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INFRARED SENSOR TEST METHODOLOGY AND FACILITIES*

N91-19139

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ABSTRACT

As the Air Force Systems Command-designated Center of Expertise for Space Simulation Testing, AEDC has defined a test methodology for the ground testing of infrared sensor systems. This test methodology and the test facilities envisioned to implement it were the topic of a paper entitled "Surveillance Systems Test and Evaluation Facilities", by Mr Ronald Dawbarn and me presented at the 14th Space Simulation Conference in 1986. This paper is a progress report on the implementation of that test methodology and describes the status of the test facilities presently existing or under construction to implement it.

INTRODUCTION

In May of 1984 the Air Force Systems Command designated AEDC as the Center of Expertise for space environment and simulation testing. In this capacity, the Center is to provide test and evaluation expertise in several assigned functional areas, including space sensors. AEDC has extensive experience in the test and evaluation of space systems and infrared (IR) sensors in particular. Figure 1 presents a summary of the testing record in the area of infrared sensor systems. The period from 1982 to 1983 was spent in a major modification of the primary test chamber, 7V. The test and evaluation of such systems is particularly challenging when one considers that they must be able to operate in hostile natural and man-made environments against extremely large numbers of targets (see Fig. 2).

Performance Testing Levels

Obviously, the duplication of the entire sensor environment in a ground test facility is impractical and unnecessary. AEDC has undertaken the task of defining a test methodology for IR space sensors as a way to break their evaluation into reasonable segments. Through studies conducted by AEDC support contractors and contractors outside of AEDC, a common set of sensor test issues were identified (see Fig. 3). These issues can be addressed through a family of ground test facilities as indicated in Fig. 4. Of particular interest on this chart is the Focal Plane Array Test Chamber (FPATC) and the Large Sensor Test Chamber (LSTC) testing levels, which together address approximately 85 percent of the common sensor issues. The development and status of these various

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The LETS facility is an extensive modification to the existing AEDC 7V facility. The facility is designed to conduct calibration and mission scenario testing of exo-atmospheric IR seekers in the 15-cm entrance aperture diameter range. Real time environment and target simulation is planned for this very versatile facility to reduce the risk and the number of flight tests which might be needed in a development program (see Fig. 12). Figure 13 depicts the LETS layout and the high-level capability planned for the facility. Significant progress has been made on this facility, as shown in Fig. 14. Initial operation is scheduled for FY92.

The LSTC facility will be designed to conduct calibration and mission scenario testing of space surveillance sensors. LSTC will be somewhat similar to the LETS facility, but will be sized for sensors with entrance apertures roughly twice as large. Requirements for the facility have been well documented by the Strategic Defense Initiative Organization (SDIO), the Army's Strategic Defense Command (SDC), and the Air Force's Space Systems Division (SSD). The concept definition contract will be conducted in FY90, with one of the options being a modification to the existing AEDC 10V facility depicted in Fig. 15. Because of the wider wavelength requirement for the LSTC, the scene generation technology will be somewhat different from that employed in the LETS facility, but will be able to provide the complexity required for scenario testing at the sensor level. The facility is scheduled to begin operation in late FY93.

Survivability Testing Level

Figure 4 also mentions survivability testing being conducted in the Radiation Effects Test Facility (RETF). Several studies have been conducted on test facilities at this level. The result of this work is a facility named DECADE to be constructed by the Defense Nuclear Agency at AEDC. An early concept for this facility, is shown in Fig. 16. This facility will provide the ability to test relatively large segments (1 m^2) of space system electronics in a simulated nuclear environment to ensure system hardness in operational scenarios. The facility is scheduled to begin operation in FY95.

CONCLUSIONS

AEDC, as the AFSC designated center of expertise for space system testing, has developed a test methodology for sensor systems and planned the associated facilities. This paper has presented a broad overview of the status of that effort. Many of the sensor systems currently in development are adopting this method of ground testing to minimize their risks as they move into the flight test portion of their program.

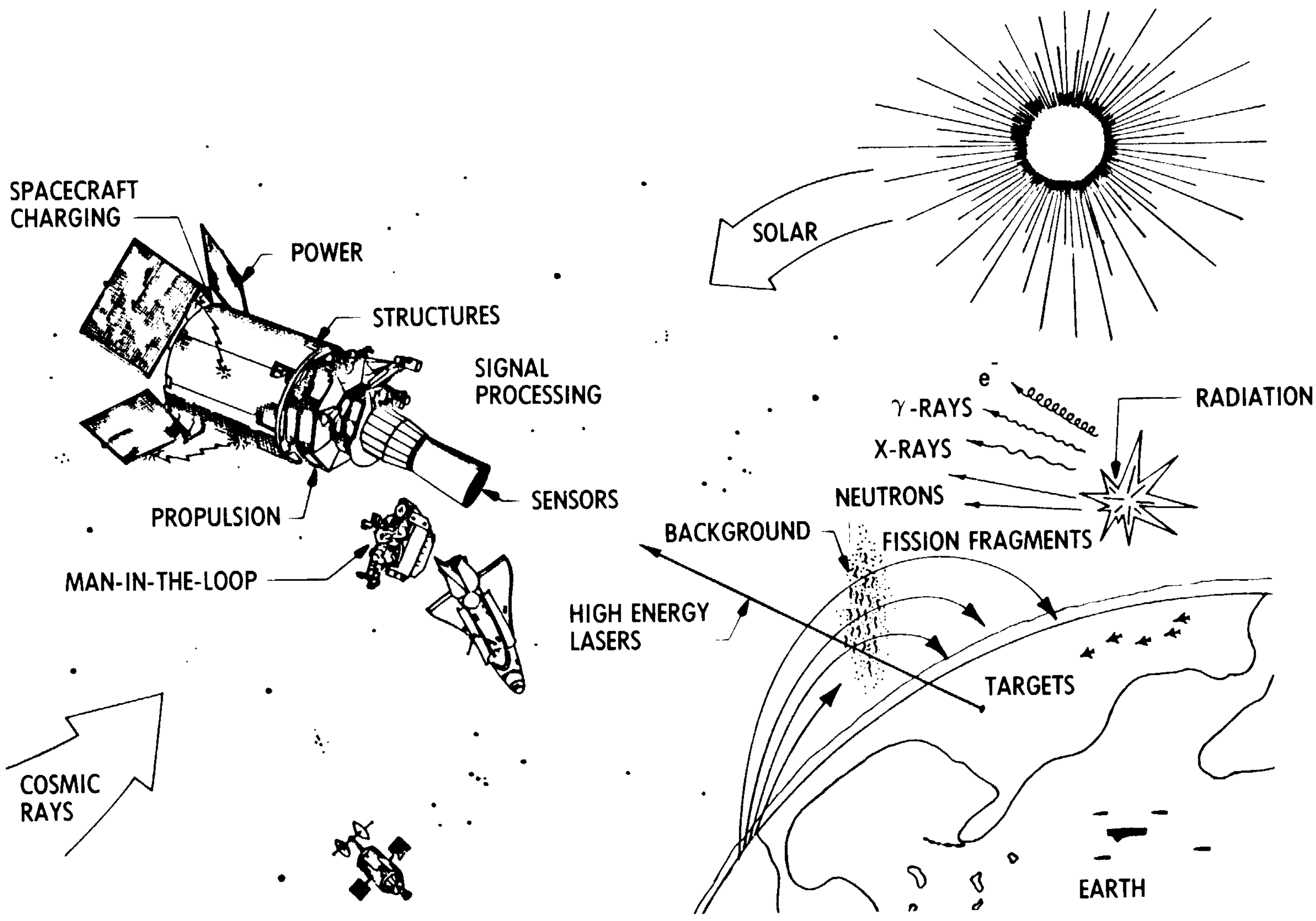


Fig. 2. Surveillance sensor operational environment.

SENSOR ISSUE	OPTICAL TEST FACILITY	COMPONENT CHECKOUT CHAMBER	FOCAL PLANE ARRAY TEST CHAMBER	RADIATION EFFECTS TEST FACILITY	LARGE SENSOR TEST CHAMBER	TOTAL ISSUE RESOLUTION
PRODUCIBILITY	30	17	37		16	100
SENSITIVITY/RANGE PERFORMANCE	18	18	57		7	100
CSO RESOLUTION	4		77	2	17	100
ANGULAR MEASUREMENT PRECISION	3	10	68	1	18	100
RADIOMETRIC MEASUREMENT PRECISION	1	9	68	2	20	100
STRUCTURED BACKGROUND REJECTION	1		84	1	14	100
CLUSTER PROCESSING	1		85	1	13	100
EXTENDED TARGET TRACKING	1	5	74		20	100
THROUGHPUT			93**		7	100
PERFORMANCE IN NUCLEAR ENVIRONMENT			57	32	11	100
CONTAMINATION*	24	2	23		51	100
TOTAL	83(7)	61(5)	723(65)	39(4)	194(19)	1100(100)

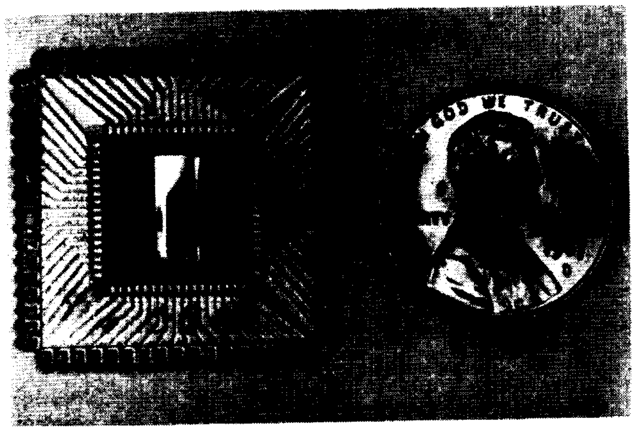
* ISSUE NOT TOTALLY RESOLVED BY THESE FACILITIES ** USES EMULATOR AND ANALOG SIMULATIONS

XX(YY)

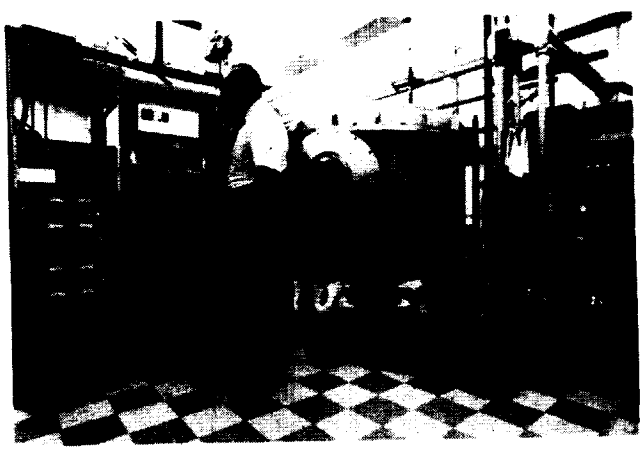
XX IS THE PERCENTAGE OF THIS TEST ISSUE WHICH HAS BEEN RESOLVED BY THIS TEST

YY IS THE PERCENTAGE OF TOTAL

Fig. 4. Sensor issue/test facility correlation matrix.



- RADIOMETRIC CHARACTERIZATIONS
- MULTIPURPOSE TEST CHAMBER
- WIDE RANGE OF TEST PARAMETERS
- HIGH-SPEED DATA ACQUISITION AND CONTROL SYSTEM
- REAL TIME GRAPHICAL DATA DISPLAYS



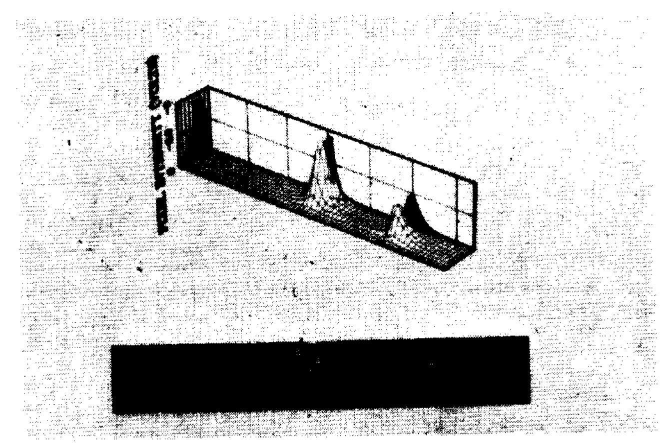


Fig. 6. Focal plane characterization testing.

SPECTRAL BAND(S)
MAX OPERATING TEMPERATURE
OPERABLE TEMPERATURE RANGE
OPERABLE LIFE
BACKGROUND IRRADIANCE
INTEGRATION TIME
ARRAY CONFIGURATION
PIXEL SIZE, CENTER-TO-CENTER
PIXEL SHAPE
PIXEL SPACING
NOISE EQUIVALENT INPUT

DYNAMIC RANGE
LINEARITY
RESPONSE UNIFORMITY
RADIOMETRIC STABILITY
CROSSTALK
RECOVERY TIME
POWER CONSUMPTION
DEGRADED CHANNELS
D*
QUANTUM EFFICIENCY

Fig. 8. FPA performance parameters menu.

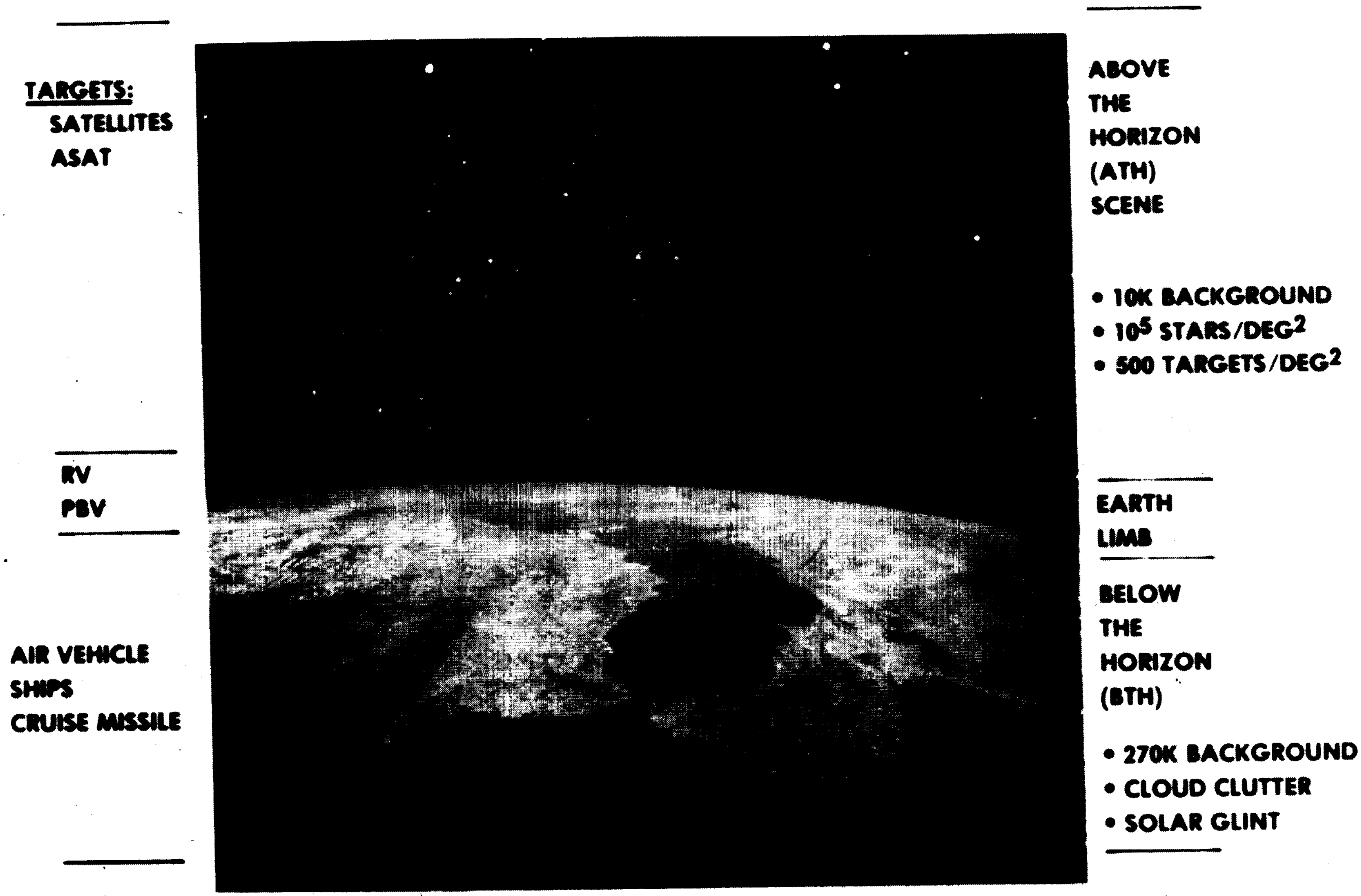


Fig. 10. Illustration of ATH/BTH scene from space platform.

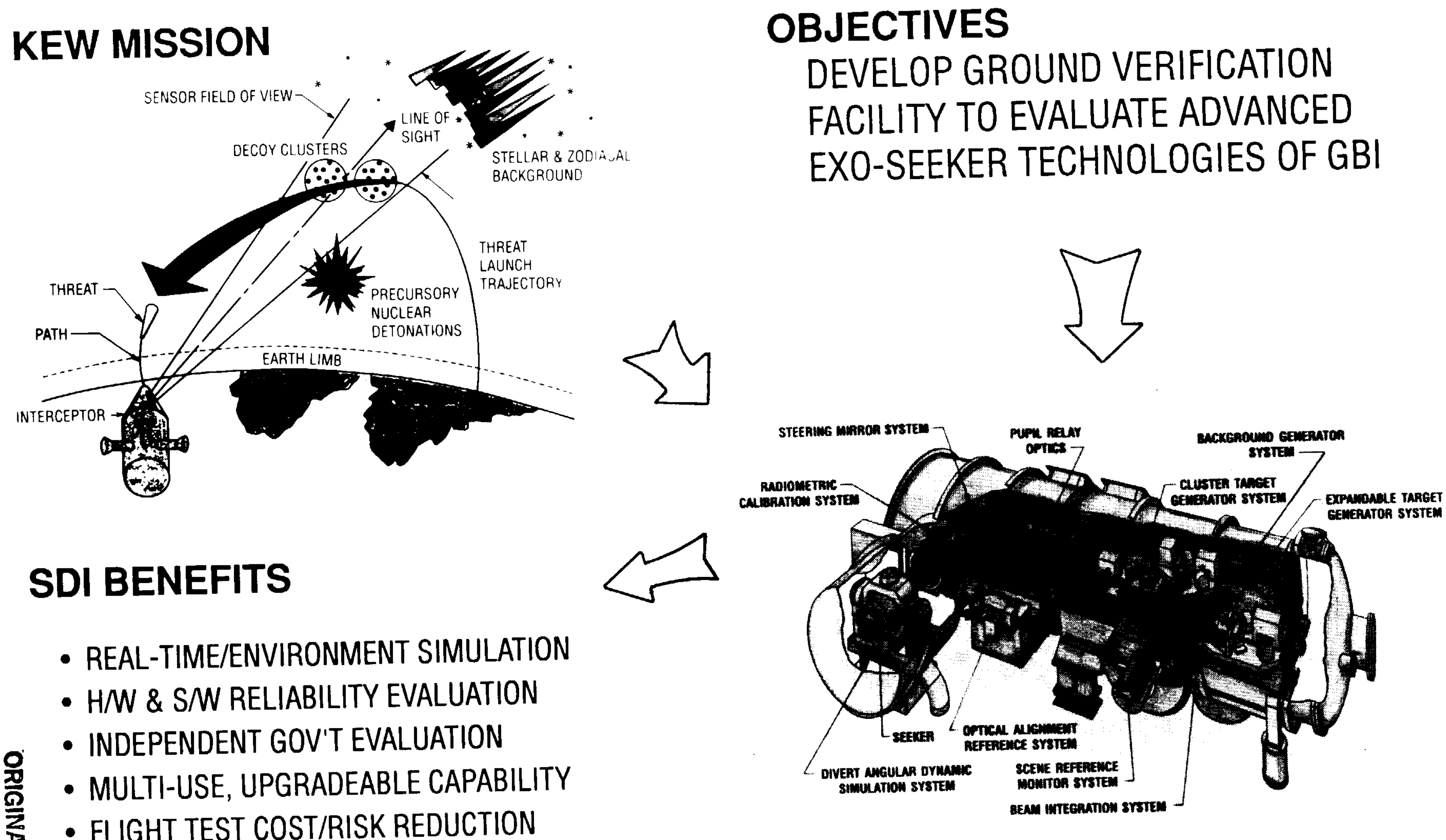


Fig. 12. LETS facility development.

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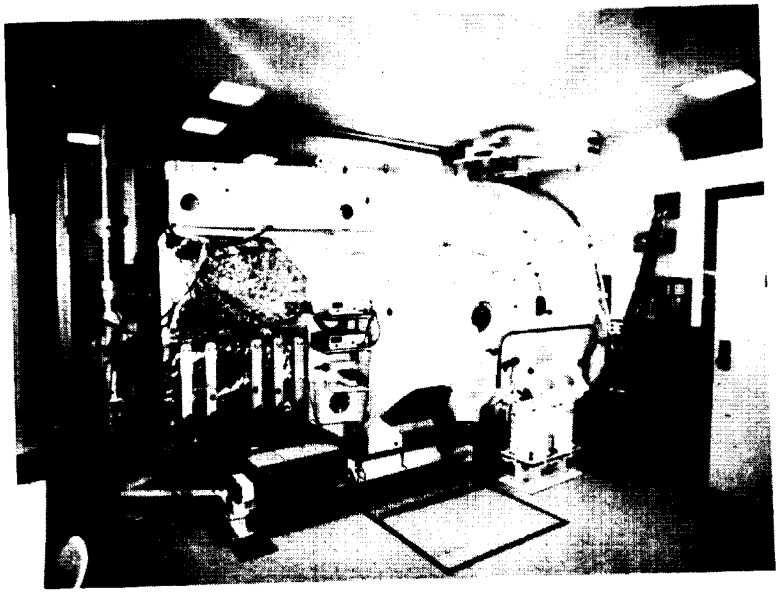
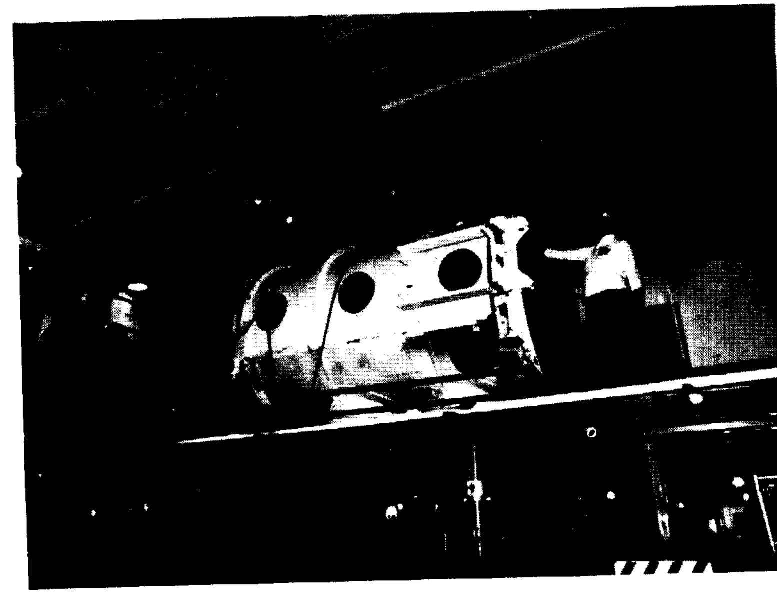


CHAMBER MODS
- DEMOLITION COMPLETED - OCT 89
- REWORK STARTED - DEC 89
- COMPLETION TARGET - MAY 90



CLEAN ROOM MODS
- DEMOLITION STARTED - SEP 89
- START CONSTR - JAN 90
- COMPLETION TARGET - SEP 90

Fig. 14. LETS facility status.

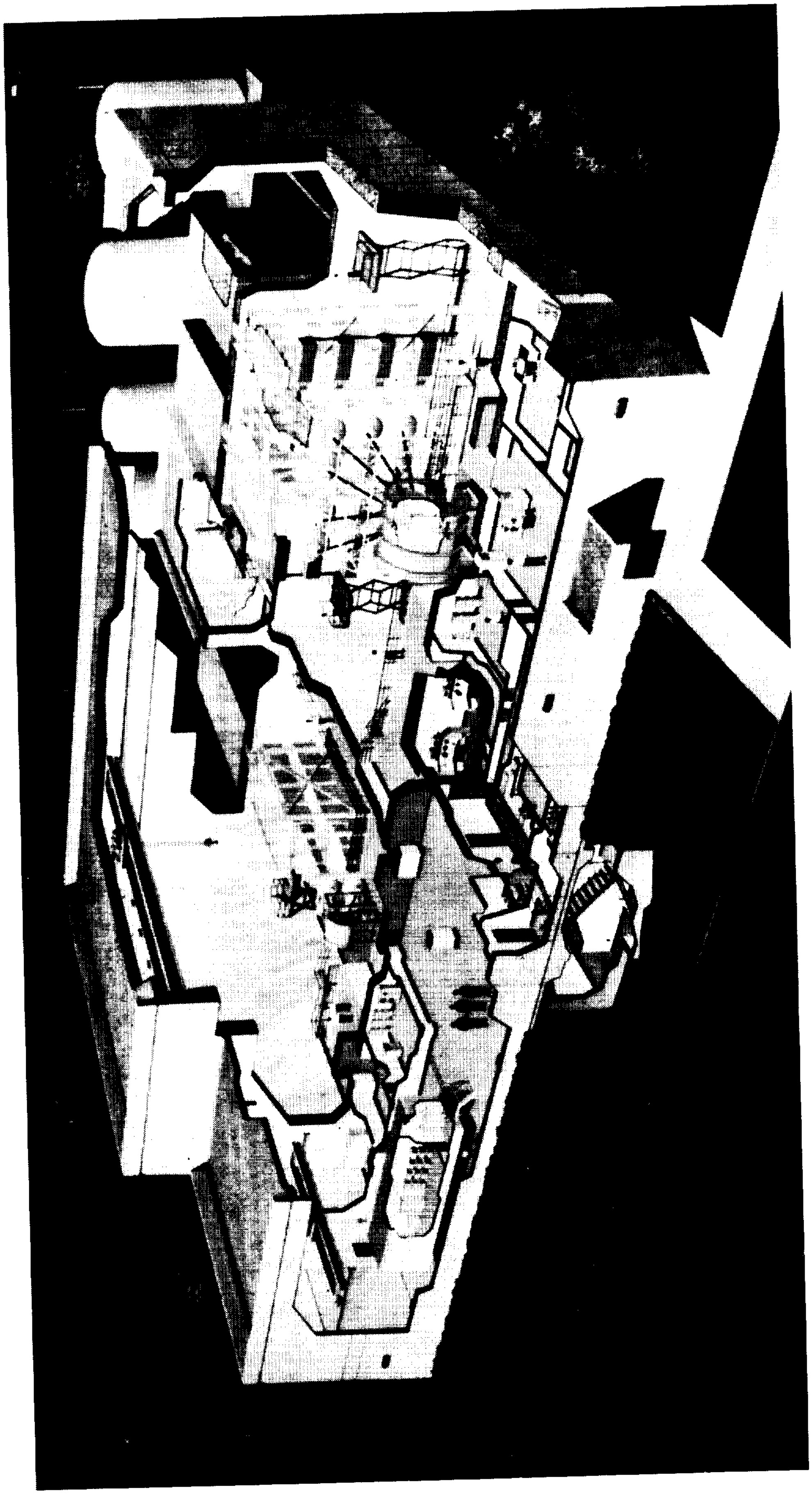


Fig. 16. DECADE Radiation Effects Test Facility.

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SESSION IV

INFRARED SENSOR TEST FACILITIES: PART II