Report of 1st Meeting of the Accelerator System Advisory Committee
10-11 October 2006

Present:
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G. Decker, APS
D. Einfeld, ALBA
P. Elleaume, ESRF, Chairman
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D. Rubin, Cornell
R.P. Walker, Diamond

Excused:
J. Galayda, SLAC

The committee is very impressed by the progress made and by the team spirit which is expressed by all the staff. The project dynamics is clearly taking place and we encourage to keep it and develop it further. Indeed the project is already quite advanced and in many areas detailed design has started. The project teams appear to be quite aware of the experience developed at other facilities.

The proposed storage ring and injector is consistent and constitutes a build able design with manageable risk. It is based on existing technology worldwide. The main new feature is the use of damping wigglers to reduce emittance, which is not considered as a risky issue, and is also being adopted for the upgrade of PETRA in DESY. The recommendations given below are directions to be explored for enhancing the performance of the NSLS-II facility.

Storage Ring Lattice

The proposed lattice looks robust and is in a advanced stage of design. The committee agrees on the requirement of a large circumference in order to reach the target low horizontal emittance. Potentially important show stoppers like intra- beam scattering have been addressed. The committee encourages the project team to review the lattice in the following directions:

- Discuss with the users the possibility of having smaller horizontal beta in some Insertion Device (ID) straights. It appears that a factor 10 reduction in horizontal beta should be possible and could have a dramatic impact on the micro-focusing beamlines, resulting in an image size a factor of 3 smaller.

- Increase the length of the space available for Insertion Devices. There are several roads that could be explored. One is to add short ID straight in some achromats with mini vertical beta, which will be ideally suited for high energy in-vacuum undulators with the ultimate smallest magnetic gap. Another one is to consider

changing the quadruplet upstream and downstream of the ID to a doublet. In this respect there exist 3 GeV light sources which accommodate the variable extra focusing from IDs by retuning only a doublet.

- Explore a more advanced and innovative design for the bending magnets with variable field along the length. We take note that, as has been presented in the presentations, to minimize horizontal emittance and energy spread while keeping RF power under control a low field has been selected for the bending magnets. Such low field dipoles with zero input dispersion could be redesigned with sections with higher and lower field with the objective of further reducing the emittance or saving circumference for a given emittance. This concept has been visited by several people in the past but never really implemented because the magnet design is generally too close to saturation. It is the opinion of the committee that the proposed lattice design of NSLS-II meets the best conditions to succeed in this direction.

The committee recommends to look at a larger energy acceptance beyond the proposed 3%.

In view of the small emittance, the issue of beam stability has been recognized by the team as critical. A number of concepts for beam position feedback were proposed. The committee would advise the team to concentrate on SVD-based global feedback with a variable number of eigenvector corrections in order to minimize the miss-steering from malfunctioning beam position monitors. The committee discourages the use of multiple local feedback systems which may drive unstable orbit oscillations due to non-perfect closure of the bump as a function of frequency. The issue of integrating x-ray beam position monitors in the loop should be carefully addressed in view of the large variety of IDs and the dependence of the position on ID gap which can be a complicated issue with EPU type IDs. It is also suggested to have, in the baseline machine, regular Beam Position Monitors (BPM) at both ends of every ID straight section, rather than to wait for the progressive ID installation.

An optimization of the non linear lattice as well as the study of a number of lattice error have already been performed. Such studies may have to be restarted if the linear lattice is changed (as suggested above). Simulations of lattice errors will need to be further developed including multipole magnet errors and coupling errors. It is recommended that injection efficiency studies continue with all field errors from the lattice as well as IDs with their reduced gap, nominal focusing and their associated multipole field errors, in order to verify the chosen beam stay clear apertures. A complete set of field quality specifications for the ring magnets and insertion devices should be developed early in the project, to be coupled with a magnetic measurement plan for quality assurance.

Considering the rather weak effect of extra damping wiggler above an initial number of 5 or 8, the committee is not convinced of the need of adjustable damping wigglers to compensate for ID gap configuration. In addition, an adjustable damping wiggler used in this way would be of limited use as a source for an x-ray beamline.

The committee takes note that the limited budget and resources may not allow the commissioning to take place with the full complement of damping wigglers and RF stations. The assumed number of damping wigglers and the associated lattice damping times were not consistent among the various presentations. The committee encourages the project team to clarify this point in a consistent fashion, with the goal of developing a baseline design with an horizontal emittance close to 1nm.

Conventional Facilities

No major concern on the proposed building infrastructure has been identified except some worry concerning the occupation of components in the tunnel and specifically the placement of the booster hanging from the ceiling above the storage ring. The main worry is the installation and servicing of the beamline front-ends when the full hardware for the booster (magnet, pipes and pumps) as well as the cables and water hoses for the accelerator magnets are in place. The committee takes note that some specific slab and roof arrangements has to be provided for the RF cavities of the Storage ring and Booster

Many members of the committee have a preference for a crane and removable roof with a booster supported on the inner wall of the storage ring tunnel (as made at SLS and planned for ALBA). Such a solution will give a tremendous benefit during the installation of the ring, booster and beamline front-end as well as beamline. The committee takes note that several recent facilities with tight budget have followed this approach successfully and is therefore not fully convinced by the cost argument raised during the presentations. The committee asks the project team to revisit this issue through more detailed engineering and consider the implications of the two choices in detail (to be reported at the next meeting of ASAC).

As civil engineering is most frequently on the critical path of a project, the committee recommends implementing a staged beneficial occupancy of the building infrastructure in order to squeeze the installation time.

Only 10 to 11 people in the NSLS II project team are working on conventional facilities. This seems to be a rather low figure, as they will have to ensure tight coordination between building design and machine design requirements as both are developed.

The committee is pleased to learn that other buildings inside BNL will be made available to the project for all sort of preparation work.

Safety regulations are becoming increasingly restrictive with time. As a consequence the shielding type and thickness should be carefully studied and compared with other facilities in the world. The injection area is of particular concern and should be the object of specific reinforcement. The thickness of the ring tunnel roof must also be sufficient to allow access to equipment while the machine is operating. The committee requests a presentation on this topic at the next Meeting of ASAC.

The committee recommends the same regulated temperature in the tunnel and experimental Hall to avoid long term drift.

Injector System

The committee is pleased with the proposed design of the injector with a low emittance, low power consumption booster ring injected by a 200 MeV linac in which a possible klystron failure can be tolerated. Such a solution has shown to be very reliable and economical to operate in a number of existing facilities. The linac design looks solid and demonstrates sufficient redundancy.

The booster lattice looks robust.

The committee agrees with the proposed procurement strategy of purchasing of a turn-key system for the linac. Concerning the purchase of the booster, the committee believes that a stronger involvement of the technical staff will be beneficial and would encourage the project team to specify and purchase the booster by subsystems.

The committee requests to be presented more details about the supporting and alignment of the booster magnets.

Bending Magnet and infra-red beamlines

The committee takes note of the proposition made to satisfy the infra-red user community by collecting infra-red radiation from inside a bending magnet. The committee suggests deepening this issue and consider both the core bending magnet and edge radiation in relation to the figure of merit of the beamline (spectral flux or spectral brightness, wavelength, polarization,…). The committee does not see the opening of the bending magnet gap from 35 to 60 mm on some or all bending magnet is a critical issue. Both strategies of a limited number of bending magnet with increased gap powered by one or a few additional power supplies or all magnets with increased gap are possible and no preference for one or the other emerged in the discussions.

Collective Effects

The committee is pleased to see that collective effects are already being investigated. The committee fully agrees that the longitudinal impedance be carefully controlled to prevent energy spread increase below the single bunch current of 0.5 mA. An increase of energy spread would result in a reduced and potentially fluctuating emission on the high harmonics of the undulator radiation.

The committee encourages to further develop the study of the current threshold for the coupled bunch instability versus lattice chromaticity and determine the need or not as well as the specification of a bunch by bunch feedback.

The committee believes that the broadband impedance from the Landau cavities should already be accounted.

Mechanical Engineering and Vacuum System

The vacuum system looks safe and benefits from extensive experience at the APS. One mm clearance between magnet and chamber looks small. The committee recommends that the magnet pole tip design be reviewed to allow this to be increased, alleviating unnecessary concerns about vacuum-induced stress.

Magnet Power Supply

A sound approach is proposed. It is important to consider the integration of the corrector magnet power supplies, beam position monitors, and data networking into a high-speed global orbit feedback system at an early phase of the project.

Insertion Devices

The presentation made was an excellent overview of up-to-date technology. The program appears suitably ambitious. It capitalizes on the competence already existing at NSLS.

The committee suggests to study in detail the dynamic aperture modifications computed from the precise 3D magnet design of the IDs and damping wigglers with particular attention to the pole width.

RF System

Superconducting solutions have shown to work and meet the requirements of beam stability but are expensive. The committee suggests to watch the recent developments in term of room temperature HOM damped cavities. The committee sees limited redundancy in the proposed klystron approach. While the committee recognizes that this approach constitutes a working solution, it recommends investigating an IOT based solution which would provide more redundancy and flexibility, and for which there exist more suppliers. The committee recalled the requirement to optimize the waveguide to cavity matching under different ring current, cavity number and power conditions.

R & D

The committee supports the proposed R & D approach. It is the opinion of the committee that future upgrade of the facility will largely be based on IDs and it is therefore crucial that extensive competence is developed through R&D.

The committee suggests, as a possible R & D effort to look into the development of solid state high power RF amplifiers.

Future Upgrade

If the electron energy is planned to be raised, shielding and heat load should be specified accordingly from the very beginning.

Budget, Manpower and Planning

The 108 M$ estimated capital cost for the linac, transfer lines, booster and storage ring looks 10 to 20 % too low in comparison with recently built facilities.

The staffing also looks somewhat light. The committee takes note that the staffing and organization which were presented are the ones necessary only for the construction of the facility and not for the operation.

A total 4 years construction time is short. The committee would recommend identifying long delivery items (building, linac, magnets,..) and convince DOE to proceed with their procurement ahead of time.

The committee suggests the construction of a centralized master schedule that will be revisited from time to time as needed and will serve as a reference document for all groups participating in the project.