



# Project of space experiment "Shadow" on ISS

New challenge and new opportunity  
for Amateur Radio Community

# Invitation

- **Russian Aviation and Space Agency (Rosaviacosmos, the Russian analogue of NASA, ESA, etc.) and its leading research organization, Central Research Institute of Machine Building (TSNIIMASH) invite VHF Amateur radio operators to take part in the space experiment "Shadow" on International Space Station.**

# organization

- TsNIIMash is today involved in the design and exploratory research to substantiate a reasonable engineering policy in the development of rocket and space technology including electric propulsion. It is involved in fundamental and applied research in aerogas dynamics, heat transfer and thermal protection, dynamics, strength and reliability of launch vehicles, spacecraft, orbital stations and space vehicles.
- The Mission Control Center at Korolev, Moscow region, is one of TsNIIMash's departament.

# "Shadow" General condition

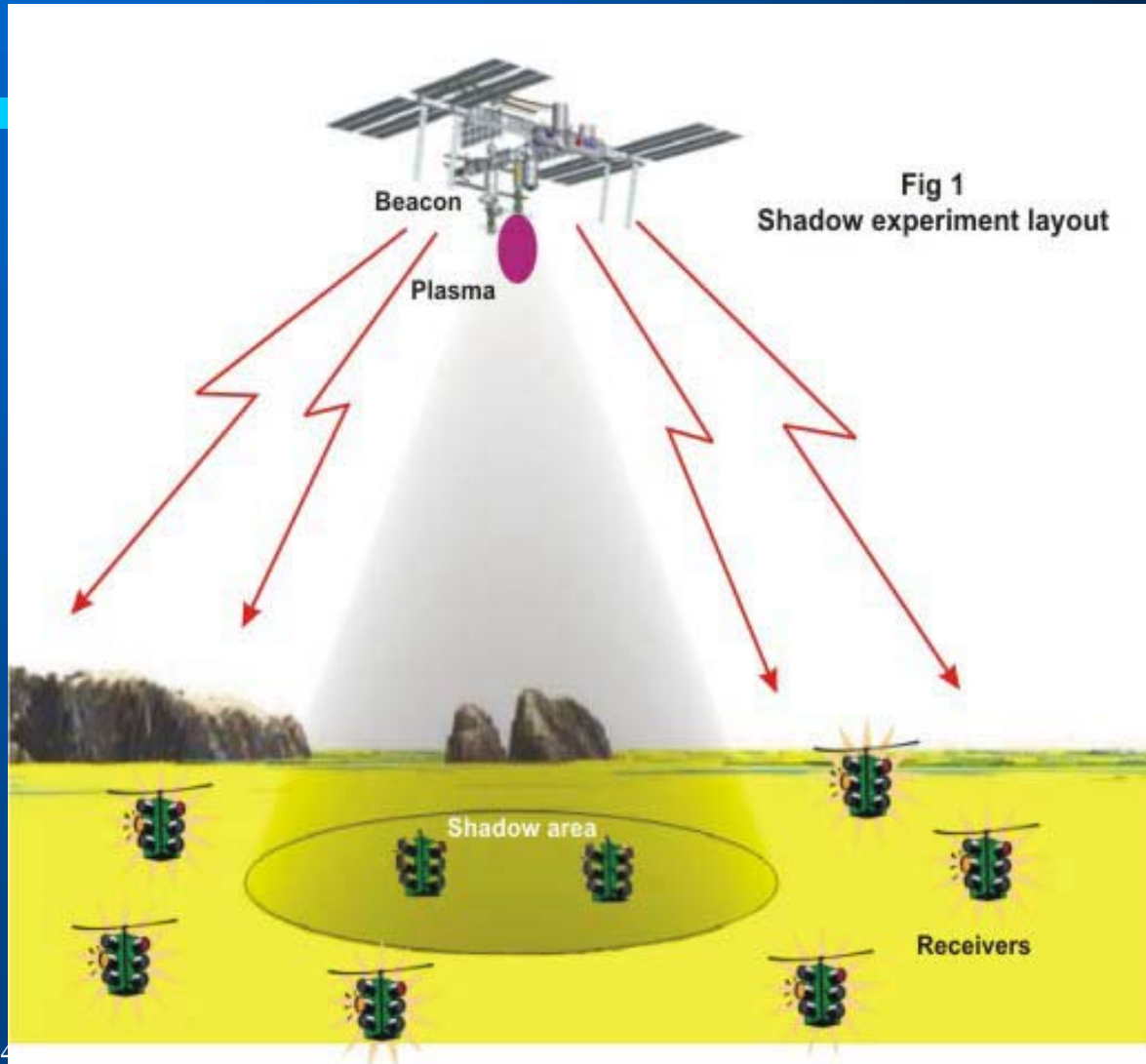
- The space experiment "Shadow" may be successfully performed under the condition that the number of participants will be great enough . The greater this number the more precise scientific result would be issued.
- Basing on claims for participation in the SpEx "Shadow", we are going to select perspective "measuring fields" where the receiving network is dense enough and where the bulk of activity will be further concentrated.

# Goal

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- **The objective of the work is observation of refraction/scattering effects in artificial plasmas using method of RF sounding in space experiments under different geophysical conditions.**

# Lay-out



# Description

- In the chosen region the onboard arcjet source injects a plasma plume in space and the onboard radio beacon transmits 144 or 430 MHz sounding signals in the form of the Universal Time marks. Passed through the plasma these signals are being instantly received by an on-ground amateur VHF network. Due to refraction/scattering of the sounding signals in the exhaust plume, the shadow region would arise adjacent to the satellite. When the shadow boundary running after the satellite along the Earth surface reaches any on-ground receiving site the signal cut-off is to be registered.

# Tasks

- The task of every individual participant is to register moments of signal cut-off and following signal restore using the Universal Time marks and to address this information along with data on its geographical position to the Information Storing Center. Every operation sequence would take up to 10 min. while the satellite is passing between two opposite points of the local radio horizon.
- The task of the crew will be download the delivered beacon soft (floppy or CD) to the onboard ham gear and to run the beacon 3 - 5 times for each measuring field according to flight schedule.



# Two phases of the Project

- The SpEx "Shadow" is included in the Program of experiments and researches on Russian segment of the ISS.
- The SpEx "Shadow" will be performed in two stages:
  - 1. of "cold" (with no plasma injection) training seances and
  - 2. of full scale "hot" experiments with plasma injection.
- What Amateur Radio frequencies will the project utilize?
- The project will utilize 144MHz and/or 430MHz band downlink. Calculation for sounding with 28 MHz predicts full black-out. However we plan to perform at least one "hot" run to check whether it is true.

## Actually the SpEx "Shadow"

consists of three technically independent parts:

- **Programmed plasma injection of about 30 seances up to 10 minutes duration each.**

*This is responsibility of Tsniimash and funding from Rosaviacosmos.*

- **Programmed translation of sounding signals by available onboard Amateur gear.**

*This is responsibility of the crew according to their flight task with technical assistance of ARISS concerning serviceability of available onboard Amateur gear.*

- **Receiving and processing of sounding signals by available ground mosaics of Amateur radio operators.**

*This is good will and personal interest of Amateur radio operators with no funding.*

During "hot" seances the independent parts of the experiment work simultaneously.

For the "cold" stage no additional certification is required since the available onboard ham gear is planned to be used.

## The general issue of 2003

The project "Shadow" has got a noticeable support from Amateur radio operators (of about 140 person in total) resulting in formation of a few measuring fields. This means that we may proceed with the project "Shadow" further to the next step of experiments in "ground air", which is a part of "cold" phase.

The main goal of this step is choosing of proper tool for generation of Universal Time Marks i.e. packets of minimal duration in format of AX25 Protocol by the onboard radio beacon. The best beacon soft should be send to ISS, say, as a floppy or CD and download to onboard ham gear.

# East-European measuring field



# West-European measuring field



# North-American measuring field



Expected shadow areas

Радиотени на Земле



$f=2.4$  ГГц



$f=430$  МГц



$f=144$  МГц

## Expected timing

- experiments in “ground air” begin now and may take up to three months.
- “cold” phase may begin this summer or autumn and would be performed occasionally to update methods and train new volunteers.
- With green light the “hot” phase may begin in closely to end of 2005.

## Problems (except funding, papers, certification, approvals etc.)

- ⑩ **Number of participant; we need at least a hundred ground operators on each measuring field;**
- ⑩ **Possible inaccuracy in measurements due to unequal sensitivity of ground net-work;**
- ⑩ **How to involve new volunteers who have only radio with no computer and Internet (it may be useful for, say, deep Russia);**
- ⑩ **And many others currently invisible.**



## What else

- **The same technology can be also applied in a space experiment on sounding of not artificially injected plasma, but of the natural ionospheric plasma in HF frequency band (14 and 28 MHz). It is expected, that due to dispersion of sounding radiation in ionosphere, an "irradiated" spot should appear on the Earth surface, and determination of boundaries of this "irradiated" spot is the science purpose of the space experiment (legend "Spot"), which can be carried out not on the ISS but on a proper amateur satellite. This idea is currently under development.**

## What we actually wish from ARISS:

- ⑩ **Clearly expressed support of the project;**
- ⑩ **Assistance in notification of the Amateur Radio Community;**
- ⑩ **Any other help for the success sake within the ranges of ARISS activity.**

## Expected results

- The scientific results of the SpEx "Shadow" will help designers of future electrically propelled spacecrafts to minimize the hazard of communication disruption by Ets' plasma plumes.
- Also realization of the space experiment "Shadow" will give an unique example and experience in involving of intellectual and technical potential of International amateur radio community in perspective scientific projects.
- It seems that the greatest world hobby does not properly understand its own strength and capability. There is a modest hope that the "Shadow" project will turn the Amateur Radio Community to see it better.

# Project of space experiment

## "Shadow" on ISS

- **New challenge and new opportunity for Amateur Radio Community**

Let us do this job together!

Russian Space Agency and Russian cosmonautic federation are going to award every participant of the space experiment "Shadow" with special diploma.