29th International Cosmic Ray Conference Pune (2005) **00**, 101-103

FLASH-TW experiment status report

T.C. Liu[a], F.Y. Chang[a], C.C. Chen[b], C.W. Chen[b], M.A. Huang[c], W-Y. P.. Hwang[b], G.L. Lin[a]

(a) Institute of Physics, National Chiao-Tung University, 1001 Ta Hsueh Rd., Hsin-chu, 300, TAIWAN, ROC.
(b) Institute of Astrophysics, National Taiwan University, 1, Sec. 4, Roosevelt Rd. Taipei, 106, TAIWAN, ROC.
(c) Department of Physics, National United University, 1, Lien-da, Kung-ching Li, Miao-Li, 36003, TAIWAN, ROC
Presenter: T.C. Liu (tsungcheliu.py92g@nctu.edu.tw), tai-liu-TC-abs1-he15-oral

FLASH-TW is an experiment to measure the shower lateral profile. Electron beams from National Synchrotron Radiation Research Center (NSRRC) at Taiwan are injected to targets, which are made of 15 blocks of 2.9 cm thick aluminum. To cope with large dynamic range of electron density, the central region use a CCD camera to record light from scintillator AF995R; while outer region is monitored by PMTs. This CCD system is successfully implemented in the run 2 and run 3 of experiment FLASH at SLAC. A test run is conducted in NSRRC in late June 2005 to study the spectrum of scintillator. Two more runs are planned in 2005 and 2006 to measure lateral and longitudinal profiles.

1. Introduction

Ultra-high energy cosmic rays (UHECR) have been observed for some time, while the existence of GZK cutoff remains to be a debatable issue among UHECR experiments. Fluorescence detector (Fly's Eye/HiRes) measure the shower longitudinal profile by observing the nitrogen fluorescence light. Charged particle detector array, such as AGASA, measures shower lateral profile, just one slice of longitudinal profile. The disagreement between two types of experiment raises many questions about their systematic errors. Two major weak points related to the disagreement are the fluorescence light yield and shower development.

The main goal of FLASH-TW experiment is to study both longitudinal and lateral profile in the same experimental setup to eliminate any bias in shower development. FLASH-TW experiment [1] will be conducted in National Synchrotron Radiation Research Center (NSRRC) [2] at Taiwan. Although the beam energy is only 1.5 GeV, the beam current is large enough to give the total energy of the order of 0.1 to 1 EeV. The showers were simulated with electron beams shooting into various thickness of Aluminum target.

Main instrument is a platform of two chambers and 15 movable aluminum blocks of size 10cm×10cm×2.9cm. Each block can be moved in or out of beam path. Therefore, it is possible to study shower longitudinal profile in 15 steps of 1/3 radiation length (R.L.). Figure 1 shows the top view of experimental platform. Left chamber contains a 6 hole wheel, which can accommodate several different materials or calibration light source for the experiment. The spectrometer run places the scintillator in the wheel and measures lights outside the chamber. The central part is 15 movable aluminum blocks. The right chamber will be used to measure the lateral profile. Electron beam shoots into the left chamber, showers in aluminum blocks. The resulting secondary electrons travel through the chamber two and hit the scintillator. Figure 2 shows a simulation of shower longitudinal profile of a 1.5 GeV electron shot into Aluminum.

Because of the large dynamic range of electron density on lateral profile, two types of detectors are used. A CCD camera takes image of the high electron density region, while a PMT system works for low electron density region. The CCD system provides coverage fine resolution over large area. It was tested in NSRRC and then used in the FLASH experiments at SLAC [3].

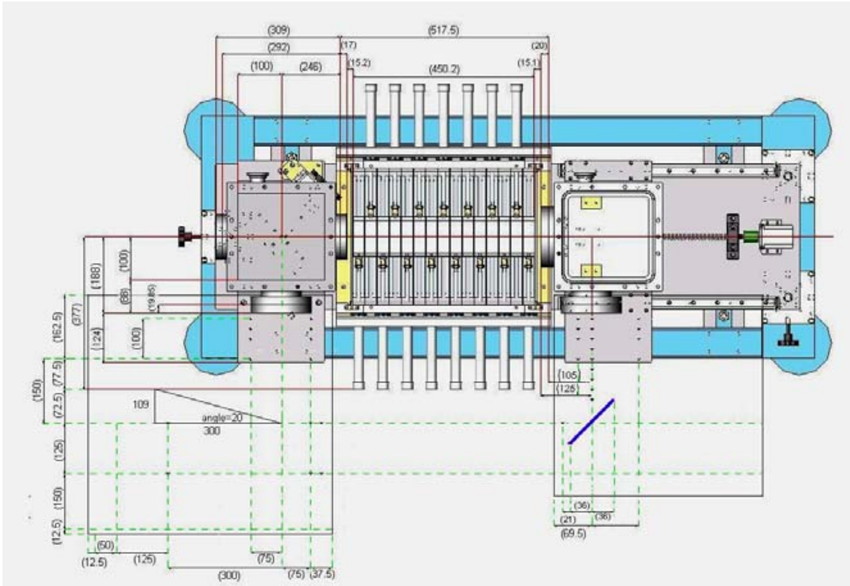

Figure 1. Top view of FLASH-TW experimental platform..

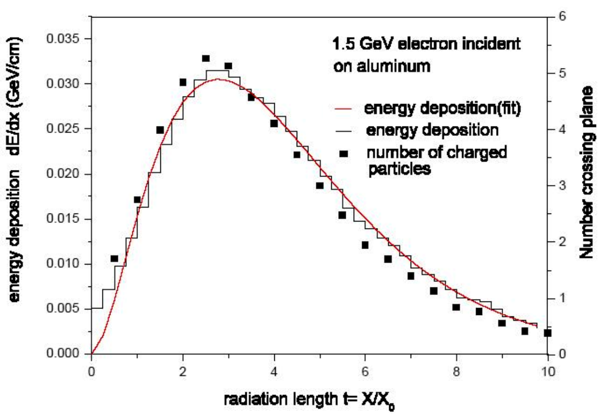

Figure 2. Shower longitudinal profile from a 1.5 GeV electron shooting into 15 Aluminum blocks. 10^6 events are simulated with FLUKA. The histogram is energy deposit in each block from simulation. The red line is a fit to a simple power law growth and a exponential decay. Both histogram and fitted line use the axis in the left side. The square is average number of charged particles and uses the axis on the right side.

2. Preliminary results

Scintillator ($Al_2O_3 + Cr^{3+}$, AF995R, Desmarquest) is widely used for beam monitoring. It is a radiation hard, high photon yield, and heat resistance upto 1850° C. Ref. [4] shows a spectrum of fluorescence photons but only one decay time 3.4 ms is listed.

To prepare for future FLASH-TW experiments, we have a test run to measure the wavelength and decay time of major bands. Delayed by the construction works of NSRRC, this experiment starts in late June 2005, only some preliminary results are presented here. Detail results will be updated in the conference.

Figure 3 show a decay measurement using a photo-diode and digital multi-meter. Electron beams are shoot in 10 Hz interval. Photons produced by scintillator AF995R are detected by a photo-diode. Their signals show a rise in first few ms, believed to be response time of electronics, and then followed by exponential decay. Two distinct wavelengths can be seen, one has wavelength 694.3 nm and 3.4 ms decay time, and the other has wavelength approximately 691 nm and decay time roughly 6.7 ms. A third spectra line may exist and its decay time could be longer than 10 ms. We will report these wavelength, decay time, and relative intensity in the conference.

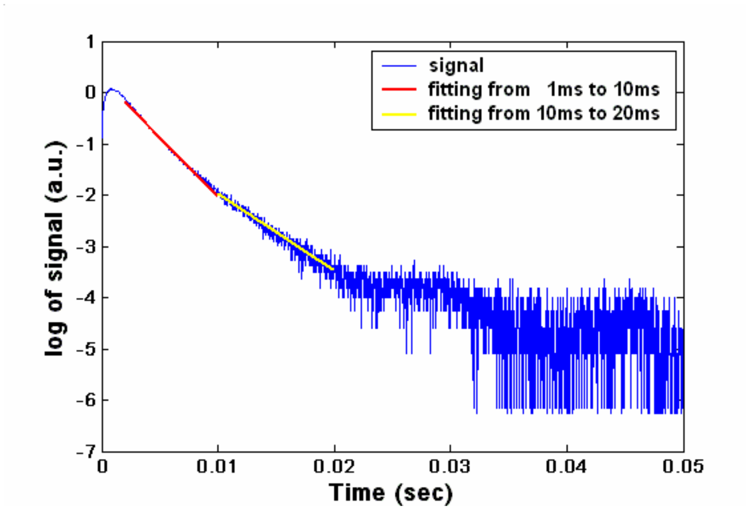

Figure 3. Preliminary results from decay time measurement. Electron beam of 1.5 GeV are shoot to scintillator AF995R. The scintillation photons are detected by a photodiode. The resulting light curve can be fitted with two component exponential decay, shown as red and yellow lines.

3. Acknowledgements

This work was supported by the National Science Council of Taiwan, Republic of China under the grants NSC-93-2112-M-002-025 (C.C. Chen, C.W. Chen, and W-Y.P. Hwang), NSC-93-2112-M-009-001 (T.C. Liu, F.Y. Chang, and G.L. Lin) and NSC-93-2112-M-239-002 (M.A. Huang). We appreciate the generous supports from National Synchrotron Radiation Research Center (NSRRC) at Hsinchu, Taiwan. We also thank K.T. Hsu of NSRRC for many assistances and discussions.

References

[1] http://phys.nuu.edu.tw/mahuang/flash/index.htm
[2] http://www.nsrrc.org.tw/
[3] FLASH collaboration, see proceeding in this conference.
[4] K.J. McCarthy, *et al.*, J. of Applied Phys., **92**, 6541 (2002).