ISOTOPE PRODUCTION AT THE KURCHATOV INSTITUTE CYCLOTRON

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Two widely used medical isotopes (Tl-201 and I-123) are being obtained at the Kurchatov Institute cyclotron. To produce Tl-201 according to Tl-203(p,3n)Pb-201-->Tl-201 reaction a target with enriched Tl-203 is irradiated with 28.6 proton beam.High purity I-123 production is based on the proton induced reactions on highly enriched Xe-124. For 4 hours irradiation with 30 MeV 20 uA proton beam the I-123 yield is up to 10 mCi/uAh.. A wide R&D program aimed to develop a high current liquid and gaseous targets is performed.

1 Introduction

The Kurchatov Institute cyclotron was put into operation as a classical one mainly for the solving of the problem of a nuclear bomb. Since 1974 the cyclotron was being reconstructed into a isochronous one. The first beam was obtained in autumn of 1976. It is a 150 cm cyclotron with maximum magnetic field of 2.1 T. Beams of various ions up to Ne are available, while the maximum proton energy being of 35 MeV.

Since 1984 the routine production of several radionuclides was started mainly for the needs of nuclear medicine. Now Kurchatov Institute is the only supplier of Tl-201 and high purity I-123 produced of Xe-124 for Russia.

2 Routine Isotope Production

2.1 Thallium-201 Production

Tl-201 is a widely used cardiac imaging agent that is produced according to Tl-203(p,3n)Pb-201-->Tl-201 reaction. The solid target with 97% enriched Tl-203 is irradiated with 28.6 MeV proton beam[1]. Energy losses in the target are 5 MeV. For 20 hours 24 uA irradiation the average Tl-201 activity after target chemical processing is about 300 mCi at the moment of delivery.

The chemical wastes comprising highly enriched Tl-203 is recycled to obtain Tl-203 for the new solid targets production procedure.

In 1995 a new production method was tested to obtain Tl-201. Highly enriched Hg-201 was used to obtain high purity Tl-201. The usage of (p,n) reaction determins relatively low yields of Tl-201. But the experiments performed proved that it is feasible to produce high purity Tl-201 using low energy accelerator (about 15 MeV).

2.2 Iodine-123 Production

High purity I-123 production is based on the proton induced reactions on highly enriched Xe-124. The automated gas target station was designed[2].

The conical aluminum Ni-plated target body with 125 cm^3 internal volume is filled with 99.98% enriched Xe-124. The initial target pressure is about 8 bar. The beamline and the gas target are separated by two 50 um Mo foil windows.

For 4 hours irradiation with 30 MeV 20 uA proton beam the I-123 yield is up to 10 mCi/uAh. The calculated energy losses are about 11 MeV.

The lack of free place around the target station limits the usage of target washout procedure. And only I-123 produced in a decay vessel is collected now.

Using this method the I-123 routine production for Moscow nuclear medicine has been started recently.

3 Special Isotope Production Procedures

The Kurchatov Institute cyclotron is open for a wide collaboration in the field of isotope production for research programs.

Special isotope production procedures can be designed for research teams that have needs in small amounts of specific radionuclides. The availability of deuteron and alpha particle beams of reasonable intensities makes the Kurchatov Institute cyclotron more flexible comparing with new H^- machines.

The recent productions of Pb-205 for geochronology or At-211 for nuclear medicine are the good examples of such activity.

4 Kurchatov Institute R&D Program for Isotope Production

The fast development of the cyclotron technology uncovered the limitations concerned with targetry. Highly intensive proton beams available in a new generation of H^- machines can not be fully utilized simply because modern targets are not designed for such a high beam power.
The state of the art of solid state targets is rather promising as the targets for intensive (more than 500 uA) proton beams were designed in several labs (TRIUMF, Canada; IBA, Belgium; Cyclotron Co. Obninsk Russia). But the situation with gaseous and liquid targets is not so optimistic.
Therefore, to develop the targets for high current proton irradiation an R&D program was started in Kurchatov Institute several years ago.
The large experimental data set obtained yielded a new design of xenon target for I-123 production and water target for F-18 production at proton beam intensities of 350-500 uA and 150 respectively. Now the experiments at high current cyclotrons are being planned to prove the operation conditions announced.

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