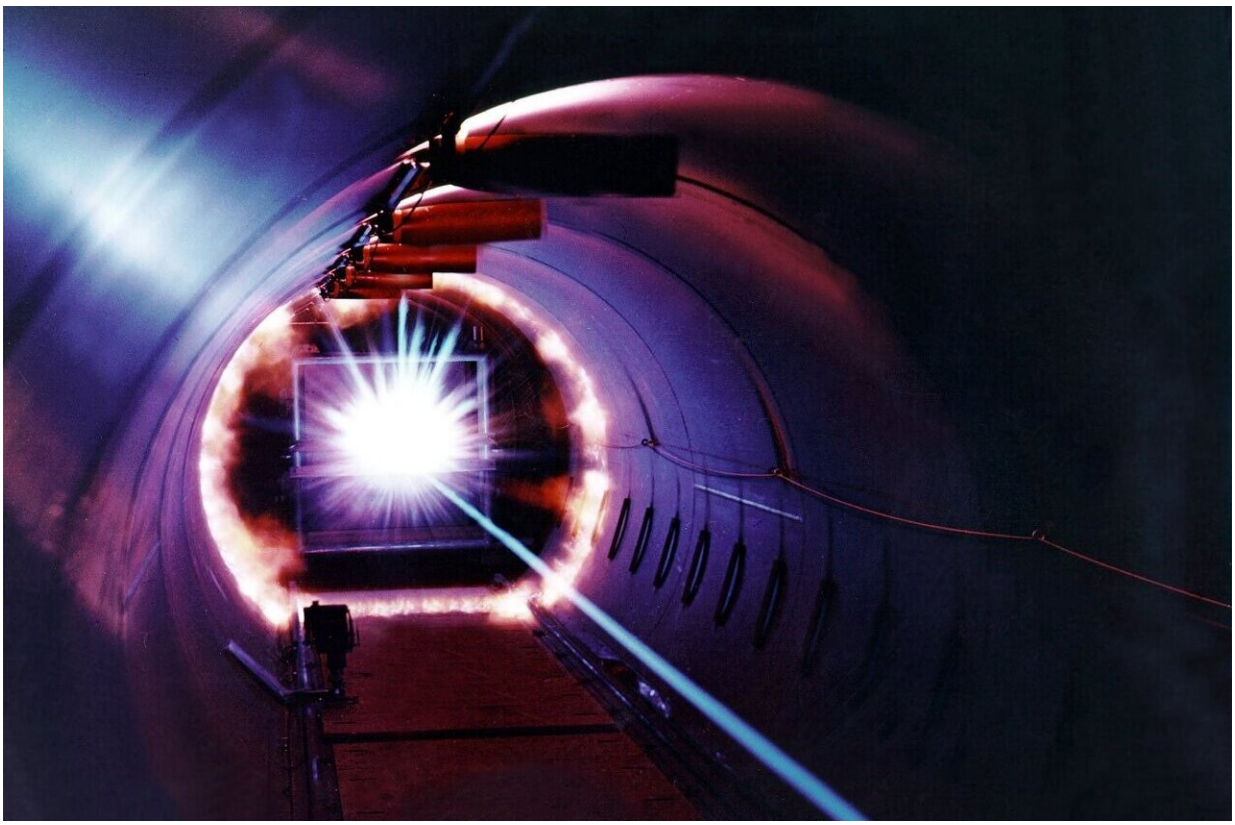
Creating surface plasmon polariton amplification using free-electron pumping to build a new kind of laser

November 10 2022, by Bob Yirka



Credit: Pixabay/CC0 Public Domain

A team of researchers at the Chinese Academy of Sciences working with a colleague from ShanghaiTech University and another from Zhangjiang

Laboratory, has developed a new way to make a laser with light in a wide range of wavelengths.

In their paper published in the journal *Nature*, the group describes their new laser and the ways it can be controlled. Nicholas Rivera from Harvard University has published a News & Views piece outlining the way conventional lasers work and the technique developed by the team in China. The team at CAS has also posted two papers on the academy's website outlining the work.

As Rivera notes, the development of the laser has had a profound impact on science research and in the development of commercial products, despite some limitations. Typically, a laser is restricted to emitting light at a given wavelength, which reduces practicality. Another type of device known as a free-electron laser overcomes this problem, but those made using the technique are bulky and expensive. In this new effort, the researchers deviated from the standard way of generating laser light by taking a new approach.

The new approach is relatively simple—light from a conventional laser is fired at an iron wire at an angle. The laser pulse lasts a short time—on the order of femtoseconds. This causes the generation of an electric field over the length of the wire, and that results in pulling electrons from the iron atoms that make up the outer edge of the wire. It also accelerates the electrons to a high speed down the length of the wire.

Under the setup, the wire serves as a source, a channel and also as an optical medium. With these conditions, the electric field generated along the wire oscillates other, more mobile electrons still in the wire, which results in spontaneous emissions that take the form of an electromagnetic wave that moves through the wire and interacts with the free electrons in each pulse. Upon meeting the end of the wire, the wave continues in the form of laser light. Control of the laser light was done using two kinds of

crystals, one terbium gallium garnet, the other zinc telluride.

More information: Dongdong Zhang et al, Coherent surface plasmon polariton amplification via free-electron pumping, *Nature* (2022). DOI: 10.1038/s41586-022-05239-2

Nicholas Rivera, Electrons turn a piece of wire into a laser-like light source, *Nature* (2022). DOI: 10.1038/d41586-022-03455-4