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COVER SHEET
FOR TRIP REPORTS SUBMITTED TO THE OFFICE OF ENERGY RESEARCH

Destination(s) and Dates for Which Trip Report Being Submitted: Tokai, Japan and Mito, JApan
5-16-88 through 6-11-88

Name of Traveler: J. A. Harvey

Joint Trip Report ☐ Yes
☒ No

If so, Name of Other Traveler(s): _____

OAK RIDGE NATIONAL LABORATORY

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ORNL

FOREIGN TRIP REPORT

ORNL/FTR-2925

DATE: June 27, 1988

SUBJECT: Report of Foreign Travel of John A. Harvey, Senior Research Staff Member, Engineering Physics and Mathematics Division

TO: Alexander Zucker, Acting Director

FROM: John A. Harvey

PURPOSE: To spend four weeks at the Japan Atomic Energy Research Institute, Japan under the JAERI/MMES Cooperative Research Agreement in the area of Nuclear Physics and also under the JAERI Foreign Researcher Inviting Program. To attend, to present a paper, and to chair a session at the International Conference on Nuclear Data for Science and Technology, May 30-June 3, 1988, in Mito, Japan.

SITES VISITED:
5/16 to 5/28/1988 JAERI, Tokai, Japan
5/30 to 6/4/1988 Nuclear Data Conference, Mito, Japan
6/6 to 6/11/1988 JAERI, Tokai, Japan

ABSTRACT: The traveler spent four weeks at the Japan Atomic Energy Research Institute (JAERI), Japan under the cooperative research agreement in nuclear physics between JAERI and MMES and also under the Foreign Researcher Inviting Program. The goal of the visit was to get the complex computer program SAMMY operating on the VAX 780 computer at the Tandem Laboratory, and also on the main computer (IBM type) at JAERI. A few limited energy regions of the new ORELA high-resolution ^{238}U transmission data were analyzed at JAERI to confirm that the program was operating correctly. The traveler presented a seminar on recent research and developments at ORELA, held discussions on the neutron programs at the Tandem and Linac at JAERI, learned about their progress on the production of slow positron beams and on free electron lasers, and visited the JPDR Decommissioning Demonstration Program and the large Tokomak Fusion Experimental device JT-60. At the Mito Conference valuable discussions were held on the present status and future needs of resonance parameters of ^{238}U, on nonstatistical spacing distributions and on systematics of neutron strength functions. To satisfy the future nuclear data needs, continued international cooperation is essential for measurements, analyses, evaluations, and testing.

1. ASSIGNMENT TO JAPAN ATOMIC ENERGY RESEARCH INSTITUTE (JAERI)

The traveler was assigned to JAERI at Tokai-mura, Japan for a four-week period under the JAERI/MMES Cooperative Research Agreement in Nuclear Physics with the understanding that he would attend the Mito Conference for one week. Although several Japanese physicists have engaged in research at HHIRF and ORELA under this agreement, S. Raman is the only other ORNL nuclear physicist who has been assigned to JAERI. The traveler was also offered an invitation under the JAERI Foreign Researcher Inviting Program and all expenses for the trip including the Mito Conference were paid for by JAERI.

The goal of the assignment to JAERI was to get the complex computer program SAMMY (developed by Nancy Larson and Francis Perey at ORELA for resonance parameter analyses) operating on the VAX 780 computer located at the Tandem Accelerator at JAERI and also on their main computer (IBM type). A few limited energy regions of the new ORELA high-resolution ^{238}U transmission data would then be analyzed at JAERI to confirm that the program was working correctly. Due principally to the cooperation, competence, and hard work of several of the JAERI physicists and to the many contacts and suggestions from Nancy Larson and Francis Perey at ORELA, SAMMY was made to operate successfully on both computers. Plots of SAMMY fits made at JAERI to the ORELA ^{238}U transmission data were presented at the Mito Conference.

The most recent parameters of the resonances of ^{238}U obtained from M. Moxon of Harwell at the Mito Conference (from his analysis of preliminary ORELA capture data by Roger Macklin and the 10-year old Olsen transmission data) were used to calculate transmissions for a few energy regions to compare to the new (1988) ORELA transmission data using a 200-m flight path and 7-ns bursts. The differences for many resonances are quite significant (~20%). It is obvious that these new ORELA data must be included in new evaluations for ^{238}U.

The traveler found the living and working conditions very interesting, educational, and efficient. All personnel at JAERI from the Director, Toyo Fuketa, to the secretaries treated the traveler with great respect and made the stay very profitable. All physicists speak and understand English, and secretaries can read and type English. I strongly recommend future assignments to JAERI. A listing of contacts at JAERI during my visit is given in Appendix B. A report on the travelers' research activity at JAERI (required under their Foreign Researcher Inviting Program) is attached as Appendix C.

2. FUTURE COLLABORATIONS BETWEEN ORELA AND JAERI

Tsuneo Nakagawa is responsible for the evaluation for ^{238}U for their new JENDL-3 file. M. Mizumoto and T. Nakagawa have agreed to complete during 1988 a resonance analyses of the ORELA ^{238}U transmission data up to about 20 keV at JAERI. Analyses will also be done at ORELA.

The traveler also suggested that we consider a cooperative program between JAERI and ORELA on other nuclides of interest to both institutions. Measurements would be made at ORELA (hopefully with a JAERI visitor participating for a short period of ~4 weeks) and then the data would be analyzed to obtain resonance parameters at JAERI. N. Shikazono, Director of the Physics Department, expressed strong support for this suggestion, and proposed M. Mizumoto and S. Chiba as possible visitors.

3. RECENT RESEARCH AT THE JAERI LINAC

3.1 NEUTRON RESEARCH

The electron linear accelerator at JAERI is operated only ~9 hours per day, 5 days a week. It is used for neutron cross section measurements only ~10% of the time. The most recent measurement was a transmission measurement of Si to obtain accurate parameters for the 55- and 188-keV resonances. Transmission measurements have also been made on samples of SVS 304 stainless steel for determining the cobalt and manganese content by neutron resonance radiography. The detection limit of cobalt in steel was estimated to be about 10 ppm.

Although there are adequate detectors and instrumentation (a Moxon-Rae detector and a 500 liter scintillation tank for capture measurements and a ^{6}Li glass and plastic detectors for transmission) for a meaningful neutron cross-section program at the linac, it does not have sufficient staff for the work. M. Mizumoto is the only staff member, S. Chiba has finished his thesis and will spend a year at Argonne with Alan Smith, another student is returning to the University of Tohoku, and a Chinese visitor from Beijing left in June. Since the minimum pulse width at the JAERI linac is nearly 10 times wider than that attainable at ORELA, and the peak current in short pulses is less than 20% of that available at ORELA, the JAERI linac cannot compete meaningfully with ORELA above 10 keV when good energy resolution is required.

M. Mizumoto also makes angular distribution measurements of both neutrons and gamma rays from inelastic scattering for MeV energy neutrons produced by the (d,d) reaction at the Tandem Accelerator. During my visit, he and coworkers ran for two days on the Tandem to evaluate the usefulness of a ^{11}B(H,n)^{11}C heavy ion reaction as a source of MeV neutrons.

3.2 PRODUCTION OF SLOW POSITRONS

The electron linac has also been used for the production of slow positrons by the use of a Ta target and a W moderator, the same technique used by L. Hulett at ORELA. The first slow positron beam was obtained in June 1987 and its intensity was too strong to be determined with their detection equipment, a Ceratron. At full linac power, ~10^{9} to ~10^{10} slow positrons per second were expected. In order to count the positrons and

for practical applications it was desirable to stretch the pulse width from 1 to ~25 μs by storing the positrons in a solenoidal tube ~1.5 m long. However, the positron intensity was too great to be measured accurately, but it was estimated to be only ~10^8 slow positrons/s, considerably lower than expected. The reason for this is not understood, but will be investigated.

3.3 FREE ELECTRON LASER LINAC

Preliminary experiments have been done in collaboration with researchers from the University of Tokyo using 127-MeV electrons to produce visible radiation (peak ~590 nm) using a wiggler magnet. The wave length spread of the radiation observed was quite large (~4 times wider than expected). This was attributed to the energy spread of the electron beam, the beam emittance, and field nonuniformity of the wiggler magnet. A large effort (five scientists) is being placed on improving the injection system consisting of an electron gun, a subharmonic buncher and preaccelerator for a future free electron laser accelerator. Calculations have been completed on this injection system and fabrication will begin this summer. The tentative design for this free electron laser linac calls for two superconducting sections of 1290 MHz with a peak beam current >20 A of 40 MeV electrons with an energy spread of <0.1%. Initially, the laser wavelength will be set at 10.6 μm. However, funding is not yet approved for this project, which may not be completed until the early 1990's. It would be built in Western Japan to be a new national facility. A block diagram with specifications for the injector are attached as Appendix D.

4. VISITS TO THE JAERI JPDR DECOMMISSIONING DEMONSTRATION PROJECT AND JAERI FUSION ENERGY TOKAMAK, JT-60

During his assignment at JAERI, the traveler had the opportunity for comprehensive tours of two of their large facilities. A power reactor built by G.E. (JPDR) was shut down in 1976 after ~21,500 MWD and a decommission permit was applied for in 1982. After a few years of detailed planning, dismantling began in 1986 and will continue until 1991. Various techniques are being tested or planned from arc-sawing and plasma arcs for dismantling the pressure vessel and reactor internals to diamond sawing and coring, abrasive water jets and controlled blasting of the biological shield. The traveler was given an excellent review and tour of the entire project by H. Ezure, Head of the Decommissioning Laboratory and witnessed the cutting of fuel holders with a plasma arc.

The traveler was very impressed with the clean appearance of the JAERI Fusion Research Establishment at Naka. The administration building with its polished marble stairs has an excellent technical exhibit of earlier JAERI plasma devices (both models and components of older experiments) and scale models of present and future reactors such as FER (a Fusion Experimental Reactor). The JT-60, a large Tokomak was completed in 1985 except for the Heating Systems of 10 MW of rf heating

and 20 MW of Neutral Beam Injector which are now installed. It was interesting to see that large electrical equipment for the same device was supplied by several Japanese companies, Mitubishi, Hitachi, etc. The tour included not only the device itself, but discussions of the diagnostics systems for measuring electron density and temperature, ion temperature, impurities, radiation flux and the data processing system. Various components of the device were being checked out the day of the visit in preparation for operation the following day.

5. VISITS TO THE NATIONAL LABORATORY FOR HIGH ENERGY PHYSICS (KEK) AND NATIONAL RESEARCH CENTER FOR DISASTER PREVENTION

The high energy TRISTAN e^+e^- collider (30 GeV energy) at KEK was in operation, hence, we only saw the large VENUS detector system located at one of the four experimental areas from a distance. The 2.5-GeV electron linac which feeds the TRISTAN is also used to inject into a storage ring which is used to produce synchrotron radiation for nine beam lines. The whole facility is very new (pieces of instrumentation and equipment are still in shipping crates). Experiments are being carried out by researchers from universities, national laboratories, and private industries.

The National Research Center for Disaster Prevention at Tsukuba Science City is devoted mainly to monitoring earthquake activities but also has a large-scale earthquake simulator and a large-scale rainfall simulator. Over thirty earthquakes a day in Japan are recorded at this center from its ~80 boreholes in Japan, mostly 200 m deep but three near Tokyo are 2000 m deep. The record of the earthquake (3.7 on Richter scale) which occurred just off the coast near Mito at ~7:00 pm during the reception at the Mito Conference was displayed for the Mito Conference tour. The large-scale earthquake simulator (consisting of a shaking table, 15 m × 15 m, and associated equipment) is used to test large-scale models of bridges, river embankments, underground tunnels, buildings, power plants, etc. The large-scale rainfall simulator consists of a movable building (15 m × 72 m × 23 m) capable of simulating rainfall from 15 to 200 mm/hr for as long as one hour at the maximum rate. This simulator is used to study hazardous phenomena such as slope collapses, surface run off, and infiltration tests.

A listing of papers acquired at JAERI and the Tsukuba tour are given in Appendix E.

6. INTERNATIONAL CONFERENCE ON NUCLEAR DATA FOR SCIENCE AND TECHNOLOGY MITO, JAPAN, MAY 29-JUNE 3, 1988

6.1 FORMAT AND ATTENDANCE OF THE CONFERENCE

The conference consisted of plenary sessions of 35 invited papers, about 80 contributed 12-minute papers in two parallel sessions, and about

166 posters most of which were displayed for the entire conference. In addition to the scheduled 90 minutes that each poster presenter was required to be at his poster, there was ample time at coffee breaks to scan the posters or to plan visits to discuss details with authors. Since the time available for oral contributed presentations is limited and there are so many contributed papers it will be essential to have poster presentations at the next conference in the series.

The conference was extremely well organized and ran very smoothly. Before the conference started it was decided not to include discussion in the proceedings. The only criticism I have is the lack of enthusiastic and controversial discussion after most of the talks. This was partly the fault of the chairmen who failed to have speakers finish their talks on time and, hence, allow sufficient time for discussion. This occurred for most talks in spite of the efforts of the local vice-chairman for the session who operated the timer and bell to keep the session on schedule. The most spirited discussion and criticism followed the excellent talk by H. V. Klapdor on "Microscopic Calculations of the Decay Heat of Nuclear Reactors."

About 60% of the participants of the nearly 280 at the conference were from Japan, 32 from the USA, 12 from the People's Republic of China, nine from the Federal Republic of Germany, eight from France, six from Belgium, five each from the USSR, U.K. and Sweden, and four to one from 21 other countries. It was impressive to have such a large number of Japanese physicists and engineers active in the measurement, analyses, evaluation, and testing of nuclear data. The differential scattering programs for MeV neutrons at several laboratories in Japan were especially noteworthy. Having the conference in Japan gave many Japanese researchers a great opportunity to meet and discuss details with the neutron physicists from the rest of the world. It was also personally rewarding to have a Japanese researcher from an industrial research laboratory discuss with me the evaluations he is doing on fission products based on resonance measurements done at ORNL years ago.

6.2 NEANDC TASK FORCES ON ^{238}U and ^{56}Fe

The traveler had several detailed and valuable discussions with M. Moxon and M. G. Sowerby from Harwell on the parameters of the resonances in ^{238}U up to ~10 keV. A new resonance analysis of ^{238}U is being performed at Harwell (with collaboration of the NEA Data Bank) of both the transmission data of Olsen (1978 data) and the recent 150-m capture data of Macklin. Just below 10 keV they claim the old transmission data of Olsen missed 2/3 of the resonances which they suggest are needed to fit the capture data. Between 9 and 10 keV these missed resonances accounts for ~36% of the capture cross section. The 200-m 1988 ORELA transmission data show nearly the same number of resonances as Macklin's capture data in the 10 keV energy region. These new transmission data must be included in future ^{238}U resonance parameter evaluations.

In his report from the Task Force the last day of the Conference, M. Sowerby reported that the origin of the discrepancies in the resonance parameters of ^{238}U prior to 1982 is now understood and that work is now in progress to obtain a complete set of parameters up to 10 keV from recent measurements. For the unresolved region at higher energies he praised the evaluation effort of Poenitz which claims an accuracy for the capture cross section of < ±3% over most of the energy region between 10 keV and 2.2 MeV. This evaluation is also consistent with integral data. However, Sowerby concluded that there is still a need for capture cross-section measurements which emphasize new approaches and techniques and which minimize corrections.

The origin of the discrepancies for the capture area ($g \Gamma_n \Gamma_\gamma / \Gamma$) for the 1152 eV resonance in ^{56}Fe is now understood. At the Antwerp meeting in 1982, John Rowlands had complained that the neutron width from capture measurements from different laboratories differed by as much as 51%. The reason for the discrepancy is due to errors in the weighting function of the pulse-height weighting method for neutron capture. Recent calculations and measurements at ORNL have now shown that the efficiency for high energy gamma rays (~8 MeV) is considerably greater than originally calculated for a variety of reasons. Hence, when the gamma-ray spectra is hard (i.e. many high energy gamma rays) and the flux is measured relative to the 4.9-eV gold resonance which has a soft spectrum, the pulse height weighting method gives too large a value for the capture area, by as much as 23% for this 1152-eV ^{56}Fe resonance. It was rewarding to learn from F. Corvi's talk that the benchmark for testing the accuracy of the capture technique is the capture area of 55.7 ± 0.8 meV for this 1152-eV resonance computed from transmission measurements made at ORELA.

6.3 NONSTATISTICAL EFFECTS IN NUCLEAR LEVEL SPACINGS

Two papers by G. Rohr, Geel reported striking deviations from the Wigner nearest-neighbor spacing distribution which was verified many years ago for heavy nuclides where the compound nucleus model is valid. However, for light nuclides (A < 38) such as $^{32}S+n$ and $^{28}Si+n$, Rohr has identified 2p-1h states from high-resolution transmission measurements and the spacings between these doorway states are quite uniform. He concluded that the probability is only 0.016% for the spacing distribution for these nuclides to be consistent with a Wigner distribution. Above 1 MeV neutron energy several 3p-2h states were identified for each 2p-1h doorway state for $^{32}S+n$. For the s-wave resonances in $^{52}Cr+n$, it was noted that there are two energy regions at ~200 and ~670 keV where at least two resonances are missing. Excluding these two gaps he calculated that the probability that the spacing distribution agrees with a Wigner distribution was <0.12%. Similar strong level repulsion effects are present for $^{40}Ca+n$ and $^{96}Zr+n$. Rohr *et al.* also studied the level spacing for $^{54}Fe+n$, $^{56}Fe+n$ and $^{58}Fe+n$. Again, the probability that these spacing distributions are consistent with a Wigner distribution was only 1.2%, 8.7%, and 1.5%, respectively. These effects should be looked at again at ORELA.

Another contribution to the conference by K. Ideno claimed strong periodicities in level spacings for the rotational rare earth and heavy nuclides. Striking periodicities such as 17.6 eV for ^{168}Er+n, 4.37 eV for J=3 resonances for ^{177}Hf+n and 3.06 eV for ^{179}Hf+n were reported. Strange correlated behaviors of the occurrence of levels of other nuclides relative to the resonances of these reference nuclides were observed which were claimed to be significant.

6.4 AVERAGE NEUTRON PARAMETERS FROM DIFFERENTIAL ELASTIC SCATTERING MEASUREMENTS

At the Antwerp Conference in 1982, the determination of neutron strength functions for s- and p-wave neutrons from preliminary poor resolution scattering measurements at Dubna were reported. New measurements made at the IBR-30 reactor in Dubna for many nuclides with 25 ns/m resolution have now been made up to an energy of 450 keV at angles of 45°, 90°, and 135° with ^{3}He detectors. The data were analyzed to obtain neutron strength functions and R' for s- and p-wave neutrons. For nuclides with A < 90 the results were systematically lower than BNL-325 values which the authors suggested was due to significant self-shielding for the thicknesses of the scattering samples which were used in this study. However, I think the disagreement may be due to the large neutron windows which occur before large s-wave resonances. Data for p-wave neutrons agreed with calculations of various optical models. This technique appears to be useful for obtaining neutron strength functions when the energy resolution is not sufficient to resolve individual resonances.

6.5 FUTURE NUCLEAR DATA NEEDS, INTERNATIONAL COOPERATION AND NEXT CONFERENCE

It was emphasized by many speakers at the conference that there is still a need for more accurate nuclear data for fusion reactors (e.g. ~1% accuracy above 10 MeV for some structural and shielding materials), for fission reactors (^{238}Pu, ^{242}Cm, and higher isotopes for high burnup fuels), for stellar nucleosynthesis (for s-process nuclides and unstable nuclides) and for applications (such as the production of ^{153}Gd for medical applications). It is essential to have international cooperation in all areas (measurements, analysis, evaluation, and integral testing). There is a large nuclear data compilation effort in Japan, ~6 full-time physicists at JAERI and many others at universities and in Japanese industries. The U.S. could benefit from close cooperation in this area. All attendees (Japanese and European) with whom I talked were strongly in favor of holding the next conference in this series in the USA, in Knoxville.

APPENDIX A

Itinerary

5/13-14/88	Travel from Oak Ridge, Tennessee to JAERI, Tokai, Japan
5/15/88	Weekend
5/16-20/88	JAERI, Tokai, Japan
5/21-22/88	Weekend
5/23-27/88	JAERI, Tokai, Japan
5/28-29/88	Weekend
5/30-6/3/88	JAERI-sponsored International Conference at Mito, Japan
6/4-5/88	Weekend
6/6-11/88	JAERI, Tokai, Japan
6/12/88	Travel from Tokai, Japan to Oak Ridge, Tennessee

APPENDIX B

Persons Contacted at JAERI

T. Fuketa, Director JAERI

N. Shikazono, Director Physics Department, JAERI

Y. Kawarasaki, Head, Linac Laboratory and Free Electron Laser Project

M. Mashiko, Chief of Linac Operations

M. Mizumoto, Group Leader for Neutron Research

X. Zeng, Visiting Scientist from IAE, Beijing, China

S. Chiba, Neutron Experimental Physicist

M. Ohkuho, Linac Laboratory, Free Electron Laser

H. Yoshikawa, Linac Laboratory, Free Electron Laser

M. Takaba, Linac Laboratory, Free Electron Laser

M. Sawamura, Linac Laboratory, Free Electron Laser

S. Igarasi, Head of Nuclear Data Center

T. Nakagawa, Nuclear Data Center

Y. Kikuchi, Nuclear Data Center

T. Asami, Nuclear Data Center

K. Shibata, Nuclear Data Center

H. Ezure, Head Decommissioning Technology Laboratory, JPDR Department

A. Sakasai, JT-60

S. Kikuchi, VAX-680, Computer Physicist

C. Nakazaki, Chief, Office of International Affairs

Y. Sugigama, Tandem Accelerator, guest at HHIRF in 1984

M. Oshima, Tandem Accelerator, guest at HHIRF in 1984 and 1985

K. Ideno, Tandem Accelerator

APPENDIX C

REPORT TO JAERI ON RESEARCH ACTIVITY DURING ASSIGNMENT

(REQUIRED UNDER THEIR FOREIGN RESEARCHER INVITING PROGRAM)

SUBJECT AND CONTENT OF RESEARCH WORK DONE AT JAERI

The goal of this visit was to get the complex computer program called SAMMY operating on both the VAX 780 computer at the Tandem and also on the main computer (IBM type) and then to analyze at JAERI a few very limited energy regions of the new ORELA high-resolution ^{238}U transmission data.

At ORELA, SAMMY runs on a VAX-785, and several significant changes had to be made in order to get it to work at JAERI. Without the assistance and cooperation of the VAX computer physicist Dr. S. Kikuchi and the enthusiastic, competent and hard work of Satoshi Chiba and Motoharu Mizumoto (and numerous contacts with Nancy Larson and Francis Perey of ORNL) this effort would not have been accomplished.

The IBM version of SAMMY which I brought from ORELA had never been completely debugged or operated with success. Through the indefatigable and extremely competent efforts of Tsuneo Nakagawa (with contributions and suggestions from several members of the JAERI Nuclear Data Center), SAMMY was made to operate on the JAERI main computer.

The new high-resolution ORELA transmission data have been analyzed at JAERI over a few small regions to compare to the results from the previous analyses of the earlier Olsen's transmission data and to the very recent preliminary analyses by Moxon of Harwell of new capture and transmission data. The differences are quite significant and the complete analyses of the new ORELA transmission and capture data must be considered in the new JENDL 3 file for ^{238}U which is being done by Tsuneo Nakagawa.

RESEARCH PAPER PRESENTED OR PUBLISHED IN CONNECTION WITH WORK DONE AT JAERI

When the analyses of the new high-resolution ORELA transmission data on ^{238}U have been completed, a paper will be prepared for submission to a journal such as Nuclear Science and Engineering.

FUTURE RESEARCH WORK IN CONNECTION WITH WORK DONE AT JAERI

I will continue to do some resonance analyses of the ^{238}U transmission data for the three sample thicknesses during this summer. A similar effort will continue at JAERI.

COMMENTS ON THE RESEARCH ACTIVITIES, FACILITIES, ETC. AT JAERI

The strongest and most valuable resource which you have at JAERI is the extremely competent, knowledgeable, hard-working physicists. The linac at JAERI is still a good accelerator and still a competitive pulsed neutron source for eV and keV neutron research. The neutron program at the Tandem should continue to produce much needed data. The VAX-780 at the Tandem is a fine computer and the main computer and terminals seem excellent. The JT-60 is very impressive.

COMMENTS ON LIVING CONDITIONS AT JAERI

I am very pleased that Mizumoto suggested that I stay at Katsuta, rather than Mito or Tokai. I think that it is important for a foreign guest to feel somewhat independent (and not impose on their Japanese hosts for everything) and the Crystal Plaza Hotel in Katsuta permits the guest to travel to Tokai by train and then bus very efficiently, and I found the trip interesting and enjoyable.

Ms. Nakazaki in the foreign visitor office was very helpful, the welcome party by the MESA Friendship Society was great, my office in the Co-60 building was fine, and the food at the cafeteria was acceptable. Finally, the cooperation, friendliness and cheerfulness of all the physicists and the personnel with whom I had contact were almost unlimited, and it is what I will remember most from my visit to JAERI.

COMMENTS ON THE FUTURE OF THIS PROGRAM

We at ORELA are very interested in continuing this program, especially when JAERI will send their young, competent, enthusiastic physicists to ORELA. It is difficult to get an ORNL physicist with a family to spend a year at JAERI. However, a three-month stay seems reasonable, and Francis Perey would be interested in such an arrangement.

OTHER COMMENTS

I think the electron linac is a very good neutron source for time-of-flight neutron spectroscopy in the eV and low keV energy region. Since most of the earlier capture measurements by Dick Macklin at ORELA started at 3 keV, there is a need for capture work <3 keV for some nuclides and the linac at JAERI could cover this energy region as well as ORELA could do it. However, the funding and manpower for a comprehensive program are too small to be very competitive with those at ORELA and LANL. I would suggest that we consider a cooperative program between JAERI and ORELA on nuclides of interest to both institutions where measurements are made at ORELA (hopefully with a JAERI visitor participating for a short period, ~4 weeks), and then the data are analyzed later at JAERI.

APPENDIX D

Free Electron Laser Linac

JAERI 自由電子レーザー

SYSTEM BLOCK DIAGRAM

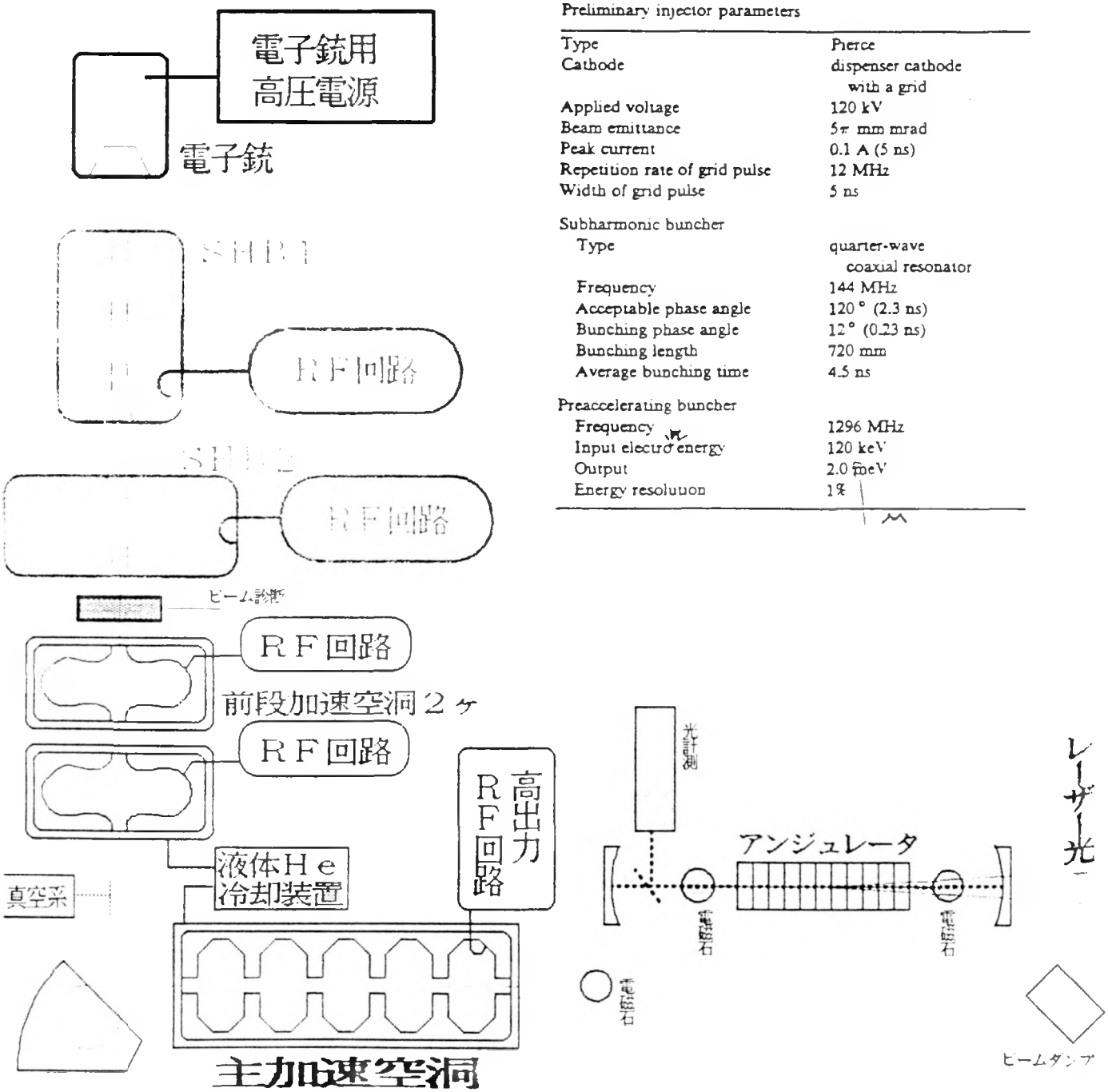

Table 2
Preliminary injector parameters

Type	Pierce
Cathode	dispenser cathode with a grid
Applied voltage	120 kV
Beam emittance	5π mm mrad
Peak current	0.1 A (5 ns)
Repetition rate of grid pulse	12 MHz
Width of grid pulse	5 ns
Subharmonic buncher	
Type	quarter-wave coaxial resonator
Frequency	144 MHz
Acceptable phase angle	120° (2.3 ns)
Bunching phase angle	12° (0.23 ns)
Bunching length	720 mm
Average bunching time	4.5 ns
Preaccelerating buncher	
Frequency	1296 MHz
Input electron energy	120 keV
Output	2.0 MeV
Energy resolution	1%

APPENDIX E

Listing of Papers and Reports Acquired at JAERI and on Tsukuba Tour

Y. Kawarasaki, M. Ohkubo, N. Shikazono, and K. Mashiko, "Linac for a Free Electron Laser Oscillator: Design Consideration of the Injector System."

Yasuo Ito, Osamu Sueoka, Yoshihiro Hirata, Masayuki Hasegawa, Saburo Takamura, Toshio Hyodo, Yoneho Tabata, Tadao Iwata, Katsuo Mashiko, and Yuuki Kawarasaki, "Extraction of Slow Positrons Using JAERI Linac."

Yuuki Kawarasaki, Makio Ohkubo, Katsuo Mashiko, Motoharu Mizumoto, Hirotada O'Hashi, Hitoshio Kobayashi, Tohru Ueda, Toshiaki Kobayashi, Chihiro Tsukishima, and Maki Kishimoto, "Observation of Spontaneous Emission of Radiation at a Visible Wavelength."

Makio Ohkubo, "Reduction of Delayed Gamma Ray Backgrounds for a Pulsed Neutron Source."

I. Ishikawa, N. Tachikawa, M. Ohkubo, and H. Tominaga, "Nondestructive Elemental Analysis by the Method of Neutron Resonance Absorption."

Keiichi Ohtani and Hiroshi Takahashi, "Outline on Research Results of Wind and Seismic Effects During 2 Decades at the National Research Center for Disaster Prevention."

National Laboratory for High Energy Physics, Monbusho, 1987.

National Research Center for Disaster Prevention, Science and Technology Agency.

Tokai Research Establishment Visitors' Guide.

Japan Atomic Energy Research Institute Booklet.

JPDR Decommissioning Demonstration Program, Japan Atomic Energy Research Institute.

"JAERI Tokamak-60," Japan Atomic Energy Research Institute, edited by Department of Large Tokamak Research, JAERI.

"Department of Physics," Japan Atomic Energy Research Institute, edited by Department of Physics, JAERI.

APPENDIX F

Literature Acquired at Mito Conference

Michael G. Sowerby and Francesco Corvi, "Matters Related to the NEANDC Task Forces on ^{238}U and ^{56}Fe Resonances."

J. Schmiedmayer and M. C. Moxon, "The Measurement of Accurate Total Cross-Sections for Lead and Carbon in the Energy Range 50 eV to 100 keV."

L. V. Mitsyna, A. B. Popov, and G. S. Samosvat, "Average Neutron Parameters From Differential Elastic Scattering Cross Sections of Neutrons with Energies Below 450 keV."

I. M. Frank, V. I. Luschikov, and E. I. Sharapov, "Fast Pulsed Reactors for Neutron Physics Experiments."

Gert H. Rohr, "New Aspects of Nuclear Level Spacing Distributions."

Gert H. Rohr, Richard C. Shelley, and Georges J. Vanpraet, "Nuclear Energy Level Spacing Distributions in Even Iron Isotopes."

Kazumi Ideno, "Shift of Neutron Resonance Levels in Periodic Structure."

Charles D. Bowman, "New Neutron Physics Using Spallation Sources."

J. J. Egan, A. Aliyar, C. A. Horton, G. H. R. Kegel, and A. Mittler, "Inelastic Scattering Cross Sections of Vibrational States in ^{232}Th for Neutrons from 2.3 to 3.0 MeV."

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