In situ rocket measurements

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Why use instrumented rockets ?

- Sounding rockets provide the only means of making in situ measurements at altitudes between the maximum altitude for balloons (40 – 50 km) and the minimum altitude for satellites (160 km).
- Can be necessary to obtain high enough spatial resolution. A resolution on meter scale can sometimes be demanded, while radar and ground based techniques typical gives 1 km – 50 km spatial resolution.

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- A sounding rocket can be launched to study short-lived physical phenomenon. By using ground based techniques (radars, lidars, all-sky cameras), a rocket can be launched into the interesting layers with almost ”surgical precision”
- Rockets have lower velocity than satellites, which means better spatial resolution with the same sampling frequency.

Sounding rockets

- Sounding rockets take their name from the nautical term "to sound," which means to take measurements. These rockets are basically divided into two parts:

  Solid-fuel rocket motor

  Payload

- Many of the motors used on sounding rockets are surplus military motors, which keeps down the cost of the rocket. The **payload** is the section that carries the instruments to conduct the experiments and sends the data back to Earth

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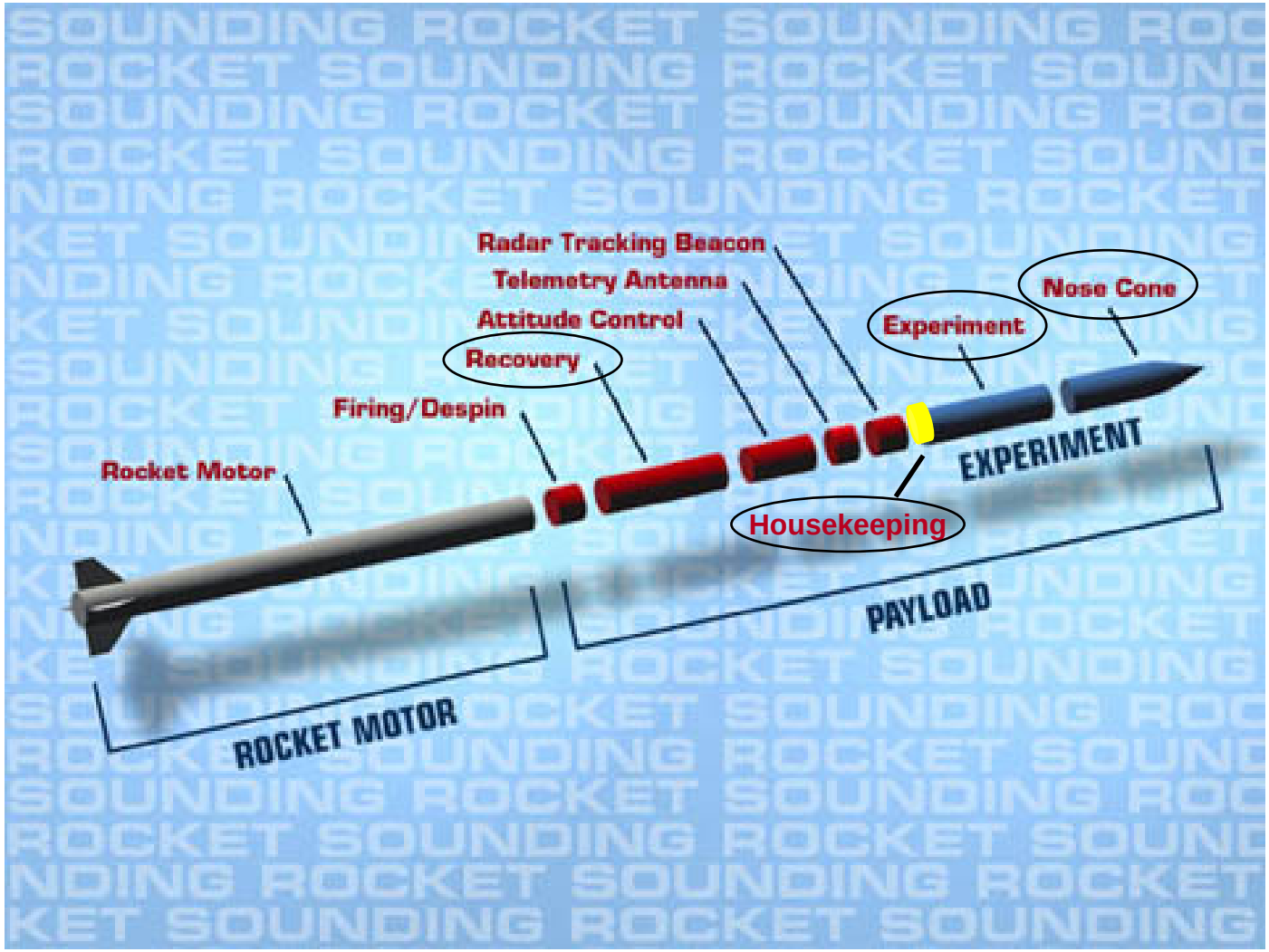

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Nose cone section

- Usually contains deployable antennas for the instruments.
- Can contain experiments and preamplifiers .
- The nose cones are separated by explosives.

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Experiment section

- Contains the scientific experiments on board.
- Sometimes hatches/doors with explosives are integrated in this structure, so antennas can be deployed from this section too, after the hatches/doors have been thrown off.

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Housekeeping section

- **Telemetry encoder**: Data from the different experiments/instruments on board are collected, (time-multiplexing), encoded and transmitted to ground.
- This section also contains instruments to monitor the status of the rocket; acceleration, velocity, temperatur, power consumption, preassure, earth magnetic field etc. This information are also transmitted to ground.

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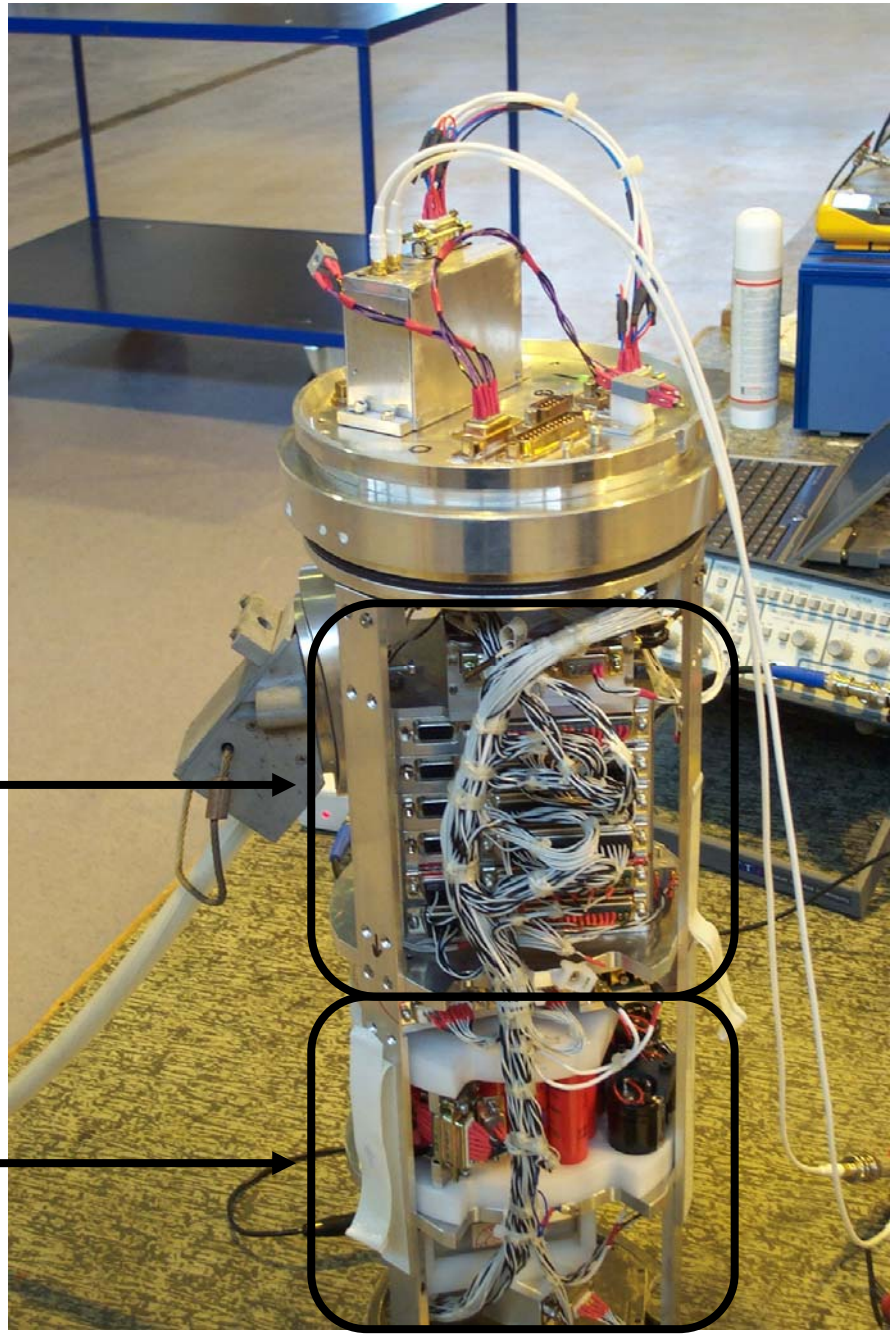
Shows instrument section and part of housekeeping section



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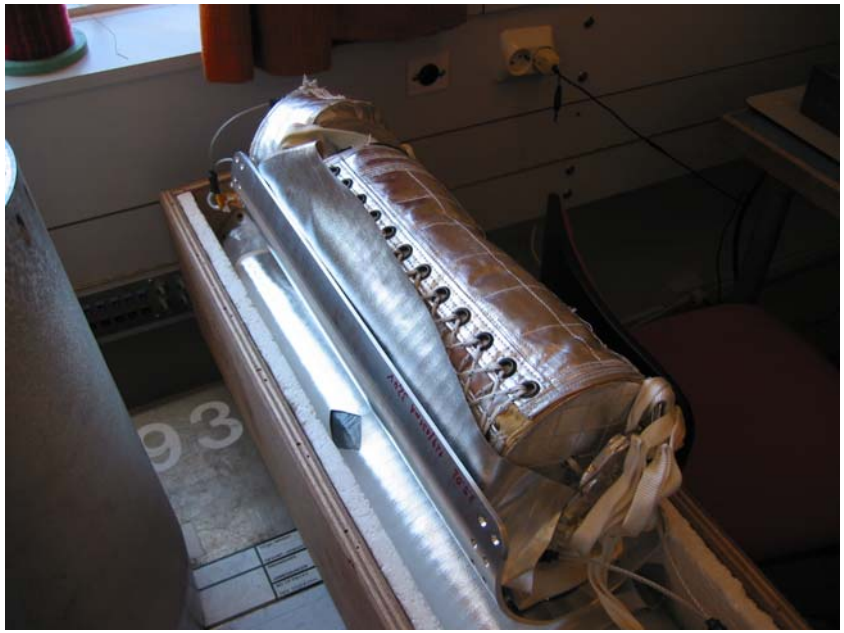
Recovery section



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The Flight Profile of a Sounding Rocket

- The flight profile of a sounding rocket follows a parabolic trajectory—it goes up and comes back down. Flight time is less than 30 minutes. However, invaluable data can be received in this short flight time.
- Following the launch, as the rocket motor uses its fuel, it separates from the vehicle and falls back to Earth. The payload continues into space and begins conducting the experiments and sends data back to earth. As the payload re-enters the atmosphere, a parachute is deployed to bring the payload gently back to Earth. The payload is then retrieved (from sea or land). Retrieving the payload can result in tremendous savings, because the payload or parts of the payload can be prepared and flown again.
- Many payloads are not rescued, which means that they have no recovery section on board.
- Not always necessary to separate the motor (for single-stage rocket motors) !

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Sounding rocket launch (two stage rocket)

1

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Rocket configurations

The rockets used varies from single-stage rockets with maximum altitude of 10 -100 km, to four-stage rockets reaching altitudes up to 1500 km. They are up to 20 meters long, and can carry a payload weight up to 500 kg.