CO12-1

Basic Research of an Intense Terahertz Light Source Based on Coherent Cherenkov Radiation Matched to the Circular Plane

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INTRODUCTION: One of the author proposed an intense terahertz (THz) light source based on paralleled coherent Cherenkov radiation (CCR) which was generated by a relativistic electron beam traveling through a hollow conical dielectric [1]. As superimposing coherent diffraction radiation with many diffraction elements, the intense THz light can be generated by matching the CCR to the circular plane. We report results of the preliminary experiments of the CCR matched the circular plane (CCR-MCP).

PRINCIPLE OF CCR-MCP: The CCR intensity increases proportionally to the length of the electron trajectory in the dielectric [2]. The CCR power obtained with a long dielectric tube can be higher than power of coherent transition radiation (CTR). However, the CCR is emitted onto a conical surface whose apex locates at the electron beam, so that it is difficult to form a plane wave of the CCR beam with matching the phase. Then, a hollow conical dielectric with its apex facing the incident electron beam was proposed to overcome this difficulty [1]. By setting an angle between the generatrix and rotation axis to be half of the Cherenkov angle, all CCR that is reflected by the conical surface is in phase, forming CCR-MCP on the base of the hollow conical dielectric. When the absorption coefficient and the refractive index of the dielectric are expressed as α and n, respectively, the CCR-MCP beam saturates at a certain length L_C, which is given by

$$L_C = \frac{n\beta}{\alpha}\ln\frac{1+n\beta}{n\beta},$$

where β is the ratio of the electron speed to the speed of light. Because it is easy to focus a plane wave, more powerful THz light can be obtained by using a hollow conical dielectric with very low absorption coefficient.

EXPERIMENTS: We performed preliminary experiments of the CCR-MCP with an L-band electron linac at the Kyoto University Research Reactor Institute (KURRI-LINAC). Figure 1 shows the schematic layout of the CCR-MCP experiments. We used high-density polyethylene for the hollow conical dielectric. The length and inner diameter of the hollow conical dielectric were 83 and 10 mm, respectively. It was located at 0.4 m from the aluminum foil mirror upstream. An aluminum collimator, whose length and inner diameter were 150 and 8 mm,

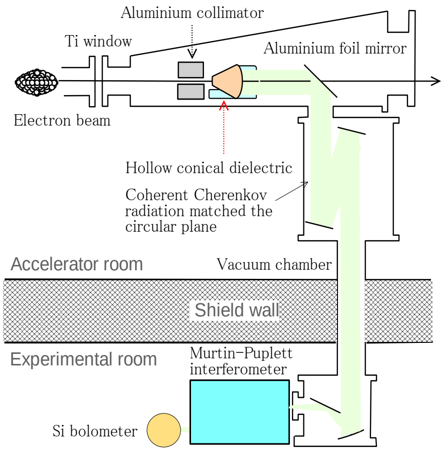

Fig. 1 Schematic layout of the CCR-MCP experiment in the KURRI-LINAC.

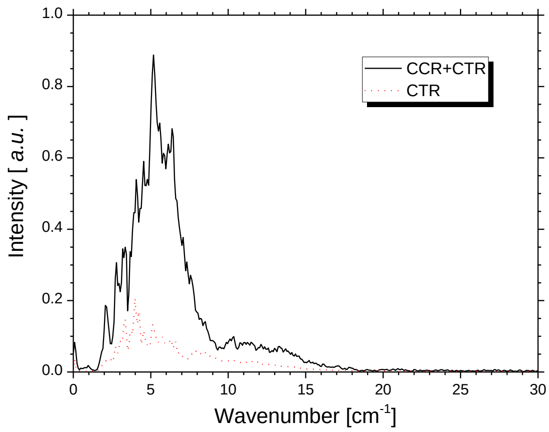

Fig. 2 Spectra of the CCR with the CTR.

was installed in front of the hollow conical dielectric not to expose the hollow conical dielectric to the electron beam. The electron energy was 42 MeV, and the charge in a micropulse was approximately 40 pC.

RESULTS: The CCR-MCP beam was observed with CTR beam generated at the aluminum foil mirror by a Martin-Puplett type interferometer. When the hollow conical dielectric was turned in the opposite direction, only the CTR beam was observed. Figure 2 shows the measured spectra of the CCR-MCP and CTR beams. The CCR-MCP intensity was strong three times of the CTR intensity. Our experimental results suggest that one can produce an intense THz light source based on the CCR-MCP with using more compact and high-charge electron beams.

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CO12-2

Effective Measures on Safety, Security, Hygiene and Disaster Prevention in Laboratories

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INTRODUCTION:
Important research aspects can be found in the following keywords such as safety, security, hygiene and disaster prevention. Nuclear research reactor is one of representative facilities together with these keywords under their operation. It is effective to investigate the latest status on practical measures on these keywords in various facilities including nuclear research reactors, to compare each other among facilities, and to discuss more optimized ones for our positive safety management. Through this process, it is also essential to investigate the latest international and/or national regulations and the movement of revision of them. This total discussion contents and its fruit are directly useful for all relating laboratories.

RESEARCH APPROACH:
General research approach is as follows.

- Measures of safety management during operation or standstill status of the real facilities would be investigated. This information would be used for our research discussion on the positive and more optimized safety management.
- It would not be a single year research, but maybe two to three years research for one theme.
- Information source of facilities would not be only KUR, KUCA or the other facilities in Kyoto University, but also the Kinki university research nuclear reactor or the facility of National Institute of Fusion Science, etc. This research is an active joint-research with these relating facilities and positive researchers on safety management.
- One of the distinctive features of this research is to involve office staffs as cooperators as well as researchers and technical staffs. In The University of Tokyo, most of the members in Division for Environment, Health and Safety are office staffs who knows real situation of safety management in laboratories very well.

Discussion target in FY of 2015 was determined as "safety control in use of small amount nuclear materials" through our member discussion. When using small amount of uranium (U) or thorium (Th) up to 300g (U) and/or 900g (Th), most of safety control procedures requested as radioactive materials are exempted by related regulations. We investigated the real situation of usage and safety control of small amount of U and Th in Japanese laboratories. In addition, training and education to safety managers, users and officers relating small amount of U and Th were also discussed.

LATEST SITUATION ON USE & SAFETY CONTROL OF SMALL AMOUNT of U & Th:
The following information was obtained by means of questionnaires which were sent to 37 users of small amount of U and Th in Japan.

<u>Usage</u>
Among 33 users who answered the questionnaires, it was 24 users to really use U and/or Th. 9 users do not use and just storage the materials in their laboratories. 17 users answered that they used the materials for the dyeing of the bio-sample in the electron microscope observation.

<u>Safety Control</u>
16 users among 24 handled the small amount of the materials in general areas without setting specified areas. Radiation safety control is not requested in the Japanese regulation for the materials, however about half of real users take some safety measures.

<u>Waste</u>
18 users among 24 keep and storage their nuclear wastes in their facilities. There were many opinions in hope of collection of the waste by the government to dispose them. Hesitation and confusion were seen in some users about the consumption and the storage disposal of the nuclear materials. Information sharing on the waste management is essential.

NEXT RESEARCH TARGETS;
We started to discuss on the education framework, curriculum and textbooks for safety managers and users as well as relating officers to fill up the nuclear material controlling sheet for the use of small amount of U and Th. This discussion and establishment should be continued next year.

We express our gratitude for their strong support and active discussion of Dr. K. Yasuda (Kyoto University), Dr. M. Takahashi, T. Saze (National Institute of Fusion Science) and Dr. H. Yamanishi (Kinki Univesity) and others.

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27016

CO12-3 **Test of a Microcell Multi-Wire Proportional Chamber for a Muon-Electron Conversion Search Experiment, DeeMe**

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INTRODUCTION: Discovery of Higgs boson filled the last piece of the Standard Model (SM) of elementary particle physics. The next coming issue is the physics beyond the SM (BSM). A discovery of mu-e conversion may be a clear clue to the BSM. DeeMe is going to search for mu-e conversion in J-PARC. The detector is required to tolerate to prompt burst pulses with an instantaneous hit rate of approximately 100GHz/mm^2 and width of 200ns and to detect electron signal with delay time of O(μ s) from the burst pulse. We have invented a new technique of dynamic gain control of wire chamber to avoid a long dead time by space charge effect.

EXPERIMENTS: Experimental setup is shown schematically in Fig. 1. Electron beam collimated to 18mm x 20mm penetrates a Multi-Wire Proportional Chamber (MWPC) and beam counters. Beam rate is tuned changing current of electron gun heater.

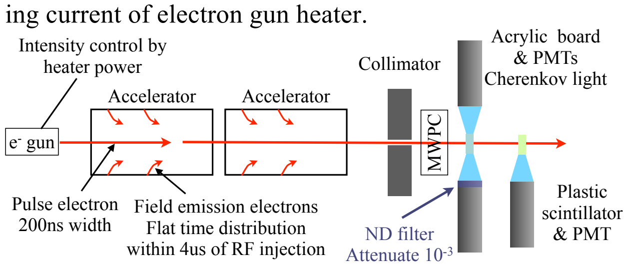

Fig 1. Experimental setup

The pulsed electron beam with tuned beam rate generated from the beam gun emulates the prompt burst pulse. Delayed electron signals are emulated by field emission electrons.

DC high voltage (HV) is applied to anode wires. MOSFET based switching module makes a pulsed HV to be applied to potential wires of the MWPC. During a main pulse comes, HV is applied to potential wires to make voltage difference between wires 0V. Soon after the main pulse passes the MWPC, potential wires are switched to ground level to make large voltage difference between anode-potential wires to detect delayed electrons. Large current is induced on the cathode strip readouts by the rapidly changing voltage on the potential wires. Amplifier should cope with this input. Fig. 2 shows the circuit of our amplifier. We tuned the circuit elements not to make the amplifier saturated by the large current input. Pole zero cancelation circuit is implemented between 2-staged amplifiers to compensate slow tail by ion movement. We have manufactured the final version of the chamber and the amplifier. This experiment was planned to be the first test of the final detector system under the condition equivalent to the final DeeMe condition.

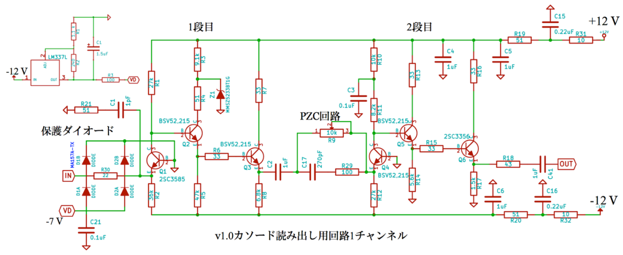

Fig 2. Circuit diagram of the amplifier

RESULTS: The chamber is operated with a gas mixture of Ar/C_2H_6. We went in a bit too much of a hurry, and exchanging the gas was not enough before applying HV on the chamber. Discharge cut all the wires of the final chamber. This told us importance of removing air contamination.

We switched the purpose of the experiment to a test of amplifiers. We replaced the broken chamber to a prototype chamber and continued the test. Amplifier test was good. The large current input by HV switching and burst electron pulse did not saturate it. The baseline successfully recovered for the delayed electron.

But we encountered another problem of applying nominal HV on the prototype chamber. A balance of electrostatic force and restoring force by wire tension determines wire position. The restoring force is stronger, so the wires stay the nominal position. But the difference of the strength is calculated to be small. High intensity electron beam may distort the balance, and cause wire position displacement a few times per some tens of minutes. Discharge occurred when wires get too close.

This gave us a hint of operating the chamber stable. In this experiment, we made the voltage difference between anode-potential wires 0V just during the burst pulse. We take data with cycle of 25 Hz and the data-taking period is just a few 10 micro-s. Attractive force between anode-potential wires made the wire position unstable. Changing the scheme of applying HV can solve this problem. Making the voltage difference just during the data-taking period, repulsive force works most of the time despite of the data-taking period. This repulsive force keeps distance between wires. Attractive force during the data-taking period is just a few 10 micro-s and the impulse is small enough to keep the wire position stability. Based on this consideration, we developed a new scheme of switching HV after this experiment. This successfully worked to make the operation of the chamber with nominal HV stable.

CO12-4 In-situ Analysis of Chemical Reaction between Phosphoesters and Iron Surface by Attenuated Total Reflection Infrared Spectroscopy and Neutron Reflectometry

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INTRODUCTION: In recent years, reduction of friction and wear in machines is one of the most important subjects from the viewpoint of global environmental issues, energy conservation and resource saving. Especially development of materials having excellent tribological properties is required to extend the life of machine parts by reducing friction loss. Particularly, under the boundary lubrication regime, oiliness additives and extreme pressure agents are used to reduce friction and wear. Extreme pressure agent is commonly known to form a ‘boundary lubrication film’ onto the metal surface via the chemical reaction by the heat generated in the friction process. The film prevents direct contact between metals, reducing the possibility of occurrence of seizure. To investigate the formation process of boundary lubrication film formed by extreme pressure agent on the metal surface, attenuated total reflection infrared spectroscopy (ATR-IR) and neutron reflectometry (NR) were used in this study.

EXPERIMENTS: As the sample substrate for ATR-IR, a germanium hemispherical ATR crystal which coated thin film of iron on flat surface was used. Poly-α-olefin and phosphate ester were used as base oil and extreme pressure agents respectively. Eight kinds of phosphate ester were selected for the study; mono-oxyl phosphate ester(mono-C8(straight chain)), di-oxyl phosphate ester(di-C8(straight chain)), mono-2- ethylhexyl phosphate ester(mono-C8(branch)), di-2-ethylhexyl phosphate ester(di-C8(branch)), mono-dodecyl phosphate ester(mono-C12(straight chain)), di-dodecyl phosphate ester(di-C12(straight chain)), mono-octadecacyl phosphate ester(mono-C18(straight chain)), di-octadecacyl phosphate ester(di-C18(straight chain)).
First, time dependence for the reaction between phosphate ester and iron was investigated measuring the change in peak made by the reaction between iron and phosphate ester. The IR absorbance profiles obtained for 20 hours per one hour. When the monoester of non-mono-C18 was used, the peak was increased with time, and the peak value was the largest in all samples (Fig. 1). NR also proved the existence of boundary film formed by the adsorption of monoester onto the iron surface (Fig. 2(a)). On the other hand, when the diester and mono-C18 were used, the peaks did not increase with time. NR also proved that the boundary film was not formed onto the surface (Fig. 2(b)). It means that all of phosphoric esters were not adsorbed onto metal surface and the adsorption characteristics depended on the molecular weight.
Second, time dependence for the reaction between phosphate ester and iron at high temperature was investigated to understand the heat effect. Heating temperature was set to be 50, 100, 150, 200, and 250ºC and heating time was 30 minutes. When the monoester was used, the peaks from the phosphoric acids increased, and the peaks became larger than the peaks measured at room temperature. When the diester was used, the peaks from the phosphoric acids did not increase.
From these studies, the phosphate ester with short alkyl chains without branch easily adsorbed onto metal surface, and their reactivity increased by heat.

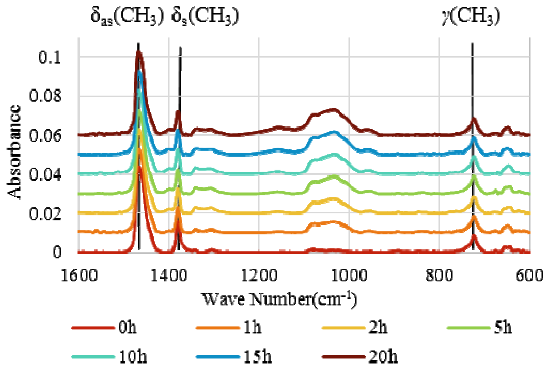
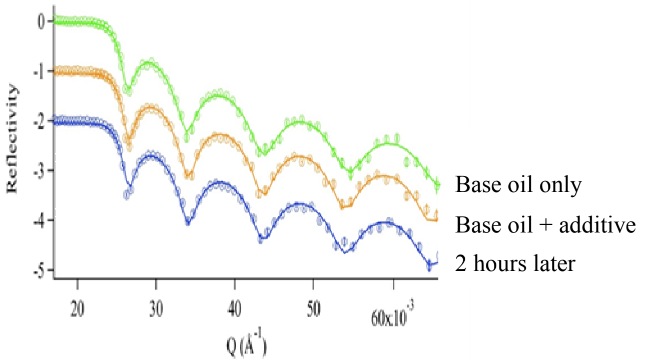
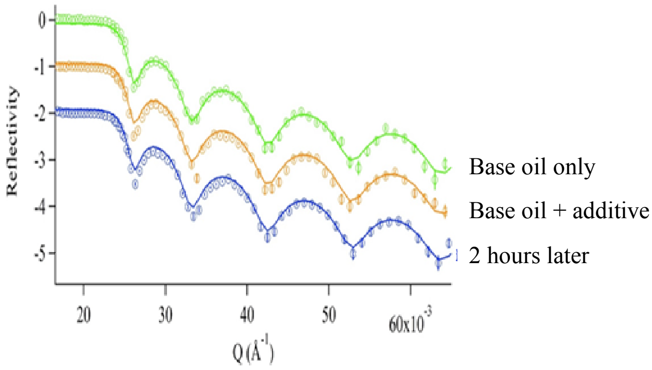


Fig. 1. IR absorbance spectrum from the interface between iron and lubricant containing mono-oxyl phosphate ester (mono-C8(straight chain))



(a) mono-C8(straight chain)



(b) di-C8(straight chain)

Fig. 2. NR profiles from the interface between iron substrate and lubricants containing phosphate ester

CO12-5 Single Event Test on On-board Computer for Nano Satellite "Horyu-4" using ^{252}Cf

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INTRODUCTION: Kyushu Institute of Technology (KIT) has been developing nano satellites as Horyu-series since 2010. The main mission of Horyu-series is the high voltage demonstration by solar array and the Electro Static Discharge (ESD) experiment on orbit. Horyu-2 launched in 2012 suffered an anomaly by Single Event Latchup (SEL) on the On-board Computer (OBC). As a result, Horyu-2 eventually could not respond to commands from the ground station[1]. For the next satellite, "Horyu-4", the project members recognized that a counter measure for SEL is necessary to avoid the same fate as Horyu-2. The project members decided to conduct radiation testing using ^{252}Cf at Kyoto University Research Reactor Institute. Radiation testing was performed twice in 2015. We used the circuit boards of Horyu-4 including OBC, Electrical Power System (EPS) and Communication and checked the failure modes caused by SEL. EPS provides 3.3 V and 5.0 V lines to each sub-system and it controls the reset system. The purpose of this test is to improve the stability of Horyu-4 under the effects of radiation. This document reports the detail of testing and results.

EXPERIMENTS: Figure 1 shows the experimental set-up. Circuit boards used in this test were EM and FM models for Horyu-4. These boards have as microprocessors H8 and PIC. The plastic package of microprocessors was removed so that the core of the microprocessors was directly exposed to ^{252}Cf source. The circuit boards were set in a vacuum chamber. The pressure during the test was approximately 30 Pa. The voltage and current fed from the power supply were measured by a DAQ and oscilloscope and the operation of the microprocessors was verified by a PC with RS232 communication. An over-current protection (OCP) was implemented in the power line between each sub-system and EPS in the circuit boards. Once OCP detects over current due to SEL on the OBC, OCP sends a reset signal to EPS. To recover from the hang-up state of OBC by SEL, EPS automatically cuts the current from EPS to OBC. In this experiment, ^{252}Cf source was mounted on XYZ stage shown in Fig. 2 and its position and height were controlled by a stage controller. The distance from microprocessors to the radiation source was from 10 mm to 30 mm.

RESULTS: The test procedure is as follows.
1) Check operation of the circuit board
2) Move ^{252}Cf source to above the microprocessor.
3) Monitor the system by PC.

The first test was conducted in August 2015. In the first test, the OCP seems to be able to detect the over current induced by SEL on the OBC and the reset signal was sent to EPS. However, our measurement system could not acquire the recovering OBC because the reset signal from the OCP was too fast. For the second test, we improved the measurement system. The second test was conducted in September 2015. We observed that EPS could not cut the current feeding to OBC even though OCP properly detected over current. As a result of the investigation, a leakage current from 5.0 V line to 3.3 V line affected the reset system when EPS cuts the current of 3.3V line to OBC. To execute a proper reset, EPS must cut the current of 5.0 V line, too. We improved the configuration of the reset system and confirmed the reset system.

The improved Horyu-4 system was verified by this radiation test. Horyu-4 was launched on Feb 17th 2016 and achieved its main mission as the world's first acquisition of ESD waveform and image on orbit[2].

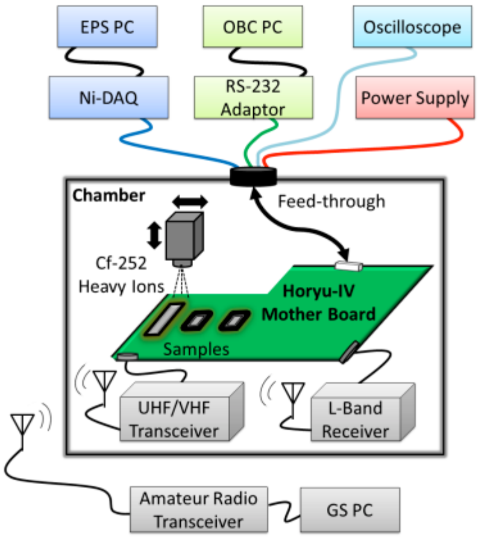

Fig. 1 Test Setup

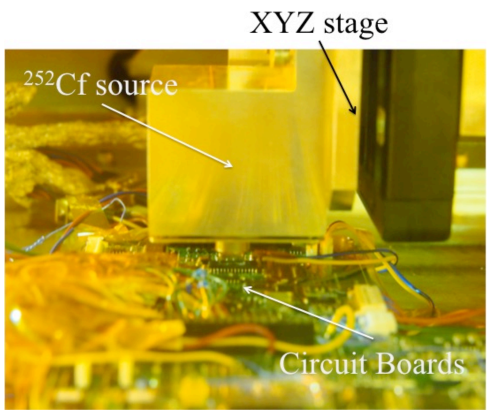

Fig. 2 ^{252}Cf source mounted on XYZ stage

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27069

CO12-6 Ethnographic Study on Nuclear Reactor - Radiation Hazard and Risk Management for Evacuee's Future in *Fukushiama* -

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In order to know about nuclear reactor in layman term, it might be highly helpful to describe it as ethnography by investigating how it has been concerned in human civilization. In this report we describe ethnography of evacuees from Fukushima Nuclear Accident in order to recover and live together in low dose radiation field as a different culture, in other words to know about it's various aspects and complicated conditions in constructing their new culture.

Topics of this progress report: We investigated the complicated difference between physical dose of radiation exposure (hazard) and sensibility feeling (risk) through scientific field works in Fukushima. And we discuss about the possibility to live in evacuee's hometown contaminated with low dose radiation (mainly ^{137}Cs).

It is essentially very difficult to apply anthropological study in Fukushima from an ethical standpoint. Fortunately, we overcome this difficulty by applying scientific participation in refuges to keep good relationship with refugees. Figure 1 shows radiation dose of an evacuee who lives in refuge and regularly visit his home in contaminated area with low dose radiation. His average radiation dose is 1.97μSv/day in his refuge, but it rises to 6.70μSv/day during stay in his home.

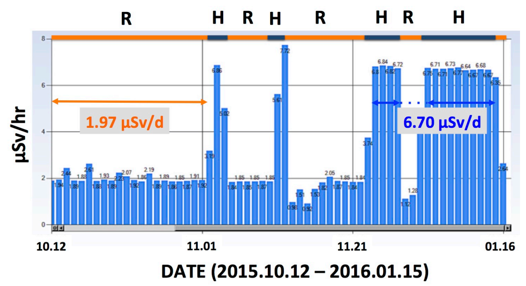

Figure 1. Daily fluctuation of radiation dose determined by a personal dosimeter (miniDOSE, Ray Systems Co.) H: at home, R: at refuge.

He says, *"It's more healthy to work in my contaminated yard than being in refuge for my safety"*. Fortunately he has regulated his radiation dose to be under regulated limit, <1mSv/year, by managing the period of home-stay and also the amount of edible wild plants cropped in his contaminated mountain. Figure 2 shows the radiation surface dose (1m high from the ground), the dose vary with altitude and configuration.

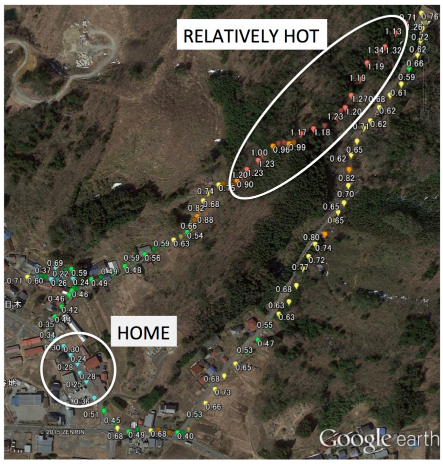

Figure 2. The radiation dose distribution in the mountain yard. HOME:aroung 0.3 μ Sv/hr, RELATIVE HOT area in the mountain yard: 0.9-1.3 μ Sv/hr. Date from Fukushima Project, measured by Hot Spot Finder, HSF-1, Nihon Shahei Giken, Co.

He says. *"I will eat the delicacies of the seasons up in mountain because I will miss it behind the season."* He can calculate a limited intake amount of delicacies to be under safety level. This case shows that possibility of living in contaminated hometown by analyzing the hazard and accepting the risk.

On the very beginning of Fukushima Nuclear Accident, why scientist's statements about radiation hazard & risk were so different among them? There is no doubt that we scientists are responsible to such situation. Our next concerns about *Fukushima* in this research are scientific participation and inspection on the actor network among nuclear scientists.

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27076

CO12-7 The XEP-e (eXtremely high Energy Plasma/ particle sensor for electron) of the ERG Satellite

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INTRODUCTION: The radiation belt called the Van Allen radiation belt exsists within the geospace that is the region of outer space near the Earth. It often causes a satellite's trouble. The Exploration of energization and Radiation in Geospace satellite (ERG) that is the JAXA's project will be lanched from the Uchinoura Space Center in 2016FY. This project aims at elucidating how highly charge electrons have been born while they generate and vanish repeatedlly along with space storms caused by disturbance solar wind. This satellite has four instrument parts, a Plasma Particle Experiment Suite (PPE), a Magnetic Field Experiment (MGF), Plasma Wave Experiment (PWE) to measure radiation particles, magnetic and electronic waves. The eXtermely high Energy Plasma/particle sensor for electron (XEP-e) is one of the PPE. It aims at measuring electrons from 400keV to 20MeV. We are now developing its Flight Model and used the KURRI-LINAC (Kyoto University) to calibrate it over 2 MeV electrons.

Table. 1. Mission Profile of the ERG

ERG satellite		
Lunch	Date	2016FY
	Location	Uchinoura Space Center
Configuration	Weight	350kg
Orbit	Altitude	Perigee:about 300km Apogee:about 30,000km
	Inclination	31°
	Type of Orbit	Elliptical orbit
	Period	about 538 min

EXPERIMENTS: The XEP-e's profile shows Table. 2. It has five solid-state silicon detectors (SSDs) and a high-Z scintillator (GSO). The XEP-e is Fig.1. The first SSD discriminates between electron and other particles. And The Other SSDs and a high-Z scintillator decide energy of perticles that are detected.

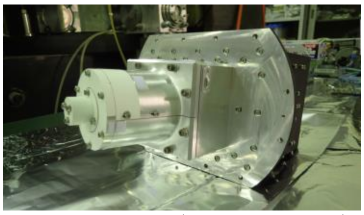

Fig. 1. XEP-e(Flight Model)

Table. 2.Parformance of the XEP-e

Energy range	Electron 400keV~20MeV
G-factor	0.0088 cm^2･sr
Angular resolution	20° ×22.5°
Energy resolution	SSDs: less than 20% GSOZ: less than 50%~60%
Size	317cm × 250cm × 174cm
Weight	5281g
Power	19.8W
Data format	Table mode (18ch) 12ch:SSD SUM 4ch:GSO List mode (for S-WPIA) Quasi-real-time data(for Space Weather)

We used the KURRI-LINAC (Kyoto University) to calibrate its energy that is between 2MeV and 20MeV electron. We also used our accelerator in Tsukuba space center under 2MeV electrons. We need very low count rate beam like 100~1000cps, we have already got datas to make a beam by using the XEP-e (Engineer Model) last year. In this year we calibrated the XEP-e (Flight Model). As shown in Fig. 2, datas of the the KURRI-LINAC and simulation datas (GEANT4) were very similar between 6MeV and 20MeV. It shows that the KURRI-LINAC can make very low count rate beam.

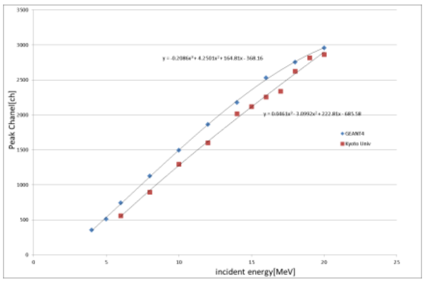

Fig. 2. Incident energy vs Loss energy channels of the XEP-e
(energy range: 6MeV~20MeV)

RESULTS:

The XEP-e could caliblate by using the KURRI- LINAC (Kyoto University) that is only a facility in Japan that makes low count rate electrons beam between 5MeV and 20MeV.