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Commissioning of Xstrahl SARRP in the μ-RayStation Treatment Planning System

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INTRODUCTION

Modern image-guided small animal irradiators mimic clinical radiation delivery systems scaled to the dimensions of a mouse or rat, including all modern tools such as 3D imaging, millimeter-scale delivery, and treatment planning.

Both leading manufacturers of such irradiators – Precision X-ray and Xstrahl, offer treatment planning systems (TPS) commissioned entirely off-site. While convenient for average users, physicists have no mechanisms to adapt the TPS to specific irradiators or circumstances, i.e. low-dose rate delivery, or different x-ray energies.

AIM

We commissioned an Xstrahl small animal radiation research platform (SARRP) for μ-RayStation 8B, the first commercially available third-party TPS.

Unlike currently commercially-available manufacturer-specific TPS, μ-RayStation is based on a clinical platform which can be commissioned directly by the end-user to match their specific irradiator or a particular scenario.

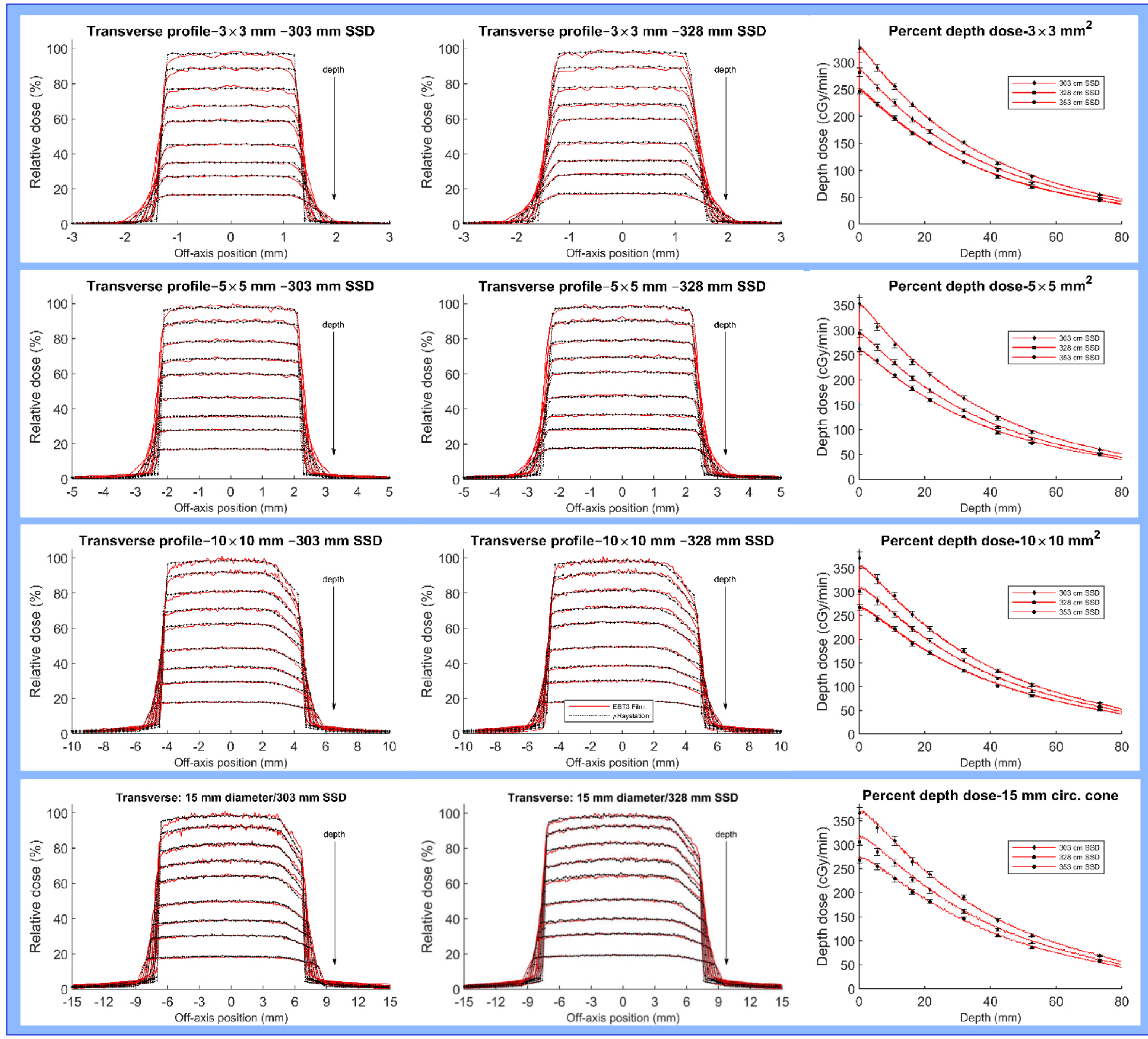
METHOD

EBT3 Gafchromic film calibrated in the 0-8 Gy range at 2 cm depth in solid water were irradiated in the Xstrahl solid water commissioning jig at depths of 0-8 cm for all collimators at 3 different source to surface distances (SSD). Profiles along the transverse (x) and radial (y) axes were calculated for comparison with the TPS beam model.

The spectrum of the SARRP was modelled using SpekCalc (Poludniowski et al., Phys Med Biol 54, N433-8 2009) matching the measured half value layer (0.574 mm Cu). Physical dimensions of the collimator assembly were approximated using best available values from the literature confirmed by caliper measurements, while cone nozzles were modelled with nominal values tweaked for agreement.

We compared dose measurements to μ-RayStation 8B calculations in a 80×80×80 mm^3 virtual water phantom to optimize the beam model. Dose distributions were calculated using a grid resolution of 0.1-0.2 mm, <0.5% relative dose uncertainty, and exported in DICOM-RT format where an in-house MATLAB script produced central axis depth dose and lateral profiles at the relevant depths.

RESULTS



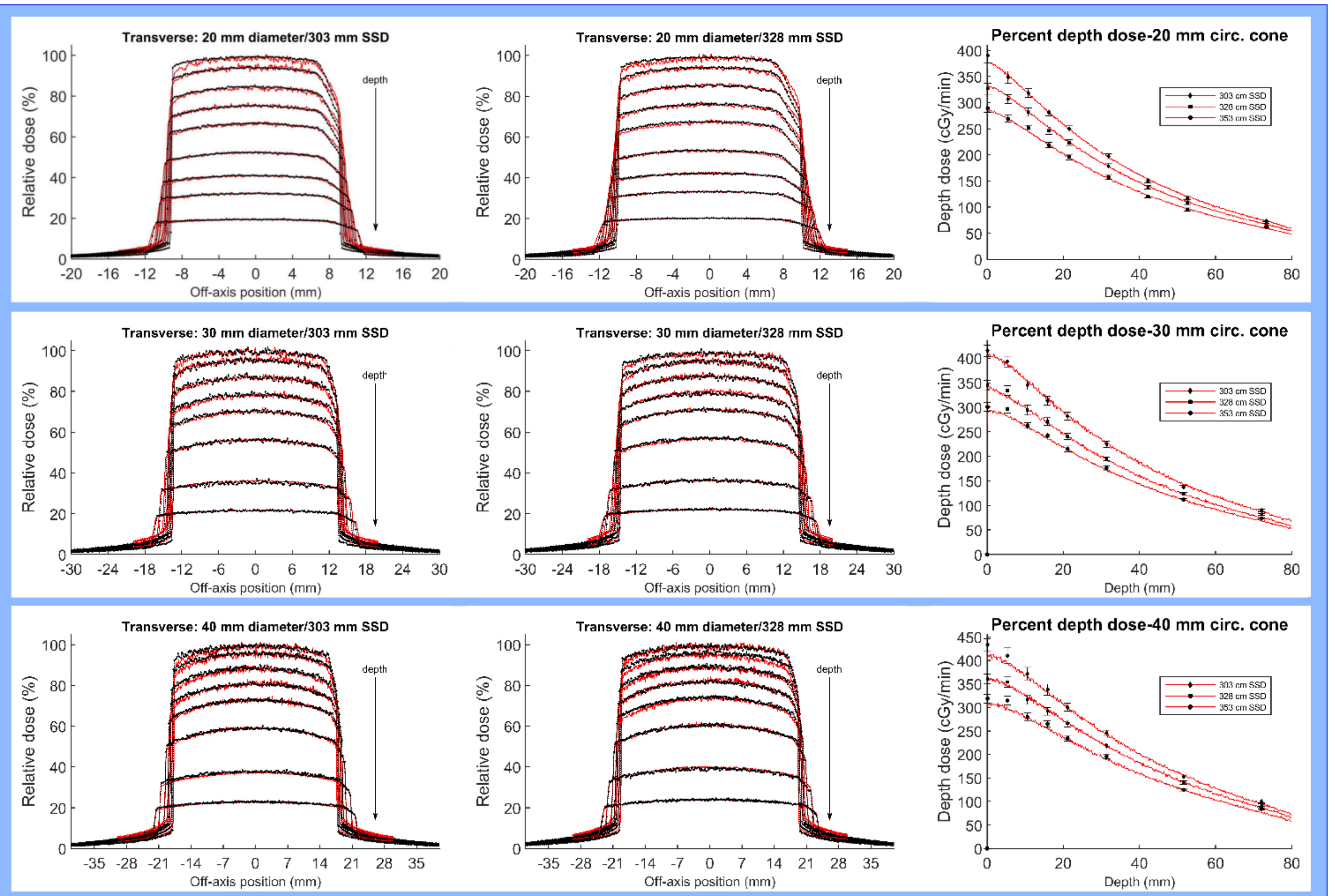


Figure 1: *Left column:* Transverse profiles for all cones and two SSD at 8-9 different depths. Dose distributions calculated using μ-RayStation (black) agree very well with film measurements (red lines). Data is normalized to the central axis. *Right column:* Percent depth doses between μ-RayStation calculated values (red lines) and EBT3 Gafchromic film measured values (dots) for all commissioned cones. Values are normalized to the fourth film calibration point (~20 mm depth) as it is both the absolute calibration point for the film, and it offers more stability than surface dose which has been reported to be more susceptible to measurement errors. In larger cones (30 and 40 mm), worse agreement is seen at depth due to the backscatter of the ~1 cm aluminum plate which is not modelled in the TPS. Other values show excellent agreement across all cone size and depths.

CONCLUSIONS

This study represents the first reported commissioning of a commercial third-party TPS at kV energies for the Xstrahl SARRP. As opposed to the manufacturer TPS, μ-RayStation was capable of modelling the transverse beam profile defect. Future studies will validate the TPS in heterogeneous geometries, different energies, the motorized variable collimator, and whole body geometries.

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