# Industries thrive on particle beams

In a recent commentary ("Bosons and grocery bags," *symmetry* May 09), Fermilab Director Pier Oddone pointed out that most Americans don't recognize accelerators, such as those used for medical therapy, as valuable by-products of particle physics research. I would like to suggest that people are even less aware of the impact one particular class of accelerators has on the economy and on our quality of life. These are commonly known as industrial accelerators.

Industrial accelerators are charged-particle accelerators that produce beams of electrons or ions for applications other than medical treatment or basic science research. While medical accelerators have a limited range of operating parameters, the beam energies and currents for industrial accelerators span more than six orders of magnitude, and their beam power varies from a few watts to as much as 700 kilowatts, making them extraordinary versatile. They are used in a surprisingly broad range of applications, such as:

- Implanting ions in semiconductors to create integrated circuits
- Welding, cutting, and melting metals and ceramics
- Producing radioisotopes
- Analyzing trace components in materials
- Sterilizing medical supplies and foods
- Modifying glass, rubber, plastics and other materials
- Making high-energy X-rays that can penetrate thick materials to reveal flaws in rocket motors, cracks in metal parts, and contraband in shipping containers
- Generating synchrotron radiation to enable very-high-resolution observations of materials
- Generating neutron beams for looking through or analyzing the composition of materials

In fact, more than 18,000 industrial accelerators have been built over the last 50 years, with most still in use.

The production of industrial accelerators is itself a worldwide business carried out by more than 65 companies and institutes. Collectively these entities ship about 1000 systems per year and have annual revenues in excess of $2 billion. While this makes a notable contribution to both the US and world economies, even more notable is that the products produced or processed by industrial accelerators have an annual sales value of about $500 billion.

It is not only the high value of these products, but their importance to modern society that is impressive. For instance, the modern integrated circuit chips produced by ion implantation are in virtually all electronics, such as cell phones, computers, game stations, PDAs, MP3 players, etc. Modern-day reliable tires, transmission parts, and many other components of motor vehicles and aircraft are produced using electron accelerators, as are shrink-wrap packaging for food and coatings for electrical wire and cable. Electron accelerators also produce laminated surfaces for furniture and cure coated surfaces. Ion accelerators are used in the commercial production of medical radioisotopes for disease diagnostics and treatment. Accelerators also provide services for the inspection of many materials, such as for forensic science and homeland security.

*Photo courtesy of Robert W. Hamm*

Like the medical therapy systems referred to by Oddone, most of today's industrial accelerators have their roots in systems originally invented to perform basic physics research. In fact, it seems that whenever a new accelerator is invented, someone very quickly suggests a practical application for it. However, while the practical uses of a new accelerator may be explored soon after its invention, its widespread adoption as an industrial tool usually takes decades. That is why it is so important not only to educate the public on the socioeconomic benefits of accelerators, both medical and industrial, but also to make it clear that investing in basic research is absolutely essential to maintaining this country's technological and economic leadership.

*Dr. Robert W. Hamm has been an industrial accelerator physicist for more than 30 years and is currently editing a book on industrial accelerators, scheduled for release early next year.*