STATUS REPORT ON THE ATLAS SUPERCONDUCTING LINEAR ACCELERATOR

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Summary

ATLAS, the Argonne Tandem-Linac Accelerator System, is a project to upgrade the existing Argonne superconducting linac heavy-ion booster which began providing beams of heavy-ions for experimental nuclear research in 1979. When completed ATLAS will provide beams of heavy ions up to approximately mass 130 at energies as high as 25 MeV/A. The construction of ATLAS is approximately 60% complete. First beam from the accelerator is expected in spring of 1985.

Introduction

The ATLAS construction project is a multifaceted undertaking consisting of the following major subsections:

a. Expansion of the existing superconducting linear accelerator from the present four cryostats to a total of seven containing a total of 42 accelerating resonators.

b. Construction of a new 300 kv ion-source injector for injecting the tandem preaccelerator.

c. Provision for the splitting of an adjacent charge state from the main beam for a simultaneous parasitic experimental program in the existing target areas.

d. Construction of a new experimental hall, accelerator tunnel, and data-acquisition room for the experimental program which the accelerator will support.

The overall floor plan of the facility is shown in fig. 1. The energies of heavy ions available initially from ATLAS are plotted in fig. 2 as is the expected performance of the facility when the accelerator is fully operational.

The superconducting-linac heavy-ion booster which forms the basis for ATLAS was constructed as a prototype development project with the ATLAS accelerator in mind. As such the superconducting linac became the first accelerator to successfully accelerate heavy-ions using superconducting technology. The linac booster continues to provide beams to a regularly scheduled heavy-ion physics research program during the present construction phase of ATLAS. Through April, 1984 the facility has provided 15000 hours of heavy-ion beams for the experimental program. The operating experience obtained from this endeavor has shown the superconducting and cryogenic technologies employed in this project to be extremely reliable. The development of a highly automated computer control system for the linac has allowed the facility to maintain a high degree of user operated features. The design of the accelerator based on short, single cavity, three-gap structures which are independently phased has also proven to be invaluable in maximizing the linac operation. The details of the present prototype linac were reported to this conference in 1981[1] as well as references therein.

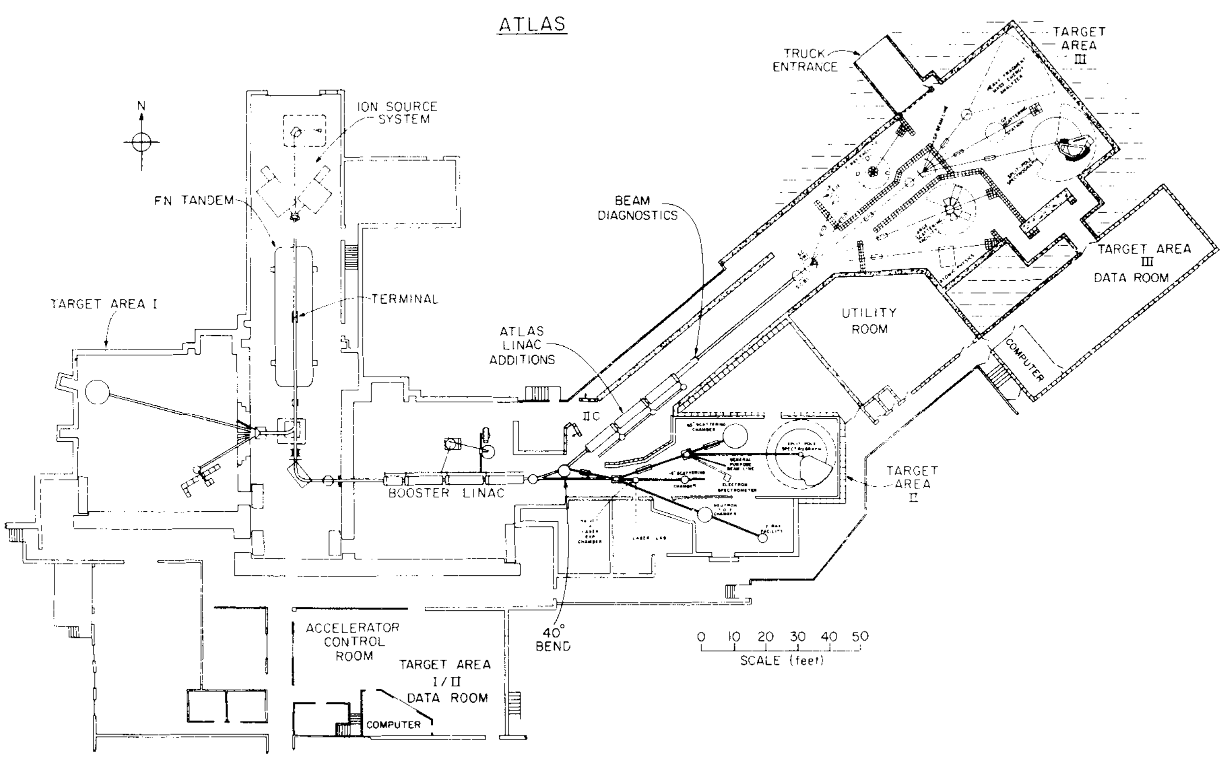

Fig. 1 Floor plan of ATLAS accelerator system.

Project Status

Resonators and Cryostats

The expansion of the accelerator will consist of the addition of three cryostats containing a total of 18 resonators and 9 solenoids. The new resonators will consist of 9 "high beta" resonators identical to the last 13 resonators in use in the present linac booster. These resonators will be placed in the first nine positions of the expanded accelerator which follows the 40 degree bend region, shown in fig. 1, filling the first cryostat and half of the second cryostat.

The construction of the first of the new cryostats is complete and has been fully outfitted with resonators and solenoids. The completed cryostat has been installed on line and is presently being used in the normal operation of the linac booster. This "test" cycle has shown it to be fully functional.

The last nine resonators are of a recently developed type which operates at a freqeuncy of 145.5 MHz and has a matched velocity of 0.16c.[2] The prototype unit for this class has been tested to an accelerating field of 3.9 MV/m at a power into liquid helium of 4.0 watts. By choosing to go to a resonant frequency of 3/2 the present frequency of 97 MHz, it was possible to design the new resonator using the same outer housing and changing only the internal drift tube structure. This choice minimized the stored energy in the resonator and allowed the existing resonator control system to be used with minimal alterations. Both design and tooling costs associated with this new design were also kept low.

Construction of the two remaining cryostats is well along. All cryostat subassembly construction has been completed for both remaining cryostats and assembly of the second cryostat is nearing completion. The installation of resonators and solenoids into the second cryostat should be completed by June, 1984. Final assembly of the third cryostat is expected to be complete by November, 1984.

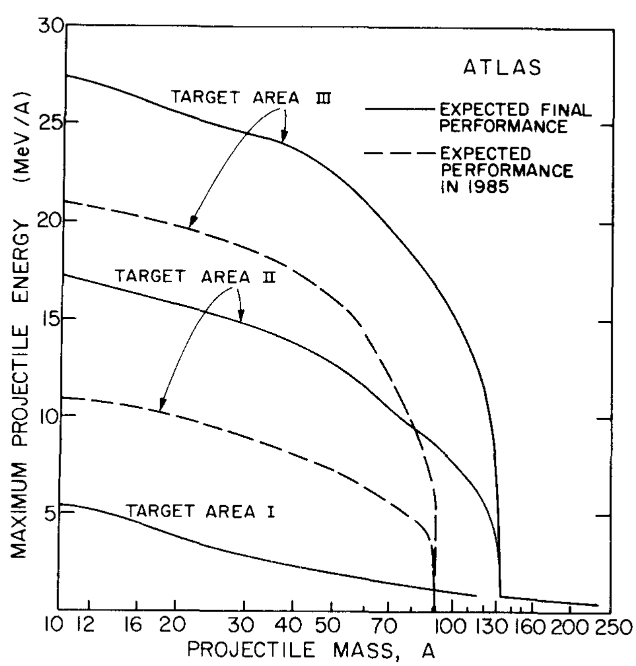

Fig. 2 Maximum beam energies available from ATLAS.

Ion Source

The existing tandem-linac accelerator system can be operated using either of two ion-source injectors. Beams from these sources are preaccelerated to a maximum of 165 keV and analyzed with a 40 degree bending magnet. The mass resolution of the system is approximately 1 part in 40. This injector system has serious limitations in separating isotopes of heavier ions. In addition, a higher injection energy would be desirable for improving beam bunching and transmission of these ions.

These problems for heavier ions are being addressed by the construction of a new ion-source injector which will have a mass resolution of 1 part in 300 and an injection energy of 300 keV. The location of the injector is shown in fig. 1. A high voltage isolation platform of dimensions 10 ft. x 13 ft. will contain the ion source, associated electronics, and a double-focusing 90 degree analyzing magnet corrected to second order. The mass analysis will be accomplished at an energy of 30 to 50 keV prior to the final acceleration of 250 keV.

The injector platform and high voltage power supply have been fully specified and bid solicitation is in progress. Specifications for the other major components are now being finalized. The target date for operation of this new injector is May, 1985.

40 Degree Bend Region

The present linac booster is joined with the expanded ATLAS linac by a region which directs the beam through an approximately 40 degree bend. This bend region was necessary due to the geographical facts of the area and to avoid disruption of the research program in the existing target area. Certain useful features are also realized by the existence of this region. The region provides an intermediated diagnostic location which allows the accelerator tune to be monitored up to that point. Another important benefit which results from this design is the ability to provide a secondary beam to another experimental area as well as the ATLAS experimental hall.

Prior to the acceleration by the linac booster, the heavy-ion beam from the tandem pre-accelerator is stripped to a higher state by a carbon foil. The stripping process produces a distribution of charge states about the charge state chosen to be accelerated by the linac. Because the linac operates in the phase focusing mode, other nearby charge states are also accelerated to approximately the same energy as the "tuned" charge state. In the 40 degree bend region, the beam is dispersed by the first bend of 22 degrees as shown in fig. 1, and has a horizontal separation of approximately 2-6 cm from adjacent charge states at the second bend. It is possible to exploit this dispersion in order to further separate the beams using a beam splitting magnetic device and thereby provide beams to two experiments simultaneously with no loss of intensity for the primary experiment. The possibility of using a superconducting flux shield and normal magnet for such a device is discussed in an associated paper[3].

All components for the 40 degree bend region except the beam splitting magnet system are specified and under construction. Installation of the first portion of the system is planned for September, 1984.

Cryogenics

The cryogenic system used in the linac booster is a forced flow sub-cooled liquid helium system. Refrigeration for the system is provided by a CTI-1400 and a CTI-2800 refrigerator. Together they provide nearly 400 watts of cooling capacity at 4.5 degrees Kelvin. The ATLAS cryogenic system will expand on the existing facility using the same design philosophy.[5,6] Improved interconnection between the two refrigerators and the ability to isolate the new system from the existing system will provide more flexible operation.

A new computer monitoring system will also be employed which will allow better data logging and improved emergency warning features than presently available. Eventual automation of some of the system is forseen.

Computer Control System

The ATLAS computer control system is a highly automated "table driven" system which was designed initially with the ATLAS facility in mind. As such much of the control system is ready for the expanded accelerator and only a parameter table which fully characterizes the accelerator needs to be expanded to include the new components of the system.

A number of improvements in the control system are under development at this time to improve the operation, make manual adjustment more accessible, and provide better monitoring of the accelerator system by installing micro-processors which will monitor and control various major subsystems of ATLAS such as ion sources, cryogenic controls, and resonator operation. These enhancements include:

a. The central computer, a PDP-11/34, has been upgraded to 22 bit addressing and one megabyte of memory by the purchase of a "Megabox".[4] This will allow complex calculations, accelerator monitoring, and program development to occur simultaneously with little interference.

b. The linac control console will be expanded to include more knobs for manual control, control of analog signals through the computer, a touch sensitive screen for control of all beam line hardware, and a remote terminal which will be located in the new data acquisition area. The new console system will be monitored by a new PDP 11/23 which will be interfaced to the 11/34 by a DMA link and will share control of the camac highway by use of a Q-bus crate controller which will operate in the auxiliary mode.

Building

Construction of the linac tunnel and new experimental hall is complete. Contracts for the building additions were awarded in late summer of 1983 during a serious recession in the construction industry. The strong competetion for the project resulted in a contract price significantly below early estimates and made it possible to increase the size of the new data acquisition room by approximately 50% from the original design. The arrangement of the experimental areas that is being implemented can be seen in fig. 1.

The configuration of the new experimental hall has begun. Radiation shielding blocks dividing the room into radiation isolated areas have been installed. A new concrete pad for a split pole spectrograph has been poured. The base mount for a new scattering chamber is in place awaiting the construction of the chamber.

Installation of cable trays, cables, and related equipment will continue into the summer and construction of beamlines will commence in the late fall of 1984.

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