Some initial comments from the RIKEN RIBF TAC

Executive summary

SRC sets record; knowledge transfer to and from industry; world-class facility; need manpower

General comments

We are impressed by the overall progress of the RIBF construction. The project is well on the way to becoming a world-leading radioactive beam facility. The instruments currently being planned and designed for phase 2 are essential to enable a broad-based experimental program at the frontiers of nuclear science, and will provide a very large incremental return on the investments in the phase 1 capabilities.

2006 will be a very busy year with most major sub-systems scheduled for commissioning. We would like to see a more detailed plan of the coordination or sequence of the commissioning process. For example, RF conditioning interferes with the commissioning of other systems such as the electrostatic inflectors and deflectors.

The type of event experienced recently with the SRC cryogenic system is not so unusual in such large systems in the early stages. Similarly, it would not be unexpected to experience more such delays during the commissioning process.

We would also like to see a more detailed plan of the beam loss diagnostics and radioprotection systems that will be essential as the commissioning proceeds towards higher intensities. For example, beam losses due to residual gas stripping should be monitored carefully during commissioning at low intensities to avoid machine activation.

The RF systems, including the flat-topping capabilities, for all 3 new cyclotrons seem to be very well done. The addition of flat-topping to the RRC is also a good idea.

The parameters of the electrostatic inflectors and deflectors seem to be within the region of experience with existing experience and hence should not be a major source of trouble during the commissioning process.

The present performance of the 18 GHz ECR source for uranium and other beams is already at the levels required for the commissioning process.

The beam intensity tables for beams lighter than Kr could be updated to higher intensities considering the lower radiation created by these beams per particle microampere.

fRC

Final magnetic maps to check the fields of the fRC are in progress.

IRC

The IRC seems to be essentially complete and ready for commissioning.

SRC

We congratulate the team on the successful operation of all 6 magnetic sectors of the SRC. The overall design of these sectors and the magnetic circuits in general seems to be very innovative and appropriate.

There will be some delay to analyze and repair the leak that developed in the cryogenics control dewar. Commissioning of other systems can proceed during this time.

The mapping hardware of the SRC sectors is being prepared.

The presence of significant magnet fringe fields in the RF cavities of this machine may influence the commissioning process.

---coil alignment issue

Charge-state stripper R&D

We are happy that the stripper problem is recognized as high priority for R&D. We encourage active work and testing of the various strippers required for the various modes of operation. Beam-based evaluation of uniformity of various candidate foils and plates is encouraged. The use of foils/degraders to match the required energies into the fRC and IRC need to be considered in terms of straggling and emittance growth as well.

28 GHz ECR R&D

We were impressed by the detailed plans for the development of the advanced 28 GHz ECR ion source. This advanced source is absolutely essential to obtain the full intensity operation of the facility, especially for the heaviest beams. Close communication with related projects in other countries in encouraged to ensure the maximum rate of progress and to avoid duplication of efforts.

New linac injector system

We recognize that the proposed new linac injector system is essential to enable continued R&D for heavy elements with the GARIS apparatus. The approach chosen seems appropriate except that it seems more appropriate to integrate the requirements of the 28 GHz ion source from the beginning. Recent international developments in room temperature accelerating structures for RFQ's and drift-tube linacs should be considered before final design selection. We also feel that a thorough analysis of the 3-D fields of the compact quadrupole triplets should be done.

BigRips

The committee is convinced that the in-flight separator BigRips, presently under construction and assembly, is indeed a world-class next generation facility for physics and applications with rare isotopes. It is based on the most advanced separation scheme with multiple degrader stages (or /and event-by-event identification) to handle the highest intensities of exotic nuclei which have ever been achieved in the magnetic rigidity range up to 9 Tm. The large-acceptance device will profit from projectile fragmentation and from fission of ^{238}U. Hexapole magnets are included and the committee would like to see them applied in simulations to find out how the degrader shape has to be optimized under the residual influence of focal plane tilt due to higher-order aberrations.

Many technical challenges have been successfully solved and the simulation of the performance clearly reflects the unique research potential. The high radiation area has been equipped with a radiation hard dipole magnet and the target and beam dumps have been prepared based on careful computer simulations and test experiments on the present facility. The committee would like to suggest in addition to consider heavy material shielding blocks to reduce the light particle and neutron flux which would impinge on the superconducting coils of the subsequent magnets after interaction in matter (target or beam dump). Collaboration with the working groups on RIA and FAIR is recommended, the planned expert meeting on next generation separators is also an excellent possibility. The instrumentation in the highest radiation fields should be kept as simple as possible to have easy maintenance and replacement. For example, as an alternative to water-cooled target, a radiation-cooled carbon target could be considered as a backup. Such a target has been used at PSI where 10 times more beam power is deposited. The handling scenario for major maintenance in the pre-separator stage has to be worked out in more detail and be tested with smaller equipment before the activation is a main issue.

The committee recommends that the full installation of the diagnostic and particle identification at the focal planes of BigRips should have the highest priority because they are needed to commission the complex device and will be required for the first experiments with RI beams. The proposed high-rate detectors fulfill the resolution requirements and also the modern data acquisition with optical fiber is an excellent solution.

RI Spin Laboratory

The RI Spin Laboratory is considered to be a very logical step towards maximizing the productivity of the RIBF and the diverse and interesting research program is backed by a strong collaboration.

Once beam-sharing is implemented, the RI Spin Laboratory will introduce true multi-user capability at the RIBF and help to increase its scientific output.

With costs being moderate and operation expected to be unproblematic an early implementation could help to establish a broad science program already at the start of phase 2.

Development of a method to independently adjust intensity for the two users is recommended for the future.

Samurai

The committee is convinced that the Samurai spectrometer is an essential part of the exotic nuclei research where different types of reactions are employed to investigate nuclear matter. Presently, a HISS type of spectrometer is planned with a large gap and a maximum magnetic rigidity of 7 Tm. Tracking detectors for charged particles and a large neutron detector will be used in combination with magnetic rigidity analysis. Since the final magnetic design has not been achieved for the spectrometer, collaboration with the corresponding groups at MSU and GSI is recommended. The design of the R3B dipole optimized for low fringe field components and high momentum resolution might be a solution if scaled to RIKEN energies. The proposed tracking is certainly well suited to achieve the required resolution. The committee suggests reserving enough space directly behind the spectrometer to have the option for higher-resolution experiments either by simply changing the distance of auxiliary detectors or even to install a high resolution spectrometer as it is planned at the high-energy branch of the Super-FRS.

The Sharaq Spectrometer

The Sharaq spectrometer is designed for the high-resolution physics program at the RIBF. The main characteristics of the spectrometer and of the matching line are well adapted to fulfill the needs for this program. The main difficulty to achieve the high resolution is related to the fact the incoming beam is a secondary beam of quite big emittance. With this large emittance an image size of 1mm for a monochromatic beam must be achieved. This is probably difficult to obtain with a secondary beam the size of which is often increased by the use of degraders in the preceeding Big Rips. Therefore mainly two solutions could be used: either use the raytracing detectors already projected for Big Rips, or construct specific detectors in the matching line. Careful trajectory calculations, starting in Big Rips should be done to optimize the final solution.

[workshop follows]

SLOWRI

Pioneering work has been done at RIKEN with respect to gas stopping and related techniques, recently rewarded by a first successful laser spectroscopy experiment of trapped Be ions from fast beam fragmentation.

The SLOWRI facility and the proposed experimental equipment will enhance the RIBF science program by providing the opportunity for low-energy beam experiments like mass measurements, laser spectroscopy or decay studies, and eventually for experiments with post-accelerated beams. While not reaching as far from stability as the proposed ring mass measurement, the mass measurements with an electrostatic time-of-flight spectrometer are considered to be a very cost-effective and unrisky approach.

The committee appreciates that the realization of SLOWRI, related R&D work, and preparation of experiments involves national and international collaborations.

The proposed R&D work towards higher intensities and faster gas cell extraction should be given high priority. With respect to next-generation systems the cyclotron ion guide appears to be the most promising option. We recommend analyzing how far a small-scale system based on an existing magnet is useful with respect to effort versus final performance or if the immediate development of a full scale system is already justified.

Rare RI ring project

The TAC committee is convinced that the project on mass measurements of short-lived exotic nuclei in the isochronous rare-RI ring has a large discovery potential due to the high primary beam intensity of the RIBF. The aimed uncertainty of 10^{-6} is sufficient to contribute to nuclear structure and astrophysics particular at the r-process path. The method provides access to nuclei with lifetimes down to the sub-millisecond range which cannot be measured with other devices with the same accuracy. The TAC committee sees no principal technical difficulties with the proposed set-up since similar measurements have been pioneered already with the FRS-ESR facility at GSI.

The injection of single particles identified inflight and the emittance measurements allow for corrections to effectively use the small range of ideal isochronicity in the ring. The transverse cooling of the fragments before they enter the storage ring improves the accuracy and also the transport efficiency. The time-of-flight measurements with an accuracy of 10^{-4} is required to correct the non-isochronism. Thin (in the microgram range) TOF detector foils have to be used to avoid that the influence of energy-loss straggling. The presented simulations are realistic and manifest the feasibility. The isochronism will be improved and optimized by trim coils (multi-pole component) and verified with stable beams at different momenta.

There are some significant challenges associated with some of the components such as the fast kickers and the tuning of isochronism to better than 10^{-6}.

SCRIT project

The stored number of ions in SCRIT in the feasibility test was $\sim 10^4$ atoms. It indicates the reality of the electron scattering experiment in the SCRIT system. However, the achieved number of stored ions is a little bit low with respect to the required luminosity of higher than 10^{27} cm^2/s. When the available electron intensity is 500 mA, the required number is higher than 10^7 ions. Further improvement is needed to reach this level. However, even if the full desired luminosity is not achieved very useful measurements can be done at luminosities as low as 10^{24}.

As for the RI-generator, the intensity of 10^8 pps of ^{132}Sn is easily obtained by uranium fission irradiated by electrons as well as protons or deuterons. Also, it is important to keep the possibility for using beams from the SLOWRI system, since this system will supply low-energy RNB of all kinds of elements.

We endorse the idea of bringing an electron ring to RIKEN for the further development of this method.

We also recommend that a full demonstration of the method be carried out with stable ions as soon as possible.