MOBILE LIDAR

# Teramobile source ready for action

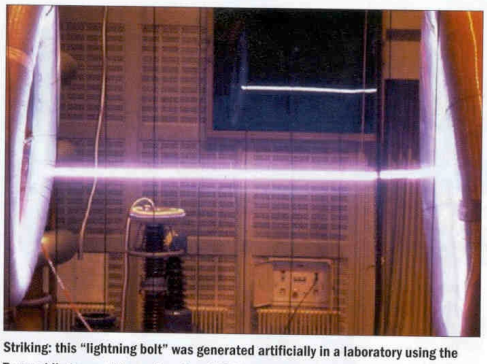
Physicists taking part in a joint German–French endeavour have developed the world's first mobile terawatt laser. "Teramobile" will mainly be used for the enhanced lidar monitoring of atmospheric gases; there are also plans to develop it as a lightning guide.

Teramobile is the end product of a collaboration between the Centre National de la Recherche Scientifique in France and the Deutsche Forschungsgemeinschaft in Germany. Four research groups based in Berlin, Jena, Lyon and Palaiseau have contributed to the development of the source.

The femtosecond-pulsed, terawatt-scale Ti:sapphire laser was built by French company Thales and can be carried between locations on a lorry. It has a peak power of 5 TW and fires ten 70 fs pulses per second. Each pulse has 350 mJ of pulse energy, centred at 790 nm. According to Jérôme Kasparian of the Lyon group, the laser can be operable within two days of transportation.

A standard 6 m long sea container houses the source, along with diagnostic equipment and systems for water cooling, vibration control, air conditioning and lidar detection. "Transportation is easy and it can operate in virtually any location, provided that a power connection or generator is available," said Kasparian.

The laser room is 2.1 m wide, 3.7 m long and 2.2 m high. "We had to develop a special design based on a T-shaped table to optimize access," added Kasparian. "Also, temperature regulation is difficult because although the volume is small, the contact surface with the outside world is huge. We resolved this problem by separating the laboratory into three compartments – a control room, a laser room and an isolation box for the power supplies. Each compartment has its own air-conditioning system."



**Striking: this "lightning bolt" was generated artificially in a laboratory using the Teramobile terawatt laser. A series of field tests to generate and guide actual lightning strikes away from areas such as airports and power plants is planned.**

The source, in operation since April this year, generates a white-light supercontinuum extending from 300 nm in the ultraviolet region to 4.5 μm in the mid-infrared. A number of important atmospheric gases – both natural and pollutant – such as sulphur dioxide, ozone and nitrous oxide absorb in the ultraviolet, while species including methane and volatile organic compounds can be detected in the mid-infrared at around 3.5 μm.

Accordingly, Teramobile will be used primarily as a lidar source that will simultaneously monitor the concentration levels of all of these gases. However, unlike existing techniques – such as differential absorption lidar – which use the Sun, Moon or weaker laser pulses as a light source, Teramobile will be able to resolve the overlapping spectra of these gases. "We will be able to obtain additional information such as the temperature [of the gas], which can be retrieved from the bandshape. By recording a wide spectrum, we should be able to deconvolute the different species and measure each of them simultaneously," said Kasparian.

The mechanism of the terawatt laser's propagation means that lidar signals are prefentially emitted in the backward direction (i.e. in the opposite direction to laser travel). This enhances the lidar signal and enables the capture of signals at a distance of 13 km.

The laser also ionizes the air as it passes through the atmosphere, which means that the "filaments" produced are electrically conducting and can therefore act as "wires". This means that the Teramobile could theoretically be used to trigger lightning bolts and guide them away from sensitive potential strike areas, such as power plants and airports.

The team's work on inducing lightning has until now been confined to the laboratory. Kasparian said: "Even without focusing the laser between electrodes, which is a more realistic configuration than has been used in similar experiments, we were able to trigger and guide discharges. The initial results seem quite promising and after some more analysis, we plan to have a campaign on a stormy site. Testing on a real site, such as an airport, golf course or vineyard, will be the third step."

**More:** www.teramobile.org

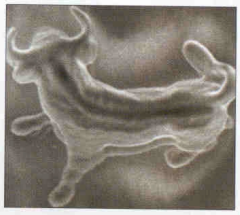
TWO-PHOTON SCULPTING

# Laser micromachines miniature bull

Satoshi Kawata and colleagues at Osaka University in Japan have created a model bull – thought to be smallest model of an animal ever made – using a Ti:sapphire ultrafast source. At a miniscule 10 μm long and 7 μm high, the sculpted bull is about the size of a single red blood cell.

The Osaka team used a mode-locked laser to fire 150 fs pulses (centred at 780 nm) at a commercially-available resin consisting of urethane acrylate. The resin is transparent to infrared light but can be photopolymerized by two-photon absorption. A fabrication accuracy of 120 nm is possible because the material is only polymerized at the high-intensity focus of the laser spot.

The group has also sculpted a spring with a spiral diameter of 300 nm – which makes it likely to be the smallest micromechanical system that has ever been created by man (*Nature* **412** 697).



**This model is the smallest bull in the world: the same size as a red blood cell.**