PREPROCESSING OF SPOT DATA AT THE TWO CENTRAL GROUND STATIONS

by Ph. COUILLARD - SPOT PROJECT MANAGER
CNES
FRANCE
COMMISSION NUMBER II

ABSTRACT

SPOT a polar orbiting earth observation satellite will transmit high resolution data taken all around the world. These data will either be recorded on board of the spacecraft or transmitted to ground receiving stations located in different countries.

Two stations are directly controlled by Centre National d'Etudes Spatiales (CNES) and will constitute the central network. The first is located near TOULOUSE, FRANCE, and the second near KIRUNA, SWEDEN, is operated by a subsidiary of Swedish Space Corporation.

The paper describes the harware installed at the preprocessing Center of these two central stations. It describes too the procedures used to transform the raw data into usable photographic or digital products.

Production time and throughput will be given in the case of standard products.

1 - PREPROCESSING CENTERS FUNCTIONS IN THE SPOT SYSTEM

The SPOT system, conceived and designed by the French Centre National d'Etudes Spatiales (CNES) is being built by French industry working in association with European partners (BELGIUM and SWEDEN). It consists essentially of an Earth Observation satellite and of a ground segment.

The SPOT ground segment is divided in two separate parts. The Mission and Control Center is in charge of :

. sending the telecommand orders and in particular monitoring and programming the payload,

. receiving housekeeping telemetry,

. computing the orbital parameters.

The Image Ground Segment includes two central receiving stations in TOULOUSE (FRANCE) and KIRUNA (SWEDEN) and several foreign receiving stations all around the world. Inside a receiving station, there are two main subsystems :

- the receiving subsystem (SRIS) recording the image telemetry signal sent by the satellite, when it passes inside the circle of visibility of the station. Raw data obtained are recorded on high density tapes.

- The preprocessing center (CRIS) in charge of archiving and transforming

telemetry data in usable image products.

The image products from CRIS (scenes of 60 km x 60 km in panchromatic or multispectral mode) are delivered to SPOT IMAGE which has been set up for the purpose of marketing and distributing on a commercial basis such products.

The present paper will describe in more details the functions and the overall organisation of the CRIS. Note that the same system will be installed in FRANCE at TOULOUSE and in SWEDEN at KIRUNA.

2 - CONCEPTION AND DESIGN OF CRIS

CRIS has two main functions : the first one is to archive data received from the satellite, the second one is to preprocess data and deliver standard products.

Archiving functions

CRIS receives telemetry data from the receiving station on high density tapes HDDT. It receives also from the SPOT Mission Center handling data as ephemeris, payload programming and datation correction parameters. Then, CRIS has to fulfill the following archiving functions :

- control of HDDT : content and telemetry quality,
- slicing of telemetry flow into elementary scenes,
- generation of quick look films for each scene,
- evaluation of cloud cover,
- creation of auxiliary data necessary for further processing,
- sending to SPOT IMAGE new elements to be incorporated in SPOT IMAGE catalogue.

Preprocessing functions

The main objective of CRIS is to be able to deliver a high number of products within short delays. This objective leads to limit the number of different types of image products that can be processed by CRIS and delivered by CRIS. It is the role of SPOT IMAGE to make specific transformation of these products to meet final user requests. The products characteristics and the production delay are defined in the figures here after.

PRODUCTS CHARACTERISTIC

1

INTERNAL PRODUCT

LEVEL 0 — RAW SCENE

COMMERCIAL PRODUCTS

ARCHIVING OUTPUTS

- UPDATING SPOT IMAGE CATALOGUE COMPUTER FILE
- QUICK - LOOK
  FILM 70 MM, 1 IMAGE PER SCENE

P : SAMPLED 1 PIXEL EVERY 6, 1 LINE EVERY 6

XS : SAMPLED 1 BAND EVERY 3, 1 PIXEL EVERY 3, 1 LINE EVERY 3

WITH CRUDE GEOMETRIC AND RADIOMETRIC CORRECTIONS.

LEVEL 1A

RADIOMETRIC CORRECTIONS: ONLY EQUALISATION OF DETECTORS

LOCALISATION ACCURACY : 1500 M RMS (NADIR VIEWING)

LEVEL 1B

- BULK PROCESSING

LOCALISATION ACCURACY : 1500 M RMS
(NADIR VIEWING)

LEVEL 2

- MAPPING TO DIFFERENT PROJECTION
  - -- LAMBERT CONFORMAL
  - -- TRANSVERSE MERCATOR
  - -- POLAR STEREOGRAPHIC
  - -- EQUATORIAL MERCATOR
  - -- OBLIQUE MERCATOR
  - -- OBLIQUE STEREOGRAPHIC
  - -- POLYCONICAL

- SAME RADIOMETRIC CORRECTIONS AS LEVEL 1B

LOCALISATION ACCURACY : 50 M RMS
(NADIR VIEWING)

LEVEL S

REGISTRATION BETWEEN SCENES OF LEVEL 1B OR BETWEEN SCENE OF LEVEL 2.
SAME RADIOMETRIC AND GEOMETRIC CORRECTIONS AS FOR LEVEL 1B OR LEVEL 2.

REGISTRATION ACCURACY : 0.5 PIXEL
P : 5 M ; XS : 10 M (SAME VIEWING ANGLE)

PRODUCTS

MEDIA PRODUCTION DELAY

INTERNAL PRODUCT

LEVEL 0 MEDIA : CCT 6250 BPI

THIS PRODUCT IS PREPROCESSED FOR THE LEVEL 2 AND LEVEL 5 PRODUCTS.

COMMERCIAL PRODUCTS

ARCHIVING OUTPUTS

MEDIA : CCT 1600 BPI AND FILM Q.L. DRY SILVER 70 MM.

THESE PRODUCTS ARE SYSTEMATIC

DELAY : 24 H MAX.

PRODUCTION : 900 SCENES

LEVEL 1A MEDIA : CCT 6250 BPI + CHECKING Q.L.

LEVEL 1B MEDIA : CCT 6250 BPI + CHECKING Q.L.

OR CCT 6250 BPI + 241 MM PRECISION FILM

OR ONLY 241 MM PRECISION FILM

THESE PRODUCTS ARE PREPROCESSED ON ORDER

DELAY : 48 H MAX.

PRODUCTION : FOR LEVEL 1 (A OR B)
50 SCENES MAX. (ON 1 TRAITIMAGE)

LEVELS 2 AND S

MEDIA : CCT 6250 BPI + CHECKING Q.L.
OR CCT 6250 BPI + 241 MM PRECISION FILM
OR ONLY 241 MM PRECISION FILM

THESE PRODUCTS ARE PREPROCESSED ON ORDER :

DELAY : 8 DAYS (IF MAPS ARE PRESENT IN THE CRIS MAP LIBRARY)

PRODUCTION : 1 SCENE EVERY 35 MIN. (ON TRAITIMAGE).

To perform all these functions, the CRIS has been organised in independant subsystems. The choice of this configuration has been made for two main reasons : to avoid too important data flow rate links due to image transmission between computers and to avoid total stop of the system in case of failure of one part.

There are four subsystems, which undertake the following functions :

CONTREX

. Interface with SPOT Mission Center,

. Cloud cover evaluation and catalogue management (interface with SPOT IMAGE),

. Internal management of CRIS.

TRAITIMAGE

. Archiving,
. Preprocessing of level 1,
. Preprocessing of level 2 (only geometric corrections).

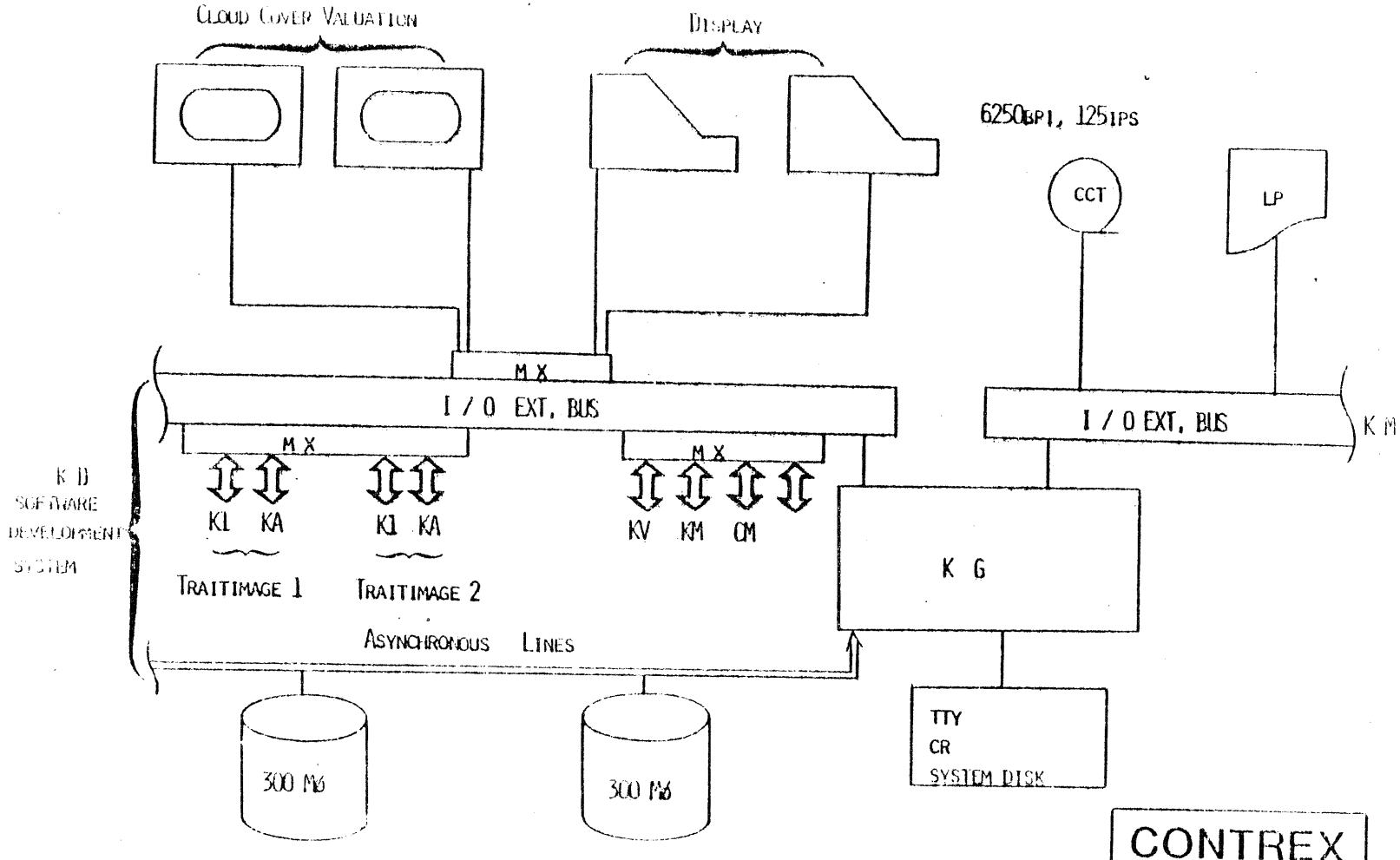
PRODIMAGE

. Film generation,
. CCT checking,
. CCT copying.

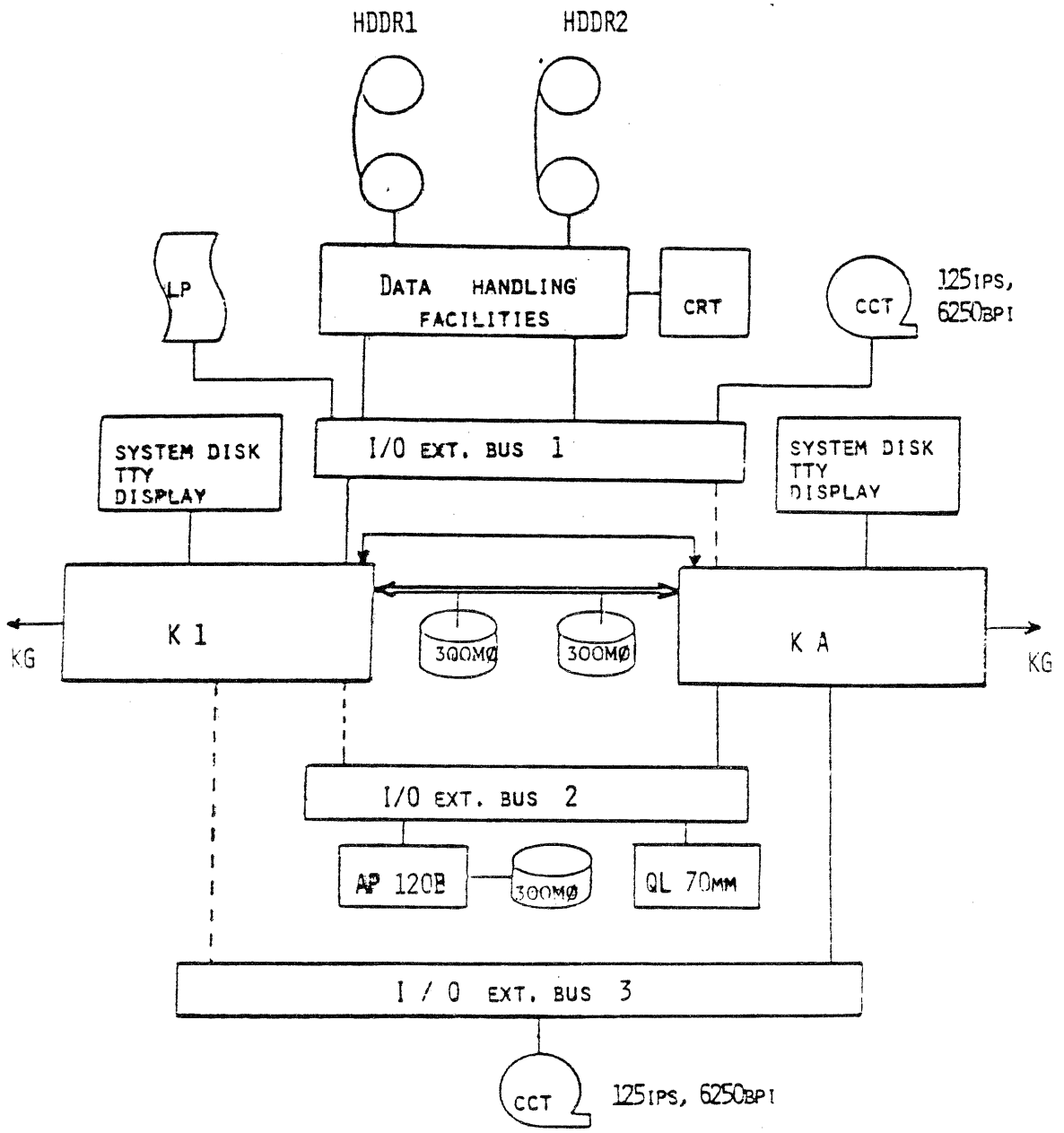
MESAMERS

. Ground control point pick up,
. Registration,
. Modelisation,
. Management of the cartographic data bank.

The hardware configuration of these subsystems are described in the figures here after :

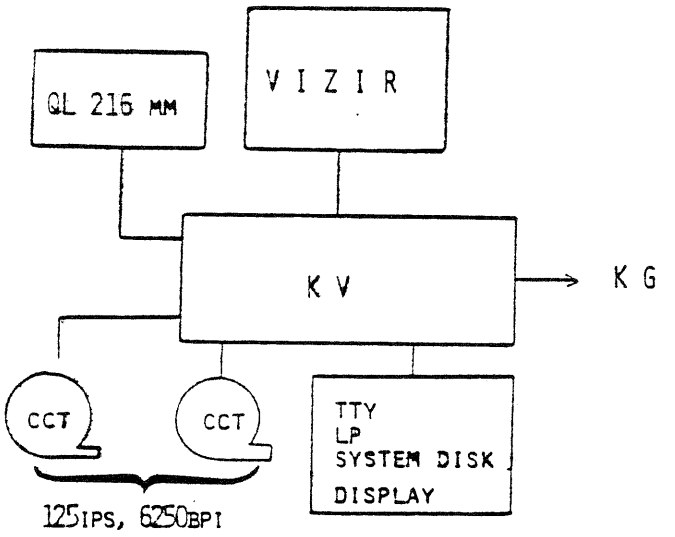


HARDWARE CONFIGURATION



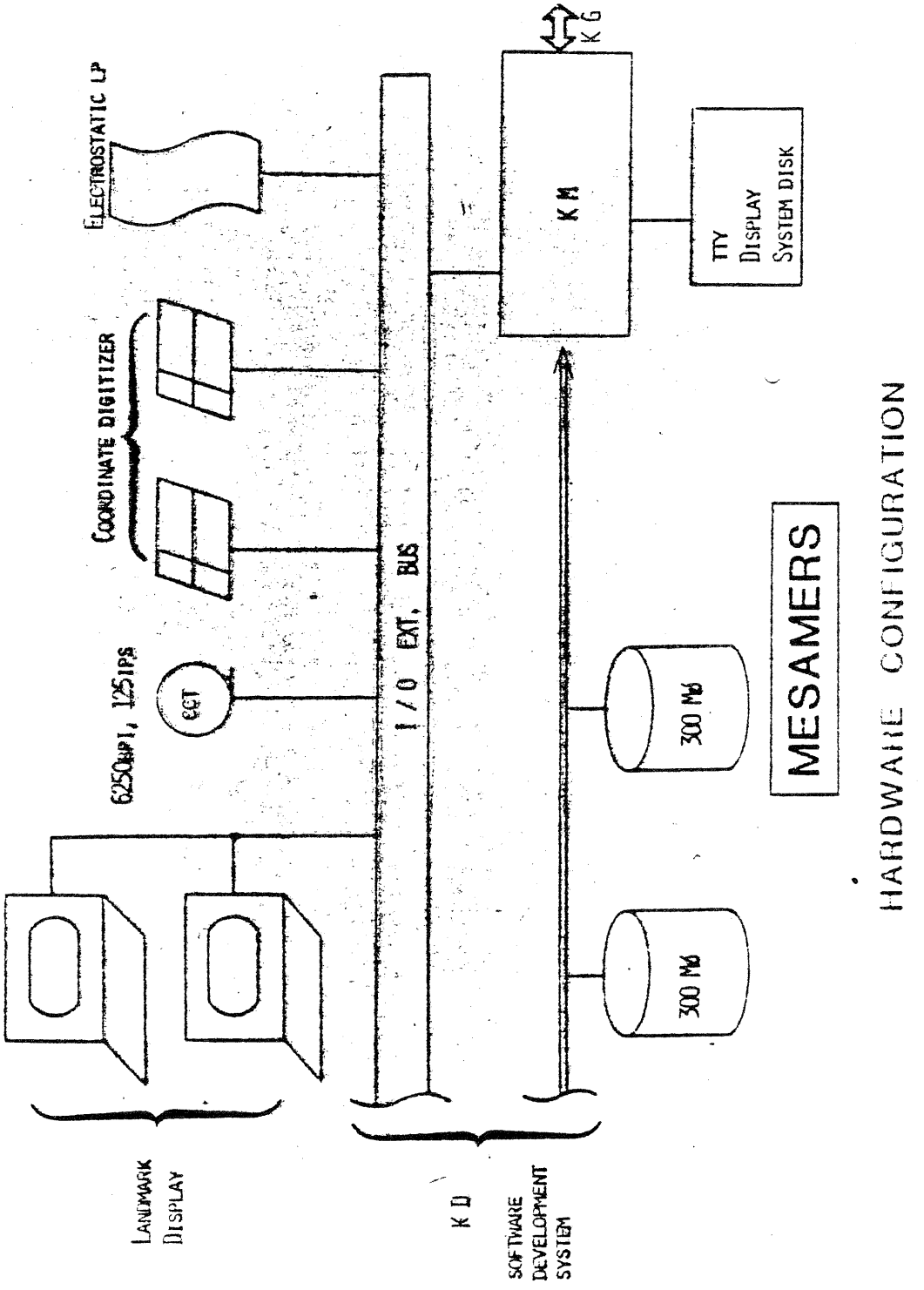
TRAITIMAGE

HARDWARE CONFIGURATION



PRODIMAGE

HARDWARE CONFIGURATION



HARDWAIRE CONFIGURATION

3 - HARDWARE TECHNICAL DESCRIPTION

The following descriptions concern only specific equipments of CRIS. Classical data processing equipments such as SOLAR computer or AP120B processor are not described.

HIGH DENSITY DIGITAL RECORDER

MANUFACTURER : ENERTEC (FRANCE)

REFERENCE : ML 2601

FUNCTION : WRITE (OR READ) SATELLITE TELEMETRY DATA ON MAGNETIC TAPES

CHARACTERISTICS : AMPEX 799 TAPE

28 TRACKS

BER = 10^{-10} WITH CORRECTING CODE

RECORDING SPEED :

V = 3,65 M/S FOR THEMATIC MAPPER

V = 2,15 M/S FOR SPOT

V = 0,65 M/S FOR MSS

DATA HANDLING SUB-SYSTEM

MANUFACTURER : ENERTEC (FRANCE)

REFERENCE : MULTIMAGE DATA PROCESSING SYSTEM

FUNCTION : THE DATA HANDLING SUB-SYSTEM IS IN CHARGE OF RECEIVING THE OUTPUT SIGNAL OF THE HDDR RECOGNIZING AND ORGANIZING THE DATA FLOW. IT SEPARATES IMAGE DATA FROM AUXILIARY DATA. THE IMAGE DATA ARE DELIVERED LINE BY LINE AND WAVELENGTH BY WAVELENGTH. THE OUTPUT CAN BE SUB-SAMPLED VIDEO DATA FOR QUICK LOOK DISPLAY

TECHNICAL CHARACTERISTICS :

- A SYNCHRO-DECOMMUTATOR FOR EACH INSTRUMENT TM, MSS, HRV. EACH MODULE IS A PREPROGRAMED MODULE

- A DEMULTIPLEXER MODULE REALISED AROUND 2 RAM 128 KOCTETS MEMORIES

- A CONTROL UNIT AROUND A SI 11-23 MICRO-PROCESSOR

- A QUICK LOOK DISPLAY WHICH INCLUDES ANOTHER LSI 11-23 MICRO-PROCESSOR, A MEMORY SCREEN AND A SCREEN FOR THE DISPLAY OF 512 X 512

QUICK LOOK FILM RECORDER

MANUFACTURER : SOPO (FRANCE)

REFERENCE : VISOR SL 70 MM

FUNCTION : PRODUCTION OF 70 MM FILMS OF EACH SCENE RECEIVED AT CRIS. IMAGE DATA ARE SUB-SAMPLED. QUICK LOOK FILMS ARE SENT TO SPOT IMAGE FOR ITS CATALOGUE

CHARACTERISTICS : DRY SILVER FILM (3M - USA)

CONTINUOUS MOTION OF THE FILM

RECORDING BY LASER BEAM (HE NE 2 m W) AND ACOUSTIC OPTICAL MODULATOR
DEVELOPMENT ON AN HEATING CYLINDER

DELAY FOR ONE SPOT SCENE 13S

OUTPUT ON 16 GREY LEVELS

SCALE FACTORS PRECISION $\leq$ 3 %

JITTER $\leq$ 10 μM

HIGH RESOLUTION LASER BEAM RECORDER

MANUFACTURER: SEP (FRANCE)

REFERENCE : VIZIR 6 IMAGES

FUNCTION : PRODUCTION OF 6 IMAGES 241 X 241 MN WITH HIGH RESOLUTION

CHARACTERISTICS : PANCHROMATIC KODAK 2415 FILM

SPOT DIAMETER : 25 µM PANCHROMATIC SCENE
50 µM MULTISPECTRAL SCENE

DELAYS : 6 PANCHROMATIC SCENES 88 MN
2 MULTISPECTRAL SCENES (3 SPECTRAL BANDS) 28 MN

OUTPUT ON 64 GREY LEVELS

SCALE FACTOR ABSOLUTE PRECISION $< 4.10^{-3}$

SCALE FACTOR STABILITY $< 8.10^{-4}$

ANISOMORPHISM $< 10^{-3}$

JITTER $\pm$ 5 µM

CCT CONTROL FILM

MANUFACTURER : SORD (FRANCE)

REFERENCE : VISOR M 216 MM

FUNCTION : PRODUCTION OF CONTROL FILM FOR CCT TAPES DELIVERED BY CRIS

CHARACTERISTICS : DRY SILVER PAPER 7773 (3M FRANCE)

STEP BY STEP MOTION (100/µM)

RECORDING BY LASER BEAMS (HE NE 2 mW) AND ACOUSTIC OPTICAL MODULATOR

DELAY FOR ONE SPOT SCENE ≃ 10 MN 30 S (INCLUDING PERFORMANCES OF SOLAR SOFTWARE)

OUTPUT ON 16 GREY LEVELS

IMAGE DISPLAY

MANUFACTURER : SINTRA ALCATEL (FRANCE)

REFERENCE : TRIADE 80

FUNCTION : AUTONOMOUS DISPLAY WITH TWO INDEPENDANT WORKING UNITS

CHARACTERISTICS : 2 SCREENS 560 LINES X 768 COLUMNS INCLUDING :

IMAGE AREA 512 X 512

GRAPHIC AREA 512 X 256

MONITORING AREA 48 X 768

2 ALPHA NUMERIC COMMAND UNITS

6 MEMORY RACKS 512 X 512 WORDS OF (8 + 2) BITS