Investigation of beam quality correction factors for flattening filter free beams

Mårten Dalaryd[1,2], T Knöös[1,2], Crister Ceberg[2]

[1]Department of Oncology and Radiation physics, Skåne University Hospital, Lund, Sweden

[2]Department of Medical Radiation Physics, Lund University, Lund, Sweden

OBJECTIVES

It has previously been shown that the use of a dual beam quality specifier consisting of two tissue-phantom ratios, $TPR_{20/10}$ and $TPR_{10/5}$, provides an accurate prediction of stopping power ratios ($s_{w,air}$) for flattening filter free (FFF) photon beams. For the current project, the intention was to evaluate this dual beam quality specifier on Monte Carlo calculated k_Q factors used in radiotherapy reference dosimetry.

CONCLUSIONS

Beam quality conversion factors for NE2571 and FC65-G farmer type ionisation chambers have been calculated, for beams with and without a flattening filter (Fig 1). Differences between beams with and without a flattening filter were found to be 0.1-0.3 %. An overestimation of k_Q factors for conventional photon beams of up to 0.9 % was found using TRS398. Using a dual beam quality measure, consisting of both $TPR_{20/10}$ and $TPR_{10/5}$, k_Q factors could be predicted to within 0.12 %. Although the difference between FF and FFF beams is small, it is a systematic difference which can be accounted for.

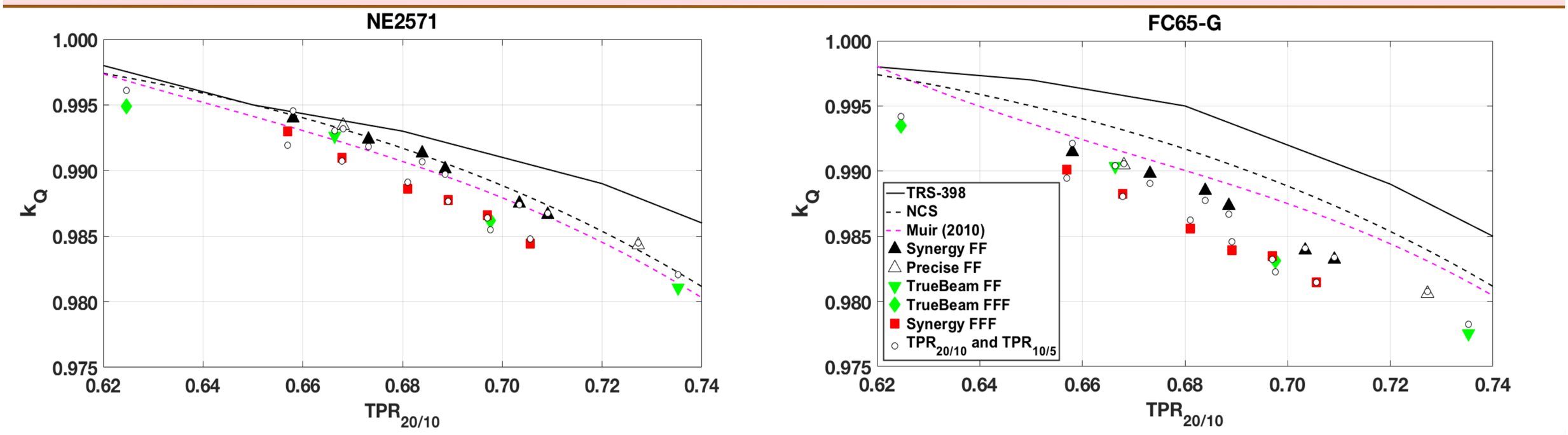

Fig. 1 Monte Carlo calculated k_Q factors for beams with flattening filter (triangles) and FFF beams (squares and diamonds) for NE2571 (left) and FC65-G (right). Open circles represents the bi-linear fit using $TPR_{20/10}$ and $TPR_{10/5}$. Also included are fits from TRS-389, NCS and Muir et al. (2010).

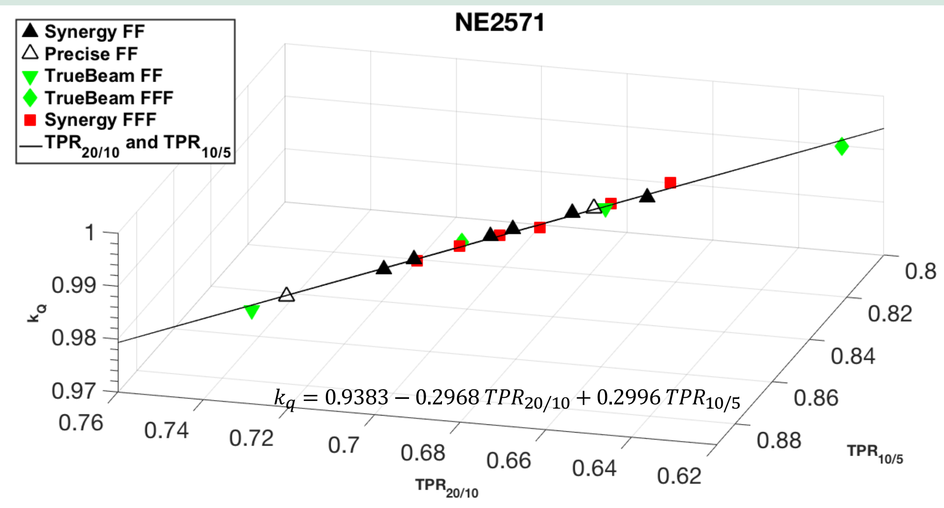

Fig 2. Beam quality correction factors for the NE2571 shown as a function of $TPR_{20/10}$ and $TPR_{10/5}$. The solid line represents the plane fitted to the calculated k_Q factors.

MATERIAL AND METHODS

Two different ionisation chambers were used in the simulations, NE2571 and FC65-G. Calculations of k_Q factors, $TPR_{20/10}$ and $TPR_{10/5}$ were performed using EGSnrc, and the chamber geometry was acquired from technical specifications from the manufacturer and from previously published articles. A total of 18 photon beams (10 with flattening filter (FF) and 8 flattening filter free) were modelled.

RESULTS

For the FFF beams, the calculated beam quality correction factors were found to be 0.1-0.3 % lower than for the beams with a flattening filter at the same $TPR_{20/10}$. Using data from TRS398 overestimated k_Q by up to 1 % for FFF beams but also up to 0.9 % for FF beam for the FC65-G chamber. The corresponding numbers for the NE2571 were 0.6 % for both FF and FFF beams. Using the dual beam quality metric fitted to the calculations, k_Q factors could be predicted within 0.12 % for all beams. In Figure 2 the correction factors are shown to lay on a plane in a three dimensional space. In Figure 3 the results from this study for the NE2571 are shown together with published data both measured (symbols and dashed black line) and Monte Carlo calculated (blue and magenta dashed lines).

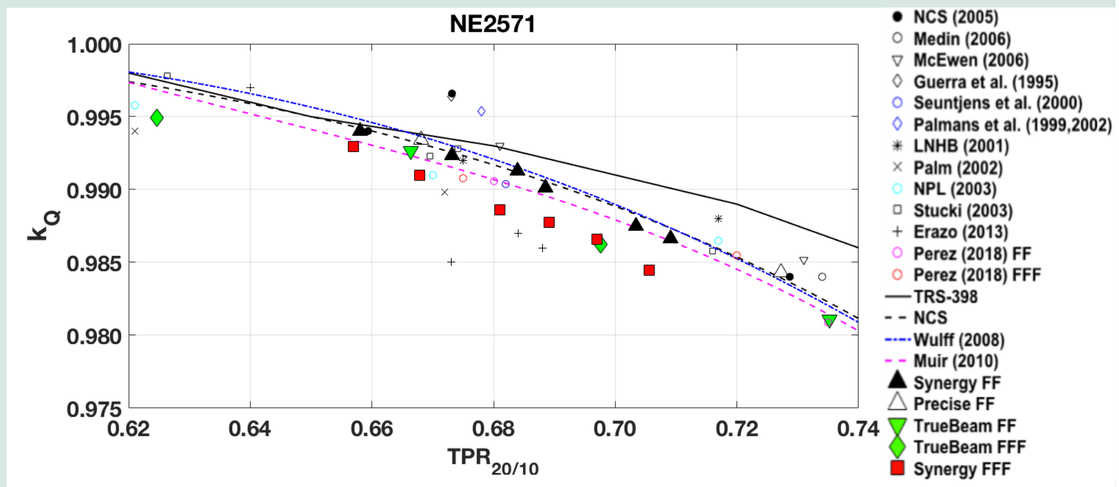

Fig 3. Beam quality correction factors for the NE2571 shown as a function of $TPR_{20/10}$. The large data points represents calculated values from the current study and the smaller data points are published measured k_Q factors. The solid black line represents data from TRS398 and the dashed black line is from the Dutch NCS protocol. The dashed magenta and blue lines are fits to Monte Carlo calculated values.

Mårten Dalaryd | Skåne University Hospital, Lund University | marten.dalaryd@med.lu.se