

Ultra Wideband Interference Effects on an Amateur Radio Receiver

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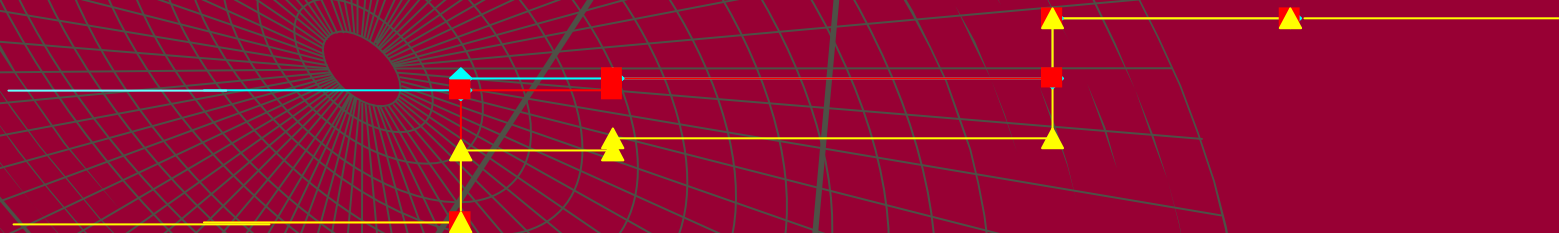
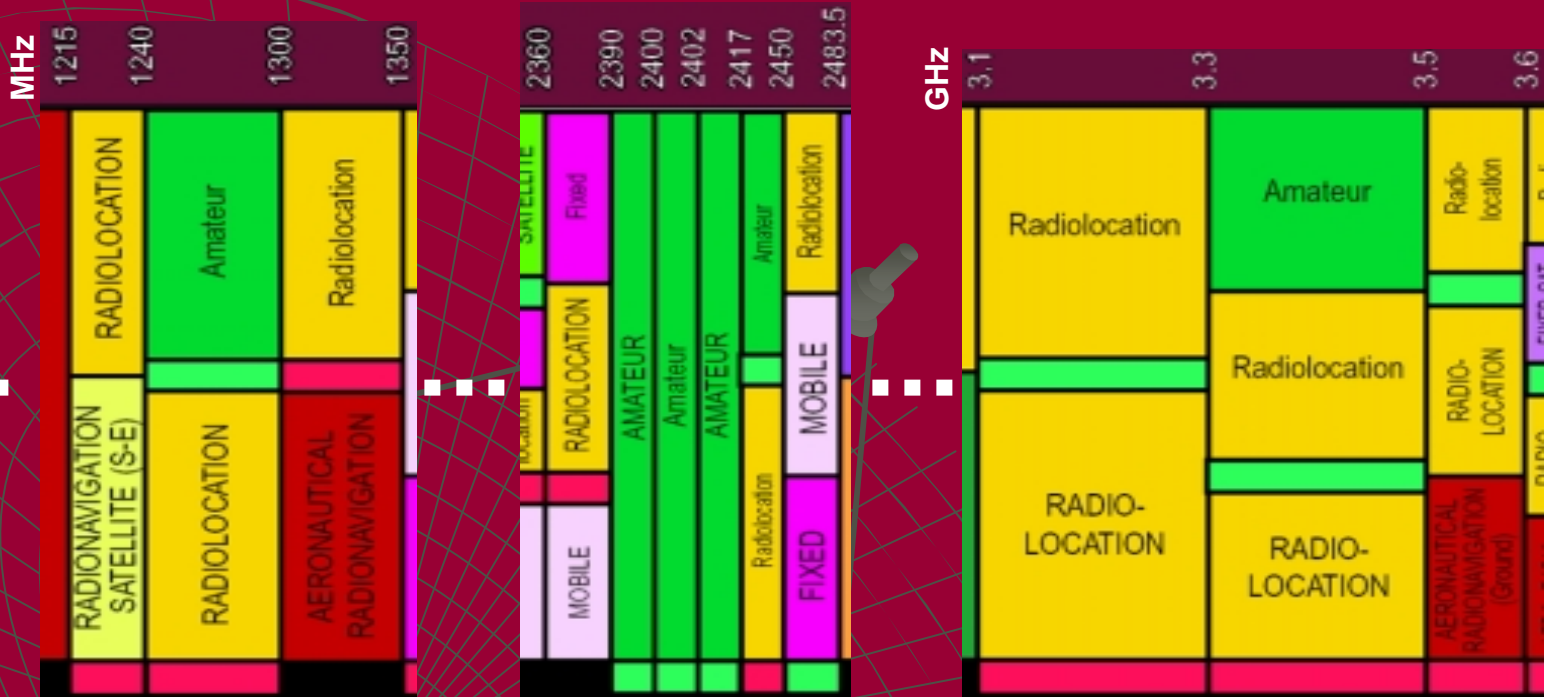
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What is the ARRL?

- ◆ Amateur radio hobbyists and public service (ARES)
- ◆ 170 000+ members¹
- ◆ Often trying to achieve long distance communication
- ◆ Sensitivity is important

1. <http://www.arrl.org>

Amateur Radio Bands



◆ Mid-Range Imaging

■ Indoor UWB

▲ Outdoor Hand-Held

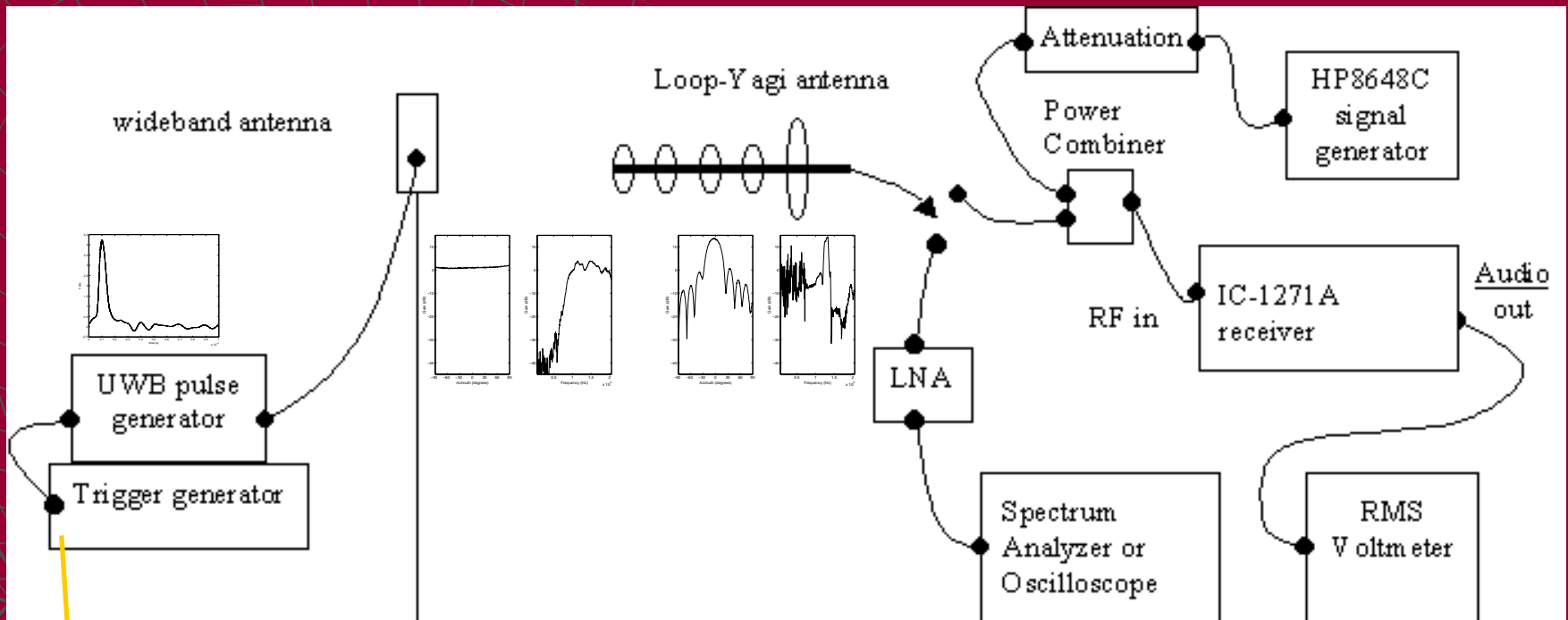
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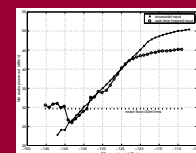
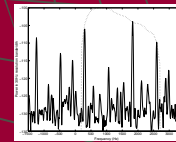
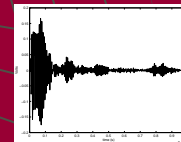
Experiments

- ◆ Receiver Linearity
 - Compare CW and UWB pulsed signals
- ◆ Receiver Sensitivity
 - Predictability of response
 - Minimum Discernable Signal

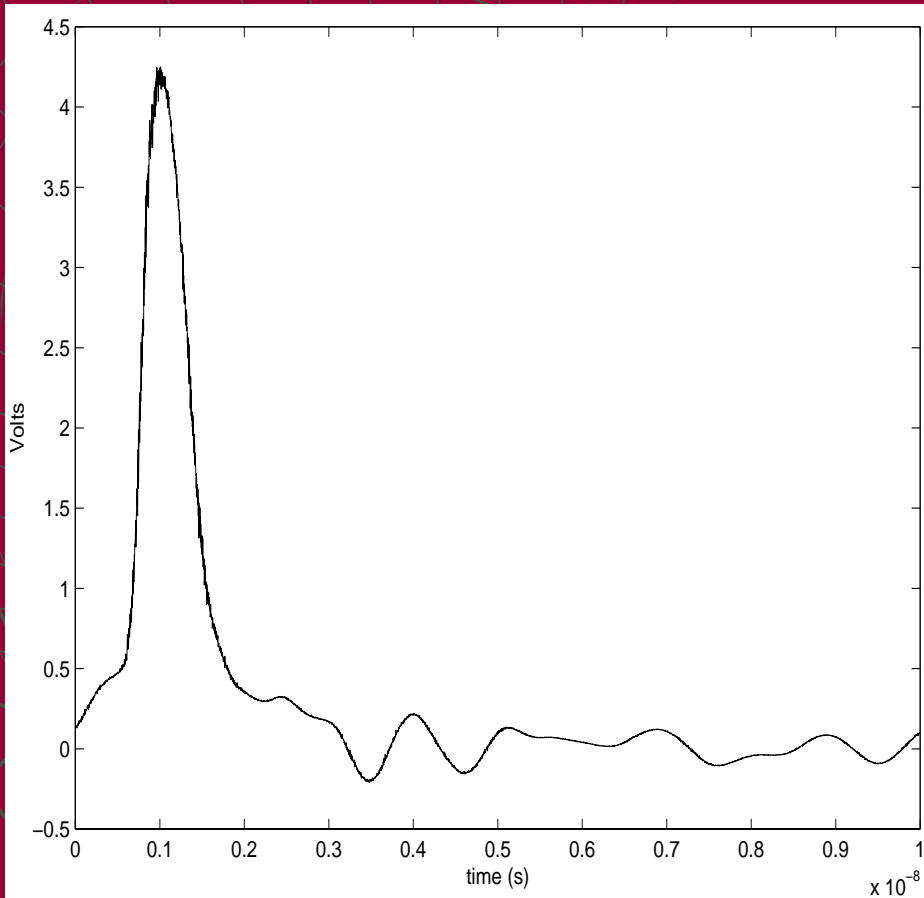
Experimental Setup



- 1023 pulse PR-time hopping
- 1.3ms period

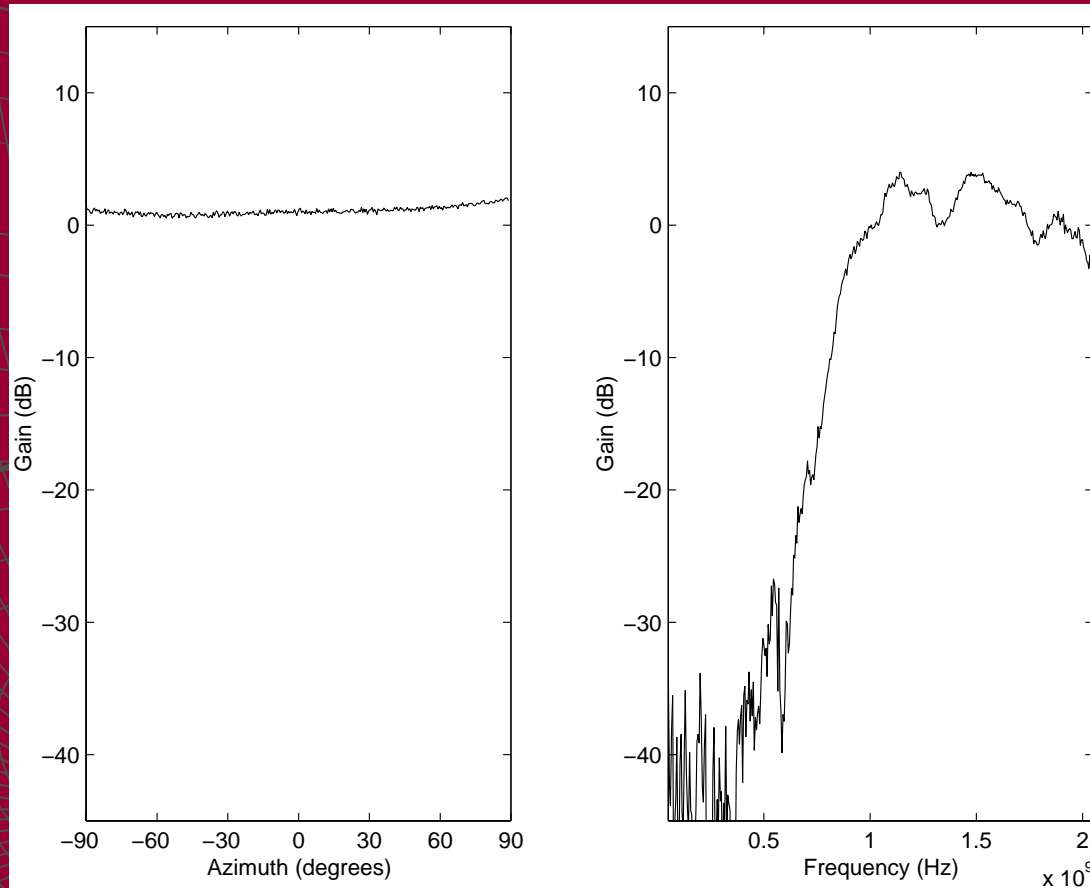


Transmitted Pulse



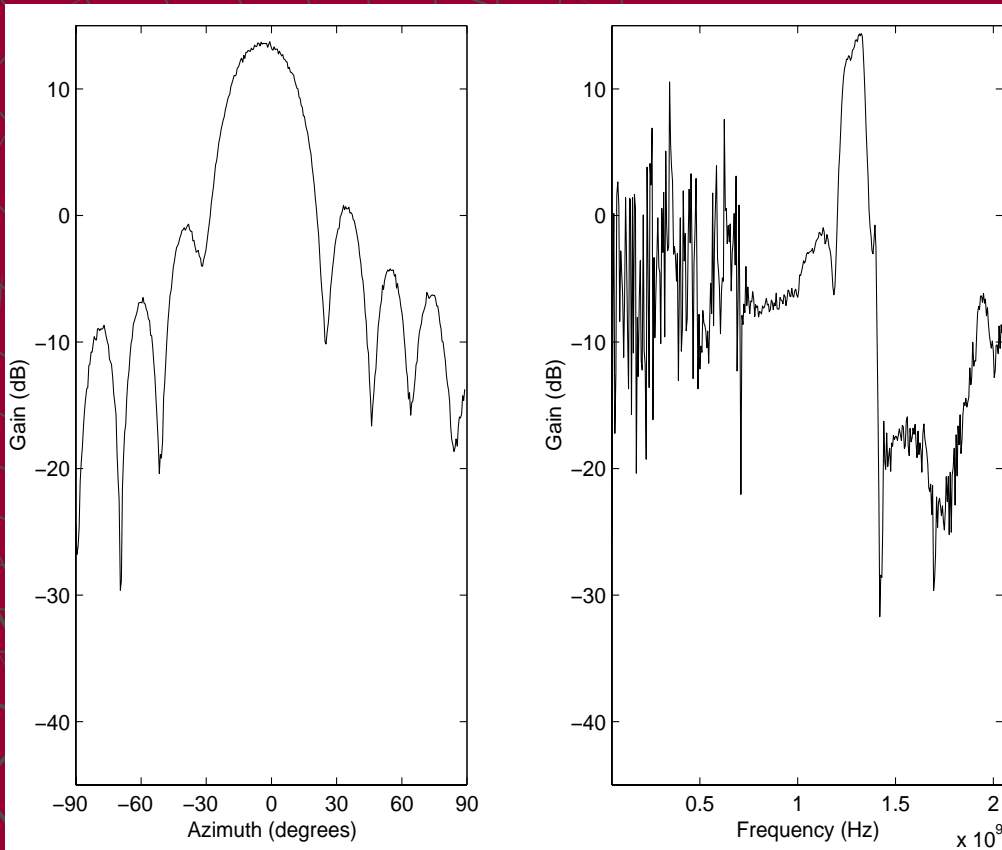
- -10.3 dBm time average output power
- ~ 1.5GHz 90% BW
- ~ 0.7ns duration
- Gaussian shape

UWB Diamond-Dipole



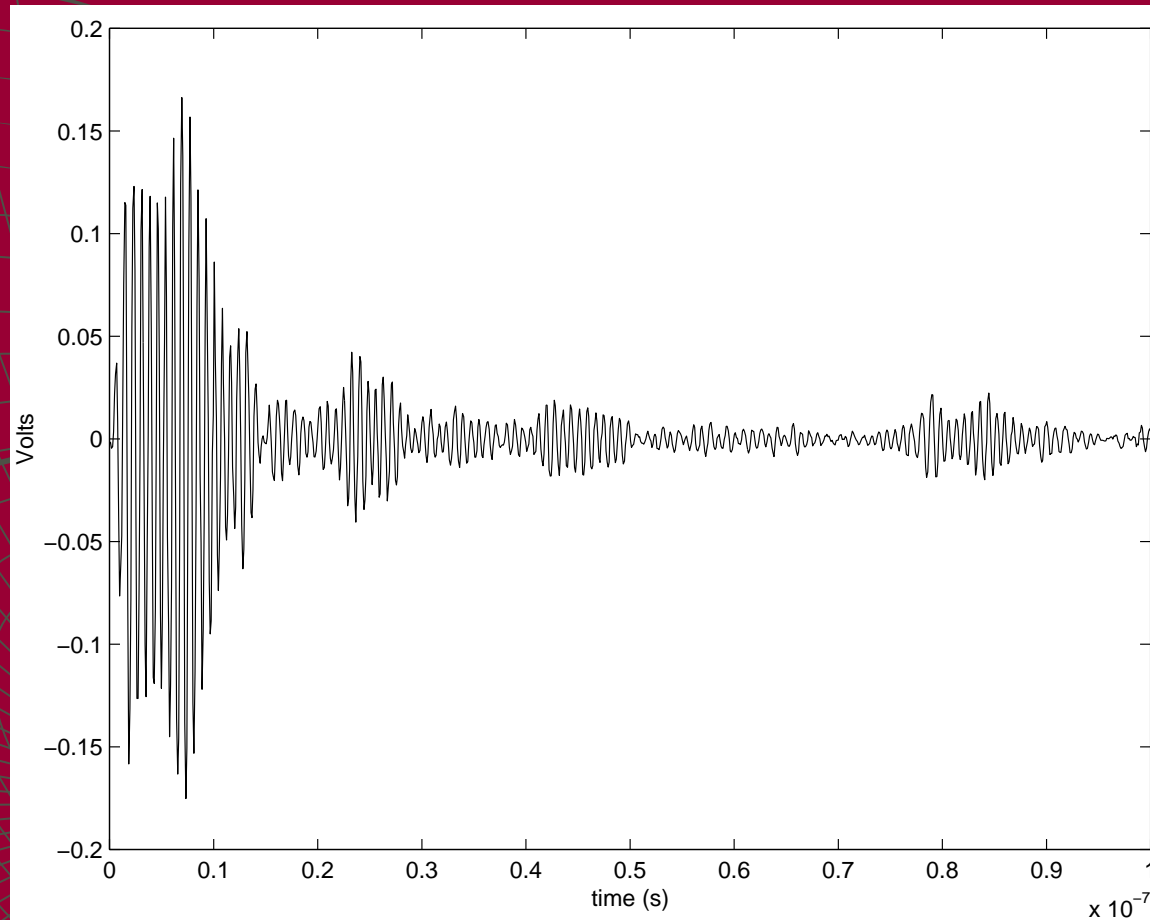
- Relatively wideband and omni-directional
- Narrowband receive antenna more important

Loop-Yagi Receive Antenna



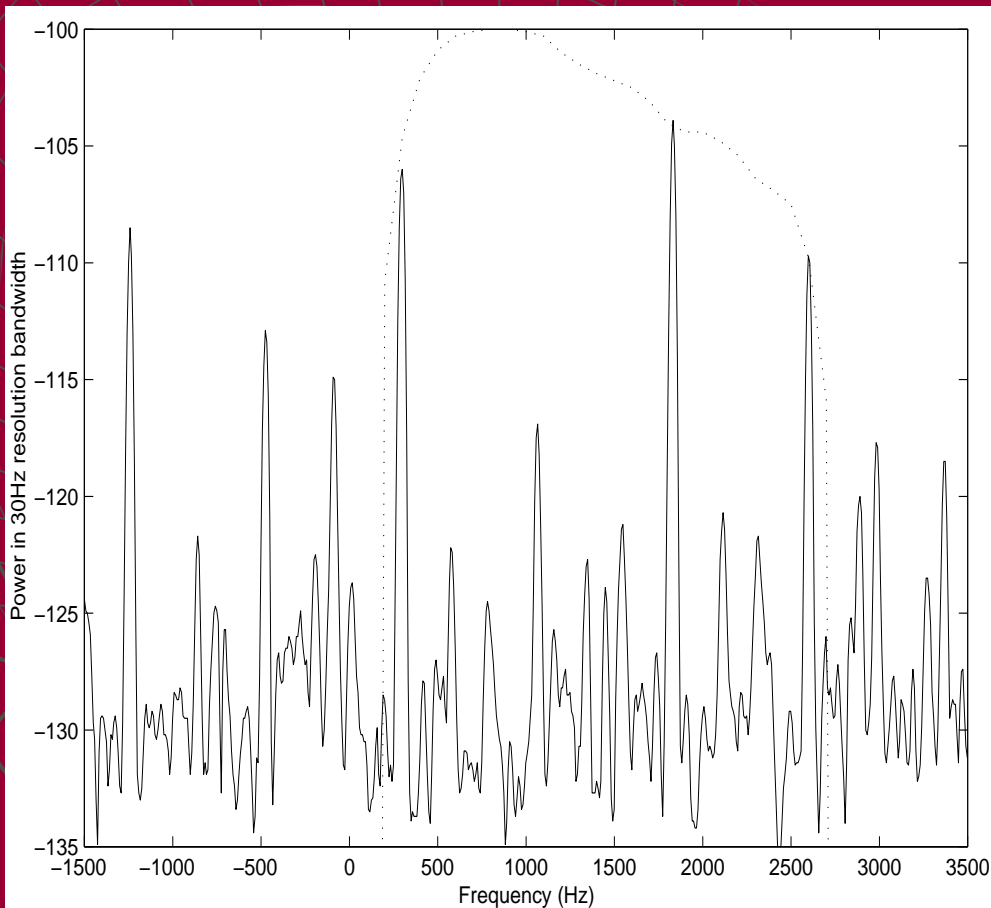
- Typical amateur equipment
- Center frequency ~ 1296MHz
- 3dB Beamwidth ~ 30 degrees
- 3dB Bandwidth ~ 100MHz

Received Waveform



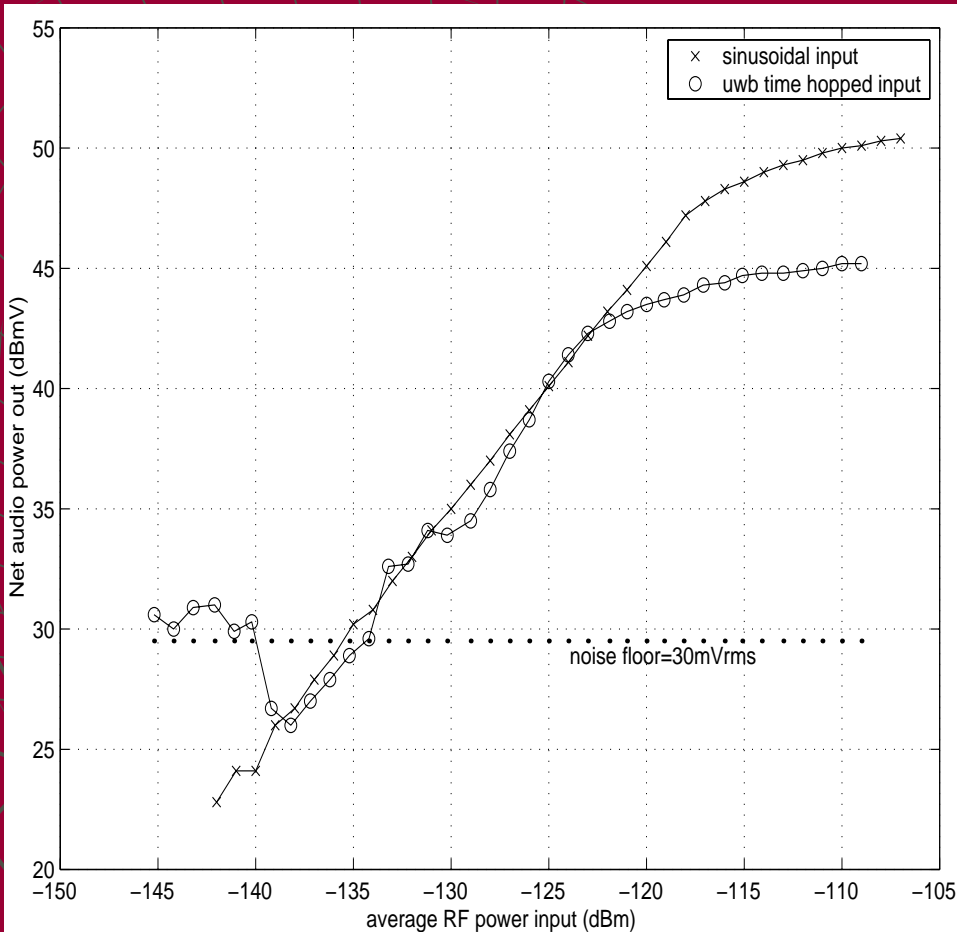
- Pulse spread to ~ 10 ns duration
- Antenna directivity minimizes multipath

UWB Spectrum and Receiver Passband



- Passband ~ 2kHz
- Code periodicity evident in 770 Hz line spacing
- 2 or 3 spectral lines in band
- More lines in-band implies whiter noise

Receiver Linearity



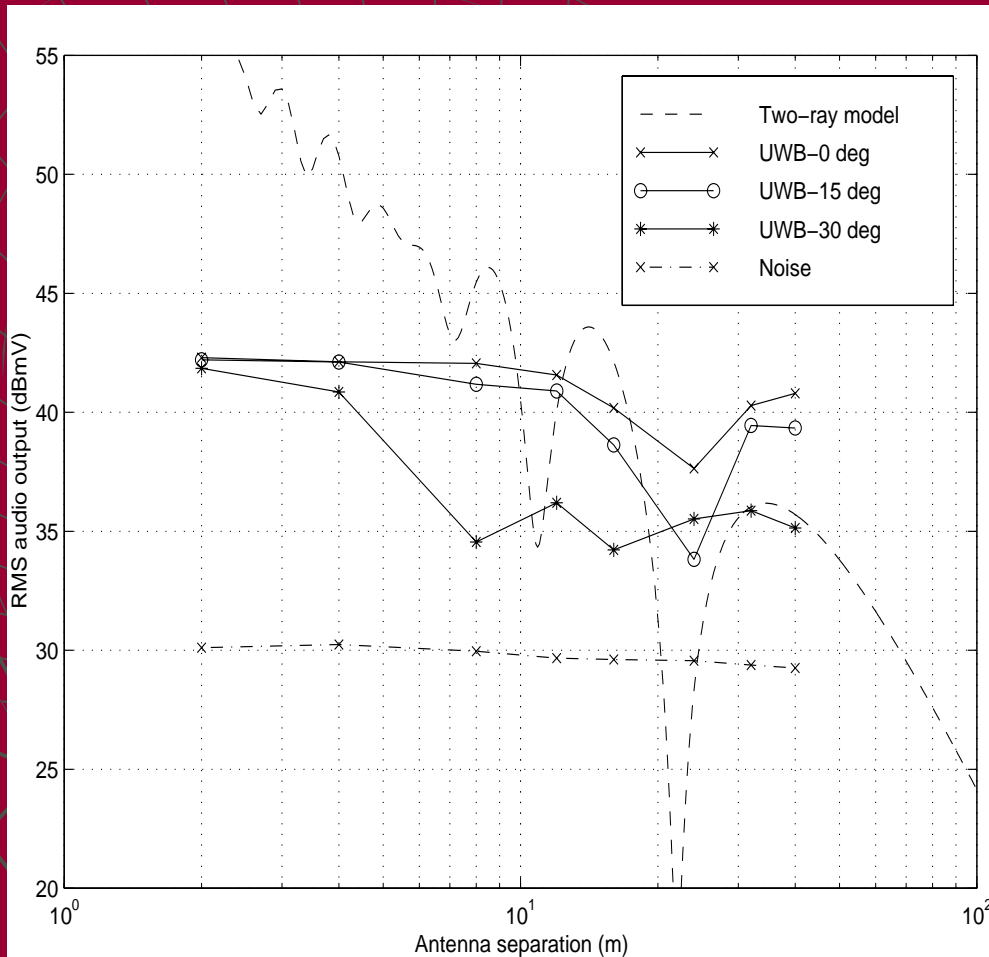
- UWB input power not directly measurable

» in-band power estimated from scope trace and pulse rate

» linear regions the same

- Compressed output level depends on clipping level and duty cycle
- 5dB differential implies UWB signal has 30% duty cycle at point of clipping
- Lower duty cycle signals cause less interference

Two-Ray Model

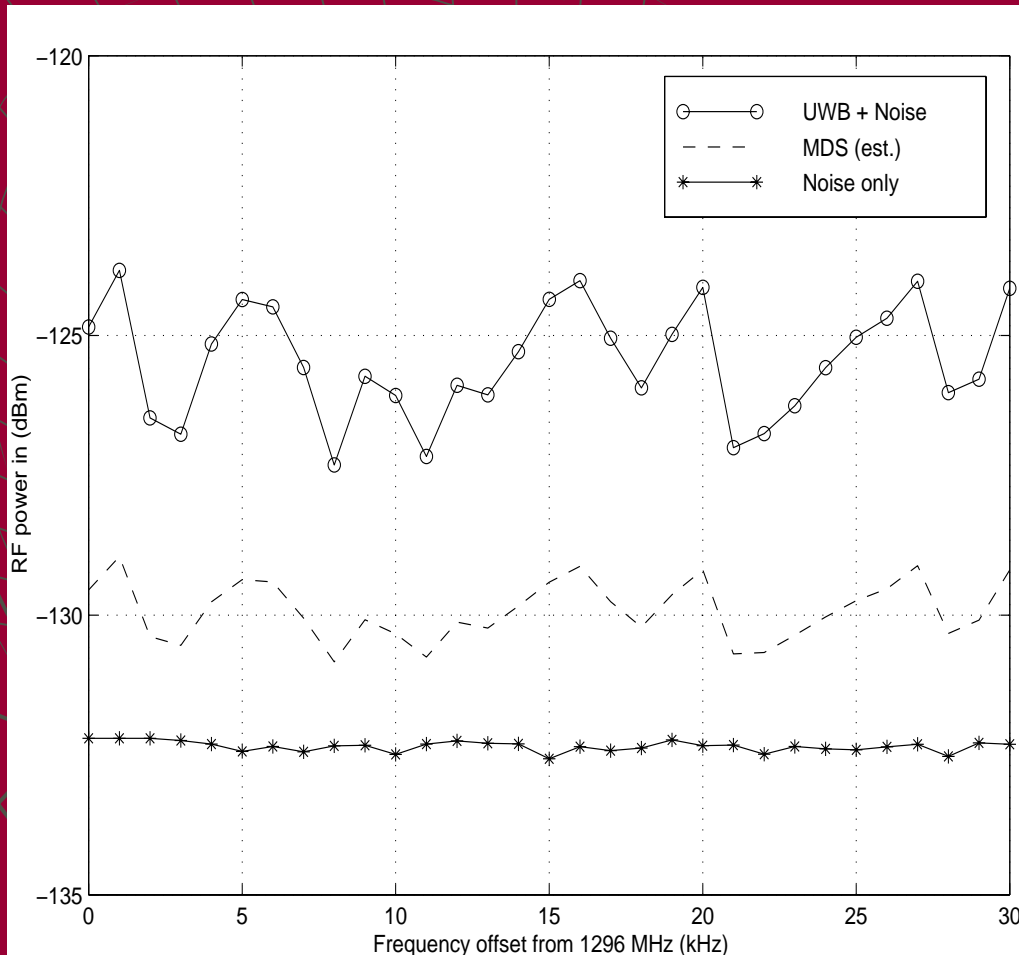


- 3 receive antenna orientations

- Comparison with 2-ray model at center frequency (1296MHz)

- Might fit a 2-ray model with a weaker reflected ray

Spectral Flatness & MDS



- Apparent received in-band power in presence and absence of UWB signal

- 5 to 8dB increase in noise floor

- » depends on number of lines in passband

- Estimated MDS if system was 12dB below FCC part 15 limit is 1 to 3dB above noise floor

- FCC UWB limit at 1296MHz is 12dB to 33dB below part 15 limit



Thank You