University of Washington
VISUAL TECHNIQUES LABORATORY
OPERATIONS NOTE

ON –	150
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page	1 of 16
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rev. date	

subject May 13 Frosh Pond Chirp Test

To: Dumand File
From: B. Egaas
Subj: May 13 Frosh Pond Chirp Test
Date: 8 July 1991

This test was the followup to the in-air tests of 9 May 1991. The same analog chirping circuit and Gespac data logging system was used. The only difference was that this experiment was done using transducers in water instead of speakers in air. Because the speed of sound is about 4 times faster in water than in air, we expected the results to be 4 times worse, with range residues on the order of 10 cm. We also expected severe multipath problems.

Roger Lord, Ken Young, and I conducted the test in Frosh Pond on 13 May. The fountain was on, providing an additional noise source. We took data at five distance around the pond, chirping at one transducer and logging data at the other (see Fig. 1, next page). Datafiles are listed in the laboratory notebook.

The signal output of the power amp appeared degraded. Figures 2 and 3 show the received pulse at 0.1, 2.3, and 52.7 m. Note the received signal is barely above quantization noise at longer ranges. The signal was far below the levels we found in our February single frequency pond test. Roger had replaced the output transistors before, and it seemed they needed replacing again.

Despite this problem, we calculated correlations with a replica taken from the transmitting transducer terminals. As with the in-air tests, jitter from the chirping circuit showed up when more than one file was taken at a given distance. Table 1 shows Ken Young's Quattro analysis, this time showing residues of as much as 22 cm. Fig. 4 shows the calculated delay vs. actual separation. A best fit line gives a speed of sound of 1445 m/s, a value which is reasonable.

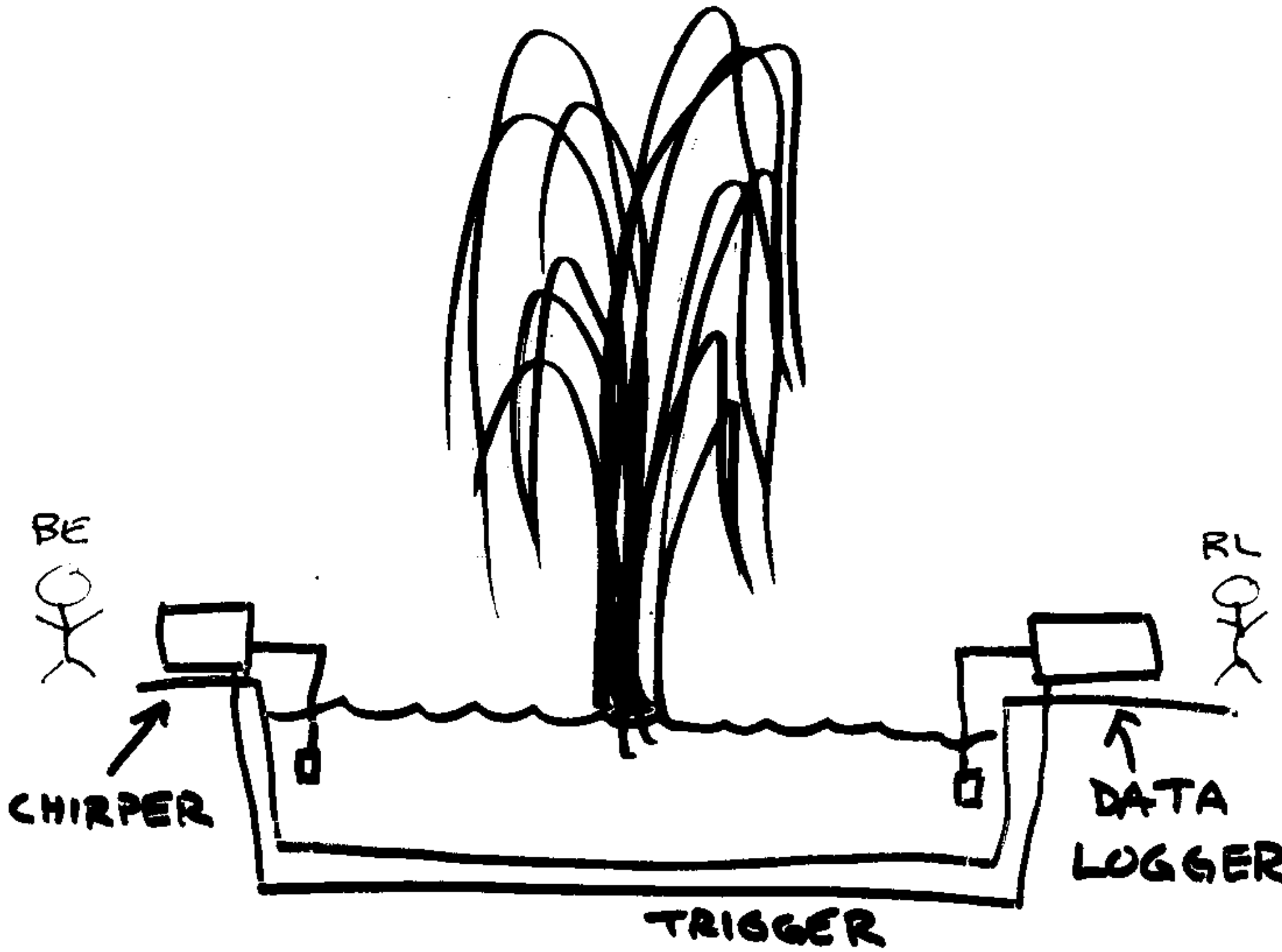
The remaining plots show the correlations for all the received signals, again computed in Matlab. In particular, the first data taken at 13.8 m shows a nice multipath characteristic.

Conclusion

The chirping worked in water, but low source level and jitter problems degraded performance. The range resolution is approximately 20 cm in the worst case.

FROSHCHP.DOC

FROSH POND CHIRPING RESULTS



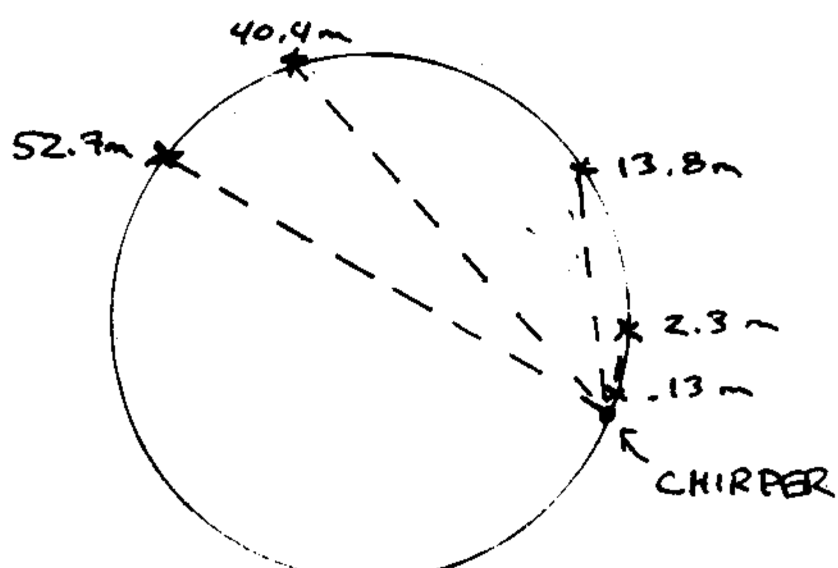
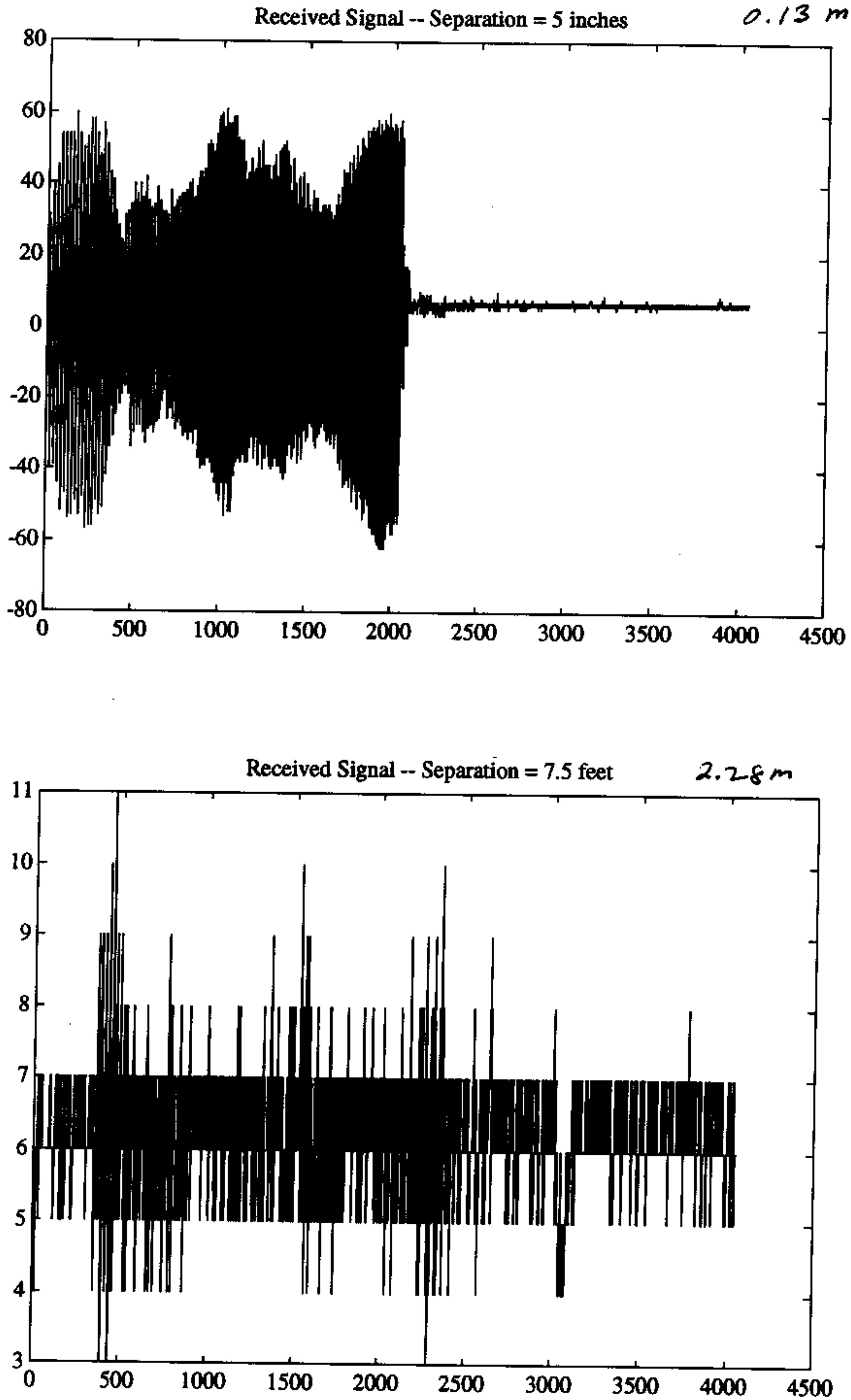


Fig. 1



Received Signal -- Separation = 5 inches
0.13 m
80
60
40
20
0
-20
-40
-60
-80
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Received Signal -- Separation = 7.5 feet
2.28 m
11
10
9
8
7
6
5
4
3
0
500
1000
1500
2000
2500
3000
3500
4000
4500

Fig. 2

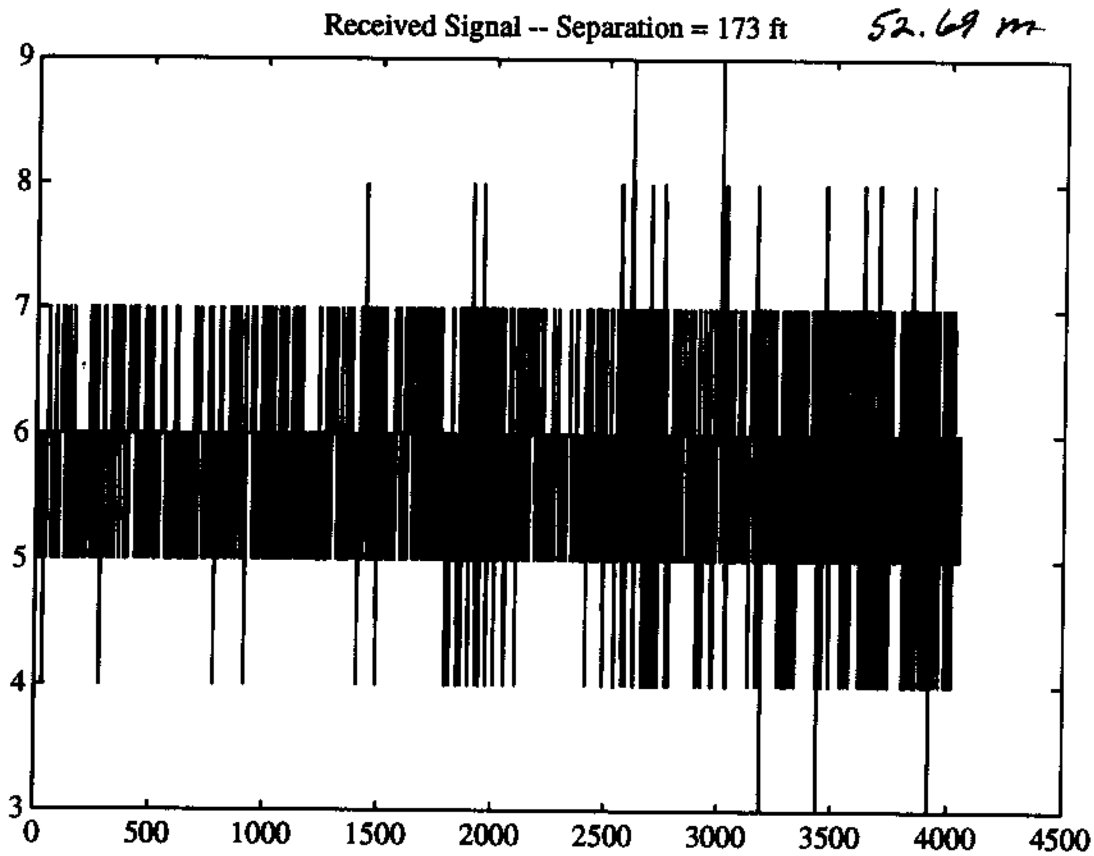

Received Signal -- Separation = 173 ft
52.69 m
9
8
7
6
5
4
3
0
500
1000
1500
2000
2500
3000
3500
4000
4500

Fig. 3

Data from 13 May/91

Chirps in pond with fountain running.

and convolution to determine time.

distance	time(ct)	time(sec)	
0.13	33	0.000165	-0.066
2.28	370	0.00185	0.219588
13.81	1925	0.009625	-0.07203
13.81	1922	0.00961	-0.09371
40.36	5606	0.02803	-0.0185
40.36	5599	0.027995	-0.06909
52.69	7323	0.036615	0.060705
52.69	7320	0.0366	0.039023

Regression Output:all		
Constant		-0.1745
Std Err of Y Est		0.113186
R Squared		0.999977
No. of Observations		8
Degrees of Freedom		6
X Coefficient(s)	1445.451	
Std Err of Coef.	2.82335	0.001938

Note that time for 40.36 m point is from first peak (smaller)

Now the fit is good. The error is .2% which is about right!!

Regression Output:last 2		
Constant		0.174984
Std Err of Y Est		0.027313
R Squared		0.99999
No. of Observations		4
Degrees of Freedom		2
X Coefficient(s)	1434.541	
Std Err of Coef.	3.17776	

The last two distances now give a decent velocity!!

Table 1

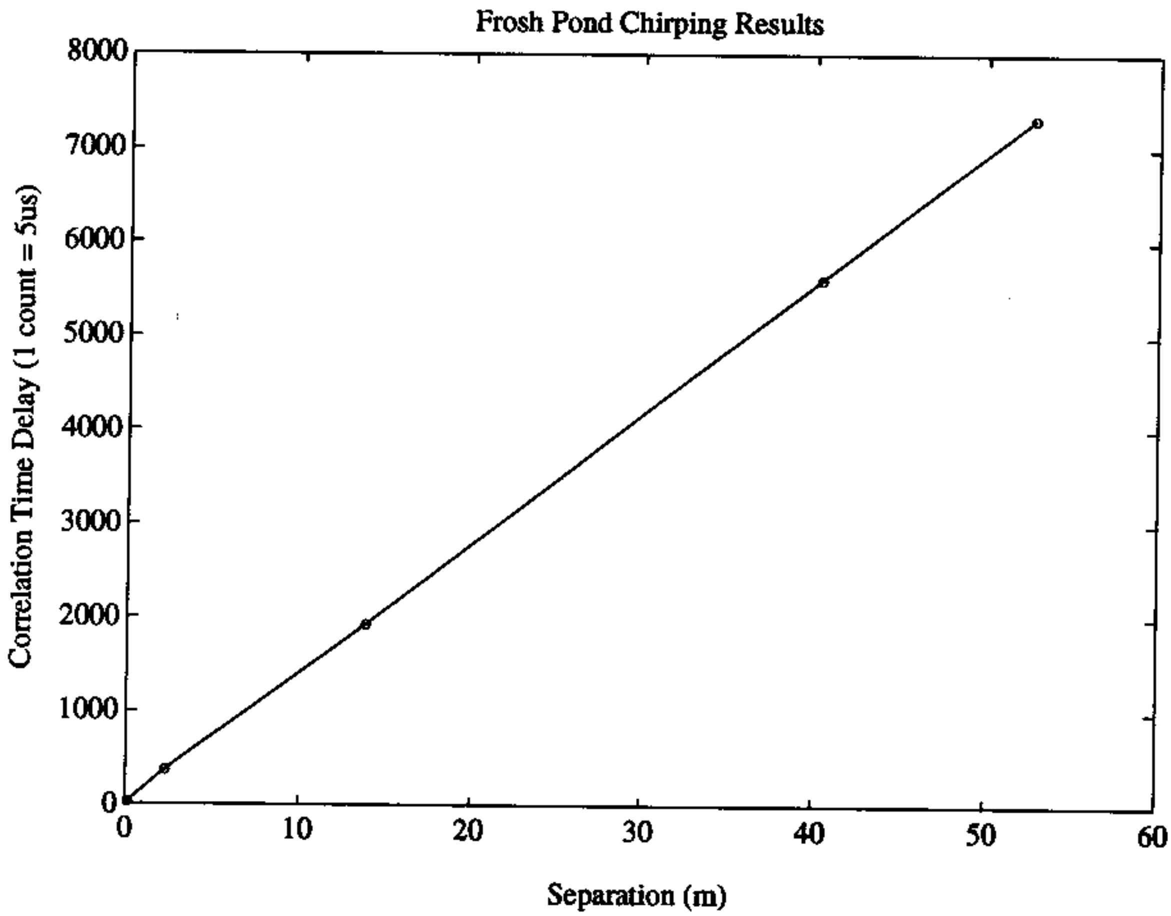

Frosh Pond Chirping Results
8000
7000
6000
5000
4000
3000
2000
1000
0
Correlation Time Delay (1 count = 5us)
0
10
20
30
40
50
60
Separation (m)

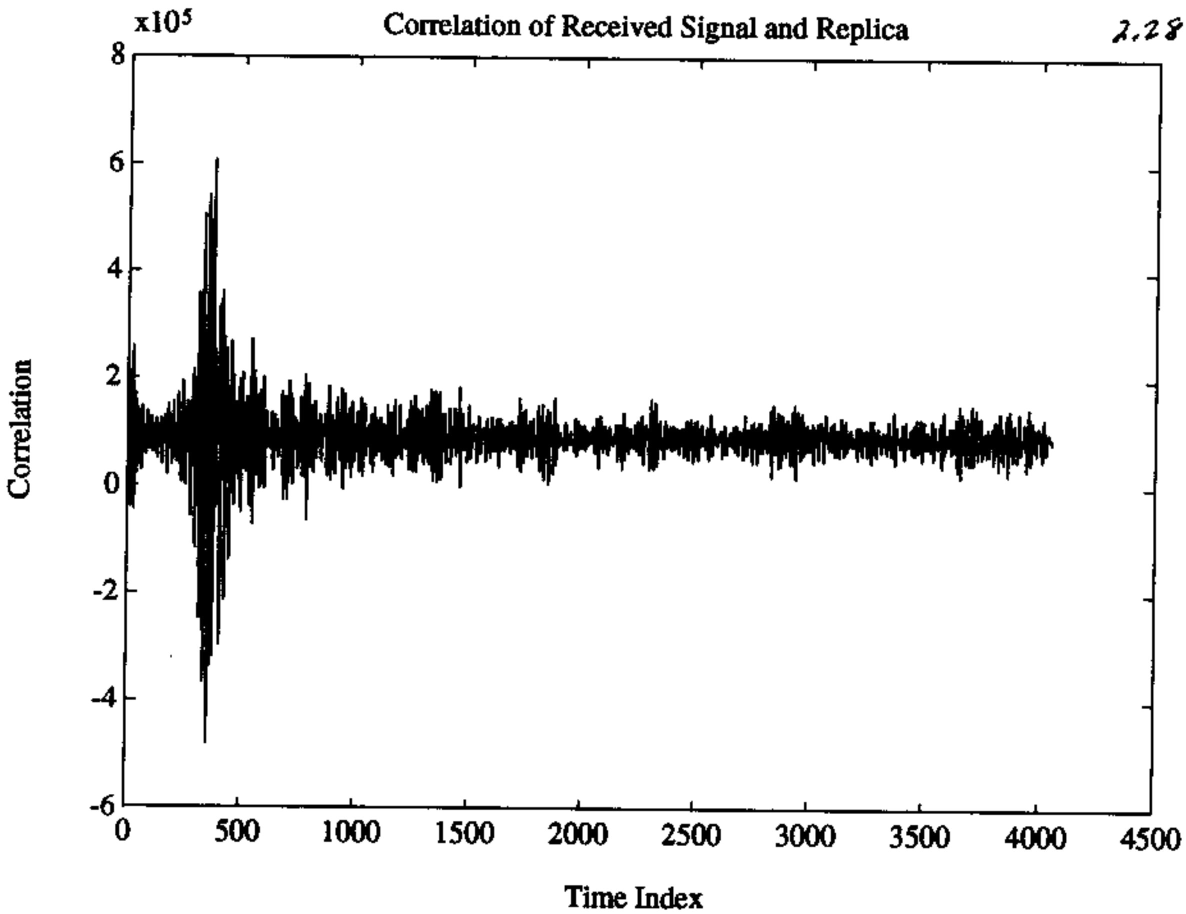
Fig. 4

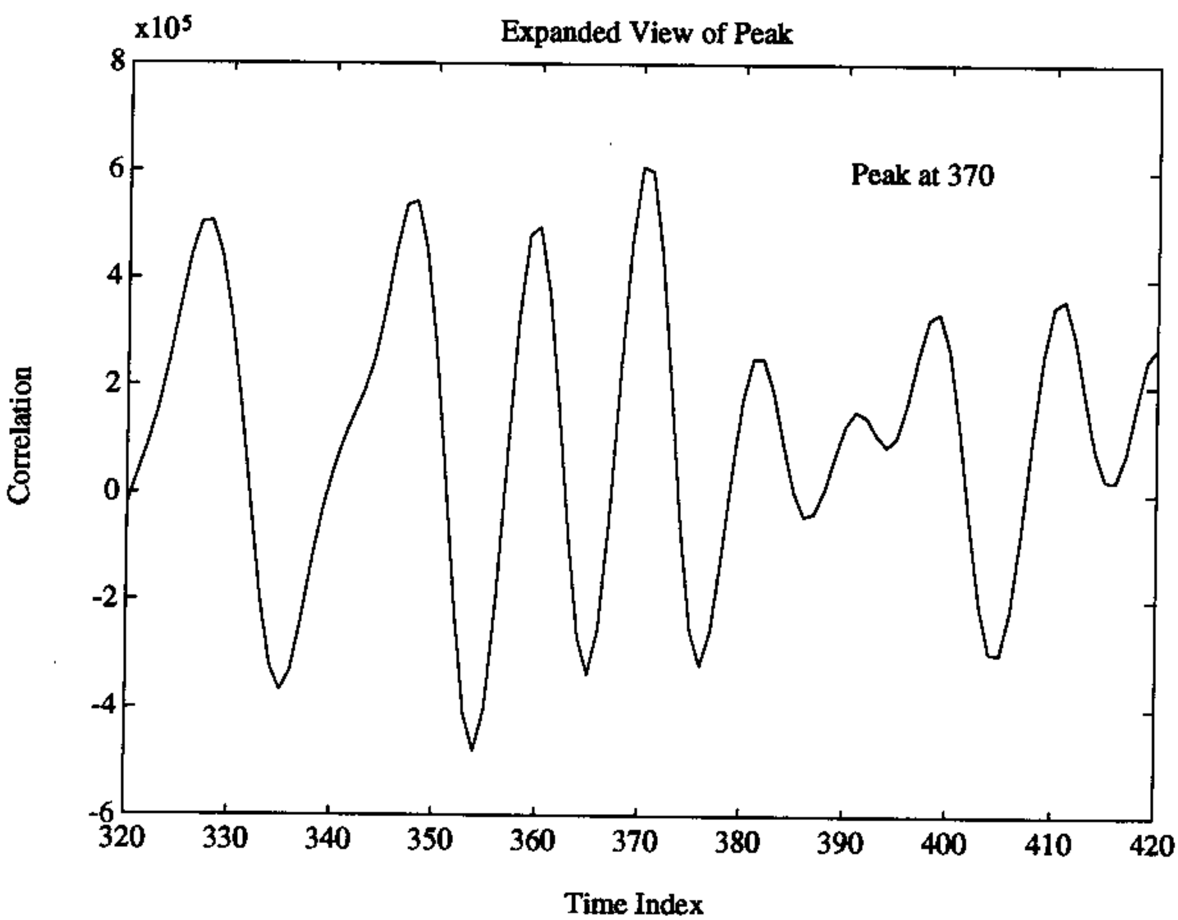
Frosh Pond Chirping Test

Results of Correlations

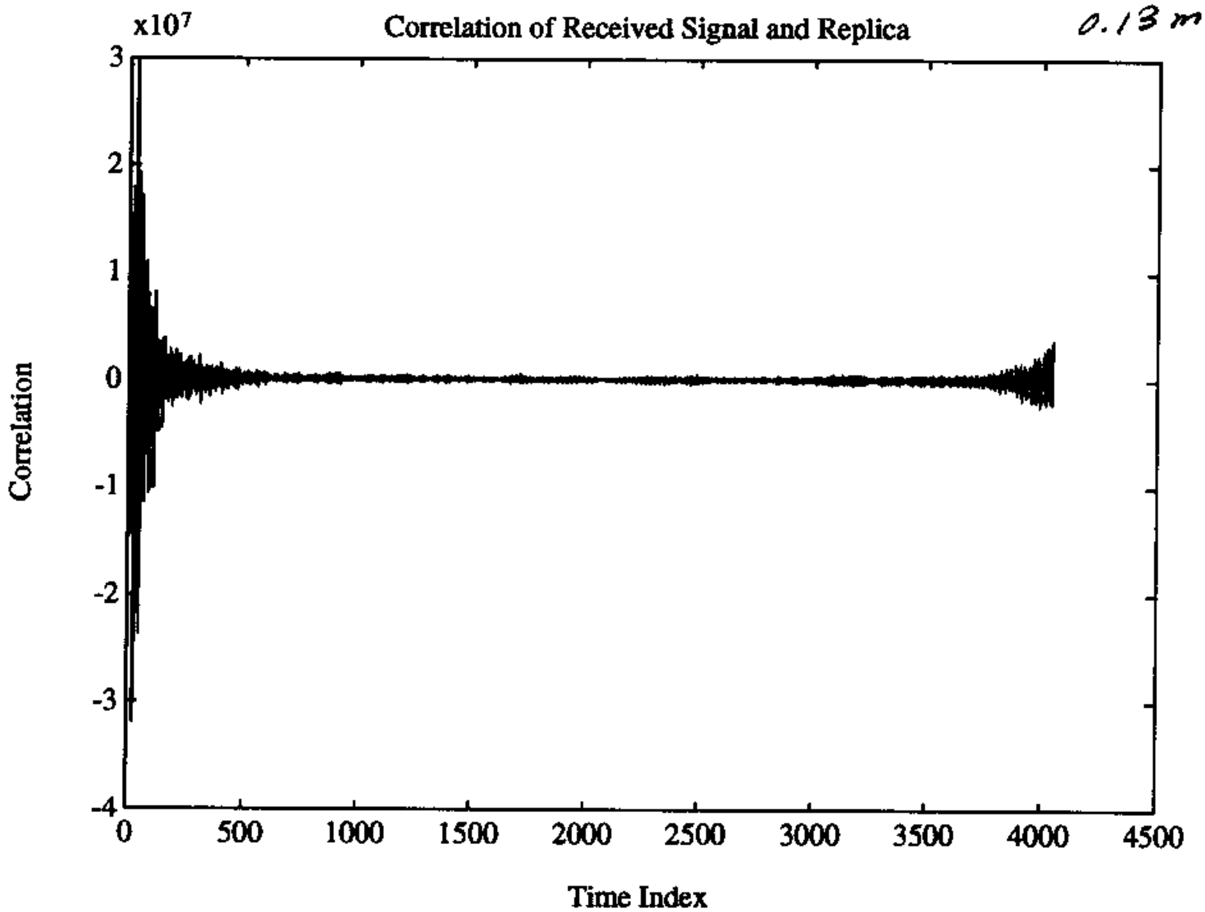
Data Taken 13 May 1991

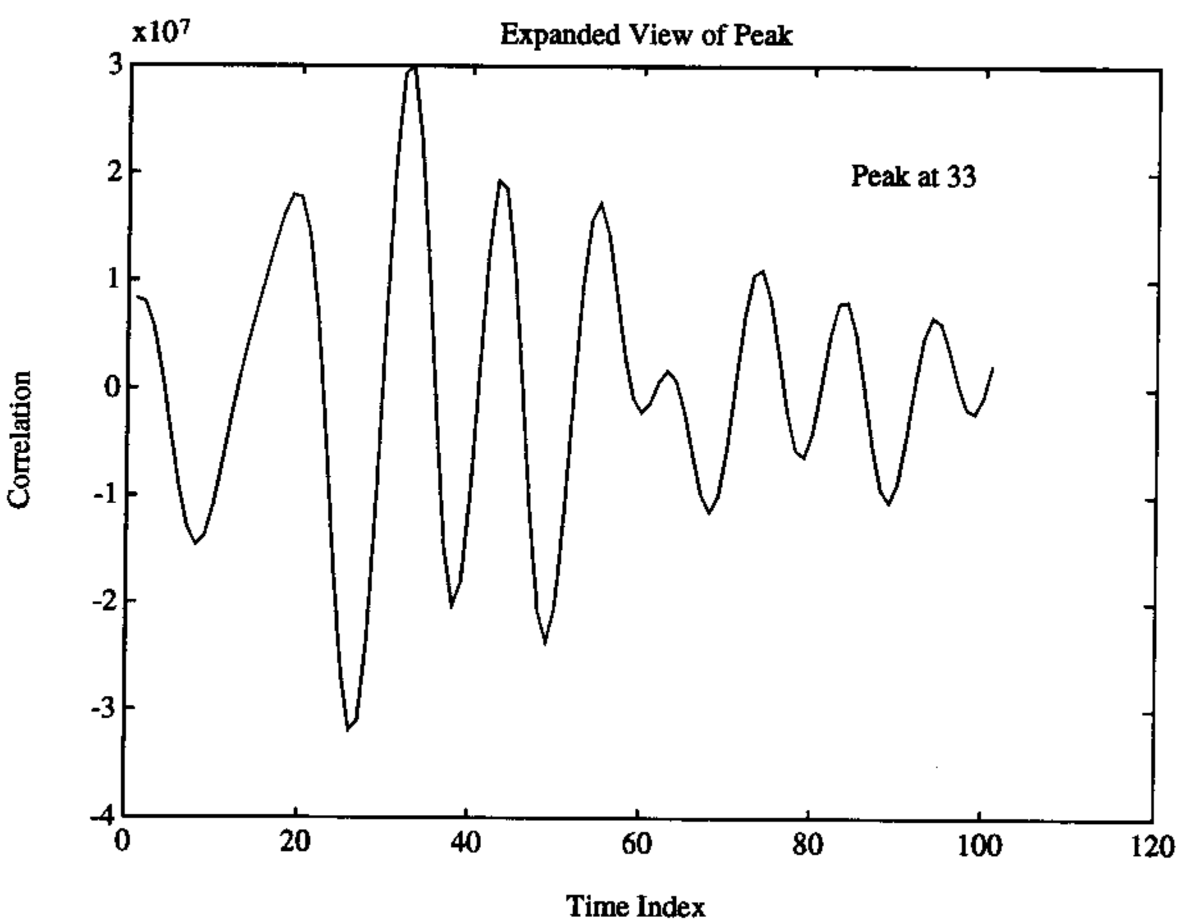
2.28 m





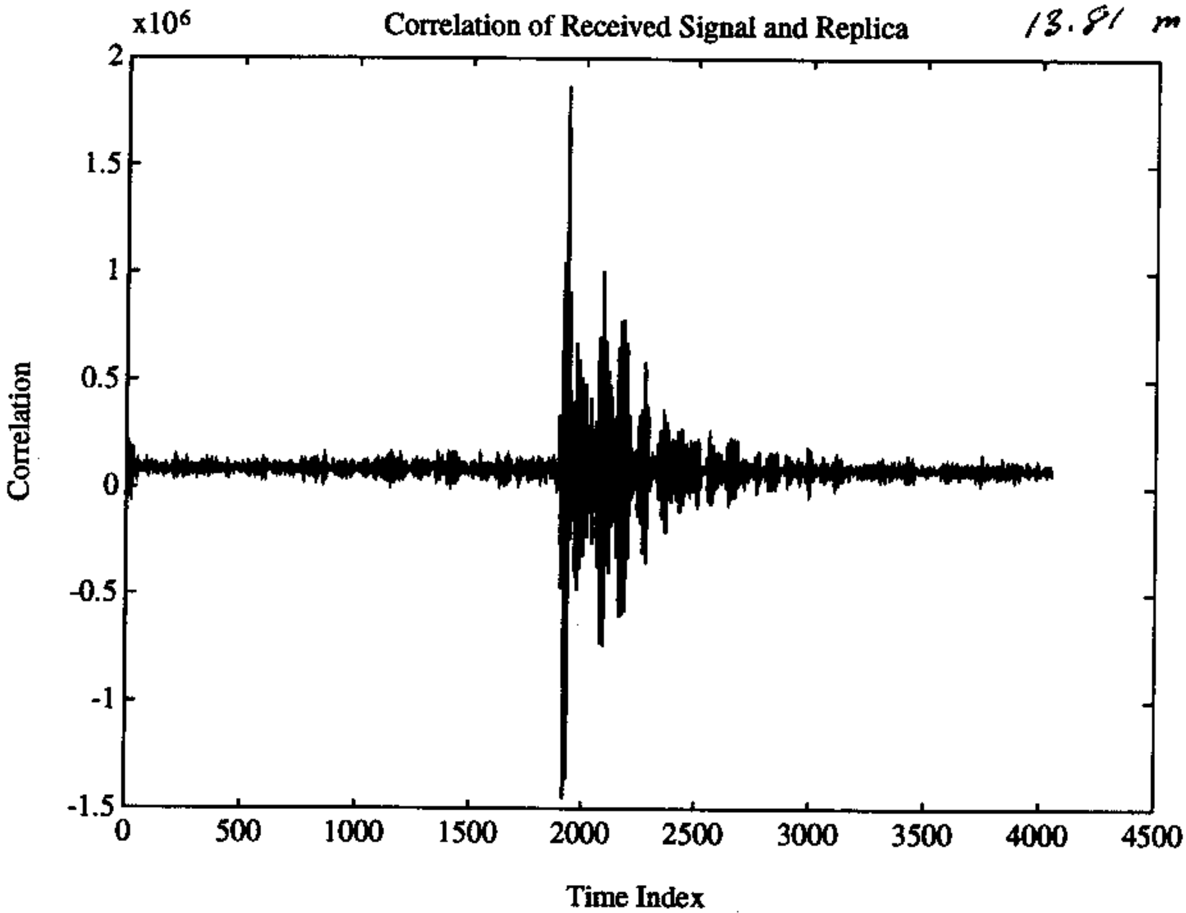
Sig 71
Rep 69

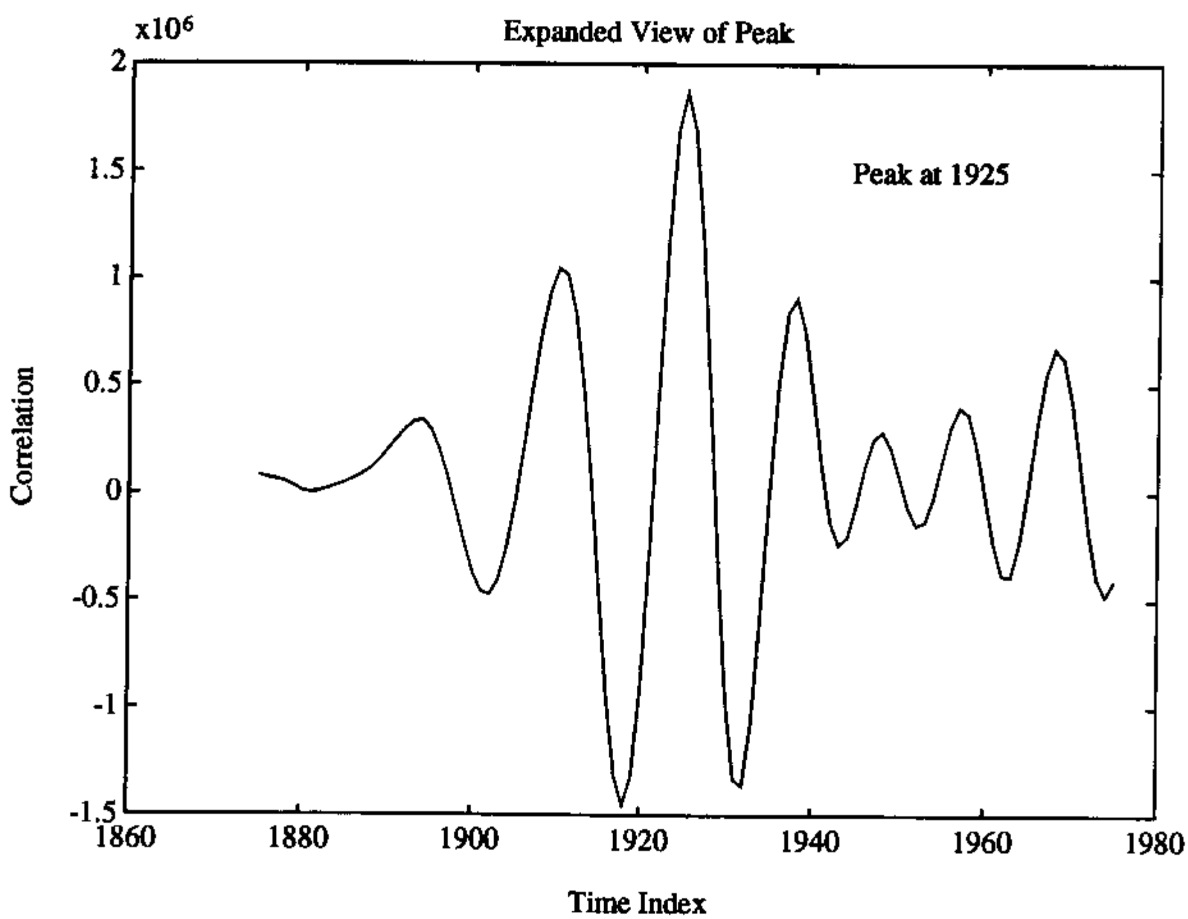

x10⁷
Correlation of Received Signal and Replica
0.13 m
3
2
1
0
-1
-2
-3
-4
Correlation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Time Index


x10⁷
Expanded View of Peak
Peak at 33
3
2
1
0
-1
-2
-3
-4
Correlation
0
20
40
60
80
100
120
Time Index

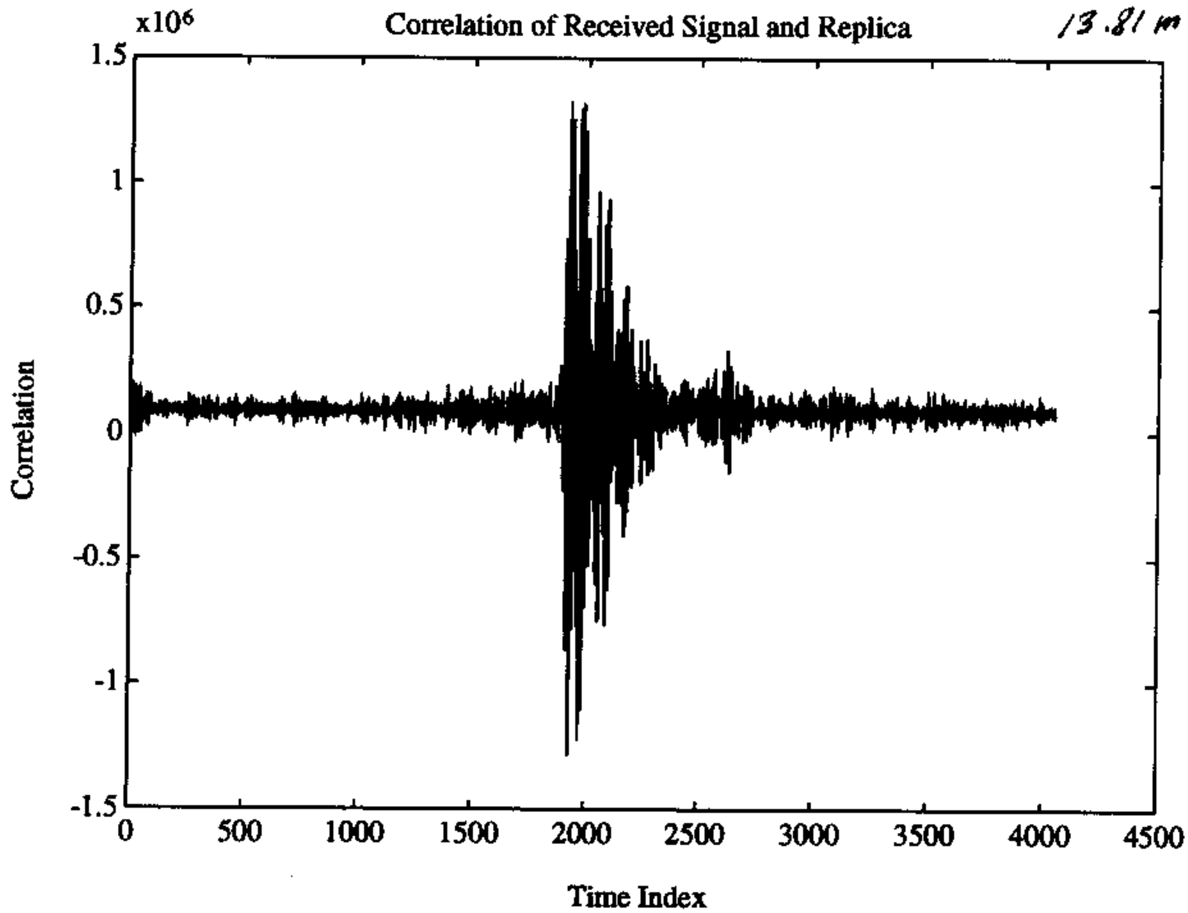
p. 72

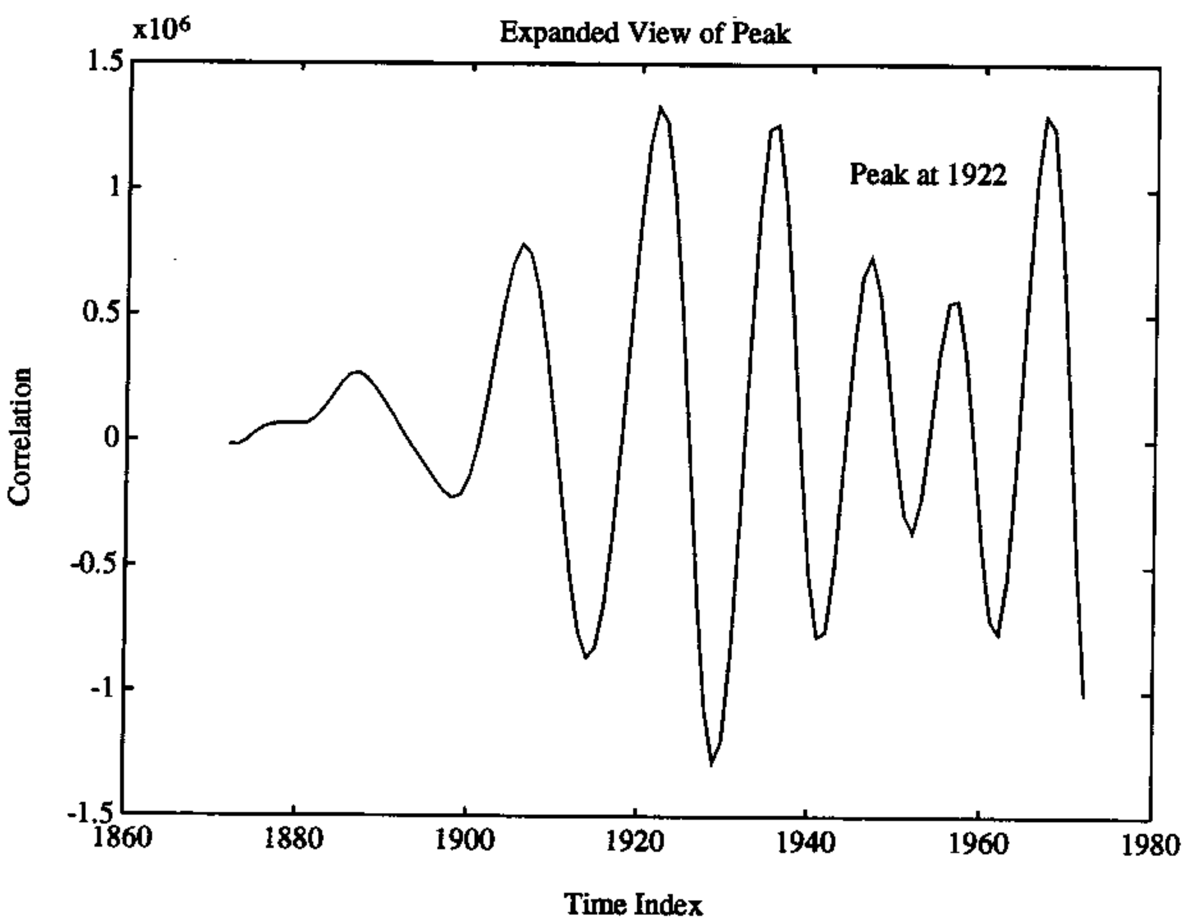
13.81 m



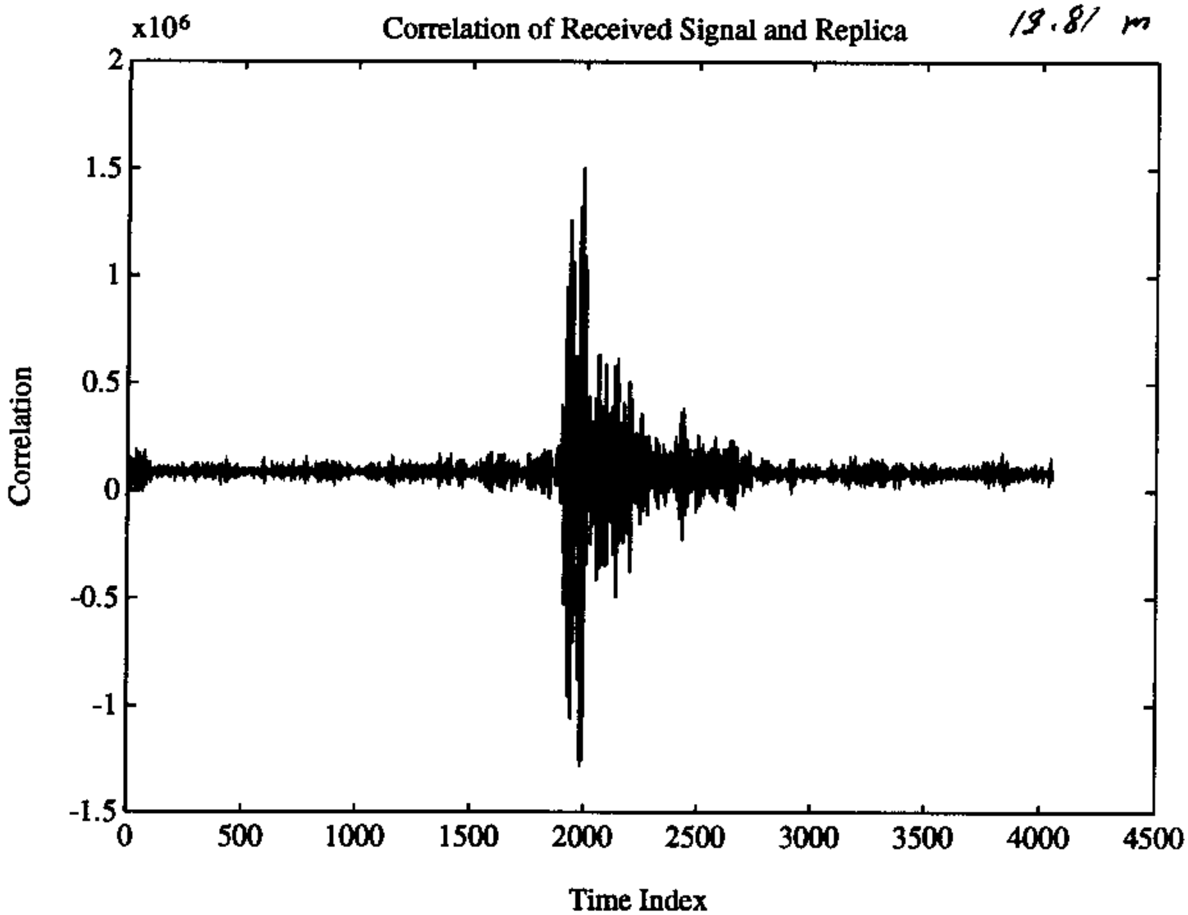


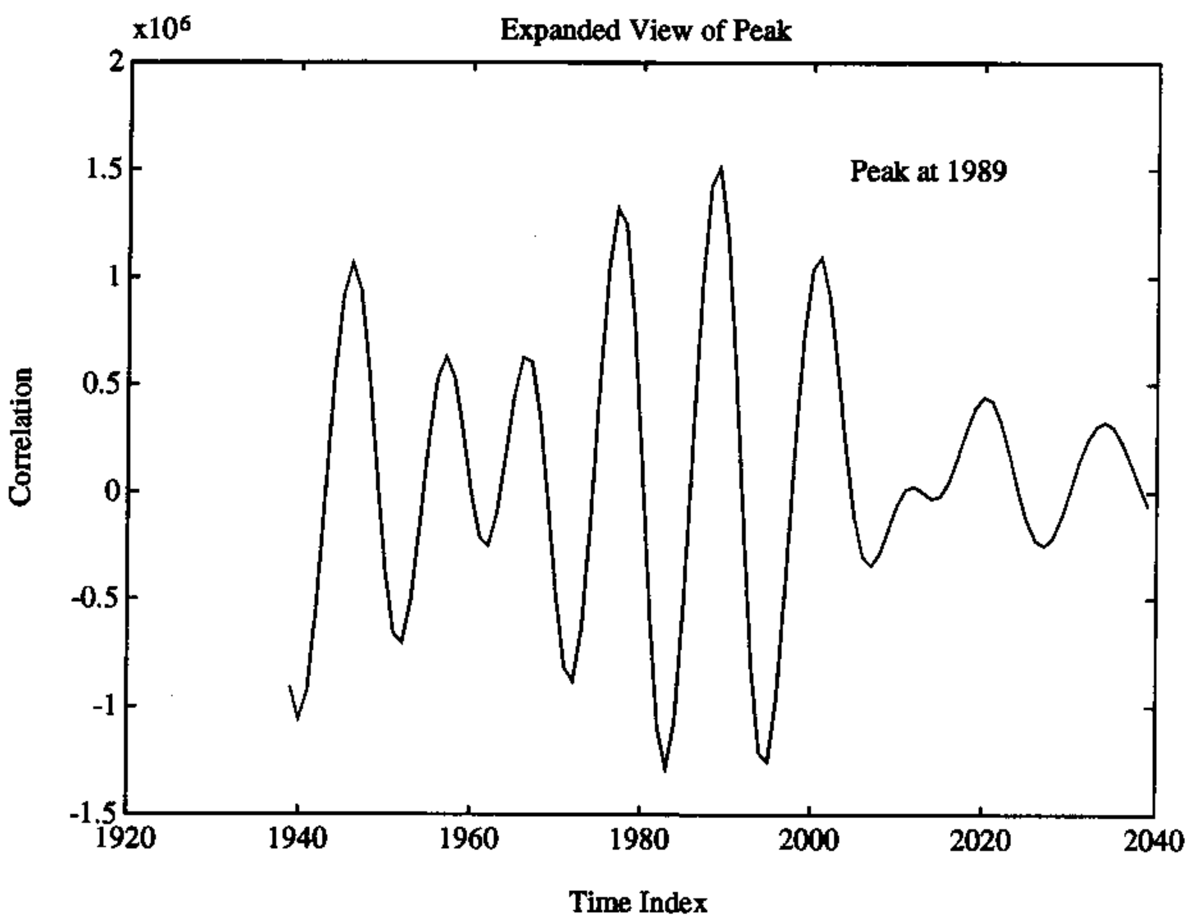
Sig 73
Rep 67


x10^6
Correlation of Received Signal and Replica
13.81 m
1.5
1
0.5
0
-0.5
-1
-1.5
Correlation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
Time Index


x10^6
Expanded View of Peak
Peak at 1922
1.5
1
0.5
0
-0.5
-1
-1.5
Correlation
1860
1880
1900
1920
1940
1960
1980
Time Index

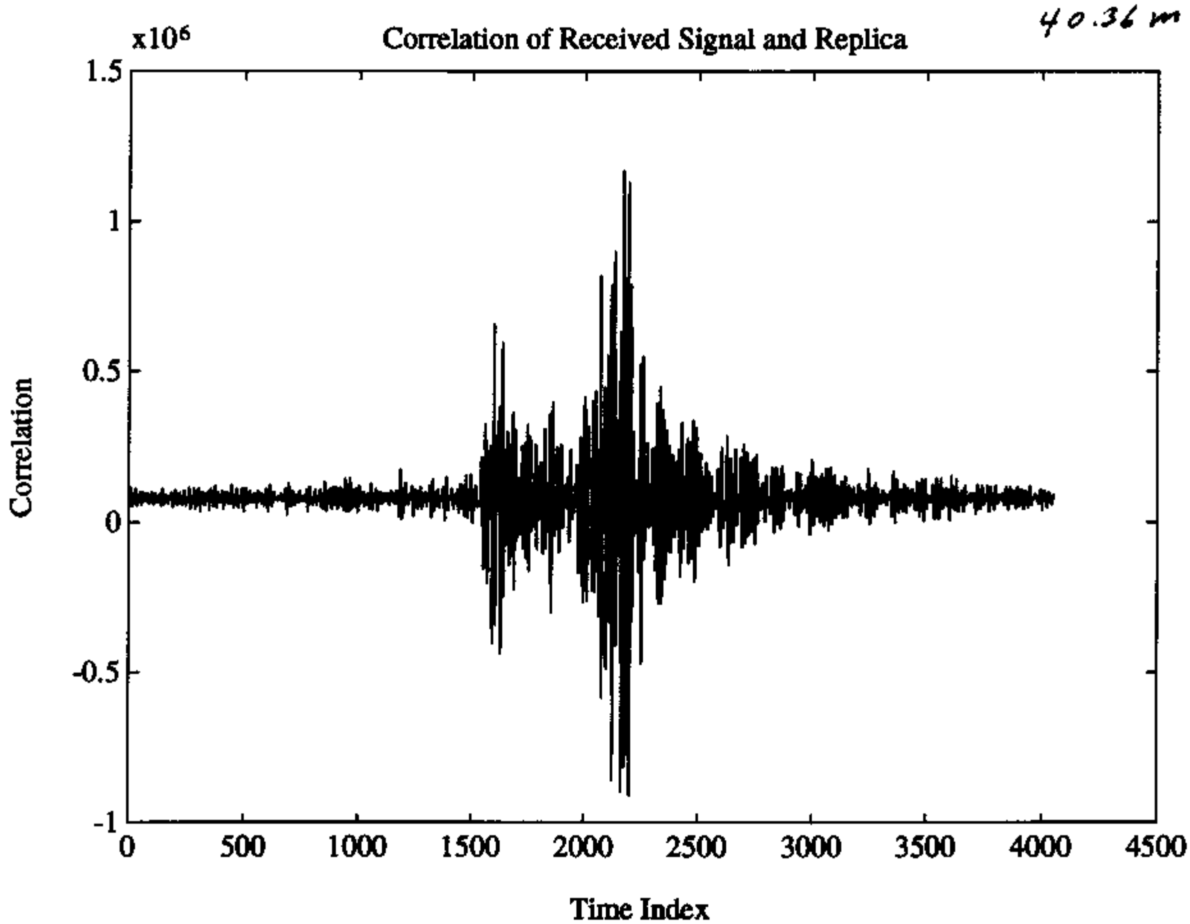
74
69

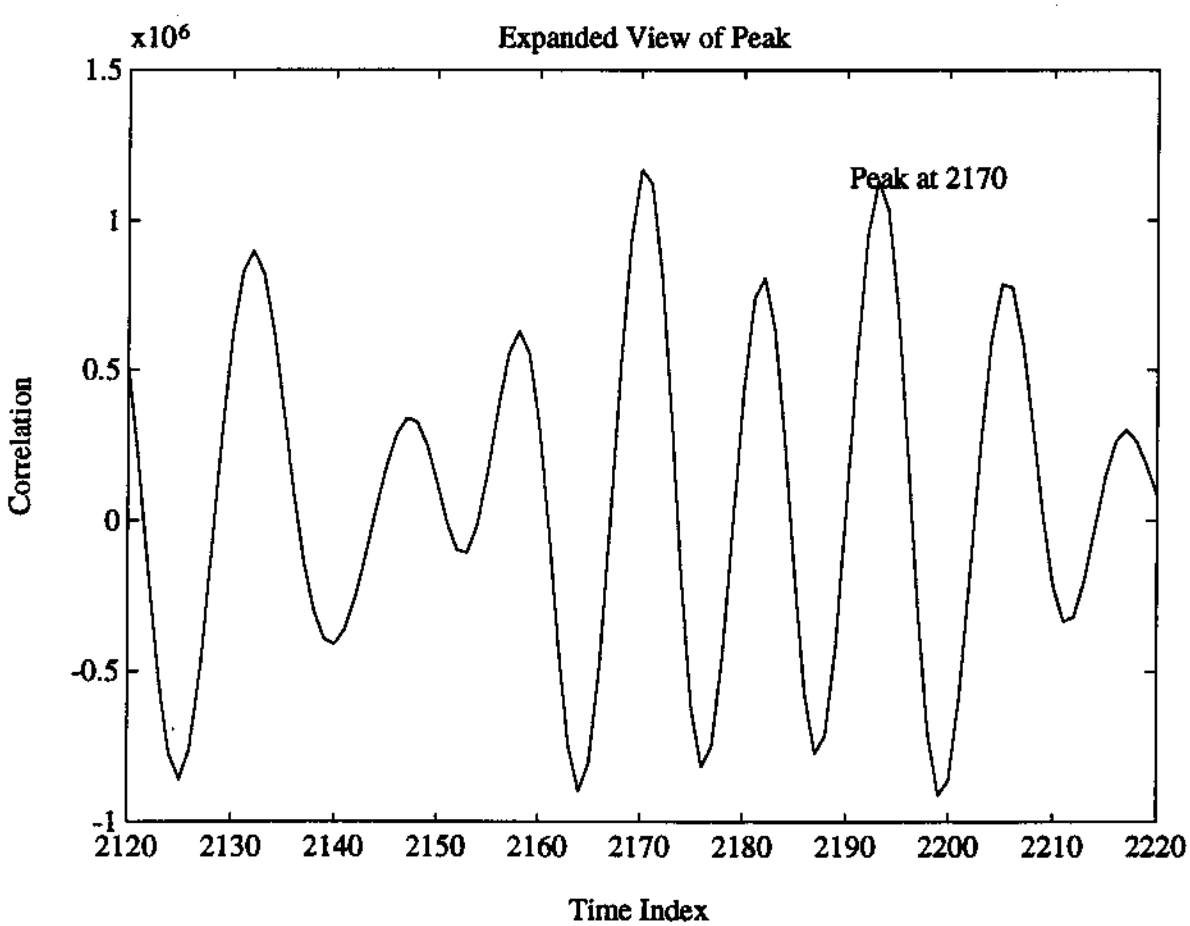

x10^6
Correlation of Received Signal and Replica
19.81 m
Correlation
Time Index
2
1.5
1
0.5
0
-0.5
-1
-1.5
0
500
1000
1500
2000
2500
3000
3500
4000
4500


x10^6
Expanded View of Peak
Peak at 1989
Correlation
Time Index
2
1.5
1
0.5
0
-0.5
-1
-1.5
1920
1940
1960
1980
2000
2020
2040

75
69

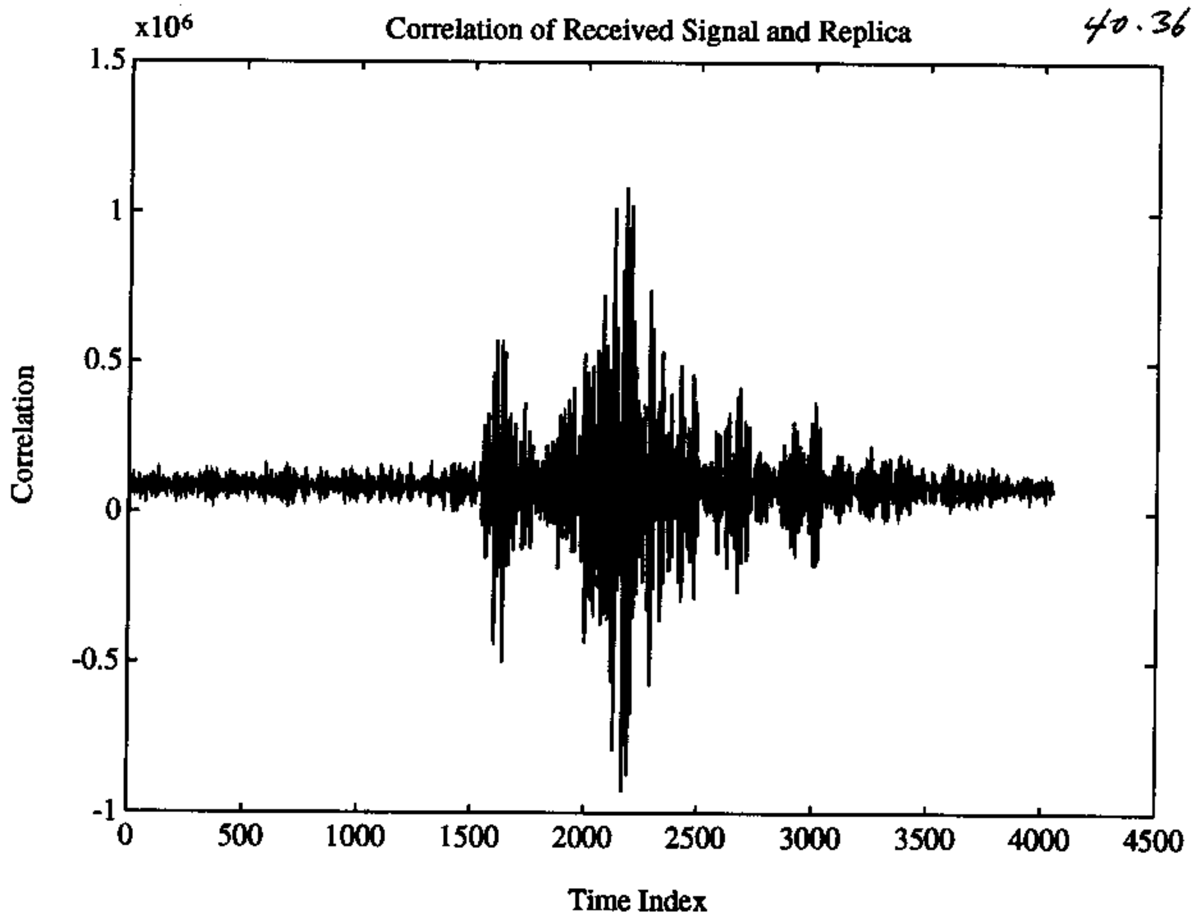
40.36 m

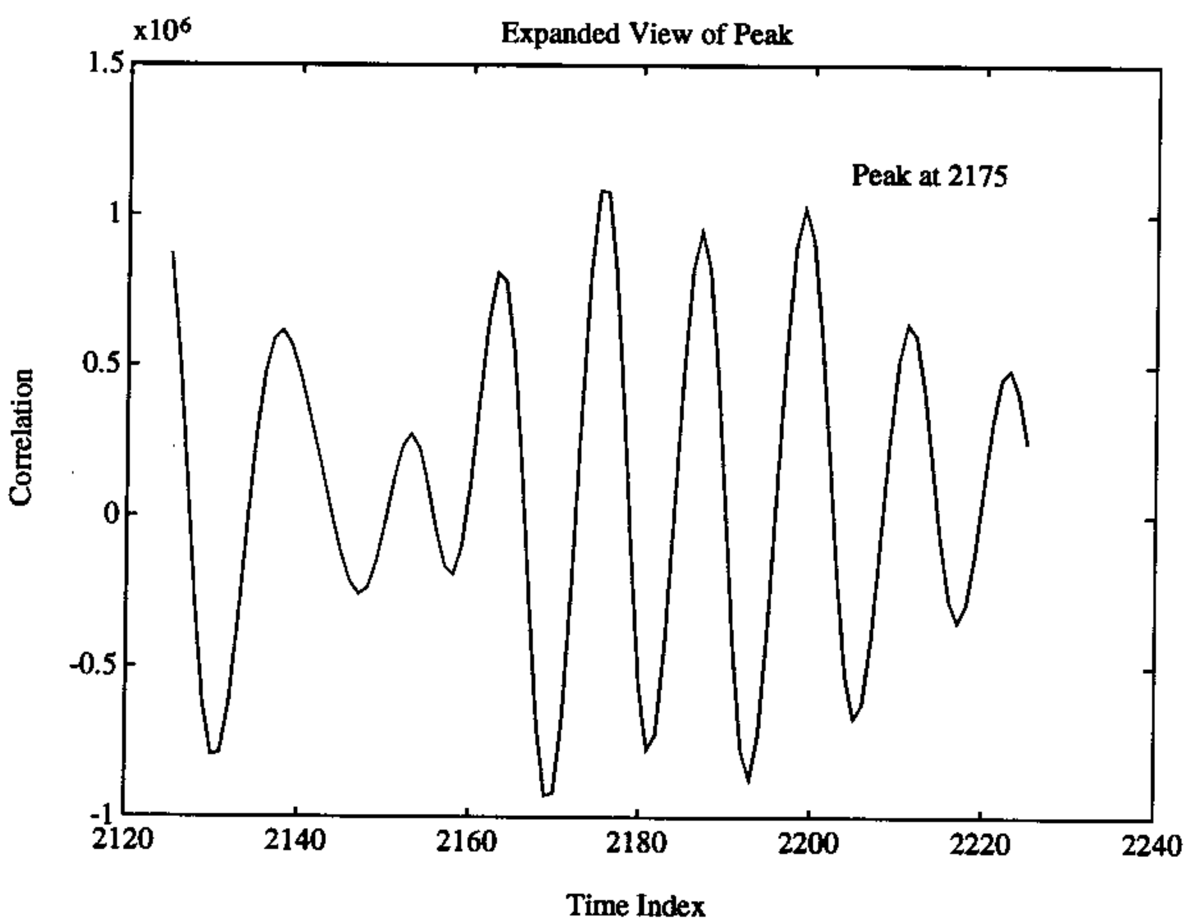




Signal 76 Offset 4000
Rep 69

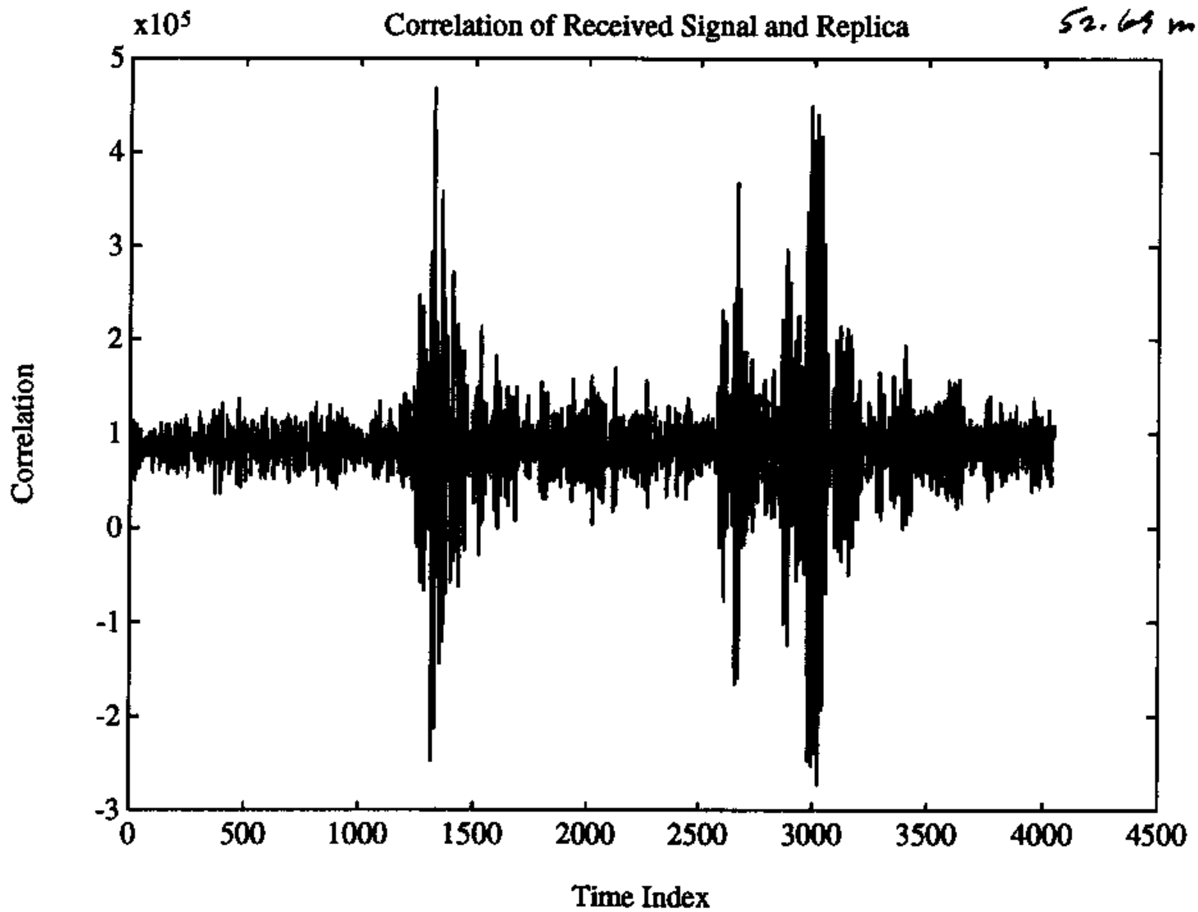
40.36 m

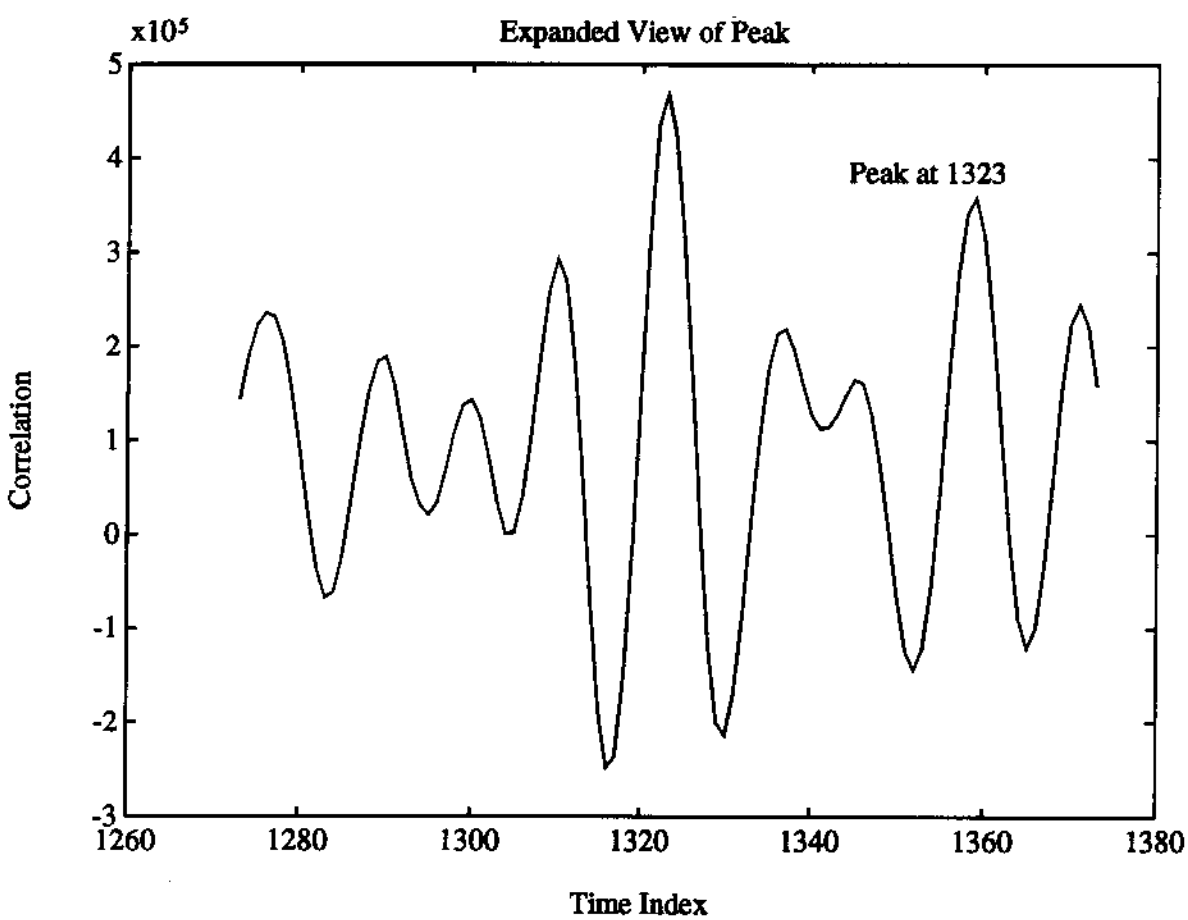




Sig 77
Rep 69

offset 4000

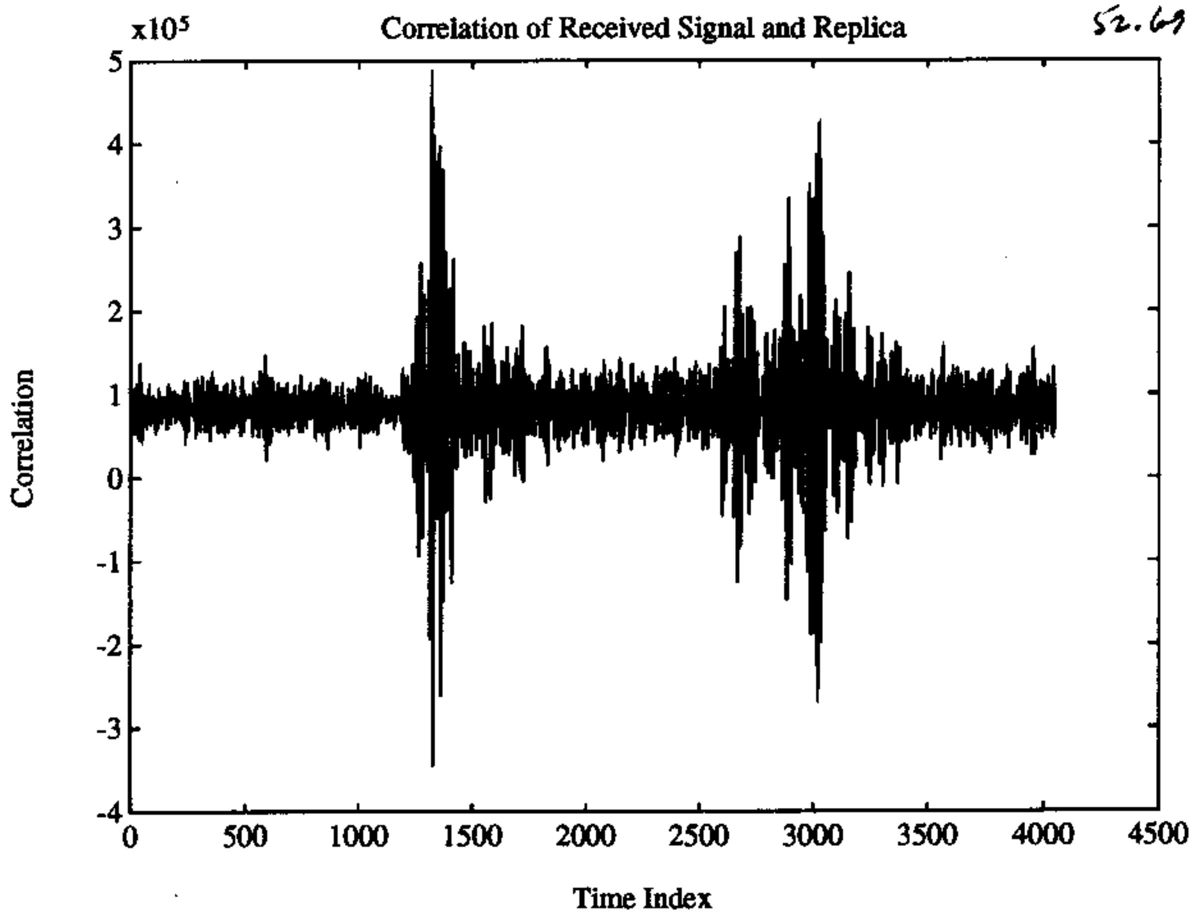


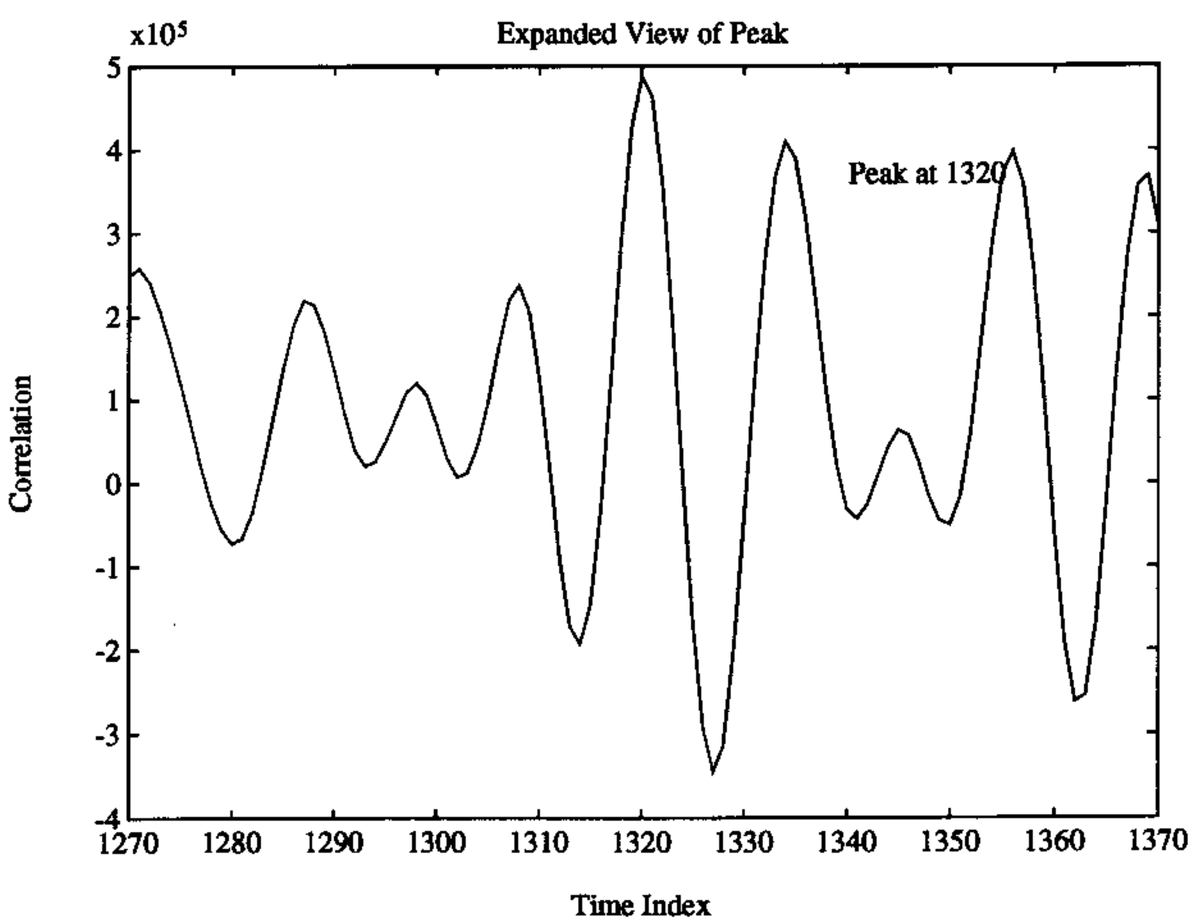


Sig 78
Rep 69

Offset 6000

52.69 m





Sig 79 Offset 6000

69