Real-Time Beam Monitoring Device Based On Cherenkov Effect For FLASH RT With Charged Particle Beams

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1 Background and Aims

FLASH RT requires real-time beam monitoring with minimal impacts on the beam, for which currently there are no obvious solutions free of saturation effects at high dose rates. We propose a miniaturized particle counter device based on the Cherenkov Effect, displaying no saturation effects, suitable for real-time monitoring of charged particle beams. We aim to estimate the number of beam particles by measuring the number of detected Cherenkov photons.

2 Methods

The developed device consists of a thin radiator placed in beamline coupled to a photodetector. Our concept has been developed theoretically and in simulation with the Geant4 toolkit. Due to the constraint of producing and detecting Cherenkov radiation, which is related to the beam particle and energy and the material's refractive index, we investigated which materials could be used as radiators. On the other hand, in simulation, we evaluated the radiator's impact on dose distribution in a water phantom.

3 Results

We concluded that the number of detected photons increases linearly with the number of beam particles, thus avoiding saturation effects - it is also proportional to the radiator's thickness. Therefore, we can provide real-time feedback to the machine with a fast photodetector and fast electronics. Regarding impacts on the beam, the presence of a radiator resulted in deviations at the millimeter scale in the transversal dose profiles.

4 Conclusions

We will present a concept based on Cherenkov Effect to monitor and give real-time feedback in FLASH radiotherapies. We found a linear relationship between beam particles and detected photons and minimal impacts on dose profile. This device, designed to meet the need of real time beam monitoring for FLASH RT, can be used for electron, proton and heavy ions beams.

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