AbstractID: 4841 Title: A novel signal-processing strategy for in vivo ultrasonic imaging of brachytherapy seeds.

Purpose:
Brachytherapy is proving to be a well-accepted means of treating prostate cancer. Unfortunately, implantation using needles inserted transperineally causes gland movement, and the resulting distortion may cause seed misplacement and dosimetry errors. Our approach employs novel methods of digitally processing ultrasound echo signals to markedly improve ultrasonic imaging of seeds during the implantation procedure. This approach will enable the radiation oncologist to determine where all implanted seeds are located and to make additional implantations to correct for dosimetry errors cause by misplaced seeds.

Method and Materials:
Our signal-processing strategy uses singular spectrum analysis (SSA) and shows promise for ultrasonically detecting and imaging radioactive seeds implanted in the prostate. This SSA-based strategy utilizes pairs of eigenvalues derived from the autocorrelation matrix of envelope-detected radiofrequency echo signals to identify seed-specific signal repetitions. The power spectrum associated with a repetition signal is computed to derive a P-value indicative of the likelihood of the presence of a seed at the location of that repetitive signal. P-values throughout each scan plane are then color-coded and superimposed on the corresponding conventional grayscale ultrasound images. These new ultrasound images are thus readily usable by clinicians to locate seeds.

Results:
Simulations assessing performance as a function of different levels of white and speckle noise and in the presence of signals at repetition periods not associated with seeds; experiments in an ideal scattering environment; and *in vitro* experiments using seeds implanted in beef were conducted and led to encouraging results. Simulations showed robustness to noise (signal-to-noise ratio < 25 dB) and *in vitro* experiments allowed for seed detection and imaging.

Conclusion:
Overall, our SSA-based strategy shows encouraging potential for seed detection and imaging in the operating room. Clinical implementation of this methodology would be straightforward because it uses enveloped-detected signals directly available from clinical scanners.