SCIENCE NEWS of the week

Plasma Pipe for Intense Laser Pulses

When traveling through a gas, a light beam has a natural tendency to spread out. This flaring effect steadily weakens the beam as it progresses through the medium.

One way of maintaining a light beam's intensity for longer distances is to focus the beam into an optical fiber, which confines the light and keeps the beam from broadening as it travels along the glassy strand. This solution doesn't work for intense laser pulses, however, which interact so strongly with an optical fiber that they cause the fiber's destruction.

Now, researchers have demonstrated a new technique they can use to channel high-intensity laser pulses through a gas for surprisingly long distances. "We make a transient optical fiber," says Howard M. Milchberg of the Institute for Physical Science and Technology at the University of Maryland at College Park.

The researchers use a laser pulse to generate a long, thin cylinder of hot, ionized gas, or plasma. They can then guide a second laser pulse in the opposite direction down this tube of expanding hot plasma, enabling the pulse to travel a much longer distance through the gas than it would normally go by itself.

"This is a significant advance," says Philip H. Bucksbaum of the University of Michigan in Ann Arbor. "It provides a way of confining a light beam so that it has a high intensity over a long distance."

"It's a very important experiment, and it could have great practical implications," says Phillip Sprangle of the Naval Research Laboratory in Washington, D.C. Optical guiding of intense laser pulses may prove a crucial element in the development of tabletop X-ray lasers, compact particle accelerators, and practical nuclear fusion reactors that rely on powerful laser beams to initiate fusion.

Milchberg and C.G. Durfee III describe their experiment in a paper scheduled for publication in the Oct. 11 PHYSICAL REVIEW LETTERS. They will also present their findings at an Optical Society of America meeting next week in Toronto.

Milchberg and Durfee arrived at their discovery indirectly. To study the interaction of light pulses with electrons in a plasma, they sent two intense laser pulses through the same lens. The first pulse generated a spark in the gas, and the second, delayed pulse probed the electrons stripped from atoms by the first pulse.

"What we saw was that the spark due to the first pulse was lensing the light coming from the second pulse," Milchberg says. "It was acting just like a short length of optical fiber."

The researchers recognized that this effect might be used to channel laser pulses, but initially they had no idea how to make the spark longer. On a visit to a plasma laboratory in Russia, Milchberg discovered that scientists there had rigged up a special kind of lens – known as an axicon – that brought light to a long, narrow focus extending out from the lens in the direction of the light's path.

When he returned to the United States, Milchberg commissioned a local company to make a similar axicon lens. But when he and Durfee tried it, the experiment didn't work. It turned out that "the alignment [of the apparatus] wasn't quite right," Milchberg says. Once this problem was solved, getting a laser pulse to travel along a plasma tube proved remarkably easy.

"We do it regularly now, and we have lots of detailed measurements," Milchberg says. The latest results show that a laser pulse of 10^{14} watts per square centimeter can be guided for a distance of more than 70 Rayleigh lengths. A Rayleigh length represents the characteristic distance (typically ranging from a few hundred microns to a millimeter) that a focused light beam of a certain diameter can travel through a given medium before spreading out excessively.

"The technique causes a gaseous plasma to modify itself to just the right geometry to make a channel for guiding a light wave," Bucksbaum says. "What's nice about it is that it's fairly easy to do."

Milchberg and his co-workers are now looking into the possibility of using their novel light pipe for building an X-ray laser. The technique's potential value for other applications depends on whether it works for laser pulses more powerful than 10^{18} watts per square centimeter.

"We had done some theoretical work on this even before [Milchberg] carried out his experiment," Sprangle says. "Our simulations show that it should work at high intensities, but one needs to do an experiment to be absolutely sure. We have a laser that can go up to 10^{19} watts per square centimeter, so we'd like to test this."

"What's left is to demonstrate that you can use this [technique] to pump a laser or accelerate electrons," Bucksbaum notes. *– I. Peterson*

Oldest known Maya burials found in Belize

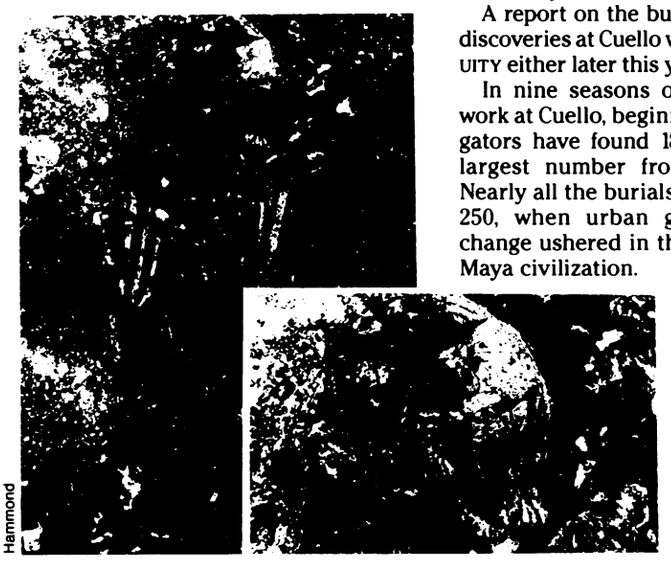
Archaeologists excavating an ancient village in Belize have uncovered the earliest known human burials from the Maya culture. The new finds consist of five individuals, lying side by side in shallow graves, who may have belonged to the same family at the time of their deaths, around 3,000 years ago.

"We regard this as a family burial plot," asserts Norman Hammond, an archaeologist at Boston University who directed the excavation. "No clues to the causes of death have been found so far, but these people probably all died at around the same time."

Hammond and his co-workers made their discovery in March at Cuello, a Maya site in Belize. The burials appeared in sediment layers that date to the earliest phase of occupation at Cuello, from 1200 B.C. to 900 B.C. More precise dates should emerge in the next few months, following radiocarbon dating of bone samples at the University of Oxford in England.

A report on the burials and other new discoveries at Cuello will appear in ANTIQUITY either later this year or in early 1994.

In nine seasons of intermittent field work at Cuello, beginning in 1975, investigators have found 180 burial sites, the largest number from any Maya site. Nearly all the burials date to before A.D. 250, when urban growth and social change ushered in the Classic period of Maya civilization.



Hammond

Cuello burial contains a woman holding a child in her right arm. Close-up shows the child's partly crushed skull lying against the woman's cheek.