

# JASMIN: Shielding Studies on High Energy Neutron Produced By 120 GeV Protons

Hee-Seock Lee<sup>1\*</sup>, Toshiya Sanami<sup>2</sup>, Yosuke Iwamoto<sup>3</sup>, Tsuyoshi Kajimoto<sup>4</sup>, Nobuhiro Shigyo<sup>4</sup>, , Kiwamu Saito<sup>2</sup>, Masayuki Hagiwara<sup>2</sup>, Hiroshi Yashima<sup>5</sup>, Yoshimi Kasugai<sup>3</sup>, Erik Ramberg<sup>6</sup>, Richard Coleman<sup>6</sup>, Doug Jensen<sup>6</sup>, Aria Meyhoefer<sup>6</sup>, Nikolai V. Mokhov<sup>6</sup>, Anthony F. Leveling<sup>6</sup>, David J. Boehnlein<sup>6</sup>, Kamran Vaziri<sup>6</sup>, Yukio Sakamoto<sup>3</sup>, Hiroshi Nakashima<sup>3</sup>

<sup>1</sup>Pohang Accelerator Laboratory, POSTECH, Pohang, Kyungbuk 790-784, Korea  
<sup>2</sup>High Energy Accelerator Research Organization, Oho, Tsukuba, 305-0801 Japan  
<sup>3</sup>Japan Atomic Energy Agency, Tokai, Ibaraki 319-1195, Japan  
<sup>4</sup>Kyushu University, Motooka, Fukuoka, 819-0395 Japan  
<sup>5</sup>Kyoto University, Kumatori, Osaka 590-0494 Japan  
<sup>6</sup>Fermi National Accelerator Laboratory, Batavia, IL 60510-5011 USA

\*E-mail: lee@postech.ac.kr

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## Introduction

JASMIN - Japanese and American Study of Muon Interaction and Neutron detection - a program for studies of shielding and irradiation effect around high energy proton accelerator at Fermi National Accelerator Laboratory (FNAL) was founded at 2007. The series of experiments and benchmarking studies were carried out until last February. The dose of secondary particles, neutron and muon, from 120 GeV proton were measured using OSL, CR39, TLD and Ion chamber. The neutron spectra from thick Cu target were measured using TOF method. The benchmark were performed for improving the accuracy of the PHITS and MARS codes.

The JASMIN, joint research program is opened for experts in Korea. At this paper, the detail scope of this program and the preliminary results of dose measurement and neutron spectrum measurements are introduced. But other residual activities and radioactive

nuclide production have been carried out using activation experiment concurrently.

## Experiments & Results

The experiments were performed at three facilities in FNAL, the anti proton production (pbar), the Neutrino from Main Injector (NuMI), and the Meson Test Beam Facility (MTBF). All beams are based on 120 GeV proton from Main Injector in FNAL. The beam scheme and structure of NuMI facility is shown in Fig.1 and Fig 2. The OSLs, CR39s, and TLDs were set up

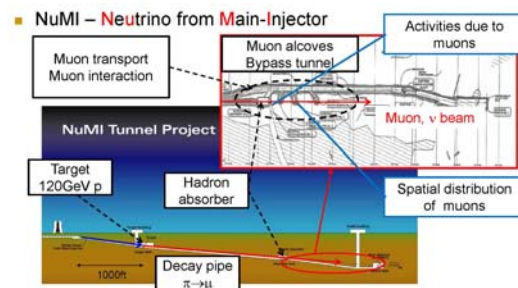


Fig. 1. Structure and beam transport scheme at NuMI facilities.

at alcove2, 3, and 4 to measure the transport of secondary particles of high energy muon. At the same time, the dose distributions at the bypass tunnel were observed using IC and BMS.

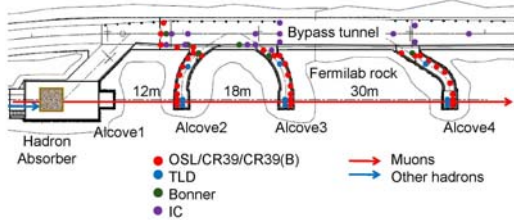


Fig. 2. Distribution map of dosimeters and measuring points.

One of results, dose distribution in Fig. 3 (presented at ISORD-5), showed agreements between measured data and calculation results by MARS, which was in acceptable range.

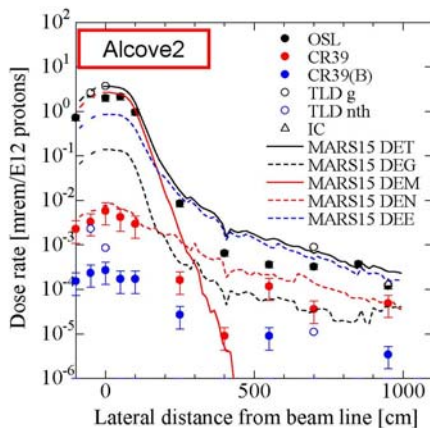


Fig. 3. Experimental and calculated results for dose distribution along alcove 2. DER, DEG, DEM, DEN, DEE means dose rate of total, photon, muon, neutron, and electron, respectively.(presented at ISORD5)

The TOF measurements of neutrons from long Cu target by 120 GeV proton were also performed using unique clean proton beam of MTBF. As shown in Fig. 4, the neutron spectra at the degree of 30 and 90 of incident proton direction are measured using NE213 liquid scintillators. The spectra were compared with results of Monte Carlo simulation using the

PHITS, MARS, and FLUKA codes.

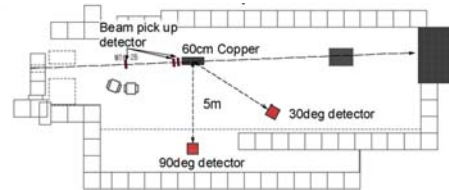


Fig. 4. The experimental geometry of TOF measurements at MT6 of MTBF.

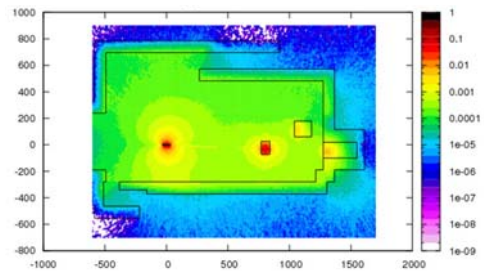


Fig. 5. Typical distribution of calculated neutron flux from Cu target by 120 GeV protons at MT6,

## Summary

The accuracy of typical dosimeters used around high energy accelerator were proved by dose rate measurements. The experimental neutron spectrum were useful for improving high energy Monte Carlo codes by validating the implemented models. In series of this joint research the experimental data will be upgrade successively. This research program is opened to experts and students in Korea, too.

## Reference

1. T. Sanami, et al "Shielding Experiments at High Energy Accelerators of Fermilab (I) - Dose Rate Around High Intensity Muon Beam", Proc. on ISORD-5, Jul 15-17, Tokyo, (2009).