Narrow-band orthovoltage x-ray generators for cancer therapy: Why? and How?

F J Currell[1], K. Butterworth[1], A P Kavanagh[1], S McMahon[1], M H Mendenhall[2] and D G Hirst[1]

1. Queen's University Belfast, Belfast BT7 1NN, United Kingdom
2. Vanderbilt Univ. FEL Centre, Nashville, TN 37235-1816 USA

E-mail: f.j.currell@qub.ac.uk

Our cross-disciplinary research programme of developing suitable narrow-band x-ray generators and using them to perform the relevant radiobiological studies will be described. The reason (*Why?*) is to develop narrow-band x-ray sources able to irradiate gold just above its K-edge. After the context of nano-particle mediated contrast enhancement has been described, two promising means (*How?*) for the required x-ray generation will be introduced: impact of highly charged ions on surfaces and impact of electrons on heavy-atom targets.

One of the major health-care challenges is the development of new treatments for cancer. Even radiotherapy, one of the major forms of treatment, fails in 30-95% of all such treatments, depending on circumstance [1]. Critical normal structures (e.g. sensitive organs) in the vicinity of the tumour can limit the dose that can be given. Increase of the dose given to a patient's tumour might be possible through the use of Gold nano-particle contrast agents preferentially taken up by tumours [2] and then irradiated in conjunction with a suitable narrow-band x-ray irradiation source.

On the grounds of dose enhancement alone for a wide range of tumour sites, narrow-band orthovoltage radiation just above the K-edge of gold should be competitive with traditional linac-based approaches to radiotherapy. Additionally this approach is likely to have particular features which would make it particularly suited to implementation in the third world where cancer incidence is rising alarmingly. Furthermore, there are strong reasons to suppose that additional radiobiological factors produce enhanced cell killing at the tumour site, beyond that simply predicted by the absorbed dose. This assertion is also supported by our recent measurements which will be described.

References:
[1] Steel GG. Introduction: the significance of radiobiology for radiotherapy. in; Basic Clinical Radiobiology, GG Steel, Ed., Arnold, London, 2002, pp1-7.
[2] Hainfeld JF, Slatkin DN, Smilowitz HM. The use of gold nanoparticles to enhance radiotherapy in mice. Phys Med Biol 2004;**49**: N309-15.