IX. Photometric Stability in High Dispersion

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I. Introduction

Previous issues in this series have dealt primarily with the photometric properties and absolute calibration in low dispersion. Now, the photometric stability in high dispersion has been studied in conjunction with the implementation of the new high dispersion extraction software (Bohlin and Turnrose 1982).

The repeatability in high dispersion for bandpasses large compared to an individual sample is similar to the result for low dispersion found by Bohlin et al. (1980), where the one σ scatter was 3% for LWR and 2% for temperature corrected SWP data. All data in this study are corrected for temperature by $-0.5\%C^{-1}$ for SWP and $-1.1\%C^{-1}$ for LWR (Schiffer 1982).

II. Results

The spectra used in this analysis are all of the photometric standard ηUMa (B3V) taken in the large aperture and spaced over the lifetime of the IUE. The data consist of 18 SWP spectra with exposures usually of 5.73 s (13) or 6.96 s (2). The three exposures of 3.69, 9.83, and 11.88 s are included and flagged in the top panel of Fig. 1. Due to non-linearities in the IUE intensity transfer function (ITF), inclusion of these extreme exposures have increased the scatter slightly over what would be expected for data all at the same exposure level. The LWR data are 15 spectra with exposures generally of 5.73 s and with extremes of 3.69 and 11.88 s. In these two cases, the extreme LWR data do not exhibit the non-linearities that often arise in LWR, especially where the background is high.

In this study, the high dispersion data are averaged in 9 bins for each spectral order m, to find the mean response in IUE FN per unit time, R_i, for each bin and, R, for the overall average for an order. Fig. 1 shows the results for the whole orders R(108) and R(83) for the two cameras. Unity represents the average of all the plotted points in each panel. The orders m=108 and 83 are chosen, because the new automatic registration technique (Thompson and Bohlin 1982) implemented on Nov. 24, 1981 at GSFC uses order 108 as the prime registration fiducial. Fig. 1 shows results for the new software using this new registration technique. The points represent the response R for individual spectra divided by the mean for each set and are connected by lines for visual clarity. The scatter is higher for order 108 than for 83 because the background is difficult to extract between the close lying orders, despite the fact that order 108 was the registration fiducial. The 1σ scatter is worse at higher orders than at order 108; however, the σ=2.4% for the well-spaced order 83 is comparable to the results in low dispersion. The scatter of σ=1% for m=83 in LWR may be spuriously low, since only 8 of the 15 spectra were useful due to chronic microphonics or saturation in this order. The decrease in sensitivity with time that is suggested for LWR in Fig. 1 is consistent with the results of Schiffer (1982).

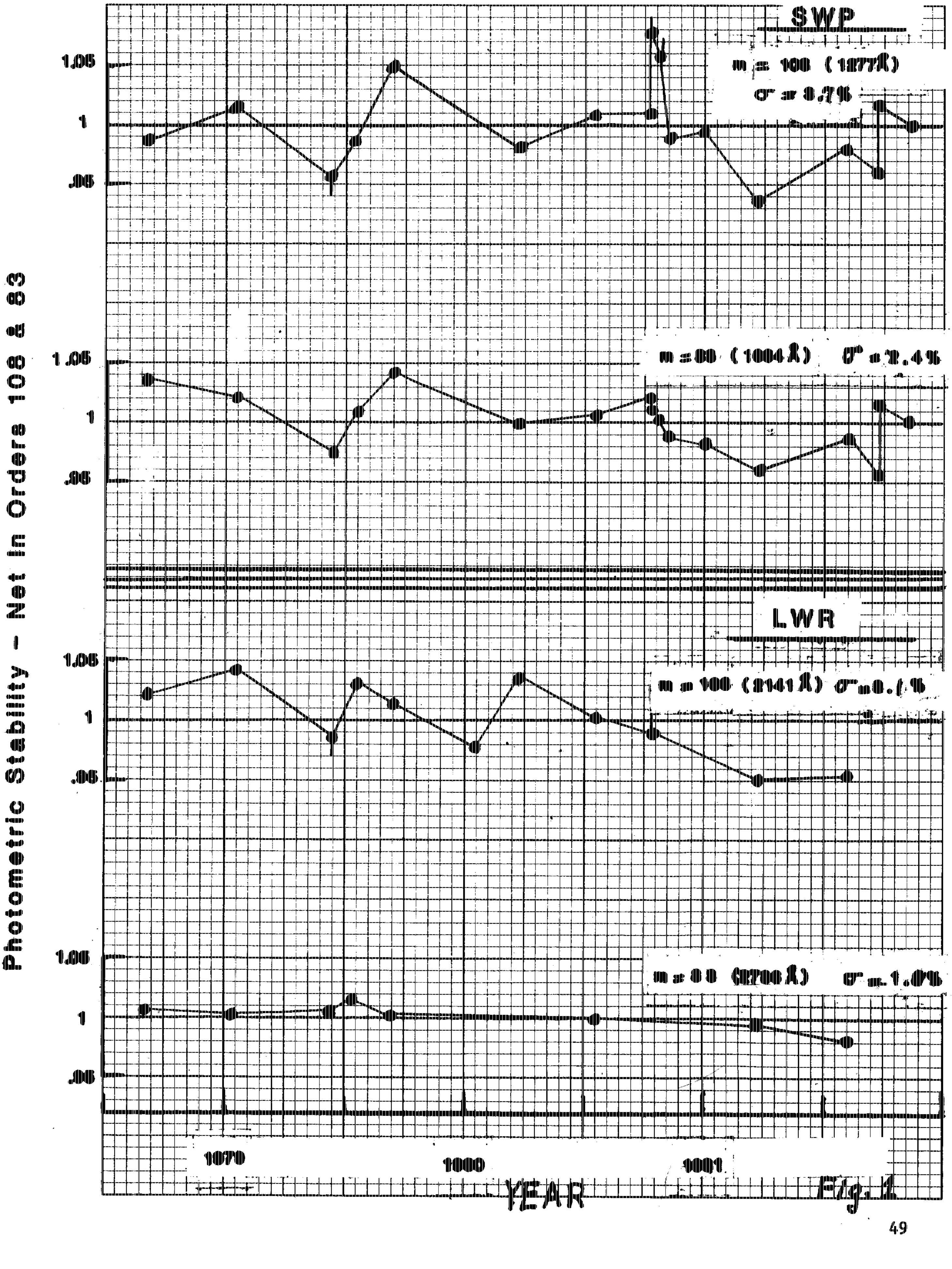
Photometric Stability - Net in Orders 108 & 83
SWP
LWR
1.05
1
.95
YEAR

Fig. 1

As a severe test of the new software, a bin R_L is examined at the long wavelength end of order 108, where the net signal has fallen from the peak by about a factor of 2. The same uncertainty in the extracted background causes larger photometric variations in this lower net R_L for both cameras. The lowest panels of Figs. 2 and 3 show the scatter for the new software in the same style as Fig. 1 for the 2 different cameras. Also shown in Figs. 2 and 3 for SWP and LWR, respectively, is the scatter for this same bin R_L (centered at 1283Å for SWP and 2151Å for LWR) in the cases of 1.) top panel-old software as originally processed and in the archives and 2.) middle panel-old software reprocessed in late 1981 using the new auto registration technique of Thompson and Bohlin (1982).

Note that the new software is somewhat better than the old software with the same auto registration, i.e., σ=4.6 vs. 5.2% for SWP and 5.4% vs. 7.7% for LWR, because of the improved treatment of the background in the new software. However, the most important point for the astronomer with high dispersion data processed before the effective date for the improved auto registration technique of Nov. 24, 1981 (at GSFC) is the large scatter in R_L of 10 to 15% typical before that time. Note also the occasional excursions up to ∿30% photometric error in R_L for archival data. <u>Astronomers attempting to use high dispersion data where photometric reproducibility is required should beware!</u> Old data at higher orders than 108 or for higher background relative to signal should have even worse scatter than found for R_L and ηUMa.

III. Conclusions

With the implementation at GSFC of the new high dispersion software on Nov. 10, 1981 and the new automatic registration technique on Nov. 24, 1981, high dispersion *IUE* data have become reasonably photometric.

This conclusion has two important corollaries:

1. A correction for the *IUE* echelle ripple exists, i.e., reproducible spectral shapes are obtained with the new software extraction techniques. See Ake (1981) with additional details in Ake (1982 in preparation).

2. The absolute calibration in high dispersion can be found and applied with some confidence. The old calibration of Cassatella et al. (1981) is no longer valid because of the increase in net signal extracted by the new high dispersion software (Bohlin and Turnrose 1982). The new ripple correction, which should be implemented in the near future, may also affect the derivation of a new absolute calibration. Work is continuing on lowering the extracted background, which is too high due to order overlap and the curvature of the orders in the spectral format. If the order overlap is reduced to zero, then the absolute calibration in high dispersion should agree for both continuum and line emission sources. Perhaps further work on high dispersion absolute calibration should follow the final resolution of the order overlap problem.

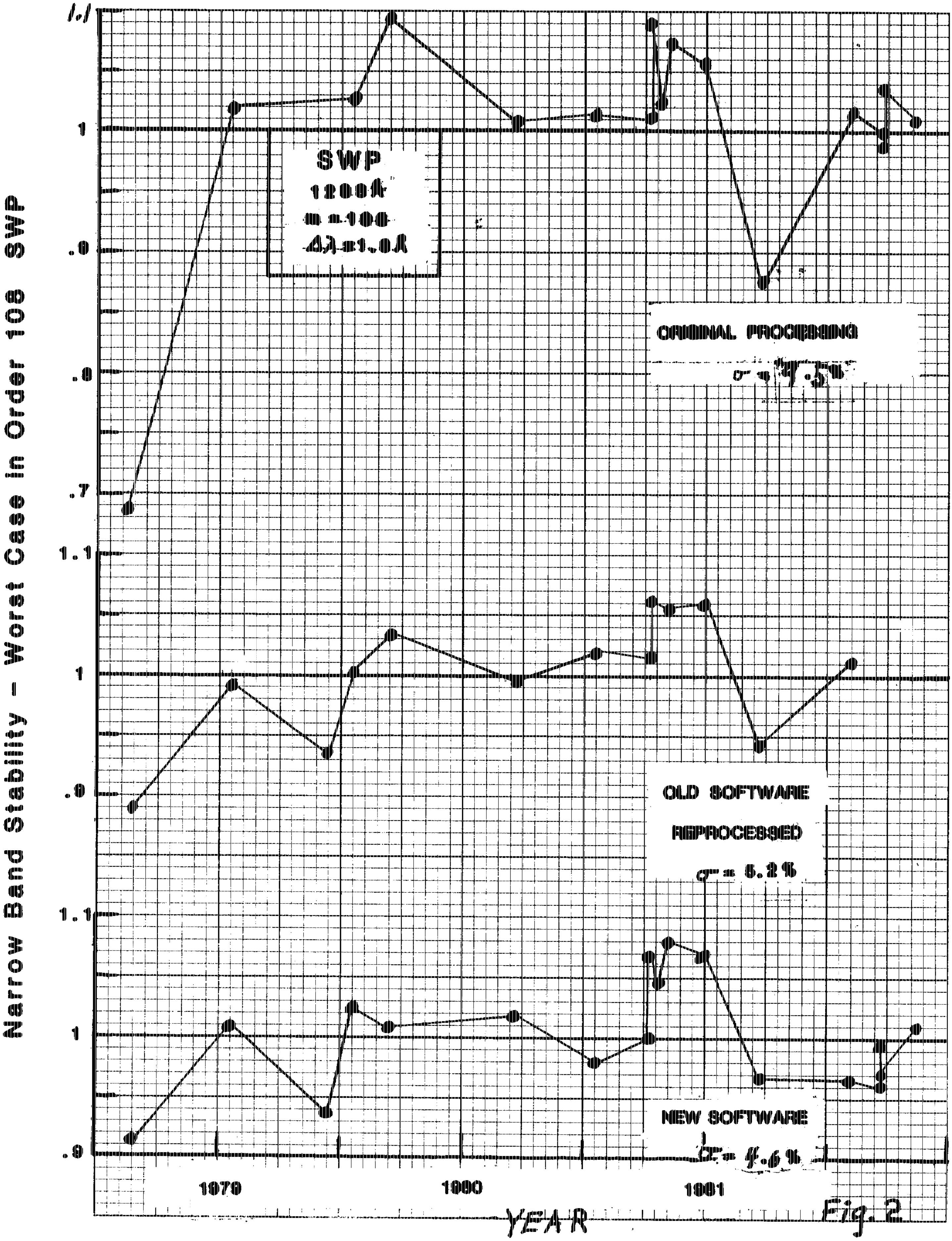
Narrow Band Stability - Worst Case in Order 108 SWP
SWP
1200Å
Δλ =1.0Å
ORIGINAL PROCESSING
OLD SOFTWARE
REPROCESSED
σ = 5.2%
NEW SOFTWARE
σ = 4.6%
1.1
1
.9
.8
.7
1979
1980
1981
YEAR

Fig. 2

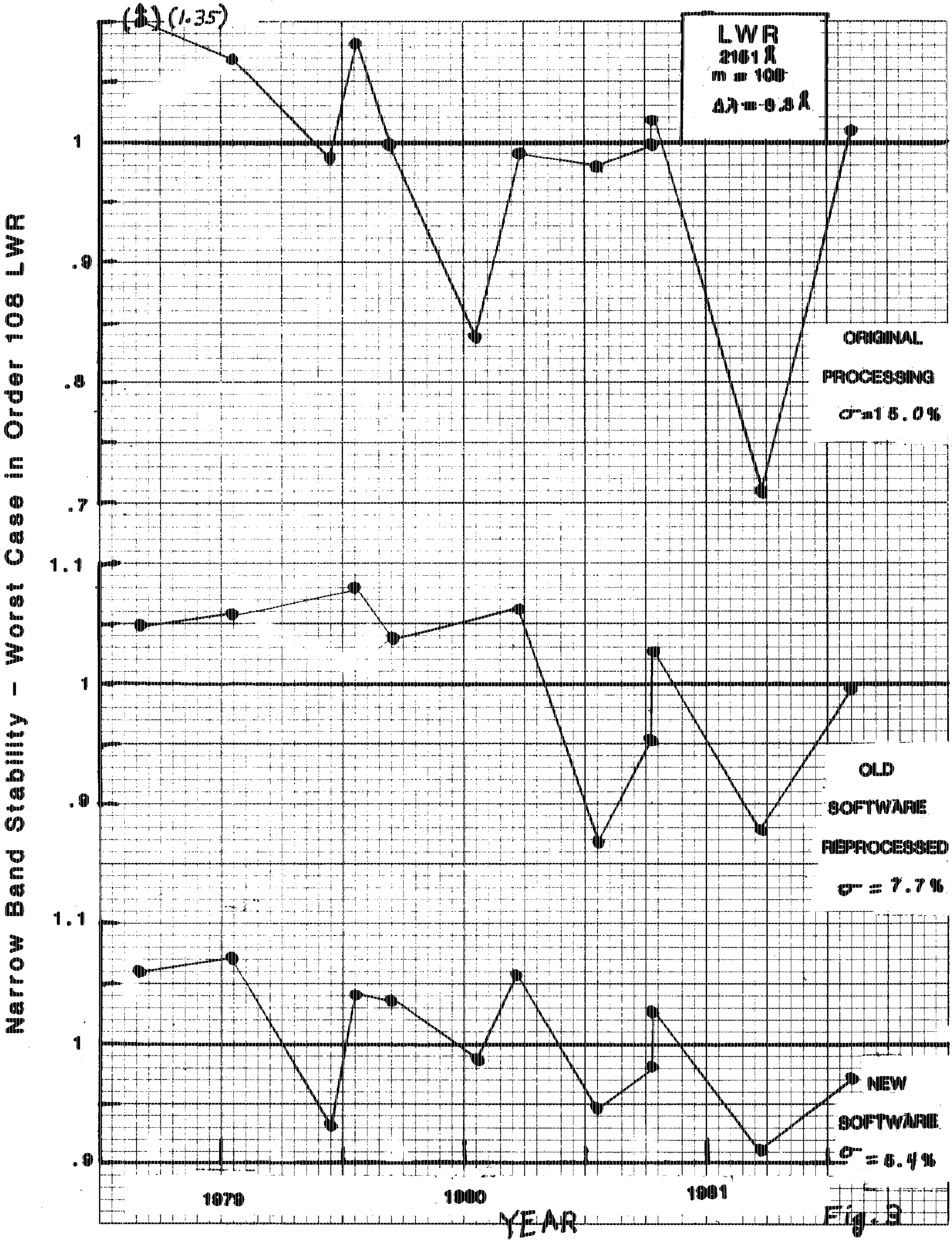
LWR
2161 Å
m = 108
(1.35)
ORIGINAL
PROCESSING
σ = 15.0 %
OLD
SOFTWARE
REPROCESSED
σ = 7.7 %
NEW
SOFTWARE
1.1
1
.9
.8
.7
1979
1980
1981
YEAR
Narrow Band Stability - Worst Case in Order 108 LWR

Fig. 3

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Cassatella, A., Ponz, D., and Selvelli, P. L. 1981, NASA IUE Newsletter No. 14, p. 170.

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