**Review of RIKEN RI-Beam Factory**
**International Advisory Committee**
**May 1999**

## 1. INTRODUCTION

Following the invitation of the President of RIKEN, Professor S. Kobayashi, the International Advisory Committee ( IAC ) of the RIKEN RI Beam Factory project met in Tokyo from May 5-8 for a review of the progress of the beam production and delivering facility and for giving an advice on the scientific and technical case of the experimental facility MUSES.

The following members of the IAC participated in the Tokyo meeting: Prof. S. Datz, Prof. H. Ejiri, Dr. B. Frois, Dr. J. Garrett, Prof. K. Gelbke, Prof. P. Kienle (Chair), Prof. K. Nakai, Prof. J. Schiffer.

Basis of the review were the following main documents.

- Status of RI - Beam Factory Project from May 1999
- RIKEN RI - Beam Factory : A new Era of Heavy-Ion Science from May 1997
- Collected Papers on the RIKEN RI - Beam Factory Project from December 1998
- RIKEN RI Beam facility and its physics program, I. Tanihata J. Phys. & Nucl. Part. Phys. 24 (1998) 1311
- MUSES Conceptual Design Report, May 1999

These documents were supplemented by presentations of various aspects of the project as documented in the enclosed agenda of the RIKEN RI - Beam Factory International Advisory Committee meeting from May 5 - 8, 1999.

Following the recommendation by the first International Advisory group in 1994, RIKEN proposed the construction of the RI Beam Factory to the Science and Technology Agency, STA. In February 1995, RIKEN received R&D support for the Superconducting Ring Cyclotron (SRC), and the Intermediate Ring Cyclotron (IRC). In February 1997, a budget was approved for ground testing and for planning the facility, followed by approval of the construction of the SRC, IRC and the RI - beam separators. The IAC welcomes these developments and those members of the present committee who also served on the earlier one, appreciate the remarkable progress of the RIKEN project, along the line of their 1994 recommendations.

The IAC has been asked to review

1. The status of the construction of the of the beam production and delivering facility: the accelerators (IRC, SRC, ion source etc.) and the design of the

RI beam separator and experimental systems.

2. The plan for MUSES and its associated experimental facilities, its design and science goals.
3. The planning for the operation of the facility and for international collaboration schemes.

## 2. STATUS AND R&D OF THE CYCLOTRON-COMPLEX CONSTRUCTION PROJECT

The accelerator complex for RI Beam production has been chosen close to optimum for providing primary beams of light nuclei of 400 MeV/u and uranium beams of 100 MeV/u with currents of 1 particle micro A (U) and higher for the lighter nuclei. The intense high energy primary beams are used to produce beams of unstable neutron deficient and neutron rich nuclei by the projectile fragmentation and fission method. The radioactive beams will be isotopically separated by fragment separators, called Big-RIPS with similar design as the FRS at GSI and the A1900 separator at NSCL/MSU including various improvements in the acceptance. Two of the Big-RIPS will be constructed with the option of switching the primary beams from one to the other. This allows a multiple use of the RI-beams. The purified RI-beams are delivered by specially designed beam lines to various experimental stations, the R & D of which is in an advanced stage. The proposed complement of experimental equipment is impressive and will allow a research program of considerable depth and breadth.

The overall progress of the construction of accelerators and experimental equipment is satisfactory. With the advice of the international Technical Advisory Committee, TAC, the technically most difficult part of the project, the SRC, has made respectable progress.

There may be some risk for cost and schedule slippage in the construction of the SRC, especially in view of the two coil designs by different firms, which hopefully can be tested soon and brought to a decision.

Another area, which carries some risk, is the charge-state multiplier, designed to use foil stripping even for the heaviest beams. Experience from the GSI and elsewhere indicates that the lifetimes of the stripper foils may become unacceptably short for the highest intensity uranium beams. Alternative options, such as gas stripping or improvements in ion source technology should be carefully considered.

With these minor caveats the creativity and ingenuity of the RIKEN groups impressed the committee. Much thought has gone into the development of fast and precise tracking detectors and on background suppression techniques. No major weakness could be identified in the overall facility plan.

## 2.1 ACCELERATOR CONSTRUCTION

The design and construction of the cyclotron complex of the RIKEN RI Beam Factory proceeds with vigor and in close collaboration with Japanese industry. The RIKEN 18 GHz ECR ion source is completed and has been placed in operation with remarkable beam intensities. An ECR source of the CAPRICE type, but using superconducting solenoid coils for providing a field of up to 3T is under construction for production of still higher currents. The K930 IRC, a four-sector ring cyclotron, has been designed and is under construction by Mitsubishi Industries. The technically most challenging part of the project is the six-sector K2500 superconducting ring cyclotron, the first one of its kind in the world. It will allow heavy ions to be accelerated to the highest energy with 100% duty factor, and using single-turn extraction will lead to unsurpassed beam qualities (small momentum spread and emittance). The close collaboration with the TAC, the members of which represent most of the international expertise in the field of superconducting cyclotrons, is most helpful. The conceptual design has been agreed on, and a full test magnet with two coils of different design is under construction. The IAC hopes, that these tests lead to a clear decision on which coil design should be used for construction of the SRC without excessive delays.

A complete system design of the SRC, which guarantees the rigidity under high strains, needed for reliable operation of this complex machine, is the next big task. The ambitious time schedule to finish the construction in 2003 requires careful technical attention by the RIKEN accelerator staff in close collaboration with the TAC, fast and clear decisions, careful organization and work by the industries involved. Perhaps one general contractor responsible for the construction of the system is desirable. Some concern was expressed about the use of a charge multiplier in front of the RRC. In its present design it is based on the use of a foil-stripper. However for beams of the heaviest elements the foil lifetimes may become unacceptably small and a gas stripper may be required which produces lower charge states. This option should be looked at as well as further developments of ion sources.

## 2.2 BEAM DELIVERING SYSTEM AND EQUIPMENTS

The beam delivery system is well matched to the capabilities of the primary beam accelerator complex and the following experimental equipments.

### 2.2.1 FRAGMENT SEPARATORS

In order to maximize the number of users two fragment separators (Big RIPS) are to be constructed. The primary beams can be apportioned to their respective production targets with great flexibility using a fast pulsing kicker magnet. The design must foresee remote handling in the target areas and preferably separated caves for the two separators to ensure radiation safety

and best operation conditions. Both fragment separators are well matched to the envisaged research program and allow nuclei with A/q=3 to be selected up to full beam energy. The Big RIPS will have high radial and momentum acceptance so that not only the well focused projectile fragments, but also fission fragments, will be separated with high efficiency. The room temperature dipole magnets and the superconducting quadrupole magnets, which provide the high acceptance of the Big RIPS are based on established technologies and pose little, if any risk.
The question of radiation damage to the superconducting quadrupoles came up, and no specific answer for magnet lifetimes in the high radiation fields could be given. Since the facility will be operated at unprecedented beam power levels this question should be addressed. Versatile complements to the Big RIPS are envisaged. The most important ones are high acceptance and high resolution forward spectrometers for kinematically complete coincidence experiments used for reaction studies with radioactive beams from the Big RIPS. These spectrometers are "musts" for an advanced fragmentation facility.

### 2.2.2 OTHER EQUIPMENT

While it is understandable that the RIKEN staff is now focusing on these major, large pieces of equipment with long leadtimes, some attention should be paid to large solid angle detection systems such as highly granular arrays of Ge detectors and/or highly segmented position sensitive particle detection systems based on silicon technology. Such devices have been and are developed at other laboratories. They are very complex, with thousands of high resolution data channels and thus may well be candidates for future external users. The IAC was pleased to learn about a number of new ingenious beam tracking and particle identification systems capable of high resolution and handling high count rates. A large and necessary effort is put into the development of a 25 kW energy loss projectile fragmentation target, which is rotated and water cooled. Test experiments with a 1.8 kW beam showed that it may be possible to handle a heat loss of 20 kW.

### 2.2.3 GAS STOPPER AND ION GUIDES

The technique of stopping short-lived nuclei in He gas and then transporting them with an rf guide field is an extremely effective way of producing stopped ion species suitable for loading into ion traps. This technique, combined with isotope selections using a fragment separator, is fast and thus compatible with the shortest lifetimes expected for particle-stable nuclei. Trapped ions then can be studied, either by laser spectroscopy to determine their nuclear spins and moments from hyperfine splitting, or their masses can be measured with great accuracy. The beta decay of trapped ions can also provide unique opportunities for precision beta decay experiments, testing the limits of the

Standard Model by making use of unique opportunities, without the usual difficulties caused by a solid-state environment associated with source backings. RIKEN work is pioneering in many aspects of these techniques that have great physics potential in a number of areas.

#### 2.2.4 RECOIL IMPLATATION OF POLARIZED RI

The recent discovery of the large polarization of projectile fragments at RIKEN allows deep implantation of polarized radioactive nuclei. The study of the following decay allows interesting experiments in fundamental and nuclear physics as well as applications in biology and industry.

## 3. THE MUSES PROJECT

For the MUSES part of the RIKEN RI Beam Factory the conceptual design has been completed. It is a unique type of experimental facility with Multi-Use Experimental storage rings. It consists of an Accumulator Cooler Ring (ACR), a Booster Synchrotron Ring (BSR) with an additional electron injector linac and Double Storage Rings (DSR). The MUSES facility is in the proposal phase, waiting for a government decision.

The ACR is proposed for accumulation and cooling of RI beams and for atomic and molecular physics experiments with the beams of the electron cooler.

The BSR serves for acceleration of ion and electron beams to energies of 1 GeV/u for 238 U,1.5 GeV/u for the ions of charge to mass ratio of 0.5, and 2.5 GeV for electrons, respectively.

The DSR is the heart of the MUSES facility by allowing various types of unique colliding beam experiments. Ion-ion colliding and merging beam experiments, with one or both ions being a RI beam, electron ion (stable or RI) colliding beam experiments, and collisions of RI beams with highly brilliant x-rays from an undulator are envisaged.

### 3.1 MUSES CONCEPT AND DESIGN

The Committee was pleased to hear the presentation of the basic design that forms the basis of the MUSES concept. The variety of accelerators and storage devices, allowing for fixed target and colliding beam experiments in a variety of geometries is arguably one of the most complex system anywhere for nuclear physics research. It includes opportunities for

-storing radioactive beams and have these react either on internal gas targets, or interact with x-rays produced by an undulator from a suitably aligned 2.5 GeV electron beam;

- allowing collisions with counter-propagating electron beams in order to determine the charge radii and higher moments of the charge and magnetization distributions of these exotic nuclei;

- scattering of protons by circulating through fixed internal hydrogen gas-jet-targets, which will determine the total nucleon matter (and thus neutron) distributions of these nuclei;
- studies of the structure of these nuclei by 'merging beam' experiments where another storage ring with proton, deuteron, or other light ion beams will intersect the radioactive beam at a small angle, and thus low relative energy, allowing the exploration of the structure of these nuclei through transfer reactions;
- allow the exploration of fusion reactions with unstable nuclei producing species that are otherwise inaccessible (e.g. perhaps neutron rich superheavy nuclei);
- also having the eventual possibility for studying hadronic excitations through the head-on collision between electrons and nucleons and producing larger center-of-mass energies than have been possible hitherto;
provide new opportunities for atomic and molecular structure studies.

These technical options offer a rich variety of unique scientific opportunities, particularly with short-lived beams, that are likely to be unique worldwide for a long time. The IAC fully endorses the scientific objectives of the project. The detailed technical feasibility of a complex and sophisticated plan must, of course, be subjected to continuing detailed reviews by technical advisory committees, a proces which has so far been extremely effective for the project. Experts with the appropriate backgrounds will have to be added to the present TAC for the feasibility studies of the MUSES facilities.

### 3.1.1 COOLING TIMES

Since the major focus of research with MUSES is the study of the property of short-lived nuclei, the storage of these ions is of particular interest. It is clear that the question of cooling times is crucial. In fact, the most interesting nuclei for study are often those that are furthest from stability and thus the shortest lived. Since the present beams will generally be produced with relatively large size and emittance, they will have to be cooled so that they can collapse into well defined compact beams that optimize the yield in these experiments. With present cooling techniques apparently the number of nuclei that can be stored begins to be limited by their lifetime for beta decay, when this is less than about a minute. Therefore, an important area for R & D is to push the limits of the state of the art in cooling and attempt to shorten the time in which this process can take place and push the limits of lifetime in which storage can be accomplished.

### 3.1.2 PULSED BEAM

Another important area for R & D is associated with the need to load the synchrotron with short pulses. In order to attain the desired levels of circulating short-lived beams, it is necessary to have the primary beam come in short and very intense pulses from the original ion source that feeds the SRC. This requires the development of new reliable pulsed ion-source techniques with a performance that is substantially better than what is presently achievable. The pulsed laser scheme has not been adopted at CERN and alternatives need to be explored.

### 3.2 MUSES EXPERIMENTAL OPPORTUNITIES

The scientific opportunities offered by the MUSES facility are unique. For the first time, the nuclear charge and matter distributions of nuclei far from nuclear stability can be studied for the medium and heavy nuclei. Nuclear charge radii can be studied both by electron scattering and by x-ray spectroscopic techniques. Merging beam experiments can provide precision nuclear structure information for those systems whose production is sufficiently large and whose lifetimes are sufficiently long to be cooled in the storage rings of MUSES. Detailed spectroscopy with fusion and transfer reactions should be possible with the physics ranging from probing the structure of new doubly-closed shell nuclei and reactions important for cosmic processes to (with some luck) production of new heavy nuclei near the predicted super heavy island of increased nuclear stability. Among the many possible research topics, RIKEN, prudently plans to focus on three priority programs, such as

1. Measurements of charge distributions of unstable isotopes.
2. X-ray fluorescence experiments on unstable isotopes for determination of the isotope shift and hyperfine splitting for chains of isotopes.
3. Merging beams experiments which require low center-of-mass energies of the colliding nuclei, such as fusion reactions or low-energy direct reactions.

In the following we comment on a few aspects.

#### 3.2.1 ELECTRON SCATTERING

Elastic electron scattering from nuclei determine the Fourier transform of the nuclear charge distribution. This method, has been used to measure the detailed shapes of the nuclear charge distributions for stable nuclei. These data are the most precise information on nuclear distributions and have been of major importance to guide nuclear theory. Unfortunately, up to now, no electron scattering experiments from unstable nuclei were possible because of the lack of appropriate targets. Using a system of double storage rings to accumulate radioactive nuclei and electrons is a novel and attractive idea to increase the currents and the energies of both the electron and the radioactive beams and the center-of-mass collision energy.

The proposed double storage ring (DSR) of the MUSES facility will allow extensive studies of the charge radii of radioactive nuclei since the available luminosity will be larger than 1024cm-2s-1. Depending on the maximum luminosity available for specific nuclei, it will also be possible to study the higher moments of the nuclear charge distributions and in particular the skin thickness of neutron rich nuclei. It will be of considerable interest to measure with precision the sizes of halo nuclei. By combining these results with measurements of matter distributions from interaction cross sections and elastic proton scattering one will infer the shapes of neutron distributions also.

The detection of the electrons will require a large solid angle and high momentum resolution detector with good tracking capability to measure with precision the location of the interaction point and the scattering angle of the electrons. The committee strongly supports the program of studying nuclear charge radii of unstable nuclei using the MUSES facility. The committee recommends that a detailed proposal of the detection system be developed in order to optimize the detector for the measurement of elastic electron scattering in the colliding mode.

### 3.2.2 HADRON PHYSICS

Several interesting experiments have been proposed to probe the hadron structure by electron scattering at MUSES. The committee believes that it is important to ensure that the design of the facility will allow the possibility of these experiments in the future. Such experiments would require a dedicated experimental set-up that needs to be studied in detail.

### 3.2.3 X-RAY STUDIES

RIKEN has started an interesting R&D program for the study of resonance absorption of x-rays by Li-like ions of radioactive nuclei stored and cooled in the double storage ring. Such experiments, if practical, will allow the measurement of the isotope shift and hyperfine structure splitting of nuclei far from stability, from which mean square charge radii and nuclear moments can be derived.

### 3.2.4 REACTIONS AROUND THE COULOMB BARRIER

The development of the merging beam technique for reaction studies in the DSR of the MUSES- facility is a very interesting approach to study reactions of radioactive nuclei with stable beams at energies around the Coulomb barrier. It requires cooled beams in two storage rings and a well defined beam crossing angle for a good center of mass energy definition. The best would be zero degree crossing angle and two beams with the desired relative energy

difference.
The problem with this new method is to reach sufficient luminosity. It can also be favorably applied to studying electron transfer reactions between highly ionized species for which luminosity should not be a severe problem.

### 3.2.5 ATOMIC AND MOLECULAR PHYSICS

The MUSES facility also offers the opportunity for unique and interesting research in atomic and molecular physics. MUSES has a bending capacity of 14 Tm, while other storage rings used for such studies are considerable lower (~2 Tm). This implies that the present limitations on the mass of the stored ions ($M/q<30$), imposed by the lower energy limit on the electron beam cooler, would be about an order of magnitude better. The present limitation is especially severe for the studies involving molecular dissociation, but also opens new areas in the study of di-electronic recombination in the electron cooler. A new and entirely unique capability for atomic and molecular physics with storage rings is the availability of photons from the undulator of the DSR, to study, e.g., photoionization and photodissociation of stored ions. Solid state applications with an extracted beam look potentially interesting, but the feasibility of extracted beams needs to be studied.

### 3.2.6 SUPERCRITICAL FIELDS

In the context of studying QED processes in supercritical fields, MUSES is proposed to be used for measurements of positron-electron pair production in merging collisions of two beams of fully stripped uranium ions at center of mass collision energies around the Coulomb barrier. This area of investigation is interesting, though the experiments are difficult and much ground has already been covered. The advantages and simplification of fully stripped species must be weighed carefully against the difficult and challenging experimental problems in a field where much work has already been done. If the experimental problems can be solved, one has the opportunity of a detailed comparison with theoretical predictions of high-field collision dynamics.

### 3.2.7 INTERDISCIPLINARY RESEARCH IN BIOLOGICAL SCIENCES

The facility under construction and proposed at RIKEN can serve for a wide variety of interdisciplinary research projects, some of which need radioactive beams, while others can be carried out with stable ion beams from low up to high energy. We heard for example of interesting studies of biological effects of low dose heavy ion radiation, which can be carried out also with stable beams at various energies. The IAC recommends that experimental facilities for those aspects of this work that utilize truly unique features of the facility should be identified and assessed, and be the basis of decisions to allow parasitic use at low as well as high energies with stable and radioactive beams.

### 3.3 ACCELERATOR RESEARCH FACILITY OPERATION PLANNING

The proposed RIKEN RI Beam Factory is a highly complex extremely versatile experimental facility, which needs very careful planing not only in the design and construction phase, which is going on now, but equally important also for the operation phase. Because of the novelty and complexity of the operation modes, especially of the MUSES facility, intensive effort is needed for the development of the various cooling methods and particularly of the various collision modes in the DSR, which have never been practiced in any project before.

In order to master all the technical problems the formation of a strong experimental group together with an expert machine group is needed for the development of the experimental techniques of the new collision experiments. In this context the IAC stresses the need that an organization should be created which integrates all scientists and students both experimentalists and theorists from inside and outside of Japan who are interested in this field of advanced heavy ion physics in a dedicated International Heavy Ion Research Center as has been proposed. It should contain a large experimental group formed from various RIKEN laboratories and, most importantly, Japanese and foreign research groups from universities and other research organizations. In addition, the formation of a flexible, project-oriented research system with several groups, in a way that is already practiced by RIKEN in other fields of research, is highly recommended by the IAC.

## 4. SUMMARY AND RECOMMENDATIONS OF THE RIKEN INTERNATIONAL ADVISORY COMMITTEE (IAC) FOR THE RI BEAM FACTORY

The RIKEN RI-Beam Factory is conceived to be the world's premier facility for research with beams of radioactive isotopes produced by projectile fragmentation or fission plus in-flight electromagnetic separation. With the high fragment energies, colliding and merging beams, and capabilities for the electron- and x-ray-nuclear collisions, this facility will truly be unique in the world for many years to come. It will provide unprecedented opportunities to investigate the detailed nuclear processes which lead to the synthesis of the elements of the cosmos, to explore the properties of nuclei with unusual neutron and proton distributions (e.g., neutron halos and skins) and exotic shapes, and to study the isospin dependence of the equation of state of nuclear matter. Theoretical models will be tested in regions in which their parameters are largely unknown, and new insight and surprises are almost certainly to emerge from the data produced at this new facility.

The present IAC review is mostly focused on the physics opportunities of the RIKEN RI- Beam Factory. The kind of nuclear species and reactions which can be studied depend largely on the technical performance of the accelerator and associated facilities which are reviewed by the TAC. The problems to be solved include the cooling power, the luminosities, the machine configurations and the cost. The IAC stresses that it is crucial for the RI Beam Factory project to attract many enthusiastic, young users from in and outside of Japan by presenting interesting and fundamental physics programs.
While the importance of international collaborations in achieving these goals is clear, there was no opportunity to discuss the broader details of user-related issues and the mechanisms of the involvement of the Japanese scientific community. These are clearly important matters that are perhaps best dealt with by other reviews.
A great deal of progress has been made, a great deal remains for the future of this promising imaginative and ambitious project. Some specific recommendations are listed based on the brief glimpse that the committee had of the status of the project.

4.1 The RI Beam production and delivering facility of RIKEN is proceeding in an organized fashion, in very close collaboration with Japanese industry and with the advice of International Technical Advisory Committees. This advice includes detailed recommendations, especially regarding the construction of the Superconducting Ring Cyclotron (SRC) which is the most challenging part of this phase of the project. It may be expected that a final layout of the SRC will be achieved following a prototype magnet test with superconducting coils of different design and with continuing interactions with the Advisory Committees. It is the recommendation of this committee that another look is warranted into the charge multiplier question, and that other options that are already under development be given serious consideration for achieving beams with the highest energy, mass, and intensity, such as improvements of the ion source and the use of gas strippers.

4.2 Overall, the R&D work and the design for the experimental facilities are proceeding with vigor and creativity. We are impressed by the design of the two fragment separators (BIG RIPs) consisting of two sections, one for online-isotope separation followed by a second for reaction studies. We were pleased to learn about a number of ingenious tracking and particle identification systems capable of excellent resolution and high rates, as well as the RF-ion guide development for reaching high transport efficiency. More attention should be paid to granular 4pi-detection systems.

4.3 The MUSES facility, opens a potential new window onto the properties of

atomic nuclei, a window that will be truly unique around the world. It will focus on those nuclei that are far
from stability, ones that play a crucial role in the formation of elements in stars and, in particular, this facility is likely to be the only one that will have the capability of determining the size and shape of these exotic pieces of matter. The committee is much impressed with the potential of this complex for new physics and supports the extensive efforts needed to begin to bring it into reality. In particular, the committee strongly supports the unique programs of measurements regarding the sizes and shapes of unstable nuclei using the MUSES facility.

4.4 The IAC appreciated the basic design considerations of MUSES, which allows for the production, capture, cooling, acceleration, storage and leading to the study of collisions of beams in an impressive complex of four rings. One of these rings is for cooling radioactive beams, a synchrotron for acceleration and a double storage ring for colliding-beam experiments. It is a worldwide, unique facility and its construction and operation represents interesting technical challenges. The key ones are various cooling devices for radioactive beams to achieve as high a phase-space density as possible, particularly for the most interesting species that generally have the shortest lifetimes. In the double storage rings, high luminosity collisions of the radioactive ions with x-rays, electrons and ions can be studied for the first time. The details of design and the luminosities that can be reached must be subjected to the TAC process in future meetings with the aim to have its critical assistance in finding the best possible schemes for the various modes of operation that will be required.

4.5 The IAC considers it timely to start designing the accelerator layout and to start the construction of the building. Also intensive R&D work on the experimental facility MUSES of the project has to be started. The R&D work must include a further detailed conceptual design of the rings including experimental facilities. It is very important to make optimal use of the rather limited space to allow maximum flexibility in the development of the experimental program at MUSES.
4.6 The RI-beam factory provides unique opportunities for studying nuclei far off stability, nuclei that are of particular astrophysical interest. The IAC strongly endorses the efforts to facilitate international use and cooperation in its research program.

4.7 The IAC strongly recommends measures to ensure that as many graduate students and young physicists as possible become interested and involved with this project from both inside and outside Japan.

4.8 The discovery potential of the facility is so large that the experimental facility construction should start now for appropriate measures, so that intensive use of the facility can be ensured.

4.9 This RI-beam factory is one of the leading nuclear physics centers located in Japan, complementing those that emphasize hadron physics.

4.10. Dai Kichi

## Agenda

RIKEN RI Beam Factory International Advisory Committee

May 5-8, 1999

May 5th (Wed) :(at Hikarigaoda Dai Ichi Hotel in Tokyo)

19.00 Brief Meeting of Advisors and Spokespersons of the RIBF

May 6th (Thu):(Meeting room of Main office in RIKEN)

09.00 IAC leave the Hotel for RIKEN

Morning session (9.30 - 12.00)

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| 09.30 | Welcome by the President of RIKEN | S. Kobayashi |
| 09.45 | Welcome and Introduction to RIBF | I. Tanihata |
| 10.15 | Coffee Break | |
| 10.35 | Accelerator construction of the 93first part94<br>Ion Source, Charge State Multiplier,<br>Super-conducting Ring, Cyclotron.... | Y.Yano, A.Goto |
| 12.00-13.30 | Lunch | |

Afternoon session (13.30 - 17.00)

Experimental plans and developments.

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| 13.00 | Nuclear Physics and Beam delivering system | H.Sakurai |
| 14.10 | Atomic and solid state physics | Y.Yamasaki |
| 14.50 | Biology | S.Yoshida |
| 15.15 | Stopping of ions from a fragment separator | M.Wada |
| 15.40 | Coffee Break | |
| 16.00-17.30 | IAC closed session | |

May 7th (Fri.) (Meeting room of Main office in RIKEN)

09.00 IAC leave the Hotel for RIKEN

Morning session (9.30 - 12.30)

Physics and experimental plans at MUSES

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| 09.30 | Overview of MUSES experiments | I.Tanihata |
| 10.00 | X-ray spectroscopy of radioactive ions | M.Wakasugi |

10.25　Coffee Break
10.45　Electron scattering　K.Maruyama
11.15　Super-critical electric field　H.Sakurai
12.30-14.00　Lunch
Afternoon session (14.00 - 17.30)
14.00　MUSES concept and design　T. Katayama
15.30-16.00　Coffee Break
16.00-17.30　IAC closed session
18.00-20.0 Reception invited by the president of RIKEN
(at RIKEN Hirosawa club)

May 8th (Sat.)　(At Daiichi Hotel)
9.30 Facility operation
A. Present Accelerator Research Facility and its operation
B. Plan for the organization and operation
10.30-10.50　Coffee Break
10.50-12.30　IAC closed session
12.30-13.30　Lunch
13.30　IAC closed session and concluding discussion
(IAC and RIKEN)
16.00　End of IAC meeting