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# Division of Bio-Medical Informatics
# Department of Radiation Biophysics


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The department of Radiation Biophysics was established as one of departments in the Division of Bio-Medical Informatics, in April 2005. Research projects of the department are based on radiation risk evaluations in cooperation with the other departments in the division, and also, previous research projects are continued. The projects for research and service are as follows:

1. Research on collection, arrangement, preservation, and analysis of data and specimens from A-bomb disaster victims. (Reassessment of A-bomb dose at Hiroshima and Nagasaki, and others.)
2. Estimation of radiation doses to residents around Chernobyl and Semipalatinsk, and study of diseases caused by the radiation and underlying mechanisms, examination of the actual conditions of the radiation exposed residents in Semipalatinsk by the survey method.
3. Biological effects of high LET radiation, e.g. neutrons, studies of the mechanism of its influence, and radiation risk estimation.

4 . Research of boron neutron capture therapy using accelerator.
5 . Promotion of international cooperative studies and organizing international symposia on radiation effects.
6 . Public program of radiation information, education and training of radiation medical workers.
7 . Dosimetry and medical assistance in radiation emergency medicine.

Prof. Masaharu Hoshi acts as the following members:
a councilor of Japan Society of Medical Physics. Further, he is a member of an investigative committee for an urgent countermeasure of Nuclear Safety Commission of Japan, an advisor of Hiroshima-Semipalatinsk Project, a member of the investigative committee, a member of Low Dose of Biological Effects in Central Research Institute of Electric Power Industry, a secretary and a member of the working group, a member of the home page (in Korean language) working group of Hiroshima International Council for Health Care of the Radiation-exposed (HICARE), a member of Japan Atomic Energy Commition, a member of The U.N. science committee domestic correspondence committee, a member of The Science Council of Japan Core Science General Research Connection Committee, Japan Radiological Society councilor, Committee member of Physical Dosimetry Network of National Institute of Radiolgical Sciences, a member of Dosimeter Calibration Committee of Association for Nuclear Technology in Medicine, a secretary of Japanese Association for Radiation Research, part time lecturer of Kyushu University, and so forth.
Dr. Satoru Endo is a member of editorial staff of Japan Radiological Society, a councilor of the Japan Radiation Research Society and a member of open school of Atomic Energy Society of Japan.

12th Hiroshima International Symposium -Radiation Effects in Semipalatinsk- on March 2, 2007 was held by Research Institute for Radiation Biology and Medicine, Hiroshima University. The Program of the Symposium is shown in Appendix 2. We have been to semipalatinsk to collect brick samples for the evaluation of external exposure and contamination of soil samples and succeeded in bringing back about 21.6kg of the samples in addition to that obtained in 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006. For this project, we accepted aid from "grant-in-aid for scientific research" of the ministry of education, culture, sports, science, and technology. We are measuring these samples now. Similarly, we are performing the study of the effects of radiation for the children living near the Chernobyl nuclear power plant. The project was supported by Sasakawa memorial health foundation and ended in April 1996. However, similar project will be continued mainly in Russia. We have been Semipalatinsk to explore the realities of hibakusha in Semipalatinsk in terms of the questionnaires and the witnesses. It is possible to clarify their life environment and health condition by means of the questionnaires. The witnesses will show their suffering. Finally, we compare the realities of hibakusha in Semipalatinsk with those in Hiroshima and Nagasaki. By this comparison, radiation effects on hibakusha will be more clear.

### 1. Effects of radiation for residents near Semipalatinsk nuclear test site

Hoshi, M., Endo, S., Tanaka, K., Kawano, N.[*1], Taooka, Y.[*2], Okamoto, T. [*3], Takeichi, N.[*4], Yamada, H., Kimura, A.[*5], Yamamoto, M.[*6], Katayama, H.[*7], Toyoda, S.[*8], Satoh, H.[*9], Ohtaki, M.[*10], Imanaka, T.[*11], Tanaka, K.[*12], Iida, S., Inaba, T.[*13], Matsuo, M.[*14], Stepanenko, V.[*15], Ivannikov, A.[*15], Chaizhunusova, N.[*16], Apsalikov, K.[*16], Rozenson, R.[*16], Gusev, B.[*16], Teleuov, M[*17], Zhumadilov, Zh.[*17], Bhattacharjee, D.[*18] and Whitehead, N.[*19], Shinkarev, S.[*20] ([*1] International Radiation Information Center, [*2] Internal Medicine II, [*3] Grad. Sch. Biomed. Sci., [*4] Takeichi Hiroshima Thyroid Medical Clinic, [*5] Dept. Hematol. Oncol., [*6] Kanazawa Univ., [*7] RERF, [*8] Okayama Univ. Sci., [*9] Ibaraki Prefectural Univ. of Health Sciences, [*10] Department of Environmetrics and Biometrics, [*11] Kyoto Univ., [*12] Institute for Environmental Sciences, [*13] Department of Molecular Oncology and

Leukemia, *14 Institute for Peace Science, *15 MRRC of RAMS, Russia, *16 Kazakh Scientific Res. Inst. Radiat. Med. Ecology, *17 Semipalatinsk Medical Academy, *18 Bhaba Atomic Research Center, India, *19 Whitehead Associates, New Zealand, *20 Institute of Biophysics, Russia)

It is estimated that there are about 500,000 of residents who were exposed by radiations due to nuclear bomb tests at Semipalatinsk nuclear test site. According to journalism, such radiation effects were very hard. However, there are no scientific reports concerning them. In this study, exposed doses for these people will be estimated separately by internal and external exposures. After this estimation thyroid and hematological diseases were examined along with epidemiological studies to verify whether the diseases are due to radiation. The differences between them and Hiroshima and Nagasaki will be considered also.

### 2. Evaluation of Hiroshima and Nagasaki atomic (A-bomb) dose

Hoshi, M., Endo, S., Tanaka, K., Imanaka, T.*1, Shizuma, K.*2, Iwatani, K.*3, Hasai, H., Oka, T.*4, Cullings, H.*5, Shibata, T.*6, Shibata, S.*1 and Komura, K.*7 (*1 Kyoto Univ., *2 Grad. Sch. Eng., *3 Hiroshima Pref. Colleg. Health Welfare, *4 Kure Univ., *5 RERF, *6 KEK, *7 Kanazawa Univ.)

Hiroshima atomic bomb (A-bomb) doses of neutrons and gamma rays have been evaluated. Processes of the evaluations are (1) collection of A-bomb irradiated rocks, roof tiles and etc., and measurements of neutron induced radioactivities, such as $^{152}$Eu Neutron doses of the Hiroshima A-bomb will be evaluated from the measured values of these radioactivities. (2) comparison of the experimental results and the oretical values calculated by a computer code MCNP. In addition to these, we are simulating A-bomb irradiation using the $^{252}$Cf fission neutron source and comparing with the experimentally obtained activity yields in the irradiated material and theoretically calculated yields of them. We are planning to evaluate DS86 and DS02 dose from (1) and (2). Concerning these studies, we are performing collaboration with U.S. groups and with those of Kyoto University and Nara University of Education.

### 3. Dosimetry study of ultrasoft X rays

Hoshi, M., Endo, S., Tanaka, K. and Sasaki, M.* (*Kyoto Univ.)

Energy region of ultrasoft X rays are usually determined to be below 5 keV. These X rays have larger relative biological effectiveness (RBE) for biological materials than those from conventional X ray apparatus or gamma rays, and are considered to have different mechanisms in the induction of biological damages in cells.

Geometrical area of the energy deposition caused by a single absorption of the X rays is as small as the sizes of the DNA double strands. Therefore, the ultrasoft X rays are unique tools to study correlation between physical and chemicalinitial processes induced by ionizations and following biological damage inductions. Such a study of the mechanisms inducing biological damages according to radiation exposures is also useful for the study using neutrons from the neutron irradiator and the $^{252}$Cf source. The explanation should include all of these radiations. At Radiation Biology Center, Kyoto University, effects of absorption of ultrasoft X rays in culture cells have been studied.

### 4. Development of "Monochromatic Energy Neutron Irradiator for Radiobiology Studies"

Hoshi, M., Endo, S., Tanaka, K., Kitagawa, K.* Suga, S.* and Sasatani, S*(*Radiat. Res. Centr. Frontier Sci.)

"Monochromatic Energy Neutron Irradiator for Radiobiology Studies (HIRRAC)" was installed in this institution. The system consists of an accelerator (3MeV, 1mA, Schenkeltype) and three target chambers (Li, Be,

$^{3}$H) for neutron generation and a PIXE target chamber. The accelerator and the two Li (for level and vertical irradiations), the $^{3}$H and the PIXE target chambers were constructed in the $^{252}$Cf irradiation room. Neutrons were mainly produced by the $^{7}$Li(p,n)7Be reaction. The production of neutrons was tested and the neutron dose rates measured by using twin chambers were verified to be more than planned one (30 cGy/min at 5 cm). Installation of the total system was completed until 1994 and dosimetry study (dose-rate and spectrum measurements) will be continued. We are now preparing proton beam extraction system for cell irradiation.

### 5. Evaluation of $^{252}$Cf and monochromatic energy neutron and gamma ray absorbed doses and their beam qualities

Hoshi, M., Endo, S., Tanaka, K., Takatsuji, T.[*1], Onizuka, Y.[*2] and Uehara, S.[*2] ([*1] Nagasaki Univ., [*2] Kyushu Univ.)

A fission neutron source (half life 2.64 years) has a beam quality similar to the Hiroshima and Nagasaki A-bombs. This $^{252}$Cf source has been installed at RIRBM in 1984 to study biological effects of fission neutrons. A monochromatic neutron generator has been installed in RIRBM also. Evaluation of neutron and gamma ray absorbed doses in biological materials and beam qualities of them is the purpose of this study. For the evaluation of doses, paired chambers (a tissue equivalent chamber and a chamber which have sensitivity only to gamma rays) were mainly used, and absorbed dose rates of neutrons and gamma rays in air and in rat and mouse plastic phantoms were determined. To discuss beam qualities a Monte Carlo computer code is used to obtain calculated neutron spectra. This code is one of those used in the project of DS86 dose evaluation. Especially, iron materials (thicknesses are from 10 to 20 cm) are used as attenuator to modify the $^{252}$Cf neutron spectrum closer to that of Hiroshima DS86 neutrons. In this study, dosimetry of neutron beams will be performed, and beam quality in relation to RBE will be discussed. Actually, we are using Drosophila and Onion to study genetic effects and induction of micronuclei, respectively.

### 6. Dosimetry study of neutrons from research reactor institute, Kyoto University and approaches to find their mechanism for biological materials

Hoshi, M., Endo, S., Tanaka, K., Onizuka, Y.[*1], Uehara, S.[*1], Kobayashi, T.[*2], Sakurai, Y.[*2] and Takatsuji, T.[*3] ([*1] Kyushu Univ., [*2] Kyoto Univ., [*3] Nagasaki Univ.)

At the Research Reactor Institute, Kyoto University they are performing two studies such as (1) effects of radiation and (2) brain tumor therapy both using thermal and epi-thermal neutrons. In this study, we are measuring dose and quality of these neutrons. Based on these studies we perform the study to solve the mechanism of damages for biological materials in relation with the other high LET radiation such as HIRRAC mono-energetic neutrons at our institute. Also this study will correspond to the better control of brain tumor. For the evaluation of radiation doses we use three method of dosimetry such as activation of gold wire, LET counter measurements and paired chamber dosimetry and compare each other. For the evaluation of radiation quality, we use LET counter and ultra miniature counter (UMC). We consider relationship between effects of radiation with biological materials.

After this differences with HIRRAC neutrons will be compared. According to these studies we proceed the study of mechanism of the radiation effects for biological materials. Also we will consider the improvement of radiation therapy technique from the side of accurate dosimetry.

### 7. Study of contamination in environment and health effect of the residents in contaminated area according to the Chernobyl accident

Hoshi, M., Endo, S., Tanaka, K., Takatsuji, T.[*1], Sato, H.[*2], Takeichi, N.[*3], Yamada, H., Stepanenko, V. F.[*4], Orlov, M.[*4], Ivannikov, A. I.[*4] Shinakrev, S.[*5], Gavrilin, Yu.[*5], Khulup, H.[*6] and Danilova, L.[*6] ([*1] Nagasaki Univ., [*2] Ibaraki Pref. Univ. Hlth. Sci., [*3] Tekeichi Thyroid Medical Clinic, [*4] MRRC RAMS, Russia, [*5] Institute of Biophysics, Russia, [*6] The Belarusian Medical Academy of Postgraduate Education, Belarus)

Examinations of the children in contaminated area according to the Chernobyl accident have been performed by the Chernobyl Sasakawa Medical and Health Cooperation Project (Chernobyl SMHC Project). The examinations begun in 1991 to help health care for the children of ages from 0 to 10 years old at the time of the accident and include three subjects concerning thyroid gland, blood and $^{137}$Cs whole body counts. This study is to measure $^{137}$Cs in the whole body and to calculate absorbed doses in them. The measurements of soil and food samples at each examiner's house are also planned and relation between children's body and soil contamination will be studied.

We have contracted between Medical Radiological Research Center Russian Academy of Medical Sciences in June 1998, and our institute continues collaboration concerning the problem of Chernobyl.

### 8. Determination of A-bomb doses for survivors registered in Hiroshima by RIRBM, Hiroshima University

Hoshi, M., Endo, S., Tanaka, K. and Ohtaki, M.* (*Dept. Environ. Biomet.)

The radiation doses in Hiroshima and Nagasaki were determined for survivors who are registered at Radiation Effects Research Foundation (RERF). However, the estimation was limited in those at RERF. It was asked to construct a radiation dose estimation system for A-bomb survivors. This study was to make such system at RIRBM, Hiroshima University. It was discussed to make the system by using only published literatures. As a conclusion in such discussion, the best one was to use the Dosimetry System 1986 (DS86) which was published at RERF in 1987. A computer program to obtain estimated doses has been considered and the program was developed. The doses for the survivors calculated by this code are those at inside and outside of Japanese houses. For the estimation, most important factor is to determine distances from the hypocenter which should be known within 100 m error. We will apply ABS93D for the rest of the registered survivors at RIRBM and will compare with those of RERF. The difference of typical dose was about 10%.

### 9. Dosimetry study on Emergency health care

Hoshi, M., Endo, S., Tanaka, K., Toyoda, S.* (*Okayama Univ. Science)

In the case of radiation accident, rapid dose evaluation for the exposed people is important for their health care. The effects of the radiation are totally different from the exposed dose levels. If the dose levels are very high, immediate care will be necessary. We have experiences of the radiation dosimetry in the cases of Semipalatinsk, Chernobyl, and Hiroshima and Nagasaki. However, these dosimetry studies have been performed long after the actual exposures. Therefore rapid dose-evaluation system is necessary to develop in the present program. There are mainly two types of radiations such as exposure by gamma rays and particles. The typical case of the latter one is neutrons. The neutron dosimetry is relatively not difficult since they induce many radioactivities, by which thermal and fast neutron doses will be evaluated. We will improve the methods of neutron dosimetry. However, for the gamma ray estimation, we have not so many ways. We can measure teeth enamel samples or perform dose reconstruction by calculation. In this study we will improve tooth enamel dosimetry and try to find any other way for the gamma-ray dose estimation.

### 10. Research for the secondary fragments from the therapeutic carbon beam at HIMAC

Endo, S., Tanaka, K., Hoshi, M., Onizuka, Y.[*1], Takada, M.[*2], Fukumura, A.[*2], Hayabuchi, N.[*3], Ishikawa, M.[*4], Maeda, N.[*5] ([*1]Kyushu Univ., [*2]NIRS, [*3]Kurume Univ., [*4]Univ. of Tokyo, [*5]Izumisano Hospital)

Purpose of this study is evaluation of the therapeutic heavy ion field at HIMAC, NIRS using the microdosimetry technique. At the results of the previous experiments, Onizuka et al. showed that the relative biological effectiveness (RBE) at the deeper part in tissue was not very strong. These trends differ from the data of LET-RBE relations, which is used for the basic data of therapeutic irradiation. We want to understand how come the differences. To do this, we measure the microdosimetric spectrum for carbon beam and the secondary fragments particles, separately. The microdosimetric spectrum for each fragment and RBE are discussed precisely.

### 11. Evaluation of the neutron and gamma-ray mixed field at UTR-KINKI

Endo, S., Tanaka, K., Hoshi, M., Fujikawa, K.*, Horiguchi, T.*, Ito, T.* (*Kinki Univ.)

Neutron energy spectra measurements of UTR-KINKI using the foil activation method coupled with artificial neural network were performed in 1999-2001. From this study showed characteristics of the neutron field at UTR-KINKI. On the other hand, Fujikawa et al. who is collaborator of this study has shown the biological effectiveness of neutron. In this study, microdosimetric evaluation using LET-counter as the next step. The microdosimetric technique can analyze the relative biological effectiveness from measured spectrum.

### 12. Development of Imaging PIXE

Endo, S., Tanaka, K., Hoshi, M., Shizuma, K.* (*Grad. Sch. Eng., Hiroshima Univ.)

It can contribute to the new research and the development in the field of the medical and material sciences that can analyze the 2 dimensional profile of the element formation. A trace element using the PIXE analysis method which the ion beam from the MeV-accelerator is established for recent thirty years. As 2 dimensional element mapping, a micro-beam was used with PIXE have been tested recently. The structure that the vibration of the beam line is restrained, and enough length are necessary, and a micro-beam costs about one billion yen. On the other hand, SPECTdeveloped recently and used in the medical diagnosis (Single Photon Emission Computer Tomography). If we succeed that the PIXE is combined with the SPECT technique, the 2 dimensional element mapping at the usual accelerator facilities without a micro-beam line can be available.

### 13. Research for the initial interaction of neutron with biological materials

Endo, S., Tanaka, K., Hoshi, M.

For many years at Hiroshima University, we have studied the radiobiological effects of atomic-bomb neutrons using a neutron generator (HIRRAC). Recent developments in track-structure studies and biophysical modeling have made it possible to make an attempt to simulate tracks of low energy neutrons at a molecular level using Monte Carlo track structure simulation methods. In general, neutron collisions with atomic nuclei lead to recoil atomic ions and nuclear reaction products in the form of secondary charged particles. The energies of these particles vary according to the energy of the incident neutrons. In hydrogen containing media such as water and tissue the most important interaction is elastic scattering with hydrogen nuclei (protons), which accounts for more than 90% of energy transfer. Protons are, therefore, considered to be the most important recoil particles for estimating neutron induced radiation effect. The recoil protons and other ions set in motion in the cell, in turn,

interact with the bio-molecule leading to DNA damage and subsequent biological lesions. Most of these recoil protons are low energy particles below 1 MeV energy. Therefore, the motivation for this work arises for a need to simulate the tracks of low energy protons emitted in neutron interactions in tissue as these simulations are needed in biophysical modeling. Although proton track simulation at energies above the Bragg peak has been achieved to a high degree of precision simulations at energies near or below the Bragg peak have not been attempted because of the lack of relevant cross section data. As the hydrogen atom has a different ionization cross section from that of the proton, charge exchange processes (CEP) need to be considered in order to calculate the electronic stopping power for low energy protons. In this study, we have used state of the art Monte Carlo track simulation techniques, in conjunction with the published experimental and established theoretical data, to develop a model for the extension of the proton track simulation in the low energy region.

### 14. Evaluation of material dose due to radioactive iodine at Semipalatinsk Nuclear Test Area

Endo, S., Tanaka, K., Hoshi, M., Nagashima, Y.[*1], Sasa, K.[*1], Yamamoto, M.[*2] ([*1] Univ. of Tsukuba, [*2] Kanazawa Univ.)

The nuclear test of 467 times in total was done at Semipalatinsk nuclear test site of the old Soviet Union between 1990's from 1949. It made 19Mt in total when output is converted into the TNT gunpowder. Radioactivity diffused into the atmosphere, and influenced the large area of about 500km by radioactive fallout. The radioactive fallout was cause of external and internal exposure. The international collaboration was continued to investigate the dose evaluation and health care for the HIBAKUSHA from 1993 to 2005. Recently, inspection by the supersonic medical examination device of the thyroid gland are done, and it was found disease in high frequency. The disease of such a thyroid gland can be thought the influence of radioactive iodine I-131 from a fission product. Furthermore, it has already been clear by Chernobyl accident investigation that the internal exposure from I-131 is dominant. However, there are no data of the radioactive I-131, because it can't be measured any more after the day when a nuclear test was done at several weeks due to the short life of I-131 (eight days). Soil samples are collected from the circumference of Semipalatinsk nuclear test area. If a released long life ($1.57\times 107$ years) I-129 at the same time can be measured, we might determine the effects of I-131. Because a chemical property of I-131 and I-129 is the same, and it becomes possible that it guesses the polluted conditions of I-131.

### 15. Accelerator-based neutron irradiation system for Boron Neutron Capture therapy

Tanaka, K., Endo, S., Hoshi, M., Kobayashi, T.[*1], Bengua, G.[*1] and Nakagawa, Y.[*2] ([*1] Kyoto Univ., [*2] National Kagawa Children's Hospital)

Boron Neutron Capture Therapy (BNCT) is appreciated for its high "Quality of Life (QOL)" derived from the possibility to destroy tumor cells selectively in cellar lever in principle. So far, BNCT treatments has been conducted using reactors. In this case, patients have to move to irradiation facilities, which are far from hospitals, after surgery to debulk the tumor. Installation of the accelerators for BNCT at hospitals will reduce patients' load and risk due to transport. The accelerator-based neutron irradiation systems for BNCT are studied in this topic. The use of $^{7}$Li(p,n)$^{7}$Be neutrons at near-threshold energies and those by 2.5 MeV protons are assumed at present.

### 16. Evaluation of dose by the $^{10}$B(n, α)$^{7}$Li reaction in Boron Neutron Capture Therapy

Tanaka, K., Endo, S., Hoshi, M., Kobayashi, T.[*1], Bengua, G.[*1] and Nakagawa, Y.[*2] ([*1] Kyoto Univ., [*2] National Kagawa Children's Hospital)

The advantage of BNCT is the possibility to destroy tumor cells selectively in cellar lever in principle. This would be realized by concentrating $^{10}B(n, \alpha)^{7}Li$ dose into tumor cells. The final goal of this study is 3-dimensional and on-time evaluation of $^{10}B(n, \alpha)^{7}Li$ dose in *in-vivo* medium. As its first step, the usage of imaging plates will be investigated for 2-dimensional evaluation of $^{10}B(n, \alpha)^{7}Li$ reaction distributions.

**A. Original papers**

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**B. Presentations**

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4. Tanaka, K., Kobayashi, T.[*1], Gerard, B.[*1], Nakagawa, Y.[*2], Endo, S and Hoshi, M. ([*1] Kyoto Univ., [*2] Natl. Kagawa Child. Hospital): Physical aspects of neutron capture therapy, 8th Meeting of Chugoku-Shikoku branch of Japanese society of nuclear physics, Okayama, May, 2006. (R)

5. Hoshi, M.: Dosimetry study by ESR method using tooth enamel samples. Session 4: Development and research of emergency medicine, dosimetry and study program. International collaboration with HICARE and NASHIM related to the education and study for the researchers and doctors, Nagasaki, June 3, 2006. (R, C)

6. Kawano, N.[*1], Hiroshima Univ. Library, Hoshi, M., Kamiya, K.[*2] ([*1] International Radiation Information Center, [*2] Department of Experimental Oncology): Database of the materials concerning the Hiroshima and Nagasaki atomic bombings and other radiation exposures -an outline and its significance-. The 47 Annual

Meeting on Late Effects of Atomic Bombs, Nagasaki, June, 4, 2006. (R, C)

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12. Zhumadilov, K., Ivannikov, A.[*1], Apsalikov, K.[*2], Zhumadilov, Zh.[*3], Zharlyganova, D., Stepanenko, V.[*2], Skvortsov, V.[*2], Berekenova, G.[*3], Toyoda, S.[*4], Endo, S., Tanaka, K., Miyazawa, C.[*5] and Hoshi, M. ([*1] MRRC, Russia, [*2] Kazakh Scientific-Research Institute for Radiation Medicine and Ecology, Kazakhstan, [*3] Semipalatinsk State Medical Academy, Kazakhstan, [*4] Okayama Univ. of Science, [*5] Ohu Univ.): Results of tooth enamel EPR dosimetry for population living in the vicinity of the Semipalatinsk Nuclear Test Site. BiodosEPR-2006, 2nd International Conference on Biodosimetry and 7th International Symposium on EPR Dosimetry and Applications. Bethesda, Maryland, USA, July 10-13, 2006. (R, C)

13. Borysheva, N.[*], Tikunov, D.[*], Ivannikov, A.[*], Skvortsov, V.[*], Stepanenko, V.[*], Hoshi, M. ([*]MRRC, Russia): Absorbed doses in tooth enamel due to external and internal irradiation of human body by $^{134}Cs$ and $^{137}Cs$ isotopes. BiodosEPR-2006, 2nd International Conference on Biodosimetry and 7th International Symposium on EPR Dosimetry and Applications. Bethesda, Maryland, USA, July 10-13, 2006. (R, C)

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20. Hoshi, M.: Dosimetry study for Chernobyl and the other accidents. Symposium of Japan Health Physics Society "20 years after the Chernobyl nuclear power plant accident - scientific explanation of its effects". Tokyo, September 4, 2006. (R, C)

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23. Tanaka, K., Kobayashi, T.[*1], Gerard, B.[*1], Nakagawa, Y.[*2], Endo, S. and Hoshi, M. ([*1] Kyoto Univ., [*2] Natl. Kagawa Child. Hospital): Characterization indexes of moderator assembly for accelerator-based BNCT using $^{7}$Li(p,n) neutrons at proton energy of 2.5 MeV, 12th International Congress on Neutron Capture Therapy, Kagawa, October 9-13, 2006. (R)

24. Kobayashi, T.[*1,*2], Bengua, G.[*2], Tanaka, K., Nakagawa, Y.[*3], Hoshi, M. ([*1] Kyoto Univ. Research Reactor Institute, [*2] Nuclear Engineering Department, Kyoto Univ., [*3] Kagawa National Children's Hospital): Study on Practical Conditions about Target Thickness and Gaussian Proton Energy using Near Threshold $^{7}$Li(p,n)$^{7}$Be Neutrons for BNCT. The Twelfth International Congress on Neutron Capture Therapy (ICNCT-12) Takamatsu, Kagawa October 9-13, 2006. (R)

25. Kumar, A.[*1], Pandey, B. N.[*1], Matsuura, S.[*2], Hoshi, M. and Mishra, K. P.[*1,*3] ([*1] Bhabha Atomic Research Center, Mumbai, India, [*2] Department of Radiation Biology, [*3] International Radiation Information Center): Potential role of herbal drugs involving free radical mechanisms in radioprotection and cancer radiotherapy (Invited Talk). 3rd SFRR-Asia Biennial Meeting, Lonavala, Mumbai, India, January 8, 2007.

26. Kumar, A.[*1], Pandey, B. N.[*1], Matsuura, S.[*2], Hoshi, M. and Mishra, K. P.[*1,*3] ([*1] Bhabha Atomic Research Center, India, [*2] Department of Radiation Biology, [*3] International Radiation Information Center): Detection and Characterization of Free Radicals by ESR Spectroscopy: Methodology and Applications (Invited Talk). International Free Radical School-Research Approaches and Methodologies, Dr Ambedkar College, Nagpur,

India, January, 2007.

27. Khvostunov, I. K.[*1], Nikjoo, H.[*2], Uehara, S.[*3], Hoshi, M., Endo, S. ([*1] MRRC, RAMS, Russia, [*2] Center for Advanced Space Studies, NASA, USA, [*3] Kyushu Univ.): The Microdosimetric Consideration of RBE of Low-Energy Proton on V79 Cells. III International symposium "Problems of Biochemistry, Radiation and Space Biology", Moscow, Dubna, January 24-28, 2007. (R, C)

28. Kumar, A.[*1], Pandey, B. N.[*1], Matsuura, S.[*2], Hoshi, M. and Mishra, K. P.[*1,*3] ([*1] Bhabha Atomic Research Center, India, [*2] Department of Radiation Biology, [*3] International Radiation Information Center): Radiation Oxidative Damage with Relevance to Cellular Apoptosis (Invited Talk). International Conference on Frontiers in Radiation and Photochemistry (PhotoRadChem-2007), Kottayam. Kerala, India, February 8, 2007. (R, C)

29. Kumar, A.[*1], Pandey, B. N.[*1], Matsuura, S.[*2], Hoshi, M. and Mishra, K. P.[*1,*3] ([*1] Bhabha Atomic Research Center, India, [*2] Department of Radiation Biology, [*3] International Radiation Information Center): Potential and Prospects of Nano-size Liposomes for Targeted Drug Delivery in Improving Cancer Therapy (Invited Talk). National Symposium on Biophysics: Trends in Biomedical Research, IBS 2007, All India Institute of Medical Sciences, Delhi, India, February 13, 2007.

30. Mishra, K. P.[*1,*2], Matsuura, S.[*3] and Hoshi, M. ([*1] Atomic Research Center, India, [*2] International Radiation Information Center, [*3] Department of Radiation Biology): Low Dose Radiation and Antioxidants Suppress High Dose Radiation Induced Tumor in Mice: Perspectives to Low Dose Health Effects. 12th Hiroshima International Symposium -Radiation Effects in Semipalatinsk-, Hiroshima, Japan, March 2, 2007.

31. Kumar, A.[*1], Pandey, B. N.[*1], Matsuura, S.[*2], Hoshi, M. and Mishra, K. P.[*1,*3] ([*1] Bhabha Atomic Research Center, India, [*2] Department of Radiation Biology, [*3] International Radiation Information Center): Potential and Prospects of Nanosize Liposomes for Targeted Drug Delivery in Improving Cancer Therapy (Invited Talk). Symposium of Biophysical Society of Japan, National Institute of Natural Sciences, Okazaki, Japan, March 16, 2007.

32. Berikkhanova, K.[*1], Hoshi, M., Honda, H.[*2] and Zhumadilov, Zh. Sh.[*3] ([*1] International Radiation Information Center, [*2] Dep. Developmental Biology, [*3] Semipalatinsk State Medical Academy, Kazakhstan): Treatment of surgical infection in Semipalatinsk region. 12th Hiroshima International Symposium. -Radiation Effects in Semipalatinsk-, Hiroshima, March 2, 2006. (R, C)

33. Endo, S.: First results of I-129 contamination in soil samples of Dolon village near Semipalatinsk Nuclear Test Site Area. 12th Hiroshima International -Symposium Radiation Effects in Semipalatinsk-. Hiroshima, March 2, 2007. (R, C)

34. Hoshi, M.: Dosimetry system 2002 (DS02) for the atomic bomb survivors in Hiroshima and Nagasaki. University of Tsukuba - KEK collaborative seminar "New developments for the use of interdisciplinary study using heavy ion beams of the Multi Tandem static electricity accelerator - results and movements for UTTAC new research study". Tsukuba, March 16, 2007. (R, C)

35. Endo, S., Tomita, J.[*1], Tanaka, K., Yamamoto, M.[*1], Fukutani, S.[*2], Imanaka, T.[*2], Amano, H.[*3], Kawamura, H.

[*4], Kawamura, K.[*5] and Hoshi, M.([*1] Kanazawa Univ., [*2] Kyoto Univ., [*3] JAEA Mutsu, [*4] Kyushu Environmental Evaluation Association, [*5] Japan Agency for Marine-Earth Science and Technology): First results of $^{129}I$ contamination measurement in soil samples of the Dolon village near the Semipalatinsk Nuclear Test Site. 8th workshop for environmental radioactivity, Tsukuba, March 22-24, 2007. (R, C)

C. Others

1. Hoshi, M.: Dosimetry study in Hiroshima and Nagasaki according to the collaborative study between Japan and US, and exposure and its effects for the residents near Semipalatinsk nuclear test site. Fukuoka, July 4, 2006.

2. Hoshi, M.: Measurements of radiation II: Dosimetry and examples. The 1st emergency medicine seminar. Chiba, September 20-21, 2006.

3. Hoshi, M.: Radiation and its comprehensive explanation. Lectures at the technicians' center. Hiroshima, November 27, 2006.

4. Hoshi, M.: Report "Study of exposure and dosimetry and its role". Post COE 1st preparation symposium "For the total analysis of the disaster of the atomic bomb" (Joint operation of Research Institute for Radiation Biology and Medicine, Hiroshima University, Hiroshima University Archives, Institute for Peace Science, Hiroshima University). Hiroshima, December 19, 2006.

5. Hoshi, M.: Study of radiation in Chernobyl and Semipalatinsk. 2007 (14th) emergency medicine seminar (under auspices of Fukushima emergency medicine Hospitals association). Koriyama, March 8, 2007.

6. Hoshi, M.: Radiation and its comprehensive explanation. Lectures by specialists in medicine - considering our activity of medical supports in Belarus. Fukuoka, March 18, 2007.

7. Endo, S.: Let's watch radiations using cloud chamber. Open school of Atomic Energy Society of Japan, July 5, 2006.

**Appendix 1**

**Scientific Lecture**

Period: 25 May, 2006

Venue: 5th lecture room, School of Medicine, Hiroshima University

"Comparative study of embryo growth disorder between Chernobyl and Hiroshima and Nagasaki"

Lazjuk Gennadj (Belorussian State Medical University)

**Appendix 2**

**12th Hiroshima International Symposium**

**-Radiation Effects in Semipalatinsk-**

Period: 2 March, 2007

Venue: Kojin Kaikan, Hiroshima University

1-2-3 Kasumi, Minami-Ku, 734-8551 Hiroshima

Sponsorship: Research Institute for Radiation Biology and Medicine, Hiroshima University

Co-sponsorship: Institute for Peace Science, Hiroshima University

Hiroshima University Archives

Hiroshima University 21st Century COE Program "Radiation Casualty Medical Research Center"

Hiroshima International Council for Health Care of the Radiation-exposed (HICARE)

Organizer: Masaharu Hoshi, Megu Ohtaki (Hiroshima University)

09:30 Opening Address (Fumio Suzuki)

Part I. Radiation exposure study in Kazakhstan (Chairperson: Akiro Kimura)

09:40 "Analyze and perspectives of further collaboration"

Kazbek Apsalikov (Kazakh Scientific Research Institute for Radiation Medicine and Ecology, Kazakhstan)

10:10 "Radiation effects and chromosome aberrations"

Nailya Chaizhunussova (Kazakh Scientific Research Institute for Radiation Medicine and Ecology, Kazakhstan)

10:40 Coffee break

Part II. Radiation exposure study in Kazakhstan (Chairperson: Masayoshi Yamamoto)

10:50 "Incidence of systemic arterial hypertension and ischemic heart disease among the groups of population exposed to radiation due to nuclear explosions"

Gulnara Azhmuratova (Kazakh Scientific Research Institute for Radiation Medicine and Ecology, Kazakhstan)

11:20 "Treatment of surgical infection in Semipalatinsk region"

Kulzhan Berikkhanova (Research Institute for Radiation Biology and Medicine, Hiroshima

University)

11:50 Lunch Time

Part III. Worldwide Study of radiation exposure (Chairperson: Dr. Masatsugu Matsuo)

13:20 "Health effect study according to questionnaire surveys in Mongolia"
Nyamsuren Tuvshinbat (Shastin Clinical Hospital / IPPNW, Mongolia)

13:50 "Low dose radiation and antioxidants suppress high dose radiation-induced tumor induction in mice: Perspectives to low dose health effects"
Kaushala Prasad Mishra (Research Institute for Radiation Biology and Medicine, Hiroshima University)

14:20 Coffee break

Part IV. Radiation exposure study by scientists in this country (Chairperson: Megu Ohtaki)

14:40 "Contamination problems in residents near Semipalatinsk nuclear test site -Measurement of radioactivities and future prospect of our study-"
Masayoshi Yamamoto (Institute of Nature and Environmental Technology, Kanazawa University)

15:00 "First results of I-129 contamination in soil samples of Dolon village near Semipalatinsk Nuclear Test Site Area"
Satoru Endo (Research Institute for Radiation Biology and Medicine, Hiroshima University)

15:20 "Genetic mutations in myelodysplastic syndrome (MDS) and leukemia among the residents of Semipalatinsk"
Akiro Kimura (Research Institute for Radiation Biology and Medicine, Hiroshima University)

15:40 Coffee break

16:00 Discussion (Chairperson: Masaharu Hoshi, Masatsugu Matsuo, Kaushala Prasad Mishra)

17:00 Closing Address (Masaharu Hoshi)

17:20 Reception