In The Name of Allah

Iran University of Science and Technology

SURFACE WAVE DRIVEN PLA MA MONOPOLE ANTENNA P ARAMETERS

Fatemeh Sadeghi-Kia

F .Hodjat-Kashani

J .Rashed-Mohassel

S.J .Ghayoomeh-Bozorgi

Iran University of Science and Technology

Index

- INTRODUCTION
- THE EXPERIMENTAL PLASMA ANTENNA SETUP
- PLASMA DENSITY
- NUMERICAL SIMULATION RESULTS
- EFFECTS OF RADIUS OF PLASMA TUBE
- CONCLUSION

Applications of plasma antenna

- suitable for wireless communication systems
- reconfigurable antennas
- time and space selective shielding
- frequency selective shielding
- smart antennas

Experimental Setup

Tube → Length = 700 mm
Radius = 12.5 mm

Excitation → Power : 120 W
Frequency : 300 MHz

Plasma → Argon
Pressure : 0.4 mb

0.9813GHz<fp< 11.846 GHz

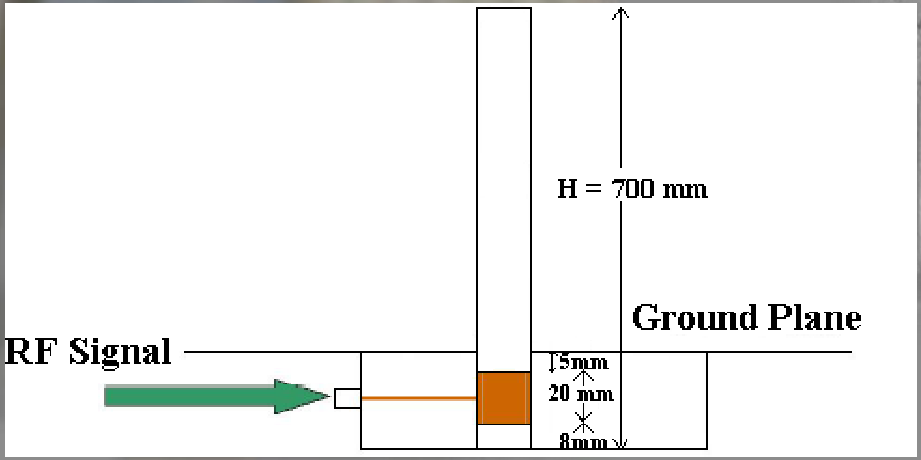


Figure 1

Plasma Density

- AXIAL PLASMA DENSITY

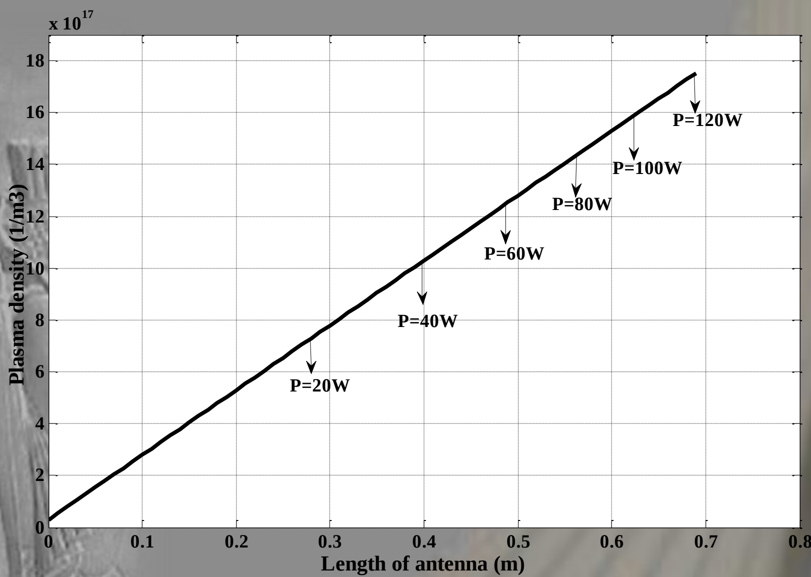


Figure 2

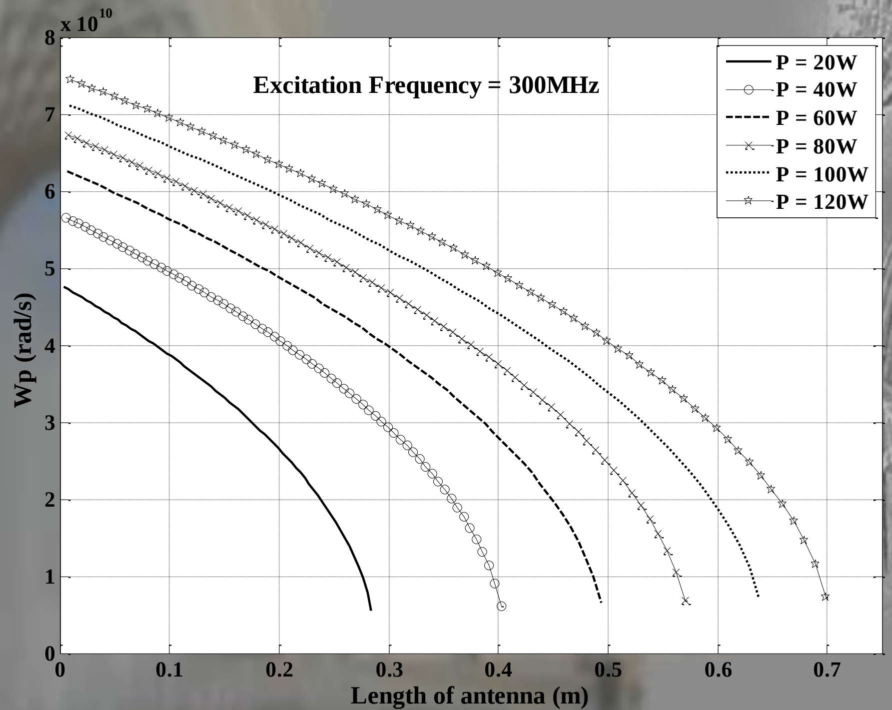


Figure 3

Plasma Density

- $\frac{dn}{dz}$ is nearly constant in the tube.
- Variation of power and pressure can control the length of the plasma monopole antenna.

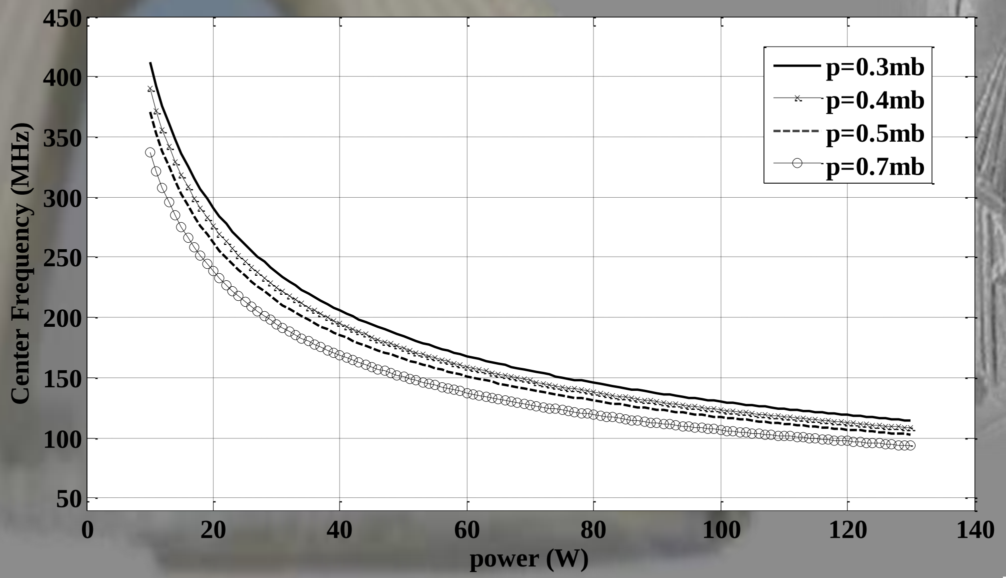


Figure 4

Plasma Density

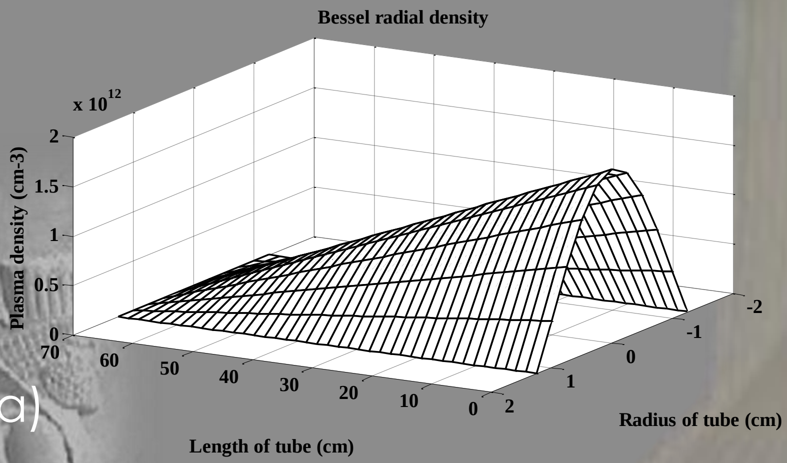
- **Radial plasma density**
  - As βa becomes larger, the wave field concentrates radially at the plasma-tube interface.
  - At or close to the wall, the electron density is lower than the cross sectional avarage density.

Plasma Density

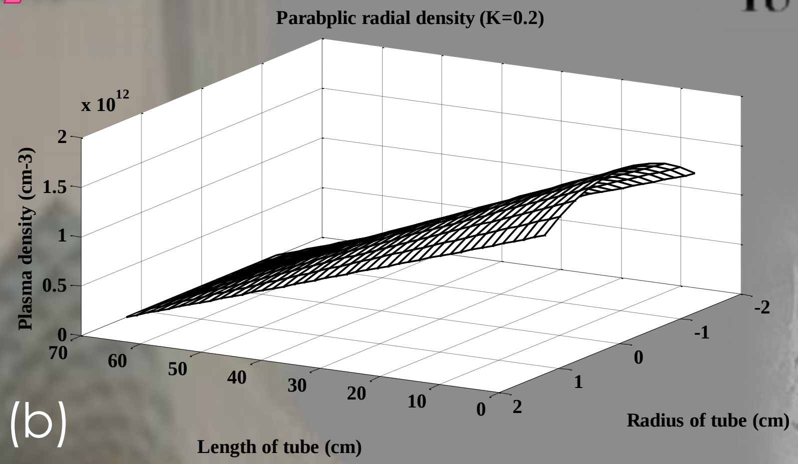
- Approximation of radial electron density
  - $\frac{n(r)}{n(0)} = J_0(2.4\frac{r}{a})$ a: radius of the tube
- $\frac{n(r)}{n(0)} = [1 - K\left(\frac{r}{a}\right)^2]$ **K: the rate of parabolic decrease**

  0 < k < 1
- $\frac{n(r)}{n(0)} = \cos(\frac{r}{a})$

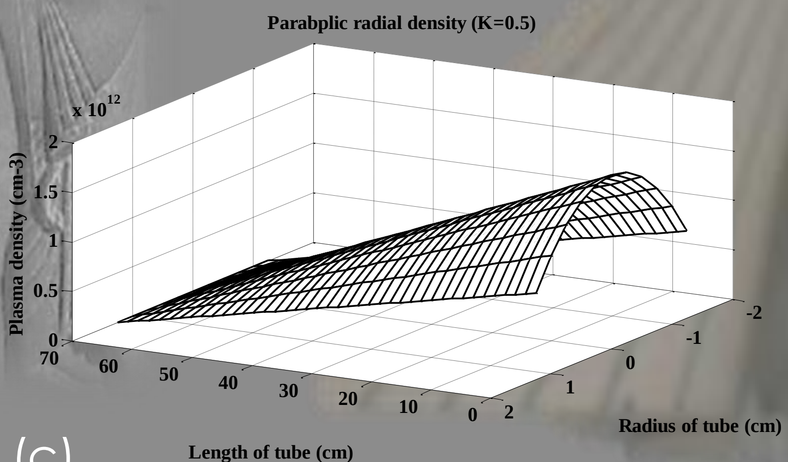
Plasma Density



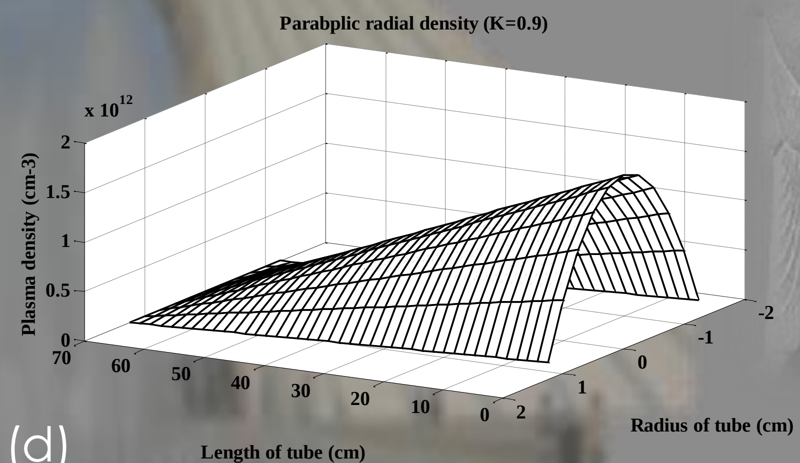
(a)



(b)

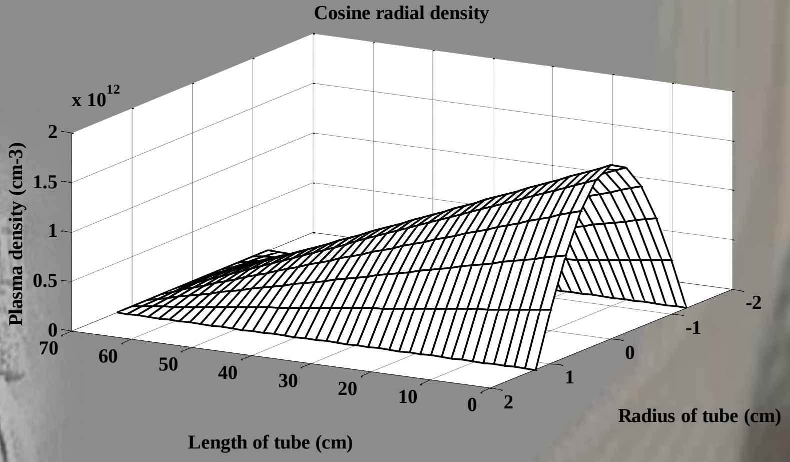


(c)



(d)

Plasma Density



(e)

Figure 5

- It is observed that the parabolic varia tion of radial density with K=0.9 and c osine and Bessel functions are nearly the same.

Numerical simulation results

- Input impedance

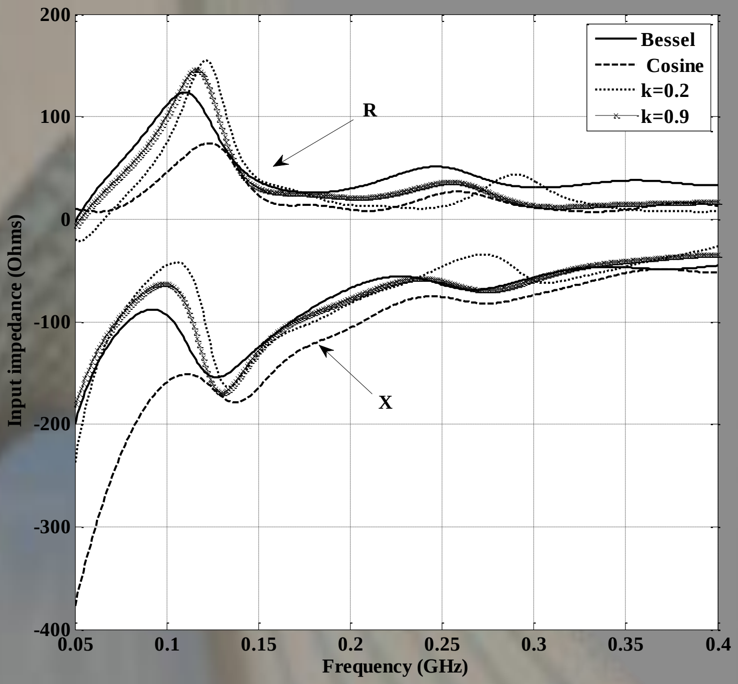


Figure 7

- E plane radiation pattern

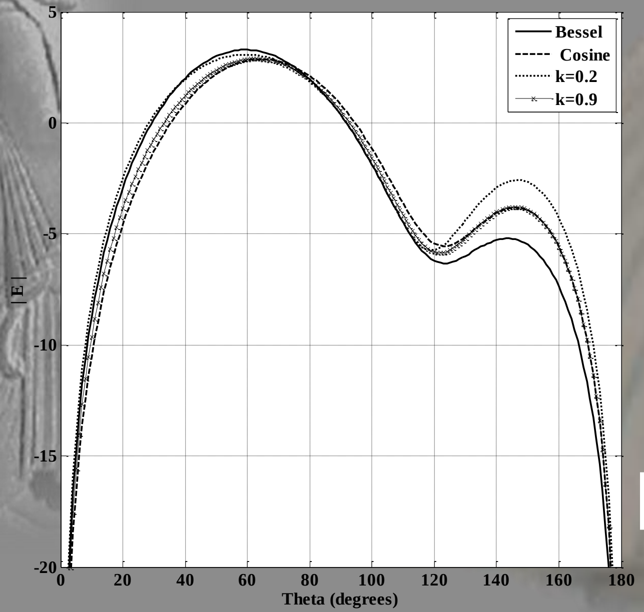


Figure 6

Reconfigurable antenna

- Variation of excitation changes the s pecifications of the antenna

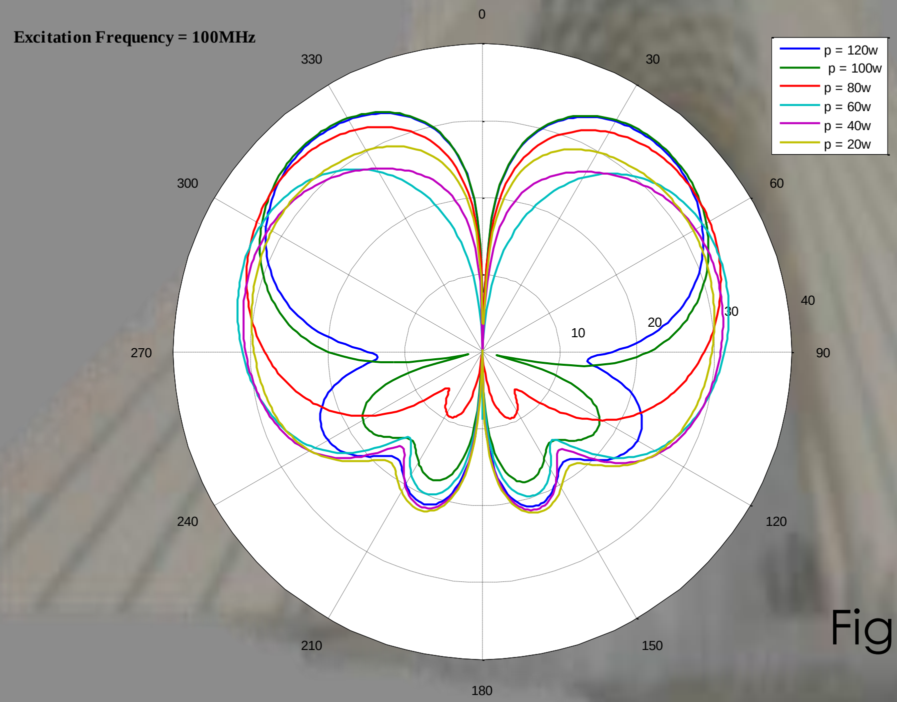


Figure 8

Reconfigurable antenna

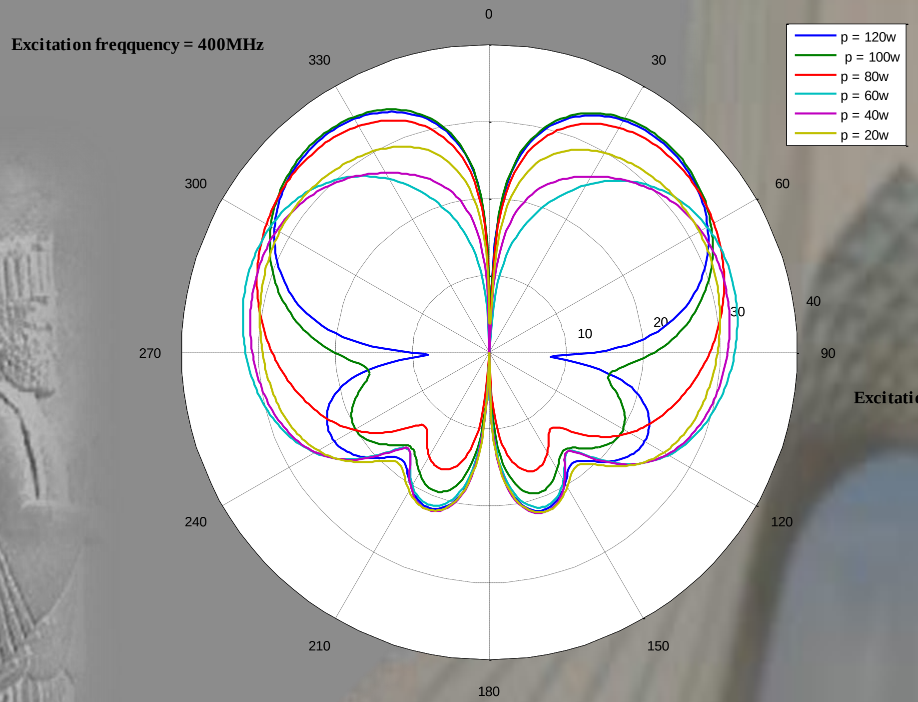
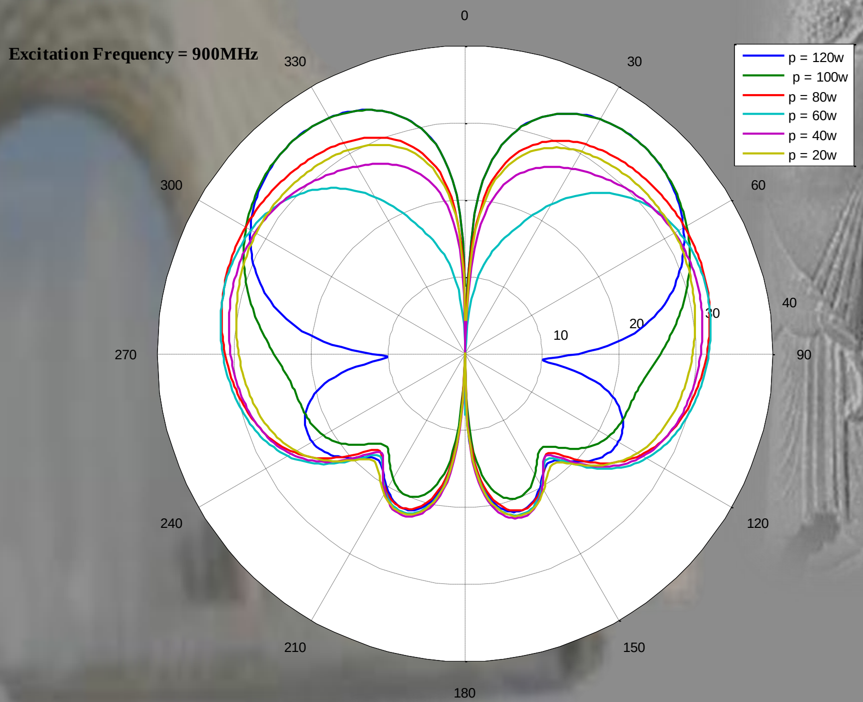


Figure 9

Figure 10



Gain in plasma antenna

- Gain of plasma monopole antenna is about 3 or 4 dB lower than the conventional antenna.
- At the center frequency gain is similar to conventional antennas.

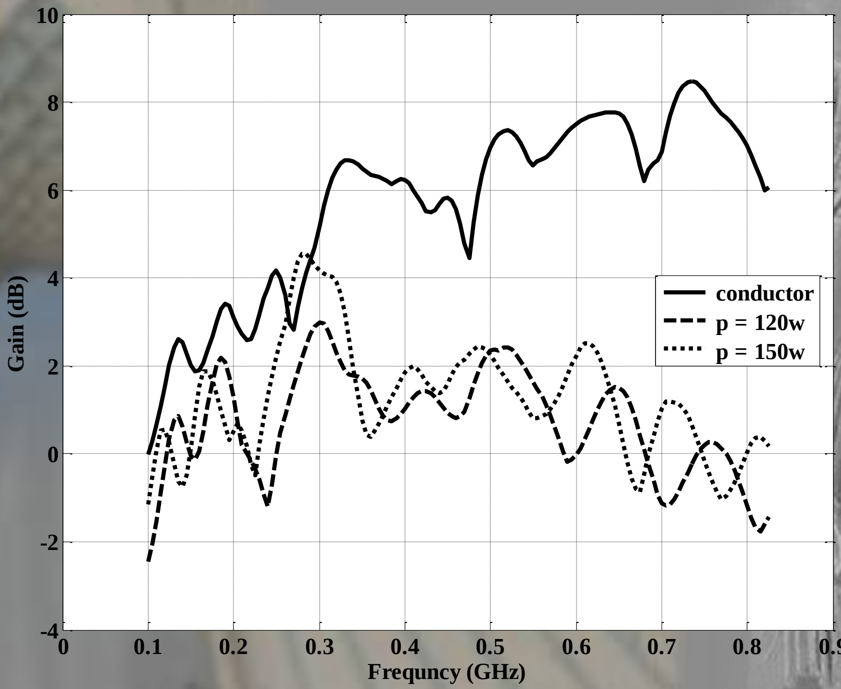


Figure 11

Radar cross section in plasma a enna

Excitation frequency = 300 MHz
Observation frequency = 800 MHz

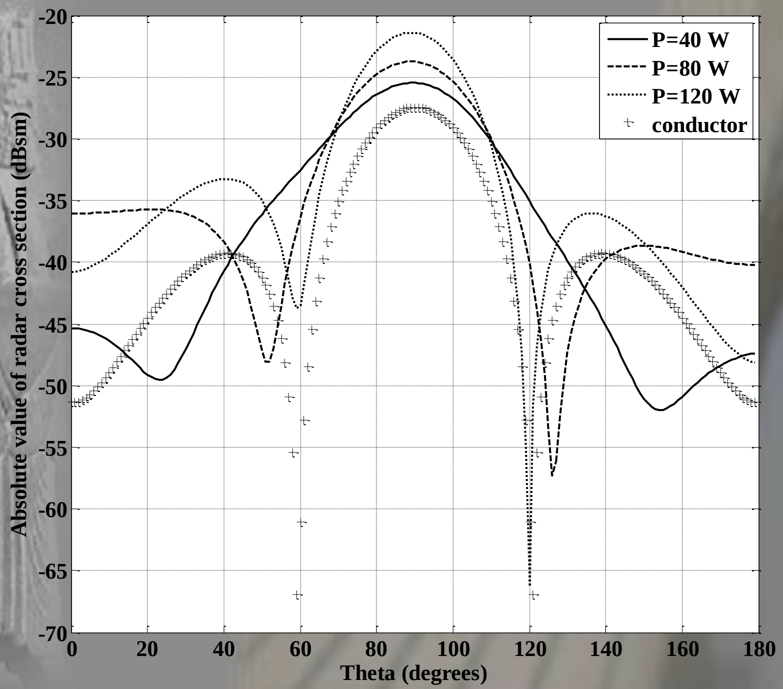


Figure 12

Excitation frequency = 300 MHz
Observation frequency = 300 MHz

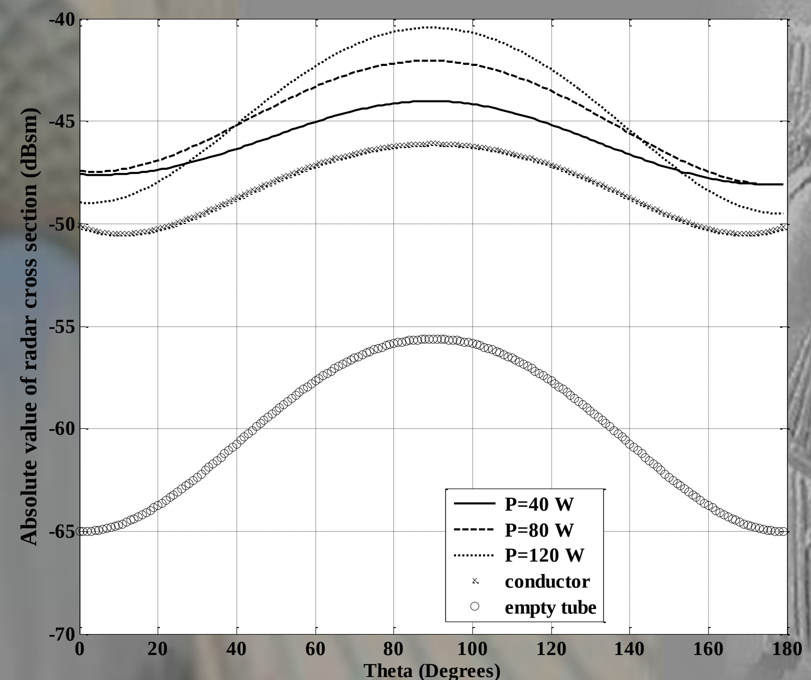


Figure 13

Radar cross section in plasma a enna

Excitation power = 120 w
Observation frequency = 800 MHz

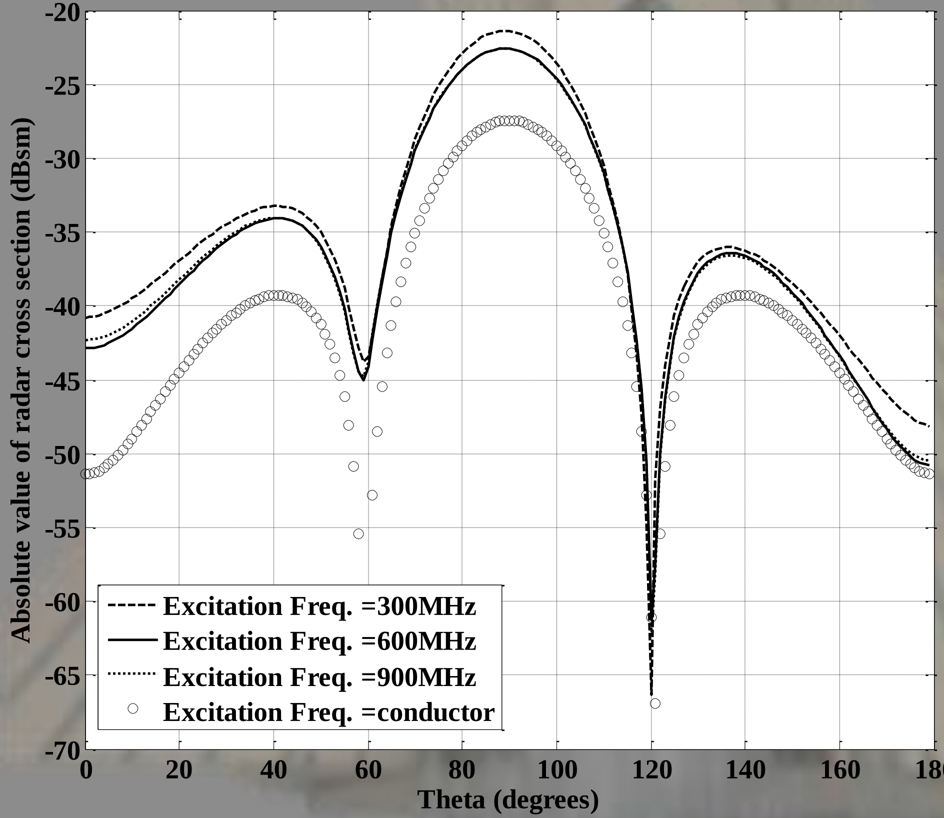


Figure 14

Effects of radius of plasma tube

- Mode selection in a SW plasma column relies essentially on the values of radius of the tube and also the excitation frequency.
- Radius of the tube sets the minimum and maximum gas pressures of SW discharges.
- The minimum pressure is defined as the pressure below which the discharge goes off and the maximum pressure is the pressure above which the discharge is no longer stable and reproducible .The larger a, the lower the maximum p values

Effects of radius of plasma t be

- Although in the conventional monopole antenna, increasing the tube radius increases the resonant impedance bandwidth, we considered the effects of increasing radius on the bandwidth of resonant impedance in plasma antennas .It is clearly observed that decreasing the value of $\frac{H}{a}$ from 66 to 34, increases the impedance bandwidth.

Effects of radius of plasma t be

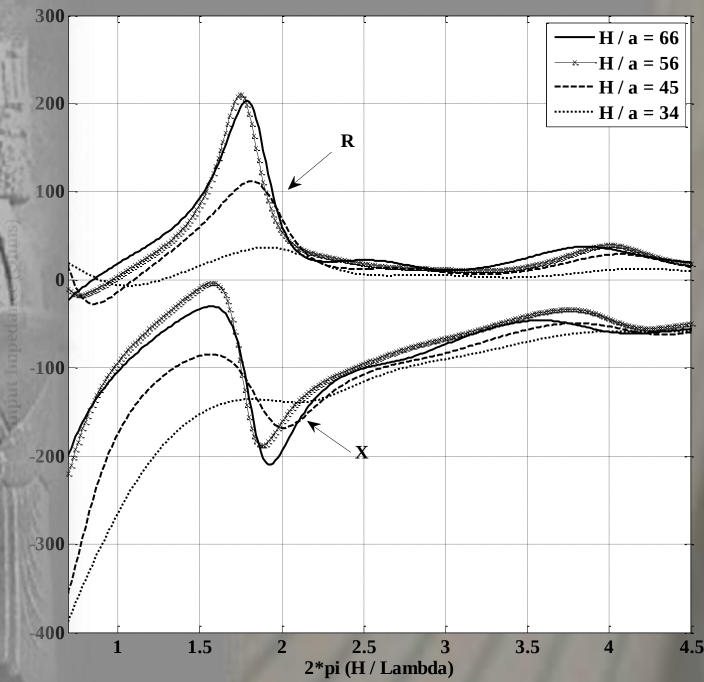


Figure 15

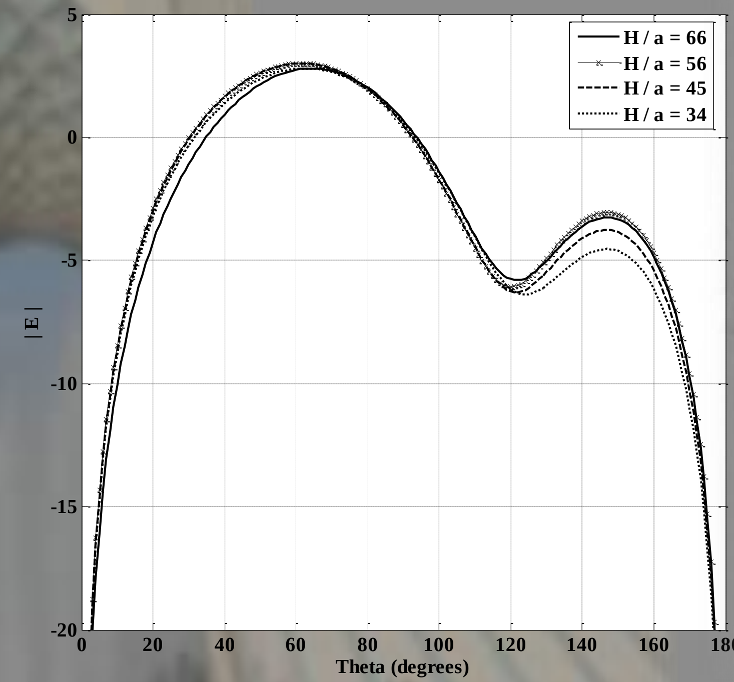


Figure 16

conclusion

- considering plasma radial density variation with different functions, will change antenna parameters.
- in higher pressures, analyzing plasma antenna parameters using both radial and axial variation is unavoidable.
- The most conventional function for radial plasma density is Bessel function, which is closer in parameters to the parabolic function with K=0.9.

conclusion

- Gain and radar cross section of plasma antenna is reasonable with respect to conventional metallic antenna.
- plasma tube radius has an important effect on impedance bandwidth of plasma antenna .Increasing the radius, increases the impedance bandwidth.

Thank you for your time and attention