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Review

Takekoshi's JAERI Linac Before and After

Yuuki KAWARASAKI

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This miscellany describes some scientific and political effects brought about by Professor Emeritus Hidekuni Takekoshi to JAERI personnels, directly or indirectly, together with the influential destiny of his greatest inheritance, the second linac (linear electron accelerator), as author's personal memory-evoking for honoring his foresighted but a little bit unfinished (continuing) activities.

KEY WORDS: Takekoshi's identity/JAERI second linac/Impact to others/

Takekoshi-san (Oji-san) has quite been a liberal, individual and somewhat academic (in a sense of the old and good period of Japanese past several decades) person, farthest from bureaucratic but full of life-enjoyment, which identity is still making him so friendly and familiar.

At Kyoto University before his movement to JAERI, he had worked on fabrication of NaI (Tl)-crystals for gamma-ray detectors as almost pioneering at that time nearly forty years ago in Japan as well as the construction of the Kyoto's cyclotron; this is of author's hearing from somebody. His attempt of NaI-crystal fabrication should be noted as his later initiative to work on fabrication of Ge (Li) detectors among JAERI members of gamma-ray spectroscopy and as his sympathy to support Dr. M. Ohkubo's effort for fabrication of neutron-sensitive glass scintillators. He seemed in full acquirement of the importance of such novel detectors as well as new accelerators as tools of experimental nuclear science.

After his movement to JAERI from Kyoto University, some thirty years ago, with his wife, Dr. Eiko Takekoshi, a female nuclear physics scientist, a weekly magazine had once reported Takekoshi's couple as Japanese Joliot and Mme Curie at JAERI.

The time was a Japanese dawn of atomic energy research. The JAERI has been established in 1956 (Showa 31).

His first research subject at the Nuclear Physics Laboratory, JAERI, had been of Moessbauer effect, being performed in collaboration with an excellent junior colleague, Dr. N. Shikazono, now a Deputy Director General of Tokai Research Establishment, JAERI, whose doctorial thesis would seemingly have been of this concern. He once sayed to me after his movement to the Linac Laboratory, "Shika-san is a person who can have already prepared his scientific paper even before his start of an experiment".

The Nuclear Physics Laboratory at that time was headed by Professor T. Momota (now retired from Tohoku University), which was organized into three or more experimental groups; Takekoshi's, late Professor K. Tsukada's (Nihon Univer-

河原崎雄紀：Linac Laboratory, Department of Physics, Tokai Research Establishment, Japan Atomic Energy Research Institute (JAERI) Tokai, Ibaraki, 319-11

sity) and other groups who used the JAERI reseach reactors. Tsukada's group had already equipped a 2-MV van de Graaff static accelerator which could have served as a fast neutron source, but Takehoshi's had no accelerator, which situation should have led them to choose a novel but accelerator - free experiment.

His wife's subject had probably been of spectroscopy of beta-and gamma-rays from radioacitive nuclides and of nuclear fissions.

During nearly the first one decade after the JAERI's establishment, the following research facilities had been successively prepared: 1) 2-MV Van de Graaff accelerator (Showa 32, May), 2) JRR-1 (Japan Research Reactor No. 1) (Showa 32, August), 3) 10-KCurie Co-60 gamma-ray irradiation facility (Showa 32, August), 4) 20-MeV electron linear accelerator (linac) (Showa 35, December) and 5) 5.5-MV Van de Graaff accelerator (Upgrading of the old 2-MV one) (Showa 37).

This period should have only been most scientifically dreamful of the JAERI, whose Board of Executive Directors had ever included late Prof. Seishi Kikuchi, late Dr. Ryokichi Sagane, late Dr. Asao Sugimoto, late Dr. Eizaburo Nishibori and late Prof. Emeritus Kenjiro Kimura (chemistry).

His group's subject should have gone to neutroncapture gammma-ray spectroscopy, employing a magnetic Compton spectrometer which sould have been installed at the JRR-3 site. Any nuclei except lightest ones following neutron capture are excited in 5 to 10 MeV higher than those of radioactive ones and hence they will eventually be able to provide much nuclear spectroscopic information.

At that time, Demidov et al. in USSR had started a compilation of the neuton capture gemma-rays' spectroscopic data, "Atlas of Neuron Capture Gemma-Rays", acquiring data also from the magnetic-Compton Spectrometer attached with a some Russian research reactor. At Chalk River Scientific Laboratory, Canada, Bartholomew, Kinsey et al. had been in the same direction. Bollinger, Cote and Jackson in ANL and Chrien et al. in BNL had been the same. Bartholomew and Bollinger had later become into their great interest in accelerators; Bollinger went to ANL's ATLAS project head; it uses a superconducting heavy-ion linac, later influential to JAERI Tandem's booster.

Other groups at the Nuclear Physics Laboratory had worked on the reactor sites: they used a crystal monochrometer, a pile-oscillator and a neutron velocity selector for neutron cross-section measurements.

The 20-MeV linac had been principally utilized as a pulsed-neutron source for neutron cross-section measurement in a time-of-flight (TOF) method and as a gamma-ray source for production of radioisotopes through gamma-n, p reactions. The author had belonged to a neutron group but worked solely on an experiment of resonant neutron capture gamma-ray spectroscopy using a time-gated NaI-detector, while the majority had done on the cross-section's. Takekoshi had suggested me to publish my work in JAERI-report or so, after looking at it.

At the early period of the installation, the linac group had belonged to Department of Applied Radiation, because the linac should have been served as an irradiation source for radiation chemistry, and then to Department of Physics.

The Linac's capability for neutron cross-section measurements in resonance

energy-regions by a TOF method revealed itself superior to that in the reactor usages.

More than twenty years ago, Takekoshi moved from the Nuclear Physics Laboratory to the Linac Laboratory with his junior colleagues; Dr. T. Fuketa, now a Vice President of the JAERI, late Dr. Jun-ichiro Matsumoto and Dr. N. Shikazono. The Nuclear Physics Laboratoy became being headed by late Professor K. Tsukada; Momota having moved to Director of Department of Physics. Takekoshi became a head of the Linac Laboratory; late Professor H. Hirakawa having moved to Tokyo University after his duty of the linac installation, whose thesis had been on beam blow-up with his experiment done on the linac (and his later major gravity waves). But Takekoshi should have substantially been an editor of the final report, "The Installation of the 20-MeV Linac", after taking over Hirakawa's; manuscript preparation had not been expectedly straightforward for young members of the writings.

Soon after his movement to the Linac Laboratory, Takekoshi had insisted to first change the name of the Laboratory from "Linac KANRI-SHITSU" to "KAKUBUTSURI DAINI KENKYUUSHITSU" (Nuclear Physics Laboratory 2); the English name unchanged, from which attitude could have been shown clearly his way. And he also projected fabrication of Ge (Li) detectors, catching appearance of novel and high performance gamma-ray detector. He quickly prepared Li-evaporation and Li-drifting apparatus and a draft box for crystal-surface etching, in parallel with the preparation of cryogenic chambers for Ge-crystals and associated electronics. Shikazono and I, and others joined the job; someone working on similar silicon-detectors. Shikazono succeeded in fabrication of a small Ge-detector. He and I went to the JRR-3 site with a Ge-centered three-crystal pair spectrometer and measured Al's and Ti's n-gamma spectra instead of using the magnetic Compaton spectrometer. Shikazono's idea was excellent; proposing gamma-gamma prime experiment on one element of zinc isotopes resonantly scattering lead-capture gamma-ray. This should be the first using a Ge-detector in the world. After that, I made a big Ge-detector (around 60 cm^3) which could be sensitive to scattered photons from samples of light elements even during the linac-pulse bremsstrahlung of the 20-MeV's; Shikazono thus proposed the linac experiment for the first time of Ge-detector use. This Ge-detector helped author's tough experiment for a doctorial thesis again at the JRR-3.

Around this period, he should have been looking for a next enterprise. That was the second Linac; officially being called the remodeling or the power-up. It was extremely tough for him to get an enough budget for it. His management was quite unique; no one had attempted in this way at the JAERI. He proposed to construct a new and hundred times powerful linac which should be assembled by hands of the members for two years, because money was so limited; one third of a reasonable cost. This made me reluctant to that as looking at some risk of man-power lack; all the member should go to soldering and wiring every days.

However, his attitude and strategy could be recently proven right from one aspect. During the midst of the JAERI's second decade, JAERI's tops seemed not to favor an academic research attitude, but to be fond of something like system of manufacturing factory.

A 300-MeV linac had already been installed at Laboratory on Nuclear Science,

Tohoku University. Design philosophy or configuration was presumably due to Professor Y. Torizuka (Prof. Emeritus, Tohoku Univ., now Nihon Univ., new giant resonances' finder): energy-efficient; one klystron feeding an rf-power to multiple accelerating waveguides, all components domestically procured and assembled in a factory.

Takekoshi's choice was contrary; beam-power efficient; one klystron to one accelerating guide; eliminating high-power phase shifters and procurement both domestically and from foreign companies.

Again soon after the commissioning of a new linac, he had returned back to Kyoto University, Institute of Chemical Research, where the old cyclotron had occasionally been operated. His interest seemed not in experimental works using the linac but in a new emterprise there; a new design and then construction of the remodelled one. He had once talked us on his consideration of possible adoption of a superconducting cyclotron when he had visited JAERI. This should have been the effect that JAERI'S had later gone to the adoption superconducting accelerators as a boosting heavy-ion linac for Tandem Van de Graaff's through Shikazono's choice and an electron one for a free-electorn laser oscillator.

Finally he had chosen a proton linac instead of a cyclotron. The pre-accelrator was of an RFQ-structure. The Institute could find a wider and suited location, Uji, from Keage. Before the commissioning, his period at the University has expired.

At another time of his visit, he introduced some klystrode amplifiers: always novelty, essence of science, charms him.

Professor A. Asami (now at KEK) took over Takekoshi's position, but there happened some troubles at the rf-windows. Asami with K. Mashiko should pay their great efforts to overcome the troubles. Dr. Fuketa moved to Nuclear Data Center and Dr. Shikazono abroad.

After Asami's movement to KEK, Mashiko almost alone improved the linac: highest attainable energy exceeded 200 MeV, which could produce pi-meson; Dr. Furuta (retired) later tried it under suggestion of Dr. Tsukada. Mashiko could actually operate the linac at a repetion rate of 600, peak current of 6 A and pulse width of 20 ns; it should be the highest in Japan. High power of the beam was required for TOF experiment as neutron intensity proportinal to beam power.

The 120-MeV linac of Takekoshi's construction and Asami's and Mashiko's improvement would supposedly have given some effects to others; Tsukada, Director of Dept. of Physics, JAERI at the time, pushing himself to construct a tandem Van de Graaff as an upgrading of the 5.5 -MeV's, getting money nearly twenty times to the linac's, KEK's (Dr. J. Tanaka) and ETL's, (Dr. T. Tomimasu). Tsukada had then turned to an rf-linac person: proposing something like FMIT, PIGMI and so on, making other persons involved. After his movement to Nihon Univ., Tsukeda's interest was in pi-therapy through electron beams', but not proton's reaction, and then in a free-electron laser oscillator of lower energy.

Takekoshi-san's nature has been so open-minded and personally attractive even to foreigners that Dr. R. A. Jameson (former Director of Accelerator Techonlogy Division, Los Alamos National Laboratory) has recently stayed at his Institute.

Jameson has more than twice visited JAERI, bringing about much information on accelerator technology to JAERI people who are starting more than one accelerator projects: a 1.5 GeV proton linac of Omega Project, ESNIT's (Energy Selective Neutron Irradiation Test facility; something like an FMIT), and FEL's (a linac for free-electron laser oscillator), and SOR (synchrotron radiation)'s linac.

His another foreign visitor was R. Bergere from Saclay, France, in the year the U. S. A's Appollo-11 had succeeded in the moon visit, a few years before the second linac's construction. Bergere had worked on gamma-n reactions using the 20-MeV linac after his acquaintace of linac technology.

At present, the linac operated by Mashiko has an overbooking schedule; roughly 2.5 times of its machine-time proposals; as an injector to a small 300-MeV storage ring, JSR, of SOR's group, as slow-positron production for surface solid-state physics and also for positron microscope development; the cofinement of slow positrons by collaboration of JAERI's and Tokyo Univ's might be the first in Japan, and as neutron resonace radiography, technology-transferred from neutron-TOF group's.

3 or 4 years ago, the fulfilment of the machine time was a half, proposed only from neutron TOF group, Linac Lab.; Mashiko once consulted me on how to increase a number of the users.

At the time for the preparation of starting a study of FEL at the Linac Lab., Takakoshi-san kindly sent me Dr. Jun Kondoh's outstanding review on FEL. And the linac could fortunately serve to people of JAERI's and another Tokyo Univ.'s the observation of visible-light rings from the electron beam passing through an undulator; fundamental light of yellow to red and second harmonics light of blue just outside the fundamental one, because the beam energy of 140 MeV and the undulator's period of 4 cm could yield to this luck.

He furthermore introduced a doctor-granduated student as a JAERI's staff, who was in high achievement except his start of writing the thesis.

He will further relaxedly and even optimistically continue his scientific and educational works in a practical way, keeping his ever lasting youth, because he has already prepared his own carriculum of an electron linac again, getting an accelerating waveguide structure in his hand.