ORIGINAL PAGE IS
OF POOR QUALITY

N86-27316

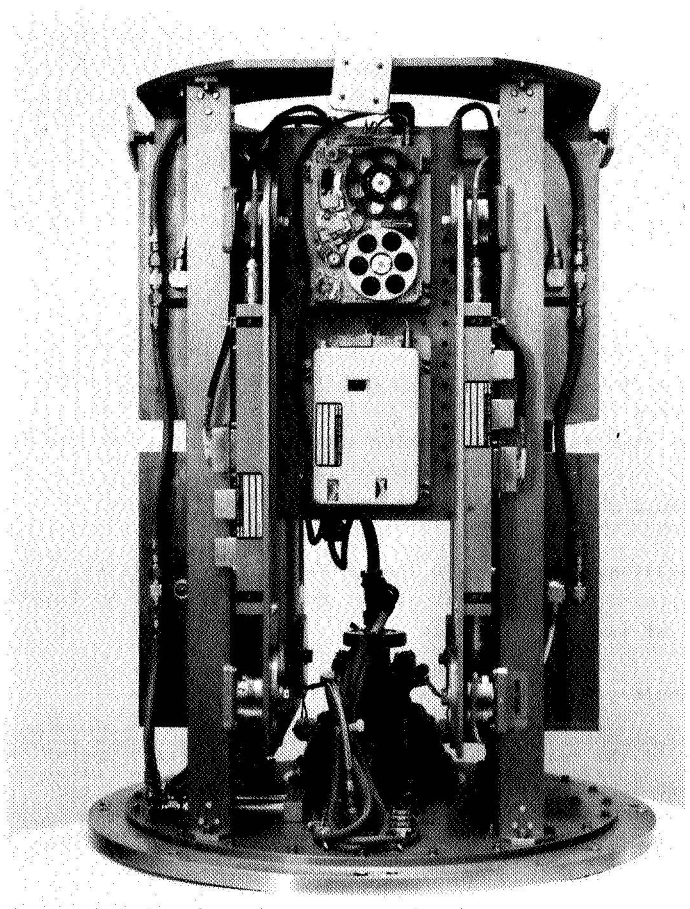
D19-35
9P.
8972

HALOGEN LAMP EXPERIMENT, HALEX

Gunter Schmitt
Kayser-Threde GMBH
Munich, FRG

Dr. Jurgen Stapelmann
Dornier System GMBH
Friedrichshafen, FRG

K1790690
D0425275



HALEX PAYLOAD

INTRODUCTION

The main purpose of the Halogen Lamp Experiment HALEX was to investigate the operation of a Halogen lamp during an extended period in a microgravity environment and to prove its behavior in space.

Halex was funded by the European Space Agency under two separate contracts. The payload was designed and built by Kayser-Threde, who also coordinated the mission with NASA. The experiment was defined, built and maintained by Dornier System.

OBJECTIVES

Mirror Heating Facilities for Crystal Growth and Material Science Experiments in space rely on Halogen lamps for their source of heat.

Dornier System developed and built a MHF Mirror Heating Facility which was flown on FSLP in 1983, the MEDEA-ELLI will be used during the upcoming D-1 Spacelab Mission 1985 also the 1988 EURECA Mission will be furnished with an AMF Automatic-Monoellipsoidal Mirror Furnace.

All these furnaces use one or two Halogen lamps where the radiation is focussed for melting a specimen.

With the AMF a long-term operation of a fully powered Halogen lamp is planned.

The HALEX aim is to verify:

- Full-power operation of a Halogen lamp for a period of about 60 hours
- Achievement of about 10% of its terrestrial life span for a particular type of Halogen lamp
- Operation of that Halogen lamp under conditions similar to the furnace operation

Therefore HALEX should show:

- Radiative behavior of a Halogen lamp during long-term operation in space
- Tungsten deposition inside bulb if not retransported on to filament
- Performance of the Halogen cycle

Therefore HALEX should prove:

- Feasibility of the mirror furnace concept for long-term operation in space by using Halogen lamps

Therefore HALEX should give:

- Design inputs for lamp improvement with respect to gas filling, gas pressure and dimension of lamp.

These goals should be verified in a relatively simple and cost effective way by using for the most part existing and proved hardware for a payload which can be carried out within NASA's GAS program.

D19-

PAYLOAD CONCEPT

The payload design is governed by the experiment requirements (table 1).

Table 1

HALEX EXPERIMENT REQUIREMENTS:

- VOLUME : ~ 7.5 LITRES
- WEIGHT : ~ 4 KG
- EVACUATED MIRROR COMPARTMENT DURING MISSION
- LAMP CURRENT : ~ 7 A
- LAMP VOLTAGE, CONTROLLED
  - UPPER LIMIT : 8,2 VDC, ± 1%
  - LOWER LIMIT : 7,0 VDC, ± 1%
- OPERATION TIME : AS LONG AS POSSIBLE, ENVISAGED ~ 60 HOURS
- PERMANENT HEAT DISSIPATION OF 65 W
- DATA RECORDING:
  - 8 MIN CONTINUOUSLY AFTER ACTIVATION, THEN 1 SECOND DATA BLOCKS EVERY MINUTE TILL DEACTIVATION
- TIME REFERENCE IN MINUTES

The experiment hardware (figure 1) mainly consists of:

- o Sealed ellipsoidal mirror shell with vacuum port
- o Halogen lamp and lamp holder.
  The HALEX 45 W flight lamp has been "designed" by OSRAM to ensure a transferability of experiment results to a 300 W lamp. The lamp is filled with 10 cm^3 Xenon and admixtures at a pressure of approx. 4,5 bars.
- o 2 photocells for light detection
- o Temperature sensors at photocells, lamp base, heat pipes and intermediate plate
- o 2 heat pipes for heat transfer from lamp base to intermediate plate

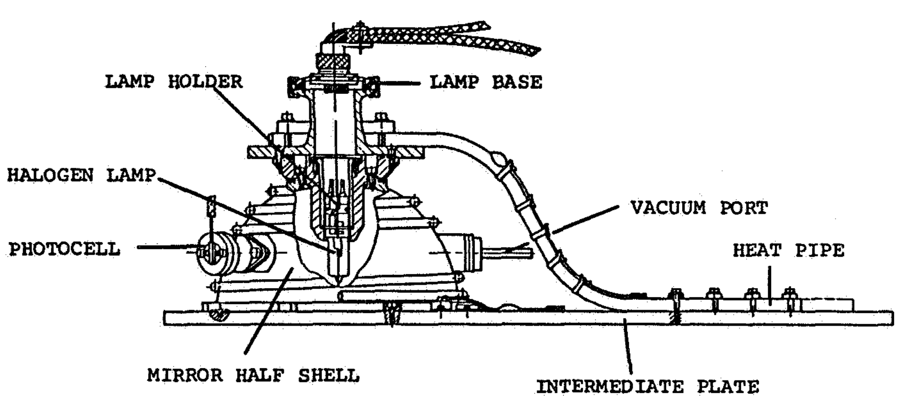


Figure 1

To economically fulfil the experiment requirements, the payload design (figure 2) is based on Kayser-Threde's concept of a standarized and modular GAS payload service system.

Attention was paid especially to:

- Maximum capacity of weight and volume of batteries in order to obtain the longest possible operation time
- Data recording in an intermittent mode for approx. 120 hours of operation
- Evacuation of mirror compartment during flight
- Sufficient heat transfer by attaching the experiment compartment to the intermediate plate underneath the GAS Experiment Mounting Plate

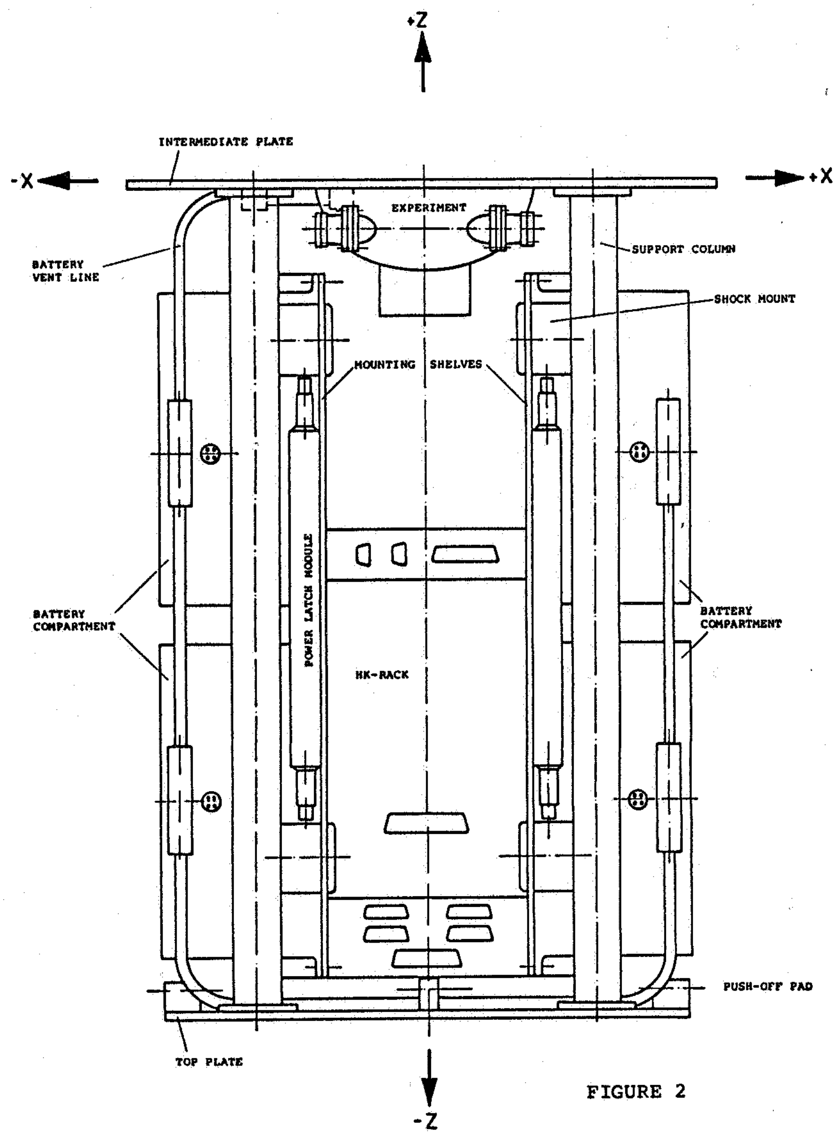


FIGURE 2

Figure 2

The mechanical support structure consists of:

- o Intermediate plate (with attached experiment)
- o Top plate and attached push-off pads
- o 4 support columns
- o 2 mounting shelves, each attached to 2 support columns via 4 shock absorbers
- o HK or electronics rack

Payload power is supplied by:

- o 8 batteries, 27 VDC at a typical capacity of 18 Ah consisting of
- o 144 silver zinc cells SHV 01500, capacity matched, total energy of 4 KWH, integrated into
- o 4 battery housings (figure 3), pressure tight, nickel plated, temperature switches, H_2 outgassing capability

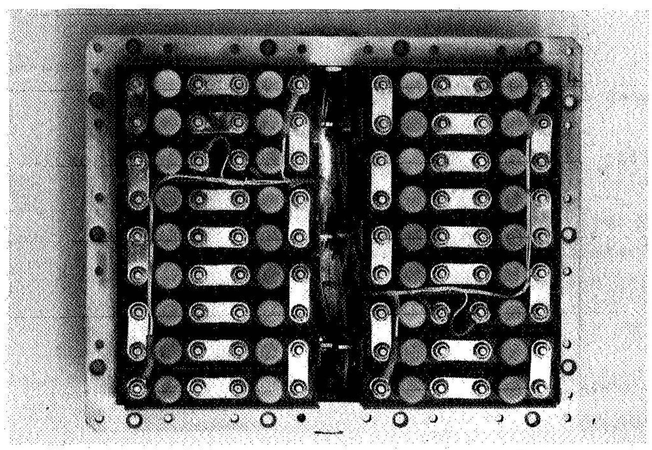


Figure 3

For safety a low voltage power cut-off at 22,3 VDC is incorporated. Regulated DC power is applied to the data acquisition and recording system and the sequencer. Controlled DC power is applied to the Halogen lamp only.

Furthermore the payload consists of:

- o Control subsystem
- o Housekeeping subsystem
- o 12 bit PCM data acquisition system (figure 4) for 12 analog and 4 digital channels at a data rate 5 kBit/sec
- o 2 redundant tape recorders with data capacity of 56 Mbit each

The ground support equipment for payload operation includes:

- o GAS interface simulator and battery simulator
- o PCM decoder K1180
- o Data channel output and display unit
- o HP power supply
- o External sequence stepper
- o Kayser Quick Apple Check out system

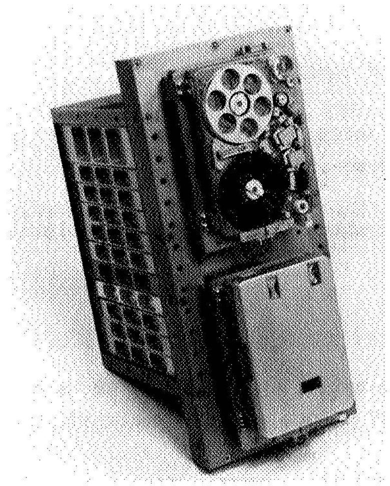


Figure 4

OPERATIONAL SCENARIO

As HALEX requires an operation time of approx. 60 hours the payload had to be activated in the very early part of the STS 41 G mission.

The experiment profile (figure 5) shows the three different experiment periods

- o Warm up (180 sec) with soft start (2 sec)
- o Setting of operation point (200 sec)
- o Long term lamp operation (57,9 hours actual)

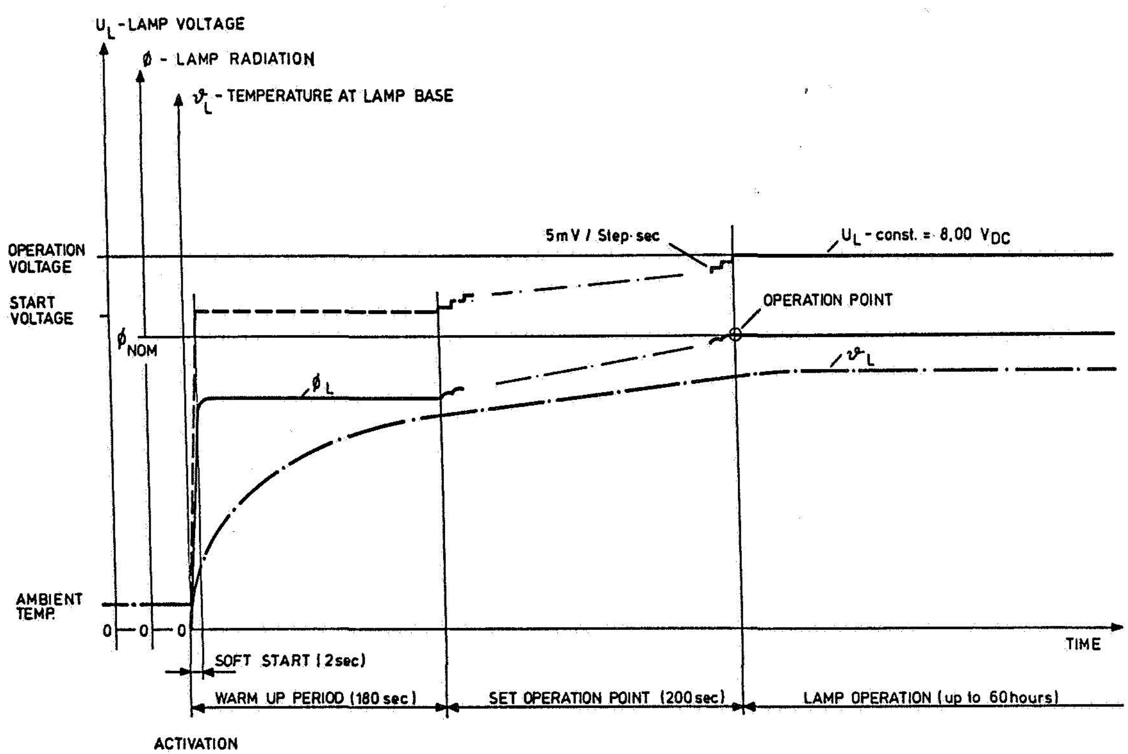


Figure 5. Experiment Profile

The mission profile (table 2) contains major events.

Table 2

MISSION PROFILE STS 41 G

- LAUNCH	: OCT/05/84	
- HALEX ACTIVATION	: T + 34 H	: 13 MIN
- DEPLOYMENT SIR-B ANTENNA	: T + 50 H	
- LAMP SWITCHED OFF AUTOMATICALLY DUE TO EXITATION OF UPPER TEMPERATURE LIMIT AT HEAT PIPES	: T + 89 H	: 55 MIN
- LAMP SWITCHED ON AUTOMATICALLY AFTER TEMPERATURE DROP	: T + 90 H	: 25 MIN
- AUTOMATIC PAYLOAD SWITCH OFF DUE TO LOW VOLTAGE POWER CUT-OFF	: T + 92 H	: 7 MIN
- HALEX DEACTIVATION	: T + 167 H	: 48 MIN
- ORBITER RETURN	: OCT/12/84	

TOTAL PAYLOAD OPERATION TIME: 57,9 HOURS

Due to the permanent heat dissipation of approx. 65 Watts a GAS can with a non insulated end cap was used to provide sufficient temperature environment (figure 7).

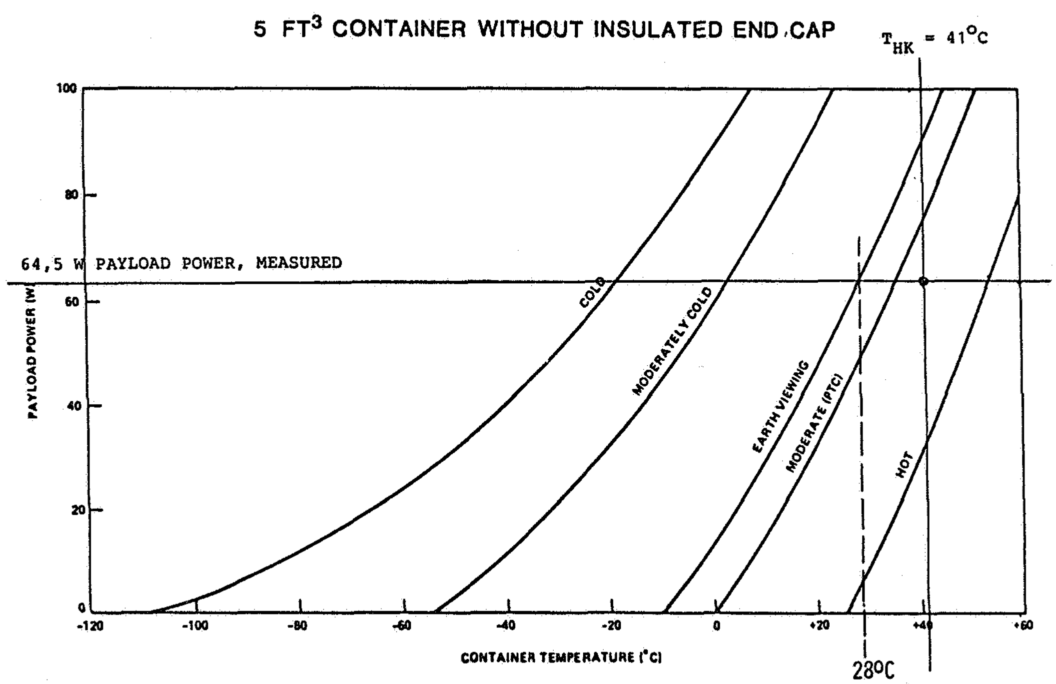


Figure 7. Get Away Special Small Self-Contained Payloads

However, the unexpected coverage of HALEX by the deployed SIR-B antenna caused a significant temperature increase (figure 8). This lead approx. 56 hours after payload activation to an automatic shut down of the lamp power for roughly 30 minutes before it came back on again. After a total payload operation time of 57,9 hours HALEX was automatically switched off by the low voltage power cut-off.

The mirror compartment was evacuated during ascent and repressurized during descent via a ventline.

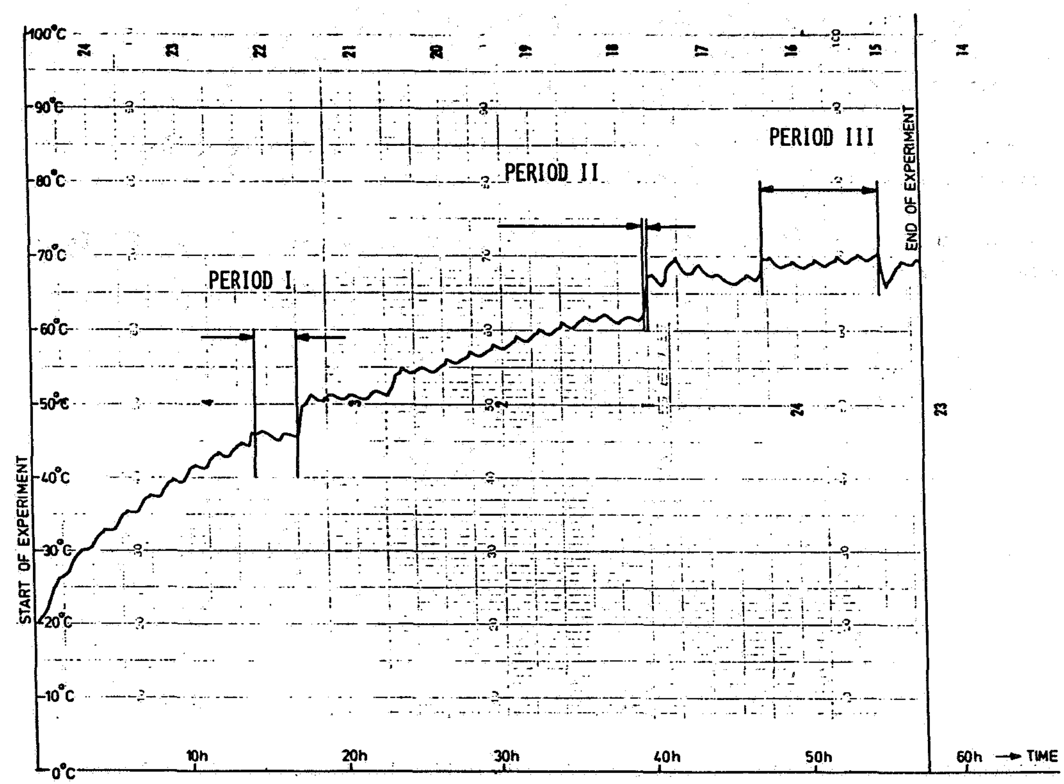


Figure 8

SUMMARY

HALEX performed as predicted within its specified limits and all experiment goals could be fulfilled. The experiment was not affected by the significantly higher temperature environment and the related 30 minutes interruption of lamp activation nor by the extension of the sequencer created time intervals for data acquisition and recording during the last eight hours of operation.

From the evaluation of the flight data it was learnt that:

- Lamp voltage was constant over the whole experiment period
- Lamp current was constant
- Resistance of lamp filament did not change (<0,1%)
- Photo signals were constant with respect to the radiation input
- Lamp base temperature showed that lamp bulb temperature was as expected
- Heat pipe temperatures showed proper function

The inspection of the flight lamp indicated:

- o No detectable disturbancies of the Halogen cycle (i.e. no deposit of Tungsten on the bulb)
- o Surface characteristics of the filament as expected (microscopic inspection)

Therefore it can be concluded that:

- o Absence of convection (under microgravity) inside the lamp bulb results in a reduction of convective heat transfer from 5% to about 2%
- o Due to this reduction the filament temperature rises about 20 K resulting in an encrease of light efficiency of about 8,8%

The duration of the HALEX flight experiment of 57,9 hours corresponds to approx. 10% of the expected life span for the envisaged future flight lamp.

Concerning all results of the HALEX experiment it can be assumed that a 300 W lamp with similar design will operate in space as well as the HALEX lamp did.