Reaching new heights in laser-accelerated ion energy

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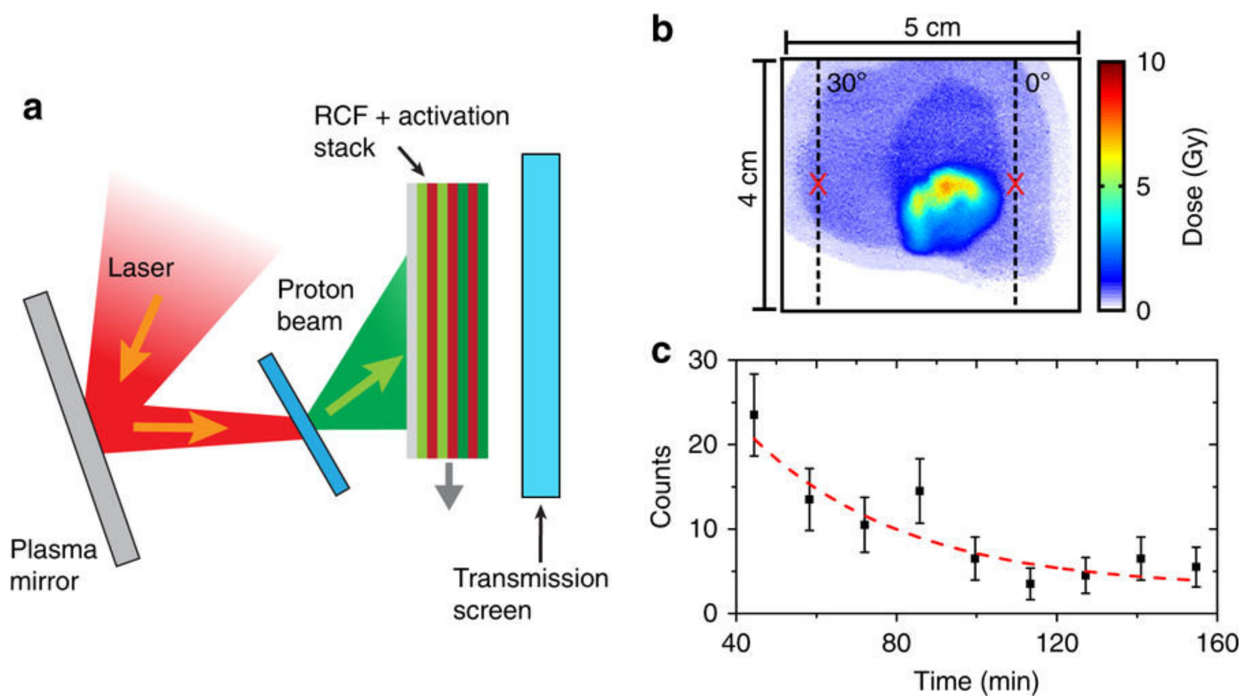

Schematic of the experiment set-up and example measurements. Credit: *Nature Communications* (2018). DOI: 10.1038/s41467-018-03063-9

A laser-driven ion acceleration scheme, developed in research led at the University of Strathclyde, could lead to compact ion sources for established and innovative applications in science, medicine and industry.

The acceleration of protons to energies in the 100 mega-electron-volts range was achieved by exciting a hybrid ion acceleration scheme in an ultrathin foil target irradiated by an intense laser pulse.

The findings of the research could have important implications for advancing smaller, cheaper, laser-driven ion accelerators and their many potential applications. The study has been published in the journal *Nature Communications*.

Professor Paul McKenna, of Strathclyde's Department of Physics, leads the project. He said: "Laser-driven accelerators have transformative potential, due to their compact nature and the unique properties of the beams of particles and radiation produced.

"A number of the promising applications of laser-accelerated ions require the ion energies to be increased. Our demonstration of high energy ion acceleration driven by a hybrid acceleration mechanism opens up a potential new route to enhancing and controlling laser-driven ion sources."

Particle accelerators have had a profound impact on science and society. They are the basis of innovative approaches to cancer treatment, are invaluable tools in materials science and biology, and are drivers for high energy physics experiments, such as those that confirmed the existence of the Higgs boson. Charged particles are conventionally accelerated in electric fields produced in radiofrequency cavities. The field strength is limited by electrical breakdown, which means that large structures are required to accelerate particles to high energies.

Over the past decade, high power lasers have emerged as a novel driver of potentially compact sources of high energy electrons and ions. Focusing the laser light into plasma produces extremely high electric fields and thus the particle acceleration occurs over a short length -

typically, about 1000 times shorter than a radiofrequency cavity accelerator for the same particle energy.

Professor McKenna said: "One of the main challenges in accelerating ions using intense lasers is that the ultrafast processes occurring over the short duration of the laser pulse can make it difficult to optimise an individual acceleration mechanism. However, as shown in our research, this can also give way to the development of hybrid schemes involving two or more acceleration mechanisms, which can enable additional degrees of control on the final ion beam properties."

More information: A. Higginson et al, Near-100 MeV protons via a laser-driven transparency-enhanced hybrid acceleration scheme, *Nature Communications* (2018). DOI: 10.1038/s41467-018-03063-9

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