ELECTROMAGNETIC SYSTEMS AND TOOLS OF INTENTIONAL IMPACT ON PHYSICAL AND BIOLOGICAL OBJECTS

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Abstract. **Modern development level of generation methods of powerfull electromagnetic impulses and radiation forming ways defines development possibility of wide class of directed energy systems and means. In electromagnetic systems and means impacted on biological objects (human) and environment development area and for force systems in electronic warfare (EW) area the following in most known: electromagnetic means of lethal effect, large power generation means for force systems of EW, electronic means of non–lethal effect and means of directed electromagnetic effect on environment.**

In the first part of the paper questions of powerful electromagnetic impulses generation improvement for force systems creation of radio–electronic suppression of different kinds of radio–electronic systems (RES) and especially systems of modern high–precision weapon are highlighted. It is exceedingly important problem in perspective armament and military equipment development. Methods and ways of powerfull nanosecond impulses generation are discussed. It contains the following works:

- theoretic justification of powerful nanosecond impulses generation method abilities and they's main parameters for possible practical use in perspective systems of force electronic warfare of RES termination development is made;

- results of foreign and domestic researches of creation of nano– and microsecond duration UHF–pulses and ultra–thin electromagnetic pulses and also electromagnetic radiators with magnetoimplosive current generators supply are given

- the variants of UHF weapon used abroad are presented and also examples are given for creation of means of directed electromagnetic impact to human for the fight against terrorism.

In the second part of the paper basing on interactive materials, issues of geophysical perturbations in ionosphere made naturally and artificially are highlighted as powerfull impact sources in nature. Corresponding description of deliberate methods and means of impact to environment (HAARP type of RLS) and directing of radiation heating stands and secondary ionosphere radiation radio–monitoring is given.

In the final third part of the paper problems of possible (expected) development directions of electromagnetic radiation impact on physical objects and environment methods and they's ways of solving are approximately formulated.

Keywords: **generators, electromagnetic radiation, electromagnetic suppression systems, physical objects, ionosphere, radiomonitoring, geophysical perturbation, heating stands.**

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Contents

1. INTRODUCTION

The present level of development of methods for the generation of powerful electromagnetic pulses and methods of forming radio emission has determined possible development of a broad class of systems and tools of directed energy. Given the current trends in the development of fundamental and exploratory research in the development of such systems and electromagnetic effects on biological objects (human) and the environment, as well as power systems in the field of radioelectronic warfare (REW) is currently the best known are the following means.

Electromagnetic means lethal effects. In the Russian literature often uses the terms: SHF-weapon, SHF-generators or generators of electromagnetic radiation (EMR), in foreign - microwave weapon (including EMR and super-EMP ammunitions). Under electromagnetic means (weapons) lethal effects (objects of defeat: personnel, weapons and military equipment (AME)) refers the directed energy weapons, the main damage factor of which is the electromagnetic radiation in the range of 100 MHz to 300 GHz (the maximum spectral density or the average frequency of the radiation) with a pulse energy of at least 100 J (or peak power greater than 100 mW or average power greater than 1 MW).

Means of generating high power for force systems radioelectronic warfare (REW). Intend to use method of generation the powerful nanosecond pulses for their practical use by the development of perspective systems of force electronic warfare on defeat radioelectronic systems (RES).

Electromagnetic means of non-lethal effects. This term means the weapon acting on enemy personnel by means of energy electromagnetic radiation for brief deprivation (from seconds to several hours) of his combat capability (to create conditions for the inability to perform set tasks).

Means of directed electromagnetic effect on environment. These funds combines some types of meteorological and geophysical weapon, using as a primary active factor the energy of electromagnetic radiation.

2. METHODS AND WAYS TO GENERATE NANOSECOND POWERFUL PULSES

Currently, areas of the opportunities and impact of electronic warfare to fight the warring parties largely expanded and becomes the basis of the information aspect of warfare, affecting virtually all processes of detection, collection, transfer, processing and use of information. The emergence of complex multilevel systems radio-radioengineering intelligence, combat control, REW and precision weapons defined sharply increased dependence of the course and outcome of combat operations on the readiness and effectiveness of operation of these systems. The purpose of electronic warfare became not only the solution of particular problems to disrupt the functioning of control systems of weapons and of troops (forces) of the enemy, but also to achieve a decisive advantage over him in efficiency, stability and quality of control.

Thus, electronic warfare is a set of activities undertaken to identify (intelligence) and subsequent electronic suppression (SES) electronic systems of different purposes (radar systems and radio communication systems), as well as for the radioelectronic protection (REP) of its RES.

Along with the evolutionary development of EW in the forecast period abroad is possible to create and deploy a new class of technology - a complex electromagnetic weapons, created through the development of generating devices with high-powered directional radiation in the microwave range, defined as *force REW on defeat different types of RES* [1, 2].

2.1. THEORY AND PRACTICE GENERATING NANOSECOND POWERFUL PULSES

Therefore, improvement of methods of generation of powerful electromagnetic pulses for creating of force systems SES of various types RES and especially modern high-precision weapons systems (HPW) is a relevant and important issue in the development of promising arms and military equipment (AME).

Generally class of objects RES can be quite wide: the input circuits of devices air defense equipment of aircraft, satellites, etc. However, the most relevant at the present time is the problem of efficient use of force REW to fight high-precision weapons.

Work to solve this problem (because of its extreme urgency) is conducted for a long time, but until now unknown to others (except as described in this paper) methods and apparatus for generating packs of powerful microwave ultrashort pulses (USP). Known and used methods and apparatuses have several drawbacks. For example, in the microwave radiolocation station (radar, MRLS), acting on the basis of parametric absorption effect (EPA), the United States used the delay unit, which due to the equidistant gap junctions provide a decomposition of a single super-power (from a few to hundreds of megawatts) microwave pulse for a pack of powerful ultrashort pulses. Disadvantages of this method are well known and are described in the scientific literature, however, so far other solution of set tasks were not.

Known not only methods how to use the packs powerful microwave USP in order to radar detection of stealth aircraft, but also a attempts to use such USP to create a stable energy formations or clots (SEC). However, to date such attempts have led to positive results in the US alone (SEC creation with time stabilize the order of several microseconds). Interest in such use USP , as well as to methods and apparatuses for generating such reams of USP, stems from the fact that a single electromagnetic pulse (EMP) emitted by SEC by destabilization can reach the energy performance comparable to a EMP of nuclear explosion of average power (which is highly relevant in terms of destructive factor, and in the sense of nuclear explosion imitation).

2.1.1. THEORETICAL RATIONALE FOR THE USE OF THE METHOD OF GENERATION OF POWERFUL NANOSECOND PULSES IN FORCE ELECTRONIC WARFARE

Purpose of this paper is a theoretical justification the possibilities of method of generation of powerful nanosecond pulses, their main parameters for possible practical use in development of advanced of systems of force electronic warfare on defeat RES.

2.1.1.1. DEVELOPMENT OF SYSTEMS OF FORCE DEFEAT RES BASED ON MODERN METHODS OF GENERATING HIGH-POWER RADIATION

In the field of elaborating as of methods of powerful radiation so and the electromagnetic weapons, now stands out area of the creation of various types of *electromagnetic weapons*. Their destruction facilities are not only the RES, but even and personnel.

Currently abroad intensive research is being conducted on the development of means of functional lesion using powerful microwave generators of different wavelength range, which indicates the relevance of the impact of powerful electromagnetic pulses on the RES as a means of the forced REW [1-8].

Analysis of the available results of works on creation of microwave means of influence (weapons) shows that the most active works in this field are deployed in the United States. In recent years, research in this area were also deployed in France, England, Germany, Israel, Japan, China and Sweden. Practically all departments of USA Ministry of Defense ordered the creation of SHF means of acting. At the same time for a tactical means of SHF (SHF generators, powerful amplifying modules and antenna systems, power supply, etc.) is characteristic the functional convergence or uniformity with promising radar technology and means REW. In particular, elaborating of tactical SHF weapons examines the concept of complex performing the radar detection and tracking of the target in reduced power mode, and at maximum power mode - its functional or forced defeat. As typical objects of defeat by the powerful microwave radiation are considered:

- digital special calculators of control systems of intercontinental ballistic rockets, tactical and operational-tactical rockets;
- systems protection and charging combat equipage of rockets;
- electrical devices undermining mines and roadside bombs;
- navigation receiverssystem "GLONASS";
- RLS of systems of AD/MD (air defense/missile defense);
- RES of homing heads of anti-aircraft guided rockets and rockets "air-to-air" and others.

The present level of development of methods for the generation of powerful electromagnetic pulses determines completely the possibility of development of a broad class of directed energy weapons.

Analysis of existing and emerging types of microwave weapons, ways to combat employment allowed to form a common scheme of classification and identify the overall dynamics of the development of such systems in the United States for the period up to 2017 as set out in **Table 1**.

The analysis of existing foreign press and data of Table 1 give the opportunity to believe that the overall dynamics of the developments in the field of *electromagnetic weapons* (microwave weapon) abroad is based primarily on the basis of the creation of the following types of sources of high-power microwave radiation:

- sources on the base of microwave generators of different wavelengths and phased arrays, which summarize power of individual microwave generators in a narrow beam of microwave radiation;
- microwave generators on relativistic electron beams;
- sources of quasi-isotropic, including broadband microwave radiation on the basis of explosion-magnetic generators;
- microwave generators on the basis of special nuclear ordnances with ultra-low power.

In Russia also performed similar work on the creation of a means of generating powerful radiation. First and foremost is work on the creation of a powerful pulsed sources of broadband microwave radiation.

Here are the results of work carried out in IRE RAS in the 2000s under the leadership of RAS Corresponding Member Cherepenin VA, on

Table 1

Overall dynamics development of existing and emerging types of microwave-forces systems in the US

Years		
2002	2003-09	2010-17
Microwave systems for protection of objects AME		
Demonstration: - small-size broadband radio-emission source high power - narrow-band radio-emission source with high pulse energy	**Demonstration:** - opportunities of small-size systems of microwave weapons to defeat of air targets	**Demonstration:** - naval systems microwave weapons for protection against high-precision weapons; - systems microwave weapons to defeat munitions, missile warheads
Microwave systems for defeat of management tools and communication		
Theoretical and experimental research, technical development	Ground tests	Tests in structure of air-basing means
Microwave systems to defeat air defense radiotechnical facilities		
Demonstration small-size narrow band radio-emission source high power	Microwave weapons systems single action of an explosive type	Impuls systems of multiple actions
Microwave systems of space–basing for AD/MD		
Theoretical and experimental research, analysis of effects	Modelling and imitation for development of concept of combat use	Ground tests complexes of defeat operative-tactical, Intercontinental ballistic missiles and space vehicles

elaborating new methods of detecting objects based on effects of use of ultrashort pulses [1, 2]. This is due primarily with the work on study the characteristics of radar systems with broadband pulses for the detection of little-noticeable objects. Work was done on the modeling and estimation of parameters of ultra-wideband pulse of the locator by the *single-pulsed location* of little-noticeable objects. Were conducted researches direction-finding complex objects on the background of the underlying surface by the monopulsesystems.

As a result, created and tested the device, where voltage source, is the high-power nanosecond generator of pulse voltages. A legitimate source for the specified conclusion are the received results of studies of a new method of radiolocation - detection of small-dimensional and weakly-emitting objects (such as "Stealth") on the basis of high-power nanosecond pulses. It is advisable for more detail elaborate on the basic provisions of this interesting research direction, the results of which can be successfully used as a basis of creating the generators of large power for forced radioelectronic means of REW.

2.1.1.2. GENERAL PROVISIONS OF THE METHOD OF SINGLE-PULSE LOCATIONS

It is known that the most commonly used in modern radiolocation the modulation method of signal forming of angular error determines the modulation depth, and the phase is determined by the direction of mismatch of antenna axis. There are three basic ways to determine the coordinates of the single-pulse direction-finding in systems - amplitude, phase and complex. Modulation method of the forming of signal angular error requires a sequence of reflected pulses, which determines its sensitivity to fluctuations in the amplitude of the received signals. This is most significant drawback of single-channel direction finding method using a conical, linear and sequential switching of directivity diagram. This deficiency in single-pulse radio location is missing. In this case, the reflected pulse contains complete information on angular position of the target with two independent receiving channels. In this case the direction-finding is carried out by one pulse at the same time on two independent channels of reception in the coordinate plane. The fluctuations of the reflected signal practically almost have no influence on the accuracy of the measurement of angular coordinates.

The single-pulse location is prospective in detection of objects on the Earth's surface, as well as in detecting low-flying objects.

Complex problem arises under location of small objects on earth and sea surface, as well as under detecting low-flying aircraft. By using long pulses in RLS the range resolution is improved with use of frequency modulation, spreading its effective spectral range. However, herewith arise spurious sidebands, through which can be fed powerful interferences, whereby a small target may mask a large target. This problem does not exist for radar with short microwave pulses, as there is no need to change compression schemes of pulses.

Reducing the pulse width reduces the range of action of monopulse radar system (detecting object and impact on it). This confirms the need to use in radar systems the super-power microwave pulses. In

this case also necessary when switching to shorter pulses save total power, which also allows to obtain a higher resolution of objects.

2.1.1.3. CHARACTERISTIC OF PARAMETERS OF RADIO- AND VIDEO-PULSES OF MONOPULSE LOCATION

What ways use now are russian and foreign researchers by creating tools generating of high power?

1st direction. With the help of a relativistic backward-wave tube in the early 90s at the Institute of Applied Physics (Nizhny Novgorod) and at the Institute of High Current Electronics (Tomsk) were obtained the high-power nanosecond radiopulses in decimeter range [9, 10]. As a result, radiopulses were generated at a frequency of 10 Hz and a duration of 5 ns at a repetition frequency of 100 GHz. Average power generator was 250 watts. Nanosecond digital locator consisted of the receiving and transmitting antennas.Isolation of the antennas was 60 dB.

At present, the test of similar radar successfully passed in England: at a distance approximately of 100 km was clearly visible small plane with an effective area of cross section (CSA) of 1 m2. Distance resolution was provided 1 m. The repetition frequency of RLS was 150Hz. The width of the diagram amounted 3º. Under digital processing of signal the noise level was reduced by 30 dB.

It was found that meter resolution on this distance enabled to identify the different purposes, including distinctly observed the rotational movement of the blades of the helicopter at the same distance.

2nd direction. Another mode of generating microwave videopulses differs significantly due to the lack of high-frequency oscillations filling, herewith had the relatively large spectral width.In fact, a video-pulse is a 1-2 oscillations with a selected carrier frequency. Wave generator voltage can be effectively converted into an electromagnetic wave at a direct radiation of special antenna, herewith high-frequency filling missing, video-pulse is characterized by a relatively large of spectral width. Development of nanosecond high-voltage powerful generators based on cutting of short pulse out of more longer pulse using sharpening and shear gas discharger (slicer). Dischargers worked in a nitrogen atmosphere at a pressure of 60 atmospheres, and were powered by transmitted high-voltage nanosecond generators (drivers) through the 50-ohm line as capacitive energy storage.

On such a device were obtained 1-5 ns pulses with an output power to 400 mW with the prospect to increase to one GW with a repetition rate of 100 Hz with a stability no less than 3%. Stability of pulse duration was less than 10%, which is insufficient to detect small effective area of the scattering. For radiation the nanosecond powerful video-pulses can be used TEM horns in the form of non-uniform strip lines.

Fig. 1 shows form of such powerful video-pulse of generator.

2.1.1.4. ADAPTATION OF SPECTRAL CHARACTERISTICS OF LOCATION PULSE

Methods of generating high-power nanosecond electromagnetic pulses, in principle, allow rapid adjustment of the parameters of radiated signals and, in particular, changes in the emission spectrum, including through the use of modular method of construction of the radiating system. Adaptation of the locator pulse can be in this case is based on the following principle.

In the first phase of the adaptive procedure is performed irradiation of space by powerful ultra-wideband electromagnetic pulse and the reflected signal gives the opportunity to make a decision about the detection of the object. In parallel with the emission of the probe pulse is carried out its spectrum analysis and the results of $S_0(\omega)$ are recorded in the information storage unit. In the case of a positive decision about detecting is produced spectrum analysis of the reflected signal $S(\omega)$.To find the maximum in the spectral characteristic of the reflecting target surface $\sigma(\omega)$, in the computer system is formed ratio $\sigma(\omega) =$

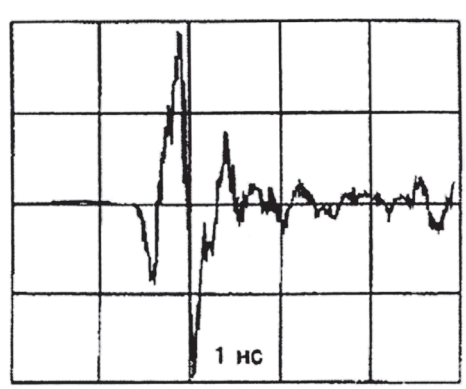

Fig. 1. *Shape of toutput video-pulse of powerful nanosecond generator.*

$S(\omega)/S_0(\omega)$ and the analysis of the maximums of this magnitude. If one or more maxima are above the average value of the effective reflecting surface, then adjusted the spectrum of the emitted pulse so, that the maximum spectrum components of location pulse accounted for the maximum value of the effective spectral reflective surface. In this case the spectral width of the emitted pulse must also be consistent with the dependence of σ(ω), so that energy of the reflected signal was taken as the maximum possible value. Concrete laws change in the spectrum of the emitted pulse, depending on the measured value of σ(ω) should be developed for specific experimental parameters generating system, in particular, the number of independent channels radiation, frequency overlapping of generation range, possible characteristics of the intended targets, coefficient of possible narrowing of spectrum of pulse generation around the carrier frequency, etc. Note that in the presence of errors in determination of the spectral amplitudes effective reflecting surface of the target the adaptation should be carried out when the difference between the maximum value of σ(ω) and average value will be more of error of determination of spectral components σ(ω).

In the process of tracking are possible slow changes of the spectral characteristic of an effective reflective surface, caused by a turnoff of target, for example, etc. In this case, to maintain high accuracy of determination of the dynamic parameters of the target is necessary periodic to conduct correction spectrum of locating pulse, which will consist the repeated measurement of spectrum of reflected signal, determining σ(ω) and changing in accordance with this new dependence of the spectral characteristics of the emitted pulse.

Note that the measurements of the spectral characteristics of effective reflecting surface targets also allows you to define a class of object to which it refers. In the case of a creation bank of information on the spectral portraits of possible targets the periodic correction of the locating pulse parameters can be carried out without feedback (without repeated measurements σ(ω)) only on data stored in a bank of information, and the dynamic characteristics of the target (distance, speed, angle of observation and etc.).

2.1.1.5. THE MAXIMUM DETECTION RANGE BY MEANS OF THE OPTIMUM RECEIVER ON NOISE BACKGROUND

In the absence of active interference noise component of signal can be considered as white Gaussian noise with spectral density $N_0 = kT$, where k - Boltzmann constant.

Signal-to-noise ratio (S/N) of the optimal receiver coherent signal will be

$$\mu = \frac{1}{N_0}\int_0^\tau \xi(t)dn = \frac{E}{N_0}, \quad (1)$$

where $E = \int_0^\tau \xi(t)dn$ - is the total energy $\xi(t)$ during the pulse duration τ.

Signal is considered to detected if the signal/noise ratio is greater than a certain threshold $\varsigma(\alpha_1, \alpha_2)$, that depend on the parameters of the probability of correct detection and probability of false alarm: $\mu > \varsigma(\alpha_1, \alpha_2)$.

Maximum range of target detection will be:

$$R_{\max} \le \frac{G_t A_t \sigma}{(4\pi)^2 \zeta} \cdot \frac{E}{N_0}. \quad (2)$$

According to the formula (2) was calculated for the initial data: $\sigma = 0.1$ m^2, the pulse duration $\tau = 5$ ns, $T = -300$K, parameter $\varsigma(\alpha_1, \alpha_2) = 5$. Admits that the receiving and transmitting antennas are identical, the output aperture videopulses $50\lambda^2$, and CSA (effective area of cross section) is 10 m^2.

The calculation results are shown in **Table 2**.

2.1.1.6. DETECTION AND ESTIMATION OF THE PARAMETERS OF THE OBJECT BYAPACKET OF LOCATING PULSES

To improve the characteristics of detection and target tracking at monopulse location of little-noticeable objects is possible, using for the location a few identical pulses. In this case it is still possible definition of all parameters of target for each of pulses, however, estimation of parameters on packet is the better, the more pulses in a packet. Further more, for effective use of an adaptive procedure locating requires relatively large value of signal/noise ratio, which also requires the use of multiple locating pulses.

Table 2

Maximum range of target by different capacities and types locating pulses

	Maximum detection range of object, km	
	Pulse power of 0.5 GW	Pulse power of 1.0 GW
Radio pulses	550	655
Video pulses	250	310

Evaluation of signal/noise ratio and detection range for packet of locating pulses. Devices generating ultra-wideband powerful microwave pulses capable of operating in the frequency mode with a repetition rate of 100-200Hz. Therefore possible monopulse location as single pulses and pulse packet, comprising up to a few thousand pulses.

In case of reception k pulses on the background stationary random process, quality detection characteristics are the same as by the reception of one pulse, but having in k times greater energy. Indeed, energy of locating signal is proportional transmitter power multiplied by pulse duration. In the case of a packet of pulses the total duration of signal is increased in k times that correspondingly increases in k times signal/noise ratio. **Table 3** shows the values of the target detection range in the case of the location of radio pulses and video pulses with different number of pulses in a packet. As is easily seen, the maximum range of video pulses location at 100 pulses per pack can reach 1000 km, and at radio pulses locations even is more than 2000 km. The total duration of location signal in this case is 1 second at a pulse repetition rate of 100Hz.

It should be noted that this gain in detection range can be achieved only in the case of coherent filtering of all the pulses of pack (phases of all pulses must be the same). This is possible in the case of simultaneous detection and estimation of target velocity. Then speed of target is a parameter, and it is possible to coherently accumulate all impulses of the pack. A "fee" for increase of sensitivity is a significant complication of optimal receiver, as in this case requires presence at least of three-dimensional comb filter for evaluation of velocities in distance and two angles.

Table 3

Maximum range of target detection by various capacities and types locating pulses and for different number of pulses in a pack

Signal characteristics	Maximum detection range of target, km	
	Pulse power of 0.5 GW	Pulse power of 1.0 GW
Locating radio pulses		
One radio pulse	550	655
Pack of 5 radio pulses	7820	980
Pack of 20 radio pulses	1160	1385
Pack of 100 radio pulses	1740	2070
Locating video pulses		
One video pulse	260	310
Pack of 5 video pulses	390	460
Pack of 20 video pulses	550	655
Pack of 100 video pulses	820	980

At the same time there is possibility of parallel processing of all information, needed for coherent accumulation, which in principle allows the preservation of the same time characteristics (speed of processing of reflected signal) as and for a single pulse in pack.

Estimates of parameters of object for locate by packet pulses. The increase ratio signal/noise through the location by pack of pulses also allows to substantially improve accuracy of estimation of object parameters – speed, angular position, angular velocity, etc. It should be noted that improvement of accuracy of parameter estimate is proportional to the square root of energy of received signal, ie, of S/N ratio, and is much more pronounced than the increase in detection range. Indeed, for 5 locating pulses in pack the estimation accuracy of target parameters increased by 2.2 times, for 20 pulses - by 4.5 times, and for 100 pulses - even 10 times. Again, as in the case of detection, increase the accuracy of the estimates is associated with a significant complication of optimal receptor that require the comb of optimal filters for each parameter of signal, since otherwise fail to implement coherent pulse accumulation.

A significant increase in signal/noise ratio by means of the location of the pack of impulses also increases the efficiency of using adaptive procedures of location. Indeed, suppose when using only one pulse locating, object can be detected (signal/noise ratio is the multiple units). This is not enough for effective use of adaptive procedure - relative accuracy of the estimate of frequencies at which the spectral amplitude of the effective reflectivity of the target surface reaches a maximum, is of ten percent. At the same time use of a pack of 100 locating pulses for the same purpose provides signal/noise ratio already several hundred, which is sufficient for adaptive procedure of tuning of the locating pulse spectrum, because the relative error in determining of required frequencies of location is no more five percent.

Note that the measurement of the spectrum using a pack containing k pulses is completely equivalent

to averaging over the ensemble of realizations of k. The reduction of variances of the estimates occurs in this case also k times.

Thus, applying pack of pulses instead of a single locating pulses by monopulse location of little-noticeable objects can significantly improve characteristics of detection and assessment of target parameters. Thus, an increase in the detection range may be more than three times for 100 pulses per pack. At the same time significantly are reduced errors of estimation of the parameters of the object and is increased the efficiency of adaptive procedure of location.

2.1.1.7. THE LIMITING ACCURACY OF ESTIMATION OF PARAMETERS OF REFLECTED SIGNAL

To assess the accuracy limit parameters by monopulse location we use the inequality Cramer-Rao [11-14]. n this case, errors variance of measurements is determined by following expression:

$$\sigma_{\lambda}^2 = -\left(\frac{d^2 S(\lambda)}{d\lambda^2}\right)_{\lambda=\lambda_0},$$

where $S(\lambda) = \frac{2}{N_0}\int_0^{\tau} s(t,\lambda_0)s(t,\lambda)dt$, $s(t,\lambda)$ - signal, λ_0 - the true value of the parameter λ.

Received for error estimation the following expression:

$$\sigma_R^2 \geq c\tau\left(\frac{E}{N_0}\right)^{-1}. \quad (3)$$

Calculations according to (3) showed that when a large signal/noise ratio error of determination range may in principle be smaller than length of pulse of electromagnetic radiation in space τ.

Dispersion of determining angular coordinates, based on Cramer-Rao inequality, is as follows:

$$\sigma_{\theta}^2 \geq \theta_{1/2}\left(\frac{E}{N_0}\right)^{-1},$$

where $\theta_{1/2}$ - a characteristic directivity diagram width of the receiving antenna.

Analysis of researches results of monopulse radar method on detection of small-dimension and weak-emitting objects (such as "Stealth") on the basis of powerfull nanosecond pulses shows that there are a number of new significant advantages of powerful ultrashort pulses in a location that can be summarized as follows.

1. Use of the nanosecond short and powerful pulses provides a range of several hundred kilometers, allowing you to escort objects with low CSA on background of large stationary noises.
2. When monopulse location by powerful nanosecond pulses with Doppler modulation, the problem of blind speeds disappears completely.
3. If pulse duration ~ 5 ns and duration of interval between pulses of about 0.01s, problem of "dead time" disappears when is blocked receiver radar station and receiving of signals about the object in this case is absent.
4. So as detection of all parameters of an object by themonopulse radiolocation occurred for the one pulse, then at the pulse repetition rate of 100 Hz there is no ambiguity on range of target. Indeed during 0.01s all echo-pulses have time to reach the receiving antenna, if the maximum detection range does not exceed 1500 km.
5. High range resolution allows for identification on a single reflected pulse. Indeed all the details of an object with dimensions of the order of 1 m^2 (planes, screws) will work as independent reflectors, creating a sort of three-dimensional portrait of the object.
6. High range resolution can give information about the height of low-flying aircraft over the relatively smooth terrain on a temporary division of solitary response and diffuse echo-signal from the underlying surface.

Overall, the single-pulse radio location by powerful nanosecond pulses, is a new direction in the radar, and represents of undoubted interest for civil and military applications.

The use of nanosecond pulses provides a good range resolution and allows you to detect and track moving targets with a small effective scattering on large stationary background noise.

These findings allow to obtain and other results, which are the main goal of this paper, ie, give suggestions of possible use of the method of generation of powerful nanosecond pulses for their practical use in the creation of prospective systems forced electronic warfare on defeat RES.

2.1.1.8. MAIN PROVISIONS IN CREATION OF LARGE GENERATORS FOR FORCED SYSTEMS REW

On basis of final results and common sense of scientific assumptions in this paper is defined the forecast of following provisions for implementation of method of generating nanosecond pulses of high-power power in forced struggle on defeat RES.

1. To facilitate penetration of electromagnetic radiation into defeatable equipment is desirable to use the most short-wave radiation of the microwave range. Optimal for stations of functional damage is a millimeter range radio waves. Most suitable for use in mobile stations is Cherenkov's generator, giving in 8-mm range a power of more than 1 GW, which is more than an order of magnitude more powerful than other generators in the microwave range.
2. For radiation of microwave pulses of millimeter range appropriate to use an active phased antenna arrays (PAAR). This increases the power level and, therefore, range lesion. Herewith takes place process of addition power in the space.
3. From analysis of circuit-design solutions foster circuits modern radio-electronic means is shown that among the semiconductor elements are most exposed to the influence a point-contact diodes with Schottky barrier, herewith possible as a forced act in pass band, so and an out-band defeat of input circuits of RES.
4. It is expected that the level of coming to these elements from external sources of microwave energy pulses is largely determined by the electoral and other characteristics of the antenna-feeder devices and the input circuits (AFU and VTs). Depending on mutual arrangement on frequency axis bandwidth AFD and spectrum of microwave pulse with its center frequency the filtering properties are determined by AFD as a whole, as well as by filtering properties of input circuit of receiver.
5. Criterial levels of destruction of microwave diodes and transistors can be the following

- when irradiated by nanosecond pulses, following with a repetition rate of $F_r \leq 1000$ Hz: up to 12 W (in the frequency range up to 10 GHz), up to 100 W (in the frequency range up to 20 GHz) and 30 W (in the frequency range up to 36 GHz);
- irradiation pulse duration of 1 ms, followed with F_r = 25-50 Hz - less than 26 W (with effects on bipolar transistors in the centimeter range);
- irradiation pulse duration of 1 ns - 1 ms, followed with F_r = 4 kHz - 8-20 W (when exposed to low-noise amplifiers);
- irradiation pulses 1.5-10 ns, following with F_r = 10-100 Hz - 4-30 W (when exposed to bipolar transistors cm range).
- level criterion of destruction microwave diodes decreases with increasing length of his working wave and with the expansion of the working bandwidth of diode. Depending on the location and conditions of the placement of sensitive elements in the equipment, type of contacts with elements of the installation, the possibility of concentration and channeling of energy of external fields by elements and circuits inside the block, actual criterial level can change on order or more.

6. Can be considered not only as a new method of registration of microwave oscillations, but also as a mechanism for disabling the input elements of the RECs and the possibility of transformation of high-power nanosecond electromagnetic pulse in acoustic.

Under the guidance of Professor JM Perunov also conducted theoretical and experimental studies on creation of powerful short microwave pulses for radar detection or defeat air targets. It is concluded that the use of high-power short-pulse radar signals in REW with the radioengineering systems is very promising.

2.1.2. GENERATORS OF MICROWAVE PULSES OF MICRO- AND NANOSECOND DURATION

As a sources microwave radiation with gigawatt levels power can be considered relativistic pulse-periodic generators and complexes with lower levels of pulsed power - traditional non-relativistic electronic devices. Multi-channel radiating systems with non-relativistic devices provide a higher level of average power, control parameters of the radiation, electronic scanning by beam. However, compared to relativistic they are difficult and have large mass-size characteristics.

Currently, highest peak power achieved in generators on high-current relativistic electron

beams generated by cold cathode, which operates on principle of explosive emission.

High repetition frequencies (up to 1 kHz) at the output pulse power of more than 1 GW can be obtained on relativistic backward-wave tubes (carcinotrons) and resonant traveling-wave tubes with rectilinear electron beams and with Cherenkov's mechanism of generation. Servis life of generator is determined to a greater extent by the durability of cathode and gas-discharge tube. For the currently used graphite cathodes and for a removable dual-channel gas arrester, this is about 108 pulses. Characteristic power of carcinotron generator, working in 3-cm wavelength range, is about 1 GW, with the pulse repetition frequency up to 500 Hz.

In particular, the maximum power is extracted into the atmosphere microwave radiation reached the generator Cherenkov type (setting I-3000 microwave, VNIIEF (Sarov), the beam energy of 3 MeV) and is 3 GW in the 3 cm band with a pulse duration of about 20 ns. There is possible generation of a train of 2 pulses. A further increase in beam energy leads to a drastic reduction in duration of pulse due to the development of breakdown at the output of the electromagnetic structure and on the output window.

Increasing of power carcinotron generator can be achieved by increasing efficiency of interaction of electron beam with electrodynamic structure. By increasing coupling parameter of structure with electron beam from input to output of structure, optimal phasing of reflector, the use of an electron gun with a high compression and application of multi-channel spark gap, according to the developers of the device, will be able to increase efficiency of 20-25%, output power of up to 2 GW and repetition rate of 1 kHz.

High level of power can be obtained in generator with relativistic resonant traveling-wave tube (TWT). In resonance TWT, an electron gun, forming a tubular beam of large diameter, and collector removed from the interaction space. This determines a high power device. Feedback in the electrodynamic structure to ensure adaptive properties of generator can be accessed by using the Bragg reflectors on input and output of structure. Projected a very high efficiency of up to 30-35%. Increasing efficiency may allow to increase power up to 3 GW.

For systems operating in UHF and in long-wave part of the centimeter wavelength range, it is possible to consider applying relativistic magnetron generators. These devices have a fairly high efficiency (up to 30%), good mass-size characteristics and a phase stability.

Adaptive properties of the magnetron compared to carcinotrons listed below. Due to the pollution of the slow-wave structure in the process of operation of the device in pulse-periodic mode can happen reducing efficiency. Magnetron has large times of establishment of vibrations (5...10 ns), which limits the efficiency of formation of short nanosecond pulses.

Since geometrical dimensions of the anode block of magnetron are proportional to wavelength, it limits energetic parameters of device and its stability with decreasing wavelength. When working magnetron with a large pulse repetition frequency important task is to ensure removal of heat from the device.

Another class of super-power microwave generators are generators with a virtual cathode - vircators. They relatively simple to manufacture, capable of operating without focusing magnetic field and over a wide range to change the frequency of oscillation. In particular, exactly on the magneto-insulated vircatorwas reached the power of 22 GW (no radiation in the atmosphere) in the US in the early 90s. This record power is not available yet for generators of other types.

In Russia today reached power levels of 1 GW at a pulse duration of 10...30 ns (with output of radiation into atmosphere). Duration of radiation pulse in vircatoris determined by the speed of movement of anode plasma to cathode. Offered in VNIIEF variant of vircator with plasma anode has allowed to solve this problem. The result was generated radiation, duration of which (3μs) is determined only by energy-capacity of capacitor power source.

At the same time, due to the multimode, multi-frequency nature of field the efficiency of vircator is low, there are complexities of effective output radiation from a space of interaction and beamforming. At the present time it was not possible to achieve high stability of powerful vircators. It should also be noted that resource of work of vircators can be substantially constrained by possibilities of anode (in most cases the grid).

All this excludes the possibility of his work in the repetitively pulsed regime with high repetition rate. Apparently, vircatorshould be considered as a source of high-power microwave radiation single acting with explosive-magnetic generator.

A promising area of researches is the development of microwave generators on the lines of magnetic insulation (*MILO*). In particular, MRTI RAS (Moscow) is developing this kind of device with a power of about 1 GW, a pulse duration of 50 ns and efficiency at the 10% level. Electrodynamic structure of this generator is a coaxial waveguide with diaphragms. In such a structure, the electron beam creates its own magnetic field, able to hold it, so it does not require an external magnetic field and the fine-tuning of the device. Another important advantage of generator is large size of cathode, which provides opportunity to work with low-impedance pulse power source, that is preferable at generation of high powers.

Of foreign works in this direction should be allocated researches on radial acceletron, belonging to group of span generators, which lead in laboratory of the North American branch of Philips (USA). Acceleron has a simple coaxial design, in which the anode of the coaxial generator diode serves simultaneously as the outer conductor of the coaxial resonator. Advantages of acceletron are compact design, exception of need of focusing magnetic system and lack a partitions of foil, that are prone to erosion, what allows increase the pulse repetition rate, that is limited only by maintaining vacuum in generator. Besides, effective grouping of electrons in the radial acceletron provides it high efficiency, and coaxial design due to the small impedance allows obtaining a high output power.

According to the calculations of developers, radial acceletron can provide generation in range 1...20 GHz with an output of more than 1 GW when powering by a DC pulses with voltage of 350 kV and a duration of 200 ns. As shows simulation, acceletrons, having a radius and a length of emitting part of the cathode, respectively, 23.4 and 3.2 cm, radius of anode 27 cm and length coaxial resonator of 6.4 cm with a unoptimized design including load, generates at a frequency of 3.1 GHz, providing an output power of about 0.6 GW when powering voltage of 300 kV. Herewith, optimization of design will provide an efficiency of over 50% and reach a output power of 2 GW at a pulse repetition rate of 1 kHz in 3 cm acceletron.

Russian achievement are relativistic beam-plasma microwave generators, developed in Prokhorov IGP of RAS (Moscow), in which the electron beam interacts with a smooth waveguide filled with plasma. Herewirh radiation is broadband (spectral width - up to 4 GHz). Beam-plasma generators have the unique possibility of tuning the frequency of radiation from pulse to pulse by changing the density of the plasma, filling the waveguide. The range of frequency tuning is unprecedentedly wide and can exceed up to an octave. Disadvantages of these generators, are relatively low efficiency and the need for a strong and uniform magnetic field. Power of available today monopulse beam-plasma generators reaches hundreds of MW for a pulse duration of 300 ns.

Main directions of development of this technology in near future, are development of pulsed-periodic systems (physically possible to build such generators with a pulse repetition rate of up to 5...10 kHz) and transition to a more high-current electron beams, which can significantly raise the level of the generated microwave power with virtually no increase mass-size characteristics.

Along with relativistic generators as sources of high-power microwave radiation can be considered the traditional non-relativistic pulse generators (magnetrons and amplifying klystrons).

Advantages of magnetic generator, are compact design, maximum power density per unit weight, high efficiency, low cost. Pulse power magnetrons is about 1 MW and 10 MW at frequencies of 10 GHz and 2 GHz, respectively, pulse period-to-pulse duration ratio is about 1000, pulse duration 1...5 ms. Efficiency of powerful magnetrons is 30...50%. Magnetrons operate in aAutogenerating mode. Operating frequency of a number of magnetrons can be tuned within a small range (~ 1%). Pulsed magnetron can be considered as a master oscillator for shapers powerful short-pulse radiation by a method of active compression.

On the klystrons can get higher power levels. Klystrons can operate in enhanced mode with a gain of over 40 dB. However, mass-size characteristics of klystron worse than that of the magnetron, this is particularly noticeable for klystrons power of more than 0.5...1 MW. Klystrons, it is preferable to use as elements of a multi-channel transmission systems

phased antenna arrays (PAAR), and in systems with phase of different frequency generators.

2.1.3. GENERATORS OF ULTRASHORT ELECTROMAGNETIC PULSES

These devices usually emit short UWB pulses with maximum spectral density, lying in long-wavelength part of microwave range. In the ultrashort pulse generators energy is stored in electric or magnetic field of accumulator, then using a key is thrown into the load. Pulse duration in load is determined or by transition of key into initial state or by time, required to fully accumulator discharge. Wavefront of pulse is determined by time of key transition from one state to another. In powerful keys the times of forward and reverse transitions may differ by many orders of magnitude. In this case, minimum time defines the edge of the pulse, and maximum time - limiting frequency their recurrence.

It is currently used many different types of quick keys, the main ones are spark arrestors and semiconductor devices.

Generators using arresters are used when you want to get a extra-large powers at low pulse repetition rates. Currently, these generators have following parameters: rise time pulses up to 100 ps, pulses amplitude of 1 MV, pulse repetition rate to 1 kHz. These parameters are, apparently, close to maximum possible at current level of technology. In particular, currently, the research-production company "Era" (S.-Petersburg) develops a generator that will have power to 20 GW when generating packs of pulses of 1 s with a pulse repetition rate inside packs of up to 100 Hz. In the US, work in this direction was carried out in framework of the project "Gindenberg-3", in which generator has been created with the same parameters.

General and most significant drawback of spark arresters is the erosion of electrodes, which originates as in gas, and in oil and linearly dependent on amount of charge flowing through the gap. It is known that erosion is caused by local melting of metal in contact area of a spark channel with electrode. It is clear that to deal with it should be used as the electrodes material the refractory and well-conductive materials. Moreover, where it is possible (in first sharpened arrester, which generates front about 1 ns) necessary to increase the working surface of electrodes. This allows in spite of erosion increase the working life of the arrester is proportional to work area of electrodes, that is treated by spark discharge. Due to the large surface area of electrodes, resource of first arrester in 2...3 times exceeds resource of output arrester, and is about 10^6 pulses. Transformer oil has about same resource.

Another disadvantage of generators based on arresters are large size and weight of the instruments, as well as the complexity of their exploitation. These deficiencies have no the rapidly developing today semiconductor generators of ultrashortpulses. In particular, in the US was being developed the radiating system GEM-2, in base of which are photo switchers on the gallium arsenide, that are synchronized with a laser beam with an accuracy of 50 ps, that provides the coherent power supply for elements of phased array antenna. Device power was 1 GW, with MTBF is 10^4 positives. Easy to calculate, at a repetition rate of 100 Hz the resource of work of installation GEM-2 does not exceed two minutes.

In Ioffe Institute of Academy of Sciences (St. Petersburg) have been developed have no analogues in the world, the silicon semiconductor switches, based on the work of two effects: the effect of ultrafast recovery voltage (drift devices with a sharp recovery) and the effect of ultrafast reversible breakdown in the high-voltage transitions (devices on delayed ionization). Currently, developed an effective technology increase the voltage, by assembling devices into "stack". Herewith In the case of two-electrode devices, assembly looks to the user as one, also the two-electrode device of greater thickness.

Drift devices are the keys-Disconnect used with drives magnetic type (inductive). Energy accumulation in a magnetic field is possible at low voltage level. High voltage at load and at break only occurs for a short time pulse. As is known, resistance to breakdown of all materials is improved by reducing the time during which high voltage is applied. Thereby there is a unique opportunity to forming voltage pulses of tens of kilovolts without immersion elements in transformer oil or other insulating liquid.

Maximum peak power of semiconductor generators is hundreds of MW at a pulse repetition rate up to 100 Hz. Essential feature of this technology is virtually unlimited service life and high stability - low jitter (phase and/or frequency random

deviations of transmitted signal).

In addition, it has been possible to create powerful nano- and subnanosecond generators with a peak power of tens and hundreds of kilowatts at pulse repetition rates up to 10 MHz.

Due to extremely small jitter exists possible of "unlimited" increase of power capacity by summing the pulses of a large number generators, herewith each generator is a simple and small-sized device.

The main disadvantage of generators of ultrashort electromagnetic pulses from the practical point of view is the low value of the average radiation power. However, in Russia (RPC "Istok" Fryazino, Moscow region) there is now scientific and technical potential, allowing in the near future to begin developing a generator layout based on electrovacuum device, wherein as output of the resonator is used multi-frequency coaxial resonator, excited grouped electron flow, similar to klystron. This unit will combine high average power, durability and efficiency of traditional electrovacuum devices, as well as ultra-widebanding, characteristic for emitters of ultrashort electromagnetic pulses. Generator will emit pulses of hundreds of ps with a repetition rate of about 1 GHz. Emission spectrum will be in the range 1...8 GHz, the average power is 1 kW or more. This elaboration of RPC "Istok" currently has no analogues in the world.

2.1.4. ELECTROMAGNETIC EMITTERS WITH THE POWERING FROM EXPLOSIVE-MAGNETIC GENERATORS CURRENT

Crucial for appearance and characteristics of throw sources of microwave pulses have parameters of power supply sources. Basis of these sources, are piezoelectric and magnetocumulative (explosive-magnetic) generators. In this field Russia holds a leading position in world.

Energy conversion explosive-magnetic generator into the microwave radiation was first carried out in Russian Federal Nuclear Center - the All-Russian Research Institute of Experimental Physics (RFNC-VNIIEF, Sarov) and the Institute of Radioengineering and Electronics named after V.A. Kotel'nikov of Russian Academy of Sciences (IRE RAS), and later its effectiveness has been confirmed in experiments under the guidance of by VE Fortov and AN Didenko.

The leading role in this area, both in the country and in the world belongs to RFNC-VNIIEF and IHED of JIHT of RAS (Moscow). As part of the program to establish basic technologies was developed a series of compact explosive-magnetic generators, satisfy the requirements for throw-source microwave radiation.

In particular, by use of explosive-magnetic generator EMG-100 (VNIIEF) is formed an electric pulse with parameters of 600 kV, 30 kA, front 50 ns, sufficient for the formation of the electron beam used to generate high-power pulse of microwave radiation. When testing EMG-100 on layout of microwave generator was obtained pulse of radiation capacity of 350 MW with a duration of 50 ns. According to estimates based on model experiments in a laboratory experimental base VNIIEF with implementation of radiation level of order of 1 GW in dimensions suitable for practice, is quite possible to get radiation of 2...3 GW. When powering of Cherenkov electromagnetic structure of EMG on the diode were provided following pulse parameters: the current of 12 kA, duration of 100 ns, electrons energy of 450 keV. This led to a microwave pulse of 3-cm range with a maximum capacity of 350 MW. In this case output power was limited of the opportunities EMG. Using modern EMG, this limitation can be overcome and move closer to powers of pulses, which are limited by the electrical strength electrodynamic structures and output windows.

To some extent, these limitations can be overcome by using generators with electrodynamic systems, parallel are connected only at entrance. When working with a six-channel TWT, investigated on the electron accelerator of direct action "Ark" (Sarov), succeeded in to achieve of addition of radiations of all channels. Processes of phasing of radiation and problem of efficiency of the antennas, to be output to high-power microwave pulse in this case require further study.

With regard to foreign developments, in France being developed the throw microwave radiation source, with a capacity of about 1 GW on the basis of explosive-magnetic technology and vircator systems. On the establishment of such a source and putting it into service in the UK reported repeatedly. However, level of open works on technique of explosive-magnetic generators compels one take

these messages quite critical.

In the USA (work on orders of the Air Force) came close to the implementation EMG, of corresponding on parameters described above EMG-100. Modern state of American researches in vircators field, apparently, corresponds to Russian.

Promising areas of research in this area seems to be finding ways of creating EMG, which generate not one current pulse, but sequence of several pulses. In addition is of great interest the develop of relativistic beam-plasmic generators, which are powered from EMG (estimates show that it is quite possible). Combining these elaborations allow by undermining VMG to generate powerful pulses, whose spectrum covers the range 1...7 GHz or 5...30 GHz. This result would be very interesting from the practical point of view. Another promising direction is to create generators ultrashort pulses, which are powered by EMG

Projected potentially possible characteristics of radiation generators, developed in the framework of non-nuclear microwave systems, are presented in **Table 4.**

Among the most research priorities in the

Table 4

Predicted characteristics of EM radiation for various types of microwave systems

Microwave generator types		Characteristics					
		Pulse power	Pulse duration	Average frequency, GHz	Spectrum width, %	Frequency repetition, kHz	Divergence, rad (antenna type)
mobile	Traditional (klystron, magnetron, etc.)[1]	up to 1 GW	1...10 μs	1...10	0.1	up to 1	0.01 (PAAR[4])
	Solid[2]	up to 10 GW	units ns	0.1...10	50...100	up to 10	no data (PAAR)
	Relativistic						
	BWT, magnetrons, klystrons, etc.	1...5 GW	tens ns	1...10	1	up to 1	0.01 (reflector)
	Beam-plasma	up to 1 GW	10 ns...1 μs	1...50	100	up to 0.1	0.1 (рупорная)
	Vircators	1...5 GW	10...500 ns	1...l0	10...100	units	0.1...0.01 (reflector, horn)
	Free-Electron Lasers	up to 10 GW	tens ns	35...100	1	up to 10	0.01...0.001 (reflector)
throwing	Vircators with powering from EMG	up to 1 GW	10...500 ns	1...10	10...100	mono-pulse[3]	0.2...0.05 (horn)
	BWT, magnetrons, klystrons and others. with powering from EMG	up to 1 GW	tens ns	5...35	1	mono-pulse	0.1...0.01 (horn)
	VMG direct conversion	0.1...100 MW	10 ns...1 μs	0.1... 100	100	mono-pulse	4π
	Beam-plasma amplifiers	tens of kW	continuously	1...8	30...40	continuously	0.1...0.2 (reflector, horn)
	Solid	up to 1 GW	units ns	0.1...10	50... 100	up to 10	no data (PAAR)
stationary	Traditional (klystron, magnetron, etc.)	up to 1 GW	100 ns...5 ms	0.3...300	0.1	up to 1	0.001 (PAAR)
	Traditional with time compression	up to 10 GW	1...10 ns	1...10	0.1 ...1	up to 1	0.001 (reflector, PAAR)
	Relativistic	1...5 GW	tens ns	1...10	1	up to 1	0.001 (reflector)

[1] For a traditional generator provides the power output of entire system, rather than one generator
[2] At output of generators this class is generated video pulse which is then fed to a special antenna
[3] Perhaps formation of pulses pack duration tens ns with a pulses repetition rate in pack tens to hundreds of Hz
[4] PAAR - phased antenna arrays

development of powerful electromagnetic emitters for the next 5-10 years include:

- Development of semiconductor generators providing formation at distances up to tens of meters of ultrashort pulses of electromagnetic radiation with duration of 50 ps, with amplitude of electric field strength up to 50 kV/m and pulses duration of 100...300 ps, with amplitude of electric field strength up to 500 kV/m, with frequency repetition of 10 kHz.
- Development of generators of ultrashort pulses based on electrovacuum devices that provide average power of radiation up to several MW for a pulse duration of order of 1 ns and pulse repetition rate greater than 1 GHz.
- Creation of relativistic beam-plasmic microwave generators with pulse power of more than 1 GW, providing restructuring of the carrier frequency radiation in the range 1...10 GHz and working in pulsed-periodic mode with a pulse repetition rate to 1 kHz.
- Increasing the duration of pulses of relativistic high-powered generators to several microseconds while maintaining the pulse power at level 1 GW and realization pulse-periodic mode of operation with a pulse repetition rate to 1 kHz.
- Development of explosive magnetic generators, providing at blasting explosive the generation of a sequence of several pulses.
- Development of beam-plasmic emitters, which are powered from explosive-magnetic generators.
- Development of emitters of ultrashort electromagnetic pulses, which are powered from explosive-magnetic generators.
- Development of phased array antennas that emit pulses with a duration to 10 μs gigawatt power level.

2.1.5. MICROWAVE WEAPONS

Study of mechanisms of AME vulnerability is at stage of elaboration of possibility of using EMR and microwave radiation to destroy AME with energy levels much lower than that required for implementation of destructive mechanisms of action. Revealed the presence of various manifestations of exposure to EMR and microwave radiation on radioelectronic and electrical systems, due to the complexity of the design solution, element base, differences in purpose, a wide range of used electromagnetic frequencies, etc.

It was expected that to 2005 must be completed theoretical and experimental works on creation database of mechanisms and threshold levels of defeat of main types of arms and military equipment (AME).

Most active works on creation of microwave weapons are held in US and Russia. In recent years, studies in this area have been deployed in France, England, Germany, Israel, Japan, China and Sweden. All R&D on creation of microwave weapons are aimed at creation of models of weapons for the following tasks: disorganization combat control, intelligence and communication in strategic and tactical scales; protection of objects from precision weapons with any guidance systems; suppression of air defense systems and missile defense; decommissioning of space objects; antiminestruggle. Already during the Gulf War, in US have been tested prototypes TFR "Tomahawk" (*Block IV*) with experimental microwave warheads, and bombs *BLU-109*, *BLU-113* with microwave-combat equipment.

American studies in the field of microwave weapons are carried out in two major, interrelated areas:

- development of microwave strategic weapon (includes terrestrial microwave complex anti-space defense, nuclear microwave weapons and cruise rockets "Tomahawk" sea-based);
- creation of a complexes microwave weapons of tactical purposes.

Creation of *tactical* microwave weapons are practically all the Contracting Departments of US Ministry of Defense. Herewith for tactical microwave weapons, due to common developtechnological base (microwave generators, powerful amplifying modules and antenna systems, power supply sources, etc.) is characterized by functional convergence or unification with promising radar technology and means of electronic warfare. In particular, by development of tactical microwave weapons examines the concept of complex, generating in reduced power mode radar detection and tracking of target, and at maximum power - its functional or forced defeat. As typical goals defeat by powerful microwave radiation are considered digital special-processors of control systems ICBR, TR, OTR; system protection and cocking fighting equip rockets, electrical appliances of undermining mines

and roadside bombs, navigation receivers of system "GLONASS", radar air defense/missile defense, electronics of the homing missiles and missiles of "air-to-air" and others.

Analysis of existing and emerging types of microwave weapons, methods of combat application has allowed us to identify common perspectives of development of such systems in United States for the period up to 2017 (Table 1).

In the area of electromagnetic weapons (microwave weapons) intensively developed the following types of sources of high-power microwave radiation:

- sources on the basis of microwave generators and phased antenna arrays, summing capacities of individual microwave generators into a narrow beam of microwave radiation;
- microwave generators on relativistic electron beams;
- quasi-isotropic sources, including broadband microwave radiation on the basis of explosive-magnetic generators;
- microwave generators on the basis of special nuclear munitions ultra-low power.

Source on basis of microwave generator and phased antenna arrays is a microwave device, that summarizes power of low-power microwave generators or amplifiers, which are excited by a single master oscillator. As a master oscillator are used magnetrons and klystrons. Currently, the most developed are the questions of creation of microwave sources based on magnetrons, compression pulse shapers (based on the long-term accumulation of microwave energy in the cavity resonators and quickly eliminate it in the load) and PAAR.

Pulse generators on relativistic electron beams, are a set of compact high-current accelerator, operating in a pulsed mode, and special electrodynamic system in which electron beam energy is transformed into energy of microwave radiation.

Sources of quasiIsotropic, including and broadband microwave radiation on basis of explosive-magnetic generators, are devices of single use, based on conversion of chemical energy of condensed explosives substances into electromagnetic energy of microwave band. There are two classes of explosive-magnetic generators: with relativistic microwave sources and direct conversion (the EMG frequencies and shock-wave radiators).

Explosive-magnetic generator acts as a power source for the relativistic oscillator single action. Principle of operation is to convert current pulse generated EMG, with help of special transformers and sharpeners of voltage, in high-voltage pulse applied to vacuum diode relativistic generator (vircator, gyrotron, Cherenkov generator, etc.). At the output of such devices received a single relatively narrow-band pulses. Operating principle of explosive-magnetic generator is based on amplification of the initial magnetic field, generated by a system permanent magnets due to work, that is performed by explosion products above moving core EMG, consistently closing coils of the circuit and reducing it inductance. Part of energy is displayed in form of microwave radiation by the turns of circuit, acting as effective radiated helical antenna (for low-frequency harmonics current circuit).

Operating principle of shock-wave emitter (SWE) is based on implementation of processes of compression of magnetic field with help of shock wave in solid body (in initial state - dielectric) by powerful converging shock wave. At the front of the shock wave occurs transition of substance single crystal into state of metallic conduction and creates a mode of radiative magnetic cumulation, occurs an ultrafast relaxation of the energy stored in single crystal due to rapid change of magnetic field.

Among the sources of radiation on the basis of special ultra-low power of nuclear munitions, which are transformed by thermonuclear or nuclear reactions into sources of energy directional flow of microwave radiation, there are two classes: generators of quasi-coherent microwave pulses, which use for their generation the electrodynamic systems similar to those used in the sources on relativistic electron beams, and generators of the two-half-cyclic electromagnetic pulses of wide spectrum. In this forecast prospects for nuclear generators are not considered.

A special place among the already builted prototypes electromagnetic weapons takes "HF-bomb" (*E-bomb*). It is assumed that the "HF bomb" will be powered from EMG, piezoelectric generators or specialized nuclear munitions. Discusses options in which as the antenna system of "HF bomb" will be used special (metallized) parachute straps.

Very promising here, are studies of new features (effects) interaction of superpowerful radiation with

matter. In particular, intensively unfolding studies of the peculiarities of relativistic mode of interaction with use of petawatt lasers power. It has been proved that mutual attraction of currents produced by "fast" charged particles inside self-focusing filaments radiation causes them to merging into a single channel with significantly increased density of radiation energy.

Thus, in the creation of powerful electromagnetic generators can distinguish following main areas of researches and development:

- development of devices traditional and relativistic microwave electronics, generating pulses with a duration of ten or more periods of carrier frequency;
- development of generators of ultrashort electromagnetic pulses, duration of which does not exceed 2...3 half-cycles of oscillations;
- creating electromagnetic emitters with powering from explosive-magnetic generators current.

2.2. TOOLS OF INTENTIONAL ELECTROMAGNETIC IMPACT ON A HUMAN

On the basis of actually existing, potential and hypothetical feasibility of realisation of weapons of non-lethal action, accepted to allocate one of its possible forms - *electromagnetic weapons of non-lethal action* (EWNA).

In studies on the mechanisms of action of EMR on human body usually allocate energetic and information processes. Most fully to date, was studied energetic impact of microwave radiation of relatively high intensity.

Depending on frequency and power of radio frequency radiation on humans observed following effects: disruption of the brain and central nervous system, sense of noise, whistling, temporary incapacitation, defeat of internal organs with a certain probability lethal outcome. Modern assessment of nature of biological action of electromagnetic fields (EMF) for creation of non-lethal weapons are shown in **Fig. 2**.

Most rapidly being developed low-power electromagnetic devices for short-term suppression psycho-volitional sustainability (management of activity nervous system) humans. From viewpoint of influence on bioobjects, electromagnetic radiation such devices are characterized, mainly, several biotropic parameters. Most important ones are intensity and frequency of exposure to EMF.

Analysis shows that the mechanisms of information exposure relatively low power microwave radiation have been studied very little. In the 70 years was reported the discovery in the US so-called effect radio-earshot (radiosound). Effect supposedly was in fact that people who were in a strong field of broadcasting stations, began to hear "inner voices", music and the like. Presence of effect was due to possibility detecting of modulated carrier oscillations radio stations in internal nonlinear media of human body with subsequent conversion into signals perceived by auditory nerve. In course conducted in first half of 70s studies have identified threshold powers for effect in microwave range in pulse mode. Feeling of audible sound occurs in humans during it irradiation by pulse-modulated electromagnetic radiation microwave range. In the event that pulse repetition frequency of microwave radiation lies in the audio frequency range the perceived sound is reminiscent usually high-frequency whistle, like tinnitus, arising from a sudden change in pressure

Maximum sensitivity of brain tissue, regulation of biorhythms (6-20 Hz frequency EMF, level of 10 W/cm^2)	→		←	Resonance with biocurrents brain, dysfunction of heart muscle (300-700 Hz frequency EMF, level of 10 W/cm^2)
The heating of deep parts of the brain, the heating of the temporal lobes, hemodynamic disturbances in peripheral circulation (300-1200 MHz frequency EMF, level of 100 mW/cm^2)	→		←	Jump of conductivity biological tissue (10-100 kHz frequency EMF, level of 10 W/cm^2)
Instability of the pulse, changes in systolic blood volume, blood pressure, peripheral vascular spasm (460 MHz frequency EMF, the level of 50 mW/cm^2)	→		←	The effect of "string of pearls" - alignment of erythrocytes and leukocytes in field (EMF frequency 1-100 MHz, level of 100 W/cm^2)
Greatest impact on central nervous system; after prolonged exposure, a violation of a regular function of higher vegetative organs (10-100 GHz frequency EMF, level of 10 mW/cm^2)	→		←	Changing level of EEG (1-100 MHz frequency EMF, level of 0.1 W/cm^2)
			←	Pain threshold for cutaneous receptors (EMF frequency 20 GHz, level of 100 mW/cm^2)

Fig. 2. *Characteristics of bioeffects, caused by energetic impact to EMF on humans.*

or various diseases of the ear. Most sensitive to irradiation is parietal head region. At irradiation of occipital and temporal areas this effect is somewhat weaker. To date found that when a frequency of 3 Hz with a pulse duration of about 20 μs the energy threshold of radio-earshot is 10 $\mu J/cm^2$.

As shown by the analysis, for explain the radio sound effect most widespread became a scientific hypothesis of thermal mechanism action. According to this hypothesis, the microwave exposure is accompanied by a negligible temperature rise of brain that can lead to vibration effects, associated with tissue expansion. However, a complete physical picture is quite complex and for its explanation is necessary to study of timing synchronization of flows of nerve impulses in the ascending neural structures of auditory apparatus. It can be expected that in future is possible to create EWNA on radio-sound effect, which capable of providing as psychological treatment of small groups of soldiers (divisions of enemy, terrorist groups, etc.) and of large masses of population.

In the US, work on EWNA conducted in the framework complex target program "*Joint Non-Lethal Weapons Program*" (JNLWP). In the early 2000s on the orders of the Ministry of Defense have been carried out fundamental and applied researches on the development of application technology of pulsed electromagnetic radiation (millimeter wave) for non-lethal effects on biological objects. The developed technology called "*Active Denial Technology*" (ADT). On its basis in framework of projects of applied research and technological development of the Ministry of Defense US are working on creation of prototypes of non-lethal weapons - "Systems of active microwave-exposure" (Active Denial System - ADS)[1]. It should be noted that basic technical characteristics of new weapons such as ADS, thus far unknown.

Available data allow us to identify the following features of technology of ADT. The technology is based on the property of intolerance thermally induced pain, that is created by heating skin from directed intense EMR in 3-mm wavelength range (in different sources are given frequencies from 94 to 96 GHz). Within this range EMR penetrates into the skin tissue to a depth of 0.3 mm, where pain receptors are located. EMR parameters are chosen so that its action does not cause burns and permanent injuries, and occurring pain effects were of short duration. Possibilities of frequency-modulated signals in system ADS are unknown. However, if we assume that modulation is supported properly, then ADS can be not only a thermal weapon, but and means, which causing obscuration consciousness.

It should also be noted that to date there has been a steady growth in studies of various biologically significant effects of electromagnetic exposure on most important functional systems of the body, such as the nervous, endocrine and humoral. Predict their results over the long term is not possible because of the high secrecy works and significant differences in the experimental results. However, it can be expected that up to 2015 will be developed generators of weak EMR, are able to effectively influence the biochemical and cellular homeostasis, modify central nervous system, alter cell morphology, i.e. are able to provide to human the non-lethal effect.

In general, direction of research in field of creation of electromagnetic weapons non-lethal action can be considered as very promising (especially for fight against terrorism), but it requires solving a number of medical, biological and radiophysical problems.

3. GEOPHYSICAL DISTURBANCES IN IONOSPHERE CREATED BY NATURAL AND ARTIFICIAL WAY AS A SOURCE OF POWERFUL EXPOSURE IN NATURE

Natural magneto forming phenomena in nature are occur in near-earth of atmosphere, in its upper layers - in ionosphere and magnetosphere, so it is advisable to briefly discuss the basic characteristics of the ionosphere, ionospheric processes of formation of radiation, as well as role of Earth's magnetosphere in the near-earth processes and what are the arising herewith the managed plasmoids.

[1]In 2003, research and development on create ADS provides project №7757, program element PE 0602202F (applied research with funding of $4.6 million), №3552, program element PE 0603605F (technological developments with funding of $2.012 million). In the future plans of R&D of Ministry of Defense US (JWSTP-2002, DTO-2002) was determined that work to create a mobile version of ADS (based on vehicle HMMWW) should be completed by 2006, and at aircraft - in period of 2010 -2012 years)

3.1. PHYSICS AND ORIGIN OF MAGNETO-EMITTING NATURAL PHENOMENA IN NATURE

3.1.1. IONOSPHERIC RADIATION AND ITS MAIN CHARACTERISTICS

Ionosphere (from the ions and the Greek. spháira - ball) – ionized part of upper atmosphere; located greater than 50 km. Upper boundary of ionosphere is outer part of Earth's magnetosphere. Due to its high electric conductivity it has specific properties that determine nature of propagation in it of radio waves and various ionosphericdisturbance. Only due to ionosphere is possible such a simple and convenient form of communication over long distances, as radio communication [15].

It is known that concentration of ions and electrons in ionosphere is distributed unevenly, there are regions or layers, where it reaches a maximum. [15, 16, 17] (**Fig. 3**).

Such ionosphere layers there are several, they do not have sharply defined boundaries, their position and intensity are changed regularly throughout day, season, and 11-year solar cycle. Top layer of *F* corresponds to principal ionization maximum of ionosphere. At night, he rises to heights of 300-400 km, and during day (mainly in summer) splits into layers F_1 and F_2 with peaks at altitudes of 160-200 km and 220-320 km. At altitudes of 90-150 km is area *E*, and below 90 km area *D*. Stratification of ionosphere caused by an abrupt change on height of conditions of its formation.

Formation ionosphere. Observed in ionosphere concentration of ions and electrons is result of a balance between rate ionization and rate recombination of electrons and ions (up to their destruction), etc. Sources of ionization and recombination processes are different in various areas of ionosphere [18-20].

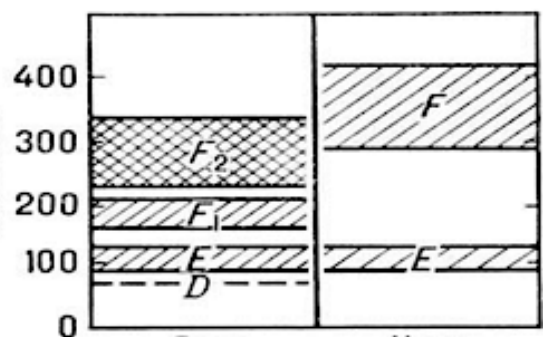

Fig. 3. *Scheme of distribution layers of the ionosphere for height (km). Left - day, right - night.*

Main source of ionization of ionosphere during the day is short-wave solar radiation with a wavelength shorter than 1038Å, but are also important corpuscular streams, galactic and solar cosmic rays and others. Each type of ionizing radiation has greatest effect on atmosphere only at certain altitudes, corresponding to its penetrating power.

Composition of ionosphere. Under influence of ionizing radiations in ionosphere there are complex physical and chemical processes, which can be divided into three types: ionization, ion-molecule reactions and the recombination corresponding to three stages of life as ions: their formation, conversions and destruction.

Changes of ionosphere. Ionosphere is continually changing. Distinguish between regular changes and indignant states. Since main source of ionization is short-wave radiation of sun, many regular changes of ionosphere are the result of changing either height of sun above horizon (diurnal, seasonal, latitudinal changes), or level of solar activity (11-year and 27-day variations).

Solar flares sharply increase ionizing radiation that causes so-called sudden *ionospheric disturbances.* Indignant states of ionosphere are often associated with *magnetic storms.* Many phenomena that occur in upper atmosphere and in Earth's magnetosphere, are closely related.

Characteristics of ionospheric layers. Regularities of parameters change of ionosphere - degree of ionization and ion composition and effective recombination coefficient are different in different areas of ionosphere. This is primarily due to a significant change on height of concentration and composition of neutral particles of upper atmosphere.

At present, *study ionosphere* continues to evolve in two directions - in terms of its impact on *propagation of radio waves* and study of *physical and chemical* processes occurring in it, which led to birth of a new science - *Aeronomy*. Modern theory helped to explain distribution of ions with altitude and effective recombination coefficient. Now next task is to build a unified global dynamic model of the ionosphere. Performance of this task requires a combination of theoretical and laboratory researches with methods of direct measurements on rockets and satellites and systematic observations of ionosphere on a network of ground stations.

3.1.2. PHYSICAL CONCEPTS OF TYPICAL CHANGES IN STRUCTURE OF MAGNETOSPHERE

Magnetosphere - the region of near-earth space from 10 to 25 Earth radii. Its boundaries and configuration are defined by solar wind, that flowing around earth - a constant stream of helium-hydrogen plasma of solar corona into interplanetary space. Processes of restructuring of the magnetosphere, local or large-scale, are significant, if not major factors of perturbed magnetosphere, that create in ionosphere *auroral radiations, auroras and magnetic substorms.* In [21] it is noted that magnetosphere is rarely quiet. Perturbations are divided into three types: permanent polar perturbations, substorm activity, magnetic storms.

Auroral radiations. Often term "auroral zone" is translated as "Northern Lights". This is due to the fact that in polar regions of Earth at high altitudes in ionosphere there are heterogeneities, that called auroral. [21-23]. This a excited ions gases united in so-called plasma ropes, stretched along the magnetic field lines of Earth. They have a length several tens of meters, and a thickness of about 10 centimeters. Causes appearance of these structures and their physical essence so far almost not been studied. During periods of solar storms a number of auroral structures, heated to degree of luminosity, increasing rapidly, and then they in the form of Aurora Borealis are visible even during day up to the equator. In [21] distinguish two areas - the auroral magnetosphere, main region habitat of auroral radiation, located within area of quasicapture (AQC), and magnetospheric tail, where streams of energetic particles appear sporadically, for a short time (**Fig. 4**).

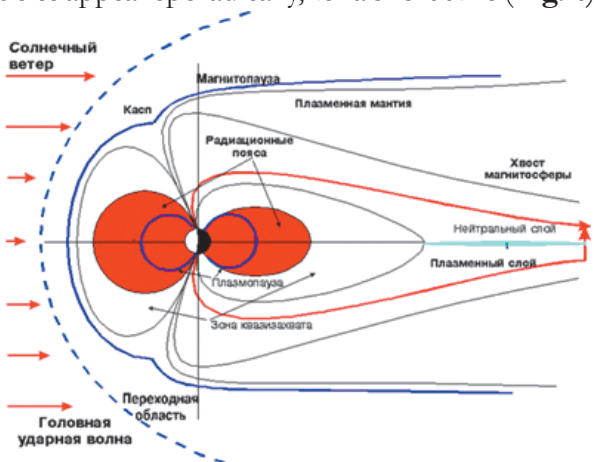

Fig. 4. *Dependence of boundaries auroral oval from level of magnetic activity: region quasicapture - auroral magnetosphere.*

AQC - unstable radiation region is located between radiation belt and tail of magnetosphere.

Auroral radiation occurs during magnetosphericsubstorms, and on different stages, phases of substorm there are several mechanisms of particle acceleration, and therefore auroral radiation should be divided into several types according to the origin, nature of temporal variations and energy spectrum.

Area in which appears and remains for some time flow of freshly accelerated particles (auroral magnetosphere), is located inside the AQC. Its instant and average statistical boundaries do not coincide with boundaries of AQC, so how determined not only by configuration of magnetic field, but also size and depth of penetration of large-scale electric field of convection and dynamics of substorm process in general.

Energy spectra of auroral protons are in range from 100 eV to 500 keV in preliminary phase of a substorm. Three energy regions, three populations of protons can distinguish here: 0.1-5 keV low energy, great variability of which indicates ionospheric origin, energetic above 50-70 keV and intermediate, units and a first tens of keV.

Thus, a common source of ionospheric and magnetic disturbances and auroral on substorm active phase is the precipitation of auroral electrons into atmosphere.

Auroras. According to accepted classification, auroras are divided into three groups: *ribbon-like, diffuse* and *rays* [24-27].

A ribbon-like forms are arcs and bands, which are characterized by a continuous lower boundary. Arcs have form of arches, which stretch from west to east with correct, usually sharply defined lower edge. Often there are a multiplet arcs at intervals of 30-40 km. If lower edge of auroral is wrong, and contains a bend or crease, form aurora called stripe. Stripe is generally more mobile than arc.

Diffuse auroral forms may be in form of spots with indistinct borders resembling clouds, illuminated by moon, and in form of veil, which is an extended homogeneous illumination and cover most of sky. The spots usually appear in the auroral zone on the last stage of development of the phenomenon.

So-called *rays* are narrow beams of light, located in the space along the magnetic field lines of the Earth, which are divided into three groups (depending on

their length): short (bright at the bottom edge and pale with height), medium (same brightness over the entire height) and long (usually uniform in brightness, but rather weak). Can also be seen bundles of rays is closely located near each other or scattered. Rays often observed in conjunction with other forms.

According to international classification, there are three types of *structures of elements auroras:* homogeneous, fibrous (grooved) and radiant. Homogeneous radiance has no internal structure of glow, with no visible rays. Fibrous structure consists of a rather chaotic strips or filaments, strips are directed substantially parallel and can have a quite regular structures of glow separated by dark intervals. The radiant structure of glow how would is woven from the masses of individual, often shimmering rays.

Magnetospheric substorms. The term substorm was introduced in 1961, C-I. Akasofu (Syun-Ichi Akasofu) to denote auroral disturbances in auroral zone lasting about an hour. Over time, term "magnetospheric substorm" combined aggregate of many processes in ionosphere and magnetosphere.

Substorms power can be estimated by the maximum value of magnetic field component (from ~100 to 1000 nT) and area space, covered by perturbation and length of substorm expansion to pole. The total potential difference is estimated at 40-100 kV. About the physical mechanism of occurrence of electric field is still there is no single universally accepted opinion.

Most widespread is idea communication electric field with vortex large-scale convection of plasma in magnetotail, so it is often called the field of convection. Convective field, intensifies and shifts to the Earth of the drift current in zone quasicapture that changes the configuration of magnetosphere, pulling lines of force into tail. The magnetic field in tail lobes increases due to the transfer of magnetic flux with day hand, and plasma layer thickness in the tail decreases. However, convective hypothesis has faced a number of difficulties.

- firstly, idea of laminar plasma flows in the tail is not confirmed by experiment, speeds of random motion on the order exceed a directional component.
- secondly, registered rapid changes of electric field are not provided by slow process of unwinding of convective vortex.

According to observations of auroras they are characterized by phases of expansion and damping.

Expansion phase can be traced from time to time according to observations of auroras that occur in north and moving south (diffuse arcs) and is most pronounced process of active phase. At the same time still remains unclear why some perturbations lead to expansion, and others - no. Perhaps a significant suppression of expansion can be caused by electric field of solar wind. If the beginning of substorm was spontaneous and the interplanetary magnetic field is negative, then expansion is suppressed and its spatial mileage limited to a few degrees. On other hand, often substorms begin when sign changes from negative to positive; wherein electric field is reduced and does not prevent expansion.

Active auroras forms may not be very bright, as in the beginning, that continue to arise and move across sky. In direction from auroral ledge to the equator develops pulsating glows, mostly in form of spots, in this way, magnetic trap is freed from excess of auroralparticles. On western flank of active aurora in area of sharp boundary of his convexity, flows powerful jet the longitudinal current, are separated populations of particles, and preparing a new intensification of substorm with expansion through jump to the west.

Phase damping. The boundary between the active phase and the phase damping rather conventional. As conventionally, and the end time of phase damping. Magnetosphere returns to relaxed structure of boundaries for 1-2 hours, if there is no new disturbance. Outer radiation belt is released from excess particles accelerated during substorms, for a long time, certain types of microbursts X-ray, evidence of dumping of particles observed one day after strong substorm.

On the discussed issues [24-27] can be made the following conclusions. Over half a century of research magnetospheric disturbances made great progress, and can even give the impression that structure, dynamics, basic processes of magnetospheric disturbances are understood and are in the process of drilling, deepening in some private questions. However, this impression is false, as is still the knowledge of dynamics and structure of electric fields is insufficient.

Electric fields are measured with great difficulties and limitations, theorists can not come to a consensus

on key issues of emergence of electric field, its penetration into magnetosphere and relationship with reconfiguration of magnetic field and the particle fluxes.

To fully clarify physical concepts of types of changes in structure of magnetosphere also is required study of many issues in solving the problem the acceleration of energetic ions. Still very rough ideas about structure and fine temporal history of auroral activations, about relationship between substorms and global magnetic storms. That's enough to make sure that study of magnetospheric disturbances is still much to come.

What is a plasmoid. Generally currently assumed two fundamental ways to impact on ionosphere - spraying it chemicals and "pumping" of selected sites by the focused beams of radio waves, "excitement" of atoms. Thus it is possible to influence the auroral streams of charged particles in vicinity of North Pole, which then are distributed along magnetic field lines of Earth over long distances, or create the local highly ionized areas of ionosphere - plasmoids (size is usually several tens of kilometers).

In principle the plasmoids are not anything special. Daily in atmosphere is registered several such natural formations arising under influence of "solar wind" and quickly absorbable. But artificial plasmoids have one distinctive feature: as long as there is "pumping", they are stable and have exogenous characteristics.

Artificial plasmoids can be used for example to improve radio communications when at certain parameters of the pump radiation they are converted into a giant mirror reflecting radio waves. But this is only one side of coin. If you change pumping parameters, you will receive a giant "jammer". If you can force "excited" atoms synchronously reset pumping energy, you get a set atomic lasers, defeating, primarily, electronic system potential enemy.

According to [15], *plasmoid* - is a *plasma* clot, limited configuration of magnetic fields and plasma. Natural plasmoid formed by interaction of *magnetic earth's field* and *solar wind* (see. Fig. 4).

At his time, Nikola Tesla received spherical plasmoids on resonant transformer using a high-voltage discharges [16-17]. Possible using of plasmoid, that generated by microwave radiation, in industry [15].

Currently literature introduces the concept of autonomous plasmoid, when plasmoid's magnetic field is maintained by own currents of plasma, and than less leakage of energy, the longer it can exist [15]. It is believed that in study of physics and natural origin magneto-emitting phenomena, study plasmoids - a possible way to obtain, for example, ball lightning in laboratory [15]. Because it is believed that formation of plasmoids occurs on model of ball lightning, according to which the plasma phase holds a thin molecular-crystallic shell consisting of electrically charged clusters "hidden" water phase [15]. And then you can get closer to a fuller comprehension of the problem being addressed in obtaining results, which explain more accurately formation of plasmoids and their management.

However, much about the shape of plasmoids was clarified already during lifetime still Tsiolkovsky, when he expressed hypothesis of existence of *life on Sun* in form of plasma, and about the plasmoid as a source of life on Earth. Was obtained experimental evidence that under certain conditions, plasmoids can multiply that illustrates their potential to be basis for life [15]. But this is not enough.

Plasmoid formation in troposphere near surface the Earth's are formed mainly over degassed structures and tectonic faults. Plasmoids sizes range from 3-5 cm up to 100 meters and more. Some of them may be recorded by camera (infrared and ultraviolet ranges of frequencies of electromagnetic waves), in rare cases can be detected even with naked eye.

To plasma formations in nature, or so-called plasmoids today accepted to attribute not only unidentified flying objects (UFOs) and ball lightning, but all that is localized in free space and illuminates some time without apparent consumption of energy [28-29].

Thus, to understand nature of plasmoids, scientists and sympathizers curious people are not limited to natural observations and descriptions of witnesses and trying to get plasmoids at least in laboratory.

3.2. GEOPHYSICAL IONOSPHERIC DISTURBANCES CAUSED BY ARTIFICIAL MEANS

Opportunity to influence the surrounding atmosphere and emergence of geophysical

disturbances by artificial means, and above all impact by electromagnetic means, began at the turn of XX-XXI centuries subject of active research. Because of direct communication of results such research with conditions of life on Earth, they have also been widely discussed in media, especially in electronic - online [see. eg., 30-42], at main resource of information infrastructure of society.

For a complete understanding of these effects we stop on natural effects and their implications for other active influences on various geospheres.

3.2.1. NATURAL PHENOMENA AS A RESULT OF THE ACTIVE IMPACT ON VARIOUS GEOSPHERE

An important problem is evaluation of criteria of impacts on one or another geosphere which may lead to planned effect. Indicative list of geophysical effects and consequences of impacts on various geosphere, compiled on basis of very limited material, as well as on basis of general physical considerations, is presented in **Table 5.** Here are the possible methods and means of influence. Obvious approach to assessment of such criteria is to compare, for begin, of total energy of any natural process with the active impact energy.

It is quite clear that with few exceptions (nuclear explosions, asteroid-meteor weapon), energetics of any active effects is incomparably small compared with the energetics of their geophysical implications.

There would be appropriate to give some examples of Internet materials of natural catastrophic events that are still not entirely clear on, but the alleged reasons occurred in recent decades in the world.

Table 5

List of effects and consequences of active impacts on different geosphere

	Geospheres	Methods and means of impact	Effects and consequences
1	Lithosphere, including crust and soil	- underground and underwater nuclear explosions or explosions of chemical explosives; - explosions on offshore or in coastal waters; - seismic vibrators or vibrators in underground mines or wells filled with water; - artificial change of trajectories of falling asteroids and meteors	- initiation of earthquakes; - possible increase volcanic eruptions and occurrence of effects of tsunami; - changing chemical and physical composition of soil, including radioactive and chemical contaminations
2	Hydrosphere (oceans, seas)	- the discharge into atmospheric near-ground layers, different chemically active substances or dust components that affect solar radiation; - creation of the regional greenhouse effect that could lead to formation of atmospheric phenomena, such as those arising in development of process of El-niño; - artificial change of trajectory of falling asteroids and meteors	- destruction of plankton and other species living organisms; - development of typhoons, hurricanes and storms; - occurrence of tsunami waves and storm surge; - changing weather and possible short-term climate changes
3	Atmospheric near-earth laye	- the discharge into atmosphere of various chemical active and aerosol (dust) components; - impact of electromagnetic microwave radiation and heat flux	- increase in rainfall, causing to floods; - accelerating melting of snows and glaciers; decrease in precipitation leading to droughts; - occurrence of devastating hurricanes at different latitudes; - changing transparency of atmosphere and, as a consequence, the weather at local or regional scales
4	Ozonosphere	- the discharge into ozonosphere different chemical substances; - creating at altitudes of ozonosphere artificial forms affecting the distribution of solar radiation; - exposure to UV and microwave radiation	- creation of new and expansion of existing ozone holes and a corresponding increase in intensity of hard ultraviolet radiation incident upon earth; - growth of ozone concentration; changes of radiation balance of atmosphere
5	Ionosphere	- injection of various chemicals (gaseous, dispersed); - injection of electrons, ions; impact of powerful VLF, HF and microwave radiations and UV radiation sources; - explosions of chemical explosives	- changes in ion and neutral composition of medium with subsequent significant impact on functioning of various radio engineering and optical means; - initiating precipitation of charged particles from different layers of ionosphere; - variations of magnetic and electric fields of Earth of local and another scale; - emergence of artificial lightnings
6	Magnetosphere and near-earth space	- injection of electrons and plasma; - impact of powerful VLF radiation; - discharge of finely dispersed matter (like “pins and needles”); - explosions of chemical explosives	- change of Earth's magnetic field; - change of electric field of near-ground layers of atmosphere; - appearance artificial or changing of parameters natural radiation belts of Earth; - possibility of increasing "space debris"

Shortly after the end of World War II in United States began to conduct research on the study of processes in atmosphere under influence of external factors: "*Skyfire*" (formation of lightnings), "*Prime Argus*" (call earthquakes), "*Stormfury*" (management of hurricanes and tsunamis). About results of these works nothing and nowhere was not reported. However, it is known that in 1961 in USA was conducted experiment on an throwing into upper atmosphere more 350 thousand two-centimetric copper needles, which dramatically changed a heat balance of atmosphere. As a result there was an earthquake in Alaska, and part of Chile coast collapsed into Pacific ocean.

"*Spinach" against guerrillas* [31]. During Vietnam War (1965-73) the US used dissipation of silver iodide in the rain clouds. Operation took place under the code name "Project Spinach» (*Project Popeye*). In five years were spent 12 million. pounds on "seeding" of clouds for artificial stimulation of heavy rains to destroy crops of enemy. Was washed out and the so-called Ho Chi Minh Trail - supply route of south-vietnamese guerrillas arms and ammunition. During operation "Spinach" rainfall in affected area increased by a third: climatic weapon successfully worked!

Very strange tsunami. In early 2003, the Americans openly announced trials of some "beam gun" in Alaska [32], that generates a control plasmoid. From specified source is provided image (**Fig. 5**): a huge wave, formed by using managed plasmoid could collapse at any coastal area, causing extensive damage.

In press via Internet (topics: tsunamis, climate weapons, nature, disasters, catastrophes) for 2007 noted: "It's been more than two years after hitting giant waves on coast of Indonesia, Thailand, Somalia, Sri Lanka and Sumatra (December 2004). It is assumed that test secret geophysical weapons in Alaska caused a tsunami that killed more than 400 thousand people in Indonesia, over the Tennessee tornado swept", consequences - **Fig. 6** [33].

Fig. 5. *Type of wave formations, caused by means* of plasmoid.

Mysterious weather phenomena in Russia. In our country, frequency of mysterious natural phenomena over the last 15 years has doubled. Even in Siberia came hurricane-force winds, tropical storms and tornadoes - phenomena that previously been considered absolutely impossible in our climate, not to mention winter thaws and frosts in July. Such extraordinary natural examples include following:

- May 29, 2002 in Kemerovo region tornado destroyed village Kalinovka. Two people were killed and 20 were wounded. Prior to that, such natural phenomena in Novosibirsk or Kemerovo regions was not observed.
- Huge, with pigeon's egg, hail fell in 2006 in village Gagino in Nizhny Novgorod region. 400 houses completely lost their roofs.

And in general - only in June 2006, Russia has flown 13 tornadoes and hurricanes. They walked the Azov, Chelyabinsk, Nizhny Novgorod (touched 68 settlements of region), then moved to Bashkiria and Dagestan. Destructions was enormous.

Let us state a hypothesis: it is possible that today's heat in the central regions of Russia is also the result of action of such weapons.

With actions radar, with powerful electromagnetic radiations is associated series of man-made disasters and strange weather phenomena observed in recent years in Europe, Asia and America. Project of impacts on ionosphere has been operating since 1960, when the United States exploded a nuclear bomb in the ionosphere. Then it became apparent that the ionosphere reacts to such effects: violations radio communication after explosion were recorded for almost a month. Since that time, have been held electromagnetic broadcasts of varying intensity and related experiments in the US (Colorado), Puerto Rico (Arecibo) and in Australia (Armidale). At about this same time on planet began to frequent disasters and climate changes. Now there is a possible explanation

Fig. 6. *Blow of giant waves on coast of Indonesia (left), right side - consequences of a tornado, swept over Tennessee (April, 2006).*

for why weather has become less predictable.

In 2002, the first deputy commander of the Russian Space Forces, General Vladimir Popovkin, [41] in his letter to DG pointed out that "at inaccurate reference to upper layer of atmosphere can be catastrophic consequences planetary character". He was supported by an expert on active influences in the atmosphere of Federal Service for Hydrometeorology and Environmental Monitoring Valery Stasenko: "Disturbances in the ionosphere and magnetosphere affect the climate. Acting on them artificially with the help of powerful settings, you can change weather, including globally".

3.2.2. INTENTIONAL METHODS AND MEANS OF ENVIRONMENTAL IMPACT

To date, the US formed a powerful set of research and development devoted to study and practical application of new propagation effects and interaction of electromagnetic radiation in radio frequency range with artificial (or natural) ionosphericirregularities. Main part of planned basic and applied researches U.S. Department of defense associated with results of realization of program *HAARP* (*High Frequency Active Auroral Research Program*), a program of high-frequency active auroral researches, initiated in 1990 in research laboratories of Air Force, Navy and of largest universities in the US. Under this program deployed a construction of research station *Gakona* (pcs. Alaska) with a powerful radio transmitting equipment and the latest set of measuring equipment. This project is closely "linked" with researches, carried out under program *HIPAS* (Research Station *Fairbanks,* pcs. Alaska).

In 2002, construction of transmitting station *Gakona* (program *HAARP*) has been completed, and its technical capabilities currently have no counterparts. Huge opportunities radiative energy equipment will allow to carry out unique experimental researches for the benefit of a comprehensive study of radio-physical properties of ionosphere, working out the mechanisms of exposure on it and arising in this study various secondary effects.

Radar complex (RLC) *HAARP* is located 320 km north-east of Anchorage (latitude 62°23'N, longitude 145°8'W). Generation of low frequency signals - is today the main objective of program *HAARP*. In 1995, this object consists of 48 antennas and transmitters capacity 960 kW. At present, company BAE Systems was able to significantly improve performance characteristics of system: object has 180 antennas, height each 24 meters, total power of 360 ionospheric radio-emitters reached 3.6 MW [41]. Whole structure occupies 15 hectares of land at the foot of the mountains (**Fig. 7**). At its creation took almost 20 years and $250 million [30-40]. The complex deployment and research on it is engaged in "Phillips Laboratory", located on US Air Force base in Kertlend, New Mexico. It includes laboratories astrophysics, geophysics and means of destruction Space Technology Centre of Air Force US.

Officially complex ionospheric research *HAARP* is built to study the nature of ionosphere and development of systems air defense and missile defense. *HAARP* is supposed to use to detect submarines and underground tomography of bowels the planet. However many researchers argue that, in fact, a monster in Alaska intended for the impact on local and global mechanisms of nature in the vicinity of US adversaries. After all, today, using *HAARP* equipment, it is possible to form plasmoids and purposefully move them almost anywhere in Northern hemisphere. For Russia this means almost complete covering from east to west, from Kaliningrad to Kamchatka, and from north to south about to forty-fifth parallel. That is up to the

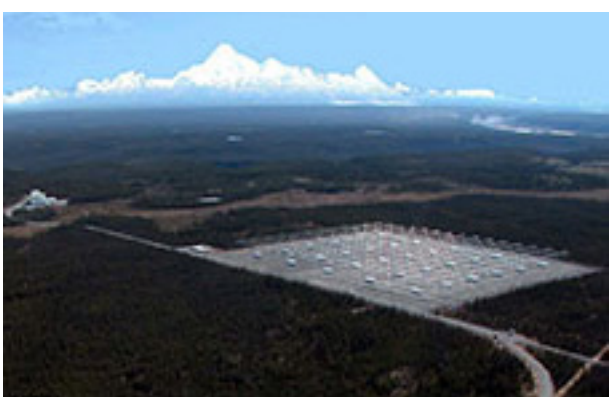

Fig. 7. *The radar system HAARP.*

level of Krasnodar and Stavropol.

If Americans build *HAARP* type setting and in Southern Hemisphere, it will cover all countries located to south of equator. *HAARP* is not so harmless project, as Americans are trying to present. Result of these risky experiments can be global cooling, destruction of ozone layer of Earth's atmosphere and the unpredictable climate changes on entire continents.

3.3. SYSTEMS (WEAPONS) ON NEW GEOPHYSICAL PRINCIPLES

Content of term "geophysical weapon" is not precisely defined. However it is implied that the object of impact of these weapons is the surrounding natural (geophysical) environment - lithosphere, hydrosphere, near-surface layers of atmosphere, ozonosphere, ionosphere, magnetosphere, near-Earth space, which are united by a common concept - geosphere.

At the present stage problem of creation and use of geophysical weapons seriously emerged in late 70's - early 80-ies of last century. Since 1987, USSR launched an extensive theoretical and experimental studies on behavior of various geophysical media (solid ground, ground-level atmosphere, ozonosphere, ionosphere, magnetosphere, near-Earth space) under a wide variety of active influences on them. So, in the one of topics are developed methods of remote influence on the earthquake weak seismic vibrations, which are known to occur by underground explosions of a nuclear or conventional chemical explosives even a relatively small capacity. This line of research in future is called "tectonic weapon". But after collapse of USSR it was abandoned. Final results were not compiled and decorated in any specific recommendations. We emphasize that the same works intensively conducted in the US.

Basic principles of weapons based on new geophysical principles. For weapons on geophysical principles or as called in [15] - hypothetical weapon, the object of influence is natural (geophysical) environment. Proof of the existence of such weapons at present in principle nonexistent.

Idea of geophysical weapons is to create a mechanism of artificially induce and targeting on certain regions, of natural phenomena leading to considerable destructions and casualties. Among such natural phenomena, above all, are called as the following:

- arthquakes, tectonic faults, volcanic eruptions and caused by them secondary disasters, such as tsunamis;
- atmospheric disasters (tornadoes, typhoons, tornadoes, heavy rains), as well as the general state of climate on certain territory (droughts, frosts, erosion);
- destruction of ozone layer over separate territories for purpose of "burning" and exposure of natural radiation of Sun;
- impacts on water resources (floods, tsunamis, storms, mudslides).

It is believed that possibility of covert use of geophysical weapons is small, since a number of countries, including the US, Russia, Germany, France, Britain and Japan have a variety of environmental monitoring system [15-17].

However, under geophysical weapon is understood a weapon that is striking when used in military applications of natural phenomena and processes induced by artificial means. Depending on the environment in which these processes occur, this weapon is divided into *atmospheric, lithospheric, hydrospheric, biospheric and ozonic* weapon. The means by which stimulated geophysical factors may be different, but energy expended at these funds is always much less than energy released as a result of forces of nature caused by geophysical processes.

Atmospheric (weather) weapons - the most studied to date a view of geophysical weapons. Its affecting factors are various kinds of atmospheric processes and their associated weather and climate conditions, which may affect life both in individual regions and entire planet. Today found that many active agents, such as silver iodide, solid carbon dioxide and other substances being scattered in clouds can cause heavy rains over large areas. On the other hand, reagents such as propane, carbon dioxide, lead iodide, provide fog dispersal. The spraying of these substances can be carried out using ground-based generators and on-board devices installed on aircraft and missiles.

In areas where the moisture content of the air is large, this method can cause torrential rains and thereby change water regime of rivers, lakes, marshes, significantly degrade trafficability of roads and terrain, and in low-lying areas to cause floods. On the other hand, if you provide an artificial rainfall at

the approaches to areas with large moisture deficit, can achieve a significant removal of this water from atmosphere and cause dryness in these areas.

Lithospheric weapons based on energy use of lithosphere, ie the outer sphere of "solid" earth, including crust and upper mantle. Here a striking effect provide such catastrophic events as earthquakes, eruption of volcanoes, movement of geological formations. In this case source the energy is the tension in seismically hazardous areas.

Experiments have shown that in some earthquake-prone areas of Earth by ground or underground nuclear explosions relatively low power can initiate earthquakes, which can lead to catastrophic consequences.

Hydrospheric weapons based on use for military purposes of energy of hydrosphere. Hydrosphere is intermittent water shell of the Earth, located between atmosphere and solid earth crust (lithosphere). It represents the totality of the oceans, seas and surface waters. Energy use hydrosphere for military purposes possible when impact on water resources (oceans, seas, rivers, lakes) and the hydro facilities, not only by nuclear explosions, but also large charge of conventional explosives. Factors of defeat of this weapons will be strong waves and flooding.

Biospheric weapons (environmental) based on catastrophic changes in biosphere. Biosphere covers part of the atmosphere, hydrosphere and the upper part of the lithosphere, which are interconnected complex biogeochemical cycles of migration of matter and energy. Currently, there are chemical and biological means, the use of which in large areas can destroy the vegetation cover, fertile surface layer of soil, food stocks, etc.

Artificially induced soil erosion, perdition of vegetation, irreparable damage to flora and fauna due to the use of various kinds of chemicals, incendiary weapons could lead to catastrophic changes in the biosphere and, consequently, the mass destruction of people.

Ozonic weapons is based on use of energy of ultraviolet radiation emitted by sun. Ozone shielding layer extends at a height of 10 to 50 km with a maximum concentration at a height of 20-25 km and a sharp decrease of the up and down. Under normal conditions surface of Earth reaches a small part of ultraviolet radiation with $\lambda = 0.01\text{-}0.2$ microns. Its main portion, passing through atmosphere is absorbed by ozone, air molecules and scattered by dust particles. Ozone - one of the strongest oxidants, kills microorganisms, toxic. Its destruction is accelerated in the presence of a number of gaseous impurities, in particular bromine, chlorine, fluorine and their compounds that can be delivered in ozone layer with missiles, aircraft and other vehicles.

Partial destruction of ozone layer over enemy territory, an artificial creation of the time "windows" in the protective ozone layer can lead to the defeat of the population, flora and fauna in planned area of globe due to the effect of large doses of UV radiation and other radiations of cosmic origin.

Despite the signing of majority of countries - UN members the Convention, 1978 "On the Prohibition of Military and any Other Hostile Use of Environmental Modification Techniques" and availability of possibility of leading industrialized nations to implement global monitoring of physical parameters of environment, a number of major corporations and firms from industrialized countries (primarily the US, Japan and the UK) in recent years have greatly expanded topics of researches on active modification of the human environment, as well as on processes that can have a significant impact on providing space systems (intelligence, communications, navigation) [36].

Thus, analysis of carried out in recent years research in the field of geophysical environmental impact indicates the probability of occurrence in the XXI century of fundamentally new approaches to technology of creation of certain types of geophysical weapons.

3.3.1. PROGRAM «HAARP» - WAY TO CREATION OF PLASMA WEAPONS

Essence of military technology is the following: above the ozone layer lies ionosphere - gas layer enriched with electric particles (ions). When this layer heats concentrated beam of high-frequency radio waves by powerful *HAARP* antennas, are created an artificial ion clouds in form similar to optical lenses. These lenses can be used to reflect low-frequency waves and for producing energetic "death rays", focusable in a given geographic location.

In the US, one of the key elements of project to create a global missile defense was the development of *plasma weapons* - one of varieties of geophysical weapons. Its action is to focus in the ionosphere

with high-energy microwave electromagnetic pulse, resulting in a plasmoid is born - a localized area of highly ionized gas, or a ball lightning. Plasmoid heats the gas of the ionosphere and are formed an artificial magnetic storms. These storms have a catastrophic impact on navigation systems, weather and mental state of people. Plasmoid moves in atmosphere and leaves a trail of heated air with reduced pressure. This trail is an insurmountable obstacle for aircraft. They get into this trail as in mouth of a tornado and are destroyed.

New mobile "plasma gun *MIRAGE*», openly now being developed in the US, will disable communication and navigation systems enemy within a radius of tens of kilometers. Device is able to change state of the ionosphere - upper layer of Earth's atmosphere, which is used as a "mirror" to transmit radio signals over long distances. Plasmoid generated in a special microwave oven, will injected by a rocket to a height of 60-100 km and will disrupt natural distribution of charged particles. According to military experts, this way you can get rid promptly from the several problems:

- firstly, the "excessive" plasma will create a barrier to enemy radar, which under normal conditions due to ionosphere can see aircraft below the horizon;
- secondly, "plasma shield" will prevent contact with satellites, whose signal passes through atmosphere.

It will create problems with orientation on ground, if for it has used GPS-receivers. Design represents a small van that easily can deliver you to the hostilities place.

Inability to control by the other countries over the use of plasma weapons, makes it dangerous not only for the country, which directly receives the impact, but also for the whole world. US presents the project *HAARP* as a research, yet it is realized mainly in the interest of the Air and naval forces of the USA. As noted in the media, experts in the field of missile defense believe that it is the *HAARP* program eventually "will grow into a key component of global US missile defense."

3.3.2. POSSIBLE APPLICATIONS OF GEOPHYSICAL SYSTEMS AS A WEAPON

On the Internet, are discussed various areas of possible military applications of *HAARP*, the most important of which are following (here we do not consider the most exotic) [36]:

- communications with submarines at low frequencies;
- a system of early warning of missile and air attack;
- exposure on electronic equipment, in particular - on communication and navigation systems of ships, spacecraft, aircraft, missiles and ground-based electronic warfare of enemy;
- geophysical weapons - you can control and change weather over territory of other country or geographic region;
- weapons for organization of large-scale accidents in electricity networks, at nuclear power plants, oil and gas pipelines;
- anti-missile and anti-air (aerospace) defense - controlled plasmoid can deform high-speed flow front of the aircraft or ballistic missile warheads, leading to a deviation of their trajectory from calculated and even to destruction of structure;
- impact on mental and physical condition of people;
- promotion of earthquakes or tsunamis.

About military capabilities of *HAARP* system, of course, created a lot of myths. In particular that it can cause destruction of ground infrastructure, including pipelines and power lines over large areas, and also destroy aircraft on airfields and missiles in mines.

Russian experts believe that with help of directional antennas such as of *HAARP*, is quite possible such "discharge" of energy of plasmoids and ionospheric currents that occur in the polar regions, which can cause serious effects "combat" application. Thus, they argue that very real the following "combat" effects:

- complete failure of electronics and control systems aircraft and cruise missiles;
- blocking or complete failure the electronic systems of ballistic missiles in the boost (before stages separation of motors) and ballistic (secession MIRV) parts of the trajectory. In particular, when rockets are launched through circumpolar region, as well as with the submarines in the waters of Arctic Ocean.

However here again it should be recalled that we are talking about impacts in polar zone. Only where there are very high density of auroral currents and

the energy of ionospheric plasma formations, are fully realizable above-described "military" effects. And exactly in the polar zone pass, according to doctrines of Russian strategic nuclear forces (SNF), main ballistic trajectories of our missiles aimed at the US. And they pass in ionosphere at altitudes of up to 400-600 km, where you can "unload" accumulated energy of plasma formations and ionospheric currents. Here pass basic combat courses of our strategic bombers with cruise missiles aimed at the US. From here it are assumed the launches (including "subglacial" starts) missiles with russian nuclear submarines.

And it is in this area:

- there are ("hanging"), american satellites of system of early warning (AWS) of missile attack;
- here there is also placed the most powerful ground-based radar stations NATO united in "their" AWS, - in the UK, Norway, Greenland, Alaska, in the Aleutian Islands;
- here there are also the antenna fields of first active system *HAARP* in Alaska under Anchorage, as well as of second, hastily expanding similar system - Tromso in Norway.

However military applications of these effects - no simple matter. And if polar area as a result will be virtually impervious to russian strategic bombers and missiles, what trajectories they have to fly to US? Of course, bypassing polar zone. That is, then you have to run them from "inconvenient" regions and through "uncomfortable ", including more longer, ballistic trajectories.

Then they will have to fly, primarily across north Pacific, where they will intercepting missile defense and air defense ships USA, in Alaska, as well as at anti-missile base, that being constructed in California.

And they will have to fly through Europe where they will be intercepted by missiles-interceptors in Poland and other countries, including Scandinavia (which by that time will be not 10, but 50 or more), as well as missiles-interceptors from ships in North Atlantic and bases in the Northeast US.

It is believed that all of this can very greatly complicate Russia's strategic nuclear forces the solution to the problem of effective response, or especially retaliatory strike against targets in the US.

And as we still need in this situation to relate to such "trifles" as creation at our borders, in the Czech Republic and Poland (and then, apparently, everywhere), the missile defense system? And what do we do if at the first stage this European missile defense would be "small", designed primarily to intercept cruise missiles and their carriers, and then - why not? - "supplemented" by the echelon of intercept of strategic missiles at a high ballistic part of trajectory?

After analyzing statistics for last decade [40-45], it is possible to find conclusive evidences of appearance of a terrible weapon, which no one can suppose that could happen to the planet if inclusion of this giant "beam gun" will at full capacity. According to experts, the power of this weapon is a thousand times more powerful than atomic bomb. Directing the beam of this "beam gun," for example, in England, it can be destroyed in a matter of seconds. Possible destroy whole ionosphere.

Below is given an example of successful researches in field of secondary radiation of ionosphere, that conducted a team of scientists of Institute Geospheres dynamics of Russian Academy of Sciences, using special heating stands.

3.4. RADIO MONITORING OF RADIATION OF THE HEATING STANDS AND SECONDARY RADIATION OF THE IONOSPHERE

Heating stands are a new technology of active effects on the ionosphere, by which is manifested complex variety of effects. Therefore, study of these effects require use of a broad class of both existing and specially designed measuring methods [43-46].

The aim of this work is to carry out theoretical estimates of conditions and characteristics of radio monitoring system to detect and analyze signals radiation of heating stands and secondary radiation excited ionosphere.

Were installed approximate values of power levels of signals at input of receiving equipment of radio monitoring systems. Shown the possibility of receiving weak signals of radiation at large distances before the heating stands.

In **Fig. 8** is a diagram [45] of possible determination the coordinate of distance before the radiation source as a function of elevation angle of wave arrival by the jumps of ionosphere-earth propagation for cases of secondary radiation of ionosphere at the point A_1 (Scheme 1) and stand at point A (Scheme 2).

As can be seen from Fig. 8, by direction finding a source of secondary radiation of the ionosphere (point A_1) possible to determine the distance to direction finder radio monitoring system (point *C*), including in conditions of jumps signals the earth-ionosphere. Value of distance is determined by formula:

$$L_2=(2N-1)R\left[\arccos\left(\frac{R\cos\beta_2}{R+H}\right)-\beta_2\right], \quad (4)$$

where β_2 - elevation pelenguemogo signal of secondary radiation of the ionosphere; L_2 - distance on the Earth's surface between the transmitting and receiving systems; *R* - radius of the Earth; *N* - number of jumps in the propagation path of radio signals; *H* - height *F* layer over the surface of the Earth.

Analogously, when determining the elevation angle of direction finding radiation of the stand or any other ground source in conditions of multiple reflections signals from the ionosphere is possible to determine the distances from the stand (point *A*) before the receiving device of monitoring system (point *B*), including when multi-jumps modes of radio propagation. Value of distance from the stand up to direction finder is defined as:

$$L_1=\left[\arccos\left(\frac{R\cos\beta_1}{R+H}\right)-\beta_1\right], \quad (5)$$

where β_1 - is the angle of elevation of direction finding signal of radiation stand.

One of parameters identification of radiations of the heating stand, when known distances between the stand (point *A*) and receiving devices monitoring system (point *B*), is tracking angle of arrival of signals radiation of stands β_1, whose value is determined by formula:

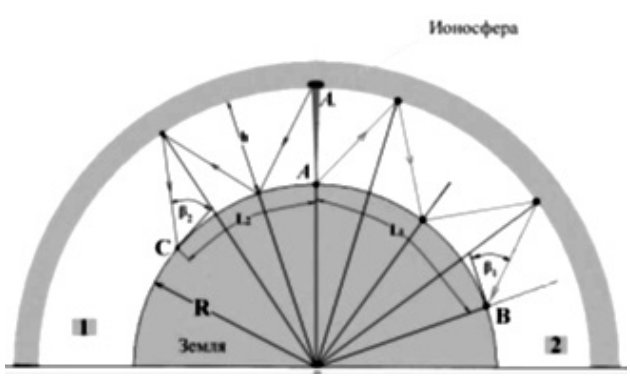

Fig. 8. *Scheme of receiving by terrestrial finders of signals of stand and the secondary radiation ionosphere in conditions jumps propagation.*

$$\beta_1=arctg\left[ctg\frac{L_1}{2NR}-\frac{R}{(R+H)\sin\frac{L_1}{2NR}}\right], \quad (6)$$

Possibility of receiving signals of heating stands by radio monitoring instruments is determined by the characteristics of the radiation patterns of these antennas stands - by level and by angular distribution of side lobes.

In **Fig. 9** for antenna pattern stand *HAARP,* which is the result of calculating the synthesis of 180-element phased array antenna with active A_{eff} = 128,000 m^2, are graphs of distance dependence of possible detection of signals of the stand from the height of *F*-layer of ionosphere.

Presented dependences allow to reliably determine the range to placement heating facilities subject to a determination of radio monitoring systems receiving equipment arrival angles β_1 radiation source.

Power level of signals at input of the receiving equipment of radio-monitoring systems defined as:

$$P_{in}=\frac{PG'KK_F^nK_Z^m\gamma}{4\pi D^2}, \quad (7)$$

where where *P* - is integral power of transmitting modules of heating stands, *G*'- gain of sidelobe radiation of phased antenna arrays in a direction of radio monitoring system, *K* - integral coefficient of radiosignal propagation losses on track is an average in HF range 0.9 at 1000 km; K_F^n - loss factor of radio wave by reflection from *F*-layer of the ionosphere; *n* - number of radio wave reflections from *F*-layer of ionosphere on track of heating stand-reception apparatus; K_Z^m - loss ratio of radio wave by

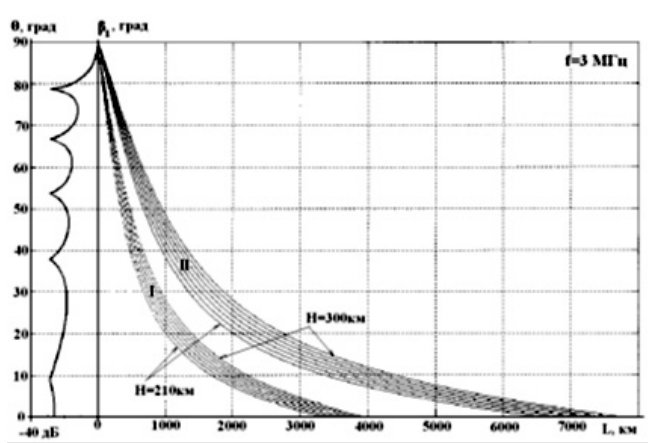

Fig. 9. *Graph of distance of detection of signals HAARP against the radiation at a frequency of 3MHz (I - one-fold reflection, II - two-fold reflection).*

reflection from surface of the Earth, whose average value in HF range of wavelengths at grazing angles 5...30 degrees is 0.95; m - number of reflections from surface of Earth in propagation track; D - total distance of propagation of signals radiation; γ - losses coefficient of mismatch the polarization of signals of radiation of stands and antenna characteristics of the receiving equipment.

Assessments of estimated the average values of losses coefficients, calculated using the model of the ionosphere *IRI*, equal at reflection from ionosphere in summer day 0.01 and winter night 0.1. Power level at location of the receiving equipment of radio monitoring system will be equal in summer day $5 \cdot 10^{-11}$ W/m^2 (electric field strength 7μV/m, magnetic field strength 2.1pT) and in winter night $5 \cdot 10^{-10}$ W/m^2 (electric field strength 22 V/m, magnetic field strength 6.6 pT) for values of coefficient of polarization losses of 0.5 and distance of passing radio waves about 4000 km (Fig. 9). It is provided with a single signal reflection from the ionosphere in conditions a detection of radiation of stand *HAARP,* having integral power of 360 MW and the side-lobe level minus 0.1 relative to main lobe.

Most important task of effectiveness of monitoring the signals radiation of heating stands in conditions a large number of interfering signals of radiation of radio stations, are a criteria the identification the signals of these radiations, which determined:

- by stable and high-precision information about the locations of the heating stands;
- in most cases by difference between the radiation signals of stands from signals of radio stations in spectral characteristics;
- by high correlation the signals radiations of stands and secondary emission signals in excited ionosphere.

Application of these criteria identification and adaptation to radiosignal situation in the location of the receiving equipment of the monitoring system, are implemented by the excluding analysis of previously detected signals interfering radio stations. These provides in real time with a high probability, the detection and analysis of signals radiation from heating stands [19-20].

Heating stand generates harmonics of secondary radiation of ionosphere of carrier frequency of stand to level 53...57 values, i.e. almost up to 180 MHz, and also radiation at the modulation frequencies from a few Hertz to kiloHertz.

Height of secondary radiation of the ionosphere depending on frequency radiation of stand is approximately 90...300 km. As shown in Fig. 8 this source conditionally, can be at point A_1. Track of signals propagation of secondary radiation of ionosphere will be different from track of stand signals propagation.Because reflection comes from earth's surface, and then from ionosphere, etc. This effect of radiosignals propagation can be applicable for HF band of wavelengths.

In low-frequency ranges, and particularly in units of hertz, radio waves propagate in a natural ionosphere-Earth waveguide. This determines necessity to incorporate these features when creating radio monitoring equipment of secondary radiation excited ionosphere.

Tracking angle of signals β_2 secondary radiation of ionosphere for HF range of wavelengths in the location of receiving equipment of radio monitoring system (point C in Fig. 8) is defined by:

$$\beta_2 = arctg\left[ctg\frac{L_2}{(2N-1)R} - \frac{R}{(R+H)\sin\frac{L_2}{(2N-1)R}}\right], \quad (8)$$

Fig. 10 shows calculated dependences of tracking angles of secondary radiation of ionosphere for different conditions of the propagation track

In general, power level at input of receiving equipment monitoring system of signals secondary radiation ionosphere is defined as:

$$P_{in} = \frac{PGKK_F^n K_Z^m K_t \gamma}{4\pi D^2}, \quad (9)$$

where G - gain of main lobe of the heating stand PAA, K_t - loss rate of transformation of power of radiation heating stand into signal power of secondary radiation of ionosphere, value of which depends on state of ionosphere and characteristics of heating stand radiation, is 0.001-0.1%.

Values of power signals of secondary radiation, calculated by formula (9) at input receivers of radiomonitoring system at distances of 4000 km and at minimal value of transformation coefficient 0.001% in HF range of wavelengths for summer time day, will be approximately $5.8 \cdot 10^{-14}$ W/m^2 (electric field strength of 0.24 μV/m, magnetic field strength 0.07 pT) and in winter night $5.8 \cdot 10^{-13}$ W/m^2

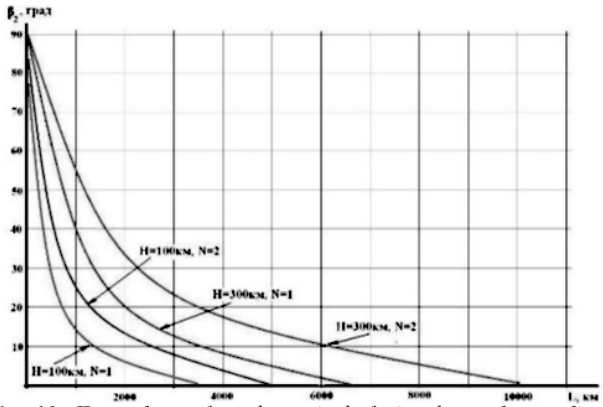

Fig. 10. *Dependence of angles arrival of signal secondary radiation ionosphere β_2 from distance L_2 in formation of signal in ionosphere at altitudes $H = 300$ km and $H = 100$ km when $N = 1$ and $N = 2$.*

(electric field strength of 0.78 μV/m, the magnetic field 0.23 pT).

Absence of sufficiently reliable values of loss coefficients appearing in expression (9) for low frequency range of lengths, does not allow estimate the values of signal levels of secondary radiation of ionosphere in this range. However, given the available data of propagation studies Schumann waves signal levels in low frequency range of wavelengths will have approximately same values as in HF range.

Obtained values of signal levels of secondary radiation are estimates and may vary plus or minus order of magnitude or more. Especially if these levels will have a tendency to change in smaller side. And if they require development and introduction of new technologies creation a high sensitivity and resolution of receiving equipment of radio monitoring system that provides necessary probability of detection and analysis of signals of radiation ionosphere.

Meeting the challenges of creating a high-performance radiomonitoring systems, providing large areas of detection space, analysis and identification of signals from radiation sources, it is possible to create a spatially distributed systems radiointerferometers constructed on basis of foster unified modules, that are united by systems of processing and analysis of detected radio sources.

Space-correlation processing of signals, that were received each receiving module, provides ability to increase equivalent sensitivity radiointerferometer and accuracy determining angular coordinates of radio source due to forming of the receiving phased antenna array.

Multifunctionality of radio monitoring system is determined by its capabilities of detection, analysis, coordinate determination and identification of essentially all radio-sources of land, air and space-based emitting in working frequency range of radio interferometers, as well as conduction basic and applied research on propagation of radio waves and geophysical processes under impact on ionosphere powerful electromagnetic radiation. Frequency range of radio monitoring system should be divided into three sub-range: <10 kHz, 10...100 kHz and 2...20 MHz.

Thus, with modern technologies of development of radioelectronic systems virtually is real creation of systems of radio monitoring to ensure reception of signals heating stands and secondary radiation ionosphere almost in all territory of Russia.

3.5. POSSIBLE CONCEPTS OF APPLICATION ARTIFICIAL IONOSPHERIC STRUCTURES IN ORDER TO CREATE A FUNDAMENTALLY NEW TYPES OF WEAPONS AND MILITARY EQUIPMENT

In field of creation of means of directional electromagnetic effects on environment take an important place studies on formation and military use of artificial ionospheric irregularities. Greatest interest here are the developments related to formation of artificial ionospheric irregularities (breakdown of ionosphere), created in the crossed beams of radio emission. Herewith in atmosphere is created an artificially ionized region where concentration of charged particles significantly (on 3-4 orders) exceed concentration of surrounding plasma. This area can be used for radio communication, because the radio waves reflect from it. The break-down expedient to carry out by short pulses. Their repetition period is chosen from condition of weak variation of plasma concentrations between pulses due to relaxation processes. This requires a very moderate average radiation power, which increases rapidly with decreasing altitude intersection of beams, place of breakdown. At altitudes, above 70-80 km, increase ohmic losses. Therefore for creation artificial ionized region is the most favorable altitude range from 30 to 70 km.

Depending on the choice of a range of radio-emitting means which form crossed beams, are formed and dimensions of region of increased ionization. So depending on the particular problem to be solved as sources forming the break-down, can

be used radio funds in ranges HF...SHF , as well as open laser systems.

Prospects use of such artificially created ionospheric mirrors are connected not only with radio communications, but also with production of noise due to reflection interference signal from region of ionosphere with high concentrations, as well as with masking surface facilities (territories) from radar surveillance from space. In addition, here seems to be a very remarkable possibility to create of "intentional" interference condition over a given area of earth's surface through use of nonlinear properties of ionospheric plasma in layers *E* and *F,* and in lower layers of artificially created areas with high ionization, in particular, biharmonic irradiation of their boundary with air.

Manifestation of nonlinear properties of ionosphere was installed with the discovery of Getmantsev effect (1980, Gorky, USSR): when exposed on lower ionosphere by the powerful modulated radioradiation, natural current systems of ionosphere are generate low-frequency radiation at frequency of modulation of signal irradiation.

Biharmonic irradiation of such surfaces with a high concentration of active particles significantly reduces energy costs for radiated HF range. Control of parameters of difference frequency and of methods of its manipulation dramatically increases efficiency of reaction of means jamming to enemy radio links at the distances. Rapidly are developing methods of targeted amplification of arbitrary components of spectrum of the combined frequencies, produced by mixing the oscillations of two frequencies on nonlinearities ionosphere and, therefore, increasing level of necessary (signaling) radiation jamming, generated by ionosphere. Orientation direction of radiation can be installed either on basis of phase relationships oscillations irradiating ionosphere, or of appropriate placement on terrain of their sources. This approach allows you to control voltage of movement of ionospheric current, taking into account the Earth's magnetic field. And, consequently, to control direction of jamming in ELF...LF at distances of 1,500 to 2,000 km. Herewith can be used as the jammers the means of KV-range, with average power transmitting devices.

We can also assume that by 2015 development of research in the use of the properties of artificial ionospheric structures (heterogeneities), will address a wide range of military tasks, such as:

- defeat of electronic equipment of AME, energy systems, communications and telecommunications, including in shelters, due to generation of a powerful electromagnetic pulse by means of non-nuclear method;
- creation of local changes in the geomagnetic field, as well as magnetic and electromagnetic anomalies (storms) in order to influence weather, objects of AME and personnel;
- hidden "information" exposure (irradiation to electromagnetic radiation of ELF, LF, VLF ranges) for personnel in places of their dislocation;
- functional defeat of the nodes of automatics system and homing warheads of ballistic missiles, powerful performances interference and also protection of space navigation systems and communication navigation system from the impact of funds the radio electronic suppression;
- detection and identification of underground military facilities (buried command facilities, depots with chemical, biological and nuclear weapons, underground utilities and other likely targets);
- ultra-long detection of small-observable air and sea targets (beyond-horizon location);
- creation of a fundamentally new radio systems (combat control) with submarines and buried objects in traditional ranges 30-300 Hz and 3-30 kHz.

It should be noted that within framework of project *HAARP* also addresses issues related to use of extremely weak alternating magnetic fields (EW AMF) as a factor affecting psycho-physical characteristics of person, as well as on human body as a whole. Impact EW AMF usually carried out against background of a constant magnetic field of Earth. Therefore, should consider bioeffects of modulated or combined magnetic fields (CMF) with very weak variable component of B_{AC} (term "biological effects CMF" is used for conciseness, as well as to emphasize the difference between the mechanism of action of this type fields on biological systems from the effects of the CMF in other modes).

1. *μT(micro-Tesla)-fields*. According to experts, available theoretical and experimental data suggest

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that variables μT-fields can induce biological effects at magnetic induction in excess of 10 μT, while possibility of biological effect of variable μT-fields at values B_{AC}<10 μT is virtually eliminated. Such a conclusion is made on basis of conflicting data regarding biological effects of "micro tesla" fields, conducted in many laboratories around world starting with first message by Spanish authors (1982) about origin of anomalies in development of embryos (teratogenic effects) when exposed to such fields (works funded by the US Navy). We can assumed, however, that contradictory of results obtained in the study of the influence of "micro tesla" fields on embryonic development, due to, first of all, dramatic differences in parameters (frequency, amplitude, pulse shape) which use a variable magnetic fields and relative complexity of registration and quantitative description of anomalies in developing embryos. It is obvious that to solve the fundamental question of "biological effectiveness" "micro tesla" fields more appropriate to use the no pulse but sinusoidal magnetic fields and relatively simple test systems. Indeed, results obtained in last 10 years using the same type (sinusoidal) CMF in four laboratories in the USA on biosystem of the same type, allowed an unambiguous conclusion about biological effectiveness "micro tesla" sinusoidal magnetic field (B_{AC} = 1.2·10^{-6} T, f_{AC} = 60 Hz). To date, the biological effectiveness "micro tesla" fields has been shown for principally different test systems and using a variety of different combinations of frequency and amplitude. However, question about mechanism of action "micro tesla" fields remains open.

2. *"nT"-fields.* There is increasing experimental evidence concerning impact of "nano tesla" fields on properties of biological and physico-chemical systems. In particular, Canadian scientists have received results of studies indicating the possibility of influence of these fields on psycho-physical and other characteristics of physiological state of a person. Results of several works of Russian scientists show that in basis of biological effects "nano tesla" and "micro tesla" fields can lie their interaction with aqueous component of biosystems.

3. *"pT"-fields.* There are only a few reports on laboratory studies of possible biological effectiveness CMF "pico tesla" range. In one of them reported on the impact of variable electric fields with parameters that mimic the Schumann resonances (amplitude of 1 mV/m, 10 Hz) on the psychophysical indicators of a man, the other was shown the possible role of Schumann resonances as a circadian synchronizer in humans. However, hypothesis on exposure to magnetic component of Schumann resonances on biological systems has not yet been subjected to a comprehensive experimental evaluation. Apparently, the main reason for the lack of open researches in this area lies in the a priori denial of the potential biological effectiveness of superweak magnetic fields characteristic for Schumann resonances. It should be noted that amplitude of magnetic component of the Schumann resonances at a frequency of 8 Hz is 1.3-3 pT (picotesla), ie, close to the magnitude of the magnetic field on the surface of the Earth, created under the program *HAARP*.

3.6. CONCLUSIONS

On the ground of the analysis of the provided materials the following conclusions can be made. But it is necessary to note that all conclusions in the text and in the final report can't be entirely true, because all problems mentioned in the report, especially in the field of creation of the special climatic weapon, require to make more theoretical and applied researches. Nevertheless, there are the following preliminary conclusions:

a) in the field of physics and origin of magnetic radiation phenomena, which are created naturally

1. Physics of origin of magnetic radiation phenomenon begins and occurs in the environment of the Earth:

- in the ionosphere as ionospheric rays and their size depends on ion and electron concentration;
- in case of changes in the magnetosphere structure with formation of plasmoids under the effect of natural phenomena (the Sun's short-wave radiation, corpuscular streams, galactic and sun space rays and other).

Each type of the ionizing radiation influences mostly on the atmosphere only in a certain area of high dimension corresponding to its penetrating capability.

2. Ionosphere study and its basic characteristics is still improving in two directions - its effect on radio waves transmission and physical-chemical processes

research, which are occurred in the ionosphere that has produced a new science - aeronomy.

3. The process of reconstruction of the magnetosphere either local or large-scale is important, if not the basic factor of the disturbed magnetosphere, creating *auroral radiations, aurora polaris and magnetospheric substorms*. The common origin of ionospheric, magnetic disturbance and aurora polaris during active phase of the substorm is a precipitation of auroral electrons in the atmosphere.

4. To understand fully physical notions about typical changes in the magnetosphere structure it is required also to study different questions about problems solving in energy ions acceleration. Also the conceptions about the structure and short period of the history about auroral activization, substorms and world magnetic storms interconnection. I.e. there will be more researches about magnetospheric disturbances.

b) in the field of geophysical disturbance in the ionosphere, which are created naturally

1. The important problem is an evaluation of effects criteria on the certain geosphere, which can bring to the planed effect. It is clear that any active influence cannot compete with more powerful energy of natural phenomena and processes that have common energetic capabilities. However, there are few exceptions (nuclear explosions, asteroidal-meteor weapon).

There is only one conclusion that humanity should think carefully and to take care about our beautiful existence on the Earth and about extremely reach nature sphere. Any rude interference into nature condition can bring to disasters.

2. Some examples of the natural disasters, which are occurred because of still unknown, but supposed reasons during last ten years on the Earth remember us that there can occur an irreversible situation, when the whole *climate control system is used, which kills its creator*.

3. The project *HAARP* is not so harmless, as the USA try to show. As a result of risky experiments there can be a global freezing, destruction of ozone layer of the Earth atmosphere and unpredictable climate changing in whole continents. There is no limit in experimentation of weather abroad, which are made on these complexes with certain types of apocalyptic weapon, which is using now actively.

c) in the field of weapon with new geophysical principles

1. The term's content "geophysical weapon" is still not defined, but it is implied that the object of the influence of such weapon is the environment (geophysical), natural atmosphere - lithosphere, gydrosphere, ground layers, ozonesphere, ionosphere, magnetosphere, circumterrestrial cosmic space, which are included into the common notion of the geosphere. The idea is to create a mechanism of artificial induction and direction on certain regions of natural phenomena causing significant destructions and victims. Among these natural phenomena are the following:

- earthquakes, tectonic faults, eruptions and secondary disasters caused by them, for example, tsunami;
- atmospheric disasters (tornado, typhoon, waterspout, storms) and also common condition of the climate in certain area (drought, light frosts, erosion);
- destruction of the ozone layer over separate territories in order to "burn" and to radiate by the natural radiation of the Sun;
- influence on water resources (flood, tsunami, storms, torrent).

2. There are possible directions of the military implementation of the *HAARP* system:

- connection with submarines on low frequencies;
- warning system about rocket and air attack;
- influence on radio electronic equipment, especially - communications and navigational systems of ships, cosmic devices, air planes, enemy's rockets and also on ground radio electrical means of the enemy;
- geophysical weapon: the weather in the country or in the geographical region can be controlled and changed;
- the weapon for organization of large-scale damages in networks, atomic stations, oil and gas pipelines;
- anti-missile and anti-aircraft (air-cosmic) defence - a guided plasmoid can deform a high-speed current in front of the flying machine or battle ballistic missile, changing their trajectory from the rated data and even to destruction of the machine;
- influence on psychological and somatic condition of people;
- stimulation of earthquakes or tsunamis.

3. Russian experts think that using a directed influence of antennas as *HAARP* it is possible to become such "sort" of plasmoid energy and ionospheric current, occurring in polar areas, which can bring to serious effects of "battle" implementation:

- full loss of electronics and air planes and cruise missiles' systems of control;
- blocking or full loss of electronic systems of ballistic rockets on boost (till motor's stages separation) and ballistic phase (till divding reentry vehicles) in certain areas of the trajectory.

In particularly, the question is about effects in polar territory, where there are high density of auroral currents and energy of ionospheric plasmic formations, which help system to function:

- there are ("hang") American satellites with early warning systems about the attack;
- there are also the most powerful ground radar stations of NATO, combined with "their" EWSA - in Great Britain, Norway, Greenland, on Alaska and Aleutian island;
- there are also aerial areas of the first active system *HAARP* in Alaska under Anchorage and also the second similar hastily extensible system in Tromso in Norway.

d) with modern technologies of radio electronic systems creation it is almost real to create radiomonitoring system with signals accepting and secondary ionosphere radiation with heated stands in almost the whole territory of Russia.

4. POSSIBLE DIRECTIONS OF IMPROVEMENT OF METHODS OF INFLUENCE OF ELECTROMAGNETIC RADIATION ON PHYSICAL OBJECTS AND ENVIRONMENT

4.1. ESTIMATED PROBLEMS:

Development of the methodology of researches of electromagnetic radiation interaction with biological and radio technical military objectives.

Development of regulations of formulation of the basic principles of formation of coupling and accepting devices, measuring technical equipment for military implementation, including the equipment for study of theoretical and practical basics for creation of radiation facilities with ultrashort and strong impulses.

4.2. SOLUTIONS (METHODS) APPROACHES

For practical implementation of MWF radiation in its remote influence on radio technical and biological objects it is necessary to develop:

- *MWF radiation generators with high power capable to radiate short and powerful radiation impulses in broad band;*
- *highly sensitive receive box with threshold sensitivity not less than 10-20W/Hz, accepting at the same time even low signals in a range of radiation of coupling devices, protecting biological objects and also identifying permissible flows of MWF radiation, which are safe for radio technical systems functioning and protection.*

Development of wide-range spectrometers with the resolution not less than 0.01 sm^{-1} for study of the areas of quasiresonant interaction between radiation and bioobjects.

Development of new generation principles of ultrashort and powerful radiation impulses and also development of necessary element base and measuring equipment for creation and researching of powerful radiation generators.

4.3. POSSIBLE METHODS OF RESEARCH WORKS FOR LONG TERM

Searching researches testing in studying of characteristics of spread of ultrashort and powerful radiation impulses in absorbing areas and also in development of methods and ways for design of interaction of such radiations with radio technical and biological objects (results assessment).

It is reasonable to concentrate efforts of phyicians who try to solve the problem about microwave radiation interaction with radio technical and bioobjects for next important researches in the field of:

- *development and theoretical researches of models of input circuits of radiolocators accepting devices, radio communication systems and navigational on-board receivers and also responsive computer elements;*
- *choosing of wave range for theoretical influence microwave modelling on input circuits in concentrated and integral implementation;*
- *analysis of generation principles in optimal choosing of microwave characteristics of the device suitable for experimental researches;*
- *development of the powerful relativistic generator of ultrashort impulses with variable power in impulse;*

- *creation of working model of the powerful wide-range relativistic microwave generator and its testing;*
- *experimental test of the results of theoretical analysis of influence and including the analysis of microwave input circuits parameters degradation depending on the level of declining power, frequency and force duration;*
- *researches of microwave radiation beams attenuation and short microwave impulses in earth atmosphere;*
- *experiments on short and strong microwave impulses effect on input circuits of receiving devices and computer;*
- *creation of the half-industrial model of powerful radiator for electronic force on certain radio technical systems (connection, location, computer machines);*
- *experimental researches of microwave ultrashort impulses influence on biological objects of vegetable and animal origin.*

5. CONCLUISION

The modern level of development of generation methods of powerful electromagnetic impulses and methods of creation of radiation showed possibility of development of wide group of systems and means of directed energy. In the field of development of electromagnetic systems and means of influence on biological objects (aman) and environment and for heavy systems from radio electronic warfare (REW) the most well-known means are the following: electromagnetic means of lethal action, generation of high power for the heavy systems REW, electromagnetic means of nonlethal action and means for directed electromagnetic action on environment.

In the first part of the article the following questions are covered: about improvement of generation methods of powerful electromagnetic impulses for creation heavy systems of radio electronic neutralization of different types of radio electronic systems (RES) and especially the systems of precision weapon. It is an extremely urgent problem in improvement of advanced armory and military technology. The methods and means of generation of nanoseconds powerful impulses are considered, including:

- it is prepared a theoretical explanation of possibilities of generation methods of nanoseconds powerful impulses and their basic characteristics for possible practical implementation with creation of advanced systems of heavy radio electronic warfare RES destruction;
- there are the results of foreign and domestic researches of generators creation of macrowave-impulses with micro-nanoseconds duration and ultrashort electromagnetic impulses and also electromagnetic radiators, which are powered fromexplosion and magnetic current generator;
- there are variants of microwave weapon, using practically abroad and also examples of creation of means for electromagnetic influence on human in favour of anti-terrorism effort.

In the second part of the article following from Internet there are considered the questions about geophysical disturbance in the ionosphere created naturally and artificially as the origin of powerful influencein nature. There is an appropriate description of the methods and means of influence on environment (RD type *HAARP*) and radiomonitoring direction of radiation of heat stands and secondary ionosphere radiation.

In the final third part of the article there are considered the problems and solutions of possible (expecting) direction of improvement of influence methods of electromagnetic radiation on physical objects and environment.

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