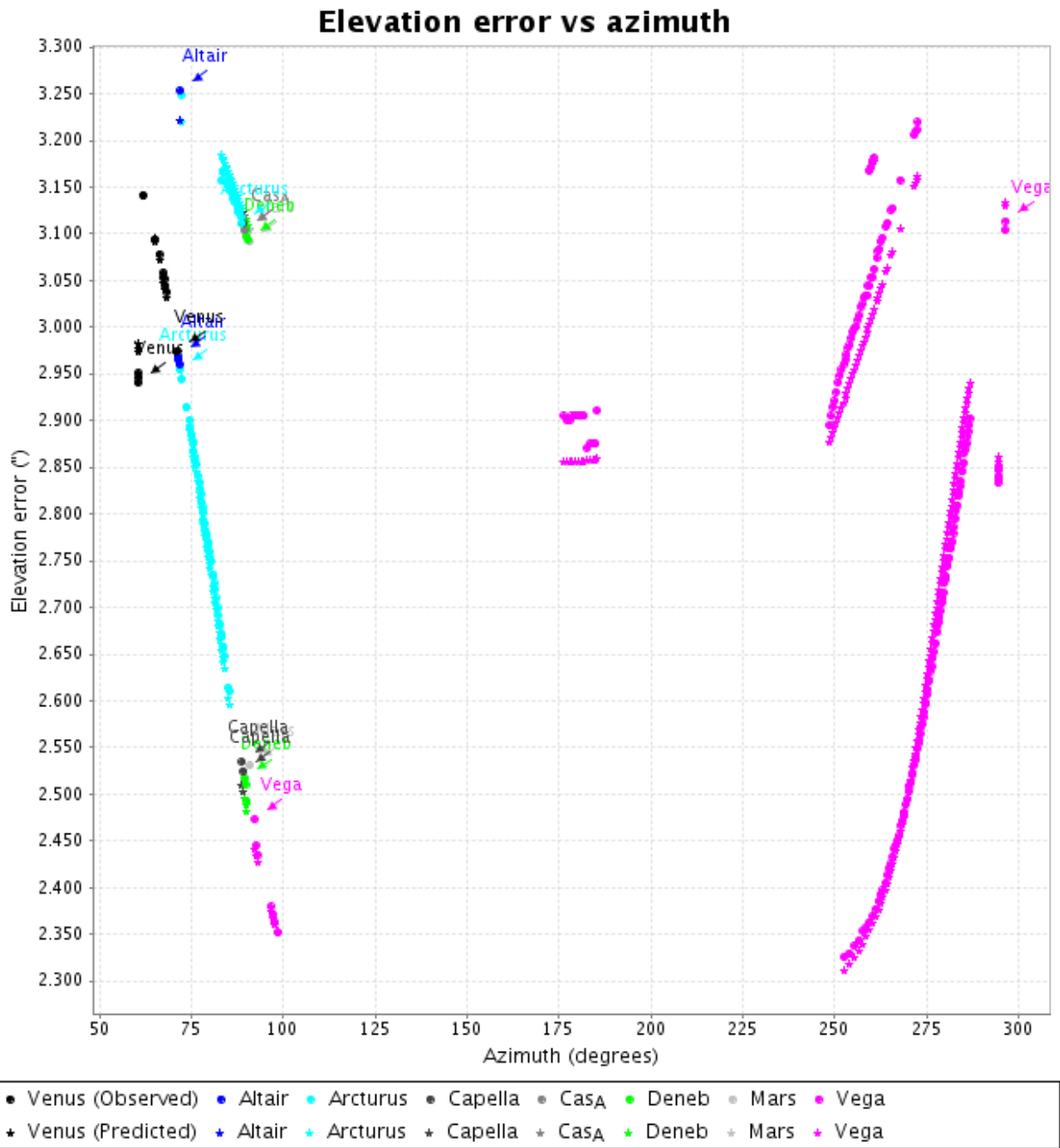


Figure 2: Elevation error vs azimuth. Mean deviation, defined as the square root of squares of each error in the chart divided by the number of points, is 44.04030301849436 ”.

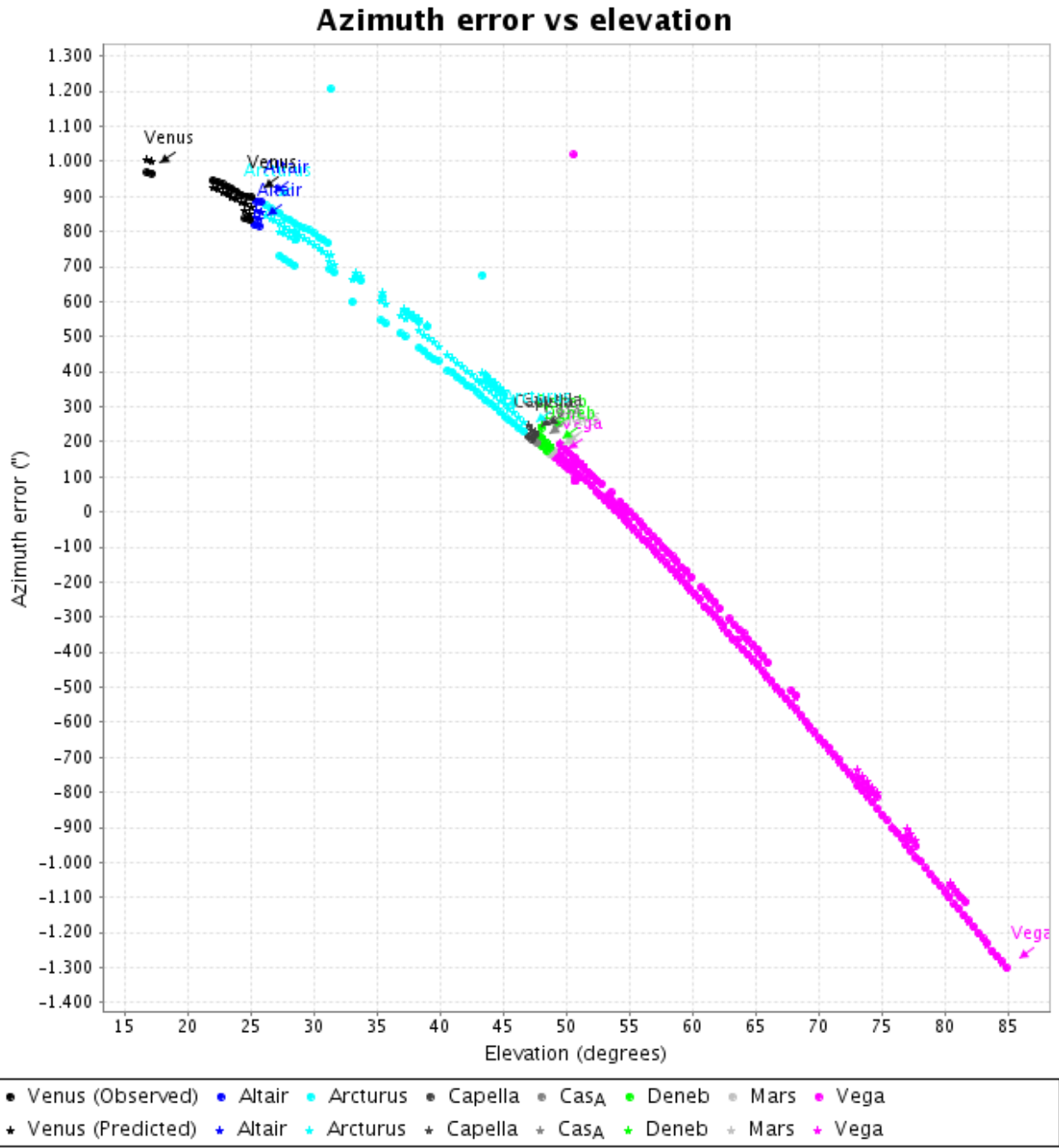


Figure 3: Azimuth error vs elevation. Mean deviation, defined as the square root of squares of each error in the chart divided by the number of points, is 67.17875400249444 ”.

### Azimuth error vs azimuth

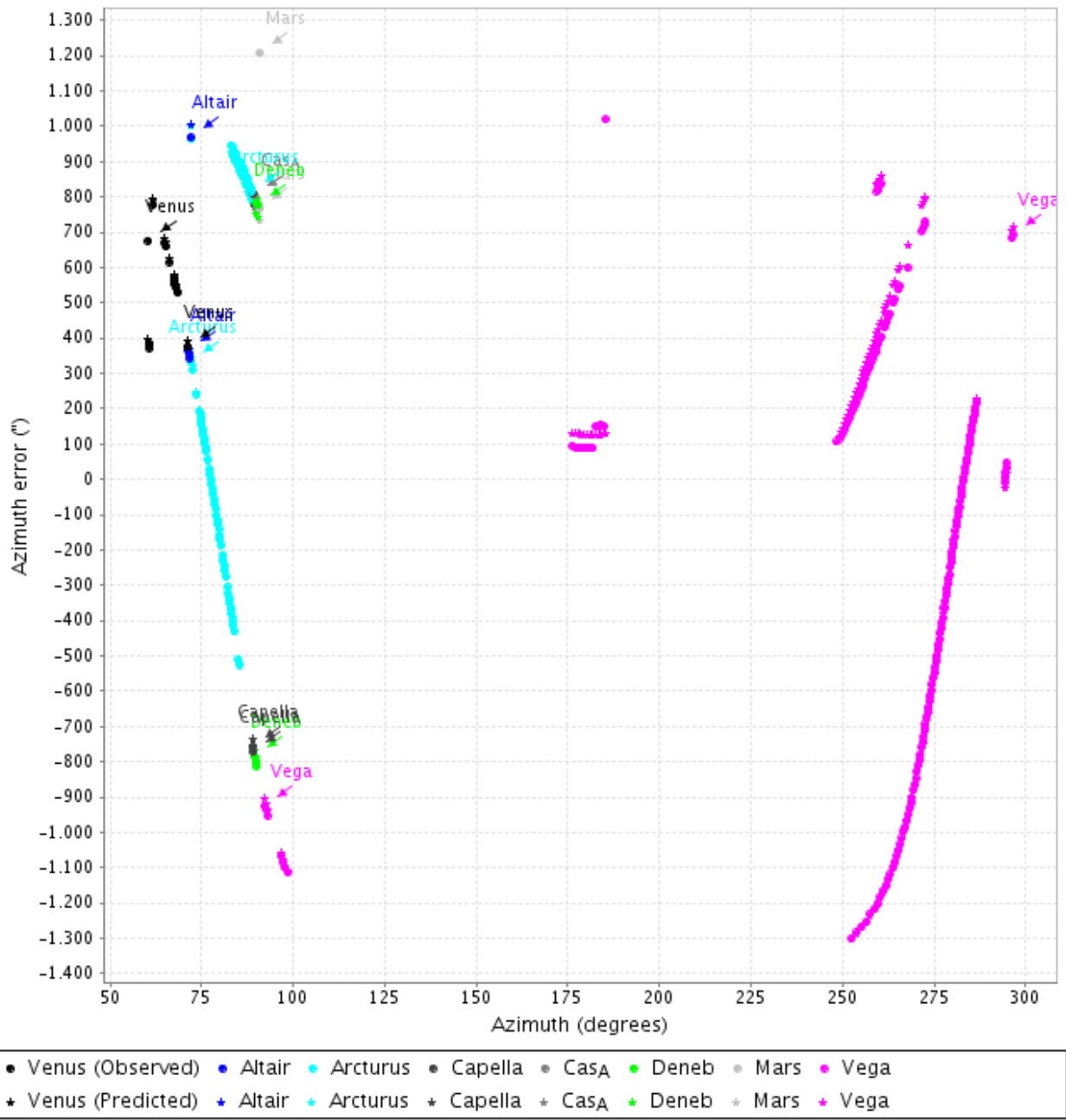


Figure 4: Azimuth error vs azimuth. Mean deviation, defined as the square root of squares of each error in the chart divided by the number of points, is 67.17875400249444 ”.

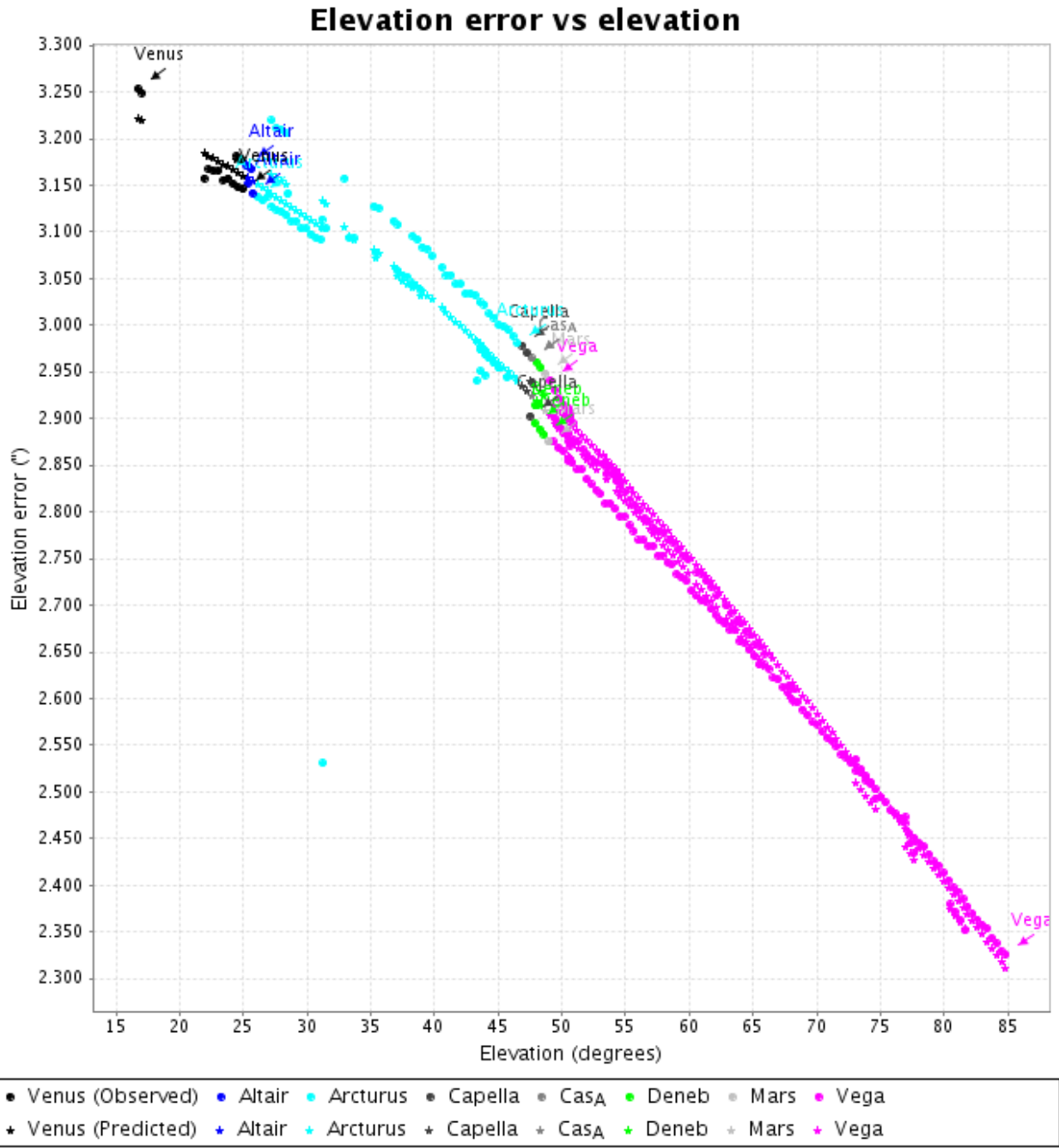


Figure 5: Elevation error vs elevation. Mean deviation, defined as the square root of squares of each error in the chart divided by the number of points, is 44.04030301849438 ”.



## Model implementation

$$dAz \cos El = (P1 + P2 \sec El + P3 \tan El - P4 \cos Az \tan El + P5 \sin Az \tan El + P6 \sin Az \sec El) \cos El$$

$$dEl = P4 \sin Az + P5 \cos Az + P6 \cos Az \sin El + P7 + P8 \sin El + P9 \cos El$$

**P1:** Constant offset that includes the azimuth encoder offset and a constant term due to the missalignment of the fixed Nasmyth mirrors.

**P2:** Collimation error. Positive when the RF axis gets nearer to the North, being the elevation axis along the North-South direction. 0 means that the RF axis should lay along the East-West axis.

**P3:** Combination of two effects: the lack of orthogonality between the azimuth and elevation axis, and the missalignment of the Nasmyth fixed mirrors. The first contribution is positive if the elevation axis gets closer to the azimuth axis. The second contribution is always positive.

**P4:** Azimuth axis missalignment along the East-West axis. Positive if the axis is tilted towards East.

**P5:** Azimuth axis missalignment along the North-South axis. Positive if the axis is tilted towards North.

**P6:** Source position uncertainty. This parameter is fixed to zero and not used in this implementation.

**P7:** Constant offset which includes both the elevation offset and a term due to the missalignment of M3 and all the other Nasmyth mirrors.

**P8:** A combination of gravitational bending / homologous deformation and missalignment of the Nasmyth fixed mirrors.

**P9:** A combination of the gravitational bending and the missalignment of the Nasmyth fixed mirrors. The first contribution should be positive since it comes mainly from the subreflector, which falls from its nominal position as elevation gets lower.

Table 2: Scan data showing azimuth, elevation, their offsets, the source name, file name, fitted flag, and observing date.

Az (deg)	El (deg)	dAz (")	dEl (")	dx (pixel)	dy (pixel)	Source	File	Fitted?	Date
176.231	50.601	95.05511	2904.9539	29.5	-64.0	Venus	opt1	yes	2007-11-8
183.344	50.609	151.38918	2875.1062	45.0	-52.0	Venus	opt10	yes	2007-11-8
184.132	50.584	154.08363	2875.1062	46.0	-52.0	Venus	opt11	yes	2007-11-8
184.926	50.553	150.80797	2875.1062	45.0	-52.0	Venus	opt12	yes	2007-11-8
185.274	50.538	1019.3873	2910.9233	304.0	-64.0	Venus	opt13	yes	2007-11-8
177.019	50.623	91.30159	2900.974	28.5	-63.0	Venus	opt2	yes	2007-11-8
177.81	50.639	91.66525	2900.974	28.5	-63.0	Venus	opt3	yes	2007-11-8
178.6	50.651	90.99004	2904.9539	28.5	-64.0	Venus	opt4	yes	2007-11-8
179.392	50.657	91.91344	2904.9539	28.5	-64.0	Venus	opt5	yes	2007-11-8
180.184	50.658	88.07753	2904.9539	27.5	-64.0	Venus	opt6	yes	2007-11-8
180.974	50.654	88.3017	2904.9539	27.5	-64.0	Venus	opt7	yes	2007-11-8
181.765	50.644	87.60176	2904.9539	27.5	-64.0	Venus	opt8	yes	2007-11-8
182.555	50.629	150.24648	2871.1265	45.0	-51.0	Venus	opt9	yes	2007-11-8
296.285	31.498	684.3081	3103.9382	204.0	-121.0	Altair	opt_Altair753	yes	2007-11-13
259.393	25.596	816.9207	3167.6133	244.0	-140.0	Altair	opt_Altair767	yes	2007-11-13
259.752	25.22	820.2291	3171.593	245.0	-141.0	Altair	opt_Altair769	yes	2007-11-13
260.111	24.843	834.1945	3177.5625	249.0	-143.0	Altair	opt_Altair771	yes	2007-11-13
85.513	24.945	898.1493	3145.725	268.0	-133.0	Arcturus	opt_Arcturus10	yes	2007-11-14
85.827	25.326	887.3974	3151.6946	265.0	-135.0	Arcturus	opt_Arcturus11	yes	2007-11-14
86.14	25.707	885.48193	3141.7454	264.0	-132.0	Arcturus	opt_Arcturus12	yes	2007-11-14
86.455	26.089	874.38983	3137.7656	261.0	-131.0	Arcturus	opt_Arcturus13	yes	2007-11-14
86.771	26.471	864.9256	3133.786	258.0	-130.0	Arcturus	opt_Arcturus14	yes	2007-11-14
87.087	26.852	857.0849	3137.7656	256.0	-131.0	Arcturus	opt_Arcturus15	yes	2007-11-14
87.404	27.233	850.86707	3127.8164	254.0	-128.0	Arcturus	opt_Arcturus16	yes	2007-11-14
87.722	27.615	837.3744	3123.8367	250.0	-127.0	Arcturus	opt_Arcturus17	yes	2007-11-14
88.041	27.997	834.27026	3121.847	249.0	-126.0	Arcturus	opt_Arcturus18	yes	2007-11-14
88.361	28.378	823.99475	3117.8672	246.0	-125.0	Arcturus	opt_Arcturus19	yes	2007-11-14
83.031	21.903	945.18365	3157.664	282.0	-137.0	Arcturus	opt_Arcturus2	yes	2007-11-14
88.683	28.761	816.9829	3111.8977	244.0	-123.0	Arcturus	opt_Arcturus20	yes	2007-11-14
89.006	29.143	808.0664	3111.8977	241.0	-123.0	Arcturus	opt_Arcturus21	yes	2007-11-14
89.329	29.526	804.14825	3103.9382	240.0	-121.0	Arcturus	opt_Arcturus22	yes	2007-11-14
89.654	29.908	794.8625	3103.9382	237.0	-121.0	Arcturus	opt_Arcturus23	yes	2007-11-14
89.98	30.29	783.69916	3097.9688	234.0	-119.0	Arcturus	opt_Arcturus24	yes	2007-11-14
90.308	30.673	777.46454	3093.989	232.0	-118.0	Arcturus	opt_Arcturus25	yes	2007-11-14
90.635	31.054	767.6874	3091.9993	229.0	-117.0	Arcturus	opt_Arcturus26	yes	2007-11-14
90.793	31.236	1206.8729	2530.8633	360.0	50.0	Arcturus	opt_Arcturus27	yes	2007-11-14
83.34	22.283	941.28485	3167.6133	281.0	-140.0	Arcturus	opt_Arcturus3	yes	2007-11-14
85.28	68.189	-522.5724	2610.457	-156.0	26.0	Arcturus	opt_Arcturus327	yes	2007-11-13
248.485	50.856	107.081955	2895.0046	32.0	-58.0	Arcturus	opt_Arcturus333	yes	2007-11-13
248.98	50.501	114.564575	2904.9539	34.0	-61.0	Arcturus	opt_Arcturus335	yes	2007-11-13
249.47	50.143	120.64818	2914.903	36.0	-64.0	Arcturus	opt_Arcturus337	yes	2007-11-13
249.954	49.785	130.26997	2920.8726	39.0	-66.0	Arcturus	opt_Arcturus339	yes	2007-11-13
250.433	49.426	143.56462	2930.8218	43.0	-69.0	Arcturus	opt_Arcturus341	yes	2007-11-13
250.907	49.065	154.16302	2940.771	46.0	-72.0	Arcturus	opt_Arcturus343	yes	2007-11-13
251.375	48.703	164.5769	2948.7305	49.0	-74.0	Arcturus	opt_Arcturus345	yes	2007-11-13
251.838	48.341	174.75214	2954.7	52.0	-76.0	Arcturus	opt_Arcturus347	yes	2007-11-13
252.296	47.977	187.45341	2960.6694	56.0	-78.0	Arcturus	opt_Arcturus349	yes	2007-11-13

252.75	47.612	197.32591	2964.6492	59.0	-79.0	Arcturus	opt_Arcturus351	yes	2007-11-13
253.198	47.247	208.303	2970.6187	62.0	-81.0	Arcturus	opt_Arcturus353	yes	2007-11-13
253.643	46.88	217.79927	2978.5781	65.0	-83.0	Arcturus	opt_Arcturus355	yes	2007-11-13
254.082	46.513	231.16118	2980.5679	69.0	-84.0	Arcturus	opt_Arcturus357	yes	2007-11-13
254.517	46.145	241.62563	2988.5273	72.0	-86.0	Arcturus	opt_Arcturus359	yes	2007-11-13
254.948	45.776	251.91714	2994.4968	75.0	-88.0	Arcturus	opt_Arcturus361	yes	2007-11-13
255.374	45.407	261.98517	2998.4766	78.0	-89.0	Arcturus	opt_Arcturus363	yes	2007-11-13
255.797	45.037	271.87936	3000.4663	81.0	-90.0	Arcturus	opt_Arcturus365	yes	2007-11-13
256.215	44.667	284.36554	3008.4258	85.0	-92.0	Arcturus	opt_Arcturus367	yes	2007-11-13
256.631	44.294	298.23425	3012.4055	89.0	-93.0	Arcturus	opt_Arcturus369	yes	2007-11-13
257.042	43.922	311.8717	3022.3547	93.0	-96.0	Arcturus	opt_Arcturus371	yes	2007-11-13
257.449	43.549	318.194	3024.3445	95.0	-97.0	Arcturus	opt_Arcturus373	yes	2007-11-13
257.853	43.176	331.48828	3032.304	99.0	-99.0	Arcturus	opt_Arcturus375	yes	2007-11-13
258.255	42.801	344.71008	3034.2937	103.0	-100.0	Arcturus	opt_Arcturus377	yes	2007-11-13
258.651	42.427	354.7791	3034.2937	106.0	-100.0	Arcturus	opt_Arcturus379	yes	2007-11-13
259.046	42.051	361.7625	3044.243	108.0	-103.0	Arcturus	opt_Arcturus381	yes	2007-11-13
259.436	41.676	375.88934	3044.243	112.0	-103.0	Arcturus	opt_Arcturus383	yes	2007-11-13
259.823	41.301	385.36255	3054.1921	115.0	-106.0	Arcturus	opt_Arcturus385	yes	2007-11-13
260.208	40.924	399.23367	3054.1921	119.0	-106.0	Arcturus	opt_Arcturus387	yes	2007-11-13
260.59	40.547	405.38116	3062.1516	121.0	-108.0	Arcturus	opt_Arcturus389	yes	2007-11-13
261.345	39.792	429.2	3074.0906	128.0	-112.0	Arcturus	opt_Arcturus393	yes	2007-11-13
261.718	39.414	436.2537	3082.05	130.0	-114.0	Arcturus	opt_Arcturus395	yes	2007-11-13
262.088	39.036	446.17493	3084.0398	133.0	-115.0	Arcturus	opt_Arcturus397	yes	2007-11-13
262.457	38.656	459.07648	3091.9993	137.0	-117.0	Arcturus	opt_Arcturus399	yes	2007-11-13
83.649	22.663	935.39056	3165.6235	279.0	-139.0	Arcturus	opt_Arcturus4	yes	2007-11-14
262.823	38.278	468.61783	3095.979	140.0	-118.0	Arcturus	opt_Arcturus401	yes	2007-11-13
263.905	37.139	499.43613	3107.918	149.0	-122.0	Arcturus	opt_Arcturus407	yes	2007-11-13
264.261	36.759	509.88	3111.8977	152.0	-123.0	Arcturus	opt_Arcturus409	yes	2007-11-13
265.317	35.617	536.9662	3125.8267	160.0	-127.0	Arcturus	opt_Arcturus415	yes	2007-11-13
265.665	35.236	546.7101	3127.8164	163.0	-128.0	Arcturus	opt_Arcturus417	yes	2007-11-13
267.715	32.947	599.75525	3157.664	179.0	-137.0	Arcturus	opt_Arcturus429	yes	2007-11-13
83.958	23.043	927.49	3165.6235	277.0	-139.0	Arcturus	opt_Arcturus5	yes	2007-11-14
84.267	23.422	921.2962	3155.6743	275.0	-136.0	Arcturus	opt_Arcturus6	yes	2007-11-14
84.578	23.803	914.8536	3157.664	273.0	-137.0	Arcturus	opt_Arcturus7	yes	2007-11-14
84.889	24.184	904.62573	3151.6946	270.0	-135.0	Arcturus	opt_Arcturus8	yes	2007-11-14
85.201	24.564	901.5011	3147.7148	269.0	-134.0	Arcturus	opt_Arcturus9	yes	2007-11-14
60.327	43.286	676.58795	2940.771	202.0	-72.0	Capella	opt_Capella1	yes	2007-11-13
60.475	43.618	382.65033	2950.7202	114.0	-75.0	Capella	opt_Capella2	yes	2007-11-13
60.622	43.951	372.11804	2946.7407	111.0	-74.0	Capella	opt_Capella3	yes	2007-11-13
260.466	24.467	837.1575	3181.5422	250.0	-144.0	Cas_A	opt_Cas_A773	yes	2007-11-13
296.508	31.156	694.34796	3113.8875	207.0	-124.0	Deneb	opt_Deneb755	yes	2007-11-13
294.315	54.6	-6.48953	2833.3196	-2.0	-40.0	Deneb	opt_Deneb757	yes	2007-11-13
294.421	54.252	7.0261507	2837.2993	2.0	-41.0	Deneb	opt_Deneb759	yes	2007-11-13
294.529	53.903	20.371506	2841.2788	6.0	-42.0	Deneb	opt_Deneb761	yes	2007-11-13
294.639	53.556	33.36204	2847.2485	10.0	-44.0	Deneb	opt_Deneb763	yes	2007-11-13
294.751	53.208	47.373398	2851.228	14.0	-45.0	Deneb	opt_Deneb765	yes	2007-11-13
71.89	16.696	968.70734	3253.1765	289.0	-165.0	Mars	opt_Mars4	yes	2007-11-13
72.181	17.059	965.7493	3249.1968	288.0	-164.0	Mars	opt_Mars5	yes	2007-11-13
88.738	73.075	-757.266	2534.843	-226.0	48.0	Vega	opt_Vega0	yes	2007-11-8
89.04	73.457	-770.7083	2524.8938	-230.0	51.0	Vega	opt_Vega1	yes	2007-11-8
92.129	76.912	-925.1587	2473.1577	-276.0	65.0	Vega	opt_Vega10	yes	2007-11-8
61.73	28.509	777.85266	3141.7454	232.0	-132.0	Vega	opt_Vega109	yes	2007-11-13

92.522	77.293	-935.2412	2445.3	-279.0	73.0	Vega	opt_Vega11	yes	2007-11-8
92.931	77.675	-951.68964	2435.3508	-284.0	76.0	Vega	opt_Vega12	yes	2007-11-8
64.868	33.289	670.71124	3093.989	200.0	-118.0	Vega	opt_Vega137	yes	2007-11-13
65.087	33.635	659.5505	3093.989	197.0	-118.0	Vega	opt_Vega139	yes	2007-11-13
96.504	80.455	-1065.9948	2379.6353	-318.0	91.0	Vega	opt_Vega14	yes	2007-11-8
66.179	35.376	615.99255	3078.0703	184.0	-113.0	Vega	opt_Vega149	yes	2007-11-13
97.105	80.835	-1082.5422	2371.6758	-323.0	93.0	Vega	opt_Vega15	yes	2007-11-8
67.259	37.132	572.6876	3058.1719	171.0	-107.0	Vega	opt_Vega159	yes	2007-11-13
97.744	81.213	-1099.4089	2363.7163	-328.0	95.0	Vega	opt_Vega16	yes	2007-11-8
67.473	37.484	562.8621	3054.1921	168.0	-106.0	Vega	opt_Vega161	yes	2007-11-13
67.688	37.838	552.7868	3052.2024	165.0	-105.0	Vega	opt_Vega163	yes	2007-11-13
67.901	38.191	542.6031	3044.243	162.0	-103.0	Vega	opt_Vega165	yes	2007-11-13
68.328	38.9	529.3309	3038.2734	158.0	-101.0	Vega	opt_Vega169	yes	2007-11-13
98.427	81.592	-1112.9269	2351.7773	-332.0	98.0	Vega	opt_Vega17	yes	2007-11-8
71.068	43.563	375.20404	2974.5984	112.0	-82.0	Vega	opt_Vega195	yes	2007-11-13
71.278	43.927	364.66946	2968.629	109.0	-80.0	Vega	opt_Vega197	yes	2007-11-13
71.486	44.289	355.44785	2964.6492	106.0	-79.0	Vega	opt_Vega199	yes	2007-11-13
89.351	73.842	-784.04596	2516.9343	-234.0	53.0	Vega	opt_Vega2	yes	2007-11-8
71.695	44.653	344.49185	2960.6694	103.0	-78.0	Vega	opt_Vega201	yes	2007-11-13
71.903	45.016	334.78897	2954.7	100.0	-76.0	Vega	opt_Vega203	yes	2007-11-13
72.319	45.744	311.836	2944.7507	93.0	-73.0	Vega	opt_Vega207	yes	2007-11-13
73.562	47.936	241.5999	2914.903	72.0	-64.0	Vega	opt_Vega219	yes	2007-11-13
74.388	49.405	193.88597	2900.974	58.0	-60.0	Vega	opt_Vega227	yes	2007-11-13
74.595	49.773	181.01788	2891.025	54.0	-57.0	Vega	opt_Vega229	yes	2007-11-13
74.802	50.142	167.85893	2885.0554	50.0	-55.0	Vega	opt_Vega231	yes	2007-11-13
75.009	50.511	156.99176	2885.0554	47.0	-55.0	Vega	opt_Vega233	yes	2007-11-13
75.216	50.881	140.78743	2877.0962	42.0	-53.0	Vega	opt_Vega235	yes	2007-11-13
75.422	51.25	126.93238	2875.1062	38.0	-52.0	Vega	opt_Vega237	yes	2007-11-13
75.629	51.62	114.02656	2867.147	34.0	-50.0	Vega	opt_Vega239	yes	2007-11-13
75.836	51.991	104.48015	2861.1772	31.0	-48.0	Vega	opt_Vega241	yes	2007-11-13
76.043	52.361	91.03611	2857.1978	27.0	-47.0	Vega	opt_Vega243	yes	2007-11-13
76.25	52.732	80.89072	2853.218	24.0	-46.0	Vega	opt_Vega245	yes	2007-11-13
76.666	53.476	57.166294	2841.2788	17.0	-42.0	Vega	opt_Vega249	yes	2007-11-13
77.082	54.221	29.866028	2833.3196	9.0	-40.0	Vega	opt_Vega253	yes	2007-11-13
77.29	54.594	16.921167	2827.35	5.0	-38.0	Vega	opt_Vega255	yes	2007-11-13
77.499	54.967	0.25319335	2821.3804	0.0	-36.0	Vega	opt_Vega257	yes	2007-11-13
77.707	55.34	-13.258846	2813.4211	-4.0	-34.0	Vega	opt_Vega259	yes	2007-11-13
77.917	55.714	-27.135138	2807.4517	-8.0	-32.0	Vega	opt_Vega261	yes	2007-11-13
78.127	56.087	-40.138264	2801.482	-12.0	-30.0	Vega	opt_Vega263	yes	2007-11-13
78.337	56.463	-56.95667	2793.5227	-17.0	-28.0	Vega	opt_Vega265	yes	2007-11-13
78.548	56.838	-70.704834	2789.543	-21.0	-27.0	Vega	opt_Vega267	yes	2007-11-13
78.759	57.213	-83.70191	2783.5735	-25.0	-25.0	Vega	opt_Vega269	yes	2007-11-13
78.97	57.588	-100.24248	2779.5938	-30.0	-24.0	Vega	opt_Vega271	yes	2007-11-13
79.182	57.963	-113.897835	2777.604	-34.0	-23.0	Vega	opt_Vega273	yes	2007-11-13
79.394	58.338	-126.862404	2769.6445	-38.0	-21.0	Vega	opt_Vega275	yes	2007-11-13
79.607	58.715	-140.3296	2767.6548	-42.0	-20.0	Vega	opt_Vega277	yes	2007-11-13
79.821	59.091	-157.17226	2759.6953	-47.0	-18.0	Vega	opt_Vega279	yes	2007-11-13
80.036	59.468	-167.31586	2753.7258	-50.0	-16.0	Vega	opt_Vega281	yes	2007-11-13
80.251	59.845	-183.9163	2749.746	-55.0	-15.0	Vega	opt_Vega283	yes	2007-11-13
80.683	60.599	-214.21133	2735.8171	-64.0	-11.0	Vega	opt_Vega287	yes	2007-11-13
80.901	60.977	-228.05632	2733.8274	-68.0	-10.0	Vega	opt_Vega289	yes	2007-11-13
81.12	61.356	-241.45682	2725.868	-72.0	-8.0	Vega	opt_Vega291	yes	2007-11-13

81.339	61.733	-255.15363	2719.8984	-76.0	-6.0	Vega	opt_Vega293	yes	2007-11-13
81.559	62.112	-275.04132	2709.9492	-82.0	-3.0	Vega	opt_Vega295	yes	2007-11-13
82.004	62.869	-304.76157	2700.0	-91.0	0.0	Vega	opt_Vega299	yes	2007-11-13
89.668	74.225	-801.20886	2510.9648	-239.0	55.0	Vega	opt_Vega3	yes	2007-11-8
82.227	63.248	-322.1367	2692.0405	-96.0	2.0	Vega	opt_Vega301	yes	2007-11-13
82.452	63.626	-335.42673	2682.0913	-100.0	5.0	Vega	opt_Vega303	yes	2007-11-13
82.678	64.006	-345.0087	2680.1016	-103.0	6.0	Vega	opt_Vega305	yes	2007-11-13
82.907	64.387	-362.21875	2672.142	-108.0	8.0	Vega	opt_Vega307	yes	2007-11-13
83.136	64.767	-378.94308	2668.1626	-113.0	9.0	Vega	opt_Vega309	yes	2007-11-13
83.367	65.147	-391.9885	2658.2134	-117.0	12.0	Vega	opt_Vega311	yes	2007-11-13
83.599	65.526	-412.11777	2656.2234	-123.0	13.0	Vega	opt_Vega313	yes	2007-11-13
83.833	65.906	-428.70035	2648.2642	-128.0	15.0	Vega	opt_Vega315	yes	2007-11-13
85.033	67.809	-509.30093	2614.4368	-152.0	25.0	Vega	opt_Vega325	yes	2007-11-13
89.974	74.588	-811.19104	2493.0562	-242.0	60.0	Vega	opt_Vega4	yes	2007-11-8
271.653	28.362	703.6553	3205.4204	210.0	-151.0	Vega	opt_Vega453	yes	2007-11-13
271.973	27.98	713.5234	3209.4	213.0	-152.0	Vega	opt_Vega455	yes	2007-11-13
272.293	27.597	719.7458	3211.39	215.0	-153.0	Vega	opt_Vega457	yes	2007-11-13
272.612	27.215	731.0472	3219.349	218.0	-155.0	Vega	opt_Vega459	yes	2007-11-13
252.479	84.828	-1299.2999	2325.9094	-360.0	100.0	Vega	opt_Vega465	yes	2007-11-13
253.984	84.462	-1282.1373	2329.8892	-353.0	100.0	Vega	opt_Vega467	yes	2007-11-13
255.321	84.092	-1264.8376	2337.8484	-346.0	99.0	Vega	opt_Vega469	yes	2007-11-13
256.518	83.722	-1250.9607	2343.8179	-340.0	98.0	Vega	opt_Vega471	yes	2007-11-13
257.6	83.35	-1230.4823	2353.767	-332.0	96.0	Vega	opt_Vega473	yes	2007-11-13
258.585	82.975	-1216.8726	2357.7468	-326.0	95.0	Vega	opt_Vega475	yes	2007-11-13
259.486	82.6	-1199.9747	2363.7163	-319.0	94.0	Vega	opt_Vega477	yes	2007-11-13
260.317	82.224	-1182.7925	2369.686	-312.0	93.0	Vega	opt_Vega479	yes	2007-11-13
261.084	81.847	-1165.8115	2377.6453	-305.0	91.0	Vega	opt_Vega481	yes	2007-11-13
261.798	81.469	-1148.7494	2385.6047	-298.0	89.0	Vega	opt_Vega483	yes	2007-11-13
262.467	81.09	-1131.9113	2393.564	-291.0	87.0	Vega	opt_Vega485	yes	2007-11-13
263.094	80.71	-1118.1578	2397.5437	-285.0	86.0	Vega	opt_Vega487	yes	2007-11-13
263.684	80.331	-1097.9661	2405.5032	-277.0	84.0	Vega	opt_Vega489	yes	2007-11-13
264.243	79.95	-1084.4976	2413.4624	-271.0	82.0	Vega	opt_Vega491	yes	2007-11-13
264.772	79.57	-1067.3688	2421.4219	-264.0	80.0	Vega	opt_Vega493	yes	2007-11-13
265.275	79.19	-1050.2551	2425.4016	-257.0	79.0	Vega	opt_Vega495	yes	2007-11-13
265.756	78.808	-1033.5144	2433.3608	-250.0	77.0	Vega	opt_Vega497	yes	2007-11-13
266.215	78.427	-1016.26587	2441.3203	-243.0	75.0	Vega	opt_Vega499	yes	2007-11-13
266.657	78.045	-995.9397	2445.3	-235.0	74.0	Vega	opt_Vega501	yes	2007-11-13
267.081	77.663	-985.6974	2451.2695	-230.0	72.0	Vega	opt_Vega503	yes	2007-11-13
267.489	77.282	-965.34064	2455.2493	-222.0	71.0	Vega	opt_Vega505	yes	2007-11-13
267.884	76.898	-948.4592	2467.1882	-215.0	68.0	Vega	opt_Vega507	yes	2007-11-13
268.266	76.516	-931.5158	2471.168	-208.0	67.0	Vega	opt_Vega509	yes	2007-11-13
268.635	76.134	-914.3446	2477.1375	-201.0	65.0	Vega	opt_Vega511	yes	2007-11-13
268.993	75.751	-900.68	2481.1172	-195.0	64.0	Vega	opt_Vega513	yes	2007-11-13
269.341	75.37	-880.31555	2489.0767	-187.0	62.0	Vega	opt_Vega515	yes	2007-11-13
269.68	74.988	-863.21906	2495.0461	-180.0	60.0	Vega	opt_Vega517	yes	2007-11-13
270.011	74.605	-846.3016	2503.0054	-173.0	58.0	Vega	opt_Vega519	yes	2007-11-13
270.334	74.223	-825.9629	2508.975	-165.0	56.0	Vega	opt_Vega521	yes	2007-11-13
270.649	73.84	-808.85846	2512.9546	-158.0	55.0	Vega	opt_Vega523	yes	2007-11-13
270.957	73.459	-791.9642	2520.914	-151.0	53.0	Vega	opt_Vega525	yes	2007-11-13
271.26	73.076	-778.3979	2522.9038	-145.0	52.0	Vega	opt_Vega527	yes	2007-11-13
271.556	72.694	-757.786	2530.8633	-137.0	50.0	Vega	opt_Vega529	yes	2007-11-13
271.847	72.312	-744.13824	2536.8328	-131.0	48.0	Vega	opt_Vega531	yes	2007-11-13

272.132	71.93	-726.6908	2540.8125	-124.0	47.0	Vega	opt_Vega533	yes	2007-11-13
272.413	71.548	-706.33813	2548.772	-116.0	45.0	Vega	opt_Vega535	yes	2007-11-13
272.689	71.167	-692.6681	2554.7415	-110.0	43.0	Vega	opt_Vega537	yes	2007-11-13
272.961	70.785	-672.0418	2558.7212	-102.0	42.0	Vega	opt_Vega539	yes	2007-11-13
273.23	70.402	-658.0154	2564.6907	-96.0	40.0	Vega	opt_Vega541	yes	2007-11-13
273.494	70.021	-644.3936	2572.65	-90.0	38.0	Vega	opt_Vega543	yes	2007-11-13
273.755	69.64	-626.85583	2574.64	-83.0	37.0	Vega	opt_Vega545	yes	2007-11-13
274.012	69.259	-609.9813	2582.599	-76.0	35.0	Vega	opt_Vega547	yes	2007-11-13
274.267	68.877	-595.9004	2588.5688	-70.0	33.0	Vega	opt_Vega549	yes	2007-11-13
274.519	68.497	-578.3837	2596.528	-63.0	31.0	Vega	opt_Vega551	yes	2007-11-13
274.768	68.115	-561.3692	2598.518	-56.0	30.0	Vega	opt_Vega553	yes	2007-11-13
275.014	67.735	-547.3847	2606.4773	-50.0	28.0	Vega	opt_Vega555	yes	2007-11-13
275.258	67.354	-530.19836	2612.4468	-43.0	26.0	Vega	opt_Vega557	yes	2007-11-13
275.5	66.973	-512.80426	2620.4062	-36.0	24.0	Vega	opt_Vega559	yes	2007-11-13
275.739	66.593	-498.45847	2622.396	-30.0	23.0	Vega	opt_Vega561	yes	2007-11-13
275.977	66.212	-481.40097	2632.3452	-23.0	20.0	Vega	opt_Vega563	yes	2007-11-13
276.213	65.832	-466.61874	2636.325	-17.0	19.0	Vega	opt_Vega565	yes	2007-11-13
276.446	65.452	-453.25888	2636.325	-11.0	19.0	Vega	opt_Vega567	yes	2007-11-13
276.678	65.072	-432.05902	2646.2742	-3.0	16.0	Vega	opt_Vega569	yes	2007-11-13
276.909	64.693	-421.52994	2652.2437	2.0	14.0	Vega	opt_Vega571	yes	2007-11-13
277.137	64.313	-403.79245	2660.2031	9.0	12.0	Vega	opt_Vega573	yes	2007-11-13
277.365	63.934	-390.08533	2662.1929	15.0	11.0	Vega	opt_Vega575	yes	2007-11-13
277.59	63.555	-365.34	2674.132	24.0	8.0	Vega	opt_Vega577	yes	2007-11-13
277.815	63.176	-361.51172	2674.132	27.0	8.0	Vega	opt_Vega579	yes	2007-11-13
278.038	62.798	-343.93466	2680.1016	34.0	6.0	Vega	opt_Vega581	yes	2007-11-13
278.261	62.419	-322.9826	2684.0813	42.0	5.0	Vega	opt_Vega583	yes	2007-11-13
278.482	62.04	-308.84232	2690.0508	48.0	3.0	Vega	opt_Vega585	yes	2007-11-13
278.702	61.663	-294.35214	2696.0203	54.0	1.0	Vega	opt_Vega587	yes	2007-11-13
278.921	61.285	-280.20706	2703.9797	60.0	-1.0	Vega	opt_Vega589	yes	2007-11-13
279.14	60.907	-268.43436	2705.9695	65.0	-2.0	Vega	opt_Vega591	yes	2007-11-13
279.357	60.529	-247.33517	2709.9492	73.0	-3.0	Vega	opt_Vega593	yes	2007-11-13
279.573	60.152	-233.47308	2715.9187	79.0	-5.0	Vega	opt_Vega595	yes	2007-11-13
279.789	59.775	-218.99927	2725.868	85.0	-8.0	Vega	opt_Vega597	yes	2007-11-13
280.004	59.398	-203.8978	2729.8477	91.0	-9.0	Vega	opt_Vega599	yes	2007-11-13
280.219	59.022	-186.14343	2733.8274	98.0	-10.0	Vega	opt_Vega601	yes	2007-11-13
280.432	58.646	-171.76794	2743.7766	104.0	-13.0	Vega	opt_Vega603	yes	2007-11-13
280.645	58.269	-160.8233	2745.7664	109.0	-14.0	Vega	opt_Vega605	yes	2007-11-13
280.857	57.894	-146.1917	2753.7258	115.0	-16.0	Vega	opt_Vega607	yes	2007-11-13
281.069	57.519	-131.89326	2753.7258	121.0	-16.0	Vega	opt_Vega609	yes	2007-11-13
281.28	57.144	-116.82984	2763.675	127.0	-19.0	Vega	opt_Vega611	yes	2007-11-13
281.49	56.77	-102.14218	2763.675	133.0	-19.0	Vega	opt_Vega613	yes	2007-11-13
281.701	56.395	-84.383286	2769.6445	140.0	-21.0	Vega	opt_Vega615	yes	2007-11-13
281.911	56.021	-76.93225	2769.6445	144.0	-21.0	Vega	opt_Vega617	yes	2007-11-13
282.12	55.647	-62.04882	2779.5938	150.0	-24.0	Vega	opt_Vega619	yes	2007-11-13
282.33	55.273	-44.047356	2785.5632	157.0	-26.0	Vega	opt_Vega621	yes	2007-11-13
282.539	54.9	-28.60907	2795.5125	163.0	-29.0	Vega	opt_Vega623	yes	2007-11-13
282.747	54.526	-20.290627	2795.5125	167.0	-29.0	Vega	opt_Vega625	yes	2007-11-13
282.955	54.154	-5.4894137	2803.472	173.0	-31.0	Vega	opt_Vega627	yes	2007-11-13
283.163	53.782	5.532454	2809.4414	178.0	-33.0	Vega	opt_Vega629	yes	2007-11-13
283.371	53.409	21.039886	2809.4414	184.0	-33.0	Vega	opt_Vega631	yes	2007-11-13
283.579	53.037	35.056366	2819.3906	190.0	-36.0	Vega	opt_Vega633	yes	2007-11-13
283.786	52.666	49.966553	2823.3704	196.0	-37.0	Vega	opt_Vega635	yes	2007-11-13

283.994	52.295	58.563915	2829.3398	200.0	-39.0	Vega	opt_Vega637	yes	2007-11-13
284.201	51.924	76.636604	2835.3093	207.0	-41.0	Vega	opt_Vega639	yes	2007-11-13
284.408	51.553	88.35456	2845.2585	212.0	-44.0	Vega	opt_Vega641	yes	2007-11-13
284.615	51.183	97.256	2845.2585	216.0	-44.0	Vega	opt_Vega643	yes	2007-11-13
284.822	50.813	108.354645	2853.218	221.0	-46.0	Vega	opt_Vega645	yes	2007-11-13
285.029	50.443	124.25124	2855.2078	227.0	-47.0	Vega	opt_Vega647	yes	2007-11-13
285.236	50.074	138.61908	2865.157	233.0	-50.0	Vega	opt_Vega649	yes	2007-11-13
285.442	49.706	151.44041	2869.1367	238.0	-51.0	Vega	opt_Vega651	yes	2007-11-13
285.649	49.338	162.73634	2875.1062	243.0	-53.0	Vega	opt_Vega653	yes	2007-11-13
285.856	48.97	175.0954	2875.1062	248.0	-53.0	Vega	opt_Vega655	yes	2007-11-13
286.063	48.602	183.27516	2883.0657	252.0	-55.0	Vega	opt_Vega657	yes	2007-11-13
286.27	48.233	195.19748	2889.0352	257.0	-57.0	Vega	opt_Vega659	yes	2007-11-13
286.477	47.867	214.73299	2895.0046	264.0	-59.0	Vega	opt_Vega661	yes	2007-11-13
286.684	47.5	222.1199	2902.964	268.0	-61.0	Vega	opt_Vega663	yes	2007-11-13