KJK/Dec. 5/2002

Opportunities for Beam Physics Research at The University of Chicago

Particle accelerators are among the most powerful scientific instruments mankind has built. They are essential for advancing our knowledge about structure and interaction of matter in various states. They are becoming larger and more complex to satisfy the ever tighter requirements on the beam properties, as can be seen from the recent development in high-energy colliders for elementary particle physics and in synchrotron radiation facilities for biology and material sciences. Beam physics--study of beams in accelerators--is thus becoming more exciting and challenging as more of the subtler beam phenomena must be understood with greater certainty in order to design accelerators with extraordinary performance.

There are two major frontiers in beam physics research. In the energy frontier, the goal is to develop methods to achieve acceleration gradients far exceeding the current state of the art, a few tens of MeV/m, so that the size of future higher energy accelerators can remain reasonable. In the brightness frontier, the goal is to develop beams with smaller size and smaller angular divergence, that is, beams occupying a small phase-space volume. High brightness is important to achieve high luminosity in particle colliders and to generate high-brightness x-ray beams in synchrotron radiation facilities and free electron lasers.

Kwang- Je Kim and his colleagues at The University of Chicago and nearby institutions are pursuing beam physics research in many different areas. At the electron microscope laboratory in the Enrico Fermi Institute (EFI) of the University of Chicago a miniature radiation source is being developed based on Smith-Purcell radiation by electron beams from electron microscopes. At Argonne National Laboratory (ANL), located about 25 miles southwest of The University of Chicago, there are several accelerator facilities: the 7-GeV electron storage ring of the Advanced Photon Source (APS), which is currently one of the world's most powerful x-ray facilities, and the injector linear accelerator where a pioneering experiment on high-gain free-electron laser in the visible or shorter wavelengths has been conducted recently; the Argonne Wakefield Accelerator for developing wakefield and plasma acceleration concepts; the ATLAS accelerator; the Rare Isotope Accelerator (RIA) project for a state-of -the-art ion accelerator based of super-conducting rf cavities. Fermi National Accelerator Laboratory (FNAL), located about 40 miles west of the University of Chicago is home to the world's highest energy accelerator complex, the Tevatron for collisions of 1-TeV protons and antiprotons. Also at FNAL are smaller facilities, in particular the A0 facility operated jointly by FNAL and Northern Illinois University (NIU), where advanced accelerator concepts and beam manipulation techniques such as flat beam generation experiments are conducted. These facilities provide an excellent environment for students to pursue theoretical or experimental beam physics research.