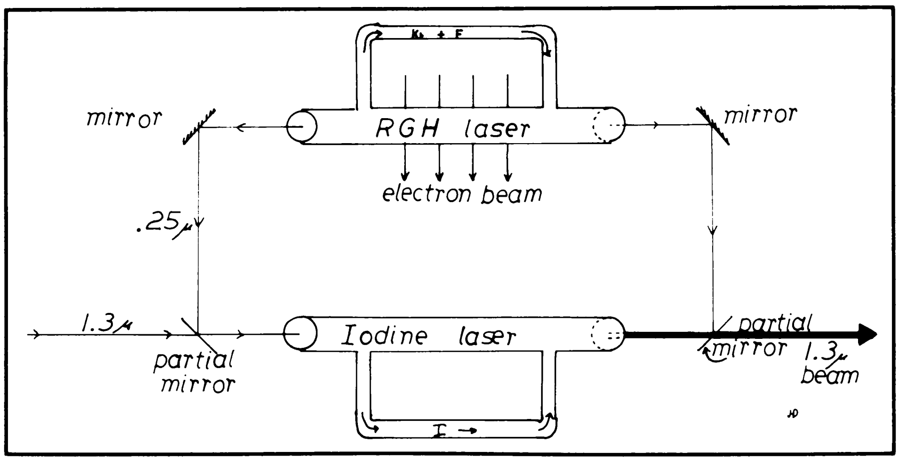
SCIENCE NEWS OF THE WEEK

Laser Fusion: Toward 'Brand X'



An RGH laser pumps iodine laser: Similar combinations may lead to fusion system.

John H. Douglas, after Krupke

In roughly three years, the idea of laser fusion has grown from a germ of speculation, discussed only by a few specialists, to a heavy-weight contender of "big science"—with a proposed budget of just over $100 million for next year and a small army of engineers talking about "milestones" and "systems approaches." Both topics were widely discussed last week at a joint technical symposium of the Society of Photo-Optical Instrumentation Engineers and the Society of Photographic Scientists and Engineers, in Reston, Va. Perhaps more important was analysis of the impact a new lasing technique may have on producing a workable fusion system.

The "milestones" of laser fusion were set forth by John D. Hunsuck, project director for the Energy Research and Development Administration (ERDA). He predicts "scientific breakeven" (fusion energy out equal to laser energy in) by 1981-82 and an operating test system by the late 1980s. A demonstration plant may be completed by the mid-1990s, he said, but the final thrust to such a practical system will be "a long, hard haul." At that point, the main concern may be how to find materials capable of withstanding the intense neutron flux that results from fusion.

Before any of the milestones beyond scientific breakeven can be reached, however, a fundamental change must occur away from present experimental systems—the combination of lasers and target pellets being used today cannot simply be scaled up to higher power levels. This realization has led some experts to speculate on the need for a high-powered "Brand X" laser, probably radiating in the visible spectrum rather than in the infrared as in today's experimental devices. This speculation was discussed at the Reston conference by W.F. Krupke of Lawrence Livermore Laboratory.

According to the Brand X theory, the simple spherical target pellets now in common use would have to be compressed by some as yet undiscovered laser that could achieve 10 percent energy efficiency at around 0.5 microns (green light). Krupke, however, points to an alternative stratagem. He says more complex targets might ease the restrictions to allow use of an infrared laser (1.0 to 2.0 microns) with an efficiency as low as 1 percent. (Long wavelength photons of infrared light are inherently less energetic and capable of compressing a pellet than the photons of visible light.)

Complex pellets, containing multiple layers and heavy elements in addition to the fusion reactants, have already apparently found increasing use (SN: 6/14/75, p. 384). Now, within the last few months, a new type of laser has been developed that may aid the search for Brand X. It is the rare gas-halogen (RGH) laser, which radiates in the ultraviolet and can be used to pump other lasers to produce desired wavelengths in either the visible or infrared spectrum. (Brand X would almost certainly be a flowing gas laser, to remove heat generated.)

So-called rare gases (krypton, argon, etc.) do not ordinarily form any chemical compounds, but when their atoms absorb energy they can form loose molecules with the very reactive atoms of the halogen gases (fluorine, chlorine, etc.). To create these energetically excited states, the reactants are bombarded with an electron beam in the presence of a third gas, which helps transfer the energy. Once formed, the new molecules (say, KrF) quickly dissociate again, releasing energy (in this case, ultraviolet light of 0.25 microns).

The dissociation is so fast that not enough energy can apparently be stored by RGH lasers for use directly in causing fusion, so the ultraviolet light is used instead to "pump" a laser of some other material. One of the first materials that appeared to have the right combination of properties (to be pumped by an RGH laser and in turn to lase at approximately the right wavelength) was iodine, which emits light in the "near" infrared (1.3 microns). Several laboratories are now exploring this laser combination, but an even more promising set-up appears to be emerging. Calculations show that if an RGH laser can be used to pump the vaporized atoms of certain "rare earth" elements (say, terbium), they should lase right in the middle of the visible spectrum (in this case, green).

It is still too early to tell whether an RGH-pumped rare earth laser will turn out to be Brand X—the first experiments are just now in progress—but the new technique has already opened several new avenues of approach. In an interview, Krupke said of the RGH lasers: "It looks like they will have a major impact on the laser community, both in isotope separation and in fusion." He estimated that in perhaps as little as two years, a decision can be made on what combination of targets and lasers to use in future power-generating fusion reactors.

Meanwhile, in the corridors, talk turned to what the Soviet Union is up to in this field. Administration of the Russian laser fusion program has reportedly shifted from a pure research institute into the USSR equivalent of ERDA, and communication on the subject—once quite open —has suddenly grown quiet. Speculated one knowledgeable scientist: "Either they've found out how to do it, or they've run into trouble." ☐

Electron beam fusion: Soviets claim advance

Although the Soviets are extremely close-mouthed (and close with their typewriters too) about their progress in controlled thermonuclear fusion research, occasionally something surfaces that gives a bit of an idea of what approaches they are into.

One such avenue that they have chosen to follow is a variant offshoot of the laser-fusion idea in which beams of accelerated electrons instead of laser light are used to implode the target pellets. This idea was taken up because it seems it might be able to get around some of the difficulties that are beginning to appear in the laser-fusion business. (It seems easier to couple the electron energy into the targets, and the targets can be larger.) Both the United States and the Soviet