Purpose:A theoretical and experiment based validation of the detector design, manufacturing and imaging performance of a prototype fiber-optic scintillation glass array (FOSGA) for megavoltage imaging is presented.

Methods:FOSGA is an emerging technology for radiotherapy image guidance consisting of high quantum efficiency scintillation glass fibers inserted into a tungsten-polymer septal grid and coupled to a-Si flat-panels. A small-field prototype detector (8 cm x 8 cm, 9 mm thickness) was constructed using 0.9 mm diameter scintillation glass fibers (1.1 mm pitch, 0.1 mm septa). Detector components were obtained and assembled using patented technology for grid fabrication (tomolithographic molding), fiber drawing, and mechanized fiber insertion. Currently, optical read-out is achieved using photographic film (~ 75% sensitivity at peak emission wavelength). Imaging measurements for modulation transfer function (MTF) and detective quantum efficiency (DQE) were conducted to verify imaging performance, while initial tests for array fabrication and assembly were conducted (TLM precision, robotic loading parameters, etc).

Results:The prototype FOSGA imager yielded good image quality (DQE measured ~ 0.05 vs DQE computed = 0.07), indicating an improvement over current commercial megavoltage imagers (DQE < 0.02). Feasibility studies for detector fabrication and automated fiber insertion were highly successful with < 50 micron grid fabrication accuracy, and nearly 100% robotic loading success.

Conclusions:This study validated the FOSGA design and component technologies used for manufacturing and assembly. The small-field image quality measurements will be used as a benchmark for a future large-field imaging system using thicker scintillator arrays with finer sampling (DQE ~ 0.25 at 0 cy/mm expected). The superior imaging properties of FOSGA supported by viable mechanisms for fabrication make it a strong candidate for low dose megavoltage cone-beam CT with soft-tissue contrast visualization.