

VIZIR - THE S.E.P. HIGH RESOLUTION LASER BEAM RECORDER

M.L. Salter and M.G. Maincent

Optical Space System Division, Société Européenne de Propulsion
Vernon, France

1. INTRODUCTION

In terms of Satellite System, there is a common tendency to think that all of the engineering and technical problems turn to the level of the onboard equipment. Although this is true in most, not to say in the majority, of the cases, there is, however, a number of equipment items for ground based stations, that raise some intricate problems ; among such equipment items, can be mentioned the image reconstruction systems on photographic films that are used in the ground based receiving stations, of the meteorological data transmitted by satellites such as the S. M.S., for instance.

I have much pleasure in having to tell you about a high performance image reconstruction unit, for which a number of delicate issues had to be solved by use of advanced techniques... sometime with a great deal of novelty.

The problem submitted to us was quite simple in its wording :

"How to reconstruct, at the ground, in real time, the image data transmitted from the S. M.S. Satellite in its various modes, while keeping the veru high resolution of the image scanned by the onboard sensors ?".

The answer to be given was just as simple : "the only requirement is to design and build an image reconstruction unit which suits to the problem".

In order to make the account less anonymous, I must tell you that the Agency that raised the problem was the French National Meteorology, and the company who solved it ; was SEP (Société Européenne de Propulsion) by proposing the VIZIR, a "laser beam recorder" I am now going to describe to you further.

2.. FUNCTIONS OF THE VIZIR IN A METEOROLOGICAL DATA RECEIVING STATION

The Wallops Station retransmits every fifteen minutes a visible image and a infrared image previously scanned by the sensors of the S. M.S/A satellite. The receiving station of the French National Meteorology, located at LANNION, therefore receives data to be stored in an amount close to 250 million points. Various approaches may be envisaged for the storage, such a "digital archiving" on high density magnetic tapes, or "analog archiving" on photographic film.

For ground based stations of which the mission is to supply data for interpretation purposes, the analog approach is selected, enabling to have images available ; in the case of gestationary meteorological satellites a succession of images is available which allows quantifying the evolution with time of the overall events.

The VIZIR shall according be regarded as a means for high density archiving of the meteorological data on a photographic film. The data are stored on-line under a form accessible to interpretation. The VIZIR thus forms the final link of the receiving system of a ground station.

It may easily be understood that the major qualities such an equipment should feature are as follows :

- a modulation transfer function not impairing that of the scanning system onboard the satellite.

- a dynamic and a photometric resolution high enough to obtain a good signal-to-noise ratio.
- a high fidelity in the reproduction of the scale of grey on the image format and from one image to the other.
- a good reproducibility of the geometry of the image as well as from one image to the other to make superpositions possible (case of the colored compositions).

All such requirements are met with the VIZIR by use of most advanced techniques at the level of the subunits that constitute it.

3. PRINCIPE OF OPERATION AND MAIN PERFORMANCE LEVELS OF THE VIZIR

The VIZIR, is first of all, a laser beam recorder in operational service for more than two years now, in the sation of the C.E.M.S. (Space Meteorological Research Center) at Lannion. In order to understand its principle of operation, the following general ideas should be kept in mind : (fig. 1).

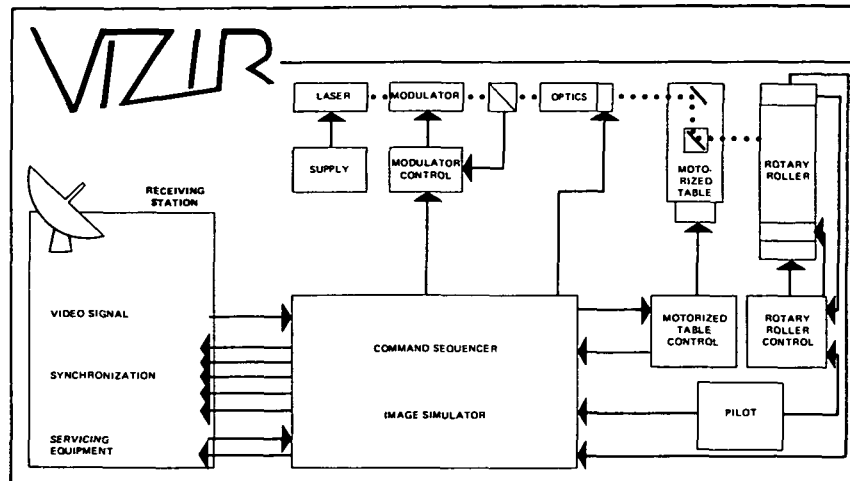


FIGURE 1 - GENERAL PRINCIPLE OF THE VIZIR

- the video-signal, proportional to the apparent ground luminance, controls a static light modulator of the electrooptical or acousticoptical type,
- the modulator placed behind a continuous beam laser acts as an optical filter the transparency of which varies at the rate of the modulation of the video-signal.
- the modulated light beam is focused on a photographic film ; the latter is placed on a rotating drum suspended on active magnetic bearings.
- a motorized table, with step by step feed motion, carries the focusing optical system ; this table travels parallel to the rotation axis of the drum at the rate of entry to the lines of the image.
- a continuous rotation of the drum at constant servolooped speed provides for point scanning.

Further, it is worth mentioning, that the equipment works in the asynchronous mode, which means that a low capacity buffer storage associated with the VIZIR mini-computer, acts as a regulator of the data rate between the output of the decoder and the input of the laser

beam recorder. This principle of operation avoids every difficulty of synchronization between the transmission and the reception.

According to the wise principle of "What can do more can do less", I shall just give the technical data of the VIZIR with the highest performance levels, therefore the one that was developed for the S. M.S. application (fig. 2).

Photographic Support	KODAK or 3 M film	Density levels	64 with $\Delta D = 0.037$
Image size	400 x 400 mm	Permanent distortion	$< 3.10^{-4}$
Number of lines	15,000	Random distortion	$< \pm 3.10^{-5}$
Spot diameter	27 microns	Gitter	$< \pm 0.610^{-5}$
Image reconstruction time	15 minutes	Video input signal	0-1 volt ; 300 KHZ

FIGURE 2 - MAIN CHARACTERISTICS OF THE VIZIR (SMS)

The large image size allows the users easy interpretation without having to resort to enlargement through a conventional process. Interest is arising in substituting the bath development type of film, by a heat development type of film providing faster access to the data and simplifying the operating procedure.

4. PRESENTATION AND OPERATING PROCEDURE OF THE VIZIR

The external presentation of the VIZIR features two separate subunits :

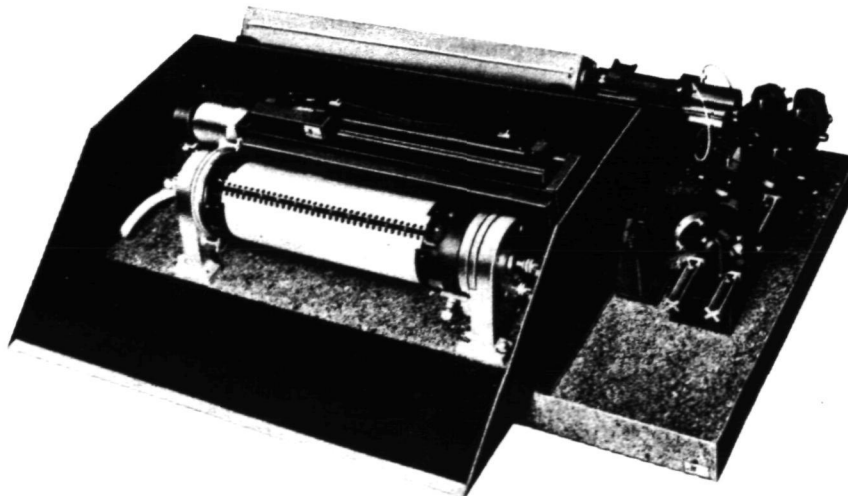


FIGURE 3 - ELECTRO-OPTICAL SUBUNIT OF THE VIZIR

- the first one, (fig. 3) referred to as the electrooptical subunit comprises the various optical components (laser, modulator, lenses) together with the mechanical components providing for line scanning (motorized table) and point scanning (rotating drum on magnetic bearings) ; all these components are arranged on a surface plate enabling strict maintaining of the optical alignments.

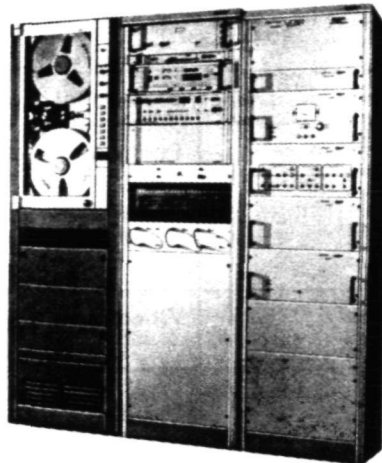


FIGURE 4 - ELECTRONIC SUBUNIT OF THE VIZIR

- the second one, (fig. 4) referred to as the electronic subunit, is in the form of a rack that comprises : the power supplies, the speed and suspension of the rotating drum servo-electronics, the mini-computer, a magnetic tape unit, eventually, and finally a control desk. It is from this desk that the operator controls the starting of the VIZIR and selects some of the options of the image reconstruction system such as the obtention of a negative or positive image, or a different resolution.

The two subunits are cable connected. They are generally used in association with an automatic film developing module.

The operator can monitor the performances of the equipment by means of a built-in test generator that internal simulator generates a scale of grey or a checker-board test pattern..

5. FIELDS OF APPLICATION OF THE VIZIR

Further to the reception of the image data transmitted from the S. M. S., it may be considered that the VIZIR is quite suited to :

- the reception of the data that will be transmitted from the European meteorological METEOSAT satellite. In that case, the resolution of the visible image (5,000 x 5,000 points) and of the infrared image (2,500 x 2,500 points) allows simultaneous and on line reconstruction of these two images on the format. This remark applies both to the reconstruction in the Central Station that will be located at Darmstadt and to the reconstruction in the Primary Data User Stations (PDUS).
- the reception of the data that are and will be transmitted from the U.S. satellites of the V. H. R. R. type. The same remark as above applies as regards the obtaining of simultaneous black and white and infrared images.

Prior to closing the list of the signal reconstruction configurations in ground stations, I would like to mention, that the VIZIR could readily be fitted to ERTS or LANDSAT receiving stations. (fig. 5).

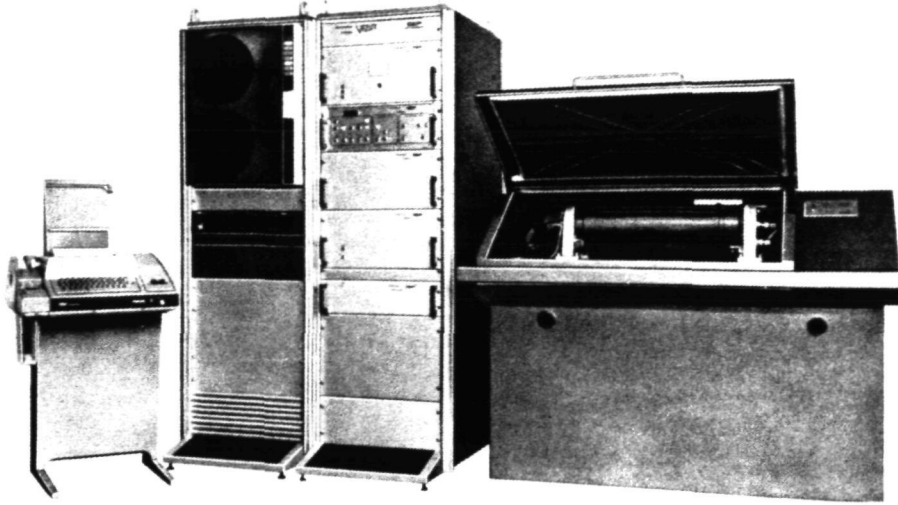


FIGURE 5 - IMAGE DISPLAY UNIT

Turning to other purposes, the applications of the high definition laser beam recorder to Digital Data Processing Centers are worth mentioning. After applying such or such calculation algorithms to image signals, a reconstruction on film is carried out with the object of subsequent data interpretation. For such type of OFF-LINE application a magnetic tape unit is added to the VIZIR, acting as the data source, together with a display console on color screen, according to the requirements, we call this grouping of equipment units an image display unit (Fig. 5). In France, "l'Institut Français du Pétrole" is already equipped with such a system. We are currently building another one for the Indian Space Organization : ISRO, and for the EURATOM CENTER of ISPRA (ITALIA).

6. CONCLUSION

Since a few years, the area of image reconstruction on photographic film has evolved towards a demand for higher and higher performance equipment. The present requirements in this area are likely to be exceeded within a short future and this is why SEP did not hesitate to develop a hardware making use of the most advanced techniques (laser, static light modulator, active magnetic bearings), enabling to effect the necessary extrapolations. Among such extrapolations there is ground to envisage, first of all, the direct reconstruction of colored photographs.