NEW FLIGHT QUALIFIED PAYLOAD BY ANDOYA ROCKET RANGE

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Abstract
During the latest years the Payload Services department at Andoya Rocket Range (ARR) have been developing and qualifying a new sounding rocket payload configuration for flight. The concept is targeted to give scientists predictability and assurance on configuration, cost and timeframe for their projects. The HotPay2 project was the first successful flight from Andoya with this payload and motor configuration, lifting the payload up to 360 km altitude. Based upon the lessons learned and the flight heritage achieved here, the ICI-2 project was launched from Svalbard in December 2008 and reached 350 km. This paper summarizes these two payloads, and explains how the basic configuration can be customized to fit new and upcoming missions hosted by ARR Payload Services, providing the customer with a flight qualified tool for future scientific discoveries in our atmosphere.

1 Introduction

The main focus of this paper is to discuss the flexibility of the recently flight qualified 14 inch / 356 mm payload configuration that has been developed by the payload services department at Andoya Rocket Range. In order to provide the reader with a better understanding of how such a payload is assembled (Fig. 1), the paper starts with a summary of the two latest successful flights, HotPay2 and ICI-2. It continues with a discussion of the similarities and differences between these two payloads, and it ends up with a discussion which summarizes the flexibility, quick turnaround and the next scheduled mission.

2 HotPay2

The HotPay2 project was financed through EU’s 6th Framework Program and was called ALOMAR eARI (enhanced Access to Research Infrastructure) [1]. The ALOMAR eARI offered scientists from member states of the European Union and associated countries two possible approaches to apply for transnational access to a selection of ground-based instruments, and/or to an instrument platform on a sounding rocket. The payload carried seven instrument packages, which can be grouped into three categories.

- Upper mesosphere/lower thermosphere science [2], The first experiment was to understand the

Figure 1: Basic Payload
Na D-line emission at 589nm, and important component of the earth’s nightglow.

- **Auroral Science** [3], Estimation of field aligned currents in narrow auroral structures.
- **Cosmic Ray flux** [4], Measure the energy spectrum of primary cosmic rays and secondary particles that are generated on collision with air molecules.

## 2.1 Mechanical

Fig. 2 illustrates the payload in active mode configuration with both the Nose cone and the doors deployed. The Faraday antennas are shown in the top section, and the Current Loop (CL) and the Search Coil Magnetometer (SCM) are shown below deployed through the doors. The CL and SCM was about 700 g each, causing major forces to be controlled during the deployment at about 4 rps. The deployment lasted about 1.2 seconds, and “despun” the payload with approximately 0.4 rps [5].

The Electronics- and the Nose cone Section are illustrated in Fig. 3. The main instrument package in this payload was the five photometers mounted on the top deck, with a forward looking field of view. Some of the instruments required an interface / electronics adjacent to the probe for signal conditioning. These interfaces were located in the Electronics Section, just below the sensors.
3.1 Scientific Objective

The scientific objective for the mission can be summarized as [6].

- Resolve density gradients / structures down to meter scale.

3.2 Mechanical

Fig. 6 illustrates the payload in active mode with both the nose cone and the doors released. The payload featured 6 ea. E-Field probes where the knee on each of the four uppermost booms were base for one cylindrical fixed bias Langmuir probe [7].

The deployment lasted about 0.1 seconds, and “de-spun” the payload with about 0.15 rps [8].

The Nose cone and the Electronics Section are displayed in Fig. 7. Here we can clearly see how the real time data handling electronics boxes were located in the Electronics Section, and the probes / sensors were located above in the Nose cone Section.

Figure 7 displays the hotel section. It contains the two booms with a probe on each tip. The basic deployment system for the booms in the Nose cone and the Hotel Section were the same [9].

The Service Section is illustrated in Fig. 9. The PCM encoder features a dual encoder capability, making it possible to transmit two independent data streams to the ground telemetry station. For that reason the payload was equipped with two transmitters, one on
the upper and one on the lower deck, each with a separate set of antennas. The magnetometer/accelerometer was located on the middle deck, with a sheet of mu-metal mounted under the transmitter in order to shield against the influence from the magnetic field from the transmitter. Mu-metal is a nickel-iron alloy (approximately 75% nickel, 15% iron, plus copper and molybdenum) that has very high magnetic permeability. The high permeability makes mu-metal a very effective at screening static or low-frequency magnetic fields, which cannot be attenuated by other methods [10].

3.3 Electrical

An overview of the electrical preferences are summarized in Tab. 2.

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCM Encoders</td>
<td>2</td>
</tr>
<tr>
<td>Analog Channels</td>
<td>8</td>
</tr>
<tr>
<td>Digital Channels</td>
<td>11</td>
</tr>
<tr>
<td>Data Bitrate</td>
<td>2 ea. 3.333 Mbit/s</td>
</tr>
<tr>
<td>Transmitter</td>
<td>2 ea. 10 Watt power output</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>3800 mA at 28 VDC</td>
</tr>
</tbody>
</table>

4 Customization

The mission objective can be different from mission to mission. But like the commercial satellite business, most of the main parts remain the same.

In order to meet the customer’s requirements for flexibility, as well as the economical aspect of a mission, ARR has successfully launched two flights with its 14 inch payload. Both payloads have been based upon the same mechanical structure, which includes
minor modifications to the inner structure in order
to meet two quite unique instrumentation packages.
The following section discuss which parts that have
the possibility of mechanical and electrical modific-
ation, and where there is fixed items that is required
in order to let the payload function as it should.

4.1 Mechanical

The basic payload configuration consists of five main
sections, listed from the front to the rear these are:

- Nose cone Section
- Electronic Section
- Hotel Section
- Service Section
- Second stage ignition Section

The three front sections are intended to be customized
according to the customers’ requirements. While the
two following sections are fixed. The latter should
not be modified mechanically.

The Hotel Section consists of a 51 dm³ vertical room
with two doors opposite to each other. This huge
volume and doors may be used to house big booms,
sensors or daughter payloads. It is commonly used
to store booms with probes that is extended outside
the wake of the payload in order to measure in undis-
turbed Plasma. Additionally it can be modified to
contain other types of instrumentation that require
to be exposed. For example Cameras looking inside
or outside the payload, looking back on the ground,
photometers looking outside, or a release system for
a set of free-flying probes.

The constructions of booms are performed upon the
request from the customer, and have been manufac-
tured by the University of Oslo (UiO), which have a
unique expertise in this kind of mechanical construc-
tion/design. The booms constructed by UiO have
also a long flight heritage history. Acceptance- and
flight qualification tests are performed by ARR.

Fig. 7 shows the Electronics and the Nose cone
Section mounted on top of each other. This gains
easy handling. The lower part (Electronics Section)
has traditionally contained electronics that has taken
care of the real time data handling of the scientific
instruments before the measurement has been sent
back to the ground station through the telemetry
system that is located in the service section. By collect-
ing preamplifiers, interfaces and converters in the
Electronics Section allows more instruments in the
Nose cone Section.

4.2 Electrical

All payloads need electrical control and data han-
dling system that takes care of the electrical inter-
faces and events for the mission.

From the beginning of scientific research the demand
for high data resolution have created challenges for
the engineers. For the ICI-2 mission there was there-
fore used two telemetry links in order to meet the
requirements from the scientists. This was the max-
imum recommended bandwidth with respect to the
signal quality, and redundant downlink to Andoya
Rocket Range from from a rocket launched from Sval-
bard.

The internal battery packages are also designed with
respect to the power consumption of the instrumen-
tation. In addition a safety margin is added in case of
unpredictable long time using internal power before
lift-off and extended flight time.

The harness is also customized for every mission, spe-
cial care is taken where analog signals is used with
respect to noise, crosstalk and radio frequency inter-
ference.

5 Discussion/Conclusion

The entire cost effective sounding rocket concept- for
middle atmosphere and ionosphere [11] that is pro-
vided by the Payload Services Department at ARR
is based upon flexibility. This is because every mission is unique, and thus requires the flexibility and adaptability in order to heritage as much as possible from the previous/earlier mission.

All the systems used have a substantially flight heritage after numerous successful launches. But in order to push the technology forward, each flight also contains new system(s) that is being qualified as a piggy-back to the main mission.

5.1 Flexibility

We have shown in the previous sections how the two previous payloads were organized, and what kind of electrical performance these had. The scientific instrument packages and the electrical subsystems were different, because of the flexible mission design.

ARR operates two launch sites in Norway, were the main base is located on Andenes at 69° north, and the second are located in Ny-Ålesund, Svalbard at 79° north. Thus, ARR have the world’s northernmost rocket range which provides the scientific community with the possibility to launch directly up into the auroral cusp along the magnetic field lines. Both launch facilities provides the customer with a unique location in the world to perform the mission [12]. It is also possible to do a joint mission from both places.

5.2 Quick Turnaround

From when a mission gets initiated and until launch it has normally taken 2 – 2.5 years. This timeframe can easily be shortened if the funding and the instruments are already done at project initiation. If there is no major re-designs of the payload inner structure, the production time from ARR could be less than a year.

5.3 Next upcoming mission

The next upcoming mission is the ICI-3 mission. This is the successor of the ICI-2 [6]. It is scheduled to be launched from Svalbard in late 2010 or early 2011.

References


