AbstractID: 11208 Title: Studying the effect of ionization chamber measurements in low-density media using Monte Carlo simulation

Purpose:
The use of small fields in radiotherapy has become widespread with techniques such as IMRT and stereotactic radiosurgery. Dose measurement in small fields in a low-density medium must be corrected for the replacement perturbation effect. This effect occurs when measurements are performed with an ionization chamber whose walls are made of water equivalent materials. Electron fluence is locally perturbated by the detector itself and the measured absorbed dose is overestimated by a factor which depends on the field size. The goal of this work is to investigate the behavior of the detector reading as a function of the detector size.

Method and Materials:
Replacement perturbation factors of an A1SL ionization chamber (Standard Imaging, USA) were calculated as a function of the field size and the medium density. Monte Carlo simulations were performed with the OMEGA/BEAMnrc code, previously validated in heterogeneous conditions. The absorbed dose to water was calculated at 10cm depth in a phantom composed of slabs of 5cm water, 13cm lung and 10cm water (5cm in the heterogeneity) and normalized by the value at 2.5cm.

Results:
The replacement perturbation factor is negligible for large fields, but increases for small fields and as the density decreases. In a lung-equivalent material (relative density = 0.2), the error due to the replacement perturbation effect can be as high as 20% with a 1 x 1 cm^2 field measured by a A1SL ionization chamber (suitable for small field measurements).

Conclusion:
The replacement perturbation factor becomes very important as the field size becomes smaller and must be taken into account when measuring in low-density media.