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

# Robustness Enhancement for VMAT-TBI Planning and Treatment Delivery for Patients Wider Than 48cm


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## ABSTRACT

**Purpose:** To identify planning techniques that consistently result in robust VMAT-TBI plans for patients wider than 48cm that allow for patient setup uncertainty 5mm or more.

**Methods:** The Built-in auto-feathering function in Eclipse fails to produce good junction dose robustness when patients body width> 48cm. A shift of 2.6 mm or less can result in 10% dose change in the junction region. Various planning techniques were systematically explored to produce consistent and robust dose gradients in junction areas for these extra wide patients.

**Results:** Successful strategies were identified as the combination of the following: A) Four half arc fields for each upper body plan are placed at off-axis isocenters so that arms outside field <2cm. B) Abdo plan iso at kidneys center, Thorax plan iso at lungs center. C) All fields are of 40cm wide in horizonal direction. D) The whole arm skin must be covered by at least one entrance field. E) a horizontal MLC field (20cm+1cm opening, collimator angle = $0^o$) covers head, and a vertical MLC field (1cm+14cm, collimator = $90^o$) covers neck. F) $90^o$ collimator angle for all other fields, with MLC opening ≤14cm for fields covering lungs or kidneys OAR, and ≤20cm for the rest. G) fields between adjacent plans overlap at least 5cm.

After these plan techniques were used, the junction dose maintains the robustness of <10% dose variation even with shifts between isocenters reaching 5 mm.

**Conclusions:** For patient width >48cm, robustness in the junction dose can be achieved through the adoption of planning strategies.



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## INTRODUCTION

The VMAT-TBI treatment delivery technique is extremely challenging because up to seven VMAT plans for a patient are dosimetrically related, yet they are delivered sequentially over an average duration of ~70 minutes. The curated planning method from our previous study results in plans with a setup error of 5.0 mm or more causing a dose change of only 10%. However, this planning method works well for ~70% of patients with a body width of less than 48 cm, but consistently fails when the patient width exceeds 48 cm, accounting for ~30% of our patients. Very few papers discuss allowable junction doses or planning techniques for slow dose gradients in junction areas, nor do they address the needs of a wide patient cohort specifically. Identifying planning techniques that result in consistent slow dose gradients across the full patient spectrum is highly desirable for the implementation of the VMAT-TBI technique and more robust treatment delivery.

## METHODS AND MATERIALS

We systematically analyzed and tested to identify planning techniques that would result in a dose change of only 10% for a setup error of 5.0 mm or more (average 6.4 mm) for all junctions where the patient's body width was greater than 48 cm for six patients.


*Figure 1: Field arrangements showing the planning strategy. There are two off-axis plans for each of the thorax, abdomen and pelvis areas. Each off-axis plan consists of upper and lower half-arc fields. The contralateral plan may have two identical fields if patient is not too tall. The blue arrows in the figure show arms outside the fields must ≤2 cm. The thorax plan ISO's and the abdomen plan ISO's are at the longitudinal center of the lungs and kidneys, respectively. The Head1 field has MLC = 0° and all the other fields have MLC = 90°. Adjacent plans must overlap by at least 5 cm and cover the skin on the arms and legs.*

## RESULTS

The successful strategies identified were a combination of the following:

- Six upper body plans are usually needed to cover the thorax, abdomen and pelvis areas, with two off-axis isocenter plans for each area. The thorax plans are at the longitudinal center of the lungs and the abdomen plans are at the longitudinal center of the kidneys, respectively.
- Four half-arc fields for each upper body plan are placed at off-axis isocenters, and the arms are 2 cm or less outside the field. See the blue arrows in Figure 1.
- The Head1 field has MLC=0°. All the other fields have MLC = 90° and Y1 = Y2 = 20 cm to cover the body horizontally as much as possible. The X-jaw opening is 15 cm when it covers the lungs or kidneys; otherwise, a 20 cm X-jaw opening works well.
- The Head1 field has Y2 = 20 cm to cover the upper head, and the Y1 jaw is 2 cm inferior to shoulder top, and X1=1 X2=20. The Head2 field has X1 touching lungs top and X2 = 1 cm.
- For the two thorax plans, one plan has upper and lower field edges reaching 2 cm from the head ISO and 2 cm from the abdomen ISO. The contra-lateral plan covers the shoulders with the upper field and the bottom of the lungs with the lower field.
- The skin of the whole arms and legs must be covered by at least one entrance field. In other words, fields from adjacent plans must overlap on the skin's surface of arms and legs.

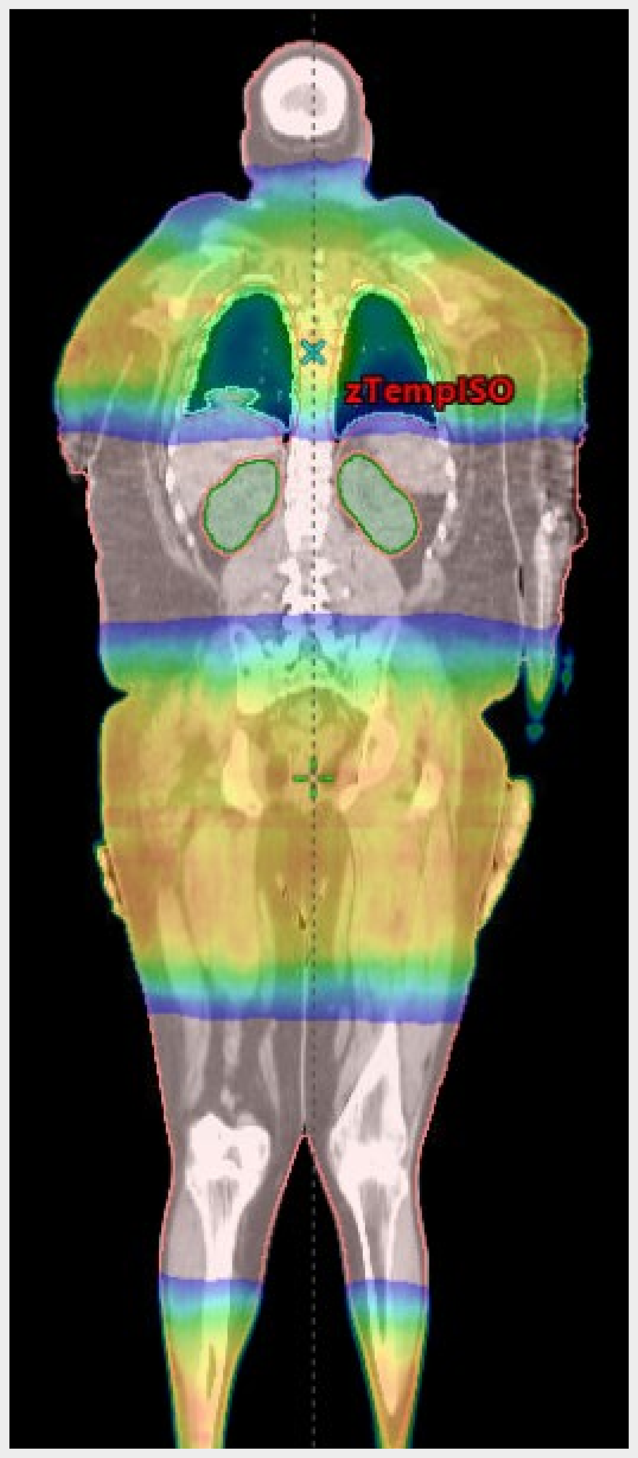


*Figure 2. every other axial plan(s) were deleted from head to toe, to show the field junction dose fall off.*

Six TBI patients with body widths ranging from 51 cm to 64 cm were tested, with isocenter off-axis distances varying from 5 cm to 12 cm. After these planning techniques were employed, the junction dose remained robust, with a dose variation of less than 10%, even when shifts between adjacent isocenters reached 5 mm or more in the sup/inf direction.

Our simulation study shows that dose variation caused by 5 mm setup uncertainty in the axial direction between two contralateral plans is much less of a concern.

## DISCUSSION

A collection of 50 CT scans of patients treated in the abdominal and pelvic regions showed that the maximum body width is 64 cm and that 30% of patients have a body width greater than 48 cm at its widest point. This indicates the importance of this planning strategy.

The left and right lung plans may have identical upper and lower lung fields with 15 cm jaw openings if the patient is not too tall and the center of the lungs is not too far from the top of the shoulder. Otherwise, one plan can have a wider than 15 cm x-jaw opening to superiorly reach 2cm below the Head plan isocenter and interiorly reach 2cm above the Abdomen plan isocenter, and the other plan can keep a 15 cm x-jaw opening to focus on lung dose sparing.

The neck junction dose is usually the biggest challenge, but there are several possible solutions. We found that a Head1 field opening that reaches 2 cm below the isocenter; that abuts the upper edge of the left or right thorax field; or that reaches a point 2 cm below the top of the shoulder are all viable solutions. Sometimes one solution is better than the others depending on the patient's anatomy, shape, and size. Further study on this is being conducted.

## CONCLUSIONS

For patient width >48cm, robustness in the junction dose can be achieved through the adoption of planning strategies.

## REFERENCES


* *PO-GPV-T-303, Robustness Enhancement for VMAT-TBI Planning and Treatment Delivery: X. S. Yan, S. J. Chungbin, J. Tan, Y. Rong, E. L. Clouser Jr., C. R. Buckey. AAPM 67th Annual Meeting & Exhibition, Washington, DC, United States. (2025, July 27–30).*