# COMPARISON BETWEEN PENCIL BEAM SCANNING AND PASSIVE SCATTERING TECHNIQUES FOR DOSE OPTIMIZATION IN PROTON THERAPY OF NASOPHARNYGEAL CANCER USING PHITS

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## ABSTRACT

Nasopharyngeal cancer is a type of head and neck cancer with a high mortality rate in Southeast Asia, largely due to its late-stage diagnosis. One effective treatment method is proton therapy, which utilizes the Bragg Peak phenomenon to concentrate radiation dose within the cancer while minimizing damage to surrounding healthy tissues. This research compares two proton dose delivery techniques Passive Scattering (PS) and Pencil Beam Scanning (PBS) in the context of dose optimization. Dose optimization here refers to achieving sufficient dose coverage to the Planning Target Volume (PTV), minimizing radiation to surrounding organs at risk (OARs), and the efficiency of dose delivery time. The comparison was conducted through Monte Carlo-based simulations using PHITS version 3.34. Simulation was chosen due to ethical and safety concerns of real patient. A mathematical head phantom was used to simulate dose distributions to the cancer and surrounding OARs. Results indicate that PBS achieved 100.1% coverage to the PTV, while PS delivered only 94.7%, slightly below the recommended minimum by ICRU which is from 95% - 107%. PBS also resulted in lower equivalent doses to nearby organs such as the brain and salivary glands. In terms of delivery time, PBS completed dose deposition in 528 seconds, almost half of PS's 1.040 seconds excluding treatment planning procedures. In conclusion, PBS demonstrates superior dose optimization by offering better cancer coverage, reducing exposure to surrounding tissues, and enabling more time-efficient irradiation during the therapy session.

Keywords: Bragg Peak, Monte Carlo, NPC, PHITS, Proton