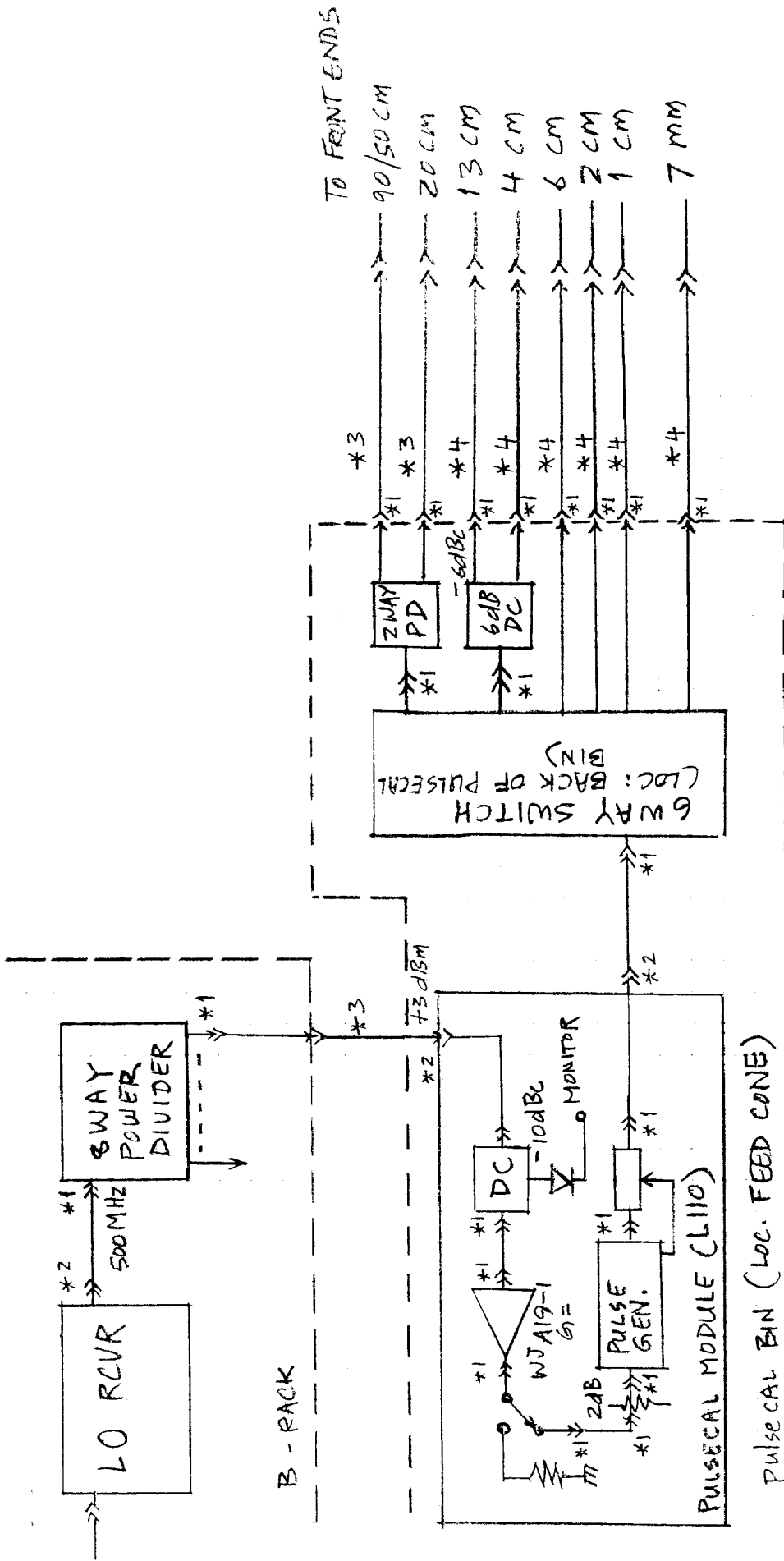# PULSECAL PHASE STABILITY—-CURRENT STATUS

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1993Mar01

VLBA style pulsecal generators have now been installed at both Los Alamos and Pie Town antennas. This memo describes results of the phase stability tests on these antennas with the new pulsecal generators and their associated injection (distribution and cabling) scheme to various frontends. The block diagram in Fig. 1 gives a schematic of the pulsecal signal distribution to various frontends in an antenna. For the distribution of the pulsecal signal we have used low temperature coefficient (phase stable) cables as far as practical. types of cables and their approximation lengths used in the system are shown in the block diagram. The expected temperature coefficients of the cables used and the pulsecal generator are also given in the block diagram. The block diagram of the test set up is shown in Fig. 2. The antennas were left in stow position during these tests. Figs. 3 and 4 give plots of temperature monitor data for PT antenna building and vertex room respectively for about 8 hours of test time on 93Feb01. Fig. 5 gives the cablecal monitor data, and Fig. 6 gives the pulsecal phases for various BBCs during the test time at PT. Figs. 7-10 are similar data for LA. From these data we see that the variations of the pulsecal phases for different BBCs track the cablecal variations roughly as expected (both in magnitude and sign). There is a few dgrees peak to peak ($\leq 5°$/GHz of BBC LO frequency, which corresponds to about 1.6 ps) variation having periodicity of station building HVAC air temperature cycling (of about 5-7°C) at both PT and LA. This can be seen more clearly from data of 93Feb12 for LA (Fig. 11: Temperature plots, Fig. 12: Cablecal values, and Fig. 13: Pulsecal phases). This is probably due to the change in phase of the 5 MHz reference to various BBCs—-variations required to be measured by the pulsecal phase monitoring system to correct phases of the astronomical signals.

During the test time temperature settings in the vertex rooms were varied by about 5°C at both PT and LA (Figs. 4 and 8). No obvious affects can be seen in the pulsecal phases at more than a couple of degrees (Figs. 6 and 10) corresponding to these temperature changes. It seems that pulsecal phases are fairly insensitive to the vertex room temperature changes. Overall the pulsecal phase monitoring system seems to perform at a few degrees accuracy which translates to less than a couple of ps for the 4 cm system where all these tests have been carried out. At this level we have to make astronomical observations in interferometer mode and use the pulsecal phases to correct the (astronomical) data, and see improvement in its quality to determine effectiveness of the (pulsecal phase measurement) system.

Phase glitches: In pulsecal phase plots for LA on 93Feb01 (Fig. 10) on four occasions there are phase glitches of about 10° in BBCs 1-6 (having 4cm band signals) and about 2-3° in BBCs 7-8 (having 13 cm band signals). These glitches seemed to have lasted for about 1-2 min and it appears that these have been caused by pulsecal (rf) comb signal injected in the two (4 and 13 cm) frontends. We have earlier noticed this type of behaivour in VLBA design pulsecal system installed at PT but did not notice such a behaviour in old design 5 MHz based pulsecal generators at other antennas or even at LA. This, combined with the fact that we have
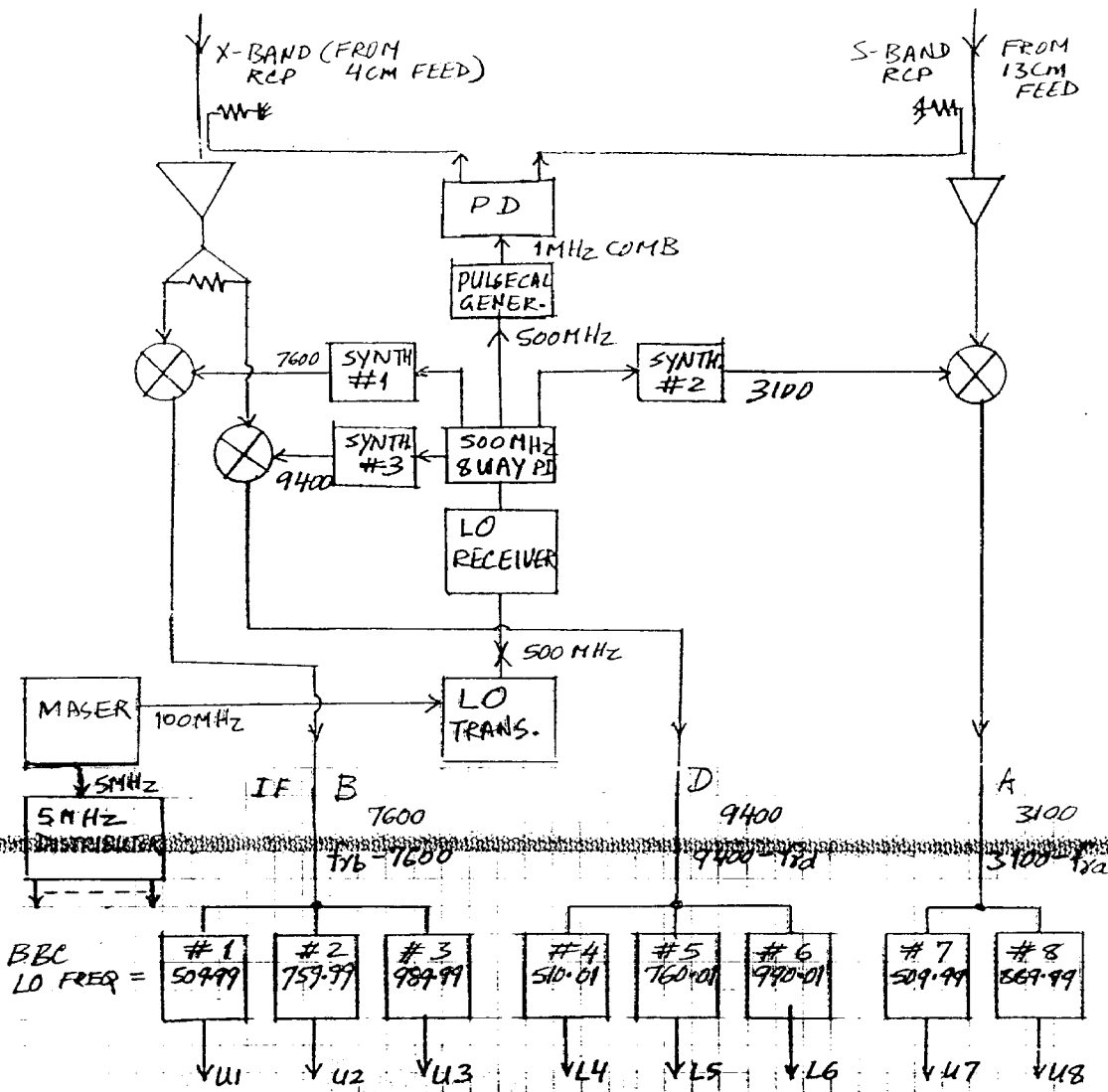
noticed some instabilty in laboratory in the 500 MHz driven comb generators, it is likely that this problem is caused by the 500 MHz driven comb generators used in these pulsecal generator modules. Larry Beno has since modified these comb generators to eliminate the instability seen in the lab. The modified units have been installed both at PT and LA. Pulsecal phase data taken at LA for more than 100 hours with the modified comb generator have not shown any glitches (i.e. Figs. 13 and 14) simultaneously in all BBCs (there have been some occasional glitch in a BBC— mostly one data point at a time, which may be due to other parts of the system like connectors or monitor/control). Therefore it appears that this problem was associated with the instability in the comb generators, and is probably solved, but we will watch for it for sometime.

LO RCVR

500MHz

8 WAY POWER DIVIDER

B - RACK

TO FRONT ENDS

90/50 CM
20 CM
13 CM
4 CM
6 CM
2 CM
1 CM
7 MM

2 WAY PD

6dB DC

-6dBc

6 WAY SWITCH
(LOC: BACK OF PULSECAL BIN)

+3 dBm

DC

-10dBc

MONITOR

WJA19-1
G =

2dB

m

PULSE GEN.

PULSECAL MODULE (L110)

PULSECAL BIN (LOC. FEED CONE)

*1 SMA
*2 OSP
*3 3/8" HELIAX CABLE (ANDREW) ±9 PPM/°C
*4 0.141 SEMI RIGID PRECISION MAKE (TYPE C1L50141: 17 PPM/°C)
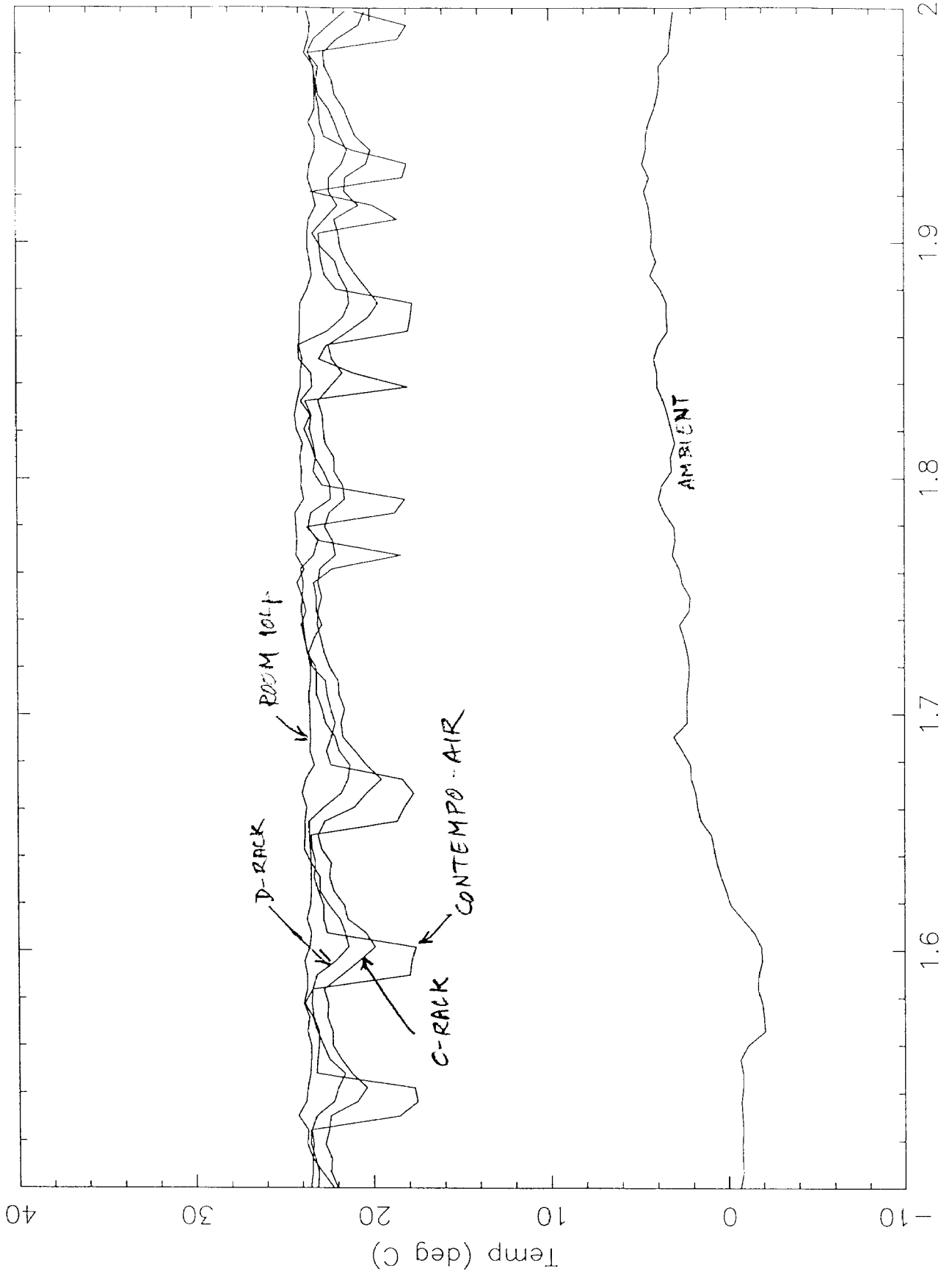
FIG. 1 — PULSE CAL DISTRIBUTION BLOCK DIAGRAM

FIGURE 2 — OBSERVING SET UP

X-BAND (FROM RCP 4CM FEED)

S-BAND RCP — FROM 13CM FEED

P D

1MHz COMB

PULSECAL GENER.

500MHz

SYNTH #1 — 7600

SYNTH #2 — 3100

SYNTH #3 — 9400

500MHz 8WAY PD

LO RECEIVER

500 MHz

LO TRANS.

MASER — 100MHz

5MHz

5MHz DISTRIBUTER

IF   B   7600

D   9400

A   3100

T_{1b} 7600

9400 T_{1d}

3100 T_{1a}

BBC LO FREQ =

#1 509.99	#2 759.99	#3 989.99	#4 510.01	#5 760.01	#6 990.01	#7 509.99	#8 869.99
$U1$	$U2$	$U3$	$L4$	$L5$	$L6$	$U7$	$U8$

RF FREQ OF SIGNAL IN BBC			10 kHz Tone RF FREQ			
1,2,3	$\nu_{rf1,2,3}$	$7600 + BBCLO_{1,2,3} + .01$	8110,	8360.	8590 MHz	
4,5,6	$\nu_{rf4,5,6}$	$9400 - BBCLO_{4,5,6} - .01$	8890	8640	8410	
7,8	$\nu_{rf7,8}$	$3100 - BBCLO_{7,8} - .01$	2590	2210		

phase of signal in BBC	BBC sideband	Frequency	Phase
1,2,3	U_1, U_2, U_3	$\nu_{rf1,2,3} - 7600 - BBC_{1,2,3}$	$\phi_{rf1,2,3} - \phi_{7600} - \phi_{BBC1,2,3}$
4,5,6	$L4, L5, L6$	$\nu_{rf4,5,6} - 9400 + BBC_{4,5,6}$	$\phi_{rf4,5,6} - \phi_{9400} + \phi_{BBC4,5,6}$
7,8	$U7, U8$	$-\nu_{rf7,8} + 3100 - BBC_{7,8}$	$-\phi_{rf7,8} + \phi_{3100} - \phi_{BBC7,8}$

PT 1993FEB01 — BLDG. Temp.

Fig 3

PT 1993FEBㄴ.--VR Temp.

B-RACK UP

B-RACK LOWER

VR DOWN

VR UP

FCUP FC DOWN

Temp (deg C)
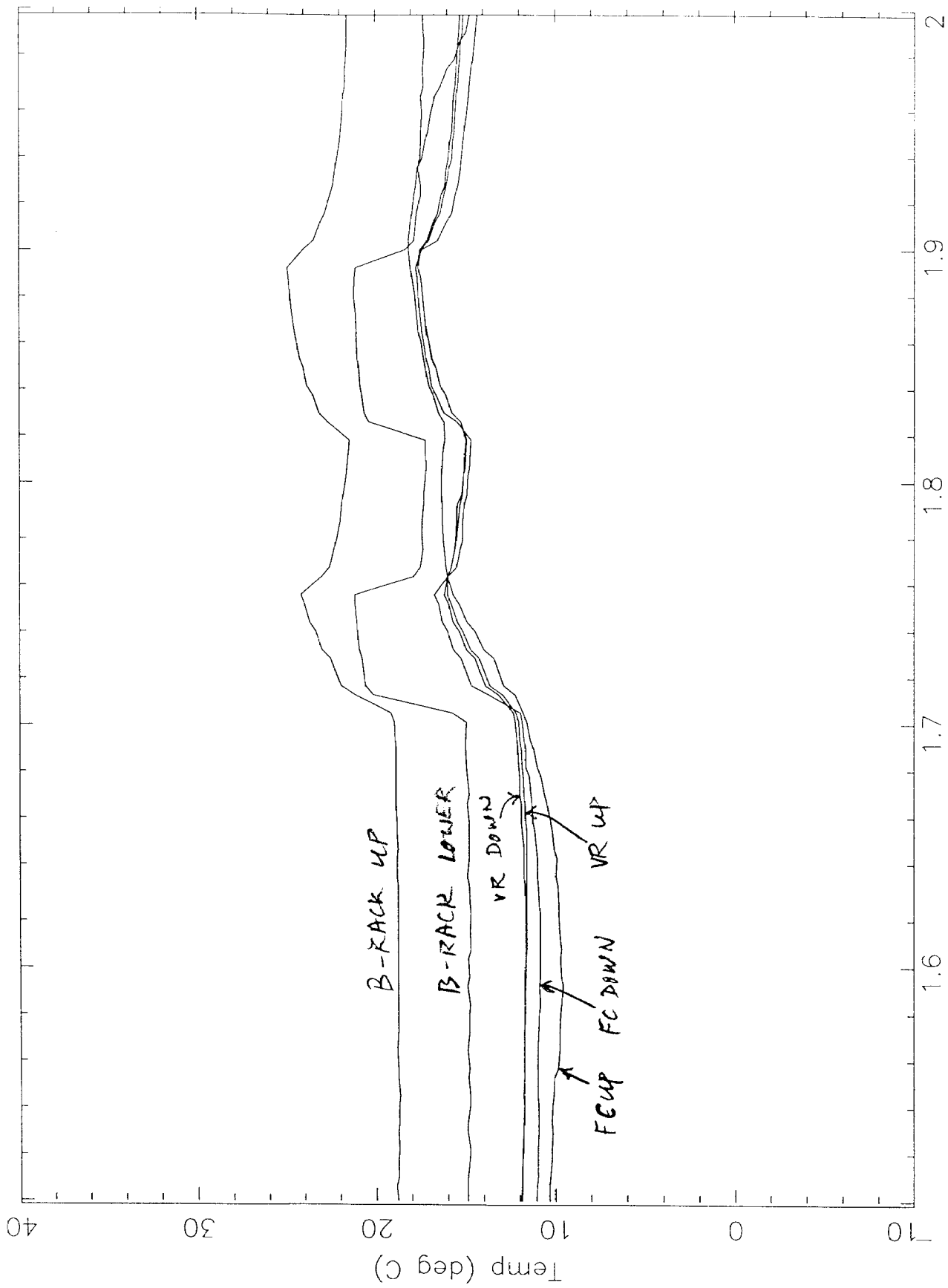
Time (days 1993Feb--)

Fig 4

PT 1993FEB01

Cablecal (psec)
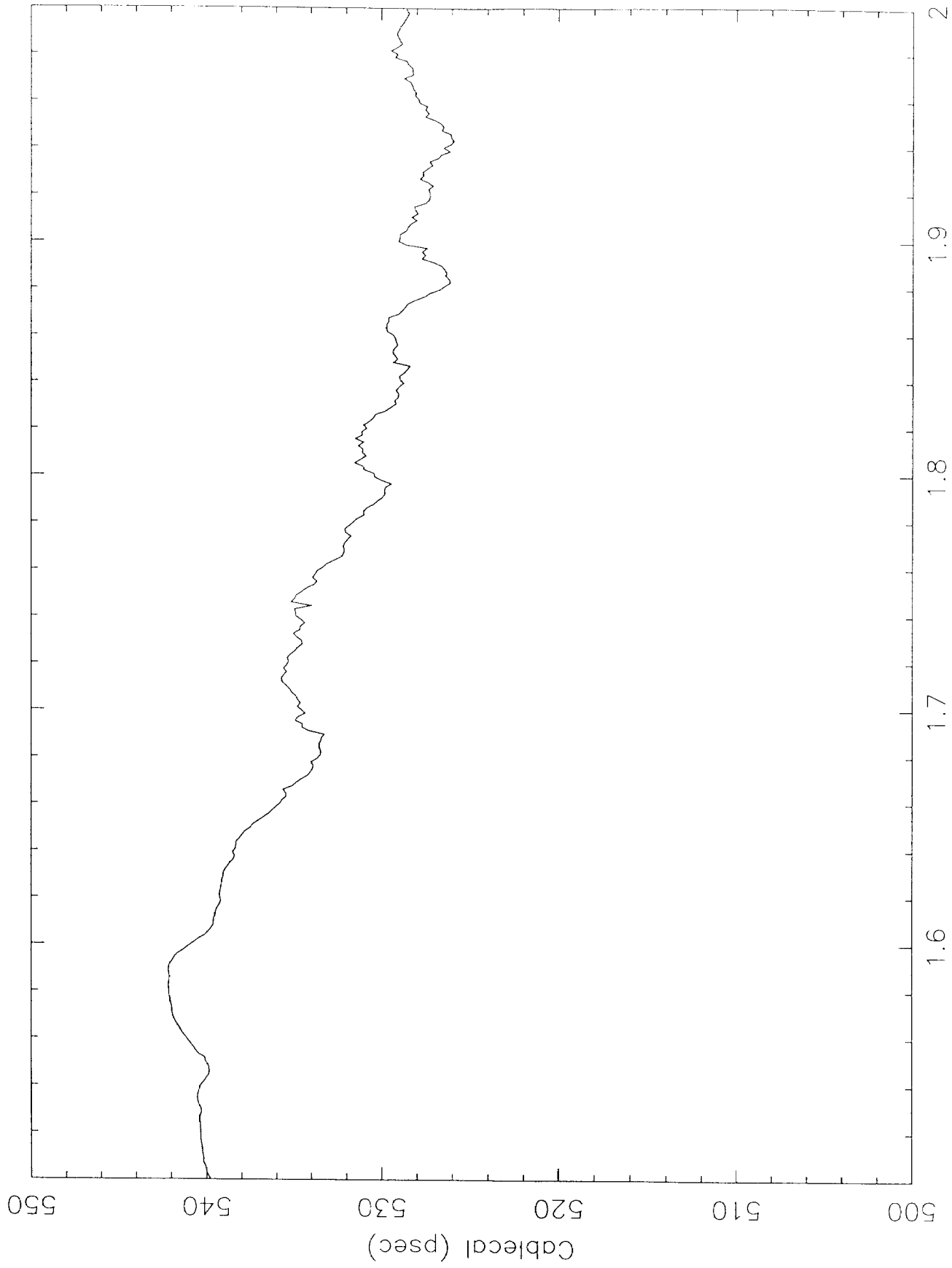
Time (days 1993FEB01)

Fig 5.

PT 1993FEB--

BBC 1
BBC 2
BBC 6
BBC 5
BBC 4

BBC 8

BBC 3

pcal phase(deg)

100

0

-100

1.6   1.7   1.8   1.9   2
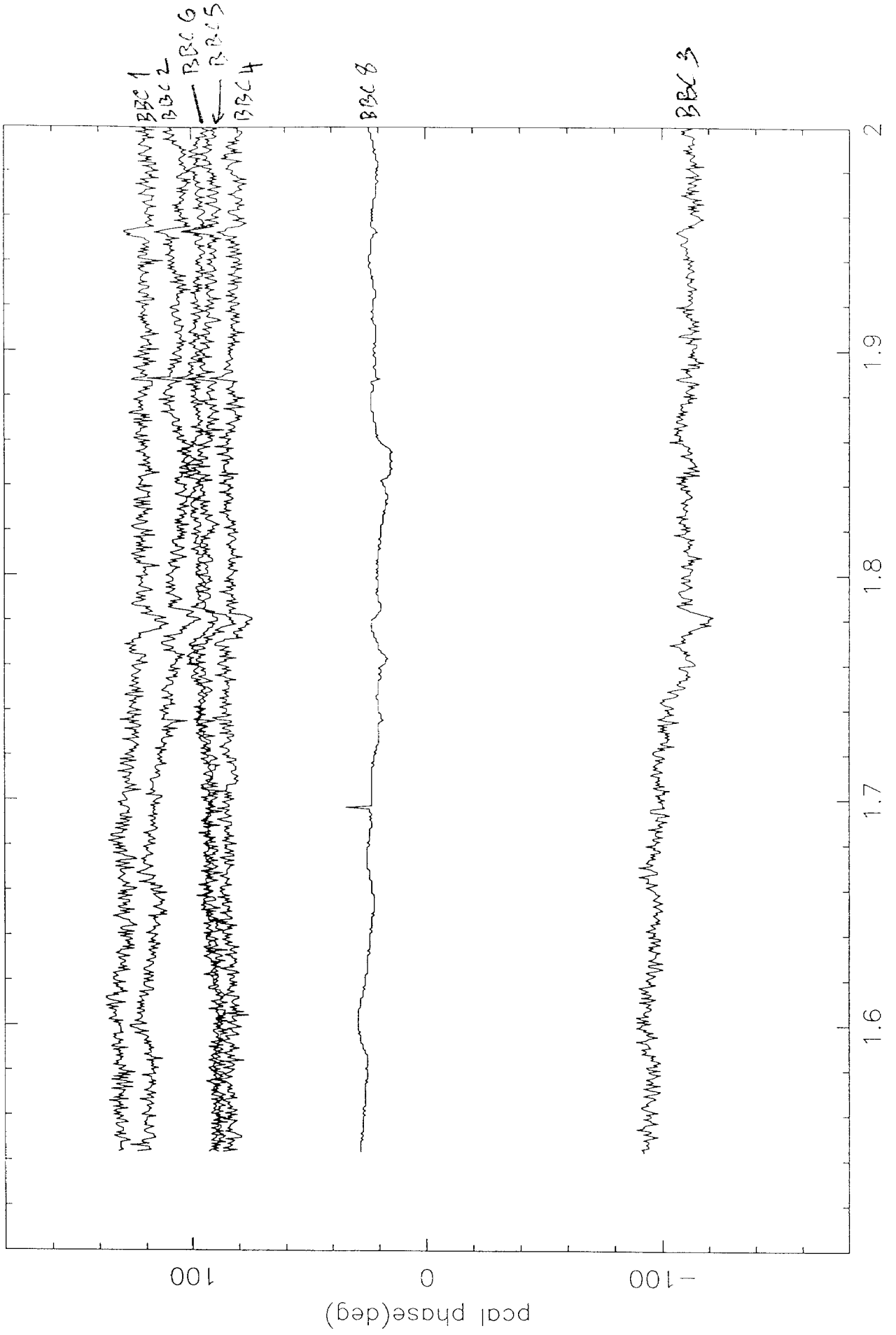
Time (days 1993FEB--)

Fig. 6

LA 1993FEB01--BLDG. Temp.

D-RACK

RM 104

C-RACK

CONTEMPO AIR

AMBIENT

Temp (deg C)

40

30

20

10

0

-10

Time (days 1993Feb——)

1.6   1.7   1.8   1.9   2
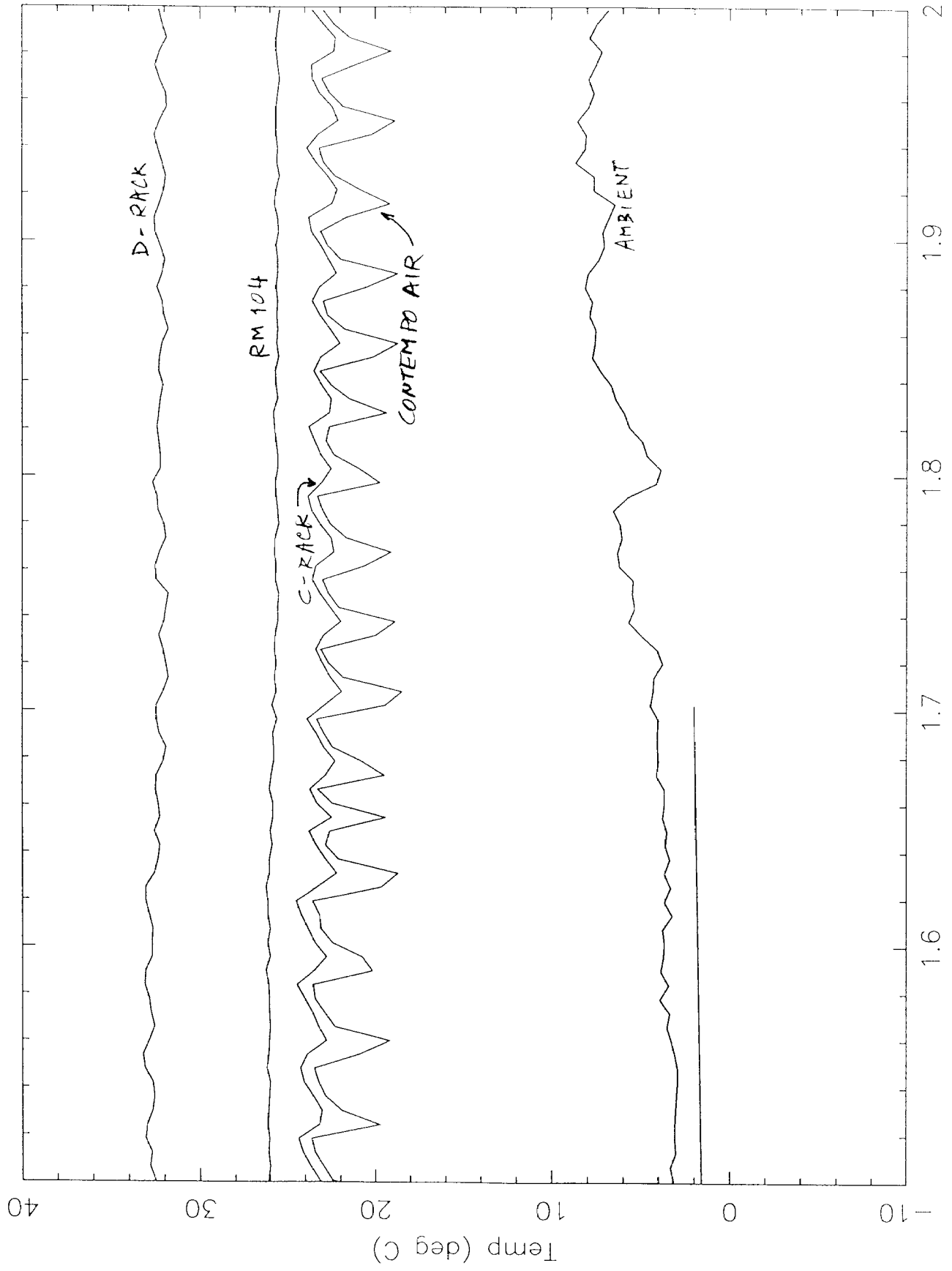
Fig. 7

LA 1993FEBU₁──VR Temp.

B-RACK UP

B-RACK LOWER

VR UP

FC DOWN

VR DOWN

FC UP

Temp (deg C)
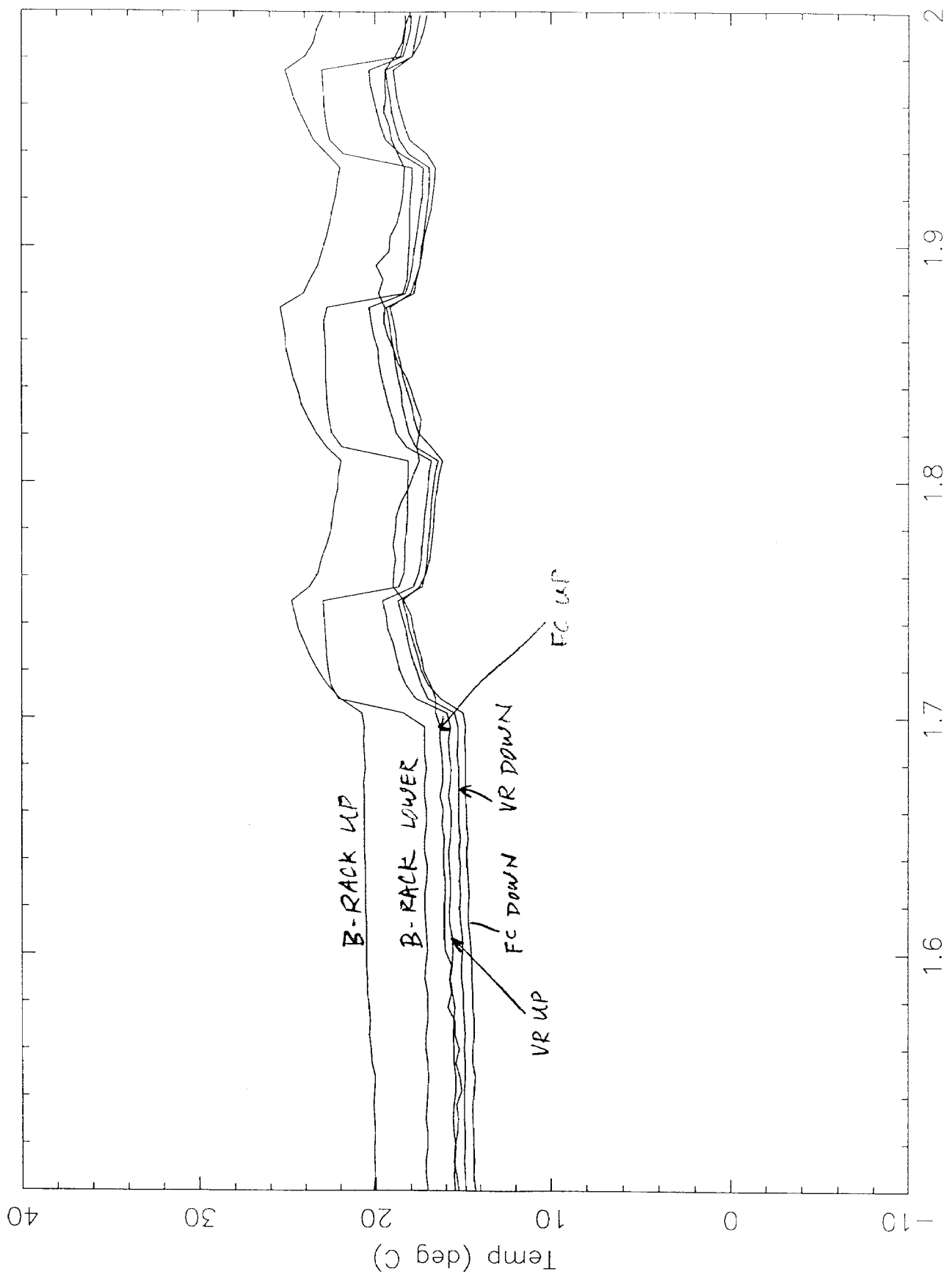
Time (days 1993Feb——)

FiG 8

LA 1993FEB01

Cablecal (psec)
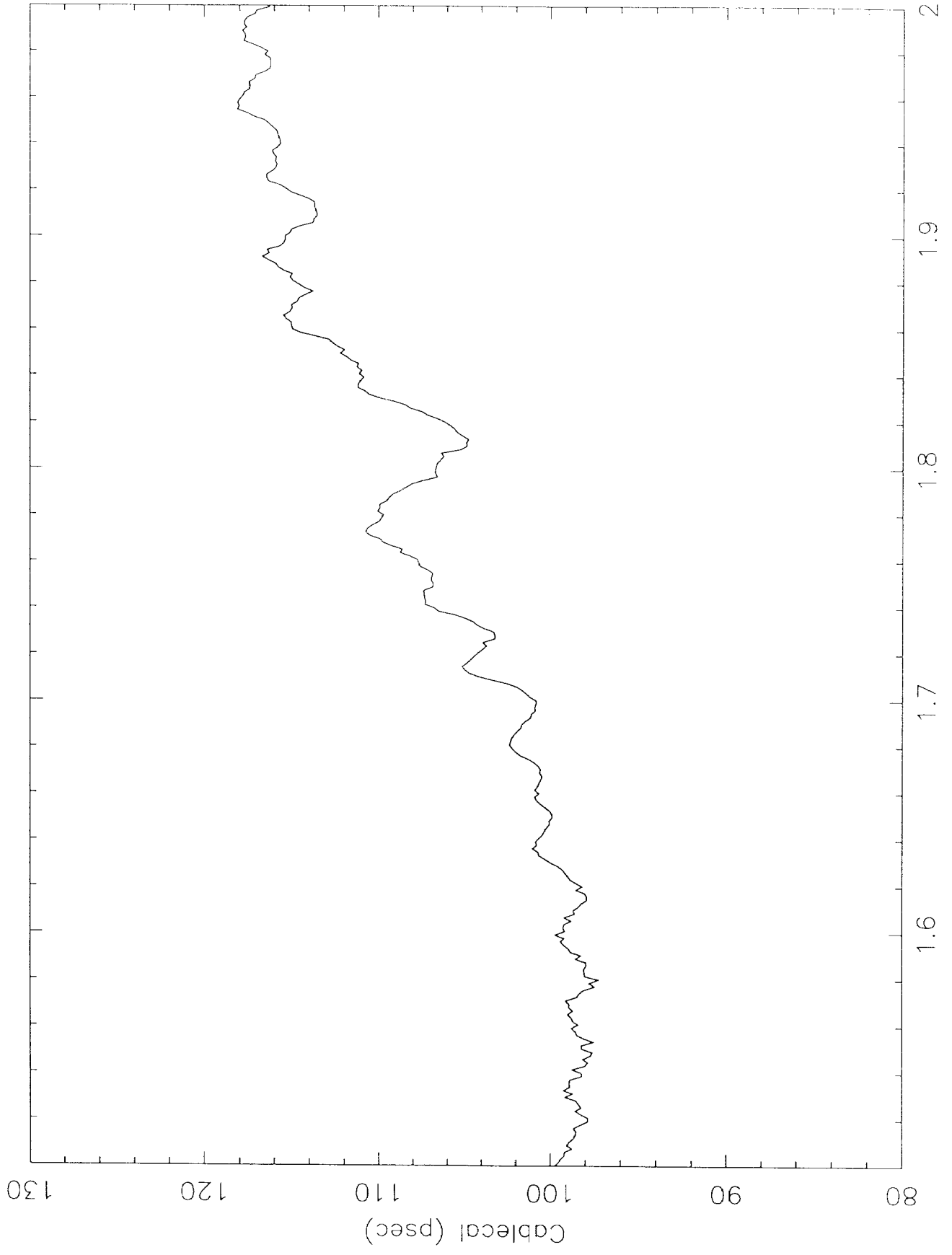
Time (days 1993FEB01)

Fig. 9

LA 1993FEB——
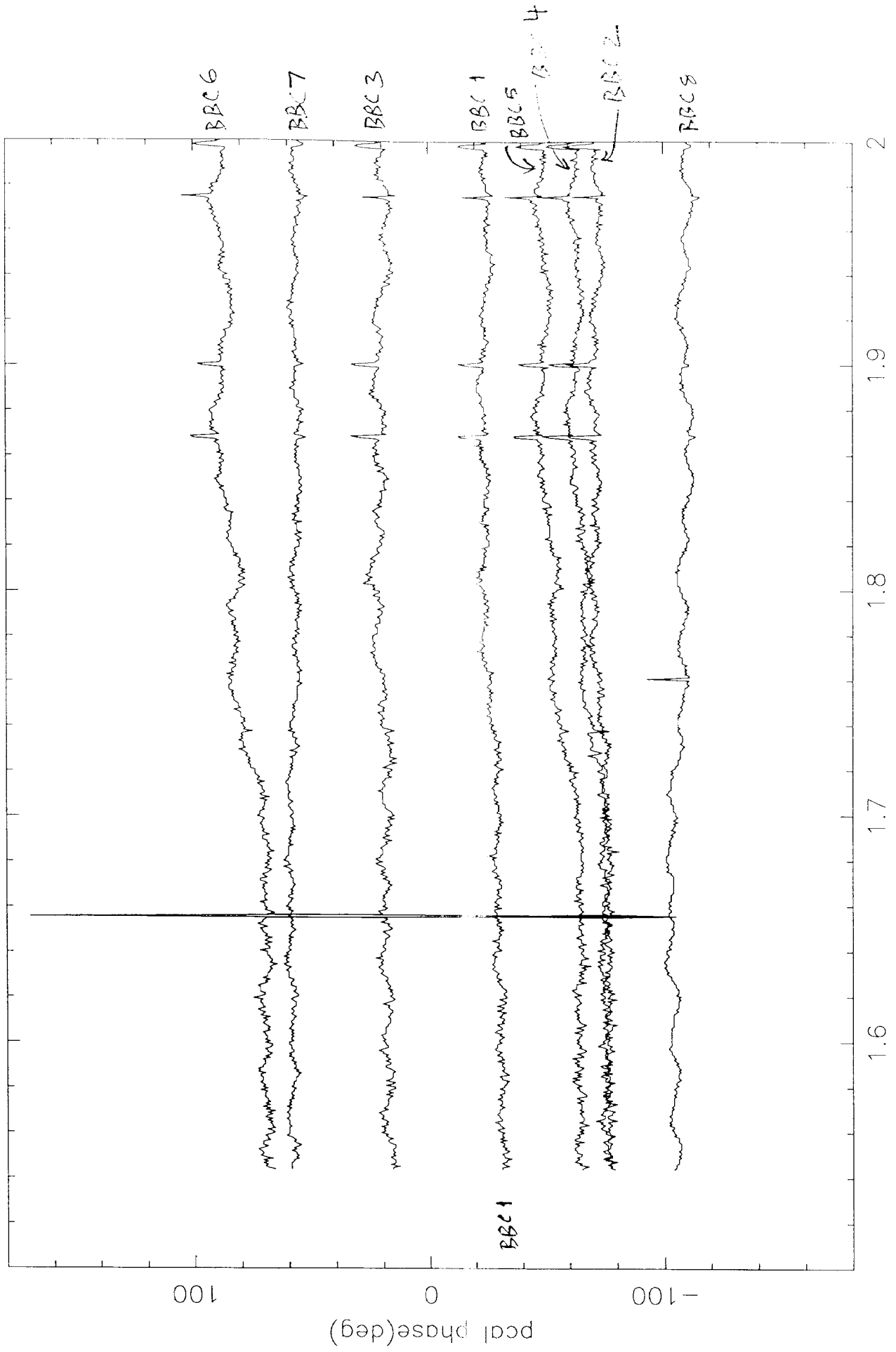
BBC6
BBC7
BBC3
BBC1
BBC5
BBC4
BBC2
BBC8

BBC1

pcal phase(deg)

100

0

-100

Time (days 1993FEB——)

1.6   1.7   1.8   1.9   2

Fig. 10

LA 1993FEB--BLDG. Temp.

D-Rack

C-RACK

ROOM 104

Bldg HVAC AIR

AMBIENT

Temp (deg C)

40 30 20 10 0

Time (days 1993Feb——)

12 12.2 12.4 12.6 12.8 13

FIG. 11

LA 1993FEB——

Cablecal (psec)
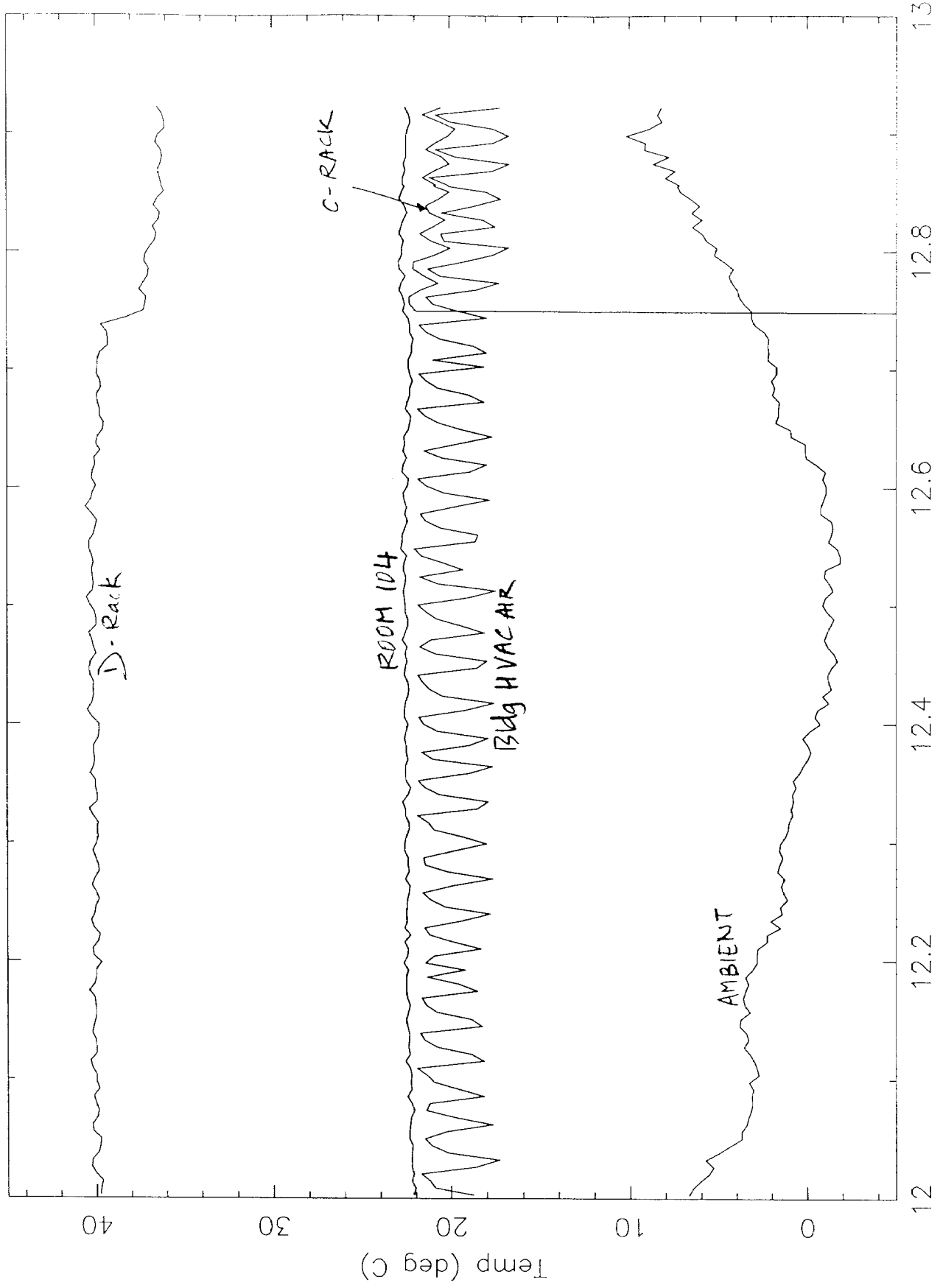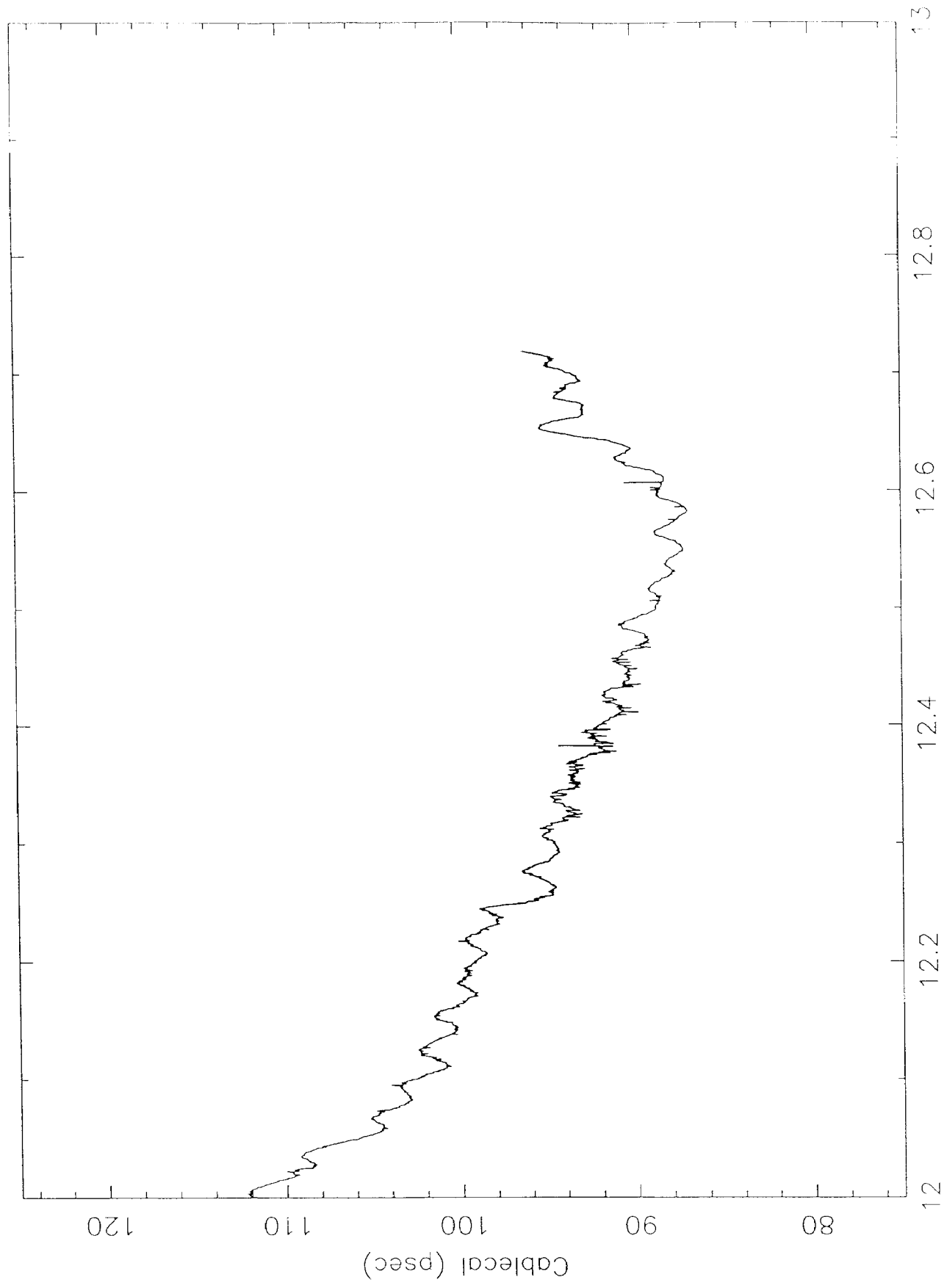
Time (days 1993FEB——)

Fig 12

LA 1993FEB---

pcal phase(deg)

100

0

−100

BBC6
BBC3
BBC8

BBC4

BBC3

BBC6

BBC6

BBC1

BBC5

BBC7

BBC2

12   12.2   12.4   12.6   12.8   13
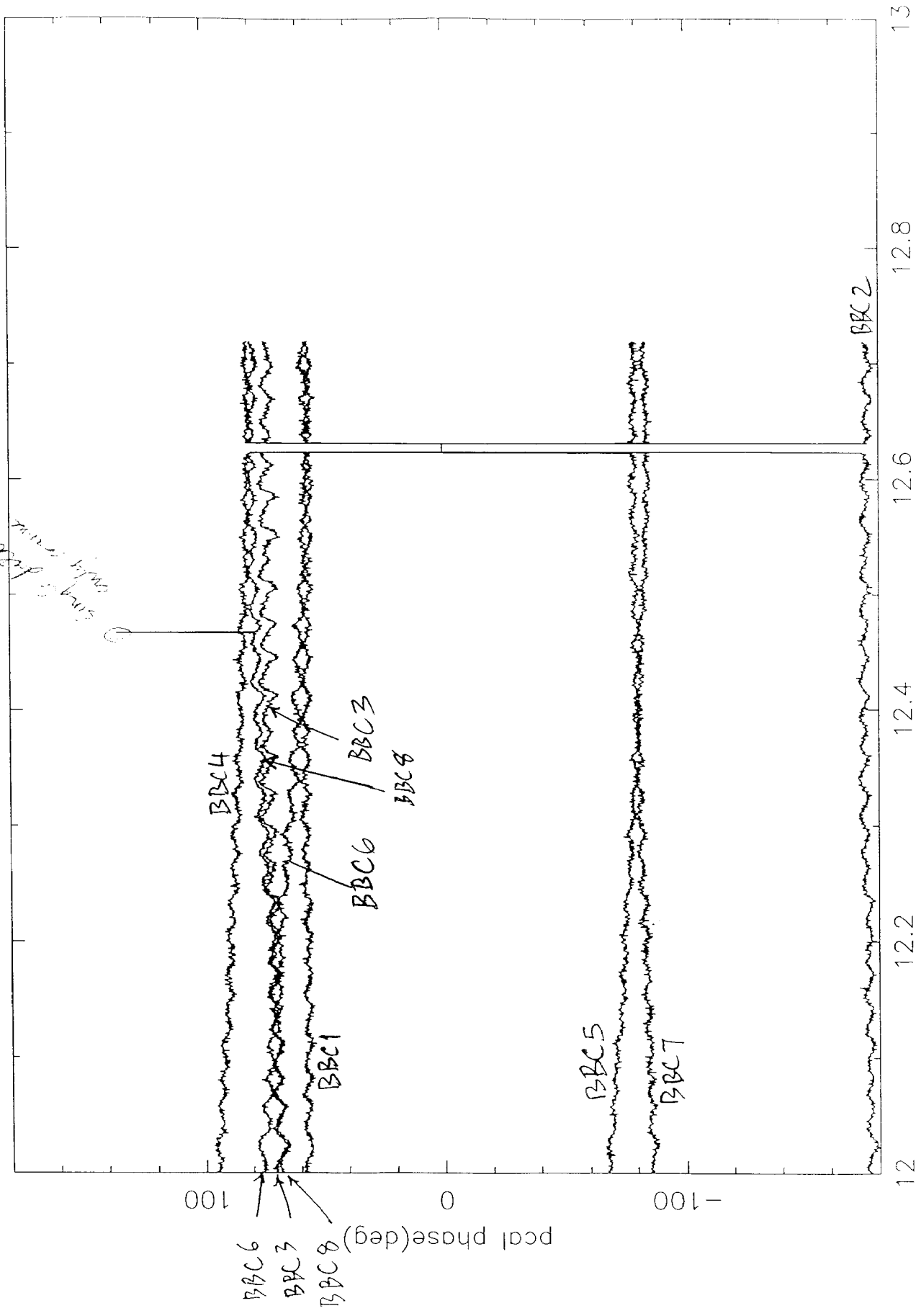
Time (days 1993FEB---)

Fig 13

LA 1993FEB——

pcal phase(deg)

BBC5
BBC4

BBC3

BBC8

BBC6

BBC1

BBC7
BBC2

BBC5
~179

BBC2
~44
(one reopt)

BBC4
re reopt
~139

BBC5
~177

100

0

-100

15   15.5   16   16.5   17

Time (days 1993FEB——)

FIG. 14