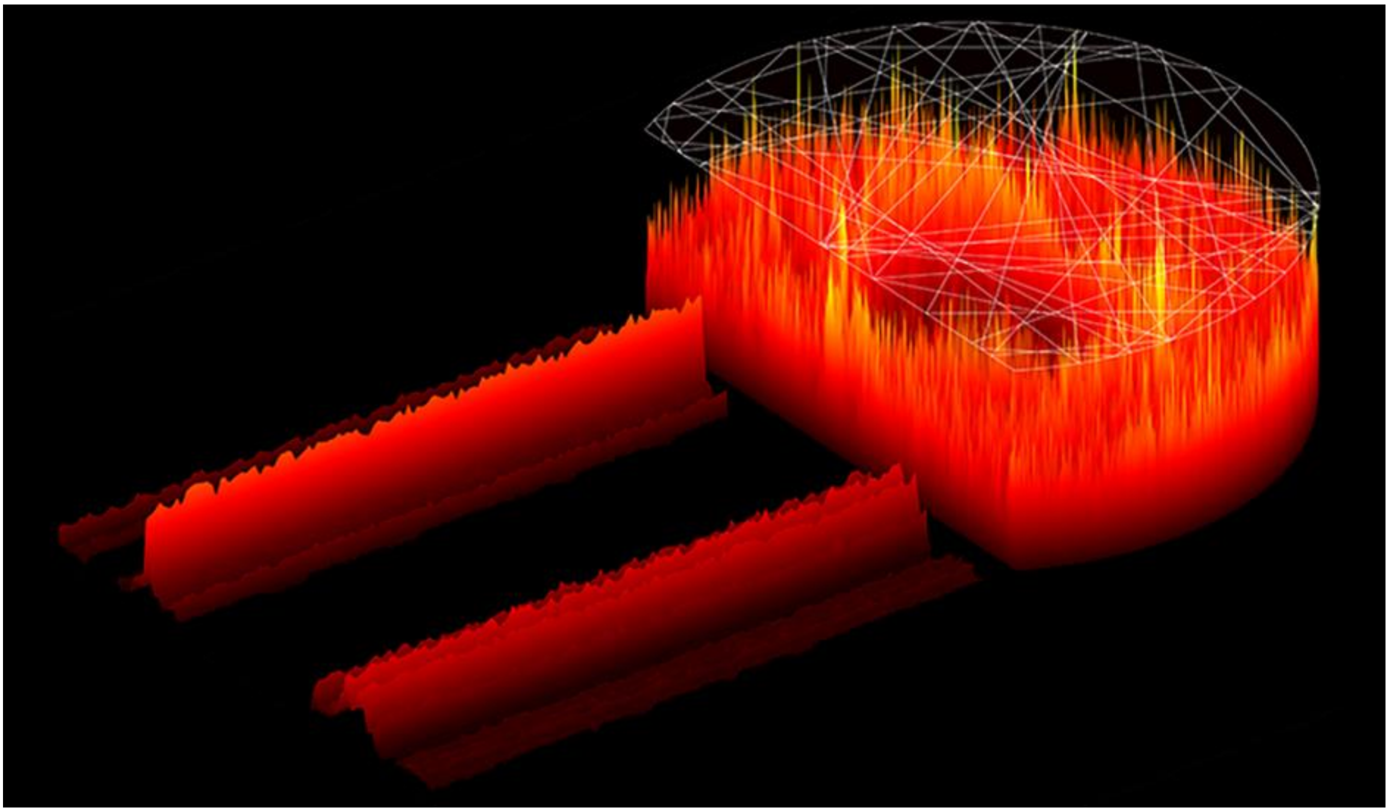
D-shaped design eradicates instabilities in high-power lasers

20th August 2018 11:12 am

An international team of scientists believes it has overcome a long-standing limitation in conventional high-powered lasers with a D-shaped laser design that limits beam instabilities.



D-shaped laser cavity tackles instability in high-powered lasers (Credit: Yale University)

High-powered lasers are used in materials processing, large-scale displays, laser surgery and LiDar, but instabilities can occur in the laser that limit their usage. This instability poses no problems for applications such as laser pointers, but becomes problematic for lasers operating at high power.

The scientists from Nanyang Technological University, Singapore (NTU Singapore), Yale University and Imperial College London and Cardiff University have developed a D-shaped laser that regulates the light emission patterns and eliminates such laser instabilities to potentially reduce the degree of fluctuations in the laser output. The team's findings are published online in *Science*.

"Traditional lasers emit fluctuations in light waves that limit their usefulness," said NTU Associate Professor Wang Qijie. "To prevent them from forming, we created an irregular-shaped laser cavity that causes light to bounce off the walls of the cavity in an unpredictable manner that however results in a stable light stream. It's like using chaos to deal with chaos."

The research was conducted on the sort of semiconductor laser found in barcode scanners and laser printers, but the team believes their findings could be extended to other types of lasers including gas and solid-state lasers.

Most traditional laser devices take on a cuboid shape, with mirrors placed parallel to each other. This allows light to reflect back and forth between the mirrors, which leads to laser instability, particularly in high-powered lasers, creating irregular peaks and troughs as light is emitted from the laser. These varying peaks could deteriorate the formation of images.

Yale's Professor Hui Cao said previous strategies to reduce interference have usually involved reducing the power of the laser. "As a result, none of the previous approaches are scalable to the power levels required for practical applications," said the Frederick W Beinecke Professor of Applied Physics at Yale. Professor Ortwin Hess, Co-Director of the Centre for Plasmonics and Metamaterials in Imperial College London, is the other principal investigator of the study.

To tackle this anomaly, Prof Wang led Zeng Yongquan and Hu Xiaonan, his two PhD students at the time, to build a D-shaped laser cavity. The NTU researchers joined the international research team two years ago.

Inside the D-shaped laser device, light is forced to bounce off mirrors along the irregular shape walls, making it travel in a disorderly manner. However, this seemingly chaotic method results in a stable pattern of light emission.

Assoc Prof Wang said imaging applications such as next-generation high-tech microscopes, laser projectors and biomedical imagery are the end goal for the joint research team.

"We have found that a D-shaped laser cavity is easy to fabricate, and is effective in significantly reducing the problematic laser instabilities. Our next step will be to find out if there are other cavity shapes that could make the laser more efficient," he said.