Purpose:To validate a novel hybrid method for the calculation of kilovoltage (kV) x-ray dose.

Methods:We performed experimental validation of a novel hybrid approach for calculating dose deposited by imaging beams (<150 kVp). The approach involves computing the primary photon component deterministically and scattered component stochastically, accounting for the real micro cross sections of the materials involved. Depth dose and profile measurements for the Varian® On-Board Imaging® unit in the radiographic mode using a 125 kVp x-ray beam (4.6 mm Al half-value layer) were performed. The measurements were made using a Farmer-type Capintec ion chamber (0.06cc) in homogeneous and heterogeneous phantoms. A phantom consisting of Certified Therapy-Grade Solid Water® (Gammex 457) was used to measure the dose under homogeneous conditions. The heterogeneous phantom was constructed using lung-equivalent material (Gammex 455) and bone-equivalent material (Gammex 450).

Results:Measurements in the homogeneous phantom agreed with theoretical calculations within 2% for depth doses and within 2% of the central axis dose for profiles. Local agreement in highly attenuated regions such as depths >10 cm or outside the beam edge were about 10%. However, the dose differences in these regions were less than 2% of the maximum dose.

Conclusions:This work provides experimental validation of our hybrid calculation method. The next step will be to test the algorithm using more complex phantoms, such as the anthropomorphic Rando® phantom, which mimics patient geometry as well as inhomogeneities. This is a crucial step in the validation of an independent tool to calculate patient dose from kV beams such as cone-beam CT and brings us closer to our goal of calculating patient-specific dose from imaging procedures.