10 GHz Dielectric Rod Antenna

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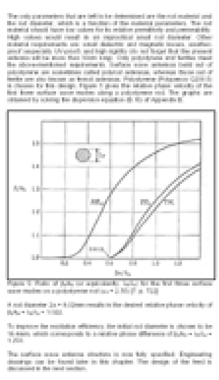
Could you believe this: **A long yagi antenna with 20.5 dBi gain, made out of plastic!**

Learn all about it by downloading this **technical report**.[1]

This technical report got mentioned in the **United States patent US 7889149 B2**.[2]

Abstract



technical report

Dielectric rod antennas provide significant performance advantages. Moreover, dielectric rod antennas are a low cost alternative to free space high gain antennas at millimeter-wave frequencies and the higher end of the microwave band.

The fundamental working principle of this antenna type is explained and guidelines are given for a maximum gain design. Applying these to an X-band antenna design, resulted in a maximum end-fire gain of 20.5 dBi for an antenna length of 11.18 λ_0.

E- and H-plane radiation patterns were measured, revealing high side lobe levels, especially in the E-plane. This is about the only intrinsic disadvantage of this dielectric rod antenna design. This could be remedied by sacrificing some end-fire gain and main beam sharpness in return for lower side lobe levels.

The tapered dielectric inside the waveguide feed proved to be well matched over an extremely wide band; over 3 GHz. The pattern bandwidth depending on the intended application of the antenna, can also be considered quite large.

Not knowing the surface wave excitation efficiency of the feed was the only difficulty encountered during the design process. As a result, the maximum end-fire gain was achieved at a frequency different from the design frequency. This problem would not have existed if the transition from feed to antenna had been computer modelled.

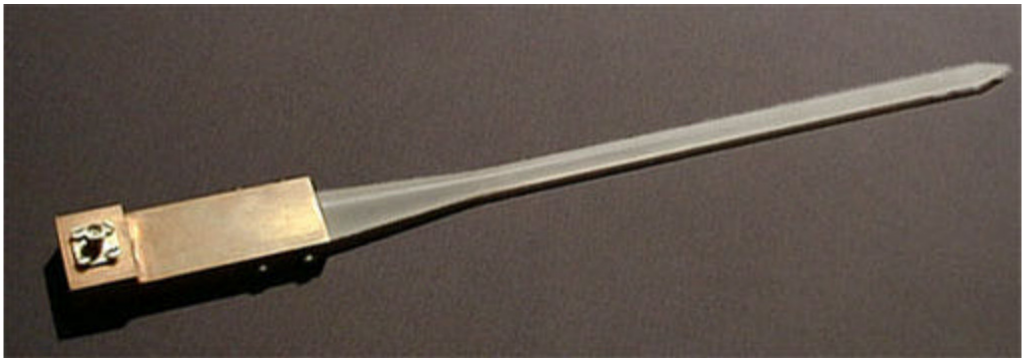


Figure 1: X-band dielectric rod antenna

Figure 2: Waveguide feed of the X-band dielectric rod antenna

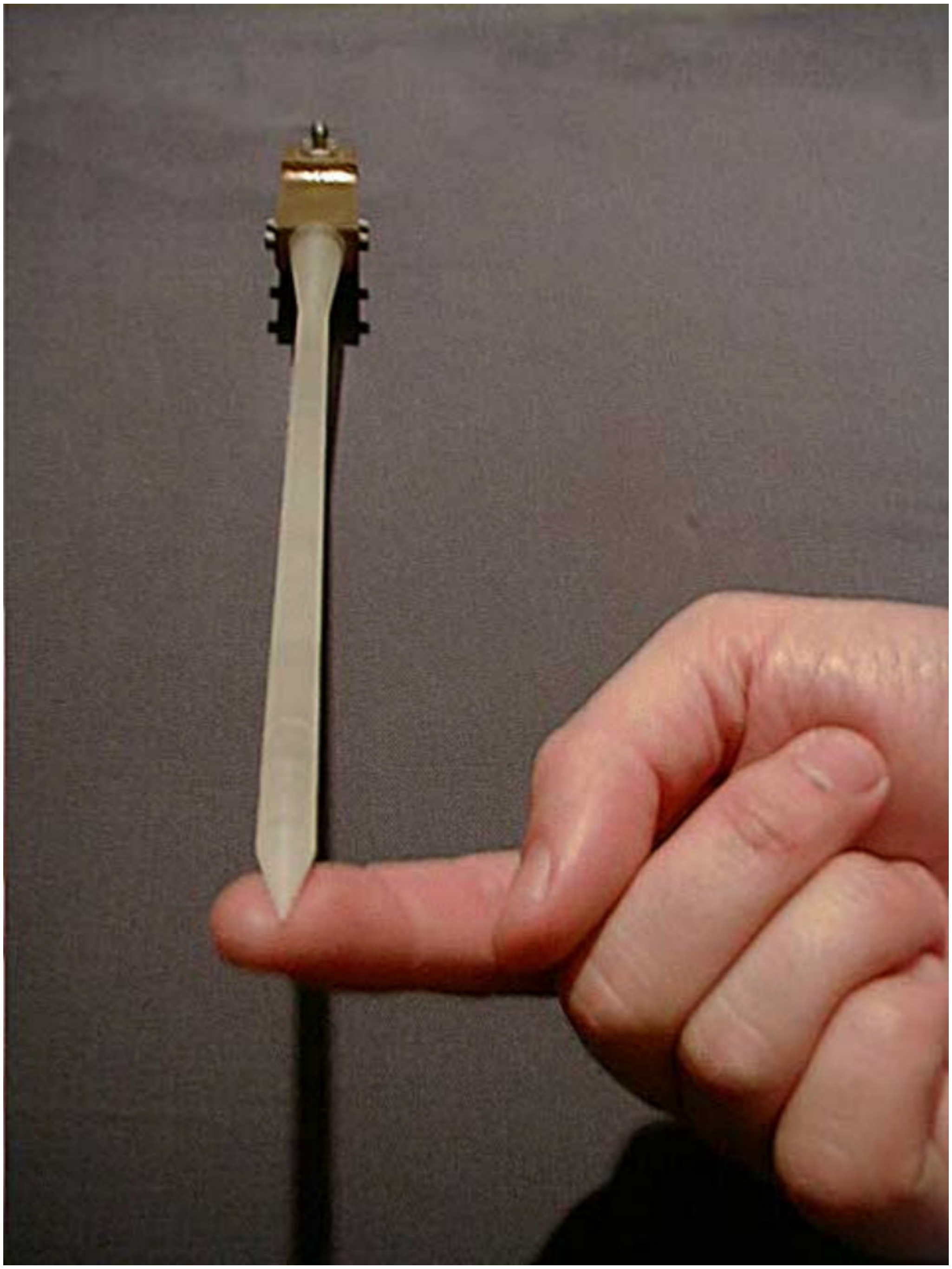


Figure 3: X-band dielectric rod antenna; frontal view

Similarity with rods & cones of the retina

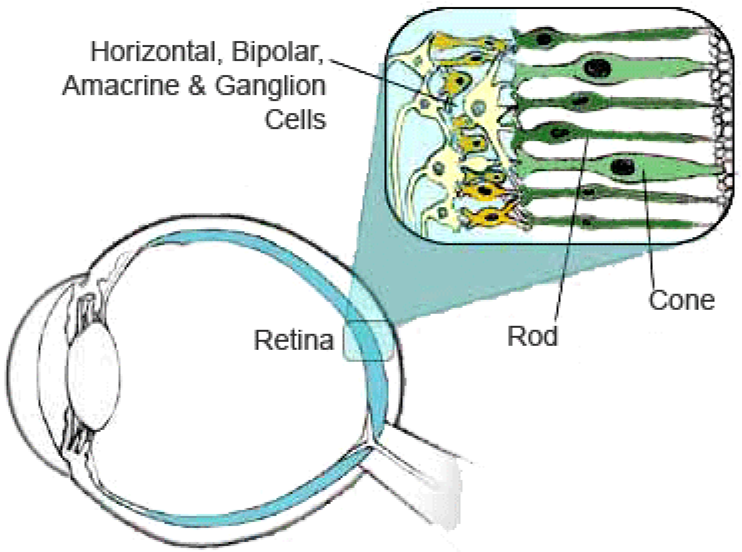


Figure 4: Anatomy of the human eye

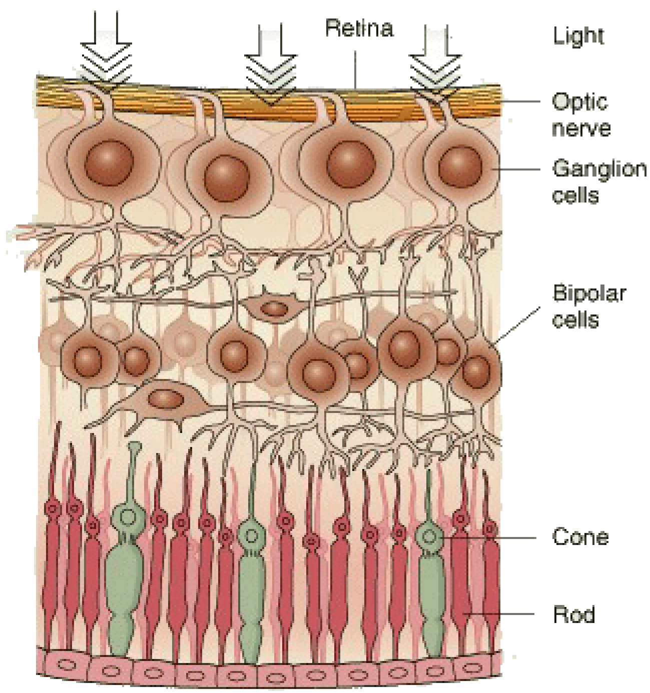


Figure 5: Anatomy of the retina

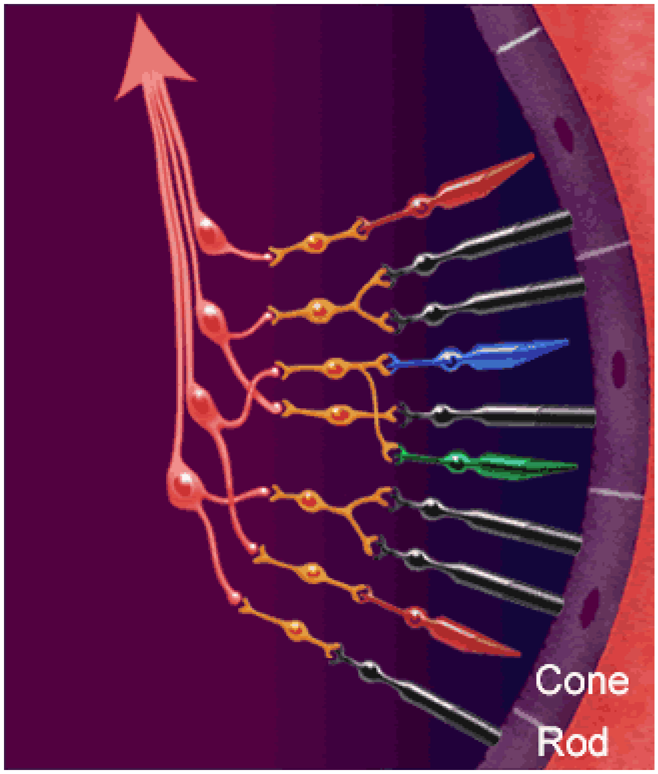


Figure 6: The retina acts as an edge-detecting signal compressor.

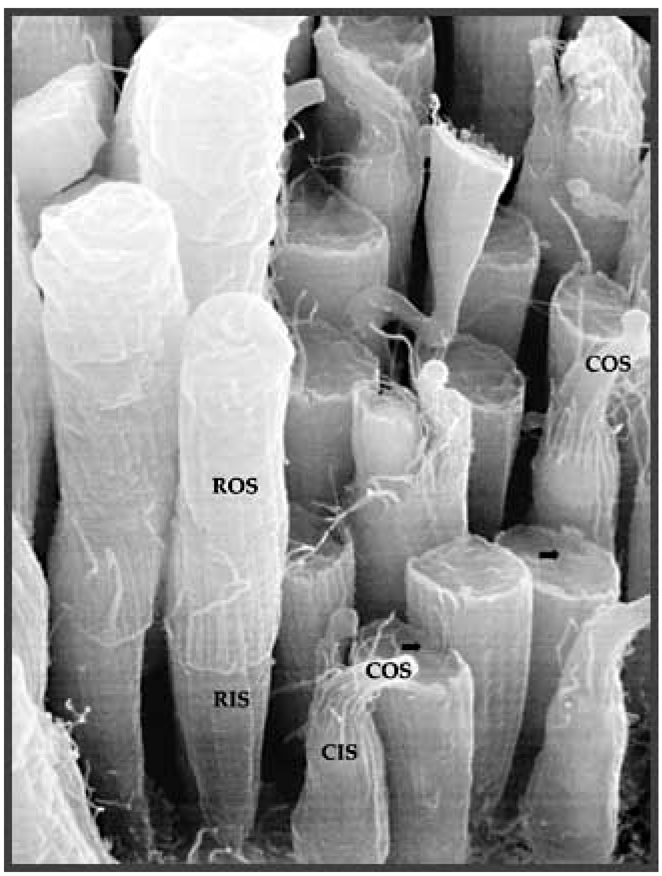


Figure 7: The retina is an array of rods and cones.

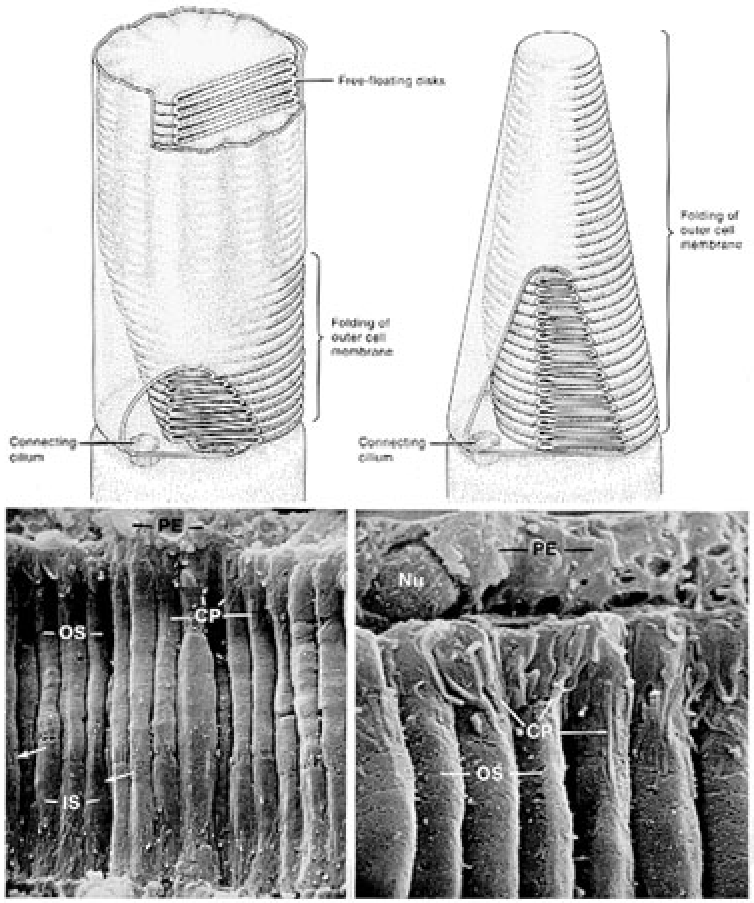


Figure 8: The rod and cone disc structures act as an artificial dielectric.

The insect compound eye

Time and again, I encounter vulgarising science magazines describing insects viewing the world as though looking through a mosaic window. For an insect, there is nothing to be gained with having a mosaic view on its surrounding world. For this reason, I rather entertain the hypothesis that the insect compound eye acts as an optical phased array with a steered focus that scans its surroundings. This is very much alike the microwave phased antenna arrays used by the military for radar.

Figure 9: The PAVE Phased Array Warning System (PAVE PAWS) at Beale AFB employs a pair of Raytheon AN/FPS-115 phased antenna arrays comprising several thousand smaller antenna elements. Its electronically steered beam is capable of detecting submarine launched ballistic missiles at ranges up to 3500 nmi (6500 km) with 2.2° azimuthal precision. *Source:* Missile Defense Agency

Figure 10: The compound eyes of *Calliphora vomitoria (blue bottle fly)*. *Source:* Wikipedia

References

1. Serge Y. Stroobandt. *An X-Band High-Gain Dielectric Rod Antenna*. Katholieke Universiteit Leuven; 1997. http://hamwaves.com/dielectric.rod/doc/dielectric_rod_antenna.pdf

2. Rodolfo Diaz, Jeffrey Peebles, Yan Guo. Aperture matched polyrod antenna. Published online 2011. http://hamwaves.com/dielectric.rod/doc/us7889149b2.pdf