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The plasma focus device Radiation in particles collision with carbon target For the production of medical radioisotopes

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Abstract

The production of radioisotopes, radio nuclides, and radio drugs and their various compounds for the use of nuclear medicine is an essential part of the nuclear activity.in this study , we explain the nuclear particles & ray risks that produced from the particles collision with carbon in the plasma focus devise. At the end we tray to suggest the ways to reduction bad influence, in this study energies are 1MeV to14MeV were used to calculate activity and gamma , alpha & beta rays energy by Geant4.10.1 toolkit

Keywords: plasma focus, Geant4 ,Radiation, Safety, ray risk

Introduction

Radiation risk

Radiation is energy. It can come from unstable atoms or it can be produced by machines. Radiation travels from its source in the form of energy waves or energized particles

Radiation can damage living tissue by changing cell structure and damaging DNA. The amount of damage depends upon the type of radiation, its energy and the total amount of radiation absorbed. Also, some cells are more sensitive to radiation. Because damage is at the cellular level, the effect from small or even moderate exposure.

Here Alpha Particles, Beta Particles, Gamma Rays Has been considered.

Experimental

plasma focus device

Currently, some scientists believe that plasma focus devise can be used as a nuclear fusion reactor[1,2,3,4]. The plasma focus device has a variety of applications in different fields. These include educational, research and industrial applications. In the research , this device is cheaper than other nuclear fusion devices, many of the dynamics plasma topics , instability, and plasma perturbation can be evaluated . [5,6,7,8]. Fig. 1 shows The simplified geometry of the DPF system and the two beam-target mechanisms in a plasma focus device.

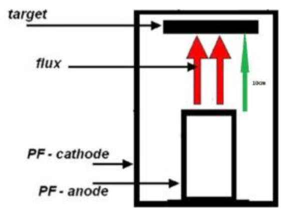

Fig 1. The simplified geometry of the DPF system and the two beam-target mechanisms in a plasma focus device.

Simulation

The particle source in this study was designed to calculate the amount of radiation for the production of medical radioisotopes such as 11Cand 123,124I in a plasma focus device, [9,10,111,12,13,14]. in a disk of 4 cm radius and neutrons with Geant4fig.2.

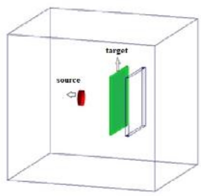

Fig2. Cube target shape simulated by Geant4

Results and discussion

For having less page to ready abstract file, Tab1, Tab2. Shows the part of the results

Tab1 - the neutron beam characters

	Energy	Activite
neutron	252.273 keV	2.91461 ns
neutron	1.15944 MeV	4.03012 ns

Tab2-producted beams for neutron collisions with c

	ENERGY	ACTIVITE	PRODUCT	ENERGY	ACTIVITE
C14	3.10052 MeV	4.6607 ns	gamma	4.41862 MeV	2.93713 ns
C14	781.683 keV	7.34787 ns	gamma	1.901 keV	2.93713 ns
C14	1.22248 MeV	7.0372 ns	e+	3.35118 MeV	3.33963 ns
C14	90.0594 keV	3.27492 ns	e+	6.51835 MeV	3.40579 ns

Conclusion

According this study the plasma focus device has produced a low volume and harmful rays during the production of medical radioisotopes.
Alpha and beta beams are absorbed by the device so it is better to use lead layers Protector because of their ability to absorb gamma rays in this device.
With this Safety, a safe environment is available for device operators and patients.

References

5. References

[1] S. GB., Radioactive decay and interaction of radiation with matter, basics of pet imaging. Cham: Springer; 2016.
[2] EL. Cole, MN. Stewart, R. Littich, et al. Radio syntheses using fluorine-18: the art and science of late-stage fluorination. Curr Top Med Chem 2014; 14(7):875–900.
[3] F. Castillo et al. Evidence of Thermal and Non-Thermal Mechanisms Coexisting in Dense Plasma Focus D-D Nuclear Reactions J. Phys, D: Appl. Phys. 33 (2000) 141-147.
[4] Dolan, Fusion Research, 1982.
[5] K. Hubner et al. Fusion Reaction Rate for A Plasma Boiler Moving an Ambient Plasma, Volume 69A, No 4, Physics Letters Dec. 1978.
[6] A. Serban et al. Correlation of Neutron Anisotropy with Neutron Yield and Soft X-ray Production from a Plasma Focus, 27th EPS Conference on Contr. Fusion and Plasma Phys. Budapest, 12-16 June 2000 ECA Vol. 24B (2000) 1677-1680s.
[7] S.M.Sadat Kiai, design a 10KJ is mather type Plasma Focus for solid target activation to produce short-lived Radioisotopes ^{12}C(d,n)^{13} N, Fusion Energy. Volume29, (2010), 421-426
[8] A.Talaei et al, Interaction of the high energy deuterons with the graphite target in the plasma focus devices based on lee model, Appl. Rad. Isotopes, volume 68,(2010) 2218-2222
[9] F. Ditroi, et al., Gas, Liquid and Molten Targets at Cyclotron Beams: Target Systems and Related Nuclear Database, (2009).
[10] D.B. Pelowitz, MCNPX 2.7.0 manual, LANL, LA-CP-07-1473. Los Alamos National
[11] Geant4 Collaboration, Introduction to GEANT4 User Documentation (2009).
[12] J.Allison, et al., Geant4 developments and applications, IEEE Nucl. Plasma, volume (53), (2006), 270-278.
[13] M. [illegible] et al., A feasibility study of the Iranian Sun mather type plasma focus source for neutron capture therapy using MCNPX2. 6, Geant4 and FLUKA codes, Nuclear Engineering and Technology, volume 25, (2019).
[14] M. Clemencic, et al. The LHCb simulation application, Gauss: design, evolution and experience, Journal of Physics: Conference Series. Vol. 331. No. 3. IOP Publishing(2011).