Report from the 4th Meeting of the Accelerator Technical Advisory Committee for the Japan Proton Accelerator Research Complex (J-PARC)

February 24-26, 2005
KEK
Tsukuba, Japan

Table of Contents

EXECUTIVE SUMMARY

The Accelerator Technical Advisory Committee (ATAC) of the Japan Proton Accelerator Research Complex (J-PARC) held its fourth meeting over the period February 24-26, 2005 at the KEK laboratory in Tsukuba, Japan.

The J-PARC Project was initiated in 2001 as a joint project carried out by KEK and JAERI. When complete the facility will support research into the areas of Neutron, Nuclear, and Elementary Particle Physics. The Project is approved with a budget of 152.7 billion yen for Phase 1, which includes funds for construction of the neutrino facility originally scheduled for Phase 2. To accommodate funding for all the Phase I facilities including the neutrino facility the linac energy in Phase 1 was formally lowered to 181 MeV a year ago. Phase 1 is scheduled for completion at the end of JFY2007, with the neutrino facility completed one year later. It is currently anticipated that the complete 400 MeV linac energy will be recovered over the period JFY2008-2011 with funding included in the request for initial operating funds for the J-PARC complex. Phase 2 of the project includes extension of the linac energy to 600 MeV, construction of the waste transmutation facility, and upgrade of the Main Ring to 50 GeV, but is not yet approved for construction. The committee notes that when complete, and operating at full performance, J-PARC will provide Japan with the preeminent facility for hadron sciences in the world.

The ATAC heard presentations covering the development, fabrication, and installation of both technical components and conventional construction facilities supporting the J-PARC Project. These presentations were well prepared and informative, as well as being responsive to most recommendations from the March 2004 ATAC meeting. Many recommendations were accepted and those that were not were carefully considered. Immediately following the meeting the committee toured the construction site and observed the civil construction nearing completion as well as testing of accelerator components. The committee was very impressed with the degree of progress since the last meeting and congratulates the project team on its very excellent progress.

Subsequent to this meeting the ATAC Report was presented to the International Advisory Committee and discussed at their meeting on February 28-March 1, 2005.

General Comments

When completed J-PARC will be a state-of-the-art proton accelerator complex with associated experimental facilities. The accelerator facility, which was the subject of this review, consists of a 181 MeV linac, a 3 GeV rapid cycling synchrotron (RCS), and a 50 GeV synchrotron denoted the Main Ring (MR), and operating with a maximum energy of 40 GeV in Phase 1. The two synchrotrons are designed to provide extremely high average beam power: 0.6 MW from the RCS and 0.72 MW from the MR. This performance is beyond that of any other facility operational in the world today. Notable components of the project currently delayed beyond Phase 1 include restoration of the full linac energy to 400 MeV, an additional 200 MeV of superconducting linac and associated waste transmutation area, and realization of the full 50

GeV performance of the Main Ring. The neutrino beamline and target previously incorporated into Phase 2 has now been funded in parallel with Phase 1.

The J-PARC project is now well advanced both in terms of civil construction and fabrication of accelerator components. The installation phase is about to begin and will be followed by commissioning shortly thereafter. Issues that the committee feels require particular attention at this stage of the project are:

- The budget and schedule to completion.
- Installation and commissioning planning, including the transition to operations.
- RCS and Main Ring performance goals.

Specific comments on the individual accelerators making up the complex are given below with particular emphasis on the above points. The committee remains of the opinion that it is unlikely the J-PARC complex will achieve the originally established performance goals (1.0 MW from the RCS and 0.75 MW from the MR) as long as operations remain based on a linac energy of 181 MeV.

Linac

Good progress has been made on all fronts. The linac enclosure and service buildings are nearing completion with full services (electrical, water, air conditioning) to be available in July 2005. The ion source is operating near the design specification for current for Phase 1, but not at full duty factor. Beam commissioning of the first DTL tank at KEK looks good—transmission is essentially 100% and the beam emittance is within 20% of the design specification. SDTL tanks are also being received (19 of 32 required) and tested under power at KEK. Linac component installation on the JAERI site is scheduled to start in April 2005. The team foresees the initiation of commissioning of the linac with beam on the J-PARC site in September 2006. A pending issue requiring resolution is identification of funds to move equipment commissioned at KEK (RFQ, ion source, DTL, etc.) to the JAERI site. The long range plan remains to upgrade the linac energy to 400 MeV based on the addition of an annular coupled structure (ACS) linac following completion of Phase 1. Funding for this upgrade is envisioned as being within the initial operating budget for J-PARC, but has not yet been secured.

Linac Comments and Recommendations

- The budget issue for moving equipment from KEK to JAERI needs to be resolved immediately.
- The ion source lifetime appears very low. The source remains in an R&D phase with two sources currently under parallel development and neither currently performing at the Phase 1 specification. The committee has a concern that development will not be completed before the initiation of beam commissioning.

Recommendation: Develop a plan for bringing one of the sources up to the Phase

1 design specification before the start of linac beam commissioning.

- The LLRF system is still in development. Beam tests of the DTL1 tank have not utilized the final system. It is unlikely the final system will be tested before the initiation of beam commissioning.

  Recommendation: Do everything possible to finalize the LLRF system prior to the start of linac beam commissioning.

- The pre-chopper is noisy and is disturbing local instrumentation. This points toward an electromagnetic compatibility issue (see last year's report).

  Recommendation: Electromagnetic compatibility needs to be addressed at the project level. The strategy in this respect should be presented at the next ATAC meeting.

- The operational mode of the chopper and potential pre-chopper have not been defined.

  Recommendation: Prepare and present a decision procedure for the chopper at the next ATAC meeting.

- The enclosure floor has settled 20-30 mm since initial construction 2 years ago. It is unknown whether it is still settling.

  Recommendation: Regularly monitor differential settlements across the site utilizing the site-wide alignment network.

- Resources required to meet the installation and testing schedule appear marginal. Forty-four people are currently assigned in the linac group.

  Recommendation: Assess the staffing needs of the Linac Group and augment as necessary to support schedule goals.

- The committee concurs with last year's assessment that the linac is likely to achieve design performance goals subject to previous comment. However, performance of the RCS and MR are unlikely to meet their full performance potential with the lowered linac energy. **We continue to urge the identification of funding for the 400 MeV linac upgrade as a high priority item**.

Rapid Cycling Synchrotron

Component procurements for the RCS are well advanced on all fronts and the initiation of installation in the RCS enclosure is imminent (March 2005). The longer range plan is to initiate hardware commissioning in July 2006 and beam commissioning in May 2007. Measurements of dipole magnets under (25 Hz) ramping conditions have been completed as recommended in last year's report. This has been accompanied by measurements of mechanical vibrations and resulted in some minor modifications to the magnet. Extended life testing was also undertaken with a dipole magnet subjected to the full ramp and ramp rate for six days. The committee heard a complete analysis of feedback vs. feedforward beam loading compensation as requested in last year's report. The coated ceramic beam tubes are under fabrication and the impedance has been well characterized. Single particle tracking simulations with two separate codes indicate the dynamic aperture looks good (following correction of Qx-2Qy resonance). The simulations assume calculated magnetic fields and no alignment errors. Measured magnetic field profiles are in the process of being integrated into the simulation. The committee received a very comprehensive and responsive presentation on impedance budget, instability assessment, and electron cloud in the RCS. A complete impedance budget has been established with good agreement between theory and hardware measurements (i.e. the ceramic vacuum chamber). Also, in response to last year's recommendation a design has been developed for momentum collimation in the L3BT line. Many constraints exist due to the location of magnets in the line being fixed at this point in time, but the design is still able to achieve a momentum acceptance of ±0.5%. A full design has started with the intention of implementing. However, funds have not been identified

RCS Comments and Recommendations

- The J-PARC staff remains engaged in R&D on aspects of cavity fabrication. (core cutting and water flow). Cavities are currently on order from industry.

  Recommendation: Make decisions on final cavity design as soon as possible.

- Differences in the excitation function of the dipole and quadrupole magnets, mainly due to saturation, require careful adjustment of the amplitudes and phases of the 8 resonant power supplies (1 dipole and 7 quadrupole circuits) to minimize variations of the lattice parameters during the ramp. The excitation functions of most of the quadrupoles still need to be measured.

  Recommendation: Model and test a complete power supply system as soon as possible and develop requirements for the tolerable lattice variations.

- The lifetime of standard carbon stripping foil appears to be very short (less than an hour) as simulated with a dc Ne beam. A promising alternative (ribbon foil) has been identified. The team is commended on this development and the ingenious use of a Ne beam to simulate performance. However, extrapolation from Ne to protons is not completely straightforward. Experience with test foils at other laboratories indicates that lifetimes may not be as short as indicated with the Ne.

  Recommendation: We encourage testing new foils with H^- beam as soon as

possible to understand the Ne to proton extrapolation.

- The installation strategy appears to have magnets and vacuum chamber installed before cables. This implies a certain risk of damage to prior installed equipment which will require care to mitigate.
- The Committee is pleased with the quality of the extensive review that has been made, investigating in-depth the suggestion from last year's review concerning utilization of feedback within the RCS rf system. The Committee understands the present preference for feed-forward in the initial phase of operation, especially since most equipment can later be re-used to implement feedback. The difficulty to precisely adjust the many parameters needed for proper feed-forward operation shall not be underestimated and adequate control software must be foreseen to ease that task.

  Recommendation: Develop and document a plan for tuning the LLRF feedback loops. Consider the use of models to optimize this plan.

- Single particle tracking simulations assume calculated magnetic fields, no alignment errors.

  Recommendation: Implement an integrated tracking simulation including alignment errors, real fields including both systematic and random errors, space charge, and the injection chicane.

- The accelerator team may want to look at correction circuits for all low order (octupole or less) resonances in close proximity to working point which are identified as significant according to simulations (e.g. 3Qx= 20).
- A prototype collimator has been assembled. However, there appears to the committee to be a mismatch between the collimator design and the specification for losses. Five (transverse) collimators are capable of 0.4 kW/jaw each. Total design load on collimators is 4 kW. No operational scenario has been developed to assure no collimator operates above its specification. The committee suggests being more conservative on the design specifications. In addition the collimator cooling design is still under development.

  Recommendation: The collimator design and development program needs immediate attention.

- This extraction kicker appears to the committee as a potentially important component of the impedance budget.

  Recommendation: Perform a comprehensive impedance and instability analysis of the extraction kicker assembly including the kicker modules, the PFN, and the cabling as a guide in optimizing the engineering design.

- Secondary emission yield (SEY) coefficients for non-coated ferrite and aluminum in the kickers could exceed 3.

  Recommendation: Consider coating as many surfaces in the RCS as possible. This should include the ferrite and aluminum surfaces of the extraction kicker.

- The kicker prototype does not yet meet field flatness specification.

  Recommendation: Implement modifications to meet the kicker flatness specification.

- The committee did not hear anything about single pulse accidents/losses in RCS (as recommended last year)

  Recommendation: Establish the potential impact of a single pulse accident in the RCS and MR, and reflect this information in the machine protection strategy.

- We suggest taking a final look at the L3BT optics to optimize the momentum collimation and diagnostics performance subject to lattice constraints.
- Currently assigned resources appear marginal for meeting the schedule. Fifty three people are assigned (not all full time). A task force is developing an installation plan but has not yet reached conclusion.

  Recommendation: Assess the staffing needs of the RCS Group and augment as necessary to support schedule goals.

- The committee concur with last year's assessments relative to RCS performance: 0.33 MW beam power represents a lower limit on what will be achieved with the RCS in Phase 1; 0.6 MW with 181 MeV injection into the RCS is plausible, but requires more developed simulations and loss analysis to provide confidence. While good progress was shown on single particle tracking, the integrated simulation suggested above and the single pulse accident consequences are required to provide confidence in the higher performance number.

<u>Main Ring</u>

Dipole, quadrupole, and sextupole magnet fabrication are nearing completion and production field measurements are underway. Magnet installation in the MR enclosure is scheduled to start in July 2005, with beam commissioning scheduled for November 2007. Beam position monitors are largely all received and are currently under test. RF equipment procurements will begin in JFY2005. A series of accelerator design reviews (covering the entire J-PARC complex) have been conducted and have led to several design improvements (most notable increased aperture in the MR injection region).

The decision has been taken to establish h=9 operations as initial operating mode. Issues with respect to h=18 include strain on the chopper dump (related to single bunch filling of the RCS), kicker risetime (minor concern), MR dwell time at 3 GeV in presence of strong space-charge (now simulated), and decreased beam power on the neutron target due to the additional RCS cycles required to load the MR. Resources available to pursue both designs in parallel is also a concern. Estimated performance in the initial operating mode is 0.45 MW (consistent with ATAC assessment last year). The approach is to keep all hardware compatible with subsequent upgrade to h=18 operations.

The committee received a very comprehensive and responsive presentation on impedance budget, instability assessments, and electron cloud. Complete impedance budgets are now established. The instability analysis indicates that the MR will require a transverse damper. The electron cloud is identified as a potentially serious issue in the MR.

<u>Main Ring Comments and Recommendations</u>

- The committee has some concern that the compressed installation schedule may result in personnel congestion within the MR enclosure. It is unclear to the committee if the neutrino beamline installation and MR beam commissioning schedules are consistent. Additionally, the installation strategy has magnets and vacuum chamber installed before cables. This sequence will require care to not damage prior installed equipment when pulling cables.
- The committee is surprised to see the reduction in the initial performance goal to 0.45 MW. This decision appears to be based on the expectation that the 400 MeV linac upgrade will occur within the first few years after Phase 1 completion. However, the committee has not seen a strategic plan for the commissioning and initial operations that can be used as a basis for discussion and planning with the user community.

Recommendation: Continue work to establish h=18 operations as a viable alternative route to 750 kW, and then develop an implementation plan as a fallback in case the 400 MeV linac upgrade is delayed.

Recommendation: Prepare an integrated installation, commissioning, and initial operations plan for the J-PARC complex. This plan should extend through the first few years of operation, and should establish estimates (by year) for:

- **Hours scheduled for machine studies, ongoing installation, maintenance, major accelerator upgrades, and operations in support of the research program.**
- **The different beam characteristics required at different phases of the commissioning.**
- **Estimated reliability (actual/scheduled hours of beam on target)**
- **Total protons delivered to the RCS and MR targets.**

The plan should take into account the need for completion of the neutrino beamline during the commissioning period and should include decision criteria for implementation of the h=18 system or the 400 MeV linac upgrade. The plan should be developed in consultation with the user community and should be in a form that it can be publicly accessible. The plan should establish resource (budget and people) requirements to (support the plan). The ATAC suggests the plan presented at next year's meeting.

- The committee suggests that the gap size of the electrostatic septum should be carefully determined to optimize the trade-offs between aperture margin and applied high voltage.
- The storage and/or machining of activated components removed from the accelerator complex represents an operational challenge. The committee suggests that operational impacts can be minimized by dealing with such components on or in close proximity to the JAERI site.
- We suggest implementing a bunch-by-bunch transverse damper in MR.
- A good start has been made at understanding the electron cloud instability. The conclusion is this could seriously impact MR performance.

  Recommendation: Fully evaluate the electron cloud instability based on a self-consistent simulation. Calculations need to be benchmarked with existing machine observations at PSR, AGS, KEK PS, and/or PS with a refined model of the e-p interaction. Consider some form of surface treatment or conditioning.

- Currently assigned resources appear marginal for meeting the schedule. Eighty one people are assigned (not all full time). The group is counting on an influx of roughly 40 people from the KEK PS to support this effort in the near future.

  Recommendation: Assess the staffing needs of the MR Group and augment as necessary to support schedule goals.

- The committee concurs with last year's assessment relative to MR performance with h=9 and 181 MeV linac: 0.44 MW is the likely performance level in this mode. Restoration to 0.75MW would require linac upgrade to 400 MeV (preferred) or implementation of h=18 system in MR

Controls, Commissioning, and Operations

Presentations were given on line synchronization issues (timing system), application programming, low-level RF (LLRF) feedforward and feedback systems and a number of beam instrumentation systems.

Controls Comments and Recommendations

- The question of synchronization to the AC line has been fully examined as recommended by the ATAC previously. The decision has been taken to stick to the current plan.
- We suggest that at next year's ATAC one presentation be devoted to a status overview of controls, touching on all the major subsystems and mentioning any issues of concern.

Recommendation: Within the next six months, develop and document a complete plan for software configuration management and release control using CVS. This should provide a uniform application development environment (ADE) for all J-PARC programmers and include a directory tree structure, rules for EPICS start-up files, a release control protocol, etc.

Management

The JFY2005 budget allocation for the J-PARC project will be about 20% below prior planning assumptions. Nevertheless, the plan is to hold the JFY2007 completion date for Phase 1 and JFY2008 completion of the neutrino beamline. This strategy is reliant on a significant (25-30%) increase in funding in JFY2006. The operating budget for the J-PARC facility has now been estimated at 150-200 OkuYen/year (depending on number of hours of operation).

Management Comments and Recommendations

- There is little-to-no margin (funding or manpower) on completing Phase 1 in JFY2007
- The J-PARC staffing level appears marginal for meeting schedule goals across all machines. The symptoms are that several systems are currently in fabrication coincident with R&D to establish final design, and installation is looming without detailed installation plans in several areas. The level of activity is expected to increase as installation and commissioning are initiated. The committee believes the project requires additional people with experience in installation, commissioning, and operations assigned during the upcoming year. (**See above recommendations.)**
- Last year the committee heard very good presentations on commissioning plans of the individual machines. The project would now benefit from creation of an integrated plan for installation and commissioning across all machines and extending through first few years of operations. This strategy needs to be worked out with and communicated to the user community to assure alignment of expectations. **(See above recommendation.)**
- The decision has been made to start out with h=9 in the MR. The projected performance is 450 kW. The achievement of 750 kW will require either h=18 operations or implementation of the 400 MeV linac upgrade (preferred). The ATAC strongly suggests preparing to pursue one of these strategies. **(See above recommendations.)**

1 INTRODUCTION

The Accelerator Technical Advisory Committee (ATAC) for the J-PARC Project held its fourth meeting over the period February 24-26, 2005 at the KEK laboratory in Tsukuba, Japan. The committee heard presentations from project staff on the 24th and 25th, held several closed sessions to discuss reactions and opinions, and presented a verbal report to project management on the 26th. The meeting agenda is attached as Appendix 3.1.

Committee members in attendance at this meeting included: R. Garoby/CERN, D. Gurd/ORNL, I. Gardner/RAL (deputy chair), I. Hoffman/GSI, S. Holmes/Fermilab (chair), N. Holtkamp/ORNL (IAC observer), A. Noda/Kyoto, T. Roser/BNL, L. Young/LANL (retired), and J. Wei/BNL.

No committee members were absent from this meeting.

The ATAC wishes to express its appreciation to JAERI and KEK management and support staff for their hospitality during this meeting, and to both the management and staff for their comprehensive presentations.

2 FINDINGS & RECOMMENDATION

2.1 Linac

The linac is in an advanced stage of preparation, in conformity with the planning. Tunnels and building are ready. The infrastructure (electricity, air conditioning and water cooling) will be completed in April 2005 and the installation of the accelerator itself will start. Linac commissioning with beam is due to begin in September 2006, to be followed by RCS in May 2007.

As decided two years ago, the beam energy will be limited to 181 MeV in Phase 1, and the beam current to 30 mA. The nominal parameters (400 MeV and 50 mA) need supplementary resources which have not yet been allocated.

Findings and Comments

Ion source

The volume-production type ion source using an LaB_6 filament has regularly delivered more than 35 mA during the commissioning of the DTL1 at KEK, without resorting to Cesium. Another power supply has been ordered to try and increase the beam pulse length from the present value of 250 μs up to the nominal value of 600 μs. Lifetime is still unknown.
In parallel, a Cesiated RF plasma source using 13 MHz RF is also under development which would probably be able to meet the required pulse length and current.
In these conditions, the source installed at the linac front-end will not have the foreseen characteristics and will continue to be a development item during the commissioning of the accelerator.

Pre-chopper and chopper

No work has been done on the pre-chopper which is still generating troublesome electromagnetic signals perturbing its environment. The possibility is being considered to suppress it by replacing the chopper with a 162 MHz deflection device distributing the chopped beam onto two dumps. Such a solution would be compatible with the 15 bunch mode operation of the MR.

These devices will have to be modified and improved after the start of Linac commissioning.

DTL & SDTL

RFQ, MEBT and DTL1 (19. 7 MeV) have been successfully tested at KEK. The adjustment procedure has been proven capable to establish the optimum set-point with an accuracy of 1 % and 1 deg. Excellent transmission has been obtained and transverse emittances of 0.3 π mm.mrad have been measured in both planes.

In the DTL tanks, post-couplers have allowed to adjust for the needed field flatness. Equipment will start being moved to J-PARC next April. Uncertainty remains with respect to the financing of this move.

All components needed for the SDTL tanks have been fabricated, and the assembly is progressing rapidly. High power RF conditioning at KEK of the six tanks already finished (32 in total) has been smooth and fast. Time will not permit to condition all the tanks at KEK, and some of them will only be conditioned after installation in the accelerator tunnel.

The procedure of calibration of the quadrupole magnets is routinely used and provides 50 μm of alignment accuracy.

Most high power RF components are already available and stored.

There are all reasons to believe that this equipment will be installed on-time and will perform satisfyingly as soon as beam commissioning begins.

Low Level RF

Adequate stabilization of the field in the cavity at the level of ±0.2 % in amplitude and ±0.25 deg in phase has been obtained with simplified electronics.

These results are promising, but the hardware to be used in J-PARC is still at the design stage and will only be demonstrated soon before the beginning of beam commissioning.

Beam instrumentation

The laser profile monitor in the LEBT is ready and performing well.

The BPMs will be installed inside the yoke of quadrupoles. Their calibration is progressing satisfyingly. A special technique will be applied to estimate the momentum spread of the beam at the end of the linac.

ACS

A prototype 972 MHz/β=0.556 buncher cavity that will be needed for the 400 MeV is under fabrication. It will be high power tested at Tokai in July 2005.

This will be a very valuable test for the future ACS structures.

Building and infrastructure

The linac and intermediate tunnels are completed, as well as the surface building. Floor painting is in progress. The klystrons and their power supplies, together with the cooling water systems will be the main occupants of the first floor. The second floor will be used by air-conditioning devices and cooling towers.

During accelerator operation the air in the linac tunnel will be recirculated without ventilation.

Nine cooling water circuits are being installed, with optimized chemical and thermal characteristics for their respective uses. Especially demanding are the RF signal distribution which will use water regulated at. 27±0.1 deg C, and the RF accelerating structures which require 27±0.2 deg.

Electrical services will be available in March 2005. Air conditioning and cooling water will be operational in June/July 2005.

Alignment survey has shown a movement of up to 20 mm of the accelerator floor.

Beam dynamics studies

Following last year's ATAC recommendation, beam transmission through the linac and transfer line has been re-analyzed, and physical aperture has been superimposed on the beam size plots. These clearly show a marginal situation in the DTL and SDTL where the 5σ size exceeds the available aperture when nominal tranverse focusing is used. If experience shows that loss are unacceptable, stronger transverse focusing could be applied, with limited detrimental consequences in the longitudinal phase plane. The better survival of tails in DTL1 for the stronger focusing design may transport larger tails throughout the linac to the effect that the loss on the arc collimator into the RCS is enhanced correspondingly and exceeds the tolerable limit. Also, a possible enhanced loss region seems to be the end of SDTL, where the radius ratio of 5 is marginal in the simulations presented (no errors included). *This clearly indicates that large clearance everywhere isn't necessarily the best choice with respect to staying within radiation tolerances.*

As recommended in 2004 by ATAC, the study has been made of the possibility to implement momentum collimation in the L3BT. Although difficult with the foreseen magnet layout, a convincing solution has been presented which allows to collimate 0.5 % in $\Delta p/p$.

The Committee recognizes that its recommendations have been properly dealt with.

It strongly supports the implementation of the collimation proposal and considers as very valuable the proposed use of the collimators for diagnostic purposes.

Linac Recommendations:

1. **There is presently no H^- source available with the required characteristics to reach the expected performance of the J-PARC complex in its Phases 1 and 2. The Committee recommends development of a plan for bringing one of the sources up to the Phase 1 design specification before the start of linac beam commissioning. We suggest this plan be presented at next year's meeting.**

2. **The final mode of operation of the pre-chopper / chopper set-up remains to be defined. The Committee recommends that the J-PARC staff prepare and present a decision procedure for the chopper at the next ATAC meeting.**

3. **The linac low level RF is only at the design stage, and the first prototype will only be tested at Tokai. The Committee foresees a risk of perturbing the linac beam commissioning and recommends doing everything possible to finalize the LLRF system prior to the start of linac beam commissioning.**

4. **Electromagnetic compatibility needs to be addressed at the project level. The strategy in this respect should be presented at the next ATAC meeting.**

5. **Regularly monitor differential settlement across the site utilizing the site-wide network**

6. **It would be helpful in future presentations to correlate the size ratio with the actually lost fraction of beam along the linac. This should be done in the end-to-end simulation, including the arc collimator, and with a sufficiently large error set of linacs (such error calculations have been already presented at ATAC04).**

2.2 3 GeV Rapid Cycling Synchrotron

The design parameters for the 3 GeV Rapid Cycling Synchrotron consists of a beam intensity of 8.3×10^{13} protons per cycle, a repetition rate of 25 Hz and, with an injection energy of 400 MeV, a 1 MW beam power at the 3 GeV extraction energy. The lower injection energy of 181 MeV that is part of the present Phase I construction project reduces to beam power of the RCS to .33 to .6 MW ($2.6\text{-}4.8\times10^{13}$ protons per cycle). The upper end of this range requires careful control of beam losses in the RCS that still needs to be supported by realistic simulations and loss analysis

In many excellent presentations the present status of the RCS was described to the committee. The civil construction is scheduled to be complete by July 2005. The component construction is also proceeding very well with about 90% of the magnets complete and 60 % of the vacuum and collimators complete. The 2-year installation period is to start in March 2005.

Comments and Recommendations

A magnetic field measuring program at operating parameters has started. The dipole magnets are being measured with a cycle that goes from 181 MeV to 3 GeV with the design rate of 25 Hz. The field uniformity in the required "good field" region of ± 120 mm is $\pm 8\text{x}10^{-4}$, somewhat larger than the design value of $\pm 5\times10^{-4}$. Measurements on the quadrupoles is scheduled to start soon.

Recommendation: Complete the magnet measurement program and develop corrective action for the field non-uniformities that exceed design values.

Vibration measurements that were also performed during the magnet field measurement showed vibrations of only about 10 microns. This is small enough to allow for mounting the ceramic vacuum chambers to the magnets.

Single particle tracking calculation were presented that include the measured dipole field non-uniformities. They show adequate dynamic aperture for the chosen working point of (Qx,Qy) = (6.68,6.27) . These tracking calculation should be extended to include quadrupole non-uniformities, magnet field error and misalignments, and be integrated with the existing space charge calculations.

Recommendation: Implement an integrated tracking simulation including alignment errors, real fields including both systematic and random, space charge, and the injection chicane.

The chosen working point allows for an incoherent space charge tune spread of about 0.2 without overlapping low order structure resonances. However, the tune foot print covers several low order non-structure resonances such as 3Qx = 20. Corrector magnets that either correct these resonances or allow for crossing them quickly could minimize their effect. Other working points should also be investigated.

Recommendation: Consider including corrector magnets to mitigate the effect of low order

non-structure resonances that are overlapped by the betatron tune footprint.

All ceramic vacuum chambers are being coated with TiN to reduce the secondary electron yield. This should suppress the formation of an electron cloud. There is presently no plan to coat the ferrite and aluminum surfaces of the extraction kicker. Both of these surfaces have large SEY coefficients. Such surfaces have been successfully coated at BNL for the SNS project. This should also be done for the RCS.

Recommendation: Consider coating as many surfaces in the RCS as possible. This should include the Ferrite and aluminum surfaces of the extraction kicker. Coating with TiN was successfully achieved for the SNS project.

Impedance calculations for the RCS were presented that were generally quite complete, in particular with regard to the ceramic vacuum chambers. However, transverse impedance calculations of the extraction kicker should be performed including the powering cables and the pulse forming network (PFN) and the results should be used to finalize the kicker design..

Recommendation: Complete the RCS stability analysis including the kicker/PFN. Benchmark the calculations against existing machines and feedback into the possible design changes.

Differences in the excitation function of the dipole and quadrupole magnets, mainly due to saturation, require careful adjustment of the amplitudes and phases of the 8 resonant power supplies (1 dipole and 7 quadrupole circuits) to minimize variations of the lattice parameters during the ramp. The excitation functions of most of the quadrupoles still need to measured.

Recommendation: Model and test a complete power supply system as soon as possible and develop requirements for the tolerable lattice variations.

Modules of the extraction kicker magnet have been tested and a pulse flatness of 9.3% was achieved. This is much larger than the design of 1%. It should be possible to achieve the required flatness with an improved circuit of the pulse forming network.

Recommendation: Implement modifications to meet the kicker flatness specification.

R&D on stripping foil lifetime was presented. The tests are using a 3.2 MeV Ne+ beam to simulate the energy deposition of the 181 MeV or 400 MeV proton beam. The foil thickness is close to the range of the Ne beam and therefore the Bragg peak creates a quite non-uniform energy deposition, which might enhance the stress on the foil. Industrially produced carbon and diamond foils as well as a new HBC-ribbon foil were tested. All foils had a thickness of about 300 $\mu g/cm^2$. The carbon and diamond foils broke after about 9 and 81 mC/cm^2 were deposited, respectively. The HBC-ribbon foils survived 7100 mC/cm^2.

The tests with the Ne+ beam do not completely simulate the operation with proton beam. In fact it likely causes significantly more thermal stress in the foil than the high energy proton beam. The results of these tests should be compared to foil lifetime tests performed with H^- at BNL.

Recommendation: Compare the stripping foil tests performed with Ne+ beam with the lifetime tests performed at BNL with H^- beam. We encourage testing new foils with H^- beam as soon as possible to understand the Ne to proton extrapolation.

A prototype ring collimator has been assembled. However, there appears to be a mismatch between the collimator design and the specification for losses. Five transverse collimators are capable of absorbing 0.4 kW beam power on each jaw. The total design beam loss on all collimators is 4 kW. No operational scenario has been developed to assure no individual collimator jaw operates above its specification. The design collimator beam loss also has little margin. It would be more prudent to design the collimators to be able to accept 8 kW. In addition the collimator cooling design is still under development.

Recommendation: The collimator design and development program needs immediate attention.

During last year's review the development of a machine protection system (MPS) was presented that can quickly stop the beam at low energy if a failure occurs. In the case of the RCS such a system will protect the ring components provided that the already circulating protons in the RCS cannot cause any damage. It should therefore be verified that a single pulse of beam cannot damage any equipment in the RCS. The committee was not presented with such a study during this year's review.

Recommendation: Establish the potential impact of a single pulse accident in the RCS, and reflect this information in the machine protection strategy.

The RCS RF system will produce up to 430 kV, h=2 accelerating voltage at 0.9 – 1.7 MHz. Eleven Magnetic Alloy (MA) disk loaded cavities with Q=2 are used to achieve this in a minimum of straight section space. The low Q removes the need for a tuning loop and allows an h=4 component to be fed through the same RF chain providing a larger stable phase area and thus a more intense beam. Eleven High Power Drives (HPDs) with two push-pull tetrodes in each provide up to 1MW of drive for each cavity and its beam power.

A CERN/J-PARC 9kW amplifier design using 9 × 1 kW amplifiers with an output combiner has been selected to drive each HPD following an assessment of the reliability and cost of commercial amplifiers. One 9 kW driver amplifier is expected by August 2005. An order will then be placed for the rest in October with delivery expected September 2006.

The low cavity Q means that the beam current loading of the cavity gap voltage will be affected by many of the harmonics in the beam pulses. To restore the required voltage waveform both feed forward and feedback systems have been considered, with feed forward currently selected as the initial option.

The Low Level RF (LLRF) generates h=2 and 4 phase controlled voltages from a Direct

Digital Synthesiser (DDS) and provides phase and amplitude control for each cavity taking account of its position in the ring. Harmonic component separation of the beam pulse signal provides controlled feed forward for the first 6 harmonics.

The Committee is pleased with the quality of the extensive review that has been made, investigating in-depth the suggestions from last year's review. The respective advantages/disadvantages of feed-forward and feedback have been correctly commented. Although the risk associated with the feedback solution is felt excessive, the Committee understands the present preference for feed-forward in the initial phase of operation, especially since most equipment can later be re-used to implement feedback. Moreover, a mixed mode of operation is also possible to gain experience, using feedback only on the harmonics where the voltage has to be minimized and no coupling is feared with the beam control's loops. The difficulty to precisely adjust the many parameters needed for proper feed-forward operation shall not be underestimated. Adequate control software must be foreseen to ease that task.

Recommendation: Develop and document a plan for tuning the LLRF feedback loops. Consider the use of models to optimize this plan.

Beam synchronization on an external reference is needed before transfer between RCS and MR as well as synchronization with the neutron chopper, and the necessary loop has also to be foreseen. In more general terms, the procedure of "cog-wheeling" between synchrotrons or between RCS and neutron chopper has to be designed, detailing the signals exchanged between RF systems and kicker timing and the precise sequence of events.

Recommendation: Develop a scheme for synchronization of the RCS extraction with the MR or the neutron chopper.

Control of the cavity Q to the desired value of 2 has required cutting very narrow radial slots in the magnetic alloy. Two solutions are under consideration. The first uses a water jet cut of 1.5 mm and cut and uncut rings are mixed to provide the correct Q. This is the hybrid solution. The second uses a grinding technique to cut 0.8 mm slots in all the rings, giving the correct Q. The grinding technique is the preferred solution as it provides a better finish in the gap and reduces gap heating. Suitable grinding equipment is now being built. Once cut the MA rings are vacuum coated with a 200 μm layer of epoxy and then installed in the cavity water jacket where they are cooled by direct contact of the epoxy layer with water. The grinding cutting will start in March 2005 and take four months to complete at two rings per day. A choice must be made on the selection of one technique or the other or a mixture of both.

Recommendation: Make decisions on final cavity design as soon as possible.

The current aim is to have 10 RF systems completed by March 2006 and 7 HPDs are already assembled. A check has to be made that the current and power capabilities of the RF tubes are sufficient to achieve the required beam loading compensation up to the highest beam current. Considerable manufacturing is required between now and the start of installation and the final cavity design is not yet made. The schedule for the RCS RF system leaves very little time for manufacturing slippages and very little time for testing, installation and commissioning.

Recommendation: Develop a plan for the necessary simultaneous installation and commissioning of the rf systems.

2.3 50 GeV Main Ring Synchrotron

The 50 GeV Main Ring assumes 8 bunch operation with harmonic number 9 at the first priority while the compatibility of operations at harmonic number 18 is maintained within the hardware. With reduced RCS bunch intensities based on 181 MeV injection energy, the provided beam power by the MR is 0.45 MW at the first phase.

Comments

Easy access and capability of quick replacement of the damaged equipment should be well prepared in order to reduce the level of human dose irradiation as low as possible. It seems inevitable to provide the capability of quick connection and disconnection of vacuum pipes, cooling water piping, and electric current feeds. An approach to realize such possibility is being evaluated by the J-PARC staff and financial support is strongly recommended. According to the foreseen radiation level, spare equipment should also be prepared in order to limit the machine down time to reasonable periods. The approach initiated in this line by the J-PARC commissioning group is strongly recommended to be supported.

Beam loss power during the usage of the hard wire beam monitor at higher energies should be investigated from both points of view of wire heating and possible radiation emission. The instability caused by electron cloud production might be serious at the injection and extraction stages of the MR and surface treatment is worth consideration. Investigation of beam instability and impedance budgets for MR is not so advanced as for the RCS, but the resistive-wall impedance of the SUS316L chamber is the dominant source for the transverse instability. A narrow-band transverse feed-back systems(~60 kHz) is already under development although particle simulations are needed in order to clarify the effect of the instability in detail

A production measurement scheme has been established for dipole and quadrupole magnetic field measurements. The deviation among magnets seems to be within tolerable limits. The committee would benefit from presentation of measured field distributions at its next meeting.

In accordance with the recommendation of ATAC last year, a accelerator design committee was organized among the J-PARC construction staff and according to their suggestion, the injection kicker arrangement has been modified, which results in wider orbit separation at septum magnets with use of wider aperture Q-magnets.

The slow extraction scheme has been much developed since last year, especially the electrostatic septum with use of Tungsten ribbon which is expected to contribute largely to reduce the septum thickness and hence the beam collision possibility. Loss analysis considering the scattering at the beam collision with the septum is very interesting and further careful studies with use of the simulation code GEANT will clarify the attainable extraction efficiency. The gap size of the electrostatic septum should be carefully evaluated comparing the tradeoffs beween aperture margin to 20 mm turn separation and the technical difficulty of high applied voltage.

The timing system without locking to the AC line is ambitious and more careful study of real application to the present accelerator complex is recommended. Ramping pattern generation without a B dot clock is also to be studied carefully about its feasibility in connection with the characteristics of real fabricated magnets.

50 GeV Ring Recommendations:

1. **Continue work to establish h=18 operations as a viable alternative route to 750 kW, and then develop an implementation plan as a fallback in case the 400 MeV linac upgrade is delayed.**
2. **Fully evaluate the electron cloud instability based on a self-consistent simulation. Calculations need to be benchmarked with existing machine observations at PSR, AGS, KEK PS, and/or PS with a refined model of the e-p interaction. Consider some form of surface treatment or conditioning.**
3. **The committee suggests the following information be presented at next year's ATAC meeting:**
   - **A maintenance concept that will minimize radiation exposure to personnel servicing the 50 GeV Ring.**
   - **Measured field distributions of the dipole and quadrupole magnets together with their AC excitation characteristics.**
   - **An analysis of trade-offs between aperture and voltage in the 50 GeV Ring extraction septum.**

– **2.4 Accelerator Physics Issues**

Findings

Significant progresses have been made to address important accelerator physics issues associated with the physical design and technical engineering, and to respond to concerns raised in the previous review.

During the 2004 ATAC review, there were three recommendations raised in the area of accelerator physics and performance projections related to 181 MeV operations. They were:

1. Evaluate beam loss and radio-activation distribution across the entire accelerator complex under the condition of reduced linac energy, taking into account realistic beam and machine configuration including injection loss (foil scattering, H- and H0 loss), static and dynamic, systematic and random errors in magnets and power supplies, optics perturbation across the injection chicane, and system malfunction (e.g. ion source malfunction, noise, kicker misfire), etc.
2. Bench-mark computer simulation / theoretical prediction with machine measurements / experience at existing Linac's, rapid-cycling synchrotrons, and high-intensity rings to identify possible performance degradation mechanisms (e.g. linac energy tail, injection efficiency, collimation efficiency, ring injection and ramping loss).
3. Appoint an "accelerator physics coordinator" to globally oversee accelerator-physics design, to track changes in machine configuration, and to oversee interface issues especially between linac and RCS, between RCS and MR, and between RCS and the neutron target.

On recommendation 1, three talks were presented in this review addressing the issues in the Linac, L3BT, rings, and slow extraction. On recommendation 2, a talk was presented on software comparison pertaining to RCS machine non-linearity. On recommendation 3, a core team was reported formed to address the interface issue. Accelerator physics topics presented in this review include commissioning results of the beam reaching the end of the first DTL tank, beam loss analysis, nonlinear effects in the RCS, impedance, instabilities, and electron cloud in both RCS and MR.

During the commissioning on September 2004, H^- beam of up to 30mA peak current and 250 μsec pulse length were accelerated at 25 Hz to the end of the DTL tank-1 with energy of 19.7 MV. The transmission efficiency was near100%. The measured rms emittances were 0.3 (H) and 0.29 (V) mm mr. The set point accuracy of 1 degree and 1% was achieved. In comparison, the design goal for the phase I of 181 MeV linac operation is 30 mA, 500 us, 25 Hz. The design goal for 400 MeV linac operation is 50 mA, 500 us, 25 Hz. The design transverse emittance is 0.25 mm mr.

Beam loss analysis was performed for the Linac, L3BT, RCS, MR, and MR during slow extraction. Loss analysis on the RCS and MR appears to be comprehensive, with the exception of fault condition analysis like one-pulse failure and kicker miss-fire.

The possibility of momentum collimation and diagnostics in the L3BT is presently under evaluation. Efficient momentum collimation in L3BT seems to be difficult due to the low peak dispersion (1.4 m) with the present lattice optics. Major change of L3BT lattice is difficult due to fixed 30 degree beam dump layout and procured hardware.

The maximum beam loss of 4 kW on RCS collimators appears to exceed the engineering design value (100 W per collimator jaw, four jaws per collimator, total five transverse collimators) first presented in the review. Later, it was reported that each jaw can withstand a power up to 400 W. However, detailed analysis including heat deposition, temperature distribution and thermal stress, and mechanical fatigue in a shielded and enclosed environment, associated with pulsed beam structure was not completed. The present collimation philosophy is based on near evenly distributed beam losses, first between each of the five collimators, then among each of the four jaws.

Dynamic aperture calculations (more precisely, beam survival calculations) with single particles including design nonlinearities from the bending magnets corresponding to 181 MeV energy have been presented. The study was done with systematic multipoles up to 6^{th} order, tracked for 5000 turns along the Ex=Ey line using both thin-lens approximation (SAD) and Runge-Kutta (MADX-PTC) methods. Comparison between SAD and MADX shows good agreement. Results look still safe in the region to be covered by the tune neck tie, except for the strong systematic third order Qx-2Qy=-6 resonance, where the survival acceptance shrinks. Tuning range was determined along with the acceptance range on the Ex=Ey line. Compensation by correction sextupoles is suggested (dynamically over ramp) to gain more flexibility in the choice of working point.

Self-consistent simulations (Simpson) have been shown, including correction sextupoles and space charge. They result in less than 4kW loss on collimators with ~1 mm COD. Hot spots elsewhere are under 10 W. The 1.5 kW with no COD is explained as result from the systematic driving terms from sextupoles and space charge.

Impedance and instability analysis was performed on RCS and MR. Impedance budgets include many key elements contributing to beam coupling impedance. Impedance calculation of the vacuum chamber included details like TiN coating, Cu shielding, and capacitors. The thickness of TiN coating was determined after evaluating the secondary emission effectiveness, impedance, and eddy current heating. Impedances of the RCS extraction kicker and the RF cavities are planned to be measured.

Electron cloud study was performed on both RCS and MR. Calculations on electron formation assumed a secondary emission yield of 2.1 on all surfaces. Calculation of electron-proton instability incorporated a wake-field model assuming given electron distribution. A comparison on electron neutralization and e-p instability threshold was made with similar accelerators.

Comments

The beam transverse emittances measured at the end of DTL 1 are about 20% larger than the design values. It is not clear where and how the emittance growth occurs. Calibration of the lattice optics using the measured phase-space profiles is needed to validate the design.

The 90 degree achromat of L3BT provides an ideal location for momentum diagnostics and collimation. Even with the present constraints imposed by the 30 degree dump, the procured magnets and hardware, we encourage continued investigation to optimize the optics possibly increasing the peak dispersion that facilitates momentum diagnostics and collimation.

We commend the practice of detailed beam loss evaluation across the accelerator complex, and encourage the team to closely integrate such analysis with engineering design. In addition to beam loss under normal operational conditions, loss under fault conditions needs to be evaluated, especially in the collimation region where engineering design and optimization is needed.

The present collimation philosophy of near even assumes that (1) the beam loss pattern is constant with time and (2) the collimator jaws, totaling 20 parameters, can be easily adjusted and maintained in a highly activated environment with heavy shielding. A detailed engineering evaluation together with cost analysis is needed to justify the feasibility. We urge a re-evaluation of the collimation philosophy and strategy considering engineering robustness, operational reliability, and maintainability (e.g. failure rate of collimator jaws and motion mechanism under severe thermal and radioactive environment; repair procedures), together with a detailed analysis including heat deposition, temperature distribution, mechanical and thermal stress, fatigue and lifetime of the material under pulsed shock in an enclosed environment during both normal and fault conditions.

We commend impedance calculations and measurements performed on key RCS and MR components. Impedance calculations were performed on the RCS vacuum chamber assembly including TiN coating, Cu shielding, and capacitors. Several similar calculations have been performed on ceramic/multi thin layer geometries, including work on SNS injection kickers. We encourage the team to compare theoretical models with others, and to fully benchmark measurement results.

The extraction kicker assembly is one of the largest impedance sources in high intensity rings. The impedance often depends not only on the ferrite geometry, permeability, and Cu sheets but also on the termination of the pulse-forming network and cabling. Theoretical estimates and measurements are available for many types of kicker design. We encourage the team to perform a comprehensive instability and impedance analysis based on both on theoretical estimation and measurements, and guide the optimization of the engineering design of the entire assembly.

Electron cloud formation depends crucially on the secondary emission yield (SEY) of the vacuum chamber surfaces. The SEY can vary significantly with surface treatment procedures. Furthermore, complicated coating patterns may have to be adopted on surfaces like ferrite. Simulation of electron-cloud needs to incorporate actual surface parameters and conditions. Special attention is also needed on concentrated locations like stripped electron and their reflection from the catcher.

We commend the practice of comparing RCS and MR with other high intensity machines pertaining to the evaluation of electron-proton formation and instability. Electron-proton instability is observed in LANL PSR with clear threshold dependence on RF voltage, and with measured growth rates. The theoretical e-p instability model needs to be validated by detailed benchmarking with experimental observations of threshold scaling, growth rates, and instability frequency range. Furthermore, we encourage self-consistent modeling of instability under multipacting electron generation.

The single-particle survival appears still safe, except for close to the major resonance lines. A sufficiently large area to accommodate the space charge and chromatic tune spread is identified, but it must be expected that it shrinks with all other nonlinearities (systematic and error) and COD included. For the presented self-consistent simulations, the origin of the collimator losses (1.5 kW without COD) warrants clarification: are they from correction sextupoles and/or space charge nonlinearities; are they consistent with a reduced dynamic aperture in corresponding single-particle tracking? Further complications are the magnetic interferences between the nearby magnets. In general, we encourage an integrated tracking simulation incorporating full design magnet fields, measured systematic and random field errors, misalignments, injection and extraction chicane/bump magnetic fields, magnet interferences incorporating space charge forces through injection painting along with actual aperture constraints.

Benchmarking exercise suggested at ATAC-2004 (comparison with data from running high intensity machines) wasn't commented by the team. We understand this is a time-consuming job in addition to the already large demands for work. A first step would be comparison with survival calculations from SAD/MADX using measured data (and ignoring space charge). The committee re-emphasizes that such benchmarking is important, in particular for the MR, where new territory of simulation of space charge effects is entered in view of the 0.6 seconds long storage time at injection energy.

Recommendations

1. **Evaluate the optics design of the linac and the mechanisms of beam quality deterioration along the linac using measurements performed in the linac commissioning.**
2. **Optimize the L3BT optics within the present hardware constraints to facilitate momentum diagnostics and momentum collimation.**
3. **Optimize the layout and design of the collimation systems based on a comprehensive evaluation of beam loss distribution in the collimator region under both normal and fault conditions, emphasizing engineering robustness, operational reliability, and maintainability.**
4. **Perform comprehensive impedance and instability analysis of the extraction kicker assembly including the kicker modules, the pulse-forming network, and the cabling as a guide in optimizing the engineering design.**
5. **Implement an integrated tracking simulation including alignment errors, real fields including both systematic and random, space charge, injection chicane, and magnet interferences. Evaluate correction strategy in the presence of such complications.**
6. **Evaluate electron cloud formation using actual beam and vacuum surface parameters (e.g. coating pattern and measured SEY) and optimize mitigation scenario in both RCS and MR**

7. **Benchmark electron-proton instability calculation with observed thresholds in machines like PSR, and improve the model if necessary.**

2.5 Controls, Commissioning and Operations

Findings with Comments

There was very little about the status of the J-PARC control system presented in open session to the committee as a whole. Presentations were given on line synchronization issues (timing system), application programming, low-level RF (LLRF) feedforward and feedback systems and a number of beam instrumentation systems. It might be useful for future committee meetings to have one presentation offering a status overview of controls, touching on all the major subsystems and mentioning any issues of concern.

Line Synchronization. In response to a recommendation made by the 2003 A-TAC Committee, the committee was presented with a comprehensive catalog and analysis of issues related to the decision to operate the J-PARC facility in a non line-locked mode. Line frequency behavior has been measured at KEK, and the same measurements will be repeated at Tokai. The conclusion is to stay with the original non line synchronous mode, however the risks are now well understood and an estimate has been made of the effort that would be required if experience dictated a later change. Such a design change would be non-trivial. The committee noted that the choice does not have to be between the two extremes of a fixed frequency or a line lock. It is possible to generate a Master clock that is derived from the line but whose frequency and phase changes are limited in slew rate to whatever can be managed by the Fermi choppers.

Application Programming. The committee heard an excellent presentation on the strategy for application program development. The SAD scripts and Python toolset developed for KEKB has been adopted. This is a rich and versatile environment that is favored by the commissioning team (that will in the end write many of the applications.) The environment allows applications to reference both accelerator models and the machine itself through extensive use of two relational databases – a static machine configuration database that contains the model (lattice description) and an "operational log" database that contains a history of device set points and beam instrumentation readback data. The machine configuration database should be the only repository of the machine description, used by designers as well as by the commissioning team. Beware any duplication of data – it will get out of synch! The downside of SAD is that it is written in poorly documented FORTRAN, and is a "nightmare" to maintain. For that reason there is a desire in some quarters to adopt the more modern and better documented and supported XAL framework developed at SNS. This is a reasonable goal, but only if the same richness and ease of use can be provided to users as is found in their comfortable SAD environment.

Feedback and Feedforward. The committee was presented with detailed plans for a beam-based DDS low-level RF (LLRF) feedforward system and a cavity voltage-based LLRF feedback system to be used in the rings. Digital versions of these circuits are only now being manufactured in industry so there have been no performance tests. These systems have a number of tunable parameters – gains, reference vectors etc. – and so operate in a complex, multi-dimensional parameter space. The feedback system can be influenced by the behavior of the feedforward system. The plan is to begin with the feedforward system only. The committee encourages the J-PARC team to develop a plan for the tuning of these loops, and to consider the required rates of data transfer in both directions to accommodate the fact that tuning parameters may change over the duration of a beam pulse, especially during injection. Performance of the digital system in a realistic environment should be measured as soon as it is available.

Beam Instrumentation. The committee heard presentations that mentioned or discussed a number of beam instrumentation devices – BPMs, BLMs, CTs, IPMs, MWPMs, emittance scanners, gas puffers, laser "wires," etc. These are in various stages of development, manufacture or test. Together they represent a comprehensive program for beam characterization. All of these devices deliver their data to EPICS for reduction, display and archiving. For many or all of these devices, the front end electronics is packaged in the same proprietary "WE" crates used for KEKB. These crates include intelligent interfaces to EPICS Input-Output Controllers (IOCs). The initial data reduction is done in the IOC, a task that could be demanding on its processor resources.

In addition to formal presentations, there were two informal meetings with members of the controls team. In all, ten controls team members participated in these meetings. A number of topics not presented formally to the A-TAC were discussed during these informal and free-ranging discussions.

Personnel and Team Integration. The controls team at present consists of five dedicated people at JAERI, 6-8 people at KEK, some of whom may also have other responsibilities, and two people from industry. This seems a small number for a project of this size, however the very significant participation of industry mitigates this problem to an extent that is difficult to assess. The controls team leader acknowledges that he is always "fishing" for more volunteers, but KEKB operations still presents an interesting and seductive alternative to some! It is gratifying to observe that notwithstanding a number of issues, the teams from KEK and JAERI are working more closely together than they appeared to be two years ago. In April, 6-8 KEK team members will move to JAERI for three days a week, to become full time by summer. This is a good thing.

Configuration Management. Like most EPICS sites, the J-PARC controls team is using the Concurrent Version System (CVS) as a tool for software release and configuration control. Both sites deposit their software in a common CVS repository. This approach is essential for success – all software should be built in a common environment – but it appears that a uniform method of *using* CVS as not yet been agreed. It is important that the team agree on directory structures, release protocols, common areas etc, and then live by those agreements. Almost any method will do, but no method at all will not. Moreover, it should be noted that CVS can also be the mechanism for controlling PLC code and FPGA code. Discipline in this area will save time and frustration for the duration of the project.

Commissioning. The controls team recognizes the commissioning team as their "customer." A well-developed commissioning plan for each machine was presented at the last meeting. This plan should influence priorities in the development of the control system, and in particular of applications. The controls and commissioning teams should work together closely to be sure that the right tools are available when required to support the commissioning plan.

Ethernet Devices. The control system contains many Ethernet-based PLCs and other Ethernet devices. These are interfaced using the elegant "NetDev" device record developed for KEKB. In the presence of the increasing number of available Ethernet-based controllers (Network Attached Devices, or NADs) the controls team is cautioned that the behavior of these devices in an EPICS network may be unpredictable and surprising. How will they react to an EPICS generated "broadcast storm?" Do they use multicasting that may require explicit enabling in network switches or routers?

Computer Security. The accelerator network is isolated from the laboratory enterprise network by a firewall. In today's environment, that is necessary but not sufficient protection. A protocol for computer security is needed. Under what circumstances can a "hole" be punched in the firewall? Should CVS and the RDB be inside or outside the firewall? How is remote access controlled? Will computers inside the firewall be scanned for vulnerabilities, and if so under what circumstances? What is the protocol for keeping machines on the accelerator network current as regards security patches? What is the protocol for attaching a laptop or other Windows computer to the network – say to update a PLC program? And so on and more…

Recommendations:

1. ***Configuration Management Plan.* Within the next six months, develop *and document* a complete plan for software configuration management and release control using CVS. This should provide a uniform application development environment (ADE) for all J-PARC programmers and include a directory tree structure, rules for EPICS start-up files, a release control protocol, etc.**

2. ***Feedback Tuning Plan.* Develop and document a plan for tuning the LLRF feedback loops. Consider the use of models to optimize this plan.**

3. ***Computer Security Plan*. Before the next A-TAC Meeting, develop and document a computer security plan for the accelerator network that makes the appropriate compromises between security and enabling operations and development. Then use it.**

ATAC05 agenda (plan1), 2005.2.14 (K. Hasegawa, Y. Irie, S. Machida)
Seminar room at Building #4, KEK

2005.2.24

9:00-9:20	Project status		S. Nagamiya
9:20-9:40	Executive session		
	Machine status		
		Linac	
9:40-10:00 (20)		Status of components	K. Hasegawa
10:00-10:20 (20)		Status of building and installation schedule	N. Ouchi
(coffee break)			
10:40-11:10		DTL beam commissioning results	Y. Kondo
		RCS	
11:10-11:40		Status of components	M. Kinsho
11:40-12:00 (20)		Charge exchange foil	I. Sugai
(lunch break)			
13:00-13:20 (20)		Status of building and installation schedule	H. Suzuki
13:20-13:50		Non-linear effects in the RCS	H. Hotchi
		MR	
13:50-14:20		Status	H. Kobayashi
(coffee break)			
	Baseline update		
14:40-15:10		MR harmonic number	H. Kobayashi
	Beam instabilities		
15:10-15:50 (40)		Impedance and instabilities	Y. Chin
15:50-16:20		Electron cloud	K. Ohmi
(coffee break)			
	Beam loss		
16:40-17:10		Linac and L3BT	M. Ikegami
17:10-17:40		Loss budget in rings	S. Machida
17:40-18:00 (20)		Slow extraction	M. Tomizawa
18:00-19:00	Executive session		
19:00-20:30	Reception		

2005.2.25

	Control, instrumentation and commissioning		
8:30-9:00		Beam profile monitor in rings	S. Lee
9:00-9:30		Beam position monitor in linac	S. Sato
9:30-10:00		Feedback and feed forward	F. Tamura
(coffee break)			
10:20-10:50		AC line locking	F. Tamura
10:50-11:20		High level application program	H. Sako
11:20-11:50		Maintenance of high radiation area	Y. Shirakabe
(lunch break)			
12:50-13:30	(Tour of KEKPS: optional)		
13:30-19:00	Executive session		

2005.2.26