Proposed ATLAS efficiency and intensity upgrade

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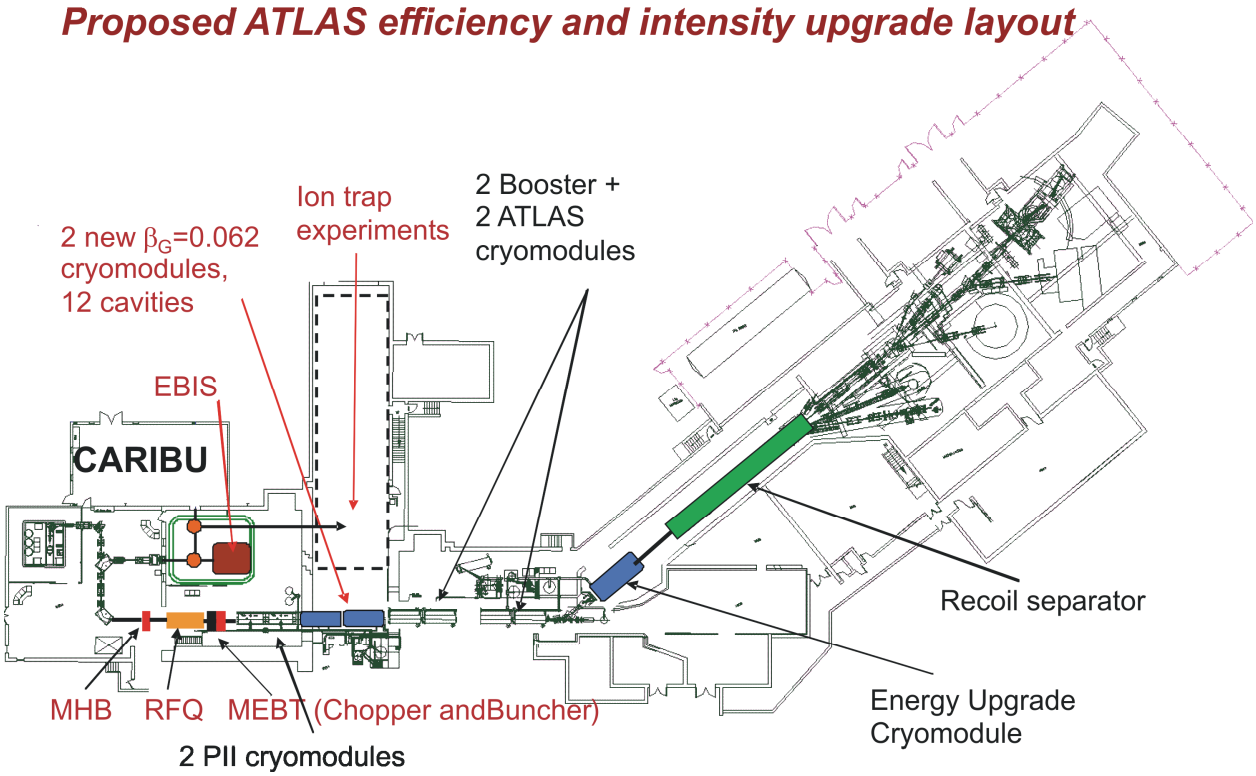
The ATLAS facility is on a constant quest to improve and increase the capabilities it offers to its Users. ATLAS currently provides beams of essentially all stable isotopes at energies in the vicinity of the Coulomb barrier. These can be used in conjunction with a suite of state-of-the-art instruments such as Gammasphere, the Fragment Mass Analyzer (FMA), the Canadian Penning Trap mass spectrometer (CPT), the split-pole spectrograph, an in-flight radioactive beam line, and the recently commissioned HELIOS spectrometer. At present, these capabilities are being augmented by (1) the addition of the CARIBU upgrade, which will provide low-intensity, neutron-rich radioactive beams from Californium fission fragments in both low-energy and re-accelerated modes and (2) by an energy upgrade, where the facility will provide mid-mass beams up to 10-15 MeV/u without stripping between the booster and the ATLAS section of the accelerator. The combination of the CARIBU source, the higher energy reach and the existing experimental equipment, including the HELIOS spectrometer, opens up exciting new programs to study the ground-state, single-particle, pairing and collective properties of neutron-rich nuclei. In combination with the on-going research programs, these additional capabilities enable the facility Users to address a broader range of the current priorities of the low-energy nuclear physics community.

In an effort to determine the additional capabilities that will allow ATLAS to best serve the field in the period leading to the Facility for Rare Isotope Beams (FRIB), it was determined from consultations between the representatives of the Users and facility management that the ability to deliver higher-intensity stable and radioactive beams at Coulomb barrier energies is a high priority. Specifically, a ten-fold intensity increase for all species (stable and radioactive), coupled with improved instrumentation, will open new venues for the study of the properties of nuclei across the periodic table, from the most neutron-rich to those along or beyond the proton drip-line or those with the highest Z. Such an upgrade is also valuable for progress in the determination of reaction rates and other nuclear properties relevant to nuclear astrophysics as well as for research in the area of fundamental interactions. Thus, this intensity increase is in line not only with the ATLAS strategic plan, but also with the priorities of the low-energy community, as expressed in the most recent NSAC Long Range Plan.

What is being proposed is a two-stage ATLAS efficiency and intensity upgrade as shown schematically on the figure below.

The *first stage* of the upgrade will replace the front end of the ATLAS Positive Ion Injector linac (PII) by a new bunching system, a Radio-Frequency Quadrupole (RFQ) and a new cryostat of resonators. A refurbishing of the ATLAS cryogenic system will take place as well. These modifications will improve the transport efficiency throughout the ATLAS system, while limiting the emittance growth for high-intensity beams so that roughly a factor of 10 higher current can be accelerated to Coulomb barrier energies. Thus, this initial phase will provide an order of magnitude gain in intensity for the stable beam and in-flight radioactive beam

experiments that can use this intensity. It will also double the CARIBU re-accelerated beam intensities because the RFQ and associated bunching systems will capture more of the ions for subsequent acceleration. This first stage of the upgrade is funded through resources made available through the American Recovery and Reinvestment Act (ARRA) for a total of $9.8M and should be completed by mid-2013.



The proposed *second stage* of the upgrade would include (1) the replacement of the CARIBU ECR charge-state booster by an EBIS breeder, (2) the removal of the tandem, (3) a reconfiguration of the main ATLAS cryostats, including the addition of two new cryostats with high-performance resonators developed recently as prototypes for FRIB, (4) improvements to the ECR sources, and (5) the installation of a large recoil separator for the in-flight radioactive beam program resulting in a better separation of the desired radioactive beam from the primary production beam. The completed upgrade will yield roughly an order of magnitude higher intensity re-accelerated CARIBU beams. It will provide stable heavy-ions over the full energy range available at ATLAS with 10-100 pμA intensities, limited only by ion source performance. Finally, it will also result in a two orders of magnitude increase in the intensity of the in-flight radioactive beams. The total cost of this second stage of the upgrade is currently estimated at 30-40 M$ and could be completed in 5 years, funding permitting.

The plans for the ATLAS efficiency and intensity upgrade are still preliminary. They represent a valuable option to optimize progress in the science to be addressed, but they are not cast in stone. Rather, they will be optimized with the input from the User community. This is a main objective of the upcoming workshop.

It is hoped that, when combined with improvements to the experimental equipment planned over the same period, the proposed upgrade will continue to provide the physics community working at ATLAS with opportunities for world-leading science with stable and radioactive beams until FRIB begins operations. In the FRIB era, the upgrade positions ATLAS ideally to fulfill its mission with unique stable beam capabilities.