Plasma Antenna Technology

Presented by

Sandeep S

INTRODUCTION

- Plasma is the fourth state of matter
- Plasmas are conductive assemblies of charged and neutral particles and fields that exhibit collective effect
- Plasmas carry electrical currents and magnetic fields
- Plasma is an efficient conducting element with a number of important advantages.

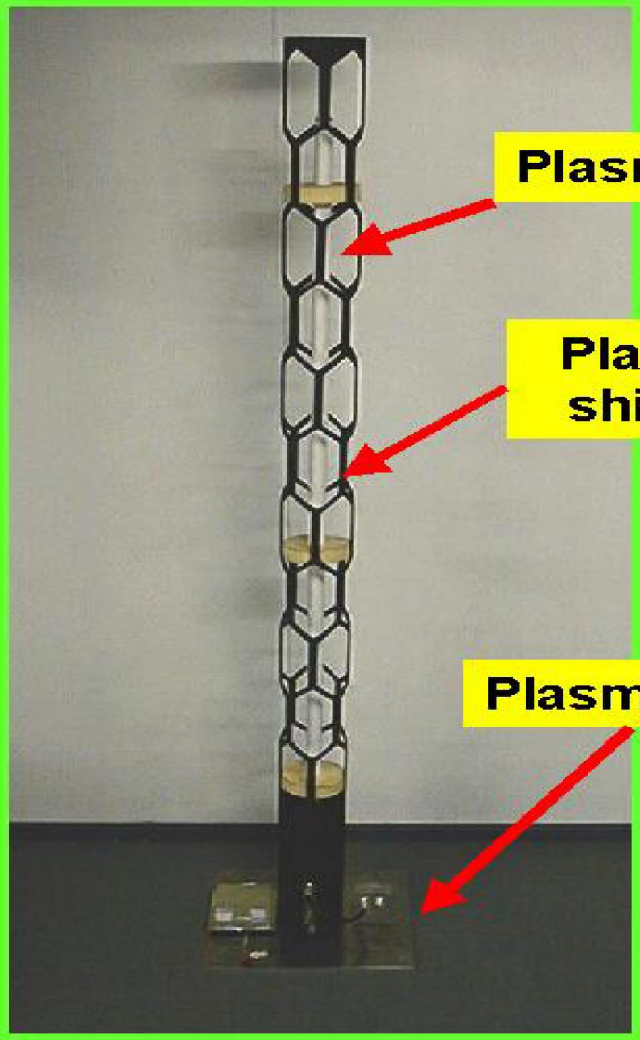
EVOLUTION

- Plasma Antenna Research Laboratory at ANU investigated the feasibility of plasma antennas as low radar cross-section radiating elements
- ASI Technology Corporation has developed prototype antennas that use ionized gas instead of metal to transmit and receive signals
- This antenna prototype proved very useful in digital communications and radar applications

TECHNOLOGY

- Plasma Antennas employ gases in plasma state enclosed in tubes as conducting element
- Gases electrically ionized to plasma allows RF signals to be transmitted and received
- Inert gases or mercury vapour is used as gas
- The tube can be of glass or ceramic in composition

BASIC STRUCTURE



ANTENNA TYPES

PUMPING

- The gas inside the antenna is turned into plasma by applying a "pump signal" of high power RF energy

- The RF energy is applied to the plasma tube using a device called a "launcher" or a "coupler"

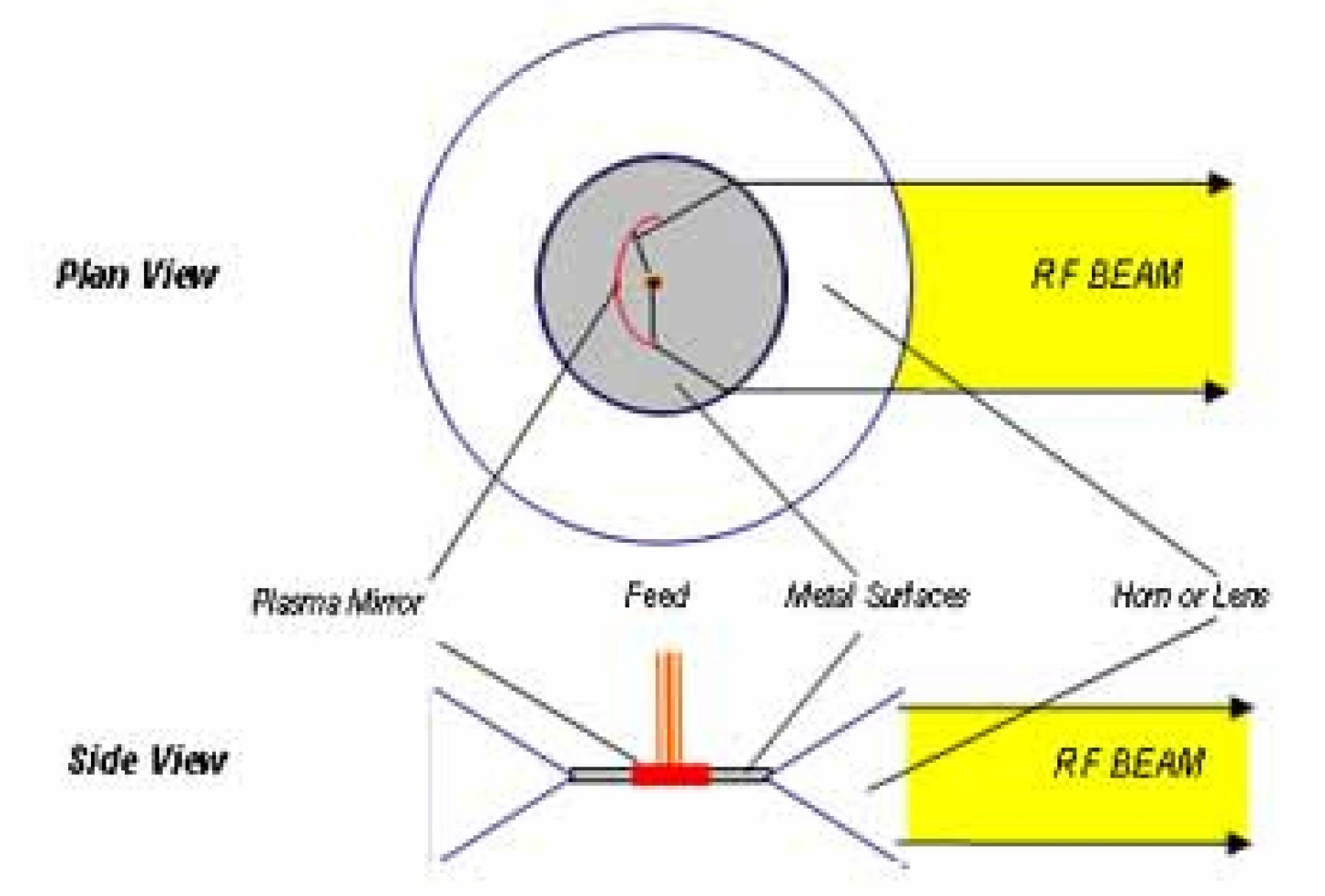
LAUNCHER

- Launcher is a metallic collar that is wrapped around the plasma tube.
- In conjunction with a ground plane, this provides the high electric field required to initiate and maintain a plasma within the tube.
- It uses RF power levels of around 100 W at 500 MHz for the antennas as the pump signal.

HOW IT WORKS?

- A plasma antenna generates localized concentrations of plasma to form a plasma mirror.
- This deflects an RF beam launched from a central feed located at the focus of the mirror.

PLASMA MIRROR FORMATION



WHY PLASMA ANTENNA?

- Ionized gases are much more efficient than solid conductors
- When energized it will transmit and receive RF signals
- When de-ionized gases has got infinite resistance for RF signals
- Thus its a new antenna solution that minimizes antenna dectectability by radar

PREDICTED PERFORMANCE

- ✓ 36 Beam Positions
- ✓ Side lobes < -23 dB
- ✓ Gain = 12.9 dB
- ✓ Beam width ~ 12 degrees
- ✓ Switching Speed ~ 2 μ seconds
- ✓ Efficiency ~50%

FEATURES

- Plasma antenna can ***appear and disappear*** in a few millionths of a second leaving behind the gas – filled column that has little effect on the electromagnetic fields
- Since the gas is ionized only for the time of transmission or reception, ***"ringing"*** and associated effects of solid wire antenna design are eliminated
- No antenna ringing provides an improved ***signal to noise ratio*** and reduces multipath signal distortion.
- Reduced radar cross section provides ***stealth*** due to the non-metallic elements.

FEATURES...

- Changes in the ion density can result in instantaneous changes in ***bandwidth*** over wide dynamic ranges.
- A circular scan can be performed electronically with ***no moving parts*** at a higher speed than traditional mechanical antenna structures.
- A single dynamic antenna structure can use ***time multiplexing*** so that many RF subsystems can share one antenna resource reducing the number and size of antenna structures.

ADVANTAGES

- ***Higher power :*** This is due to lower ohmic losses.This can enhance target discrimination and track ballistic missiles
- ***Heat Resistance:*** Due to the fact that plasma do not melt
- ***Enhanced bandwidth:*** Controlled variation of plasma density suggests greater band width
- ***EMI:*** Since plasma antenna ceases to exist when not energized

ADVANTAGES...

- ***Higher efficiency and gain:*** 20% improvement in efficiency due to low ohmic losses

- ***Lower noise :***This is because plasma antennas have lower collision rate among its charge carriers than a metal antenna

- ***Perfect reflector:*** When the plasma density is high the plasma becomes a loss-less perfect reflector. Hence there exist the possibilities of a wide range of lightweight plasma reflector antennas.

MARKET APPLICATIONS

- Shipboard/submarine antenna replacements.
- Unmanned air vehicle sensor antennas.
- IFF land-based vehicle antennas.
- Stealth aircraft antenna replacements.
- Detection and tracking of ballistic missiles
- Side and back lobe reduction
- Cellular radiation protection

CONCLUSION

Researches has been going on to investigate the possibility of using plasmas like those generated in fluorescent ceiling lights, for antennas. Plasma antenna technology offers the possibility of building completely novel antenna arrays, as well as radiation pattern control and lobe steering mechanisms that have not been possible before. The research has produced many novel antennas using standard fluorescent tubes and these have been characterized and compare favorably with their metal equivalents. Current research is working towards a robust plasma antenna for field demonstration to Defense Force personnel.

REFERENCES

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THANK YOU