THE BRESEX MULTISPECTRAL CAMERA: PRELIMINARY CHARACTERISTICS

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ABSTRACT

This work describes the Multispectral Camera that will be integrated into BRESEX (Brazilian Remote Sensing Experiment). It's envisaged to fly this camera on board the Space Shuttle in the first half of 1987. This camera will have three spectral bands in the visible and near--infrared with a ground resolution of 20 meters for a flight altitude of 300 kilometers. It will use pusbroom imaging technology with silicon Charge-Coupled Device (CCD) linear arrays as sensors.

1. INTRODUCTION

In 1979 the Brazilian Committee on Space Activities (COBAE) proposed a small but ambitious space mission, called Brazilian Complete Space Mission (MECB) that envisages the design, manufacturing, launching and operation of four satellites, to be completed in the early nineties. The third and fourth satellites of this Mission will have as the main payload a CCD Multispectral Camera specifically designed for applications in remote sensing. The Sensor Systems Division of the Instituto de Pesquisas Espaciais (INPE), the Brazilian Space Research Center, is responsible for the development of that camera.

Recently, INPE has been offered the opportunity to participate in a cooperative experiment with NASA to fly an early version of the CCD Multispectral Camera on the Space Shuttle. The basic objectives of this experiment, called Brazilian Remote Sensing Experiment (BRESEX), are to develop a prototype of the instrument that will later fly in the brazilian remote sensing satellites and to use this instrument on board the Shuttle to obtain data over Brazil in the greatest possible variety of conditions (time of day, off-nadir sighting, etc). It is expected that the results of this experiment will help freezing the specifications of the final satellite instrument.

2. BRESEX PRELIMINARY ARCHITECTURE

Figure 1 shows the block diagram of BRESEX that consists of the following components:

- Multispectral Camera (MC)
- On Board Supervisor (OBS)
- Power Module (PM)

- High Density Tape Recorder (HDTR)
- Shuttle Avionics

The On Board Supervisor is a microcomputer that basically will control all the experiment and will interface with some Shuttle Avionics.

The digital output video signal of the Multispectral Camera will be recorded in a High Density Tape Recorder installed in the Shuttle cabin. The Power Module will supply the different voltage levels necessary to operate BRESEX subsystems.

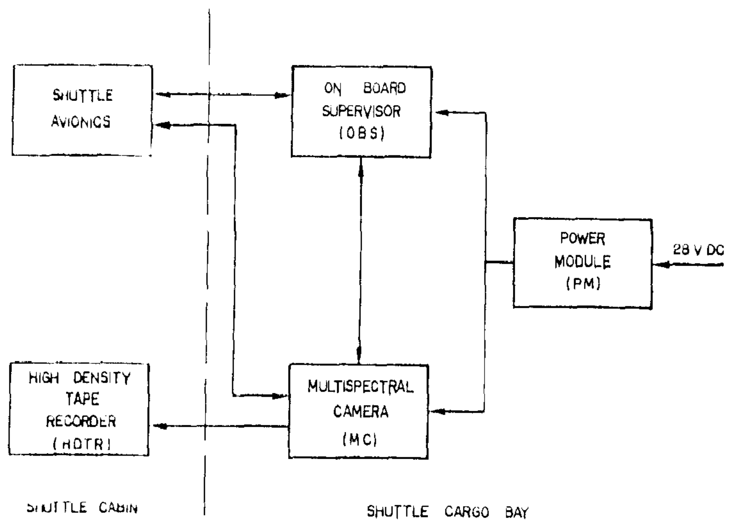

Fig. 1 - BRESEX block diagram.

The Shuttle Avionics that will be utilized by BRESEX are presently beeing identified. All BRESEX subystems except the HDTR will be mounted on a carrier attached to the Shuttle cargo bay as illustrated artistically in Figure 2.

3. THE MULTISPECTRAL CAMERA (MC)

A diagram of the optical concept of the MC is shown in Figure 3, and Table 1 summarizes its preliminary characteristics.

The incoming light from the Earth's surface is reflected by a front flat mirror (4) and focused on the detector arrays (3), one per each spectral band, through a telescope (1). A spectral separator (2), using dichroic prisms, is used to separate the light into three spectral bands.

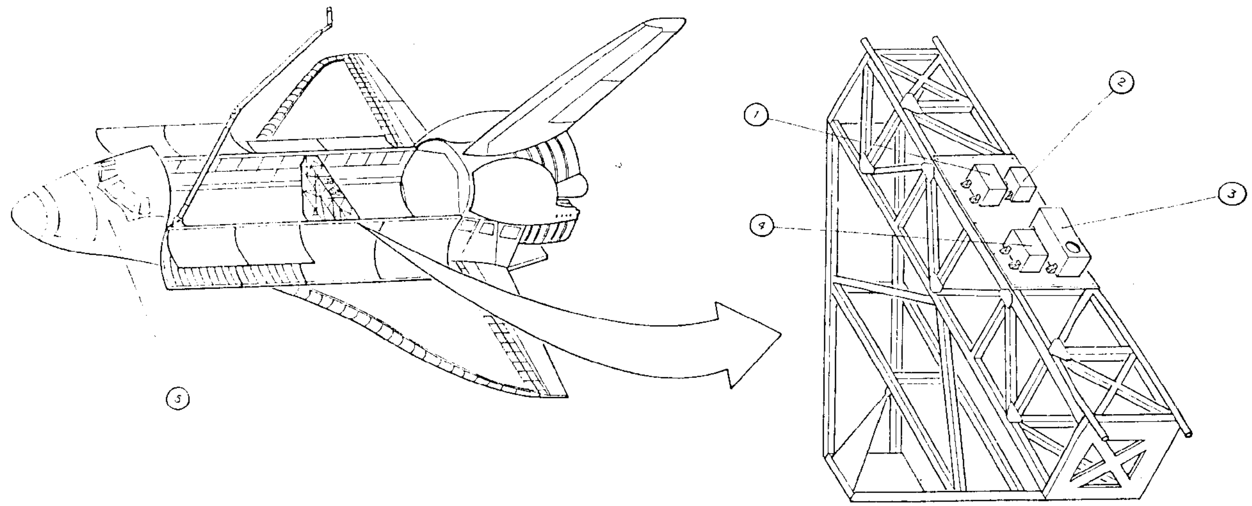

Fig. 2 - Artistic view of BRESEX attachment in the Shuttle cargo bay (1) On Board Supervisor; (2) Power Module; (3) Multispectral Camera; Optoelectronic Module; (4) Multispectral Camera; Central Electronics; (5) High Density Tape Recorder and Shuttle Avionics: all inside the cabin; (6) Carrier.

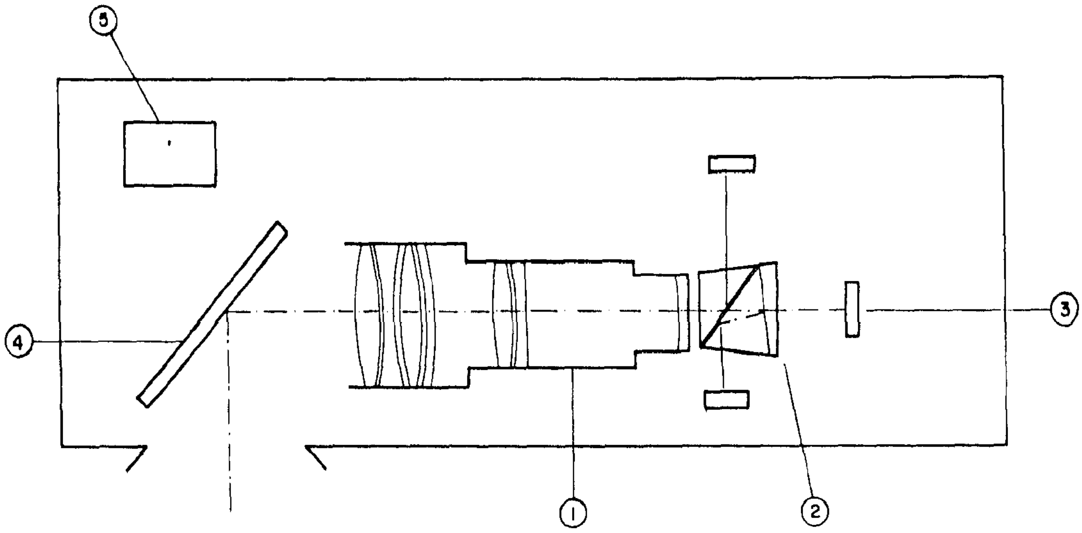

Fig. 3 - Optical concept of the Multispectral Camera (1) Telescope; (2) Spectral separator; (3) Detector array; (4) Pointable mirror; (5) Calibration light source.

TABLE 1

PRELIMINARY CHARACTERISTICS OF THE MULTISPECTRAL CAMERA

- High resolution optics
  - . Telescope with 195 mm focal length
  - . ± 15° side pointing flat mirror
  - . Spectral separation with dichroic prisms and interference filters.
- Field-of-view on ground: 40.96-kilometer swath at 300-kilometer altitude.
- 20-meter ground resolution.
- Pushbroom imaging technology with 2048 elements CCD line arrays.
  - . 13 μm x 13 μm photosites
  - . 2.71 milliseconds integration time.
- Spectral coverage from visible to near-infrared in three spectral bands:
  - . Band 1: 0.47 - 0.53 μm
  - . Band 2: 0.63 - 0.68 μm
  - . Band 3: 0.83 - 0.91 μm
- Encoding: 8 bits/pixel (256 levels of gray)
- Raw data rate: 18 Mbits/sec (for 3 bands)

Figure 4 shows more details of the spectral separator. The wavelengths below 0.60 µm are reflectec by a multilayer dichroic coating into Band 1. A dichroic coating on the smaller wedged element reflects wavelengths longer than 0.69 µm. These are then reflected to Band 3 by total internal reflection. The band from 0.60 µm to 0.69 µm is transmitted through the wedged element to Band 2. The final definition of the spectral bands is accomplished by interference filters, placed in front of the CCD arrays.

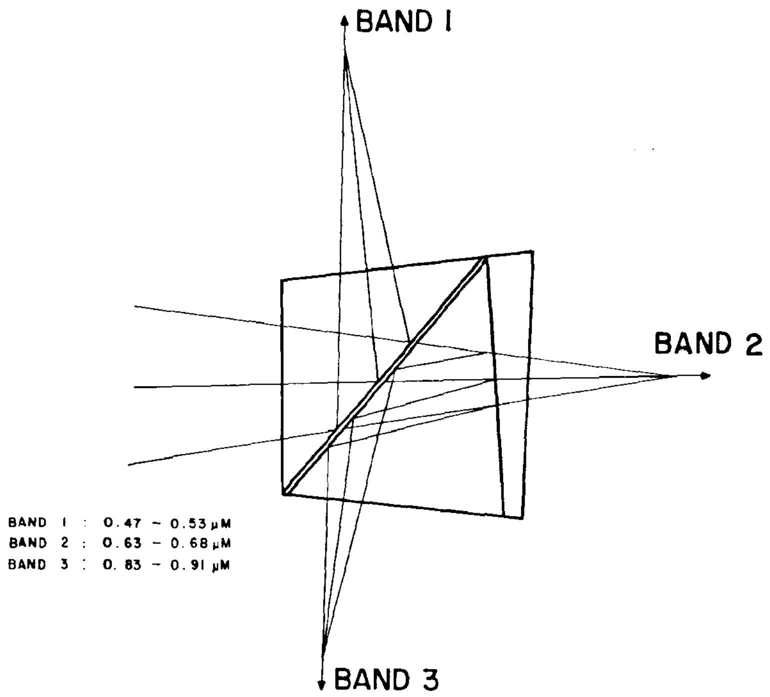

Fig. 4 - The spectral separator.

The silicon CCD focal plane for each color channel will consist of a 2048 elements linear array with 13 µm by 13 µm photosites. Each spectral band array will be registered and oriented to within a fraction of a pixel. The detector elements will be precalibrated and must be sufficiently stable to provide radiometric accuracy limited by signal-to--noise ratios only. Calibration and geometric distortion corrections in the images will be carried out through ground processing.

The rotation of the flat front mirror about the roll axis of the MC will permit the observation of a swath centered laterally on either side of nadir as illustrated in Figure 5. The mirror can also be positioned so that the camera can be calibrated using the internal light source (5) in Figure 3.

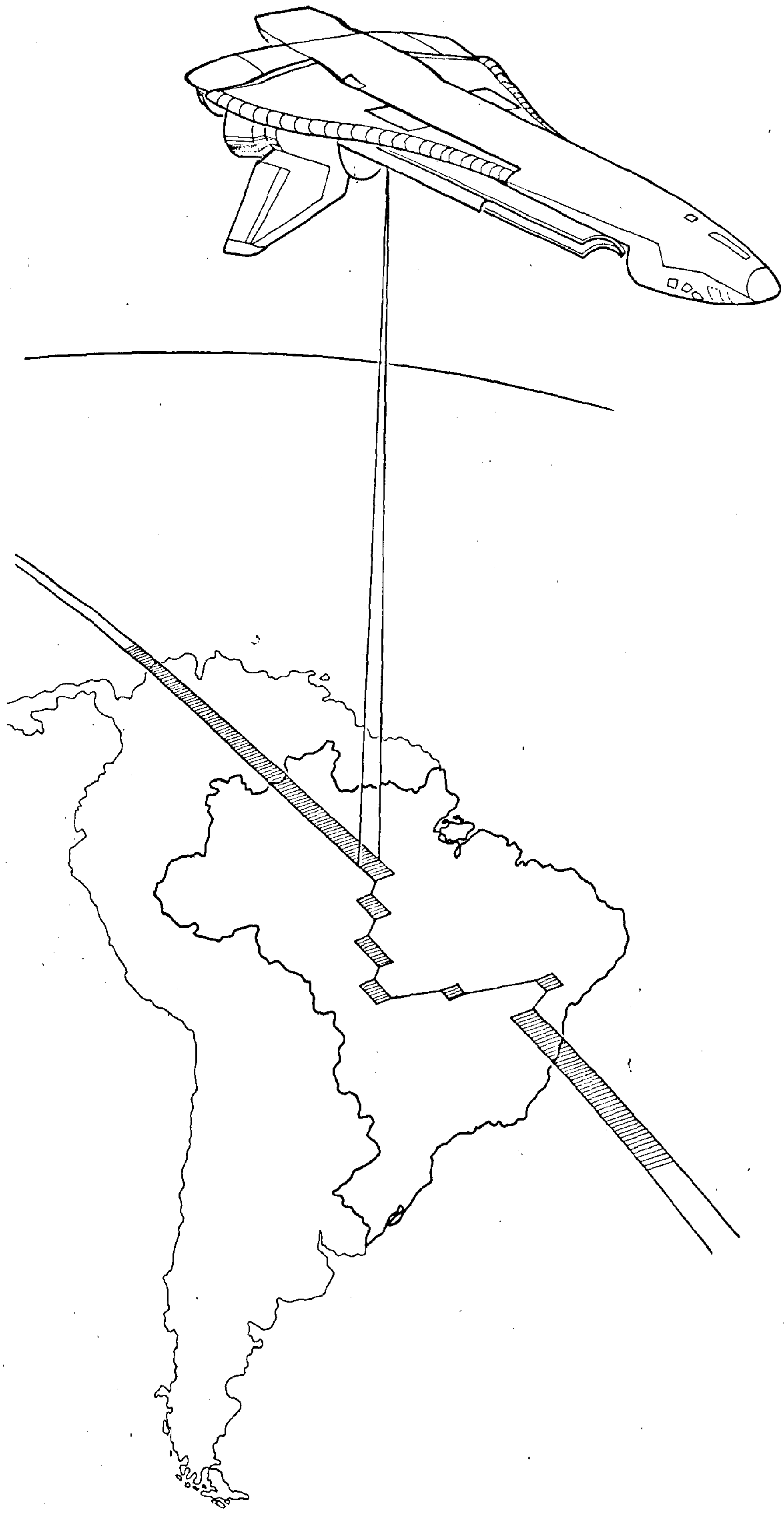

Fig. 5 - Off-nadir viewing using the side pointing mirror of MC.

4. FINAL COMMENTS

Presently, work is in progress to identify the best mission parameters (orbit inclination, orbit altitude, time of the year with minimum cloud coverage over Brazil, etc., to maximize the probability of reaching the main objectives of BRESEX, so that NASA can manifest the experiment. Preliminarly it is envisaged to fly BRESEX on the Shuttle in the first half of 1987.