

Figure 1.17. Pixel-level timing diagram for delta reset sample mode. Several relevant timing signals are shown at the top of the diagram, and the signals that control the signal processor are shown at the bottom. The hatched regions indicate the limits of the asynchronous conversion completion, according to the specifications of the A/D converter device.

MIRAC DELTA RESET MODE TIMING

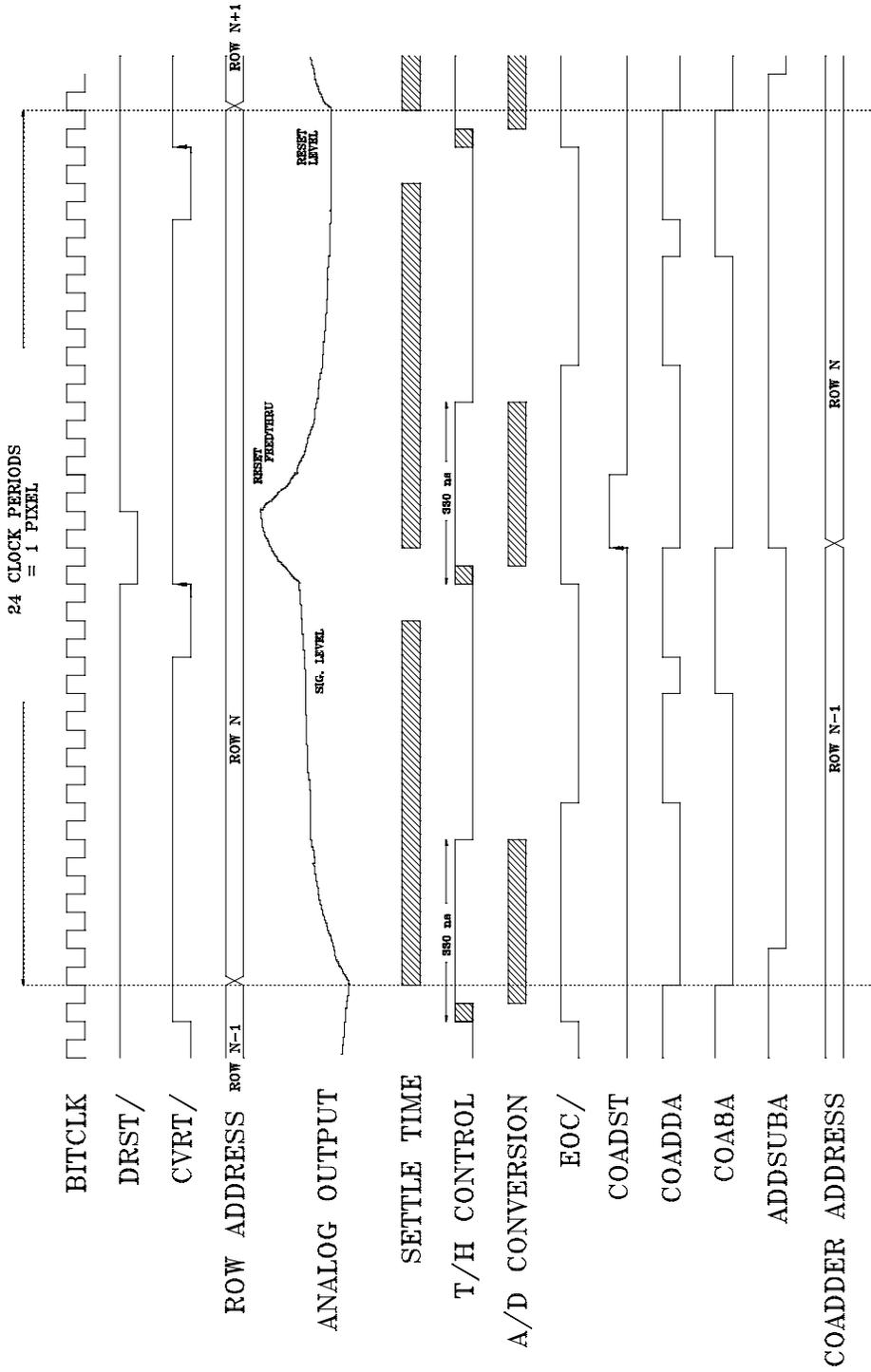


Figure 1.17

MIRAC Dewar Cooldown

February 3-4, 1991

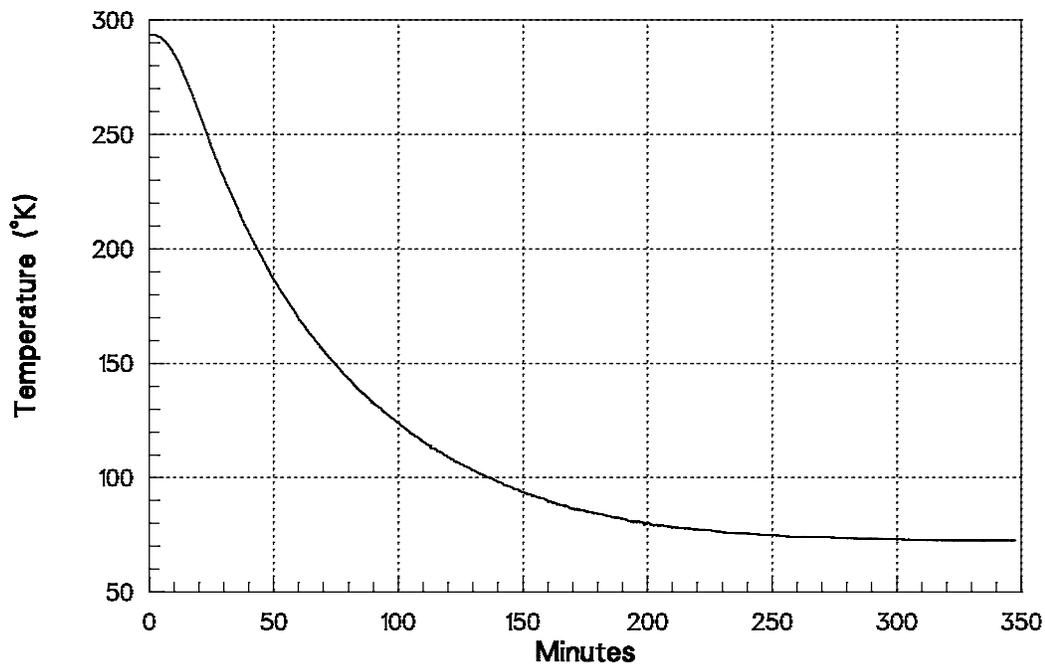


Figure 1.18. MIRAC cooldown from room temperature.
1.18a. With the dewar at room temperature, LN₂ is added to both the nitrogen and helium reservoirs at 0 minutes. The temperature is allowed to stabilize at 77K. Normally, the LN₂ would be removed from the helium reservoir and the LHe fill begun after the temperature drops below 100K.

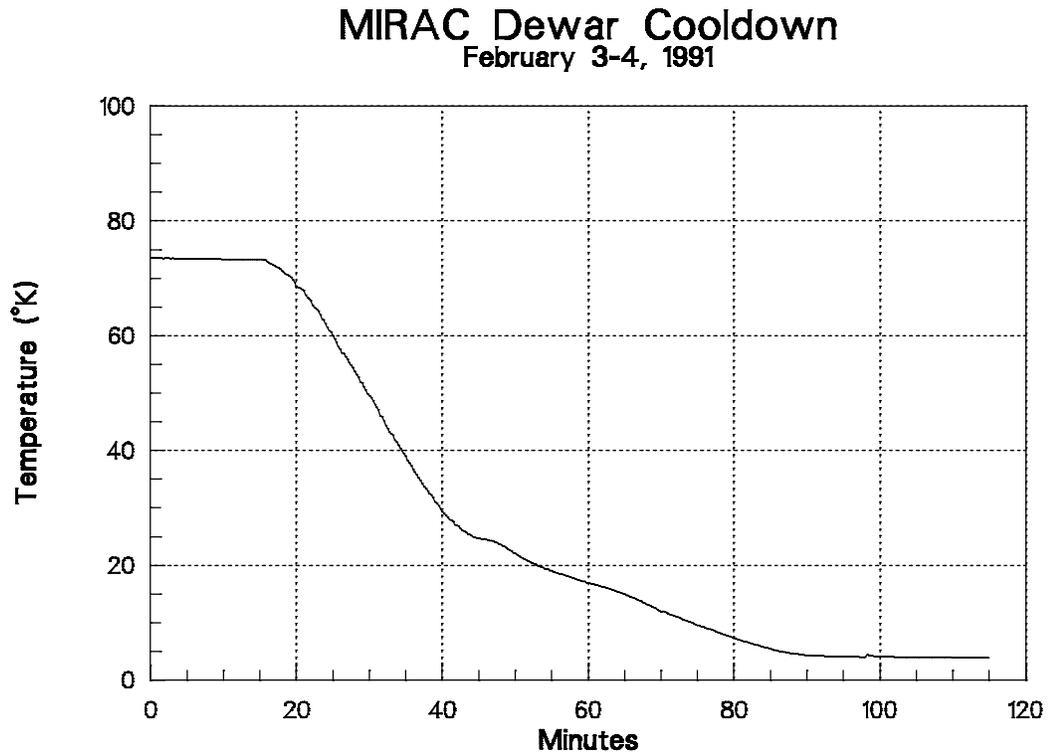


Figure 1.18b. The dewar has stabilized at 77K. At a time of approximately 15 minutes, the LN₂ is blown out of the helium reservoir, and it is filled with LHe. The temperature stabilizes at 4K in about 75 minutes.

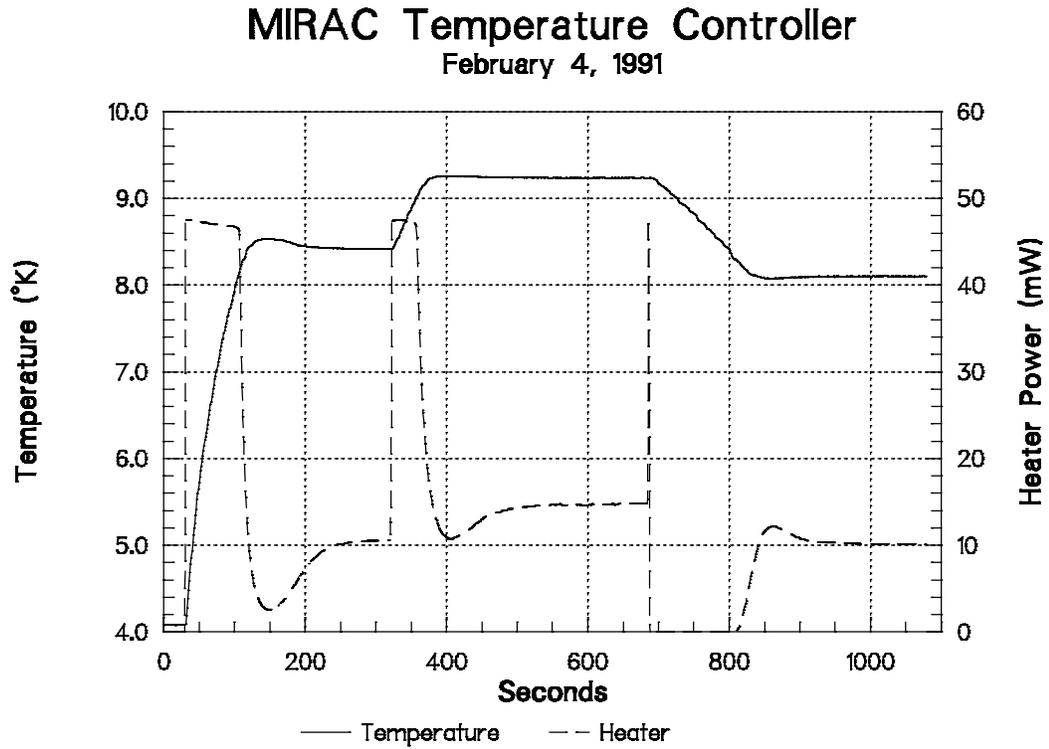


Figure 1.19. MIRAC temperature and heater power. The temperature controller was set at a goal temperature of 8.5 K and turned on with the detector block initially at 4.1K. At approximately 320 seconds into the test, the temperature goal was set to 9.2K. Then at approximately 680 seconds the temperature goal was set to 8.1K.

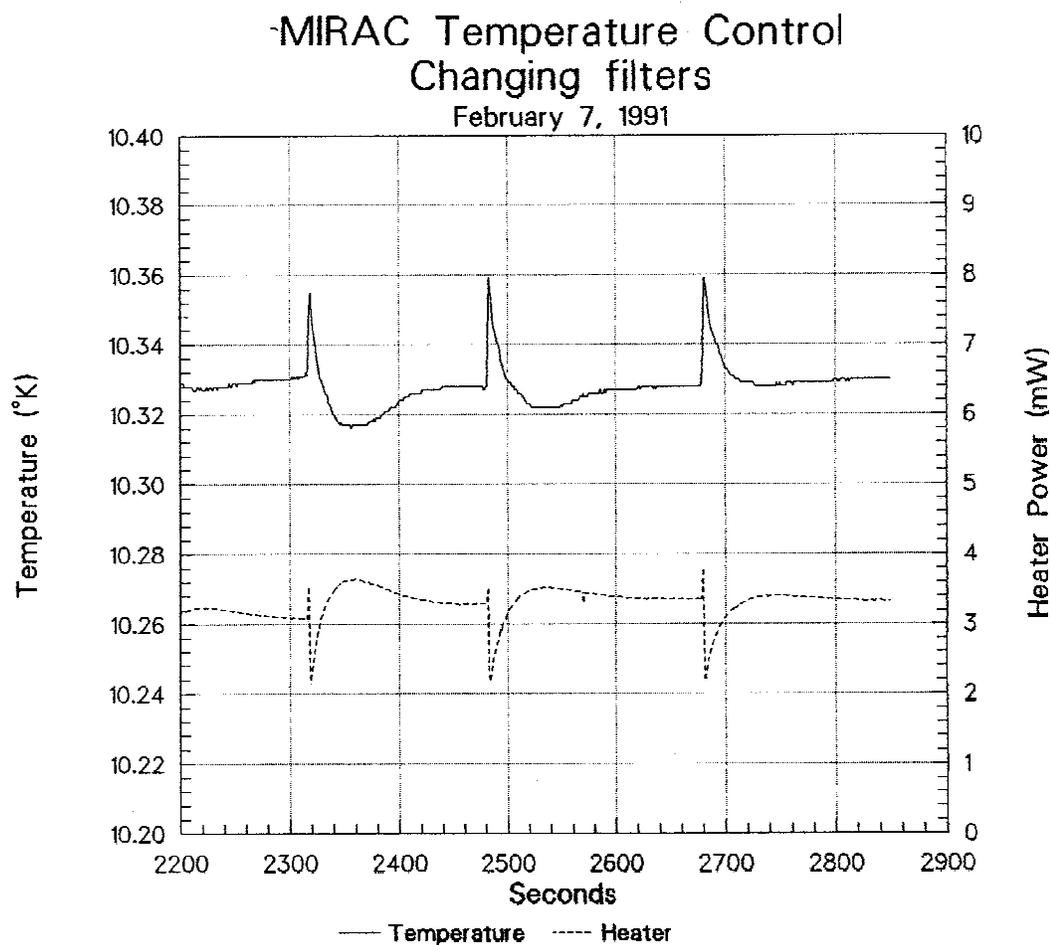


Figure 1.20. MIRAC temperature while changing filters. The initial filter was the 8.8 μm with the 20% neutral density, and the filter was changed successively to the next three adjacent ones, the 9.8, 11.7, and 12.5 μm . The filter wheel motors take approximately 5 seconds to move from one filter to the next. In the plot, a spike in the temperature occurs just as the filter is changed. This is because the detector is momentarily blanked off as the filter wheel turns to the next filter, and the self-heating of the array increases. This causes the temperature to increase, so the controller lowers the heater power. It takes approximately 150 seconds for the temperature to stabilize to the original value.

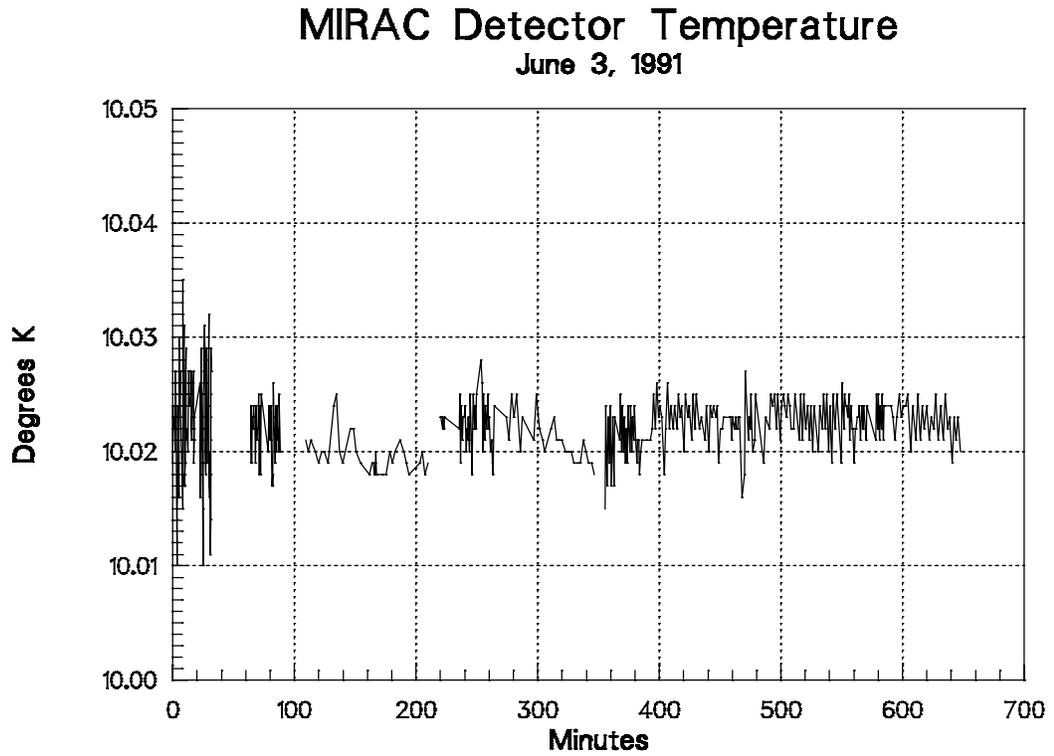


Figure 1.21. MIRAC detector temperature and heater power for June 3, 1991. The temperature was recorded at the beginning of each observation taken.
1.21a. Detector Temperature.

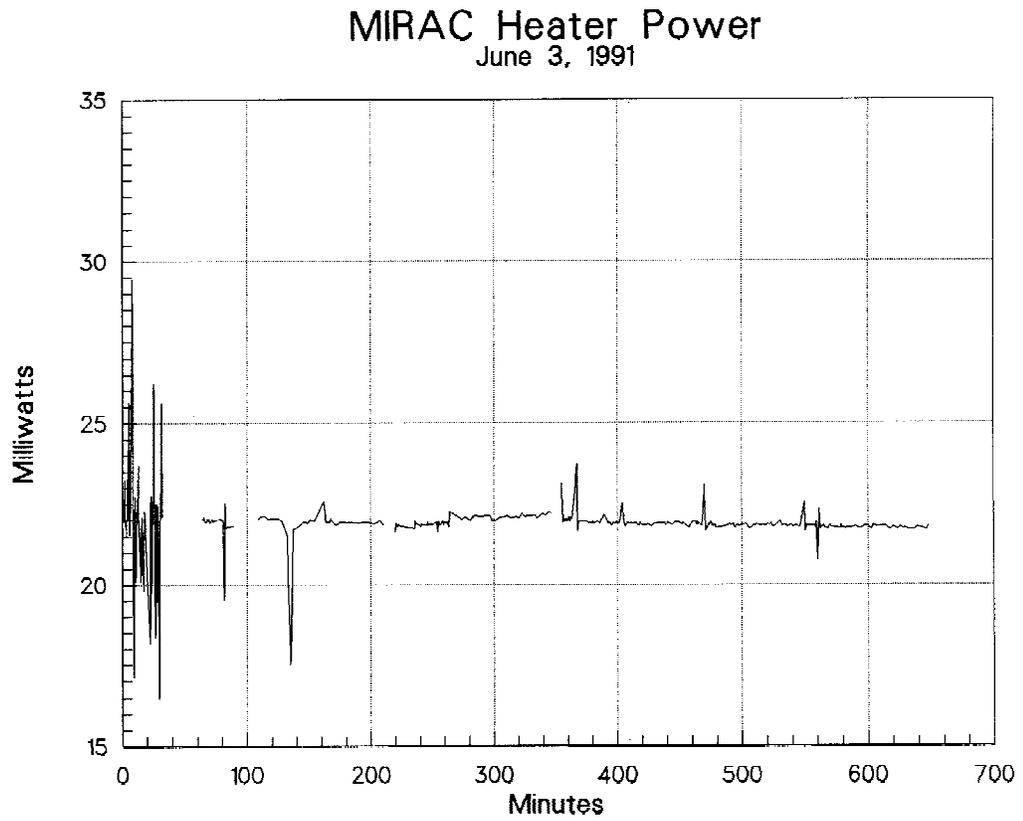


Figure 1.21b. Heater Power for June 3, 1991.

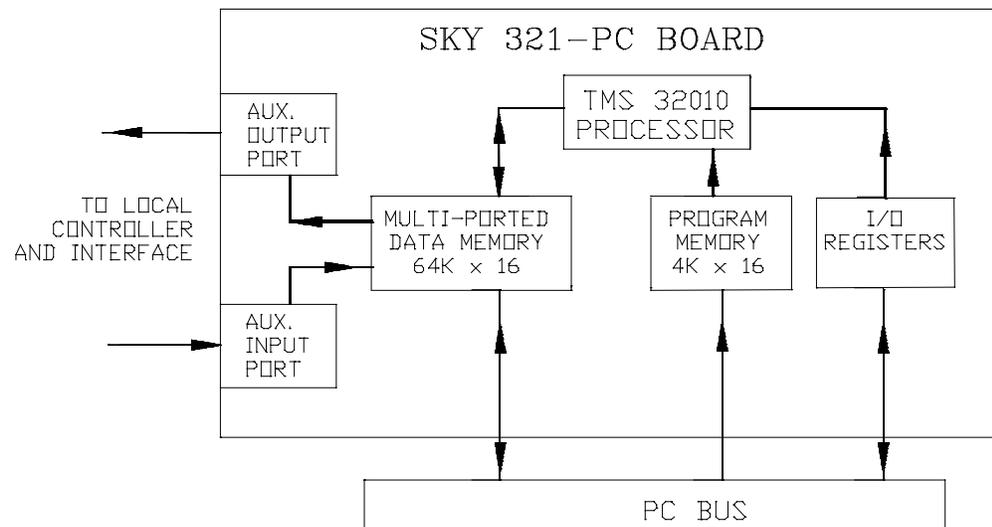


Figure 1.22. Block diagram of the Sky board. The PC can write to data and program memory and registers on the SKY board, and read registers and data memory. The TMS 32010 processor's program is read from program memory, and it can read and write from the data memory and registers. It can also direct transfers to and from the auxiliary input and output ports, which are connected to the local controller/interface which provides communication with the MIRAC electronics.

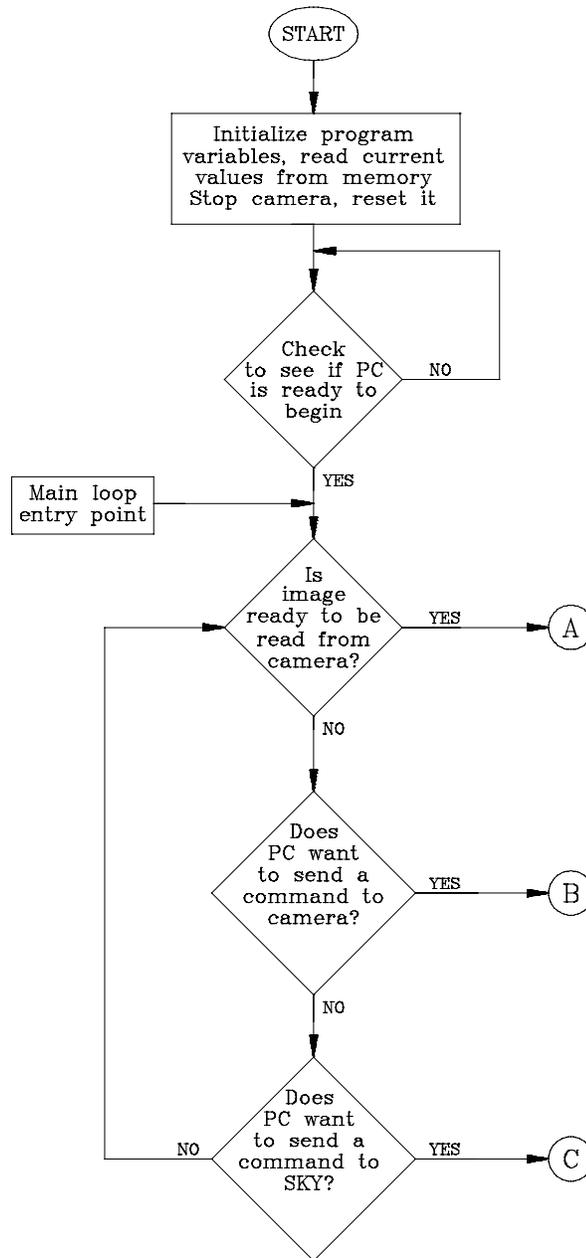


Figure 1.23. Flowchart of the SKY program. The letters (A), (B), and (C) refer to subroutines that return to this main loop at the point marked main loop entry point.

a. Main sky board loop.

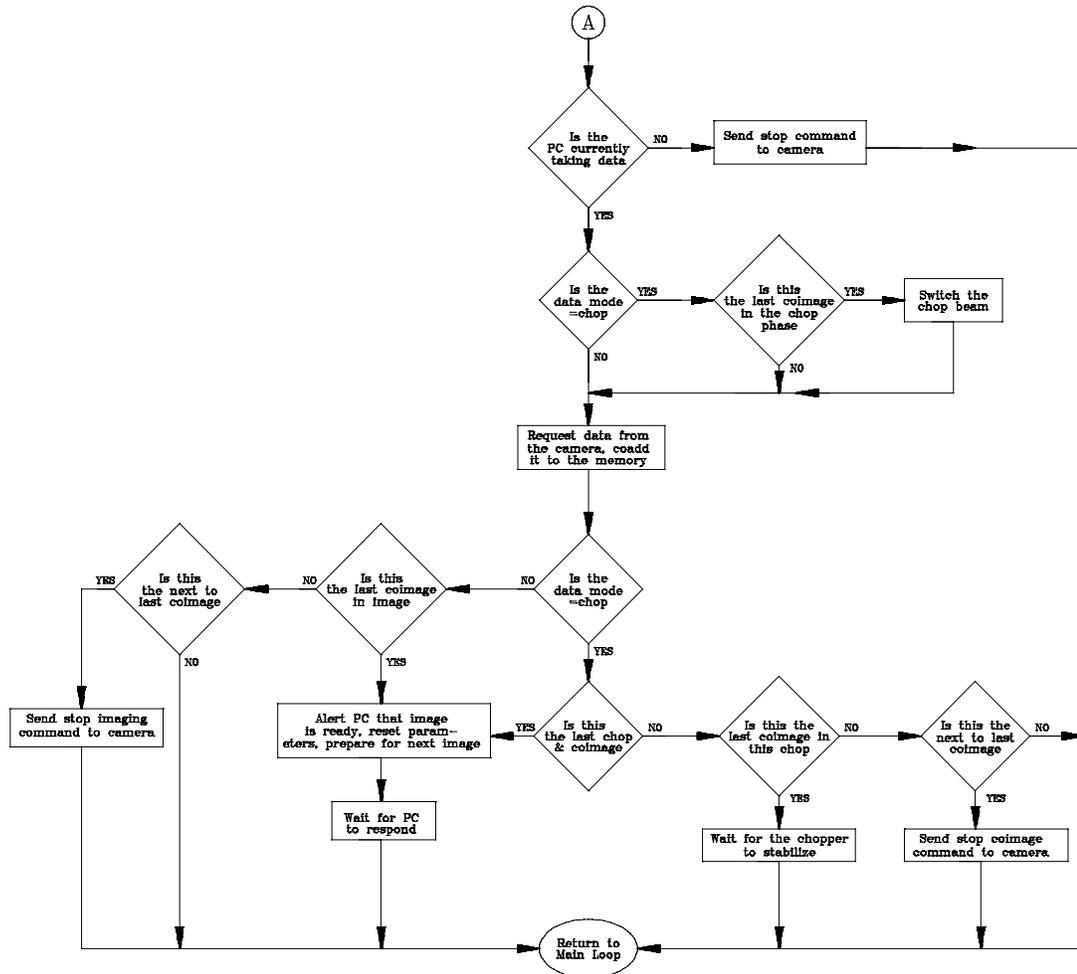


Figure 1.23b. image ready loop. This routine is executed at the point marked **A** in Figure 1.23a. Two different observing modes are handled, depending on whether chopping is active.


```

OBS:  Unit  Mode  Header  Run  Wait  Save  Filter  Locat  Disp  Util  Quit

IntTime: 0.00      SampleM: 4 Reset      Off_RA : 0.00
ObsMode:  Grab    ClkRate: 15.000 MHz  Off.Dec: 0.00
Hvlgth : 13.20   Fr Time: 1.0240E-4  Filter 1: Nonstd
Chop Fr: 0.15    ChpMait: 0.000ms   Filter 2: Baf2
ElcTemp: 0.00    DetTemp: 0.000

Dmax: 1.39 ( 12, 5 ) Dmin: -0.27 ( 31, 3 )
Fit= Max: 0.92 ( 11, 08, 0.00 ) FWHM-X: 4.79 FWHM-Y: 0.00
Total RMS: 0.410 Avg: 0.21 Num: 318
Background RMS: 0.102 Avg: -0.08 Num: 89
Source Sum: 70.13 Num: 255 ( 3 )
Sky Flux: 0.0 RMS: 0.00 DIF: 0.0

OBS: 7-12-91 13:29:25 C910712A.001      IDLE 0:00/0:00 0/1
DISP: 6-02-91 9:45:15 f:\data1\C910602A.160 BD+30 3639

```

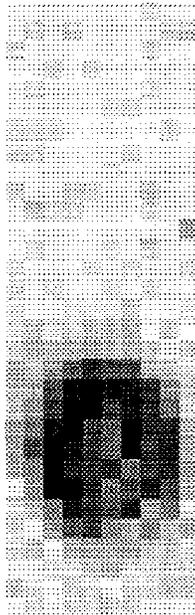


Figure 1.24. MIRAC program main screen.
 1.24a. Main screen in OBS: command line with sample image.

OBS: Init Mode Header Run Wait Save Filter Locat Disp Util Quit

IntTime: 4.82 SampleM: ^ Reset Off. RA : 0.00
ObsMode: Chop-Mod ClkRate: 7.324 KHz Off. Dec: 0.00
Wvlngth : 0.00 Fr Time: 1.0486E-1 Filter 1: Nonstd
Chop Fr: 4.35 ChpWait: 10.00ms Filter 2: Open
ElcTemp: 0.00 DetTemp: 10.629

A. Filter Nonstd
B. Filter Open
Time (sec) 4.823
Total Coadds 46
Clock Rate 7.324 KHz
Sample Mode ^ Reset 0
of Raster Positions 1
Frames per Coimage 1.0E-0001
Frame Time 0.58
Magnification 4.00
Nod Time 4.353
Chop Frequency 10.000
Chop wait time (ms) 1
Per Chop phase



Dmax: 0.30 (63, 63) Dmin: -0.13 (48, 63)
Total RMS: 0.047 Avg: -0.00 Num: 315
Background RMS: 0.030 Avg: -0.01 Num: 286
Source Sum: 2.89 Num: 29 (6)
Number of observations: 1.0
Sky Flux: 0.0 RMS: 0.00 DIF: 0.0

OBS: 2-25-91 16:27:51 C910225A.001 Blank sky IDLE 0:00/0:24 0/1
DISP:02-14-91 10:35:11 e:\data12\m4151sh.nap NGC 4151

Figure 1.24b. A MIRAC program pull-down menu showing options.

7-12-91 14:07:16 File: ~tal\C910602A.160 7-12-91 14:06:52

Date: 6-02-91 Time: 9:45:15

Object information:		Camera parameters:	
Name	: BD+30 3639	DtBias:	-2.60
R. A.	: 19:32:47.50	ADTemp:	-41.38
Dec.	: 30:24:20.00	ERTemp:	9.22
Off.RA	: 2.00 arcs	DtTemp:	10.03
Off.Dec:	2.40 arcs	HPower:	19.95
		Extent:	Half
		Offbuf :	0
		DelayCy:	0
		Row Cnt:	64
		Bndwdth:	1400 KHz
		Gain :	-1.00
		Array :	32 x 10

Observing Parameters:		Telescope:90-inch	
Filtr 1:	Nonstd	SampleM:	Reset
Filtr 2:	Nonstd	TotCoad:	24600
Wvlgth :	12.80	IntTime:	10.08s
ClkRate:	1.875 MHz	ObsMode:	Chop-Nod
FrPerCo:	200	Fr Time:	4.0960E-4
		Magnif.:	0.29
		Chop Fr:	5.16
		NodWait:	4.00s
		T Scale:	1.99"/mm
		ChpWait:	15.0ms

Mask : msk11 20.map
Gain Map : e:\data10\gain125.map
Comment : c910602a.160

Data Max:	1.39 (12, 5)	Min:	-0.27 (31, 3)
Display Max:	1.39	Min:	-0.27
Fit> MAX:	0.92 (11.08, 0.00	FWHM-X:	4.79
Total Sigma:	0.410	Avg:	0.21
Background Sigma:	0.102	Num:	318
Source Sum:	70.13	Num:	63
Number of Observations:	1.0	Num:	255 (3)
Sky Flux:	1445.014	RMS:	0.833
		DIF:	0.319

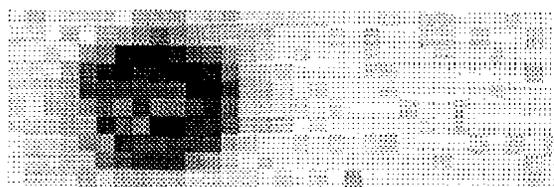


Figure 1.25. Sample MIRAC output, showing header information, map statistics, and image.

Figure 1.26. MIRAC Guider box assembly diagram, side view. At the top is the mounting flange that attaches to the telescope. The upper, largest mirror can be rotated into the beam to reflect it to a viewing port, but is usually stored in the vertical position to allow the beam to reach the dichroic. The MIRAC dewar and mounting mechanism are shown attached to the right side, and the TV can be attached to the port on the lower left. The position of the relay optics can be adjusted to properly focus the MIRAC and the TV on a common telescope focus. The magnification flip mirror has two positions, one for each magnification of the camera.

1.26a. Low magnification. After passing through the dichroic, the optical light is reflected directly into the TV relay optics.

MIRAC GUIDER BOX AND CAMERA MOUNT

Low Magnification

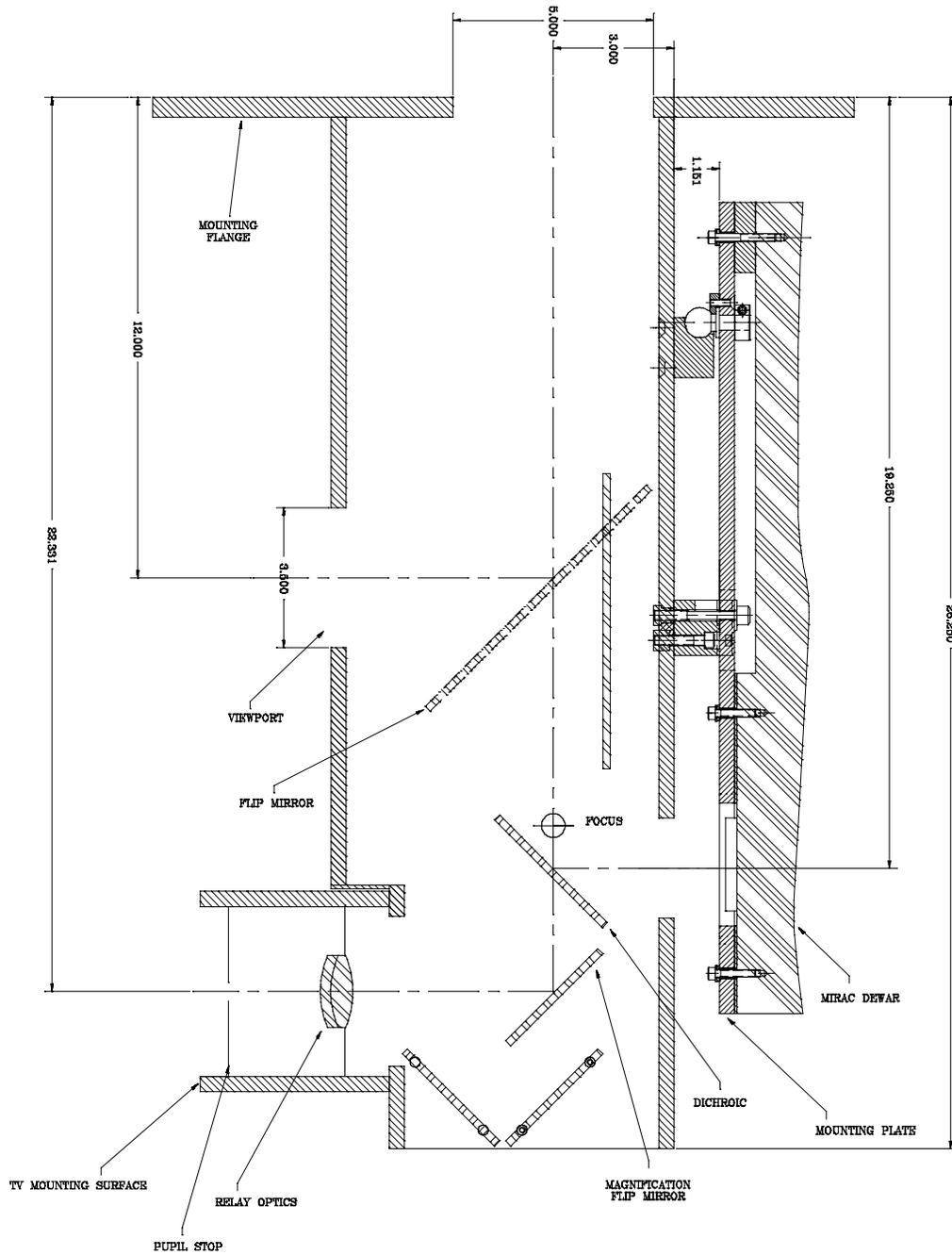


Figure 1.26a

Figure 1.26b. High magnification. The magnification flip mirror is rotated 90° clockwise in this diagram. The optical light is allowed to pass to the pair of mirrors at the bottom of the box. The beam is then reflected up to the flip mirror in its alternate position and then into the TV relay optics.

MIRAC GUIDER BOX AND CAMERA MOUNT

High Magnification

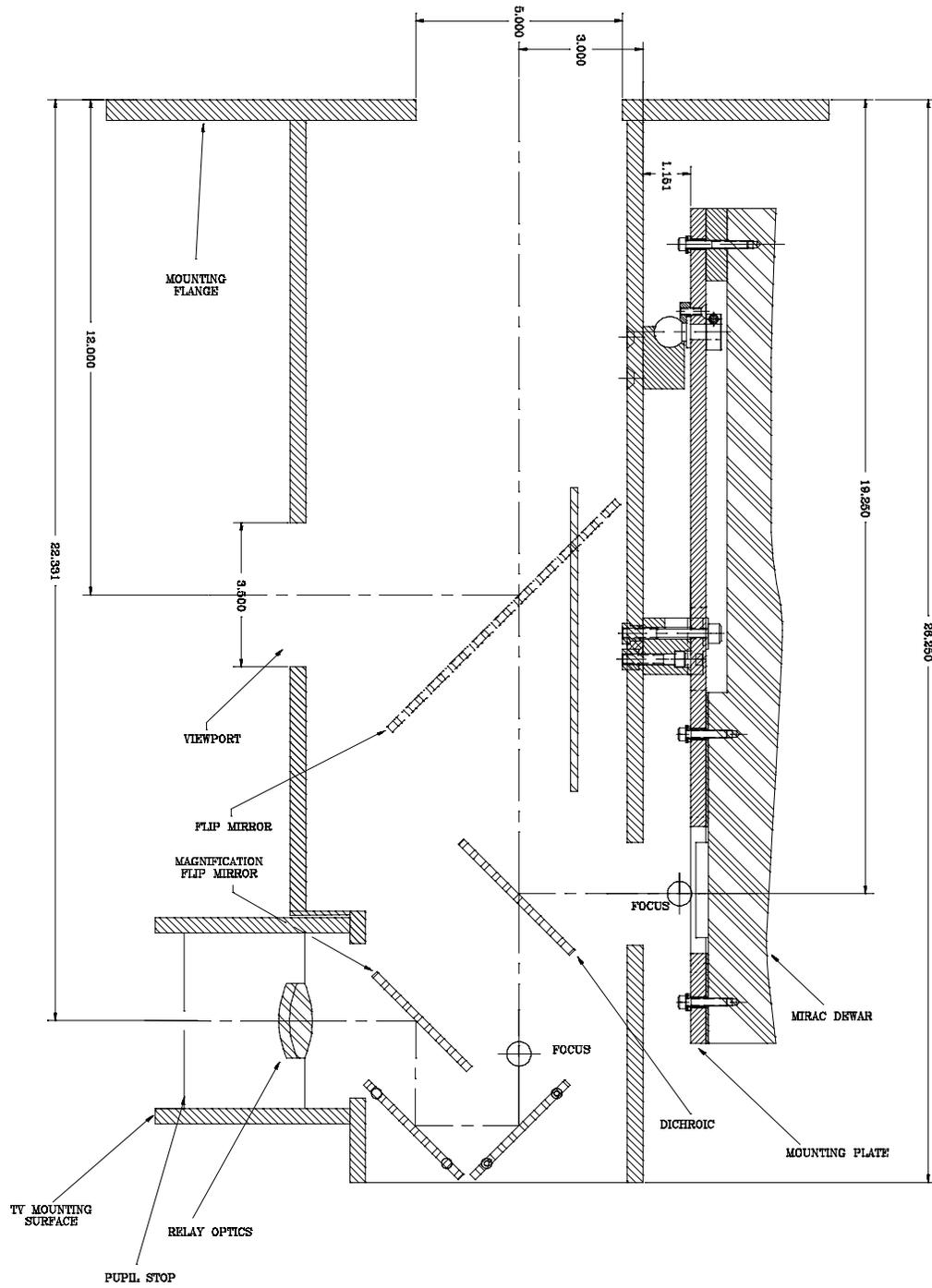


Figure 1.26b

Figure 1.27. MIRAC Guider box dichroic holder. The dichroic is mounted in a plate which "floats" above a larger plate which is attached to the inside walls of the box. The floating plate has three points of support, two pivot screws and a stainless steel ball, and is held in place by three springs pulling the plate against these points of support. By turning the pivot screws using knobs outside of the guider box, the alignment can be adjusted in R.A. and Dec.

MIRAC Dichroic Mount

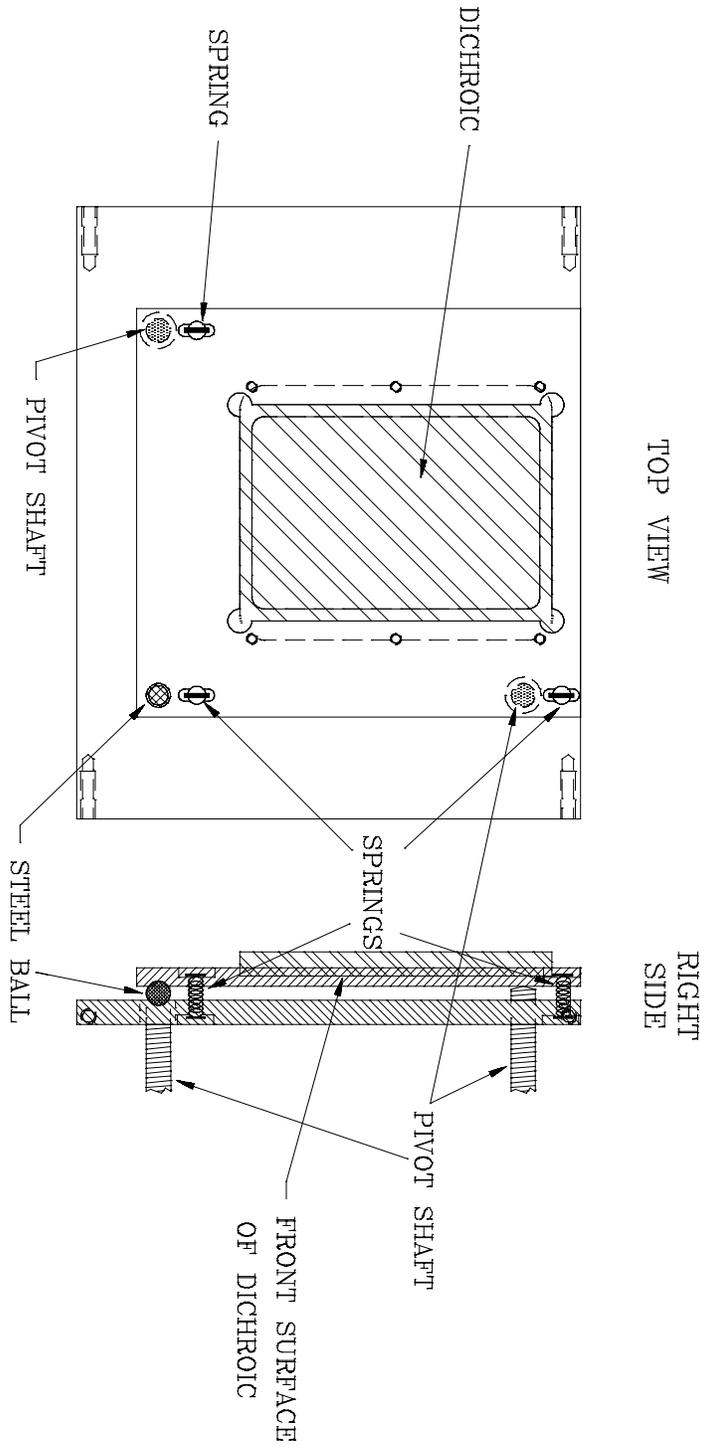


Figure 1.27

Figure 1.28. MIRAC dewar mounting plate. The side view shows the dewar and mounting plate on the left, and the guider box front plate on the right. The mounting plate is separated from the dewar by G-10 spacers and attached using nylon-insulated screws, isolating the dewar from the telescope. A round ball on the mounting plate fits into a socket on the guider box, and a rectangular post slips into a groove on the mounting plate to align the dewar laterally. Two screws on the mounting plate on either side of the post screw into the guider box to secure the dewar.

Figure 1.29. MIRAC Lab test setup. The pinhole and XYZ stage were present only for the optics evaluation. The chopper is controlled by the MIRAC computer with a logic pulse, just as it controls the chopper on the telescope.

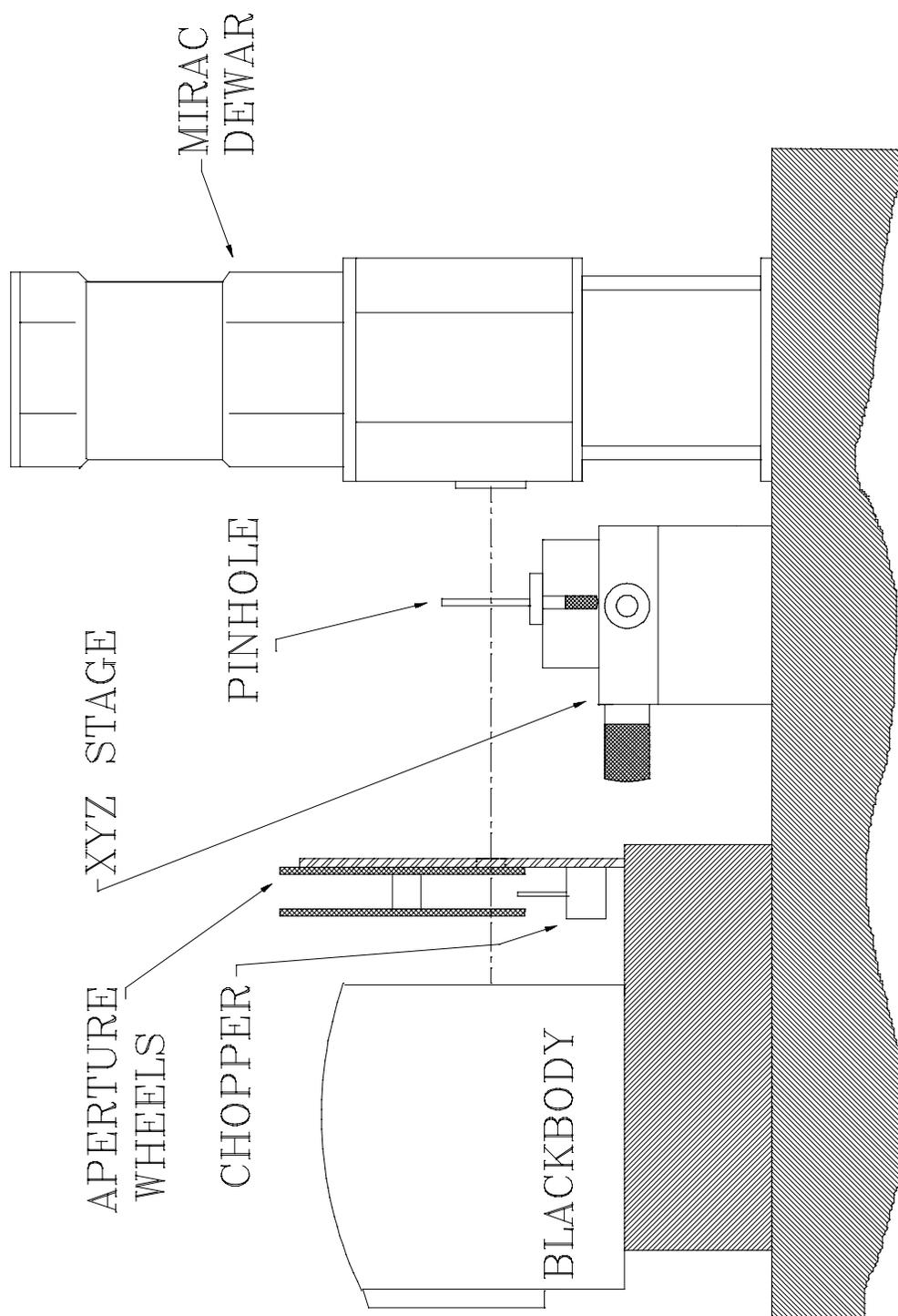


Figure 1.29

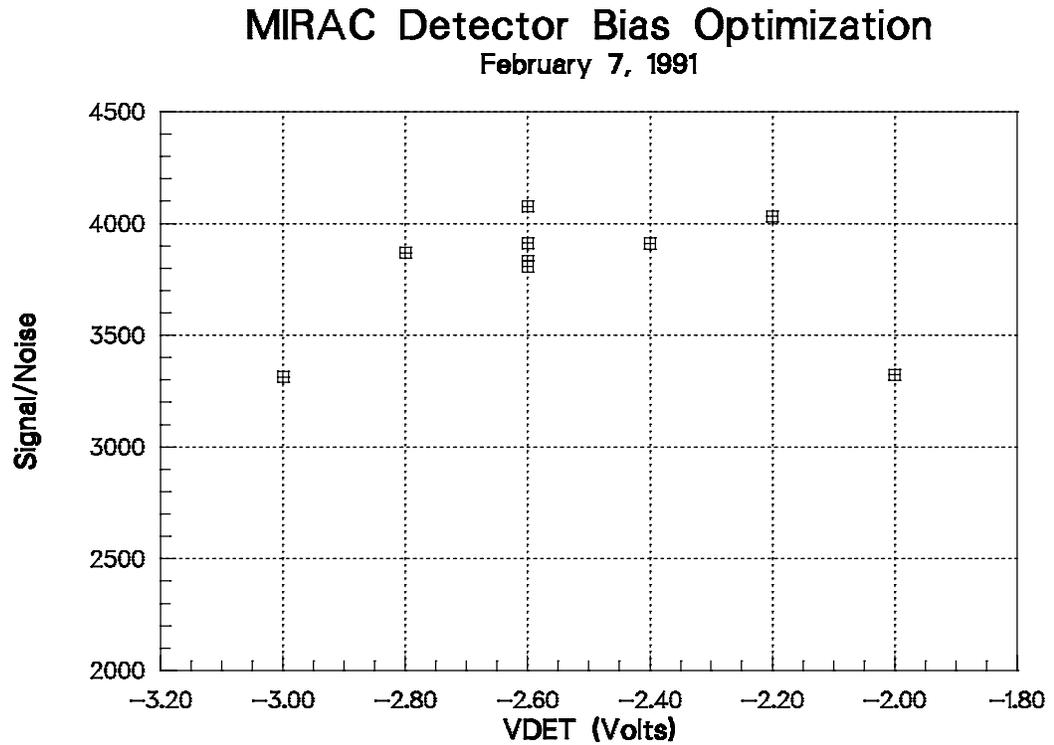


Figure 1.30. Mirac optimization measurements.

1.30a. Signal/Noise as VDET is adjusted from -3.0 to -2.0 V. The S/N is relatively flat over the range -2.8 to -2.2 V, with a definite downturn outside this range at -3.0 and -2.0 V.

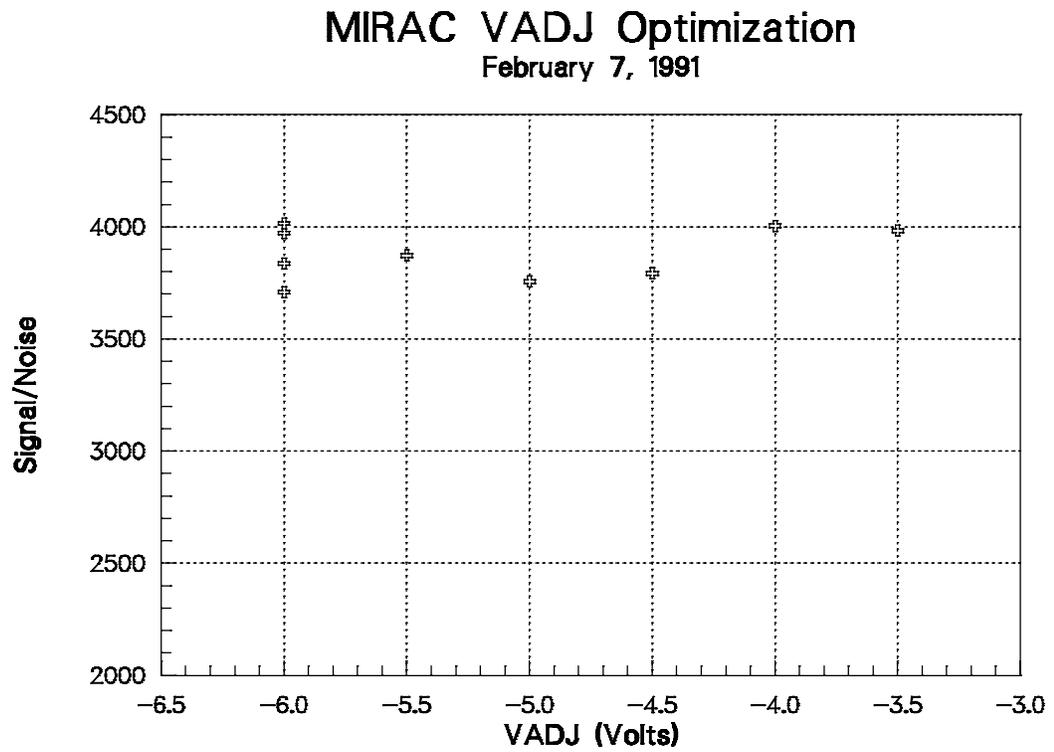


Figure 1.30b. Signal/noise as VADJ is adjusted over the range -6 to -3.5 V. Changes in VADJ has a negligible effect on S/N over this range.

MIRAC NOISE vs BACKGROUND

Feb 9, 1991

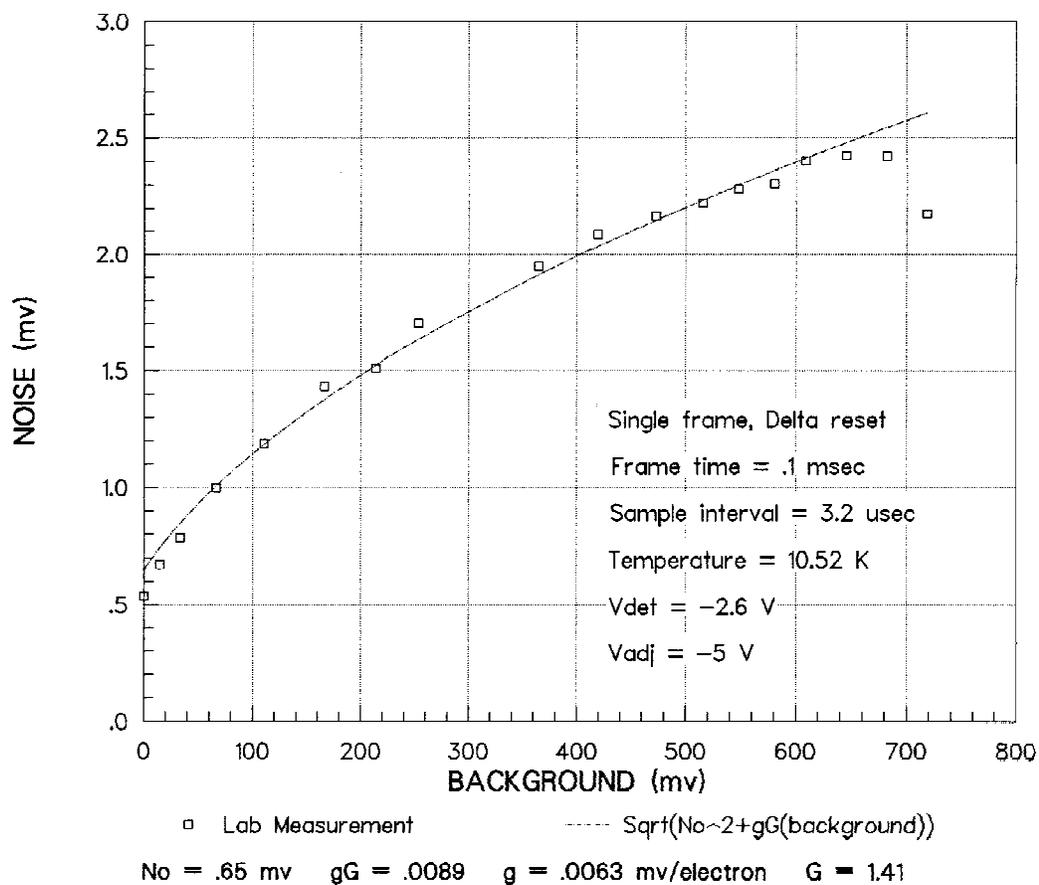


Figure 1.31. MIRAC noise as a function of background flux. The data were taken using various filter and attenuator combinations to achieve different backgrounds, using a 308K blackbody as a source. The noise was taken from an image formed by differencing successive frames, and taking the sum of all the differences. The noise was defined to be the standard deviation of this image.

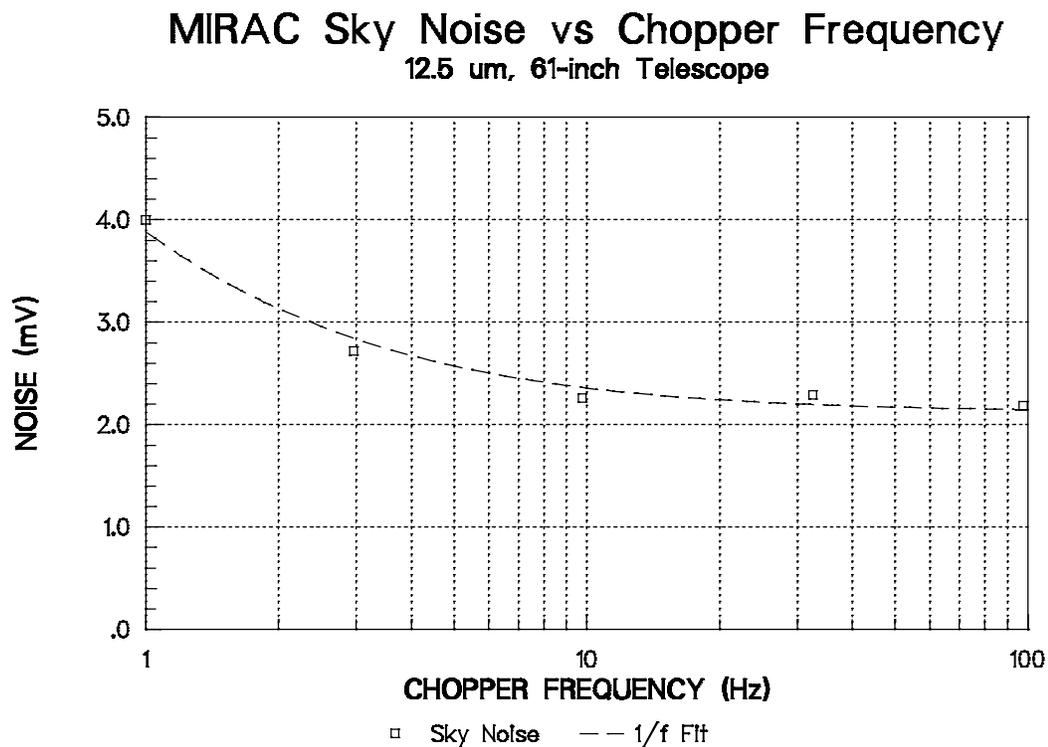


Figure 1.32. Sky noise as a function of chopper frequency at 12.5 μm . The noise was determined from a time sequence of 50 one-second chop pairs on blank sky at an airmass of 1. The curve is the best fit of the data to the function of the form $n = \sqrt{A^2 + B/f}$, where n is the noise, A and B are constants, and f is the chop frequency. The best fit values for parameters A and B are 2.1 mV and 3.3 mV, respectively.

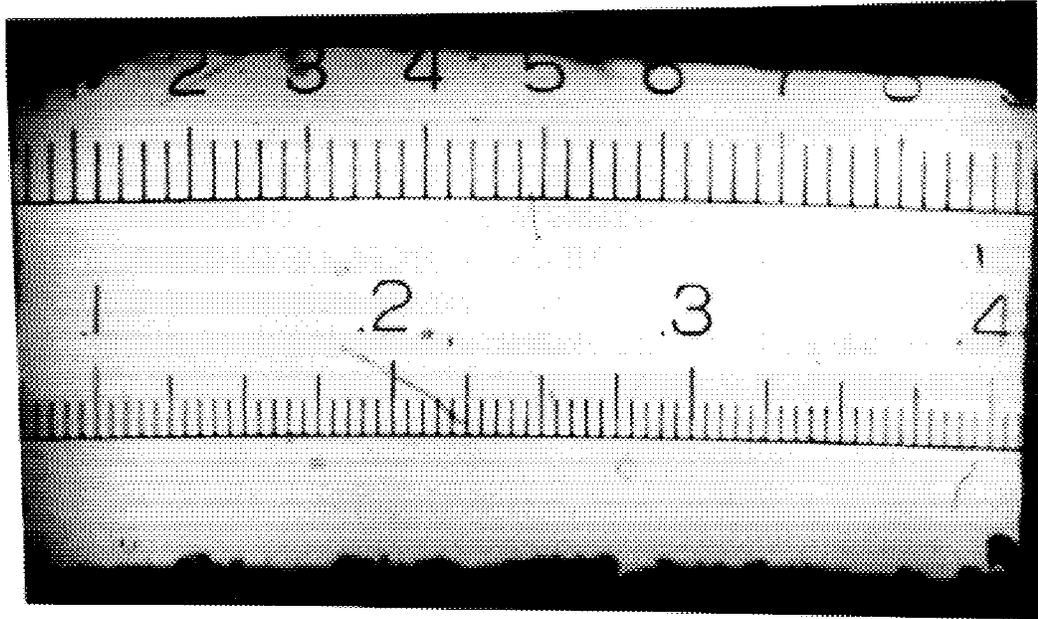


Figure 1.33. Photograph of reticle through MIRAC optics. The lower reticle scale is labeled in inches, with the smallest divisions being .005 inch. The upper scale is labeled in mm, with the smallest divisions being .2 mm (the detector pixel spacing is .1 mm). The reticle was masked to be roughly 4 mm x 8 mm and placed at the low magnification position and back-illuminated. The photo was taken at the focus position outside of the dewar with a 35mm camera with the lens removed. The f/35 MIRAC pupil was used, and the position was determined by achieving the best optical focus through the camera.

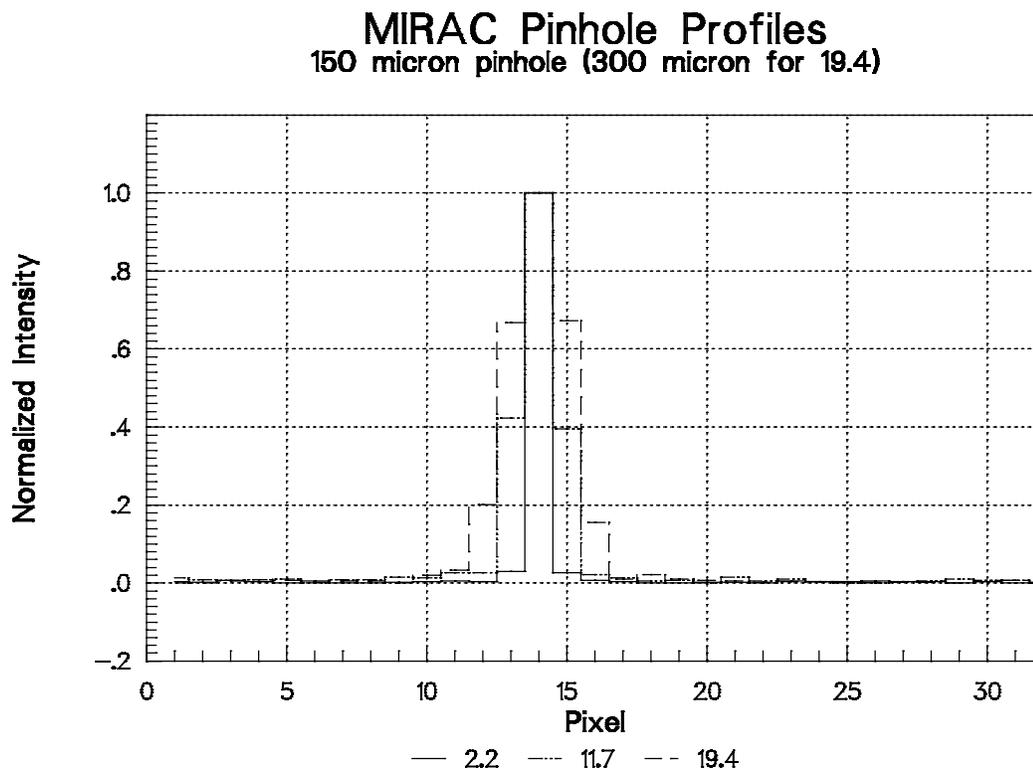


Figure 1.34. MIRAC pinhole profiles. This measurement was obtained in the lab, using the test setup illustrated in Figure 1.29. The profiles shown are 2 second chopped images which have been multiplied by a gain matrix. Each profile has been normalized to a peak value of 1.

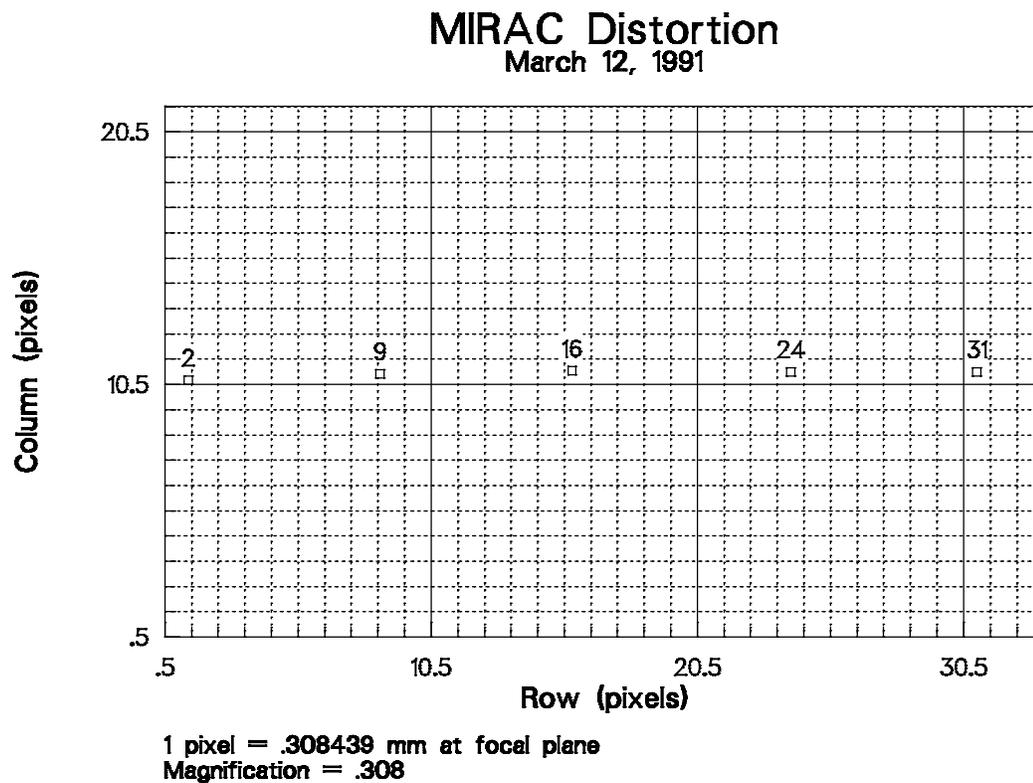


Figure 1.35. MIRAC optics distortion measurement, using 150 μm pinhole source. The camera was set to low magnification, and the pinhole placed at the focus outside the dewar, 14.2 cm from the case. The pinhole was centered on various pixels (2, 9, 16, 24, 31) of column 11, and the displacements were measured using the stage micrometers. The determination of the magnification assumes that there is no distortion between pixels 24 and 31.