

Effective Date: 4-1-88
(GMT 92:23:00)

IUE Data Reduction

XXXV. Implementation of New Dispersion Constants

On April 1, 1988 (GMT 92:23:00) updated dispersion constants and correlation coefficients were implemented in production processing at Goddard Space Flight Center for the long wavelength prime (LWP), long wavelength redundant (LWR), and short wavelength prime (SWP) cameras. These files replace those originally implemented on June 20, 1984.

The new calibration files were primarily implemented to update the second-order time corrections used for low dispersion LWR and SWP spectra. The previous time correction resulted in a systematic wavelength error that has gradually increased in magnitude since 1984. WAVECAL spectra obtained in the fall of 1987 showed that the low dispersion wavelength assignments had become approximately 2.5 angstroms too low for SWP and approximately 5 angstroms too high for LWR. High dispersion wavelength assignments appeared to have smaller systematic errors which were approximately 5 km/sec too high for LWR and 3 km/sec too high for SWP.

Table 1 shows statistics for the new dispersion constants and standard deviations before and after the corrections are applied. Table 2 lists the actual dispersion constants and correlation coefficients as implemented on the effective date shown above. The dispersion constants (A and B) given in Table 2 relate the wavelength in angstroms (W) and the order number (M) to the line (L) and sample (S) pixel location in geometrically-correct space by the following expression:

$$S = A1 + A2MV + A3(MV)**2 + A4M + A5W + A6W(M)**2 + A7M(W)**2 \quad (1)$$

$$L = B1 + B2MV + B3(MV)**2 + B4M + B5W + B6W(M)**2 + B7M(W)**2 \quad (2)$$

For low dispersion ($m=1$) only the first two terms are used.

Shifts in the location of the spectral format as a function of temperature and time are compensated for using the terms W(S) and W(L) which are added to the A1 and B1 terms, respectively. These are computed from the relations

$$W = W1 + W2T + W3t + W4t**2 \quad (3)$$

where

T = head amplifier temperature (C) and
t = number of days since January 1, 1978.

The correlation coefficients W are defined such that the mean time and temperature correspond to a correction of zero. For the LWP camera $W3 = 0$ and $W4 = 0$, since no time correction is applied. Results of a study to compare various correlations using time and temperature are shown in table 3. The numbers represent the total RMS scatter for the various corrections to the mean dispersion constants. It can be seen that the 2nd order time correction reduced the standard deviations for the LWR and SWP cameras but not for the LWP.

The errors described above and the improvement found using the new dispersion relations are shown in the plots below. The plots basically represent the scatter in the position of a particular wavelength assignment (about the mean) as a function of time. The 'x' symbols represent wavelength positions that were derived from dispersion relations generated from WAVECAL images (i.e. Pt-Ne lamp plus TFLOOD exposures) that have been obtained approximately every two weeks since launch, and are shown in a coordinate system which runs along and perpendicular to the dispersion direction. The '+' symbols connected by a jagged line represent the same positions minus a correction for spacecraft temperature (THDA). The curved line represents the additional 2nd-order correction for time. (Note for the LWP plots just a 1st-order time correction is shown.) The temperature and time corrections were derived from correlations using the data points designated by the '+' symbols. An error in the correlations is evident when the smooth curve (time correction) does not correspond to the jagged line (difference between the raw data points and the temperature correction).

Figures 1 through 6 show how the previous dispersion relations model the wavelength assignments for recent WAVECAL images for each camera and dispersion. As seen in the low dispersion LWR and SWP plots (figures 2 and 3), the smooth line deviates from the jagged line starting around 1984 (i.e., 2190 days since 1/1/78), indicating that a systematic error was introduced that has increased with time. Tests on spectra obtained in December 1987 verified the magnitude of these errors in low dispersion. No systematic errors are seen in the LWP plots.

Figures 7 through 12 show the same type of data as in figures 1 through 6 using the updated dispersion relations and correlation coefficients. As shown, the time correction no longer introduces a systematic error in the wavelength assignments for the LWR and SWP images (figures 8 and 9). The plot for low dispersion LWP (figure 7) shows a small possible time dependence amounting to a correction of about .15 pixels/year. Since the dependence is so small however, it was decided to continue applying only a correction for temperature in production processing.

Figures 13 to 18 show the difference in the predicted positions of the Pt-Ne lines, for each camera and dispersion, using the old and new mean dispersion relations. The diamond-shaped symbols represent the positions predicted by the old dispersion relations and the scaled

vectors point to the positions determined by the new relations. The difference is mainly due to the shift in the location of the spectral format as a function of time. It can be seen that the shift is basically independent of wavelength and dispersion mode.

A more complete description of the wavelength errors and a possible correction algorithm for low dispersion spectra obtained between 1984 and 1988 is planned for the next IUE Newsletter.

Table 1
Dispersion Constant Statistics

	LWP		LWR		SWP	
	<u>Low</u>	<u>High</u>	<u>Low</u>	<u>High</u>	<u>Low</u>	<u>High</u>
No. of D.C.	125	124	149	147	181	183
Mean time	9/27/84	11/15/84	10/20/82	11/13/82	4/30/83	4/16/83
Start	6/16/80	6/16/80	7/16/78	10/1/78	10/1/78	9/12/78
End	8/10/87	8/10/87	10/21/87	10/21/87	8/10/87	8/10/87
Mean THDA (°C)	9.2	9.5	13.3	13.6	8.9	9.0
Lowest	6.2	6.2	8.8	9.5	5.1	5.1
Highest	13.8	14.2	18.3	18.3	13.2	13.2
Slope (DL/DS)	-.8594	1.20*	.7466	-1.38*	-.8061	1.28*
"Plate" Scale (pixel ⁻¹)	2.64Å	7.22 km/sec	2.65Å	7.23 km/sec	1.67Å	7.70 km/sec
Raw scatter (l in pixels)						
Parallel	.39	.70	.36	1.49	.99	1.18
Perpendicular	.66	.38	1.76	.32	1.16	.55
Scatter after correction [THDA only]			[THDA & 2nd order time]			
Parallel	.29	.36	.29	.42	.23	.26
Perpendicular	.39	.22	.42	.25	.30	.15

* average slope for order 100

Table 2. Coefficients Defining the Dispersion Relations For
The Small Aperture (1 of 2)

DISPERSION CONSTANTS

	LWP LAW	LWP LAW	SWP LAW
A1	1.046761751474290E 03	-2.996629722540309E 02	9.842537704680175E 02
A2	-2.868001122699011E-01	3.022883838744345E-01	-4.666079542464260E-01
A3			
A4			
A5			
A6			
A7			
B1	-2.719730910826736E 02	-2.643542338472613E 02	-2.630561357770229E 02
B2	2.464817837517009E-01	2.257008693375577E-01	3.761477738077073E-01
B3			
B4			
B5			
B6			
B7			

CORRELATION COEFFICIENTS

W1(S)	-8.791381716728210E-01	5.767917633056641E 00	-4.013411521911621E 00
W2(S)	9.590029716491699E-02	-2.406980395317078E-01	-8.571829646825790E-03
W3(S)		-2.169568324461579E-03	3.169863950461149E-03
W4(S)		3.144138531752105E-07	-4.454670374798297E-07
W1(L)	-3.502341270446777E 00	-8.896263122558594E 00	-2.038312911987305E 00
W2(L)	3.814837932586670E-01	4.788957238197327E-01	1.484615206718445E-01
W3(L)		2.082946710288525E-03	7.285187020897865E-04
W4(L)		-2.835006398527185E-07	-1.499050767961307E-07

Table 2. Coefficients Defining the Dispersion Relations For
The Small Aperture (2 of 2)

DISPERSION CONSTANTS

	LWP HIGH	LWP HIGH	SWP HIGH
A1	4.803657002963457E-03	-4.692199700079563E-03	1.631454641827589E-02
A2	-1.644785837005490E-01	1.456544391180930E-01	-1.65967977725873E-01
A3	6.417917757320172E-07	-5.486889310991500E-07	1.251129072284586E-06
A4	1.765972022959533E-01	4.210961364595948E-02	1.431417433419038E-01
A5	4.293823686782681E-01	2.794913241835652E-01	-4.456618951605544E-01
A6	-7.610870340777773E-05	-1.235455019355905E-07	-1.016828512840550E-06
A7	-3.086633847872316E-06	1.001362711452285E-07	-1.557535090051680E-07
B1	1.707191128477559E-03	1.574206920842157E-04	-7.235787738562120E-03
B2	-1.524320940545044E-01	-2.803452890142334E-01	-1.170159622288736E-01
B3	6.232836317562505E-07	9.140342957564075E-07	1.217535534619699E-06
B4	1.862659356576263E-01	6.052784971102065E-02	-1.218764071519810E-01
B5	3.133576774038163E-01	2.255877040558232E-01	3.905721994031134E-01
B6	-7.369889159816985E-07	-1.302666030513332E-08	8.920912742277709E-07
B7	-2.897738952325312E-07	6.585438728256127E-09	-1.133312364675460E-07

CORRELATION COEFFICIENTS

W1(S)	-8.979568481445313E-01	5.822890281677246E-00	-3.485797882080078E-00
W2(S)	9.507745504379272E-02	-2.920082807540894E-01	5.037758871912956E-02
W3(S)		-1.580609008669853E-03	2.452150452882051E-03
W4(S)		2.399144705123035E-07	-3.681943212541228E-07
W1(L)	-4.343306541442871E-00	-8.799000740051270E-00	-3.268136024475098E-00
W2(L)	4.589727520942688E-01	5.368530154228210E-01	2.289363741874695E-01
W3(L)		1.171087380498648E-03	9.673056192696095E-04
W4(L)		-1.444790314053535E-07	-1.419936666025023E-07

Table 3.

Total* RMS Scatter (1σ in pixels) for Various
Corrections to the Mean Dispersion Constants

HIGH DISPERSION

	<u>LWP</u>	<u>LWR</u>	<u>SWP</u>
Raw Scatter	0.79	1.52	1.30
1st Order THDA	0.42	0.99	1.09
1st Order Time	0.78	1.15	0.59
THDA & Time	0.41	0.53	0.43
THDA & 2nd order Time	0.41	0.49	0.30
No. of Points	124	147	183
Mean Time (1 = 1/1/78)	2510	1777	1931

LOW DISPERSION

	<u>LWP</u>	<u>LWR</u>	<u>SWP</u>
Raw Scatter	0.77	1.79	1.52
1st Order THDA	0.48	1.48	1.42
1st Order Time	0.72	1.13	0.59
THDA & Time	0.43	0.61	0.53
THDA & 2nd order Time	0.43	0.51	0.38
No. of Points	125	149	181
Mean Time (1 = 1/1/78)	2461	1754	1945

* Perpendicular and parallel components combined.

Figure 1

Old Low Dispersion

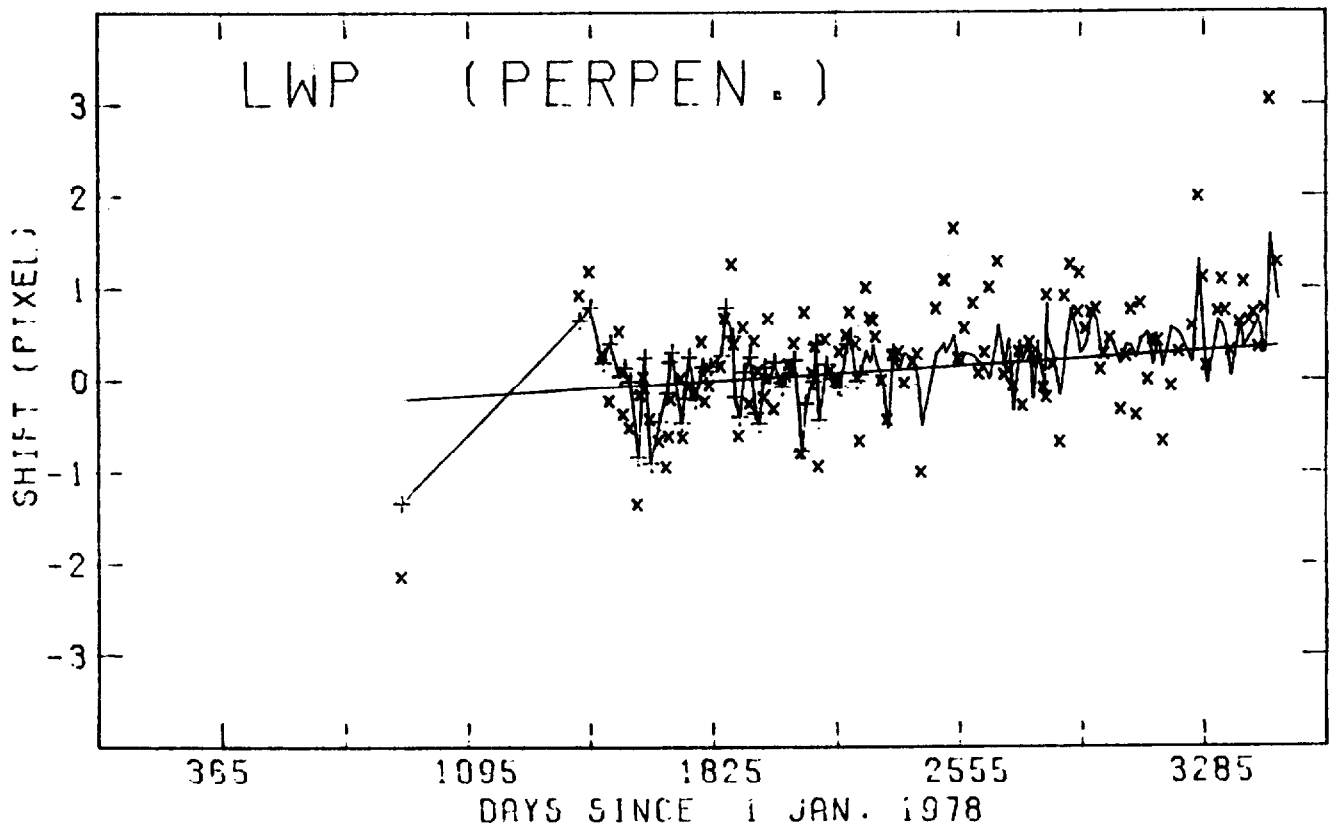
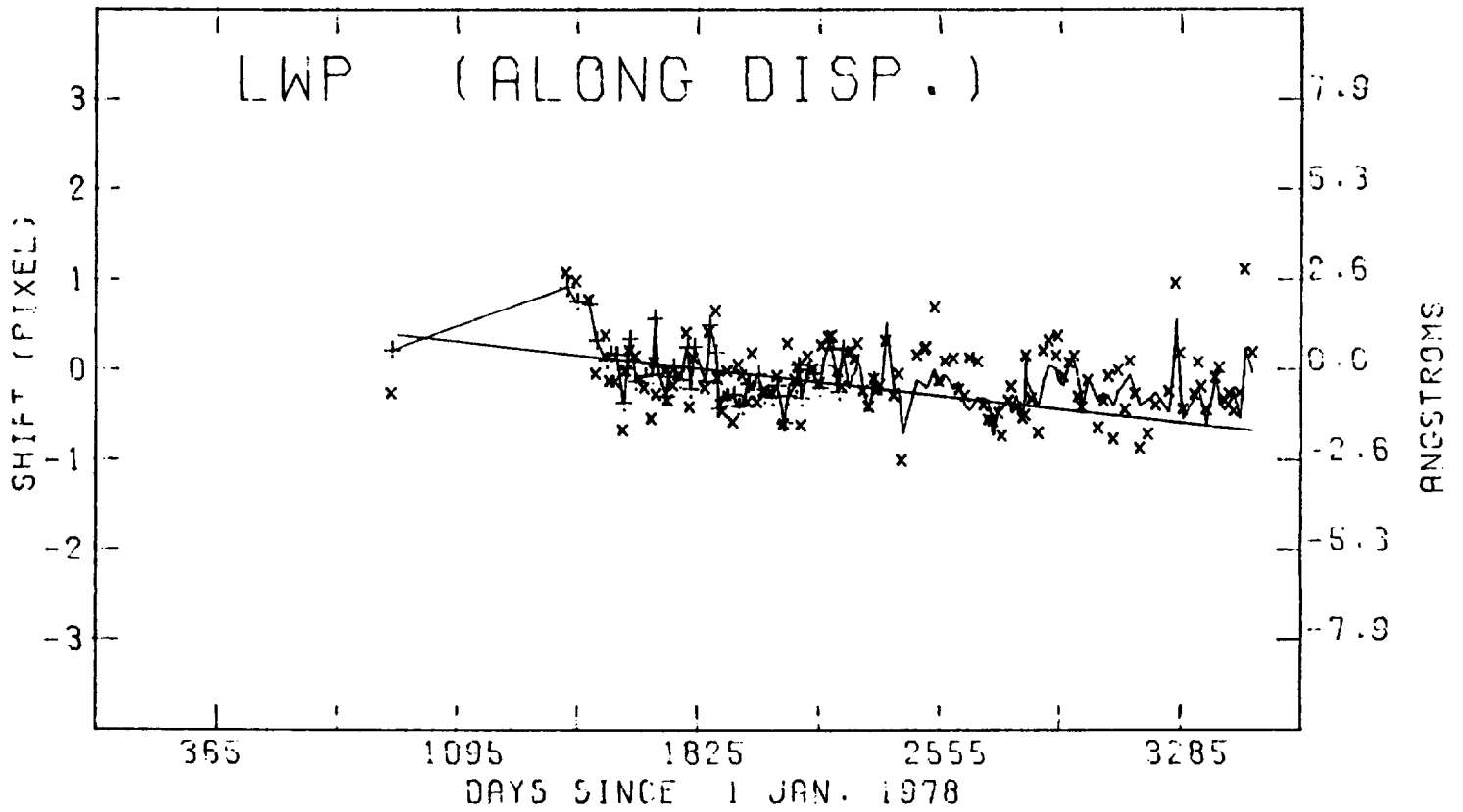


Figure 2

Old Low Dispersion

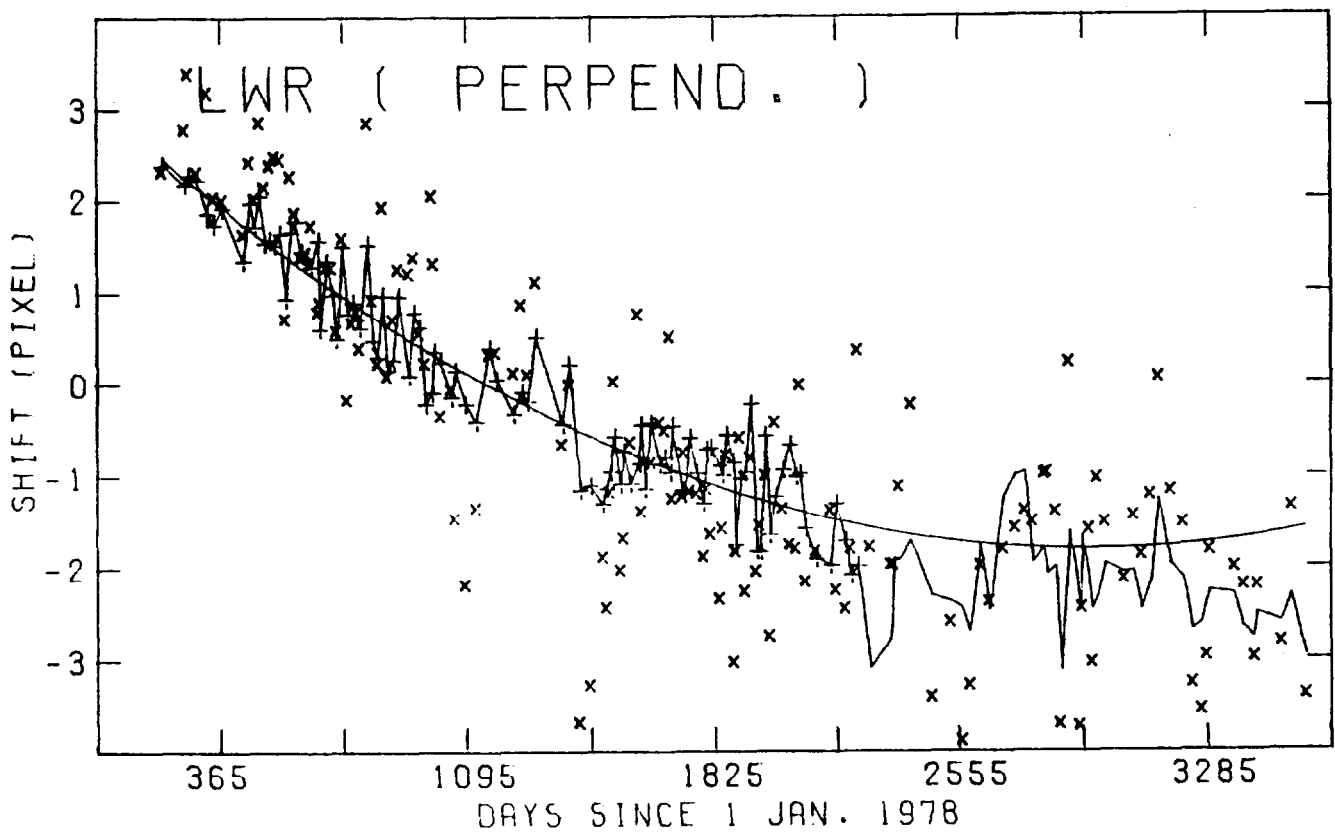
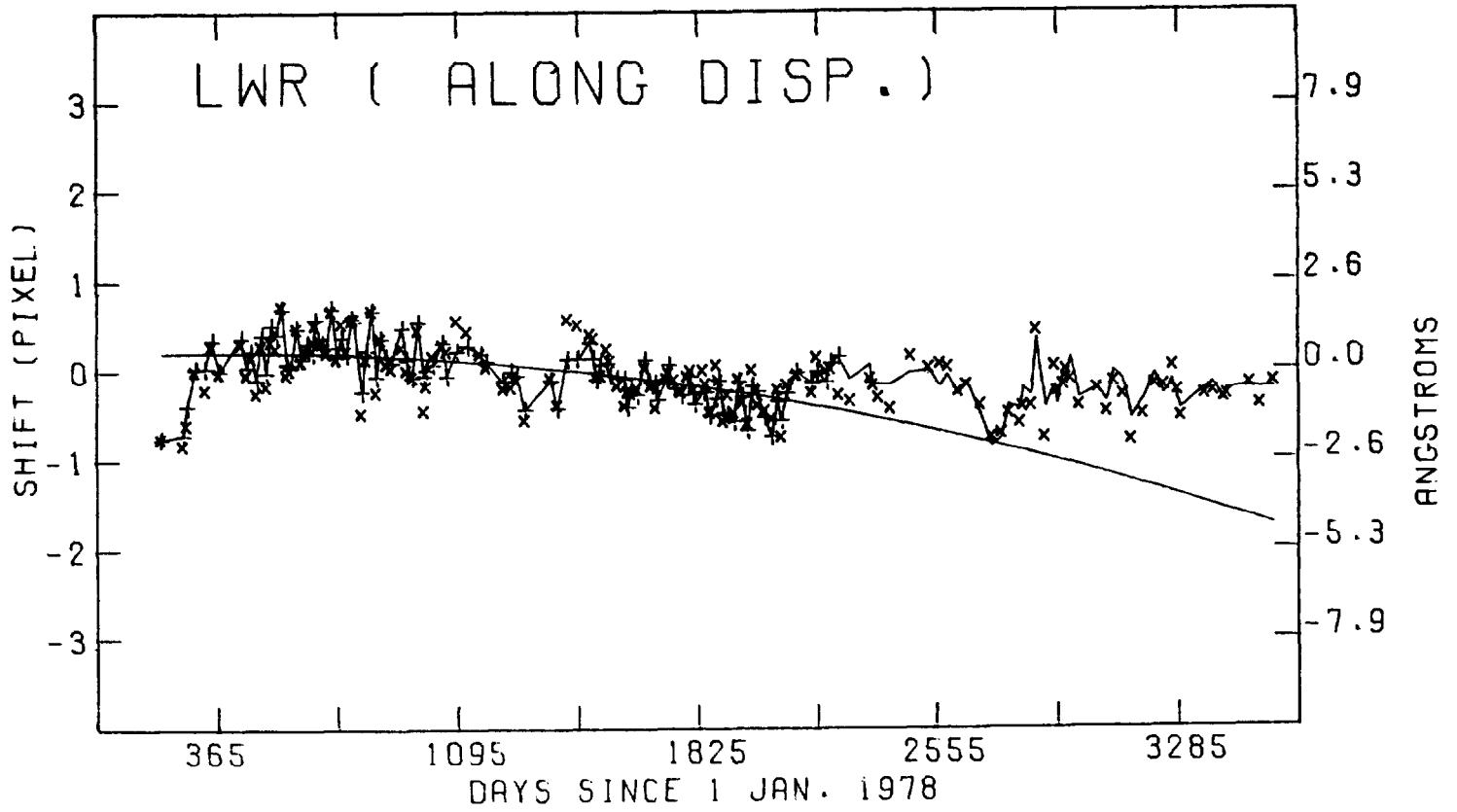


Figure 3

Old Low Dispersion

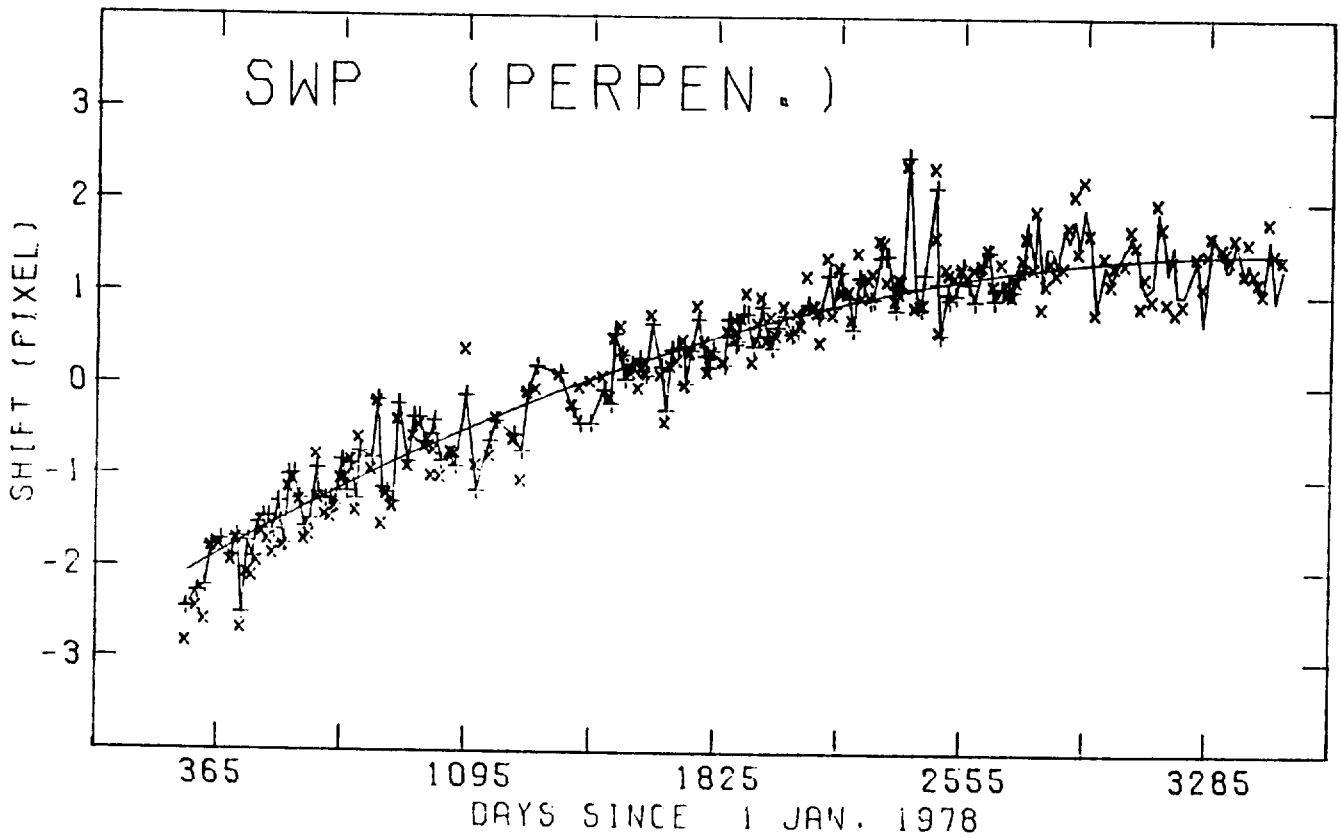
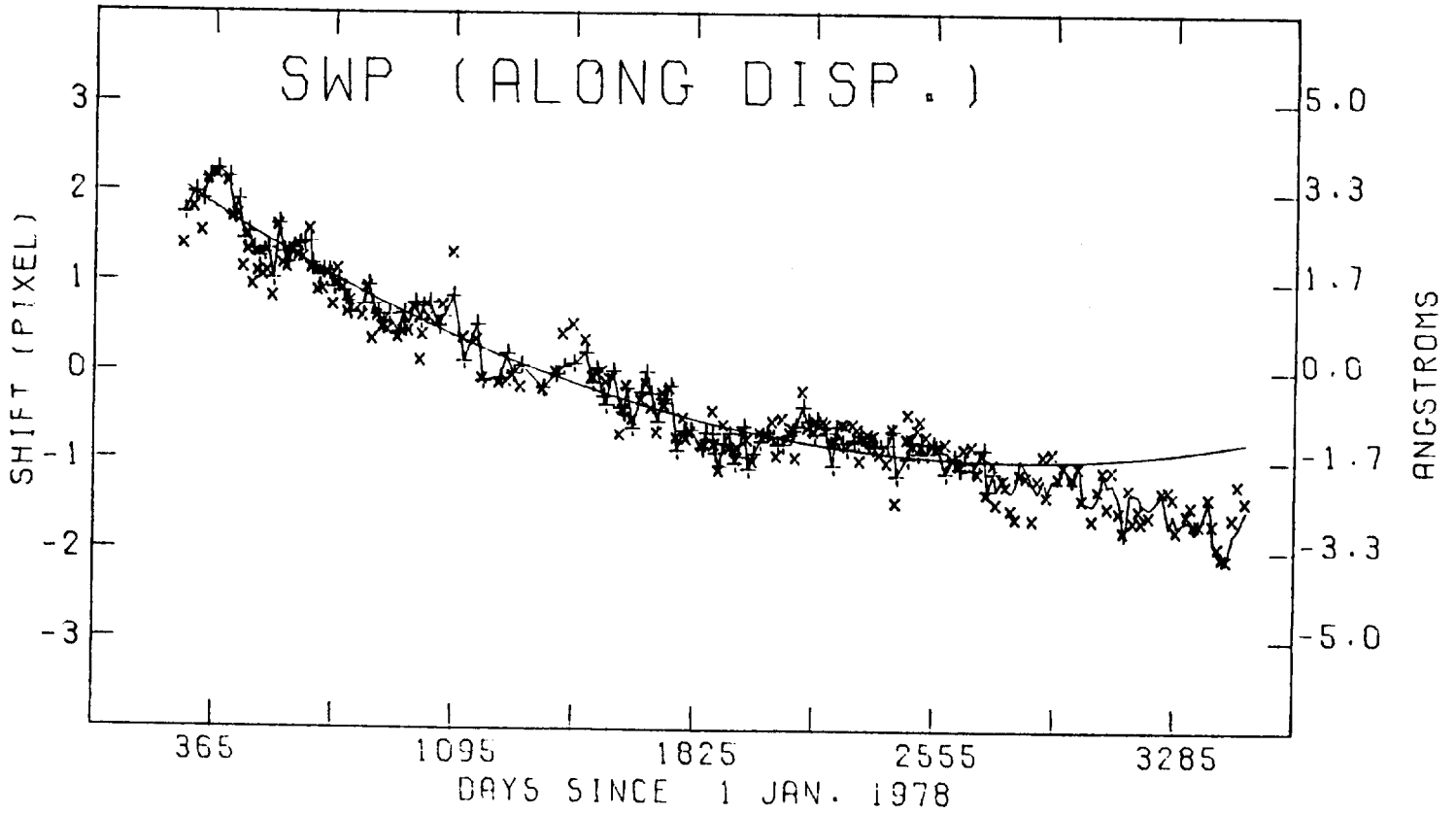


Figure 4

Old High Dispersion

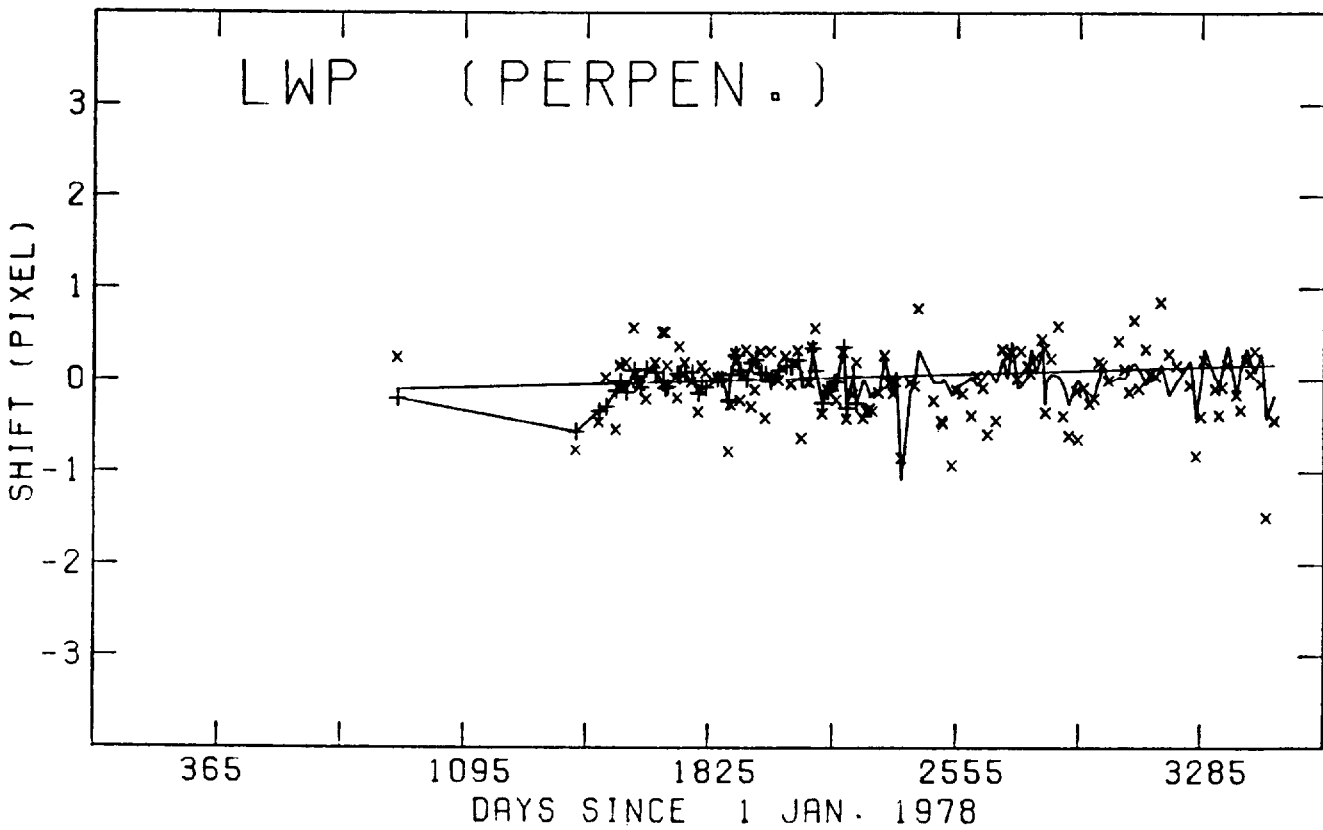
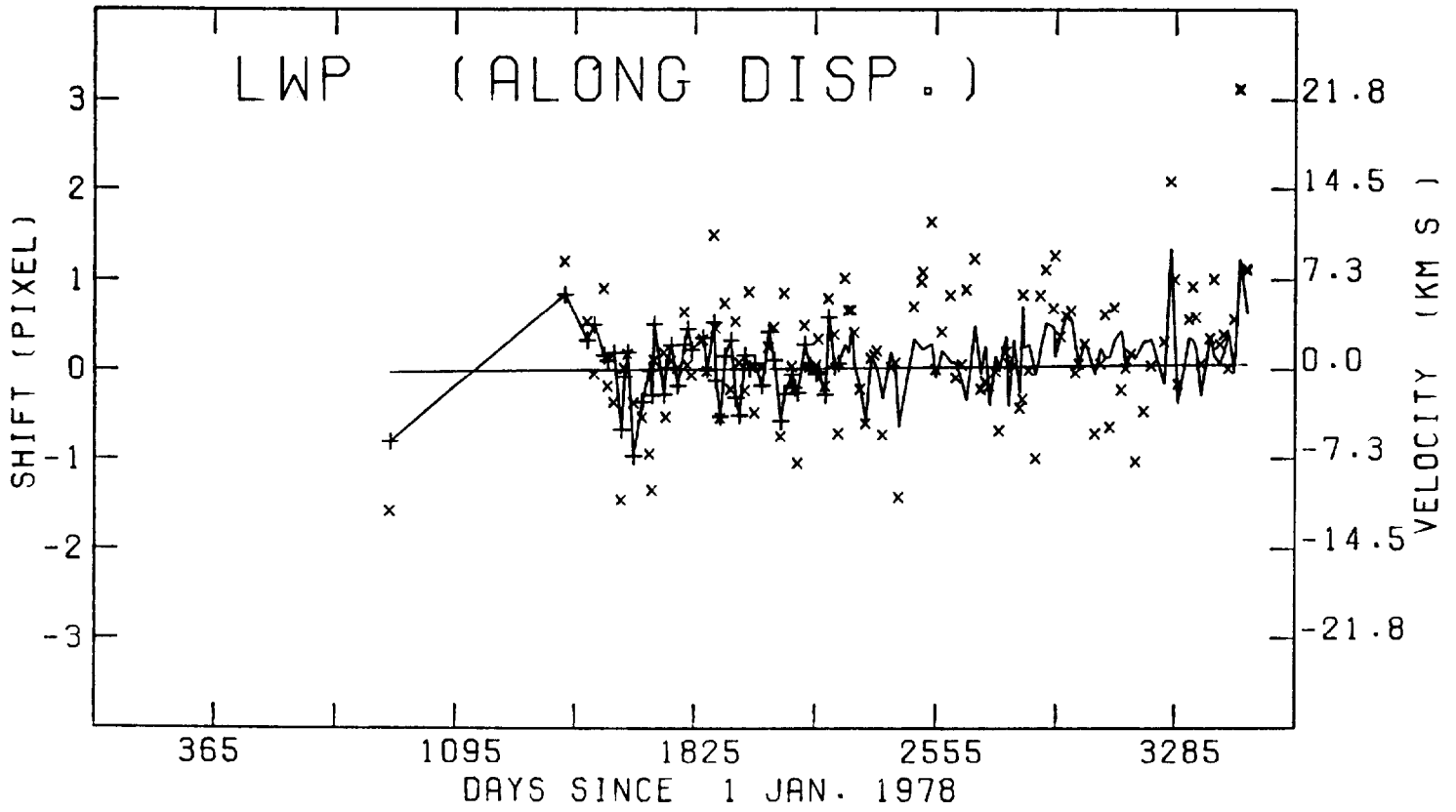


Figure 5

Old High Dispersion

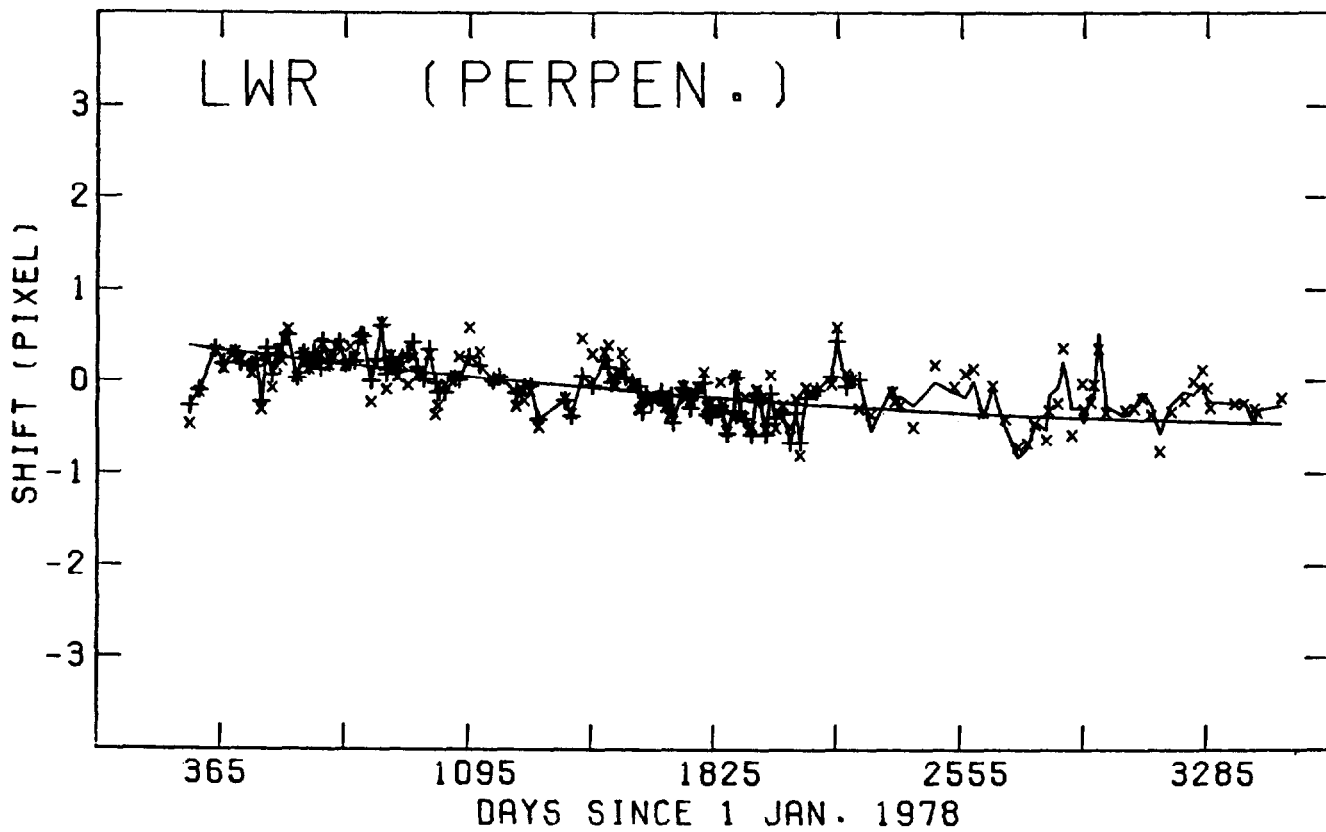
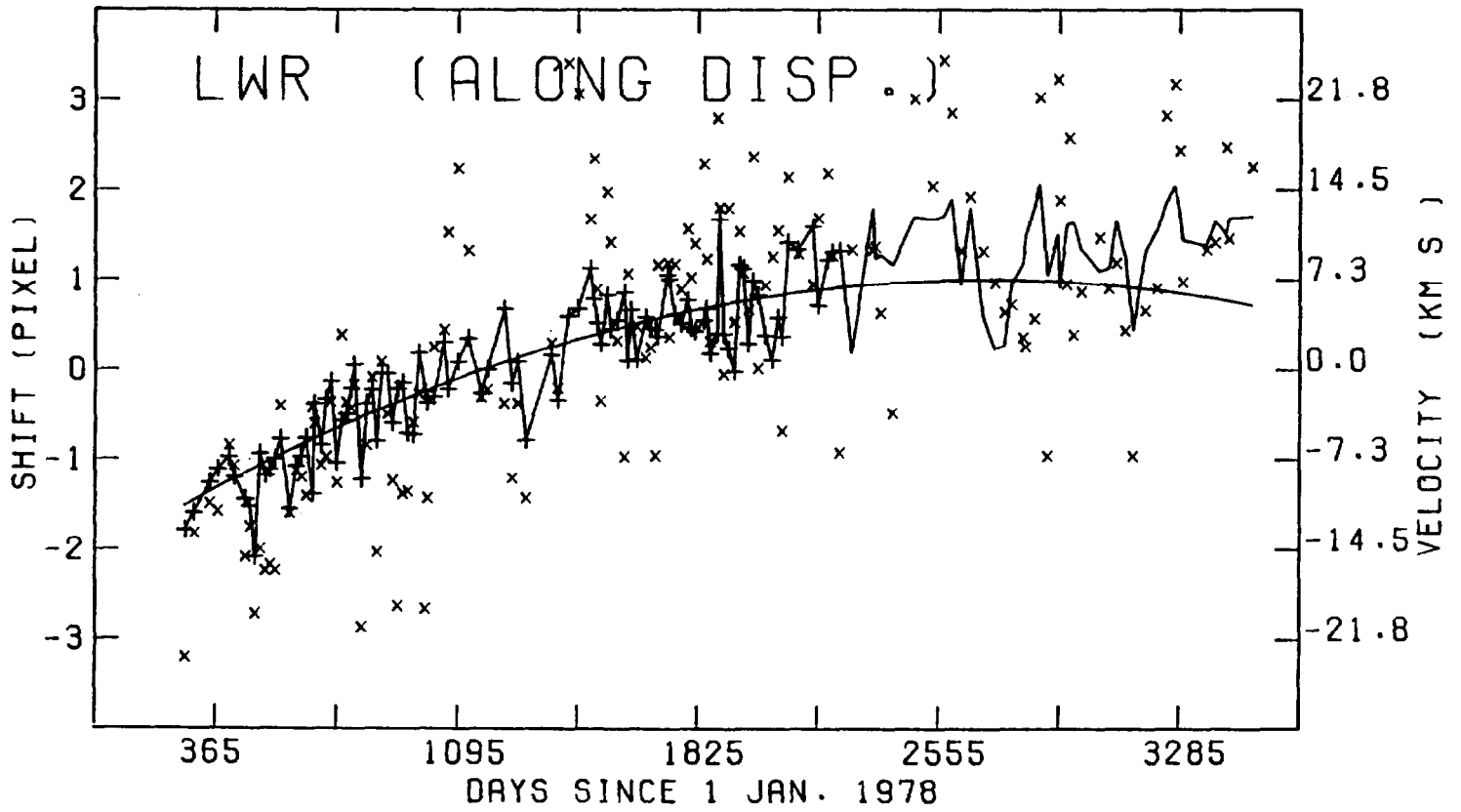


Figure 6

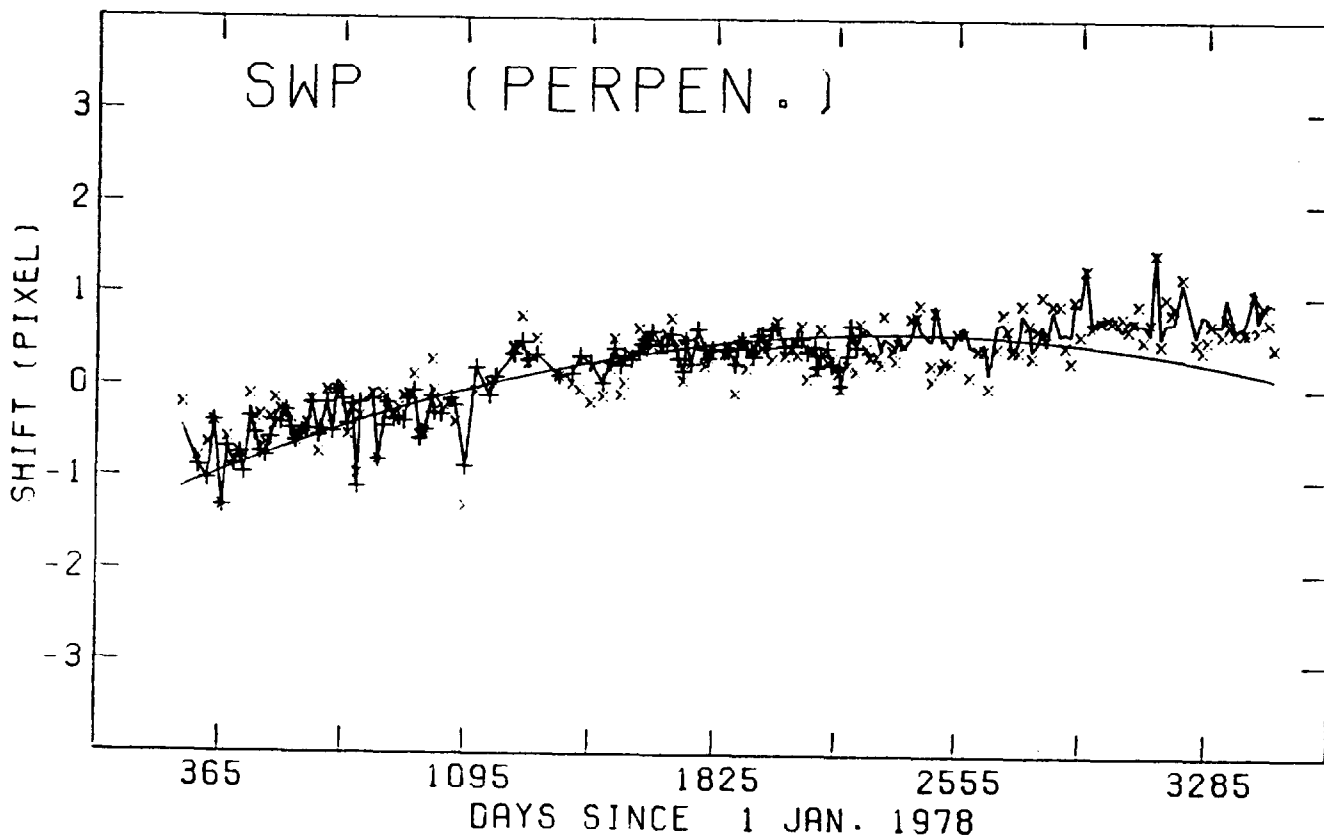
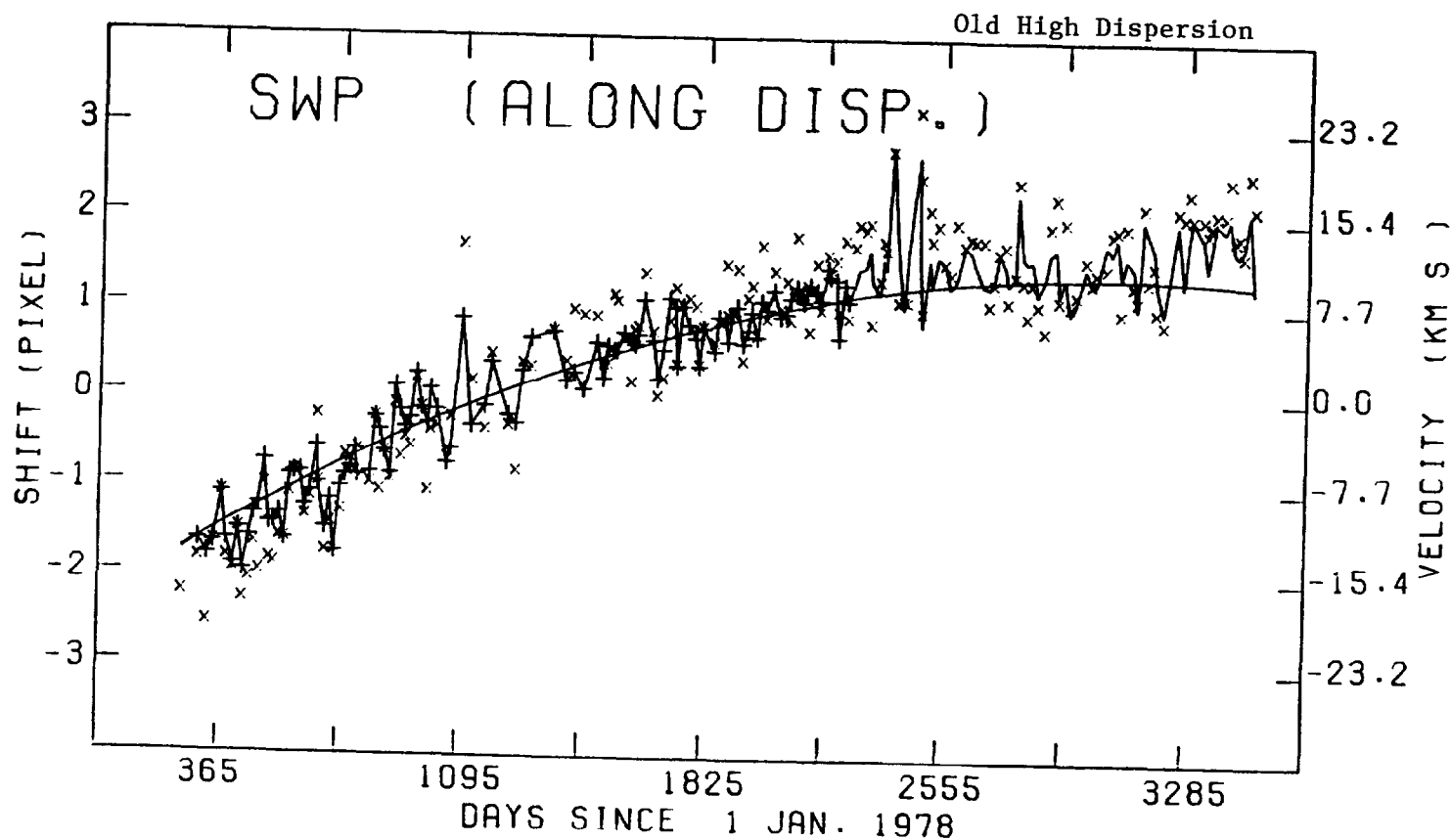


Figure 7

New Low Dispersion

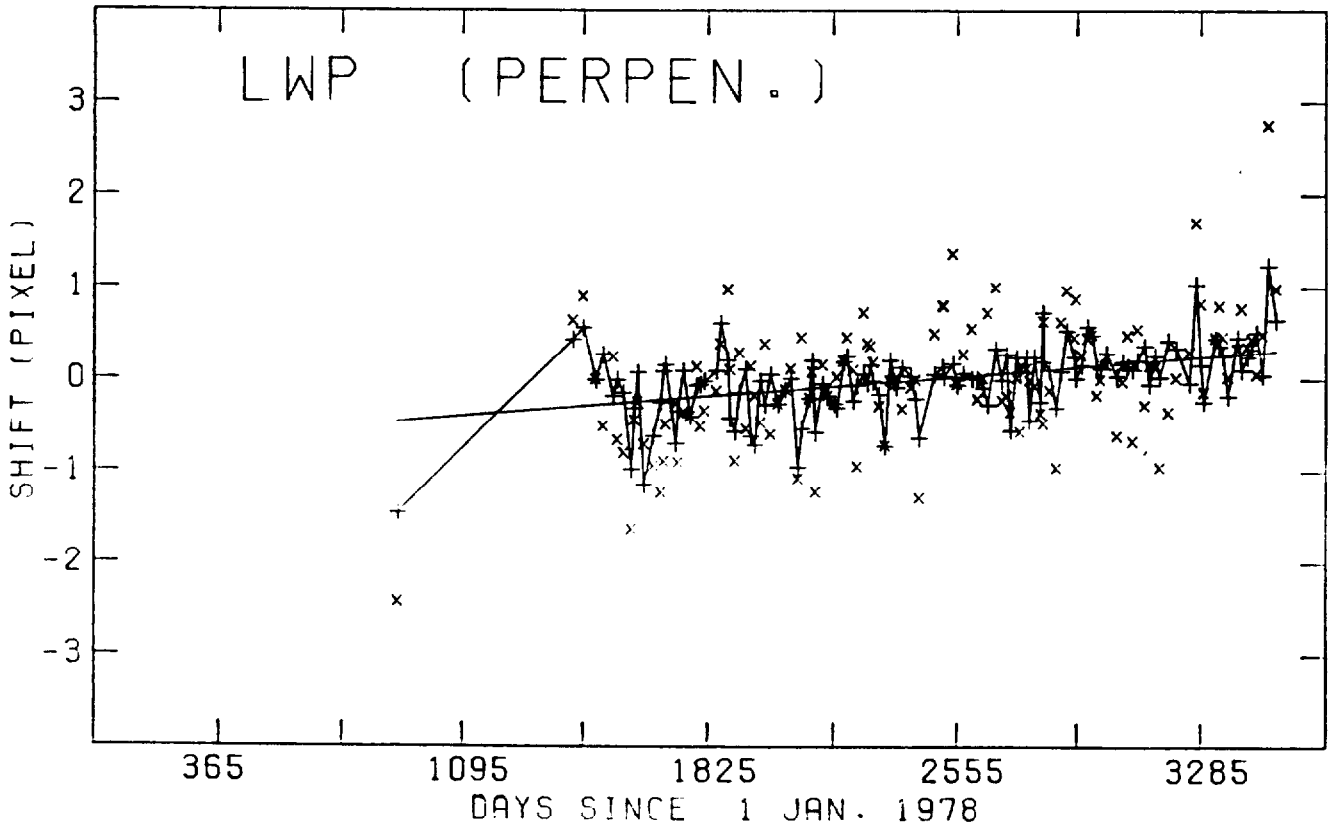
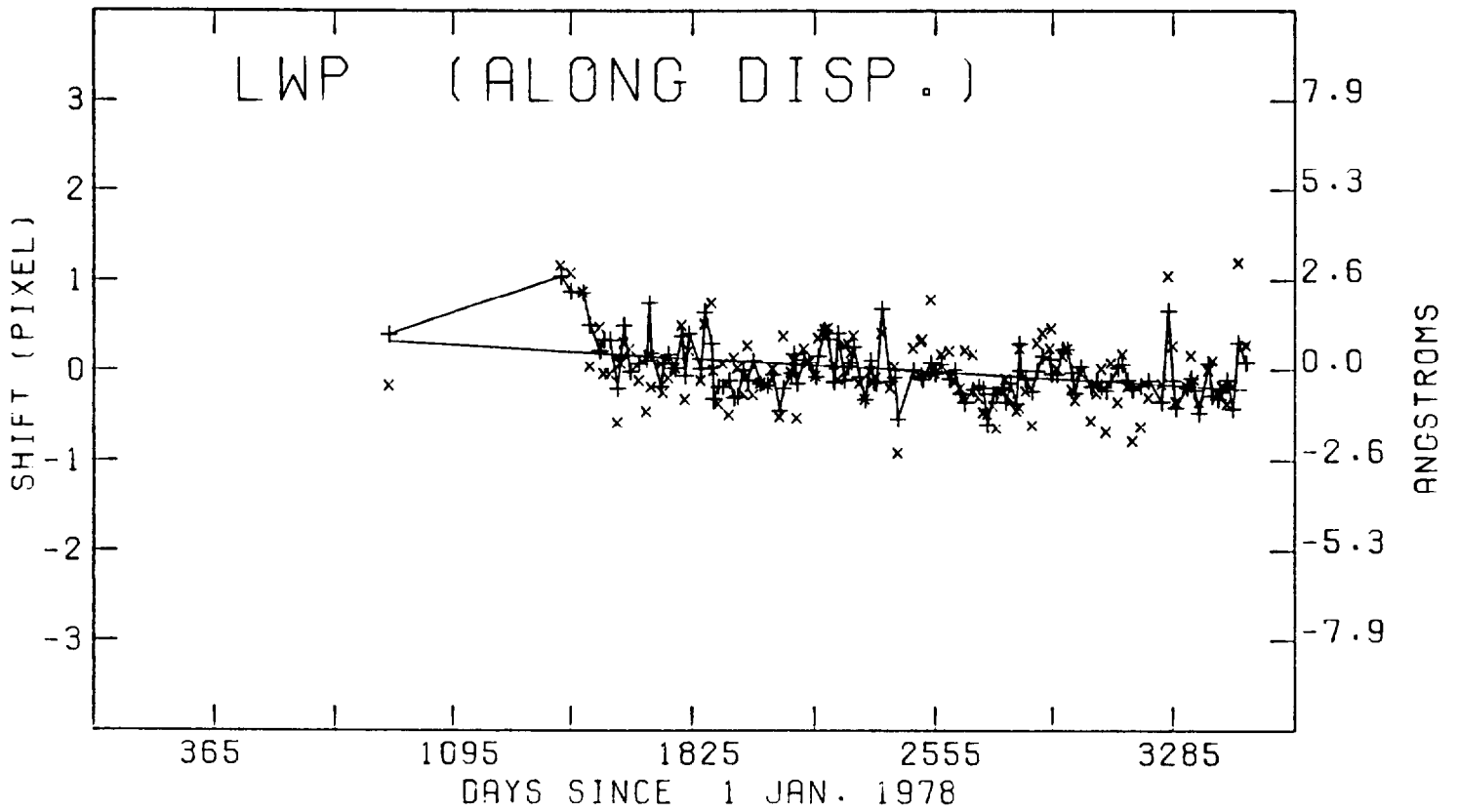


Figure 8

New Low Dispersion

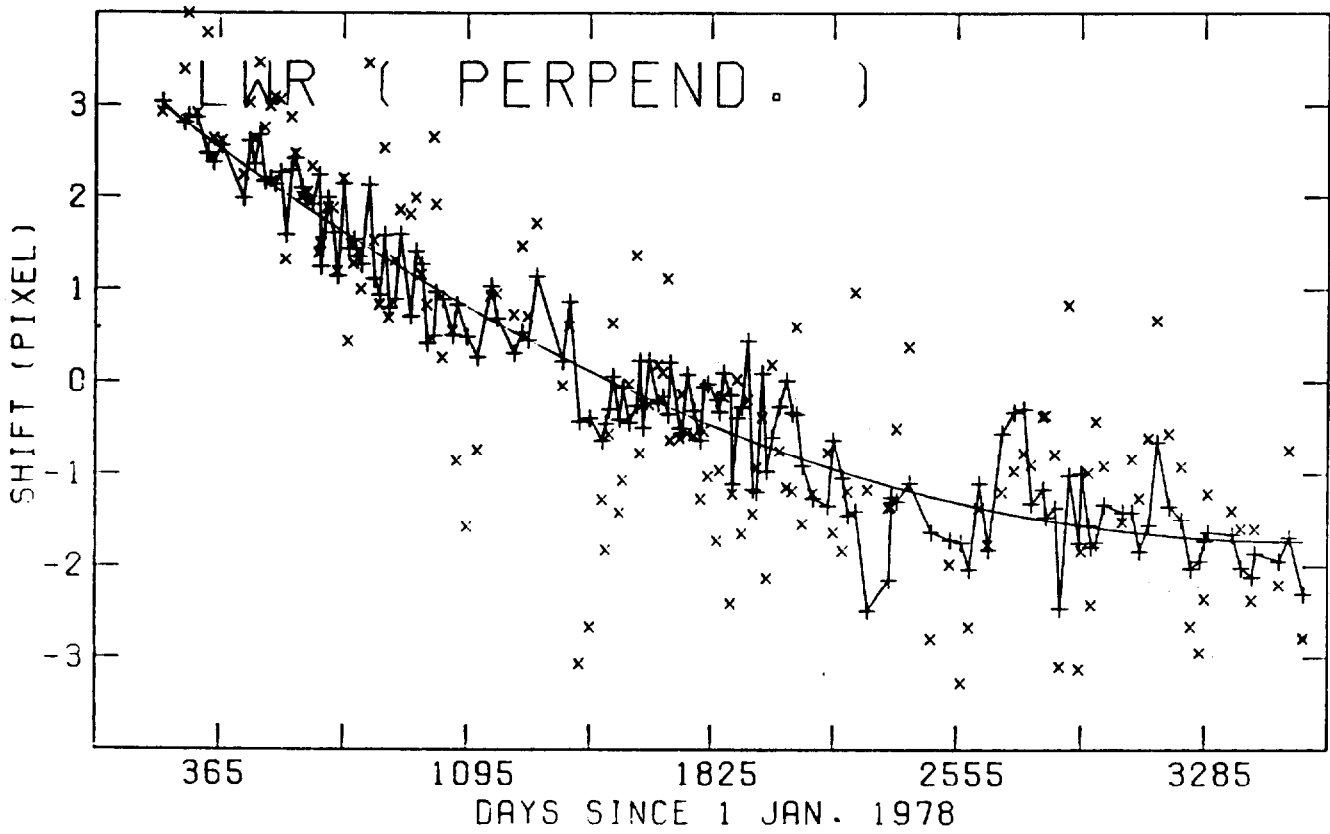
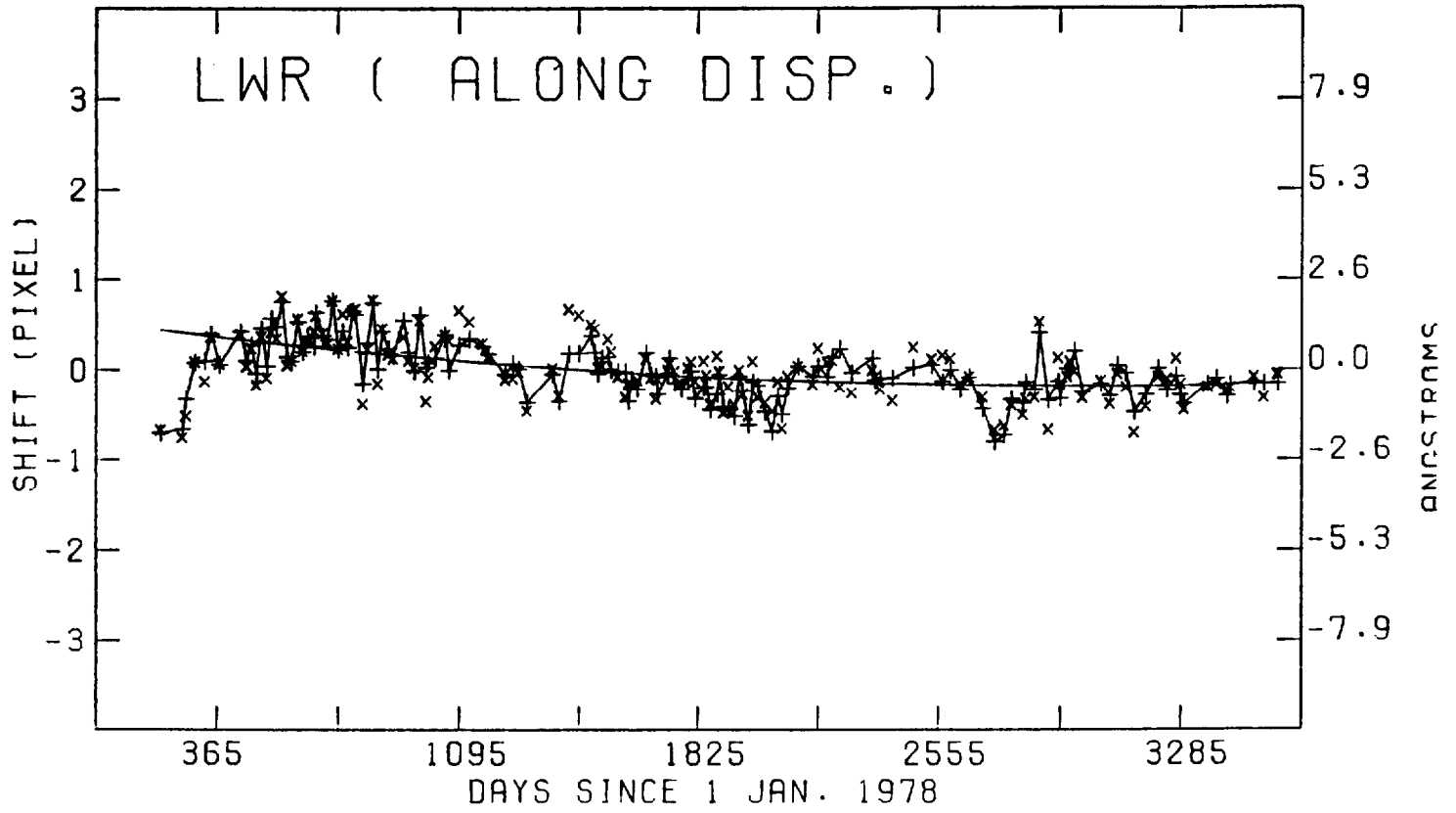


Figure 9

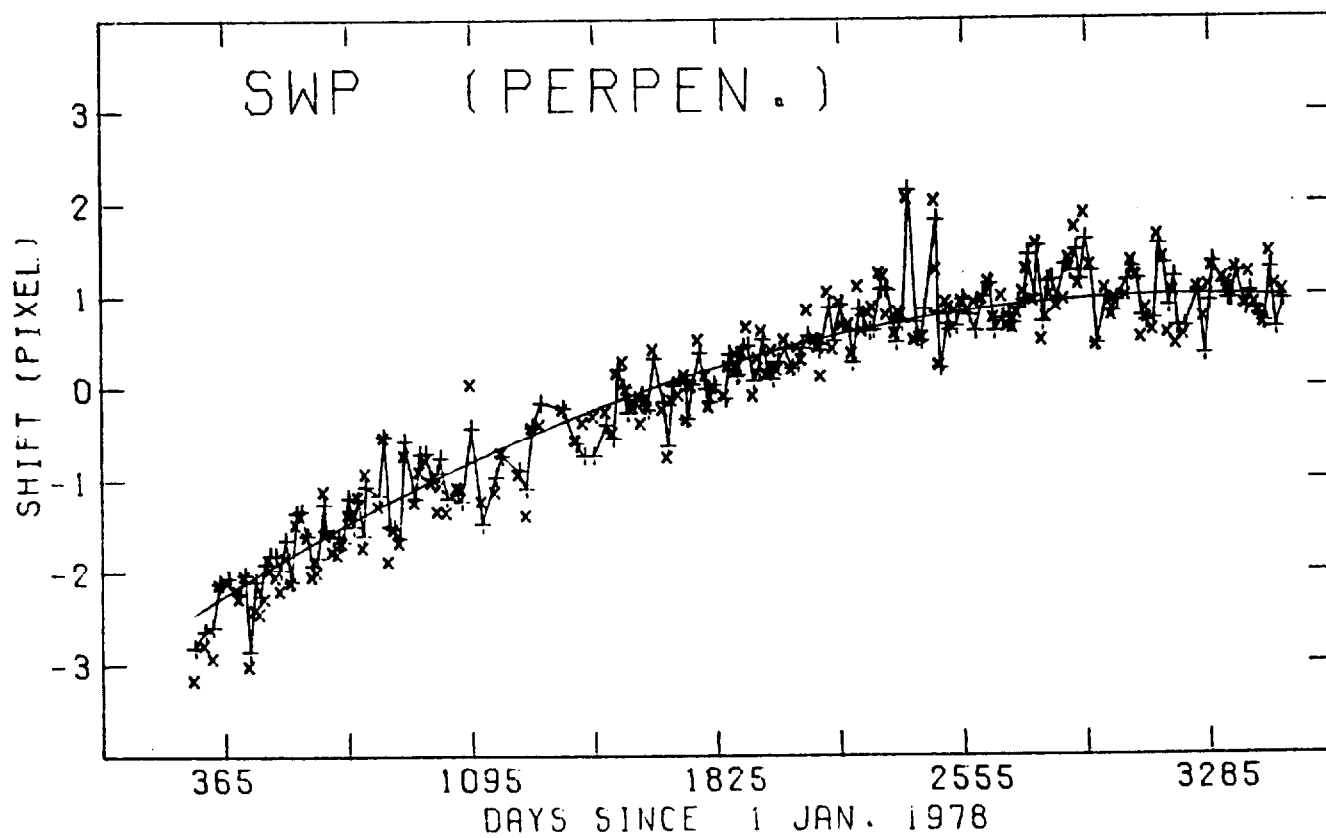
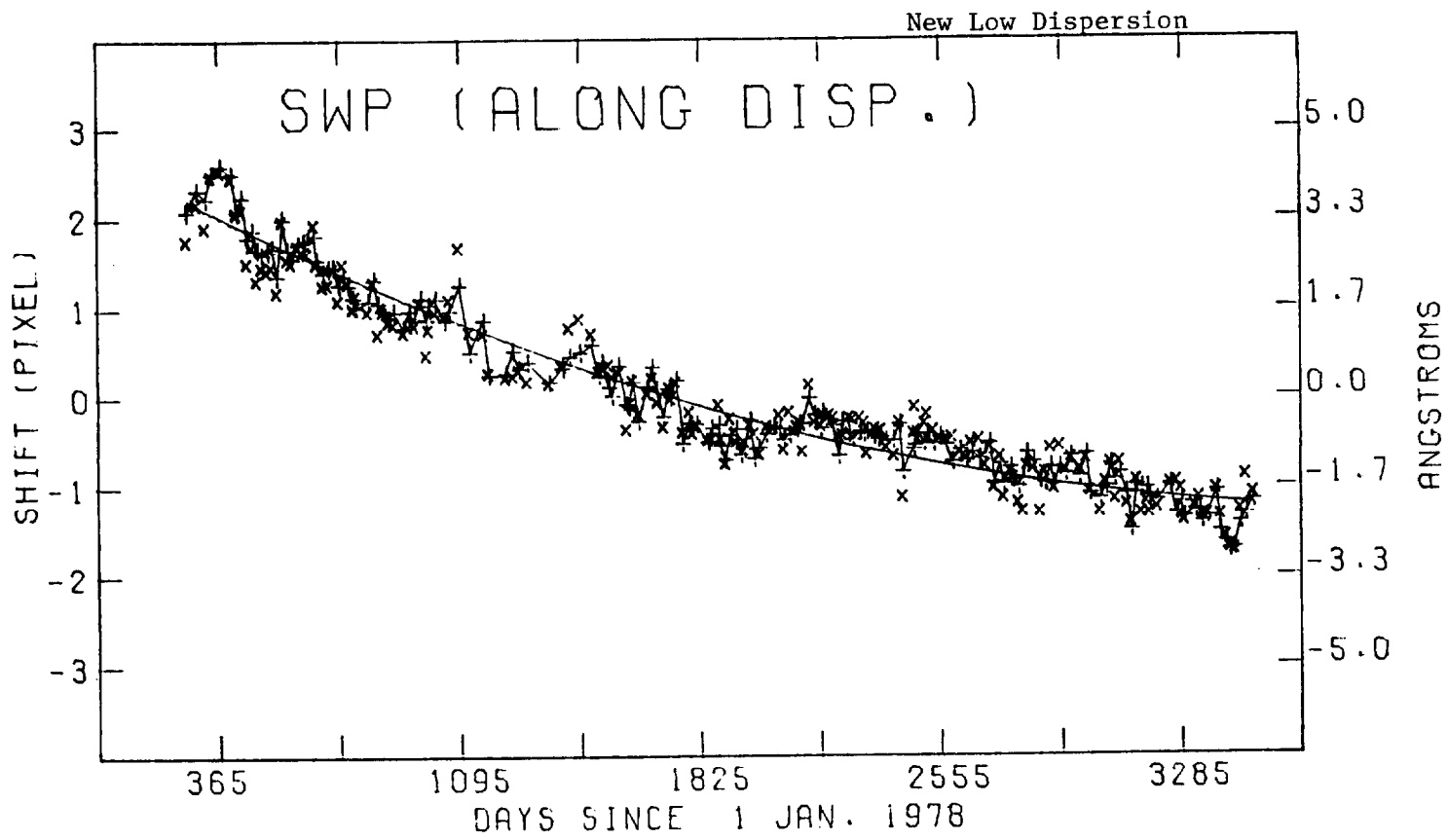


Figure 10

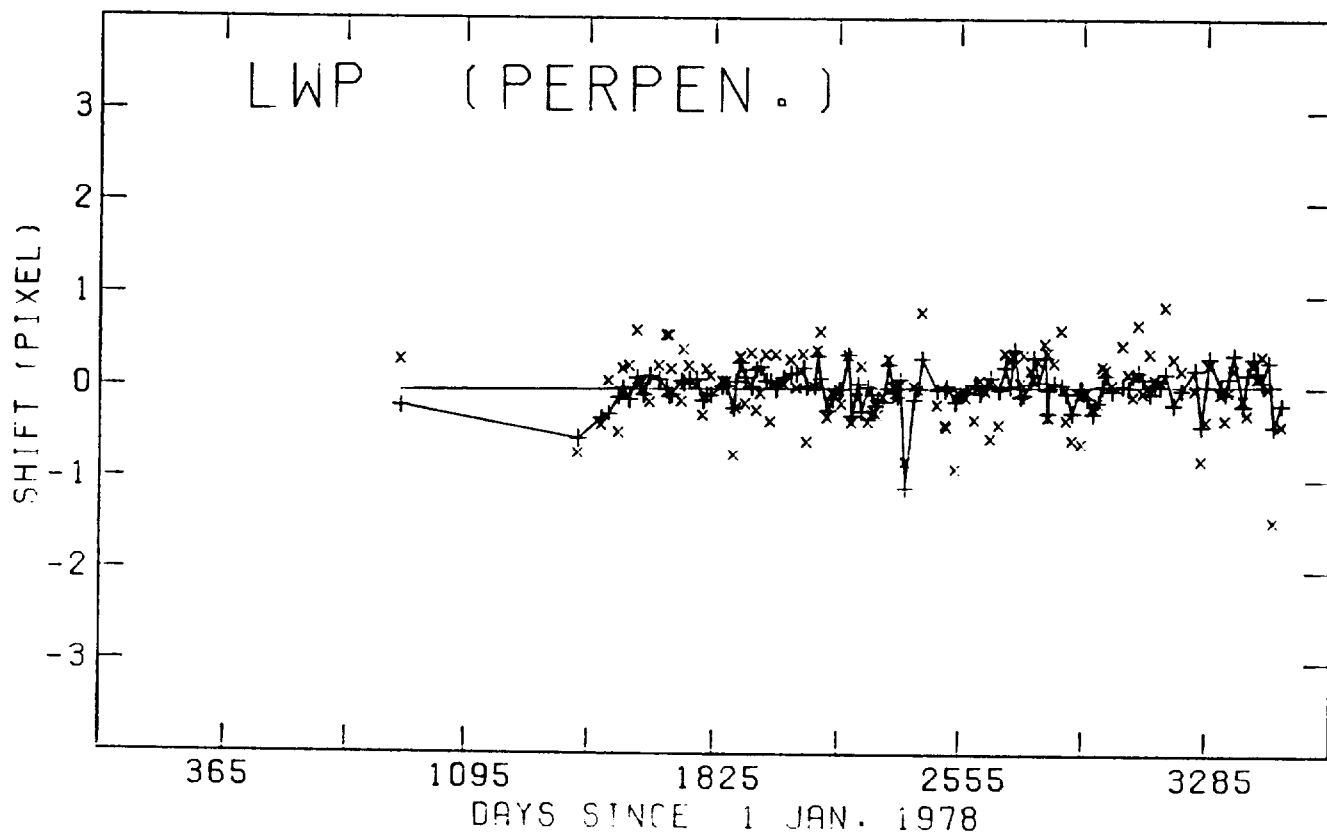
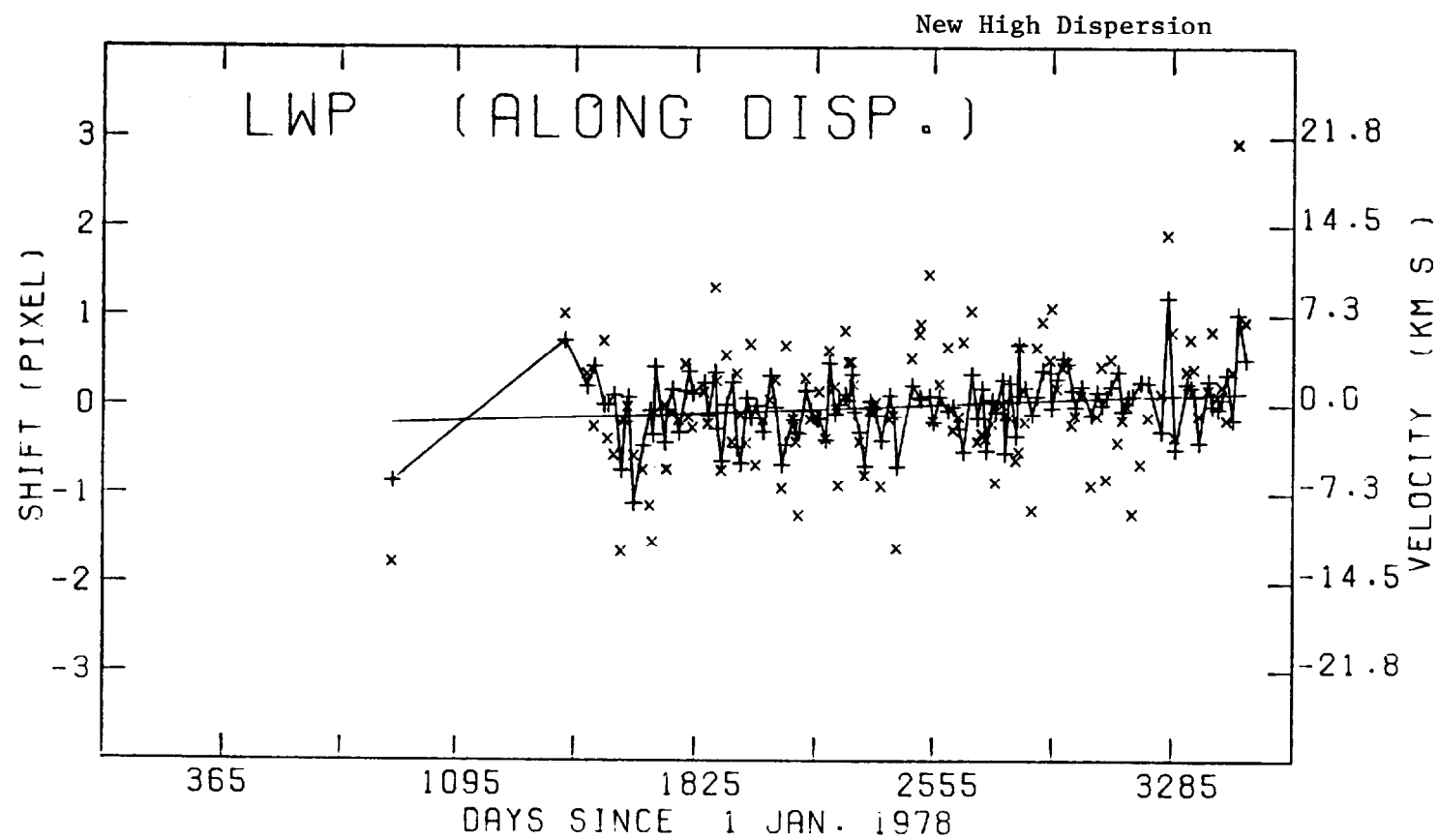


Figure 11

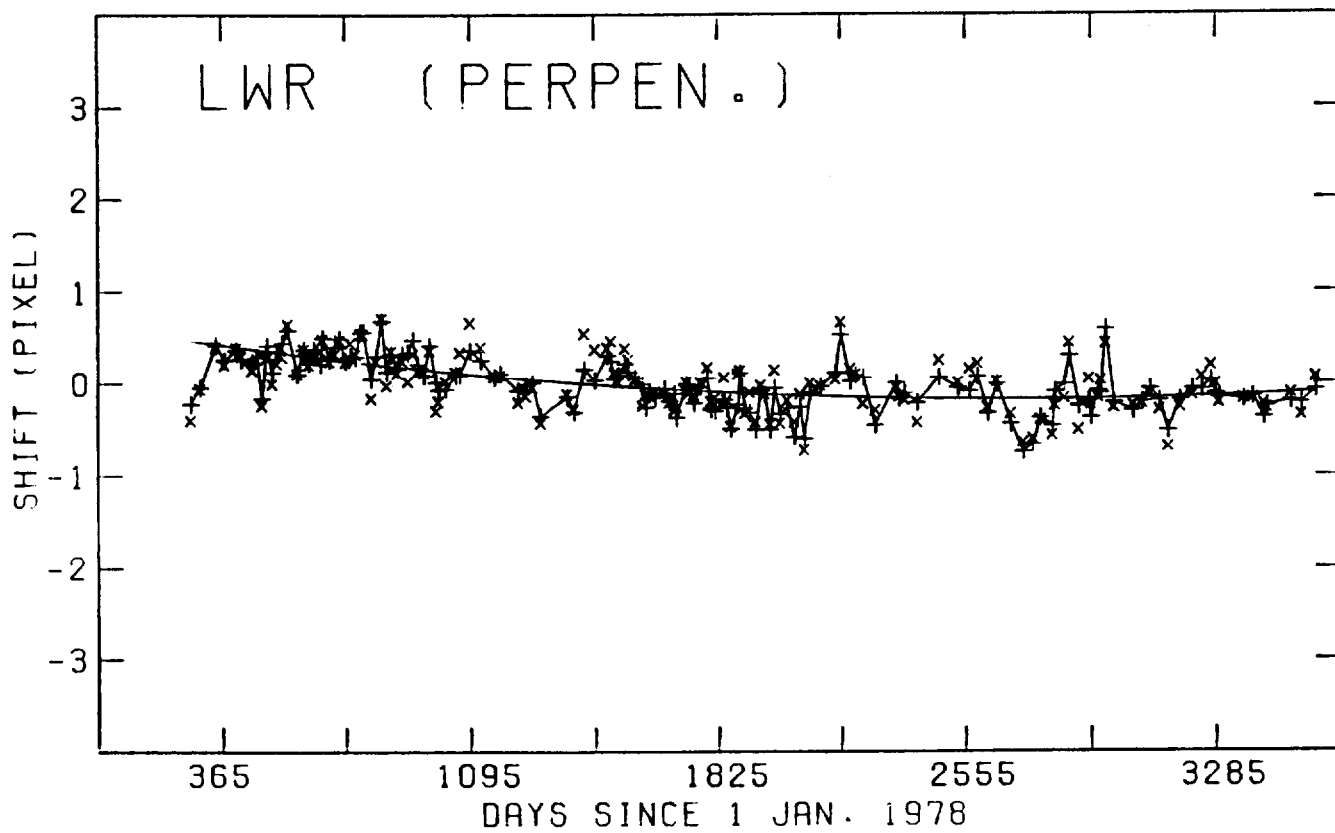
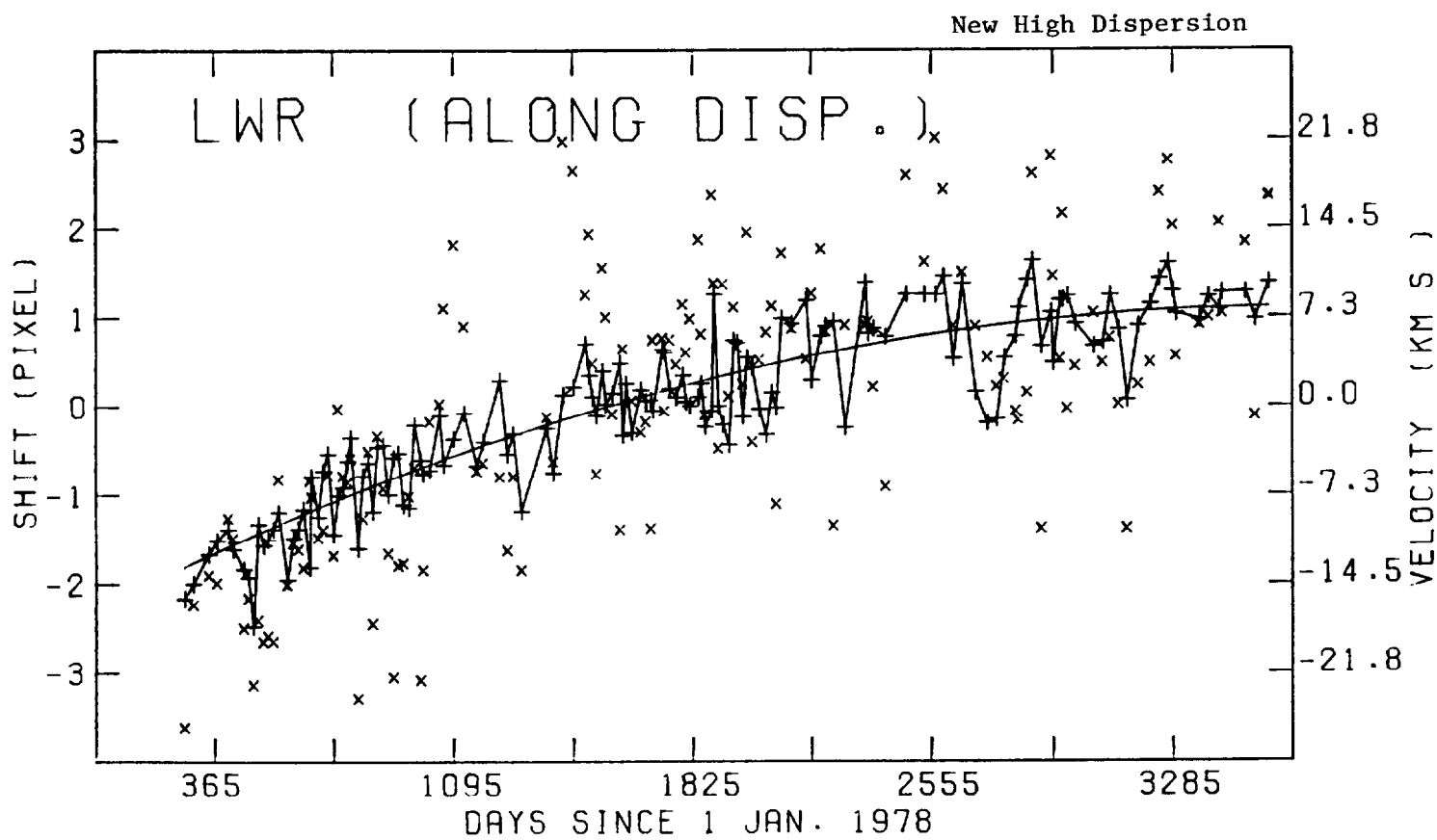


Figure 12

New High Dispersion

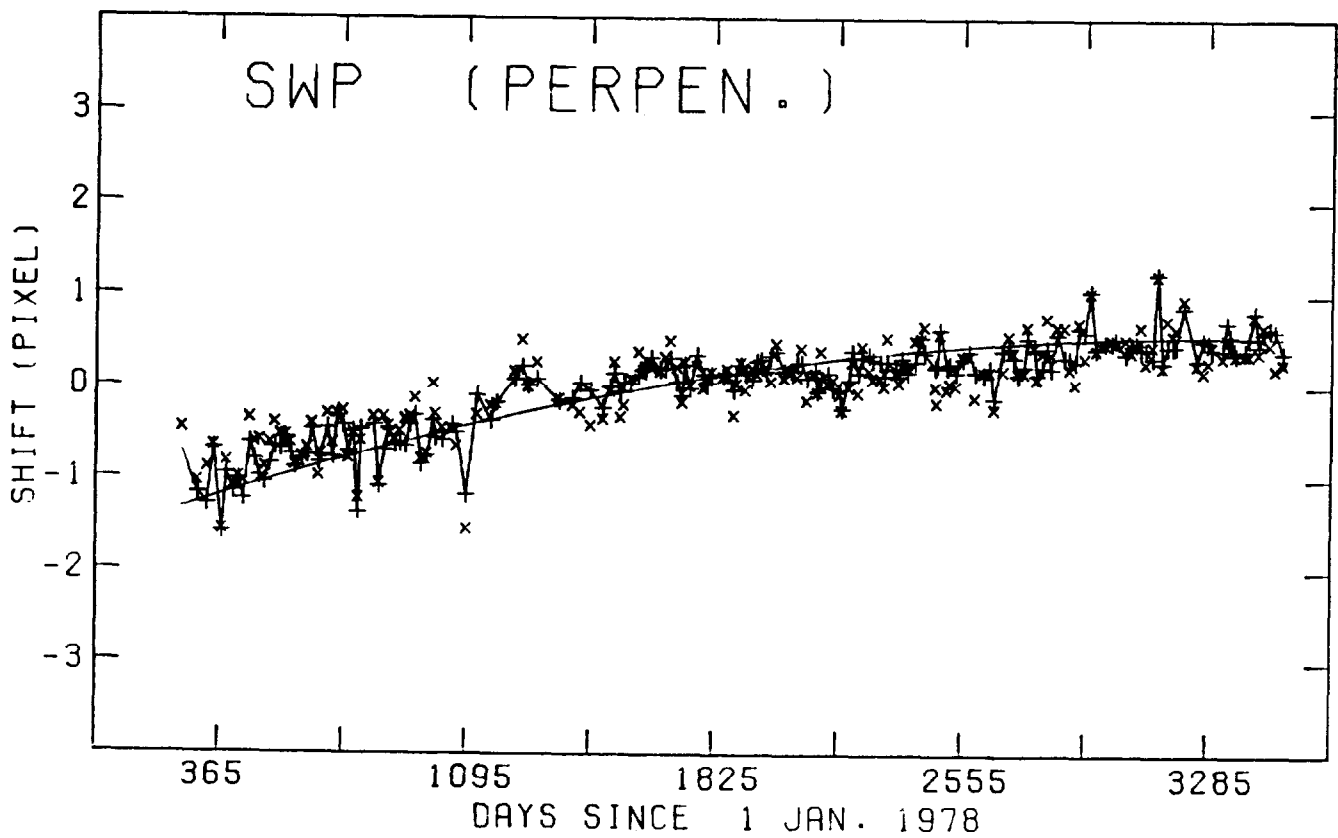
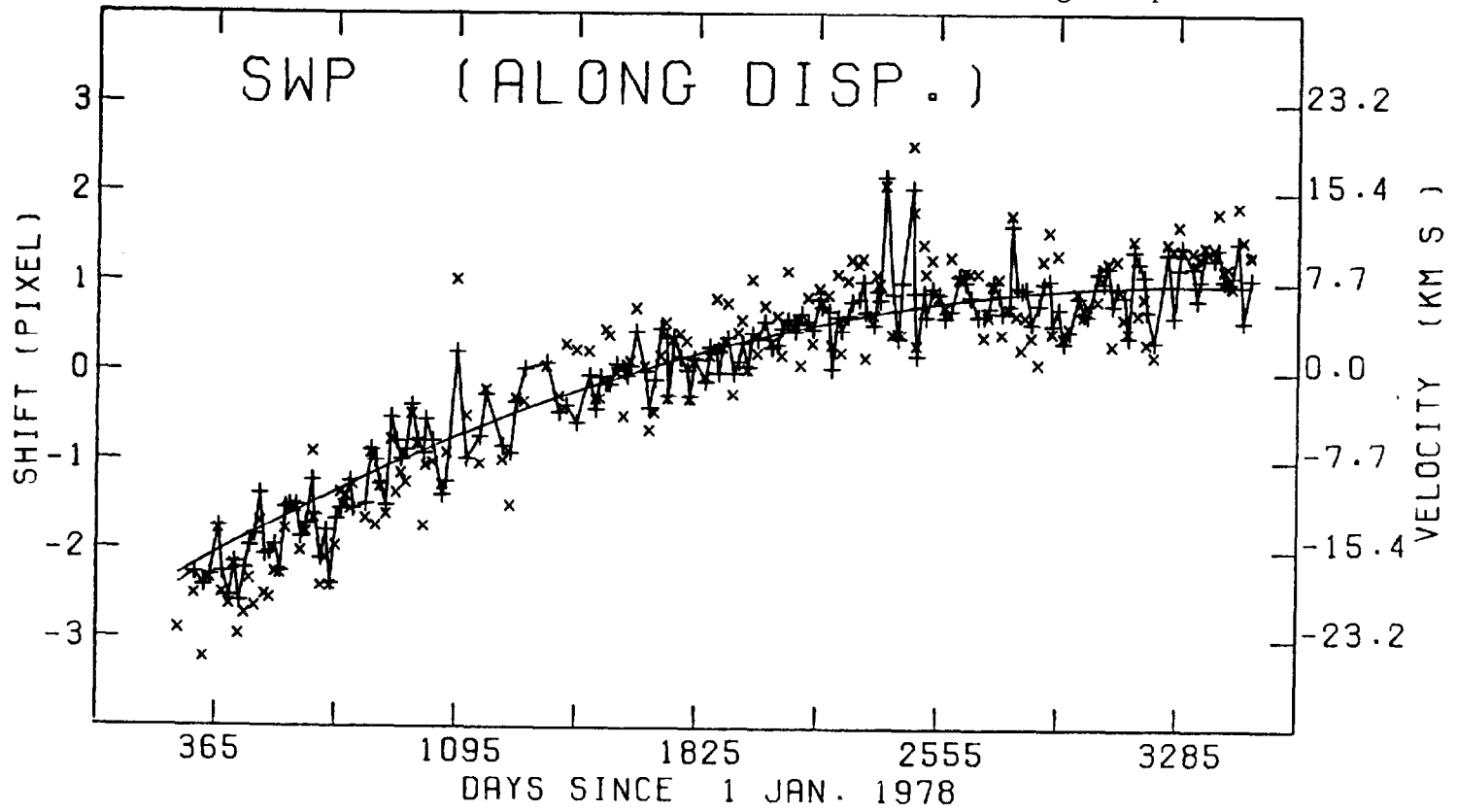
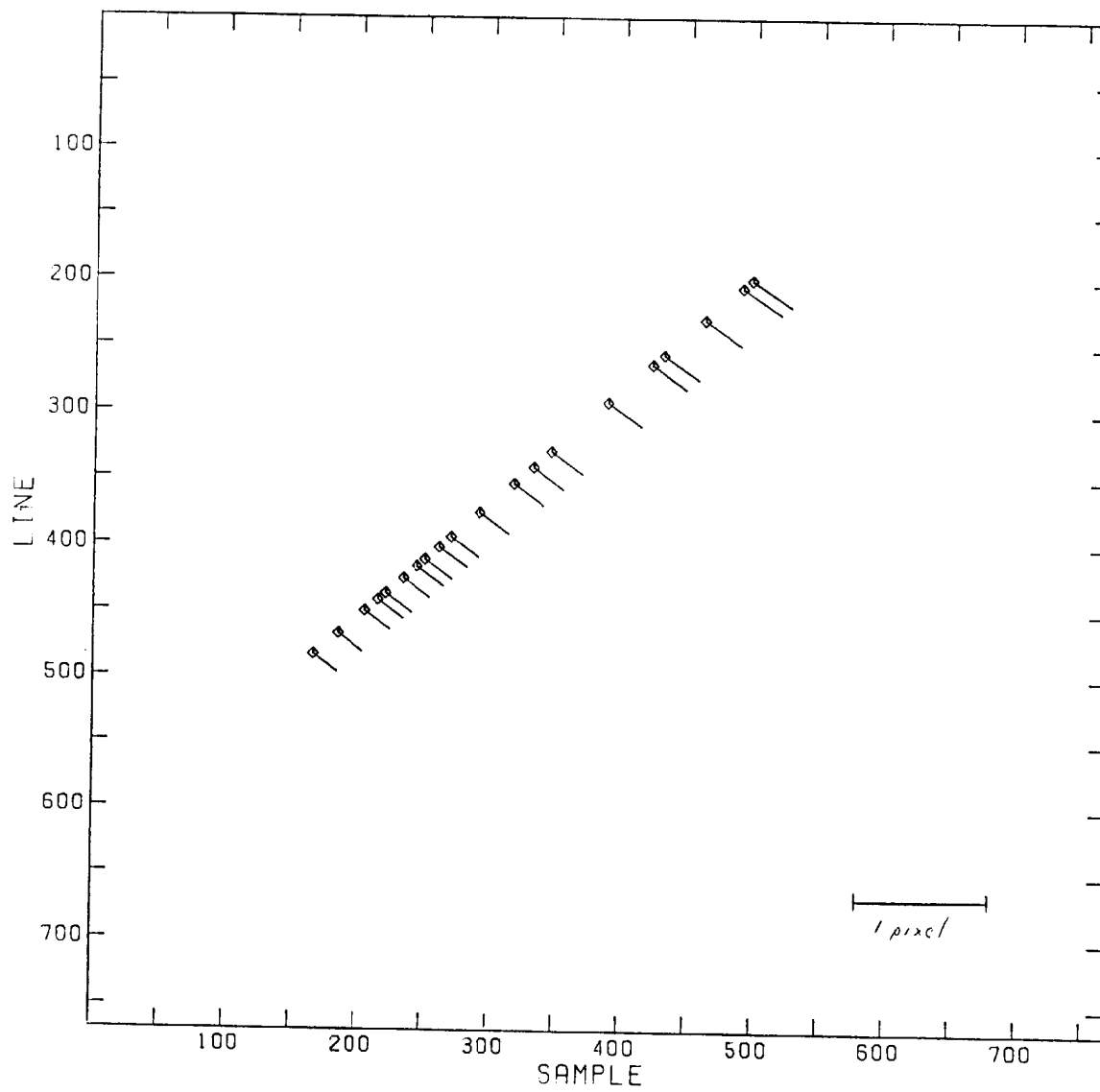


Figure 13



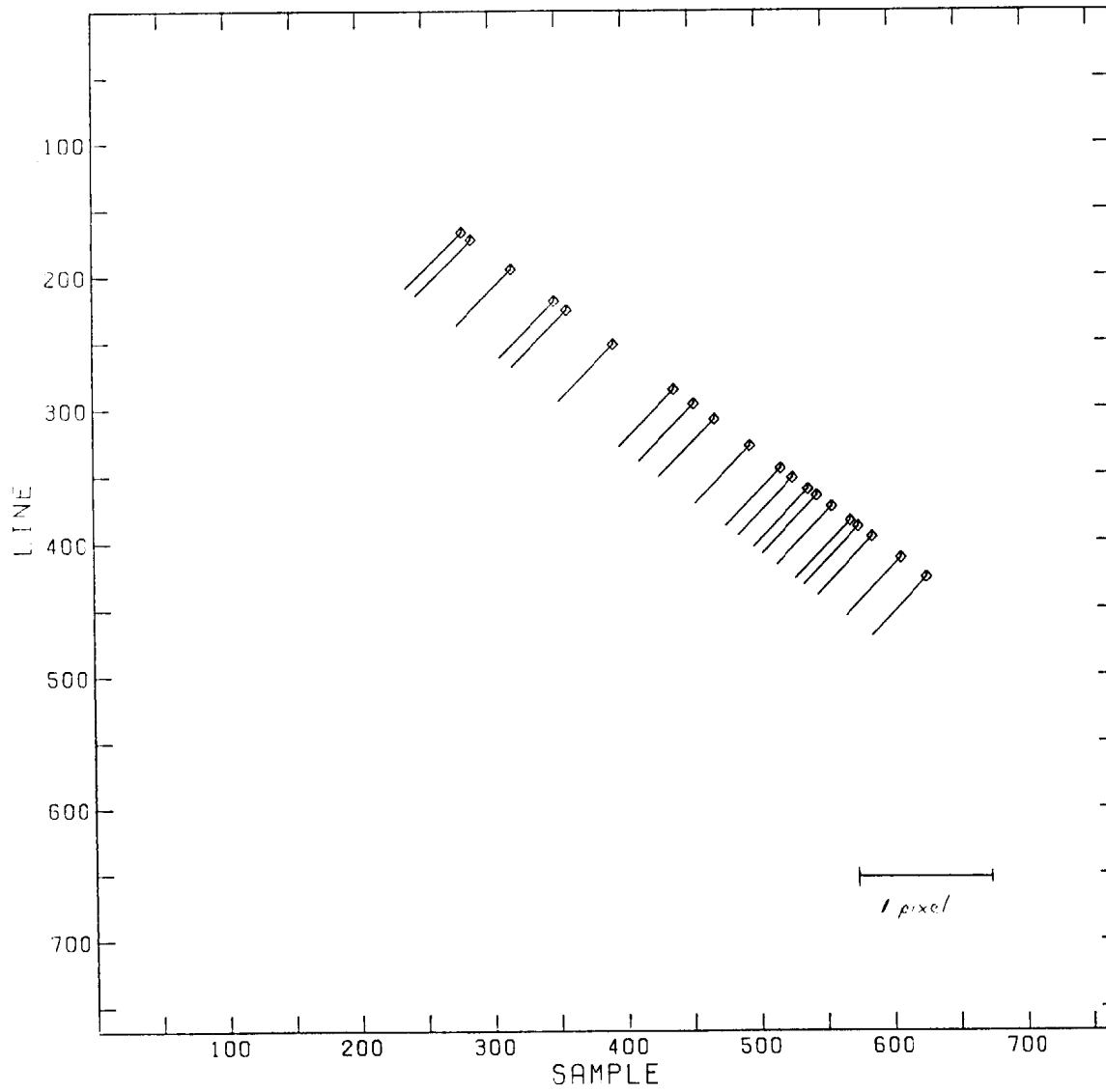
Low Dispersion

LWP CAMERA

MEAN

14:57 JAN 15, '88

Figure 14



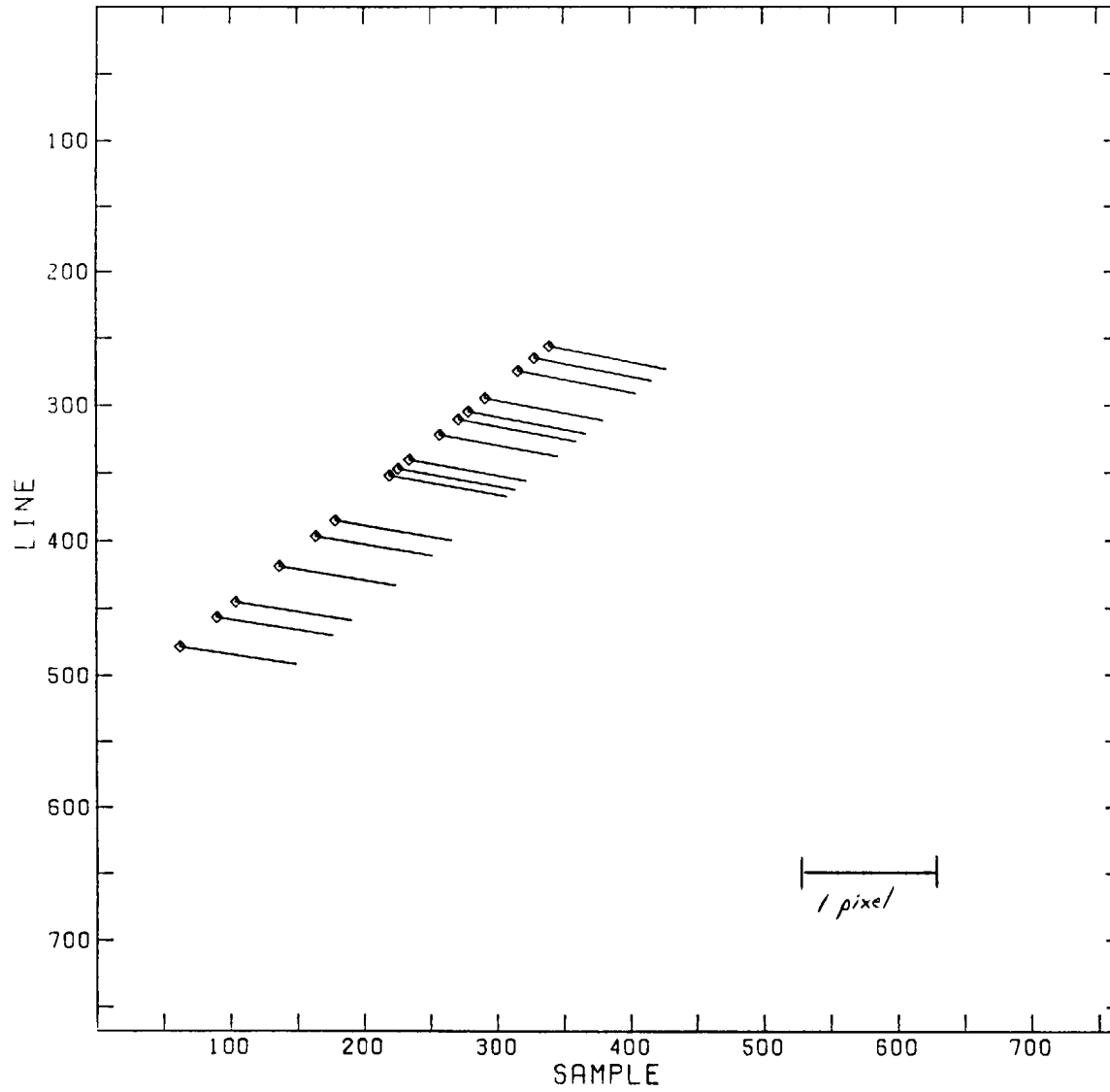
Low Dispersion

LWR CAMERA

MEAN

19:10 DEC 22 '87

Figure 15



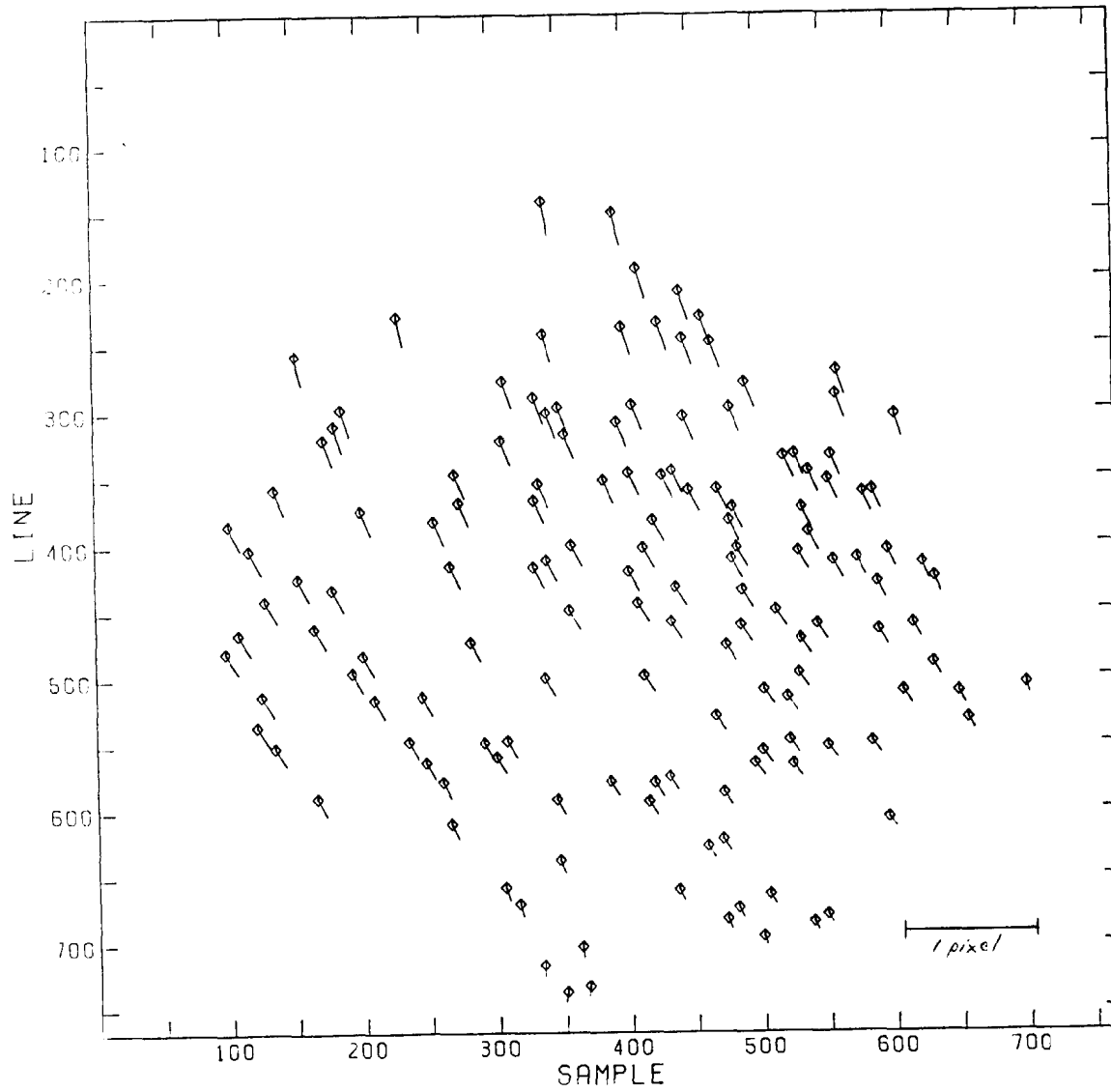
Low Dispersion

SWP CAMERA

MEAN

18:56 DEC 22, '87

Figure 16



130

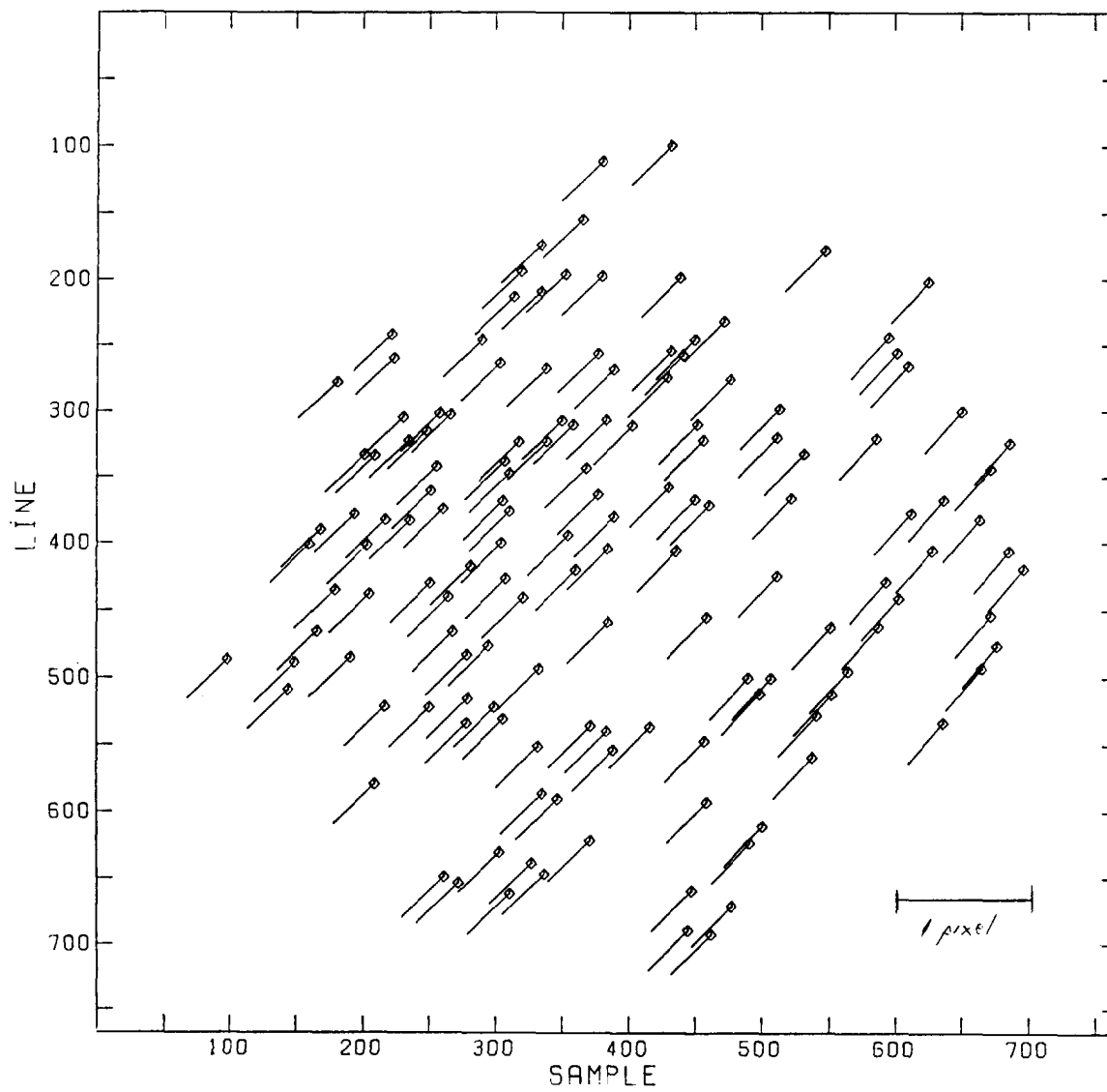
High Dispersion

LWP CAMERA

MEAN

15:31 JAN 15 '88

Figure 17



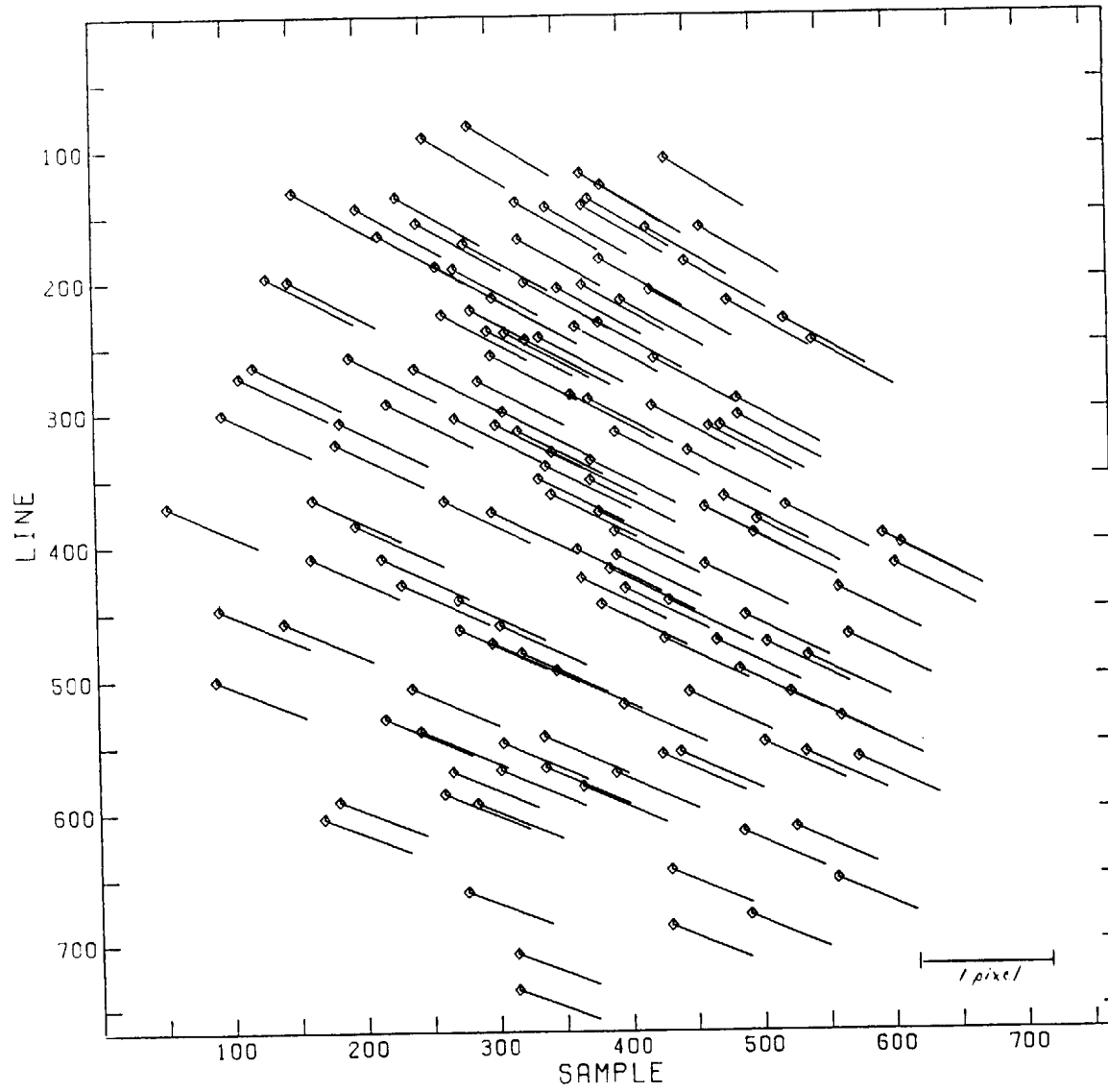
High Dispersion

LWR CAMERA

MEAN

19:04 DEC 22 '87

Figure 18



High Dispersion

SWP CAMERA

MEAN

18:51 DEC 22, '87