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Observation of the Radio Frequency Interference (RFI) at the National Space Centre, Malaysia

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ABSTRACT

Important results of the Radio Frequencies Interference (RFI) at the National Space Centre, Sg Lang Selangor, Malaysia has been reported. In order to make sure that the data of solar monitoring in radio region is reliable, we need to study the variation of interference and the possible sources that contribute to this interference. This data has been taken from 1-2000 MHz at the main site of installation e-CALLISTO system. The study is one of a main part of an initiative of e-CALLISTO networking research in order to identify the main RFI sources and to monitor continuously the behavior of the RFI at the site. Our main objective is to qualify the potential of monitoring a continuous radio emission of the Sun. This work is also an initiative of the International Space Weather Initiative (ISWI) project where Malaysia is one of the countries that joined the e-CALLISTO network. Due to our results this site showed the positive impact for the solar monitoring purpose. It is hoped that the survey will continue from time to time in a consistent mode so that any polluted signal for radio astronomy purpose can be protected. Overall, we can still get a good solar burst data, especially at 40-400 MHz. Perhaps, we can contribute the good data for solar burst monitoring towards the maximum cycle beginning the end of this year 2013.

***Keywords*:** Sun; low frequency; Radio Frequency Interference (RFI); solar radio astronomy; RFI sources; e-CALLISTO

1. INTRODUCTION

Monitoring the Radio Frequency Interference (RFI) are now being the most active research for radio astronomical purpose in Malaysia. The preliminary analysis of RFI at candidate sites for the solar monitoring purpose has started since 2010 [1]. Radio frequency interference (RFI) is a growing problem for all radio astronomy applications, but is especially problematic in the search for extraterrestrial intelligence (SETI). In order to start any radio

astronomical observation, it is important to initially identify and then analyze carefully all the possible RFI in the targeted windows [2].

In principle, the radio astronomy telescopes are very sensitive instruments of the radio-frequency background levels as they use the most sensitive radio-wave receivers in the world. The main reason why this study is important is Radio frequency interference (RFI) is now the growing problem that affected radio astronomy. RFI can occur progressively in several different ways and time scales. In order to make sure that the data of solar monitoring in radio region is reliable; we need to study the variation of interference and the possible sources that contribute to this interference. Our main objective is to qualify the potential of monitoring a continuous radio emission of Solar. In our work, we choose Malaysia Space Centre (3°5′00″N 101°32′00″E), Banting, Selangor for candidate site as a study case. The size of this centre is about 400 acres land and the best site so far to setup and install the e-CALLISTO project due to complete facilities that relevant enough to build up the radio astronomical sites. It is also an initiative of the International Space Weather Initiative (ISWI) project where Malaysia is one of the countries that bid an e-CALLISTO project [3]. Based on this issue, it is important to identify the factors that might influence the solar monitoring data [4].

Although we are now are facing the challenges of development next generation radio telescope for astronomy is its capacity to cope with increasing polluted of RFI, Malaysia still one of the potential country to focus on solar monitoring using ground-based telescopes due to 12hours per day throughout a year. Therefore, National Space Centre, Sg Lang, Selangor is one of the prime candidate sites for the first radio astronomical telescope. Nevertheless, we still need to identify and continuously monitor the unwanted signals which are emitted due to the massive global increase in technology application.

In this work, we detect the main RFI sources that need to remove effectively every time observations are taken. RFI in our case will refer to any undesired signal mainly in the frequency band of interest in 45MHz till 870 MHz region. However, we also extend the frequency from 1MHz till 2000 MHz for general purpose.

2. E-CALLISTO NETWORK

E-CALLISTO networking is an internationalization research collaboration that investigates the phenomena of solar flare in broadband radio region of (45 -870) MHz [5]. As we know, the Sun exhibits a variety of interesting and complicated physical phenomena, which are being studied mainly by analysis of its radiation.

This study is focused on monitoring solar burst that generally associated with solar flares and originates from all levels of the solar atmosphere between the lowest chromospheres and the outer corona to heights of several solar radii. Normally, they attain an equivalent brightness temperature up to 10^{12} K and originate by Bremssthrahlung, synchrotron and plasma radiations. It is hoped that by monitoring 24 hours all over the world, the precise data will lead to understand about the causes of spectacular ejection of material from flare region that associated with the coronal magnetic field [6]. This system will be installed in March 2012. So far, we have two spectrometers and in preparation for constructing the log periodic dipole antenna [7-14].

3. RESULTS AND ANALYSIS

One approach keeps an ongoing database of RFI signals as they are identified, and abandons frequency ranges where the RFI is recently or persistently observed. In most cases, we considered the influence of is being classified as below than -100 dBm. We therefore suggest that this range should be neglected for observations purpose. For qualitative analysis and carefully analyze we need to divide into 3 regions (i) 1-400 MHz (ii) 400-800 MHz and (iii) 800-1200 MHz (iv) 1200-1600 MHz and (v) 1600-2000 MHz in the targeted observational windows respectively. In Figure 1, the two dimensional view of the data RFI is assumed to be quite minimum in the region of 1-400 MHz. In this region the average value of -100.427 dBm. Maximum value of RFI is -99.8 dBm and it can be low as -103.44 dBm. In this region we potentially observed 1) solar wind (73.00-74.60 MHz), solar burst (45-800 MHz). Solar burst type I (80-200) MHz and II (20-150) MHz easily can be monitored at this site. These frequency bands of spectral are protected by International Spectrum Allocations. The level of input to LNA in dBm is listed in Table 1.

Table 1. The level of input to LNA in dBm.

Frequency (MHz)	Level at Input to LNA (dBm)
935	-97.11
957.5	-92.75
1210	-94.16
1220	-95.92
1805	-87.92

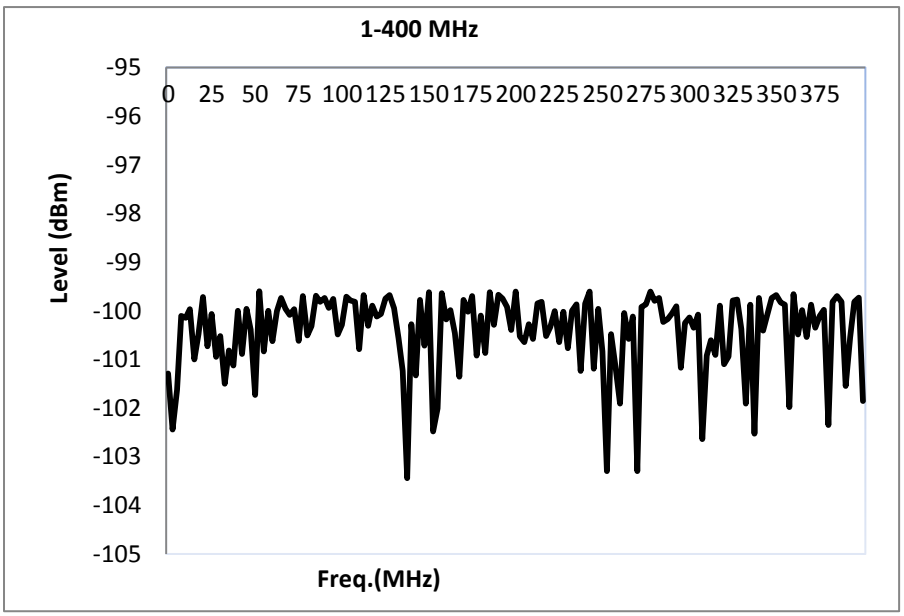

Figure 1. The RFI profiles at 1-400 MHz and 400-800 MHz respectively.

Meanwhile, with an average of 100.508 dBm in the region of 400-800 MHz, this region shows not many different as in Fig 1. According to the results, we can focus to observe continuum solar radio emission (1-800) MHz in this region.

The phenomena of interference can be extremely seen in the region of above 800 MHz as can be observed in Figure 2. We recognize that the main influence come from telecommunication sources. The average level of noise floor is -100.2 dBm.

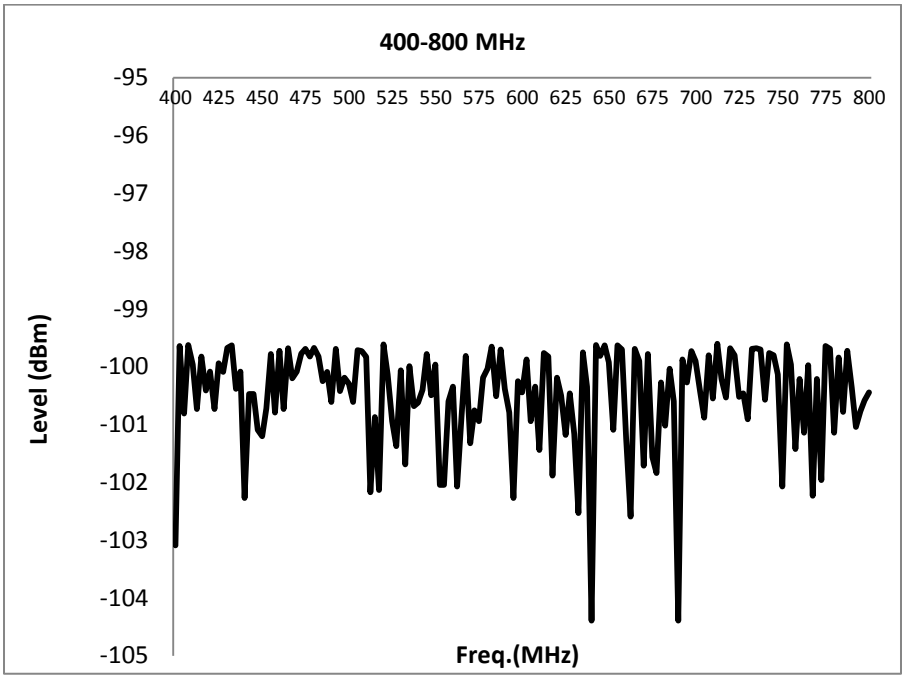

Figure 2. The RFI profiles at 400-800 MHz.

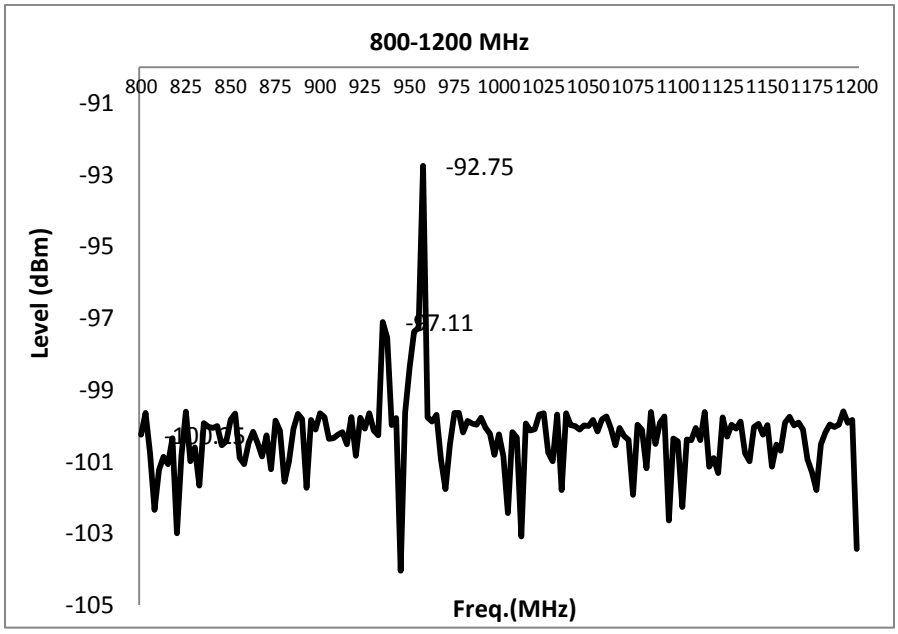

Figure 3. The RFI profiles at 800-1200 MHz.

We present the results of numerical simulation of RFI. In principle, as there is low interference in the channel range (1-800) MHz, it would be possible to simply not apply the projection to this portion of the spectrum. This is a good indicator for solar burst monitoring purpose as well as the other astronomical object, generally.

Since Radio Frequency Interference (RFI) is a major issue at these frequencies, a dedicated RFI monitor has been added and has been in operation since the start of the e-Callisto project. We have seen that pattern averaging is very important to identify the unnecessary noise from the data. From the RFI profile results we can conclude that there are five strong sources that can be classified as a strong RFI. However, we could not prevent RFI from occurring, but we could deduct the noise by identifying the specific wavelength that have been polluted.

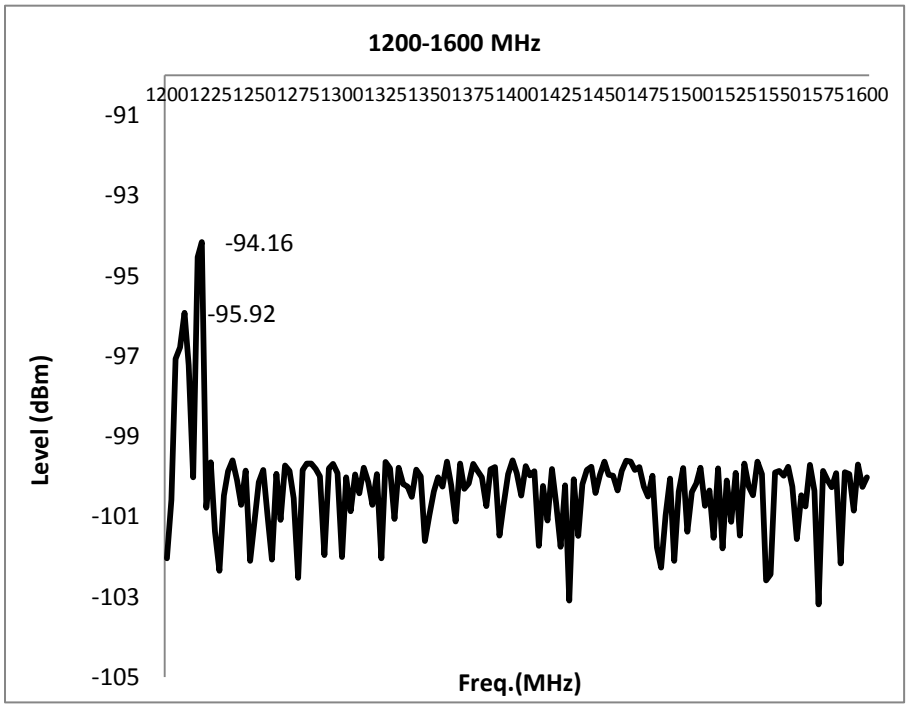

Figure 4. The RFI profiles at 1200-1600 MHz.

We continue to analyze the phase from 1600-2000 MHz. There is one source of RFI with -87.92 mainly from satellite telecommunication. This is detected at 1805 MHz. It is considered to be a strong signal of RFI in this region. However, it can be eliminated by subtract the signal from original data which might have a signal from the Sun during data processing.

In order to solve such problem, we strongly suggested that this monitoring should be consistently being doing in order to avoid irrelevant data while doing observations. There are many different methods for both determining the presence of RFI in an observation and also for removing it. These include online techniques, where the correction is applied in real time as the signal is received, detected, and integrated, and offline techniques; with the correction occurring after the signal has been recorded.

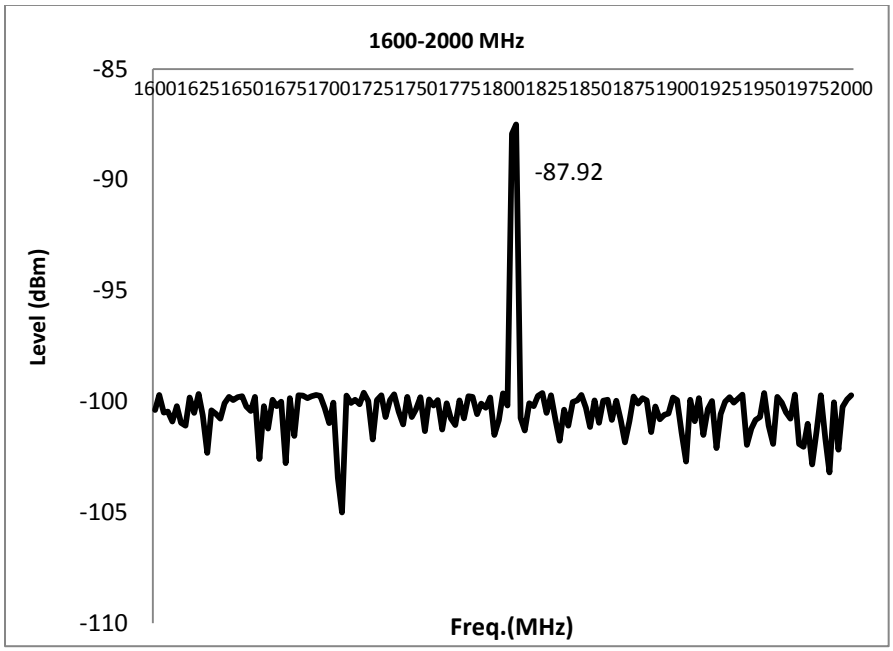

Figure 5. The RFI profiles at 1600-2000 MHz.

4. CONCLUSION

The growing number of radio applications is deteriorating the radio frequency spectrum every year, consequently continuous RFI monitoring is obligatory. One of the best ways to ensure the safety of radio astronomical measurements is by choosing the protected frequency bands for the measurements. To illustrate the conclusion, we can generally say that the National Space Centre, Sg. Lang, Selangor, Malaysia is one of the strategic countries to monitor the Sun due to consistent 12 hours per day throughout the year. Overall, we can still get a good solar burst data, especially at 40-400 MHz.

However, it is suggested that the antenna that will be constructed for the e - CALLISTO system should have a higher gain and sensitivity in order to get a good data and eliminate unwanted signal of RFI. It should be noted that the cable that connected from the antenna to the spectrometer should be less than 5 meters. It is hoped that the survey will continue from time to time in a consistent mode so that any polluted signal for radio astronomy purpose can be protected. Perhaps, we can contribute the good data for solar burst monitoring towards the maximum cycle beginning the end of this year 2013.

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BIOGRAPHY

Zety Sharizat Hamidi is currently a PhD candidate and study in Solar Astrophysics specifically in radio astrophysics at the University of Malaya. Involve a project under the International Space Weather Initiative (ISWI) and also a lecturer in School of Physics and Material Science, at MARA University of Technology, Shah Alam Selangor.

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