

## Experiments with a Non-Line-of Sight (NLOS) beacon using a 940 nm LED array

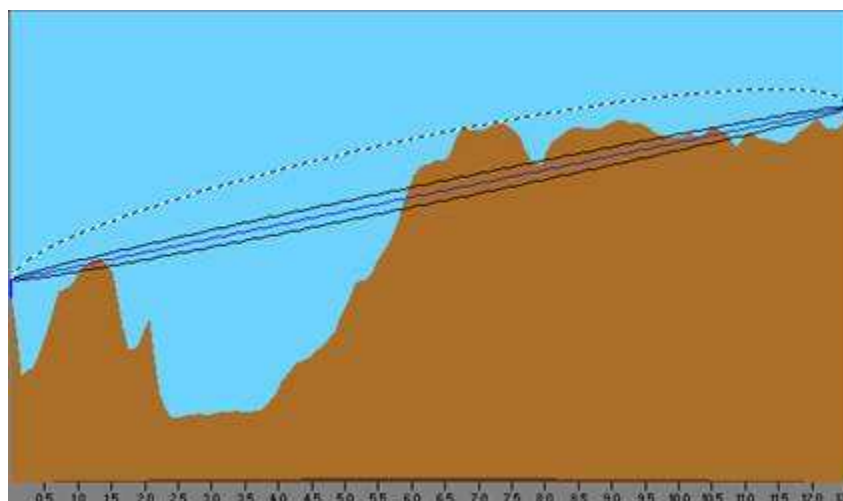
Kerry Banke – N6IZW

Lee Scheppmann – KD0IF

The San Diego Microwave Group

A few of us in the San Diego Microwave group have been experimenting for several years now with house-to-house communications using IR lasers to illuminate the haze in the atmosphere caused by moisture and pollution. This has primarily been done using a 910 nm Laser collimated to a 4 inch beam very accurately positioned at the Tx site to be pointed directly at the other site in azimuth and just above the optical horizon in elevation. The receivers used have typically been 4 to 8 inch lenses with the Pin photo detectors and a K3PGP style preamplifier. In our local San Diego area, clouds suitable for cloud bounce are very infrequent most of the year. The heavy haze of typical Summer days here tends to preclude mountain top LOS optical experiments as well.

To make use of the typical Summer haze here, Lee, KD0IF and I set up an experimental IR beacon located on top of his work building some 7.5 miles (12.5 km) West of my home. The following plot from Radio Mobile provides an idea of the elevation profile between the Tx and Rx sites.



The beacon, located on top of a single story building, consists of an array of 200 LEDs pointed approximately horizontal and in the direction of my home. It has a timer to turn it on from 9:00-10:00 every evening and at the present time only sends out a tone at exactly 450 Hz for propagation studies. Eventually we plan to install an MP3 player capable of sending messages in several digital formats including PSK31, Jason, and Wolf GUI. The LEDs have a 20 degree beam width and have 0.1 A peak current flowing through them. They are connected in an array of ten LEDs in series with a 10 ohm resistor and there are 20 of these series strings in parallel. The input power to the array is 17 Volts at 2 amps peak. A crystal clock oscillator is divided down to provide accurate 450 Hz on/off modulation.



With this type of beacon, the horizon is illuminated over a large area and it was found that a larger receiver aperture provides more signal even though it may not focus the received signal as well on to a small detector. The best receiver used so far consists of a 12 inch P-Com 39 GHz cast Aluminum dish antenna which has been lined with shiny Aluminum foil tape. A plastic shroud was added to help block ambient light entering from the sides. The photo detector is a 7mm area silicon pin diode with a 780 nm long pass filter in front to help reduce unwanted ambient light. Eventually we hope to have a matching band pass filter for the 940 nm LEDs ( currently have a 940-60-75 filter on order from Intor).



The basic K3PGP style preamplifier provides audio to a laptop running Spectrum Lab software to detect the 450 Hz tone. The beacon has been checked randomly for about 2 night each week since the beacon was installed in early July 2008. The signal has always been detectable at my home with the S/N typically ranging from 8-20 dB in a 1 Hz BW. Past experience has shown that about a 10 dB S/N tone in 1 Hz BW with our setup is required for good PSK31 communications. We have found with our setup that using Jason, communications works well down to 0 dB S/N in a 1 Hz BW. The Wolf GUI software has been tried but showed no advantage over Jason as we were not equipped to do the required fine frequency calibration on both ends of the path to take advantage of it's capabilities.