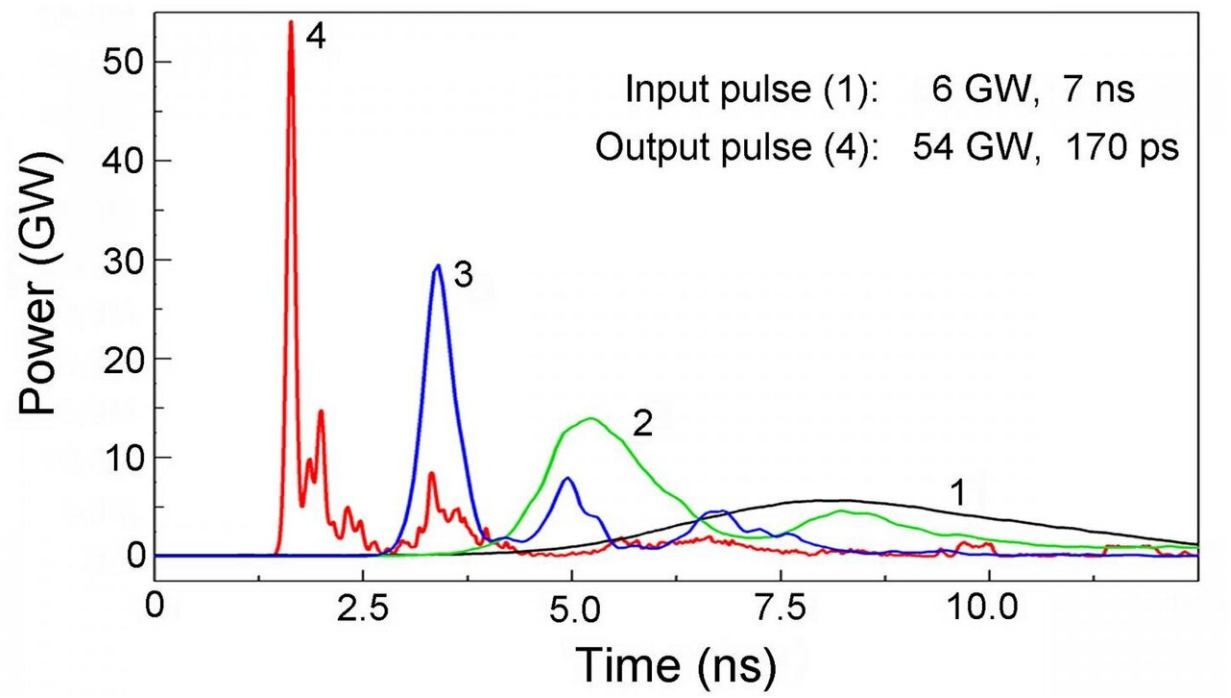
Record high values of peak power with picosecond generators

October 13 2020



Compression of the pulse over time (1 to 4) with an increase in peak power as the pulse travels along the magnetic compression lines Credit: Sergei Rukin

Powerful picosecond generators are in demand in various fields of experimental electrophysics to produce ultrashort electron beams and X-ray pulses in vacuum diodes and to form runaway electron flows in gases.

They also have applications in high-power microwave electronics, but researchers are constantly striving to obtain shorter and more powerful pulses.

In *Review of Scientific Instruments,* by AIP Publishing, scientists showed compact solid-state pulse generators could generate electrical pulses of less than one-billionth of a second in duration and up to 50 billion watts in power.

"For comparison, the most powerful hydroelectric power plant in China has an output power of 22.5 billion watts," said Sergei Rukin, one of the authors.

Improving picosecond generators and mastering higher peak power levels in the picosecond range sets the groundwork for new applications in the coming years.

"This also happened with the development of powerful nanoscecond pulsed devices during the last 60 years," said Rukin.

At first, generators with unique parameters were developed and then, application areas appeared, such as high-power microwave electronics and X-ray imaging devices for medical and engineering applications.

An input pulse of a nanosecond duration from a solid-state semiconductor opening switch generator was amplified in power and reduced in duration by a three-stage magnetic compressor on ferrite gyromagnetic lines.

The line of each stage operated in the magnetic compression line mode, which occurs at close values of the input pulse duration and the period of oscillations generated in the line.

In the picosecond range of pulse duration, record high values of peak power and rate of rise of the output voltage and power were achieved.

A surprising feature was that neither closing nor opening switches were required in the pulse compression system. The pulse amplification in power and its compression in time occurred automatically during the passage of the pulse among magnetic compression lines.

The researchers are working on an additional stage of energy compression that can be used to generate powerful microwave oscillations and to study the development of electrical discharges in various dielectric media at extremely high electric fields.

More information: E. A. Alichkin et al, Picosecond solid-state generator with a peak power of 50 GW, *Review of Scientific Instruments* (2020). DOI: 10.1063/5.0017980

Provided by American Institute of Physics