Pre-clinical evaluation of a next-generation PET-based biology-guided radiotherapy platform for targets with inhomogeneous tracer avidity

Huixiao Chen[1], Henry S. Park[1], Dae Y. Han[1], Emily Draeger[1], Rajit Tummala[1], Andrew Groll[2], Sanchit Sharma[2], Manoj Narayanan[2], Gopinath Kuduvalli[2], Karine A. AL Feghali[2], Zhe (Jay) Chen[1], David J. Carlson[1]

[1]Department of Therapeutic Radiology, Yale University School of Medicine, [2]RefleXion Medical

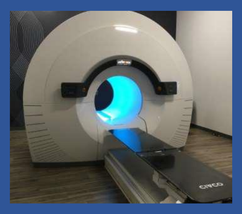
2026 JULY 19–22 VANCOUVER, BC
JOINT AAPM | COMP MEETING

SU-315-GPD-T-421

Innovation and Impact

This study provides the first preclinical evidence demonstrating recent advances in PET-based biology-guided radiotherapy on the RefleXion X2 platform, which includes anchor-point-tracking delivery algorithm for the software (currently in development) and FDA cleared hardware for the widened PET field of view. It is designed to overcome known limitations of current clinical X1 platforms when treating target volumes of more than 5cm or targets with highly heterogeneous radiotracer uptake. By demonstrating the feasibility, accuracy and robust delivery in challenging phantom scenarios with largely partial tracer-avid targets, and with a target length of about 7 cm, this work supports that the translational expanded biological targeting capability has the potential to significantly broaden patient eligibility beyond the current Reflexion X1 platform.

ACKNOWLEDGEMENT



RefleXion Medical

CONTACT

Huixiao Chen, PhD
Department of Therapeutic Radiology
Yale University School of Medicine
Yale New Haven Health
20 York Street, new Haven, CT 06525
Huixiao.chen@yale.edu

Yale SCHOOL OF MEDICINE

INTRODUCTION

The next-generation PET-based SCINTIX® Biology-guided radiotherapy (BgRT) **X2** platform incorporates a four-time PET widened field of view (WFOV) and an anchor-point-tracking delivery algorithm (currently in development). These advancements are intended to improve biological signal sensitivity, workflow efficiency, and delivery robustness compared to the X1 platform, particularly for targets with heterogeneous radiotracer uptake. In this study, we perform a pre-clinical, phantom-based evaluation of the next-generation platform, focusing on scenarios with markedly inhomogeneous tracer avidity.

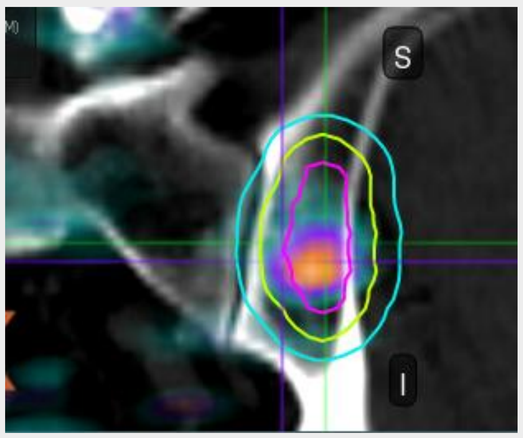
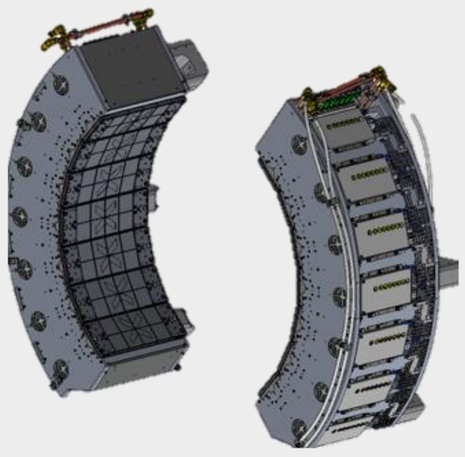


Figure 1. Clinical challenged on X1 for partial avid target



Wide field-of-view PET arcs of the new **X2** platform (X1: 5cm → X2: 21.5cm

METHODS

Preclinical BgRT delivery was evaluated using ArcCHECK phantom experiments with single and dual spherical targets (1.5 cm or 2.5 cm) exhibiting highly heterogeneous tracer update in a 7 cm length target. System performance was assessed using PET metrics and dosimetric validation in software's post treatment review sessions plus ArcCHECK gamma analysis (3%/3mm).

X2 algorithms define and align an Anchor Point for the estimated location of each LTS to deblur the image and reduce uncertainty

RESULTS

By systematically testing highly heterogeneous activity distributions, the study shows the successful delivery of the BgRT plans below with largely partial PET tracer avid targets (plan 1 to plan 3) and with a target length more than 5 cm. In addition, for the biodistribution isotropic increased case (plan 4) with the tracer-avid diameter from 1.5cm to 2.5cm within a 7 cm wide target.

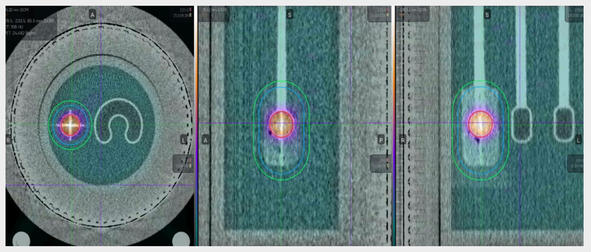


Figure 2. Red: GTV; Blue contour: PTV; Green contour: BTZ

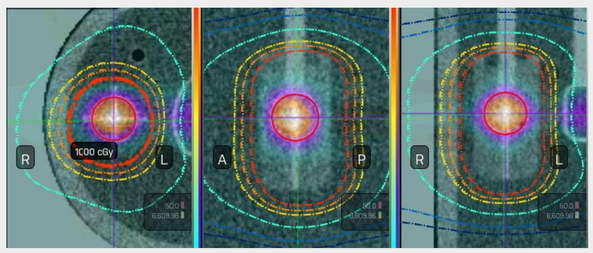


Figure 3. Dose distribution comparison: identical planned (dash) vs. delivered isodose lines (dot) in post treatment review session

Plan	NTS	AC (kBq/ml)	%BDVH	3%/3mm Gamma (Absolute Dose)
1	29.63	11.93	100%	99.4%
2	12.85	17.16	100%	99.7%
3	22.10	10.68	100%	99.0%
4	23.19	28.90	100%	99.4%

Table 1. Summary of PET metrics during pre-treatment PET evaluation and QA passing rates for four partially avid BgRT plans

CONCLUSIONS

Post-treatment review and gamma pass rates indicate that the RefleXion X2 platform (with anchor point tracking currently in development) is able to accurately deliver planned dose to the largely partial tracer-avid targets. The next generation PET-based BgRT platform demonstrated accurate delivery for targets with pronounced intra-target tracer heterogeneity. Compared to X1, which is constrained by tumor length (<5cm) and non-PET avid area to the PTV edge (<2cm). These preclinical results of X2 support further clinical BgRT implementation with a broader patient selection.

REFERENCES

1. Surucu M, Ashraf MR., et al., Han B. Commissioning of a novel PET-Linac for Biology-guided radiotherapy (BgRT). Med Phys. 2024; 51(6): 4389-4401

© Poster Template by Genigraphics® 1.800.790.4001 www.genigraphics.com