# Automated Brachytherapy Calibration: System and Phantom Design

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**Purpose:** Success of transperineal brachytherapy treatment for prostate cancer critically depends on the accurate positioning of the implanted radioactive seeds. For this reason, the transrectal ultrasound (TRUS) image, the electronic encoder of the probe stepper and the needle insertion template must be spatially (and temporally) co-registered. Building off the automated brachytherapy calibration system developed by Chen *et al*. [1], this paper presents a design that will allow for automated calibration of both the sagittal and transverse transducers of the TRUS probe, as well as for making it easy for the medical physics staff to store, transport and setup the integrated system.

**Methods:** The needle insertion template and calibration phantom is built as a single body. The unibody design allows for directly computing the coordinate transformation between the phantom and template. In the design of the system, Standard Engineering Design Methodology was followed, consisting of problem definition, background research, requirement specifications, alternative solutions, and design selection.

**Results:** The proposed design contains three main components: the mounting system, the phantom, and the cart, as can be seen in Figure 1. The mounting system is a simple freestanding vertical mount composed of welded A36 steel weighing approximately 15 lb. and containing a small polyester rope ratchet that provides a horizontal force to hold the stepper in place. This design allows for a stable and easy method of mounting the TRUS probe in a water container without getting the stepper wet. Similar to previous transverse phantom design, the new dual-plane phantom will be composed of ABS plastic and manufactured using a 3D printer. A grid of holes on each side of the phantom will be placed to allow fiducial wires to run in optimal directions and with optimal spacing (Figure 2). The fiducial wires will provide bright image points in both sagittal and transverse planes. The calibration software automatically segments these points and, by knowing 3D configuration of the fiducial wires, computes the calibration parameters. The integrated system will be contained in a cart with a fixed water container, a storage component, and a place to use and store a laptop, with the objective of making the system user-friendly, easy to transport and easy to store in a standard brachytherapy care facility.

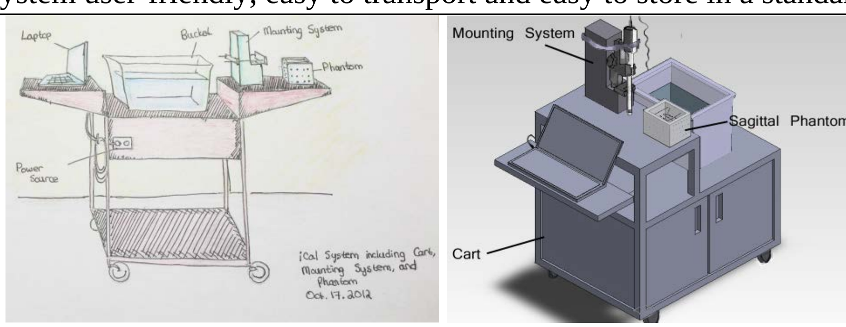


**Fig 1.** Hand drawing (left) and preliminary CAD design (right) of proposed calibration system setup

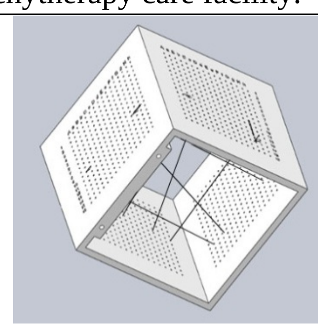

**Fig 2.** CAD model of the phantom's wiring grids

**Conclusions:** The proposed design will provide a simple and convenient apparatus to contain the calibration system which will ensure that the device is calibrated accurately and with minimum manual work and user interaction. The dual-plane phantom design has the potential to increase the accuracy of system by allowing calibration in a both the transverse and sagittal image planes. The next steps are to prototype, redesign as necessary, and experimentally validate the apparatus and associated software.

[1] TK Chen, T Heffter, A Lasso, Cs Pinter, P Abolmaesumi, EC Burdette, G Fichtinger, Automated intraoperative calibration for prostate cancer brachytherapy, Med. Phys. 38(11), 6285-6299 (2011)