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Portable Infrasound Generator Insonifies IMS Array I59US

Unlimited Distribution

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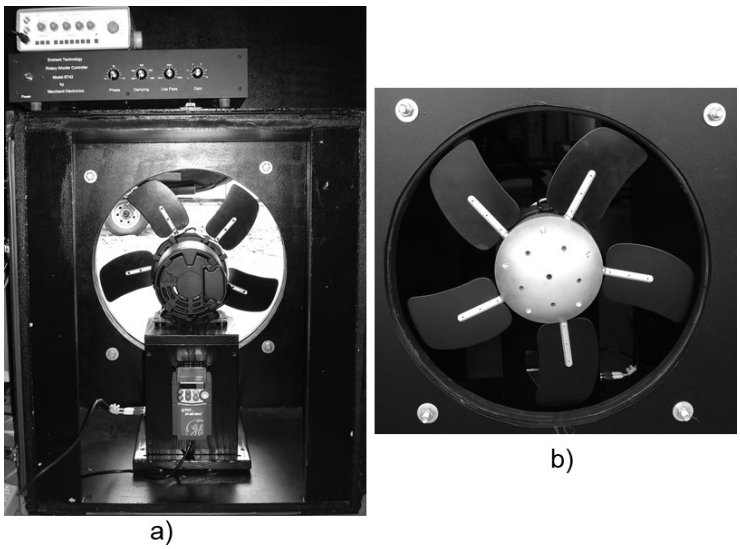
Summary: The Kona Infrasound Noise Generator (KING) is a novel low frequency acoustic transducer capable of projecting controllable infrasound from a compact, energy efficient source. On September 26, 2008 a portable, prototype version of KING was deployed approximately 3.8 km from the central element (H1) of IMS array I59US on the western flank of Hualalai volcano, Hawaii. A series of continuous wave (CW), constant frequency & amplitude sine waves were broadcast and recorded by all four elements of I59US. Signal-to-noise ratios (SNR) on the order of 5 – 15 dB were detected at broadcast frequencies from 5 to 8 Hz. This may be the first controlled insonification of an operational IMS infrasound array from a portable device.

Infrasound Generator: The KING consists of a baffled fan with dynamically controlled blade pitch that is modulated according to an input signal. KING is a version of the Thigpen Rotary Woofer, designed and constructed by Eminent Technologies[1]. High particle velocities at the fan blades are created through a combination of blade rotation around the fan hub axis, and blade pitch modulation about the axis of each blade. As a result, the KING is able to produce high amplitude coherent pressure oscillations in a controlled manner. A photograph of the KING installed at the Infrasound Laboratory is shown in figure 1.



a) b)

Figure 1. The Kona Infrasound Noise Generator installed at the Infrasound Laboratory. a) view inside the building showing the function generator, amplifier, motor controller and motor, b) view from the exterior showing the main rotor hub and blades.

[1] Eminent Technology Inc., 225 East Palmer Street, Tallahassee, FL 32301, E-Mail: info@eminent-tech.com

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The KING was installed in a 17 foot U-Haul truck to investigate its portability. A photograph of the portable system at the broadcast location is shown in figure 2. Figure 3 shows the geographic layout of the deployment. The axis of the projector was roughly aligned to point in the direction of the array.

Figure 2. The Kona Infrasound Noise Generator in it's portable configuration, located approximately 3.8 km from the central element of I59US.

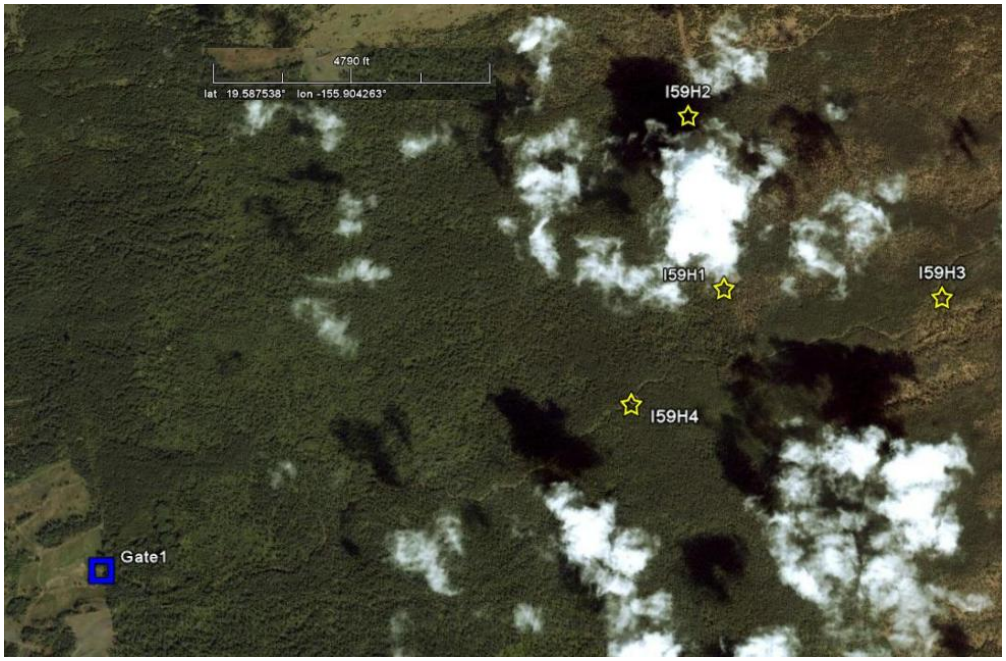

Figure 3. Geographic layout of the KING and the I59US elements. The KING was located at the position marked Gate1, approximately 3.8 km from the central array element H1.

Approximate distances from the KING to the I59US array elements are listed in table I.

Array Element	Distance (km)
H1	3.77
H2	4.16
H3	4.90
H4	3.02

Table I. Approximate distance from I59US sensors to the KING.

Operation: The KING was powered at the I59US array site by a portable generator. CW sine wave signals were broadcast for durations of 4-5 minutes. The input signal power was monitored with a portable oscilloscope. Table II lists the broadcast schedule with approximate signal frequencies and power.

UTC	Frequency (Hz)	Signal Amplitude (V_{RMS})
9/29/08 23:53 - 23:56	8	6.8
9/29/08 23:56 – 23:58	8	10.5
9/29/08 23:59 – 24:03	6	13.1
9/30/08 00:03 – 00:07	4	11.9
9/30/08 00:10 – 00:15	3	18.0
9/30/08 00:15 – 00:20	1	25.6
9/30/08 00:20 – 00:24	3	13.2
9/30/08 00:24 – 00:29	5	16.4
9/30/08 00:29 – 00:34	7	16.0
9/30/08 00:34 – 00:39	8	17.6

Table II. Broadcast schedule and signal parameters.

Analysis: Figure 4 plots the PSD of all four array microphones at broadcast frequencies of 5, 6, 7 and 8 Hz. A notable feature is the significant signal-to-noise ratio observed at sensors H1, H2, and H4, on the order of 15 dB. At the most distant sensor (H3) SNR's in excess of 5 dB are readily apparent.

Broadcast frequencies below 5 Hz were not easily identified in the data. This is likely a result of several factors: 1) The background noise levels are significantly higher, 2) the output power of the prototype KING falls off below 3 Hz, and 3) KING was not operated at maximum power output during this test.

Conclusion: A prototype of the KING modified for field deployment has demonstrated the ability to insonify an operational IMS infrasound array with CW signals from a stand-off distance of approximately 3.8 km. High SNR coupled with the ability to increase the output of the KING indicates that this technology has merit as a field-deployable infrasound generator.

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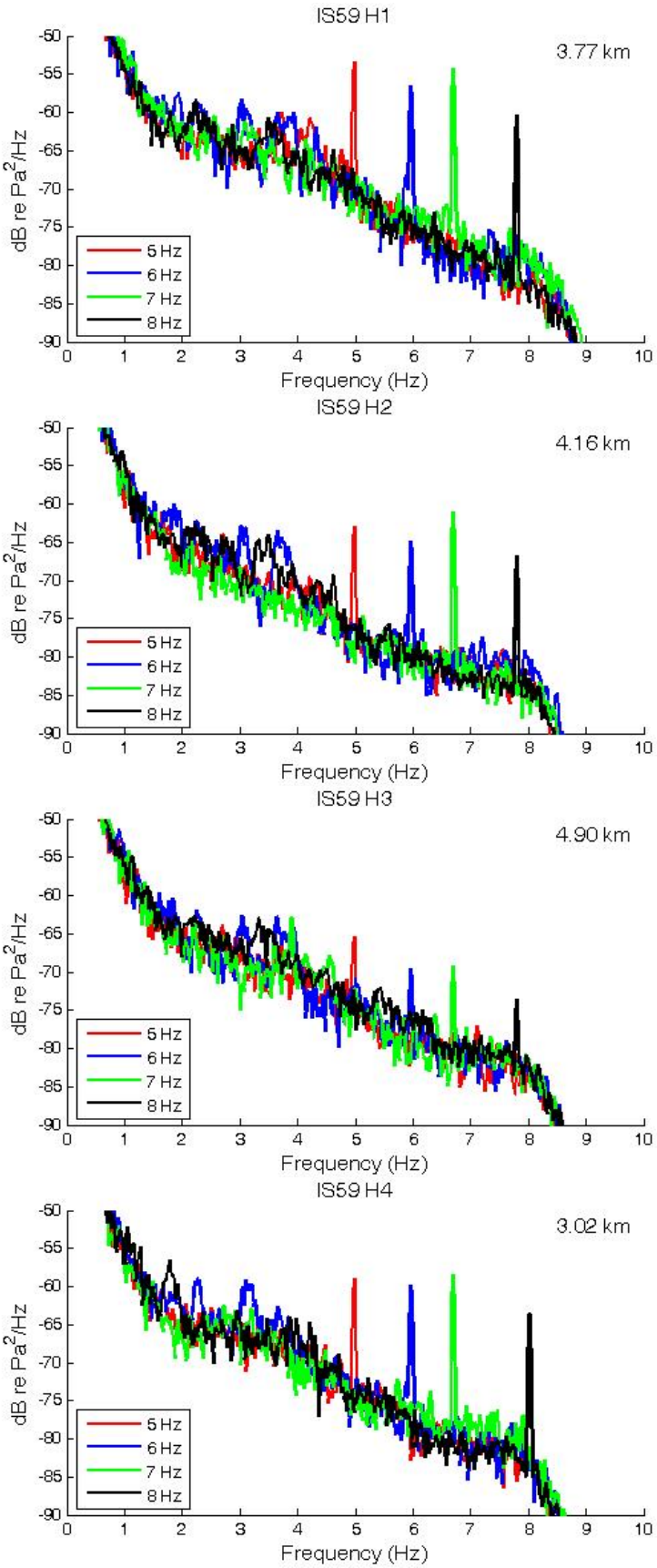

Figure 4. Power spectrums of microphones at I59US from the broadcast of 5, 6, 7, and 8 Hz signals.