INTRODUCTION TO THE CANOROCK PROGRAM

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ABSTRACT

This paper will present the proposed CaNoRock program. The CaNoRock program is scientifically oriented and focuses on the exchange of students of physics, engineering and related technologies between Canada and Norway. Most countries in the western world strive to motivate young people to choose natural science and technical studies. A lack of highly educated employers can become a problem if the western countries intend to maintain a leading role in the technical development. The field of space research and space utilisation is not an exception. Norway and Canada intend to be in the forefront, thus they have invested resources in a program to motivate young students to seek a career within the space research field – the CaNoRock program.

1. COOPERATION TO MOTIVATE STUDENTS – THE CANOROCK PROGRAM

The proposed CaNoRock program is aimed to serve as a basis for a 10-year bilateral student sounding rocket program between Canada and Norway from 2011 - 2021. Here it is vital to motivate students to join space activities and acquire enhanced knowledge in physics, engineering and electronics for sounding rockets and stratospheric balloons. The program may also include working with other scientific platforms such as Unmanned Aircraft Systems and Long Duration Balloons. The universities of Oslo, Tromsø, Alberta, Calgary and Saskatchewan have common research interests in atmospheric, aurora and magnetospheric physics. Each institution specializes in different experiment types, and in collaboration we can produce even more advanced scientific rocket and satellite payloads.

Figure 1: Students from CaNoRock III together with the Canadian ambassador, John Hannaford.

2. CANOROCK KICK-OFF ROCKET LAUNCH

On 17 to 21 of January 2011, a total of 21 students from Norway and Canada gathered at Andøya Rocket Range to design, build and launch their own instruments onboard the CaNoRock III rocket. CaNoRock III marks the official start of the 10-year sounding rocket collaboration program between Norway and Canada and was officially opened by the Canadian ambassador, John Hannaford.

Students from the Universities of Oslo, Bergen, Tromsø, Saskatchewan, Calgary, Alberta and Østfold University College attended the CaNoRock III course. The students prepared a student sounding rocket, performed the rocket operation and analysed the data from the rocket. The students performed the work, guided by professionals from the Norwegian Centre for Space-related Education (NAROM) and Andøya Rocket Range. There were also highlight lectures given by the best professors within their scientific background.

Topics like trajectory analysis, introduction to rockets, payload integration and telemetry were covered. The main focus was the preparation of the student rocket where the students built the instruments, performed the rocket launch operation, tracking the rocket and

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analyzing data from the rocket. The course also included a guided tour at Andøya Rocket Range and ALOMAR. The students had to deliver a final report, which they can get 5 ECTS-credits from the course provided by the University of Oslo.

This type of student rocket course will be arranged twice a year with both Norwegian and Canadian participants.

The interest for the project has been overwhelming in both countries. Worth to mention is the fact that the universities in Alberta and Calgary both had 50 applications for the four available student spots in Canada to the first CaNoRock student rocket from Andøya in November 2009. "CaNoRock I and II″ were conducted as a test before the project officially started in 2011.

Figure 2: Launch of CaNoRock II

3. SCIENCE AND TECHNOLOGY IN FOCUS

The CaNoRock program is going to be a student program based on science, an important contribution to "The High North Commitment" when it comes to innovation, development of knowledge and recruiting to the knowledge-based industry in the region. The start of the CaNoRock happened simultaneously with the increased intensity of sunspot cycle 24 and gives increased chances for sun storms and thus breakdowns of navigation and communication systems under the flaring northern lights. It is becoming a greater challenge to ensure safe systems as the polar ocean opens for economical exploitation.

4. THE NAROM STUDENT ROCKET

Student rockets have been launched from ARR since 1998. Since then more than 60 student rockets have been launched and the concept has evolved in several stages both technical and educational.

The current student rocket uses a C14 rocket motor from the CRV-7 air-to-ground weapon system [1]. In the short burn time of 2.2 seconds, the motor propels the 5 kg payload to a maximum speed close to 1000 meters per second. The electronic payload is subjected to an acceleration around 80 G in the rockets direction of travel and a maximum spin rate close to twenty rounds per second. The spin of the rocket flips direction three times during the flight which lasts for about 85 seconds. The high acceleration and the peculiar spin dynamics, makes it exiting for the student to study the flight data.

The 700mm payload section of the student rocket is made of steel and aluminium, shown in Fig. 3. The payload is equipped with an encoder, a transmitter and antennas, all prefabricated and mounted on the instrumentation plate by Andøya Rocket Range. The transmitter frequency is in the S-band (2279.5 MHz). This is the same frequency band as the scientific rockets use; hence all telemetry systems at the rocket range can be applied for the student rocket.

Figure 3. The student rocket payload

5. WORK IN GROUPS

During the preparation of the CaNoRock III rocket the students were divided into four different groups;

A. The Rocket and Atmospheric Physics group
B. The Experiments group
C. The payload group
D. The Telemetry group.

The different groups had to work separately and together in order to prepare all stations before launch.

The rocket and atmospheric Physics group were responsible of preforming pre-flight modulation and simulation of the rocket. Using the two software packages Aerolab and Launch the students made a computer model of the Student Rocket based on physical measurements and specifications of the rocket motor. With the Student Rocket properties set, the students simulated rocket trajectories, flight stability and flight dynamics. After launch the simulations could be compared to the actual flight data.

This group was also responsible for a weather balloon release, collecting atmospheric measurements from ground and up to an altitude of about 20000 meters. The weather balloon measured temperature, relative humidity and position. From these measurements the students could derive a wind profile and determine the altitude of cloud layers. These data were also compared to measurements from the NAROM student LIDAR, a ceilometer that uses an infrared laser beam to calculate the altitude of cloud layers.

The Experimenters group was responsible for the scientific instruments in the payload. The CaNoRock III payload contained sensors for measuring temperature, pressure, magnetic field, light intensity and acceleration. The students assembled the sensors for the payload, soldering all the surface mounted components. They also tested and calibrated the instruments. This group also programmed the decoding computers to display real time visualisation of the measurements.

The Payload group was responsible for assembling the payload and preforming qualification tests before launch. The students integrated all sensor boards. All sensors and circuit boards need to be mounted in a way that can withstand the enormous acceleration, spin and velocity of the rocket. All wires are made by the students to be exact in length.

Before the Student Rocket Campaign could start, students carried out stability and spin tests of the payload. To balance the payload it was rolled in horizontal position on a bench. Extra weight was added to counter for instability. The completed payload is then spin tested on a spin table at the rocket range. The payload is transmitting telemetry while spinning at 13 RPS.

The final group is the Telemetry group. In this group students have to set up and prepare the TM stations. This includes tuning receivers setting up storage media and testing the trajectory positioning systems. Students in this group are responsible for tracking and receiving data from the rocket during testing and flight.

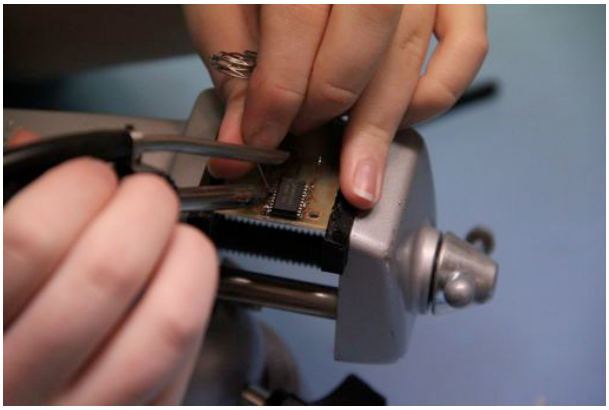

Figure 4. A student soldering a sensor board

6. ROCKET LAUNCH OPERATION

The CaNoRock III rocket had a successful launch Thursday the 13th of January 2011. All procedures during the launch of Student Rockets are the same as for larger scientific rockets. The same strict safety procedures are kept up, and the students experience that their rocket is as important as any other scientific sounding rocket from ARR.

During the campaign students were assigned to do the tasks of the personnel usually involved in scientific rocket campaigns. The staff at NAROM and ARR supervised the students in the different stations during countdown and launch. In Launch Control a student was assigned to be the Head of Operation (HO). HO controls the countdown and communication on the campaign, as well as reporting to the air traffic control, the ships radio and closing the road before the launch.

In the Launch Area students were assigned to be Pad Supervisor (PaS) and Payload Manager (PM). Students at this station reports to Launch Control and are inside the Block House during the entire countdown. For safety reasons only the ARR personnel handles all the matters of the rocket engine. The student PaS in block house fires the rocket.

In the Telemetry stations students were assigned to be Telemetry Supervisors. In these stations the students reports to Launch Control, and assists with receiving and processing data from the payload.

As for every scientific rocket launch from ARR, pre-flight and post-flight meetings are arranged. In the pre-flight meeting all the stations report their status to HO. The countdown procedure is reviewed in this meeting to ensure that all the students know the campaign procedures. Countdown for a Student Rocket usually takes 1 hour. After the launch a post-flight meeting is arranged. In this meeting the students report to HO how the operation went at their station. The experiments group presents preliminary data from the rocket at this meeting [1].

The different groups were assigned different tasks for the post flight data analyses. As an example the experiments group was going to examine the peculiar the spin of the rocket. For this they had to study data from an accelerometer, measuring the centripetal acceleration in the rocket, a magnetometer and a phototransistor. The phototransistor registered the rockets orientation relative to the sun. All groups presented their work in a final presentation on the last day of the camp.

7. THE SCIENTIFIC ROCKETS

The CaNoRock program is still under development however the smaller student rockets are meant to be an introduction for students who would like to continue to study space science and maybe in the future take part in the larger scientific rocket campaigns. The CaNoRock program opens up for participation for Master and PhD students for the larger scientific rockets, in cooperation with the Norwegian and Canadian scientists. More information about the CaNoRock program can be found at http://www.rocketrange.no/?page_id=246

8. REFERENCES

1. Nylund, A. & Rønningen, J.E. (2006) Technical and Educational Improvements of the Student Rocket Program at NAROM and Andøya Rocket Range, International Aeronautical Congress