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Heavy ion physics

D. M. Lazarus

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Collider Accelerator Department
Brookhaven National Laboratory

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Alternating Gradient Synchrotron Department
BROOKHAVEN NATIONAL LABORATORY
Associated Universities, Inc.
Upton, New York 11973

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Heavy Ion Physics with the AGS competes with the conventional High Energy Physics program (A=1 physics) in three general areas: (1) running time, (2) experimental floor space, and (3) personnel or money, which are to some degree equivalent.

1. Of the three areas of competition, running time is the most serious. In FY84 we were shutdown for less than three months. In FY85 we plan to be off for less than two months. In reality the periods of non-operation are shorter still inasmuch as the AGS startup begins two to three weeks before scheduled operations and an even longer period is required by the Experimental Areas Group for turning on magnets and power supplies along with checking out water systems, protective circuits and security systems. Maintenance, AGS improvements and experimental construction also require AGS downtime.

At present there are four incompatible modes of operation: SEB, FEB with the narrow band neutrino beam, FEB with a wide band neutrino beam, and polarized protons. At least a month of polarized protons commissioning will be necessary in FY85 and a similar investment of time is anticipated in FY86 for heavy ion injection, acceleration and extraction studies, thereby eliminating all time that would be used for maintenance and improvements.

2. The presently approved heavy ion program includes only one large experiment (E802) approved for 1000 hours and a number of short nook and cranny experiments. Experiment 802 is likely to be installed in B1, a high energy unseparated beam that is the only high quality test beam currently available at the AGS. For the first round approvals for research with heavy ion beams, B1 will have to be upgraded to 28 GeV/c and test beam activities diverted to B4, which has a maximum momentum of 9 GeV/c. This branch of the Medium Energy Separated Beam would then be lost to High Energy Physics unless a new test beam area was to be developed, e.g. at I-10, at several million dollars cost. This impact is minimal. The conflicts become serious when additional large heavy ion

research programs are approved, e.g. Lissauer's Coulomb excitation of high isospin states, "isofreaks," or Igo's di-lepton spectrometer. Serial scheduling of experiments of this magnitude in one beam with only five to ten weeks of running available each year would quickly produce a five year backlog. This would not result in a physics program that would justify the cost of bringing heavy ions to the AGS and user interest would atrophy.

Experience at the Bevalac indicates species contamination problems associated with splitting heavy ion beams and experimental incompatibility arising from varying heavy ion species requirements has led to a policy of running only one experiment at a time. In addition, the requirements of the radiotherapy program limit physics runs at the Bevalac to nights and weekends also enhancing the climate for serial, fast turn-around experiments.

The program at the AGS would presumably be driven by physics that would require the highest nuclear densities and the demands would likely be for the highest energy, the largest atomic number A or, for that matter, the highest nuclear charge as in the Lissauer experiment rather than for a great variety of species as has been the case in studying the systematics of nuclear structure at lower energies. Small, fast experiments will still be carried out but they are not likely to be the main thrust of the program.

The problem of splitting the beam while maintaining the purity of species can be approached with large magnetic field gradients and good collimation which would waste beam, but the AGS is likely to accelerate far more heavy ions than the experimental program can readily digest in a one to three second spill.

The only beams available that could easily be made to transport the maximum energy available are Al, A3, B5, Dl, and C3 in addition to Bl. Al goes to the MPS and is not now shielded for high intensity ($> 10^6$/second) running. A3, B5 and Dl have several years of scheduled experiments. A realistic plan for a major commitment to heavy ion physics would begin with one major experiment running with smaller or shorter experiments running parasitically or serially. Further development of the experimental program might entail splitting the heavy ion beam among Bl, C3 and a branch behind the D target which is presently designed to dump the primary beam downstream of Exp. 777. Should further growth be necessary, the area behind the D2, D4 and D6 experiments could be developed into a new experimental area. The present building is not large enough to house new large experiments and an extension of the building with crane coverage and services may become necessary in time.

3. Assuming funds to provide electronics, special magnets, AGS vacuum upgrade, new instrumentation and other easily identifiable capital equipment as well as electric power costs comes from the nuclear or intermediate energy office of the DOE, high energy funds still pay the salaries

of riggers, surveyors, safety and maintenance personnel, engineers, physicists and some of the people who spend their time on task forces. The radiation burden attendant on switching from one mode of operation to another, e.g. running vacuum through target station areas as well as the expanded responsibility for a larger and more diverse program with an already overburdened staff cannot fail to have a significant impact.