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Topical plan for Joint Institute for Nuclear Research (JINR) research and international cooperation:
Theme 03-5-1130-2017/2021: Synthesis and Properties of Nuclei at the Stability Limits

International Student Practice Project: Radiochemical methods in nuclear data research for radionuclides production

Project description:

Nuclear data are the basis on which to base the development of a production method. For some reactions, they are well established, while in many cases the data are insufficient or contradictory. Obtaining of new nuclear data and diversification of production pathways allows us to offer production solutions on a regional scale, to broaden the base for pre-clinical and clinical trials. We plan to apply unconventional ways alpha particles, 3He, photonuclear processes, light ions etc. for production of these radionuclides.

The project aims, on the one hand to expand the range of potential medical radionuclides, on the other hand to search for new methods of production of already used radionuclides. In terms of the project the investigation of new ways of production of therapeutic radiolanthanides (^{161}Ho, ^{167}Tm), copper isotopes (^{64}Cu, ^{67}Cu), scandium (^{47}Sc) and platinum (^{193m}Pt, ^{195m}Pt) will be done. In particular, it is planned to obtain new nuclear data (cross sections and yields of nuclear reactions) and the development of new radiochemical separation techniques of medical radionuclides from irradiated targets.

Photonuclear reactions ^{196}Pt(γ, n)^{195}mPt and ^{195}Pt (γ, γ ')^{195m}Pt and the method of collection of recoil will be used to obtain high specific activity 195mPt. This approach for the production of radioisotopes of platinum is offered for the first time. According to the results of preliminary experiments metal platinum can not be used as a target material, as the substance with an fcc and bcc are too compact packaging, whereby the products of the nuclear reaction is delayed in the parent compound and does not fall into the collection recoil. Thus, as a target to be studied platinum compounds with rhombic or trigonal lattice. For the first time as a collection will be used different materials H_2PtCl_6, NaCl, cryptomelane, PtO_2. Feature cryptomelane application is that the emitted particles penetrate into the pores of cryptomelane and stabilized in certain chemical form. Opportunity of separation based on different chemical properties of the starting material and recoil nuclei is provide. For the simulation of the program will be used SRIM, allowing rely runs recoil nuclei in the material. This approach will allow determining the effectiveness of the method for specific radionuclides.
As a result, data will be obtained about the reactions leading to the accumulation of isomeric nuclei. Develop methods of dissolving a small amount of iridium powder (100-200 mg) of high activity is necessary for obtaining of platinum isomer from irradiated iridium metal target in a nuclear reactor by double neutron capture. With considering requirements, the most optimal method is the dissolution of platinum metals and their alloys by means of alternating current in aqueous solutions. For the development of techniques required to investigate the effect of the concentration, volume, and temperature of the solution, cell shape, material and shape of the

electrodes, the influence of the electric double layer velocity redox Ir (III) / Ir (IV) and other factors on the speed and efficiency of dissolution.

We will use an experimental set-up for production and slowing down of neutrons at the MT-25 accelerator at FLNR JINR. The microtron MT-25 (fig.1) accelerates electrons up to energy of 23 MeV and provides beam power of up to 0.4 kW at the current of up to 20 μA. A specially constructed set-up described in [1] consists of a convertor and a moderator. It converts energy of electrons into bremsstrahlung, and then into fast neutron flux, which is then slowed down to thermal energy. The set-up contains such elements as tungsten converter for bremsstrahlung generation, beryllium plates for neutron production in reactions (γ, n) and (n, 2n) in Be and graphite cube for slowing down neutrons. According to our data the flux of thermal neutrons is provided in the center of the moderator at a beam current of 10 μA, whereas the flux of epithermal neutrons is 35 times lower. Hard bremsstrahlung is reduced by 4 orders of magnitude.

[1] Базаркина Т.В. и др. // ОИЯИ 18-12629. Дубна, 1979; и Белов А.Г. и др. // ОИЯИ 18-80-841. Дубна, 1980.