AbstractID: 7098 Title: Charge trapping in a prototype Active Matrix Flat Panel Dosimeter and its implications

Purpose:
This work models charge trapping behavior of a prototype Active Matrix Flat Panel Dosimeter (AMFPD) using three parameters and explains a number of published observations. An understanding of charge trapping and release is necessary to estimate non-linearities in the AMFPD response due to trapping and to correct artifacts in the resulting dose image.

Method and Materials:
The AMFPD consisted of an amorphous silicon flat panel imaging array operated without a phosphor screen. Fluoroscopic and radiographic modes were used to obtain a series of fixed field dosimetric measurements at different doses and dose rates. Data were acquired in order to test the assumptions upon which the model was based:

(1) Trapped charge density in the metastable defects can be described by a stretched exponential function, $N(t)=N_0\exp[-(t/\tau)^{\beta}]$.
(2) Trapped charge starts to release from the trapping centers when the photodiode is recharged.
(3) Charge release is not affected by subsequent irradiations when the dose per frame is small.
(4) The charge trapping rate depends on bias voltage and varies slowly with dose when the dose is small.

Model stretch parameter β, time constant τ, and the charge trapping rate p were determined from a fit to the pixel signal decay following irradiation. These parameters were then applied to simulate results for the AMFPD operated in fluoroscopic mode based on the above assumptions.

Results:
The simulated results agreed well with the measurements. It was determined that β is constant for a detector array, τ depends on bias voltage, and the charge trapping rate depends on bias voltage and dose. Furthermore, the model qualitatively explains observations reported in published papers on charge trapping.

Conclusion:
A three parameter model was found to successfully describe the behavior of charge trapping and release at different values of bias voltage, frame rate, dose rate and dose.