Summary Report of Working Group I – Circulator Accelerators

L. Teng*

Argonne National Laboratory, Argonne, IL

Working Group I was very well attended by some 60 people at the peak. The two half-day sessions were fully loaded with 16 talks. Since it did not appear possible to have scheduled time dedicated to structured "discussion" or "work," we tried to allow as much time as possible after each talk for comments and discussions. The 15 talks (one withdrawn) are widespread in subject matter and content. They can roughly be grouped into the following categories.

Projects

3-GeV Ring at the JHF	F. Noda (JAERI)
AGS High Power Upgrade Plan	W.T. Weng (BNL)
AHF Project	A. Thiessen (LANL)

Beam Studies and Simulations

High Density and High Intensity Beams at CERN-PS	R. Cappi (CERN)
Impedance Reduction in the SPS	E. Shaposhnikova (CERN)
Emittance Dilution in HERA-p	R. Wanzenberg (DESY)
Investigations of Beam Tune and Stability in the IPNS-RCS	J. Dooling (ANL)
Multiparticle Longitudinal Dynamics Tracking Code ESME	J. MacLachlan (FNAL)
UAL-Development and First Application	N. Malitsky (BNL)

Hardware (JHF and PD)

Longitudinal Dynamics and RF Hardware in JHF	M. Yoshii (KEK)
JHF Beam Injection and Extraction	I. Sakai (KEK)
High Intensity Proton Beam Profile Monitor	T. Toyama (KEK)
Proton Driver Magnet Design	F. Ostiguy (FNAL)
Dual-Harmonic Resonant Power Supply	C. Jach (FNAL)
Proton Driver Vacuum System	T. Anderson (FNAL)

Since full-length papers from the speakers will follow, in this summary I will only review some interesting features that struck my own fancy and point out some connections and similarities between the various subjects discussed.

Of the three projects reported, the Japan Hadron Facility (JHF) is the only one funded and under construction. The parameters and general features of JHF have already been reported in other sessions at this workshop. Other than aiming for high intensity, the unique feature of the project is that the utilities of the beam at each stage of acceleration (600 MeV, 3 GeV, 50 GeV) have been investigated and planned from the beginning. Thus, it will likely prove to be a very productive facility.

The planned high-power upgrades of the AGS are quite ambitious but straightforward in concept. The two stages of beam power upgrade to 0.47 MW and to 2 MW should be attainable; however, much effort and care are required.

The Advanced Hydro Facility (AHF) is actually an elaborate proton radiography facility. It consists of a slow-cycling synchrotron that provides very high per-pulse intensity. The 6×10^{13} protons/pulse in the ring are fast extracted into 12 beamlines that converge onto the target. Each beam consists of 29 bunches with 1×10^{11} protons/bunch (allowing for losses), which is adequate for one "frame" of the radiograph. As expected, this interesting machine requires several innovative design features.

A great deal of effort has been devoted to the study of high-intensity beam behaviors (emittance growths, coherent instabilities, transition crossing losses, etc.) in the CERN-PS and SPS. These are difficult measurements. The dynamic behaviors of the beam are difficult to measure, and the beam parameters are hard to control. Nevertheless, persistent and meticulous efforts have paid off. They have brought agreement between measurement and computation, thereby establishing a reliable understanding of the phenomena.

* Work supported by the U.S. Department of Energy, Office of Basic Energy Sciences, under Contract No. W-31-109-ENG-38.

In the HERA-p ring there is an observed luminosity decay due to intrabeam scattering and a factor of 6 growth in longitudinal emittance due to coupled bunch instability. On the other hand, in the Argonne Intense Pulsed Neutron Source — Rapid Cycling Synchrotron (IPNS-RCS) the longitudinal emittance is intentionally blown up using a phase shaker (scrambler) to avoid instability.

Two computing developments were reported. The long available longitudinal dynamics program ESME is now equipped with multiparticle capabilities to simulate high intensity beam motions. Both the space-charge and the beam-environment impedances can be input directly. Two interesting movies were shown, which exhibit bucket formation in beams interacting with empty rf cavities. An ambitious Unified Accelerator Library (UAL) composed of some ten programs has been compiled, debugged, and benchmarked at BNL. An initial application on the SNS ring has been successfully run.

Several hardware innovations were advanced for both the JHF and the Proton Driver (PD) projects. In the JHF 50-GeV ring we have the following:

1. Split ferrite rings are used in the rf cavities to control the Q.
2. Bipolar kickers and septa were designed for fast beam extraction and abort towards both the inside and the outside of the ring.
3. A clever gas sheet blasted across the beam is developed to use as the screen for displaying the profile of a very intense beam.

For the 15-Hz PD ring:

1. A dual-harmonic resonant power supply is designed to give a slower rise time and faster fall time.
2. To minimize the ring magnet gap, hence the size and cost of the magnet, the magnet-in-vacuum design is again contemplated. A low-temperature (150°C) bake will hopefully keep outgassing under control. The impedance of the exposed magnet laminations would be reduced by a liner or a cage structure. Thin silicon-steel laminations and multi-small-wire cables with radiation-resistant ceramic insulation and water cooling will be used for the magnets.

It s clear that for high intensity machines, beam loss is a major concern. Therefore, reliable and precise evaluation of the beam behavior based on high intensity beam dynamics is of paramount importance.