The Variance Formation of M9.3 Solar Flare Associated with Solar Radio Burst Type V Occurred at Eight (8) Different Sites of the CALLISTO System on 4th August 2011

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Abstract. We report a detailed examination of the variance formation of M9.3 solar flare associated with solar radio burst Type V that occurred on 2011 August 4. Solar radio burst type V was identified occurred with present of Coronal Mass Ejection (CME) towards earth which moving estimated about 1,950 km/s which can gives major impact to our Earths in terms of satellites. The event was observed by using Compound Astronomical Low-cost Low-Frequency Instrument for Spectroscopy Transportable Observatory (CALLISTO). CALLISTO is a radio spectrometer that has been used 24 hour per day which designed for solar observation. The solar radio burst was occurred at 21.1 MHz at 3 minutes (0358 UT till 0401 UTC). Noted that all the sites are less suffering from local RFI with solar wind speed and density reached 411.6 km/sec and 3.8 proton/cm³. Solar radio burst Type V is known as smooth with short-lived continuum which sometime followed by a type III burst. We show radio flux density in eight (8) different sites. Finally, we discuss the X-ray flux density to determine classes of the solar flares.

1. Introduction
Significance formation of M9.3 solar flare associated with Type V solar burst almost exceed the X-territory. The strong and energetic particle can cause major disruption to human technology and health risk to astronaut. Solar Radio Burst divided into five (5) types (I-V) and it can differentiate by referring to the frequency and duration of the burst on that day. Solar Radio Burst Type I can be classified as solar storm which has short and narrow-bandwidth bursts. The Type II burst is known as Coronal Mass Ejection (CMEs) which cause by shock waves [1] has slow frequency drift bursts and accompanied by a stronger intensity and take about three to thirty minutes in duration for an event occurred. Next, Solar Radio Burst Type III is known as solar flares which also known as fast frequency drift burst and occurred in three situations which are singular, in groups or storms. Since mid-1996 the SOHO Large Angle Spectrometric Coronagraph (LASCO) instruments have observed numerous halo or partial-halo CMEs [2].

In this paper, we examine solar radio burst Type V known as the combination of Type I and Type III burst with slightly different in a range of frequency and the duration of the burst. Type V usually in 1-3 minutes which usually appears caused by electron streams pass through a region which was heated from the passage of the electron stream which associated with type III burst (Warwick, 1967). We
show radio flux density in eight (8) different sites. Finally, we discuss the X-ray flux density to determine classes of the solar flares.

2. Experimental Setup and Methodology
Compound Astronomical Low-cost Low-Frequency Instrument for Spectroscopy Transportable Observatory (CALLISTO) is used to interpret the radio bursts that have been detected by the antenna before the results appeared on the computer's screen [3, 4]. This system is one of the most outstanding project under ISWI with there are more than 80 instruments in more than 43 locations with users from more than 116 countries [4]. In order to study solar activities that relating to solar flare or Coronal Mass Ejection (CMEs) is usually related to solar burst and sometimes can affect the telecommunication system and radio navigation operating systems and even electric power supply [5]. The aim of this project is to monitor the solar activity in radio region for 24/7 in order to support develop country participate direct or indirect with the latest technologies of instruments [6].

Log Periodic Dipole Antenna (LPDA) has a twisted balanced transmission line that, fed by a coplanar linear array of equal and unequal spaced parallel linear dipoles [7]. The antenna has set up with range of frequency 45 MHz till 870 MHz. The LPDA that situated at National Space Centre (ANGKASA), Selangor at (3.0833333˚N 101.53333333E) which has been connected will CALLISTO system that minimum Radio Frequency Interference (RFI) with average (85-100) dBm and has 45-870 MHz range of frequency [7, 8]. The other different sites used different pattern or types of radio telescopes so that can received good signal from sun radiation.

3. Result and Discussion
Data below showed that the radio flux density for 8 different sites where the antenna has been set up with the CALLISTO spectrometer. From this solar radio burst, we can conclude that it was from Type V Solar Radio Burst which has high intensity of burst from 20 MHz – 200 MHz (21.1 MHz) with the duration of burst about 3 minutes from 03:58 till 04:01 UTC. It has smooth and short lived continuum burst. There are several associated phenomena tend to occur which are eruptive prominences and magnetohydronamic shock waves and on 5th August 2011, a major geomagnetic storm occurred impact from the CMEs occurred on 4th August 2011. Although it has been set up at different sites with different frequency range of the antenna, the radio burst still can detect if the burst was in the range of frequency of the type of burst and the antenna has been set up with different polarization and connection with the presence of low in noise and RFI sources thus gave the clearer data.

Sometimes the data that have been collected are not showing the clearer image because of the different value gain of antenna that has been used and the different polarization of the antenna also affect the amount of radiation that the antenna could be received. The higher the value of the gain of an antenna, the clearer the image of data. Some of the data does not show the same pattern of burst because of the different amount of radiation of the signal that the antenna could be received due to the different RFI level of noise and the different in polarization of the antenna itself. This will affect the intensity of the solar radio burst detected thus give different pattern in solar radio flux density. At the conclusion, the best data solar radio burst collected by Radio Flux Density on 4th August 2011 was from Ooty, India.
Figure 1 (A) showed Radio Flux Density from Alaska, Figure (B) showed Radio Flux Density (ALMATY) from Kazakhstan Figure (C) showed Radio Flux Density, e-CALLISTO (GAURI) from India Figure (D) showed Radio Flux Density, e-CALLISTO (KASI) from Daejeon, South Korea, Figure (E) showed Radio Flux Density (MRO) from Metsähovi (Finland), Figure (F) showed Radio Flux Density (MRT1) from Mauritius, Figure (G) showed Radio Flux Density (Ooty) India and last but not least, Figure 8. Radio Flux Density (RCAG), Ulaan Baatar from Mongolia (Credited to: e-CALLISTO Website)

By referring GOES X-Ray flux below, it showed that the solar flares have the highest value at 0358UT which in M9.3 class of flares where it can cause brief radio blackouts that affect Earth’s polar regions. Besides that, minor radiation storms sometimes follow M-class of flares. It quite highest rate in M-Class solar flares where it can exceed to X1-class of flares which can caused planet-wide radio blackouts and long lasting radiation storms.
Figure 2 X-ray flux density to determine classes of the solar flares (credit to: www.solarmonitor.org)

Figure 3 Solar Extreme Ultraviolet Irradiance on 4th August 2011 (credit to: www.solarmonitor.org)

From above graph, it showed that the graph was used to measure the solar extreme ultraviolet (EUV) irradiance with 0.1NM spectral resolution, which include with array detectors so all EUV wavelengths can be measured simultaneously. From this graph, it has 6.0 mWm$^{-2}$ irradiance from 15:00 till 17:00 UTC where the solar radio burst type V occurred during that time. Solar irradiance is the output of the light energy from the entire disk of the sun, which measured at the Earth and it can be used to measure for any glowing object (stars, the moon) which can be seen in many wavelengths (from visible and infrared rays) through UV to EUV and X-ray.

4. Conclusion
The data that have been collected on 4th August, 2011 showed the same pattern of solar radio burst type V with different range of frequency that has been set up at the antenna at different sites and gave the same pattern of burst at the same time 03:58 till 04:01 UTC in 3 minutes. The difference of the intensity of radio burst received caused by the difference in polarization of the antenna and RFI level of noise which also will affect the signal that received. A major geomagnetic storms followed the following day caused by CMEs and the data showed by radio flux density influenced by the gain of the antenna, the maximum amount of radiation or signal that received from the sun and the lower noise level thus give the best and the clearest image of the burst. The antenna should not located near the RFI sources so that it does not affect the data received.

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