MUNIN – A SWEDISH NANOSATELLITE

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ABSTRACT

Munin was a 21 x 21 x 22 cm, 6 kg nanosatellite developed at the Swedish Institute of Space Physics (IRF) in Kiruna, Sweden together with Umeå and Luleå universities and Southwest Research Institute (SwRI), Houston, Texas. It carried three instruments for investigations of the auroral regions. The MEDUSA-2 miniaturized top hat electron and ion spectrometer, the DINA high energy ion and neutral particle detector and the HiSCC miniaturized CCD camera to image the aurora. Munin was launched as a piggyback payload on a Delta-II rocket from Vandenberg AFB, California on November 21, 2000. It made measurements for nearly three months before contact was lost after a system reboot on February 12, 2001.

1. INTRODUCTION

September 1996 the decisions to build a small research nanosatellite were taken at the Swedish Institute of Space Physics. The institute's participation of the Swedish microsatellites Astrid 1 and 2 [1, 2] had been a success and plans to build a small, cost-efficient satellite to study the auroral regions took form.

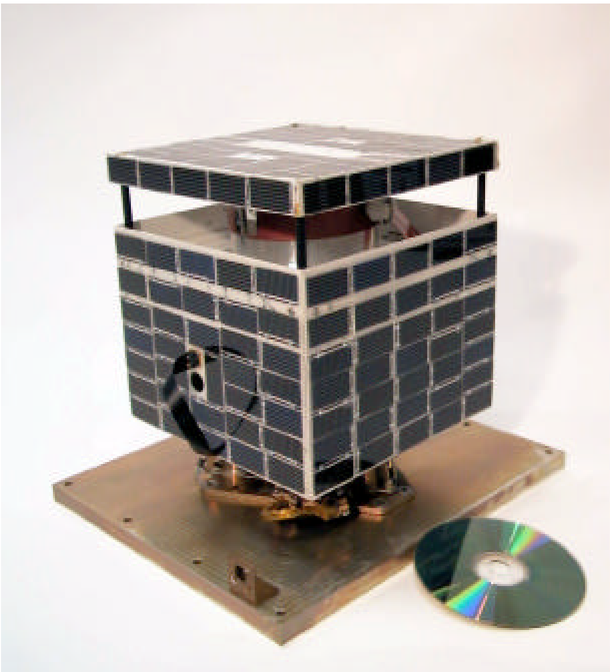

Figure 1.1: The Munin nanosatellite.

2. TECHNOLOGY USED

Munin [3] was constructed on an aluminium frame housing a data processing unit, battery, attitude magnet, radio transceiver, and the MEDUSA-2, DINA and HiSCC experiments. The satellite dimensions were 213 x 213 x 218 (height) mm. Munin contained no moving parts such as booms or other deployment systems.

Solar cells cut in sizes of 20 x 40 mm covered all sides of the satellite. Munin had one string of 40 cells on each of the satellite's six sides. Onboard was a Li-Ion battery pack from Duracell with a capacity of 4200 mA at nominal voltage 10.8 V. The charging current and voltage to the battery was 0.5 A and 12.35 V respectively.

The Munin communication system consisted of a modified amateur radio model TEKK KS-1000 transceiver. This radio was modified to transmit at 400.55 MHz and receive at 449.95 MHz, the same frequencies as used on the Astrid and Freja satellites. Some components were replaced to allow the radio to withstand the space environment.

A passive attitude control system in the form of a permanent magnet was used on Munin. The intension was that Munin would simply follow the alignment of the Earth's magnetic field on its polar orbit as in figure 2.1.

The DPU was based on the Texas Instrument TMS320C50 signal processor. The DPU spare unit of the PIPPI instrument onboard Astrid-2 microsatellite with slight modification was used as the Munin unit. With 20 kb of internal memory and a 40 MHz clock frequency this processor controlled all actions onboard the satellite. The Munin DPU also included an external RAM (16kb) and as program memory, 64k word EPROM for flight software and 32 k word EEPROM for various data and software patches. The data storage capacity onboard Munin was 2 Mb of RAM. All instrument data, packing and buffering before downlink took place here. All monitoring were routed through a 10 bit A/D converter. All Munin subsystems were realised on 3 electronics boards, a battery pack layer and a bottom layer with the radio transceiver and the DINA instrument. The pictures of the different boards are in figure 2.2a-d.

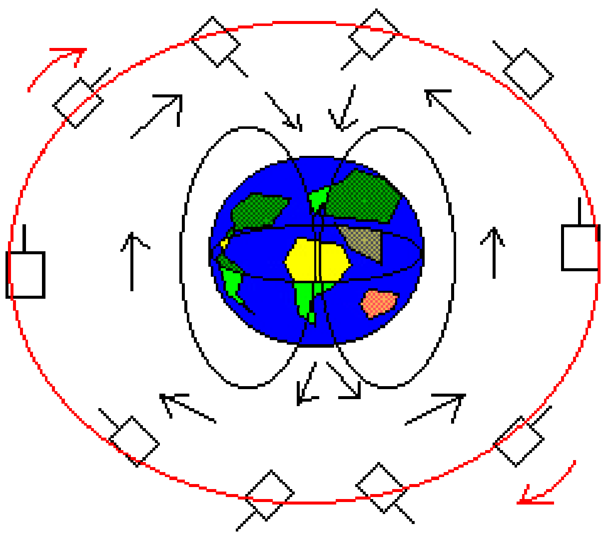

Figure 2.1: Munin's intended attitude during one Earth orbit.

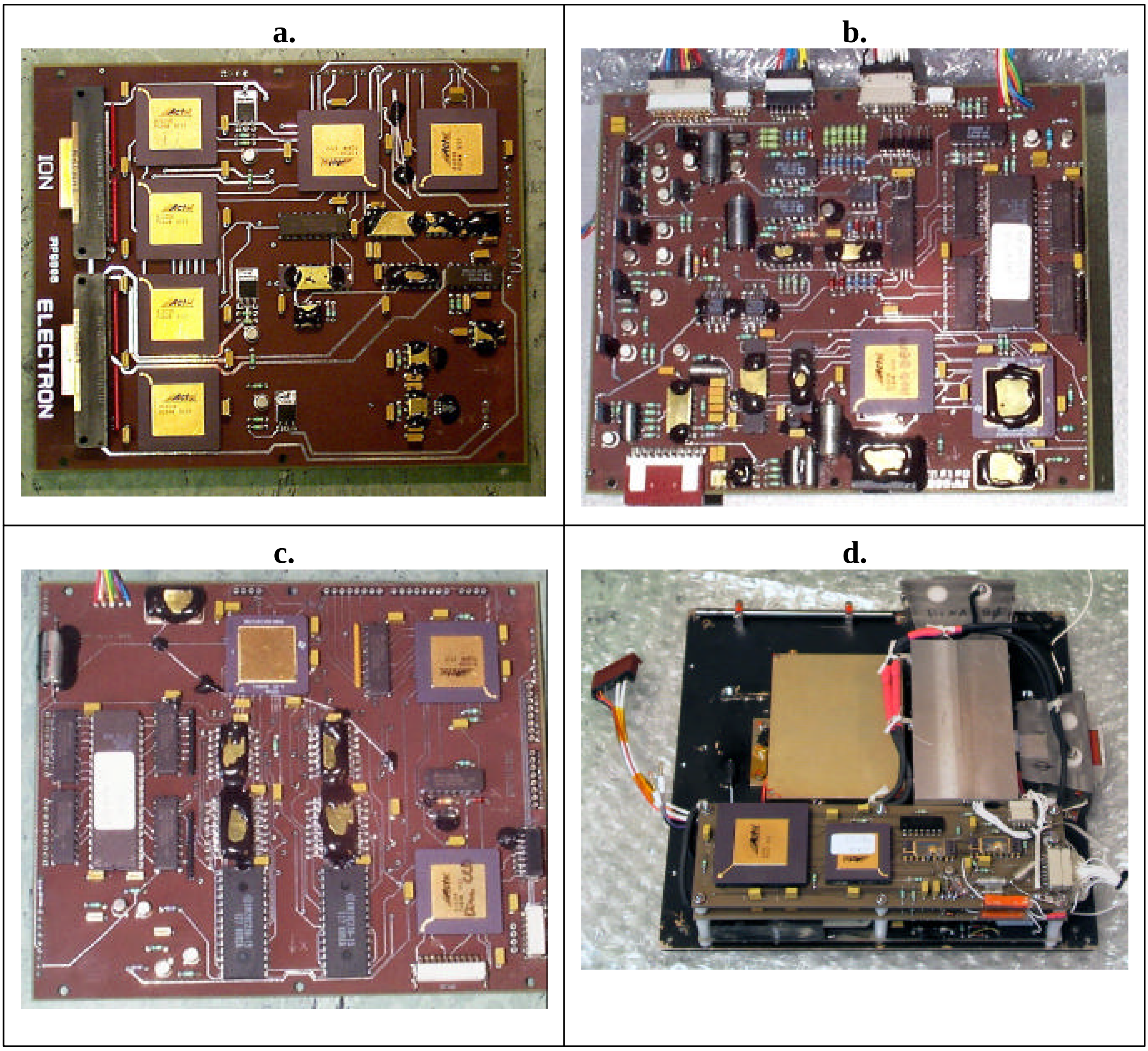

Figure 2.2: a.) The MEDUSA-2 DPU. This board also contain a 2-axis magnetometer in lower right corner. **b**.) The Munin system board for various housekeeping duties. **c**.) The DINA and HiSCC DPU board. **d**.) The bottom layer of Munin holds the radio transceiver (left center), the permanent magnet for attitude control (top left) and the DINA instrument (aperture 1 top and aperture 2 right).

3. RESULTS

The data from the Munin experiments have not yet been fully analysed. There are some existing data plots from the MEDUSA-2 instrument (figure 3.1) and pictures from the HiSCC camera. DINA data is available but has not yet been analyzed. There is a question whether the attitude is sufficiently known to allow analysis of the DINA data. Attitude determination of Munin is currently ongoing at the Keldysh Institute of Applied Mathematics RAS, Russia. Data from the experiments is available online at http://munin.irf.se/rpg/bin/munin/munin.shtml.

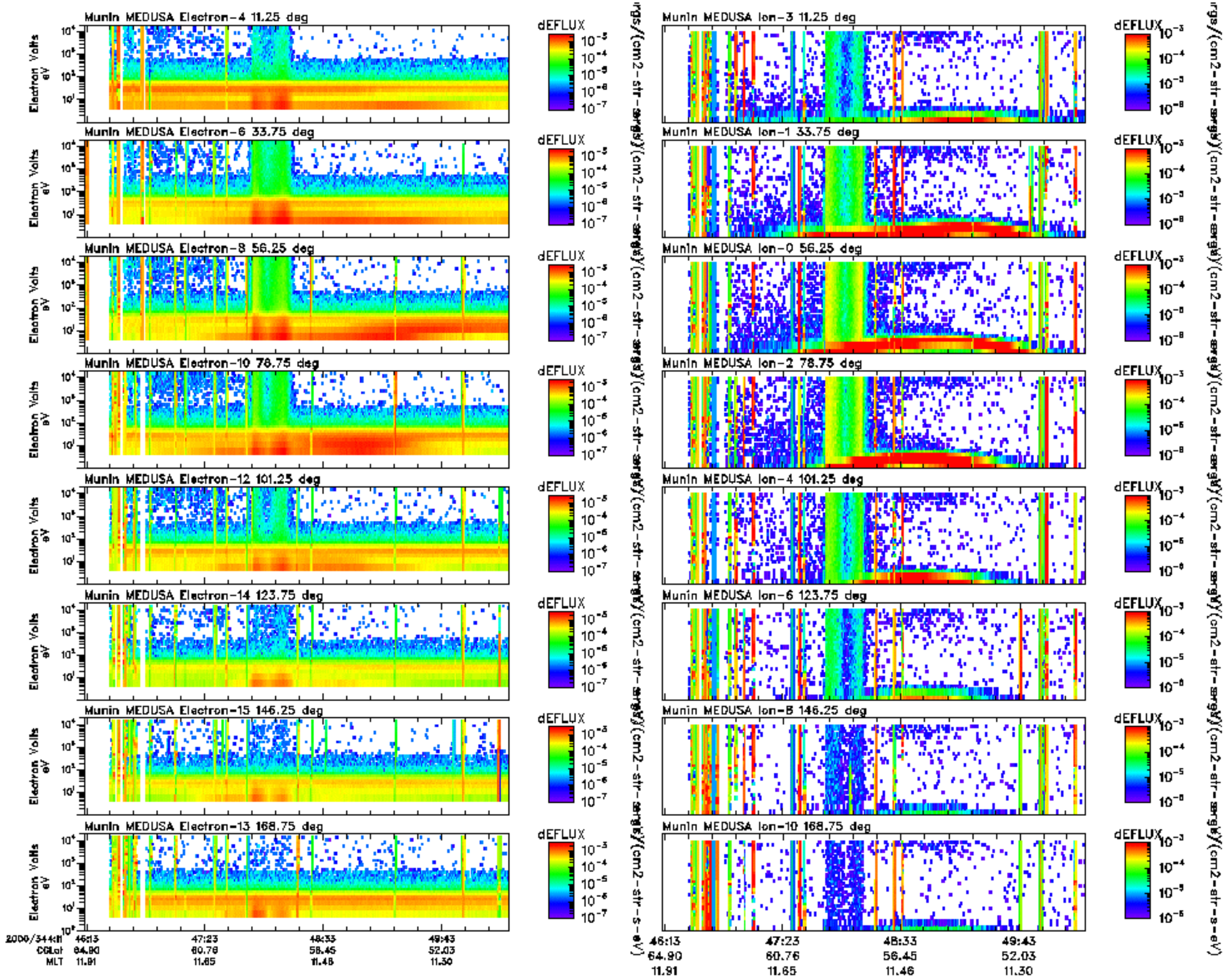

Figure 3.1: An example of MEDUSA-2 formatted data plots available.

REFERENCES

2. O. Norberg et.al., The microsatellite ASTRID, *Proceedings 12th ESA Symposium* on European Rocket and Balloon Programmes and Related Research, ESA - PAC, Lillehamer, Norway, 29 May - 1 June, 273-277 (1995)
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Web resources at: http://munin.irf.se