



Sensors

Tabletop Accelerators and Beyond

Robust, compact technology settles into the mainstream.

by Joan Zimmermann/jzimmermann@nttc.edu

A compact tabletop linear accelerator with some deep tap-roots in MDA funding has found a branch of service in numerous applications, such as neutron detection for hidden explosives, cancer treatment, isotope production for medical diagnosis, mineral and hazardous material analysis, and materials modification.

Based on a concept originally conceived in the Cold War-era Soviet Union, the radiofrequency quadrupole (RFQ) linear accelerator, or linac, was the stepchild of several collaborations, including Los Alamos National Laboratory (LANL), MDA (when it was SDIO), the Department of Defense, and the Defense Advanced Research Projects Agency (DARPA). A linear accelerator is a device that accelerates subatomic particles to very high velocities. Because of the RFQ linac's potential as a directed energy weapon, SDIO assumed partial support for LANL's work in 1984.

An unusual duo of physicists, husband and wife Drs. Robert W. and Marianne E. Hamm, worked on this project and eventually left LANL with the technology in 1985, using it to found their start-up company, AccSys Technology, Inc. (Pleasanton, CA). The company underwent some classic Valley of Death travails as they struggled to establish their products, and now their company is the world's leading commercial supplier of RFQ linacs for medical, industrial, and research applications. AccSys provides three major product lines—Pulsar™, LANSAR®, and LiNSTAR™, as well as custom systems. All AccSys accelerators feature cost efficiencies, long life, and robustness, as well as footprints that are small enough to provide a portable device for the production of radioisotopes. The Pulsar fits this latter bill and can produce ^{11}C , ^{13}N , ^{15}O , and ^{18}F for diagnostic tests. In 1994, the Pulsar became available as a component of the first mobile-unit-based positron-emission

tomography (PET) isotope production system; it is also available in more conventional hospital-based centers. The Pulsar's features make it superior to cyclotron-based systems due to low life-cycle cost, minimal space requirements, and simplicity and reliability of performance.

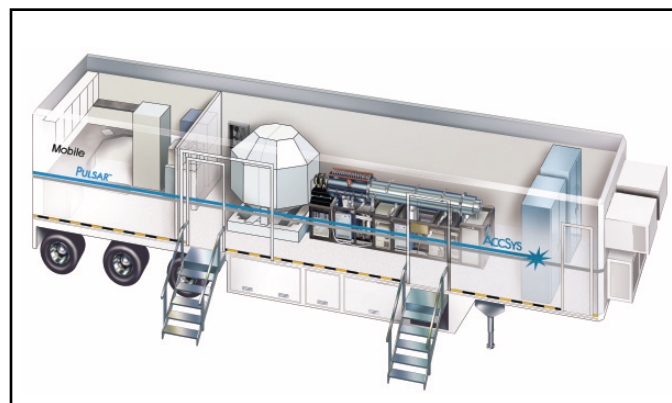
In 1989, the first LiNSTAR™ system was installed as part of the synchrotron injector system at the Loma Linda University Medical Center Proton Treatment Center. Since

then, the device has helped to generate protons for the treatment of more than 10,000 cancer patients. The synchrotron system functions 24 hours a day, 6 days a week. While still costly compared to targeted x-ray-based therapies such as conformal radiation techniques, proton therapy is useful for deep tumors, those in delicate areas such as the brain and spinal cord, and in localized cancers. Unlike x-rays, which pass through the body and scatter damage both in the path leading to the tumor

and the avenue outward, protons, which have a mass, actually stop at a certain depth and cause little damage until then. This property makes it possible for the therapist to plan treatment that leaves less collateral cell damage around the tumor site, and delivers more destructive energy to the tumor itself. The result is much less discomfort to the patient and little to no "radiation sickness." AccSys has also placed three LiNSTAR™ systems in Japanese proton therapy centers and one at the MidWest Proton Radiotherapy Institute in Bloomington, IN.

Linear accelerators can also be used for low-energy, high-current applications such as bombarding lower-quality gemstones for the purpose of cosmetic enhancement. In addition to helping enhance gemstones, RFQ linacs can be used in neutron radiographic applications for detecting them.

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▲ This mobile medical unit for providing PET scans relies on Pulsar™ linear-accelerator technology from AccSys Technology, Inc.

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In neutron radiography, the radiation transmitted through an object is detected, giving a picture much like a classic x-ray. DeBeers, a well-known diamond company that pioneered the use of radiation systems for detecting diamonds in kimberlite, a kind of “diamond ore,” made a significant discovery using an AccSys LANSAR® system developed for this application.

AccSys accelerators are compact enough to be placed in trucks at security checkpoints to detect such hazards as conventional explosives or even highly enriched uranium, which some fear could be smuggled in shipping containers at busy port facilities. Much attention has been trained on these containers, millions of which circulate the globe on ships, aircraft, rail cars, and trucks. Individual inspection of these containers at large ports and cargo transfer sites is physically and economically infeasible, thus inspectors rely increasingly on nondestructive evaluation of their contents. In neutron inspections, a substance is bombarded with neutrons, after which the bombarded material emits a pattern

of gamma (or other) radiation by which it can be identified. Other applications of note include ion implantation, a method used to dope semiconductors, harden steel, and engineer surfaces to improve their resistance to corrosion and wear.

AccSys is a private company and an affiliate of Hitachi, Ltd. The company continues to design and manufacture high-quality, commercial systems and is actively engaged with research laboratories to improve the state of the art. AccSys has designed, built, and delivered 35 linacs worldwide since demonstrating its first prototype in 1987. 

CONTACT INFO

Gerard C. Goldner

AccSys Technology, Inc.

Tel: (925) 462-6949, ext. 103

E-mail: ggoldner@accsys.com

Web: www.accsys.com

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