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Relative energy response of an OSLD system for RT dosimetry in the keV energy range

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Background

This work studies **the beam quality correction factor, k_Q,** for application of the latest commercial Optically Stimulated Luminescence Dosimetry (OSLD) system based on **BeO** ceramic in **the keV energy range** (including both **medium-dependent energy dependence, $k_{Q,M}$,** and **intrinsic energy dependence, $k_{Q,INT}$**).

Materials & Methods

OSLDs (myOSLchip, RadPro Int. GmbH) were irradiated in solid water using a 6MV linac beam, and in air using the 9 beam qualities of an orthovoltage therapy system (XStrahl200, XSTRAHL LTD). This provided the calibration coefficient $N_D = \frac{D_w}{M}$ for the different beam qualities, Q_i, and in turn $k_Q = \left(\frac{D_w}{M}\right)^{Q_i}_{Q_{ref}=6\,MV}$. $k_{Q,M} = \left(\frac{D_w}{D_{BeO}}\right)^{Q_i}_{Q_{ref}=6\,MV}$ was approximated using Burlin cavity theory with data from NIST for the max E, mean E, and full spectrum of Q_i, and 3 models for the derivation of mean chord length. $k_{Q,INT} = \left(\frac{D_{BeO}}{M}\right)^{Q_i}_{Q_{ref}=6\,MV}$ was estimated by **the ratio of k_Q by $k_{Q,M}$**.

Results

k_Q increased (system under-responds) with decreasing energy (up to 1.60 for Q_i with 24 keV mean E). $k_{Q,M}$ increases as energy decreases (up to 1.11 for Q_i with 24 keV mean E), in agreement within 2% with the literature. These results imply a considerable intrinsic energy dependence with **$k_{Q,INT}$ up to 1.45 for 24 keV mean E**.

Conclusion

$k_{Q,INT}$ must be considered in myOSLchip based absolute dosimetry in brachytherapy or orthovoltage beams. Relative dosimetry necessitates the careful review of spectral changes. Accurate $k_{Q,INT}$ estimation requires further work. Its effect can be abated by use of reference quality close to the experimental one at the expense of increased uncertainty.

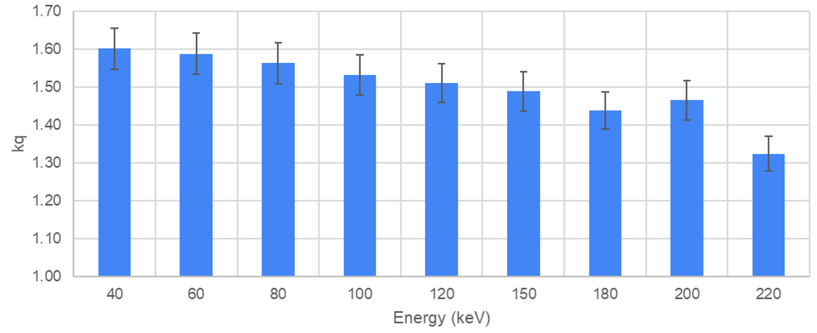

Fig. 1: Beam quality factor (k_Q) in the keV range (E shown are max E for the Q_i used) relative to 6 MV

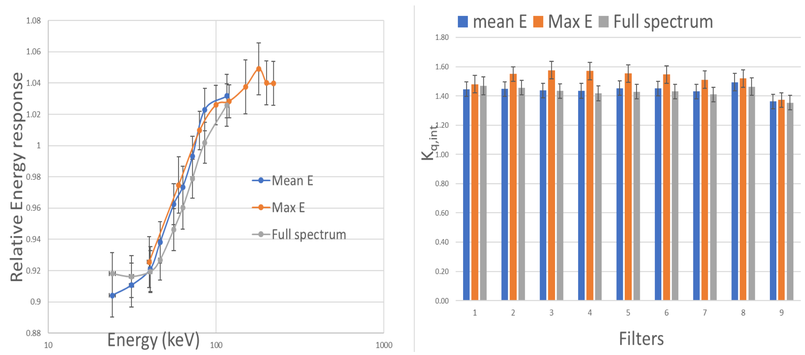

Fig. 2: (Left): Relative energy response ($1/k_{Q,M}$) versus beam quality Q_i, calculated using Burlin cavity theory for mean E, max E and full spectrum of Q_i
(Right): corresponding results of intrinsic energy dependence $k_{Q,INT}$ versus beam quality Q_i