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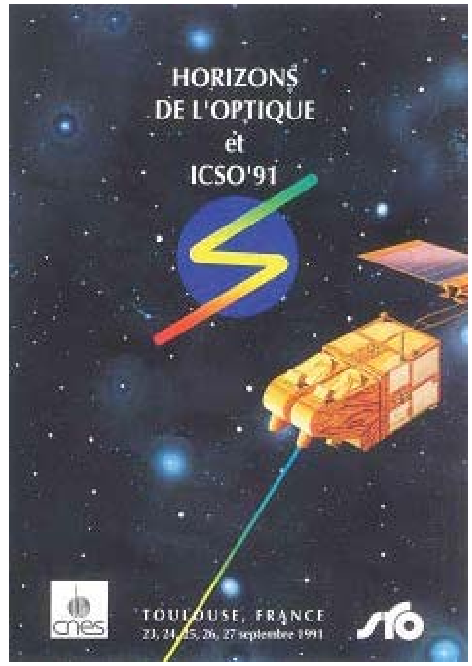

Session 1: Optical Space Communications

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THE SILEX PROJECT THE FIRST EUROPEAN OPTICAL INTERSATELLITE LINK EXPERIMENT

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ABSTRACT

A significant improvement of a space communication system can be achieved through the implementation of a link between two geostationary satellites or one geostationary satellite and one Low Earth Orbiter.

In the frame of ESA ARTEMIS programme, MATRA is the Prime Contractor of the SILEX project ("Semiconductor Intersatellite Link EXperiment"), which is the first European optical communication system dedicated to an interorbit link. As the hardware development phase is currently starting, this paper summarizes the concept based on 0.8 um diodes and describes the key features of the mission and its technical definition. This will permit demonstration of a link between the French satellite SPOT IV and ARTEMIS in 1995.

SYSTEM TEST BED
The demonstration of the optical space communication feasability

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ABSTRACT

The use of laser diodes for optical communications between satellites is the object of the European SILEX program funded by ESA for which MATRA is prime contractor. As a step towards the development of a full scale space system , a complete System Test Bed (STB) dedicated to optical space communication feasability demonstration has been built on ground It uses functional breadboards of all key equipments required for an optical terminal. Communication and pointing functions have been studied and evaluated, both at subsystem and system level. At system level a complete link includes two terminals, one of which is a simulator .

Measurements results at subsystem and system level have strengthened the theoretical predictions.As examples:

*The measured sensitivity for BER < 10^{-6} is -62.5 dBm at 60 Mbit/s (39 photons/bit). A 1.7 dB degradation has been measured with 4 10^{-10} W of optical background.To our knowledge,this is actually the best performing system using direct detection.

*The one sigma pointing error in presence of nominal platform mechanical disturbances was expected (from simulation) to be 0.3 urd, the measured pointing error was 0.2 urd.This result consolidates the PAT (Pointing Acquisition Tracking) analysis method and hence validates the theoretical pointing budgets for flight model.

STB DESCRIPTION

The purpose that have been set to the STB are multifold. It must :

- provide an on-ground demonstration of the feasibility of optical links with a particular mention of the SILEX system.
- Allow the measurements of subsystem terminal and system performances.
- Become one of the integration and verification tools for the terminal flight model.

A functional sketch of the SILEX system is shown in figure 1 and has been translated to a STB functional diagram in figure 2 where a test arrangement has been inserted to interface between optical beams and electrical signals while the counterterminal. the CPA and the telescope are simulated .

CPA and telescope simulations are justified in that the Far Field Pattern (FFP) conditions for the telescope are reached for distances over 150 km and in that a Coarse Pointing Assembly (CPA) usually operates under 0g conditions. If the chosen model and characteristics are representative enough, thanks to breadboarding results, much simplicity and versatility are

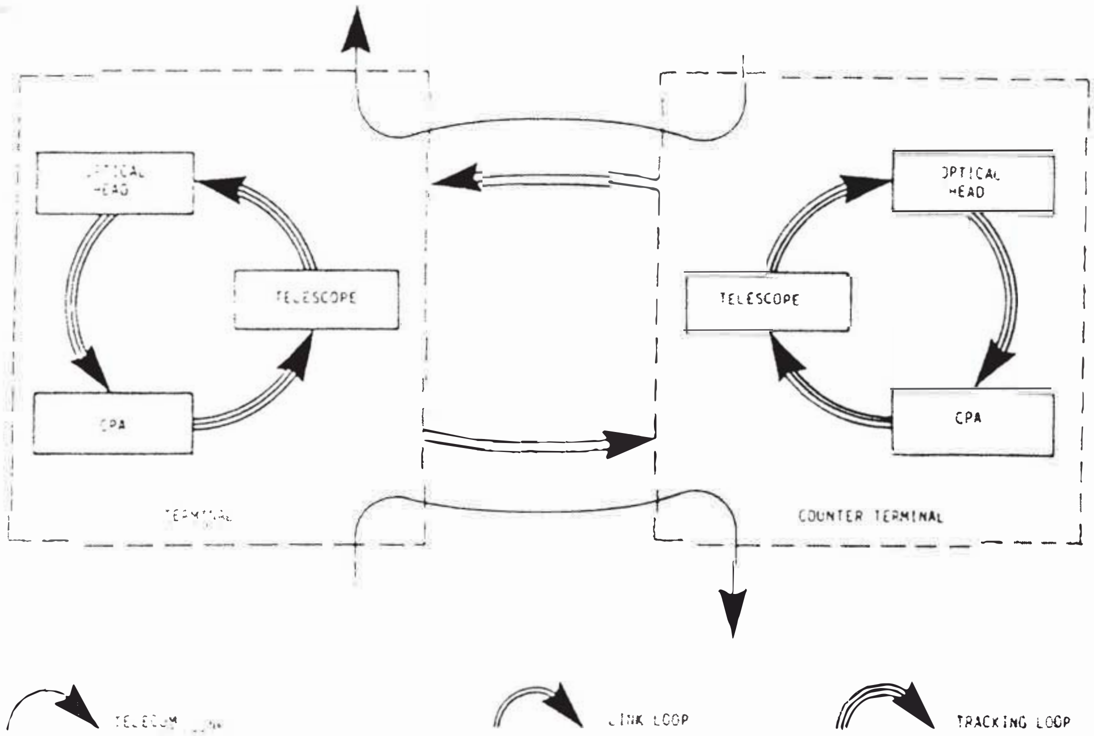

Figure 1 : SILEX Functional diagram

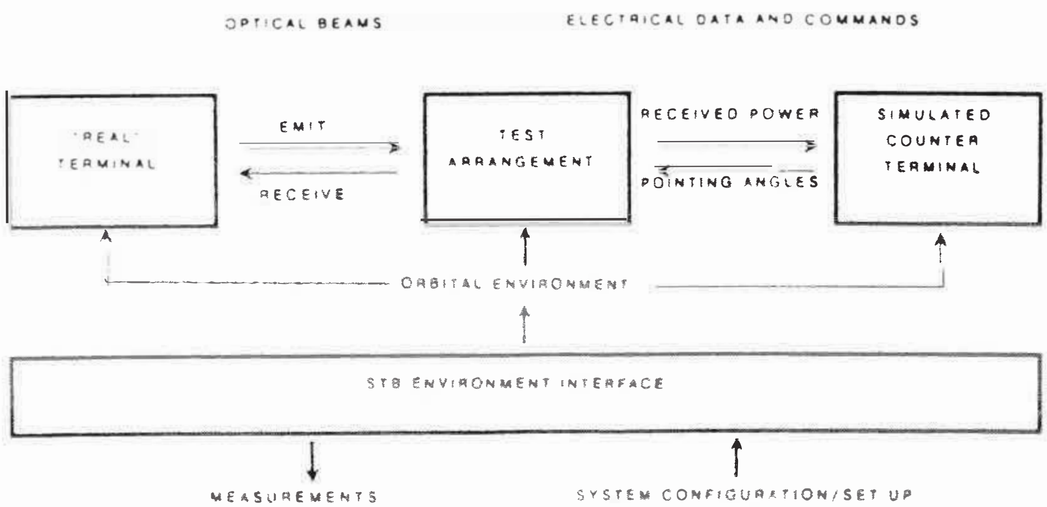

Figure 2 : STB Functional outline

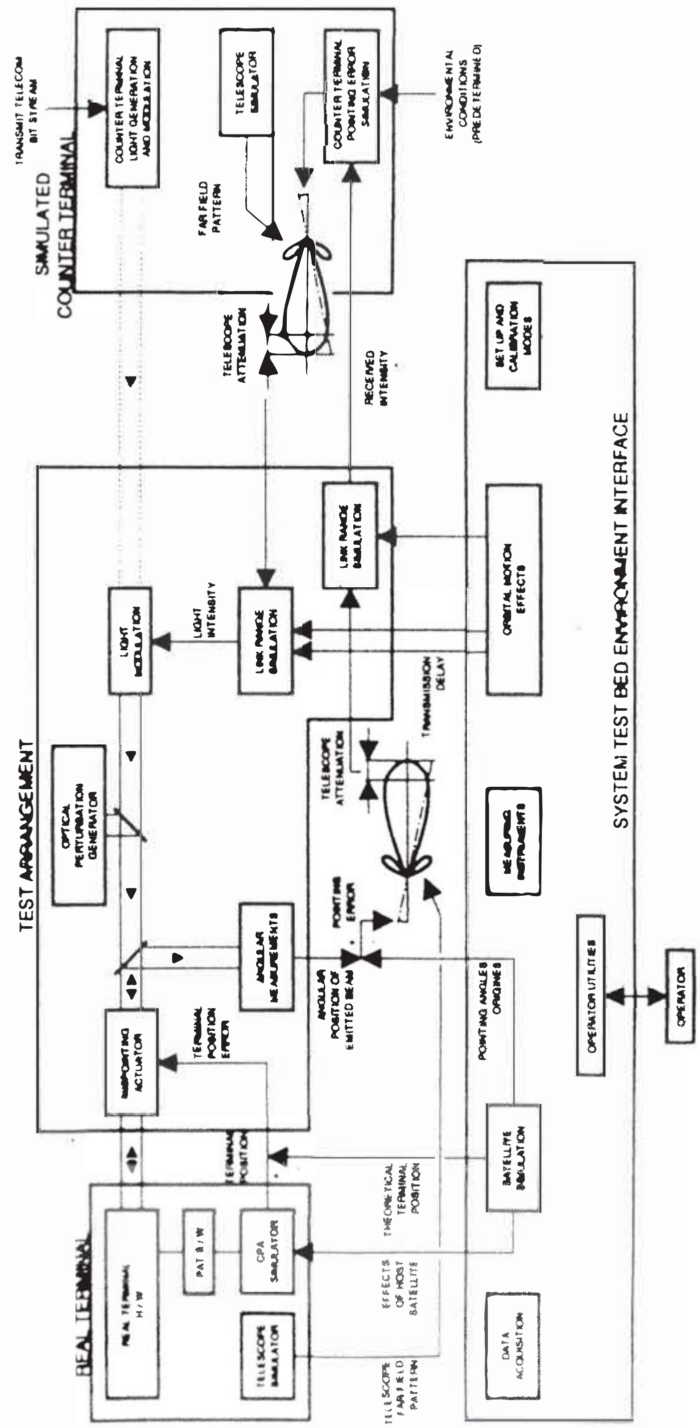

Figure 3 : STB Functional architecture

BALISE OPTIQUE SILEX

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La Balise est un des équipements du programme SILEX de l'Agence Spatiale Européenne, qui a pour but d'établir une liaison de télécommunications par voie optique entre satellites.

Implantée dans le terminal du satellite géostationnaire, la fonction de la balise est de générer un faisceau optique continu intense, uniforme et collimaté, qui, dirigé vers le satellite en orbite basse, permettra s'assurer l'alignement précis des deux télescopes afin d'établir la liaison de télécommunication.

La définition de cet équipement est basée sur l'utilisation de 19 diodes laser émettant chacune 500 mW continus. Le flux lumineux provenant de chaque diode est couplé à l'aide d'une optique anamorphique dans une fibre optique multimode à saut d'indice. Les 19 fibres sont ensuite compactées et mises en regard d'une fibre unique dont les fonctions sont d'assurer un mélange incohérent des 19 flux unitaires et de garantir l'uniformité requise du flux total émergeant. Ce dernier est ensuite collimaté à l'aide d'un objectif dioptrique assurant la conjugaison entre le champ proche de la fibre et le champ lointain la balise.

La communication présentera la définition de l'architecture générale de l'instrument établie à partir des spécifications fonctionnelles et des besoins opérationnels (fiabilité en particulier) et la définition optique en découlant. Les résultats expérimentaux obtenus sur une maquette de développement seront également présentés.

STUDY OF AN INTERSATELLITE OPTICAL LINK WITH COHERENT RETURN LINK.ASPECTS OF MASS REDUCTION AND SUBSYSTEMS DECOUPLING BY MEANS OF OPTICAL FIBERS.

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Reduction of masses,volumes and power consumption is one of the most important tasks to be reached in order to make an intersatellite optical link attractive.

In this work, we report the results of the study on two kinds of Low Earth Orbit (LEO) satellite and Geostationary Earth Orbit (GEO) optical links in which the return LEO to GEO is realized with a TEM00 Nd-YAG laser beam placed on LEO satellite.

The use of a single mode laser beam makes it possible to use a transmitter telescope of reduced aperture,thanks to the very high antenna gain achievable.

In the present study, we consider a symmetric (equal telescopes on LEO-GEO terminals = 150 mm) and an asymmetric (different telescopes apertures on the terminals LEO telescope's aperture =150 mm,GEO telescope's aperture = 250 mm).

Moreover,the use of a TEM00 beam allows very high coupling efficiencies in singlemode polarization-mantaining optical fibers.As a consequence,the possibility of decoupling the laser source with the electric supplies from the optical aerial terminal may be foreseen,together with a further decreasing of the aerial terminal mass,in particular for LEO terminal.