DIRCM FLASH Flight Tests

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ABSTRACT

The experimental DIRCM FLASH, developed by EADS, DBD and Thales has been integrated into a C-160 aircraft and successfully tested under in-flight conditions. FLASH is an active closed loop Directed Infrared Countermeasure (DIRCM) against heat-seeking missiles. FLASH operation is as follows: After handover following an alarm from the missile warning system FLASH enters autonomous passive tracking mode for tracking a missiles and sending a laser beam onto the missile. Fine tracking is achieved by active laser tracking and the missile is countered by laser jamming and laser damaging.

In the presented flight tests performed at CEV (Cazaux, France), the MILDS AN/AAR-60 MWS was used for generating the missile warning after SIDEMIR missile launches. The aim of the tests was to prove the correct handover from the MWS to the DIRCM and the autonomous passive IR tracking capability, obtaining sufficient tracking time and tracking accuracy for countermeasures.

In a following campaign at DBD (Röthenbach, Germany) the active closed loop capability could be proven by performing active tracking against a functional and approaching seeker head. The aim of these tests was to demonstrate the correct handover from passive IR tracking to active laser tracking and to quantify the achievable active tracking accuracy.

Results for both test campaigns are presented as well as live video scenes from air and ground.

1. INTRODUCTION

This article describes the flight tests with the closed-loop, laser-based DIRCM system called FLASH demonstrator ("**F***lying* **L***aser self defence system* **A***gainst* **S***eeker head missiles of* **H***igh performance").*

FLASH is designed to protect wide body aircraft against attacks from all types of IR-guided Surface-to-Air and Air-to-Air missiles. It is conceptually able to counter all existing and future IR-guided missile threats by using a combination of closed-loop-jamming and seeker head damage/destroying techniques. By continually analysing the output from its own and external sensors, FLASH is able to react adaptively

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to a threat engagement by selecting the optimum countermeasure mode (jamming or damage) to maximize survivability probability. Another important advantage of the FLASH concept is its ability to combat multiple IR missile attacks even at short ranges due to the short defeat time and instantaneous defeat assessment.

The FLASH demonstrator is the result of a ten-year German-French cooperation of EADS GmbH, Diehl BGT Defence (DBD), and Thales Optronique S.A. (TOSA) in the field of Directed Infra-Red Countermeasures. The goal was to show the feasibility of system functionality, like closed loop active tracking etc., on seeker head and missile simulators as well as real seeker heads during different ground and flight test phases.

The presented flight tests were performed at CEV (Cazaux, France) and the DBD test site (Röthenbach, Germany) in cooperation with CEV (France), WTD 81 and WTD 61 (Germany).

2. EXPERIMENTAL SETUP

FLASH is a closed-loop laser-based DIRCM system designed to be initiated by any missile warning system (MWS) that delivers the threat warning with sufficient accuracy and warning time.

Figure 1 shows the principle of the FLASH engagement sequence:

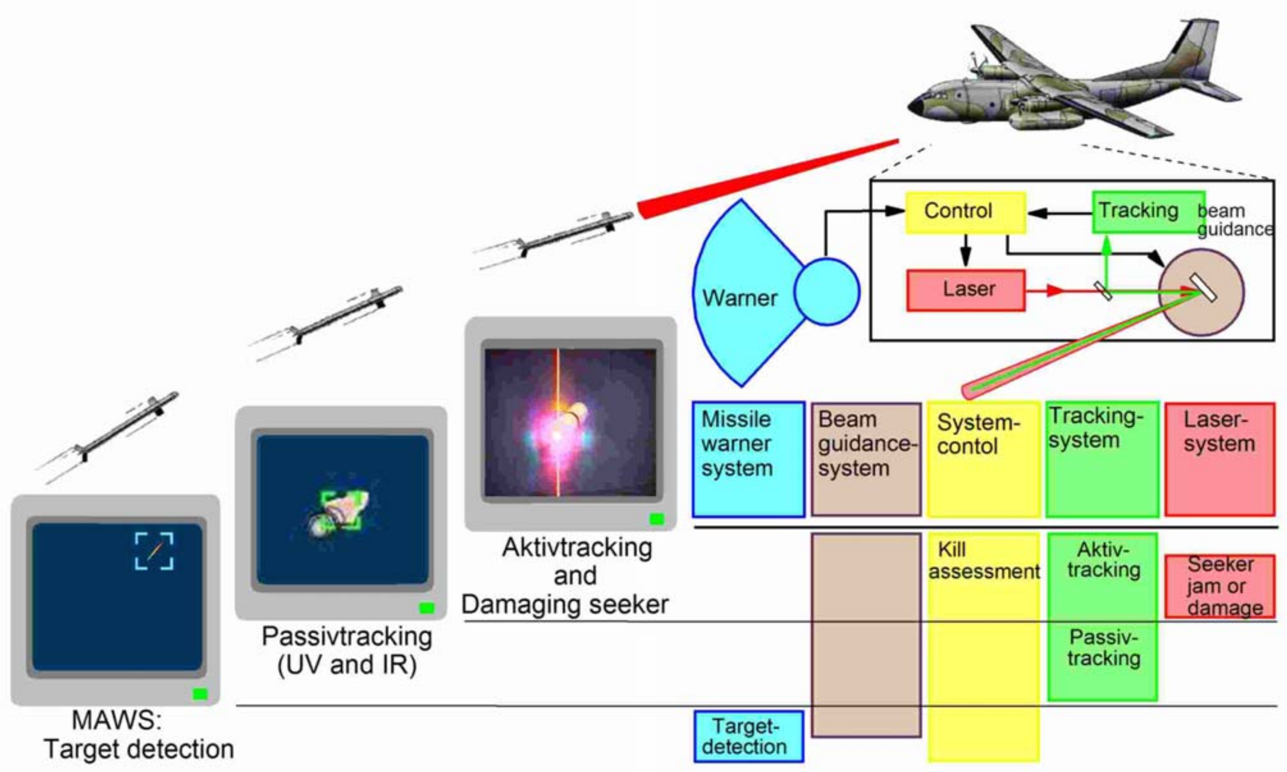

Figure 1 FLASH engagement sequence

Initiated by the MWS' detection and warning, FLASH starts its engagement sequence with slewing and passive tracking of the threat, followed by an active tracking via backreflected laser signal of the tracking laser. This active tracking capability provides for high tracking precision and accuracy, for closed-loop jamming and damaging of the threatening missile’s seeker head. In addition, the active tracking signal enables the system to gather information about the incoming missile allowing it to decide on the most appropriate neutralization strategy (either by jamming with an adapted jam code or by damaging the seeker head's sensor) and, at the end, getting a kill assessment in case of a successful engagement.

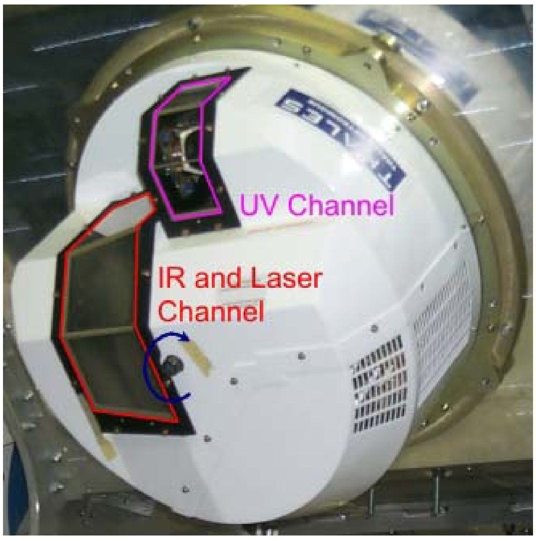

Figure 2 FLASH Demonstrator Turret

The major goal of the FLASH demonstrator program was to manufacture an experimental demonstrator (Figure 2 – FLASH Demonstrator Turret) for validation of the above described operational concept, comprising:

- MWS acquisition and hand-over to the FLASH
- Passive acquisition and tracking
- Active tracking
- Seeker head jamming or damaging

The system was also investigated concerning its performance characteristics, like fast reaction time, tracking accuracy etc. which are necessary for a successful engagement.

3. TEST AND EVALUATION

The FLASH experimental program started in 1997 with the system definition phase. In the year 2002 the experimental demonstrator was manufactured, integrated and functionally tested. Until the beginning of the year 2005 an intensive test phase took place including ground and flight tests with seeker head simulators and missile simulators as well as real seeker heads in the loop.
This test phase will be presented in the following chapters.

3.1 Ground Tests

Most of the ground tests took place at the DBD test site in Röthenbach, Germany. Figure 3 shows the experimental ground test setup: On the right, the FLASH demonstrator together with a MILDS® AN/AAR60 missile warner is mounted on a two-axis turntable which was used to simulate the movements of an aircraft. On the left, a fast moving sledge simulates the target movements with UV and IR sources to create targets for both, UV and IR tracker, a corner cube for seeker head simulation and operational instrumented seeker heads.

Figure 3 Moving Platform (left), Moving Target (right)

The ground tests comprise of the following tests:

- Engagements sequence against a moving target
- Engagement sequence from a moving platform (two-axis turntable)
- Laser tracking performance against a seeker simulation
- Performance evaluation of the system against different operational seeker heads

In addition a series of missile sledge firing tests at the test range of CEL (Biscarosse, France) to validate the passive tracking part of FLASH for different missiles' propulsions (Figure 4).

Figure 4 Sledge Missile Firing

3.2 Flight Tests

Two types of tests were to be performed for more dynamic testing than the above explained ground trials.

- Flight testing the system onboard a C-160 aircraft against approaching rockets
- Testing the system against an approaching seeker head mounted on a Puma helicopter

3.2.1 Flight tests onboard a C160 aircraft

After being transferred back to Germany from ground tests in France, the system was reassembled at the WTD61 facility in Manching and prepared on ground to operate with the identical flight rack configuration which was to be used onboard the C-160. This FLASH system configuration was installed inside the C-160 cargo bay with these components looking out of the rear door:

- FLASH turret,
- a MILDS® AN/AAR60 missile warner
- 2 wide angle video cameras.

The flight racks inside the cargo bay included operator consoles for:

- startup and controlling the system
- adaptation of input and system parameters,
- recording of data, analog video and digital video
- GPS startup and recording

All three tracking systems (MWS – MILDS® AN/AAR60, FLASH - UV tracker, FLASH - IR tracker) could be monitored online through control fields on the system monitor.

The recorded data included

- complete MWS data set sequences,
- FLASH system data,
- FLASH UV tracker data set,
- FLASH IR tracker data set and video,
- two wide-angle analog daylight color video camera sequences,
- handheld digital video camera sequence, GPS data

Figure 5 FLASH mounted on C160 (Transall)

After integration into the C-160 aircraft and ground test, the transition flight from WTD61, Manching to CEL, Cazaux was performed with the system onboard.

In the following days the flight tests were performed. The test plan established by CEV included in-flight testing of FLASH against static sources on ground and against the missile simulation SIDEMIR (a simulator type often referred to as "smoky SAM"). The pre-determined C-160 flight paths comprised of parallel paths at distances between .8Km and 3Km from the launch pad (or the ground sources)

3.2.1.1 Static target trials

The trials started with a series of tests using fixed ground sources for "static" MWS activation and DIRCM handover and tracking trials. The ground sources provided were a halogen lamp, a deuterium lamp and IR sources. The sources were activated when in the FOV of the MWS and the field of regard of FLASH. For the trials, the MWS was used in "test" mode to deliver all data. A static ground source could otherwise not have been used for tests since in operational mode only missile data are delivered to the DIRCM.

3.2.1.2 SIDEMIR dynamic trials

After the test runs with the static sources, the trials with SIDEMIR began. SIDEMIR is an unguided test rocket simulating a typical SAM signature, duration of boost and kinematics. For the dynamic trials SIDEMIRs were fired when in the FOV of the MWS and the field of regard of FLASH, with an elevation angle pointing at the aircraft and an azimuth angle ahead of the aircraft. Shortly after burnout, the SIDEMIR airbrakes activated automatically to prevent it from hitting the aircraft.

Figure 6 SIDEMIR Missile Simulator

The MILDS® AN/AAR60 missile warning system detected ("test mode") the ground sources and SIDEMIR approaches ("operational mode") and delivered the resp. direction data to FLASH. Upon these data, the FLASH turret and mirrors were slewed to the given direction. Once the UV source or the SIDEMIR became visible in the FLASH UV tracker FOV, the FLASH operating mode changed to autonomous UV tracking, centering the source in the UV tracker's FOV. As the IR source or the SIDEMIR is inside the IR FOV, passive IR tracking was activated and took over control from the UV tracker. The task was to keep the IR tracking process until burn out of the SIDEMIR. This could be proven successfully. At all the foreseen distances the system performed well, so that the test distance could be even largely extended to greater distances form the launch pad.

Figure 7 SIDEMIR firing at C160

3.2.2 Operational Seeker onboard Puma Helicopter

Another part of the tests was performed with an operational seeker head mounted on a helicopter (Figure 8) and the FLASH system mounted on the two-axis turntable at DBD test site (Figure 3) in Röthenbach, Germany. The goal of these tests was performance evaluation with an emphasis the active tracking part. At the same time the behavior of the seeker head when exposed to jamming IR radiation was to be examined. The recording and evaluation of these data was performed by CEV of France.
The helicopter was equipped with a UV source, an IR source, a retro-reflector for testing and calibration, an operational seeker head and devices for operating the seeker, visualization and recording of data and video sequences.

Figure 8 Seeker head mounted on helicopter

In contrast to the ground tests performed in the project, the helicopter approaching the FLASH system and carrying the seeker head was able to simulate an approaching missile. The ability of passive and especially active tracking as well as jamming could be proven under dynamic conditions. The signal of the missile simulation sources is weaker at greater distances and becomes stronger as the helicopter approaches. Therefore the ability of the system to cope with strong signal intensity variation was tested and proven during a number of flights.

4. CONCLUSIONS

The aim of the FLASH experimental program was to demonstrate the functionality of the FLASH concept. After completion of the demonstrator a series of ground and flight tests was successfully performed. During the ground tests the demonstrator performance could be further improved. The ground test results were confirmed during the flight tests, showing the performance under more operational conditions.
The FLASH demonstrator program is now finished and the German-French government-industry team is heading towards development and concentrating on specific issues of a series equipment, miniaturization, airworthiness, etc.

5. ACKNOWLEDGEMENT

The infrared countermeasure demonstrator FLASH was funded and developed under contracts from German BWB and French DGA. R&D funding and contracts awarded to the FLASH industrial team of EADS, DBD and Thales Optronique for further studies are still ongoing in Germany and France.