Project:

“Study of deep subcritical electro-nuclear systems and feasibility of their application for energy production and radioactive waste transmutation. Part II – quasi infinite target.”

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Participating Countries and International Organizations:

Armenia, Australia, Belarus, Bulgaria, Czech Republic, India, Germany, Greece, Kazakhstan, Moldova, Mongolia, Poland, Romania, Russia, Serbia, Slovak Republic, Ukraine.

Scientific Programme

Investigation of new aspects of electronuclear power engineering and process of energy production and radioactive waste transmutation at various subcritical setups.

Expected main results:

- Investigation of physical characteristics of the following setups: "the lead target plus graphite moderator" (set-up "Gamma–3"), the massive uranium target with a lead reflector – (set-up "Quinta"), the quasi infinite uranium target BURAN at the energies of the Nuclotron proton and deuteron beams within the range from 0.6 up to 12.0 GeV. Data on the multiplicities and special distribution of energy–time neutron spectra. Study on possibilities of energy production and radioactive waste processing at massive targets of natural (depleted) uranium and thorium on the base of basic principles of nuclear relativistic technologies.

Expected main results in 2014:

- Completion of the development of a heavy ion beam spatial monitoring system; 0n–line operational test at the Nuclotron–M experiments.
- Development of detector for measuring the radiation dose rate based on diamond detectors.
- Study on efficiency of heating FEL ferromagnetic nano–clusters with microwave radiation regarding the feasibility of its application to the cancer cell destruction.
- Study of neutron generation and multiplication in heavy targets (Pb, U, etc.) at the Nuclotron proton and deuteron beams within the energy range from 1.0 to 8.0 GeV. Data taking on energy release, number of fissions, plutonium recovery, on neutron energy spectra and neutron spatial distribution in the uranium target (set-up "Quinta") and in the lead target with graphite moderator ("Gamma–3" set-up). Precise definition of transmutation rate for highly toxic long–lived radioactive waste (^{129}I, ^{237}Np, ^{238}Pu, ^{239}Pu and ^{241}Am) in the neutron fields with reinforced hard component.
- The technical specifications elaboration and carrying out the 1–st stage of design work on the construction of the experimental setup "Buran", based on the quasiinfinite target of depleted uranium with the mass of ~21 tonns.

Introduction.

The physical aspects of electro-nuclear energy production method are actively studied today in many scientific centers all over the world: USA, Germany, France, Sweden, Switzerland, Japan, Russia, Belarus, China, India etc. Most activities are concentrated on the classical electro-nuclear systems – Accelerator Driven Systems (ADS) – based on spallation neutron generation, with a spectrum harder than that of fission neutrons, by protons with an energy of about 1 GeV in a high-Z target. These neutrons can also be used for generating nuclear energy in the active zone having criticality of 0,94-0,98 and surrounding the target.

The large national projects devoted to the creation of industrial ADS demonstration prototypes are implemented in Japan (JPARC), USA (RACE), the joint European project EUROTRNS is carried out.

The main advantage of electro-nuclear technology, as compared to conventional reactor technologies, is that subcritical active core and external neutron source (accelerator and neutron-producing target) are used. This advantage not only provides intrinsic safety of the system but also makes it possible to obtain high fluxes of high energy neutrons independent of fission neutrons of the subcritical assembly material. The high-energy neutrons are an ideal tool to induce fission in most trans-uranium isotopes and thus transmute most of the dangerous radioactive waste from nuclear power production and other sources.

MOTIVATION

The results on Plutonium yield and number of fission events per proton in quasi infinite targets with a mass of about 3,5 t made from depleted and natural uranium under 660 MeV proton irradiation at synchrotron DLNP JINR, obtained by R.G.Vasilkov and V.I.Goldansky et al. These targets are equivalent to those with a mass of 6,0 t due to non-central beam injection.