Abstract for a General Audience on the Dielectric Laser Acceleration Group at SLAC

Louis Lukaczyk
University of Virginia

Science Undergraduate Laboratory Internship
SLAC National Accelerator Laboratory

Dielectric laser acceleration is a novel concept which could make particle accelerators more compact and economical. Conventional accelerators based on radio frequency technology have reached a limit for the maximum accelerating gradient they can provide even with superconducting cavities. By using micro-fabricated dielectric structures and conventional high power lasers, dielectric laser acceleration is estimated to produce an accelerating gradient up to 2 orders of magnitude greater than gradients produced by conventional RF accelerators.

The Dielectric Laser Acceleration group currently uses an accelerator structure consisting of a sandwich of lithographically defined diffraction gratings. The gratings on the top and bottom have a small vacuum gap between them through which the electrons travel. The gratings intensify the electric field of the laser in the pillar region and diminish the electric field in the gap region. This is because electric fields tend to be stronger close to a dielectric. The electrons perfectly matched to the laser phase experience a strong accelerating force in the pillar region, and a weak decelerating force in the gap region. The result is net energy gain after a single grating period. Current structures are a millimeter long and consist of hundreds of grating periods.

Particle accelerators have seen widespread use in modern science and technology. Important tools powered by accelerators such as the X-ray free electron laser are enabling groundbreaking research in physics, chemistry, and biology. Accelerators are also used in the medical physics industry as radiation sources for cancer therapy. The widespread use of particle accelerators is thwarted by the size, complexity, and cost of conventional radio-frequency structures. The development of the dielectric laser accelerator could herald a new age of scientific research enabled by compact accelerator technology.

SLAC National Accelerator Laboratory, 2575 Sand Hill Road, Menlo Park, CA 94025
This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Workforce Development for Teachers and Scientists (WDTS) under the Science Undergraduate Laboratory Internship (SULI) program, under Contract No. DE-AC02-76SF00515.

SLAC NATIONAL ACCELERATOR LABORATORY
E163 DIELECTRIC LASER ACCELERATION
U.S. DEPARTMENT OF ENERGY | Office of Science
UNIVERSITY of VIRGINIA