LOFAR MSP Scintillation Study
A Pilot Effort

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LOFAR MSP scintillation

the ASTRON team:

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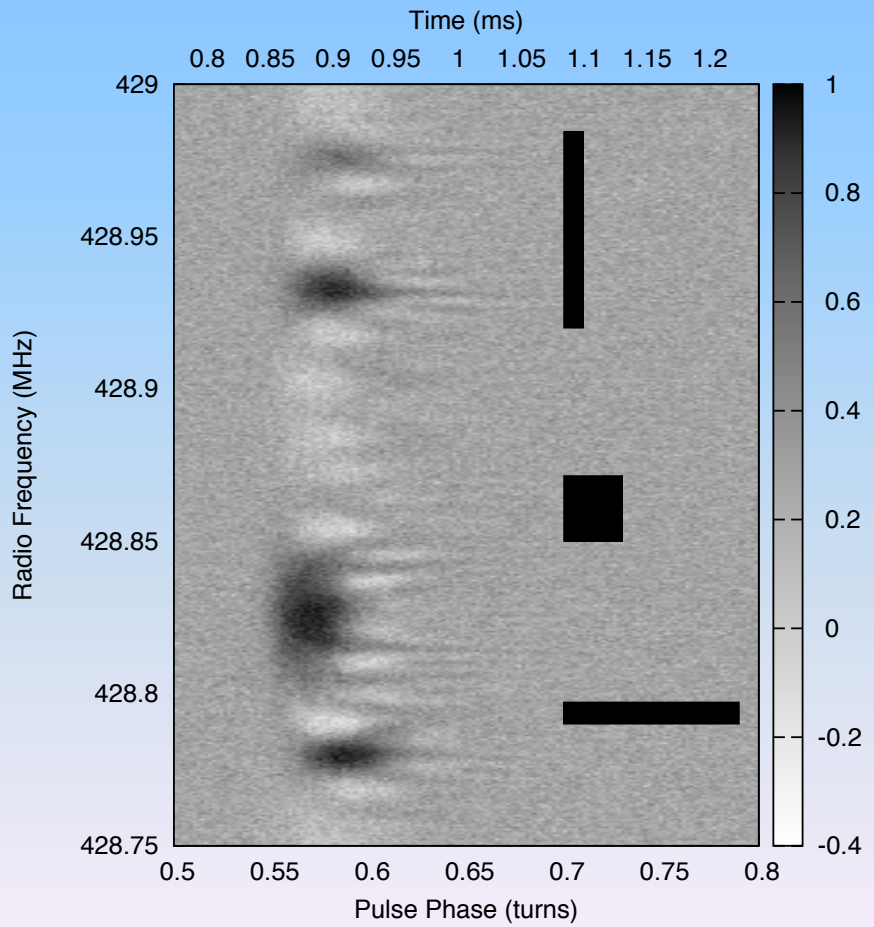
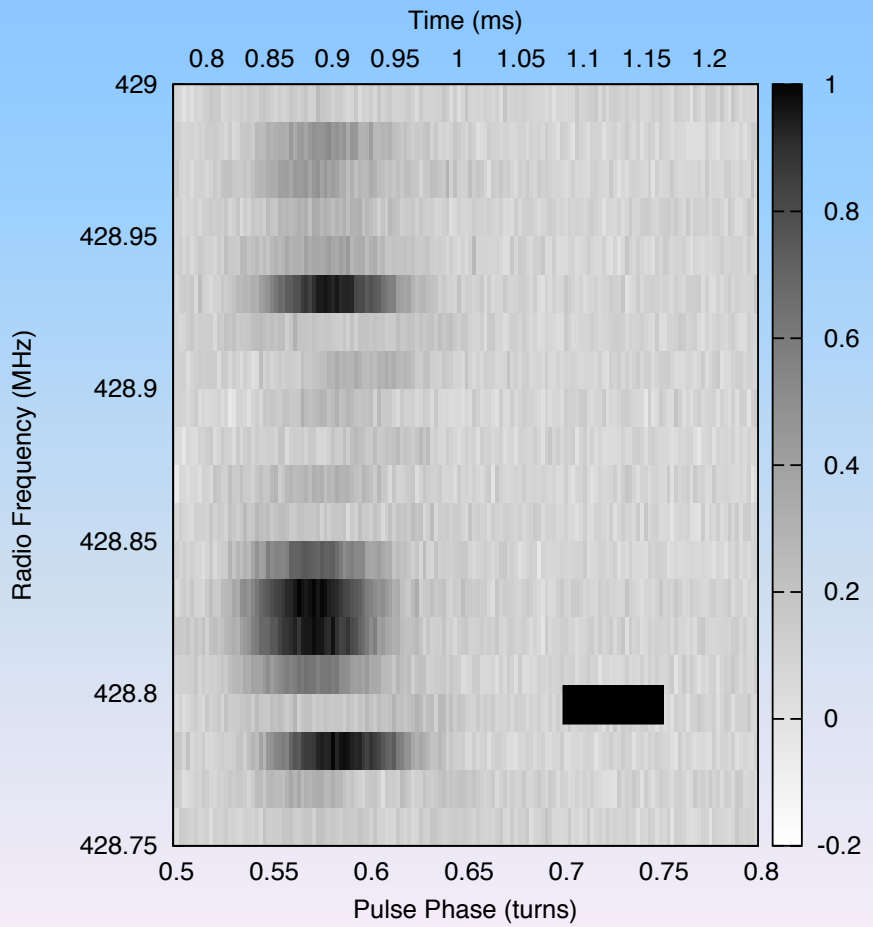
Jason Hessels
Vlad Kondratiev
Dan Stinebring

the data:

B1257+12 (20 min)
J1810+1744 (5 min!)
black widow
J2317+1439 (20 min)

the technique:
cyclic spectroscopy (Demorest 2011)





A 350-MHz GBT Survey of 50 Faint *Fermi* γ-ray Sources for Radio Millisecond Pulsars

J. W. T. Hessels[*,†], M. S. E. Roberts[**], M. A. McLaughlin[‡,§], P. S. Ray[¶], P. Bangale[‡], S. M. Ransom[‖], M. Kerr[††], F. Camilo[‡‡], M. E. DeCesar[§§] and the Fermi PSC[¶¶]

[*]*ASTRON, Postbus 2, 7990 AA Dwingeloo, The Netherlands*

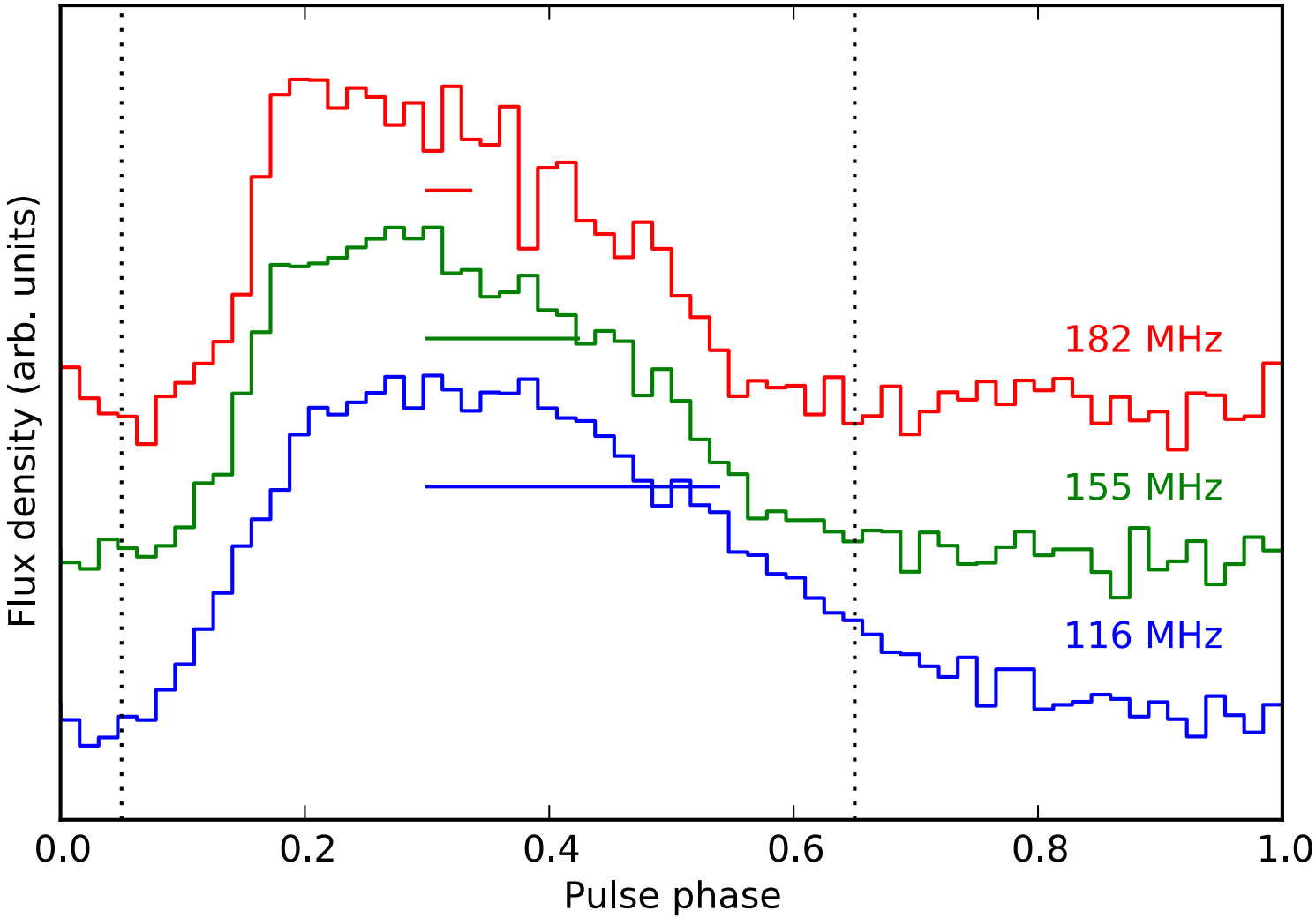
2011

PSR J1810+1744

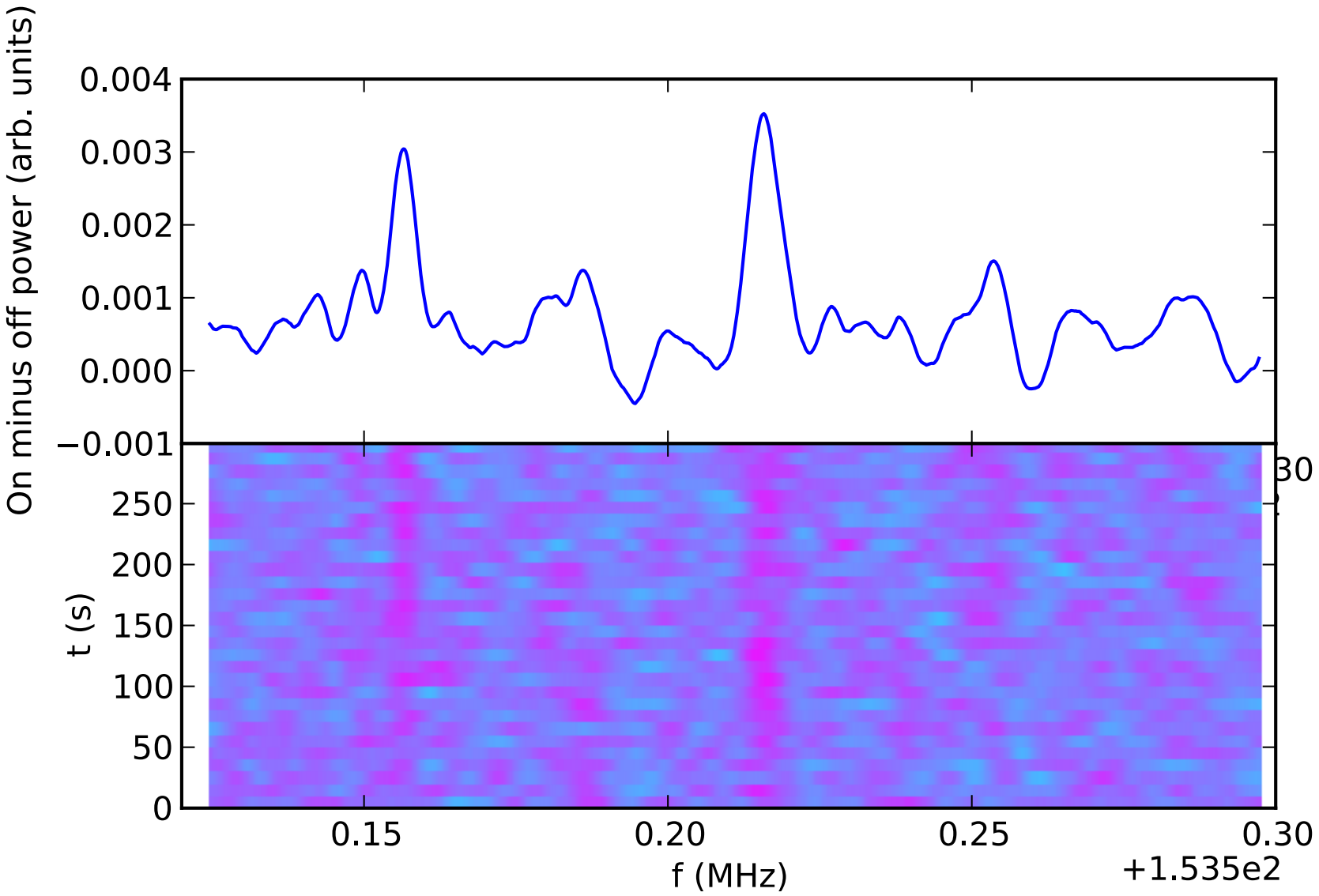
3.5 hour "black widow" system – accretion onto white dwarf companion

P = 1.6 ms pulsar

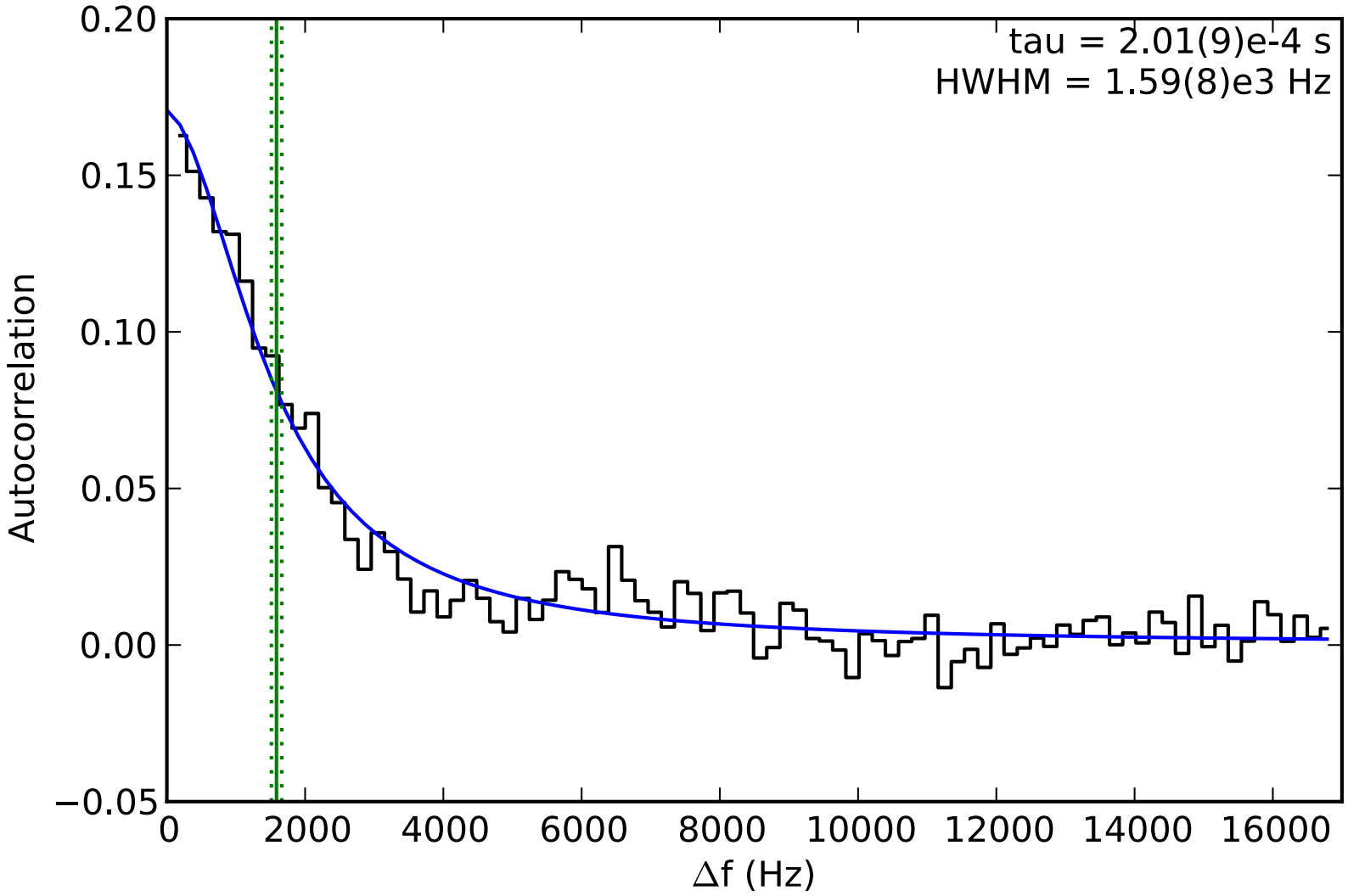
all plots for J1810+1744



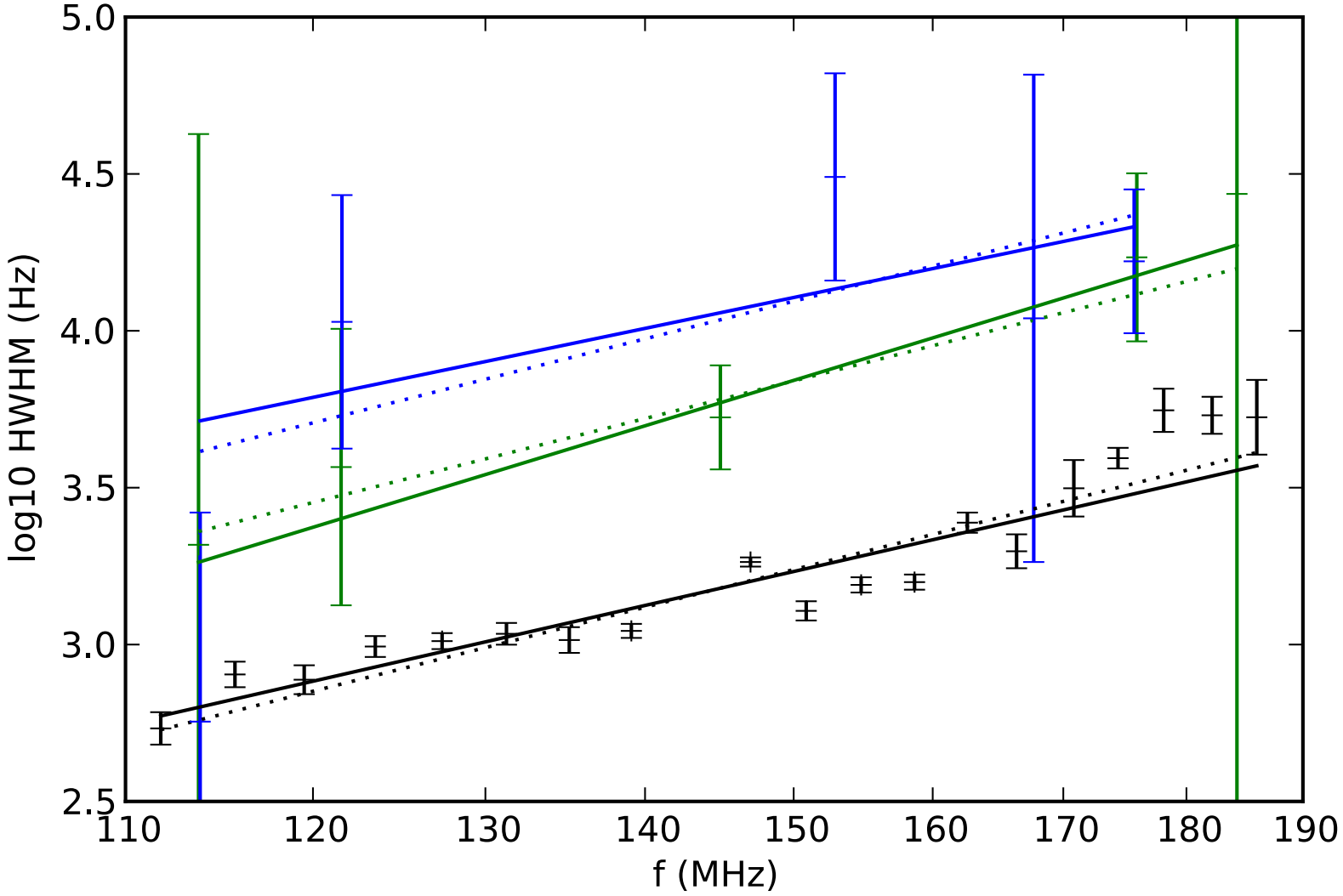
Archibald et al. 2014, in prep.



Archibald et al. 2014, in prep.



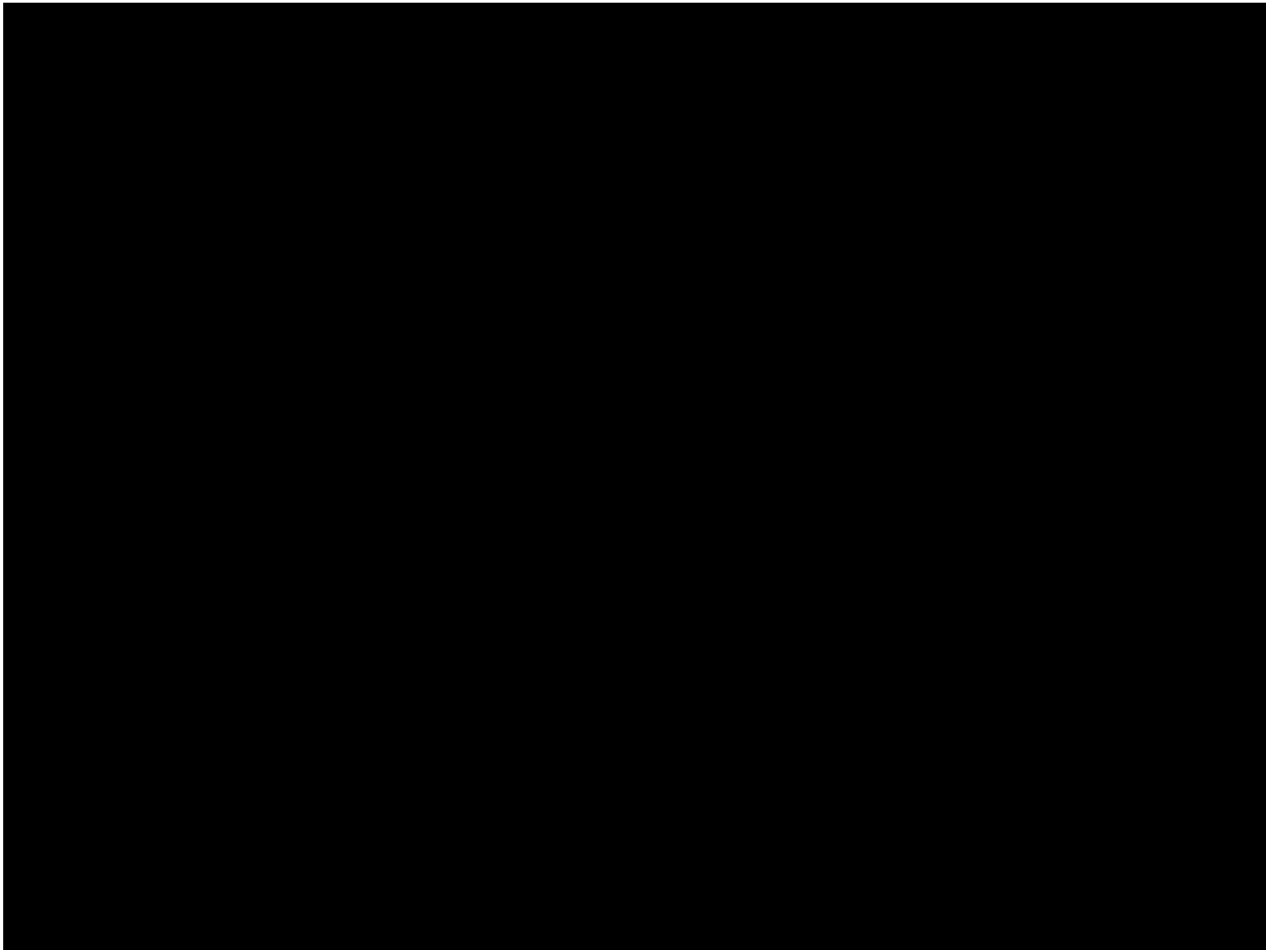
Archibald et al. 2014, in prep.

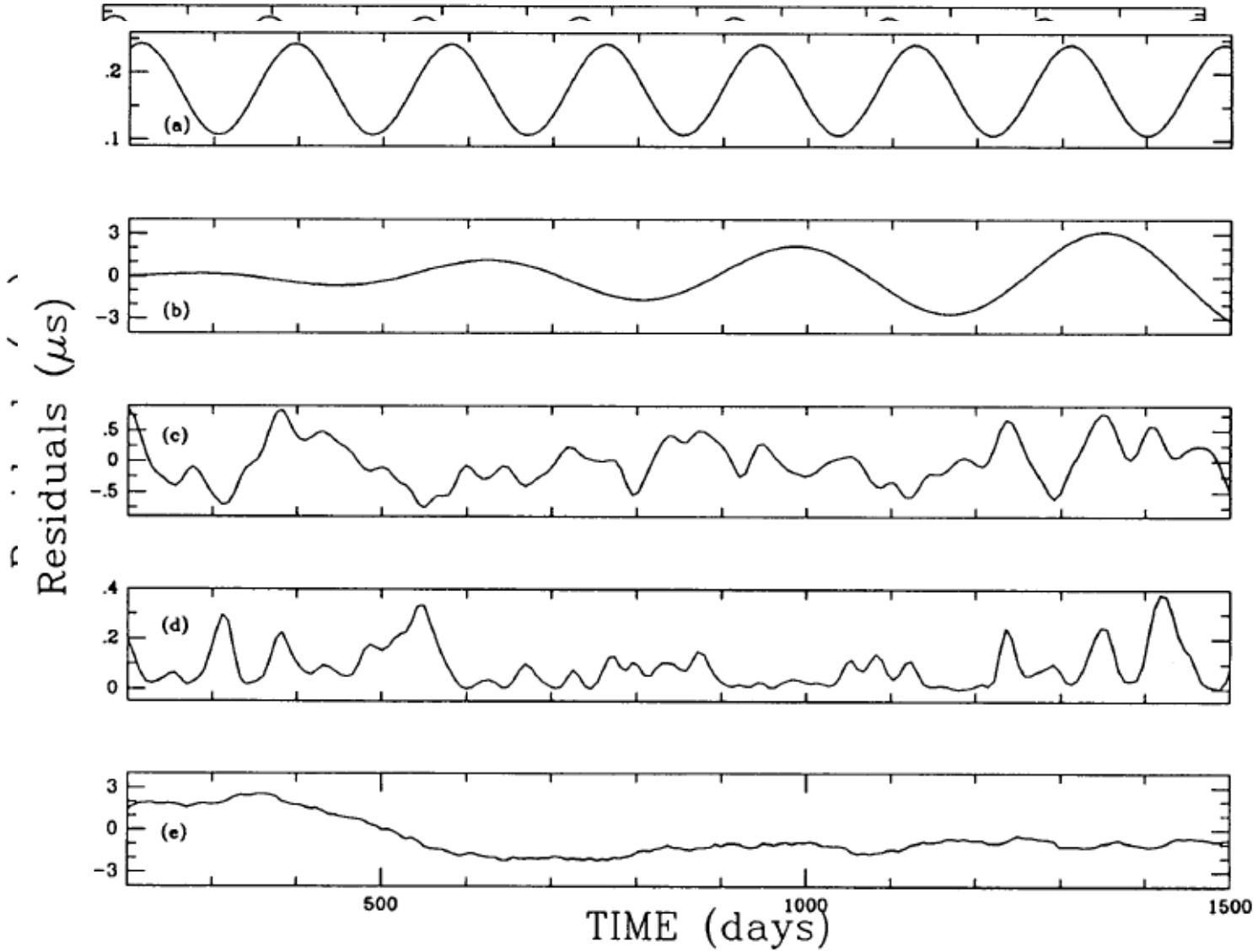


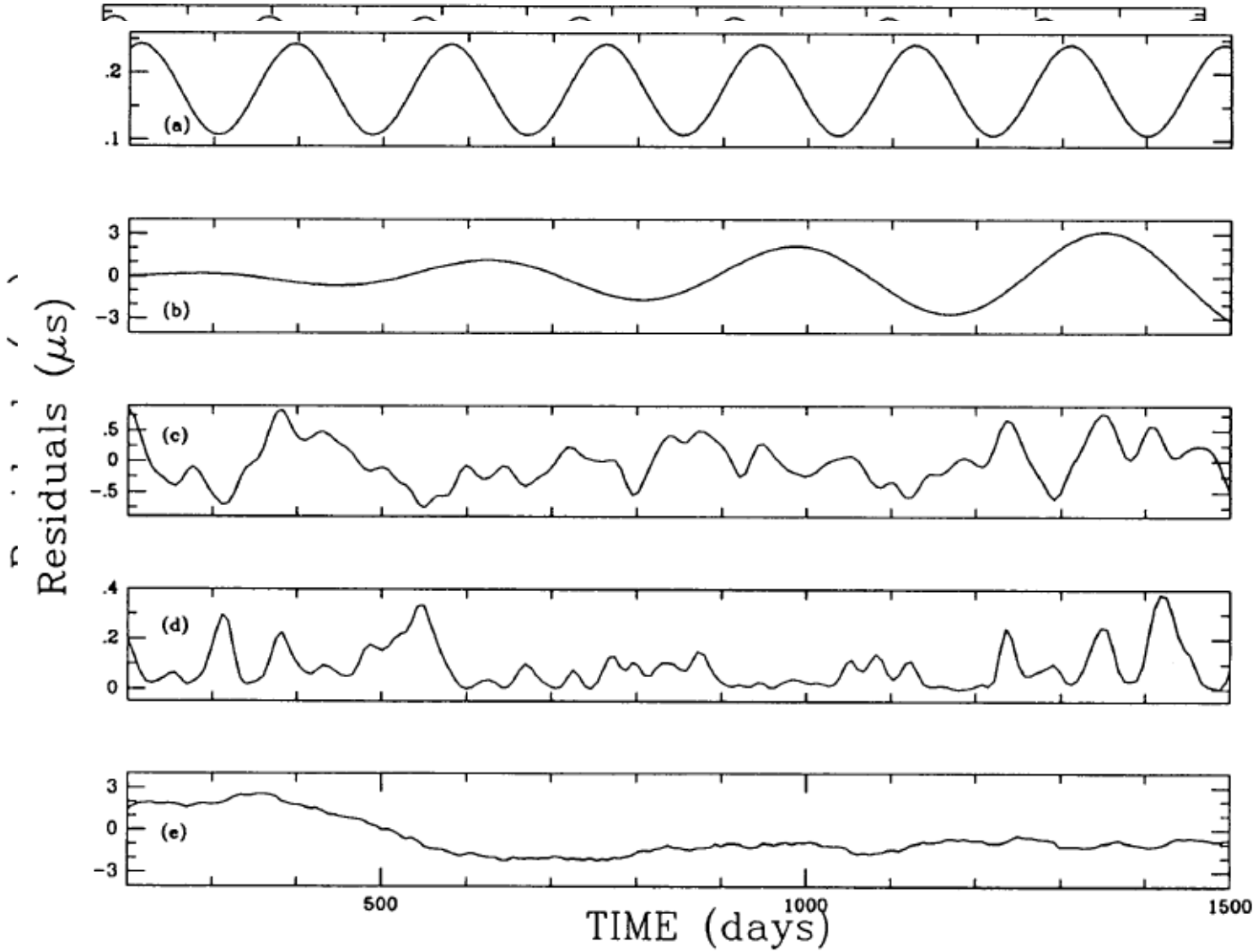
Archibald et al. 2014, in prep.

Summary

- Initial success, particularly with J1810+1744
- 40 hours of Cycle 2 time to follow up with 6 millisecond pulsars and 2 “normal” pulsars
- May help us correct high-frequency precision timing for GW detection




Residuals (μs)
(a)
(b)
(c)
(d)
(e)
.2
.1
3
0
-3
.5
0
-.5
.4
.2
0
3
0
-3
500
1000
1500
TIME (days)


Residuals (μs)
(a)
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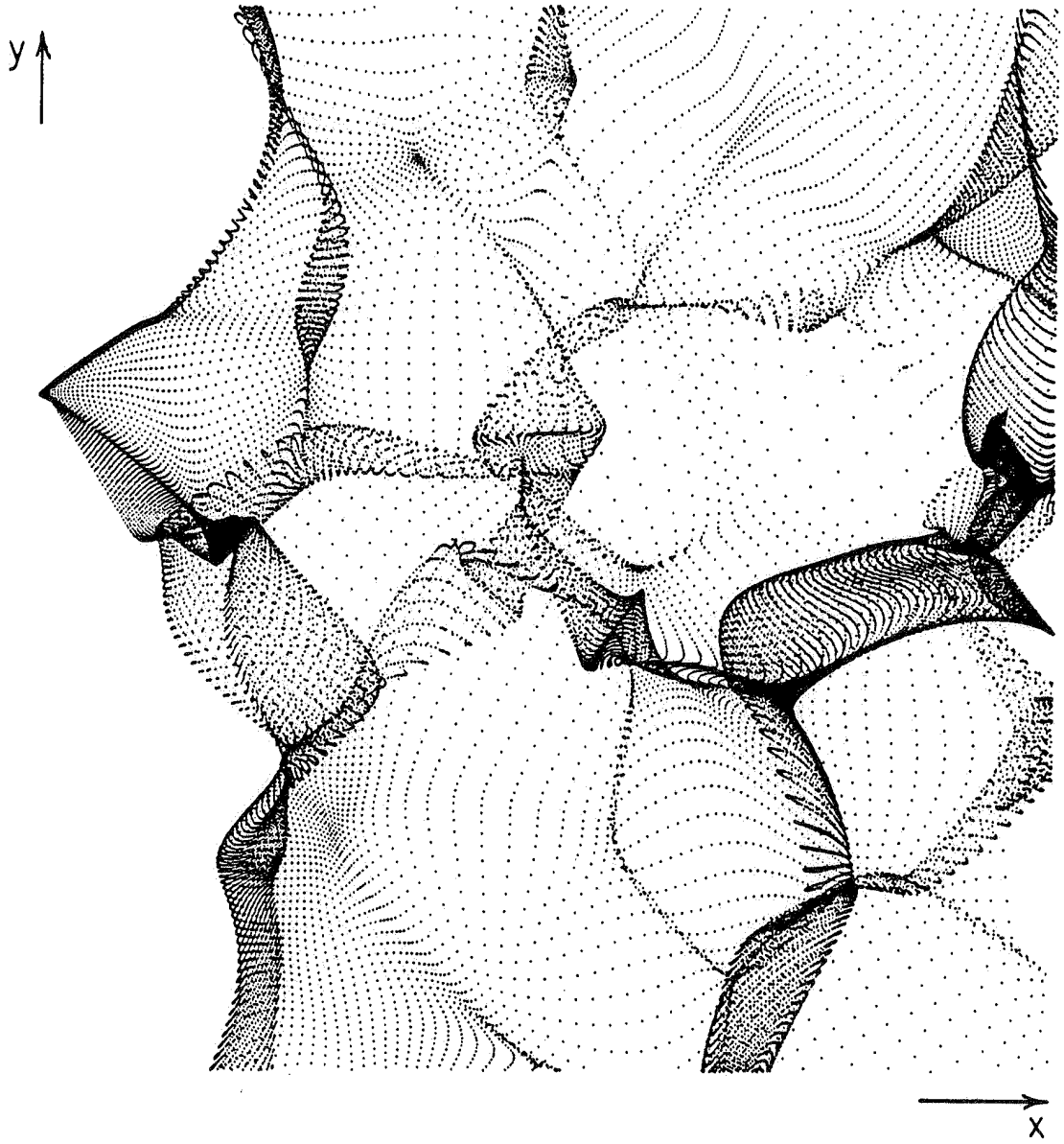
(e)
.2
.1
3
0
-3
.5
0
-.5
.4
.2
0
3
0
-3
500
1000
1500
TIME (days)


y
x

SIMULATION AND ANALYSIS OF WAVE PROPAGATION THROUGH RANDOM MEDIA

A Thesis

Presented to the Faculty of the Graduate School

of Cornell University

in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

by

Alexander Tidwerbetsky

January 1988

Foster and Cordes 1990

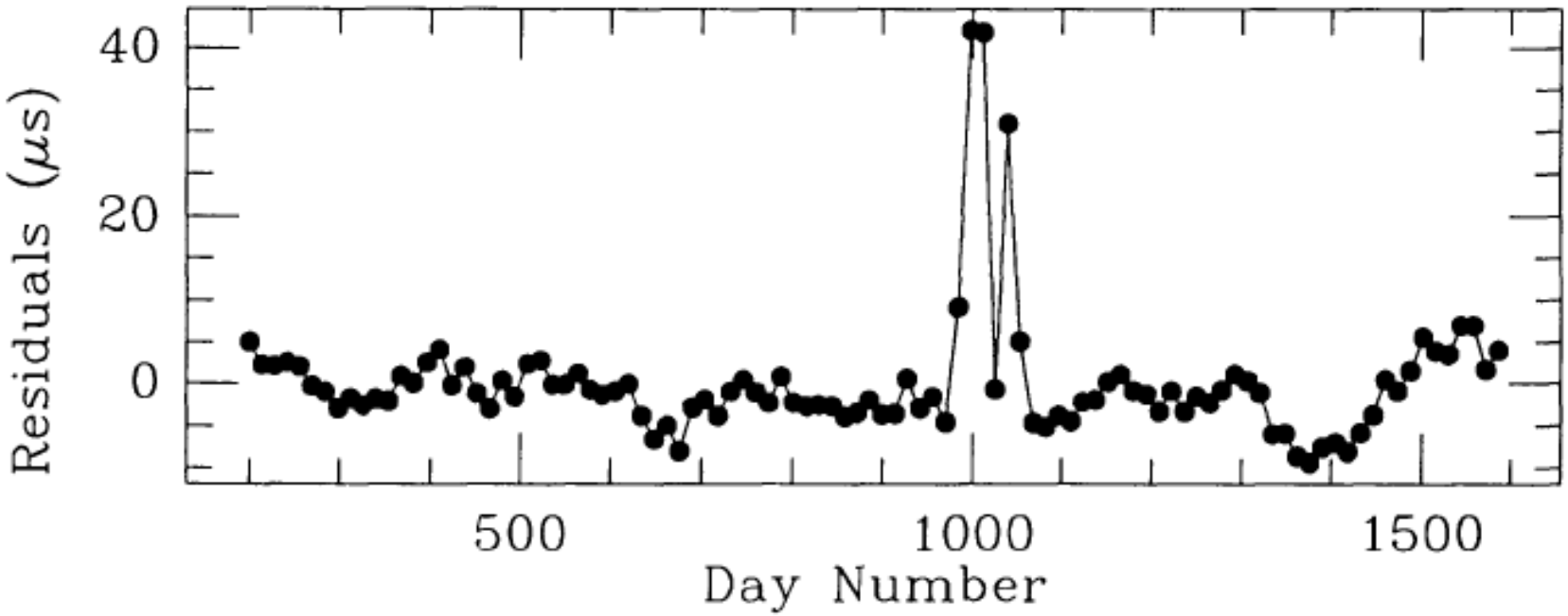
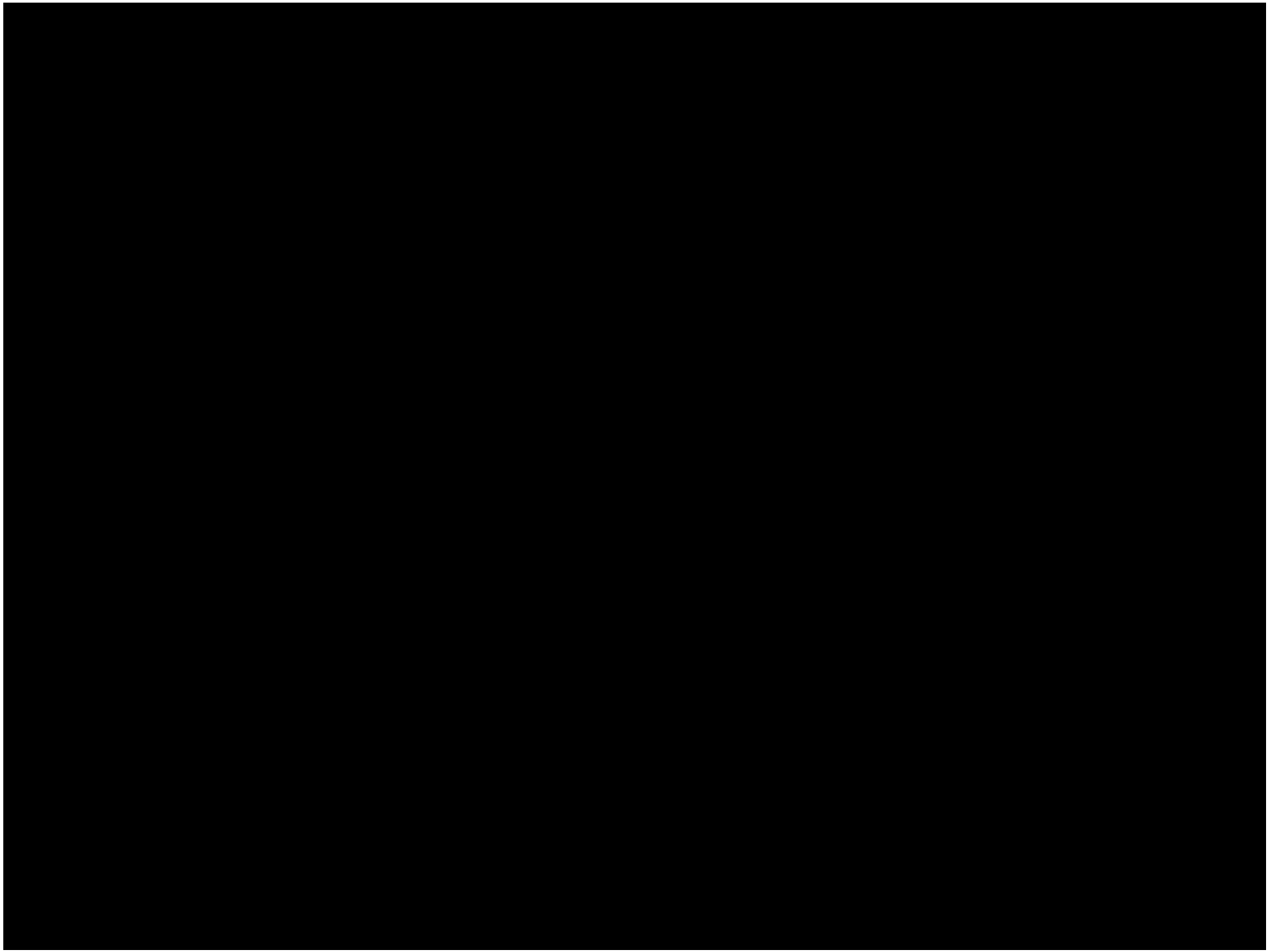
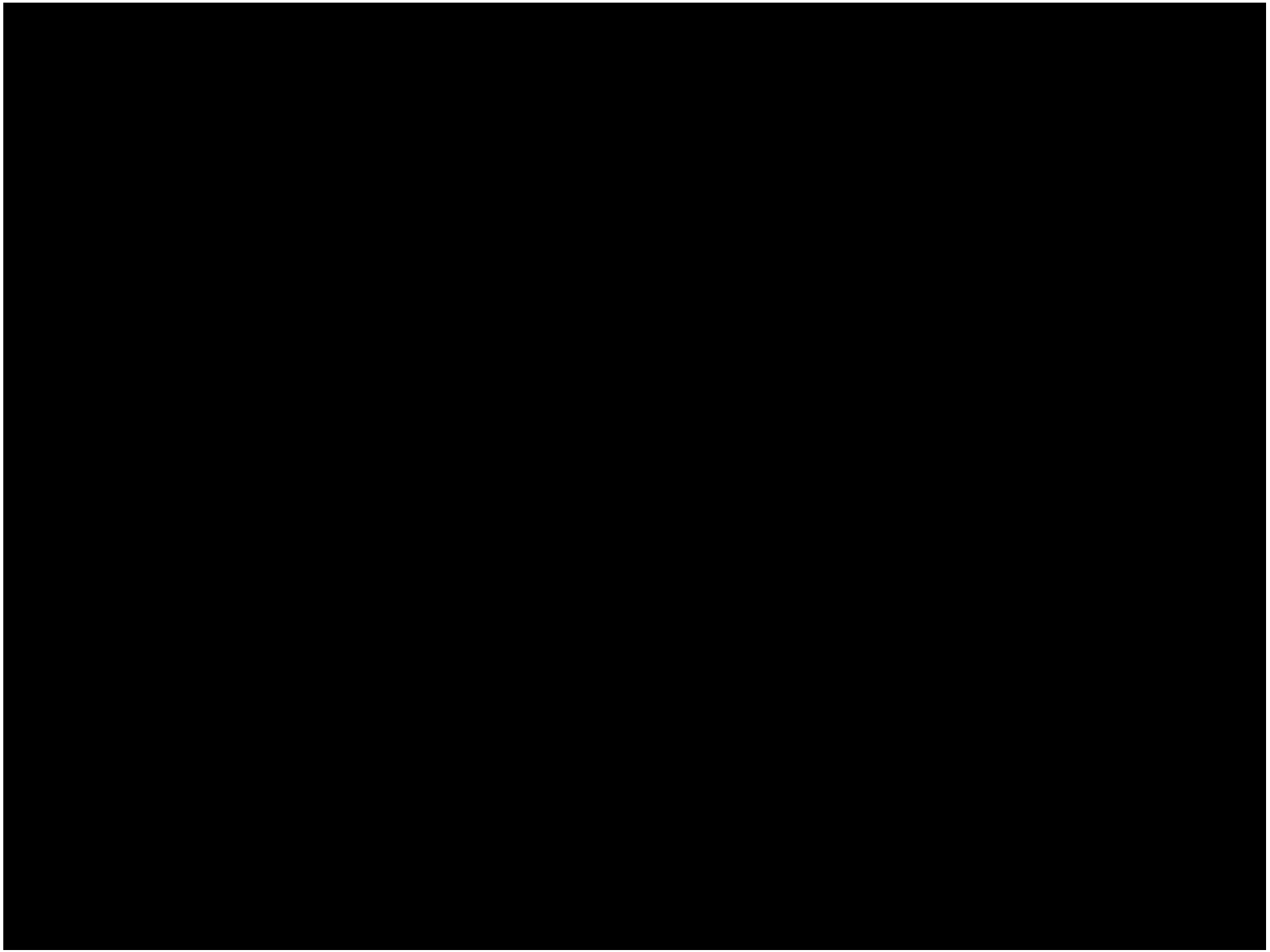


FIG. 10.—Post-fit timing residuals in microseconds are plotted vs. day number showing the effect of a plasma cloud passing between the Earth and the pulsar as observed at 1 GHz. The total change in dispersion measure is 8×10^{-3} pc cm^{-3}.





+ transverse motion of

pulsar $\gtrsim$ 200 $\frac{km}{s}$

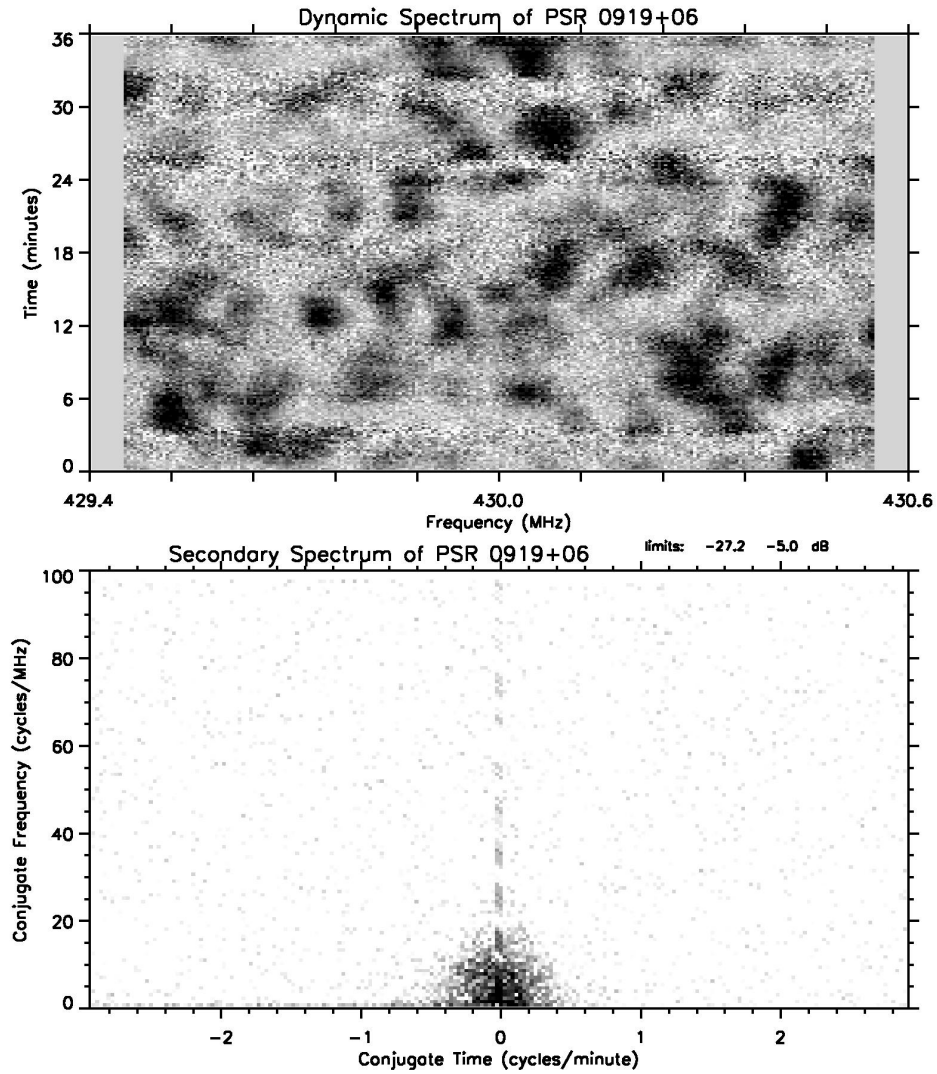
Earth 30 $\frac{km}{s}$

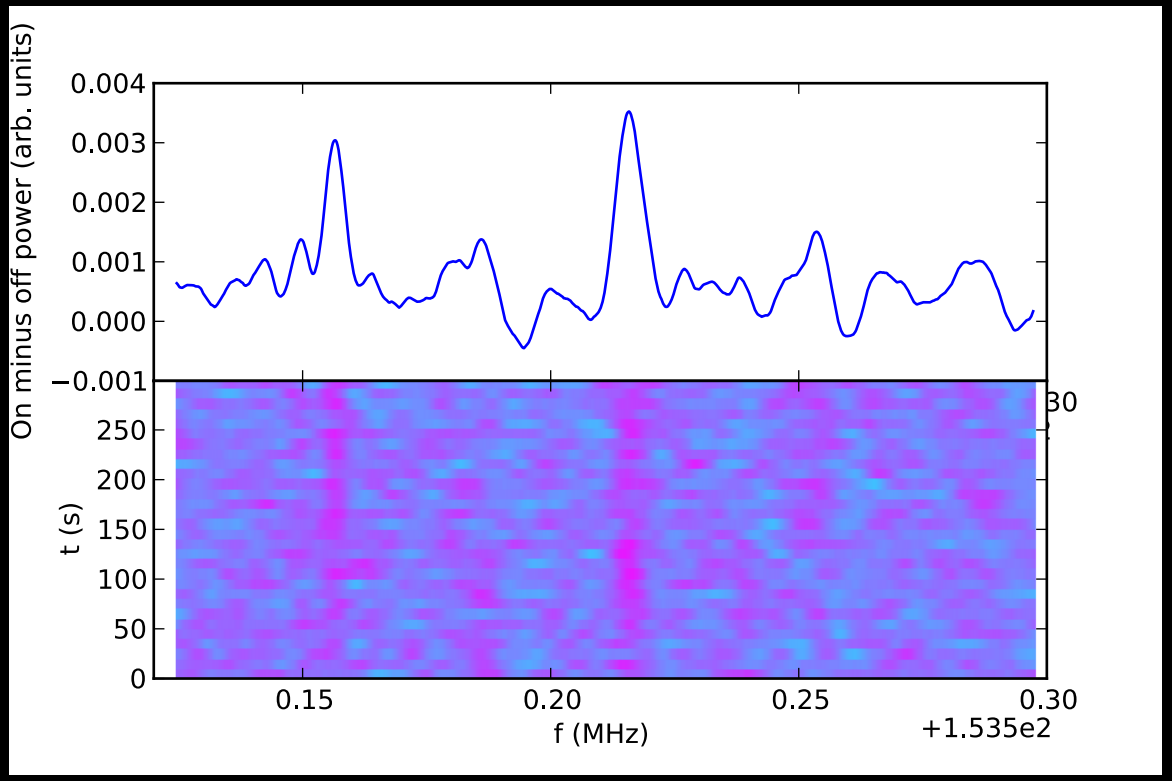
ISM $\lesssim$ 10 $\frac{km}{s}$

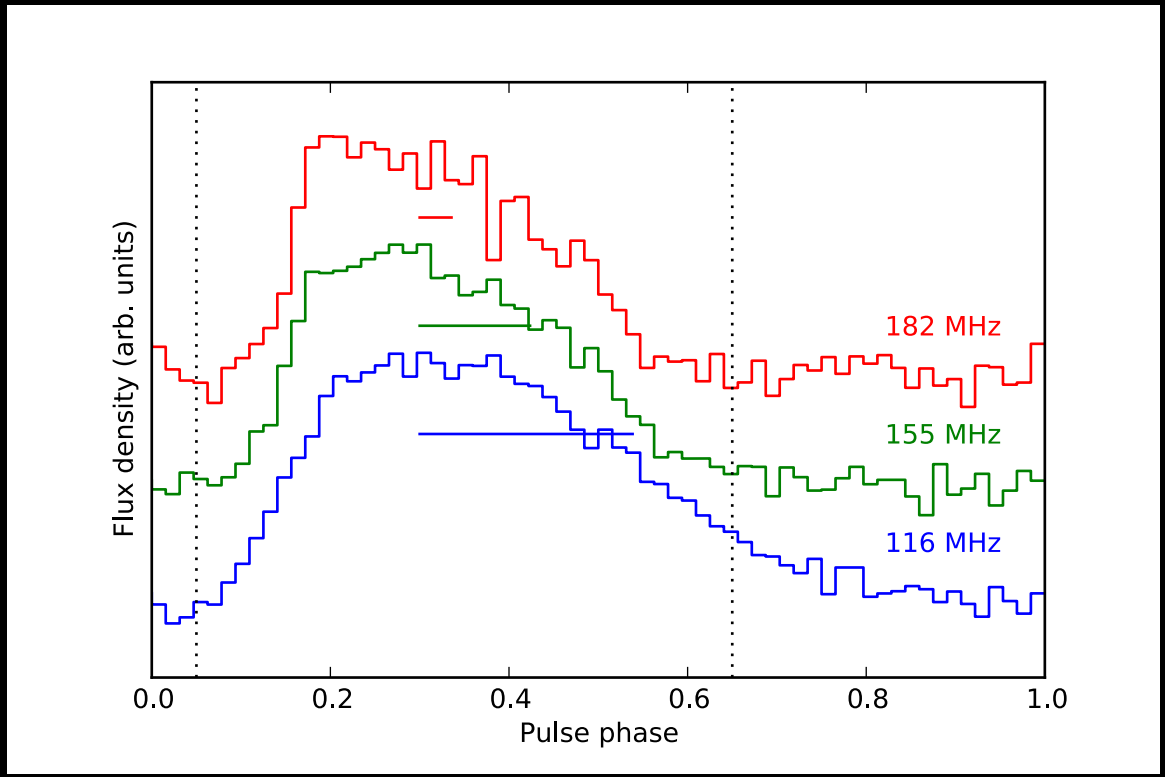
$\Longrightarrow$ time variability of spectrum

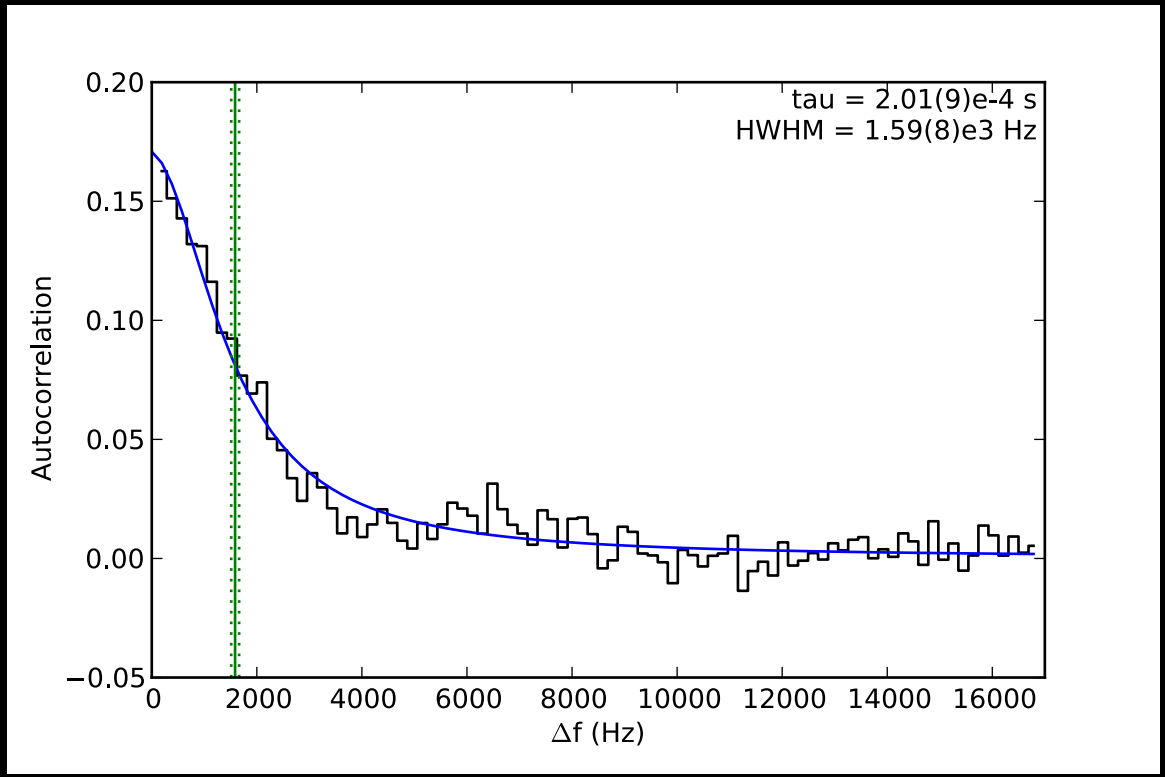
i.e. Dynamic Spectrum

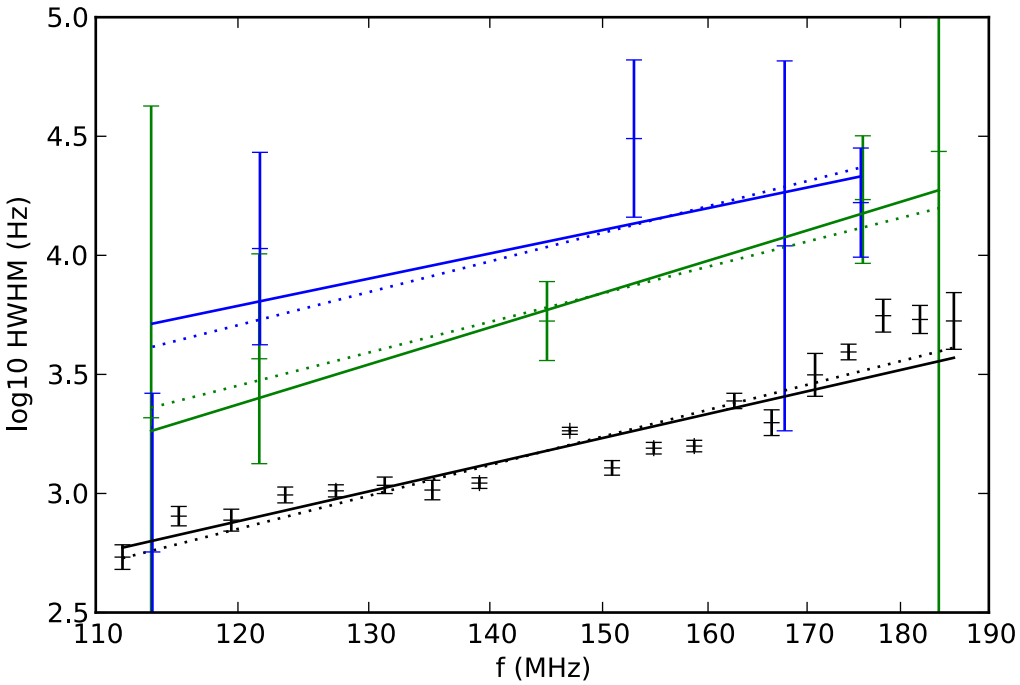
$S(\nu, t)$

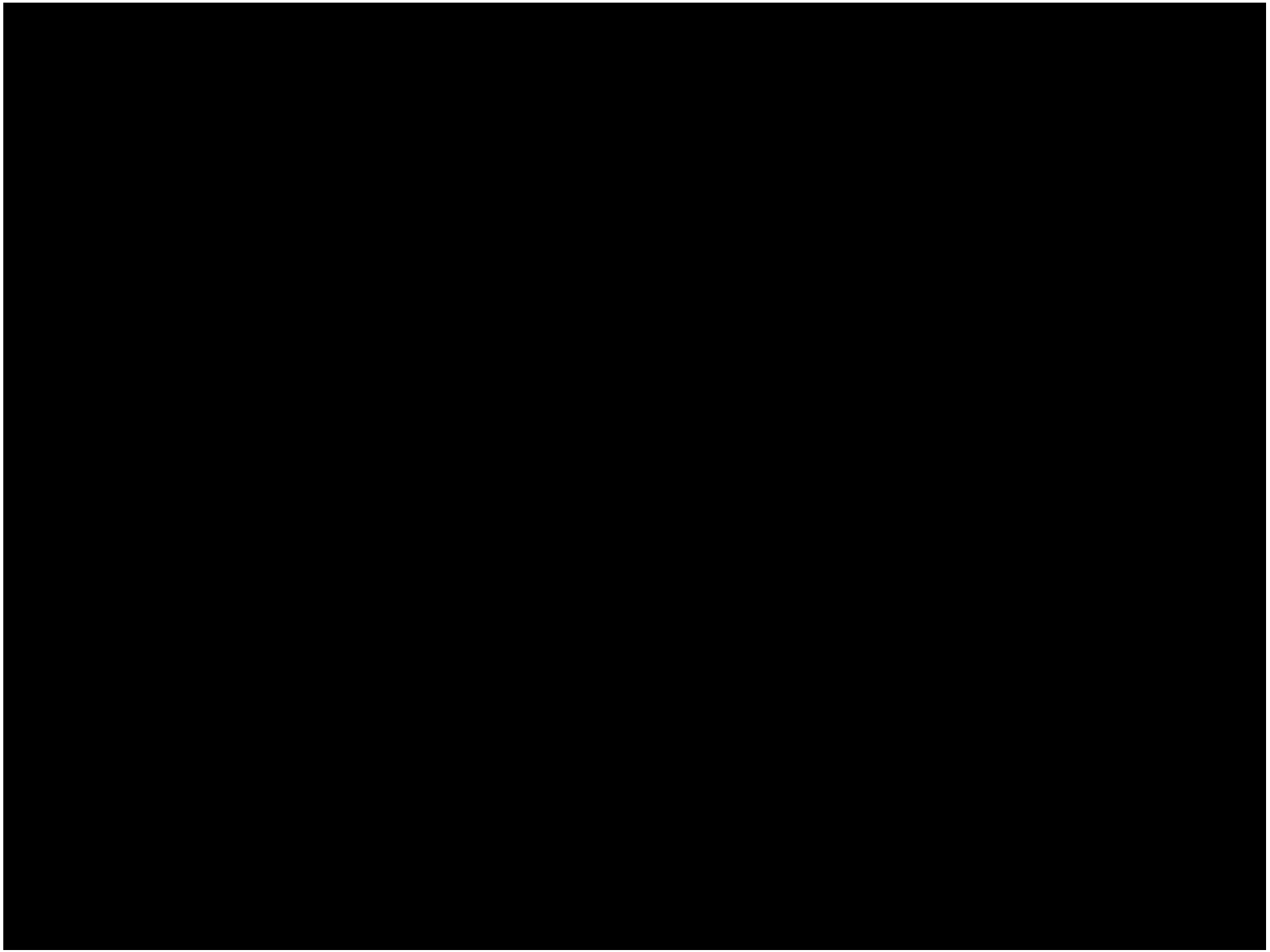

Dynamic Spectrum of PSR 0919+06
Time (minutes)
36
30
24
18
12
6
0
429.4
430.0
430.6
Frequency (MHz)
Secondary Spectrum of PSR 0919+06
limits: -27.2 -5.0 dB
Conjugate Frequency (cycles/MHz)
100
80
60
40
20
0
-2
-1
0
1
2
Conjugate Time (cycles/minute)

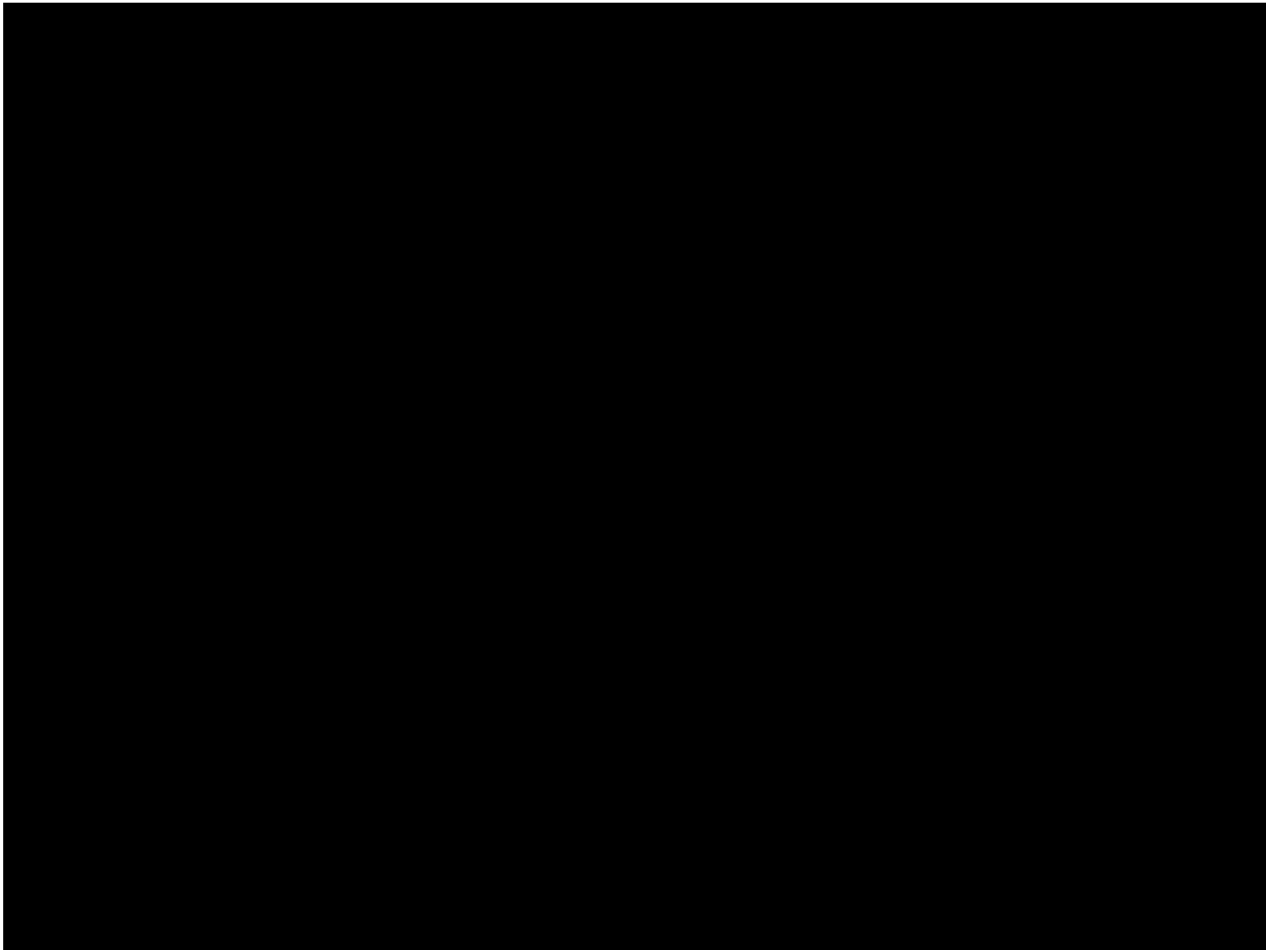

On minus off power (arb. units)
0.004
0.003
0.002
0.001
0.000
−0.001
t (s)
250
200
150
100
50
0
0.15
0.20
0.25
0.30
f (MHz)
+1.535e2

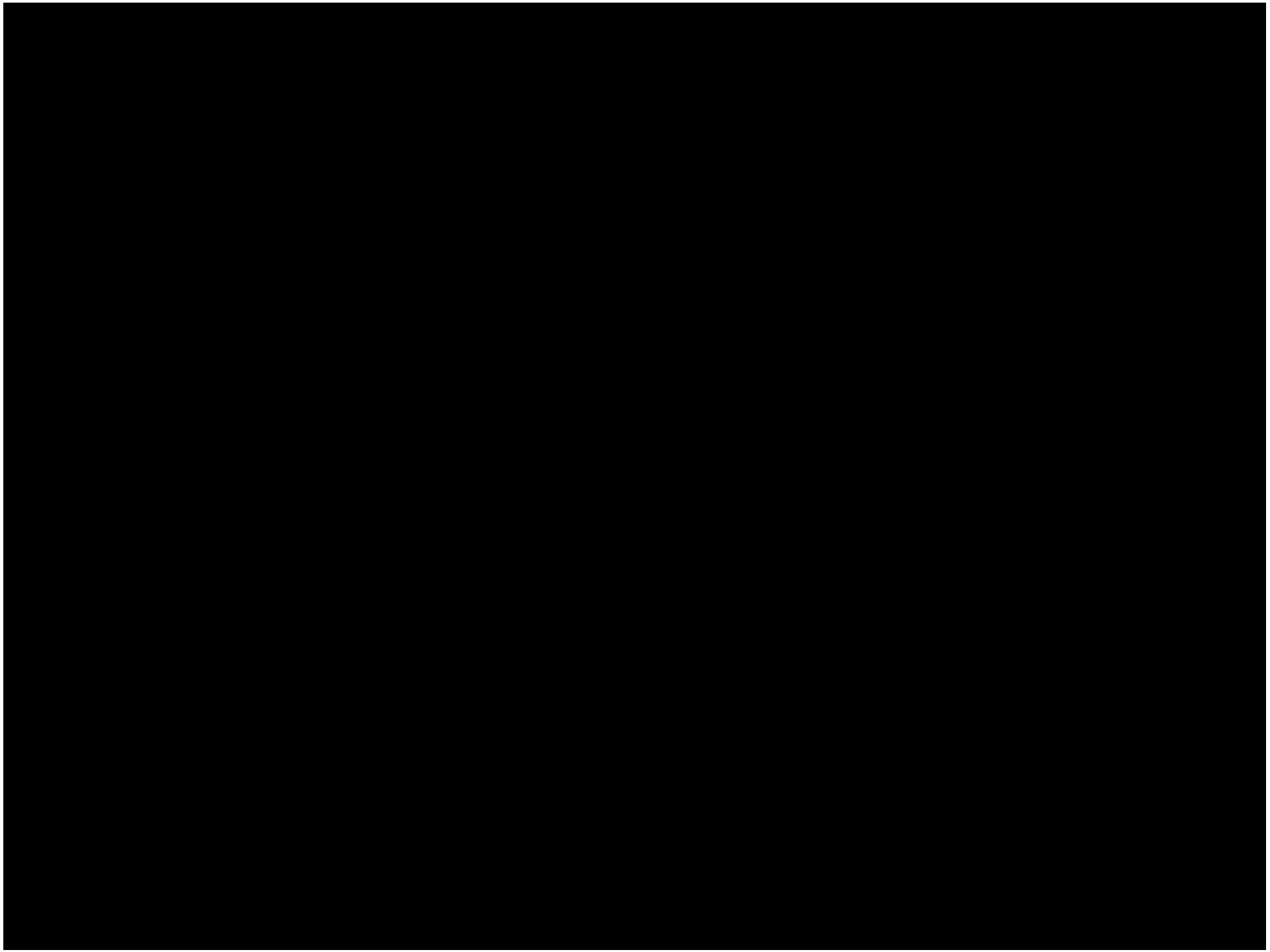

Flux density (arb. units)
182 MHz
155 MHz
116 MHz
0.0
0.2
0.4
0.6
0.8
1.0
Pulse phase

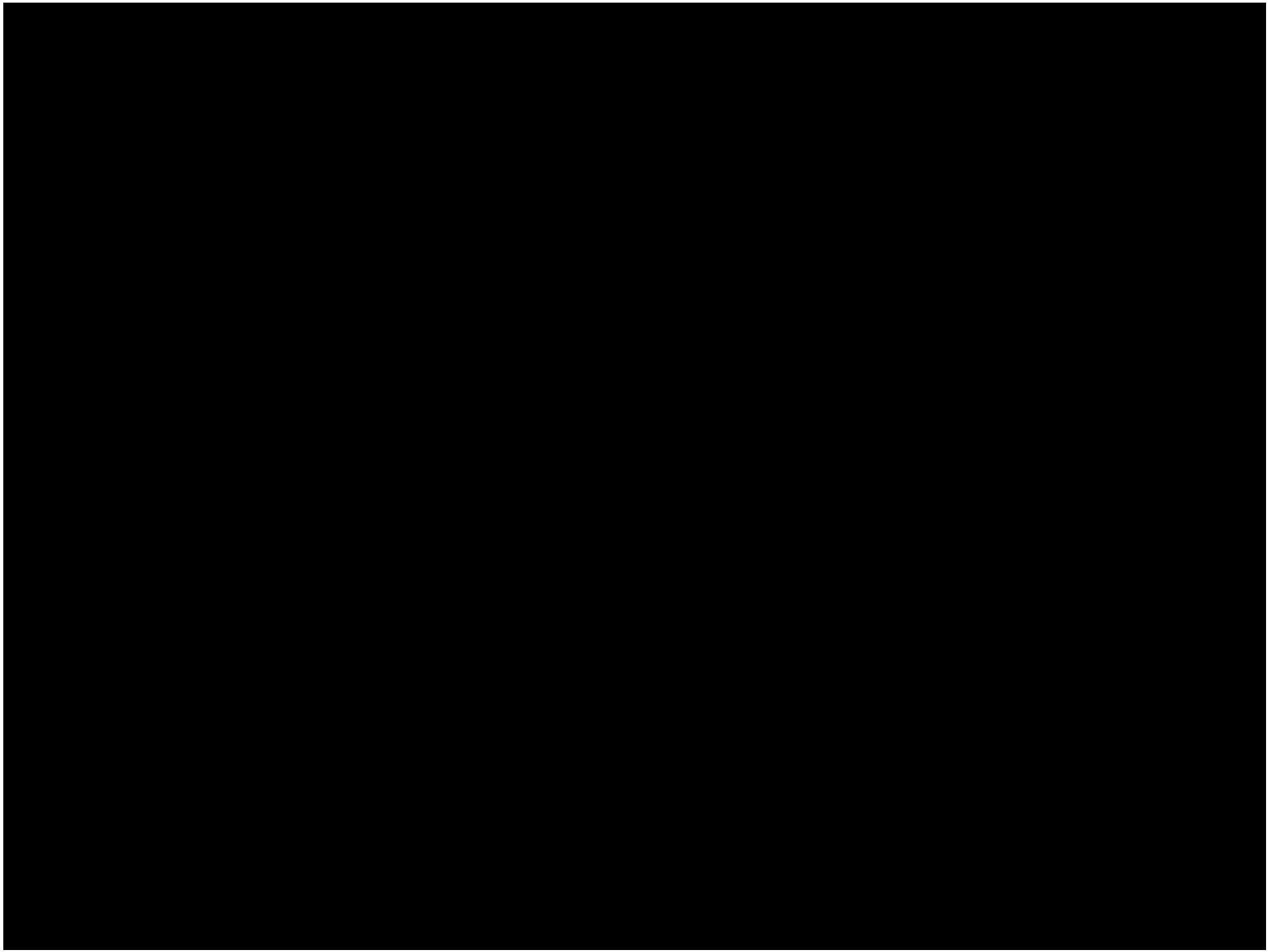

tau = 2.01(9)e-4 s
HWHM = 1.59(8)e3 Hz
Autocorrelation
0.20
0.15
0.10
0.05
0.00
−0.05
0
2000
4000
6000
8000
10000
12000
14000
16000
Δf (Hz)


5.0
4.5
4.0
3.5
3.0
2.5
log10 HWHM (Hz)
110
120
130
140
150
160
170
180
190
f (MHz)

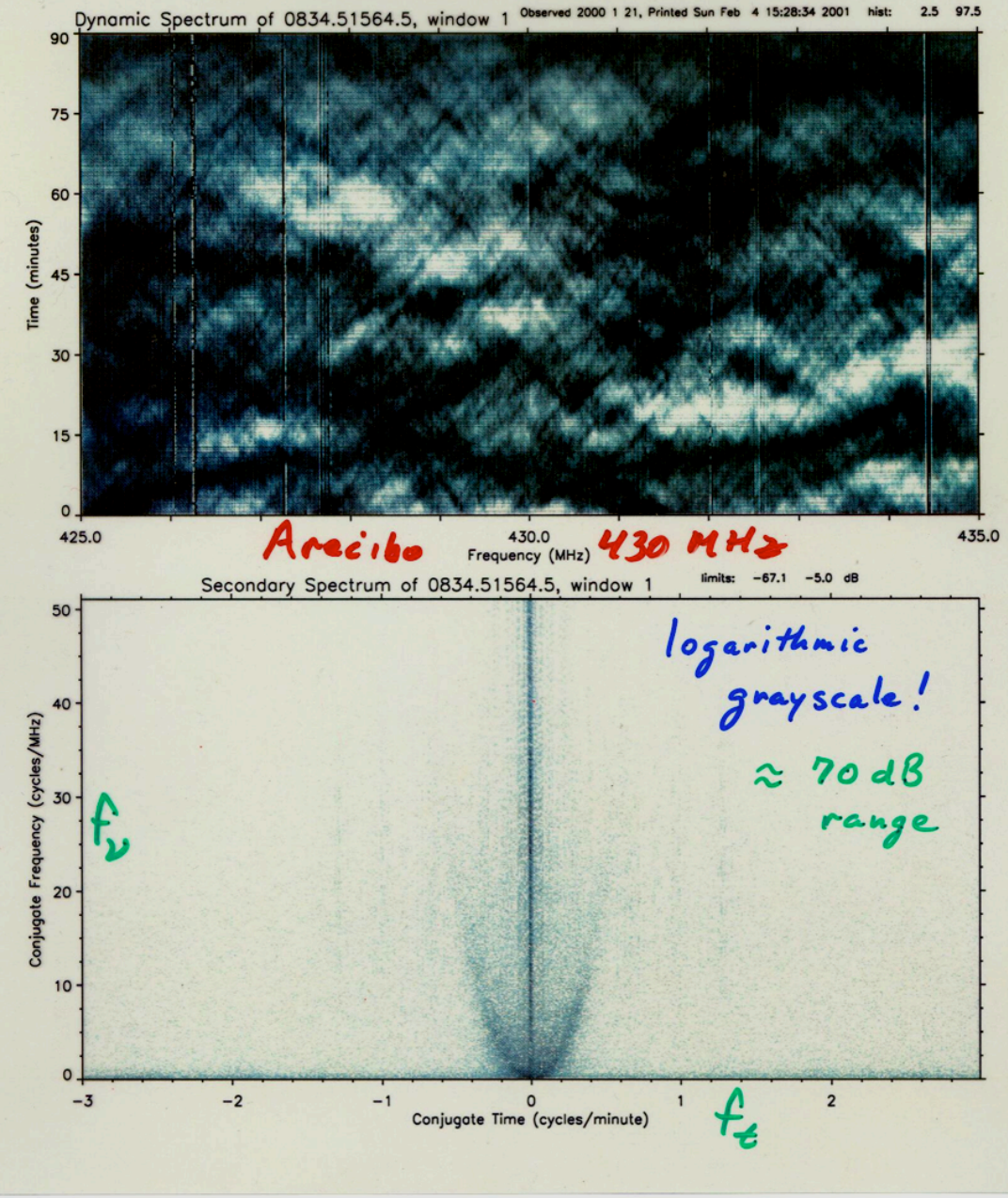




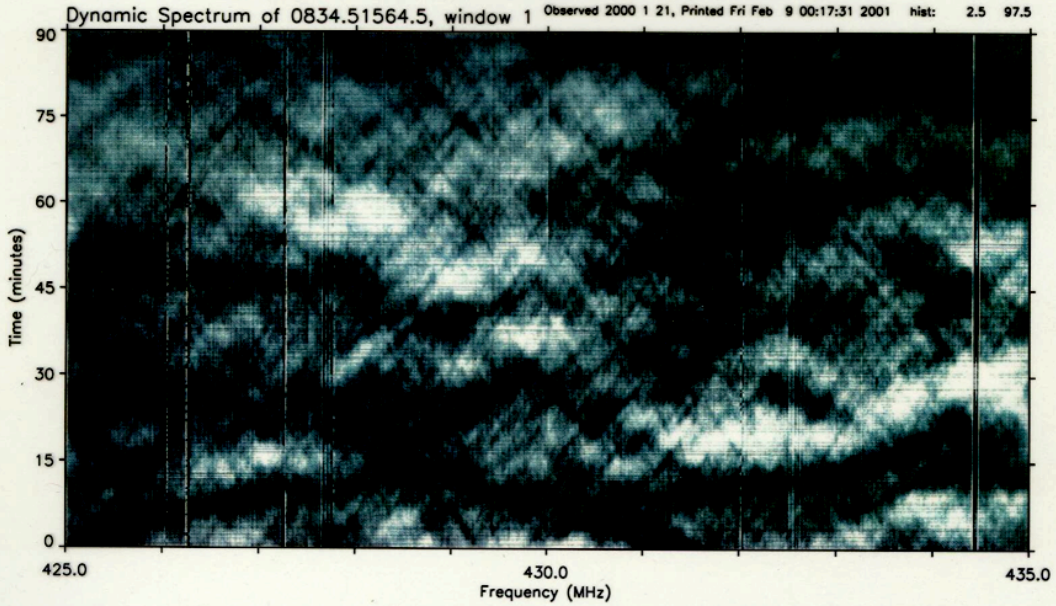


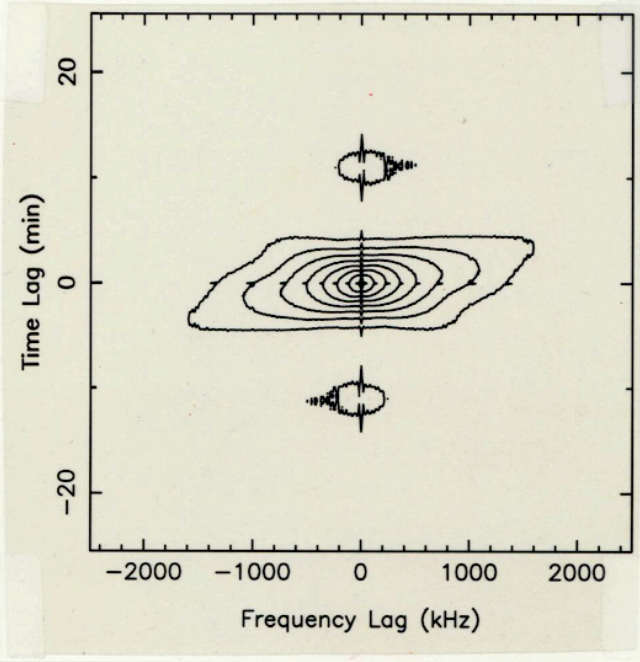


PSR B0834+06


Dynamic Spectrum of 0834.51564.5, window 1
Observed 2000 1 21, Printed Sun Feb 4 15:28:34 2001
hist: 2.5 97.5
Time (minutes)
90
75
60
45
30
15
0
425.0
430.0
435.0
Frequency (MHz)
Arecibo
430 MHz
Secondary Spectrum of 0834.51564.5, window 1
limits: −67.1 −5.0 dB
Conjugate Frequency (cycles/MHz)
50
40
30
20
10
0
−3
−2
−1
0
1
2
Conjugate Time (cycles/minute)
f_ν
f_t
logarithmic grayscale!
≈ 70 dB range

PSR B0834+06


Dynamic Spectrum of 0834.51564.5, window 1
Observed 2000 1 21, Printed Fri Feb 9 00:17:31 2001 hist: 2.5 97.5
Time (minutes)
90
75
60
45
30
15
0
425.0
430.0
435.0
Frequency (MHz)


Time Lag (min)
20
0
−20
−2000
−1000
0
1000
2000
Frequency Lag (kHz)

the data:

B1257+12 (20 min)
J1810+1744 (5 min!)
  black widow
J2317+1439 (20 min)