

# Automatic patient positioning and gating window thresholds for respiratory-gated pancreatic cancer stereotactic body radiation therapy using fiducial markers and orthogonally acquired fluoroscopic images

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## Purpose

Patient position and gating window must be correctly set in respiratory-gated pancreatic radiotherapy (RT). This is currently done manually, and setup accuracy will therefore be user dependent. In this study, we present an automatic method for finding the patient position and the gating window thresholds using fluoroscopy in pancreatic cancer patients with implanted fiducials.

## Methods

We use sequentially acquired anterior-posterior and lateral fluoroscopic imaging with simultaneous breathing amplitude monitoring. We then automatically track the fiducial positions, and compare them with the corresponding planning CT contours. Shifts to ensure that the fiducials and contours are aligned, and gating window thresholds that correspond to when the fiducials are within the contours are calculated. We retrospectively compared clinically used setups to the automatic setups by our method in five pancreatic cancer patients treated with hypofractionated RT in five fractions.

## Results

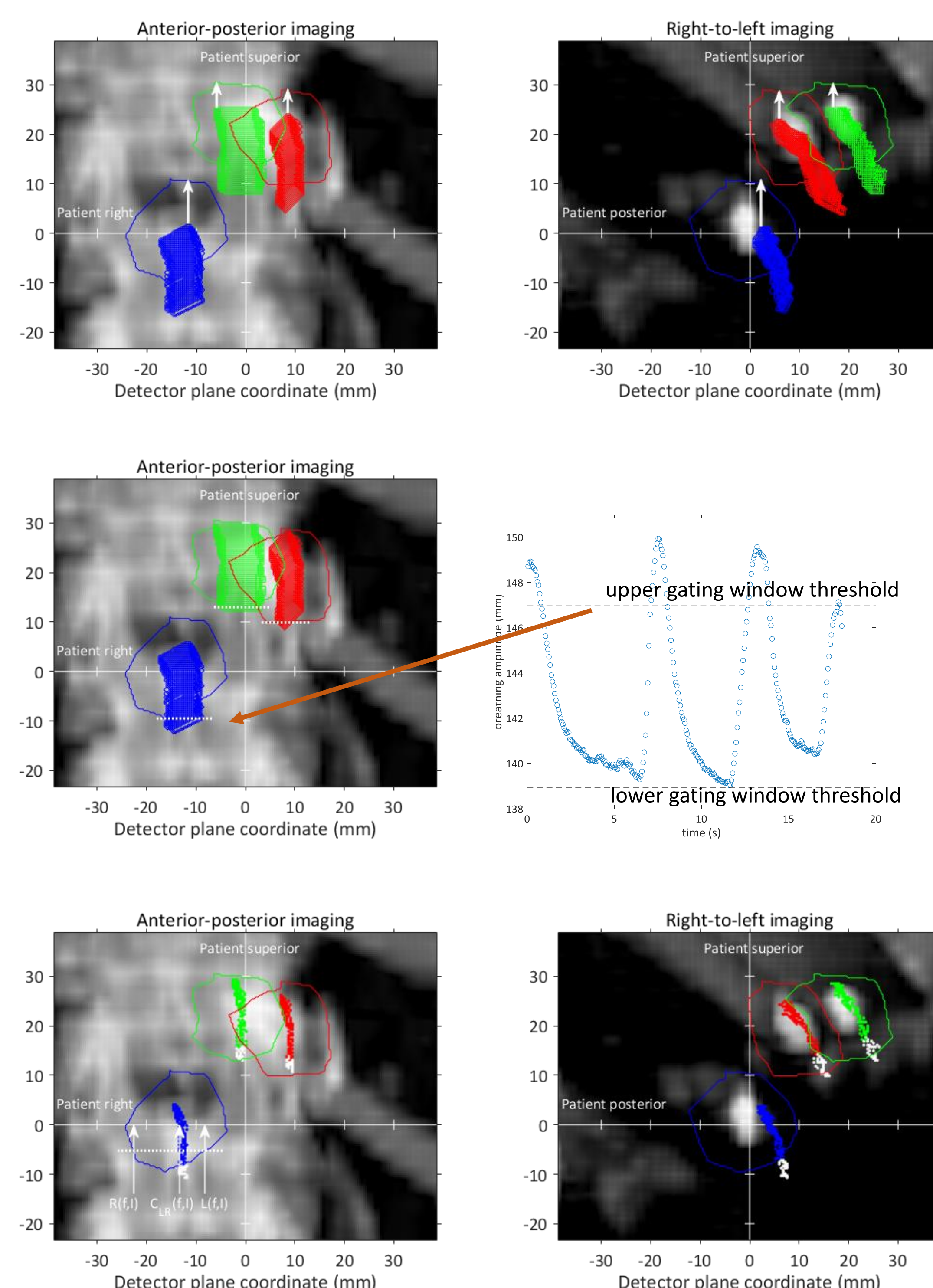
In 15 of the 25 delivered fractions, we had imaging data for at least one breathing cycle for both fluoroscopic sequences. The overall mean ( $\pm$ SD) for the calculated patient 3D shift was  $2.6 \pm 1.1$  mm (maximum larger than 4 mm). Using the automatic setup method, the duty cycle could be improved in six fractions, in four fractions the duty cycle had to be lowered to improve accuracy, and in five fractions both the gating accuracy and the duty cycle could be improved. After imaging, the patient shifts and gating window thresholds are calculated in 1-2 seconds.

## Algorithm steps

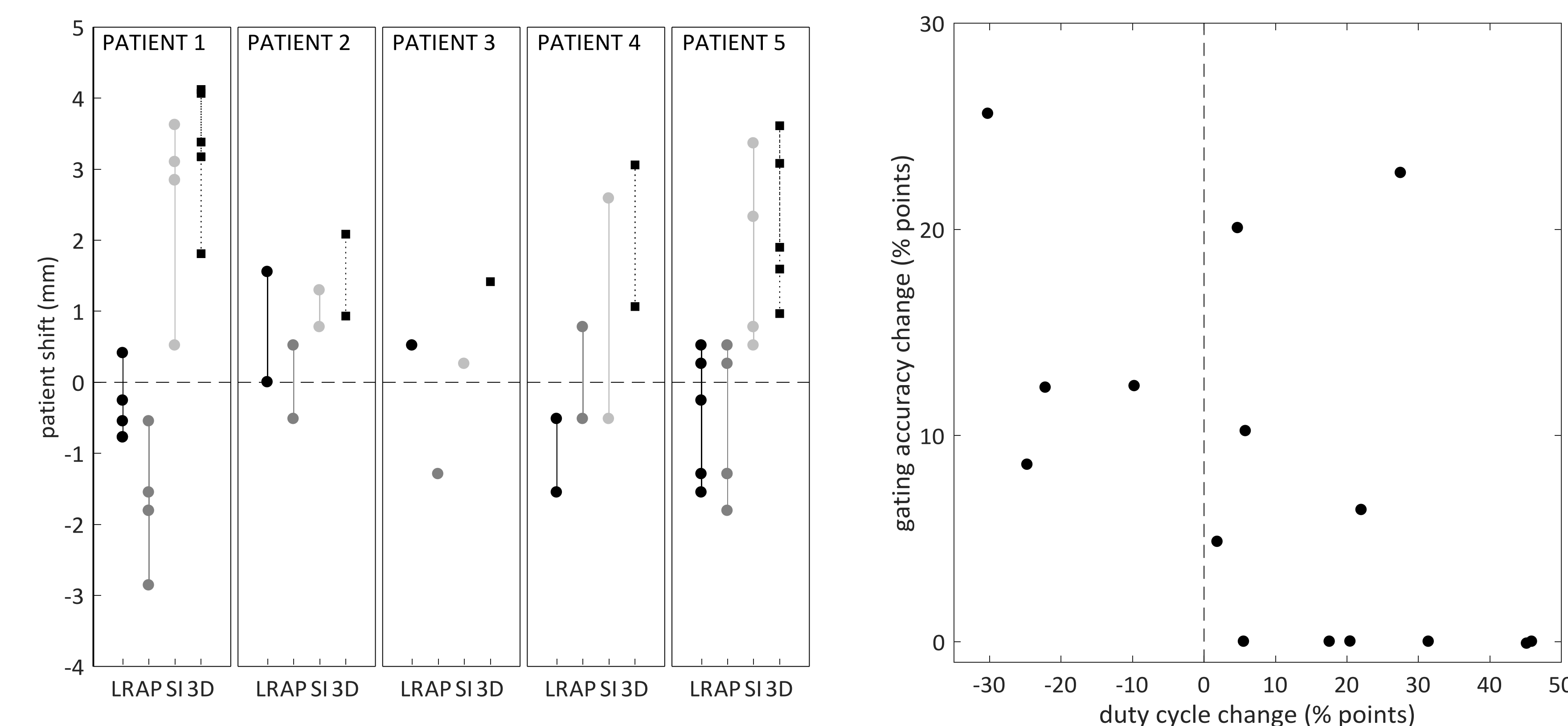
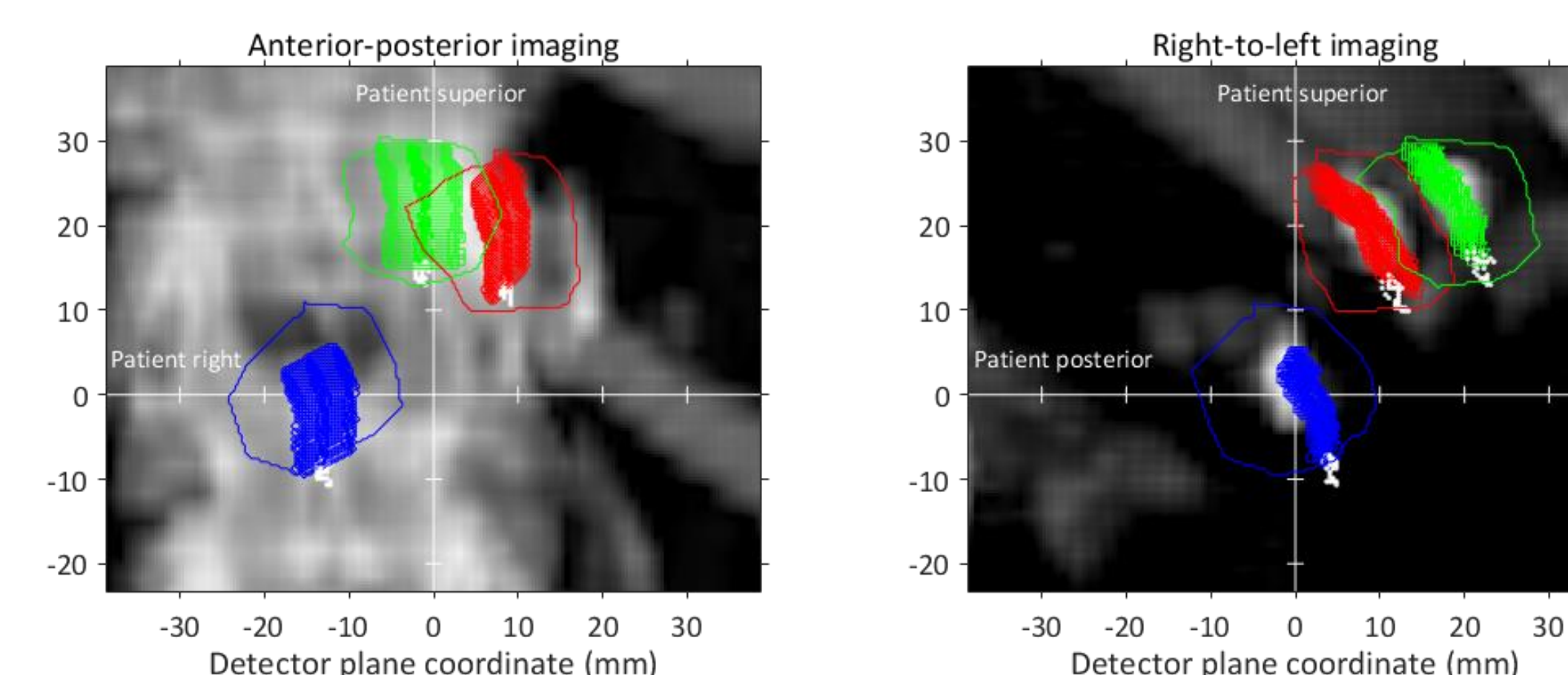
**Step 1:** The tracked fiducial positions are compared to the projected fiducial contours on the DRRs to find the patient SI shift.

**Step 2:** Taking the SI shift from step 1 into account, the gating window thresholds are defined to exclude fiducial positions outside the projected contours (the breathing signal and gating window thresholds are shown instead of the lateral view).

**Step 3:** The patient LR and AP shifts are found by centering the fiducial positions (within the gating window) inside their projected contours.



**Resulting setup:** An example of the final result in patient positioning after shifts are applied. This patient was shifted 0.3 mm to the right, 1.9 mm anteriorly, and 3.1 mm superiorly.



Calculated patient shifts in the LR, AP, SI directions and the overall 3D shift for the automatic method compared to the clinically used setups.

Improvement in duty cycle and gating accuracy: positive values mean better metric by the automatic method.

## Conclusions

Our automatic method has the potential to increase accuracy and decrease user dependence of setup for patients with implanted fiducials treated with respiratory-gated radiotherapy. If deemed necessary, it could be used at any time during treatment delivery.