Commissioning of proton beam uniform scanning for a commercial treatment planning system

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INTRODUCTION

The IBA Uniform Scanning (US) modality [Ion Beam Applications, Louvain-Neuve, Belgium] was commissioned for the RayStation version 9A (RS) treatment planning system (TPS) [RaySearch Laboratories, Stockholm, Sweden] at the Seattle Proton Therapy Center (SPTC).
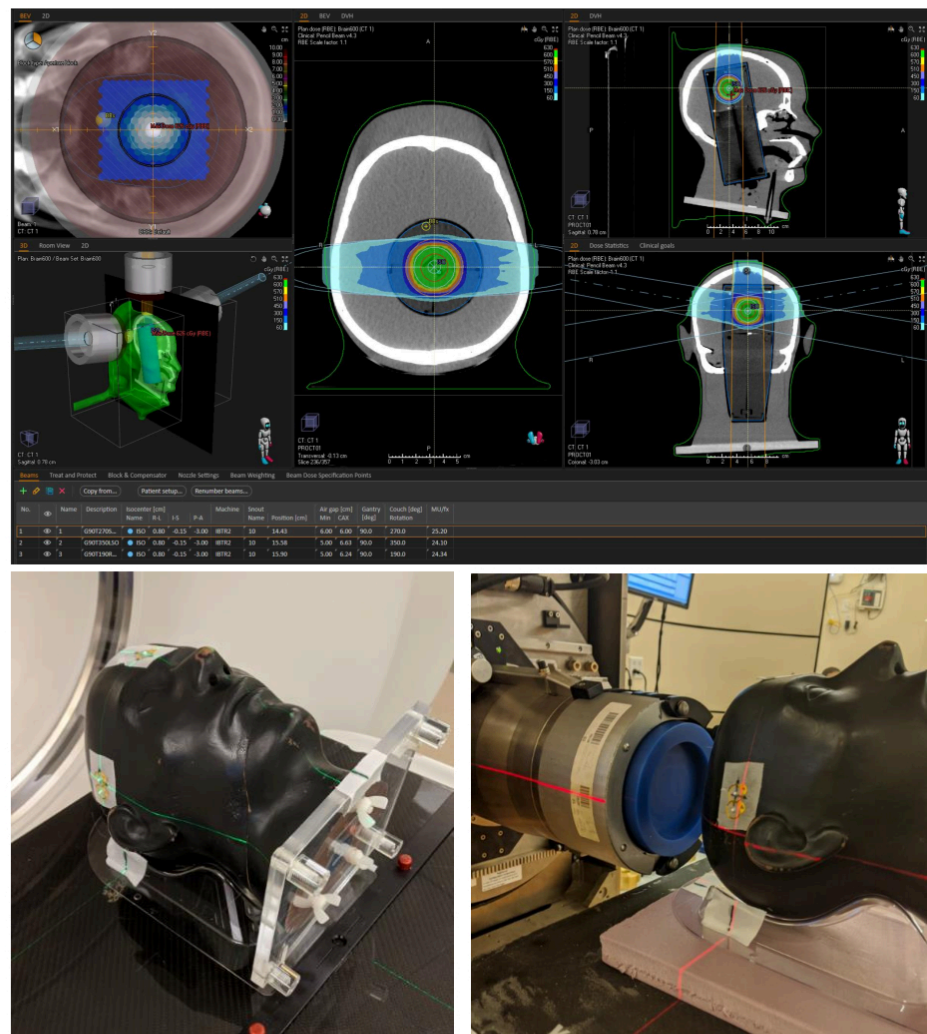
METHODS

The IBA US method (a.k.a beam wobbling) repeatedly raster-scans a proton pencil beam to achieve lateral uniformity while depth-wise uniformity is achieved by appropriately spaced and weighted energy layers. The beam is then shaped laterally by brass apertures and distally with wax compensators. RaySearch provided a list of central-axis SOBP, pristine peak, and lateral profile curves of various ranges and modulation widths to be measured for model inputs. All depth-profiles were measured with a multi-layered IC and lateral-profiles with an IC array. Measured data was submitted to RaySearch and the returned model was validated by comparing model outputs to both input measurements and a wide array of non-input beam geometries. All model validation calculations, data export, and comparison analyses have been completely automated by in-house developed Python code in conjunction with the RS scripting interface. Final clinical commissioning included a simulation-to-delivery end-to-end test utilizing absolute film-dosimetry, development of an in-house machine-learning-based secondary MU calculation, and several other minor modifications to the existing non-RS workflow.
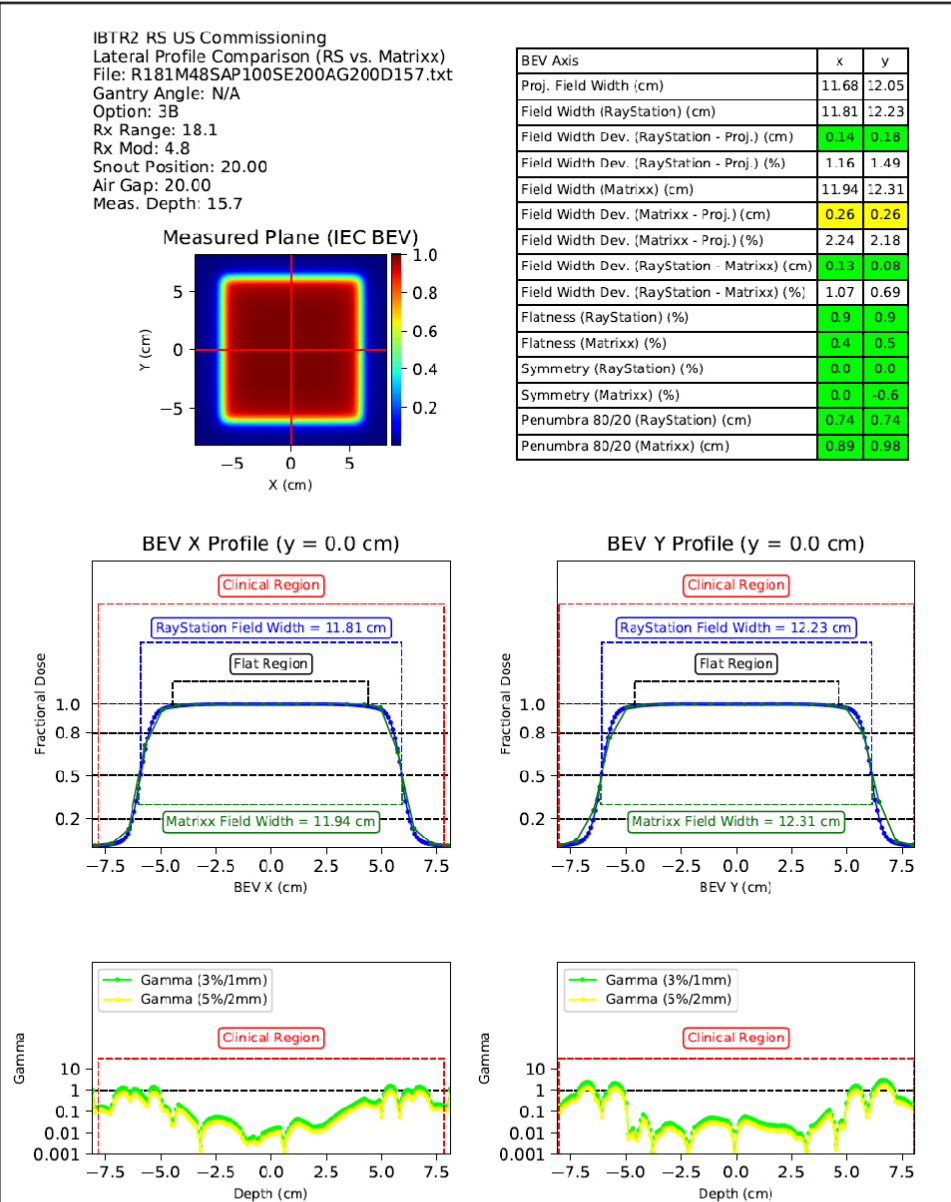
CONTACT INFORMATION

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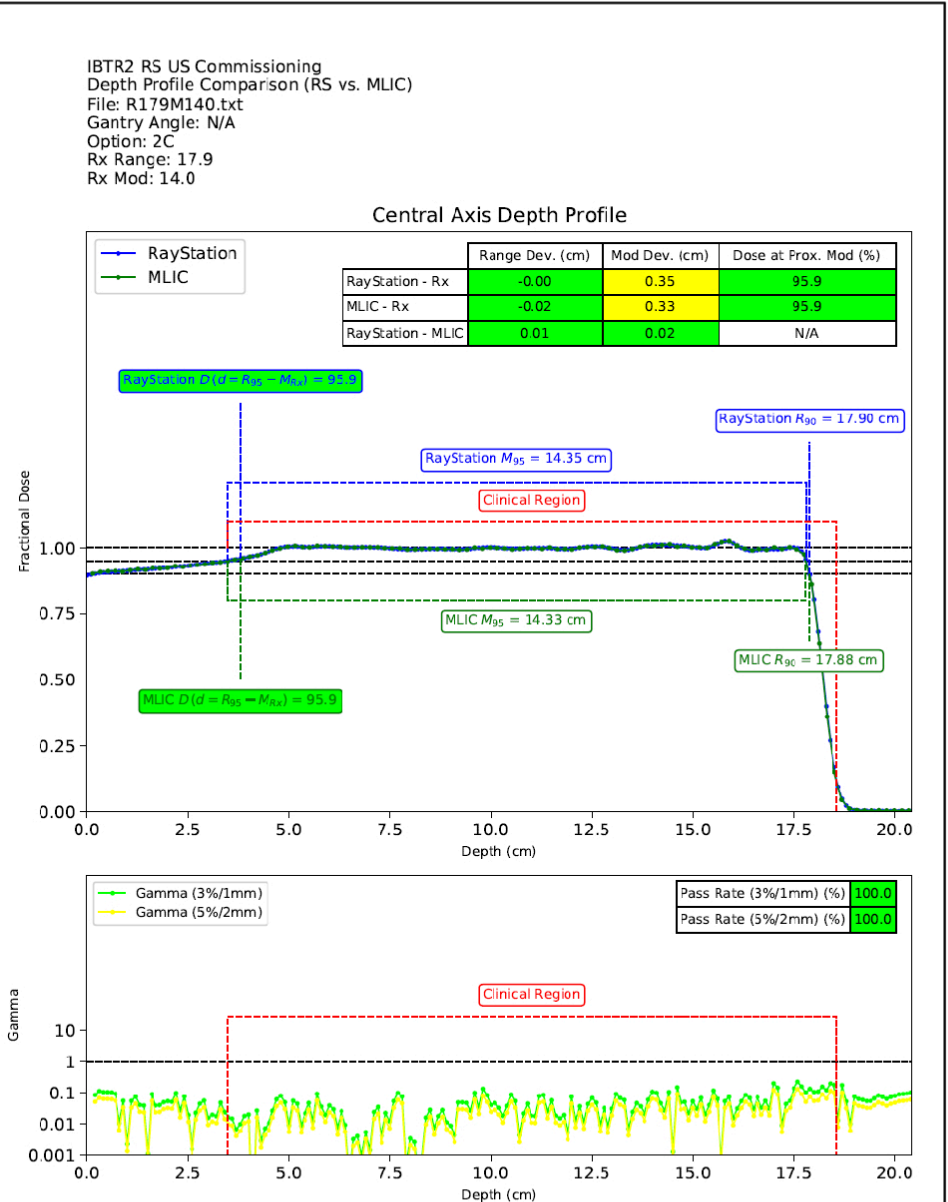Mobile: 484-955-7849

RESULTS

These tools were initially developed to assist in the commissioning of IBA uniform scanning [Ion Beam Applications, Louvain-Neuve, Belgium] for the RayStation treatment planning system [RaySearch Laboratories, Stockholm, Sweden]. The RayStation scripting interface was used in conjunction with Python code to automate beam model parameter variation, dose calculation, and data export. Parameter set lists can either be scraped from previously measured data file names or specified manually. Comparison data searching/matching, device-specific data file reading (e.g. multi-layer ion-chamber or planar array), data-type-specific reformatting (e.g. noise smoothing or curve normalization), and finally analysis (e.g. gamma comparison) is all fully automated requiring just minutes of user-specific configuration. Validation results are documented in pdf printing of comparison plots and tables, and analysis metrics across multiple comparison instances are compiled in csv files for easy review in spreadsheet software.

The IROC brain phantom was used for independent verification of the beam model and MU calculation.

Example lateral profile comparison of RayStation calculated and IC array measured data as analysed by in-house developed analysis software.

Example depth profile comparison of RayStation calculated and multi-layered IC measured data as analysed by in-house developed analysis software.