

REFLIGHT OF THE METRIC CAMERA ON THE ATLAS-1 MISSION

M. Schroeder, R. Stätter
DFVLR, FR Germany

Abstract:

It is planned to fly the Metric Camera again on a Space Shuttle Flight - the ATLAS-1 Mission in 1990. The camera will be a modified ZEISS RMK A 30/23 with 305 mm focal length, equipped with a Forward Motion Compensation. The paper will deal with technical and operational aspects of the deployment of this camera in space and will outline the present state of development of this project.

1. Introduction

The Metric Camera of the type ZEISS RMK A 30/23 was flown in space for the first time in the Spacelab 1 Mission (Space Shuttle Flight No. 9) in Nov./Dec. 1983. The camera was then operated in the manned Spacelab module and delivered over 1000 stereo images of about 30 m photographic ground resolution. The thematic and geometric information derived from these images were suitable to contribute to mapping at scales 1 : 100 000 and smaller.

During the Spacelab 1 Mission the lighting conditions were very unfavorable as the sun elevation for all camera operations never exceeded 30°; this was the reason that NASA agreed to reflly the Metric Camera on one of their next Shuttle Flights.

The Metric Camera has recently been selected to be part of the ATLAS-1 payload, a mission which is presently scheduled for launch in September 1990.

ATLAS stands for Atmospheric Laboratory for Applications and Science and will be flown in a pallett only configuration. To accommodate the Camera System on this mission it has to be completely redesigned as a canister version.

The camera itself will be equipped with a Forward Motion Compensation which increases the ground resolution considerable. The scientific objective of the Metric Camera in this mission is to demonstrate the capability of high resolution space photographs for topographic mapping at scales from 1 : 50 000 to 1 : 100 000.

2. Camera Payload System

In the ATLAS-1 mission the Metric Camera has to be accommodated in the Cargo Bay of the Space Shuttle. To achieve controlled environmental conditions the Camera will be enclosed in a pressurized container, which will be installed on the starboard side of the Shuttle's Cargo Bay. Fig. 1 shows the position of the Camera Container. The container is closed on one side with a 2,5 cm thick window of high optical quality quartz glass, through which the photographs will be taken. In non operational phases the window will be protected by a lid, which will be opened for camera operations. The environmental conditions inside the container are given in Table 1. Fig. 2 shows the installation of the camera in the container.

The reason for filling the container with wet air is to avoid drying and hardening out of the film. The temperature will be controlled to keep the nominal operation temperature at 22°C and to avoid temperatures below 13°C, which would cause condensation.

The camera is a slightly modified ZEISS RMK A 30/23 equipped with a Forward Motion Compensation Magazine ZEISS CC 24. Characteristics of this camera system are listed in Table 2. The magazine will be loaded with a thin layer film of 700 ft length corresponding to approx. 780 image frames.

The camera will be controlled by an experiment dedicated microprocessor, which is also housed inside the container. This microprocessor is linked to the onboard central computer system. The camera will be switched on and off by preprogrammed timeline commands from the central computer; camera adjustments such as exposure settings, overlap, v/h value for the Forward Motion Compensation etc. are premission stored in the dedicated experiment computer and will be transferred to the camera during operation. Monitoring of the camera function will take place at the Payload Operations Control Center at Huntsville, Alabama. Changes in the preprogrammed operation cycles can be made by telecommands from the Control Center.

In a contingency case the camera can also be operated manually by the crew from a Standard Switch Panel in the Aft Flight Deck of the Orbiter.

The design of the whole camera system was investigated in a Phase-B Study in 1987 and the development of the hardware started mid of 1988. The camera system is planned to be ready for integration into the Space Shuttle at the beginning of 1990.

3. Data Acquisition

For operation of the camera the Space Shuttle is oriented with the open cargo bay towards the earth. In this flight attitude the camera looks vertical down with an accuracy of $\pm 0.5^\circ$.

The total operation time scheduled for the camera is about 6 h, of which actually 2 h will be used to expose all the film material that is available. The potential target areas to be photographed are shown in Fig. 3. The decisions which of these target areas will actually be photographed will be made some hours before the camera operations by means of a daily worldwide cloud cover forecast at the Payload Operations Control Center.

In 80 % of all operations the Kodak Panatomic-X 3412 film will be used, whereas for the remaining 20 % a Colour Infrared Film will be applied. The expected Area Weighted Average Resolution (AWAR) with the Panatomic-X film is 70 lp/mm for high contrast and 55 lp/mm for low contrast (1 : 1.6).

The nominal flight altitude will be 250 km, which results in a ground coverage of 189 km x 189 km per image frame at a scale of approx. 1 : 820 000. The expected average ground resolution at low contrast is 14.5 m, equivalent to 7 m pixel size. Stereoscopic evaluation of the photographs will be taken with 60 % overlapping in flight direction, which means a shutter release every 10 sec. During this mission 390 stereo pairs will be obtained covering an area of 11 Mio. km² which corresponds to approx. 5 % the world's landmass.

4. References

Metric Camera Workshop, Proceedings of a joint DFVLR/ESA Workshop, Oberpfaffenhofen 11 - 13 February 1985, ESA SP-209, 1985

M. Schroeder, E. Suckfüll, G. Todd, P. Lohmann
Spacelab 1 - Metric Camera User Handbook and Data Catalogue, ESA/DFVLR 1986

R. Stätter, E. Suckfüll, T. Miski
Metric Camera on ATLAS-1, Recommendations for Redesign of the Experiment
DFVLR-Internal Report, 1987

Volumen:	240 Ltr.
Filled with:	normal air
Relative humidity:	50 %, at 24°C
Pressure:	1.013 bar
Dew Point Temperature:	13°C
Temperature (operational):	20 - 28°C
Temperature (nominal):	22°C

Table 1: Environmental conditions in container

The Metric Camera System comprises

- ZEISS RMK A 30/23, Metric Camera with Forward Motion Compensation (FMC)
- Film Magazine, preloaded with black & white and color-infrared film, spliced together
- Pressurized Canister with High Quality Window (HQW) and Motorized Door Assembly (MDA)
- Camera Control Unit (CCU) with a Dedicated Experiment Processor (DEP) for camera operation, interfaced to the central computer and for monitoring the canister environment (pressure, temperature, dew point)

The Metric Camera with the attached magazine and the control unit are accommodated in the pressurized canister.

Type:	ZEISS RMK A 30/23
Lens:	TOPAR A1, focal length = 305 mm
Average Distortion:	4 μ m max.
Resolution (static):	90 line pairs/mm, at high contrast with Panatomic-X film in the image center
Field of View:	56 deg diagonal, 42 deg across
Shutter:	AEROTOP-Rotating-Disc (between lens) Shutter
Exposure Time:	1/50 sec to 1/425 sec, adjustable in 31 steps
F-Stop:	1/5.6 to 1/11, adjustable in 31 steps
Film Dimension:	24 cm width, 220 m length (max)
Image Size:	23 cm x 23 cm square
Image Scale:	1 : 820 000 (at 250 km altitude)
Ground Coverage:	189 km x 189 km (at 250 km altitude)
Cycling Time:	10 sec for 60 % overlap 5 sec for 80 % overlap
Forward Motion Comp:	FMC moves film in same direction as Orbiter velocity vector while shutter exposes film
FMC-Speed:	9.2 mm/sec, based on SL $v/h = 0.03 \text{ sec}^{-1}$

Table 2: Characteristics of the Metric Camera System

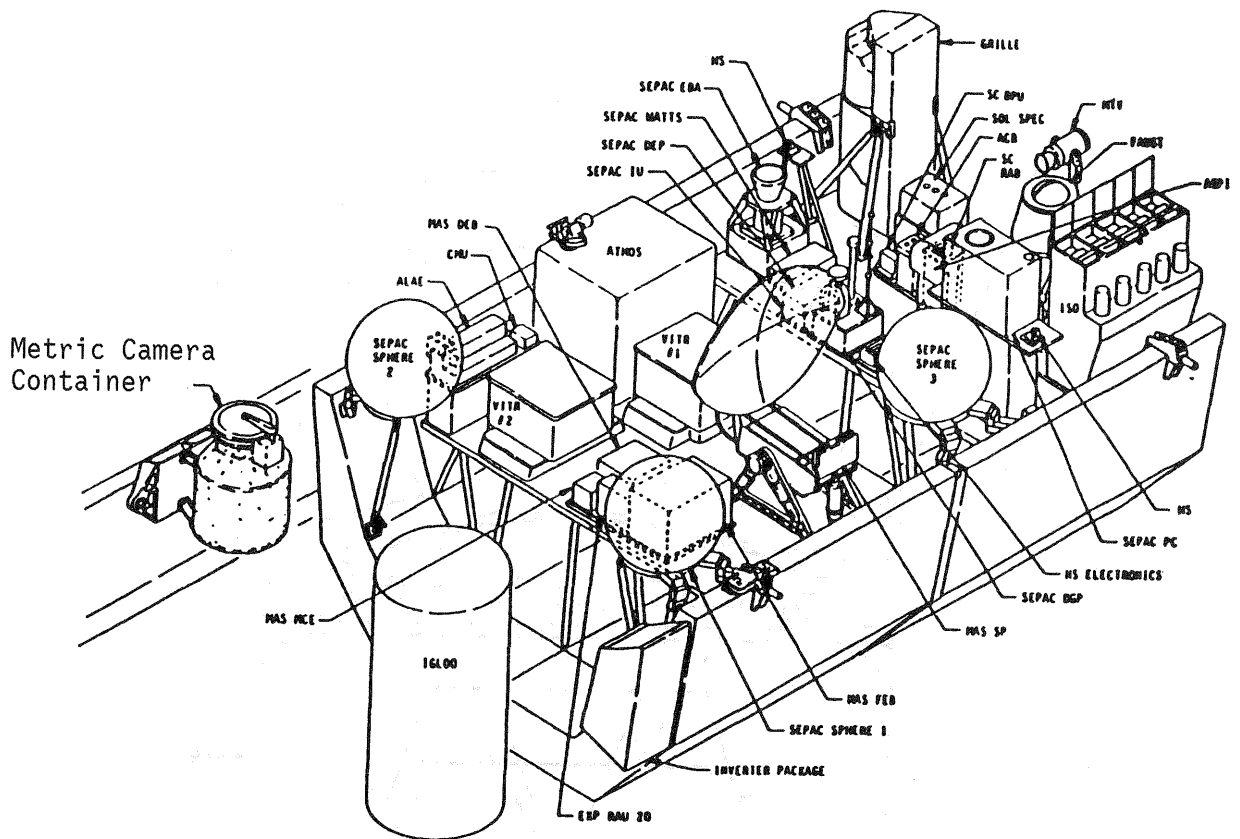
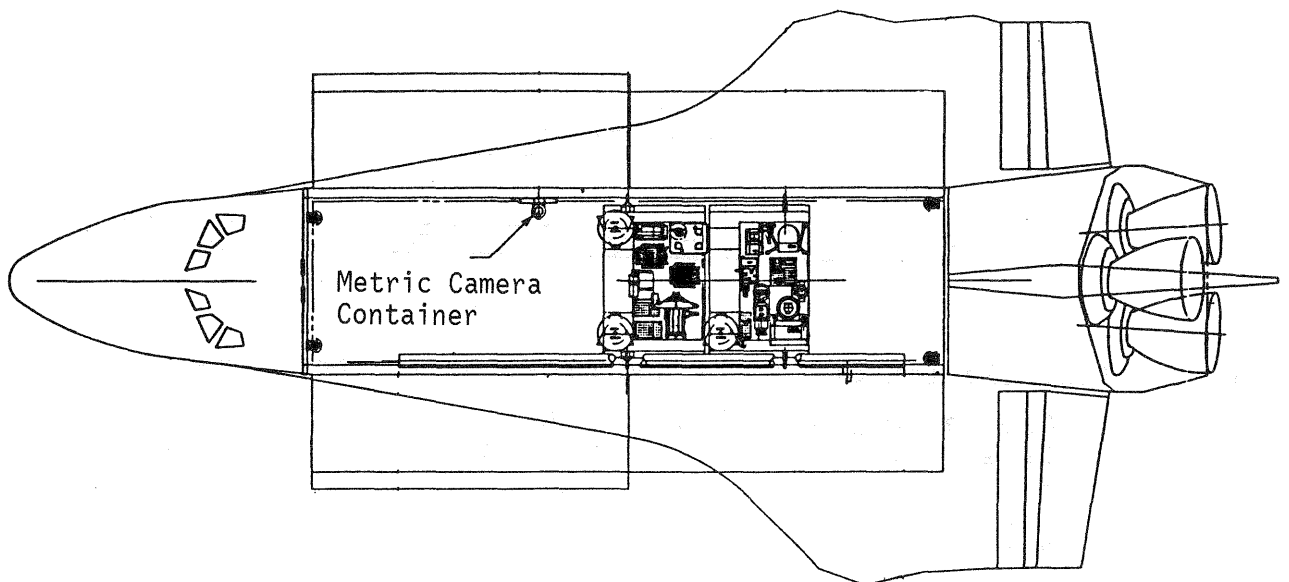


Fig. 1 Position of the Metric Camera Container on starboard side of the orbiter's cargo bay



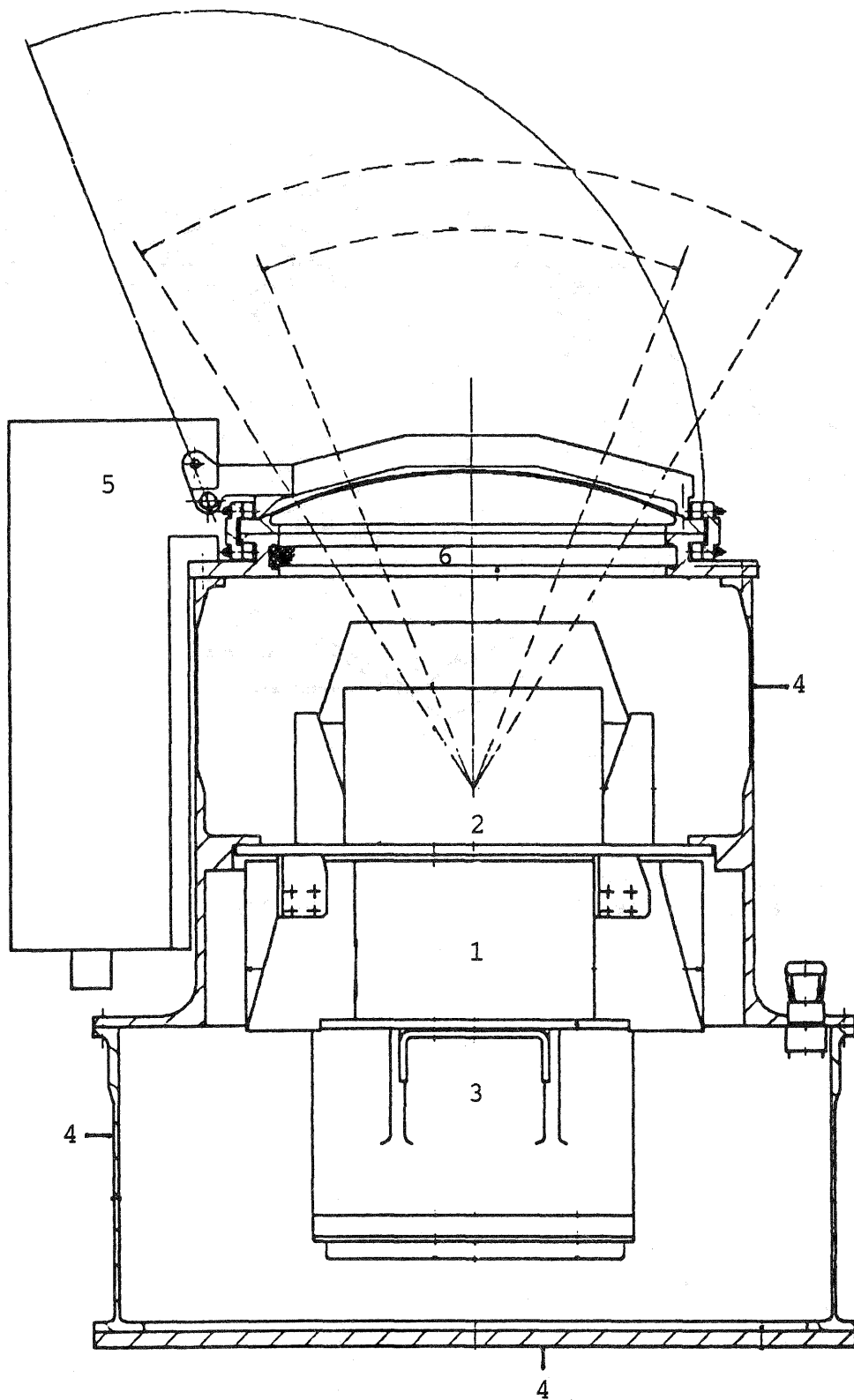


Fig. 2 Installation of camera and magazine in the container

- 1 Camera Body with Control Unit
- 2 Lens Cone (Field of View: 42 deg across, 56 deg diagonal)
- 3 Magazine
- 4 Container
- 5 Motorized Door Assembly
- 6 Window Pane

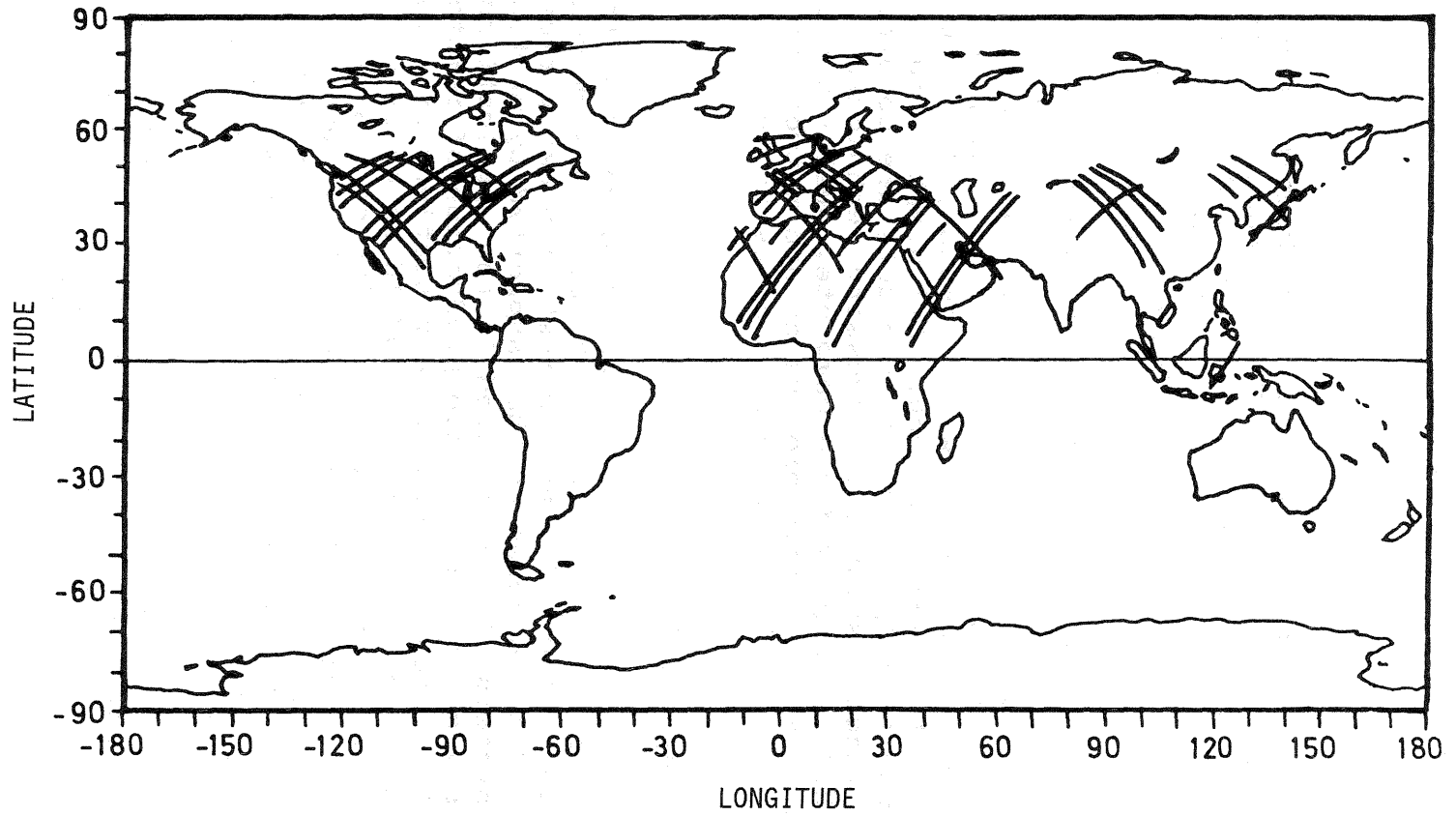


Fig. 3 Potential target areas to be photographed at ATLAS-1 mission (so called camera operation cycles)