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Physicists create tabletop antimatter 'gun'

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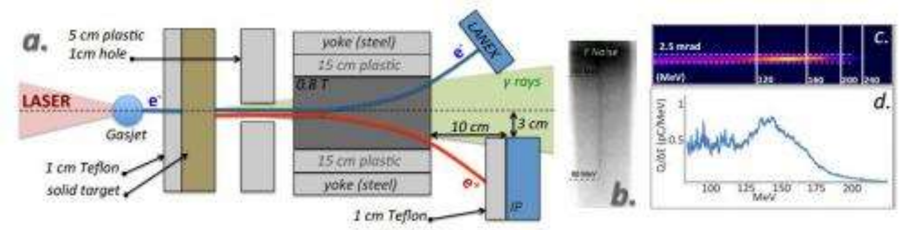

a. Top-view of the experimental setup. Plastic and Tefon shielding was inserted to reduce the noise due to low energy divergent particles and x-rays. b. Typical positron signal as recorded by the Image Plate. The region labelled with gamma noise is predominantly exposed by the gamma-rays escaping the solid target. c. Typical signal of the electron beam as recorded on the LANEX screen, without a solid target and d. extracted spectrum. Credit: arxiv.org/abs /1304.5379

(Phys.org) —An international team of physicists working at the University of Michigan has succeeded in building a tabletop antimatter "gun" capable of spewing short bursts of positrons. In their paper published in the journal *Physical Review Letters*, the team describes how they created the gun, what it's capable of doing, and to what use it may be put.

Positrons are anti-particles, the opposite twin of electrons. Besides being created in physics labs, they are also found in jets emitted by black holes and pulsars. To date, the creation of positrons for study has involved very big and expensive machines. One of those is the particle accelerator at CERN. Another is a device built by scientists at Lawrence Livermore National Laboratory that created positrons by firing a hugely powerful laser at a tiny disc made of gold. Other recent work by researchers at the University of Texas has involved building a desktop sized accelerator. This new effort builds on that work—this team has built a device not more than a meter long that is capable of generating short bursts of both electrons and positrons, very similar they report, to what is emitted by black holes and pulsars.

To achieve this feat, the team fired a petawatt laser at a sample of inert helium gas. Doing so caused the creation of a stream of electrons moving at very high speed. Those electrons were directed at a very thin sheet of metal foil which caused them to smash into individual metal atoms. Those collisions resulted in a stream of electron and positron emissions—the two were then separated using magnets.

The researchers report that each blast of their gun lasts just 30 femtoseconds, but each firing results in the production of quadrillions of positrons—a density level comparable to those produced at CERN. The researchers suggest their device could be used to mimic the jet streams from black holes and/or pulsars, hopefully offering some answers to questions such as, what sort of proportion of particles are present in such streams, how much energy is in them, and in what ways do the particles in them interact with the environment into which they are spewed.

More information: Table-Top Laser-Based Source of Femtosecond, Collimated, Ultrarelativistic Positron Beams, *Phys. Rev. Lett.* 110, 255002 (2013). prl.aps.org/abstract/PRL/v110/i25/e255002 . On Arxiv: arxiv.org/abs/1304.5379

Abstract
The generation of ultrarelativistic positron beams with short duration ($\tau_{e+} \simeq 30$ fs), small divergence ($\theta_{e+} \simeq 3$ mrad), and high density ($n_{e+} \simeq 10^{14}–10^{15}$ cm-3) from a fully optical setup is reported. The detected positron beam propagates with a high-density electron beam and γ rays of similar spectral shape and peak energy, thus closely resembling the structure of an astrophysical leptonic jet. It is envisaged that this experimental evidence, besides the intrinsic relevance to laser-driven particle acceleration, may open the pathway for the small-scale study of astrophysical leptonic jets in the laboratory.

via Synopsis

Journal information: Physical Review Letters