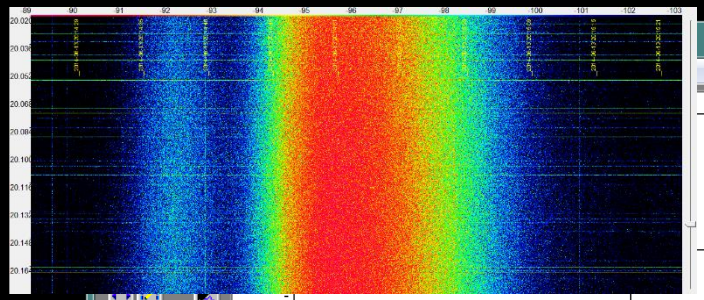
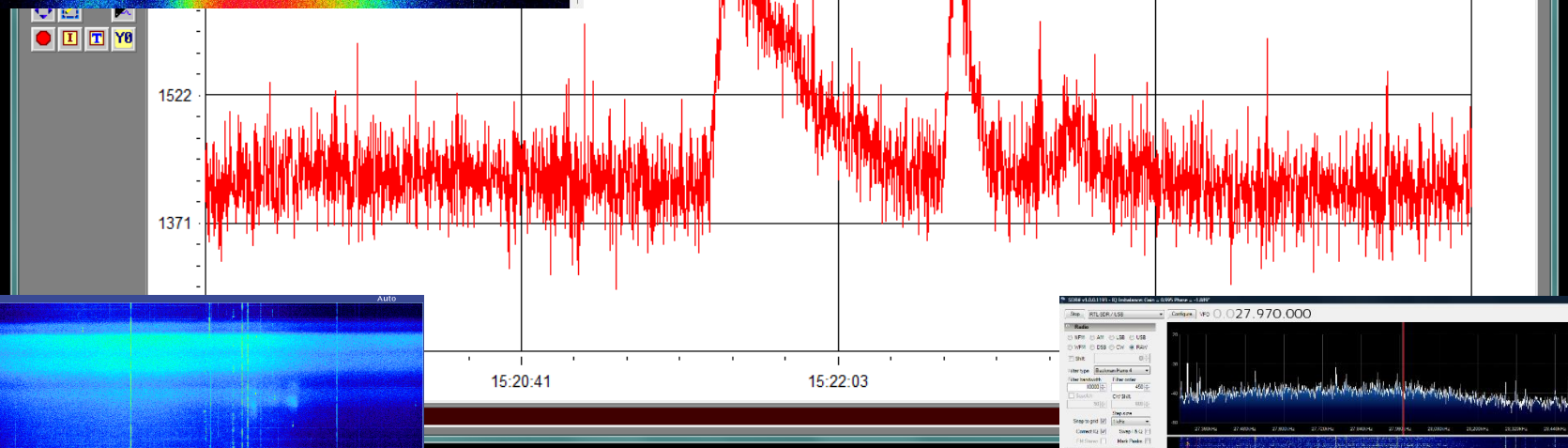
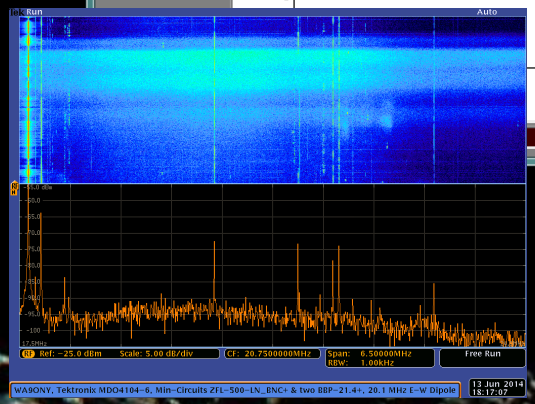
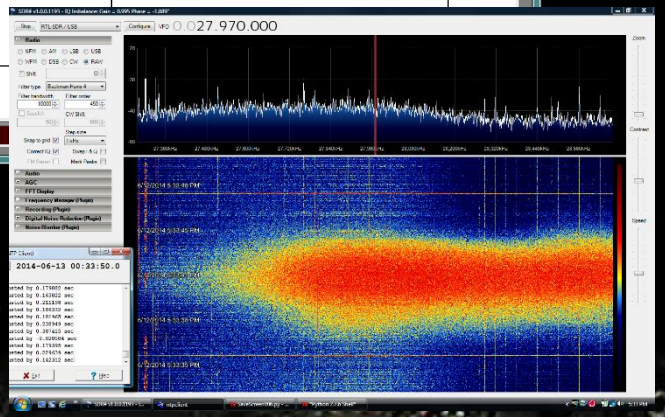
Radio Astronomy
Observing the Sun









David Haworth
www.stargazing.net/david
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Sun Radio Emissions

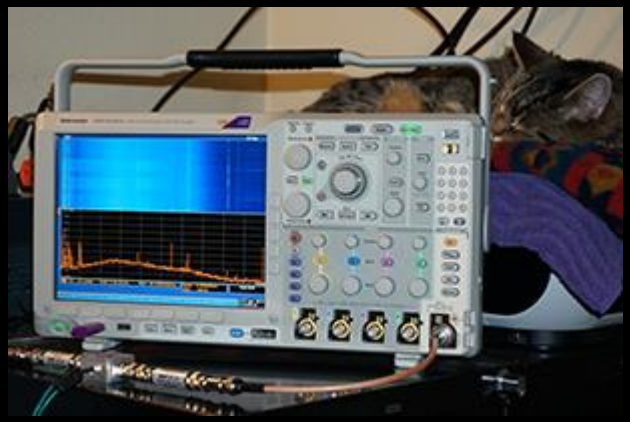
June 13, 2014: 17.5 MHz to 28.5 MHz

- 0033 UT: Type V/2 & III/3 Radio Burst
- 1521 UT: Type III/2 Radio Burst
- 1815 UT: Type III/2 Radio Burst
- 2014 UT: Type III/2 Radio Burst
- 2057 UT: Radio Burst

Sun Type V/2 & III/3 Radio Burst

June 13, 2014, 0033 UT

- Observed with
  - Tektronix MDO4104-6 spectrum analyzer
  - RFSpace SDR-IQ receiver
  - RTL-SDR receiver (~$20)



NOAA Solar Event Report

June 13, 2014, 0033 UT

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gt:Product: 20140613events.txt
:Created: 2014 Jun 14 1802 UT
:Date: 2014 06 13
# Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center
# Please send comments and suggestions to SWPC.Webmaster@noaa.gov
#
# Missing data: ////
# Updated every 30 minutes.
#                              Edited Events for 2014 Jun 13
#
#Event    Begin    Max      End  Obs  Q  Type  Loc/Frq   Particulars      Reg#
#-----------------------------------------------------------------------------
3640 +     0029    0033     0044  LEA  3   FLA  S22E63    SF      DSD      2092

3660       0030    0034     0041  G15  5   XRA  1-8A      C8.5    3.8E-03  2087
3660 +     0031    0034     0056  LEA  3   FLA  S19E45    1F      ERU      2087
           0032    ////     0034  LEA  C   RSP  025-180   V/2              2087
           0033    ////     0034  CUL  C   RSP  018-200   III/3            2087
```

NOAA Solar Event Report

Observatory & Quality Codes

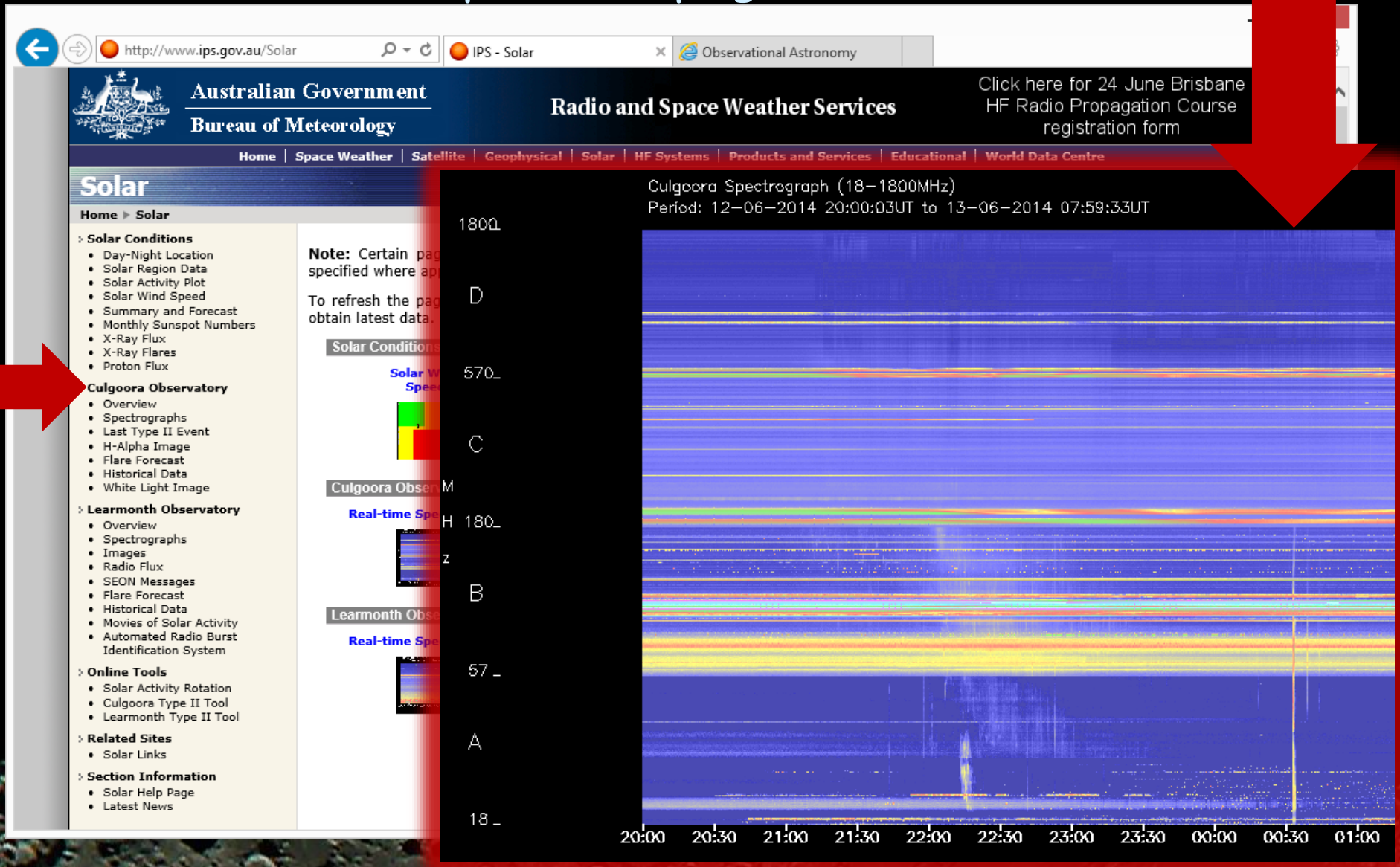
```
Obs   - The reporting observatory.
        CUL - Culgoora, Australia
        HOL - Holloman AFB, NM, USA    LEA - Learmonth, Australia
        PAL - Palahua, HI, USA         RAM - Ramey AFB, PR, USA
        SAG - Sagamore Hill, MA, USA   SVI - San Vito, Italy

Q     - Quality
        For radio bursts at fixed and sweep frequencies, and for storms, this
        shows the quality of the data
                        C = Corrected report
                        G = Good
                        U = Uncertain
        For optical flares, this shows the quality of observing conditions,
        from 1 to 5, where:  1 = very poor and 5 = excellent

        X-ray events and SXI flare have a quality of 5 (meaning excellent).
```

Culgoora Observatory, AU

http://www.ips.gov.au/Solar



NOAA Solar Event Report

Type Codes

```
Type  - Type of report, see http://www.swpc.noaa.gov/info/glossary.html
          BSL = Bright surge on the limb
          DSF = Filament disappearance
          EPL = Eruptive prominence on the limb
          FIL = Filament
          FLA = Optical flare observed in H-alpha
          FOR = Forbush decrease (cosmic ray decrease))
          GLE = Ground-level event (cosmic ray increase)
          LPS = Loop prominence system
          PCA = Polar cap absorption
          RBR = Fixed-frequency radio burst
          RNS = Radio Noise Storm
          RSP = Sweep-frequency radio burst
          SPY = Spray
          XFL = SXI X-ray flare from GOES Solar X-ray Imager (SXI)
          XRA = X-ray event from SWPC's Primary or Secondary GOES spacecraft
```

NOAA Solar Event Report

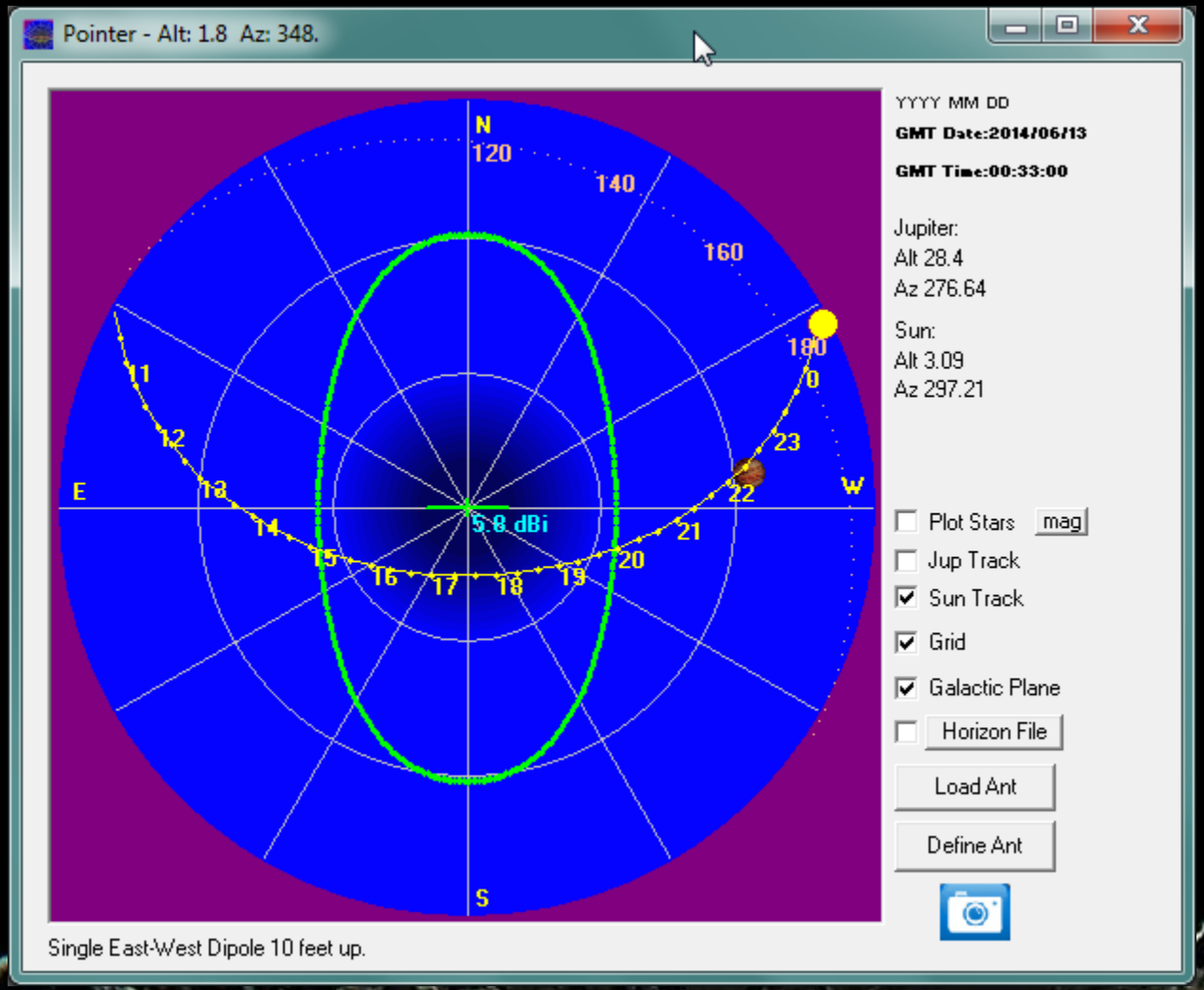
Sweep-Frequency Radio Burst (RSP) Codes

```
RSP:
 Type/Intensity
     Type  II: Slow drift burst
     Type III: Fast drift burst
     Type  IV: Broadband smooth continuum burst
     Type   V: Brief continuum burst, generally associated with Type III bursts
     Type  VI: Series of Type III bursts over a period of 10 minutes or more,
               with no period longer than 30 minutes without activity
     Type VII: Series of Type III and Type V bursts over a period of 10 minutes
               or more, with no period longer than 30 minutes without activity
     Type CTM: Broadband, long-lived, dekametric continuum

     Intensity is a relative scale 1=Minor, 2=Significant, 3=Major
```

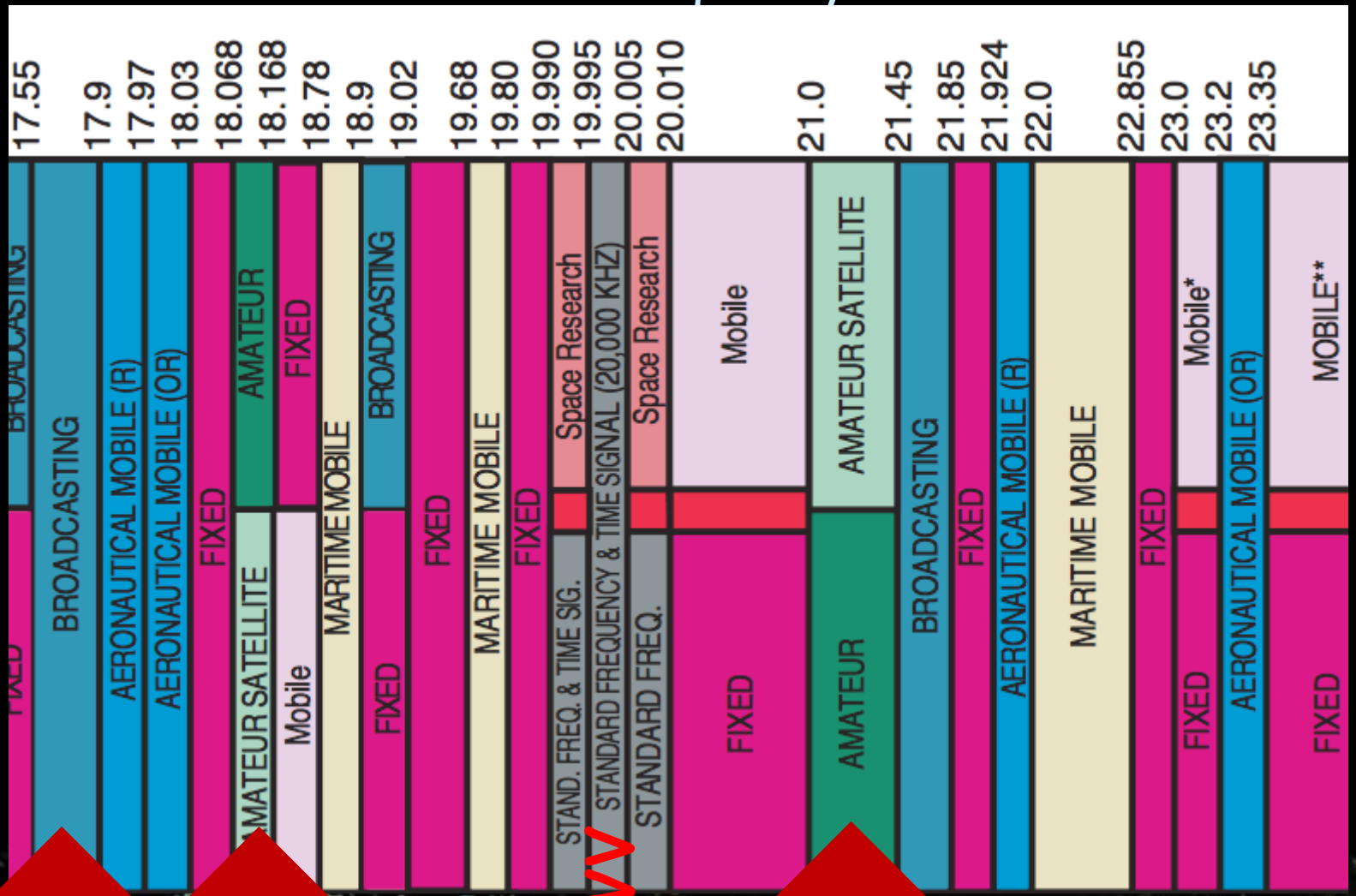
Sun Location with Respect to Camas, WA

June 13, 2014, 0033 UT



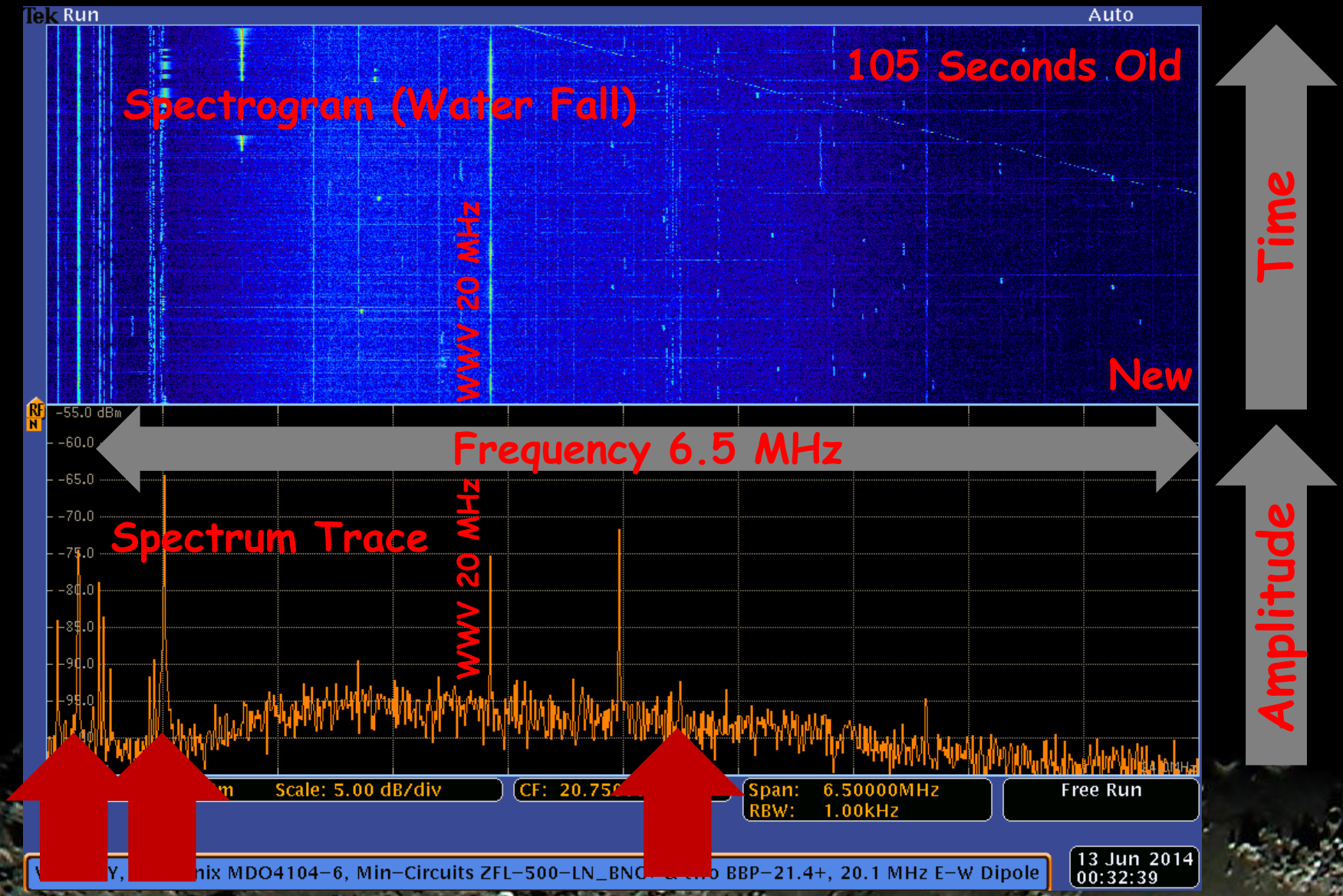
Tektronix MDO4104-6 Spectrogram

United States Frequency Allocations



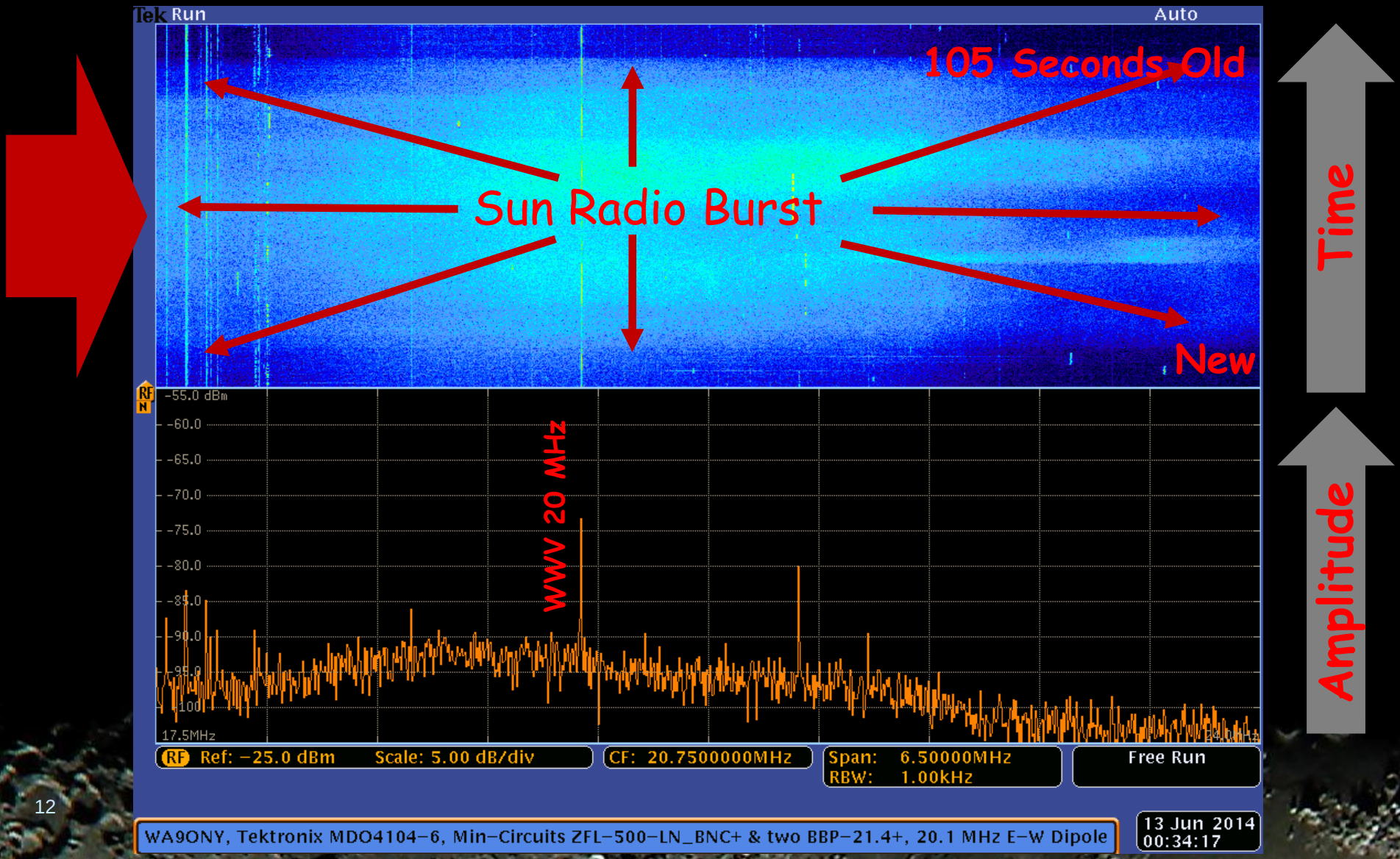
Tektronix MDO4104-6 Spectrogram

June 13, 2014, 0032 UT



Tektronix MDO4104-6 Spectrogram

June 13, 2014, 0033 UT

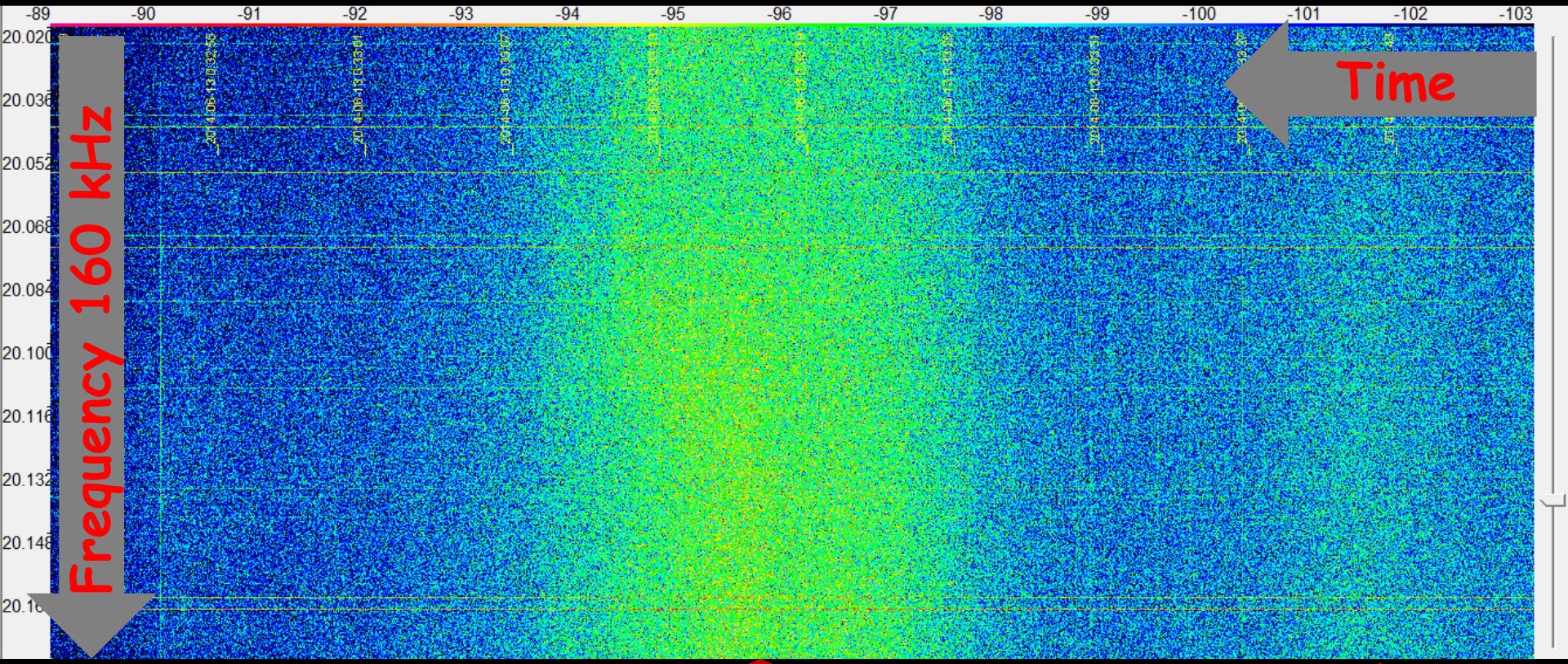


RFSpace SDR-IQ Receiver

June 13, 2014, 0033 UT

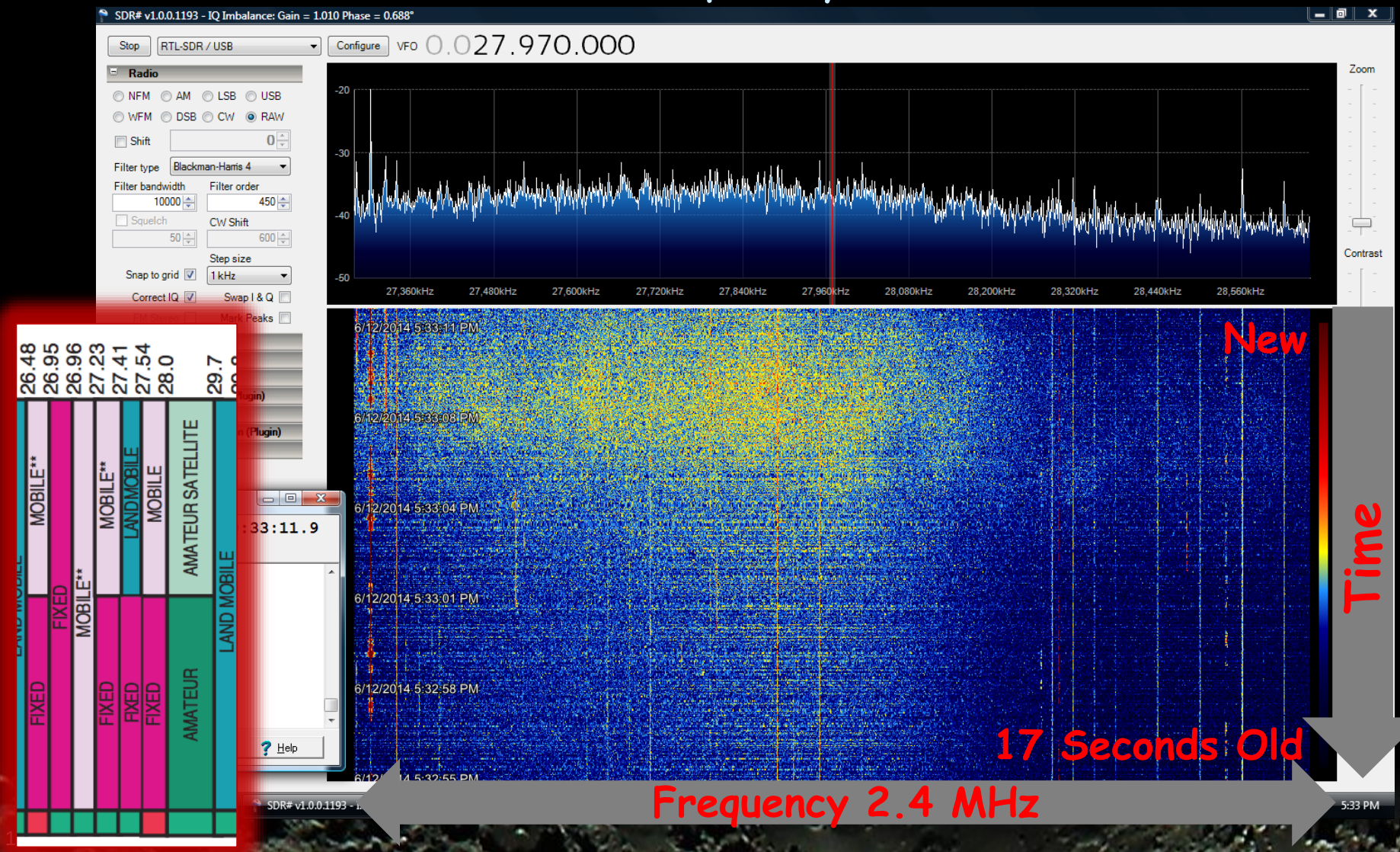
62 Seconds Old

New



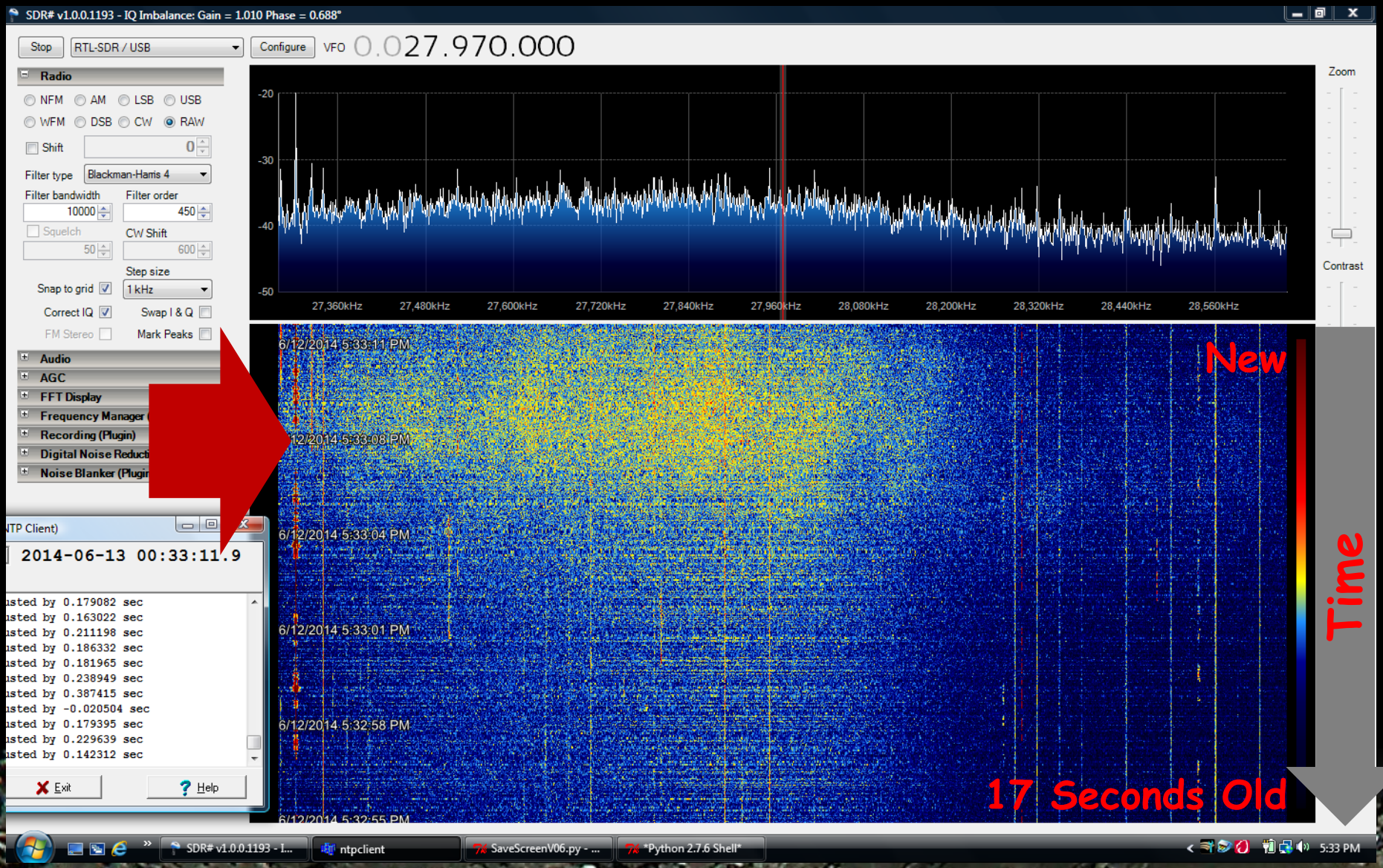
RTL-SDR Receiver

United States Frequency Allocations



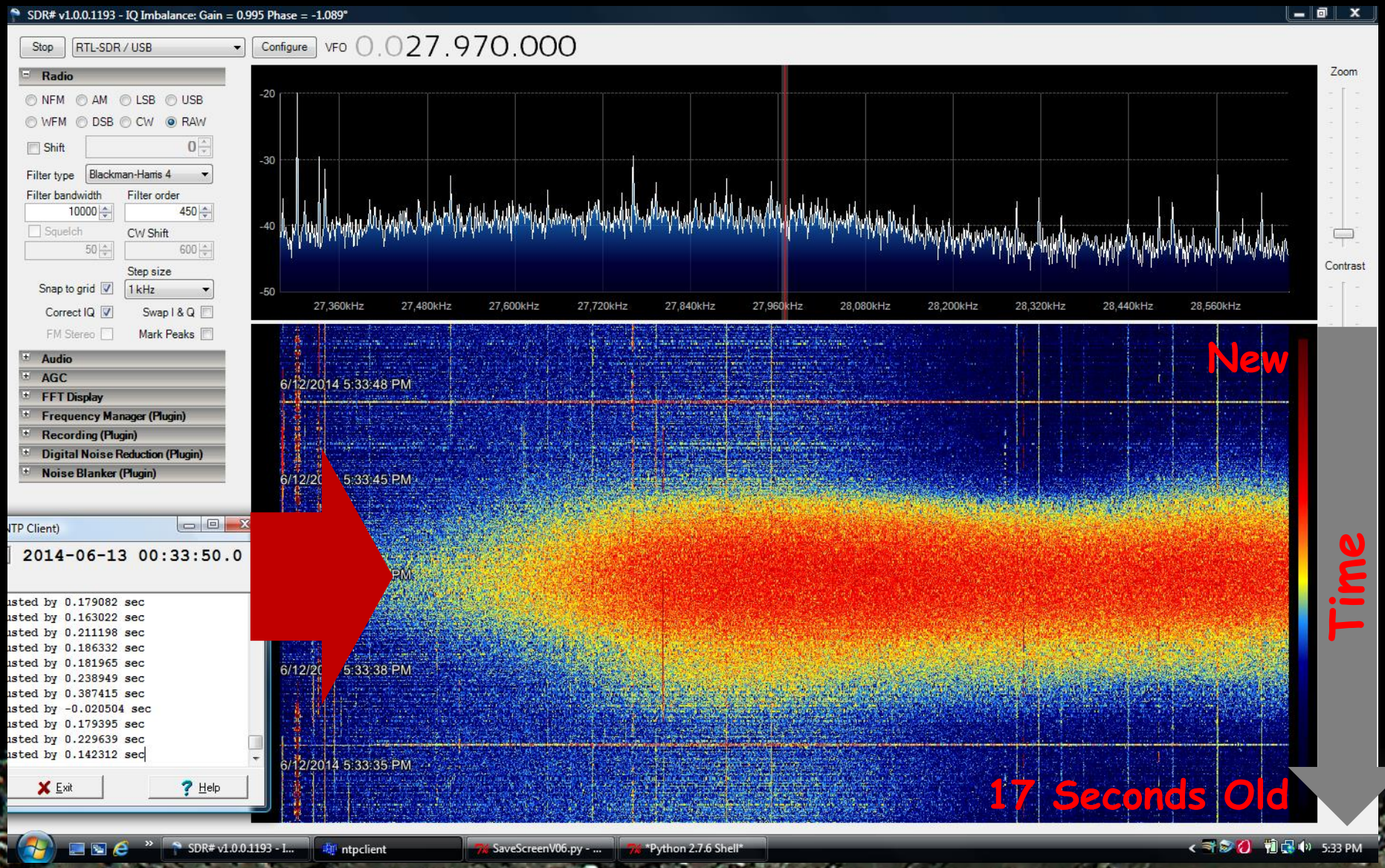
RTL-SDR Receiver

June 13, 2014, 0033 UT



RTL-SDR Receiver

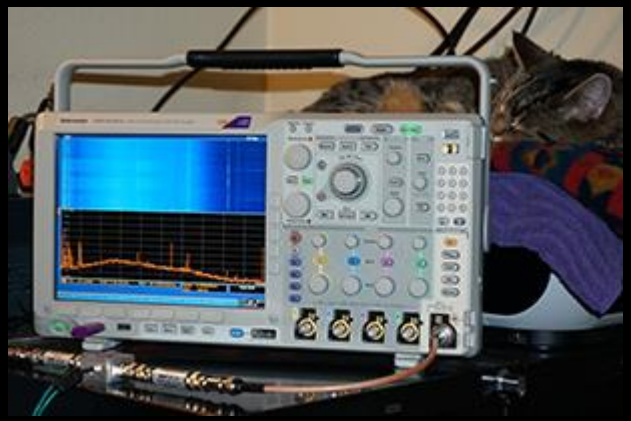
June 13, 2014, 0033 UT



Sun Type III/2 Radio Burst

June 13, 2014, 1521 UT

- Observed with
  - Tektronix MDO4104-6 spectrum analyzer
  - Icom IC-R75 radio receiver
  - RFSpace SDR-IQ receiver
  - RTL-SDR receiver



NOAA Solar Event Report

June 13, 2014, 1521 UT

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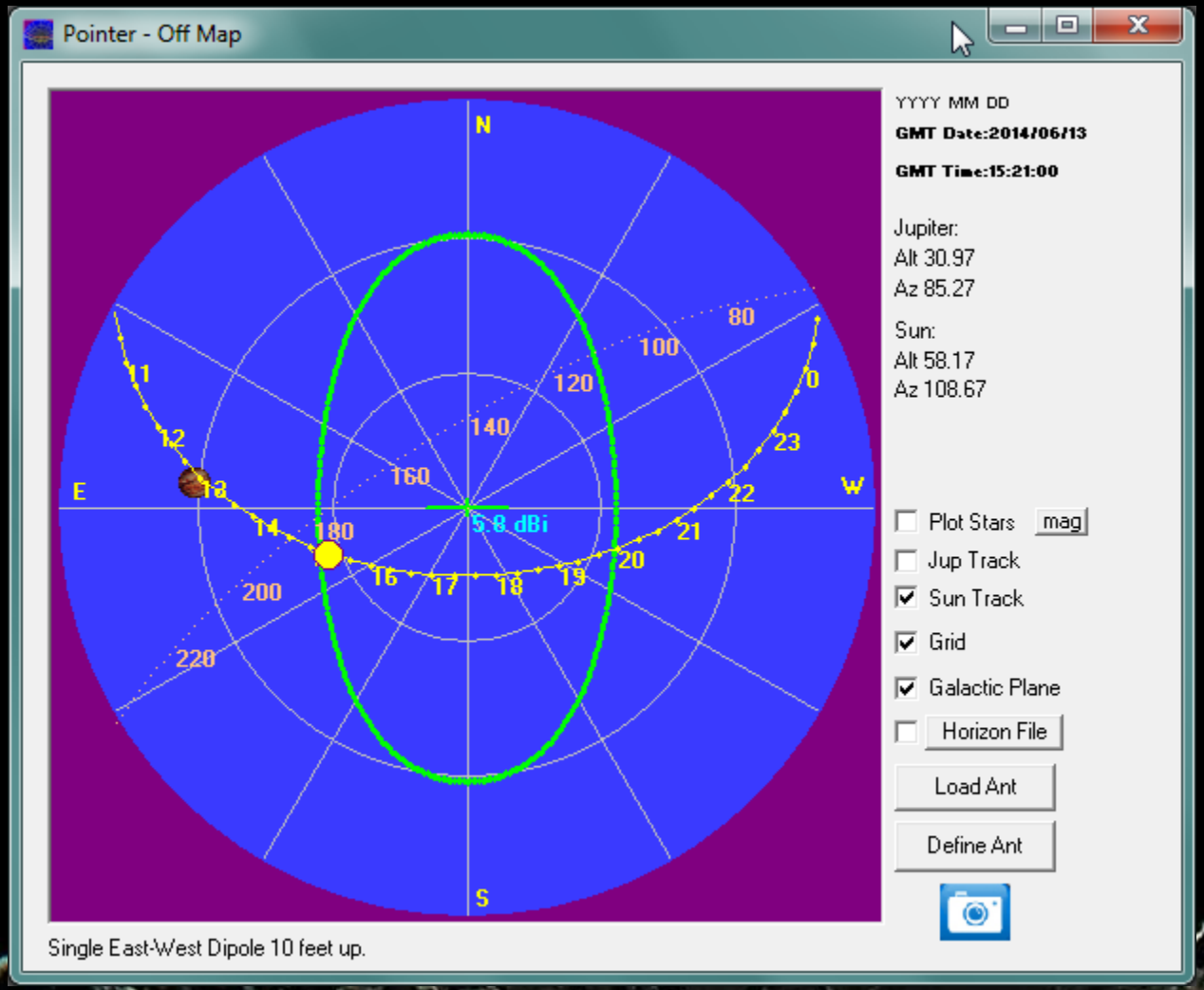
gt:Product: 20140613events.txt
:Created: 2014 Jun 14 1802 UT
:Date: 2014 06 13
# Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center
# Please send comments and suggestions to SWPC.Webmaster@noaa.gov
#
# Missing data: ////
# Updated every 30 minutes.
#                              Edited Events for 2014 Jun 13
#
#Event    Begin    Max       End  Obs  Q  Type  Loc/Frq   Particulars       Reg#
#-----------------------------------------------------------------------------
3940       1521   1524      1527  G15  5   XRA  1-8A      C2.4    5.2E-04   2087
3940 +     1521   1522      1523  SAG  G   RBR  245       290               2087
           1521   ////      1523  SAG  C   RSP  025-180   III/2             2087
3940 +     1522   1522      1525  HOL  3   FLA  S19E38    SF                2087
```

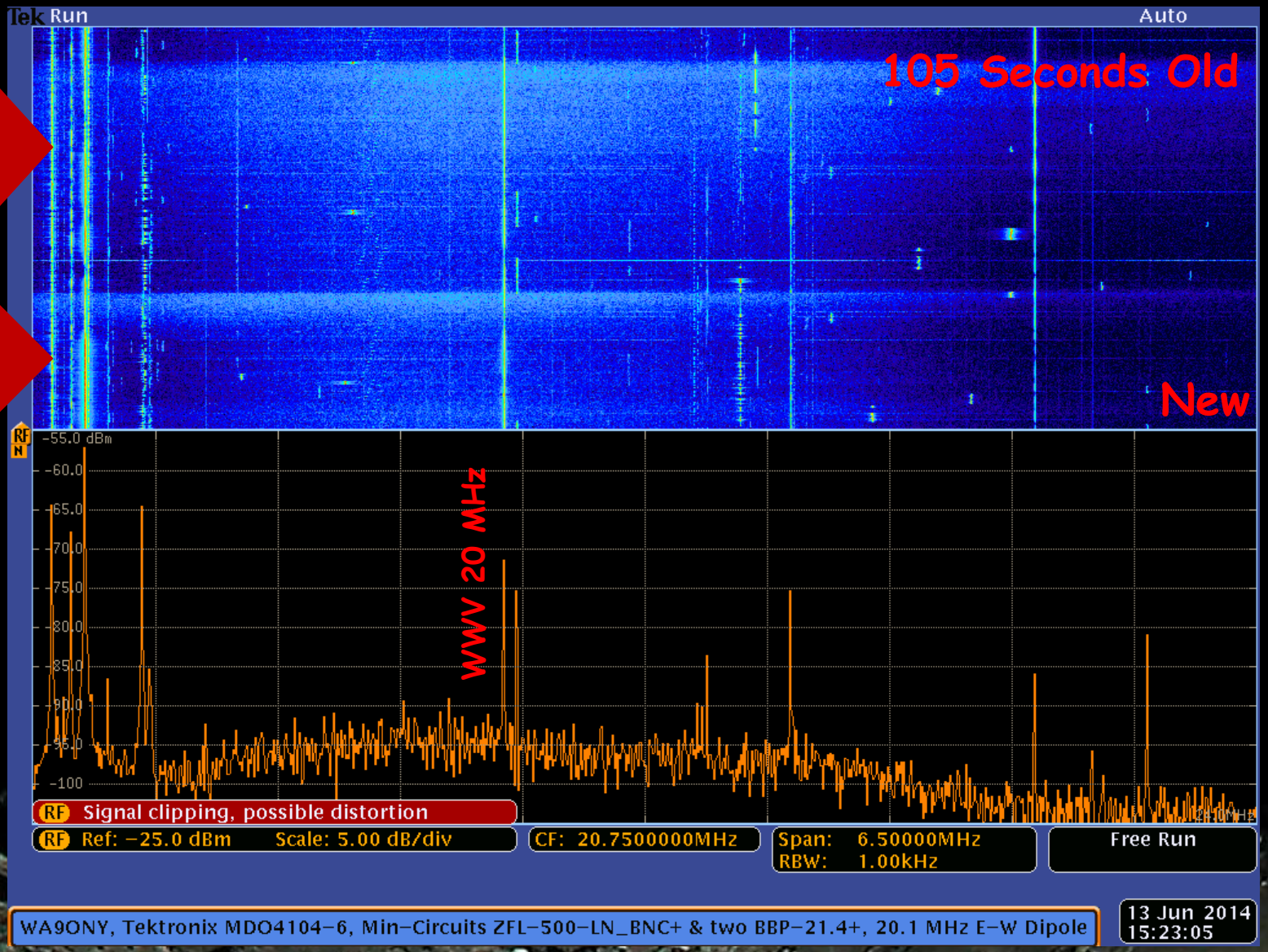
Sun Location

June 13, 2014, 1521 UT



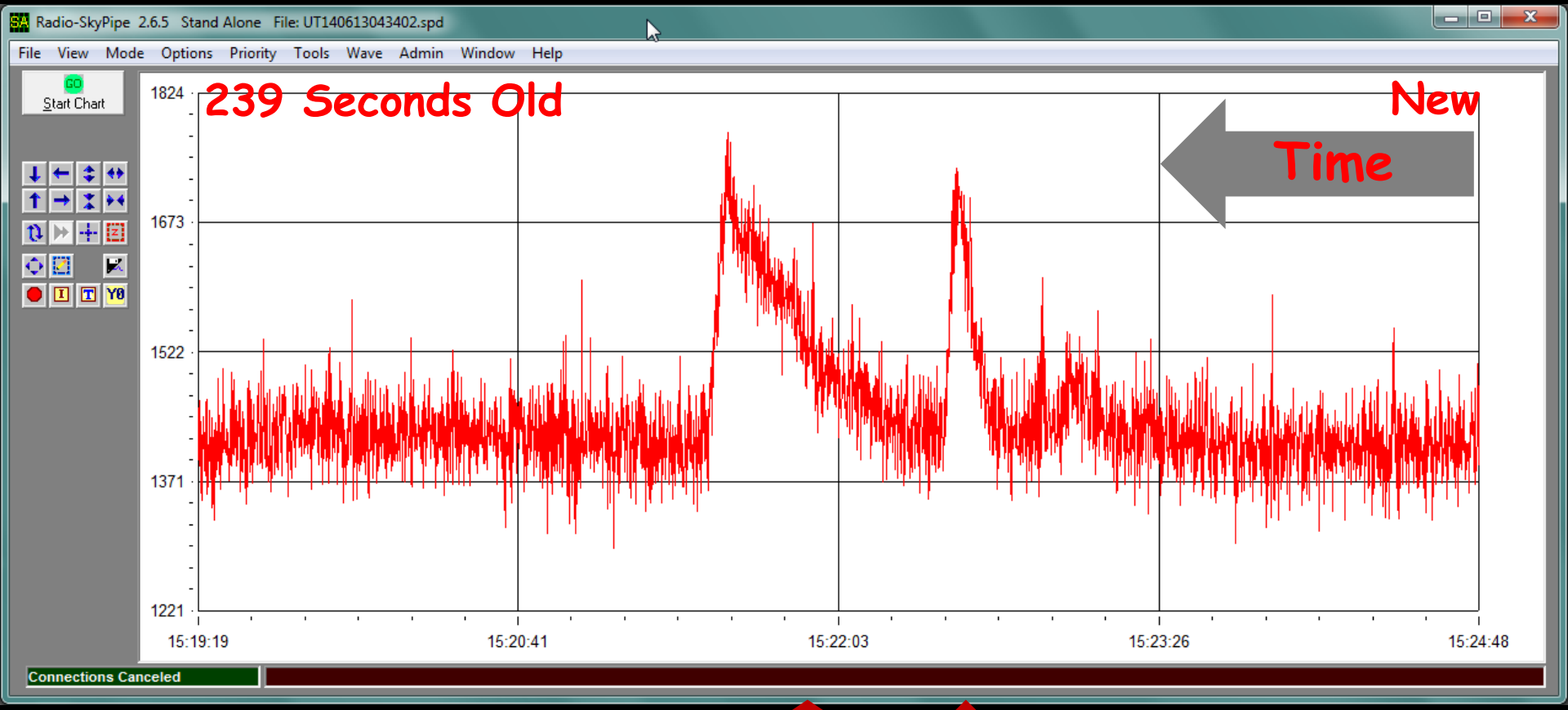
Tektronix MDO4104-6 Spectrogram

June 13, 2014, 1521 UT



Icom IC-R75 Receiver

June 13, 2014, 1521 UT

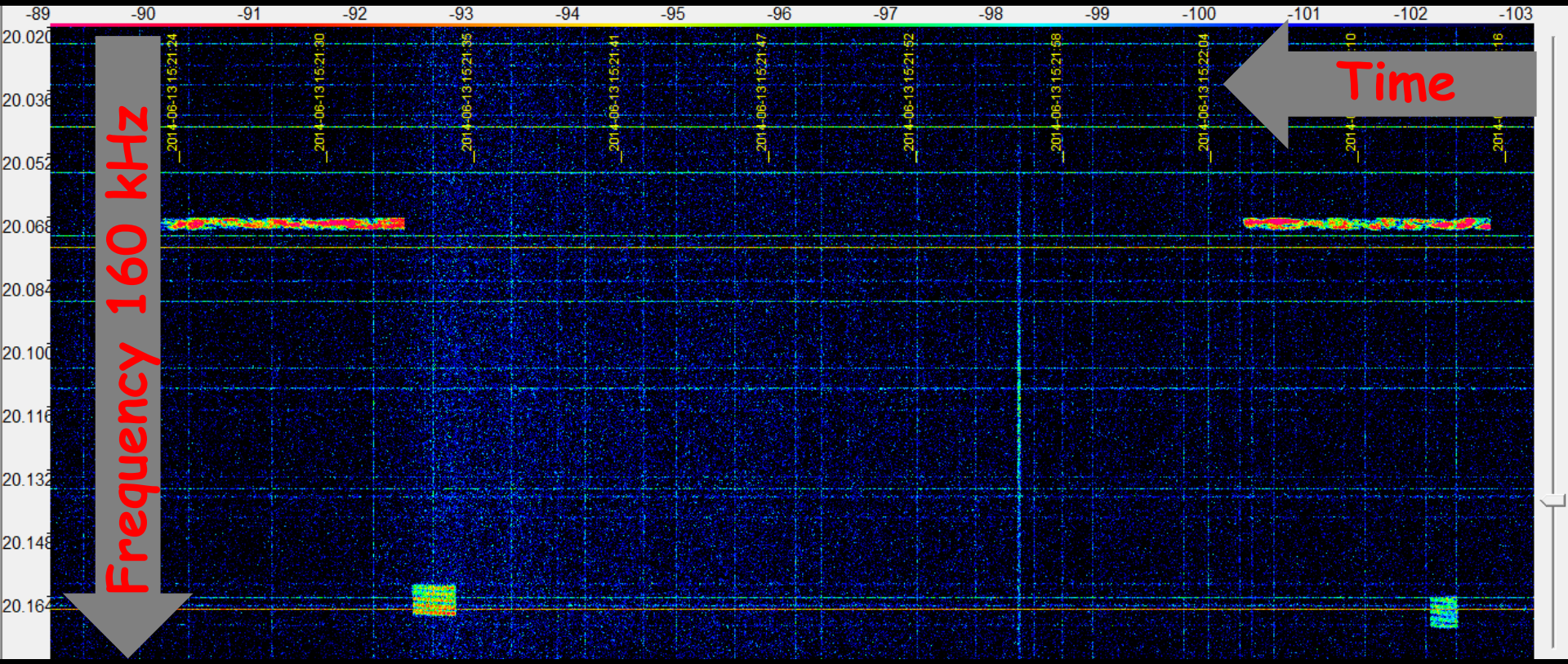


RFSpace SDR-IQ Receiver

June 13, 2014, 1521 UT

62 Seconds Old

New

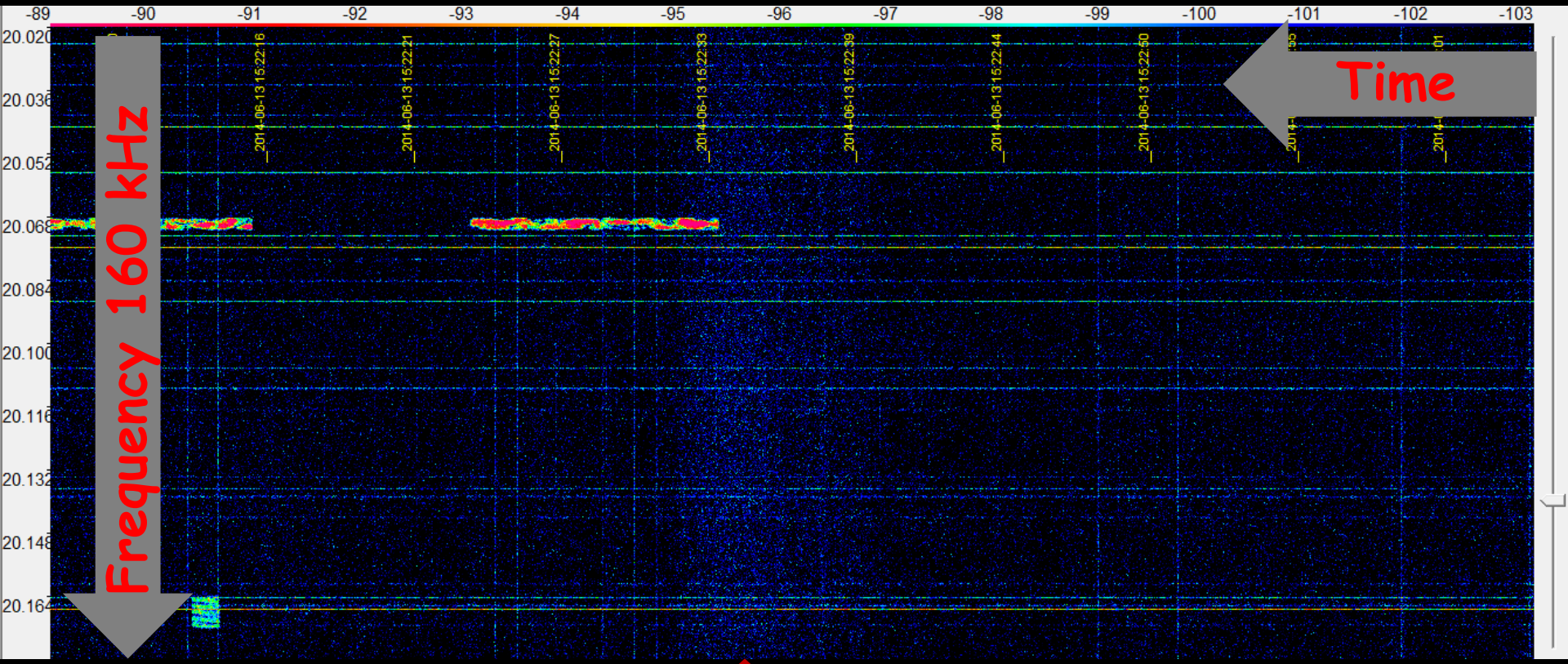


RFSpace SDR-IQ Receiver

June 13, 2014, 1521 UT

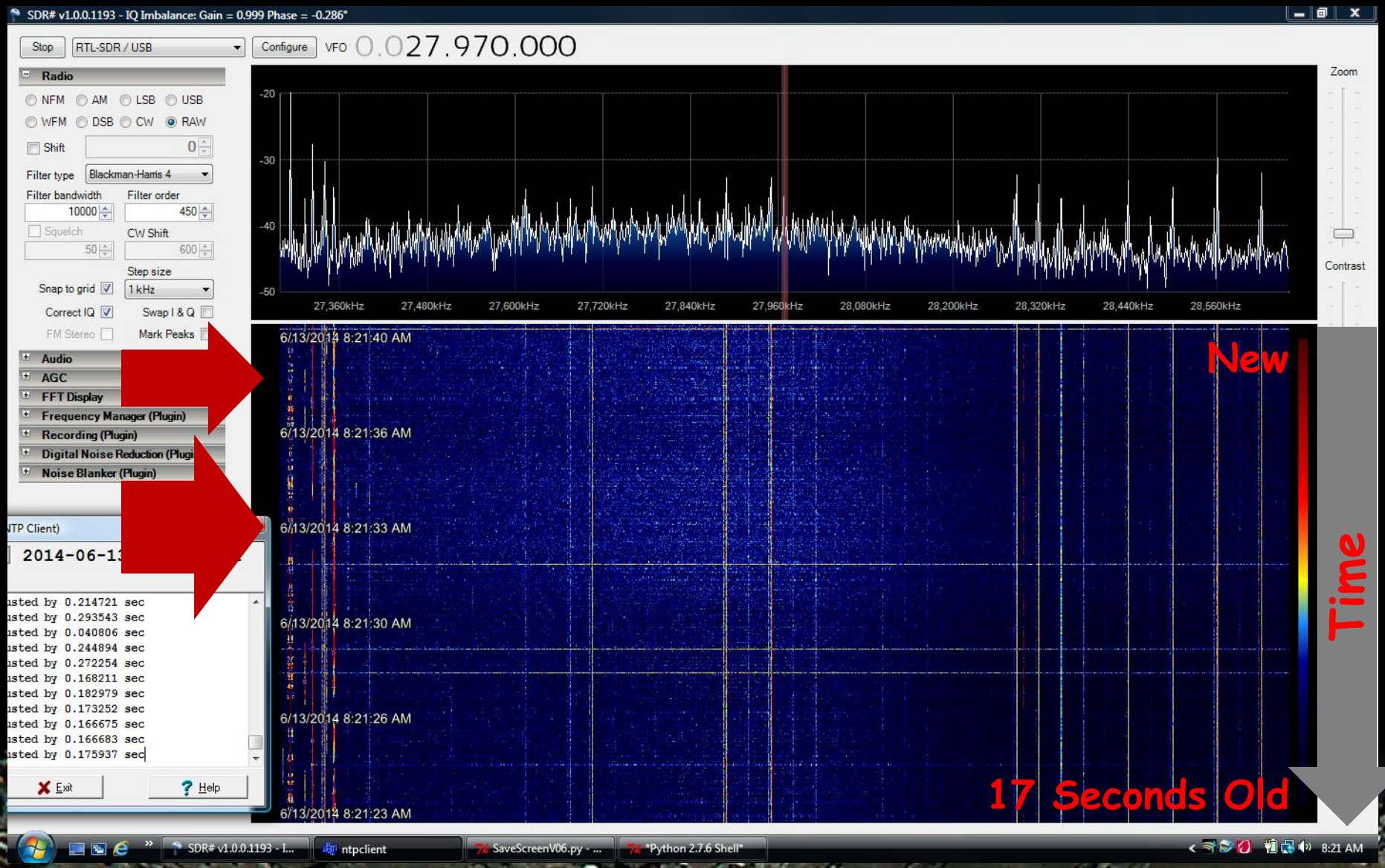
62 Seconds Old

New



RTL-SDR Receiver

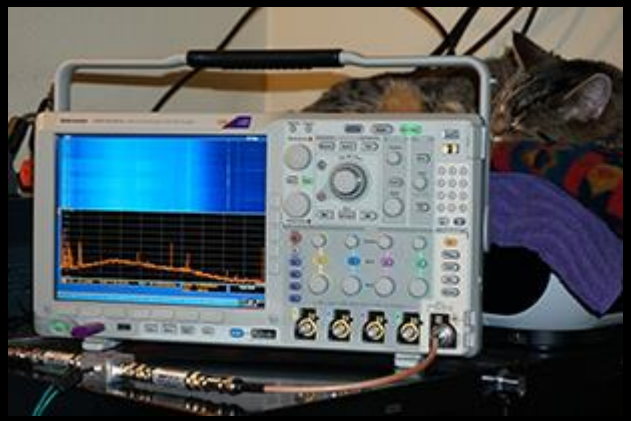
June 13, 2014, 1521 UT



Sun Type III/2 Radio Burst

June 13, 2014, 1815 UT

- Observed with
  - Tektronix MDO4104-6 spectrum analyzer
  - Icom IC-R75 radio receiver
  - RFSpace SDR-IQ receiver
  - RTL-SDR receiver



NOAA Solar Event Report

June 13, 2014, 1815 UT

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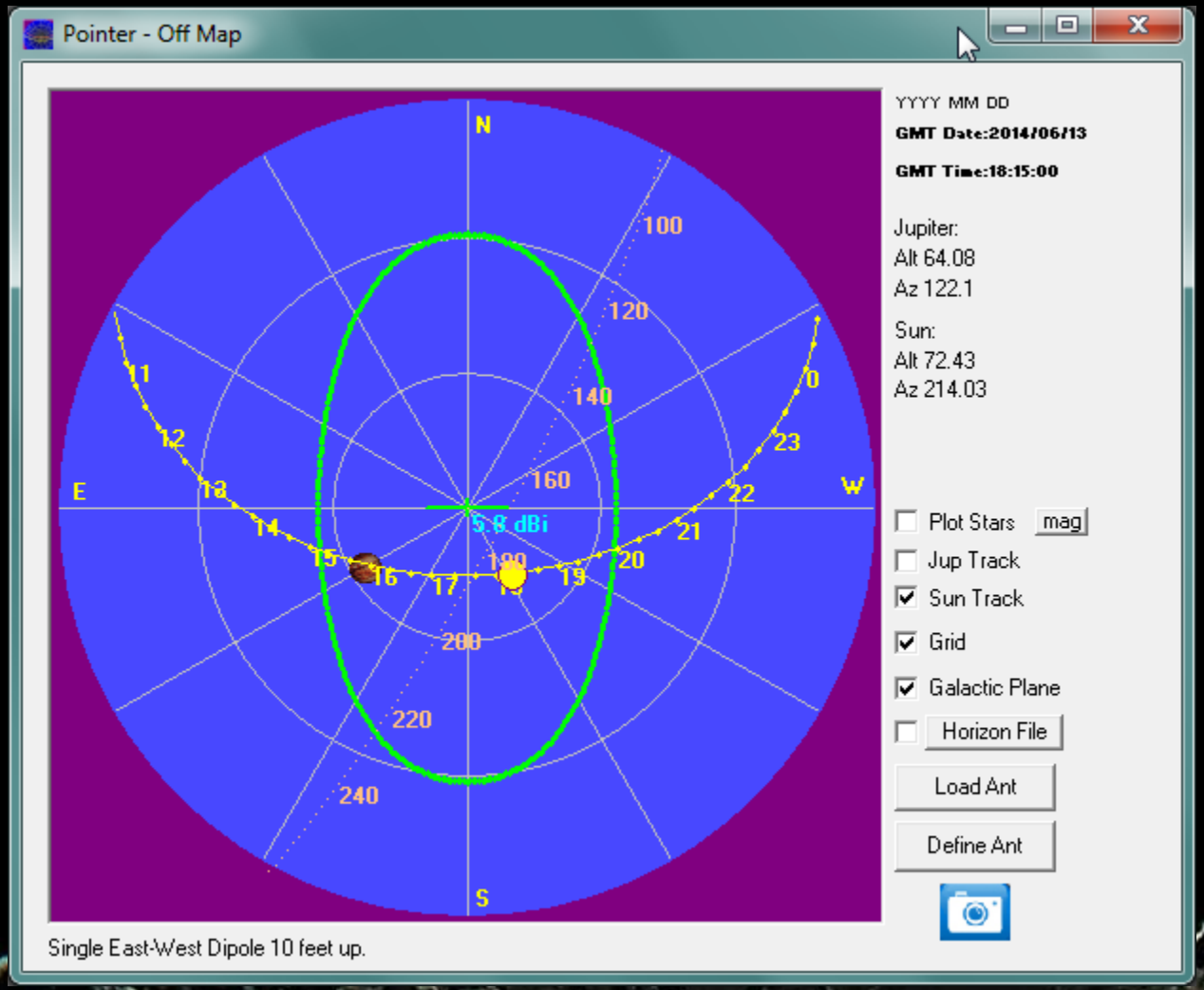
:Created: 2014 Jun 14 1802 UT
:Date: 2014 06 13
# Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center
# Please send comments and suggestions to SWPC.Webmaster@noaa.gov
#
# Missing data: ////
# Updated every 30 minutes.
#                              Edited Events for 2014 Jun 13
#
#Event    Begin    Max       End  Obs  Q  Type  Loc/Frq   Particulars       Reg#
#-----------------------------------------------------------------------------
          1809    ////      1817  SAG  C   RSP  025-180   III/2             2087
4080      1815    1817      1819  HOL  3   FLA  S20E35    SF      ERU       2087
4080 +    1815    1815      1815  SAG  G   RBR  245       180               2087
```

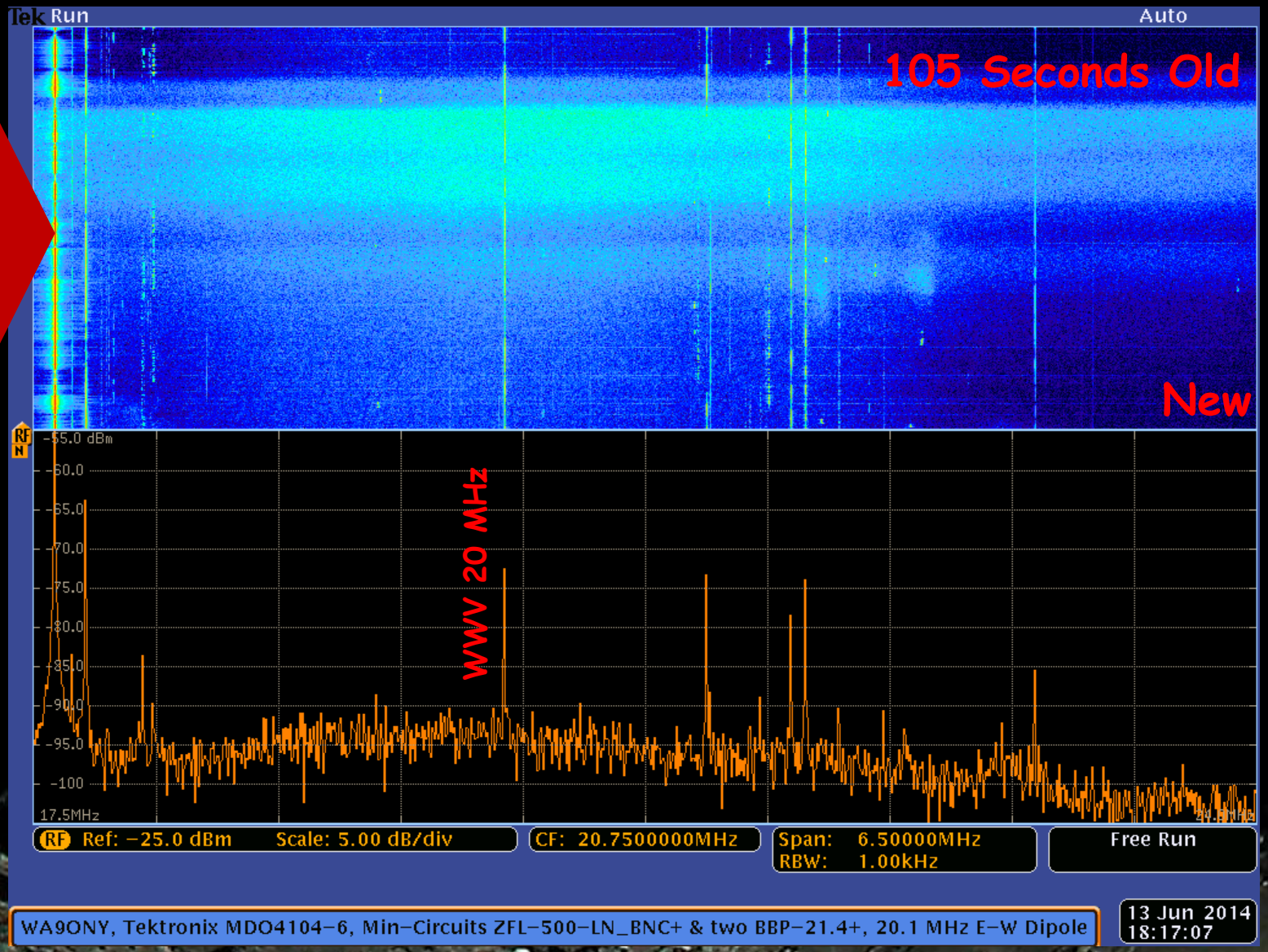
Sun Location

June 13, 2014, 1815 UT



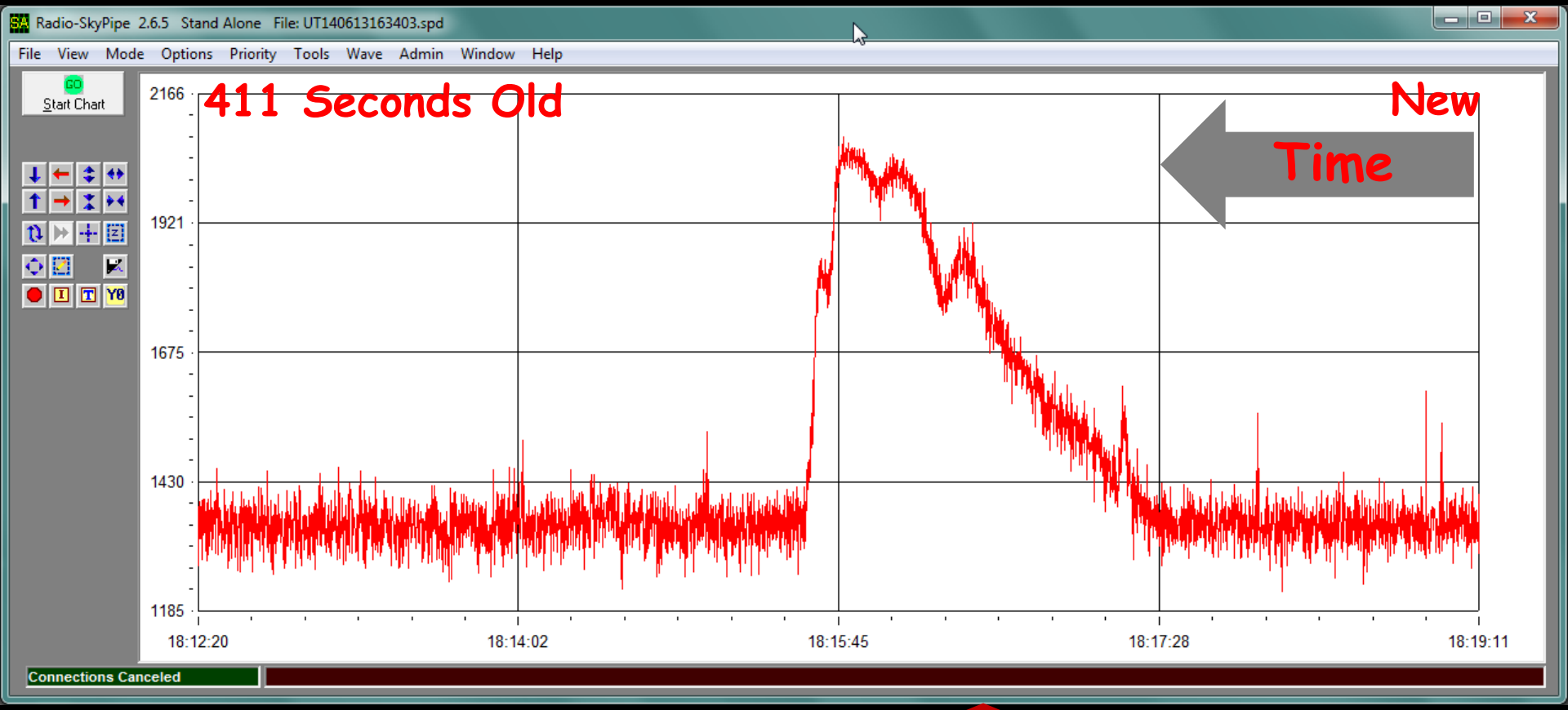
Tektronix MDO4104-6 Spectrogram

June 13, 2014, 1815 UT



Icom IC-R75 Receiver

June 13, 2014, 1815 UT

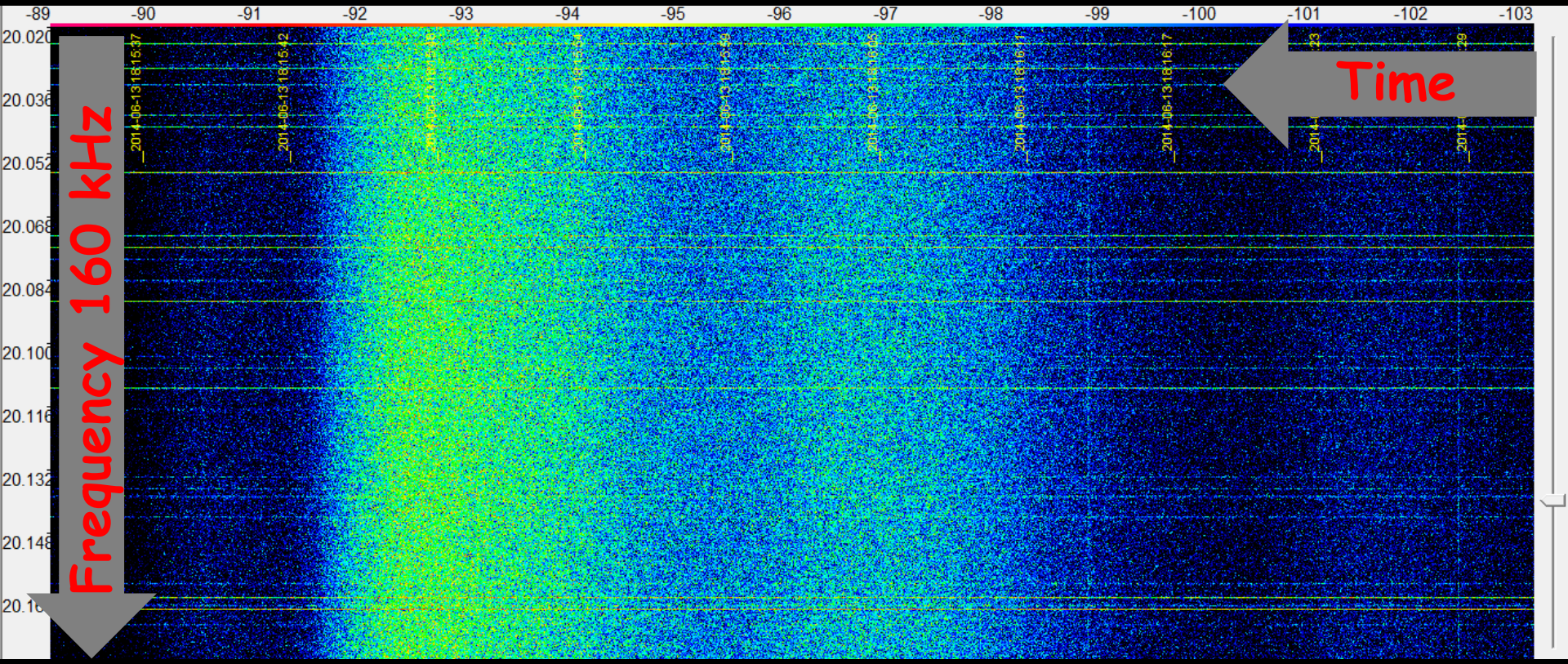


RFSpace SDR-IQ Receiver

June 13, 2014, 1815 UT

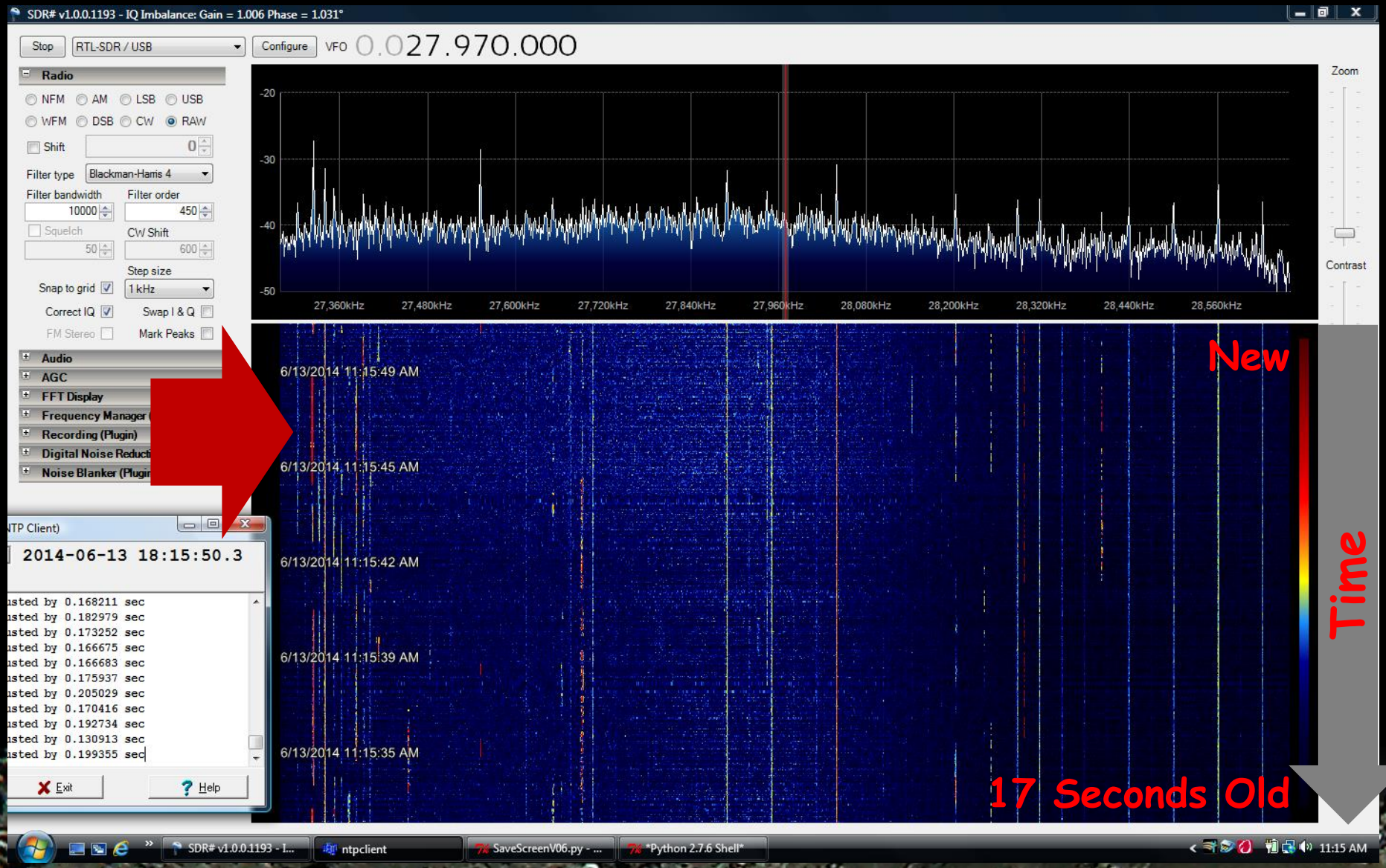
62 Seconds Old

New



RTL-SDR Receiver

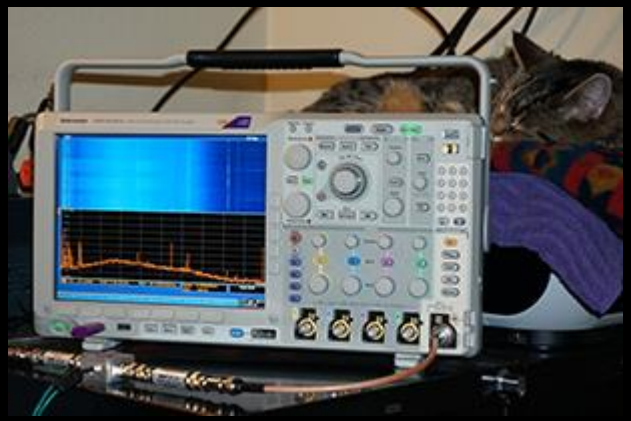
June 13, 2014, 1815 UT



Sun Type III/2 Radio Burst

June 13, 2014, 2014 UT

- Observed with
  - Tektronix MDO4104-6 spectrum analyzer
  - Icom IC-R75 radio receiver
  - RFSpace SDR-IQ receiver



NOAA Solar Event Report

June 13, 2014, 2014 UT

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:Created: 2014 Jun 14 1802 UT
:Date: 2014 06 13
# Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center
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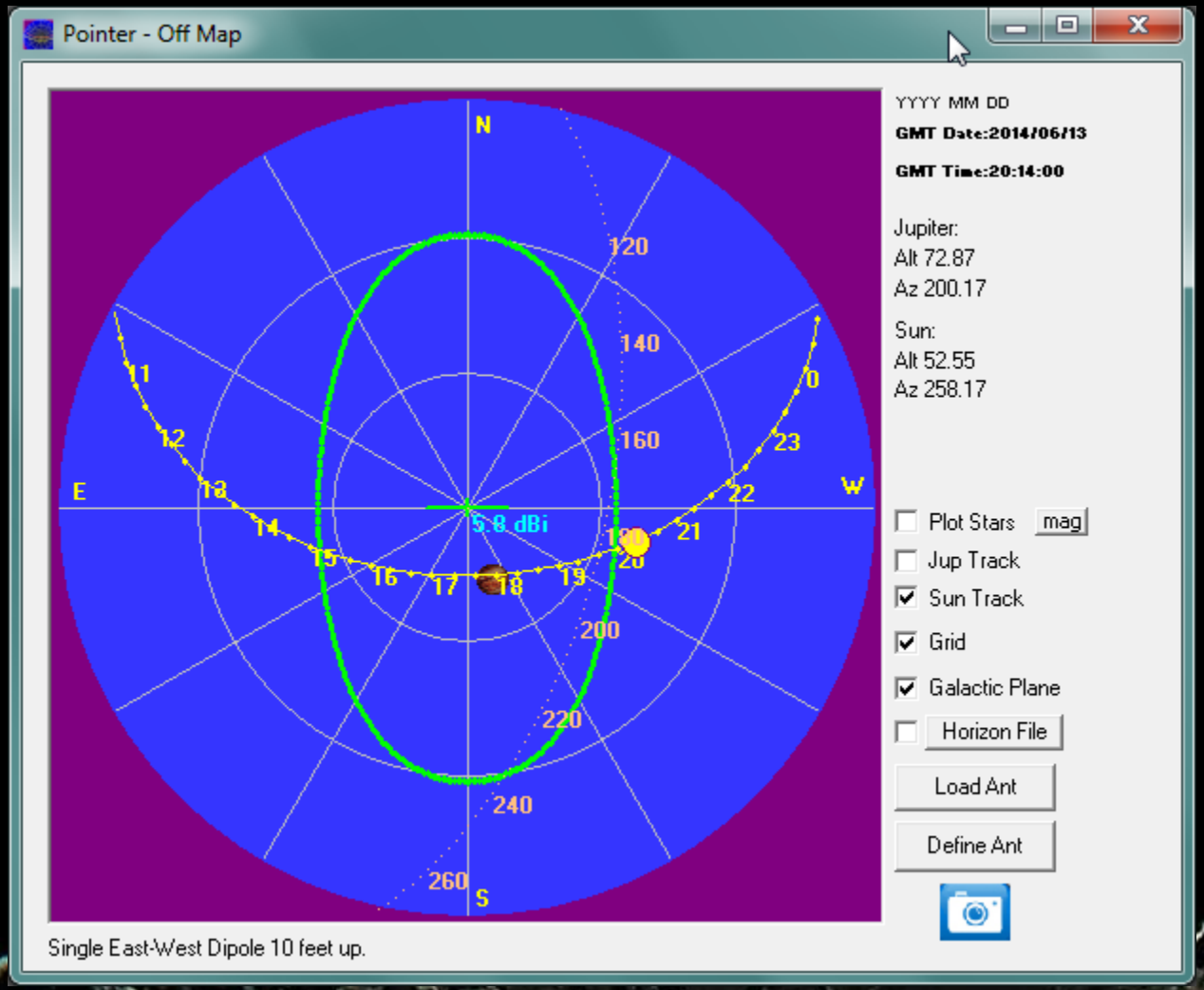
#
# Missing data: ////
# Updated every 30 minutes.
#                          Edited Events for 2014 Jun 13
#
#Event    Begin    Max      End   Obs  Q  Type  Loc/Frq   Particulars      Reg#
#-----------------------------------------------------------------------------
4110       2013   2017     2020  G15  5   XRA  1-8A      C9.0    2.3E-03  2087
4110       2014   2015     2025  HOL  2   FLA  S20E34    SF      ERU      2087
4110 +     2014   2014     2014  PAL  G   RBR  245       1300             2087
           2014   ////     2015  SAG  C   RSP  025-180   III/2            2087
4110 +     2014   2014     2014  PAL  G   RBR  410       460              2087
```

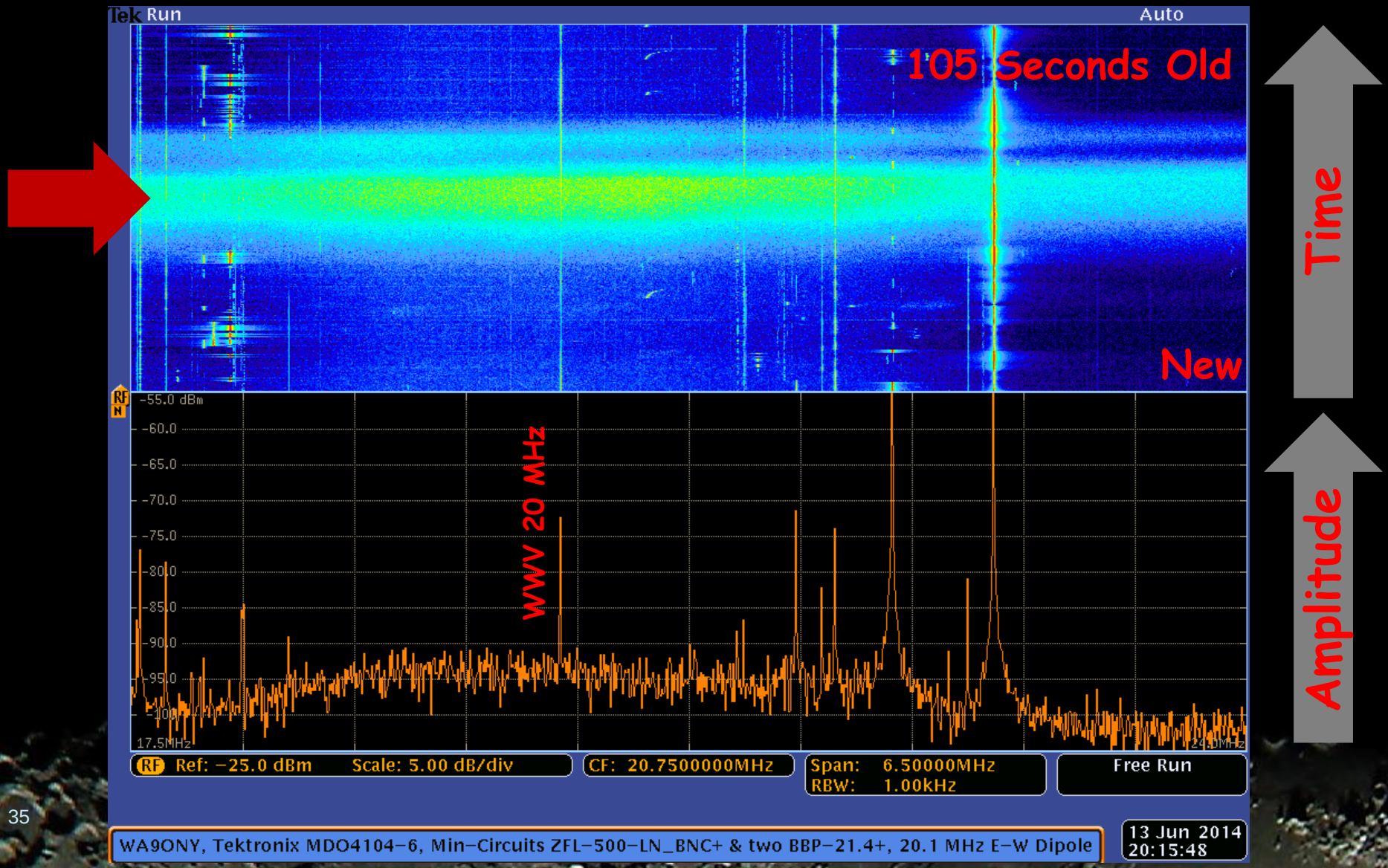
Sun Location

June 13, 2014, 2014 UT



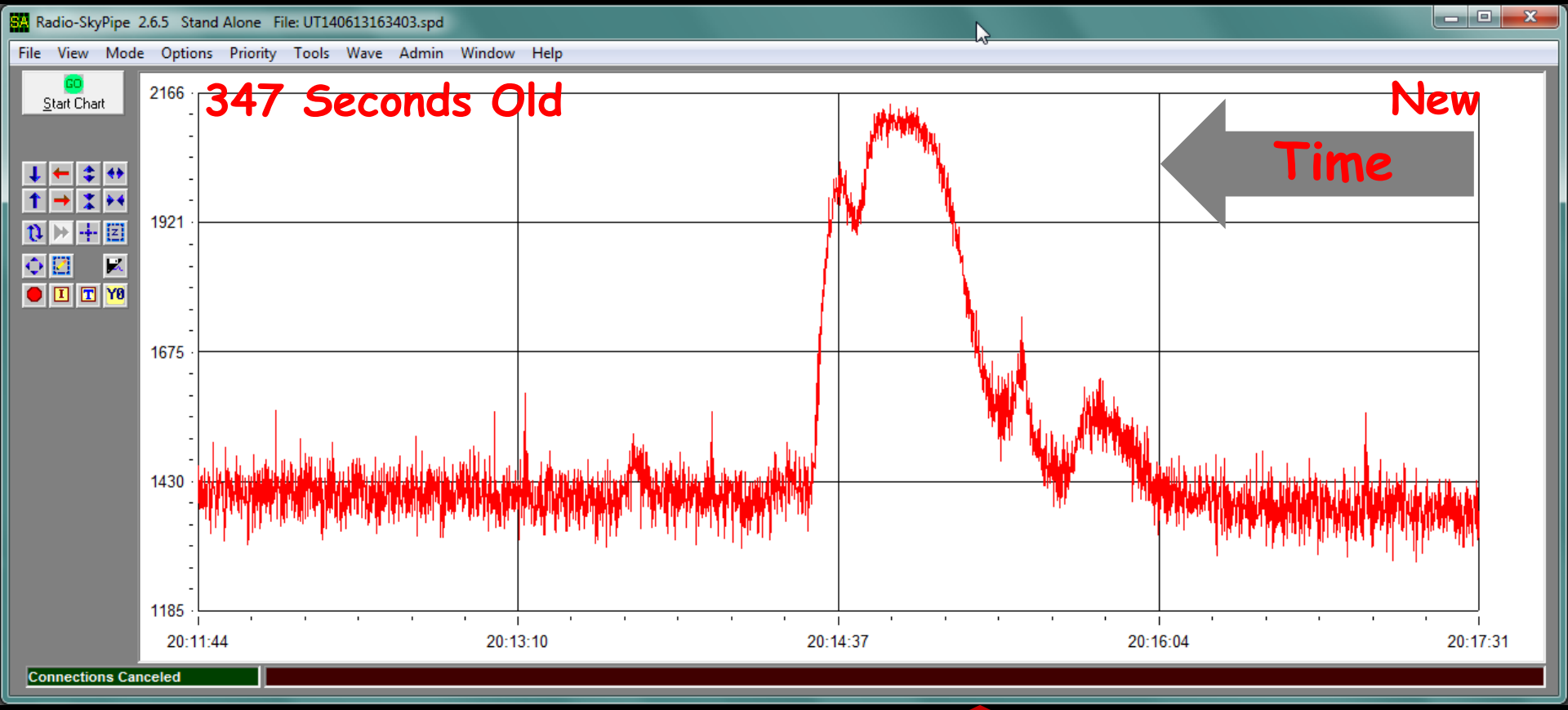
Tektronix MDO4104-6 Spectrogram

June 13, 2014, 2014 UT



Icom IC-R75 Receiver

June 13, 2014, 2014 UT

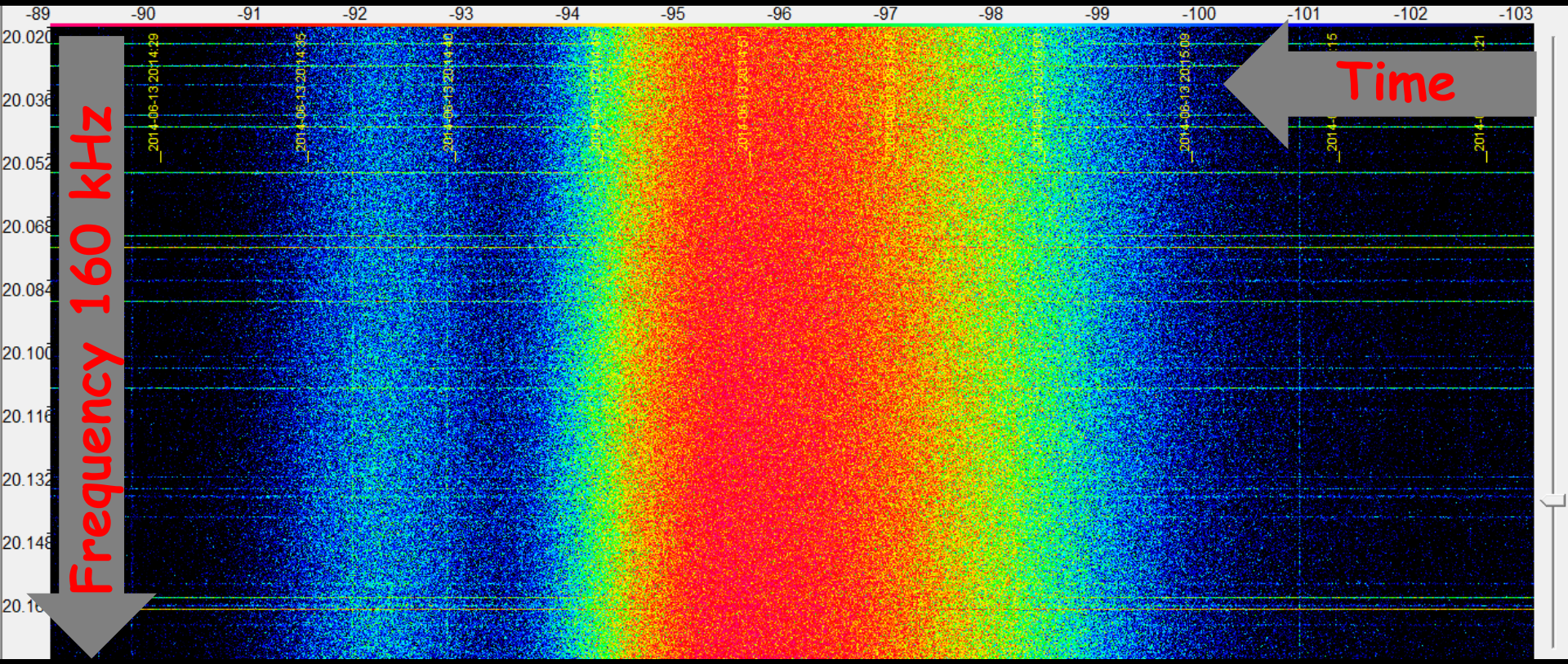


RFSpace SDR-IQ Receiver

June 13, 2014, 2014 UT

62 Seconds Old

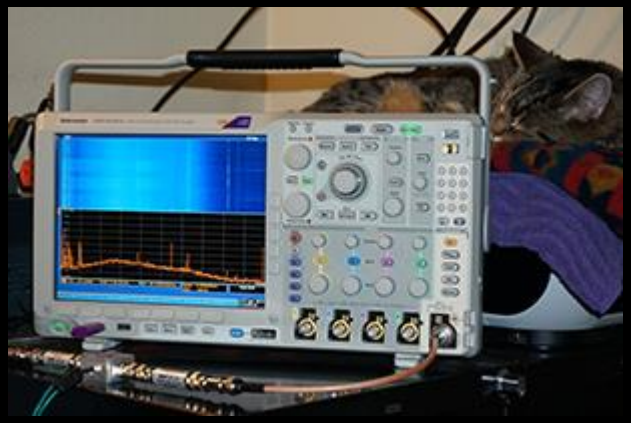
New



Sun Type Radio Burst

June 13, 2057, 2057 UT

- Observed with
  - Tektronix MDO4104-6 spectrum analyzer
  - Icom IC-R75 radio receiver



NOAA Solar Event Report

June 13, 2014, 2057 UT

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:Date: 2014 06 13
# Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center
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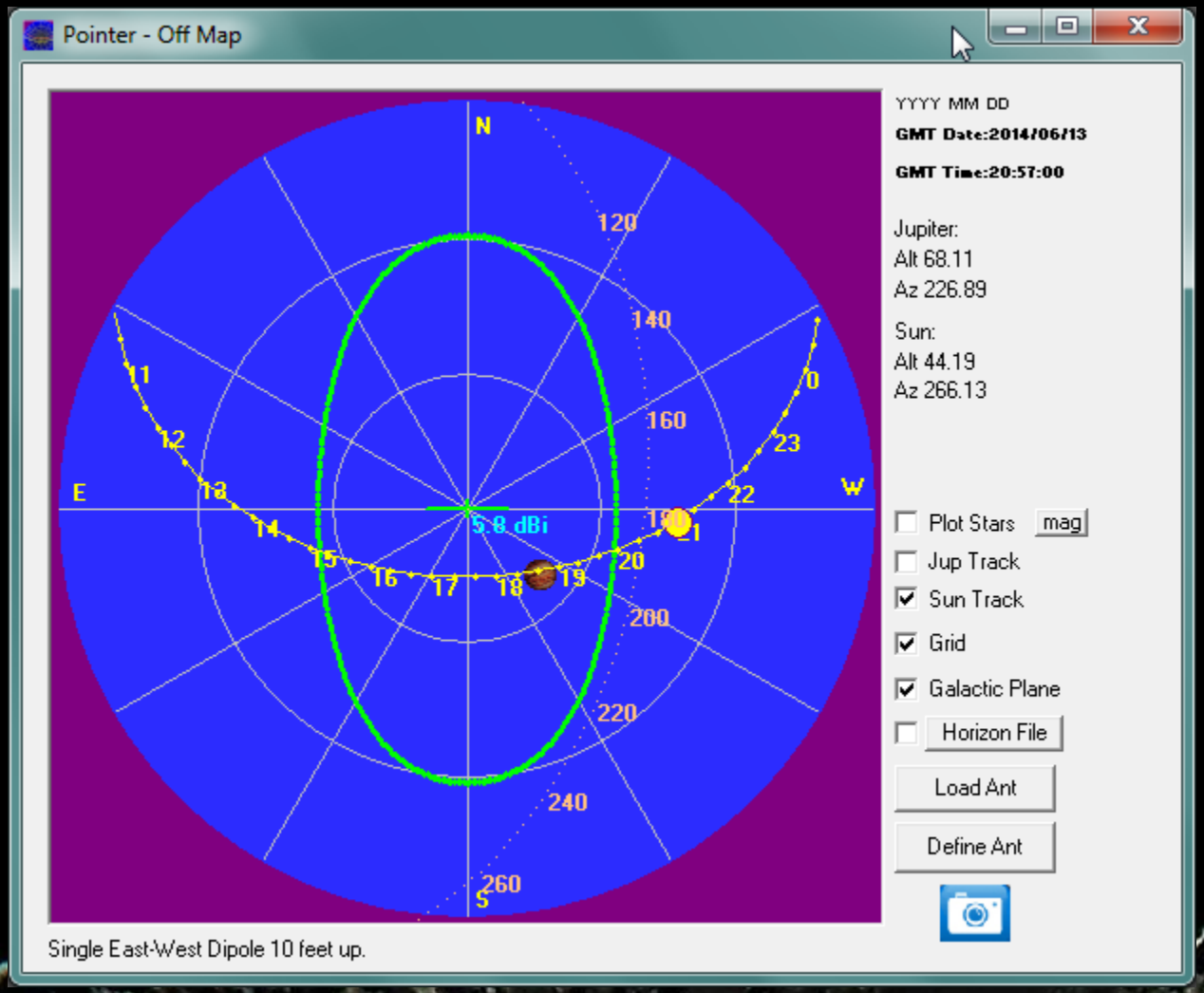
#
# Missing data: ////
# Updated every 30 minutes.
#                              Edited Events for 2014 Jun 13
#
#Event    Begin    Max       End  Obs  Q  Type  Loc/Frq   Particulars       Reg#
#-----------------------------------------------------------------------------
4120       2055   2101      2109  G15  5   XRA  1-8A      C4.1    2.7E-03   2087
4120       2058   2058      2110  HOL  2   FLA  S19E38    SF      ERU       2087
```

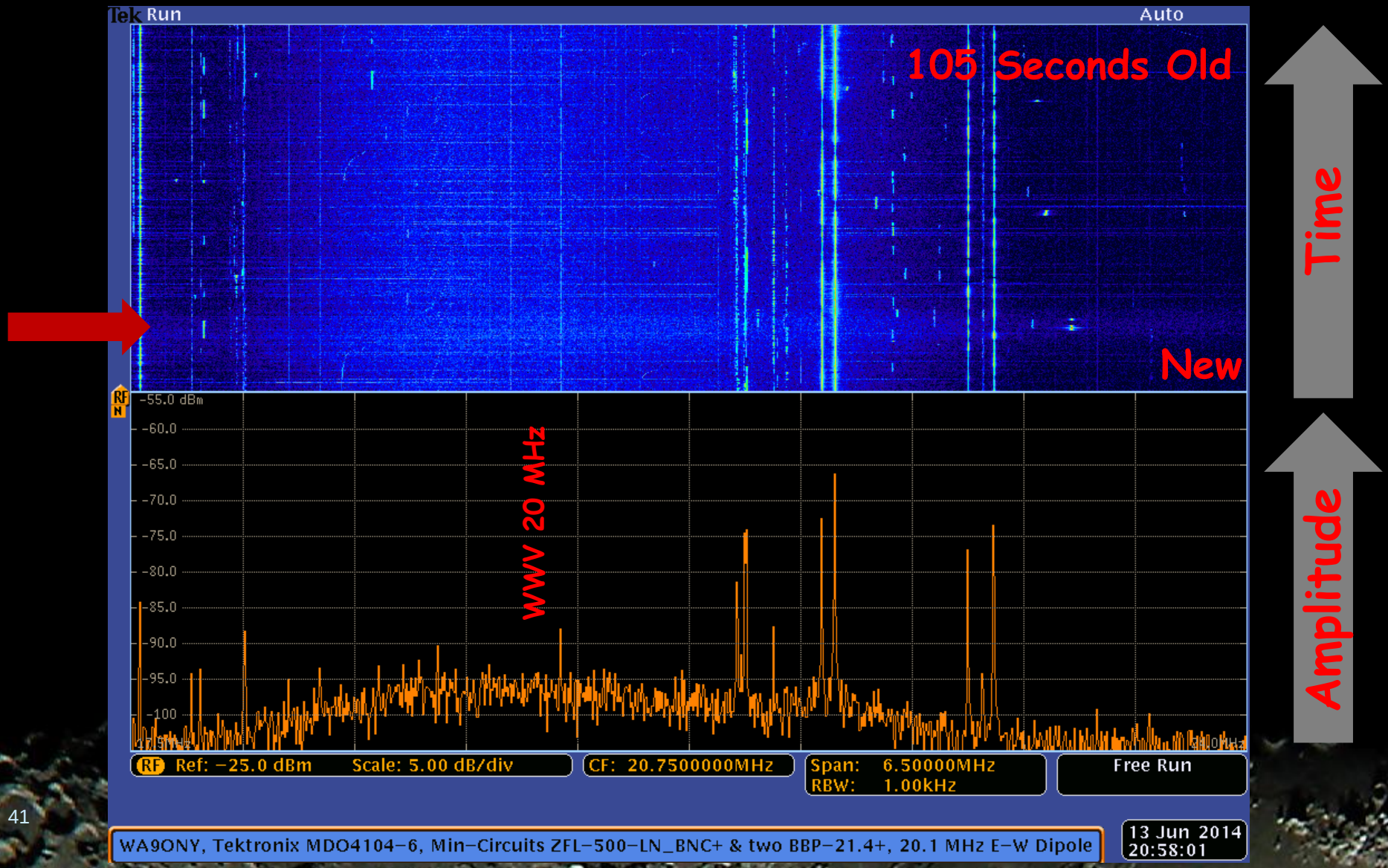
Sun Location

June 13, 2014, 2057 UT



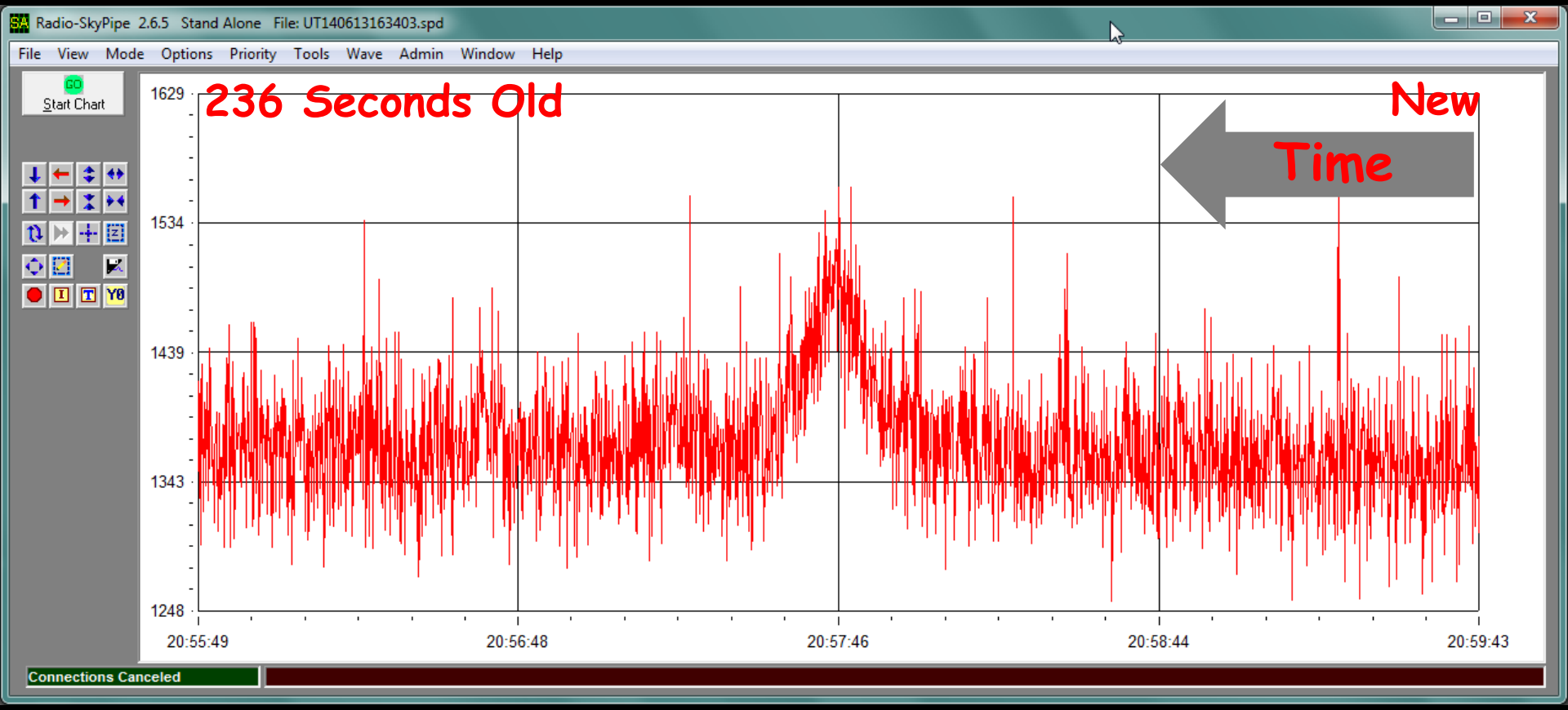
Tektronix MDO4104-6 Spectrogram

June 13, 2014, 2057 UT



Icom IC-R75 Receiver

June 13, 2014, 2057 UT

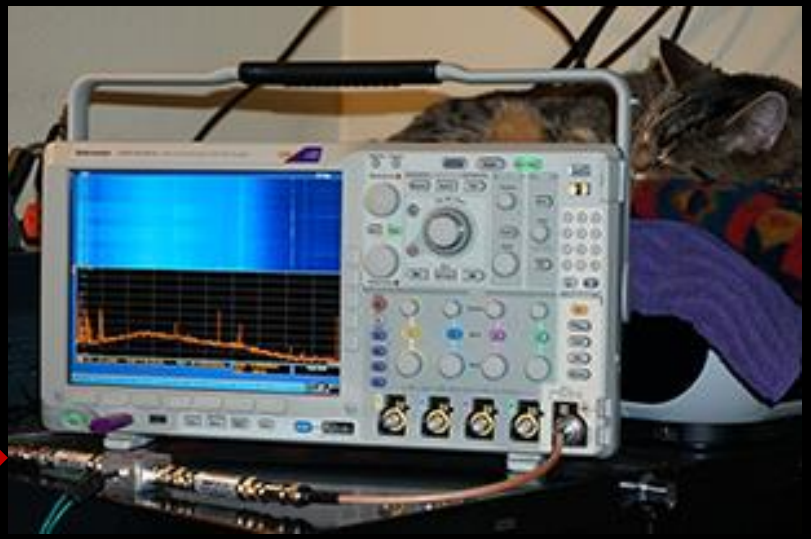


Antennas

- Tektronix MDO4104-6 spectrum analyzer
  - Radiowavz 15-DP11 15M dipole antenna with 1:1 Balum
- Icom IC-R75 radio receiver
  - Radiowavz 15-DP11 15M dipole antenna with 1:1 Balum
- RFSpace SDR-IQ receiver
  - Radiowavz 15-DP11 15M dipole antenna with 1:1 Balum
- RTL-SDR receiver
  - Scanner Ant-Base 30-1300 Mhz by Antennacraft

Signal Conditioning

- Tektronix MDO4104-6 spectrum analyzer
  - Mini-Circuits 21.4 MHz band pass filter 19.2 to 23.6 MHz
  - Mini-Circuits ZFL-500LN+ Coaxial Low Noise Amplifier minimum 24 db gain, noise figure 2.9 dB typical, 0.1 to 500 MHz, flatness +/-0.5 dB total range
  - Mini-Circuits 21.4 MHz band pass filter 19.2 to 23.6 MHz



Signal Conditioning

- Icom IC-R75 radio receiver
  - MFJ Enterprises MFJ-1040C Preselector
- RFSpace SDR-IQ receiver
  - MFJ Enterprises MFJ-1040C Preselector
- RTL-SDR receiver
  - MFJ Enterprises MFJ-1040C Preselector

Laptop Computers

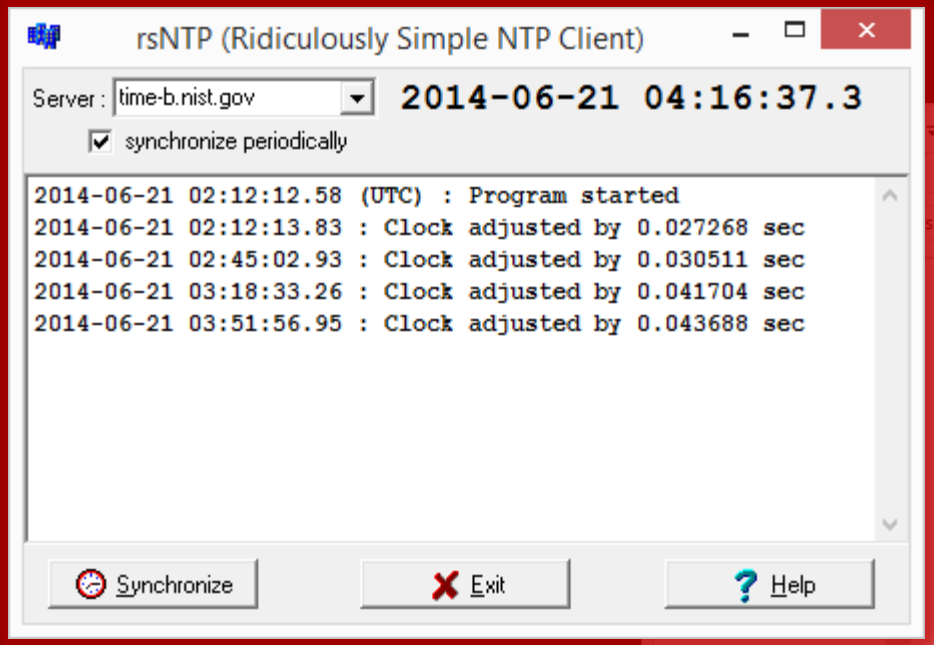
- Tektronix MDO4104-6 spectrum analyzer & Icom IC-R75 radio receiver
  - HP G70 Notebook PC, 32-bit
  - Pentium Dual Core CPU, T4200 @ 2 GHz, 3 GB RAM
  - Microsoft Windows Vista Home Premium, SP 2
- RFSpace SDR-IQ receiver
  - HP Pavilion dv7 Notebook PC, 64-bit
  - Intel Core™ i7-2630QM CPU @ 2 GHz, 8 GB RAM
  - Windows 7 Home Premium SP1
- RTL-SDR receiver
  - HP G70 Notebook PC, 32-bit
  - Pentium Dual Core CPU, T4200 @ 2 GHz, 3 GB RAM
  - Microsoft Windows Vista Home Premium, SP 2

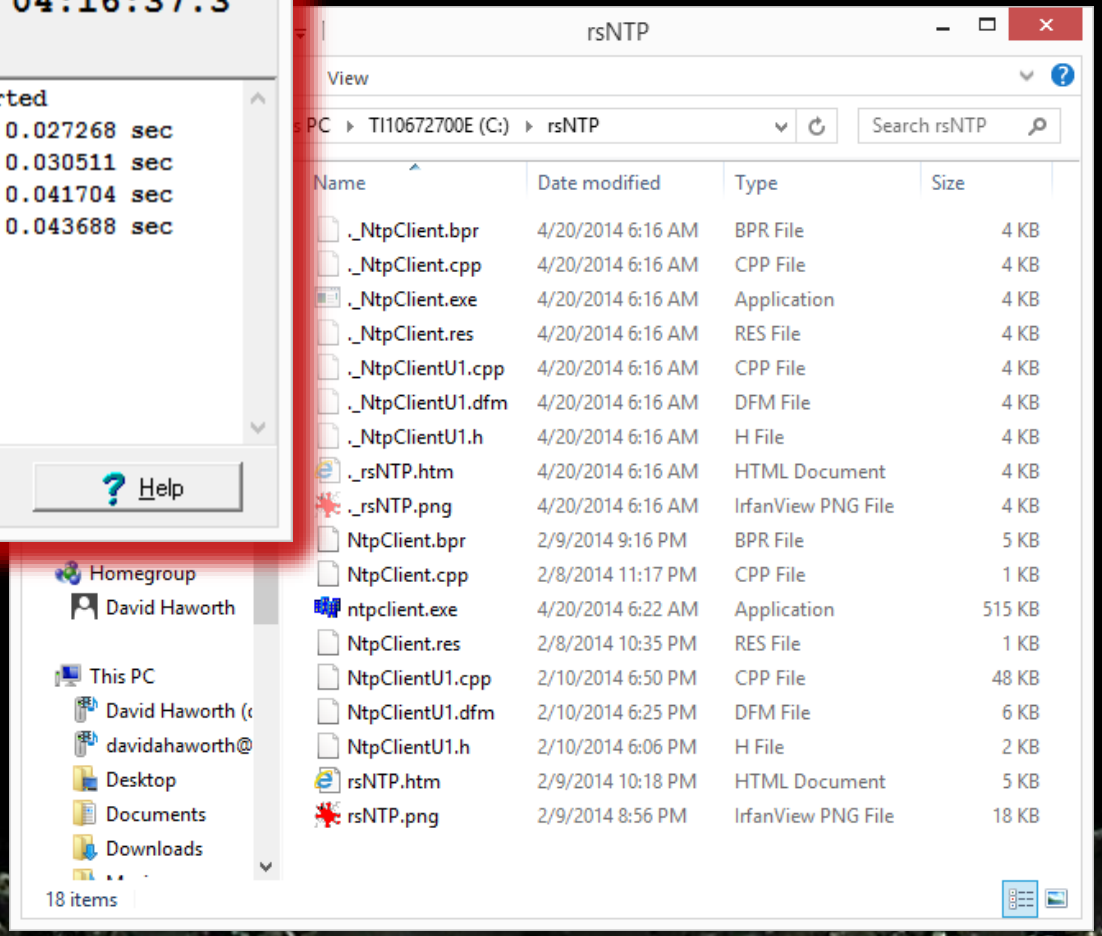
Software

- Tektronix MDO4104-6 spectrum analyzer LAN
  - Python 2.7.6 script taking screen captures every 12 seconds
  - Set the spectrum analyzer time every 4 hours
- Icom IC-R75 radio receiver Audio Out
  - Radio-Sky Radio-SkyPipe II strip chart recorder
- RFSpace SDR-IQ receiver USB
  - SpectraVue V3.28 software
- RTL-SDR receiver USB
  - SDR# V1.0.0.1193
  - Python 2.7.6 script taking screen captures

Keeping Time Between Instruments

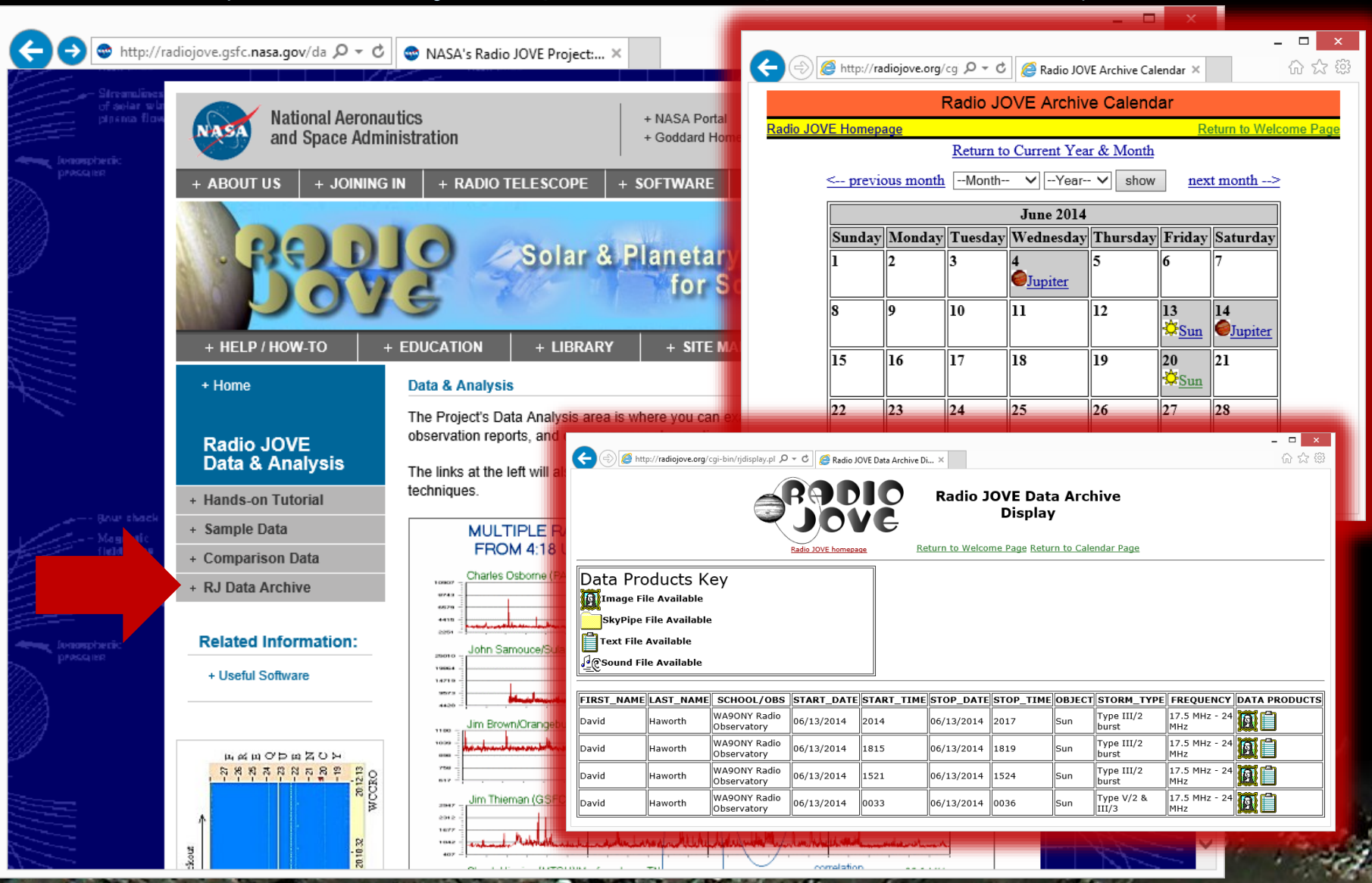
http://www.qsl.net/dl4yhf/rsNTP/rsNTP.htm





Radio Jove Data Archive

http://radiojove.gsfc.nasa.gov/data_analysis/



More Details at

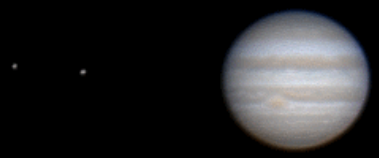
http://www.stargazing.net/david/radio/

http://www.stargazing.net/david/radio/in

Radio Astronomy

NEW

Radio Astronomy



Jupiter Radio Emissions

- January 31, 2014, 0715 UT

Sun Radio Emissions

- Sun Type III/3 Radio Burst January 28, 2014, 1525 UT
- Sun Type V/2 Radio Burst February 8, 2014, 1852 UT
- Sun Type III Radio Burst April 30, 2014, 2339 UT
- Sun Type III Radio Burst May 10, 2014, 1600 UT
- Sun Type V Radio Burst May 10, 2014, 1753 UT
- Sun Type III Radio Burst May 11, 2014, 2237 UT
- Sun Type V/2 & III/3 Radio Burst June 13, 2014, 0033 UT
- Sun Type III/2 Radio Burst June 13, 2014, 1521 UT
- Sun Type III/2 Radio Burst June 13, 2014, 1815 UT
- Sun Type III/2 Radio Burst June 13, 2014, 2014 UT
- Sun Radio Burst June 13, 2014, 2057 UT

SID: Sudden Ionospheric Disturbance

- April 25, 2014, 0017 UT

Radio Equipment & Techniques

- Radio Astronomy Units Conversion
- Tektronix MDO4104-6 Signal Conditioning for Jupiter Radio Emissions
- Tektronix MDO4104-6 Setup for Jupiter Radio Emissions
- Tektronix MDO4104-6 Spectrogram
- Itty Bitty Radio Telescope
- Receivers for Radio Telescopes