INTISARI

Desain Uji Klinis *Boron Neutron Capture Therapy* (BNCT) pada Kanker Payudara Menggunakan Sumber Radiasi *Coaxial Compact Neutron Generator* D-D dengan Metode Simulasi *Monte Carlo N-Particle eXtended* (MCNPX)

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Penelitian desain uji klinis *Boron Neutron Capture Therapy* (BNCT) pada kanker payudara telah dilakukan di Badan Tenaga Nuklir Nasional (BATAN) Yogyakarta, Indonesia. Penelitian ini didasari oleh tingginya laju kejadian kanker payudara di dunia, secara khusus di Indonesia. BNCT adalah jenis terapi nuklir yaitu reaksi tangkapan $^{10}B(n,\alpha)^{7}Li$ yang menghasilkan energi kinetik total 2,79 MeV. *Linear Energy Transfer* (LET) dari partikel α dan *recoil* ^{7}Li akan terdeposit secara lokal pada rentang jarak 5-9 μm, yang bersesuaian dengan diameter sel manusia, ~10 μm. Neutron cepat yang dihasilkan *Compact Neutron Generator* (CNG) dimoderasi menggunakan material Fe dan MgF_2. Sebuah sistem kolimator beserta kanker payudara dan organ beresiko didesain berdasarkan *Monte Carlo N-Particle eXtended* (MCNPX). Simulasi radiasi dilakukan dengan *software* MCNPX dan besaran fisika diukur menggunakan kode *tally* yang terdapat pada MCNPX. Fluks tertinggi neutron termal diperoleh pada kedalaman 1,4 cm pada jaringan lemak. Teknik radiasi sisi depan (*en face*) dan sisi bawah (*upward intersection*) dilakukan pada irradiasi kanker. Laju dosis rata-rata yang diperoleh pada kanker payudara dengan teknik sisi depan $1{,}72\times10^{-5}$ Gy/s dan $8{,}98\times10^{-6}$ Gy/s pada teknik sisi bawah. Dosis sebesar 50±3 Gy pada sel kanker; $(4{,}18\pm0{,}06)\times10^{-2}$ Gy pada jantung dan $(8{,}16\pm0{,}06)\times10^{-2}$ Gy pada paru-paru diperoleh selama iradiasi 806,34 jam.

Kata kunci: *Boron Neutron Capture Therapy*, *Compact Neutron Generator*, Kanker Payudara, Dosimetri

ABSTRACT

Clinical Trial Design of Boron Neutron Capture Therapy on Breast Cancer using D-D Coaxial Compact Neutron Generator as Neutron Source by Monte Carlo N-Particle eXtended (MCNPX) Simulation Method

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A clinical trial simulation of Boron Neutron Capture Therapy (BNCT) for breast cancer was conducted at National Nuclear Energy Agency Yogyakarta, Indonesia. This was motivated by high rate of breast cancer in the world, especially in Indonesia. BNCT is a type of therapy by nuclear reaction $^{10}B(n,\alpha)^{7}Li$ that produces kinetic energy in the total of 2.79 MeV. High Linear Energy Transfer (LET) radiation of α-particle and recoil ^{7}Li would locally deposit their energy in a range of 5-9 μm, which corresponds to the human cell diameter. Fast neutron coming out of Compact Neutron Generator (CNG) was moderated using Fe and MgF_2 materials. A collimator, along with breast cancer and the corresponding organ at risk were designed compatible to Monte Carlo N-Particle eXtended (MCNPX). The radiation was simulated by the MCNPX software and the physical quantities were counted by tally MCNPX codes. The highest neutron thermal flux was found at a depth of 1.4 cm on fat tissue. En face and upward intersection radiation techniques were adopted for the breast cancer radiation. The average dose rate of radiation used on breast cancer was found to be 1.72×10^{-5} Gy/s for the en face method and 8.98×10^{-6} Gy/s for the upward intersection method. Dose 50±3 Gy was given into cancer cell, $(4.18\pm0.06)\times10^{-2}$ Gy into heart and $(8.16\pm0.06)\times10^{-2}$ Gy into lung for 806.34 hours irradiation.

Key words: Boron Neutron Capture Therapy, Compact Neutron Generator, Breast Cancer, Dosimetry