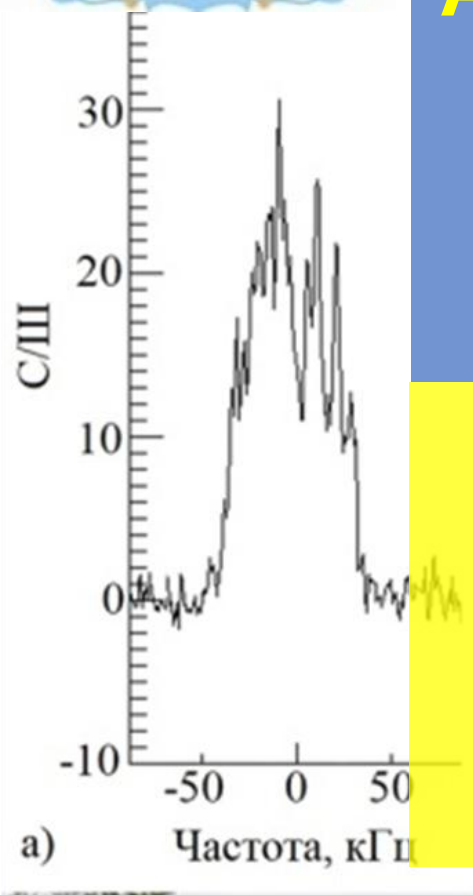
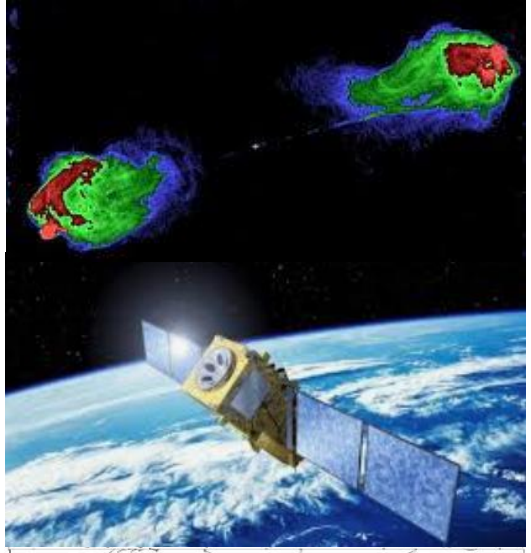
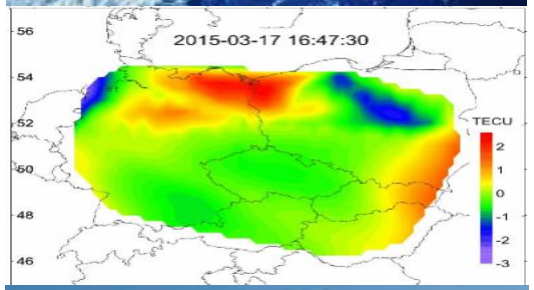
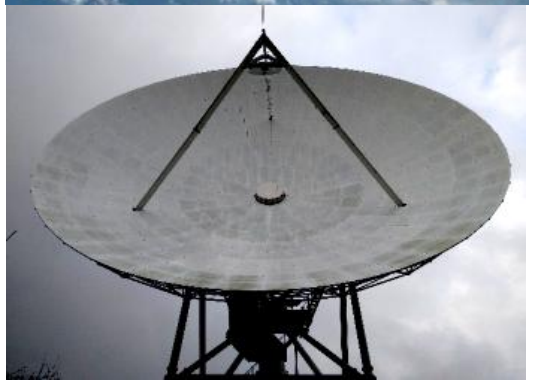
A SYSTEM FOR REMOTE SOUNDING OF THE NEAR-EARTH ENVIRONMENT USING THE RT-32 RADIO TELESCOPE

Vyacheslav Zakharenko
and IRA NASU – RT-32 team

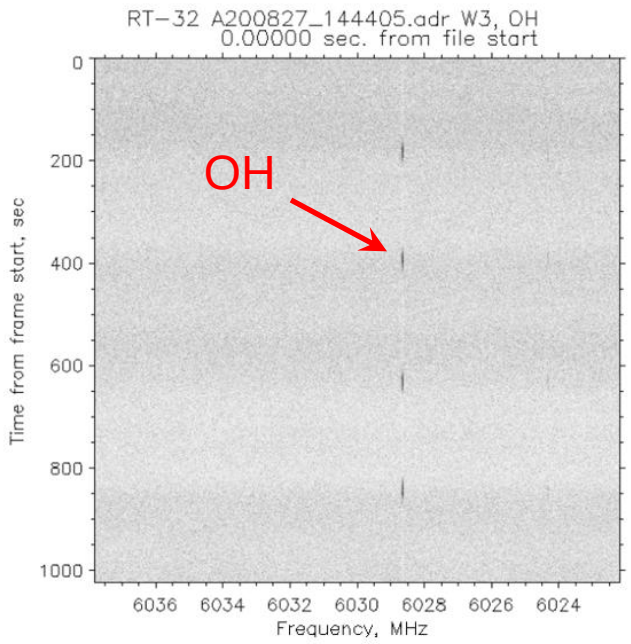


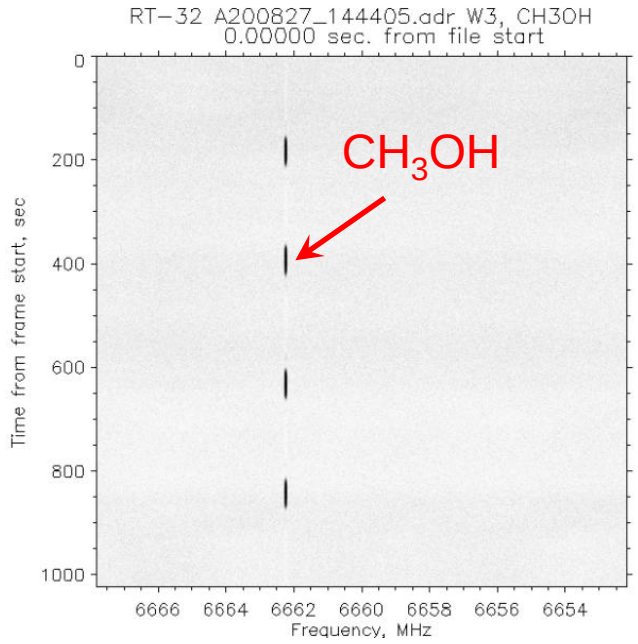


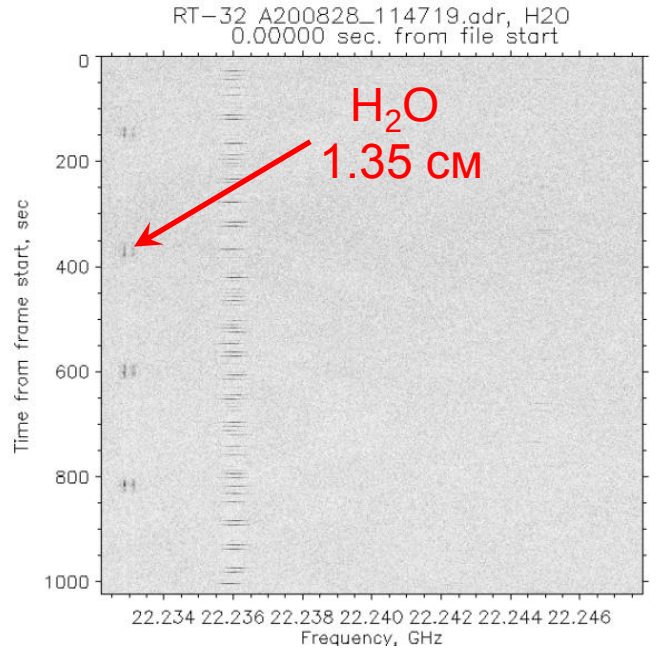




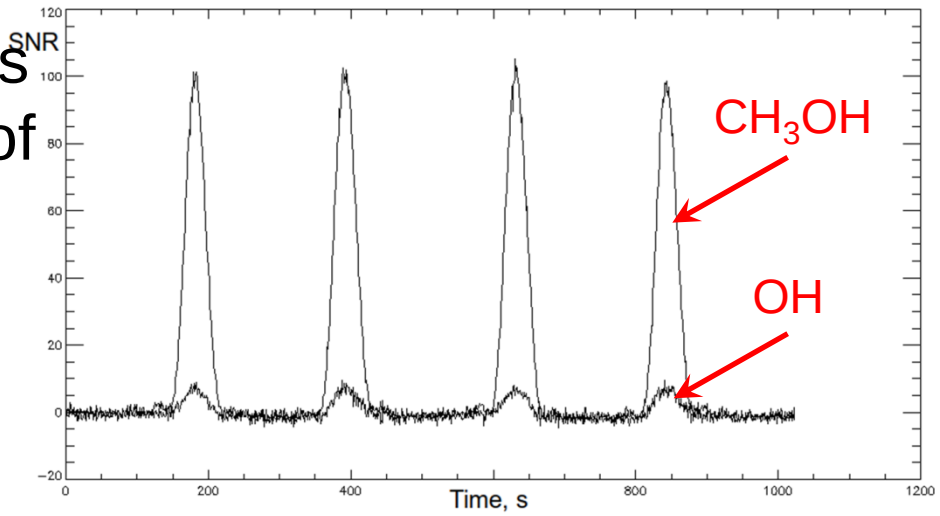
OH, methanol and water maser lines in the ranges of 6 and 1.35 cm (telescope - in scan mode)

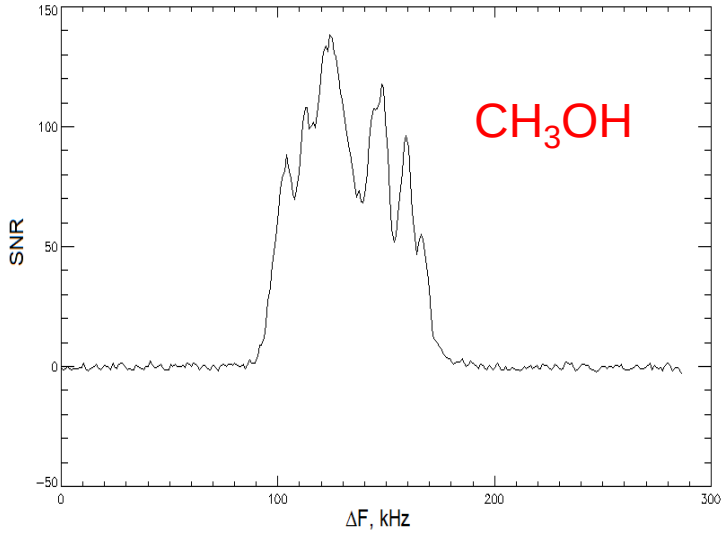






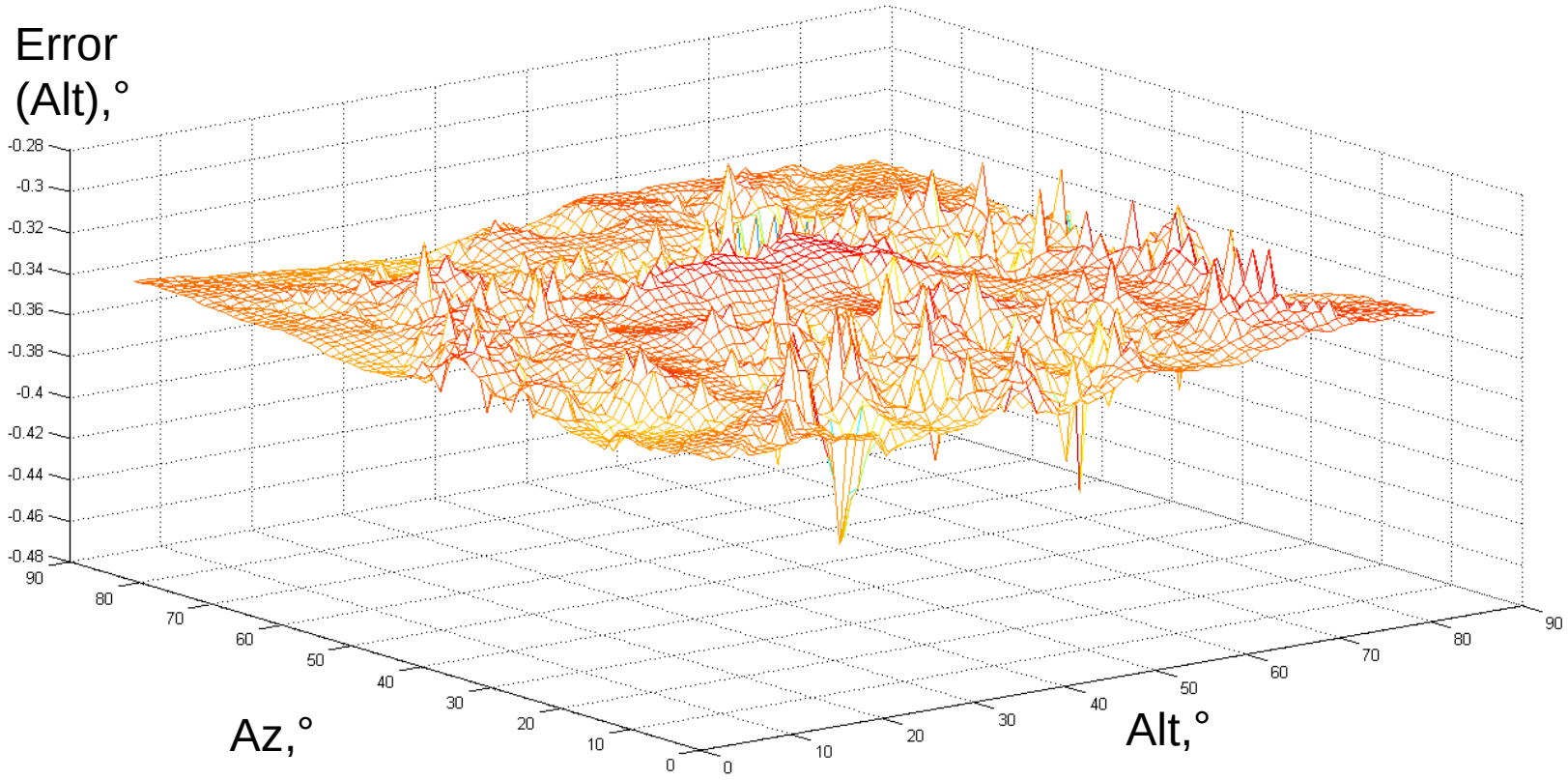
Simultaneous observation of OH and methanol lines





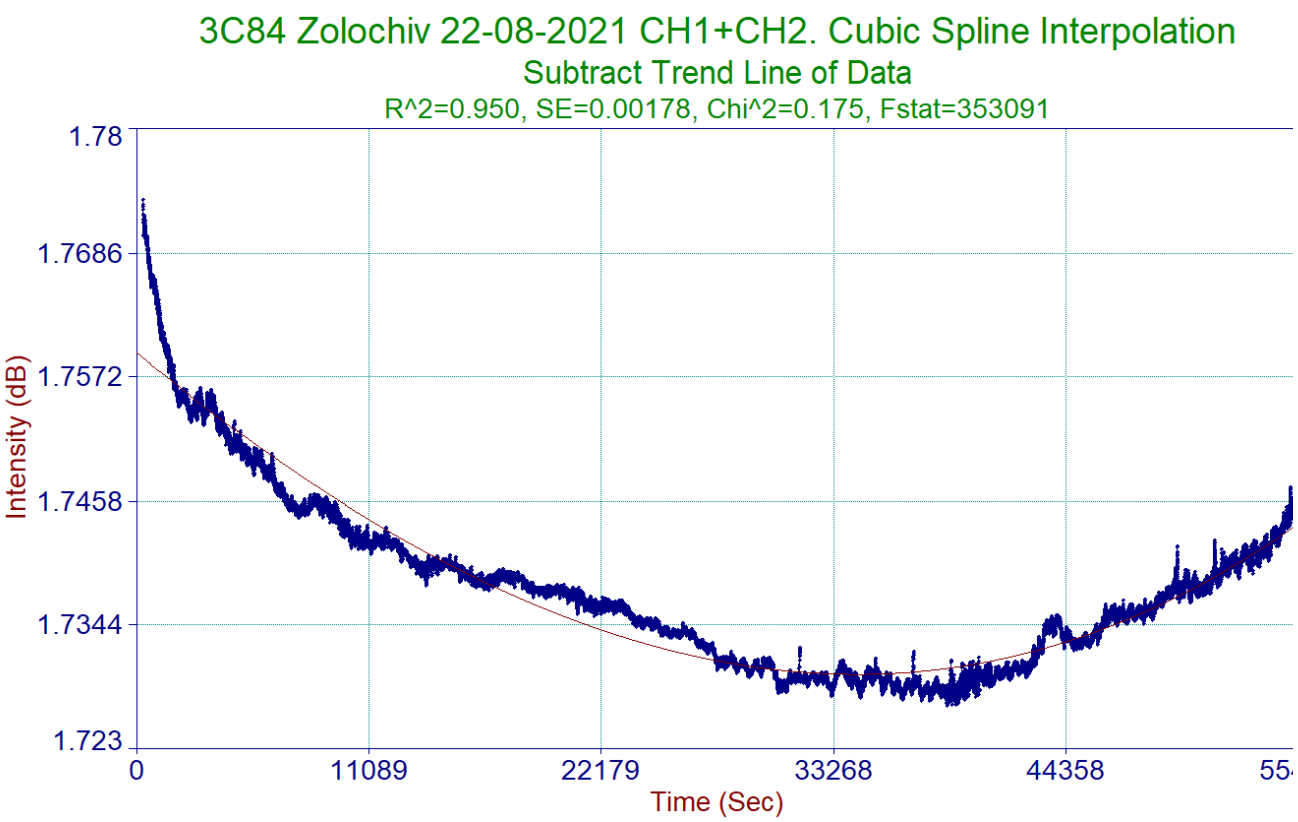
Signal/noise at accumulation of 20 s is equal to **140**

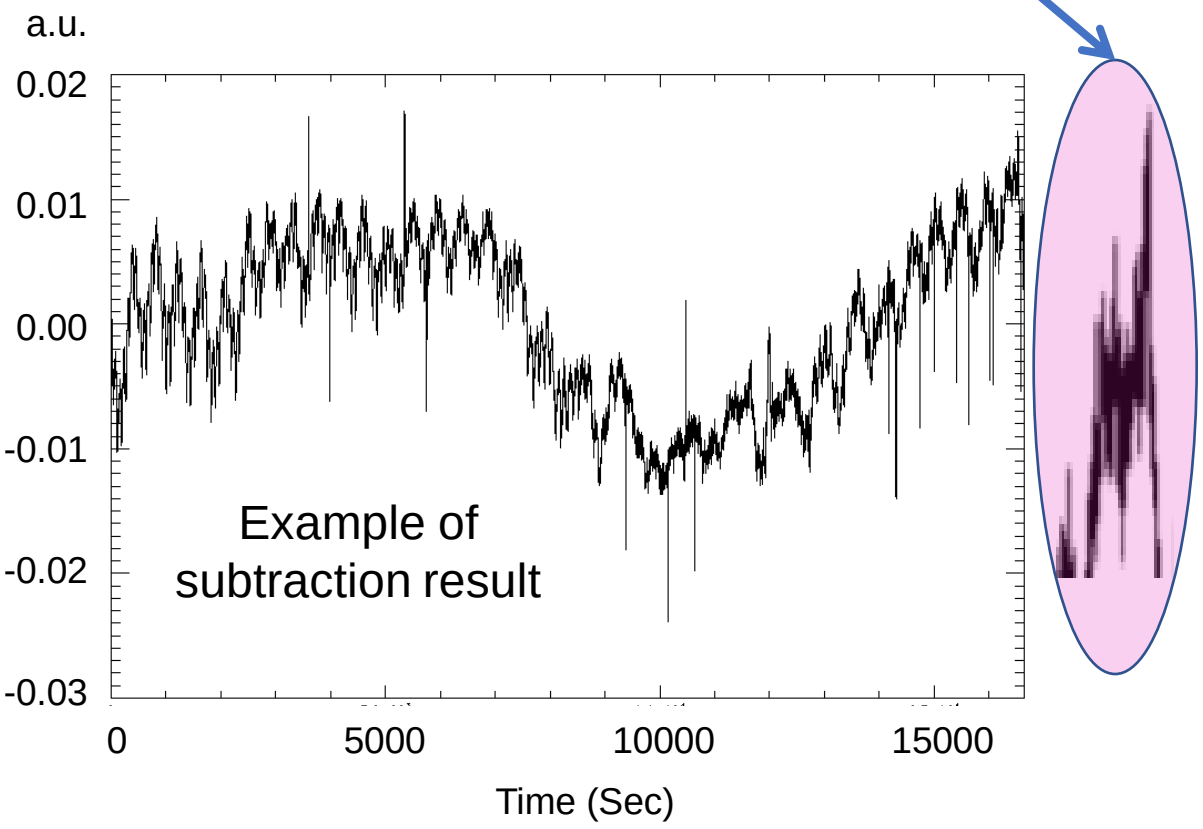
Matrix of radio telescope guidance errors: during six months of experimental operation the errors are reduced several tens of times: up to 30 angular seconds (the narrowest antenna diagram in the range of 1.35 cm is 2 angular minutes).



"Joint Latvian-Ukrainian study of peculiar radio galaxy “Perseus A” in radio and optical bands. Nr: lzp-2020/2-0121"

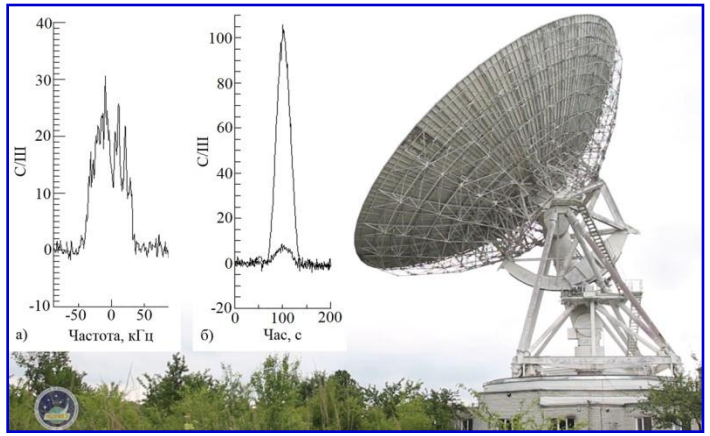
Previous receiving system





Noises < change in (i) radio telescope pointing (improvement in progress) < (ii) environment

We propose to develop a system for remote sensing of the near-Earth environment using the RT-32 radio telescope.

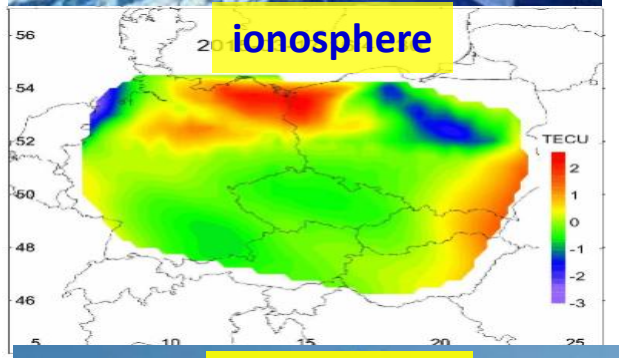


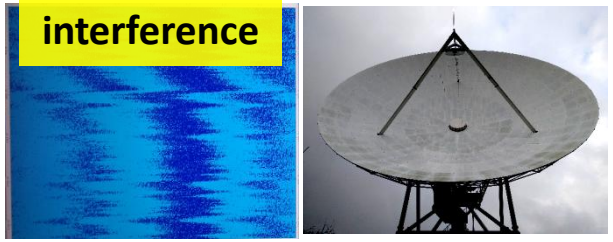
RT-32 with radio astronomical equipment

+

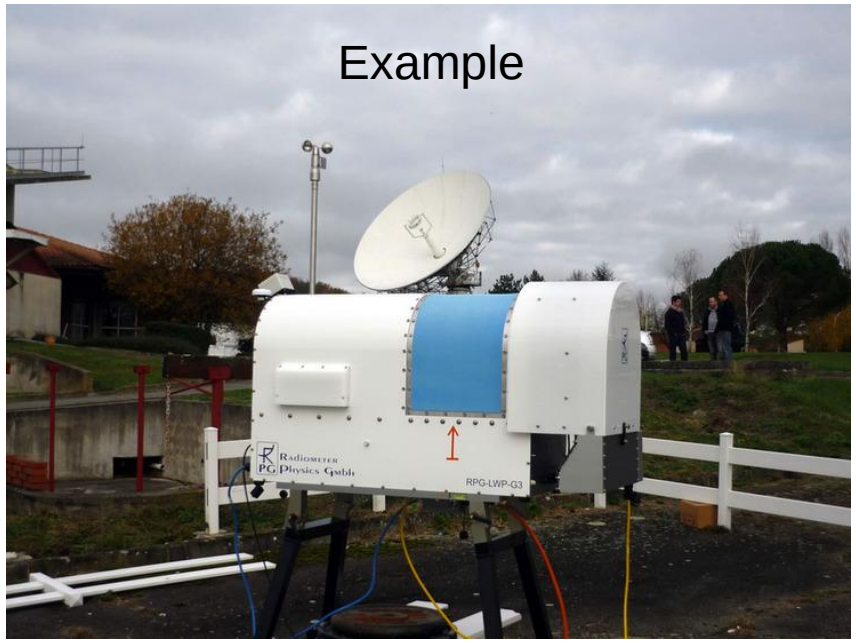
It is planned to create a modern system of remote radio sounding of near-Earth space (atmosphere, ionosphere, magnetosphere) with the development of specialized equipment and original (environmentally friendly and cost effective - without additional radiation) techniques using emission from radio astronomical sources and signals from onboard satellite transmitters.

The results are planned for use for monitoring and predicting the state of atmospheric and space weather systems in the interests of the space industry, ecology and to provide world-class radio astronomy observations.

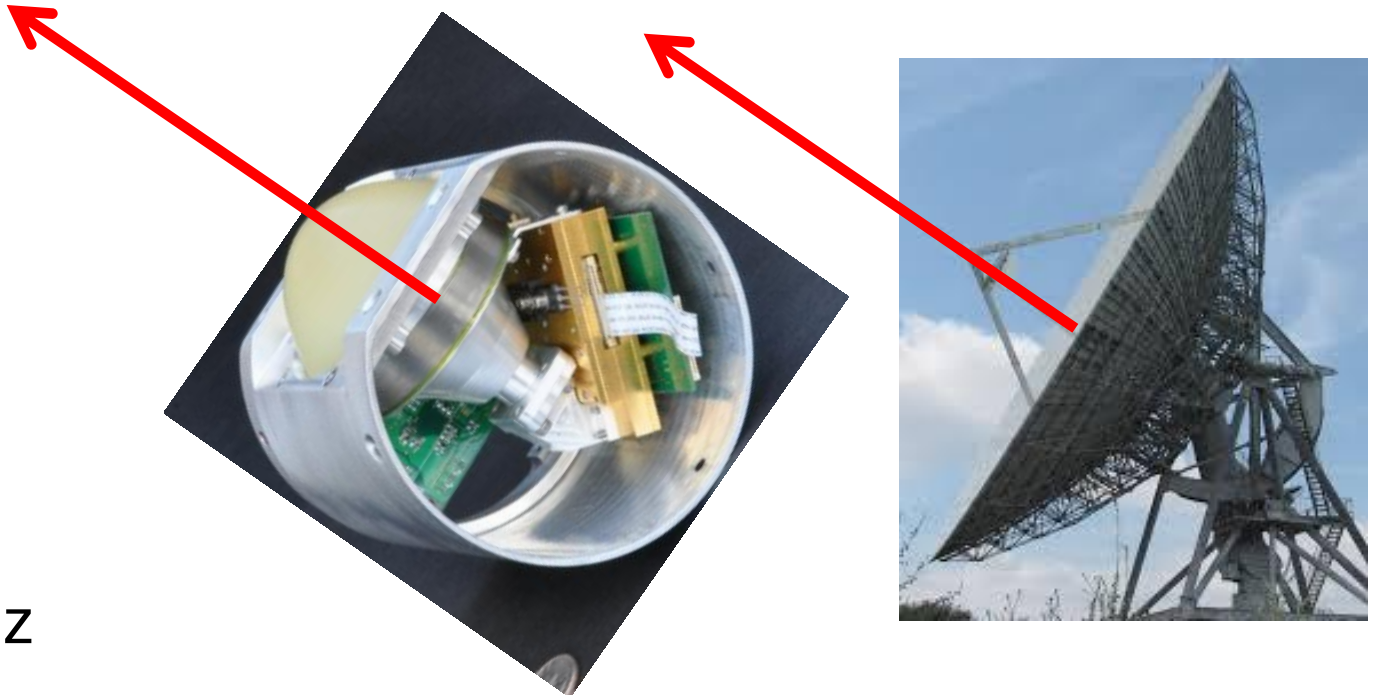




Development of an ultra-high-sensitivity broadband radiometer for the range of 22-24 GHz for measuring integral tropospheric absorption.



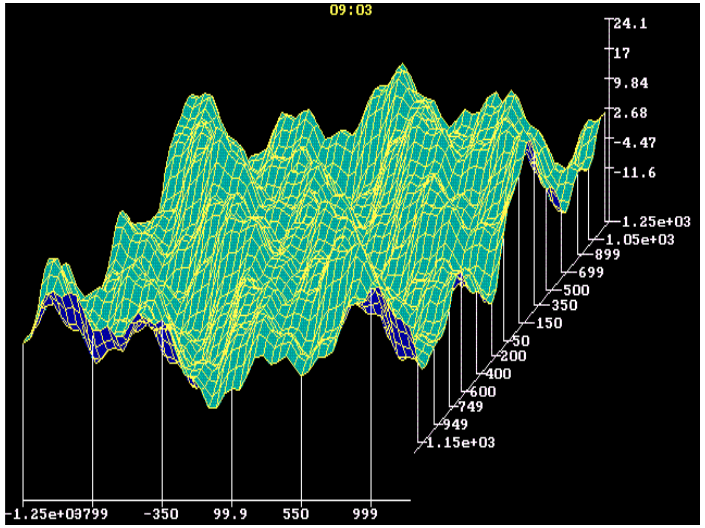
IRA NASU has developed 115 GHz and 142 GHz high-sensitivity radiometers for mesosphere measurements and conducts long-term observations



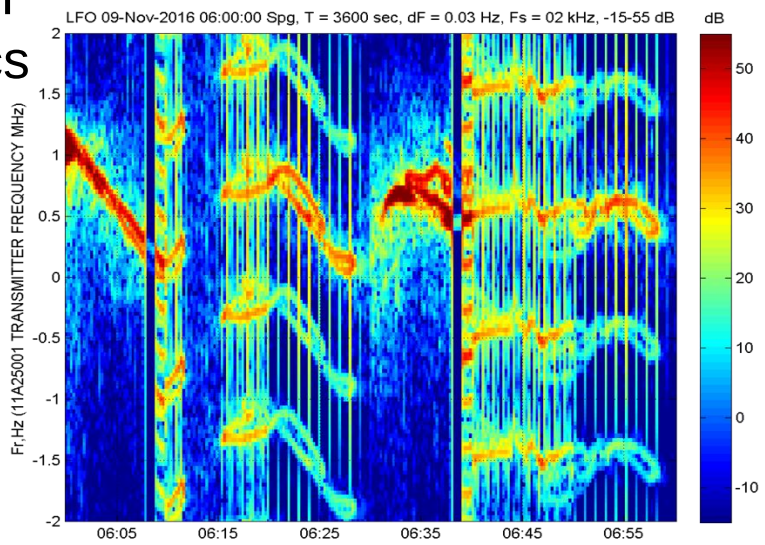
Telescope beam tracking is preferred

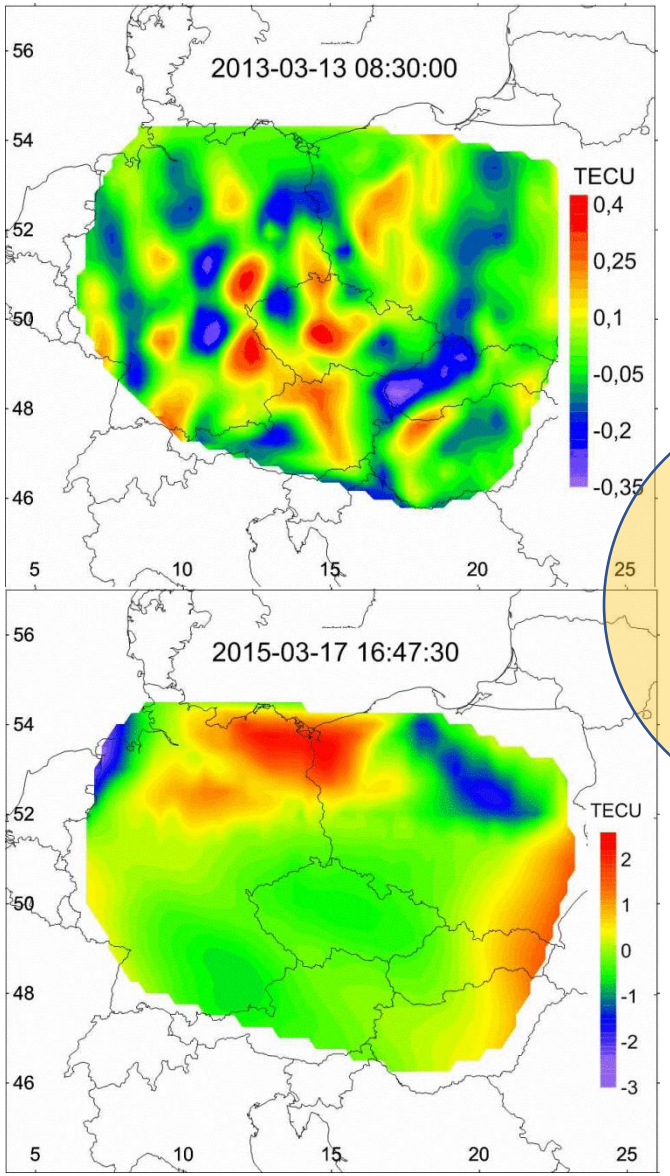
Diagnosis of ionospheric disturbances excited by waves of the neutral atmosphere

Frequency-angle HF sounding

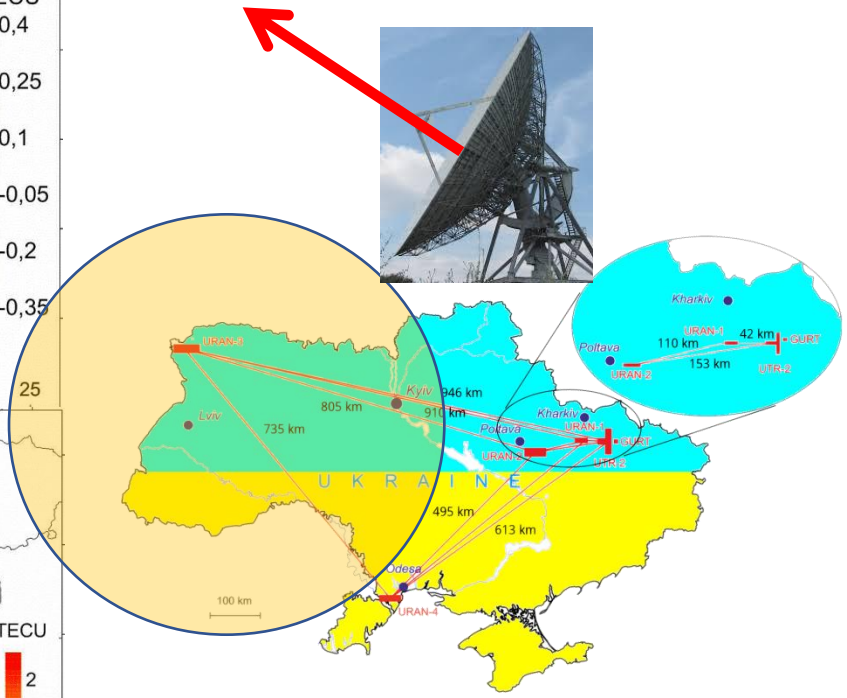


Doppler HF diagnostics





GNSS -TECU diagnostics



Characteristic distance ~ 400 km

Processing of satellite data + development of payload

Polar Orbiting POES (NOAA-15, -18, -19, -20 (launch in 2022))

830 km

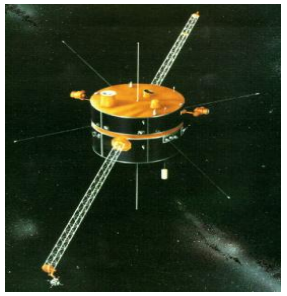
35900 km

Geostationary GOES (-14,-15, -16, -17)

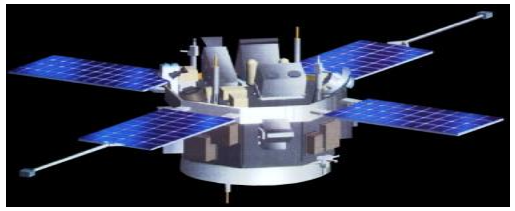
L1 Lagrange point

≈ 1 500 000 km

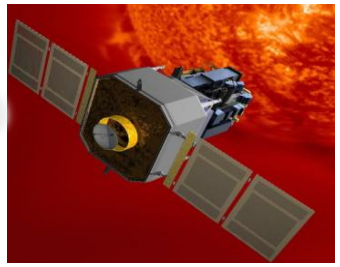
WIND



ACE



SOHO



≈ 0.6 a. u. variable

≈ 1 a. u.

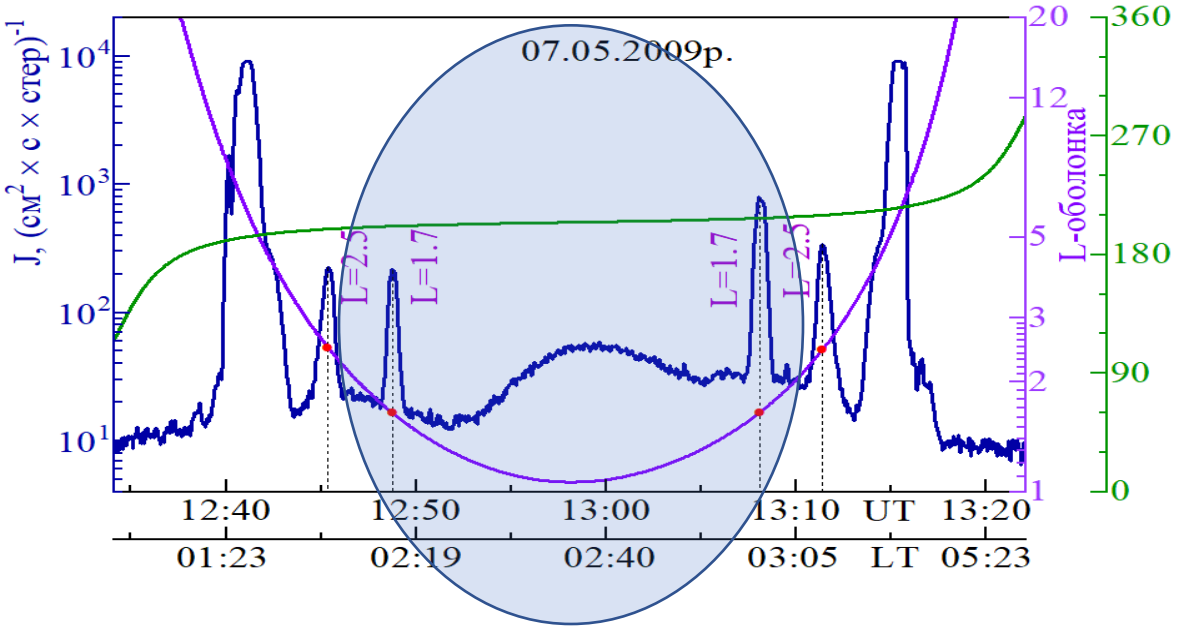
SOLAR ORBITER

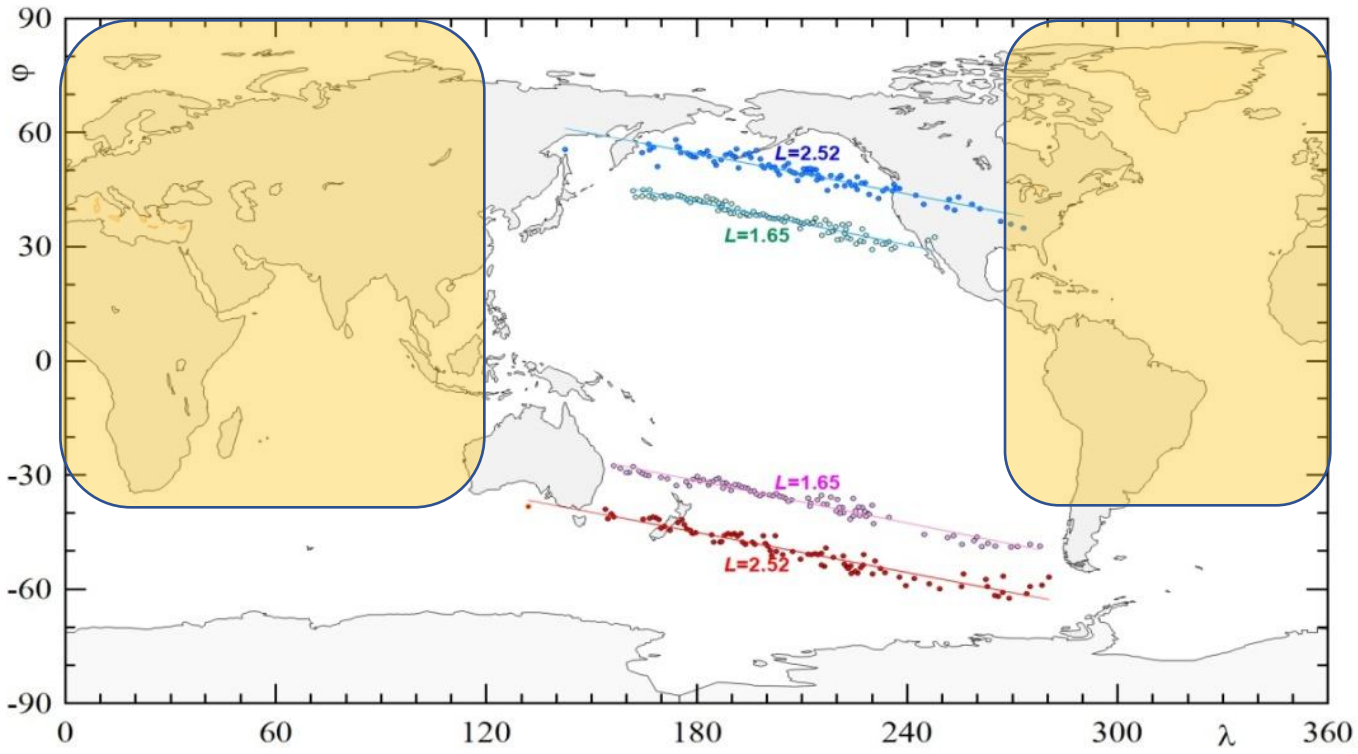
STEREO-A -B

Processing of satellite data.

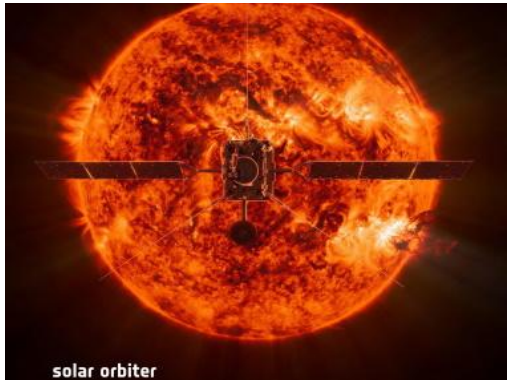
Characteristic distance ~ few thousand km

STEP-F: 3rd radiation belt





AGREEMENT
between IRA NASU and the Space Research Center (Poland)
«…joint processing and interpretation of data of the STIX spectrometer-telescope of the Solar orbiter spacecraft»

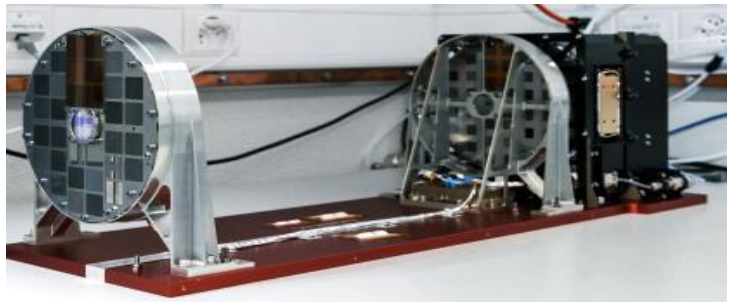


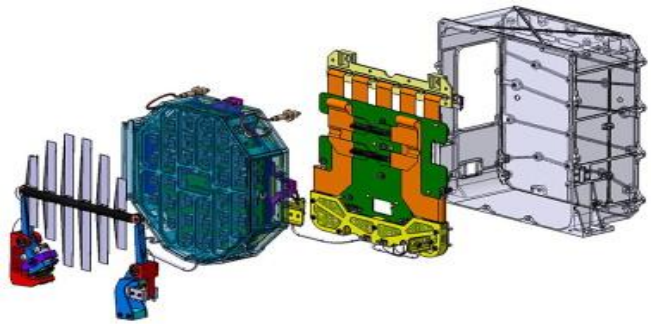
ДОДАТКОВА УГОДА №2 2021
до Договору про співпрацю від 10.06.2014 р.
між
Центром космічних досліджень Польської Академії Наук
(Республіка Польща)
та
Радіоастрономічним Інститутом Національної Академії наук України
(Україна)

2.1. Сторони виявляють намір об'єднати зусилля щодо наукових астрономічних і космофізичних досліджень навколоземного і міжпланетного простору, об'єктів сонячної системи, у тому числі спільної обробки і інтерпретації даних спектрометру-телескопу з візуалізації рентгенівського випромінювання STIX міжпланетної космічної місії Solar Orbiter.

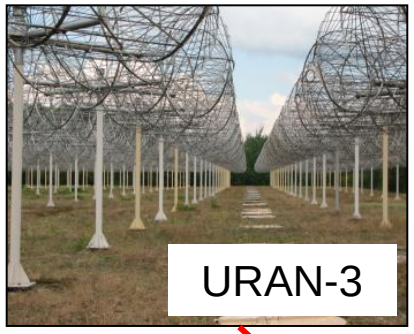
Aneks № 2 2021
do Umowy o współpracy z 10.06.2014
między
Centrum Badań Kosmicznych Polskiej Akademii Nauk
(Rzeczpospolita Polska)
i
Instytutem Radioastronomicznym Narodowej Akademii Nauk Ukrainy
(Ukraina)

2.1. Strony zamierzają prowadzić wspólne działania dotyczące badań naukowych w zakresie astronomii i fizyki kosmicznej zarówno w obszarze bezpośredniego otoczenia Ziemi, jak i innych ciał układu słonecznego, w tym Słońca. Dotyczy to przede wszystkim wspólnego przetwarzania i interpretacji danych spektrometru/teleskopu z tworzenia obrazów rentgenowskich STIX międzyplanetarnej misji kosmicznej Solar Orbiter.





Ukraine. Constellation of radio telescopes


URAN-3


URAN-2


GURT


RT-32


URAN-1


URAN-4


UTR-2

Institute of Radio Astronomy of NAS of Ukraine

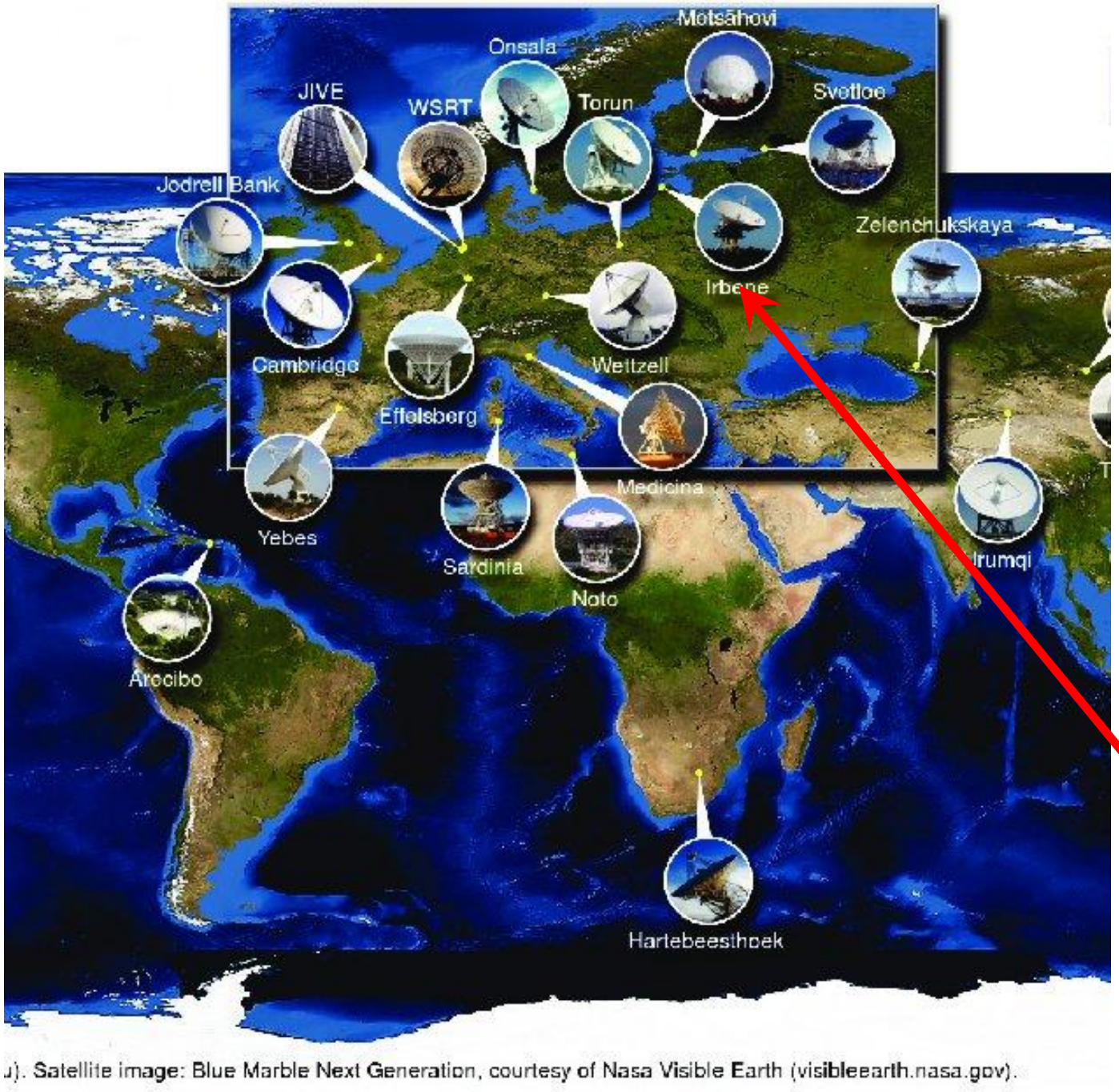
The project plans (2 years):

1.1. Development of an ultra-high-sensitivity **radiometer** of 22-24 GHz;

- 1.2. development and testing of a **reference load** (absolutely black body);
- 1.3. **methodology for spatio-temporal mapping** of variations in total electronic content and tropospheric zenith delay;
- 1.4. development of a miniature **digital module for particle detector for satellites in cubesat** format;
- 1.5. design of a **spectrally pure synthesizer** in the 4-25 GHz band for calibrating the receiving systems of the RT-32 radio telescope.

2.1. Installation of a of 22-24 GHz **radiometer** on the RT-32;

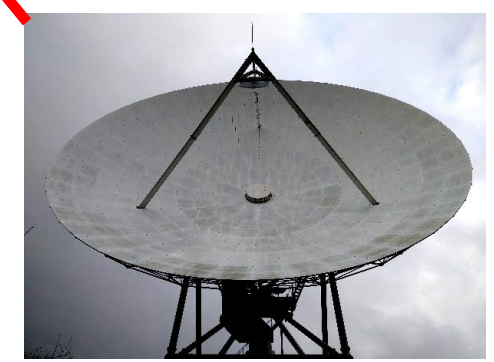
- 2.2. development of software for building **of TECU and TZD space-time maps**;
- 2.3. manufacturing of a spectrally pure synthesizer in the 4 - 25 GHz band and **calibration the receiving systems of the RT-32** radio telescope;
- 2.4. development of original techniques **for polarimetric** investigation of **near-Earth spheres** with the help of sattelite signals **using the RT-32**;
- 2.5. **visualization of different space and atmosphere weather** parameters;
- 2.6. **correcting and improving the results of radio astronomy observations** taking into account variations in the properties of the atmosphere, ionosphere and interplanetary space;
- 2.7. development of proposals for the inclusion of the System in **national and global networks** for monitoring environmental properties.

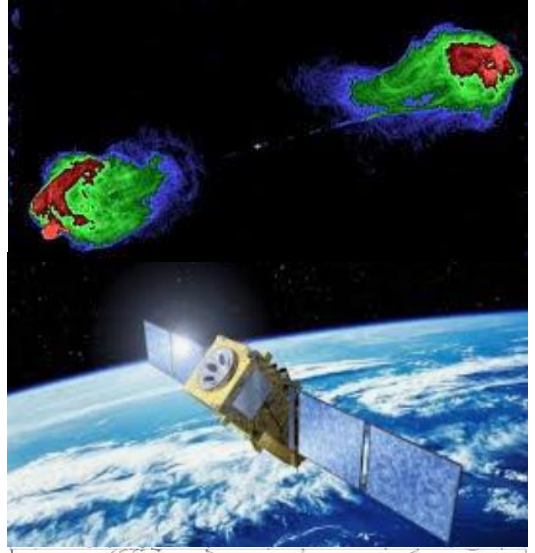


). Satellite image: Blue Marble Next Generation, courtesy of Nasa Visible Earth (visibleearth.nasa.gov).

Conclusions:

The proposed System, on the one hand, will allow obtaining more **accurate radio astronomy data**, and on the other hand, obtaining data in (almost) real time on the state of the **atmospheric and space weather** systems, interactions between the ionized and neutral shells and can be **included in global networks** of information on the state of the environment.





THANKS FOR YOUR ATTENTION!