Physics

Laser fusion comes into the open . . .

For 30 years, researchers at the Lawrence Livermore (Calif.) National Laboratory have been investigating the possibility of using short, powerful pulses of laser light to initiate the fusion of atomic nuclei. But because the research was classified, scientists could release very little information about these experiments and their results.

In a major policy change, the Department of Energy announced last December that it will gradually declassify information related to its inertial-confinement fusion program. The decision allowed researchers at Livermore and elsewhere to begin describing their work at open meetings and publishing detailed results in journals.

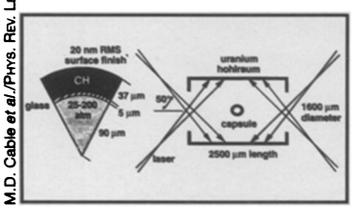
Four papers in the Oct. 24 PHYSICAL REVIEW LETTERS now reveal details of experiments conducted over the last few years involving Livermore's immensely powerful Nova laser. The laser's light was used to create X rays for irradiating a tiny spherical capsule containing gaseous hydrogen fuel.

In the Livermore scheme, the Nova laser generates 10 beams of ultraviolet light at a wavelength of 351 nanometers. These beams enter a special cylindrical vessel known as a Hohlraum and strike its interior walls, which are made of uranium. The interaction between the ultraviolet light and the uranium produces X rays, which irradiate the pinhead-size, fuel-containing capsule (see illustration).

The X rays vaporize the capsule's outer plastic coating, creating a plasma that pushes against the inner sphere of fuel. This action compresses the fuel, which typically consists of a mixture of deuterium and tritium gas, to extremely high densities at a temperature greater than 100 million °C. In principle, such densities can get high enough to prompt the fusion of nuclei. The resulting nuclear reactions create helium nuclei and release energy.

In their four papers, the Livermore researchers describe experiments designed to test their understanding and control of the fusion process. They particularly wanted to check whether the X rays produced in the Hohlraum irradiated the capsule evenly enough to ensure that the fuel was compressed uniformly. They were also concerned about the possibility that instabilities during the compression phase could disrupt the process.

"These experiments . . . allowed detailed comparisons to simulations and permitted a deeper understanding of the sensitivity of the implosion process to factors such as laser power balance," the researchers conclude. The results indicate that the approach developed at Livermore could be scaled up to achieve nuclear fusion.



M.D. Cable *et al.*/PHYS. REV. LETT.

Diagrams showing cross section of capsule (left) and Hohlraum geometry (right) for indirect-drive laser fusion.

. . . and takes another step

As the next step toward achieving nuclear fusion using lasers, the Department of Energy last month announced its decision to proceed with the National Ignition Facility (NIF). Construction is to begin at a Livermore site in 1996, and the facility, which will cost $1.07 billion, should be in operation by the year 2002.

The project design includes a laser system capable of generating 500 trillion watts of power. That's 10 times the power produced by Livermore's Nova laser, which currently ranks as the most powerful in the world. This power level should produce enough heat in an imploding capsule to achieve self-sustaining nuclear fusion.

Science & Society

Massive Russian spill threatens Arctic

In late August, an 18-year-old pipeline just south of the Arctic Circle spewed crude oil onto fragile Russian tundra near the town of Usinsk. Komineft, the Russian oil company that owns the pipeline, erected earthen dams to contain the growing lakes of oil as crews worked to patch the latest in this pipeline's long history of leaks.

But around Oct. 1, heavy rains caused some of the oil-holding dikes to collapse, Komineft acknowledged last week. The body of crude released — variously described as anywhere from one-half to eight times the size of the 1989 *Exxon Valdez* spill — fouled miles of local rivers and streams.

Cold weather has slowed the spilled oil's flow rate, and cleanup technologies have removed much of the crude. But Russian officials warn that once the area thaws next spring, the remaining oil may continue wending its way north toward the Barents Sea and Arctic Ocean.

Desertification treaty on the way

The United Nations Environment Programme (UNEP) estimates that the welfare of up to 900 million persons may be in jeopardy from desertification — a severe drying out of the already arid lands that now feed them. A worldwide growth of dry lands also threatens many species with extinction. Hoping to slow or even reverse desertification, representatives of 87 nations signed a convention in Paris on Oct. 14 and 15. First proposed at the June 1992 Earth Summit in Rio de Janeiro, this document will become an international treaty when ratified by 50 of these countries.

Any of a range of agricultural practices and natural forces can foster desertification, including overgrazing, overcultivation, changing climatic conditions, and erosion of topsoil by inappropriate irrigation or deforestation. Though many affected nations know what policies or technologies would save their soils and water resources, most lack the money to adopt them. UNEP estimates that successfully fighting desertification will cost between $10 billion and $22 billion annually for the next 20 years. Currently, less than $1 billion per year is spent globally on programs to halt this form of land degradation.

The proposed treaty would work to channel "substantial" additional funds into protecting the fertility of arid lands. Though industrial donor nations refused to commit themselves to legally binding contributions during the Paris meeting, several pledged to boost the aid packages they would earmark for antidesertification programs in the next few years — prior to the treaty's ratification.

Pests: Beware of bees' powdered knees

On Sept. 20, a trio of U.S. Department of Agriculture (USDA) employees received a patent for their design of a novel front porch for honeybee hives. This architectural innovation dusts outgoing bees with a virus-laced talc. At each flower they visit, the treated insects leave behind a powdery trail that, while harmless to them, spells death to designated pests.

The new device resembles a two-story addition to the entrance of a hive. It forces bees to walk in a lower hallway and out an upper one, explains John Hamm at USDA's Insect Biology and Population Management Research Lab in Tifton, Ga. Because the upper porch floor is filled with a pesticidal powder, it coats the bees' feet and legs during each departure.

Hamm and his coworkers field-tested the new duster with a nuclear polyhedrosis virus (NPV), which kills corn earworm and tobacco budworm caterpillars. In a trial in crimson clover, the dust tracked in by bees killed 74 to 87 percent of the earworm larvae present — six to seven times the earworm mortality observed in a field pollinated by undusted bees.