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THE CALIBRATION OF PHOTOGRAPHIC AND SPECTOSCOPIC FILMS

A DENSITOMETRIC ANALYSIS OF IIaO FILM FLOWN ABOARD THE SPACE SHUTTLE #3

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A DENSITOMETRIC ANALYSIS OF IIaO FILM FLOWN ABOARD THE SPACE SHUTTLE #3

Since the United States of America is moving into an age of reuseable space vehicles, both electronic and photographic materials are an integral part of the recording techniques available to man. The military and civilian significance will not be discussed here. However, film as a scientifically viable recording technique in astronomy is well documented. Thus, there is a real need to expose various types of film to the Shuttle environment. Thus, the purpose of this study is to look at the subtle densitometric changes of IIaO film that was placed onboard the Space Shuttle #3.

Since the first major use of Skylab in 1974, scientists used over 400 rolls of photographic film in the space environment to obtain sensitometric and densitometric data.[1] The present research team prepared 3 canisters of IIaO Film along with packets of color film from the National Geographic Society, which was then placed on the Space Shuttle #3. The ultimate aim was to obtain reasonably accurate data concerning the Background Fogging Effects on IIaO Film as related to the total

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[1]Photographic Film in the Skylab Environment. Published in Applied Optics, Vol. 16, No. 4. April 1977.

environmental experience of the film including the groundbased packing and loading of the film from Goddard Space Flight Center to Cape Kennedy and of particular interest are the affects of solar wind, humidity, cosmic rays, the Van Allen Belt radiation exposure, various thermal affects, and re-entry and off-loading of the film during take off and 8 day, 3 hour 15 minute orbit. The development and analysis of the returned film constitutes the basis of this report. The object of this experiment was to examine the total densitometric change caused by all of the above factors.

IIaO Film for this experiment was obtained from the same roll of Kodak Film Mfg date 5-76-A5J. The film was loaded into specially prepared aluminum anodized packages that would fit aboard the Space Shuttle's Getaway Special Container. One roll of film was cut from the same stock and maintained as the Control. The control film was maintained at a temperature of 32 degrees C at Goddard Space Flight Center. After the mission, the three rolls of IIaO film were shipped back to the Small Payload Section of the Laboratory for Astronomy and Solar Physics. One film and the Control were developed Set I, while the other IIaO sample film were developed Set II Sample A and B.

Using a MacBeth Densitometer, measurements were obtained from the film every 2 centimeters, developing data forming 3 columns, including the left, the

middle, and the right. Significant differences were found when samples were compared with the control. Sample A and Sample B had a 5.26% increase in density or fogging background, while the film developed shortly after its arrival at Goddard Space Flight Center showed a 3.8% increase in the density or the fogging background.

Individual data for each of the films aboard the Space Shuttle giving the average deviation, the fractional average, and the fractional standard deviation is listed below.

An analysis of the data for each sample film aboard the Space Shuttle indicates variation in intensity with respect to the fogging levels as a function of position on the film. There is a tendency of more random variation toward one end of the film, but the actual orientation in the Space Shuttle is unknown. Some possible theory might be that the high energy cosmic rays had penetrated the aluminum film cartridges aboard the Space Shuttle causing certain secondary reactions that produce variations toward one end of the film because of the wrapping procedure used in the placement of the film within the canister. Other theories might revolve around the point that thermal affects cause density variation also because of the wrapping of the film within the canister.

Control	Left	Middle	Right
Average	.1791	.18083	.18291
Average Deviation	.00555	.006492	.007325
Fractional Average	3.098%	3.59%	40%
Standard Deviation	.01036	.008423	.00991
Fractional Standard Deviation	5.78%	4.65%	5.41%

Shuttle Set I	Left	Middle	Right
Average	.18826	.18692	.1876
Average Deviation	.004169	.00533	.004284
Fractional Average	2.2%	2.8%	2.28%
Standard Deviation	.055036	.006115	.005364
Fractional Standard Deviation	2.92%	3.27%	2.9%

Shuttle Sample A Set II	Left	Middle	Right
Average	.19122	.1894	.19157
Average Deviation	.00448	.00205526	.00335
Fractional Average	2.3%	1.08%	1.751%
Standard Deviation	.011845	.012567	.005274
Fractional Standard Deviation	6.19%	6.63%	2.75%

Shuttle Sample B Set I'	Left	Middle	Right
Average	.19078	.188627	.19137
Average Deviation	.005007	.004397	.003935
Fractional Average	2.6%	2.3%	2.0%
Standard Deviation	.012536	.006389	.006932
Fractional Standard Deviation	6.5%	3.3%	3.6%

CONTROL vs TOTAL DENSITY % DIFFERENCE

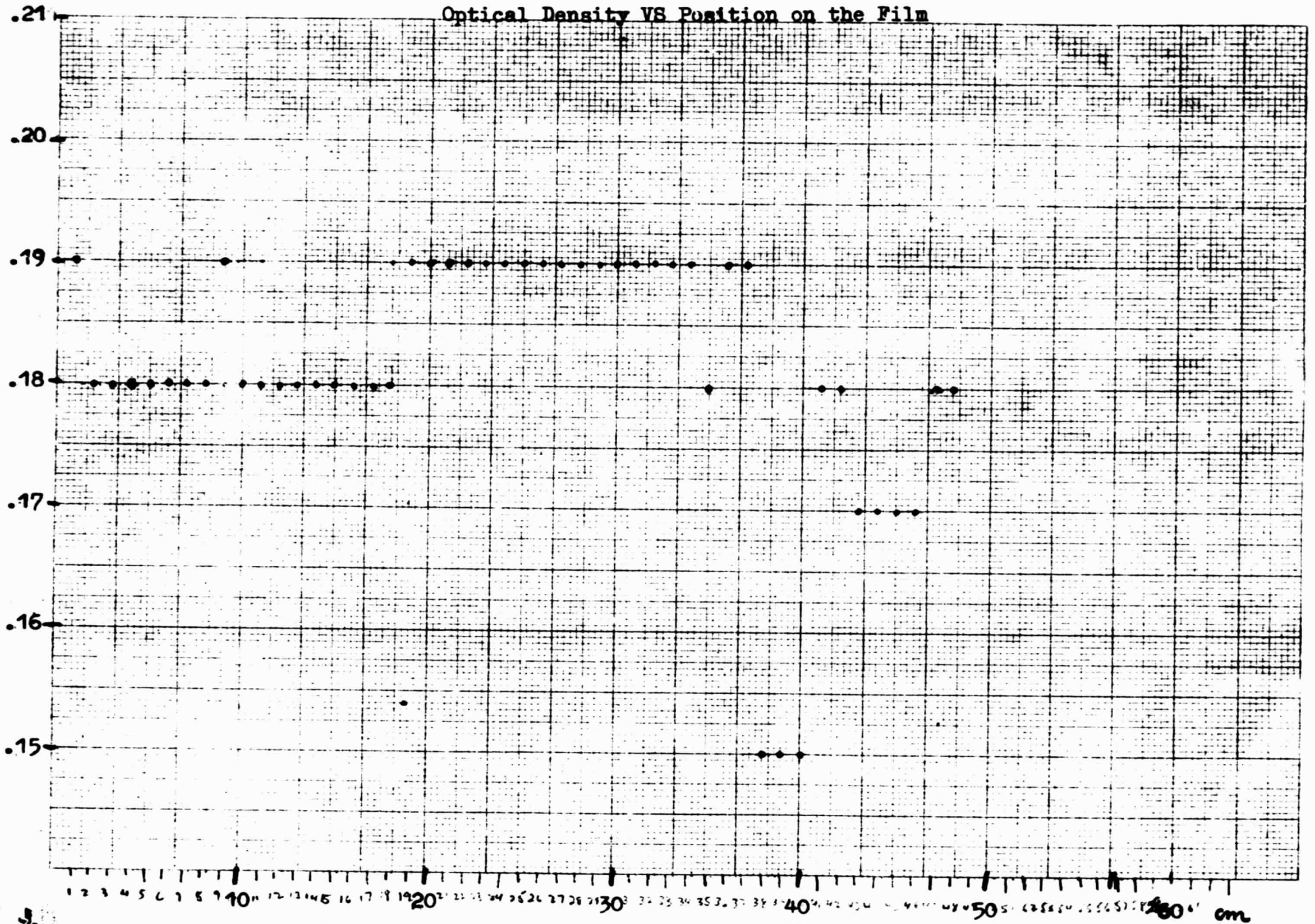
	LEFT	MIDDLE	RIGHT
Shuttle Set I	5.11%	3.36%	2.67%
Shuttle Set A	6.76%	4.73%	4.73%
Shuttle Set B	6.52%	4.30%	4.62%

% DIFFERENCE BETWEEN SHUTTLE SET A & B

	LEFT	MIDDLE	RIGHT
Shuttle Set Sample A & B	.23%	.41%	.10%

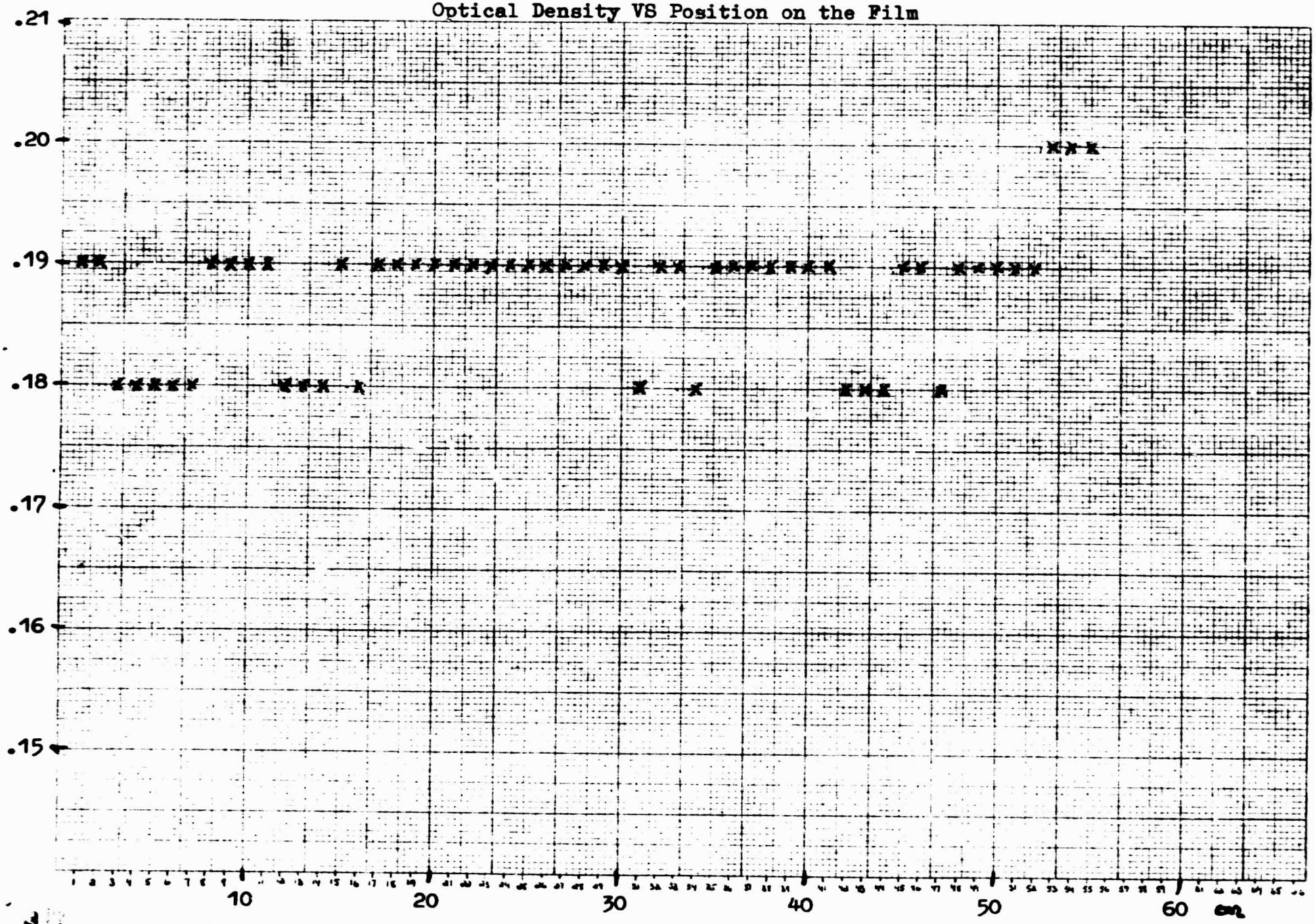
CONTROL VS

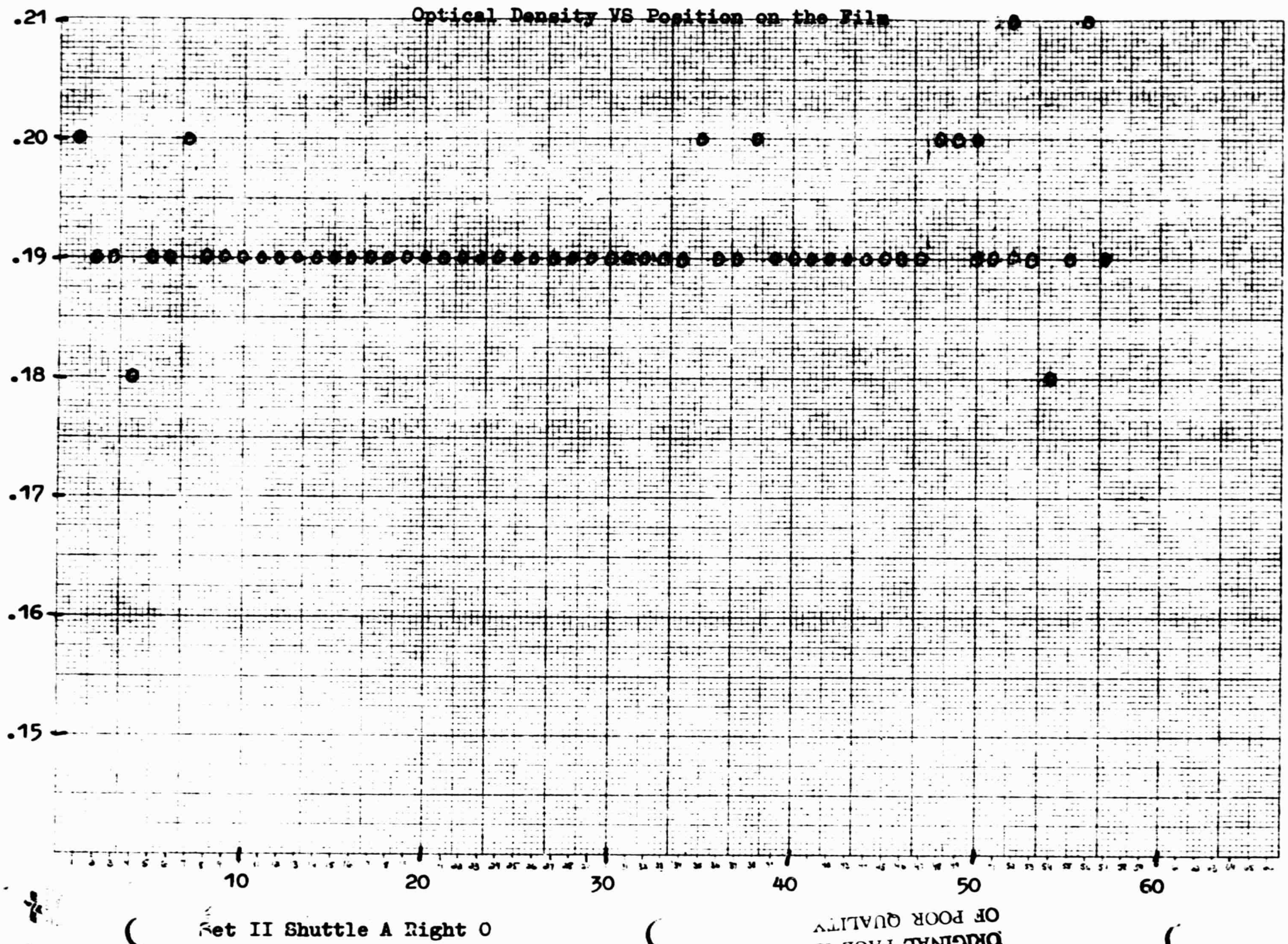
SHUTTLE SET I	3.81%
SHUTTLE SET A	5.41%
SHUTTLE SET B	5.117%
TOTAL SHUTTLE SAMPLES	4.779%

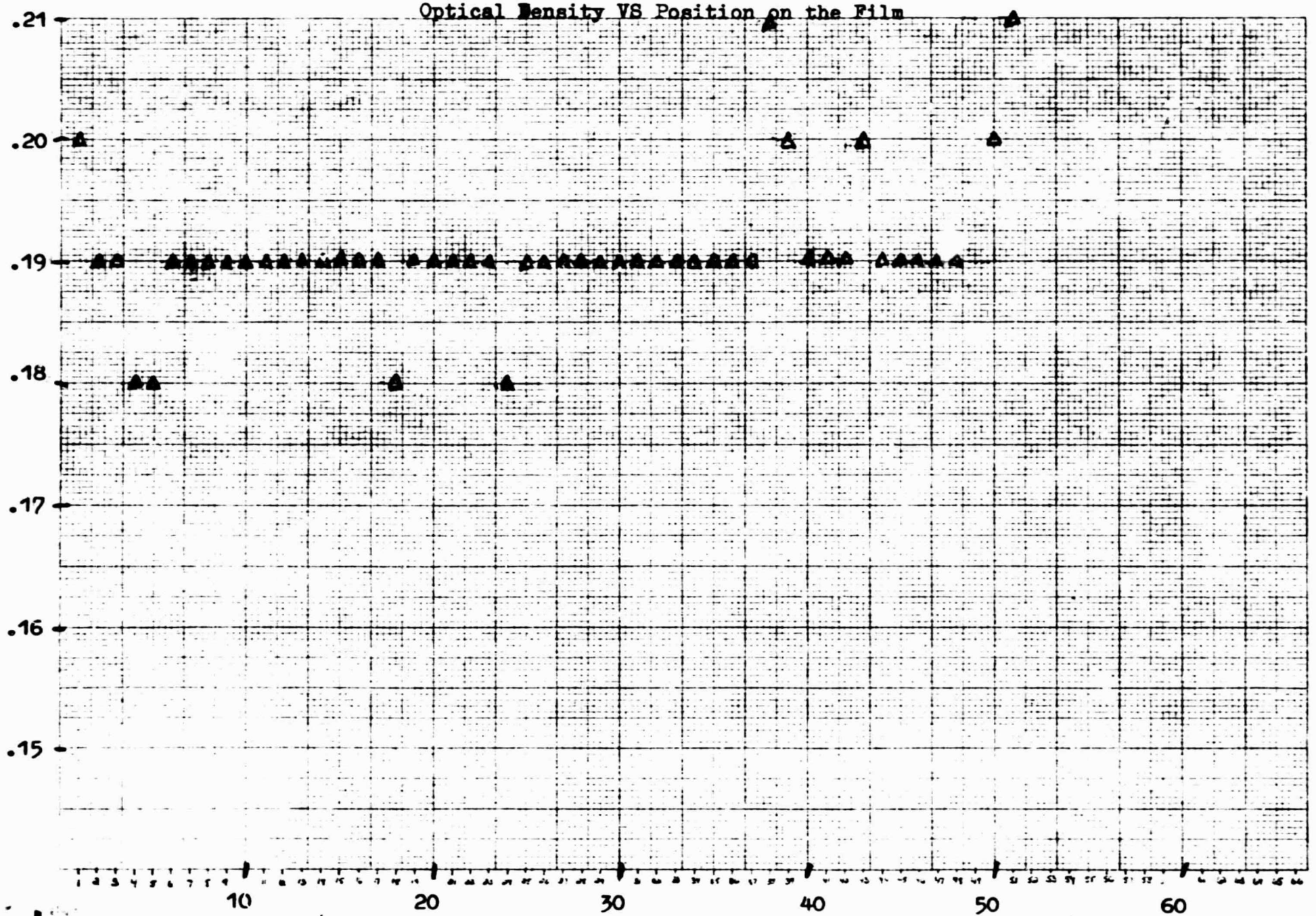


Right Control •

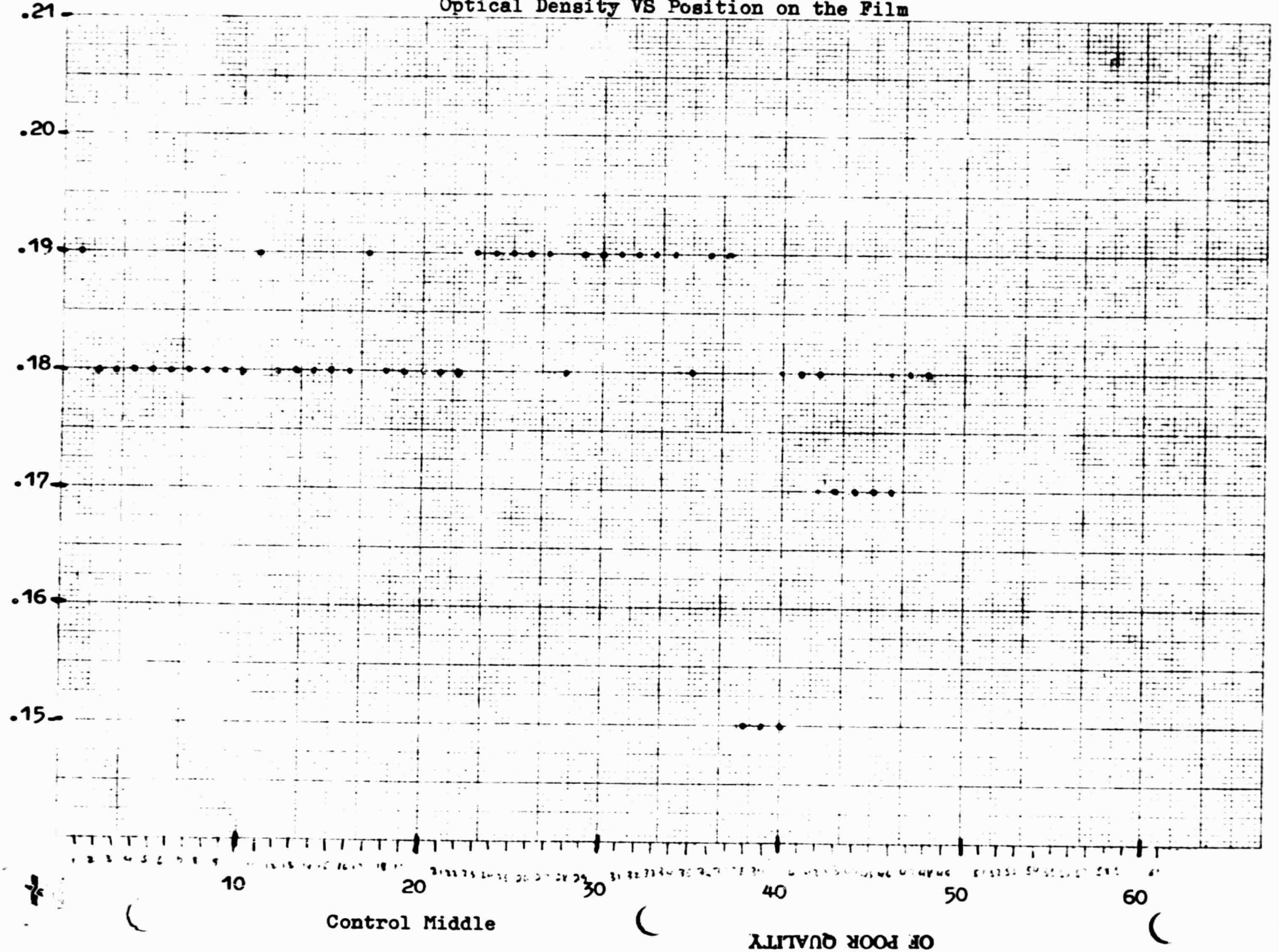
20 Squares to the Inch

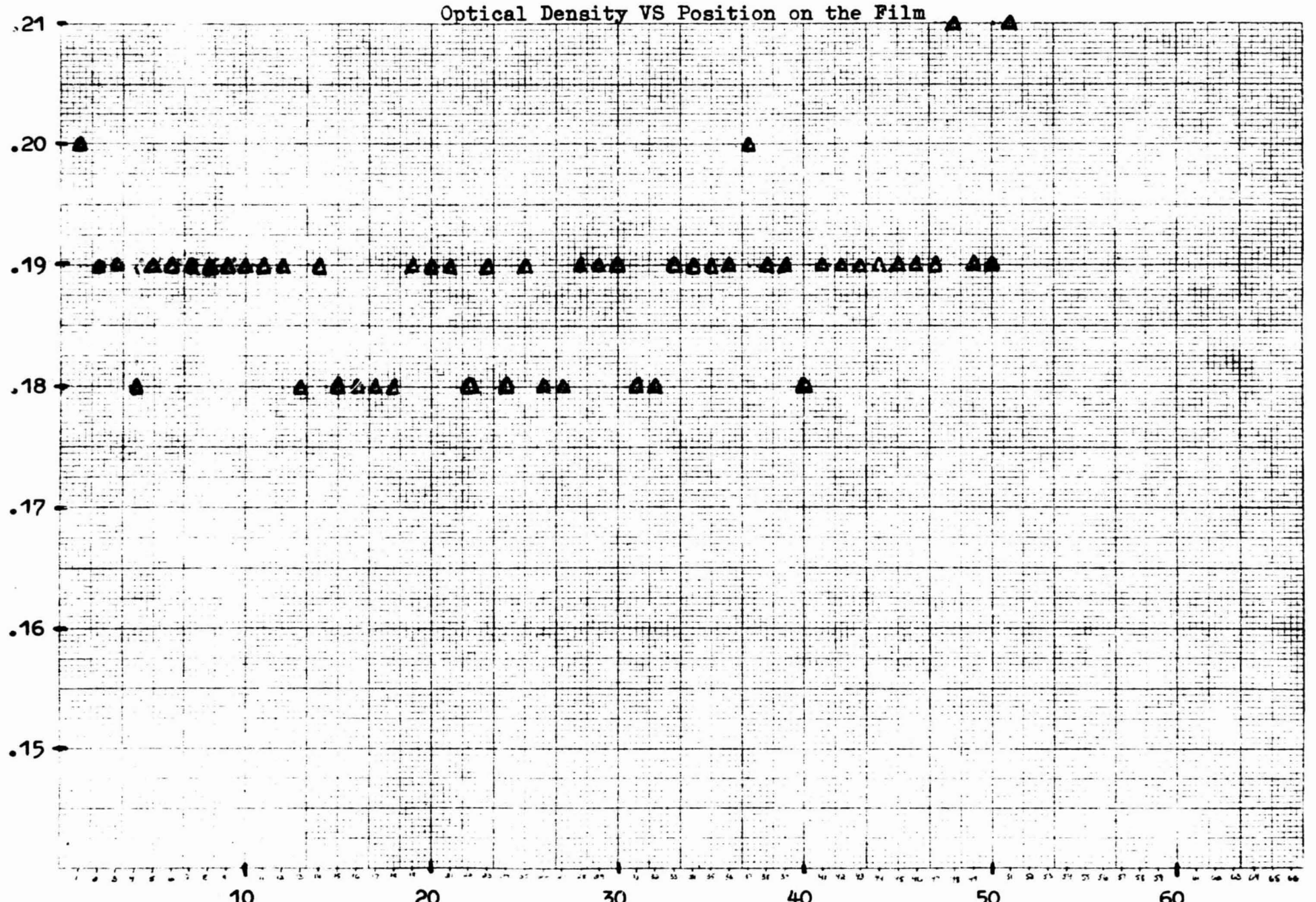


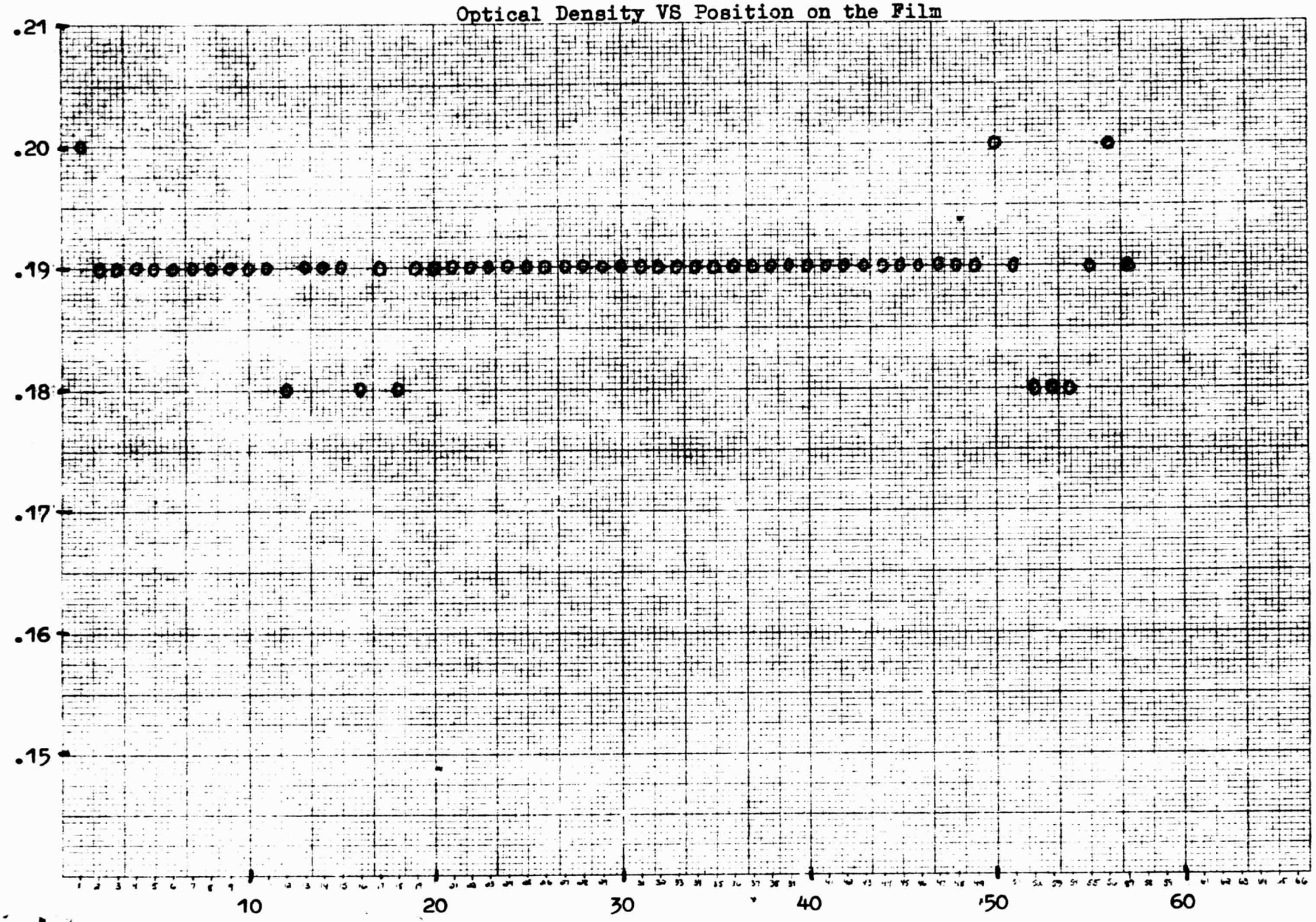




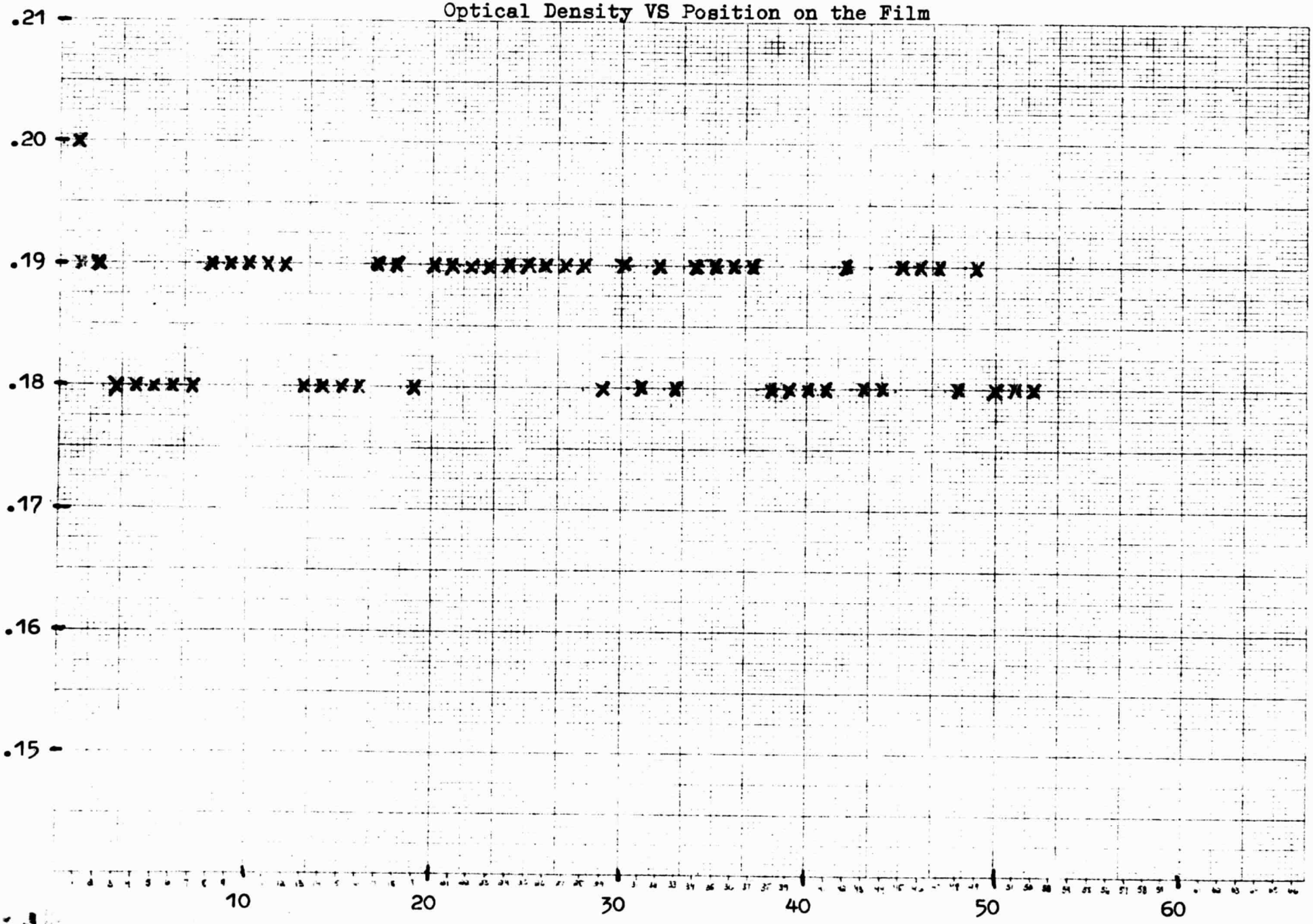
Set II Shuttle B Right

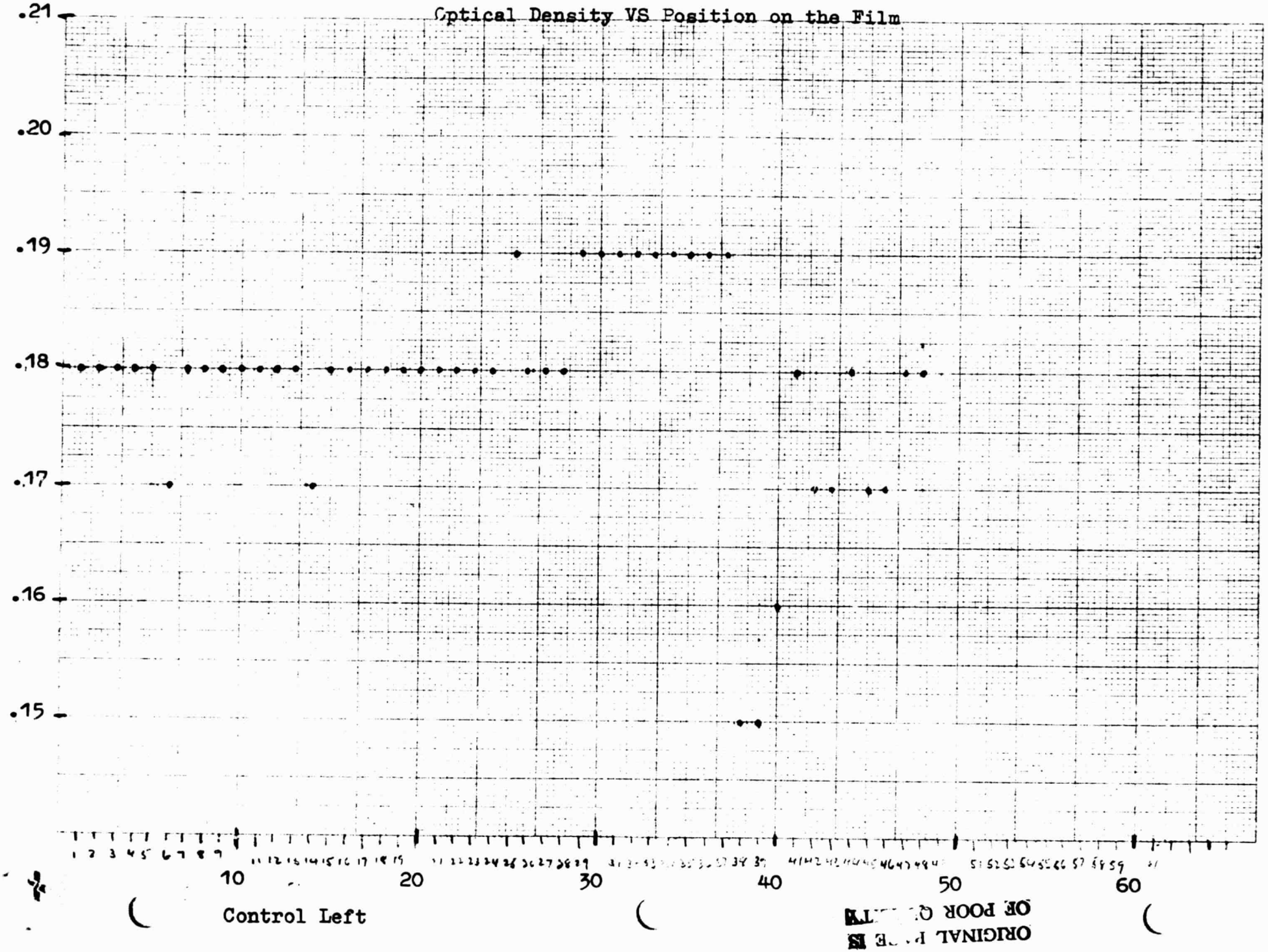


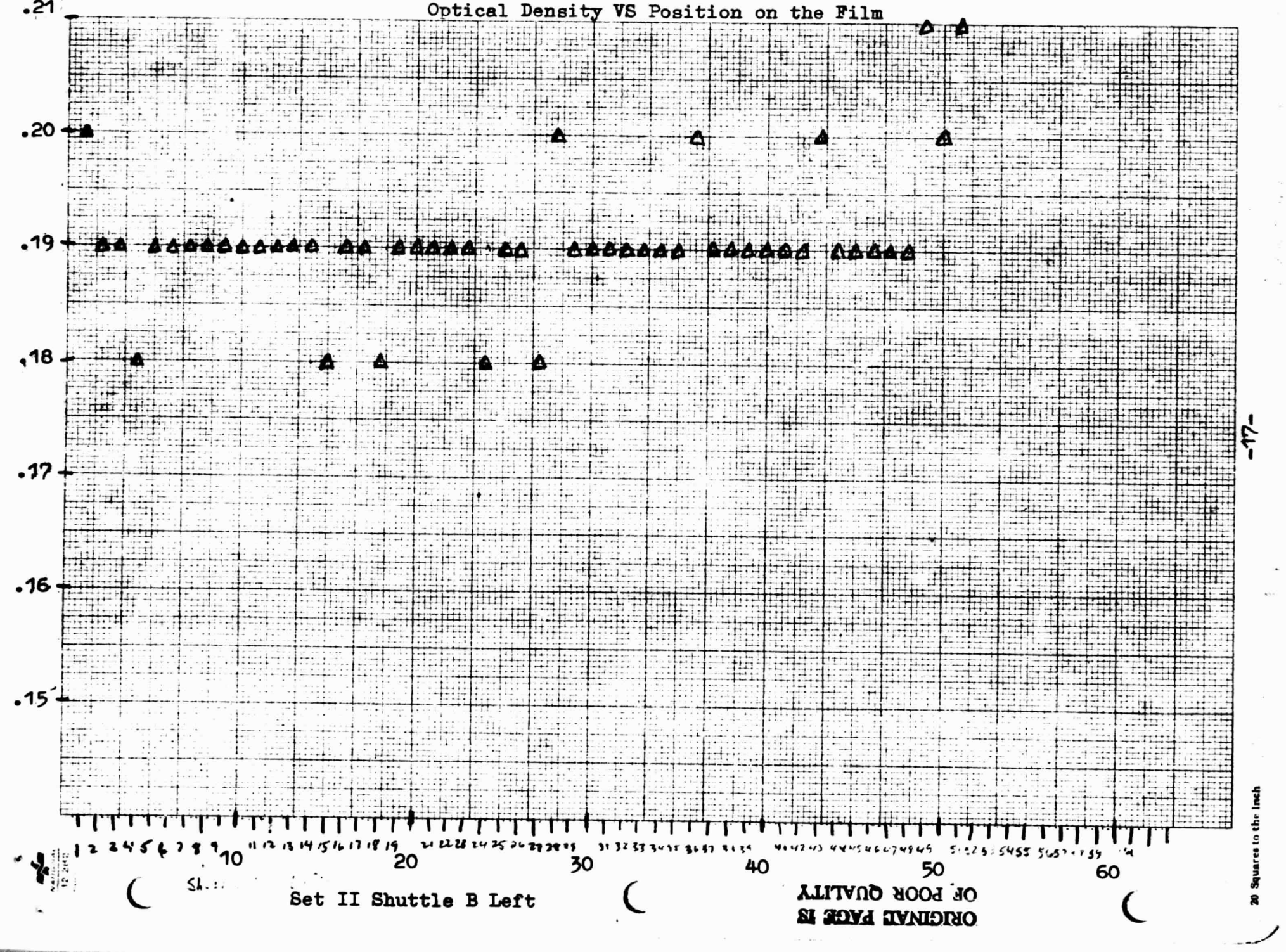


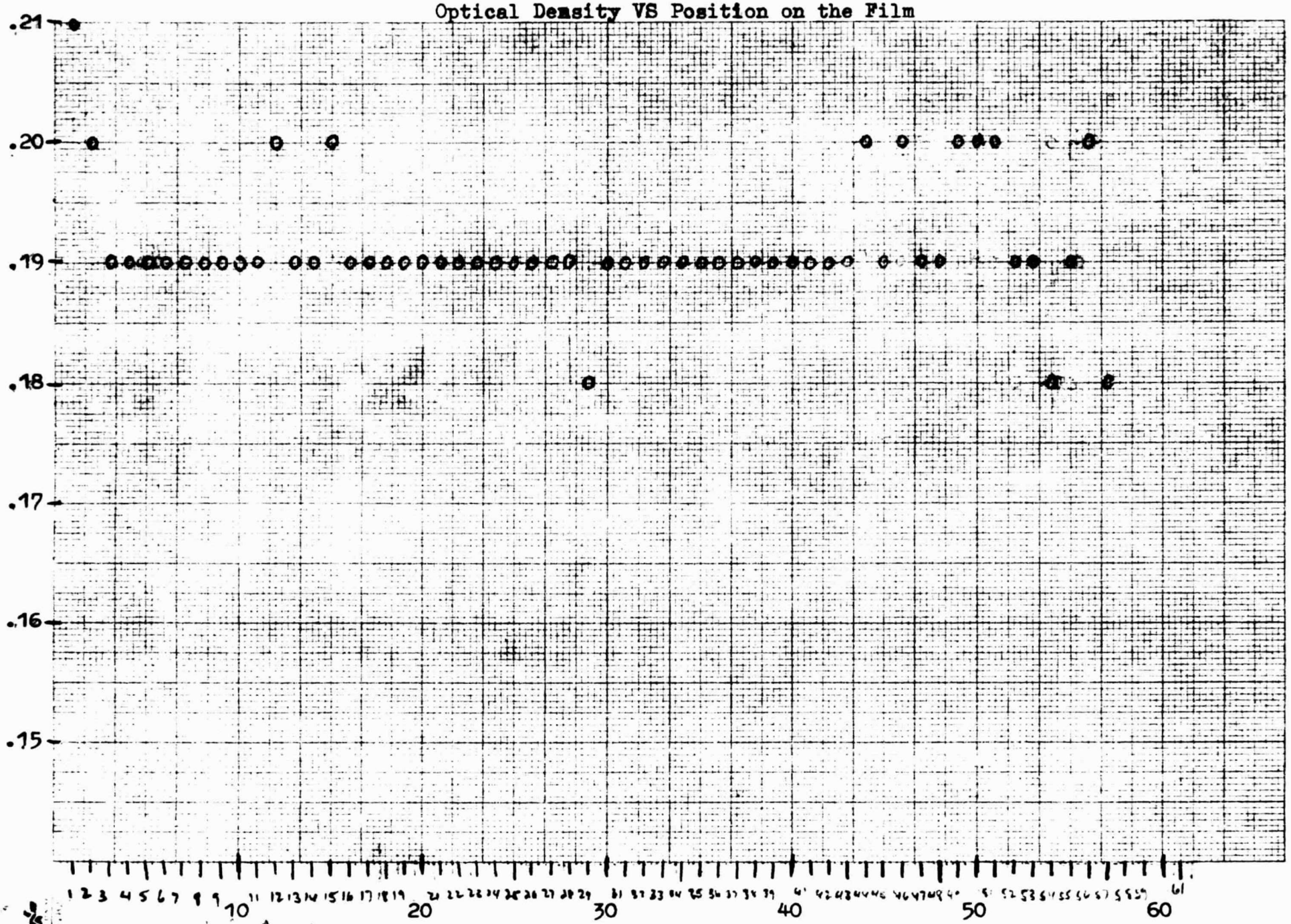


Set II Shuttle A Middle 0









Set II Sample A Left A-0