Solar radio burst in National Space Agency of Malaysia (ANGKASA)

Asnor Nadirah Ishak,
Nur Zulaikha Mohd Afandi,
Roslan Umar,
Nor Hazmin Sabri,
Zahira Mohd Radzi,
Asnor Juraiza Ishak,
Radial Anwar

1National Space Agency (ANGKASA), Lot 2233, Jalan Turi, Kg. Sg. Lang, 42700 Banting, Selangor, Malaysia
2East Coast Environmental Research Institute, Universiti Sultan Zainal Abidin, Gong Badak Campus, 21300 Kuala Nerus, Terengganu, Malaysia
3School of Fundamental Science, Universiti Malaysia Terengganu, 21030, Kuala Terengganu, Terengganu, Malaysia
4Department of Electrical and Electronic Engineering, Faculty of Engineering, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
5Department of Telecommunication Engineering, School of Applied Science, Telkom University, Jl. Telekomunikasi Terusan Buah Batu, Bandung 40257, Indonesia

asnor@angkasa.gov.my, zulaikhafendy@yahoo.com.my, roslan@unisza.edu.my, norhazmin@umt.edu.my, zahira@angkasa.gov.my, asnorji@upm.edu.my, radialanwar@tass.telkomuniversity.ac.id

Abstract. The sun is an active star that produces large-scale energetic events, such as solar flares and coronal mass ejections (CMEs). These phenomena are observable across the electromagnetic spectrum, from gamma rays at hundreds of MeV to radio waves with wavelengths of tens of metres. Solar flares and CMEs can excite plasma oscillations which can emit radiation at metric and decametric wavelengths. These radio bursts are classified in five main types. This paper gives a solar radio burst type III (16 July 2017) in National Space Agency (ANGKASA), Banting, Selangor, Malaysia. Compact Astronomical Low-Cost Instrument for Spectroscopy in Transportable Observatories (CALLISTO) is used in this system to observe solar radio activities. The main applications for this CALLISTO is to observe a solar radio bursts and radio frequency interference (RFI) monitoring for astronomical science, education and outreach. The CALLISTO natively operates between 45MHz to 870MHz and its observed daily.
1. Introduction
The sun is the star at the heart of the solar system, where it is by far the largest object, which consists of hot plasma with magnetic field surrounding it, mostly made up of hydrogen and helium. Its gravity holds the solar system together, keeping everything from the biggest planets to the smallest particles of debris in its orbit. Electric currents in the Sun generate a magnetic field that is carried out through the solar system by the solar wind, a stream of electrically charged gas blowing outward from the Sun in all directions. The connection and interactions between the Sun and Earth drive the seasons, ocean currents, weather, climate, radiation belts and aurora.

Monitoring the solar activities are now being the most active research for solar radio in Malaysia. Commonly, solar flare and coronal mass ejections (CMEs) exists as couple with the emission of solar radio burst during active sun and can be categorized as rapidly drift varies over period of second or minutes. Emissions of burst occurred when high velocity of charged particles from the flare activity ejected away from sun and moved toward outer atmosphere (corona) of the sun. Based on the activity, charged particles from moving solar flare will excite the radio wave in corona, there are some findings found that unsavory radiation may affect human daily life on earth. Due to the disturbance caused by solar flare, the investigation of solar radio burst is important for future research on the importance of space weather.

In addition, with continuous meteorological and space weather observation can give the early awareness of solar flare and coronal mass ejections (CMEs) to space weather. Today the prediction of space weather become one of important to human as well as increasing the role of technology in daily life. Therefore, there are number of radio receivers and magnetometers that monitor the activity of the solar flare from the sun. The receiver must be able to detect within radio frequency.

In this paper, the main objective is to study the solar radio burst using Compact Astronomical Low-Cost Instrument for Spectroscopy in Transportable Observatories (CALLISTO) in National Space Agency of Malaysia (ANGKASA), Banting, Selangor, Malaysia. ANGKASA is one of the government agency under Ministry Science, Technology and Innovation (MOSTI) is responsible in leading and observing the development of space science in Malaysia.

CALLISTO is a radio spectrometer used extensively for solar radio astronomy and radio frequency interference monitoring. CALLISTO spectrometer is used extensively as heterodyne receiver designing and leading by Christian Monstein and Radio and Plasma Physics Group from ETH Zurich, Switzerland in order to study the magnetic activity of a wide range of the Sun. Many CALLISTO spectrometer have been deployed more than 80 locations with users from more than 144 countries. The e-CALLISTO system has had its first success already in December 2006, when the last large flares of the present cycle occurred.

2. Methodology
The CALLISTO system is an instrument that was operated by ETH Zurich back in several years ago to observe solar radio activities by solar radio spectrometers. This system are used to monitor solar radio activities between 45MHz until 870MHz. This instrument can be operated by using a basic system that consisting of the receiver, linear polarized antenna system and a logging software as in Figure 1. Based on a new instrument developed in China, the new device comes with different and improved specifications and characteristics that functions to observe the solar radio observation using different frequency range of CALLISTO which was called as Solar Broadband Radio Spectrometer. The specification are the most important parameter for performance (Fu et al. 2004).
Figure 1: Configuration CALLISTO system

The data was collected from official CALLISTO station through downloading the data. The Log Periodic Dipole Antenna (LPDA) antenna is used for this system. The conversion of the fits file are necessary in order to use the data. Data was collected for 16 July 2017 and its show the type III solar radio burst.

The data was extracted using zip file software. Figure 2 and Figure 3 shows the data is analyzed using MATLAB by converting the fits files into intensity data in decibel (dB). The average intensity level was obtained through coding. The spectrum was recorded the color code intensity in frequency (MHz) vs time in second. The time for each spectrum was standardize in 15 minutes (900sec).

3. Result and Discussion
Both spectrum in Figure 2 and Figure 3 have been recorded the burst at National Space Agency of Malaysia referring to Malaysia Banting station with 2°46’58.8"N 101°30’25.2"E. In order to enhance the appearances of burst on the spectrum, the pre-processing process was applied by using MATLAB software. The solar radio burst type III (storm) is clearly seen through red circle in Figure 2 and Figure 3. This burst was confirmed with Solar Weather Prediction Center by NOAA as noted in the green rectangle of Figure 4. The burst was start 015940 UTC until 020150 UTC with frequency range from 650 MHz until 870 MHz. Solar flare C3.1 from 0158UTC until 0257UTC recorded in the purple rectangle of in Figure 4. The image in Figure 5 was taken from website https://www.solarmonitor.org is similar with the Reg#2665 in Figure 4. The solar radio burst type III (storm) is associated with solar flare C3.1.
Figure 2: The spectrum of Malaysia Banting in 20170716 at 014500 UTC after enhancement using MATLAB software

Figure 3: The spectrum of Malaysia Banting in 20170716 at 0200 UTC after enhancement using MATLAB software
Figure 4: The data from Space Weather Prediction Center for 16 July 2017 event

| Event | Begin | Max   | End Obs | Q | Type | Loc/Freq | Particulars | Reg# |
|-------|-------|-------|---------|---|------|----------|-------------|------|
| 510 + | 0158  | 0235  | 0257 G1S | 5 | XRA  | 1-BA     | C3.1        | 9.2E-03 | 2665 |
| 510 + | 0152  | 0200  | 0204 LEA | G | RBR  | 245      | 27000       | 2665 |
| 510 + | 0159  |       | 0202 PAL | C | RSP  | 025-180  | 21773       | 2665 |
| 510 + | 0159  | 0200  | 0202 LEA | G | RBR  | 410      | 4280        | 2665 |
| 510 + | 0200  | 0200  | 0200 LEA | G | RBR  | 610      | 220         | 2665 |
| 510 + | 0202  | 0202  | 0250 LEA | 3 | FLA  | S06W61   | SF          | DSD  | 2665 |
| 520 + | 0229  | 0229  | 0229 LEA | G | RBR  | 245      | 110         |       |
| 580 + | 0251  | 0518  | 0555 LEA | G | RNS  | 245      | 350         |       |
| 530 + | 0314  | 0314  | 0315 LEA | G | RBR  | 410      | 120         |       |
| 550 + | 0322  | 0322  | 0322 PAL | G | RBR  | 245      | 120         |       |
| 560 + | 0431  | 0431  | 0432 SVI | G | RBR  | 245      | 270         |       |
| 570 + | 0544  | 0547  | 0549 G1S | 5 | XRA  | 1-BA     | B7.6        | 1.2E-04 | 2665 |
| 590 + | 0641  | 0641  | 0641 LEA | G | RBR  | 245      | 210         |       |
| 600 + | 0723  | 0726  | 0728 G1S | 5 | XRA  | 1-BA     | C1.1        | 1.6E-04 | 2665 |
| 600 + | 0725  | 0728  | 0728 LEA | 3 | FLA  | S06W64   | SF          | 2665 |
| 600 + | 0725  | 0725  | 0725 SVI | C | RSP  | 025-180  | II/2        | 2665 |
| 600 + | 0725  | 0725  | 0725 LEA | G | RBR  | 245      | 12000       | 2665 |
| 600 + | 0725  | 0725  | 0725 LEA | G | RBR  | 410      | 1500        | 2665 |

Figure 5: The image from https://www.solarmonitor.org
4. Conclusion
As a conclusion, the solar radio burst type III has been collected at National Space Agency of Malaysia (ANGKASA) using CALLISTO system with LPDA antenna. The antenna can be operated with frequency 45MHz until 870MHz. The solar radio burst type III (storm) is associated with solar flare C3.1 and this burst was confirmed with Solar Weather Prediction Center by NOAA. Malaysia has a very good potential to monitor solar activities due to the consistency of period observation throughout a year.

References
[1] N.Z.M. Afandi, S.N. Hazmin, R. Umar, A.N. Ishak, 2017. Automated Solar Radio Burst Detection on Radio Spectrum: A Review of Techniques in Image Processing. Journal of Fundamental and Applied Sciences. ISSN 1112-9867.
[2] Z.S. Hamidi, N.N.M. Shariff, Z.Z. Abidin, Z.A. Ibrahim and C. Monstein, 2012. Coverage of Solar Radio Spectrum in Malaysia and Spectral Overview of Radio Frequency Interference (RFI) by Using CALLISTO Spectrometer form 1MHz to 900MHz. Middle-East Journal of Scientific Research 12(6): 893-898. doi: 10.5829/idosi.mejsr.2012.12.6.1733*
[3] Abidin, Z. Z., Anim, N. M, Hamidi, Z. S., Monstein, C., Ibrahim, Z. A., Umar, R., Shariff, N. N., M., Ramli, N., Aziz, N. A. I. & Sukma, I., 2015. Radio frequency interference in solar monitoring using CALLISTO. New Astronomy Reviews. 67, 18-33.
[4] Benz, A.O., Monstein, C., Meyer, H., Manoharan, P. K., Ramesh, R., Altyhynster, A., Lara, A., Paez, J. & Cho, K. S., 2009. A World Wide Net of Solar Radio Spectrometer: e-CALLISTO. Earth Moon Planet. 104, 277-285.
[5] Hamidi, Z. S., Abidin, Z. Z., Ibrahim, Z. A., N. N. M., Shariff & C. Monstein., 2012. Signal detection performed by Log Periodic Dipole Antenna (LDPA) in Solar Monitoring. International Journal of Fundamental Physical Sciences. 2, 2, 24-26.