5.4 OPTICAL NAVIGATION CALIBRATION RESULTS

Excerpt from Reference 5.4-1(with slight modification of first 2 sentences, shown as first sentence below)

Reference 5.4-1 - "Cassini WAC FM Radial Distortion (notes from PT, 14 April 1997); Nav Target Test", Peter Thomas, April 14, 1997

5.4.1 NAV TARGET TESTS

An example of NAV target images of disks is given in Figure 5.4-1(also shown at the Oct 1996 team meeting). The standard limb-finder was run on disks in selected images to measure the shape distortion at the three locations, and the distance between the three disk images. Two kinds of tests were done: the distortion prediction as a function of position, and differences between filters.

5.4.2 DISTORTION AS FUNCTION OF POSITION

The targets are about 41 pixels in radius. Ellipses fit to the disks have mean residuals of less than 0.1 pixels (as low as 0.03 pixels). Their shapes and orientations are crudely those expected, but significant differences, probably due to the shading and possibly due to slightly non-circular shape, or other effects, are apparent. The results are listed below in Table 5.4-1 grouped by filters.

Figure 5.4-2 shows the fit ellipses for the three disks as a function of sample (L= left target, ~sample 62; C=center, sample -500, R= right, sample ~~967.) Circles are short axes, x's are long axes. The differences in the fit axes are shown in the right column of plots in Figure 5.4-2. Maximum differences in axes are about 0.4 pixels.

Figure 5.4-3 plots the shapes predicted solely on the basis of the distortion parameter calculated by C. Avis (see above and attached) and the observed average shape at the three distances sampled. The shape of the center disk, located only 160 pixels from the predicted optic axis, suggests that there is some additional distortion: non-circular shape of the disk, distortion in the collimator, window, and camera not accounted for, tilt of the target (~0.1°), or systematic limb-fitting error as a function of azimuth. The relative change in the shape of the target disk as a function of radius is approximately that expected, but the differences between the right and left shapes, at approximately the same radial distance, suggests fitting these values beyond 0.1 pixels may be unwarranted. The control on the distortion parameter, is thus only about 30%.

Figure 5.4-4 shows the predicted (c = 9.5 x10-9) radial shift in pixels of the disk center as a function of radius, to illustrate the total distortion of location of features in a WAC image.

5.4.3 EFFECTS OF DIFFERENT FILTERS

Figure 5.4-5 shows distances between the fit centers of the disks; the data fall into filter groupings (see also Table 5.4-1). The data scatter from straight lines, but suggest detection of slight variations in effective focal length in the different filter combinations, but greater than what I would predict from the focus shift notes given us. (?)

NOTE: The NAV calibration team has not done the disk targets yet; Claude Hildebrand of that group has been sent these results (which are of only selected images; a variety of tests on crescent disks and distorted disks has not been done here).

Also, these are all measurements of what happens through the entire test set-up, not just of the camera effects!

5.4.4 SUMMARY

No detectable difference with and without anti-blooming.

Distortion parameters found by C. Avis seem reasonable.

NAV target distortions very roughly agree with grid distortion parameter.

Slight (up to 1/1600) differences in effective focal length of different filter combinations may be detected, but may involve additional experimental effects.

The real geometric calibration will occur with star images. We will need them in all the filter combinations, but it is not obvious we need them in different modes (at least for geometry).

In flight, also, in the event we are allowed to image near Earth encounter, we should take lunar images at a variety of ranges for limb-finder calibration. The known radius of the Moon (sphere) allows this operation to calibrate limb finding to accuracies of 0.05 pixels or better.
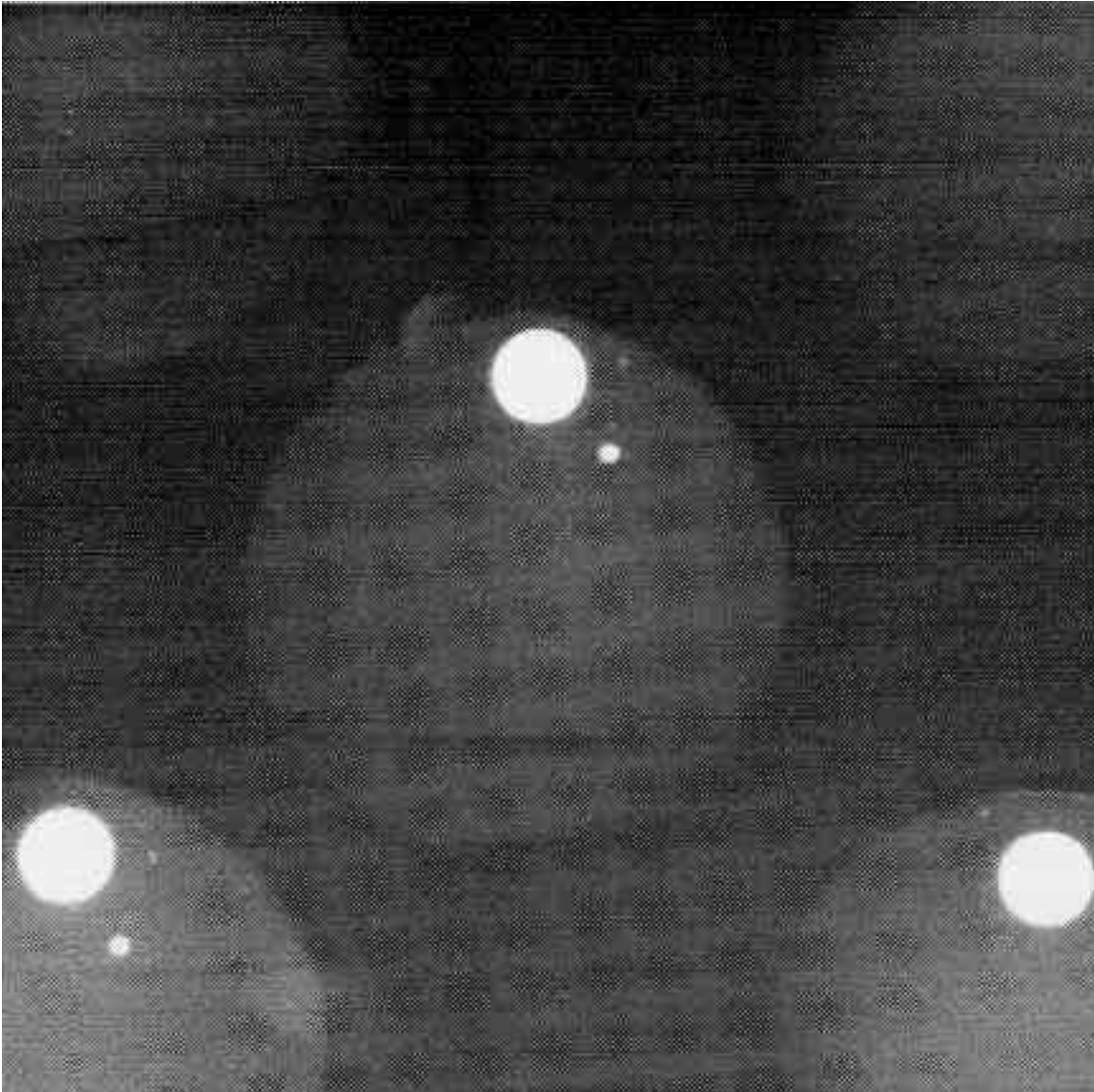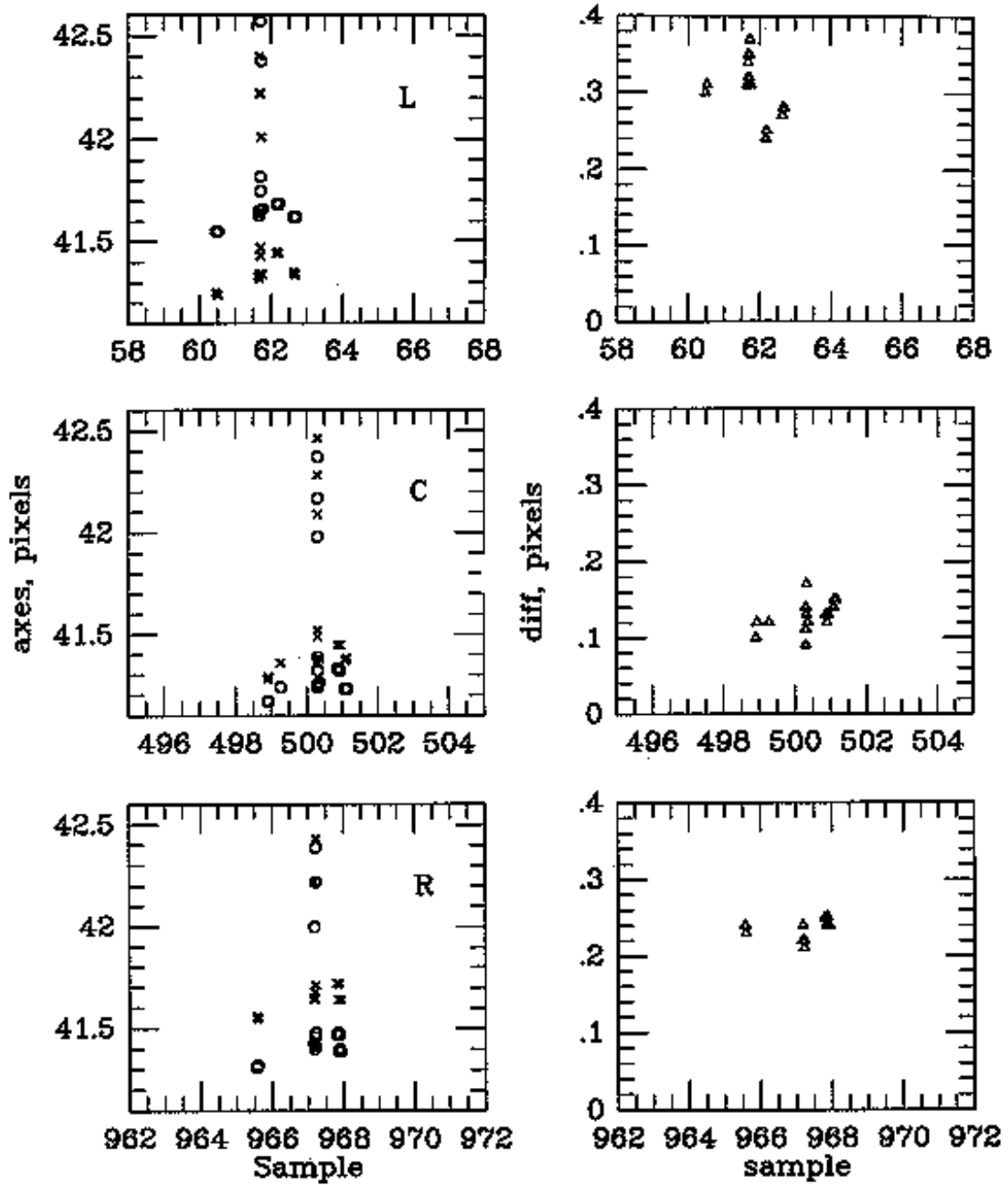
Figure 5.4-1- Nav Disk Target Image

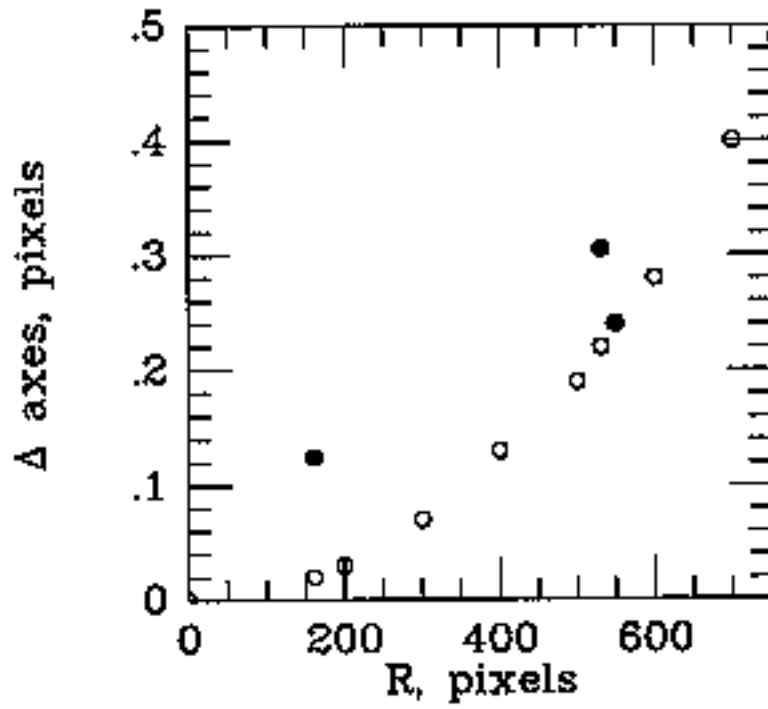**Figure 5.4-2 - WAC FM Ellipse Fits to Disks**
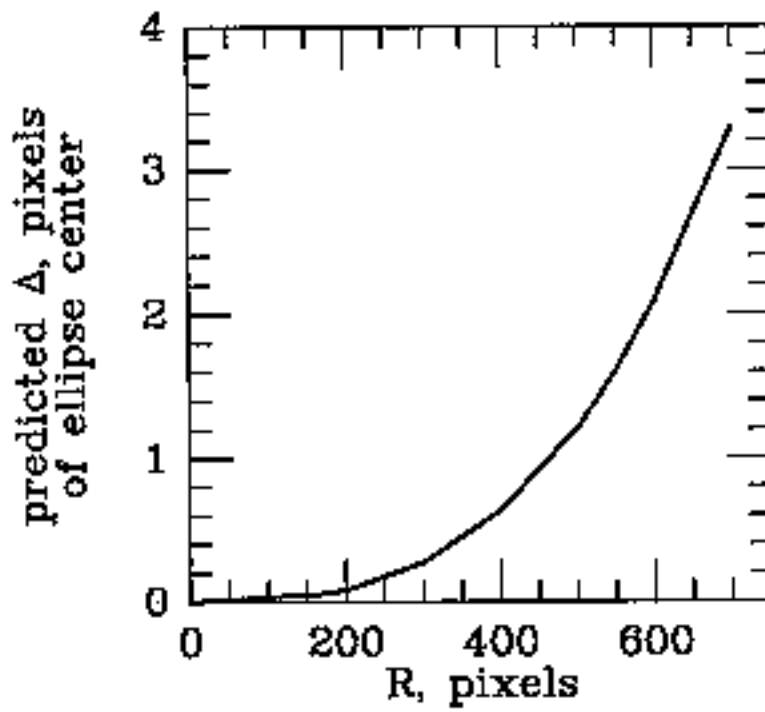
Figure 5.4-3 - WAC FM Nav Target Shapes

Figure 5.4-4 - WAC FM Nav Target Offsets

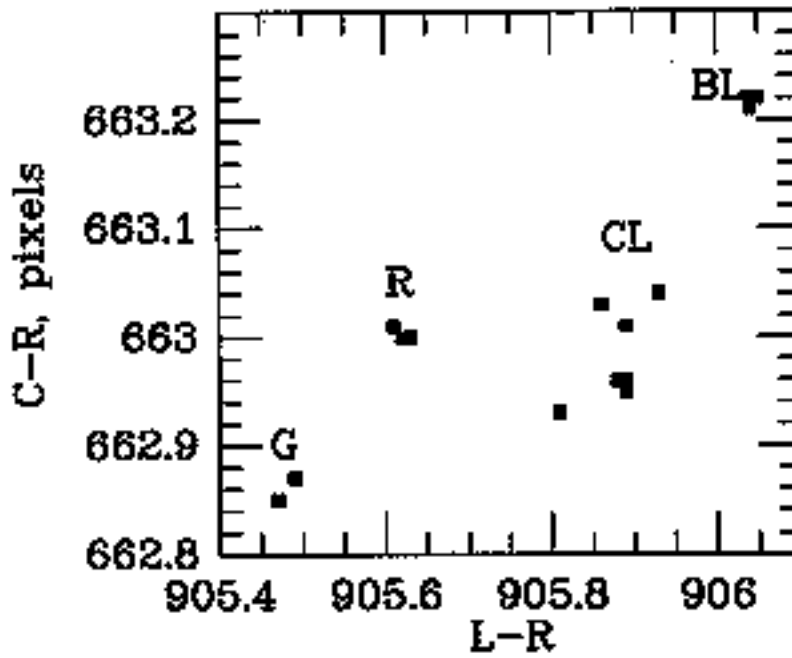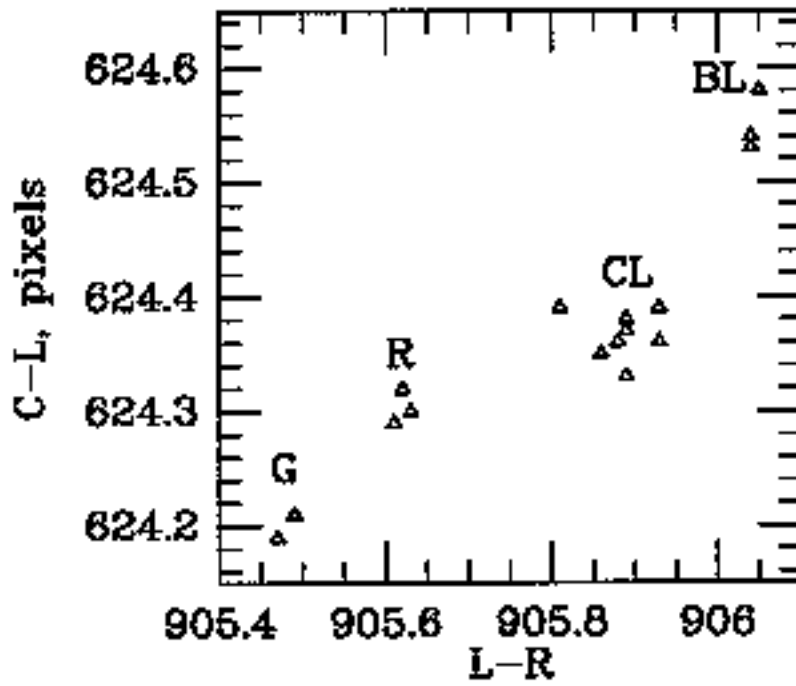**Figure 5.4-5 - WAC FM Inter Disk Distances**

image	#	c samp	c line	angle	a	b	res**2	distance		
								C-L	L-R	C-R
128471C	240	501.14	351.82	71.00	41.38	41.23	0.49			
128471L	238	62.69	796.27	43.00	41.34	41.62	0.57			
128471R	230	967.92	822.65	42.00	41.64	41.39	0.41	624.32	905.62	663.00
128472C	236	501.10	351.83	70.00	41.38	41.23	0.43			
128472L	235	62.65	796.26	44.00	41.34	41.62	0.47			
128472R	236	967.89	822.65	41.00	41.64	41.40	0.38	624.30	905.63	663.00
128473C	235	501.08	351.77	70.00	41.37	41.23	0.40			
128473L	236	62.64	796.19	44.00	41.35	41.62	0.48			
128473R	237	967.86	822.62	41.00	41.64	41.39	0.36	624.29	905.61	663.01
128476C	235	498.93	351.03	65.00	41.29	41.17	0.23			
128476L	238	60.51	795.33	47.00	41.24	41.55	0.26			
128476R	236	965.59	821.77	38.00	41.55	41.32	0.23	624.19	905.47	662.85
128477C	234	498.90	350.94	66.00	41.28	41.17	0.18			
128477L	233	60.46	795.25	48.00	41.25	41.55	0.20			
128477R	235	965.57	821.71	38.00	41.56	41.31	0.21	624.21	905.49	662.87
128483C	234	500.94	349.40	73.00	41.45	41.32	0.38			
128483L	236	62.20	793.93	49.00	41.44	41.68	0.37			
128483R	234	967.87	820.39	40.00	41.72	41.47	0.37	624.58	906.05	663.22
128484C	237	500.89	349.39	71.00	41.45	41.33	0.37			
128484L	239	62.20	793.89	50.00	41.44	41.69	0.35			
128484R	237	967.85	820.36	41.00	41.72	41.48	0.33	624.53	906.04	663.22
128485C	236	500.89	349.33	71.00	41.45	41.32	0.39			
128485L	238	62.18	793.84	50.00	41.45	41.69	0.38			
128485R	237	967.84	820.30	41.00	41.72	41.48	0.34	624.55	906.04	663.22
128486C	233	500.86	349.37	71.00	41.45	41.33	0.39			
128486L	236	62.16	793.87	50.00	41.44	41.69	0.41			
128486R	238	967.81	820.33	40.00	41.72	41.47	0.36	624.53	906.04	663.22
128508C	231	500.35	50.92	69.00	41.38	41.26	0.96			
128508L	236	61.75	795.33	43.00	41.34	41.66	1.17			
128508R	236	967.18	21.60	37.00	41.64	41.43	1.02	624.40	905.81	662.93
128513C	235	500.31	350.92	69.00	41.49	41.32	0.39			
128513L	238	61.70	95.26	40.00	41.43	41.75	0.58			
128513R	236	967.20	21.60	44.00	41.68	41.46	0.82	624.36	905.88	662.96
128516C	237	500.30	350.97	64.00	42.09	41.98	0.43			
128516L	235	61.72	95.34	45.00	42.01	42.38	0.53			
128516R	239	967.19	21.74	37.00	42.22	42.00	0.36	624.35	905.86	663.03
128520C	237	500.30	50.83	60.00	41.38	41.24	0.76			
128520L	238	61.68	795.20	46.00	41.34	41.65	1.10			
128520R	239	967.19	21.57	36.00	41.65	41.42	0.92	624.38	905.89	663.01

Table 5.4-1 - Nav Target Ellipse Fits

image	#	c samp	c line	angle	a	b	res**2	distance		
								C-L	L-R	C-R
128524C	234	500.31	50.94	63.00	41.52	41.39	0.24			
128524L	238	61.70	95.25	44.00	41.47	41.82	0.32			
128524R	237	967.22	21.58	46.00	41.71	41.48	0.73	624.33	905.89	662.95
128528C	240	500.30	50.94	63.00	42.28	42.17	0.47			
128528L	241	61.69	795.29	46.00	42.22	42.57	0.57			
128528R	237	967.23	21.67	39.00	42.43	42.22	0.54	624.36	905.93	663.04
128531 C	233	500.29	351.21	62.00	41.36	1.25	0.72			
128531L	237	61.68	95.58	46.00	41.32	41.63	0.83			
128531 R	236	967.19	821.88	37.00	41.64	41.42	0.68	624.37	905.89	662.96
128532C	233	499.26	351.13	62.00	41.36	41.24	0.80			
128532L	237	61.65	95.48	46.00	41.33	41.63	0.86			
128532R	237	967.19	821.81	36.00	41.64	41.40	0.65	623.66	905.92	663.70
128541 C	239	500.30	51.26	64.00	42.46	42.37	0.61			
128541 L	242	61.68	795.64	48.00	42.40	42.74	0.73			
128541 R	244	967.22	22.01	34.00	42.61	42.39	0.66	624.39	905.93	663.04

Table 5.4-1 - Nav Target Ellipse Fits (cont'd)