

The GAO's report vindicates Teller on the x-ray laser

The full text, including notes, of "Strategic Defense Initiative Program: Accuracy of Statements Concerning DOE's X-Ray Laser Research Program," issued June 30, 1988, as a United States General Accounting Office Briefing Report to the Honorable George E. Brown, Jr., House of Representatives.

United States General Accounting Office
National Security and International Affairs Division

June 30, 1988

The Honorable George E. Brown, Jr.
House of Representatives

Dear Mr. Brown:

Your letter dated October 26, 1987, requested that we review certain allegations regarding the X-ray laser research program being carried out at the Lawrence Livermore National Laboratory (LLNL) as part of the Strategic Defense Initiative (SDI) program. LLNL is operated by the University of California under a contract with the Department of Energy (DOE). Specifically, you were concerned with how the results of this program have been presented to the Congress, administration officials, and the American public.

The X-ray laser is important to the SDI program because the final SDI design could depend upon whether the X-ray laser is feasible. If the Soviets could build an X-ray laser, then the survivability of American space assets could be questioned. Therefore, the United States would have to design its ballistic missile defense system to either survive or counter a Soviet X-ray laser attack.

According to your letter and discussions with you, the basis for your concern was statements contained in correspondence between Mr. Roy Woodruff, former LLNL Associate Director for Defense Systems, and the University of California concerning a grievance filed by Mr. Woodruff with the University on April 3, 1987. You said that this grievance alleged that reprisal action was taken by the then LLNL Director, Dr. Roger Batzel, against Mr. Woodruff following his resignation as Associate Director for Defense Systems. Contained in this correspondence were claims that technical information about the X-ray laser program had been misrepresented to the Administration. Mr. Woodruff said

that LLNL scientists, Drs. Edward Teller and Lowell Wood, had made "overly optimistic and technically incorrect statements regarding this research to the Nation's highest policy makers." Mr. Woodruff also said that he was prevented by Dr. Batzel from sending correcting information to those who he believed had received inaccurate information about the X-ray laser. Furthermore, you told us that Mr. Woodruff indicated his resignation was prompted by what he felt were insupportable claims by Drs. Teller and Wood.

At our request, Mr. Woodruff identified specific X-ray laser statements by Drs. Teller and Wood that he felt were "overly optimistic and technically incorrect." These statements concerned the status and the potential of the X-ray laser as a military weapon and were contained in

—Dr. Teller's December 22, 1983, letter to George Keyworth,¹ Science Adviser to the President;

—Dr. Teller's December 28, 1984, letters to Ambassador Nitze, Chief Arms Control Negotiator, and Robert McFarlane, National Security Adviser to the President; and

—Dr. Wood's April 23, 1985, briefing to William Casey, Director of the Central Intelligence Agency (CIA), and Stanley Sporkin, CIA's General Counsel.

As agreed with your Office, we compared information about the X-ray laser program presented by Drs. Teller and Wood (categorized by Mr. Woodruff as the other LLNL channel) to congressional and administration officials with the information presented to these same officials by LLNL X-ray laser program and LLNL management personnel (categorized by Mr. Woodruff as the official LLNL channel).

We provided a classified briefing to you on the results of our review on February 25, 1988. This report is an unclassified version of that briefing and therefore includes general, rather than specific, information about the X-ray laser. Brackets show where general information was substituted for specific information that is classified.

Summary of findings

We found that the LLNL official channel, which included Mr. Woodruff,² had made statements about the status and potential of the X-ray laser, which were similar to most of the statements identified by Mr. Woodruff as being "overly optimistic and technically incorrect."

Mr. Woodruff prepared letters to send to Dr. Keyworth

and Ambassador Nitze clarifying the statements made by Dr. Teller. However, Dr. Batzel said that he preferred that Mr. Woodruff's clarifying letters not be sent, and they were not. We found that Mr. Woodruff presented his opinions on information that had been provided by Dr. Teller to Dr. Keyworth and Ambassador Nitze. Mr. Woodruff told us he did not have opportunities to present his views to Mr. McFarlane and Mr. Casey.

In addition, we asked selected LLNL scientists, who had specific knowledge about the X-ray laser program, for their opinions as to the accuracy of the statements challenged by Mr. Woodruff. From these interviews, we concluded there was no general agreement among these scientists regarding the accuracy of the statements.

Proposed new LLNL policy on dissemination of views and opinions

The LLNL Executive Officer told us that LLNL generally adheres to the University of California tradition of permitted free and open expression of individual viewpoints to persons inside and outside LLNL. At the University of California's request, LLNL plans to issue a formal, written policy with respect to the dissemination of official management views and opinions, versus personal views and opinions, expressed by individual scientists outside of the laboratory.

Mr. Woodruff's objections to Dr. Teller's letter to Dr. Keyworth

In his December 22, 1983, letter, Dr. Teller discussed the status of the X-ray laser program. Mr. Woodruff felt that Dr. Teller's letter to Dr. George Keyworth contained "overly optimistic, technically incorrect" statements and specifically objected to two of Dr. Teller's statements. These statements were that (1) three factors measured in a nuclear test were in "essentially quantitative agreement" with predictions and (2) the X-ray laser program was, in his opinion, ready for engineering. Mr. Woodruff wanted to send a letter to Dr. Keyworth clarifying Dr. Teller's letter. However, Dr. Batzel said that he preferred the clarifying letter not be sent, and it was not.

According to Dr. Teller, the purpose of his letter to Dr. Keyworth was to inform him that LLNL had successfully demonstrated X-ray lasing. In addition, Dr. Teller, being a theoretical physicist, felt the basic scientific question, can an X-ray laser be demonstrated, had been answered. Therefore, in his opinion, all that remained to be accomplished was "engineering."

Mr. Woodruff's proposed clarification letter:

In his unsent letter of December 28, 1983, Mr. Woodruff said he wanted to "mitigate" what he felt were "premature conclusions" arrived at by Dr. Teller. Regarding the first statement, he wanted to change the phrase from "essentially quantitative agreement" to "solid *qualitative* agreement,"



Dr. Edward Teller. "Being a theoretical physicist, [he] felt the basic scientific question, can an X-ray laser be demonstrated, had been answered."

implying a lesser understanding of X-ray laser physics.³ In addition, he wanted to clearly state that many physics questions remain to be answered and that military application for the X-ray laser has not been established.

Concerning the second statement, Mr. Woodruff wanted to state that (1) the X-ray laser was not ready for engineering at this time and (2) critical physics scaling and characterization experiments needed to be carried out before the weapons feasibility of the concept could be assessed. Only then could LLNL be ready for engineering. Dr. George Miller, the current LLNL Associate Director for Defense Systems, supported Mr. Woodruff's views and stated that the X-ray laser was not ready for engineering then or now.

Dr. Batzel's reasons for not sending Mr. Woodruff's clarification letter:

Dr. Batzel, then the LLNL Director, expressed the view that Dr. Keyworth would not misinterpret Dr. Teller's letter. Accordingly, as far as he was concerned, there was no need for a clarification letter. Dr. Batzel told us that Dr. Keyworth is a knowledgeable physicist and had been briefed on the X-ray laser program. Furthermore, Dr. Batzel said he believed Dr. Keyworth understood that Dr. Teller is a theoretical physicist and, like others, knew Dr. Teller to be a "technical optimist."

Mr. Woodruff did communicate with Dr. Keyworth:

Although Mr. Woodruff did not send his clarification letter, we found that he distributed a memorandum dated January 13, 1984, which described the X-ray laser program status. This memorandum was addressed to Dr. Keyworth as

well as to various Department of Energy (DOE) and Department of Defense (DOD) officials. In this memorandum, Mr. Woodruff made statements similar to some of Dr. Teller's statements, which Mr. Woodruff had questioned.

For two of the three factors cited by Dr. Teller as having results that were in "essentially quantitative agreement" with predictions, Mr. Woodruff stated that the results were "in excellent quantitative agreement with predictions." Regarding the third factor, Mr. Woodruff stated that results "are in solid qualitative agreement with predictions." He further stated that there may ultimately be "sufficient quantitative agreement" to achieve greater understanding of the laser physics and that more data and experimentation were needed before the feasibility or potential of an X-ray laser weapon could be determined.

Finally, in addition to communicating his views in his January 13, 1984, memorandum, Mr. Woodruff met with Dr. Keyworth on February 15, 1984. Mr. Woodruff told us that, at this brief meeting, he presented the X-ray laser program's status and clarified Dr. Teller's letter.

Opinions of selected LLNL scientists:

We asked selected LLNL scientists, who had specific knowledge about the X-ray laser program, for their opinions as to the accuracy of Dr. Teller's statements. There was no uniformity of opinion among the scientists who offered an opinion regarding the accuracy of these statements.

Mr. Woodruff's objections to Dr. Teller's letters to Ambassador Nitze and Mr. McFarlane

In his December 28, 1984, letters, Dr. Teller described the potential of the X-ray laser. Mr. Woodruff regarded Dr. Teller's letters as being "overly optimistic." Mr. Woodruff told us the statements in this letters appeared to describe the X-ray laser as almost a reality when, in fact, it was an evolving concept and, at best, a paper weapon. These statements concerned (1) the time frame for developing Excalibur and (2) certain statements about Super-Excalibur.⁴

With regard to Excalibur, the specific comment regarded by Mr. Woodruff as being "overly optimistic" was the following.

—"We expect to be able to realize this advance [Excalibur level of brightness]⁵ in [the foreseeable future]." (letter to Nitze)

With regard to Super-Excalibur, Mr. Woodruff objected to the following statements.

—"Assuming even moderate support, together with considerable luck, this [Super-Excalibur concept] might be accomplished in principle [within a few years]." (letter to McFarlane)

—"While this progress has by now some solid experimental foundation, theoretical calculations indicate that beams can be directed even more precisely giving rise locally to an

additional [deleted] enhancement, giving rise altogether to a seemingly impossible [Super-Excalibur] enhancement." (letter to McFarlane)

—"The overall military effectiveness of X-ray lasers . . . may thus be as large as a [Super-Excalibur level of brightness]. . . ." (letter to Nitze)

—The Super-Excalibur concept "seems likely to make X-ray lasers a really telling strategic defense technology. For instance, a single X-ray laser module the size of an executive desk which applied this technology could potentially shoot down the entire Soviet land-based missile force, if it were to be launched into the module's field of view." (letter to Nitze)

In his December 1984 letters, Dr. Teller primarily discussed the new Super-Excalibur. At that time, Super-Excalibur existed primarily as a theoretical concept. Experimentation had begun on components that could be used in Super-Excalibur, but no nuclear tests of the concept had been performed. Shortly after Dr. Teller's December 1984 letters, the official LLNL channel, including Mr. Woodruff, included mention of the significantly higher Super-Excalibur brightness goal in oral presentations and written materials about the X-ray laser program.

Mr. Woodruff's proposed clarification letter:

To clarify Dr. Teller's December 28, 1984, letter, Mr. Woodruff prepared a letter to Ambassador Nitze, dated January 31, 1985. However, Dr. Batzel preferred this letter not be sent, and it was not. In this letter, as the Associate Director responsible for the X-ray laser program, Mr. Woodruff said he wanted to correct what he felt was the overly optimistic balance in Dr. Teller's letter and to present his views as to both the status and potential of the X-ray laser as a military weapon.

Concerning Excalibur brightness, Mr. Woodruff stated that at the current funding level, the Excalibur level of brightness could not be achieved [in this century]. If additional funding were provided (approximately \$150 million per year for the next [several] years), this goal could be achieved [in the foreseeable future]. Beyond that, development of a full X-ray laser weapon system would require an additional [deleted] years and several billion dollars.

Concerning Super-Excalibur's brightness and the potential for shooting down the entire Soviet land-based missile force, Mr. Woodruff stated they did "not have sufficient understanding nor data to be quantitative about the possibility of achieving these results." Furthermore, in his clarification letter, Mr. Woodruff stated, "Will we ever develop a weapon close to the characteristics described in the above quote?⁶ Not impossible, but very unlikely."

Dr. Batzel's reasons for not sending Mr. Woodruff's clarification letter:

According to Dr. Batzel, there was nothing in Dr. Teller's letters that violated any laws of physics. In addition, Dr.

Teller identified the Super-Excalibur concept as “in principle,” and the letters contained many qualifiers.

Dr. Batzel told us he had no problems with Mr. Woodruff’s comments concerning the X-ray laser. However, he was concerned with Mr. Woodruff making budgetary comments and requesting specific funding from Ambassador Nitze. He told us that the normal budgetary process is through DOE and that this process should not be circumvented. He preferred this letter not be sent and that Mr. Woodruff make his point in person to Ambassador Nitze.

Mr. Woodruff’s briefing to Ambassador Nitze:

Mr. Woodruff briefed Ambassador Nitze for about 2 hours on February 7, 1985. In this meeting, he said he talked about SDI, nuclear versus non-nuclear issues of interest within SDI at that time, and the letter from Dr. Teller. According to Mr. Woodruff, he reviewed Dr. Teller’s letter to Ambassador Nitze in considerable detail and had ample opportunity to state his views. However, Mr. Woodruff told us he did not leave written documentation with Ambassador Nitze.

Mr. Woodruff did not contact Mr. McFarlane:

Mr. Woodruff did not write a clarification letter to Mr. McFarlane. Since Dr. Batzel preferred he not write to Ambassador Nitze, he said he concluded the same would be true for a letter to Mr. McFarlane.

Mr. Woodruff did not meet with Mr. McFarlane, but he did meet with two National Security Council staffers on February 20, 1985. However, according to Mr. Woodruff, the X-ray laser was not discussed at this meeting.

LLNL statements about the X-ray laser potential:

We found the official LLNL channel, including Mr. Woodruff, made statements in oral presentations and written materials about the potential of the X-ray laser program, which were similar to many of the statements made by Dr. Teller in his letters to Ambassador Nitze and Mr. McFarlane. These statements generally supported achieving Excalibur [in the foreseeable future] and discussed the possibility of developing Super-Excalibur. We did not find any statements addressing when, specifically, Super-Excalibur might be achieved.

Achieving Excalibur level of brightness [in the foreseeable future]:

The official LLNL channel, including Mr. Woodruff, had prepared estimates of when the Excalibur brightness goal could be reached. These estimates were based upon LLNL receiving budget and program support, which have never materialized. However, they generally supported Dr. Teller’s December 1984 statement of [in the foreseeable future]. For example

—At the June 23, 1982, presentation to the White House Science Council Military Technology Panel, Dr. Tom Weaver,

then the X-ray Laser Program Leader, gave an X-ray laser presentation that included an estimated date for achieving the Excalibur brightness goal of [deleted]. Mr. Woodruff attended this meeting.

—At the February 17, 1983, presentation to the White House Science Council Technology Panel, the estimated date had [slipped a few years] but was still within Dr. Teller’s time frame. Mr. Woodruff and Dr. Weaver also attended this meeting.

—On May 15, 1984, LLNL submitted a Program Plan for X-ray Laser Weapon Technology Development in Support of the Strategic Defense Initiative to the DOE Office of Military Application. This plan, that personnel at LLNL, Los Alamos National Laboratory, and Sandia National Laboratory had prepared, indicated that the Excalibur brightness goal could be achieved [in the foreseeable future].

Super-Excalibur brightness:

Shortly after Dr. Teller’s December 1984 letters, the X-ray laser program officials and Mr. Woodruff began to mention the significantly higher Super-Excalibur brightness goal in presentations and written materials. Mr. Woodruff’s statements, made shortly after Dr. Teller’s letters, are presented below.

In a February 6, 1985, letter to the DOE Office of Military Application, Mr. Woodruff stated that Super-Excalibur had been discussed within LLNL for quite some time. In addition, he stated that although Super-Excalibur is conceptually much simpler, the physics may prove to be more difficult. A few days earlier, Mr. Woodruff had circulated an earlier version of this letter within LLNL.

In this earlier version, which was not distributed to DOE, Mr. Woodruff stated:

“Much work and many experiments need to be done before we will know if this idea [Super-Excalibur] is viable, and it is much too early to sell this as anything more than a concept. However, it is a very good idea, and we should and will proceed to develop it as rapidly as possible.”

In a February 13, 1985, presentation to the Senate SDI Working Group, Mr. Woodruff presented X-ray laser information. This presentation included the Super-Excalibur brightness goal, but did not include a specific date for achieving this goal.

We did not find estimates by the official LLNL channel that gave specific dates when the Super-Excalibur brightness goal could be achieved. The official channel estimates contained dates for achieving the Excalibur brightness goal with Super-Excalibur to follow.

We asked selected LLNL scientists, who had specific knowledge about the X-ray laser program, for their opinions as to the accuracy of Dr. Teller’s statement about how soon the Super-Excalibur brightness goal would be achieved. Most of the scientists who offered an opinion regarding the accuracy of the statements felt that achieving Super-Excalibur

[within a few years] was conceivable or not impossible, especially if considerable support were available.

Super-Excalibur application:

In his letter to Ambassador Nitze, Dr. Teller discussed the potential of a single X-ray laser destroying the entire Soviet land-based missile force. As this was a potential application for a concept, which at that time existed primarily as a theoretical concept, we did not examine the official LLNL records for statements relating to this potential application.

However, during a hearing before the House Committee on Armed Services on February 19, 1986, Dr. Batzel was asked whether there was quantitative data to support this potential application. Dr. Batzel said "there are no data at this stage of the game which would support that." Concerning his testimony, Dr. Batzel told us that although there were no quantitative data to support Dr. Teller's executive desk concept, tests had been conducted pertaining to certain aspects of Super-Excalibur. Dr. Batzel also said there were no data refuting Dr. Teller's concept.

Mr. Woodruff's objections to Dr. Wood's briefing to CIA

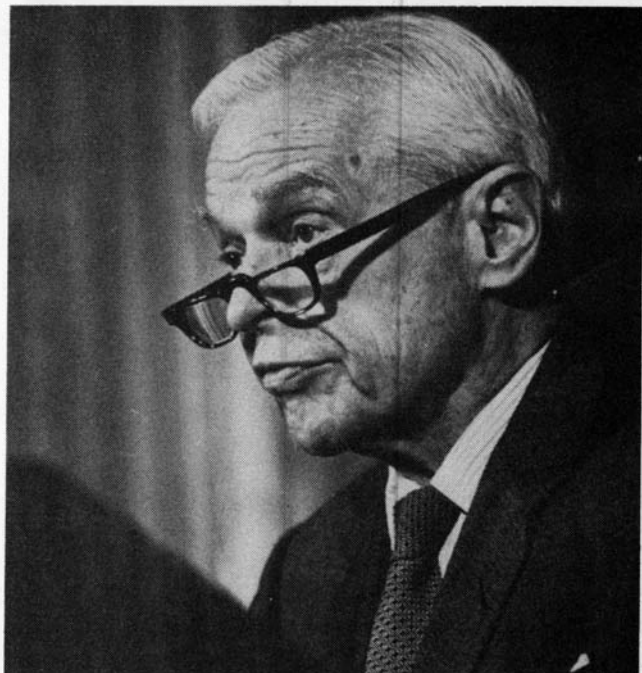
On April 23, 1985, Dr. Wood briefed William Casey, Director of the CIA, and Stanley Sporkin, CIA's General Counsel, on the X-ray laser research program. Copies of this briefing were distributed to various DOE and DOD officials.

Mr. Woodruff's objections to certain statements:

In one part of his briefing, Dr. Wood stated the X-ray laser can have "as many as [specific number of] independently aimable beams." In another part of his briefing, Dr. Wood presented five conditions that he stated had been accomplished by the X-ray laser nuclear tests. Mr. Woodruff objected to the statement concerning the number of independently aimable beams and to two of the five stated conditions.

According to Mr. Woodruff, the statement concerning the number of independently aimable beams was an example of Dr. Wood "selling Super-Excalibur." He also felt that Dr. Wood's use of artist's drawings depicting possible X-ray laser usage implied an unwarranted reliability to something that did not exist other than as a theoretical calculation.

With regard to the two of the five conditions that Dr. Wood stated LLNL nuclear tests had achieved, Mr. Woodruff stated (1) LLNL had not produced the amount of laser energy claimed by Dr. Wood and (2) the usage of the term intrinsic energy conversion efficiency was inappropriate and he believed this specific level of efficiency had not been achieved. According to Mr. Woodruff, intrinsic energy conversion efficiency refers to the efficiency of a single laser beam, not the overall efficiency of a possible weapon configuration. Therefore, achieving this goal did not mean that a laser weapon was possible.



Stuart Lewis

Arms control negotiator Paul Nitze. Woodruff briefed him "in ample detail" on his views on Dr. Teller's letter, but "did not leave written documentation."

Mr. Woodruff's contacts with recipients of briefing:

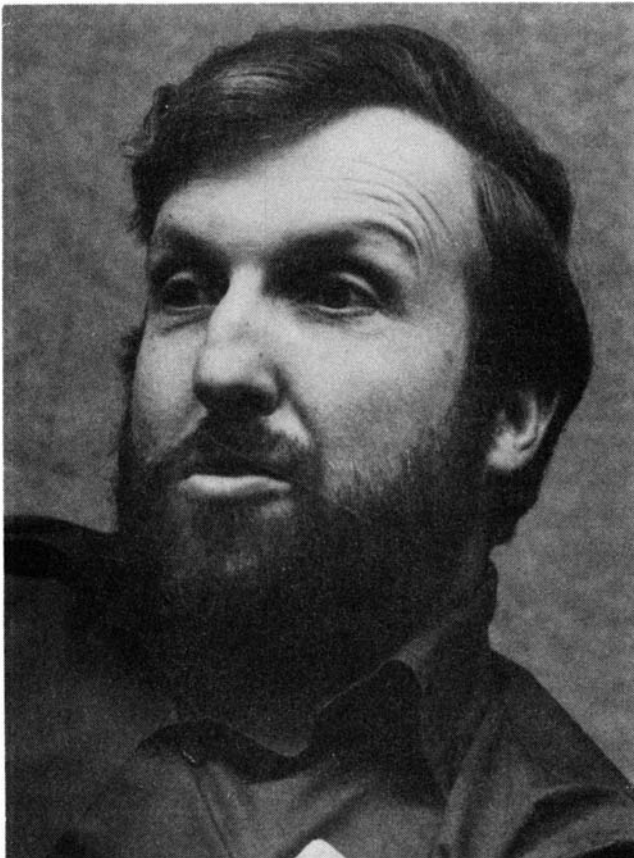
Mr. Woodruff told us he could not arrange a meeting to present his opinions and views to Director Casey. However, he did successfully present his views and opinions to most of the other recipients of copies of this briefing.

LLNL statements regarding Dr. Wood's CIA briefing:

In the case of the independently aimable beams of the Super-Excalibur concept, we found the official LLNL channel made a statement that was similar to Dr. Wood's statement in his briefing to the CIA. Wording similar to the phrase challenged by Mr. Woodruff, "as many as [specific number of] independently aimable beams," was presented by Dr. George Miller (then Mr. Woodruff's deputy and eventual successor) to the DOE Office of Military Application in early April 1985.

Concerning laser energy achieved and intrinsic energy conversion efficiency, we found that Dr. Wood's April 1985 CIA briefing was based upon nuclear test results, which LLNL later found to be incorrect, and, as a result, it was subsequently modified in the summer of 1985. Based upon the uncorrected results, we were told by Dr. Weaver, then the X-ray Laser Program Leader, that LLNL thought it had achieved the energy level out of the laser and the intrinsic energy conversion efficiency as stated by Dr. Wood.

We asked selected LLNL scientists, who had specific knowledge about the X-ray laser program, for their opinions concerning the accuracy of the above statements. There was



LLNL

Dr. Lowell Wood. Most scientists who knew about the X-ray laser program, felt that his "level of energy achieved statement was technically correct."

no uniformity of opinion; however, most of these scientists felt the level of energy achieved statement was technically correct, based upon (1) uncorrected test results and (2) measuring the energy at the laser rather than at the target. In addition, most of these same scientists also felt the conversion efficiency statement was also technically correct. However, some of these scientists felt that Dr. Wood's statements could be misunderstood.

DOE's investigation

DOE tasked Drs. Dacey⁷ and Foster⁸ to investigate Mr. Woodruff's allegations. Their reports were issued to DOE in April and May 1987, respectively.

In summary, they found that Drs. Teller and Wood were optimistic about the potential of the X-ray laser. They concluded that the views of Drs. Teller and Wood were presented as views of individual scientists and not represented as the official position of LLNL.

In addition, Dr. Foster noted that the administration officials who received these presentations (General Abrahamson, Dr. Keyworth, Mr. McFarlane, Ambassador Nitze, and Mr. Poindexter) felt the presentations were no different than presentations provided by other experts advocating "vision-

ary" technological approaches. These administration officials felt they had not been misled.

Dr. Dacey further stated that Mr. Woodruff had access to administration officials, at least verbally, and concluded that Dr. Batzel's request that Mr. Woodruff not put his countervailing opinions in writing was within Dr. Batzel's management scope as Laboratory Director. He also stated that in retrospect the record would have been more complete if Mr. Woodruff's views had been more extensively documented.

We discussed the results of our review with Mr. Woodruff; LLNL officials (including Dr. Roger Batzel, Dr. Edward Teller, Dr. Lowell Wood, and the new LLNL Director, Dr. John Nuckolls); and DOE officials. They all generally concurred with the information in this report.

Unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after its issue date. At that time, we will send copies to the Chairman, Committee on Armed Services, House of Representatives; the Secretaries of Defense and Energy; the Director of the Strategic Defense Initiative Organization; and other interested parties upon request.

Sincerely yours,
Frank C. Conahan
Assistant Comptroller General

Appendix I: objectives, scope, and methodology

Based upon your request, as subsequently modified by discussions with your Office, we compared information about the X-ray laser program presented by Drs. Teller and Wood (categorized by Mr. Woodruff as the other LLNL channel) to congressional and administration officials with the information presented to these same officials by LLNL X-ray laser program and LLNL management personnel (categorized by Mr. Woodruff as the official LLNL channel). As agreed, we did not examine Mr. Woodruff's grievance with the University of California.

We accepted the information presented by the official LLNL channel, without additional verification, as the standard or basis of comparison. We did not (1) determine whether the information presented by either channel was correct or incorrect, (2) systematically examine information presented by either channel to the general public, and (3) attempt to establish what was specifically presented orally by either channel. We relied on written documentation to the maximum extent possible.

At our request, Mr. Woodruff identified specific X-ray laser statements by Drs. Teller and Wood that he felt were "overly optimistic and technically incorrect." These statements concerned the status and the potential of the X-ray laser as a military weapon and were contained in

—Dr. Teller's December 22, 1983, letter to George Keyworth, Science Adviser to the President;

—Dr. Teller's December 28, 1984, letters to Ambassa-

dor Nitze, Chief Arms Control Negotiator, and Robert McFarlane, National Security Adviser to the President; and —Dr. Wood's April 23, 1985, briefing to William Casey, Director of the CIA, and Stanley Sporkin, CIA's General Counsel.

We reviewed LLNL records and files, dating from early 1981 through December 1987, to identify pertinent statements by either channel pertaining to these identified statements. In addition, LLNL scientists identified documents containing pertinent statements for our review. We also used data obtained in our prior review of the X-ray laser program.⁹ Our audit was performed at LLNL and the DOE Headquarters.

We interviewed various LLNL scientists concerning the accuracy of Mr. Woodruff's allegations. We contacted

—all the principals named in Mr. Woodruff's allegations,

—the current and prior X-Ray Laser Program Leaders, and

—other individuals identified as possessing key information, including persons named by Mr. Woodruff and Dr. Wood who could support their views.

Our review was conducted from November 1987 through June 1988 in accordance with generally accepted government auditing standards.

Notes

1. Dr. George A. Keyworth (PhD in Physics) was the Physics Division Leader at Los Alamos National Laboratory before becoming the Science Adviser to the President.

2. Mr. Woodruff was the LLNL Associate Director for Nuclear Design from 1980 until February 1984. At that time, he became the Associate Director for Defense Systems, a position he held until resigning in October 1985.

3. Based on their understanding of the physics of an X-ray laser, LLNL scientists developed computer models, which were used with other means to predict the results of underground tests. If the results of an underground test agreed with the prediction, LLNL scientists concluded that they generally understood the physics of how the aspect being measured worked. If there were significant differences, this meant that the physics were not well understood. In general, quantitative means that the results were "close" to the predictions, and qualitative means the results were "not as close." We did not find any agreement on what specific numbers (such as 80% agreement) determine when the results should be described as quantitative or qualitative.

4. The initial LLNL X-ray laser design concept was referred to as Excalibur and had an established brightness (power intensity) goal. Theoretical calculations on a different idea evolved into the Super-Excalibur concept in early to mid-1984, which had a brightness goal significantly higher than Excalibur.

5. The amount of power that can be delivered (per unit solid angle) by a directed-energy weapon. Brightness of the laser beam can be measured either at the laser device (source) or at the target, where the brightness would be less than at the source due to the source-target separation.

6. Mr. Woodruff was referring to Dr. Teller's quote about a single X-ray laser module potentially shooting down the entire Soviet land-based missile force.

7. Dr. George C. Dacey (PhD in Physics) was President of Sandia National Laboratories.

8. Dr. John S. Foster, Jr. (PhD in Physics) helped form LLNL in 1952, was Director of LLNL from 1961 to 1965, and was Director of Defense Research and Engineering in the Department of Defense from 1965 to 1973.

9. *SDI Program: Evaluation of DOE's Answers to Questions on X-Ray Laser Experiment* (GAO/NSIAD-86-140BR).

Call for Investigation: Was there sabotage at Ramstein?

The Schiller Institute issued the following "Call for an exhaustive investigation into the possibility of sabotage in NATO military aircraft crashes" on Sept. 8, following the disaster Aug. 28 at the Ramstein Air Show in Ramstein, West Germany, in which three planes of the Italian "Frecce Tricolori" acrobatic team crashed, killing the pilots and 50 civilians. Endorsements may be sent to the Schiller Institute, P.O. Box 66082, Washington, D.C. 20035-6082, or in Europe, to EIR Nachrichtenagentur GmbH., Postfach 2308, Dotzheimerstr. 166, 62 Wiesbaden, B.R.D.

Since early 1988, an alarming and unprecedented number of NATO military aircraft have crashed in Western Europe, above all in West Germany. With the tragedy at the Ramstein air base, this series of crashes reached a high point. Since then, more military aircraft have crashed.

More and more experts doubt that the cause of these NATO air accidents has really been pilot error or mechanical failure. Since Ramstein, the question of sabotage is being posed with even greater urgency.

There is a wide array of possible sabotage methods, emphatically including sabotage through electro-magnetically induced effects on the pilot and/or on the aircraft's electronics.

The psychological-political and strategic usefulness of the crashes of NATO military aircraft for the Soviet leadership is obvious. After NATO's intermediate range nuclear weapons systems, NATO's tactical air forces are the primary target of Soviet-influenced political campaigns.

In light of this, we the undersigned demand an immediate exhaustive investigation into the series of NATO military aircraft crashes, with respect to possible sabotage operations. We demand that aircraft and pilots be effectively protected against electro-magnetic signal interference. Furthermore, we demand that the relevant information obtained from such investigations be made available to the public.