Abstract:
On June, 23, 2007 a two way contact was made between members of the San Diego Microwave Group: Kerry Banke N6IZW and Lee Scheppmann KD0IF, over a 14 km path using a recently installed optical repeater on San Miguel peak near San Diego. PSK31 was used along with 910 nm laser diodes and PGP style detectors. The optical repeater was assembled from two LED array beacons, (the type normally used on communications towers), and driven by a prototype detector circuit. The PSK31 base-tone was at 750 Hz and the received signal was greater than 43 dB above the noise floor.

Background:
Optical communications has been an interest of the San Diego Microwave Group for several years with a broad range of experiments being conducted by group members. Equipment has included home-brew transmitters based on laser pointers, high-powered LEDs and most recently, high-powered laser diodes. On the receiving end various optical arrangements usually driving a version of the PGP detector. Experiments have included very high bandwidth, linear communication, (near 1 GHZ), various digital communication modes, long range communications, and most recently the linear optical repeater designed by Kerry N6IZW.

The group maintains a repeater site on San Miguel Mt, (DM12MQ), where San Diego State University and its PBS affiliate; KPBS-TV has provided the group with mounting and power. The microwave and optical equipment operates under flexible, 450 MHz remote control link, provided and maintained by Greg K6QPV. The first optical equipment on the mountain was a simple retro-reflector which is useful for equipment alignment. This was followed by a small, 5 LED, high power array acting as an optical beacon modulated with 750 Hz. This provides a signal for scintillation measurements and experiments. This beacon can also be driven from an MP3 player with repeating message and ID. So far, this small beacon has been received at a distance of 50 miles.

The Optical Repeater:
Recently, Kerry designed and constructed a first generation repeater with a simple, single lens input coupled to a PGP detector driving two very high power Radio Tower LED arrays. The input signal from the PGP detector is amplified, filtered, run thru an AGC circuit and then coupled to current limiting output drivers for the arrays. The arrays operate at 16VDC with an idle current of 3.6 A, rising to 8 amps on modulation peaks. Each semicircular array is 18” high and 12” in diameter and consists of 324 bright red LEDs with horizontal, cylindrical lens which maintain a narrow horizontal beam. All of this is packaged in a weather-proof enclosure. This configuration does a good job of lighting the San Diego area, but improvements are planned to enable the detector to see a much wider field of view.

An added feature is the ability to turn on the small 5 LED 750 Hz beacon which is in sight of the repeater input so that the 750 Hz signal is retransmitted thru the large array. Recent experiments with this configuration show a 70 db signal over the noise floor at 8

miles. This is probably a good indication of the LED array output when driven to maximum illumination.

The Contact:

Located at a distance about 7 km from the repeater in DM12MS, Kerry N6IZW and Lee KD0IF set up their equipment and initially focused on the beacon for alignment. At that distance the beacon was very strong and a webcam view (fig 1) thru Lee's 135 mm telephoto lens shows the beacon array in the lower right. The two lights above it are the regular tower beacons on the KPBS transmitting towers. Both stations received very solid signals from the 750 Hz tone modulation and after Greg K6QPV turned off the tone and opened up the repeater using the 450 Mhz control link, the first PSK31 contact was made without a hitch. The received signals were greater than 43 db over the optical noise floor.

Fig 1. Webcam Telephoto image: 7 km distance Beacon/Repeater is bottom right

Fig 2. PSK31 Screen

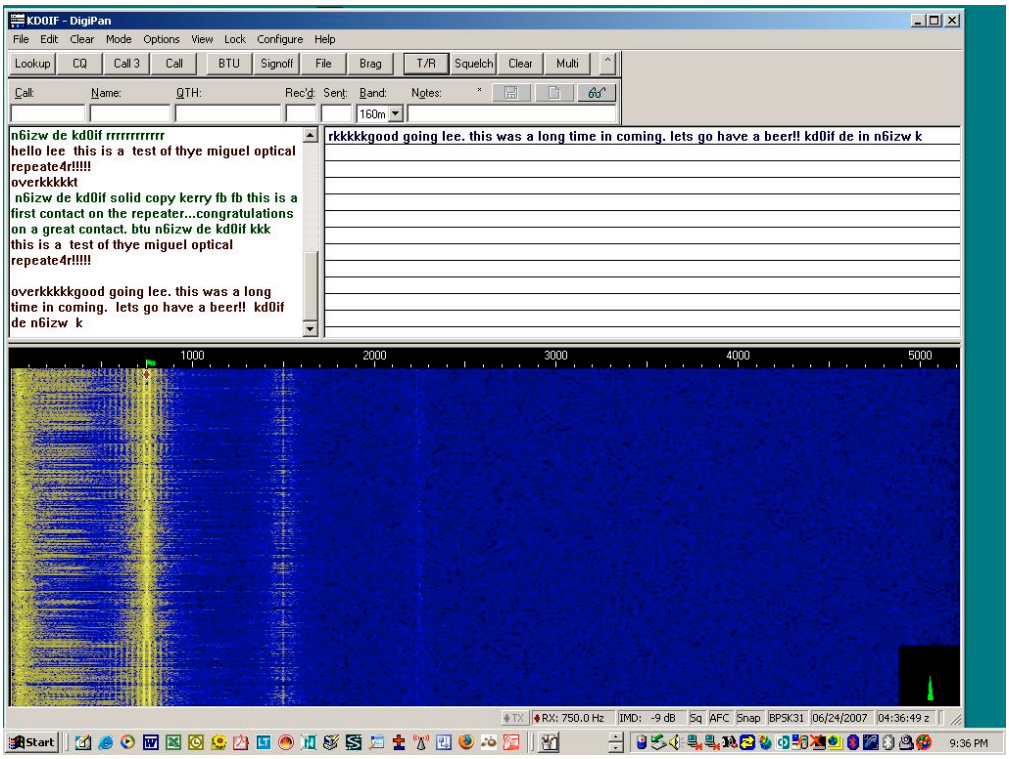

Fig 3. Kerry's Equipment

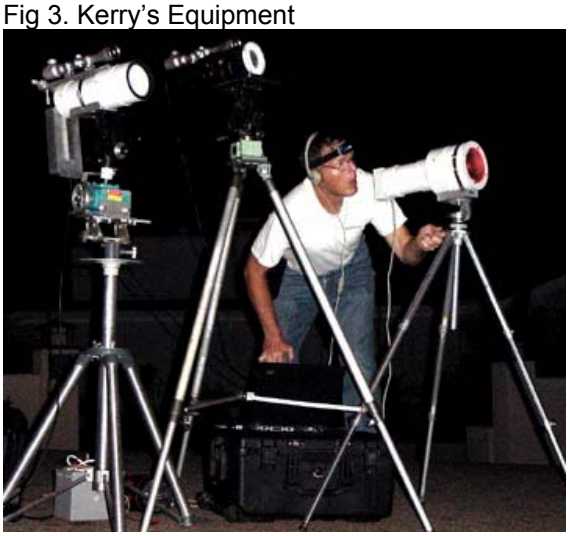

Fig 4. Lee's Equipment

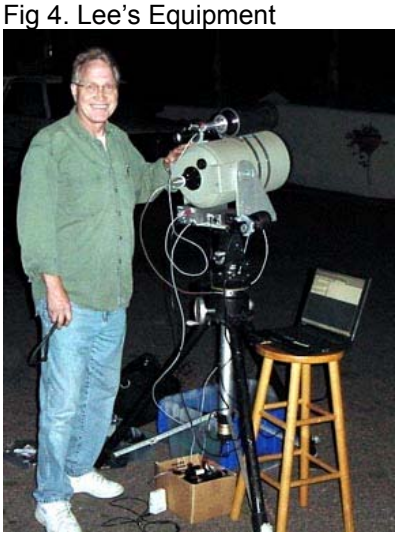

Fig 5. The Team: Greg K6QPV, Lee KD0IF, Kerry N6IZW

The Equipment:

From his end Kerry N6IZW runs a home brew 4", single lens into a PGP detector. On the transmit side he has a 1 watt, 910 nm laser diode into a 4" single lens collimator. Lee's equipment consists of a PIN Diode head at the focal point of an 8 inch SC telescope feeding a PGP circuit. On the transmit side is a 4", single lens collimator in front of a 1 watt 910 nm laser diode. Laptops were used by both, running PSK31

software under Spectrum Lab on Kerry's end and Digipan on Lee's end. Needless to say, tripods and precise pointing are key ingredients.

Fig 5. Kerry with one of the repeater enclosures

Fig 6. One Tower Array on Greg's bench

The Next Steps:

Given the high S/N level, and previous experience over a 50 mi path, we expect that this repeater will be good for at least that distance. More work needs to be done on the receive optics before we can operate at more divergent angles. We will also be using the increased output of the beacon for scintillation studies.