NCAC Meeting
May 26-28, 2011

Recommendations and Conclusions From the NISHINA Center Advisory Council

Contents:

Foreword:

On March 11 of 2011, a gigantic earthquake hit a large area in eastern Japan. About twenty thousand people are either dead or missing. It was the largest earthquake in Japan, 9.0 on the Richter scale. Shaking was severe, and the tsunamis destroyed many towns. One of the nuclear power stations, Fukushima #1, had significant trouble due to an explosion and associated radiation spills.
For physics, some important facilities were seriously damaged. Many foreign visitors returned to their home countries. Although not direct damaged, research work has slowed down significantly, and has not yet returned back to normal.
Immediately after the earthquake Nishina Center has contributed to radiation surveys around Fukushima. Fortunately, facilities at RIKEN Nishina Center received minimum damage. But the operations of cyclotrons have been suspended. All the accelerators and detectors have been recovered and they are ready to run for users in the early fall.

The NCAC committee would like to express to all our colleagues at Nishina Center and beyond to all the members of the Japan Nuclear physics community its support and care. We are preparing to help Nishina Center in its recovery plans by using all the means of international cooperation at our disposal.

1. Executive Summary.

First of all, the NCAC thanks the President Ryoji Noyori, Executive Director Maki Kawai and Nishina Center Director Hideto En'yo and all the members of Nishina Center for their hospitality and for addressing the NCAC by presenting the view and scope of the Nishina Center at this difficult time in Japan.
The Nishina Center Advisory Council (NCAC) has reviewed the organization, resources, operation, development, science programs, ongoing projects and the 10 year Strategic plan of the Center guided by the terms of references given to us by the president of RIKEN Prof. R. Noyori and Director of the Nishina Center H. E'nyo.

- Evaluate our Plan–Do-Check-Actions responding to NCAC 2009 recommendations
- Evaluate our scientific achievements and organizational improvements since NCAC 2009
- Evaluate our future directions in terms of the strategic plan
- Evaluate our recovery plan from the disaster.

We are overall very impressed with the high quality of the Nishina Center as indicated by their scientific output, leading people and facilities, outreach and relevance.
The NCAC notes the progress since the last meeting and the management's responses to our recommendation:

- Continued improvement in the efficiency of the RIBF facility and eight month operation is the top priority

- We are pleased with the development of new instrumentation at RIBF. But these devices and the successful effort to involve the international community will require additional technical support for users.

- The theory effort is central to all aspects of the Nishina Center and we note the progress in hiring key people and their efforts to integrate the program.

- The RIKEN BNL Center is a model for success that we strongly support.

- The RIKEN RAL program is highly successful and its subsequent evolution toward involvement at J-PARC is a priority

- The Nishina Center management has developed a strategic plan with a number of excellent opportunities. We endorse their overall approach and recommend, as proposed, that they proceed to make the necessary analysis to choose the optimal solutions.

2. Organization, Management, and Budget.

An overview of the present organizational structure at the Nishina Center was provided to the NCAC early in the committee meeting. Much has changed in this structure since the previous committee meeting in 2009 (NCAC2009).
In the report issued by that committee, there was some concern expressed about the lack of diversity in the management. The report suggested that RIKEN might consider a broader, possibly international, approach to identify the associate director for this division. A number of changes in the Nishina Center management have occurred since the last advisory committee meeting. Effective October 1, 2009, Dr. H. En'yo was appointed as the new

Director of the Nishina Center. In assembling his team, Dr. En'yo has followed the suggestion from NCAC2009 and appointed Dr. W. Henning as Deputy Director for RIBF. In addition, he has made other changes including the additions of Dr. Sakai as the Leader of the User Liaison and Industrial Cooperation Group, Dr. Motobayashi as the Synergetic-Use Coordinator and SAMURAI team leader, Dr. Abe as the Head of Accelerator Application Research and Dr. Uesaka as the Head of the Spin-Isospin Laboratory. A new User Support Office has been another excellent addition to the RIBF organization. It is providing much needed help for outside user groups who come to use the facility.

Overall, the new organizational structure seems to be working very well. The NCAC was particularly pleased to see that the Nishina Center organization now includes an international leader in nuclear structure and reaction physics from outside of Japan.

The Nishina Center management is clearly focused on providing more beam time for RIBF users. The stated priority of the director is to operate RIBF for eight months per year starting in FY2012. The NCAC strongly supports this priority. The increase in user beam time is urgently needed to take advantage of the unique opportunities to conduct first class experiments at RIBF, as has been demonstrated by recent scientific achievements that are highlighted in this report and by the increased interest in using the facility in the international community. The window of opportunity for RIBF to be the premier radioactive ion beam facility will last at least until major new facilities that are being built in Europe and the USA become operational. But the time is finite. To further increase experimental running time at RIBF, the amount of time spent on beam development has been reduced. It is important for a new facility to devote time to developing new beams and to increasing the intensity of existing beams that are now limited in beam current.

In the future, management must continue carefully weighing the need for beam development versus running experiments. Finding the optimum mix to the two can be very difficult.

One concern noted by the NCAC at the 2011 meeting is the size of the operations and support staff. It is extremely small for a facility the size of RIBF and it has not increased with the beginning of operations. Contract workers are used to supplement the permanent staff. While this may be efficient for management, it does not provide the same long-term support that a larger permanent staff would provide. This is particularly noticeable for the major experimental equipment operated as part of the facility. The lack of technical staff to provide support for outside users to mount experiments on the equipment can slow progress and result in less efficient overall operation. Furthermore, it adds an undue burden on the professional staff members who are responsible for the equipment.

An increase in permanent staff by about 20% would provide a significant boost to the overall efficiency of the operation.

Several years ago, a 6.5 MW generator was added to the RIKEN facility to provide back-up power for RIBF. This generator has been extremely important in the recovery operations that have been on-going at RIBF following the March 11 earthquake. In addition to the damage caused to buildings and roads, several power plants were affected by the quake and are now shut down. The disruption in the power grid has been felt across Japan, including at RIKEN. Mandatory reductions in power usage have been in place since the earthquake. Without the power generator at RIKEN, the effort to turn on and verify that the accelerator systems at RIBF are working would not have been possible. Under full operation, the laboratory requires just less than 17 MW of power. If RIKEN were to add a second 10 MW generator to the facility, it would have the power that is required to operate RIBF without using power from the grid.

The NCAC supports investigating the feasibility of adding this second 10 MW generator.

It could be extremely beneficial as a way to provide operating time at RIBF during the time when work is underway to repair the earthquake damage to the infrastructure along the east coast of Japan.

3. Highlights, Operation, and New Proposals

Research Highlights

A healthy and broad science program centered on the RIBF facility was presented to the advisory committee. ***The NCAC was very impressed by the output of the Nishina Center, which we feel has been of the highest quality, as shown by the rapid publication of results in high impact journals***. The RIBF facility is now the world leader in the study of exotic nuclei near the limits of nuclear binding.

The success of the facility has lead to worldwide recognition. For his role in making this possible, Dr. Yano won the European Physical Society Accelerator Group Gersh Budker Prize in Accelerator Science in 2011. A number of key new research results have been achieved with results published in highly respected journals like Physical Review Letters and Physics Letters. At least five of these results were reported on in the Japanese and international press.

The accelerator applications group continues to make important discoveries related to gene mutations. Salt-resistant rice developed at RIKEN using heavy-ion irradiation is being used to help farmers recover from the Tohoku Pacific offshore earthquake. The RIBF facility is now making isotopes, such as ^{65}Zn, ^{109}Cd, and ^{88}Y as part of the Japan Radioisotope Association.

The facility has made the first study of what appear to be among the largest exotic halo nuclei ^{31}Ne (published in Physical Review Letters) and ^{37}Mg. In one experiment a remarkable 45 new neutron-rich isotopes were discovered. These isotopes are important for astrophysical r-process nucleosynthesis (which is thought to be responsible for creation of more than half of elements heavier than iron). The ability to produce these isotopes for the first time demonstrates the power of the RIBF facility for production of important isotopes (the work won a prize from Journal of the Physical Society of Japan). Expanding on the discovery, ***18 new half-lived of neutron-rich nuclei in and near the r-process were measured for the first time. The exciting results imply that the r-process in supernovae may run faster than expected (the results were published in Physical Review Letters)***. The new capabilities allowed the study of very neutron rich zirconium isotopes ^{106}Zr and ^{108}Zr with hint that ^{110}Zr may show a subshell closure at N=68; a long discussed possibility that could never before be studied (results published in Physical Review Letters and Physics Letters B). A new measurement of states in ^{38}Mg shows N=28 is not a magic number and moreover the structure of ^{34}Mg to ^{38}Mg is remarkably the same. This is an unusual behavior for light nuclei and is contrary to the expectations for the region of deformation around ^{32}Mg.

A novel and exciting two-step method was invented to produce aligned and polarized rare isotope beams by the use of dispersion matching. This technique will open many new possibilities to measure moments of exotic isotopes. The NCAC was also impressed with the continued progress in the exploration of the heaviest elements. ***The superheavy element program continues to be among the leaders in the world. An experiment for the production of element Z=120 is planned for next year.***

An exciting program has begun with SHARAQ on the study of the spin and isospin response of nuclei where the isovector monopole response of ^{208}Pb was measured for the first time. A large program is now possible to study the spin response of nuclei. This is made possible by the optimal beam energy of the RIBF facility and the new SHARAQ spectrometer. To lead this effort, the NCAC was pleased to see that Tomohiro Uesaka was named as head of the Spin-Isotope Laboratory.

Operations

The RIBF accelerators have been operating stably after shut down in 2008 due to repair of the refrigerator system. However, the Tohoku Pacific offshore huge earthquake on March 11th, 2011 stopped the operation of the RIBF facility for a short time, but apparently did not cause major damage. Fortunately limited experiments were restarted despite the severe shortage of electrical power. Operation was permitted due to the availability of the 6.5 MW co-generation system, which worked well as an uninterruptible power source for operation of the accelerator. The single co-generation system is essential, but insufficient to restore full, reliable operation. It is clear that the co-generation system is highly important to stable and reliable operation. To allow full operation with some independence from the power grid, another co-generation system is needed. ***This would be highly desirable and hence we recommend investigating the possibility to add another co-generation system.***

Single-turn extraction of a polarized deuteron from the SRC has been obtained by off-centering and flat-top techniques. A collaboration with CNS, the University of Tokyo has proven effective for improvement of the AVF cyclotron. The 28 GHz superconducting ECR ion source was moved from the Cockcroft-Walton high voltage deck at the RILAC building to the new building connected with the AVF building where the well-designed RILAC2 and its beam transport system were installed. The RILAC2, which consists of a four-rod RFQ and three DTL cavities began to accelerate the ^{124}Xe beam produced by the ECR ion source in December 2010. The intensity of the ^{124}Xe from the 28GHz ion source was twice that of the 18MHz ion source. Hydrogen and helium gas strippers are also showing good performance.

The dramatic improvement in facility operation and scientific output over recent years is very clear. The RIBF staff should be commended for their excellent work leading to the wealth of new scientific results. The NCAC is pleased with the overall improvement process implemented since the last committee report. The number of days of science from high energy beams from the SRC for users jumped from 20 days in 2009 to close to 70 in 2010; an impressive increase. However continued progress toward more days is essential. RIBF is now in a unique position worldwide and can perform forefront science not possible anywhere else. It is important to take advantage of this position and operate effectively and efficiently.

The accelerator group should be complimented for development of operational indicators; these include operation days, machine study days, experimental days, operating reliability. Analysis and correction of the failures leading a low efficiency have lead to an improvement from 64% efficiency in 2008 to 82% in 2010 for ^{48}Ca operation. The NCAC encourages management to continue to monitor the indicators and search for further increases in efficiency. The accelerator group found that one of the primary reasons for the unscheduled down time came from the multipactoring discharge of in the RF cavity of the SRC, and the long time to condition the system to avoid the discharge. The down-time has been greatly

reduced by a CW mode of conditioning instead of the former pulse mode. As a result, the user's beam-time has increased in the last two years
The NCAC strongly supports the goal of 80% efficiency of operation and greater than 90% availability. These levels are necessary for a successful user program.
The NCAC also consider that eight months of operation are needed to optimize the physics output in the coming years.

However there are challenges to achieving the necessary level of efficiency and operation. The permanent accelerator science staff appears too minimal to operate the facilities, to make intensity improvements, to improve reliability, and to develop the plans for facility upgrades. ***We strongly support an increase in the permanent accelerator and research support staff*** as the facility moves to eight months operation. This higher level will also be necessary to allow sufficient free time to allow the staff to define its future program.

Future Developments

The committee is impressed by the activities underway to improve the facilities, the beam qualities (including intensity) and to construct the new instruments to enhance the physics output. ***In particular the NCAC was pleased to see that the accelerator group has completed RILAC2, allowing superheavy element research in parallel to SRC operation***. This is an important development that the NCAC supported in past reviews.

The NCAC was impressed by the advances made to increase the facility beam intensity. Already, remarkable progress lead to the facility reaching the design goal of 1 pμA from the SRC for ^{18}O beams. The accelerator group should be complimented for this achievement. A number of key steps have enabled these increases. Notably, the ECR source was upgraded to higher frequency, yielding a large gain in beam intensity.

The plan for reaching the full design intensity for all ions was presented to the NCAC. The plan is to further increase intensity to 1 pμA for most ions and 100 pnA for uranium. ***We feel this plan is sound and should be pursued with a high priority.*** The plan involves addition of gas striping plus modification of fRC cyclotron to work with a lower charge state. These will significantly improve reliability and efficiency and we support the effort in this area. In particular we support the long-term upgrade plan to design and build a super-conducting fRC to work with lower charge states. We recommend that design work begin on this new cyclotron and the project move forward. We note that the accelerator group has a number of successful international collaborations addressing key issues, which has helped to achieve the recent successes. Further collaborations with other cyclotron-based facilities such as PSI and MSU are important and may be effective to overcome future technical difficulties.

The suite of instrumentations for research with RIBF beams is excellent, and great progress has been made in this area since the last review. ***The addition of SHARAQ and soon SAMURAI are critical additions to the facility. We note the strong international involvement and partnership with universities in both projects.***

Progress was made on SCRIT. The electron storage ring SR2 accepted the 150MeV electron beam from the race-track microtron RTM, accelerated up to 700MeV and successfully stored the beam in February 2010. Then the SCRIT was inserted in the storage ring in September 2010. A radioactive ion source and its related isotope production based on the RTM are under construction. This system is independently operated from the RIBF, and will be effective to give another beam time for RI beam physics.

The gas-stopping program has advanced in its planning and could be an important part of the RIBF future. It is very important to move quickly on SLOWRI's first stages with gas stopping; this project would allow parasitic operation and is important to lay the foundation for future upgrades. The NCAC also heard plans for a ring for collecting and studying rare isotopes. The Rare RI Ring project is well matched to the power of the RIBF facility to produce very exotic nuclei. It would allow the masses of single exotic atoms to be determined to one part in one million in a few milliseconds.

A number of impressive international collaborations have been designing and bringing equipment to RIBF. ***This development is encouraging and the RIBF management should be complimented for encouraging these collaborations***. The movement of the RISING gamma-ray detection device to RIKEN (now renamed EURICA) is an excellent example of international stature of RIBF with around 100 non-Japanese scientists shifting their research programs to RIKEN. The program of MUST2 research at RIBF is another example of a major piece of international equipment that was brought to RIBF.

The NCAC was also encouraged by the future plans presented by the Accelerator Applications Research Group. There appear to be interesting results possible on gene mutation using the rather unique LET (Linear Energy Transfer) of the heavy ions delivered by the RIBF facility. We encourage this program to continue. There are also interesting possibilities to use the AVF Cyclotron to produce new radioactive isotopes that are strongly demanded but lack supply sources: for example ^{75}Se, ^{85}Sr, ^{139}Ce, ^{56}Co, and isotopes for molecular imaging. We support the related advanced needed to pursue this work including upgrade of the AVF beam energy, development of new targets, and investigation of what useful isotopes can be produced with the ring cyclotron or harvested from the BigRIPS beam dump.

4. Theory

RNC has reorganized the structure of its theory department. It now comprises of 4 groups led by renowned scientists with backgrounds in different areas in particle, hadron, nuclear and strangeness physics. It is envisioned that the efforts of the groups will be largely concentrated approaching the description of nuclear structure, reactions and nucleosynthesis jointly from different angles. ***This new organizational structure strengthens the position and visibility of theory within the Nishina Center and beyond.***

NCAC notes the large scientific output of the theory department. It is also satisfying to see that the theory activities cover essentially all the experimental activities of RNC. This is reflected by the number of publications and of postdoctoral fellows being promoted to faculty positions. It is also very nice to see that collaborations among scientists in the theory group have already started.
The theory efforts as well as the connection to the experimental activities at RNC should be further enhanced by strengthening the collaboration with nuclear theory groups at Japanese universities working on RIBF physics. This can be enhanced by establishing a domestic theory forum, where such efforts can be coordinated. ***Furthermore NCAC recommends adding an expert in nuclear astrophysics doing large-scale nucleosynthesis simulations in order to make the theory as well as the experimental efforts of RNC coherent.***

We are pleased to see that two of the Peta-Scale computational projects in the 'Particle, Nuclear and Astrophysics' strategic program at the Advanced Institute for Computational Science in Kobe have strong participations of RIKEN theorists.

Professor Hatsuda has just started his appointment as Chief Scientist in the theory group. It would be advantageous if he could keep ties with the University of Tokyo to optimize the attraction of talented theory students. ***RIKEN should explore the possibility of a joint appointment.***

5. Hadron Physics at RNC

The hadron physics group at RNC focuses on studies of mesons implanted into nuclei, providing new insight to the nuclear physics. In particular:
- At J-PARC facility, an experiment is under preparation to search for K^-pp system. It is expected that the strong attraction of the kaon makes the nuclear size smaller resulting in higher density nuclear matter. ***The planned experiment has a day-one priority at J-PARC.***
- Another experiment is under development for J-PARC to search for the ϕ-meson mass modification in nuclei due to chiral symmetry breaking.
- RNC is also planning to build an antiproton beam line at J-PARC, allowing the investigation of ϕ-mesons implanted into nuclei forming bound states.

RNC proposes to establish a RIKEN-J-PARC center. They plan to build an extension of the hadron hall and accommodate further beam lines including the low momentum kaon line and the anti-proton beam line***. NCAC endorses this proposal, since the RIKEN hadron group can play important roles in thisscientific field.***

RNC together with RCNP have a plan to study the quark-nuclear physics with photon beams at SPring-8. They have already made a building to accommodate the detector system. The corresponding experimental facility based on the BNL detector system is now under construction at SPring-8. ***NCAC supports this activity to collaborate with scientists at RCNP on quark nuclear physics.***

The experimental programs of RNC at J-PARC and SPring-8 provide an excellent example of collaboration at a domestic level. NCAC would like to see scientists in various universities in Japan participating in the experimental activities through these collaborations.

Other fascinating plans of RNC are related to X-ray detectors, which will be launched into space to carry out astrophysical studies of elemental production in supernovae and EoS in neutron stars. The technologies developed for nuclear and particle physics are very important for these plans. In this respect we would like to see the theory activities to tie the nuclear-particle physics with astrophysics.

6. Accelerator Applications

In Dr. M. Kawai's presentations, she introduced one of the president's initiative as :
"*4) RIKEN that is useful to the world:*
- Find and foster ties with industry and society
- Produce science and technology that will support science in a more fundamental way than simply working with industry."
The RIKEN Nishina Center has taken initiatives to promote applications based upon its heavy ions and radioactive ions beams. This is the role of the Accelerator Application Group under Dr. Tomoko Abe's leadership. The committee heard presentations by Drs. T. Abe and H. Haba on the Radiation Biology team and on RI applications team respectively.

There are three classes of activities: those done in scientific collaborations which are competing for beam time with other academic proposals, those done as a fee for service and those driven by industrial partners for proprietary research.

Competitive Research collaborations

This effort is centered around the exploitation of the high energy heavy Ion beams at RIBF for biological experiments. The high Linear Energy Transfer (LET) of these beams below the Bragg peak allows for uniform dose delivery throughout the samples. This work is done in collaboration with academic societies, National Agriculture and Food Research Organisations and agricultural companies.
Quantitative work to establish suitable dose for mutation and DNA disruption by a range of Heavy ions represents a benchmark for this type of activity. Two examples were cited dealing with improving salt tolerant rice species and new flower breeding.
This is one example where the RIKEN researchers are part of the collaborative team and are included in the resulting publication's authorship. The team is focused and is using a modest amount of beamtime (40Hrs). The intellectual property remains with RNC, which generates some royalty revenues. This is an interesting use of the unique facilities of RNC.

"Service" function to other institutions and groups

The RI application team is focusing on the radioisotope production and delivery of a broad range of long lived isotopes exploiting the accelerator and ion sources technologies available within RNC. A rather modest amount of beamtime is used by this group so far (12 days). It was not too clear how much was for collaborative research versus commercial distribution.
Several key RNC expertises such as new developments for isotope production technology and preparation of ion source materials are being harnessed to deliver isotopes for application research and commercial distribution. The team is focused on isotope production exclusively.
The committee sees very good potential in the planned activity that will increase the impact of the laboratory. The strategic plan presented focuses on production technologies R/D rather than on science, which is fine for the small team in the short term but it should also broaden its horizon and seek more bona fide scientific collaborations. To do so may require linking with radiochemists. A healthy balance between research and service should be aimed at.
Within the RIKEN Wako campus, more synergetic collaborations should be developed by linking directly to the newly formed Research Cluster for Innovation. For example, even short lived isotopes could be promoted making unique use of the RNC production capabilities within the Wako campus.

Industrial Applications

To deal with this category, a new PAC was formed in Nov 2009 to review industrial (Non-academic) pay for beam time proposals. So far 6 proposals have been reviewed and 5 have received beam time. If this program becomes very successful, ***a strategy for accommodating a larger industrial user demand should be established to maintain a good balance with the main fundamental research activities.***

National service

The RIKEN Nishina Center is a major resource center for expertise in Nuclear Science. As such, it is involved in the national recovery process for example in the nuclear contamination surveys. *The visibility of this expertise should be increased by RIKEN management.*

Recommendation:

NCAC strongly supports the efforts by RNC management to increase the visibility of the Accelerator Applications Research Group.

7. RIKEN BNL Research Center (RBRC)

The Council's overall assessment is that:

The physics issues addressed by the RBRC continue to be among the most important in particle and nuclear physics, and that the results obtained to date are highly significant and of long term value.

The focus on understanding QCD matter using a broad range of experimental, theoretical, and computational tools has been a key to success. In addition, recruitment of outstanding young physicists, close interaction with US and Japanese universities and research centers and with the RHIC experimental program, and active participation and organization of international meetings has made RBRC an enviable, powerful paradigm for effective international collaboration in science. This success of the RBRC is based on the close collaborations among experimentalists, QCD simulation physicists and theorists. ***RBRC fosters excellent international collaboration (on three continents) and the development of young leaders.***

The discovery of the *perfect fluid* in heavy ion collisions at RHIC has now been confirmed at higher energies at the LHC. The recently installed silicon vertex tracker in PHENIX, with major RBRC leadership, will open a new window on the study of this new form of matter. The first measurement of parity violating W-production in polarized proton-proton collisions has provided a new tool with which to study the spin structure of the proton. The realization of the QCDCQ (400 Tflops) computing capability later this year will accelerate the ability of lattice QCD calculations to provide insight for both the heavy ion and spin experiments.

Council has considered the proposed 6 year extension for RBRC in the years FY2012 through 2017. With increased collision luminosity, uranium beams and low energy scan capabilities plus the upgraded PHENIX, hot dense matter at RHIC energies will be studied in a comprehensive and precise way. The goal will be to reach a deeper understanding. This will require careful attention to systematic uncertainties, an emphasis on measurement of rare processes and close collaboration with theorists and lattice QCD computing. The RHIC-spin program will focus on achieving in the extension the most definitive determination of the gluon contribution to the proton's spin and measurement of the sea quark polarizations**.** ***The proposed 6 year extension is well thought out, matches superbly the strengths of RBRC and addresses important and timely questions. It has the potential for major scientific discoveries.*** The years FY2012 through 2017 will be occupied with *reaping the harvest* sown in previous years.

Worldwide, physicists are developing the science case for an electron-ion collider. This is widely viewed as the next generation accelerator to continue the study of QCD, in the regime where the virtual particles (sea-quarks and gluons) dominate. It addresses fundamental questions relevant to the understanding of both the origin of proton spin and the *perfect fluid***.** ***Future development of high energy QCD physics at RHIC represents a great opportunity for RBRC for the present (R&D in accelerators and detectors) and the future science.***

8. RIKEN-RAL

The RIKEN-RAL Facility provides unique instruments, which serve a dynamic user community and produce excellent science at a competitive cost. The superb technical skills used to develop state of the art equipment are matched by the competence and dedication of a strong physics team. RIKEN should be proud of such an achievement.

The Committee recommends continuing to build on the success of RIKEN-RAL by Focusing on the two prioritised pillars:

- Condensed matter: exploiting the unique CHRONUS spectrometer
The condensed matter and molecular science programme is diverse and productive. There is a very strong publication record, and many collaborating groups from Japan and overseas. The new spectrometer will enable further programme developments.

- Low energy muons: development of new laser systems
Development of an intense ultra slow muon (USM) beam will provide unique capabilities for condensed matter and materials science, and ultimately for fundamental particle physics. The activity at RIKEN-RAL provides a necessary stepping-stone to enable future implementation at J-PARC.

These two programme pillars are “star” activities and should have the primary call on resources RIKEN-RAL muon facility when prioritisations are made.

Establishing the core group of RIKEN-RAL staff needed for the ongoing success of RIKEN-RAL. The condensed matter and molecular science programme has huge potential, and there is a large and growing community of researchers using the facility. Presently it has only a single permanent staff member, together with short-term post-doctoral workers leading to rapid staff turn-over. With the addition of the CHRONUS spectrometer, there is a need for sufficient manpower resource to be allocated to this programme pillar to ensure that it is sustainable. This work, together with the USM development, will act as a springboard for the subsequent exploitation of J-PARC.

Creating of an action plan, with milestones and resource allocation, for the USM project to ensure its success and for its full potential to be realised at J-PARC.

Post the Earthquake disaster, ***using*** RIKEN-RAL to support the Japanese Muon User Programme. This is an excellent opportunity to enable the continuity of the Japanese muon user programme during this period, particularly with the capabilities and capacity to be provided by CHRONUS.

Building a successful condensed matter programme for the Japanese and International community and transitioning the activity to J-PARC at the end of the Third Midterm Plan. The RIKEN-RAL facility has enabled RIKEN to foster strong international collaborations in muon science. There are opportunities to continue these collaborations beyond the point at which activity is transferred to J-PARC. This is both in terms of Japanese researchers benefiting from UK facilities together with UK and European scientists accessing J-PARC. These international collaborations should be sustained beyond the transition in 2018.

Exploring opportunities for further collaboration within RIKEN, particularly within the area of condensed matter and molecular science, at other RIKEN sites and centers.

9. Strategic Plan

A presentation was made to the advisory committee outlining the present strategic plan for the Nishina Center. The committee commends the management for having developed a well-articulated and forward-looking plan with significant short-term, mid-term, and long-term components.

The main focus in the short- and mid-term components of the plan is the present RIBF program. The short-term goal of 8 months of operation of RIBF is strongly endorsed by the NCAC as is the goal to reach the design intensities for the heavier beams.

A number of upgrades to RIBF equipment were presented as part of the plan. The short-term upgrades are modest ones that involve improvements in existing devices such as BigRIPS, completion of devices now under construction including SAMURAI and SCRIT, and the design and development of new devices such as SLOWRI, a Mass Ring, and SHOGUN. Also included in the short-term list of projects is the installation of a clover detector array, EURICA/CLOVER, which is provided by external users. The mid-term goals for RIBF involve the use of a number of new detector and spectrometer systems to carry out the physics program and the continued development of new devices such as SLOWRI, the Mass Ring, Return BT and SHOGUN, which should be pursued vigorously.

In addition to equipment upgrades, the plan includes accelerator improvement projects and the development of several advanced concepts for the accelerator complex. The near-term accelerator improvement projects are well defined. The longer-term projects are in the early stages of development and will require a significant R&D effort. In the area of RIBF applications, the present radioisotope production program will be extended to new isotopes and to higher yields of isotopes presently being produced. Much of this effort will focus on the capabilities of the AVF cyclotron***. Improvements to increase the beam energy and intensity will be needed to carry out the expanded program and work in this direction is recommended.***

The strategic plan includes components for hadron physics and muon science. The hadron physics component calls for continued exploitation of RHIC for heavy-ion and spin physics studies in the short and mid term. The long-term direction of this program depends on the operation of the RHIC facility at Brookhaven National Laboratory in the USA. The Nishina Center management made it clear that they plan to support the RHIC program as long as RHIC operates. Nishina Center scientists are now involved in many experiments that are being planned for J-PARC. A new effort in hadron physics, the development of a RIKEN J-PARC center, is scheduled to begin as part of the mid-term program plan. The RIKEN group will take on a major role in developing facilities and carrying out hadron physics experiments at J-PARC according to the plan. At present, the muon science program at RIKEN uses facilities located at the Rutherford Accelerator Laboratory in the UK. This effort will continue with the recent signing of a seven-and-a-half-year RIKEN-RAL agreement. During the mid-term part of the strategic plan, the muon science program will begin a transition to J-PARC. The goal to have the program running at J-PARC by the end of the present RIKEN-RAL agreement is fully supported by this committee.

The NCAC enthusiastically endorses the longer-term strategy to develop a strong science program at J-PARC. The two components that are envisioned for this effort—hadron-physics and muon science—are both extremely well suited for J-PARC. Once the J-PARC facility recovers from the damage caused by the March 2011 earthquake, it can continue commissioning new experimental apparatus. This will allow researchers from RIKEN to begin carrying out experiments that have been approved by the hadron physics PAC. The J-PARC facility will have a unique program in the world once it has transitioned to full operation.

The NCAC was presented with two different options for long-term upgrades to RIBF. One of the options focused on harvesting isotopes produced by the high-intensity RIBF beam and then accelerating the isotopes to carry out experiments at lower energies, up to about 10-12 A MeV. The other option would use neutron induced fission to produce high yields of fission fragments that would then be harvested for acceleration in the existing RIBF cyclotrons. Both options offer intriguing, but different, science opportunities. They also both need a considerable amount of R&D to determine their cost and feasibility. ***We recommend that both options be pursued as potential upgrade paths for the facility in the future. A choice based on the potential physics program that will be enabled by an upgrade may need to be made in the future if both options are found to be feasible but resources dictate that only one can be carried out.***

For the Nishina Center Advisory Council

S. Gales
Chair of NCAC