IUE DATA REDUCTION

VII. Intrinsic Resolution and Planned Changes to the Extraction Slit

Visual comparison of raw and geometrically corrected IUE spectra suggested that there might be a significant degradation of resolution in the geometric correction step of the reduction. In addition, the standard artificial extraction slit of $\sqrt{2}$ pixel width seemed somewhat too large for the measured resolution of ~ 2.5 pixel FWHM in raw images. Therefore, we have studied raw spectral images of the Pt-Ne lamp in order to determine the proper extraction slit for the new planned IUE reduction programs. Figure 1 is a hand extraction of a pair of emission lines from a position near the center of SWP, where the camera focus is best. The solid line connects points that would be extracted by a slit $\sqrt{2}$ px wide (i.e., the "old" standard slit), while the dashed line connects the open circles extracted with a slit of $\sqrt{2}/2$ effective width. This latter slit is defined by a row of pixels along a diagonal and is, therefore, called a "jagged" slit. The crosses are a third extraction defined again for a slit of $\sqrt{2}/2$ px effective width by using bi-linear interpolation in the image.

The conclusion from Figure 1, where the emission peaks are separated by ~6 px, is that the narrower extraction slits give only a slightly better resolution of the features, which are already well resolved. A better test is shown in Figure 2, where a barely resolved line pair on LWR is separated by only ~ 3 px. Here the narrower slits show a dip between the two lines, and the old extraction looks more like a single feature with a flat top.

In order to remove the effects of noise, synthetic spectra were constructed and extracted as before to produce Figures 3 and 4. A separation of 2.8 px along a diagonal was used for 2 lines with the gaussian shape and FWHM of 2.5 px, appropriate for IUE raw images. In the case of Figure 3 the 2 lines were centered on pixels, and in Figure 4 the centers were moved one-half of an old slit width along the diagonal. The results of Figure 2 are confirmed by Figures 3 and 4. Furthermore, the visibility of weak features depends critically on the way the data is sampled for the old, broad slit.

A possible problem in the use of the jagged slit is that the ratio of adjacent extracted points from a perfect continuum might not be unity because of the way in which the spectrum is digitally sampled with respect to the peak of the order on adjacent TV scan lines. The significance of this problem was thus assessed in two ways. First, a synthetic continuum spectrum was created with a gaussian shape and the realistic value of FWHM = 2.5 px. The extraction of neighboring points gives a ratio of 1.0006, or less than 0.1% error. (Note that this ratio is very sensitive to the adopted FWHM, being 1.005 for FWHM = 2.0 px and 1.075 for FWHM = 1.5 px.) Second, similar measurements were made from hand extractions of smooth stellar continua, using the jagged slit on actual high dispersion images of EtaUMa, SWP 4259 and LWR 3767. Samples at four locations including the narrowest orders over the tube face in each camera yielded mean ratios of adjacent points which did not deviate from unity in a statistically significant way. This "adjacent sample" problem was accordingly judged to be insignificant.

In conclusion the narrower and more frequently sampled extraction slits seem to reveal enough additional narrow features in IUE data to justify the increase in the number of points in the extracted IUE data tape format. In the new reduction era there will be a maximum of 1022 points (in tape records of 1024 words of 16 bits each) extracted per order instead of the old maximum of 600 points (in tape records of 602 16-bit words). In high dispersion, the jagged extraction slit will be used. In low dispersion, bi-linear interpolation is preferable because of the importance of geometric accuracy along the lengths of the large aperture, and because wide spectra require an extraction slit oriented along the large aperture and <u>not</u> along the diagonal. In both high and low dispersion, the effective slit width will be $\sqrt{2}/2$ pixel.

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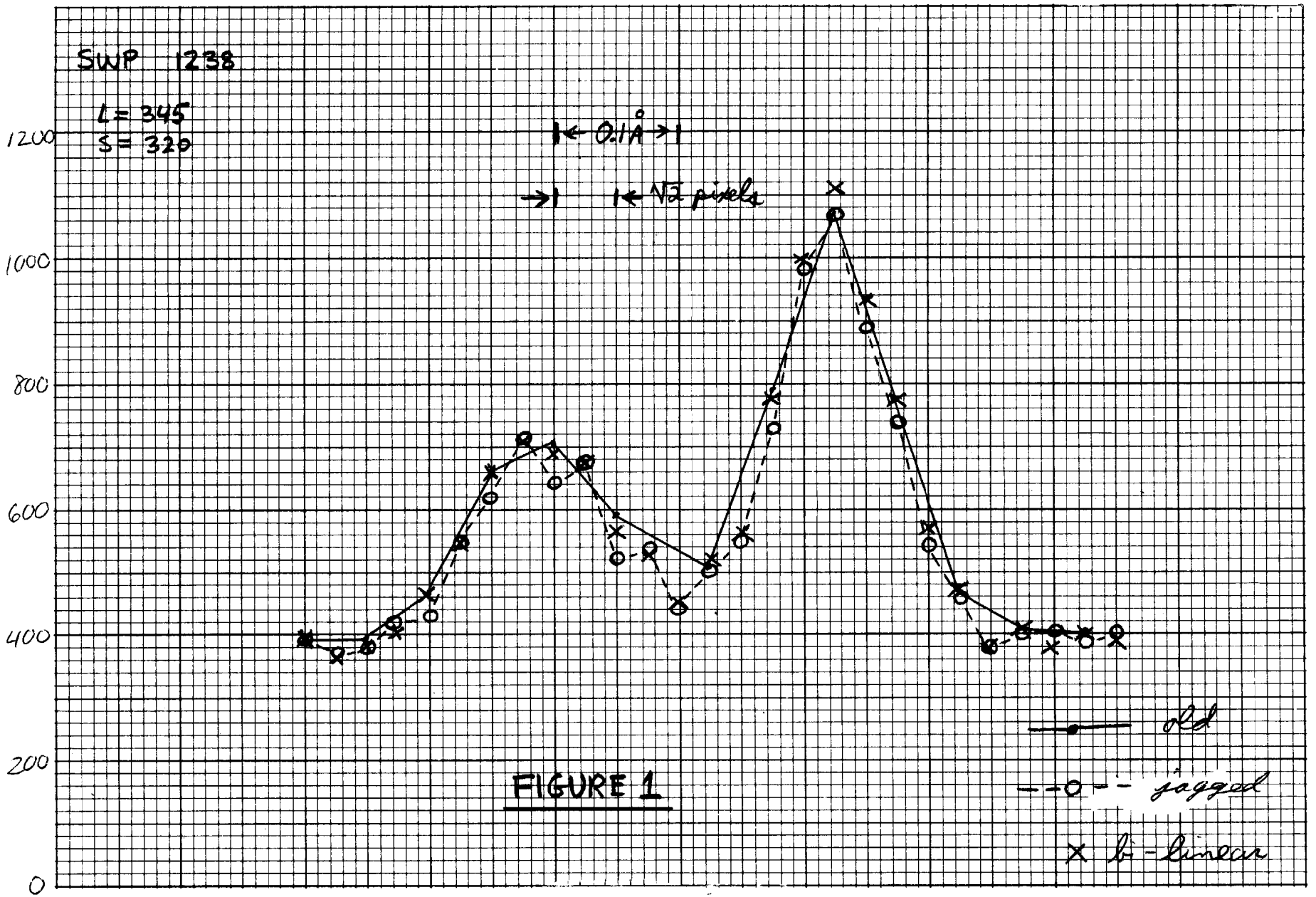
SWP 1238
L = 345
S = 320
1200
1000
800
600
400
200
0
← 0.1Å →
← √2 pixels
old
jagged
× bi-linear

FIGURE 1

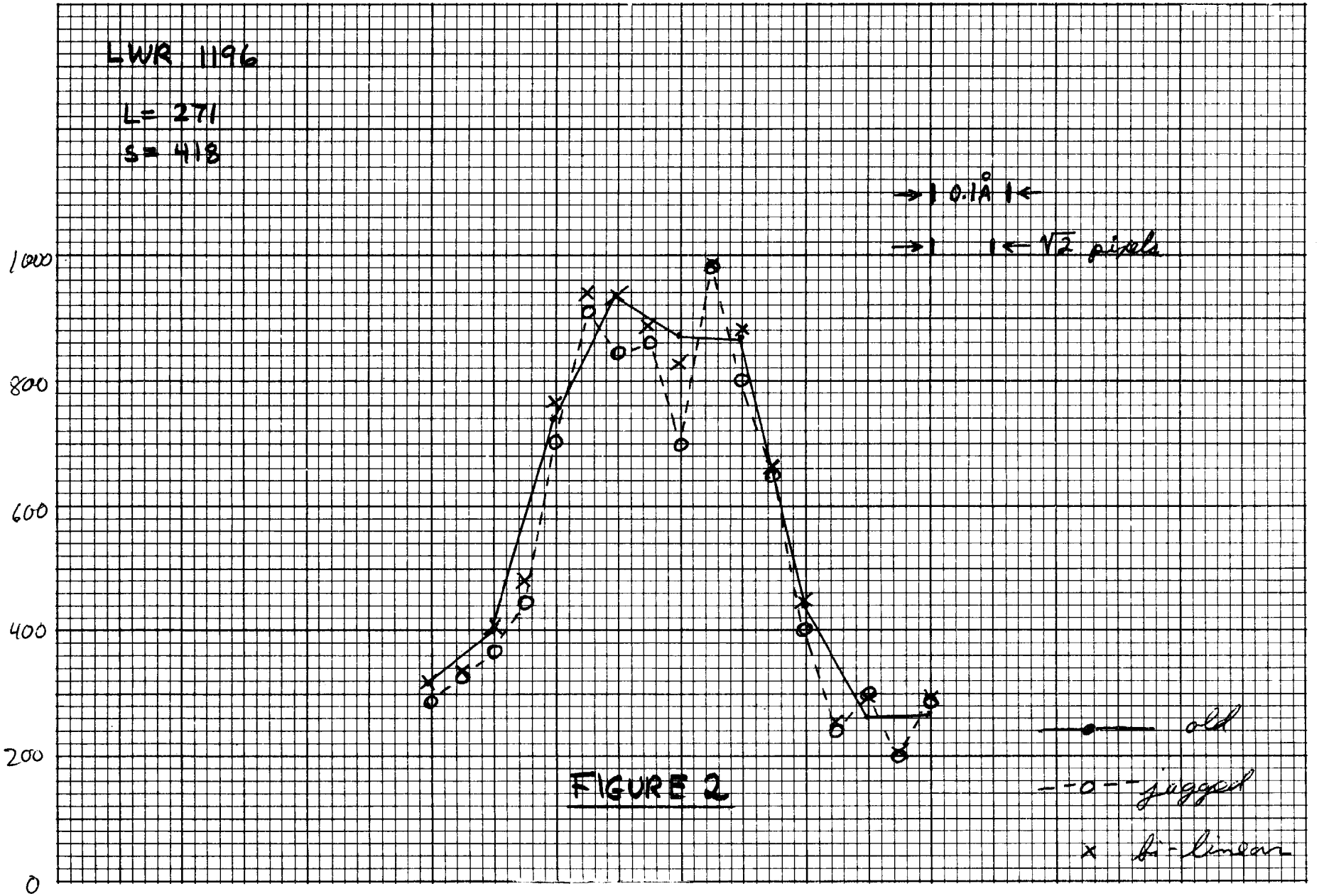
LWR 1196
L= 271
S= 418
→| 0.1Å |←
→| |← √2 pixels
1000
800
600
400
200
0
old
-+o- jagged
× bi-linear

FIGURE 2

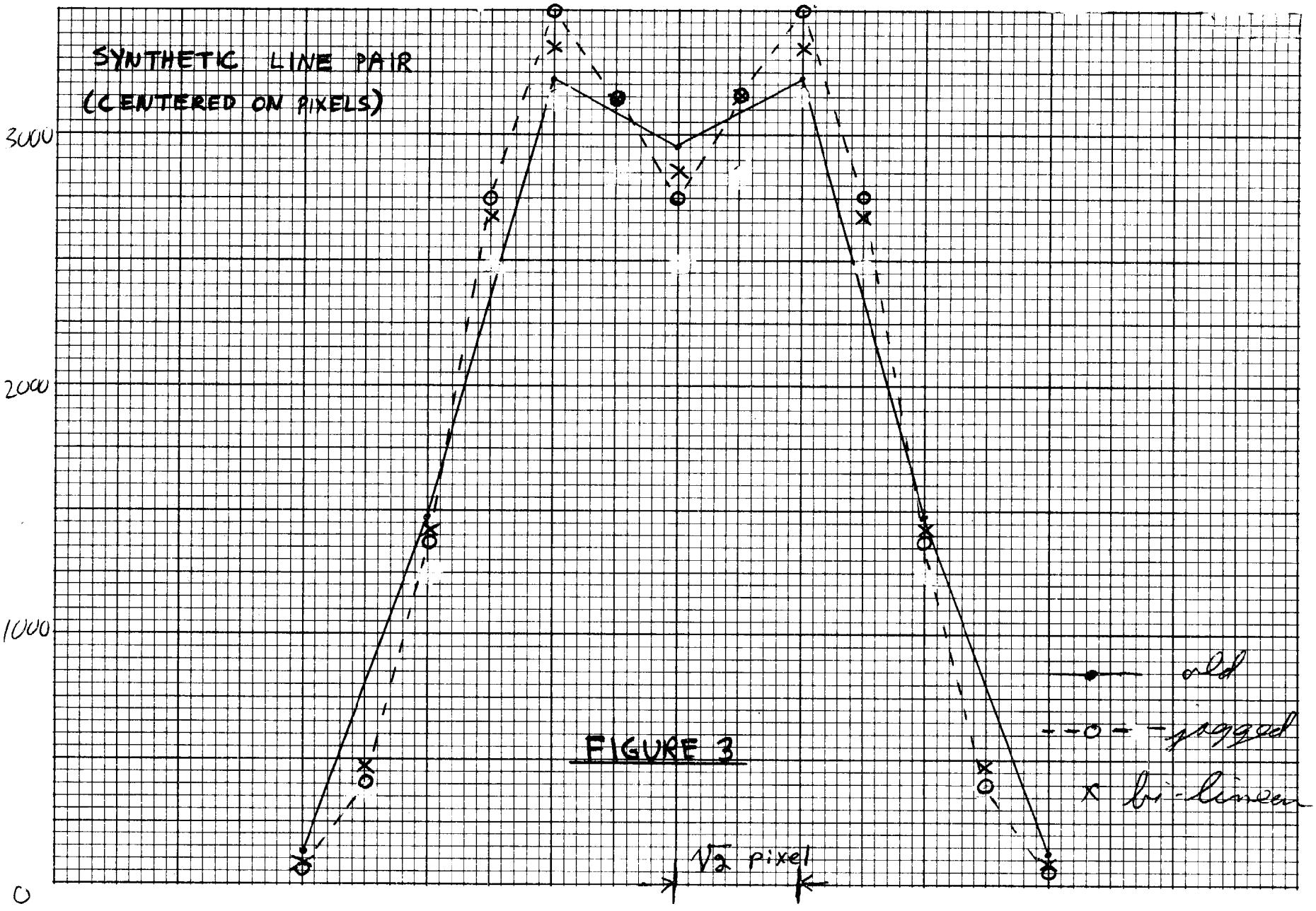

FIGURE 3

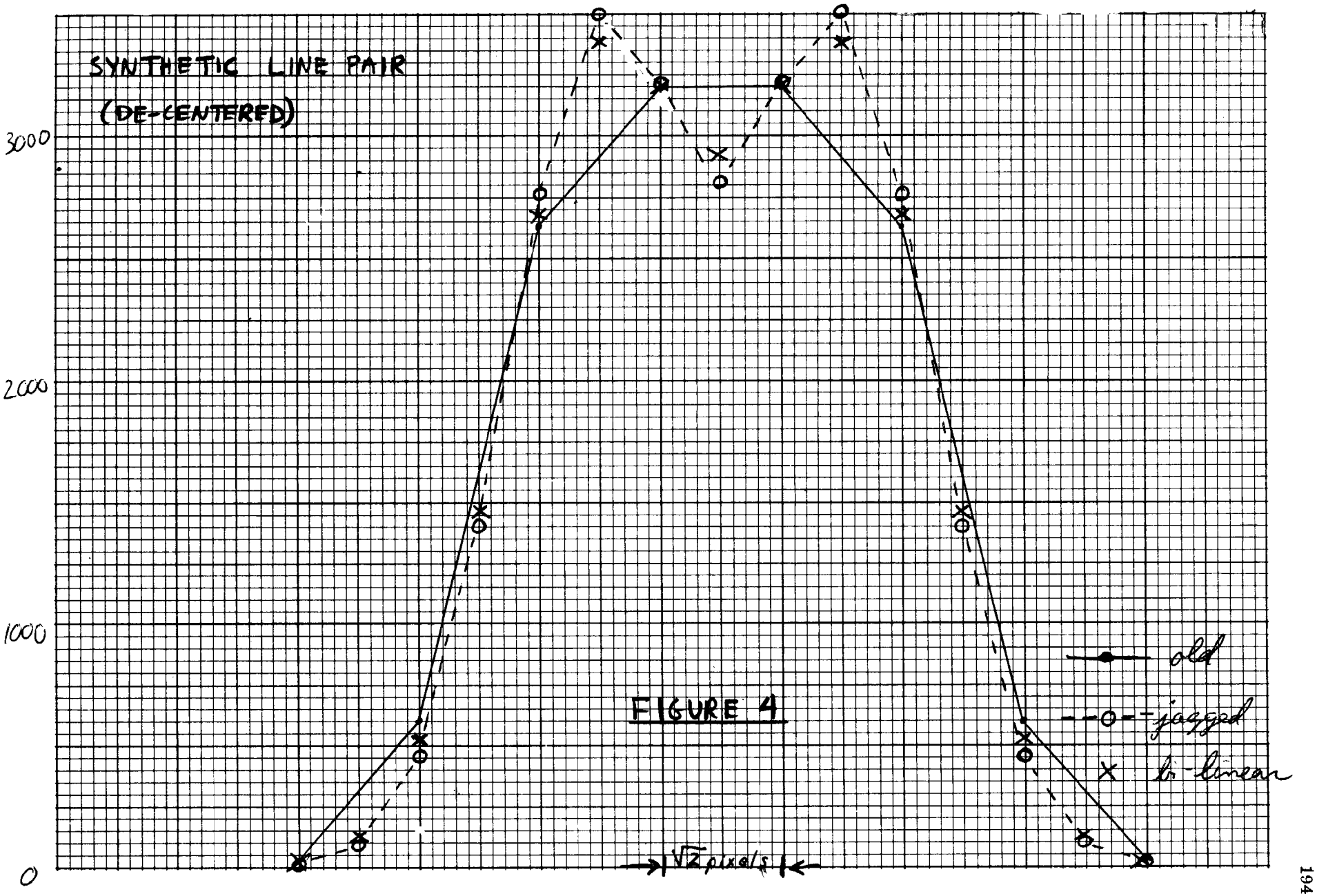
SYNTHETIC LINE PAIR
(DE-CENTERED)
3000
2000
1000
0
old
jagged
bi-linear
$\sqrt{2}$ pixels

FIGURE 4