

1.45

COOP COMPUTATION BOOK

NAME	NUMBER
William H. Black	

Agassiz Station, Harvard, Mass.

Course.....

Used from April 1, 1966, to 19.....

HARVARD COOPERATIVE SOCIETY
1400 MASS. AVE., CAMBRIDGE, MASS. 02138

TECH. COOP
84 MASS. AVE. CAMBRIDGE, MASS. 02139

Wm H. Black
Agassiz Station

Alignment of Damon Patrol Cameras

① Conversion between Units of Time and Arc

Time Units	Arc Units
24 ^h	360°
1 ^h	15°
4 ^m	1°
1 ^m	15'
4 ^s	1'
1 ^s	15"

② Damon Camera Plate Scale $P = 576''/\text{mm.}$; $38.4''/\text{mm}$

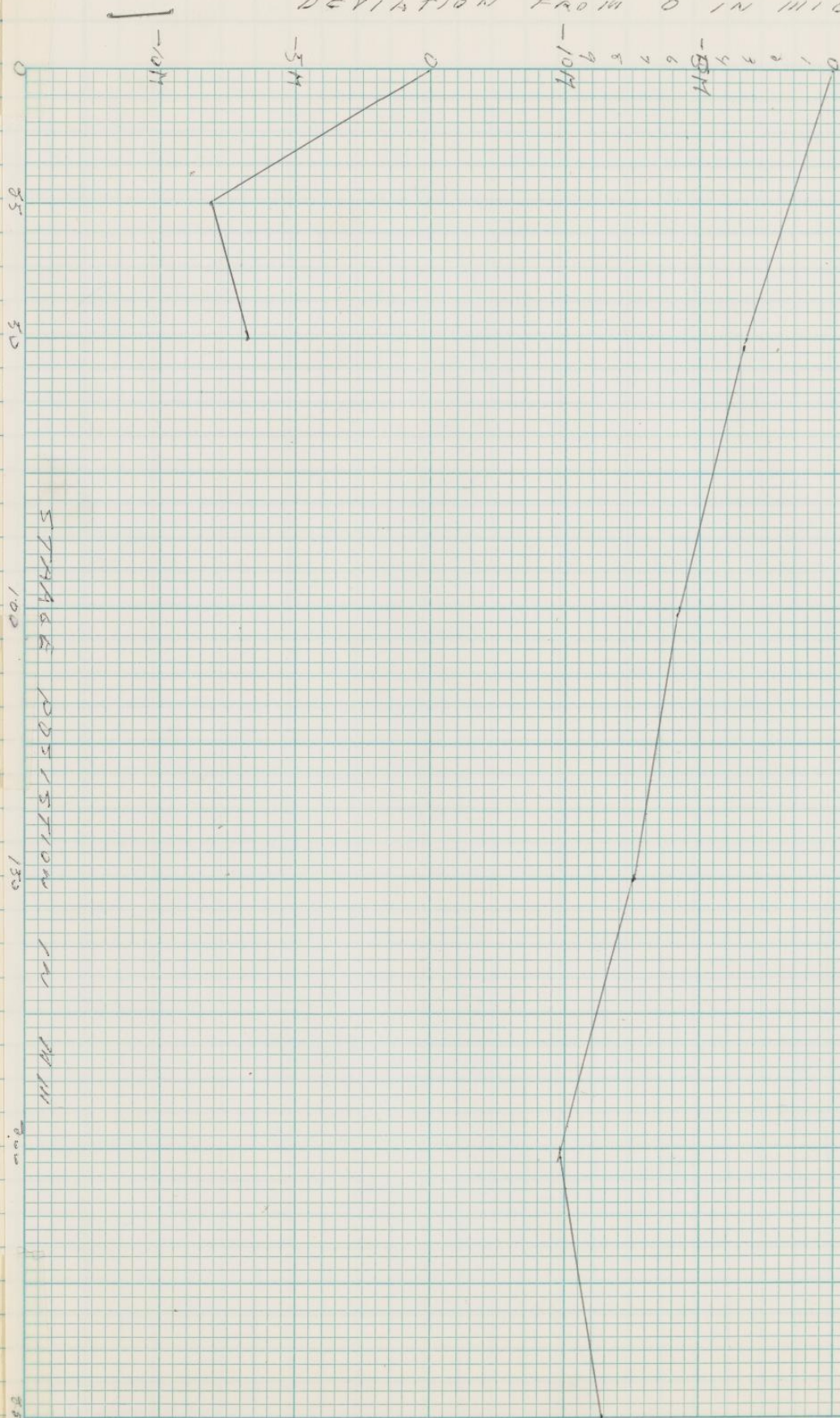
③ Coordinates of Agassiz Station: R.A. = $+4^{\text{h}} 46^{\text{m}} 14.2^{\text{s}}$ (longitude)
Dec. = $+42^{\circ} 30' 13''$ (latitude)

DEVIATION FROM 0 IN MICRONS.

CHARACTERIZATION OF X-Y AXIS ON
 4000 BY 4000 ON 4-1-62 DESIGN
 STANDARD NO 773 350 R

X AXIS

REMARKS
 CORRECT AT 0800
 SCALE PLACED IN
 CENTER OF STAGE



12 5705
 10 X 10 TO THE INCH

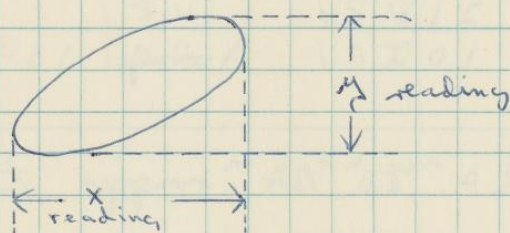
KEUFFEL & ESSER CO.
 MADE IN U.S.A.

Monday, April 4, 1966

Using the Mann machine, readings were made on several star images along the Declination and R.A. axes to obtain an idea of how each image departed from circularity. By measuring the lengths and widths of these images, corrections can be developed for properly aligning the camera that took the picture.

Plate Used : DNY 18
 Class L
 RA $20^h 34^m$
 Dec. $0^{\circ} 0'$
 Date July 10-11, 1965
 Exposure 60^m

Image sense refers to the slope of the elongation with respect to the x and y axes, or R.A. & Dec. axes, respectively.



all readings made on the Mann machine are made rotating the dials clock-wise.

R.A. $20^h 34^m$
 Dec. $0^{\circ} 0'$

readings made on star in approximate center of plate (#1)

x-reading	556	554	557
	380	380	379
	176	174	176

Average 175μ

y-reading	202	199	198
	66	67	67
	136	132	131

Average 133μ

6

Star at approx. $+8^\circ$; R.A. $20^h 34^m$

x-reading	234	231	231	
	<u>073</u>	<u>072</u>	<u>072</u>	
	161	159	159	

Average 160 μ

y-reading	258	260	260	
	<u>140</u>	<u>138</u>	<u>137</u>	
	118	122	123	

Average 121 μ Star at approx. $+16^\circ$

x-reading	1057	1056	1056	
	<u>908</u>	<u>906</u>	<u>905</u>	
	149	150	151	

Ave. 150 μ

y-reading	320	321	320	
	<u>216</u>	<u>216</u>	<u>218</u>	
	104	105	102	

Average 104 μ Star at approx. -6° ; R.A. $20^h 34^m$

x-reading	825	825	827	
	<u>676</u>	<u>677</u>	<u>675</u>	
	149	148	152	

Average 150 μ

y-reading	323	320	324	
	<u>235</u>	<u>230</u>	<u>230</u>	
	88	90	94	

Average 91 μ

Star at approx. -18° ; R.A. $20^h 34^m$

x-reading	969	962	964	Average	199μ
	769	766	764		
	200	196	200		
y-reading	322	320	326	Ave.	100μ
	222	223	223		
	100	97	103		

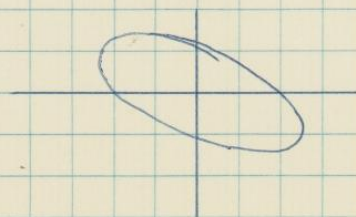
Star at approx. 21^h ; Dec. 0°

x-reading	1122	1126	1125	Ave.	157μ
	966	969	967		
	156	157	158		
y-reading	257	253	256	Ave.	103μ
	154	151	151		
	103	102	105		

Star at approx $21^h 15^m$ Dec. 0°

x-reading	916	915	916	Ave.	152μ
	761	765	764		
	155	150	152		
y-reading	474	476	474	Ave.	93μ
	382	380	384		
	92	96	90		

The sense of this star is as indicated:



8

Star at approx. R.A. 20^h Dec. 0°

x-reading	538	539	538	
	<u>398</u>	<u>399</u>	<u>397</u>	
	140	140	141	Ave. 140 μ

y-reading	207	205	205	
	<u>128</u>	<u>126</u>	<u>123</u>	
	79	79	82	Ave. 80 μ

Star at approx. $19^h 30^m$; Dec. 0°

x-reading	303	302	303	
	<u>170</u>	<u>170</u>	<u>169</u>	
	133	132	134	Ave. 133 μ

y-reading	352	351	353	
	<u>262</u>	<u>266</u>	<u>264</u>	
	90	85	89	Ave. 88 μ

image sense,
unless
specified
otherwise

R.A. $20^h 34^m$
Dec. $0^\circ 0' \rightarrow +20^\circ 0'$

DNY-18

R.A. $20^h 34^m$
Dec. $0^\circ 0' \rightarrow -20^\circ 0'$

center
image

$\approx +8^\circ$

$\approx +6^\circ$

$\approx -6^\circ$

$\approx -18^\circ$

KE
20 X 20 TO THE INCH 46 1240
7 X 10 INCHES
MADE IN U.S.A.
KEUFFEL & ESSER CO.

$\approx 21^h$

$\approx 21^h 15^m$

$\approx 20^h$

$\approx 19^h 34^m$

Dec. $0^\circ 0'$
R.A. $\approx 20^h 34^m \rightarrow 21^h 30^m$

Dec. $0^\circ 0'$
R.A. $\approx 19^h 30^m \rightarrow 20^h 34^m$

10

Tuesday April 19, 1966

Actual photography begun with Damon Blue Camera
IIa-0 film

Sky condition: clear, except in extreme West

Exposure Started:

Exposure Stopped

EST: \approx 2100 hoursEST: \approx 2146Sidereal \approx ~~21~~00 hours
11^hSidereal: \approx ~~21~~46
11^h 46^m $\delta = 0^\circ$ R.A. = 12^hSky completely clouded over after 2300
Closed down at midnight

After discussing the developing procedure for Damon plates with Steve Perrin, it has been decided that a "Quick" method of plate development can be employed at Agassiz Station for the purpose of having a quick look at the plates. These plates are for alignment purposes only, and it is not important that the developed plate have any permanence.

- ① Remove exposed plate and place in developing rack in total Darkness!
- ② Place in D-19 for 4 minutes; move plates slowly.
- ③ Place in stop bath for 30 seconds
- ④ Place in Rapid Fix for 4-8 minutes
- ⑤ Rinse for 5 minutes
- ⑥ Dip in Photo Flo, then allow to dry

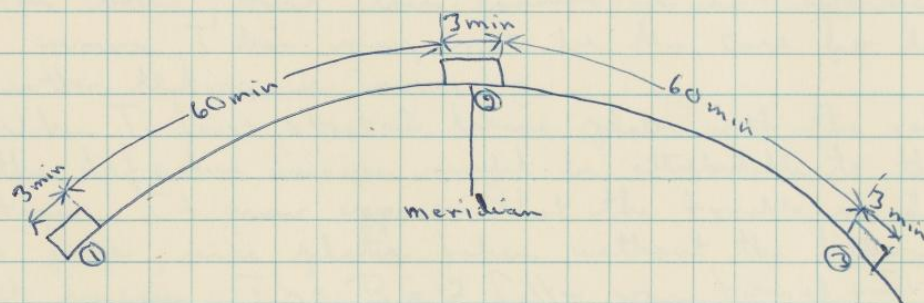
Film types for Damon Cameras

Blue	IIa-0
Yellow	103a-G (possibly 103a-0)
Red	103a-E

Numerous plates have been exposed to become familiar with exactly how the actual photography is handled. These plates would include A14000 thru A14006. There is little, if any, useful information on these plates.

Plates A14007 thru A14010 are one each of film types IIa-0, 103a-E, 103a-G and 103a-0, which have been developed, but not exposed. These will be considered as back ground films.

Plates A14011, A14012, and A14013, are three plates taken following the procedure outlined by Latham and Snowden



Each camera is tracking 1 hr each side of the meridian. 3-3min exposures are made: ① 1 hr east of the meridian; ② on the meridian; ③ 1 hr west of the meridian. The resulting three images per star are then indications of the misalignment of the cameras with respect to the refracted celestial pole. For specifics, refer to "On Adjusting A Polar Axis Photographically" by Latham & Snowden.

Red Camera 5-17-66

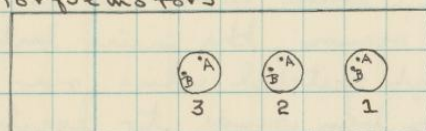
A noise has been detected in the Red Camera which is not present in either of the other cameras. When it occurs, the noise lasts for about 5 seconds, and sounds like a high pitched whine, over the regular gear train noise. An attempt has been made to localize the noise with a stethoscope, but the trouble is too fleeting to use this method.

The camera was set 1 hour angle east of the meridian, and the drive cut on. This noise was noted at the following times in minutes after starting the drive: 6.6; 26.6; 46.3; 67.3. Each time the noise was noted, it persisted for only about 5 seconds, and the frequency of the drive voltage was constantly at 60 cycles.

Two plates were taken to determine if this trouble is affecting the true sidereal tracking rate of the camera. Plate C28034 was taken for 5 minutes without the noise and without the RG-2 filter. Plate C28035 was taken for 5 minutes without the filter, and with the noise occurring 1.6 minutes into the 5 minute exposure. Both plates look identical on the Mann machine, so I am assuming, for the time being, that this trouble is not affecting the tracking rate of the camera. This may not be the case for long time periods, and further testing is necessary.

When I first started taking plates with the red camera, I thought that the defective images might be attributable to the noise in the gear train. It now appears that the trouble is due to a defective RG-2 filter, since plates taken without the filter produce relatively perfect images. The RG-2 filter was turned over to H.C. Ingras on 5-25-66 to be evaluated. Also, some vacuum grease has gotten on the filter, and may be affecting its optical qualities.

Looking into Kepco D.C. power supply
for torque motors



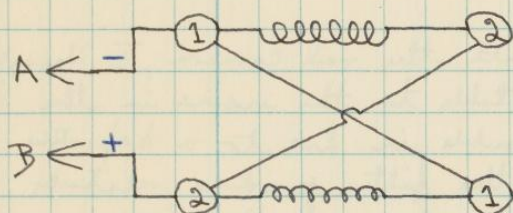
① A⁺
B⁻

② A⁻
B⁺

③ A⁺
B⁻

Input plug at :	Input plug to torque motor	plug numbers
Blue Camera G ⁻ N ⁺	A ⁺ B ⁻	1 2
Red Camera G ⁻ N ⁺	A ⁺ B ⁻	1 2
Yellow Camera G ⁺ N ⁻	A ⁺ B ⁻	2 1

The above conditions existed as of 7-11-66. An inspection of the torque motors showed the following wiring scheme for each motor:



This indicates the correct voltage polarity to the torque motors.

However, if the input plug to torque motors are assumed correct, one can see that the input voltage to the Red & Blue torque motors is reversed. They were apparently wired correctly originally, even tho there is no consistency in plug nomenclature.

For the Blue & Red Cameras at the input plug: A & B leads were reversed, so that the voltage polarity to each torque motor is now correct, even tho the plug wiring is wrong.

Adjustments in Polar Alignment of Damon Camera to bring Instrumental Pole in coincidence with Refracted Celestial Pole.

- ① Date of Adjustment : May 11, 1966
 Plates Used : A14020, A14021, A14022

Camera	West	East	
Blue	- 0.14	- 0.05	+ clockwise turn
Yellow	- 0.08	- 0.25	- counter clockwise turn
Red	+ 0.12	+ 0.05	

- ② Date of Adjustment : May 20, 1966
 Plates Used : A14024, B18024, C28024

	West	East	
Blue	No adjustment made; apparently alignment is o.k. (found to be not o.k.)		
Yellow	- 0.055	- 0.166	(NE)
Red	- 0.226	- 0.122	(NW)

- ③ Date of adjustment : May 26, 1966
 Plates Used : A14027, B18026, C28029

	West	East
Blue	+ 0.104	+ 0.037
Yellow	- 0.048	- 0.142
Red	- 0.166	- 0.046

- ④ Date of adjustment : May 27, 1966
 Plates Used :

	West	East
Blue	- 0.104	- 0.037

These adjustments are counter-adjustments to #③. A deterioration resulted from ③, so the blue camera was returned to its prior condition of alignment.

Plate A14030 was exposed for 60 min, and confirmed that adjustment
 ④ improved image quality. A series of 1 hour exposures will be made, using very small changes, to see if "trial & error" adjustments can produce satisfactory alignment. The details of these changes are listed on page 16.

Sunday night, May 29, 1966

	West	East	
Blue Camera	- 0.030	- 0.010	using plate A14030
" "	- 0.050	- 0.020	" " A14031

⑤ Date of Adjustment: June 6, 1966

Plates Used: A14034, B18029, C28038


	West	East	
Blue	- 0.01	- 0.03	(NE)
Yellow	- 0.19	- 0.30	(NE)
Red	- 0.38	- 0.02	(NW)


⑥ Date of Adjustment:

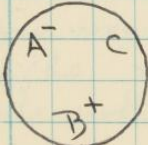
Plate Used:

	West	East
Blue	+ 0.124	+ 0.027

On Thursday, June 23, 1966 the inputs to the torque motors of all three cameras were checked. The following sets of conditions were found:

	input plug	inside wiring	At Motor terminals
Blue:		Black wire to A Red wire to B	ground + 26 volts

Yellow:		Black wire to A Red wire to B	+ 26 volts ground
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Red:		Black connected to A Red wire to B	ground + 26 volts
------	---	---------------------------------------	----------------------

- ground
+ 29 volts

Test plates have shown that the Yellow Camera is in perfect optical alignment, and the sidereal drive is operating properly. Since I know that the Yellow Camera is set up correctly, it becomes obvious enough that the Blue & Red Cameras have had their torque motors wired incorrectly. Therefore, all subsequent alignment plates for these two cameras are worthless. The connections to the Blue & Red Cameras were changed on 6-23-66 by Joe Barry (to the torque motors).

Plate A14045, taken the night of 6-23-66, shows that the Blue Camera drive is now correct, but that some further optical alignment is necessary.

Plate C 28052, taken 6-23-66, also shows the drive has been improved, but some obvious trailing still exists, and an almost constant noise in the motor tends to indicate that the gear train is defective.

⑦ Date of Adjustment: July 7, 1966

Plate Used: C 28053

West	East
- 0.217	+ 0.030

Test Plates For Best Focus

July 9-10, 1966

The focus of the lens on the Yellow Camera is at its best point. Several plates have revealed this.

The focus of the Blue & Red Cameras has been questionable, so a test plate was obtained from each camera. The method employed was to track and expose (anywhere, preferably overhead) for 20 seconds with the focus setting at 0. Then stop exposing and stop tracking, in that order, and reset the focus at 10. Another 20 second exposure is made while tracking. This procedure is carried out three complete revolutions of the lens, and the last image is tracked and trailed for reference. The following sequence was used for the Blue & Red Cameras:

Blue: Plate No. A14052

Exposure No.	Lens setting
1	0
2	10
3	20
4	30
5	40
6	50
7	60
8	70
9	80
10	90
11	0 (100)
12	10
13	20
14	30
15	40
16	50
17	60
18	70
19	80
20	90
21	0 (200)
22	10 (trailed)

Red: Plate No. C28055

Exposure No.	Lens setting
1	0
2	10
3	20
4	30
5	40
6	50
7	60
8	70
9	80
10	90
11	0 (100)
12	10
13	20
14	30
15	40
16	50
17	60
18	70
19	80
20	90
21	0 (200)
22	10 (trailed)

For each camera, the best compromise focus selected is indicated as 4 for the Blue, and 7 for the Red.

Adjustment made on Red Camera 8-18-66, with new red filter
[See page 24]

Alignment Changes Due to Temperature Variations

The two Alvia gauges were left attached to the Blue camera to get an indication of alignment changes with time and temperature. The first few times that the Blue camera was opened, extending over a period of about 1 week, the changes were small, random changes, on the order of ± 0.01 (turns of the micrometer screw). When the Blue camera was opened on 6-6-66, at an ambient temperature in the high 80's, the gauges were reading:

West - 0.055
East - 0.030

These changes, if they are real, are much larger than any corrections applied to the camera.

20

Blue Camera

Clock

	Plate Number	Exposure time	Dec.	start	stop	Image length
1	A 1 4 0 9 5	120 min	0°	000.0	120.0	
2	A 1 4 0 9 6	120 min.	0°	120.0		
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Yellow Camera

Clock

	Plate Number	Exposure time	Dec.	start	stop	Image length
1	B 18066	120 min	0°	000.0	120.0	
2	B 18067	120 min	0°	120.0		
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

22

Red Camera

Clock

	Plate Number	Exposure time	Dec.	start	stop	Image length
1	C 28081	120 min.	0°	000.0	120.0	
2	C 28082	120 min.	0°	120.0		
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Modified Damon Plate Holders

Two hour exposures were made at 42° to check the modified plate holders, using the following plates:

A 14110

B 18080

C 28102

The A14110 plate showed exposure on the bottom edge from exposure to stray light, apparently from the slide accidentally opening. A second plate (not numbered) was used to check the holder, and it was found to be o.k. All three plateholders are satisfactory, but care must be ~~exercised~~ exercised to avoid accidental opening of the slide.

Test Plates for Best Camera Focus

The procedure outlined on page 18 was repeated on 2-11-67 for the Red and Yellow Cameras:

Red (C28106)

Yellow (B18083)

1 -	0
2 -	20
3 -	40
4 -	60
5 -	80
6 -	0
7 -	20
8 -	40
9 -	60
10 -	80
11 -	0

1 -	0
2 -	80
3 -	60
4 -	40
5 -	20
6 -	0
7 -	80
8 -	60
9 -	40
10 -	20
11 -	0

Position #5 was selected as the best focus for the Red Camera, and position #7 was the best focus for the yellow camera.

This focus test was necessary because the lens of the red and yellow cameras were switched ~~to~~ to ascertain red camera performance with the yellow camera lens, and vice versa. The focal lengths are not compatible, but the run conclusively showed that the image defect in the red plates was due to the fact the red camera is still not properly aligned. These results are on plates B18081 and C28104

Light leakage Tests on New Damon Transport Boxes.

1	A14075	o.k.	7	A14081	o.k.
2	A14076	o.k.	8	A14082	o.k.
3	A14077	Leaks	9	A14083	Leaks
4	A14078	o.k.	10	A14084	o.k.
5	A14079	o.k.	11	A14085	o.k.
6	A14080	o.k.	12	A14086	o.k.

Damon Camera Three-Color Photographic Atlas

Section Number	R.A.	Dec.	Blue	Yellow	Red
----------------	------	------	------	--------	-----

1	24	90			
2	1	60			
3	4	60			
4	7	60			
5	10	60			
6	13	60			
7	16	60			
8	19	60			
9	22	60			
10	2	30			
11	4	30			
12	6	30			
13	8	30			
14	10	30			
15	12	30			
16	14	30			
17	16	30			
18	18	30			
19	20	30			
20	22	30			
21	24	30			
22	1	0			
23	2	0			
24	3	0			
25	4	0			
26	5	0			
27	6	0			
28	7	0			
29	8	0			
30	9	0			
31	10	0			
32	11	0			
33	12	0			
34	13	0			
35	14	0			
36	15	0			
37	16	0			
38	17	0			
39	18	0			
40	19	0			
41	20	0			
42	21	0			
43	22	0			
44	23	0			
45	24	0			

Table of Contents

page

1	Title Page
2	Constants and Relationships
3	Calibration curve for Mann Comparator
4	
5	↑ } Readings taken on Mann Comparator from which plot on page 9 is drawn ↓ }
6	
7	
8	
9	Plots of image distortions from plate DNY-18
10	Damon photography for alignment started; Darkroom procedure
11	
12	
13	Noise in gear train of Red Damon Camera; RG-2 filter
14	
15	Polar Axis Adjustments
16	
17	
18	Test Plates for Best Focus
19	Alignment Changes Due to Temperature Variations
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	Damon Three-Color Photographic Atlas Plate Record

