AbstractID: 3144 Title: Simple acoustic beam model for thermoradiotherapy implemented in an open source treatment planning research system

Purpose:
Several clinical trials have shown that hyperthermia can significantly increase both local tumor control rates and duration of local control, significantly improving the quality of radiation treatment. No existing treatment planning systems provide tools for planning and analyzing thermal and radiation doses simultaneously in the same volume of interest. We propose to modify our Matlab-based open-source-code system CERR (Computational Environment for Radiotherapy Research) for the development of thermoradiotherapy treatment planning (radium.wustl.edu/cerr).

Method and Materials:
We implemented a simple exponentially attenuated acoustic beam model in CERR, accounting for reflection, transmission and refraction of the primary beams. The model applies to sub-volumes that are assumed "homogeneous" (air, soft tissue, bone), that make up a composite "heterogeneous" total computational volume, and that account for interface phenomena, i.e. reflection, transmission and refraction of the primary beams at impedance mismatched interfaces between sub-volumes.

Results:
We calculated the SAR (specific absorption rate) for a single acoustic beam at 3.5 MHz for a chest wall breast plan. The field size was 12cm x 12cm. Calculation of a single beam takes approximately 60 seconds for plan size of 512x512x131 voxels. The power deposition of this beam for the CERR plan is shown. An attenuation profile for the beam is shown. The model correctly shows zero SAR values outside the beam and in the lung areas.

Conclusion:
We propose tools to display SAR, temperatures, thermal doses, hybrid thermo-radio-therapy doses, etc., simultaneously, along with calculation of volume histograms for the various dose parameters. Significant advances in clinical thermoradiotherapy have been hampered by the lack of advanced treatment planning systems. We are embarking on a long-term project to develop a CERR-based system for superficial ultrasound hyperthermia that includes implementation and validation of complex acousto-thermal numerical models. The system will be freely distributed to the hyperthermia research community for IRB-approved research.