Argonne National Laboratory's
Accelerator Experimental Infrastructure

Argonne National Laboratory is somewhat unique among the Office of Science National Laboratories in that it possesses active accelerator programs funded by HEP, NP, and BES, as well as some activities funded by other sources. Over the years each of these Argonne divisions has developed unique capabilities associated with their primary mission for the Office of Science. We have gathered the information requested by HEP from each of these divisions and therefore present it along these lines. Internal to Argonne we do attempt to work across these boundaries, and additionally benefit greatly from our multidisciplinary strengths by using expertise in other divisions, notably material science, to further accelerator R&D objectives. We touch on some of this in the following, but an understanding of the state of this work, in moving from basic R&D to applied capabilities of which industrial users could benefit will take a longer look.

We also include capabilities at two accelerators managed by the Chemical Science and Engineering (CSE) Division. These are older accelerators, but they may have unique capabilities well matched to the needs of industrial users, and in general have time available for outside users.

Capabilities within the Physics Division (NP)

Superconducting Radio-frequency (rf) Facility at ANL

The present SRF facility at ANL includes the joint ANL/FNAL superconducting cavity surface processing facility (SCSPF) located in bldg. 208 and the rf cavity test area in building 203. The 200 m^2 SCSPF consists of a pair of Class 10 and 100 clean rooms and chemistry rooms for the electropolishing of elliptical and TEM-class superconducting cavities. The SCSPF is equipped with a high-pressure water rinsing (HPR) system and an ultrasonic bath suitable for the cleaning of any type of SC cavity. The rf cavity test facility comprises a concrete-shielded area for two test cryostats with a dedicated connection to a liquid helium refrigerator. Both cryostats can provide 4K and 2K continuous test capability. One of the cryostats is very large and can house practically any TEM-class or elliptical SC cavity known to date.

Currently, ANL plans a significant expansion of the SRF facility to include additional large clean rooms for assembly of cryomodules and for cold testing of entire cryomodules.

During the past 40 years ANL has developed efficient collaborations with industrial partners in the field of SRF. The existing and upgraded SRF facility at ANL will be available for interested industrial partners for roughly 20% of time. In addition, the SCSPF surface processing

equipment can be operated around the clock if necessary, making it available to industrial users for 20-40% of the time.

ECR Ion Sources

There are by now three ECR ion sources in the Physics Division. Two of these sources are dedicated to operations at ATLAS and the third is located in an off-line development area.

The two sources at ATLAS have been used in a number of SBIR collaborative development projects over the past ten years and are available for ion source and low-energy beam transport studies to industrial partners. Beam species of all elements (and isotopes, in principle) are available from these sources. Depending on the time requirements, the two ATLAS sources may require review and approval by the ATLAS PAC or Division management. These sources are available for only a few percent of the year (at most 10-15%).

The ECR source in the accelerator development area is somewhat more flexible in its use, but demand for time with it may require coordination with internal projects that also need it. In principle, this source is available for longer periods of time and could be used for beam tests of other equipment developed by the outside user.

Beamlines at ATLAS

The ATLAS facility has two so-called general purpose beamlines where users can install their own experimental equipment for experiments approved by the facility's PAC. Furthermore, users are welcome to use any of the existing experimental equipment at the facility, provided that their measurement has been approved by the PAC. In the past, a number of irradiations by industrial users have taken place, representing about 5% of the available beam time. These irradiations have mostly used existing target chambers and have always been carried out on a full-cost recovery basis. The facility remains available for industrial applications. The maximum usage for such applications is negotiable with management but would not be expected to exceed 10% of the available beam time.

Capabilities within the High Energy Physics Division:

The Argonne Wakefield Accelerator Facility (AWA)

Argonne's High Energy Physics Division is capable of providing electron beams with the following characteristics:

- Energy = 15 MeV
- Charge per bunch = up to 100 nC
- Repetition rate = 1, 2, 5, or 10 pps

The facility operates four L-band klystrons, and each one generates 25 MW of rf power, at the frequency of 1.3 GHz, with a duration of 10 microseconds, at the same repetition rates that the electron beam can operate (1, 2, 5, 10 pps).

Capabilities that could be made available to industrial users include an L-band rf test stand (Muons Inc. is presently using this stand as part of an SBIR project) and an L-band gun test stand.

At the conclusion of the ongoing facility upgrades, the electron beam energy will increase to about 75 MeV, and instead of single electron bunches, bunch trains of up to 32 bunches will be produced (the spacing between bunches in the train will be 0.77 ns).

The facility could be made available for use by industrial partners for roughly 20% of the time, without a major impact on the research program carried out at Argonne. Effort resources primarily limit the time available.

Capabilities at the Advanced Photon Source (BES)

The APS has two rf test stands that could be made available to industrial users approximately 20% of the time. One of these is an S-band stand, and the other provides 352 MHz from a 1-MW cw klystron.

The APS also has an injector test stand utilized to test thermionic and photocathode S-band guns. This stand could also be made available about 20% of the time.

There has been considerable discussion at various "applications of accelerators" meetings (e.g., the workshop on Accelerators for America's Future) on including the industrial users of the Office of Science light sources as an industrial application of accelerators. We do consider them as such and, for industrial collaborators who would like to use the APS, you are directed to the "APS Industrial User Portal" at http://www.aps.anl.gov/industry/.

It is beneficial to point out that the capabilities of the APS can be used to further accelerator R&D. For instance, we have used the APS to characterize experimental SRF surface properties and photocathode R&D. In particular, any material issues of the sort that the APS is suited for can be addressed at our beamlines. Industrial users can have access to these capabilities through our normal beamline proposal process.

Capabilities at CSE Accelerators

Linac: Accelerator Infrastructure

The Linac housed in building 211 at Argonne is an L-band (1300 MHz) linear accelerator with a maximum transient energy of 58 MeV. The transient-mode pulses are 30 ps, 4 ns, 6 ns, 8

ns, 10 ns, 20 ns, 40 ns, and 100 ns. Steady-state pulses are continuously variable from 200 ns to 5.5 µsec. Peak currents are approximately 1000 amps for the picosecond pulse. The maximum repetition rate is 240 Hz. The accelerator consists of a high-voltage high-current gun, a 1/12 harmonic buncher, two pre-bunchers, a main buncher, and two accelerating cavities. The accelerator section is followed by a transport system that includes magnets, beam switches, a kicker magnet and the appropriate steering and focusing components.

Linac: Associated Experimental Infrastructure

Adjacent to the Linac is a room in which several adaptable beamlines have been assembled. Provisions for flux measurements and beam diagnostics have been made in the facility. A wide variety of both solid and liquid targets have been designed and manufactured and can be accommodated using either liquid or gas cooling. The facility is specifically designed and suited for materials irradiation and subsequent chemical characterization. A lead-shielded cell and several glove boxes allow for handling and analysis of a wide variety of activated and radioactive materials. Significant expertise exists in designing, building, and operating equipment for remote analysis of irradiated materials.

Linac: Current Applications

Argonne's Linac is currently used for the study of medical radioisotope production methods. In particular, several accelerator-based technologies for the commercial production of ^{99}Mo are being researched and developed. Methods using solid Mo and U-bearing solution targets are currently being demonstrated and optimized. In addition, the Linac is utilized in a project to develop technologies for the production of ^{67}Cu using a solid Zn target.

Van de Graaff: Accelerator Infrastructure

The Model KS Van de Graaff accelerator housed in building 211 at Argonne is designed to produce electrons at energies from 2.0 to 3.0 MeV and will produce a stationary beam to a beam scanner or target of from 1.0 microampere to 1.0 milliampere.

Van de Graff: Associated Experimental Infrastructure

Argonne's Van de Graaff facility is designed and suited for materials irradiation, radiolysis, and radiation damage studies.

Current Applications

Argonne's Van de Graaff accelerator is currently used to study (1) radiation damage to experimental materials and equipment needed for medical radioisotope production research at the Linac and (2) effects of radiation on aqueous solution chemistry. Any devise or material to be used in a Linac experiment must first be exposed to radiation using the Van de Graaff. This allows estimation of expected lifetime under Linac irradiation conditions. Additional studies are being done to understand the chemical behavior of solutions during and after irradiation.