The production of stable isotopes

Production of stable isotopes (deuterium, boron, beryllium, etc.) for nuclear power industry has long been carried out on an industrial scale. In recent years, dramatically increased requirements for stable isotopes for medical purposes. Stable isotope of oxygen O^{18} is used for early diagnosis of cancer by positron-emission tomography (PET). Recently the firm "Oksimed "(Roshchino) began its industrial production. The project is designed to produce 10 kg of isotope of oxygen 18O per year, all products are for export

The need for mass use of medical drugs labeled isotope C^{13} diagnostic purposes require a substantial increase in its global production to hundreds of kilograms per year. Unfortunately, the cost of obtaining it by traditional methods is very high. Further laser technology of separation of stable isotopes of elements is perspective in this sense average mass, which in the production of isotope 13C makes it possible to significantly reduce cost price. On the basis of SSC RF TRINITI in 1997 in the city of Kaliningrad established factory witht he volume of production is about 15 kg per year of isotope 13C, and on the same equipment is received in a year to 150kg of the isotope 12C enriched to 99.99%.

Technological line for the 13C

The process of obtaining isotope 13 C

Production of high-enriched isotope 13Cby combined technology, in which enrichment is carried out in 2 admission:-
I (laser) stage is carried out selective multiphoton dissociation of molecules Freon by means of laser radiation is obtained product with 30-35% of the content of 13C in performance of 3 modules up to 1.5 g / h (at reducing productivity to 0.6 g / h can get 90% enrichment);
II stage is higher enrichment up to 99.9% is obtained in the traditional way by centrifuges.

Isotopes with an excess of neutrons are usually produced in nuclear reactors. In addition, a proton accelerator can be used to produce neutron-emitting isotopes. Protons are converted into neutrons on targets with large mass number. The radioactive isotopes obtained by the method of adiabatic resonance overlap (Adiabatic Resonance Crossing, ARC). (Arc method was proposed by K. Rubbia for transmutation and radioisotope production.) When bombarded with accelerated protons, neutrons are generated in the target. Then they dispersed into the lead, gradually declining to the resonance energy, then there is neutron capture by nuclei that are selected for production of the desired isotope.

Different reactions are used to produce isotopes:

(p,n), (p,α), (p,pn), (p,2n), (p,3n),
(p,5 n), (d,p),(d,n), (d,2n), (d,3n), (d,α), (^{3}He,n), (^{3}He,α), (^{3}He,αn),
(^{3}He,2n), (^{3}He,3n), (α,p), (α,n), (α,2n), (α,pn), (α,3p).

Isotope production using accelerators is often preferable to that of reactors. So if the production of a short-lived isotope can be realized both by reaction (n,γ) in the reactor or (d,p) in a small cyclotron equally successfully, the cyclotron is preferable. It is easier to install it close to the patient.

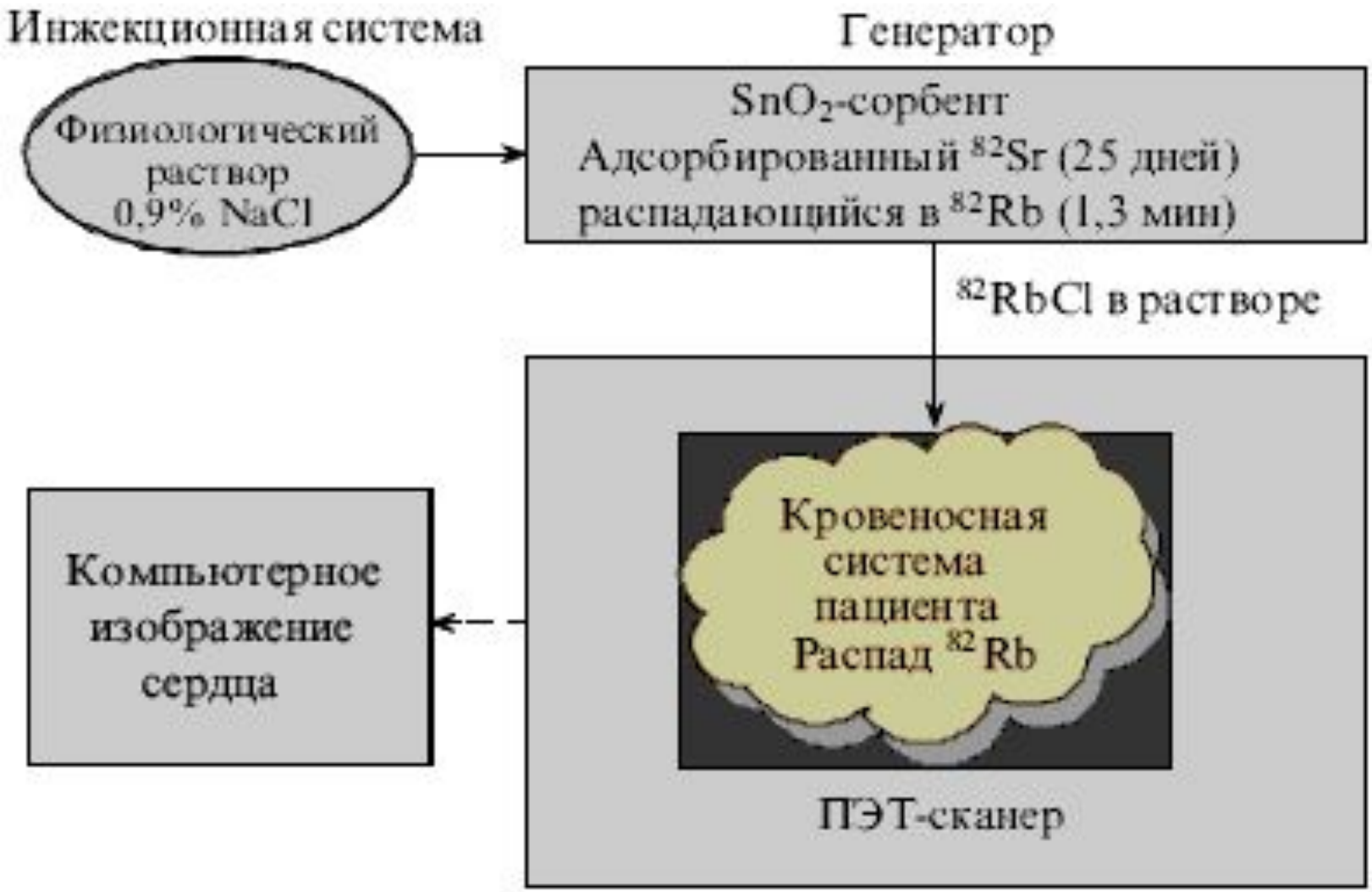
Radioisotopes often used in medicine, which are produced on cyclotrons and proton energy necessary for their production	
Energy, MeV	Isotopes
0–10	^{18}F, ^{15}O
11–16	^{11}C, ^{18}F, ^{13}N, ^{15}O, ^{22}Na, ^{48}V
17–30	^{124}I, ^{123}I, ^{67}Ga, ^{111}In, ^{11}C, ^{18}F, ^{13}N, ^{15}O, ^{22}Na, ^{48}V, ^{201}Tl
≥30	^{124}I, ^{123}I, ^{67}Ga, ^{111}In, ^{11}C, ^{18}F, ^{13}N, ^{15}O, ^{82}Sr, ^{68}Ge, ^{22}Na, ^{48}V

The Central part of the radionuclide production facility at a linear proton accelerator with an energy of up to 160 MeV

In order to increase isotope production capacity, specialized accelerators with a high average beam current, with large and variable energy, with simultaneous processing of different isotopes are needed. For example, protons with energy of 70 MeV allow to produce 123I, using mono isotope iodine 127I by reaction 127I (p,5n)123Xe → 123I. 123I can also be produced with proton energy 30 MeV using 124Xe. But this isotope is extremely rare (0.0952% in natural compound) and accordingly very expensive

Generators of radionuclides

Radionuclide generator is a device in which there is a relatively long-lived "parent" isotope, which decays constantly produces necessary, for example, PET, short-lived isotope, which is then released by chromatography, extraction or sublimation. As an example, the scheme and appearance of the generator 82Sr→82Rb are shown. The use of such a generator, which changed in the installation of PET once a month, made it possible to eliminate the need for a cyclotron and a radiochemical laboratory in the clinic, which significantly reduced the cost of diagnosis of cardiac diseases.


Инжекционная система
Генератор
Физиологический раствор 0,9% NaCl
SnO_2-сорбент
Адсорбированный ^{82}Sr (25 дней)
распадающийся в ^{82}Rb (1,3 мин)
$^{82}RbCl$ в растворе
Кровеносная система пациента
Распад ^{82}Rb
Компьютерное изображение сердца
ПЭТ-сканер