Measurements and Analysis of Urban Spectrum Usage

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Its 300 GHz do you know where your spectrum is?

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Spectrum Study Variables

- Frequency (400 MHz – 7.2 GHz)
- Time (short term usage, minutes)
- Time Period (6 discrete time periods per day, hours)
- Polarization (Linear: Horizontal & Vertical)
- Azimuth (6 directions)
- Location type (Urban, Suburban, Rural)

~2.5 billion data points per location!

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Spectrum Study Variables

- Characterize Spectrum Usage
- Assists in Identifying Signals

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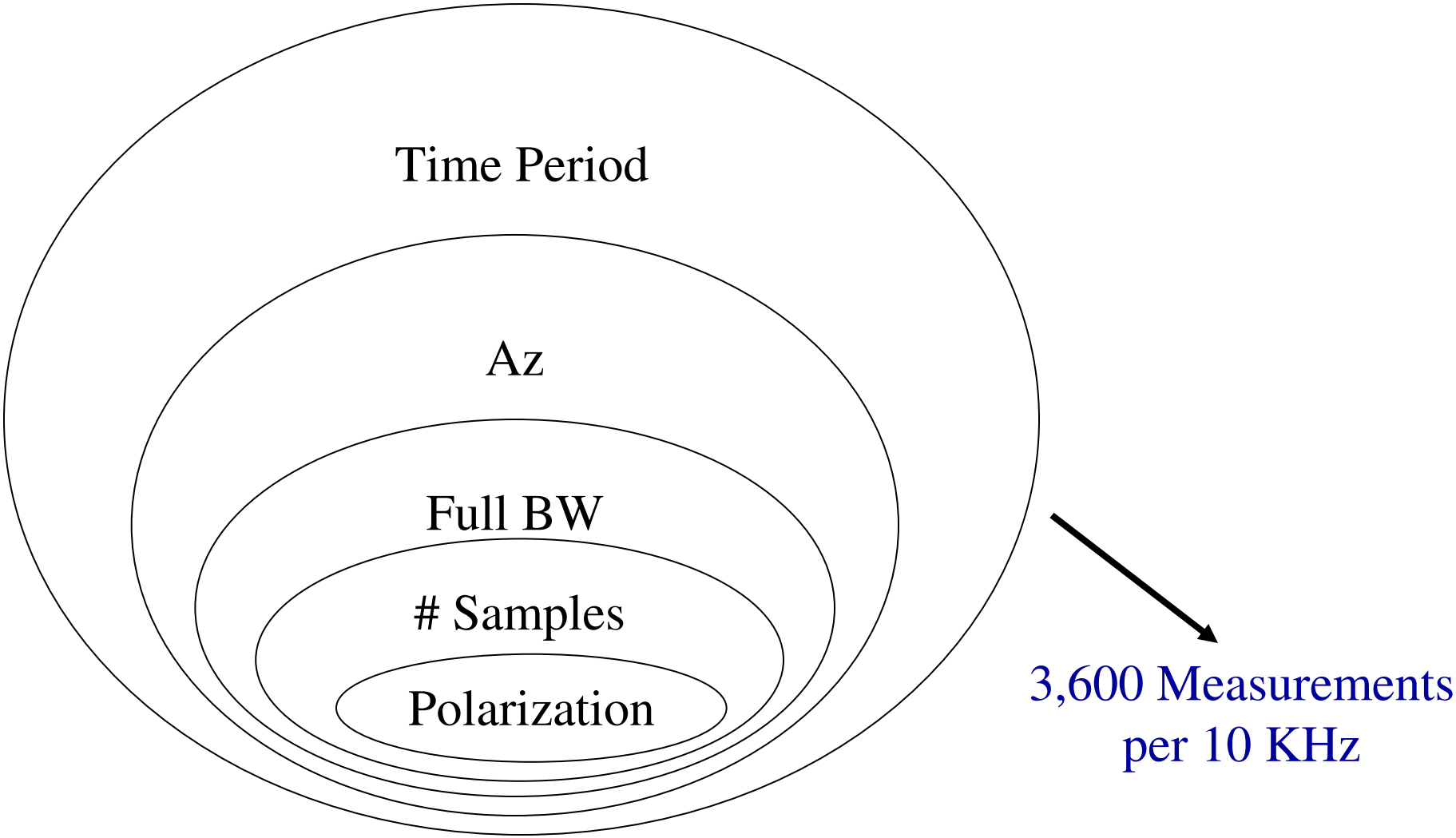
Measurement of Variables



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Atlanta Measurement Site

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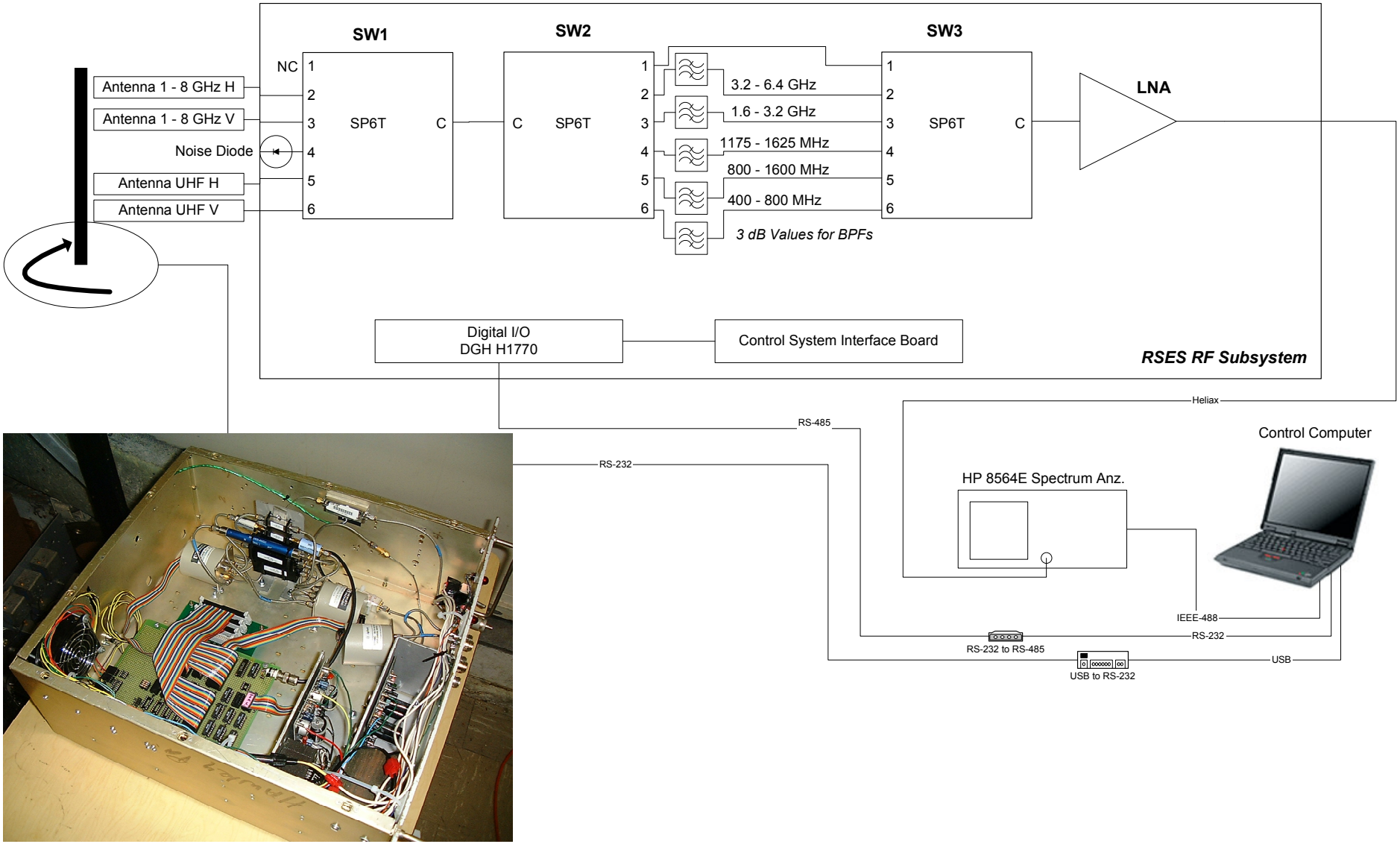
System Block Diagram



RSES RF Subsystem

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Bands

- UNII
- ISM 2.4 GHz
- GPS
- Satellite (space-to-earth)
- Land Mobile: Public Safety, FRS, GMRS

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UNII
(Unlicensed National Information Infrastructure)

- 5.15 GHz – 5.25 GHz
- 5.25 GHz – 5.35 GHz
- 5.725 GHz – 5.825 GHz

- 802.11a
- Hyperlan
- Fixed Wireless

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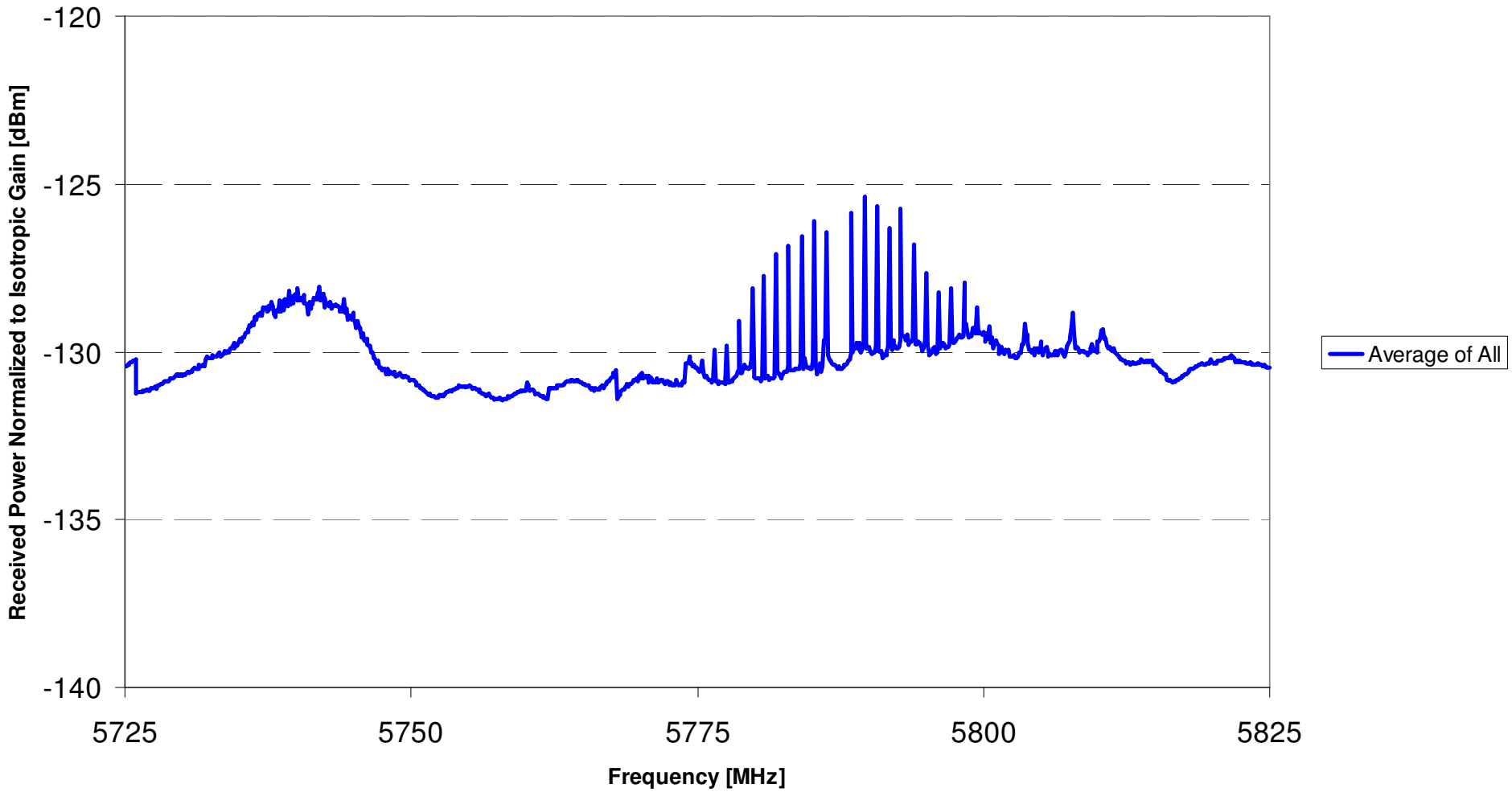
UNII: 5.725GHz – 5.825GHz

Average Power



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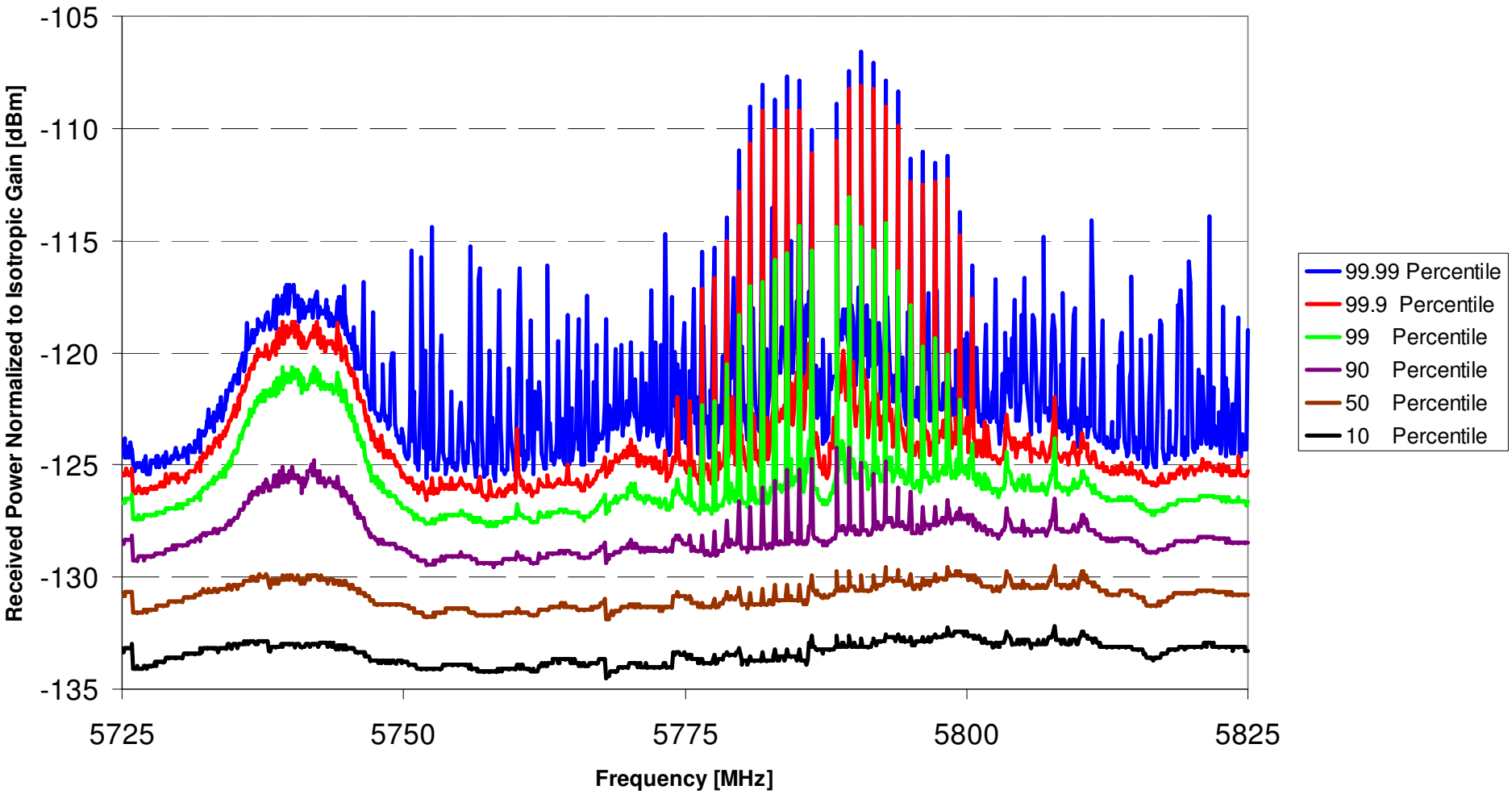
UNII: 5.725GHz – 5.825GHz

Percentile Profile



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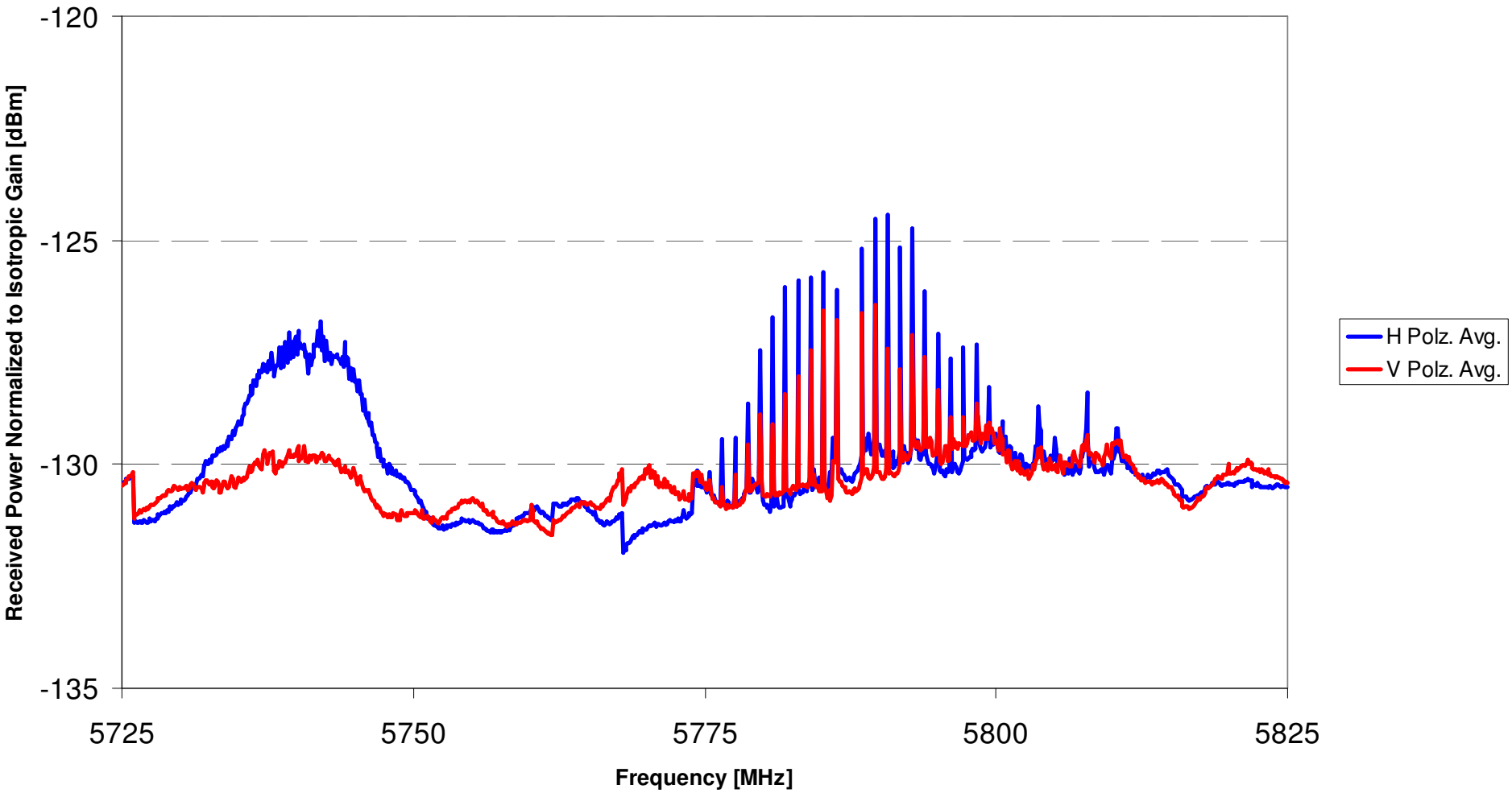
UNII: 5.725GHz – 5.825GHz

Comparative Linear Polarization



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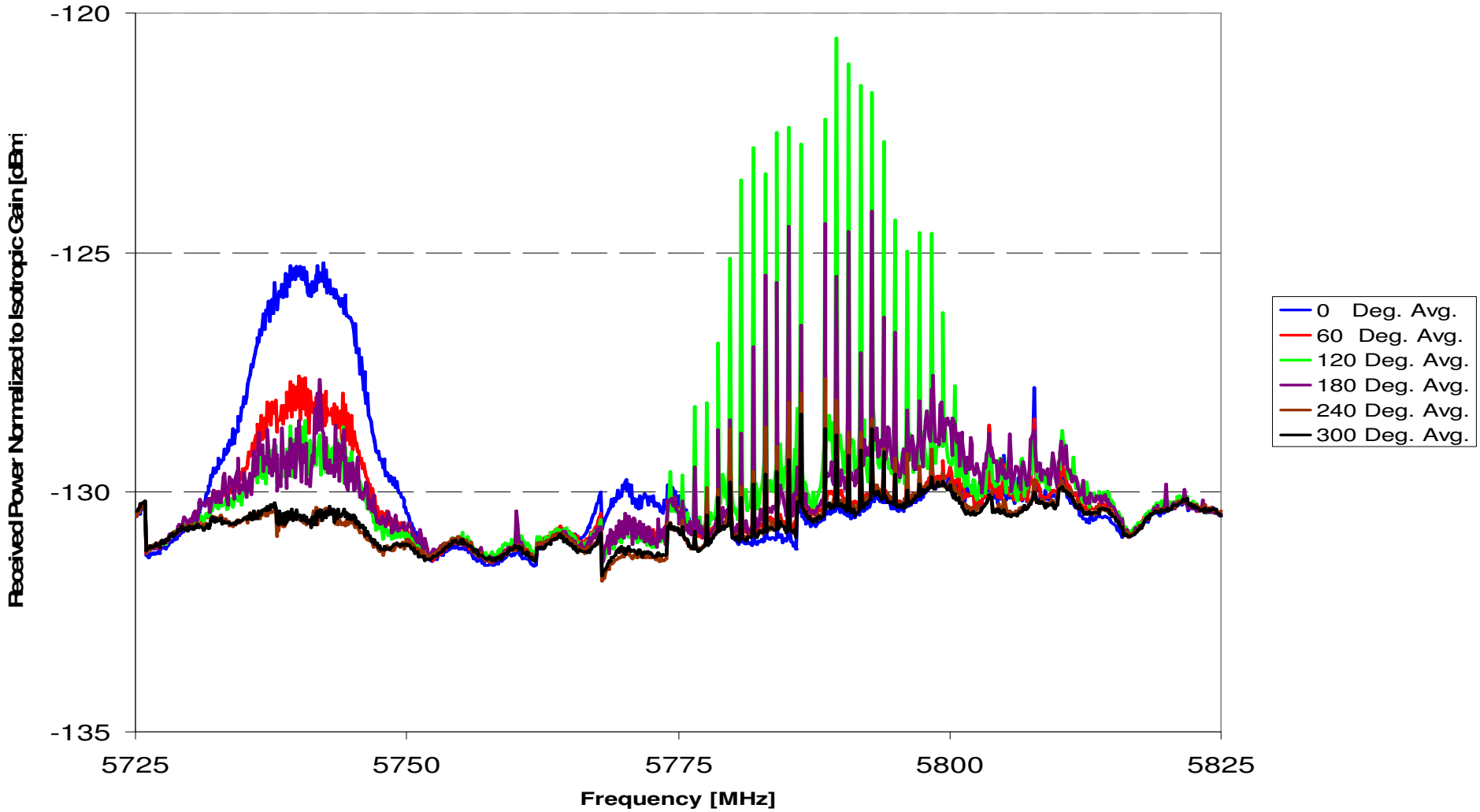
UNII: 5.725GHz – 5.825GHz

Azimuthal Direction



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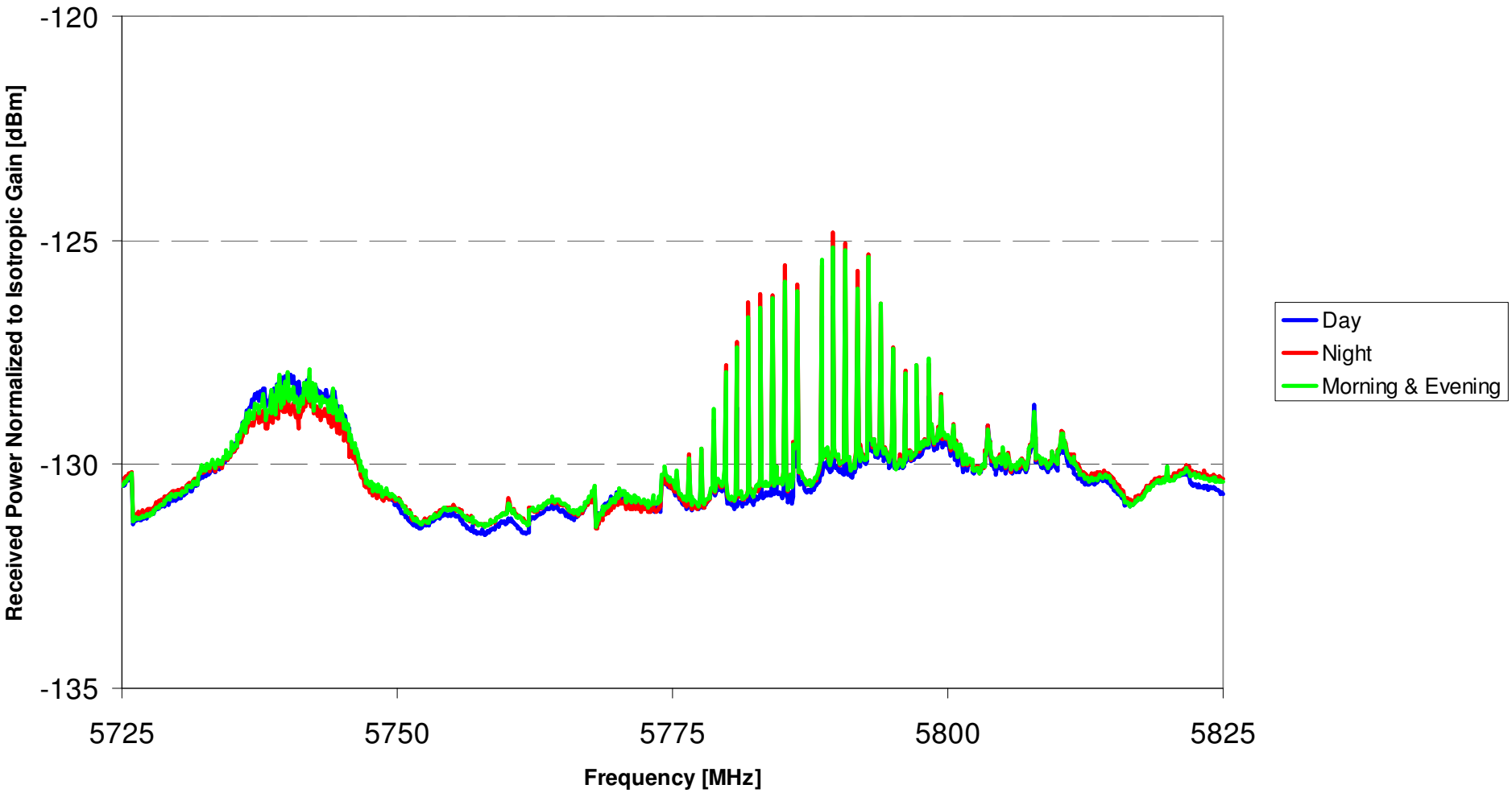
UNII: 5.725GHz – 5.825GHz

Time Region



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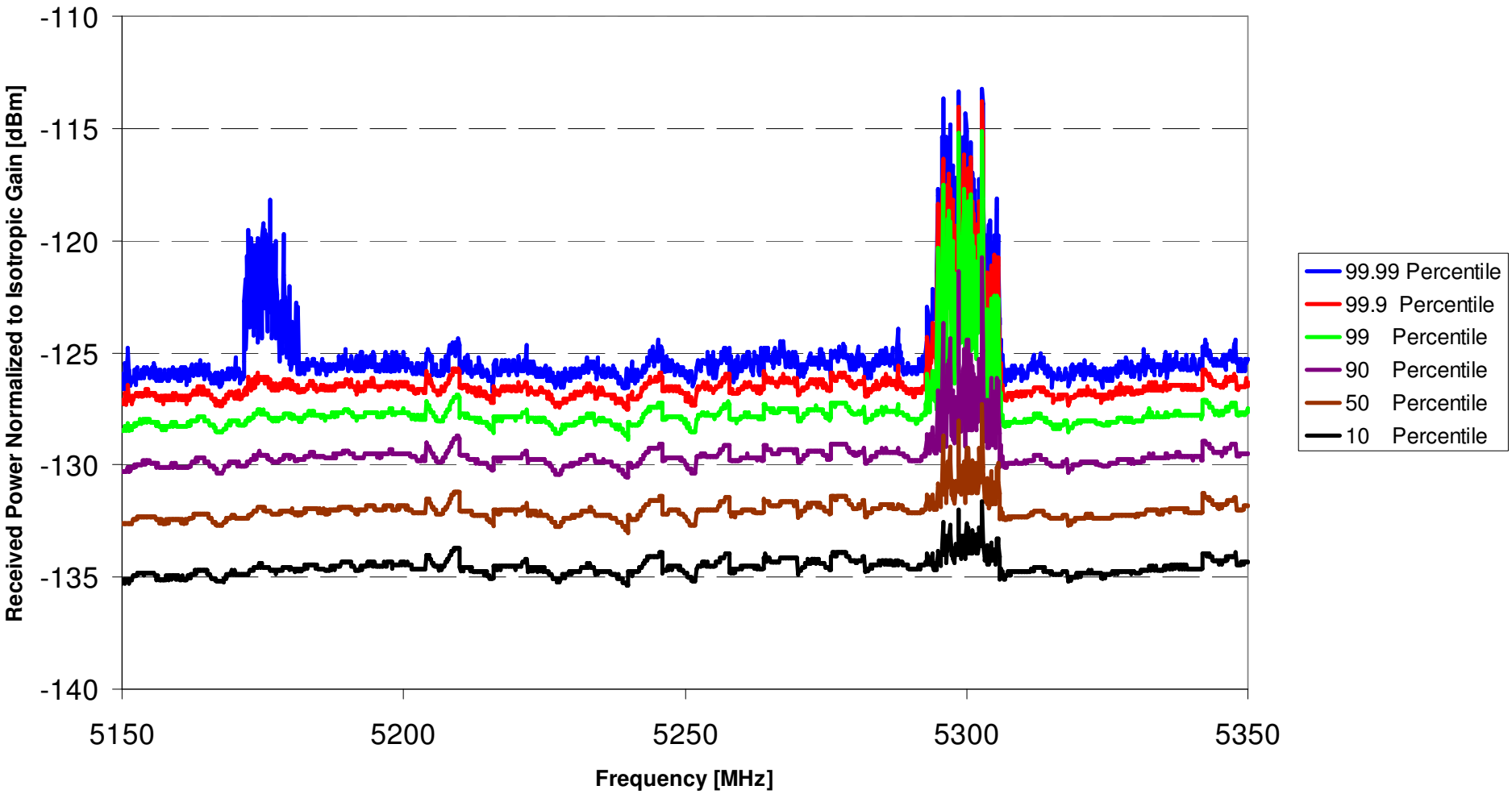
UNII: 5.15GHz – 5.35GHz

Percentile Profile



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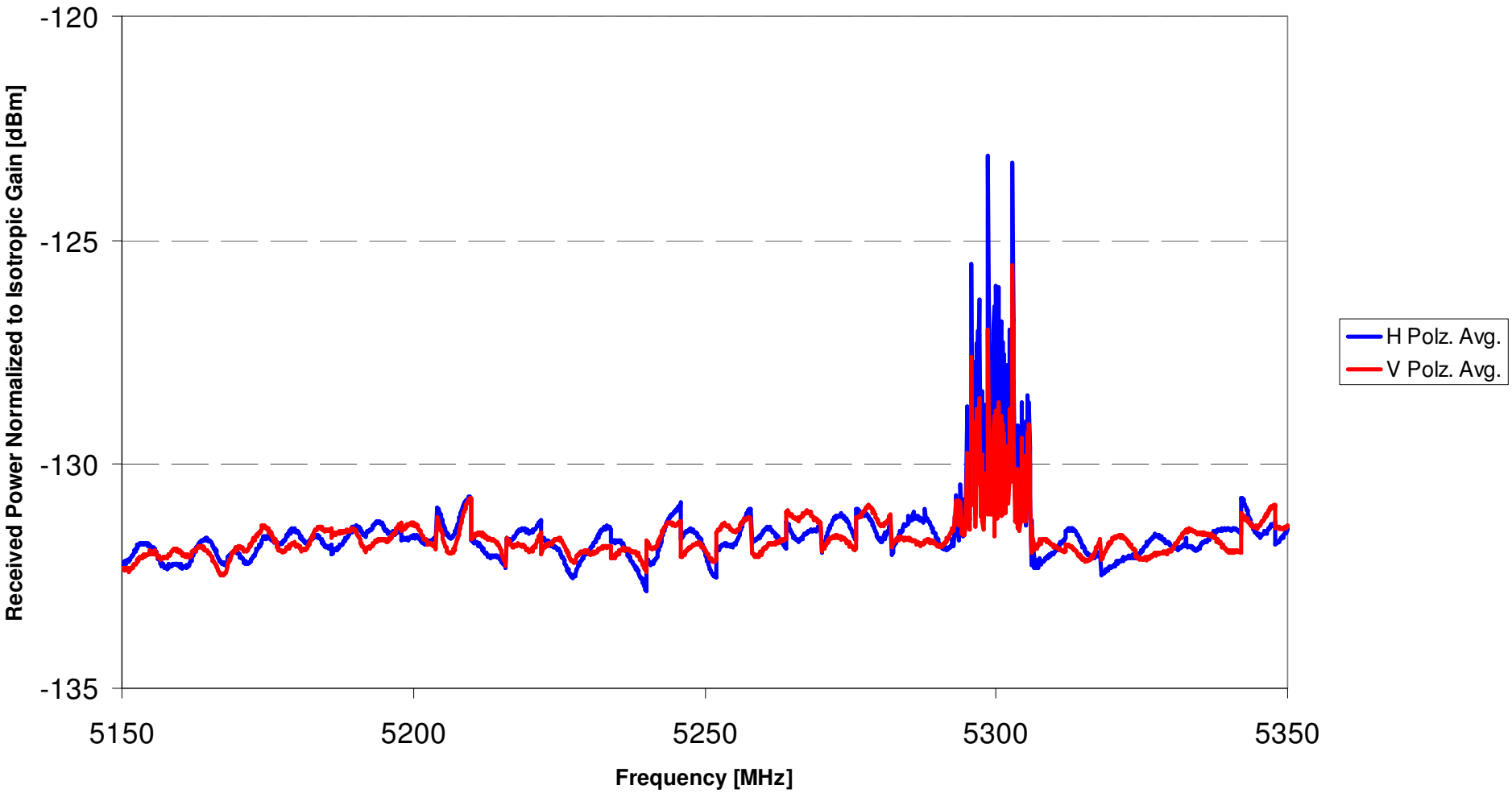
UNII: 5.15GHz – 5.35MHz

Comparative Linear Polarization



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ISM: 2.4000 GHz - 2.4835 GHz

- Still Experiencing High Usage

- 802.11b
- 802.11g
- Bluetooth
- Cordless Phones

- Microwave Ovens

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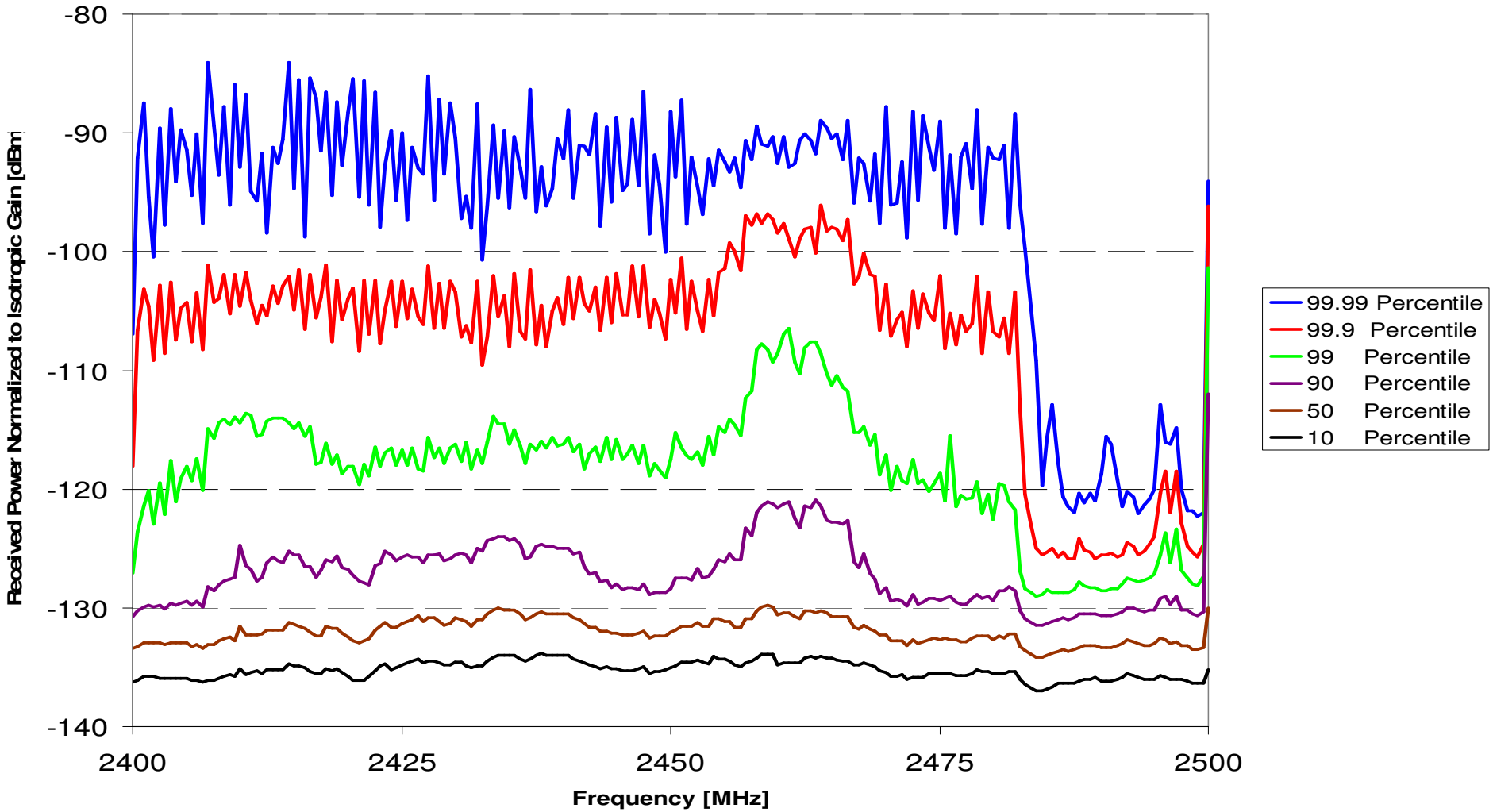
ISM: 2.4000 GHz - 2.4835 GHz

Percentile Profile



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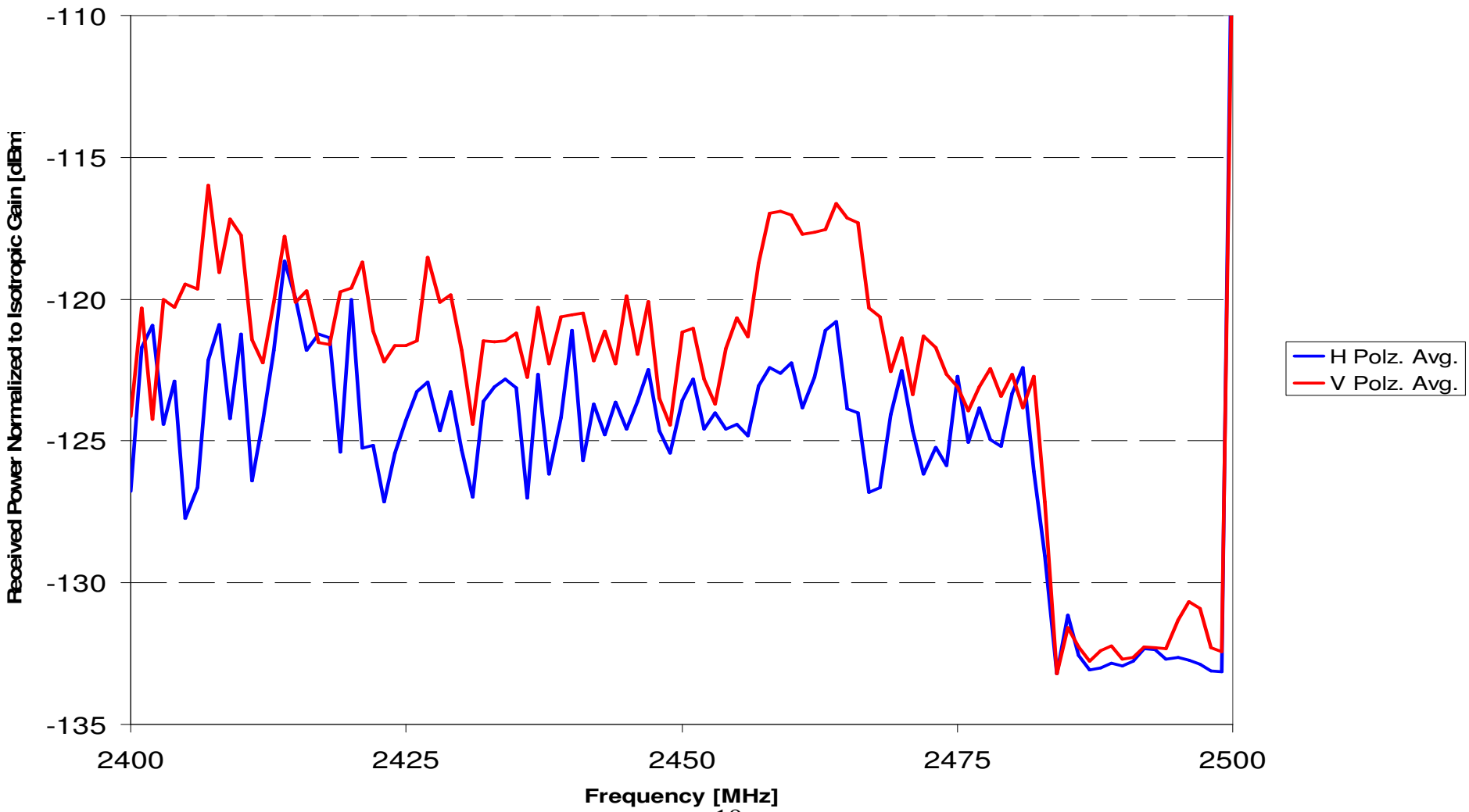
ISM: 2.4000 GHz - 2.4835 GHz

Comparative Linear Polarization



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GPS

- L1 1.57542 GHz
- L2 1.22760 GHz

- Civilian BW: 2.046 MHz
- P-Code BW: 20.46 MHz

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GPS

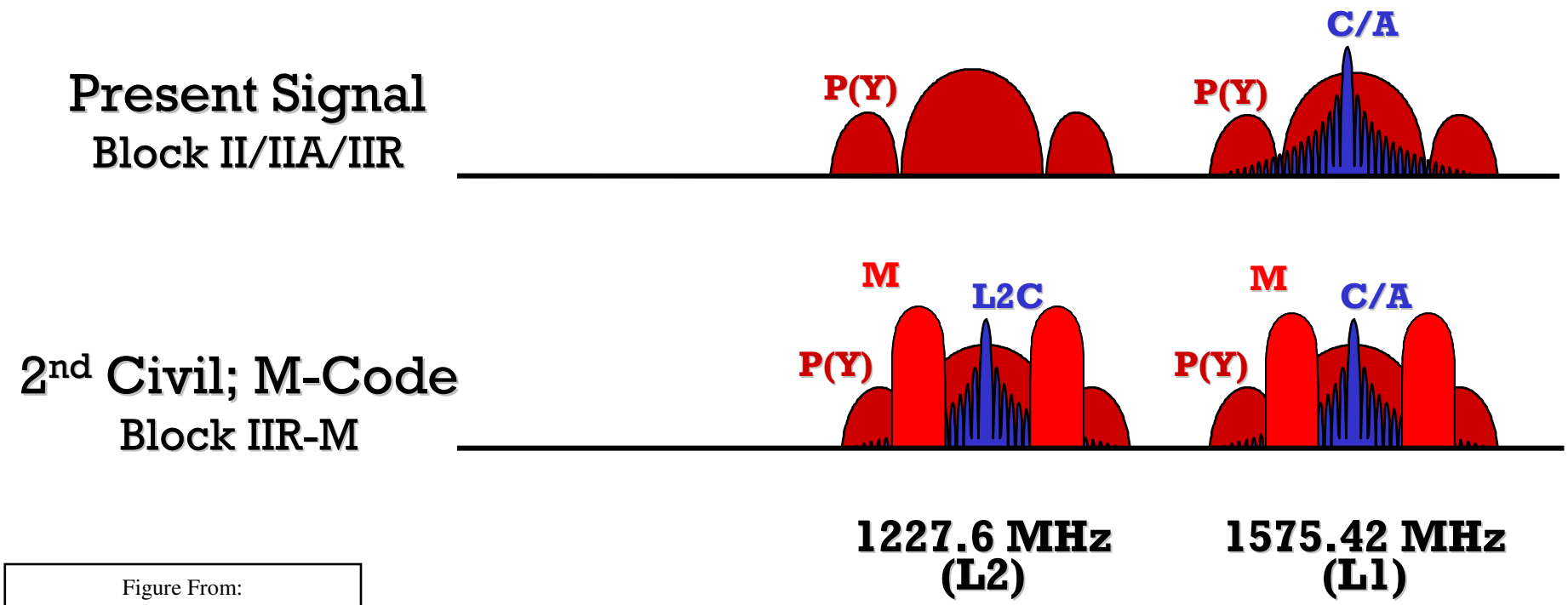

Figure From:

RALPH BRAIBANTI
Office of Space &
Advanced Technology
U.S. Department of State

JASON Y. KIM
Office of Space
Commercialization
U.S. Department of Commerce

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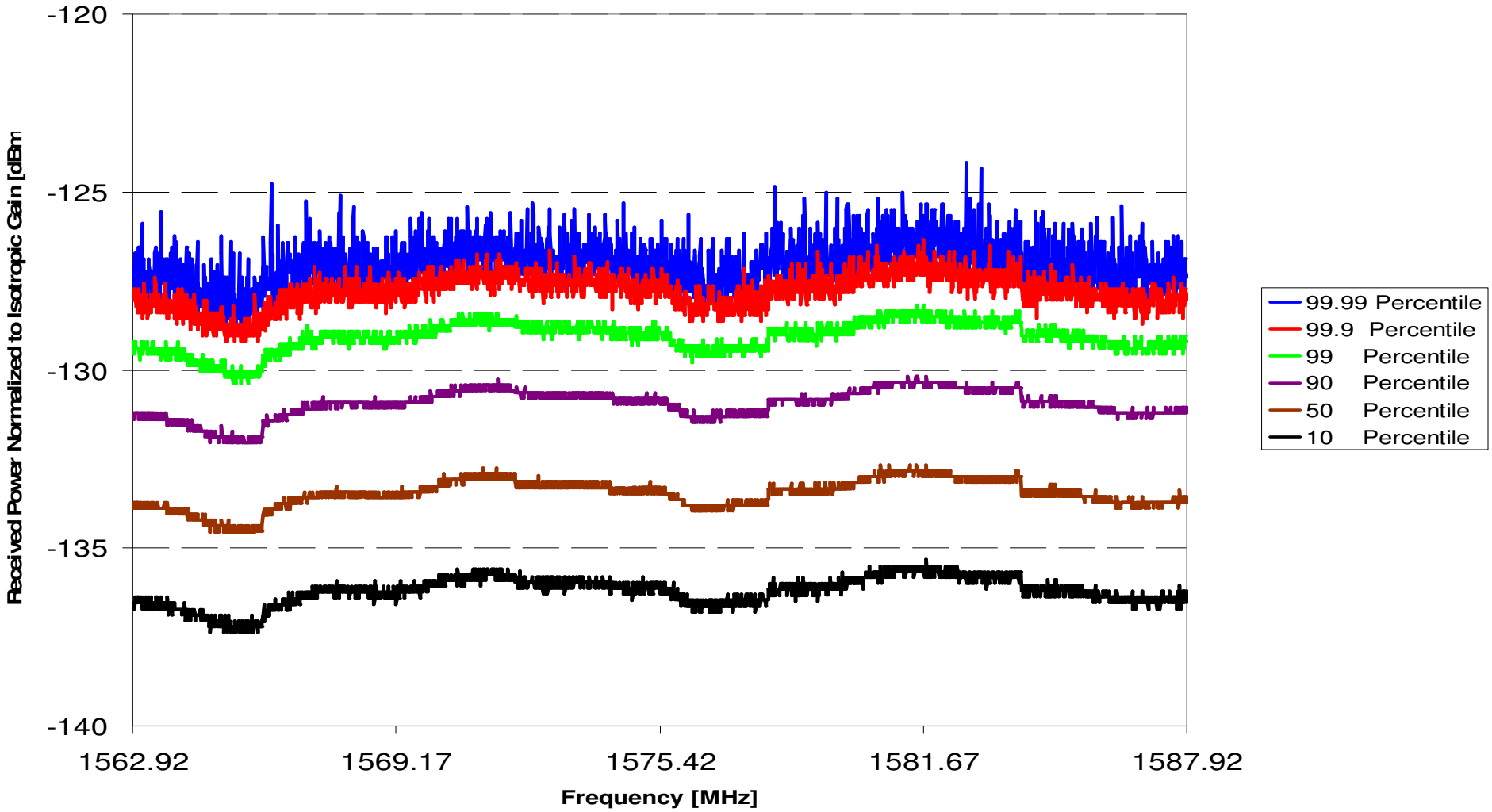
GPS L1: 1575.42 MHz

Percentile Profile



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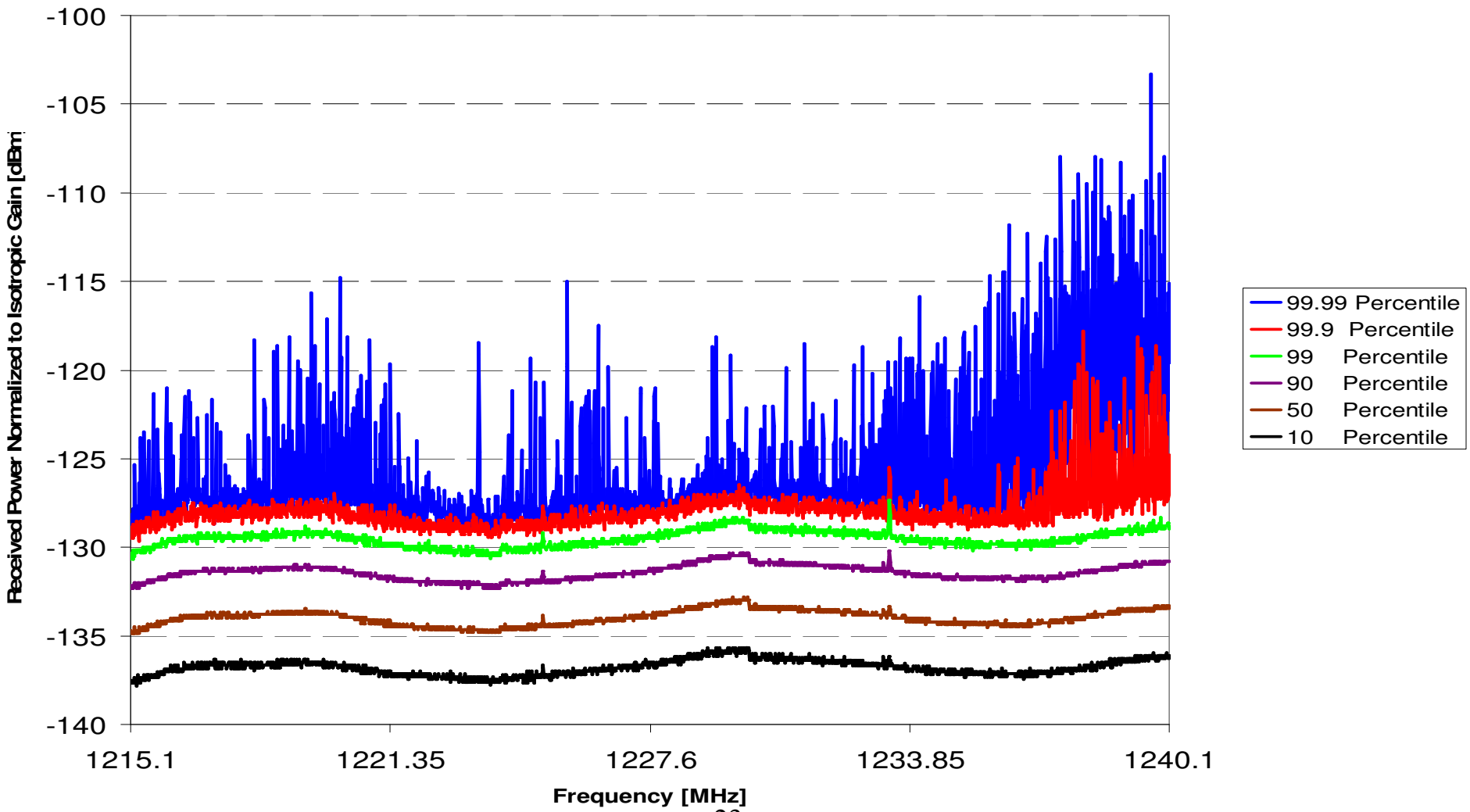
GPS L2: 1227.6 MHz

Percentile Profile



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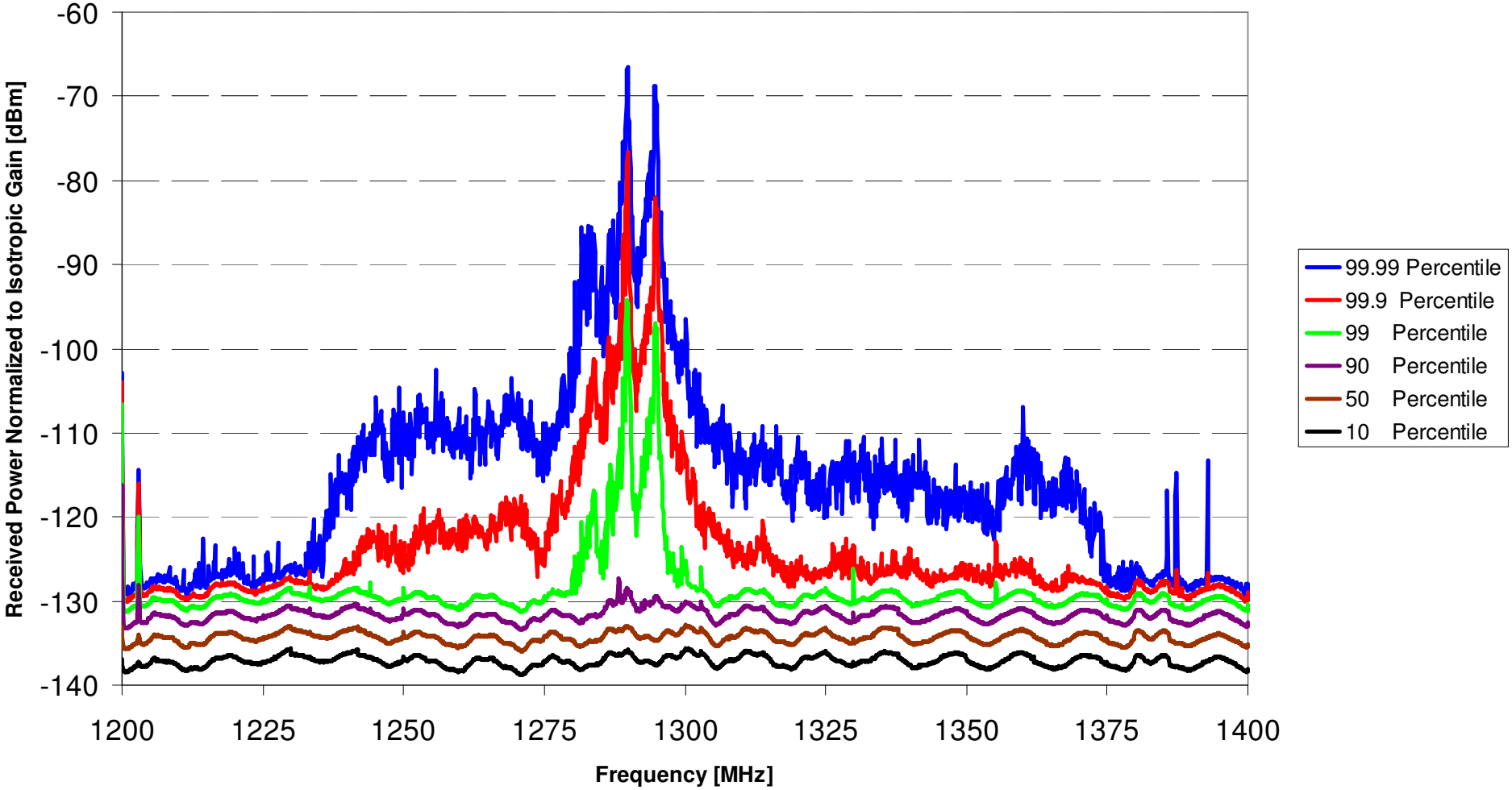
1200 MHz to 1400MHz

Percentile Profile



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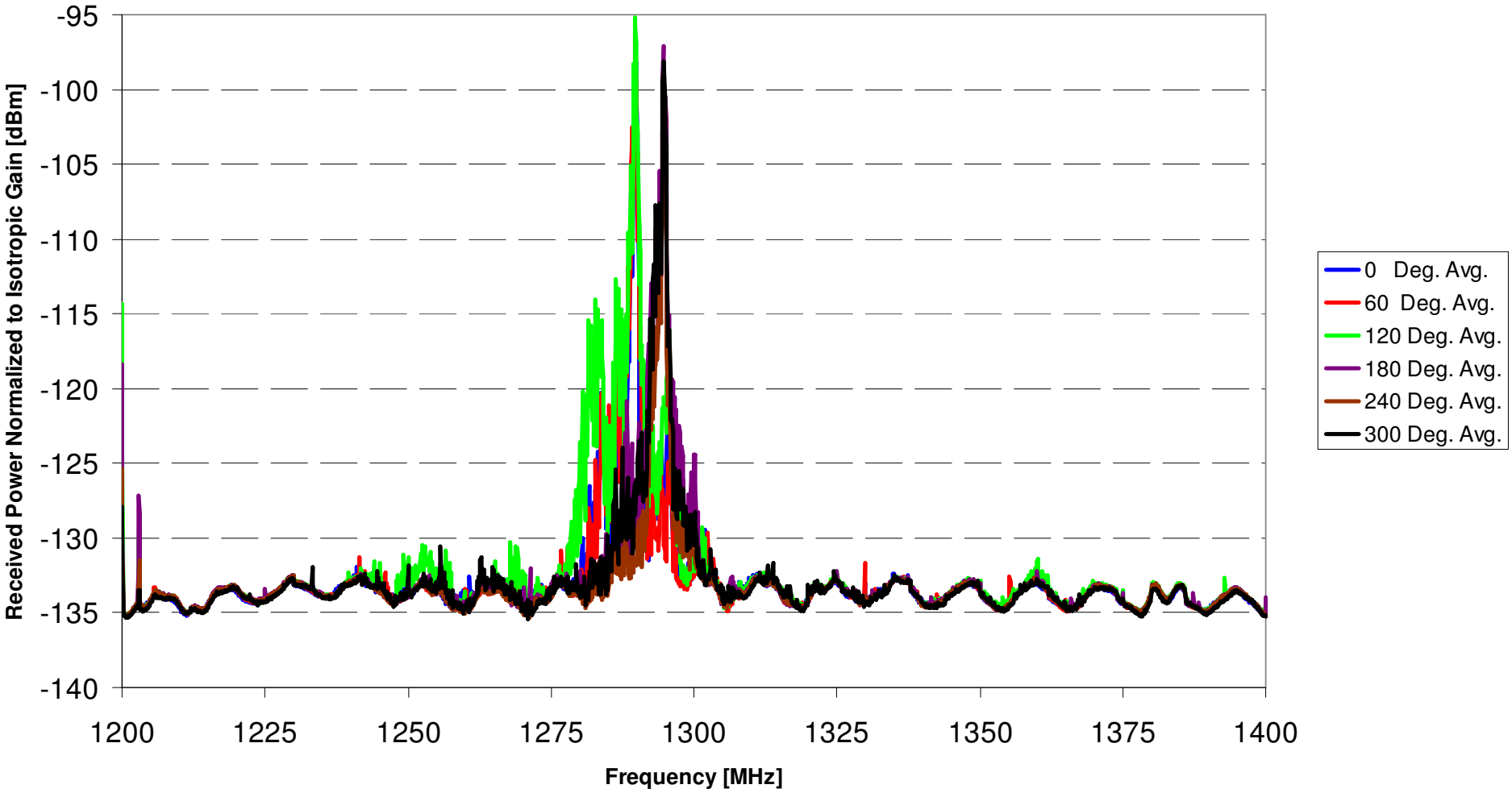
1200 MHz to 1400MHz

Azimuthal Direction



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Mobile Satellite: 1525 MHz – 1559 MHz

- Space-to-Earth
  - COSPAS/SARSAT
  - INMARSAT
  - Motient
  - TMI

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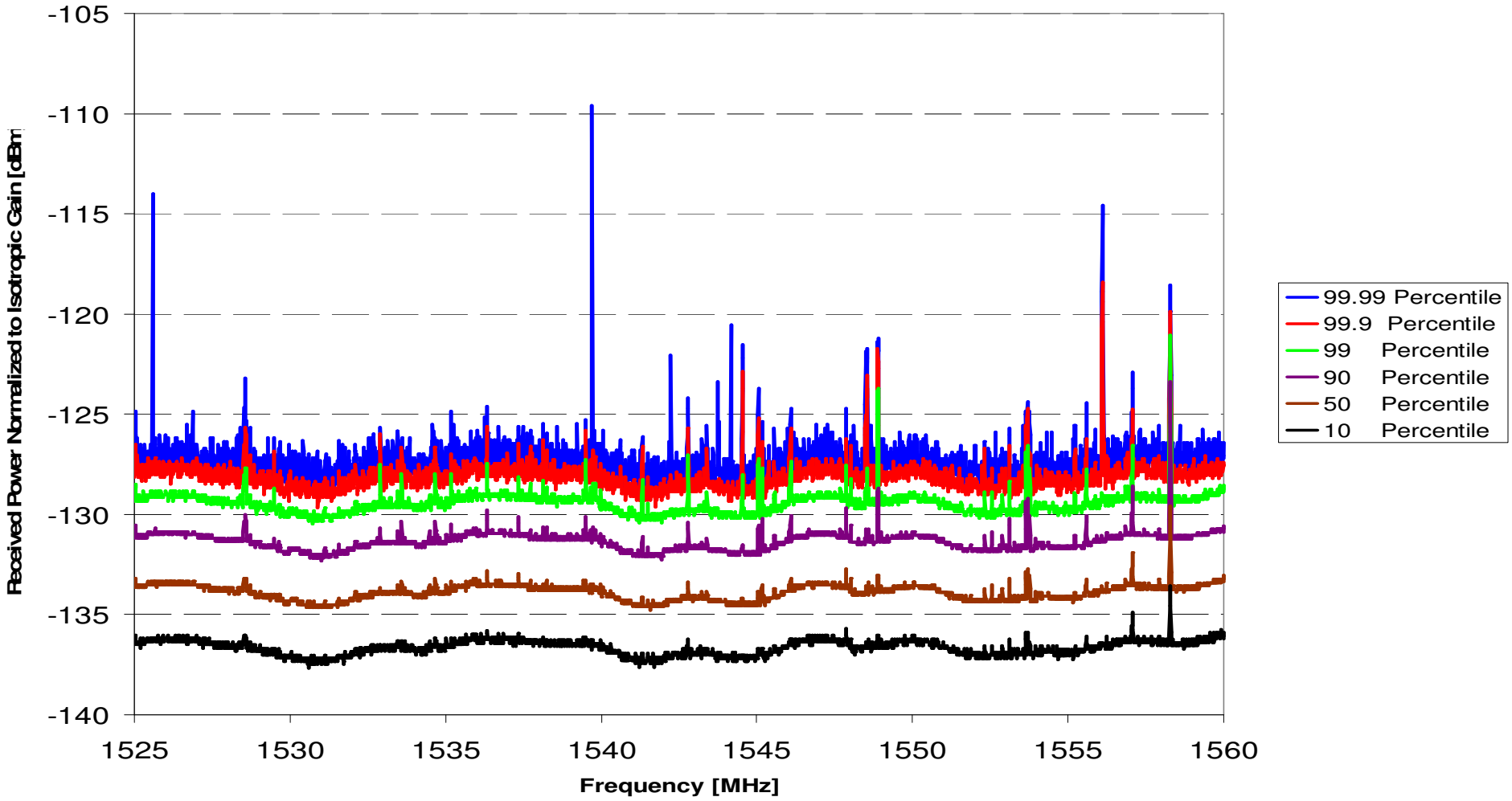
Mobile Satellite: 1525 MHz – 1559 MHz

Percentile Profile



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Land Mobile: 460 MHz – 470 MHz

- Medical Telemetry & Voice (MED)
- General Mobile Radio Service (GMRS)
- Family Radio Service (FRS)

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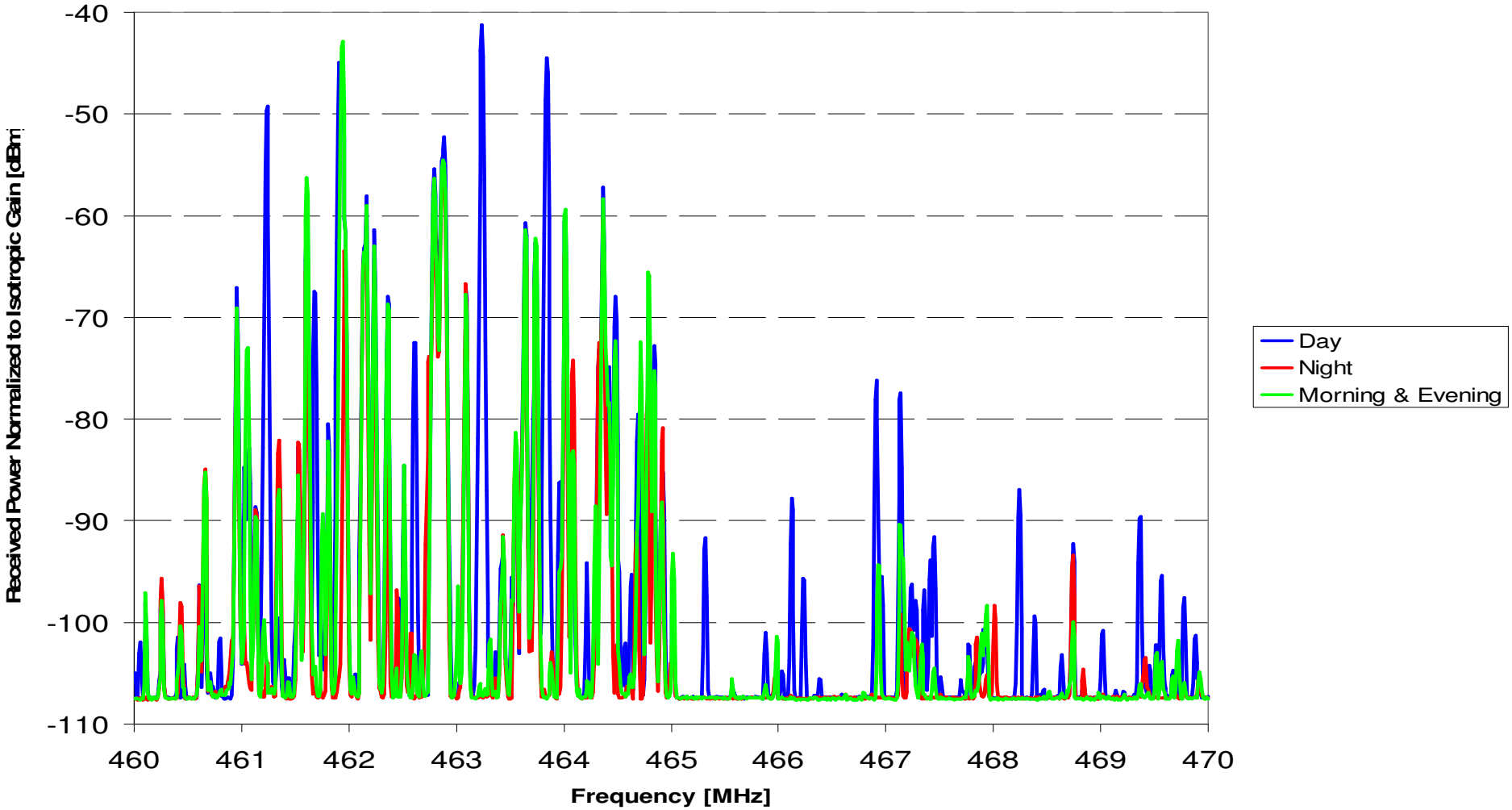
Land Mobile: 460 MHz – 470 MHz

Time Region



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Goals of Spectrum Study

- Perform billions of measurements
- Examine spectrum usage in multiple dimensions
- Identify periodic usage
- Look for long term trends

- Obtain interference information for passive and sensitive users

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Facilitate Development of Frequency Agile Radio

- Determine (given data rate & QOS requirement)
  - Opportunistic frequency bands to occupy
  - Bandwidth requirement of radio system

- Simulate protocols with Spectrum Study Data

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Conclusion

- Spectrum from 400 MHz to 7.2 GHz is being used
- Measuring spectrum is essential
- Interference is a growing problem

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