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Petawatt and Exawatt Class Lasers Worldwide

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An international team of scientific experts has gathered to examine the current status of ultra-high-powered lasers around the world and look to the future, to predict what the next generation of laser systems will offer[1].

The journey this review takes starts with the 2018 Nobel Prize in Physics which was awarded to Prof Donna Strickland and Prof Gerard Mourou for the development of the technique of Chirped Pulse Amplification (CPA) in 1985[2]. This seminal paper marked a significant point in high power laser development. The CPA technique would be implemented in all future ultra-high power laser systems and allow the construction of lasers which would have powers many orders of magnitude higher than previously possible.

This talk highlights many of the findings of that review looking at the historical context of this technology; the current global capability; and future developments. These ultra-high-power lasers can create some of the most extreme conditions found in our solar system, if only for a tiny fraction of a second. They are used for understanding fundamental physics and producing secondary sources such as x-rays, electrons, protons and neutrons.

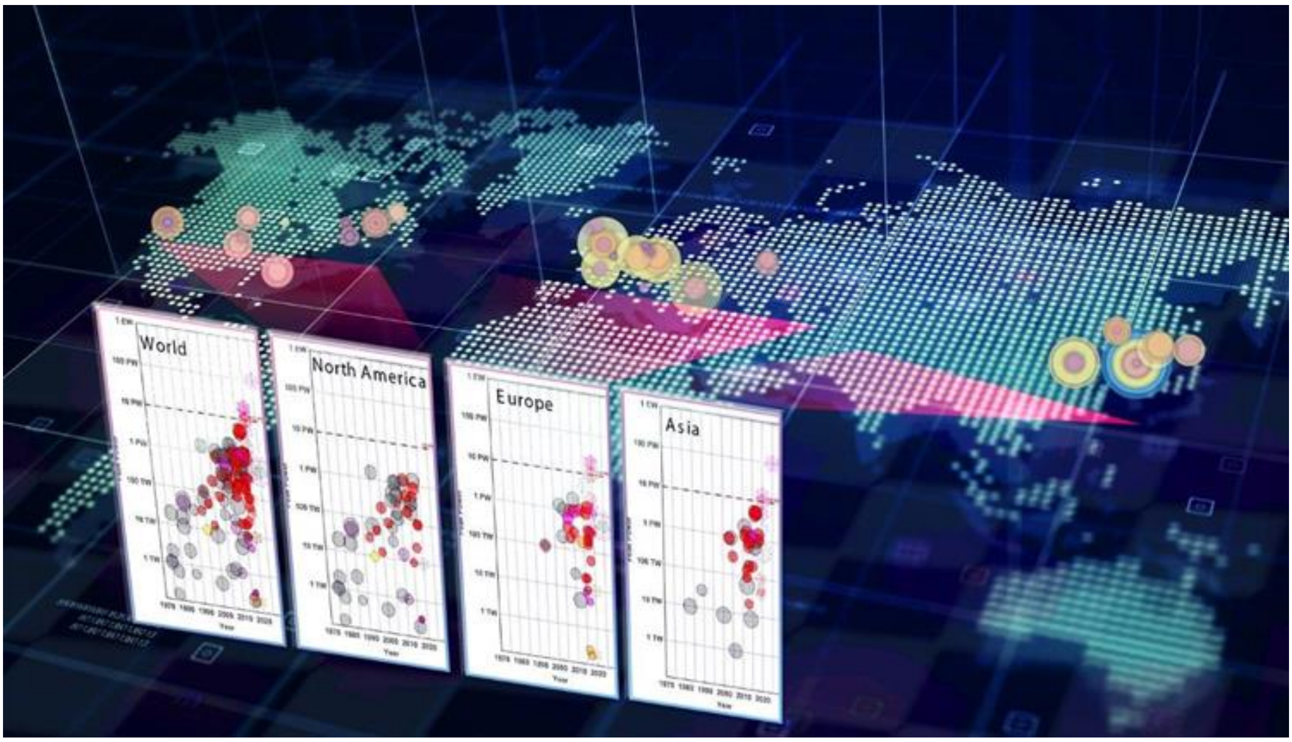
The presentation takes a geographical tour of the location of these laser facilities in North America, Europe and Asia documenting operational facilities and those under construction.

This is followed by a focus on future technologies where we have identified two main laser development streams: ultra-high-power and high-average-power systems. The first of which describes how scientists will produce exawatt class lasers, whilst the latter looks at how we can produce petawatt class lasers at and beyond kHz repetition rates.

The review then concludes with a view to the future and what grand challenges need to be overcome in order to achieve the ultra-high-power and high-average-power lasers.

References

[1] Colin Danson et al. High Power Lasers Science and Engineering Vol. 7, e54 (2019)
[2] Donna Strickland and Gerard Mourou. Optics Communications 56, 219 (1985)



Geographic distribution of high-peak-power lasers (top). The diameter of the circle is logarithmically proportional to peak laser power and circle colour is chosen for graphical clarity. Evolution of high-peak-power lasers (>100 GW) in the world over the last fifty years (bottom).