AbstractID: 11214 Title: Coherent Bremsstrahlung in Image Guided Radiotherapy

Purpose:
To determine the suitability of coherent bremsstrahlung (CB) from monocrystalline targets for improving the quality of megavoltage imaging in radiotherapy by selectively enhancing the amount of photons in the energy range useful for diagnostic applications.

Method and Materials:
A theoretical investigation of CB was carried out in first-order Born approximation. The interaction cross-sections derived allow to study features of CB particularly at electron energies in the low MeV regime as used by common clinical linear accelerators. Special emphasis was placed on the comparison with incoherent bremsstrahlung, arising simultaneously. Photon energy distributions were calculated for electron beams hitting various monocrystalline targets at different angles with respect to major crystal axes. The suitability of various elemental crystals for creating low energy photons from megavoltage electrons was determined.

Results:
Examination of the cross-sections identified diamond and tungsten crystals to be capable of significantly reducing average photon energies when used as bremsstrahlung targets. The mentioned effect is especially pronounced at electron energies between 10 and 20 MeV and, on a cross-section level, outperforms ordinary bremsstrahlung produced with 5 MeV electron beams. In case of tungsten a further enhancement can be achieved by cooling the target.

Conclusion:
Monocrystalline targets carry the potential of creating considerably softer photon spectra than common amorphous or polycrystalline materials. They also offer the possibility of tuning the photon energy distributions by rotating the crystal with respect to the direction of the incident electron beam. Experimental realization, however, appears challenging as the emitted x-rays are mainly concentrated in the forward direction, thus being unable to illuminate fields of view large enough for IGRT. An array of differently oriented crystals hit by a divergent electron beam is thought to circumvent this limitation.