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Progress in Particle Therapy Enabled by Technology

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Particle and in particular proton therapy is a form of radiation therapy that is successfully used to treat tumors. The physical properties of the protons allow precise irradiation of the tumor volume and optimal sparing of the surrounding healthy tissue. To achieve this, not only the number of protons but also their kinetic parameters must be precisely modulated. When the therapy was clinically introduced, the protons were adapted to the target volume using mechanical means such as scattering foils and collimators.

More than 20 years ago, the development of spot scanning technology started, in which the protons are directed electronically controlled to the right position with the help of magnets. This new technique also allowed the implementation of intensity-modulated proton therapy, which allows even more optimal dose distributions. This development was coupled with the availability of powerful computers, which made the optimization of the dose possible at all. Since the last 10 years the spot scanning technique has gained acceptance and made a crucial contribution to the establishment of proton therapy.

The aim of current developments is to make irradiations even more dynamic and to reduce the treatment duration. For this purpose, the proton current can be varied from spot to spot or the protons are continuously scanned over the target (line scanning). This requires a precise adaptive controller for the proton current, which is directly connected to the actuators of the proton accelerator. Another important parameter is how fast the energy of the protons can be changed. As a result, the demands on the verification system are also increasing. The beam parameters must now be monitored in real-time and it must be possible to interrupt the proton beam in fractions of a ms. In order to achieve this, parts of the control and monitoring algorithms must now be implemented directly in hardware using FPGAs.

All these developments towards even more dynamic radiation modalities will open up new clinical possibilities. Such highly dynamic radiation modes will play an important role in the treatment of so-called mobile tumors (e.g. lung tumors) and thus offer new perspectives for proton therapy.

Minioral

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