A Novel Approach to Non-invasive way of Treating Skin Cancer using Dipole Fed Corner Reflector Antenna with Sub Nano Second Electric Pulse

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***Abstract*- Skin cancer has become major threat to mankind, apart from various treatments of curing cancer like Radiation therapy, our paper deals with the new way of treating skin cancer using Dipole fed corner reflector antenna because of its effective focus on the affected area only. This antenna uses sub Nano second electric pulse for radiating on the skin. This way of treating cancerous cells ensure very less radiation on the normal part of our body. The successful Antenna is designed, so that it could be adjusted for any part of human body. High gain is achieved by reducing spacing between the solid plates (Reflectors) of the antenna. The design provides a new way of treating skin cancer, which assures better treatment than the rest one due to its effective focus, good directivity and effectively treats deep-seated tumours. Simulation of designed antenna using Antenna magus version 3.3.0and its observed parameters are open in this paper.**

***Index Terms*- Dipole fed corner reflector antenna, Sub Nano second electric pulse, Gain, Directivity, Tumours.**

I. Introduction

In recent years, the world of electronics has changed a lot since the applications of electronics are opened to medical therapy. But the question is how we are converting this technology into something that can indeed benefit us.

One of the important applications is the cancer treatment [1], [2].Among the various types of cancer, skin cancer is frequently diagnosed cancer. Recent statistics also shows the greater increase in number of persons affected with skin cancer [3].

Conventional methods of treating skin cancer are radio therapy and chemotherapy. These kinds of treatments not only treat the tumours but also involves in affecting neighbouring healthy tissues. But the use of Dipole fed corner reflector antenna in the treatment of cancer elevate the temperature of the tumour between 43-45^{o}C due to the action of pulse on the tissue (Hyperthermia) . This brings out good action on the deep seated tumours. By the use of intense nanosecond electric pulses (snEPs) provide a new tool for cancer treatment [4], [5].

In this research of treating cancer, we have designed an antenna with spacing 16.325mm and input frequency of 9.188 GHz (Sub Nano second electric pulse) this increases the tissue temperature of about 43-45^{o}C (Ensures deep seated treatment) [6] and are simulated using Antenna magus version 3.3.0 [7]. The antennas for radiating and focusing high-power signals with low dispersion and high directivity are observed and various parameters are presented in this paper.

II. Antenna-Structural Design And Modelling

The geometry of Dipole fed corner reflector antenna consists of two flat reflecting sheets intersecting at an angle of 50.4°.Dipole, the main part of the antenna, is placed at a distance of (S) 16.3250mm from the vertex, and it involves in radiating the sub Nano second electric pulse [8], [9].

The dipole of the antenna connected to the arrangement generates SnEp. Antenna is designed for the length Lr and width Wr is shown in the Fig 1.a.

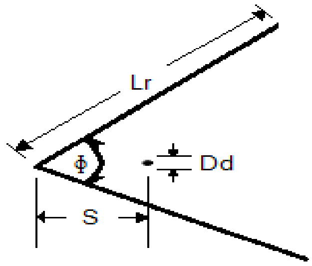

Figure 1. A: Top View of the Dipole fed corner Reflector antenna with its physical parameters are listed below:

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Length of the reflecting plate	Lr=148.7mm
Width between the plates	Wr=71.87mm
Length of the Dipole	Ld=15.17mm
Dipole diameter	Dd=326.3 µm
Vertex to dipole spacing	S=16.3250mm

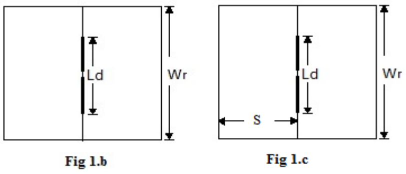

Figure 1. B. End view of the Dipole fed corner reflector antenna shows the length of the dipole.Fig 1.C. Side view of the dipole fed corner reflector antenna shows vertex to feed distance (S) with dipole length and width (Wr).

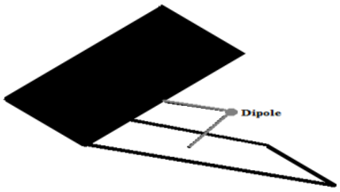

Figure 2. Schematic view of the dipole fed corner reflector antenna with its dipole.

The wave incident at the dipole is reflected by the reflecting surfaces spaced at an angle of (Φ) 50.4. The antenna is designed in such a manner to have high gain. Fig. 2. Shows the schematic design of the Dipole fed corner reflector antenna with the dipole placed at a distance of 'S' from the vertex (vertex to feed distance).

It was found that the antenna with small dipole have been given considerable attention in recent years, due to their nature of increases in their power of radiation.

III. Field Intensity of An Antenna

The field intensity of the dipole fed corner reflector antenna is the main criteria. This is because human tissues generally provide a lossy medium for the snEP wave with finite electric conductivity. The energy of these snEP waves increases the cell's temperature and thereby destroying the deep seated tumour [10]-[11].

The dipole fed corner reflected antenna has two solid reflector plates. These solid plates are spaced at an angle of 50.4^o (for n=3.5).We have designed an antenna with an input frequency of 9.188 GHz with a time period of T=0.108ns.This mean that dipole of the antenna is fed with sub nano second electric pulse (SnEP).

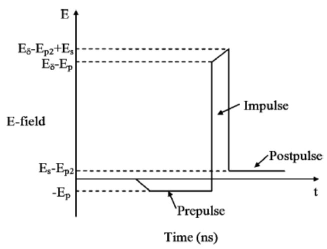

Figure 3. Schematic view of input step function. Shows various stages of the pulse

When the sub nano second electric pulse is incident at the human tissue produces an electric field comprises of three components: the pre pulse, the impulse and the post pulse (Fig 3) [4]. The pre pulse (Ep) is radiated directly from the transmission line and the impulse will get reflected from the reflector and only those impulse are focussed at the tissue that generates an electric field of

$$E\delta\ (\Phi) \approx 2.78 \times 10^{-3}\ k \tag{1}$$

The electric field Equation (1) is generated around the tissue makes the human tumour cells to get heat up, notably the antenna is kept at the Fraunhofer zone.

Fraunhofer zone of our design is between 14.09mm to 1.3m. Within this region radiation will be effective. The radiation intensity is quite less than X ray therapy [3].

IV. Cancer Back Ground and New Way of Treatment

A. Human Tissue

Human body comprises of group of cells (Tissue) Fig. 3.a.The old cells are being removed continuously from our body by proper biological actions (apoptosis) [11-13, 14]. If our body fails to perform that action it results in tumour cells Fig. 3.c. Human tissue exhibit electrical property due to proper chemical and biological reactions that happen in our body. The body tissue has plenty of electrons and those electrons are capable for conduction.

As already mentioned in Fig. 3.b cytoplasm equivalent has resistor in that with high resistances [14].

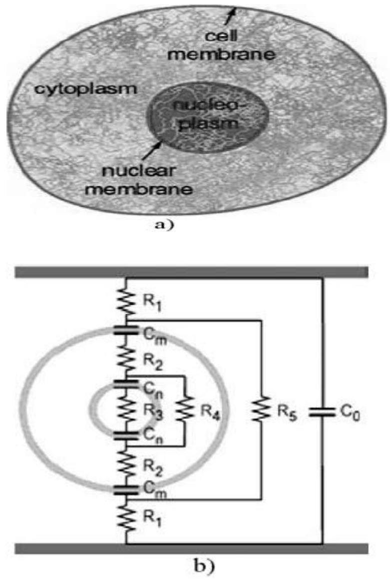

Figure 3. (a).Structure of a biological cell (as would be seen with a light microscope). (b)Double-shell model of a biological cell and superimposed equivalent circuit of the cell.

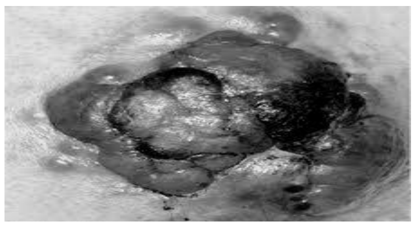

Figure 3. c. Skin tumour cell.

B. *Action of Sub Nano Second on the Tissue*

Pulsed electric fields of 10's kV amplitude delivered in nanoseconds or shorter timescale are an exciting new development in the biomedical field. snEPs have shown the potential to kill skin cancer cells.

A cell can be modelled as an electrical circuit as in Fig. 3.b. One can model the various cell membranes by their capacitances. The cytoplasm and organelles can be modelled by their resistances. The cytoplasm is conductive, whereas the membranes have low conductivity. Therefore, one can model the cell as a conductor surrounded by an ideally insulating envelope. Embedded proteins in the membrane serve as valves or channels for ions [11-13],[14].

Biological materials are generally lossy mediums for snEP waves with finite electric conductivity. When snEP waves propagate though the biological materials, the energy of snEP waves are absorbed by the materials. Cancer cells highly absorb SnEP due its less sensitivity [14].

Becomes heat and causes the temperature of materials to increase [3-6], [8]. Heating and temperature increase cause other mechanical and chemical changes to the biological materials. These actions of snEP on the tumour cells kill the affected cells non-invasively with the efficiency of 35.66% for efficiency factor of 0.3566.

V. Observation and Discussions

We have observed that our design is highly directive with directivity (D) of 46.5, this ensures in preventing host tissues from radiation. This also proves the non-invasive way of treatment. Observed values are listed in Table I.

TABLE I. Showing the Details of Observed Value.

S .No	Parameters	Observed values
1.	Frequency	9.188GHz
2.	Gain	16.60dB
3.	VSWR	2.579
4.	Spacing	16.3250mm
5.	Wavelength	32.65mm
6.	Efficiency	35.66%
7.	Beam solid angle	0.27Sr
8.	Fraunhofer zone	14.09mm-1.3m
9.	Directivity	46.5
10.	Effective aperture	1.408mm

From Table I inference made with high gain confirms operative treatment only on the affected region. Our design safe guards the rest part of the patient from radiation due to its high directivity.

VI. Simulation and Synthesis Results

Dipole fed corner reflector antenna is designed with input frequency of 9.188GHz. Reflectors (Solid plates) are spaced with the Relative angle of (Φ) 50.4° (for n=3.5) with the dipole is spaced from the vertex (Vertex to Feed distance 16.3250mm) and is simulated using Antenna magus 3.3.0 version [7] with the physical parameters as shown in Fig 4. a.

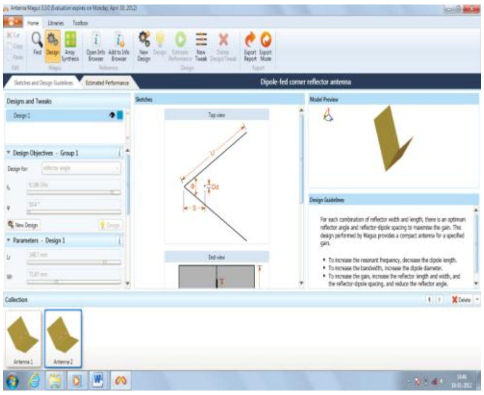

Figure 4. a. Simulation of Dipole fed corner reflector antenna with the input frequency of 9.188GHz using Antenna magus 3.3.0 version.

Our research of designing antenna to treat skin cancer non-invasively shows increase in gain with increases in frequency is shown in Fig 5.a.

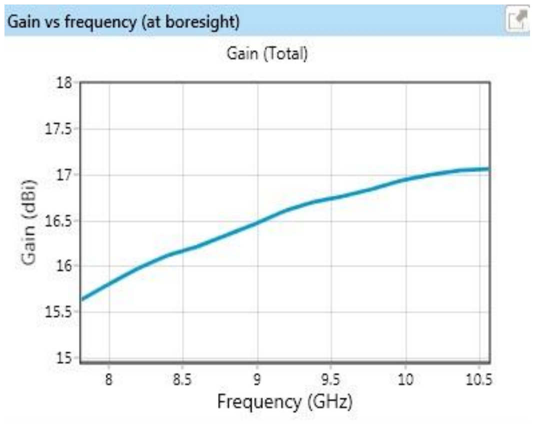

Figure 5. a. Gain Vs Frequency.

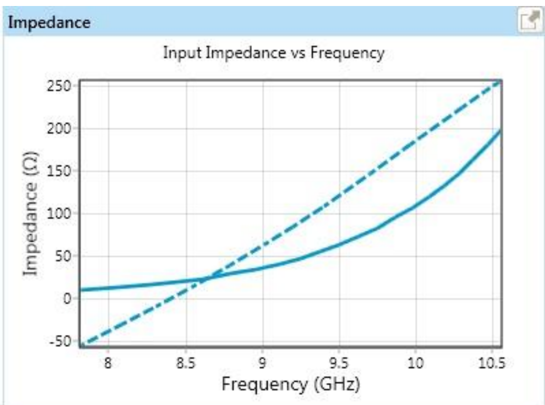

Figure 5. b. Variation of input impedance with Frequency.

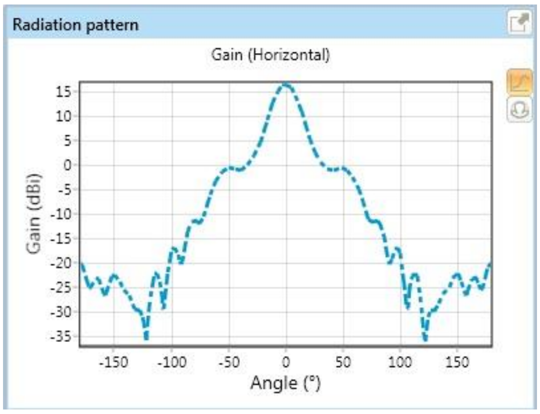

Figure 5. c. Gain Horizontal-cartesian.

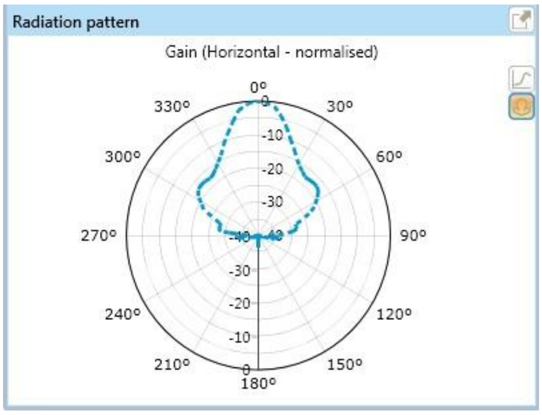

Figure 5. d. Gain in polar co-ordinates.

Our design has impedance of Z= (62.55+j89.14) Ω and radiation resistance (Rr) is 73Ω with reference impedance 50Ω.This high gain endorses operative treatment only on the affected region. Our design safe guards the rest part of the patient from radiation due to its high directivity.

VI. CONCLUSION

The most important intention of this paper is to design an antenna that could be used for treating skin cancer non-invasively. We have designed a Dipole fed corner reflector antenna with antenna spacing of 50.4o and feed to vertex distance of 16.3250mm.Our design uses SnEP that is focussed on the cancerous area.The antenna designed ensures directed focus with directivity of 46.5 and gain of 16.60dB. This design treats effectively than radiation therapy.

VII. FUTURE WORK

Our main part of future work involves in implementing this idea of treating skin cancer using dipole fed corner reflector antenna in real time which could be an alternative for radiation therapy and chemotherapy. We planned to design an antenna for mammography detection by using Prolate Spheroid reflector with ultra short sub nano second electric pulse and for skin cancer treatment with the same antenna (prolate).

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