How much momentum acceptance is required to track breathing variability in NSCLC patients?

Conference Poster

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PURPOSE / OBJECTIVES

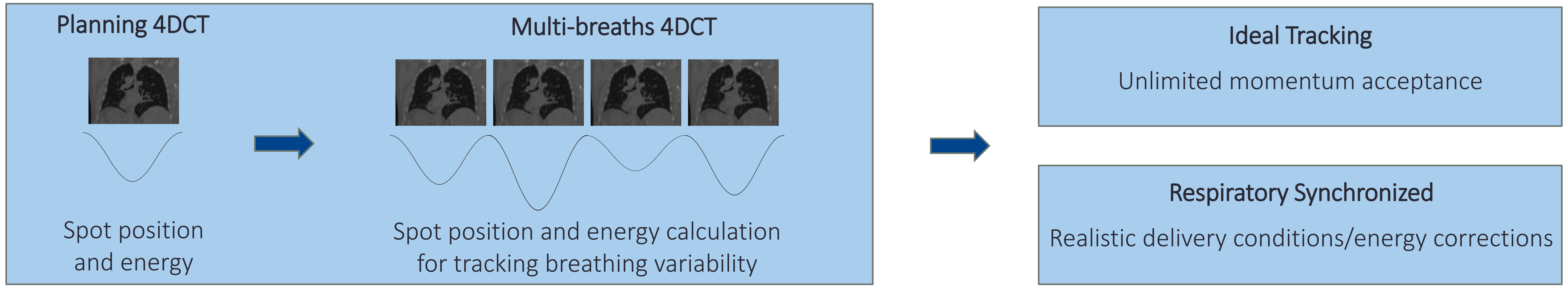
Fast energy change within beamline momentum acceptance is investigated as an option to track organ motion in pencil beam scanning proton therapy. Although prior knowledge of the patient's organ motion can be used to optimize scan paths that minimize acceptance requirements, allowance has to be made to account for breathing variability. We investigate how much variation in beam momentum (dp/p) is required to track lung tumors under realistic breathing scenarios.

MATERIAL & METHODS

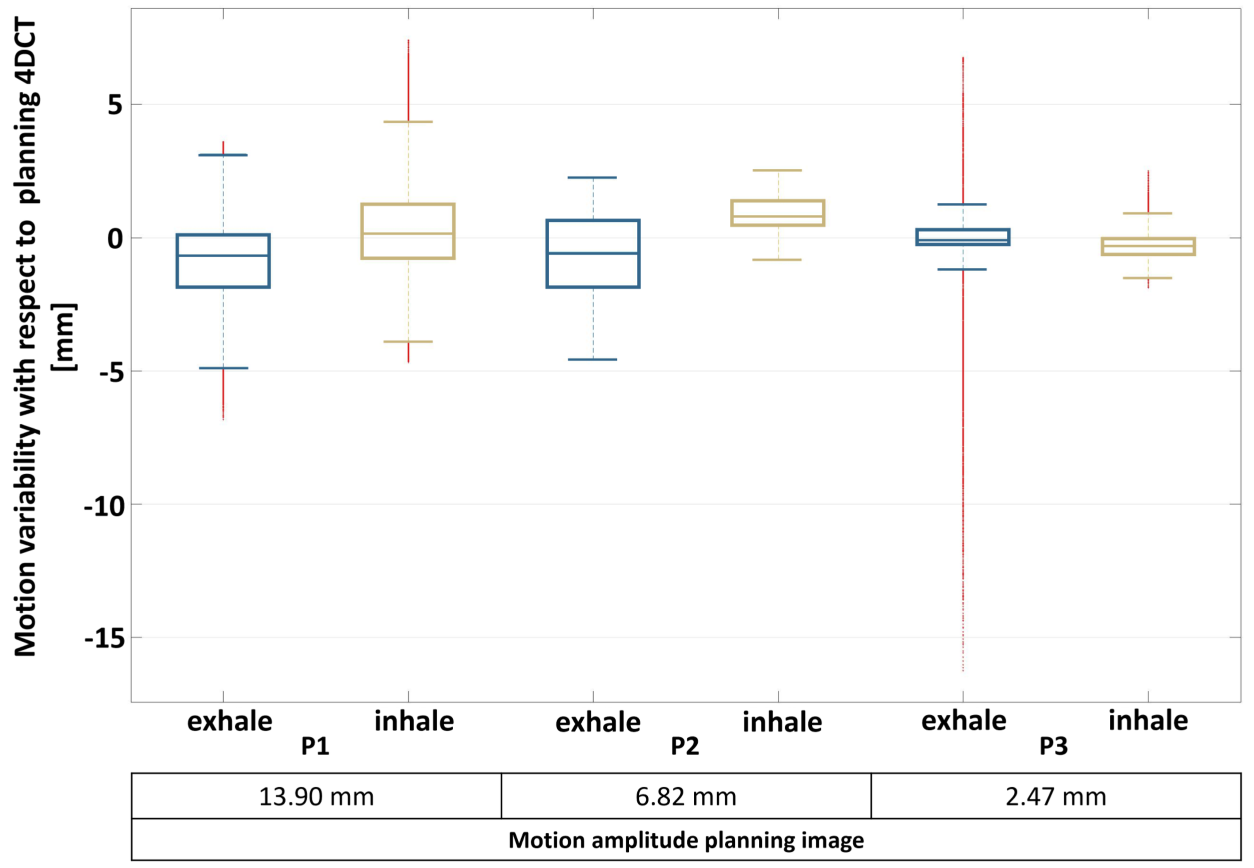
Treatments were simulated for three NSCLC patients provided with repeated (5x) 4DCT imaging. Tumor tracking plans were optimized on the first image set and the remaining ones combined via deformable image registration to mimic the breathing variability happening during beam delivery. Ideal tumor tracking with unconstrained energy offset was compared with respiratory synchronized tracking, minimizing energy corrections based on prior considerations of the organ motion. For both strategies, the amount of dp/p required to track tumors under irregular breathing was quantified together with the assessment of quality indexes such target dose-coverage (V95) and homogeneity (D5-D95).

RESULTS

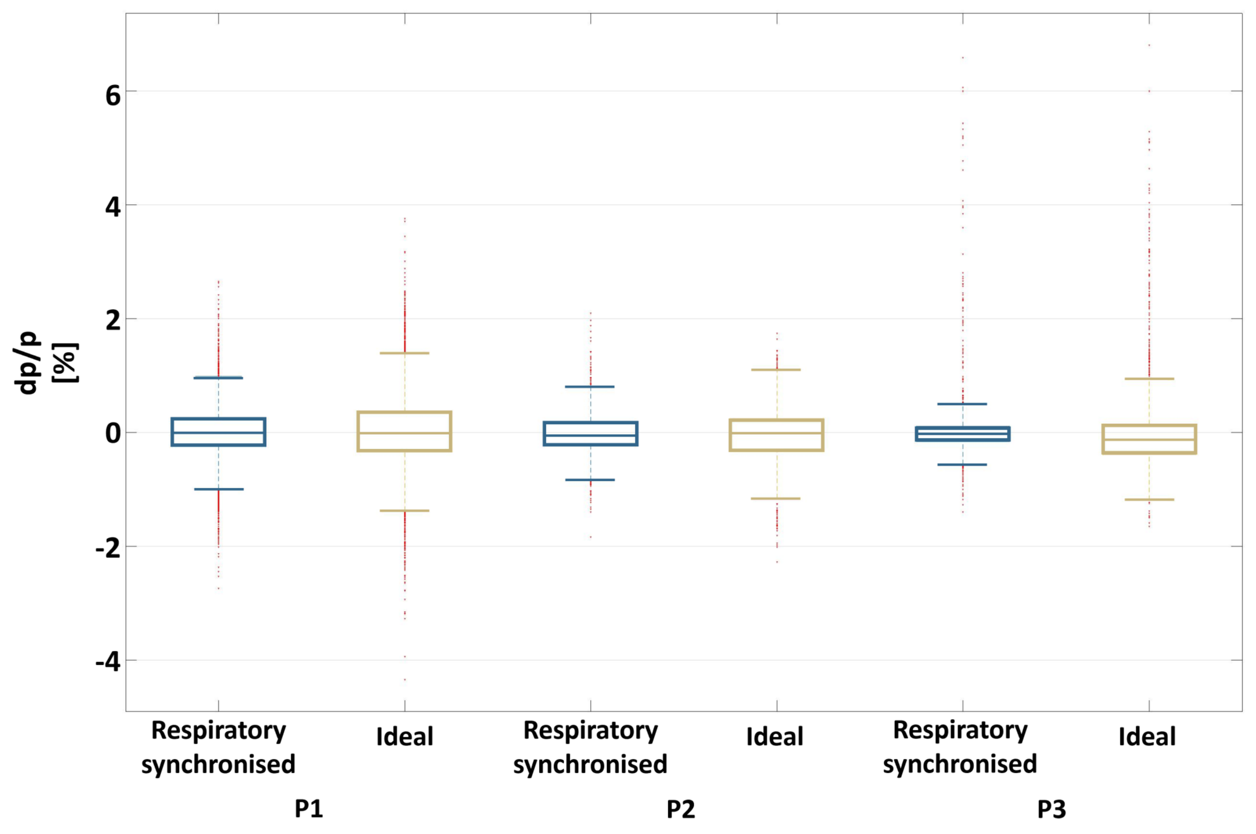
For all patients, organ motion was predominantly in superior-inferior direction, with an amplitude ranging between 2.5mm and 13.9mm on the planning images and increasing up to 37% of that value due to breathing variability during treatment delivery simulations. Beamline acceptance requirements were found to be reduced for respiratory-synchronized tracking (dp/p=0.39%) compared to ideal approaches (dp/p=0.59%) while ensuring comparable dose-coverage and homogeneity, respectively 90.9% and 27.9% for respiratory-synchronized tracking and 90.6% and 30.4% for ideal one.



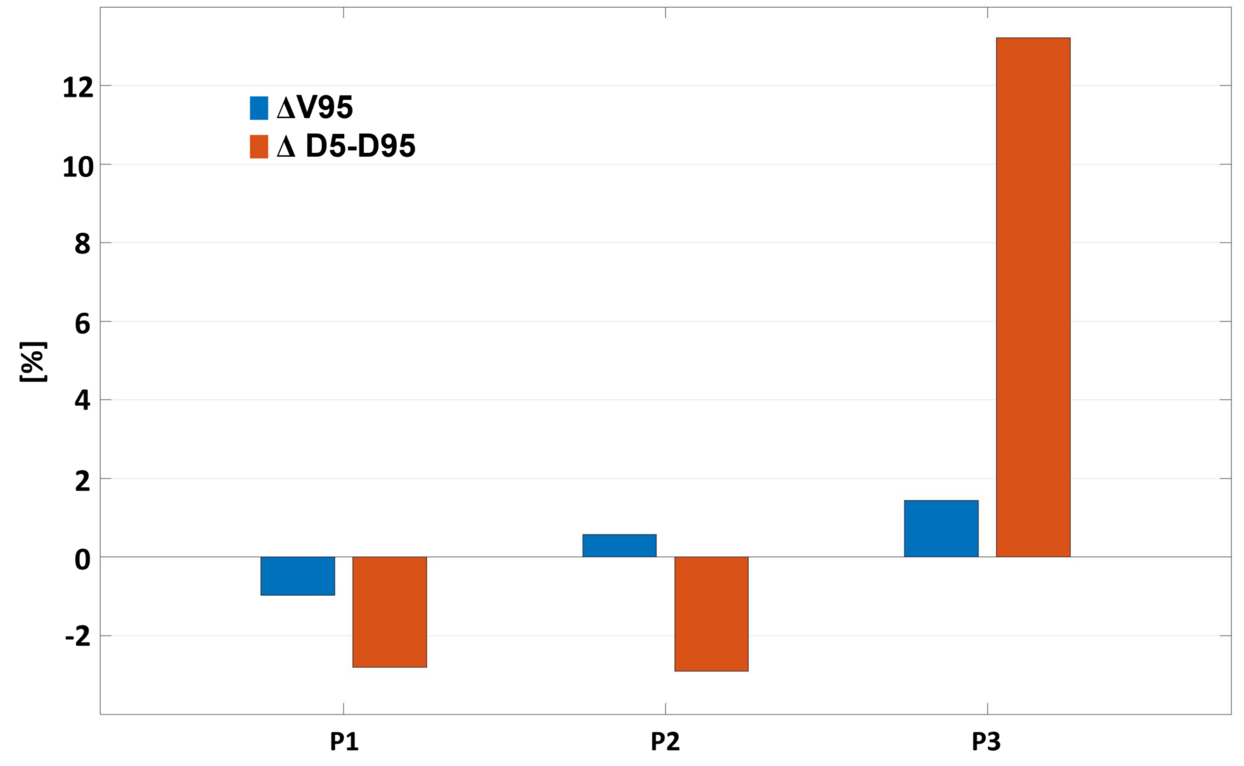
Breathing amplitude variability



Momentum required for tumor tracking



Treatment quality



SUMMARY / CONCLUSION

To minimize demands on beamline technology, whilst ensuring treatment quality, respiratory-synchronized tumor tracking should be further investigated as a concrete option to bring this motion mitigation technique one step closer to clinical implementation.

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New concept for adaptive real time tumour tracking.

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