Anderson, Donovan; Hinton, Thomas; Mathew, Thomas
Colorado State University
Donovan.anderson@colostate.edu

Title: **Cesium and Plutonium Partitioning in Boar**

The project will examine the partitioning of Cs and Pu in tissues of free-ranging wild boar chronically exposed to fallout from the accident at Fukushima. The Fukushima Dachii event altered the way Cs and Pu behave in the environment and there is currently no way to directly correlate existing models to describe current Fukushima Prefecture conditions. We predict that the Pu concentrations will differ in young wild boar due to an expected higher metabolic rate of calcareous tissues in young animals as they are actively developing. Pu is known to concentrate in bones of animals, while Cs concentrates in soft tissues. However, the factors that govern isotopic partitioning and sequestering among tissues is not understood well enough to be reliably predicable. Tissues and organs will be measured via gamma ray spectroscopy to determine the internal dose due to ingested and inhaled Cs-134 and Cs-137. We expect to be able to to calibrate field whole-body assay methods for determining the concentrations of radionuclides in live animals at the time of capture by analyzing the the tissue specific distribution data. Our data will complement and support the existing monitoring programs conducted by the national and prefecture governments in Japan. The data can also support the estimated risk to wild boar chronically exposed to radiation at levels sufficient to cause evacuation by humans. Results will be gathered Summer 2016.

Bell, Justin; Mann, Kelly; Kraft, Susan; Brandl, Alexander
Colorado State University
justin.bell@colostate.edu

Title: **Mote Carlo based internal dosimetry assessment of cancer bearing canine patients treated with ^{64}Cu-ATSM**

^{64}Copper (II)-diacetyl-bis(N^4-methylthiosemicarbazone), ^{64}Cu-ATSM, is a novel radiopharmaceutical with translational value, currently being assessed at the Colorado State University Veterinary Teaching Hospital as a cancer theranostic agent for canine patients. The biokinetic properties of the carrier molecule, ATSM, are selective for hypoxic regions within the body producing unique internal distributions of the radiopharmaceutical. ATSM's selectivity for hypoxic tissue, coupled with the unique decay of ^{64}Cu allow for hypoxic imaging via Positron emission tomography paired with computed tomography (PET-CT) with possible therapeutic gain from the emission of Auger electrons. Utilizing the patient's acquired PET-CT images, patient specific voxelized models were created and converted into Monte Carlo N-Particle (MCNP) input files to assess the radiation dose each patient received from treatment with ^{64}Cu-ATSM. This internal dose assessment allows for the identification of dose limiting tissues and provides necessary information concerning the possible therapeutic benefits or damages that altering the administered dose of ^{64}Cu-ATSM may have in future trials.

Brassard, Richard
Colorado State University
richardtime402@gmail.com

Title: **Shielding Verification after Occupancy Changes Near a Linear Accelerator**

The Colorado State University Veterinary Medical Center is in the process of undergoing renovations along with relocating office space. Changes to immediate area surrounding the accelerator necessitates a change in the occupancy factor for rooms adjacent to the Varian Trilogy Linear Accelerator to ensure compliance with occupational and public dose limits. Although a complete shielding survey was accomplished upon commissioning of the accelerator, changes in room location and removal of walls will require a new complete survey of the re-purposed rooms. Previous surveys demonstrated that NCRP 147 predictive models, did not directly correspond to measured doses. A Reuter Stokes RSS-120 high pressure ion chamber was used to measure dose rates for the rooms in question. Our goal is to determine if additional shielding is needed, or occupancy must be limited in order to keep doses as low as reasonably achievable (ALARA), while also meeting occupational, and public dose limits.

Brogan, John R.; Brandl, Alexander
Colorado State University
richardtime402@gmail.com

Title: **Development of Bayesian Statistical Algorithms for Radiation Detection at the Decision Threshold**

The detection, localization, and identification of special nuclear materials (SNM) continue to present both technological and data assessment challenges. They emit weak radiation signatures that become increasingly difficult to discern when shielded by materials in containers, by natural or man-made structures, or when they coincide with natural background radiation. Regularly used detection media employ frequentist statistics in their analysis, but have the disadvantage of discarding useful past measurement data. For that reason, there has been an increasing interest in using Bayesian statistics for the detection and analysis of SNM. Currently, no uniform agreement upon the Bayesian theory of measurement uncertainty and characteristic limits exists. More specifically, a decision threshold utilizing a Bayesian approach has not been established. International standards utilize an approach where the prior distribution is shaped by the a priori knowledge that the count rate is always non-negative when the activity of a radiation source is the measurand. Alternatively, a system involving the use of priors that include a finite probability where the source rate is exactly zero has also been developed. This model is referred to as "zero-inflated." We propose to enhance existing and future data analysis tools by developing Bayesian statistical algorithms that will provide improved detection and identification capabilities for radiation detection instruments. Our goal will be aided by creating computational designs of the Bayesian approaches mentioned above. This investigation will shed light on how these two processes either compare or contrast, including the ability to optimize both approaches and implement them into a statistical algorithm.

Byrnes, Ian; Johnson, Thomas
Colorado State University
itbyrnes@colostate.edu

Title: **Radiocesium dynamics in irrigation ponds in the proximity of Fukushima Dai-ichi Nuclear Generating Station**

The goal of this research is to better understand the dynamics of radiocesium in irrigation ponds located in the ten kilometer deposition zone surrounding the Fukushima Dai-ichi nuclear accident site in Japan. Four ponds have been selected for sampling. A soil coring tool will be utilized to extract samples from the bottom of each pond. Upon returning the samples to the lab, they will be sliced and prepped for analysis. Preparation will include chemical sequential extraction to separate elements not bonded with any ions in the soil. Bonded radiocesium will not transport through the environment. Once extracted, the soil will be counted for radiocesium content via gamma spectroscopy. This will provide a measure of the isotope in the ponds and is the primary focus of this research.

In addition, each of these ponds will be modeled via MOIRA – LAKE. MOIRA – LAKE is a computerized tool to choose optimal intervention techniques for contaminated lakes and ponds. The model will be used to make a long term assessment of the dynamics of cesium in the four ponds. Assuming the ideal results, the field data will validate the model. Our research will support a greater effort to understand and correctly model the transportation of radiocesium in the irrigation ponds surrounding the Fukushima Dai-ichi accident site. Utilizing the model for exchange strategies to mitigate the risk of exposure will be developed.

Carradine, Matthew
Colorado State University
Matt.Carradine@colostate.edu

Title: **Vertical distribution of radiocesium in soils and sediment deposits on the contaminated areas after the Fukushima Daiichi Nuclear Power Plant accident**

An accident at the Fukushima Daiichi Nulcear Power Plant (FDNPP) occurred on March 11, 2011 which resulted in an environmental contamination of radiocesium species ^{134}Cs and ^{137}Cs. Due to the long half-lives of the species, contamination has been prevalent in the area surrounding FDNPP for years. The purpose of this research is to study the vertical distribution of radiocesium in different soils contaminated after the accident. A soil core sampler will be used to collect soil core samples to be profiled and analyzed. It is important to study the vertical distribution because it affects dose rate, wash-off by surface runoff, wind resuspension and soil to plant transfer. The results will be compared to data on radiocesium vertical migration in the Chernobyl zone for a similar period after the accident and data observed in Fukushima contaminated area (Konoplev et al. 1992; Konoplev et al., 2015). The expectation of this research is that it will yield reliable predictions of future soil contamination in the Fukushima District.

Gift, Matthew; Rademacher, Steven; Johnson, Thomas
Colorado State University
mgift@colostate.edu

Title: **Characterization of Dose Rate Discrepancies between Energy Compensated Geiger Muller Tubes and Pressurized Ionization Chambers Due to Cosmic Radiation**

The goal of this research is to characterize the bias of energy compensated Geiger Mueller (GM) tubes versus pressurized ionization chambers (PIC) due to cosmic radiation. Energy compensated GM tubes are gaining popularity in the industry, however, they over-sensitive to high energy cosmic radiation which leads to inaccurate measurements of dose rates. Since dose rate measurements are of high importance in radiation protection, it is crucial to have a method to provide accurate measurements. The difference in response due to muons versus photons can be modeled using Electron Gamma Shower (EGS) software to characterize this bias. The response to muons was chosen since they provide the largest additional contribution other than photon-electron showers to the cosmic ray dose for relatively low altitudes. The differences in detector response can be obtained based on the average energy deposition per particle in the detector. The average energy deposited in the detector can be calculated from the average chord lengths of a simulated GM tube, and the stopping power of each particle. Once the bias is characterized, energy compensated GM tubes can be adjusted to measure dose rates equivalent to those measured with a pressurized ionization chamber.

Halim, Nadia; Johnson, T.E.; Hinton, T.G.; Bailey, S.M.
Colorado State University
nhalim@rams.colostate.edu

Title: **Quantifying Biomarkers in Wildlife Exposed to Low Doses of Environmental Radiation**

Exposure of free-ranging wildlife to environmental radiation is of concern following the nuclear accident at the Fukushima-Daiichi facilities in 2011. The uncertainty associated with exposure to chronic ionizing radiation in the vicinity of the accident continues to confuse the general population, as well as produce conflicting scientific results. The appropriate risk factor to use when considering chronic, low dose/low dose rate radiation exposures, especially to wildlife, remains relatively unknown. Here, we propose estimating chronic radiation dose to wild boar exposed to low levels of lingering environmental ionizing radiation in Fukushima prefecture, as compared to wild boar residing in areas experiencing only natural background radiation. Blood samples will be collected from wild boar at five sites throughout the Fukushima prefecture, and at the more isolated Sadogashima Island. Physical dose will be estimated using extensive field survey radiation data. Biomarkers of radiation exposure will also be evaluated, including quantification of chromosome aberrations (dicentrics, reciprocal translocations) and telomere length. It is expected that exposure of wild boar to low-dose, long-term radiation in Fukushima prefecture will not result in statistically significant increases in chromosome aberrations or decreased telomere length. The data obtained from this investigation will greatly assist the field of health physics by providing direct measures of environmental radiation exposure and DNA abnormalities in wildlife following a nuclear accident.

Reference:
Brenner, D. et al. 2003. Cancer risks attributable to low doses of ionizing radiation: Assessing what we really know. *PNAS* 100:13761

Heard, Jadtrl; Johnson, Thomas; Hinton, Thomas;
Colorado State University
jadtrl.heard@colostate.edu

Title: **Electron Spin Resonance of Plutonium and Cesium in mammalian wildlife near Fukushima Daiichi Nuclear Power Plant**

The purpose of this experiment is to conduct a dose assessment of Plutonium and Cesium in the bones of wild mammalian located near the Fukushima Daiichi Nuclear Power Plant (FDNPP). Cesium and Plutonium accumulate and are cleared at different rates in the muscles, bones, and other organs of the mammal. A Plutonium bone dose is permanent and is not cleared out of the animal's system as an organ dose is. Cesium has in the past been labeled as a "bone seeker", but that title is now being challenged because of lack of actual evidence to support this notion relative to Cesium itself. In order to measure the dose of the bones I will employ electron spin response. Electron spin resonance, or sometimes referred to as electron paramagnetic resonance, is a spectroscopic technique for studying materials with unpaired electrons.

Bone is an integrating dosimeter which records the radiation history of the skeleton. When irradiation occurs, electrons become trapped in the hydroxyapatite, crystalline component of bone mineral. The population of trapped unpaired electrons is proportional to the radiation dose administered to the bone and can be measured in excised bone samples using electron spin resonance. Bone is an in-vivo linear dosimeter which can be exploited to develop accurate estimates of the radiation dose delivered during the nuclear accident. The test subjects of this experiment are the wild boar and monkeys located in the Fukushima Prefecture. During the nuclear incident it was assumed that all wild life in the area had become contaminated. As time has passed, researchers are not quite sure how much dose has remained in the animal population, and are the animals actually "contaminated". The results of this experiment will assist in spreading knowledge about the internal dose received by the wildlife of that area.

Labrake, Michael
Colorado State University
mlabrake@colostate.edu

Title: **Detection of Nuclear Material below Counting Threshold**

The persistent presence of background radiation affects nearly all measurements of radioactive materials. Since no shielding provides complete protection against natural background radiation, including cosmic radiation and naturally occurring radionuclides, nuclear instruments will nearly always register at least minor indicators of radioactivity. Background radiation will thus be present in nearly any measurement intended to ascertain radioactivity presence and must be accounted for in measurements. Rigorous statistical analyses of background radiation distributions will enable more accurate methods to detect presence of nuclear materials. Current methods require detection of a minimum threshold of counts, which may ignore the statistical significance of the presence of a high number of counts just below the threshold considered to indicate presence of a radioactive material. This study will establish background radiation distributions, which will subsequently be utilized to develop a more reliable method for detecting hidden or well-shielded nuclear materials. The method will be tested in a laboratory setting to analyze the robustness of the algorithm, using common radiation detection instrumentation.

Mann, Jenelle
Colorado State University
jenelle.e.mann@gmail.com

Title: **Improved Detection of Radioactive Material Using a Series of Measurements**

The goal of this project is to develop improved algorithms for detection of radioactive sources that have low signal compared to background. The detection of low signal sources is of interest in national security applications where the source may have weak ionizing radiation emissions, is heavily shielded, or the counting time is short (such as portal monitoring). Traditionally to distinguish signal from background the decision threshold (y^*) is calculated by taking a long background count and limiting the false negative error (α error) to 5%. Some problems with this method include: background is constantly changing due to natural environmental fluctuations and large amounts of data are being taken as the detector continuously scans that are not utilized.

If the continuously scanned background data is utilized, in many circumstances the decision threshold can be decreased by taking into account if the previous measurement exceeded or was less than the decision threshold. A new decision threshold (y^*_{new}) can be calculated by holding the cumulative probability the next measurement will exceed the decision threshold constant. For instance, if the decision threshold is calculated as a false positive error of 5% and the background measurement is below the decision threshold for greater than 95% of the time, the new decision threshold can be decreased until the background measurement exceeds the decision threshold 5% of the time. This allows for increased detection capability at low signal compared to background.

Several possible background distributions are discussed: rectangular, triangular, sinusoidal, Poisson, and Gaussian.

Marcinko, Rion; Johnson, Thomas
Colorado State University
rmarcinko@gmail.com

Title: **Calibration of an Irradiation Facility**

The purpose of this study was to accurately and precisely determine dose rates at different locations at an irradiation facility. The irradiation platforms were first examined for “hot spots” using GAFChromic © film to provide a qualitative estimate of the dose distribution. A quantitative assessment of doses was then performed using Fricke Dosimetry (a primary standard). Finally, MCNP modeling was used to simulate irradiation at the various measured points and intermediate points in the radiation field. The results were used to provide dose rates within the radiation field for future researchers, and demonstrated how precision and accuracy vary using theoretical (MCNP) and measurement methodology. The hypothesis for this project was that the MCNP results will match the measurements within 10%, or the limitations of the dosimetry.

Miller, Vivien
Colorado State University
vivien.miller@colostate.edu

Title: **Dynamic Modeling of Cesium in a Eutrophic Pond through Deterministic and Stochastic Methods**

The experimental addition of 4 kg of Cs-133 to an 11-ha eutrophic pond in South Carolina, USA, has provided the opportunity to obtain a robust set of measurements of Cs concentrations in the water and biota. These measures, along with estimates of the biota's biomass, allowed for the modeling and evaluation of the kinetic behavior of Cs in the pond. This data set is unique because it supports the estimation of the inventory of Cs in each of the biotic components for several hundred days following the Cs release. A deterministic compartment model is proposed to quantify the major flow paths of Cs through the pond's different trophic levels. The model estimates uptake, loss, and transfer coefficients between the different compartments through evaluating the solutions to a proposed set of differential equations. The ability to estimate transfer coefficients from these data allows for a kinetic evaluation of the Cs behavior that is not possible with only concentration data. Initially, time invariant transfer coefficients are estimated and used, though the impact of seasonal variations such as water temperature will also be evaluated. An initial evaluation of the model structure and its parameter estimates obtained by comparing the projected pattern of Cs dynamics among its components to those observed among the pond's biota support the proposed model. Subsequently, the model framework will be subject to Markov Chain and Bayesian Inference stochastic approaches to evaluate how these compare to the deterministic methodology. A potential benefit of the Bayesian approach is that prior knowledge on the behavior of Cs flow can incorporated in the model. Given the data provided from the lake study and an appropriate prior distribution, a posterior distribution that displays the uncertainty in the results can be obtained. Additionally, the method of approximate Bayesian computation is evaluated to see if the parameters and their uncertainties may be estimated simultaneously. It is anticipated that the transfer coefficients obtained through the Bayesian approach will have the additional benefit of an associated uncertainty distribution for each parameter, and this will be useful for better understanding the kinetic behavior of Cs-133 in the pond.

Ordinario, Donald; Brandl, Alexander
Colorado State University
donaldordinario@yahoo.com

Title: **Neutron/Muon Correlation Functions to Improve Neutron Detection Capabilities outside Nuclear Facilities**

The natural neutron background rate is largely due to cosmic ray interactions in the atmosphere and the subsequent neutron emission from the interaction products. The neutron background is part of a larger cosmic radiation shower that also includes electrons, gamma rays, and muons. Since neutrons interact much differently than muons in building materials, the muon and neutron fluence rates in the natural background can be compared to the measured muon and neutron fluence rate when shielded by common building materials. The simultaneous measurement of muon and neutron fluence rates might allow for an earlier identification of man-made neutron sources, such as hidden nuclear materials. This study will compare natural background neutron rates to computer simulated neutron rates shielded by common structural and building materials. Correlation functions will be determined to predict neutron fluence rates in different urban environments. A comparison of predictions using the correlation functions will be made to operational measurement results to determine the usefulness of neutron/muon fluence correlation factors in discovering hidden nuclear materials.

Owens, Andrew; Bertelli, Luiz; Sugarman, Steve; Johnson, Thomas
Colorado State University
andrew.owens@colostate.edu

Title: **Rapid Acute Radiation Dose Assessment Using MCNP6**

Acute radiation doses due to physical contact with a high-activity radioactive source have proven to be an occupational hazard. Multiple injuries have been reported due to manipulating a source with bare hands or placing a source inside a shirt or pants pockets. An effort to reconstruct the radiation dose must be performed in order to properly assess and medically manage the potential biological effects such doses. Dose reconstruction involves multiple parameters, including, but not limited to, time and distance estimates and the utilization of available dose coefficients. Skin dose, dose to organs, and isodose curves associated with contact radiation doses will be assessed using MCNP6 with the ICRP 110 voxel phantoms for various photon and beta particle energies. The simulated sources will be unshielded so the data will not include secondary particles generated from interactions with a shielding material. The results obtained will be plotted as dose vs. energy for both photons and beta particles. The resulting skin and organ doses as a function of energy could be used to interpolate doses from various nuclides given their energies and energy intensities. This work will be used as a tool in the field to rapidly ascertain skin dose, doses to organs, and the doses across the body explicitly from beta and gamma sources.

Phillips, Preston; Borak, T.B.; Weil, M.M.
Colorado State University
preston5789@gmail.com

Title: **Dosimetry for Low Dose Rate Neutron Exposures in Mice**

Astronauts will be exposed to low dose rates (~0.5 to 1 mGy per day) from galactic cosmic rays (GCR) during space exploration missions. A projected mission to Mars will have a duration up to 1000 days. There is considerable uncertainty in risk estimates for carcinogenesis particularly in extrapolation from acute to chronic exposures (e.g., inverse dose rate effect). The purpose of this study is to compare incidence of cancer in mice following 100 to 400 days of continuous exposure at 1 mGy per 20 hour day with the incidence of cancer following acute exposures on the order of minutes to the same doses. The methodology is based on using fast neutrons as a high LET surrogate for GCR. Chronic exposures will be made using fission neutrons from ^{252}Cf and the acute exposures will be made at the USGS Triga Reactor facility. Mixed filed dosimetry presents several challenges relating to photon contamination and neutron energy distributions that might differ between the two protocols. This presentation will describe the suite of detectors and instrumentation assembled to characterize dose and radiation quality. These include a miniature GM counter, ^{7}LiF TLDs, threshold activation foils, bubble detectors and a tissue equivalent proportional counter. Monte Carlo computations will be used to design the experiments and supplement measurements where necessary. Results from these investigations apply to radiation health in general since carcinogenesis studies from whole-body chronic exposures to high LET radiations at 1 mGy per day have not been performed. Acknowledgements: This work supported through NASA NSCOR Grant NNX15AK13G.

Takada, Momo; Yamada, Toshihiro; Okuda, Toshinori
Hiroshima University
taka-momo@hiroshima-u.ac.jp

Title: **Spatio-temporal variation of radiocesium in soil in Japanese mixed deciduous forests**

Radioactive materials released from the Fukushima Daiichi Nuclear Power Plant in 2011 remains in the neighbouring forests, where large amounts of radiocaesium were deposited on the forest floor. As studies on the dynamics of radiocaesium within a forest ecosystem are important over the coming decades, the spatial and temporal variations of radiocaesium in forest soils are need to be clarified. We examined the spatial variation and the downward migration of radiocaesium the forest soil. Field surveys were conducted in Fukushima Prefecture from August 2013 to November 2015. We selected the study site in mixed deciduous forests in northern part of Fukushima Prefecture. The canopy layer of the plot is dominated by Quercus crispula and Abies firma. In the results, there was marked spatial heterogeneity of the radiocaesium distribution in the forest soil. The spatial variation in the forest was larger than that found in open areas in previous research. The activity of soil radiocaesium decreased with increasing distance from trees. These patterns are thought to be affected by throughfall and stemflow containing radiocaesium. In addition, radiocaesium migration from the litter layer to the soil layer was observed. The activity of radiocaesium in the litter layer decreased by 90%, while the activity in the soil layer increased in 2013. Subsequently, the vertical distribution of radiocesium in forest litter and soil seemed to be stable. The migration rates from the litter layer to the soil layer were much larger than those within the soil layer, suggesting that most radiocaesium persists near the soil surface as shown in many previous studies after the Chernobyl accident. However, downward migration of small amount of dissolved radiocesium was observed with lysimeter method.

Townsend, Amanda; Ruedig, Elisabeth; Gomi, Takashi; Sakai, Masaru; Johnson, Thomas
Colorado State University
preston5789@gmail.com

Title: **Modeling of Cesium Movement through a Terrestrial-Aquatic Forest Ecosystem near Fukushima**

In the 2011 Fukushima Daiichi Nuclear Power Plant accident, radioactive fission products were released and dispersed over much of north eastern Japan. Nearly 70% of this contaminated area is covered by forest ecosystems. In situations like the nuclear accident it is important that researchers are able to make accurate predictions and recommendations for the well-being of both civilians and the environment. Perhaps one of the most useful tools for evaluating such a situation is a mathematical model. Models are one of the most useful tools for understanding the impacts of radionuclide assimilation in the environment both immediately, and over time. Through a collaborative effort between Colorado State University and Tokyo University of Agriculture and Technology, a model is being developed to represent a segment of this contaminated forest area. Researchers from Tokyo University of Agriculture and Technology gathered soil, animal, and plant samples from the forest over several months during 2011 and 2012 and measured the Cs-137 concentrations of each. A representative model was then built that outlines the relationships between each compartment. The transfer factors were gathered through an extensive literature search. The model will be built using a Los Alamos National Laboratory sponsored environmental compartment solving software. Upon completion of the model it will be used to illustrate the cesium concentrations as they change over time, make predictions in the case of a future deposition, and perhaps most importantly, allow for evaluation of the efficiency of remediation options.

Poster Presentations in Grey Rock Room

Nguyen Thanh Hai[1, 2)] and Satoru Nakashima[1, 2, 3)] Sunao Miyashita[2)]

1) Radioactivity Environmental Protection Course, Phoenix Leader Education Program, Hiroshima University
2) Department of Chemistry, Graduated School of Science, Hiroshima University
3) Natural Science Center for Basic Research and Development, Hiroshima University

Title: **The effect of fallowing on the uptake of radioactive cesium in rice in Fukushima Prefecture after the nuclear accident**

5 years after 2011 East Japan great earthquake followed by nuclear disaster at the TEPCO Fukushima Daiichi Nuclear Power Plant (FDNPP), environmental pollution by radioactive materials is still the subject of great consideration in Fukushima. Fukushima is an agricultural area where heavily affected by pollution from emissions of radioactive substances after the accident in March 2011. Although the mechanism of cesium uptake by plants has been studied[1)] and effect of potassium on the absorption of cesium into rice has been shown[2)], there are some points which deviate from the correlation.

Contaminated rice was observed in the rice from the paddy field in Oguraji, Fukushima City, which is northwest, approximately 60 km far from FDNPP. The situation was investigated by Subcommittee concerning by chemical treatment, Japanese Society of Radiation Safety Management in 2013.[3)] There were four paddy fields (which is named as A, B, C and D from upstream side to downstream side). The fields are close to mountains. The supplied water is taken from water of the mountain and Abukuma River. Slightly contaminated rice was observed in Field B. We have already revealed the correlation between the transfer factor of radioactive cesium from soil into rice plants and the grain size distribution of paddy soil.[4)]

Fields A and B were left fallow in 2015. Soil, water, rice plant were obtained on August 22nd, and October 30th, 2015. Potassium and other ions in water were analyzed by ICP-AES. After drying at room temperature the rice plant was divided into root, body and rice in the husk. The rice plant and soil were encased separately in a U-8 vessel and the radioactivity of ^{134}Cs and ^{137}Cs, ^{40}K was measured by Ge semiconductor detector. The result in 2015 indicated that there are high radioactivity in rice at sites C-4 and D-4. It was thought that the clay at C-4 and D-4 was washed away to downstream, while the clay was not supplied from Field A and B, because there is a correlation between transfer factor and grain size distribution[4)].

1) Philip J. White and Martin R. Broadley, Mechanisms of caesium uptake by plants, Sciences, E. (2000) (113), 241–256.
2) T. Saito et al., Proc Int Symp Environ Monit Dose Estim Resid Accid TEPCO's Fukushima Daiichi Nucl Power Stn 2012.
3) N. Matsuda and S. Nakashima, Radioactive Cesium in Water and Soil and Its Absorption by Rice Plant (in Japanese), Japanese J. Rad. Safety Manage., 13, 89 (2014).
4) M. Tsujimoto et al., A correlation between the transfer factor of radioactive cesium from soil into rice plants and the grain size distribution of paddy soil in Fukushima, Radiation Safety Management, in press.

U. Tsegmed; N. Fahim[1]; A. K. Batcha[1]; T. Nakashima[2;] Y. Nagata[3]; M. Abdel-Wahab[4]

[1]Intern at the International Atomic Energy Agency, Vienna, Austria
[2]Division of Radiation Therapy, Hiroshima University Hospital, Hiroshima, Japan
[3]Department of Radiation Oncology, Graduate School of Biomedical and Health Sciences, Hiroshima University, Hiroshima, Japan
[4]Division of Human Health, International Atomic Energy Agency, Vienna, Austria

Title: **Accidental overexposure related to new radiation therapy technologies**

The discovery of X-ray at the end of nineteenth century allowed the use of radiation in medicine for diagnostic and therapeutic purposes. Over the decades, new diagnostic and therapeutic techniques developed rapidly and contributed to improvements in health care. Along with the greater realization of the benefits of these advances in healthcare came a greater recognition of the impact of medical accidental overexposures as well as the importance of preventive measures to avoid or minimize their occurrence. Furthermore, recent literature suggests that medical radiation can contribute to radiation exposure at the population level [1]. During the period between 1966 and 2007, accidents in medical use was one of the leading causes of acute health effects and even deaths [2]. The greatest number of people overexposed and deaths due to radiation therapy overexposure were during 1980-2013 period [1]. Hence, enhancing safety of the currently available techniques in the radiation oncology field is essential.

This study will examine medical overexposure incidents related to new technologies in radiation therapy during the period between 2000-2009. The main causes of the accidents will be analyzed, and conclusions made regarding opportunities for quality- improvement for patients receiving radiation therapy.

This paper will show that proper preparation of resources and focusing on quality-assurance might reduce the number of accidental events related to the use of new radiation therapy technologies.

References

1) Coeytaux, K., et al., Reported radiation overexposure accidents worldwide, 1980-2013: A systematic review. PLoS One, 2015. 10(3): p. e0118709.
2) UNSCEAR 2008 Report: Volume II, Annex C: Radiation exposures in accidents, p. 38.