

CHAPTER I

INTRODUCTION

Background and significance of the research problem

Cosmic rays are the energetic particles or gamma rays which come from an explosion on the surface of the Sun, interstellar or intergalactic space. They come through the Earth with high speed and collide with atom or molecules in the atmosphere. Most cosmic rays are charged particles which have a wide range of energy. The number of cosmic rays will change depending on the activity on the Sun such as solar flare, which is a sudden explosion on the Sun and releasing high energy particles into the interplanetary system known as cosmic rays or solar energetic particles. Some solar flare may be met with shock waves in space after its explosion and release Coronal Mass Ejection (CMEs). Cosmic rays have important effect on the Earth. These include damage to electric power, interruption of communications systems, and noise to aircraft and the satellites. Therefore, it is necessary to know the intensity of these particles on the Earth to analyze and report early warning signs to the relevant agencies for prompt action, which can reduce the incidence of damage.

There are several ground-based measurements of the number of neutrons from cosmic rays which is called neutron monitor. It was developed by J.A. Simpson in 1984 who found that the Earth's magnetic field act as a cosmic energy filter. Because cosmic rays will move along the magnetic field lines they hit the atmosphere and produce many secondary particles including neutron particles which can be detected by neutron monitor.

Currently, the neutron monitors are set up in the worldwide network around the world for studying and analyzing the number of neutrons from space that reach the Earth. In Thailand, Princess Sirindhorn Neutron Monitor (PSNM) station was set up at the highest mountain, Doi Inthanon in Chiang Mai province. This station set at Thailand's highest mountain 2,565 meters above sea level, is a special location at the highest magnetic cutoff rigidity of 16.8 GV on the Earth. Figure 1 shows the vertical cut-off rigidity (GV) on the Earth, where Thailand is located within the contour line at

17 GV. The data detected from the PSNM are the highest energy neutrons more than 16.8 GeV that have never been observed from anywhere else in the world. Accordingly, the PSNM's data are extremely essential data for scientific researchers to study and analyze information of the solar energetic particles from space that come through the Earth. This information will be useful for early warning signs on the Earth (Leerungnavarat, et al., 2003) and is faster than NASA (National Aeronautics and Space Administration) which uses data of the Advanced Composition Explorer with warning in one hour.

In the measurement of the number of cosmic rays with high accuracy and efficiency by using the same standard, calibration is necessary for the worldwide neutron monitors which have different location and specific rigidity. The smaller size neutron monitor calibration will be easy and convenient to transport. It is designed to support the intercalibration between the various neutron monitors around the world. The different locations of neutron monitors will affect the neutron data because the surrounding environment and the value of vertical cut-off rigidity will affect the energy of detected particles.

If we know the process of the neutron measurement inside the calibration neutron monitor and environment which affect the detector, then we can control the neutron monitor measurement to report accurate and efficient data. In this research, we simulated the calibration neutron monitor which was used to calibrate the Princess Sirindhorn Neutron Monitor and studied the environment effect on the calibrator in order to measure the count rate of the secondary neutron particles. This research will help us to understand the response of calibration neutron monitor to cosmic rays which are detected on the Earth.

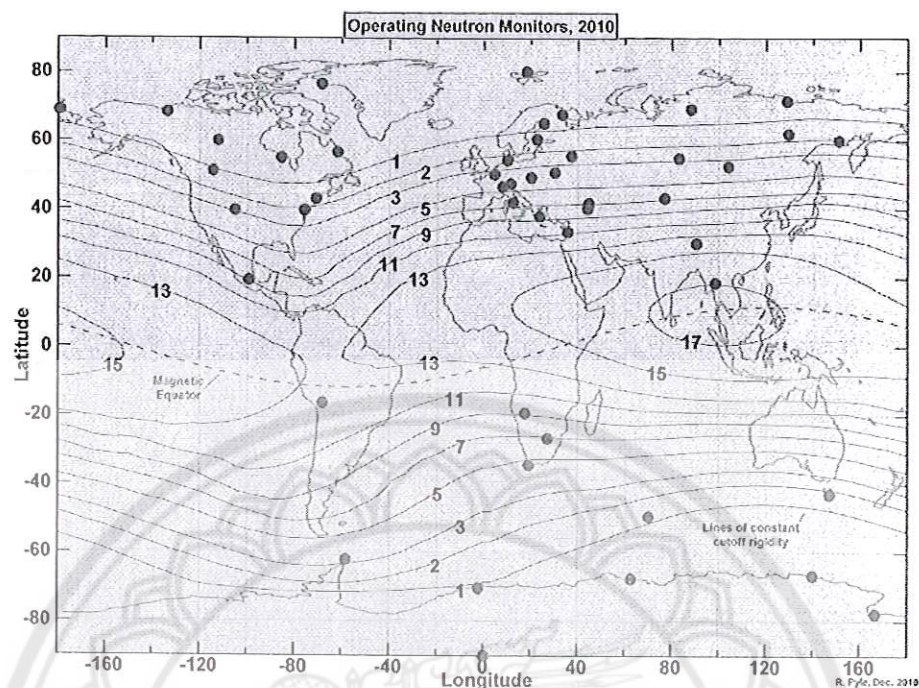


Figure 1 A world map of vertical cutoff rigidity including the location of various neutron monitor stations. The maximum cutoff rigidity of ≈ 17 GV is found in and around Thailand



Figure 2 Princess Sirindhorn Neutron Monitor station in 2009

Objectives

1. To simulate the calibration neutron monitor at Princess Sirindhorn Neutron Monitor station
2. To study other responses and interactions of cosmic rays in the neutron monitor from the calibration neutron monitor simulation
3. To analyze the effect of environment on the count rate of the calibration neutron monitor

Scope of research

In this research, we created the intercalibration monitor model for calibration at Princess Sirindhorn Neutron Monitor station by Simple Geo program. We simulated the interaction process in neutron monitor using FLUKA program with Monte Carlo method. We changed the conditions of the environmental sensitivity to the calibration neutron monitor and then analyzed and compared the results between the neutron count rate of experiments and simulations.

Expected benefits

1. Understand the other responses of cosmic rays to the intercalibration neutron monitor.
2. Understand the information of the high energy cosmic rays that come into the Earth at the highest cutoff rigidity of 16.8 GV, that have never been detected anywhere else.
3. Provide early warning signs to the relevant agencies with precise data for prompt solvable action plan to reduce the incidence of damage.