

Disturbances of Solar Eruption From Active Region AR1613

Z. S. Hamidi^{1,*}, N. N. M. Shariff², C. Monstein³

¹School of Physics and Material Sciences, Faculty of Sciences, MARA University of Technology, 40450, Shah Alam, Selangor, Malaysia

²Academy of Contemporary Islamic Studies (ACIS), MARA University of Technology, 40450, Shah Alam, Selangor, Malaysia

³Institute of Astronomy, Wolfgang-Pauli-Strasse 27, Building HIT, Floor J, CH-8093 Zurich, Switzerland

*E-mail address: zetysh@salam.uitm.edu.my

ABSTRACT

The paper describes an investigation of the solar radio bursts of spectral type III due to disturbances of the active region AR 1613. A solar flare occurred on 2012 November 15, between 2:00 UT to 3:30 UT. The sequence images from a burst from our site revealed that although the solar flare is considered moderate, it is still possible to obtain the solar burst type III in a single and group forms within one and half hour. It can easily produce misleading results in terms of non-thermal electron density and magnetic field strength. The burst is originated in the same active region of the solar corona. The C-6 level enhancement was detected in GOES 1.8 a soft X-ray. Based on the results, we suggest that radio wave source motion manifests the displacement of particle sites caused by plasma eruptions. Time variability in the emission may due to the changes in the electron density. The group and individual solar burst type III can be related to the distance travelled before an electron beam becomes unstable to Langmuir waves. In conclusion, the interactions non-thermal electron and magnetic trapping can influence the transporting of electrons and this is still a subject of interest of intense investigation.

Keywords: Solar radio emission; solar burst type III; e-CALLISTO; solar flare; Active Region AR1613

1. INTRODUCTION

It has been a long thought that the disturbance of the solar eruption initiated by active region with a strong magnetic field. The repeat heating by coronal and chromospheric material will expand to the interplanetary medium and Earth's atmosphere which can be detected in radio region. Normally this solar eruption is synonymous with solar radio burst type III. In principle, the radio observations specifically in low region provide an indication of Sun activities such as Coronal Mass Ejections (CMEs), solar flare, evolution of sunspots and

others unpredictable phenomena [1]. It plays an important role in understanding the mechanism of energy release, plasma heating, the particle acceleration and transfer in magnetized plasmas. In fact, they originate in the same layers of the solar atmosphere in which geo-effective disturbances probably originate the layers where energy is released in solar flares, where energetic particles are accelerated and where Coronal Mass Ejections (CMEs) are launched [2,3]. Therefore, the dynamical process during the burst of flares or CMEs events can be traced from this observation [4,5]. The solar radio bursts type III has a high probability of being followed by geomagnetic disturbances [6]. It forms in a fast drift formation and can last from hours to a few days in the region of KHz till GHz [7]. As the energetic electrons from the solar flare move outward from the corona, they stimulate oscillations at the electron plasma frequency, f_p , which is a characteristic oscillation frequency of the plasma at the atmosphere of the Sun. There are three low-frequency variants of type III burst that originate in the interplanetary (IP) medium [8]: (i) isolated type III bursts from flare-scale energy releases, (ii) complex type III bursts during CMEs, and (iii) type III storms. Determination of solar burst type III could be interpreted as a very fast outward movement of the disturbance through the solar corona with could exceed from 3×10^4 to 10^5 km/sec. This velocity represents one-third velocity of light. The electrons in this type are accelerated to energies of at least 10^4 to 10^5 eV. Previous study also shown that this type of burst extends out to 1 AU [9] with more than 20 keV electrons [10]. Therefore, this type is used as tracers of magnetic field structures. At very low frequencies (~ 1 MHz), several thousand of bursts can be emitted from an active region during one complete solar rotation [11]. An important question concerning the origin of this burst is how they correlate with the mildly relativistic electrons and Langmuir waves produced from the electrons. It should be noted that observations show that Langmuir waves associated with solar type III radio bursts are highly localized [12]. One fundamental theory, it is believed is that Landau resonance with the unstable electron beam is responsible generates Langmuir waves, which are thought to undergo nonlinear wave-wave interactions that produce electromagnetic emissions at the local electron plasma frequency (f_{pe}) and its second harmonic ($2f_{pe}$) [13-15].

2. EXPERIMENTAL SETUP AND METHODOLOGY

The radio astronomy in Malaysia has just started in a few years ago since 2006 [16]. Considering the observational facts, we used the Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory (CALLISTO) system which is connected to the Log Periodic Dipole Antenna (LPDA) [17,18]. The LPDA is constructed in February 2012 [19]. The system is located at the National Space Centre (ANGKASA), Selangor located at (3.0833333°N 101.5333333°E) with minimum Radio Frequency Interference (RFI) noise level, with an average – (85-100) dBm [17,20,21]. Until now, we have construct and modified the LPDA in order to obtain a better data of solar burst [22]. Although the main purpose of the instrument is to provide imaging data, in order to study a large number of bursts, we restrict ourselves to total power data without spatial resolution. Basically, a LPDA that can cover the range of frequency from 45 - 870 MHz is connected to the CALLISTO spectrometer [23]. Nevertheless, in order to minimize the noise level, we focus only in the region of 150 MHz till 400 MHz [24,25]. We have to note that it is difficult to measure the duration of the burst more than 400 MHz seems the region has a moderate noise [26,27]. It also has a moderate population density of people and technology applications [28,29]. This region also has been evaluated and compared with the observatory in Thailand

[30]. The distribution data radio flux density in burst versus the frequency range of the spectral peak and intensity level has been collected daily starting from 11:30 UT till 23.30 UT [31,32]. Each burst consists of 15 minutes of dynamic spectrum with 0.25 second time resolution [33]. One of the apparent disadvantages of the spectral expansion and the limited averaging procedure is that this data can be only automatically saved on a daily basis only. In principle, a regular practice to distinguish metric solar radio burst signals is to record the digital dynamical spectra, extract sequences of single frequency events with limited discrete length and to determine quantitative characteristics on the basis of these observations [34-48].

3. RESULTS AND ANALYSIS

In the present work, we considered times profiles of solar radio burst type III from 150 - 400 MHz. The Active Region 1613, located at the South - West of the Sun, was recorded by the Geostationary Operational Environmental Satellites (GOES). During the impulsive phase, six Active Region at the center of the Sun (i) 1610, (ii) 1611, (iii) 1612, (iv) 1614, (v) 1615 and (iv) 1616 an be observed directly. These Active Region seems to be passive within this few days. The significant solar burst variations happened starting from 1:57 UT. The time profiles of the from 2:45 UT - 3:00 UT is sometime complex contain more that one than one type of burst. The increase of radio burst is accompanied by a decrease in distance between source of seven active regions. These estimates are rather subjective and need elaboration For this study, we also used the data from the space weather website. Detailed is the condition of the Sun and the percentage of solar flare an M and X class on 15th November 2012 during this event is listed in Table 1 and Table 2.

Table 1. Current condition of the Sun (Credited to Space Weather).

Parameter	Value
Solar wind speed	403.5 km/sec
Density	1.7 protons/cm ³
Sunspot number	126
10.7 cm flux	146 sfu
6-hr max	C1
24-hr	C6

Table 2. The percentage of solar flare an M and X class on 15th November 2012 (Credited to Space Weather).

Flare	0-24 hours	24 – 48 hours
Class M	40 %	40 %
Class X	5 %	5 %

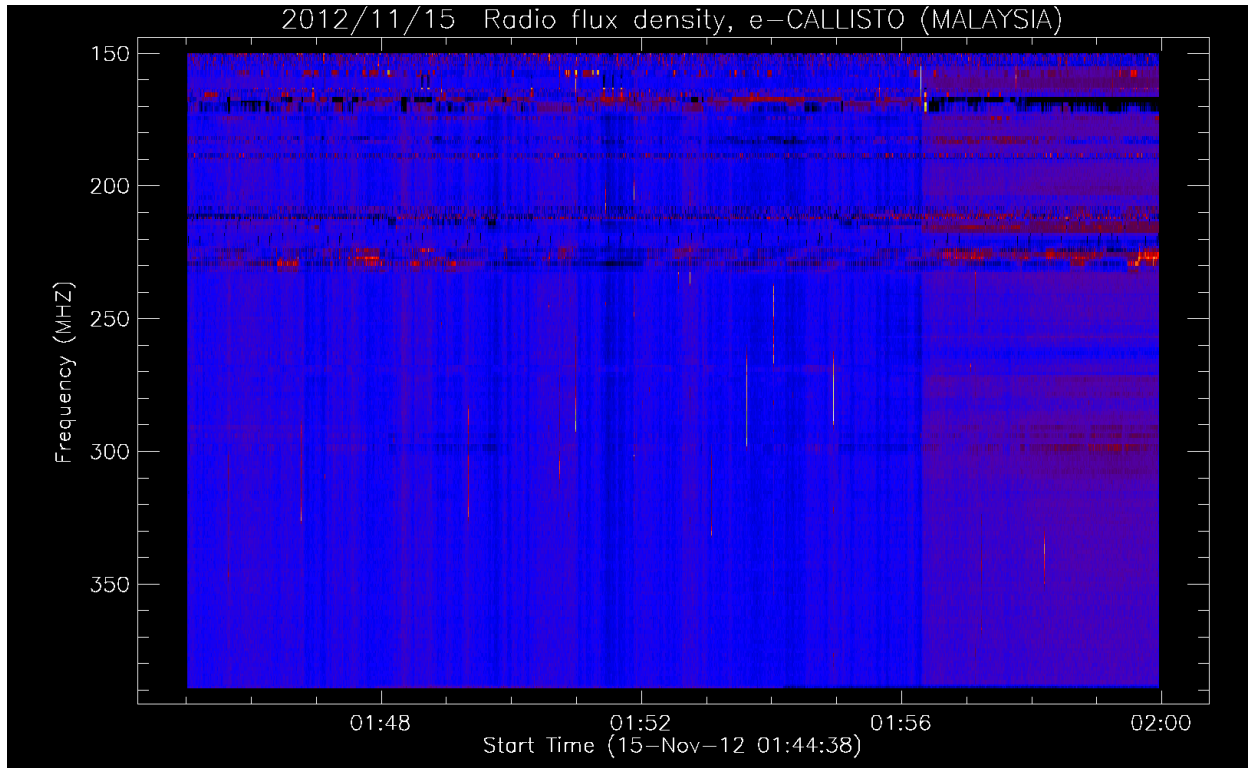


Figure 1. Time profile of the radio burst type III associated with a C-6 class solar flare on 15th November 2012 from 1:45 UT- 2:00 UT at the National Space Centre, Banting Selangor.

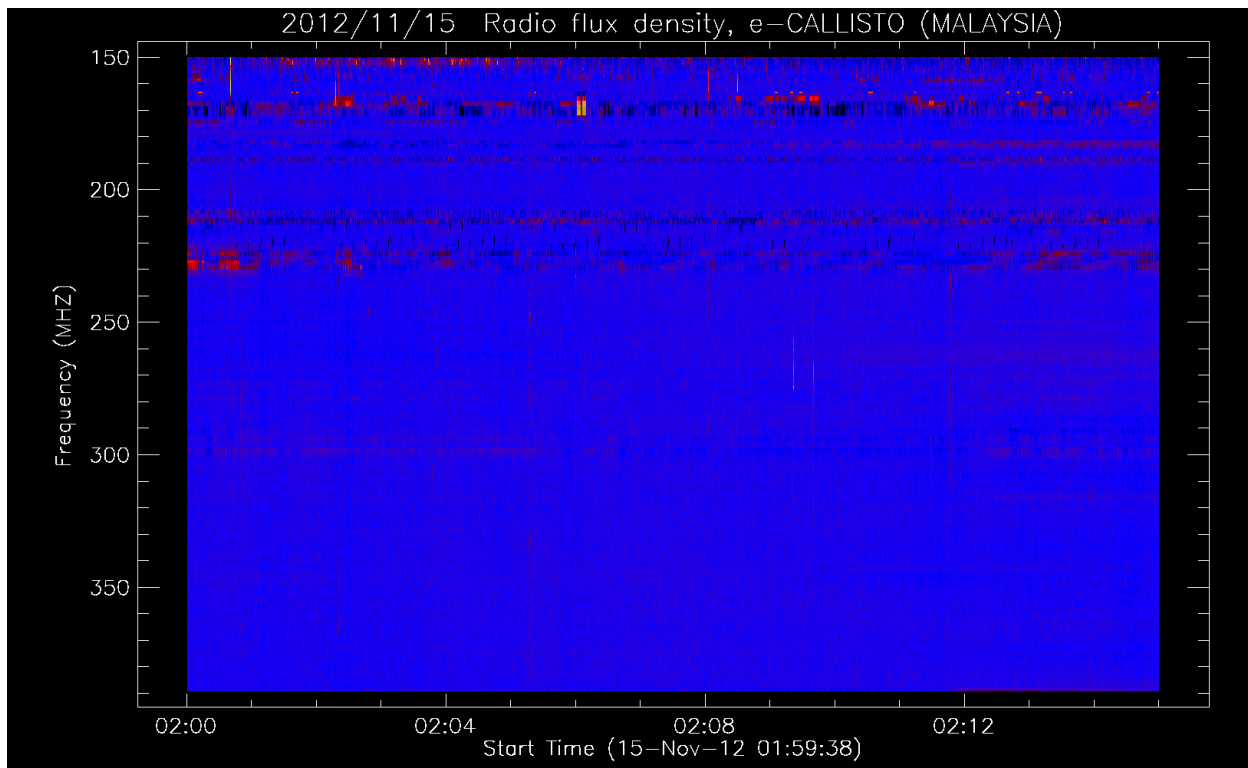


Figure 2. Time profile of the radio burst type III associated with a C-6 class solar flare on 15th November 2012 from 2:00 UT- 2:15 UT at the National Space Centre, Banting Selangor.

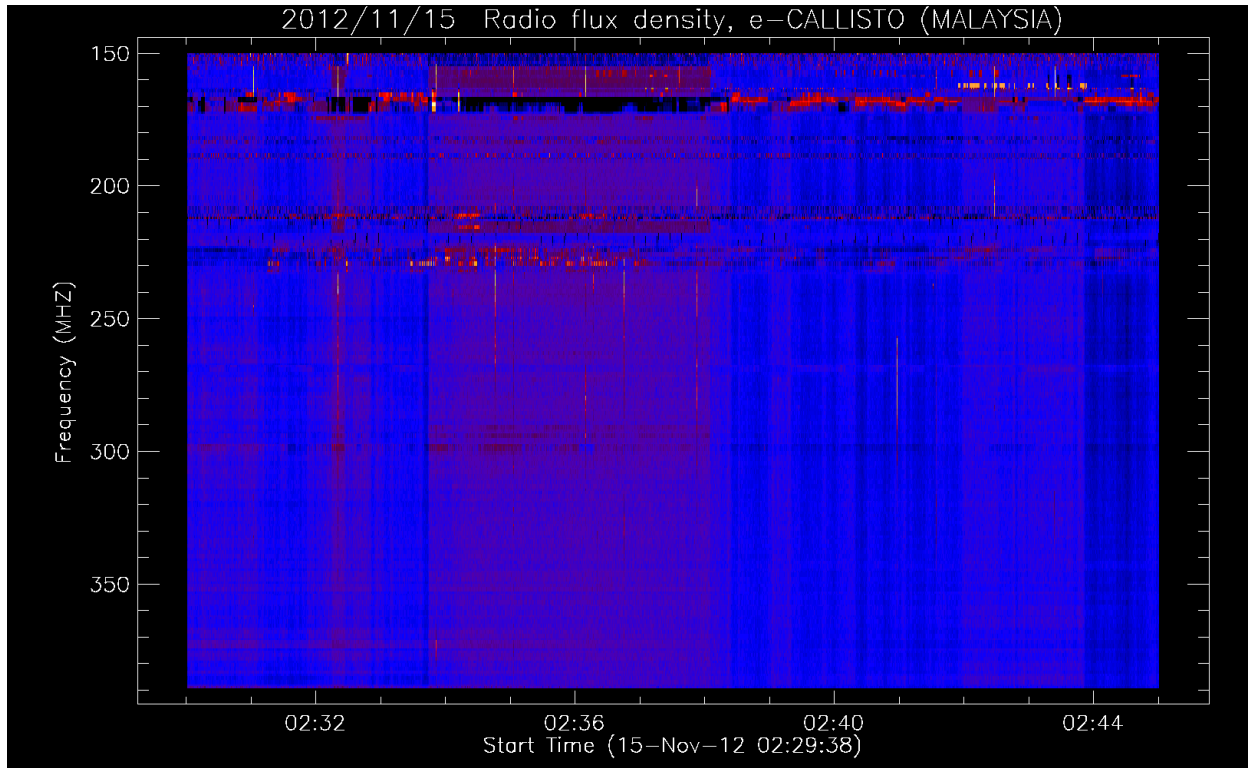


Figure 3. Time profile of the radio burst type III associated with a C-6 class solar flare on 15th November 2012 from 2:15 UT- 2:30 UT at the National Space Centre, Banting Selangor.

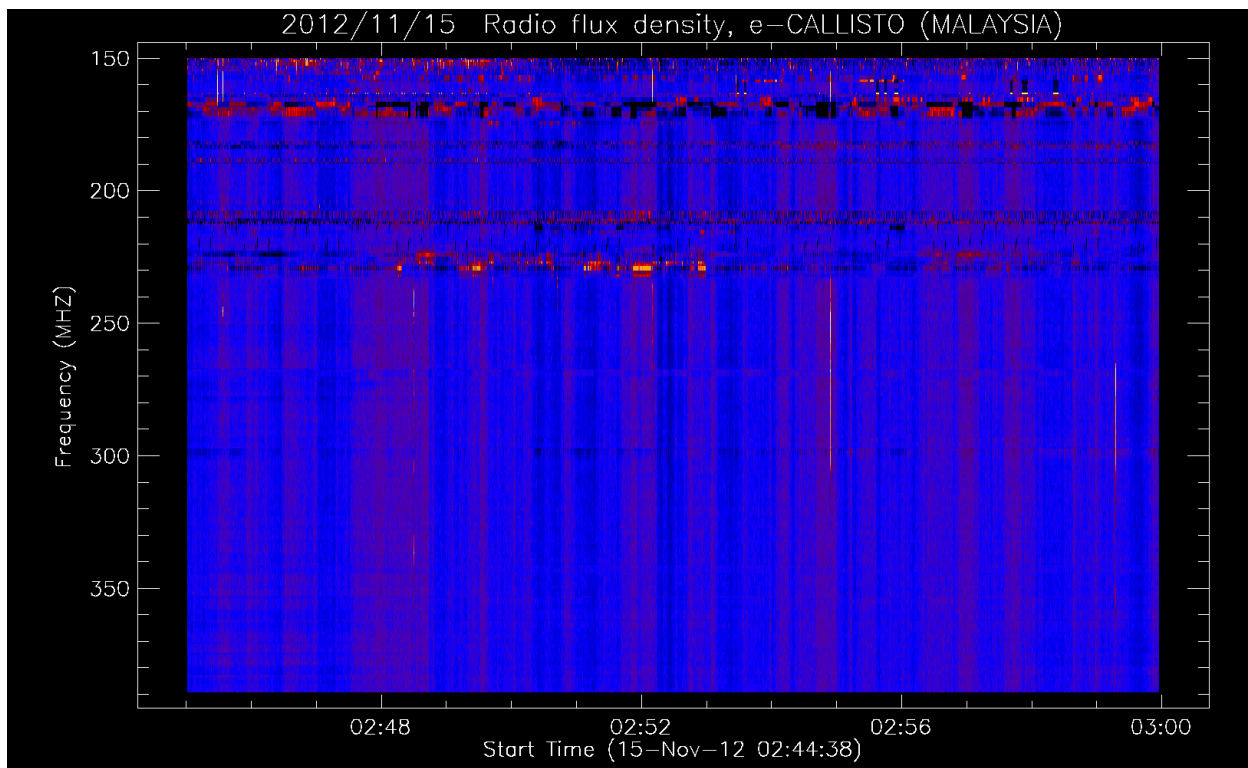


Figure 4. Time profile of the radio burst type III associated with a C-6 class solar flare on 15th November 2012 from 2:30 UT- 2:45 UT at the National Space Centre, Banting Selangor.

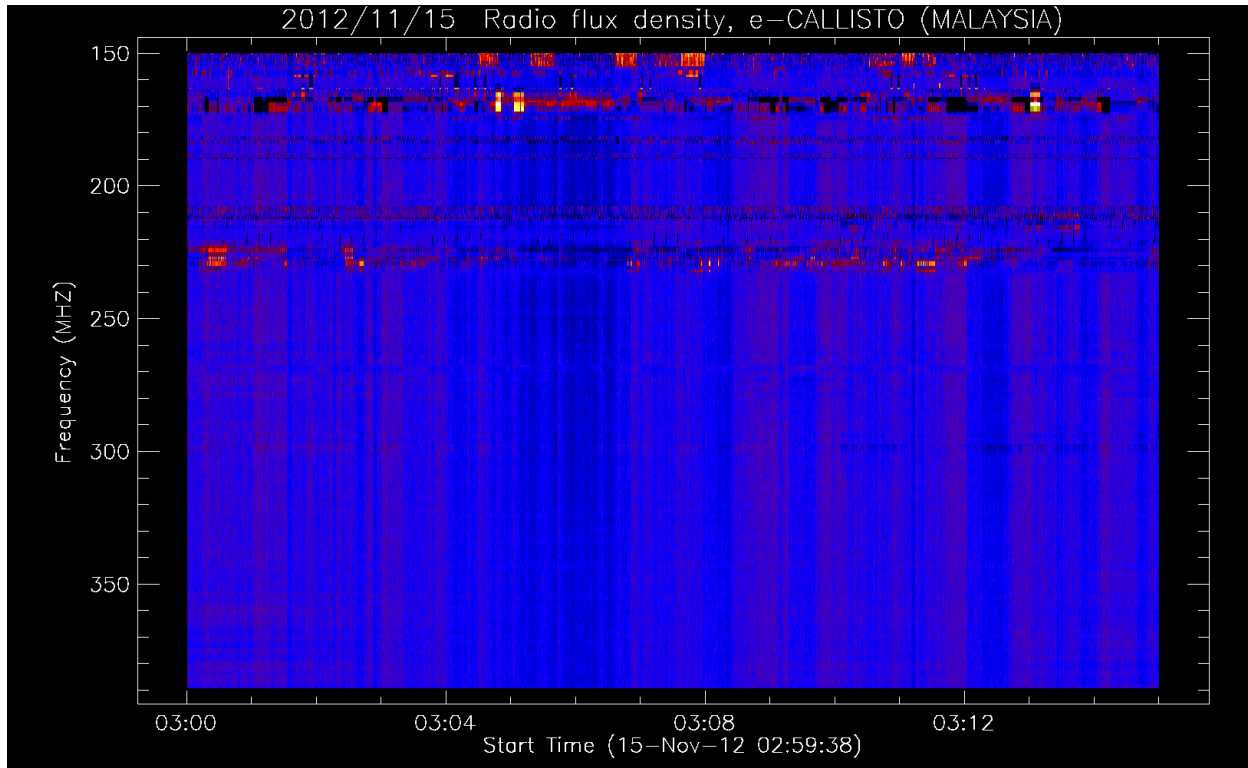


Figure 5. Time profile of the radio burst type III associated with a C-6 class solar flare on 15th November 2012 from 3:00 UT- 3:15 UT at the National Space Centre, Banting Selangor.

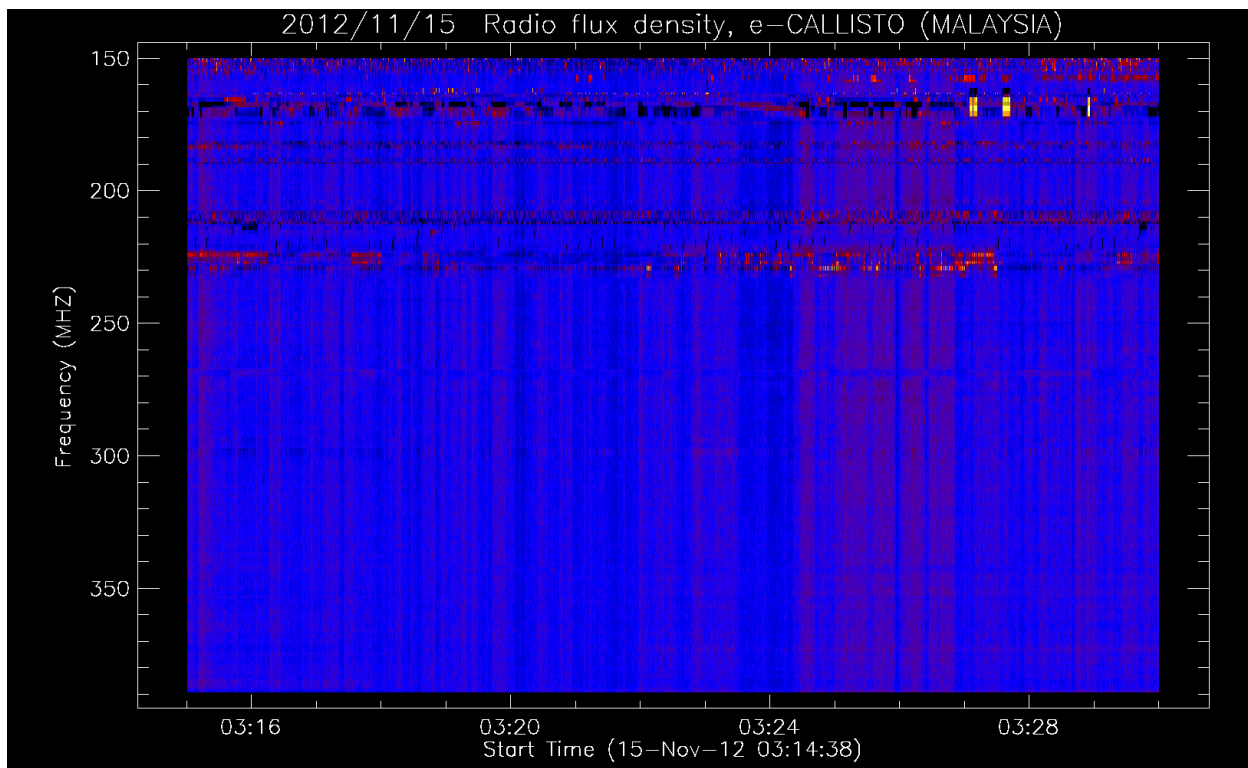


Figure 6. Time profile of the radio burst type III associated with a C-6 class solar flare on 15th November 2012 from 3:15 UT- 3:30 UT at the National Space Centre, Banting Selangor.

The sequence images from a burst from our site revealed that although the solar flare is considered moderate, it is still possible to obtain the solar burst type III in a single and group forms within one and half hour. Such as the short duration and small flare loop, and latter case is more plausible. The burst is originated in the same active region of the solar corona in which geo-effective disturbance probably initiates. Based on the observations, strong bursts that caused by extraordinary solar flares due to magnetic reconnection effect potentially induced in the near-Earth magneto tail. It can easily produce misleading results in terms of non-thermal electron density and magnetic field strength. Theoretically, time variability in the emission may due to the changes in the electron density. The tenuous plasma in that region is then accelerated down magnetic field lines into the Polar Regions, striking Earth's atmosphere and exciting nitrogen and oxygen atoms as well as the other atoms present in our atmosphere. These properties indicate that emission from numerous high energy electrons in a very strong magnetic field suggesting high energy release in the flare formation process.

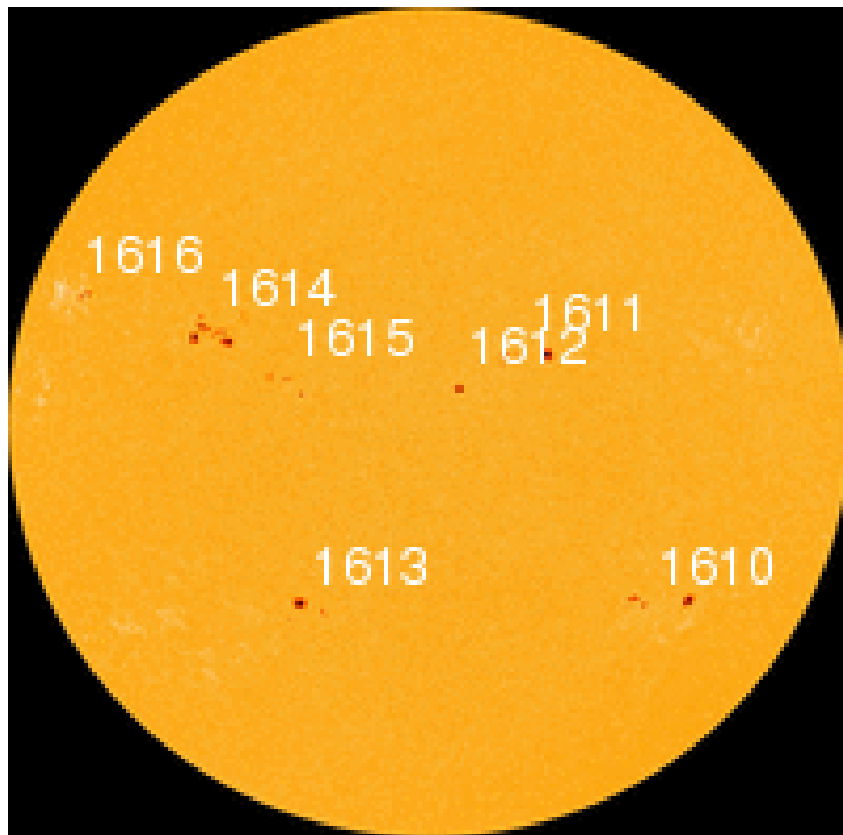


Figure 7. The Active Region 1613 on 15th November 2012.

The combination of radio with the Hard X-ray (HXR) observations can help us to analyze the release of flare energy and acceleration of energetic particles during the pre-phase of the flare. Out of this database, we expected general the procedure, by comparing the GOES data. From our analysis, one possible reason behind the formation of this very complex, long duration of this loop is the magnetic reconnection and disruption of the loops which is observed during flare maximum. Time variations in the emission may due to the changes in the electron density.

4. CONCLUDING REMARKS

The C-6 level enhancement was detected in the GOES 1.8 a soft X-ray. Based on the results, we suggest that radio wave source motion manifest the displacement of particle sites caused by plasma eruptions. To summarize, the burst characteristics of low-frequency solar radio burst type III has been deliberated. A group and individual solar burst type III can be related to the distance travelled before an electron beam becomes unstable to Langmuir waves. In this work, a good agreement was reached and it is believed that Sun's activities are more active to pursuit the solar maximum cycle at the end of this year. In conclusion, the interactions non-thermal electron and magnetic trapping can influence the transporting of electrons and this is still a subject of interest of intense investigation.

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BIOGRAPHY

Dr Zety Sharizat Hamidi is currently a lecturer and focused in Solar Astrophysics research specifically in radio astrophysics at the School of Physics and Material Sciences, Faculty of Sciences, MARA University of Technology, 40450, Shah Alam, Selangor, Malaysia. Involve a project under the International Space Weather Initiative (ISWI).

C. Monstein is a senior Engineer at Institute of Astronomy, Wolfgang-Pauli-Strasse 27, Building HIT, Floor J, CH-8093 Zurich, Switzerland and one of the researchers who initiated the CALLISTO system around the world.

Dr Nur Nafhatun Md Shariff is a senior lecturer in Academy of Contemporary Islamic Studies (ACIS), MARA University of Technology, 40450, Shah Alam, Selangor, Malaysia. Her current research is more on sustainability; environmental aspect. She is looking forward for cross-field research, i.e. solar astrophysics, light pollution measurement (mapping) and religious studies.

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