THE G-002 JUFO-1 PAYLOAD, ITS OBJECTIVES AND RESULTS

Guenter Schmitt
Kayser-Threde GmbH
Munich, FRG

Objectives:

The G-002 JUFO-1 payload was successfully flown during the STS-7 mission in June 1983.

It was intended to:

- establish a forum for space relevant experiments of high school and university students

- demonstrate that simple and cheap technology can be flown on the shuttle without compromising safety and reliability

- experience the capabilities of the GAS flight opportunities, its advantages and restraints

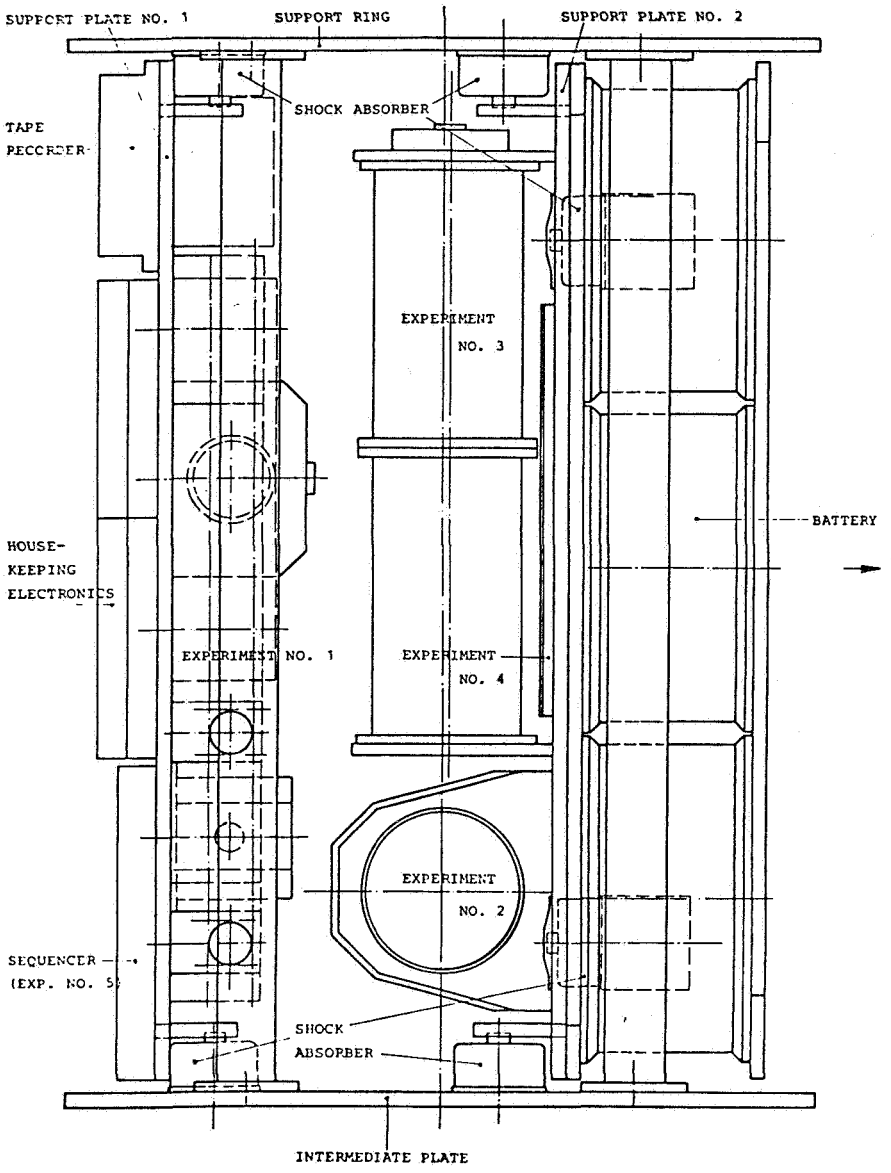
- evaluate proceeding of different experiment types mainly with respect to the long standby time ahead of the mission

Concept of payload and its operation:

The payload basically consists of the mechanical support structure with two shock isolated mounting shelves for the experiment hardware and the service systems.

For the envisaged operation time of 72 hours three 28 VDC batteries, with a total capacity of approx 1,7 kWh are chosen as partially redundant power source.

G-002 JUFO-1 PAYLOAD



Every minute, experiment and housekeeping data are acquired by a 12 bit PCM system and stored on a cassette tape recorder. The PCM system provides twelve analog and four digital channels at a data rate of 5 kbit/sec.

Payload and experiments are activated by switching the GAS relay contacts and are controlled by an internal sequencer.

In order to maintain adequate payload temperatures at a low power consumption, a thermally insulated endplate was used with the GAS container.

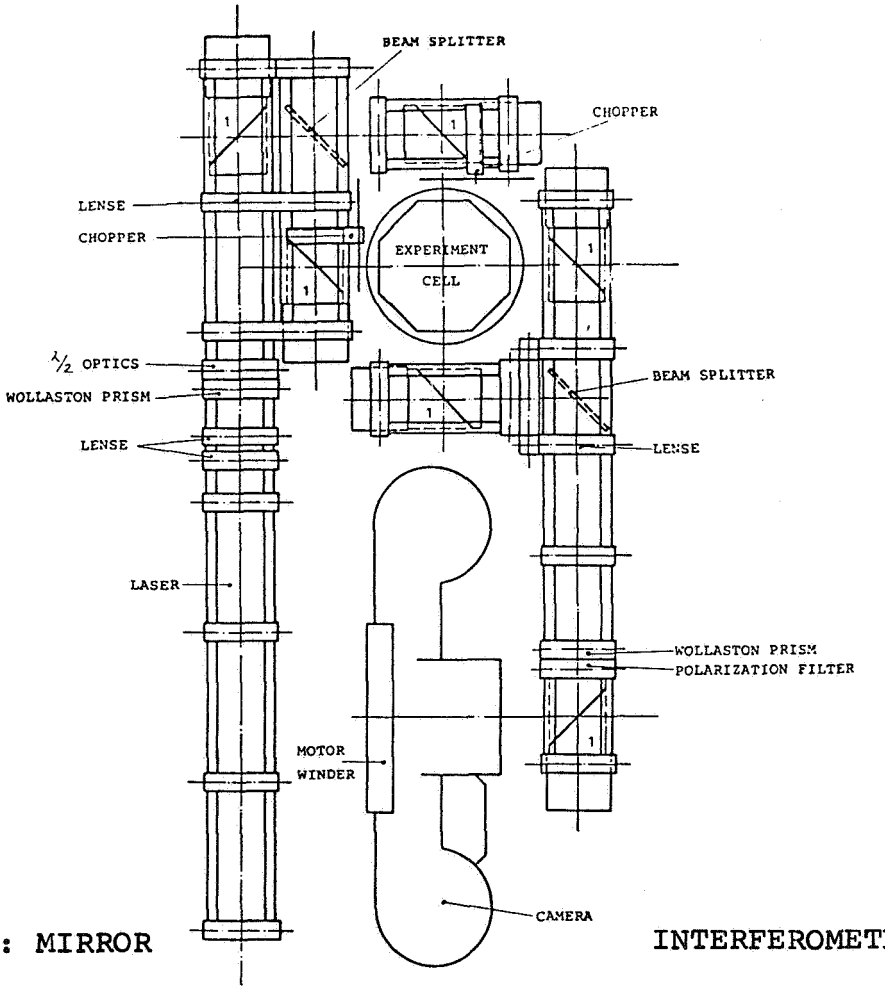
Experiments in various areas of science:

Five experiments, concerning physics, chemistry, biology and technology were carried within this payload.

Experiment no. 1): Crystal growth

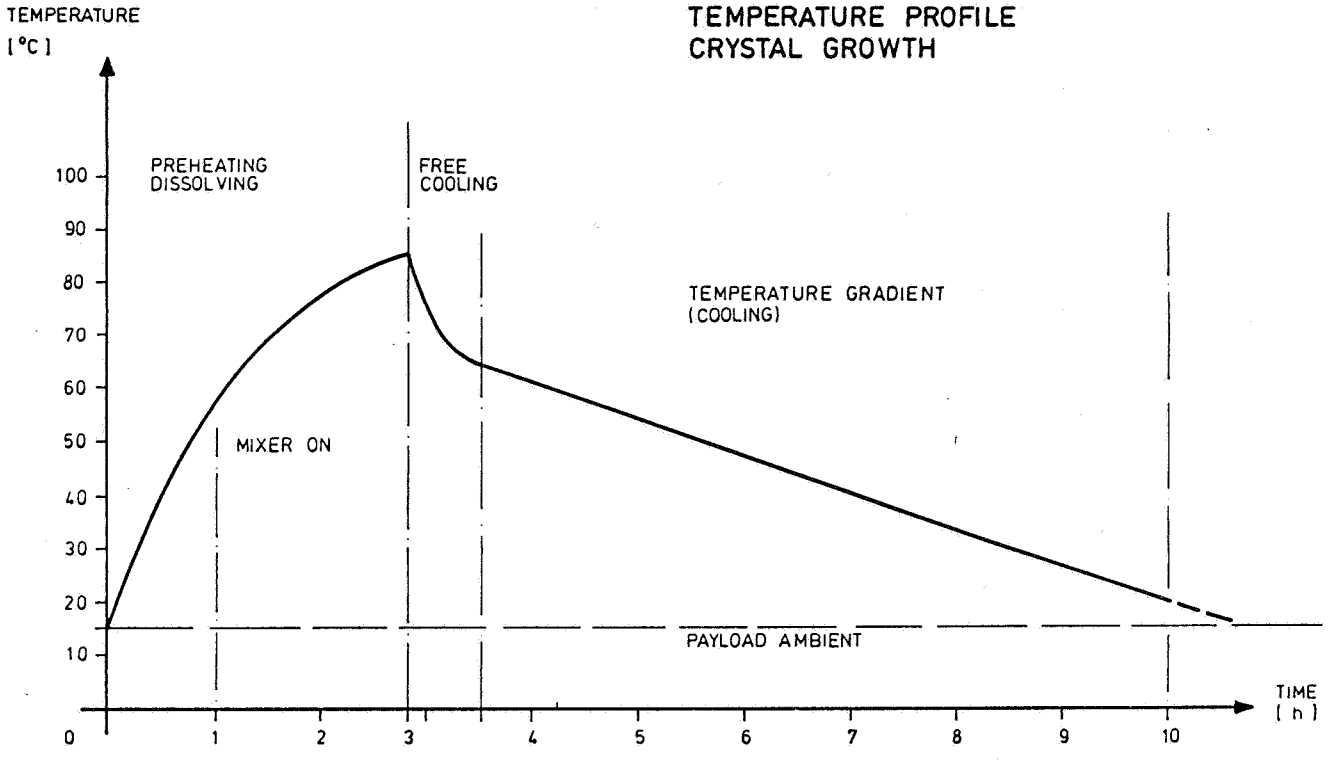
The growth of a crystal in a liquid $KH_2\ PO_4$ salt solution - saturated at 60 ^{o}C - was observed under micro gravity environment.

A thermally isolated experiment cell, furnished with four orthogonal, optical windows, four foil heaters (20 W), a mixer and a neoprene membrane contains approx 160 ccm liquid solution. Leading across the cell a nylon rope acts as an initiator for crystal growth in the center of the cell. The experiment cell is integrated into a laser Doppler interferometer with an orthogonally splitted H_e-N_e laser beam of approx. 0,5 mW output power.



INTERFEROMETER

During the controlled cooling period of the experiment density structures of the solution around the growing crystal are detected.



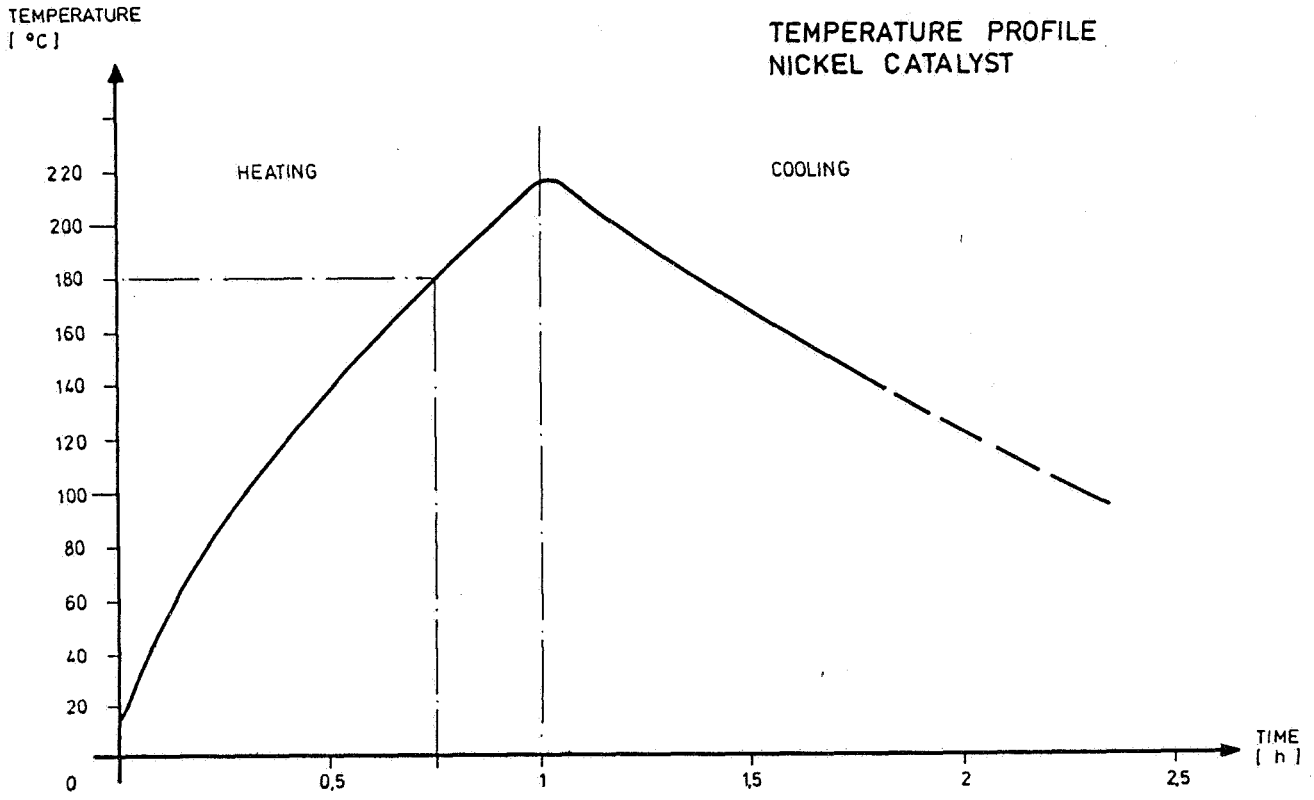
Every four minutes two pictures of interferograms in orthogonal planes are taken in between ten seconds. Though a total of 250 interferograms is registered by a photographic camera. For association to the recorded temperature data the experiment time is displayed on each picture.

The experiment performed as expected, the predetermined temperature profile was achieved, a crystal was growing in the center of the cell and stills of interferograms were obtained. One optical window could not be cleared completely because some salt crystals didn't get dissolved during the preheating phase. Some unexpected gas bubbles caused disturbancies in the density structures, too. Some of the experiment results are still evaluated at the present time.

Experiment no. 2): Nickel catalysts

Nickel catalysts were manufactured by thermal processing of four specimen cartridges inside a furnace.

The 55 W isothermal furnace heats up four nickel cartridges to 240 °C. Each cartridge contains a mixture of potassium hydroxide/nickel formiate or sodium hydroxide/nickel formiate and dry nitrogen to avoid moisture.



During the heating period the materials inside the cartridges are exposed to a temperature environment above 180 °C for more than 15 minutes and a peak temperature minimum of 205 °C. After reaching a predetermined temperature the furnace gets switched off while the cartridges are cooled down passively. The furnace performed as predicted.

A comparison of ground test results with "in space" and "on earth" processed nickel catalysts shows significant differences. In space processed catalysts experience higher efficiency. The experiment results are still under evaluation.

Experiment no. 3): Plant contamination

Water cress shoots were used to determine the transport mechanisms of heavy metals in plants.

Three cylindrical growth compartments contain approx. 60 seeds each, liquids for initiation and fixation stored in standard syringes and air at atmospheric pressure.
The seeds are glued to cellulose wadding at the bottom of bores in plexiglass cylinders. For initiation of the experiment spring loaded plungers are released and the liquids are injected into the wadding using $H_2O/Cd\ (NO_3)_2$ solution with two compartments and H_2O with the third. The temperature is controlled closely to 24 ^{o}C during the three day experiment activation time. Within this period three 12 hours day/night cycles are simulated by LED arrays. For fixation of the seeds after three days saturated Reinecke salt solution is injected into two compartments while formaldehyd and methanol stabilized in H_2O is injected into the third.

The experiment performed satisfactorily. Some plungers could not be driven by its spring load after release most likely because of the long standby period.

However micro cuts through the "in space" developped plants show significant differences in their cell structures compared with plants grown on earth. Traces of Cd have been detected in the plant shoots. Some of the results are still to be evaluated.

Experiment no. 4): Biostack

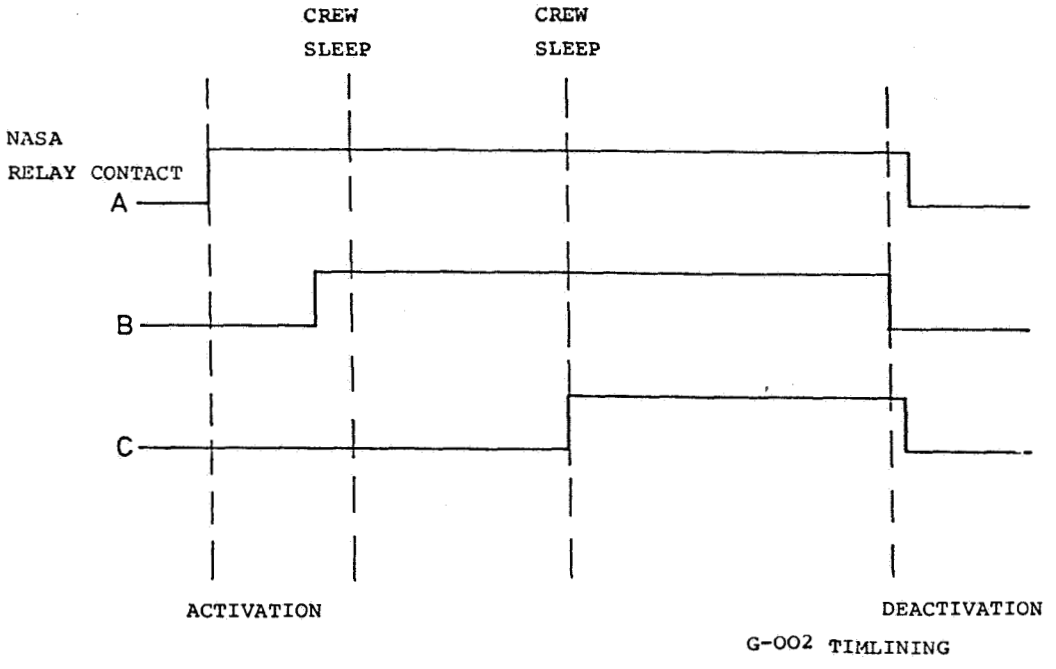
The biostack was designed to determine the influence of cosmic radiation on plant seeds.

Four different plant seeds - wheat, grain, oats and beans - are embedded in single bores of flat plexiglass blocks. Diallyl-diglycolcarbonate foil is attached to top and bottom of each block to detect and locate impact of particles.

Mostly impacts of α-particles were detected, however, three impacts of heavy particles were located. Comparing plant development tests are still in progress and not finished yet.

Experiment no. 5): Microprocessor-sequencer

The microprocessor controlled sequencer uses a new approach for payload control and sequencing at a low power consumption.



G-002 TIMLINING

All payload functions are timed by the sequencer based on a NSC 800 CPU. Its main routine is activated by GAS relay contact A. This routine controls data acquisition, tape recorder, housekeeping system and water cress experiment during the whole payload operation time. Subroutines for timing of crystal

growth and nickel catalysts experiments are initiated by GAS relay contacts B and C. Therefore redundancy is obtained in processing the different experiments. The sequencer performed as predicted.

Summary:

The G-002 JUFO-1 payload was very successful under the aspect of its objectives. Micro gravity relevant scientific results were obtained.

However, critical items were experienced due to the long stand-by period of two months and more in advance of the mission. Nevertheless, a basis to maintain a low cost program with frequent flights could be established encouraging junior scientists to participate in space activities. Today a follow on mission is already planned.