Impacts from Non-resonant Conductive Objects on RX Directional Antennas

Chavdar Levkov, lz1aq@abv.bg, www.lz1aq.signacor.com

Rev.1.0, January 2017

Radiation patterns of 2-element receiving phased arrays are presented on the following pictures. Small loops and small dipoles arrays are modeled with MMANA program [2]. The arrays are with vertical polarization placed at low height above the ground. All models are above real ground setup with (Eps=13, Sigma= 5 mS/m). The impact of non-resonance closely spaced conductive objects on the patterns are shown. The pictures are self explaining.

1. Dipole Array

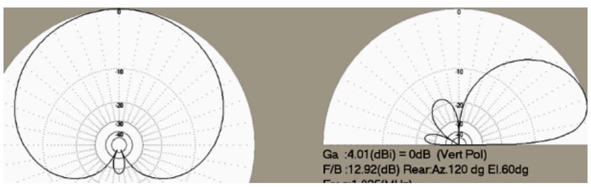


Fig.1 *Radiation pattern of dipole array at free place.*

In the model, the distance D (Y axis) between dipoles and the fence is variable and the corresponding patterns are shown. The distance D is denoted at the left side of each picture. Preliminary tests with single wires shorter than WL/2 (wavelength/2) showed that their impact on the array radiation pattern is negligible. The next tests were with more massive conductive object - a non-resonant fence with height 1.5m and 27.5 m length.

1.1 **Fence 1**

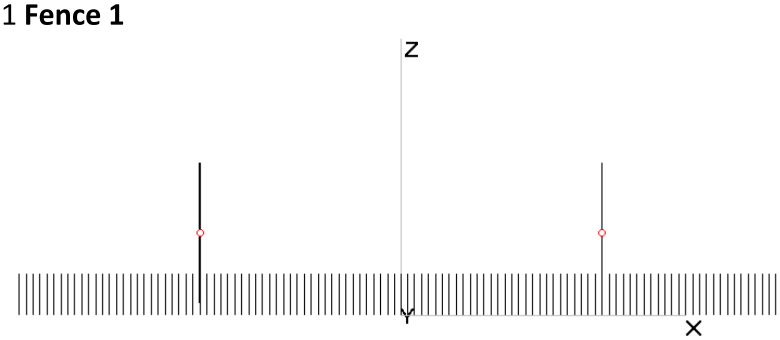


Fig.2 *The Fence 1 model is made from separate metal rods with 2mm diameter, not connected electrically with height= 1.5 m. They are placed 0.1m above MMANA ground level 0.The length of the fence =27.5m. Small red circles are sources.*

0.1m

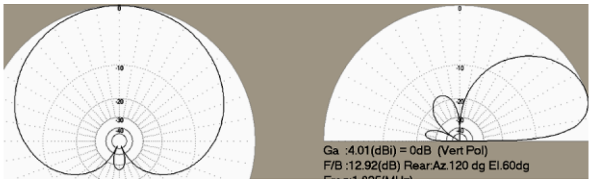


Fig.3 *Dipole array, Fence1. There is no impact at D= 0.1m and at any distance, no matter if each rod is grounded or floating.*

1.2 **Fence 2**

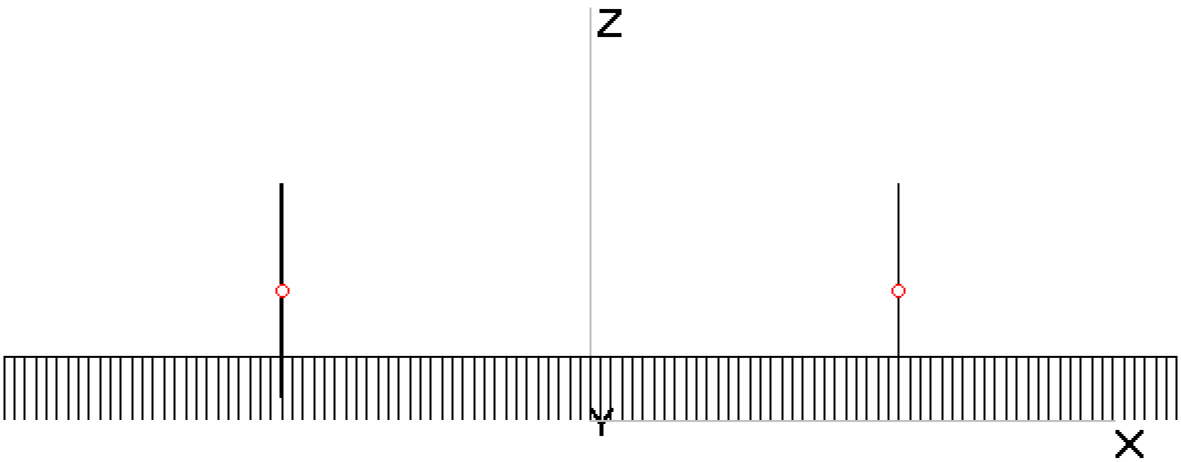


Fig.4 *Fence 2 model is the same as Fence 1 but with horizontal conductor which connects electrically all rods together at higher end.*

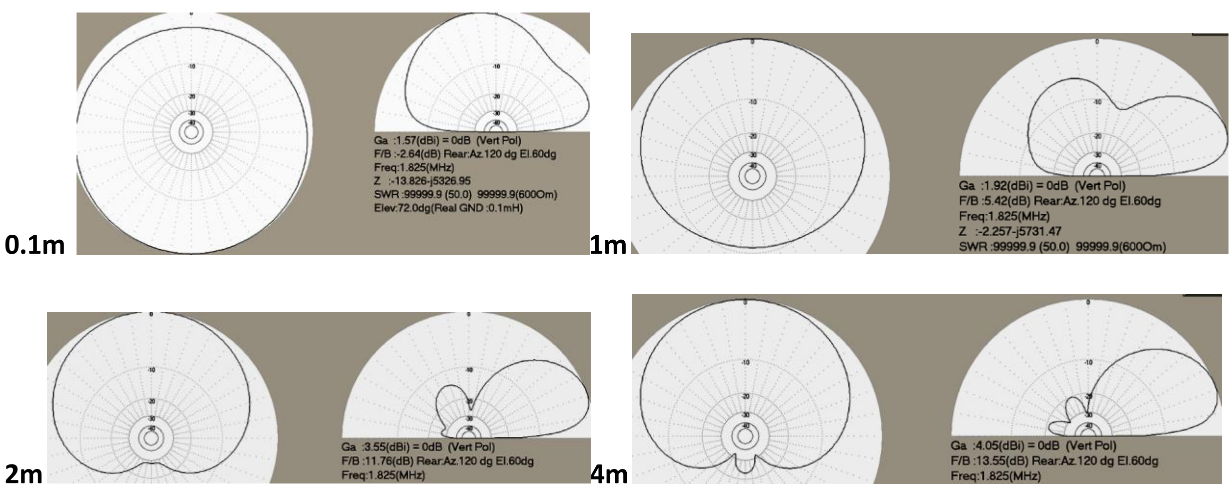


Fig.5 *Dipole array, Fence2. These pictures are for not- grounded case; When each rod of the fence is grounded (MMANA level 0 m) there is no impact even at 0.1m distance.*

1.3 **Fence 3**

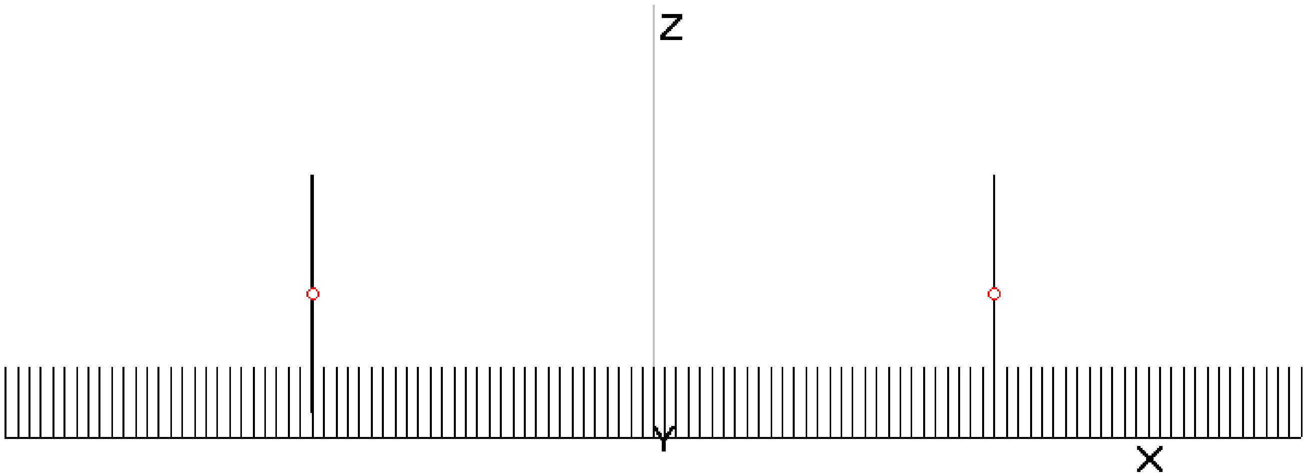
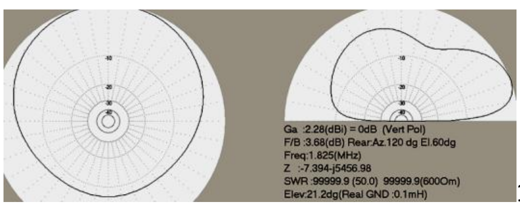
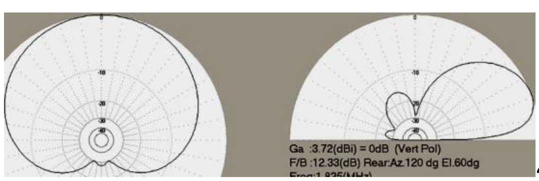


Fig.6 *Fence 3 model is the same as Fence 1 but with horizontal conductor which connects electrically all rods together at lower end. At the both sides of the lower horizontal conductor there are two short wires with 0.1m length which can connect the fence electrically to MMANA ground level.*

0.1m


1m


2m


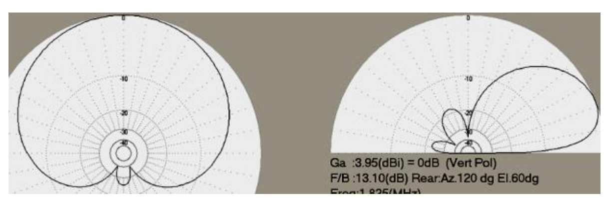
4m


Fig.7 *Dipole array, Fence 3. These pictures are for not- grounded case; When each rod of the fence is grounded (ideal ground at MMANA level 0 m) there is no impact even at 0.1m distance.*

1.4 **Fence 4**

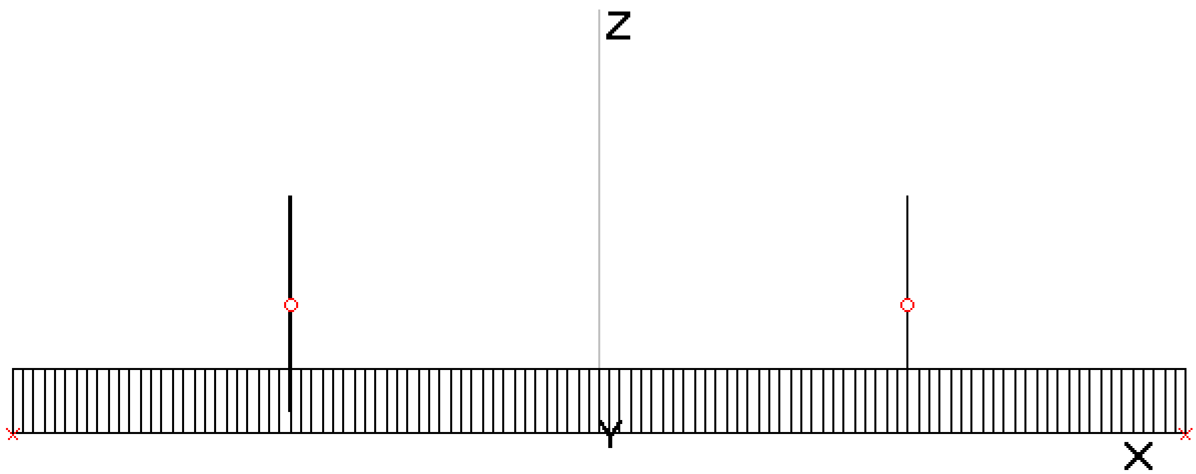


Fig.8 *The Fence 4 model is the same as Fence 1 but with 2 horizontal conductors which connect electrically all rods together at lower and higher ends. At the both sides of the lower horizontal conductor there are two short wires with 0.1m length which can connect the fence electrically to MMANA ground level (denoted with small red x).*

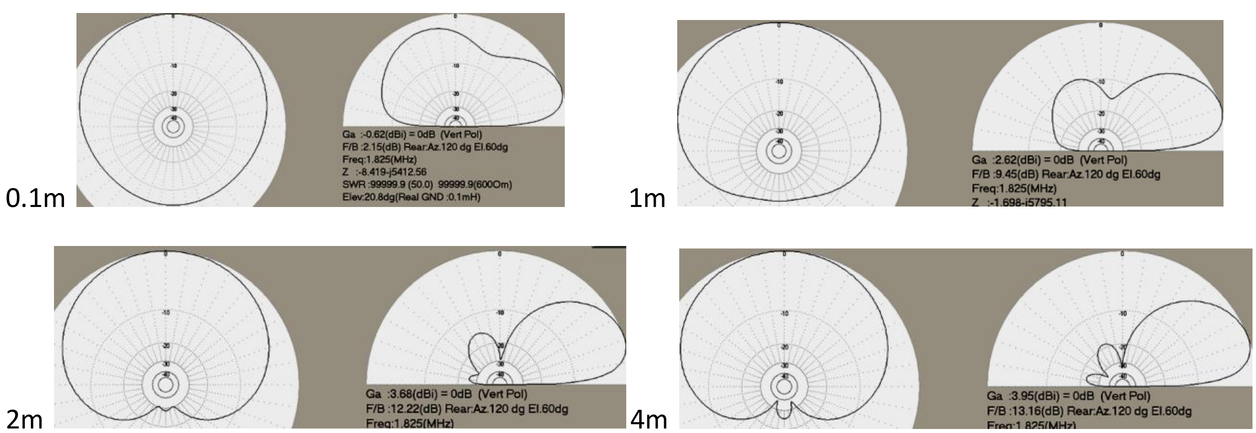
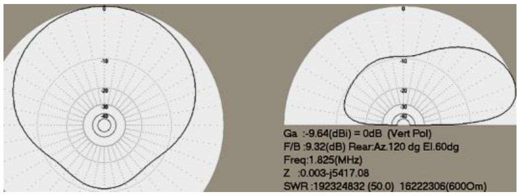


Fig.9 *Dipole array. Fence 4. These pictures are for non- grounded case; When each lower end of the fence is grounded (MMANA level 0 m) there is no impact even at 0.1m distance.*

0.1m



1 m

2m

Fig.10 *Dipole array, Fence 4. Left and right lower edges of the fence are connected to ground (MMANA level 0 m) with short wire and 100 ohms resistor.*

The dipole array was tested also at 5.36 MHz which half wavelength (WL) is 27.5 m in order to observe some resonance effects of the fence. No harmful impacts were found.

2. Loop Array

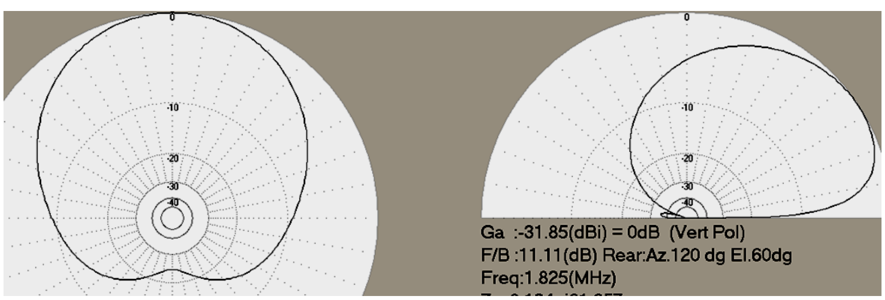


Fig.11 *Loop Array Pattern in free place*

Loop elements are quads with 1 m side with 14 mm diameter of the conductor. The centers of the loops are 2.5 m above the ground level. The distance D between elements is 14.5m. The frequency is 1.825 MHz with delay set to optimal *[1].* The distance D (in Y axis) between loops and the fence is changed and the corresponding patterns are shown. The conducting object model is a fence with height 1.5m and 27 m length - the same as for dipoles case. Only the results from model with Fence 4 are presented since it has the heaviest impact on the RX array.

2.1 **Fence 4**

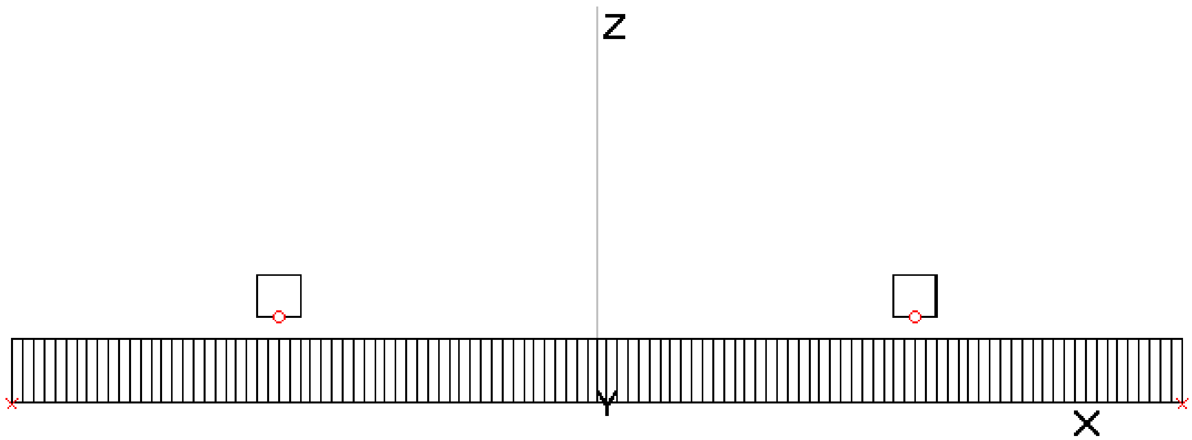


Fig.12 *Loop array**.** Fence 4 with two loops.*

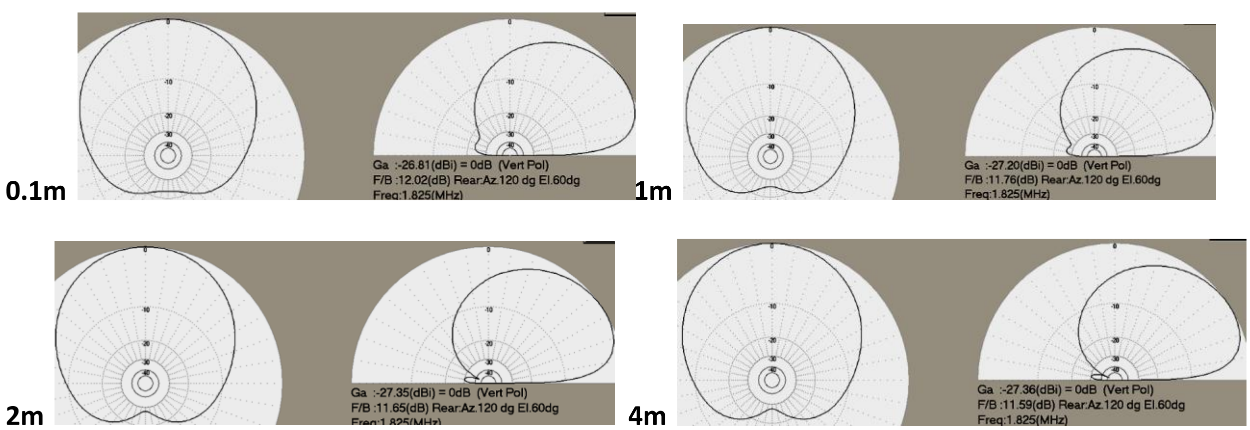


Fig.13 *Loop array, Fence 4. Not- grounded case*

1m

Fig.14 *Loop array, Fence 4 . Left and right lower edges of the fence are connected to ground (MMANA level 0 m) with short wire and through 100 ohms resistors.*

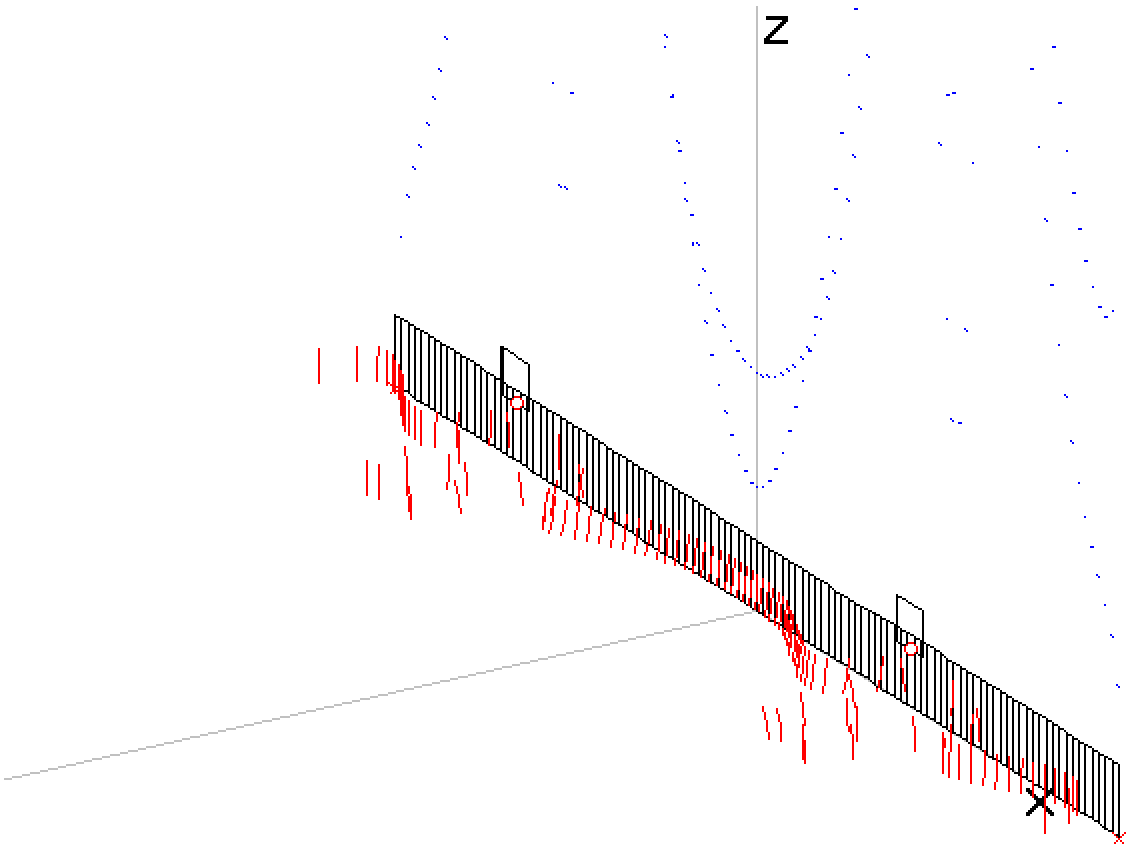


Fig.15 *Loop array. Example of a current distribution in the Fence 4 induced by the loops at 1 m distance. Red currents are from vertical wires and blue – from horizontal wires. The currents in the loops are much higher and are not visible.*

3. Conclusions

- Separate wires shorter than WL/2 do not have impact on the radiation pattern even if they are very close (centimeters) to the array elements.
- Longer (>WL/2) random wires will not impact the radiation pattern if their natural resonance is far away from the receiving frequency but usually we do not have this information. So we must be suspicious to any long wire around the array. [3].
- Massive non-resonant conducting objects have impact on the patterns. The dipole array is relatively more sensitive and must be away at least 4 – 5 m from such objects . The loop array can be placed much closer - 1 m away is usually sufficient.
- The model shows that if the object is grounded the impact to dipole array is reduced significantly but we should be very careful since this is only a model with many restrictions. In real world there is no ideal ground and usually the objects can not be grounded with low resistance. For the loop antennas it does not matter much whether the object is grounded or not.

- We can use short active dipoles and small active loops on the same mast – practically there is no influence between them even if the distance between their conductors is several cm.
- More massive non-resonant objects such as metal roof of a house or big mast surely influence the radiation pattern . Stay away from them if possible. Otherwise make a model .
- These models cannot predict accurately what the real world will serve. But some useful conclusions can be drawn. Probably these conclusions are valid and can be applied to other RX antennas as beverages, Flags, K9AY etc.

4. Links

[1] http://www.lz1aq.signacor.com/docs/phased-array/2-ele_phased_array11.pdf

[2] MMANA http://hamsoft.ca/pages/mmana-gal.php

[3] Impact of Resonant TX antennas on the Radiation Pattern of RX Directional Antennas. In www.lz1aq.signacor.com