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Recommendations and Conclusions of the International Advisory Committee for the RIBF@RIKEN

I. Introduction

The radioactive-isotope-beam (RIB) facility, which is called "RI beam factory (RIBF)", is under construction at RIKEN. This facility is based on the so-called "in-flight RI beam separation" scheme. In the first phase of the RIBF project, a new high-power heavy-ion accelerator system will be operational late in 2006. This system is a cascade of three ring cyclotrons with K=570 MeV (fixed frequency, fRC), 980 MeV (Intermediate stage, IRC) and 2500 MeV (superconducting, SRC), respectively. It will boost energies of the output beams from the existing K540-MeV ring cyclotron up to 440 MeV/nucleon for light ions and 350 MeV/nucleon for very heavy ions. These energetic heavy-ion beams are converted into intense RI beams via the projectile fragmentation or in-flight fission of uranium ions by the superconducting isotope separator, BigRIPS. The combination of the SRC and BigRIPS will expand our nuclear world on the nuclear chart into presently unreachable region. The construction of the RIBF building will be finished in May 2005. Major experimental installations to be constructed in the second phase of the project are under priority discussion, and in connection with this, an international peer review committee meeting had been held on November 18-20,2004. Experimental installations under discussion are: a zero-degree forward spectrometer, a large acceptance superconducting spectrometer, a gamma-ray detector array, a facility utilizing very slow RIBs provided via a gas-catcher and rf ion guide system, a low-to-medium energy polarized RIB facility (at RIPS) consisting of a gas catcher and a Stern-Gerlach separator connected to a return beam line from the IRC, an high-resolution RI-beam spectrometer, an electron-scattering experimental apparatus consisting of a self-confining RI-ion target (SCRIT) in an electron storage ring and a uranium-photo-fission ISOL system, and a rare RI precision mass measurement apparatus consisting an isochronous storage ring and an individual injection system. A new additional injector linac to the RRC to make it possible to concurrently conduct RIBF experiment and super-heavy-element experiment is also planned. Construction of the second phase is expected to start in 2006. According to its terms of Reference, the International Advisory Committee was asked to review:

1) The program for upgrading the present heavy-ion accelerator system to act as an injector for the RI beam (RIB) generator of the RIBF
2) The on-going progress of the RIB generator construction project
3) The proposed "Day-one" experiments

4) The proposed major RIBF experimental installations, as well as the experiments proposed for them in terms of priority, scientific benefit and cost performance and

5) To make recommendations and suggestions for successful progression of the RIBF project in terms of manpower, budget, organization and possible international collaboration schemes.

The recommandations and conclusion of IAC are the following:

The presentations during the meeting and the visit of the site have demonstrated to the IAC that the facility under construction has great scientific and technical potential and is well on its way to becoming a world-leading center in the field of RIB science.

II- Upgrading the present heavy ion accelerator system to act as an injector for the RIB generator of RIBF

Several upgrade activities over the past 5 years have enhanced the performance of the present accelerator system. This is of benefit for the ongoing research program but - more importantly - for the performance of the system as injector for the future RIBF.

A key indicator for the high-intensity RIBF is ion source performance. The existing 18GHz ECR ion source has been optimized by exploring technical parameters such as the plasma electrode and bias disc position. Systematic measurements provide scaling relations which demonstrate sufficient intensity for RIBF specifications for beams up to xenon but not for uranium. For the latter a super-conducting ECR source at 28GHz is under design. The recent studies on the 18 GHz together with studies on ECR sources at other laboratories are believed to provide a safe basis for extrapolation of adequate uranium beam production for RIBF with the future 28GHz source.

Several improvements were carried out in connection with the injector linac. To improve transmission efficiency, a new solenoid magnet was installed between the ECR source and the analyzing magnet, which allowed a better matching of the transverse emittance to the linac acceptance. Instabilities in the longitudinal phase of the linac beam were eliminated by newly designed phase control units. Most importantly, a booster section consisting of six resonators was added to the linac allowing the acceleration of very heavy ion beams. A self-oscillation of the rf amplifier of the last resonator was damped by auxiliary dumping resistors. The improvement in linac performance provided for successful searches for super-heavy elements and discovery of element 113. The desire to continue these activities leads to considerations for an alternative injector into RIBF (see below).

The first cyclotron in the beam acceleration chain, the azimuthally varying field (AVF) cyclotron, was successfully modified for better transmission and energy spread. A flattop accelerating system based on a superposition of fundamental and third harmonics allowed more easily for single-turn extraction and a momentum spread reduced to one-third. This also improved beam transmission

through the AVF and the subsequent RIKEN ring cyclotron (CCR).
The plans and R&D in order to upgrade the present facility to act as an injector to RIBF are therefore well under way. The Key components (ECR ion-source, beam-line optics, rebunching, and stripper systems) have been properly identified.
However, the Committee would like to stress the importance of two issues.

In addition, the project group has proposed to build a new dedicated very low energy heavy ion linear injector to RIBF. This proposal is presented as part of the budget request of Phase II. This proposal simplifies the injection process in the existing K=540 SSC and opens the door for parallel operation of the existing linac which will be devoted to the quest of Super Heavy Elements

III-Ongoing progress in RIBF construction

The progress in RIBF construction over the past years is impressive.
The main building for Phase I, which houses the new IRC and SRC sector cyclotrons, has been completed. In addition, the building with the experimental hall and offices is nearing completion.
The new cyclotrons (IRC and SRC) have been manufactured and are presently being installed in the accelerator building. , including assembly of magnets, cryostats, rf systems, vacuum systems, cabling, and helium supply plumbing. Cool-down and powering of magnets seems on schedule with first tests scheduled for mid-2005. With assembly of rf resonators, vacuum systems and diagnostics scheduled for the first half of 2006, commissioning and delivery of first beams from RIBF seems on track for the second half of 2006.
The superconducting large-aperture magnets of the first half of the BigRIPS fragment separator are ready for test and installation. Detailed design calculations have been made to assure a beam dump configuration that can handle the 100 kW total beam power. Superconducting dipole magnets have been designed, prototyped and tested. The problematic negative curvature side appears under control. After field measurements at the beginning of 2005, assembly, cabling, cool-down and testing of magnets is scheduled for the rest of 2005. The overall schedule for completing the assembly and commissioning of all three cyclotrons by late 2006 may be somewhat optimistic. Fields mapping and commissioning the sectors magnets of SRC may be more time consuming than expected.
Progress in the construction and installation of BigRIPS looks very good. The initial operation for several months with reduced beam power will be very useful to establish some of the practical limitations such as performance of the beam dump. Experience with various reactions that put the beam in various dump positions are needed. In addition quantitative indication of the cryogenic heat load from secondary neutrons and charged particles, and realistic measures of the radiation damage rates in various components have to be planned in the

commissioning period. Experience with the cleanliness of the secondary beams and the degree that ion by ion tracking will also be useful. Validating the optics simulations with actual magnet performance and calibrations is also an important step to be carried out with the lower intensity operation. Therefore completion of BigRIPS on a time scale to accept first beam is a challenge. In particular, the full beam line system and Zero Degree Spectrometer also need to be installed during the same time period. Installing in parallel detectors, controls and DAQ in 2006 may be pushing the schedule. It will be tough to meet the deadline for first beams if these are indeed delivered from the accelerators at the end of 2006.

It appears important that the experimental efforts be focused on a reasonable first round of experiments. This also requires early decisions on the first experiments.

Since the committee cannot comment on the technical details on the basis of the present meeting alone, it recommends establishing a Technical Advisory Committee to ensure the successful operation of the accelerator and BigRIPS.

IV-Day-One Experiments

When the new facility first starts its operation, it should have an initial set of experiments that are technically simple and allow the exploration of the parameters of the both the experimental systems yet produce unique physics results. In the first functioning of an accelerator it is important to have a first set of measurements that have important physics goals but are also simple enough so that useful results can be obtained during the learning periods when both the operators of the machine and the experimentalists explore the properties of the new systems. A list of 'Day-One' experimental programs was presented to the committee.

The list contains a large variety of interesting and promising measurements. Some of these are likely to fit the above requirements, such as measurements of radii through interaction cross sections, Coulomb excitation studies and other in-beam gamma spectroscopy. Others are more demanding of the beam properties, in terms of intensity, emittance, or in having the beam slowed down or stopped in an appropriate environment. These will take some time to develop. Yet others that represent potentially important measurements which will be unique to the new facility, will require the thorough testing, development, and optimization of the instruments and the experimental environment before they can be pursued usefully. Some of this exploration and testing is likely to be feasible in this initial period but real physics results will most likely emerge after the system has been thoroughly understood and refined.

It will take a careful review of the available capabilities and resources, to develop a set of priorities for the allocation of resources. Some 'day one' experiments must be ready to be carried out in time, and an appropriate number of the other ideas should begin a program toward implementing their physics goals.

The committee does wish to observe that in the likely initial accelerator scenario presented the uranium capabilities at first likely to be somewhat limited, but the projected ^{86}Kr and ^{48}Ca intensities, for instance, are expected to be formidable. While the focus on uranium is important for the eventual capabilities of the facility, it may be wise to seriously consider how much of the 'day one' program should be planned around the unique initial capabilities represented by such beams. They represent unique opportunities in the early stages of the research program and an excellent way of producing new scientific insights from the very beginnings of the facility. Among these are fragmentation reactions to measure interaction radii of new neutron-rich nuclei, Coulomb excitation studies, and the pursuit of very heavy elements.

The committee did not have time to learn of the projects in sufficient detail to be able to assist with setting priorities or identify problem areas. We simply note that "day one" is approaching and that decisions must be made soon and resources allocated to make certain that **some** "day-one" experiments are ready to be carried out in time.

V-PHASE II Instrumentation proposals

Phase I experiments will provide unique results and new physics insights. However, the enormous potential of the facility requires a considerably more substantial investment in Phase II instrumentation in order to fully realize the unique science opportunities of this forefront facility.

1. SAMURAI(7)

The large-acceptance superconducting spectrometer SAMURAI(7) [**S**uperconducting **A**nalyzer for **Mu**lti-particles from**Ra**dio**i**sotope Beams with 7 Tm Bending Power] is a versatile spectrometer which will in phase II instrumentation of RIBF at RIKEN be instrumental together with Big-RIPS in realizing the enormous physics potential of this facility. It is designed with the aim to address several nuclear physics research domains which require large acceptance both in solid angle and momentum. Its versatility lies in its design allowing it to be used in different geometrical configurations, together with various ancillary equipment, to best address the physics questions under consideration. In one of its configurations, which will probably be most used, SAMURAI has a large angular and momentum acceptances of around 50 msr and 300% (covering from heavy fragments to protons), respectively, combined with a moderate momentum resolution of about 1/500. Furthermore, it allows for particle identification for A < 100. The moderate momentum resolution is sufficient for the invariant-mass and missing-mass measurement methods. However, SAMURAI could also be used in a high-resolution mode, Q3D configuration, with primary polarized deuteron beam. In this configuration it will have high momentum resolving power of 3122 but limited acceptance of _30 mr, _60 mr and 9 msr for the horizontal, vertical and solid angles, respectively. SAMURAI will be mounted on a rotatable base that can rotate from 0 to 90 degrees to enable the various configurations. Furthermore, it has been designed to have a large vertical gap of 80 cm for detecting projectile-rapidity neutrons in coincidence with heavy fragments over a large angular acceptance of ±80 mrad and a hole in the return yoke for detecting projectile-rapidity protons in coincidence with heavy fragments. The last two options will facilitate the determination of the invariant mass of the projectile.

The possibility to detect a few particles in coincidence and measure their 4-momenta enhances the possibilities for physics experiments with the large solid angle multi-particle spectrometer SAMURAI. Invariant-mass measurements will allow study of single-particle orbits and soft-dipole modes in light and medium-heavy nuclei, respectively, as well as furnish information on rates of radiative capture reactions in *p*- and *sd*- shell nuclei which are of relevance to astrophysics, e.g. explosive nucleosynthesis in novae and supernovae. These reactions are induced by Coulomb dissociation on a heavy target, which acts as the source of the virtual photons. The heavy fragments detected in SAMURAI will be measured in coincidence with either projectile-rapidity protons (for proton-rich nuclei) detected in SAMURAI or with projectile-rapidity neutrons (for neutron-rich nuclei) detected in the forward direction with a high-efficiency ancillary neutron detection array. This forms an ideal setup for this type of measurements.

In elastic, inelastic and knockout reactions induced by protons, deuterons or α -particles in inverse reactions, i.e. heavy projectile impinging on p, d or He targets, the missing-mass method will be used. The recoiling light target nuclei will be detected in solid-state detectors. The excitation energies of the residual nuclei are readily deduced. SAMURAI could be used here to tag the heavy projectile fragment allowing study of the residual-nucleus decay.

Investigation of the two- and three-body forces and their spin dependence will be investigated with analyzing-power and spin-transfer measurements induced by polarized deuteron beams. For this purpose, SAMURAI will be used in the high-resolution Q3D configuration. The large gap of the dipole will be utilized to install a TPC (time-projection chamber) for 4π_measurements of the isospin dependence of π^+ and π^- production ratios in multi-fragmentation reactions induced by heavy-ion collisions. This will yield information on the asymmetry energy of the nuclear equation of state (EOS).

The design of SAMURAI(7) with its multiple configurations, also allowing different ancillary equipment and providing enough space for detectors in the target region, will ensure that this spectrometer will be heavily used in pursuing various forefront research objectives. It will most probably become the workhorse for RIBF. The broad and versatile multi-use of this spectrometer will most certainly bring problems of coordination and logistics, if not technical, with it. These have to be inventoried and addressed.

In summary: SAMURAI spectrometer will facilitate a broad, interesting and

challenging physics program with radioactive ion beams ranging from Coulomb dissociation to nuclear astrophysics to direct nuclear reactions (elastic and knockout) and to investigation of few-body systems.

2. SHARAQ

The construction of a high-resolution spectrometer at any nuclear physics facility purporting to investigate nuclear structure is a must. The High-resolution SHARAQ (**S**pectroscopy of **Ha**dron Systems with **R**adio**a**ctive **Q**uantum Beams) with a momentum resolution of 1/15000 fulfils this need at RIBF, RIKEN in the Phase II instrumentation period. This will facilitate nuclear structure studies where the missing-mass, and hence excitation-energy resolution will be superb. The energies of the high-quality radioactive ion beams provided by RIBF will be in the range of 100-400 MeV/u. This is the energy region where the spin-isospin term in the nucleon-nucleon (NN) interaction dominates over the spin and isospin terms, whereas the central term of the NN interaction is at a minimum providing a region of nuclear transparency with little absorption and distortion. Therefore, it is natural that the Tokyo University Group, which designed and will build SHARAQ, will address questions in nuclear structure which will be strongly influenced by the dominance of the spin-isospin term of the NN interaction. In particular, advantage will be taken of double-charge-exchange (DCX) reactions with radioactive beams that have small Q-values and thus proceed with almost zero momentum transfer. This is not possible with stable beams which usually have large negative Q-values for DCX reactions. With exothermic DCX reactions, such as (^{8}He,^{8}Be) on targets of ^{3}He,^{4}He or ^{6}Li,^{7}Li multi-neutron (^{3}n, ^{4}n) and heavy hydrogen - ^{6}H,^{7}H - systems can be investigated. The (^{8}He,^{8}Be) reaction and other DCX reactions such as (^{18}O,^{18}Ne) or (^{20}Mg,^{20}Ne) can access the double Gamow-Teller (GT) giant resonance in both the b+ and b- directions. This will furnish invaluable information on double GT matrix elements.

The cross sections for the DCX reactions are large enough for these reactions to be studied within a reasonable period of time. However, the proposed mass measurements of neutron-rich r-process nuclides, which are of strong astrophysical interest, in multi-neutron transfer reactions, such as (^{18}C,^{12,10}C), (^{14}Be,^{7,8}Be), (^{8}He,^{4,8}He), etc. may be strongly hindered by very small cross sections. Therefore, priority should be given to investigations of multi-neutron and heavy hydrogen systems as well as studies of double GT states.

In summary: This spectrometer provides an interesting option for exploring low-momentum transfer exotic reactions with high resolution, such as double-charge exchange reactions allowing investigation of multi-neutron systems, double Gamow-Teller states and precise determination of masses of r-process nuclides. A high-resolution spectrometer is a must for any facility with nuclear structure studies at the core of its mission.

3- SLOWRI

SLOWRI will be located at one of the exit branches of the BigRIPS fragment separator. It intends to provide secondary, low energy beams for high precision experiments mainly on ground state properties of exotic nuclei. The proposed facility includes instrumentation for studies of nuclear ground state properties such as the masses, the electromagnetic moments, charge and valence neutron radii, angular momenta as well as matter periphery of nuclei.

The planned instrumentation includes a multi-reflection time-of-flight mass spectrometer, collinear laser spectroscopy setup, hyperfine structure spectrometer setup as well as a setup for decay spectroscopy. Also, an ambitious plan to study antiprotonic radioactive atoms is presented where antiprotons produced elsewhere and stored in a portable trap are introduced in the combination trap at RIKEN . The committee considers that the experiments on slow or stopped exotic, short-lived isotopes should be considered an important component of the phase II program. Innovative developments on ion catcher technique carried out by the RIKEN SLOWRI group has placed this group as one of the leading teams worldwide. Potential physics output of this facility is substantial, ranging from precision mass measurements and laser spectroscopy to potential for reacceleration for astrophysics experiments.

There is potential for substantial impact by small university groups. Participation should be encouraged worldwide. One needs to leave capability for implementation of additional tools in the rapidly developing field of ion manipulation. Especially, the newest developments in Penning trap method should be carefully exploited. With its exceptional production capabilities RIKEN will be unique for few years to come in this field. Therefore, early implementation of the described facilities is important.

4- SCRIT:e-RI scattering

The electron ring with a radioactive ion target confined in a longitudinal magnetic mirror and transversely by the electron beam constitutes a very innovative, novel and daring proposal to study nuclear charge densities and structure of unstable nuclei. Here it will be necessary to demonstrate the feasibility of achieving the proper luminosity for the determination of the radii and diffuseness of nuclear charge distributions.

5- RI Spin Laboratory:

The proposal addresses two main aspects:

1.) The measurement of nuclear properties (in particular moments) of a large variety of RI produced by the new facilities.

2.) The spin-related applications of RI with known nuclear properties essentially as nuclear probes in condensed matter, in particular at surfaces, interfaces, and nano-structured materials.

Nuclear properties

The nuclear-measurement techniques are well known and were already used at RIKEN in many cases. The extension of special measuring techniques in order to exploit fully the advanced production techniques of RI are in preparation and already partially in a promising test status.

Nuclear Solid State Physics

The RI Spin Laboratory offers a world-wide unprecedented opportunity for basic research on the subnano scale towards future functional materials.

At present and in the near future, nano-scaled materials play a big role in science and in advanced technical applications. In the next 20-50 years, Feynman's famous prediction about 50 years ago might become true, i. e., the existence of functional materials where single atoms are the building blocks of memories, switches or sensors.

Such a goal requires a tremendous amount of basic research, namely, **the study of the interaction of isolated atoms with their environment at well-defined and reproducible sites,** e.g., at surfaces and interfaces.

Combining the production of the large variety of RI (and thus enabling the arbitrary choice of a desired species) with a state-of-the-art investigation equipment for solid state physics, **this laboratory (RIBS) may take over the leading position** in the world. In conventional solid-state physics big efforts are undertaken to strive after smaller and smaller units from three-dimensional systems to two-dimensional (layers, surfaces) and one-dimensional systems like nanowires. RI at well-defined sites on surfaces or interfaces allow for he study of the final goal, namely zero-dimensional cluster-like systems; examples may be the behaviour of rare earth atoms on semiconductor or ferromagnetic surfaces. Other laboratories like ISOLDE/CERN or ISAC/TRIUMPH offer similar opportunities (although on a restricted scale) and a variety of successful experiments have already been performed, e.g., it was found that 10^{11} RI cm^{-2} can be positioned on a surface in an ordered structure and, furthermore, the RI form well-defined cluster-like units with their environmental host atoms. Thus, the proposed RI Spin Laboratory offers **materials *modification* on the atomic** scale with **simultaneous materials *analysis*** measuring the hyperfine interactions at the RI.

The Laboratory also offers materials analysis on the atomic scale when nuclear methods like β-NMR, PAD, PAC, Mößbauer spectroscopy **are applied to solid state samples using RI as *probes*.** The proposal mentions a few RI examples, e.g., Se or O.

Se would be a favourable isotope for the investigation of the photo-voltaic material $CuInSe_2$ which is currently under investigation at different laboratories in the world, e. g., Tsukuba/Japan. Se RI would allow for local investigations on the surface and at the interface. Such investigations would need a close co-operation with solid state groups.

Oxygen as RI ^{19}O would be one of the most desirable probes for local surface investigations. The production rate at RIBF (and only at RIKEN) is sufficient for PAC measurements. After a technical realisation the need for this probe will be very large, perhaps comparable with 57Fe in the early Mö bauer spectroscopy days.

Technical Realisation

The proposal offers several technical solutions for nuclear measurements and applications to condensed matter using a rail system for the different set-up systems. The **atomic-beam device** (gas stopper and spin-selection apparatus) is used for measuring nuclear moments and the production of polarised nuclei, e.g., for β-NMR and PAD experiments. Furthermore (making advantage of the rail system) it is proposed to re-ionise the stopped atoms and accelerate them for transport to solid state samples. This can be achieved by an **on-line mass separator**, as it was used at GSI/Darmstadt. The heavy-ion target in the FEBIAD ion source has simply to be replaced by a stopper for the RI, all other requirements are solved and are similar as at GSI and ISOLDE. The RI will be separated and brought to a catcher from where they will be evaporated onto a surface in a **UHV chamber as part of a solid state laboratory.** Because of these thermal energies, soft landing on an arbitrary surface is achieved. The surface can be covered by molecular beam epitaxy (MBE) in order to produce interfaces, thus, the RI are at well-defined sites for studies with PAC or Mö bauer spectroscopy.

A whole set of applications in the domains of environment, material, chemistry, and industry are expected to be developed in the RIBF project

6- RARE RI Ring

It is proposed to perform high-resolution mass measurements on unknown nuclei produced in fragmentation with an isochronous ring acting as a long baseline time-of-flight spectrometer.

The cw duty cycle of the accelerator system and the pulsed beam structure needed for optimum storage ring filling are poorly matched in general. However, by limiting acceptance (and control) to individual ions, this becomes irrelevant and thus the proposed scheme should work with 100% efficiency for ion beam intensities well below the 1 kHz that is acceptable, given the needed circulation time (at least 1 ms) of an individual ion. The idea, to remove ambiguities in rotation number by a 10-4 time-of-flight measurement (about 200 meter flight-path) preceding injection of the ion into the ring is simple and clever.

The scheme of a long baseline TOF measurement using an isochronous ring has been shown to work well at GSI although with a more complicated scheme requiring a transit-time measurement with every circulation. Also, stochastic cooling is considered for a more advanced system. The present scheme is intriguingly more simple with, however, the limitation to very low rates. On the other hand, the number of ions far from stability to be produced at RIBF will clearly be limited, and given a sensitive selection and sweeper system before the ring, the accepted ions can be limited only to the ones of interest. This makes this proposal a limited, yet cost-effective solution (disregarding the cost for space and building that the extended beam transport and ring system require) and innovative for mass measurements of are isotopes far from stability

General conclusion on Phase II instrumentation program.

The IAC strongly feels that the overall program proposed is both important and necessary to fully exploit the potential of this forefront facility.
The total cost of 5.1 BYen for Phase II instrumentation, is about 10% of the total cost for the RIBF construction. This is appropriate and necessary.

VI- Recommendations and suggestions for successful progression of RIBF in terms of manpower, budget and organization.

VI.1. Organization

Construction of the RI Beam Factory is underway by the group(s) within the Discovery Research Institute in the Wako Institute. A new proposal was presented that, at the operational stage of the RI Beam Factory, an Accelerator Research Center would be established directly under the Director of the RIKEN Wako Institute, in order to allow an easier operation of a large-scale facility such as the RI Beam Factory. This new idea was well received by the Committee. The Committee also notes that the new Center will add a visibility of RI Beam Factory both within and outside RIKEN.

The proposed Center has two basic Divisions; Accelerator Division and Nuclear Physics Division. In addition, the creation of a Collaborative Research Division (CRD) within the Center is proposed, which is a new concept at RIKEN. In the past, RIKEN facilities have been open to outside users only through the collaboration with the RIKEN staff members, whereas, in a new scheme, active outside user groups can be integrated directly in the RIKEN organization through this new Collaborative Research Division. The Center should make a special effort to incorporate theoretical activities to be included in the CRD. The new scheme is an attractive idea, because it will broaden significantly the usage of RIBF by university and other outside users. The Committee supports this addition of the CRD.

The introduction of a Steering Committee (SC) is also important, since the mechanism to regularly monitor the project by the outside members has not existed at the construction stage of RIBF. The relation between the International Advisory Committee (IAC) and SC should, however, be well defined. One missing point in the proposed new organization is that non-nuclear physics RIBF user groups at RIKEN are not included in the chart. In addition, the relation to a broader domestic user community must be clarified in the organizational chart. The present RI Beam Factory would form one of the most visible research centers in the world. Thus, it must be open to the international communities, especially to Asian countries. The process to open this facility to the international communities is, however, not well formulated. A possible idea, which was proposed by a committee member at the IAC meeting, is to create a standing committee attached to the new Center by having members from Asian countries as China, India, Korea, etc. to discuss regularly mechanisms of how to enhance a closer collaboration among Asian countries. Clearly, this is only one example and a stronger effort is encouraged toward the international usage of the RI Beam Factory.

VI.2. Operational Budget

The budget scale proposed for the operation is about 6 billion yen. Among them, one third goes to the usage of electric power. The Committee did not have time to review individual items in detail. A general consensus of the Committee is that the proposed operational budget is about 10% of the total investment and this amount is, to a first order approximation, reasonable

VI.3. Manpower

To reap the fruits of the unique scientific investment represented by RI Beam Factory, an appropriate level of manpower is needed. In this respect, RIKEN has made several efforts. A notable example is that RIKEN has established a collaboration agreement with CNS (Center of Nuclear Study) of University of Tokyo by inviting this CNS within the RIKEN campus and, more recently, an agreement on academic exchange with the entire University of Tokyo. Also, RIKEN has established graduate-course education agreements with many universities including those outside Japan.

However, the manpower level is still short. We strongly encourage an increase of the scientific and technical staff at RIKEN as well as the relevant university user community.

On behalf of IAC
Sydney Galès
Chair of IAC-RIKEN