A Low-Cost SDR Platform for Receiving AM Broadcast Stations for Ionospheric Research

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HamSCI Workshop 2018

Original proof-of-concept (2012):

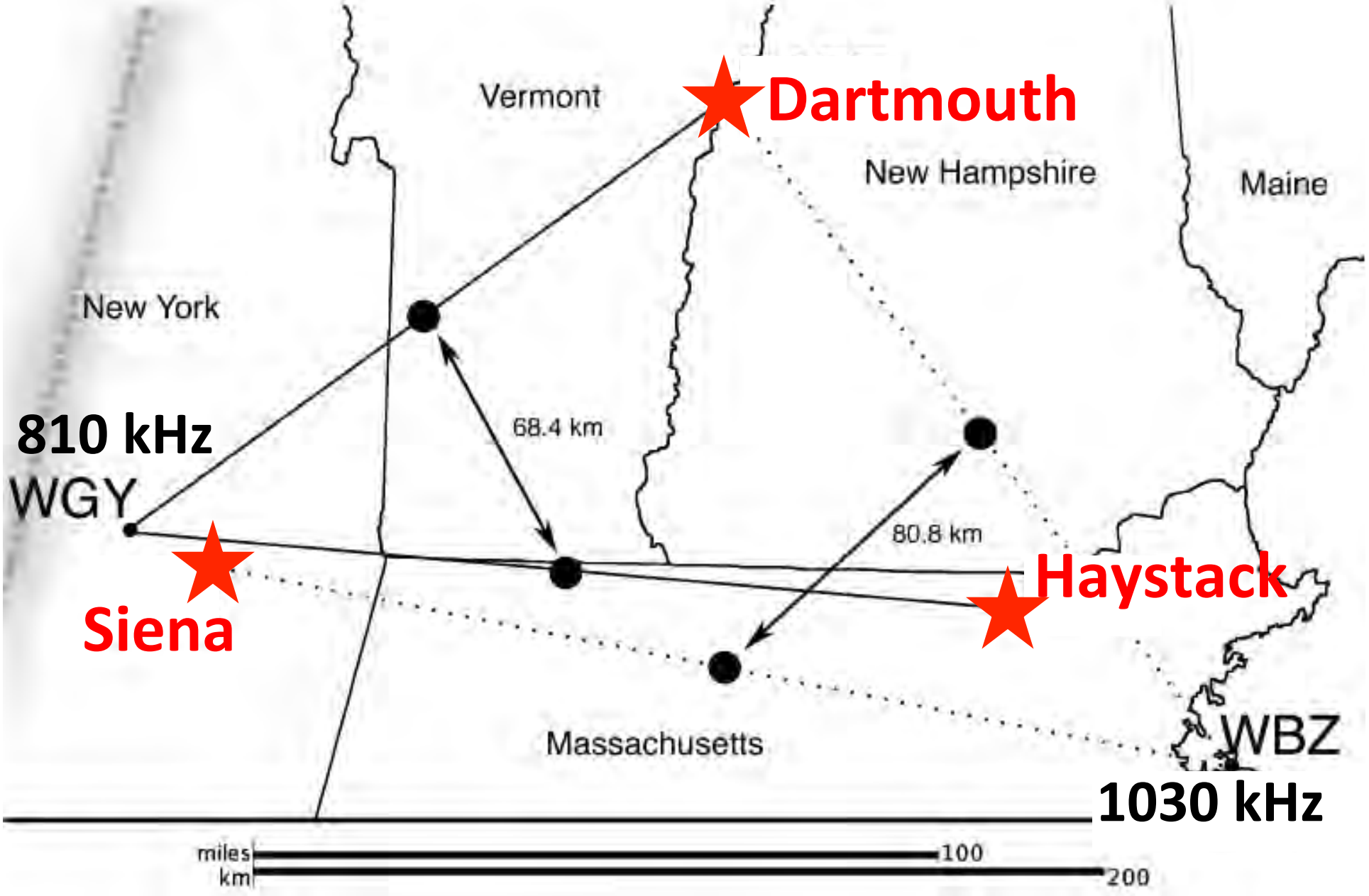
Detection of Traveling Ionospheric Disturbances by Medium Frequency Doppler Sounding Using AM Radio Transmissions

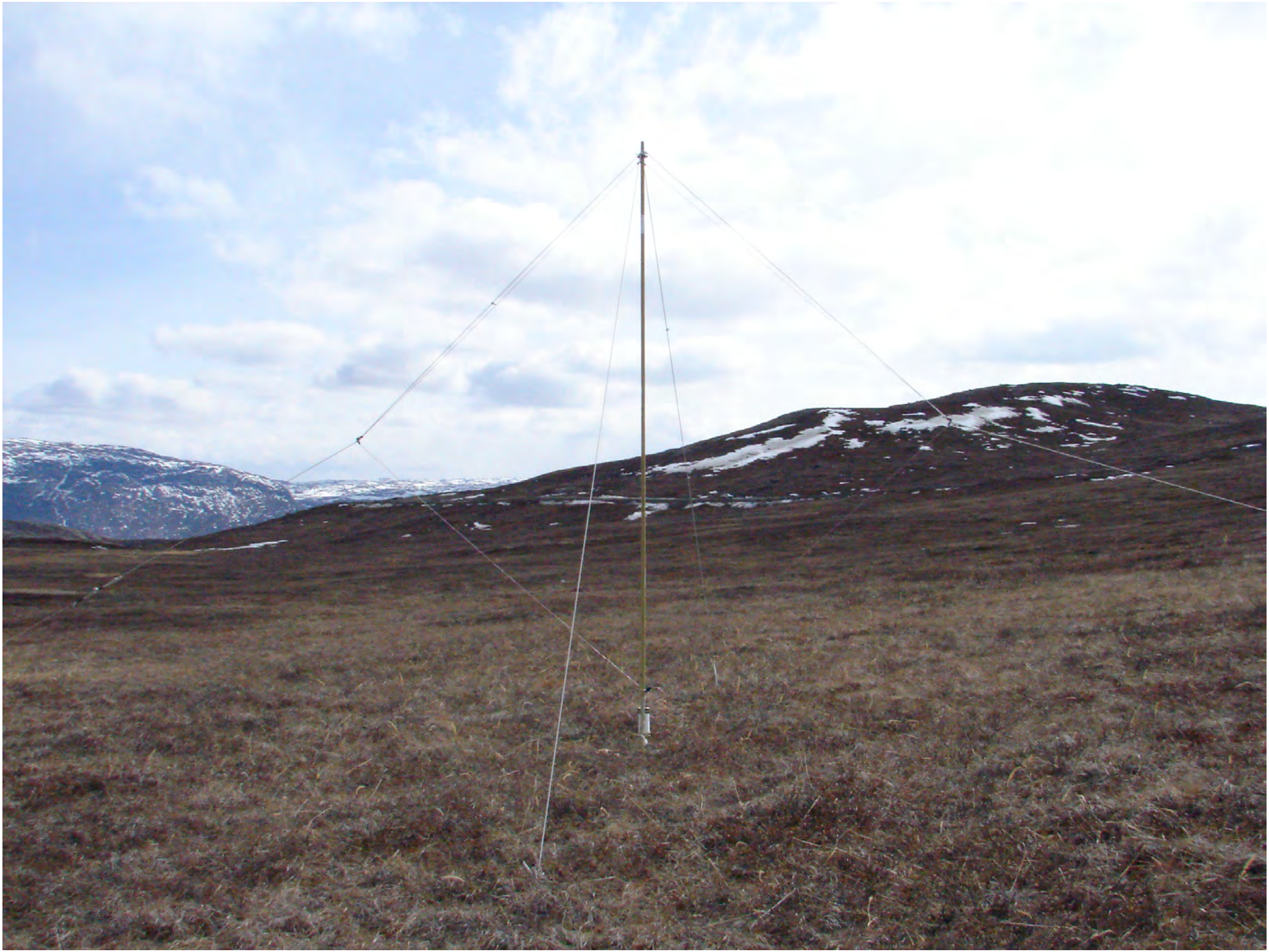
M. Chilcote,[1] J. LaBelle,[1] F. D. Lind,[2] A. J. Coster,[2] E. S. Miller,[3] I. A. Galkin,[4] and A. T. Weatherwax[5]

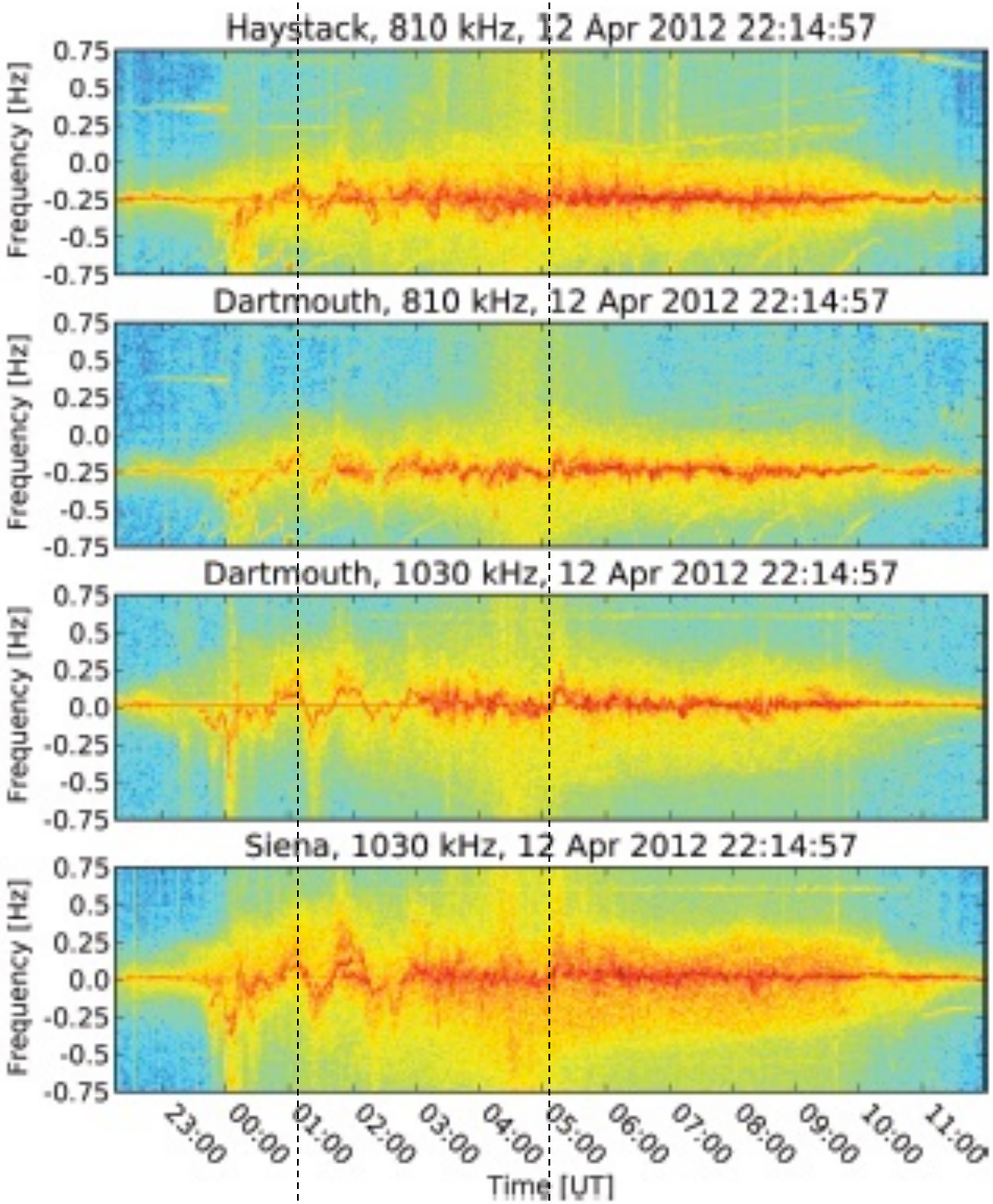
Published AGU Radio Science, 2015

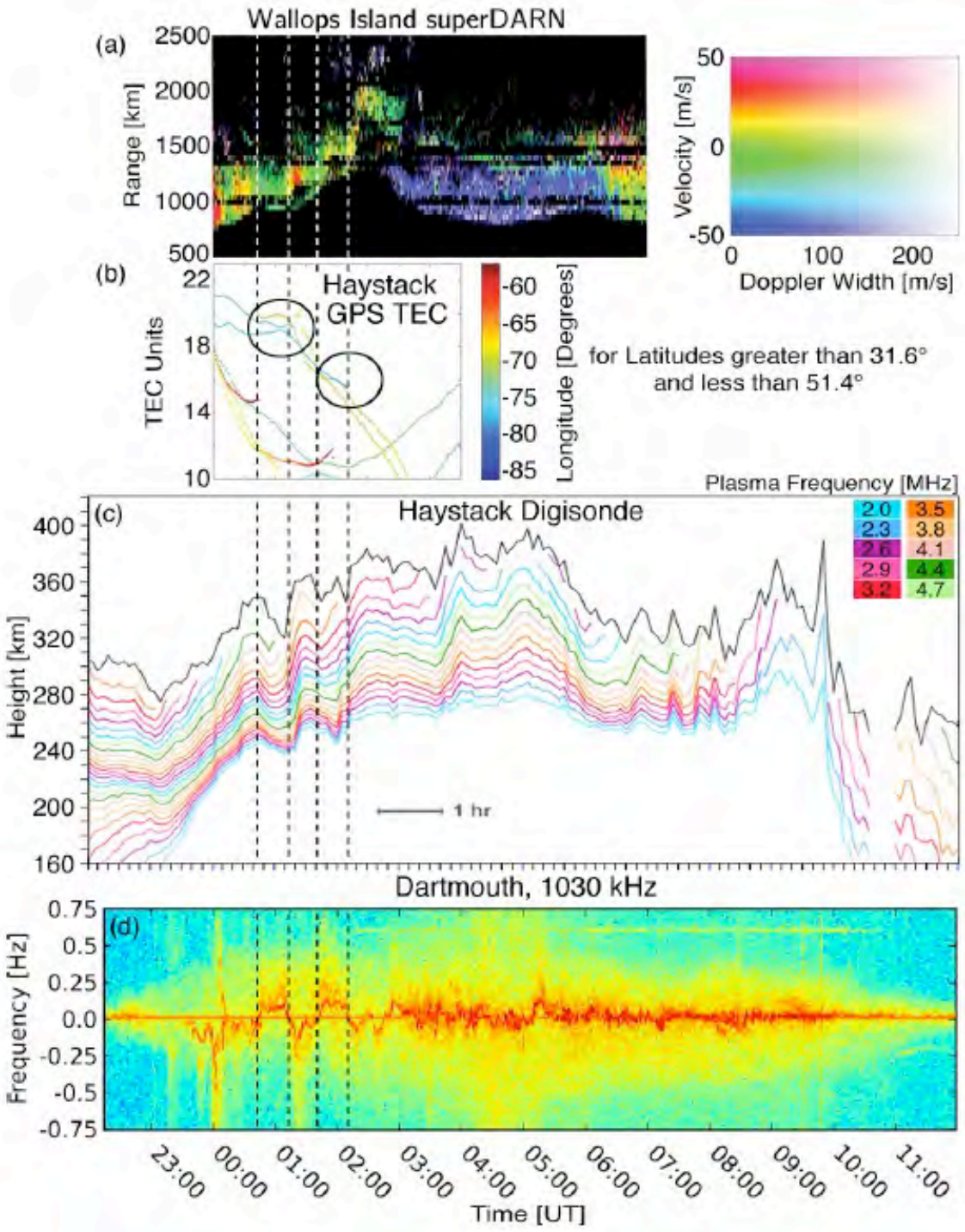
Undergraduate students at Dartmouth:
Eldred Lee (Fall, 2014), Eric Tao (Winter, 2015)

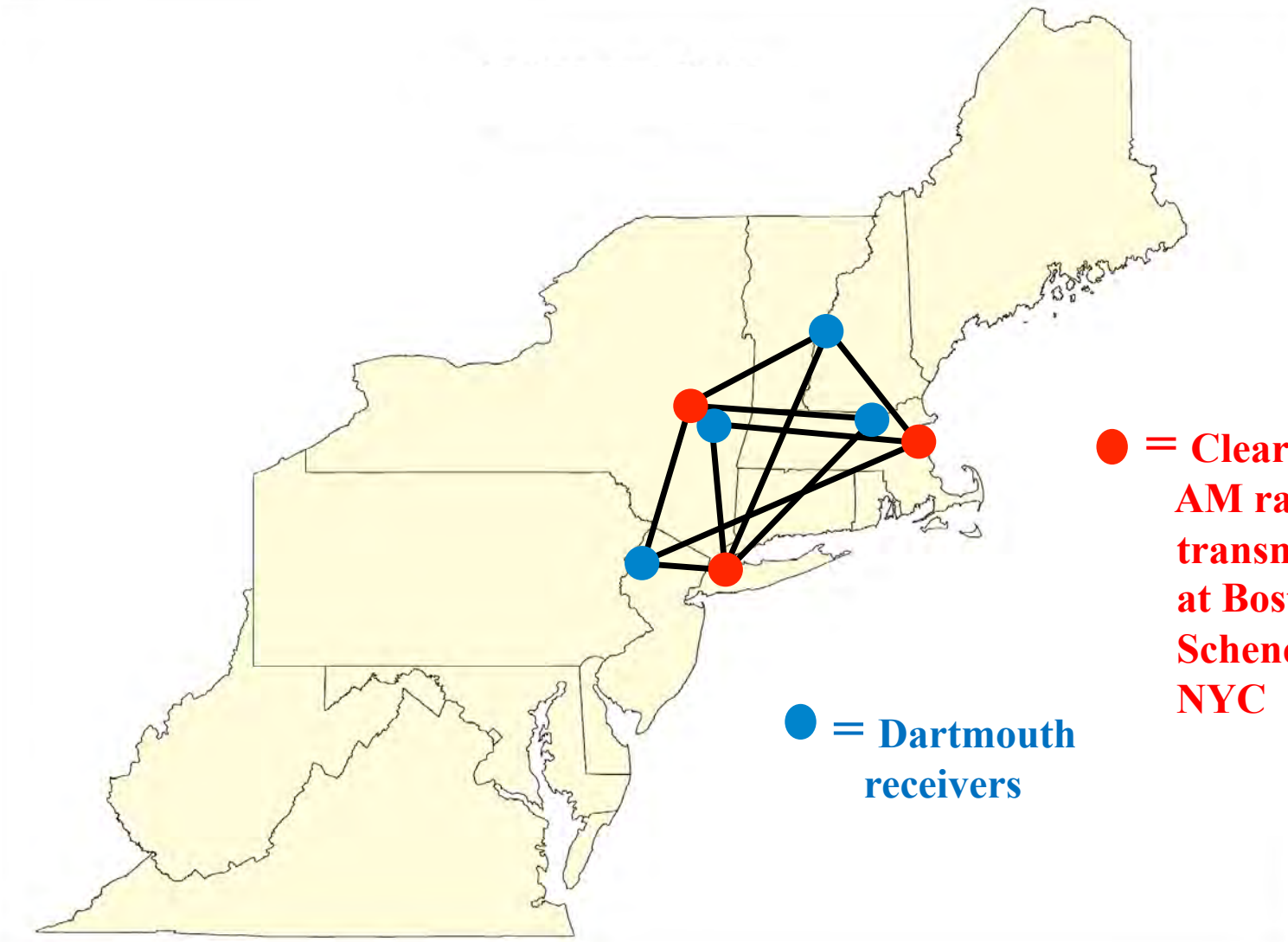
With help from J. Vierinen (MIT Haystack)


Vermont
Dartmouth
New Hampshire
Maine
New York
810 kHz
WGY
68.4 km
80.8 km
Haystack
Siena
Massachusetts
WBZ
1030 kHz
miles
km
100
200



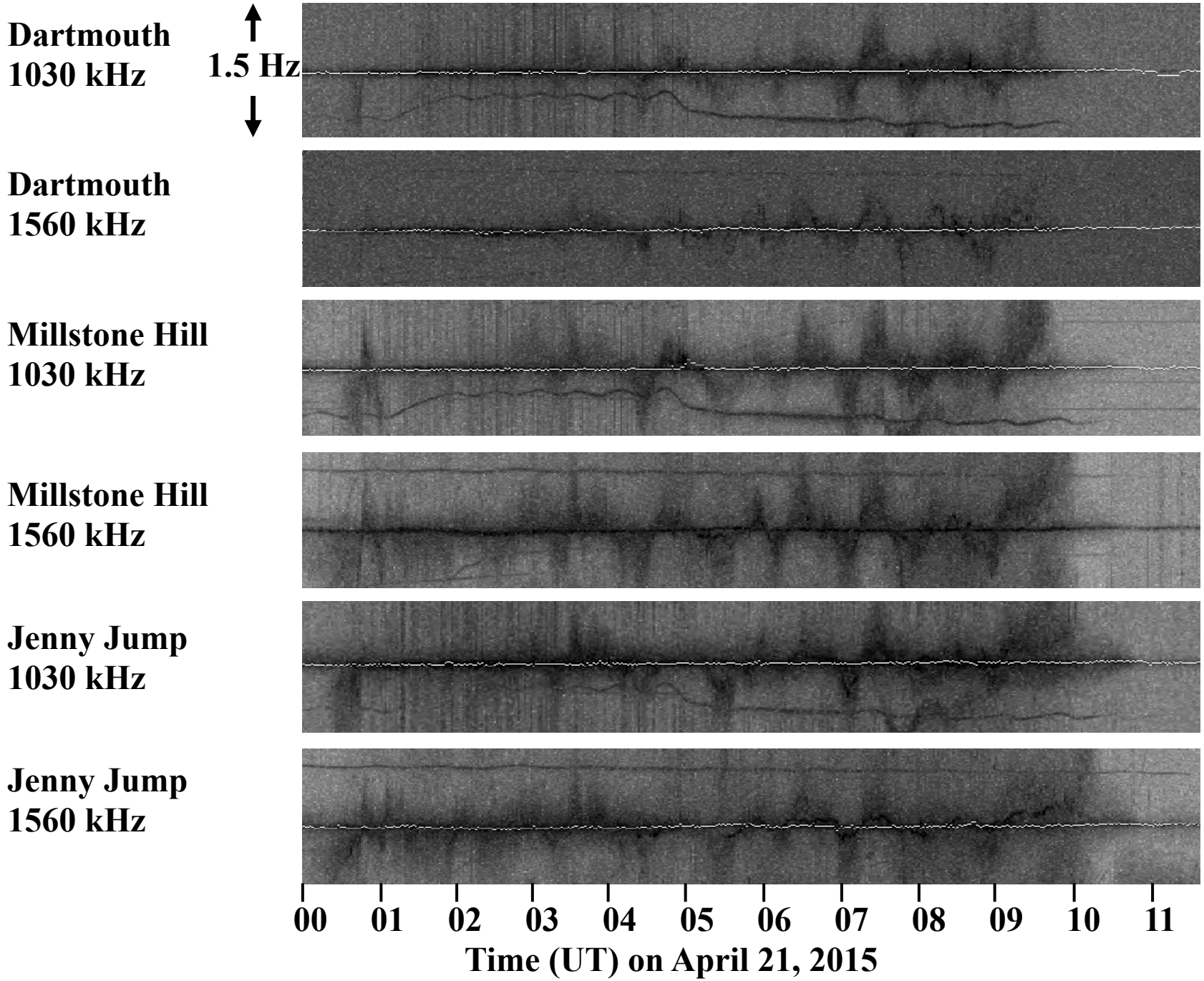

Haystack, 810 kHz, 12 Apr 2012 22:14:57
Dartmouth, 810 kHz, 12 Apr 2012 22:14:57
Dartmouth, 1030 kHz, 12 Apr 2012 22:14:57
Siena, 1030 kHz, 12 Apr 2012 22:14:57
Frequency [Hz]
0.75
0.5
0.25
0.0
-0.25
-0.5
-0.75
23:00
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
Time [UT]

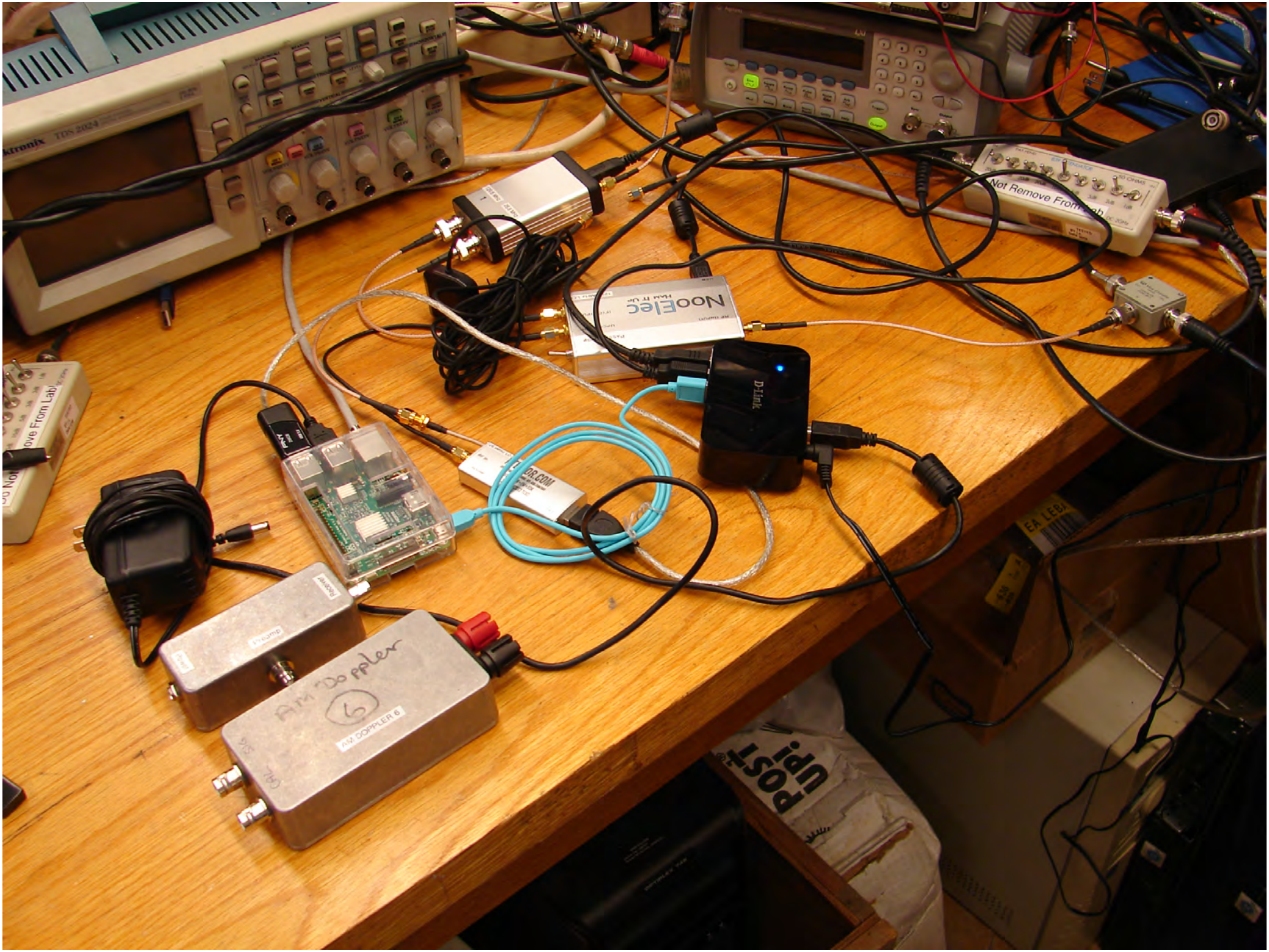

Wallops Island superDARN
(a)
Range [km]
2500
2000
1500
1000
500
Velocity [m/s]
50
0
-50
0
100
200
Doppler Width [m/s]
(b)
Haystack
GPS TEC
TEC Units
22
18
14
10
-60
-65
-70
-75
-80
-85
Longitude [Degrees]
for Latitudes greater than 31.6°
and less than 51.4°
Plasma Frequency [MHz]
(c)
Haystack Digisonde
Height [km]
400
360
320
280
240
200
160
2.0
2.3
2.6
2.9
3.2
3.5
3.8
4.1
4.4
4.7
1 hr
Dartmouth, 1030 kHz
(d)
Frequency [Hz]
0.75
0.5
0.25
0.0
-0.25
-0.5
-0.75
23:00
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
Time [UT]

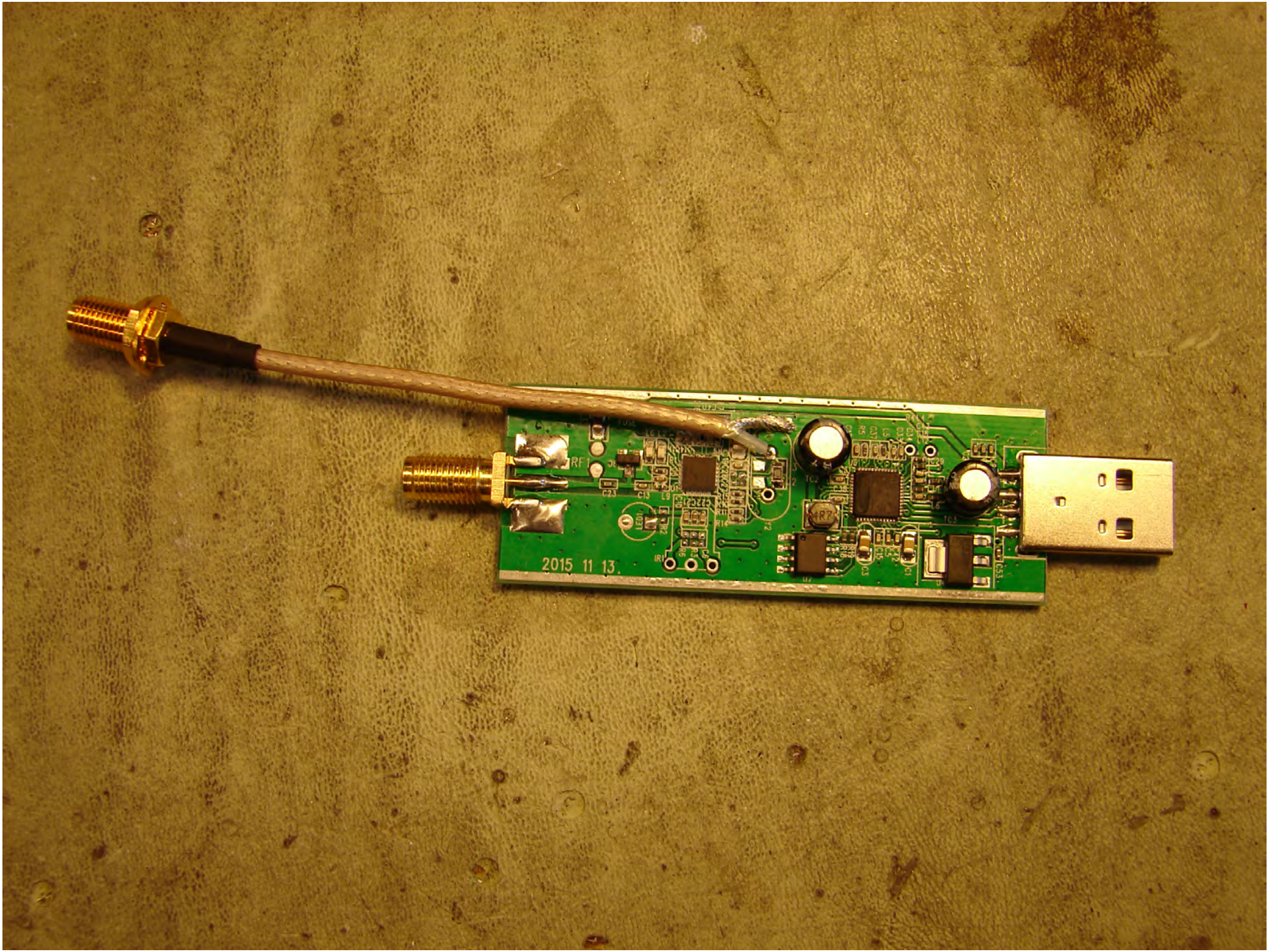


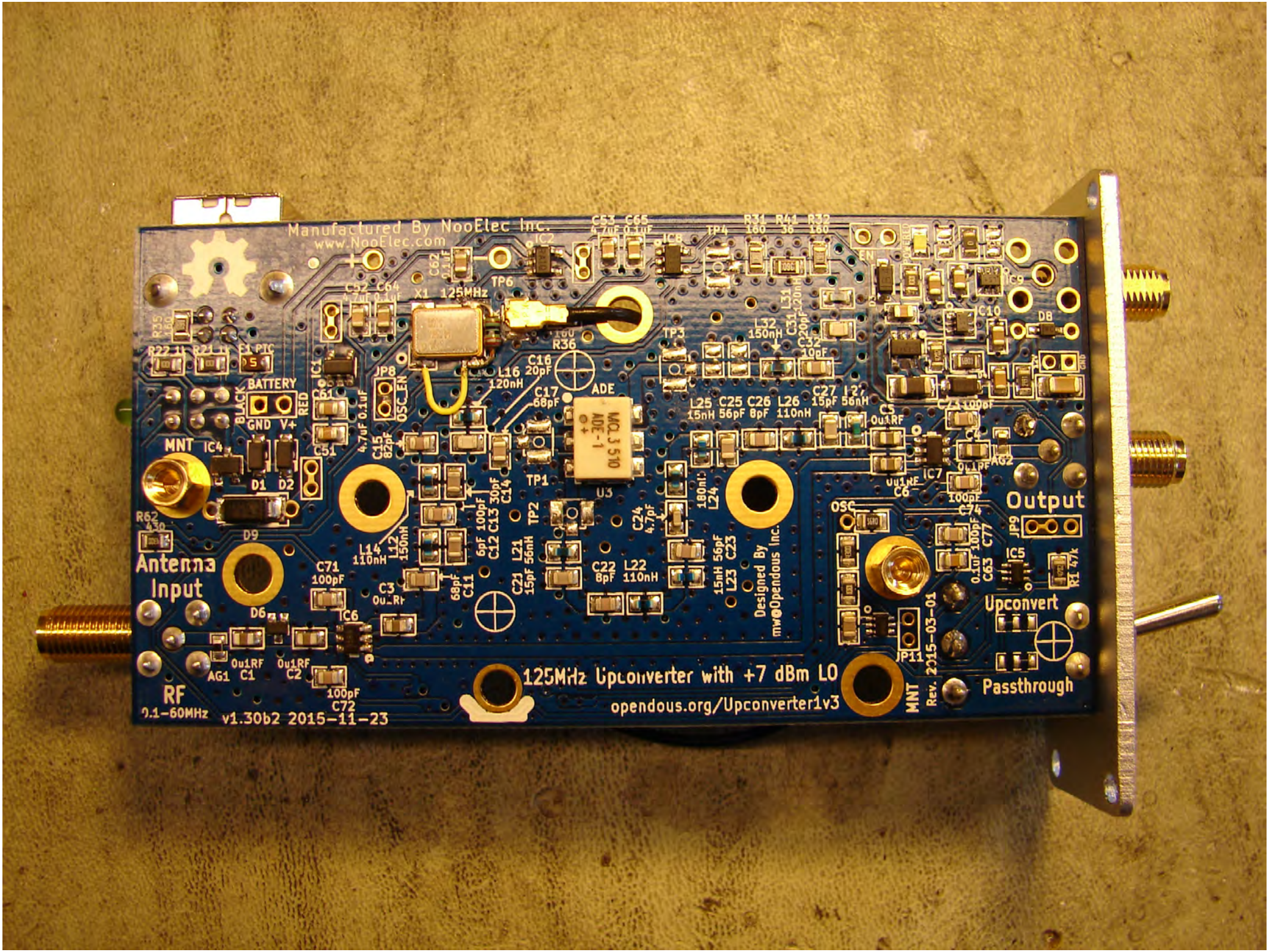
● = Clear-channel AM radio transmitters at Boston, Schenectady, NYC

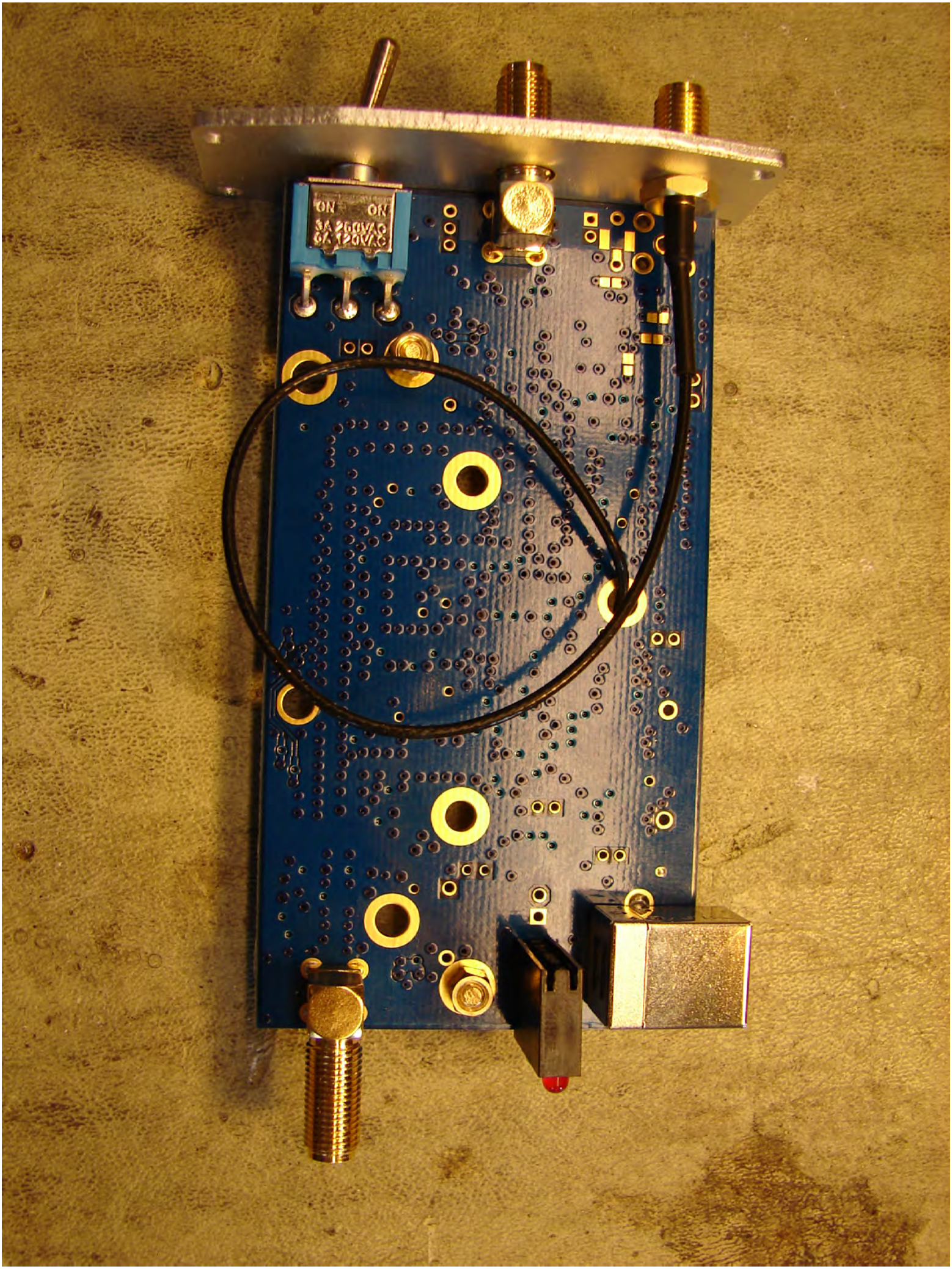
● = Dartmouth receivers


Dartmouth
1030 kHz
1.5 Hz
Dartmouth
1560 kHz
Millstone Hill
1030 kHz
Millstone Hill
1560 kHz
Jenny Jump
1030 kHz
Jenny Jump
1560 kHz
00
01
02
03
04
05
06
07
08
09
10
11
Time (UT) on April 21, 2015

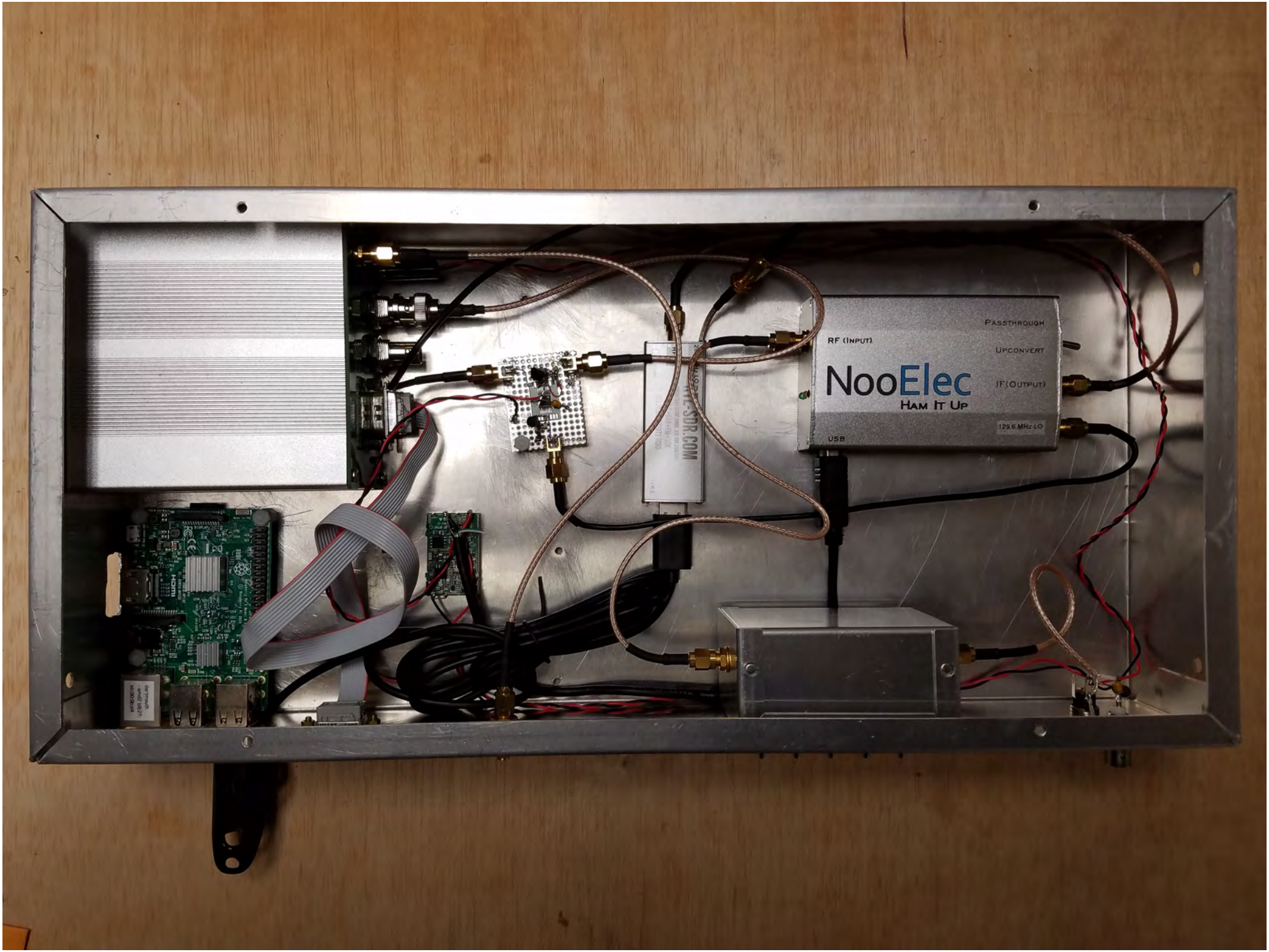

Not Remove From Lab
NooElec
D-Link
AM Doppler
6
AM-DOPPLER 6
UPS


2015 11 13.


Manufactured By NooElec Inc.
www.NooElec.com
125MHz Upconverter with +7 dBm LO
opendous.org/Upconverter1v3
v1.30b2 2015-11-23
Rev. 2015-03-01
Designed By
mw@Opendous Inc.
RF
0.1-60MHz
Antenna
Input
Output
Upconvert
Passthrough
BATTERY
GND
V+
BLACK
RED
MNT
OSC
X1
125MHz
TP1
TP2
TP3
TP4
TP6
U3
MCL 3 510
ADE-1
ADE
JP8
OSCEN
JP9
JP11
D1
D2
D6
D9
IC1
IC2
IC4
IC5
IC6
IC7
IC8
L16
120nH
L32
150nH
L25
15nH
L26
110nH
L14
110nH
L12
150nH
L21
56nH
L22
110nH
L24
180nH
L23
15nH
C16
20pF
C17
68pF
C15
82pF
C32
10pF
C31
20pF
C27
15pF
C25
56pF
C26
8pF
C24
4.7pF
C22
8pF
C74
100pF
C71
100pF
C72
100pF
C63
0.1uF
C61
4.7uF
C62
0.1uF
C64
0.1uF
C65
0.1uF
C53
4.7uF
R31
160
R41
36
R32
160
R36
100
R62
430
R35
100
R22
1k
R21
1k
R14
47k

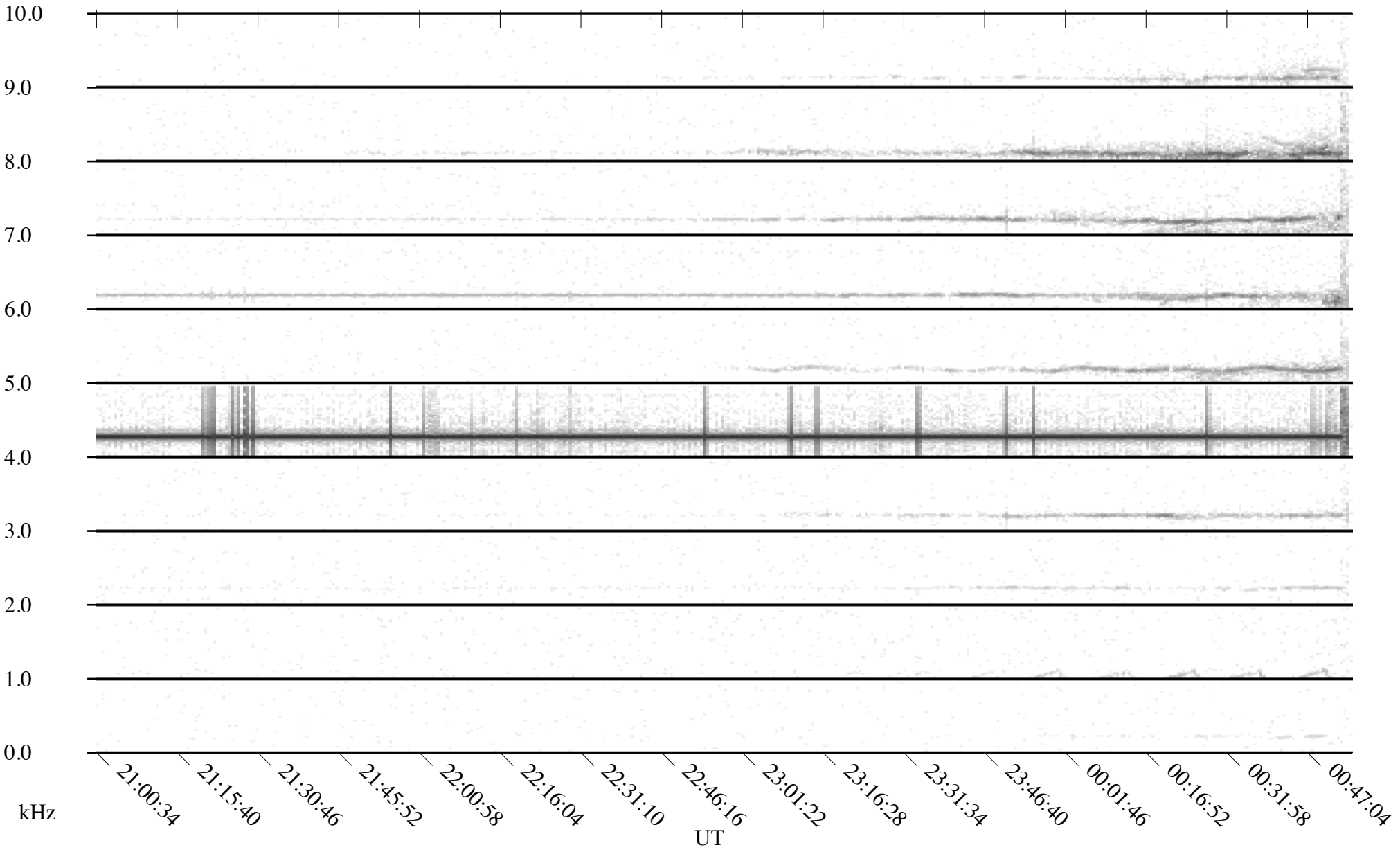

ON
ON


Dartmouth AM Doppler Receiver
dartmouth-amd2
b8:27:eb:90:9b:d4
Raspberry Pi
GPS Serial Pt
GPS Ant
24
12
6
3
1.5dB
Attenuator
Ant Preamp
12V Pwr
HD


PASSTHROUGH
RF (INPUT)
UPCONVERT
NooElec
HAM IT UP
IF (OUTPUT)
129.6 MHz LO
USB

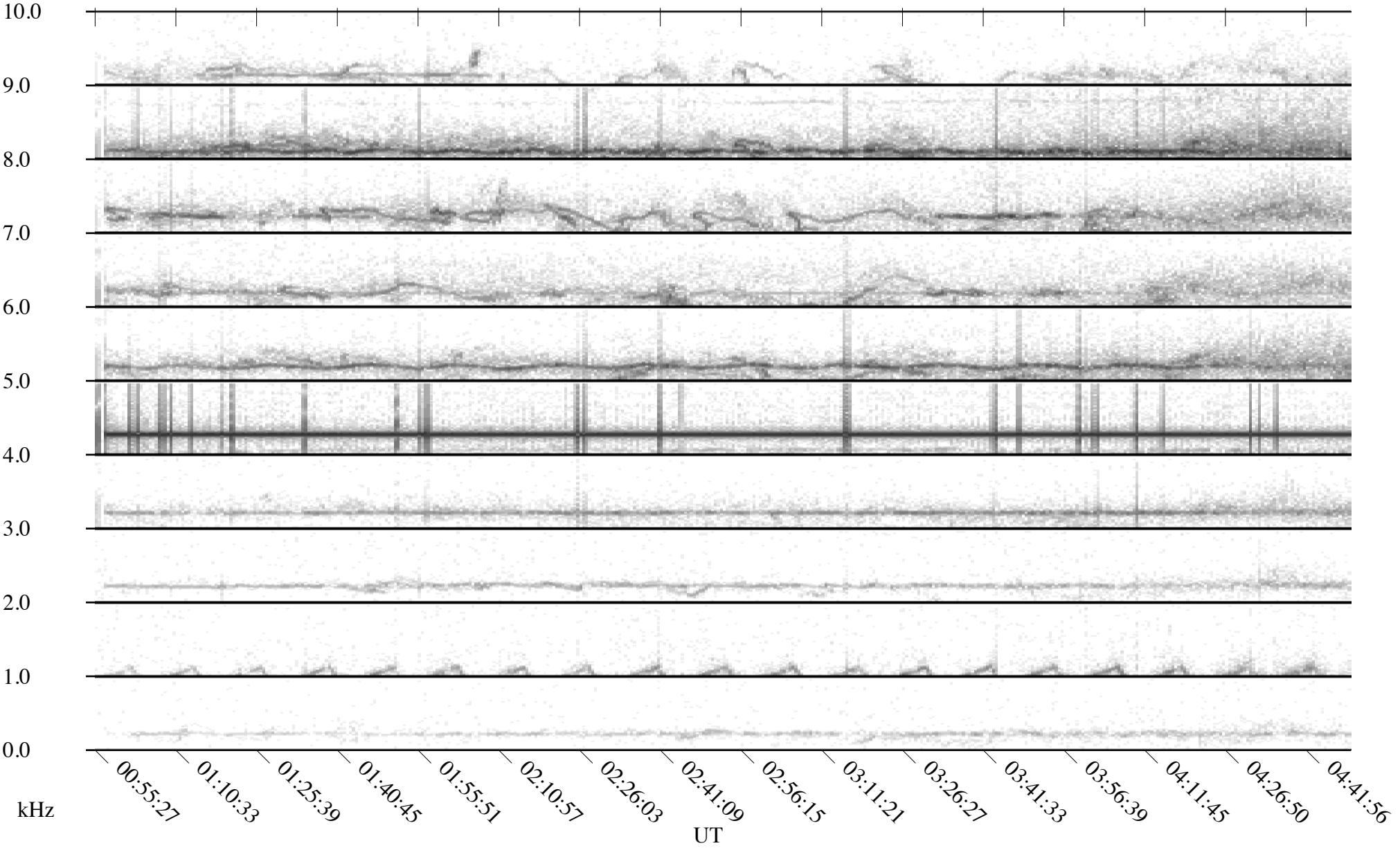
Dartmouth 22/05/17

Linear Scale Black = 1500 White = 700 AM Doppler data



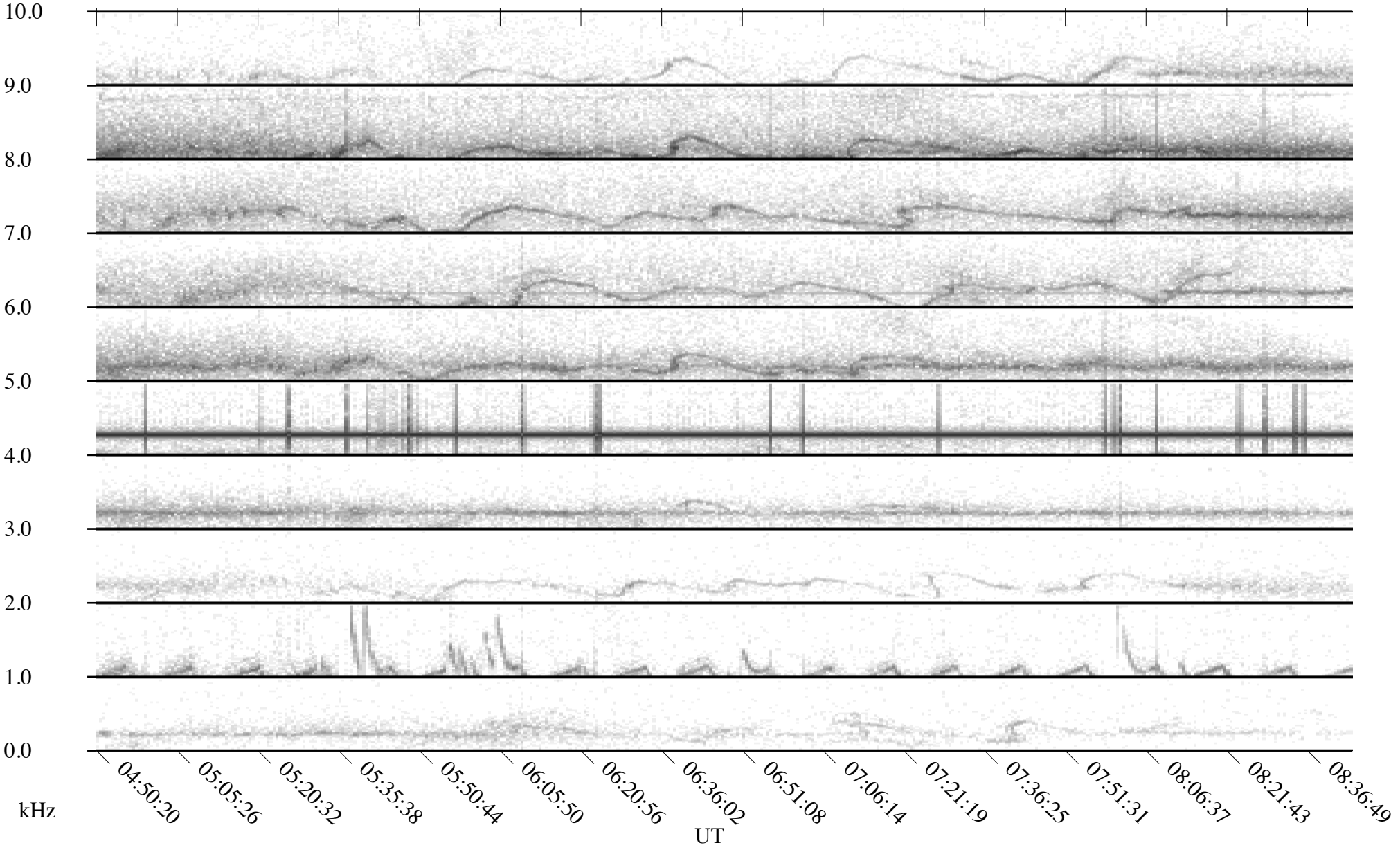
Dartmouth 22/05/17

Linear Scale Black = 1500 White = 700 AM Doppler data



Dartmouth 22/05/17

Linear Scale Black = 1500 White = 700 AM Doppler data



Dartmouth 22/05/17

Linear Scale Black = 1500 White = 700 AM Doppler data