UVLBI MEMO #018

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To: UVLBI Group
From: Alan E.E. Rogers
Subject: VLBI set-up and tests at SMT April 2010

Figure 1 shows the block diagram for the VLBI at SMT in April 2010. For this experiment the downconverter was modified to support dual polarization observations at 230 and 345 GHz. The block diagram of the downconverter, as modified for dual channels is shown in Figure 2. Figure 3 shows a photo of the converter with jumper cables connected to the 768 MHz (Nyquist zone 2) filters in each channel. The spare 1280 MHz filters are still in the box.
For this experiment the equipment was mounted in a rack as shown in the photograph of Figure 4.

A large number of tests of the system were performed as follows:

1. Comparison of the 10 MHz from the H-maser with an Oscilloquartz BVA Crystal.
2. The relative phase drift between the LCP and RCP channels at 230 GHz. These channels have separate harmonic mixers, Gunn oscillators and millimeter-wave multipliers locked to a common reference frequency near 10 GHz.
3. Phase noise measurements of the local oscillators for both the 230 and 345 GHz receivers.
4. Noise temperature and atmospheric opacity measurements at both 230 and 345 GHz.

H-maser vs Oscilloquartz

τ (sec)	Alan std. dev
1	$2e^{-13}$
10	$7e^{-14}$
100	$1e^{-13}$

Dev (Hz)	Phase_noise (dBc/Hz@10 MHz)
0.1	-100
1	-118
10	-125

Phase_drift LCP vs RCP @230 GHz appeared to be mostly driven by ambient temperature with coefficient of ~ 12 deg_phase/degC

L.O. loss due to phase noise > 1Hz (from spectral plots)

Freq (GHz)	Loss (percent)
230	~1
345	~3

Long term time drift of L.O. (from zero-beat drift chart)

Freq (GHz)	Typ. Phase drift (deg/min)
230	70
345	360

Noise temperatures (Tsys above atmosphere @Zenith)

Freq (GHz)	Trec(K)	Tsys(K)	Sideband τ_{atmos}
230	~65	~250	SSB ~ 0.1
345	~150	~600	DSB ~ 0.3
345	~300	~1200	SSB ~ 0.3

Figure 5 shows the rate of the maser relative to GPS.

Typical Y-factor on Saturn was 1.05 which corresponds to 12.5 K out of a 250K system temperature. If Saturn's brightness is 100K at 1.3 mm then the estimated antenna temperature is about 14K for 50% aperture efficiency.

The session was run by A. Rogers, V. Fish and R. Freund.

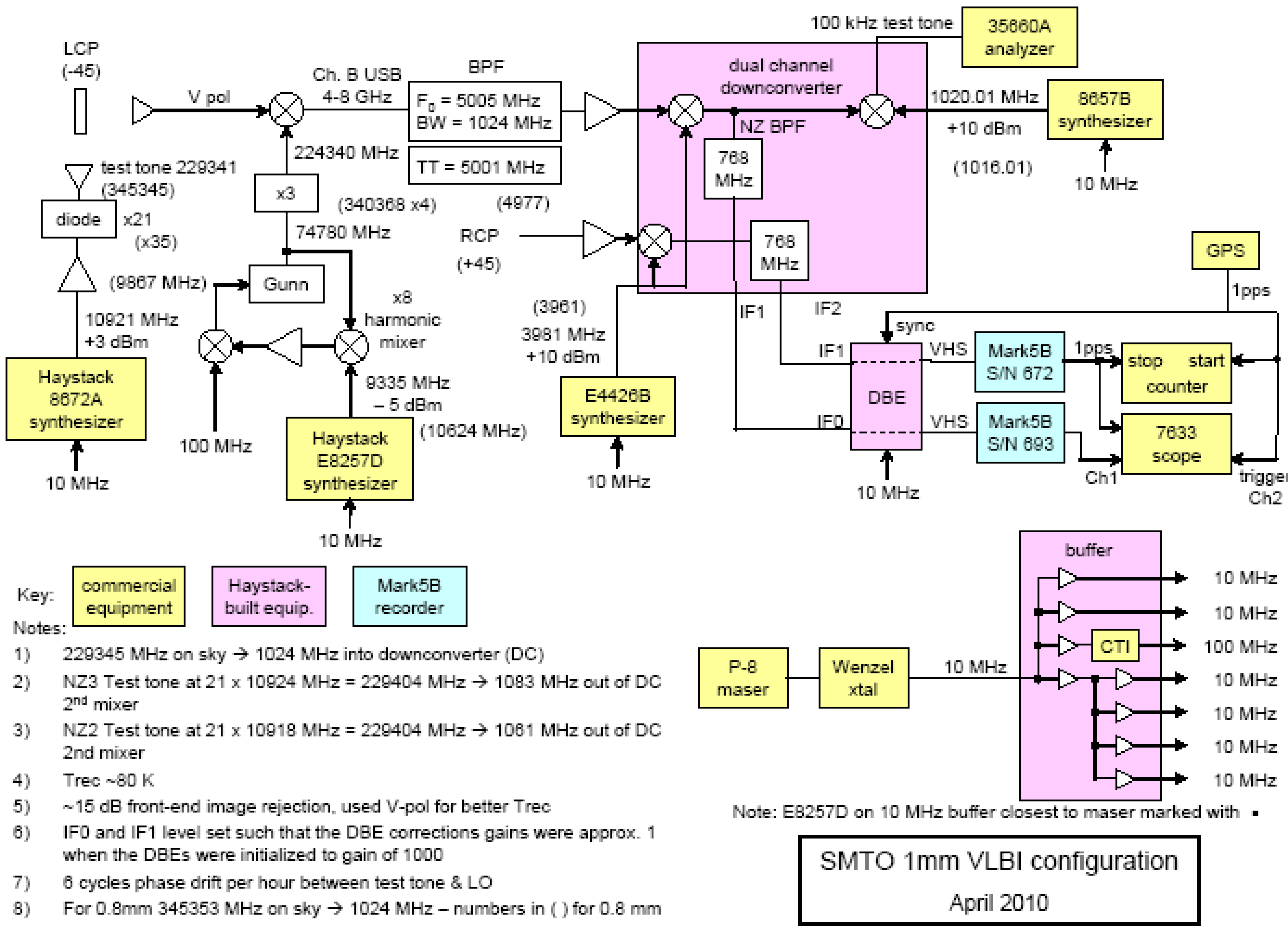
LCP
(-45)
V pol
Ch. B USB
4-8 GHz
BPF
F0 = 5005 MHz
BW = 1024 MHz
TT = 5001 MHz
(4977)
dual channel
downconverter
100 kHz test tone
35660A
analyzer
1020.01 MHz
+10 dBm
(1016.01)
8657B
synthesizer
10 MHz
NZ BPF
768
MHz
768
MHz
test tone 229341
(345345)
diode
x21
(x35)
224340 MHz
x3
(340368 x4)
74780 MHz
RCP
(+45)
(9867 MHz)
Gunn
x8
harmonic
mixer
10921 MHz
+3 dBm
Haystack
8672A
synthesizer
10 MHz
100 MHz
9335 MHz
– 5 dBm
Haystack
E8257D
synthesizer
(10624 MHz)
10 MHz
(3961)
3981 MHz
+10 dBm
E4426B
synthesizer
10 MHz
IF1
IF2
GPS
1pps
sync
IF1
IF0
DBE
10 MHz
VHS
VHS
Mark5B
S/N 672
Mark5B
S/N 693
1pps
stop start
counter
7633
scope
Ch1
trigger
Ch2
buffer
10 MHz
10 MHz
CTI
100 MHz
10 MHz
10 MHz
10 MHz
10 MHz
P-8
maser
Wenzel
xtal
10 MHz
Note: E8257D on 10 MHz buffer closest to maser marked with ▪
Key:
commercial
equipment
Haystack-
built equip.
Mark5B
recorder
Notes:
1) 229345 MHz on sky → 1024 MHz into downconverter (DC)
2) NZ3 Test tone at 21 x 10924 MHz = 229404 MHz → 1083 MHz out of DC 2nd mixer
3) NZ2 Test tone at 21 x 10918 MHz = 229404 MHz → 1061 MHz out of DC 2nd mixer
4) Trec ~80 K
5) ~15 dB front-end image rejection, used V-pol for better Trec
6) IF0 and IF1 level set such that the DBE corrections gains were approx. 1 when the DBEs were initialized to gain of 1000
7) 6 cycles phase drift per hour between test tone & LO
8) For 0.8mm 345353 MHz on sky → 1024 MHz – numbers in ( ) for 0.8 mm
SMTO 1mm VLBI configuration
April 2010

Figure 1.

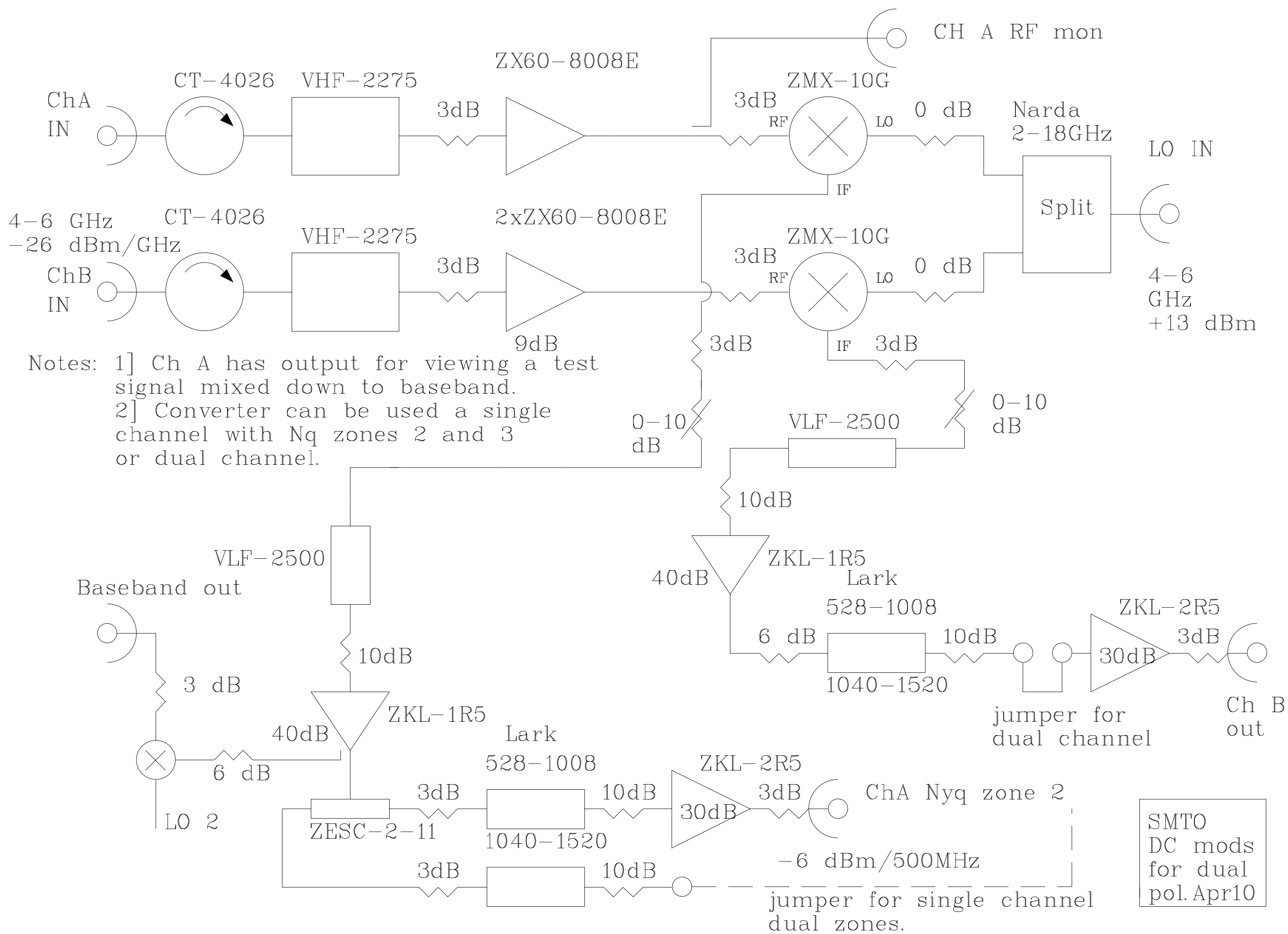

Figure 2. Block diagram on modified downconverter

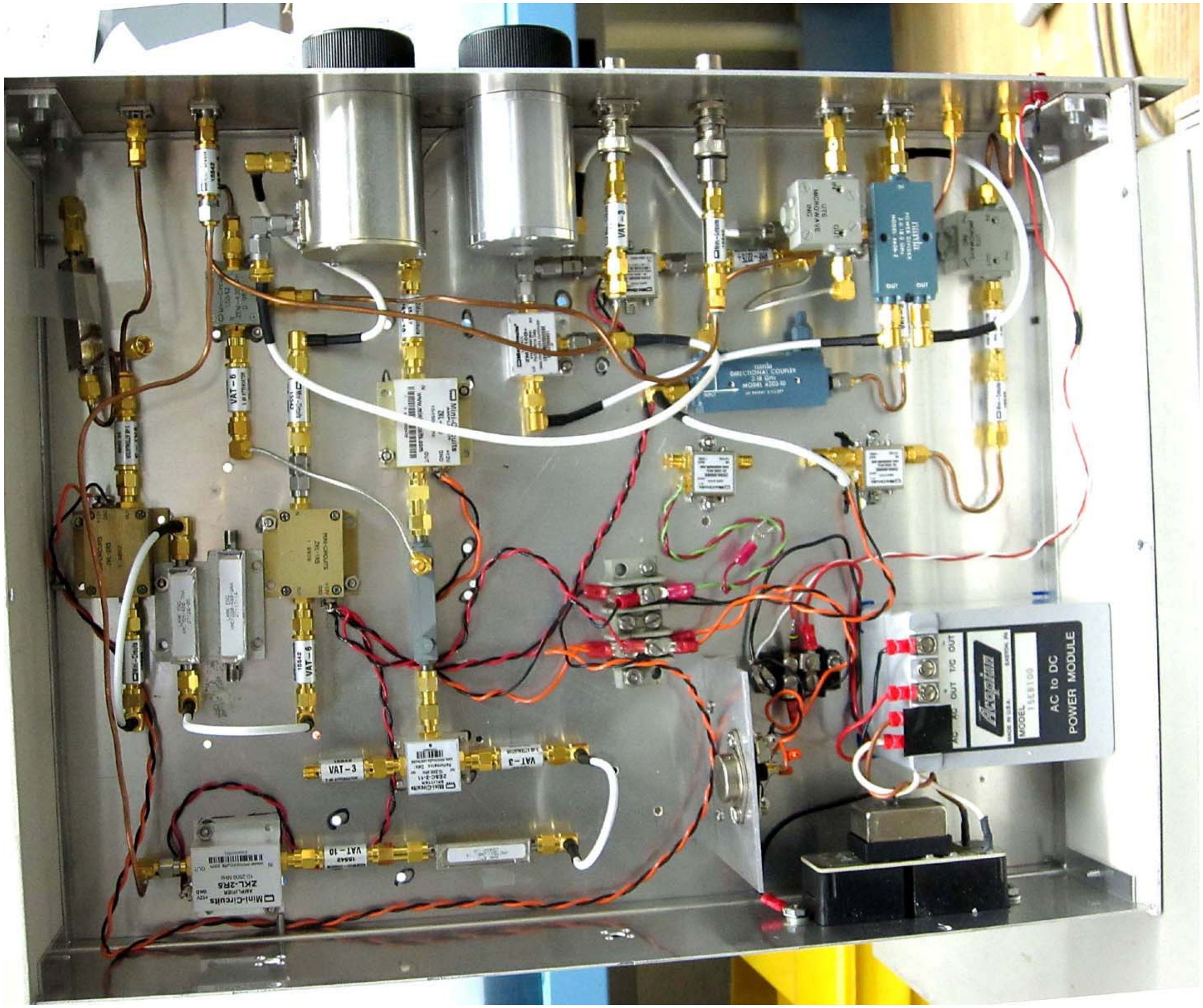

Figure 3. Down converter modified for dual channel

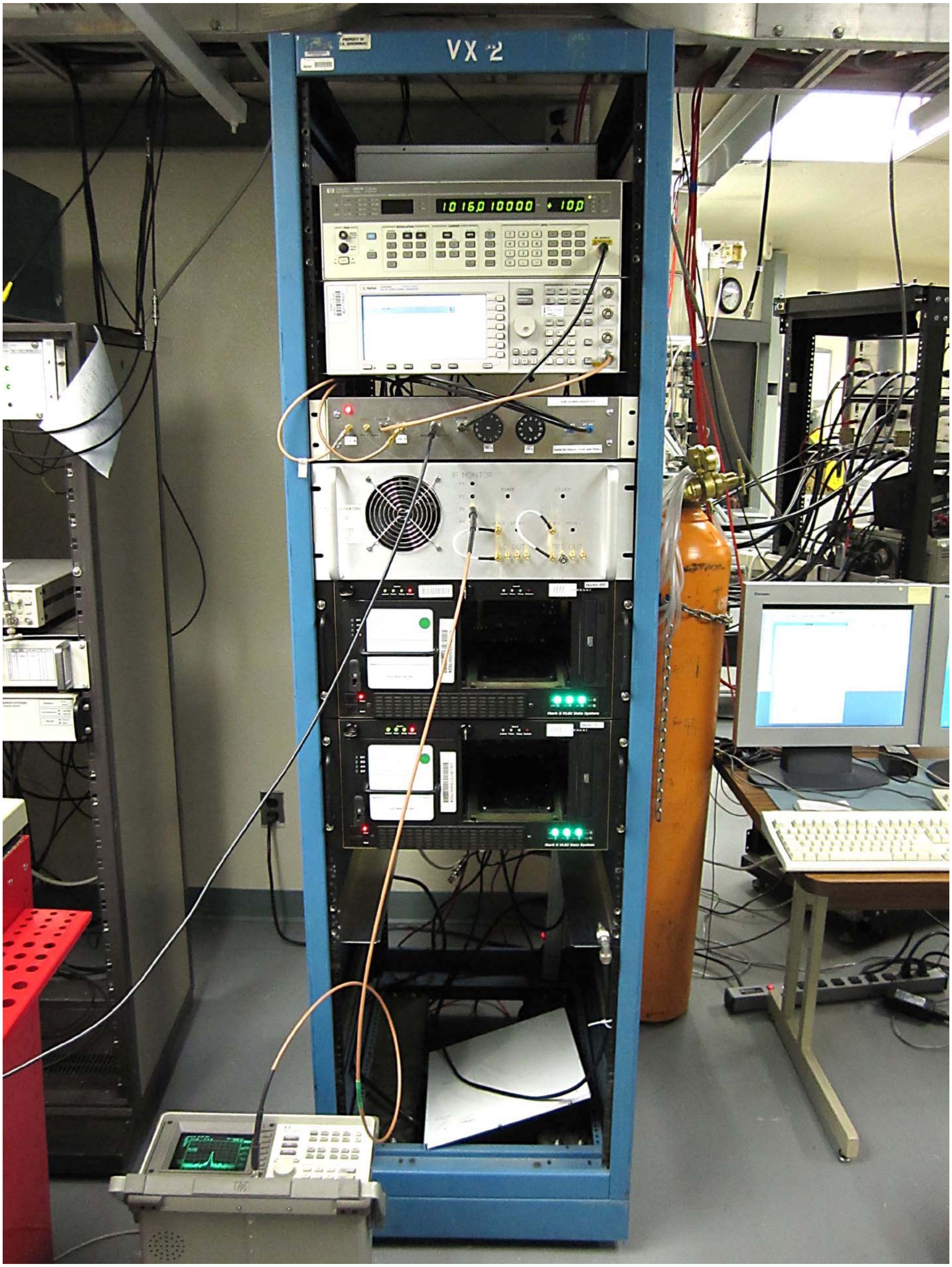

Figure 4. VLBI rack

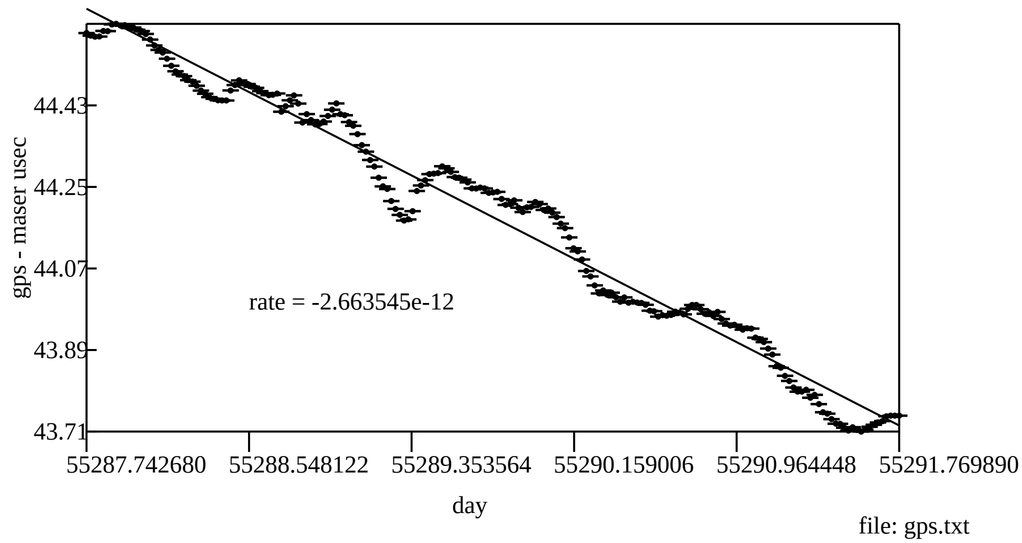

Figure 5. Shows the rate of the maser relative to GPS.