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kuin harppaus 1990-luvun alun
webittömästä tietotekniikasta
nykypäivään tai kivikautisesta
ruuhesta valtamerifregattiin.
Uusi toimintaperiaate, uudet
sovellukset, uusi maailma.*

Sähköpurjekolumni s. 4



Kosmisen järjestyksen puolustaja tiikerin kimpussa

Tapahumhorisontti s. 4-5

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SATS on keskeinen ja avoin avaruusalan yhteistyöfoorumi, joka edistää avaruusasioita Suomessa.

Suomen avaruustutkimusseura ry – Sällskapet för astronautisk forskning i Finland rf on 1959 perustettu yhdistys, jonka tarkoituksena on harjoittaa avaruusalan kokeilu-, harrastus-, tutkimus- ja tiedotustoimintaa sekä toimia avaruustutkimuksesta kiinnostuneiden henkilöiden yhdyssiteenä. Seura on Suomen äänivaltainen edustaja Kansainvälisessä astronautiikkaliitossa (IAF; International Astronautical Federation). Suomen avaruustutkimusseura julkaisee Avaruusluotain-lehteä ja ylläpitää kirjastoa, josta voi lainata alan kirjallisuutta, kuva- ja videomateriaalia. Seura järjestää avaruusaiheisia näyttelyitä ja tapahtumia sekä ylläpitää aihepiiriin liittyvää harrastustoimintaa.

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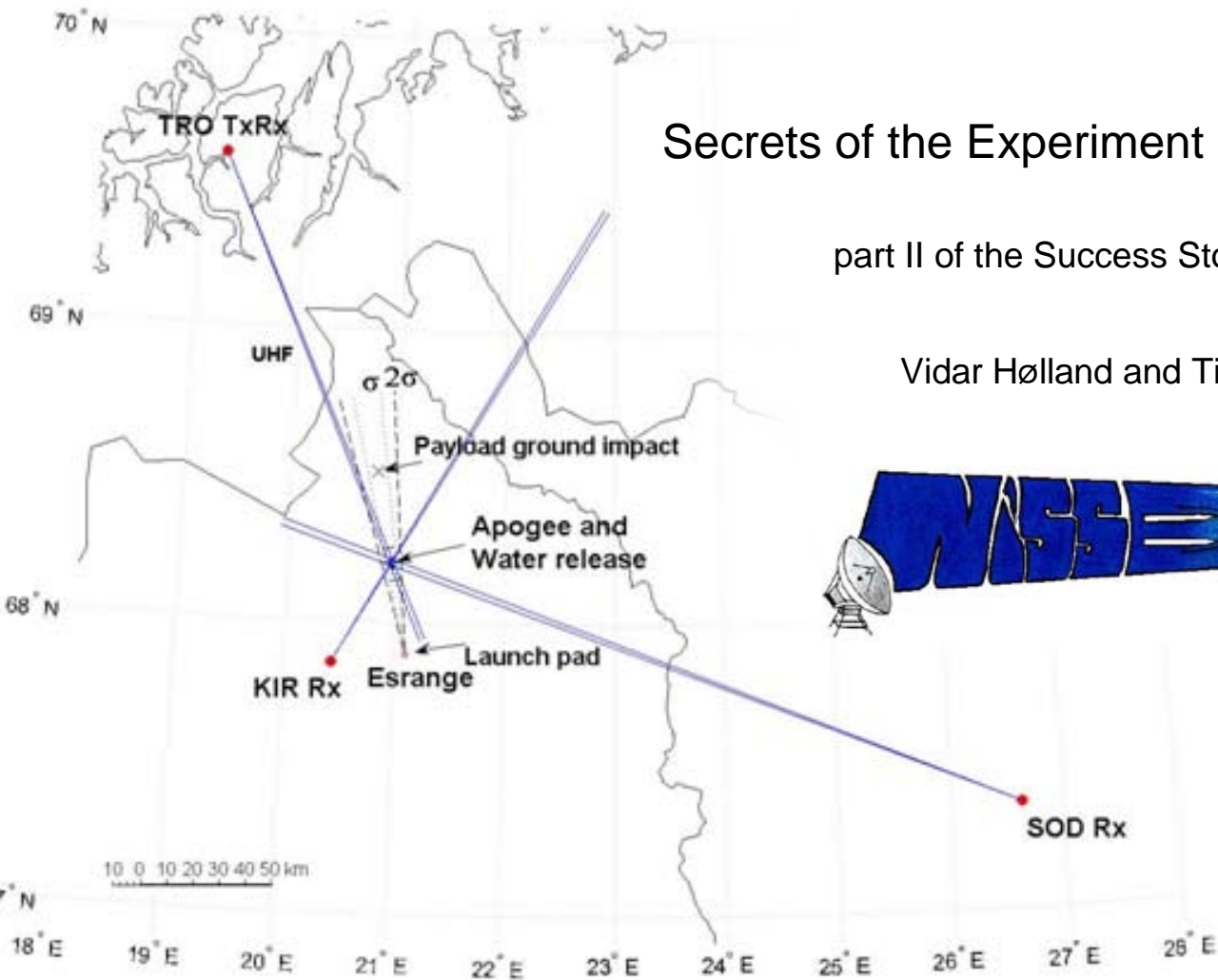
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Nimellä tai nimimerkillä kirjoitetuissa artikkeleissa esitetyt mielipiteet ovat kirjoittajien henkilökohtaisia käsityksiä, eivätkä välttämättä vastaa seuran tai lehden virallista kantaa.



Secrets of the Experiment Revealed

part II of the Success Story of NISSE

Vidar Hølland and Timo Pitkänen



In the Spaceprobe 3/2008, our forthcoming student rocket experiment NISSE was introduced to the readers. In this issue, we continue discussing the objectives and science, and introducing some details of the experiment and the payload construction.

The REXUS 6 rocket was launched at ESRANGE (European Sounding rocket Range) in Kiruna, Sweden March 12, 2009. In the NISSE experiment 11 kg water will be released into the daytime upper atmosphere at the rocket's apogee altitude of about 95 km. Impact of the released water on the atmosphere/ionosphere will be studied by observations using the tri-

static EISCAT UHF incoherent scatter radar system.

The primary scientific objective is to find out whether we are able to detect the effects of the released water on the upper atmosphere by the EISCAT UHF radar. The rocket will be launched close to the midday to ensure as strong as possible background ionization level for the radar backscattering at the release altitude of about 95 km. The surroundings of the expected release volume will be scanned with the radar.

Besides the standard EISCAT measurement, the UHF raw data is planned to be sampled real-time in collaboration with the Sodankylä Geophysical Observatory. The availability of the raw data enables to do additional post-experiment data ana-

lysis investigate possible influence of the water release on the UHF incoherent scatter spectrum.

In addition with the UHF radar, the ESRAD MST radar and the riometer in ESRANGE are planned to be used to monitor the prevailing atmospheric/ionospheric close to the release region. Several magnetometers of the other experiment on the REXUS 6 rocket, AGADE by a German student team, will measure the geomagnetic field.

As being a student project, NISSE has also a strong educational perspective. The REXUS student rocket program educational objectives include in obtaining experience in planning, building and executing a scientific experiment in space physics. Another important objective is getting expe-

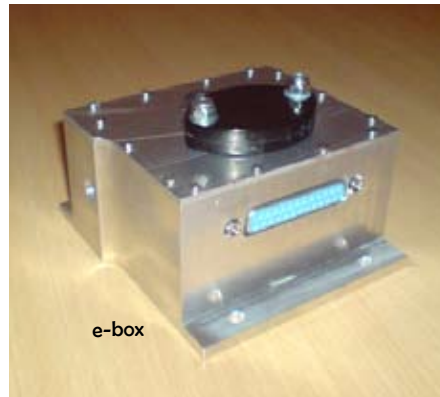
rience about international scientific collaboration.

The NISSE experiment is placed in two 356 mm diameter REXUS modules. The total height of the modules is 600 mm plus 40 mm of pipings extending into the module above. The water is stored inside a 12 L actuator tank placed in the bottom module. The tank is a clenching vessel split with a bleather filled with nitrogen gas in the bottom half that exerts a pressure on the water in the top half. The maximum operational pressure of the tank is ten bars on ground. The total pressure is set to eight bars after considering effects of acceleration, rotation, vibration and the removal of the outside air pressure when the release altitude is reached. The total water payload at this pressure is about 11 liters of non-sparking mineral water. Mineral water will be used to ensure that we know roughly its constituents.

The top module contains the release system. The outlet of the tank is split into two. In one end there is a valve for filling the tank with water when the whole system is assembled with the REXUS 6 rocket. This system is mounted 40 mm above the two modules where there will be a hatch through the rocket skin. In the other end the pipe leads to the main valve. The main valve is operated by two small, electrically triggered explosives (SQUIBs). From the main valve the water is led into the dividing system with nine pipes directed radially out through the rocket skin. The whole dividing system is mounted on a metal rack. The movement and 3

Hz spin of the rocket will assist the tank pressure in spreading the water at the release point.

The electronic system is mounted inside a small aluminium box. The



box contains the fire circuit for the main valve and supporting electronics for two sensors. Release signal and power is delivered by cable from the REXUS main computer in the so called service module (SM), and sensor signals is transferred back to the SM. The fire circuit is controlled by a baroswitch to start operating at 20 000 feet altitude. The capacitor then charges and is ready for delivering power to the SQUIBs on the release signal.

A temperature sensor and a pressure sensor are mounted on the release system in order to monitor how temperature and pressure of the water changes during the launch. Total weight of the whole experiment when filled is 30 kg.

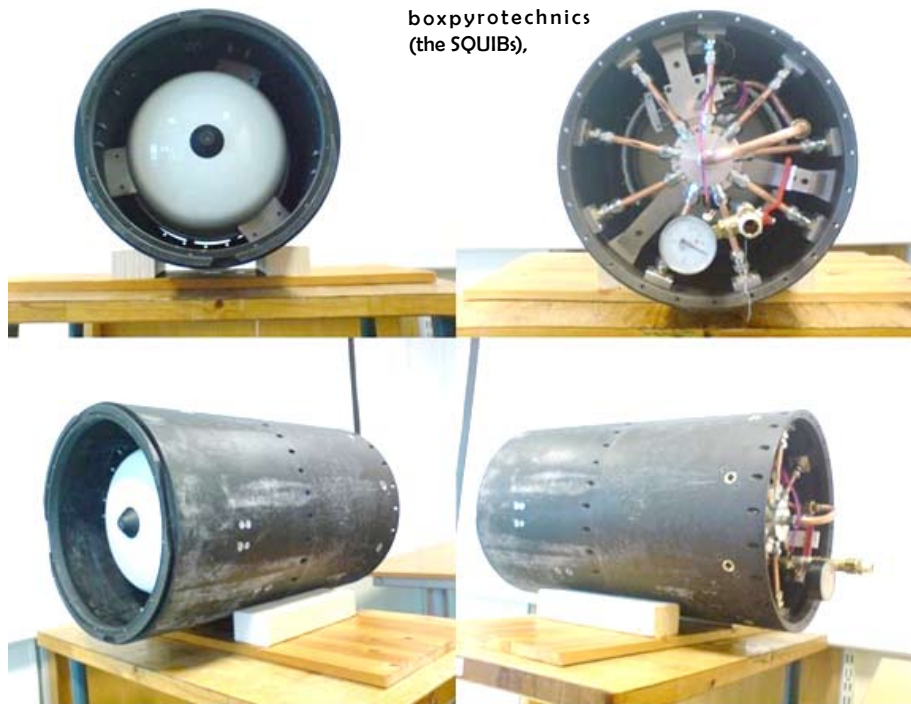
What will happen to the water released into the ionosphere at 95 km altitude? We are not exactly sure, but have the

following scenario. Immediately after the release the following sequence of events is expected to take place: The water starts to evaporate due to the low-pressure atmosphere. Part of the water solidifies to ice releasing latent heat, which allows the evaporation to continue. The simultaneous solidification and evaporation continues until the liquid vanishes. The resulting vapour cools down while expanding rapidly adiabatically into the surrounding space. The vapour molecules may condensate first to a cloud of tiny ice crystals due to the abrupt temperature drop caused by cooling, but re-evaporate then back into a gaseous stage when reaching the temperature of the background atmosphere. The H₂O molecules will be ionized by solar radiation and ion chemistry, modifying the ambient plasma properties in the cloud.

What effects the released water could generate into the ambient ionosphere? F region (altitude region above 120 km) water releases lead clear electron density depletion due to the rapid water molecule charge exchange reaction with O⁺, and subsequent recombination of the created H₂O⁺ ion with the ambient ionospheric electron. In the upper mesospheric-lower thermospheric (UMLT) region, where NO⁺ and O₂⁺ are the dominant ion species, the above reaction chain is unfortunately not effective. However, it has been suggested that water vapour injection below 120 km altitude could cause reduction of the ionization due to screening of solar Lyman- α radiation. An additional reduction of ionization could be caused by conversion of ambient NO⁺ and O₂⁺ ions to heavy water cluster ions, which have more rapid recombination times. Water cluster ions are naturally common below altitudes of 75-85 km where the air is wetter, but may exist higher up depending on the moisture level of the region.

During the last summer, we made some modeling in collaboration with the Sodankylä Geophysical Observatory using their sophisticated Sodankylä Ion Chemistry model (SIC). The modeling results of a 10 kg water vapour point release at an altitude of 95 km showed indeed a clear depletion formation in the back-





boxpyrotechnics
(the SQUIBs),

round electron density. However, the modeling results surely overestimated the impact since the diffusion model was not suitable to such a low altitude region. In addition, no aerosol formation (ice particles) or transportation like neutral winds were taken into account. Moreover, the modeling was made for a point release. In our experiment the water will be spread

on a fairly long distance along the trajectory (few kilometers). Thus, it is realistic to think that the amount of water is too small to generate any effect.

Another vision is that the life time of the ice crystals turns out to be long enough to form a cloud of ice particles. These ice particles could then act together with other impurities in

the region as condensation nuclei for ambient atmospheric moisture and induce a formation of an artificial noctilucent cloud. This could lead strong polar mesospheric summer echo-like radar echoes. Polar mesospheric summer echoes (PMSE) are detected during summer months when the UMLT region gets very cold (as low as ~ 133 K mean temperatures can prevail at the mesopause at around 88 km altitude) and noctilucent clouds may form naturally at those altitudes. PMSEs are thought to be caused as a result of neutral-atmosphere turbulence and subvisual charged ice particles and they are observed often in association with the noctilucent clouds. In our case the spinning of the payload could create local transient turbulence.

Was 11 kg too small amount of water? Could we even measure the background electron density? Were we able to detect any effect? Did the rocket explode? Read the reports about the launch campaign and the results in the future editions of the Avaruusluotain.



SATS:n Kevätkokous to 23.4.2009

Space Systems Finland, Espoo

Seuran kevätkokous 23.4.2009 osoitteessa **Kappelitie 6, Espoo.**

Kallelse till vårmöte

Sällskapet för Astronautisk Forskning i Finland (SAFF) vårmöte hålles torsdagen den 24.3 klo 18:00 i Space Systems Finland. Välkommen!

Call to Spring Meeting

Finnish Astronautical Society's spring meeting is held on April 23rd starting at 6 p.m. in the Space Systems Finland premises. Wellcome!

