Towards helium ions for radiotherapy

F. Schmitz[1,2]*, M. Krämer*[2]*, and M. Durante*[2]
[1]Univ. Heidelberg; [2]GSI, Darmstadt, Germany

Rationale

The majority of ion beam radiotherapy sites uses protons, but an increasing number also applies heavier ions such as carbon. However, there might be room between these two, in particular for the helium isotopes. One of the major drawbacks of protons, for example, is the beam broadening due to multiple scattering. This is expected to be significantly reduced for helium beams, Fig.1.

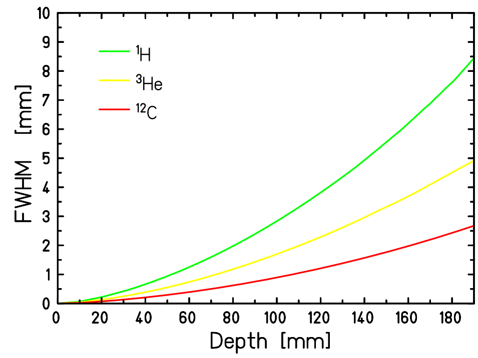

Figure 1: Beam broadening due to multiple scattering.

Beam Modelling

Only few basic data are available to construct the pencil beam model for treatment planning with our inhouse TRiP98 system [1]. For ^{3}He previous work exists [2], based on GSI measurements. For ^{4}He, a literature search was performed to obtain basic cross section data and a semi-empirical model was established [3]. Fig.2 shows total nuclear reaction cross sections, one of the main ingredients to calculate depth dose distributions, since they determine the degradation of the ion beam as it passes tissue.

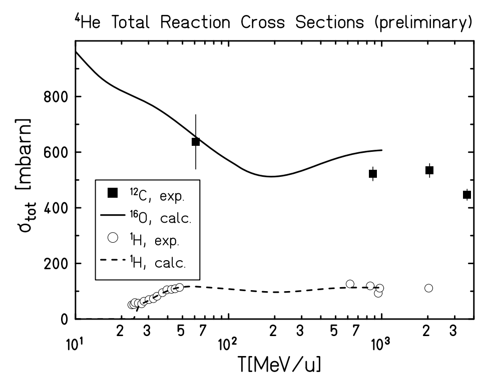

Figure 2: Total reaction cross sections.

Results

Fig.3 shows typical depth dose distributions for various modalities applicable to tumour sites at approximately 15cm depth. Compared to protons, the helium Bragg peak is sharper, and compared to carbon ions, the fragmentation tail is significantly reduced. Only small differences are expected between the two helium isotopes.

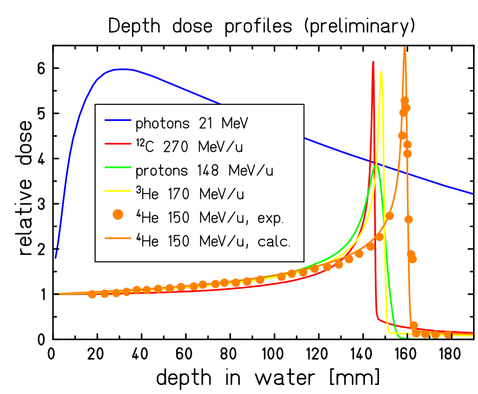

Figure 3: Depth dose distributions for various modalities.

Outlook

Since HIT is commissioning therapeutical ^{4}He beams, it would be attractive to perform further validation measurements. However, only comparative treatment planning studies involving multiple ions will allow proper assessment of potential benefits.

References

[1] M. Kraemer, E. Scifoni, C. Waelzlein, M. Durante, "Ion beams in radiotherapy - from tracks to treatment planning" J. Phys.: Conf. Ser., 373 (012017) : (2012)

[2] G. Kragl, "Tumortherapie mit schweren Ionen: Anpassung des Strahlmodells für ^{3}He", Diplomarbeit TU Wien, 2006; GSI Report Dipl. 2006-01

[3] F. Schmitz, "A semiempirical beam model for ^{4}He projectiles in ion beam radiotherapy", Master Thesis Univ. Heidelberg, 2013

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