

## Crystal Laser Wakefield Accelerator and Its Applications

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### BRIEF DESCRIPTION

The technology is a development of a more efficient particle accelerator in terms of energy, cost and space considerations. It is used in particle acceleration applications (cancer treatment, manufacture of components for electronic devices, etc.)

The technology is an ultra-compact particle accelerator and particle source. The properties include: Laser Wakefield Accelerator in a solid medium, i.e. crystal in which the Laser Wakefield by charged particle beam bunch. The driver is a high intensity pulsed x-ray. The technology applicable to electron, proton, and ion acceleration and can be used for ultra-compact particle source (neutrons, muons, and neutrinos)

### FULL DESCRIPTION

The Crystal LWFA makes use of new laser technology to drive particles in dense material. The Crystal LWFA uses Chirped Pulse Amplification (CPA) of an optical laser to create a high intensity pulsed X-Ray that drive particles in the accelerator. The high energy x-rays are so effective that the LWFA can use a medium of solid density (i.e. crystal) as its medium of acceleration. This process results in an energy gain can be up to a million times greater than with a conventional RF accelerator.

The process described above for electron acceleration can also be applied to proton and ion acceleration. A two-step method involving a radiation pressure driven injector is used to inject relativistic protons or ions into the LWFA. This technology allows for the creation and use of compact linear accelerators of protons and ions with lower energy applications. Technology that derives from the proton and/ or ion accelerators includes an ultra-compact neutron source and ultra-compact muon and neutrino sources.

In addition, beyond a certain laser intensity threshold, a highly efficient gamma ray originates from the accelerated electrons via a radiative damping process. This aspect of the technology is quite promising in its ability to be an ultra-compact, ultra-bright, and ultra-fast gamma beam source.

A unique aspect of using this ultra-intense optical laser technology is the capability to manipulate neutrons, something previously not possible. By latching on to a neutron's tiny, but finite, magnetic moment, a neutron can be "kicked" by a laser of sufficiently strong intensity. This way a cold neutron can be manipulated.

The amount of energy attainable from any particle accelerator is directly related to its size, i.e. the larger the accelerator, the greater the energy output. The rate at which accelerators have previously improved the amount of energy they can produce is likely unsustainable due to the increasing costs and scale of building successively larger accelerators.

Current particle accelerator technology is based on radio-frequency waves propagating in vacuum tubes. The accelerating gradient in RF accelerators has an upper limit beyond which electrical breakdown within the vacuum tube occurs, causing the metallic surface of the RF tube to spark and breakdown, creating plasma in the tube. The existence of this electrical breakdown effectively means that the amount of acceleration achievable over a given distance is limited and hence greater acceleration requires longer accelerators. A laser wakefield accelerator (LWFA) overcomes that limitation by using plasma as the medium of acceleration (as opposed to vacuum). An LWFA uses a laser pulse to create a charge "wake" in plasma. Particles then "ride" the wake to accelerate to great speeds. Thus, a plasma accelerator can reach and maintain a much greater acceleration gradient than a typical RF accelerator using plasma as opposed to vacuum as the medium of acceleration.

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### OTHER INFORMATION

#### CATEGORIZED AS

- » **Engineering**
  - » Engineering
- » **Nanotechnology**
  - » Electronics
  - » Tools and Devices
- » **Security and Defense**
  - » Screening/Imaging
- » **Semiconductors**
  - » Materials
  - » Processing and Production
  - » Testing
- » **Sensors & Instrumentation**
  - » Analytical

## SUGGESTED USES

» Particle acceleration applications (cancer treatment, manufacture of components for electronic devices, etc.)

## ADVANTAGES

» Potential to be up to 100,000 times smaller, 10 to 100 times cheaper and produce up to a million times more energy than conventional RF accelerators

## PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	9,839,113	12/05/2017	2014-608

## PUBLICATIONS

[Laser acceleration in novel media](#)

## LEAD INVENTOR

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