Dosimetric evaluation of an efficient skin marker for marking scars, sarcomas, and larger treatment areas during proton therapy

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PURPOSE:

- A new skin marker, that helps to exclude skin from the automatic body contour is evaluated for the clinical use for proton beam therapy (PBT), for marking field borders, scars, sarcomas, and larger treatment areas.
- The dosimetric advantages and clinical efficiency are presented.

METHODS:

- The new marker (RT-SPOT) uses a 2.0 mm diameter, elevated, lower density, a non-metallic line that minimizes artifacts.
- An anthropomorphic phantom with the current marker on one side and the new marker on the other side was scanned with 3.0 mm slice thickness.
- The image set was duplicated, with marker densities overridden to air in one set and without override in the other set.
- Body and Wire structures were contoured, by 3 similar expert-level dosimetrists, as per our clinical guidelines.
- Five monoenergetic plans, comprising the energy ranges in our clinic, with and without range shifters (70 -245 MeV) were generated on each image set, with a single beam at gantry angle 0º and snout position at 42 cm for no range shifter and snout at 16 cm for the 3 cm range shifter plans.
- For each plan, the field size was 20cmx20cm, 0.25 cm voxel size, 0.25 cm spot spacing, and 0.4 cm spot size with 10 MUs per spot.

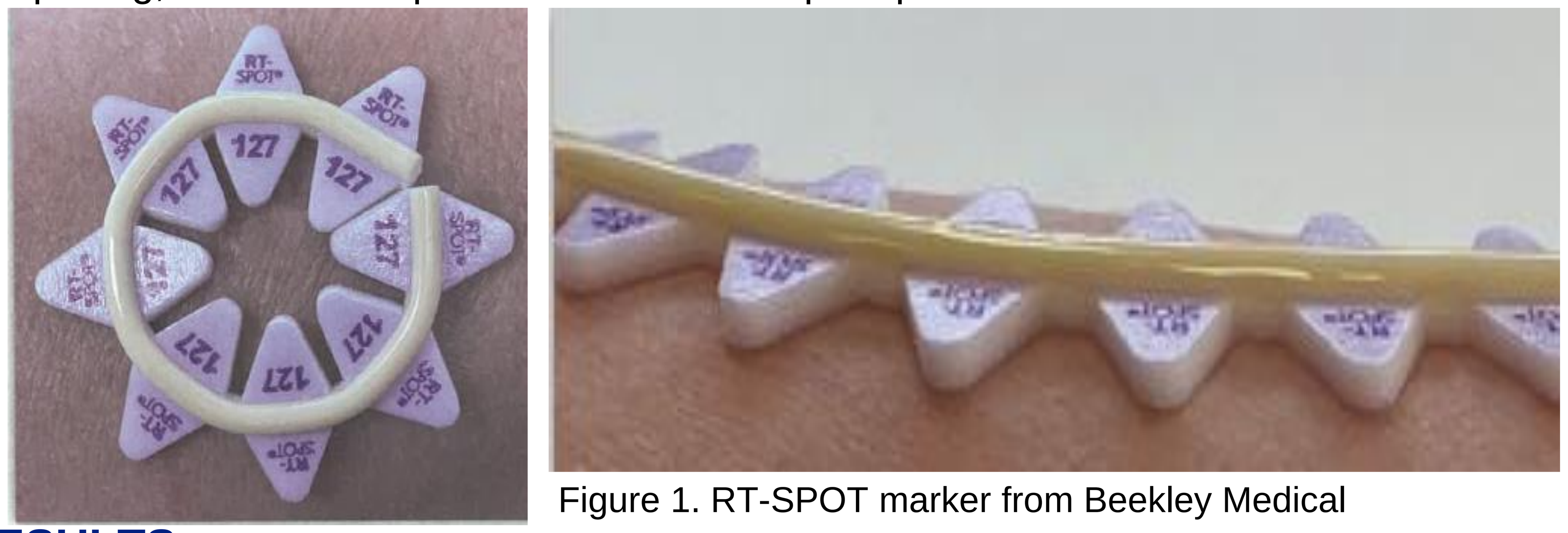

Figure 1. RT-SPOT marker from Beekley Medical

RESULTS:

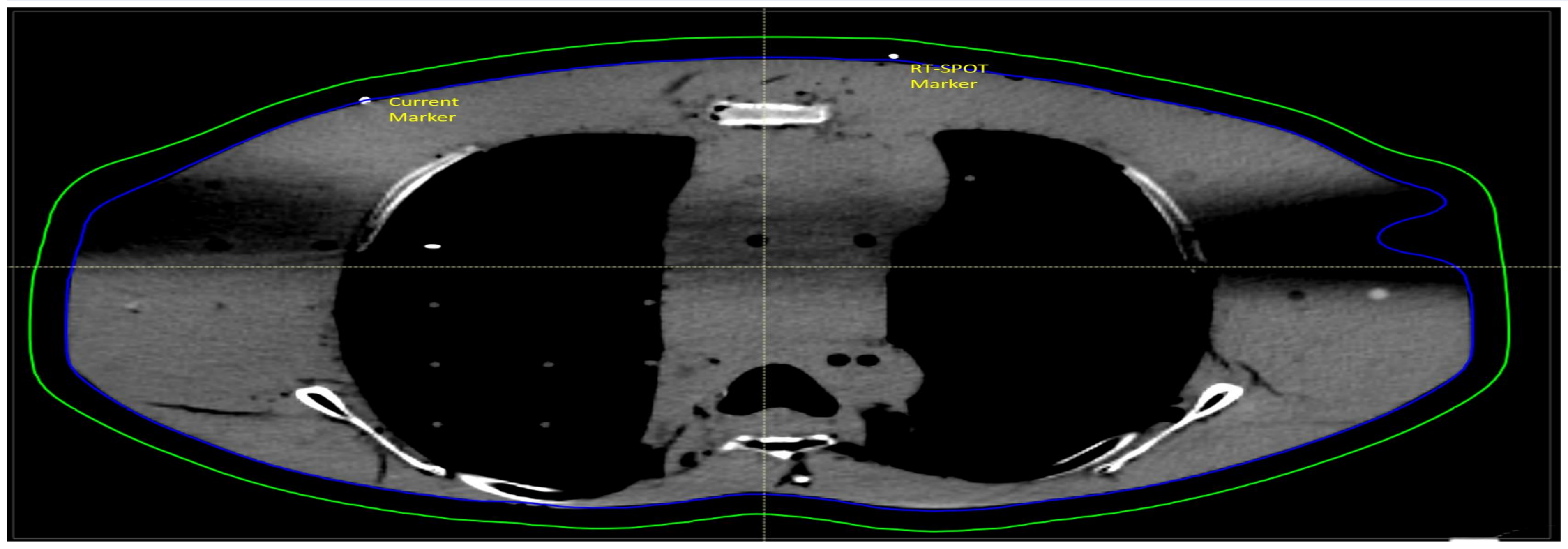

Figure 2. A representative slice of the CT image set, current marker on the right side and the RT-SPOT marker on the left side.

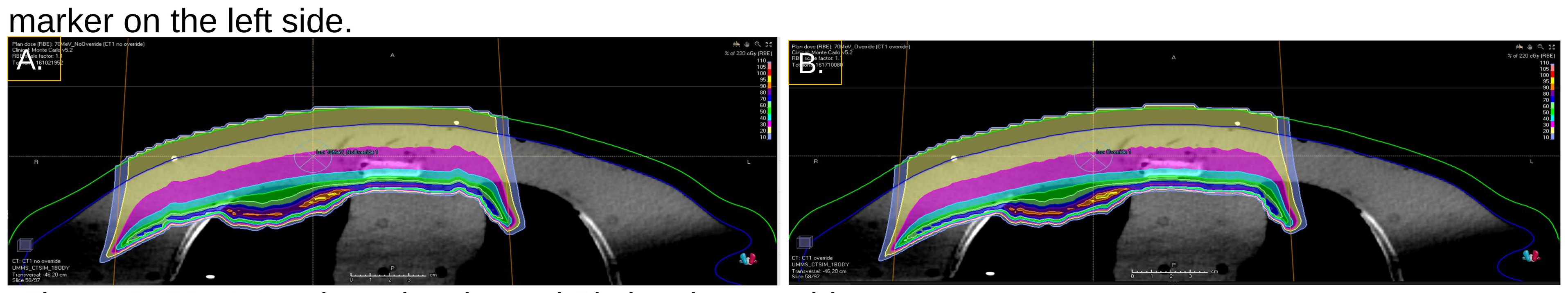

Figure 3. 70 MeV; A) no density and B) density override.

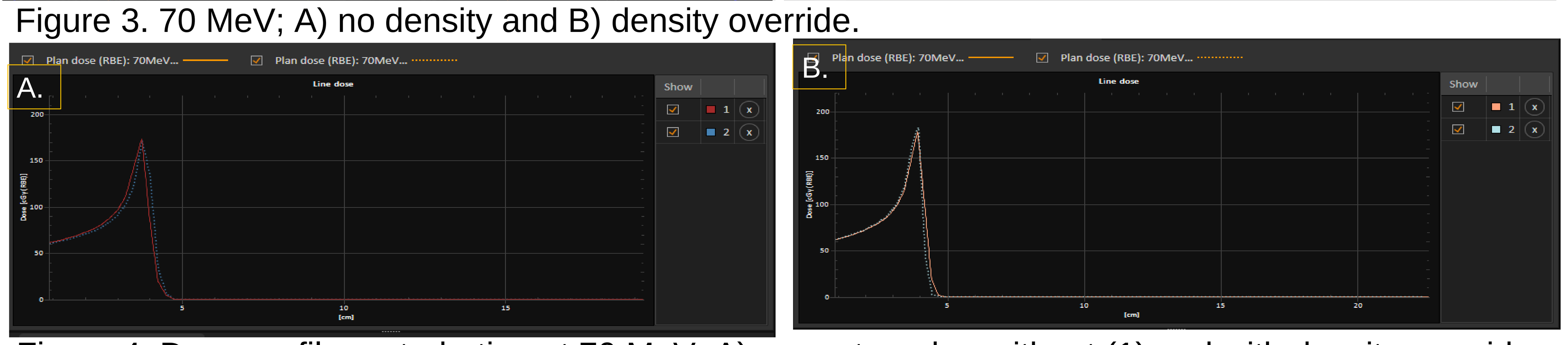

Figure 4. Dose profile perturbation at 70 MeV. A) current marker without (1) and with density override (2), B) RT-SPOT marker without (1) and with density override (2). Very little difference is seen.

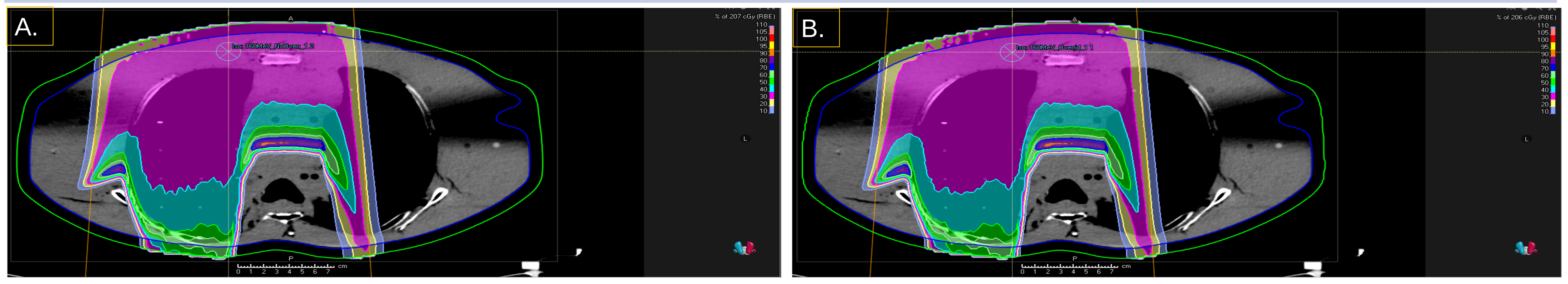

Figure 5. 160 MeV; A) no density and B) density override.

Figure 6. Dose profile perturbation at 160 MeV. A) current marker without (1) and with density override (2), B) RT-SPOT marker without (1) and with density override (2). No differences found.

- The average CT number for the current marker was 1378 HU (-73 to 3851 HU) and that of the new marker was 1130 HU (-27 to 2499).
- The dose perturbations due to the current marker and new marker were compared and found that the perturbations were smaller due to the new marker when the densities were not overridden to air.
- The dose perturbations were slightly larger for lower energies than those with higher energy.
- For the plan with 240 MeV energy, the dose perturbations were negligible for both the markers.
- Also, if a planner forgets to contour and override the RT-SPOT marker, then the dose differences are smaller in comparison to the current marker.
- The contouring time for the Body and wires was reduced from 30 minutes for the current marker to 3-5 minutes for the RT-SPOT marker.

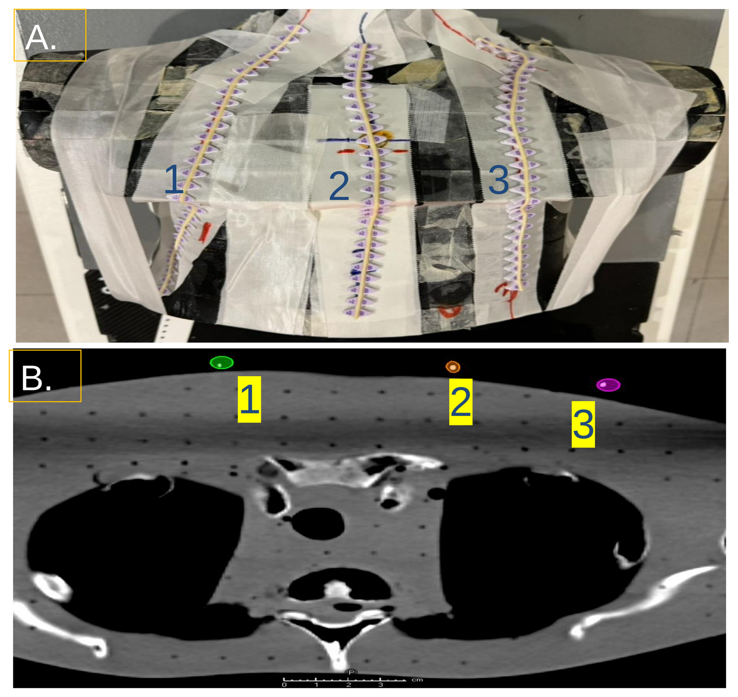

Figure 7. A) Setup for the CT scanning of the wires with 1-layer, 2-layer, and 3-layer foam backing on Anthropomorphic Phantom. B) Axial CT slice with all 3 wires contoured.

	Time to Contour the Body (minutes)			Time to Contour the Wires (minutes)		
	1 Layer Foam	2 Layers Foam	3 Layers Foam	1 Layer Foam	2 Layers Foam	3 Layers Foam
Dosimetrist : 1	3.85	3.25	2.50	3.15	3.08	3.00
Dosimetrist : 2	3.28	3.50	1.60	3.80	2.00	1.73
Dosimetrist : 3	2.85	1.07	1.22	2.22	1.88	1.45
Average	**3.33**	**2.61**	**1.77**	**3.06**	**2.32**	**2.06**

Table 1. Recorded times to contour the Body and Wires with 1-, 2-, and 3-layers of foam backing by 3 similar expert-level dosimetrists. The average time (in minutes) presented in the last row, shows a significant reduction in the time. It takes around 30 minutes to contour the Body and the Wires with the current marker.

- To further reduce the contouring time, and keep the wire marker separated from the skin, prototypes with 1, 2, and 3 layers of backup foam material have been fabricated and compared.
- The markers were attached to an anthropomorphic phantom and scanned (Figure 7).
- The body contour and the markers were drawn by 3 similar expert-level dosimetrists.
- It was found that the time needed to contour the patient's body was reduced by 47 % when changing from 1 to 3 layers of foam backing, that is much lower than 30 minutes with the current marker.
- The time required to contour the marker wire was reduced by 24% for 2 layers of foam backing and 33% for 3 layers of foam backing when compared to 1 layer of foam backing.

CONCLUSION:

- These new markers are safe and reliable to use in clinics for proton therapy. This has certain advantages over the existing skin markers.
- It uses a 2.0 mm diameter, elevated, lower density, non-metallic line that minimizes artifacts.
- This new marker is a flexible line that contours more easily into desired shapes and stays in place without lifting.
- Current skin markers affect dose calculations and must be manually contoured out, increasing the planning time per patient. Using this new marker saves time by reducing the need for additional manual contouring. The contouring time was drastically reduced from 30 to 2 minutes.