Purpose: To investigate the hardware necessary for implementing our Dynamic Modulated Brachytherapy (DMBT) treatment concept for rectal cancer.

Methods: The DMBT robot has three major parts: 1) shield and shield delivery module, 2) controlling module, and 3) DMBT controlling and monitoring software. The shield is a tungsten alloy cylinder (r=0.95cm, l=4.5cm) with a 5.5mm rectangular-shaped opening. The shield is controlled by an aluminum pipe with gear set (1:3) and linear actuator (2mm/turn). An Ir-192 radiation source will be placed through the aluminum pipe. The power source is a Nema-17 stepping motor with EvoDrive ST-17 (EVA Robotics, Queensland, Australia) and USB-6009 DAQ (National Instrument, Austin, TX). With our in-house operating program through LabView (National Instrument, Austin, TX), we can make and load plans for treatment as well as testing. Checking the shield position is also possible through the operating program. For safety, a lexan sheath tube and emergency buttons are built-in.

Results: The DMBT robot has 2 degrees of freedom, which are linear translation and rotation. With our power delivery system, the spatial resolutions are 0.0125mm (linear stage) and 0.012° (rotation). In 0.5s, motors achieve the desired position with the maximum speeds 450 step/s (1°), 7,500 step/s (30°), and 12,000 step/s (5mm). Four registers are triggered with USB-6009 DAQ signals. The operating program includes gages for checking shield position, loading treatment plans, and safety buttons.

Conclusions: In all, we have designed the hardware components of the DMBT system for rectal cancer. For treatment, the system needs more elements to support the DMBT robot; lexan sheath tube holder, DMBT robot security joint, and a system for reducing friction between the tube and shield. We will also refine our system to be more compact by using DC servomotors instead of the larger Nema-17 stepping motors.