USER FACILITY STATUS IN 1998

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During 1998, the K1200 cyclotron delivered beam for Research and Development for a total of 4736 hrs, distributed as follows: 4199 hrs for 35 PAC-approved experiments, 346 hrs for 16 short test runs and discretionary experiments, and 191 hrs for accelerator and equipment development. Included in the last category were 81 hrs for a test run to develop multihit capability for the S800 spectrograph focal plane detector and 37 hrs for deflector development. Of the 35 PAC-approved experiments, 23 used secondary beams produced by the A1200 fragment separator.

Approximately 180 scientists took part in these experiments: 45 from within the NSCL and 135 from outside. They came from 52 institutions in 14 countries. The number of foreign visitors was 48. The number of students (mostly graduate students) participating in the experiments was about 50, consisting of 20 from the NSCL and 30 from other institutions.

Besides three routine shutdowns of 17-day duration for maintenance and upgrade work, there was a five-week suspension of operation from mid-May to mid-June to install a new cooling tower plus other equipment needed to upgrade the NSCL's low-conductivity water system (described below).

The operation of the facility was generally smooth, except for three episodes of unscheduled downtime. There were two periods of unscheduled downtime in February 1998. A sudden loss of electrical power in the S800 Spectrograph vault and nearby areas during an S800 experiment turned out, after several days of diagnosing and trying to fix the problem, to be due to a bad power switch and some blown 1200-amp fuses; this interrupted operation for a week. A week later, the main helium refrigerator plugged up and the K1200 magnet warmed up extra-rapidly; coupled with some intermittent vacuum problems in the K1200 cyclotron, there was a loss of eight days for operations due to this breakdown. In late August, there was loss of electrical power to the building for several hours and the helium compressors could not operate for 7 hrs. This caused the helium dewars to run out of liquid helium and warmed up the superconducting ECR ion source. Cyclotron operation was disrupted for nearly three days.

The situation regarding the RF amplifier tubes was improved during 1998 by acquiring six new tubes, three for the K1200 and three (on CCP funds) for the K500. The K1200 presently operates with two old tubes (having about 40,000 and 50,000 filament operating hours, respectively) and one new tube. The two old tubes are long past their normal lifetime of 25,000 to 30,000 hours and could fail any time. With two spare tubes in house, the risk of serious disruption of the experimental program due to RF tube failures should be relatively small.

A theoretical study was performed to understand the relatively low (typically ≤60%) extraction efficiency of the K1200. The study highlighted the extreme importance of precise centering of the beam in the central region of the machine for achieving high extraction. Accordingly, an automatic beam centering program was written and is now being tested.

A detailed study was undertaken over the summer to identify measures which would significantly improve the reliability of facility operations. The long-term goal is to achieve about 90% reliability for coupled cyclotron facility (CCF) operation. In order to achieve this goal, the presently experienced K1200 failure rate must be reduced by about a factor of two. A significant number of improvements were identified, the most important ones being a major upgrade of the helium refrigeration system and deflector improvement. To be in place for the commissioning of the coupled cyclotron facility, most identified reliability improvements must be implemented during the 18-month shutdown, i.e. during FY2000.

Following the recommendation of the Technical Review Panel for the Coupled Cyclotron Project in July 1998, an extensive study was undertaken by NSCL staff and cryogenics experts from Jefferson Lab to determine the most cost-effective upgrade of the helium refrigeration system needed to achieve reliable CCF operation. It was decided to replace the existing refrigeration system by a plant of approximately 2 kW cooling capacity at 4.5K. A used and refurbished turbine expander system would be augmented by a contamination removal system. Two identical new compressors will allow maintenance of one compressor while running the other. Contingency in case of unforeseen significant (>24 hrs) downtime will be provided by the present Blue refrigerator which will have to be refurbished and maintained as a backup unit. The entire refrigeration system will be placed in a separate building annex. The present White refrigerator must be kept in service during the A1900 construction period to provide liquid helium for cooling of the installed A1900 magnets and to support initial commissioning activities. Upon completion and commissioning of the new refrigeration plant, the White unit and the old compressors will either be sold or stripped for spare parts and scrapped.

Implementation of this plan was started. A used plant from the Bureau of Mines operation at Masterson, Texas was moved to Jefferson Laboratory for refurbishing. The building for housing the new equipment is in the design stage. Anticipated equipment failure modes and needed corrective actions were analyzed, and cryo-system components were prioritized to minimize disruption of the experimental program. Modifications of the transfer line system, which will allow full utilization of the higher BOM plant capacity for coupled cyclotron operation, are being implemented.

A new control program for the K1200 main magnet power supply was installed early in 1998 and it worked well. It uses the same code that was created for the K500 main magnet power supply in the preceding six months. This has made it easier to maintain the programs for the two cyclotrons.

A multi-year project was initiated to upgrade the VME level of the control system to use the EPICS software. This upgrade will enable us to use the more flexible database and device grouping mechanisms of EPICS and to better integrate data from multiple sources (VME, Modicon, etc.). Additionally, this upgrade will allow us to use current generation PowerPC CPU boards, replacing our obsolete 15-year-old boards and other non-commercial boards originally built at the NSCL. Since about 100 facilities use EPICS, we will benefit from the combined effort and know-how which exist at these institutions. We have already taken advantage of this by having a staff member of the Thomas Jefferson National Laboratory come to the NSCL to install EPICS and introduce our programmers to the system.

The NSCL's processed water cooling system, used to cool the deionized water circulating in the lab's many magnets, was modernized and its capacity expanded. The previous system consisted of two (30 and 15 years old) cooling towers, two heat exchangers (one of them completely worn out), and pumps. The new system consists of a two-cell single cooling tower, one old and one new heat exchanger, and three low-conductivity-water (LCW) flow loops with capacities of 275, 400, and 300 (expandable to 400) gallons/minute, respectively. Funds for this upgrade came in part from the CCP and from a special MSU allocation. The installation work was carried out under the direction of laboratory personnel over a five-week period in May-June and has already proved its worth during the hot days of summer.

Progress was made during the year on three significant projects to advance the experimental equipment capability of the laboratory.

(a) A collaboration between Indiana University, Washington University, and the NSCL designed and built a compact, position-sensitive, high-resolution Si-CsI(Tl) array called LASSA (Large Area Silicon Strip Array). LASSA has 9 telescopes, each consisting of a single-sided 16-strip 65 μm thick silicon detector backed by a 32-strip double-sided 500 μm thick detector and four 6-cm CsI(Tl) scintillator crystals with photodiode readout. The device is geared for the investigation of isotopic distributions and two-particle correlations with high efficiency. It was used in conjunction with the Miniball/Miniwall array in a challenging set of four reaction experiments that studied isospin effects in multifragmentation and neck fragmentation in a variety of systems.

(b) The technical specifications of the position-sensitive segmented Germanium detector array (funding for which was received in the last quarter of 1997) were finalized in March 1998. This is a golf-club-shaped design with 8 segments along the crystal axis and 4 segments perpendicular to it, for a total of 32 segments. Bids were received within five weeks following this, and Eurisys Mésures of France was awarded the order. The winning bid was very cost-effective and made it possible to order 18 detectors. First delivery was promised in October, but this has been substantially delayed; the delivery still has not taken place at the end of 1998. The signals will be processed with conventional electronics, but we have left open the option to incorporate gamma-ray tracking capability by replacing the analog shaping electronics with digital pulse-shape analysis electronics when such modules will become available commercially at a reasonable cost. Currently, the design of the readout electronics and a test-stand is proceeding.

(c) Funding was received from the NSF in September 1998 to construct a 4-Tesla compact superconducting sweeper magnet for radioactive beam experiments at the NSCL. The magnet will be built at the National High Magnetic Field Laboratory (NHMFL) of Florida State University. The purpose of the sweeper magnet is to allow the measurements of the structure of very neutron- and proton-rich nuclei. The magnet will be designed for beams from the coupled cyclotron. Neutron coincidence experiments will be a major part of the experimental program and the large gap (14 cm) of the magnet will allow the detection of the neutrons at zero degrees. The magnet will be used in stand-alone mode, in combination with the Neutron Walls, and in combination with the S800/Neutron Walls.

The 24th meeting of the NSCL Program Advisory Committee (PAC-24) was held on on June 29, 1998, to consider 25 proposals for 3183 hours from 152 scientists at 40 institutions in 11 countries. The Committee recommended allocation of 1933 hours of K1200 beam time, including 60 hours of reserve time, for 15 proposals. The distribution of time was: 821 hours for experiments with outside spokespersons and 1112 hours for experiments with NSCL spokespersons. Most of the approved time (1407 hours) was for collaborations between NSCL and outside groups. The members of PAC-24 were Sam Austin (NSCL), William Friedman (University of Wisconsin at Madison), Hans Geissel (GSI, Darmstadt, Germany) Robert Janssens (Argonne National Laboratory), Witek Nazarewicz (Oak Ridge National Laboratory), and Robert Vandenbosch (University of Washington).

There will be no more PAC meetings before the planned 18-month K1200 shutdown starting around July 1999. During the PAC-23 and PAC-24 meetings, a more-than-usually strict constraint was placed on the total beam time granted, because of the need to match the approved time to the expected available time prior to July 1999. Presently it appears that, barring any prolonged breakdown, there is a good match between these two times. The plan is to start with a clean slate of new proposals for coupled-cyclotron operation in 2001.