



Electromagnetic Environment Spectrum Survey Hampton Harbour Center March/April 2016

Kenneth L. Dudley and Truong X. Nguyen
NASA Langley Research Center

William B. Moore and John McNabb
Hampton University

Introduction

Multiple 24 hour observations over 12 consecutive days, including 2 weekends, form the basis of an Electromagnetic Environment (EME) Survey of the Hampton University Harbour Center Building. Data was acquired continuously over these consecutive days in order to capture a clear and representative understanding of the electromagnetic environment at any time of the day for representative operation of a proposed Earth Observation Satellite Receiving Base Station. The objective of the Survey was to determine if there exists any external sources of electromagnetic interferers within the intended operating frequency bands of the proposed Satellite Receivers operating in the L and X bands.

This presentation covers the

Survey Site

Antennas

Instrumentation

Measurements and Observations

Conclusions

Survey Site

Hampton University



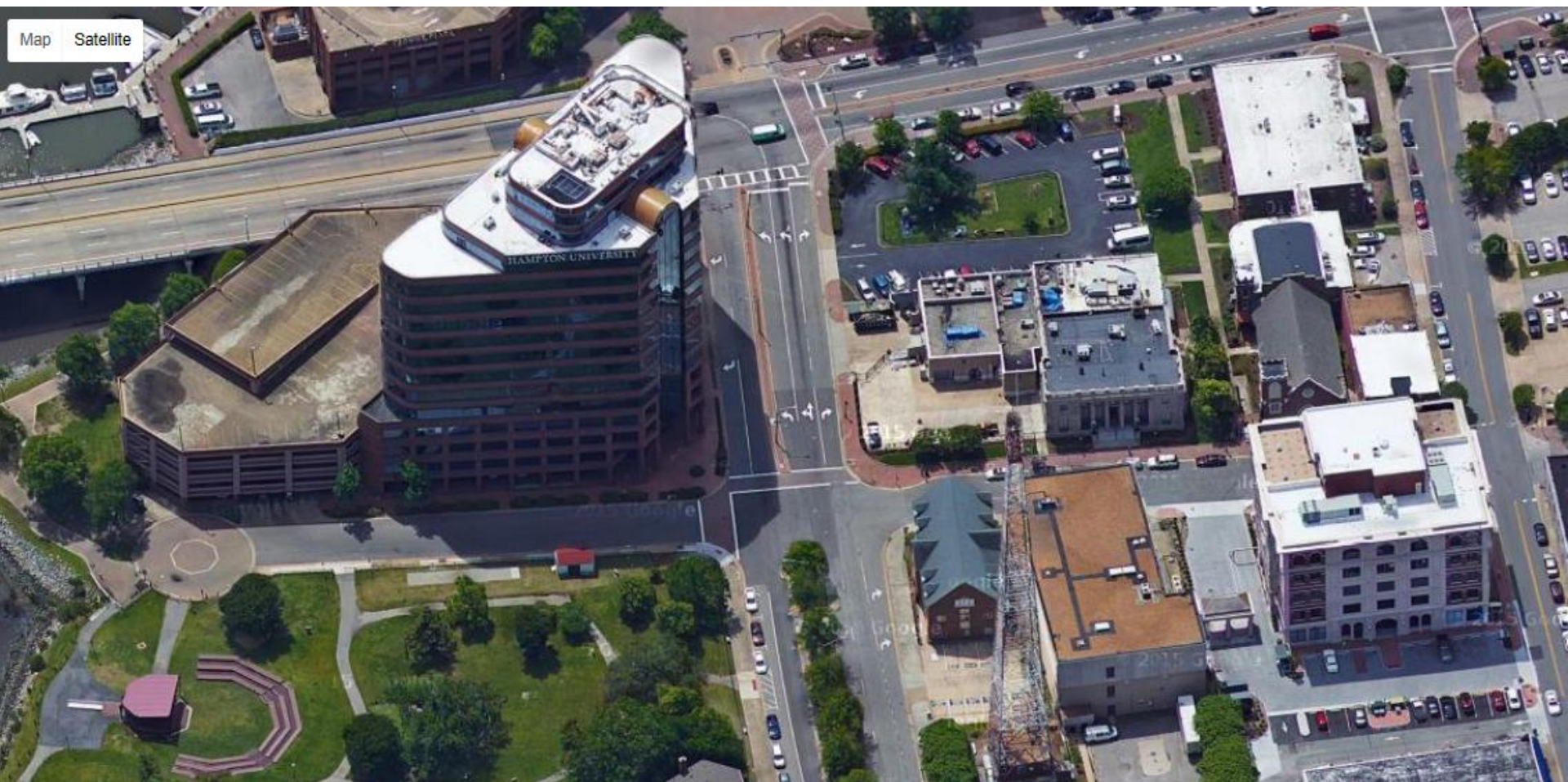
Hampton Harbour Center

Hampton University



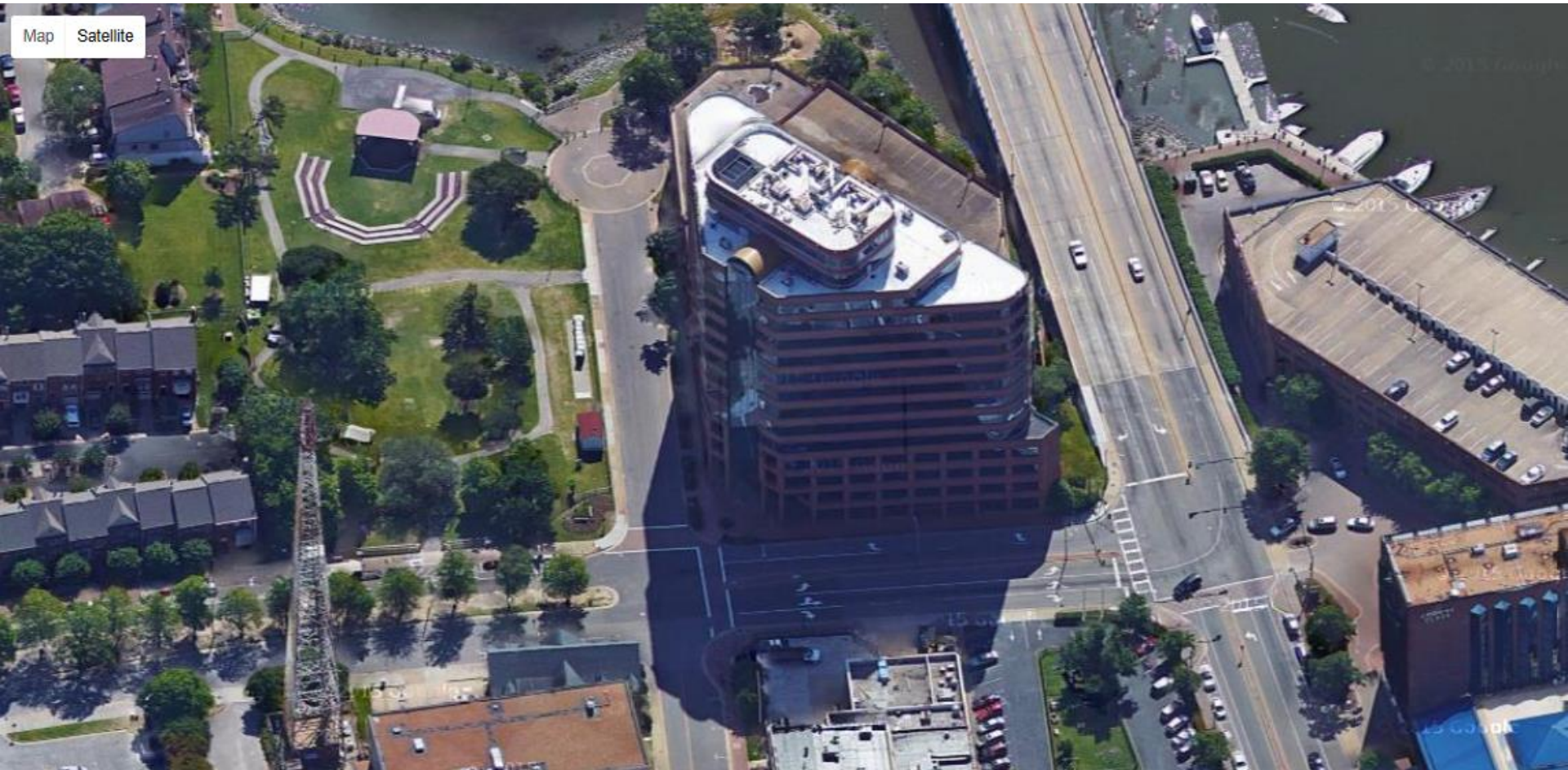
**Hampton Harbour Center
East**

Hampton University



Hampton Harbour Center North

Hampton University



**Hampton Harbour Center
West**

Hampton University



Hampton Harbour Center South

Communications Tower

North of Harbour Center Building



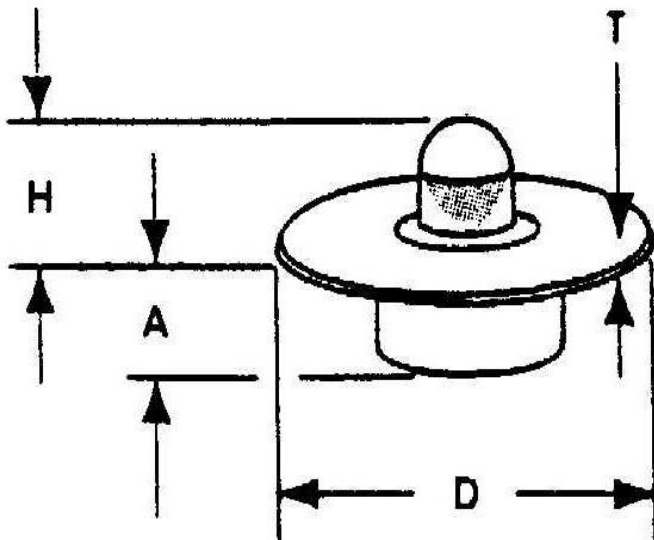
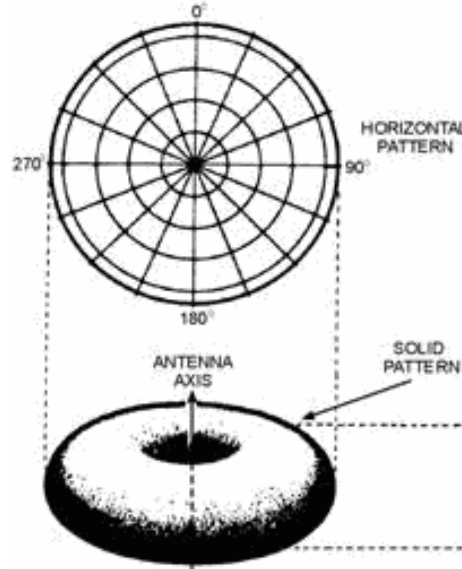
Hampton University Campus

Panoramic View from top of Harbour Center Building

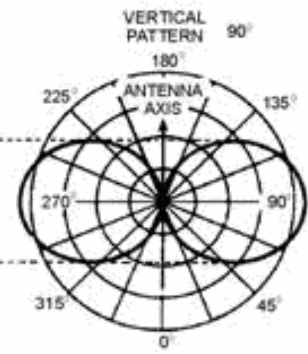




**Spectrum Survey
Antennas
East Balcony
Harbour Center Building**



Omni Directional

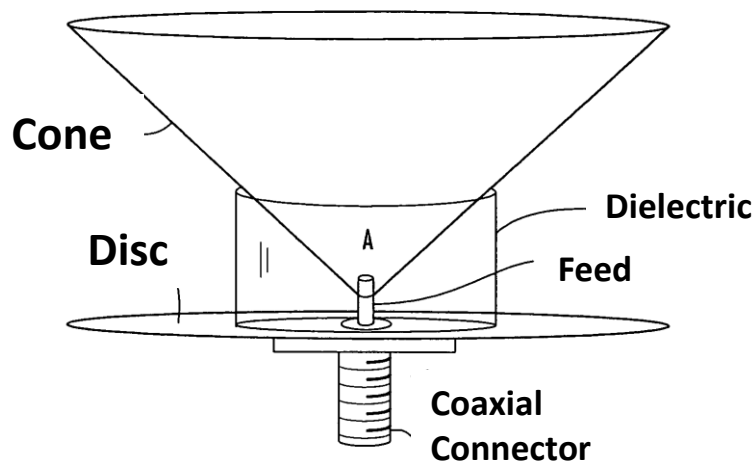


Low Band

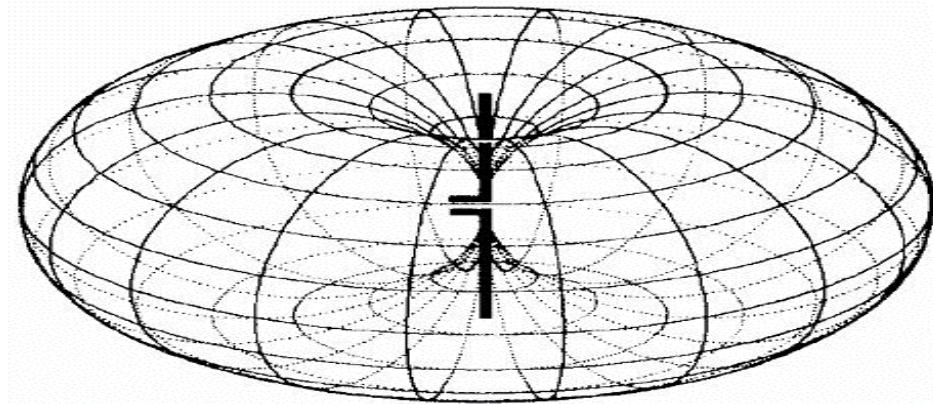


PRODYN's precision high frequency ground plane electric field (D-DOT) sensors are designed to measure time rate-of-change of electric displacement over a wide frequency spectrum. They can also be used to measure the time rate-of-change of surface current density. D-Dot can also perform well as EME survey antenna. Configurations allow testing flexibility.

AD-60 D-Dot Probe Antenna

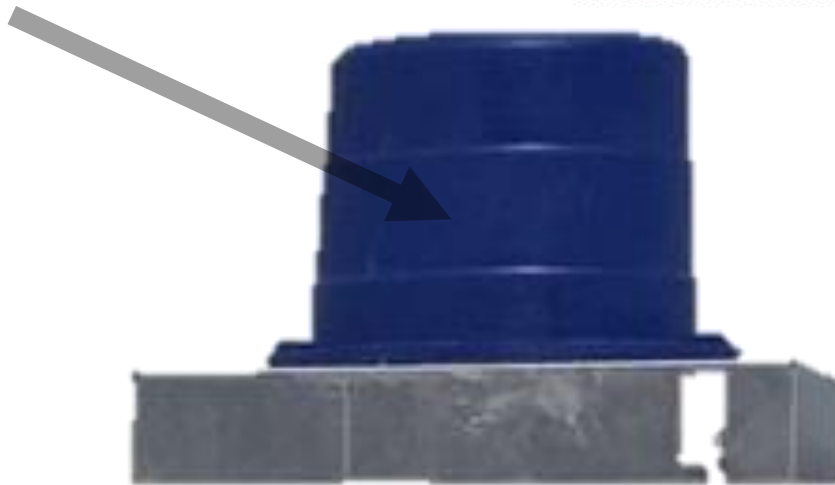


Omni Directional



Radiation Pattern

High Band



A discone antenna is a version of a biconical antenna in which one of the cones is replaced by a disc. It is omnidirectional, vertically polarized and with gain similar to a dipole, it is exceptionally wideband, offering a frequency range ratio of up to approximately 10:1. The horizontal plane radiation pattern is quite narrow, making its sensitivity highest in the direction of the horizon.

Discone Antenna

Spectrum Survey
Antennas
East Balcony
Harbour Center Building



Parabolic Dish Concept
East Balcony
Harbour Center Building

Instrumentation

Instruments



Agilent FieldFox N9918A
5 kHz – 26.5 GHz



Tektronix RSA
DC – 8 GHz



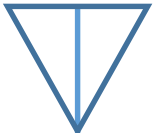
Agilent E4402B
9 kHz – 3 GHz



Agilent E4407B
9 kHz – 26.5 GHz **x2**

Spectrum Analyzers

Broadband
Omni Directional
Antenna



Spectrum Analyzer



Data Acquisition and
Analysis Computer

Typical Instrument Setup

SA

Ref 0.00 dBm

#Atten 0 dB



Log

10.0

dB/

Pk

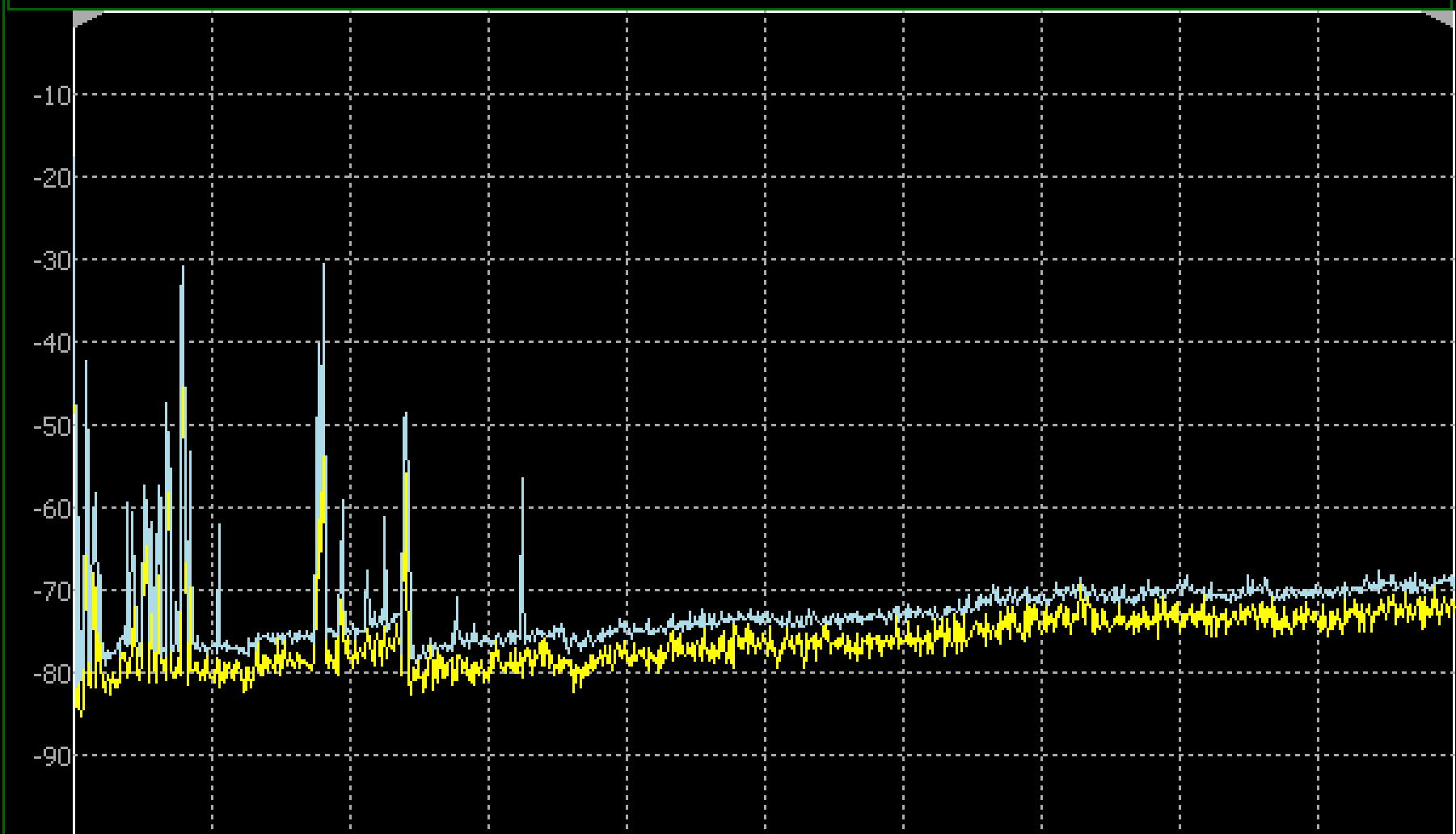
1 2 3 4

WM

LgAv

10

Step



Start 1.000000 MHz

Stop 11.00000 GHz

#Res BW 300.0 kHz

VBW 300.0 kHz

Swp 5.775 s (1001 pts)

Typical Spectrum Analyzer Screen

SA Ref 0.00 dBm #Atten 0 dB



Log

10.0

dB/

Pk

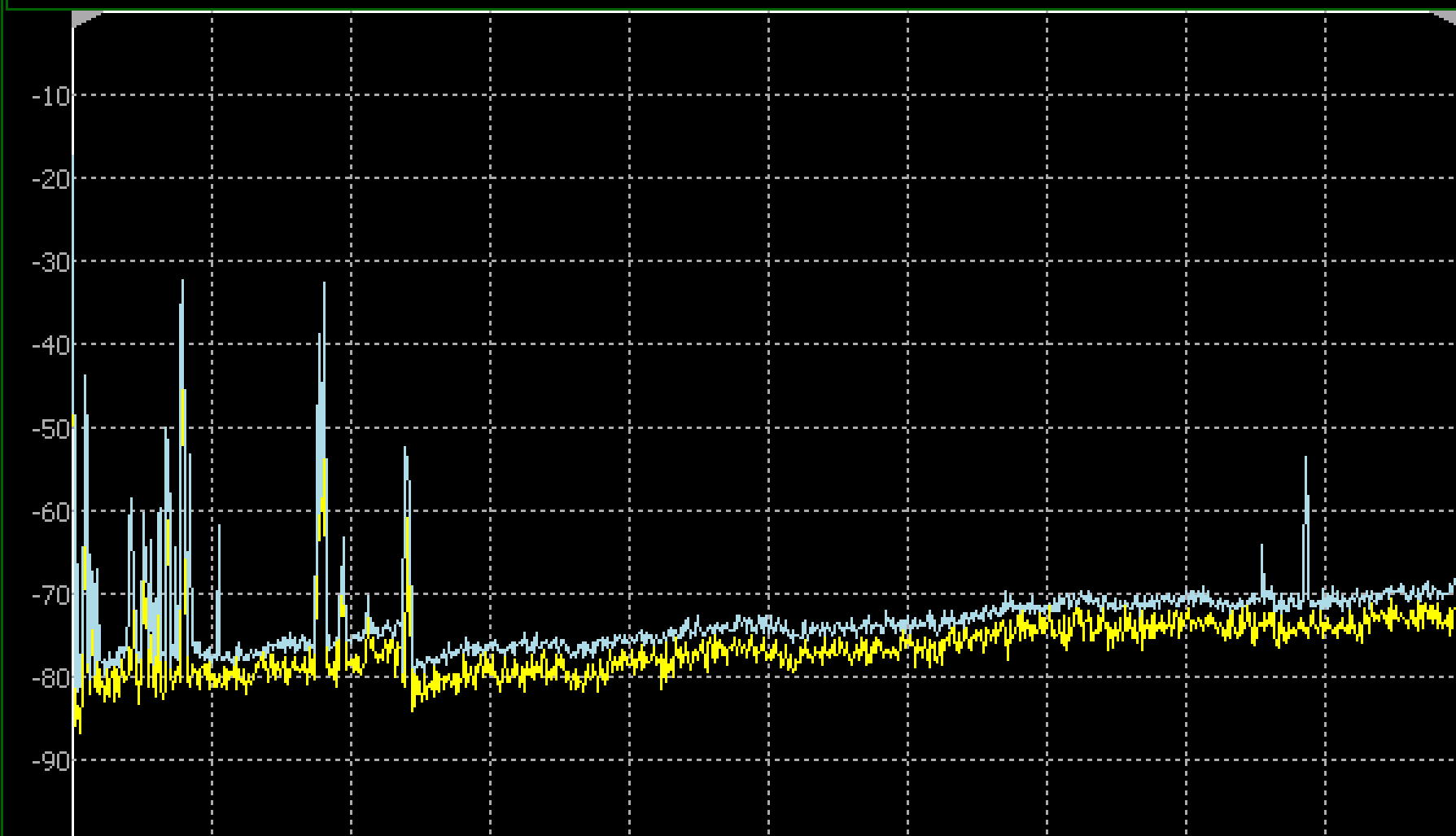
1 2 3 4

WM

LgAv

10

Step



Start 1.000000 MHz

#Res BW 300.0 kHz

VBW 300.0 kHz

Stop 11.00000 GHz

Swp 6.109 s (1001 pts)

Typical Spectrum Analyzer Screen







Measurements and Observations

Snapshot Observations:

(Broadband, slow sweep <secs>, good resolution <kHz>, short duration <15min>)

The noise floor for the handheld spectrum analyzer is about -90 dB. There was essentially no cable losses using the handheld unit as the antenna was directly connected to the instrument. This portable unit could also be turned and positioned to acquire multiple antenna polarizations.

Broadband spectrum Snapshots were taken every weekday of the survey for approximately 10 to 15 minutes duration with both real time (blue) and maximum hold (orange) trace features. Data are shown in charts 1 and 2 for snapshots on two consecutive days. The wideband broad spectrum containing both frequency bands of interest are observable in a single chart. These data were taken in conjunction with the Detail measurements

Charts 3 and 4 reset the analyzer frequency span so as to zoom in on the features of the Low Band and the High Band respectively. In chart 3 all the other frequency sources surrounding the FCC protected spectrum are evident. In chart 4, frequencies attributed to radars are evident but they are well above the frequency band of interest.

Broadband Spectrum Snapshot 31Mar2016 5:00pm

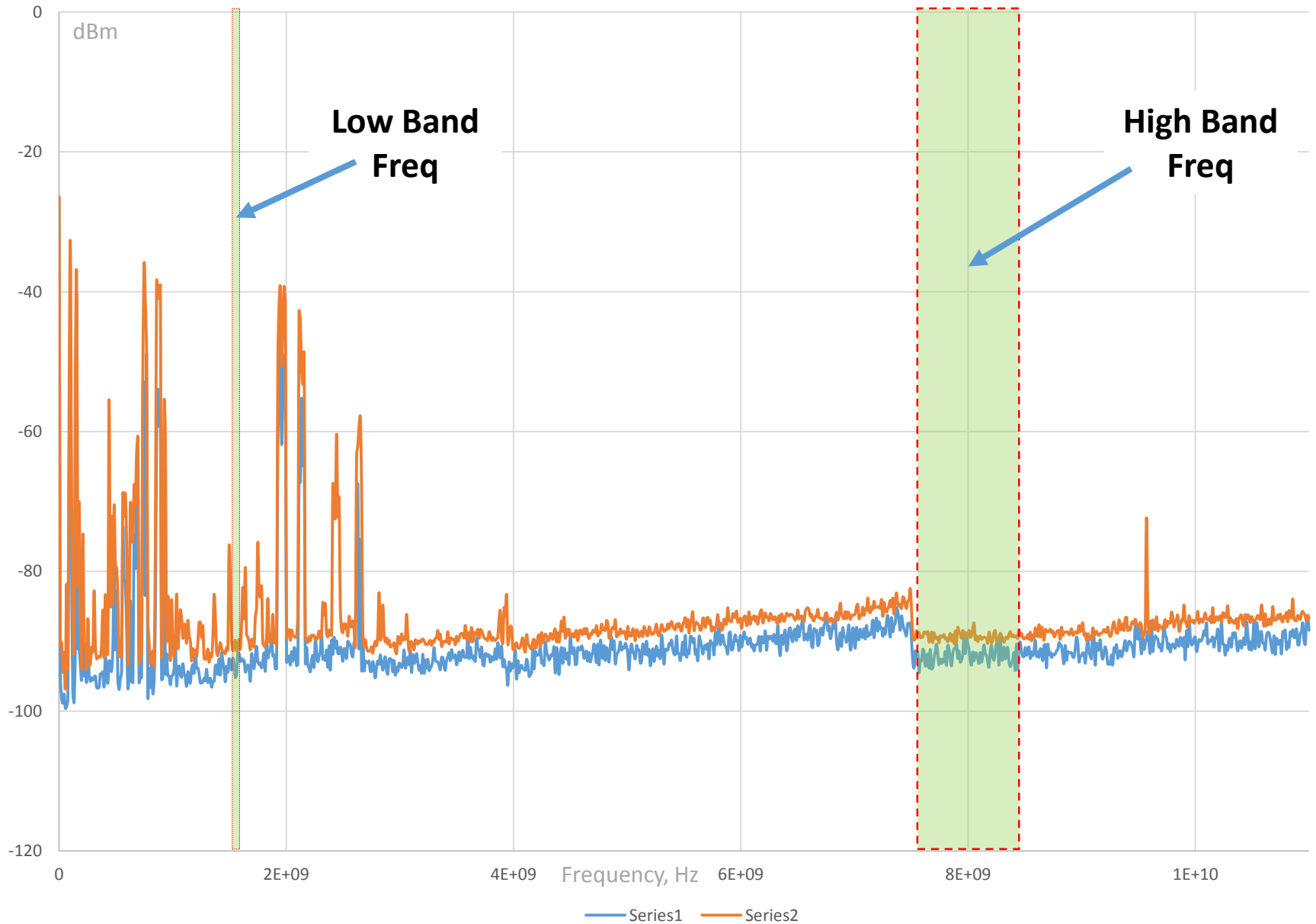


Chart. 1

Broadband Spectrum Snapshot 1Apr2016 12:28pm

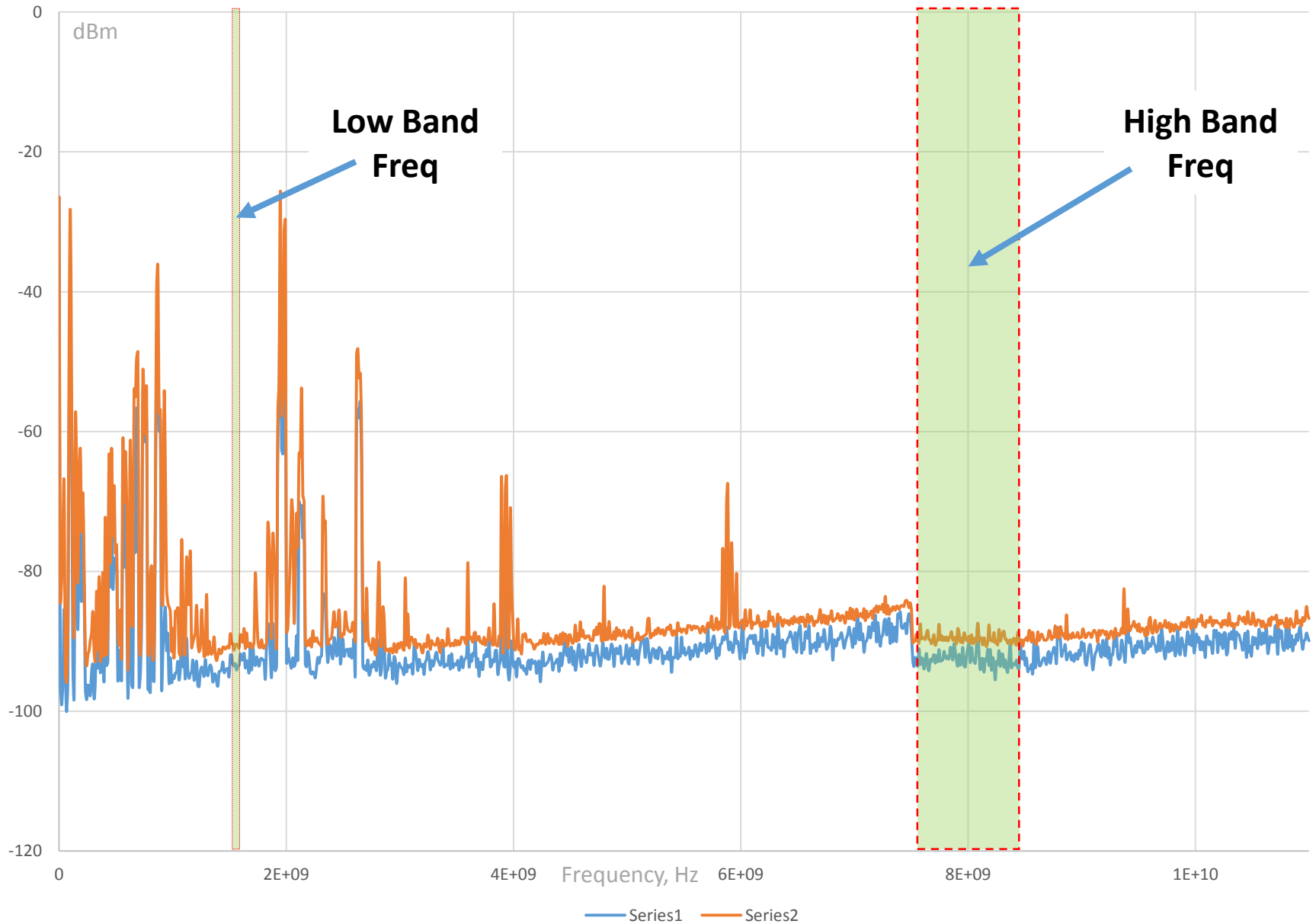


Chart. 2

Zoom In

L-Band (Low) 31Mar2016

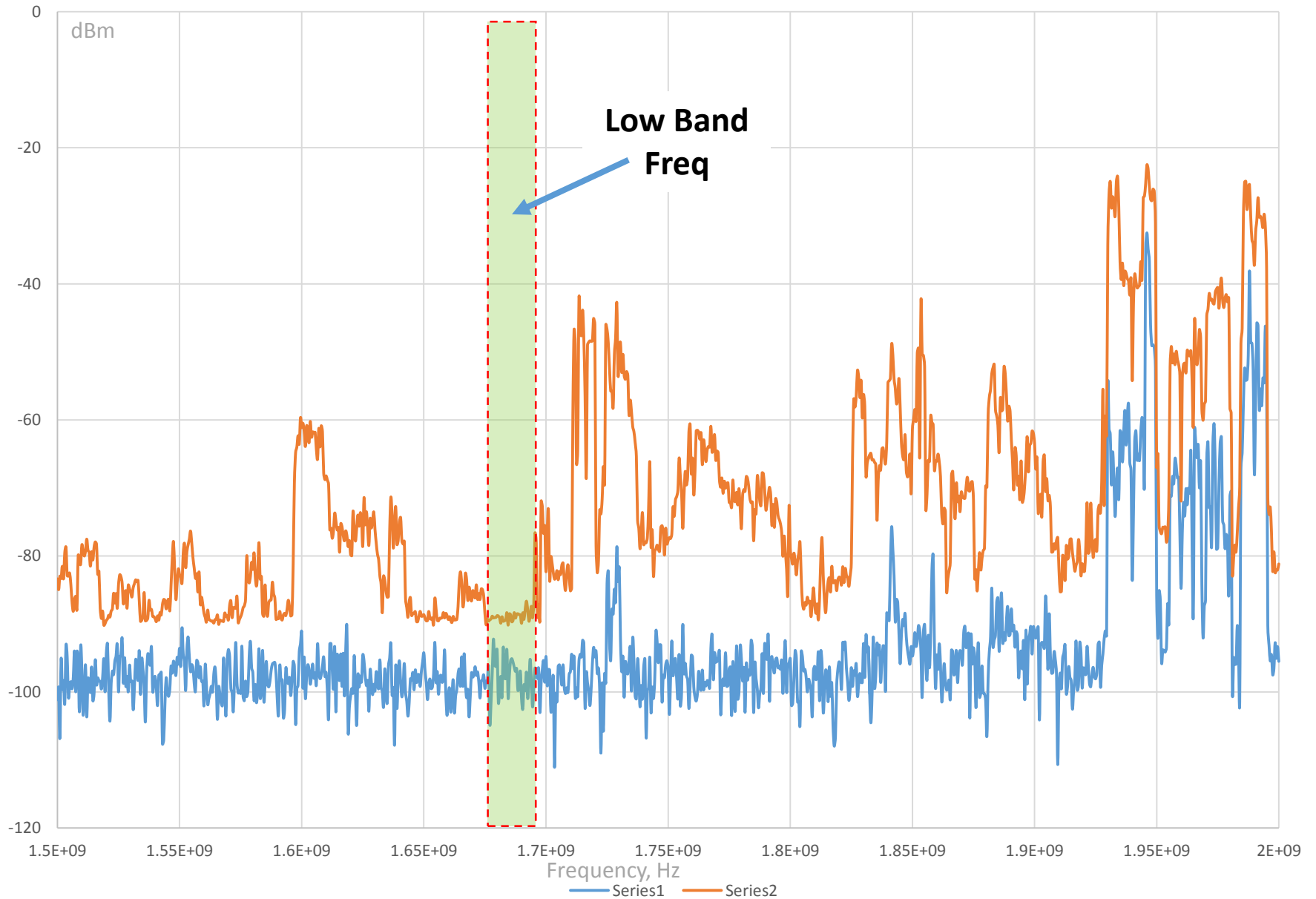


Chart. 3

Zoom In

X-Band (High) 31Mar2016 *Full Sector HHC RADAR*

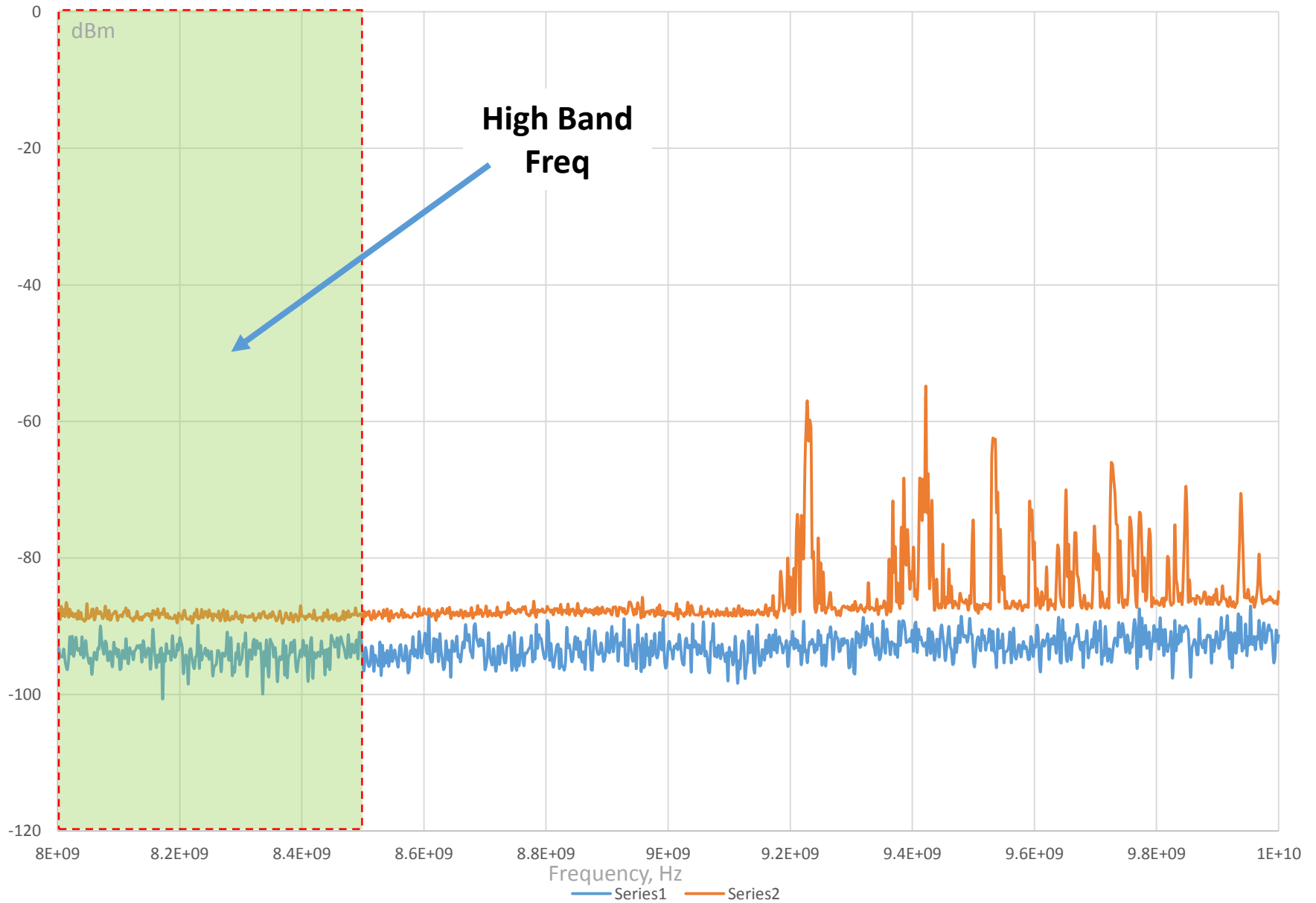


Chart. 4

Detail Observations:

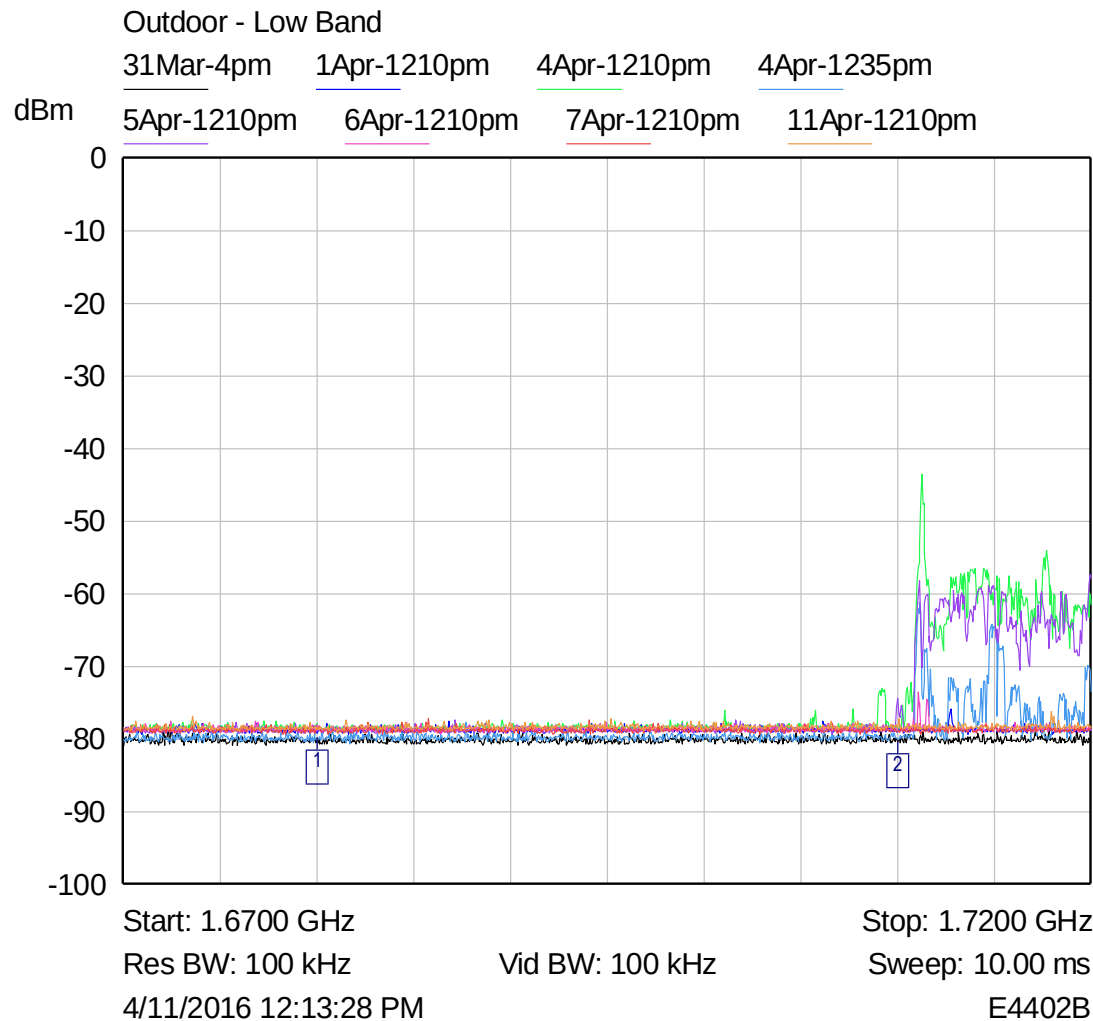
(Narrow band, faster sweep <ms>, good resolution (kHz), very long duration <24hr>)

The noise floor for all spectrum analyzers are about -80 dB. Considering cable losses (above) for the outdoor antenna,

- the low-band noise floor is equivalent to -74.4 dBm ($= -80 + 5.6$) for low-band.
- For hi-band outdoor antenna, the equivalent noise floor is -58.3 dBm.
- For the indoor antenna, assuming 0 dB cable loss, the equivalent noise floor is -80 dBm.

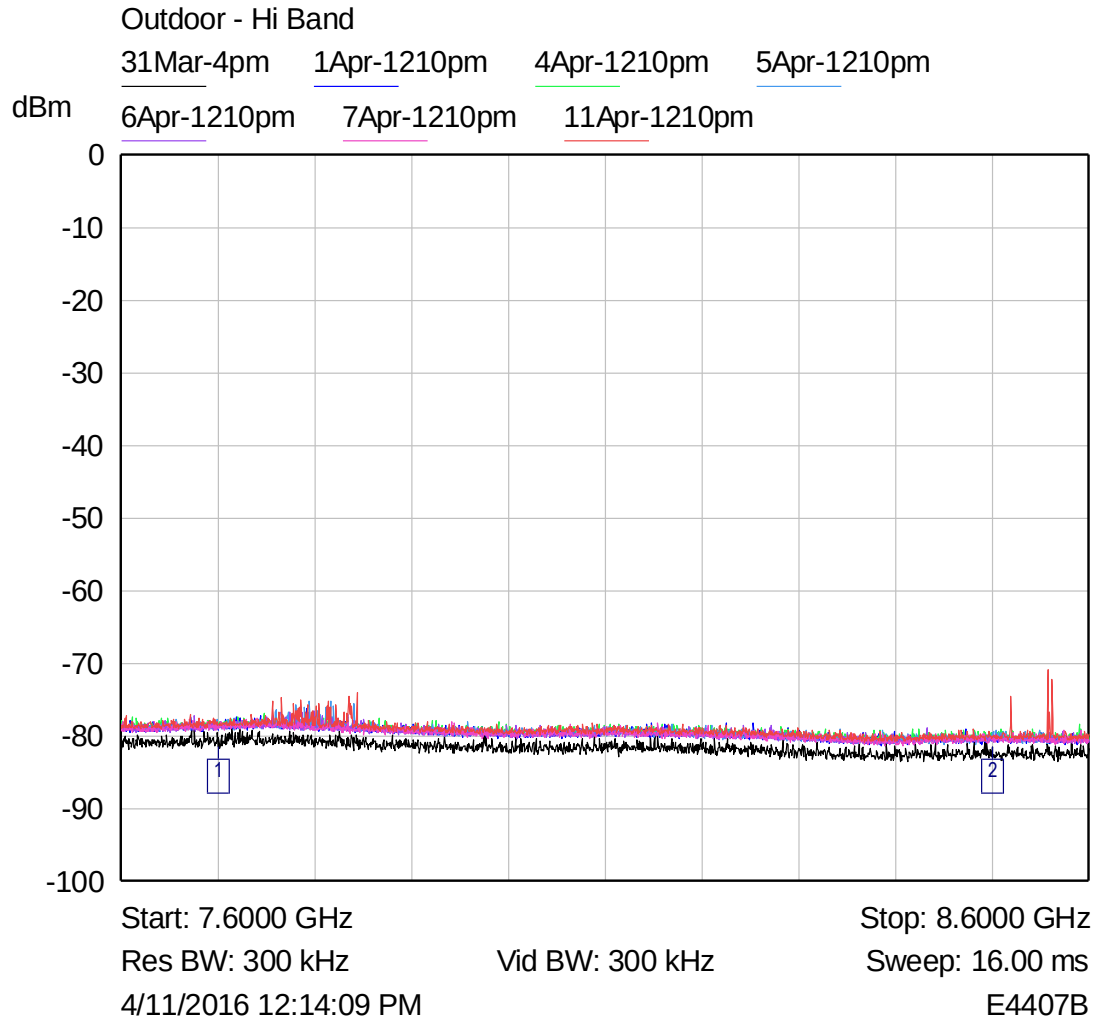
Fig. 1 shows spectrum noise starting 1.71 GHz, the upper limit of the L-band spectrum of interest. Though there is a slight amount of noise detected close to 1.71 GHz, no significant level of noise appear above the noise floor for most of the band.

Both bands are generally quiet except for hi-band data on 5Apr and again on 11Apr. The outdoor antenna detected signals close to its noise floor, while the indoor antenna detected signals noticeably above the noise floor. Data are shown in fig. 2 and 3. The 5Apr-1210pm data and the 11Apr-1210pm data represent measurements in the 24 hours preceding the respective time stamps.



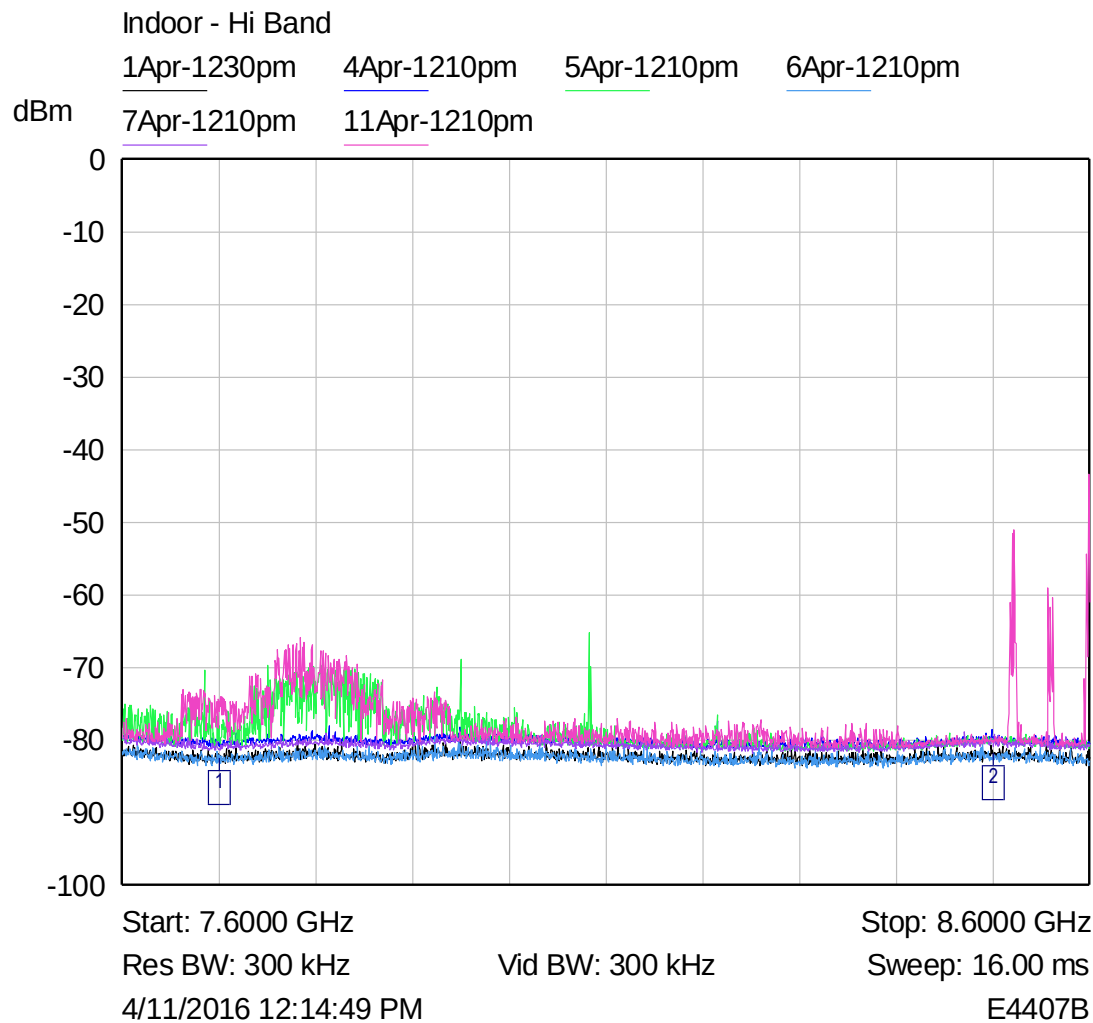
Mkr	Trace	X-Axis	Value	Notes
1	31Mar-4pm	1.6800 GHz	-79.83 dBm	1.68 GHz
2	31Mar-4pm	1.7100 GHz	-80.38 dBm	1.71 GHz

Fig. 1



Mkr	Trace	X-Axis	Value	Notes
1	31Mar-4pm	7.7000 GHz	-81.46 dBm	7.7 GHz
2	31Mar-4pm	8.5000 GHz	-81.44 dBm	8.5 GHz

Fig. 2



Mkr	Trace	X-Axis	Value	Notes
1	1Apr-1230pm	7.7000 GHz	-82.49 dBm	7.7 GHz
2	1Apr-1230pm	8.5000 GHz	-81.80 dBm	8.5 GHz

Fig. 3

Conclusions

Conclusions:

The FCC protected spectrum bands are evident.

No significant level of noise observed above the noise floor for the low frequency band of interest.

Some weak noise was observed in the interested high frequency band during 2 of the 12 survey days.

The source of this ambiguous in-band high frequency noise is undetermined.

Both bands are generally radio quiet.

Confidence is good that there are no significant Electromagnetic Environment issues against establishing the proposed Satellite Receiver Base Station at the survey site.

