# 2.1 ACCELERATOR PHYSICS 5/9/02 1100

Steve Peggs, BNL

## Findings

Much excellent Accelerator Physics work is being performed, both on the SNS site and at the partner laboratories. The Accelerator Physics group at ORNL continues to enhance its lead role.

**At the last review it was recommended to:**

> **"Resolve how to control the halo of the beam distribution, as it emerges from RFQ, for example by putting collimators in DTL tank 1."**

Accelerator Physicists at ORNL, BNL, and LANL have made a careful simulation study of this issue, summarized in the extensive report *"Linac Halo*

*Mitigation"*. One scenario considers inserting scrapers in the first 10 empty drift tubes in DTL tank 1. A second scenario places a collimator next to the chopper target in the middle of the MEBT section. A last scenario considers optics changes in the MEBT, designed to make the beam rounder, and therefore less susceptible to the generation of halo tails.

**The report concludes that a hybrid solution is optimal, with a collimator in the MEBT chopper target box and modified MEBT optics.** Simulations suggest that this results in a 97% reduction in the halo, when nominal beam parameters are used. **This proposal has been accepted, and will be implemented** when the Front End is re-commissioned at SNS in fall 2002.

Real beam distribution measurements are becoming available, now that the commissioning of the Front End at LBL is entering its final stages. For example, the beam emittances at moderate beam currents appear to be consistent with nominal specifications.

The other recommendation at the last review was to:

> "Prepare, for Front End recommissioning at ORNL in fall 2002, a diagnostic system in the Medium Energy Beam Transport to demonstrate beam gap cleanliness, as well as to measure transverse halo."

There is a plan to put instrumented isolated scrapers in the chopper target box that. It is hoped that this diagnostic will be able to measure the beam distribution, including halo, over 4 orders of magnitude. Also present in this plan is an in-line emittance measurement device.

The interfaces between Accelerator Physics, Controls, and Diagnostics groups are strong, and are developing in a healthy fashion. This is necessary for efficient and rapid beam commissioning. The "global database" is a central repository for the well regulated maintenance of public data owned by these three groups and others, including the survey, magnet measurement, power supply, and RF groups. There are two version of this database -- "development" and "production". The first "production" release is about to take place. While it

is clear that this database will expand greatly over the next few years, the present effort is going very well.

A list of approximately 200 application codes has been generated, in the process of writing the *"SNS Commissioning Program Plan"*. The majority of these codes will be written by individuals within the ORNL Accelerator Physics group. Some scope has been transferred from Controls to Diagnostics, with the shift to "Network Attached Devices". The ORNL Diagnostic group has significant operational and physics experience. Currently there are 5.8 FTEs in the ORNL diagnostics group, 7.0 at BNL, 7.5 at LANL, and 1 at LBNL. There are 2 open requisitions at ORNL with more to come.

The Accelerator Physics, Controls, and Diagnostics groups will also be centrally involved in the full "system integration" tests that the 4 Area Managers from the Accelerator Physics group will lead. These Area Managers represent accelerator sections: the Front End, Warm Linac, Cold Linac, and Transport lines and Ring. The goal of these "dry runs" is to save precious beam-time. The philosophy is to set readiness deadlines some weeks ahead of beam, to enable the broad exercise of the next accelerator section as if it were fully operational, with enough time to fix problems before actual beam commissioning.

Remote operations proved very useful during initial MEBT commissioning, for example in debugging Network Devices, and in testing applications. Long run benefits of remote operations include the enhancement of continued long term involvement of specialists at the partner labs. For example, when the Front End is re-commissioned at ORNL the remote operations connection will work the other way around, enabling specialists from LBNL to remain closely connected.

An anomalously large spread in Transfer Functions is observed in Ring dipoles, as delivered. About 70% of this effect comes from variations in the iron, and 30% from dimensional errors. It is easily possible to correct these errors for operation at 1.0 GeV by shimming the magnets.

The neutron back scattering and RTBT aperture problems that arose since the last review have been resolved. There is now a close collaboration between ASD and XFD, enhanced by the assignation of a liaison between the two divisions. For example, XFD perform shielding calculations for ASD.

The "*Critical Decision 4 Criteria*" document includes the statement that "the SNS must have in place all capital facilities to achieve a proton power on target

of ≥ 1 MW" but goes on to state that "these tests will consist of demonstrating that particles can be stored in the accumulator ring to a level of $1 \times 10^{13}$ protons in a pulse (and) can be extracted .. and transported to the target" (et cetera). This is consistent with the."*Operational Aspects and Reliability*" white paper that describes the evolution from CD-4 to full operation over a two year period. In particular, operation at average power beyond 10 kW is only possible after the Accelerator Readiness Review, scheduled for 6 months after CD-4.

Many other important Accelerator Physics studies are also making good progress at ORNL, in collaboration with the partner labs. These include:

- the fate of partially chopped beams
- sources of beam loss in the linac
- linac mismatch
- missing superconducting cavity
- drift tube linac tuning results
- Ring/Target integration, aperture, fault studies, and target parameters
- collective effects and impedance budgeting
- $H^-$ laser stripping
- electron cloud code development and data analysis

## Comments

**Great advances have been made in Front End commissioning at LBNL since the last review. More realistic data are becoming available for input into halo evolution simulations, now that MEBT commissioning is in its final stages. Enhanced understanding can be gained from continued, more realistic, beam halo studies.**

**It is vital that the accelerator system groups ''buy-in'' to contributing and maintaining public data that they own, in the global database. This necessitates the full support of management, including the provision of appropriate database administration support.**

**The 4 Area Managers need adequate management support in planning and implementing broad system integration tests without beam, before beam commissioning each of the accelerator sections.**

**Other partners labs such as LANL can expect significant benefits from remote operations, and should carefully observe its ongoing use in the Front End activities.**

## Recommendations

1. **Prepare, for Front End recommissioning at ORNL in fall 2002, a diagnostic system in the Medium Energy Beam Transport to demonstrate beam gap cleanliness, as well as to measure transverse halo.**

2. **Present, at the next review, refined beam dynamics simulations down the accelerator chain, using the latest beam distribution input information from the commissioning and re-commissioning of the Front End.**

3 **Keep up the good work.**