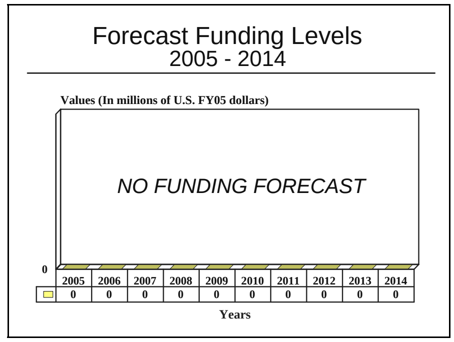
Space-Based Laser - Archived 8/2005

Outlook

- No direct funding for Space-Based Laser; program is put on back burner
- Missile Defense Agency (MDA) focusing on mid-course missile defense research



Orientation

Description. Space-based, high-energy laser, ballistic missile defense system.

Sponsor
Missile Defense Agency
Washington, DC 20301-7100
USA
Web site: http://www.acq.osd.mil/bmdo

Licensee. No known licenses have been granted.

Status. Original program no longer being funded. Some program elements now being used as testbed for future applications.

Total Produced. Equipment limited to developmental prototype components and the integration of those elements for system concept validation purposes only.

Platform. Satellite; unspecified.

Application. Ballistic missile defense.

Price Range. Indeterminate

Contractors

Northrop Grumman Space Technology, Division HQ, http://www.st.northropgrumman.com, One Space Park, Redondo Beach, CA 90278-1001 United States, Tel: + 1 (310) 812-4818, Fax: + 1 (310) 813-7548, Prime

Technical Data

Characteristics. Not applicable.

Dimensions. Diameter believed to be approximately 4+ meters, based on comparative measurements of the Alpha laser core rings.

Design Features. The following subsystems are being individually developed for potential application in an space-based laser (SBL) platform.

Alpha High Energy Laser (HEL). The Alpha laser is the heart of the SBL project. The system was initially based on the Ballistic Missile Defense Organization (BMDO) Mid-Infrared Advanced Chemical Laser (MIRACL), but had to be redesigned because MIRACL was intended for sea-level operations. The current Alpha HEL has been optimized for space operations.

The basic design includes stacked cylindrical wings of nozzles for reactant mixing. The gain generation assembly can achieve higher powers by the simple addition of more rings. A 1991 test in a low-pressure, space operational environment showed that the Alpha

HEL was capable of megawatt-class power comparable to MIRACL.

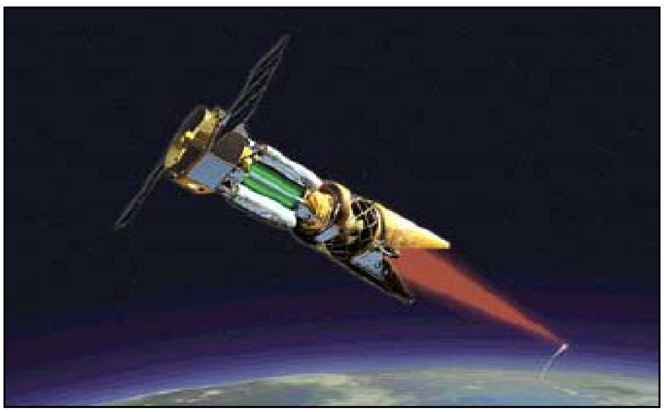
Large Advanced Mirror Program (LAMP). This program focused fabricating the large mirror required for use on the SBL system. The current mirror was fabricated in 1989 as a lightweight, segmented, 4-meter-diameter product. The mirror consisted of a 17-mm-thick facesheet bonded to fine figure actuators mounted on a graphite epoxy supported reaction structure.

Beam Control Large Optics Demonstration Experiment (LODE) and Alpha-LAMP Integration (ALI). This effort integrated the software and physical drivers of the actual beam control with the Alpha-HEL and LAMP program systems.

Acquisition, Tracking, Pointing/Fire Control (ATP/FC). This system had its first successful test in 1985, when subscale operational elements needed in an operational ATP/FC passed all performance requirements. These included separate pointing and tracking apertures, an illuminator, inertial reference gyro, fire control mode logic, sensors, and trackers.

Operational Characteristics. Proponents maintain that SBL is the only U.S. technology under development that can provide global, 24-hour, early boost-phase intercept (BPI) of both theater and strategic ballistic missiles. SBL has also been cited as increasing the probability of the hard kill of missiles in the midcourse bus phase, improving re-entry vehicle (RV) decoy discrimination, and negating long-range strategic bombers and cruise missiles.

Among the very considerable potential liabilities of SBL technology, according to some scientists, would be the sheer cost of launching these extremely heavy systems into orbit and the challenge of keeping the satellites stocked with chemicals for the lasers once they were in position.



Proposed Space-Based Laser Satellite

Source: U.S. DoD

Variants/Upgrades

This is an evolutionary technology development program in which the configuration of the equipment being developed is subject to continual change and improvement.

Program Review

Background. The history of the highly publicized Strategic Defense Initiative (SDI) program has been strategically, politically, administratively, and financially turbulent. The program began in the late 1970s under the auspices of the Defense Advanced Research Projects Agency (DARPA) and was then transferred to the specially formed Strategic Defense Initiative Organization (SDIO) in 1984. The dissolution of the USSR and the end of the Cold War prompted a change in U.S. political emphasis, causing the subsequent demise of the SDIO and the downsizing of the SDI program from space-flight program status to a research effort.

Responsibility for the remaining elements of the program would become the province the Ballistic Missile Defense Organization (BMDO). BMDO's SBL activities were largely abandoned during the first two years of the Clinton administration. Limited support was eventually recovered, however, under the influence of a conservative Congress and because the Clinton administration was receptive to the idea of a U.S. ballistic missile defense system.

While the threat of large-scale global warfare declined significantly with the end of the Cold War, the 1991 Gulf War highlighted the sobering truth that local sources of instability will continue to generate conflict. This realization caused the U.S. to rethink its defensive posture and the U.S. Department of Defense subsequently to initiate the development of a ballistic missile defense system. This was to provide protection to the United States, its forward deployed forces, allies, and other friendly nations against a limited ballistic strike, regardless of origin. Focused under the Missile Defense Act of 1991, the concept was given the name Global Protection Against Limited Strikes (GPALS).

To view the SBL program in perspective, one should note that the SDI/GPALS concept called for a multilayer ballistic missile defense system that would have consisted of a sophisticated sensory and command network and an arsenal of alternate weapon elements. The SBL would be one element of the overall program. In its full format, SDI development was covered under an umbrella of the following program elements:

PE#0603216C Theater Missile Defense (TMD) – Upgrade of Patriot and AEGIS systems and development of Corps SAM and the Theater High Altitude Area Defense (THAAD) system.

PE#0603205C Limited Defense System (LDS) – Development of ground-based interceptor sites and space-based sensors specifically designed to protect the continental U.S. (CONUS) and Alaska and Hawaii. Included Brilliant Eyes.

PE#063214C Space-Based Interceptors (SBI) – Research on space-based kinetic-kill interceptors such as Brilliant Pebbles and associated sensors that could provide an overlay to ground-based ABM interceptors.

PE#0603217C Other Follow-on Systems – Development of technologies to provide future enhanced SDI performance. Included were the Lightweight Exo-Atmospheric Projectile (LEAP) and high-energy laser, directed beam, and hypervelocity technologies. Projects to improve the speed and quality of acquisition, tracking, and discrimination capabilities of sensor platforms were also included.

PE#0603218C Research and Support Activities – Research, general test and evaluation, and support of other program elements. Included administration of SDIO.

Under PE#0603217C (which has since transitioned to PE#0603714C Support Technologies) – SBL critical technical issues were grouped into five areas: the laser device; optics; beam control; acquisition, tracking, pointing, and fire control (ATP/FC); and integration of the high-power elements of the system.

The program's laser device is a chemical laser that produces a high-power coherent beam from molecules excited by the hyperbolic combination of hydrogen and fluorine. In tests conducted between 1990 and 1992, the TRW-developed power output scaleable Alpha HF laser demonstrated a near-weapons-level continuous wave operation capability.

The program's optics can be divided into two categories: small, high-incident power (i.e., high-energy flux density) optics that create the optical path within the SBL system; and large, moderate incident power optics for expanding the beam to minimize diffraction limiting divergence effects and directing the energy toward the target. Small high-power optics technology has been demonstrated in several high-energy laser programs.

Government documentation reported that a break-through and extensive engineering developments in ultra-high-performance optics have permitted technologists to baseline uncooled high-power optics for both the near-term demonstration and first generation of operational high-energy (HE) chemical laser systems. This significantly reduced the complexity, weight, and cost of HE chemical laser systems, as well as improving their reliability.

The remaining portion of program activity is the Alpha/Lamp Integration (ALI) program, which would integrate Alpha, LODE, and LAMP hardware in an end-to-end laboratory-like ground-based experiment (exclusive of ATP/FC).

Upon completion of the ALI demonstration, the SBL program plan was to perform a formal Advanced Technology Demonstration (ATD) to substantiate the readiness of the SBL to enter engineering and manufacturing development (EMD). The conceptual design and program plan for this effort was previously developed and given the designation Star Lite. If supported, Star Lite would repackage ALI components for space flight and perform initial ground tests to ensure operability. This would be followed by the space demonstration of a scaleable Star Lite SBL weapon against simulated ballistic missile targets. The ultimate objective would be to achieve an initial operational capability around 2015.

However, SBL was slated for cancellation in FY95. The 103rd Congress directed that the SBL be phased out. Accordingly, only the ALI tests and initial HABE ground tests were to be performed. The high-power Alpha laser was placed in "maintenance only" status until required by ALI testing (in early FY97). No further SBL plans were financed.

Although the SBL program had been provisionally canceled, it managed to absorb some minimal funding.

Support continued, and the situation soon began to change.

In its FY96 defense authorization report, the Senate Armed Services Committee (SASC) recommended an increase of US$70 million to the program element covering SBL. SASC was particularly troubled by the administration's cancellation of SBL, noting that a space-based laser would be the most effective system for intercepting ballistic missiles of all ranges in the boost phase. The committee urged the secretary of defense to reinvigorate this program. An increase of US$50 million was approved for, among others, the SBL.

SASC again recommended increased funding for SBL in FY97, this time for US$40 million. Again the committee referred to SBL as the most effective BPI (boost phase intercept) system being developed by the Department of Defense. SASC was still skeptical of rival BPI program Airborne Laser. Even so, it agreed to the Pentagon's request for US$56.8 million to fund ABL in FY97.

A significant milestone for the SBL program was announced in April 1997. The first integrated ground test of the high-power chemical laser and optical subsystems for an SBL prototype was successfully completed. The test was conducted by TRW, builder of the Alpha chemical laser, and Lockheed Martin, developer of the Large Advanced Mirror Program beam projection telescope and the Large Optics Demonstration Experiment beam control system. Test personnel generated a megawatt-class chemical laser beam and fed it through the 4-meter-diameter beam expander and beam projection system for the first time.

Around mid-1997, Congress took a more active interest in the SDI concept as a whole, and the SBL program and its airborne cousin, the ABL, in particular. In the FY98 budget, Congress included unrequested funding that brought the recommended budget up to US$118 million for SBL R&D. Follow-on years apparently stabilized around the US$138 million mark.

In January 1998, the U.S. Air Force put out a search for a prime contractor to build the Space Based Laser Readiness Demonstrator (SBLRD). The first phase would be the awarding of a series of conceptual studies in order to determine the best approach to fielding an SBLRD by the 2005/06 timeframe.

Both TRW and Lockheed Martin were selected to provide contract definition studies of the SBLRD in March 1998. During this time, TRW released a statement that it was teaming with its ABL partner, Boeing, as Team SBL to bid for the SBL contract.

Early in that same year, the USAF had partially backed off of its 2005/06 commitment and had requested that the studies encompass two time schedules, fast and normal. The fast schedule would place an SBLRD in orbit by 2005, while a normal schedule would see the system deployed in 2008. The tentative schedule for an operational SBL could have such a unit in orbit between 2018 and 2020.

The USAF released a Draft Request for Proposal for the SBLRD acquisition in July 1998. This detailed the entire effort expected by the prime contractor from initial design to the completion of in-orbit testing. The award type would be for the procurement of one SBLRD as part of a cost-plus-award-fee contract. Also listed with this Draft RFP was an annotation that the preferred site of the SBL program had been identified but had not yet been published.

In February 1999, the USAF contracted with an industry joint venture for the SBL Integrated Flight Experiment (IFX). The award constituted the first increment of a cost-plus-award-fee/cost-plus-fixed-fee contract valued at US$2 billion to US$3 billion once completed. The first increment of approximately US$125 million supports tasks to be conducted in the first 18 to 24 months of the effort. These efforts include baseline development activities and an affordability and architecture study. The joint venture was formed by Lockheed Martin, the Boeing Company, and TRW Inc to advance and assess the feasibility of the SBL concept and its technologies, culminating in a demonstration in space.

Late in 1999, House of Representatives and Senate conferees criticized the SBL schedule for not being aggressive enough. They expressed the belief that funds made available in FY00 would have to be focused on development of an IFX baseline and necessary supporting technology. Consequently, the Senate added US$10 million to the administration's SBL request and directed the U.S. Air Force and BMDO to begin work on an SBL ground test facility, which would be up and running two years before the planned IFX launch date.

Before the November 2000 presidential election, the U.S. Air Force appeared to be downplaying expectations for deployment of SBL. In published statements from July 2000, the service indicated its belief that deployment would most likely not occur until at least 2020. This was due in large part to the slow pace of research and development. Also at this time, the decision to determine a site for an SBL test chamber was postponed. This may have been due as much to a slow research pace as it was to the jockeying by key senators to have the site located in their home states.

Almost immediately after George W. Bush took over the White House and came out in favor of his own version of ballistic missile defense (which may or may not include SBL), an avalanche of new rhetoric ensued.

Adding to the argument against investing in the costly program, the U.S. Marine Corps issued a statement in May 17, 2001, sharply questioning the worthiness of the program, citing feasibility, the estimated US$200 billion cost, and the harm to international relations. The statement also strongly posited that "the NMD [national missile defense] program by Bush is over-ambitious, diplomatically unsound, and perhaps overly-motivated by politics," and later, "the best defense is not always the biggest, shiniest, new weapon, but rather superior presence of mind and leadership."

In October 2000, the U.S. Air Force awarded Team SBL-IFX a US$97.4 million modification contract for the second increment of the SBL-IFX project. This work will involve system definition review and continued risk reduction testing of the laser, beam control, and beam direction aspects of the system. Work for this contract was completed by November 30, 2001.

A Pentagon funding boost in the summer of 2001 for FY02 promised to keep the program on schedule for the 2012 flight experiment. Under a new budget plan, SBL would be transferred back to BMDO management and the program would receive an additional US$50 million for FY02 for a total request of US$165 million. Tragic events about to befall the nation, however, would once again threaten the program.

With the September 11, 2001, terrorist attacks and the subsequent commencement of military operations to destroy future attackers, many defense programs would have to be evaluated under a vastly more critical light. By November, congressional authorizers had advocated a US$148 million cut to the FY02 budget. The DoD immediately announced its opposition to the cuts by arguing that the reduction would lead to the dismantling of SBL-IFX.

While this was transpiring, the DoD awarded the SBL team a US$50 million contract modification to provide for the initial phase of the third increment of the program's IFX project. The work would involve continued risk reduction testing in the areas of laser, beam control, and beam direction.

By the end of 2001, the Pentagon's aggressive attempts to reverse proposed cuts to the program apparently paid off. House and Senate authorizers decided to fully fund the FY02 effort with US$165 million. With many serious considerations still on the table (not the least of which are the possible violations of the Outer Space Treaty, which the U.S. ratified in 1967), the debate promised to rage on as 2001 turned to 2002, and congressional appropriators would once again be forced to deal with the issue.

With the release of the DoD's FY03 budget, the U.S. Air Force and BMDO SBL efforts were formally combined and placed within the Missile Defense Agency (MDA) under Boost Defense Segment program (PE#0603883C), Project #4043 Space-Based Laser. It was not immediately clear, from an organizational standpoint, how the division of labor would work out under this new arrangement.

SBL was re-evaluated by the DoD in its entirety during 2002. Results of this review included a general program restructuring and the cessation of prior SBL-specific program goals. In FY03 and beyond, the legacy SBL program would be evolved into a Laser Technology program and would be managed as part of the Advanced Systems (AS) program.

This directorate would now focus efforts and build on existing knowledge to further refine the directed energy (DE) concept, and provide options for future system production. Emergent technologies resulting from this investment would provide MDA with the ability to pursue DE systems, possibly including a space-based DE program. This strategy was consistent with the MDA spiral development and evolutionary acquisition approach to building effective and capable missile defenses.

Funding for the SBL program was then transferred in FY03 from the Boost Defense Segment to the Laser Technology program, Project #0503, as part of the MDA's Ballistic Missile Defense Technology program (PE#0603175C). The Laser Technology program focuses on developing lasers and related component technology for low-power applications including tracking, weapon guidance, and imaging, while investing in high-energy laser technologies that could lead to future SBL efforts. The emphasis on low-power systems is driven by their considerable potential to improve and support MDA's hit-to-kill weapons. The agency plans to select concepts and award contracts for six focused technology projects in FY03, continue these through FY04, and initiate two to four new projects in FY04.

In the FY03 MDA RDT&E descriptive summary annual budget, amounts through FY09 were made public. Through the FY04 and FY09 time period, between US$47 million and US$50 million will be spent every year on the program. The last year of funding for the program under SBL, in FY03, saw a budget of US$22.8 million.

During all this funding shifting and program realignment, the actual work of SBL continued. In FY02 many critical milestones were met, including the successful completion of the system level SBL-IFX design. In keeping with new program goals, however, the Team SBL-IFX contract was closed out. Around this same time Northrop Grumman acquired TRW and effectively ended the latter company's team leadership of the SBL-IFX effort.

Funding

In FY02, all SBL efforts previously split between the U.S. Air Force (under PE#0603876F – Space-Based Laser) and the Ballistic Missile Defense Organization (BMDO) (under PE#0603174C – Support Technology) were transferred to the Missile Defense Agency (MDA) (under PE#060388C – Boost Defense Segment, Project 4043 – Space-Based Laser). Beginning in FY03, funding for the Space Based Laser program (Project 0503) transitioned to support MDA's Laser Technology program (as part of Program Element 0603175C).

Recent Contracts

Contractor	Award (US$ millions)	Date/Description
Team SBL	10.1	Jul 2000 – Modification to contract to incorporate additional effort into the SBL-IFX program and extend delivery of the Systems Readiness Review from October 31, 2000, to December 5, 2000. Contract complete December 31, 2000. Space and Missile Systems Center, LA AFB, CA, is contracting authority. (F04701-99-C-0026-P00017)
Team SBL	97.4	Oct 2000 – Modification to provide for second increment (through November 2001) of SBL-IFX project to mature and integrate the component technologies, including a component and system-level test program leading to a proof-of-concept-on-orbit demonstration. Involved system definition and review and continued risk reduction testing in laser, beam control, and beam direction. Completed November 30, 2000. Space and Missile Systems Center, LA AFB, CA, is contracting authority. (F04701-99-C-0026-P00021)
Team SBL	49.9	Nov 2001 – Modification to provide for the initial phase (December 2001 through April 2002) of third increment of SBL program's IFX project. Project will mature and integrate the component technologies and will include a component and system-level test program leading to a proof-of-concept-on-orbit demonstration. Third increment involves continued risk reduction testing in the areas of laser, beam control, and beam direction. Work completed April 2002. Space and Missile Systems Center, LA AFB, CA, is contracting authority. (F04701-99-C-0026-P00036)

Timetable

Year	Major Development
1985	Subscale testing of all primary components of Acquisition, Tracking, Pointing/Fire Control (ATP/FC) system completed
1989	Large Advanced Mirror Program (LAMP) data available
1991	Successful tests of Alpha laser in the megawatt range
1993	Validation of ATP/FC slewing controls
1995	Demonstration of ATP/FC system at near weapons-level-scale disturbances
1997	Successful completion of Alpha-LAMP Integration demonstration
1998	Conceptual studies contracts awarded as the first step in determining a prime contractor
1998	Testing of SBL ATP/FC system against thrusting ballistic missile
1999	Team SBL (Boeing, Lockheed Martin, TRW) agreed to combine development efforts
2001	Congressional authorizers threaten US$148 million in cuts to program for FY02; most funding restored by end of 2001
2002	System Definition Review (SDR) for IFX completed; Northrop Grumman acquires

Year	Major Development
	TRW; SBL-IFX team terminated by DoD
2003	SBL program renamed within DoD and moved within MDA from Ballistic Missile Defense Boost Defense Segment to Ballistic Missile Defense Technology under the Laser Technology program

Worldwide Distribution

This is a **U.S.** only program with limited engineering developmental hardware produced to date.

Forecast Rationale

Funding for the development of the Space-Based Laser (SBL) has been put on hold for the foreseeable future. The costs associated with conducting a nearly all-consuming war against global terrorism have once again taken their toll on a cold-war era, high-profile, and extremely expensive U.S. defense program. Just as the Pentagon abruptly ended the development of the Comanche helicopter – for which billions of dollars had been spent on research – the SBL has also proven to be too much of a luxury given the present state of affairs.

The system (dubbed "Star Wars" during the Reagan years) was never quite able to escape its virtual founding in science fiction. SBL was intended to provide 24-hour, boost phase intercept capability and defense against a surprise first strike. Approximately 10 percent of the Earth would theoretically be covered by the footprint of just one satellite. A platform of 20 SBL satellites would provide overlapping, full-time coverage of missile threats from anywhere on Earth.

With the start of FY03, funding for the SBL program was, for all intents and purposes, wiped out and transferred from the Boost Defense Segment of the Missile Defense Agency (MDA) to the Laser Technology program, as part of the MDA's Ballistic Missile Defense Technology program.

According to the FY05 budget's mission description, the Laser Technology program will focus on developing lasers and related component technology for low-power applications including missile tracking, weapon guidance, and imaging, while investing in high-energy laser technologies that could lead to future SBL efforts. At present, however, the MDA is focusing much of its research toward the perfection of a ground-based mid-course element.

At the very least, there is important work related to laser technology that will be done in the next few years. In their efforts, developers could find a way to get the program re-started at a much more modest budget. SBL could then very well transition back to active status. It must be kept in mind that if there was ever the slightest hint that another nation was close to perfecting this technology for their own use, SBL would immediately be placed back on the fast track.

Ten-Year Outlook

No direct funding is forecast for this program at this time.

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