

## **Imaging-Therapy Computed Tomography with Quasi-Monochromatic X-rays**

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### Introduction:

Computed tomography (CT) working in the 50 keV range is a widespread and highly precise technique for radiological diagnosis. For radiotherapy, however, the MeV energy range offers better dose distributions. This gap between diagnosis and therapy can be overcome by the use of CT in combination with a photoelectric radiation enhancer (e.g. x-ray contrast media) targeted to the region of interest (tumor). Monochromatic x-rays tuned to the maximum dose amplification range of the radiation enhancing element can significantly improve CT based radiation therapy. In diagnostics the change from polychromatic to monochromatic x-rays increase imaging contrast and lower radiation burden. The current work presents a near monochromatic CT optimized for radiotherapy.

### Material and Methods:

The experimental setup consists of an x-ray monochromator and concentrator module mounted at the exit of the x-ray tube of a clinical CT. The module was designed to convert polychromatic radiation into high flux, quasi-monochromatic radiation in an energy range optimized for photoelectric radiation enhancement. Furthermore, the module converts the CT fan beam into a pencil beam. The radiation was characterized using a detection system consisting of an energy-dispersive CdTe-detector and a Kapton scattering foil. The detection system was calibrated in the calculable synchrotron radiation of a wavelength-shifter at the storage ring BESSY II. Dose measurements were performed by gel dosimetry.

### Results:

The monochromator module filters selectively the energy of the tungsten K-alpha emission line (59.3 keV) with a FWHM of 5 keV and concentrates the monochromatic radiation in the focal spot (3.5 mm by 3.5 mm) which coincides with the isocenter of the gantry. The x-ray source rotates around the center of the gantry leading to a steep radiation dose gradient. Thus, the radiation is concentrated to the target volume and the surrounding healthy tissue is spared. In comparison with polychromatic the quasi-monochromatic x-rays increase the photoelectric radiation enhancement by about 30% for iodine or gadolinium.

### Conclusion:

An additional monochromatic module allows the combination of diagnosis and radiotherapy on a clinical CT. The module was designed for radiotherapy in combination with a photoelectric radiation enhancer.

**KEYWORDS:** x-ray concentrator, monochromatic computed tomography, contrast enhanced radiotherapy