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# A Study on Plasma Antenna

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***Absrtact*-- In the era of high speed communication and cognitive radio, Plasma antenna grown for its beam forming, to hide and fast switching properties. Using non thermal plasma sources in glass tubes, containing neutral gases, it is possible to design a Plasma Antenna. This paper shows the status of Plasma Antenna research, basic operation and its scope for the future.**

## I. INTRODUCTION

A column of ionized gas when use to radiated or receive electro-magnetic signal, then it is said to be a Plasma antenna. Plasma antennas are the future of antennas. This article reviews the current status of plasma antennas. Revelation of plasma as an antenna is done in 1917, by J. Hettinger suggested that long beam of ionized or ionizing medium can be used to radiate and to receive wireless signals [1]. Here in after referred to as the "ionized beam Ariel". In the 1960s, Askar'yan [2] proved this prediction by experiments. Kang W L, Rader M, and Alexe I in 1996, IEEE International Conference on Plasma Science, Boston demonstrated a construction of an antenna with a glass tube filled with low pressure gas [3]. Then after measurements of Efficiency and Radiation patterns of plasma column antenna had been developed by Gerard G. Borg and Jeffrey H. Harris in 1999 [4].

Characteristics of the plasma antenna largely depend on the behavior of an electromagnetic wave propagating in plasma. In the 21st century there are so many experiments had done for its characterization. In between 1999 to 2002 T.R.Anderson, Igor Alexeff, J. H. Harris, G. G. Borg and some other eminent scientist patented some of the plasma antenna. Now Plasma Antenna is capable of both the transmission and reception.

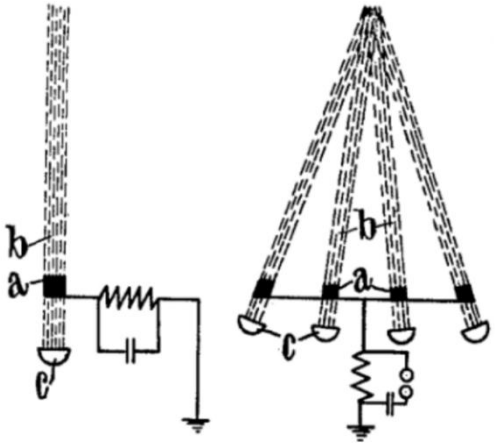


**Figure 1: Picture of proposed ionized beam Aerial[1]**

There some important research had been done throughout the past decade.The length of the plasma column increases as the square root of the applied power [5]. So by increasing power it is possible to control its effective length as well as antenna resonant frequency. Different from copper antenna, the characteristics of a plasma antenna vary simultaneously with plasma frequency and collision frequency and this property can be used to construct dynamically reconfigurable antenna [6]. Array Plasma Antenna, length and number of elements can be controlled by the operating parameters such as input power, working pressure [7]. Innovative range of selectable Multi-Beam antenna, Smart Plasma Antenna, Stacked Plasma Antenna Arrays and High directivity Antenna are in row of development. They will meet exact demands in today's wireless communication sector, defence and security markets.

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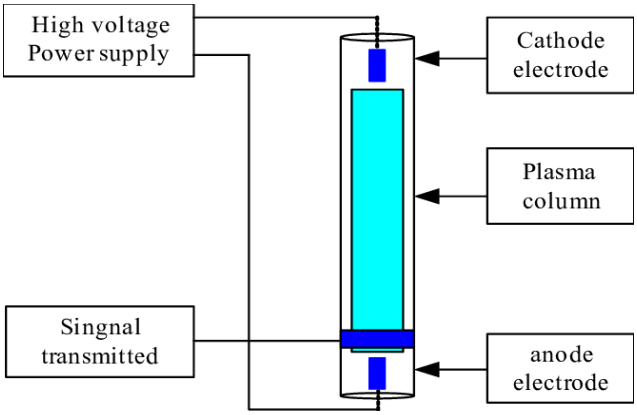
## II. Basic Operation

Procedure to operate Plasma antenna is first fill the neutral gas (e.g. Argon) in the vacant glass tube. At some fix pressure sealed the tube; a care for the pressure should be taken sufficiently less than glass breakdown pressure. Connect a non thermal plasma generation power source example RF and Microwave discharge. At lower frequencies, the ions accelerated in the field move towards the electrodes and produce secondary electrons, similar to what happens in a dc discharge. As the frequency increases, the ions and subsequently also the electrons can no longer reach the electrode surface during the acceleration phase of the exciting external field [8]. Connect a signal source or the receiver probe with coupling sleeves over the glass tube of plasma antenna, it is better to use a good conductor as a coupling sleeves. Take care of the distance between coupling sleeves and power source arrangement. By controlling applied power vary the effective length of plasma column, and thus get the desired result.

By changing the operating parameters, as working pressure, source frequency, input power, radius of glass tube, length of plasma column, and neutral gas, effective length and efficiency of plasma antenna should be change




Experiments has also carried out on Fluorescent tube as a Plasma Antenna and shown the simplest model of plasma antenna. Using this model it has shown that Frequency above 200Hz are enough to get stable plasma state in Plasma column, and to use it as a Plasma Antenna.

## III. Applications

- *Mobile Communication:* Fast switching of working frequency is the need of mobile communication. In plasma antenna fast switching antenna power is possible, and results in change in effective length and frequency at very high speed.
- *Defence:* Plasma elements can be energized and de-energized in microseconds. When de-energized, the Plasma antenna behaves as a dielectric tube, which has a small radar scattering cross section. So it will be difficult to detect by hostile radar.
- *Satellite Communication:* Satellites are equipped with Phased array antenna, and it requires fast beam focusing and steering. The plasma antenna can steer very fast using power control.
- *Protection from EMP:* Plasma Antenna having lower plasma frequency is transparent for higher frequencies. In the electronic-warfare, dangerous signal can pass through the antenna without interfering its transmission and reception. So this antenna is safe in electronic warfare.
- *Mechanical Robustness:* If the plasma antennas are composed of flexible fiber tubes and if the fiber tubes will more heat resistive for plasma heat than it can be used as a portable antenna.

## IV. Conclusion

Using non thermal plasma source and neutral gas filled tube, it is possible to make an agile antenna. Plasma antenna can do better in star exploration where weight of the product has to lift up from the earth's surface should be under limit.

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