Purpose:
Prompted by a desire to increase the complexity and precision with which radiation can be distributed at the small scale demanded by preclinical studies, several institutions have developed dedicated platforms for small animal irradiation research. Such systems have the potential to probe the physiological response of spatially inhomogeneous dose distributions in the controlled preclinical environment. The performance of such a system (Xrad225Cx, Precision X-Ray, Inc., North Branford, CT) in terms of its ability to spatially modulate dose was assessed for a dose pattern broadly characterized as 'grid' therapy.

Methods:
By programming the animal positioning stage to move between a series of irradiations, complex dose patterns can be delivered. A spatially modulated grid irradiation pattern consisting of a 5x11 array of irradiations delivered with a fixed 1 mm diameter circular collimator and a 2 mm distance between the isocenter of each irradiation was delivered. Individual irradiations were performed for 30 seconds at an energy of 225 kVp and current of 13 mA. Gafchromic EBT2 radiochromic film placed between two 4.9 mm thick water equivalent slab phantoms was used for quantitative dosimetric analysis. After irradiation, the films were scanned at a resolution of 400 DPI (~0.06 mm/pixel).

Results:
The 55 separate irradiations forming the 'grid' pattern were delivered with 93% of the irradiations within 0.15 mm of the desired 2.0 mm spacing. Dose falloff from each individual irradiation was rapid with a typical falloff of 1.24 Gy / mm (57% / mm). The dose-depth curve was roughly exponential with a decay constant of 0.040 / mm.

Conclusions:
The preliminary characterization of the delivered dose demonstrates the ability of the small animal irradiation platform to deliver precisely modulated dose distributions comparable to that employed in 'grid' therapy. This dosimetric capability holds promise for in vivo radiobiological studies of complex radiation delivery schemes.

Funding Support, Disclosures, and Conflict of Interest:

Some of the co-authors are inventors of the small animal irradiation system described herein, and may financially benefit through its successful commercialization by Precision X-Ray, Inc.