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DESIGN OF THE ELECTRIC ANTENNA FOR THE DETECTION OF THE CORONAL MASS EJECTIONS FROM THE SUN

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ABSTRACT

The Electric antenna is designed to significantly advance the understanding of the three- dimensional (3-D) structure and evolution of coronal Mass Ejections (CMEs) and their interaction with the interplanetary medium and terrestrial. The Electric Antenna is subjected on spacecraft to measure the evolution of coronal Mass Ejections (CMEs). Interplanetary radio bursts are generated from electron beams at interplanetary shocks and solar flares and are observed from the sun to 1 AU, corresponding to frequencies of approximately 200 MHz to 10 KHz. This phenomenon is measured by using three monopole antennas which are placed orthogonal to each other and mounted on spacecraft. The design of antenna is essentially a continuation of research, using a newer version of the CADFEKO software.

KEYWORDS: Sun, Coronal Mass Ejection, S-parameter, CADFEKO Software

INTRODUCTION

A coronal Mass Ejections (CMEs) is a Massive burst of solar wind and magnetic fields rising above the solar corona being released into space, in which large amount of superheated particles are emitted at nearly the speed of light 4]. Coronal Mass Ejections are often associated with other forms of solar activity, most notably solar flares, but a causal relationship has not been established. Most Ejections originate from active regions on the Sun's surface, such as groupings of sunspots associated with frequent flares. Near solar maxima, the Sun produces about three CMEs every day, whereas near solar minima, there is about one CME every five days.

A coronal Mass Ejections (CMEs) goes through the heliospheres are called interplanetary coronal Mass Ejections and are known to drive strong interplanetary (IP) shocks as they propagate through the heliosphere and often contain magnetic flux ropes (or "Magnetic clouds") carrying plasma thought to be remnants of solar filaments and loops[1].

The Coronal Mass Ejections (CMEs) radiates radio bursts in different type. The Coronal mass ejections propagate in type II burst and observed from high low frequencies [5].

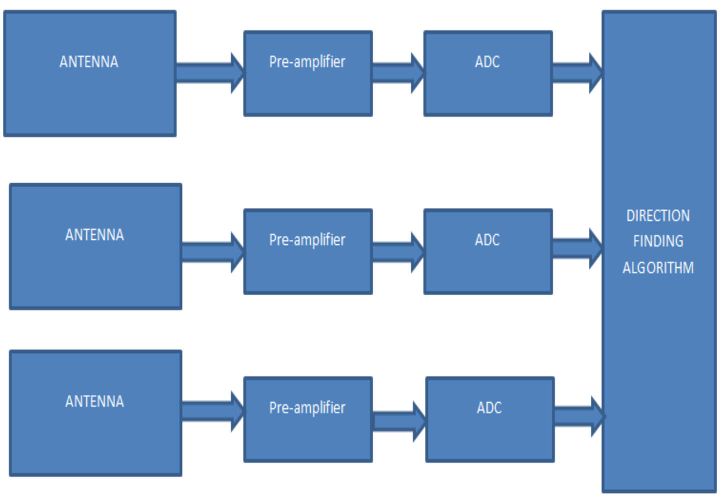

Figure 1: Generalized Block Diagram of the Antenna System

First block is of "Antenna Design" in which three monopole orthogonal antennas subjected on spacecraft and having some elevation with respect to the spacecraft. For designing of antenna in project, the main thing is frequency which is to be considered for height of the antenna

Second block is of "Pre Amplifier", the primary function of a preamplifier is to extract the signal from the detector without significantly degrading the intrinsic signal-to-noise ratio. A preamplifier (preamp) is an electronic amplifier that prepares a small electrical signal (The CMEs signal which antenna capturing in space) for further amplification or processing

Third block is of ADC, an analog-to-digital converter (abbreviated ADC, A/D or A to D) is a device that converts a continuous physical quantity (usually voltage) to a digital number that represents the quantity's amplitude. The signal coming from the Pre Amplifier is analog signal it requires to convert into digital for the further procedure (Measurement, Evolution of the CMEs) therefore after Pre Amplifier block ADC block is used.

Fourth block is of "Direction finding Algorithm" for the measurement of the signal coming from the different antennas which are mounted on the spacecraft

DESIGN METHODOLOGY

There are many way to design of antenna for the measurement of the Coronal Mass Ejections from the sun. The designed Antennas are installed onto the spacecraft and the detected CME is further carried out for the detection finding algorithm for measurement of the Coronal Mass Ejections. Softwares which are using for the design of antenna should be powerful for the accurate measurement of the frequencies related with Coronal mass ejections. Cad feko software is used for the designing of the antenna. CAD-FEKO Software is newer version in softwares and can do more operations than other softwares do. The length of antenna for the measurement of the coronal mass ejections is to be selected as per the related frequencies. The designing is carried out for the measurement of the corresponding frequencies of 200MHz to 10 KHz. The approximately wavelength for the Antenna less than 15 m is to be considered. For our design the length of antenna is to be considered as approximately 6 m. So that related frequency is to be detected which comes into the frequency of the coronal mass ejections. The antennas are kept close to each other and the spacing between each antenna is also most important. The following parameters for the antenna are to be considered.

Table 1: Co-Ordinate Systems for the Antennas

Antenna Elements	Co-Ordinates of the Antenna in the Spacecraft (Starting Points)		
	X-Coordinate	Y-Coordinate	Z-Co-Ordinate
A Antenna	0.0E+0.0	(-d/2)	0
B Antenna	0	d/2	0
C Antenna	-1	0	0

Table 2: Co-Ordinate Systems for the Antennas

Antenna Elements	Co-Ordinates of the Antenna in the Spacecraft (End Points)			Antenna Length
	X- Co-Ordinate	Y- Co-Ordinate	Z-Co-Ordinate	
A Antenna	0.0E+0.0	(-d/2)	0	5.88
B Antenna	0	d/2	0	5.88
C Antenna	-1	0	0	5.88

As the antennas are 5.88 m in length and placed in different co-ordinates as shown into the tables 1 and 2 so that they can be placed as orthogonal to each other and distance between the antennas are to be also considered for the Getting S11 parameter as good as possible and less than -10dB. So that the antenna can detect the coronal mass ejections at particular frequencies. The spacing between two antennas is kept as d, is equal to 2.59m.

The Radius of antenna is selected as per required bandwidth the Antenna radius is kept 0.32m so that we can get good bandwidth around the required frequencies. There is some tradeoff between the radius of the antenna and the bandwidth. Antenna Input impedance is taken as 50 Ohms and the voltage source is connected for the excitation of the Antenna. Antennas are approximately orthogonal to each other but Angle between to antenna is changed for the keeping VSWR good and S11 parameter less than -10dB. Meshing of the antenna is also important for the designing of the antenna.

The antenna port is connected between two antennas for the measurement of the S11 parameter and getting S11 parameter between two antennas, small line wire is connected. The two antennas will be worked as dipole and third antenna will be reflector and the different radiation patterns are observed.

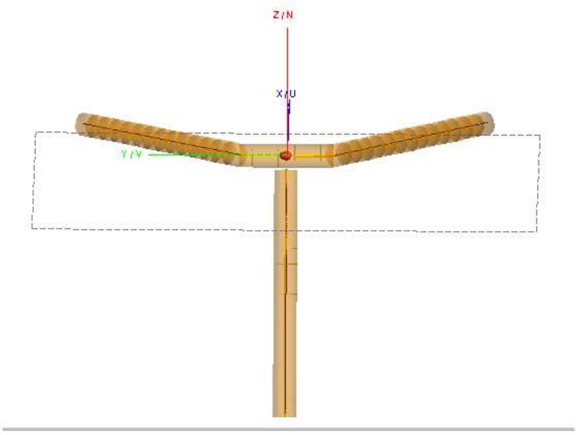

Figure 2: Three Antennas for Detection of the Coronal Mass Ejections

Three antennas are connected and placed as shown into the figure 2. By using CAD-FEKO software. Some variables are already defined into the software which are necessary for the designing of the antennas such as epsilon, light frequency and mu0. for the calculation of the impendence.

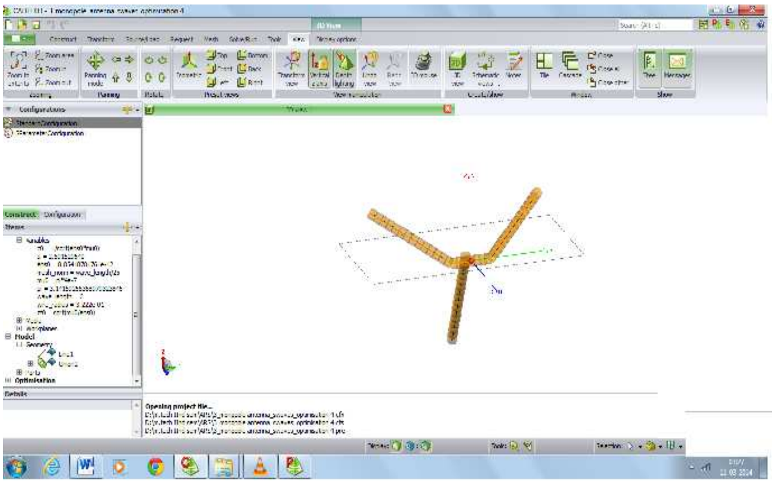

Figure 3: Antenna Design Using CAD-FEKO Software

The use of CAD-FEKO software is shown into figure 3. The figure 3 is the GUI of the CAD-FEKO software. Co-ordinates can be set into the software and desired parameters can be changed as per the requirement.

RESULTS

The S11 parameter for different frequencies are shown into figure (4) the S11 parameter for the 9.5 MHz is -20 dB so it is good for detecting the coronal mass ejections and the coronal mass ejection is available at 9.5 MHz frequency. But the bandwidth is near about 3 MHz at the same frequency. There are also some good S11 parameter at the 30.5 MHz and 50.5MHz. The S11 parameter at the 30.5 MHz frequency is -9dB and the S11 parameter at the 50.5 MHz frequency is at -7.5dB. At the given bandwidth The S11 parameter showing

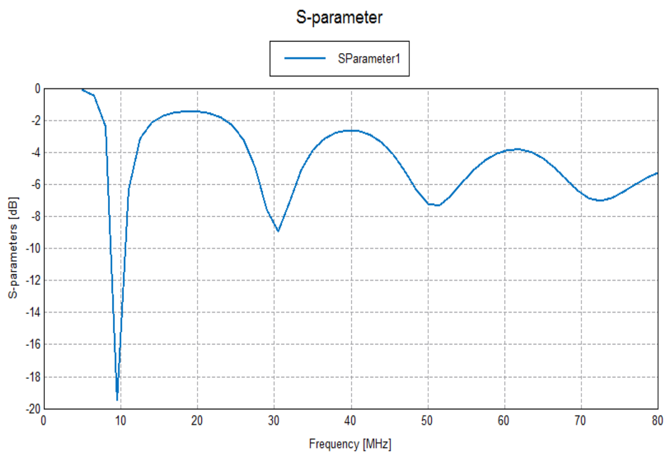

Figure 4: S-Parameter for the Designed Antenna

Result less than -2 dB But the S11 Parameter less than -10 dB give Good radiation pattern than other S11 parameter. From the figure 4. It indicates that as Frequency increases from low MHz to high MHz S11 parameter decreases, but the bandwidth increases. The Gain for different frequencies are also plotted in figure 5 Gain for the maximum bandwidth is approximately 1.5 which is good for the antenna. Gain at the frequencies of 9.5 MHz, 30.5 MHz and are 1.5 and 2.3. Initially for Designed Antennas the gain is increased for the frequency range of 5 MHz to 30.5 MHz from 1.5 to 2.3 and then it goes down to the 1.5 at the frequency range of 38 MHz and then it goes below 1.5 MHz at the frequency of 60MHz it becomes 0 but after the same frequency it again goes up.

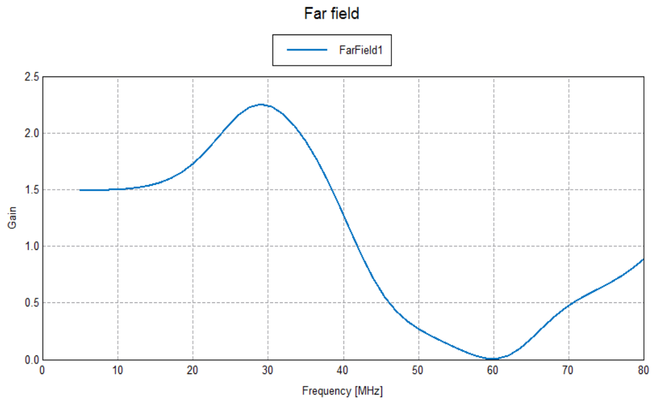

Figure 5: Gain Parameter for the Designed Antenna

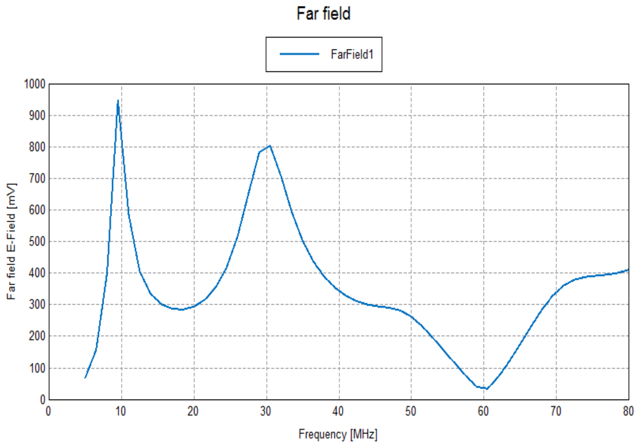

Figure 6: E-field Parameter for the Designed Antenna

The E-field for the designed antenna is shown into the figure 6. The highest is at the frequency of 9.5 MHz it is 950mv. and the second highest is given at the frequency of 30.5MHz it is of 800mv.Intially E-field is increase from 100 mv to 900 mv and at the frequency of the 9.5 MHz it gives highest frequency. From the same frequency E-field is decreased rapidly to the 300 mv at the frequency of the 20 MHz and again it is increased up to 800 mv at the frequency of the 30 MHz Different radiation patterns for the designed antenna are shown into the figure 7-8-9.Figure 7 shows the radiation pattern for the 9.5 MHz; actually at the 9.5 MHz Frequency the radiation pattern is same as that of dipole The effect of third antenna is not considered and effect of the third monopole is negligible. The radiation pattern at the different field is different and it is showing far field radiation pattern.

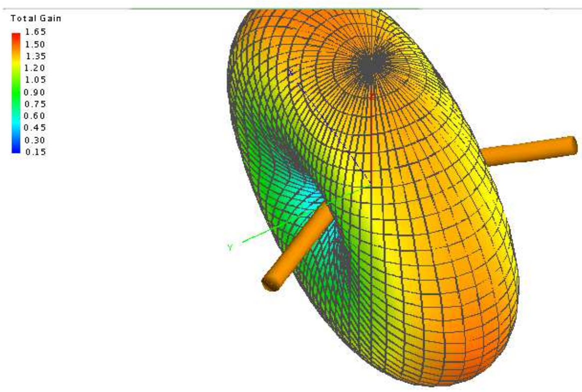

Figure 7: Radiation Pattern for the 9.5.MHz Frequency

Figure 8 is showing radiation pattern at the frequency of the 30.5 MHz. The radiation pattern at this frequency is just like butterfly and giving some back lobe. But its having good radiation pattern at the front side. The Effect of third antenna is shown onto radiation pattern.

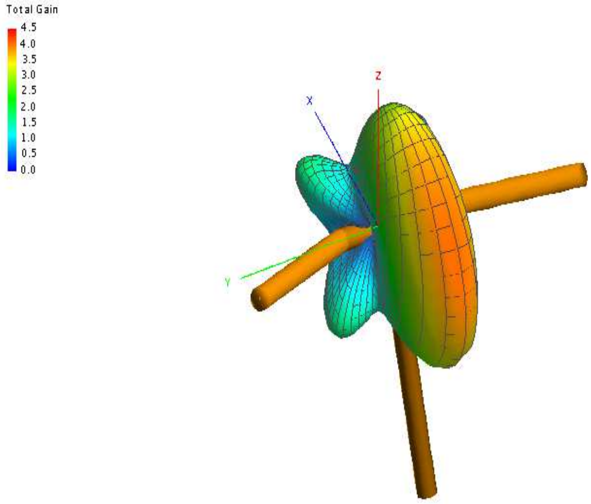

Figure 8: Radiation Pattern for the 30.5.MHz Frequency

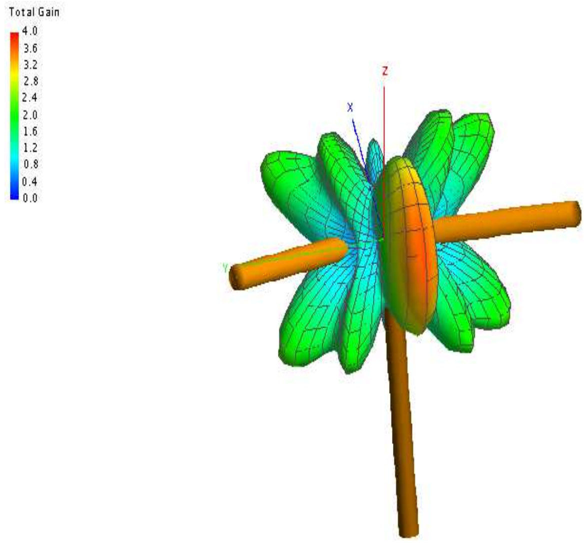

Figure 9: Radiation Pattern for the 50.0MHz Frequency

Figure 9 is the radiation pattern for the 50 MHz frequency. The radiation pattern for 50 MHz contains more number of the Side lobes. Third antenna works as the reflector.

CONCLUSIONS

In Antenna design, the designer's first goal is to achieve the S11 parameter as less as possible between the 200MHz to 10 MHz frequency and it is achieved in burst II radio frequency. some of the frequencies are giving S11 parameter less than -6dB. As we achieve S11 parameter as less as possible we have to sacrifice the bandwidth As we increase the frequency from low MHz to High MHz then Radiation pattern of the antenna giving more number of side lobes. The gain of the antenna is also giving good value for the radiation of the antenna. The orientation and the length of antenna both are very important and plays very important role for detection of the coronal mass ejections from the sun.

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