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Current Situation of Radio Frequency Interference (RFI) Profile at Outdoor and Indoor Sites of Faculty of Applied Sciences, UITM, Malaysia

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ABSTRACT

This Radio Frequency Interference (RFI) study is currently one of a main sub-research in radio astronomy in Malaysia. The main objective of this monitoring is to test and qualify the potential of radio astronomical sources that can be observed in Malaysia generally. Analysis process focuses at indoor and outdoor of Faculty of Applied Sciences, UITM Shah ALAM, Malaysia (latitude: 03°06.534'N, longitude: 101°50.396'E). There are three mobile network communications that operate at the upper band frequency of 1800MHz, which are Maxis (1805-1830 MHz), Celcom (1830-1855 MHz) and Digi (1855-1880 MHz) for GSM/LTE network. We observed that both sites having the highest and second highest peak at the same frequency of 420 MHz and 1835 MHz with the same source, which were due to mobile application followed by the lowest peak due to radio navigation satellite. We verified that the source of RFI of 1835 MHz at the Faculty of Applied Sciences may come from Celcom mobile telecommunication network signal because there is transmitter on top of two Celcom towers. This observation

must be continuously done to ensure that RFI level does not increase drastically and to ensure that allocation spectrum band that was reserved for radio astronomy activities was always protected.

***Keywords*:** Radio Frequency Interference (RFI); radio astronomy; RFI sources

1. INTRODUCTION

The analysis of Radio Frequency Interference (RFI) is very important progress in order to discover the potential radio astronomical sources. It is the radiation or conduction of radio frequency energy (or electronic noise produced by electrical and electronic devices at levels that interfere with the operation of adjacent equipment. Frequency ranges of most concern at 10 kHz to 30 MHz (conducted) and 30 MHz to 1 GHz (radiated).

This study is currently one of a main sub-research in radio astronomy in Malaysia [1,2]. Common sources include components such as switching power supplies, relays, motors and triacs, and equipment such as business computing devices, work processors, electronic printers, medical instrumentation, industrial controls, personal computers and electronic games. Governments and safety agencies of major industrial countries, including the United States, Canada, Germany, Sweden, and Switzerland, have established noise emission regulations that are focused on digital and other electronic equipment [3].

Continuity RFI surveying has been conducted at several sites such as at the University of Malaya [3], Langkawi, National Space Centre Banting, Selangor [3], and other relevant sites to select the best candidate site for radio astronomical research. Previous study also focused on the effect of population density on the RFI spectrum [4]. The radio region just not only covers a wide range with the longest wavelength compare other types of electromagnetic windows, but is also contain a very good potential to determine a new celestial object in our Universe. However, the main challenges of the next generation radio telescope for astronomy are its capacity to cope with increasing polluted of RFI [5].

Due to the developments in electronics technology, the need for electromagnetic shielding has increased [6]. In recent years, due to the increasing conflict between scientific and commercial users of the radio spectrum Radio frequency Interference (RFI) is a serious problem for passive and active radio and microwave sensing of the Earth [4].

As a result, it is very significant to verify the unwanted signals which are emitted due to the massive global increase. In order to determine a strategic site for radio astronomical research an effort has been made by penetrating a site that has very minimum radio frequency interference.

An RFI is often localized in time and frequency, relative to the integration times and pre-detection bandwidths over which a space borne microwave radiometer acquires its samples of the brightness temperature. Based on this issue, we analyze the Radio frequency Interference (RFI) profile at three (3) different periods [7]. This preliminary work also is a part of an initiative of the International Space Weather Initiative Program (ISWI) [8]. In this committee, we are hosting the e-CALLISTO (Compound Astronomical Low Cost Low Frequency Transportable Observatory) network [9].

In previous work, we have compared the RFI level at two (2) different sites [7]. Therefore, in this work, we need to identify all RFIs sources in the range of 1 MHz till 2000 MHz continuously [5].

2. MEASUREMENT SETUP AND OBSERVATIONS

A combination of detachable 9'' whip antenna with gain 30 dB and 0.37 dB of NF connected with Radio Frequency Field Strength Analyzer Figure 1. The minimum RFI from the wavelength will give the best range for astronomical purpose, while the maximum level of RFI, in contrast, is good to identify the elements that make it polluted. All digital electronics are located in a single screened enclosure to minimize self-generated RFI. The measurement system is routinely gaining calibrated by using the low noise amplifier. In order to avoid the unnecessary noise due to weather condition, the strength of RFI were measured only when the atmosphere was optically clear so that the path of light through the Earth's atmosphere is completely stable [10]. We also have identified the peak signals of the frequency from the spectrum analyzer. Data acquisition hardware consists the strength of noise level in dB unit which will be transferred to a computer for further analysis [3]. We can also predict the sources that caused the interference. This observation has been done from 9.00 am till 17:00 pm. We monitored an RFI profile at frequencies from 1-2000 MHz located at Faculty of Applied Sciences, Universiti Teknologi MARA (3°5′00″N 101°32′00″E / 3.0833333°N 101.5333333°E) [9].

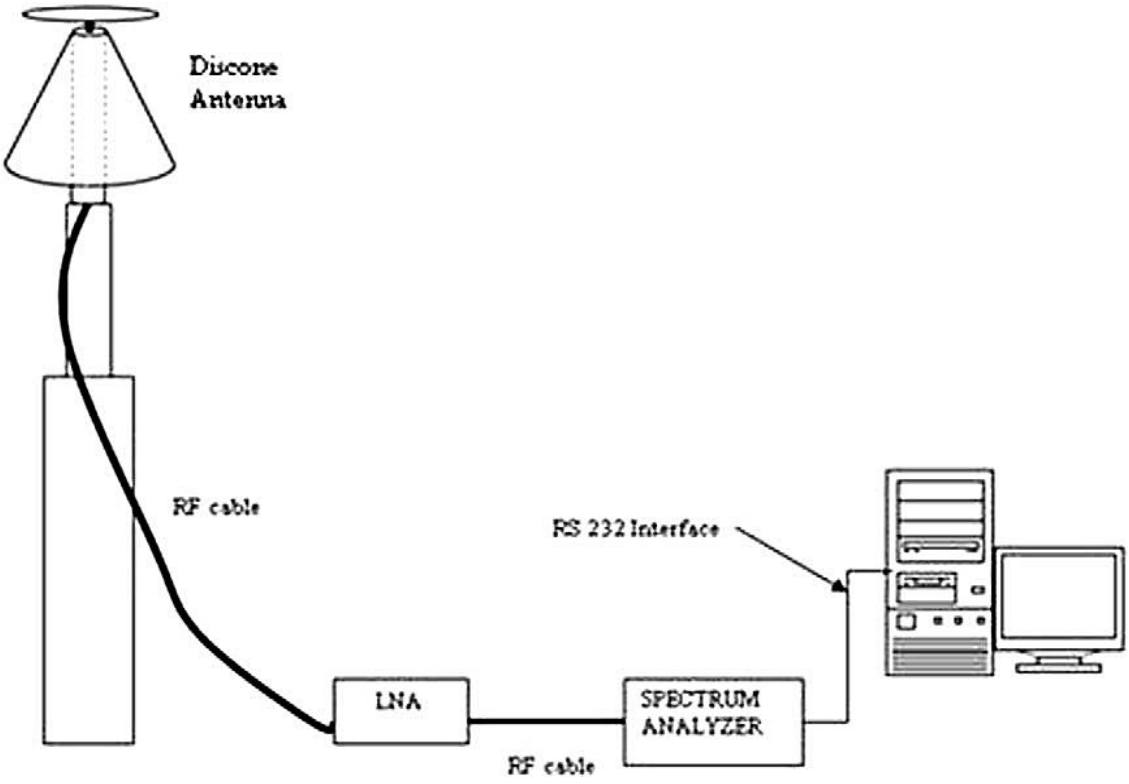

Figure 1. RFI system connection.

Figure 2. Location of Faculty of Applied Sciences in UiTM Shah Alam.

3. RESULTS AND ANALYSIS

After choosing five locations for indoor and five locations for outdoor sites in Faculty of Applied Sciences in UiTM Shah Alam (latitude: 03°06.534'N, longitude: 101°50.396'E), we make measurements for three types of bandwidth which was the wideband, narrowband and single side band (SSB) to detect the RFI source at the sites. Figure 4 shows observation sites in Faculty of Applied Science. We need to make comparisons between RFI of indoor site and outdoor site. This is because we need to investigate the possible sources of RFI for both sites and determine the suitable location between outdoor and indoor sites for radio astronomy observation in Faculty of Applied Sciences in UiTM Shah Alam. We chose the level noise as a indicator to measure the signal strength of the RFI level for those sites. The noise level was defined as a power ratio in decibels (dB) of the measured power referenced to one miliwatt (mW) and measured in negative (-) dBm. If the measurements are closer to the zero, it means that the source of RFI having a greater noise level. For the analysis to find the highest peak level, we have combined result of wideband, narrowband and SSB for both sites. Results of RFI are represented in Figure 3 and Figure 4.

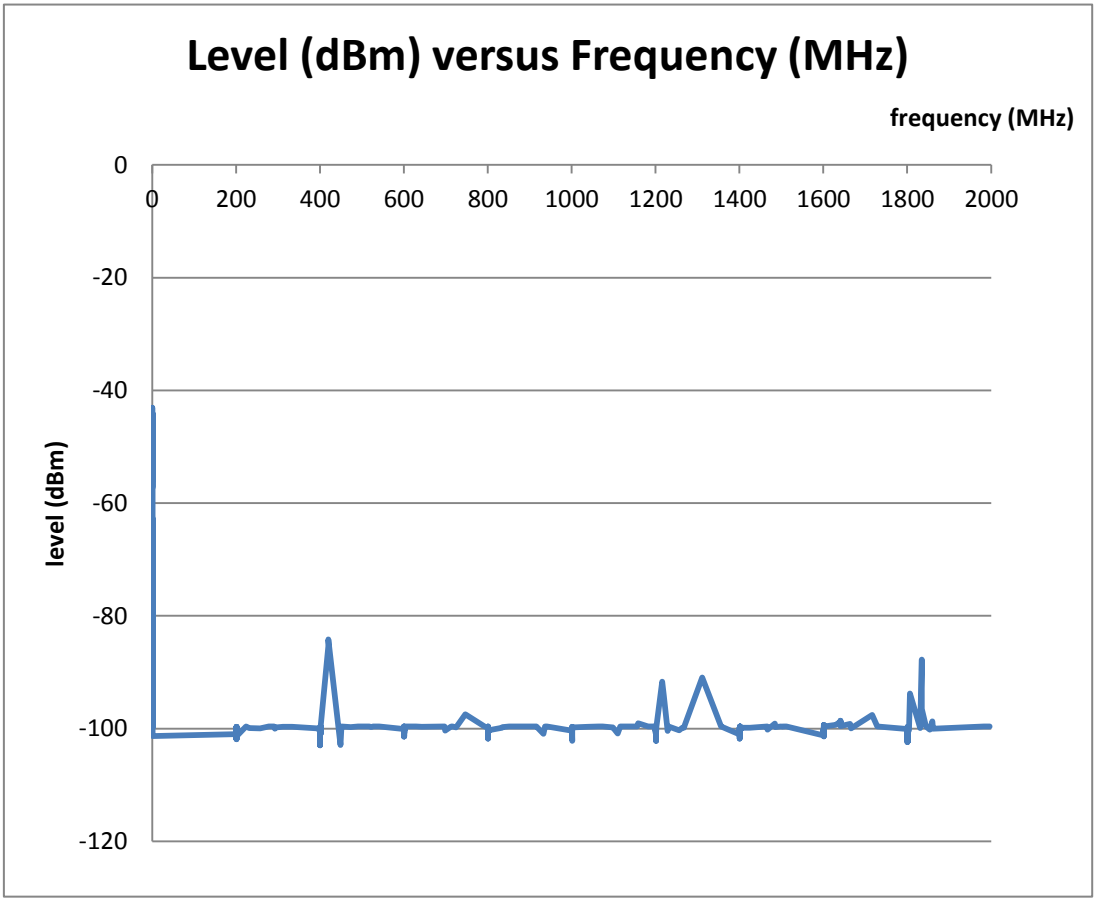

Figure 3. RFI level at outdoor site of Faculty of Applied Sciences in UiTM Shah Alam.

Figure 3 shows the result of RFI for the outdoor site. According to the result, it shows the outdoor site has the value of noise level with an average of -95.60 dBm in the band 0 – 2000 MHz. There are several signals appearing on that site such as at the frequency 400-451 MHz, 1200-1356 MHz and lastly 1806-1835 MHz. We have observed that among this range of frequency the highest peak of the signal is at 400-451 MHz with a noise level of -85.43 dBm (420 MHz). The signal may come from the mobile phone application and space research based on the radio spectrum allocation in Malaysia and ITU.

The second highest signal peak is at -87.76 dBm (1835MHz), from our analysis, we believed that the signal come from mobile phone telecommunication such as Celcom, Maxis and Digi. For the range of frequency between 1200-1356 MHz we found that the peak is at – 90.95 dBm (1311.25 MHz), the signal may come from radio location and radio navigation satellite.

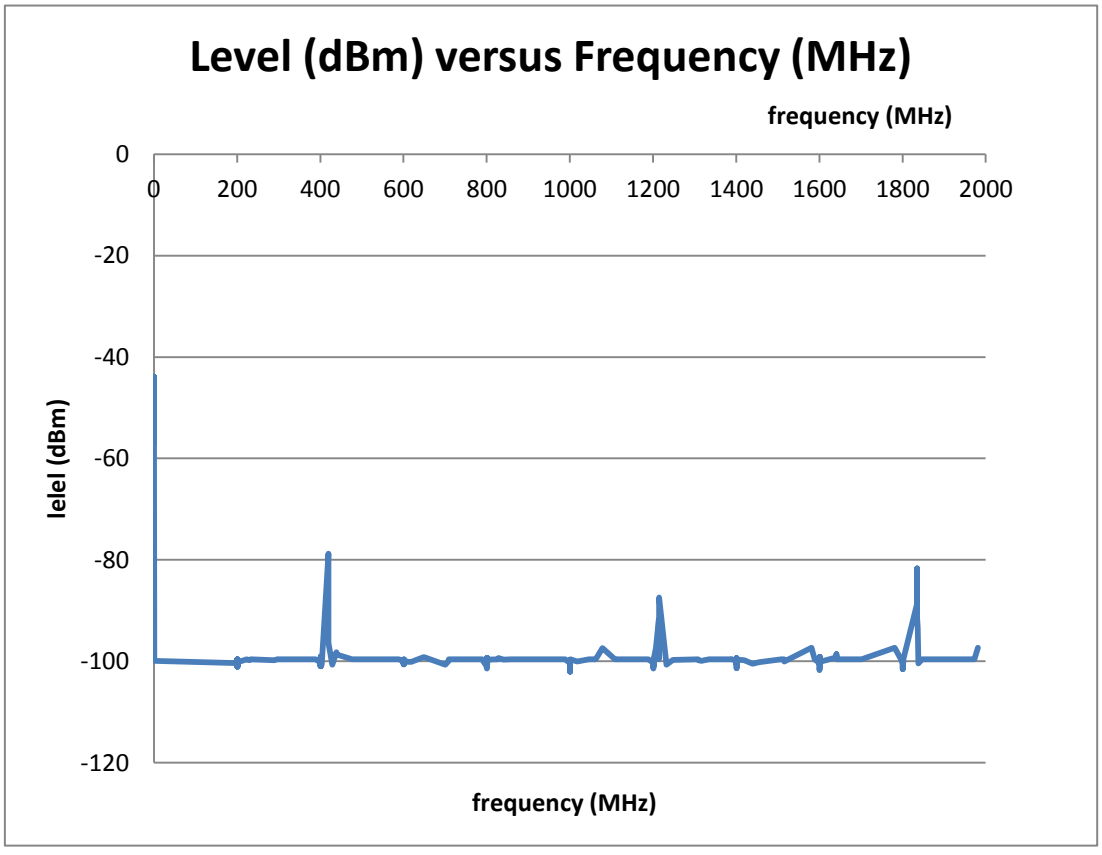

Figure 4. RFI level at indoor site of Faculty of Applied Sciences in UiTM Shah Alam.

According to the result shown in figure 4, the average signal for this frequency is -94.79 (dBm). From the analysis, we found out that for indoor sites there are the 3 highest peaks of signal from the frequency range of 401-439 MHz, 1201-1214 MHz and 1801-1838 MHz. The highest peak is from the frequency range 401-439 MHz, which the peak at 78.77 dBm (420 MHz) followed by peak at -89.29 dBm (1835 MHz) and -87.43 dBm (1215 MHz), (1835 MHz) and -87.43 dBm (1215 MHz).

By referring to the spectrum allocation in Malaysia, the highest peak is coming from a mobile phone application and space research. For the second highest peak the signal came from mobile phone telecommunication such as Celcom, Maxis and Digi. The signal that came from the lowest peak may come from aeronautical radio navigation.

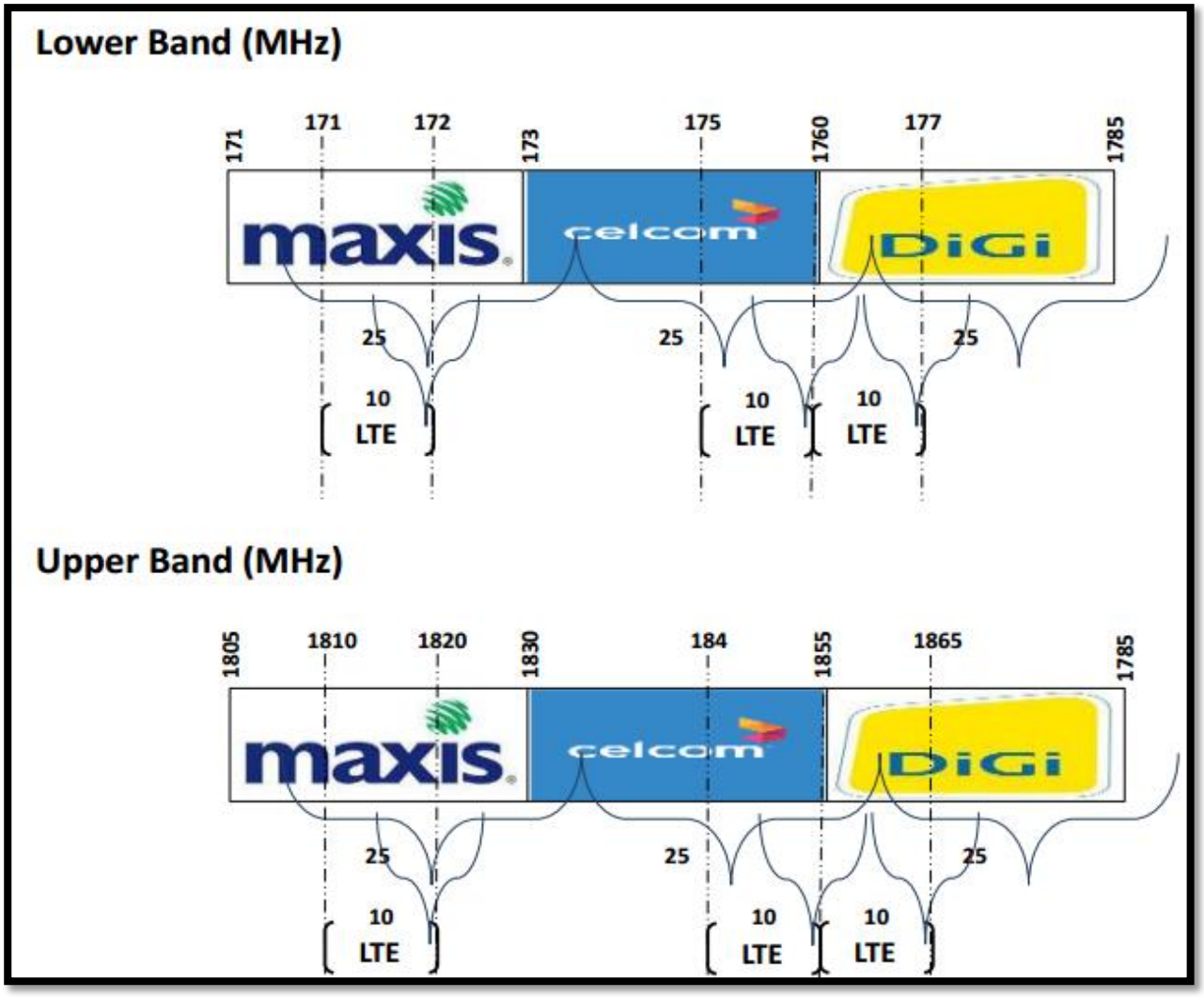

Figure 5. Global System for mobile 1800 (GSM1800) for Maxis, Celcom and Digi.

We observed that both sites having the highest and second highest peak at the same frequency of 420 MHz and 1835 MHz with the same source, which were due to mobile application followed by the lowest peak due to radio navigation satellite. Further investigations have been made to determine that the source affects the RFI level in our observing sites.

The source that contributed to the highest peak for both sides may come from mobile application such as Digital Trunked Radio System (DTRS). It is a two-way radio, mobile system contain of multiple-channel repeater stations and their control station. Walkie-talkie was one of mobile application of DTRS.

This system operates at the digital frequency band of UHF 410-430MHz. Malaysian Communication and Multimedia Commission (MCMC) have stated the frequency band for this application. The detail about the frequency range allocated for 410-430 MHz in Malaysia.

In UiTM Shah Alam, this type of radio system may be used for communication by the Department of Safety in UITM to communicate with are post guard for each gate in UiTM near by the Faculty of Applied Sciences. Source of RFI at Faculty Applied Science may contributed by this communication system.

There are three mobile network communications that operate at the upper band frequency of 1800 MHz, which are Maxis (1805-1830 MHz), Celcom (1830-1855 MHz) and Digi (1855-1880 MHz) for GSM/LTE network. We verified that the source of RFI of 1835 MHz at the Faculty of Applied Sciences may come from Celcom mobile telecommunication network signal because there is transmitter on top of two Celcom towers that were located nearby (Figure 5).

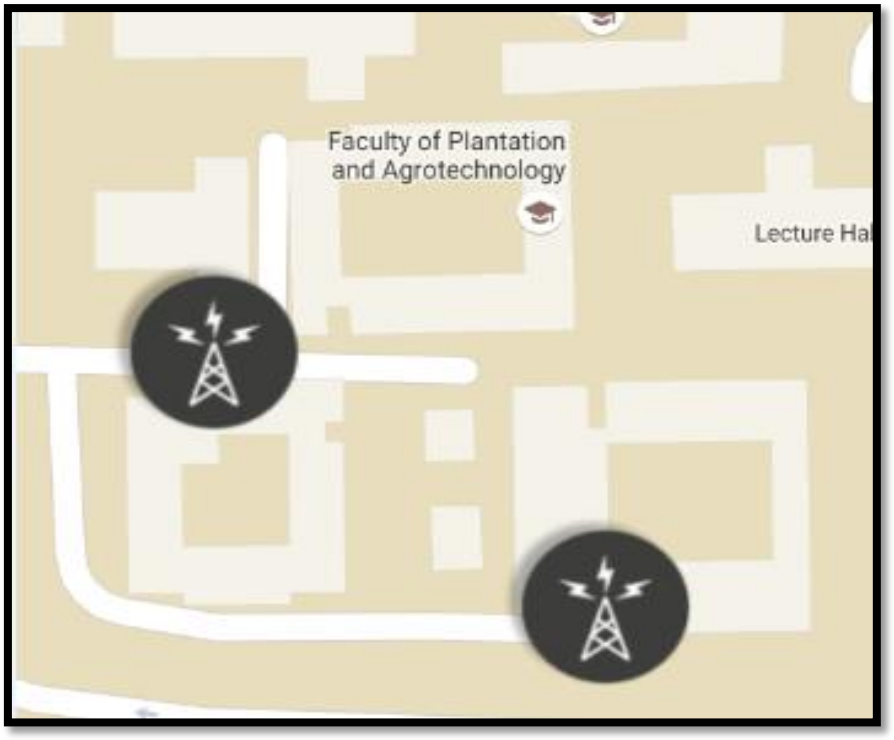

Figure 6. Location of Celcom towers nearby Faculty of Applied Sciences.

By comparing the RFI source level among the peaks for both site locations we concluded that outdoor site having low RFI level than the indoor site which was suitable for radio astronomy activities in Faculty of Applied Sciences. The outdoor site also has a low average signal level compared to indoor site. However, the outdoor site was considered as an intermediate site for radio astronomy observation based on its value of the average signal level. As shown in Table 1, there are eight selected ranges of frequency that will be used for the radio astronomical activities. This was the frequency band that protected by the MCMC from the unwanted man-made signal that disturbing the radio astronomy observations. As we

make further investigations by dividing both sites result in the selected range, which is 0-800 MHz and 800-1600 MHz which associated with the radio astronomy observation frequency.

Table 1. Frequency range of radio astronomy observation.

No	Frequency (MHz)	Application in Radio Astronomy
1	13.36 - 13.41	Solar observation
2	25.55 - 25.67	Jupiter observation
3	37.50 - 38.25	Continuum observation
4	73.00 - 74.60	Solar wind observation
5	150.05 - 153.00	Pulsar observations Solar observations
6	322.00 - 328.65	Deuterium observation
7	406.00 - 410.00	Pulsar observation
8	1400.00 - 1427.00	Hydrogen line observation

4. CONCLUSIONS

From the result and the analysis, we can conclude that this study has supported the objectives that have been mentioned earlier. Some observation for the selected sitesof indoor and outdoor were performed to find the source of the RFI and also to choose the suitable site between both sites which one is suitable for the radio astronomy purpose.

We found out that the source of RFI mostly came from the mobile phone application such as Celcom, Maxis and Digi. Others source of RFI may come from the radio location, and radio navigation satellite. However, this observation must be continuously done to ensure that RFI level does not increase drastically and to ensure that allocation spectrum band that was reserved for radio astronomy activities was always protected. We should expose to the public about the effect of RFI on the radio astronomical activities through the media.

We also concluded, the most suitable site for the radio astronomical observation in Faculty of Applied Science in UiTM Shah Alam is the outdoor site compared to the indoor site. This is because outdoor location seems to have low RFI level among the highest peak between both sites. However, the outdoor site still intermediate sites to perform the radio astronomical activities.

We cannot control the increasing of the RFI level due to the growth of telecommunication and broadcasting technologies. So, it is suggested that some migitations should be done in this location in order to ensure the RFI level will not give damaged to the radiometer.

Acknowledgement

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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.

N. N. M. Shariff Her current research is communicating sustainability. She is looking forward for cross-field research i.e. solar astrophysics, light pollution measurement (mapping) and application of technology on sustainability.

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