# Coherent Ka-band radar with a semiconductor transmitter for airport surface movement monitoring

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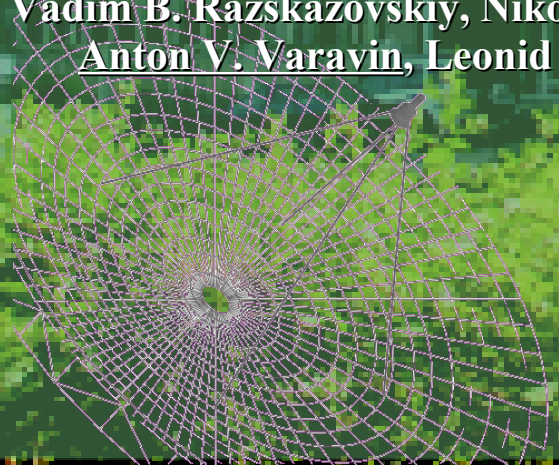

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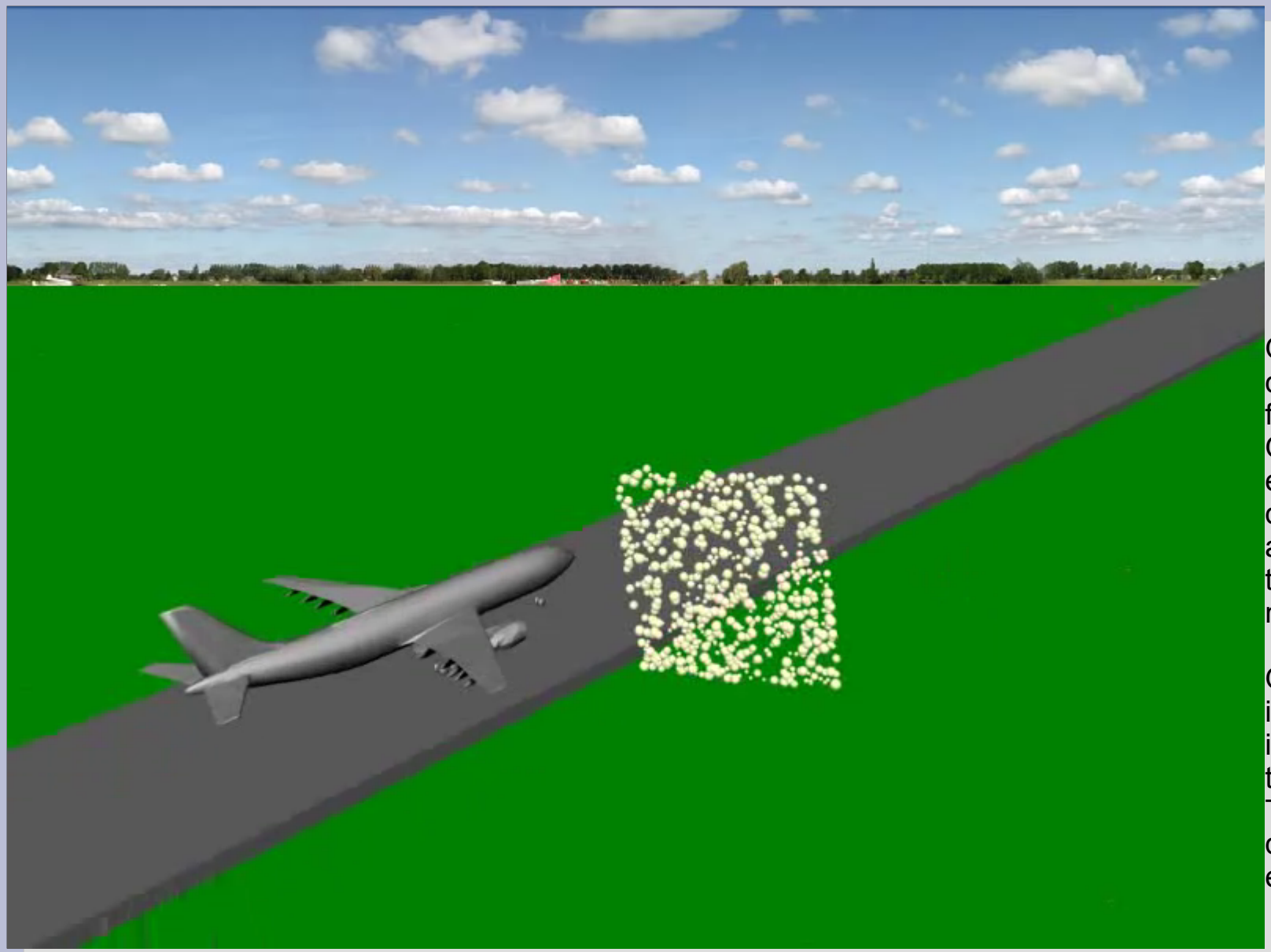

Our institute has been developing different radars for more than 50 years. Our specialists have experience in antenna developing, digital and analog signal processing, transceivers design and manufacture.

One of the features of our institute is that specialists in different areas work together on one solution This enables us to execute difficult projects fast and effective.

# Coherent Ka-band radar with a semiconductor transmitter for airport surface movement monitoring

There are some typical requirements for such radar type. Some of the requirements advanced by EUROCAE.

Resolution for such system must be sufficient to detect the targets with RCS less than 0,5 sqw meter That is typically for a human or a big animal

To perform moving target detection under the interference created by reflections from fixed objects condition.

Such radars might use low height bases for radar placing.

Low level of Microwave irradiation

High update rate.

# Coherent Ka-band radar with a semiconductor transmitter for airport surface movement monitoring

A system that meets all these requirements was developed in IRE. We use solid state coherent transceiver developed at Saturn Factory in Kiev

The distinctive features of the radar are:
A fully solid-state coherent pulse transceiver, which makes Doppler target selection and coherent accumulation possible

A diffraction antenna that transforms a surface wave into a bulk wave.

A digital signal processing unit with a firmware that allows coherent processing and is capable of distinguishing moving targets against the background of an intensive static objects' reflection

A component layout that simplifies the mechanical scheme.

One of the results of the project is a stable group of experienced specialists in different areas that can solve a variaty of practical tasks

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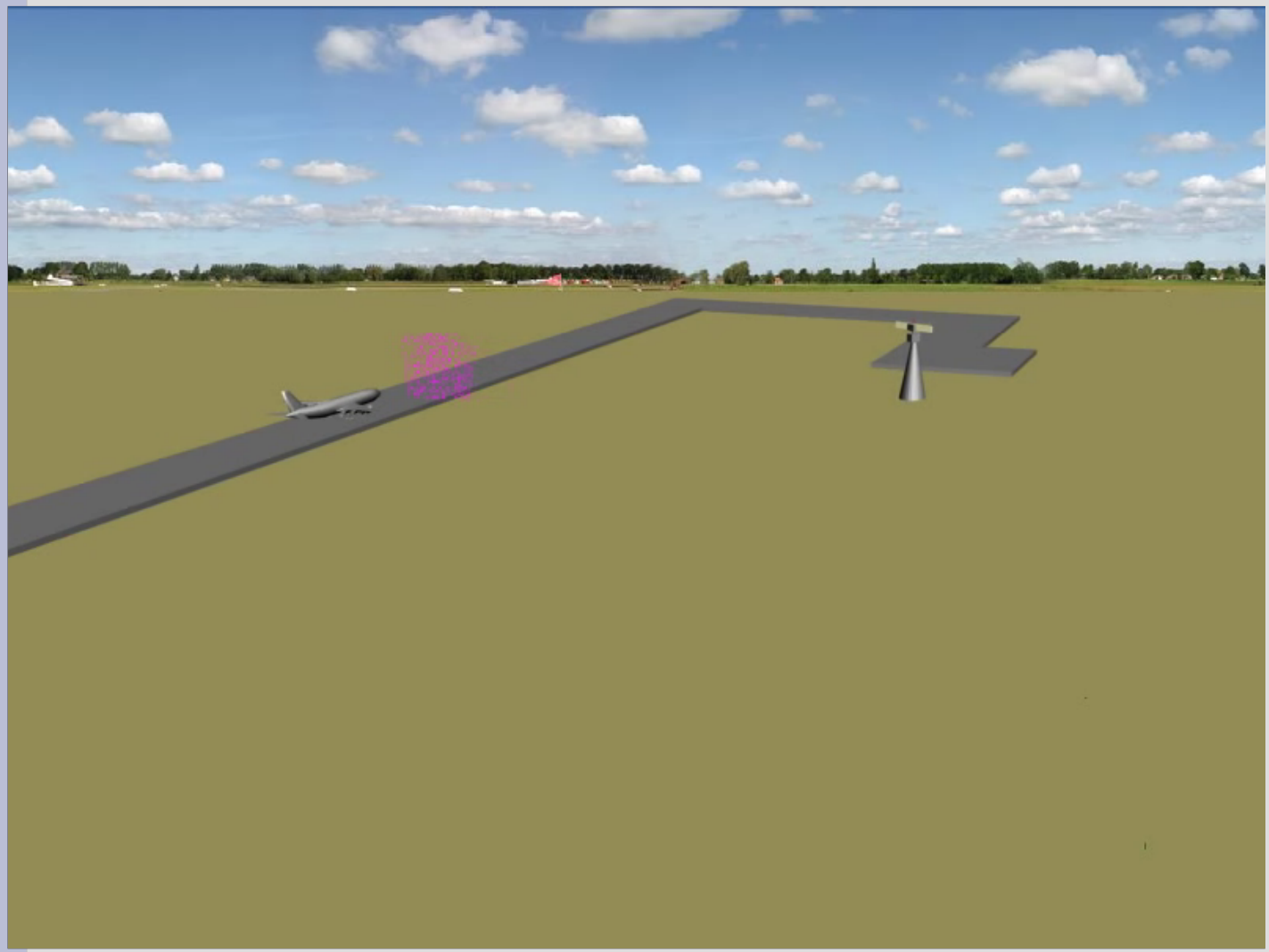

## CHOICE OF THE WORKING FREQUENCY

The choice of the working frequency is based on several reasons.

The first reason is the requirements to the size of the antenna aperture for providing the needed resolution.

Second is the need of coherent processing of the signal which enables us to perform target selection basen on its Doppler shifts.

Next is the ability to form short pulse, which increases the space resolution.

Finally, another key factor for the choice of a frequency band is the availability of generators with a sufficient power and highly sensitive receivers.

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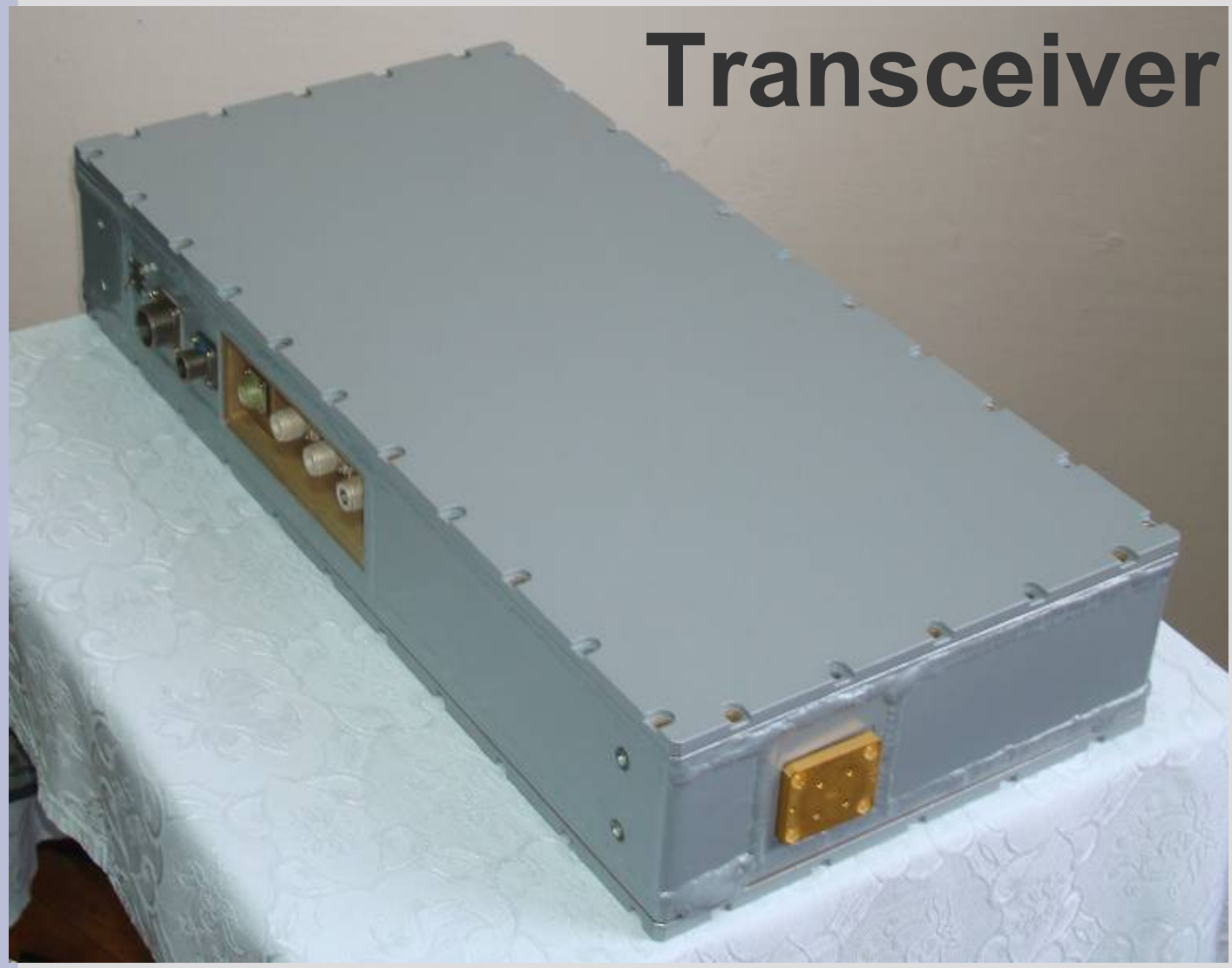


The transceiver was developed according to the coherent scheme.
It takes some additional efforts to build, but has some advantages.

possibility of target selection based on its Doppler shift against the background of an intensive static objects' reflection
Possibility of coherent signal accumulating up to few milliseconds
possibility of decreasing the influence of precipitation

the transceiver was developed especially for the radar.

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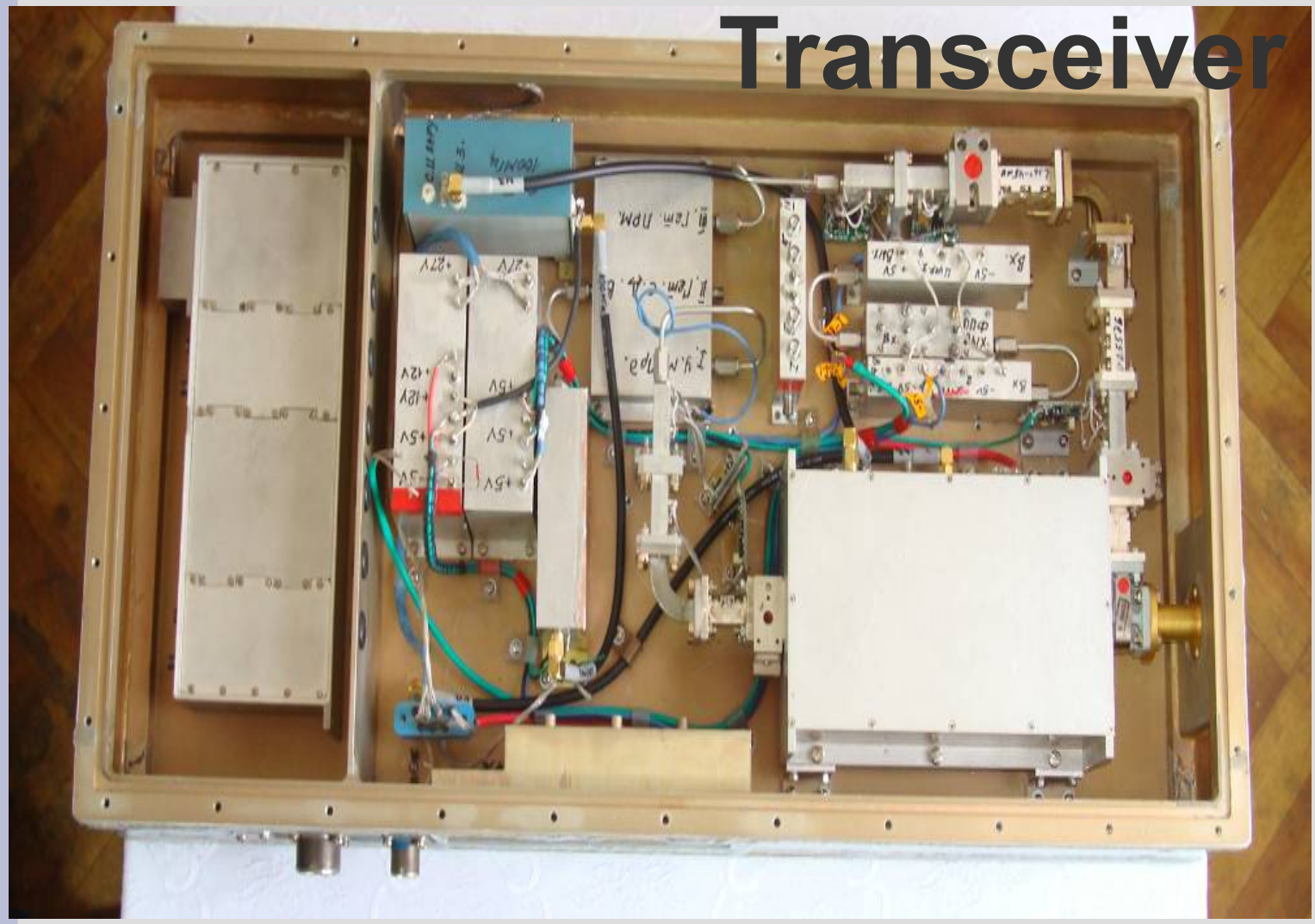



Transceiver is the heart of the radar. It was specially designed and manufactured in Kiev on the Saturn and Orion factories.

Here we can see the main view of the transceiver.
We can see IMPATT diode20 watt pulse amplifier, transmitter, reviver coupled by common heterodyne.

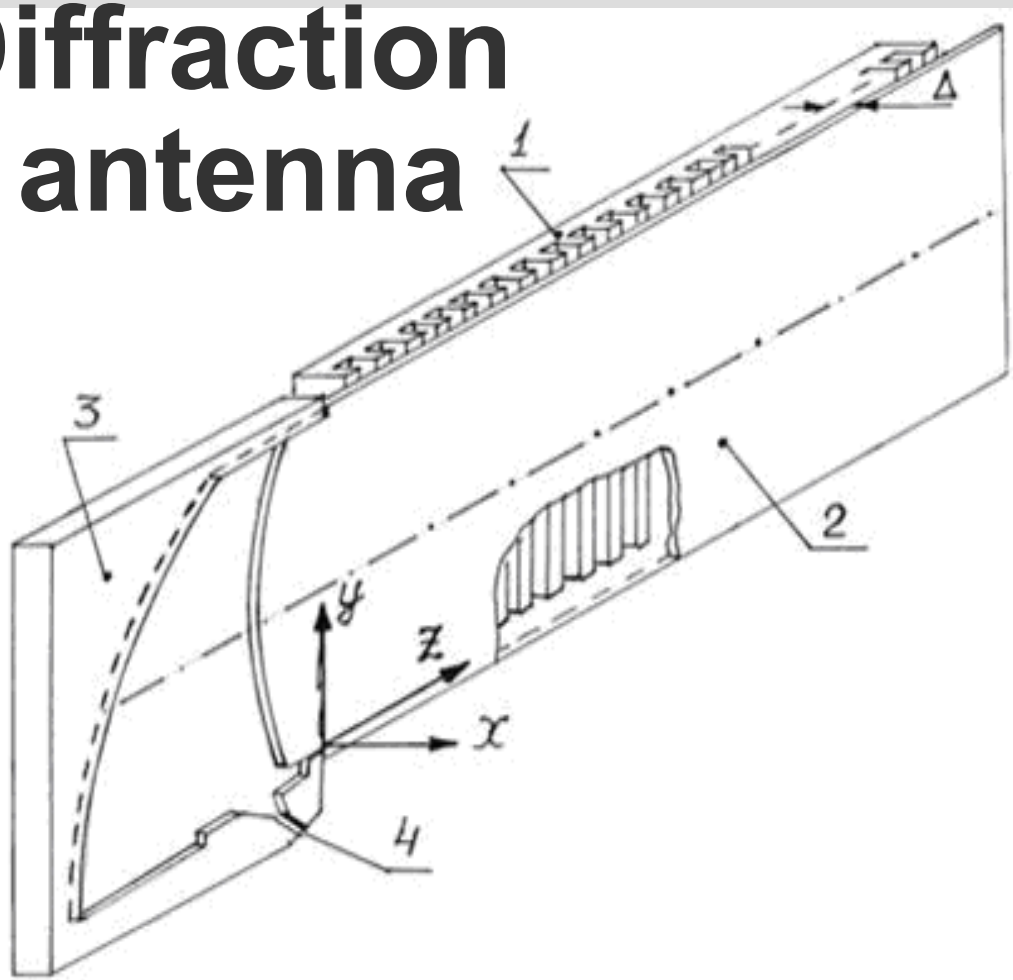
Converters , filters power supply.

As result, was developed solid state coherent transceiver with impulse power 20 w with probe pulse Wigth 10 ns

We haven't found any information on the similar developments in all accessible sources

# Coherent Ka-band radar with a semiconductor transmitter for airport surface movement monitoring

## Diffraction antenna




A big diffraction antenna was developed especially for the project.

Our specialists in antenna design have a big experience in developing this kind of antennas

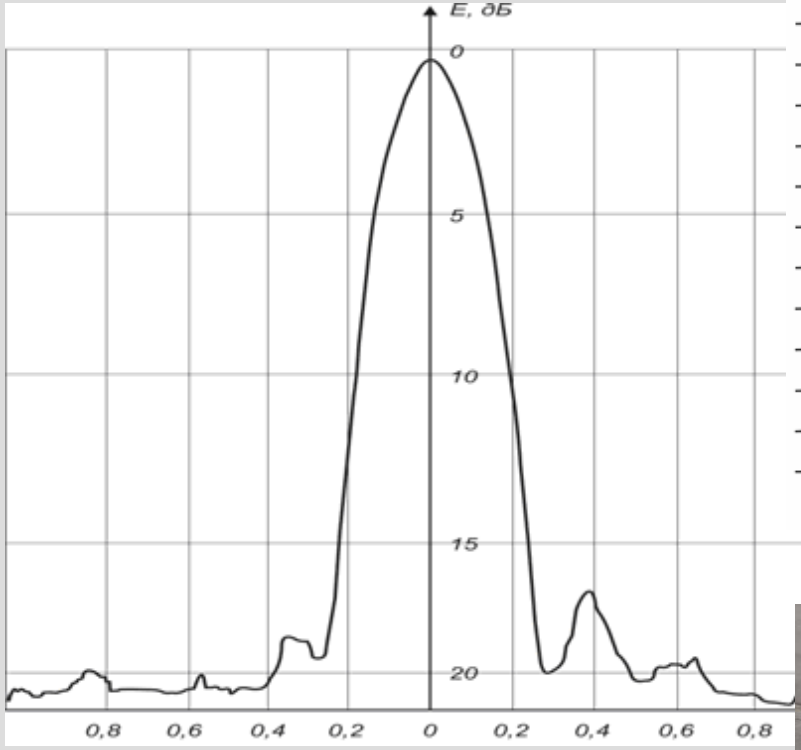
Operation principle of the antenna is as follows. Wavegide wave in rupor-parabolic converter transforms to the surface wave in dielectric wavegide 2.

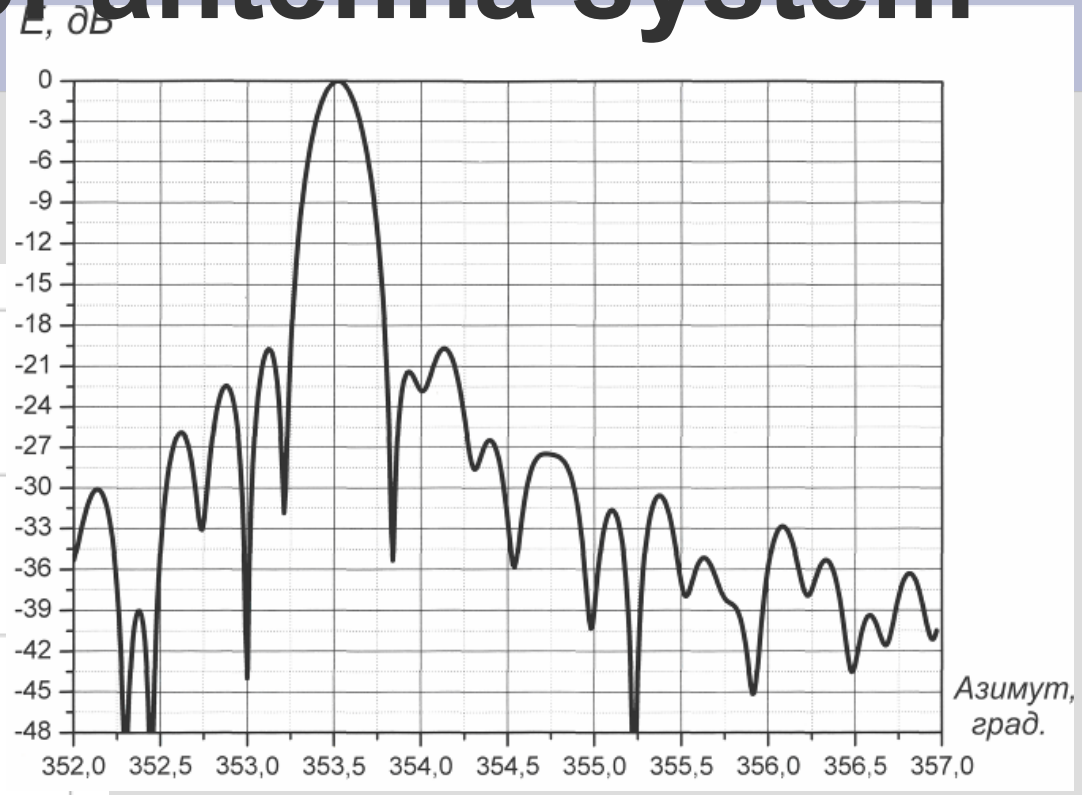
Then the surface wave in dielectric wavegide interact with diffraction gratings. It interaction convert surface wave in dielectric wavegide to the body wave in the free space.

During the design several serious problems have been solved:
plane front of surface wave was formed on a more than 20 wave length dimension
wave transfer more than 300 wavelength without plane front corruption:
special law of interference between surface: wave and diffraction gratings was formed to get the optimal antenna pattern.

As result we have a 2 meters wide antenna with the height of 300 mm and the depth near 50 mm
antenna diagram is 0.25degree in azimuthal plane and 3 degree in vertical plane
With level of side lobes near -20 Db

# measuring of antenna system




During the design a special method was developed that allows us to predict quite accurately the resulting diagram of the antenna relying only on the measurements taken in the near field

Such type of antennas are used over the years in space on research satellites and on surveillance system in airport Borispil'

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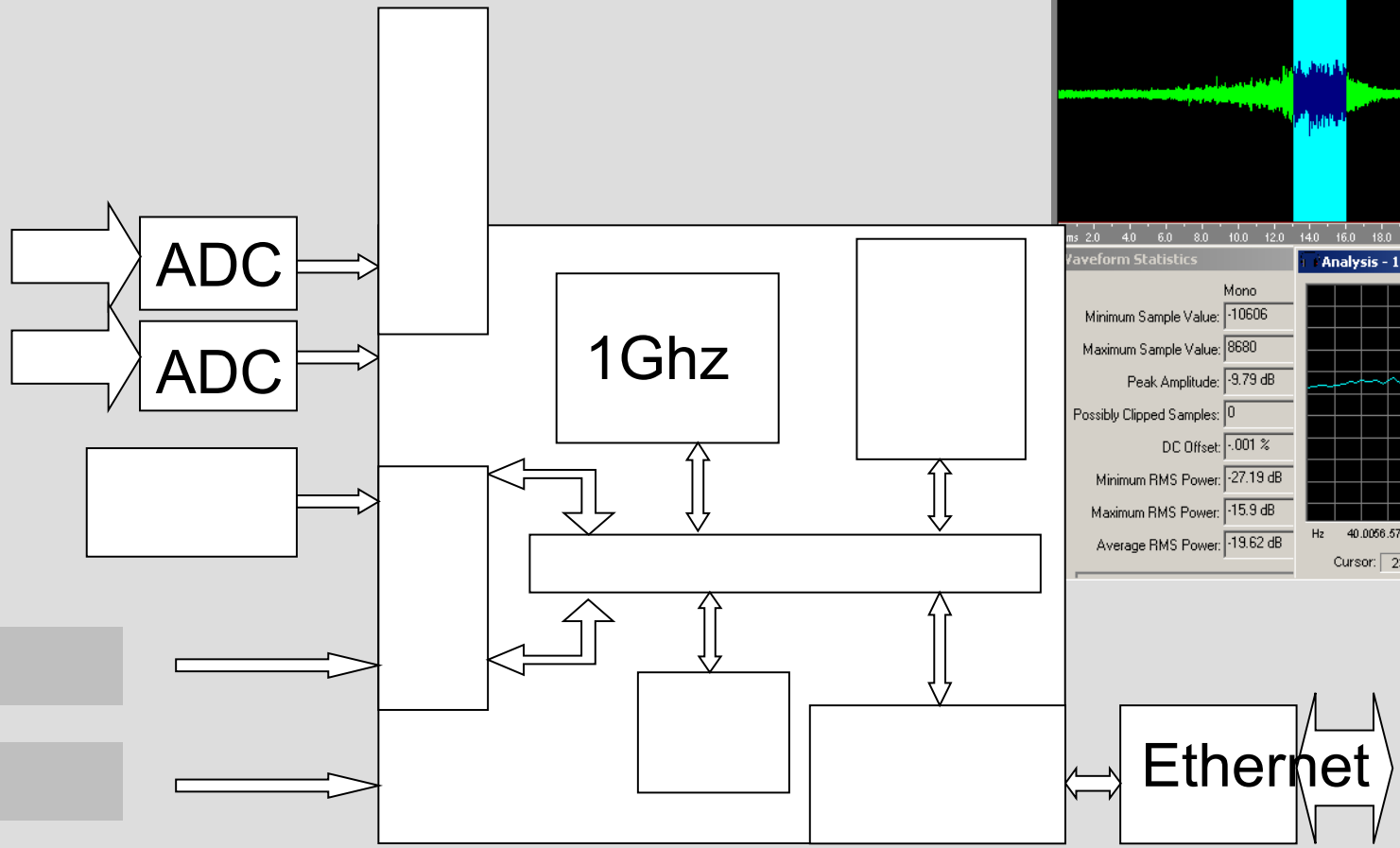
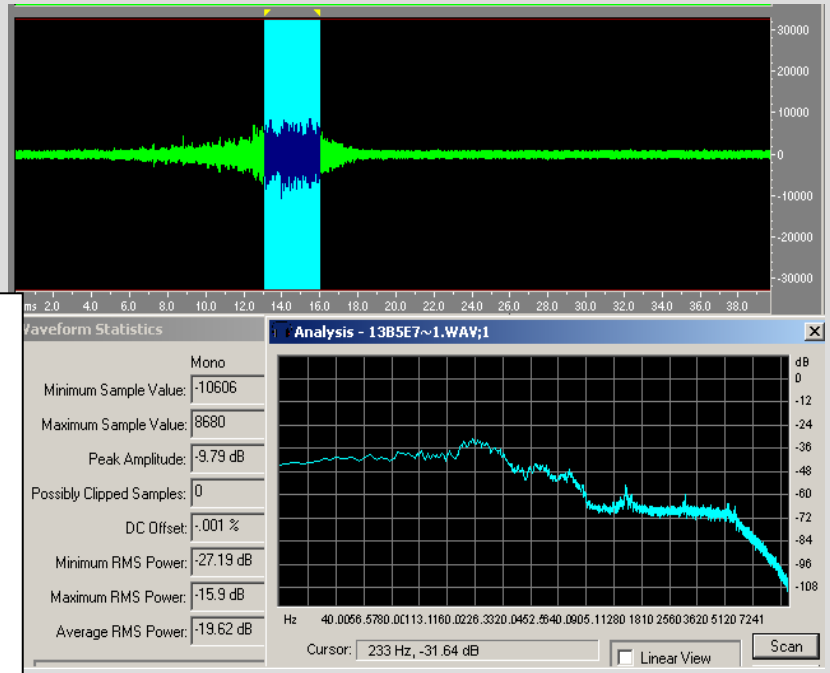
## DSP Unit

Here is a structure of DSP Unit. There is an ADC with 12 bit resolution
1 Ghz processor Ethernet interface that allows to build radar nets for increasing the update rate and decrease radio shadows



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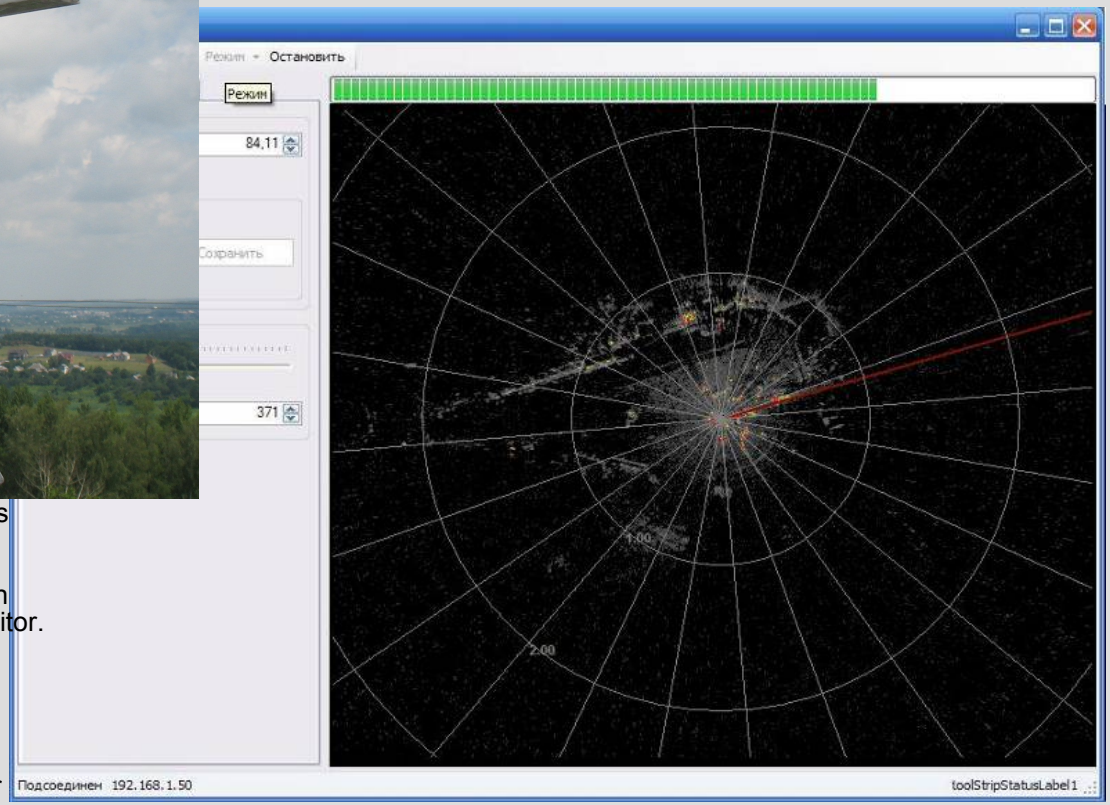
## Layot




The layout of the radar is such that all signal processing elements such as diffraction antenna transceiver DSP unit communication transceiver are placed on a rotated part.
Radiolocation picture formed in DSP unit is transferred via communication transceiver to the terminal, where this information is indicated on the monitor.
Such layout eliminates the need of a rotated wavegide, that has bad parameters in the bandwidth
Used communicated channel allow to make network of radar sensors, to increase update rate : except black zones and make target detection

it creates additional possibilities to resolute low dimensions targets better under different whether and static reflection condition

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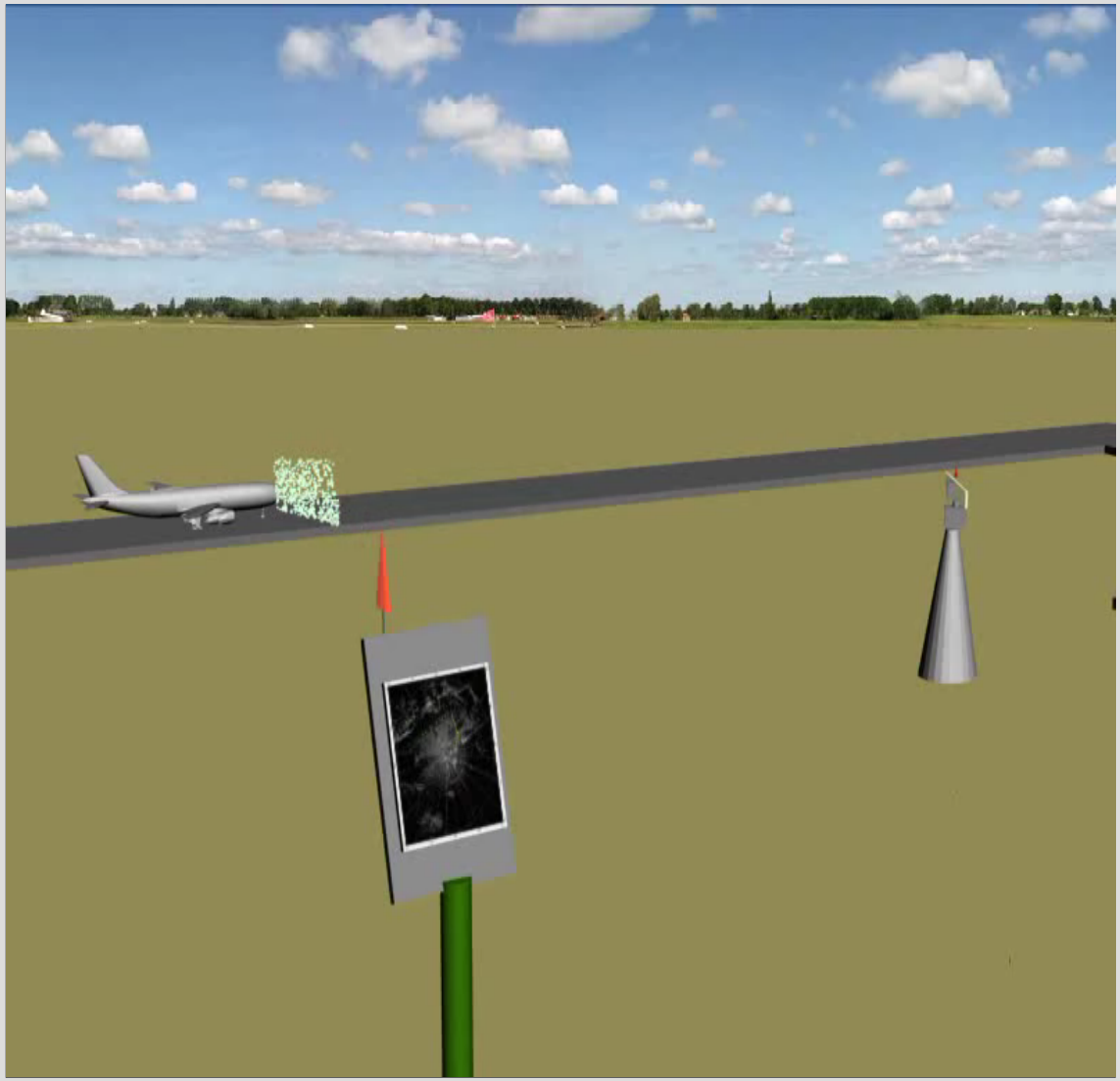
## Results

- carrier frequency 36 GHz;
- repetition rate of pulses 20 kHz;
- duration of pulse 100 ns;
- power of pulse 20 W;
- coefficient of receiver noise < 5 dB;
- intermediate frequency 9 GHz;
- width of the antenna pattern:

o azimuthal 0.25.;
o in vertical plane 4.;

- velocity of the circular surface scan 0.25 turn/s;
- power consumption < 1 kW;
- weight < 150 kg;
- required height of antenna installation 5 m.

detection of target with the RCS above 1 m2 exceeds 5 km for conditions of no atmospheric precipitation.



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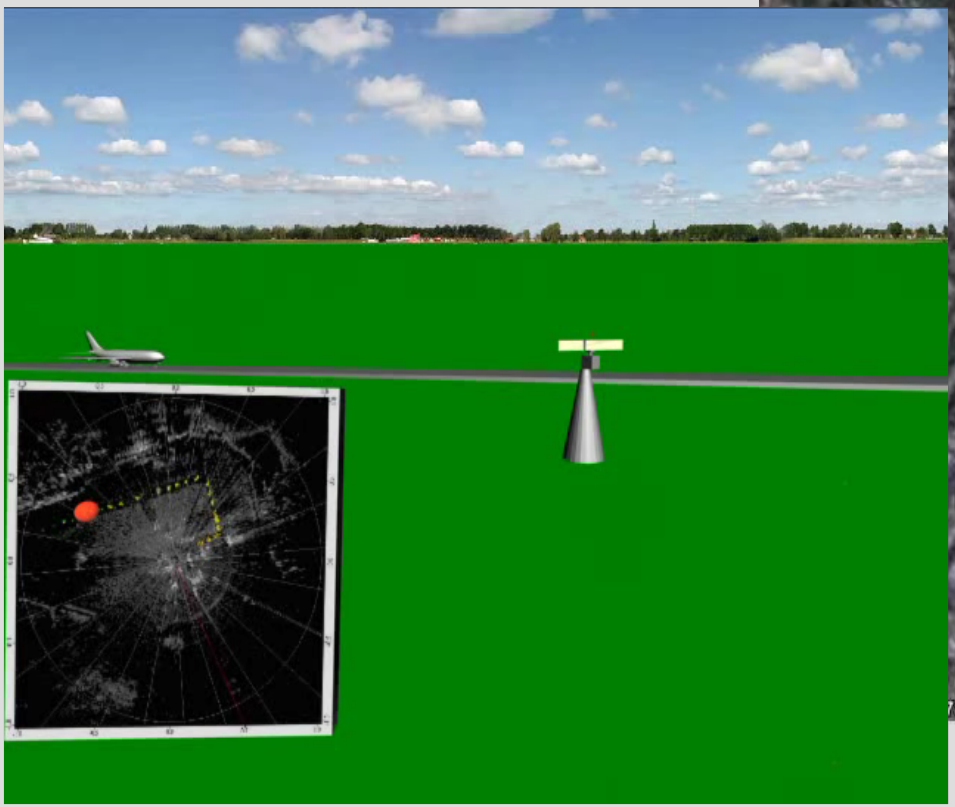
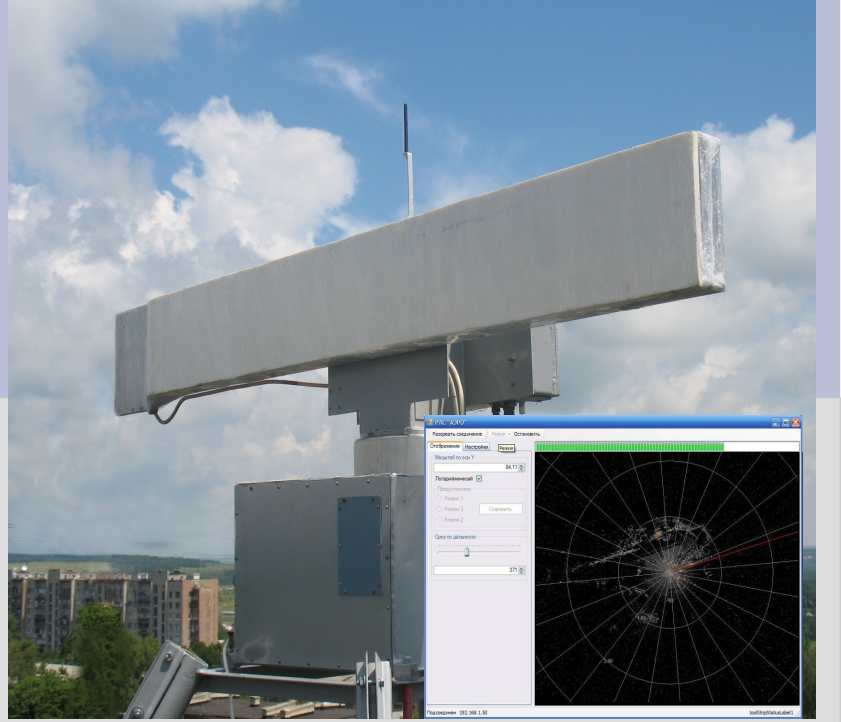
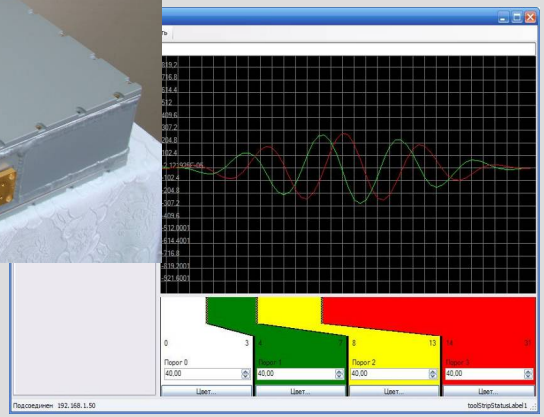
## Testings

Testing was carried out at the Kharkov Aircraft Factory. We observed all type of most typical radio location targets such as Human  Jet, Bus, all targets were good resolved.
Tests shows that using of the radar for airport surface movement monitoring is posible.



# Conclusion





- We can see that coherent radar sensor , that allows radar network building, was developed.
- Doppler target selection and coherent signal accumulating modes were realized.
- diffraction antenna was developed.
- DSP Unit
- using of the layout allow to avoid difficult mechanical and wavegide solution
- tests shows ability of using the radar like element of airport surveillance radar network